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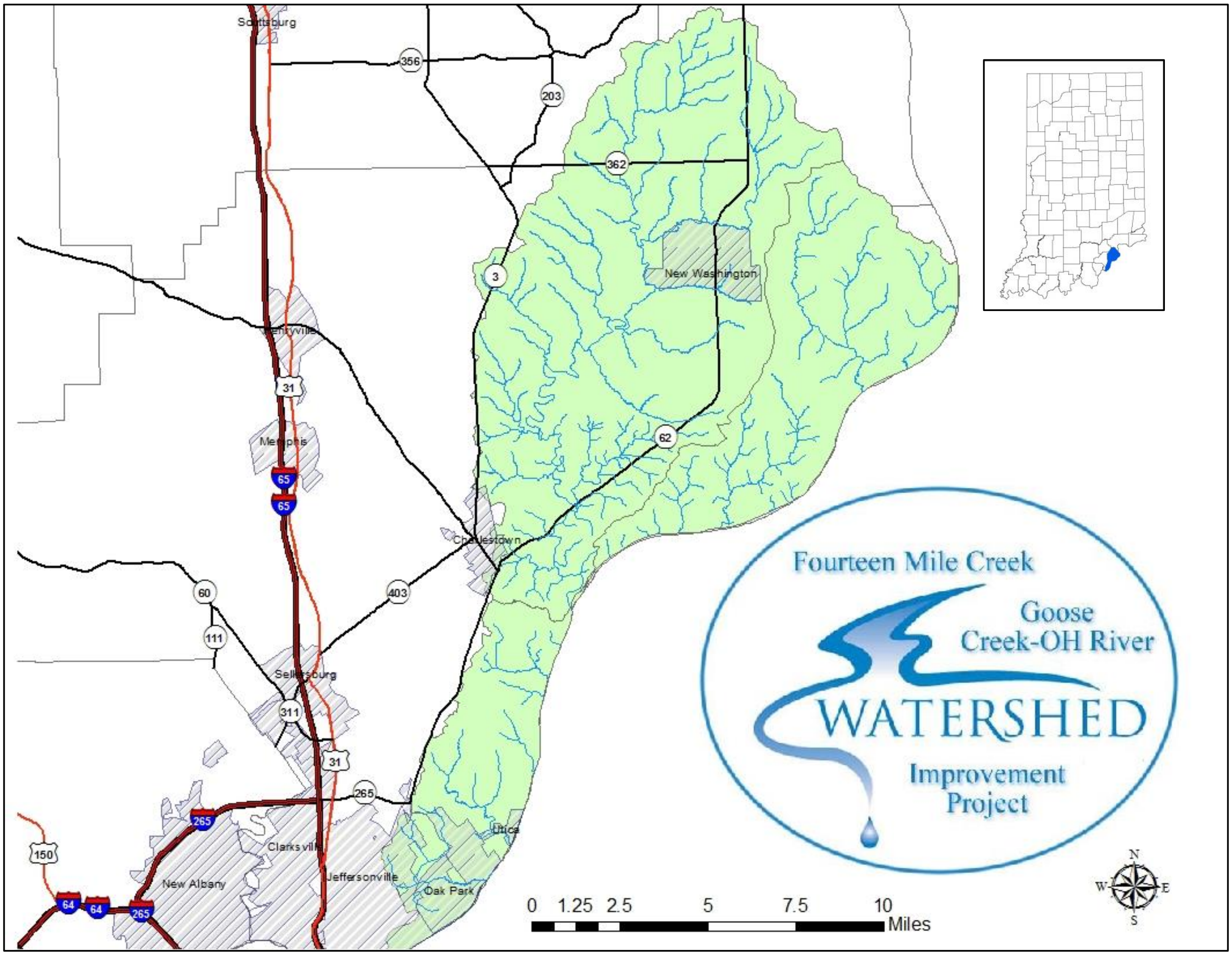
Project Manager: Kathleen Hagan

Fourteen Mile Creek/Goose Creek-OH River Watersheds Improvement Project

WATERSHED MANAGEMENT PLAN



Fourteen Mile Creek/Goose Creek-OH River Watersheds Improvement Project
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Table of Contents

Index of Figures

Appendix

1. Project Introduction

Below you will find information that details the reasons the community set out to create a watershed management plan. In addition, you will find a list of some of the major parties involved, as well as a list of important community concerns that shaped the development of this project.

The Fourteen Mile Creek/Goose Creek-OH River Watersheds Improvement Project is a community initiative in southern Indiana with a goal to improve water quality in the project area. To do this, the project will complete a watershed inventory and craft a watershed management plan.

1.1 Project Inception

The lack of recent data pertaining to the Fourteen Mile Creek/Goose Creek watersheds sparked community concern and interest in the overall health of the streams within those watersheds. When approached by community members with their concerns, the Clark County Soil and Water Conservation District (SWCD) decided to assist them in researching data (visual or recorded) that might lend insight into the current state of water quality in the watersheds.

The SWCD's research efforts immediately uncovered the fact that several water bodies in the watersheds are listed on the 303(d) impaired waters list for E.coli, dissolved oxygen, and biotic communities. While these tributaries were listed as impaired, little information was found regarding the extent, sources, and causes of the impairments. Piquing particular interest in this regard is the fact that one of the impaired tributaries meanders through all three Nature Preserves located in the watersheds. *(The 303(d) list is a government maintained list under the Environmental Protection Agency's (EPA) Clean Water Act. Refer to Figures 24 and 25, for the impaired waters in the Water Quality Information of the plan.)*

Further research revealed that land use in the Fourteen Mile Creek and Goose Creek watersheds is predominantly agricultural (row crop and pastureland) – a use that has the potential to produce excess sediment loads to surface waters, stream bank erosion, and degradation of water quality from livestock access to streams. Urban areas were also identified. Though low density in nature, many of these urban areas were found to be unsewered, and therefore considered as another potential contributor to degradation via septic seepage. The balance is classified as forest vegetation (shrub land, woodland), urban (low-density), wetland (Palustrine: forest, shrub land, herbaceous), and open water.

After researching the concerns of the initial community over the health of the streams in the watersheds, the Clark County SWCD decided to hold a public meeting in August of 2012, to gather the greater community concerns and perceptions of the watershed. Once this was done, the SWCD conducted a round of water sampling in five streams of the watershed, using Hoosier Riverwatch monitoring methods, in order to gain a snapshot of watershed health.

Though none of the data or information collected proved conclusively that the Fourteen Mile Creek/Goose Creek watersheds were unhealthy, they did indicate that there was room for improvement. Therefore, the SWCD decided to submit a Federal Clean Water Act Section 319(h) grant application. They did so in November of 2012; the application received approval, and the Fourteen Mile Creek/Goose Creek-OH River Watersheds Improvement Project began in October of 2013.

1.2 Partners and Stakeholders

The Fourteen Mile Creek/Goose Creek Watersheds project needed support not only from members of the community, but also various agencies and partners in order to be successful. The project received support in the form of media outlets, assistance with workshops/events/activities, meeting space, and supplies from the three SWCDs located in the watershed (Jefferson, Scott, and Clark). In addition, the project benefited from other partners such as the Oak Park Conservancy District, Health Departments (Jefferson, Scott, and Clark), Indiana State Department of Agriculture, and the IDNR Division of Nature Preserves. Figure 1 lists key partners and their roles for the project.

Figure 1: Key Partners and Stakeholders

Partner	What Partner Can Provide	Benefits to the Partner	Contact Person
SWCDs: **Clark** **Scott** **Jefferson**	Information, publicity, administrative, and technical support	Assist them in providing technical assistance, conservation planning, education and program information support to private land owners.	Melanie Davis Linda Jackson Kayla Hubbard
Indiana Department of Environmental Management	Guidance and funding for the grant	Provide community level perspective and assistance to achieve their goals	Kathleen Hagan
Oak Park Conservancy District	Assistance with E. coli sampling	Accomplish their goals	Bryan Wallace
Indiana State Department of Agriculture	Technical assistance/guidance	Accomplish their goals	Ted McKinney, Director
IDNR Division of Nature Preserves	Access to Nine Penny Branch Nature Preserve for water sampling	Accomplish the goals of DNR	Jason Larson, SE Regional Ecologist
Natural Resource Conservation Service	Technical assistance/guidance	Accomplish their goals	Darrell Nicholson, SE Area Conservationist
Health Departments: **Clark** **Scott** **Jefferson**	Distribute educational information/information on the project	Public relations and accomplishing their goals	Doug Benefield, Env. Health Spec., Clark County Tim Brunner, Environmentalist, Scott County Tammy Monroe, Administrator, Jefferson County
Hoosier River Watch Volunteers	Assistance with water quality sampling	Knowledge and experience	Riverwatch Volunteer List Maintained by Coordinator
Chicks on the Farm	Location for workshop	Public relations and accomplishing their goals	Pat Larr and Betty Joubert, landowners

The Fourteen Mile Creek/Goose Creek Watersheds project needed a governing force to keep the project moving forward. After gathering community support at public meetings, community leaders, stakeholders, and interested parties were asked to participate on the Steering Committee. Steering Committee meetings were held at least quarterly in order to make timely decisions regarding the future of the watershed project. Members of the Fourteen Mile Creek/Goose Creek Watersheds' Steering Committee are listed below in Figure 2.

Figure 2: List of Steering Committee Members

Name	Affiliation
David Trotter	Clark County SWCD
Dana Coots	Clark County SWCD
Tami Kruer	Clark County SWCD
Dennis Gleason	Clark County Farm Bureau
Bryan Wallace	City of Jeffersonville
Jay Thompson	City of Jeffersonville
Mike Johnson	ISDA
Melanie Davis	Clark County SWCD
Linda Jackson	Scott County SWCD
Kayla Hubbard	Jefferson County SWCD
Jennifer Kipper	USDA-NRCS

1.3 Stakeholder Concerns

In moving forward with this project, and in constructing a management plan, the first step was establishing the community's concerns. To do this, the Fourteen Mile Creek/Goose Creek Watersheds project held public meetings. These meetings provided an opportunity to not only educate the community on the status of the project, but also to allow the public to voice concerns, and bring attention to, issues they felt need to be addressed. In addition, at each of the public meetings, and at the Fourteen Mile Creek/Goose Creek Watersheds project steering committee meetings, attendees were given the opportunity to complete a stakeholder concern survey. Listed below in Figure 3, is a compilation of the concerns gathered. Based on the responses from that survey, a simplified, more streamlined survey was created that could be easily completed by residents of the watershed at fairs, workshops, and other events. Each concern was ranked via frequency of response; there were 32 responses.

Figure 3: Stakeholder Concerns for the Fourteen Mile Creek/Goose Creek Watersheds Project

Type	Stakeholder Concern	Frequency of Concern
Soil	Excessive gully erosion in cropland and pastures	4
	Too much conventional tillage of cropland	3
	Stream bank erosion	9
	Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	3
	Sedimentation from erosion caused by overgrazing	3
Water	Livestock with direct access to streams	8
	E. coli within the streams	15
	Pollution from failing septic systems	14
Air	Application of chemicals	2
Plant	Invasive species in watershed	3
	Low quality plants in pastures	4
	Need for more cover crops on cropland	6
	Using biological methods to control bank erosion	6
Animals	Fencing of livestock from sensitive areas	12
	Wildlife feces contamination	15
	Need for education on wildlife	3
	Overpopulation of deer in watershed	13
	Dumping of wildlife remains by hunters	6
Human	Sediment filling pools for fish	4
	Unchecked Development	17
	Trash/ Litter in streams	25

2. The Watershed

In this section you will find general information and descriptions about the Fourteen Mile Creek/Goose Creek Watersheds.

2.1 The Origin of the Name

The Fourteen Mile Creek/Goose Creek watersheds gets its name due to simple geography. The mouth of Fourteen Mile Creek is fourteen miles (23 km) upstream from the Falls of the Ohio. The Goose Creek watershed name origin in unknown, but some locals speculate that the abundance of migratory geese contributed to the name.

2.2 Describing the Watershed

The Fourteen Mile Creek/Goose Creek Watershed project focuses on a 108,192 acre area of land located in the eastern portion of Clark County, the southeastern portion of Scott County, and the southwestern corner of Jefferson County. Although the complete watershed includes areas of Kentucky that drain into the Ohio River, for purposes of feasibility the project and this management plan focuses on the Indiana side of the watershed. A watershed is simply an area of land that water flows over and under on its way to particular body of water. In the case of this project, the watershed flows to the Ohio River. In the US, watersheds are identified using a coding system referred to as Hydrologic Unit Codes (HUC). HUCs are used as a way of categorizing parts of a landscape based upon drainage. The shorter the HUC, the larger the watershed is. The Fourteen Mile Creek/Goose Creek watersheds fall within the 8 digit HUC, 05140101 (Silver – Little Kentucky), noted by the larger outlined area in purple in Figure 4. The 10 digit HUCs for the Fourteen Mile Creek/Goose Creek Watersheds project include numbers 0514010104 and 0514010106. The two 10 digit HUCs are comprised of 108,192 acres of land.

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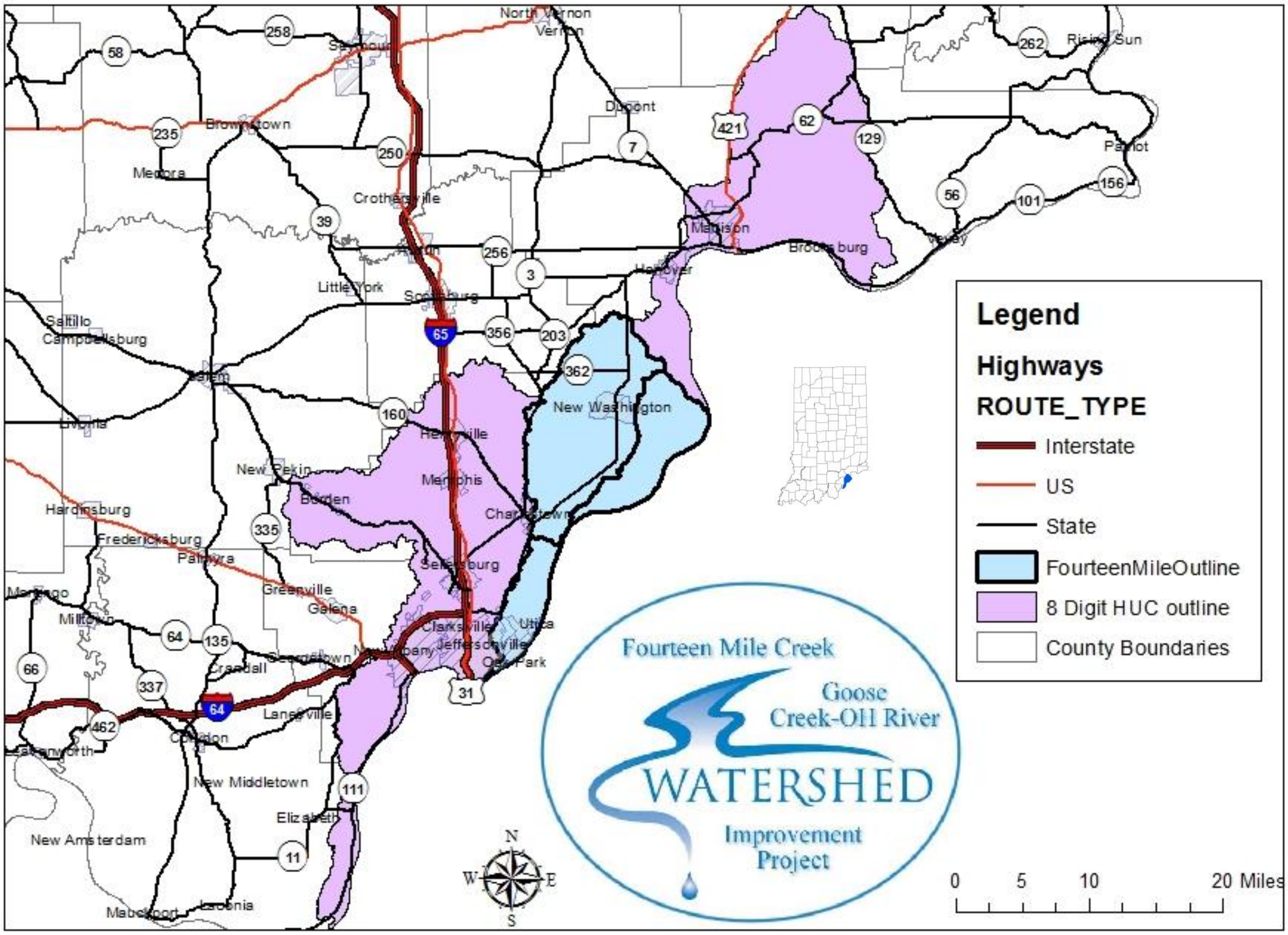
Figure 4: Location of Fourteen Mile Creek/Goose Creek Watersheds



History of the Fourteen Mile Creek/Goose Creek Watersheds

The Fourteen Mile Creek/Goose Creek watersheds has long been a special place. The abundance of fish and wildlife made the area a favorite destination for native people and early settlers. Eventually the streams and rivers of the Fourteen Mile Creek/Goose Creek watersheds played an important role in the mill industry, commerce, and settling of the area. In many respects, the Fourteen Mile Creek/Goose Creek watersheds has a truly “legendary” history.

Devil’s Backbone – A rocky ridge located on the peninsula at the confluence of Fourteen Mile Creek and the Ohio River, is named Devil’s Backbone. The Devil’s Backbone is located about three miles southeast of Charlestown, IN. At its highest point, Devil’s Backbone rises 250 feet above the river. A geological survey completed in 1873 describes a fortress on the ridge including a structure with walls 10 feet to 14 feet high, 5-feet wide with ditches and moats. Many legends surround Devil’s Backbone and much time has been spent speculating about those who constructed the fortress found on the ridge.

John Work Mill – One of nine sites within the watershed listed on the National Register of Historic Places is the John Work Home and Mill site. John Work, born 1760 in Pennsylvania, came with family to Clark County, Indiana Territory circa 1804. He purchased land along Fourteen Mile Creek and would later acquire extensive property in the county.

His Federal-style brick home was built circa 1811. Work built a grist mill, tunnel and dam on the creek between 1814 and 1816. The tunnel which was considered an engineering feat measured six feet tall, five feet wide, and was over 385 feet long. The tunnel served as a millrace, providing a consistent water supply to “Tunnel Mill”. The Mill was three stories tall with a limestone foundation and the upper two stories were made of wood.

Over time, John Work operated three grist mills, flour saw mills, a powder mill, a distillery, a stone sawing mill and a general store. It is recorded in historical archives that Mr. Work did business with not only the earliest of settlers, but with the Native Americans who occupied the area. Mr. Work died in 1832 and is buried in the Work-Faris Cemetery on the property he once owned near Fourteen Mile Creek.

John Work’s son, John Work, Jr., operated the mill until 1854; subsequent owners operated it until the mill burnt down in 1927. In 1928, Henry Murphy, the last owner/operator of the Mill sold 135 acres to the George Rogers Clark Boy Scout Council and the property became known as the Tunnel Mill Boy Scout Reservation.

Fern Grove/Rose Island – In the 1880’s, an Ohio River regional recreation area named Fern Grove was situated on a forested peninsula along Fourteen Mile Creek near Devil’s Backbone. It was mostly used as a church camp, and was equipped with picnic tables, benches and other simple amenities. It was named “Fern Grove” due to the many ferns that were found there.

In 1923, Louisville, KY, business man, David Rose, purchased the property and added an amusement park, hotel and swimming pool. He renamed the area Rose Island. The amusement park included a wooden roller coaster named Devil’s Backbone (paying homage to the geological formation), and a ferris wheel. To access Rose Island, people either took a steamboat or they drove to a footbridge. One of the steamboats was called *Idlewild*, which would later become known as the Belle of Louisville. The footbridge was a wooden swinging bridge 50 feet above the creek and easily swayed

Rose Island closed in 1937 after experiencing extensive damage from the 1937 Flood which devastated much of the local area. It subsequently became part of the Indiana Army Ammunition Plant.

Indiana Army Ammunition Plant (INAAP) – In July of 1940, the City of Charlestown with a population of approximately 940, was chosen to be the future site of the world’s largest smokeless powder plant. Smokeless powder is the name given to a number of propellants used in firearms and artillery that produce negligible smoke when fired, unlike the black powder they replaced. *(Please see section 2.3.8, of this document, Little Huckleberry Creek subwatershed, for more information on smokeless powder, and environmental concerns at the INAAP.)*

Built to support the U.S. efforts in WWII, the Charlestown Powder Plant, later renamed the Indiana Army Ammunition Plant (INAAP), was formed by the combination of three sites: the Indiana Ordinance Works (IOW) Plant 1, IOW Plant 2, and Hoosier Ordnance Plant (HOP). The government paid for the plant and owned it, but contracted with DuPont to build it and operate it. It is recorded that as many as 28,000 construction workers were involved in building the many different aspects of the plant.

The IOW Plant 1 was a Smokeless Powder plant originally consisting of 900 buildings on 6,000 acres, built by DuPont at a cost of $112,643,031. IOW Plant 2 was a rocket propellant plant built on 8,300 acres northeast of, and adjacent to, IOW Plant 1. The Hoosier Ordnance Plant (HOP) was a bag loading facility that originally consisted of 451 buildings built by Goodyear that occupied 4,929 acres southwest of, and adjacent to, IOW Plant 1; original construction cost was $27,815,661. These installations were built as small, self-contained cities.

Early rumors were that the Powder Plant would employ 5,000 workers; over five times the population of the City of Charlestown. At its peak, INAAP employed 9,000 permanent workers, many of whom relocated to Charlestown from other states, finding inadequate infrastructure, housing, schools, health services, sewer system, etc. A large number of workers sought refuge in Louisville and made the drive to Charlestown each day.

After the war, the facility served as a storage depot, resuming production during the conflicts in Korea and Vietnam. A large portion of the undeveloped INAAP was donated in parcels to the State of Indiana for use as a park. That park is named Charlestown State Park.

Charlestown State Park - Once a largely undeveloped portion of the Indiana Army Ammunition plant, Charlestown State Park is located in southern Indiana. With scenic vistas of the Fourteen Mile Creek valley and the Ohio River, and with elevation changes of over 200 feet, Charlestown State Park has much to offer the visitor with its rugged hills and deep ravines. While hiking the rugged terrain you will see Devonian fossil outcrops and areas of karst sinkhole topography. Bird watchers will enjoy the 72 species of birds, including bluebirds, black vultures and an occasional bald eagle. Park amenities include hiking trails, picnic areas with shelters, fishing along Fourteen Mile Creek, a playground and camping sites.

Nature Preserves – There are three Nature Preserves located within the Fourteen Mile Creek/Goose Creek watersheds. They are the Fourteen Mile Creek Nature Preserve, Nine Penny Branch Nature Preserve, and Chelsea Flatwoods Nature Preserve.

Fourteen Mile Creek Nature Preserve – The Fourteen Mile Creek Nature Preserve consists of 1602 acres. The preserve is located within the Charlestown State Park; five State Park Trails lie within the preserve.

This preserve contains high-quality limestone cliffs, and a range of dry upland to floodplain forests. The dry upland areas support species that can grow in well-drained soils, such as Eastern red cedar, chinquapin oak, prickly pear cactus, shooting star, puccoon, nodding onion, and the adder's tongue fern.

The area known as the Devil's Backbone, at the south end of the preserve, is a moister habitat, with sugar maple, tulip, red, white, black, and chinquapin oaks, American beech, and a variety of flowers and ferns such as mayapple, columbine, twinleaf, Jack-in-the-pulpit, sessile trillium, and walking fern.

Nine Penny Branch Nature Preserve – The Nine Penny Branch Nature Preserve consists of 121 acres. The trailhead is located on Tunnel Mill Road in Charlestown, IN.

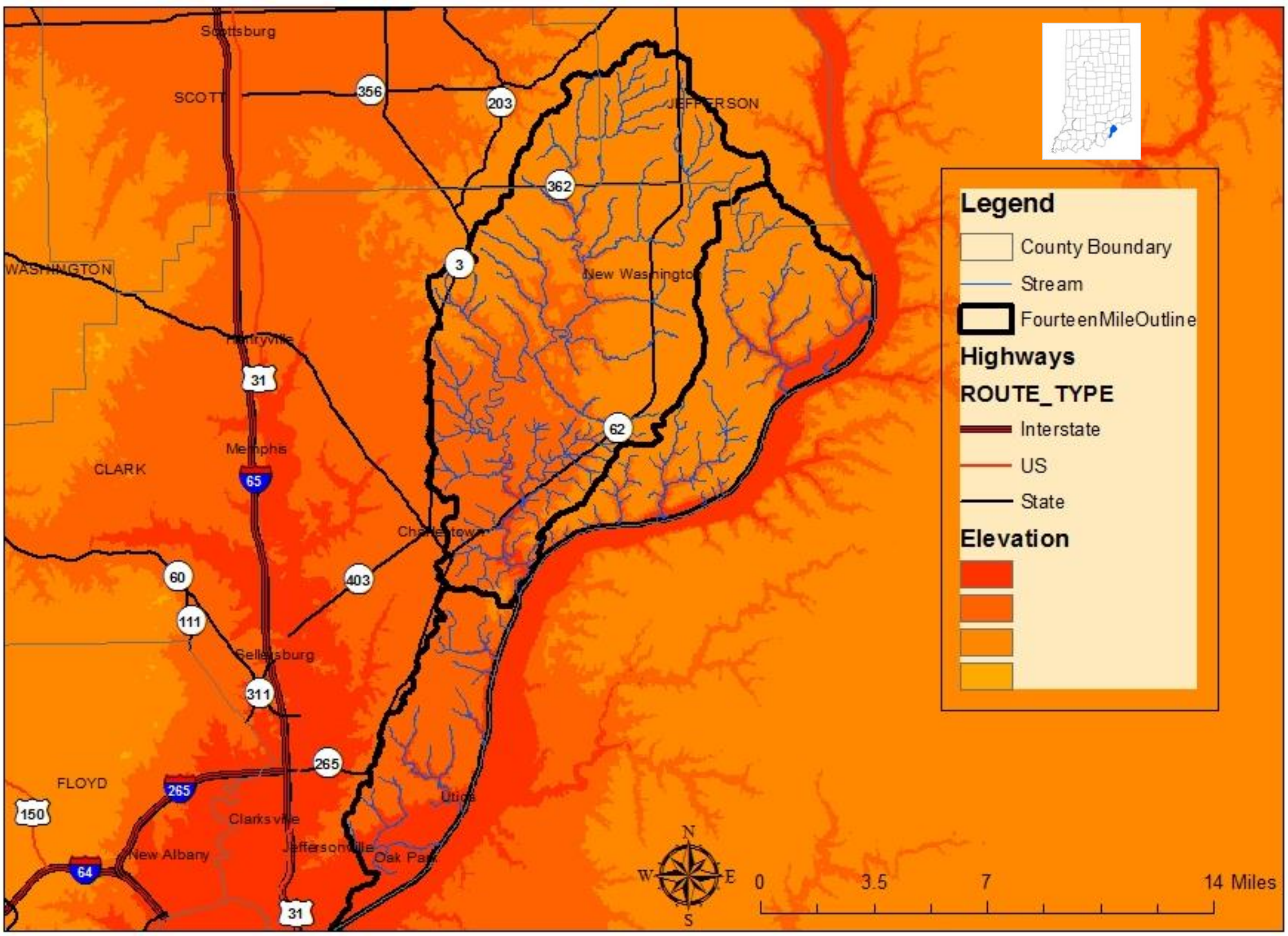
Nine Penny Branch contains an old growth mesic upland forest, dominated by beech and tulip poplar. It also contains areas of young, second growth forest. Nine Penny Run bisects the preserve, cutting a moderately deep ravine into the limestone bedrock. The streambed is composed of slabs of limestone, with small waterfalls, pools, and riffles. A historic stagecoach route runs along the stream corridor. Remnants of early stone fences can still be seen along the stage route.

Chelsea Flatwoods Nature Preserve - One of the largest, wettest and most diverse examples of the Bluegrass Tillplain flatwoods in Indiana, Chelsea Flatwoods is a forest offering various wildflowers, ferns and an interesting mix of trees. American beech, sweet gum, sugar maple and a variety of oaks dominate the woods while a number of ferns cover the forest floor. Its 388 acres are located in Jefferson County, and it is owned and managed by The Nature Conservancy in partnership with the Indiana Heritage Trust.

2.2.1 Geology/ Topography

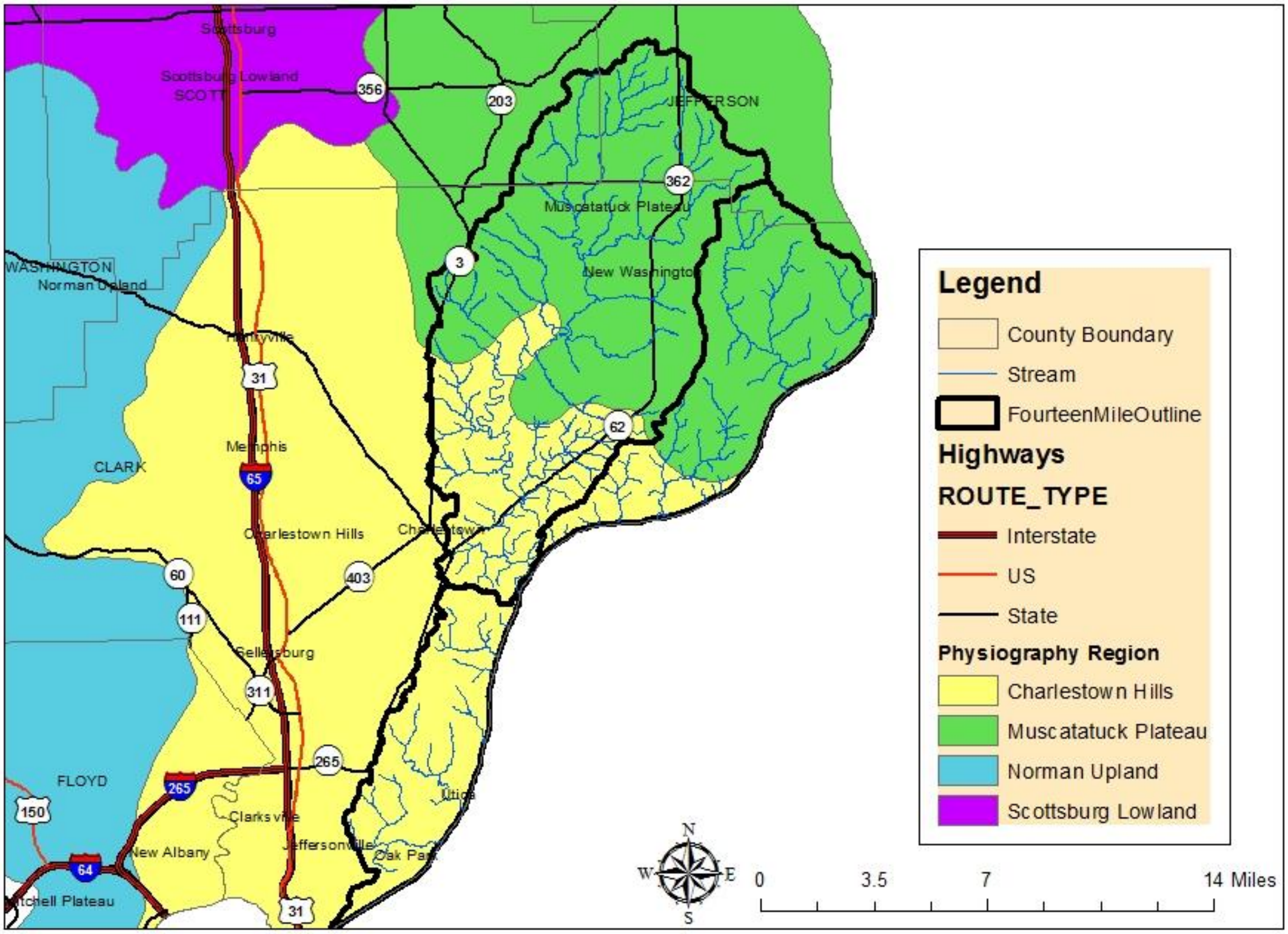
Like most watersheds in the U.S., the Fourteen Mile Creek/Goose Creek watersheds' drainage pattern is mostly determined by elevation. In Figure 5, areas of lower elevation are represented by dark orange; color lightens progressively with elevation to the highest elevations represented by light orange. Water in the Fourteen Mile Creek/Goose Creek watersheds flows downhill from north of New Washington to the Ohio River. The topography in the watersheds is characterized by steep terrain.

Figure 5: Elevation of the Fourteen Mile Creek/Goose Creek Watersheds



The topography in the watershed also has specific physiographic regions: the Charlestown Hills region is bedrock hills of low relief, somewhat modified by pre-Wisconsin glacial activity; the Muscatatuck Plateau region is a broad, till-covered upland entrenched by major valleys. Figure 6 shows the locations of the physiographic regions.

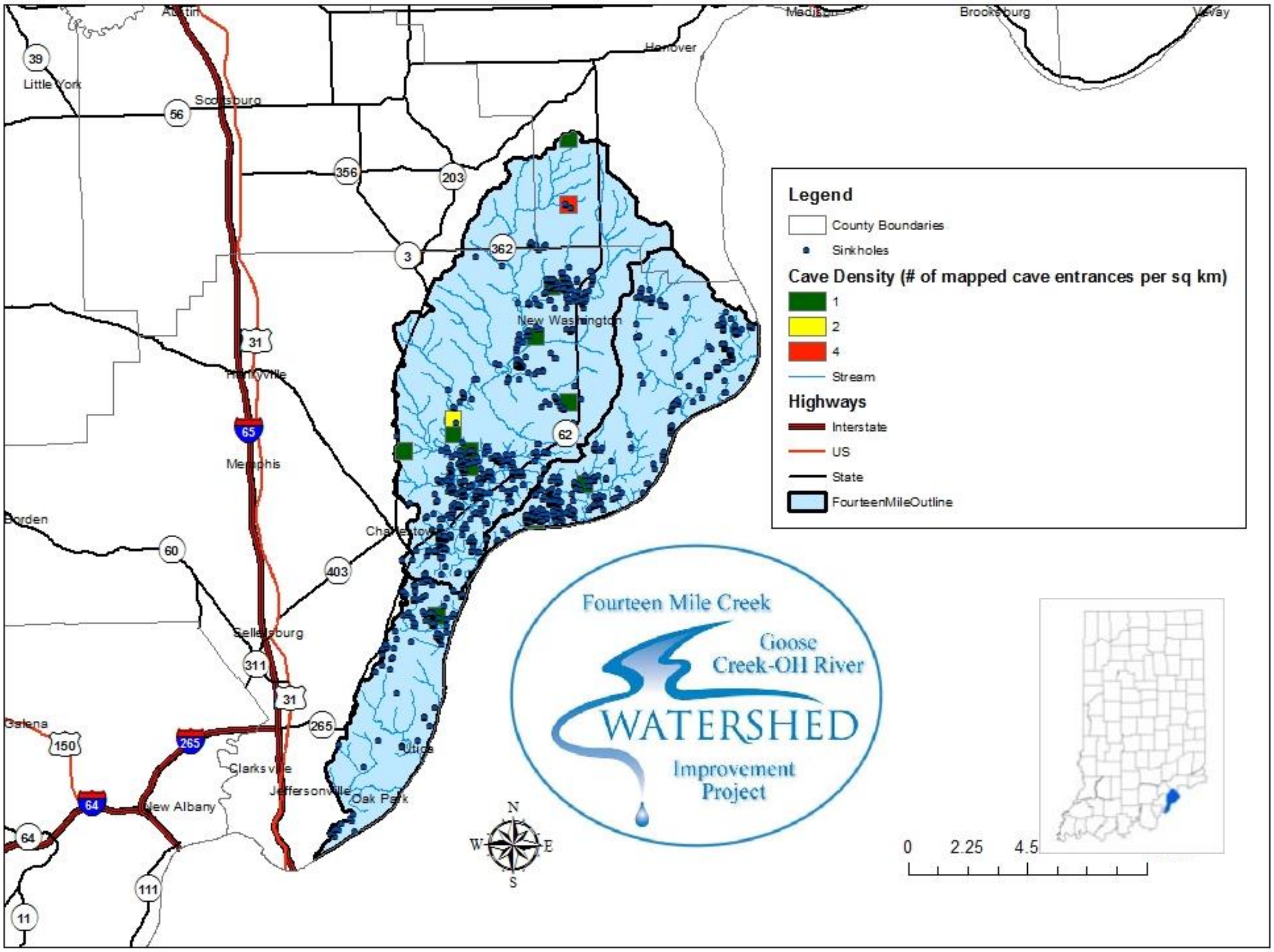
Figure 6: Physiographic Regions of the Fourteen Mile Creek/Goose Creek Watersheds



According to the Clark County Soil Survey, several soil types found in this watershed have a karst component. Karst is defined as a landscape with topographic depressions, such as sinkholes and caves, caused by underground dissolution of limestone bedrock. This landscape features underground streams and aquifers, which supply many wells and springs used for drinking water. The hollow nature of karst terrain results in very high pollution potential, because streams and surface runoff entering sinkholes and caves bypass natural filtration through the soil, and provide direct conduits for contaminants. Groundwater can travel quite rapidly through these underground networks, and contaminants can be transmitted quickly to wells and springs in the vicinity. This adds a degree of difficulty in establishing a “point” of the “nonpoint” source pollution. If water flows swiftly underground, well water may be unsafe for human consumption if not filtered through an aquifer first.

Caves provide recreation to spelunkers, however, most of the caves in the Fourteen Mile Creek/Goose Creek watersheds are too small to be explored; many have small entry ways. For locations of the caves in the watershed see Figure 7. In addition, the Fourteen Mile Creek/Goose Creek watersheds are home to many sink holes. Sinkholes show little outward signs of erosion, but can suddenly collapse, causing safety and other issues for watershed residents. Figure 7 identifies the numerous sinkholes present in the watershed.

Figure 7: Sinkholes and Caves in the Fourteen Mile Creek/Goose Creek Watersheds



Documentation of the management of sinkholes in the watersheds is not available. Anecdotal evidence from stakeholders indicates that landowners are for the most part unsure how to address sinkholes on their properties. As a result, they resort to filling them with materials on hand such as dirt, rock, or, as we shudder to mention, other man-made items not intended for burial. Farmers who are row-cropping seem to be more inclined to fill sinkholes in crop fields with rock (we're assuming for stability should they accidently cross them), and/or plant around them. NRCS-USDA's Conservation Reserve Program (CRP) can assist landowners in installing filter strips around sinkholes in fields, however landowners have not taken advantage of this program to any extent in our project area.

In addition to the elevation and karst features, Fourteen Mile Creek/Goose Creek watersheds contain eleven major geologic units, which are shown in Figure 8. They represent bedrock units and surficial deposits (sediment) of the Pre-Wisconsinan, Wisconsinan, Silurian, Devonian, Late Ordovician, Holocene, and Middle Devonian to Early Mississippian periods. There are three major types of units in the watershed and they are: limestone/dolomite, loam to sandy loam, and upland silt complex.

Limestone and Dolomite

Dating back to the Silurian and Devonian era, over 40,000 acres of the Fourteen Mile Creek/Goose Creek watersheds are comprised of this deposit, which has a higher risk for sinkholes, and can present potential groundwater pollution and development issues. This particular type of rock serves as an excellent pH buffer due to its chemical makeup. The permeable nature of the carbonate rocks also makes them natural conduits for conveying solid and liquid wastes.

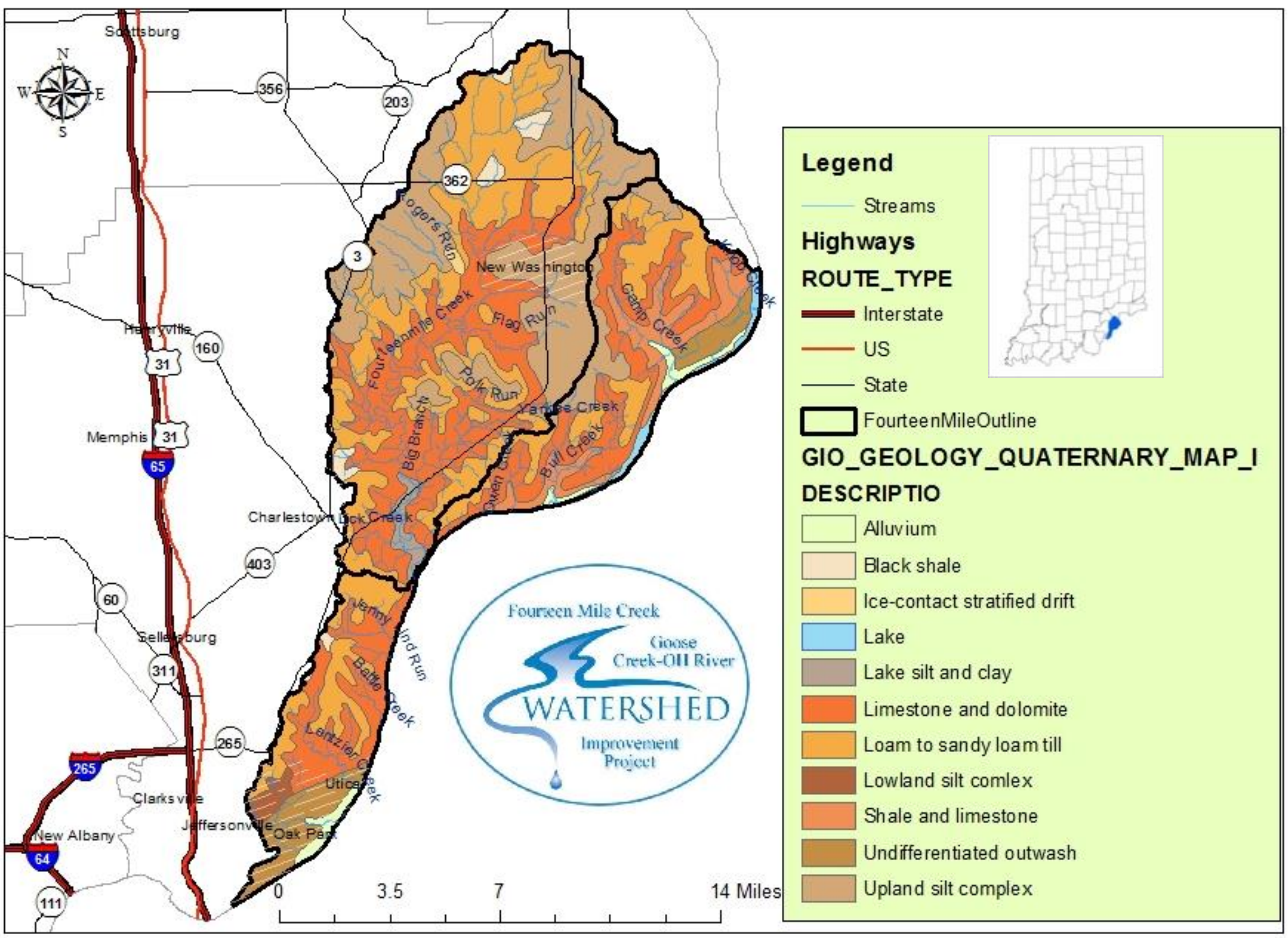
Loam to Sandy Loam (sediment)

This type of deposit dates back approximately 100,000-150,000 years to the Pre-Wisconsinan era. Often found under areas of fertile agricultural practices, this deposit becomes more and more compacted over time. Roughly 16,200 acres of the Fourteen Mile Creek/Goose Creek watersheds are comprised of this type of deposit.

Upland Silt Complex (sediment)

Finally, the Upland Silt Complex type of deposit dates to the Wisconsinan era, and makes up roughly 22,000 acres of the Fourteen Mile Creek Watershed. The upper layers of the Upland Silt Complex often have high levels of volcanic ash. The deposit has a very rocky, strongly sloping complex that can be poorly drained.

Figure 8: Fourteen Mile Creek/Goose Creek Watershed Surficial Geology



2.2.2 Hydrology

Defined as the total area of land draining to a particular water body, watersheds are delineated utilizing topography which indicate areas of elevation and natural divides as discussed in the previous sections. However, drainage areas typically coincide with stream size. Just as smaller streams flow to combine with larger streams, smaller watersheds converge to form larger watersheds. In this way, watersheds are identified by scale, and are coded as such. Watersheds can be broken down into small portions called subwatersheds. Fourteen Mile Creek (0514010104) and Goose Creek (0514010106) watershed's 10 digit HUCs, can be broken down into nine subwatersheds (Figure 9). These nine subwatersheds are identified by 12 digit HUC codes; Figure 10 lists these.

Figure 9: Subwatersheds (12 digit HUCs) in the Fourteen Mile Watershed

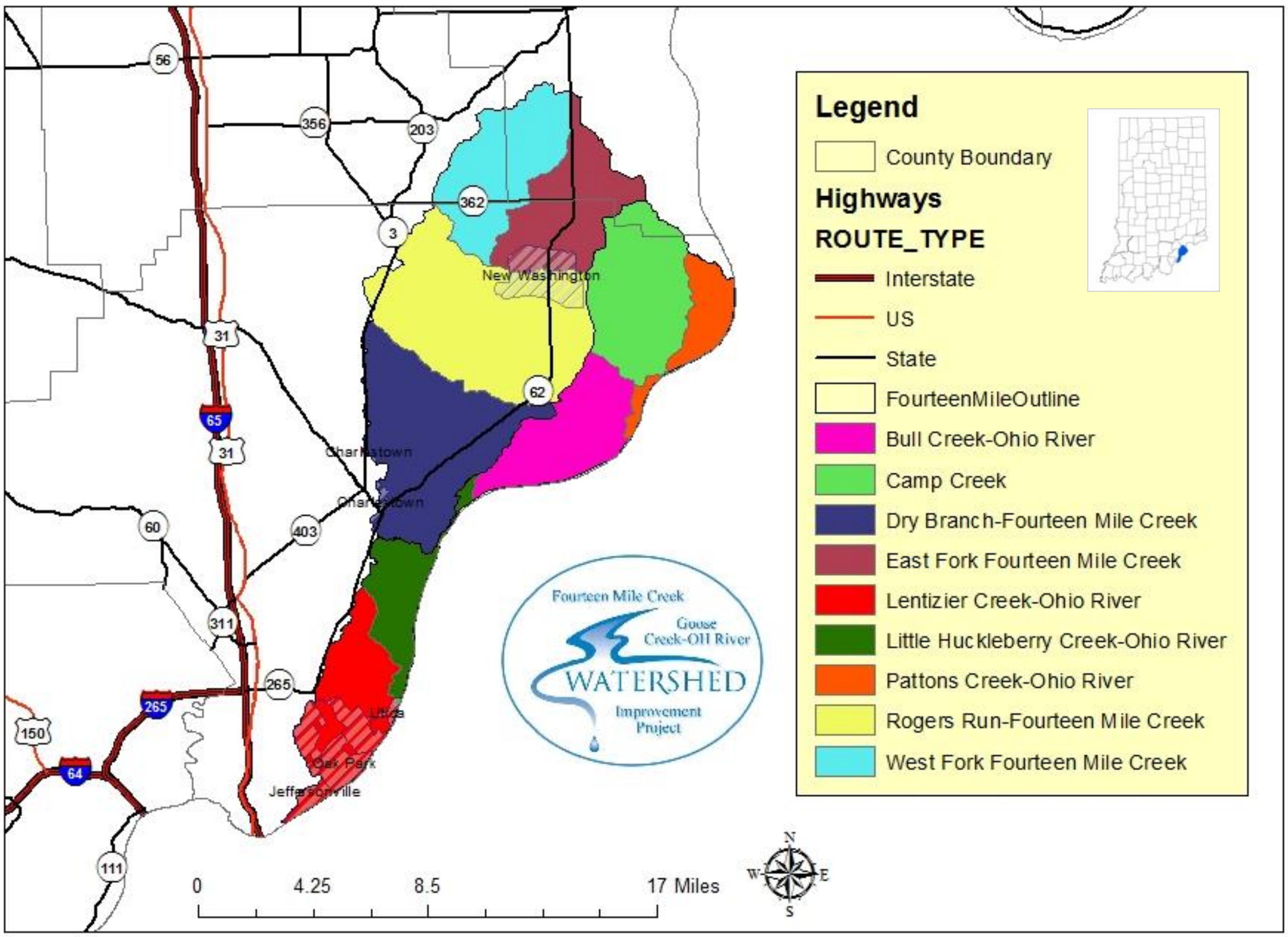


Figure 10: Subwatershed Names and HUCs for Fourteen Mile Creek/Goose Creek Watersheds

Subwatershed Name	12 Digit HUC
East Fork Fourteen Mile Creek	051401010401
West Fork Fourteen Mile Creek	051401010402
Rogers Run – Fourteen Mile Creek	051401010403
Dry Branch – Fourteen Mile Creek	051401010404
Camp Creek	051401010601
Pattons Creek – Ohio River	051401010602
Bull Creek – Ohio River	051401010603
Little Huckleberry Creek – Ohio River	051401010604
Lentizier Creek – Ohio River	051401010605

The Fourteen Mile Creek/Goose Creek watersheds are home to many rivers, streams, and tributaries. Some of the major streams include: Fourteen Mile Creek, West and East Forks-Fourteen Mile Creek, Rogers Run, Camp Creek, Bull Creek, Lacassange Creek, and Lentizier Creek. Some of the streams and tributaries in the watershed are impaired for E. coli, dissolved oxygen, and/or biotic communities. Specific impairments will be discussed in the subwatershed analysis sections of this plan. Figure 11 shows the locations of the streams in the Fourteen Mile Creek/Goose Creek watersheds.

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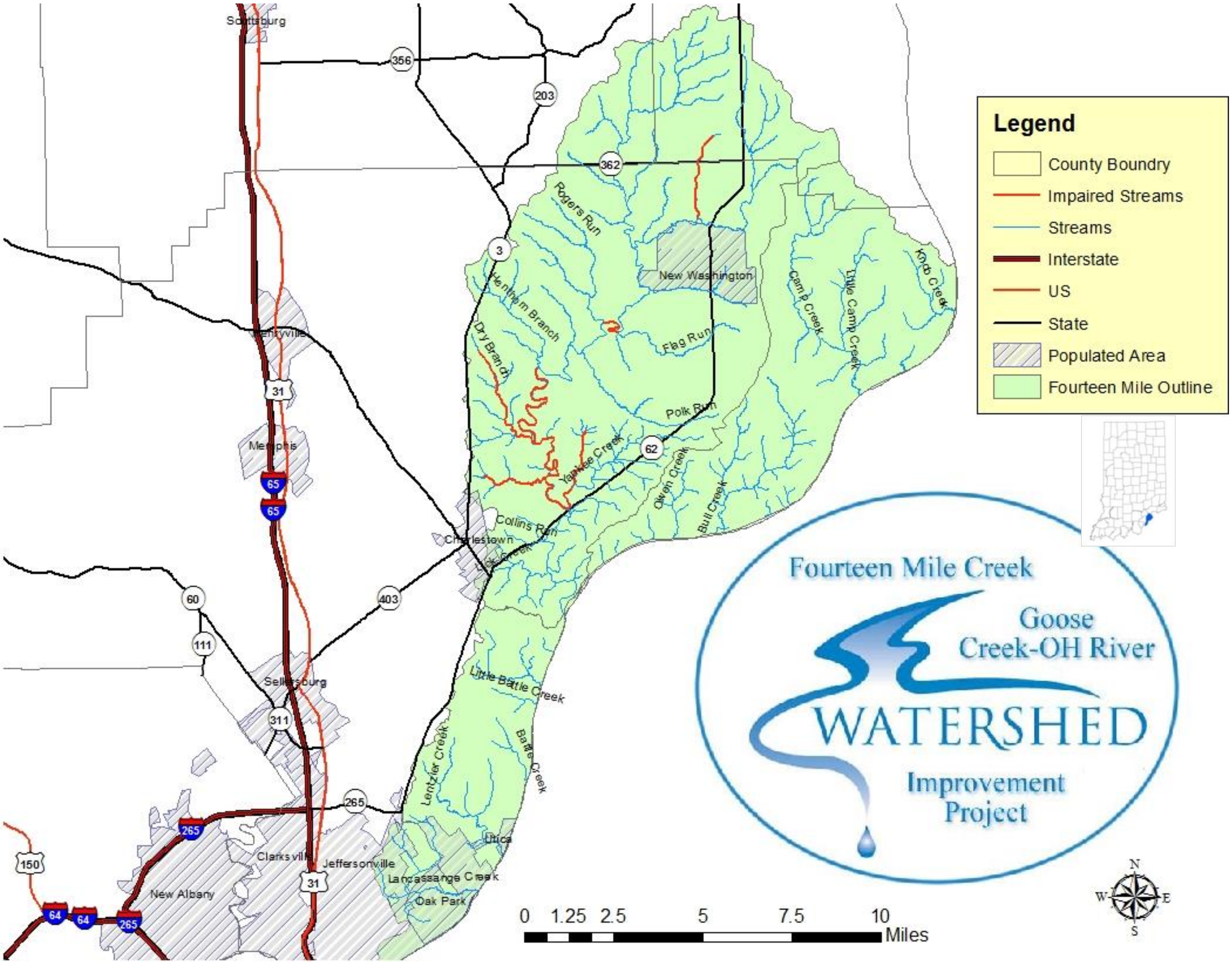
Figure 11: Hydrology of Fourteen Mile Creek/Goose Creek Watersheds

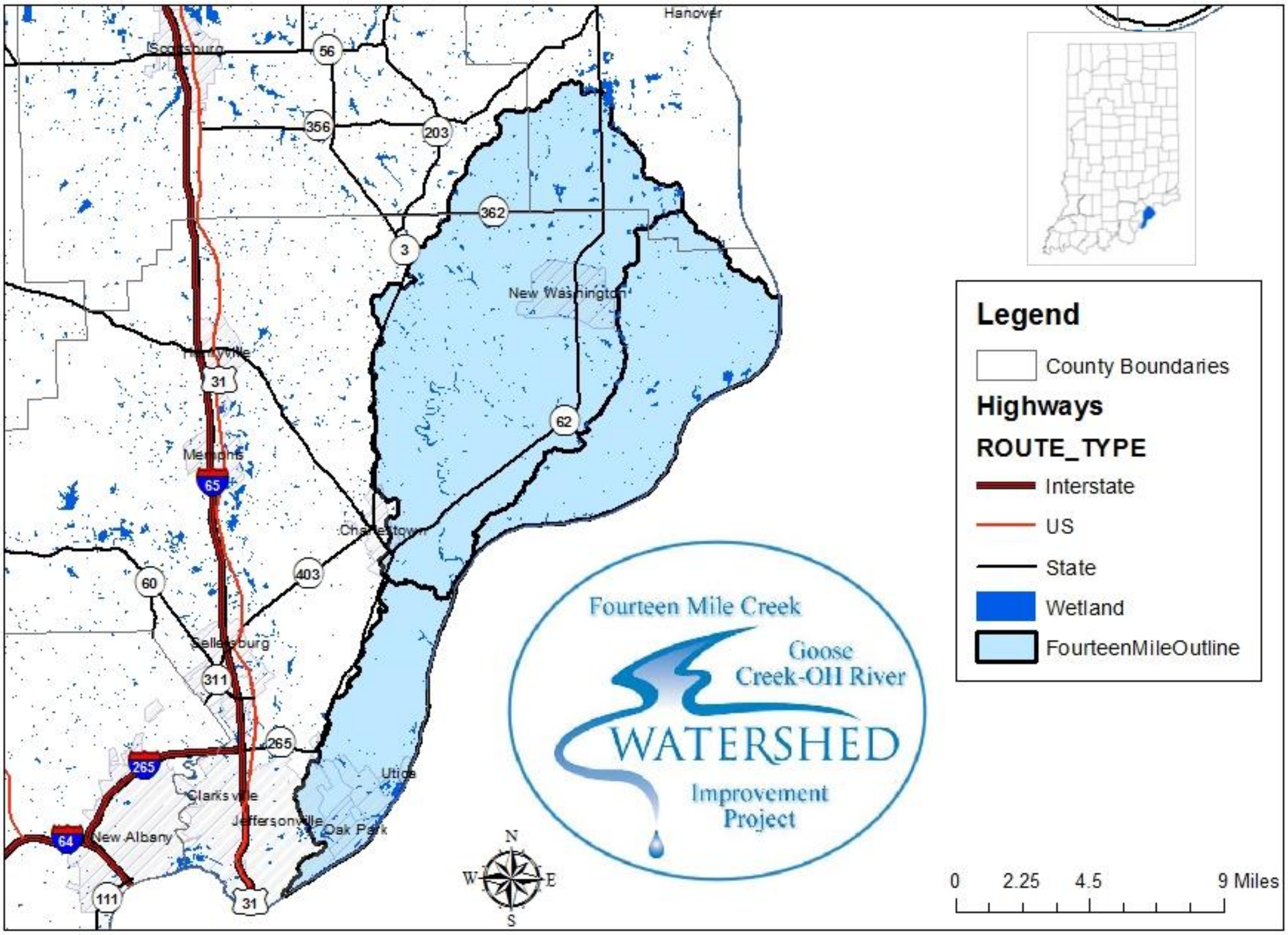


In the Fourteen Mile Creek/Goose Creek watersheds there are roughly 266.57 miles (429.016km) of streams. Of the total number of streams, approximately 52% of the streams are perennial, having a continuous flow of water in all or parts of their stream bed year round during years of normal rainfall. The remaining 48% of streams in the watershed are intermittent streams, which cease flowing for weeks or months each year. The watersheds also contain roughly 1,537 miles of ditches. No legal drains exist within the watersheds.

These streams and ditches provide a water source for livestock, and a habitat for wildlife. Larger streams provide recreation for residents in the form of fishing, boating, and swimming activities. Many residents also get their drinking water from underground aquifers in the watershed. These uses make the watersheds' water sources valuable to the area, however, there is concern amongst stakeholders (as listed in Figure 3) that water quality is not the best for these uses. Livestock having direct access to streams, E. coli within the streams, and pollution from failing septic systems, were the most frequently commented concerns on surveys completed by stakeholders.

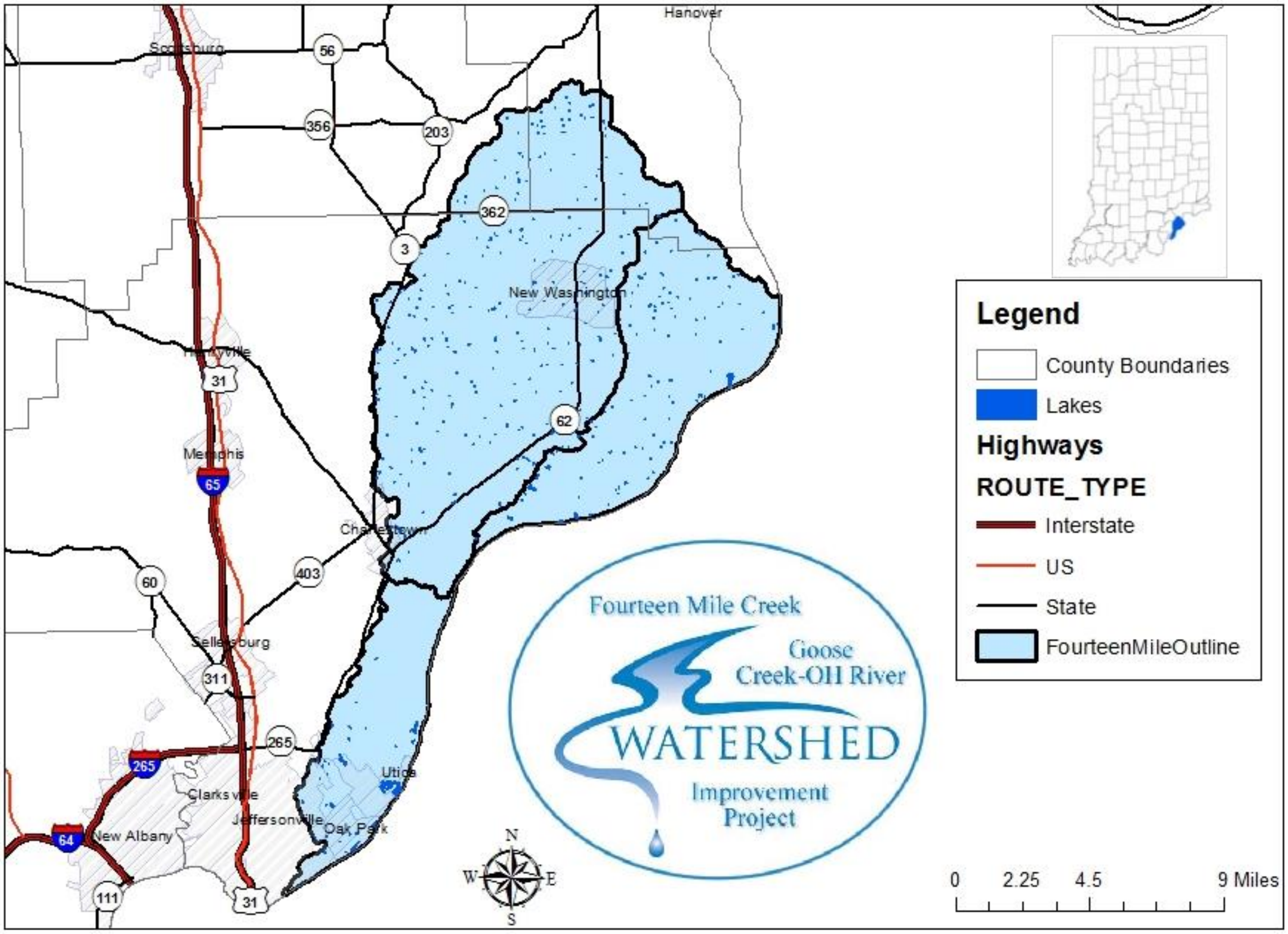
Wetlands serve as a natural filtration system for the water in the watershed. They also provide habitat for many different kinds of animal and plant life. Historically, the area in the Fourteen Mile Creek/Goose Creek watersheds was rich in wetland habitat, however, wetlands have diminished over the years. There are currently 1,738.05 acres of wetlands in the watersheds. This is due in large part to development (residential as well as commercial) that has taken place within the watersheds. Stakeholders are concerned about this as "unchecked development" rated high on the surveys they completed. Locations of wetlands in the Fourteen Mile Creek/Goose Creek watersheds is given in Figure 12.

Figure 12: Wetlands in the Fourteen Mile Creek/Goose Creek Watersheds



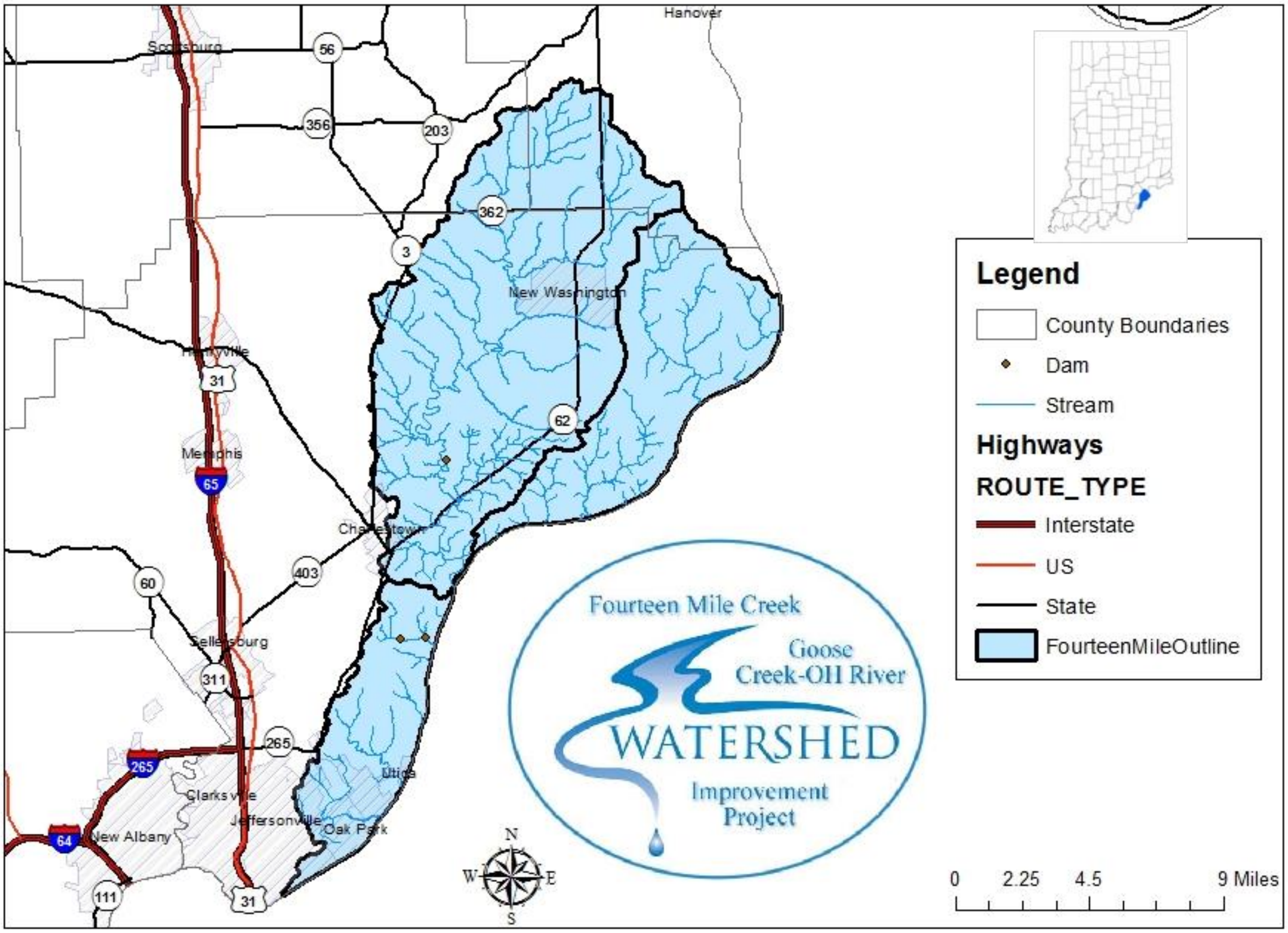
There are over 569 lakes and ponds in the watersheds. Many of the ponds are smaller agriculture ponds averaging 0.85 acres (0.00348 square km) in size; some are used as a water source for livestock, and/or for fishing. There are roughly 489.26 acres (1.98 square km) of lakes in the watersheds. Figure 13 details the locations of the lakes in the Fourteen Mile Creek/Goose Creek watersheds.

Figure 13: Lakes in the Fourteen Mile Creek/Goose Creek Watersheds



There are also man-made alterations of the hydrology in the watershed. Because areas of southern Indiana often experience flooding hazards, dams have been erected. The Fourteen Mile Creek/Goose Creek watersheds are home to three dams, whose locations are given in Figure 14. Each of the dams is rated low hazard, and helps control flooding. Last inspection of each of the dams was scheduled in 2012.

Figure 14: Dams Located in the Fourteen Mile Creek/Goose Creek Watersheds



2.2.3 Soil Characteristics

Soil characteristics can potentially impact water quality in any given watershed. Referencing the most recent soil survey completed for Clark County, Indiana, the following general soil associations are found within the Fourteen Mile Creek/Goose Creek watersheds:

*Cobbsfork-Avonburg-Rossmoyne-Nabb-Cincinnati-Hickory (Illinioian Till) Associa*tion

Soils are formed in a layer of windblown silty material called loess and loamy Illinoian glacial till. Slopes can range from 0 percent in the Cobbsfork and Avonburg soils to more than 25 in the Hickory soils. Natural soil drainage ranges from poorly drained in the Cobbsfork soils to well-drained in the Hickory soils. Depth to root restrictive layer or fragipan range from 24 inches in the Cincinnati soils to more than 60 inches in Cobbsfork and Avonburg soils. Water movement through the fragipan is slow. Available water capacity can be affected by the depth of the fragipan. Shallower fragipans limit the amount of soil material to hold water that can be made available to plants and increase erosion potentials. These soils are not flooded, and except for Cobbsfork, are not ponded. Shrink swell potentials are low. Organic matter in the surface horizons averages 2 percent.

Ryker-Grayford-Crider-Haggatt-Caneyville (Limestone) Association

Ryker and Grayford soils are formed in loess, a layer of highly weathered glacial till that is underlain by limestone bedrock. Crider, Haggatt, and Caneyville soils are formed in a layer of loess and underlying material weathered from limestone bedrock called residuum. Slopes range from 2 percent in the Ryker soils to more than 60 percent in the Caneyville soils. Natural soil drainage is well drained in all these soils. Depth to a root restrictive layer or limestone bedrock in this association ranges from 20 inches in the Caneyville soils to more than 120 inches in the Ryker soils. Water movement ranges from moderately low to moderately high in the soil profile. Available water holding capacity ranges low in the shallower to bedrock soils, to high in the deeper soils. These soils are neither flooded nor ponded. Shrink swell potentials are moderate to high. Organic matter in the surface averages 2 to 3 percent.

*Huntington-Wakeland-Bonnie-Markland-Bartle-Elkinsville (Flood-plain and Stream Terrace) Associatio*n

These soils are formed in various ages of alluvial or flood plain deposits. Slopes in the flood plain soils range from 0 to 2 percent, and in the stream terrace soils from 0 to over 50. Natural soil drainage ranges from well-drained in soils like Huntington, to poorly drained in soils like Bonnie. Depth to a root restrictive layer is greater than 120 inches in most of these soils. Some stream terraces have a fragipan similar to that in the Illinioian till soils at a depth of more than 60 inches. Available water holding capacity is moderate to high in all these soils. Flooding occurs occasionally to frequently in the flood plains, and rarely on some stream terrace soils. Ponding can occur in some areas, especially after a flooding event. Shrink swell potentials range from low to moderately high. Organic matter in the surface averages 2 to 3 percent.

Deputy-Trappist-Scottsburg-Whitcomb-Rohan (Black Shale) Association

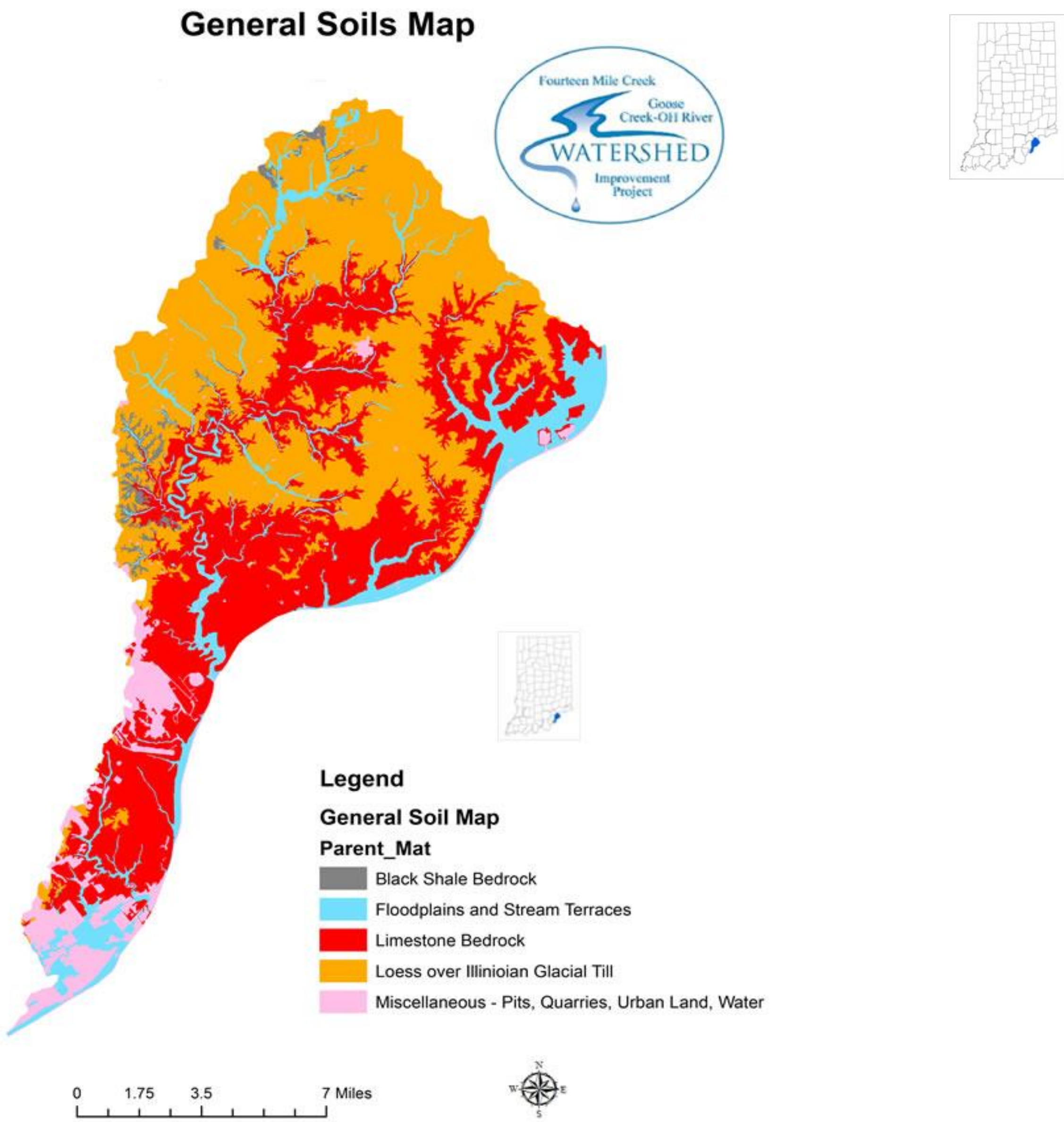
These soils have formed in a thin layer of loess and the underlying material weathered from black shale called residuum. Slopes range can from 0 percent in the Whitcomb soils to 60 percent in the Rohan soils. Natural soil drainage ranges from somewhat poorly drained in the Whitcomb soils to well-drained in the Trappist and Rohan soils. Depth to a root restrictive layer or black shale bedrock in this association ranges from 10 inches in the Rohan soils to 80 inches in the Whitcomb soils. Water movement ranges from very low to moderately high in the soil profile. Available water holding capacity ranges very low in the shallower to bedrock soils, to high in the deeper soils. These soils are neither flooded nor ponded.

Miscellaneous Units:

Gravel Pits, Limestone quarries, urban lands and water. These units are highly variable and require onsite soil investigation to evaluate most soil properties.

Displayed below is a map of the soil associations found in the Fourteen Mile Creek/Goose Creek watersheds.

Figure 15: General Soils of the Fourteen Mile Creek/Goose Creek Watersheds



Management Concerns for Soil Associations Found in the Fourteen Mile Creek/Goose Creek Watersheds

The soil surveys for Clark, Jefferson and Scott all discuss the general management concerns affecting the use of soils in the county for crops and pasture. One of these is water erosion. Water erosion becomes a hazard in areas where the slope reaches more than 2 percent. Erosion causes the organic matter rich topsoil to be washed into drainage ways, causing sedimentation and nutrient displacement problems in streams, rivers and lakes. As soils become more eroded and tillage incorporates higher clay subsoil material, seedbed preparation becomes more difficult and seed germination is hindered. Loss of the surface layer is also very detrimental to soils that have fragipan or fragic soil properties in the subsoil or have bedrock within a depth of 60 inches (Avonburg, Nabb, Cincinnati, Caneyville, Grayford, Haggatt, Deputy and Trappist map units). The rooting zone of these soils is above the fragipan or bedrock, therefore, when the surface layer is lost, the thickness of the rooting zone and the available water capacity are compromised.

Limited rooting depth and a limited amount of moisture available for plant growth are caused by root-restrictive features within a depth of 40 inches. The quality and quantity of the pasture may be reduced in areas where the soils have a low or very low available water capacity. The soil moisture may be inadequate for the maintenance of a healthy community of desired pasture species and, thus, the desired number of livestock. A poor quality pasture may increase the hazard of erosion and increase the runoff of pollutants. Planting drought-resistant species of grasses and legumes helps to establish an adequate vegetative cover.

It is noted in recent Natural Resources Conservation Service publications that planting cover crops helps control erosion in the more sloping areas, and reduced tillage methods that leave at least 50 percent residue on the surface can protect most soils from excess erosion during winter and early spring months. This is especially true on sloping soils where row crops are grown year after year. Cover crops increase organic matter in the soil which in turn increases water infiltration and water holding capacity, reducing surface run off. Reduced run off holds nutrients in place instead of being displaced into surface water sources.

Many of the soils in the Fourteen Mile Creek/Goose Creek watersheds have a surface layer of silt loam that has a moderate to low content of organic matter. In these type soils, when little or no crop residue is left on the surface, a hard crust forms after periods of intensive rainfall. This crust reduces the infiltration rate, increases runoff rate, and inhibits plant emergence. Regular additions of crop residue, cover crops, manure, and other organic material helps improve soil structure and to minimize crusting. Intensive tillage during crop production generally has an adverse effect on the content of organic matter and overall soil quality.

Tilling or grazing many of the soils with silty surfaces when saturated causes surface compaction, which restricts penetration by tillage equipment and plant roots, and limits plant growth. Increased organic matter helps improve the strength of the soil in moist conditions. Certain types of cover crops can help break up the compaction naturally.

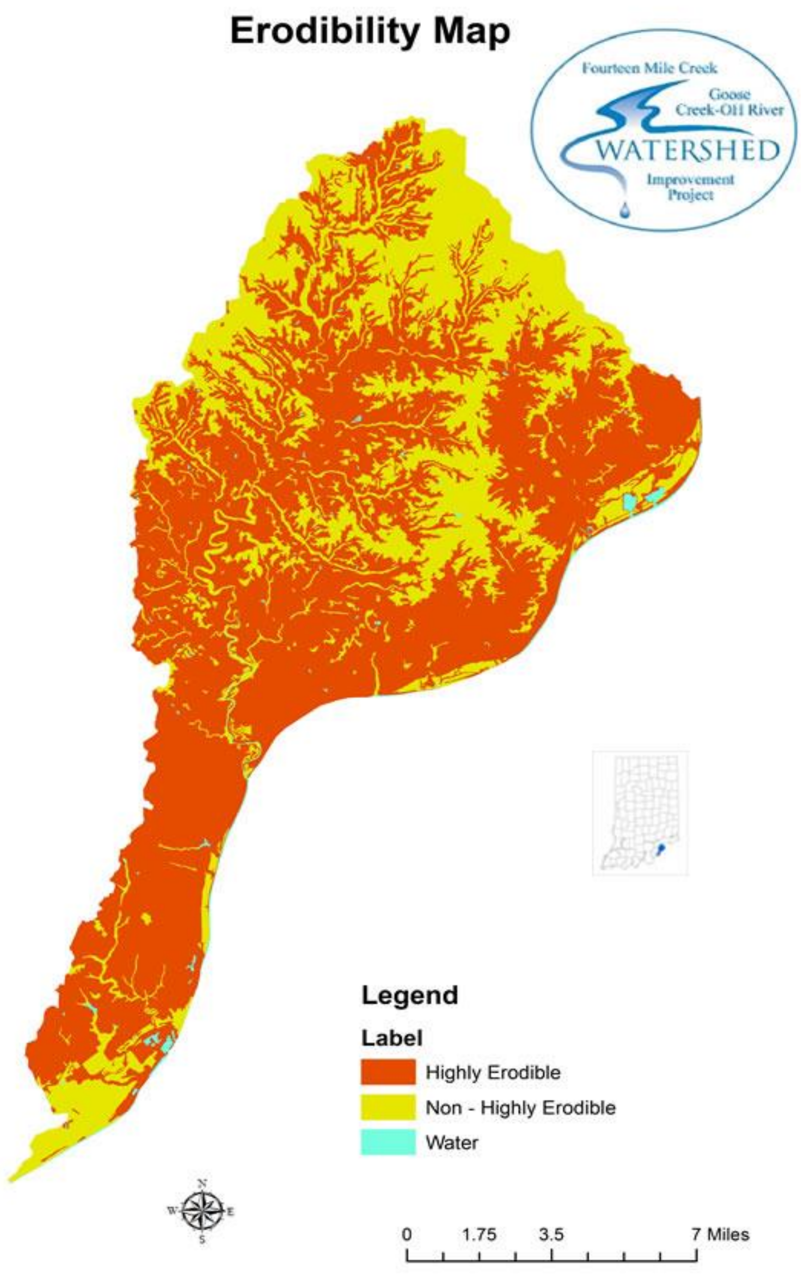
Given the characteristics of each soil association, and the management concerns presented above, it can be seen that the following stakeholder concerns are supported:

> **Stakeholder concerns – soil:** excessive gully erosion in cropland and pastures; too much conventional tillage of cropland; stream bank erosion; need for soils education involving compaction, cover crops, and nitrogen fixation; sedimentation from erosion caused by overgrazing.
>
> **Stakeholder concerns – plant:** need for more cover crops on cropland; low quality plants in pastures; invasive species in watershed.
>
> **Stakeholder concerns – water:** pollution from failing septic systems.

In planning for successful watershed management it is important to know where the most highly erodible soils are. Highly erodible land (HEL) is cropland, hayland, or pasture that contains these types of soil, and therefore, can erode at excessive rates. Highly erodible land is classified numerically as: 1 – highly erodible land; 2 – potentially highly erodible; and 3 – not highly erodible. The Cincinnati, Crider, and Grayford soil components found in the Fourteen Mile Creek/Goose Creek watersheds are designated HEL class 1. Roughly 67% (33%

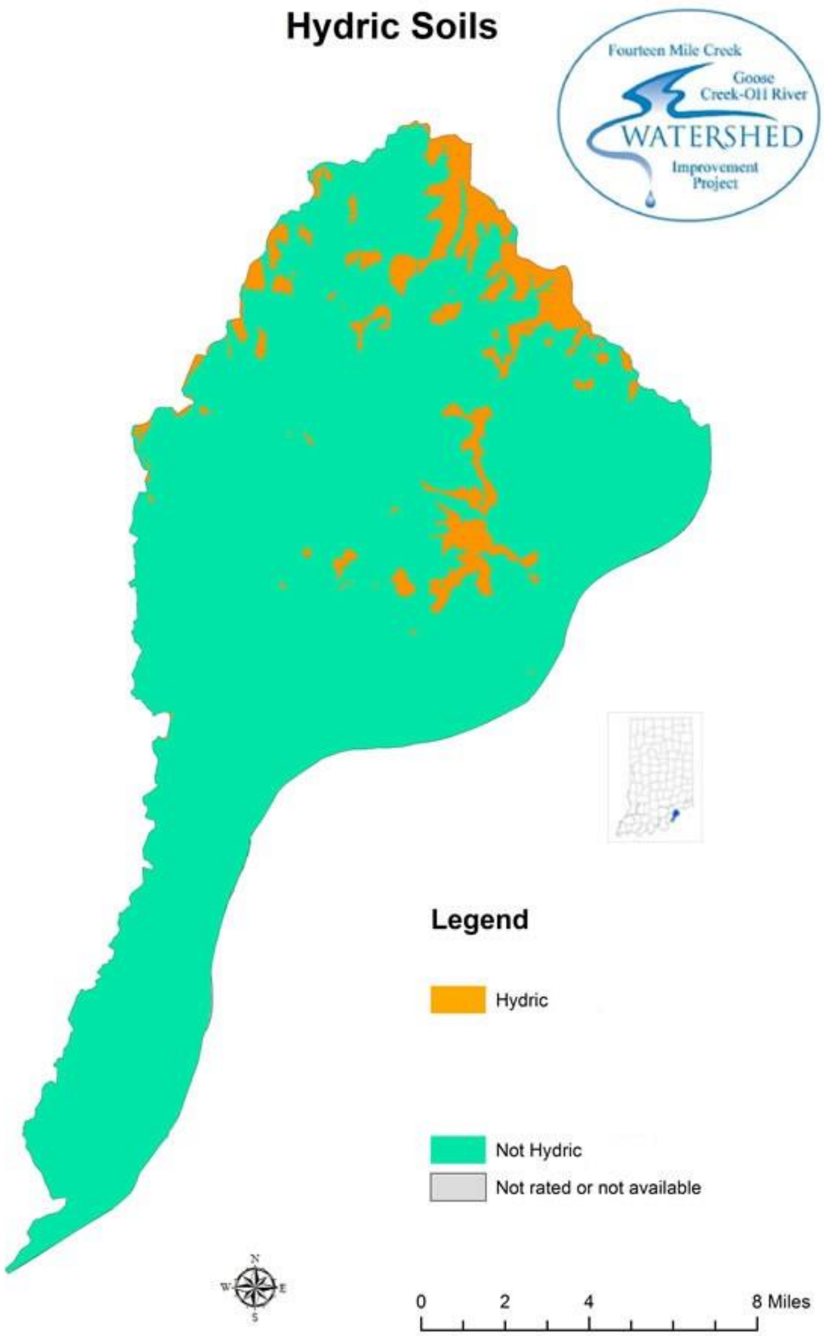
non-HEL) of the watershed is classified as highly erodible and is at a severe risk for erosion. In Figure 16 below, the highest potential for erosion is marked on the map in red.

Figure 16: Highly Erodible Lands in the Fourteen Mile Creek/Goose Creek Watersheds



In addition to understanding where the highest potential for erosion is, it's important to understand where hydric soils are found within the watersheds. Hydric soils may be permanently or seasonally saturated with water as in swamps or wetlands. These soils result in anaerobic conditions even after they are drained. It is likely that these soils developed under wetland conditions, therefore, they are a good indicator of historic or current wetland locations within the watershed. Currently 14% of the Fourteen Mile Creek/Goose Creek watersheds is comprised of hydric soils. The highest concentrations of hydric soils are found along the north borders, and north central areas of the watershed (Figure 17).

