VFC Index - Watershed (Plan)

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Owen County Lower White River Watershed Project

Watershed Management Plan

The purpose of the Owen County Lower White River Watershed Initiative is to study land use impacts on tributaries of the Lower White River, develop a watershed management plan, and identify partnerships to improve water quality.

Sponsored by the Owen County Soil and Water Conservation District and made possible by a Clean Water Act Section 319 Grant administered by the Indiana Department of Environmental Management

February 2009

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Part 1: Project Introduction

1.1 Introduction

The Owen County Soil and Water Conservation District (SWCD) successfully submitted an application in 2006 for a Clean Water Act Section 319 Grant to develop a Watershed Management Plan (WMP) for the following watersheds in Owen and Monroe Counties: Limestone/Big; Mill/Little Mill; and Fall/McCormick's (HUCs 05120202020010; 05120202020020; 05120202020030 respectively).

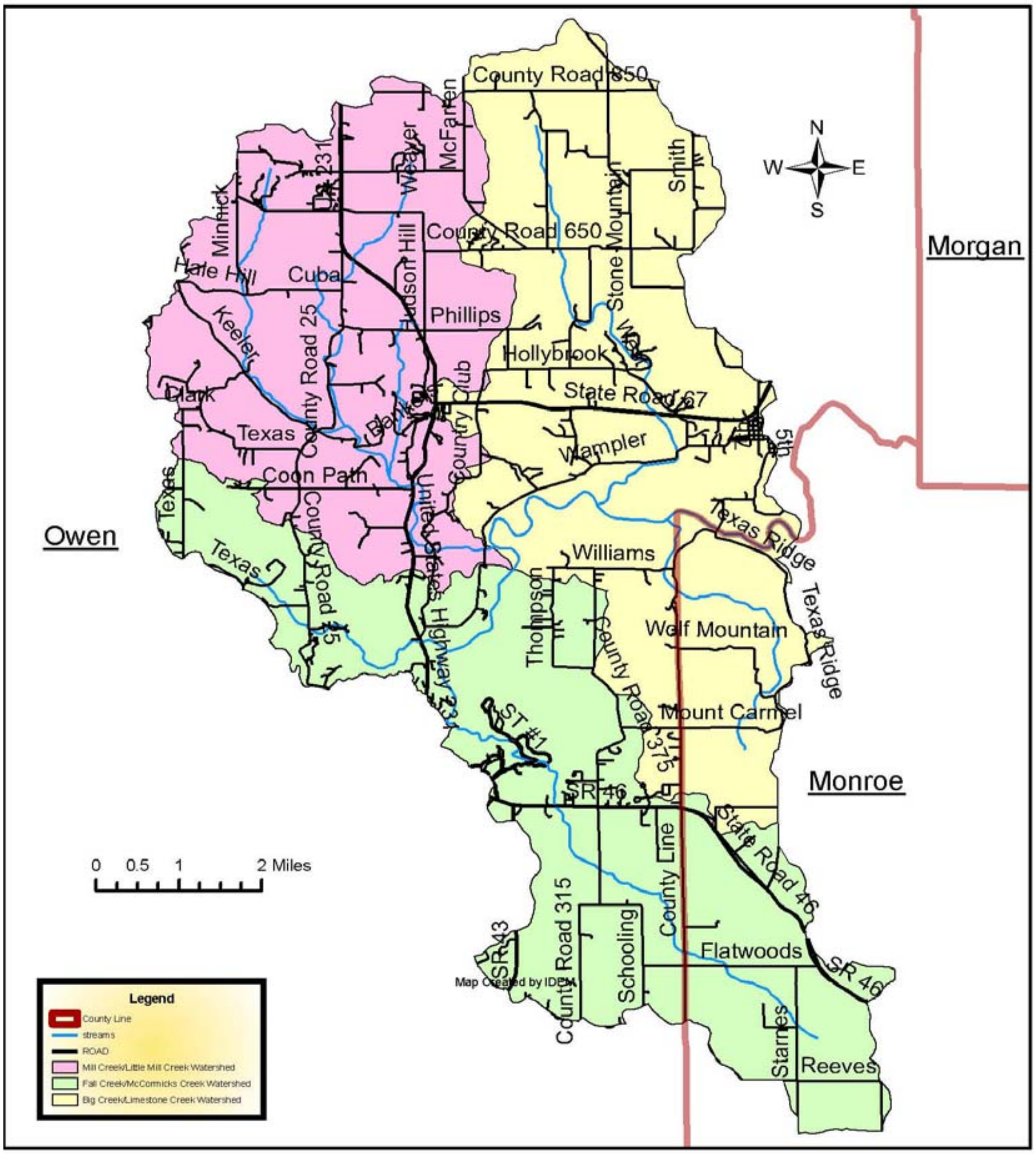

Figure 1. Project area

The SWCD Board of Supervisors and staff were motivated to develop this Watershed Management Plan based on the fact that the Indiana Department of Environmental Management (IDEM) 305(b) Report documents that water quality impairments exist in the White River, McCormick's Creek, Fall Creek, and Limestone Creek watersheds. These watersheds are listed on the 303(d) list of impaired water bodies for Impaired Biotic Communities and *E.coli* levels that exceed the state water quality standard.

While Mill Creek, Little Mill Creek, and Big Creek watersheds are not on the 303(d) list, it is the belief among Owen County residents and the Owen County Soil and Water Conservation District that existing land uses as well as ongoing changes to the landscape may contribute to sediment loading and bacteria problems in these watersheds.

In 2006 the IDEM conducted a Total Maximum Daily Load (TMDL) study for *E.coli* that included sampling points in all of the project watersheds. The purpose of the study was to identify the sources and determine the allowable levels of *E.coli* bacteria that would result in the attainment of applicable water quality standards. Data collected revealed that *E.coli* levels routinely exceed the Indiana Administrative Code (IAC) Standard of 235 colony forming units (cfu) per 100 milliliters of sample water.

This watershed management plan combines relevant data, sound economics, resource protection, wise land use principles, future planning, and the ideas of interested individuals. It provides a framework for individuals, government agencies, and resource planners to consider when making land use and water resource decisions in the project watersheds.

1.2 Natural History

According to the Soil Survey of Owen County, Updated Version, October 2005, the earliest evidence of occupation in Owen County is found in burial mounds throughout the county that were created by Native Americans. The Native Americans, who were of the Miami, Potawatami, Eel River, and Delaware tribes, planted corn on the rich bottomland and hunted wild game, which was abundant on the rolling, wooded uplands.

In 1809, when pioneers came to this area, the natives ceded to them most of the area that is now Owen County. The treaty that transferred this land was called the Treaty of Fort Wayne. The boundary established by this treaty, known as the Ten O'Clock Line, runs diagonally across the northeastern part of the county.

An act passed by the Indiana State Legislature on December 21, 1818, to become effective January 1, 1819, established Owen County. The first towns established were Spencer, Freedom, and Gosport. All of these towns were established on the White River, which was used for travel by flatboat and steamboat.

1.3 Physiography, Climate, Precipitation

In the Winter, the average temperature is 29 degrees Fahrenheit. In the summer, the average temperature is 73 degrees Fahrenheit.

Freeze dates in the Spring and Fall are May 15 and September 29 respectively.

The average annual total precipitation is 44.32 inches. Of this total, about 25.19 inches, or 57 percent, usually falls during April through September.

The average seasonal snowfall is 16.9 inches.

The project area is represented by two physiographic units, the Crawford Upland in the western part, and the Mitchell Plain in the eastern part.

The Crawford Upland is characterized by gently sloping or moderately sloping ridges that are separated by valleys with steep side slopes. Nearly level flood plains occur along the streams of both physiographic units.

The Mitchell Plain is characterized by rolling upland areas underlain by limestone. Karst topography is a distinctive feature of this plain.

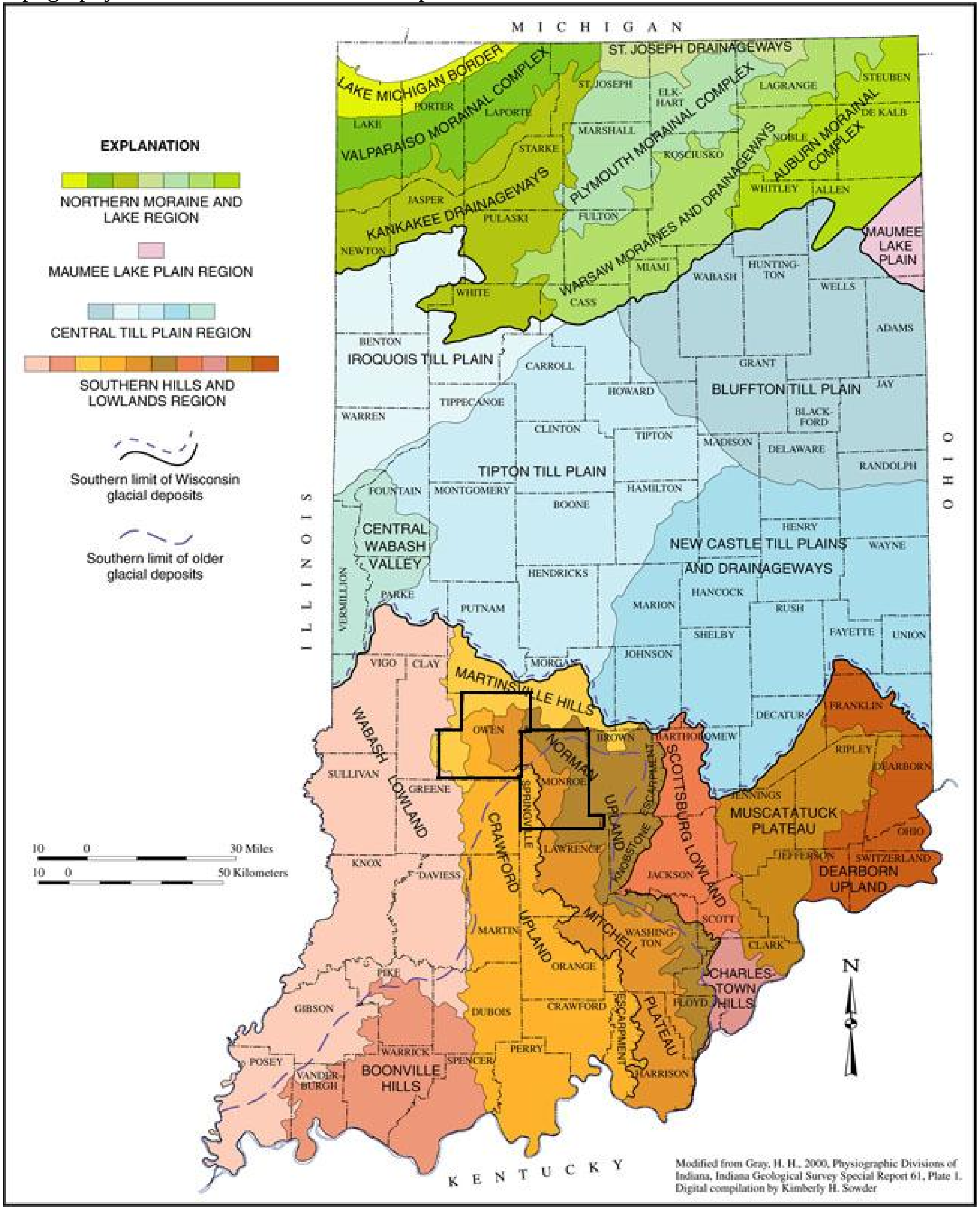

Figure 2. Physiographic Divisions of Indiana (Indiana Geological Survey, 2000)

The karst areas of the Mitchell Plain represent a distinctive type of landscape where water quality concerns are elevated. Karst landscapes occur where carbonate rocks (limestone, gypsum, and dolostone) underlie the surface. Slightly acidic rainwater and the water in the soil slowly dissolve fractures in the rock and create sinkholes and caves.

Shallow aquifers in karst terrains are extremely vulnerable to contamination. The aquifers receive water either by percolation through the soil or by concentrated flow directly into the aquifer from sinkholes. Contaminants associated with agricultural and urban activities that reach these aquifers may be a threat to people using water supplies in karst terrains and to the aquatic life in caves.

Karst features are present throughout the project area.

Research conducted for the Watershed Management Plan will not include ground water studies due to limited resources.

1.4 Natural Resources

1.41 Soils

Because there are a large number of individual soil types within the boundaries of the project area, this report will focus on soil associations. Soil associations are developed by studying the soils in a locality, the way they are arranged, and their main patterns. Each association contains a few major soils and several minor soils, in a pattern that is characteristic although not strictly uniform. Data for the soil associations has been taken from the Owen County Soil Survey and cross-referenced with the Monroe County Soil Survey. Descriptions for the associations are the same, but the two survey's label them differently due to differences in major soil type names.

There are four major soil associations in the project area.

Association Label	Name	General Area	Description	Limitations
1	Genesee-Eel & Stendal-Pope	Along the White River	Nearly level, silty soils of flood plains and terraces	Frequent flooding, drainage, droughtiness
2	Dubois-Otwell	Primarily McCormick's Creek Watershed	Nearly level to very steep, silty soils on old lake bed sediments	Drainage, erosion
3	Negley-Parke	Primarily Mill and Fall Creek Watersheds	Nearly level to steep, silty soils on glacial outwash	Erosion
6	Grayford	Primarily Limestone and Big Creek Watersheds	Nearly level to steep, silty soils on limestone	Erosion, karst features

Table 1. Soil Association Descriptions

1.42 Endangered Species

The project area falls within the ranges of several federally listed species that are either endangered or threatened. Primarily, the endangered Indiana Bat (Myotis sodalist) and the threatened Bald Eagle (Haliaeetus leuccephalus).

Indiana Bats hibernate in caves from late autumn through Winter. They disperse in the Spring to reproduce and forage in relatively undisturbed areas associated with forest and water resources in the Spring and Summer months. The young are raised in nursery colony roosts in trees, typically near drainage ways in undeveloped areas.

Non-reproductive adults usually roost singly in trees, and temporary roosting also occurs on the underside of bridges. Like all other bat species in Indiana, the Indiana Bat's diet consists exclusively of insects.

Eagles nest in close proximity to lakes, rivers, or reservoirs. They construct their nests near habitat ecotones, such as lakeshores, rivers, and timber management areas. Tolerance of human activity during the nesting season has been variable, but, ideally, human disturbance of eagles should be avoided. The Bald Eagle's food base includes carrion, waterfowl, and especially fish. As a top-level predator, they are very sensitive to environmental contaminants.

Table 2 lists both the state and federal species within Owen County that are listed as endangered, threatened, or rare. Since the watershed project covers such a large area, it is likely to contain many of the species listed.

Species Name	Common Name	Federal	State
Diplopoda			
Conotyla bollmani	A Millipede		SR
Crustacean: Malacostraca			
Orconectes inermis testii	Troglobitic Crayfish		ST
Mollusk: Bivalvia (Mussels)			
Fusconaia subrotunda	Longsolid		SE
Lampsilis teres	Yellow Sandshell		
Ligumia recta	Black Sandshell		
Obovaria subrotunda	Round Hickorynut		SSC
Pleurobema clava	Clubshell	LE	SE
Pleurobema pyramidatum	Pyramid Pigtoe		SE
Potamilus capax	Fat Pocketbook	LE	SE
Ptychobranchus fasciolaris	Kidneyshell		SSC
Quadrula cylindrica cylindrica	Rabbitsfoot		SE
Insect: Coleoptera (Beetles)			
Pseudanophthalmus shilohensis boonensis	Cave Beetle		SE
Fish			
Ammocrypta pellucida	Eastern Sand Darter		
Amphibian			
Scaphiopus holbrookii holbrookii	Eastern Spadefoot		SSC
Reptile			
Crotalus horridus	Timber Rattlesnake		SE
Liochlorophis vernalis	Smooth Green Snake		SE
Bird			
Accipiter striatus	Sharp-shinned Hawk	No Status	SSC
Aimophila aestivalis	Bachman's Sparrow		
Ardea herodias	Great Blue Heron		
Coragyps atratus	Black Vulture		
Dendroica cerulea	Cerulean Warbler		SSC
Haliaeetus leucocephalus	Bald Eagle	LT,PDL	SE

Lanius ludovicianus	Loggerhead Shrike	No Status	SE
Mammal			
Lynx rufus	Bobcat	No Status	
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE
Taxidea taxus	American Badger		
Vascular Plant			
Asplenium montanum	Mountain Spleenwort		SE
Carex atlantica ssp. atlantica	Atlantic Sedge		ST
Carex decomposita	Cypress-knee Sedge		ST
Chelone obliqua var. speciosa	Rose Turtlehead		WL
Didiplis diandra	Water-purslane		SE
Erysimum capitatum	Prairie-rocket Wallflower	No Status	ST
Glyceria acutiflora	Sharp-scaled Manna-grass		SE
Hydrastis canadensis	Golden Seal		WL
Juglans cinerea	Butternut		WL
Matteuccia struthiopteris	Ostrich Fern		SR
Panax quinquefolius	American Ginseng		WL
Platanthera psycodes	Small Purple-fringe Orchis		SR
Poa paludigena	Bog Bluegrass		WL
Poa wolfii	Wolf Bluegrass		SR
High Quality Natural Community			
Forest - floodplain mesic	Mesic Floodplain Forest		SG
Forest - floodplain wet-mesic	Wet-mesic Floodplain Forest		SG
Forest - upland dry-mesic	Dry-mesic Upland Forest		SG

Federal Ranking: LE = Endangered; LT = Threatened; C = Candidate; PDL = Proposed for delisting.
State Ranking: SE = State Endangered; ST = State Threatened; SR = State Rare; SSC = State Species of Special Concern; SX = State Extirpated; SG = State Significant; WL = Watch List.

Table 2. Owen County Endangered, Threatened, and Rare Species List (Indiana Natural Heritage Data Center)

1.5 Land Use

1.51 Land Use by Category

Table 3 and Figures 2 -7 show how the watershed project area is divided in to land use categories.

Watershed	Water	Commercial	Agriculture	Residential	Grass Pasture	Forest	Other	Total Acres
Big Creek	12	2	1,013	13	1,068	2,092	0.2	4,200.2
Fall Creek	48	0.2	440	4	436	2,000	0.2	2,928.4
Limestone Creek	51	3	4,569	50	2,009	2,529	0.2	9,211.2
Little Mill Creek	24	0	1,802	Unknown	983	1,285	0.2	4,094.2
McCormick's Creek	23	1	4,641	34	2,557	1,540	0	8,796
Mill Creek	72	2	1,974	13	1,303	4,678	14	8,056
Totals	230	8.2	14,439	114	8,356	14,124	14.8	37,286

Table 3. Acres of land use types by watershed. (National Land Cover Database, 1992)

Big Creek Watershed

Big Creek Watershed is located north of Hwy. 46 in Owen and Monroe counties. It encompasses approximately 4,200 acres.

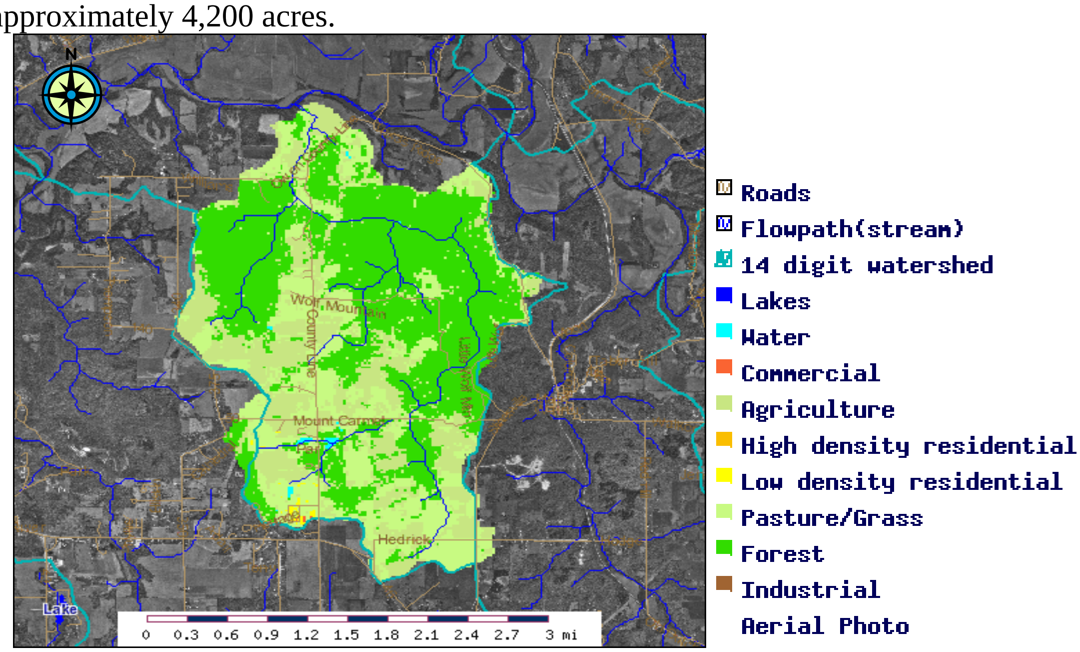

Figure 3. Big Creek Watershed

Fall Creek Watershed

Fall Creek Watershed is located north of Spencer and west of Hwy. 231. It encompasses approximately 2,928 acres.

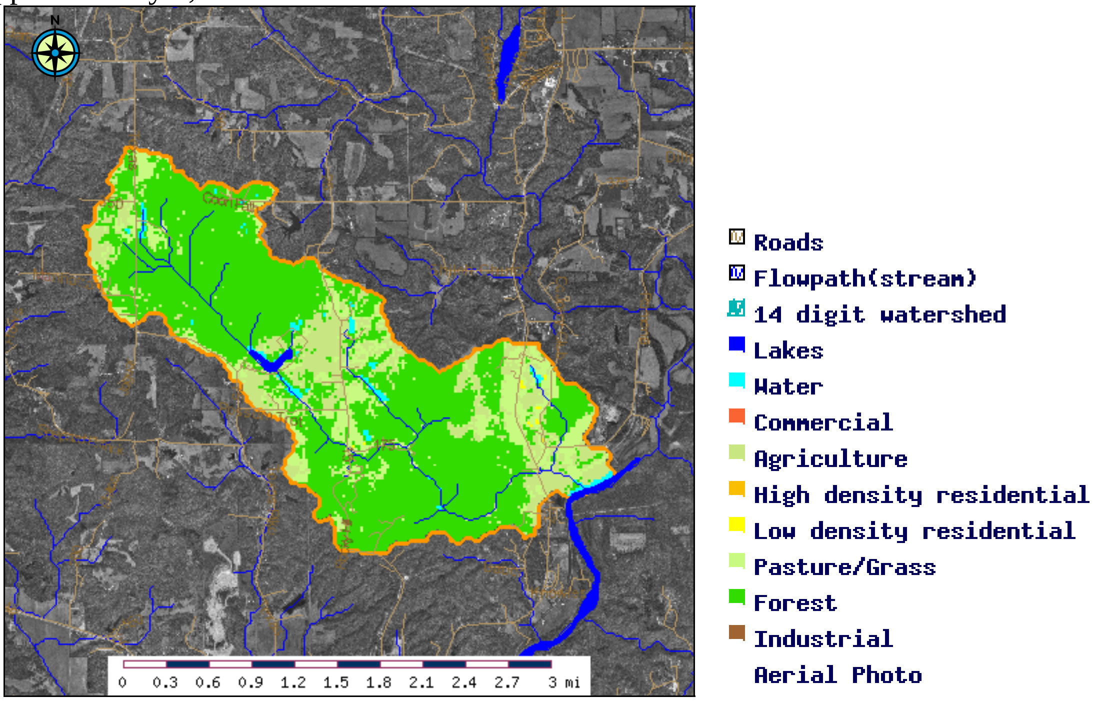

Figure 4. Fall Creek Watershed

Limestone Creek Watershed

Limestone Creek Watershed is located primarily north of Hwy. 67 and west of Gosport. It contains Lake Hollybrook, a privately owned lake approximately 30 acres in size. The watershed encompasses approximately 9,211 acres.

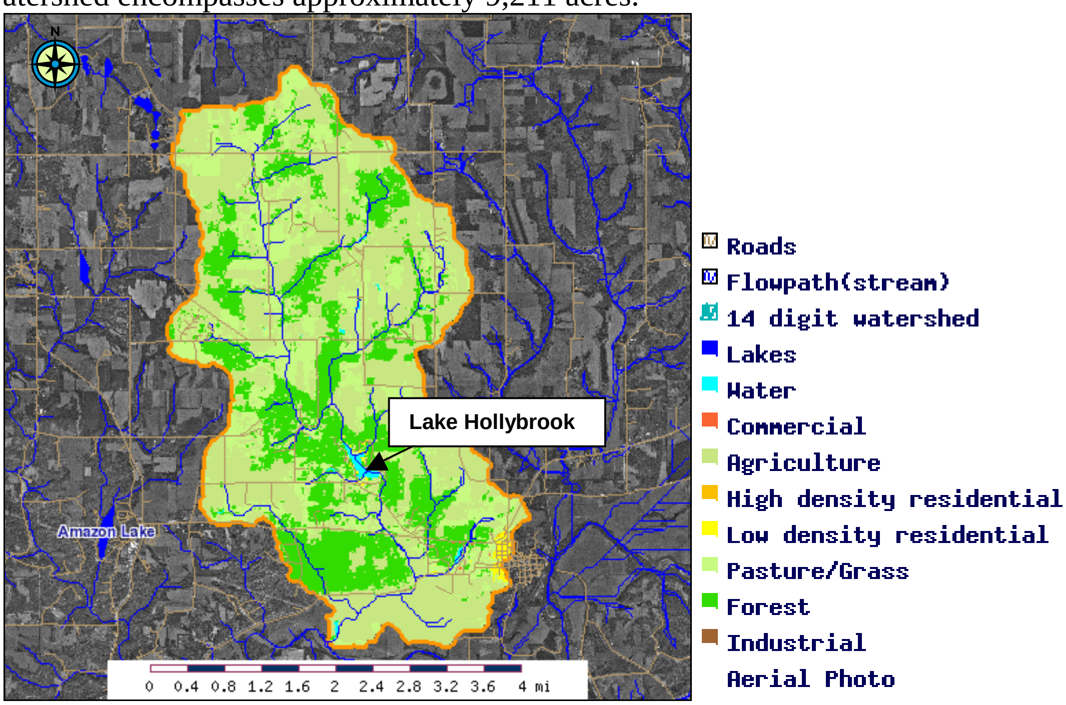

Figure 5. Limestone Creek Watershed

Little Mill Creek Watershed

Little Mill Creek Watershed is a sub-watershed of Mill Creek Watershed. It is located north of Fall Creek Watershed and west of Hwy. 231. It encompasses approximately 4,094 acres.

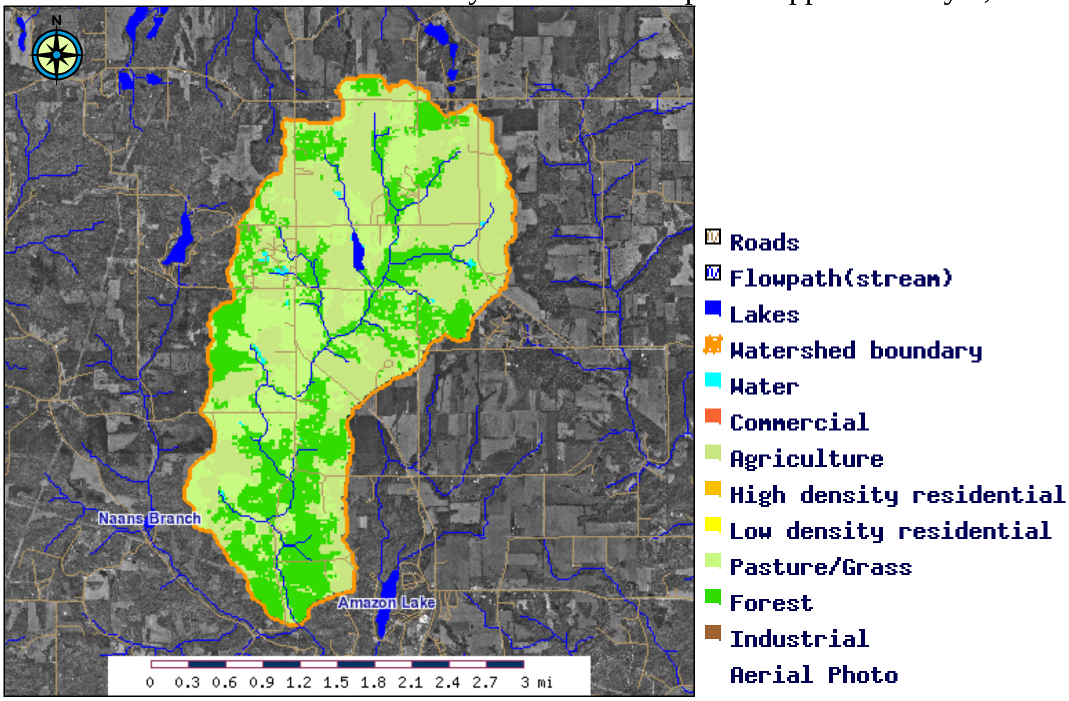

Figure 6. Little Mill Creek Watershed

Mill Creek Watershed

Mill Creek Watershed is located north of Fall Creek Watershed and primarily west of Hwy. 231. It encompasses approximately 12,150 acres (minus Little Mill Creek Watershed, it contains 8,056 acres). Amazon Lake, a privately owned lake is located on the tributary just east of the Little Mill Creek watershed. Locust Lake, another privately owned lake, is located on the tributary west of the Little Mill Creek Watershed.

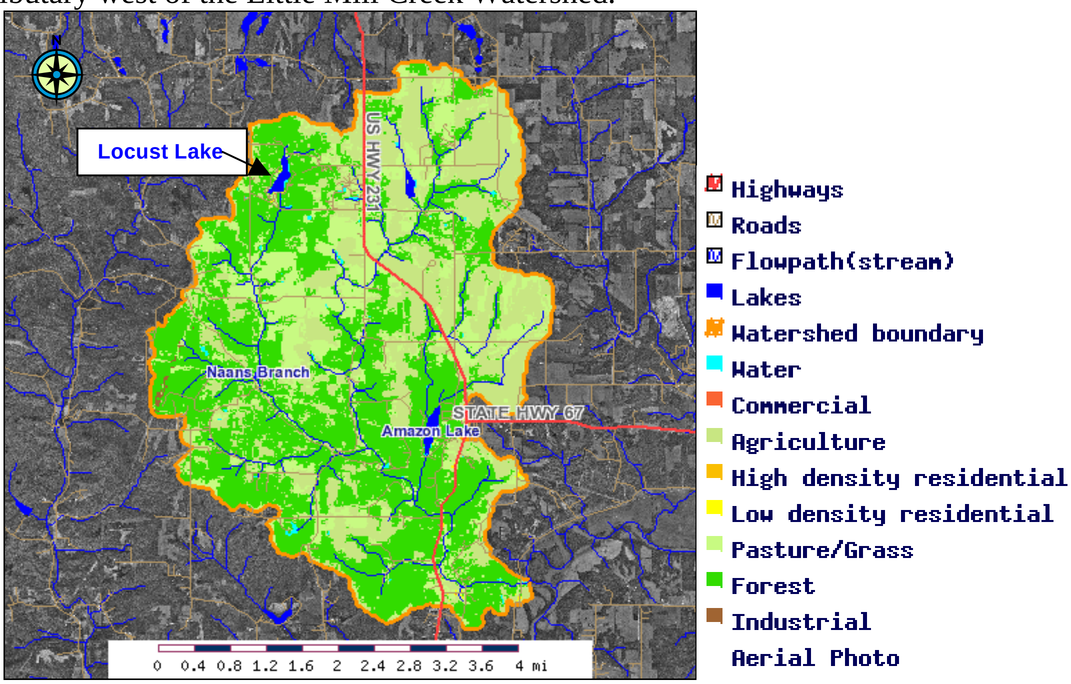

Figure 7. Mill Creek Watershed

<u>McCormick's Creek Watershed</u>
McCormick's Creek Watershed is located in Owen and Monroe counties. It encompasses 8,796 acres with the majority of this acreage south of Hwy. 46. When McCormick's Creek flows under Hwy. 46, it enters McCormick's Creek State Park.

