Indian Creek Watershed Management Plan

Stantec

Prepared for Harrison County Commissioners

HARRISON COUNTY

July 7, 2008

Acronyms and Abbreviations

AQL	Aquatic Life
BASINS	Better Assessment Science Integrating Point and Nonpoint Sources
BIT	Bacterial Indicator Tool
C	Centigrade
CAFO	Confined Animal Feeding Operation
CFO	Confined Feeding Operation
CFS	Cubic Feet per Second
CFU	Colony Forming Unit (Bacteria)
DO	Dissolved Oxygen
FCA	Fish Consumption Advisory
FEMA	Federal Emergency Management Agency
FGDC	Federal Geographic Data Committee
FMSM	Fuller, Mossbarger, Scott and May Engineers
GIS	Geographic Information System
HMGP	Hazard Mitigation Grant Program
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IGS	Indiana Geological Survey
ISDH	Indiana State Department of Health

LIDAR	Light Detection and Ranging
Mg/l	Milligrams per Liter
MIBI	Macroinvertebrate Index of Biotic Integrity
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NRCS	Natural Resource Conservation Service
OWQ	Office of Water Quality (IDEM)
PCBs	Polychlorinated Biphenyls
PDM	Pre-Disaster Mitigation (Grant)
QHEI	Qualitative Habitat Evaluation Index
RSD	(Harrison County) Regional Sewer District
SSO	Sanitary Sewer Overflow
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UWA	Unified Watershed Assessment
WQ	Water Quality
WWTP	Wastewater Treatment Plant

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1.0 Introduction and Watershed Description

A watershed is defined as an area of land that drains to a common point. A watershed is like a bowl; it has a ridge that defines its boundary and a valley that collects each drop of water that falls within its boundary. Human impacts as well as natural characteristics within the watershed boundaries affect the quality of water of that system. For this reason watersheds are logical units for water resource management and provide a holistic approach to address water issues.

Section 205(j) of the Federal Clean Water Act provides funding for water quality management planning. Funds are provided for projects that gather and map information on water pollution (point and nonpoint), develop recommendations for increasing involvement of organizations in watershed activities, and develop and implement watershed management plans (IDEM 2006). In January 2004, Harrison County submitted a Clean Water Act Section 205(j) grant application to the Indiana Department of Environmental Management (IDEM) with the intent to develop a watershed management plan (WMP) to address water quality issues in the Indian Creek Watershed.

The following steps were taken under the grant to develop the watershed management plan:

- Hire a watershed coordinator
- Establish an Indian Creek Watershed Subcommittee to the Harrison County Regional Sewer District
- Form watershed mission and approach
- Conduct public outreach
- Compile and assess data
- Conduct water quality monitoring
- Inventory sinkholes
- Develop watershed management plan
- Implement watershed management plan

Stantec Consulting Services, Inc. (formerly Fuller, Mossbarger, Scott, and May Engineers) was retained by the Harrison County Board of Commissioners to act as the watershed coordinator, help lead the development of the watershed management plan, and conduct data collection efforts. Stantec's Steve Hall served as watershed coordinator, assisted by support staff from the Watershed Planning and GIS departments.

1.1 WATERSHED SUBCOMMITTEE

An important element for the development and implementation of a watershed plan is the active participation and buy-in of elected officials and policy makers, as well as broad participation from local governments, agencies and interested individuals. Development of this watershed plan was guided by the *Indian Creek Watershed Subcommittee,* which was established through the Harrison County Regional Sewer District (RSD). The Subcommittee was appointed to provide focus, goals, policy direction and recommendations for the watershed plan.

The Committee met from October 2006 to March 2008 to discuss the progress of the plan, concerns of the group, and strategies for implementation. The RSD Indian Creek Subcommittee members are listed in **Table 1.1**. Additional information regarding the Indian Creek Watershed Subcommittee is provided in **Appendix 1.1**.

Table 1.1. RSD Indian Creek Watershed Plan Subcommittee

Name	Affiliation
Anthony Combs	Harrison County Regional Sewer District & Harrison County Health Department.
Chris Cunningham	Harrison County Health Dept.
Gary Davis	Harrison County Council President
Daniel Lee	Harrison County Regional Sewer District, & Tyson Foods
Don Lopp	Floyd County Planner
Kevin Russel	Harrison County Engineer
Bill Sanders	Heritage Engineering
Dan Schroeder	Harrison County Health Department
Ralph Schoen	Harrison County GIS
Tom Tucker	Harrison County Regional Sewer District
Eric Wise	Harrison County Planning Commission
Bob Woosley	Heritage Engineering
Laura Fribley	Indiana State Department of Agriculture
Donald Jones	Soil and Water Conservation District, Floyd Co Farm Bureau
Virginia Morris	Soil and Water Conservation District
Ken Griffin	City Manager, City of Georgetown

The following personnel from the Indiana Department of Environmental Management assisted with the subcommittee with development of the watershed plan:

Pamela Brown
Alice Rubin
Kathleen Hagan
Crystal Rehder
Bonny Elifritz

1.2 WATERSHED VISION

The following watershed vision statement was developed by the Indian Creek Watershed Plan Subcommittee.

> ***Vision:*** *Foster economic development, preserve environmental quality and enhance the quality of life for all who live and work in the Indian Creek Watershed.*

This vision is supported by the following objectives which were included in the 205(j) grant application:

- Improve quality of life by ensuring clean water and healthy natural resources
- Evaluate and prioritize problems affecting ground and surface waters
- Develop the watershed management plan in advance of IDEM's schedule for the Total Maximum Daily Load (TMDL)
- Reduce pollutants and provide protection in high quality areas

The Indian Creek Watershed Management Plan addresses three major, inter-related water quality issues:

- Water Quality Impairment
- Karst Ecosystem Protection
- Ground Water Protection

1.3 WATERSHED PLAN APPROACH

In 2005, IDEM awarded the County with a $99,930 grant to develop the watershed management plan. The grant was for a two-year project period from April 2006 through March 2008. Representatives from the Harrison County Board of Commissioners and the County Engineer selected Fuller, Mossbarger, Scott, and May Engineers, Inc. (FMSM) from Jeffersonville, Indiana as the watershed consultant for the two-year project period.

The Indian Creek Watershed Management Plan meets the requirements outlined in IDEM's "What needs to be in a Watershed Management Plan" checklist, effective for 2003.

1.4 WATERSHED DESCRIPTION AND HISTORY

1.4.1 Watershed Location

The Indian Creek Watershed is a subwatershed within the Blue Sinking Watershed located in South Central Indiana. **Figure 1.1** depicts the location of the Indian Creek Watershed within Indiana.

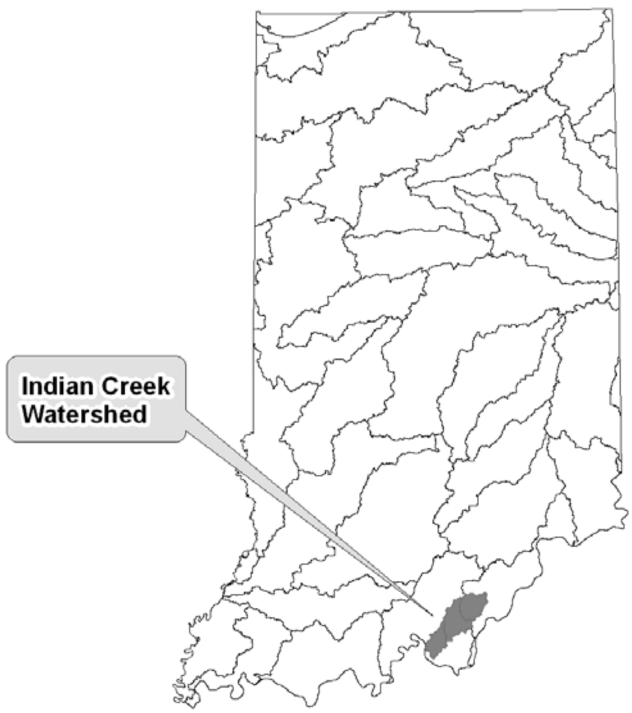

Figure 1.1 Indian Creek Watershed Location

As shown in **Figure 1.2**, the Indian Creek Watershed, one of seventeen subwatersheds in the Blue Sinking Watershed, encompasses three 11-digit hydrologic unit code (HUC) subwatersheds (05140104080, 05140104090, and 05140104100).

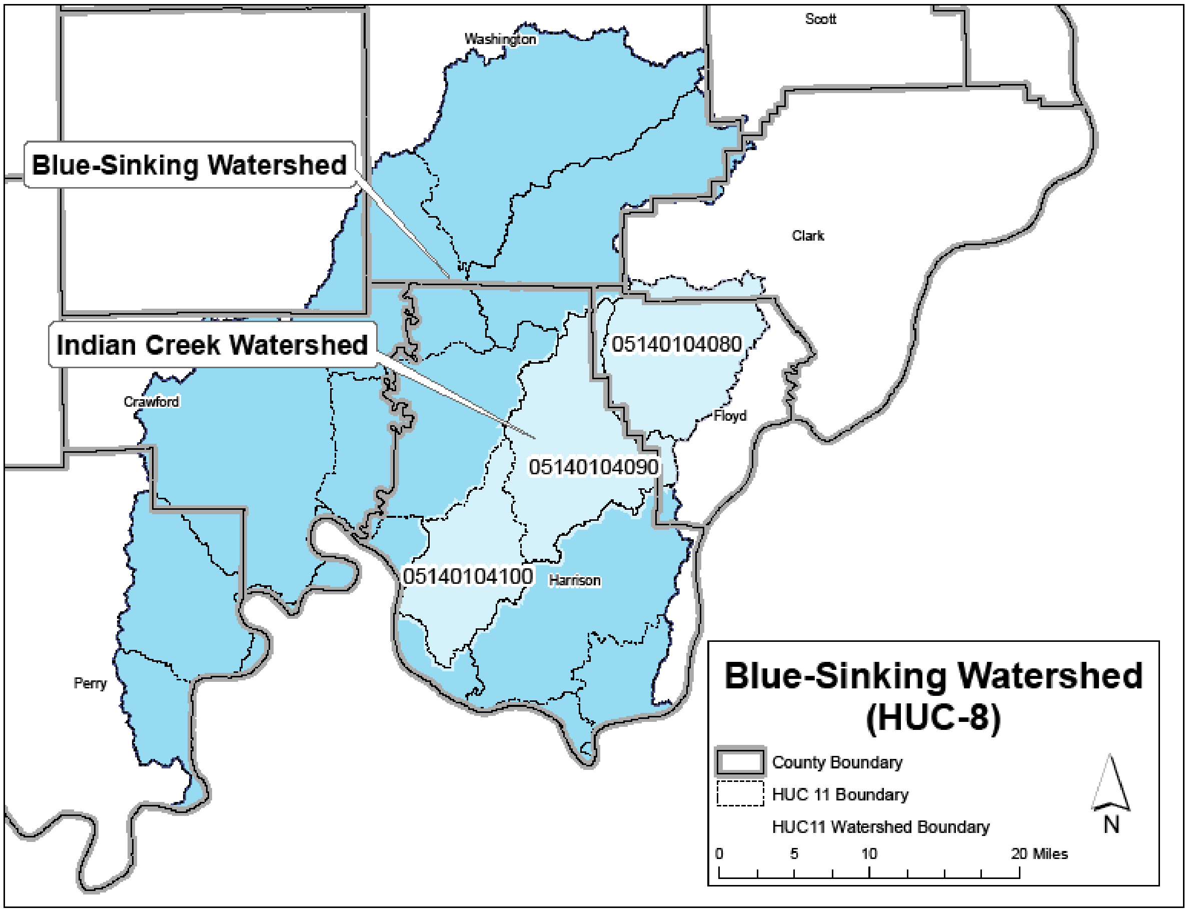

Figure 1.2 Blue Sinking Watershed

The drainage area for the Indian Creek Watershed is 256 square miles. The watershed drains a significant portion of Harrison County and Floyd Counties, as well as a small portion of Clark County. The Indian Creek Watershed has approximately 176.5 miles of streams which flow to the southwest, eventually draining to the Ohio River. The Indian Creek Watershed is approximately 48 miles long and 19 miles wide. The headwaters are located in the knobs of Clark and Floyd Counties.

1.4.2 Physical Setting

The present landscape in Floyd County was formed by the Illinoisan glaciation. Harrison County is an unglaciated area. The Mitchell Plateau, a broad limestone karst plateau is located in Southern Indiana. This plateau extends from the eastern part of Owen County south to the Ohio River in Harrison County (Indiana Geological Survey, 2006). The southern half of the Indian Creek Watershed is underlain with karst geology, including Binkley Cave, the largest cave in Indiana.

Karst features include sinkholes, springs, caves and underground channels. In karst systems surface contaminants can travel quickly into sinkholes, caves and groundwater or can resurface in streams without being filtered and broken down by soils. Therefore, water quality in this area is vulnerable to water quality degradation.

The karst system present in the Indian Creek Watershed is part of a much larger karst system that transcends watershed boundaries, as shown in **Figure 1.3**.

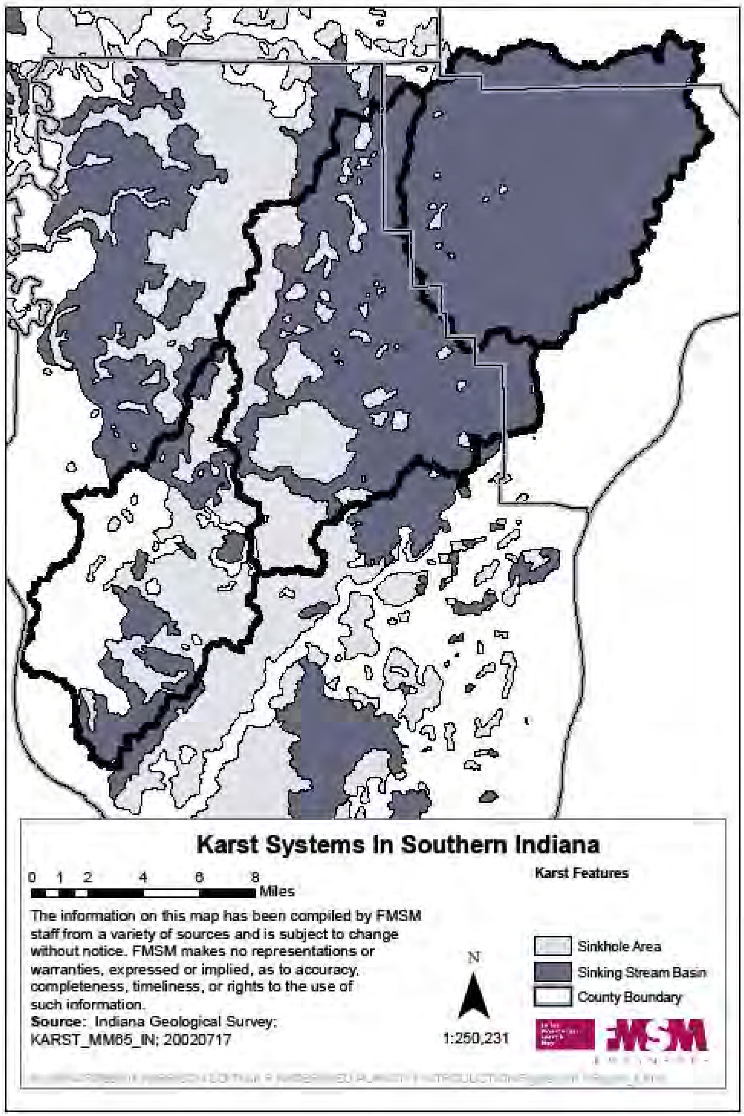

Figure 1.3. Karst Systems in Southern Indiana

This map shows generalized sinkhole areas and sinking stream basins. Prior to the development of this watershed plan, there was a generalized understanding that the karst system was well developed in the watershed. In order to develop more specific data, a sinkhole inventory was conducted as a component of this watershed plan. Over the long term, this inventory, coupled with dye tracing, can be used to improve our understanding of flow volume and flow paths through the karst system. Additional information regarding the sinkhole inventory is provided in **Section 2.8 Sinkhole Inventory**.

The Sinks of Indian Creek are an example of a sinking stream. The Sinks of Indian Creek are located within the channel of Indian Creek approximately 2.5 miles southwest of Corydon. These sinks divert a portion of the flow into subterranean channels. Some of these sinks have historically been dammed to retain flow in Indian Creek. Dye-trace studies have indicated that water from The Sinks of Indian Creek feed into Blowing Hole Cave, cross under the watershed boundary, and resurface in the Blue River Watershed at Harrison Spring. The water then flows into the Blue and Ohio Rivers. The average gradient between the elevation in the Sinks of Indian Creek and Harrison Spring is more than 21 feet per mile. This gradient is far steeper that that of Blue River, which is merely 5 feet per mile for great portion of its length.

Harrison Spring, the spring at which the sinks of Indian Creek resurface, is the largest spring in Indiana. The sub-circular pool of Harrison Spring, where the subterranean water rises, is about 80 feet wide, 110 feet long and 35-feet deep. Flows of 1.7 million gallons per day have been measured in Harrison Spring and an estimate of the drainage area needed to feed Harrison Spring is 200 square miles, which may include a large portion of the Indian Creek Watershed. The spring has been known to give off a violently muddy discharge.

The Indian Creek Watershed is considered to be a major tributary of the Blue River due to this underground connection. The Nature Conservancy operates the Blue River Project Office to protect this system. The Blue River is on the Outstanding Rivers List for Indiana under several categories, including High Water Quality, and it is also a National Wild and Scenic River.

A total of 224 cave entrances have been identified in the Indian Creek Watershed by the Indiana Geological Survey. Cave density is calculated using the number of mapped cave entrances per square kilometer. A map of Indian Creek Watershed cave density is provided in **Appendix 1.2**.

Historically Harrison County has relied on the karst system as a means for stormwater drainage. Presently, Harrison County is proactively working towards the development and adoption of a Stormwater Management Ordinance, which will provide a legal means to address stormwater quantity and quality management, floodplain management, and karst system management.

Climate data were summarized by the Department of Natural Resources (2006). Long-term climatic data for Harrison County were based on the Paoli, Indiana weather station (Midwestern Regional Climate Center, 2005). This weather station is located in Orange County Indiana, near the Indian Creek Watershed. This is the closest operating long term weather station and was considered to be representative of the watershed. Normal monthly maximum, minimum, and mean temperatures for the period 1971-2000 are listed in the following table. Air temperatures reach a high point in July with a monthly mean of 75.5 °F and dip to a mean of 28.2 °F in January.

Table 1.2. Annual Temperatures (1971-2000)

°F	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Min	18.4	21.9	31	40.4	50.1	59.7	63.8	61.5	52.8	40.1	32	22.7	41.2
Mean	28.2	32.9	42.8	52.9	62.7	71.4	75.5	73.5	66	54.1	43.5	32.7	53
Max	37.9	43.8	54.5	65.4	75.2	83	87.1	85.4	79.2	68.1	54.9	42.7	64.8

Source: Gerald A. Unterreiner, 2006.

Precipitation averages nearly 48 inches per year. Normal monthly and annual precipitation for the period 1971-2000 and precipitation extremes for the period 1901-2001 are listed in the following Table.

Table 1.3. Precipitation

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Min	0.57	0.24	0.5	0.88	0.8	0.45	0.2	0.51	0.48	0.04	0.42	0.35	25.38
Normal	3.29	3.1	4.37	4.84	5.14	4.19	4.46	4.17	3.26	2.9	4.22	3.64	47.58
Max	17.38	8.3	14.29	10.69	12.13	12.72	10.69	8.83	10.92	13.57	9.26	8.19	63.45

Source: Gerald A. Unterreiner, 2006.

1.4.3 Natural History

Native vegetation in the area consisted of hardwood trees (tulip-poplar, oak, hickory, elm, maple, and ash), and swamp grasses and sedges. With a history dating back approximately 4,000 years ago, early Native American cultures prospered in this area.