Figure 17: Hydric Soils in the Fourteen Mile Creek/Goose Creek Watersheds

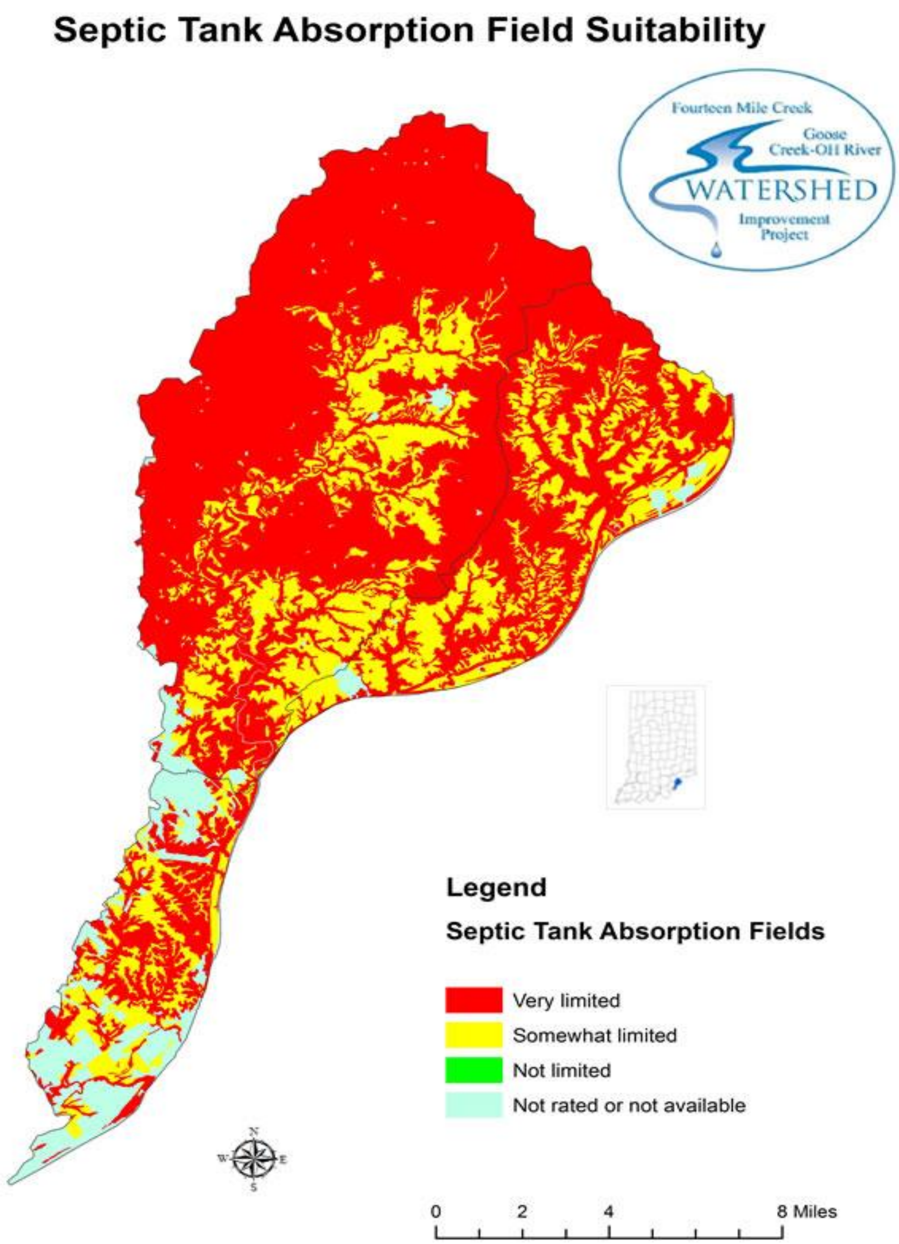


Malfunctioning or failing septics are one of the major sources of E.coli contamination to our stream systems (animal waste being the other). The northern portion of the Fourteen Mile Creek/Goose Creek watersheds is rural in nature, consisting of small, unsewered communities, and individual homes. The exception in this area is the community of New Washington, IN, located in the East Fork Fourteen Mile Creek and Rogers Run subwatersheds. New Washington is an unincorporated community of 566 people, and is sewered.

Other sewered communities found in the Fourteen Mile Creek/Goose Creek watersheds are the City of Jeffersonville, and Oak Park Conservancy District. Both of these entities have been designated MS4s. Permit information and map of their locations can be found in Section 2.2.5 of this document.

Septics have been identified as a concern of our stakeholders. Supporting this concern are reports from stakeholders who have noticed odors from areas with septics, and ponding in some of those areas. In order to address this concern, considering the suitability of the soils in the watersheds for septics is key. As can be seen in Figure 18, most of the soils are not ideal for septics. In fact, according to data from the National Resource Conservation Service (NRCS), 42.1% of soils are listed as very limited for septic systems with another 27.6% listed as limited. These statistics, and the fact that stream segments in the watersheds have been identified as impaired for E.coli, brings immediacy to addressing this concern.

Figure 18: Septic Suitability in the Fourteen Mile Creek/Goose Creek Watersheds



Tillage patterns can give insight into the amount of soil that is or is not being lost within a watershed, and ours in no exception. According to the 2015 Spring Tillage and Cover Crop Transect, Clark County as a whole follows a trend of plowing less, and using sound conservation practices that preserve and build valuable topsoil. A tillage transect is an on-the-ground survey that identifies the types of tillage systems farmers are using, and long-term trends of conservation tillage adoption using GPS technology, plus a statistically reliable model for estimating farm management and related annual trends.

There are many forms of conservation tillage, but the ultimate is "no-till," where farmers directly plant into the previous crop with little soil disturbance. No-till farming methods can reduce soil erosion by 75 percent when compared to a conventional (chisel-disk) tillage system, and they are a critical component to improving soil organic matter and soil health.

The 2015 Spring Tillage and Cover Crop Transect report shows farmers in Clark County saved an estimated 5.1 tons of soil per acre by using reduced tillage methods as compared to conventional tillage. Additionally, fields are tracked that plant cover crops as a conservation practice. In Clark County, 8% of acres were recorded as cover cropped in the spring transect.

Fourteen Mile Creek/Goose Creek watersheds would obviously be included these county-wide results, however, though these are favorable percentages, stakeholders have noted instances of conventional tillage within the watersheds, leading them to identify it as a concern.

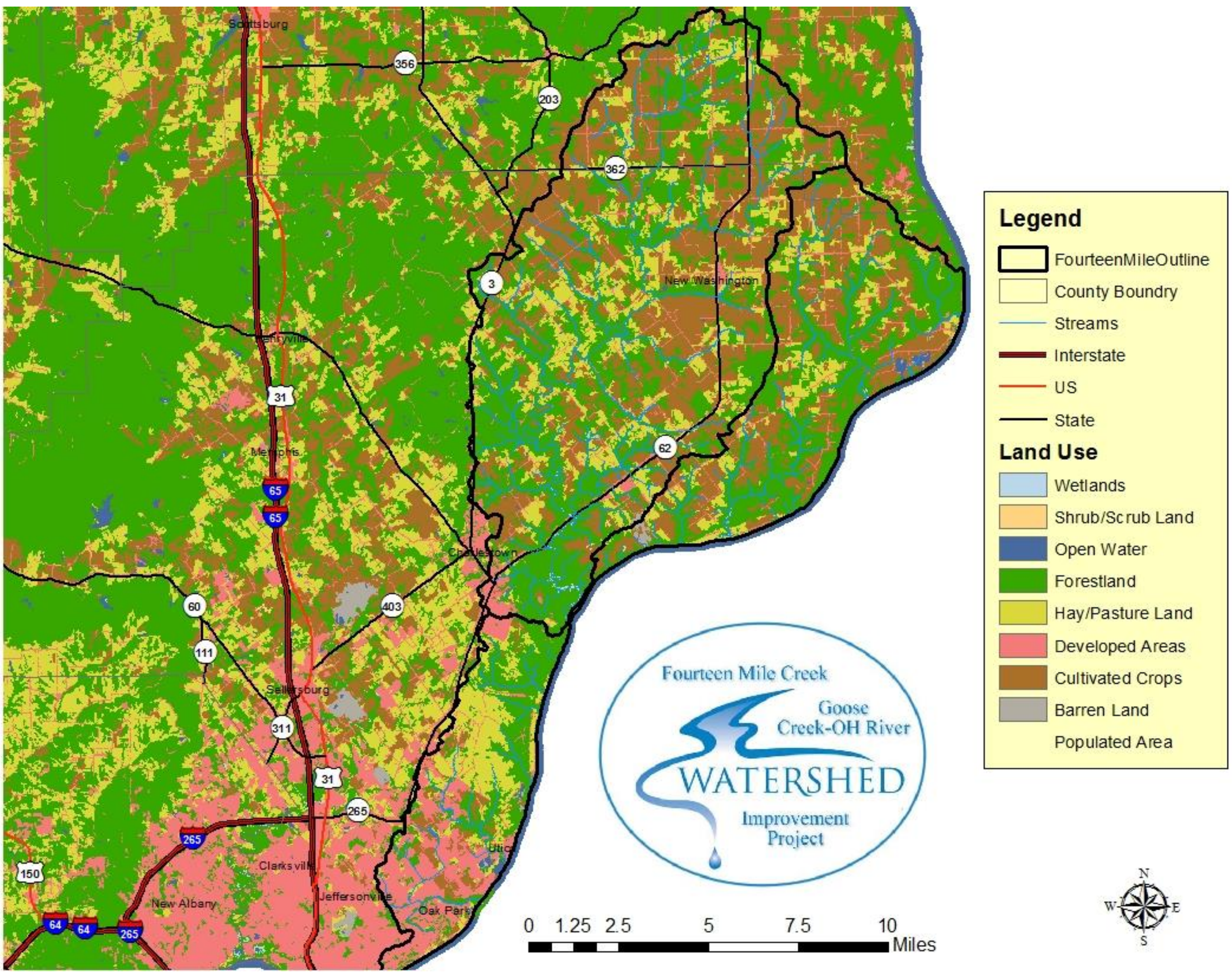
Figure 19: 2015 Clark County Spring Tillage and Cover Crop Transect Report

	No Till		Strip Till		Ridge Till		Mulch Till		Reduced Till		Conven-tional Tillage		Tillage Unknown or N/A		Cover Crops		Risers / Inlets	
Present crop	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts
Corn	81%	52	0%	0	0%	0	6%	4	3%	2	6%	4	3%	2	2%	1	0%	0
Soybeans	75%	92	0%	0	0%	0	11%	13	2%	3	11%	14	0%	0	1%	1	0%	0
Small grains	50%	10	0%	0	0%	0	50%	10	0%	0	0%	0	0%	0	80%	16	0%	0
Hay/Pasture	6%	4	0%	0	0%	0	3%	2	0%	0	0%	0	91%	59	2%	1	0%	0
Fallow	50%	1	0%	0	0%	0	0%	0	0%	0	0%	0	50%	1	50%	1	0%	0
Specialty Crops	0%	0	0%	0	0%	0	50%	1	0%	0	50%	1	0%	0	50%	1	0%	0
CRP and similar	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
TOTALS	58%	159	0%	0	0%	0	11%	30	2%	5	7%	19	23%	62	8%	21	0%	0

2.2.4 Land Use

There are roughly 32,111 acres of cropland (29.69% of watershed) in the watershed with an additional 18,385 acres of pastureland (17% of watershed). Another 44,012 acres is forest vegetation (40.69% of watershed). A small percentage of the watershed is comprised of developed areas (11,029 acres, 10.2%), along with wetlands, and open water (845 acres, .78%). The land cover in the central and northern portion of the watershed is almost evenly split between agriculture and forest vegetation. Farms in this region tend to be of medium size (80-100 acres) or smaller tracts of less than 25 acres.

Figure 20: Land Use in the Fourteen Mile Creek/Goose Creek Watersheds



Over the last decade, development in urban areas in the southern part of the watershed has expanded. With the release of the 6,000 acres of land that comprised the old Ammunition Plant to the Local Reuse Authority for commercial/industrial development, stakeholders expect to see this trend continue. In fact, results of the stakeholder concern survey revealed that one of the highest frequencies of concerns was the issue of unchecked urban development in the watershed.

The addition of impervious surfaces in areas of urban development, along with urban drainage systems (i.e. curbs, gutters, and storm drain pipes), alters the natural hydrology in a watershed by increasing the volume of stormwater runoff and reducing groundwater recharge. The result is more frequent flooding, higher flood peaks, lower base flow in streams, and lower water table levels. These hydrologic extremes can damage plant, fish, and invertebrate habitat. The increase in water volume during storm events causes erosion of stream banks and changes the stream channel's shape. In addition, stream edge habitat and stream channel protection is lost when the natural, vegetated stream buffer is replaced by impervious surfaces.

Impervious surfaces and urban drainage systems also accelerate the delivery of pollutants from the watershed to rivers, lakes, and streams. Since urban areas tend to have higher concentration of lawn fertilizer use, and in some cases, overuse, this leads to excess nutrients, such as nitrogen and phosphorus, entering the stream system and degrading water quality. Other pollutants of concern in urban areas are toxic contaminants, such as metals and oil, from vehicles and business/homeowner activities that are washed off impervious surfaces and into waterbodies via stormwater.

In the same manner as fertilizer and oil, pet waste washes into storm water systems, and can cause elevated levels of E. coli in the waterbodies it is released to. Pet waste tends to be more of an issue in urban than in rural areas due to greater impervious area, therefore, it would be a concern our Lentizier Creek and Little Huckleberry Creek subwatersheds where development is on the increase. Wildlife waste would not commonly be an issue in most urban areas, however in these subwatersheds, that potential exists in these two subwatersheds due the old Ammunition Plant being located within them. The Plant sat dormant for so many years that it became a refuge for wildlife. Now that development is inching across that land, animals are being displaced, and there have been many reports and stories of them making new homes amidst residential areas. Reduction of E. coli is a high stakeholder concern, therefore, being aware of where the heaviest concentrations of pets and/or wildlife exists, is a useful analysis tool.

2.2.5 Planning Efforts

As discussed in the land use section, ensuring that development proceeds in a way that is less detrimental to water quality is a priority for stakeholders in the Fourteen Mile Creek/Goose Creek watersheds.

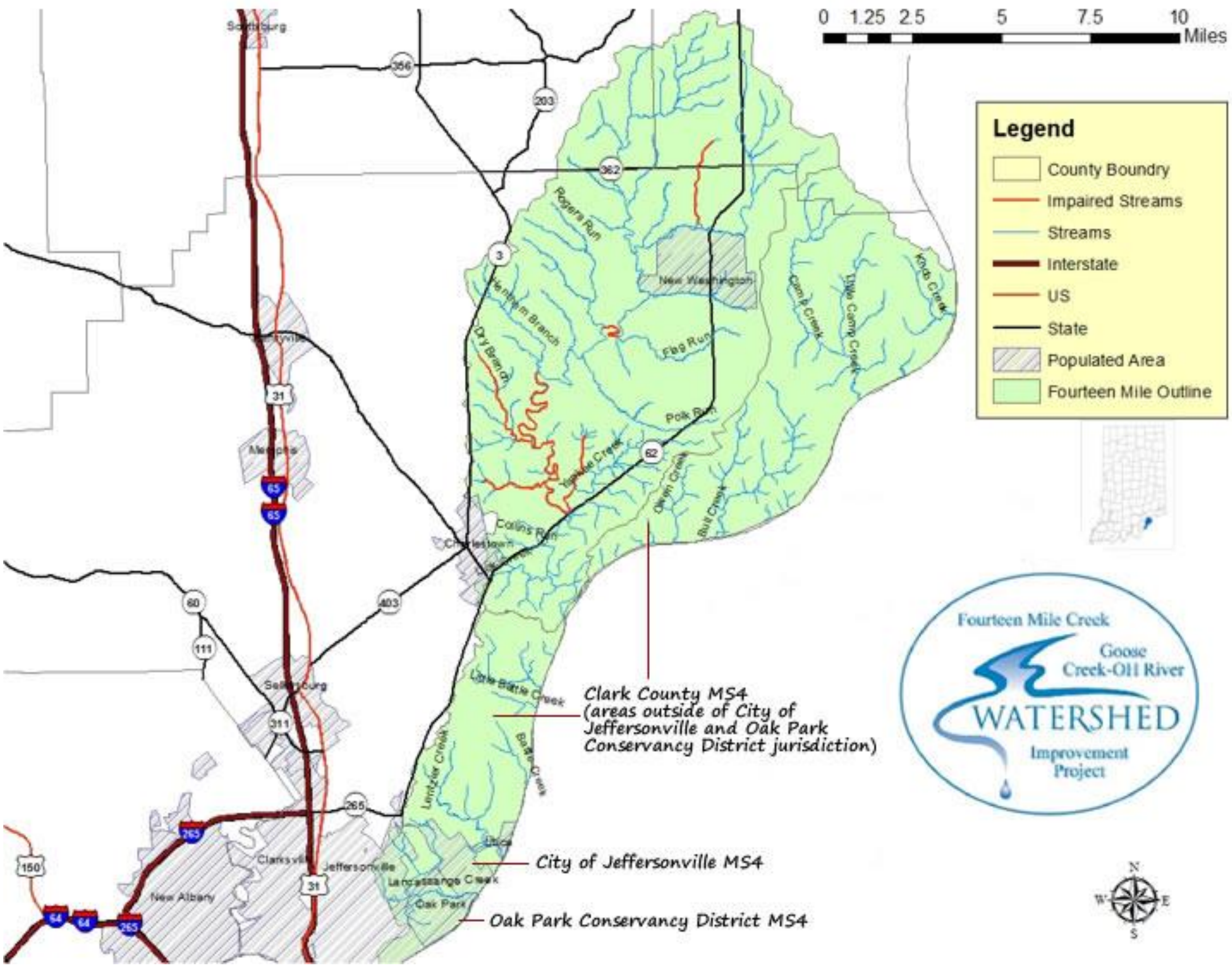
Stakeholders voiced concern over soil loss from erosion, and its negative effect on water quality, many times in discussion of this plan. Unchecked, and unmonitored, development creates a risk for soil erosion, therefore regulations have been put in place by the state that construction and development sites are required to follow in order to protect water quality. The Clark County Soil and Water Conservation District (SWCD) currently employs an Urban Specialist who reviews construction plans and performs site inspections for the City of Jeffersonville, and Clark County. This person is in close contact with those entities on a daily basis, and therefore can assist in stakeholders' efforts to track areas where erosion may be a problem. The Urban Specialist, because of the nature of their position, is also aware of enforcement actions taken by the State, and areas in need of enforcement. There are currently no areas in need of Rule 5 enforcement in the watershed area.

Storm water runoff is also a concern when considering water quality. To that end, municipalities with Municipal Separate Storm Sewer Systems (MS4s) need to be identified in the watershed. MS4s are defined as a conveyance, or system of conveyances, that is designed or used for collecting or conveying storm water that discharges to waters of the United States. These are usually owned by a state, city, town, or other public entity. In Indiana, IDEM requires that population areas of a certain size have a plan that details how storm water pollution will be controlled within their permitted MS4 area. In the Fourteen Mile Creek/Goose Creek watersheds, three MS4s exist, and are listed and mapped below in Figures 21 and 22.

Figure 21: MS4 Entities in the Fourteen Mile Creek/Goose Creek Watersheds

County	MS4 Entity	Permit Number	Phone
Clark	Oak Park Conservancy District	INR040001	(812) 283-3960
Clark	Jeffersonville, City of	INR040117	(812) 248-0730
Clark	Clark County	INR040118	(502) 643-3886

Figure 22: Map of MS4 Entities in the Fourteen Mile Creek/Goose Creek Watersheds



A comprehensive plan for Clark County, dated December 2007, exists in draft form. It was created through a Community Planning Grant awarded to the County in 2004 by the Indiana Department of Transportation (INDOT), however, it was never approved by the County, and therefore is not enforceable. Stakeholders have stated that the plan is outdated, and lacks power for any regulation or change regarding water quality. The

Steering Committee has expressed interest in contacting county planners to discuss the possibility of re-writing the plan as it does contain environmental components that are of interest to this project, such as:

- *Explore the management structures, capital costs and financing mechanisms associated with the improvement of natural and manmade drainage systems to adequately accommodate stormwater flows.*
- *Use best management practices for erosion and sedimentation control during and after site preparation.*
- *Buffer streams and lakes to prevent water quality degradation.*
- *Protect, to the extent possible, areas of endangered species, wetlands, public parks, unique natural areas, and other areas with significant natural features.*

(Clark County Comprehensive Plan, December 2007, prepared by Bernardin, Lochmueller and Associates, Inc., Evansville, Indiana.)

Clark County as an entity does not participate in the Wellhead Protection Program administered by IDEM's Office of Water Quality, however, there are public water suppliers within the County that do. We have included all suppliers in our watershed area that have wellhead protection plans in Figure 23 below.

Figure 23: Water Suppliers with Wellhead Protection Plans in Fourteen Mile Creek/Goose Creek Watersheds

Systems' Phase I plans were required to establish a Local Planning Team, delineate the Wellhead Protection Area, identify and inventory potential contaminant sources, develop a Management Plan for potential contaminant sources, and develop a Contingency Plan. In Phase II, they are required to document implementation of Phase I, and update their management strategy. Every five years after Phase II approval, systems are required to submit an update to their Wellhead Protection Plan.

PWSID	System Name	Population Served	Next Plan Due
5210003	Charlestown Water Dept.	6750	Phase 2
5210008	Riverside Water Company	2220	Phase 2
5210010	Sellersburg Water Dept.	11948	Phase 2
5210013	Sunset Village/Bushmans Lake & Marina	406	5 Year Update
5210015	Washington Township Water	4040	5 Year Update
5210016	Watson Rural Water Company	14265	5 Year Update
5210018	Charlestown/River Ridge	6025	5 Year Update
5210022	Wastewater One/Rivers Edge Utility	250	Phase 2

2.2.6 Endangered Species

The Fourteen Mile Creek/Goose Creek watersheds are home to several endangered plant and animal species identified at both the state and federal level. These species are known to inhabit some of the sensitive habitats found in the watersheds. [1]

[1] Data, descriptions, and ranges for state and federal species provided by the US Fish and Wildlife Service and the Indiana Department of Natural Resources

Mammals:

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

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

Gray bat (*Myotis grisescens*): The Gray Bat is listed both in Indiana, and federally as endangered, and is protected by the Endangered Species Act. This bat is very cave dependent, and has declined due to human disturbance. Thanks to conservation efforts, the population of the Gray Bat is thought to be on the rise.

Fish:

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

Lake Sturgeon (*Acipenser fulvescens*): The lake sturgeon is listed as endangered in the state of Indiana, and is listed as a species of special concern federally. This bottom feeding fish can grow to be quite large, reaching 6 feet long and topping 200 pounds.

Reptiles and Amphibians:

Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*): The Eastern Hellbender is listed as endangered in the state of Indiana. These salamanders average about two feet in length. They fill unique niches in ecosystems where they can be both a predator and prey.

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

Kirtland's Snake (*Clonophis kirtlandii*): The Kirtland's Snake is a semi-aquatic snake that prefers waters in prairie habitat. This non-venomous snake can flatten its body to remarkable thinness, and become very rigid when threatened. The Kirtland's Snake is listed as state endangered in Indiana.

Southeastern Crowned Snake (*Tantilla coronate*): The Southeastern Crowned Snake is a state endangered snake, but listed as a species of least concern at the federal level. The venom of the Southeastern Crowned Snake is mild, and doesn't pose a risk to human health, but redness and swelling may occur.

Birds:

Bald Eagle (*Haliaeetus leucocephalus*): Known as the National Bird, the Bald Eagle has been a national symbol since 1782. The Eagle is designated as state endangered in Indiana. It is thought to be in decline due to decreasing wetland habitat. The watershed is home to a few nesting pairs of birds, which have been spotted along Fourteen Mile Creek.

Bachman's Sparrow (*Aimophila aestivalis*): This state endangered bird prefers pine forests, and lacks suitable habitat in the Fourteen Mile Creek/Goose Creek watersheds' predominantly deciduous forests. This may be contributing to the decline of the Bachman's Sparrow population.

Henslow's Sparrow (*Ammodramus henslowii*): The Henslow's Sparrow is listed as state endangered, and near threatened at the Federal level. This small sparrow prefers wet bushy habitat, which has been declining due to human development.

Cerulean Warbler (*Dendroica cerulean*): Known for its brilliant blue color, the Cerulean Warbler is a favorite of bird watching enthusiasts. Listed as endangered in Indiana, and vulnerable at the Federal level, this small bird prefers to nest and forage high in trees.

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

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

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

Mollusks:

Note: These species are found in the Ohio River, but are of interest to our project as our watersheds drain into the Ohio.

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

Longsolid Mussel (*Fusconaia subrotunda*): The Longsolid is a mollusk that is listed as endangered in Indiana. This mussel is often found in river gravel.

Fat Pocketbook (Potamilus capax): The Fat Pocketbook is listed as endangered in Indiana as well as federally. The decline in population is thought to be caused by dredging for flood control.

Insects:

Clark Cave Millipede (*Pseudotremia nefanda*): This state endangered species of millipede is only found in the watershed area. The Clark Cave Millipede is eyeless as it doesn't need sight in its preferred habitat.

A Dipluran (*Campodea plusiochaeta*): This state endangered hexapod is rarely seen because of its preference for a subterranean lifestyle.

Bousfield's spring amphipod (*Gammarus bousfieldi*): This very tiny arthropod is state endangered in Indiana. Because of its small size, it faces a variety of threats. Its main predators include stoneflies, salamanders, and many types of fish.

Mackin's cave amphipod (*Stygobromus mackini*): The Mackin's Cave Amphipod is listed as state endangered in Indiana. The small arthropod is light blue grey in water, and because of its sensitivity, is an excellent indicator of good water quality.

Cave Beetle (*Pseudanophthalmus barri*): The Cave Beetle is listed as endangered in Indiana. Part of one of 200 similar species, the beetle is eyeless and prefers cave habitats.

Vascular Plants:

Green Milkweed (*Asclepias viridis*): This species of milkweed is listed as state endangered. The Green Milkweed is commonly found in overgrazed pastures. Like other forms of milkweed, it is host to the monarch butterfly.

Black-stem Spleenwort (*Asplenium resiliens*): This distinctive fern is listed as state endangered for Indiana. Known for its distinctive black stripe, it is often found growing on limestone substrates.

Pretty Dodder (*Cuscuta indecora*): The Pretty Dodder is listed as endangered in Indiana. This parasitic flower can be identified by its yellow orange stems and white flowers.

Glades Spikerush (*Eleocharis bifida*): The Glades Spikerush is listed as endangered in Indiana, and as vulnerable nationally. The decline in population is likely due to the narrow preference in habitat. Glades Spikerush are only found in wet cedar glades.

Bluntleaf Spurge (*Euphorbia obtusata*): Although the Bluntleaf Spurge is listed as state endangered in Indiana, it is widely distributed across most of the United States.

2.2.7 Relevant Relationships

Relationships between watershed parameters are revealed when watershed data is examined as a whole. A general discussion of those relationships is included here. More detailed, subwatershed specific discussions are found in subsequent sections.

The extent of the karst topography in the Fourteen Mile Creek/Goose Creek watersheds presents us with challenges in our effort to minimize nonpoint source pollution. It is difficult to track the flow of underground, unfiltered streams, and where they may, or may not, be discharging into surface waters. This leaves much to guesswork in determining the amount of nonpoint source pollution present, and how exactly to prevent it. The fact that this same karst topography provides unique habitats for several endangered species within the watersheds makes the challenge of combating nonpoint source pollution both urgent and more difficult.

Highly erodible soils, highly sloped soil types, and conventional till agricultural practices can create a plethora of soil erosion issues. Unfortunately, all those things are present to some degree in the Fourteen Mile

Creek/Goose Creek watersheds. Reaching out to land owners to help reduce erosion is key. Encouraging them to use no-till practices, fence livestock out of streams, and generally working to implement best management practices will improve the overall water quality.

Development has encompassed some areas of the watersheds, and has altered much of the natural conditions. Moving forward, it will be important to keep a close eye on these areas to ensure that water quality is not further degraded.

2.2.8 Water Quality Introduction

In order to properly evaluate a watershed, an inventory and assessment of the watershed, as well as known existing information and data is needed. Examining previous and current water monitoring efforts, allows the project to have a better understanding of the water quality conditions and health of the watersheds. The following sections detail the water quality, and watershed assessment efforts.

One of the objectives of the project was to conduct biological, chemical, and habitat analysis at ten different sites in the watershed. The data from these analyses would be used to give insight to the current conditions of the watershed as a whole. In addition, results could easily be examined at the subwatershed level. Detailed information on each of the subwatersheds within the Fourteen Mile Creek/Goose Creek watersheds, including data results and analysis, HUC codes, and maps follows in Section 2.3 Watershed Inventory Summary of this plan. For a complete map of all subwatersheds, please refer to p. 19 of this plan. For each section below, data collected by the project will be referred to as current data.

In addition to data collected by the Fourteen Mile Creek/Goose Creek Watersheds project, other sources of historical data exist. Historical data is limited to that which has been gathered with the last fifteen years as anything prior would likely not reflect current land use. In addition, data older than five years is used for trend or reference data, as changes in the watersheds may have affected its relevance. Historical data comes from sources such as:

- Indiana Department of Environmental Management (IDEM) water quality data
- Indiana's 303(d) listing of impaired streams and water bodies
- National Pollutant Discharge Elimination System (NPDES) violation data

Historically, streams listed on IDEM's 303(d) list have prompted community involvement and concern in the Fourteen Mile Creek/Goose Creek watersheds. The term "303(d) list" is short for the list of impaired and threatened waters (stream/river segments, lakes) that the Clean Water Act requires all states to submit to the EPA for approval, every two years on even-numbered years. The states identify all waters where required pollution controls are not sufficient to attain, or maintain, applicable water quality standards, and establish priorities on the severity of the pollution, and the sensitivity of the uses to be made of the waters, among other factors. States then provide a long-term plan for completing load reductions within eight to thirteen years from first listing.

Figure 24 is the 2012 303 (d) list of impaired stream segments within the Fourteen Mile Creek/Goose Creek watersheds. This list is comprised of streams that fall into Category 5 on the IDEM Integrated Water

Monitoring and Assessment Report. Each entry has the impaired assessment unit ID and assessment unit name for stream reaches of the Fourteen Mile Creek/Goose Creek watersheds. The table also contains the cause of impairment for those reaches, and the category of impairment. The categories from IDEM's Integrated Water Monitoring and Assessment Report are organized as follows:

- Category 1- Attaining the water quality standard and other applicable criteria for all designated uses and no use is threatened.
- Category 2- Attaining some of the designated uses; no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.
- Category 3- Insufficient data and information is available to determine if any designated use is attained.
- Category 4- Impaired or threatened for one or more designated uses, but does not require the development of a total maximum daily load (TMDL).
    A. A TMDL has been completed that is expected to result in attainment of all applicable water quality standards and has been approved by U.S. EPA.
    B. Other pollution control requirements are reasonably expected to result in the attainment of the water quality standards in a reasonable period of time.
    C. Impairment is not caused by a pollutant.
- Category 5 (all streams in this category make up the 303d list)- The water quality standards or other applicable criteria are not attained and require a TMDL.
    A. The waters are impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL.
    B. The waters are impaired due to the presence of mercury or PCBs, or both in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants.

Four segments within Fourteen Mile Creek/Goose Creek watersheds were listed on the 2012 303(d) list of impaired streams at the inception of our project. They are the segments on which we based the selection of our sampling sites, and formed the core of our project research and plan development. These segments are shown below in Figure 24.

Figure 24: 303(d) Listings in the Fourteen Mile Creek/Goose Creek Watersheds

ASSESSMENT UNIT ID	ASSESSMENT UNIT NAME	CAUSE OF IMPAIRMENT	CATEGORY
INN0174_02	Rogers Run-Fourteen Mile Creek	E.coli	5A
INN017A_00	Yankee Creek	E.coli	5A
INN0171_T1002	Fourteen Mile Creek, East Fork, Unnamed tributary	dissolved oxygen, E.coli, impaired biotic communities	5A
INN0179_00	Dry Branch-Fourteen Mile Creek	E.coli	5A

Since the inception of our project, IDEM has identified additional stream segments as impaired within our watersheds. Those segments are given below in Figure 25, and appear on the 2014 303(d) list:

Figure 25: Additional Streams Added to the 303(d) List in the Fourteen Mile Creek/Goose Creek Watersheds

ASSESSMENT UNIT ID	ASSESSMENT UNIT NAME	CAUSE OF IMPAIRMENT	CATEGORY
INN0143_03	Fourteen Mile Creek	E.coli	5A
INN0144_T1004	Big Branch	E.coli	5A
INN0163_01	Bull Creek	Dissolved oxygen, E.coli	5A
INN0165_04	Lancassange Creek	E.coli	5A
INN0165_05	Lancassange Creek	E.coli	5A

We have considered the information on these segments, and discussed it in the appropriate subwatershed section.

The goal of the Fourteen Mile Creek/Goose Creek Watershed Management Plan is for all stream reaches to meet water quality standards. This can be accomplished by confirming existing impairments, recognizing other impairments if found, and identifying the sources and causes of those impairments. The work expressed within this document will strive to do that, as well as to identify action strategies, and management techniques to address these impairments.

Since some point source units can discharge pollutants into streams, it is important to note their location when managing watersheds. Figure 26 details the locations of National Pollutant Discharge Elimination System (NPDES) permits in the Fourteen Mile Creek/Goose Creek watersheds. Figure 27 provides available compliance data for the NPDES facilities and pipes mapped in Figure 26.

Figure 26: NPDES Facilities and Pipes in the Fourteen Mile Creek/Goose Creek Watersheds

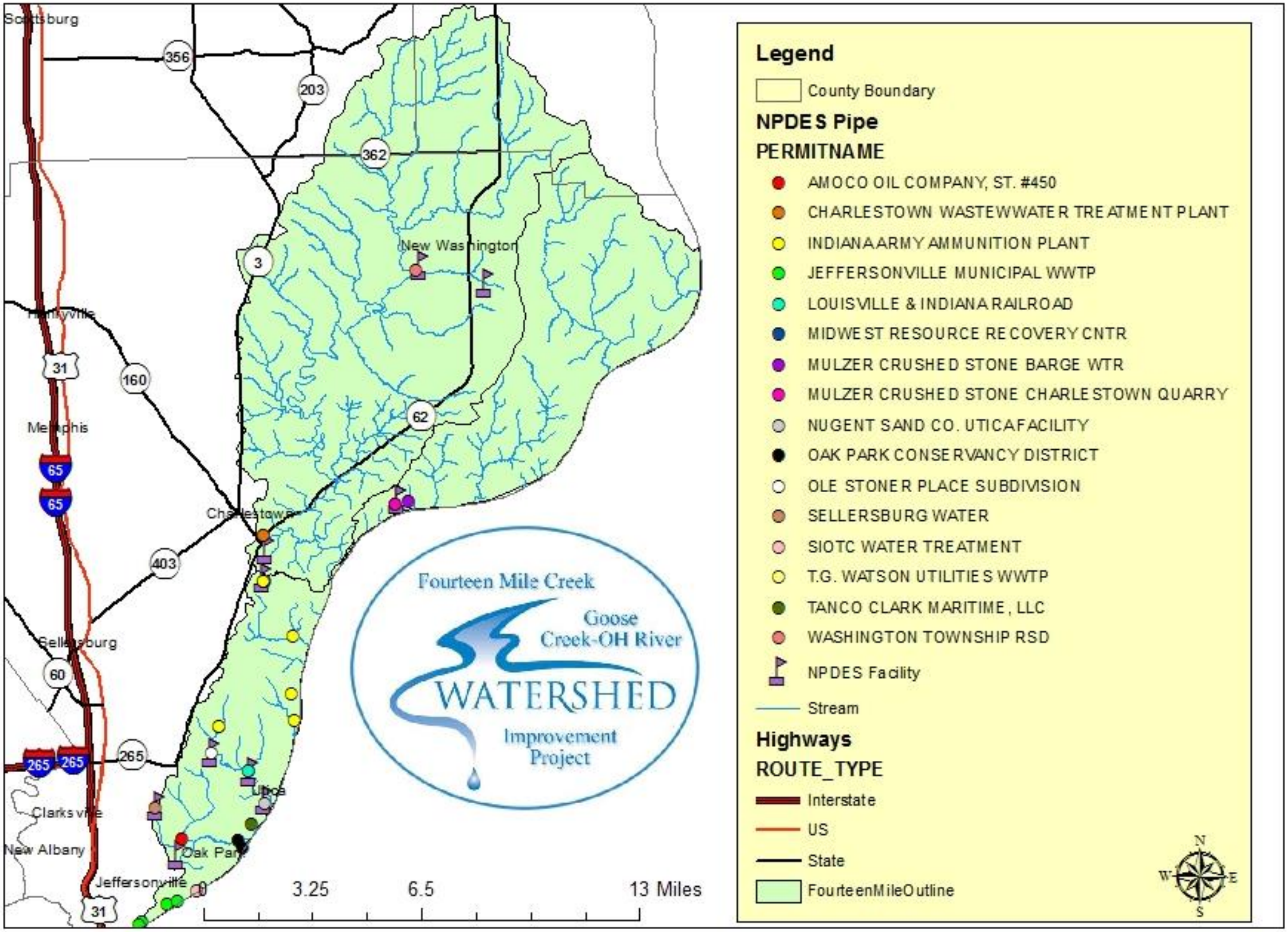


Figure 27: NPDES Facilities and Pipes in the Fourteen Mile Creek/Goose Creek Watersheds Details

NPDES Permit Name NPDES ID# Current Permit Status	Subwatershed Location	Quarters (out of 12) of Noncompliance Last 3 Years	Current Violation Status	Effluent Exceedances
AMOCO Oil Company, ST. #450 **ING080016** **Terminated**	Lentizier Creek	Not available	Not available	Not available
Charlestown Wastewater Treatment Plant **IN0020508** **Effective**	Dry Branch-Fourteen Mile Creek	3	No violation	0
Indiana Army Ammunition Plant **IN0001163** **Terminated**	Lentizier Creek	Not available	Not available	Not available
Jeffersonville Municipal WWTP **IN0023302** **Effective**	Lentizier Creek	12	8 minor violations out of 87 parameters monitored	8
Louisville & Indiana Railroad **IN0061875** **Effective**	Lentizier Creek	5	1 minor violation out of 7 parameters monitored	7
Midwest Resource Recovery CNTR **ING340024** **Terminated**	Dry Branch-Fourteen Mile Creek	Not available	Not available	Not available
Mulzer Crushed Stone Barge Water **IN0060194** **Effective**	Bull Creek	2	In violation	4
Mulzer Crushed Stone Charlestown Quarry **IN0053571** **Effective**	Bull Creek	1	No violation	0
Nugent Sand Co. Utica Facility **IN0061549** **Effective**	Lentizier Creek	0	No violation	0
Oak Park Conservancy District **IN0023965** **Effective**	Lentizier Creek	2	No violation	0
Ole Stoner Place Subdivision **IN0050512** **Terminated**	Lentizier Creek	Not available	Not available	Not available
Sellersburg Water **IN0049212** **Effective**	Lentizier Creek	3	No violation	3
SIOTC Water Treatment **IN0060224** **Effective**	Lentizier Creek	0	No violation	0
T.G. Watson Utilities WWTP **IN0057177** **Terminated**	Lentizier Creek	Not available	Not available	Not available
Tanco Clark Maritime, LLC **ING340059** **Effective**	Lentizier Creek	1	No violation	0
Washington Township RSD **IN0109533** **Effective**	Rogers Run-Fourteen Mile Creek	6	No violation	0

2.2.9 Data and Targets

In considering a plan for monitoring, the first step is to establish a set of targets in order to determine whether a result is acceptable or unacceptable. There are various targets levels for water depending on use. Drinking water targets are very stringent because of the implications to human health. For the purposes of this project, the typical use targets selected should be more representative of an aquatic habitat standard. Having water that the community feels safe to recreate in and come into full body contact with, and that provides resources for wildlife to thrive in, is the goal in choosing benchmarks for water quality data.

Figure 28: Water Quality Targets for Measured Parameters

Parameter	Target	Reference
pH	> 6 and < 9	Indiana Administrative Code (327 IAC 2-1-6)
Temperature	Monthly standard	Indiana Administrative Code (327 IAC 2-1-6)
Dissolved oxygen	> 4 mg/L and < 12mg/L	Indiana Administrative Code (327 IAC 2-1-6) & Consolidated Assessment and Listing Methodology (CALM)
Biochemical Oxygen Demand 5-day	< 2 mg/L	University of Wisconsin (2011)
E. coli	5 week Geometric mean <125 cfu /100mL	Indiana Administrative Code (327 IAC 2-1.5-8)
Nitrate-nitrogen	< 1.5 mg/L	Dodds et al. (1998)
Nitrite	< 1 mg/L	Indiana Administrative Code (327 IAC 2-1-6)
Orthophosphorus	< 0.05 mg/L	Dunne and Leopold (1978)
Total Phosphorus	< 0.07 mg/L	Dodds et al. (1998)
Turbidity	< 25 NTU	Minnesota TMDL criteria (2001)
Citizens Qualitative Habitat Evaluation Index	> 60 points	Hoosier Riverwatch (2008)
Water Quality Index	> 69%	Hoosier Riverwatch (2012)
Pollution Tolerance Index	>16 points	Hoosier Riverwatch (2012)
Macroinvertebrate Index of Biotic Integrity (mIBI)	> 35	Indiana Administrative Code (327 IAC 2-1-3) and Sobat et al (2006)

After selecting appropriate targets and parameters, the next task is choosing sampling sites that are representative of the watershed being considered. All subwatersheds were driven, however we were unable to find a location in each of them that could be easily accessed, and could provide an element of safety for our volunteers. We did not want volunteers sampling in remote conditions where they would not have phone service if something happened, or where streambank conditions were perilous enough to risk injury. Multiple sites were selected in the Rogers Run and Dry Branch-Fourteen Mile Creek subwatersheds in an effort to determine the source of E.coli impairment in the 303(d) list streams within them. These sites were positioned above, below, and at confluences near the impaired segments.

Sites were tested monthly for chemical data using Hoosier Riverwatch (HRW) methods from March 2014 to December 2015, and for biological and habitat data twice annually (once in 2014 and once in 2015) during the life of the project. HRW volunteers also collected geometric mean samples for E.coli in late September/early October 2014, and late May/early June 2015.

Additionally, samples were collected annually by a team from the University of Louisville, Department of Biology lab (Louisville, KY), and were tested for chemical, and biological and habitat data as follows (excerpted from the subcontract between the Clark County SWCD and University of Louisville, Department of Biology lab):

Water quality monitoring: Contractor will *"conduct a monitoring program to assess Indiana Department of Environmental Management's Core Parameters. The contractor shall sample once (1) yearly for two (2) years at ten (10) predetermined sites in the watershed for pH, dissolved oxygen, temperature, nitrate+nitrite, orthophosphates, chloride, total suspended solids, total dissolved solids, turbidity, and flow."*

Biological monitoring: Contractor will *"conduct stream macroinvertebrate sampling once (1) yearly for two (2) years at ten (10) predetermined sites in the watershed. The contractor shall analyze the collected community using the State of Indiana's macroinvertebrate Index of Biotic Integrity (mIBI). The contractor shall conduct a habitat assessment during the biological sampling activities at each of the (10) sites using the State of Indiana's Qualitative Habitat Evaluation Index (QHEI)."*

University of Louisville valued their services at $8,720, but agreed to reimbursement of $5,000; any costs exceeding $5,000 would be provided by the University as in-kind services. Professional sampling events coincidentally occurred one year to the date from each other – July 25, 2014 and July 25, 2015.

It should be noted that 2014 was a "wet" year, and our sampling sites experienced flash flooding conditions during that period. The tributaries that Sites 1 and 3 are located on feed directly into the Ohio River, however, back water was not a factor at any time they were sampled, nor was it at any of the other sites.

The following Figure 29 displays a map of the ten testing site locations. Figure 30 details each testing site location, whether a corresponding IDEM site exists at the location, the rationale behind the site's selection, and the site's 12-digit HUC identifier.

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Figure 29: Location of Sampling Sites for the Fourteen Mile Creek/Goose Creek Watershed Project

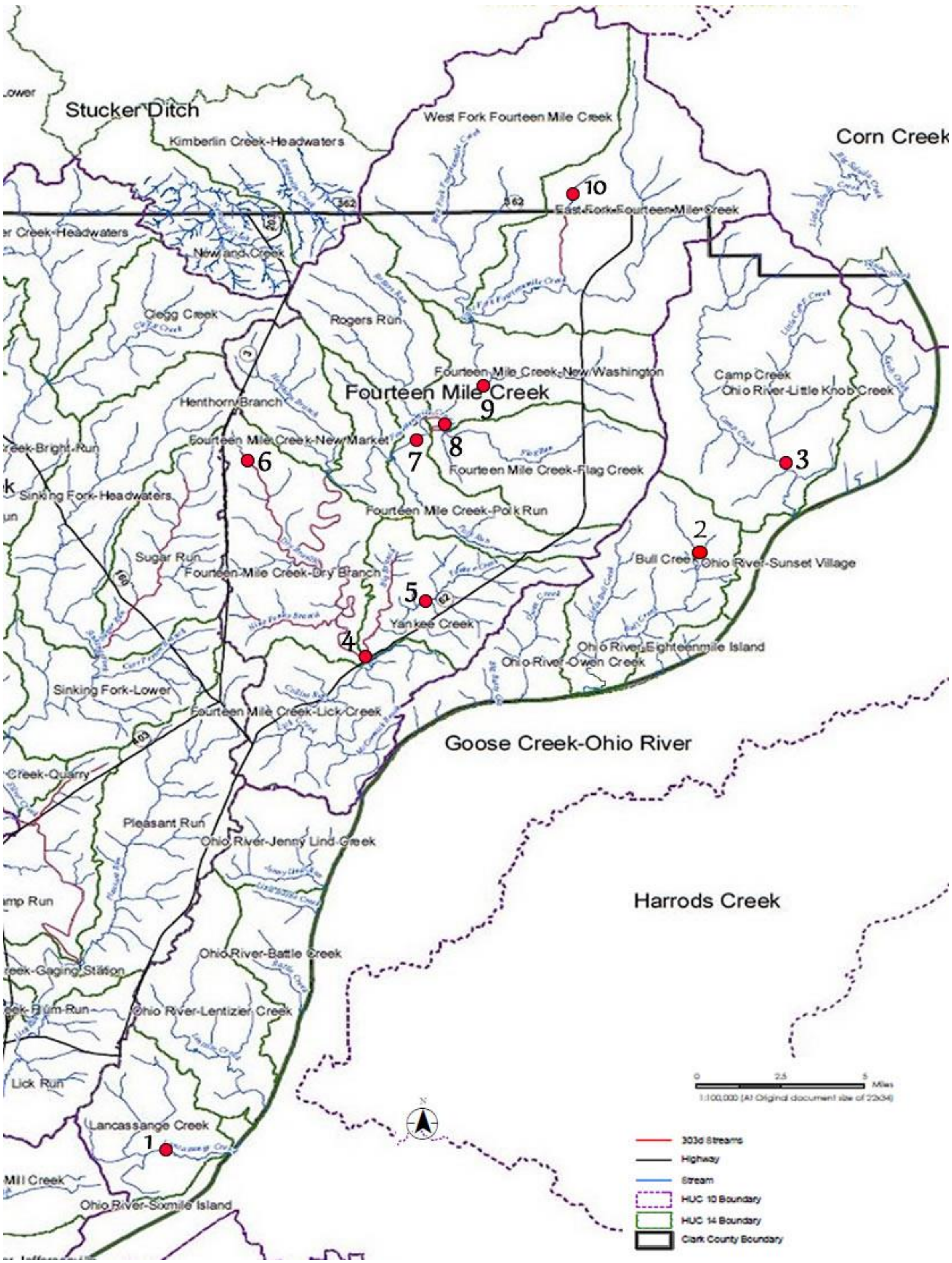


Figure 30: Fourteen Mile Creek/Goose Creek Sample Site Locations, Coordinates, Subwatersheds, and Descriptions

Site #	IDEM Site #	Physical Location & Watershed Location	Rationale	Coordinates	Subwatershed HUC
1	OSK100-0001	Bridge on Allison Lane near Jeffersonville Fire Station, and intersection of Middle Road. Lancassange Creek; 051401010605	Highly populated, growing business area; next to a re-claimed Brownfield site; southernmost location in Goose Creek watershed	38.228N 85.7075W	051401010605
2	OSK-06-0003	Bridge at 4308 Blue Ridge Rd., Charlestown; Bull Creek	Close to IDEM sampling site OSK060-0001 on Bull Creek in Goose Creek Watershed	38.488465N 85.499575W	051401010603
3		Bridge on Flintridge Road at the intersection with Bethlehem Rd. 051401010601; Confluence of Camp Creek and Little Camp Cr.	Confluence of Camp Creek and Little Camp Creek in Goose Creek Watershed	38.7569N 85.5872W	051401010601
4	OSK070-001	Bridge on Tunnel Mill Road 051401010604; Confluence of Nine Penny, Big Branch, and Dry Branch	Confluence of Nine Penny, Big Branch, and Dry Branch which were on 2012 303 (d) streams for E. Coli	38.665N 85.8456W	051401010604
5		Bridge on Salem Church Road 051401010404; Confluence of Yankee Creek and two unnamed tributaries	Confluence of Yankee Creek and two unnamed tributaries - livestock area	38.515N 85.765W	051401010404
6		Bridge on Gum Corner Road 051401010404; Fourteen Mile Creek-Dry Branch	2012 303 (d) stream for E.coli	38.7311N 85.8358W	051401010404
7	OSK070-00002	Bridge on Zimmerman Road east of New Market Rd. 051401010403; Confluence of Polk Run and Fourteen Mile Cr.	On the 2000 Corvallis list; confluence of Polk Run and Fourteen Mile Creek	38.695N 85.7392W	051401010403
8	OSK070-0014	Bridge on New Market Road north of Faye Amick Road 051401010403; Rogers Run-Fourteen Mile Creek	2012 303 (d) stream for E. coli	38.6981N 85.6511W	051401010403
9		Bridge on Westport Road close to intersection of New Market Road 051401010403; Confluence of West Fork of Fourteen Mile and Fourteen Mile	Accessible segment west of the Wastewater Treatment plant for New Washington and at the confluence of West Fork of Fourteen Mile Creek and Fourteen Mile Creek	38.6044N 85.6769W	051401010403
10	OSK07-0015	Bridge on 362 west of State Rd 62 between Frank Fisher and Kettle Bottom Road; 051202070502; Fourteen Mile Creek, East Fork-Unnamed tributary	2012 303(d) stream segment, E. coli, Dissolved Oxygen and IBC	38.7N 85.6769W	051202070502

Historical data collected by IDEM's Assessment branch is considered in conjunction with our project's results in the appropriate subwatershed section. IDEM sampled several locations in the Fourteen Mile Creek/Goose Creek watersheds in 2000, 2005, and 2010, as part of their rotating basin/probabilistic monitoring program. IDEM's Probabilistic Monitoring Program samples at least 38 randomly selected sites in a given basin and is the primary source of data used in IDEM's Clean Water Act assessments. This program, which focuses specifically on rivers and streams, is designed to characterize the overall environmental quality of each major river basin and to identify those monitored waterbodies within each basin that are not fully supporting their beneficial designated uses. The results of IDEM's monitoring program are given in Figure 31 below.

Figure 31: 2000, 2005, and 2010 Results of IDEM's Basin/Probabilistic Monitoring in the Fourteen Mile Creek/Goose Creek Watersheds

HUC	SITE ID	WATERBODY NAME	YEAR	PARAMETERS	NOTES
51401010401	OSK070-0003	East Fork Fourteen Mile Creek	2000	Chemistry	No water quality standard violations. Nitrate and total phosphorus exceeded project targets.
51401010403	OSK070-0002	Fourteenmile Creek	2000	Chemistry, Fish, Macroinvertebrates	No water quality standard violations. Nitrate and total phosphorus exceeded project targets.
51401010403	OSK070-0005	Fourteenmile Creek	2000	E. coli	No water quality standard violations.
51401010404	OSK070-0001	Yankee Creek	2000	Chemistry, Fish	Fish IBI did not meet water quality standards, but segment was not designated as impaired. Nitrate and total phosphorus exceeded project targets.
51401010404	OSK070-0011	Fourteenmile Creek	2000	E. coli	E. coli geomean did not meet water quality standards and segment is designated as impaired.
51401010401	OSK070-0015	Tributary of East Fork Fourteenmile Creek	2005	Chemistry, E. coli, Fish	E. coli, dissolved oxygen, and fish IBI did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.
51401010403	OSK070-0014	Fourteenmile Creek	2005	Chemistry, E. coli, Macroinvertebrates, Fish	E. coli geomean did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.

HUC	SITE ID	WATERBODY NAME	YEAR	PARAMETERS	NOTES
51401010403	OSK070-0018	Fourteenmile Creek	2010	Chemistry, E. coli, Macroinvertebrates, Fish	E. coli geomean did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.
51401010603	OSK060-0001	Bull Creek	2010	Chemistry, E. coli, Macroinvertebrates, Fish	E. coli and dissolved oxygen did not meet water quality standards and segment is designated as impaired.
51401010605	OSK100-0001	Lancassange Creek	2010	Chemistry, E. coli, Macroinvertebrates, Fish	E. coli geomean did not meet water quality standards and segment is designated as impaired.

2.2.9.1 Monitoring Parameters - Nitrogen

Nitrogen is the earth's fifth most common element, and makes up roughly 78 percent of the air we breathe. It exists as a gas, or as organic nitrogen found in proteins, which is recycled by plants and animals. The largest use of nitrogen is for the production of ammonia (NH_3), which is a major component of fertilizers.

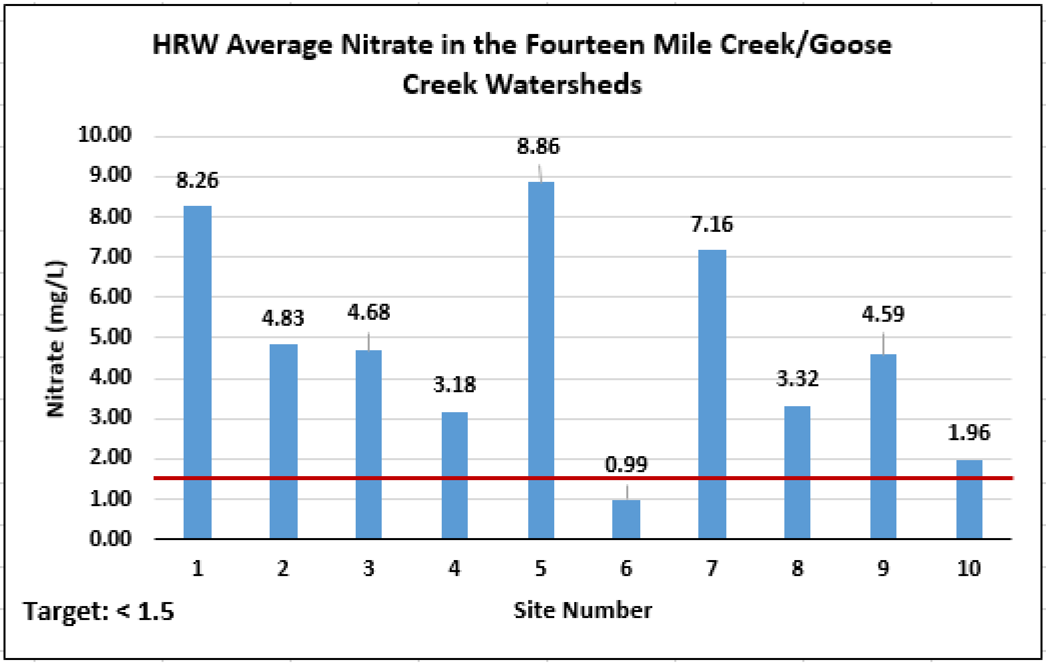
The forms of nitrogen that may exist in water are: nitrate, nitrite, ammonia, and organic nitrogen. Nitrate is the inorganic form of nitrogen. Nitrite is a dissolved form of nitrogen that is converted quickly to nitrate by bacteria in surface water, therefore, nitrate and nitrite are often combined when water samples are analyzed.

Although nitrogen is essential as a plant nutrient, too much in streams and lakes can cause significant water quality issues. Paired with phosphorus, nitrates in excess can cause eutrophication (a dramatic increase in aquatic plant growth). This in turn affects levels of dissolved oxygen available to aquatic species, increases temperature, and can have catastrophic effects on the ecosystem. In heathy systems, the natural level of nitrate in surface watershed is less than 1 mg/L.

Nitrates can be found everywhere - in animal wastes, in the effluent from wastewater treatments plans, in runoff from fertilized lawns or cropland, in failing septic fields, and in discharges from car exhausts. Watersheds with a high percentage of tile-drained agricultural land often have particularly high levels of nitrate. In addition to having many sources, nitrates are highly mobile in the waters. They can be passed through soil layers into underground water sources, leeched from fertilizers on the surface, and discharged from cave systems.

Currently, a standard for nitrate concentration in surface water that is not being used as a public water supply does not exist. The Indiana water quality standards available at this time state that nitrate+nitrite-nitrogen levels in surface water are not to exceed a 30-day average of 10 mg/L at a public water supply intake (327 IAC 2-1-6). The nitrate+nitrite reference condition for USEPA Aggregate Ecoregion IV, Ecoregion 71 is 1.2 mg/L and is based on median nitrate+nitrite concentrations for the top 25th percentile of streams sampled (2000). It has been shown that streams that have available phosphorous will experience eutrophication when nitrate levels exceed 1.5 mg/L. For this reason, 1.5 mg/L was set as the upper limit for the nitrate water quality target for this project. The data presented in Figure 32 represents average nitrate values in the Fourteen Mile Creek/Goose Creek watersheds that were collected during the project.

Figure 32: Average Nitrate Values in the Fourteen Mile Creek/Goose Creek Watersheds



HRW volunteers tested for the presence of nitrites in the samples they collected over the course of this project, however, there were no noticeable traces of nitrites found in the watersheds; professional sampling did not analyze for nitrate and nitrite separately. All data values were calculated by averaging the monthly values over the course of the sampling period. All sites except Site 6 had average values that exceeded the 1.5 mg/L target. We would attribute this to the topography of Site 6 as the land lays low in this area, keeping it wetter longer than other areas, and thus, making it unconducive to profitable row-cropping, and the resulting applications of fertilizer. Site 6 is also in a rural area, so application of fertilizers to lawns would be unexpected. All other sites, with the exception of Site 1, are in agricultural production areas where fertilization of fields would be commonplace. Site 1 is in a highly residential/commercial area, and therefore, would be subject to runoff from the fertilization of lawns.

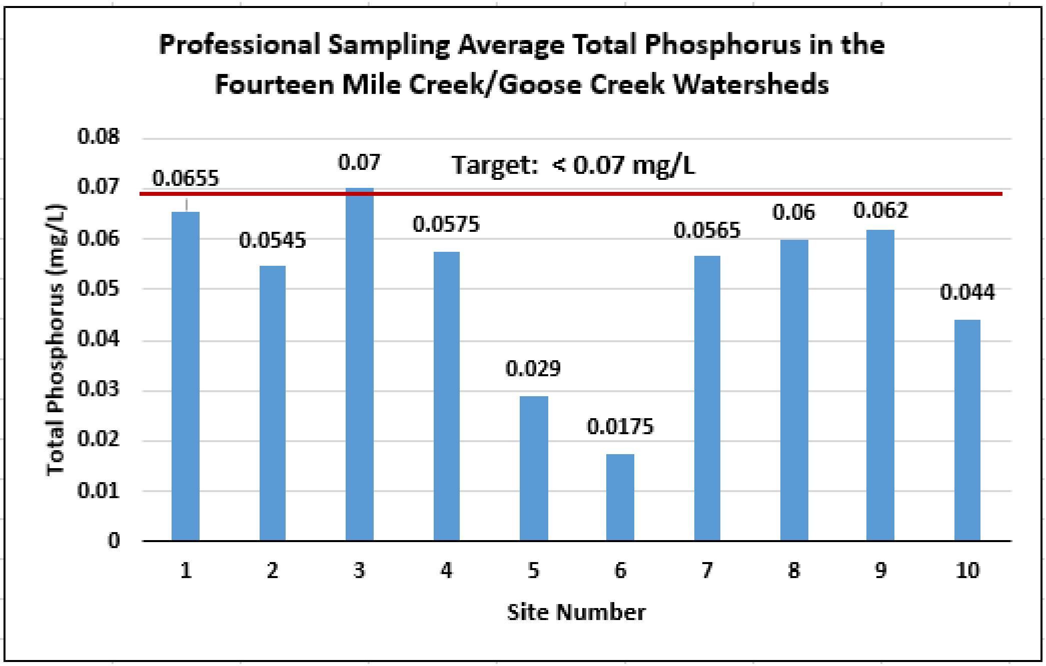
2.2.9.2 Monitoring Parameters – Phosphorus

Phosphorus is a naturally occurring nutrient essential to plants and animals in all aquatic systems, however it is the one commonly found in short supply in most fresh waters. Therefore, when even a minor increase in phosphorus occurs, water quality can quickly degrade, and eutrophication can result. Eutrophication leads to higher water temperature and lower dissolved oxygen, which stresses aquatic life and often results in fish kills. There are many sources that can contribute to elevated phosphorus levels in aquatic systems: runoff from fertilized lawns and cropland, human/animal waste, disturbed land areas, drained wetlands, and industrial waste discharges.

Phosphorus is found in three forms in water: 1) organic – which is bound to plant or animal tissue, 2) inorganic – or orthophosphates – that is most available to aquatic organisms, and 3) polyphosphates – a complex inorganic form. Though orthophosphate is the only form readily available to algae or aquatic plants, the other forms can be converted to it. A measure of all three – total phosphorus – is the best indicator of eutrophication potential. Measuring total phosphorus requires a lab, therefore, total phosphorus was measured only during the professional samplings completed during this project. Volunteers used HRW methods, which do not require a lab, to measure orthophosphate during monthly samplings. Measurements of orthophosphate indicate the amount of phosphorus that is already available for plant growth.

An Indiana water quality standard for phosphorus currently does not exist. It has been determined that the dividing line between mesotrophic and eutrophic streams is a total phosphorus concentration of 0.07 mg/L (Dodds et al. 1998), or an orthophosphate concentration of 0.05 mg/L (Dunne and Leopold, 1978). For this reason, < 0.07 mg/L was chosen as the target concentration for total phosphorus, and < 0.05 mg/L as the target concentration for orthophosphate in streams within Fourteen Mile Creek/Goose Creek watersheds. The data presented below in Figure 33 represents the average total phosphorus values obtained during the professional monitoring events. All sites met the target with the exception of site 3, which was borderline at 0.07 mg/L.

Figure 33: Average Total Phosphorus Values in the Fourteen Mile Creek/Goose Creek Watersheds



During the HRW sampling events, there were no significant amounts (average of 0 at all 10 sites) of orthophosphate detected in the Fourteen Mile Creek/Goose Creek watersheds.

2.2.9.3 Monitoring Parameters - Turbidity

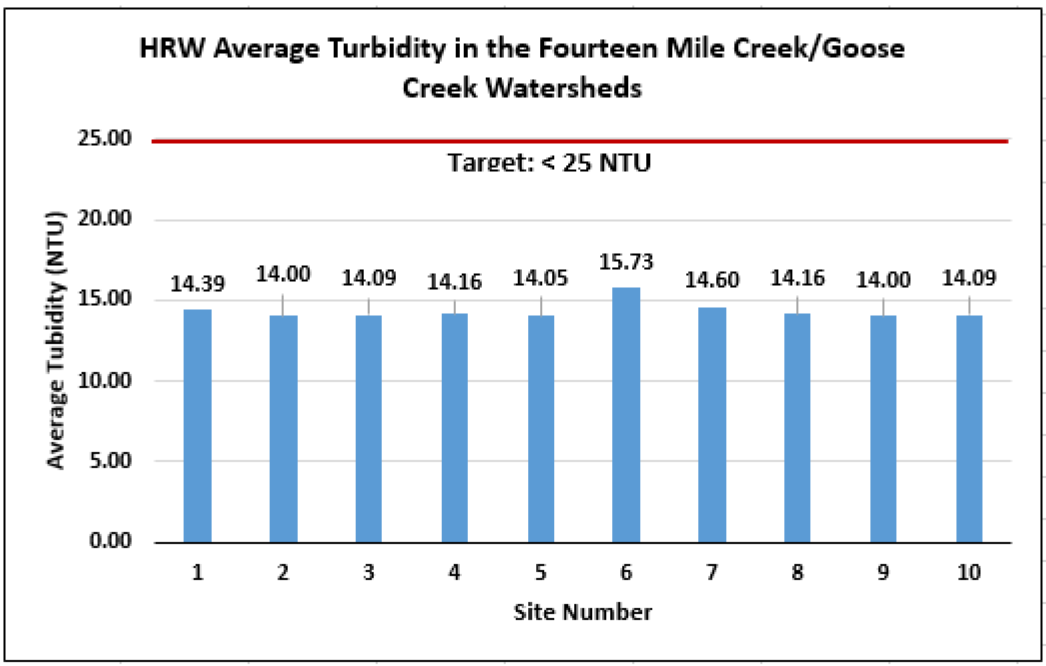
Turbidity is a measure of water clarity that is done by measuring the scattering and shadowing effect on light shining through the water. Higher turbidity can increase water temperature, because suspended particles absorb more heat. When temperature in the water increases, the concentration of oxygen decreases, because warm water holds less dissolved oxygen than cold water. In addition to affecting temperature and oxygen, higher turbidity reduces the amount of light able to penetrate the water thereby reducing photosynthesis. Finally, suspended materials can clog fish gills, making the fish less resistant to disease, slowing their growth rate, and affecting their egg and larval development.

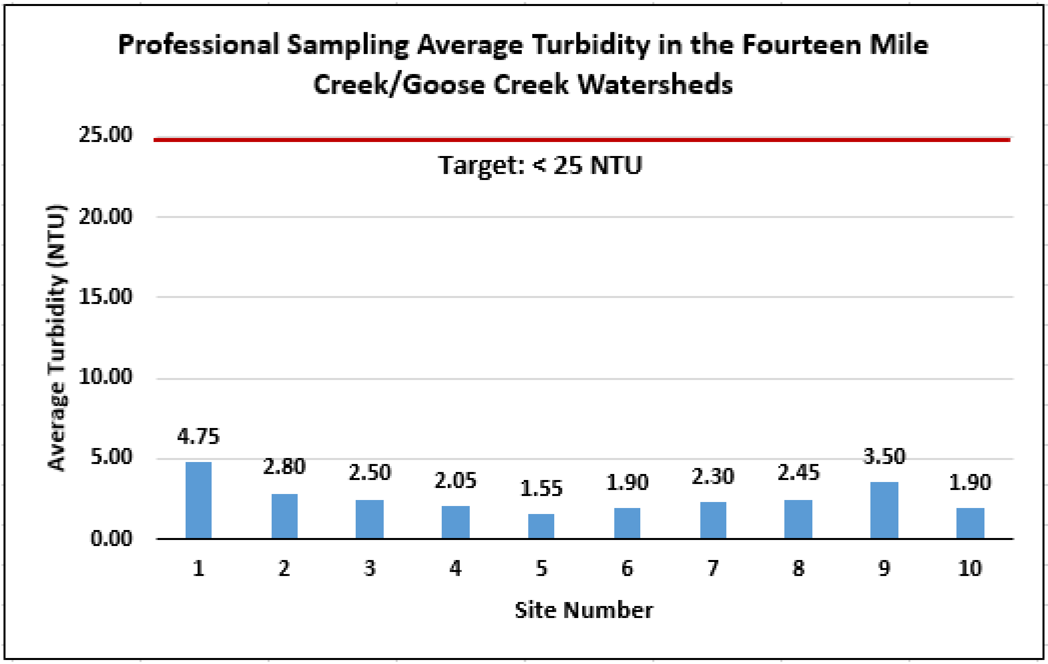
Turbidity can result from soil erosion, waste discharge, runoff from urban areas, a high population of bottom feeders (which stir up bottom sediments), and excessive algae. High turbidity values can often be an indicator of the effects of runoff from construction, development, agricultural practices, or logging activity. After a large amount of rain, turbidity often increases dramatically due to increased flow and disturbances.

HRW volunteers for this project measured turbidity using a transparency tube, which gives results in centimeters; centimeters are then converted to Nephelometric Turbidity Units (NTU). The average turbidity value for Indiana surface water is 36 NTU (IDNR, 2008). The turbidity reference condition for USEPA Aggregate Ecoregion VI, Ecoregion 71 is 7.0 NTU, which is based on turbidity concentrations for the top 25th percentile of streams sampled (2000). The top 25th percentile consisted of streams with the lowest turbidity levels. There is little in the way of concrete parameters and targets for turbidity due to the variance in stream conditions, and lack of research to date. However, in a study done by the state of Minnesota for their TMDL reports, streams that had a turbidity reading greater than 25 NTU were found to have a negative effect on wildlife and water quality. For this reason the project target was selected to be less than 25 NTU. Figure 34 presents the average turbidity results for the HRW and professional samplings.

Figure 34: Average Turbidity in the Fourteen Mile Creek/Goose Creek Watersheds

Please note: Volunteer sampling was done using a transparency tube; professional sampling used a meter.





With one exception, none of the test sites in the Fourteen Mile Creek/Goose Creek watersheds had average values that exceeded the project target of 25 NTUs during volunteer sampling. Site 6 did exceed the target on one occurrence (5/20/2014). Volunteers noted that there was a considerable amount of vegetative debris in the stream on this day, so much so that they could almost walk on the debris and not touch water. All samples taken from Site 6 following this day fell below target. There were no other occurrences where a site exceeded the 25 NTU target. No sites exceeded the target in the two professional samplings.

In examining the charts above, there appears to be quite a discrepancy between the results of the HRW and professional samplings. We feel this is attributed to the following factors:

- Professional samplers used a turbidity meter – an electronic device designed for utmost accuracy – as opposed to HRW volunteers who relied on their eyesight (and how good or bad that might be) to determine how well they could see through a turbidity tube. The HRW Manual (pg. 18) states: *"The reliability of water quality data depends on its accuracy and precision. Both tend to increase when more sophisticated technologies are used."* Therefore, we would expect discrepancy.
- Professional samplers measured turbidity only two times, and those two times coincidentally occurred on the same date, one year apart. HRW volunteers measured turbidity at each monthly sampling event. The HRW Manual (pg. 18) states: *"The water flowing past a point in the stream constantly changes. Taking multiple measurements and averaging the values captures some of the natural variation and provides a more representative result."*
- HRW values for turbidity, after conversion from centimeters to NTUs, resulted in values <15 NTUs the majority of the time. In creating our chart, we use "14" to represent the <15 value. These, when averaged with the few higher results recorded, resulted in a higher overall average than the average of the two professional samplings.

2.2.9.4 Monitoring Parameters – Escherichia coli (E. coli)

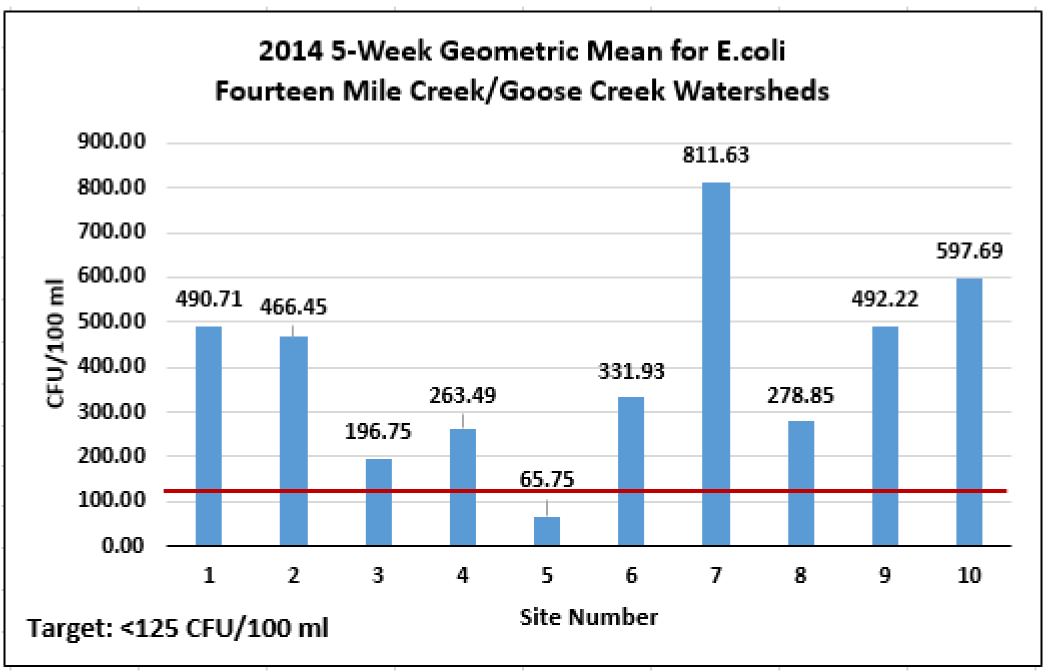
Escherichia coli (E. coli) is a fecal coliform bacteria that is found in the feces of many warm-blooded animals, including humans, livestock, and waterfowl. This specific species of fecal coliform bacteria is used in many states in water quality testing. The US EPA has determined that E. coli bacteria populations above 235 colonies per 100mL indicates that more than eight out of a thousand people who come in contact with the water may become sick.

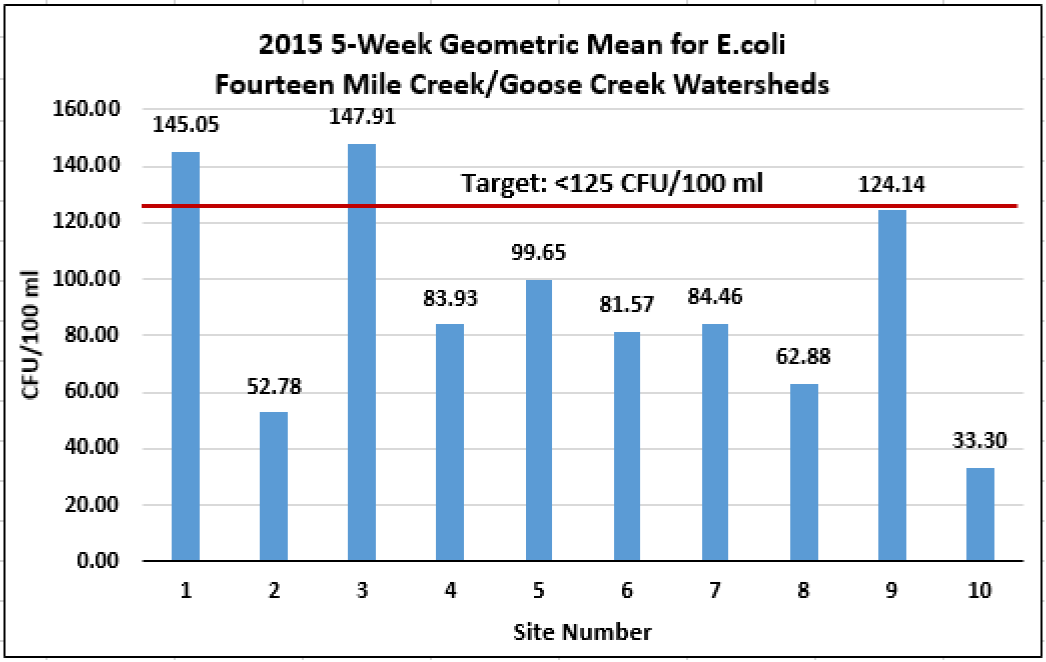
E. coli levels that are too high often occur throughout the year, though Indiana's water quality limit only applies to the recreation season (April through October) when the chance of someone coming into contact with unsafe water is highest. Sources of E. coli in the watershed include human waste resulting from failing septic systems, combined sewer overflows, and sanitary sewer overflow bypasses; and animal waste resulting from wildlife having direct access to water, and urban and agricultural runoff occurring from pets and livestock.

Over the years, there have been many attempts to differentiate E. coli from that of humans and of animals. While possible, the technology and resources to do so go far beyond a nonpoint source pollution project. Streams often contain a variety of species of bacteria, viruses, protozoa, fungi, and algae, most of which occur naturally, and pose little risk to human health.

This project adopted the 5-week geometric mean target defined in Indiana Administrative Code (327 IAC 2-1.5-8) for E. coli concentrations in water. In a 5-week time frame the geometric mean of E.coli per 100mL is not to exceed 125 colonies per 100mL. This target is an Indiana Water Quality Standard for E.coli during the recreational season. Figure 35 below details the results of the 5-week annual E. coli sampling in the Fourteen Mile Creek/Goose Creek watersheds.

Figure 35: 2014 and 2015 5-Week Geometric Means for E.coli in the Fourteen Mile Creek/Goose Creek Watersheds





E.coli bacteria live in soil naturally and can attach to sediment particles, which leaves their concentrations vulnerable to the effects of weather and season, and therefore, difficult to predict at any one time. Bacteria numbers often increase following a heavy storm, snow melt, or other runoff events when the streambed is stirred up by increased flow. Runoff itself can carry bacteria with it, adding to concentrations. In our samplings, much higher counts were recorded during the wet weather of the 2014 sampling period (9/23-10/21/14), than in the dryer weather of the 2015 period (5/20-6/16/15). Only Site 5 fell below the 125 CFU/100 ml target in 2014, while all but two sites (Site 1 and 3) met the target in 2015.

2.2.9.5 Monitoring Parameters – Dissolved Oxygen and Biochemical Oxygen Demand

In an aquatic system there is a natural exchange and production of oxygen. The system gains oxygen from the atmosphere and from plants via photosynthesis. The system loses oxygen by aquatic organisms through respiration, decomposition, and from various chemical reactions. Oxygen is measured in an aquatic system in its dissolved form as dissolved oxygen (DO). The amount of dissolved oxygen consumed by organisms in decomposing organic matter is known as biochemical oxygen demand (BOD).

If more oxygen is being consumed than either produced or available in the aquatic system, dissolved oxygen levels decline, and loss of aquatic life can occur. Dissolved oxygen fluctuates not only seasonally, but also within a 24-hour period. This is because oxygen capacity in water varies with water temperature and photosynthesis/respiration cycles. Generally, colder water holds more oxygen than warmer water, and water holds less oxygen at higher altitudes. Hoosier Riverwatch's Volunteer Monitoring Training Manual states that DO typically ranges from 5.4 to 14.2 mg/L, with the Indiana average being 9.8 mg/L. DO levels below 4 mg/L are stressful to aquatic life, and levels below 2 mg/L will not support fish.

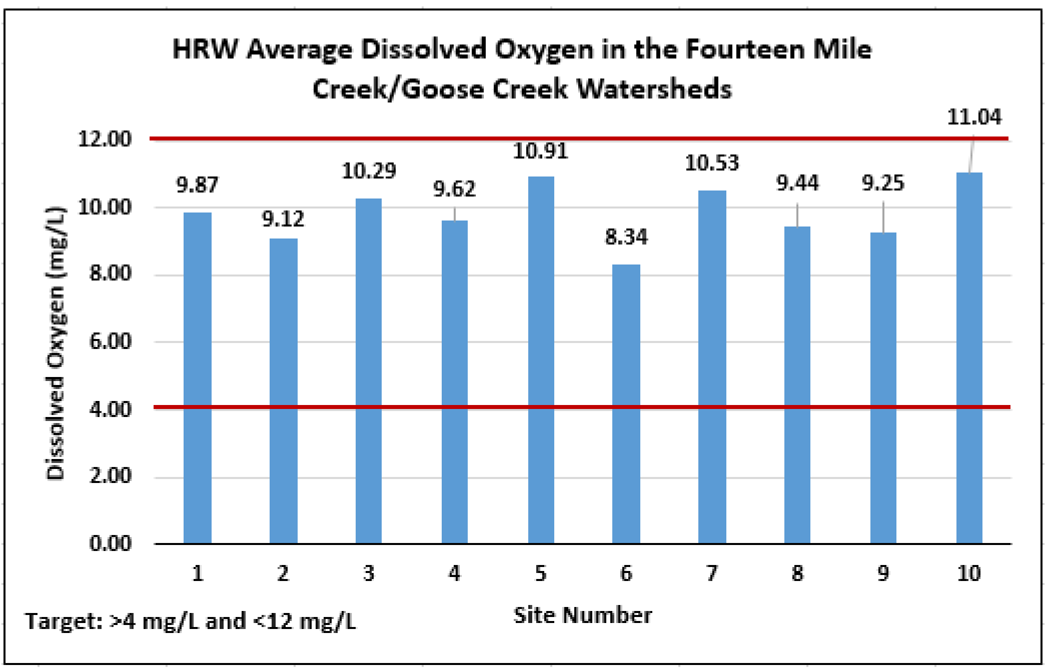
BOD is directly related to, and affects, the amount of dissolved oxygen in the aquatic systems. The greater the BOD, the more rapidly oxygen is being used up from the system. This means that less oxygen is available for higher forms of aquatic life. However, the consequences of too high BOD in a system are the same as too low DO. Without proper levels, organisms may become stressed and die. Sources of organic wastes that influence

BOD levels include leaves, woody debris, deceased plants, decomposing animals, manure, effluent from wastewater treatment plants, failing septic systems, and urban storm water runoff.

BOD levels in fresh water are an indicator of the overall health of the water. Levels from 1-2 mg/L indicate clean water with little organic waste. Levels from 3-5 mg/L indicate fairly clean water with some organic waste. Levels from 6-9mg/L indicate water with lots of organic material and bacteria. Finally, levels greater than 10mg/L indicated very poor water quality with very large amounts of organic material in the water.

Target levels for dissolved oxygen in the Fourteen Mile Creek/Goose Creek watersheds has been set at greater than 4mg/L but less than 12mg/L. The target level for BOD is set at less than 2mg/L. Both targets were selected using data collected by IDEM and Hoosier Riverwatch, which indicates stress to organisms occurs at levels outside those targets. Figure 36 displays the average DO levels obtained during HRW and professional sampling; Figure 37 gives the BOD averages obtained in HRW sampling.

Figure 36: Average Dissolved Oxygen in the Fourteen Mile Creek/Goose Creek Watersheds



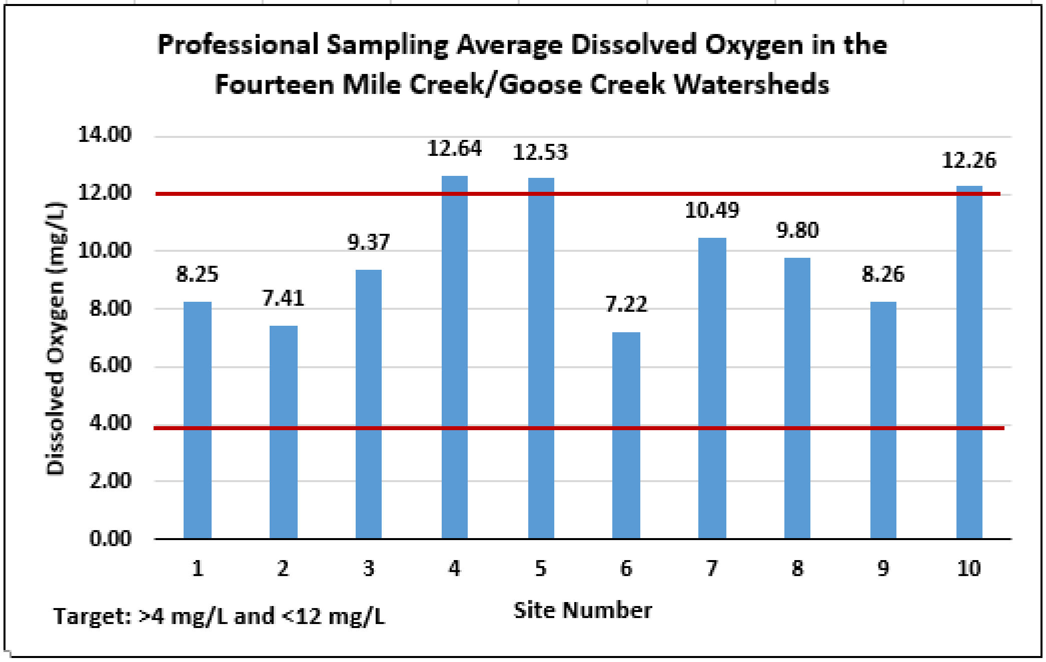
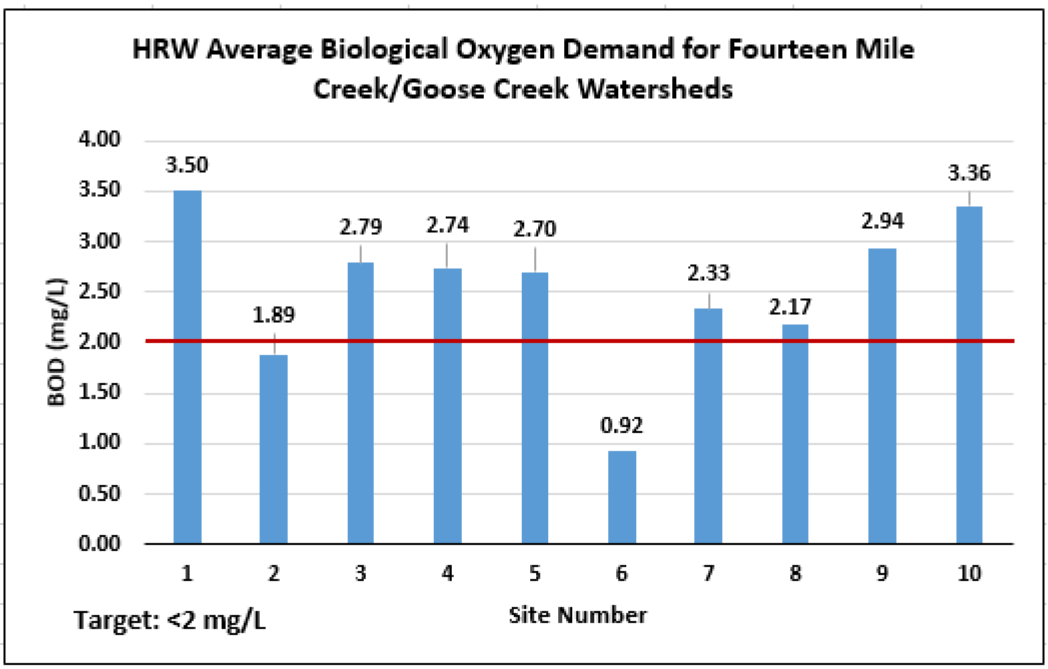


Figure 37: Average Biochemical Oxygen Demand in the Fourteen Mile Creek/Goose Creek Watersheds



Site averages during volunteer monitoring for DO in the Fourteen Mile Creek/Goose Creek watersheds stayed consistently within the target range over the sampling period. Professional sampling returned averages slightly higher than the project target for Sites 4, 5, and 10, however, they were still within the HRW typical range for DO. This could be attributed to the fact that there were only two professional samplings, and both occurred in July when air and water temperatures are normally elevated in this project's area. Only sites 2 and 6 fell below the target for BOD.