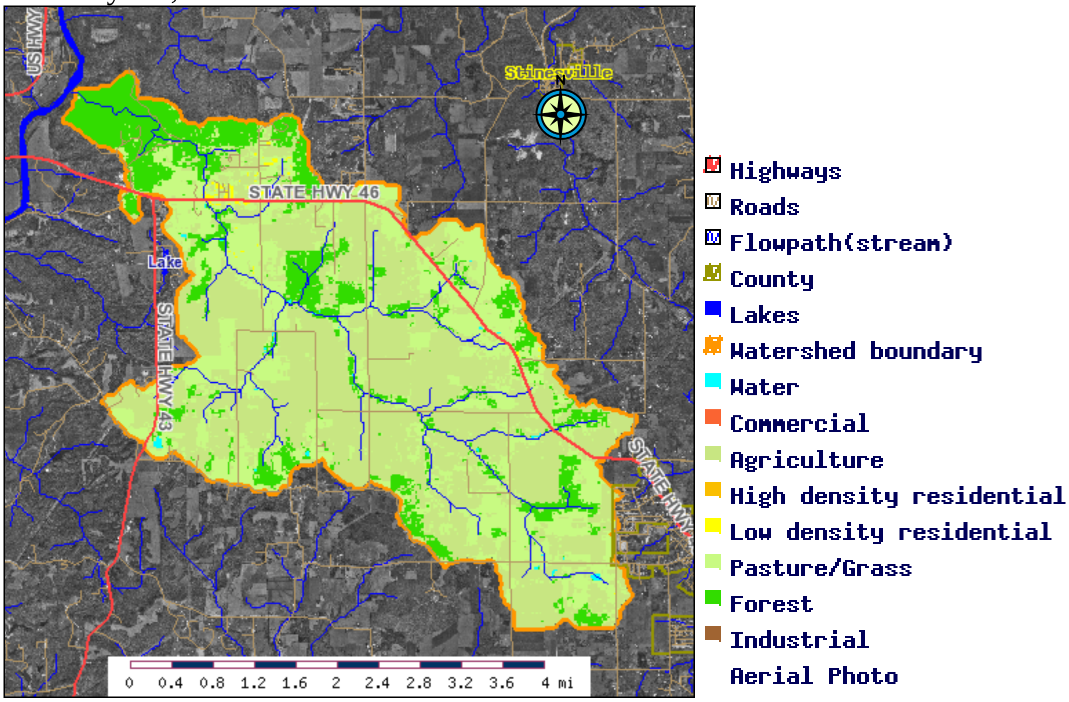

Figure 8. McCormick's Creek Watershed

(Orthophotos source: USGS/NRCS, 1998. Watershed data from Purdue University)

1.52 Forestland

Approximately 38% (14,124 acres) of the watershed project area is forested.

Virgin forest once covered most of the land in Owen and Monroe Counties, but the trees have been removed from most of the land suitable for cultivation. In much of the remaining forestland, the soils are too steep or too wet for farming. Under proper management, the soils in these areas produce trees of high quality. While virtually all of the forested land in the entire project area has been timbered at one time or another during the last 150 years, much of the steeply sloped areas have returned to a state of mature forest.

The most common trees in the uplands are mixed hardwoods, mainly yellow-poplar, sugar maple, white oak, sycamore, red maple, silver maple, and pin oak.

Forested lands that are idle pose no threat to water quality. In fact, they do a great deal to help water quality by holding soil in place to prevent soil erosion and associated sedimentation in receiving waters. The leaf litter and decaying wood help build healthy nutrient rich soil and the canopy creates shade to help maintain water temperatures necessary for fish habitat.

During an interview in October, 2007, District Forester Ralph Unversaw with the Indiana Department of Natural Resource, Division of Forestry, discussed the following existing and pending threats to forest lands in the project area that may contribute to water quality problems.

Poor Timber Harvesting Practices

Timber harvesting companies are aware of recommended Best Management Practices (BMPs) that should be used during harvesting activities to minimize the potential for soil erosion to turn into off-site sedimentation. Many of the timber harvesting companies that operate in Owen and Monroe Counties implement BMPs, but some do not. The timber industry is not regulated by local, state, or federal agencies, so implementation of BMPs is voluntary.

BMPs include: sediment traps; temporary stream crossings; slope protection; perimeter protection; water bars on logging roads; temporary stabilization; and phased land disturbing activities.

Failure to implement BMPs can result in excessive soil erosion. Eroding soil washes off poorly managed logging areas and enters streams, rivers, lakes, and sinkholes.

How trees are selected for harvest can also determine the potential for erosion problems. Selective Harvest, where less than 10% of the canopy is cut, is the best way to insure that no off-site impacts will occur. With this method, only 5 to 12 trees per acre are selected based on their health, maturity and competition with better trees. Unfortunately, only 30 – 40% of landowners in the project area use Select Harvest methods.

A more common method used by timber buyers to select which trees to harvest is referred to as Diameter Limit. With this approach, all trees that are at least 21 inches at the base are harvested. No consideration is given to tree species.

Clear Cutting is another method used in Owen and Monroe Counties. Just as the name implies, all trees are removed during harvest operations. This method denudes the land and has the greatest potential to cause severe erosion/off-site sedimentation problems.

With any harvesting method, it is best to leave the tree tops lying on the ground. Tree tops provide shelter to wildlife and protect new seedlings from browsing deer.

Conversion

Changing land use poses a threat to forested acres. In the watershed project area, conversion usually takes the form of forestland converted to agricultural land uses, or large parcels split into small parcels.

It is anticipated that the changing agricultural markets (corn/biodiesel) will drive producers to convert forestland to cropland. We need to learn from past mistakes for this endeavor to be successful. An excerpt from the Owen County Soil Survey reminds us that…

"During the settlement of Owen County, the pioneers cleared many acres of moderately steep and steep land, as well as nearly level to sloping areas. In the steeper areas productive surface soil was lost through erosion, and as a result, crop yields were reduced within a few years. These areas were abandoned to grow up to brush. Later, many acres of gently sloping land were also abandoned because of depleted fertility and soil erosion. The farmers often moved away, leaving the areas for nature to salvage by natural reforestation. Today, many of these areas are covered by stands of timber that are good to excellent quality."

Large tracts of forested land are commonly converted to small tracts for numerous reasons. In many cases, property owners split land for investment purposes. This trend is expected to continue in light of rising land values. Fragmentation of forest acres creates small parcels that are not managed as successfully as larger parcels.

Invasive Species

Foresters are watching the movement and effects of two primary invasive species that stress forest ecosystems.

The Emerald Ash Borer is a beetle that arrived in the United States from Asia in pallet wood, and the Gypsy Moth.

The Gypsy Moth has been present in Indiana for several years but has not yet been documented in the project area. From late April through May, caterpillars hatch from an egg mass that may contain 500-1000 eggs. The caterpillars climb to the tops of trees where they feed on foliage or dangle from silk strands and drift in the wind to colonize other trees. Oak leaves are their preferred food, but they can eat the foliage of 500 kinds of trees and plants.

The caterpillars can defoliate entire trees. Most trees defoliated by caterpillars eventually produce more leaves, but the reduction of reserve energy stresses the trees. Continued annual defoliation of trees already under stressful conditions may kill them in 2 – 4 years.

Tree mortality can result in significant loss of timber value to forest owners and reduces a forests ability to protect water quality.

Much more information about the Gypsy Moth can be found in the *Strategic Plan for Management of Gypsy Moth in Indiana.*

The Emerald Ash Borer (EAB) targets Indiana's Ash trees. The Emerald Ash Borer has been present in Indiana for several years but has not yet been documented in the project area.

Once infested with EAB, ash trees typically begin declining over a period of 2 – 3 years and become hazardous. Dead and dying trees, weakened or killed by EAB pose a threat to homes, buildings, and public safety.

The burden of dealing with hundreds or thousands of dead trees in a short period of time can place an enormous strain on landowner resources. Mass removal of dead/dying trees by bulldozing is a common practice that leaves soil exposed to the elements and increases the likelihood of off site sedimentation. Downed trees are sometimes burned or pushed into ravines.

The following organizations promote wise use of Indiana forest resources and provide information and assistance on all topics related to woodland management and forestry:

- Indiana Department of Natural Resources, Division of Forestry
- Indiana Forestry and Woodland Owners Association
- Purdue Extension Service
- Indiana Society of American Foresters
- Indiana Woodland Steward

1.53 Agriculture

Agriculture is by far the largest land use category in the project area. Approximately 14,439 acres (39%) are utilized for row crops such as soybeans and corn. Approximately 8,356 acres (22%) are in pasture. Because of these great numbers and the potential land disturbing activities that can occur, agriculture has the greatest potential to contribute pollutants that affect water quality.

Water quality concerns from agriculture are generally defined as non-point source (NPS) pollution. (NPS pollution comes from diffuse sources such as runoff from farm fields, urban areas, subdivisions, etc.)

The 2000 National Water Quality Inventory from EPA identified non-point source pollution as the leading source of water quality impairment for all water bodies in this country. Agriculture is identified as the major contributor of NPS pollutants in the United States. Agricultures impact on the environment should be considered in the context of the amount of land supporting agricultural activities. While other sources of NPS such as urban runoff are significant, agriculture's effect is magnified by the large percentage of land in agricultural use.

Agricultural activities that can contribute to water pollution include confined animal facilities, grazing, plowing, pesticide spraying, fertilizing, planting, and harvesting. The major agricultural pollutants that result from these activities are sediment, nutrients, pathogens, and pesticides. Agricultural activities also can damage habitat and stream channels.

According to the publication "Water Quality and Agriculture," published by the Natural Resources Conservation Service in 1996, "sediment, nutrients, and pesticides become pollutants when they are lost from the farm operation through leaching, runoff, and airborne volatilization or drift. In fact, when chemicals of any kind are used in excess of plant needs, they can migrate beyond the field and become an environmental burden.

Nitrogen, an essential plant nutrient, continually cycles between plants, soil, water, and the atmosphere. Throughout this cycle, nitrogen undergoes complex biochemical transformation to nitrate, a water soluble form that is easily absorbed by plant roots. Excess nitrate can run off and leach through the soil, potentially polluting both ground and surface water. Nitrogen compounds sometimes cause eutrophication (a harmful increase and acceleration of nutrient delivery to water bodies). The eutrophication process depletes oxygen, kills fish, and results in cloudy, putrid water.

Phosphorus, another essential nutrient, is the agent responsible for eutrophication in water bodies in which it is the limiting nutrient. Excessive phosphorus will support unlimited rates of aquatic plant growth that choke the water body.

Pesticides cost the agricultural sector about $6 billion annually. For many, pesticides are key to producing a nationally abundant supply of low cost food and fiber. Some 70 percent of the pesticides used in agriculture are herbicides. Pesticides present health risks to humans and aquatic life.

Sediment has been called a soil resource out of place. Sediment is eroded soil deposited on the land and in streams, rivers, drainage ways, and lakes. It degrades water quality and often contains agrichemicals." Sediment is the number one pollutant by volume in Indiana.

1.54 Urban and Residential Areas

Land use analysis data documents that urbanized areas (residential and commercial) cover 122 acres in the project area. Most of the residential areas are accounted for in small homesteads, minor subdivisions, and the western-most sides of the towns of Gosport and Ellettsville. Commercial areas are located in Gosport, Ellettsville, and scattered throughout the project area. They are defined as: gas stations; one limestone quarry; churches; the Humane Society; Department of Transportation facilities; and miscellaneous small businesses.

The *Indiana Stormwater Manual* published by the Urban Wet Weather Section of IDEM in 2007 does an excellent job of explaining the impacts of urbanization on a watershed. The following excerpt summarizes how urban areas affect water quality.

During the study phase of this project, we will set out to determine if the following urban impacts are present in the project area.

"A watershed's physical, chemical, and biological characteristics are generally altered when land undergoes some type of development. The watershed's storm water runoff quantity and quality can also be significantly affected. This is particularly true when undeveloped or agricultural land is converted to urban uses. For example, the hydrologic changes in an urban watershed are often magnified due to an increase in impervious surfaces such as rooftops, streets, sidewalks, and parking lots. This increase in impervious surface area usually decreases the amount of time it takes for storm water runoff to move from remote areas of the watershed to the receiving stream or water body. In addition, urban development usually requires the construction of storm water conveyance systems which are typically designed to convey storm water runoff in an efficient manner without regard for its impact. Therefore, not only is it quicker for storm water runoff to flow over paved surfaces versus a natural landscape, but these conveyance systems can expedite drainage into the nearest receiving water body. The overall result is a significant change to the predevelopment hydrologic conditions of the watershed. A drop of water that used to take hours or days to make its way through the watershed to a receiving water body now take a matter of minutes or hours.

An increase in peak runoff volumes generally results in the alteration of stream channels, natural drainageways, and riparian habitats. These alterations can have a significant impact on the reduction, and in some instances the elimination, of aquatic vegetation and organisms and can degrade water quality. Other potential effects include increased streambank erosion and streambed scouring, channel siltation, increased water temperatures, decreased dissolved oxygen levels, and changes to the morphology of the watercourse.

Increased pollutant loadings and discharges are still another impact of urban storm water runoff from impervious surface areas. Pollutants associated with urban areas are specific to the type and intensity of the land use. Some examples of pollutants associated with urban land uses include sediments, nutrients, oxygen demanding substances, road deicing agents, heavy metals, oil and grease, hydrocarbons, and bacteria."

Developing lands have the potential to adversely affect water quality. Sediment is the most common pollutant associated with storm water runoff from construction sites. Sediment is also the primary pollutant that is addressed by state and local officials when they regulate construction projects. However, there are several other pollutants associated with construction activities. These pollutants include, but are not limited to, solid wastes, nutrients, pesticides, petroleum products, and chemicals associated with construction activities. On projects where heavy equipment is utilized there is potential for the release of pollutants from vehicle refueling, fuel storage facilities, and equipment and maintenance areas.

Septic Systems

There are a significant number of homes and businesses on septic systems within the project area and failing septic systems are known sources of *E coli* impairment in waterbodies.

A typical septic system consists of a septic tank and a soil absorption field. The system relies on the soil to remove all of the contaminants. The ideal location for a soil absorption field is a large area with deep, well-drained soils.

Unfortunately, such soils are hard to find in the project area. Most of the soil types have limiting conditions such as a high water table, shallow water-impermeable soil horizons, gravel layers, or compacted zones.

Most home and business owners recognize the signs of a failed septic system: indoor plumbing facilities that won't drain down or back up; discolored, malodorous water surfacing in the leach field; and a "spongy" feeling in the ground around the leach field. They also understand that problems with septic systems can lead to unhealthy conditions in the home and yard that can lead to illness.

Some septic systems owners who cannot afford to repair or replace their failed septic systems, "fix" the system by installing drain pipes that carry effluent away from their yards. These pipes may outlet on the surface of the ground or directly into waterways. This type of "midnight connection" contributes to high *E.coli* readings in water bodies, particularly during dry weather conditions.

1.55 Public Lands

The McCormick's Creek Watershed is home to two parcels of public land. Flatwoods Park, owned and operated by the Monroe County Parks Department, and McCormick's Creek State Park, a premier Indiana State Park operated by the Indiana Department of Natural Resources.

Figure 9. Flatwoods Park on a beautiful summer day.

Figure 10. Waterfall in McCormick's Creek State park.

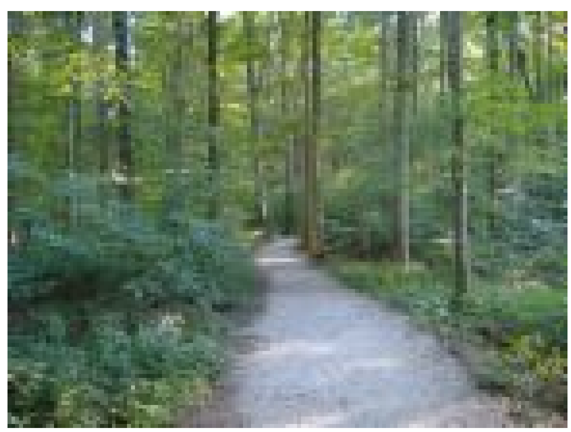

Figure 11. Hiking path in McCormick's Creek State Park

Public lands have the potential to adversely effect water quality due to the volume of people present in the parks during peak seasons and the urban pollutants they generate.

Both facilities have been monitored for pollutants during the research phase of this watershed project. Thanks to diligent over-site and maintenance by the Monroe County Parks

Department and the staff at McCormick's Creek State Park, neither facility has been shown to be a major source of NPS.

Part 2: Partnership Building

2.1 Watershed Partnership and Public Participation

In January, 2007, the Watershed Project was introduced to the public by the Watershed Coordinator at the Owen County Soil and Water Conservation District's Annual Meeting. Speaking to a group of two hundred conservation minded individuals, the Coordinator explained the goals of the project and invited interested individuals to participate. An introductory article was also was published in the District's Annual Report.

In February, 2007, an article entitled "Owen County SWCD Receives New 319 Grant" was published on the front page of the Spencer Evening World newspaper. The article invited the public to participate in the project and provide input.

In March, 2007, the first public meeting was held at McCormick's Creek State Park. Fifteen people were in attendance to learn more about the project and provide input on Resource Concerns.

These initial outreach activities lead to the formation of the Steering Committee.

Partnerships are the key to effective watershed management. That is why the Owen County Lower White River Watershed Initiative was formed at the very beginning of this project. Through the Initiative, people and organizations have worked together on a Steering Committee to address common interests and concerns.

This partnership has proven to be the best way to develop and implement a successful watershed management plan because everyone who is interested has been involved from the beginning. This approach allows for the highest probability that the finished plan will have the consensus of all parties who have a stake in the watershed.

Steering Committee Members

- Aaron Zeis, Chairman, representing Lake Hollybrook
- Donna Klewer, Recorder, representing Public Interest
- Larry Dickinson, representing Public Interest
- Marquita Manley, McCormick's Creek State Park
- Marc Evans, McCormick's Creek State Park
- Paul Cummings, Office of Energy Development
- Connie Schneider, Owen County Soil and Water Conservation District
- Gwen Dieter, Owen County Soil and Water Conservation District
- Martha Miller, Monroe County Soil and Water Conservation District
- Matt Jarvis, Natural Resources Conservation Service
- Dan Perez, Indiana State Department of Agriculture
- Sharon Hall, Consulting Watershed Coordinator

2.2 Mission Statement

The Steering Committee developed the following mission statement as a means to focus and give meaning to the task of developing the Watershed Management Plan.

"The purpose of the Owen County Lower White River Watershed Initiative is to study land use impacts on tributaries of the Lower White River, develop a watershed management plan, and identify partnerships to improve water quality."

2.3 Public Outreach

Public outreach efforts have played an important role in sharing and receiving information about the watershed project area and public concerns.

From the project onset, the Watershed Coordinator, SWCD staff, and members of the Steering Committee have kept the public informed and invited input through newspaper articles, fact sheets, displays, presentations, personal contacts, brochures, and workshops.

Outreach Activities….

- March 22, 2007 – Kick-Off meeting
- Display and presentations at the Owen and Monroe County Annual Meetings
- Display and personal contacts at the Owen County 4-H Fair
- Presentations for the Owen and Monroe County SWCD Board of Supervisors
- Presentation for the Friends of McCormick's Creek Group
- Presentation for the Lake Hollybrook Association
- Presentation for the Amazon Lake Assoication
- Presentation for the Locust Lake Association
- Presentation for the Owen and Monroe County Commissioners
- Presentation for the Owen and Monroe County Drainage Boards.
- Presentation for the Gosport Town Council
- Numerous articles in local newspapers
- Three presentations for middle school students
- Two presentations at public library for children/families
- Thirteen Steering Committee meetings

Septic System Workshop

On August 16, 2008 a free workshop entitled "Flushing Into the Future" was offered to the public. Twenty-seven people were in attendance to hear Debbie Barnhizer of the Indiana State Board of Health discuss how septic systems work and how to maintain them.

The workshop was sponsored by the Watershed Initiative and the Owen and Monroe County Health Departments.

2.4 Resource Concerns

The following list of concerns related to water quality was generated at the March 2007 Grant Kick-Off meeting:

Lake Sedimentation
Lake Non Point Source Pollution
Education
Trash in Streams and in the White River
Illegal Dumping Along Roadsides
Pet Waste at the Owen County Humane Society
Animal Waste
Proper Application of Animal Waste on Cropland
Bank Stabilization
Flooding of Property and Roads
Faulty Septic Systems
E.coli
Lack of Conservation Buffers
Designation of Application Areas for Septic Haulers

At the first Steering Committee meeting on May 16, 2007, the committee clarified and combined the list of concerns, added their own input, then sorted the concerns into four working categories:

1. Education – illegal dumping; faulty septic systems; *E.coli*; trash in streams; homeowner/residential/commercial issues including herbicide/pesticide application.
2. Agriculture- poorly managed livestock feedlot/drylot runoff; pasture management; lack of vegetated buffers along streams, ditches, and other environmentally sensitive areas; improper application of animal waste on cropland; improper herbicide/pesticide application; poor timber harvesting techniques; lack of nutrient management plans.
3. Water Quality – lake sedimentation; unstable stream banks; *E.coli*; improper nutrient management; improper herbicide/pesticide application.
4. Other – impacts from the towns of Ellettsville and Gosport.

Research was conducted to determine if pet waste at the Humane Society was impacting water quality. The Watershed Coordinator visited the facility numerous times during rain events and did not observe conditions where pet waste would effect water quality. The Steering Committee opted to drop this item from the list of concerns.

Research was conducted to determine if there were any designated areas where septic haulers land apply human waste. A check of IDEM's database revealed that there are no permitted waste disposal areas in the project area. The Steering Committee opted to remove this item from the list of concerns.

The Steering Committee discussed the item "flooding of property and roads" and determined that this issue deals more with water quantity not water quality. This item was removed from the list.

Problem Statements

To further clarify the meaning behind each item noted on the List of Concerns, the Steering Committee developed a preliminary set of Problem Statements (as follows).

With the concerns and problems clarified and sorted, the research phase of the project began. The group set out to determine how, if at all, each of the suggested problems were affecting water quality. The findings of this research are documented in Part 3, Watershed Inventory.

Category: Sediment - Agricultural Land
Problem statements:

1. Poorly managed pastures are eroding and contributing to sedimentation of water resources.
2. Poorly managed highly erodible cropland acres are eroding and contributing to sedimentation of water resources.
3. Cultivation of cropland near streams, ditches, and other environmentally sensitive areas causes erosion of banks and contributes to sedimentation of water resources.
4. Poor timber harvesting techniques increase surface erosion and sedimentation of receiving waters.
5. Livestock that have access to streams and creeks contribute to excessive bank erosion.

Category: Sediment - Urban Lands
Problem Statement:

1. Developing lands that do not use erosion and sediment control best management practices during construction contribute to sedimentation of water resources.

Category: Sediment - Water Resources
Problem Statement:

1. Unstable stream banks and lake shores contribute to sedimentation of water resources.

Category: Nutrients – Agricultural Land
Problem Statements:

1. Poorly managed livestock feedlot and dry lot runoff contributes excess nutrients to receiving waters.
2. Improper application of animal waste and fertilizers on cropland acres allows contaminated runoff to enter surface and subsurface waters.
3. Improper usage of herbicides and pesticides allows contaminated runoff to enter surface and subsurface waters.
4. Poorly managed pastures are eroding and contributing excess nutrients to water resources.

Category: Nutrients – Urban Lands
Problem Statement:

1. Over-fertilization of lawns/grassy areas allows contaminated runoff to enter surface and subsurface waters.

Category: Nutrients – Water Resources
Problem Statement:

1. An over-abundance of geese on the lakes in the project area contribute excess nutrients to the lakes and associated down-stream water resources.

Category: *E.coli* - Agricultural Land
Problem Statements:

1. Poorly managed livestock feedlot and dry lot runoff contributes bacteria in the form of *E.coli* to receiving waters.
2. Improper application of animal waste on cropland acres allows runoff contaminated with *E.coli* to enter surface and subsurface waters.
3. During rain events with runoff, animal waste on poorly managed pastures washes into receiving waters and contributes to excessive *E.coli* levels.
4. Waste from livestock that have access to streams and creeks contributes to excessive *E.coli* levels.

Category: *E.coli* – Urban Land
Problem Statement:

1. Faulty residential septic systems contribute to elevated *E.coli* levels in receiving waters.

Category: *E.coli* – Water Resources
Problem Statement:
None

Category: Miscellaneous Urban Issues
Problem Statements:

1. Illegal dumping along roads contributes trash and unknown pollutant impacts to receiving waters.
2. During runoff events, urbanized areas contribute the following pollutants that degrade water quality: oil, grease, antifreeze, hydraulic fluids, brake dust, gasoline, transmission fluid, and salt/sand from winter deicing activities.

Part 3: Watershed Inventory

This section summarizes a number of water quality studies that have been conducted in the watershed, and examines new data collected to access the extent of water quality impairments and the potential sources for the impairments

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3.1 Water Quality Targets

During the November, 2007 Steering Committee meeting, the committee identified the following water quality targets/standards to be used for the purpose of this Watershed Management Plan. Where Indiana Standards are available, they have been used.

- Dissolved Oxygen >5 mg/l
- Nitrates <4 mg/l
- pH between 6 and 9
- Phosphorus 0.3 mg/l
- Turbidity 36 NTU
- TSS 40 mg/l
- *E.coli* 235 cfu

The standards set for *E.coli*, Dissolved Oxygen, pH, and Phosphorus (draft), come from Indiana Standards established by The Indiana Department of Environmental Management.

The Water Quality Target set for Nitrates, <4 mg/l, is recommended by Hoosier Riverwatch, a state-sponsored water quality monitoring initiative.

The Water Quality Target set for Total Suspended Solids (TSS), 40 mg/l, coincides with the maximum allowable discharge standard used for discharges from waste water treatment plants.

The Water Quality Target set for Turbidity, 36 Units of Turbidity (NTUs), coincides with the Indiana average as identified by Hoosier Riverwatch.

3.2 Existing Information

Several water quality reports done in recent years analyze and address problems found in portions of the watershed project area. These reports provided the basis for which this watershed study was initiated.

3.2.1 The 305(b) Report documents that water quality impairments exist in the White River, McCormick's Creek, Fall Creek, and Limestone Creek watersheds. These watersheds are listed on the 303(d) list of impaired water bodies for Impaired Biotic Communities and *E.coli* problems.

The research conducted for Impaired Biotic Communities occurred in 1992 and 2001. Because so many years have passed since this research was done, this WMP will not attempt to compare or contrast data collected during this project with the IBC data. It is anticipated that the land use data collected for this document will be a valuable resource when IDEM conducts IBC re-sampling activities in the future.

While Mill Creek, Little Mill Creek, and Big Creek watersheds are not on the 303(d) list, these watersheds, being similar in nature to the others, are suspected of having the same non-point source water quality impairments.

3.2.2 In 2006, IDEM conducted an *E.coli* **Total Maximum Daily Load (TMDL)** study on the Lower White River Watershed. Since the entire project area is comprised of sub-watersheds of the Lower White River Watershed, this study provides relevant information on *E.coli* problems.

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). TMDLs provide states a basis for determining the pollutant reductions necessary from both point and non-point sources to restore and maintain the quality of their water resources. The purpose of the TMDL is to identify the potential sources and determine the allowable levels of *E. coli* bacteria that will result in the attainment of the applicable WQS in the Lower White River Watershed.

The conclusions reached in the TMDL study found that the sources of *E.coli* in the Owen County tributary watersheds include both point and nonpoint sources. Non-point sources include wildlife, failing septic systems, and small livestock operations.

In order for the watersheds to achieve Indiana's *E.coli* WQS, a wasteload and load allocation has been set to the *E.coli* standard of 125 Colony Forming Units per one hundred milliliters as a geometric mean based on not less than five samples collected equally spaced over a thirty day period from April 1st to October 31st.

Achieving the wasteload and load allocations depends on:

- Nonpoint sources of *E.coli* being controlled by implementing best management practices in the watersheds.
- National Pollutant Discharge Elimination System permitted dischargers not violating their permits.
- Implementation of this Watershed Management Plan.
- Addressing failing septic systems.

3.2.3 National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are three NPDES permitted facilities in the Owen County. Watershed Initiative area. All three of the facilities have *E. coli* discharge limits in their permits. At the time of this writing, all three facilities are in compliance with their permits.

- Deer Creek Subdivision
- McCormick's Creek State Park
- McCormick's Creek Elementary School

3.2.4 Storm Water General Permit Rule 13

There are no municipal separate storm sewer systems (MS4) communities in the Owen County. Watershed Initiative area.

3.2.5 Combined Sewer Overflows (CSO)

There are no CSO communities in the Owen County Watershed Initiative area

3.2.6 Confined Feeding Operations (CFO) and Concentrated Animal Feeding Operations (CAFO)

There are no livestock operations within the Owen County Watershed Initiative area that can be described as CFOs or CAFOs. There are however numerous small farms, horse farms, and hobby farms.

3.3 Macroinvertebrate Research

Benthic Macroinvertebrates are organisms 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.

Macroinvertebrates include aquatic insects (mayflies, stoneflies, caddisflies, midges, beetles), snails, worms, freshwater mussels, and crayfish.

Macroinvertebrate monitoring focuses on the number and type of organisms in an area. It allows us to observe changes in the population and richness of aquatic communities. Decreasing diversity of organisms and population counts may indicate the effects of pollution on a stream.

Biological stream monitoring is conducted because aquatic organisms react to pollution in different ways. Pollution-sensitive organisms such as mayflies, stoneflies, and caddisflies are more susceptible to the effects of physical and chemical changes in a stream than other organisms. Pollution-tolerant organisms such as midges and worms are less susceptible to changes in physical and chemical parameters. The presence or absence of such indicator organisms is an indirect measure of pollution. When a stream becomes polluted, pollution-sensitive organisms decrease in number or disappear; pollution-tolerant organisms increase in variety and number.

Six sampling sites, one in each sub-watershed, were selected for macroinvertebrate monitoring. Site 4 in McCormick's Creek Watershed. Site 5 in Fall Creek Watershed. Site 7 in Mill Creek Watershed. Site 8 in Little Mill Creek Watershed. Site 9 in Limestone Creek Watershed. Site 12 in Big Creek Watershed.

Sampling was conducted on September 22, 2007 in McCormick's Creek and Fall Creek watersheds. On October 6, 2007, in Limestone Creek and Big Creek. On October 28, 2007, in Mill Creek and Little Mill Creek watersheds.

Sampling activities were conducted using Hoosier Riverwatch techniques and results have been interpreted using the Riverwatch recommended Biological Monitoring Data Sheets to determine the Pollution Tolerance Index (PTI) for each watershed.