Floyd County, as it is known today, was organized in 1819. Settlement in Harrison County occurred in the 1800s near the town of Lanesville. As development began to occur in the area, forests were cleared for farmland and agriculture became a major part of the County's economy. In some portions of the County, as a result of clearing performed with disregard for soils and slope steepness, the area is prone to severe erosion (USDA 1975). Although farming is still an important part of the local economy, land uses are transitioning to suburban, commercial and light industrial development. (USDA 1974).

Figure 1.4 depicts natural regions that occur within the Indian Creek watershed. The natural regions have been defined by the US Geological Survey as follows:

- **Knobstone Escarpment:** a steep slope that outlines the eastern boundary of the Norman Upland.
- **Mitchell Karst Plain:** includes extensive areas of rolling hills underlain by limestone and large sections of karst including solution valleys, sinkholes, caves, underground drainage, and springs.

- **Escarpment**: marks the location of steep cliffs, which rise above the Ohio River floodplain.

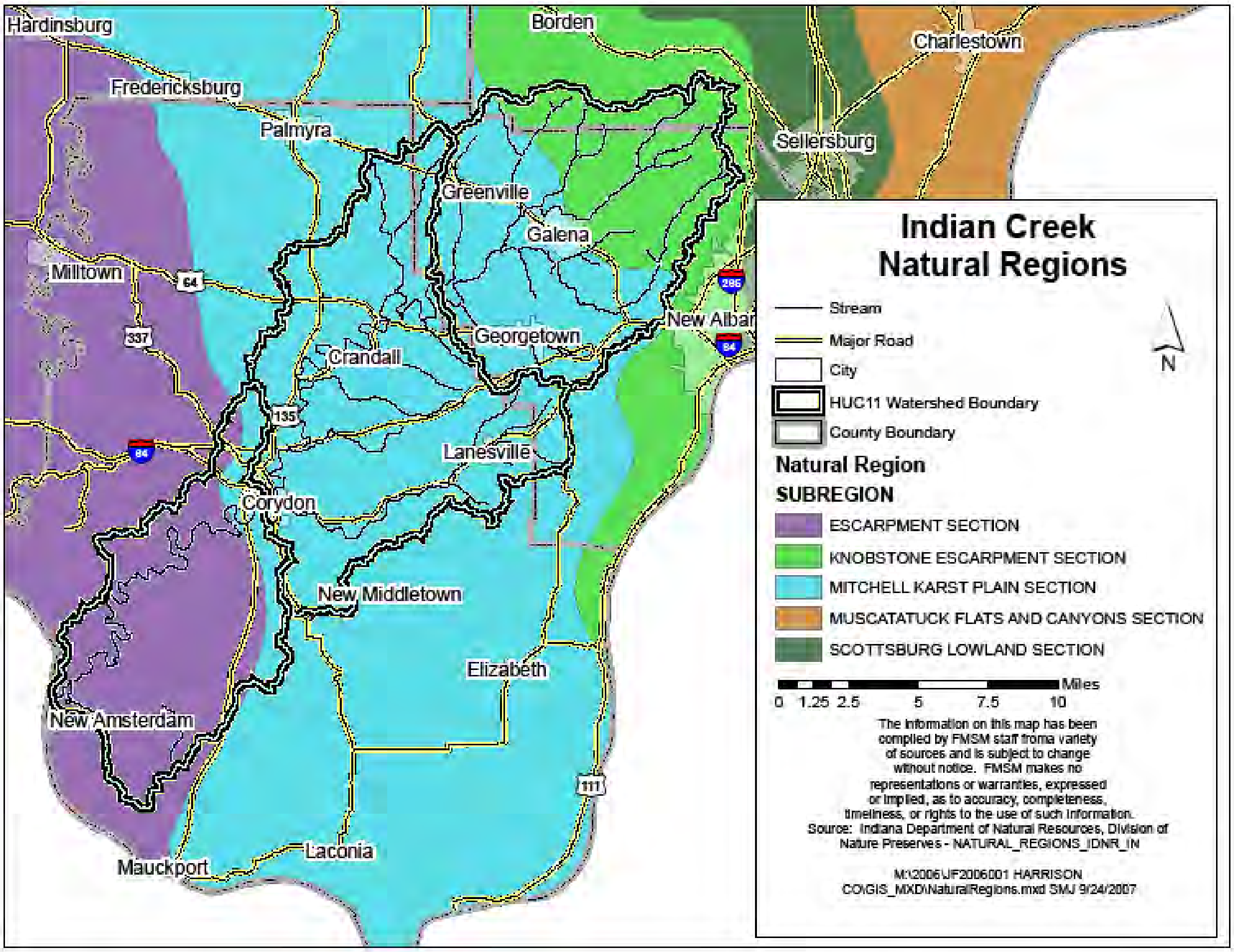

Figure 1.4 Natural Regions

Natural features of Harrison and Floyd Counties including soils, topography, climate, and vegetation are favorable for wildlife (USDA, 1975).

- Open-land wildlife – rabbits, red foxes, skunks, quails, etc.
- Woodland wildlife – deer, squirrels, raccoons, woodpeckers, nuthatches, etc.
- Wetland wildlife – muskrats, wild ducks and geese, kingfishers, red-winged blackbirds, etc.

1.4.4 Rare, Threatened and Endangered Species

Many rare, threatened, and endangered species of flora and fauna have been identified in Harrison and Floyd Counties, mainly because of the unique natural features present in the area (i.e. the extensive cave system due to the karst geology). The 22-mile long Binkley Cave system is home to 74 species, including 6 critically imperiled species (G1- five or fewer locations worldwide), 9 imperiled species (G2 - known from 6-20 locations) and 6 vulnerable species (G3 - known from 21-100 locations). A US Endangered Species, the Indiana Brown Bat, was found in the cave in January 1997, but is thought to be lost due to the March 1997 flood. Eight new species were found in the caves in the Corydon area.

A list of endangered, threatened and rare species for Harrison and Floyd Counties is provided in **Appendix 1.3**. It is important to note that the species lists are provided on a county-wide basis so species may or may not be present in the Indian Creek Watershed. Species may be identified as endangered, threatened or rare in an area due to natural conditions or because of potential human impacts on that species natural habitat. The list was compiled over many years based on a combination of isolated observations and systematic species surveys.

1.4.5 Soils

The soils in Harrison County were formed from limestone, sandstone, shale, lacustrine deposits of Wisconsin age, and loess. The bedrock closest to the surface is sedimentary rock from the Mississippian Age. The parent material in Floyd County consists of glacial till and outwash of Illinoisan Age, lacustrine deposits of Illinoisan and Wisconsin age, residuum from limestone, sandstone, shale, and alluvium (USDA 1975: USDA 1974).

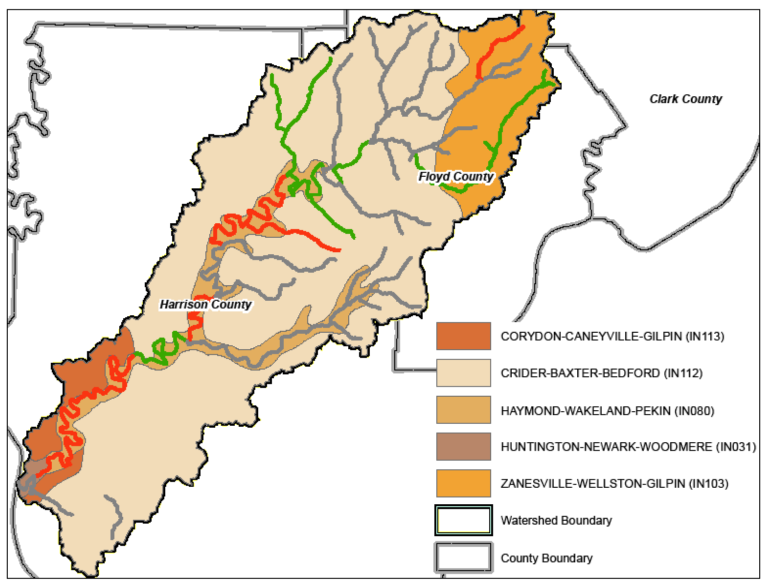

Figure 1.5. Soil Associations

According to the Soil Surveys for Harrison and Floyd County, there are five soil associations in the Indian Creek Watershed, shown in **Figure 1.5**. In Floyd County, the northern section of the watershed, the prevalent Association is the Zanesville-Weston-Gilpin. In Harrison County, which includes the middle and southern sections of the watershed, the Crider-Baxter-Bedford Association is dominant. Present to a lesser extent are the Haymond-Wakeland-Pekin, Corydon-Caneyville-Gilpin and Huntington-Newark-Woodmere associations. Characteristics of the soil associations are shown in **Table 1.4.**

Table 1.4 Indian Creek Soil Associations

Zanesville-Weston-Gilpin	**Zanesville -** deep, well drained, and slowly permeable, on ridgetops and upper side slopes. **Weston** - sandy loam surface, poorly drained; very slow runoff; moderately slow permeability. **Gilpin -** moderately deep, well drained soil, permeability is moderate.
Crider-Baxter-Bedford	Rolling deep, well-drained, medium textured, cherty soils on uplands. Contains sinkholes that range from 15 feet to ½ mile in width and 3 feet to 90 feet in depth.
Haymond-Wakeland-Pekin	**Haymond** - very deep, well drained soils on flood plains and flood-plain steps, moderate permeability
Corydon-Caneyville-Gilpin	**Corydon** - shallow, well drained, moderately slowly permeable soils, on sloping to very steep hills underlain with limestone **Caneyville -** moderately deep, well-drained soils with moderate permeability, on gently sloping to steep upland ridgetops and hillsides **Gilpin** - moderately deep, well drained soils, on nearly level to very steep uplands
Huntington-Newark-Woodmere	**Huntington -** very deep, well drained, moderately permeable soils, on flood plains **Newark -** very deep, somewhat poorly drained soils, level flood plains and in upland depressions **Woodmere -** very deep, moderately well drained soils on flood plains and flood-plain steps

Source: USDA 1975; USDA 1974

Each soil type has a soil erodibility index assigned by the Natural Resources Conservation Service (NRCS). This value is a numerical expression for a soil's probability to erode based on its physical and chemical properties and the climate conditions of the soil's location. The most recent soils data, published by the NRCS as Soil Survey Geographic (SSURGO) were used for the evaluations that follow.

Indian Creek Erodible Soils were mapped in **Figure 1.6** using the Kf Erosion Factor. The Kf erosion factor indicates the susceptibility of a soil to sheet and rill erosion by water. Areas with high Kf factors are mapped in red. These soils are shown with the 303d assessment of streams which will be further explained in **Section 2.3.2. Water Quality Assessments**.

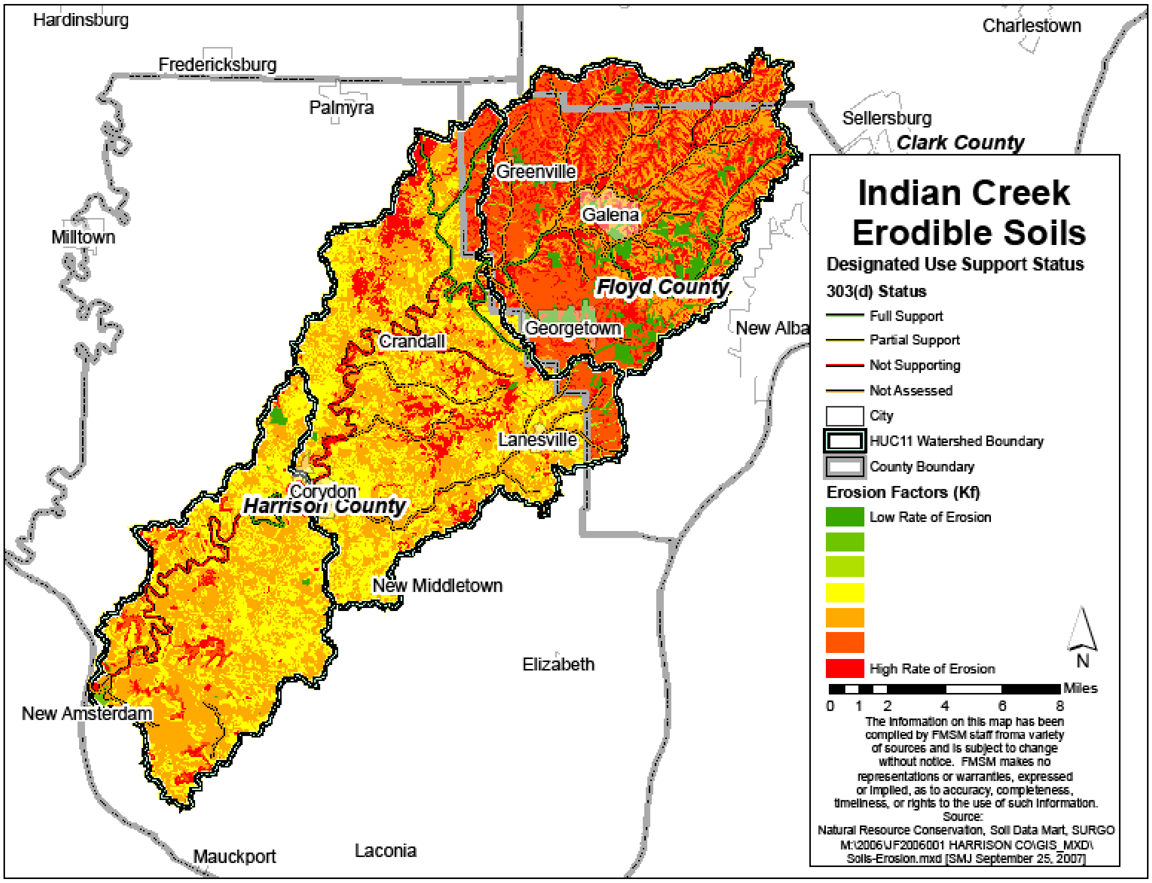

Figure 1.6. Erodible Soils

In order to function properly, septic systems need well-drained soils. The ideal location for a soil absorption field is a large area within a lot which contains deep, well-drained soils. As shown in **Figure 1.7**, the majority of the soils in the Indian Creek Watershed are “somewhat limited”, meaning that the soil has features that are moderately suitable for the septic systems, and “very limited”, implying that the soil has one or more features that are unfavorable for septic systems. It is important to consider that soils data are generalized over large areas and that individual lot suitability is evaluated by the Health Department prior to installation of new systems. Limitations on individual lots may be addressed through siting and design.

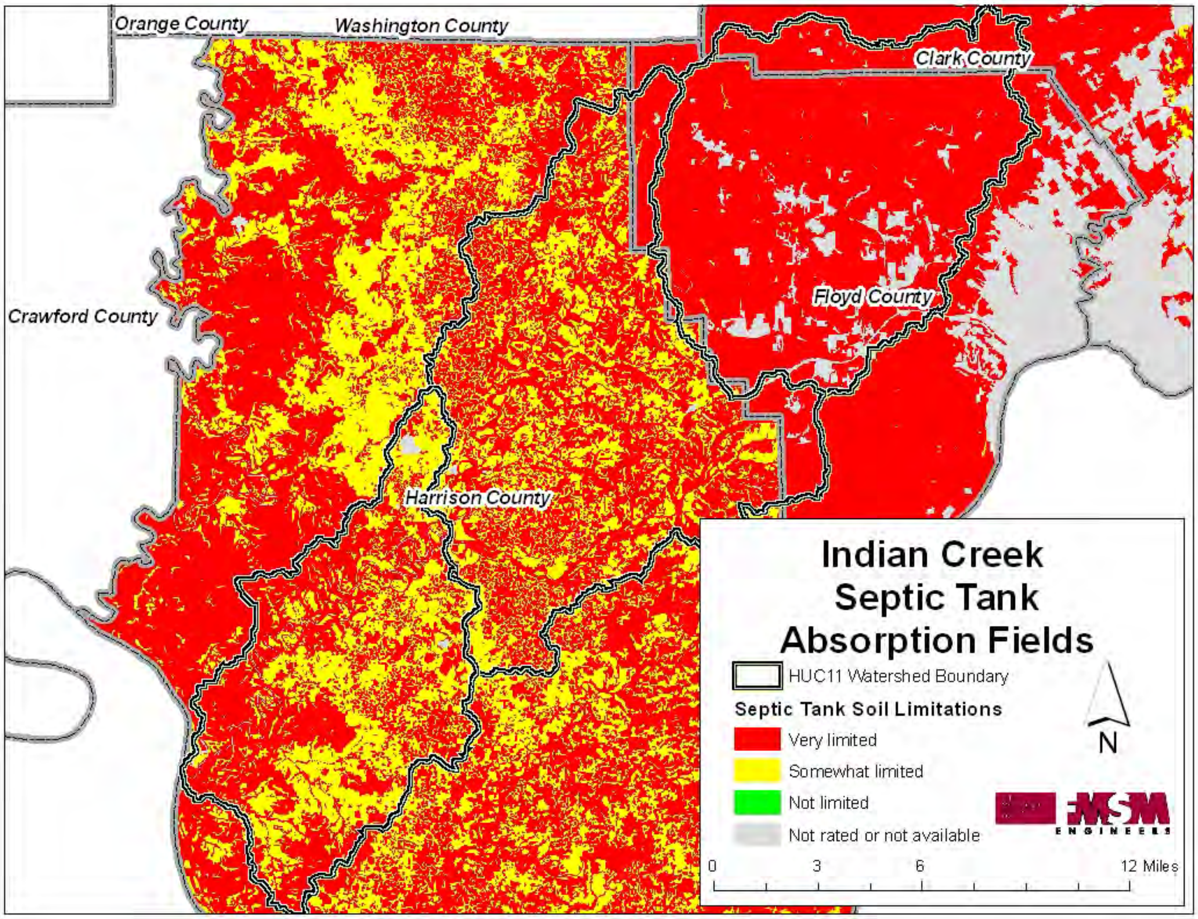

Figure 1.7. Septic Suitability of Soils

Table 1.5 summarizes soil suitability for septic systems in Harrison and Floyd Counties. The percent and number of households with septic systems numbers are from the 1990 Census, the most recent information available. The soil information was derived from SSURGO data.

Table 1.4. Soil Suitability for Septic Systems

Characteristic	Harrison County	Floyd County
Percent of Households with Septic Systems	31%	80%
Number of Households with Septic Systems	7,915	9,214
County Area (acres)	94,288	310,633
Density of Septic Systems (acres per septic system)	11.9	33.7
Percent of Area with Soils Having Severe Limitations for Septic Systems	81%	67%

Source: Hoosier Environmental Council's Watershed Restoration Toolkit: A Citizen's Guide to Improving Water Quality

Because land in the Indian Creek Watershed is predominantly used for agriculture, soil quality is critical. Soils are considered 'prime agricultural soils' when they have the best chemical and physical characteristics for producing food, feed and crops. In the watershed, the majority of the soils are prime farmland soils (Bedford, Crider, Huntington series). However, some soils, such as those found in the Haymond and Wakeland series, require additional measures (i.e. drainage, flooding protection) in order to yield a good crop.

1.4.6 Topography

The highest point of the watershed, located in Floyd County, is 1,020 feet. The lowest point of the watershed, located in Harrison County, goes down as low as 380 feet. Due to the steep gradients in Floyd County, the Indian Creek Watershed is prone to significant flooding. Indian Creek often overflows its banks after heavy precipitation. The Indian Creek tributaries in Floyd County have also overflowed and caused significant damage to nearby roads.

Floyd County is divided from northeast to southwest by Floyds Knobs, a hilly region characterized by sharp elevation changes on the east side and more gradual but still steep changes on the west side.

There are significant floodplains throughout Harrison County located in the ravines along major streams. Currently, the west side of the Knobs in Floyd County is experiencing expanding residential development. It is a significant challenge to design adequate drainage for these new developments, especially on steep slopes. These additional impervious areas associated with existing and new developments may be contributing to flooding issues in the northwestern portion of Floyd County.

1.4.7 Hydrology

There are approximately 176.5 miles of streams in the Indian Creek Watershed. The drainage area for the watershed is 256 square miles. Big Indian Creek flows through the central part of the watershed and drains approximately one-third of Harrison County. In Floyd County, Indian Creek drains the western part of the County. The stream density in this watershed is 0.7 miles of stream per square mile of watershed drainage area. This low stream density is indicative of the extensive karst system in the watershed, and surrounding area.