2.2.9.6 Monitoring Parameters – pH

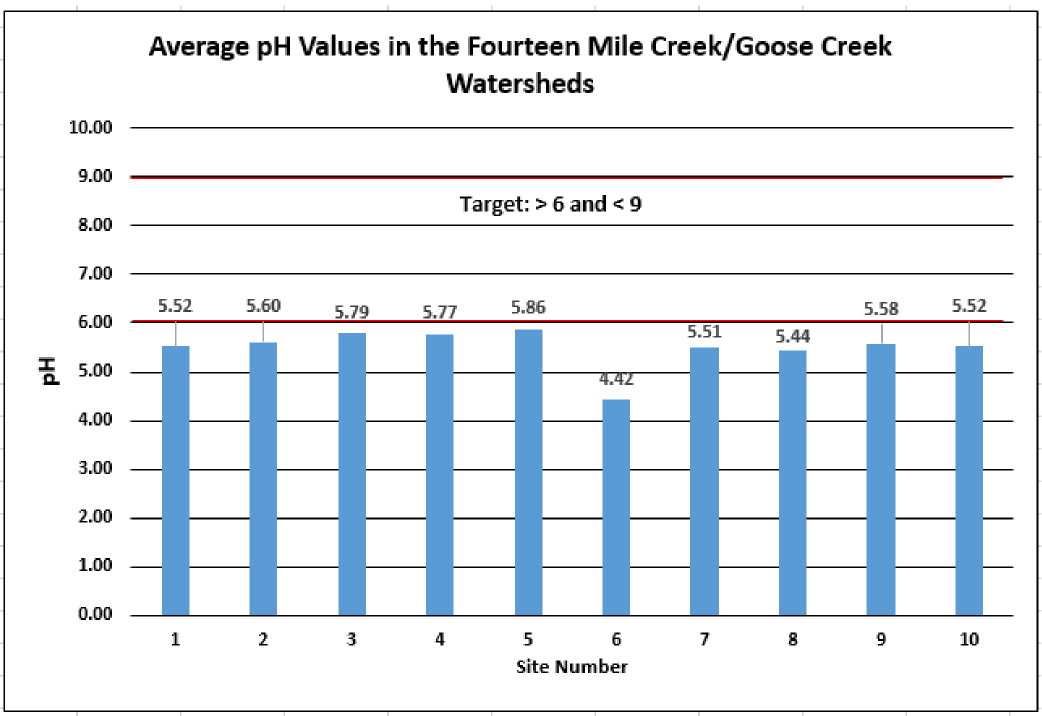
pH describes the relative concentrations of hydrogen and hydroxide ions in a solution, and is used in water testing to determine how alkaline or acidic a water system is. pH values range from 1.0 to 14.0, where 1.0 is very acidic and 14.0 is very basic. A change of 1 unit on a pH scale represents a 10-fold change in pH.

Many different chemical and biological reactions in water are dependent on certain pH levels. The greatest percentage of aquatic life prefers a range between 6.5 and 8.0. When pH levels fall below or above this range, organisms can be stressed. Many factors can affect the pH level of a water body such as acid rain, the composition of the rock the water flows over, wastewater discharges, and runoff from abandoned coal mines.

A pH range of 6.5 to 8.2 appears optimal for most aquatic organisms; Indiana Water Quality Standards state pH must be above 6 and below 9. Therefore, pH range for the Fourteen Mile Creek/Goose Creek watersheds project was selected to be greater than 6 and less than 9.

After recording initial readings in or very close to the desired 6-9 range, pH readings fell well below 6 at all sites midway through the project. It was determined that the test strips being used by volunteers were faulty. The volunteer coordinator obtained new strips, and thereafter pH readings were consistently higher at all sites. We concluded that the faulty readings would skew averages low, and thereby present an inaccurate picture of the water quality. The annual professional samplings supported this reasoning as they recorded pH values in the 6-9 range at all sites. Average values are presented below in Figure 38 for informational purposes.

Figure 38: Average pH Values in the Fourteen Mile Creek/Goose Creek Watersheds



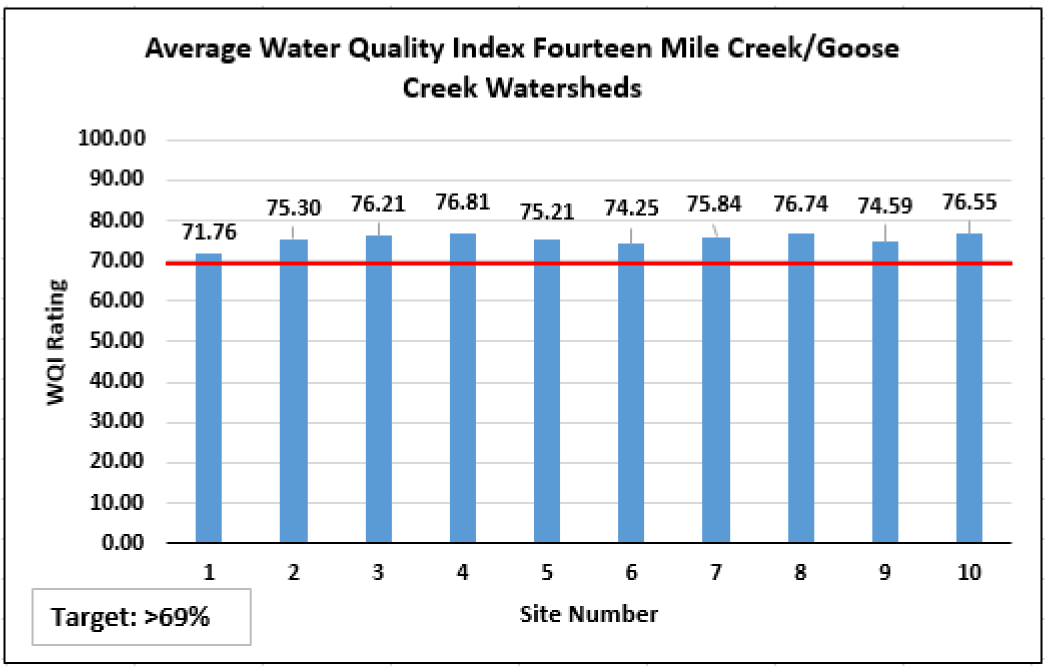
2.2.9.6 Monitoring Parameters – Water Quality Index (WQI)

The Water Quality Index (WQI) is a computation developed and used by the Hoosier Riverwatch volunteer monitoring program since 1995. It provides a single number that expresses overall water quality at a certain location and time based on the testing results of eight parameters: dissolved oxygen, E.coli, pH, biochemical oxygen demand, water temperature change, total phosphorus, nitrate, and turbidity. The objective of the WQI is to turn complex water quality data into information easily understood by the general public.

Each of the eight tests is weighted according to its level of importance. For example, dissolved oxygen has the highest weighting factor, therefore, the oxygen results are most important in determining the water quality rating using the index. The final single score, a percentage, classifies the stream as: excellent (90-100%), good (70-89%), medium (50-69%), bad (25-49%), and very bad (0-24%). *(IDNR Hoosier Riverwatch Volunteer Stream Monitoring Training Manual, Spring 2011.)*

Target level for the WQI in the Fourteen Mile Creek/Goose Creek watersheds has been set at greater than 69. This target was selected using data collected by Hoosier Riverwatch, which indicates ratings above this number support a high diversity of aquatic life. All sites sampled in our project fell in the "good" category range. Average WQI scores are presented below in Figure 39.

Figure 39: Average Water Quality Index in the Fourteen Mile Creek/Goose Creek Watersheds



2.2.10 Habitat/ Biological Information

In an effort to gain true representation of the water quality in the Fourteen Mile Creek/Goose Creek watersheds, data on the habitat and biological communities in the watersheds was collected. The following sections detail information gathered during the windshield survey, results of the citizen's qualitative habitat evaluation surveys, and results of the pollution tolerance index surveys.

2.2.10.1 Fourteen Mile Creek/Goose Creek Watersheds Windshield Survey

In March 2015, two members of the Steering Committee completed the Fourteen Mile Creek/Goose Creek watersheds windshield survey. As they drove, they documented every area where a resource concern was observed.

Little Huckleberry Creek and the southern portion of Lentizier Creek subwatersheds were not included in the survey. River Ridge Redevelopment is located, and encompasses most of the land in Little Huckleberry subwatershed. We determined that land in this area would either be inaccessible due to restrictions placed by the Development Authority and lacks roads to travel on, or it would be in some stage of commercial development. The southern portion of Lentizier Creek is highly residential and commercial in nature, and includes the City of Jeffersonville, Oak Park Conservancy District, and the Port of Indiana. We determined, therefore, that concerns in this area would be the result of urban development, such as pavement instead of riparian buffers along streams (and bank erosion as a result), trash in streams, and alteration of stream habitat due to increased flow off impervious surfaces. It may be deemed unwise to assume these concerns, however, each of the Steering Committee members travels these areas on a weekly, if not daily basis, and have familiarity with them. In addition, the Clark County SWCD monitors construction sites in these areas regularly as part of its MS4 Phase II Assistance Program.

The survey committee documented a total of forty-nine sites with resource concerns. These sites were not pre-determined, but rather were designated a "site" if a concern existed. It should be noted that some sites had multiple concerns present. Figure 40 below summarizes the results of the windshield survey; Figure 41 maps the survey sites. For summary results by subwatershed, please see the Watershed Inventory Summary (section 2.3) of this document.

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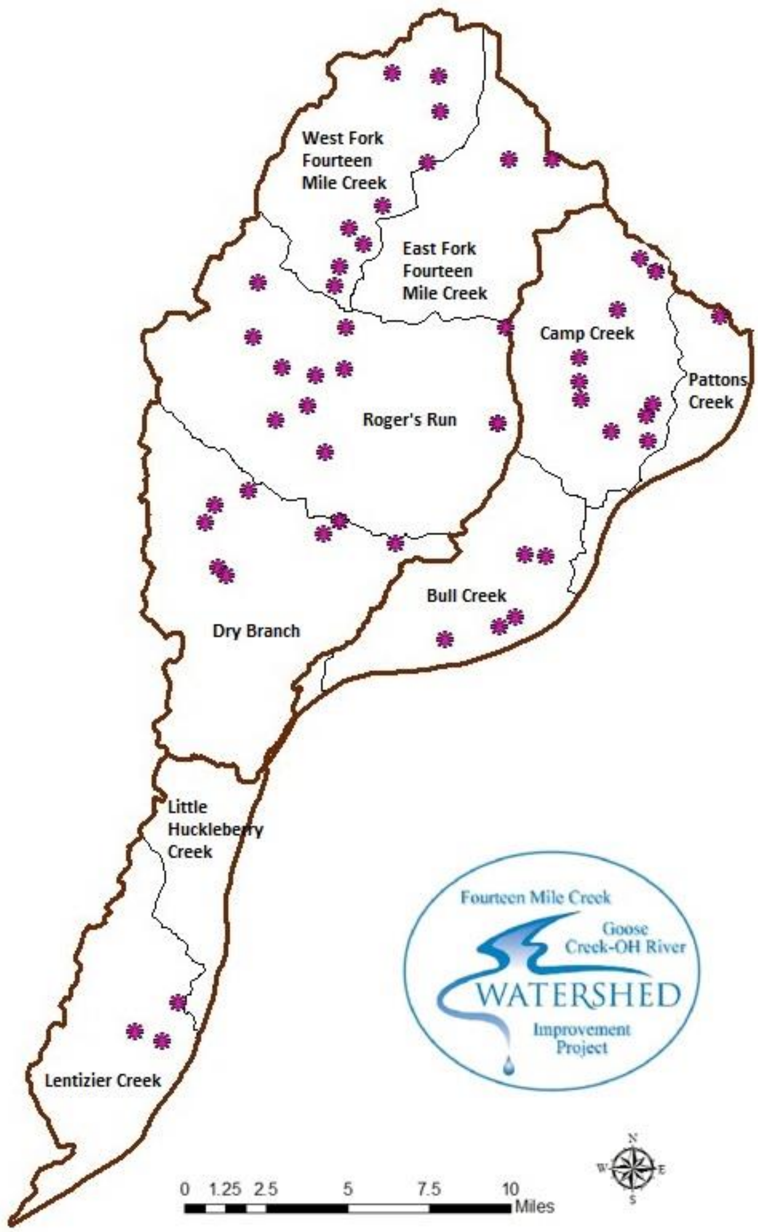
Figure 40: Windshield Survey Summary for the Fourteen Mile Creek/Goose Creek Watersheds

Subwatershed	Resource Concerns Found		Totals
West Fork-Fourteen Mile Creek **Number of Sites = 8**	Overgrazed	3	Overgrazed = 25 HUAP Needed = 27 Livestock Access to Water Bodies/Sensitive Areas = 25 Fall Tillage = 10 Gully Erosion = 10 Dumping Site = 1 Sheet and Rill Erosion = 2 Livestock Access to Woodland = 3
	HUAP Needed	4	
	Livestock Access to Water Bodies/Sensitive Areas	4	
	Conventional Tillage	1	
East Fork-Fourteen Mile Creek **Number of Sites = 3**	Overgrazed	2	
	HUAP Needed	2	
	Livestock Access to Water Bodies/Sensitive Areas	2	
Pattons Creek **Number of Sites = 1**	Overgrazed	1	
	HUAP Needed	1	
	Livestock Access to Water Bodies/Sensitive Areas	1	
	Gully Erosion	1	
Camp Creek **Number of Sites = 10**	Overgrazed	4	
	HUAP Needed	4	
	Livestock Access to Water Bodies/Sensitive Areas	4	
	Fall Tillage	4	
	Gully Erosion	5	
	Sheet & Rill Erosion	1	
	Livestock Access to Woodland	2	
Little Huckleberry Creek	*Not surveyed – land in transition from inactive Army Ammunition Plant to commercial development via River Ridge Redevelopment Authority*		
Lentizier Creek northeast of Allison Lane **Number of Sites = 3**	Overgrazed	2	
	HUAP Needed	2	
	Livestock Access to Water Bodies/Sensitive Areas	2	
	Gully Erosion	1	
	Sheet & Rill Erosion	1	
Lentizier Creek south of Allison Lane	*Not surveyed – land highly residential/commercial*		
Bull Creek **Number of Sites = 5**	Overgrazed	2	
	HUAP Needed	1	
	Livestock Access to Water Bodies/Sensitive Areas	3	
	Gully Erosion	1	
	Conventional Tillage	2	
	Dumping Site	1	
Dry Branch-Fourteen Mile Creek **Number of Sites = 8**	Overgrazed	2	
	HUAP Needed	2	
	Livestock Access to Water Bodies/Sensitive Areas	3	
	Gully Erosion	1	
	Conventional Tillage	1	
	Livestock Access to Woodland	1	
Rogers Run **Number of Sites = 11**	Overgrazed	9	
	HUAP Needed	11	
	Livestock Access to Water Bodies/Sensitive Areas	6	
	Gully Erosion	1	
	Conventional Tillage	2	

Figure 41: Map of Windshield Survey Sites in the Fourteen Mile Creek/Goose Creek Watersheds

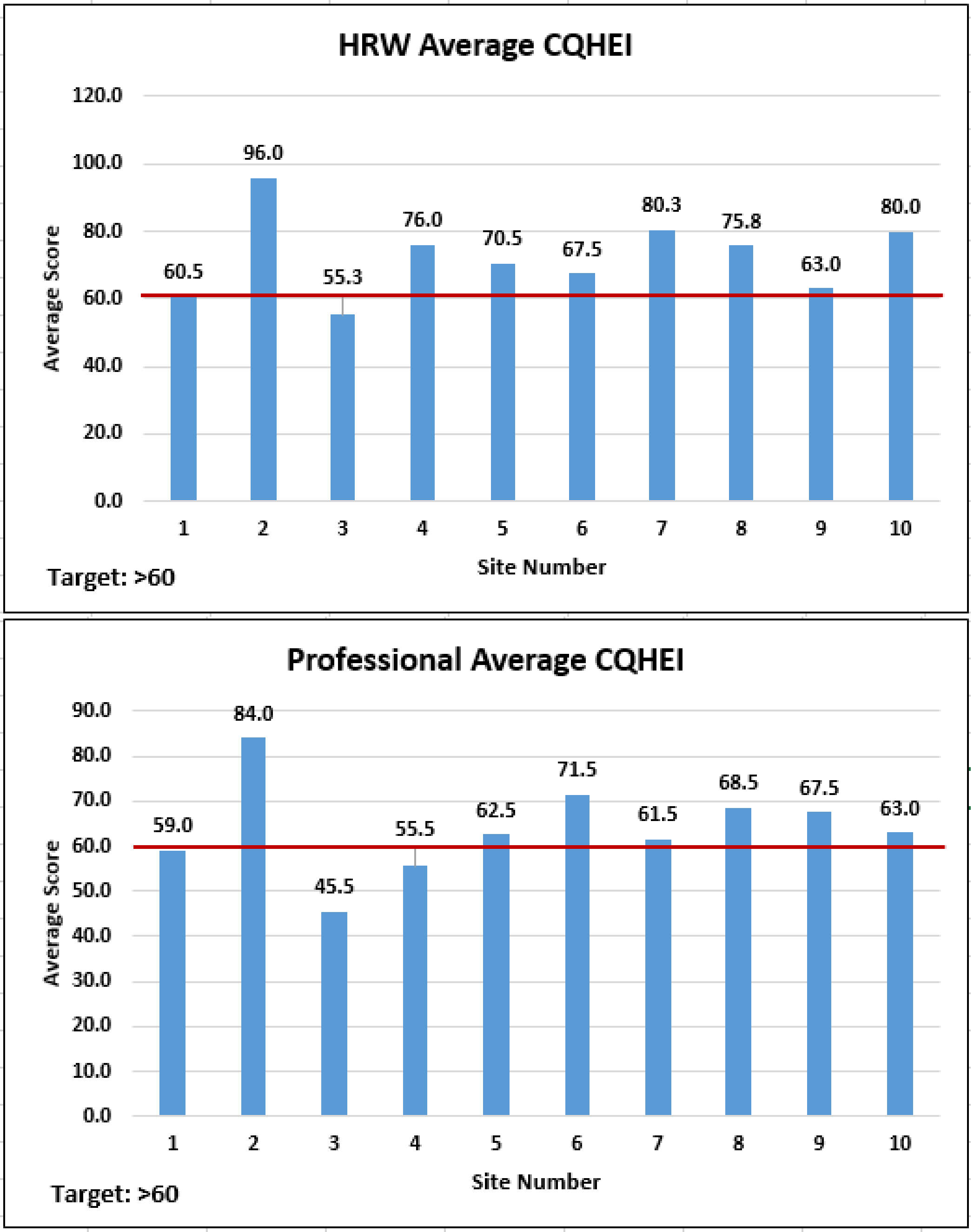


2.2.10.2 Fourteen Mile Creek/Goose Creek Watersheds Citizens Qualitative Habitat Evaluation

The Fourteen Mile Creek/Goose Creek Watersheds project also conducted an evaluation of the habitat at each sampling site. Since habitat and riparian health correspond to the physical factors that affect aquatic life, conducting an analysis allows the project to compare changes over time, and to other sites. The Citizens Qualitative Habitat Evaluation Index (CQHEI) is a system that was developed by the Ohio Environmental Protection Agency. The index compares conditions of substrates, fish cover, stream shape, depth, velocity, riparian areas, erosion, and riffles and runs.

The maximum score a stream can achieve is 114. According to the Hoosier Riverwatch manual, any score over 100 is considered exceptional stream quality; scores over 60 have been found to be conducive to the existence of aquatic life. For this reason the target for this project is set at 60. The charts below represents averages for each site from the annual HRW and professional evaluations.

Figure 42: Average HRW and Professional CQHEI for Fourteen Mile Creek/Goose Creek Watersheds



In looking at the charts above, it can be seen that there is some variation between the volunteer and professional evaluations. This could be attributed to volunteers, in some instances, not having the same concept or level of experience in interpreting stream conditions that water monitoring professionals do.

Despite this, Sites 2, 5, 6, 7, 8, 9, and 10 exceeded the project target in both the professional and volunteer evaluations. Site 2 scored highest of any sites for habitat, which could be attributed to it being in a rural, undeveloped area. As evidence of this, Site 2 received a maximum score for substrate, and riparian area, and scored highly for the amount of fish cover, and naturalness of the stream.

Site 3 was the lowest scoring site in both evaluations. BOD results for this site were above target. Site 3 CQHEI volunteer field sheets indicate it is on a shallow, slow-moving stream, with a poor substrate, median fish cover, and median riparian area.

CQHEI scores for Site 1 hovered around the project target, which could be expected at this site. It is an urban area that is becoming increasingly more so due to its proximity to the construction of the Kentucky/Indiana "east end" bridge, and to annexation by the City of Jeffersonville. The site still has enough green space surrounding it so that it hasn't been overwhelmed by imperviousness, but that may not be the case within a few years. Volunteers noted that water temperature at this site was always higher than any of the other sites.

2.2.10.3 Fourteen Mile Creek/Goose Creek Watersheds Pollution Tolerance Index

It has been said that chemical sampling is similar to taking a snap shot of a stream at a certain point in time; biological monitoring is similar to taking a video. Biological monitoring focuses on the aquatic organisms present in streams and rivers. It is based on the fact that different species of aquatic organisms react to pollution in different ways, and they react quickly. Therefore, they are good indicators of water quality, and the overall health of a stream system.

The Fourteen Mile Creek/Goose Creek Watersheds project conducted biological monitoring annually (once in 2014 and once in 2015) for benthic macroinvertebrates. These are water-dwelling organisms that are large enough to be seen with the naked eye. Each species of macroinvertebrates has a different sensitivity and tolerance to pollution. Some macros are very sensitive, and can't reproduce or thrive in areas of even a little pollution, while other macros are very tolerant of high levels of pollution. By collecting and assessing what types of macros are in the stream, as well as how many different species of macros there are, we can gain a better understanding of water quality.

Hoosier Riverwatch biological monitoring results in a Pollution Tolerance Index (PTI) score and rating for each site sampled. These scores range from bad to excellent. Any score over 23 is considered excellent, 17 to 22 is good, 11-16 is fair, and 10 or less is bad. The target for the Fourteen Mile Creek/Goose Creek Watersheds project is a score above 16, indicating "good" or "excellent" conditions. Figure 43 below summarizes the Pollution Tolerance Index Rating Results for the Fourteen Mile Creek/Goose Creek Watersheds.

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Figure 43: Pollution Tolerance Index Scores and Rating in the Fourteen Mile Creek/ Goose Creek Watersheds

Site Number	2014 Score	2014 Rating	2015 Score	2015 Rating
1	25	Excellent	27	Excellent
2	23	Excellent	16	Fair
3	30	Excellent	11	Fair
4	18	Good	11	Fair
5	9	Bad	8	Bad
6	8	Bad	3	Bad
7	7	Bad	10	Bad
8	17	Good	22	Good
9	23	Excellent	19	Good
10	25	Excellent	21	Good

In 2014, 70% (7 out of 10) of the testing sites met the project standard for the PTI Rating. In 2015, 40% (4 out of 10) of the testing sites met the project standard for the PTI Rating. Sites 5, 6, and 7 consistently scored the worst of the 10 sites. Analyzing the areas in which these three sites are located leads us to speculate reasons why they would score low.

Site 6, as aforementioned, is not in an area used for production agriculture, so we would not consider runoff from fertilizers to be affecting the water quality. However, the amount of water present in this stream segment could. On three occasions, HRW volunteers were unable to sample this site because it was dry, and on three other occasions they could not monitor the flow because the water was pooled. Obviously, no water would be unconducive to aquatic life, as would pooling water where temperatures would be higher and flow stagnant.

Site 7 was similar to Site 6 in that it had one occasion where there was no water present to be sampled, and three others where the water was pooled. However, unlike Site 6, Site 7 is in an agricultural production area, and we, therefore, could consider the detrimental effects of fertilizer runoff on stream health (and rightly so as Site 7 had one of the three highest nitrate levels of the 10 sites – 7.16 mg/L). BOD at this site averaged 2.33 mg/L, above the project target (<2 mg/L), indicating some organic matter present in the stream that would degrade habitat.

The production of livestock is a common use of land surrounding Site 5, as evidenced by it having the highest nitrate level – 8.86 mg/L – of any of the ten sites. BOD at this site was also above the project target with an average of 2.70 mg/L.

Professional biological monitoring for this project used metric-based data analysis to derive a macroinvertebrate Index of Biotic Integrity (mIBI) score for each of the 10 stream sites. Scores less than or equal to 35 are suggestive of an impaired stream site, while sites with a score greater than 35 are considered unimpaired. The target score for the Fourteen Mile/Goose Creek Watersheds project is >35. A simple table of the professional results obtained is given below in Figure 44; a detailed table and a full discussion of the professional stream bioassessment can be found in the Appendix.

Figure 44: mIBI Professional Sampling Results for the Fourteen Mile Creek/Goose Creek Watersheds

Site Number	2014 mIBI score	2014 Rating	2015 mIBI Score	2015 Rating
1	40	Unimpaired	22	Impaired
2	40	Unimpaired	34	Impaired
3	36	Unimpaired	26	Impaired
4	42	Unimpaired	34	Impaired
5	28	Impaired	28	Impaired
6	30	Impaired	30	Impaired
7	30	Impaired	30	Impaired
8	32	Impaired	28	Impaired
9	34	Impaired	34	Impaired
10	30	Impaired	32	Impaired

As the table above illustrates, only four of the project sites achieved a score of >35 in 2014, while none reached the target in 2015; sites 5, 6, and 7, scored consistently low in both the HRW and professional assessments. The most significant drop in scores occurred with Sites 1 and 3, which could likely be attributed to the intense floods of 2015. Site 1, located in an urban area, would no doubt have received more than its normal share of pollutants from impervious runoff. In addition, the stream segment that Site 1 is located on drains directly to the Ohio River, which remained well above crest after the initial flooding occurred. Though the site was not ever sampled in back water conditions, pollutants may have been received there due to the presence of back water after the flood. Site 3, though it is in a rural area, also is on a segment that drains directly to the Ohio, and could have received pollutants in the same manner.

Sites 2 and 4 mIBI scores did not drop as dramatically as Sites 1 and 3 between the two sampling events. The professional assessment narrative states that "…it is likely that the sites with mIBI scores that fell just short of 36 – e.g., sites 2, 4, and 9 – would have made the unimpaired list had species resolution been recorded, or even genus resolution with the chironomidae." Since professional samplings took place a year to the day apart, it is of interest to consider the weather conditions surrounding the two events. The temperature on July 25, 2014, was 86^{o}, and project area had received 1.8 inches of rain to that date. On July 25, 2015, the temperature was 90^{o}, and the area had received 8.51 inches of rainfall to date. Obviously, July 2015 was a wetter period than 2014. Whether this had a bearing on the sampling results is inconclusive. Future sampling at these two sites would be beneficial to determine if they are truly impaired.

In investigating how the macroinvertebrate assessments completed for our project could reflect impairment (discussed in the following Section 2.2.10.3), while overall CQHEI averages indicated "good" habitats, we reviewed the field sheets for the volunteer CQHEI evaluations (we do not have the field sheets used in the professional sampling). We set what we felt were breaking points between a "high" and "low" scores for each category of the evaluation, and counted the number of instances of occurrence for each (2 evaluations x 10 sites x 6 categories = 120 occurrences). We hoped by doing this, we might be able to identify where stream conditions might be affecting the macro population. The results are presented below in Figure 45.

Figure 45: Average Citizen Qualitative Habitat Evaluation Index Volunteer Field Sheet Results Categorized

Category	High - # Occurrences	Low - # Occurrences
Substrate **High = >14, Low = 14 or less**	**15**	**5**
Fish Cover **High = >10, Low = 10 or less**	**5**	**15**
Stream Shape & Human Alterations **High = >10, Low = 10 or less**	**20**	**0**
Stream Forests & Wetlands (Riparian Areas) & Erosion **High = >10, Low = 10 or less**	**16**	**4**
Depth & Velocity **High = > 7.5, Low = 7.5 or less**	**4**	**16**
Riffles/Runs **High = > 7.5, Low = 7.5 or less**	**16**	**4**

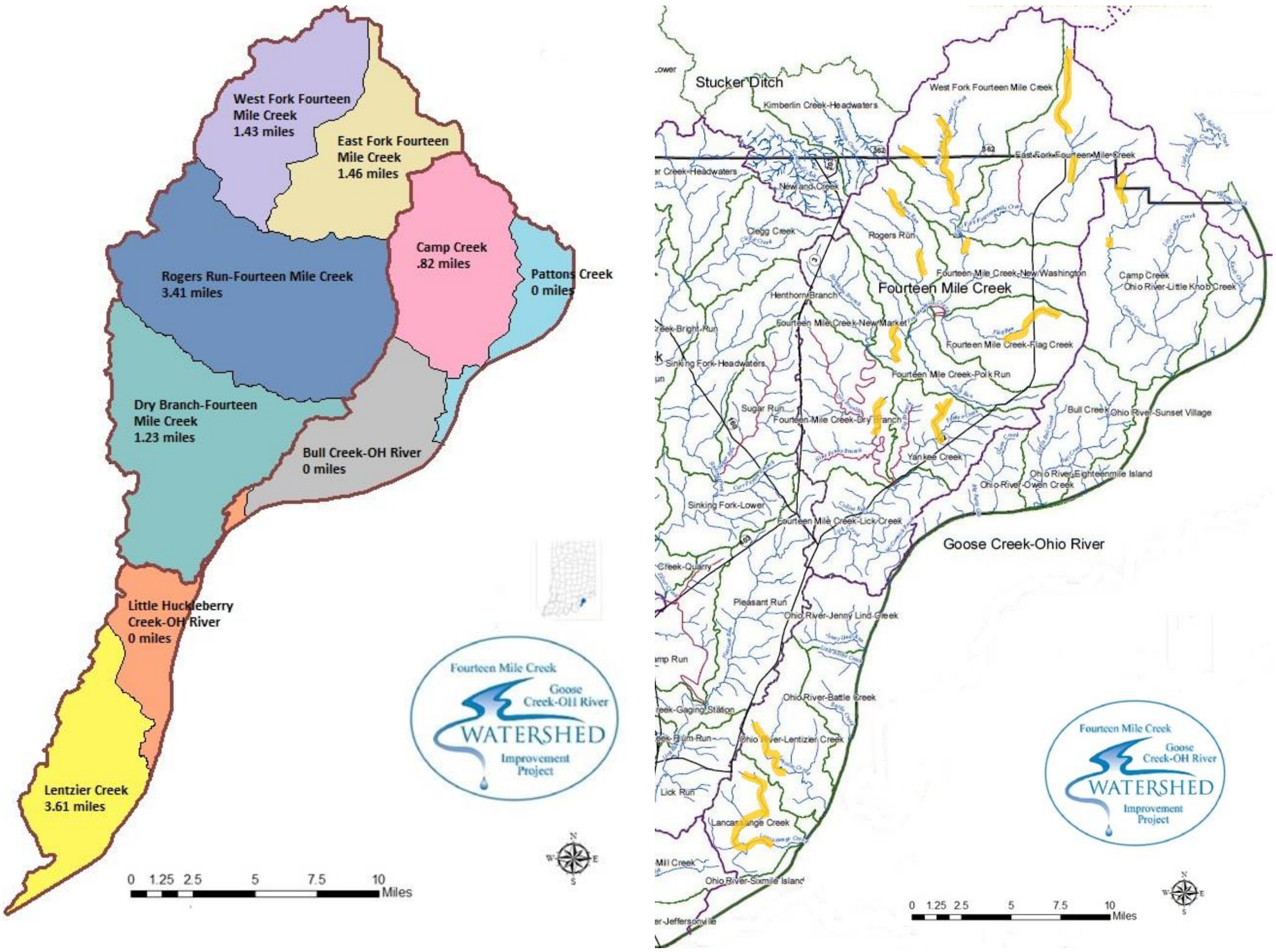
As can be seen from the results above, fish cover and depth and velocity were the two categories most lacking in occurrences. Low scores for depth and velocity – which considers how deep pools are within the stream and how fast it is flowing – lead us to speculate that our sites overall are shallow and slow-flowing, and not ideal conditions for the macroinvertebrate population. Low scores for fish cover, obviously, indicates insufficient habitat for fish, but gives no indication of an effect on macroinvertebrates. Therefore, we could draw no clear conclusions by this means as to why mIBI scores would reflect impairments in an overall good habitat.

2.2.11 Other Applicable Landuse Information

Anyone journeying from the northernmost point in the Fourteen Mile Creek/Goose Creek watersheds to the southernmost tip will see a very noticeable change in landuse as they travel. They will find pastures, crops, and forest common in the north; houses become more numerous and closer together as they advance south, and small communities begin to form; midway through, established subdivisions as well as new development will appear; finally, in the southern reaches, suburbia will be found, and areas of industrial, commercial, and residential growth will be the norm. This great diversity challenges the Steering Committee to develop a plan to address the concerns presented by it effectively.

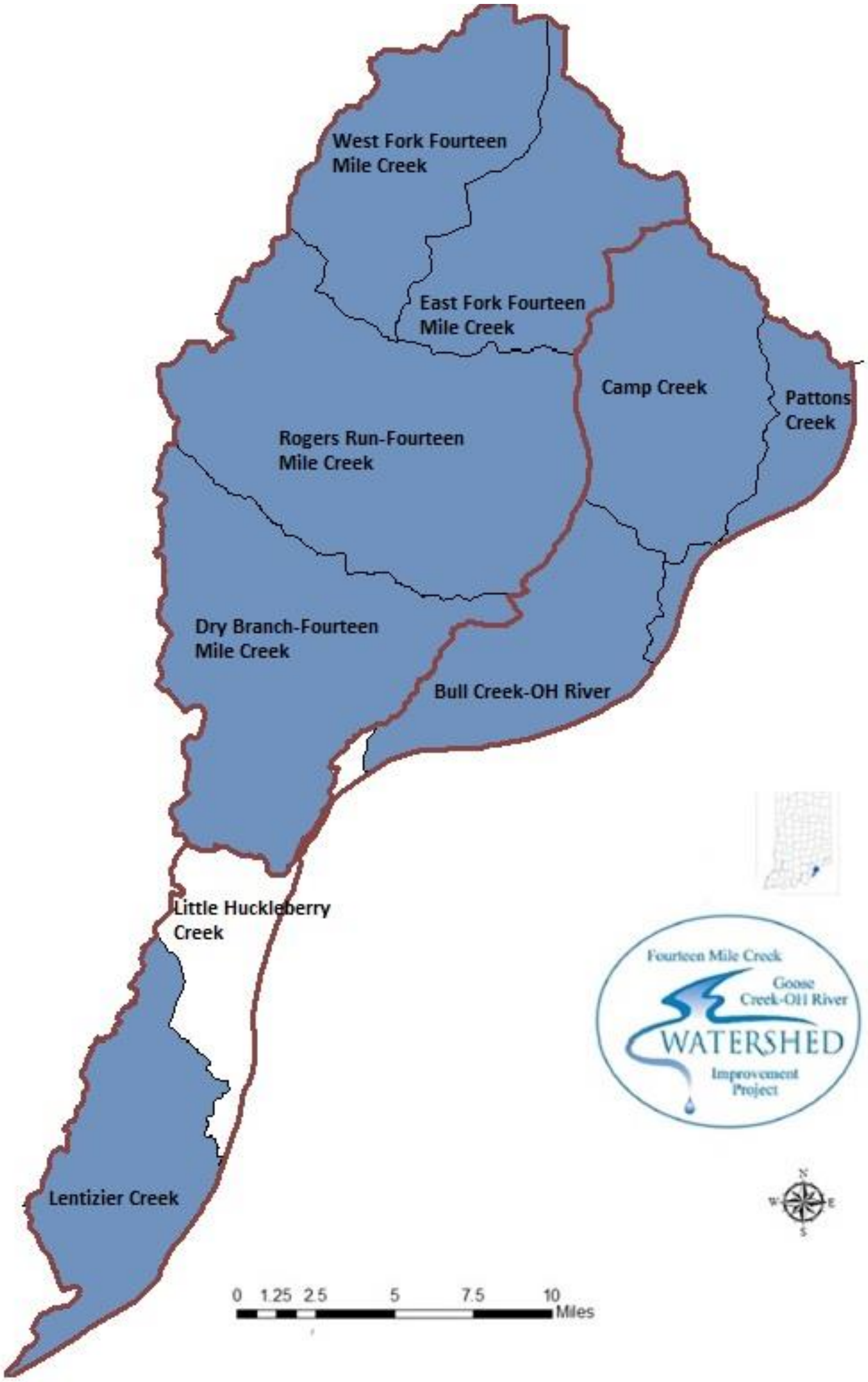
The windshield survey completed during the development of this plan indicated areas where livestock were accessing water bodies, land was being overgrazed, and various types of erosion was occurring. Anecdotal evidence gathered indicated the same, and in addition, alluded to the need of buffers along streams, and/or streambank stabilization. To confirm the need of buffers, a desktop survey was completed. An estimated 11.96 miles of stream was determined to need buffers. The survey results are presented in Figure 46 below by subwatershed.

Figure 46: Number of Stream Miles by Subwatershed that would benefit from the Installation of Buffers; Locations of Stream Miles (represented in yellow)



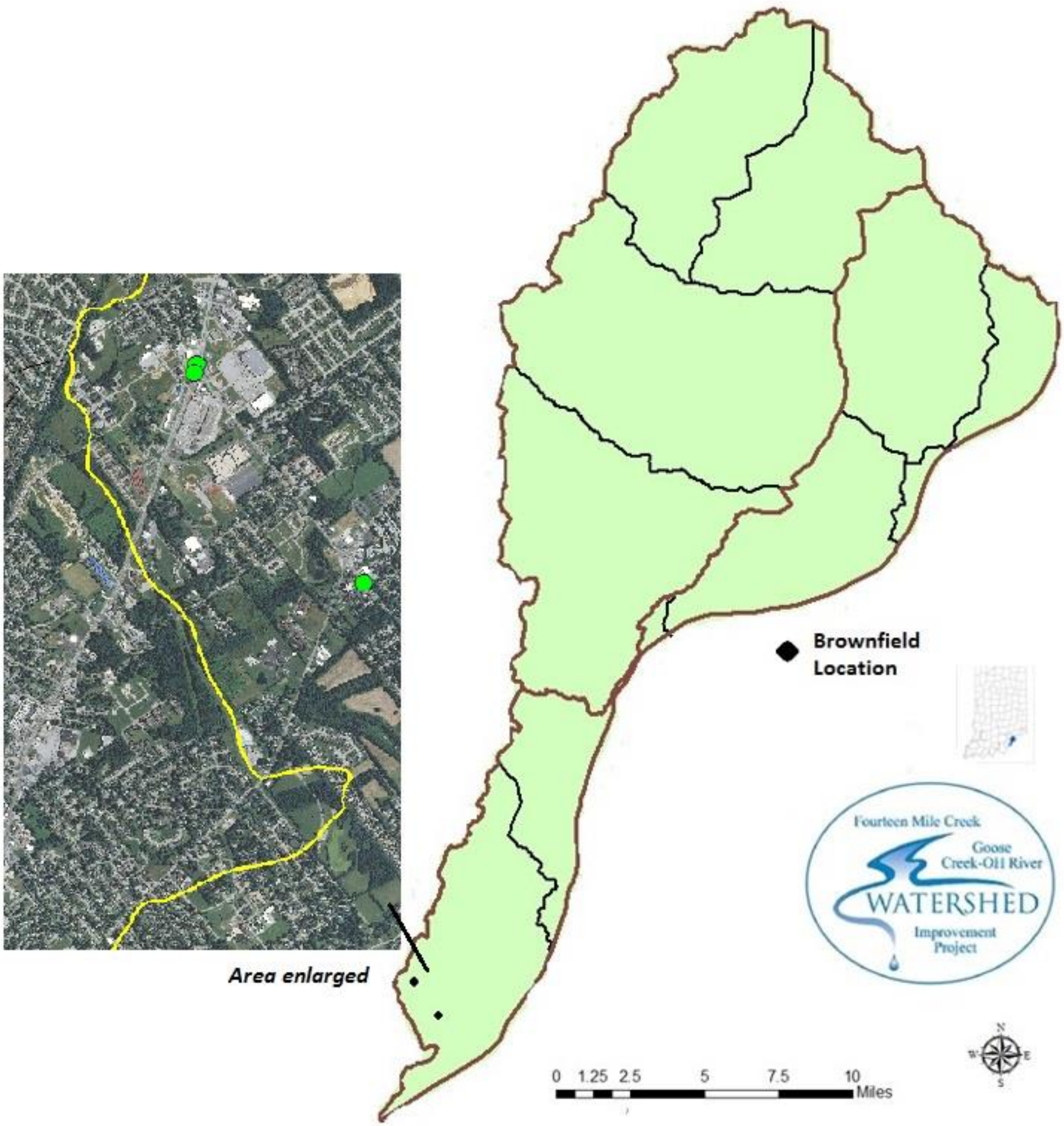
Given that, without going door to door and requesting access to individual landowners' properties, it is difficult to determine with a windshield survey the extent of streambanks that need stabilized. Steering Committee members rationalized, however, that with sites already identified where livestock were accessing water bodies in a subwatershed, it would be likely that others exist. They also rationalized that these sites would likely need to be stabilized if livestock are accessing and degrading the banks of the stream. In addition, along the 11.96 miles of stream identified in the desktop survey as in need of buffers, they rationalized that those streambanks may also need to be stabilized as they are unprotected, bare, or minimally vegetated and subject to erosion from the forces of nature. Therefore, based on those two criteria, the subwatersheds presented below in blue in Figure 47 were determined to be areas where streambank stabilization is needed.

Figure 47: Subwatersheds (represented in blue) where Streambank Stabilization is Needed



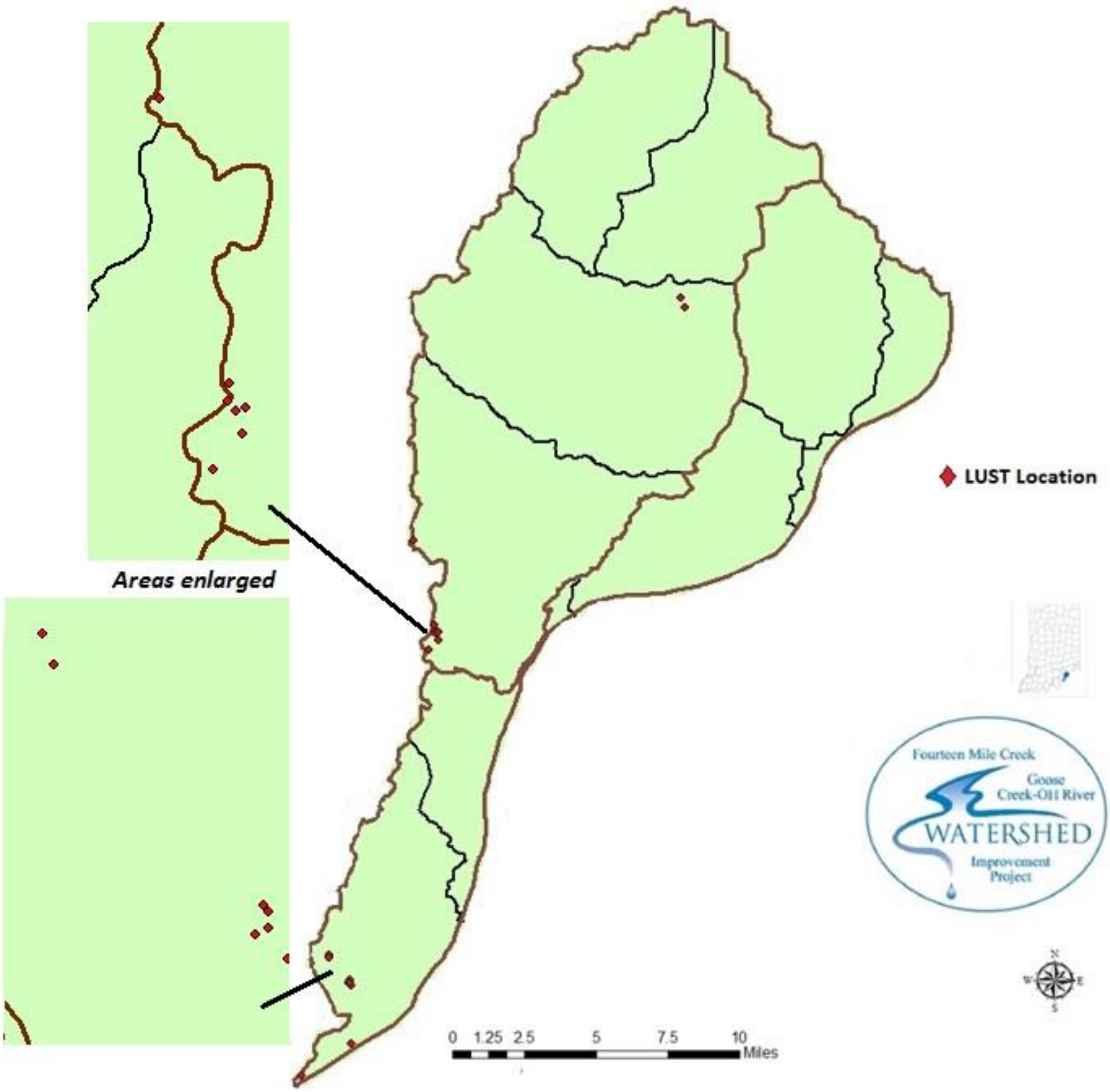
Additional data gathered revealed concerns for how present and past land use might affect/be affecting water quality. Three brownfields were identified in the watersheds, all of which are located in the Lentizier Creek subwatershed, and are shown below in Figure 48.

Figure 48: Brownfield Locations in the Fourteen Mile Creek/Goose Creek Watersheds



Eighteen Leaking Underground Storage Tanks (LUSTs) were also identified in the watersheds, and their locations are shown below in Figure 49.

Figure 49: Leaking Underground Storage Tanks (LUSTs) Locations in the Fourteen Mile Creek/Goose Creek Watersheds



Six locations of Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs) were found in the watersheds, and are shown below in Figure 50.

Figure 50: CSO and SSO Locations in the Fourteen Mile Creek/Goose Creek Watersheds

There are no areas where municipal wastewater sludge is applied in the watersheds. All facilities dispose of their sludge in a landfill. There are also no Animal Feeding Operations (AFOs) in the project area. Anecdotal evidence indicates hobby farms present in some subwatersheds with opportunities for others to develop.

All information presented in this section is discussed more fully in the appropriate watershed sections.

2.3 Watershed Inventory Summary

The following section summarizes all water quality data (biological, chemical, and habitat), and provides separate discussion of that data for each subwatershed. This allows for a more in-depth look at land use, conditions, and results. *Please note: Not all subwatersheds contained a water sampling site. Also, all sites were sampled twenty-two times over the life of the project unless weather or other conditions prevailed – those instances are noted in the narrative.*

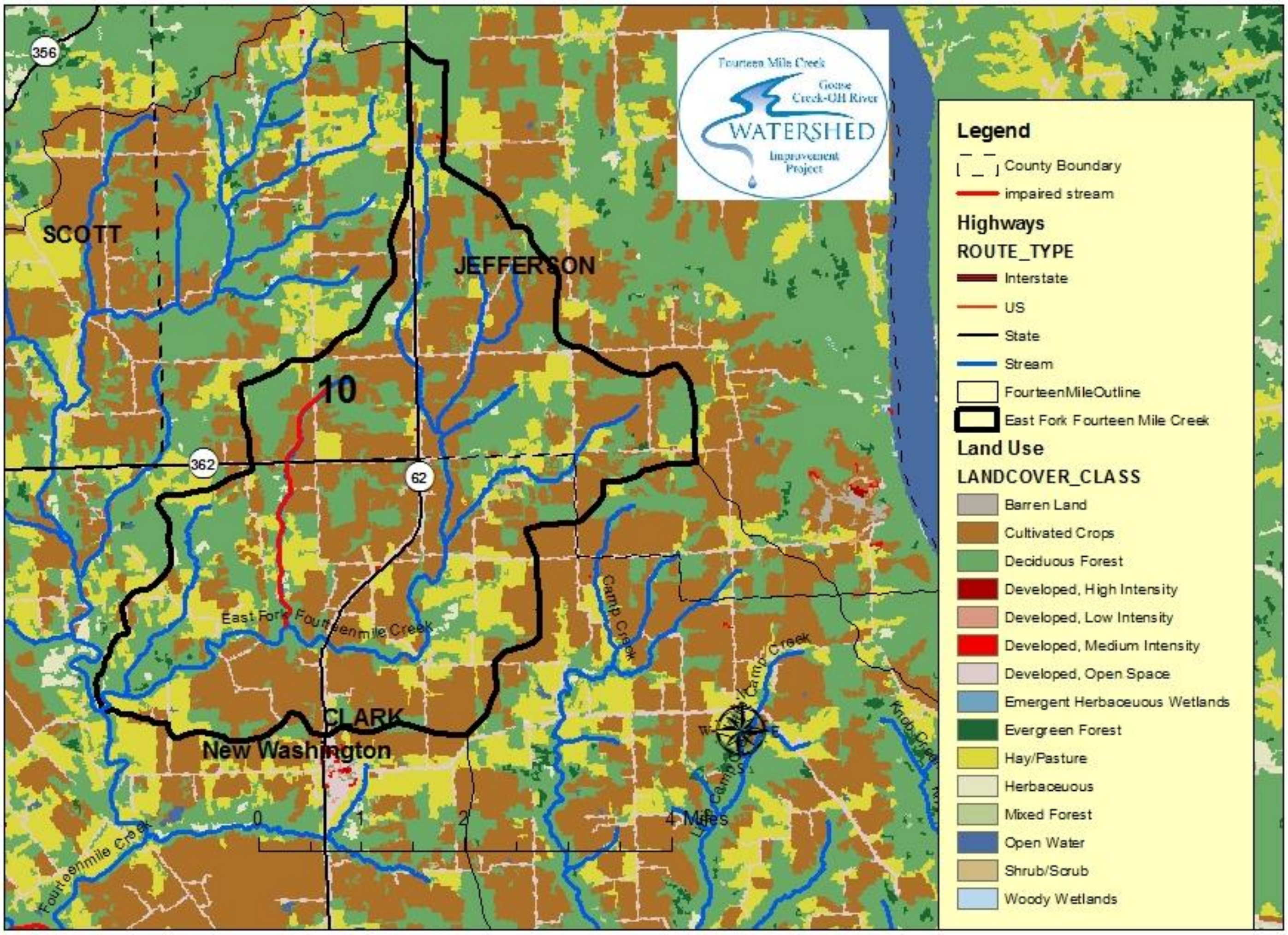
2.3.1. East Fork Fourteen Mile Creek (051401010401)

Almost half (45.48%) of the 10,926.6 total acres in the East Fork-Fourteen Mile Creek subwatershed is cultivated for crops, while almost as much (33.5%) is retained in forest. There is a sprinkling of acres in pasture and hay (13.98%) around the subwatershed, along with a few areas of developed open space (6.09%). Anecdotal evidence indicates the existence of hobby farms, but they tend to be the exception, not the norm. The Chelsea Flatwoods Nature Preserve is located in this subwatershed, and is open to the public, however there are no other prominent recreational areas.

Development may eventually reach this subwatershed via a ripple effect as work on the two new Ohio River bridges located at the southern end of the Fourteen Mile Creek/Goose Creek watersheds is completed. It is predicted by local officials and residents alike that these bridges will increase traffic and development throughout the county. However, at present, industry is not prominent, and new development occurring in this subwatershed is minimal.

The town of New Washington is located at the southern tip of this subwatershed, downstream from sampling Site 10. Figure 51 below shows the streams (in blue), and impaired streams (in red) in the watershed along with the location of Site 10.

Figure 51: East Fork – Fourteen Mile Creek Subwatershed



Site 10 is located on East Fork – Fourteen Mile Creek off of a bridge on Highway 362, west of State Road 62 between Frank Fisher and Kettle Bottom Road. The stream segment (Fourteen Mile Creek, East Fork-Unnamed tributary) on which this site sits is listed on IDEM's 2012 303(d) list as impaired for E.coli, Dissolved Oxygen, and Biotic Communities. Two IDEM sampling sites are located on this segment: OSK070-0003 – East Fork Fourteen Mile Creek, which is located at the southern end of this segment in Clark County, and OSK070-0015 – Tributary of East Fork Fourteen Mile Creek, which is located at the upper end of this segment in Jefferson County. Results which led to the impairment designations are given below in Figures 52 and 53.

Figure 52: IDEM Sampling Results for Site ID OSK070-0003, 2000 Corvallis

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	2.37	mg/L	2/3	67%
Dissolved Oxygen	9.23	mg/L	0/3	0%
Total Phosphorus	0.13	mg/L	2/3	67%
Turbidity	14	NTU	0/3	0%
Total Suspended Solids	5.33	mg/L	0/3	0%
Notes: No water quality standard violations. Nitrate and total phosphorus exceeded project targets.				

Figure 53: IDEM Sampling Results for Site ID OSK070-0015, 2005 Corvallis, Corvallis E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	2.4	mg/L	1/1	100%
Dissolved Oxygen	5.86	mg/L	2/7	29%
Total Phosphorus	0	mg/L	0/1	0%
Turbidity	8.7	NTU	1/7	14%
Total Suspended Solids	0	mg/L	0/1	0%
E. coli (geomean)	458	CFU/100 ml	4/5	80%
IBI (fish)	26	points	1/1	100%
QHEI (fish)	49	points	1/1	100%
Notes: E.coli, dissolved oxygen, and fish IBI did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.				

Ease of access afforded by the bridge, and the fact that the stream segment is on the 303(d) list, led to the selection of Site 10 for sampling. The area of this site can be described as an agricultural setting; natural riparian buffers are lacking along some areas of this stream segment.

Average nitrate concentration for Site 10 was 1.96 mg/L, which is slightly above the project target of 1.5 mg/L. However, Site 10 exceeded the target for BOD 55% of the time, and did not meet the target for total phosphorus 50% of the time. Dissolved oxygen readings were consistently high, but the final average of them (11.04 mg/L) falls just under the target (<12 mg/L). Samplings at IDEM's Site OSK070-0003 in 2000 noted nitrate and total phosphorus exceeding the project target; Site OSK070-0015 (in proximity to our Site 10) also noted nitrates in excess in the 2005 Corvallis sampling.

Results from the 2014 E. coli sampling seemed to confirm IDEM's designation of impairment as the geometric mean of 597.69 CFU/100 mL was well above the 125 CFU/100 mL target. That situation reversed in 2015, however, when the mean was found to be 33.3 CFU/100 mL, and well below the target. We speculate that weather could be a factor in this disparity, as heavy rains were experienced during the 2014 sampling period, indicating that NPS is an issue in this subwatershed.

Further, recognizing that NPS is an issue would lead to concern over the karst topography in the Clark County portion of this watershed (south of Highway 362 and skimming the town of New Washington's northern border). As aforementioned (Section 2.2.1, Geology/Topography), the hollow nature of karst terrain results in very high pollution potential, because runoff bypasses the natural filtration from the soil when it enters sinkholes and caves, and travels rapidly underground. This allows contaminants to be transmitted quickly, and makes it difficult to determine their source. Since sinkholes are prolific in the area north of the community of New Washington, we can speculate some E.coli contamination may be occurring as a result of failed or malfunctioning septic systems in that unsewered area. Our Site 10 is located in this area; IDEM's Site OSK070-0003 is in the area, but was not sampled for E.coli in the 2000 Corvallis sampling.

Biological monitoring at Site 10 did not conclusively support IDEM's impairment designation. Hoosier Riverwatch's Pollution Tolerance Index results score the site as "good" to "excellent", contradicting the designation. However, professional samplings found it at the "impaired" level on both occasions. For a complete water quality summary see Figure 54 below.

Figure 54: Site 10 Water Quality Analysis – East Fork Fourteen Mile Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.96	mg/L	7/22	32%
Nitrites	0	mg/L	0/22	0%
Temperature	14.36	Celsius	0/22	0%
Dissolved Oxygen	11.04	mg/L	0/22	0%
BOD	3.36	mg/L	11/22	55%
Total Phosphorus	.044	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.10	NTU	0/22	0%
Water Quality Index	76.60	%	0/22	0%
CQHEI	80	points	0/2	0%
E. coli	597.69 (2014) 33.3 (2015)	CFU / 100mL	1/1 0/1	100% 0%
Pollution Tolerance Index (Macros)	25 (2014) 21 (2015)	points	0/1 0/1	0% 0%
mIBI	30 (2014) 32 (2015)	points	1/1 1/1	100% 100%

Additional data was collected on the East Fork subwatershed through the windshield survey that was completed by two members of the Fourteen Mile Creek/Goose Creek watersheds' steering committee in mid-March of 2015. During the survey, three sites were observed in this subwatershed which could benefit from the installation of heavy use area protection (HUAP). Though not specifically identified by stakeholders, potential for soil erosion/degradation would exist at these sites. Other sites were found where pastures were overgrazed, and where livestock had access to waterbodies, both of which were mentioned as stakeholders' concerns. Complete results of the windshield survey in the East Fork subwatershed are given below in Figure 55.

Figure 55: East Fork – Fourteen Mile Creek Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Three Sites Surveyed
Overgrazed	2
HUAP Needed	2
Animals with Access to Waterbodies	2

Due to the number of occurrences of overgrazed sites, sites where HUAPs were needed, and sites where animals had access to waterbodies, recorded during the windshield survey, we speculate that there are likely other problem sites in this subwatershed. If so, they could be contributing to the E.coli levels found at IDEM's Site OSK070-0015, and our Site 10.

Figure 56: East Fork – Fourteen Mile Creek Subwatershed Stream Banks Needing Buffers

The desktop survey completed during this project to determine stream miles in need of buffers, revealed a total of 1.46 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 56 represents these miles. Additionally, as discussed in Section 2.2.11, Landuse Information, some of these miles are likely to require bank stabilization if livestock have been accessing and degrading them where buffers are not present.

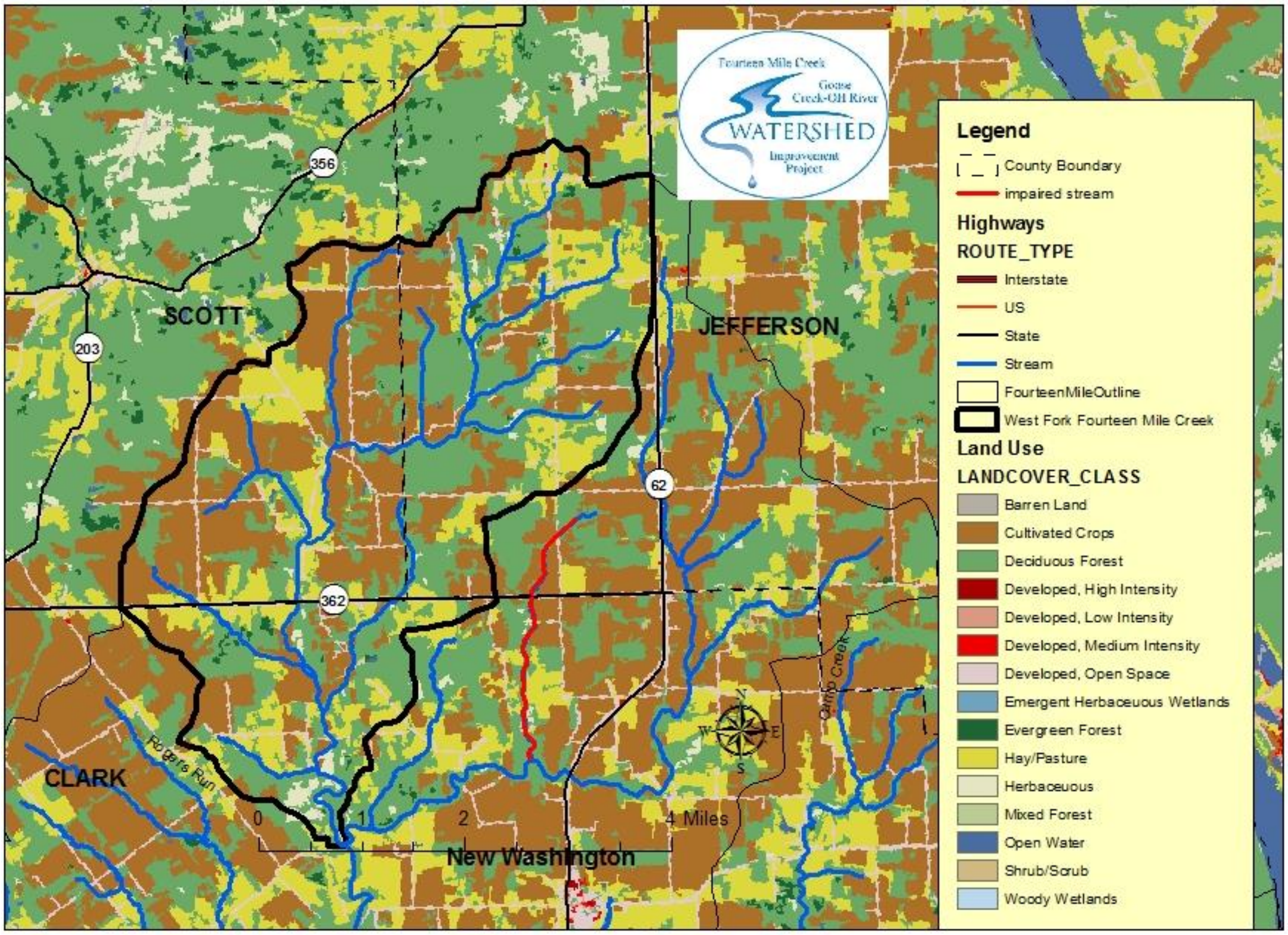
No LUSTs, CSOs, SSOs, or Brownfields were identified in this subwatershed.

2.3.2. West Fork – Fourteen Mile Creek (051401010402)

The West Fork – Fourteen Mile Creek subwatershed is located in the northwestern corner of the watershed, and is the only subwatershed that spans three counties - Clark, Jefferson, and Scott. The predominant land use here is split almost evenly between agricultural purposes and forested areas. There are roughly 4,472 acres of cropland in the subwatershed, most of which produce corn or soybeans, while forested land encompasses approximately 4,444 acres. Land in pasture and hay is the next most prominent land use at 2,048 acres. Only 563 of the total 11,696.5 acres in this subwatershed is developed open space. Anecdotal evidence indicates the existence of hobby farms, but they tend to be the exception, not the norm.

As with the East Fork – Fourteen Mile Creek subwatershed, development may eventually reach this subwatershed as work on the two new Ohio River bridges is completed. However, at present, industry is not prominent, and new development occurring in this subwatershed is minimal. Land use in the West Fork – Fourteen Mile Creek subwatershed is mapped below in Figure 57.

Figure 57: West Fork – Fourteen Mile Creek Subwatershed



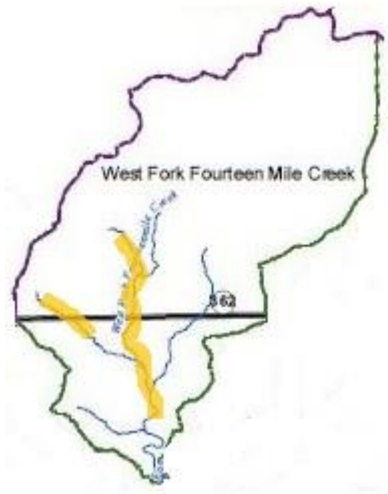
A water sampling site was not chosen in the West Fork – Fourteen Mile Creek subwatershed, nor is there an established IDEM site. Therefore, determinations of water quality must come from considering land use, windshield survey information, and stakeholder's personal observations. In the future, locating a testing site within this subwatershed is advisable so that baseline information on water quality can be established.

Data was collected on the West Fork subwatershed through the aforementioned windshield survey. Areas that could benefit from heavy use area protection (HUAP) were observed, and again, though not specifically identified by stakeholders, potential for soil erosion/degradation would exist at these sites. Areas where livestock have access to waterbodies, where overgrazing exists, and where conventional tillage is used were also observed, and are of concern to stakeholders. Complete results of the windshield survey in the West Fork subwatershed are detailed in Figure 58.

Figure 58: West Fork – Fourteen Mile Creek Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Eight Sites Surveyed
Overgrazed	3
HUAP Needed	4
Animals with Access to Waterbodies	4
Conventionally Tilled	1

Figure 59: West Fork – Fourteen Mile Creek Subwatershed Stream Banks Needing Buffers



The desktop survey completed during this project to determine stream miles in need of buffers, revealed a total of 1.43 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 59 represents these miles. Additionally, as discussed in Section 2.2.11, some of these miles are likely to require bank stabilization if livestock have been accessing and degrading them where buffers are not present.

No LUSTs, CSOs, SSOs, or Brownfields were identified in this subwatershed.

2.3.3. Rogers Run (051401010403)

Rogers Run is the largest of the subwatersheds covering 23,651 acres in the northwestern portion of the Fourteen Mile Creek/Goose Creek watersheds. The unincorporated community of New Washington, containing a population of 566 people (2010 Census), is located in its northeastern corner. Land use in the Rogers Run subwatershed is almost equally divided between conventional cropland (36.79%) and forested acres (37.99%). Land in pasture and hay is significant (20.35%), and could be accounted for by the fact that there are several large cattle operations in this subwatershed.

New development and industry in this subwatershed is minimal, however, it too may eventually experience growth as work on the Ohio River bridges is completed. Anecdotal evidence alludes to the presence of hobby farms scattered throughout this watershed, which may increase in number if new growth consumes farm homesteads. Public recreational areas are lacking at present, but may evolve with growth.

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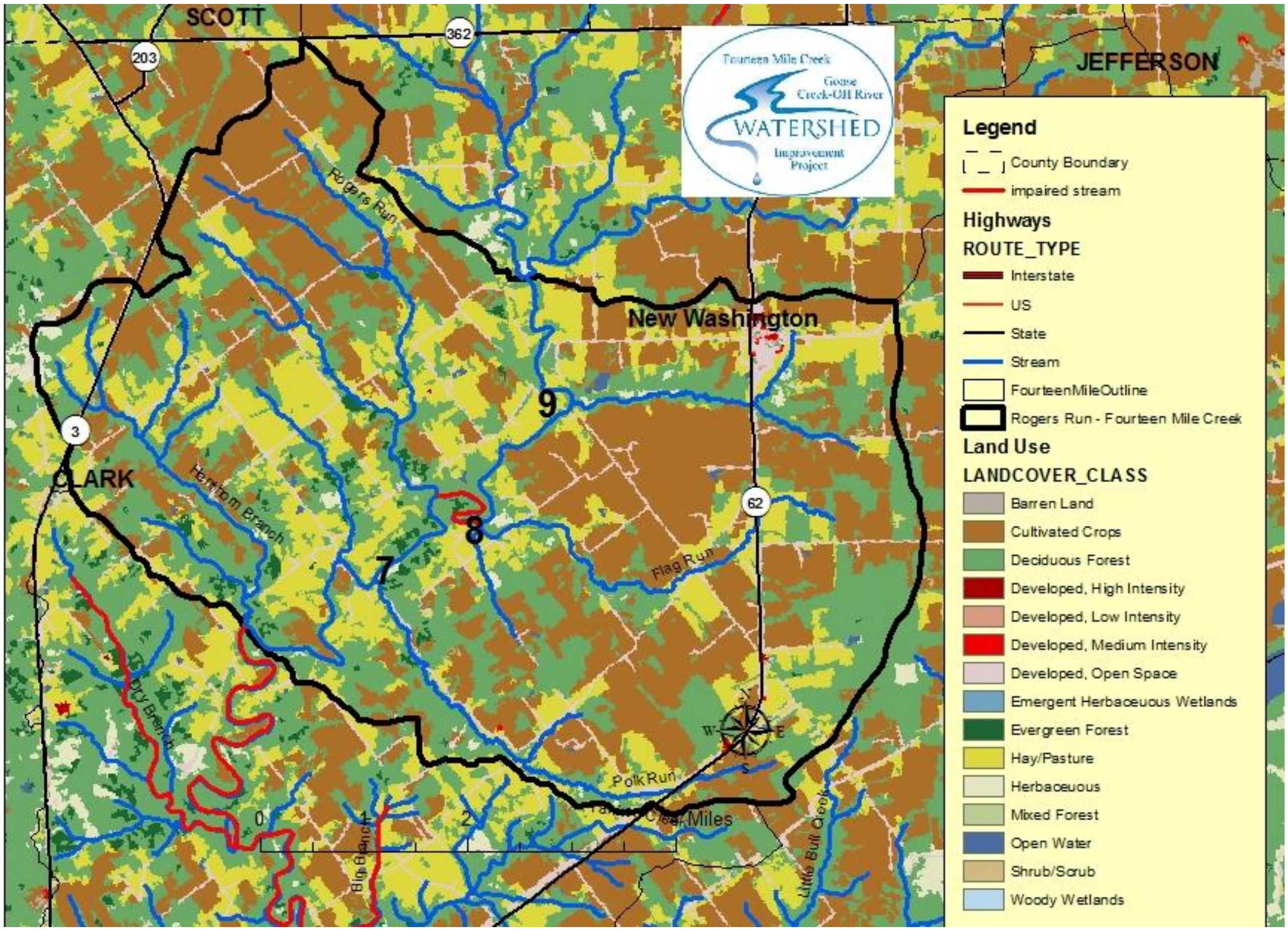
Figure 60: Rogers Run Subwatershed



Rogers Run is home to water sampling sites 7, 8, and 9. Site 7 is located at the confluence of Polk Run and Fourteen Mile Creek, with access next to a bridge on Zimmerman Road east of New Market Rd. The location of Site 7 roughly corresponds to the location of IDEM's sampling site OSK070-0002. Results of IDEM's monitoring is given in Figure 61 below.

Figure 61: IDEM Sampling Results for Site ID OSK070-0002, 2000 Corvallis

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	1.63	mg/L	2/3	67%
Dissolved Oxygen	7.70	mg/L	0/3	0%
Total Phosphorus	0.07	mg/L	1/3	33%
Turbidity	1.2	NTU	0/1	0%
Total Suspended Solids	10	mg/L	0/3	0%
IBI (macros)	4.2	points	0/1	0%
QHEI (macros)	66	points	0/1	0%
IBI (fish)	50	points	0/1	0%
QHEI (fish)	66	points	0/1	0%
Notes: No water quality standard violations. Nitrate and total phosphorus exceeded project targets.				

As noted in the results above, IDEM found nitrates exceeding their project target 67% of the time at the OSK070-0002 site. Our HRW volunteers also recorded high levels of nitrates at Site 7 (exceeding the target 48% of the time with a single occurrence as high as 44mg/L), as well as BOD (failed to meet the target 52% of the time). Total phosphorus levels were just over the target in 2014 (.076), but fell to less than half that (.037) in 2015. This resulted in a final average below target.

Biological assessments were consistently low for this site, indicating that this stream segment may be impaired for biotic communities. Pollution Tolerance Index scores were in the “bad” category both times HRW volunteers sampled; professional sampling returned an “impaired” score each instance.

E.coli sampling gave mixed results as heavy rains sent E.coli levels soaring during the 5-week sampling period in 2014, causing Site 7 to have the highest geometric mean of all sites (811.63 CFU/100 m/L). In 2015, Site 7’s geometric mean dropped to 84.46.

The land surrounding Site 7 is predominantly used for pasture, and the production of hay and row crops. As the above results indicate, this stream segment is likely receiving runoff from the application of fertilizers to that land, in addition to waste from livestock, which are causing the elevated levels of nutrients, and impairing water quality. Failed or malfunctioning septic systems are also a suspect here in the elevated E.coli results, as this is an unsewered area. A complete water quality summary for this site is given below in Figure 62. *This site sampled only 21 times due to weather conditions.*

Figure 62: Site 7 Water Quality Analysis – Rogers Run Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	7.16	mg/L	10/21	48%
Nitrites	0	mg/L	0/21	0%
Temperature	15.47	Celsius	0/21	0%
Dissolved Oxygen	10.53	mg/L	0/21	0%
BOD	2.33	mg/L	11/21	52%
Total Phosphorus	.0565	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/21	0%
Turbidity	14.66	NTU	0/21	0%
Water Quality Index	75.84	%	4/21	19%
CQHEI	70.9	points	0/4	0%
E. coli	811.63 (2014) 84.46 (2015)	CFU / 100mL	5/5 1/5	100% 20%
Pollution Tolerance Index (Macros)	7 (2014) 10 (2015)	points	1/1 1/1	100% 100%
mIBI	30 (2014) 30 (2015)	points	1/1 1/1	100% 100%

Site 8 is located along Rogers Run – Fourteen Mile Creek, off of a bridge on New Market Road north of Faye Amick Road. This stream segment is listed on IDEM's 2012 303(d) list as impaired for E.coli. Ease of access afforded by the bridge, and the fact that the stream segment is on the 303(d) list, led to the selection of Site 8 for sampling. The location of Site 8 roughly corresponds to the location of IDEM's sampling site OSK070-0014. Results of IDEM's monitoring are given below in Figure 63.

Figure 63: IDEM Sampling Results for Site ID OSK070-0014, 2005 Corvallis, Corvallis E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	1.5	mg/L	1/2	50%
Dissolved Oxygen	10.21	mg/L	1/9	11%
Total Phosphorus	0	mg/L	0/2	0%
Turbidity	6.2	NTU	0/9	0%
Total Suspended Solids	5	mg/L	0/2	0%
E. coli	154	CFU/100 ml	2/5	40%
IBI (macros)	42	points	0/1	0%
QHEI (macros)	61	points	0/1	0%
IBI (fish)	52	points	0/1	0%
QHEI (fish)	82	points	0/1	0%
Notes: E.coli geomean did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.				

Site 8 exceeded the single sample E. coli target 20% of the time in 2014, but not at all in 2015. As a result, the geometric mean exceeded the project target in 2014 (278.85 CFU/100 mL), but was well under in 2015 (62.88 CFU/100 mL). As stated previously, this disparity could be attributed to heavy rains during the 2014 sampling period.

Nitrates were high at this site 41% of the time. The average of 3.32 mg/L exceeds the target for this project of 1.5 mg/L. As noted in the results above, IDEM also found nitrates exceeding their project target 50% of the time at the OSK070-0014 site. BOD also exceeded the project target 50% of the time, and resulted in a final average of 2.17 mg/L over the sampling period. Total phosphorus levels were just over the target in 2014 (.076), but fell by almost half (.044) in 2015. This resulted in a final average below target.

Biological assessments were mixed at this site. Pollution Tolerance Index scores were in the "good" category both times HRW volunteers sampled. Professional sampling, however, returned an "impaired" score each instance, with 2015 scoring lower than 2014. These results suggest that this stream segment may be impaired for biotic communities; future samplings would be recommended to make that determination.

Like Site 7, Site 8 is in an area where land is being used for pasture, and the production of hay and row crops. Therefore, the stream segment is likely receiving runoff from the application of fertilizers, and animal waste, which are causing the elevated levels of nutrients, and impairing water quality. Failed or malfunctioning septic systems are also a suspect here in the elevated E.coli results, as this is an unsewered area. A complete water quality summary is given below in Figure 64.

Figure 64: Site 8 Water Quality Analysis – Rogers Run Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.32	mg/L	9/22	41%
Nitrites	0	mg/L	0/22	0%
Temperature	13.95	Celsius	0/22	0%
Dissolved Oxygen	9.44	mg/L	0/22	0%
BOD	2.17	mg/L	10/20	50%
Total Phosphorus	.06	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.18	NTU	0/22	0%
Water Quality Index	76.74	%	3/22	14%
CQHEI	72.1	Points	0/4	0%
E. coli	278.85 (2014) 62.88 (2015)	CFU / 100mL	2/5 0/5	40% 0%
Pollution Tolerance Index (Macros)	17 (2014) 22 (2015)	Points	0/0 0/0	0% 0%
mIBI	32 (2014) 28 (2015)	points	1/1 1/1	100% 100%

Site 9 is located at the confluence of West Fork – Fourteen Mile, and is accessed off of a bridge on Westport Road close to intersection of New Market Road. It was chosen as a sampling site due to its proximity to the community of New Washington's wastewater treatment facility. We were curious to see to what extent, if any, the facility's discharges were affecting water quality in the stream. There is no corresponding IDEM sampling site in proximity to Site 9.

Nitrate levels were high at this site (exceeding the target 64% of the time), as were BOD (exceeding the target 50% of the time). Total phosphorus levels exceeded the target in 2014, but were below target in 2015, resulting in an average below target (.062).

E. coli results followed the same pattern as the other sites in this project, exceeding the single sample target in 2014 (60% of the time), and falling below the single sample and geometric mean target in 2015. Biological assessments were fairly consistent at this site. The Pollution Tolerance Index score for 2014 was "excellent", and "good" in 2015 when HRW volunteers sampled. Professional sampling returned an "impaired" score each instance, however, the scores (34 each year) were just under the target (>35). Details of the water quality analysis for Site 9 are given below in Figure 65.

Figure 65: Site 9 Water Quality Analysis – Rogers Run Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	4.59	mg/L	14/22	64%
Nitrites	0	mg/L	0/22	0%
Temperature	14.41	Celsius	0/22	0%
Dissolved Oxygen	9.25	mg/L	0/22	0%
BOD	2.94	mg/L	11/22	50%
Total Phosphorus	.062	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.00	NTU	0/22	0%
Water Quality Index	74.59	%	2/22	10%
CQHEI	65.3	Points	1/4	25%
E. coli	492.22 (2014) 124.14 (2015)	CFU / 100mL	3/5 0/5	60% 0%
Pollution Tolerance Index (Macros)	23 (2014) 19 (2015)	points	0/0 0/0	0% 0%
mIBI	34 (2014) 34 (2015)	points	1/1 1/1	100% 100%

IDEM has two additional sampling sites within this subwatershed: Site IDs OSK070-0005 and OSK070-0018. These sites are located in the south central portion of this subwatershed, and are downstream from all sampling sites discussed above. Data obtained from these sites follows Figures 66 and 67.

Figure 66: IDEM Sampling Results for Site ID OSK070-0005, 2005 Corvallis, USGS E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Dissolved Oxygen	10.90	mg/L	2/5	40%
Turbidity	7.29	NTU	0/5	0%
E. coli (geomean)	105	CFU/100 ml	1/5	20%
Notes: No water quality standard violations.				

Figure 67: IDEM Sampling Results for Site ID OSK070-0018, 2010 Corvallis, Corvallis E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	1.83	mg/L	1/2	50%
Dissolved Oxygen	8.41	mg/L	0/8	0%
Total Phosphorus	0	mg/L	0/2	0%
Turbidity	9.0	NTU	0/7	0%
Total Suspended Solids	5	mg/L	0/2	0%
E. coli (geomean)	>230	CFU/100 ml	2/5	40%
IBI (macros)	44	points	0/1	0%
QHEI (macros)	45	points	1/1	100%
IBI (fish)	52	points	0/1	0%
QHEI (fish)	72	points	0/1	0%
Notes: E.coli geomean did not meet water quality standards and segment is designated as impaired. Nitrate exceeded project targets.				

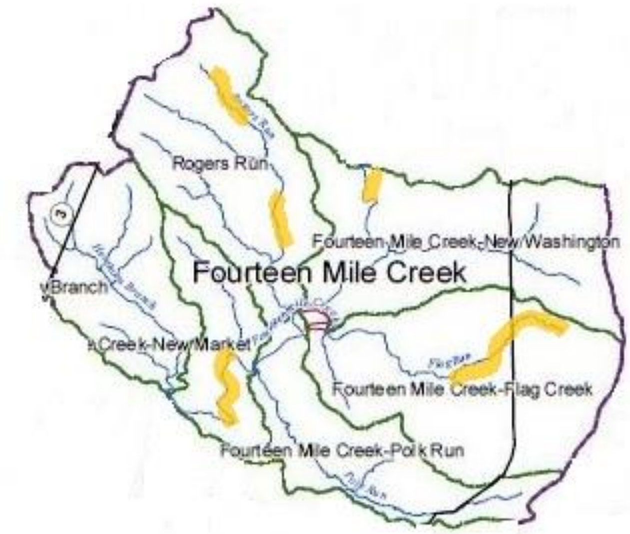
Though there are no water quality standard violations at Site OSK070-0005, nitrate levels are somewhat elevated. Excess nitrates, and high E.coli levels, are present at Site OSK070-0018; QHEI score indicates poor habitat. Again, land use in this area is likely contributing runoff fertilizer application, and animal waste, causing the elevated levels of nutrients, and impairing water quality. Failed or malfunctioning septic systems may also be factors in the elevated E.coli results.

Data was collected on the Rogers Run subwatershed by observation of 11 sites during the aforementioned windshield survey. More than half the sites observed had areas that could benefit from heavy use area protection (HUAP), which is not a specifically identified stakeholder concern, but one with potential for soil erosion/degradation. Overgrazing, and animals accessing waterbodies, were prevalent at the sites in this subwatershed, while a minimal amount of conventional tillage and gully erosion existed; all of these issues are stakeholder concerns. Complete results of the windshield survey for Rogers Run subwatershed are listed below in Figure 68.

Figure 68: Rogers Run Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Eleven Sites Surveyed
Overgrazed	9
HUAP Needed	11
Animals with Access to Waterbodies	6
Conventionally Tilled	2
Gully Erosion	1

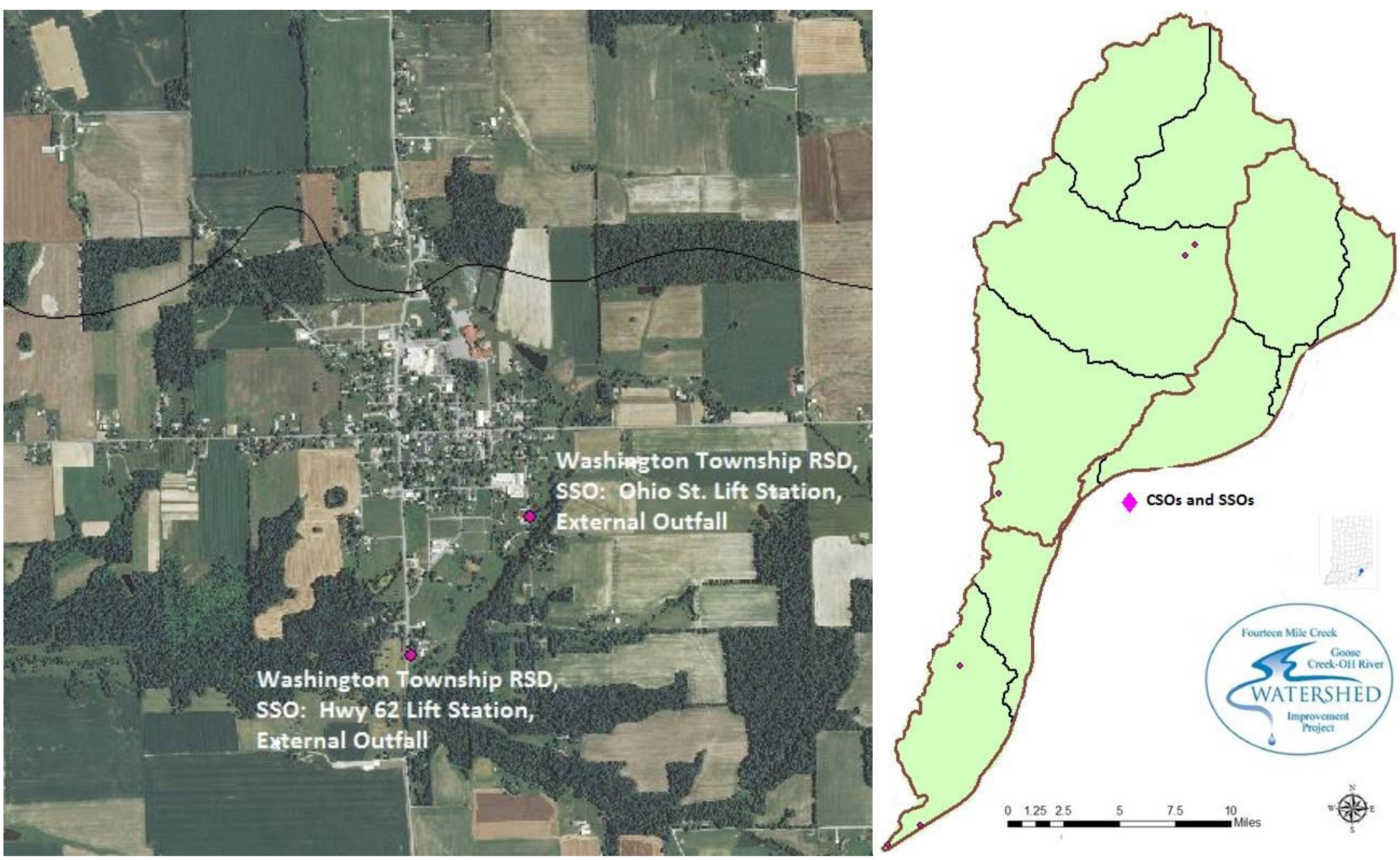
Figure 69: Rogers Run – Fourteen Mile Creek Subwatershed Stream Banks Needing Buffers



The desktop survey completed during this project to determine stream miles in need of buffers, revealed a total of 3.41 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 69 represents these miles. Additionally, as discussed in Section 2.2.11, some of these miles are likely to require bank stabilization if livestock have been accessing and degrading them where buffers are not present.