On the PTI rating scale, a value of 23 or more is considered "excellent." A value between 17 – 22 is considered "good." A value between 11 – 16 is considered "fair." A value of 10 or less is considered "poor."

Based on this rating system, the following scores were recorded:

McCormick's Creek – 30
Fall Creek – 18
Mill Creek – 29
Little Mill Creek – 23
Limestone Creek – 16
Big Creek – 27

3.31 Summary of Macroinvertebrate Research

The baseline macroinvertebrate data collected in McCormick's Creek, Fall Creek, Mill Creek, Little Mill Creek, and Big Creek documents the presence of sufficient indicator organisms to designate the watersheds a rating of "excellent" to "good".

Future macroinvertebrate studies can use the information collected in these watersheds to observe changes in the population and richness of aquatic communities over time.

Based on the "fair" designation assigned to Limestone Creek, the Limestone Creek Watershed has been identified as an area of concern.

3.4 Stream Habitat Analysis

To access stream habitat and riparian area health, the Citizens Qualitative Habitat Evaluation Index (CQHEI) was used. The CQHEI provides a look at how physical factors in and around the stream effect aquatic organisms and overall stream health.

The CQHEI produces a total score that can be used to compare changes at one site over time or compare different sites. The maximum total points for the CQHEI is 114. Streams that score over 100 are considered to be of exceptionally high quality. A set of ranges for "excellent, medium, poor, very poor" have not yet been developed for this index. However, scores of >60 have been found to be generally conducive to the existence of warmwater fauna.

Based on this rating system, the following scores were recorded:

McCormick's Creek – 84
Fall Creek – 69
Mill Creek – 89
Little Mill Creek – 90
Limestone Creek – 54
Big Creek – 87

3.41 Summary of Habitat Research

McCormick's Creek, Fall Creek, Mill Creek, Little Mill Creek, and Big Creek are considered to be streams (with scores of 60 or more) that are conducive to the existence of warm water fauna. Future habitat studies can use the information collected in these watersheds to observe changes in the physical characteristics of the streams over time.

The score of 54 for Limestone Creek is below the desired score of at least 60. Finding this, the Limestone Creek Watershed has been identified as an area of concern.

3.5 Land Use Analysis

Water chemistry sampling, macroinvertebrate research, and stream habitat analysis are only pieces of the water quality puzzle. To a great degree, water quality problems begin on land.

Evaluating how people use the land in a watershed provides the information necessary to evaluate existing conditions and plan for the future.

The Land Use Maps in Section 1.5 help us get a general idea of the lay of the land. On a large scale, they show agricultural land, forests, residential and urbanized areas, and water resources.

In this section, we will take a close look at these resources and assess their potential to contribute to poor water quality. We translate this information into Pollutant Sources.

3.51 Windshield Surveys

In the Fall of 2007, Steering Committee members and the SWCD staff worked with the Watershed Coordinator to conduct windshield surveys of the project area. Windshield surveys are done to gain first hand knowledge of where resources are located and to identify possible pollutant sources.

Teams of two to three people (driver, recorder, observers) traveled throughout the watersheds stopping at bridges and other points of interest to fill out data sheets where information was recorded on: tillage; field erosion; streambank erosion; riparian buffers; animal access to streams; pasture land management; and urban impacts.

A sample of one of the Windshield Survey forms can be found in Appendix D.

The parameters that were observed are defined as follows:

- Tillage – whether fields were planted using conventional or conservation tillage (determined by the amount of residue present).
- Field Erosion – Signs of erosion included bare soil with rills or gullies formed.
- Streambank Erosion – In-channel erosion of banks quantified as major, moderate, or minor.
- Riparian Buffers – indicated the presence or absence of a vegetated area between the crop field and stream. If a buffer was in place, indicated the vegetation type present. Inadequate buffers were defined as buffers less than 30 feet wide
- Animal Access to Streams – indicated whether or not domestic animals have access to streams.
- Pasture Land Management – indicated the presence or absence of overgrazing, bare soil, and trampled vegetation.
- Urban Impacts – indicated whether urban impacts were major, moderate, or minor. (trash, impacts from land use such as construction sites, parking lots, heavy use residential , impacts from roads such as salt, sand, heavy metals, petroleum products…)

Figure 12 identifies and locates potential pollutant sources observed during Windshield Survey activities. These include: a limestone quarry; urban areas, trash, animal access to surface water, field and stream bank erosion, over-grazed pastures, and areas where vegetated buffers are needed.

Windshield Survey Summary by Watershed

<u>McCormick's Creek Watershed</u>

Data collectors stopped at sixteen sites in the McCormick's Creek Watershed.

- Trash in a sinkhole was identified as a minor problem at one site.
- Trash along County Line Road was identified as a major problem.
- No visual observances of failing septic systems were noted.
- Stream bank erosion was identified as a problem at five sites.
- Negative urban impacts were identified as a problem at four sites.
- No visual observances of field erosion were noted.
- Riparian buffers were either inadequate or absent at five sites.
- Over-grazed pastures were noted at two sites.
- Domestic animal access to surface water was identified at two sites.

<u>Mill Creek Watershed</u>

Data collectors stopped at fourteen sites in the Mill Creek Watershed.

- Trash was identified as a minor problem at two sites.
- No visual observances of failing septic systems were noted.
- Stream bank erosion was identified as a problem at ten sites.
- Negative urban impacts were identified as a problem at six sites.
- Field erosion was noted at two sites.
- Riparian buffers were either inadequate or absent at five sites.
- Over-grazed pastures were noted at two sites.
- Domestic animal access to surface water was identified at one site.

Little Mill Creek Watershed

Data collectors stopped at seven sites in the Little Mill Creek Watershed.

- Trash was identified as a minor problem at one site and a major problem at one site.
- No visual observances of failing septic systems were noted.
- Stream bank erosion was identified as a problem at four sites.
- Negative urban impacts were identified as a problem at three sites.
- Riparian buffers were either inadequate or absent at one site.
- Domestic animal access to surface water was identified at one site.

Fall Creek Watershed

Data collectors stopped at four sites in the Fall Creek Watershed.

- Trash was identified as a major problem at one site.
- Stream bank erosion was identified as a problem at two sites.
- Negative urban impacts were identified as a problem at two sites.
- Field erosion was noted as a problem at two sites.

Big Creek Watershed

Data collectors stopped at six sites in the Big Creek Watershed.

- Stream bank erosion was identified as a problem at two sites.
- Major urban impacts were identified at one site (a golf course).
- Over-grazed pastures were identified at two sites.

Limestone Creek Watershed

Data collectors stopped at fourteen sites in the Limestone Creek Watershed.

- Trash was identified as a major problem at one site and a moderate problem at one site.
- Stream bank erosion was identified as a problem at six sites.
- Negative urban impacts were identified at two sites.
- Signs of field erosion were identified at one site.
- Riparian buffers were either inadequate or absent at eight sites.
- Animal access to surface water was identified at three sites.
- Over-grazed pastures were identified at two sites.

General Windshield Survey Summary

The Windshield Survey provided a small glimpse at the land use activities in the project area. It is at best, “the tip of the iceberg” due primarily to the rolling topography, lack of interior roads, and wide spans of forest limiting the Collector’s line of site.

In general, the need for sound natural resource management to preserve and protect water quality had been documented.

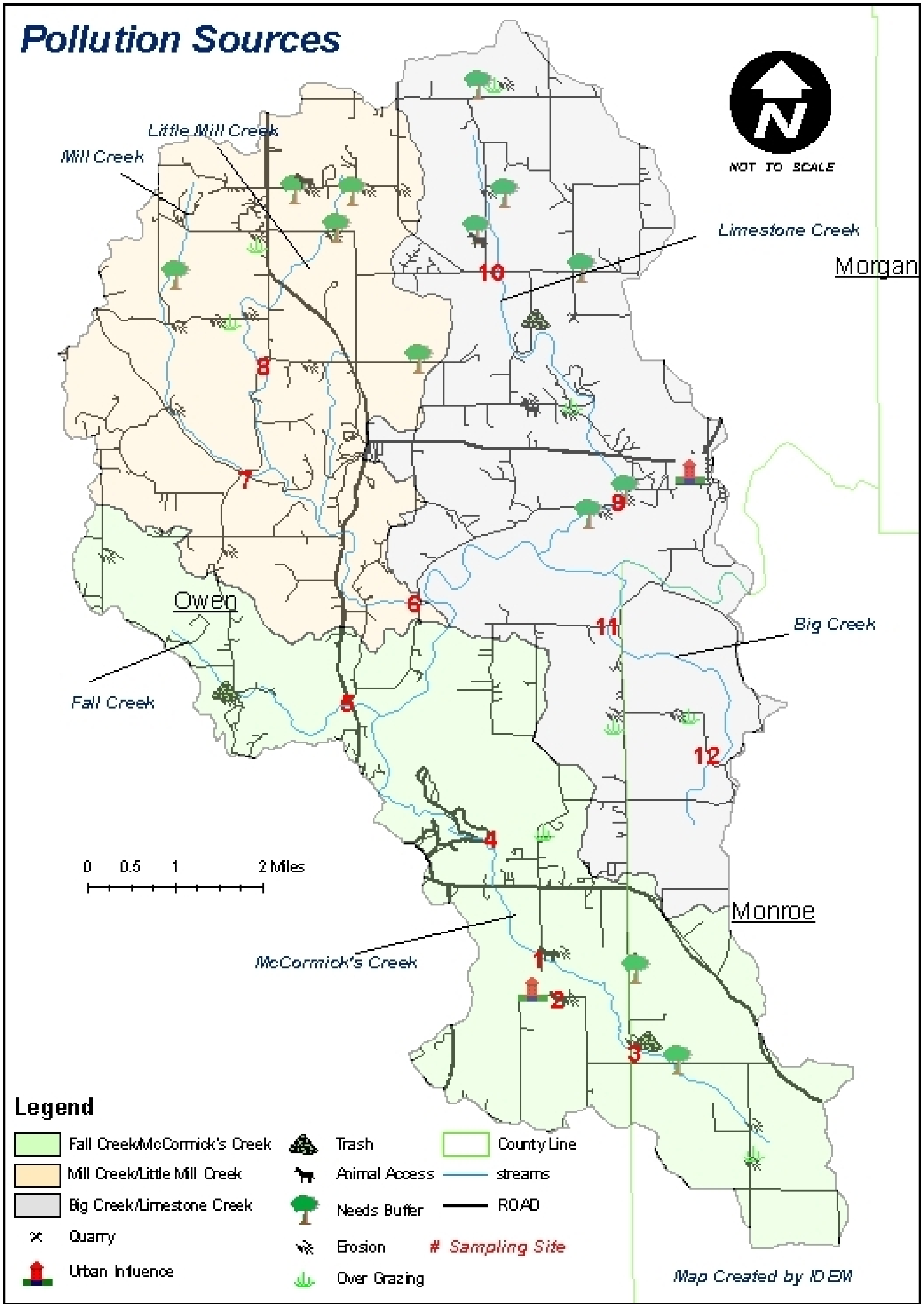


Figure 12. Windshield Survey Source Map

3.52 Forestry

Poor Timber Harvesting Practices

The negative environmental impacts of poor timber harvesting practices begin during the actual harvest and continue for years. Case in point, the following pictures were taken in July of 2008, three years after the subject land (in the Limestone Creek Watershed) was timbered. The current owners purchased the land after the harvest was complete, so they bear no responsibility for the problems, only the challenge of stabilizing severely eroding areas.


Eroding areas left unstable after logging operation.

Since harvesting takes place on private lands, there is no way to quantify the negative impacts to water quality of past and present harvests.

Although it varies greatly, it is estimated that 5 – 6 harvests occur in the project area each year.

Conversion

Conversion of forest acres to agricultural land uses was not observed during the study phase of this project. The Owen County SWCD will partner with the IDNR, Division of Forestry to monitor conversion over the years to determine the impacts to water quality.

Invasive Species

The negative effects of the Emerald Ash Borer and the Gypsy Moth were not observed during the study phase of this project. Field studies are currently being conducted by the IDNR Division of Forestry to track the presence of these species.

3.53 Residential and Urbanized Areas

Trash

Traveling throughout the project area, it is a common occurrence to encounter trash along roadsides, in sinkholes, and in streams. This illegal dumping of trash comes in three forms. Trash carelessly throw from a car window while driving down the road, purposeful dumping of bagged household trash, purposeful dumping of household appliances.

Illegal dumping is hazardous to the environment. Refrigerators, tires, auto parts and televisions contain heavy metals and others toxins.

Illegally dumped material quickly becomes a breeding habitat for mice, rats and mosquitoes, which can spread diseases such as encephalitis, and West Nile Virus Disease.

Illegal dumping costs County tax payers thousands of dollars each year. The burden of removing trash falls on state and local highway departments who must invest man hours in clean up activities and then pay to dispose of trash in landfills.

Trash in tributary of Mill Creek.

Trash along Ramona Road (Limestone Creek Watershed)

Trash was frequently observed along roadsides during land use inventory activities. During rain events, trash washes off of the roads and into receiving waters. Trash was occasionally observed in streams. Most notably trash was observed in McCormick's Creek at County Line Road and in Limestone Creek along Ramona Road. This threat to water quality can be classified as minor due to the low volume of trash, but not insignificant.

Septic Systems

Conversations with staff from the Monroe and Owen County Health Departments indicate that septic system failure does occur. The Monroe County Health Department indicates a failure rate of approximately 2-3% from experimental evidence (Cain, 2007 Personal Communication), and the Owen County Health Department indicates an approximate failure rate of 10 to 15 % (Reeves, 2007 Personal Communication).

The septic systems described by this information provide a constant source of *E.coli* particularly during low to mid-range stream flow conditions.

Rural subdivisions where septic systems are in use have the potential to have substantial impacts to water quality due to the concentration of housing. Figures 10 and 11 show the location of rural subdivisions in Monroe and Owen Counties respectively. Appendix G contains the names of the subdivisions.

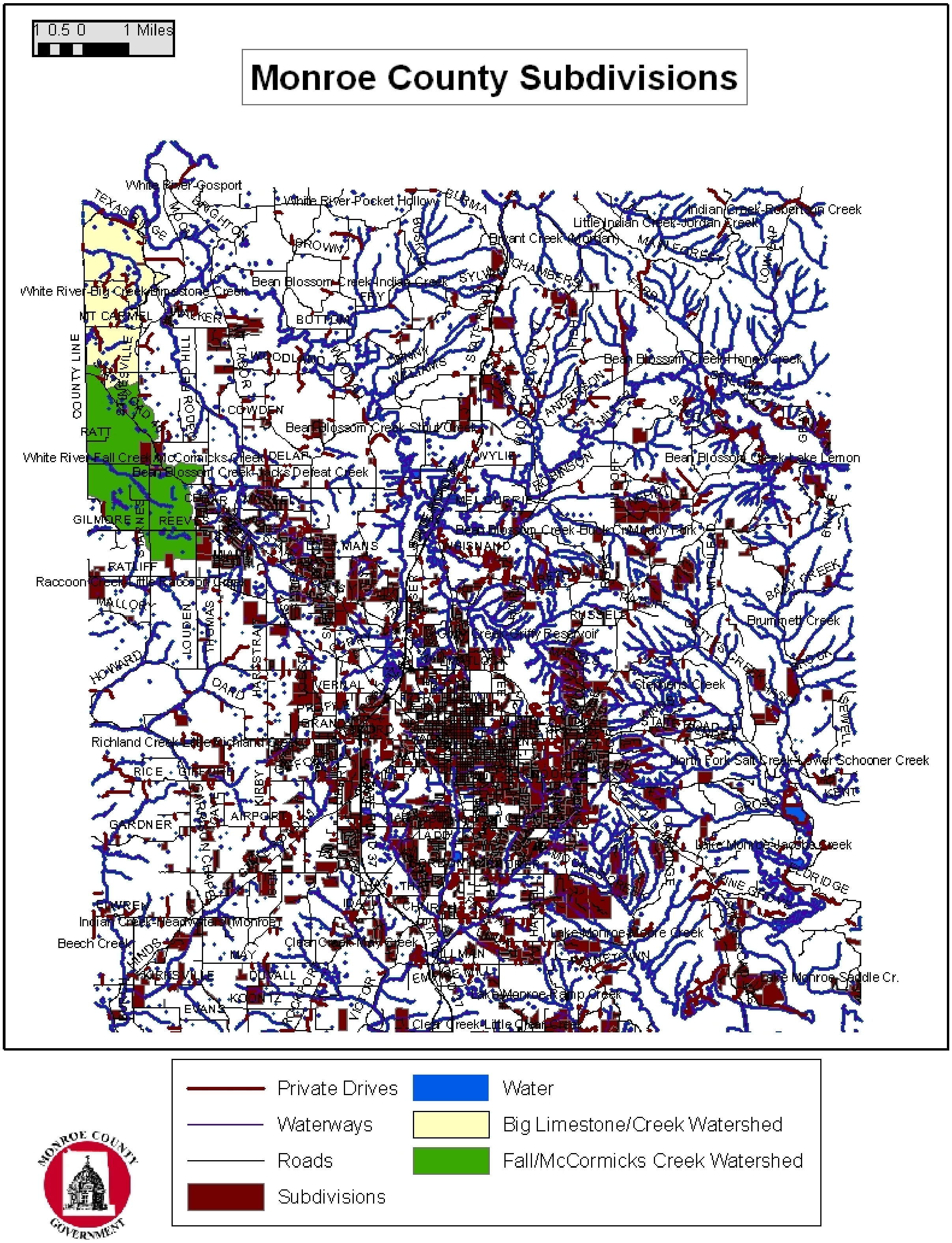


Figure 13. Monroe County Rural Subdivisons in the watershed project area. Map courtesy of the Monroe County Planning Department (August 14, 2008).

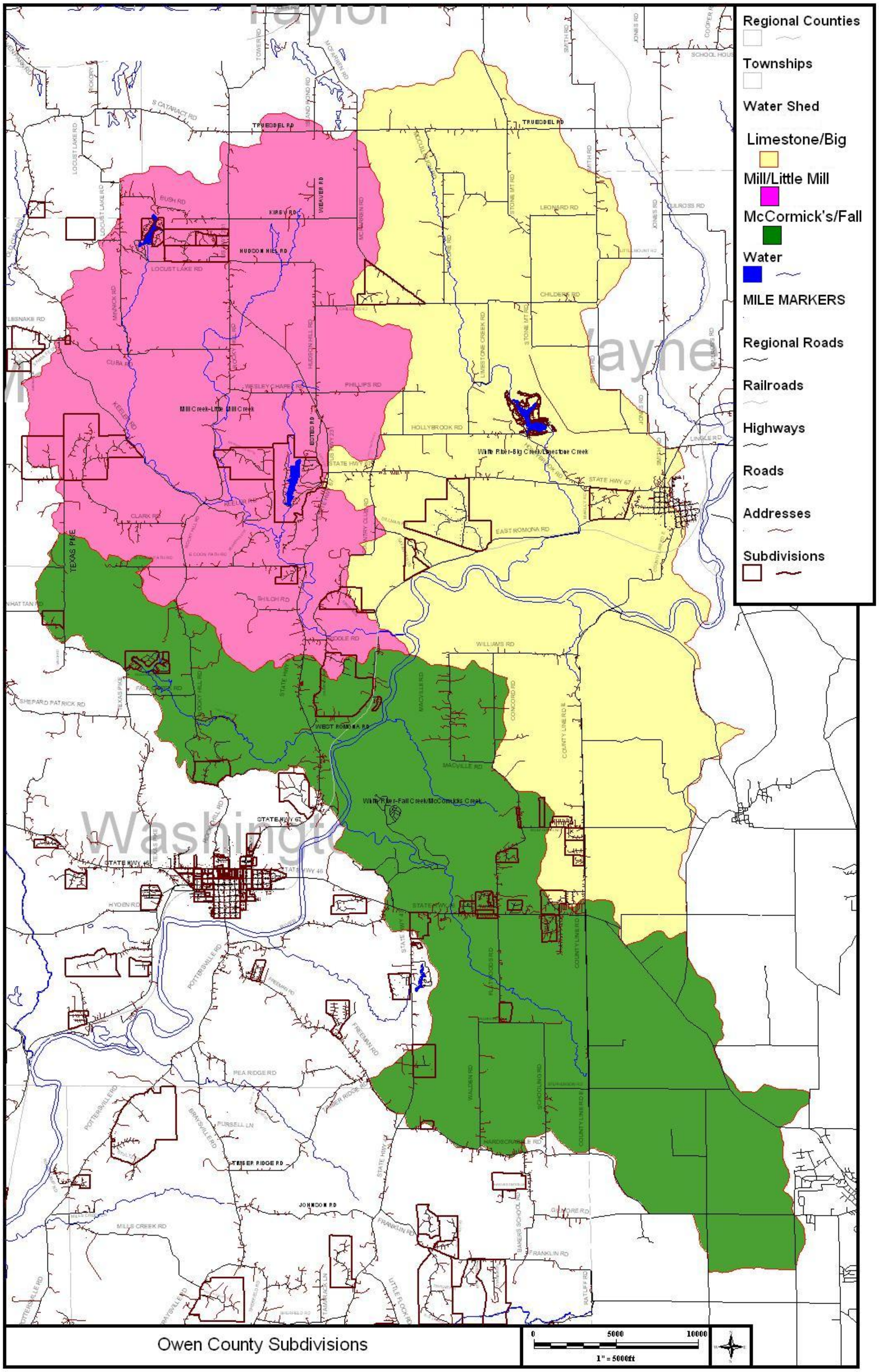


Figure 14. Owen County Rural Subdivisions. Map courtesy of the Owen County Mapping Department (Aug. 14, 2008)

Urbanized Areas

There are two urbanized areas in the project boundaries. These are the town of Gosport and the town of Ellettsville. Both towns are split by a watershed divide. In Gosport, only the north and western-most portions of the town (approximately 125 acres) drain into the Limestone Creek watershed.

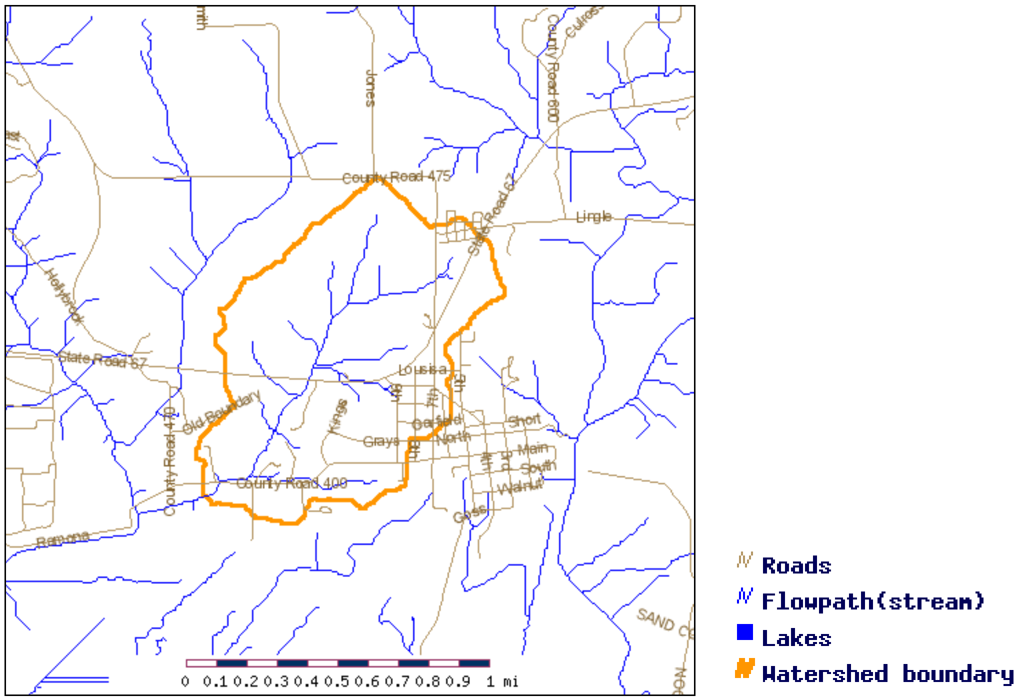


Figure 15. Map showing section of Gosport in the project area.

The town of Gosport has a waste treatment plant that is utilized by homes and businesses. The outfall for the waste treatment plant is located on the south side of town and outside of the watershed project area.

Within the Gosport watershed area, there are numerous homes, several small businesses, town and state roads, a gas station, a sewage lift station, Gosport Elementary School, a community building, and one church.

During the course of this study, two construction projects occurred in Gosport.

Pollutants typical of urban areas are present in Gosport. These include: sediments, lawn care fertilizers and pesticides, grass clippings and leaves, road deicing agents, heavy metals from brake pad wear, oil and grease, hydrocarbons, soap, and bacteria from pet waste.

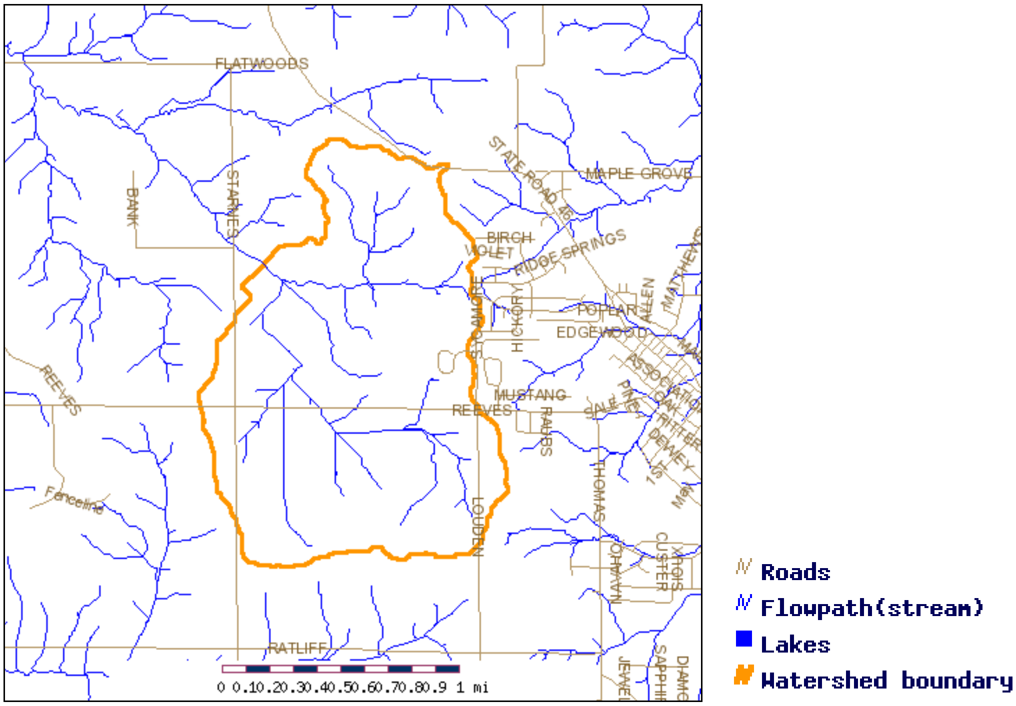


Figure 16. Map showing section of Ellettsville in the project area.

In Ellettsville, the western-most portion of the town (approximately 120 acres) drains to the McCormick's Creek watershed.

The town of Ellettsville is served by a waste treatment plant. The outfall for the plant is located north of the town and outside of the watershed project area.

Within the Ellettsville watershed area, there are numerous homes, small businesses, town and state roads, a cemetery, and Edgewood Elementary School. There is a subdivision under construction in Ellettsville that is in the project area.

Pollutants typical of urban areas are present in Ellettsville. These include: sediments, lawn care fertilizers and pesticides, grass clippings and leaves, road deicing agents, heavy metals from brake pad wear, oil and grease, hydrocarbons, soap, and bacteria from pet waste.

3.54 Agriculture

Agricultural activities that can contribute to water pollution include tillage operations particularly on highly erodible cropland, confined animal facilities, grazing, pesticide spraying, and fertilizing.

Tillage Operations

In 2007 a Tillage Transect was conducted in Owen and Monroe counties. A tillage transect is a survey of randomly selected farm fields used to compile statistics on what types of tillage systems Indiana farmers use. Transects were initiated in 1990 because conservation tillage systems have more potential than anything else to affect soil erosion, water quality and long term productivity of soils in the intensive cropping systems that are prevalent in Indiana agriculture.

Figure 17 provides a summary of the Owen County 2007 crop tillage survey.

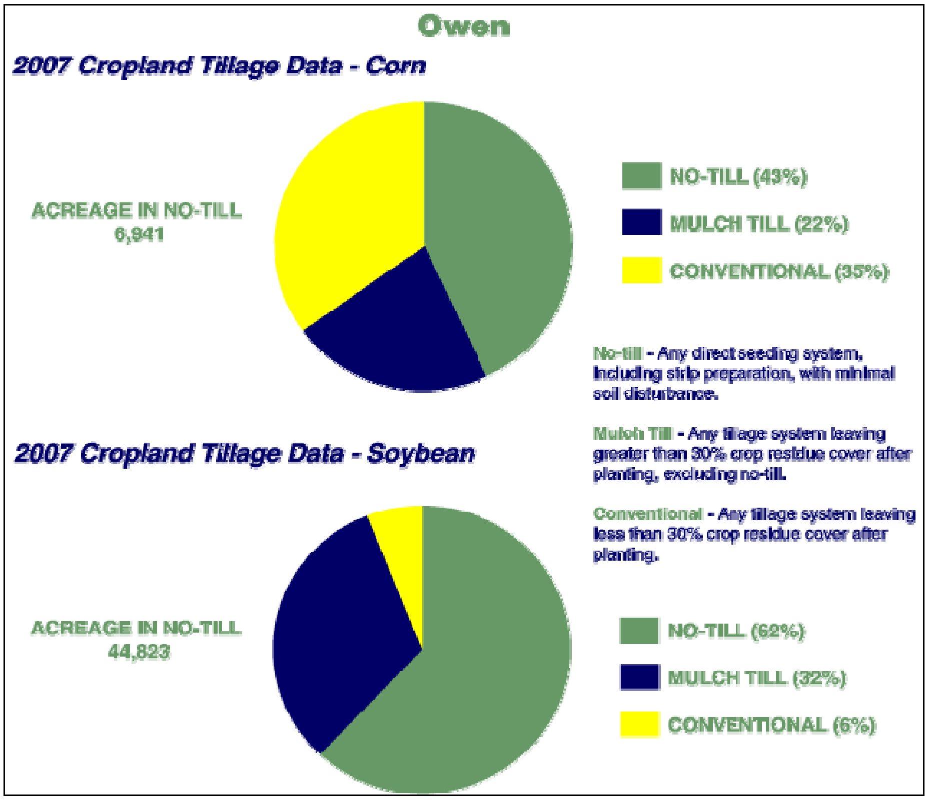
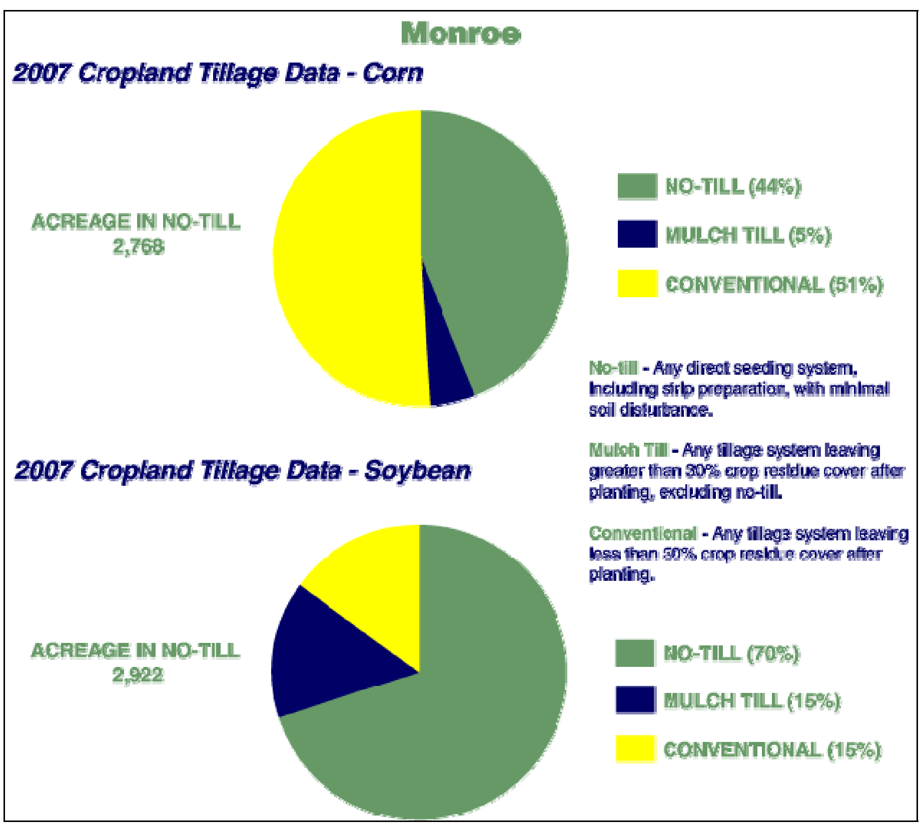


Figure 18 provides a summary of the Monroe County 2007 crop tillage survey.