The headwaters are located in the knobs of Clark and Floyd Counties, the mid and lower watersheds are located in Harrison County. The Indian Creek headwaters flow from the Floyds Knobs (Floyd County) in areas that have undergone significant development in the last few decades. Major tributaries of the watershed include Corn Creek, Crandall Branch, Raccoon Branch, Brush Heap Creek, and Little Indian Creek. See the **Figure 1.8.** Use support is further explained in **Section 2.3.2 Water Quality Assessments**.

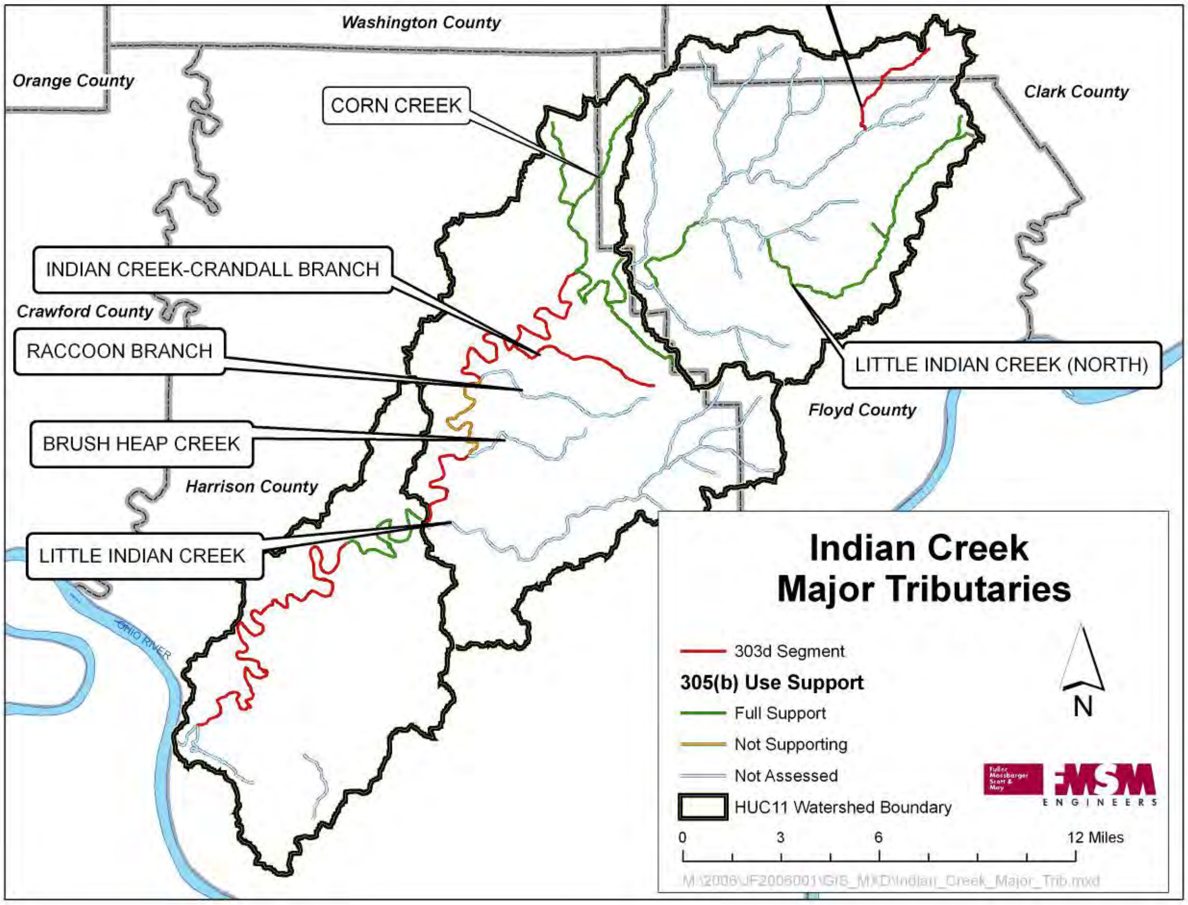

Figure 1.8. Major tributaries in the Indian Creek Watershed

Indian Creek, from the Floyd-Harrison County line to its confluence with the Ohio River in Harrison County, has been designated as an Outstanding River by the Indiana Natural Resources Commission. An Outstanding River designation is applied to streams that are environmentally or aesthetically important. Indian Creek received the designation because it is a State Heritage Program Site, which includes rivers identified by state natural heritage programs or similar state programs as having outstanding ecological importance.

Channel Modifications: Systematic data on channel modifications, such as straightening, were not available. However, much of this watershed is rural, so modifications associated with urbanization are thought to be relatively minimal. Modifications associated with agricultural practices may be more common. Another consideration is the relatively low stream density due to the karst system. Because there are fewer miles of stream per square mile of watershed area, there may be a lower potential for channel modifications.

Monitoring and habitat data have indicated that there are locations in the watershed where channel banks are eroding. This may be attributed to increased volume and velocity of stormwater runoff. Chapter 3 includes a strategy to conduct a habitat and visual assessment to identify locations where erosion is occurring and prioritize these locations for stabilization and restoration projects.

Dams: Sixteen (16) dams were identified in the Indian Creek Watershed by the Indiana Department of Natural Resources and two additional dams were identified through a review of EPA BASINS database, for a total of eighteen (18) dams in the watershed. Dams are characterized by location, storage, hazard potential and height in **Table 1.6**.

Table1.5. Indian Creek Watershed Dams

County	Name	Drainage Area (Square Miles)	Maximum Storage (acre-feet)	Hazard Potential	Height (feet)
Clark	Huber Bros. Lake Dam	0.360	143	Significant	26.00
Clark	Stumler Dam	0.150	129	Low	31.00
Floyd	Brazil Lake	0.170	125	Low	39.00
Floyd	Floyds Knobs Lake Dam	0.320	88	Low	22.00
Floyd	Georgetown Reservoir Dam	0.740	160	High	42.00
Floyd	Krotzki Lake Dam **	0.070	24		
Floyd	Lime Ridge Dam	0.806	293	Low	34.00
Floyd	Mt. St. Francis	0.410	245	Low	40.00
Floyd	Silver Mining Dam	0.169	66	High	30.00
Floyd	Sycamore Ridge Dam	0.113	38	High	28.50
Floyd	Ulrich Lake Dam	0.050	95	Low	28.00
Harrison	Big Indian Bluff Dam	0.030	6	Low	25.50
Harrison	Corydon Water Works Dam #2 (Middle)	154.000	120	Low	23.00
Harrison	Corydon Water Works Dam #3 (North)	148.000	160	Low	23.00
Harrison	Indian Creek (In-Channel) Dam No. 1	0.000	0	Low	11.50
Harrison	Lanesville Reservoir Dam	0.650	192	High	35.00
Harrison	Lutheran Laymens Lake Dam	0.440	73	Low	25.00
Harrison	Pine Springs Lake Dam	0.160	56	Low	28.00

Sources: Indiana Department of Natural Resources
EPA, BASINS

The safety of dams was ranked into three categories as defined below.

- **High:** Loss of human life, major infrastructure damage, homes destroyed
- **Significant:** No loss of human life, but damage may occur to county roads and farm crops, and flooding may occur downstream

- **Low:** No loss of human life, but damage to crops may occur

Four (4) dams were rated as high hazard and one dam was rated as a significant hazard potential by IDNR. Additional watershed planning considerations for dams include their potential to impede fish passage and act as a sink for sediment and associated pollutants within the impoundment.

Drinking Water Sources: Drinking water is supplied by public water systems that rely on the Ohio River as source water. In addition, some residents continue to use wells for potable and agricultural supplies. There are over 250 mapped wells in the Indian Creek Watershed, many within the karst region.

Routine testing of private potable supply wells is not required, so data on well water quality are not available. However, these wells may be vulnerable to contamination due to their location within the vulnerable karst region. In addition, wells are located in areas served by septic systems. The Watershed Restoration Action Strategy for the Blue-Sinking Watershed (WRAS 2002) has identified high septic system densities in the area. Although septic systems can be can be a safe and effective way for treating wastewater, malfunctioning septic systems can pollute groundwater and surface water posing threats to human health and the environment by contaminating nearby wells, drinking water supplies, as well as fishing and swimming areas (WRAS 2002). Strategies to improve management of septic systems are discussed Chapter 3.

Wetlands: Wetland resources are very minimal in this watershed, with land cover data indicating 167.7 acres (0.1%) of woody wetlands and 13.1 acres (0.007%) of emergent herbaceous wetlands. These acreages were estimated from the 2001 Land Cover Data for Indiana published by the United States Geological Survey (USGS). Small local wetlands may not have been mapped through this statewide mapping effort. Wetland habitats are typically diminished in karst areas and in steep terrain.

1.4.8 Land Use

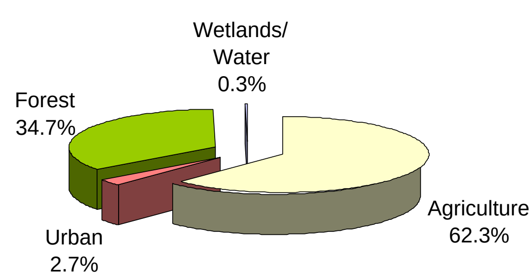

Figure 1.9. Indian Creek Watershed Land Use

Land use and land cover was evaluated using the 2001 Land Cover Data for Indiana published by USGS. As shown in **Figure 1.9,** farmland dominates the Indian Creek Watershed landscape. Sixty-two percent (159 square miles) of the watershed is utilized for agricultural production. Another ninety square miles (35%), is covered by forested land (deciduous, evergreen, and mixed forests). Approximately 6.4 square miles (3%) consists of developed land. Less than one percent is covered with water and wetland features. Land use and land cover data are summarized in **Table 1.7**.

Table 1.6. Indian Creek Land Use and Land Cover

Category	Land Use Classification	Acres	Percentage
Agriculture	81-Pasture/Hay	66,552.6	40.5%
	82-Row Crops	35,753.4	21.8%
	SUBTOTAL	**102,306.0**	**62.3%**
Urban	21-Low Intensity Residential	3,413.5	2.1%
	23-Commercial/Industrial/Transportation	815.1	0.5%
	22-High Intensity Residential	145.0	0.1%
	85-Urban/ Recreational Grasses	65.4	0.0%
	33-Transitional	17.3	0.0%
	SUBTOTAL	**4,456.3**	**2.7%**
Forest	41-Deciduous Forest	51,142.4	31.2%
	42-Evergreen Forest	5,475.6	3.3%
	43-Mixed Forest	282.4	0.2%
	SUBTOTAL	**56,900.4**	**34.7%**
Wetlands/Water	91-Woody Wetlands	167.7	0.1%
	92-Emergent Herbaceous Wetlands	13.1	0.0%
	11-Open Water	323.8	0.2%
	SUBTOTAL	**504.6**	**0.3%**
TOTAL		**164,167.3**	**100.0%**

Source: Land Cover for Indiana, USGS (2001)

Using data from Land Cover in Indiana (USGS, 2001), the distribution of land uses spatially in the watershed is shown in **Figure 1.10**. Although urban lands currently comprise a small percentage of the watershed (2.7%), this area is anticipated to increase. According to the 2000 Census, between 1990 and 2000, Harrison County's population growth of 14.8 percent exceeded statewide growth of 9.7 percent. Harrison County's growth rate has also exceeded that of the surrounding areas. Significant residential development has occurred in the area around Corydon, Crandall and Lanesville, which account for 25.7% of the Harrison County population.

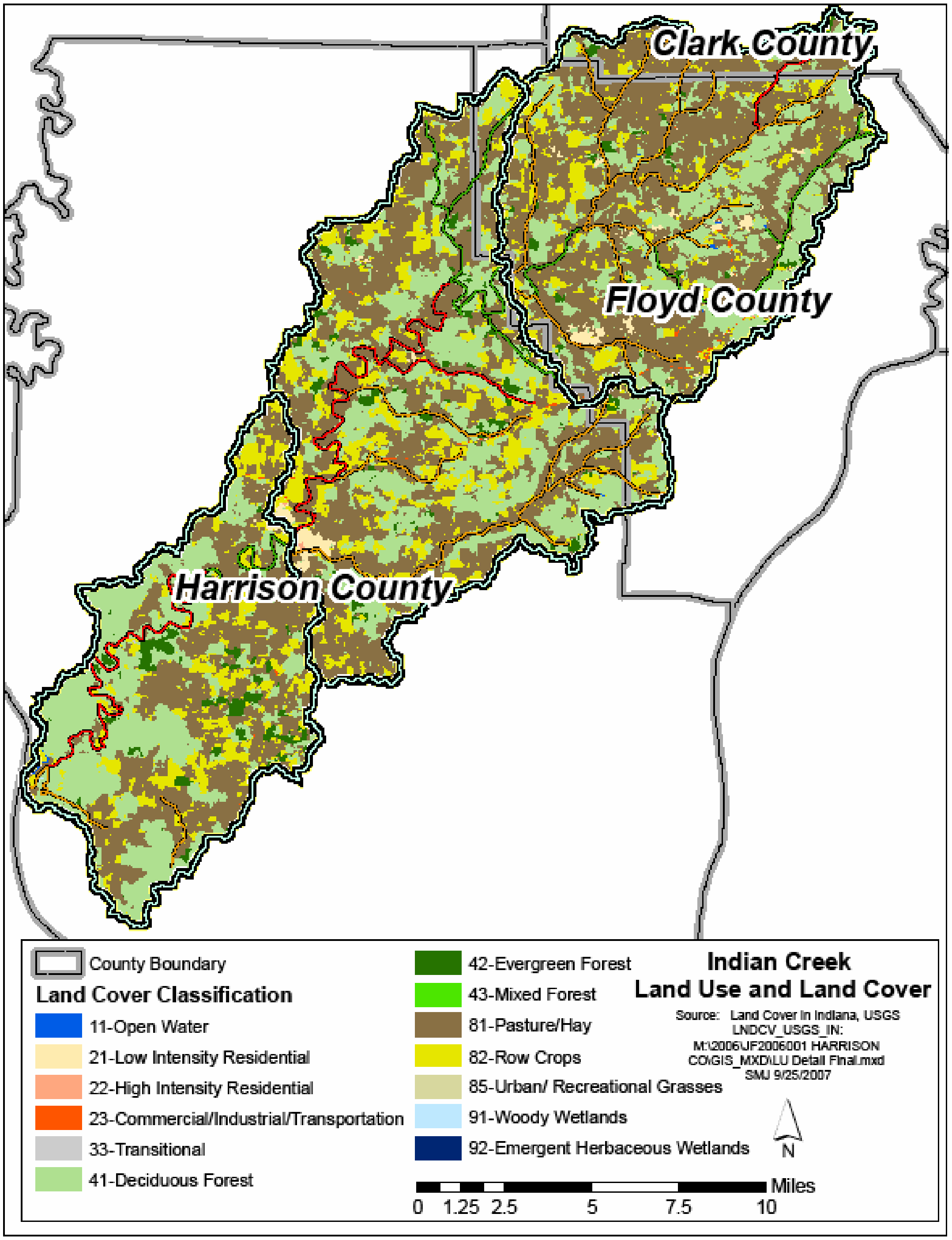

Figure 1.10 Indian Creek Watershed Land Use and Land Cover

The largest town in the Indian Creek Watershed is Corydon with a population of 2,715, according to the 2000 Census. The historical importance of the town is threefold. The state's constitution was drawn up in Corydon. Corydon was also the original state capital, as well as the site of the only Civil War battle fought in Indiana (July 9, 1863). The location of Corydon was an ideal place for trade, as it was surrounded by hills and positioned at the convergence of Indian Creek and Little Indiana. A rail line was later built to add to Corydon's accessibility (Downtown Corydon Revitalization Plan).

The Historic District in the Town of Corydon sits within the natural boundary of Indian Creek to the north and west with Little Indian Creek to the south. Corydon is home to several sites listed in the National Register of Historic Places, including the Corydon Battle Site, Corydon Historic District, Kintner House Hotel, Kintner-Withers House, and the Kintner-McGrain House, the last three of which are listed due to their architectural as well as historical significance (National Register of Historic Places).

According to the 2000 United States Census, the total population of Floyd County has reached 70,823. The County has experienced a 15.7 percent increase in population since 1980. (US Census Bureau).

Without a doubt, the 1998 opening in Harrison County of Caesar's Glory of Rome Riverboat Casino has had a significant impact on Southern Indiana's economy. Caesar's has become Harrison County's largest employer and is also a major tourist attraction and a large source of tax revenue (Lanesville Interchange Master Plan, 2002).

Corydon Interchange on I-64 (#105) is another major employment center in Harrison County. The area south of the interchange includes commercial development (highway service and retail). The area north of the interchange is primarily industrial, with limited highway service uses. The Harrison County Chamber of Commerce owns 43 acres of land at the Corydon interchange available for development. Approximately 160 acres of land zoned industrial is available at the Corydon Interchange. This area has developed because of the availability of public utilities, including water, sewer, electricity and telephone, along with rail service. (Lanesville Interchange Master Plan, 2002). The Tyson poultry processing plant in Corydon has also experienced an expansion in recent years.

In Floyd County, the largest industry in the county is manufacturing. This industry employs 22.3% of the county's workforce, followed by educational, health and social services, which employ 17.1% of the workforce. Retail trade is the third largest industry accounting for 10.2% of the county's employment (US Census Bureau).

In order to further this growth, Harrison County and the Harrison County Economic Development Corporation initiated discussions for two projects – a new county hospital west of Corydon and the Lanesville interchange and road corridor. The hospital is under construction and is anticipated to attract jobs, additional residents and contribute to the economic growth of the area.

The planned Lanesville interchange, seventeen miles west of downtown Louisville, would connect State Road 64 and Interstate 64. In order to plan for development and guide land use decisions in the area, the County developed a supplement to the 1996 Comprehensive Plan for Harrison County entitled the Lanesville Interchange Master Plan, 2002. Although a timeframe for construction has not been established, this project is anticipated to spur additional residential, commercial and light industrial development near the interchange and along the road corridor.


Source: The Nature Conservancy

Figure 1.11. Cedar Farms, Harrison County

The Harrison and Floyd County Comprehensive Plans have similar goals. Both Plans promote and encourage planned community growth in areas best suited for economic development, while preserving and protecting agricultural lands and natural resources. Floyd County is proactively trying to manage growth. Floyd County's Sub-Division Control Ordinance is currently under revision and in the process of being updated to include new requirements for subdivision development. New growth and development, as a result of land use planning, will bring new prosperity to the region. However, these changes will also create new challenges for the region and in turn will affect the water quality in the Indian Creek Watershed.

Recreational Resources: There are numerous recreational resources available in the Indian Creek Watershed. Over 1,900 acres are available for publicly accessible recreational activities, as shown in **Table 1.8**.

Table 1.7. Recreational Acreages by Facility Type

Facility Type	Acreage
Dedicated Nature Preserve	593.5
Fishing/Boating Access	34
For-Profit Facility	68
Golf Course	315
Historic/Cultural	7.3
Non-Profit Facility	452
Other	25.5
Park/ Recreation Area	227
School Grounds	242
Total	**1964.3**

Source: IDNR, 2003. Recreational Facilities IDNR Shapefile.

Land Ownership: Although land in the Indian Creek Watershed is mainly privately owned, the watershed does include some County-owned land. Within the watershed, Harrison County owns and maintains Hayswood Nature Preserve and Indian Creek Woods (410 acres). Harrison

County participated on the Watershed Subcommittee, involving this land owner. The Nature Conservancy owns the Dewey Hickman Nature Preserve (125 acres) and Flint Hills Barrens Nature Preserve (58.53 acres). The Nature Conservancy participated on the Stakeholder Committee, representing this landowner. The 24,000 acre Harrison- Crawford State Forest is located in western Harrison County and eastern Crawford County. Approximately 4,000 acres of the Harrison Crawford State Forest are located in the Indian Creek Watershed. This forest is not a dedicated nature preserve.