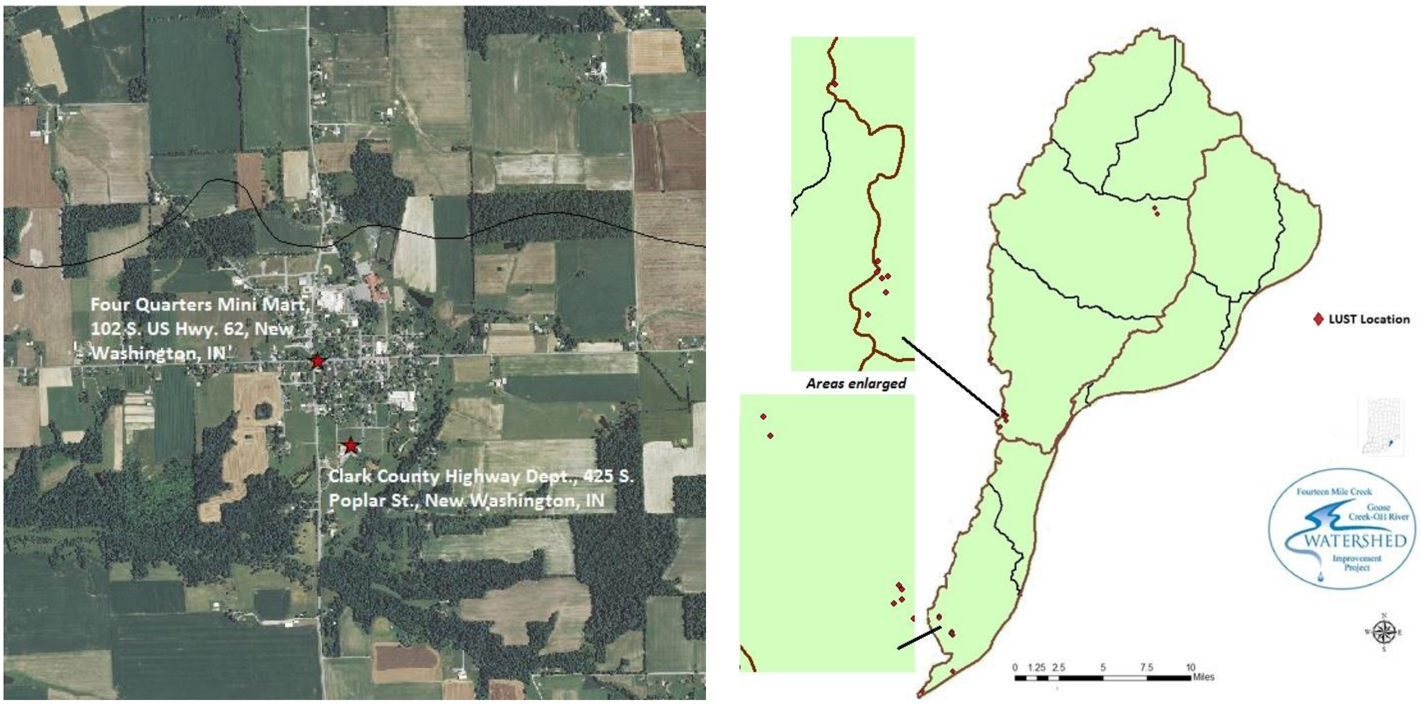
Two LUSTs are located in the community of New Washington, as well as two SSOs. The two SSOs are part of the Washington Township Regional Sewer District (RSD), and have external outfalls into Fourteen Mile Creek. The locations of these SSOs are pictured below in Figure 70.

Figure 70: SSO Locations in Rogers Run Subwatershed



The two LUST locations found in this subwatershed are located in New Washington, IN, at the Four Quarters Mini Mart, and the Clark County Highway Department, as displayed below in Figure 71.

Figure 71: LUST Locations in Rogers Run Subwatershed



No Brownfields are found in this subwatershed.

2.3.4 Dry Branch – Fourteen Mile Creek (051401010404)

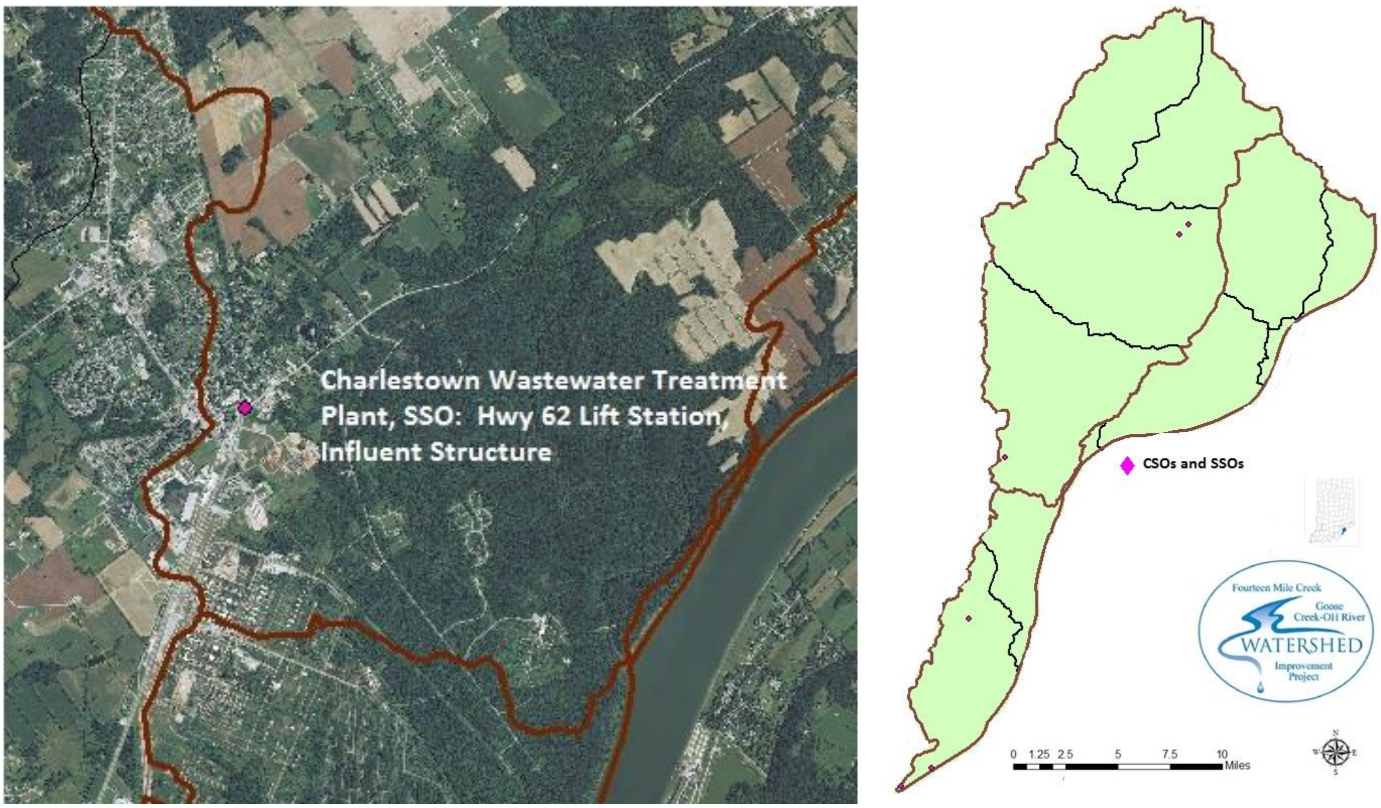
The Dry Branch – Fourteen Mile Creek subwatershed is the second largest of the subwatersheds, containing 18,396 acres, and is located in the western half of the Fourteen Mile Creek/Goose Creek watersheds. Forest land comprises more than half the acreage of this subwatershed (55.26%). The remaining acreage is divided closely in use between cultivated cropland (18.33%) and pasture/hayland (15.28%), with much smaller percentages in various land use capacities.

New development is reaching towards this subwatershed rapidly, not only in lieu of the completion of the two Ohio River bridges, but also due to the growth occurring just south at River Ridge (Little Huckleberry Creek subwatershed). Rumors have circulated that duplex housing once built to house workers employed at INAAP, will be torn down, and new housing will be built to accommodate workers of the many industries located at the old plant site, but this rumor has not been confirmed to date. Some new development is occurring in this subwatershed currently, but at a slow pace. Anecdotal evidence alludes to the presence of hobby farms scattered throughout this watershed, which may increase in number if new growth consumes farm homesteads.

Portions of the City of Charlestown lie within this watershed, and are included in the total percentage of developed acres (7.76%). Charlestown was cited by the IDEM in 2005 for sanitary sewer overflows (SSOs) that would occur during heavy rains. In four separate areas in Charlestown, manhole covers were being pushed off of the sewers because of wastewater overwhelming the sewer system, which ran from Spring Street through Greenway Park.

According to the agreed order, Charlestown was required to perform a Sanitary Sewer Evaluation Study and to make improvements to deficiencies in the system found during the course of the study. The city met compliance with IDEM requirements May 14, 2012.

Figure 72: SSO Location in Dry Branch-Fourteen Mile Creek Subwatershed

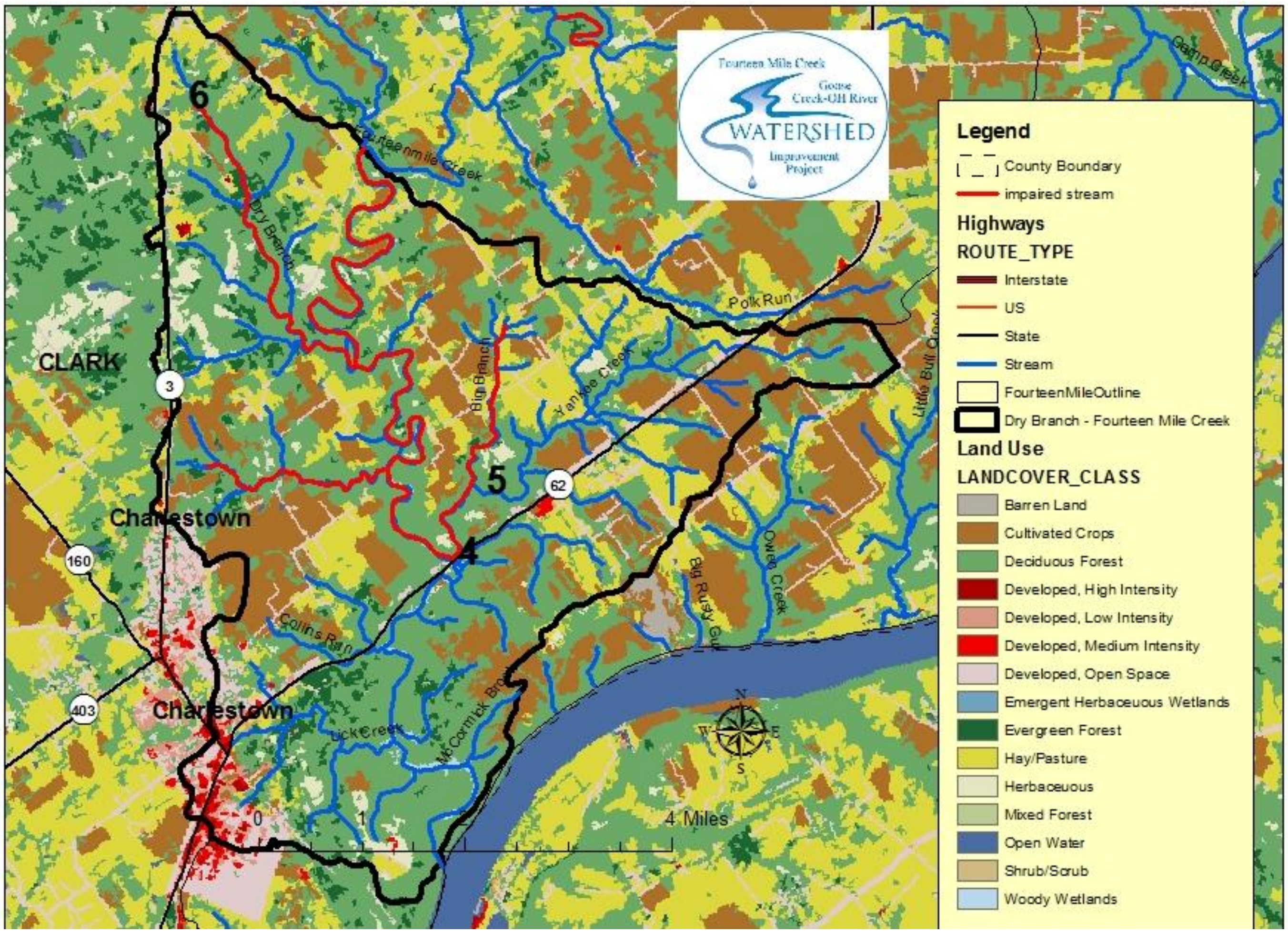


Dry Branch – Fourteen Mile Creek subwatershed is unique in that it contains all but two of the impaired streams listed on IDEM's 303 (d) list for the Fourteen Mile Creek/Goose Creek watersheds. It also unique in that it's the only subwatershed in the project to contain a nature preserve (Nine Penny Branch) with an impaired stream flowing through it. To offer a better analysis and understanding of the streams, and possibly support IDEM's designation of E.coli impairment, three sites were selected for sampling in this subwatershed. Sites 4, 5, and 6 are located on or within close proximity to the impaired stream segments. There are some livestock operations near the test sites, as well as approximately 800 homes utilizing septic systems for waste disposal.

Charlestown State Park is located in this subwatershed. Contained within the park is another of the three nature preserves in the project area, the Fourteenmile Creek Nature Preserve. This preserve covers 1602 acres of the park, and although a stream flows through it, the stream has not been determined to be impaired. Both park and preserve are open to the public.

Sinkholes, representative of the karst topography in this subwatershed, are abundant in the Dry Branch – Fourteen Mile Creek subwatershed. As aforementioned (Section 2.2.11), the hollow nature of karst terrain makes it very susceptible to pollution as runoff bypasses the natural filtration from the soil, making their source is difficult to determine. Documentation of the management of sinkholes in the Fourteen Mile Creek/Goose Creek watersheds as a whole, and in this subwatershed, is not available, however, anecdotal evidence indicates that landowners are for the most part unsure how to address sinkholes on their properties. As a result, they tend to fill them with materials on hand such as dirt, rock, or non-biodegradable items. Farmers who are row-cropping seem to be more inclined to fill sinkholes in crop fields with rock, and/or plant around them. NRCS-USDA's Conservation Reserve Program (CRP) can assist landowners in installing filter strips around sinkholes in fields, however landowners have not taken advantage of this program to any extent in this area.

Figure 73: Dry Branch – Fourteen Mile Creek Subwatershed



Site 4 is located at the confluence of Nine Penny Creek, Big Branch Creek, and Dry Branch Creek next to a bridge on Tunnel Mill Road. Site 4 is closest to the Nine Penny Branch Nature Preserve. HRW volunteers noted a change in the flow of the stream at this location after the devastating flood events of July 2015. Debris in the form of trees and other vegetation collected in the natural path of the stream during those events, so much so that the stream has now created a new path away from the debris.

IDEM has an established a monitoring site in the vicinity of Site 4 (Site ID OSK 070-0011, Assessment Unit ID: INN0179_00). Monitoring results are given below in Figure 74. This segment has been designated as impaired for E.coli.

Figure 74: IDEM Sampling Results for Site ID OSK070-0011, 2000 USGS E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Dissolved Oxygen	7.41	mg/L	0/5	0%
Turbidity	5.15	NTU	0/5	0%
E. coli (geomean)	136	CFU/100 ml	1/5	20%
Notes: E.coli geomean did not meet water quality standards and segment is designated as impaired.				

HRW monitoring found nitrates at Site 4 exceeding the target 41% of the time, and BOD exceeding the target 36% of the time. Total phosphorus levels were over the target in 2014 (.089), but well under (.026) in 2015. This resulted in a below target average.

E. coli exceeded the geometric mean target in 2014 due only to an extremely high reading after a heavy rainfall event. Otherwise, single sample readings at this site were low to negligible for each sample taken, and the geometric mean for 2015 was well below target. Considering that this site is at the confluence of three impaired stream segments, higher readings for the course of sampling would have been expected. Results at this site seem to refute E.coli impairment, however, future testing would be advisable to confirm that. A complete water quality summary for Site 4 is below in Figure 75.

Figure 75: Site 4 Water Quality Analysis – Dry Branch – Fourteen Mile Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.18	mg/L	9/22	41%
Nitrites	0	mg/L	0/22	0%
Temperature	14.81	Celsius	0/22	0%
Dissolved Oxygen	9.62	mg/L	0/22	0%
BOD	2.74	mg/L	8/22	36%
Total Phosphorus	.0575	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.18	NTU	0/22	0%
Water Quality Index	76.81	%	3/22	14%
CQHEI	65.8	points	1/4	25%
E. coli	263.49 (2014) 83.93 (2015)	CFU / 100mL	1/5 0/5	20% 0%
Pollution Tolerance Index (Macros)	18 (2014) 11 (2015)	points	0/1 1/1	0% 100%
mIBI	42 (2014) 34 (2015)	points	0/1 1/1	0% 100%

Site 5 is located at the confluence of Yankee Creek, and 2 unnamed tributaries, at a bridge off of Salem Church Road. E.coli impairment was a concern at this site due potential runoff from nearby livestock areas. However, it was the only site that didn't exceed the geometric mean target (<125 CFU/100 mL) for E. coli for either sampling year. The geometric mean for 2014 was 65.75, and for 2015 it was 99.65.

Nitrate levels at this site were higher than any other site in the project. Single samples did not meet the target 68% of the time, and the resulting average of 8.86 mg/L was considerably above target. BOD levels were also high, but not to the extreme of the nitrates. BOD exceeded the target 55% of the time. Total phosphorus levels were well below target for both years sampled, resulting in a low average (.029).

Site 5 received a "bad" rating for the pollution tolerance index both years of the project, an indication of low biodiversity, and impaired biotic communities. Professional samplings supported volunteer data as mIBI scores were in the "impaired" range. A complete water quality summary for Site 5 is given below in Figure 76.

Figure 76: Site 5 Water Quality Analysis – Dry Branch – Fourteen Mile Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	8.86	mg/L	15/22	68%
Nitrites	0	mg/L	0/22	0%
Temperature	15.64	Celsius	0/22	0%
Dissolved Oxygen	10.91	mg/L	0/22	0%
BOD	2.70	mg/L	12/22	55%
Total Phosphorus	.029	mg/L	0/2	0%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.05	NTU	0/22	0%
Water Quality Index	75.21	%	3/22	14%
CQHEI	66.5	points	0/4	0%
E. coli	65.75 (2014) 99.65 (2015)	CFU / 100mL	0/5 0/5	0% 0%
Pollution Tolerance Index (Macros)	9 (2014) 8 (2015)	points	1/1 1/1	100% 100%
mIBI	28 (2014) 28 (2015)	points	1/1 1/1	100% 100%

Located at the most northeastern point of this subwatershed, Site 6 is next to a bridge on Gum Corner Road. The stream on which Site 6 is located is identified as impaired for E. coli on IDEM's 2012 303(d) list; the site was chosen for this reason. It proved difficult to confirm IDEM's findings, however. As with other sites in this project, E.coli levels were considerably higher in the rainy 2014 sampling (geometric mean 331.93), falling much lower in 2015 (geometric mean 81.57). Future testing would be advisable to determine impairment.

Although nitrate levels at this site exceeded the target 37% of the time, the average (.99 mg/L) is lower than any other site in the project, and well below the project target. BOD levels were also low, exceeding the target only 5% of the time. Total phosphorus levels at this site were lowest of all sites in the project (.0175 mg/L), and well below target.

Site 6 scored lower than any site in the project in 2015 with a "bad" rating (score of 3) for the pollution tolerance index. And, if you average the 2014 score (8) with that, Site 6 had the lowest average (5.5) of any site in the project. Professional samplings supported volunteer data as mIBI scores were in the "impaired" range. It would appear that this stream warrants a 303(d) "impaired" designation for biodiversity and biotic communities. A complete water quality summary for Site 6 is given below in Figure 77. *This site sampled only 19 times due to weather conditions.*

Figure 77: Site 6 Water Quality Analysis – Dry Branch – Fourteen Mile Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	.99	mg/L	7/19	37%
Nitrites	0	mg/L	0/19	0%
Temperature	13.95	Celsius	0/19	0%
Dissolved Oxygen	8.34	mg/L	0/19	0%
BOD	0.92	mg/L	1/19	5%
Total Phosphorus	.0175	mg/L	0/2	0%
Orthophosphate	0	mg/L	0/19	0%
Turbidity	15.94	NTU	1/19	6%
Water Quality Index	74.25	%	2/19	11%
CQHEI	69.5	points	0/4	0%
E. coli	331.93 (2014) 81.57 (2015)	CFU / 100mL	2/5 0/5	40% 0%
Pollution Tolerance Index (Macros)	8 (2014) 3 (2015)	Points	1/1 1/1	100% 100%
mIBI	30 (2014) 30 (2015)	points	1/1 1/1	100% 100%

IDEM has an additional monitoring site on Yankee Creek (Site ID OSK 070-0001), upstream from our Site 5. Monitoring results are given below in Figure 78. This segment has not been designated as impaired, but nitrate and phosphorus levels exceeded the project targets.

Figure 78: IDEM Sampling Results for Site ID OSK070-0001, 2000 Corvallis

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	1.02	mg/L	1/3	33%
Dissolved Oxygen	8.91	mg/L	1/3	33%
Total Phosphorus	1.13	mg/L	3/3	100%
Turbidity	52	NTU	1/1	100%
Total Suspended Solids	21	mg/L	1/3	33%
IBI (fish)	20	points	1/1	100%
QHEI (fish)	47	points	1/1	100%
Notes: Fish IBI did not meet water quality standards, but segment was not designated as impaired. Nitrate and total phosphorus exceeded project targets.				

Data was collected on the Dry Branch – Fourteen Mile Creek subwatershed by observation of 8 sites during the aforementioned windshield survey. Animals accessing waterbodies was the most commonly identified problem on the sites. Locations in need of heavy use area protection, and where land was overgrazed, were equal in frequency of occurrence. Conventional tillage was noted at one site, as was livestock accessing woodlands, and gully erosion. All these issues are stakeholder concerns with the exception of areas needing heavy use protection, which, as noted previously in this narrative, have the potential for soil erosion/degradation. Complete results of the windshield survey for the Dry Branch – Fourteen Mile Creek subwatershed follow below in Figure 79.

Figure 79: Dry Branch – Fourteen Mile Creek Subwatershed Windshield Survey Results

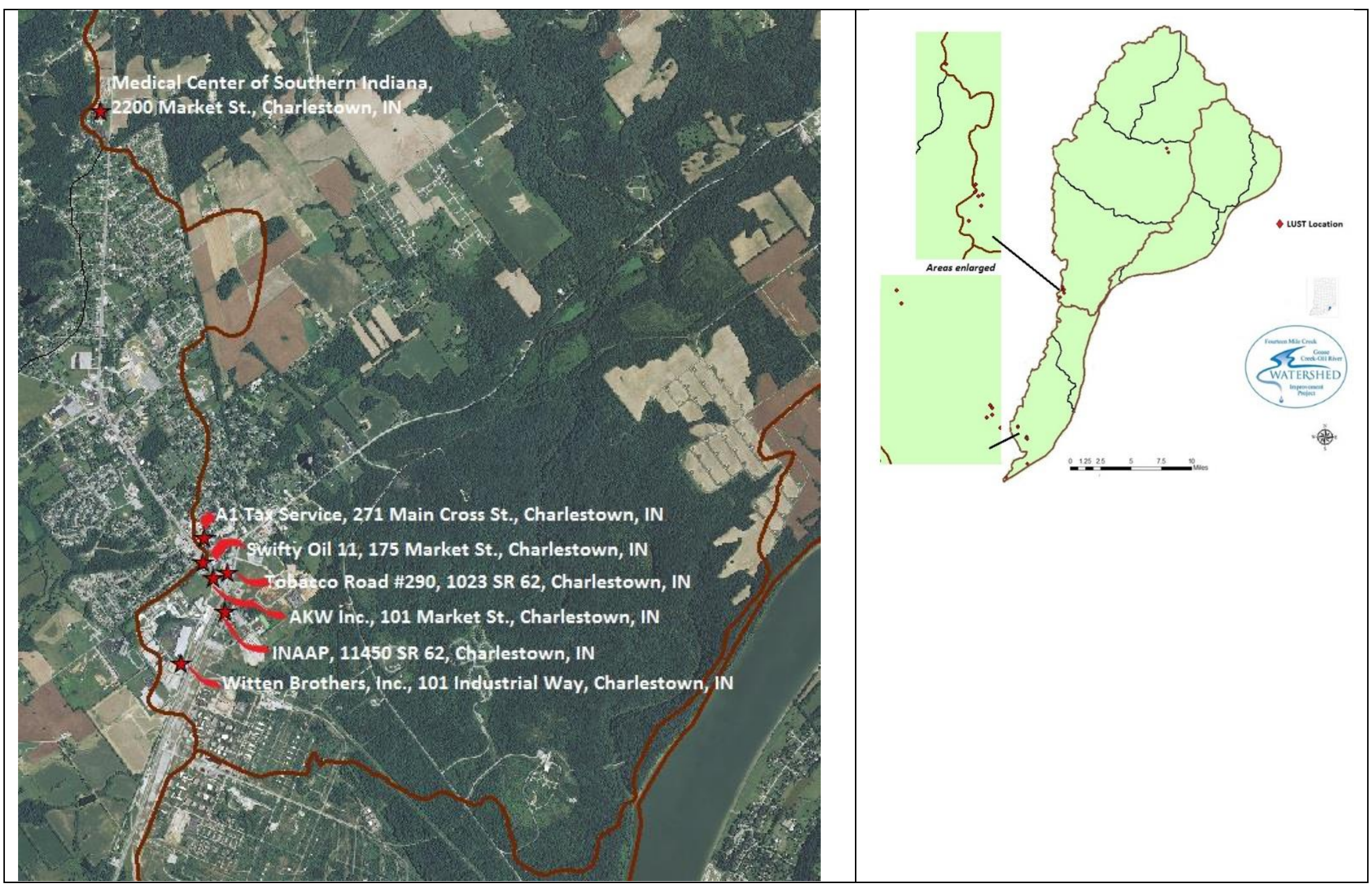
Problem/Issue Observed	Number of Occurrences in the Eight Sites Surveyed
Overgrazed Land	2
HUAP Needed	2
Animals with Access to Waterbodies	3
Conventionally Tilled	1
Livestock with Access to Woodland *(erosion, habitat deterioration observed)*	1
Gully Erosion	1

The desktop survey completed during this project to determine stream miles in need of buffers, revealed a total of 1.23 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 80 represents these miles. Additionally, as discussed in Section 2.2.11, some of these miles are likely to require bank stabilization if livestock have been accessing and degrading them where buffers are not present.

Figure 80: Dry Branch – Fourteen Mile Creek Subwatershed Stream Banks Needing Buffers

Seven LUSTs are located this subwatershed within the City of Charlestown: Medical Center of Southern Indiana, A1 Tax Service, Swifty Oil, Tobacco Road #290, AKW, Inc., INAAP, and Witten Brothers, Inc. Figure 81 displays their locations.

Figure 81: LUST Locations Dry Branch – Fourteen Mile Creek Subwatershed



No Brownfields are found in this subwatershed.

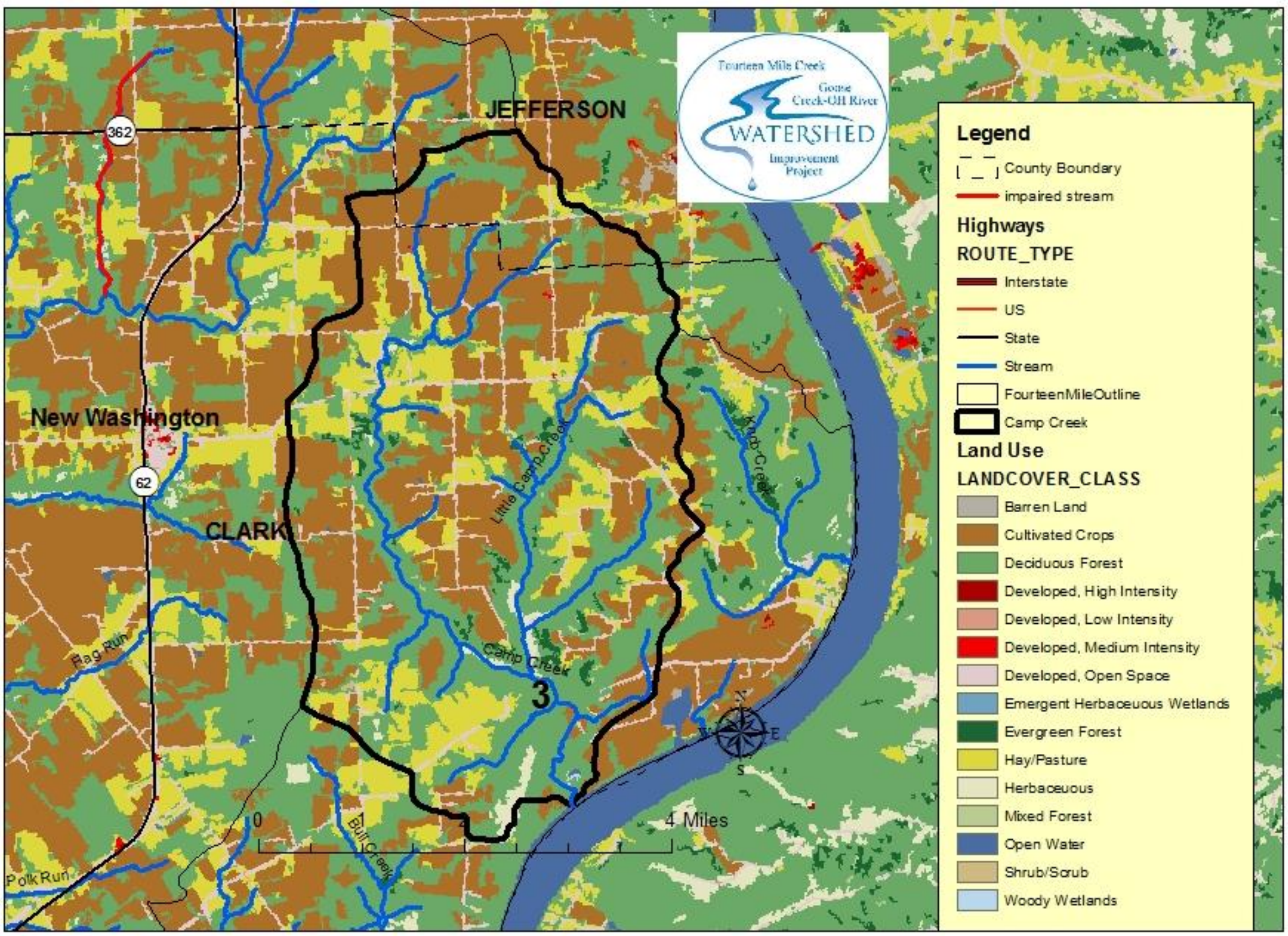
2.3.5 Camp Creek (051401010601)

The Camp Creek subwatershed is located at the eastern corner of the watershed. The majority of the watershed's 12,563 acres are contained in Clark County, however, its most northern acres flow into Jefferson County. It is the home of sampling site 3.

Land use in Camp Creek is almost evenly split between cultivated cropland (38.80%) and forested land (39.86%). Areas of pasture and hay land (15.05%) are the only other predominant land use. There is a small amount of developed, open space (4.77%), leaving this subwatershed rural in nature. Anecdotal evidence indicates a minimal number of hobby farms in this subwatershed. Public recreational areas are lacking at present.

As with the other subwatersheds in the northern reaches of the project area, development may eventually reach this subwatershed as a result of the Ohio River bridges construction. However, at present, industry is not prominent, and new development occurring in this subwatershed is minimal. Land use in the Camp Creek subwatershed is mapped below in Figure 82.

Figure 82: Camp Creek Subwatershed



Site 3 is located at the confluence of Camp Creek and Little Camp Creek, and was chosen due to the easy access next to a bridge on Flintridge Road at its intersection with Bethlehem Rd. HRW volunteers noted a change in the conditions of the stream at this location after the devastating flood events of July 2015. The path of the stream has changed – not from debris preventing its flow as is the case at Site 4, but just a change in how it meanders. The bed of the stream has also changed with the new flow, with rocks being more numerous, and the bed being deeper in some sections. This is particularly true directly under the bridge. HRW volunteers were able to wade this section at the beginning of this project, but can no longer do that safely.

Nitrate levels exceeded the target at this site 45% of the time. BOD levels were also high, but not to the extreme of the nitrates. BOD exceeded the target 55% of the time. The highest total phosphorus level for the project was recorded at Site 3 in 2014 (.119 mg/L). The level dropped drastically in 2015 (.021 mg/L), leaving it with an overall average (.07 mg/L) just at the target.

Site 3's WQI scores stayed above target (> 69%) throughout the sampling period, ending with an average score of 76.21%, however, it did not fare as well when habitat was evaluated. CQHEI scores were fairly close, but below target, in the 2014 volunteer (53 points) and professional samplings (54 points). Scores in 2015 were somewhat contradictory as volunteers scored it higher (57.5 points) than the professionals (37 points). Nonetheless, the site's 50.4 overall point average leaves it below target. Site 3 exceeded the single sample target for E. coli on two occurrences, of course, during rainy 2014, but also twice in 2015. Geometric means for each year exceeded the target, but were fairly close to each other. Further testing would be advised to deem it impaired. A complete water quality summary for Site 3 is given below in Figure 83.

Figure 83: Site 3 Water Quality Analysis – Camp Creek Subwatershed

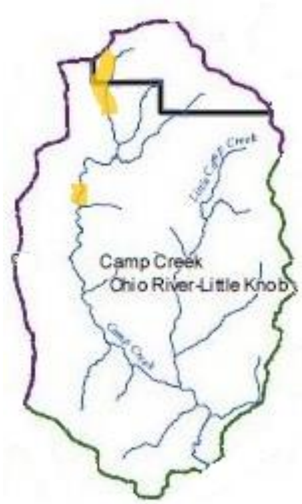
Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	4.68	mg/L	10/22	45%
Nitrites	0	mg/L	0/22	0%
Temperature	13.95	Celsius	0/22	0%
Dissolved Oxygen	10.29	mg/L	0/22	0%
BOD	2.79	mg/L	9/22	41%
Total Phosphorus	.07	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.10	NTU	0/22	0%
Water Quality Index	76.21	%	0/22	0%
CQHEI	50.4	points	1/1	100%
E. coli	196.75 (2014) 147.91 (2015)	CFU / 100mL	2/5 2/5	40% 40%
Pollution Tolerance Index (Macros)	30 (2014) 11 (2015)	Points	0/1 1/1	0% 100%
mIBI	36 (2014) 26 (2015)	points	0/1 1/1	0% 100%

Data was collected on the Camp Creek subwatershed by observation of 10 sites during the aforementioned windshield survey. Gully erosion was most frequent in occurrence, being observed at 5 sites, while livestock with free access to waterbodies, overgrazing, heavy use areas needing protection, and land being conventionally tilled were all close behind with 4 occurrences each. Livestock accessing woodlands were noted at two sites, and one instance of sheet and rill erosion was found. As noted previously, areas needing heavy use protection is not specifically listed as a stakeholder concern, but they do have the potential for soil erosion/degradation. Dumping sites are not specifically mentioned either, but can be related to the concern of trash/litter found in streams. All other issues observed are stakeholder concerns. A complete result of the windshield survey in the Camp Creek subwatershed are given below in Figure 84.

Figure 84: Camp Creek Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Ten Sites Surveyed
Overgrazed Land	4
HUAP Needed	4
Animals with Access to Waterbodies	4
Conventionally Tilled	4
Gully Erosion	5
Sheet & Rill Erosion	1
Livestock with Access to Woodland *(erosion, habitat deterioration observed)*	2

Figure 85: Camp Creek Subwatershed Stream Banks Needing Buffers



The desktop survey completed during this project to determine stream miles in need of buffers, identified .82 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 85 represents these miles. Additionally, as discussed in Section 2.2.11, some of these miles are likely to require bank stabilization if livestock have been accessing and degrading them where buffers are not present.

No LUSTs or Brownfields are found in this subwatershed.

2.3.6 Pattons Creek – Ohio River (051401010602)

Pattons Creek subwatershed is located in the northeastern corner of the watersheds, with its eastern border being the Ohio River. It is the smallest of the subwatersheds containing 4,396.8 acres. There are no sample sites in the Pattons Creek subwatershed, therefore windshield surveys, and stakeholder observations provide us insight into the water quality.

More than half the land in the Pattons Creek forested (53.21%). Forest land has a higher potential for wildlife waste pollution - a stakeholder concern - but at the same time, it allows for increased natural filtration of water. Land in use for cultivating crops takes another primary percentage (29.90%); corn and soybeans are the main crops grown on these lands. Less pasture and hay land (5.37%), and more open water (5.10%) is found in this subwatershed as compared to others in the Fourteen Mile Creek/Goose Creek watersheds.

Developed land is minimal (4.84%). As with the other subwatersheds in the northern reaches of the project area, development may eventually reach this subwatershed as a result of the Ohio River bridges construction. However, at present, industry is not prominent, and new development occurring in this subwatershed is minimal. Anecdotal evidence indicates few hobby farms; public recreation areas are not present.

Areas of karst topography, and its associated sinkholes, are scattered throughout this subwatershed. We have discussed nature of karst terrain, and its high susceptibility to pollution, earlier in this document (Section 2.2.1). Documentation of the management of sinkholes in the Fourteen Mile Creek/Goose Creek watersheds as a whole, and in this subwatershed, is not available. Anecdotal evidence from stakeholders indicates that landowners tend to fill them with materials on hand such as dirt, rock, or non-biodegradable materials. Farmers who are row-cropping seem to be more inclined to fill sinkholes in crop fields with rock, and/or plant around them. NRCS-USDA's Conservation Reserve Program (CRP) can assist landowners in installing filter strips around sinkholes in fields, however landowners have not taken advantage of this program to any extent in this area.

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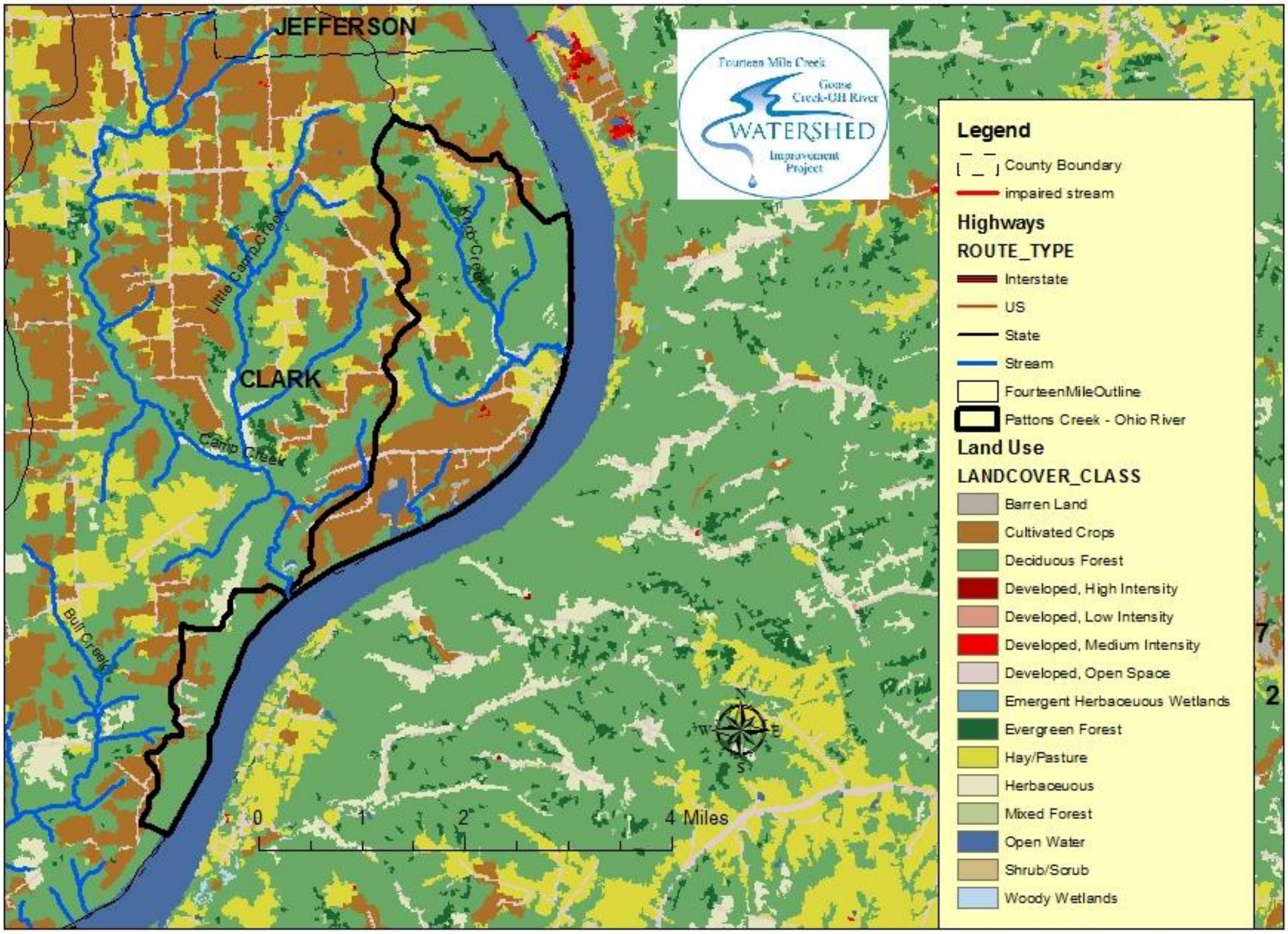
Figure 86: Pattons Creek – Ohio River Subwatershed



Data was collected on the Pattons Creek subwatershed by observation of 1 site during the aforementioned windshield survey. Overgrazed land, an area needing heavy use protection, and animals accessing waterbodies were noticed at that site, as was some gully, and sheet and rill erosion. All these issues are stakeholder concerns with the exception of areas needing heavy use protection, which have been noted previously to have the potential for soil erosion/degradation. Figure 87 below presents the complete results of the windshield survey in the Pattons Creek subwatershed.

Figure 87: Pattons Creek – Ohio River Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences at the One Site Surveyed
Overgrazed Land	1
HUAP Needed	1
Animals with Access to Waterbodies	1
Gully Erosion	1

The desktop survey completed during this project to determine stream miles in need of buffers, indicated buffers along stream banks in this subwatershed to be sufficient. However, Pattons Creek was designated as a subwatershed where bank stabilization may be needed due to the occurrences noted of livestock accessing waterbodies.

No LUSTs or Brownfields are found in this subwatershed.

2.3.7 Bull Creek – Ohio River (051401010603)

The Bull Creek – Ohio River subwatershed is located slightly southeast of the community of New Washington, with the Ohio River forming its eastern border. The 9,602.6 acres in this subwatershed are comprised of predominantly forested land (46.03%) and cultivated crop land (32.04%). A small amount of land is dedicated to pasture and hay (12.82%), as well as grasslands (3.41%), and development (3.81%). Albeit low, this subwatershed has the highest percentage (1.33%) of barren land. Sample site 2 is located within this subwatershed.

Located centrally within the Fourteen Mile Creek/Goose Creek watersheds, Bull Creek will likely experience increased development as the Ohio River bridges are completed, and River Ridge expands. Currently new development is minimal in this subwatershed. Anecdotal evidence says hobby farms are scattered in this subwatershed, and may increase in number with growth and consumption of farm homesteads. A public recreational area, River's Edge Marina, is located here along the Ohio River at Ohio River Mile 584.6.

Areas of karst topography, and its associated sinkholes, are scattered throughout this subwatershed. Ae discussion of karst terrain, and its high susceptibility to pollution, is found earlier in this document in Section 2.2.1. Documentation of the management of sinkholes in the Fourteen Mile Creek/Goose Creek watersheds as a whole, and in this subwatershed, is not available. Anecdotal evidence indicates that landowners resort to filling them with materials on hand such as dirt, rock, and non-biodegradable items. Farmers who are row-cropping seem to be more inclined to fill sinkholes in crop fields with rock, and/or plant around them. NRCS-USDA's Conservation Reserve Program (CRP) can assist landowners in installing filter strips around sinkholes in fields, however landowners have not taken advantage of this program to any extent in this area.

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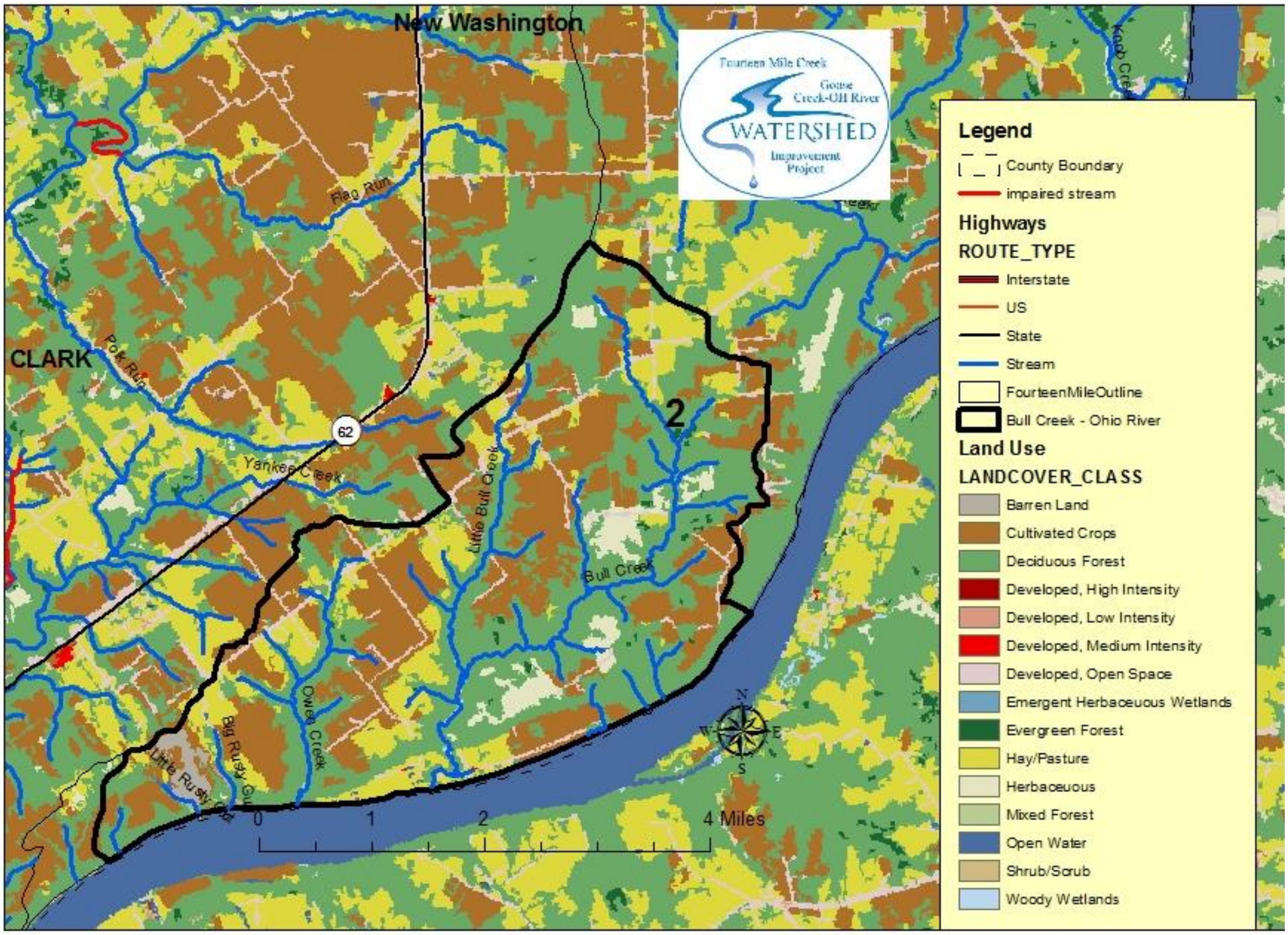
Figure 88: Bull Creek – Ohio River Subwatershed



Sample Site 2 is located on Bull Creek next to a bridge at 4308 Blue Ridge Rd., Charlestown, and in close proximity to IDEM sampling site OSK060-0001. Though this site is not far from where the stream segment feeds into the Ohio River, HRW volunteers did not experience back water conditions when sampling at this site, nor did we note those conditions during our site selection process.

Nitrate levels exceeded the project target 65% of the time at this site; nitrate levels at IDEM's site did not exceed the project target. The reverse was true with DO: our volunteers noted good flow at this site the majority of the time and recorded results within the project target; IDEM found DO not meeting the target 22% of the time, and designated the stream segment as impaired for that element. HRW samplings found BOD levels high, exceeding the target 40% of the time. Total phosphorus was above target in 2014 (.083 mg/L), but dropped dramatically in 2015 (.026 mg/L), leaving it with an overall average (.0545 mg/L) below the target.

E. coli levels at this site were erratic during the rainy 2014 sampling period, jumping from 33.3 CFU/100mL in the first week to 8,325 CFU/100mL in the fourth week, and causing the site to exceed the geometric mean project target. Results from the 2015 were quite the reverse. After maintaining a steady 33.3 CFU/100mL for the first three weeks, levels climbed to 66.6 CFU/100mL the fourth week, before finishing off the five week period at 166.6 CFU/100mL. This kept Site 2 below the geometric mean target for the year. IDEM's sampling results returned E.coli levels above target, and they have designated the stream segment as impaired. Given that the Ohio River is also designated as impaired for E.coli, the effects of backwater on these segments would be a consideration. However, as stated above, we did not note those conditions during our samplings; we are not aware of the conditions during IDEM's samplings. Future monitoring for E.coli would be recommended, especially if our project advances to the implementation phase to note any changes after BMPs are installed.

Site 2 exceeded the WQI target 30% of the time during the sampling period, however, it's 74.06% average is above the target. This site had consistently high CQHEI scores at each sampling, and the highest CQHEI score (90 points) of any site in the project. Biological data gathered during 2014 by volunteers returned an "excellent" rating in 2014 (PTI 23 points), however 2015 data showed a decline in intolerant species with a "fair" rating (PTI 16 points).

All these results taken together indicate the presence of nonpoint source pollution. Although forested land buffers most of this stream system, areas of land in use for cultivating crops and keeping livestock surround it, and in some instances, such as upstream from our Site 2, flank it. We can expect pollution from the runoff of fertilizers and animal waste. And, since this subwatershed is rural, malfunctioning and failed septics are a consideration in the high E.coli levels.

A complete summary of HRW testing results at Site 2 are below in Figure 89. Results of IDEM's sampling at Site ID OSK060-0001 immediately follow in Figure 90. *This site was sampled only 20 times during HRW sampling due to weather conditions.*

Figure 89: Site 2 HRW Water Quality Analysis – Bull Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	4.83	mg/L	13/20	65%
Nitrites	0	mg/L	0/20	0%
Temperature	13.35	Celsius	0/20	0%
Dissolved Oxygen	9.12	mg/L	0/20	0%
BOD	1.89	mg/L	8/20	40%
Total Phosphorus	.0545	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/20	0%
Turbidity	14.00	NTU	0/20	0%
Water Quality Index	74.06	%	6/20	30%
CQHEI	90	points	0/4	0%
E. coli	466.45 (2014) 52.78 (2015)	CFU / 100mL	3/5 0/0	60% 0%
Pollution Tolerance Index (Macros)	23 (2014) 16 (2015)	points	0/1 0/1	0% 0%
mIBI	40 (2014) 34 (2015)	points	0/1 1/1	0% 100%

Figure 90: IDEM Sampling Results for Site ID OSK060-0001, 2010 Corvallis, Corvallis E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	0.7	mg/L	0/3	0%
Dissolved Oxygen	7.5	mg/L	2/9	22%
Total Phosphorus	0	mg/L	0/3	0%
Turbidity	12.8	NTU	2/7	29%
Total Suspended Solids	6	mg/L	0/3	0%
E. coli (geomean)	437	CFU/100 ml	3/5	60%
IBI (macros)	44	points	0/1	0%
QHEI (macros)	60	points	0/1	0%
IBI (fish)	40	points	0/1	0%
QHEI (fish)	62	points	0/1	0%
Notes: E. coli and dissolved oxygen did not meet water quality standards and segment is designated as impaired.				

Data was collected on the Bull Creek subwatershed by observation of 5 sites during the aforementioned windshield survey. Livestock accessing waterbodies was the most frequent in occurrence, while overgrazed land, and conventional tillage were observed at two sites. Gully erosion, and heavy use areas needing protection, were present at one site each; one dumping site was found. All these issues are stakeholder concerns with the exception of areas needing heavy use protection, which, as noted previously in this narrative, have the potential for soil erosion/degradation. Complete results of the windshield survey for the Bull Creek subwatershed follow below in Figure 91.

Figure 91: Bull Creek-OH River Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Five Sites Surveyed
Overgrazed Land	2
HUAP Needed	1
Animals with Access to Waterbodies	3
Conventionally Tilled	2
Gully Erosion	1
Dumping Site	1

The desktop survey completed during this project to determine stream miles in need of buffers, indicated buffers along stream banks in this subwatershed to be sufficient. However, Bull Creek was designated as a subwatershed where bank stabilization may be needed due to the occurrences noted of livestock accessing waterbodies.

No LUSTs or brownfields are found in this subwatershed.

2.3.8 Little Huckleberry Creek (051401010604)

Little Huckleberry Creek subwatershed is located in the southern portion of the Fourteen Mile Creek/Goose Creek watersheds, and has the Ohio River as its eastern border. Little Huckleberry's upper limits include the southern portion of the town of Charlestown, and as it proceeds in a southeasterly direction from Charlestown, it takes in portions of River Ridge Development Authority (formally the INAAP referred to on page 13 of this document).

IDEM's OLQ-Hazardous Waste Permits Section oversaw environmental investigation and cleanup at the Indiana Army Ammunition Plant after its closure. Propellant, explosives, semi-volatile organic compounds, volatile organic compounds, and metals were the primary contaminants of concern. Trinitrotoluene (TNT) was produced at the plant at the north end of the base near Charlestown. This portion of the plant was constructed toward the end of the Vietnam War. It ran a single partial run as a check run, and then was closed and never used. Sampling was conducted for all contaminants, but no detrimental environmental effects were found.

The inclusion of River Ridge in this subwatershed is evidenced by the fact that 56.89% of the land is in forested acres, and another 23.88% in pasture and hay land. In the time from its abandonment in 1992 as an active ammunition manufacturing facility until it was transferred to the Development Authority in 2007, the land was in modified caretaker status. Thus forested areas became more dense and spreading, and once groomed areas became overgrown with vegetation. Open areas were rented to local producers as pasture for cattle, and at one point the plant was home to the largest cattle operation in the county. Although this subwatershed does not contain the whole of River Ridge, it does contain much of the final portion of acreage that was released from explosive residue threat and building demolition operations, and as such, is just beginning to be commercially developed. Access to some areas of River Ridge remain restricted, and other areas that are not restricted can only be accessed on foot.

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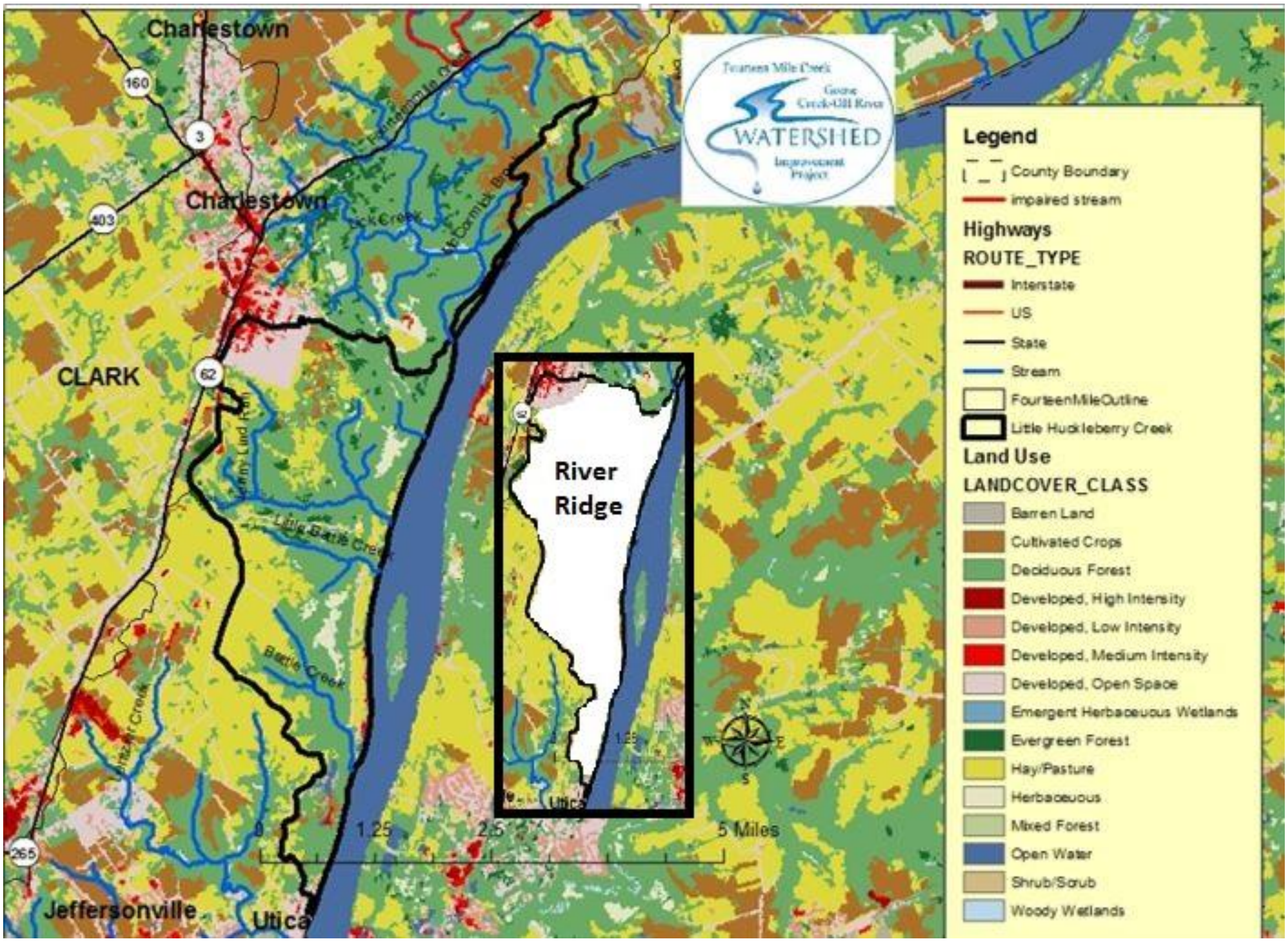
Figure 92: Little Huckleberry Creek Subwatershed



There are no HRW sample sites in the Little Huckleberry Creek subwatershed, nor IDEM monitoring sites. No windshield survey was conducted due to River Ridge occupying so much of the acreage. Therefore, we must rely on speculation as to the water quality conditions. In addition, livestock that grazed the land accessed the natural water bodies, presenting another potential source of E.coli, and the possibility of eroded stream banks. Since some areas of the plant were left undisturbed for years, the presence of invasive plants (and low quality plants) has to be considered, as well as the overpopulation of deer, and other wildlife feces contaminating water bodies. All these issues are stakeholder concerns and should be investigated as River Ridge becomes more accessible.

On the fringes of the River Ridge area, there are small parcels of developed land in this subwatershed. Development normally carries with it higher concentrations of urban non-point source pollution from sources such as pet waste, lawn fertilizers, and chemical runoff from cars and buildings. Though we feel it to be minimal at this point, opportunity for it will increase as River Ridge develops.

The desktop survey alluded to the natural state of this subwatershed (i.e., River Ridge) as buffers along the stream system appeared sufficient, therefore it was speculated that bank stabilization would not be a priority in Little Huckleberry Creek. No LUSTs or brownfields are found in this subwatershed.

2.3.9 Lentizier Creek – Ohio River (051401010605)

The Lentizier Creek – Ohio River subwatershed is located at the southernmost tip of the Fourteen Mile Creek/Goose Creek watersheds. The subwatershed is home to testing Site 1.

The land use in the Lentizier Creek – Ohio River subwatershed surpasses all the other subwatersheds in the project area with a whopping 48.06% of the land in some form of development. This would be expected since it contains much of the eastern expanses of the City of Jeffersonville, the more developed areas of River Ridge, and most of the town of Utica. Other land is forested (18.38%), or being used as pasture and hay land (21.90% - a sign that farming is hanging on in this subwatershed). A very small percentage of land is in grasslands (.21%), barren land (.16%), and open water (1.65%). Anecdotal evidence says backyard and small hobby farms exist here; recreational opportunities abound in neighborhood parks.

Figure 93: Lentizier Creek – Ohio River Subwatershed

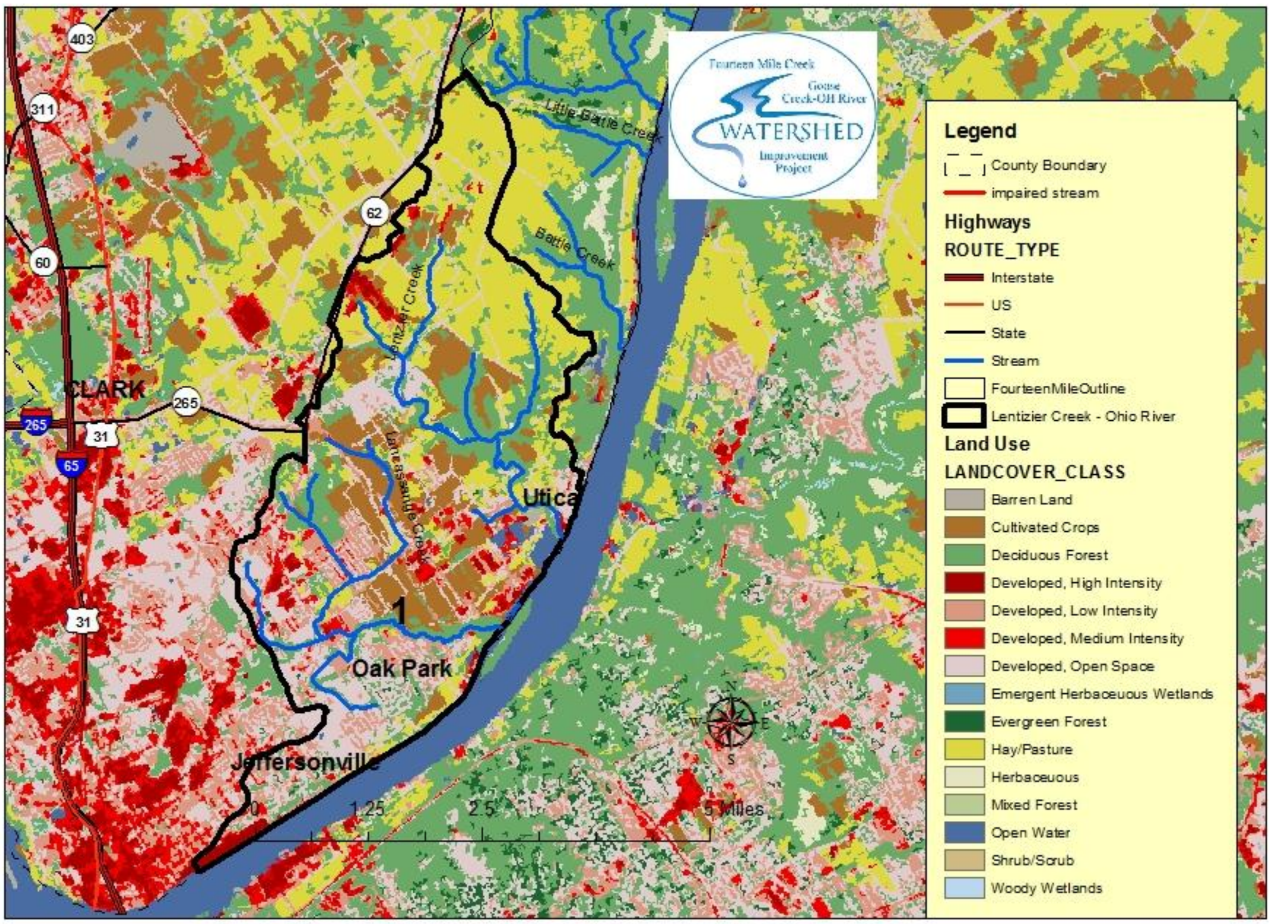


Figure 94: Lentizier Creek Subwatershed Stream Banks Needing Buffers

The desktop survey completed during this project to determine stream miles in need of buffers, identified 3.61 miles of stream banks in this subwatershed that could benefit from the installation of buffers. These are not continuous miles, but are scattered along the stream systems. Figure 94 represents these miles.

Additionally, some of these miles are likely to require bank stabilization, not because of the presence of livestock, but rather as a result of development. As stated previously in this document, the addition of impervious surfaces in areas of urban development, along with urban drainage systems (i.e. curbs, gutters, and storm drain pipes), alters the natural hydrology in a watershed by increasing the volume of stormwater runoff and reducing groundwater recharge. The result is more frequent flooding, higher flood peaks, lower base flow in streams, and lower water table levels. These hydrologic extremes can damage plant, fish, and invertebrate habitat. The increase in water volume during storm events causes erosion of stream banks and changes the stream channel's shape. In addition, stream edge habitat and stream channel protection is lost when the natural, vegetated stream buffer is replaced by impervious surfaces.

Data was collected on the Lentizier Creek subwatershed by observation of 3 sites during the aforementioned windshield survey. Two of the three sites were in need of heavy use area protection, were overgrazed, and were allowing livestock access to waterbodies. One instance each of gully erosion, and sheet and rill erosion was noted. All these issues are stakeholder concerns with the exception of areas needing heavy use protection, which, as noted previously in this narrative, have the potential for soil erosion/degradation. Complete results of the windshield survey for the Lentizier subwatershed follow below in Figure 95.

Figure 95: Lentizier Creek-OH River Subwatershed Windshield Survey Results

Problem/Issue Observed	Number of Occurrences in the Three Sites Surveyed
Overgrazed Land	2
HUAP Needed	2
Animals with Access to Waterbodies	2
Gully Erosion	1
Sheet and Rill Erosion	1

Test site 1 is located along Lancassange Creek right off a bridge that crosses Allison Lane near Jeffersonville Fire Station #5, and its intersection with Middle Road. The location of Site 1 was chosen due to its ease of access, and because of its close proximity to a reclaimed brownfield. IDEM has a sampling site (OSK100-0001) in close proximity to Site 1.

Nitrate levels exceeded the project target 77% of the time at this site. BOD levels were also high, exceeding the target 45% of the time. Total phosphorus was above target in 2014 (.074 mg/L), but dropped below in 2015 (.057 mg/L), leaving it with an overall average (.0655 mg/L) just below target. IDEM data shows no instances of these parameters exceeding the project target.

Site 1 exceeded the project target for E. coli in both 2014 and 2015. A few spikes in single sample readings elevated the geometric mean in 2014; not the case in 2015, but the project target was still not attained. IDEM found E.coli in exceedance of the project target at their site, which resulted in their declaration of the stream segment as impaired. The source of the E.coli contamination occurring here may truly be hard to delineate. Major livestock operations have been removed from this area for quite some time, and the majority of the area is sewered due to the amount of commercial and residential development.

Despite being located in a residential with influx of commercial development area, water quality results returned an index rating of 71.76%, giving the site a "good" rating and exceeding the target. This site's CQHEI scores hovered just below or just above the target at each sampling, and resulted in a final average (59.8 points) that is below target. Biological data gathered by volunteers returned an "excellent" rating in 2014 (PTI 35 points), and 2015 (27 points). Professional sampling agreed with the volunteer data in 2014 with an unimpaired rating (40 points), however the site's rating declined in 2015 (22 points). A complete summary of testing results from Site 1 are below in Figure 96; IDEM's site OSK100-0001 follows in Figure 97.

Figure 96: Site 1 Water Quality Analysis – Lentizier Creek Subwatershed

Parameter	Mean or Average	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	8.26	mg/L	17/22	77%
Nitrites	0	mg/L	0/22	0%
Temperature	16	Celsius	0/22	0%
Dissolved Oxygen	9.87	mg/L	0/22	0%
BOD	3.50	mg/L	10/22	45%
Total Phosphorus	.0655	mg/L	1/2	50%
Orthophosphate	0	mg/L	0/22	0%
Turbidity	14.43	NTU	0/22	0%
Water Quality Index	71.76	%	6/22	27%
CQHEI	59.8	points	2/4	50%
E. coli	490.71 (2014) 145.05 (2015)	CFU / 100mL	2/5 1/5	40% 20%
Pollution Tolerance Index (Macros)	35 (2014) 27 (2015)	Points	0/1 0/1	0% 0%
mIBI	40 (2014) 22 (2015)	points	0/1 1/1	0% 100%

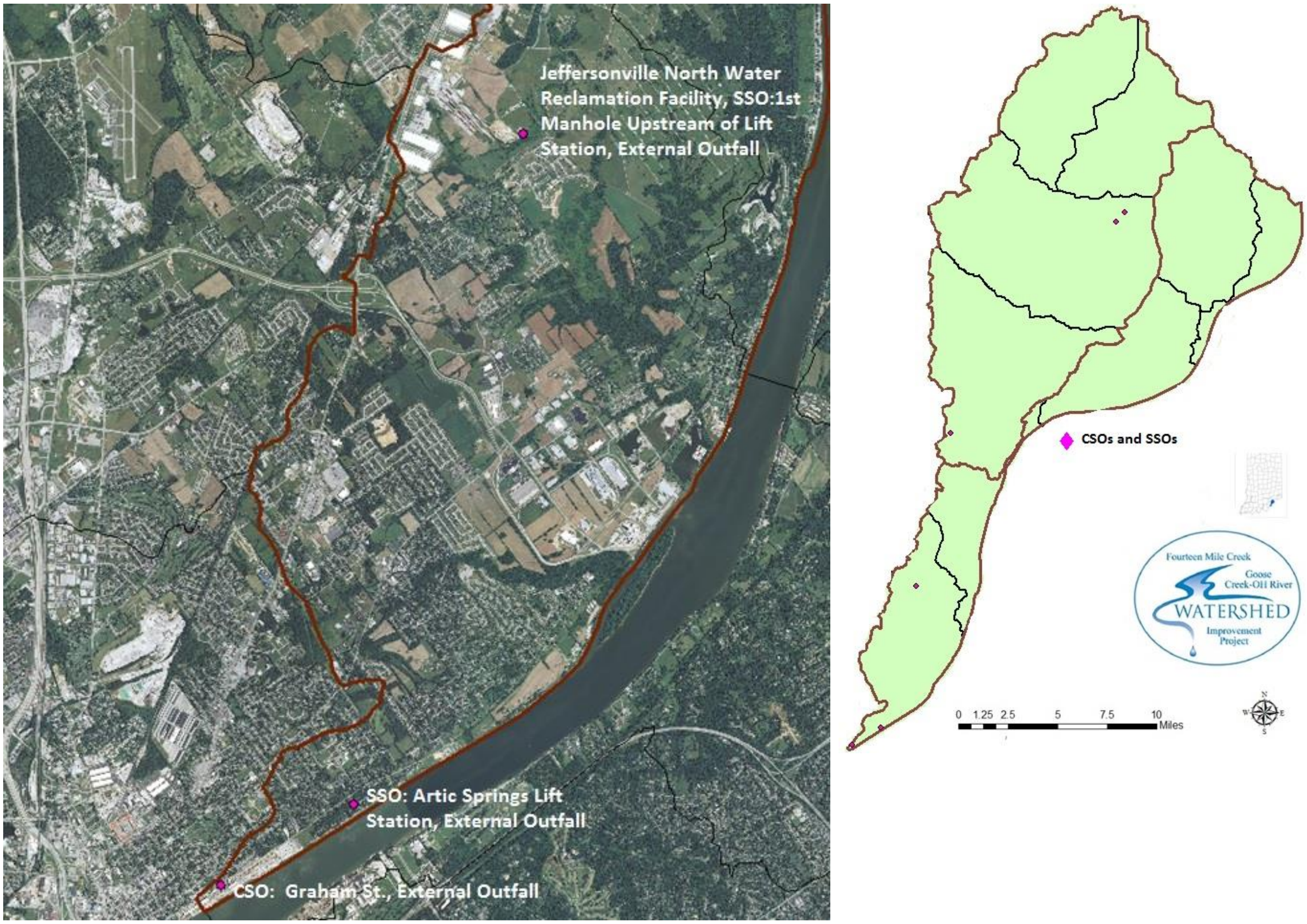
Figure 97: IDEM Sampling Results for Site ID OSK060-0001, 2010 Corvallis, Corvallis E.coli

Parameter	Mean or Average	Unit	# Times Does Not Meet Target	% Does Not Meet Target
Nitrate-Nitrite	0.46	mg/L	0/3	0%
Dissolved Oxygen	5.81	mg/L	0/10	0%
Total Phosphorus	0	mg/L	0/2	0%
Turbidity	10.8	NTU	0/7	0%
Total Suspended Solids	16	mg/L	1/3	33%
E. coli (geomean)	>530	CFU/100 ml	4/5	80%
IBI (macros)	40	points	0/1	0%
QHEI (macros)	68	points	0/1	0%
IBI (fish)	42	points	0/1	0%
QHEI (fish)	63	points	0/1	0%
Notes: E.coli geomean did not meet water quality standards and segment is designated as impaired.				

It should be noted when considering the water quality of this subwatershed that the City of Jeffersonville is among 772 communities in the United States, which suffer from combined sewer overflows. Combined sewers carry sanitary and storm water in the same pipes. In dry conditions or when there is light precipitation, this isn't necessarily a problem. But when there are moderate to heavy rainfalls or snow melts, the sewer lines cannot handle all of the liquids that need to be transported to the wastewater treatment plant and they overflow into nearby waterways. In Jeffersonville's case, the combined sewer overflows affect the Ohio River and Cane Run.

Jeffersonville has entered into a consent decree for combined sewer overflows between the Jeffersonville Sanitary Sewer Board, the U.S. Environmental Protection Agency, U.S. Department of Justice and Indiana Department of Environmental Management. The Combined Sewer Overflow Long Term Control Plan that is currently under EPA review will require that Jeffersonville spend between $90 million and $120 million through 2020 or 2025 to reduce sewer overflows into the Ohio River and other local waterways. Work to be accomplished under the Long Term Control Plan includes: 1. Increasing the capacity of the 10th Street pumping station from 15 million gallons a day to 50 million gallons a day of wet-weather flow; 2. Building a new outfall sewer up Pennsylvania St./old railroad out to Mill Creek, to handle the increase in capacity at the 10th Street station; and, 3. Increasing capacity of the downtown plant to 50 million gallons from the current 34 million gallons of wet-weather flow to alleviate flooding in the downtown area. Figure 98 below shows a map of the three CSO locations in Jeffersonville.

Figure 98: City of Jeffersonville's Combined Sewer Overflow Locations



Nine LUSTs are found in this subwatershed: BP, 7 Eleven Store 216, Former AMOCO 450, Speedway 5191, Snelling Marathon, Kayrouz Marine Service, Inc., Jeffboat, Thornton Oil, and Kmart. They are mapped below in Figure 99.

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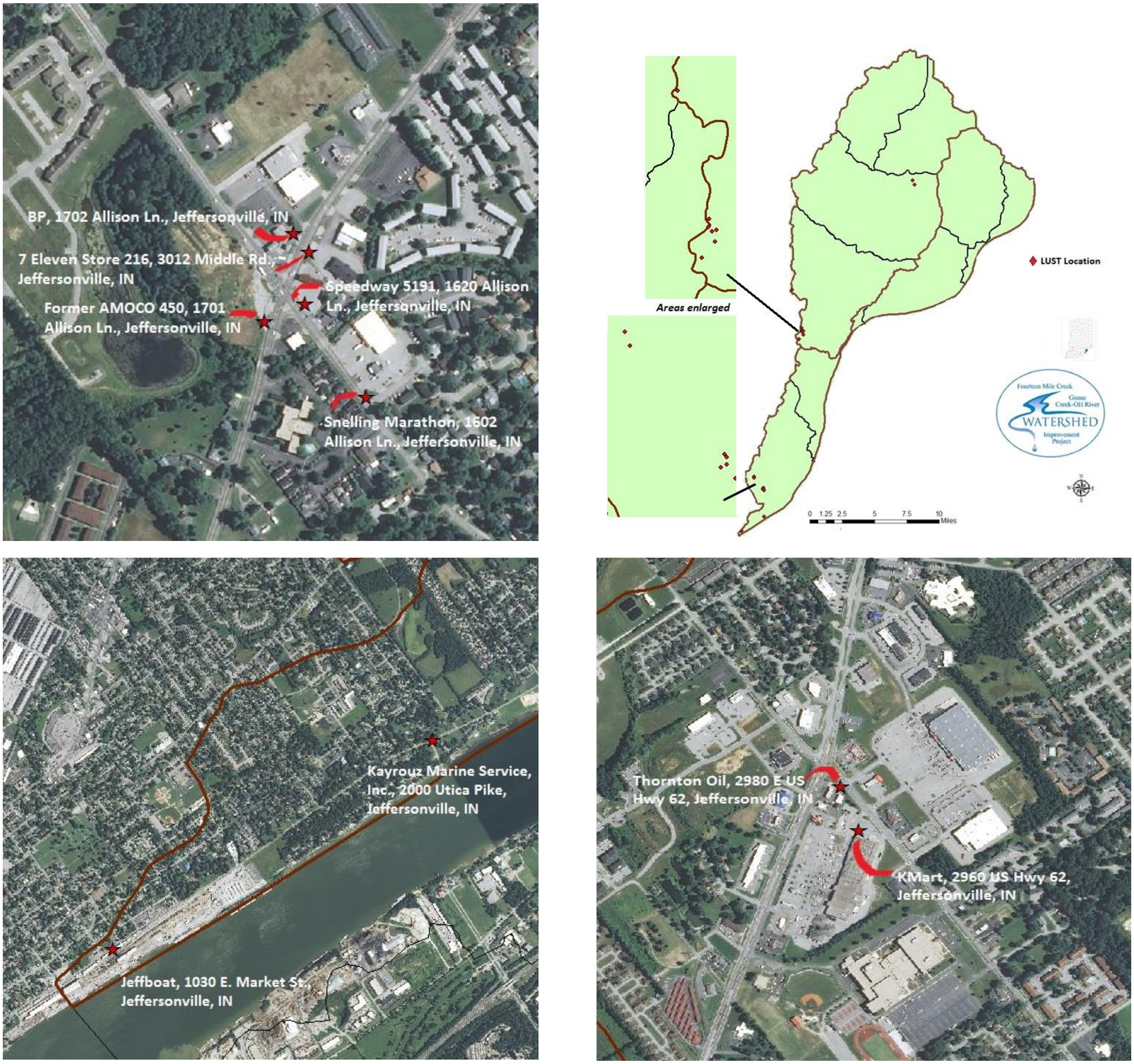
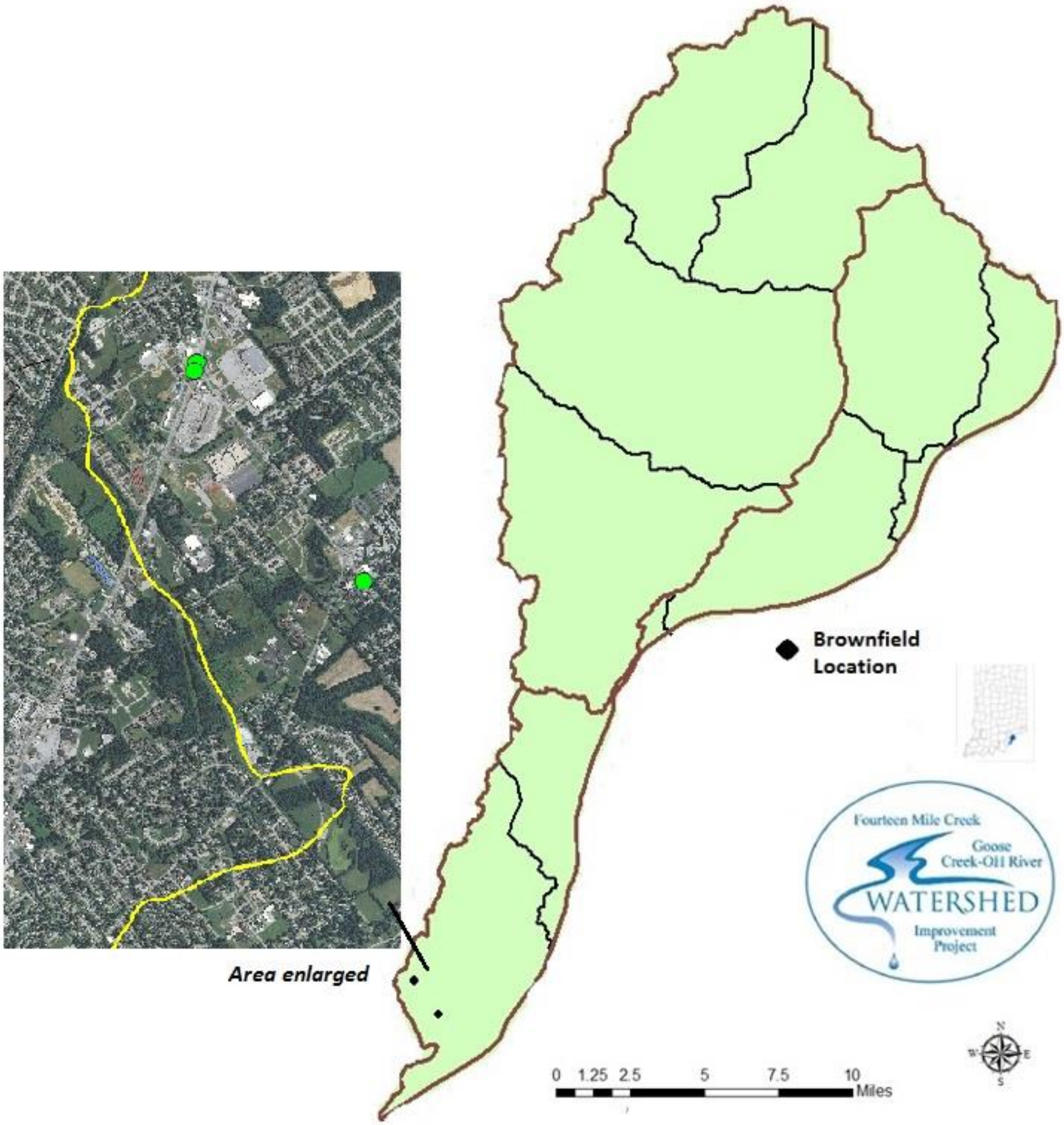
Figure 99: City of Jeffersonville's LUST Locations



The only brownfields found in the Fourteen Mile Creek/Goose Creek watersheds are located in the Lentizier Creek subwatershed, and are shown below in Figure 100: ICI Americas, Inc./INAAP, River Ridge Tract 11A, and Allison Lane Animal Hospital.

Figure 100: Lentzier Creek Subwatershed Brownfield Locations



2.4 Watershed Inventory Part Three

Looking at water quality data for the subwatersheds in this project individually, as we have done in the previous sections, allows for detailed insight into the conditions of each subwatershed. However, looking at the "big" picture, and considering how the data relates to Fourteen Mile Creek/Goose Creek watersheds as a whole, is important to determining overall water quality and health of the watersheds. The narrative below summarizes the important water quality, habitat, and biological results, explains any relationships or trends found, and relates them to stakeholder concerns if applicable.