Conservation tillage is defined as any tillage and planting system that leaves at least 30% residue after planting.

In Owen County, 35% of corn acres are planted using conventional tillage methods as compared to only 6% of soybean acres. In Monroe County, 51% of corn acres are planted using conventional tillage methods as compared to only 15% of soybean acres. Clearly adoption of conservation tillage on soybean acres has been much more successful than corn acres.

The low success rate for adoption of conservation tillage on corn acres prompted the Steering Committee to develop a Tillage Survey (Appendix E). The survey was designed to provide an opportunity for agricultural producers and landowners to explain the obstacles that prevent the adoption of conservation tillage on corn acres and what, if anything could be done to improve soil conservation efforts on corn acres.

In July, 2008, the SWCD office mailed a copy of the survey to 40 agricultural landowners and operators in the project area. Only nine individuals responded to the survey. The information gathered from the returned surveys did not prove to be helpful in determining the obstacles to using conservation tillage on corn acres.

The Owen County SWCD will continue efforts to solicit input on this topic and develop ways to increase conservation tillage on corn acres.

Tillage

The use of Fall tillage on level and sloping lands is common throughout the watershed project area. Fall tillage operations minimize or completely eliminate crop residue thereby exposing soil to the erosive forces of Spring rains. Exposed soils are also more prone to erode throughout the freeze/thaw cycles of Winter. Soil loss on crop land translates directly into sedimentation of receiving waters.

Fall Tillage on cropland in the Limestone Creek Watershed

Highly Erodible Land

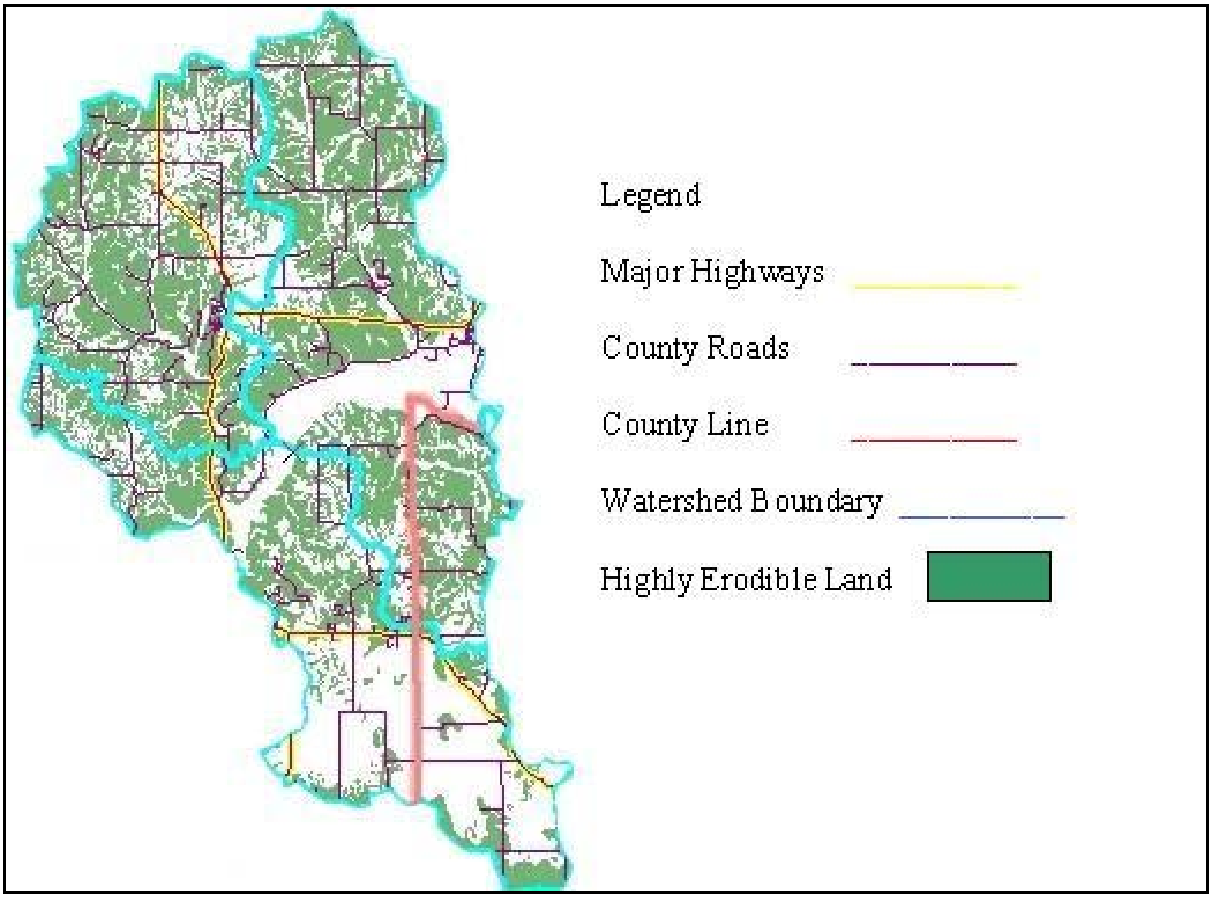


Figure 19. Highly Erodible Land Map of project area

The Highly Erodible Land Map shows all of the areas classified as highly erodible. Nearly all of the upland areas above the White River plateau and the old glacial lake bed in McCormick's Creek watershed have sufficient slope to be labeled with this designation.

Of special concern to this project are the Highly Erodible Cropland Acres.

Highly erodible cropland acres are technically defined by the Natural Resources Conservation Service as farmed areas where the annual soil erosion rate exceeds the maximum rate that will permit crop productivity to be sustained economically and indefinitely.

This map can be cross-referenced with the watershed land use maps on pages 10 – 13 to get a general idea of where highly erodible land is cropped.

Land use inventory activities document that row crop production on highly erodible land throughout the project area is frequently occurring without the use of adequate conservation measures.

Livestock Impacts

The exact number and size of livestock operations in the project area is unknown. No operations were observed during land use inventories that would meet the definition of a Confined Feeding Operation (any animal feeding operation engaged in the confined feeding of at least 300 cattle, or 600 swine or sheep, or 30,000 fowl).

More commonly observed were small beef cattle, dairy, sheep, horse, and buffalo operations. During the spring, summer and fall, livestock are usually allowed to graze in open pastures, but this is not possible year-round. Animals are frequently confined to small areas for the winter months. In this situation, manure management becomes necessary. Manure is stockpiled and when necessary, broadcast onto crop land to serve as fertilizer for future crops.

Over-grazed pastures were commonly observed and associated with the beef cow, dairy cow, horse, and buffalo operations. Over-grazed pastures contribute to water quality concerns by allowing nutrients and soil to enter surface water during rain events. Based on the number of over-grazed pastures observed during land inventory activities, this should be considered a major threat to water quality.

Livestock with access to streams are having a major impact on water resources. Stream bank erosion leading to sedimentation of receiving waters is common. Livestock waste deposited directly into streams is contributing to high *E.coli* levels throughout the project area.

Buffalo in tributary of Limestone Creek.

Cattle in tributary of McCormick's Creek.

Nutrients

High Nitrogen readings throughout the watershed project area may be contributed in part to the over-application of Nitrogen on agricultural lands. Since most of the water quality data was collected during dry weather, (not rain events where Nitrogen washes from the land), excess Nitrogen is likely leaching through the soil and being transported by field tile to the streams

Water quality sampling data for Phosphorus, collected throughout the watershed project area, did not exceed the Water Quality Target of <0.3 mg/l. Based on this information, Phosphorous does not appear to be a water quality concern.

3.55 Water Resources

Locust Lake

Locust Lake is a 20 acre private lake located in the Mill Creek Watershed. There are approximately 25 homes around the lakeshore.

Most homeowners maintain their yards in a natural state with a minimum of mowed areas. Only one homeowner is reported to use a commercial lawn service to minimize weeds.

In 2006, the primary spillway for the lake was reconstructed to comply with IDNR, Division of Water requirements. This would appear to be money proactively well spent considering the damage many lake spillways/dams incurred in the June 2008 floods. The Locust Lake dam was not damaged in the floods.

On May 31, 2008, fifteen residents from the Locust Lake Association attended a presentation about the LWR Initiative offered by the Watershed Coordinator. The response to the presentation was favorable, and the residents invited the Coordinator to Locust Lake to help assess the lake's water quality.

On July 1, 2008, the Coordinator met several residents at the lake and water quality sampling was done at four locations. Three test sites were in the lake and one was downstream of the dam.

Sample points were tested for: Dissolved Oxygen; pH; Orthophosphates; Nitrates; Turbidity; and *E.coli*.

The results of the Dissolved Oxygen, pH, Orthophosphates, Nitrates, and Turbidity tests were all in the normal range. The results of the *E.coli* test showed a count of 10 CFU/100ml in three locations and a count of 20 CFU/100ml in one location.

Locust Lake appears to be a healthy lake that is well taken care of by the homeowners.

Information on how to dye test septic systems was left with the residents for them to consider with the idea that they might voluntarily test their septic systems every few years.

Amazon Lake

Amazon Lake is a 25 acre private lake located in the Mill Creek Watershed. There are approximately 25 homes around the lakeshore.

On June 9, 2007, the Watershed Coordinator did a presentation for the Amazon Lake Association about the LWR Initiative with special emphasis on the Mill Creek Watershed.

Most of the lawns around the lake are maintained in a natural state. It is not known how many residents use lawn fertilizers/pesticides.

Lake residents voluntarily dye test their septic systems every two years.

Lake Hollybrook

Lake Hollybrook is a 30 acre privately owned lake in the Limestone Creek Watershed.

On June 10, 2007, the Watershed Coordinator did a presentation for the Lake Hollybrook Association about the LWR Initiative with special emphasis on the Limestone Creek Watershed.

Most of the lawns around the lake are maintained in a natural state. It is not known how many residents use lawn fertilizers/pesticides.

There are many older homes around the lake that were originally constructed as weekend cottages. In some cases, these cottages are now serving as primary residences. Aging septic systems and limited lot size present unique challenges for lake residents.

3.6 Chemical Monitoring Program

To establish baseline water quality in each sub-watershed, an aggressive chemical monitoring program was established. As mentioned in Section 3.1, the following Water Quality Targets were established and used to access water quality concerns:

- Nitrates <4 mg/l
- Dissolved Oxygen >5 mg/l
- pH between 6 and 9
- Phosphorus 0.3 mg/l
- Turbidity 36 NTU
- TSS 40 mg/l
- *E.coli* 235 cfu

Parameters to be tested were selected based on the following information:

3.61 Chemical parameters monitored and why…

(Information on Nitrogen, Phosphorus, and Sediment taken from the NRCS working paper #16, *Water Quality and Agriculture*)

"**Nitrogen** - Nitrogen (N) is an essential nutrient required for the survival of all living things. It is the mineral fertilizer most applied to agricultural land because mobile nitrogen compounds are so difficult to retain in soils where plant and animal diversity is restricted and nitrogen-fixing bacteria are absent. Available soil nitrogen supplies are often inadequate for optimum crop production. Many sources of nitrogen can contribute to water quality problems. Typical point sources include human and animal waste disposal sites, industrial sites, and sites where nitrogenous materials accumulate through handling and accidental spills. In farmed areas, agricultural activities contribute heavily to non-point sources. For example, commercial fertilizers are used to supply additional nitrogen for crop needs. High density animal operations are also significant agricultural sources of nitrogen. Large amounts of feed (containing nitrogen) are transported into the watershed from other areas, but manure is not taken out of the watershed because of high transportation costs. The result of disposing of all manure near the animal operations is that nitrogen is applied to the land in measures far exceeding crop nutrient requirements. A primary concern about the impact of nitrogen on the environment is the possibility of nitrate leaching into ground water. This concern stems largely from potential health effects on humans and ruminant animals from drinking contaminated water (Follett and Walker, 1989).

Phosphorus - Phosphorus (P) is an essential element for plant growth and increased crop yields. However, because soil phosphorus is commonly immobilized in forms unavailable for crop uptake, phosphorus amendments—mineral fertilizer or animal manure—are needed to achieve desired crop yields. Since phosphorus is often bound more tightly to soils than nitrogen, a different approach to control agricultural phosphorus losses is required (National Research Council 1993). Despite its benefit to crop production, phosphorus becomes a pollutant when it enters surface water in substantial amounts. Some phosphorus compounds ingested in high level concentrations can be highly toxic to humans. Others can be caustic on skin contact. Phosphorus is not believed to be toxic at concentrations normally found in food and water, partly because most naturally occurring phosphates are comparatively low in solubility. Excessive phosphorus concentrations in surface water can accelerate eutrophication, resulting in increased growth of undesirable algae and aquatic weeds. This growth can impair water use for industry, recreation, drinking, and fisheries. Although nitrogen and carbon are also associated with accelerated eutrophication, most attention has focused on phosphorus as the limiting element. Because it is difficult to control the exchange of nitrogen and carbon between the atmosphere and a waterbody and because of the fixation of atmospheric nitrogen by some blue-green algae, phosphorus control is seen as the primary way to reduce the accelerated eutrophication of surface water.

Turbidity and Total Suspended Solids (TSS) - As rich, productive topsoil erodes through the physical and chemical forces of weathering, it becomes sediment suspended in water and deposited where it is not wanted. Not only is sediment aesthetically unpleasant, it also carries chemical contaminants, decreases the depth of water bodies, and causes physical damage to farmland, wildlife,
water treatment systems, and power generators. High concentrations of suspended sediment in streams diminish their recreational uses because pathogens and toxic substances commonly associated with suspended sediment are threats to public health. High sediment concentrations reduce water clarity and the aesthetic appeal of streams. Suspended sediment is also harmful to stream biota; it inhibits respiration and feeding, diminishes the transmission of light needed

for plant photosynthesis, and promotes infections (U.S. EPA, 1986). Sediment deposited on the streambed can suffocate benthic organisms, especially in the embryonic and larval stages. Most sediment must be removed from water intended for human use, and high sediment concentrations add significantly to the cost of water treatment. Suspended sediment can also cause significant wear to bridge footings and other stream structures. Sediment accumulations in reservoirs decrease their storage capacity and threaten their safe operation by forcing spillways to flow more often or longer."

(Information on Dissolved Oxygen, *E.coli*, pH, and Temperature taken from the *Hoosier Riverwatch Volunteer Stream Monitoring Manual, Spring 2006)*

Dissolved Oxygen (DO) - The amount of oxygen in water is called the Dissolved Oxygen concentration. Oxygen dissolves into the water from the atmosphere until the water is saturated. Aquatic plants, algae, and plankton also produce oxygen as a by-product of photosynthesis. The presence of oxygen in water is a positive sign, while the absence of oxygen from water often indicates water pollution.

E.coli - Fecal coliform bacteria are found in the feces of warm-blooded animals, including humans, livestock, wildlife, and waterfowl. These bacteria are naturally present in the digestive tracts of animals, but rare or absent in unpolluted waters. Fecal coliform bacteria typically enter water via faulty septic systems, and runoff from agricultural feedlots. The bacteria can enter the body through the mouth, nose, eyes, ears, or cuts in the skin. *E.coli* is a specific species of fecal coliform bacteria used in Indiana's state water quality standards. Some strains of *E.coli* can lead to illness in humans. While not all strains of *E.coli* are pathogenic themselves, they occur with other intestinal tract pathogens that may be dangerous to human health. We test for the presence of *E.coli* as an indicator of fecal contamination.

pH - The activity of hydrogen ions is expressed in pH units (pH = power of Hydrogen). The concentration of H^+ ions is used to estimate pH. The pH scale ranges from 0 (most acid) to 14 (most basic). The pH level is an important measure of water quality because aquatic organisms are sensitive to pH, especially during reproduction. A pH range of 6.5 to 8.2 is optimal for most organisms.

Temperature - Water temperature is very important to overall water and stream quality. Temperature affects: Dissolved Oxygen levels (warmer water holds less dissolved oxygen), the rate of photosynthesis, and the metabolic rates of aquatic organisms. Thermal pollution (temperature increases) can threaten the balance of aquatic ecosystems.

3.62 Collection Points

Water samples were collected at twelve locations during the recreational season of April through October in 2007 and 2008. Sampling points were selected based on ease of access, representativeness, distribution, and proximity to areas of concern. Seven sampling points (points 3, 5, 6, 8, 9, 10, and 11) coincide with sampling points used in the 2006 TMDL Study for *E.coli*.

Appendix B, Data Table for Sampling Points, provides a description for each sampling point along with the longitude and latitude.

Figure 20 shows the location of each sampling point.

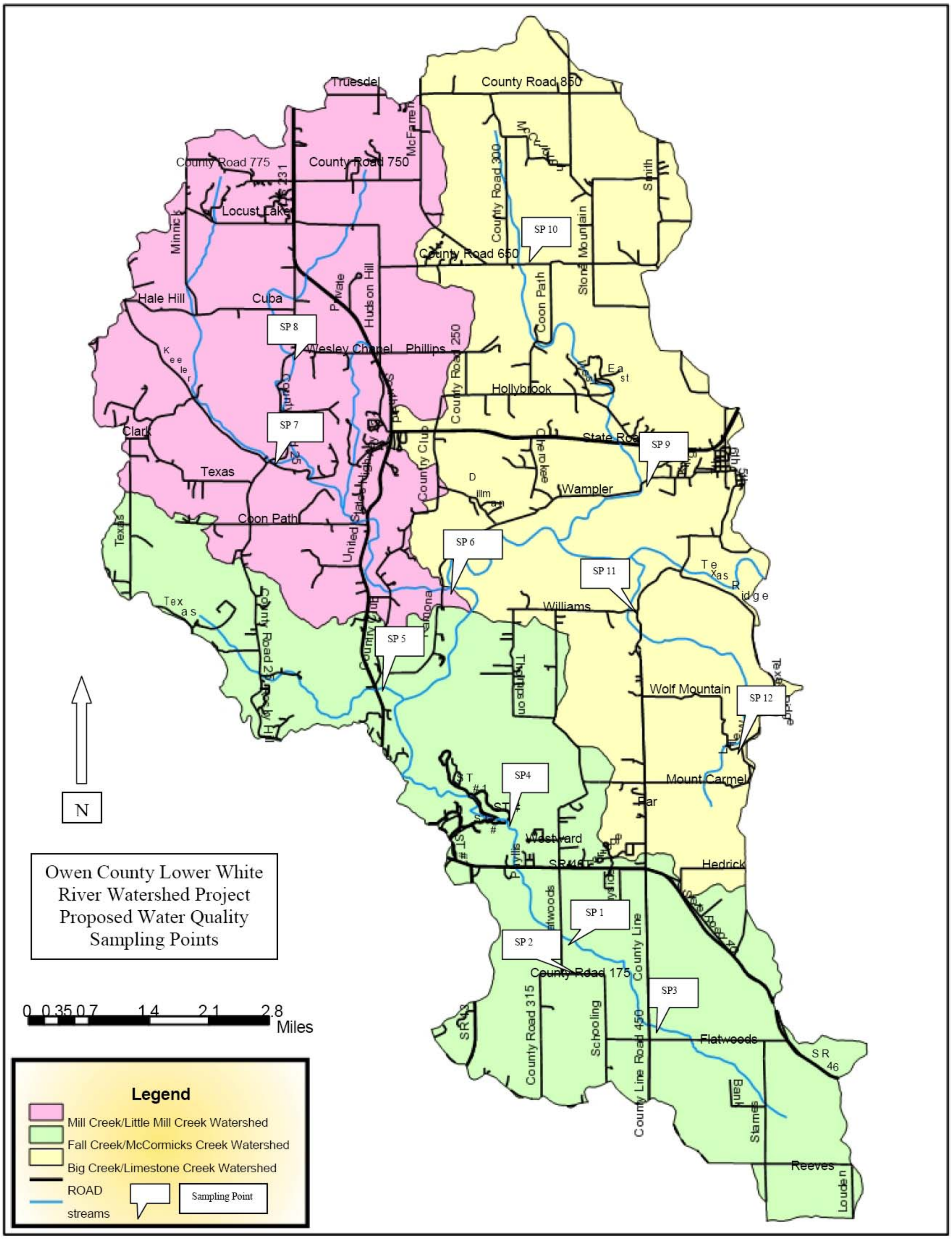


Figure 20. Water Chemistry Sampling Points

3.63 Sampling Program Details

During the seven month period of April through October in 2007 and 2008, all twelve sites were monitored for: Total Suspended Solids (TSS); Turbidity; Total Nitrogen; Total Phosphorus; Dissolved Oxygen; pH; Temperature; and Flow.

Sampling points 1, 2, 4, 9, and 10 were monitored for *E.coli* monthly during the sampling period of April through October. Sampling points 3, 5, 6, 7, 8, 11, and 12 were monitored for *E.coli* once each grant year.

The increased frequency of *E.coli* monitoring at sampling points 1, 2, 4, 9, and 10 was done because these sites were identified as high priority sites. They were so designated because sites 1, 2, and 4 are located in the McCormick's Creek Watershed and drain through McCormick's Creek State Park where children frequently play in the creek, and sites 9 and 10 are associated with Lake Hollybrook in the Limestone Creek Watershed.

E.coli and TSS samples were analyzed at the Dillman Road Quality Control Laboratory in Bloomington, Indiana.

Turbidity, Total Nitrogen, Total Phosphorus, Dissolved Oxygen, pH, and Temperature, samples were tested in the field using Hoosier Riverwatch techniques and supplies.

In September of 2008 a water sample from each sampling site (with the exception of Site 3 which was dried up) was sent to Dillman Laboratory for a Total Phosphorus reading. This was done for quality control purposes to compare results obtained with the Riverwatch testing procedures versus a professional lab.

Flow readings were obtained with a Global Water Instruments FP201 Flow Probe.

The results of the chemical sampling program are presented for each site on the next few pages.

A summary of the potential sources of water quality concerns is presented by watershed. The summary for McCormick's Creek Watershed is located after the information on Site 4. The summary for Fall Creek Watershed is located after the information on Site 5. The summary for Mill Creek Watershed is located after the information on Site 8. The summary for Limestone Creek Watershed is located after the information on Site 10. The summary for Big Creek Watershed is located after the information on Site 12.

Site 1 Description and Overview

McCormick's Creek at Flatwoods Road

Site 1 is in the McCormick's Creek Watershed and located immediately west of the bridge over McCormick's Creek on Flatwoods Road. The sampling site is located in a wooded riparian corridor. Adjacent land uses include: south – McCormick's Creek Elementary School, residential, and cropland; north – cropland and residential; west – forests, McCormick's Creek Elementary School's waste disposal facility, and cropland; east –rural residential, subdivision with package plant; pasture and cropland.


DOWNSTREAM


UPSTREAM

Figure 21 shows the watershed above Sampling Site 1 and provides a break down of land use categories. The watershed contains approximately 6,840 acres.

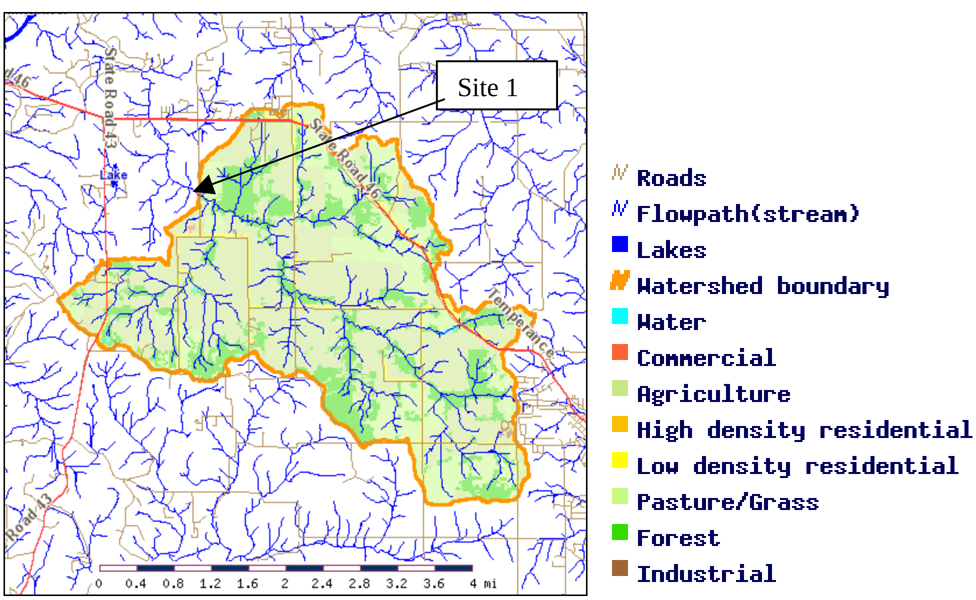


Figure 21

Chemical Sampling Program Summary for Site 1

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 1 was 7 mg/l. In June of 2007, July of 2007, and August of 2008, the Dissolved Oxygen readings at this site were at a low of 4.5 mg/l, 5mg/l, and 3 mg/l respectively.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 1 was 7.2. All of the pH readings taken at this site were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 1 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.12 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 1 was 21 NTU. On one occasion, June 30, 2008, the Turbidity reading exceeded the Water Quality Target with a reading of 60 NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 1 was 13 mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

The average *E.coli* reading at Site 1 was 967 CFU. The Water Quality Target was exceeded on ten of the thirteen sampling dates.

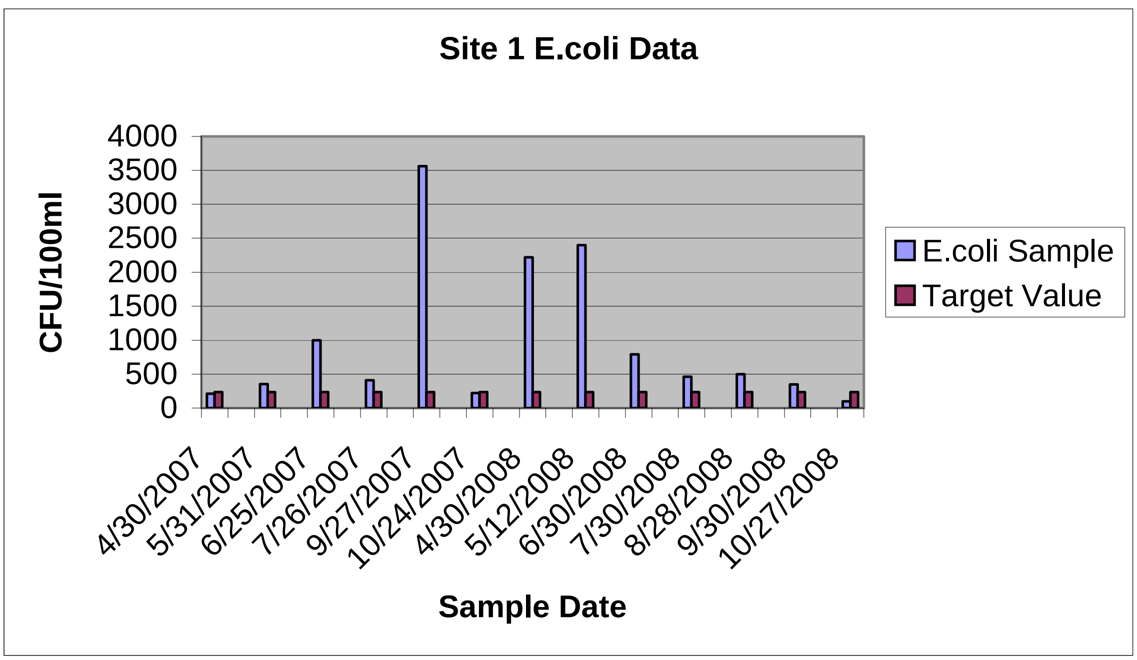


Table 4. *E.coli* data for Site 1

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 1 was 3.9 mg/l. The Water Quality Target was exceeded on four of the thirteen sampling dates

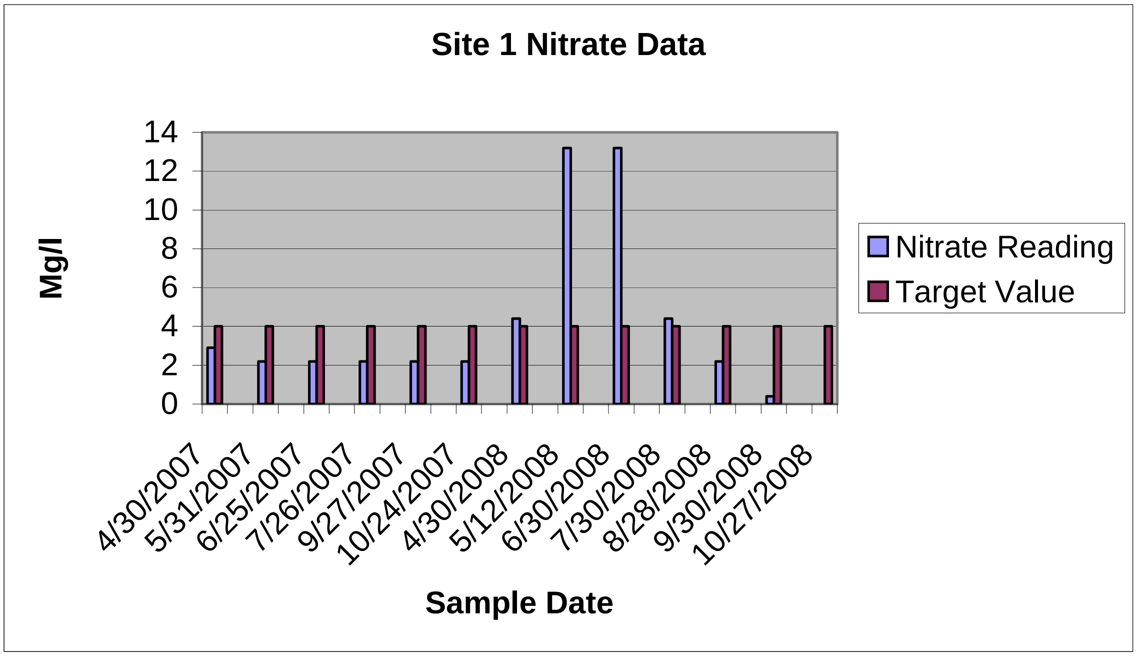


Table 5. Nitrate Data for Site 1

Site 2 Description and Overview

McCormicks's Creek at Walden Road

Site 2 is in the McCormick's Creek Watershed and located immediately south of the bridge over a tributary of McCormick's Creek on Walden Road. The sampling site is located in a mixed residential/agricultural area. Adjacent land uses include: south – cropland and forest; north – cropland and residential, east – cropland and residential; and west – cropland and residential.