1.5 PUBLIC EDUCATION AND OUTREACH

1.5.1 Public Meetings

Three public meetings were held to inform community members about the project's progress, gather information, raise awareness and support for the watershed plan. All public meetings were advertised with press releases to local newspapers, flyers and on the watershed website.

The first meeting was held on October 18, 2006 at the Harrison County Annex Building and focused on presenting an overview of watershed management planning and approach. The discussion focused on the creeks critical areas, as well as flooding and septic systems.

The second public meeting was held on July 24, 2007 at the Lanesville Jaycees Building. A presentation was given by FMSM that detailed the draft of the watershed management plan, sample collection efforts to date, and information on sinkhole inventory. Citizens made recommendations in reference to flooding, septic system education efforts, and storm water quality. The following priorities were identified: storm water quantity / flooding (1st), septic systems (2nd), water quality (3rd), and karst issues (4th). While this is not a comprehensive list of issues discussed, these broad issue categories cover the major interest areas and topics of discussion. **Appendix 1.4** includes meeting summaries for additional detail.

The third public meeting was held on February 5, 2008 at the Harrison County Annex Building and focused on presenting monitoring results, an overview of the watershed plan and gathering input on watershed strategies from a wide range of engaged citizens. Citizen recommendations were discussed and utilized in Chapter 4 of the watershed plan. Additional information regarding public meetings is provided in **Appendix 1.4**.

1.5.2 Events

A booth was set up at the Harrison County Fair to provide citizens with information about the watershed management plan. Project brochures were dispersed. Input was gained regarding citizen's views of waters quality. Many citizens were displeased with current water quality conditions. They complained of unclear well/tap water, past unawareness of straight pipes, and wastewater disposal issues. A health department nurse also expressed concern regarding the proper disposal of unused medicines, which can potentially accumulate in and contaminate natural water sources.

1.5.3 Website, Publications, and Brochure

An Indian Creek Watershed website was launched at the start of the project to raise public awareness, provide basic information regarding watersheds and to provide a publicly accessible calendar of events. The website also included a password protected page allowing subcommittee members to exchange draft information for review prior to public release. The homepage is shown in **Figure 1.12.** The web address is:

http://www.indiancreekwatershed.com/index.htm

Figure 1.12. Indian Creek Watershed Website

Quarterly public outreach publications were released and watershed information was distributed to raise awareness of watershed issues. Over 400 copies of the Indian Creek Watershed brochure were distributed, and the brochure is included in **Appendix 1.4.**

1.6 PRIORITIZATION OF WATER QUALITY PROBLEMS

The following priorities were discussed at the Indian Creek Watershed Plan Public Meeting held on October 18, 2006. These considerations were integrated into Chapter 3. Goals and Decisions for the Indian Creek Watershed Plan.

1.6.1 Flooding

While flooding is not necessarily a water quality problem, it is related to the increasing impervious land cover from land development. Unmanaged stormwater runoff from existing and new development often contributes to both water quality and flooding issues. Flooding causes a more rapid transport of surface pollutant to streams. Some points to consider when discussing the impact of flooding are as follows:

- Buffers benefit aquatic life, water quality, and provide flood protection.

- Impacts of flooding on facilities and production.

- Low head dams: The ford bridge and Little Indian Creek backwater are likely contributors and the problem is anticipated to worsen as the area develops.

- Flash Floods: The system is very flashy, with floodwaters rising and receding very quickly. This may be attributed to high velocity runoff from local impervious surfaces and rapid runoff from steep sloped in the Floyd Knobs headwater area.

- Funding for agricultural buffers and stabilization In the Blue River, agricultural buffers and stabilization projects have been implemented to mitigate flooding. Agricultural funding sources typically require significant match (up to 50%). Grants can be sought to offset the farmers match requirement.

- Contour practices can reduce agricultural runoff and soil erosion. These practices are common where rainfall is scarcer, but could be useful locally.

- The Federal Emergency Management Agency (FEMA) provides Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grants. These grants are available to study natural hazard problems and build solutions. Data and documentation of the nature and extent of the flooding problem are critical to a successful grant application. Regional solutions can incorporate recreational uses such as linear parks along rivers. Lanesville has a series of parks that provide flood storage and recreational use.

- FEMA buy-outs for repetitive loss structures are also available. This has been used on 1-2 structures in Harrison County. Buy-outs compliment regional solutions by providing land.

- Floyd County involvement is very important since drainage from the knobs and developing areas is increasing. Floyd County is developing a storm water utility that will provide a funding source for storm water/drainage projects that could benefit Harrison County.

- Flood Control Structures: The watershed plan should include a recommendation to identify possible flood control structures and locations.

1.6.2 Failing / Inadequate Septic Systems

Failing septic systems are considered a potentially significant source of E. coli and bacteria.

- Failing septic systems are a problem, but are difficult to quantify. Additional work is needed to study the problem further. Infrared photography can potentially be used to identify failing septic systems. If funding is provided a study could be done in the watershed locate potential problems.

- The existing data is complaint driven and typically arises from lack of percolation. Systems that are failing into karst features don’t have percolation issues and are not being detected. Repairs can be triggered by failures or changes to the system such as expansions to handle home additions.

- New Salisbury and Laconia have more repair needs than Lanesville and Corydon.

- Projects to address this issue in other communities have included using GIS to analyze repair, failure and soils data and have resulted in identification of issues such as clay lenses and perched water tables that limit infiltration. Soil testing requirements were changed as a result.

- Help bring solutions to homeowners with failing septic systems. If septic systems failures are to be highlighted, it is important to bring solutions to homeowners. Some are not likely to have the financial means to repair failing systems.

- Some communities have implemented septic system districts that require routine inspections and pump-outs and repairs for failing systems. Fees are charged for the services, but are typically much lower than tie-on fees for sewage collection and monthly sewer bills. The RSD has the authority to address septic systems and septic education is a major charge for the RSD.

1.6.3 Water Quality

- A water quality problem – foaming – was identified in a Corn Creek cave stream near the Floyd County boundary. There is development in the area, served by septic systems that may be contributing. Existing data did not include these northern Harrison County karst features. This area could be examined further in the Sinkhole Inventory.

- Preservation and protection: The discussion so far has focused on problems, but preservation and protection are often less expensive and less onerous than remediation. Additional discussion on protection measures is needed.

- Citizen stakeholders recommended the following measures to protect and improve water quality: Buffers for runoff; stabilize creek crossing areas with grasses; cows should be kept out of the creeks.

- Straightening of Indian Creek for rapid stormwater conveyance, which leads to further water quality and flooding problems.

- Erosion problems in the headwaters of Floyd County portion of the watershed effect Harrison County downstream.

1.6.4 Karst

- Septic systems that are failing into karst features typically don't have visible surface percolation issues and are not being detected.
- State Department of Health does not approve mound septic systems although they may be a better option for a highly karst area
- Foaming was identified in a stream emanating from a cave on Corn Creek near the Floyd County boundary.
- Some retention ponds may open up into karst.
- Not all parcels are suitable for development in Harrison County due to the high intensity of the karst system.
- Stormwater Best Management Practices (BMPs) that are suited to karst should be identified and tested

2.0 Water Resource Issues

2.1 INTRODUCTION

This chapter addresses:

- Water Quality Problems previously identified by existing data and reports.
- Water Quality Problems recently discovered as a result of the Indian Creek Watershed monitoring conducted through this project.
- The causes of Water Quality Problems including the identification of specific pollutants or processes that cause or contribute to impairments.
- The sources of Water Quality Problems involving the identification of point and nonpoint sources of pollutants that cause or contribute to impairments.
- Recognized Data Gaps through the process of Sinkhole Inventory.
- The Prioritization of Water Quality Problems based on input gathered from public meetings and the Steering Committee.

2.2 BACKGROUND

In 1972 Congress enacted the Clean Water Act to restore and maintain the chemical, physical, and biological integrity of the nation's water resources. The goal of the Clean Water Act is to conserve water for recreational, agricultural and industrial uses, as well as for use as a public water supply and as a means to propagate fish and aquatic life.
Indiana's water quality goals stated in Article 2 of the Indiana Administrative Code. The goals are to restore and maintain the chemical, physical, and biological integrity of the waters of the state (327 IAC 2-1-1.5).
Each body of water is subject to water quality standards identified by its use (ex. drinking water supply, aquatic life support) and is then evaluated by numerical or narrative criteria to support that use (Refer to 327 IAC 2-1 for Indiana's water quality standards). When multiple uses have been designated for a body of water, the strictest applicable standards apply. Designated uses for waters in the Indian Creek Watershed include:

- Full-Body Contact Recreation
- Warm Water Aquatic Community
- Fish Consumption
- Water Supply (public, industrial, agricultural water supply at the point of withdrawal)

2.3 PREVIOUSLY IDENTIFIED WATER QUALITY PROBLEMS

IDEM uses monitoring and assessment programs to collect data and assess each water body's designated uses according to the water quality criteria in Indiana's streams, rivers and lakes. An overview of water quality monitoring programs and water quality assessment results is provided below, along with identified water quality impairments documented in the Indian Creek Watershed. This summary of historical and current water quality assessment results was used to identify data gaps.

The Surveys Section of IDEM's Office of Water Quality's Water Quality Assessment Branch provides the water quality and hydrological data required to assess Indiana's waters through Watershed/Basin Surveys and Stream Reach Surveys. These surveys evaluate the degree to which water quality standards are being met and if each body of water's designated uses are accurately assigned. Indiana streams and lakes are monitored and water quality is assessed on a five-year rotating basin cycle. Results are reported every two years, with the most recent results published as the Indiana Integrated Water Monitoring and Assessment Report 2006 (IDEM, 2006)

2.3.1 Water Quality Monitoring Programs

IDEM's Office of Water Quality (OWQ) Water Quality Assessment Branch has operated multiple surface water quality monitoring programs statewide, including stations within the Indian Creek Watershed. The monitoring programs, which have been outlined in the Surface Water Monitoring Strategy, were designed to collect data regarding the physical, chemical, and biological integrity of Indiana's waterbodies (IDEM, 2001).

IDEM monitored fourteen stations within the Indian Creek Watershed between 1996 and 2006. These monitoring stations are shown in the table and figure below.

Table 2.1. Indian Creek IDEM Monitoring Stations

Site Id	Stream Name	Location	County
OBS080-0001	Little Indian Creek	Banet Road	Floyd
OBS080-0004	Little Indian Creek	Near Galena	Floyd
OBS080-0005	Indian Creek	at Greenville Road, NW of Georgetown	Floyd
OBS080-0007	Georgetown	Parent Lake	Floyd
OBS080-0008	Indian Creek	Navilleton Road	Floyd
OBS090-0002	Indian Creek	Southern Railroad	Harrison
OBS090-0004	Indian Creek	at SR 335 near Corydon Junction	Harrison
OBS090-0005	Indian Creek	Landmark Way	Harrison
OBS090-0007	Indian Creek	Pleasant Valley Road	Harrison
OBS100-0001	Indian Creek	Rocky Hollow Road	Harrison
OBS100-0004	Indian Creek	City Park South of Corydon, SR 135	Harrison
OBS100-0005	Indian Creek	Corydon City Park, off SR 135 S	Harrison
OBS100-0006	Indian Creek	at Lickford Bridge Road	Harrison
OBS100-0007	Indian Creek	Downstream of Little Indian Creek at Corydon	Harrison

Hoosier Riverwatch monitored a total of five (5) sites on June 25, 2001. A review of the Hoosier

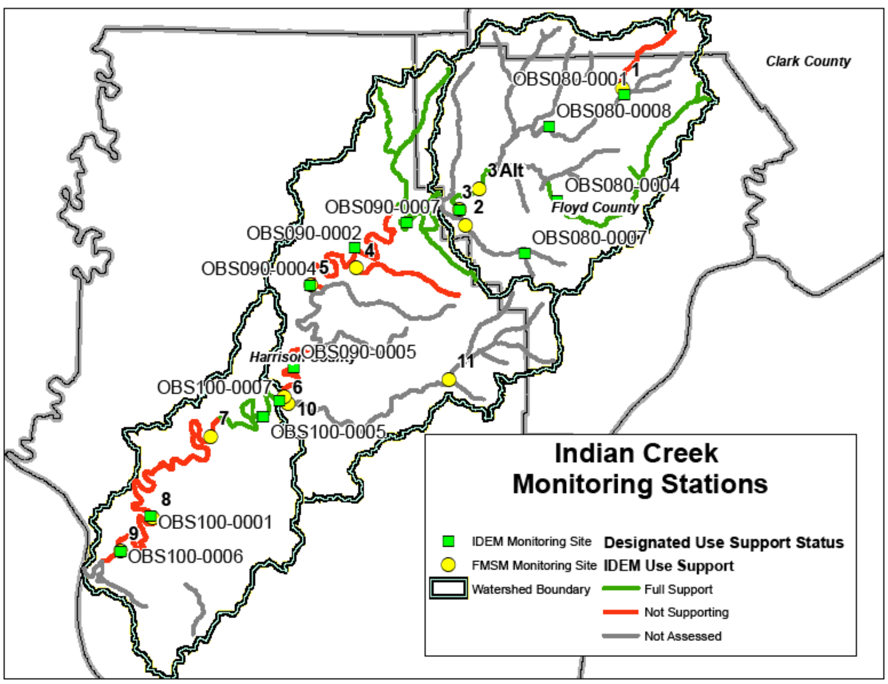

Figure 2.1. Indian Creek Monitoring Stations

Riverwatch database indicates that these sites were only monitored once. Sites are summarized in the table below. Since single sample events are generally considered insufficient to understand water quality conditions and trends, the assessments that follow rely on IDEM data and assessments.

Table 2.1. Hoosier Riverwatch Monitoring Sites in Indian Creek Watershed

Site #	Location
246	Indian Creek at Renn Road
249	Indian Creek at Stiller Road
250	Indian Creek at Old Vincennes Road
251	Little Indian Creek at back of trucking firm on SR 150
252	Little Indian Creek at Phil Scharf's house off Duffy Road

2.3.2 Water Quality Assessments

IDEM conducts assessments of data collected in order to evaluate which waterbodies are correctly designated and if the proper standards are being attained. Results of the most recent, as well as several historical assessments are presented below. The most recent water quality and biological data collected by IDEM are summarized in **Appendix 2.1**.

2006 Integrated Report: Section 305(b) of the Clean Water Act requires states to prepare and submit a Water Quality Inventory Report to the U.S. Environmental Protection Agency (USEPA) every two years. This report describes the condition of Indiana's waterbodies and states whether or not standards with respect to the waterbodies' designated uses are being upheld (ex. aquatic life, fish consumption, drinking water supply and recreational use). Waterbodies that did not meet one or more of their designated uses were placed on the 303(d) List of Impaired Waterbodies, also published every two years.

In 2002, USEPA issued guidelines requesting that states integrate the Water Quality Inventory Report (305b) and 303(d) List of Impaired Waterbodies. The first Indiana Integrated Water Monitoring and Assessment Report was submitted to USEPA in 2002. The 2006 Integrated Water Quality Monitoring and Assessment Report is Indiana's third integrated report (IDEM 2006). USEPA Integrated Report Guidance requested that states use five lists to document the condition of their waterbodies. IDEM assesses recent data using published assessment methods and assigns each water body to a category of stream use attainment as described in the **Table 2.3** below. A water body can be assigned to only one category.

Table 2.3. Indiana Categories of Stream Use Attainment

Category	Definition
1	Attaining the water quality standard for all designated uses and no use is threatened.
2	Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if remaining uses are attained or threatened.
3	Insufficient information to determine if any designated use is attained.
3A	Little or no information is available with which to make an assessment.
3B	Available data suggest that a problem may exist but more information is needed to verify whether impairment exists or will occur within the next two years.
4	Standard is not supported or is threatened for one or more designated uses but does not require the development of a TMDL.
4A	TMDL has been completed and approved by USEPA.
4B	Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.
4C	Nonsupport of the water quality standard is not caused by a pollutant.
5	Category 5 comprises the 303(d) List. The water body does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
5A	Impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL.
5B	The waterbodies are impaired due to a Fish Consumption Advisory for PCBs or mercury, or both (TMDL not required).
5C	Impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL, which is expected to be completed prior to the next listing cycle.

Source: IDEM, 2006.

A TMDL (Total Maximum Daily Load), established under section 303(d) of the federal Clean Water Act, is a calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards, and allocates pollutant loadings among point and non-point sources. States must develop TMDLs that achieve water quality standards, allowing for seasonal variations and an appropriate margin of safety. A TMDL is a quantitative assessment of water quality problems, contributing sources, and load reductions or control actions needed to restore and protect individual water bodies.

Indian Creek Watershed assessment results and categories for 2006 are presented in **Table 2.4**.

Table 2.4. Indian Creek Water body Assessment Results

Water body Segment Name	Water body Segment ID	Length (Miles)	Aquatic Life	Primary Contact	Fish Consumption	Category
Little Indian Creek (North)	INN0482_00	3.87	N	X	X	5A
Indian Creek-South Trib	INN0491_00	8.84	F	X	P	3A
Indian Creek-Crandall Branch	INN0494_00	15.43	F	N	P	5A
Indian Creek	INN0495_T1050	4.75	X	N	P	3A
Indian Creek	INN0496_T1051	4.20	X	N	P	5A
Indian Creek-North Karst Area	INN04A1_00	6.27	X	X	N	3A
Indian Creek-Devils Backbone	INN04A3_00	17.02	N	N	P	5A
Indian Creek-Blue Spring	INN04A4_00	4.89	X	X	P	3A

Source: IDEM, 2006.

Use Categories: F = Full Support, P = Partial Support, N = Not Supporting, X = Not Assessed.

Only segments which include a drinking water intake are assessed by IDEM for drinking water use. Since drinking water in the Indian Creek Watershed is provided through groundwater sources, IDEM did not assess drinking water use in this watershed.

Category 3A: Little or no information is available with which to make an assessment. Category 5A: Impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL.

Georgetown Lake was classified by IDEM as "mesotrophic" in the 2006 Integrated Report. Mesotrophic is a term applied to clear water lakes and ponds with beds of submerged aquatic plants and medium levels of nutrients. These lakes are of intermediate clarity, depth and temperature.

Over time, IDEM will collect additional data and information on Category 3A waters to determine if classified designated uses are being met. The impairments affecting the Category 5A waters are shown in the table below and **Appendix 2.2.**

Table 2.5. Category 5A Waters (Impaired & TMDL Required)

Basin	HUC	County	Waterbody Segment ID	Waterbody Segment Name	Impairment
Ohio Tributaries	5140104080020	Floyd	INN0482_00	Little Indian Creek (North)	Impaired Biotic Communities
Ohio Tributaries	5140104090040	Harrison	INN0494_00	Indian Creek-Crandall Branch	E. Coli
Ohio Tributaries	5140104090060	Harrison	INN0496_T1051	Indian Creek	E. Coli
Ohio Tributaries	5140104100030	Harrison	INN04A3_00	Indian Creek-Devils Backbone	Dissolved Oxygen
Ohio Tributaries	5140104100030	Harrison	INN04A3_00	Indian Creek-Devils Backbone	E. Coli

Source: IDEM, 2006.

IDEM published a schedule for TMDL development with the 2008 Integrated Report. Based on this schedule, IDEM anticipates developing TMDLs for the Indian Creek Watershed between 2017 and 2023. Note that this schedule may be amended at IDEM's discretion with USEPA approval.

By developing and implementing this watershed plan, the Indian Creek Watershed Subcommittee is taking a proactive approach to addressing impairments prior to IDEMs TMDL development. An anticipated benefit of this long term watershed plan is to reduce the TMDL burden on the Indian Creek Watershed communities by implementing watershed improvements outside of the regulatory context of the TMDL.

Fish Consumption Advisory: Since 1972, members from the Indiana State Department of Health (ISDH), Department of Environmental Management (IDEM), and Department of Natural Resources (IDNR) have met to discuss the findings of recent fish monitoring data and to develop the new statewide Fish Consumption Advisory (FCA). Indiana's fish consumption advisories are issued by ISDH. However, IDEM collects and manages about 98% of the data used to develop the fish advisories for the State through previously described programs (ISDH 2006). Criteria for the 2006 Indiana Fish Consumption Advisory were developed from the Great Lakes Sport Fish Advisory Task Force (ISDH 2006).