2.4.1 Water Quality Summary

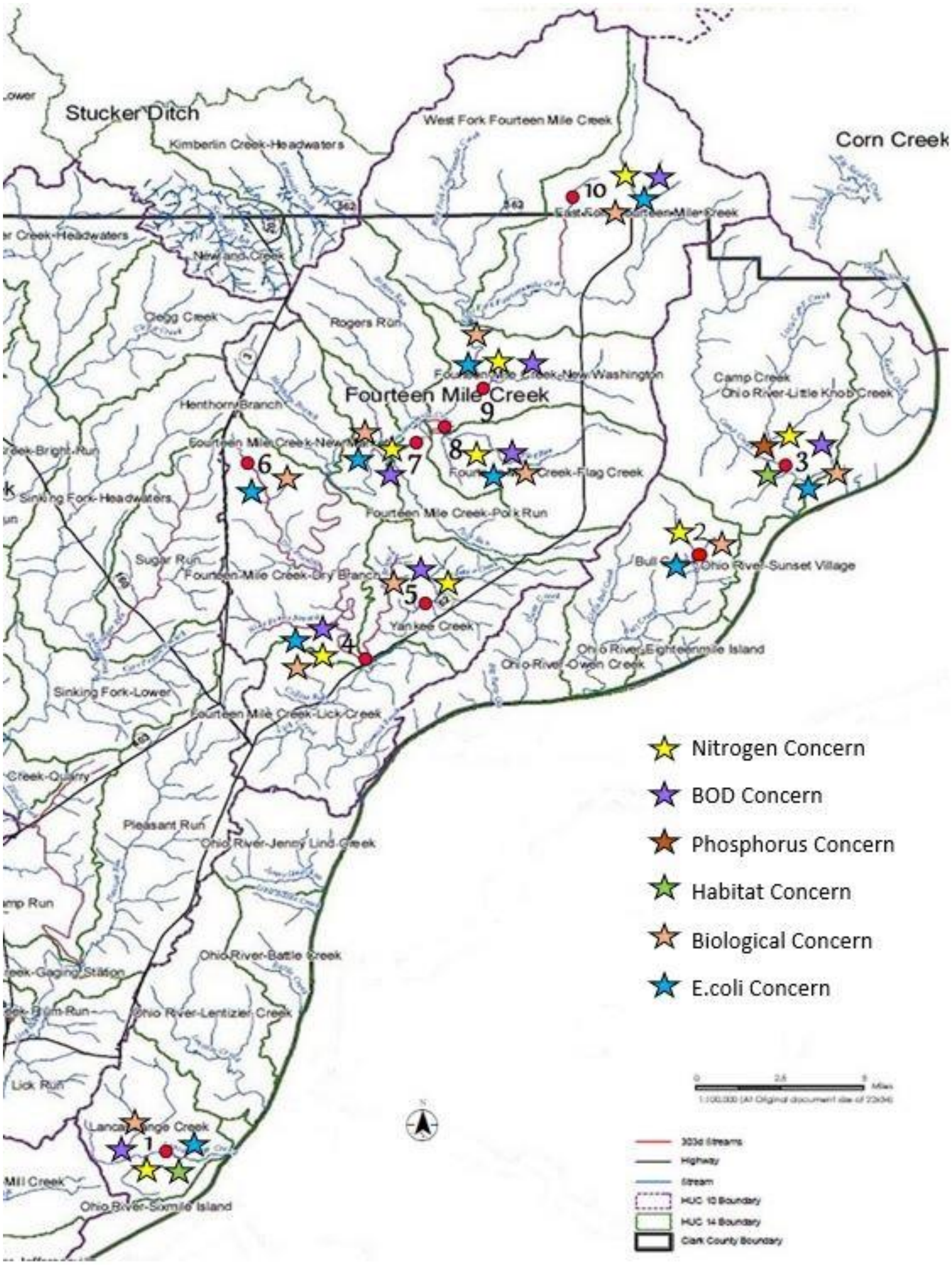
Prior to the start of our project, IDEM had identified E.coli, dissolved oxygen, and biotic communities as impairments found within the stream system of the Fourteen Mile Creek/Goose Creek watersheds; four stream segments were involved. We gathered data on 13 parameters during our water quality samplings in order to support or refute IDEM's findings for these segments, determine the health of other areas of the stream system, and uphold or deny stakeholders' concerns for the watersheds. *(Since the inception of our project, IDEM has identified four additional segments with impairments for E.coli, and one segment for E.coli and dissolved oxygen as noted on page 41 of this document.)*

Our results are summarized in table form in Figure 101, and in map form in Figure 102, which follow.

Figure 101: Summary of water sampling results by subwatershed indicating whether the site exceeded (E), or met (M) the target for the given parameter. Parameters that were not exceeded by any site are not listed here. Please refer to Figure 28 on page 44 of this document for a complete listing of measured parameters and their targets.

Subwatershed	NO3	BOD	TP		CQHEI	E.coli	PTI	mIBI
Lentizier Creek								
Site 1	E	E	M		E	E (2014) E (2015)	M (2014) M (2015)	M (2014) E (2015)
Bull Creek-Ohio River								
Site 2	E	M	M		M	E (2014) E (2015)	M (2014) E (2015)	M (2014) E (2015)
Camp Creek								
Site 3	E	E	E		E	E (2014) E (2015)	M (2014) E (2015)	M (2014) E (2015)
Dry Branch-Fourteen Mile Creek								
Site 4	E	E	M		M	E (2014) M (2015)	M (2014) E (2015)	M (2014) E (2015)
Site 5	E	E	M		M	M (2014) M (2015)	E (2014) E (2015)	E (2014) E (2015)
Site 6	M	M	M		M	E (2014) M (2015)	E (2014) E (2015)	E (2014) E (2015)
Rogers Run								
Site 7	E	E	M		M	E (2014) M (2015)	E (2014) E (2015)	E (2014) E (2015)
Site 8	E	E	M		M	E (2014) M (2015)	M (2014) M (2015)	E (2014) E (2015)
Site 9	E	E	M		M	E (2014) M (2015)	M (2014) M (2015)	E (2014) E (2015)
East Fork-Fourteen Mile Creek								
Site 10	E	E	M		M	E (2014) M (2015)	M (2014) M (2015)	E (2014) E (2015)

Figure 102: Mapped summary of water sampling results. The map below highlights the sampling sites within the watersheds where concentrations of the parameters measured higher than the target concentrations, or where poor habitat or biological scores were recorded.



Elevated nitrate-nitrogen concentrations were observed in all subwatersheds. In the upper reaches of the Fourteen Mile Creek/Goose Creek watersheds, cropland and pastures are common, and many homes are on septic systems. Potential contaminants – commercial fertilizers, and animal and human waste - would be expected there. Numerous instances of livestock having access to water bodies and sensitive areas were observed during the windshield survey, which would support this expectation. In the lower reaches of the watersheds, where development and manicured lawns are the norm, there is a great potential for contamination from fertilizers, and not so much from human waste since more areas are sewered. Pet waste rather than livestock/wildlife waste would be of some concern in these reaches.

Biochemical Oxygen Demand (BOD) levels were elevated in every subwatershed except the Bull Creek-Ohio River subwatershed. Again, the extent of unsewered areas in the upper reaches of the watersheds, could be contributing factors to these levels. The lower reaches would likely be more affected by contaminants, such as pet waste and trash, carried in stormwater runoff from impervious surfaces. We know that the habitat of the streams at two of our sampling sites (Camp Creek, Site 3; Dry Branch-Fourteen Mile Creek, Site 4) changed after the floods of 2015, increasing the amount of debris in the streambeds, and in turn increasing the organic matter, and therefore BOD levels. We can speculate this happened to some extent throughout the project area as all reaches were affected by the flooding.

Total Phosphorus was found to be elevated in the Camp Creek subwatershed, and then only marginally (average .07 mg/L; target <.07 mg/L); orthophosphates were negligible in all subwatersheds. Instances of livestock accessing water bodies, woodlands, and sensitive areas were observed during the windshield survey in Camp Creek, as well as overgrazing, and gully/sheet and rill erosion. Contamination from sediment and nutrient runoff would be expected under those conditions. In addition, since cropland, and pasture and hayland, are predominant land uses in Camp Creek, runoff from fertilized fields could be considered a contributor to elevated phosphorus levels.

All subwatersheds exceeded the geometric mean target for E.coli during the first "wet weather" year of the project. With the exceptions of Lentizier Creek and Camp Creek subwatersheds, E.coli levels fell during the second year of the project. Lentizier Creek is predominantly commercial/residential development, therefore pet waste could be considered as a contributor to the elevated levels. A portion of the City of Jeffersonville's CSO is in this subwatershed, and since the City's Long Term Control Plan is currently under EPA review, it can be assumed that there are still elements of the plan to be addressed, and that some contamination is still occurring from sewer overflows. Camp Creek, however, being rural in nature, is more likely to be receiving contaminants from unsewered areas, and livestock accessing water bodies and sensitive areas. In fact, our windshield survey of the Camp Creek/Pattons Creek area (Section 3) revealed several areas where livestock *did* have access to water bodies, sensitive areas, and woodlands, as well as instances of overgrazing, and where HUAP was needed. Manure management in this area would consist of manure being spread over fields when convenient, as there are no manure storage facilities or manure management plans documented.

Volunteer observation indicated healthy habitat in all subwatersheds, with the exception of Camp Creek, and Lentizier Creek. Lentizier Creek was marginal, hovering just below or above the target level during sampling, however, loss of and/or degradation of habitat would be expected given the amount of development this subwatershed is experiencing. Camp Creek, also hovered close to the target level, however flooding may have affected more areas of this subwatershed than just the stream segment noted.

It should be noted that the Water Quality Index (WQI) for all subwatersheds met the target during the project term. In regards to aquatic life, however, the Pollution Tolerance Index (PTI) indicated impairments within the Bull Creek-Ohio River, Camp Creek, Dry Branch-Fourteen Mile Creek, and Rogers Run subwatersheds.

Macroinvertebrate Indices of Biotic Integrity (mIBI) scores indicated impairments throughout all the subwatersheds, but concentrated in the Dry Branch-Fourteen Mile Creek, East Fork-Fourteen Mile Creek, and Rogers Run subwatersheds. Impairments discussed above are likely limiting factors for macroinvertebrates in the watersheds. In addition, the extremely wet conditions of 2014, and the sporadic floods of 2015, no doubt led to scouring throughout the watersheds, limiting habitat, and skewing mIBI scores.

We speculate that the karst topography found throughout the watersheds, which we have discussed earlier in this document (Section 2.2.1), likely has detrimental effects on water quality, whether by underground streams and aquifers transmitting contaminants rapidly, or sinkholes being filled with trash or other man-made items. In either instance, watershed health is compromised to some extent.

2.4.1 Analysis of Stakeholder Concerns

In order to understand how residents view the watershed they live in, a stakeholder concern survey was distributed at project events, fairs, and meetings throughout the project area. Each stakeholder was asked to check a box if they felt a particular concern was a problem in the Fourteen Mile Creek/Goose Creek watersheds. The list of concerns were gleaned from input given by Steering Committee members via larger and longer surveys. There were no limits as to how many or how few boxes each survey recipient could check, and write-in comments were encouraged. For a complete list of results from the survey see Figure 3. Surveys representative of all subwatersheds were submitted. Of the thirty-two surveys completed, there were seven categories that at least 30% of stakeholders viewed as a concern:

- E. coli within the streams - 46.9%
- Pollution from failing septic systems – 43.8%
- Fencing livestock from sensitive areas – 37.5%
- Wildlife feces contamination – 46.9%
- Overpopulation of Deer in the Watershed – 40.6%
- Unregulated Development – 53.1%
- Trash/Litter in Streams – 78.1%

In deciding how to move forward to improve water quality in the watershed, each concern must be analyzed. Figure 103 details each concern, the evidence for each concern, whether the concern is supported by data, if the concern in quantifiable, if the concern in in the project's scope, and which concerns the project will be focusing on.

Figure 103: Analysis of Stakeholder Concerns

Concern	Concern Supported by Data?	Evidence For Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
Excessive gully erosion in cropland and pastures	Yes	10 gully erosion concern sites identified in windshield survey Anecdotal evidence	Yes	Yes	Yes
Too much conventional tillage of cropland	Yes	10 conventionally tilled (fall tillage) sites identified in windshield survey	Yes	Yes	Yes
Stream bank erosion	Yes	Anecdotal evidence, results from stakeholder concern survey	Yes	Yes	No*
Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	Yes	Stakeholder observations of improper soil practices Low attendance at soil health workshops. Anecdotal evidence	No	Yes	Yes
Sedimentation from erosion caused by overgrazing	Yes	25 overgrazed sites identified in windshield survey CQHEI results note overgrazed banks at 60% of testing sites	Yes	Yes	Yes

Concern	Concern Supported by Data?	Evidence For Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
Livestock with direct access to streams	Yes	25 sites identified in windshield survey where animals have direct access to streams Higher levels of E. coli at sites near pastureland	Yes	Yes	Yes
E. coli within the streams	Yes	90% testing sites exceeded geometric mean limits for E. coli in 2014; 20% in 2015 Streams listed on the 303d list for E.coli	Yes	Yes	Yes
Pollution from failing septic systems	Yes	Anecdotal evidence (smells and ponding noted by stakeholders)	No	Yes	Yes
Application of airborne chemicals (i.e. fertilizers and pesticides)	No	Anecdotal evidence	No	No	No
Invasive species in watershed	No	Anecdotal evidence (stakeholders mentioned several invasive plant species in watershed)	No	No	No
Low quality plants in pastures	Yes	25 overgrazed sites identified in	Yes	Yes	Yes

Concern	Concern Supported by Data?	Evidence For Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
		windshield survey 2 sites identified in windshield survey for sheet and rill erosion			
Need for more cover crops on cropland	Yes	8% of fields cover cropped county-wide 10 conventionally tilled (fall tillage) sites identified in windshield survey	Yes	Yes	Yes
Need for using biological methods to control bank erosion	No	Anecdotal evidence	No	Yes	Small Scale Demo Site
Fencing of livestock from sensitive areas	Yes	25 access sites identified in windshield survey High E. coli levels near pastureland	Yes	Yes	Yes
Wildlife feces contamination	No	Anecdotal evidence (stakeholders observed high amounts of deer in watershed)	No	No	No
Need for education on wildlife	No	Anecdotal evidence	No	No	No

Concern	Concern Supported by Data?	Evidence For Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
Overpopulation of deer in watershed	No	Anecdotal evidence , results from stakeholder concern survey	No	No	No
Dumping of wildlife remains by hunters	No	Anecdotal evidence, results from stakeholder concern survey	No	No	No
Sediment filling pools for fishing	No	Anecdotal evidence, results from stakeholder concern survey	No	No	No
Unregulated Development	No	Anecdotal evidence, results from stakeholder concern survey	No	No	No
Trash/ Litter in streams	Yes	1 dumping site identified in the windshield survey Anecdotal evidence (stakeholders observed high amounts of trash and litter near road sides and steams)	No	Yes	Yes

**Thought:* *Though stream bank erosion is a concern supported by data, it will not be focused on in this project. The costs associated with the practice of stabilizing stream banks have proven prohibitive to landowners in our region in the past, resulting in very few installations. Over the lifetime of the project, we feel there will be negligible benefits to water quality by focusing on this concern.*

Identifying Problems and Causes

3.1 Identifying Local Concerns and Problems

Several water quality problems have been identified within the Fourteen Mile Creek/Goose Creek watersheds through various means. Concerns were voiced during the initial stages of the project via surveys and meetings, and at subsequent workshops and events. Others were discovered during water samplings, and the windshield survey. This section attempts to connect the concerns with their associated problems, and identify potential causes of those problems. Problems that are identified through these various methods will be the basis for management and planning in order to address the causes of each problem.

The Steering Committee identified specific problems relating to each concern on which the group wished to focus (See Figure 102-Analysis of Stakeholder Concerns). Figure 104 links stakeholder concerns to specific water quality problems, and generalized water quality problem categories. By further discussing the problems associated with each concern that the Steering Committee decided to focus on, a better grasp of direction for the project can be obtained.

Figure 104: Stakeholder Concerns and Related Problems

Concerns	Specific Problems	Problem Category
Excessive gully erosion in cropland and pastures	Erosion can increase suspended sediment and degrade stream habitat. Eroded cropland and pastureland (without any natural buffer) can also cause high nutrient levels and E. coli to enter the watershed	• Sedimentation • Degraded Habitat • High Nutrient Levels • High E. coli Levels • Decrease in Biodiversity
Too much conventional tillage of cropland	Conventional tillage can increase the erosion in the watershed by diminishing the natural filtration process for rain and storm water. Eroded cropland and pastureland (without any natural buffer) can also cause high nutrient levels and E. coli to enter the watershed	• Sedimentation • High Nutrient Levels • High E. coli Levels • Decrease in Biodiversity • Degraded Habitat
Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	Poorly managed soils can cause increased levels of nutrients, poor filtration of rainwater, and increased levels of E. coli (compaction of septic soils). In addition, conventionally tilled cropland can caused increased sedimentation.	• High Nutrient Levels • High E. coli Levels • Sedimentation • Decrease in Biodiversity • Degraded Habitat
Sedimentation from erosion caused by overgrazing	Runoff from poorly managed pastureland can cause increased E. coli and nutrient levels in streams. Erosion causes increased	• High E. coli Levels • High Nutrient Levels • Sedimentation • Degraded Habitat

Concerns	Specific Problems	Problem Category
	sedimentation which degrades stream habitat.	• Decrease in Biodiversity
Livestock with direct access to streams	Erosion from trampled banks increases suspended sediments; degraded stream habitat; nutrient and *E. coli* inputs;	• High Nutrient Levels • High E. coli Levels • Sedimentation • Degraded Habitat • Decrease in Biodiversity
E. coli within the streams	Too high E. coli levels make public streams unsafe for recreation.	• High E. coli levels
Pollution from failing septic systems	Failing septics increase the amount of E. coli and nutrients in streams	• High E. coli levels • High Nutrient Levels • Decrease in Biodiversity
Low quality plants in pastures	Without proper quality plants, pastureland may become overgrazed. Overgrazed land leads to increased sedimentation, higher nutrient levels, and increased E. coli levels.	• Sedimentation • High E. coli Levels • High Nutrient Levels • Decrease in Biodiversity • Degraded Habitat
Need for more cover crops on cropland	Cover crops provide a natural filtration system and erosion control. Without them, higher levels of E. coli, nutrients, and sedimentation enter the watershed.	• Sedimentation • High E. coli Levels • High Nutrient Levels • Decrease in Biodiversity • Degraded Habitat
Fencing of livestock from sensitive areas	When livestock have access to sensitive areas they can increase E. coli and nutrient levels and sediment.	• Sedimentation • High E. coli Levels • High Nutrient Levels • Decrease in Biodiversity • Degraded Habitat
Trash/ Litter in streams	Trash may contain hazardous materials; reinforces public perception that trash in natural areas is acceptable	• Trash • Degraded Habitat • Decrease in Biodiversity

3.2 Identifying Potential Stressors

Potential stressors for each problem category were also identified. A stressor is an event, agent, or series of actions that produce a problem. For the purpose of watershed management planning, identifying stressors and causes of water quality problems give direction to the project for the future, and help manage that watershed most effectively. Figure 105 looks at those problem categories, and associates some potential stressors.

Figure 105: Problem Categories and Potential Stressors

Problem Categories	Potential Stressors	Background Information
Trash	Peoples' learned behavior and lack of knowledge of the pollution consequence to the environment	Dumping site located in Dry Branch-Fourteen Mile Creek subwatershed
High E. coli levels	E. coli levels exceeding water quality standards	90% of the testing sites (9/10) exceeded the geometric mean target (<125 cfu/mL) over the project period Readings after rain events high in all subwatersheds (as high as 9,990 in HUC 051401010403) 4 stream segments on 303(d) list at project inception; additional 5 segments added in 2014
Sedimentation	Excess of suspended particulate matter in water	67% of the land in the watersheds classified as HEL
High Nutrient Levels	Nutrient levels exceeding water quality targets; insufficient public understanding of nutrient sources	90% of the testing sites exceeded the project target (1.5 mg/L) for Average Nitrate No sites exceeded the project target for Average Total Phosphorus (.07 mg/L) but 70% (7/10) were in high range (.05-.07) 42.1% of soils in the watersheds are listed as very limited for septic systems with another 27.6% listed as limited
Degraded Habitat	Sedimentation; lack of riparian vegetation; lack of adequate year-round ground cover; high volume of urban runoff	10.2% developed areas in entire watersheds; 48.06% of subwatershed HUC 051401010605 in development 11.96 stream miles in need of buffers 30% of sites with average QHEI values below project target (>60); 30% with low values (60-63)
Decrease in Biodiversity	Sedimentation; high nutrient levels that upset natural balance of ecosystem; lack of riparian vegetation	11.96 stream miles in need of buffers 90% of the testing sites exceeded the project target (1.5 mg/L) for Average Nitrate No sites exceeded the project target for Average Total Phosphorus (.07 mg/L) but 70% (7/10) were in high range (.05-.07) 30% of sites scored well below (<10) project target (>16) consistently; only 10% scored well above (25-27) consistently Only 20% (4/20) mIBI samplings results were unimpaired over project period

3.3 Identifying Sources

The steering committee linked identified water quality problem categories, and stressors for those problems, to sources based on windshield survey data, water monitoring data, and other observations made in the watershed (Figure 106). Sources can be any cause of nonpoint source pollution.

Figure 106: Potential Pollutant Sources per Problem Category

Problem Categories	Potential Stressors	Potential Sources	Magnitude
Trash	Peoples' learned behavior and lack of knowledge of the pollution consequence to the environment	Peoples' learned behavior and lack of knowledge of the pollution consequence to the environment	Illegal dumping of materials into ditches, streams, and sinkholes scattered through all subwatersheds Dumping site located in Dry Branch-Fourteen Mile Creek subwatershed
High E. coli levels	E. coli levels exceed water quality standards .	Urban NPS	10.2% developed areas in entire watersheds; 48.06% of subwatershed HUC 051401010605 in development
		Inadequate or improper septic system designs & maintenance	Failing septic systems (anecdotal evidence-all subwatersheds) 42.1% of soils in watersheds are very limited for septics; another 27.6% limited
		Inadequate buffers	11.96 stream miles in need of buffers
		Livestock with access to streams and sensitive areas	Livestock accessing water bodies and sensitive areas – 25 instances via windshield survey
		Insufficient management, or lack thereof, of manure produced by livestock	Anecdotal evidence No current data available, but the potential problem does exist with livestock present
Sedimentation	Excess of particulate matter in water	Erosion (gully, sheet & rill)	67% of the land in the watersheds classified as HEL Windshield survey revealed: gully erosion at 10 sites; overgrazed pastures at 25 sites; 27 sites needing HUAPs; tillage at 10 sites
		Lack of knowledge/lack of planning for cropland	11.96 stream miles in need of buffers

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			Lack of cover on fields (cover crops/residue) – 8% of acres cover cropped
High Nutrient Levels	Nutrient levels exceed water quality targets Insufficient public understanding of nutrient sources Disregard for consequences of excess fertilizer use	Livestock access to streams/sensitive areas	25 sites identified during windshield survey
		Inadequate or improper septic system designs & maintenance	Failing septic systems (anecdotal evidence-all subwatersheds) 42.1% of soils in watersheds are very limited for septics; another 27.6% limited
		Fertilizer use Improper manure management	10.2% developed areas in entire watersheds; 48.06% of subwatershed HUC 051401010605 in development – Excessive fertilizer use is a potential problem but no current data is available Cropland – (fertilizer use) makes up almost 30% of the watersheds (32,111 acres) No current data available, but the potential problem does exist with livestock present
		Erosion	Lack of cover on fields (cover crops/ residue) – 10 sites identified as conventionally tilled during the windshield survey; 8% of watershed acres cover cropped Windshield survey revealed: gully erosion at 10 sites; overgrazed pastures at 25 sites; 27 sites needing HUAPs; tillage at 10 sites
Degraded Habitat	Sedimentation	Erosion	Site 1 (Lentizier Creek subwatershed) and Site 3 (Camp

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			Creek) scored low on CQHEI for riparian area/erosion during annual samplings; both sites below target score (>60 points) Site 3 scored consistently low (10 points or less out of 20) on substrate during annual samplings Windshield survey revealed: gully erosion at 10 sites; overgrazed pastures at 25 sites; 27 sites needing HUAPs; tillage at 10 sites Lack of cover on fields (cover crops/ residue) – 10 sites identified as conventionally tilled during the windshield survey; 8% of watershed acres cover cropped
	Lack of Riparian Vegetation	Lack of Riparian Vegetation	11.96 stream miles in need of buffers Site 1 (Lentizier Creek subwatershed) and Site 3 (Camp Creek) scored low on CQHEI for riparian area/erosion during annual samplings 6 sampling sites consistently scored low (10 points or less out of 20) for fish cover during annual samplings
	High Volume of Runoff	Runoff from urban acres	10.2% developed areas in entire watersheds; 48.06% of subwatershed HUC 051401010605 in development
Decrease in Biodiversity	Sedimentation	Erosion	Site 1 (Lentizier Creek subwatershed) and Site 3 (Camp Creek) scored low on CQHEI for riparian area/erosion during annual samplings; both sites below target score (>60 points)

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			Site 3 scored consistently low (10 points or less out of 20) on substrate during annual samplings Windshield survey revealed: gully erosion at 10 sites; overgrazed pastures at 25 sites; 27 sites needing HUAPs; tillage at 10 sites Lack of cover on fields (cover crops/ residue) – 10 sites identified as conventionally tilled during the windshield survey; 8% of watershed acres cover cropped
	High nutrient levels that upset natural balance of ecosystem	Inadequate or improper septic system designs & maintenance	Stream segment on IDEM's 303(d) list as impaired for DO and biotic communities in East Fork-Fourteen Mile Creek subwatershed Failing septic systems (anecdotal evidence-all subwatersheds) 42.1% of soils in watersheds are very limited for septics; another 27.6% limited
		Fertilizer use Improper manure management	Average Nitrogen exceeds project target (1.5 mg/L) at 90% of testing sites High nitrate readings (above 10mg/L) on 111 single samples 10.2% developed areas in entire watersheds; 48.06% of subwatershed HUC 051401010605 in development – Excessive fertilizer use is a potential problem but no current data is available Cropland – (fertilizer use) makes up almost 30% of the watersheds (32,111 acres)

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			No current data available, but the potential problem does exist with livestock present
		Livestock access to streams/sensitive areas	25 sites identified during windshield survey
	Lack of Riparian Vegetation	Lack of Riparian Vegetation	11.96 stream miles in need of buffers Site 1 (Lentizier Creek subwatershed) and Site 3 (Camp Creek) scored low on CQHEI for riparian area/erosion during annual samplings 6 sampling sites consistently scored low (10 points or less out of 20) for fish cover during annual samplings

3.4 Calculating Loads

Estimating the total amount of a contaminant in a watershed is a challenging task. However, load estimation is very useful for any watershed plan to determine how much reduction in pollutants is needed to achieve water quality standards or targets. In addition, quantifiable goals and objectives give projects a way of measuring improvement and success. Load is defined as the amount of a pollutant (usually in pounds, kilograms, or tons) that passes through a point on a stream or river in a certain amount of time (often in one day or one year).

3.5 Load Reduction Estimates

In order to estimate loads for the Fourteen Mile Creek/Goose Creek watersheds the Spreadsheet Tool for Estimating Pollutant Load (STEPL) was used. STEPL is a spreadsheet-based model that uses landuse and information on animals, septic systems, Universal Soil Loss Equation (USLE) factors, and precipitation to calculate annual runoff volume, and sediment, nitrogen, and phosphorus loads for the watershed. Information on animals and septic systems was obtained from EPA's STEPL Input Data Server.

Nitrogen, phosphorus, and sediment loads were calculated for each subwatershed. Target loads were calculated using the annual runoff volume and the watershed group's water quality targets. Reductions needed were calculated by subtracting the target loads from the estimated loads. The results are shown in Figure 107 below.

Figure 107: Load data for Nitrogen, Phosphorus, and Total Suspended Sediment- includes load amounts to meet targets and load reductions needed.

Subwatershed	Nitrogen Estimated Annual Load (lbs/year)	Maximum Nitrogen Annual Load to Meet Target (lbs/year)	Nitrogen Load Reduction Needed to Meet Target (lbs/year)	Nitrogen Load Reduction Needed to Meet Target (%)	Phosphorus Estimated Annual Load (lbs/year)	Maximum Phosphorus Annual Load to Meet Target (lbs/year)	Phosphorus Load Reduction Needed to Meet Target (lbs/year)	Phosphorus Load Reduction Needed to Meet Target (%)	Sediment Estimated Annual Load (tons/year)	Maximum Sediment Annual Load to Meet Target (tons/year)	Sediment Load Reduction Needed to Meet Target (tons/year)	Sediment Load Reduction Needed to Meet Target (%)
East Fork-Fourteen Mile Creek	72,177	40,821	31,357	43%	16,115	1,905	14,210	88%	7,595	340	7,255	96%
West Fork-Fourteen Mile Creek	71,221	41,584	29,637	42%	15,216	1,941	13,276	87%	6,937	347	6,591	95%
Rogers Run	141,184	84,815	56,369	40%	27,942	3,958	23,984	86%	11,536	707	10,829	94%
Dry Branch-Fourteen Mile Creek	75,600	59,530	16,069	21%	14,739	2,778	11,961	81%	5,344	496	4,847	91%
Camp Creek	73,808	44,487	29,321	40%	16,089	2,076	14,013	87%	7,340	371	6,970	95%
Pattons Creek	19,881	13,953	5,928	30%	5,013	651	4,362	87%	2,492	116	2,375	95%
Bull Creek	48,477	31,315	17,161	35%	10,859	1,461	9,398	87%	5,023	261	4,762	95%
Little Huckleberry Creek	24,287	18,379	5,908	24%	3,884	858	3,026	78%	1,117	153	964	86%
Lentizier Creek	81,424	52,743	28,681	35%	13,074	2,461	10,613	81%	3,250	440	2,811	86%
Total	608,059	387,627	220,432	36%	122,931	18,089	104,842	85%	50,635	3,230	47,405	94%

Excessive E. coli in a watershed poses a threat to the health of that watershed, and the people who live in it, therefore, understanding the extent of E. coli pollution in the Fourteen Mile Creek/Goose Creek watersheds is critical. A load for E. coli is not included in the previous table as E.coli has no mass to measure. Instead, its "load" is expressed as a concentration of colony forming units (CFU). Figure 30 on page 47 of this document highlights where each sample site is located in the watersheds. The tables below detail the geometric mean, and average E. coli for each site. By using the geometric mean for this analysis, it eliminates that potential for extreme outliers. However, the average E. coli (CFU/100 mL) can indicate whether or not E. coli can be an issue in the area. Those cells highlighted in orange in Figures 108 and 109 are those with a geometric mean that exceeded the target level (< 125 CFU/100 ml). Percentage of reduction needed to bring levels to target at each site are given. Sites where the mean was below target are indicated by "no reduction needed." We feel future monitoring at all sites would be wise due to the disparity in weather conditions experienced during our sampling. This may allow us to establish a true trend in E.coli levels for the sites.

Figure 108: 2014 E.coli Results Fourteen Mile Creek/Goose Creek Watersheds – Coliscan Easygel Method – Colonies per 100 ml of water

Site	9/23/2014	9/30/2014	10/7/2014	10/13/2014	10/21/2014	Average	Geometric Mean	% Reduction Needed
1 – Lentizier Creek	333	0	166.5	2,131.2	0	526.14	490.71	75%
2 – Bull Creek-OH River	33.3	0	466.2	8,325	366.3	1,838.16	466.45	73%
3 – Camp Creek	99.9	333	799.2	166.5	66.6	293.04	196.75	36%
4 – Dry Branch-Fourteen Mile Creek	166.5	0	133.2	3,263.4	66.6	725.94	263.49	53%
5 – Dry Branch-Fourteen Mile Creek	66.6	33.3	99.9	166.5	33.3	79.92	65.75	No reduction needed
6 – Dry Branch-Fourteen Mile Creek	33.3	3,330	199.8	1,365.3	133.2	1,012.32	331.93	62%
7 – Rogers Run	233.1	1,232.1	1,798.2	4,095.9	166.5	1,505.16	811.63	85%
8 – Rogers Run	199.8	66.6	1,565.1	2,430.9	33.3	859.14	278.85	55%
9 – Rogers Run	233.1	133.2	699.3	9,990	133.2	2,237.76	492.22	75%
10 – East Fork-Fourteen Mile Creek	399.6	399.6	1,098.9	3,263.4	133.2	1,058.94	597.69	79%

Figure 109: 2015 E.coli Results Fourteen Mile Creek/Goose Creek Watersheds – Coliscan Easygel Method – Colonies per 100 ml of water

Site	5/20/2015	5/27/2015	6/3/2015	6/10/2015	6/16/2015	Average	Geometric Mean	% Reduction Needed
1 – Lentizier Creek	266.4	0	99.9	99.9	166.5	126.54	145.05	14%
2 – Bull Creek-OH River	33.3	33.3	33.3	66.6	166.6	66.6	52.78	No reduction needed
3 – Camp Creek	399.6	99.9	199.9	266.4	33.3	199.82	147.91	15%
4 – Dry Branch-Fourteen Mile Creek	133.3	66.6	0	66.6	0	53.28	83.93	No reduction needed
5 – Dry Branch-Fourteen Mile Creek	199.8	66.6	133.2	166.5	33.3	119.88	99.65	No reduction needed
6 – Dry Branch-Fourteen Mile Creek	66.6	0	0	0	99.9	33.3	81.57	No reduction needed
7 – Rogers Run	0	229.7	33.3	66.6	99.9	44.54	84.46	No reduction needed
8 – Rogers Run	133.2	66.6	99.9	33.3	33.3	93.24	62.88	No reduction needed
9 – Rogers Run	199.8	166.5	133.2	66.6	99.9	166.5	124.14	No reduction needed
10 – East Fork-Fourteen Mile Creek	33.3	0	0	0	33.3	13.32	33.30	No reduction needed

Setting Goals and Identifying Critical Areas

4.1 Goal Statements

Goals were developed to address the identified problem categories, and concerns above. By addressing these concerns, marked improvement in water quality should be seen in the Fourteen Mile Creek/Goose Creek watersheds. The identified problem categories from Section 3.2 were: trash, high E. coli levels, sedimentation, high nutrient levels, degraded habitat, and decrease in biodiversity.

Some of the primary goals address more than one problem category. For instance, achieving the goal to reduce sedimentation will also improve degraded aquatic habitat, reduce stream nutrient levels, and create potential for an increase in aquatic biodiversity. Reducing nutrient loads will also create the potential for increased biodiversity by making our rivers better suited for sensitive species. Decreasing the levels of E. coli in the streams will make the watershed safer for stakeholders and citizens. Trash that finds its way to streams and sinkholes is expected to decrease once citizens become more aware and knowledgeable about water quality through outreach efforts to increase public awareness.

The six primary goals developed are listed here. Their order does not indicate a level of importance.

GOAL 1: Reduce soil erosion and sedimentation so current water quality conditions are protected or improved. Currently sediment load within the watersheds is 50,635 tons per year. This is 47,405 tons of sediment above the target level. The project hopes to:

- A 20% decrease (10,127 tons/year) in the sediment load in 5 years
- An additional 40% decrease (16,203.2 tons/year) in the sediment load in 10 years
- An additional 60% decrease (14,582.88 tons/year) in the sediment load in 20 years
- Add 100 acres of riparian buffers and filter strips to the watershed in 20 years

GOAL 2: Increase public awareness on how individual choices and activities impact the watershed by:

- Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.
- Increase educational signage at applicable, highly visible, locations in the Fourteen Mile Creek/Goose Creek watersheds within a 10 year period. This signage will highlight best management practices, and offer general watershed education.
- Conduct educational workshops and programs to help foster learning, and a passion for protecting the Fourteen Mile Creek/Goose Creek watersheds.

GOAL 3: - Sites sampled for E. coli during the term of this project exceeded the 125 CFU/100 mL geometric mean water quality standard eleven times. Reductions needed ranged from 0% to 85%. Our goal is to reduce E. coli concentrations throughout the watershed to meet water quality standards within the next 20 years. In addition, we will strive to:

- Promote BMPs that control livestock direct access to streams to landowners of sites found during our windshield survey (25 sites) of the watershed; identify other sites where direct access is occurring.
- Seek outside sources to fund data collection for progress monitoring of E. coli levels in the watershed.
- Promote proper septic maintenance for landowners in the watershed by hosting workshops, and distributing educational materials.
- See a delisting of stream segments impaired for E.coli from IDEM's 303 (d) list within 20 years.

GOAL 4: Aquatic organisms' diversity and populations are declining, and are now impaired in some watersheds. In order to maintain a rich biodiversity in the Fourteen Mile Creek/Goose Creek watersheds, we want to protect and enhance critical habitat and the unique natural areas of the watersheds as well as threatened, endangered, and rare species. We would like to see:

- Practices installed to protect or restore critical areas (defined in Section 4.3, page 136, of this document) in 10 years
- Habitat improvement and protection measures promoted in the Fourteen Mile Creek/Goose Creek watersheds by the hosting of educational workshops, and distributing of educational materials.
- Stakeholders educated on current state endangered, rare, and invasive species in the watershed.

GOAL 5: Litter and trash in the watershed may contain hazardous materials that can cause adverse effects on water quality. Trash and litter reinforces public perception that trash in natural areas is acceptable. We would like to see:

- A decrease in roadside and stream bank litter through cleanups and outreach efforts.
- An increase in signage discouraging public littering.
- A decrease in the number of trash bags of litter cleaned up annually from the watershed.

GOAL 6: Nutrients need to be reduced within the watershed. There are currently 608,059 lbs./year of nitrogen in the watershed, and 122,931 lbs./year of phosphorus circulating in the waters of the watersheds. This an excess of 220,432 pounds of nitrogen, and 104,842 pounds of phosphorus per year above the target levels for these two nutrients. We would like to see:

- A 20% decrease (121,611.8 N lbs./year; 24,586.2 P lbs./year) in the nutrient loads in 5 years.
- An additional 30% decrease (145,934.16 N lbs./year; 29,503.44 P lbs./year) in the nutrient loads in 10 years.
- An additional 50% decrease (170,256.52 N lbs./year; 34,420.68 P lbs./year) in the nutrient loads in 20 years.
- Partnerships formed with other agencies and organizations that would result in the reduction of excess nitrogen on agricultural lands.

Education and outreach, and BMP implementation, are components of achieving the goals stated above. They are intertwined – lack of knowledge of BMPs results in lack of desire/motivation to install them – therefore, both education and BMP installation will be offered from the onset of our project. The resulting awareness and BMPs installed will be indicators (see Sec. 4.2 below) of how successful we are in reaching our goals.

4.2 Indicators

Detailed descriptions of milestones for the indicators in the following figures can be found in the Action Register on pages 162-178 of this document.

Reduce Sediment

Reduction of sediment in the streams of the Fourteen Mile Creek/Goose Creek watersheds will help improve aquatic habitat, and aquatic life. Soil erosion is a significant source of sediment in streams. Soil erosion is a gradual process that occurs when the impact of water or wind on the soil detaches and removes soil particles, causing the soil to deteriorate. Soil erosion by water, and the impact of sediment-attached nutrients (i.e., phosphorus) on lakes and streams, adversely affects both agricultural land, and water quality. Currently sediment load within the Fourteen Mile Creek/Goose Creek watersheds is 50,635 tons per year; 47,405 tons above the target level (25 mg/L; 3,230 tons/year). Sediment loads needs to be reduced within the watersheds to target level. To achieve this, we would like to see a 20% decrease in the sediment load in 5 years, an additional 40% decrease in the sediment load in 10 years, and an additional 60% decrease in the sediment load in 20 years. Figure 110 lists sub-goals to accomplish the primary goal, and potential indicators for measuring progression toward the primary goal.

Figure 110: Reduction in Sediment - Goals and Indicators

Sub Goal	Indicator
Short term (1-5 years)	• Number of educational events
Educate agricultural producers and livestock owners on the function and value of BMPs as beneficial practices for crop production and water quality	• Survey data tracking changes in attitude and behaviors of agricultural producers, livestock owners, pet owners, land managers, and/or homeowners
Educate watershed residents on the function and value of BMPs to reduce erosion	• Number of articles, and educational materials generated
Increase utilization of native plants/wildlife habitat for erosion control	• Number of urban and agricultural BMPs installed
Implement sediment reducing BMPs (i.e., cover crop, critical area planting, alternative water system, grassed waterways) Install stream buffers and filter strips in potential high sediment producing areas	• Feet of stream length with stream buffers • Number of landowners and linear feet of installed fence who apply for funding • Number of cropped acres covered during off season • Acres of pastures with healthy cover
Medium-term (6-10 years)	• Number of Karst literature resources uncovered
Continued education and BMP implementation	• Acres of forests enrolled into classified forest
Increase utilization of native plants/wildlife habitat for erosion control	• Sediment Load Reductions achieved with BMP implementation • Measured improvement in CQHEI, PTI/mIBI scores
Long-term (11-20 years)	
Continued education and BMP implementation	
Increase utilization of native plants/wildlife habitat for erosion control	
Increased recreational value and wildlife habitat quality	

Increase Knowledge & Capacity

The Steering Committee believes that many problems in Fourteen Mile Creek/Goose Creek watersheds stem from the fact that landowners have an insufficient understanding of water quality issues, and how their actions can make a difference, as well as general apathy. Over the next twenty years, the Steering Committee desires to increase the knowledge and understanding of water quality issues held by landowners through education and outreach.

To this end, the project website (www.14milecreekwatershed.weebly.com) will be maintained and updated on a regular basis throughout the life of the project. Information on the progression towards goals, "Watershed Update" newsletters, and activities and events will be available there. The "Watershed Update" newsletter will likewise keep constituents abreast of current information and activities, and will be distributed on a quarterly basis. In addition, updates on project progress will be given at Steering Committee meetings, which will be advertised as public events. Information will also be available at all project events and activities.

Figure 111 lists sub-goals to accomplish the primary goal, and potential indicators for measuring progression towards the primary goal.

Figure 111: Increase Knowledge and Capacity - Goals and Indicators

Sub Goal	Indicator
Short term (1-5 years)	
Establish education, outreach, and clean-up programs to reduce stream, sinkhole, and roadside dumping.	• Number of educational events
Develop appropriate planning to insure the long-term viability and effectiveness of the Fourteen Mile Creek/Goose Creek Project	• Number of articles, and educational material generated
Provide human and intellectual resources required to further the goals and mission of the Fourteen Mile Creek/Goose Creek Project	• Increased number of urban, forest, and agricultural BMPs installed over time
Build and Utilize Partnerships	• Number of grants applied for and awarded
Educate stakeholders on pollution prevention options	• SWCD Plan of Work includes education and outreach items targeted to watersheds
Develop a pride program for keeping the local community clean	• SWCD Business and Financial Plan incorporates goals of the watersheds and allocates funds to those goals
Medium-term (6-10 years)	• Working, filterable volunteer database in place
Continued education and BMP implementation	
Look for alternative funding mechanisms for increasing knowledge and concern of water quality	• Number of clean water signs placed within watershed demonstrating pride
	• List of partners developed and utilized
Long-term (11-20 years)	• Percent of applications that are completed through conservation programs
Continued education and BMP implementation	• Statistics from landowner interviews indicate positive change in understanding of water quality issues
Long term viability of the Fourteen Mile Creek/Goose Creek Watersheds Project is realized	• Statistics from landowner surveys indicate positive change in understanding of water quality issues

Reduce E. coli

E. coli is a type of fecal coliform bacteria that comes from both human and animal waste. It is one of the most common sources of non-point source pollution, but one of the most difficult to treat, or even to identify potential sources. This project is following EPA and IDEM recommendations on E. coli levels to ensure that the water in the Fourteen Mile Creek/Goose Creek watersheds is safe for recreational use. In order to do this, sites must meet the target of less than 125 CFU/100mL for the five-week geometric mean. The overall goal is to reduce E. coli concentrations throughout the watershed to meet water quality standards. Figure 112 lists sub goals and indicators that can be measured in reaching this goal.

Figure 112: Reduction of E. coli - Goals and Indicators

Sub Goal	Indicator
Short term (1-5 years)	• Increased septic system awareness and changing attitudes measured by program attendance and survey data • Number of landowners installing use exclusion, waste storage, or manure management plans, who apply for funding • Residences participating in group discount maintenance programs if such a program is offered • Number of educational events • Number of urban and agricultural BMPs installed • Local ordinances adopted • Health Departments increase number of inspections • Number of failing/outdated septic systems replaced
Educate homeowners so that they understand how failing septic systems impact water quality	
Educate livestock owners so that they understand how livestock wastes impact water quality. Encourage implementation of best management practices	
Build and utilize partnerships with Health Departments within the watersheds.	
Encourage replacement of failing/outdated septic systems	
Develop a local ordinance(s) requiring upgrades to failing systems at the time of real estate transactions	
Implement E.coli reducing BMPs (i.e., stream crossings, fence, critical area planting, alternative watering systems)	
Voluntary maintenance and upgrades are made to suitable on-site septic systems	
Medium-term (6-10 years)	• Number of homes connected to municipal sewer • Measured reduction in E. coli concentrations: 50% of samples tested do not exceed the 235 CFU/100mL single sample target consistently each year by year 10; 100% of samples tested do not exceed it by year 20. 50% of sites do not exceed the 125 CFU/100mL five-week geometric mean target consistently each year by year 10; 100% do not exceed it consistently by year 20.
Continued education and BMP implementation	
Continued voluntary maintenance and upgrades to suitable on-site septic systems	
Town annexation of neighborhoods that are not suitable for on-site septic systems	
Continued development of local ordinance(s) requiring upgrades to failing systems at the time of real estate transactions	
Long-term (11-20 years)	• Removal from 303(d) list for E. coli impairments
Continued education and BMP implementation	
Fourteen Mile Creek / Goose Creek is removed from the 303d list for E. coli impairment and is safe for recreation	
Continued voluntary maintenance and upgrades to suitable on-site septic systems	
Continued development of local ordinance(s) requiring upgrades to failing systems at the time of real estate transactions	

Improve Aquatic Organism Diversity and Population

Aquatic organisms diversity and populations are declining, and are now impaired in some areas of the Fourteen Mile Creek/Goose Creek watersheds. We would like to see an increase in macroinvertebrate populations and diversity in the next 20 years (PTI >17), and see a delisting of the stream segment (Assessment Unit INN0171_T1002) from IDEM's 303(d) list for impaired biotic communities within 20 years. Figure 113 lists sub-goals to accomplish the primary goal, and potential indicators for measuring progression toward the primary goal.

Figure 113: Aquatic Organism - Goals and Indicators

Sub Goal	Indicator
Short term (1-5 years)	
Educate landowners on effects that runoff has on aquatic organisms	• Increased awareness and changing attitudes measured by survey data
Educate agriculture producers of the value and function of nutrient and pest management plan	• Number of articles, and educational material generated
Educate residents on the influence that personal care products have on organisms	• Number of urban and agricultural BMPs installed
Work to connect natural areas with stream buffers and other land set-asides	• Amount of stream length with stream buffers
Medium-term (6-10 years)	• Number pharmaceutical take back events
Continued education and BMP implementation	
Determine if BMPs are having a positive effect on biologic populations	• Number of follow up interviews of BMP implementation for determining success & lessons learned
Investigate alternative BMPs for improving aquatic life	
Long-term (11-20 years)	
Increase Habitat quality within the watershed	• Sediment Load Reductions achieved with BMP implementation
Continued education and BMP implementation	• Increase in macro populations and diversity
Stream segment (Assessment Unit INN0171_T1002) is removed from the 303d list for Impaired Biotic Communities	
	• Increase in CQHEI scores • Number of installed practices
	• Measured increase in macroinvertebrate populations and diversity; all sites meet or exceed PTI target (>16 points) up from current 55% of sites doing so

Decrease Litter and Trash

Trash and litter in the Fourteen Mile Creek/Goose Creek watersheds has a negative impact on overall water quality and health. Increased amounts of trash, and even some dumping areas, have been reported by Steering

Committee members, and spotted in the windshield survey. Trash and litter can not only leak or drain hazardous materials into the watersheds, but it also lowers the public perception of the watersheds. We want residents and stakeholders in the watersheds to take pride in their local resource, and decreasing the amount of trash and litter will help us achieve that. Figure 114 lists sub goals and indicators that can be measured in reaching this goal.

Figure 114: Decrease Litter and Trash - Goals and Indicators

Sub Goal	Indicator
Short term (1-5 years)	
Host educational cleanups in the watershed	• Number of clean ups
Establish education, outreach, and clean-up programs to reduce stream, sinkhole, and roadside dumping.	• Number of articles, and educational material generated
Create and distribute educational signage that discourages litter in the watershed	• Number of participants in cleanups
Work with partners in DNR to assist with take in, carry out trash programs in the state park	• Number of signs to discourage littering created and placed
	• SWCD Plan of Work recognizes DNR as a partner and incorporates education and outreach items related to trash cleanup in the state park
Develop a pride program for keeping the local community clean	
Medium-term (6-10 years)	• Working, filterable volunteer database in place
Continued education and trash cleanups	
Create signs and display with partners at state park to promote the reduction of litter	• Number of clean water signs placed within watershed demonstrating pride
	• List of partners developed and utilized
Long-term (11-20 years)	
Continued education and BMP implementation	• Statistics from cleanups indicate a 50% reduction in the number of bags of trash removed from the watersheds during cleanups from year 1 to 10; another 50% reduction from year 10 totals to end of year 20
Overall reduction of trash / litter in the watershed	• Statistics from resident surveys indicate a realization of less trash within the watersheds, and a positive feeling/attitude towards the appearance and health of the watersheds.

Reduce Nutrients

In the right balance, nutrients such as phosphorus and nitrogen are beneficial in aquatic ecosystems. However, when nutrients are in excess, they are harmful to the environment, and to aquatic organisms found in streams. For example, excess nutrients can stimulate algal blooms, which deplete the oxygen in natural waters, and result in conditions that cannot sustain aquatic life. Therefore, it is important that excess nutrients be reduced. Currently, there are 220,432 pounds of excess nitrogen, and 104,842 pounds of excess phosphorus, per year above the target levels, circulating within the Fourteen Mile Creek/Goose Creek watersheds' streams. We would like to see a 20% decrease in nutrient loads in 5 years, a 30% decrease in of nutrient loads in 10 years, and a 50% decrease in of nutrient loads in 20 years. Figure 115 lists sub-goals to accomplish the primary goal, and potential indicators for measuring progression toward the primary goal.

Figure 115: Reduction of Nutrients - Goals and Indicators

Sub Goal	Indicators
Short term (1-5 years)	
Educate watershed landowners on methods of reducing nutrient runoff	• Number of educational events
Implement nutrient reducing BMPs	• Number of articles, and educational material generated
Install stream buffers in potentially high nutrient production areas	• Number of urban and agricultural installed BMPs
Fence livestock out of critical areas	• Amount of stream length with stream buffers
Educate agricultural producers on how no-till, cover crops, and precision ag can reduce nutrient inputs	• Number of landowners installing fence, etc. who apply for funding
Distribute educational material to help educate the public on dumping and negative use	• Number of septic maintenance workshops, databases, and reminders developed
Develop a septic maintenance educational program	• Load Reductions achieved with BMP implementation
Educate watershed landowners on proper fertilization methods	• Measured reduction nitrogen and phosphorus concentrations
Seek resources to investigate sinkhole and karst influence on nutrient loading to waterways and groundwater	
Medium-term (6-10 years)	
Continued education and BMP implementation	
Research methods for treating farm runoff within or around sinkholes	• Number of karst literature resources uncovered
Investigate standard for sinkhole treatment BMP	• Survey data tracking changes in attitude and behaviors of agricultural producers, livestock owners, pet owners, land managers, and/or homeowners
Work with county on updating septic ordinances	
Long-term (11-20 years)	
Continued education and BMP implementation	
Continued investigation of new and alternative methods for treating nutrient runoff in karst	
Continued investigation of new and alternative funding sources for failing septic replacement & alternative systems	

4.3 Critical Areas of Implementation

Critical areas are defined by IDEM as areas where watershed management plan (WMP) implementation can remediate nonpoint pollution sources in order to improve water quality, and are defined areas where WMP implementation can mitigate the impact of future sources in order to protect water quality. Identifying those critical areas will help our project focus on areas that will have the greatest impact on improving water quality. This section focuses on identifying the critical areas located within the Fourteen Mile Creek/Goose Creek watersheds.

The Fourteen Mile Creek/Goose Creek Watersheds project considered a variety of criteria and factors in determining which subwatersheds would be defined as critical areas: water monitoring data in the form of nutrients, dissolved oxygen, and E. coli were compared; current sediments loads were calculated using STEPL; biological data was analyzed to determine overall quality of aquatic life; habitat data in the form of indexes, and windshield surveys were considered; data on land use types, current practices in the watershed, and individual accounts and recommendations, were all factored into the ranking process. Each subwatershed was listed in a spreadsheet and scored based upon the information just discussed (Figure 108).

For each criteria category the subwatersheds were assigned a “1” or a “2”. A “1” indicating that the target for a parameter was exceeded less than 50% of the time; a “2” indicating that the parameter was exceeded 50% or more of the time. The parameters that the committee were most concerned about were nitrates+nitrites, total phosphorus (TP), biochemical oxygen demand (BOD) and E. coli. Those parameters were double weighted (score multiplied by 2). If a subwatershed had E. coli levels that were consistently above targets (all sites exceeded) an additional 2 points was given. For subwatersheds that did not have a water monitoring site within their boundaries (West Fork-Fourteen Mile Creek, Little Huckleberry Creek, and Pattons Creek-OH River), the committee estimated the impact of current land use trends, and considered windshield survey data, to assign scores.

The Fourteen Mile Creek/Goose Creek Watershed project Steering Committee used their best discretion to assign each subwatershed a score in each category. The scores for the subwatersheds were then totaled in each category to produce a total score. Those that showed elevated concentrations of multiple ecological concerns at multiple sample sites scored high (21-23 points) in the table, and those with a lesser degree of concerns ranked lower (15-16 points). As a result of the score, natural rankings and divisions appeared. Those that ranked 1 or 2 were designated as priority watersheds, and should receive a higher priority when applying for BMP implementation. Those ranked 3 or below were designated secondary priority watersheds, and should receive a lower priority when applying for BMP implementation.

EPA’s planning guidance states an entire watershed area cannot be designated critical, therefore, our Steering Committee considered which areas of the Fourteen Mile Creek/Goose Creek watersheds should be listed as “no priority”. The committee decided to mark three areas as no-priority. Those areas with the reasoning for their selection are:

- Pattons Creek-Ohio River subwatershed – this subwatershed is the smallest of the subwatersheds, has a low population density, and a high percentage of land is forested (over 50%) as compared to land used for cultivated crops and pasture/hay (35%).

- The area of Little Huckleberry subwatershed containing River Ridge – access to River Ridge is limited at this point in time, and those areas that can be accessed are being developed commercially or are in the process.
- Lentizier Creek-Ohio River subwatershed – though this subwatershed ranked high as a critical area, it contains the growing industrial development of the Port of Indiana, and is also highly residential. We plan to supplement the work of our two MS4 partners (City of Jeffersonville, Oak Park Conservancy District) in this area, and address it with educational efforts.

The table below in Figure 116 illustrates the rankings of the subwatersheds and the points each scored. Subwatersheds with highest concern (weighted score) are noted in red; those determined to be low priority are noted in green; and those determined "no-priority" are in gray. A map of the subwatershed priority ranking follows in Figure 117.

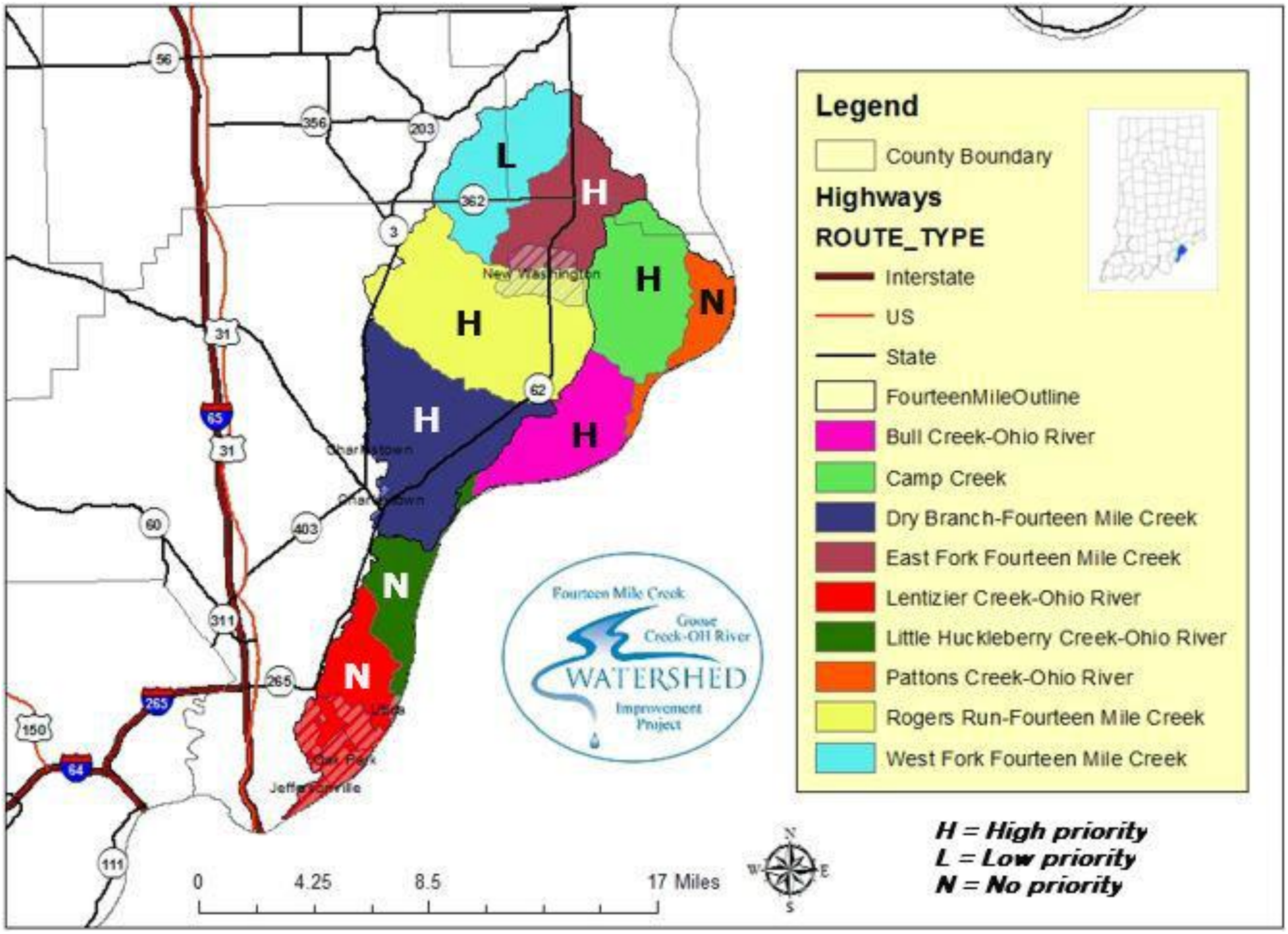
Figure 116: Critical Area Ranking Scores for the Subwatersheds in the Fourteen Mile Creek/Goose Creek Watersheds

Subwatershed	Nitrate+Nitrite*	Total P*	E. coli*	Sediment	Biochemical Oxygen Demand	Habitat	Macroinvertebrates	Urban Pollution	Agricultural Pollution	Score	Rank
East Fork	2	2	6	1	6	1	2	1	2	**23**	**1**
West Fork	2	2	2	1	4	1	1	1	2	**16**	**3**
Rogers Run	4	2	6	1	2	1	2	1	2	**21**	**2**
Dry Branch	4	2	6	2	4	1	2	1	1	**23**	**1**
Camp Creek	4	2	4	1	4	2	1	1	2	**21**	**2**
Pattons Creek – Ohio River	2	2	2	1	2	2	1	1	2	**15**	**4**
Bull Creek	4	2	6	1	4	1	1	1	1	**21**	**2**
Little Huckleberry Creek (excluding River Ridge)	2	2	4	2	2	1	1	1	1	**16**	**3**
Lentizier Creek	4	2	6	1	4	2	1	2	1	**23**	**1**

Parameters that were double weighted are indicated with an asterisk "*"

21-23	High Priority
15-17	Low Priority
	No Priority

Figure 117: Map of Subwatersheds Priority Ranking in the Fourteen Mile Creek/Goose Creek Watersheds



Applying Improvement Measures

In order to best improve water quality, certain management strategies are put on the land that are referred to as Best Management Practices or BMPs. BMPs are effective, practical, structural or nonstructural methods, which prevent or reduce the movement of sediment, nutrients, bacteria, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of various land use activities. These practices are developed to achieve a balance between water quality protection, conservation, and land production within natural and economic limitations.

A thorough understanding of BMPs, their purpose and their application are of vital importance in selecting BMPs that will be most effective in improving water quality in the Fourteen Mile Creek/Goose Creek Watersheds project. Each parcel of land is unique, and therefore must be considered individually to determine the BMPs that are most applicable to its needs. The right BMPs are ones that are practical and economical, while maintaining water quality and the productivity of the land.

5.1 Best Management Practices (BMP’s)

In deciding which Best Management Practices (BMP’s) to implement, the Fourteen Mile Creek/Goose Creek Watersheds Steering Committee met to discuss which practices would be most beneficial to water quality, and would address stakeholder concerns. In addition to BMPs, the Steering Committee included topics and ideas for educational outreach. By implementing both the BMPs and the educational outreach, an improvement in water quality should be seen. It is important to note that no single practice will address all issues, rather, it will require a combination of practices to make lasting changes in the Fourteen Mile Creek/Goose Creek watersheds.

5.1.1 Agricultural Management Practices

Agricultural best management practices are implemented on agricultural lands, typically either row crop or pasture. These practices are designed to protect water quality and aquatic habitat while improving land resources. They help control nonpoint source pollutants, reducing their loading input to the Fourteen Mile Creek/Goose Creek watersheds by minimizing the volume of available pollutants. Potential agricultural best management practices designed to control and trap agricultural nonpoint sources of pollution include:

- Alternate Watering Systems
- Cover Crop
- Critical Area Planting
- Fence
- Filter Strip
- Forage & Biomass Planting
- Grassed Waterway
- Heavy Use Area Protection (HUAP)
- Nutrient Management Planning
- Prescribed (Rotational) Grazing
- Residue and Tillage Management
- Roof Runoff Structure – gutter
- Stream Crossings

These BMPs would be appropriate for all subwatersheds based on resource concerns identified during the windshield survey, and the fact that all subwatersheds contain some crop and/or pasture land. Priority for the BMP implementation will be based on the ranking of the critical areas: High – East Fork Fourteen Mile Creek, Camp Creek, Bull Creek, Rogers Run, and Dry Branch; Low Priority – West Fork Fourteen Mile Creek; and No Priority – Pattons Creek, Little Huckleberry Creek, Lentizier Creek. The high priority critical areas will receive funding first.

Alternate Watering Systems

Alternative watering systems provide an alternate location for livestock to seek water rather than using a surface water source. This removes the negative impacts of livestock access to streams, including direct deposit of manure and bank erosion and destabilization. Watering systems improve the health of livestock by providing a clean water source and better footing while drinking. As a result, there is less potential for E. coli, phosphorus, nitrogen, and sediment to enter streams. Two primary types of alternative watering systems are pump systems and gravity systems.

Cover Crops
Cover crops include legumes, such as clover, hairy vetch, field peas, alfalfa, and soybean, and non-legumes, such as rye, oats, wheat, radishes, turnips, and buckwheat, which are planted prior to or following crop harvest. Cover crops are typically grown for one season, typically a non-cropping season. Cover crops are used to improve soil quality, and future crop harvest by improving soil tilth, reducing wind and water erosion, increasing available nitrogen, suppressing weed cover, and encouraging beneficial insect growth. Cover crops are a familiar and somewhat widely used conservation practice throughout the watershed. Additional operators will likely consider this practice as the benefits of reduced fertilizer use becomes known.

Critical Area Planting
Critical Area Planting is used to establish permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. It is applicable to highly disturbed areas, such as: active or abandoned mined lands; urban restoration sites; construction areas; conservation practice construction sites; areas needing stabilization before or after natural disasters such as floods, hurricanes, tornados and wildfires; eroded banks of natural channels, banks of newly constructed channels, and lake shorelines; and other areas degraded by human activities or natural events. It is used successfully to prevent soil erosion and soil quality degradation, thereby improving water quality.

Fence
A fence is a constructed barrier to animals or people. The fence practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals and people, as well as vehicles. It may be applied on any area where management of animal or human movement is needed. Fence is often used in conjunction with other practices to effectively address resource concerns (e.g., Prescribed Grazing, Alternative Water).

Forage & Biomass Planting
Forage and biomass planting is the process of establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production. These plantings are designed to improve or maintain livestock nutrition and/or health, provide or increase forage supply during periods of low forage production, reduce soil erosion, improve water quality, and produce feedstock for biofuel or energy production. For the purposes of our project, the objectives of reducing soil erosion and improving water quality would be applicable.

Filter Strip
A filter strip is a strip or area of herbaceous vegetation that removes contaminants from overland flow. Installing natural filters along major and minor drainages in the watershed helps reduce the opportunity for nutrients and sediments to reach surface and subsurface waterbodies, and increases nature's natural filtration methods. Filter strips have been found not only to reduce sediment-bound nutrients, but also sediment load itself. Sediment, phosphorus, nitrogen, and E. coli are at least partly removed from water when passed through a naturally vegetated buffer such as this. Filter strips should be designed as permanent plantings to treat runoff, and should not be considered part of the annual rotation of adjacent cropland. Filter strips should receive only

sheet flow, and they should be installed on stable banks. A mixture of grasses, forbs, and herbaceous plants should be used. The percentage of pollutants removed via this method depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the filter area.

Grassed Waterway

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

Heavy Use Area Protection (HUAP)

Heavy Use Area Protection (HUAP) is a practice used to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles, and to protect or improve water quality. This practice applies to all land uses where a frequently or intensively used area requires treatment to address one of more resource concerns, exclusive of roads, lands, or other linear practices. In instances where livestock are involved, other practices may be included where a HUAP is installed in order to collect, store, utilize, or treat manure and contaminated runoff where contaminated runoff will cause a resource concern. This practice requires the stabilization of all areas disturbed by construction of the HUAP as soon as possible after construction; BMP Critical Area Planting (NRCS 342) should be used for the establishment of vegetation.

The treated area can include all areas where livestock congregate and cause surface stability problems. This includes feeding areas, portable hay rings, watering facilities, feeding troughs, mineral boxes, animal trails and walkways requiring surface stabilization, and other facilities where livestock concentrations cause resource concerns.

Nutrient Management

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater. Several producers in the watershed have not adopted this planning technique for their nutrient applications. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil. A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater. Nutrient management plans may consider the use of Nitrogen Stabilizers as a method to retain nitrogen in the fields for crop production, and decrease the amount of nitrogen leaving fields through leaching and runoff to nearby surface or subsurface channels.

Prescribed (Rotational) Grazing

Livestock that have unrestricted access to a stream or wetland have the potential to degrade the waterbody's water quality and biotic integrity. Livestock can deliver nutrients and pathogens directly to a waterbody through defecation. Livestock can also degrade stream ecosystems indirectly by trampling and removal of vegetation when they graze riparian zones. This can weaken banks, and increase the potential for bank erosion. Trampling can also compact soils in a wetland or riparian zone decreasing the area's ability to infiltrate water runoff. Removal of vegetation in a wetland or riparian zone also limits the area's ability to filter pollutants in runoff. Degradation of a waterbody's water quality, and habitat typically results in the impairment of the biota living in the waterbody.

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

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

Residue and Tillage Management – No-till

Residue and tillage management refers to limiting soil disturbance to manage the amount, orientation and distribution of crop and plant residue on the soil surface year around. Tillage methods encompassed by this practice include no-till, quality no-till, never-till, zero till, slot plant, zone till, direct seeding, or strip till. The purpose of residue and tillage management is to reduce sheet and rill erosion, reduce tillage-induced particulate emissions, maintain or improve soil quality and organic matter content, reduce energy use, increase plant-available moisture, and provide habitat and cover for wildlife. The remaining crop residue helps reduce soil erosion and runoff volume.

Several researchers have demonstrated the benefits of conservation tillage in reducing pollutant loading to streams and lakes. A comprehensive comparison of tillage systems showed that no-till results in 70% less herbicide runoff, 93% less erosion, and 69% less water runoff volume when compared to conventional tillage (Conservation Technology Information Center, 2000). Although there are many producers in the Fourteen Mile Creek/Goose Creek watersheds that use conservation tillage methods, there are still some that have not implemented the change. There were 10 sites identified in the windshield survey that were conventionally tilled lands.

Roof Runoff Structure

A roof runoff structure is a structure that will collect, control and convey precipitation runoff from a roof. This practice is applied to achieve one or more of the following purposes: protect surface water quality by excluding roof runoff from contaminated areas; protect a structure foundation from water damage or soil erosion from excess water runoff; increase infiltration of runoff water; and capture water for other uses. It is applied where roof runoff from precipitation needs to be diverted away from the foundation of a structure or contaminated areas, to be collected and conveyed to a stable outlet or infiltration area, or to be collected or captured for other uses such as evaporative cooling systems, livestock water and irrigation.

When runoff is conveyed through a gutter and downspout system, it is protected from contamination (e.g., by manure), and routed onto pervious landscaped areas (e.g., mass planting areas, infiltration trenches, or natural areas) to increase infiltration of runoff. These areas are capable of infiltrating the runoff in such a way that replenishes soil moisture without adversely affecting the desired plant species, and without creating a soil erosion problem.

Stream Crossings

A stream crossing is a stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. It is used to improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream, to reduce streambank and streambed erosion, and to provide crossing for access to another land unit. Other BMPs, including Fence (382), and Critical Area Planting (342), are often used in conjunction with this practice to effectively address resource concerns.

5.1.2 Urban Management Practices

Development and the spread of impervious surfaces are occurring throughout the Fourteen Mile Creek/Goose Creek watersheds. As impervious surfaces continue to spread throughout the watershed, the volume and velocity of stormwater entering the watersheds will also increase. The best way to mitigate stormwater impacts is to infiltrate, store, and treat stormwater onsite before it can run off into the karst system or streams in the area. Urban best management practices designed to complete these actions are as follows:

- Bioretention Practices
- Detention Basin
- Green Roof
- Infrastructure Retrofit
- Low Impact Development
- Pervious Pavement
- Pet Waste Control
- Rain Barrels/Cisterns
- Rain Garden
- Trash Control and Removal

The critical areas in our project are not urban in nature, therefore we do not foresee implementing the above practices (with the exception of Trash Control and Removal as noted in the descriptions below) through this project. However, we *can* foresee their use as education and outreach topics. In addition, we would like to supplement the work of this project by securing other grant funds, or partnership funds, that would assist us in their implementation.

Bioretention Practices

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

Detention Basin

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

Green Roof

A green roof is a building partially or completely covered with vegetation and a growing medium planted on top of a waterproof membrane. Irrigation and drainage systems carry water from the roof through the plant material and medium to the building drainage system. Green roofs absorb rainwater, provide insulation, reduce air temperatures, and provide habitat for wildlife. Green roofs can retain up to 75% of rainwater gradually releasing it via condensation and transpiration while retaining sediment and nutrients. Green roofs can be installed on any type of roof – slanting to flat – with an ideal slope of 25%.

Infrastructure Retrofit

Typical stormwater infrastructure includes pipe and storm drains, or hard infrastructure, to convey water away from hard surfaces and into the stormwater system. Retrofitting these structures to implement low impact development techniques, use green practices, and introduce plants and filters to reduce sediment and nutrient concentrations contained in stormwater. Many of the treatments listed in this section can be utilized to retrofit infrastructure including pervious pavement, green roofs, constructed wetlands, rain gardens, and more. In order for the installation to meet a "retrofit" requirement, existing infrastructure must already be in place, subsequently removed, and replaced with green infrastructure.

Low Impact Development

Several techniques can be used for protecting natural areas and open space in both public and private ownership. Open space can be protected using conservation design development techniques. Low Impact Development (LID) is a land development or re-development process that works in concert with nature to manage stormwater at the source, or as close as possible to the source. Preservation of open space, recreation of natural landscape features, reduction of impervious surface coverage, and utilization of on-site drainage to treat stormwater are the key features of low impact development. This technique uses a suite of practices detailed in this section including bioretention, rain gardens, green or vegetated roofs, rain barrels, pervious pavement, and more. LID can be used anywhere as part of a new development, redevelopment, or retrofit of existing development or infrastructure. If used correctly, LID can restore a watershed's hydrologic and ecological function.

Pervious Pavement

Pervious pavement comes in many forms including porous pavement and modular block pavement. Both types of pervious pavement can be installed on most any travel surface with a slope of 5% or less.

Pervious pavement has the approximate strength characteristics of traditional pavement with the ability to percolate water into the groundwater system. The pavement reduces sediment and nutrient transmission into the groundwater as water moves through the pores in the pavement. When installed, porous pavement includes a stone layer, filter fabric, and a filter layer covered by porous pavement. Correctly, mixed porous pavement eliminates fine aggregates found in typical pavements. Porous asphalt is a type of porous pavement, which includes a mix of Portland cement, coarse aggregates, and water that results in the formation of interconnected voids.

Pet Waste Control

Pet waste cannot be considered the predominant waste product within a watershed nor the one that produces the greatest impact. Nonetheless, the cumulative impact of pet waste within a watershed can produce a major impact on water quality. Pet waste contains bacteria and parasites, organic matter, phosphorus, nitrogen, and E. coli and can carry diseases including Campylobacteriosis, Salmonellosis, and Toxocarisis. Studies indicate that the average dog produces 13 pounds of nitrogen, 2 pounds of phosphorus, and 1,200 pounds of sediment annually (Miles, 2007). Dogs are numerous within the watersheds, therefore the impact of this volume of nutrients and sediment on the river system could be detrimental.

Many options for managing pet waste are available with most efforts focusing on educational options to turn pet waste from an 'out of sight, out of mind' issue to one that every pet owner considers for their pet. Pet waste can be flushed, resulting in waste traveling to the wastewater treatment plant or through the septic system for treatment, buried, where it gradually breaks down over time with nutrients entering the soil and microorganisms converting diseases and bacteria into less benign forms, or trashed, resulting in potential landfill issues. Some signage and public education is available in the watershed currently, but more is needed to inform the community about options for treating pet waste issues.

Rain Barrel/Cisterns

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

Rain Garden

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

Trash Control and Removal

Trash and debris located throughout urban areas indicate that these materials can have a significant negative impact on water quality within the Fourteen Mile Creek/Goose Creek watersheds. A majority of trash observed occurs adjacent to streets, road right of ways, and sidewalks in the watershed. Surveys in larger urban areas indicate that plastic bottles, Styrofoam cups, and paper are the most common trash items found in or adjacent to storm drains. This practice is appropriate for all subwatersheds, but particularly the Dry Branch-Fourteen Mile Creek subwatershed where a dumping site was identified during the windshield survey.

5.1.3 Miscellaneous Practices

Other practices that may be beneficial to water quality and aquatic life that are not specific to agricultural, urban, or forestry land uses are included here as follows:

- Conservation Plan
- Education
- Indiana Rule 5 and Rule 6 Compliance
- Riparian Buffers
- Septic System Care and Maintenance
- Threatened and Endangered Species Protection

Conservation Plan

In farming, the key to successful total resource management is careful, complete planning. Every agricultural BMP installed works to address a specific resource concern, and helps improve a farm, however, each practice will work most effectively in combination with others when part of a plan. To design a plan, all resources on a farm need to be inventoried – every field, pasture, pond, stream, and wooded area. Then the soil conservation, water quality, wildlife habitat and energy conservation practices that would contribute to an environmentally and economically sound farm are considered. As practices are specific to each farm situation, thus are the pollutants removed and removal efficiency for conservation plans, therefore it is difficult to calculate an overall pollutant efficiency for this practice.

This practice would be appropriate for all subwatersheds as landuse patterns indicate percentages of cultivated crops, forest, and pasture/hayland in each.

Education

Educating – "the act or process of teaching someone", "imparting knowledge" – can be a rewarding, positive process. When dealing with a large audience that has not "signed up" to learn about a topic, as opposed to a student taking a college class they have interest in, it can be a long process. Features of education include that it is a practice that is not limited by topic, but only by what the teacher knows. It is also not limited by genre, gender, race, nationality, or ability. Therefore, it is an appropriate practice for us to use in all subwatersheds.

Indiana Rule 5 and Rule 6 Compliance

Land development activities commonly involve the clearing of vegetation followed by land moving, and excavation activities. When such activities are conducted and bare soil is exposed, the natural forces of wind and water can transport small amounts, to hundreds of tons, of soil and sediment from construction sites to lakes, streams, rivers, wetlands, and other environmentally sensitive areas. In addition to sediment, other pollutants such as oils and greases, and a variety of chemicals, can be discharged from construction sites as well.

Indiana Administrative Code 327 IAC 15-5, commonly known as "Rule 5", regulates construction projects that result in the disturbance of 0.40 hectare (1 acre) of land or more. Types of construction projects affected by Rule 5 include roads, residential housing, and commercial, industrial, and municipal projects.

Indiana Administrative Code 327 IAC 15-6, commonly known as "Rule 6", applies to stormwater discharge that has been exposed to manufacturing and processing activities, raw materials, or intermediate product storage areas at an industrial facility.

This practice is appropriate for all subwatersheds where new development takes place, but particularly Lentizier Creek subwatershed, which is currently experiencing various forms of development (residential/commercial/industrial), and the area of River Ridge (Little Huckleberry Creek subwatershed) that is being developed commercially.

Riparian Herbaceous/Riparian Forest Buffer

Riparian buffers are important for good water quality. Riparian zones help to prevent sediment, nitrogen, phosphorus, pesticides, and other pollutants from reaching a stream. Riparian buffers are most effective at improving water quality when they include a native grass or herbaceous filter strip along with deep-rooted trees and shrubs along the stream.

Herbaceous Riparian cover includes grasses, sedges, rushes, ferns, legumes, and forbs that are tolerant of intermittent flooding or saturated soils, which are established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats. Riparian cover:

- Provides or improves food and cover for fish, wildlife and livestock.
- Improves and maintains water quality.
- Establishes and maintains habitat corridors.
- Increases water storage on floodplains.
- Reduces erosion and improves stability to stream banks and shorelines.
- Increases net carbon storage in the biomass and soil.
- Enhances pollen, nectar, and nesting habitat for pollinators.

- Restores, improves, or maintains the desired plant communities.
- Dissipates stream energy and traps sediment.
- Enhances stream bank protection as part of stream bank soil bioengineering practices.

Forested Riparian Cover is an area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. Forested riparian cover:

- Creates shade to lower or maintain water temperatures to improve habitat for aquatic organisms.
- Creates or improves riparian habitat and provides a source of detritus and large woody debris.
- Reduces excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduces excess nutrients and other chemicals in shallow ground water flow.
- Reduces pesticide drift entering the water body.
- Restores riparian plant communities.
- Increases carbon storage in plant biomass and soils.

This practice is appropriate for subwatersheds exceeding E. coli, nutrient, sediment, and habitat targets during water monitoring, and/or in subwatersheds where locations were identified during the windshield survey as having practices with the potential to cause excessive levels of those parameters. Additionally, subwatersheds identified as lacking buffers: East Fork-Fourteen Mile Creek, Dry Branch-Fourteen Mile Creek, Rogers Run, Camp Creek, and Bull Creek-OH River, West Fork-Fourteen Mile Creek, Little Huckleberry Creek, and Lentizier Creek.

Septic System Care and Maintenance

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

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

Funding for this practice is limited. This practice is appropriate for all subwatersheds as all have some degree of septic use. It would be particularly applicable, to the predominantly rural subwatersheds: East Fork-Fourteen Mile Creek, Dry Branch-Fourteen Mile Creek, Rogers Run, Camp Creek, and Bull Creek-OH River, West Fork-Fourteen Mile Creek, and Little Huckleberry Creek.

Stream/Sinkhole Treatment
Sinkholes are a direct conduit to sensitive habitats and fresh water resources. Karst sinkholes, epikarst, and sinking streams make water more susceptible to non-point source pollution. Surface water is rapidly channeled into the subsurface in karst landscapes via sinkholes without the benefit of extensive filtration or exposure to sunlight which reduces contaminants. Groundwater is easily contaminated before reemerging as springs. Sinkholes should be protected to reduce the risk of contamination of these resources. The treatment of sinkholes with filtration materials has occurred in recent years around this area and in other states with karst features. Investigation into the viability of conducting treatment in sinkholes for agricultural areas including feed lots, crop fields, and pastures, for urban runoff including stormwater runoff, roadway drainage, and impervious surface drainage, and other areas susceptible to direct nonpoint source inputs should be considered. Vegetative treatments should be the first line of defense, but alternative treatments should be investigated further for situations where this would not be effective.

This practice is appropriate for all subwatersheds as sinkholes are present to some degree in all of them. It would be particularly applicable to the East Fork-Fourteen Mile Creek, Dry Branch-Fourteen Mile Creek, and Bull Creek-OH River subwatersheds, as sinkholes are abundant in them.

Threatened and Endangered Species Protection
Threatened and endangered species are those plant and animal species whose survival is in peril. Federally and state listed species identified within the Fourteen Mile Creek/Goose Creek watersheds are highlighted in the Watershed Inventory section of this document. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana.

Protecting threatened and endangered species requires consideration of their habitat including food, water, nesting and roosting living space for animals, and preferred substrate for plants and mussels. Corridors for species movement are also necessary for long-term protection of these species. Protection of habitat can include providing clean water and available food but likely requires protection of the physical living space and associated corridor. Protection of cave and karst features can protect several species listed due to the significance of this habitat, and lack of migration in these species. Conservation management plans should be developed for each species, if they are not already in place. Such plans should consider habitat needs such as purchase or protection of properties adjacent to current habitat locations, hydrologic needs, pollution reduction, outside impacts, and other techniques necessary to protect threatened and endangered species.

Though not a practice, protected threatened and endangered species should be of foremost consideration in all the subwatersheds.

Section 5.2 - Implementation Program Design
In order to address the problems associated with degraded water quality in the Fourteen Mile Creek/Goose Creek watersheds, practices must be implemented to ensure that water does not degrade further, and water quality improves over time. The goals set previously will address many of the problems identified within the watershed, but in order to reach those goals, a series of management strategies must be considered. First, an analysis of the most cost-effective Best Management Practices should be considered to efficiently address the

issues with the funding available. Secondly, the concerns need to be associated with practices that would be able to achieve the goals listed.

Lastly, those practices should be considered for their urgency and feasibility of implementation. Some problems can spiral out of control if not addressed in a timely manner. For example, once a stream bank becomes destabilized, the forces of water can quickly erode away large sections of stream bank. This problem would be of high urgency. Feasibility is the ease of installing practices or addressing concerns. In this same example, stream banks that become destabilized are sometimes extremely expensive to fix, and may not hold up to the power that water would have on the installed structures. This can be especially true if the cause of this bank destabilization is not addressed first. Additionally, the destabilization may be on a landowner's property that may not be able to afford such costly repairs. This example shows that this practice might have a low feasibility.

5.2.1 Management Strategies

Practices that will address the concerns in our watersheds, the number of those practices we expect to implement, the load reduction we can expect from their installation, and cost information is presented below in Figure 118.

The Figure 118: Estimated Load Reductions and Costs of Implementation of BMPs Over 20-year Project Life.

Suggested BMPs	BMP load reduction efficiency per unit of BMP			Unit	BMP Targets	Estimated Cost (per unit)	Total Estimated Cost
	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)				
Alternative Water (NRCS 642, 614, 574, 516 & 378)	25	12	18	System*	40	$1,500	$60,000
Cover Crop (340)	11	5	6	acre	8,000	$45.42	$363,360
Critical Area Planting (342)	17	8	8	Acre	150	$661.97	$99,295.50
Fence (382)	.9	.9	.9	feet	63,360	$2.50	$158,400
Forage and Biomass Planting (512)	17	8	8	Acre	1,000	$201.43	$201,430
Filter Strip (393)	34	17	16	Acre	50	$581.06	$29,053
Grassed Waterway (412)	.9	.9	.9	Acre	40	$2,537.42	$101,496.80
Heavy Use Area Protection (561)	25	12	18	Feet	118,800	$1.03	$122,364
Nutrient Management (590)	4	2	-	Acre	2,100	$12.24	$25,704
Prescribed Grazing (528)	17	8	8	Acre	1,200	$21.31	$25,572
Residue and Tillage Management (329)	17	8	10	Acre	2,500	$15.01	$37,525
Riparian Herbaceous & Forest Buffer (390 & 391)	7	4	4	Acre	50	$780.54	$39,027
Roof Runoff Structure (558) - gutter	-	186	-	System*	20	$1,750	$35,000
Stream Crossing (578)	4.1	2	2	Unit*	40	$2,311	$92,440

Suggested BMPs	BMP load reduction efficiency per unit of BMP			Unit	BMP Targets	Estimated Cost (per unit)	Total Estimated Cost
	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)				
**These practices commonly incorporate several BMPs to make an effective "unit" or "system", and are therefore priced as such.*							

Figures 119, 120, and 121 estimate available load reductions for each of the BMPs in relation to 5-, 10-, and 20-year goals.