UPSTREAM

DOWNSTREAM

Figure 22 shows the watershed above Sampling Site 2 and provides a break down of land use categories. The watershed contains approximately 1,360 acres.

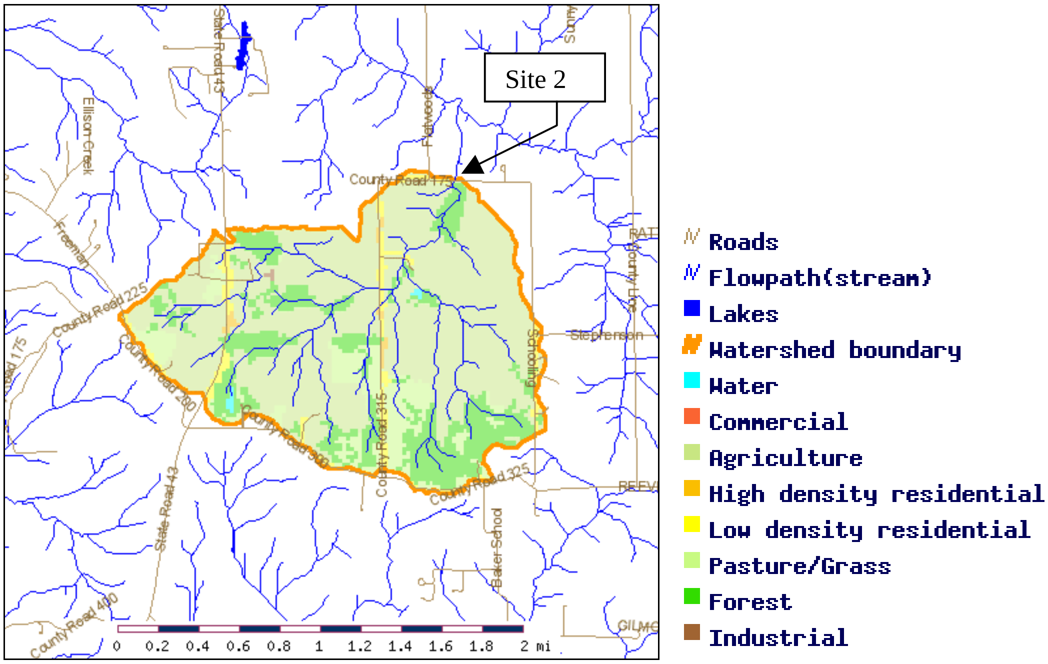


Figure 22

Chemical Sampling Program Summary for Site 2

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 2 was 8 mg/l. All thirteen Dissolved Oxygen samples were within the water quality target.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 2 was 7.2. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 2 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.06 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 2 was 19 NTU. On one occasion, May 12, 2008, the Turbidity reading exceeded the Water Quality Target with a reading of 50 NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 2 was 12 mg/l. On one occasion, June 30, 2008, the TSS reading exceeded the Water Quality Target with a reading of 56 mg/l.

E.coli (Water Quality Target: <235 CFU)

The average *E.coli* reading at Site 2 was 312 CFU. The Water Quality Target was exceeded on six of twelve sampling dates. In May 31, 2007 the *E.coli* count provided by Dillman Laboratory was “Too Numerous To Count” meaning there was not enough separation of colonies to make an accurate count.

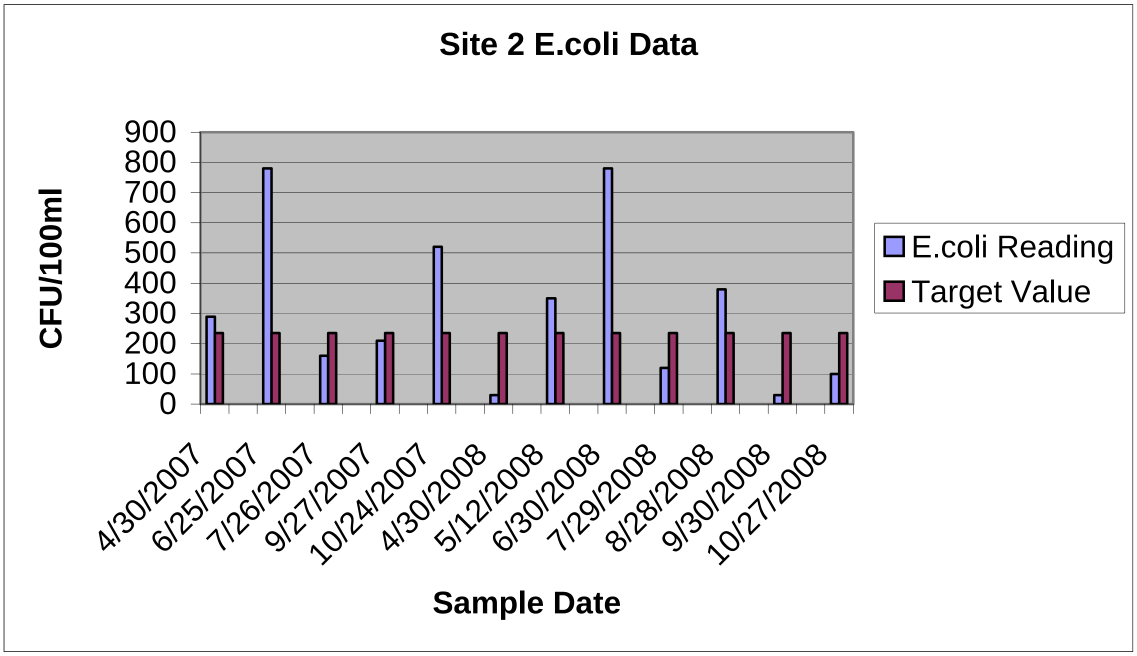


Table 6. *E.coli* data for Site 2

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 2 was 8.1 mg/l. The Water Quality Target was exceeded on nine of thirteen sampling dates.

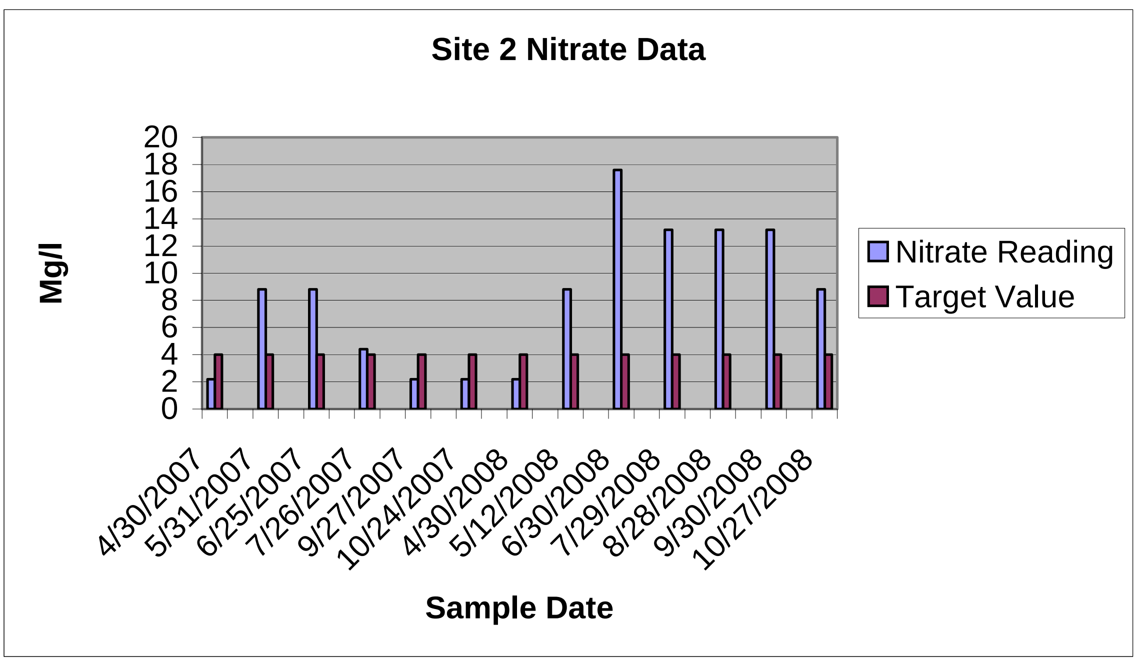


Table 7. Nitrate Data for Site 2

Site 3 Description and Overview

McCormicks's Creek at East County Line Road

Site 3 is in the McCormick's Creek Watershed. The sampling site is located in a forested riparian corridor immediately west of the bridge at County Line Road. Adjacent land uses include: south – forest and cropland; north – cropland and residential; west – forest and cropland; east – forest and cropland.

UPSTREAM

DOWNSTREAM

Figure 23 shows the watershed above Sampling Site 3 and provides a break down of land use categories. The watershed contains approximately 2,765 acres.

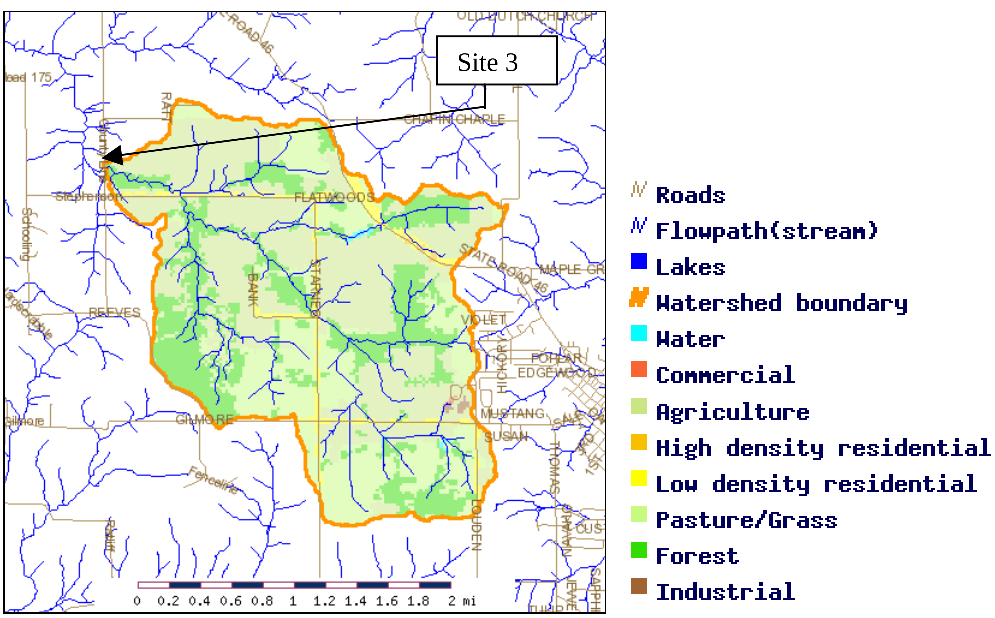


Figure 23

Chemical Sampling Program Summary for Site 3

On five of the thirteen sampling runs, Site 3 did not contain an adequate amount of water for sampling to take place. Sampling parameter averages are based on eight sampling events.

Throughout the two-year sampling program, three whitetail deer carcasses and two wild turkey carcasses were found in proximity of Site 3. Household trash was also frequently present at this site. It appears that these items were thrown off of the bridge, landing in the stream below.

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 3 was 7.3 mg/l. In October of 2007 the Dissolved Oxygen level at this site was at a low of 3 mg/l. All other readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 3 was 7.3. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 3 was 0.1. All of the Phosphorous readings were within the Water Quality Target range.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 3 was 18.6 NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 3 was 10.7mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were processed at Site 3 on two occasions. On October 24, 2007 the reading was 720cfu. On April 30, 2008 the reading was 50cfu.

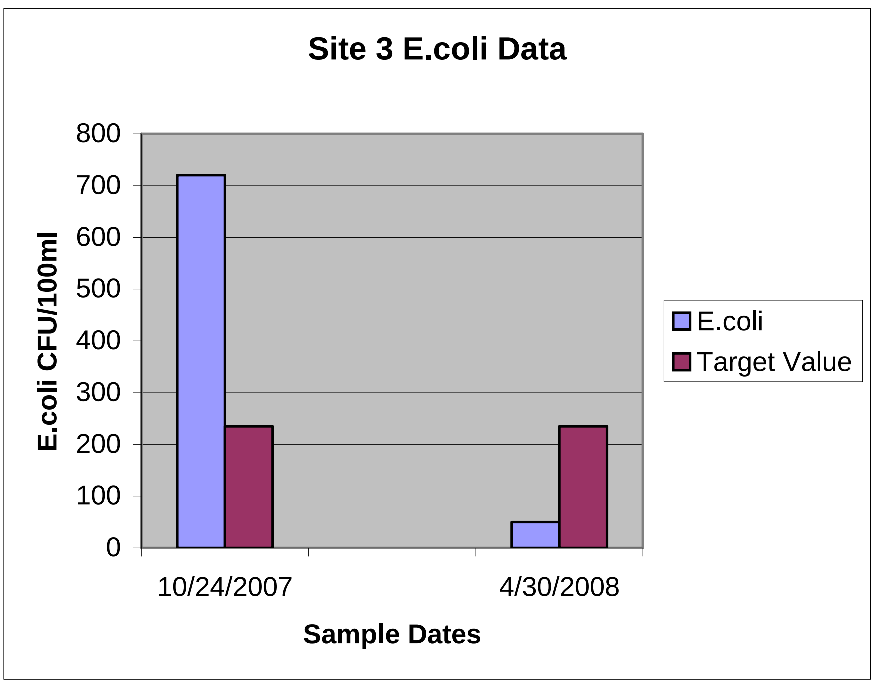


Table 8. *E.coli* data for Site 3

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 3 was 8.9 mg/l. The Water Quality Target was exceeded on six of eight sampling dates

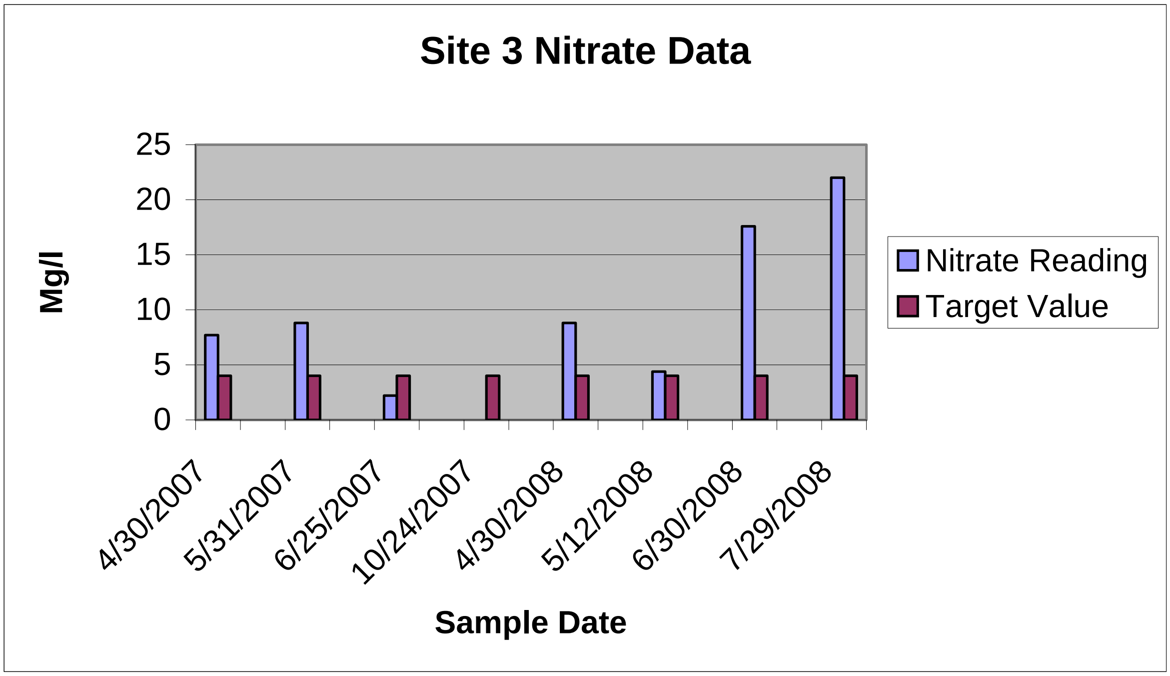


Table 9. Nitrate Data for Site 3

Site 4 Description and Overview

McCormicks's Creek in McCormick's Creek State Park

Site 4 is in the McCormick's Creek Watershed. The sampling site is located in a forested area of McCormick's Creek State Park. Adjacent land uses include forest and park land.

UPSTREAM

DOWNSTREAM

Figure 24 shows the watershed above Sampling Site 4 and provides a break down of land use categories. The watershed contains approximately 8,235 acres.

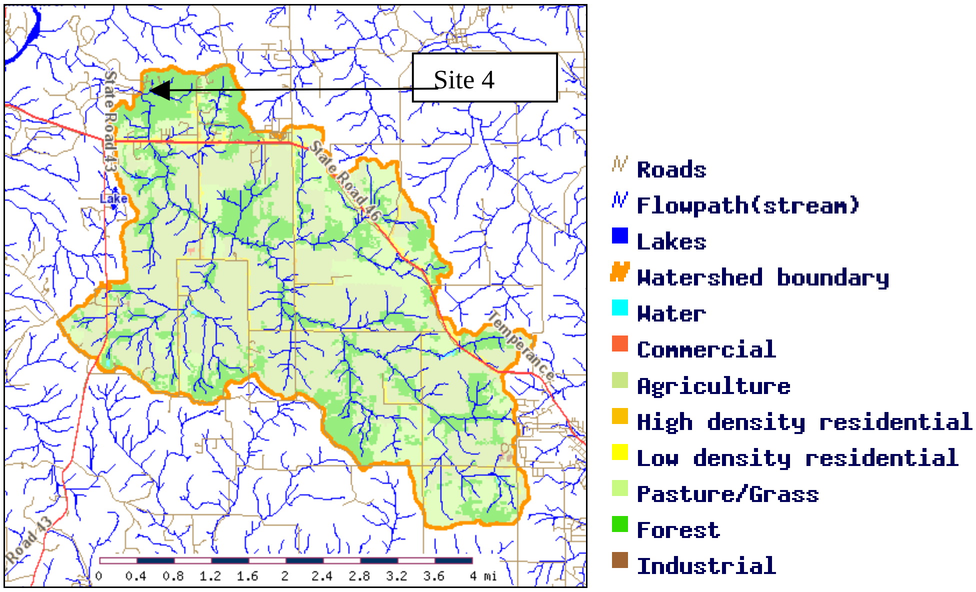


Figure 24

Chemical Sampling Program Summary for Site 4

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 4 was 7.7 mg/l. All of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 4 was 7.5. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 4 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.06 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 4 was 17.2 NTU. On one occasion, May 12, 2008, the Turbidity reading exceeded the Water Quality Target with a reading of 39 NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 4 was 9.1 mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

The average *E.coli* reading at Site 4 was 297 CFU. The Water Quality Target was exceeded on five of the thirteen sampling dates.

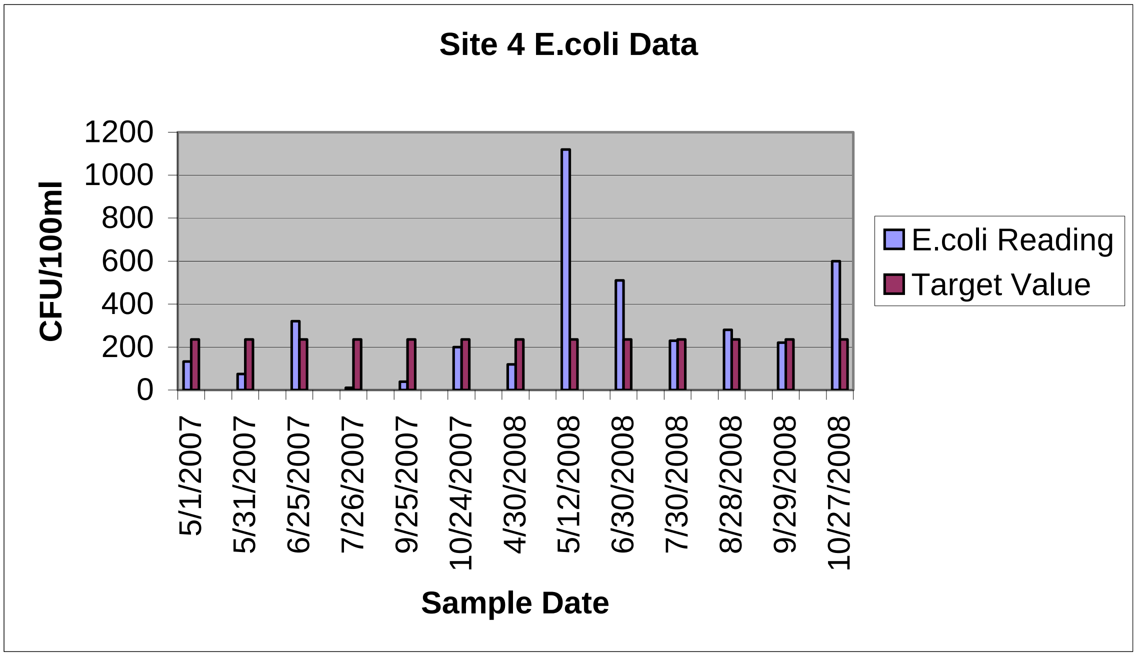


Table 10. *E.coli* data for Site 4

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 4 was 3 mg/l. The Water Quality Target was exceeded on three of the thirteen sampling dates.

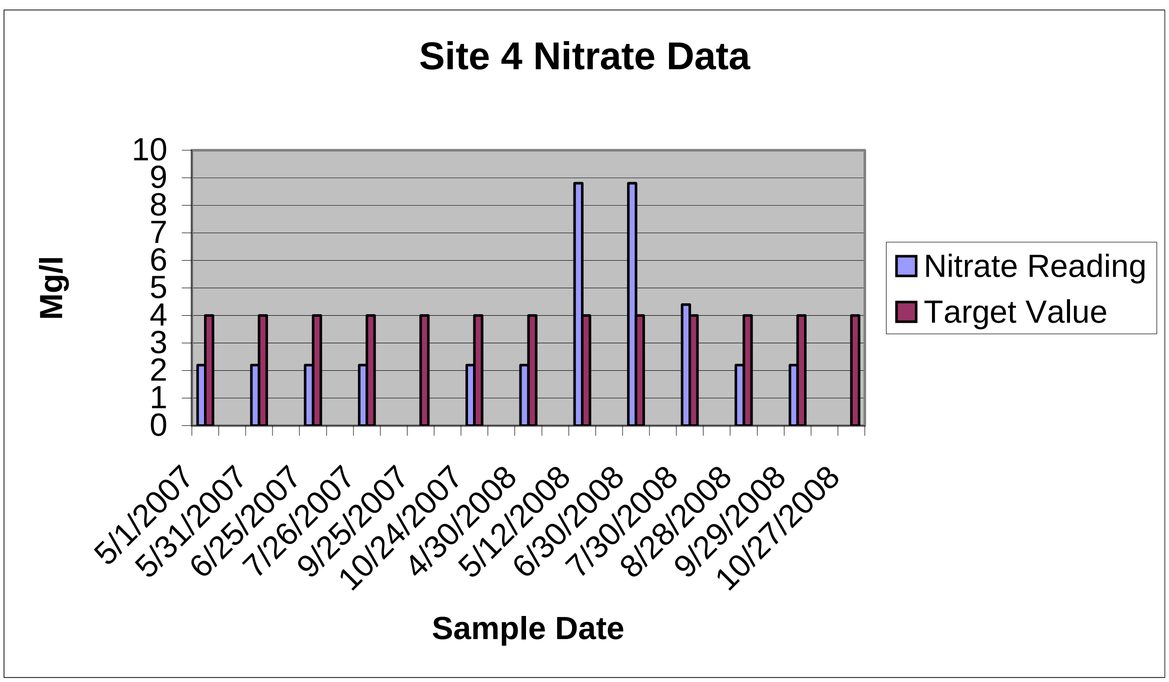


Table 11. Nitrate Data for Site 4

Summary of chemical sampling program in the McCormick's Creek Watershed (Sampling Sites 1, 2, 3, and 4.)

Sources of Pollutants of Concern

E.coli

Immediately east (upstream) of Site 1, the stream lacks an adequate riparian buffer and exclusion fencing so cattle have access to the stream. This is not the only place where livestock have access to a stream. It is mentioned because of the close proximity to Sampling Site 1.

The land use in this watershed is predominately agriculture, particularly adjacent to the streams. The soils in this watershed necessitate the use of field tiles to drain excess water from the fields. The field tiles then drain to the nearest stream. Field tiles are not themselves sources of *E.coli*, but they carry *E.coli* from land applied manure, runoff from pastures and fields, and other sources of *E.coli* not adjacent to the streams.

Wildlife is a known source of *E.coli* impairments in waterbodies. Many animals spend time in or around waterbodies. Deer, geese, raccoons, turkeys, and other animals all create potential sources of *E.coli*. Wildlife contributes to the potential impact of contaminated runoff from animal habitats such as urban park areas, forest, and cropland. There are two parks in this watershed where wildlife numbers are concentrated due to disturbed habitat conditions outside of the parks.

There are a significant number of homes on septic systems in this watershed. Failing septic systems are a known source of *E.coli* impairments in waterbodies.

High *E.coli* readings at site 1 and 2 may be linked to failing residential and commercial septic systems in the watershed.

Non-point sources contribute to the elevated *E.coli* readings in this watershed.

Nitrates

The flat glacial lake bottom ground surrounding this sampling site has been cleared primarily for farming purposes and is drained by tile, most of which discharge directly into McCormick's Creek and it's tributaries. Excess nitrate applied to cropland may be running off and/or leaching through the soil, potentially polluting surface water.

Failing septic systems may also be contributing to high nitrate readings during dry weather sample collection.

Site 5 Description and Overview
Fall Creek at State Road 231

Site 5 is in the Fall Creek Watershed just west of the Highway 231 bridge. The sampling site is located in a wooded riparian corridor. Adjacent land uses include: south, north, and west – residential and forest; east – forest and cropland.

UPSTREAM

DOWNSTREAM

Figure 25 shows the watershed above Sampling Site 5 and provides a break down of land use categories. The watershed contains approximately 2,480 acres.

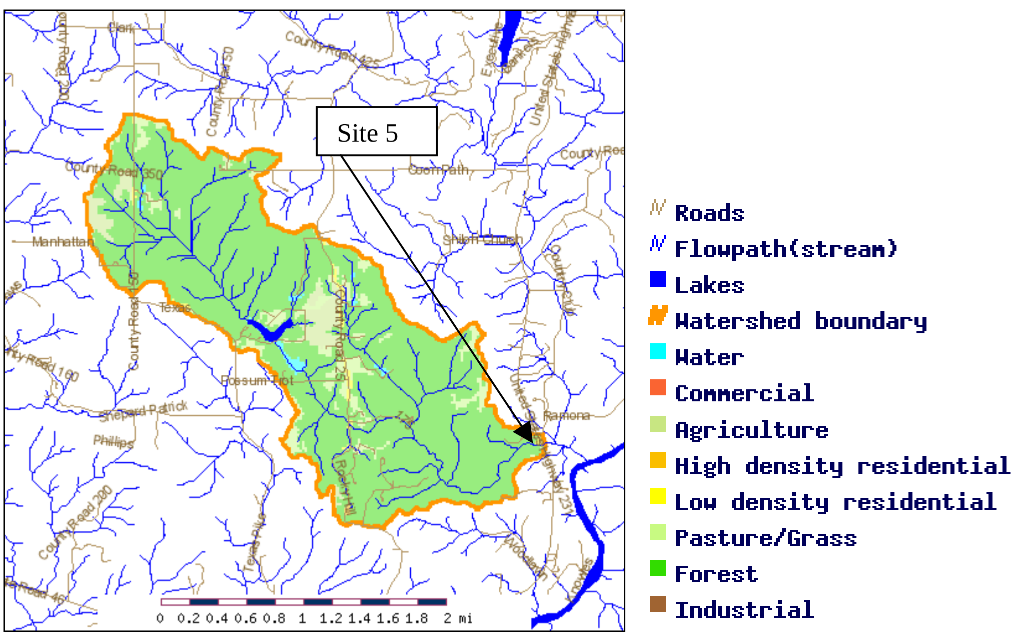


Figure 25

Chemical Sampling Program Summary for Site 5

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 5 was 8.5 mg/l. All of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 5 was 7.3. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 5 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.02 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 5 was 15 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 5 was 3.5mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 5 on two occasions. On September 26, 2007 the *E.coli* count was 560 CFU. On April 28, 2008, the *E.coli* count was 110 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 5 was 0.7 mg/l. All of the nitrate readings were within the Water Quality Target range.

Summary of chemical sampling program in the Fall Creek Watershed

The chemical sampling program, represented by Site 5, has shown that water quality in the Fall Creek Watershed is good. This is most likely due to the high number of forested acres and low agricultural and residential impacts.

Site 6 Description and Overview

Mill Creek at Country Club Road

Site 6 is in Mill Creek Watershed. The sampling site is located in a mixed residential/forested area. Adjacent lands uses include: south, north, and east – forest and residential; west – residential and cropland.

UPSTREAM

DOWNSTREAM

Figure 26 shows the watershed above Sampling Site 6 and provides a break down of land use categories. The watershed contains approximately 11,940 acres.

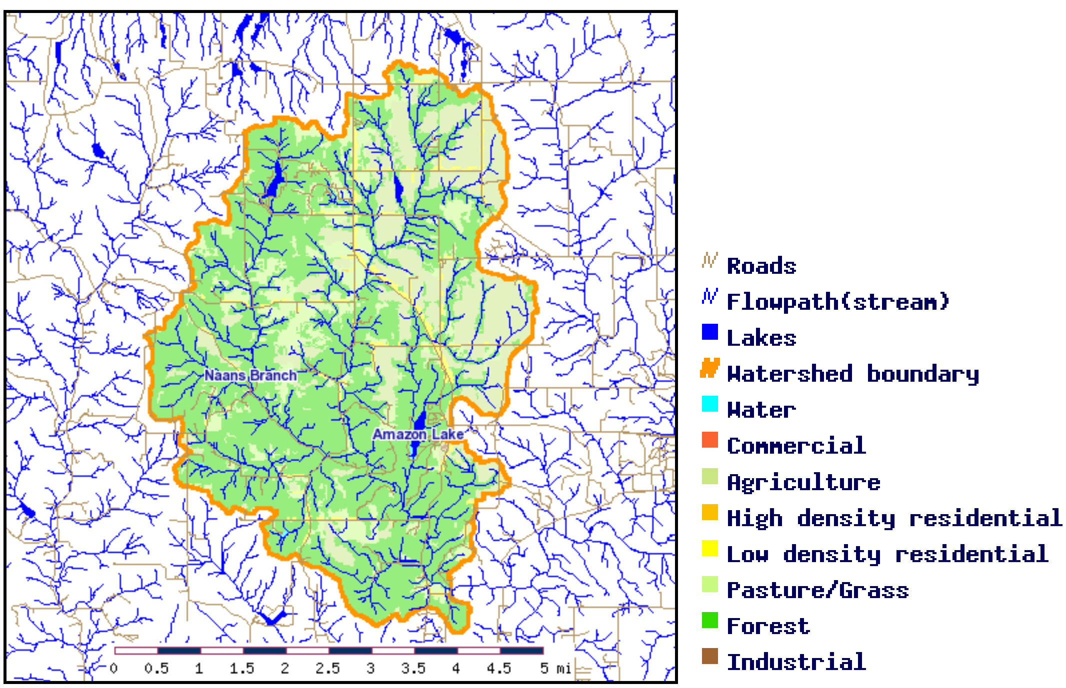


Figure 26

Chemical Sampling Program Summary for Site 6

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 68.7 was 8 mg/l. All of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 6 was 7.3. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 6 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.02 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 6 was 17 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 6 was 10.5 mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 6 on two occasions. On September 27, 2007 the *E.coli* count was 1560 CFU. On April 28, 2008, the *E.coli* count was 90 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 6 was 3.8 mg/l. The water quality target was exceeded on four of the thirteen sampling events.