The FCA is based on the statewide collection and analysis of fish samples for contaminants found in fish tissue, such as polychlorinated biphenyls (PCBs), pesticides, and heavy metals (e.g. mercury). These contaminants collect in the soil, water, sediment, and in microscopic animals. They are typically found in greater amounts among larger, older, predatory fish. PCBs and pesticides are likely to be stored in the fat of fish due to the fact that they absorb mercury from their food which then gets tightly bound to their muscles.

Several waterbodies in Indian Creek Watershed partially support fish consumption as a designated use due to slightly elevated mercury concentrations. In addition, the Indiana State Department of Health has issued a statewide advisory to limit consumption of carp from all Indiana waters because this species is commonly contaminated with PCBs. The advisory is summarized in the table below.

Table 2.6. Statewide Carp Fish Consumption Advisory

Advisory Group	Carp Size (inches)	Description	
		Women of childbearing years, nursing mothers and children under 15	Other Adults
1		Limit to 1 meal per week	Unlimited consumption
2		One meal per month	One meal per week
3	15-20	No consumption (Do Not Eat)	One meal per month
4	20-25	No consumption (Do Not Eat)	One meal every two (2) months
5	Over 25	No consumption (Do Not Eat)	No consumption (Do Not Eat)

Source: ISDH, 2006. Note: A meal is defined as 8 ounces (before cooking) of fish for a 150-pound person or 2 ounces of uncooked fish for a 40-pound child.

Unified Watershed Assessment: A Unified Watershed Assessment (UWA) is one of 111 Action Items of the Clean Water Action Plan of 1998. The Clean Water Action Plan included incentives directed toward accelerating the control of nonpoint source pollution in America and prioritized watersheds for nonpoint source pollution remediation. The UWA, a multi-agency effort to prioritize watershed restoration needs in each state, was developed through the cooperation of state, federal, and local agencies, as well as the general public. The Guidelines for completing the UWA, published by the USEPA in June 1998, charged the USDA Natural Resources Conservation Service (NRCS) and the state water quality agency (IDEM) with organizing the assessment process. The watersheds in the state were prioritized for restoration work through the evaluation of water quality data, natural resource concerns, and human activities that have the potential to impact water quality.

1999-2000 UWA: In the first version of the UWA, HUC-8 watersheds were prioritized according to the present condition of the water in lakes, rivers, and streams. The data provided information about the water column, organisms living in the water, or the suitability of the water for supporting aquatic ecosystems. The measured parameters were scored from one to five, with one representing good water quality and five representing degraded water quality (IDEM OWQ 2001). This assessment involved multiple organizations and recognized impaired and healthy watersheds.
Scores for each HUC-8 watershed were compiled, and the watersheds were grouped into four categories as per the USEPA guidance (USEPA 1998). The four categories are as follows:

> **Category I**. Watersheds in need of restoration: waters do not meet designated uses or other natural resource goals. 25% or more of the waters that have been assessed do not meet state water quality standards. (Note that in some watersheds, only a very small percentage of waters have been recently assessed.)
> **Category II.** Watersheds that on average meet state water quality goals and require attention to sustain water quality. In most of these watersheds, there is habitat which is recognized as critical for threatened or endangered species.
> **Category III.** Watersheds with pristine or sensitive aquatic systems on federal or state managed lands.
> **Category IV**. Watersheds with insufficient data to make an assessment.

The Indiana UWA identified eleven (11) HUC-8 watersheds for restoration funding during 1999-2000 (IDEM 2001). In this initial assessment, the Blue-Sinking HUC 8, including the Indian Creek Watershed, was not identified as a priority.

2000-2001 UWA: For 2000-2001 UWA, Indiana used additional data sources to identify the resource concerns and stressors for each of the HUC-11 subwatersheds. Due to the potential of human activities to impact the ecosystem, this refined UWA included a more thorough examination, allowing water resource managers to focus on areas where restoration was most critical. The UWA aimed to identify areas where the interests of two or more partner agencies converged in order to achieve a more effective allocation of resources for restoration and protection activities. The information included in the UWA was designed to assist local groups in prioritizing watershed activities and providing a starting point for watershed planning. The amended UWA was designed to have the following benefits:

- Provide a logical process for targeting funds, which may be expanded or updated without changing the basic framework.
- Provide information at a finer resolution (HUC-11 vs. HUC-8) to agencies and local groups interested in watershed assessment.
- Identify data gaps.
- Compliment other assessments, such as the 305(b) Report and 303(d) List.

The 2000-2001 UWA was conducted at the subwatershed (HUC-11) scale and assigned a score ranging from 1 (good water quality or minimum impairment) to 5 (degraded water quality or heavily impacted) for 15 parameters. Subwatersheds with higher scores were given a higher priority. Assessment parameters and Indian Creek Watershed scores are shown in the table below. The middle and lower HUCs (05140104090 and 05140104100) were identified for priority funding due to multiple scores of 4, while the upper HUC (051401004100) received higher-quality scores and therefore did not meet these criteria. Selected assessment parameters are detailed below.

Table 2.7. HUC Scores for Each Parameter Assessed in the Unified Watershed Assessment

HUC-11 Watershed	Mussel Diversity and Occurrence	Aquatic Life Use Support	Recreation Use Attainment	Stream Fishery	Lake Fishery	Eurasian Milfoil Infestation Status	Lake Trophic Status	Critical Biodiversity Resource	Aquifer Vulnerability	Population Using Surface Water for Drinking	Residential Septic System Density	Degree of Urbanization	Density of Livestock	% Cropland	Mineral Extraction Activities
05140104080 Upper Indian Creek	ND	ND	ND	ND	ND	ND	ND	2	4	3	5	2	3	1	1
05140104090 Mid-Indian Creek	ND	ND	ND	2	ND	ND	ND	4	1	3	4	2	4	1	2
05140104100 Lower Indian Creek	4	ND	ND	4	ND	ND	ND	4	3	3	3	2	4	1	2

Source: IDEM OWQ, 2001. ND = no data.

Mussel Diversity and Occurrence: This indicator measures the incidence of freshwater mussel beds, with consideration given to the rarity and diversity of the species found. Scores of 4 indicated either degraded diversity or rare species in Lower Indian Creek, with insufficient data for the remainder of the watershed. Report authors noted that this indicator should be interpreted carefully.

Stream Fishery: This indicator is a measure of the quality of the small mouth bass community in streams based on the catch per unit effort. A score of 4 for Lower in Indian Creek indicates that fisheries were degraded.

Critical Biodiversity Resource: This indicator is a measure of the level of concern for reported endangered and threatened species or other biological communities of concern. A score of 4 was given to Middle and Lower Indian Creek, which has had between 150 and 299 threatened or endangered species reports filed with the State. This indicates a comparatively high number of biological resources in the watershed that may need protection.

Residential Septic System Density: USEPA has stated that a residential septic system density greater than 40 per square mile is a potential water quality problem (IDEM 2001). A score of 5 was given to Upper Indian Creek because the septic system density in this area was above the recommended level.

Density of Livestock: This parameter is a measure of the number of swine, poultry, cattle, and sheep animal units reported through the 1997 Census of Agriculture. As with the stream fisheries, HUC-11 watersheds were ranked by quintile. A score of 4 given to Mid and Lower Indian Creek due to a high livestock density when compared to the rest of the State.

2.4 RECENT WATER QUALITY CONDITIONS

The Indian Creek Watershed Plan Subcommittee of the Harrison County Regional Sewer District developed a plan to conduct additional water quality monitoring. The purpose of the monitoring program was to collect additional data for impaired segments and to assess water quality conditions in previously unassessed reaches. Both water quality and biological monitoring were included.

2.4.1 Indian Creek Watershed Monitoring Design

Initially 15 sites were evaluated for sampling and 11 sites were selected to be included in the final monitoring program. A Site Reconnaissance Report was prepared to document the 15 sites investigated. This report is provided as **Appendix 2.3**.

This program included 10 sites for bacteria and water quality monitoring and 5 sites for biological monitoring. A targeted sampling design was used in order to meet the goals for the monitoring program. Sites were located in reaches that were identified as impaired for primary contact or biological uses, that had known or suspected pollution sources, and those not recently sampled by IDEM or other entities to address data gaps. Monitoring sites are shown in the figure and table below.

Table 2.8. Indian Creek Watershed Monitoring Sites

Site #	IDEM Site ID	Location	WQ	AQL	Rationale
1	OBS080-0001	Indian Creek North at Banet Road, IDEM Site OBS080-0001		X	303(d) Segment – Aquatic Life
2		Georgetown Creek below Georgetown at Malinee Ott Road	X		Unassessed reach below Georgetown
3	OBS080-0005	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	X		Floyd County drainage, near County boundary, developing
4		Crandall Branch above SR335 Bridge	X		303(d) Segment – Recreation (may be an artifact of mapping?)
5	OBS090-0004	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	X		303(d) Segment – Recreation
6		Indian Creek above Little Indian Creek at Water Street	X		Downstream end of HUC, 303(d) Segment – Recreation, above WWTP, receives Corydon runoff
7		Indian Creek at Mathis Road bridge	X	X	Upstream end of 303(d) Segment – Recreation, Aquatic Life
8	OBS100-0001	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	X	X	303(d) Segment – Recreation, Aquatic Life
9	OBS100-0006	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	X	X	303(d) Segment – Recreation, Aquatic Life
10		Little Indian Creek above Water Street Bridge	X	X	Major tributary, classified as “unassessed” by IDEM
11		Little Indian Creek below Lanesville at State Road 62	X		Upper reach of major tributary classified as “unassessed” by IDEM, downstream of Lanesville and Lanesville STP
		Number of Sites	**10**	**5**	

WQ – water quality sampling site. AQL – aquatic life sampling site.

The following parameters were monitored and results were compared with applicable Indiana Water Quality Standards (327 IAC 2-1). Note that in the original monitoring design, three base flow and three elevated flow samples were to be collected. However, because of severe drought conditions, five samples were collected under base flow and one sample was collected under elevated flow. The elevated sample event took place on August 21, 2007 (sample event #6). Samples were analyzed for the water quality parameters shown in the table below.

Table 2.9. Water Quality Monitoring Parameters

Chemical	Physical	Biological
Total Phosphorus (TP)	Dissolved Oxygen (DO)	E. coli
Ortho-Phosphorus (PO4)	pH	Benthic Macroinvertebrate
Total Kjeldahl Nitrogen (TKN)	Temperature (T)	Habitat
Nitrate-Nitrogen (NO3)	Specific Conductivity (SC)	
Total Ammonia (NH3+NH4)	Turbidity	
Total Solids (TS)	Stream Flow	

E. coli: In accordance with State water quality standards for calculation of geometric mean, 5 evenly spaced E. coli and flow samples were collected during a 30-day period. One set of 5 samples was collected at each of 10 sites. Flow readings were collected concurrently.

Water Quality: Six water quality sample events were conducted at each of the 10 sites. Samples were collected under base flow (3 events) and elevated flow (3 events) to evaluate water quality over a range of hydrologic conditions. Grab samples were analyzed for Total Kjeldahl Nitrogen (TKN), Nitrate-Nitrogen (NO3), Total Ammonia (NH3+NH4), Total Phosphorus (TP), Ortho-Phosphorous (PO4), and Total Solids (TS). Field parameters and flow were collected concurrently.

Biological: Biological (benthic macro invertebrate) data was collected at 5 sites. Samples were collected between July and October 2007. Field parameters and flow were collected concurrently at each site. Water quality data were collected concurrently at 4 of 5 sites.

Qualitative habitat was measured using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA and has been used extensively as a tool for the qualitative assessment of riparian and aquatic habitat. The tool addresses substrate condition, fish cover, stream shape, human interference, stream cover, erosion, depth, velocity, and presence and quality of riffles and runs. Habitat data was collected at 11 sites.

Field Parameters: Field parameters collected during each sample event include: pH, Dissolved Oxygen (DO), Temperature (T), Specific Conductivity (SC), Turbidity.

Flow: Flow records for the Indian Creek Watershed were examined. There was not a flow gage in the Indian Creek Watershed with sufficient historical data and accuracy to allow a quantitative approach to determine flow conditions; therefore a qualitative approach was devised.

Since water quality often exhibits a strong relationship with flow, monitoring was designed to include consideration of flow condition (i.e. base flow and elevated flow). The flow condition for sampling was qualitatively determined by evaluating recent precipitation and comparing current flow to the long term daily median for the nearby USGS Gage 03302220 Buck Creek near New Middletown. Dry conditions were defined as 3 or more days of dry conditions and wet conditions were defined as greater than 0.25 inches of wet precipitation or snowmelt. Since this amount of precipitation does not always produce runoff due to soil moisture deficits, base flow and elevated flow conditions were also defined. Base flow was defined for this study as less than the long term daily median flow and elevated flow is greater than the 65th percentile. This qualitative approach was necessary because USGS no longer operates flow gages in the Indian Creek Watershed. However, because a drought occurred during the sample period, five (5) samples were collected under low flow conditions and one (1) sample was collected under elevated flow conditions. The elevated sample event took place on August 21, 2007 (sample event #6).

The sample design is summarized in the table below. Additional information is included in the Quality Assurance Project Plan, provided as **Appendix 2.4** to this watershed plan.

Table 2.10. Sample Design Summary

Sample Type	# Parameters	# Sites	# Sample Events	# Results
E. Coli	1	10	5	50
Water Quality	6	10	6	360
Biological	1	5	1	5
Field Parms	5	11	6	330
Flow	1	11	11	115
Habitat	1	11	1	11

2.4.2 Indian Creek Watershed Monitoring Results

Results of the monitoring program are summarized below; data are provided in **Appendix 2.5**.

Table 2.2. Water Quality Monitoring Results Summary

Characteristic Name	Units	# Results	Minimum Value	Average Value	Maximum Value	Criteria or Comparison Value
Dissolved oxygen (DO)	mg/L	63	**0.08**	7.8	**16.2**	**4.0 mg/l minimum;** Maximum < 12
E. Coli	CFU / 100 ml	56	1	172.8	**2,200**	**125 (geometric mean); 576 maximum**
Nitrogen - nitrate+nitrite	mg/L	56	0.1	0.8	**5.9**	5
Orthophosphate	mg/L	65	0.03	0.1	**2.15**	0.3
pH	su	63	6.91	7.7	8.88	**6.0-9.0**
Phosphorus, total	mg/L	66	0.03	0.1	**2.88**	0,3
Solids, total	mg/L	65	**162**	**284.1**	**475**	261
Specific conductance	us/cm	61	190	416.8	720	**1,200**
Stream Flow	ft/sec	101	-0.72	1.1	28.3	-
Temperature, water	C	63	13	20.8	29.8	**Criteria tables**
Total Ammonia	mg/L	66	0.1	0.1	0.8	**Calculate un-ionized ammonia**
Total Dissolved Solids	mg/L	43	145	219.3	362	-
Total Kjeldahl Nitrogen	mg/L	66	0.1	0.6	1.5	5
Turbidity	NTU	62	1.13	12.7	**80.2**	25
Note: Numerical criteria shown in bold, other comparison values in plain text. Concentrations exceeding the criteria or comparison value are shown in bold.						

With the exception of bacteria and dissolved oxygen, all water quality samples met the required water quality criteria. Results for these parameters are discussed in detail in the sections that follow and **Section 2.7** outlines estimated load reduction targets for bacteria.

Elevated concentrations of nutrients (phosphorus and nitrogen) are discussed in **Section 2.5.5.** However, load reduction estimates were not calculated for nutrients because water quality criteria have not yet been adopted and the relationship between nutrients and dissolved oxygen is complex. Therefore, additional information regarding appropriate nutrient concentrations for this watershed are needed prior to calculating load reduction targets.

Bacteria: Bacteria data were collected between July 18, 2007 and August 15, 2007, with five (5) samples collected in 30 days. This sample design supported direct comparison to water quality criteria for E. coli. The water quality criteria for the recreational season is provided below.

> ***E. Coli Criteria:*** *April 1 – October 31: Geometric mean of 5 samples collected within a 30-day period shall be less than 125 MPN / 100 ml and no single sample can exceed 576 MPN / 100 ml.*

Bacteria data are summarized in **Table 2.12**. Results indicate that recreational contact criteria were met below Corydon. If additional sampling performed by IDEM confirms this result, de-listing could be pursued in this lower portion of the watershed.

Results indicate that recreational criteria were not met in the Indian Creek above Georgetown Creek and Indian Creek above Crandall Branch. Recreational criteria were also not met Georgetown Creek and Crandall Branch tributaries. Crandall Branch had previously been listed for recreational impairment by IDEM. Georgetown Creek had been classified by IDEM as unassessed. The potential sources of bacteria were evaluated using the Bacteria Indicator Tool developed by USEPA. The tool and results are discussed in **Chapter 2.4.**

Table 2.12. Indian Creek Watershed Bacteria Results

Site	Description	Geometric Mean	Maximum Concentration	Criteria Met?
2	Georgetown Creek below Georgetown at Malinee Ott Road	194	300	No
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	147.2	430	No
4	Crandall Branch above SR335 Bridge	779.2	2,200	No
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	268.8	410	No
6	Indian Creek above Little Indian Creek at Water Street	93.3	180	Yes
7	Indian Creek at Mathis Road bridge	19.4	32	Yes
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	46.8	177	Yes
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	44.2	132	Yes
10	Little Indian Creek above Water Street Bridge	119.2	140	Yes
11	Little Indian Creek below Lanesville at State Road 62	118.8	226	Yes

Water Quality: Water quality samples were collected during 6 events between July 18, 2007 and September 24, 2007. Since the lower 17 miles of Indian Creek (i.e., Devil's Backbone segment) is included on the 303(d) List of Impaired Waters due to low dissolved oxygen, these data are summarized in the table below.

Indiana water quality criteria establish that the minimum concentration of dissolved oxygen shall be above 4.0 mg/l at all times and the average over a 24-hour period shall be above 5.0 mg/l at all times.

Sites 7, 8, and 9 were used to better understand water quality in the 17 mile long Devils Backbone segment of lower Indian Creek. As shown in the table below, the dissolved oxygen criteria were met in all six samples collected at Sites 7 and 8. The dissolved oxygen criterion was not met at Site 9, where the minimum concentration was 3.1 mg/l DO. This site is located in Ohio River backwater in a watershed that loses significant flow to the karst system. Therefore, this lower reach often has little or no stream flow. Agricultural operations are similar throughout the reach characterized by these three sites, and no other sources of pollution were identified. Therefore, the portion of the reach characterized by Sites 7 and 8 could be considered as meeting water quality criteria. Site 9 could be considered affected by natural conditions that may preclude attaining water quality criteria for dissolved oxygen.

Table 2.13. Indian Creek Watershed Dissolved Oxygen Results

Site	Description	Minimum Concentration (mg/l)	Average Concentration (mg/l)	Criteria Met?
2	Georgetown Creek below Georgetown at Malinee Ott Road	4.6	7.4	Yes
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	5.7	7.0	Yes
4	Crandall Branch above SR335 Bridge	6.4	8.1	Yes
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	4.5	6.0	Yes
6	Indian Creek above Little Indian Creek at Water Street	7.6	10.2	Yes
7	Indian Creek at Mathis Road bridge	5.6	7.3	Yes
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	6.3	7.2	Yes
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	3.1	4.9	No
10	Little Indian Creek above Water Street Bridge	7.7	9.8	Yes
11	Little Indian Creek below Lanesville at State Road 62	4.9	10.6	Yes

Benthic Macroinvertebrates and Habitat: Macroinvertebrate samples were collected from four locations within the Indian Creek Watershed on September 20, 2007 the sampling locations were as follows:

- **Site 1** – Indian Creek North at Banet Road – This site was dry and not sampled
- **Site 6** – Indian Creek above Little Indian Creek at Water Street in Corydon, (duplicate)
- **Site 7** – Indian Creek at Mathis Road bridge,

- **Site 8** – Indian Creek above Rocky Hollow,
- **Site 10** – Little Indian Creek above the Water Street bridge.