Figure 119: Estimated 5-year Load Reduction for BMP Targets

BMP	BMP Targets	Estimated 5 Year Load Reduction for BMP Targets		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Alternative Water (NRCS 642, 614, 574, 516 & 378)	10	250	120	180
Cover Crop (340)	2,000	22,000	10,000	12,000
Critical Area Planting (342)	37.5	637.5	300	300
Fence (382)	15,840	2423.5	1211.8	1211.8
Forage and Biomass Planting (512)	250	4,250	2,000	2,000
Filter Strip (393)	10	340	170	160
Grassed Waterway (412)	10	799.8	399.9	399.9
Heavy Use Area Protection (561)	54,450	56	28	41
Nutrient Management (590)	525	2100	1050	-
Prescribed Grazing (528)	300	5100	2400	2400
Residue and Tillage Management (329)	625	10,625	5,000	6,250
Riparian Herbaceous & Forest Buffer (390 & 391)	10	70	40	40
Roof Runoff Structure (558) - gutter	5	-	930	-
Stream Crossing (578)	10	41	20	20
Total Load Reduction from Target Amount of BMPs		**48,692.8**	**23,669.7**	**25,002.7**
Load Reduction needed to meet water quality goals		**121,611.8**	**24,586.2**	**10,127**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**72,919 still required to meet target**	**916.5 still required to meet target**	**Target exceeded by 14,875.7**

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Figure 120: Estimated 10-year Load Reduction for BMP Targets

BMP	BMP Targets	Estimated 10-Year Load Reduction for BMP Targets		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Alternative Water (NRCS 642, 614, 574, 516 & 378)	20	500	240	360
Cover Crop (340)	4,000	44,000	20,000	24,000
Critical Area Planting (342)	75	1,275	600	600
Fence (382)	31,680	4847	2423.5	2,423.5
Forage and Biomass Planting (512)	500	8,500	4,000	4,000
Filter Strip (393)	30	1,020	510	480
Grassed Waterway (412)	20	1,599.6	799.8	799.8
Heavy Use Area Protection (561)	108,900	112	56	82
Nutrient Management (590)	1050	4,200	2,100	-
Prescribed Grazing (528)	600	10,200	4,800	4,800
Residue and Tillage Management (329)	1250	21,250	10,000	12,500
Riparian Herbaceous & Forest Buffer (390 & 391)	30	210	120	120
Roof Runoff Structure (558) - gutter	10	-	1860	-
Stream Crossing (578)	20	82	40	40
Total Load Reduction from Target Amount of BMPs		**97,795.6**	**47,549.3**	**50,205.3**
Load Reduction needed to meet water quality goals		**145,934.16**	**29,503.44**	**16,203.2**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**48,138.56 still required to meet target**	**Target exceeded by 18,045.86**	**Target exceeded by 34,002.1**

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Figure 121: Estimated 20-year Load Reduction for BMP Targets

BMP	BMP Targets	Estimated 20-Year Load Reduction for BMP Targets		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Alternative Water (NRCS 642, 614, 574, 516 & 378)	40	1000	480	720
Cover Crop (340)	8,000	88000	40000	48000
Critical Area Planting (342)	150	2550	1200	1200
Fence (382)	63,360	9694.1	4847	4847
Forage and Biomass Planting (512)	1,000	17000	8000	8000
Filter Strip (393)	50	1,700	850	800
Grassed Waterway (412)	40	3119	1599.5	1599.5
Heavy Use Area Protection (561)	217,800	195	97	136
Nutrient Management (590)	2,100	8400	4200	-
Prescribed Grazing (528)	1,200	20400	9600	9600
Residue and Tillage Management (329)	2,500	42500	20000	2500
Riparian Herbaceous & Forest Buffer (390 & 391)	50	350	200	200
Roof Runoff Structure (558) - gutter	20	-	3720	-
Stream Crossing (578)	40	164	80	80
Total Load Reduction from Target Amount of BMPs		**195,072.1**	**94,873.5**	**77,682.5**
Load Reduction needed to meet water quality goals		**170,256.52**	**34,420.68**	**14,582.88**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**Target exceeded by 24,815.58**	**Target exceeded by 60,452.82**	**Target exceeded by 63,099.62**

The target amount of BMPs proposed to be installed in the above tables are not required to be implemented as the quantities suggest. These targets are simply guidelines for achieving goals. The BMPs were chosen based on landuse, windshield survey concerns identified, and water quality data. Estimates for load reductions were calculated using the Region V model. Load reductions solely using this model do not meet the project targets for nitrogen and phosphorus for the 5- and 10-year goals, but exceed the target by year 20; the target for sediment reduction exceeded the goal in each instance. The steering committee realizes that the model's calculations are only an estimate, and actual reductions could be beyond the model's estimation. The Region V model does not provide estimated reductions for all suggested BMPs, therefore, those load reductions are not accounted for. Also, these tables do not take into account BMPs implemented through other funding sources (such as the NRCS Environmental Quality Incentives Program), and without any assistance, during the life of our project. If these were tracked, additional load reductions could be realized.

It is important to prioritize practices so that those with the greatest potential for improving water quality are implemented. The Fourteen Mile Creek/Goose Creek watersheds Steering Committee met in October of 2015 to prioritize concerns, and list corresponding practices to address them. Figure 122 below summarizes the results of that discussion. Each concern was ranked high, medium, or low, in terms of urgency and feasibility, and practices that would address each concern were listed. Finally, each concern and group of practices were assigned a priority ranking from 1 to 5, with 5 representing the highest priority, and 1 the lowest.

Figure 122: Prioritizing Concerns and Best Management Practices for Implementation

Concern	Urgency	Feasibility	Practices	Priority
Excessive gully erosion in cropland and pastures	Medium	High	Grassed Waterways Fence Prescribed (Rotational) Grazing Forage and Biomass Plantings	3
Too much conventional tillage of cropland	Low	High	Conservation Plan Residue & Tillage Management Cover Crop	2
Stream bank erosion	High	Low	Riparian Herbaceous/Forest Buffer Critical Area Planting Stream Crossings	2
Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	Medium	High	Education Forage and Biomass Plantings Cover Crop Plantings	3
Sedimentation from erosion caused by overgrazing	Medium	High	Prescribed (Rotational) Grazing Forage and Biomass Plantings Fence Conservation Plan Grassed Waterways Critical Area	4
Livestock with direct access to streams	High	High	Fence Stream Crossings Alternative Water Riparian Herbaceous/Forest Buffer Conservation Plan	5
E. coli within the streams	High	High	Fence Stream Crossings Alternative Water Prescribed (Rotational) Grazing Conservation Plan Filter Strips	5

Concern	Urgency	Feasibility	Practices	Priority
			Grassed Waterways Roof Runoff Structure	
Pollution from failing septic systems	High	Low	Education	3
Low quality plants in pastures	High	High	Prescribed (Rotational) Grazing Forage and Biomass Plantings Education Conservation Plan Nutrient Management	5
Need for more cover crops on cropland	High	High	Cover Crops Education Conservation Plan Nutrient Management	5
Fencing of livestock from sensitive areas	High	High	Fence Stream Crossings Education Alternative Water Conservation Plan	5
Trash/ Litter in streams	High	Medium	Education Trash Control and Removal	4

6. Moving Forward

Below you will find information that details the plans for the Fourteen Mile Creek/Goose Creek watersheds to move forward. You will find scheduled objectives along with measurable objectives and milestones. You will also find an estimated cost for the project moving forward, as well as strategies for tracking the effectiveness of the project.

6.1 Action Register

Creating an action register is an effective tool to help facilitate implementation of goals and objectives of a watershed management plan. It includes specific and measurable objectives that the project wishes to carry out to improve the water quality.

At the inception of our project, baselines for our objectives will be established in order to track our progress towards them. For example:

- In order to determine % increases in field day participation, participant numbers will be recorded at the initial field day, and entered into a spreadsheet. Attendance at subsequent field days will be added to the spreadsheet as each occurs, and compared to the initial (baseline) field day figure.

- To determine if milestones are being reached in regards to BMP installation, we will track the number of acres/feet/units of the given BMP from project inception, and record those numbers in spreadsheet format.

- Load data for BMPs installed will be determined using the Region 5 Model, and will be recorded in spreadsheet format. Reductions achieved will be compared to the load reductions we are striving to achieve as set forth in our goals, pgs. 132-134.

- To determine % increases in effectiveness of educational efforts, surveys will be conducted pre- and post-event, and changes noted. Spreadsheet format will be used to record and tack results.
  +

The Clark County SWCD and the project Steering Committee will monitor progress towards targets to ensure the project stays on track, and goals can be achieved. Monitoring will be completed at least annually on the anniversary date of project inception, as well as at the increments given in the "Milestones" column of the Action Register. If monitoring indicates that the project is not progressing towards targets as anticipated, we will review our action plan and strategies to see if modifications can be made, or new strategies need to be developed, in order to achieve those targets.

Figure 123 below details the action register for the Fourteen Mile Creek/Goose Creek watersheds. In it you will find objectives, milestones for objectives, cost estimates for objectives, and possible partners.

Please note that in this table many milestones are repeated as they are applicable to the achievement of more than one goal and/or objective. For example, the milestone of "6 acres of Riparian Buffers planted in first 5 years" listed in regards to controlling soil erosion is the same 6 acres listed in regards to reducing E.coli.

Figure 123: Action Plan and Strategies for the Fourteen Mile Creek/Goose Creek Watersheds

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
Reduce soil erosion and sedimentation so current water quality conditions are protected or improved.	Educate agricultural producers and livestock owners on the function and value of BMPs as beneficial practices for crop production and water quality	Landowners, agricultural producers, residents	1 BMP Field Day is held annually years 1-20	$150 per field day = $3,000	SWCD Purdue Extension NRCS ISDA	SWCD Purdue Extension NRCS ISDA
			A 10% increase in participation at Field Days is recorded from year 1 to year 5; additional 10% increase by year 20	Estimate 3% staff time per year = $900/yr.	SWCD Purdue Extension	SWCD Purdue Extension
			15,840 feet of Fence installed during first 5 years; 31,680 feet by year 10; 63,360 by year 20	$158,400	SWCD NRCS	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			37.5 acres Critical Area Planting installed during first 5 years; 75 by year 10; 150 by year 20	$99,295.50	SWCD NRCS	SWCD NRCS ISDA
			300 acres converted to Prescribed Grazing during first 5 years; 600 by year 10; 1,200 by year 20	$25,572	SWCD NRCS	SWCD NRCS ISDA
			54,450 sq.ft. HUAPs installed during first 5 years; 108,900 sq.ft. by year 10; 217,800 by year 20	$122,364	SWCD NRCS	SWCD NRCS ISDA
	Educate watershed residents on the function and value of BMPs to reduce erosion		3 BMP Field Days held during first 5 years; 10 additional Field Days held during years 6-20	$3,900	SWCD Purdue Extension NRCS	SWCD Purdue Extension NRCS
			A 10% increase in participation at Field Days is recorded from year 1 to year 5; additional 10% increase by year 20	Estimate 3% staff time per year = $900/yr.	SWCD Purdue Extension	SWCD Purdue Extension
	Increase utilization of native plants/wildlife habitat for erosion control		10 acres of Grassed Waterways installed in first 5 years; 20 acres by year 10; 40 acres by year 20	$101,496.80	SWCD NRCS	SWCD NRCS ISDA
			10 acres Riparian Buffers planted in first 5 years; 30 acres by year 10; 50 acres by year 20	$39,027	SWCD NRCS	SWCD NRCS ISDA
			1 new Conservation Plan initiated that	N/A	SWCD NRCS	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			includes native plants/wildlife habitat for erosion control each year through year 20			
	Decrease the sediment load within the watersheds by 20% in 5 years; by an additional 40% in 10 years; and by an additional 60% in 20 years		250 acres Forage and Biomass Planting installed during first 5 years; 500 acres by year 10; 1,000 acres by year 20	$201,450	SWCD NRCS	SWCD NRCS ISDA
			10 acres Riparian Buffers planted in first 5 years; 30 acres by year 10; 50 acres by year 20	$39,027	SWCD NRCS	SWCD NRCS ISDA
			10 acres of Filter Strips installed during first 5 years; 30 acres by year 10; 50 acres by year 20	$29,053	SWCD NRCS	SWCD NRCS ISDA
			Within 6 months, partnership established with local university, municipality, or business to do water monitoring biannually; funding source secured by end of 1st year to cover cost if not offered as in-kind OR re-enlist HRW volunteers to monitor; monitoring to include parameter for turbidity	$0	SWCD University of Louisville Indiana University Southeast City of Jeffersonville City of Charlestown Oak Park Conservancy District Business that offers water monitoring services HRW	SWCD University of Louisville Indiana University Southeast City of Jeffersonville City of Charlestown Oak Park Conservancy District Business that offers water monitoring services HRW
	Add 100 acres of riparian buffers and filter strips to the watershed by year 20		10 acres Riparian Buffers planted in first 5 years; 30 acres by year 10; 50 acres by year 20 10 acres of Filter Strips installed during first 5 years; 30 acres by year 10; 50 acres by year 20	Riparian Buffers = $39,027 Filter Strips = $29,053	SWCD NRCS	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	Continue education and BMP implementation		At end of year 5, reevaluate education programs and determine updates/changes; reevaluate every 2 years thereafter to year 20	Estimate of 16 days staff time = $4,480	SWCD Purdue Extension	SWCD Purdue Extension
			New BMPs are added annually, reaching BMP targets given in Figure 120 by year 20	$1,390,667.30 total estimated cost as listed in Figure 120	SWCD NRCS	SWCD NRCS ISDA
	Increased recreational value and wildlife habitat quality		Survey of residents in year 1 regarding their perspective of recreation value and wildlife habitat compared to survey in year 20 shows a marked positive increase in perspective	Estimate of 4 weeks staff time = $3,200	SWCD Purdue Extension	SWCD Purdue Extension
Increase public awareness on how individual choices and activities impact the watershed	Place educational signage at applicable well-seen locations in the Fourteen Mile Creek/Goose Creek watersheds, highlighting best management practices and general watershed education over first 10 years	Landowners, agricultural producers, residents, business owners, county agencies	Install 30 signs in first 5 years; at least one new location added each year thereafter	Minimum 35 signs = $3,500	SWCD Highway Department	Highway Department
	Conduct various educational workshops/programs to help foster learning and passion for protecting the watersheds		Conduct 2 community awareness events annually	$200 annually	SWCD Purdue Extension Landowners	SWCD Purdue Extension
			Personal interviews and/or surveys are conducted with participants before and after each event from year 1 through year 20; statistics show increased understanding of watersheds and how to protect water quality over that period	Estimate of 4 weeks staff time = $3,200	SWCD Purdue Extension	SWCD Purdue Extension

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	Create an educational program and material to deliver to stakeholders regarding the value and importance of watershed work		Minimally quarterly newsletters/fact sheet/pamphlet sent to stakeholders	$400 / quarter	SWCD Purdue Extension Landowners	NA
	Establish education, outreach, and clean-up programs to reduce stream, sinkhole, and roadside dumping		Within 1st year, establish schedule of clean-up events that will rotate through the subwatersheds so that each hosts an event at least every 3rd year (e.g., 3 subwatersheds in year 2, 3 in year 3, 4 in year 4; rotation repeated)	$200 per event	SWCD Purdue Extension Landowners Highway Department	SWCD Highway Department
			Adapt or create educational materials focused on negative impacts of dumping for distribution to stakeholders at clean-up and other pertinent events	Estimate of 2 weeks staff time = $1,600 Printing estimate = $1,000 initial supply recurring as replenish	SWCD Purdue Extension	SWCD Purdue Extension
			Minimally articles included in quarterly newsletters; news releases submitted	Estimate 10% staff time per year = $3,000/yr.	SWCD Purdue Extension	SWCD Purdue Extension
	Develop appropriate planning to insure long-term viability and effectiveness of the project Long term viability of project is realized		SWCD Plan of Work includes education and outreach items targeted to watersheds SWCD Business and Financial Plan incorporates goals of the watersheds and allocates funds to those goals	Estimate 40 hrs. supervisor and staff time every 5 years = $3,200	SWCD	SWCD ISDA
			Personal interviews and/or surveys are conducted with participants before	Estimate of 4 weeks staff time = $3,200	SWCD Purdue Extension	SWCD Purdue Extension

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			and after each event from year 1 through year 20; statistics show increased understanding of watersheds and how to protect water quality			
	Provide human and intellectual resources required to further the goals and mission of the project		Working, filterable volunteer database in place within 1st year; ongoing recruiting of volunteers thereafter with updates to database made	Estimate 10% staff time per year = $3,000/yr.	SWCD	SWCD
	Build and utilize partnerships		Partnerships are sought and built, and initial partner list is in place by 1st; additional partners are sought on an ongoing basis	Estimate 5% staff time per year = $1,500/yr.	SWCD	SWCD
			Grants are sought on an annual basis using partnerships established where needed; awards are received	Estimate 20% staff time per year = $6,000/yr.	SWCD Partner(s) from partner list	SWCD
	Educate stakeholders on pollution prevention options		Minimally articles included in quarterly newsletters; news releases submitted	Estimate 10% staff time per year = $3,000/yr.	SWCD Purdue Extension	SWCD Purdue Extension
	Develop a pride program for keeping the local community clean		Framework of pride program developed during 1st year; initiation of program during 2nd year; program well-established and functioning by year 3	Estimate 5% staff time per year = $1,500/yr. Community volunteers assist with development = $0	SWCD Community leaders Volunteers Purdue Extension	SWCD Purdue Extension
			Signs demonstrating pride in clean water are placed	Absorbed by community associations or volunteer groups = $0	SWCD Communities Volunteers	SWCD

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			within the watersheds			
	Look for alternative funding mechanisms for increasing knowledge and concern of water quality		Educational grants are sought on an annual basis using partnerships established where needed; awards are received	Estimate 20% staff time per year = $6,000/yr.	SWCD Partner(s) from partner list	SWCD
Reduce E. coli concentrations throughout the watershed to meet water quality standards	Reduce the number of streams in the watershed to which cattle have direct access Educate livestock owners on how livestock wastes impact water quality, and encourage implementation of BMPs.	Landowners, agricultural producers, residents, university personnel, county agencies, homeowners	15,840 feet of Fence installed during first 5 years; 31,680 feet by year 10; 63,360 feet by year 20	$158,400	SWCD NRCS	NRCS ISDA
			10 Stream Crossings installed during first 5 years; 20 by year 10; 40 by year 20	$92,440	SWCD NRCS	SWCD NRCS ISDA
			37.5 acres of Critical Area installed during first 5 years; 75 by year 10; 150 by year 20	$99,295.50	SWCD NRCS	SWCD NRCS ISDA
			10 acres Riparian buffers planted in first 5 years; 30s by year 10; 50 acres by year 20	$39,027	SWCD NRCS	SWCD NRCS ISDA
			1 new Conservation Plan initiated that includes BMPs applicable to E.coli reduction each year	N/A	SWCD NRCS	SWCD NRCS ISDA
			10 Alternative Watering Systems installed during first 5 years; 20 by year 10; 40 by year 20	$60,000	SWCD NRCS	SWCD NRCS ISDA
			10 acres Filter Strips installed during first 5 years; 30 by year 10; 50 by year 20	$29,053	SWCD NRCS	SWCD NRCS ISDA
			10 acres Grassed Waterways installed during first 5 years; 20	$101,496.80	SWCD NRCS	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			acres by year 10; 40 acres by year 20			
			5 Roof Runoff systems installed during first 5 years; 10 by year 10; 20 by year 20	$35,000	SWCD NRCS	SWCD NRCS ISDA
			1 BMP Field Day is held annually for 5 years; 10 additional Field Days held during years 6-20	$150 per field day = $2,250	SWCD Purdue Extension NRCS ISDA	SWCD Purdue Extension NRCS ISDA
	Seek outside sources of funding for data collection on progress monitoring of E. coli levels in the watershed		Partnership established with local university, municipality, or business to continue E. coli monitoring; monitoring to be completed in years 2, 5, 10, 15, and 20; funding or in-kind source secured within 6 months of project start	Estimate 10% staff time per year = $3,000/yr. $1,250 for five monitoring periods	SWCD University; municipality; business	University; municipality
	Promote proper septic maintenance for landowners in the watershed through workshops and educational materials; emphasize how failing septic systems impact water quality		Host 2 septic seminar's annually	$100 annually for seminars	SWCD Health Department	Health Department
			Septic care brochure produced during the Silver Creek Watershed Implementation Project adapted for distribution to landowners in Fourteen Mile Creek/Goose Creek watersheds; other related materials created or adapted	$500 initial printing; recurring as needed to replenish	SWCD Health Department	Health Department
			Increased septic system knowledge and changing attitudes measured by program attendance and survey data	Estimate 3% staff time per year = $900/yr.	SWCD Health Department Purdue University	Health Department

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			Residents participate in group discount maintenance programs if such a program is offered	Estimate 5% staff time per year = $1,500/yr.	SWCD Health Department	Health Department
	Voluntary maintenance and upgrades are made to suitable onsite septic systems		By end of year 1, define areas with onsite septics and develop "Have you upgraded or maintained your system?" survey; include surveys in newsletters to those areas in year 2 and evaluate results returned; surveys distributed bi-annually thereafter to determine change	Estimate 5% staff time per year = $1,500/yr.	SWCD Health Department Purdue Extension	Health Department
	Develop a local ordinance(s) requiring upgrades to failing systems at the time of real estate transactions		By end of year 1, committee established to work on creation of ordinance By end of year 2, draft ordinance is presented to local authorities Ordinance is adopted by at least one locality within first 5 years; subsequent adoptions by 10 year mark; all localities adopt by year 20	Estimate 12 hours committee time per year = $960/yr.	SWCD Health Department Purdue Extension	Health Department Purdue Extension
	Encourage town/city annexation of neighborhoods not suitable for onsite septic systems		By end of year one, identify neighborhoods within the project area that are not suitable for onsite septics; begin conversations with cities/towns to encourage annexation during year two; ongoing thereafter	Estimate 2% staff time per year = $600/yr.	SWCD Purdue Extension Health Department	SWCD Purdue Extension Health Department

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			Residences connect to municipal sewers in annexed areas where municipal connection is offered			
	Stream segments in the Fourteen Mile Creek/Goose Creek watersheds are removed from the 303(d) list for E.coli impairment and are safe for recreation.		Results of 2, 5, 10, 15, and 20 year monitoring compared as project progresses; CFU/100 ml drops consistently over time until 5-week geometric mean of 125 CFU/100ml is reached on or before year 20 Stream segments are removed from 303 (d) list for E.coli impairment	Estimate 8% staff time = $2,400	SWCD University; municipality; business	University; municipality
Protect and enhance critical habitat and unique natural areas of the Fourteen Mile Creek River, its tributaries, and the entire watershed including threatened, endangered, and rare species	Install practices to protect or restore critical areas through year 20	Landowners, agricultural producers, residents, state agencies (DNR)	Number of agricultural, urban, and miscellaneous BMPs installed is tracked through year 20	Estimate 1% staff time per year = $300/yr.	SWCD NRCS	SWCD NRCS
	Promote habitat improvement and protection measures in the Fourteen Mile Creek/Goose Creek watersheds through educational workshops and materials		Host 1 workshop annually on BMPs that contribute to habitat improvement and protection	$100/workshop	SWCD DNR USDA NRCS USFWS IDEM	DNR USDA NRCS USFWS IDEM
			Articles included in newsletters; news releases submitted to local papers; educational materials distributed	Estimate 2% staff time per year = $600/yr.	SWCD Purdue Extension	SWCD Purdue Extension
	Educate stakeholders on current state endangered, rare, and invasive species in the watershed		Bi-annual pamphlet sent to stakeholder highlighted endangered species	$500 bi-annual	SWCD Purdue Extension DNR USFWS	Purdue Extension DNR USFWS
	Educate landowners on effects that runoff has on aquatic organisms		Articles included in newsletters; news releases submitted to local papers; educational	Estimate 2% staff time per year = $600/yr.	SWCD Purdue Extension	SWCD Purdue Extension

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			materials distributed Surveys are conducted via in person and print media from year 1 through year 20; statistics show increased understanding of negative effects of runoff			
	Educate agriculture producers on the value and function of nutrient management plans		Articles included in newsletters; news releases submitted to local papers; educational materials distributed Personal interviews and/or surveys are conducted with participants before and after BMP initiation; statistics show positive understanding of value and function; reveal attitudes of success or failure	Estimate 2% staff time per year = $600/yr.	SWCD Purdue Extension	SWCD Purdue Extension NRCS
			Nutrient Management BMP on 2,100 acres by year 20	$25,704	SWCD NRCS	SWCD NRCS ISDA
	Work to connect natural areas with stream buffers and other land set-asides		10 acres Riparian buffers planted in first 5 years; 30s by year 10; 50 acres by year 20	$39,027	SWCD NRCS	SWCD NRCS ISDA
			Ongoing promotion of stream buffers and set-asides continues through year 20; amount of stream length with stream buffers is tracked from year 1 through year 20	Estimate 2% staff time per year = $600/yr.	SWCD NRCS	SWCD NRCS
	BMPs have a positive effect on biologic populations and habitat quality is		HRW volunteers enlisted to monitor for CQHEI and PTI	$0	SWCD HRW	HRW

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	improved within the watershed		Monitoring results show CQHEI scores are consistently above 60 (medium) by end of year 7; consistently in the "good" range (70-89) by year 14; excellent (90-100) at end of year 20 Monitoring results show PTI scores consistently "good" or above by year 7; "excellent" by year 14; remaining there after			
			Sediment load reductions are calculated for each BMP installed; results indicate sediment load reduction exceeds target set forth in WMP (Figure 120) by end of year 20	Estimate 1% staff time per year = $300/yr.	SWCD	SWCD NRCS ISDA
	Investigate alternative BMPs (e.g., sinkhole treatment) for improving aquatic life		Alternative BMPs discovered and evaluated for effectiveness ongoing through year 20	Estimate 1% staff time per year = $300/yr.	SWCD Purdue Extension NRCS	NRCS ISDA
	Stream segment (Assessment Unit INN0171_T1002) is removed from the 303 (d) list for Impaired Biotic Communities		Measured increase in macroinvertebrate populations and diversity; all sites meet or exceed PTI target (>16 points) up from current 55% of sites Stream segments are removed from 303 (d) list for E.coli impairment	Estimate 1% staff time per year = $300/yr.	SWCD HRW	HRW
Decrease litter and trash throughout the watersheds	Increase signage that discourages public littering	Landowners, agricultural producers, residents, homeowners,	Within year 1, begin conversations with local officials to invest in additional	Estimate 2% staff time per year = $600/yr.	SWCD Municipalities County	Highway Dept.

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
		community groups	signage in public places to discourage littering; number of signs placed is tracked from year 1 through year 20			
	Achieve a decrease in the number of trash bags of litter cleaned up annually from the watershed		Create pamphlet discouraging litter and encouraging volunteerism to pick up trash from public places	$500	SWCD	Purdue Extension
	Achieve a decrease in roadside and stream bank litter through cleanups and outreach efforts		Host 3 cleanups annually Number of participants in cleanup events is tracked and an increase is seen over time to year 20	Estimate 10% staff time per year = $3,000/yr.	SWCD Stakeholders Community Groups	ORSANCO - River sweep
	Establish education, outreach, and clean-up programs to reduce stream, sinkhole, and roadside dumping		Articles included in newsletters; news releases submitted to local papers; educational materials distributed Personal interviews and/or surveys are conducted with participants before and after events; statistics show positive change in understanding of detrimental effects of dumping	Estimate 2% staff time per year = $600/yr.	SWCD Purdue Extension	SWCD Purdue Extension NRCS
	Partner with Charlestown State Park/DNR to assist with take in, carry out trash programs at the park		Within 6 months, partnership established with Charlestown State Park for education and outreach SWCD Plan of Work includes education and outreach items that will promote the state park trash program	Estimate 40 hrs. supervisor and staff time every 5 years = $4,000	SWCD DNR	SWCD DNR

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	Develop a pride program for keeping the local community clean		Framework of pride program developed during 1st year; initiation of program during 2nd year; program well-established and functioning by year 3	Estimate 5% staff time per year = $1,500/yr. Community volunteers assist with development = $0	SWCD Community leaders Volunteers Purdue Extension	SWCD Purdue Extension
			Signs demonstrating pride in clean water are placed within the watersheds	Absorbed by community associations or volunteer groups = $0	SWCD Communities Volunteers	SWCD
			Working, filterable volunteer database in place within 1st year; ongoing recruiting of volunteers thereafter with updates to database made	Estimate 5% staff time per year = $1,500/yr.	SWCD Communities	SWCD
	Work with partners at state park to reduce litter using signs and display		Ideas for signs discouraging littering and a display on detrimental effects of littering developed by end of year 1	Estimate 1% staff time = $300	SWCD DNR	SWCD DNR
			10 signs produced and installed in high use areas (e.g., picnic area, campground), and a display for park office created and in place by end of year 2	$350 for 10 signs; $200 for display = $500	SWCD DNR	SWCD DNR
Reduce the amount of nutrients in the watershed	Decrease the phosphorus and nitrogen nutrient loads in the watershed by 20% in 5 years, 30% in 10 years, and 50% in 20 years by implementing nutrient reducing BMPs (e.g., stream buffers in potentially high nutrient production areas, Fence to keep	Landowners, agricultural producers, residents	2,000 acres of Cover Crops installed during first 5 years; 4,000 acres by year 10; 8,000 by year 20	$363,360	SWCD NRCS	SWCD NRCS ISDA
			15,840 feet of Fence installed during first 5 years; 31,680 feet by year 10; 63,360 feet by year 20	$158,400	SWCD NRCS	SWCD NRCS ISDA
			10 Stream Crossings installed	$92,440	SWCD NRCS	SWCD NRCS

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	livestock out of critical areas)		during first 5 years; 20 by year 10; 40 by year 20			ISDA
			37.5 acres of Critical Area installed during first 5 years; 75 acres by year 10; 150 acres by year 20	$99,295.50	SWCD NRCS	SWCD NRCS ISDA
			10 acres Riparian buffers planted in first 5 years; 30 acres by year 10; 50 acres by year 20	$39,027	SWCD NRCS	SWCD NRCS ISDA
			5 new Conservation Plans initiated that include BMPs applicable to nutrient reduction each year	N/A	SWCD NRCS	SWCD NRCS ISDA
			10 Alternative Watering Systems installed during first 5 years; 20 by year 10; 40 by year 20	$60,000	SWCD NRCS	SWCD NRCS ISDA
			10 acres Filter Strips installed during first 5 years; 30 acres by year 10; 50 acres by year 20	$29,053	SWCD NRCS	SWCD NRCS ISDA
			10 acres Grassed Waterways installed during first 5 years; 20 acres by year 10; 40 acres by year 20	$101,496.80	SWCD NRCS	SWCD NRCS ISDA
			5 Roof Runoff systems installed during first 5 years; 10 by year 10; 20 by year 20	$35,000	SWCD NRCS	SWCD NRCS ISDA
			Nitrogen and Phosphorus load reductions are calculated for each BMP installed; results indicate nitrogen,	Estimate 1% staff time per year = $300/yr.	SWCD	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			phosphorus, and sediment load reductions exceed targets set forth in WMP by end of year 20 (Figure 120)			
			Number of agricultural producers installing nutrient reducing BMPs is tracked from year 1 to 20, and number increases over time	Estimate 1% staff time per year = $300/yr.	SWCD	SWCD NRCS ISDA
	Educate landowners on methods of reducing nutrient runoff and proper fertilization methods		At least 5 nutrient management workshops are held from year 1 to 20 Personal interviews and/or surveys are conducted with participants before and after events; statistics show positive change in understanding of detrimental effects of excess nutrient runoff	Minimum $750	SWCD NRCS ISDA	SWCD NRCS ISDA
	Partnerships formed with other agencies and organizations that would result in the reduction of excess nitrogen and phosphorus on agricultural lands		Within first 3 months, partnerships are formed	Estimate of 2 weeks staff time = $1,600	SWCD	SWCD
	Educate agricultural producers on how no-till and cover crops can reduce nutrient inputs		At least 5 no-till and cover crop workshops are held from year 1 to 20 Number of agricultural producers using no-till and/or cover crops is tracked from year 1 to 20, and number increases over time	Minimum $750	SWCD NRCS ISDA	SWCD NRCS ISDA

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
	Distribute educational materials to educate the public on dumping and negative use		Adapt or create materials on effects of dumping and negative use; ongoing distribution	$100/yr.	SWCD	Purdue Extension
	Develop a septic maintenance educational program		Host 2 septic seminar's annually	$100 annually for seminars	SWCD Health Department Purdue Extension	Health Department
			Septic care brochure produced during the Silver Creek Watershed Implementation Project adapted for distribution to landowners in Fourteen Mile Creek/Goose Creek watersheds; other related materials created or adapted	$500 initial printing; recurring as needed to replenish	SWCD Health Department	Health Department
			Increased septic system knowledge and changing attitudes measured by program attendance and survey data	Estimate 1% staff time per year = $300/yr.	SWCD Health Department Purdue Extension	Health Department
	Investigate sinkhole and karst influence on nutrient loading to waterways and groundwater		By end of year 1, committee established to research sinkhole and karst influence; ongoing until resources are exhausted	Estimate 5% staff time per year = $1,500/yr.	SWCD Purdue Extension NRCS ISDA Health Dept.	SWCD NRCS ISDA
	Research methods for treating farm runoff within or around sinkholes		By end of year 1, committee established to research methods; ongoing until resources are exhausted	Estimate 5% staff time per year while needed = $1,500/yr.	SWCD NRCS ISDA	SWCD NRCS ISDA
	Investigate standard for sinkhole treatment BMP		Approach NRCS for possibility of adding this BMP standard; partner to develop one if positive response; encourage development of	Estimate 1% staff time per year while needed = $300/yr.	SWCD NRCS	SWCD NRCS

Goal	Objective	Target Audience	Milestones	Cost	Possible Partners	Technical Assistance
			one if negative response			
	Work with County on updating septic ordinances		By end of year 1, committee established to research local ordinances By end of year 2, begin conversations with local authorities regarding updating ordinances Ordinance is updated by at least one locality within first 5 years; subsequent adoptions by 10 year mark; all localities adopt by year 20	Estimate 12 hours committee time per year = $240/yr.	SWCD Health Department Purdue Extension	Health Department Purdue Extension
	Continued investigation of new and alternative funding sources for failing septic replacement & alternative systems		Grants and in-kind funds are sought on an annual basis	Estimate 1% staff time per year = $300/yr.	SWCD Health Department	SWCD Health Department

6.2 Tracking Effectiveness

Upon implementation of this plan, water quality monitoring will resume at all testing sites on at least a quarterly basis using HRW methodology. If professional lab services are offered in-kind, or if grant funds can be obtained to cover their cost, professional monitoring will resume on an annual basis. Parameters considered will be the same as in the development of this WMP. Results will be analyzed and tracked by the SWCD and potential project partners HRW volunteers, and a professional lab.

Education and outreach will also begin upon plan implementation, and the resulting data for social and administrative indicators will be tracked on an ongoing basis. Databases will be built from workshop/event participation. Public knowledge of water quality and related items set forth in this WMP will be measured through surveys and/or personal interviews at workshops and events. Purdue Cooperative Extension, Clark County Health Department, ISDA, NRCS, are potential partners to assist in tracking these indicators.

BMP installation will be encouraged and promoted from the onset of implementation. BMP installation, and the related load reductions, will be tracked on an ongoing basis as BMPs are implemented; comparisons to targets will be made at the 5-, 10-, and 20-year marks (Figures 118, 119, 120). Costs for installation will be borne on a cost-share basis with landowners when grant funding can be obtained by the SWCD and its partners. Landowners will be responsible for the total cost if cost-share is not an option. Technical assistance in either case will be provided by potential project partners NRCS and ISDA in coordination with the SWCD.

Detailed information on milestones and costs related to tracking environmental, social, and administrative indicators are included in the Action Register (Figure 123).

6.3 Future Activities

The Fourteen Mile Creek/Goose Creek Watersheds Management Plan is a culmination of much research regarding the watersheds. The watersheds have been described, historic and present data water quality issues presented, and suggestions have been made for addressing water quality concerns in the watersheds. In order to make this information common knowledge, the Fourteen Mile Creek/Goose Creek Watersheds project will introduce the key findings of this plan to the public through public meetings, executive summaries to community leaders, and educational programs. By helping stakeholders identify with the watersheds they call home, we can begin to foster passion and enthusiasm for conservation of the watersheds. This increased awareness and passion will hopefully foster individuals' willingness to change behaviors so that they may have a positive impact on water quality.

Approval of this WMP and validation of this project's completion will move us forward to implementing what we have set forth in this document. Persons charged with this responsibility will be the supervisors and staff of the Clark County SWCD along with the members of the Steering Committee that was formed during this project. Together, they will develop a cost-share program based on the goals and management strategies located in this plan. By formulating a plan that will implement the best management practices (BMPs), as well as the educational components and goals, the project can put into action the goals stated in this plan.

Funds will be sought to initiate the implementation program by applying for a Year 2018 Section 319 Grant. In the first step of that process, the SWCD and Steering Committee have crafted a Notice of Intent letter, which was submitted to IDEM by the June 1, 2017, deadline. The grant application itself will be written and submitted by the September 1, 2017 deadline; anticipated start date will be last quarter 2018 if awarded. If not awarded, we will continue to seek Section 319 funds with subsequent applications.

Since watersheds constantly evolve as land use changes, actions taken to manage and improve water quality must evolve with them. Whether awarded an implementation grant or not, we will continue to monitor the Fourteen Mile Creek/Goose Creek watersheds for land use and/or any other pertinent changes that may occur. As they do, or at least annually, we will evaluate this management plan to determine if what we have set forth is still applicable considering the changes, and if not, we will make revisions to make it so.

Further questions on this project may be directed to the Clark County Soil and Water Conservation District, Attn: Melanie Davis, 9608 Highway 62, Charlestown, IN 47111, via postal mail, by phone at 812-256-2330, ext. 3, or by email at melanie.davis@in.nacdnet.net.

APPENDIX

MATERIALS FROM THE PROJECT

APPENDIX

EAL @ U of L Water Chemistry/Physical Data Report

PROJECT ID: 14 Mile Creek, Indiana

DATE: July 25, 2014

Sample ID	NO3 + NO2 (mg/L)	NH3 (mg/L)	TN (mg/L)	SRP (mg/L)	TP (mg/L)	Si (mg/L)	Cl (mg/L)	SO4 (mg/L)	Chl a (ug/L)	Pheo a (ug/L)	DOC (mg/L)
14 Mile Creek 1	0.849	0.039	1.776	0.032	0.074	3.52	64.17	45.24	1.361	1.303	3.89
14 Mile Creek 2	3.708	< 0.020	4.827	0.051	0.083	7.88	8.67	12.37	0.649	0.944	7.74
14 Mile Creek 3	0.301	0.064	0.703	0.022	0.119	9.51	18.06	11.71	4.064	2.076	8.44
14 Mile Creek 4	3.237	0.114	4.065	0.059	0.089	9.39	20.54	13.82	5.842	4.075	4.65
14 Mile Creek 5	0.646	0.027	0.911	0.011	0.027	6.06	40.49	12.31	5.092	1.515	7.41
14 Mile Creek 6	< 0.020	< 0.020	0.126	0.011	0.023	10.12	18.74	28.48	0.107	0.229	5.64
14 Mile Creek 7	0.103	0.133	0.589	0.027	0.076	4.47	17.43	16.64	1.767	2.247	7.13
14 Mile Creek 8	0.387	0.025	0.872	0.045	0.076	7.92	16.22	21.31	1.361	1.356	5.53
Site 8 Rep	0.381	0.024	0.866	0.046	0.079	7.97	16.63	21.44	1.352	1.616	5.21
14 Mile Creek 9	1.349	0.068	2.164	0.063	0.072	6.23	18.42	11.25	0.521	1.411	4.33
14 Mile Creek 10	0.036	0.166	0.395	0.009	0.067	4.62	18.33	22.09	5.204	3.688	6.35
Field Blank	< 0.020	< 0.020	0.035	0.004	0.013	0.24	< 0.050	< 1.00	0.000	0.000	0.47

Sample ID	Citizens Habitat Evaluation	Flow (cfs)	Turbidity (NTU)	Temp (deg C)	pH (Std Unit)	Dissolved Oxygen (mg/L)	% Saturation	Hardness (mg/L)	Specific Cond (uS/cm)	TDS (mg/L)	TSS (mg/L)	TVSS (mg/L)
14 Mile Creek 1	61	0.794	3.7	24.9	7.29	8.27	100.6	164	586	392	5.1	3.1
14 Mile Creek 2	88	0.703	4.2	23.1	7.19	6.97	81.1	146	281	244	6.3	4.3
14 Mile Creek 3	54	0.018	2.9	25.5	6.93	7.52	91.4	190	359	280	15.9	4.2
14 Mile Creek 4	48	0.024	1.8	27.4	7.75	11.15	140.6	206	413	303	19.1	11.4
14 Mile Creek 5	64	0.389	< 1.0	24.2	7.76	14.04	166.9	202	422	369	2.6	2.6
14 Mile Creek 6	72	0.256	< 1.0	25.4	6.16	6.88	83.8	86	199	154	0.8	0.8
14 Mile Creek 7	62	0.031	2.4	25.6	8.08	10.29	126.1	136	281	243	3.7	3.7
14 Mile Creek 8	71	0.511	2.4	23.3	7.54	9.78	114.1	150	309	231	5.4	5.4
Site 8 Rep	XXX	XXX	2.3	23.2	7.57	9.53	111.2	152	313	232	6.6	6.6
14 Mile Creek 9	64	26.875	5.2	24.2	7.24	7.94	94.4	138	382	286	5.7	5.7
14 Mile Creek 10	63	0.408	2.2	25.1	8.19	10.82	130.4	132	364	256	8.9	8.9
Field Blank	XXX	XXX	< 1.0	22.9	6.22	7.21	83.3	0	0	3	0.0	0.0

NOTE: Site locations are as follows:	
14 Mile Creek 1	Lancassange Creek @ Bridge on Allison Lane
14 Mile Creek 2	Bull Creek @ Bridge on Blue Ridge Road
14 Mile Creek 3	Confluence of Camp Creek & Little Camp Creek @ Bridge on Flintridge Road/Bethlehem Road
14 Mile Creek 4	Confluence of Nine Penny, Big Branch, & Dry Branch @ Bridge on Tunnel Mill Road
14 Mile Creek 5	Confluence of Yankee Creek & Two Unnamed Tribs @ Bridge on Salem Church Road
14 Mile Creek 6	Fourteen Mile Creek-Dry Branch @ Bridge on Gum Corner Road
14 Mile Creek 7	Confluence of Polk Run & Fourteen Mile Creek @ Bridge on Zimmerman Road
14 Mile Creek 8	Rogers Run & Fourteen Mile Creek @ Bridge on New Market Road
14 Mile Creek 9	Confluence of West Fork of Fourteen Mile & Fourteen Mile @ Bridge on Westport Road
14 Mile Creek 10	Fourteen Mile Creek, East Fork-Unnamed Trib @ Bridge on 362 west of State Road 62

EAL @ U of L Water Chemistry/Physical Data Report

PROJECT ID: 14 Mile Creek, Indiana

DATE: July 25, 2015

Sample ID	NO3 + NO2 (mg/L)	NH3 (mg/L)	TN (mg/L)	SRP (mg/L)	TP (mg/L)	Si (mg/L)	Cl (mg/L)	SO4 (mg/L)	Chl a (ug/L)	Pheo a (ug/L)	DOC (mg/L)
14 Mile Creek 1	2.881	< 0.020	3.227	0.035	0.057	9.35	43.75	47.9	0.198	0.593	4.17
14 Mile Creek 2	1.307	< 0.020	1.895	0.013	0.026	7.98	8.09	15.9	0.204	0.448	5.42
14 Mile Creek 3	3.691	0.046	5.611	0.011	0.021	5.62	13.29	24.8	0.292	0.396	6.06
14 Mile Creek 4	2.746	< 0.020	4.576	0.009	0.026	7.64	12.31	7.6	0.316	0.842	6.29
14 Mile Creek 5	2.303	< 0.020	3.245	0.022	0.031	8.41	14.32	10.1	1.299	1.217	7.17
14 Mile Creek 6	0.314	< 0.020	0.702	< 0.005	0.012	9.09	7.27	24.2	0.208	0.003	4.82
14 Mile Creek 7	1.641	0.029	2.002	0.026	0.037	10.37	9.26	8.2	0.109	0.146	5.07
14 Mile Creek 8	0.889	< 0.020	1.107	0.028	0.044	9.66	13.02	15.8	0.225	0.111	4.72
Site 8 Rep	0.853	< 0.020	1.082	0.027	0.043	9.75	13.22	16.1	0.241	0.136	4.77
14 Mile Creek 9	3.196	< 0.020	4.379	0.036	0.052	6.89	12.81	10.7	0.011	0.892	7.24
14 Mile Creek 10	0.631	0.103	1.192	< 0.005	0.021	8.91	10.88	17.9	0.206	0.642	6.69
Field Blank	< 0.020	< 0.020	< 0.025	< 0.005	< 0.005	< 0.025	< 0.025	< 1.0	0.000	0.000	< 0.5

Sample ID	Citizens Habitat Evaluation	Flow (cfs)	Turbidity (NTU)	Temp (deg C)	pH (Std Unit)	Dissolved Oxygen (mg/L)	% Saturation	Hardness (mg/L)	Specific Cond (uS/cm)	TDS (mg/L)	TSS (mg/L)	TVSS (mg/L)
14 Mile Creek 1	57	3.516	5.8	19.6	7.13	8.23	89.2	234	591	408	4.3	4.3
14 Mile Creek 2	80	0.945	1.4	28.5	7.66	7.85	102.3	216	431	312	3.6	3.1
14 Mile Creek 3	37	0.388	2.1	28.6	7.77	11.21	147.8	226	499	379	3.4	3.4
14 Mile Creek 4	63	0.467	2.3	23.1	7.85	14.12	163.8	206	449	294	3.3	2.4
14 Mile Creek 5	61	4.412	2.1	21.1	7.72	11.02	123.5	234	469	316	2.6	2.6
14 Mile Creek 6	71	0.381	2.8	26.1	6.47	7.56	93.2	84	198	149	2.4	2.4
14 Mile Creek 7	61	1.169	2.2	23.8	7.83	10.68	126.2	180	374	257	3.7	3.7
14 Mile Creek 8	66	1.185	2.5	22.7	7.37	9.82	113.1	170	364	252	2.4	2.4
Site 8 Rep	XXX	XXX	2.4	22.7	7.39	9.79	112.9	166	363	257	2.8	2.8
14 Mile Creek 9	71	15.939	1.8	21.8	7.22	8.57	101.2	214	458	322	3.1	3.1
14 Mile Creek 10	63	2.591	1.6	30.7	8.29	13.69	185.4	142	328	219	3.9	3.9
Field Blank	XXX	XXX	< 1.0	23.7	6.08	8.06	90.6	0	0	2	0.0	0.0

NOTE: Site locations are as follows:	
14 Mile Creek 1	Lancassange Creek @ Bridge on Allison Lane
14 Mile Creek 2	Bull Creek @ Bridge on Blue Ridge Road
14 Mile Creek 3	Confluence of Camp Creek & Little Camp Creek @ Bridge on Flintridge Road/Bethlehem Road
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14 Mile Creek 9	Confluence of West Fork of Fourteen Mile & Fourteen Mile @ Bridge on Westport Road
14 Mile Creek 10	Fourteen Mile Creek, East Fork-Unnamed Trib @ Bridge on 362 west of State Road 62

A Stream Bioassessment Utilizing Benthic Macroinvertebrates Collected from Fourteen Mile Creek, Indiana.

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Abstract. On July 25th, 2014, University of Louisville biologists working in conjunction with the Indiana Department of Environmental Management (IDEM) sampled 10 preselected stream sites along Fourteen Mile Creek in southeastern Indiana. More than 760 aquatic macroinvertebrates were collected, representing 65 genera, 49 families, and 16 orders. Metric-based data analysis was utilized to derive a macroinvertebrate Index of Biotic Integrity (mIBI) score for each of the 10 stream sites. Scores less than or equal to 35 are suggestive of an impaired stream site, while sites with a score greater than 35 are considered unimpaired. The results of this bioassessment ranged from a low score of 28 (site 5) to a high score of 42 (site 4). This paper provides a detailed summary of the July 2014 macroinvertebrate bioassessment, along with a comparative analysis of the ten sampling sites.

Keywords: Fourteen Mile Creek Watershed, environmental quality, macroinvertebrate, IDEM, index of biotic integrity, mIBI, stream bioassessment, water quality

Introduction.

Various aquatic organisms, including fish, algae, protozoans, and macroinvertebrates, have been used to assess water quality since the early part of the 20th century (Merritt and Cummins 2008). Until the 1970's, however, most institutional monitoring programs relied primarily on physical and chemical measurements (Carter *et al*. 2006), despite the fact that the assessment of water quality is principally a biological problem since the primary effect of water pollution is on living organisms (Hilsenhoff 1982). In recent decades, biomonitoring of water quality conditions has increased in prevalence due to the recognition that physico-chemical approaches provide merely a 'snapshot' of stream water conditions at the time that the samples are collected, whereas the utilization of biological approaches provide more of a 'moving picture' of past and present stream water conditions. The application of a suite of physical, chemical, and biological approaches can therefore provide a spatially and temporally integrated measure of ecosystem health (Carter *et al*. 2006).

Benthic macroinvertebrates represent an integral part of lotic systems by processing organic matter and providing energy to higher trophic levels. They are typically abundant and easily collected from most streams; are representative of most aquatic habitats; have life cycles longer than one year; and their diversity of species exhibit a range of responses to environmental stress (Merritt and Cummins 2008). It is for these reasons that an understanding of the effects of human, as well as natural stressors, on their distribution and abundance is critical for comprehensive impact assessment of streams and rivers (Carter *et al*. 2006).

The basic principal behind assessing stream impairment by evaluating the structure and function of macroinvertebrate assemblages is the comparison of presumed impaired sites to unimpaired, or least-impaired reference sites. For the purposes of calculating a biotic index, species are assigned pollution tolerance values of 0 through 10 based upon observations from field studies documenting the restricted occurrences of certain taxa in response to various environmental conditions (Merritt and Cummins 2008) – leading to the development of reference lists of *indicator species* and *indicator communities* (for example, see Barbour *et al.* 1999). A value of 0 is assigned to species found only in unaltered streams of very high water quality, and a value of 10 is assigned to species known to occur in severely polluted or disturbed streams. Intermediate values are assigned to species that occur in streams with intermediate degrees of pollution or disturbance.

The process of analyzing macroinvertebrate assemblage data for bioassessments is often divided into two approaches: multimetrics and multivariate. As described by Carter *et al*. (2006), the distinction between the two approaches lies in how variables are defined. Both use the same raw species x sample data matrix. However, in the multimetric approach, the variables analyzed are derived by estimating certain summary characteristics on a per sample basis. These characteristics include the richness or percentage composition of certain taxonomic or feeding groups, measures of species diversity or evenness, and biotic indices based on tolerance scores. Once metrics are estimated, the value of each metric or combined multimetric is then compared among other samples. On the other hand, in the multivariate approach metrics are not estimated as they are in the multimetric approach. Instead, samples are compared by their position in species-space by using either the presence, or a measure of abundance, of each taxon in each sample as input to a classification and/or ordination procedure.

The bioassessment data analyses discussed in this paper were conducted in accordance with a modified multimetric assessment protocol adopted by the Indiana Department of Environmental Management (IDEM 2010) and outlined in the document *Multi-Habitat (MHAB) Macroinvertebrate Sampling Procedure* (see Table 1 in Appendix D). The multimetric approach is based on the premise that certain measures of the benthic assemblage can be used to indicate its ecological condition and, by extension, the condition of the stream ecosystem (Carter *et al*. 2006). For example, an expected change in species richness accompanying impairment is based on the premise that a loss of species occurs with increased impairment. Similarly, a change in the number or proportion of individuals within a certain taxon is based on the notion that, with some types of pollution, more intolerant individuals may be lost, e.g., EPT, (Appendix B, Figure 4) while the numbers of tolerant individuals may rise, e.g., certain species of Chironomidae (Carter *et al*. 2006). This type of *community-level* approach lends itself well to a field sampling protocol known as rapid bioassessment (see, for example, Barbour *et al.* 1999), which attempts to summarize the magnitude, ecological consequences, or significance of a particular stress on the system being examined by utilizing time-saving and cost-effective strategies which limit: (1) the number of habitats examined; (2) the number of samples collected; (3) the amount of sample-sorting time; and (4) the number and/or level of taxonomic identifications made. Summary scores are then used so that site surveys can be understood not only by biologists, but also by managers, decision makers, and the general public (Merritt and Cummins 2008). The disadvantage of using a multimetric rapid bioassessment protocol is the lack of sample replication. In the case of the bioassessments discussed in this paper, only one sample per site, per year, was collected. Therefore, analysis of variability along with certain other statistical operations may not be reliable or even appropriate.

Background.

The bioassessment discussed in this paper was conducted in conjunction with the Indiana Department of Environmental Management (IDEM) in order to obtain baseline water monitoring data in support of the Fourteen Mile Creek Watershed Management Plan currently under development and initiated by the Clark County Soil and Water Conservation District (SWCD). In October 2013, the SWCD received a Federal Clean Water Act Section 319 Nonpoint Source Management Grant for the Fourteen Mile Creek Watershed due to several portions of Fourteen Mile Creek and its tributaries being listed on the IDEM 2012, 303(d) list of impaired category 5A water bodies for nonpoint source pollutants (Watershed Improvement Project, 2014). Impaired waters are defined as those that do not meet federal or state water quality standards, and in the case of Fourteen Mile Creek include E. coli, dissolved oxygen, and biotic community impairments. The Fourteen Mile Creek Watershed is in Clark County in southeastern Indiana, and is a part of the Ohio River basin.

Methods.

On July 25th, 2014, benthic macroinvertebrate samples were collected from Fourteen Mile Creek at ten sites that were pre-selected by the IDEM (see Table 2 below). Aquatic macroinvertebrate samples were collected at each site upstream of bridges (if present) to decrease any effects that the bridges might have on the downstream fauna. Following a modified D-frame dipnet method (IDEM 2010), a one-minute kick sample was taken within a riffle (if available), run, or a typical glide area at each site. In addition, a 50-m length of stream habitat was sampled with a D-frame dipnet to obtain a multi-habitat (MHAB) sample. In-stream habitats included emergent vegetation, submerged macrophytes, depositional zones, logs, sticks, rootwads, rootmats, cobble, and sand. All habitats were sampled as encountered. The MHAB sample and the kick sample were combined and elutriated a minimum of five times through a 50-μm sieve. The contents of the sieve were then emptied into a tray and picked through for 15 minutes, with the goal of collecting at least 100 organisms per site and obtaining the greatest diversity of organisms possible. Aquatic macroinvertebrates were preserved in 70% ethanol onsite, and returned to the lab to be processed and identified using regionally-recognized taxonomic references (refer to References below).

The entire sample was processed in the laboratory (since subsampling had already been performed in the field), and all individuals were counted, with the exception of empty shells, larval and pupal exuviae, and adults of non-Coleoptera specimens. The specimens were pre-sorted into separately labeled glass scintillation vials with the aid of a professional quality desk magnifier equipped with a 5-inch diameter glass lens with 5-diopter (2.25x) magnification. Subsequent to this pre-sort, each specimen vial that had been preliminarily sorted and quantified was then formally identified, and resorted and quantified using a Motic SMZ-168TL stereo zoom microscope equipped with a 10x eyepiece set affording a magnification range of 7.5x to 50x. To identify subfamilies of Chironomidae, the 10x eyepieces were swapped out with a set of 30x eyepieces that afforded a magnification range up to 150x. Specimens were identified to the lowest 'practical' taxonomic level. In general, Oligochaeta (aquatic worms, Hirudinea, and Branchiobdellida), Planaria, and Acari were only identified to family or a higher level; freshwater snails and clams were identified to genus; freshwater crustacea were identified to genus (Amphipoda and Isopoda), or species (Decapoda – if form I male specimens were present); and aquatic insects were identified to family (Collembola), or genus, and species (all other insects).

Table 2. Site localities for all stream sites sampled during the July 2014 Fourteen Mile Creek bioassessment. Site numbers correspond to alphanumeric codes used in figures elsewhere.

Site	State / County	Locality	Latitude N	Longitude W
S1	IN / Clark	Bridge on Allison Lane near Jeffersonville Fire Station & Intersection of Middle Rd.	38.311159	85.702403
S2	IN / Clark	Bridge at 4308 Blue Ridge Rd., Charlestown; Bull Creek	38.489817	85.501601
S3	IN / Clark	Bridge on Flintridge Rd. at Intersection w/Bethlehem Rd.	38.528481	85.470656
S4	IN / Clark	Bridge on Tunnel Mill Rd.	38.488596	85.610622
S5	IN / Clark	Bridge on Salem Church Rd.	38.485410	85.594403
S6	IN / Clark	Bridge on Gum Corner Rd.	38.526024	85.667274
S7	IN / Clark	Bridge on Zimmerman Rd. (East of New Market Rd.)	38.527422	85.608224
S8	IN / Clark	Bridge on New Market Rd. (North of Faye Amick Rd.)	38.543267	85.603396
S9	IN / Clark	Bridge on Westport Rd. Near Intersection of New Market Rd.	38.553136	85.574934
S10	IN / Clark	Bridge on 362 West of SR62 Between Frank Fisher & Kettle Bottom Rd.	38.606122	85.578804

After every specimen in the sample was identified to the lowest practical taxon, each taxon was then associated with their appropriate water quality tolerance value, functional feeding group, and habit values using reference lists provided by IDEM. As time permits, digital images of representative specimens from each taxon will be obtained and archived in a database with a

Moticam 2000 high-resolution imaging microscopy camera using the Motic Images Advanced 3.2 software package. Likewise, the taxonomic database will be updated and refined as time, expertise, and resources permit, e.g., slide-mounting and identifying chironomid larvae.

Results and Discussion.

The purpose of this paper, as previously stated, is to present a comparative analysis between ten preselected stream sampling sites along the Fourteen Mile Creek watercourse, hereafter referred to in all figures and tables by individual site with alphanumeric codes, e.g., sampling site number one is shown as S1; sampling site number two is shown as S2, and so on. The single day, ten site sampling effort resulted in the collection of 768 aquatic invertebrates representing 65 genera, 49 families, and 16 orders. The most diverse order among all sites combined was Diptera (14 taxa), followed by Coleoptera (11 taxa) and Trichoptera (8 taxa). The lowest taxa richness among the ten sites was found at site 6, (9 taxa), whereas the highest taxa richness (33 taxa) was located at site 2 (Table 3). The total abundance of macroinvertebrates collected at each site ideally should exceed one hundred specimens, in accordance with the Indiana Department of Environmental Management (IDEM 2010) document *Multi-Habitat (MHAB) Macroinvertebrate Sampling Procedure* – however this bioassessment produced only two samples that individually totaled in excess of one hundred invertebrates (Sites 8 and 9).

Table 3 also shows values for some common diversity indices, although their relevance is questionable. According to Merritt and Cummins (2008), the reliance of diversity indices in biomonitoring programs has been strongly, and rightly, criticized due to their application being theoretically invalid. However, diversity indices are used routinely in water quality monitoring programs, and the requirement to use this flawed approach has, in some cases, even been codified through environmental legislation (Merritt and Cummins 2008). That said, the Shannon-Weiner diversity index *H'* will approach zero if the majority of abundance is determined by one species amongst one or more rare species, and conversely *H'* will become larger in value as the total community abundance approaches evenness amongst all species. This is do to the fact that *H'* takes into account both species richness *S,* and evenness, *J*. The evenness index *J* will approach a value of 1.0 as the abundances of each taxon become more similar, and conversely, will approach a value of 0.0 as the abundance of each taxon become more dissimilar. The Simpson's dominance index *D* can account for a possible outlier, and validate the evenness and diversity values given by *H'*, and *J*. Generally, the higher the value of *D*, the more the total abundance is distributed amongst multiple taxa, whereas a low value of *D* is indicative of much of the total abundance being attributed to just a few taxa, or even one taxon. Each of these diversity indices - *H', J*, and *D* – clearly show sites 1, 2, and 4 to be much more diverse and balanced in the distribution and abundance of their associated taxa (Table 3). It is noteworthy to point out that the three sites with the highest values of *H'* are also the three sites with the highest calculated mIBI scores (Table 5) and the only sites with mIBI scores of 40 or higher. The rank abundance graph (Figure 1 Appendix B) clearly depicts this trend graphically (lines with low slope values), whereas conversely the steep initial drop ($\Delta Y/\Delta X$) by the curves representing sites six and seven indicate that either one or a very few taxa are accounting for a disproportionately large amount of the abundance.

Table 3. Indices depicting taxa richness, diversity, evenness, and dominance.

Total Richness and Diversity						
Site	Year	Abundance	Taxa Richness	Diversity *H'*	Evenness *J*	Dominance *D*
S1	2014	54	26	3.088	0.948	18.456
S2	2014	90	33	3.164	0.905	17.686
S3	2014	88	21	2.511	0.825	7.854
S4	2014	74	31	3.108	0.905	16.901
S5	2014	77	20	2.249	0.751	4.793
S6	2014	27	9	1.848	0.841	5.098
S7	2014	57	18	2.451	0.848	8.528
S8	2014	116	20	2.560	0.855	9.695
S9	2014	133	16	2.152	0.776	5.958
S10	2014	50	20	2.743	0.916	12.626

Table 4. Top 10 taxa for all sites combined by % abundance – Most abundant (top table) and least abundant (bottom table).

	Taxa	% Abundance – All Sites Combined and Individual Sites										
		ALL	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
2014 Top 10 Taxa (% Abundance)	*Cheumatopsyche spp.*	9.11	5.56	4.44	9.09	1.35	0.00	0.00	0.00	22.4	17.3	10.0
	Microvelia spp.	8.98	7.41	4.44	0.00	13.5	42.9	0.00	19.3	6.03	0.00	0.00
	Chironominae (sub-family)	8.59	3.70	14.4	4.55	4.05	2.60	29.6	10.5	0.00	18.8	6.00
	Baetis spp.	8.20	5.56	0.00	7.95	0.00	1.30	0.00	1.75	9.48	30.1	0.00
	Stenelmis spp.	7.81	9.26	5.56	9.09	1.35	6.49	25.9	5.26	12.9	7.52	2.00
	Tanypodinae (sub-family)	6.51	3.70	4.44	29.6	2.70	0.00	14.8	0.00	1.72	1.50	16.0
	Caenis spp.	3.65	0.00	5.56	0.00	2.70	0.00	0.00	8.77	10.3	1.50	4.00
	Physidae	3.65	12.9	0.00	3.41	1.35	1.30	3.70	21.1	0.00	0.00	6.00
	Maccaffertium spp.	3.39	0.00	8.89	1.14	0.00	1.30	0.00	0.00	6.90	6.02	0.00
	Peltodytes spp.	2.99	5.56	0.00	1.14	10.8	2.60	0.00	7.02	0.00	0.00	10.0

	Taxa	% Abundance – All Sites Combined and Individual Sites										
		ALL	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
2014 Bottom 10 Taxa (% Abundance)	*Atrichopogon spp.*	0.13	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Stratiomyidae (family)	0.13	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00
	Pseudolimnophila spp.	0.13	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Paraleptophlebia spp.	0.13	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Hydroptila spp.	0.13	1.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Triaenodes spp.	0.13	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00
	Polycentropus spp.	0.13	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Curculionidae (family)	0.13	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00
	Dineutus spp.	0.13	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Cymbiodyta spp.	0.13	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

While the figures and tables presented above and elsewhere in this paper are useful tools for gaining an understanding of site specific ecological characteristics with respect to the macroinvertebrate community and its associated populations, the actual bioassessment is based upon a summary score calculated from the twelve metrics listed in Table 1 (Appendix D). Multimetric indices are designed to spread the risk of making incorrect assessments by using a variety of types of measurements, i.e., metrics (Merritt and Cummins, 2008). The various types of metrics listed in Table 1 (Appendix D) are generally classified as measuring either community structure – e.g., number of taxa – or measuring community function – e.g., % collector-filterers. To assign a score for each individual metric, either a total count or a percentage of the respective taxa or taxon is calculated, and then that value is given a score of 1, 3, or 5, depending on where that value lay within the range of potential values. Once a score is calculated for all twelve metrics, a total score is calculated by summing the scores (Table 5 below). A cumulative score of 35 or less is indicative of an impaired site, while a score above 35 suggests an unimpaired site.

Table 5. Bioassessment (mIBI) scores for Fourteen Mile Creek.

Metric	BIOASSESSMENT MATRIX									
	SITE 1		SITE 2		SITE 3		SITE 4		SITE 5	
	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**
Total Number of Taxa	26	**3**	33	**3**	21	**3**	31	**3**	20	**1**
Total Number of Individuals	54	**1**	90	**1**	88	**1**	74	**1**	77	**1**
Total Number of EPT Taxa	4	**3**	8	**5**	3	**1**	4	**3**	3	**1**
Total Number of Diptera Taxa	6	**1**	6	**1**	6	**1**	7	**3**	5	**1**
% Orthocladinae + Tanytarsini	20.00	**5**	5.56	**5**	16.67	**5**	16.67	**5**	60.00	**1**
% Non-Insects minus Crayfish	11.11	**5**	8.89	**5**	13.64	**5**	14.86	**5**	5.19	**5**
% Intolerant Taxa (Score 0 - 3)	18.52	**3**	21.11	**3**	25.00	**3**	14.86	**1**	9.09	**1**
% Tolerant Taxa (Score 8 - 10)	9.26	**5**	2.22	**5**	10.23	**5**	8.11	**5**	5.19	**5**
% Predators	25.93	**3**	24.44	**3**	44.32	**5**	41.89	**5**	50.65	**5**
% Shredders plus Scrapers	31.48	**5**	24.44	**5**	15.91	**3**	27.03	**5**	19.48	**3**
% Collector-Filterers	9.26	**5**	15.56	**3**	14.77	**3**	1.35	**5**	11.69	**3**
% Sprawlers	0.00	**1**	1.11	**1**	1.14	**1**	0.00	**1**	0.00	**1**
TOTAL	**mIBI =**	**40**	**mIBI =**	**40**	**mIBI =**	**36**	**mIBI =**	**42**	**mIBI =**	**28**
Metric	BIOASSESSMENT MATRIX									
	SITE 6		SITE 7		SITE 8		SITE 9		SITE 10	
	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**
Total Number of Taxa	9	**1**	18	**1**	20	**1**	16	**1**	20	**1**
Total Number of Individuals	27	**1**	57	**1**	116	**1**	133	**3**	50	**1**
Total Number of EPT Taxa	0	**1**	3	**1**	5	**3**	6	**3**	2	**1**
Total Number of Diptera Taxa	3	**1**	2	**1**	6	**1**	4	**1**	6	**1**
% Orthocladinae + Tanytarsini	0	**1**	14.29	**5**	50.00	**1**	0.00	**5**	21.43	**5**
% Non-Insects minus Crayfish	7.41	**5**	24.56	**3**	3.45	**5**	4.51	**5**	6.00	**5**
% Intolerant Taxa (Score 0 - 3)	0.00	**1**	14.04	**1**	45.69	**5**	52.63	**5**	16.00	**3**
% Tolerant Taxa (Score 8 - 10)	7.41	**5**	22.81	**3**	0.00	**5**	3.01	**5**	14.00	**3**
% Predators	25.93	**3**	31.58	**3**	20.69	**3**	4.51	**1**	40.00	**5**
% Shredders plus Scrapers	33.33	**5**	33.33	**5**	23.28	**5**	13.53	**3**	18.00	**3**
% Collector-Filterers	3.70	**5**	1.75	**5**	28.45	**1**	21.05	**1**	22.00	**1**
% Sprawlers	0.00	**1**	0.00	**1**	0.00	**1**	1.50	**1**	0.00	**1**
TOTAL	**mIBI =**	**30**	**mIBI =**	**30**	**mIBI =**	**32**	**mIBI =**	**34**	**mIBI =**	**30**

Conclusions.

Very clearly, the data in Table 5 suggests that there is serious impairment to the structure and function of the biological community at site five, as well as sites six, seven, and ten. Conversely, it is clear that the physico-chemical conditions at sites one, two, and four favor a relatively rich and even diversity of macroinvertebrate taxa.

Consideration should also be given to the fact that several of the metrics for sites one, two, and four that incorporate EPT taxa, as well as the taxa richness metric, would likely score higher if the taxonomic resolution was increased to the level of species. This does not hold true for site five, as it did not have anywhere near the richness or abundance of EPT organisms that were collected from the aforementioned unimpaired sites. Therefore, it is very likely that the mIBI differential is much greater than reported between the impaired and unimpaired sites.

One final point of consideration concerns the fact that none of the ten site samples produced a specimen from the order Plecoptera – taxa that are generally associated with unimpaired sites and conversely not likely to be found in habitats exhibiting some type of impairment. Further investigation in this area is recommended outside of any annual monitoring.

Appendix A provides a complete list of taxa collected from all ten sampling sites on July 25th, 2014. Appendix B provides several additional figures depicting the macroinvertebrate characteristics of the sampling sites. Appendix C provides a comparison of the complete taxa collection from all ten sampling sites of Fourteen Mile Creek to a reference list of aquatic insect species known to occur in Indiana, published by Hellenthal *et al*. in 2003. Appendix D provides the mIBI bioassessment scoring matrix.

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Appendix A.

Table 6. Aquatic invertebrates collected from Fourteen Mile Creek at sites 1 thru 10 on July 25th, 2014. Insect orders are arranged phylogenetically, followed by the alphabetical listing of the families, genera, and species, if applicable. Alphanumeric codes associated with each taxon correspond to the site and year collected.

Insects

Order Ephemeroptera (5 families)
- Family Baetidae
  - *Baetis spp.*
    - 2014-S1/S3/S5/S7/S8/S9
- Family Caenidae
  - *Caenis spp.*
    - 2014-S2/S4/S7/S8/S9/S10
- Family Ephemeridae
  - *Pentagenia spp.*
    - 2014-S7/S9
- Family Heptageniidae
  - *Maccaffertium*
    - 2014-S2/S3/S5/S8/S9
  - *Stenacron*
    - 2014-S1
  - *Stenonema*
    - 2014-S2
- Family Leptophlebiidae
  - *Paraleptophlebia spp.*
    - 2014-S2

Order Odonata (4 families)
- Family Aeshnidae
  - *Boyeria spp.*
    - 2014-S2/S3/S4/S10
- Family Calopterygidae
  - *Hetaerina spp.*
    - 2014-S1/S4
- Family Coenagrionidae
  - *Nehalennia spp.*
    - 2014-S1
- Family Gomphidae
  - 2014-S7/S10

Order Plecoptera (0 families)

Order Hemiptera (5 families)
- Family Belostomatidae
  - 2014-S10
- Family Corixidae
  - *Genus TBD*
    - 2014-S2/S3/S4/S5/S7/S10
- Family Gerridae
  - *Limnoporus*
    - 2014-S2/S4/S5/S10
  - *Trepobates*
    - 2014-S1/S2/S7/S9/S10
- Family Notonectidae
  - *Genus TBD*
    - 2014-S10
- Family Veliidae
  - *Microvelia*
    - 2014-S1/S2/S4/S5/S7/S8
  - *Rhagovelia*
    - 2014-S1

Order Megaloptera (2 families)
- Family Corydalidae
  - *Chauliodes spp.*
    - 2014-S7
  - *Nigronia spp.*
    - 2014-S2/S3/S7/S8
- Family Sialidae
  - *Sialis spp.*
    - 2014-S2/S6

Order Trichoptera (7 families)
- Family Helicopsychidae
  - *Helicopsyche*
    - 2014-S4/S5/S8
- Family Hydropsychidae
  - *Ceratopsyche*
    - 2014-S2
  - *Cheumatopsyche*
    - 2014-S1/S2/S3/S4/S8/S9/S10
- Family Hydroptilidae
  - *Hydroptila*
    - 2014-S1
- Family Leptoceridae
  - *Triaenodes*
    - 2014-S4

(Table continued on next page)

Appendix A.

Table 6. – Continued

Family Philopotamidae
Chimarra spp.
2014-S2/S9
Family Polycentropodidae
Polycentropus spp.
2014-S2
Family Polycentropodidae
Polycentropus spp.
2014-S2
Order Orthoptera (1 family)
Family Unknown
2014-S1/S2
Order Coleoptera (9 families)
Family Curculionidae
Genus TBD
2014-S4
Family Dryopidae
Helichus spp.
2014-S5/S6/S8
Family Dytiscidae
Genus TBD
2014-S5
Family Elmidae
Stenelmis
2014-ALL SITES
Family Gyrinidae
Dineutus spp.
2014-S3
Family Haliplidae
Peltodytes spp.
2014-S1/S3/S4/S5/S7/S10
Family Hydrophilidae
Cymbiodyta spp.
2014-S2
Enochrus spp.
2014-S4
Tropisternus
2014-S3/S4/S5/S6/S7/S8/S10
Family Psephenidae
Psephenus spp.
2014-S2/S4/S8
Family Staphylinidae
Genus TBD
2014-S1/S5
Order Diptera (7 families)
Family Chironomidae
Subfamily Chironominae
2014-S1/S2/S3/S4/S5/S6/S7/S9/S10
Tribe Tanytarsini
2014-S2/S3/S5/S7/S10
Subfamily Tanypodinae
2014-S1/S2/S3/S4/S6/S8/S9/S10
Subfamily Orthocladiinae
2014-S1/S3/S4/S5/S8/10
Family Ceratopogonidae
Atrichopogon spp.
2014-S3
Probezzia spp.
2014-S2/S9
Family Culicidae
Anopheles spp.
2014-S10
Family Simuliidae
Simulium spp.
2014-S1/S2/S5/S6/S8
Family Stratiomyidae
Genus TBD
2014-S4
Family Tabanidae
Chrysops spp.
2014-S3/S4/S10
Family Tipulidae
Hexatoma spp.
2014-S8/S9
Pilaria spp.
2014-S4/S8
Pseudolimnophila spp.
2014-S2
Tipula
2014-S1/S4/S5/S8

(Table continued on next page)

Appendix A.

Table 6. – Continued

<u>Non-Insects</u>
Order Amphipoda (1 family)
Family Hyalellidae
Hyalella spp.
2014-S2
Order Decapoda (1 family)
Family Cambaridae
2014-S1/S4/S5/S7/S8/S9/S10
Order Isopoda (1 family)
Family Asellidae
Lirceus spp.
2014-S1/S4/S5/S6/S7
Order Veneroida (1 family)
Family Sphaeriidae
Pisidium spp.
2014-S3
Sphaerium spp.
2014-S8/S9

Order Basommatophora (2 families)
Family Planorbidae
Planorbella spp.
2014-S3/S4
Family Physidae
Physella spp.
2014-S1/S3/S4/S5/S6/S7/S10
Subclass Copepoda
2014-S4
Phylum Annelida
Subclass Oligochaeta
2014-S1/S2/S3/S4/S9
Phylum Platyhelminthes
Class Turbellaria
2014-S1/S2

Appendix B.

Figure 1. Joint rank abundance diagram depicting relative abundance by species rank. (For illustrative purposes, select sites are highlighted for comparative context.

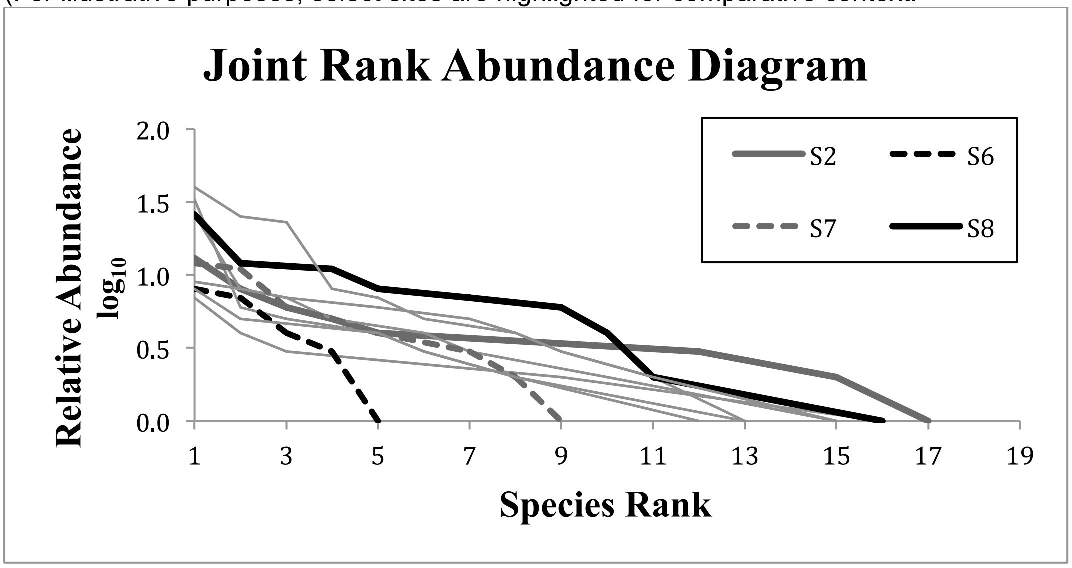
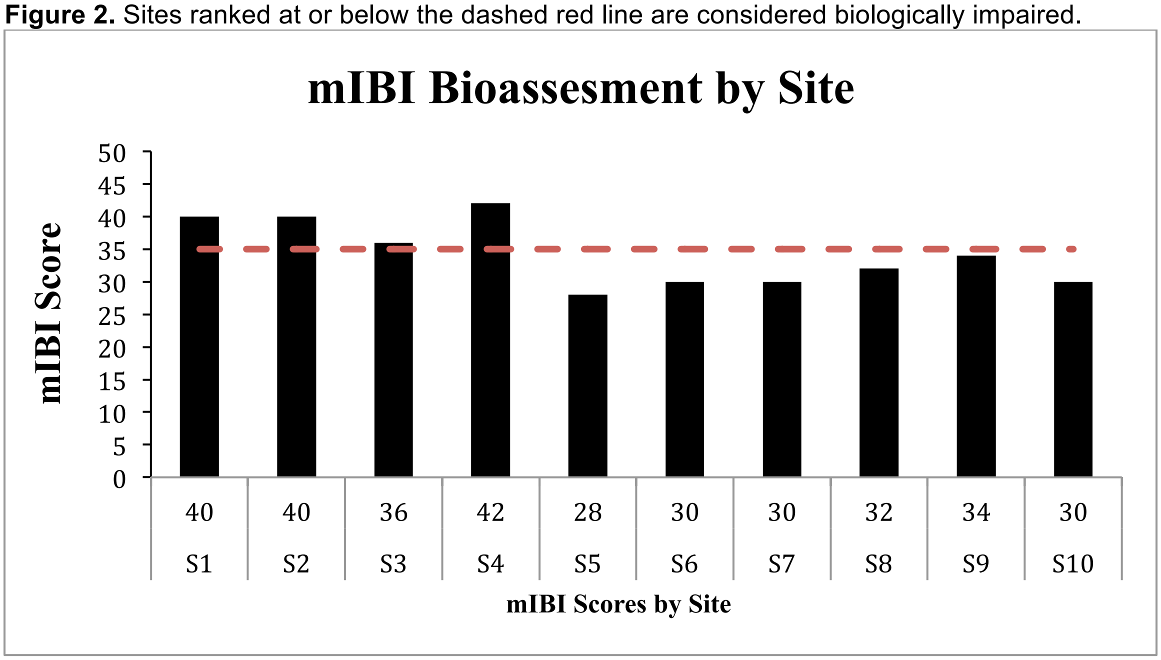


Figure 2. Sites ranked at or below the dashed red line are considered biologically impaired.



Appendix B (continued).

Figure 3. Functional feeding groups (FFG) by % abundance for each site.

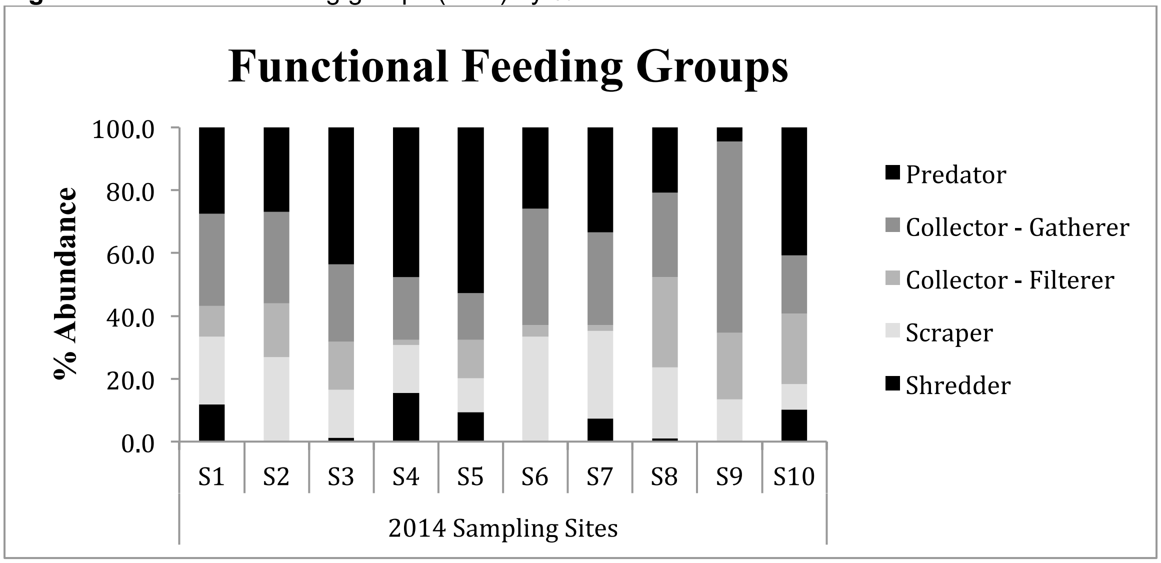
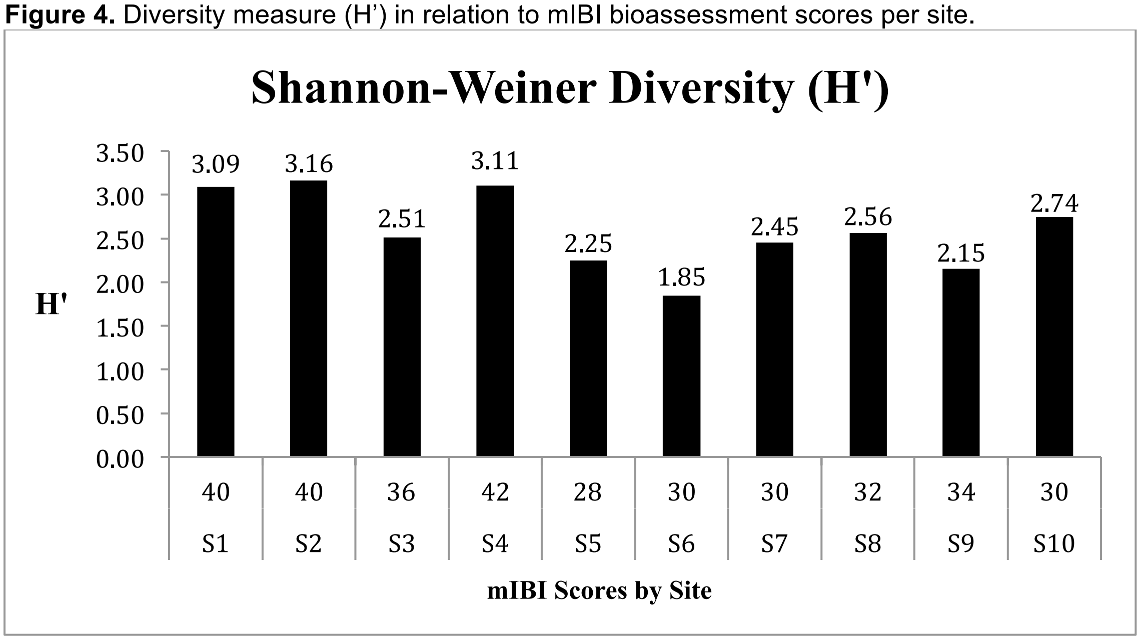
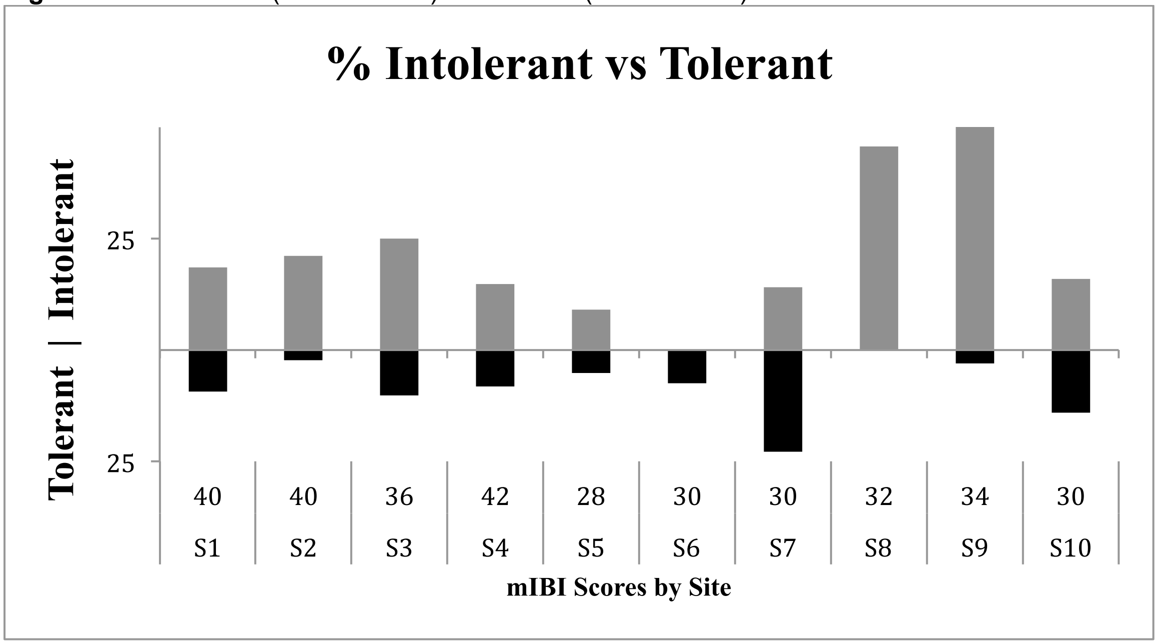


Figure 4. Diversity measure (H') in relation to mIBI bioassessment scores per site.