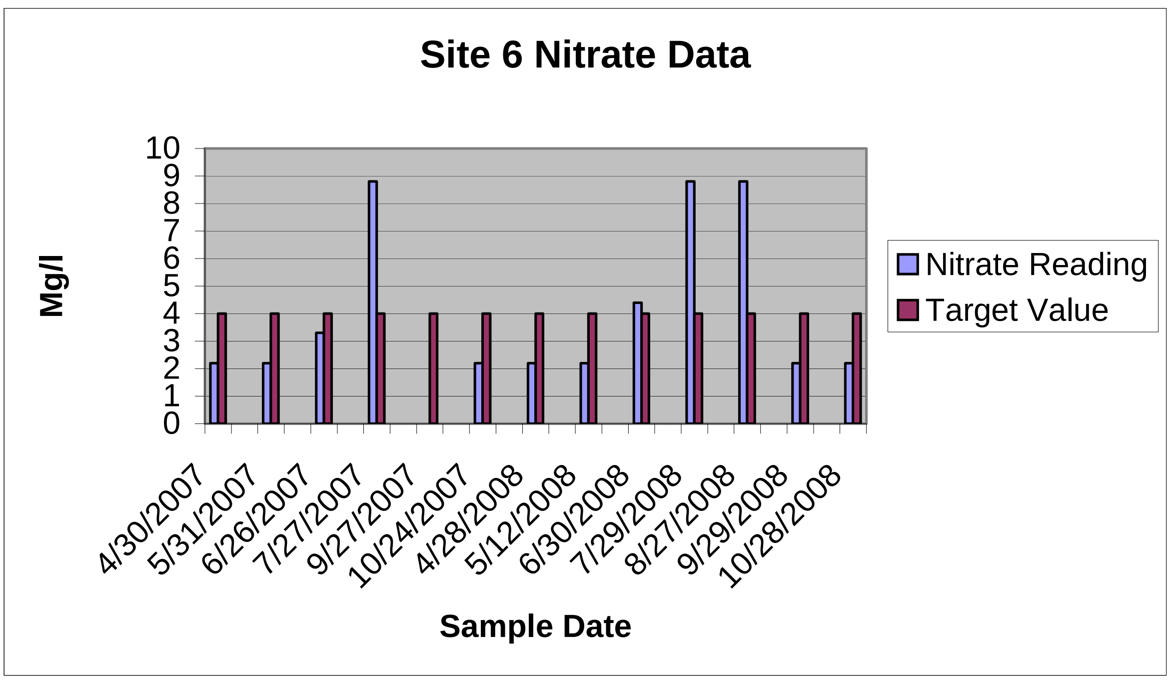


Table 12. Site 6 Nitrate Data

Site 7 Description and Overview

Mill Creek at Rocky Hill Road

Site 7 is in Mill Creek Watershed. The sampling site is located in a mixed forest/residential area. Adjacent land uses include; all directions – forest and residential.

UPSTREAM

DOWNSTREAM

Figure 27 shows the watershed above Sampling Site 7 and provides a break down of land use categories. The watershed contains approximately 4,025 acres.

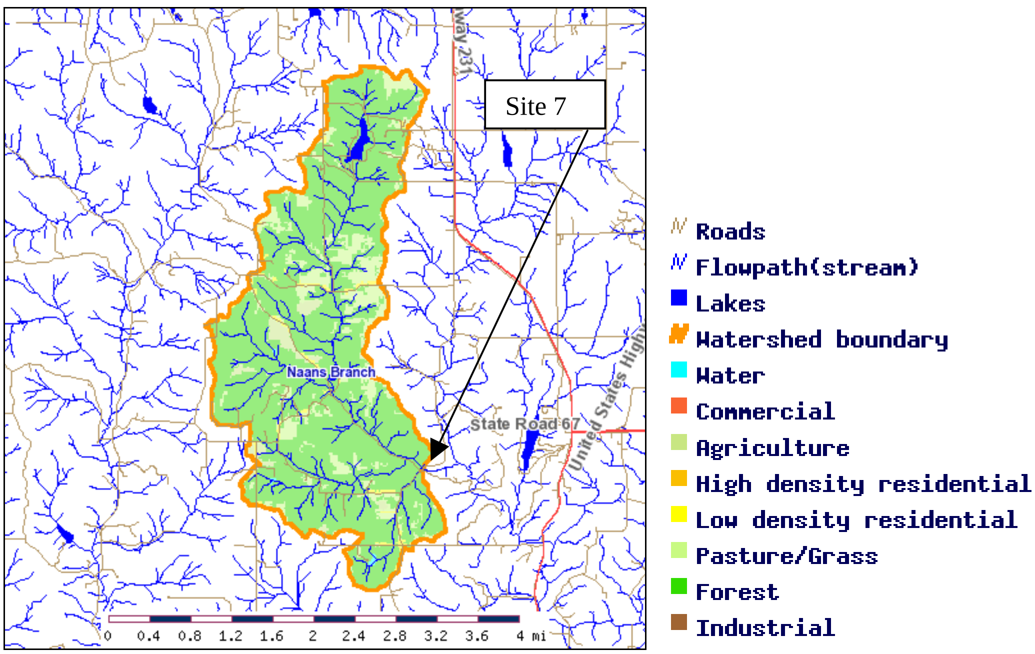


Figure 27

Chemical Sampling Program Summary for Site 7

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 7 was 8.7 mg/l. All of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 7 was 7.4. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 7 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.02 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 7 was 15.5 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 7 was 5.4 mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 7 on two occasions. On September 27, 2007 the *E.coli* count was greater than 5000 CFU. On April 28, 2008, the *E.coli* count was 60 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 7 was 1.9 mg/l. In June of 2007, the nitrate reading exceeded the water quality target with a reading of 4.4. The remaining twelve readings were all within the Water Quality Target.

Site 8 Description and Overview

Little Mill Creek at Rocky Hill Road

Site 8 is in the Little Mill Creek Watershed. The sampling site is located in a forested riparian corridor. Adjacent land uses include; all directions – forest and residential.

UPSTREAM

DOWNSTREAM

Figure 28 shows the watershed above Sampling Site 8 and provides a break down of land use categories. The watershed contains approximately 3,170 acres.

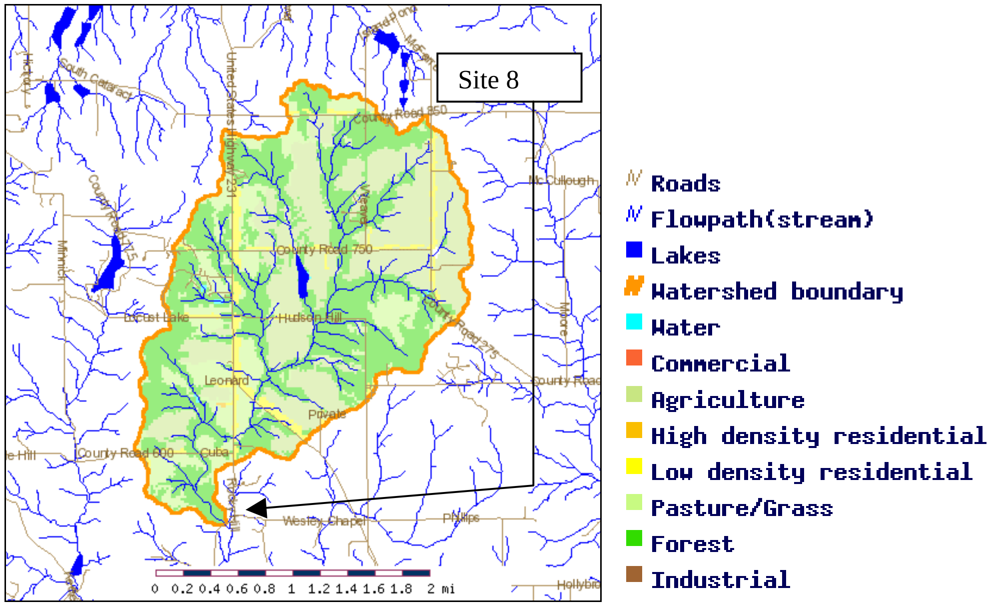


Figure 28

Chemical Sampling Program Summary for Site 8

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 8 was 7.8 mg/l. All of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 8 was 7.5. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 8 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.02 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 8 was 15.8 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 8 was 5mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 8 on two occasions. On September 27, 2007 the *E.coli* count was 1590 CFU. On April 28, 2008, the *E.coli* count was 100 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 8 was 3.9 mg/l. Six of the thirteen nitrate sampling events exceeded the water quality target.

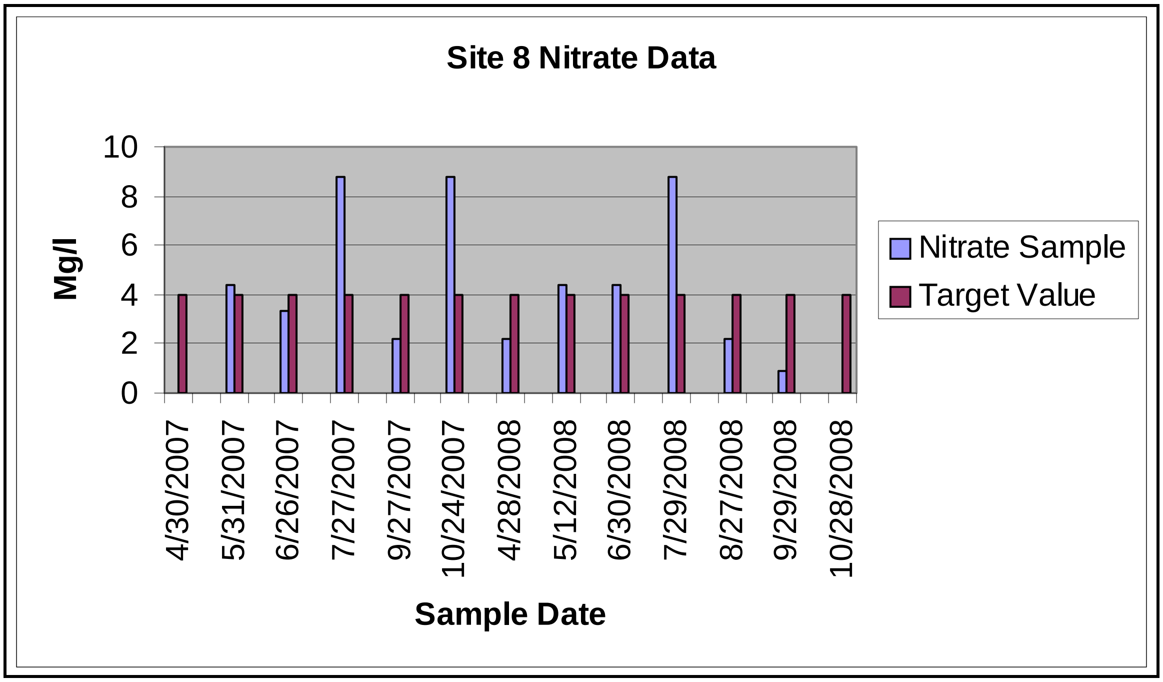


Table 13. Nitrate Data for Site 8

Summary of the chemical sampling program in the Mill Creek Watershed (Sites 6, 7 and 8)

E.coli and Nitrates

In the Total Maximum Daily Load *E.coli* Study done in 2007 on the West Fork of the White River in 2007, *E.coli* data was collected in the Mill Creek Watershed. Sampling point 9 of the TMDL Study corresponds to sampling point 6 of this study. Sampling point 7 of the TMDL Study corresponds to sampling point 8 of this study.

For economic reasons, only two *E.coli* samples were collected at each site during this study. This data alone, ranging from readings of 5000cfu to 50cfu would seem to be inconclusive. But this data joined with data from the TMDL study reveals that *E.coli* levels frequently exceed the water quality standard in the Mill Creek watershed.

The land use in this watershed is predominately forest. Agriculture and pasture areas comprise the second highest landuse catagories. Even though agriculture is a small percentage of the land use, it is the dominant use of land adjacent to the streams. The soils in this watershed necessitate the use of field tiles to drain excess water from the fields. The field tiles then drain to the nearest stream. Field tiles are not themselves sources of *E.coli* and Nitrates, but they carry *E.coli* and Nitrates from land applied manure, runoff from pastures and fields, and other sources of *E.coli* and Nitrates not adjacent to the streams.

There are non-regulated small animal operations in this watershed. If animals have direct access to a stream, this could contribute to elevated *E.coli* and Nitrate levels during dry and wet conditions.

Wildlife is a know source of *E.coli*. The predominant agricultural and forested landuses in the watershed create ideal habitat for wildlife.

Septic systems are a know source of *E.coli* for this watershed based on information provided to this study by the Owen County Health Department. The septic systems described by this information would contribute a constant source of *E.coli*, particularly during low to mid-range flow conditions.

Based on water quality data, it can be concluded that the majority of sources of *E.coli* and Nitrates in this watershed are nonpoint sources that include agricultural operations, small animal operations, wildlife, leaking and failing septic systems.

Site 9 Description and Overview

Limestone Creek at Ramona Road

Site 9 is in the Limestone Creek Watershed. The sampling site is located in a lightly forested riparian corridor. Adjacent lands use in all directions: forest and cropland.

UPSTREAM

DOWNSTREAM

Figure 29 shows the watershed above Sampling Site 9 and provides a break down of land use categories. The watershed contains approximately 7,390 acres. Lake Hollybrook is in this watershed.

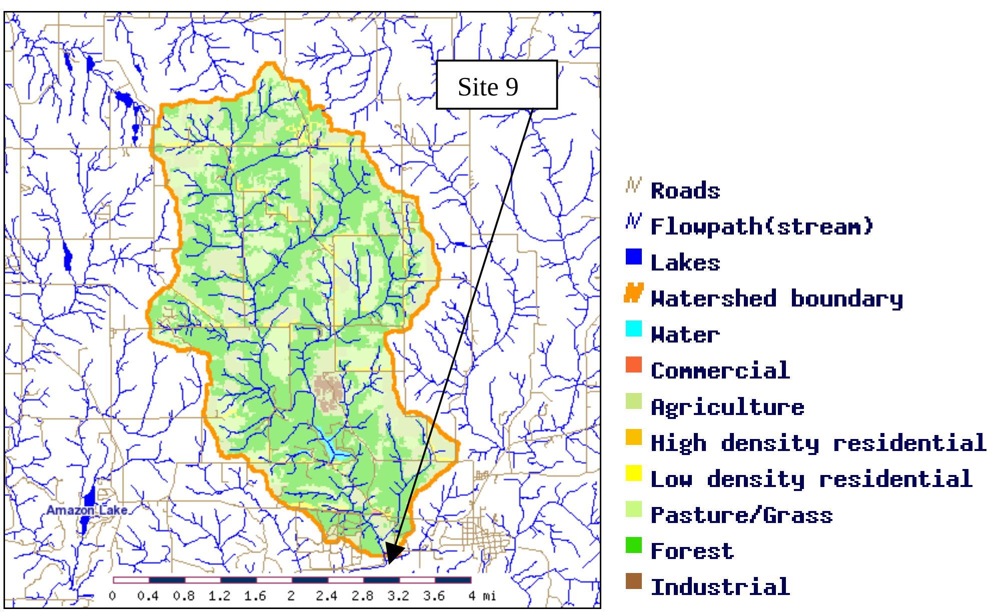


Figure 29

Chemical Sampling Program Summary for Site 9

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 9 was 7 mg/l. In May of 2007 and October of 2008, the Dissolved Oxygen at this site was at a low of 5.0 mg/l and 4.5 mg/l respectively.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 9 was 7.2. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 9 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.04 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 9 was 17 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 9 was 15 mg/l. On July 26, 2007 the TSS water quality target was exceeded with a reading of 83mg/l. The remaining twelve readings were within the water quality target range.

E.coli (Water Quality Target: <235 CFU)

The average *E.coli* reading at Site 9 was 526cfu. The water quality target was exceeded on seven of the thirteen sampling events.

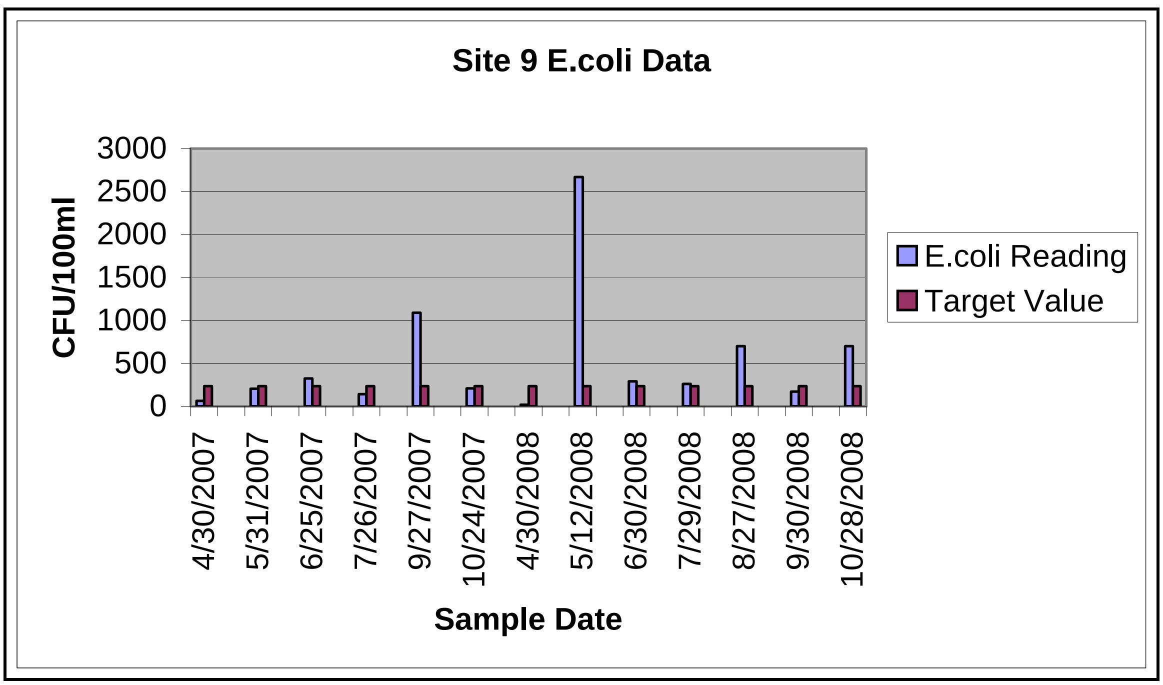


Table 14. Site 9 *E.coli* Data

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 9 was 1.7 mg/l. With the exception of a nitrate reading of 8.8mg/l on May 12, 2008, the remaining twelve nitrate readings were within the Water Quality Target.

Site 10 Description and Overview

Limestone Creek at Childers Road

Site 10 is located in Limestone Creek Watershed. The sampling site is located in an agricultural area. Adjacent land uses include: west – residential and pasture; east – cropland and pasture; north – cropland and forest; south – pasture.

UPSTREAM

DOWNSTREAM

Figure 30 shows the watershed above Sampling Site 10 and provides a break down of land use categories. The watershed contains approximately 2,980 acres.

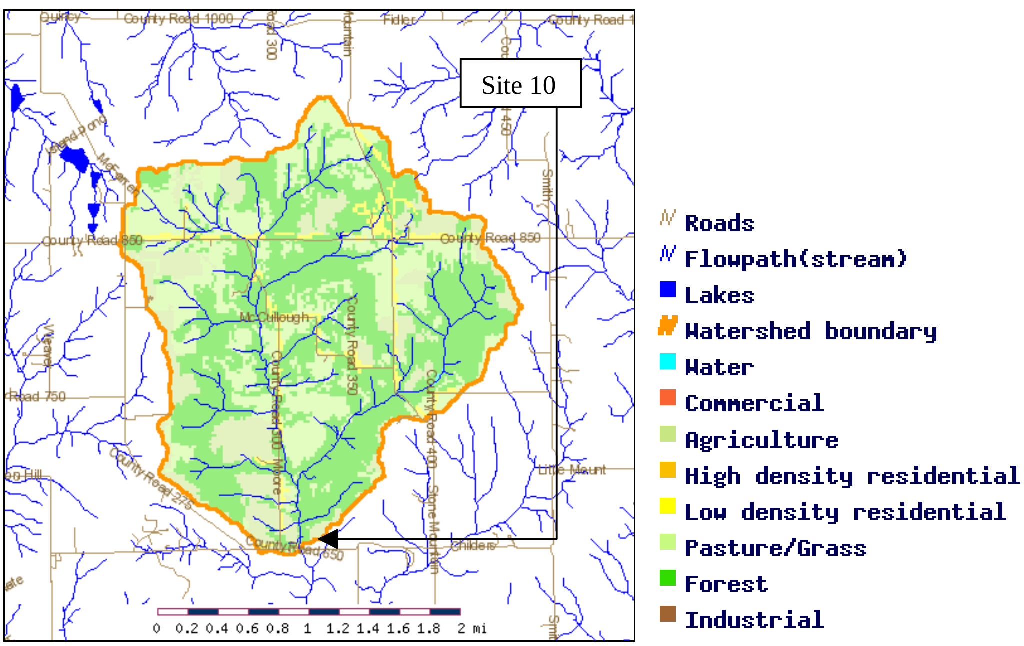


Figure 30

Chemical Sampling Program Summary for Site 10

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 10 was 7.4 mg/l. In September of 2008 the Dissolved Oxygen reading at this site was at a low of 4.5 mg/l. The remaining twelve readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 10 was 7.5. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 10 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.07 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 10 was 17 NTU. All of the turbidity readings were within the Water Quality Target range.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 10 was 8.2mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

The average *E.coli* readings for Site 10 was 740cfu. On May 31, 2007, Dillman Laboratory reported an *E.coli* reading of "Too Numerous To County" (TNTC) meaning there was not enough separation of colonies to make an accurate count.

The Water Quality Target was exceeded on seven of the twelve sampling events used to calculate the average.

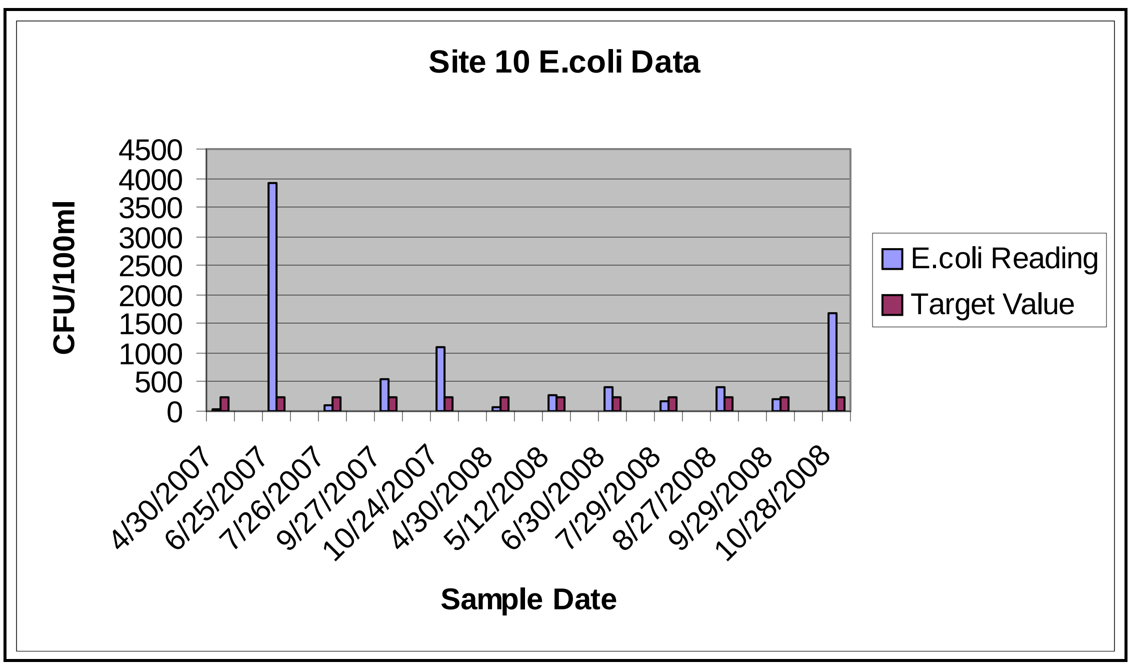


Table 15. *E.coli* data for Site 10

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 10 was 3.3 mg/l. The Water Quality Target was exceeded on three of the thirteen sampling events.

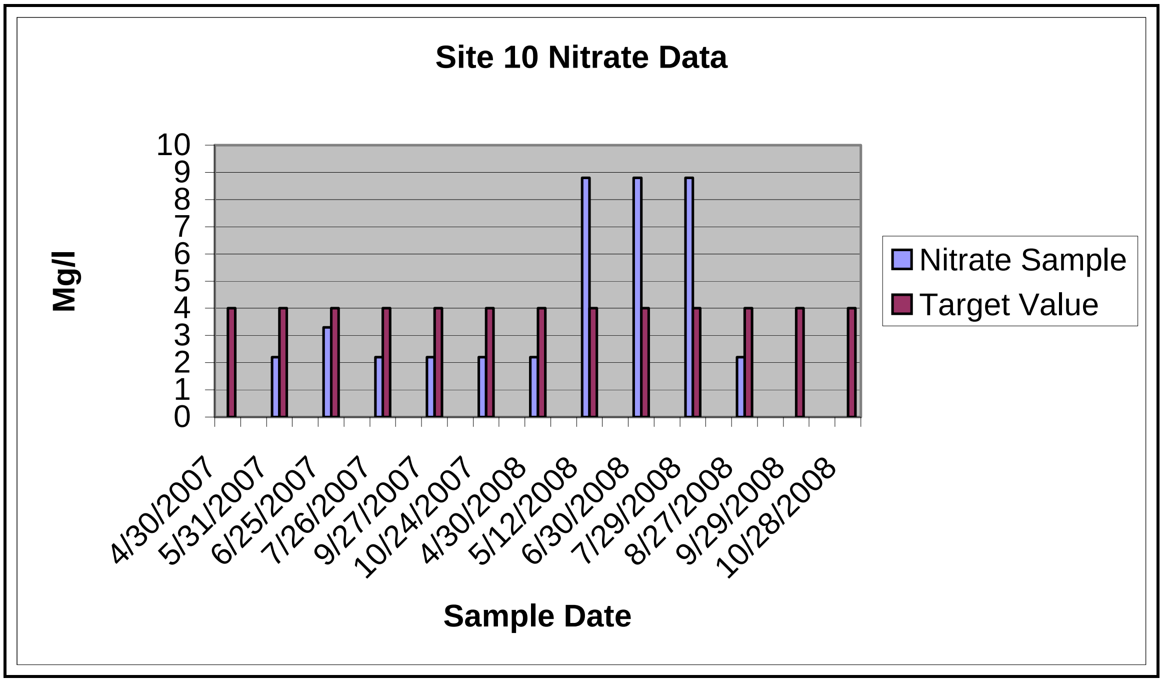


Table 16. Nitrate data for Site 10

Summary of the chemical sampling program in the Limestone Creek Watershed (Sites 9 and 10)

E.coli and Nitrates

The land use in this watershed is predominately agriculture, particularly adjacent to the streams. The soils in this watershed necessitate the use of field tiles to drain excess water from the fields. The field tiles then drain to the nearest stream. Field tiles are not themselves sources of *E.coli* and Nitrates, but they carry *E.coli* and Nitrates from land applied manure, fertilizers, runoff from pastures and fields, and other sources of *E.coli* and Nitrates not adjacent to the streams.

There are non-regulated small animal operations in this watershed. If animals have direct access to a stream, this could contribute to elevated *E.coli* and Nitrate levels during dry and wet conditions.

Wildlife is a know source of *E.coli*. The predominant agricultural and forested landuses in the watershed create ideal habitat for wildlife.

Septic systems are a know source of *E.coli* for this watershed based on information provided to this study by the Owen County Health Department. The septic systems described by this information would contribute a constant source of *E.coli*, particularly during low to mid-range flow conditions.

Based on water quality data, it can be concluded that the majority of sources of *E.coli* and Nitrates in this watershed are nonpoint sources that include small animal operations, wildlife, agricultural lands, and leaking and failing septic systems.

Site 11 Description and Overview

Big Creek at Williams Road

Site 11 is in Big Creek Watershed. The sampling site is located in an agricultural/pasture area. Adjacent land uses in all directions include residential, pasture, and cropland.

UPSTREAM

DOWNSTREAM

Figure 31 shows the watershed above Sampling Site 11 and provides a break down of land use categories. The watershed contains approximately 3,980 acres.

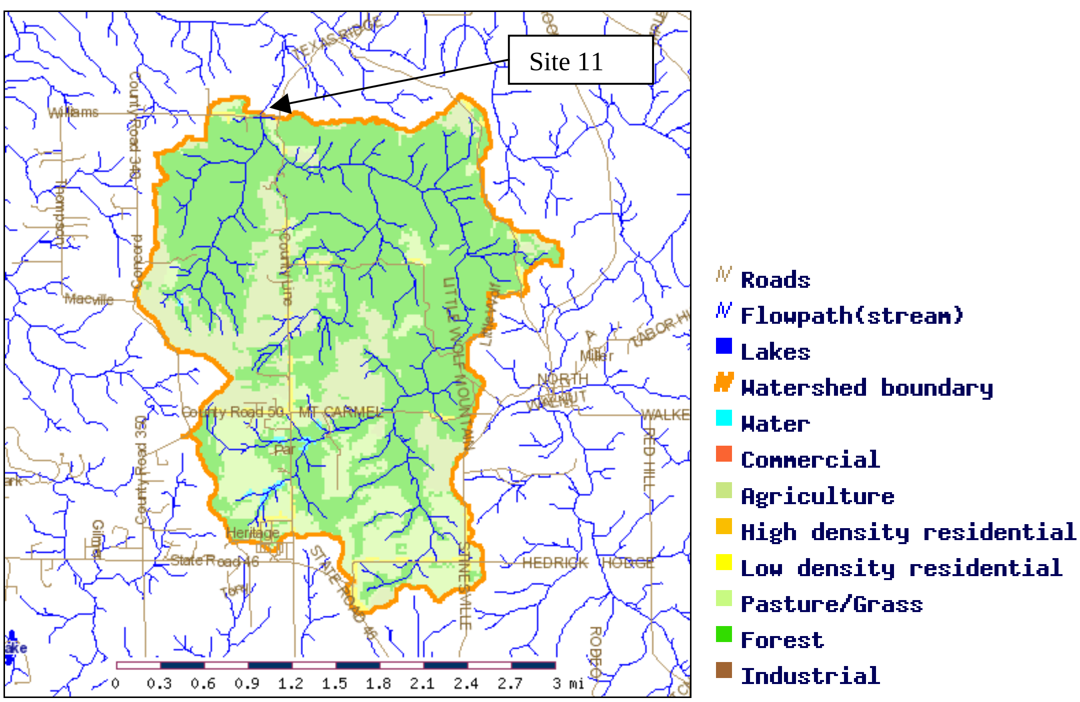


Figure 31

Chemical Sampling Program Summary for Site 11

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 11 was 8.3 mg/l. In July of 2007, the Dissolved Oxygen at this site was at a low of 5.0 mg/l. The remaining twelve Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 11 was 7.7. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 11 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.04 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 11 was 17 NTU. On one occasion, September 27, 2007, the Turbidity reading exceeded the Water Quality Target with a reading of 40NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 11 was 6.7 mg/l. All of the Total Suspended Solids readings were within the Water Quality Target range.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 11 on two occasions. On September 27, 2007 the *E.coli* count was +5000 CFU. On April 30, 2008, the *E.coli* count was 20 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 11 was 2.3 mg/l. Two of the thirteen Nitrate readings exceeded the Water Quality Target.