The drought of 2007 had a severe impact on the Indian Creek drainage. Two of the four sites were pooled-up with no flow in the riffle areas (Sites 7 and 8). At the two sites with flow (Sites 6 and 10), the flow was so reduced that it was barely sufficient in the riffle areas to carry invertebrates into the sampling net. Furthermore, the riffles were so reduced by the drought that only one third of a meter was sampled quantitatively. Virtually all bank habitats, i.e. undercut banks, root wads, etc., were out of the water. The only consistently available habitats were Justicia (water willow) beds and bedrock.
The MIBI was only calculated for Sites 6 and 10 where quantitative data was collected. The macroinvertebrate data, including a taxa list and metric data, are presented in **Appendix 2.5**.

Table 2.14. Benthic Macroinvertebrate Data Summary

Site	Macroinvertebrate Index of Biotic Integrity (MIBI)	Qualitative Result
Site 6 - Indian Creek above Little Indian Creek at Water Street in Corydon	40	Poor
Site 6 (Duplicate) - Indian Creek above Little Indian Creek at Water Street in Corydon	43.9	Fair
Site 7 -Indian Creek at Mathis Road bridge	Not assessed	
Site 8 - Indian Creek above Rocky Hollow	Not assessed	
Site 10 – Little Indian Creek above the Water Street bridge	43.2	Fair

These MIBI values are the result of two factors, the habitat reduction due to the severe drought and elevated nutrients. The macroinvertebrate communities from all sites are made up principally of organisms that are found in nutrient enriched streams. The elevated nutrients may have probably arisen from urban sources such as the Corydon Wastewater Treatment Plant (WWTP) and rural agricultural practices (livestock grazing and row crops). The highest taxa richness and EPT values were observed at station 7 (42 and 11, respectively), a portion of the stream that had only hyporheic flow. However, all sites had low taxa richness and EPT values, again at least in part due to the severe drought.

Habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) concurrently with benthic marcoinvertebrate sample collection. Since habitat conditions can influence water quality, habitat data were collected at all Indian Creek monitoring sites. Results are summarized below and data are provided in **Appendix 2.5**. A review of the individual components of the QHEI score indicates that flow-related habitat characteristics scored low, due in part to the severe drought.

Table 2.15. Indian Creek Watershed Habitat Results

Site	Description	Habitat Score	Qualitative Result
1	Indian Creek North at Banet Road, IDEM Site OBS080-0001	46	Fair
2	Georgetown Creek below Georgetown at Malinee Ott Road	39.5	Poor
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	61	Good
4	Crandall Branch above SR335 Bridge	61.5	Good
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	40	Not Assessed
6	Indian Creek above Little Indian Creek at Water Street	42	Poor
7	Indian Creek at Mathis Road bridge	62	Good
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	55.5	Fair
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	63.5	Good
10	Little Indian Creek above Water Street Bridge	36	Poor
11	Little Indian Creek below Lanesville at State Road 62	58	Good

2.5 BACTERIA INDICATOR TOOL

Previously identified water quality problems as well as Indian Creek Watershed monitoring results identify bacteria as the main pollutant of concern in Indian Creek. To gain a better understanding of sources and loadings bacteria in the watershed, the EPA Bacteria Indicator Tool (BIT) was used.

2.5.1 Tool Selection

EPA's Bacteria Indicator Tool (BIT) was chosen because it can be used to estimate relative contributions of bacteria sources on a watershed basis. The tool is used to develop input data for the Hydrological Simulation Program Fortran (HSPF) water quality model within BASINS. The tool estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland), as well as the asymptotic limit for that accumulation should no wash-off occur. The BIT also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems. The tool does not calculate the amount of fecal coliform to reach stream from land based sources. When the BIT is used in conjunction with HSPF, land-based source estimates can be generated. However, development of an HSPF model was beyond the scope of this watershed plan. More information on EPA's Bacteria Indicator Tool can be found at the following website: http://www.epa.gov/waterscience/ftp/basins/system/BASINS3/bit.htm

2.5.2 Bacterial Input Tool Development

While BIT does assume a direct contribution from septics and cattle in streams, it does not simulate transport to streams or sinkholes from nonpoint sources of bacteria. The tool's outputs for nonpoint source contributions are reflected as bacteria accumulation on land. Only a fraction of the land-based bacteria reaches the stream. Therefore, the BIT outputs were used to compare relative importance of the bacteria sources.

The BIT was applied on the HUC-14 subwatershed level to provide output that would allow for the comparison between subwatersheds. There are 24 HUC-14 subwatersheds in the Indian Creek Watershed, shown in **Table 2.16**.

Table 2.16 Bacterial Indicator Tool Subwatersheds

BIT Watershed	HUC 14	HUC Watershed Name
1	05140104080020	Little Indian Creek (north)
2	05140104080050	Indian Creek-Jersey Park Creek
3	05140104080010	Indian Creek-Headwaters (Floyd)
4	05140104080040	Indian Creek-Middle Fork
5	05140104080100	Indian Creek-Richland Creek
6	05140104080090	Georgetown Creek
7	05140104080060	Little Indian Creek-Headwaters
8	05140104080030	Indian Creek-Galena
9	05140104080070	Little Indian Creek-Lower
10	05140104080080	Indian Creek-above Georgetown Creek
11	05140104090020	Corn Creek
12	05140104090030	Indian Creek-Corydon Junction Karst Area
13	05140104090040	Indian Creek-Crandall Branch
14	05140104090010	Indian Creek-south trib (Sec 36)
15	05140104090050	Indian Creek- Raccoon Branch
16	05140104090090	Little Indian Creek (Lanesville)
17	05140104090060	Indian Creek-Brush Heap Creek
18	05140104090070	Little Indian Creek-North Karst Area
19	05140104090080	Little Indian Creek-South Karst Area
20	05140104090080	Little Indian Creek-South Karst Area
21	05140104100010	Indian Creek-North Karst Area
22	05140104100030	Indian Creek-Devils Backbone
23	05140104100020	Indian Creek-East Karst Area
24	05140104100040	Indian Creek-Blue Spring

2.5.3 Bacterial Input Tool Data

The Bacteria Indicator Tool used inputs such as land use, livestock numbers, population, septic system density and failure, grazing patterns, wildlife numbers, and manure application rates.

Land Use Land Cover: GIS data were used to derive acres of land use types for each subwatershed. Land Cover in Indiana (2001), derived by the USGS was used.

Animal Census: A combination of USDA Census of Agriculture data and confined feeding operations data was used to determine the number of livestock animals in each subwatershed. Livestock numbers were available by county from USDA and by confined feeding operation from IDEM. Data were retrieved from the following websites:

http://www.nass.usda.gov/QuickStats/Create_County_Indv.jsp http://www.nass.usda.gov/QuickStats/Create_County_All.jsp

Manure Application: IDEM provided data for manure application rates.

Grazing: County extension offices provided data on grazing patterns in the area.

Septic Systems: County health departments provided information on the percent of population using septic systems and the estimated septic system failure rates.
Information on pet contribution was readily available and therefore was not included. It was assumed that all cattle have access to streams. Topographic information and flow simulation is not included in the BIT. In steeper topography that occurs largely in the northern half of the watershed in Floyd County, cattle tend to graze in valley bottoms. In the rolling topography of Harrison County, cattle pastures tend to include areas farther from streams. Only a portion of the bacteria from land-based sources reaches streams or groundwater.

2.5.4 Bacterial Input Tool Results

The tool provided output data in counts/acre/ day of fecal coliform from land-based sources - forestland, cropland, pastureland, built-up land, as well as direct (in-stream) estimations of count/day contributions from septic systems and cattle in streams.

Forest, Cropland, Pasture, and Built-Up Land: As shown in the chart below, pasture and crop have the highest accumulation rate of bacteria. Both forested and developed (i.e. Built-up) lands in the Indian Creek Watershed accumulate less than 1 percent of the total bacteria counts/day.

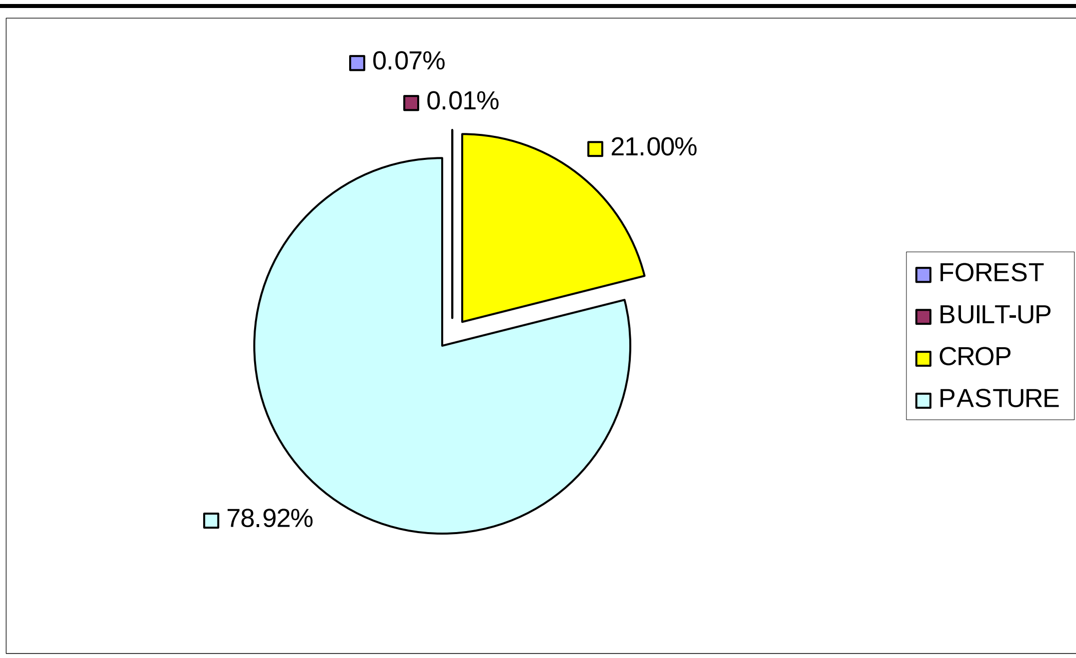

Figure 2.2. Percent Accumulation of Bacteria from Land-Based Sources

Bacterial accumulation rates, expressed as fecal coliform counts/acre/day were mapped by subwatershed in **Figure 2.3**. Subwatersheds 11, 19, 20, 21, and 23 are estimated to have the highest nonpoint source counts of bacteria in the watershed, reaching up to 9.9 billion counts/acre/day of fecal coliform in the Little Indian Creek South – Karst Area subwatershed (HUC 05140104090080). A graph showing sources of bacteria in each subwatershed is provided in **Figure 2.4.**

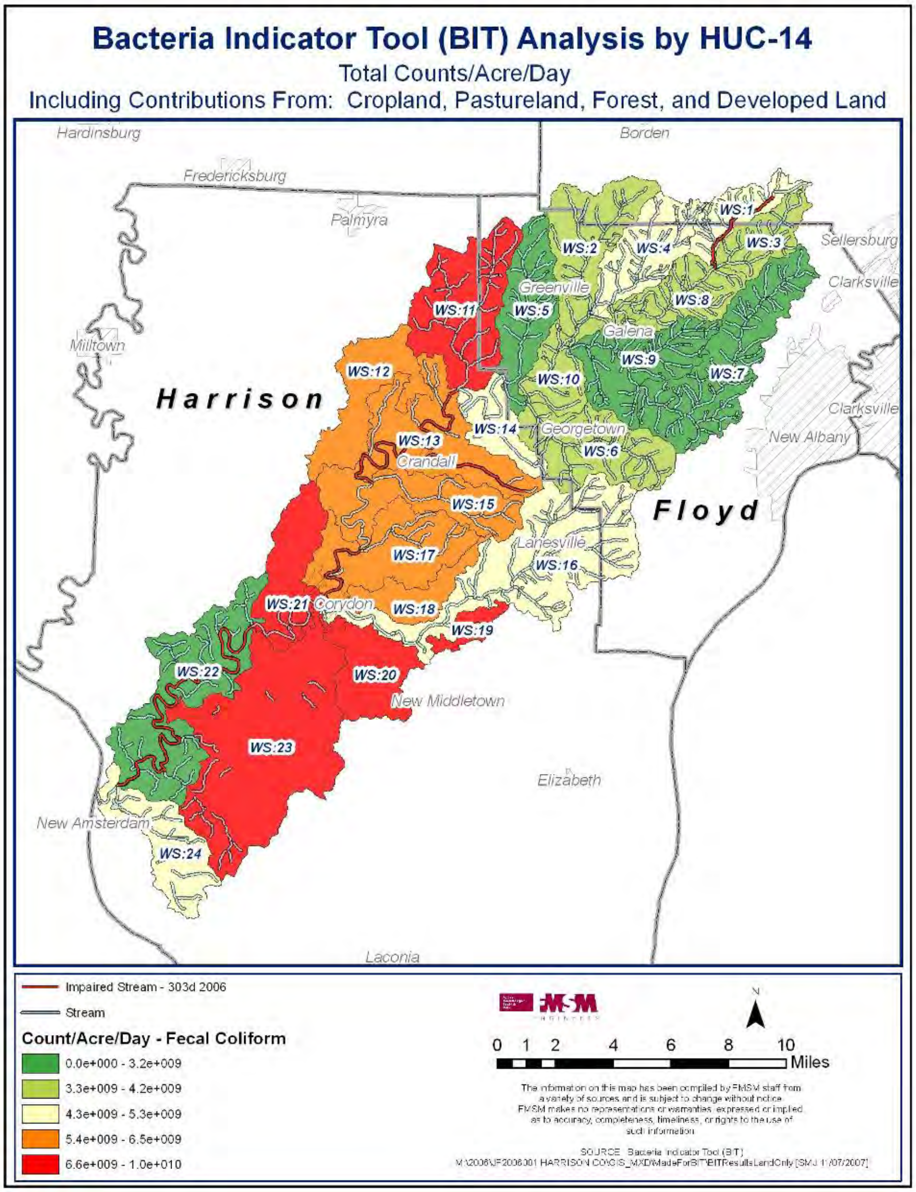

Figure 2.3. BIT Results for Land Based Bacteria Sources

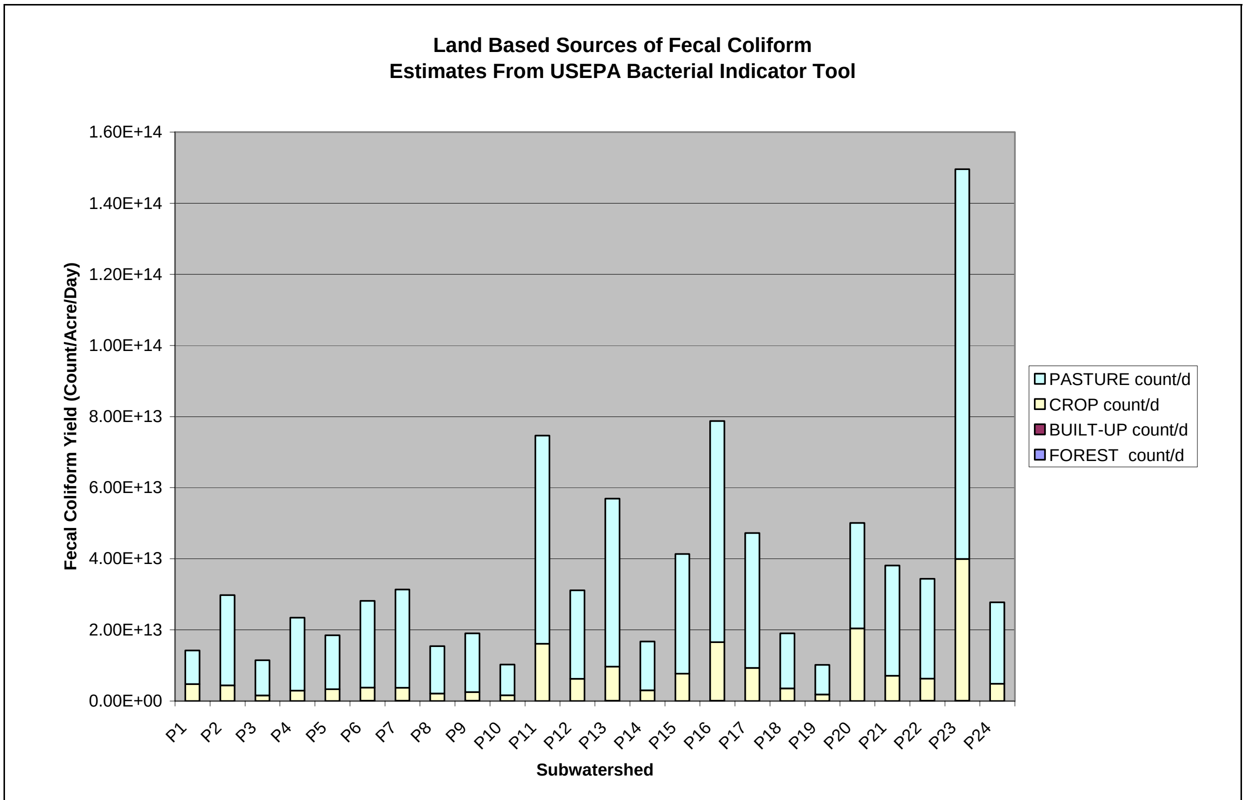

Figure 2.4. BIT Results - Land Based Bacteria Sources

Cattle in Streams and Septic Systems: Two maps were produced to show additional direct contributions of fecal coliform from cattle in stream and failing septic systems. The model does not take into consideration livestock exclusion practices currently in place. Cattle in streams are shown by the BIT to contribute over one-thousand times the count/day of fecal coliform to stream than failing septic systems; however this trend does not account for relative human health concern.