Appendix B (continued).

Figure 4. % intolerant (above x-axis) vs. tolerant (below x-axis) macroinvertebrates for each site.



Appendix C.

Table 7. Comparison of aquatic insect taxa collected from Fourteen Mile Creek (all sites) on July 25th, 2014 to reference list of aquatic insect taxa known to exist in Indiana.

	Families	Genera	Species
Ephemeroptera			
Hellenthal *et al*. (2003)	16	50	143
Fourteen Mile Creek (2014)	5	7	n/a
% representation	31.3%	14.0%	-
Odonata			
Hellenthal *et al*. (2003)	10	47	154
Fourteen Mile Creek (2014)	4	4	n/a
% representation	40%	8.5%	-
Plecoptera			
Hellenthal *et al*. (2003)	8	29	71
Fourteen Mile Creek (2014)	0	0	n/a
% representation	0%	0%	-
Trichoptera			
Hellenthal *et al*. (2003)	16	58	194
Fourteen Mile Creek (2014)	7	8	n/a
% representation	43.8%	13.8%	-

Appendix D.

Table 1. Multimetric scoring matrix for rapid bioassessment data analyses (IDEM 2010).

Biological Metric	Poor	Fair	Excellent
Number of Taxa			
	< 21	≥ 21 and < 41	≥ 41
Score	**1**	**3**	**5**
Number of Individuals			
	< 129	≥ 129 and < 258	≥ 258
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: < 5 mi^2			
	< 2	≥ 2 and < 4	≥ 4
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: ≥ 5 & < 50 mi^2			
	< 4	≥ 4 and < 8	≥ 8
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: ≥ 50 mi^2			
	< 6	≥ 6 and < 12	≥ 12
Score	**1**	**3**	**5**
Number of Diptera Taxa			
	< 7	≥ 7 and < 14	≥ 14
Score	**1**	**3**	**5**
% Orthocladiinae + Tanytarsini			
	≥ 47	≥ 24 and < 47	< 24
Score	**1**	**3**	**5**
% Non-insects Minus Crayfish			
	< 15.9	≥ 15.9 and < 31.8	≥ 31.8
Score	**1**	**3**	**5**
% Intolerant			
	< 15.9	≥ 15.9 and < 31.8	≥ 31.8
Score	**1**	**3**	**5**
% Tolerant			
	≥ 25.3	≥ 12.6 and < 25.3	< 12.6
Score	**1**	**3**	**5**
% Predators			
	< 18	≥ 18 and < 36	≥ 36
Score	**1**	**3**	**5**
% Shredders + Scrapers			
	< 10	≥ 10 and < 20	≥ 20
Score	**1**	**3**	**5**
% Collector-Filterers			
	≥ 20	≥ 10 and < 20	< 10
Score	**1**	**3**	**5**
% Sprawlers			
	< 3	≥ 3 and < 6	≥ 6
Score	**1**	**3**	**5**

A Stream Bioassessment
Utilizing Benthic Macroinvertebrates
Collected from Fourteen Mile Creek, Indiana.

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Abstract. On July 27th, 2015, University of Louisville biologists working in conjunction with the Indiana Department of Environmental Management (IDEM) sampled 10 preselected stream sites along Fourteen Mile Creek in southeastern Indiana. More than 560 aquatic macroinvertebrates were collected, representing 51 genera, 38 families, and 14 orders. Metric-based data analysis was utilized to derive a macroinvertebrate Index of Biotic Integrity (mIBI) score for each of the 10 stream sites. Scores less than or equal to 35 are suggestive of an impaired stream site, while sites with a score greater than 35 are considered unimpaired. The results of this bioassessment ranged from a low score of 22 (site 1) to a high score of 34 (sites 2, 4, and 9). This paper provides a detailed summary of the July 2015 macroinvertebrate bioassessment, along with a comparative analysis of the ten sampling sites.

Keywords: Fourteen Mile Creek Watershed, environmental quality, macroinvertebrate, IDEM, index of biotic integrity, mIBI, stream bioassessment, water quality

Introduction.

Various aquatic organisms, including fish, algae, protozoans, and macroinvertebrates, have been used to assess water quality since the early part of the 20th century (Merritt and Cummins 2008). Until the 1970's, however, most institutional monitoring programs relied primarily on physical and chemical measurements (Carter *et al*. 2006), despite the fact that the assessment of water quality is principally a biological problem since the primary effect of water pollution is on living organisms (Hilsenhoff 1982). In recent decades, biomonitoring of water quality conditions has increased in prevalence due to the recognition that physico-chemical approaches provide merely a 'snapshot' of stream water conditions at the time that the samples are collected, whereas the utilization of biological approaches provide more of a 'moving picture' of past and present stream water conditions. The application of a suite of physical, chemical, and biological approaches can therefore provide a spatially and temporally integrated measure of ecosystem health (Carter *et al*. 2006).

Benthic macroinvertebrates represent an integral part of lotic systems by processing organic matter and providing energy to higher trophic levels. They are typically abundant and easily collected from most streams; are representative of most aquatic habitats; have life cycles longer than one year; and their diversity of species exhibit a range of responses to environmental stress (Merritt and Cummins 2008). It is for these reasons that an understanding of the effects of human, as well as natural stressors, on their distribution and abundance is critical for comprehensive impact assessment of streams and rivers (Carter *et al*. 2006).

The basic principal behind assessing stream impairment by evaluating the structure and function of macroinvertebrate assemblages is the comparison of presumed impaired sites to unimpaired, or least-impaired reference sites. For the purposes of calculating a biotic index, species are assigned pollution tolerance values of 0 through 10 based upon observations from field studies documenting the restricted occurrences of certain taxa in response to various environmental conditions (Merritt and Cummins 2008) – leading to the development of reference lists of *indicator species* and *indicator communities* (for example, see Barbour *et al.* 1999). A value of 0 is assigned to species found only in unaltered streams of very high water quality, and a value of 10 is assigned to species known to occur in severely polluted or disturbed streams. Intermediate values are assigned to species that occur in streams with intermediate degrees of pollution or disturbance.

The process of analyzing macroinvertebrate assemblage data for bioassessments is often divided into two approaches: multimetrics and multivariate. As described by Carter *et al*. (2006), the distinction between the two approaches lies in how variables are defined. Both use the same raw species x sample data matrix. However, in the multimetric approach, the variables analyzed are derived by estimating certain summary characteristics on a per sample basis. These characteristics include the richness or percentage composition of certain taxonomic or feeding groups, measures of species diversity or evenness, and biotic indices based on tolerance scores. Once metrics are estimated, the value of each metric or combined multimetric is then compared among other samples. On the other hand, in the multivariate approach metrics are not estimated as they are in the multimetric approach. Instead, samples are compared by their position in species-space by using either the presence, or a measure of abundance, of each taxon in each sample as input to a classification and/or ordination procedure (Carter *et al*. 2006).

The bioassessment data analyses discussed in this paper were conducted in accordance with a modified multimetric assessment protocol adopted by the Indiana Department of Environmental Management (IDEM 2010) and outlined in the document *Multi-Habitat (MHAB) Macroinvertebrate Sampling Procedure* (see Table 1 in Appendix D). The multimetric approach is based on the premise that certain measures of the benthic assemblage can be used to indicate its ecological condition and, by extension, the condition of the stream ecosystem (Carter *et al*. 2006). For example, an expected change in species richness accompanying impairment is based on the premise that a loss of species occurs with increased impairment. Similarly, a change in the number or proportion of individuals within a certain taxon is based on the notion that, with some types of pollution, more intolerant individuals may be lost, e.g., EPT, (Appendix B, Figure 4) while the numbers of tolerant individuals may rise, e.g., certain species of Chironomidae (Carter *et al*. 2006). This type of *community-level* approach lends itself well to a field sampling protocol known as rapid bioassessment (see, for example, Barbour *et al.* 1999), which attempts to summarize the magnitude, ecological consequences, or significance of a particular stress on the system being examined by utilizing time-saving and cost-effective strategies which limit: (1) the number of habitats examined; (2) the number of samples collected; (3) the amount of sample-sorting time; and (4) the number and/or level of taxonomic identifications made. Summary scores are then used so that site surveys can be understood not only by biologists, but also by managers, decision makers, and the general public (Merritt and Cummins 2008). The disadvantage of using a multimetric rapid bioassessment protocol is the lack of sample replication. In the case of the bioassessments discussed in this paper, only one sample per site, per year, was collected. Therefore, analysis of variability along with certain other statistical operations may not be reliable or even appropriate.

Background.

The bioassessment discussed in this paper was conducted in conjunction with the Indiana Department of Environmental Management (IDEM) in order to obtain baseline water monitoring data in support of the Fourteen Mile Creek Watershed Management Plan currently under development and initiated by the Clark County Soil and Water Conservation District (SWCD). In October 2013, the SWCD received a Federal Clean Water Act Section 319 Nonpoint Source Management Grant for the Fourteen Mile Creek Watershed due to several portions of Fourteen Mile Creek and its tributaries being listed on the IDEM 2012, 303(d) list of impaired category 5A water bodies for nonpoint source pollutants (Watershed Improvement Project, 2014). Impaired waters are defined as those that do not meet federal or state water quality standards, and in the case of Fourteen Mile Creek include *E. coli*, dissolved oxygen, and biotic community impairments. The Fourteen Mile Creek Watershed is in Clark County in southeastern Indiana, and is a part of the Ohio River basin.

Methods.

On July 27th, 2015, benthic macroinvertebrate samples were collected from Fourteen Mile Creek at ten sites that were pre-selected by the IDEM (see Table 2 below). Aquatic macroinvertebrate samples were collected at each site upstream of bridges (if present) to decrease any effects that the bridges might have on the downstream fauna. Following a modified D-frame dipnet method (IDEM 2010), a one-minute kick sample was taken within a riffle (if available), run, or a typical glide area at each site. In addition, a 50-m length of stream habitat was sampled with a D-frame dipnet to obtain a multi-habitat (MHAB) sample. In-stream habitats included emergent vegetation, submerged macrophytes, depositional zones, logs, sticks, rootwads, rootmats, cobble, and sand. All habitats were sampled as encountered. The MHAB sample and the kick sample were combined and elutriated a minimum of five times through a 50-μm sieve. The contents of the sieve were then emptied into a tray and picked through for 15 minutes, with the goal of collecting at least 100 organisms per site and obtaining the greatest diversity of organisms possible. Aquatic macroinvertebrates were preserved in 70% ethanol onsite, and returned to the lab to be processed and identified using regionally-recognized taxonomic references (refer to References below).

The entire sample was processed in the laboratory (since subsampling had already been performed in the field), and all individuals were counted, with the exception of empty shells, larval and pupal exuviae, and adults of non-Coleoptera specimens. The specimens were pre-sorted into separately labeled glass scintillation vials with the aid of a professional quality desk magnifier equipped with a 5-inch diameter glass lens with 5-diopter (2.25x) magnification. Subsequent to this pre-sort, each specimen vial that had been preliminarily sorted and quantified was then formally identified, and resorted and quantified using a Motic SMZ-168TL stereo zoom microscope equipped with a 10x eyepiece set affording a magnification range of 7.5x to 50x. To identify subfamilies of Chironomidae, the 10x eyepieces were swapped out with a set of 30x eyepieces that afforded a magnification range up to 150x. Specimens were identified to the lowest 'practical' taxonomic level. In general, Oligochaeta (aquatic worms, Hirudinea, and Branchiobdellida), Planaria, and Acari were only identified to family or a higher level; freshwater snails and clams were identified to genus; freshwater crustacea were identified to genus (Amphipoda and Isopoda), or species (Decapoda – if 'form I' male specimens were present); and aquatic insects were identified to family (Collembola), or genus, and species (all other insects).

Table 2. Site localities for all stream sites sampled during the July 2015 Fourteen Mile Creek bioassessment. Site numbers correspond to alphanumeric codes used in figures elsewhere.

Site	State / County	Locality	Latitude N	Longitude W
S1	IN / Clark	Bridge on Allison Lane near Jeffersonville Fire Station & Intersection of Middle Rd.	38.311159	85.702403
S2	IN / Clark	Bridge at 4308 Blue Ridge Rd., Charlestown; Bull Creek	38.489817	85.501601
S3	IN / Clark	Bridge on Flintridge Rd. at Intersection w/Bethlehem Rd.	38.528481	85.470656
S4	IN / Clark	Bridge on Tunnel Mill Rd.	38.488596	85.610622
S5	IN / Clark	Bridge on Salem Church Rd.	38.485410	85.594403
S6	IN / Clark	Bridge on Gum Corner Rd.	38.526024	85.667274
S7	IN / Clark	Bridge on Zimmerman Rd. (East of New Market Rd.)	38.527422	85.608224
S8	IN / Clark	Bridge on New Market Rd. (North of Faye Amick Rd.)	38.543267	85.603396
S9	IN / Clark	Bridge on Westport Rd. Near Intersection of New Market Rd.	38.553136	85.574934
S10	IN / Clark	Bridge on 362 West of SR62 Between Frank Fisher & Kettle Bottom Rd.	38.606122	85.578804

After every specimen in the sample was identified to the lowest practical taxon, each taxon was then associated with their appropriate water quality tolerance value, functional feeding group, and habit values using reference lists provided by IDEM. As time permits, digital images of representative specimens from each taxon will be obtained and archived in a database with a

Moticam 2000 high-resolution imaging microscopy camera using the Motic Images Advanced 3.2 software package. Likewise, the taxonomic database will be updated and refined as time, expertise, and resources permit, e.g., slide-mounting and identifying chironomid larvae.

Results and Discussion.

The purpose of this paper, as previously stated, is to present a comparative analysis between ten preselected stream sampling sites along the Fourteen Mile Creek watercourse, hereafter referred to in all figures and tables by individual site with alphanumeric codes, e.g., sampling site number one is shown as S1; sampling site number two is shown as S2, and so on. The single day, ten site sampling effort resulted in the collection of 561 aquatic invertebrates representing 51 genera, 38 families, and 14 orders. The most diverse order among all sites combined was Diptera (11 taxa), followed by Coleoptera (9 taxa) and Trichoptera (7 taxa). The lowest taxa richness among the ten sites was found at site 7, (7 taxa), whereas the highest taxa richness (21 taxa) was located at site 2 (Table 3). The total abundance of macroinvertebrates collected at each site ideally should exceed one hundred specimens, in accordance with the Indiana Department of Environmental Management (IDEM 2010) document *Multi-Habitat (MHAB) Macroinvertebrate Sampling Procedure* – however this bioassessment produced only one sample that individually totaled in excess of one hundred invertebrates (Site 9).

Table 3 also shows values for some common diversity indices, although their relevance is questionable. According to Merritt and Cummins (2008), the reliance of diversity indices in biomonitoring programs has been strongly, and rightly, criticized due to their application being theoretically invalid. However, diversity indices are used routinely in water quality monitoring programs, and the requirement to use this flawed approach has, in some cases, even been codified through environmental legislation (Merritt and Cummins 2008). That said, the Shannon-Weiner diversity index *H'* will approach zero if the majority of abundance is determined by one species amongst one or more rare species, and conversely *H'* will become larger in value as the total community abundance approaches evenness amongst all species. This is due to the fact that *H'* takes into account both species richness *S,* and evenness, *J*. The evenness index *J* will approach a value of 1.0 as the abundances of each taxon become more similar, and conversely, will approach a value of 0.0 as the abundance of each taxon become more dissimilar. The Simpson's dominance index *D* can account for a possible outlier, and validate the evenness and diversity values given by *H'***,** and *J*. Generally, the higher the value of *D*, the more the total abundance is distributed amongst multiple taxa, whereas a low value of *D* is indicative of much of the total abundance being attributed to just a few taxa, or even one taxon. Each of these diversity indices – *H', J*, and *D* – when taken together suggest that sites 1, 2, 3, 4, 5, and 8 are more diverse and balanced in the distribution and abundance of their associated taxa than sites 6, 7, 9, and 10 (Table 3). It is noteworthy to point out that the site with the highest value of *H'* (site 1) is also the site with the lowest calculated mIBI score (22 – see Table 5). The rank abundance graph (Figure 1 Appendix B) clearly depicts this trend graphically with lines with low slope values – e.g., sites 2 and 8, whereas the steep initial drop (ΔY/ΔX) by the curves representing sites 6 and 7 indicate that either one or a very few taxa are accounting for a disproportionately large amount of their respective abundance (both of which are the lowest of all ten sites).

Table 3. Indices depicting taxa richness, diversity, evenness, and dominance.

Total Richness and Diversity						
Site	Year	Abundance	Taxa Richness	Diversity *H'*	Evenness *J*	Dominance *D*
S1	2015	39	17	2.607	0.920	10.942
S2	2015	60	21	2.549	0.837	8.108
S3	2015	35	15	2.536	0.936	11.036
S4	2015	60	18	2.551	0.883	10.465
S5	2015	42	17	2.550	0.900	10.256
S6	2015	30	11	2.101	0.876	6.522
S7	2015	12	7	1.748	0.898	4.800
S8	2015	88	20	2.502	0.835	9.005
S9	2015	152	14	1.775	0.673	3.759
S10	2015	47	14	2.148	0.814	5.375

Table 4. Top 10 taxa for all sites combined by % abundance – Most abundant (top table) and least abundant (bottom table).

	Taxa	% Abundance – All Sites Combined and Individual Sites										
		ALL	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
2015 Top 10 Taxa (% Abundance)	*Baetis sp.*	20.1	15.4	0.00	5.71	3.33	16.7	26.7	0.00	19.3	46.1	2.13
	Stenelmis sp.	11.4	2.56	36.7	20.0	1.67	11.9	6.67	33.3	7.95	9.87	0.00
	Chironominae (sub-family)	8.38	18.0	10.0	8.57	10.0	2.38	13.3	8.33	2.27	9.87	4.26
	Simulium sp.	6.60	7.69	11.7	0.00	5.00	9.52	10.0	25.0	9.09	2.63	4.26
	Ceratopsyche sp.	6.06	0.00	0.00	0.00	1.67	11.9	0.00	0.00	0.00	18.4	0.00
	Caenis sp.	4.63	0.00	1.67	8.57	0.00	2.38	0.00	8.33	1.14	0.66	38.3
	Tanypodinae (sub-family)	3.92	2.56	5.00	8.57	0.00	0.00	26.7	0.00	0.00	1.97	8.51
	Microvelia sp.	3.92	0.00	3.33	0.00	13.3	2.38	20.0	0.00	4.55	0.66	0.00
	Cheumatopsyche sp.	3.39	0.00	0.00	0.00	0.00	4.76	0.00	8.33	15.9	0.00	4.26
	Peltodytes sp.	3.21	5.13	0.00	0.00	15.0	9.52	0.00	0.00	0.00	0.00	6.38

	Taxa	% Abundance – All Sites Combined and Individual Sites										
		ALL	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
2015 Bottom 10 Taxa (% Abundance)	*Anopheles sp.*	0.18	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00
	Pilaria sp.	0.18	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Ephemera sp.	0.18	0.00	0.00	0.00	0.00	2.38	0.00	0.00	0.00	0.00	0.00
	Maccaffertium sp.	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.00	0.00
	Diplectrona sp.	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.13
	Hydroptila sp.	0.18	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Chimarra sp.	0.18	0.00	0.00	0.00	0.00	2.38	0.00	0.00	0.00	0.00	0.00
	Helichus sp.	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.00	0.00
	Dytiscus sp.	0.18	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Uvarus sp.	0.18	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

While the figures and tables presented above and elsewhere in this paper are useful tools for gaining an understanding of site specific ecological characteristics with respect to the macroinvertebrate community and its associated populations, the actual bioassessment is based upon a summary score calculated from the twelve metrics listed in Table 1 (Appendix D). Multimetric indices are designed to spread the risk of making incorrect assessments by using a variety of types of measurements, i.e., metrics (Merritt and Cummins, 2008). The various types of metrics listed in Table 1 (Appendix D) are generally classified as measuring either community structure – e.g., number of taxa – or measuring community function – e.g., % collector-filterers. To assign a score for each individual metric, either a total count or a percentage of the respective taxa or taxon is calculated, and then that value is given a score of 1, 3, or 5, depending on where that value lay within the range of potential values. Once a score is calculated for all twelve metrics, a total score is calculated by summing the scores (Table 5 below). A cumulative score of 35 or less is indicative of an impaired site, while a score above 35 suggests an unimpaired site.

Table 5. 2015 Bioassessment (mIBI) scores for Fourteen Mile Creek.

Metric	BIOASSESSMENT MATRIX									
	SITE 1		SITE 2		SITE 3		SITE 4		SITE 5	
	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**
Total Number of Taxa	17	**1**	21	**3**	15	**1**	18	**1**	17	**1**
Total Number of Individuals	39	**1**	60	**1**	35	**1**	60	**1**	42	**1**
Total Number of EPT Taxa	2	**1**	3	**1**	3	**1**	4	**3**	7	**3**
Total Number of Diptera Taxa	5	**1**	7	**3**	4	**1**	4	**1**	3	**1**
% Orthocladinae + Tanytarsini	33.33	**3**	10.00	**5**	25.00	**3**	25.00	**3**	75.00	**1**
% Non-Insects minus Crayfish	20.51	**3**	3.33	**5**	31.43	**3**	3.33	**5**	4.76	**5**
% Intolerant Taxa (Score 0 - 3)	15.38	**1**	10.00	**1**	20.00	**3**	26.67	**3**	28.57	**3**
% Tolerant Taxa (Score 8 - 10)	15.38	**3**	3.33	**5**	28.57	**1**	3.33	**5**	4.76	**5**
% Predators	7.69	**1**	15.00	**1**	11.43	**1**	16.67	**1**	7.14	**1**
% Shredders plus Scrapers	10.26	**3**	50.00	**5**	25.71	**5**	33.33	**5**	23.81	**5**
% Collector-Filterers	10.14	**3**	11.67	**3**	2.86	**5**	8.33	**5**	30.95	**1**
% Sprawlers	0.00	**1**	0.00	**1**	0.00	**1**	0.00	**1**	0.00	**1**
TOTAL	**mIBI =**	**22**	**mIBI =**	**34**	**mIBI =**	**26**	**mIBI =**	**34**	**mIBI =**	**28**
Metric	BIOASSESSMENT MATRIX									
	SITE 6		SITE 7		SITE 8		SITE 9		SITE 10	
	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**	VALUE	**SCORE**
Total Number of Taxa	11	**1**	7	**1**	20	**1**	14	**1**	14	**1**
Total Number of Individuals	30	**1**	12	**1**	88	**1**	152	**3**	47	**1**
Total Number of EPT Taxa	0	**1**	2	**1**	7	**3**	4	**3**	6	**3**
Total Number of Diptera Taxa	5	**1**	2	**1**	4	**1**	5	**1**	4	**1**
% Orthocladinae + Tanytarsini	7.69	**5**	0.00	**5**	60.00	**1**	0.00	**5**	0.00	**5**
% Non-Insects minus Crayfish	10.00	**5**	8.33	**5**	1.14	**5**	0.00	**5**	4.26	**5**
% Intolerant Taxa (Score 0 - 3)	3.33	**1**	16.67	**3**	43.18	**5**	52.63	**5**	48.94	**5**
% Tolerant Taxa (Score 8 - 10)	10.00	**5**	0.00	**5**	0.00	**5**	0.00	**5**	4.26	**5**
% Predators	53.33	**5**	0.00	**1**	6.82	**1**	3.29	**1**	10.64	**1**
% Shredders plus Scrapers	6.67	**1**	33.33	**5**	19.32	**3**	15.79	**3**	8.51	**1**
% Collector-Filterers	13.33	**3**	41.67	**1**	45.45	**1**	21.05	**1**	12.77	**3**
% Sprawlers	0.00	**1**	0.00	**1**	0.00	**1**	0.00	**1**	0.00	**1**
TOTAL	**mIBI =**	**30**	**mIBI =**	**30**	**mIBI =**	**28**	**mIBI =**	**34**	**mIBI =**	**32**

Conclusions.

Very clearly, the data in Table 5 and Figure 2 suggest that there is moderate to serious impairment to the structure and function of the biological communities at all ten of the sampling sites. This report does not give consideration to the results of the water chemistry analyses for each of the ten sampling sites on July 27th 2015 (reported elsewhere), nor does it give consideration to the inter-annual variation between the same ten sample sites as reported from July 25th 2014 (also reported elsewhere). The same two biologists that conducted the July 25th 2014 bioassessment of Fourteen Mile Creek also conducted all of the field and subsequent lab work that is reported here for July 27th 2015.

Consideration should also be given to the fact that sites with disproportionately high taxa richness and/or abundances – e.g., sites 8 and 9 – would likely score higher if the taxonomic resolution was increased to the level of species. This does not necessarily hold true for the sites where taxa richness and abundance were very low – e.g., sites 6 and 7. Therefore, it is very likely that the mIBI differential is much greater than reported between the impaired and unimpaired sites. Furthermore, it is likely that the sites with mIBI scores that fell just short of 36 – e.g., sites 2, 4, and 9 – would have made the unimpaired list had species resolution been recorded, or even genus resolution with the chironomidae.

One final point of consideration concerns the fact that none of the ten site samples produced a specimen from the order Plecoptera – taxa that are generally associated with unimpaired sites and conversely not likely to be found in habitats exhibiting some type of impairment. Further investigation in this area is recommended outside of any annual monitoring.

Appendix A provides a complete list of taxa collected from all ten sampling sites on July 27th, 2015. Appendix B provides several additional figures depicting the macroinvertebrate characteristics of the sampling sites. Appendix C provides a comparison of the complete taxa collection from all ten sampling sites of Fourteen Mile Creek to a reference list of aquatic insect species known to occur in Indiana, published by Hellenthal *et al*. in 2003. Appendix D provides the mIBI bioassessment scoring matrix.

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Appendix A.

Table 6. Aquatic invertebrates collected from Fourteen Mile Creek at sites 1 thru 10 on July 27th, 2015. Insect orders are arranged phylogenetically, followed by the alphabetical listing of the families, genera, and species, if applicable. Alphanumeric codes associated with each taxon correspond to the site and year collected.

Insects

Order Ephemeroptera (5 families)
- Family Baetidae
  - *Baetis sp.*
    - 2015-S1/S3/S5/S6/S8/S9/S10
- Family Caenidae
  - *Caenis sp.*
    - 2015-S2/S3/S5/S7/S8/S9/S10
- Family Ephemeridae
  - *Ephemera sp.*
    - 2015-S5
- Family Heptageniidae
  - *Maccaffertium sp.*
    - 2015-S8
  - *Stenonema sp.*
    - 2015-S2/S8/S9/S10
- Family Leptophlebiidae
  - *Paraleptophlebia sp.*
    - 2015-S3

Order Odonata (3 families)
- Family Calopterygidae
  - *Hetaerina sp.*
    - 2015-S6
- Family Coenagrionidae
  - *Coenagrion sp.*
    - 2015-S1
- Family Libellulidae
  - *Perithemis sp.*
    - 2015-S5/S7/S10

Order Plecoptera (0 families)

Order Hemiptera (3 families)
- Family Corixidae
  - *Genus TBD*
    - 2015-S10

Order Hemiptera (continued)
- Family Gerridae
  - *Limnoporus sp.*
    - 2015-S2/S10
  - *Rheumatobates sp.*
    - 2015-S6
  - *Trepobates sp.*
    - 2015-S2/S7/S9/S10
- Family Veliidae
  - *Microvelia sp.*
    - 2015-S2/S4/S5/S6/S8/S9

Order Megaloptera (2 families)
- Family Corydalidae
  - *Chauliodes sp.*
    - 2015-S8/S9
- Family Sialidae
  - *Sialis sp.*
    - 2015-S3

Order Trichoptera (4 families)
- Family Helicopsychidae
  - *Helicopsyche sp.*
    - 2015-S2/S4/S8/S10
- Family Hydropsychidae
  - *Ceratopsyche sp.*
    - 2015-S4/S5/S9
  - *Cheumatopsyche sp.*
    - 2015-S5/S7/S8/S10
  - *Diplectrona sp.*
    - 2015-S10
  - *Hydropsyche sp.*
    - 2015-S1/S5/S8
- Family Hydroptilidae
  - *Hydroptila sp.*
    - 2015-S1
- Family Philopotamidae
  - *Chimarra sp.*
    - 2015-S5

Order Orthoptera (0 family)

(Table continued on next page)

Appendix A.

Table 6. – Continued

Order Coleoptera (7 families)
Family Dryopidae
Helichus sp.
2015-S8
Family Dytiscidae
Dytiscus sp.
2015-S4
Uvarus sp.
2015-S1
Family Elmidae
Stenelmis sp.
2015-S1/S2/S3/S4/S5/S6/S7/S8/S9
Family Haliplidae
Peltodytes sp.
2015-S1/S4/S5/S10
Family Hydrophilidae
Tropisternus sp.
2015-S4
Family Psephenidae
Ectopria sp.
2015-S2
Psephenus sp.
2015-S2/S8
Family Staphylinidae
Genus TBD
2015-S1/S2/S4/S8
Order Diptera (6 families)
Family Chironomidae
Subfamily Chironominae
Genus TBD
2015-S1/S2/S3/S4/S5/S6/S7/S8/S9/S10
Tribe Tanytarsini
Genus TBD
2015-S1/S3/S6/S8
Subfamily Tanypodinae
Genus TBD
2015-S1/S2/S3/S6/S9/S10
Subfamily Orthocladiinae
Genus TBD
2015-S1/S2/S3/S4/S5/S8

Order Diptera (continued)
Family Ceratopogonidae
Bezzia/Palpomyia sp.
2015-S2/S9
Family Culicidae
Anopheles sp.
2015-S4
Family Simuliidae
Simulium sp.
2015-S1/S2/S4/S5/S6/S7/S8/S9/S10
Family Tabanidae
Chrysops sp.
2015-S6/S10
Family Tipulidae
Pedicia sp.
2015-S2
Pilaria sp.
2015-S2
Ormosia sp.
2015-S9

Non-Insects

Order Amphipoda (1 family)
Family Hyalellidae
Hyalella sp.
2015-S1/S2/S3
Order Decapoda (1 family)
Family Cambaridae
Genus TBD
2015-S1/S2/S4/S5/S7/S8/S9/S10
Order Isopoda (1 family)
Family Asellidae
Lirceus sp.
2015-S1/S5/S6/S10
Order Veneroida (1 family)
Family Sphaeriidae
Sphaerium sp.
2015-S7/S8

(Table continued on next page)

Appendix A.

Table 6. – Continued

<u>Non-Insects (continued)</u>

Order Lymnophila (1 family)
Family Lymnaeidae
Fossaria sp.
2015-S3
Order Basommatophora (1 family)
Family Physidae
Physella sp.
2015-S1/S4/S5
Phylum Annelida
Subclass Oligochaeta
2015-S2/S3/S4/S6

Appendix B.

Figure 1. Joint rank abundance diagram depicting relative abundance by species rank. (For illustrative purposes, select sites are highlighted for comparative context.

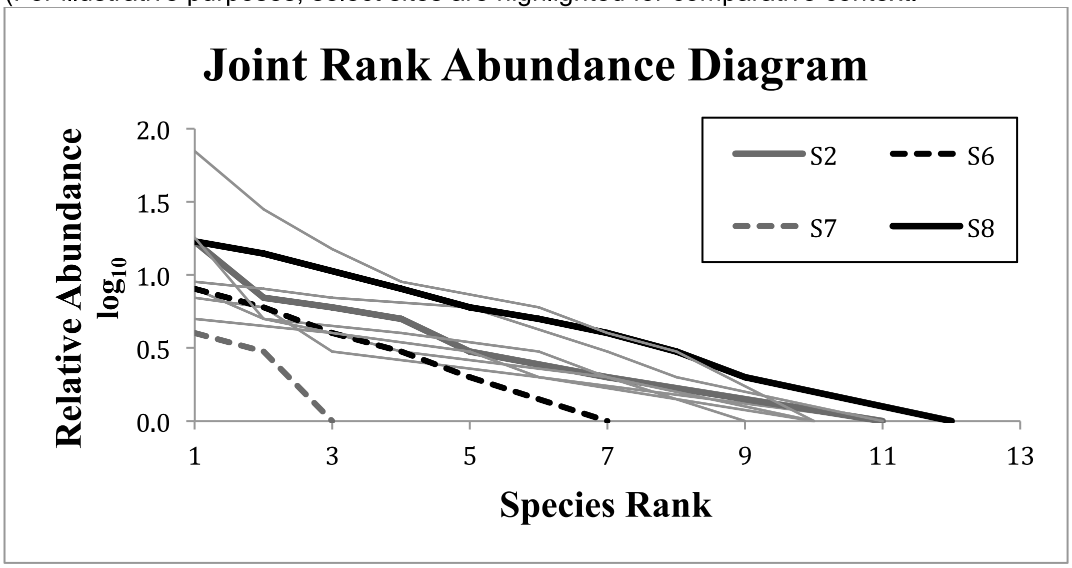
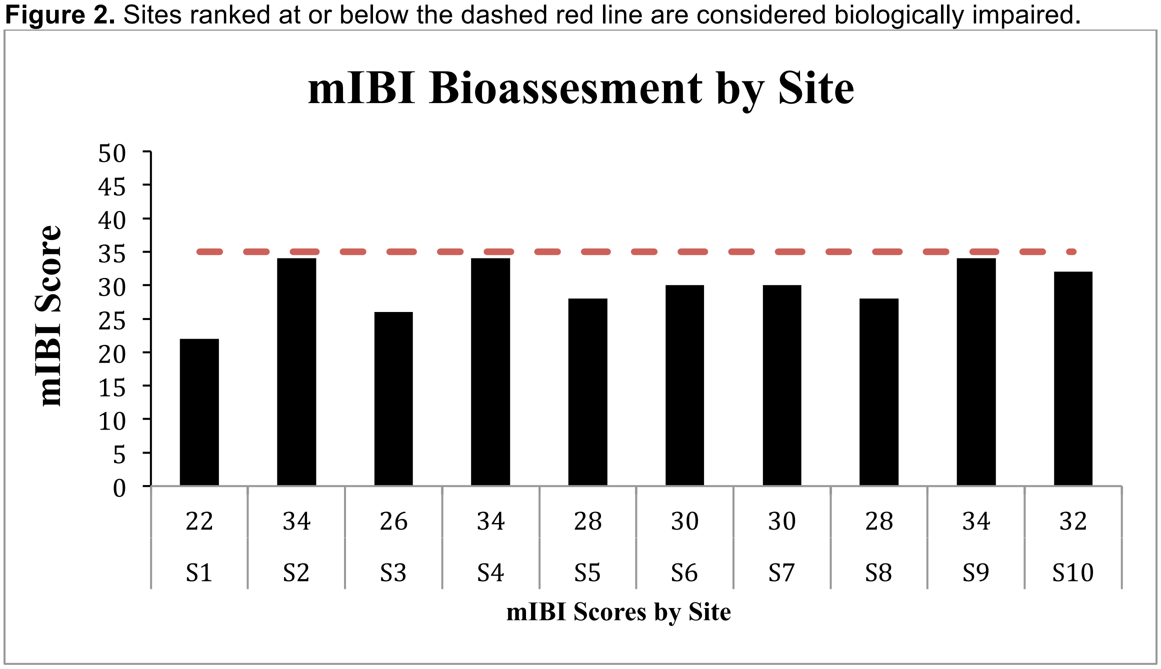


Figure 2. Sites ranked at or below the dashed red line are considered biologically impaired.



Appendix B (continued).

Figure 3. Functional feeding groups (FFG) by % abundance for each site.

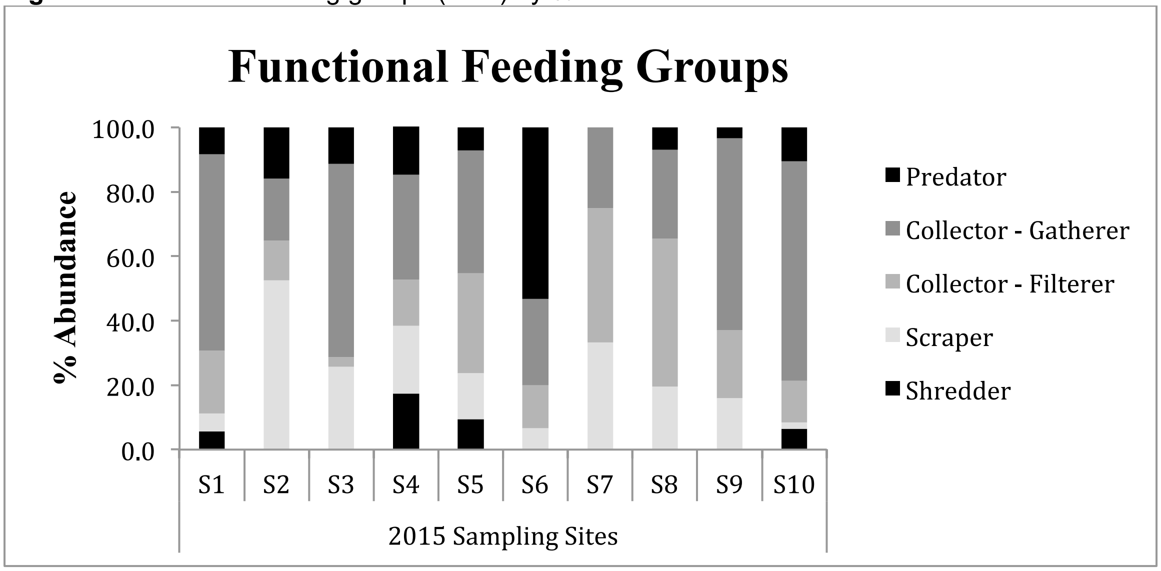
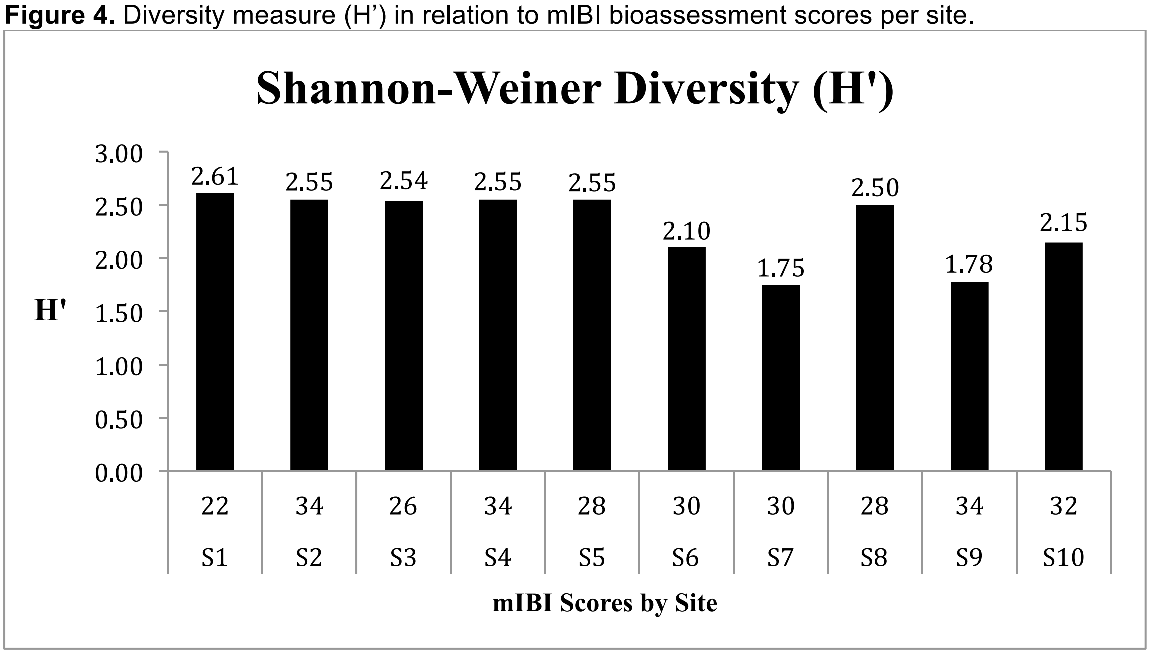
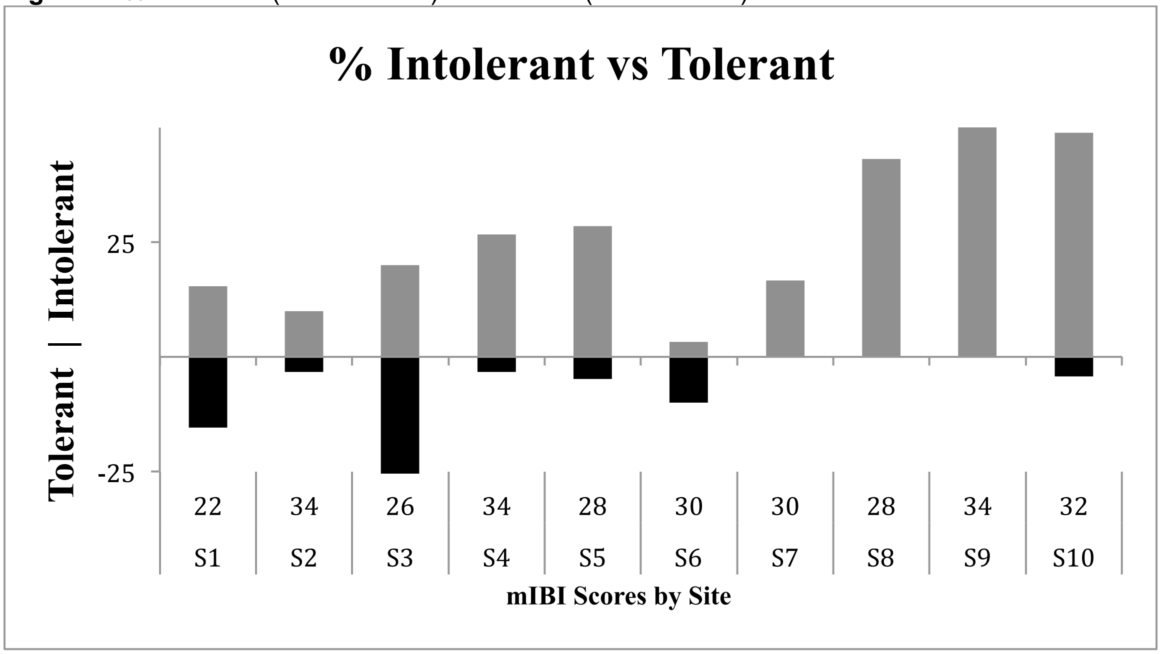


Figure 4. Diversity measure (H') in relation to mIBI bioassessment scores per site.



Appendix B (continued).

Figure 4. % intolerant (above x-axis) vs. tolerant (below x-axis) macroinvertebrates for each site.



Appendix C.

Table 7. Comparison of aquatic insect taxa collected from Fourteen Mile Creek (all sites) on July 27th, 2015 to reference list of aquatic insect taxa known to exist in Indiana.

	Families	Genera	Species
Ephemeroptera			
Hellenthal *et al*. (2003)	16	50	143
Fourteen Mile Creek (2015)	5	6	n/a
% representation	31.3%	12.0%	-
Odonata			
Hellenthal *et al*. (2003)	10	47	154
Fourteen Mile Creek (2015)	3	3	n/a
% representation	30%	6.4%	-
Plecoptera			
Hellenthal *et al*. (2003)	8	29	71
Fourteen Mile Creek (2015)	0	0	n/a
% representation	0%	0%	-
Trichoptera			
Hellenthal *et al*. (2003)	16	58	194
Fourteen Mile Creek (2015)	4	7	n/a
% representation	25%	12.07%	-

Appendix D.

Table 1. Multimetric scoring matrix for rapid bioassessment data analyses (IDEM 2010).

Biological Metric	Poor	Fair	Excellent
Number of Taxa			
	< 21	≥ 21 and < 41	≥ 41
Score	**1**	**3**	**5**
Number of Individuals			
	< 129	≥ 129 and < 258	≥ 258
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: < 5 mi^2			
	< 2	≥ 2 and < 4	≥ 4
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: ≥ 5 & < 50 mi^2			
	< 4	≥ 4 and < 8	≥ 8
Score	**1**	**3**	**5**
# of EPT Taxa / Drainage Area: ≥ 50 mi^2			
	< 6	≥ 6 and < 12	≥ 12
Score	**1**	**3**	**5**
Number of Diptera Taxa			
	< 7	≥ 7 and < 14	≥ 14
Score	**1**	**3**	**5**
% Orthocladiinae + Tanytarsini			
	≥ 47	≥ 24 and < 47	< 24
Score	**1**	**3**	**5**
% Non-insects Minus Crayfish			
	< 15.9	≥ 15.9 and < 31.8	≥ 31.8
Score	**1**	**3**	**5**
% Intolerant			
	< 15.9	≥ 15.9 and < 31.8	≥ 31.8
Score	**1**	**3**	**5**
% Tolerant			
	≥ 25.3	≥ 12.6 and < 25.3	< 12.6
Score	**1**	**3**	**5**
% Predators			
	< 18	≥ 18 and < 36	≥ 36
Score	**1**	**3**	**5**
% Shredders + Scrapers			
	< 10	≥ 10 and < 20	≥ 20
Score	**1**	**3**	**5**
% Collector-Filterers			
	≥ 20	≥ 10 and < 20	< 10
Score	**1**	**3**	**5**
% Sprawlers			
	< 3	≥ 3 and < 6	≥ 6
Score	**1**	**3**	**5**

Watershed Site # 1
Hoosier Riverwatch Site # 2181

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD)	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	10	12	106	4	6.2	0	0	0	<15	79.44	0.971
4/10/2014	17	10	103	2	5	0	0	0	22.5	73.47	1.308
5/20/14	19	10	108	4	5.3	0	0	0	<15	73.33	0.944
6/17/14	24	10	119	9	6	0	2.1	0	<15	71.53	NA
7/18/14	19	6.7	72	.7	6	0	22	0	<15	70.83	0.90
8/13/14	21	8	90	2	5	0	13.2	0	<15	68.75	1.08
9/19/14	16	6.7	68	1.7	5	0	8.8	0	<15	66.11	0.50
10/21/14	14	10	97	2	5	0	22.0	0	<15	69.31	NA
11/5/14	13	6	57	1	5	0	2.2	0	<15	68.06	0.65
12/5/14	9	10	86	0	5.3	0	22.0	0	<15	71.81	1.07
1/20/15	7	12	99	0	4	0	22.0	0	<15	67.36	0.87
2/11/15	6	12	96	0	4.7	0	22.0	0	<15	70	0.86
3/25/15	16	12	121	0	4	0	8.8	0	<15	66.53	0.88
4/21/15	14	12	117	2	5	0	8.8	0	<15	69.58	1.23
5/13/15	17	12	124	7	6.5	0	8.8	0	<15	69.86	0.81
6/1/15	28	10	128	9	7	0	2.2	0	<15	75	0.76
7/22/15	21	10	112	9	6	0	2.2	0	<15	73.47	1.36
8/12/15	25	10		8	5.67	0	8.8	0	<15	64.14	0.93
9/16/15	18	10	104.17	9	6.33	0	2.2	0	<15	75.74	NA*
10/13/15	17	5.7	58.45	2.7	6.5	0	0	0	<15	72.19	0.87
11/3/15	11	12	**109.09**	**4**	**6**	**0**	**2.2**	**0**	**<15**	**78.89**	**1.70**
12/3/15	**10**	**10**	**88.50**	**0**	**6**	**0**	**1.47**	**0**	**<15**	**83.33**	**2.16**

Watershed Site # 2
Hoosier Riverwatch Site # 2193

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014											
4/10/2014	8	10	85	2	4	0	8.8	0	<15	68.33	.809
5/20/2014	14	8	78	0	7	0	0	0	<15	87.92	1.082
6/17/14	20	6.7	74	0.7	6	0	0	0	<15	79.31	0.67
7/18/14	17	8	82	3	6	0	2.2	0	<15	76.67	.84
8/13/14	18	8.7	91	3.7	6.3	0	0	0	<15	79.86	.37
9/18/14	15	6	59	0	5	0	2.2	0	<15	68.89	1.07
10/21/14	13	9.3	89	1.3	5	0	0	0	<15	79.31	1.01
11/3/14	11	8	73	3	5	0	8.8	0	<15	64.17	3.77
12/5/14	7	10	83	2	4	0	0	0	<15	73.19	1.01
1/20/15	2	11	80	0	4	0	8.8	0	<15	68.89	1.37
2/11/15	2	12	85	0	4	0	22	0	<15	67.08	0.90
3/25/15	9	12	103	0	4	0	8.8	0	<15	72.36	1.90
4/21/15	12	12	111	2	6	0	8.8	0	<15	75	1.97
5/13/15	14	10	97	4	6.2	0	8.8	0	<15	73.75	1.11
6/16/15	23	5.3	62	3.3	6.8	0	0.2	0	<15	72.64	0.53
7/22/15	19	9.3	100	3.3	7.2	0	0	0	<15	86.25	2.00
8/12/15	19	8		3	7.17	0	2.2	0	<15	84.53	0.7
9/16/15	15	8	79.21	3	6	0	2.2	0	<15	76.40	NA*
10/13/15	15	10	99.01	2	6	0	0	0	<15	83.39	1.35
11/13/15	**8**	**12**	**101.69**	**2**	**6**	**0**	**8.8**	**0**	**<15**	**75.56**	**2.09**
12/3/15	**6**	**7.3**	**58.64**	**1.3**	**6**	**0**	**8.8**	**0**	**<15**	**67.78**	**2.59**

Watershed Site # 3
Hoosier Riverwatch Site # 2182

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	11.3	96	3.3	6.3	0	0	0	<15	82.08	2.148
4/10/2014	10	10	88	0	5	0	0	0	<15	79.31	0.654
5/20/2014	15	12	119	2	6.7	0	0	0	<15	85.14	0.172
6/17/14	23	6.7	78	0.7	7	0	0	0	16	82.08	0.55
7/18/14	19	10	108	4	6	0	2.2	0	<15	78.33	.57
8/13/14	20	12	132	4	6	0	0	0	<15	74.72	.75
9/18/14	18	10	104	2	5	0	2.2	0	<15	77.36	0.74
10/21814	12	10	93	2	5	0	2.2	0	<15	77.08	1.04
11/5/14	13	10	95	2	5.7	0	13.2	0	<15	73.47	0.83
12/3/14	7	9.3	77	1.3	4	0	0	0	<15	73.61	1.43
1/20/15	4	12	92	0	4	0	17.6	0	<15	69.17	1.35
2/11/15	2	12	89	0	4	0	15.4	0	<15	69.17	1.30
3/25/15	10	12	106	0	4	0	6.6	0	<15	72.78	1.00
4/21/15	12	12	111	0	4	0	8.8	0	<15	70.83	1.83
5/13/15	16	12	121	4	6.5	0	8.8	0	<15	73.33	0.81
6/16/15	28	12	154	11	7.2	0	0.2	0	<15	78.33	1.57
7/22/15	20	11.3	124	10.3	7.8	0	1.5	0	<15	77.64	1.2
8/12/15	20	8.7		6.7	7.6	0	8.8	0	<15	77.28	1.33
9/16/15	17	5.67	58.45	4.67	6.67	0	4.4	0	<15	70.94	NA*
10/13/15	15	4.3	42.87	0.3	6.8	0	0	0	<15	75.13	0.86
11/13/15	11	11	100	3	6	0	2.2	0	<15	78.75	1.26
12/3/15	7	12	99.17	0	6	0	8.8	0	<15	80.00	1.45

Watershed Site # 4
Hoosier Riverwatch Site # 2183

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	8.6	74	1.3	6.5	0	0	0	17.5	83.19	1.647
4/10/2014	14	8	78	2	5	0	1.1	0	<15	74.86	1.148
5/20/2014	16	9.3	94	3.3	5	0	0	0	<15	75.69	0.793
6/17/14	27	10	112	5	7	0	0	0	<15	81.25	NA
7/18/14	18	8	83	2	6	0	8.8	0	<15	74.17	.59
8/13/14	22	8	92	2	6	0	0	0	<15	81.39	.89
9/18/14	17	8	82	5	5	0	8.8	0	<15	64.03	0.67
10/21/14	13	8	76	2	4.7	0	8.8	0	<15	66.94	0.78
11/5/14	12	8	74	2	5	0	0	0	<15	73.75	0.74
12/3/14	8	10	85	2	5	0	17.6	0	<15	67.22	1.08
1/20/15	4	12	92	0	4	0	8.8	0	<15	71.80	0.96
2/11/15	5	12	94	0	4	0	2.2	0	<15	77.64	1.44
3/25/15	12	12	111	0	4	0	0	0	<15	77.36	1.47
4/21/15	13	12	114	0	5.3	0	0	0	<15	81.94	1.70
5/13/15	17	12	124	4	6.5	0	8.8	0	<15	72.92	1.26
6/16/15	24	8	95	7	7	0	2.2	0	<15	80.14	NA
7/22/15	20	10	110	9	8	0	2.2	0	<15	79.86	0.96
8/12/15	22	10		7	8	0	0	0	<15	79.17	NA*
9/16/15	20	10	109.89	6	6.5	0	0	0	<15	79.90	NA*
10/13/15	16	5.7	57.27	0.7	6.5	0	0	0	<15	77.10	NA*
11/13/15	10	10	88.50	0	6	0	0	0	<15	84.17	0.534
12/3/15	8	12	101.69	0	6	0	0.73	0	<15	85.28	1.01

Watershed Site # 5
Hoosier Riverwatch Site # 2184

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	9	8	69	-2	6.3	0	0	0	<15	81.11	1.574
4/10/2014	14	12	117	4	5	0	1.1	0	<15	73.33	2.959
5/20/2014	16	12	121	6	6	0	0	0	<15	75.83	0.962
6/17/14	25	10.7	129	2.7	7	0	2.1	0	<15	80.83	NA
7/18/14	19	10	108	4	6	0	22.2	0	<15	70.14	1.17
8/13/14	20	8	88	0	5	0	0	0	<15	79.31	.76
9/18/14	20	12	132	4	5.3	0	8.8	0	<15	64.58	1.32
10/21/14	13	8	76	0	4.7	0	22.0	0	<15	67.64	1.05
11/5/14	12	10	93	2	5.3	0	6.6	0	<15	73.75	2.61
12/3/14	10	10.7	95	.07	5	0	22.0	0	<15	71.39	2.28
1/20/15	5	12	94	0	4.3	0	22.0	0	<15	70.56	0.97
2/11/15	4	12	92	0	4	0	22	0	<15	69.17	1.10
3/25/15	13	12	114	0	4	0	17.6	0	<15	68.89	1.13
4/21/15	13	12	114	0	5	0	22	0	<15	71.81	0.96
5/13/15	19	12	129	4	6.5	0	8.8	0	<15	72.08	1.47
6/16/15	28	10	128	5	7	0	2.2	0	<15	80.83	NA
7/22/15	20	10.7	118	6.7	7.8	0	1.5	0	<15	79.72	0.93
8/12/15	24	12		7	7.8	0	8.8	0	<15.5	77.46	1.5
9/16/15	21	12	134.83	6	7.5	0	2.2	0	<15	77.54	
10/13/15	17	10	103.09	4	7	0	0	0	<15	85.11	0.85
11/13/15	12	12	92.59	4	6.5	0	0.73	0	<15	82.22	1.14
12/3/15	10	12	106.19	2	6	0	2.2	0	<15	81.25	1.61

Watershed Site # 6
Hoosier Riverwatch Site # 2185

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	9.3	79	1.3	3.5	0	0	0	19.25	73.06	1.459
4/10/2014	15	7	69	1	3.25	0	0	0	22.5	69.44	0.077
5/20/2014	17	8.7	90	0.7	4.7	0	0	0	29.2	76.67	0.861
6/17/2014	21	8.7	98	2.7	5	0	0	0	<15	74.31	NA
7/18/2014	19	6.7	72	1.7	4	0	2.2	0	<15	70.83	.44
8/13/2014	20	8.3	91	0.3	4	0	.7	0	<15	77.78	0
9/18/14	16	8	81	2	4	0	.7	0	<15	71.39	0.45
10/21/14	13	6	57	0	4	0	2.2	0	<15	67.08	NA
11/5/14	12	5.7	53	0.7	5	0	0	0	<15	67.92	0.40
12/3/14	7	8	66	0	4	0	2.2	0	<15	70.14	1.50
1/20/15	5	12	94	0	4	0	2.2	0	<15	78.19	0.88
2/11/15	5	12	94	0	4	0	2.2	0	<15	78.19	0.90
3/25/15	15	10	99	0	4	0	0	0	<15	77.78	1.27
4/21/15	14	12	117	2	4	0	2.2	0	18	72.36	1.03
5/13/15	17	7.3	75	1.3	6.5	0	2.2	0	<15	81.94	0.56
6/16/15	Dry										
7/22/15	21	8	90	2	4	0	0	0	<15	74.03	1.13
8/12/15	21	4		0	4	0	0	0	<15	63	NA
9/16/15											
10/13/15											
11/13/15	11	9	81.82	0	6	0	0	0	<15	83.33	1.42
12/3/15	8	10	84.75	0	6	0	0	0	<15	83.33	1.50

Watershed Site # 7
Hoosier Riverwatch Site # 2186

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	8.7	74	2.6	6.5	0	0	0	15.58	79.44	1.746
4/10/2014	14	11	107	3	3.5	0	0	0	<15	71.53	2.095
5/20/2014	18	11.3	118	1.3	6	0	0	0	<15	81.39	0.688
6/17/2014	27.5	10.7	137	2.7	6	0	0	0	<15	73.89	NA
7/18/2014	20.5	9.3	102	1.3	6	0	2.2	0	<15	83.75	.78
8/13/2014	20	11.3	124	3.3	5	0	0	0	<15	73.19	.56
9/19/14	15	8	79	2	5	0	0	0	<15	74.58	0.91
10/21/14	14	12	117	4	4.3	0	14.7	0	<15	62.64	0.80
11/5/14	13	12	114	6	5	0	0	0	<15	71.11	1.17
12/3/14	8	10.7	91	0.7	4	0	44.0	0	<15	65	1.86
1/20/15	6	12	96	0	4	0	22	0	<15	68.47	0.87
2/11/15	5	12	94	0	4	0	22	0	<15	68.89	0.64
3/25/15	12	12	111	0	4	0	22	0	<15	69.17	0.78
4/21/15	13	12	114	0	4.7	0	8.8	0	<15	72.5	2.56
5/13/15	20	12	132	4	6.7	0	8.8	0	<15	85.41	1.04
6/16/15	28	8.7	112	3.7	7	0	2.2	0	<15	84.31	NA
7/22/15	23	8.7	101	3.7	7.8	0	0	0	<15	85	1.25
8/12/15	24	10		6	7.7	0	0		<15	81.86	1.0
9/16/15											
10/13/15	16	6.7	67.37	0.7	6.5	0	0	0	25	81.34	NA
11/13/15	12	10	92.59	4	6	0	0.73	0	<15	78.06	1.09
12/3/15	8	12	101.69	0	6	0	2.93	0	<15	81.17	1.58

Watershed Site # 8
Hoosier Riverwatch Site # 2187

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	10.7	91	2.7	6.25	0	0	0	17.5	82.08	2.167
4/10/2014	12	11	93	3	4.5	0	0	0	<15	76.11	1.048
5/20/2014	15	8	79	0	5.7	0	0	0	<15	81.25	1.365
6/17/2014	23	10	116	4	6	0	2	0	<15	77.92	NA
7/18/2014	19	8	86	2	5	0	8.8	0	<15	70.14	.80
8/13/2014	20	6	66	2	5	0	0	0	<15	70.14	0
9/19/14	14	6.7	65	5.7	5	0	0	0	<15	65.14	0.67
10/21/14	12	7.3	68	1.3	5	0	0	0	<15	73.06	0.73
11/5/14	11	8	73	3	5	0	2.2	0	<15	70.83	NA
12/3/14	6	10	80	0	4	0	22.0	0	<15	66.81	0.59
1/20/15	3	12	89	0	4	0	22	0	<15	68.61	1.29
2/11/15	3	12	89	0	4	0	0	0	<15	77.78	1.24
3/25/15	10	12	106	0	4	0	0	0	<15	78.06	0.66
4/21/15	14	12	117	0	5	0	0	0	<15	78.89	2.16
5/13/15	17	10.7	110	6.7	6.5	0	2.2	0	<15	78.75	0.58
6/16/15	28	8	103	3	6.7	0	0	0	<15	85	NA
7/22/15	21	10	112	7	6.8	0	0	0	<15	80.56	2.57
8/12/15	23	8		3	6.8	0	2.2	0	<15	85.59	0.68
9/16/15	17	9.33	96.19	4.33	6	0	2.2	0	<15	78.24	NA
10/13/15	15	6	59.41	0	6.5	0	0	0	<15	78.92	1.31
11/13/15	10	10	88.50	0	6	0	0.73	0	<15	84.58	1.40
12/3/15	6	12	96.00	0	6	0	8.8	0	<15	79.86	1.76

Watershed Site # 9
Hoosier Riverwatch Site # 2188

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	8	7.3	62	-0.7	6.5	0	0	0	<15	78.89	1.076
4/10/2014	12	12	111	6	4	0	0	0	<15	68.61	
5/20/2014	16	8	81	0	6	0	0	0	<15	83.06	0
6/17/2014	23	8	93	2	7	0	8.8	0	<15	81.81	NA
7/18/2014	20	6.7	74	0.7	6	0	22.5	0	<15	72.5	1.2
8/13/2014	21	6	67	2	5.3	0	0	0	<15	71.67	.27
9/19/14	15	6	59	2	5	0	2.2	0	<15	66.25	0
10/21/14	13	8.7	83	2.7	5	0	0	0	<15	73.75	0.65
11/5/14	11	8	73	4	5	0	2.2	0	<15	69.31	1.01
12/3/14	7	10	83	0	4	0	0	0	<15	75.97	0.96
1/20/15	4	12	92	0	4	0	8.8	0	<15	72.36	0.75
2/11/15	3	12	89	0	4	0	8.8	0	<15	71.81	0.95
3/25/15	11	12	109	0	4	0	4.3	0	<15	73.75	0.76
4/21/15	12	12	111	4	4	0	2.2	0	<15	70.97	0.63
5/13/15	18	9.3	97	4.3	6.5	0	8.8	0	<15	75.42	1.37
6/16/15	28	9.3	119	8.3	6.5	0	1.5	0	<15	76.11	0.93
7/22/15	20	12	132	11	7.7	0	2.2	0	<15	75.83	0.98
8/12/15	23	8	93.02	6	7.3	0	8.8	0	<15	77.81	1.2
9/16/15	19	8	86.02	6	6	0	2.2	0	<15	75.70	NA
10/13/15	15	6.3	62.67	2.3	6.5	0	0	0	<15	75.69	NA
11/13/15	11	12	109.09	4	6.5	0	8.8	0	<15	75.69	0.61
12/3/15	7	10	82.64	0	6	0	8.8	0	<15	78.06	0.8

Watershed Site # 10
Hoosier Riverwatch Site # 2189

Date	Water Temp. C	Dissolved Oxygen mg/l	DO % Saturation	Biochemi-cal Oxygen Demand (BOD	pH	Ortho-Phosphate mg/l	Nitrate (NO3) mg/l	Nitrite (NO4) mg/l	Turbidity (NTU)	Water Quality Index	Flow ft./sec.
3/19/2014	7	10	83	2	6	0	0	0	<15	80.14	1.455
4/10/2014	10	12	106	4	4.5	0	0	0	<15	73.06	2.138
5/20/2014	17	12	124	6	6	0	0	0	<15	75.42	1.53
6/17/2014	24	10	119	9	6	0	0	0	<15	73.47	0.94
7/18/2014	20	12	132	7	6	0	2.2	0	<15	72.92	.90
8/13/2014	19	12	129	4	5	0	0	0	16	70.42	.77
9/18/14	17	9.3	96	3.3	5	0	0.7	0	<15	74.58	2.65
10/21/14	12	11.3	105	1.3	5	0	0	0	<15	79.72	1.47
11/5/14	12	12	111	2	5	0	0.7	0	<15	76.81	1.33
12/3/14	6	10	80	0	4	0	0	0	<15	75.42	2.45
1/20/15	4	12	92	0	4	0	8.8	0	<15	72.36	1.37
2/11/15	3	12	89	0	4	0	8.8	0	<15	71.81	1.00
3/25/15	10	12	106	0	4	0	1.5	0	<15	77.92	1.91
4/21/15	12	12	111	2	4	0	2.2	0	<15	74.17	2.81
5/13/15	16	12	121	6	6.7	0	6.6	0	<15	73.61	0.74
6/16/15	30	11.3	151	10.3	7	0	0.7	0	<15	79.86	0.81
7/22/15	21	12	135	6	7.3	0	0	0	<15	79.58	1.34
8/12/15	24	12		6	7.2	0	0	0	<15	84.01	0.88
9/16/15	20	9	98.90	5	6	0	2.2	0	<15	78.34	NA
10/13/15	15	4	39.60	0	6.83	0	0	0	<15	74.24	0.48
11/13/15	10	12	106.19	0	6	0	0	0	<15	85.69	1.07
12/3/15	7	12	99.17	0	6	0	8.8	0	<15	80.56	1.97

E. coli Results 14 Mile/Goose Creek Watershed

Coliscan Easygel Method
Colonies per 100 ml of water

Site	9/23/2014	9/30/2014	10/7/2014	10/13/2014*	10/21/2014	Average
2181	333	0	166.5	2,131.2	0	526.14
2193	33.3	0	466.2	8,325	366.3	1,838.16
2182	99.9	333	799.2	166.5	66.6	293.04
2183	166.5	0	133.2	3,263.4	66.6	725.94
2184	66.6	33.3	99.9	166.5	33.3	379.92
2185	33.3	3,330	199.8	1,365.3	133.2	1,012.32
2186	233.1	1,232.1	1,798.2	4,095.9	166.5	1,505.16
2187	199.8	66.6	1,565.1	2,430.9	33.3	859.14
2188	233.1	133.2	699.3	9,990	133.2	2,237.76
2189	399.6	399.6	1,098.9	3,263.4	133.2	1,058.94

*This was after a 2-3 inch rain.

State Water Quality Standard for total body contact recreation:
<235 CFU/100 ml (Single sample) and <125 CFU/100 ml (Geometric mean of 5 samples equally spaced over 30 days)

E. coli Results 14 Mile/Goose Creek Watershed

Coliscan Easygel Method

Colonies per 100 ml of water

Site	5/20/2015	5/27/2015	6/3/2015	6/10/2015	6/16/2015	Average
2181	266.4	0	99.9	99.9	166.5	126.54
2193	33.3	33.3	33.3	66.6	166.6	66.6
2182	399.6	99.9	199.9	266.4	33.3	199.82
2183	133.3	66.6	0	66.6	0	53.28
2184	199.8	66.6	133.2	166.5	33.3	119.88
2185	66.6	0	0	0	99.9	33.3
2186	0	229.7	33.3	66.6	99.9	44.54
2187	133.2	66.6	99.9	33.3	33.3	93.24
2188	199.8	166.5	133.2	66.6	99.9	166.5
2189	33.3	0	0	0	33.3	13.32

State Water Quality Standard for total body contact recreation:
<235 CFU/100 ml (Single sample) and <125 CFU/100 ml (Geometric mean of 5 samples equally spaced over 30 days)

Biological Data 14 Mile/Goose Creek Watershed 2014

Organisms	Site 2181	Site 2193	Site 2182	Site 2183	Site 2184	Site 2185	Site 2186	Site 2187	Site 2188	Site 2189
Group 1 Intolerant										
Stonefly Nymph	lots	x	x					x		
Mayfly Nymph		x		x				x		
Caddis Fly Larva		x	x							x
Riffle Beetle	x					x				x
Dobsonfly Larva	x		x							
Right-handed Snail	x	x	x	x	100s			x	x	
Water Penny		x	x					x	x	
Group 2 Moderately Intolerant										
Damselfly Nymph	x								x	x
Dragonfly Nymph										
Scud	x		x	x	x	x				x
Sowbug	x						x			x
Crane Fly Larva									x	x
Clam/Mussels	x								x	x
Crayfish	x		x	x					x	
Group 3 Fairly Tolerant										
Leech	x	x	x		Several		x		x	
Midge Larva				x						
Planaria/ Flatworm										
Black Fly Larvae										
Group 4 Very Tolerant										
Aquatic Worms			100s	x		x	x	x	x	x
Blood Midge Larva	x		x							
Rat-tailed Maggot										
Left-Handed or Pouch Snail	x	x		x			100s			x
Score	35	23	30	18	9	8	7	17	23	25
Pollution Tolerance Index Rating	Excellent	Excellent	Excellent	Good	Bad	Bad	Bad	Good	Excellent	Excellent

Biological Data 14 Mile/Goose Creek Watershed 2015

Organisms	Site 2181	Site 2193	Site 2182	Site 2183	Site 2184	Site 2185	Site 2186	Site 2187	Site 2188	Site 2189
Group 1 Intolerant								x		x
Stonefly Nymph	x	x	x						x	x
Mayfly Nymph								x		
Caddis Fly Larva	x	x		x					x	
Riffle Beetle										
Dobsonfly Larva										
Right-handed Snail	x				x		x	x		100s
Water Penny				x				x	x	
Group 2 Moderately Intolerant										
Damselfly Nymph	x			x						x
Dragonfly Nymph							x			
Scud	x									
Sowbug	x								x	
Crane Fly Larva			x							
Clam/Mussels	x	x								
Crayfish								x	x	x
Group 3 Fairly Tolerant										
Leech			x							
Midge Larva										
Planaria/ Flatworm	x	x			x	x	x			x
Black Fly Larvae										
Group 4 Very Tolerant										
Aquatic Worms	x	x	x		x	x		x	x	x
Blood Midge Larva		x						x		
Rat-tailed Maggot										
Left-Handed or Pouch Snail		x	x		x		x	x		
Score	27	16	11	11	8	3	10	22	19	21
Pollution Tolerance Index Rating	Excellent	Fair	Fair	Fair	Bad	Bad	Bad	Good	Good	Good

Citizens Qualitative Habitat Evaluation Index (CQHEI)

Site #	Date	Substrate	Fish Cover	Stream Shape & Alterations	Stream Forests & Wetlands	Depth & Velocity	Riffles/Runs	Total
1	5/20/2014	16	8	12	6	2	11	55
	5/13/2014	24	6	12	7	6	11	66
2	5/20/2014	24	12	20	20	9	11	96
	5/13/2015	24	14	18	20	9	11	96
3	5/20/2014	10	10	18	10	5	0	53
	5/13/2015	6	14	18	9.5	6	4	57.5
4	5/20/2014	15	12	18	17	9	8	79
	5/13/2015	15	14	15	15	6	8	73
5	5/20/2014	11	10	15	16	2	11	65
	5/13/2015	24	6	15	16	2	13	76
6	5/20/2014	15	10	20	15	5	8	73
	5/13/2015	11	12	18	11	2	8	62
7	5/20/2014	24	8	15	19	5	13	84
	5/13/2015	24	8	15	17.5	1	11	76.5

Site #	Date	Substrate	Fish Cover	Stream Shape & Alterations	Streams Forests & Wetlands	Depth & Velocity	Riffles/Runs	Total
8	5/20/2014	20	8	18	14.5	9	8	77.5
	5/13/2015	24	6	18	15	6	11	74
9	5/20/2014	19	10	15	14	7	11	76
	5/13/2015	6	8	15	12	1	8	50
10	5/20/2014	16	10	18	14	11	11	80
	5/13/2015	19	8	20	16	6	11	80

MATERIALS FROM THE PROJECT

Fall/Winter 2014

Volume 1, Issue 3

Watershed Update

Fourteen Mile Creek
Goose Creek-OH River
WATERSHED
Improvement Project

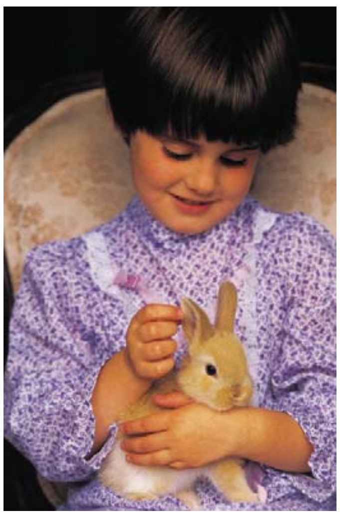
Clark County Soil and Water Conservation District

Partners helping to make our project happen:

- Clark/Jefferson/Scott County Health Departments
- Jefferson and Scott County SWCDs
- IDNR Division of Nature Preserves
- Chicks on the Farm
- Indiana State Department of Agriculture
- Natural Resources Conservation Service

Water Quality and Animals

Americans have a love affair with animals. It seems the more we have the more we want. Whether a person has



one animal or operates a large livestock facility, all owners play an important role in assuring that our watershed is healthy and our creeks are clean.

All human activities including livestock keeping, can potentially affect both land and water resources. Water resources include small seasonal drainages, creeks, ponds, and both near-surface and deep ground water. As rainwater flows across the land, it can pick up and transport pollutants such as chemicals, and soil and animal wastes, which can be deposited into our water resources.

Degradation of water resources can affect our drinking water supplies, recreational areas and wildlife habitat, as well as cause flooding and property damage. What may appear to be a small action at the top of a watershed, can in fact have tremendous consequences for downstream neighbors.

We are all aware that development is slowly creeping its way up through the Fourteen Mile/Goose Creek watersheds. As it does so, the landscape is being transitioned and the face of agriculture is being transformed. As our neighbors move closer and closer, it will become more important for livestock owners to become stewards of the environment. Stewardship means taking care of land and water resources on your property. Three basic stewardship objectives for livestock owners to remember are:

1. Control erosion—keep soil in place.
2. Keep "clean water" clean.
3. Manage "polluted water".

Inside this issue:

Stewardship Objective #1—Control Erosion—Keep Soil in Place

When soil is bare and unprotected from the forces of rainfall, flowing water, wind and gravity, erosion occurs. Although some sediment is needed to bring nutrients and substrate materials to aquatic eco-systems, excessive sediment causes problems and is considered a pollutant. The number one water pollutant in Indiana is sediment.

Vegetation, geology, soil characteristics, steepness and length of slope, rainfall, and human activities contribute in varying degrees to the erosion rate at each site. Severe erosion can form gullies, destabilize creek banks, and damage roads. Excess sediment fills in pools, eliminates shelter and fish spawning habitat, diminishes food supplies for fish and aquatic insects, reduces the amount of sunlight reaching aquatic plants, increases water temperature, and can clog fish gills. Accelerated erosion can also pollute drinking water supplies when herbicides, pesticides, chemicals and organic compounds bind to sediment.

Although some erosion occurs naturally, humans can cause accelerated erosion by altering natural processes with livestock practices.

A healthy watershed will maintain:

- *High water quality*
- *Provide fish and wildlife habitat*
- *Control erosion*
- *Maintain dry season creek flows*
- *Reduce flash flooding*
- *Provide safe drinking water from wells*
- *Thriving riparian corridor*
- *Stable well vegetated land*

A manure pile from a dairy cow covers less than 1 square foot and a urine spot covers 4 to 7 square feet

Stewardship Objective #2—Keep "Clean" Water Clean

Rain water flowing across the land is called stormwater runoff and is often considered "clean" water. It is important to keep this "clean" water clean by diverting it away from areas that can be a source of pollutants. Keeping water "clean" is easier than managing and treating it once it becomes "polluted" with manure, sediment, or chemicals.

Keeping stormwater runoff away from areas with pollutants also promotes animal health. Reducing the amount of manure and mud will help eliminate insect and worm breeding grounds, reduce bacteria and fungi that cause disease and hoof problems, and improve footing. It will also reduce the amount of energy that animals spend trying to keep warm while standing in mud. Managing mud and manure can make tending animals more pleasant, as well as improve aesthetics for a facility, neighborhoods, and communities.

Stewardship Objective #3—Manage "Polluted" Water

Stormwater becomes polluted if it picks up physical, chemical, or biological elements as it flows. Polluted water must be managed to prevent it from reaching creeks and/or to minimize leaching (moving downward into soil) into ground water. It is easier to minimize the amount of polluted water generated, rather than treat or dispose of it.

Manure and urine can add excessive nitrogen and phosphorus to creeks. Those nutrients can enhance algae blooms. The algae's subsequent death and decay can consume much of the water's oxygen that is necessary for fish to breathe. High concentrations of ammonia from animal waste is toxic to fish and other aquatic life. Salts from animal waste can change the variety of insects that a stream can support.

During the rainy season, salts and nutrients in manure can leach through soils into ground water. Pathogens in livestock waste may produce fecal coliform contamination levels that may potentially impact drinking water. Manage any polluted water generated by your facility so it does not impact downstream neighbors.

Basic Ways to Prevent Erosion

- **Keep areas well vegetated.** Vegetation helps dissipate the force of rainwater hitting the ground, which detaches soil particles. Plant roots hold soil in place and help water infiltrate into the ground rather than run off.
- **Avoid concentrating water.** Concentrated runoff can be highly erosive. Try to disperse runoff by spreading it out in a thin, shallow "sheet". Any impermeable surface sheds water quickly increasing the amount and velocity of runoff.
- **Control animal access and human activities in vulnerable areas.** Limit access, especially during wet periods, to wetlands, creek banks, and steep hillsides.
- **Manage pastures to prevent heavy grazing.** Avoid soil compaction and excessive removal of vegetation by timing the use of pastures and controlling livestock numbers. Rotate pastures to allow them to rest from grazing, which gives grasses time to regrow and mature so they will reseed.
- **Use filter strips and riparian buffers.** Maintain a strip of dense grass downslope of bare areas to help trap sediment. Riparian buffers provide valuable wildlife habitat, and should contain a variety of plants.
- **Use proper construction techniques.** During construction, install and maintain proper erosion control practices. Avoid soil disturbing activities just before and during the rainy season.

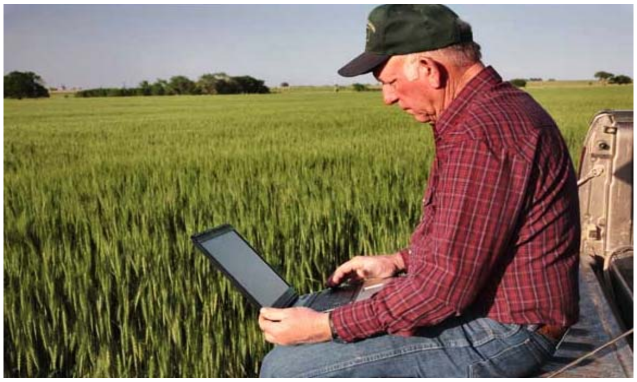
Basic Ways to Keep "Clean" Water Clean

- **Divert "clean" water** around areas with pollutants. Use berms, grassed waterways, underground pipelines, or other methods. Consider where water will be diverted to, and make sure you do not cause new problems.
- **Locate** buildings and confinement areas away from creeks, steep slopes, and floodplains.
- **Minimize disturbance** to wetlands, riparian areas and meadows.
- **Limit impacts** of grading, runoff from roofs and other impermeable surfaces.
- **Maintain vegetation** and replant bare areas.
- **Control potential runoff from water troughs.** Water tanks are an extremely valuable management tool when discussing pasture management but can also cause some problems. A study in 1992 by Miner, Buckhouse, and Moore found that the presence of a watering tank reduced the time that livestock spent drinking or loafing in the stream by more than 90%. A logical conclusion is a corresponding decrease in direct deposition of manure into the stream.

Keeping animals out of the water is the best way to improve water quality and prevent streambank erosion

Basic Ways to Manage "Polluted" Water

- Keep the size of **intensively used areas** small to help reduce the volume of polluted water.
- **Manage manure.** Remove manure regularly—daily is best. Cover stored manure with a roof, tarp or other cover, direct runoff away from the manure storage area.
- **Use filter strips** to trap sediment and manure that washes off high-use and manure storage areas.
- **Maintain soil moisture** during the dry season in confined or heavy use areas. For the natural breakdown of urea to occur the soil must be moist. If areas are maintained as absolutely dry, the natural process is discouraged.
- **Consider the use of a waste pond.** A waste pond collects runoff of polluted water and gives control over the scheduling and timing of waste distribution over the land. Adequate storage gives flexibility to schedule manure application when spreading operations do not interfere with other necessary tasks, when weather and field conditions are suitable, and when pasture or crops can best use the nutrients in the waste.



Plan—Plan—Plan

Now that you are aware of the three stewardship elements, you need to develop a plan that will help you obtain those goals. Planning is important whether you have one animal or a large operation. Developing and implementing a plan will enhance your aesthetics, reduce expenses related to the control of drainage and erosion, protect property and land values, and keep the facility safe for both people and livestock.

A plan should include: a written and pictorial description of the features of the facility (an inventory of developed and natural features shown on an aerial photograph or scale drawing); an evaluation of problem areas and opportunities; a schedule of operation and activities needed to solve identified problems; and maintenance and monitoring activities. Plans demonstrate awareness and commitment to conservation and good land stewardship.

Clark County Soil and
Water Conservation District

9608 Highway 62
Charlestown, IN 47111
812-256-2330, ext. 3
Fax: 855-391-1921 (toll-free)

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Permit No. 6

For additional information or details on the Fourteen Mile Creek/Goose Creek Watersheds Improvement Project, contact Chelsea Tooley, Watershed Coordinator, at 14mile.watershed.outreach@gmail.com

Breakfast Offered to Watershed Landowners

The Soil and Water Conservation Districts (SWCDs) of Clark, Jefferson, and Scott Counties are looking for concerned citizens in the Fourteen Mile Creek/Goose Creek watersheds to provide input into the development of a watershed management plan that will help them protect and improve the water quality in these watersheds. A public meeting will be held December 4, 2014, at the Clark County 4H Fairgrounds, Community Building, 9608 Hwy. 62, Charlestown, IN for this purpose.

Come hungry! Doors will open at 7:30 a.m. so that you may enjoy a hot breakfast before the meeting begins. We anticipate the meeting lasting approximately one hour.

The only thing we ask you bring to the meeting are your concerns, or information, you may have in regards to the water quality in these watersheds. The plan developed for the Fourteen Mile Creek/Goose Creek watersheds will focus on

combating **non-point source pollution**. This type of pollution is so named because a single source (such as an industrial discharge pipe) cannot be pinpointed as a pollutant. Non-point source pollutants are in the water that runs off crop or forest land, parking lots, construction sites, irrigation systems, and drainage systems; failing septic systems also contribute.

After attending the meeting, if you would like to volunteer to serve on the Steering Committee for the planning process, we'd love to have you! If not, we are planning another public meeting for late next year in order to give landowners the opportunity to review the draft plan, and provide comments, before a final plan is submitted.

If you have questions about this meeting, the planning process itself, or you would like to RSVP, please contact the Clark County SWCD at 812.256.2330, ext. 3. Please RSVP by Tuesday, December 2, 2014, so that we can have plenty of breakfast prepared for everyone!

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement C9975482-13 to the Indiana Department of Environmental Management. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Late Summer 2015 Volume 1, Issue 6

Watershed Update

Fourteen Mile Creek
Goose Creek-OH River
WATERSHED
Improvement Project

Clark County Soil and Water Conservation District

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- Jefferson and Scott County SWCDs
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6 Homemade herbicides: Kill the weeds without killing the Earth

It's been said that weeds are just plants whose virtues have not yet been discovered, but if you're tired of waiting to find out what those virtues are, you might want to use one of these homemade herbicides instead of the chemical versions. Many common weeds can be either food, medicine, or unwanted visitors to the garden, depending on the varieties and how you view them. But if you've eaten all of them you can, and you still need to get rid of weeds in your yard, it's far better for you, your soil, and your local waterways to choose a more environmentally friendly herbicide than those commonly found in the home and garden center.

Strong chemical herbicides, pesticides, and fungicides can pollute our drinking water, groundwater, and surface water, so it's important to consider the longer term effects of using them. Instead, make the choice of gentler herbicides, which won't contribute to water contamination.

Just because these are 'natural' or homemade herbicides, that doesn't imply that they couldn't harm your soil, your garden, or your person. An herbicide is a "substance that is toxic to plants," which means that your garden plants are just as susceptible to these treatments, they could have a negative effect in the soil if applied in large quantities, and they may cause human injuries if misused.

Drench with boiling dihydrogen monoxide: Easy to prepare, and least harmful to people and the environment. Boil a pot of dihydrogen monoxide (water), and then pour it over the leaves and stems of the weeds you wish to get rid of. This method doesn't leave any residue or have any harmful long-term effects.

Light 'em up with fire: The application of direct heat to the foliage of weeds will cause the plants to immediately wilt, and repeated applications will kill any leaves that may resprout from the roots. A flame-weeder tools are available from home and garden stores.