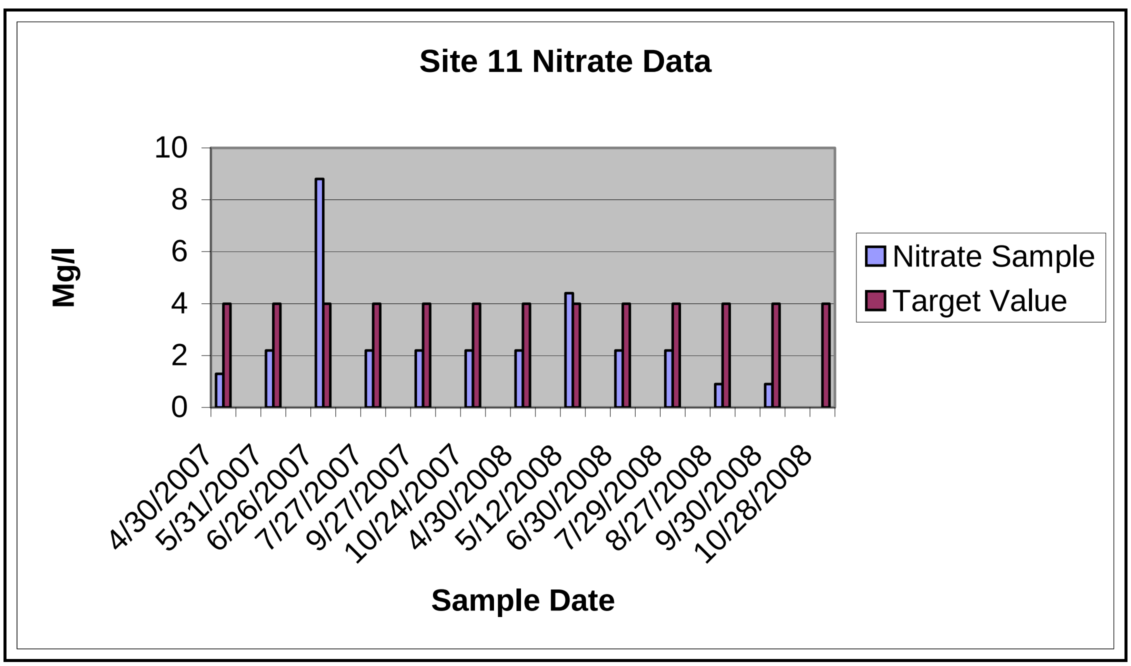


Table 17. Nitrate Data for Site 11

Site 12 Description and Overview

Big Creek at Little Wolf Mountain Road

Site 12 is in the Big Creek Watershed. The sampling site is located in a forested riparian corridor. Adjacent land use in all directions is forested land.

UPSTREAM

DOWNSTREAM

Figure 32 shows the watershed above Sampling Site 12 and provides a break down of land use categories. The watershed contains approximately 1,530 acres.

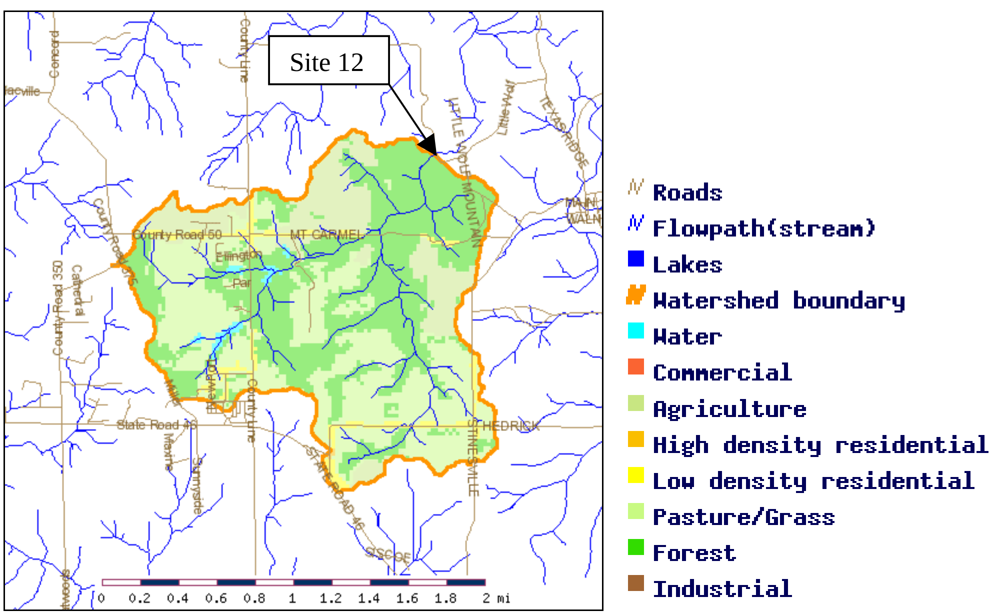


Figure 32

Chemical Sampling Program Summary for Site 12

Dissolved Oxygen (Water Quality Target: >5 mg/l)

The average Dissolved Oxygen reading at Site 12 was 8.5 mg/l. All thirteen of the Dissolved Oxygen readings were within the Water Quality Target range.

pH (Water Quality Target: between 6 and 9)

The average pH reading at Site 12 was 7.5. All of the pH readings were within the Water Quality Target range.

Orthophosphate (Water Quality Target: < 0.3 mg/l)

The average Phosphorous reading at Site 12 was 0. All of the Phosphorous readings were within the Water Quality Target range. In September of 2008, a water sample was sent to Dillman Laboratory to access Total Phosphorous levels. The result of this test was 0.03 mg/l.

Turbidity (Water Quality Target: 36 NTU)

The average Turbidity reading for Site 12 was 17.7 NTU. On one occasion, September 27, 2007, the Turbidity reading exceeded the Water Quality Target with a reading of 50 NTU.

Total Suspended Solids (Water Quality Target: 40 mg/l)

The average Total Suspended Solids reading for Site 12 was 6.3 mg/l. On one occasion, September 27, 2007, the TSS reading exceeded the Water Quality Target with a reading of 43mg/l.

E.coli (Water Quality Target: <235 CFU)

E.coli samples were collected at Site 12 on two occasions. On September 27, 2007 the *E.coli* count was +5000 CFU. On April 30, 2008, the *E.coli* count was 220 CFU.

Nitrates (Water Quality Target: <4 mg/l)

The average Nitrate reading at Site 12 was 3 mg/l. The Water Quality Target was exceeded on five of the thirteen sampling events.

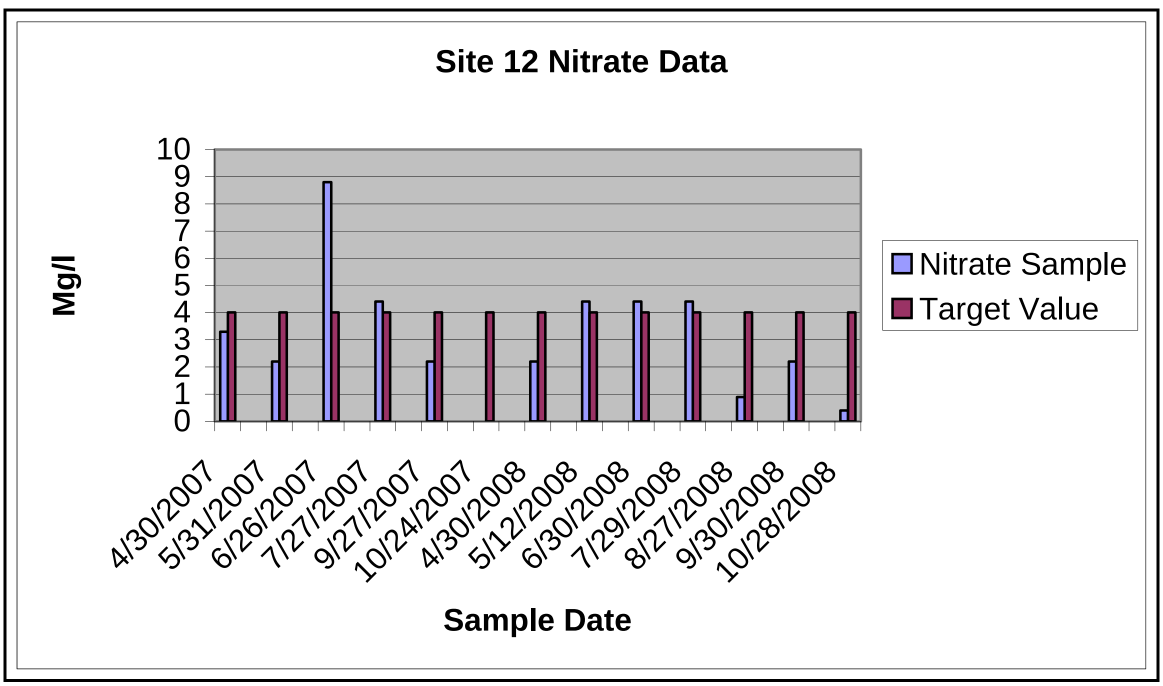


Table 18. Nitrate data for Site 12

Summary of the chemical sampling program in the Big Creek Watershed (Sites 11 and 12)

E.coli and Nitrates

For economic reasons, only two *E.coli* samples were collected at each site during this study. Both sites showed elevated readings on one occasion, and a reading below the Water Quality Target on the second occasion. Given what is know about mixed use watersheds, it is appropriate to consider the water quality impacts of *E.coli*.

The land use in this watershed is predominately forest. Agriculture and pasture areas comprise the second highest landuse catagories. Even though agriculture is a small percentage of the land use, it is the dominant use of land adjacent to the streams. The soils in this watershed necessitate the use of field tiles to drain excess water from the fields. The field tiles then drain to the nearest stream. Field tiles are not themselves sources of *E.coli* and Nitrates, but they carry *E.coli* and Nitrates from land applied manure, runoff from pastures and fields, and other sources of *E.coli* and Nitrates not adjacent to the streams.

There are non-regulated small animal operations in this watershed. If animals have direct access to a stream, this could contribute to elevated *E.coli* and Nitrate levels during dry and wet conditions.

Wildlife is a know source of *E.coli*. The predominant agricultural and forested landuses in the watershed create ideal habitat for wildlife.

Septic systems are a know source of *E.coli* for this watershed based on information provided to this study by the Owen County Health Department. The septic systems described by this information would contribute a constant source of *E.coli*, particularly during low to mid-range flow conditions.

Based on water quality data, it can be concluded that the majority of sources of *E.coli* and Nitrates in this watershed are nonpoint sources that include agricultural operations, small animal operations, wildlife, leaking and failing septic systems.

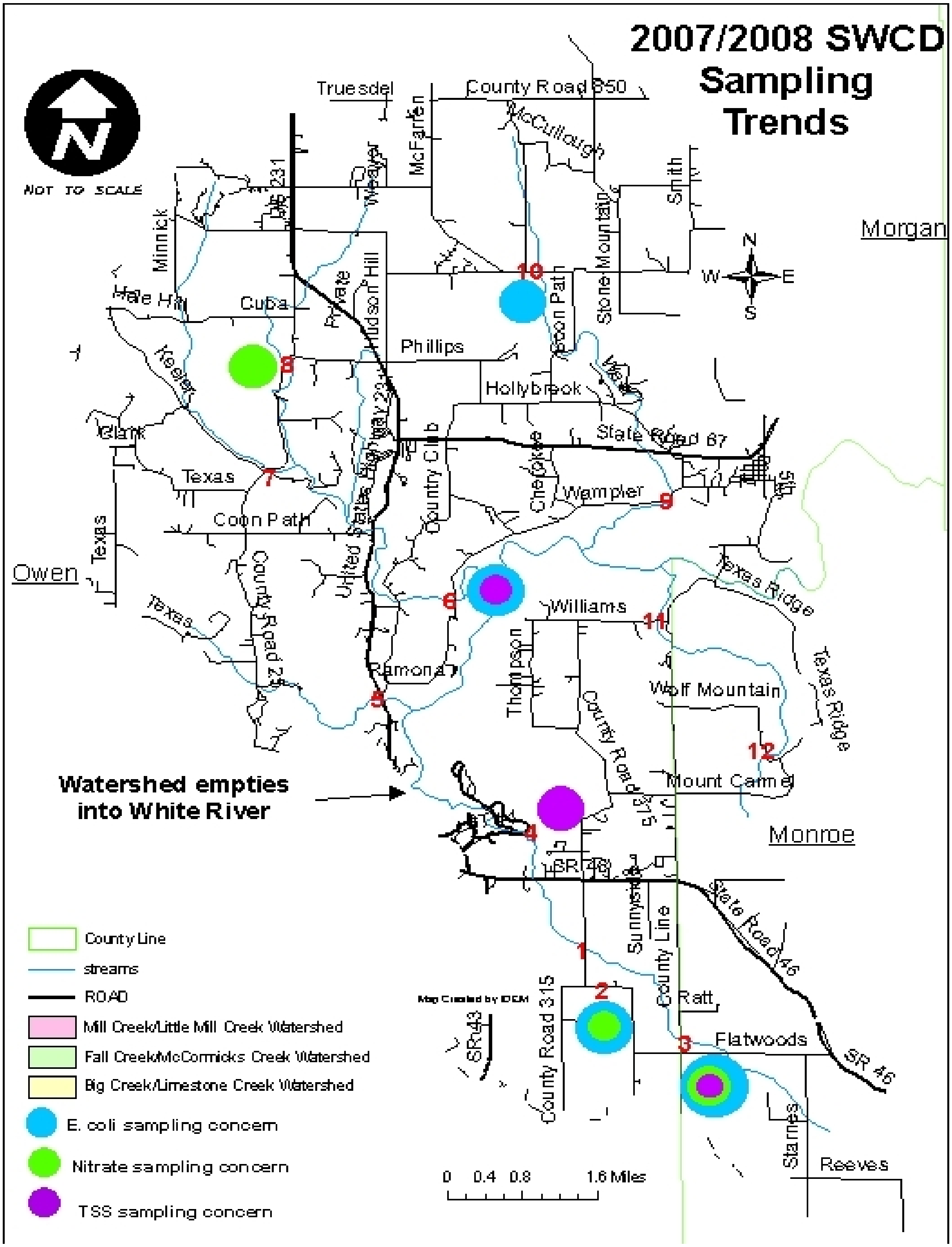


Figure 33. Chemical Sampling Program Trends Map

Problem Statements Re-visited…

Having conducted extensive research throughout the project area through chemical water sampling, macroinvertebrate studies, habitat studies, personal interviews, and land use studies, the Steering Committee re-visited the perceived Problem Statements noted on page 22.

In the following list of problem statements, the research method that confirms the existence of the problem has been added in **bold** type:

Category: Sediment - Agricultural Land
Problem statements:

6. Poorly managed pastures are eroding and contributing to sedimentation of water resources. **Windshield survey, macroinvertebrate study.**
7. Poorly managed highly erodible cropland acres are eroding and contributing to sedimentation of water resources. **Windshield survey, macroinvertebrate study.**
8. Cultivation of cropland near streams, ditches, and other environmentally sensitive areas causes erosion of banks and contributes to sedimentation of water resources. **Windshield survey, macroinvertebrate study, habitat study.**
9. Poor timber harvesting techniques increase surface erosion and sedimentation of receiving waters. **Interview with IDNR Forester.**
10. Livestock that have access to streams and creeks contribute to excessive bank erosion. **Windshield survey.**

Category: Sediment - Urban Lands
Problem Statement:

2. Developing lands that do not use erosion and sediment control best management practices during construction contribute to sedimentation of water resources. **Observations made at two sites under construction in the town of Gosport.**

Category: Sediment - Water Resources
Problem Statement:

2. Unstable stream banks and lake shores contribute to sedimentation of water resources. **Windshield survey.**

Category: Nutrients – Agricultural Land
Problem Statements:

5. Poorly managed livestock feedlot and dry lot runoff contributes excess nutrients to receiving waters. **Windshield survey, chemical sampling program.**
6. Improper application of animal waste and fertilizers on cropland acres allows contaminated runoff to enter surface and subsurface waters. **Windshield survey, chemical sampling program.**
7. Improper usage of herbicides and pesticides allows contaminated runoff to enter surface and subsurface waters. **Windshield survey.**
8. Poorly managed pastures are eroding and contributing excess nutrients to water resources. **Windshield survey, chemical sampling program.**

Category: Nutrients – Urban Lands
Problem Statement:

2. Over-fertilization of lawns/grassy areas allows contaminated runoff to enter surface and subsurface waters. **No direct observances made but problem is typical of these areas.**

Category: Nutrients – Water Resources
Problem Statement:

2. An over-abundance of geese on the lakes in the project area contribute excess nutrients to the lakes and associated down-stream water resources. **Observed by several Steering Committee members.**

Category: *E.coli* - Agricultural Land
Problem Statements:

5. Poorly managed livestock feedlot and dry lot runoff contributes bacteria in the form of *E.coli* to receiving waters. **Windshield survey and chemical sampling program.**
6. Improper application of animal waste on cropland acres allows runoff contaminated with *E.coli* to enter surface and subsurface waters. **Windshield survey and chemical sampling program.**
7. During rain events with runoff, animal waste on poorly managed pastures washes into receiving waters and contributes to excessive *E.coli* levels. **Windshield survey and chemical sampling program.**
8. Waste from livestock that have access to streams and creeks contributes to excessive *E.coli* levels. **Windshield survey and chemical sampling program.**

Category: *E.coli* – Urban Land
Problem Statement:

2. Faulty residential septic systems contribute to elevated *E.coli* levels in receiving waters. **Chemical sampling program.**

Category: *E.coli* – Water Resources
Problem Statement:
None

Category: Miscellaneous Urban Issues
Problem Statements:

3. Illegal dumping along roads contributes trash and unknown pollutant impacts to receiving waters. **Windshield survey.**
4. During runoff events, urbanized areas contribute the following pollutants that degrade water quality: oil, grease, antifreeze, hydraulic fluids, brake dust, gasoline, transmission fluid, and salt/sand from winter deicing activities. **Windshield survey.**

Part 4: Water Quality Targets and Critical Areas

4.1 Water Quality Targets

During the November, 2007 Steering Committee meeting, the committee identified the following water quality targets/standards to be used for the purpose of this Watershed Management Plan:

- Dissolved Oxygen >5 mg/l
- Nitrates <4 mg/l
- pH between 6 and 9
- Phosphorus 0.3 mg/l
- Turbidity 36 NTU
- TSS 40 mg/l
- E.coli 235 cfu

The standards set for E.coli, Dissolved Oxygen, pH, and Phosphorus (draft), come from Indiana Standards established by The Indiana Department of Environmental Management. Where Indiana Standards are available, they have been used.

The Water Quality Target set for Nitrates, <4 mg/l, is recommended by Hoosier Riverwatch, a state-sponsored water quality monitoring initiative.

The Water Quality Target set for Total Suspended Solids (TSS), 40 mg/l, coincides with the maximum allowable discharge standard used for discharges from waste water treatment plants.

The Water Quality Target set for Turbidity, 36 Units of Turbidity (NTUs), coincides with the Indiana average as identified by Hoosier Riverwatch.

4.2 Pollutants of Concern

In November 2007, the Steering Committee reviewed the data collected during 2007 for water chemistry, macroinvertebrates, stream habitat, and land use. They compared the data to the hypothetical problem statements (on page 22) that were developed from the list of concerns at the onset of the project. Finding that the data collected during the research phase of this project confirms and validates the problem statements, the committee selected the following Pollutants of Concern:

- Nitrates
- E.coli
- TSS and Turbidity (in the form of sediment)

In October 2008, the Steering Committee revisited the Pollutants of Concern and determined that the water chemistry, macroinvertebrates, stream habitat, and land use data collected throughout the project term continued to support the designated Pollutants of Concern.

4.3 Critical Areas

Critical Areas are defined as those areas where conservation best management practices are most needed to improve water quality.

During the November, 2007 Steering Committee meeting, the committee determined Critical Areas by considering all of the information included in the Watershed Inventory process (water quality data, macroinvertebrate data, habitat data, previous studies, land use data, current interviews with professionals, and the windshield survey data).

Critical Areas for E.coli and Nitrates are identified as:

All subdivisions – sources include septic systems and urban fertilizer use.

Limestone Creek watershed above Lake Hollybrook – sources include subdivisions, lack of vegetative buffers, and animal access. Water quality data revealed E.coli problems.

McCormick's Creek watershed above McCormick's Creek State Park – sources include subdivisions, lack of vegetative buffers, animal access. Water quality data revealed E.coli and nitrate problems.

Critical Areas for TSS are identified as:

Mill Creek watershed above Coon Path Road – sources include bank erosion, lack of vegetative buffers, eroding cropland, and over-grazed pastures.

The entire Little Mill Creek watershed – sources include bank erosion, lack of vegetative buffers, eroding cropland, and over-grazed pastures.

Limestone Creek watershed above Lake Hollybrook – sources include bank erosion, lack of vegetative buffers, eroding cropland, and over-grazed pastures.

McCormick's Creek watershed above McCormick's Creek State Park - sources include bank erosion, lack of vegetative buffers, eroding cropland, and over-grazed pastures.

Other Critical Area are identified as: Urban/recreational areas such Gosport, Ellettsville, the golf course on County Line Road, schools, Department of Transportation facilities, McCormick's Creek State Park, and Flatwoods Park. The designation of "critical" has been assigned to these areas because they have the potential to contribute high concentrations of pollutants.

In October 2008, the Steering Committee revisited the designated Critical Areas and determined that the data collected throughout the project term continued to support the designated Critical Areas.

Part 5: Goals and Objectives

5.1 The Steering Committee

The Steering Committee and the Owen County SWCD Board of Supervisors worked together to identify and prioritize the goals, indicators, objectives, action items, timetable, costs, and responsible party components of the WMP.

The goals and implementation schedules are based on input and consideration of partner organizations and their experiences working with stakeholders for many years. These partners include the following:

- SWCD staff and board of Supervisors in Owen and Monroe counties
- NRCS Staff
- ISDA Staff
- Friends of McCormick's Creek State Park
- Health Departments in Owen and Monroe counties
- County Commissioners in Owen and Monroe counties
- The Monroe County Drainage Board
- The Cooperative Extension Service personnel
- The Solid Waste District
- Monroe County Parks and Recreation Department

The overall vision of this effort is to reduce the loads of sediment, pathogens, and nutrients in the White River and it's tributaries so as to meet the water quality standards described in this report. This notable effort will protect human health, watershed biodiversity and the aesthetic and economic value of the river.

Efforts to implement the WMP will rest primarily with the Owen and Monroe County SWCD staff and Supervisors. The Lower White River Watershed Initiative Steering Committee will dissolve upon final approval of the WMP, but may be revived when funding becomes available to implement the WMP.

The following goal tables represent the culmination of two years of research, discussion, idea sharing, and planning.

5.1 Goal and Objective Tables

E.coli Goal Statement

Throughout the entire watershed project area, 56% of the total sampling events for *E.coli* exceeded the Indiana Standard of 235 CFU/100ml. All of the subwatersheds included in this study have elevated *E.coli* levels. Within 25 years, we hope to meet the Indiana Standard in each subwatershed. We hope to begin accomplishing this by reducing *E.coli* levels by 12% in the McCormick's Creek and Limestone Creek watersheds in 10 years.

E.coli Goal Indicators

Water quality data will be used as an indicator to show progress toward attaining this goal. Either Hoosier Riverwatch techniques or the use of a professional lab will be employed to test water samples for *E.coli* levels. We will use the same sampling sites identified in this study. Chemical testing will be funded through grants. In addition, we will use surveys to measure the changes created through our education programs.

Action Register for E.coli Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Promote E.coli Education Programs for Homeowners	Hire a consultant to conduct a user survey for educational programs within 1 year of implementation starting	$500.00	RP = SWCD TH = University to create survey
	Promote and distribute educational programs/materials about pet waste within 1 year of implementation starting	$500.00	RP= SWCD working with the Solid Waste District
	Create a web page with information about septic systems within 1 year of implementation starting	$500.00	RP= SWCD
	Explore options for partnerships and opportunities to extend/create community waste treatment systems within 5 years of implementation starting	$500.00	RP= SWCD working with Rural Community Assistance Program (RCAP)
	Support existing efforts to lobby the State Board of Health to approve alternatives to traditional septic systems within 1 year of implementation starting	$500.00	RP= SWCD
	Provide septic system/water quality educational kits to homeowners within 1 year of implementation starting	$750.00	RP= SWCD working with local health departments
	Promote innovative ideas (i.e. septic management districts) that address rural waste disposal issues within 5 years of implementation starting	$500.00	RP= SWCD
	Place septic system information in County Health Departments within 1 year of implementation starting	$500.00	RP= SWCD

Action Register for E.coli Goals Continued			
Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Cost-share on agricultural best management practices to reduce E.coli contributions from livestock	Cost share on liquid manure injector knives within 1 year of implementation starting	$5000.00	RP= SWCD TH = NRCS
	Cost share on manure staging facilities within 1 year of implementation starting	$50,000.00	RP= SWCD TH = NRCS
	Cost share on pasture management plans/practices within 1 year of implementation starting	$30,000.00	RP= SWCD/ISDA
	Cost share on limited access areas within 1 year of implementation starting	$5000.00	RP=SWCD TH = NRCS
	Cost share on alternative watering systems and fences to keep livestock out of streams within 1 year of implementation starting	$50,000.00	RP= SWCD TH = NRCS
	Cost share on nutrient management plans within 1 year of implementation starting	$10,000.00	RP= SWCD/ISDA TH = NRCS
Promote educational programs for agricultural producers	Promote and distribute educational programs/materials about the effects of agriculture on E.coli levels within 1 year of implementation starting	$500.00	RP= SWCD TH= Purdue University
	Conduct field days to promote nutrient management within 1 year of implementation starting	$1000.00	RP=SWCD
	Establish demonstration projects to promote nutrient management within 3 years of implementation starting	$5000.00	RP=SWCD TH= NRCS

Nitrate Goal Statement
Throughout the entire watershed project area, 29% of the Nitrate readings were above the Hoosier Riverwatch recommended level of <4 mg/L. Within 20 years, we hope to meet the Hoosier Riverwatch recommended nitrate level at sampling locations in the McCormick's Creek Watershed. We hope to begin accomplishing this by reducing Nitrate levels by 25% within 10 years. We hope to reduce elevated nitrate readings by 25% within 10 years in the Mill Creek, Limestone Creek, and Big Creek watersheds.

Current loads and load reductions needed to meet pollutant benchmark or water quality standard were calculated by IDEM using the IDEM Load Calculation Tool. The tool can be found at: http://www.in.gov/idem/5235.htm .

Nitrate Load Reduction Table by Sampling Location

Sampling Location	Average Current Load (Tons/Year)	Average % Reduction Needed	Average Reduction Needed to Reach Water Quality Target 10 Year Goal (Tons/Year)
1- McCormick's Creek	72.07	39.4	18.02
2- McCormick's Creek	34.45	53.02	8.61
3- McCormick's Creek	12.66	55.68	3.17
4- McCormick's Creek	19.31	39.37	4.83
6- Mill Creek	57.47	43.15	14.37
7- Mill Creek	18.61	9.1	4.65
8- Mill Creek	48.57	36.34	12.14
9- Limestone Creek	277.03	54.5	69.26
10- Limestone Creek	57.42	54.5	14.36
11- Big Creek	14.86	24.23	3.72
12- Big Creek	8.66	18.18	2.17

Table .

Nitrate Goal Indicators
Water quality data will be used as an indicator to show progress toward attaining this goal. Hoosier Riverwatch techniques will be employed to test water samples for Nitrate levels. We will use the same sampling sites identified in this study. Chemical testing will be funded through the Hoosier Riverwatch program as long as this program is available. In addition, we will estimate Nitrate load reductions as Best Management Practices are installed on agricultural land.

Action Register for Nitrate Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Implement Educational Programs about Nitrates for Homeowners and Agricultural Producers	Promote and distribute educational programs/materials about residential lawn care within 1 year of implementation starting	$500.00	RP= SWCD working with the Solid Waste District
	Coordinate with other agencies to support educational programs about agricultural chemical application within 1 year of implementation starting	$500.00	RP = SWCD working with Purdue University
	Insure that agricultural chemical programs provide Certified Crop Advisor (CCA) credits within 1 year of implementation starting	$500.00	RP= SWCD
	Support emphasis of establishing nutrient BMPs in flood plains within 1 year of implementation starting	$500.00	RP= SWCD
	Support educational programs for agricultural producers for interpretation of nutrient management plans within 1 year of implementation starting	$500.00	RP= SWCD
Cost-share on agricultural best management practices to reduce Nitrate contributions from agricultural practices	Cost share on reduced tillage practices on 500 acres within 3 years of implementation starting to meet the goal in the McCormick's Creek watershed	$10,000.00	RP= SWCD
	Cost share on cover crops within 1 year of implementation starting	$20,000.00	RP= SWCD
	Cost share on liquid manure injector knives within 1 year of implementation starting	$5000.00	RP= SWCD
	Cost share on manure staging facilities within 1 year of implementation starting	$50,000.00	RP= SWCD working with NRCS
	Cost share on six alternative watering systems and 4 miles of fencing to keep livestock out of streams within 3 years of implementation starting in the McCormick's Creek watershed	$50,000.00	RP= SWCD working with NRCS
	Cost share on limited access areas within 1 year of implementation starting	$5,000.00	RP= SWCD working with NRCS
	Cost share on vegetative buffers within 1 year of implementation starting	$20,000.00	RP= SWCD working with NRCS
	Cost share on nutrient management plans within 1 year of implementation starting	$10,000.00	RP= SWCD working with NRCS
	Cost share on GPS systems within 3 years of implementation starting	$15,000.00	RP= SWCD
	Support the emphasis of establishing nutrient management BMPs in flood plains within 1 year of implementation starting	$20,000.00	RP= SWCD

Sediment Goal Statement

Water quality data did not support the identification of Total Suspended Solids (TSS) as a problem due to the fact that few high flow samples were taken. The land use data collected as part of this study suggests that TSS sources should be considered problematic. The Steering Committee feels that TSS should be addressed by reducing soil loss on agricultural lands within 8 – 10 years by working with 12 landowners/year to install BMPs.