As shown in **Figure 2.5**, subwatersheds in Harrison County contribute more bacteria to the stream from cattle in stream, than subwatersheds in Floyd and Clark counties.
The subwatersheds in Floyd County contribute higher counts of bacteria from septic systems than the subwatersheds in Harrison. **See Figure 2.6.**

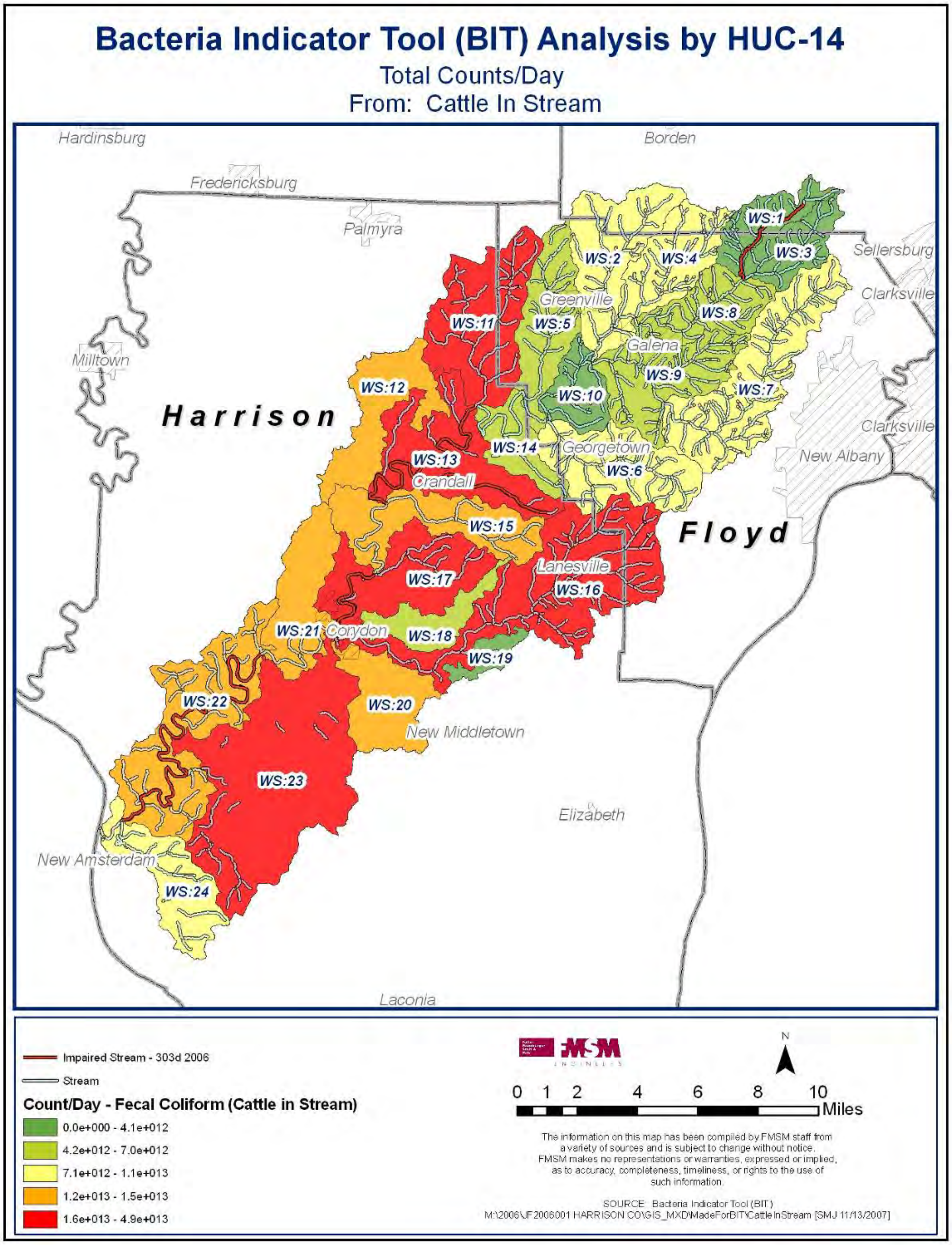

Figure 2.5. BIT Results for Cattle in Streams

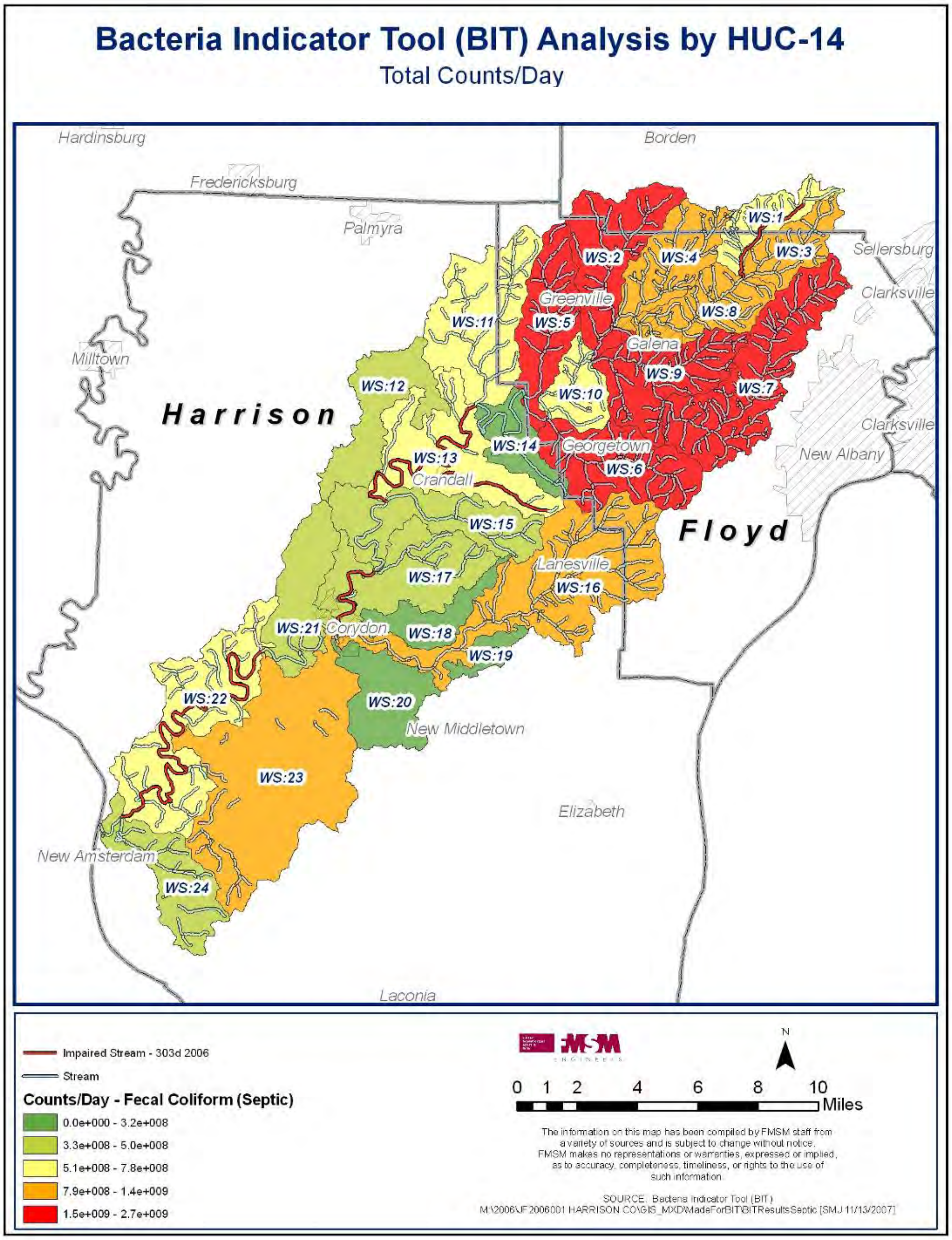

Figure 2.6. BIT Results for Septic Systems

Figures 2.7 and 2.8 below depict in-stream contribution of bacteria from septics and cattle in streams.

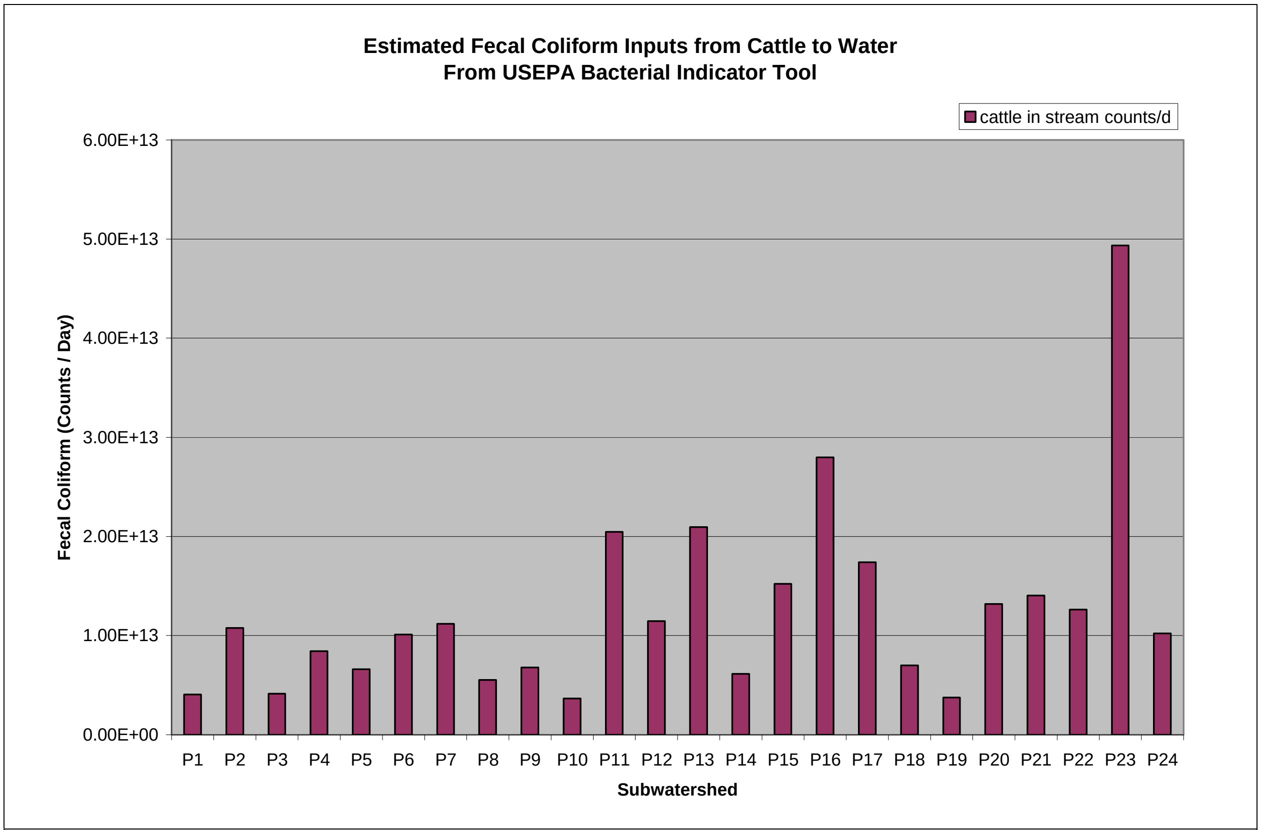

Figure 2.7. BIT Result for Cattle in Streams

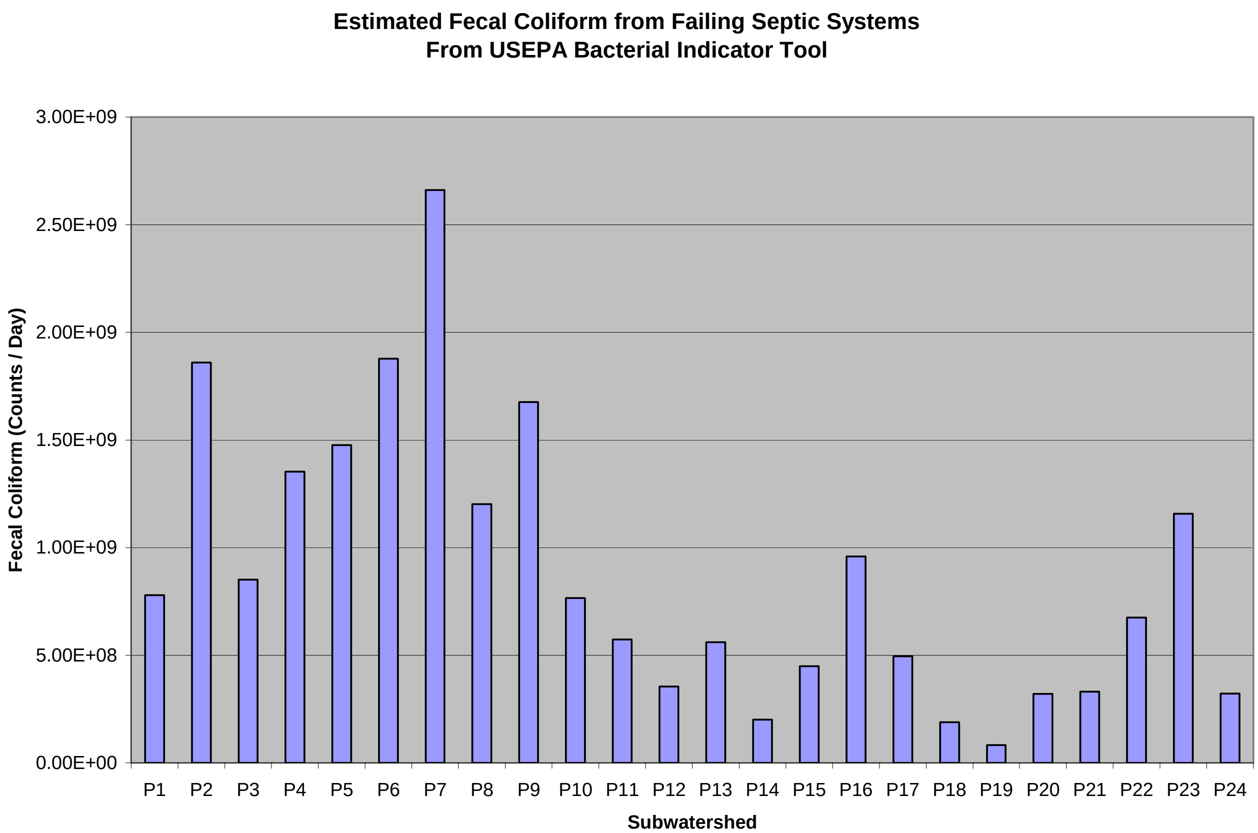

Figure 2.8. BIT Result for Septic Systems

2.6 CAUSES AND SOURCES OF WATER QUALITY PROBLEMS

Pollution sources may be categorized as point sources or nonpoint sources (NPS). Point source pollution refers to pollution that can be traced back to a specific, identifiable source, such as a pipe, ditch, or other outlet. Point sources include the following:

- Wastewater discharges, including large and small wastewater treatment plants.
- Stormwater discharges including regulated discharges from industrial activity and municipal separate storm sewer systems (MS4s).
- Discharges from Confined Feeding Operations (CFOs), and Concentrated Animal Feeding Operations (CAFOs).

As of February 2007, there were eighteen (18) NPDES-permitted facilities in the Indian Creek Watershed, and fifteen associated outfalls. Overall, facilities are in compliance with permit requirements. Only one facility has been in violation in since 1996, and that situation is being monitored in a manner satisfactory to IDEM (IDEM 2006). The Towns of Corydon and

Lanesville both operate publicly owned wastewater treatment plants that serve the community. There are several semi-public treatment plants or “package plants” that are used to treat sewage for subdivisions, schools, and other small facilities that are too far from a large WWTP to treat waste in a cost-effective manner. Several private plants are also in operation, including two that provide pretreatment before releasing waste to the Corydon Municipal STP. One facility is State-owned, and is the only facility which has been in violation of its permits. NPDES facilities are illustrated in **Appendix 2.2** and shown in the table below.

Table 2.17. NPDES Facilities in Indian Creek Watershed

Permit Number	Facility Name	Facility Type	City	County	Receiving Water or Facility
IN0020893	Corydon Municipal STP	Public	Corydon	Harrison	Indian Creek
IN0031178	Galena Elementary and Floyd Central High Schools	Semi-Public	Floyds Knobs	Floyd	Little Indian Creek
IN0038385	Dairy Dip Car Wash	Private	New Salisbury	Harrison	Indian Creek
IN0040215	Lanesville Municipal STP	Public	Lanesville	Harrison	Little Indian Creek
IN0043923	Wymberly Woods Utilities	Semi-Public	Floyds Knobs	Floyd	Yellow Fork to Little Indian Creek
IN0045942	Lanesville Welcome Center I-64	State	Lanesville	Harrison	Lazy Creek to Indian Creek
IN0050032	Highlander Point Shopping Center	Semi-Public	Floyds Knobs	Floyd	Unnamed tributary to Little Indian Creek
IN0050181	Chimneywood Sewage Works	Semi-Public	Clarksville	Floyd	Unnamed tributary to Little Indian Creek
IN0052019	Highlander Village Subdivision	Semi-Public	Galena	Floyd	Unnamed tributary to Little Indian Creek
IN0052159	Country View Subdivision	Semi-Public	Floyds Knobs	Floyd	Yellow Fork to Little Indian Creek
IN0054101	Deerwood Environmental	Semi-Public	Floyds Knobs	Floyd	Little Indian Creek
IN0055794	Huber Family Restaurant	Semi-Public	Borden	Clark	Unnamed Tributary to Thompson Creek to Indian Creek
IN0058564	Greenville Elementary School	Semi-Public	Greenville	Floyd	Richland Creek to Indian Creek
IN0058572	Floyds Knobs Elementary School	Semi-Public	Floyds Knobs	Floyd	Little Indian Creek
IN0059382	Jacobi’s Car Wash and Store	Private	Galena	Floyd	Ditch to Little Indian Creek
IN0059803	Clean Car Auto Wash Corp.	Private	Floyds Knobs	Floyd	Ditch to Little Indian Creek
INP000117	Tyson Foods, Inc.	Private	Corydon	Harrison	Corydon Municipal STP
INP000153	Daramic Incorporated	Private	Corydon	Harrison	Corydon Municipal STP

Source: IDEM OWQ, 2002.

Nonpoint sources are indirect and diffuse. They can include:

- Stormwater runoff from unregulated communities or lands
- Failing septic systems
- Contaminated groundwater discharges to streams
- Air deposition.

Land uses in the Indian Creek Watershed are quickly changing as development spreads from the Louisville Metro area. The I-64 corridor is undergoing rapid expansion and previously fallow or agricultural land is being converted for residential, commercial, and industrial uses.

With increasing development comes an increase in impervious area or hard surfaces, which prevents rainwater absorption into the soil. Greater impervious area also means that the volume of stormwater runoff generated will increase, and that the runoff will be exposed to more pollutants before it enters a stream – including oil and grease form parking lots and roadways, nutrients from over-fertilized lawns, bacteria from pet wastes, and other chemicals related to household wastes. An increase in the volume and velocities of water transported to streams is also likely and can lead to erosion and streambank failure.

2.6.1 Causes and Sources of Recreational Use Impairments

Recreational designated use impairments are caused by elevated bacteria (E. coli). In the Indian Creek Watershed, 36.7 miles (four segments) are impaired by bacteria. This issue is common in Indiana and throughout the United States.

E. coli is generally used as an indicator of harmful bacteria loading because it is easier and less expensive to monitor than pathogenic organisms, and it is derived solely from the intestinal tract of warm-blooded animals. Fecal coliform bacteria are present in soil as well as in animals.

Indiana water quality standards require that the geometric mean of five (5) E. coli samples collected in a thirty (30)-day period should not exceed 125 colony forming units (CFU) per 100 milliliters, and a single sample should not exceed 576 CFU per 100 milliliters.

IDEM sampled seven (7) sites for E. coli bacteria in 2000 and 2005. Six (6) of the seven (7) sites did not meet the water quality criteria for E. coli. Concentrations of E. coli bacteria at all sites ranged from 20 CFU per 100 milliliters to 4,500 CFU per 100 milliliters. Geometric mean concentrations ranged from 128 to 423 CFU per 100 milliliters and single sample maximum concentrations ranged from 180 to 4,500 CFU per 100 milliliters. IDEM bacteria data are summarized in **Appendix 2.1**.

Possible sources of elevated bacteria may include human sources such as wastewater treatment plants that are not in compliance with disinfection requirements, failing septic systems, and straight pipes. Animal sources include pets, wildlife, and livestock. It is important to note that pathogenic (i.e. disease causing) organisms occur in both human and animal wastes. Available data and information related to each of these sources is discussed below.

The following sources of bacteria were evaluated:

- **Direct**: Cattle in creek, straight pipes, non-compliant wastewater treatment plants, sanitary sewer overflows (SSO), stormwater discharges and dry weather discharges from the stormwater system which indicate illegal sanitary sewer connection or other illicit discharge to stormwater system.

- **Indirect**: Overland runoff from pastures, manure piles, pet waste, wildlife and failing septic systems.

Compliance at Regulated Facilities: IDEM provided effluent quality data for a recent 5-year interval, summarized in the table below. These data indicated that several regulated facilities in the watershed had E. coli violations, including the Woods of Lafayette (12), and Lanesville Welcome Center (8) had the most violations for E. coli. Sanitary sewer overflows have not been reported in the Indian Creek Watershed.