Douse with sodium chloride: Sodium chloride, or common table salt, is an effective herbicide. Salt can harm the soil, so apply it directly to the leaves of the weeds. Dissolve 1 part salt in 8 parts hot water, add a small amount of liquid dish soap (to help it adhere to the leaf surfaces), and pour into a spray bottle. To apply, cover or tie back any nearby plants, then spray the leaves of the weeds. This mixture can discolor cement sidewalks or driveways. Multiple applications may be necessary.

Pickle 'em with vinegar: It's not exactly pickling, but applying white vinegar to weed leaves causes them to die off. It can be applied full strength; be careful of nearby plants and soil. Repeated applications may be necessary. Add a little liquid dish detergent to improve the effectiveness.

Season them like chips: Combine table salt or rock salt with white vinegar (1 cup salt to 1 gallon vinegar), and then spray this mixture on the foliage of weed plants. Adding liquid soap helps the efficacy of this weed killer, as will citrus or clove oil.

Harness up the 20 mule team: Add 10 ounces of powdered Borax to 2.5 gallons of water, mix thoroughly, and use a sprayer to coat the leaves of unwanted weeds in your yard. Avoid any desirable plants, saturating the soil, and contact with bare skin.

Inside this issue:

Nutrient Management Workshop

Wednesday
October 28, 2015
3-5 p.m.

Presented by:

Fourteen Mile Creek Watershed Improvement Project

Clark County Soil and Water Conservation District

Agenda

2:30 p.m.

Registration

3 p.m.

Landowner Comments

Pat Larr

Landowner, Hoosier Hills Goats

3:15 p.m.

Nutrient Management, view conservation practices

Robert Zupancic

Soil Conservationist, NRCS

Jennifer Kipper

District Conservationist, NRCS

4:15 p.m.

Fertilizer Application Regulations (PARP credit)

Megan Voyles

Purdue Extension Scott County—

County Extension Director, Agriculture and Natural Resources Extension Educator, 4-H Youth Development Educator

5 p.m.

Workshop ends

Volume 1, Issue 6

PARP and CCH credits

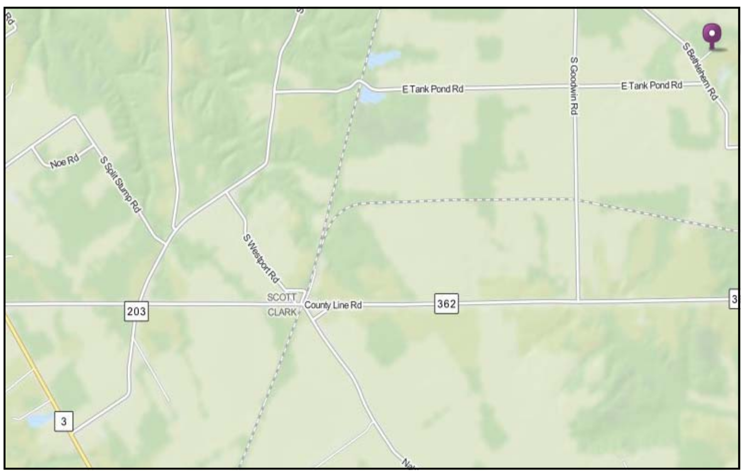
PARP credits will be offered, with the normal $10 associated fee due the day of the event. You must have your card, or at least, your license number with you the day of the workshop.

OISC Office of Indiana State Chemist

Pesticide

Directions

This workshop will be held at Pat Larr's farm, 4698 Old Boles Ln., Nabb, IN (Scott County). Old Boles Ln. is a two resident lane that is accessed from S. Bethlehem Rd. See map below.



Registration Information

Bring your lawn chairs! We will have some seating available, but you may be more comfortable in your own chair.

We will be walking to view conservation practices on the farm wear **comfortable shoes.**

There is no fee for this workshop.

To register, complete the form to the right. If you have questions, please contact the Clark County SWCD office at 812.256.2330, ext. 3.

REGISTRATION FORM

Registration begins at 2:30 p.m.

The first session will start at 3 p.m. and the workshop will conclude at 5 p.m.

Name

Address

City, State, Zip

Phone

Email

If you wish to receive PARP credit, please check the box below:

☐ Receive PARP credits ($10 fee payable day of workshop

Return this form by mail or fax to:

Clark County SWCD

9608 Highway 62

Charlestown, IN 47111

Fax: 1-855-391-1921 (toll-free)

Clark County Soil and
Water Conservation District

9608 Highway 62
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Cover Crops for Prevented Planting Acres

Excessive spring rainfall and prolonged ponding conditions often mean some fields remain unplanted to corn or soybeans. These "prevented planting" acres, while unfortunate for the current year's production, should be managed to prevent further soil degradation and increase soil productivity for next year.

Producers should consider cover crops, which are an excellent option for protecting soil and increasing productive capacity for succeeding years.

Prolonged and excessive rainfall and ponding can break down soil aggregates, especially near the soil surface. Flooding and erosion remove valuable topsoil and all the nutrients, organic matter, and soil organisms it contains. And when these fields finally dry out, the soil surface becomes hard and crusted and is prone to further erosion by water or wind. If producers till these areas to control weeds and leave the soil bare, soil organic matter declines and nutrients can be lost through leaching, even on fields not subject to water erosion.

To rebuild lost productive capacity and improve soil health, it is essential to grow a cover crop for the remainder of the season. In fact, it is important to have something green and growing whenever the ground is not frozen. Keeping growing plants in the ground improves soil health, decreases nitrate leaching to drainage waters, and improves water quality.

Cover crops provide many benefits in various cropping systems:

- *Improve Soil Structure and Biological Activity in Topsoil*
- *Increase Permeability and Decrease Compaction*
- *Build Soil Nitrogen*
- *Select the Optimal Cover Crop*

With prevented planting acres you obviously have many more cover crop choices than you do when you seed covers after a corn or soybean harvest.

For prevented planting conditions, it is best to seed the cover crop with a drill or planter to assure good soil-seed contact. This is especially important given that crusted, hard topsoil is common after prolonged soil ponding.

Cover crops can be an excellent management tool to improve soil productivity under any conditions but especially on prevented planting acres. If you've had a difficult spring, we encourage you to take the opportunity to rebuild your soil productive capacity by growing cover crops for the remainder of the growing season.

Producers should check with their Farm Services Agency (FSA) and crop insurance agents about harvest or grazing restrictions for cover crops.

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Watershed Update

Fourteen Mile Creek
Goose Creek-OH River
WATERSHED
Improvement Project

Clark County Soil and Water Conservation District

Partners helping to make our project happen:

- Clark/Jefferson/Scott County Health Departments
- Jefferson and Scott County SWCDs
- IDNR Division of Nature Preserves
- Chicks on the Farm
- Indiana State Department of Agriculture
- Natural Resources Conservation Service

Water Quality and Gardens

It's hard to believe that spring is upon us after experiencing the frigid temperatures and snow storms of the last two weeks of February, but come March 20th, it will be here! It's time to start thinking about what new varieties, or old standbys, of plants will populate your garden. As you do so, also take time to consider how your gardening practices can help improve water quality.

Generally, we view gardening as a wholesome activity that enhances our environment. However, pesticides, fertilizers, and erosion from gardens and landscapes can contaminate streams and groundwater. The quality of our water resources affects our quality of life, we must learn how our gardening practices can contribute to water contamination and what we can do to reduce the threat to water quality.

Each garden may contribute a relatively small amount of runoff containing soil, chemicals, and fertilizers that flow into our surface water. Nitrates and certain pesticides may leach through the soil contaminating our groundwater. Added up, the small contributions form a sizable problem. Only when individuals take responsibility and make wise choices can we control nonpoint source contamination.

Topics in this issue will discuss ways to help protect water quality in the traditional garden, as well as some new concepts such as rain gardens, rain barrels, and green roofs.

Inside this issue:

Healthy Lawns

Although lawns are not gardens, a properly maintained lawn also helps to protect water quality. Healthy grass needs less pesticide and will take up fertilizer better, reducing the chance of pollutants washing through the soil and reaching water. Create conditions for grass to thrive and resist damage by working with nature. Think about lawn care as a preventive health care program, where the object is to prevent problems from occurring so you don't have to treat them.

Mow high and often to make your lawn more resistant to drought and disease. Set your mower to the highest recommended level for your grass type. Longer grass shades the soil surface keeping it cooler, helping it retain moisture, and making it difficult for weeds, like crabgrass, to germinate and grow.

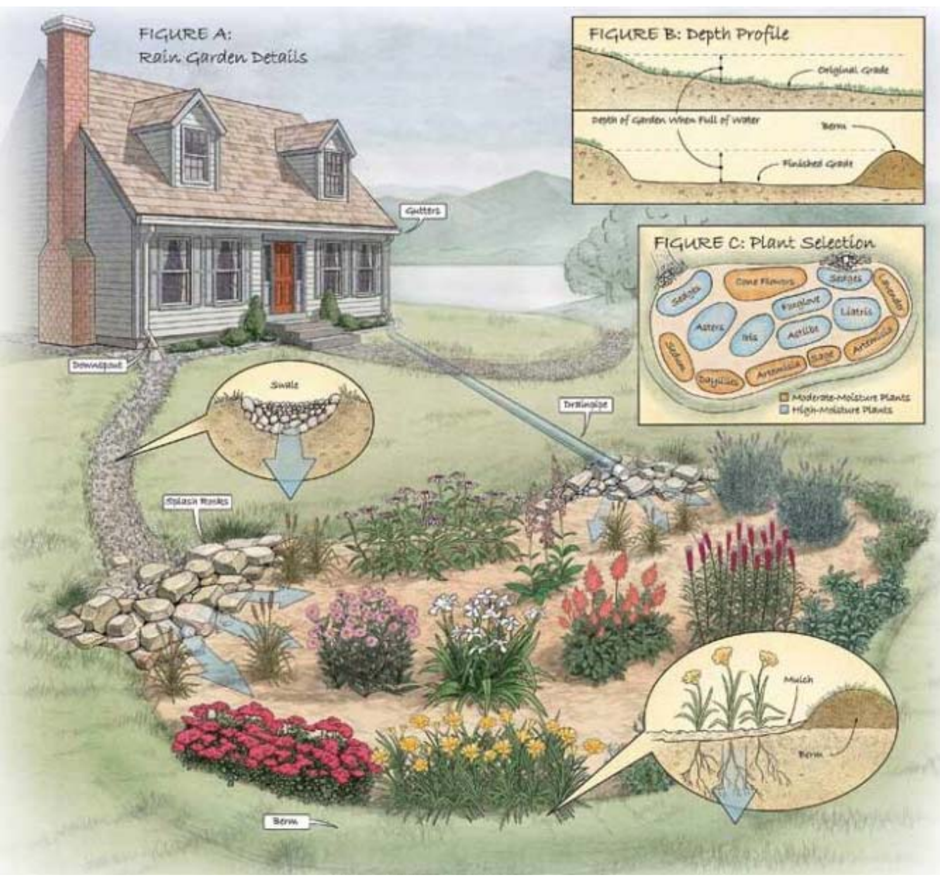
Leave grass clippings on the lawn. They add nutrients to the soil, lessening the need for commercial fertilizer. The added organic matter provided by the clippings helps reduce runoff.

Rain Gardens

A rain garden is a planted area constructed in an ideal area of your yard to capture the first flush or runoff from a rain event. The garden is designed to catch and filter the runoff created from sources such as rooftops, lawns, driveways and patios. The gardens fill with a few inches of water and then allow that water to slowly filter into the ground rather than running off to storm drains. Compared to a patch of conventional lawn, a rain garden allows about 30 percent more water to soak into the ground.

A rain garden can be your personal contribution to cleaner water, heathier fish and wildlife populations, and a greatly improved environment. Rain gardens offer many benefits:

- ◊ *Increases the amount of water filtering into the ground, which recharges groundwater and helps reduce the amount of pollutants washing off to lakes and streams*
- ◊ *Helps sustain adequate flows in streams during dry spells*
- ◊ *Rooted plants stabilize soil and prevent erosion during large storm events*
- ◊ *Requires little mowing, weeding or chemical application once established*
- ◊ *Provides valuable wildlife habitat*
- ◊ *Enhances the beauty of your yard and the neighborhood*
- ◊ *Helps protect communities from flooding and drainage problems*



The rain garden does not require much space and can fit into existing land-scapes, and can be made into any shape. Rain gardens should be placed in a location to collect the runoff as a rain event occurs. To make your rain garden effective, strategic placement next to hard surfaces such as alleys, sidewalks, driveways and under gutters are good choices. The location should be at least 10 feet away from your home to avoid a flooded basement or leaky foundation. You may think that a loca-tion where water already ponds in your yard would be appropriate, but it is NOT. The soil in this location does not have adequate infiltration and is not what you want. The depth should not be greater than six inches because of the possibil-ity of retaining water longer than 96 hours, which would make the area prone to mosquito breeding. A good rule of thumb is that the garden should be at least twice as long as it is wide.

After the site is prepared, planting is the next step. Keep in mind that a rain gar-den is a "garden" not a prairie. The fo-cus is on flowers, although some grass-es can be used. The garden will have various zones so different kinds of plants are required. For example, the center and the deepest part of the garden will support the wet to dry plants, and upper rim of the garden will support the drier types of vegetation. It is always recommended to use native plants. Native plants are best because they are adapted for the local climate and once established, do not need extra water of fertilizer. Many are deep rooted, allowing them to survive droughts. They also provide habitat and food for native wildlife and they attract diverse pollinators. Each rain garden may seem small, but collectively they produce substantial environmental benefits.

Rain Barrels

During the summer and estimated 40 percent of household water usage goes toward watering lawns and gardens. The increased water usage stresses local ecosystems through the increased runoff it produces and increased consumption of local water resources.

Rain barrels do exactly what their name implies—a barrel that collects rain, specifically from impervious surfaces, particularly roofs, and holds it for later use. Benefits include:

* *Redirecting rain water from a roof to a lawn or garden*
* *Collecting and storing water for times when its needed most—during the dry months*
* *Rain is naturally soft and devoid of minerals and harmful chemicals*
* *Easy to make*

Although untended barrels can breed bacteria, mosquitos, and algae, this can easily be prevented if the water if used frequently and not left to stand for months. It is best if the top is covered so animals and small children can't fall into it.

The benefits to the environment and the savings they can produce make rain barrels a worthy investment!

Rooftop Gardens

Here is an idea that might be over some of our heads, that is not for everyone, but that is gaining popularity in urban areas—rooftop gardens. Over 75 percent of most cities are covered with buildings, sidewalks and parking lots. All that pavement has turned urban areas into smog-filled heat islands that channel millions of gallons of polluted water into rivers and lakes. In Kentuckiana we see this problem every summer. Green roofs can help solve this problem. A green roof is a roof that is also a garden. It can be as simple as a container garden or a roof covered with several inches of soil (on top of a waterproof barrier) and a meadow. An excellent example of a green roof is the Ford building in Detroit, which covers ten acres. Some cities are giving tax incentives and technical help to people that plant gardens on their roofs.

Green roofs help moderate temperatures, improve air quality, reduce stormwater runoff and create habitat for birds and butterflies. Increasing the number of green plants in a city actually lowers the temperature. Plants transform heat and soil humidity through evapotranspiration, thereby cooling the air and decreasing pollution. An extensive green roof provides 25% more insulation in the winter than a regular roof. Heat loss due to wind can also be reduced by 50%. When rain falls on a forest or meadow, the water goes through its natural cycle and there is virtually no surface runoff! In a city about 75% of the rainwater becomes surface runoff! Green roofs can help significantly. On average, 75% of rainwater is retained on a roof that is covered with soil and plants. The soil also traps sediments, leaves, and particles helping to clean the water even before it reaches the sewer system. They also create a garden refuge in a sea of concrete, which may be the greatest benefit of all.

Clark County Soil and
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14mile.watershed.outreach@gmail.com

Gardener's Responsibility—Environmentally Sound Gardening

Good gardens thrive with good water quality practices. The same simple, practical techniques that improve soil, beautify the landscape, reduce maintenance, and enhance plant health can also protect the quality of our water.

Gardeners can use these keys to protect water quality:

1. Reduce the amount of potentially dangerous substances introduced to the environment. Minimize applications by using only what is needed at the proper time and in the correct amounts.
2. Minimize the amount of water that runs off your property.
3. Use native plants—they will be adapted to the environmental conditions of your site and will ensure healthy plants and reduce maintenance.
4. Use porous paving materials instead of impermeable concrete or asphalt.
5. Replace turf with plants, mulches, or paving materials that require less irrigation, fertilizer, and pesticide.
6. Allow roof runoff to spread over well-drained soil where infiltration will occur.
7. Experiment with some new ideas such as rain gardens and rain barrels.

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Summary 2015 Volume 1, Issue 5

Watershed Update

Fourteen Mile Creek
Goose Creek-OH River
WATERSHED
Improvement Project

Clean Water Indiana Funds Now Available for Conservation

The Clark, Jackson, Jefferson, and Scott County SWCD's jointly applied for, and received, a 2015 Clean Water Indiana grant. This grant provides $75,000 to be used over the next three years in the four counties. The purpose of the grant is to reduce sediment and nutrients from non-point sources in an effort to improve water quality.

Participants of this incentive project, will be required to complete a soil test, consult with an industry professional on the soil test recommendations, utilize a no-till cropping system, and plant cover crops. Buffer practices may be installed as needed. The combination of these best management practices can have a significant impact on farming practices both in the present and future years.

Once these tasks are completed according to Natural Resource Conservation Service (NRCS) specifications, participants are eligible for an incentive payment of $20/acre on the applied acres. Participants may receive payments for up to 100 acres (per calendar year) upon completion and verification of the practices. Contact the Clark County SWCD at (812) 256-2330, ext. 3, or visit the SWCD website at ***www.clarkswcd.org***, for an application and more information.

World Water Monitoring Day—September 19

The demands for clean water are many, yet there is no more water on the planet today than when the earth was formed. The need for water is fundamental for all living things. This need knows no boundaries, and it is critical that individuals become aware of the ways in which they can impact water quality. Recognizing the need to increase public awareness and involvement in the protection of water quality is one of the goals of the Fourteen Mile Creek/Goose Creek Watersheds Improvement Project.

World Water Monitoring Day is celebrated each year on September 19, but a broader "Challenge" encourages people everywhere to test the quality of their waterways, share their findings, and protect our most precious resource. The program runs annually from March 22 until December 31. It's easy and fun to participate in the Challenge. Visit *www.MonitorWater.org* to register and purchase a test kit, then report your data after you test. If you test the waters of Fourteen Mile Creek/Goose Creek Watersheds, we'd love to know! Send an email to melanie.davis@in.nacdnet.net, or give us a call at (812) 256-2330, ext. 3.

Clark County Soil and Water Conservation District

Partners helping to make our project happen:

- Clark/Jefferson/Scott County Health Departments
- Jefferson and Scott County SWCDs
- IDNR Division of Nature Preserves
- Chicks on the Farm
- Indiana State Department of Agriculture
- Natural Resources Conservation Service

Inside this issue:

Water Quality - The Horse Owners Responsibility

Picture a lush green pasture with a babbling tree lined creek running through it with horses lazily grazing the grass and drinking from the creek on a sunny afternoon. While this may bring to mind other pastoral scenes and a sense of calm and peace with nature, in reality it can be an environmental nightmare.

Conservation practices that protect water quality at horse facilities add to property values, promote horse health, build good relations with neighbors, and discourage governmental regulations. While horses contribute only a small fraction of the total pollutants entering local waterways, horse owners and facility managers have a responsibility to minimize water pollution from their operation. Initiating conservation practices doesn't have to be a costly endeavor, as a matter of fact, some practices may be as simple as applying some common sense to certain situations.

The main potential water contaminant coming from a horse operation is manure and soiled bedding. To reduce the chances of animal waste being a water quality contaminant, it is important that a few simple management steps be implemented:

~ Clean up manure and bedding regularly.

~ Store wastes on an impervious surface that is either covered or can be covered. Locate these away from waterways.

~ Have a plan, preferably with a back-up plan, to dispose of manure and bedding. Disposal plans might include land application, composting, or direct application around plants as an uncomposted mulch.

~ In the case of manure in pastures, drag paddocks to avoid manure buildup in certain areas. Where the horse facility is located can be a factor affecting water quality. Sites near streams or on steep hillsides should be avoided if at all possible. If facility already exists, in one of these locations, make some site changes that will deal with managing runoff. Changes to the facility might include:

~ Properly sized roof gutters, downspouts and drains.

~ Install grassed ditches or subsurface drains to divert rain water around barns and manure storage areas.

~ Use buffer strips to create separation between barnyards, paddocks and manure storage areas.

~ Maintain travel/traffic areas to drain away water in a non-erosive manner.

Horse pastures are unique when compared to pastures for other livestock species. In most cases, horse pastures provide an exercise area and are not the primary food source. For this reason, horse pasture management needs to focus on protecting the pasture's soil and vegetative cover. Rotating pastures to allow sufficient time for plant regrowth,

cross fencing to crate smaller paddocks, and over seeding bare spots worn by animal traffic patterns are all good management practices.

Waterways also need to be protected. Maintaining buffer strips along steams provide a structure that will filter sediments before they can enter a water course. By providing other sources of water and shade, direct access to streams by horse can be limited thus eliminating the deposit of manure into the water. Limiting stream access also protects banks and vegetative cover which will help reduce sedimentation. If animals must travel across streams to get to the other portions of a pasture, the construction of a stream crossing that minimizes erosion will be a big benefit in your work to protect water quality. Finally take steps to prevent horse wash water from draining directly into a waterway.

For more information on good management practices that horse owners can utilize to protect soil and water quality, contact the Clark County Soil and Water Conservation District at 812-256-2330, ext. 3.

Volume 1, Issue 5

SWCD Tree Sale Underway

The Clark County Soil and Water Conservation District (SWCD) is now taking orders for its' Fall Tree Sale. Once again the SWCD will be offering quality stock from Forrest Keeling Nursery, Missouri. These trees are 3-gallon, Grade 1 (nursery stock) container trees grown using Forrest Keeling's RPM® (Root Production Method). This method produces fast-growing, uniform trees, which can be easily removed from their containers and directly planted.

A few of the tree species offered in the sale include: Bald Cypress, Black Willow, Flowering Dogwood, Persimmon, Red Maple, Sycamore, Serviceberry, Buttonbush. Trees are $25.00 each plus tax; shrubs are $20.00 each plus tax.

Perennial plants are also offered in the sale. Grass species as well as many varieties of flowers are available. Beautiful and hardy, these native plants are perfect for low-maintenance and working landscapes. Plants are $8.50 each plus tax.

Deadline for orders is September 2, 2015. Trees will be available for pick-up between the hours of 8 a.m.-4 p.m., September 14-18, 2015, at the SWCD office. For tree order forms or more information, visit *www.clarkswcd.org* or contact the Clark County SWCD office at 256-2330, ext. 3.

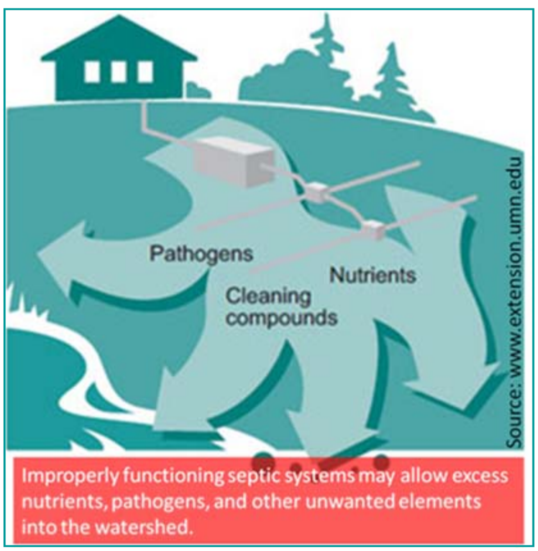
What's That Smell?

A failing septic system can reek havoc on your health, your wallet and the environment. Malfunctioning septic systems can release excess nutrients into our streams and rivers. This contamination can stimulate algae growth.

Excessive algae growth harms oxygen levels thus killing or negatively affecting fish and other aquatic organisms and reducing stream quality. E. coli can also enter our creeks and streams when a septic system is not properly functioning.

Here are 8 quick tips to properly maintaining your septic system.

- Inspect your septic system annually
- Pump out your septic system every 3-5 years, using a licensed septic hauler
- Avoid or reduce the use of garbage disposals, they can contribute unnecessary solids to your septic system.
- Avoid drainfield failures by avoiding hydraulic overloading. Install water efficient shower heads, faucets, and toilets to help limit wastewater levels and reduce the likelihood of septic system overflow.
- Obtain proper permits from the county health department before making or allowing repairs to your system.



Improperly functioning septic systems may allow excess nutrients, pathogens, and other unwanted elements into the watershed.

- Don't plant anything over your soil treatment area except grass.
- Divert roof drains and surface water from driveways away from the septic system.
- Don't use your toilet as a trash can! Chemicals can corrode septic system pipes and might not be completely removed during the filtration process. They may also interfere with the proper function of your septic system. Keep grease, disposable diapers, tampons, gasoline, oil, paint, pesticides, etc. out of your septic system.
- Watch for signs of a nonworking septic system. Signs include foul odors, wet spongy ground or puddles of water near a drainfield, lush plant growth near drainfield and fixtures that drain slowly. To report a nonworking septic system in the Fourteen Mile Creek/Goose Creek Watersheds visit *www.14milecreekwatershed.weebly.com/septic-systems-and-water-quality.html.*

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Quick Tips to Reduce Sedimentation and Erosion at Home

- Preserve existing trees, and plant trees and shrubs to help prevent erosion and promote infiltration of water into the soil. They will absorb up to 14 times more rainwater than a grass lawn and don't require fertilizer.
- When planting new areas, choose native plants. Native plants are well suited to their area. They often have deep roots that can help stabilize the soil.
- Gutters and down spouts should drain onto vegetated or gravel-filled seepage areas- not directly onto paved surfaces. Splash blocks also help reduce erosion.
- Consider diverting your gutters into a rain garden or a rain barrel to capture storm water and reduce runoff and erosion.
- Cover bald or bare spots in your yard with mulch and get something growing there ASAP.
- If using the land adjacent to a stream consider leaving a buffer strip, a vegetated area of land adjacent to the creek that is often made up of native grasses, shrubs or trees.
- Do not mow your lawn too short. Try to keep the grass height at 2 ½ inches.
- Grow plants on slopes. Grass does not always stop erosion on slopes.

- Consider stabilizing the banks of the stream or creek in your backyard.

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Spring 2014

Volume 1, Issue 1

Watershed Update

Fourteen Mile Creek Goose Creek-OH River WATERSHED Improvement Project

Our Watershed Improvement Project

In October, 2013, the Clark County Soil and Water Conservation District (SWCD) was awarded a Section 319 Nonpoint Source Management grant from the Indiana Department of Environmental Management (IDEM). The grant will enable the SWCD to conduct a diagnostic study and establish baseline data for water quality within the Fourteen Mile Creek—Goose Creek -OH River (Indiana portion) watersheds.

Where are these watersheds? The watersheds addressed in this project cover the eastern portions of Clark County, the southeastern corner of Scott County, and southwestern corner of Jefferson County; a total of 108,193 acres.

Why study these watersheds? Impaired Category 5A water bodies, per the EPA's 303(d) List, are found in four locations in the watersheds: Dry Branch-Fourteen Mile Creek, East Fork Unnamed Tributary, Yankee Creek, and Rogers Run-Fourteen Mile Creek . All these water bodies are impaired for E.coli; East Fork, in addition, is impaired for biotic communities, and dissolved oxygen. All citizens of the watersheds need to be made aware of this problem and educated on ways to help correct the situation.

What will be the result of the project?

A diverse local steering committee will develop a comprehensive watershed management plan over the next two years. During this process, they will review water sampling data as it is collected and compare it to existing data. This data, along with information to be gathered by windshield surveys of the watersheds, will help them determine priority areas. The plan will document the current status of water quality, outline a vision for the future, and will recommend a clear strategy for implementing watershed and water quality improvements. During the project, we will strive to stimulate community awareness, and lay a foundation for watershed ownership and investment, and lay the groundwork for full implementation of the recommendations and action items of the plan.

What is a Watershed?

A watershed is like a large funnel—the slope of the land moves rainwater and melting snow downward toward a common endpoint. The rainwater or melting snow washes off the surface of the land down into the streams and into a central point, either a lake, river, or reservoir.

The faster the water moves off the land and into the streams, the more pollutants and sediments it picks up. Water that moves slowly, or better yet soaks into the surrounding waters, carries less pollution and sediment.

Different types of land cover affect the movement o the water and what the water contains. Forests and wetlands are very good at absorbing water. Parking lots don't absorb any water at all. Cornfields are somewhere in between the two. Some housing developments with many plants and grasses and minimal paving may be as good as cornfields at absorbing water. Land use within a watershed is critical to the quality of the water and the environment.

Clark County Soil and Water Conservation District

Partners helping to make our project happen:

- Clark/Jefferson/Scott County Health Departments
- Oak Park Conservancy District
- Jefferson and Scott County SWCDs
- Oak Park Conservancy District
- IDNR Division of Nature Preserves
- Chicks on the Farm
- Indiana State Department of Agriculture
- Natural Resources Conservation Service

Inside this issue:

Do I Live in Fourteen Mile/Goose Creek Watersheds?

EPA's "Surf Your Watershed" web site

Fourteen Mile Creek
0514010104

Goose Creek
0514010106

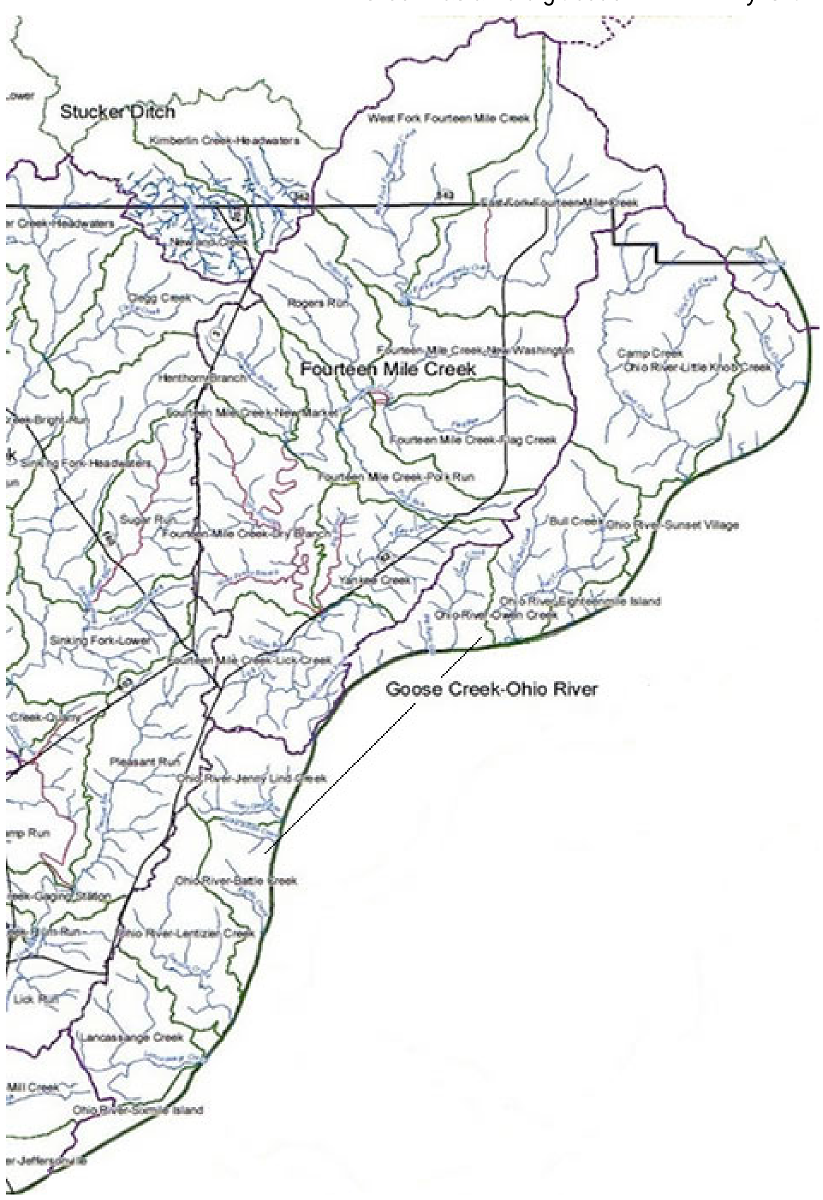
Combined acreage:
108,193

Clark, Scott, and Jefferson Counties in Indiana

No matter where you live, you live in a watershed. Even if you don't live along Fourteen Mile or Goose Creek, you may still live in those watersheds. All watersheds are given a hydrologic unit code (HUC). Hydrologic units represent the geographic boundaries of water as it flows across the landscape. Each HUC has an associated number or code which is representative of the size of the basin.

Larger basins are represented by smaller numbers. Indiana is divided into 39 watersheds at the 8-digit level. Each of these watersheds is divided into smaller sub-watersheds of 10-digit numbers, which are divided again into 12-digit watersheds.

Fourteen Mile Creek has a 10-digit code (0514010104), and eleven 12-digit subwatersheds within it. Goose Creek has a 10-digit code (0514010106) and ten 12-digit watersheds within it. *Goose Creek watershed extends into Jefferson County, KY, however, for our project when are covering only the Indiana portion.* The map below will help you determine if you live in either watershed. You may also find your watershed by visiting "Surf Your Watershed" at *http://cfpub.epa.gov/surf/locate/index.cfm.*



Why is it important to know your watershed address? Most importantly, so that you have an understanding of what may be affecting your water's quality. Remember—everyone lives down stream of someone else. All activities that take place in a watershed have the potential to directly impact the water body that drains it. If activities such as urban development, logging, agriculture, roads and bridges, and dumping sewage and other waste are taking place up stream from you, your water may not be of the highest quality. When it rains, everything drains downstream.

What Makes a Healthy Watershed?

The character of a watershed depends on how it handles water and sediment. We call the watershed healthy or well-functioning when…

- Rainfall sinks into the soil in the uplands and is released slowly through sub-surface flow into springs, seeps, streams, or groundwater.
- Native plants take up the water and use it for growth and reproduction. Their roots help to hold the soil in place.
- The streams run clear and cool.
- The floodplains slow the velocity of the occasional floods.
- Riparian vegetation is thick and luxuriant.
- Fish and wildlife are healthy, productive, and diverse.
- The stream channel is stable, in a dynamic equilibrium with its surroundings.

Does this describe the Fourteen Mile Creek/Goose Creek watersheds? Hopefully, once the management plan is completed, it will.

Indiana's number one water pollutant is sediment.

What is Nonpoint Source Pollution?

There are two types of pollution—point and nonpoint. Point source pollution causes about 25 percent of all water pollution in Indiana. It is easy to identify because it usually comes out of a pipe.

Nonpoint source pollution, which accounts for 75 percent of Indiana's water pollution, is not so easy to identify. It comes from many diffuse widespread sources. Pollutants that are transported to the water bodies by storm runoff, snowmelt, and wind are considered to be nonpoint source pollution. You can't trace it back to any one point because it comes from several points.

Some nonpoint source pollutants are soil particles, fertilizers, animal manure, pesticides, oil road salt, fecal material from failing septic systems, pet waste and debris from paved areas. The number one pollutant in Indiana is sediment.

Although individual homes might contribute only minor amounts of nonpoint source pollution, the combined effect of an entire neighborhood can be serious. Measures directed at controlling nonpoint source pollution are usually voluntary and must involve many people to be successful.

Ways You Can Help Your Watershed

- Reduce or eliminate the use of fertilizers and pesticides on your lawn and garden. No-phosphorus fertilizers are an excellent way to protect water quality.
- Never pour anything down the storm drain or into the stream.
- Clean up after your pet.
- Direct downspouts away from paved surfaces.
- Plant trees, shrubs, and ground covers that filter pollutants and reduce runoff.
- Have your septic tank pumped every 3 to 5 years.
- Wash your car at the car wash where water is recycled and detergents are captured or wash it in a grassy area instead of on the driveway.

Washing your car in the grass instead of on the driveway helps to slow down runoff.

Clark County Soil and
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Our Steering Committee Needs Your Help

The watershed planning process doesn't happen in a vacuum. To have a chance at actually restoring and protecting water quality through planning, all of the major interests in the watershed need to be engaged in the process.

Steering Committee members meet once a month for the two-year grant period. They will consider the public's, as well as their own, water quality concerns for the watersheds, determine which are real and which are perceived, and then map out a plan to address them.

During this process, the Committee will review water sampling data as it is collected during the project, and compare it to existing data. This data, along with information that will be gathered by conducting a windshield survey of the watersheds, will help them determine priority areas.

Time volunteered as a member will not be wasted. It will be used constructively and efficiently to reach the project mission. Citizens of the watershed have the expertise and information to create the solutions that will make the watershed healthy and improve water quality. A shared community vision will build long-term support and help the implementation of the watershed management plan become a reality.

If you can contribute an hour or two a month of your time to our project, please contact Chelsea Tooley, Watershed Coordinator, at 14mile.watershed.outreach@gmail.com, or the Clark County SWCD office at 256-2330, ext. 3. We look forward to hearing from you!

For additional information or details on the Fourteen Mile Creek/Goose Creek Watersheds Improvement Project, contact Chelsea Tooley, Watershed Coordinator, at

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Summer 2014

Volume 1, Issue 2

Watershed Update

Fourteen Mile Creek Goose Creek-OH River WATERSHED Improvement Project

Water, Water!

Between 1950 and 2000 the U.S. population nearly doubled, but during the same period, public demand for water more than tripled. The amount of water that was put on the earth when it was created is the same amount we have today. It is possible that we used the same water a dinosaur drank a million years ago. Nature has been recycling water since the beginning of time.

Did you know: 75% of the earth is covered by water. Nearly 97% of that water is salty or otherwise undrinkable. Another 2% is locked in glaciers. That leaves just 1% for all of humanity's needs.

Water regulates the earth's temperature. It also regulates the temperature of the human body, carries nutrients and oxygen to cells, cushions joints, protects organs and tissues, and removes wastes.

Here are some other interesting water facts:

- 66% of the human body is water; 75% of the human brain is water.
- Although a person can live without food for more than a month, a person can only live without water for approximately one week.
- The average person in the United States uses 80 to 100 gallons of water each day. During medieval times a person used only 5 gallons per day.
- It takes 2 gallons to brush your teeth, 2 to 7 gallons to flush a toilet, and 25 to 50 gallons to take a shower.
- It takes about 1 gallon of water to process a quarter pound of hamburger.
- It takes 2,072 gallons of water to make four new tires.
- Water is the only substance found on the earth in three forms—solid, liquid, and gas.
- Ancient Egyptians treated water by siphoning water out of the top of huge jars after allowing the muddy water from the Nile River to settle.
- Golf courses used 55.6 billion gallons of water in 2005.
- It wasn't until the 1950's that scientists began to suspect that water might carry diseases. Until then, water treatment was mainly done to improve the taste, smell or looks of the water.
- The first United States water plant with filters was built in 1872 in Poughkeepsie, New York.
- A chicken is 75% water; an egg is 74% water.
- Water boils at 212^{o} Fahrenheit or 100^{o} Celsius.
- Water freezes at 32^{o} Fahrenheit or 0^{o} Celsius.

Clark County Soil and Water Conservation District

Partners helping to make our project happen:

- Clark/Jefferson/Scott County Health Departments
- Oak Park Conservancy District
- Jefferson and Scott County SWCDs
- Oak Park Conservancy District
- IDNR Division of Nature Preserves
- Chicks on the Farm
- Indiana State Department of Agriculture
- Natural Resources Conservation Service

Inside this issue:

Top Ten Litter Items in the United States

In the 2001 International Coastal Cleanup, these items comprised 82% of all debris found in the U.S.

1. *Cigarette butts/cigarette filters*
2. *Bags/food wrappers*
3. *Caps, lids*
4. *Beverage bottles (glass)*
5. *Beverage cans*
6. *Cups, plates, forks, knives, spoons*
7. *Beverage bottles (plastic) 2 liters or less*
8. *Straws, stirrers*
9. *Fast food Containers*
10. *Cigar tips*

Annual Used Oil Collection Day
A **FREE** Service to Farmers and Homeowners
Tuesday, September 2, 2014
8:30 A.M. to 4:00 P.M.
Clark County 4-H Center
9608 Hwy. 62, Charlestown, IN

Used oils and petroleum products in any size container
Acceptable Materials: Motor Oils, Gear Lubricants, Hydraulic Oils, Heating Oils, and Transmission Oils
A special container will be available to accept used oil filters

Aquatic Litter and Its Impact

Any manufactured or processed solid waste that enters the aquatic environment from any source is considered aquatic litter. In short, it is our misplaced waste and trash. It is a highly pervasive and visible form of pollution that has harmful impacts on wildlife and human health.

Aquatic litter impacts:
Aquatic Habitat— habitat destruction or harm is caused when submerged debris (for example, a piece of plastic sheeting) covers seagrass beds, or smothers bottom-dwelling species. Some debris can also cause physical damage.

Water Quality—debris can also affect the water quality by adding chemicals to the water. Construction waste illegally dumped in a stream can include buckets that once held paints, solvents, and other chemicals that can enter the water. Some littered items contain toxic chemicals that leach into the water.

Aquatic Animals — Entanglement and Ingestion
Aquatic debris can be particularly dangerous and often lethal to wildlife. Each year, more than 100,000 marine mammals die when they ingest debris or become entangled in ropes, fishing line, fishing nets, and other debris dumped into the ocean. Animals are curious by nature and will investigate unusual items in their environment. Once entangled, animals have trouble eating, breathing, finding food, escaping predators, or swimming, all of which can have fatal results. Entanglement can also cause wounds that can become infected. Ingested items often give animals have a false feeling of being full, and may die of starvation. Ingested items can also block the intestinal tract and prevent digestion.

Human Health and Safety—hazards include glass and metal left on the beach, or hospital needles and syringes that can carry disease. Fishermen and recreational boaters can also be endangered as nets and monofilament fishing line wrap around a boat's propeller. Plastic sheeting and bags can also block the cooling intakes on boats, which leads to costly repairs.

Economic—A tremendous amount of time, effort, and machinery is devoted to cleaning up litter on the land and in our waterways. Other economic impacts are harder to put a price on such as lost of tourist income, and decreased fish yield.

Stream Sweep Scheduled

The Fourteen Mile Creek/Goose Creek Watersheds Improvement Project will be partnering with the Youth Group of First Christian Church Disciples of Christ, Jeffersonville, and the Oak Park Conservancy District (OPCD), to conduct a stream sweep of Lancassange Creek on August 9, 2014. The section of Lancassange to be "swept" runs along Middle Road directly behind the church.

The project will provide the youth volunteers with gloves and trash bags to remove litter and debris from the stream. They will also receive a Ohio River Sweep t-shirt to recognize their participation.

Other groups interested in sweeping a stream within the Fourteen Mile/Goose Creek watersheds, are welcome to call us at 256-2330, ext. 3. We would be happy to coordinate a sweep with you!

Volume 1, Issue 2

High Schoolers Trained in Water Sampling

On May 28, 2014, twenty-four students from the Advanced Biology class at Jeffersonville High School joined us for some basic training in how to sample for benthic macroinvertebrates. These are animals that are big enough (macro) to be seen with the naked eye. They lack backbones (invertebrate) and live at least part of their lives in or on the bottom (benthos) of a body of water.

The training took place along Lancassange Creek near the intersection of Allison Lane and Middle Road in Jeffersonville. Sylvia Hottel, Water Monitoring Coordinator for our project and a certified Hoosier Riverwatch instructor, led the training; Bryan Wallace, Stormwater Coordinator for the City of Jeffersonville, and Melanie Davis, Watershed Education Co-Coordinator, assisted.

Sylvia began by explaining how benthic macroinvertebrates (or "macros" as they are called in the water sampling community) can help determine water quality. Dependent on the amount of dissolved oxygen in the water to live, macro numbers decrease as pollutants eat up their oxygen supply.

Sylvia then demonstrated the use of kick seines to collect macros, and also how to identify macros that have made their homes under rocks.

Students then spent the next two hours wading the stream and recording the macros they discovered. They were excited that several of the macros they found indicated that the quality of the water at that location was good. Sylvia ended the class with a demonstration and discussion of how to determine water flow.

Additional sampling events are being planned with the students when they return to school in the fall.

Sylvia conducting macroinvertebrate sampling at a Hoosier Riverwatch training

Water Efficiency

The growing population and the demand for water consuming gadgets (hot tubs, Jacuzzi, family swimming pools) has put stress on water supplies. By using water more efficiently, we can help preserve water supplies for future generations, save money, and protect the environment. **Remember: Every drop counts!**

Using too much water also significantly contributes to "nonpoint source pollution" (NPS). NPS pollution is when water moves across the ground, collecting pollutants from various sources, and eventually depositing them into our water. Failing to use water efficiently can hurt our water supply by:

- Altering stream flows due to excessive withdrawals
- Causing saltwater to intrude into freshwater aquifers due to excessive withdrawals (not a problem here but extremely important along our coastline)
- Increasing the amount of dirty runoff water that flows into natural water supplies. This runoff water carries sediment, nutrients, salts and other pollutants. Nutrients such as nitrogen, phosphorus, and potassium are naturally occurring, but habitats can be destroyed when excess amounts of any one nutrient, especially phosphorus, are concentrated in the soil and water.
- Creating the need to build additional dams. Dams generate NPS pollution by trapping sediment and other pollutants. This concentrates pollutants, causes sediment in the river to pile up, decreases dissolved oxygen, and alters water temperatures.

Of course the biggest benefit of water efficiency is to save water. The average household spends as much as $500 per year on its water bill. A few simple changes for efficiency, could save about $170. Also, when we use water more efficiently, we reduce the need for costly water supply infrastructure investments and new wastewater treatment facilities. We all know that it takes energy to make hot water, but supplying cold water requires a significant amount of energy too. Cutting our water use helps save public water companies electricity, which helps the environment. If we continue to deplete reservoirs and groundwater aquifers we are putting our health and environment at serious risk. Lower water levels can lead to higher concentrations of natural contaminants and chemical wastes. Using water more efficiently helps maintain supplies at safe levels protecting human health and the environment.

Clark County Soil and
Water Conservation District

9608 Highway 62
Charlestown, IN 47111
812-256-2330, ext. 3
Fax: 855-391-1921 (toll-free)

BULK RATE
U.S. Postage PAID
Charlestown, IN
Permit No. 6

For additional information or details on the Fourteen Mile Creek/Goose Creek Watersheds Improvement Project, contact Chelsea Tooley, Watershed Coordinator, at

14mile.watershed.outreach@gmail.com

Working In and Around the Waters of the State

If you have a pond, a creek, a stream, a wetland or other water holding/movement structure on your property, chances are, at some point you have considered doing some work to "improve" those sites. But, did you know, those water bodies, and others, are considered to be Waters of the State, and as such are regulated by at least three (3) different government agencies?

Typically, the three agencies with jurisdiction are the U.S. Army Corps of Engineers (USACE), the Indiana Department of Environmental Management (IDEM), and the Indiana Department of Natural Resources (IDNR). Locally, the County Drainage Board and the County Surveyor might also need to be consulted regarding projects.

So, what type of "improvement" projects might require one or more permits from one or more of these agencies or departments? Chances are good, that if you are considering any of the activities listed here, you will need one or more permits.

*Filling, dredging, or excavating within wetlands or any other water body for any purpose, including construction of buildings, roads, or leveling of property.
*Construction in the floodway of a water body.
*Mechanical clearing of vegetation, such as trees along a stream, creek or river or in a wetland.
*Channeling, widening, or otherwise altering the flow or path of a stream, creek, ditch, or river.
*Construction of any type of permanent or temporary dam, causeway, or other related structure.
*Construction of a new seawall, seawall refacing, underwater beaches, boat wells, boat houses, and underwater fish attractors.
*Ditch construction and/or reconstruction; tile drain installation and/or repair; and installation of pipeline having non-watertight joints.
*Widening, deepening, or construction of a pond or detention/retention basin within a river, stream, or wetland.
*Bank armoring or other related practices, such as the placement of riprap or glacial stone, construction of a storm water outfall, or any other stream bank or shoreline armoring activities.
*Removal of debris and logjams from streams, creeks or ditches depending on the method of removal.
*Construction of any bridge or culvert crossing, (pedestrian or vehicular), or related structure over a wetland or water body.
*Sand, gravel, peat, or other related mining activity within any water body.

And there may be more activities that require permits as this list is by no means complete.

For more information on regulations, it individuals may obtain a copy of "Waterways Permitting Handbook" available at www.wetlands.IN.gov or by calling 800-451-6027 or 317-233-8488.

FOR IMMEDIATE RELEASE

What's the Point of Non-Point Source Pollution?

Charlestown, IN - When we don't know exactly where pollution comes from, we call it non-point source (NPS) pollution. Nonpoint source pollution is the largest water quality problem in the United States today. NPS pollution results from rainfall or snowmelt contacting with and carrying contaminants over and through the ground, eventually entering our creeks, rivers, lakes and even our underground drinking water sources.

Examples of non-point source pollutants include fertilizers, herbicides, and insecticides as well as oil, grease and other chemicals. When sediment is not properly managed from construction sites, crop and forest lands, or eroding stream banks, it's considered NPS pollution too! Bacteria and nutrients from livestock, pet wastes, and faulty septic systems are also forms of non-point source pollution. Because nonpoint source pollution can come from so many places, we all can help prevent it.

Everyone can do their part to help prevent NPS pollution at home. Carefully using fertilizers and pesticides on our lawns and gardens is a good start. We should all keep our cars in good working condition. If we fix oil leaks and are careful not to spill things like antifreeze, we can keep these pollutants out of our water. Protecting storm drains can also help and we can do this by keeping leaves and litter away from them and by keeping our pet waste picked up. Maintaining our home septic systems by having them regularly pumped out can also protect the quality of our water. Agricultural land owners can install Best Management Practices (BMP's) to prevent non point source pollution. Conservation practices like cover crops, riparian forested buffers, stream bank stabilization, livestock exclusion or alternative watering systems are just a few examples of BMP's that protect our water bodies from a variety of contaminants.

Our everyday actions can have a huge impact on what gets washed into our local creeks. By doing our part to protect our waters, we are doing our part to improve water quality in Indiana and for those who live downstream.

Nonpoint source pollution is the leading cause of water quality problems in Indiana and is responsible for many of the impairments identified on the Indiana Department of Environmental Management's (IDEM) 303(d) List of Impaired Waterbodies. The Clark County Soil and Water Conservation District (SWCD) is currently in the process of developing a watershed management plan for the Fourteen Mile Creek/Goose Creek-OH River (Indiana portion) watersheds. If you live in these watersheds and are interested in learning more about our project, or volunteering, please contact the SWCD office at 812-256-2330, ext. 3, or email Chelsea Tooley, Watershed Coordinator, at 14mile.watershed.outreach@gmail.com.

FOR IMMEDIATE RELEASE

Fertilizing Lawns

Charlestown, IN - Fertilizing, along with mowing and irrigating, is one of the basic cultural practices used to produce healthy, dense, green lawns. A common question homeowners have, though, is:

Do I really need to fertilize my lawn?

In terms of turf survival, the answer probably is no. The majority of lawns can receive little or no fertilizer and be more or less functional. However, unfertilized lawns tend to be thin, light green or brown in color, and have high weed populations. Adequately fertilized lawns look better than underfertilized lawns, compete better against weeds, hold up better under wear and tear, and recover more quickly from damage. So it is a personal preference question then, that you as a homeowner can only answer for yourself.

Should you have your soil tested before fertilizing?

If you make the decision to fertilize then you should consider soil testing. In the best of all worlds, everyone would get a soil test before planting a lawn and would repeat the test each year and adjust the fertilizer program according to the results. This is a common practice at golf courses and athletic field complexes, however it may seem a daunting task to a homeowner. As a result, very few people get their soil tested regularly. If you suspect you have a problem soil, contact a local professional analytical lab or estimate your soil nutrient content by using a soil test kit purchased from a retail nursery center.

How often do I need to fertilize my lawn?

The ultimate goal is to apply the least amount of fertilizer needed to produce healthy turf and meet your personal aesthetic standards. The proper rates, frequency, and timing of fertilizer application depend on:

- Your desired turf quality – Do you want a consistently dense, dark green turf? Or only during the time of an event such as a relative's visit?
- The type of fertilizer you use – Slow release nitrogen sources generally react more slowly but last slightly longer.
- The type of grass in your lawn – Different species of grass will respond differently to rate and timing of fertilizer.
- Whether you leave clippings on the lawn – Clippings extend the effects of fertilizers by recycling nutrients during decomposition.

What about environmental pollution?

The two nutrients of greatest concern as pollutants are nitrogen and phosphorus. The primary concerns are leaching into groundwater (nitrogen) and runoff that contaminates surface waters (phosphorus). To ensure that lawn fertilizer doesn't contribute to pollution, follow these tips:

- Make sure the fertilizer goes on the lawn and not on sidewalks or in the street. The single greatest source of pollution from lawn fertilizers is the fertilizer that ends up in the street.
- Remove any fertilizer from hard surfaces before irrigating to avoid flushing fertilizer into storm sewers.
- Apply fertilizer at times when grass is growing and actively absorbing nutrients (i.e., spring through fall).
- Fertilize more often at lower rates rather than less often at higher rates.

- Observe your lawn over time to determine the least amount of fertilizer needed annually to provide the quality of grass you desire.
- Use fertilizers with low or no phosphorus (the middle number in the analysis).
- On sandy soils, use slow-release fertilizers to avoid an overload of nitrogen immediately after application. Both synthetic slow-release and natural organic fertilizers are good choices in this situation.
- Leave unfertilized buffer zones near lakes or streams. The best solution is to eliminate mowed turf next to waterways in favor of unmowed natural grass stands or dense native or native-like vegetation that requires no fertilizer. Mowed grass all the way to the water surface is an accident waiting to happen.
- Be cautious when selecting composts and natural organic fertilizers, since they generally contain relatively high levels of phosphorus.

FOR IMMEDIATE RELEASE

Get a Handle on Your Septic System

Charlestown, IN – Don't let your septic system get the best of you! Keeping your system working properly is a wise investment for many reasons including:

Health: Wastewater can contain bacteria, viruses and household chemicals. The safe disposal of sewage containing these contaminants prevents the spread of infection and disease and protects groundwater. If groundwater becomes contaminated a significant threat is posed to wells and drinking water.

Environment: Malfunctioning septic systems can release excess nutrients into our streams and rivers. This contamination can stimulate algae growth; excessive algae growth harms oxygen levels thus killing or affecting fish and other aquatic organisms and reducing stream quality.

Economic: Failed septic systems are expensive to replace or repair. They can even cause a decline in property values.

Quick Tips to Proper Septic System Maintenance:

- Inspect your septic system annually.
- Pump out your septic system every 3 to 5 years, using a licensed septic hauler.
- Avoid or reduce the use of garbage disposals, they can contribute unnecessary solids to your septic system causing them to need pumping more frequently.
- Avoid drainfield failures by avoiding hydraulic overloading. Installing water-efficient shower heads, faucets, and toilets help limit wastewater levels and reduce the likelihood of septic system overflow.
- Don't make or allow repairs to your septic system without obtaining the required health department assistance and permit.
- Don't plant anything over your soil treatment area except grass.
- Divert roof drains and surface water from driveways away from the septic system. Keep the water from sump pumps, water softeners, and foundation drains out of the septic system.
- Don't use your toilet as a trash can! Chemicals can corrode septic system pipes and might not be completely removed during the filtration process. They may also interfere with the proper function of your septic system. Keep the following items OUT of your septic system: *Grease, Disposable Diapers, Tampons, Gasoline, Oil, Paint, Paint Thinner, Pesticides, Antifreeze, Etc.*

Failed systems may be reported on the Fourteen Mile Creek/Goose Creek Watersheds Improvement Project web site at www.14milecreekwatershed.weebly.com. The report will be sent to the appropriate county health official who will investigate the report. Some signs of a nonworking septic system include: *foul odors, wet spongy ground or puddles of water near a drainfield, lush plant growth that appears near a leaky tank, or drainfield fixtures that drain slowly.*

FOR IMMEDIATE RELEASE

Sedimentation and Nonpoint Source Pollution

Charlestown, IN – Nonpoint source pollution occurs when rain runs off farmland, city streets, construction sites, and suburban lawns, roofs and driveways and enters our waterways. This runoff often contains harmful substances such as toxics, pathogens, excess nutrients and sediments. It is called nonpoint source pollution because it does not come from a single source, or point, such as a sewage treatment plant or an industrial discharge pipe.

There are four main forms of nonpoint source pollution: sediments, nutrients, toxic substances and pathogens.

- Sediments are soil particles carried by rainwater into streams, lakes, rivers and bays. By volume, sediment is the greatest pollutant of all. It is caused mainly by erosion resulting from bare land, some farming practices, and construction and development.
- Nutrients are substances that help plants and animals live and grow. The main concern is excessive amounts of two nutrients: nitrogen and phosphorus.
- Toxic substances are chemicals that may cause human and wildlife health concerns. They include organic and inorganic chemicals, metals, pesticides, household chemicals, gasoline, motor oil, battery acid, roadway salt and other pollutants.
- Pathogens are disease-causing microorganisms present in human and animal waste. Most pathogens are bacteria.

Indiana's nonpoint source pollution prevention efforts focus strongly on managing nutrients and sediments because they pose the most significant threat to the health of our waterways.

Nonpoint source pollution from farms yields sediment, toxic substances and excess nutrients. Statewide, farmland loses several tons of soil per acre per year. While this soil is productive on land, in the water it reduces light needed by aquatic plants, obstructs waterways and covers aquatic habitat with sediment. Soil from farmland sometimes takes with it pesticides and nutrients. An estimated 50 percent of the nitrogen and 29 percent of the phosphorus entering surface waters come from farmland.

Sediment clouds water too, and it obstructs waterways, clogs sewers, interferes with navigation, and smothers fish and shellfish spawning grounds. Natural erosion and sedimentation occur at a lower rate than that resulting from human land use activities. Underwater plants and aquatic animals are particularly threatened by nonpoint source pollution.

More information on watersheds and water quality can be obtained through the Clark County Soil and Water District's (SWCD) Fourteen Mile Creek/Goose Creek Watershed Improvement Project. Contact the SWCD office at 256-2330, ext. 3.

FOR IMMEDIATE RELEASE

Septic Systems – What To Do After The Flood

Charlestown, IN - We're a little over halfway through 2015 and how have precipitation totals and temperatures compared to normal? Well, it's been a wet year so far. Much of the lower Ohio Valley west toward the mid-Mississippi Valley is averaging 8 to as much as 20 inches above normal. Kentucky and Indiana have both observed above average precipitation so far in 2015, and the next few months may well be the same. According to the National Weather Service's Climate Prediction Center, the latest 1 month and 3 month outlooks shows that there is higher chances for below normal temperatures and above normal precipitation.

If you have a septic system on your property, and were caught off-guard by the recent heavy rains and flooding, here are some tips to help you be better prepared should those conditions occur again.

Do I pump my tank during flooded or saturated drainfield conditions? No! At best, pumping the tank is only a temporary solution. Under worst conditions, pumping it out could cause the tank to try to float out of the ground and may damage the inlet and outlet pipes. The best solution is to plug all drains in the basement and drastically reduce water use in the house.

What do I do with my septic system after the flood? Once floodwaters have receded, there are several things homeowners should remember:

- Do not drink well water until it is tested. Contact your local health department.
- Do not use the sewage system until water in the soil absorption field is lower than the water level around the house.
- Have your septic tank professionally inspected and serviced if you suspect damage. Signs of damage include settling or an inability to accept water. Most septic tanks are not damaged by flooding since they are below ground and completely covered. However, septic tanks and pump chambers can fill with silt and debris, and must be professionally cleaned. If the soil absorption field is clogged with silt, a new system may have to be installed.
- Only trained specialists should clean or repair septic tanks because tanks may contain dangerous gases. Contact your health department for a list of septic system contractors who work in your area.
- If sewage has backed up into the basement, clean the area and disinfect the floor. Use a chlorine solution of a half cup of chlorine bleach to each gallon of water to disinfect the area thoroughly.
- Pump the septic system as soon as possible after the flood. Be sure to pump both the tank and lift station. This will remove silt and debris that may have washed into the system. Do not pump the tank during flooded or saturated drainfield conditions.
- Do not compact the soil over the soil absorption field by driving or operating equipment in the area. Saturated soil is especially susceptible to compaction, which can reduce the soil absorption field's ability to treat wastewater and lead to system failure.
- Examine all electrical connections for damage before restoring electricity.
- Be sure the septic tank's manhole cover is secure and that inspection ports have not been blocked or damaged.

- Check the vegetation over your septic tank and soil absorption field. Repair erosion damage and sod or reseed areas as necessary to provide turf grass cover.

Remember: Whenever the water table is high or your sewage system is threatened by flooding, there is a risk that sewage will back up into your home. The only way to prevent this backup is to relieve pressure on the system by using it less.

Where can I find information on my septic system?

Please contact your local health department for additional advice and assistance. For more information on onsite/decentralized wastewater systems, you can visit EPA's Septic Systems Web site, *http://water.epa.gov/infrastructure/septic/index.cfm* or visit the National Environmental Services Center (NESC) Web site, *http://www.nesc.wvu.edu/*, or call NESC at (800) 624-8301.

FOR IMMEDIATE RELEASE

Homeowners Can Be Conservationists in Their Own Backyard

Charlestown, IN – You don't have to be a landowner of 100 acres or more to be a conservationist. Even folks with a small home site in a housing subdivision can practice natural resource conserving practices that reflect positively on their concern for our environment.

Conservation goes hand-in-hand with good lawn care practices that protect and improve water quality. By using proper feeding and mowing practices, we all can enjoy a healthy home landscape, and conserve our natural resources for future generations.

When it comes to the home lawn, three areas of maintenance can have a major effect on your impact on the environment and natural resources.

<u>Fertilizing</u>
Mature, established lawn grasses rarely need phosphorus fertilizer. Generally, only new grass plantings require the addition of phosphorus to fertilizer applications as phosphorus promotes initial root growth. The best times of the year to apply lawn fertilizers is in the early spring and late summer when cool-season grass plants are actively growing. Actively growing grass will readily take-up and utilize the fertilizer, thus reducing the chance of this material from being washed away from the location where it was intended. Use a drop spreader or rotary spreader with a side guard to keep fertilizer on the grass and off of sidewalks and driveways where it can be washed away and into storm drains.

<u>Mowing and Mulching</u>
Set your mower at its highest setting. Taller grass is stronger grass as deep roots are encouraged that enable grass plants to find water and nutrients, and better withstand stress, such as periods of heat and drought. Also, taller grass plants tend to shade the soil, thus preventing weed seed germination. A mulching mower is a good choice when making a decision about your next lawn mower purchase. A mulching mower returns grass clippings to the soil. Grass clippings break down quickly and return valuable nutrients and organic matter back into the soil. Nutrients and organic matter are also returned to the soil in the fall when your mower is used to mulch tree leaves.

<u>Watering</u>
Reduce utility bills by using rainfall, as much as possible, to water your lawn. During most of the growing season our area receives enough natural rainfall to support lawn growth. The key is to let the rain soak into the soil. To aid in doing this, you can direct downspouts out into the lawn or into rain barrels for later use. In the Midwest, in an average year, most lawns don't need supplemental irrigation. The amount of water needed for lawns varies by grass type, soil condition and environmental conditions. In general, the typical Midwestern turf needs an average of ½ to 1 inch of water per week. If you must irrigate a lawn, it is best to wait until the grass shows signs of wilt. Also, less frequent but longer periods of watering are preferred over frequent short periods. This practice will tend to promote a deeper grass plant root system, which can withstand extended periods between irrigations. New turf grass cultivars have recently become widely available that require even less water than traditional cultivars. Consider fall over-seeding with these new cultivars to eventually transition a lawn to a more sustainable, environmentally sound yard.

Please Answer a Few Questions About 14-Mile Creek

The Clark County Soil and Water Conservation District is interested in your concerns for Fourteen Mile Creek Watershed. Please list your top three concerns about the condition of the Fourteen Mile Creek Watershed. Remember that the watershed includes not only Fourteen Mile Creek and its tributaries but also all the land that drains into those waterbodies.

1.____

____

2.____

____

3.____

For Fourteen Mile Creek Watershed to become the healthy watershed we would all like to live in, it needs your help. If you would like to volunteer in one of the following areas, check the item and we will be in contact with you soon.

__ Become a member of the steering committee and help develop the watershed plan.

__ Monitor water quality.

__ Organize a stream cleanup.

__ Help with conservation projects throughout the watershed (example of work to be done, plant/design a rain garden, plant a riparian buffer, etc).

__ Help with a field day to educate landowners about best management practices to improve water quality.

__ Educate local governmental units concerning a policy to protect and enhance riparian areas in the urban environment.

__ Submit information to the local media.

__ Other (Suggestion____).

Name____

Address____

Phone ________________ **E-mail**____________________________________

Please return completed form to:
Clark County SWCD
9608 Highway 62
Charlestown, IN 47111
812-256-2330, ext. 3

Public Meeting
February 27, 2014

Fourteen Mile Creek/Goose Creek Watersheds

Thursday, February 27th
6:30 p.m.
Trinity United Presbyterian Church Annex Building
(former FFA building)
New Washington, IN

Citizens are encouraged to attend the meeting and provide feedback regarding water quality issues they are aware of in these watersheds so that a watershed management plan can be developed. Citizens may also volunteer their time to serve as a Steering Committee members for the project.

For more information, contact the:
Clark County Soil & Water Conservation District
9608 Highway 62
Charlestown, IN 47111
812.25.2330, ext. 3
14mile.watershed.outreach@gmail.com

Public Meeting
December 4, 2014

Fourteen Mile Creek/Goose Creek Watersheds

Thursday, December 4th
7:30—8:30 a.m.
Food Stand, Clark County 4H Fairgrounds
9608 Highway 62, Charlestown, IN

Citizens are encouraged to attend the meeting and provide feedback regarding water quality issues they are aware of in these watersheds so that a watershed management plan can be developed. Citizens may also volunteer their time to serve as a Steering Committee members for the project.

COME HUNGRY! BREAKFAST WILL BE SERVED!

For more information, contact the:
Clark County Soil & Water Conservation District
9608 Highway 62
Charlestown, IN 47111
812.256.2330, ext. 3
swcdclark@gmail.com

FOR IMMEDIATE RELEASE
November 18, 2014

Charlestown, IN – The Soil and Water Conservation Districts (SWCDs) of Clark, Jefferson, and Scott Counties are looking for concerned citizens in the Fourteen Mile Creek/Goose Creek watersheds to provide input into the development of a watershed management plan that will help them protect and improve the water quality in these watersheds. A public meeting will be held December 4, 2014, at the Clark County 4H Fairgrounds, Food Stand, 9608 Hwy. 62, Charlestown, IN, for this purpose.

Come hungry! Doors will open at 7:30 a.m. so that you may enjoy a hot breakfast before the meeting begins. The meeting will last approximately one hour.

The only thing you are asked to bring to the meeting are concerns, or information, you may have in regards to the water quality in these watersheds. Please note that the plan developed for the Fourteen Mile Creek/Goose Creek watersheds will focus on combating **non-point source pollution**. This type of pollution is so named because a single source (such as an industrial discharge pipe) cannot be pinpointed as a pollutant. Non-point source pollutants, such as fertilizers, pesticides, and sediment, are in the water that runs off crop or forest land, parking lots, construction sites, irrigation systems, and drainage systems. Failing septic systems also contribute. Much progress has made in regulating and controlling this type of pollution, however, water quality problems resulting from non-point source pollution have proven difficult to isolate.

Attendees may volunteer to serve on the Steering Committee for the planning process if they so choose. If not, another public meeting is planned for late next year in order to give attendees the opportunity to review the draft plan, and provide comments, before a final plan is submitted.

If you have questions about this meeting, the planning process itself, or you would like to RSVP, please contact the Clark County SWCD at 812.256.2330, ext. 3. Please RSVP by Tuesday, December 2, 2014, so that we can have plenty of breakfast prepared for everyone!

NUTRIENT MANAGEMENT PLANS

The objective of a nutrient management plan is to ensure that, as practical as possible, nutrients are applied in the right place, in the right amount, at the right time, and from the right source to optimize profitability and to minimize losses to our air and water resources.

On a typical livestock farm, nutrients cycle from the soil, to the crops, to the animals, and then finally back to the soil as manure.

Nutrient cycling on most farms does not form a closed loop, and farmers often purchase off-farm nutrients to compensate for those lost to the environment. Farmers may also unknowingly apply nutrients in excess of recommended rates. For example, some farmers may apply commercial fertilizers without giving proper credit to the nutritive value of their manure. This can harm crop production, incur additional costs, and jeopardize soil and water quality. Similarly, the application of too few nutrients can sacrifice yield and quality. Testing soil, and animal manure, on a routine basis is an integral part of nutrient management, and alleviates the guesswork of applying additional nutrients.

Find out more about nutrient management planning, and other conservation practices that benefit water quality at the Natural Resources Conservation website:
www.nrcs.usda.gov/wps/portal/nrcs/site/in/home.

FINANCIAL AND TECHNICAL ASSISTANCE

Financial and technical assistance for developing a nutrient management plan, and installing best management practices, is available through many Soil and Water Conservation Districts, and the Natural Resources Conservation Service.

Fourteen Mile Creek Goose Creek-OH River WATERSHED Improvement Project

CLARK COUNTY soil and water conservation DISTRICT

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement number C9975482-10 to the Indiana Department of Environmental Management. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

NUTRIENT MANAGEMENT

IN GRAZING LIVESTOCK OPERATIONS

HOW NUTRIENTS AFFECT WATER QUALITY

Although livestock waste is organic, biodegradable material, many of its' biological and chemical properties can be detrimental to fish, insects, and other aquatic life if those wastes get into local waterbodies.

Many of the nutrients ingested by animals return to the environment in feces and urine. On land, moisture and atmospheric oxygen support the bacterial conversion of these wastes to nutrients available for plants. However, when carried by stormwater runoff to streams and lakes, excessive amounts of these same nutrients can stimulate unwanted algae blooms. Algae respiration uses up dissolved oxygen, which is essential to all aquatic life.

Ammonia is an intermediate by-product of the bacterial conversion of urea, a component of urine. A very small amount of ammonia dissolved in water can kill fish.

Salts contained in all animal waste do not breakdown, and can be carried by rain runoff into local surface and ground waters. Increased salt loads in streams limits the species of fish, amphibians, and invertebrate life.

Though not a nutrient, the bacteria, *Escherichia coli (E.coli)*, found in animal and human waste, poses a serious health risk to people when it contaminates water sources.

BEST MANAGEMENT PRACTICES (BMPs)

Pictured here are just a few of the BMPs that can be used to prevent soil erosion, control nutrient movement, and protect water quality in livestock operations.

Livestock exclusion or access control is the temporary or permanent exclusion of livestock from a designated area—often to protect streambanks, wetlands, woods, cropland, wildlife habitat or conservation buffers. Access controls can also be used to keep wildlife, people, equipment and vehicles out of an area.

The **water tank** in this pasture is located to serve four pastures, allowing a water supply for four-pasture rotational grazing. In this instance, water is piped from a nearby pond to the tank.

Stream crossings, such as the one shown above, are stabilized fords, culverts or bridges that allow livestock, people, equipment or vehicles to cross a stream in a safe and environmentally sound manner. Stream crossings help prevent streambank erosion, water pollution, aquatic habitat degradation and damage to stream beds and channels

Native plants and grasses have deep root systems that help absorb storm water pollutants, and assist in bank and slope stabilization. Vegetative buffers serve as a final filtering out of sediment, fertilizers, pesticides , livestock waste, and other pollutants before runoff enters the water.

Partners

In October, 2013, the Clark County Soil and Water Conservation District (SWCD) received a Federal Clean Water Act Section 319 Nonpoint Source Management Grant for Fourteen Mile Creek/Goose Creek - OH River (IN) watersheds.

The ultimate goal of the project is to develop a comprehensive watershed management plan that documents the current status of water quality within the watershed, outlines a vision for its future, and recommends a clear strategy for implementing watershed/water quality improvements.

More information on the project can be found at www.14milecreekwatershed.weebly.com or by contacting the SWCD office at 812.256.2330, ext. 3.

Natural Resources Conservation Service

NRCS employees work in every county in Indiana. District conservationists, resource conservationists, wetland conservationists, soil conservationists, soil conservation technicians, engineers, biologists, agronomists, and soil scientists work hand-in-hand with land users to conserve natural resources on private lands. NRCS is committed to providing high quality technical assistance, conservation planning and program information support to private land users.

Purdue Cooperative Extension—Scott County

Purdue Extension's mission is to serve the needs of people and help to make their communities stronger. The Scott County Extension office is located at 1 E. McClain Ave., Suite G-30, Scottsburg, IN. They may be contacted at 812.752.8450, or visit their web site at www.extension.purdue.edu/scott/Pages/aboutus.aspx

REGISTRATION FORM

Registration begins at 2:30 p.m.

The first session will start at 3 p.m. and the workshop will conclude at 5 p.m.

Name

Address

City, State, Zip

Phone

Email

If you wish to receive PARP credit, please check the box below:

☐ Receive PARP credits ($10 fee payable day of workshop)

Return this form by mail or fax to:

Clark County SWCD
9608 Highway 62
Charlestown, IN 47111
Fax: 1-855-391-1921 (toll-free)

Registration deadline October 26, by 4 p.m.

Wednesday October 28, 2015

Nutrient Management

Workshop

PRESENTED BY:

FOURTEEN MILE CREEK WATERSHED IMPROVEMENT PROJECT

PURDUE COOPERATIVE EXTENSION - SCOTT COUNTY

USDA NATURAL RESCOURCES CONSERVATION SERVICE

Agenda

2:30 p.m.

Registration

3 p.m.

Landowner Comments

Pat Larr

Landowner, Hoosier Hills Kiko Goats

3:15 p.m.

Nutrient Management, view conservation practices

Robert Zupancic

Grazing Specialist, NRCS

Jennifer Kipper

District Conservationist, NRCS

4 p.m.

Fertilizer Application Regulations

Megan Voyles

Purdue Extension Scott County—

County Extension Director, Agriculture and Natural Resources Extension Educator, 4-H Youth Development Educator

5 p.m.

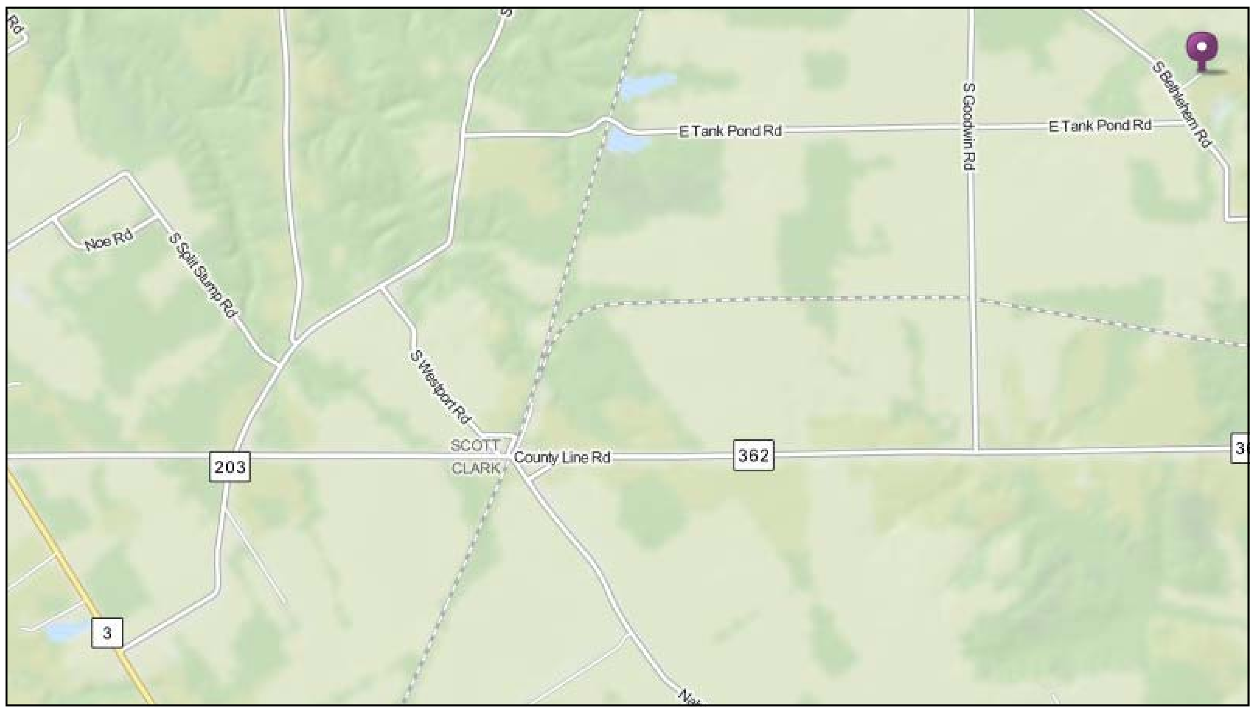
Workshop ends

PARP credits

PARP credits will be offered, with the normal $10 associated fee due the day of the event. You must have your card, or at least, the last 4 digits of your SSN with you the day of the workshop.

Directions

This workshop will be held at Pat Larr's farm, 4698 Old Boles Ln., Nabb, IN (Scott County). Old Boles Ln. is a two resident lane that is accessed from S. Bethlehem Rd. See map below.



Registration Information

Bring your lawn chairs! We will have some seating available, but you may be more comfortable in your own chair.

And wear **comfortable shoes for walking!** Our nutrient management session will involve walking to view conservation practices.

There is no fee for this workshop.

To register, complete the form on the reverse side of this brochure. If you have questions, please contact the Clark County SWCD office at 812.256.2330, ext. 3.

Help us "Get a Handle" on water quality in the Fourteen Mile Creek/Goose Creek-OH River watersheds!

The Clark County SWCD is currently working on an EPA Section 319 grant to develop a watershed management plan for Fourteen Mile Creek, and the Indiana portion of Goose Creek-OH River. These watersheds cover the eastern portions of Clark County, the southeastern corner of Scott County, and the southwestern corner of Jefferson County.

Both watersheds contain water bodies that are currently listed on the EPA's 303(d) list of impaired waters for E.coli. The sources of this strain of bacteria are human and animal waste, therefore, we encourage you to follow the steps outlined in this brochure to maintain your septic system and prevent contamination of our water resources. Just as in Silver Creek, good water quality in the creeks, lakes, and streams of these watersheds starts **at home!**

To report a nonworking septic system within the Fourteen Mile Creek/Goose Creek-OH River watersheds, visit our "Septic Systems and Water Quality" page at *www.14milecreekwatershed.weebly.com*.

Fourteen Mile Creek/Goose Creek-OH River (IN portion) Watersheds Improvement Project
14mile.watershed.outreach@gmail.com
Clark County Soil and Water Conservation District
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National SepticSmart Week September 21-25 2015

Do Your Part, Be SepticSmart:

The Do's and Don'ts of Your Septic System

Learn these simple steps to protect your home, health, environment, and property value:

Protect It and Inspect It:

- Have your system inspected (in general) every three years by a licensed contractor and have the tank pumped, when necessary, generally every three to five years.

Think at the Sink:

Don't:

- Pour cooking grease or oil down the sink or toilet.
- Rinse coffee grounds into the sink.
- Pour household chemicals down the sink or flush them.

Do:

- Eliminate or limit the use of a garbage disposal.
- Properly dispose of coffee grounds & food.
- Put grease in a container to harden before discarding in the trash.

Don't Overload the Commode:

Don't:

- Flush non-degradable products or chemicals, such as feminine hygiene products, condoms, dental floss, diapers, cigarette butts, cat litter, paper towels, pharmaceuticals.

Do:

- Dispose of these items in the trash can!

Shield Your Field:

Don't:

- Park or drive on your drainfield. The weight can damage the drain lines.
- Plant trees or shrubs too close to your drainfield, roots can grow into your system and clog it.

Do:

- Consult a septic service professional to advise you of the proper distance for planting trees and shrubs, depending on your septic tank location.

Don't Strain Your Drain:

Don't:

- Concentrate your water use by using your dishwasher, shower, washing machine, and toilet at the same time. All that extra water can really strain your septic system.

Do:

- Stagger the use of water-generating appliances. This can be helpful especially if your system has not been pumped in a long time.
- Become more water efficient by fixing plumbing leaks and consider installing bathroom and kitchen faucet aerators and water-efficient products.

Know Your Septic System

Do I have a septic system? If so, how can I find it?

Here are a few tips to determine if you have a septic system and how to locate it.

You most likely have a system if:

- You are on well water.
- The water line coming into your house does not have a meter.
- Your neighbors have a septic system.

You can find your septic system by:

- Looking on the "as built" drawing for your home.
- Checking in your yard for lids or manhole covers.
- Using an inspector/pumper, who can also help you find exactly where the system is located.

Why is it important to properly maintain my septic tank?

It saves you money.

Malfunctioning systems can cost $3,000-$7,000 to repair or replace compared to maintenance costs of about $250-$500 every three to five years.

It protects the value of your home.

Malfunctioning septic systems can drastically reduce property values, hamper the sale of your home, and even pose a legal liability.

It keeps your water clean and safe.

A properly maintained system helps keep your family's drinking water pure, and reduces the risk of contaminating community, local, and regional waters.

It keeps the environment clean.

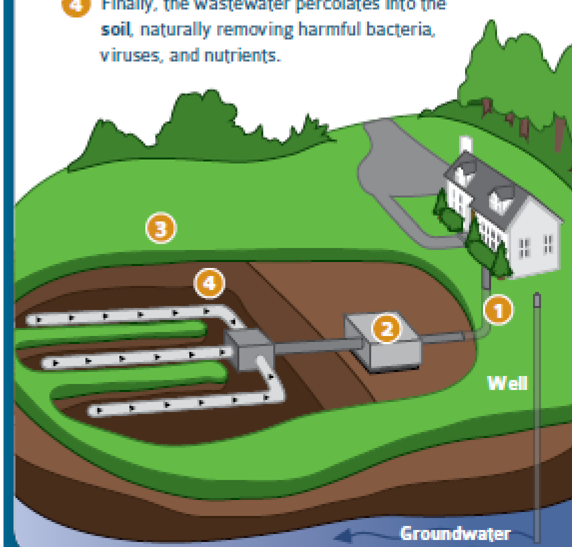
Malfunctioning septic systems can harm the local ecosystem by killing native plants, fish, and shellfish.

*Being **SepticSmart** helps protect your home and family. The U.S. Environmental Protection Agency's SepticSmart initiative helps ensure that we all know how to do our part to safeguard our community's health and protect our environment. It can also protect your family and keep you from spending thousands of dollars repairing or replacing a damaged system.*

How does a septic system work?

This is a simplified overview of how a septic system works.

1. All water runs out of your house from one main **drainage pipe** into a septic tank.
2. The **septic tank** is a buried, water-tight container usually made of concrete, fiberglass or polyethylene. Its job is to hold the wastewater long enough to allow solids to settle down to the bottom (forming sludge), while the oil and grease floats to the top (as scum). Compartments and a T-shaped outlet prevent the sludge and scum from leaving the tank and traveling into the drainfield area.
3. The liquid wastewater then exits the tank into the **drainfield**. If the drainfield is overloaded with too much liquid, it will flood, causing sewage to flow to the ground surface or create backups in toilets and sinks.
4. Finally, the wastewater percolates into the **soil**, naturally removing harmful bacteria, viruses, and nutrients.



Proper Landscaping On and Around Your Septic System

The drainfield is a vital part of your septic system. Having the right landscaping on and around your system is important, as tree and shrubbery roots can grow into the drain lines. Also, other heavy items like cars and livestock can break drain lines. Strong roots and heavy items can cause the drainfield to fail. And if the drainfield fails, your system fails.

Here are some tips to keep your drainfield out of harm's way.

Locate your septic tank and drainfield. Then make sure the area is clear of:

- Underground sprinkler lines
- Decks and patios
- Sports courts
- Storage sheds
- Swimming pools
- Swing sets
- Sand boxes
- Driveways
- Vehicles

Plant native, drought-tolerant plants. These are some of the best for your septic system and its drainfield:

Grass:

- Fescue
- Lawn
- Ornamental grasses
- Wildflower meadow mixes

Groundcovers for shade:

- Bunchberry (Cornus)
- Chameleon (Houttuynia)
- Ferns
- Mosses
- Sweet woodruff (Galium Odoraturn)
- Wild ginger (Asarum)
- Wintergreen (Gaultheria)

Groundcovers for sun:

- Bugleweed (Ajuga)
- Carpet heathers (Calluna vulgaris)
- Cotoneaster (Cotoneaster)
- Ground ivy (Glechoma)
- Kinnikinnick (Arctostaphylos)
- Periwinkle (Vinca)

Follow Septic Sam's landscaping do's and don'ts:

Don't:

- Plant a vegetable garden on or near the drainfield.
- Put plastic sheets, bark, gravel, or other fill over the drainfield.
- Reshape or fill the ground surface over the drainfield and reserve area. However, just adding topsoil is generally OK if it isn't more than a couple of inches.
- Make ponds on or near the septic system and the reserve area.

Do:

- Plant grass or keep existing native vegetation. These are the best covers for your drainfield.
- Direct all surface drainage away from the septic system.
- Use shallow-rooted plants (see plant list above). Tree and shrub roots can grow into the drainlines, clogging and breaking them.
- Avoid water-loving plants and trees.
- Make sure the tank lid is secure.