Sediment Goal Indicators

Water quality data will be used as an indicator to show progress toward attaining this goal. Either Hoosier Riverwatch techniques or the use of a professional lab will be employed to test water samples for TSS and turbidity levels. We will use the same sampling sites identified in this study. Chemical testing will be funded through the Hoosier Riverwatch Program and grants. We will use surveys to measure the changes created through our education programs. Data collected during the annual Tillage Transect will utilized to measure changes in land use.

Action Register for Sediment Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Promote Sediment Education Programs for Homeowners and Agricultural Producers	Educate about how wetlands can increase lake life within 5 years of implementation starting	$500.00	RP= SWCD
	Promote and distribute educational programs/materials about soil loss/retention within 1 year of implementation starting	$500.00	RP= SWCD
	Coordinate with other agencies to support educational programs about soil loss/retention within 1 year of implementation starting	$500.00	RP= SWCD
Cost-share on agricultural best management practices to reduce Sediment contributions from agricultural practices	Cost share on wetland construction within 9 years of implementation starting	$50,000.00	RP= SWCD working with NRCS and alternative partnerships
	Cost share on reduced tillage practices within 1 year of implementation starting	$10,000.00	RP= SWCD working with NRCS
	Cost share on cover crops within 1 year of implementation starting	$20,000.00	RP= SWCD
	Cost share on erosion/sediment control practices within 1 year of implementation starting	$50,000.00	RP= SWCD working with NRCS

Action Register for Sediment Goals Continued			
Objective	Milestones	Cost	Responsible Party (RP) and needed Technical Help (TH)
Cost-share on agricultural best management practices to reduce Sediment contributions from agricultural practices	Cost share on stabilization of heavy use areas within 1 year of implementation starting	$15,000.00	RP= SWCD working with NRCS
	Cost share on alternative watering systems and fences to keep livestock out of streams within 1 year of implementation starting	$50,000.00	RP= SWCD working with NRCS
	Cost share on vegetative buffers within 1 year of implementation starting	$30,000.00	RP= SWCD working with NRCS
	Support emphasis of establishing sediment BMPs in flood plains within 1 year of implementation starting	$20,000.00	RP= SWCD working with NRCS
	Cost share on limited access areas within 1 year of implementation starting	$5,000.00	RP= SWCD working with NRCS

Urban Goal Statement
The land use data collected as part of this study suggests that urban sources are contributing to poor water quality and should be considered problematic. The Steering Committee feels that urban areas should be addressed by reducing urban pollutants by working with 100 landowners to install BMPs within 20 years.

Urban Goal Indicators
We will note the number of BMPs installed each year to track the success of this goal.

Action Register for Urban Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Promote Educational Programs for Urban Areas	Promote and distribute educational materials/ programs about illegal trash dumping within 1 year of implementation starting	$500.00	RP= SWCD working with the Solid Waste District
	Create a web page with information about green living within 2 years of implementation starting	$500.00	RP=SWCD
	Promote educational programs/materials on urban best management practices within 10 years	$500.00	RP= SWCD
	Demonstrate urban BMPs (rain barrels, permeable pavement…) within an urban areas within 10 years of implementation starting	$15,000.00	RP= SWCD
	Cost share on rain gardens, rain barrels, and bioretention within 10 years of implementation starting	$15,000.00	RP= SWCD

Forestry Goal Statement
The data collected as part of this study suggests that poor timber harvesting techniques contribute to degraded water quality and should be considered problematic. The Steering Committee feels that timber harvesting should be addressed by reducing the number of harvests that take place without BMPs in place by working with harvesters to implement BMPs on 10 sites/year.

Forestry Goal Indicators
We will note the number of BMPs implemented each year to track the success of this goal.

Action Register for Forestry Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Promote Educational Programs for Landowners Considering a Timber Harvest	Support development of Timber Contract Standards that protect the environment and landowners within 7 years of implementation starting	$500.00	RP= SWCD working with IDNR
	Provide educational opportunities to help landowners understand BMPs within 7 years of implementation starting	$500.00	RP= SWCD
	Encourage landowners to hire professional foresters to oversee timber harvests within 7 years of implementation starting	$500.00	RP= SWCD

Organic Farming Goal Statement

The data collected as part of this study suggests that sustainable agricultural practices that favor organic farming methods would be beneficial to water quality. The Steering Committee recommends increasing the use of organic production methods by achieving the educational goal program within 10 years.

Organic Farming Goal Indicators

We will note the number of BMPs implemented each year to track the success of this goal.

Action Register for Organic Farming Goals

Objective	Milestone	Cost	Responsible Party (RP) and needed Technical Help (TH)
Promote Educational Programs for Landowners	Support educational programs/materials for organic farming and alternative agricultural practices within 7 years of implementation starting	$500.00	RP= SWCD
	Promote organic farming BMPs within 7 years of implementation starting	$500.00	RP= SWCD
	Support development of organic farming demonstrations sites within 7 years of implementation starting	$5000.00	RP= SWCD

Part 6: Plan Evaluation

This plan will be revisited and reviewed by the Owen County SWCD Board of Supervisors and staff every two years until implementation begins. Once implementation begins, the plan may require updating and adjusting annually.

Watershed partner groups as well as the general public will be invited to provide input on plan updating and revisions.

During the implementation phase, work sessions will be scheduled to review the Goals and Objectives to see what has been accomplished. This will also be the time when adjustments are made to reflect new information or changes in the watershed.

The Watershed Management Plan will be considered finished when the goals have been achieved.

Appendix A. Acronyms

ACOE	United States Army Corps of Engineers
BMPs	Best Management Practices
CAFOs	concentrated/confined animal feeding operations
CES	Cooperative Extension Service
CRP	Conservation Reserve Program
CSO	combined sewer overflow
CTIC	Conservation Tillage and Information Center
CWA	Clean Water Act
DO	dissolved oxygen
EQIP	Environmental Quality Incentive Program
E/SCP	Erosion and Sediment Control Plan
FIP	Forest Improvement Program
FSA	USDA Farm Services Agency
GIS	Geographical Information Systems
GPS	Global Positioning Satellite
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IC	Indiana Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IDOT	Indiana Department of Transportation
IDOW	Indiana Department of Natural Resources Division of Water
IGS	Indiana Geological Survey
LA	Load Allocations
LARE	Lake and River Enhancement Program
mIBI	Macroinvertebrate Index of Biotic Integrity
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	Non-point Source
NRCS	Natural Resources Conservation Service
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QHEI	Qualitative Habitat Evaluation Index
RC&D	Resource Conservation and Development Area
SIP	Forest Stewardship Incentive Program
SWCD	Soil and Water Conservation District
SWPPP	Storm Water Pollution Prevention Plan
TMDL	total maximum daily load
USDA	United States Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UWA	Unified Watershed Assessment

Appendix B: Data Table for Sampling Points

Sample Point	Latitude	Longitude	Watershed	Description	IDEM 2006 TMDL site?
1	39.27009889	-86.70346328	McCormick's	Bridge at Flatwoods Rd	no
2	39.26391757	-86.70089934	McCormick's	Bridge at Schooling Rd.	no
3	39.25240360	-86.69363307	McCormick's	Bridge on County Line Rd.	yes - 12
4	39.29008235	-86.71682529	McCormick's	Bridge in State Park, road to nature center	no
5	39.31327994	-86.74358728	Fall	Bridge at Hwy. 231	yes - 10
6	39.32881781	-86.74033192	Mill	Bridge at Countryclub Rd.	yes - 9
7	39.35082852	-86.76680306	Mill/Naans Branch	Bridge at Rocky Hill Rd.	no
8	39.36933551	-86.76175875	Little Mill	Bridge at Rocky Hill Rd.	yes - 7
9	39.34673245	-86.68590923	Limestone	Bridge at Ramona Rd.	yes - 2
10	39.38419252	-86.71216906	Limestone	Bridge at Childers Rd.	yes - 1
11	39.32558072	-86.68891540	Big	Bridge at Williams Rd.	yes - 4
12	39.30234432	-86.66679145	Big	Bridge at Little Wolf Mountain Rd.	no

Appendix C. Water Chemistry Data Tables

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/30/2007	1	SH	18	15	6	8	210	0	2.9	17	11.2	
5/31/2007	1	SH	27	22	7	8	352	0	2.2	15	7.2	
6/25/2007	1	SH	26	23	4.5	8	1000	0	2.2	19	11	1.4
7/26/2007	1	SH	22	21	5	7.5	410	0	2.2	17	5	0.8
9/27/2007	1	SH	21	19	8	7	3560	0	2.2	18	8	0.8
10/24/2007	1	SH	13	13	6	7	220	0	2.2	15	17.5	0.5
4/30/2008	1	SH	10	10	9	7.5	2220	0	4.4	15	6	3.8
5/12/2008	1	SH	16	12	10	6	2400	0	13.2	33	31	19
6/30/2008	1	SH	26	22	8.5	6.5	790	0	13.2	60	33	1.6
7/30/2008	1	SH	26	26	9	7.5	460	0	4.4	15	11	1
8/28/2008	1	SH	24	22	3	6.5	500	0.2	2.2	15	1	0.6
9/30/2008	1	SH	18	18	8	7.5	350	0	0.4	15	15	0.3
10/27/2008	1	SH	12	9	7	7	100	0	0	15	5	0.4
4/30/2007	2	SH	18	15	6	8.5	289	0	2.2	16	7.6	
5/31/2007	2	SH	28	20	8.5	8	TNTC	0	8.8	15	5.2	
6/25/2007	2	SH	27	21	8	7.5	780	0	8.8	15	6	0.6
7/26/2007	2	SH	22	20	5.5	7.5	160	0	4.4	15	3	0.4
9/27/2007	2	SH	19	19	8	7.5	210	0	2.2	15	3	0.4
10/24/2007	2	SH	13	13	7	6.5	520	0	2.2	16	10	0.3

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/30/2008	2	SH	11	9	9.5	7	30	0	2.2	15	7	0.5
5/12/2008	2	SH	16	11	9.5	6	350	0	8.8	50	25	13
6/30/2008	2	SH	26	22	9	6.5	780	0	17.6	30	56	0.2
7/29/2008	2	SH	33	27	10	7.5	120	0	13.2	15	2	0.2
8/28/2008	2	SH	22	19	7	6.5	380	0	13.2	15	2	0.5
9/30/2008	2	SH	19	17	8	7.5	30	0	13.2	15	30	0.3
10/27/2008	2	SH	13	10	9	7	100	0	8.8	15	1	0.2
4/30/2007	3	SH	18	14	5.8	8.5		0	7.7	16	14.8	
5/31/2007	3	SH	28	20	6.5	8		0	8.8	19	13.6	
6/25/2007	3	SH	27	21	7	8.5		0	2.2	19	15	0
7/27/2007	3	SH										0
9/27/2007	3	SH										0
10/24/2007	3	SH	12	12	3	6	720	0.8	0	25	15.5	0
4/30/2008	3	SH	12	9	10	6.5	50	0	8.8	15	6	0.8
5/12/2008	3	SH	16	12	9	6		0	4.4	25	19	8
6/30/2008	3	SH	24	22	9	7		0	17.6	15	1	0.4
7/29/2008	3	SH	32	26	8	7.5		0	22	15	1	0.1
8/28/2008	3	SH										0
9/30/2008	3	SH										0
10/27/2008	3	SH										0

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
5/1/2007	4	SH	29	17	8.5	9	132	0	2.2	15	3.2	
5/31/2007	4	SH	25	19	6	8.5	74	0	2.2	15	2.4	
6/25/2007	4	SH	26	20	6	7.5	320	0	2.2	16	7	1.4
7/26/2007	4	SH	22	20	7	8	10	0	2.2	15	2	1.6
9/25/2007	4	SH	24	20	6	7.5	39	0	0	15	2.5	2.6
10/24/2007	4	SH	8	13	7	7	200	0	2.2	15	3.5	12
4/30/2008	4	SH	14	11	10	7.5	120	0	2.2	15	6	3
5/12/2008	4	SH	18	12	10	6	1120	0	8.8	39	33	3
6/30/2008	4	SH	26	23	9	7.5	510	0	8.8	19	24	2.2
7/30/2008	4	SH	24	27	8	7.5	230	0	4.4	15	2	3
8/28/2008	4	SH	25	21	7	7	280	0	2.2	15	6	1.6
9/29/2008	4	SH	16	17	7	7.5	220	0	2.2	15	32	0.9
10/27/2008	4	SH	9	9	9	7	600	0	0	15	1	1.5
5/1/2007	5	SH	24	16	7	8		0	0	15	1.2	
5/31/2007	5	SH	23	18	8	8		0	0	15	14.4	
6/26/2007	5	SH	24	20	6	7.5		0	2.2	15	2	2
7/27/2007	5	SH	26	20	7	8.5		0	2.2	15	1	2
9/26/2007	5	SH	21	20	8	7.5	560	0	0	15	3	0.9
10/24/2007	5	SH	9	12	8	7		0	0	15	2.5	2.7

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/28/2008	5	SH	20	13	10	7	110	0	0	15	1	2
5/12/2008	5	SH	19	14	10	6.5		0	0	17	11	10
6/30/2008	5	SH	20	18	10	7		0	0	15	1	0.7
7/29/2008	5	SH	22	23	9	7.5		0	2.2	15	1	1.6
8/27/2008	5	SH	20	18	9	7.5		0	2.2	15	1	0.6
9/29/2008	5	SH	20	17	9	7		0	0.9	15	5	0.6
10/28/2008	5	SH	-2	6	9	6.5		0	0	15	1	0.2
4/30/2007	6	SH	24	17	7.5	8		0	2.2	15	2.4	
5/31/2007	6	SH	22	19	8.5	8		0	2.2	15	3.2	
6/26/2007	6	SH	23	20	6	7.5		0	3.3	16	11	5.7
7/27/2007	6	SH	25	20	9.5	7.5		0	8.8	15	2	4.3
9/27/2007	6	SH	17	18	8	7.5	1560	0	0	20	19	7.5
10/24/2007	6	SH	9	12	8	7		0	2.2	15	6	7.1
4/28/2008	6	SH	18	13	8.5	7.5	90	0	2.2	15	3	18
5/12/2008	6	SH	18	13	11	7		0	2.2	20	34	27
6/30/2008	6	SH	21	19	9	7		0	4.4	30	36	15.3
7/29/2008	6	SH	26	24	9	7.5		0	8.8	17	16	12
8/27/2008	6	SH	21	18	10	7		0	8.8	15	1	2.6
9/29/2008	6	SH	22	16	8	7.5		0	2.2	15	1	1.9
10/28/2008	6	SH	0	6	10	6.5		0	2.2	15	2	1.9

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/30/2007	7	SH	27	18	8	8.5		0	0	15	1.2	
5/31/2007	7	SH	22	17	7	8		0	2.2	15	1.6	
6/26/2007	7	SH	25	19	7	7.5		0	4.4	15	5	4.3
7/27/2007	7	SH	27	20	8	7.5		0	2.2	15	1	3.3
9/27/2007	7	SH	17	18	6.5	7.5	5000+	0	2.2	19	14	2
10/24/2007	7	SH	9	12	9	7		0	2.2	15	3	3.3
4/28/2008	7	SH	19	14	10	7	60	0	0	15	14	1.3
5/12/2008	7	SH	21	14	10	7		0	2.2	17	21	25
6/30/2008	7	SH	22	18	9	7.5		0	2.2	16	5	3.9
7/29/2008	7	SH	26	24	10	8		0	2.2	15	1	3.2
8/27/2008	7	SH	22	18	9	7.5		0	2.2	15	2	2.2
9/29/2008	7	SH	23	16	9	7		0	2.2	15	1	4.9
10/28/2008	7	SH	1	6	10	6.5		0	0	15	1	1.9
4/30/2007	8	SH	27	17	7.5	8.5		0	0	15	2	
5/31/2007	8	SH	22	20	5.5	8		0	4.4	15	1.2	
6/26/2007	8	SH	25	22	7	8		0	3.3	15	5	1.8
7/27/2007	8	SH	27	20	8	8		0	8.8	15	1	0.9
9/27/2007	8	SH	17	18	8	8	1590	0	2.2	15	4	2.2
10/24/2007	8	SH	9	12	8	7		0	8.8	15	4	8.5

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/28/2008	8	SH	12	13	9	7	100	0	2.2	15	1	1.7
5/12/2008	8	SH	20	14	9	7		0	4.4	25	28	22
6/30/2008	8	SH	22	20	9	7.5		0	4.4	15	3	13.3
7/29/2008	8	SH	26	27	9	8		0	8.8	15	2	1
8/27/2008	8	SH	24	20	9	7.5		0	2.2	15	1	0.4
9/29/2008	8	SH	24	18	6	7		0.1	0.9	15	13	0.1
10/28/2008	8	SH	4	8	6	6.5		0	0	15	1	0.1
4/30/2007	9	SH	27	18	7.5	9	62	0	0	15	5.6	
5/31/2007	9	SH	19	20	5	8	206	0	2.2	15	4	
6/25/2007	9	SH	24	23	5.5	8.5	326	0	1.3	15	5	0.7
7/26/2007	9	SH	26	21	6	7	140	0	0	19	83	2
9/27/2007	9	SH	19	20	8	7	1090	0	0	16	8	5.1
10/24/2007	9	SH	12	14	7.5	6	210	0	0	15	5	8.8
4/30/2008	9	SH	18	14	10	7	20	0	2.2	15	9	3
5/12/2008	9	SH	22	14	9	7	2670	0	8.8	36	33	32
6/30/2008	9	SH	24	26	7	7	290	0	2.2	17	14	6.8
7/29/2008	9	SH	30	29	8	7.5	260	0	2.2	16	11	1.4
8/27/2008	9	SH	25	21	7	7.5	700	0	2.2	15	3	0.5
9/30/2008	9	SH	18	18	7	6	170	0.1	0.9	15	9	0.6
10/28/2008	9	SH	9	8	4.5	6	700	0	0	15	7	0.7

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
4/30/2007	10	SH	27	15	8	9	31	0	0	15	4.4	
5/31/2007	10	SH	19	19	7	8	TNTC	0	2.2	18	4.4	
6/25/2007	10	SH	21	20	5.5	8.5	3900	0	3.3	16	4	2.7
7/26/2007	10	SH	27	23	8.5	7.5	100	0	2.2	15	9	0
9/27/2007	10	SH	18	18	7	8	540	0	2.2	15	3	0.9
10/24/2007	10	SH	11	12	8	7	1100	0	2.2	15	5.5	2.7
4/30/2008	10	SH	16	10	10.5	7.5	60	0	2.2	15	2	2.4
5/12/2008	10	SH	20	15	10	7	260	0	8.8	18	21	16
6/30/2008	10	SH	26	21	10	7.5	400	0	8.8	16	11	0.9
7/29/2008	10	SH	30	27	6	8.5	180	0	8.8	17	11	3
8/27/2008	10	SH	26	23	6	6.5	400	0	2.2	19	3	1.3
9/29/2008	10	SH	23	19	4	6.5	210	0	0	17	11	1.5
10/28/2008	10	SH	5	8	6	6.5	1700	0	0	26	17	1.9
4/30/2007	11	SH	18	14	7	9		0	1.3	15	4.4	
5/31/2007	11	SH	17	18	8.5	8		0	2.2	15	4	
6/26/2007	11	SH	26	21	8	8		0	8.8	15	3	1.9
7/27/2007	11	SH	27	21	5	8		0	2.2	15	3	1.9
9/27/2007	11	SH	18	19	8	7.5	5000+	0	2.2	40	33	6.8
10/24/2007	11	SH	13	13	6.5	7		0	2.2	15	4.6	3.3
4/30/2008	11	SH	22	12	10	7.5	20	0	2.2	15	2	3.2
5/12/2008	11	SH	18	12	10.5	7.5		0	4.4	15	3	23

Sample Date	Site ID	Primary Sampler	Air Temp	Water Temp C°	DO (mg/l)	pH	E.coli (colonies/ 100ml)	Orthophosphate (mg/l)	Nitrate (mg/l)	Turbidity (NTU)	TSS	Flow cfs
6/30/2008	11	SH	28	22	9	7.5		0	2.2	15	5	2
7/29/2008	11	SH	31	27	8	8		0	2.2	15	17	1.2
8/27/2008	11	SH	26	20	9	7.5		0	0.9	15	2	0.4
9/30/2008	11	SH	16	17	9	7		0.1	0.9	15	5	0.5
10/28/2008	11	SH	8	7	9	7		0	0	15	1	0.6
4/30/2007	12	SH	24	15	8	8.5		0	3.3	15	3.2	
5/31/2007	12	SH	14	17	6.5	8		0	2.2	15	4.4	
6/26/2007	12	SH	26	20	7.5	7		0	8.8	15	4	0.9
7/27/2007	12	SH	26	20	7	7.5		0	4.4	15	3	0.3
9/27/2007	12	SH	18	22	8	7	5000+	0	2.2	50	43	2.3
10/24/2007	12	SH	12	13	7.5	7		0	0	15	3	0.4
4/30/2008	12	SH	22	12	10	7.5	220	0	2.2	15	3	1
5/12/2008	12	SH	18	13	10	7.5		0	4.4	15	5	6
6/30/2008	12	SH	26	22	9	7.5		0	4.4	15	2	0.5
7/29/2008	12	SH	32	27	9	8		0	4.4	15	7	1.4
8/27/2008	12	SH	28	20	9	7.5		0	0.9	15	1	2.2
9/30/2008	12	SH	17	17	9	7.5		0.1	2.2	15	2	0.6
10/28/2008	12	SH	9	8	10	7		0	0.4	15	1	0.4

Appendix D. Sample Windshield Survey Form

Lower White River Watershed Project
Land Use Inventory

	Trash			Septic System Problem			Timber Harvest Erosion			Bank Erosion			Residential Stewardship		Urban Impacts			C
Site ID	Minor	Moderate	Major	Outfall Present	Water Suspect	Other	Minor	Moderate	Major	Minor	Moderate	Major	Present	Not Present	Minor	Moderate	Major	

Appendix E. Example of Tillage Survey

Owen County Soil and Water Conservation District
Lower White River Watershed Initiative

Tillage Survey

According to 2007 Cropland Tillage Data, approximately 35% of Owen County's corn acres are planted using conventional tillage methods. Conventional tillage systems leave less than 30% crop residue cover after planting. Such little residue exposes precious topsoil to the elements thereby increasing the potential for erosion and off-site sedimentation to occur.

This survey is being conducted to determine what obstacles exist that prevent the adoption of conservation tillage on corn acres and what, if anything, can be done to improve soil conservation efforts on corn acres.

Please answer the following questions for your operation. When answering, please think of conservation tillage as including no-till, ridge till, reduced tillage, mulch till, or any practice that leaves at least 30% crop residue on the surface after planting.
All individual responses will be confidential. Only group summarizations will be documented in the Owen County Lower White River Watershed Management Plan.

1. I am a: _____ Landowner
   _____ Operator
   _____ Landowner/Operator
2. How many acres of land are you cultivating for corn this year? _____________ 2008 Corn acres
3. How many corn acres were planted using *conservation* tillage? _____________
4. At any time in the past, have you used conservation tillage?
   ___________ No, I do not know much about conservation tillage
   ___________ No, I looked into conservation tillage but decided against it
   ___________ Yes, I tried it but quit after _____ years
   ___________ Yes, I currently use conservation tillage
5. *If applicable*: I do not use conservation tillage because: (Check all that apply)
   ___________ My equipment is not suitable
   ___________ My landowner/operator is against it
   ___________ Could not control weeds
   ___________ Poor stands
   ___________ Expense
   ___________ Increased time
   ___________ Reduced yield per acre
   ___________ Fields stay wet in Spring delaying planting
6. *If applicable*: I started using conservation tillage because: (Check all that apply)
   ___________ Required by government policy
   ___________ Other farmers had success
   ___________ Saved time and fuel
   ___________ Lowered production costs
   ___________ Reduced soil erosion
   ___________ Increased yield per acre
7. To be able to do more, or start using, conservation tillage, would you:
   ___________ Rent equipment, if available
   ___________ Custom hire services
   ___________ Purchase equipment
   ___________ Adapt present equipment
8. Would you no-till corn if you received a monetary incentive? ___________ Yes ___________ No

Appendix F: Monroe and Owen County HEL Soil Data

← OWEN COUNTY

Symbol	Soil Series	Tolerable Soil Loss (Tons/Year)
AfeD	Alvin-Bloomfield	5
AffE	Alvin-Bloomfield	5
AftD	Alvin-Princeton	5
CkkC2	Cincinnati	4
CkkC3	Cincinnati	2
CkkD2	Cincinnati	4
CkkD3	Cincinnati	2
CspC2	Crider	5
CspC3	Crider	4
EaaD2	Ebal	4
GaaE2	Gallimore	4
GabG	Gallimore-Chetwynd	4
GmcD3	Grayford	1
GmcE2	Grayford	1
GmhD2	Grayford Ryker	1
GmpE2	Greybrook	5
GmpF	Greybrook	5
HarD2	Haggatt	3
HarD3	Haggatt	2
HasE2	Haggatt Caneyville	3
HccC3	Haubstadt	2
HefG	Hickory	5
HelD2	Hickory Stinesville	5
HeoE	Hickory	5
HeoE3	Hickory	4
HeoG	Hickory	5
HepG	Hickory Adyeville	5
HesG	Hickory Chetwynd	5
HeuE	Hickory Wellston	5
HeuF	Hickory Wellston	5
MrcG	Minnehaha	5
OmkC2	Otwell	4
OmkC3	Otwell	2
OmkD3	Otwell	2
PbbC2	Parke	5
PbbC3	Parke	4
PbbD2	Parke	5
PbbD3	Parke	4
PcrC2	Pekin	4
PsaD3	Pottersville	3
PsaG	Pottersville	4
PsbF	Pottersville	4
RpzG	Romona Corydon Rock	2
RtcC3	Ryker	4
SfyC2	Shircliff	4
SneC2	Solsberry	4
SneC3	Solsberry	2
SneD2	Solsberry	4
SneD3	Solsberry	2
SneD5	Solsberry	2
StfC2	Stinsville	5
StgD2	Stinsville Ryker	5
SwhG	Stubenville Hickory	4
TcgG	Tipsaw Rock	3
TtaG	Tulip Tipsaw	4
TtcE	Tulip Wellston Adyeville	4
WhfD2	Wellston	4
ZamC2	Zanesville	4
ZamC3	Zanesville	2
ZamD2	Zanesville	4
ZamD5	Zanesville	2
ZapD3	Zanesville	2

MONROE COUNTY

FIELD OFFICE HEL DATA
Table iii-A-5
Survey Area - MONROE COUNTY, INDIANA

Map unit Symbol	Component Name	NEL Classification	Compliance and CRP Slope Information	
			Length	Percent
AfB	ALFORD	2	120	4
Ba	BARTLE	2	150	1
BdB	BEDFORD	1	100	4
BkF	BERKS	1	80	50
BkF	WEIKERT	1	80	50
Bo	BONNIE	3	300	0.2
Bu	BURNSIDE	3	100	1
CaD	CANEVILLE	1	80	14
Cb	CANEVILLE	1	80	12
Cb	HAGERSTOWN	1	80	12
ChF	CHETWYND	1	80	60
CoF	CORYDON VARIANT	1	80	610
CoF	CANEYVILLE VARI	1	80	60
CrB	CRIDER	1	140	5
CrC	CRIDER	1	100	8
CrD	CRIDER	1	80	14
CsC	CRIDER	1	80	8
CsC	CANEYVILLE VARI	1	80	8
CtB	CRIDER	1	140	5
CtC	CRIDER	1	100	8
Cu	CUBA	3	150	0.2
EbE	EBAL	1	100	20
EbE	GILPIN	1	100	20
EbE	HAGERSTOWN	1	100	20
EdD	EBAL	1	100	12
EdD	WELLSTON	1	100	12
EdD	GILPIN	1	100	12
EkB	ELKINSVILLE	2	120	4
EkF	ELKINSVILLE	1	60	60
GpD	GILPIN	1	75	16
GrD	GILPIN	1	75	16
HaC	HAGERSTOWN	1	100	8
HaD	HAGERSTOWN	1	75	14
HaE	HAGERSTOWN	1	75	20
HbD3	HAGERSTOWN	1	75	16
Hc	HAGERSTOWN	1	80	6
Hc	CANEYVILLE VARI	1	80	6
Hd	HAYMOND	3	200	0.5
HkF	HICKORY	1	60	60
HoA	HOSMER	3	150	2
HoB	HOSMER	2	120	4
HoC	HOSMER	1	100	9
HtB	HOSMER	1	120	4
IvA	IVA	3	250	1
MbB	MARTINSVILLE	2	120	4
PaB	PARKE	2	120	4
PaC	PARKE	1	80	8
PcD	PARKE	1	150	12
PcD	CHETWYND	1	150	12
PeA	PEKIN	3	200	2
PeB	PEKIN	1	100	4
PeC	PEKIN	1	80	8
Po	PEOGA	3	300	0.2
PrC	PRINCETON	1	80	8
PrE	PRINCETON	1	60	20
RcB	RYKER	1	120	5
RcC	RYKER	1	125	8
RcD	RYKER	1	100	15
Sf	STEFF	3	125	0.5
St	STENDAL	3	175	0.2
Sx	STONELICK	3	100	1
T1A	TILSIT	3	150	2
T1B	TILSIT	1	125	3
Wa	WAKELAND	3	200	0.5
WeC	WELLSTON	1	100	9
WmC	WELLSTON	1	100	9
WmC	GILPIN	1	100	9
Wo	WHITAKER	3	200	1
Wr	WILBUR	3	100	0.5
ZnC	ZANESVILLE	1	100	9
Zo	ZIPP	3	300	0.2
Zp	ZIPP	3	300	0.2
Zs	ZIPP VARIANT	3	300	0.2

Appendix G

Monroe County Subdivisions in the Project Area.
Grace Farms, Flatwoods, Edwards Group, Janell , Geiselman, David Harden, Orville Hunter

Owen County Subdivisions in the Project Area
10 OCLOCK LINE SUBDIVISION
AMAZON SHORES
AUTUMN HILLS SUBDIVISION
BASS HAVEN ESTATES PHASES I-V
BLAKER ESTATES
CAMP ROMONA SUBDIVISION
CHRISTIE HEIGHTS SUBDIVISION
CONCORD ADDITION
CONCORD VILLAS
CONCORD VILLAS II
COON PATH ACRES
COUNTY LINE EAST PHASE 1
COUNTY LINE PHASE II
DEER RUN SECTION I
DEER RUN SECTION II
FRAKERS ADDITION
FRANKLIN
HERITAGE HILLS ADDITION
INDIAN HILLS ADDITIONS I & II
INDIAN HILLS ESTATES SUBDIVISION
KELLEY FARM
KINNIKINNICK RIDGE
LAKE HOLLYBROOK
LAKEVIEW HILLS ADDITION
LINDLEY ESTATES
LOCUST LAKE ADDITION
LOVE LAND SUBDIVISION
MCCORMICK ACRES
MIN-FARMS SUBDIVISION
POWELL SUBDIVISION
QUARRY WOODS SUDBIVISION
RIVER BLUFFS SUBDIVISION
Rolling Meadows Phase 2
ROLLING MEADOWS SUBDIVISION
ROLLING MEADOWS VILAS
THE UPLANDS SUBDIVISION
TRIPLE J SUBDIVISION
TUCKER ESTATES-1
WINDCREST ESTATES PHASE 1
WOODLAND SUBDIVISION

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