Table 2.18. National Pollution Discharge Elimination System (NPDES) Violations

Map Reference ID Number	NPDES Permit #	Facility Name	Total # of Violations (03/2002 - 02/2007)	# of E. coli Violations (03/2002 - 02/2007)	Most Recent E. Coli Violation (03/2002-02/2007)
1	IN0020893	Corydon Municipal WWTP	1	0	N/A
2	IN0031178	Galena Elem & Floyd Central HS	6	1	5/31/2006
3	IN0038385	Dairy Dip Car Wash	1	0	N/A
4	IN0040215	Lanesville Municipal STP	10	5	9/30/2006
5	IN0043923	Wymberly Sanitary Works, Inc	1	0	N/A
6	IN0045942	Lanesville Welcome Center I-64	81	8	5/31/2006
7	IN0050032	Highlander Point Shopping Cent	0	0	N/A
8	IN0050181	Chimneywood Sewage Works, Inc.	16	0	N/A
9	IN0052019	Galena WWTP	22	0	N/A
10	IN0052159	Country View Subdivision	1	0	N/A
11	IN0054101	Woods Of Lafayette's WWTP	46	12	6/30/2006
12	IN0055794	Huber Family Restaurant	37	0	N/A
13	IN0058564	Greenville Elementary School	55	0	N/A
14	IN0058572	Floyd Knobs Elementary School	15	0	N/A
15	IN0059382	Jacobi's Car Wash & Store	32	11	10/31/2002
16	IN0059803	Cleancar Auto Wash Corp.	42	0	N/A
17	INP000117	Tyson Foods, Inc.	2	0	N/A
18	INP000153	Daramic Incorporated	7	0	N/A

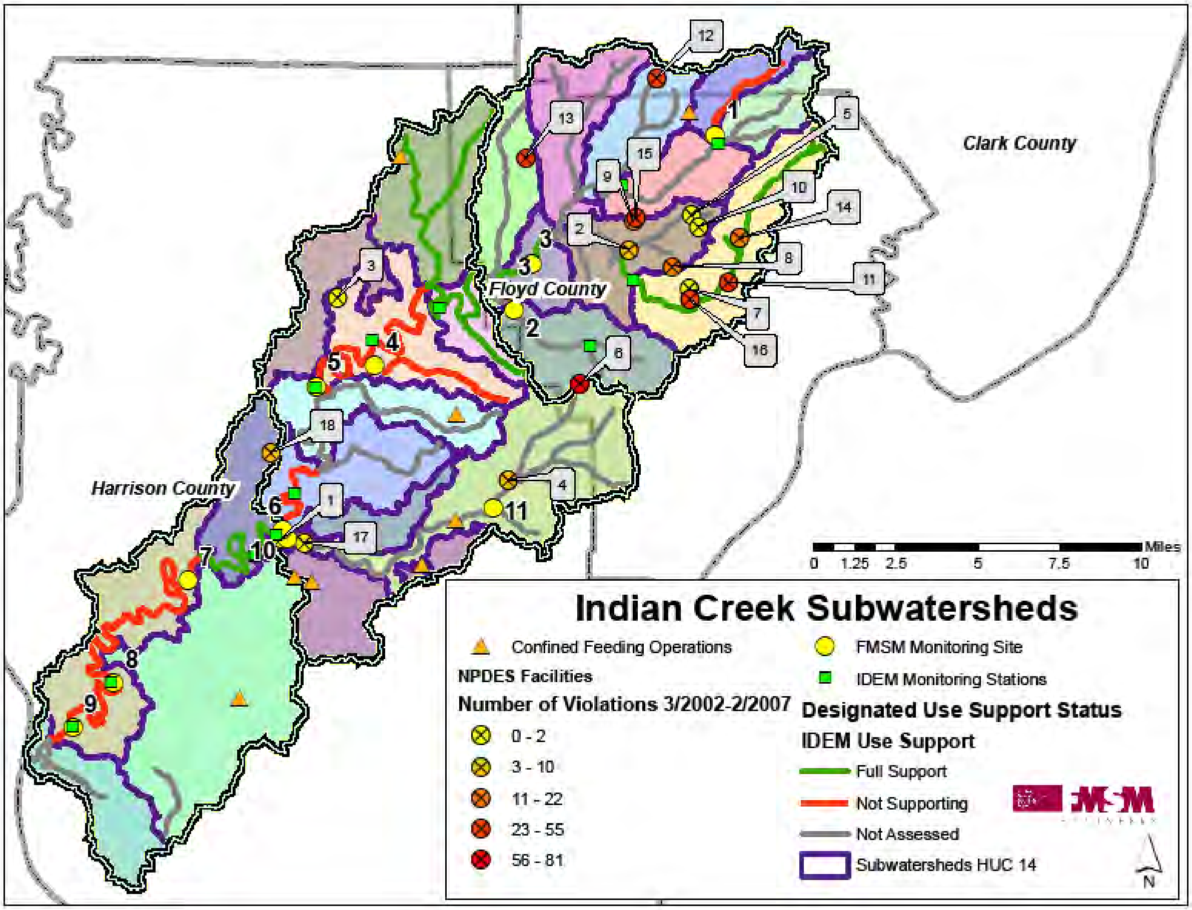

Figure 2.9. Indian Creek NPDES Facility Compliance

Stormwater: Stormwater runoff can carry oxygen consuming wastes, toxic substances, nutrients, sediment, and bacteria to area streams. It can also become contaminated by failing or inappropriately located septic systems. In order to control pollutants from stormwater systems, regulated communities are required to implement six minimum controls (MCMs), including:

1. Public education and outreach
2. Public participation and involvement
3. Illicit discharge detection and elimination
4. Construction site runoff controls
5. Post-construction stormwater management
6. Municipal operations pollution prevention and good housekeeping

Communities regulated in the Stormwater Program are required to adopt ordinances to control runoff from construction sites, post construction sites, and illicit discharges. Ordinances to control runoff associated with construction are an important tool to control sediment. Illicit discharge ordinances are an important control for bacteria and other wastewater pollutants. These ordinances require communities to identify and eliminate non-stormwater discharges into the stormwater system.

Currently, Floyd County is regulated under this program and is in its third year of implementing the first stormwater permit. Among other accomplishments, Floyd County had mapped 64,940 feet (13.2 miles) of stormwater conveyance, and 540 stormwater outfalls as of December 2007. All outfalls had been screened for illicit discharges, and one possible illicit discharge had been detected. The possible illicit discharge, associated with a potentially failing septic system, is being investigated. Harrison County is currently not regulated by the Stormwater Program, but is developing a comprehensive stormwater ordinance.

Septic Systems and Straight Pipes: Septic systems are very common in the Indian Creek Watershed, even though soil conditions are not ideal for their use. Thirty-one percent (31%) of 29,087 households in Floyd County use septic systems. Eighty percent (80%) of Harrison County's 12,917 households use septic systems as per the Hoosier Environmental Council's Watershed Restoration Toolkit. Thus, there are approximately 9,000 septic systems in Floyd Count and approximately 10,000 septic systems in Harrison County. Data to support this analysis on a watershed basis were not available. Additional information is provided in Chapter 1.4.

Although septic systems work best on large lots with deep permeable soils, there are a variety of system designs available that can overcome some of the obstacles that are encountered on less than ideal sites. However, poor sitting design, installation or maintenance of septic systems can result in surface ponding in yards, polluted groundwater, and impacted streams and wells. Systems may also be "straight-piped" or discharged directly to a stream, which is illegal in the State of Indiana (327 IAC 5-1-1.5).

Concern regarding failing septic systems was documented in the Harrison County Stormwater and Wastewater Feasibility Study (Harrison County, 2003), which indicated that up to 70% of the septic systems in Harrison County are "functioning improperly" (Harrison County, 2003). Discussions with staff of both the Floyd and Harrison County Health Departments indicated that septic systems are a significant problem. In the highly karst terrain in the southern portion of this watershed, septic system failures may go undetected because effluent is transported to underground channels rather than surfacing.

Failing septic systems may be a major source of E. coli pollution in the watershed and they can also contribute phosphate, phosphorus and nitrogen as ammonia or nitrate. However, as discussed in subsequent sections, nutrient problems were not widespread.
Harrison County Health Department has begun to compile complaints and other information regarding septic system issues. Municipalities routinely respond to reports of, and inspect for, illicit connections and failing systems. There is interest in identifying resources to further investigate the condition and failure rate of septic systems in this watershed and developing a series of strategies to address the issue. The number of straight pipes in the watershed is currently unknown.

Animal Sources: As of June 2004, six (6) Confined Feeding Operations and one (1) Confined Animal Feeding Operation were regulated by IDEM in the Indian Creek Watershed.

Indiana law defines a Confined Feeding Operation (CFO) as any animal feeding operation engaged in the confined feeding of at least 300 cattle, or 600 swine or sheep, or 30,000 fowl, such as chickens, turkeys or other poultry.

Confined animal feeding operations (CAFO) are defined as:

- 700 mature dairy cows
- 1,000 veal calves
- 1,000 cattle other than mature dairy cows
- 2,500 swine above 55 pounds
- 10,000 swine less than 55 pounds
- 500 horses
- 10,000 sheep or lambs
- 55,000 turkeys
- 30,000 laying hens or broilers with a liquid manure handling system
- 125,000 broilers with a solid manure handling system
- 82,000 laying hens with a solid manure handling system
- 30,000 ducks with a solid manure handling system
- 5,000 ducks with a liquid manure handling system

Compliance data provided by IDEM indicated that the one CAFO facility, Tyson Foods, was regulated for bacteria, and that this facility was in compliance with bacteria limits during the last 5 years, see **Table 2.11**.

The USDA National Agricultural Statistics Service provides livestock census data by county. Data for Clark, Floyd and Harrison Counties are summarized in the table below. (http://www.nass.usda.gov/QuickStats/Create_County_Indv.jsp).

Table 2.19. Livestock, Poultry and Farms in Clark, Floyd, and Harrison Counties

	Cattle		Hogs		Horses		Poultry	
	Head	Farms	Head	Farms	Head	Farms	Head	Farms
Clark	10,972	288	2,288	18	865	144	84	29
Floyd	2,621	135	70	7	598	103	162	10
Harrison	19,640	607	3,184	30	1522	279	1,122,449	52
Total	33,233	1,030	5,542	55	2985	526	1,122,695	91

Source: ISDA DSC, 2004.

Clark and Floyd County have developed illicit discharge ordinances which prohibit non-stormwater discharges into the stormwater system, including the improper disposal of animal waste; Harrison County is in the process of developing a comprehensive stormwater ordinance which addresses prohibited discharges.

2.6.2 Causes and Sources of Aquatic Life Impairments: Low Dissolved Oxygen

The State water quality criteria for dissolved oxygen (DO) requires concentrations of at least five (5) milligrams per liter per calendar day average and at least four (4) milligrams per liter in any sample (327 IAC 6(b)(3)).

Eleven (11) of twelve sites monitored for DO by IDEM in the Indian Creek Watershed had acceptable levels of DO. Five DO samples were collected at Indian Creek at Lickford Bridge Road (Site OBS100-006) in July and August of 2000. Four of the 5 samples were below 5 milligrams per liter, with concentrations ranging from 2.5 to 7.8 milligrams per liter (mg/l), average 4.3 mg/l DO. As a result, IDEM listed one (1) stream segment, Devil's Backbone (17.2 miles), as impaired for DO in 2006. Data collected upstream at Indian Creek at Rocky Hollow Road (OBS100-001) indicated acceptable levels of DO. These data are summarized in **Appendix 2.1**.

Low DO may be caused by "organic enrichment" and/or low flow or stagnant water. Organic enrichment refers to elevated nutrients and pH, algal blooms, and oxygen depletion. Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, periphyton attached algae, and nuisance plants weeds). This enhanced plant growth, often called an algal bloom, reduces dissolved oxygen in the water when dead plant material decomposes and may cause other organisms to die.

Nutrient data were not collected by IDEM at the Indian Creek at Lickford Bridge Road (Site OBS100-006). However nutrient data collected by IDEM at Indian Creek at Rocky Hollow Road (OBS100-001) indicated very low levels of total phosphorus (maximum concentration of 0.063 mg/l) and nitrate (0.005 mg/l). A watershed survey did not indicate watershed sources of nutrients between these sites.

Therefore, the low DO levels may be attributed to low flow and backwater from the Ohio River. Backwater is introduced into the lower reaches of the watershed when the water surface elevation of the Ohio River is higher than the water surface elevation of Indian Creek. Ohio River water enters the lower reaches of Indian Creek and greatly reduces or stops flow in Indian Creek. "Losing streams" may also contribute to low DO. Segments of Indian Creek are considered "losing streams" and a portion of their flow is diverted into underground karst features. This may result in low flow and stagnant water near karst features.

2.6.3 Causes and Sources of Aquatic Life Impairments: Aquatic Habitat

IDEM monitored fish communities and habitat using the Index of Biotic Integrity (IBI) and Qualitative Habitat Evaluation Index (QHEI) at four locations in the Indian Creek Watershed. Three sites on the Indian Creek mainstem were not impaired. One site, on Little Indian Creek (Site OBS080-001), was identified as impaired. IBI scores of less than 36 are considered impaired and this site had a score of 24. This location, Little Indian Creek North (INN0482_00) was listed on the 303d list for Aquatic Life Impairments (3.87 miles) based on this fish community assessment. Results are summarized in the following table.

Table 2.20. Fish Community and Habitat Data Summary

Site #	Location	Fish Community IBI Score	Habitat Score (of 100)
OBS080-0001	Little Indian Creek at Banet Road	24 Impaired	57
OBS080-0008	Indian Creek at Navilleton Road	38 Full Support	48
OBS090-0002	Indian Creek at Southern Railroad	54 Full Support	59
OBS090-0002	Indian Creek at Landmark Way	50 Full Support	92

Source: IDEM, 2006.

The quality of the aquatic community may be affected by numerous factors, including water quality, habitat and climatic conditions (e.g., drought, flood). The IBI score has been calibrated to address the influences of ecoregion and drainage area. The watershed of the impaired site is relatively small (4.7 square miles). The watershed draining to this location is primarily agriculture and forestry.

Fish species such as darters and smallmouth bass, which indicate good water quality, were present at this site. IDEM collected water quality data at the time of sampling and during the summer of 2000. Dissolved oxygen was at levels that are supportive of aquatic life (>8 mg/l for all samples), pH was within criteria limits (between 7.5 and 8.2 pH units) and nutrients were low (total phosphorus less than 0.08 mg/l and nitrate less than 0.9 mg/l). Specific conductivity was 240 us/cm, temperature was 20.5 C and turbidity was 6.6 NTU. These fish community and water quality data indicate that water quality around the time of sampling was within acceptable ranges and may not be a significant contributor to the impairment.

The habitat at Little Indian Creek at Banet Road (IDEM Site OBS080-0001) was suboptimal. The following in-stream habitat scores were given:

- Substrate Score – 13 (20 maximum)
- Instream Cover Score – 7 (20 maximum)
- Channel Morphology – 12 (20 maximum)
- Riparian Zone & Bank Erosion Score – 6 (10 maximum)
- Pool/Glide Quality Score – 4 (12 maximum)
- Riffle/Run Score Quality – 5 (8 maximum)
- Gradient Score – 10 (10 maximum)
- **Total habitat score – 57 (100 maximum)**

These scores indicate that in-stream cover, pool/glide quality, riparian zone/ bank erosion and channel morphology were less than ideal.

2.6.4 Causes and Sources of Fish Consumption Impairments

The fish consumption advisories, applied to waterbodies in the Indian Creek Watershed, are caused by elevated mercury and polychlorinated biphenyls (PCBs) contamination.

Mercury: Mercury is a naturally occurring metal. Elemental mercury is a liquid that occurs in some ore deposits. It may also be concentrated around hot springs. The health hazards of mercury exposure depend on the form of mercury to which an individual is exposed. The greatest health hazards have been attributed to exposure to methylmercury. Methylmercury is highly soluble in water and is concentrated in fish and shellfish. Species higher on the food chain typically bioaccumulate more mercury throughout their lifespan. Consumption of fish containing high levels of methylmercury can lead to health concerns especially for women and small children. Chronic mercury exposure can result in mood swings and severe nervous disorders. Both short-term and long-term exposure to high mercury levels has been found to cause kidney damage.

There is no evidence of local pollution from mercury such due to contaminated sites and industries, such as metal-refining operations. Therefore, the largest likely contributor to mercury contamination regionally is the combustion of fossil fuels. USEPA is currently implementing additional regulations to control emissions from coal-fired power plants. The goal is to reduce mercury and other air-pollutants in the long term.

Polychlorinated Biphenyls (PCBs): PCBs are man-made chemicals that were once manufactured and widely used for their physical properties, including heat resistance, non-flammability, electrical conductance, and chemical stability. These substances were used in a wide variety of applications, including plastics, paints, and electrical equipment. In the 1960s and 1970s, PCBs were discovered to be less chemically stable than previously thought through their detection in streams and wildlife. Because of concerns over health effects associated with PCBs, including reproductive and immune system disorders and cancer, PCBs were banned by Congress in 1976 through the Toxic Substances Control Act (USEPA 2006). Although the Indian Creek Watershed had no streams identified by IDEM as contaminated for PCBs, there is a statewide fish consumption advisory for carp greater than 15 inches in length.

2.6.5 Other Water Quality Concerns: Nutrients and Solids

Nutrients: The major nutrients of concern for stream systems are phosphorus and nitrogen. Phosphorus and nitrogen are found in commercial fertilizers, manure, and other crop production enhancers, as well as in human waste. These nutrients are found naturally in streams and are required for a healthy aquatic ecosystem. However, excess nutrients can lead to eutrophication, excessive algae growth contributing to decreased levels of dissolved oxygen. In extreme cases, fish kills can result. Elevated nutrients are most detrimental during periods of high temperature and low flow conditions.

Indiana’s has not yet established eutrophication criteria for nitrate; the threshold for for nitrate at potable water supply intakes is 10 mg/L. However, a concentration of 5 mg/l nitrate was used for planning purposes in this watershed to provide an “early warning system” for elevated nitrates. While the State has not set a criterion for phosphorus, levels greater than, or equal to, 0.3 mg/L are used by IDEM to indicate eutrophication. Monitoring results, criteria and comparison values are shown in **Table 2.21.**

Table 2.21. Nutrient Data Summary

Characteristic Name	Units	# Results	Minimum Value	Average Value	Maximum Value	Criteria or Comparison Value
Nitrogen - nitrate+nitrite	mg/L	56	0.1	0.8	**5.9**	5
Total Kjeldahl Nitrogen	mg/L	66	0.1	0.6	1.5	5
Orthophosphate	mg/L	65	0.03	0.1	**2.15**	0.3
Phosphorus, total	mg/L	66	0.03	0.1	**2.88**	0,3
Solids, total	mg/L	65	**162**	**284.1**	**475**	261
Turbidity	NTU	62	1.13	12.7	**80.2**	25
Stream Flow	ft/sec	101	-0.72	1.1	28.3	-
Dissolved oxygen (DO)	mg/L	63	**0.08**	7.8	**16.2**	**4.0 mg/l minimum;** Maximum < 12

Elevated concentrations of nitrate, total phosphorus and orthophosphate wree found at Site 11. Little Indian Creek below Lanesville at State Road 62, a previously unassessed reach. This site is located downstream of Lanesville and the Lanesville WWTP.

Total solids were also found to be elevated. Since most of the samples were collected during warm weather and low flow conditions, these total solids concentrations may be associated with algal activity.

The Office of the Indiana State Chemist (OISC) publishes fertilizer data annually, including the tonnage sold. **Table 2.22.** provides an estimate of the fertilizer sales, and thus potentially used, in the Indian Creek Watershed based on 2005 OISC data.

Table 2.22. Estimate of 2005 Nutrient Applications in the Indian Creek Watershed

County	% County in ICW	X	Total Nutrients (tons)		X 2,000 lbs/ton	Nutrients in IWC (lbs)	
			N	P2O5		N	P2O5
Clark	2.8%	X	5646.3	6950.1	X 2000	158	194
Floyd	58.0%	X	190.5	108.7	X 2000	220,934	126,150
Harrison	32.9%	X	3588.9	2117.0	X 2000	2,361,529	1,392,979
Total						**2,582,621**	**1,519,323**

Source: OISC, 2005.

However, agricultural practices are in place to reduce nutrient, pesticide, and sediment runoff from corn and soybeans, as shown in the following tables.

Table 2.23. Conservation Tillage in Indian Creek Watershed, Corn

County	No-Till		Mulch-Till		Reduced Till		Conventional		County Rank for % No-Till
	Acres	%	Acres	%	Acres	%	Acres	%	
Clark	9,773	63	455	3	682	4	4,546	30	8
Floyd	1,176	79	0	0	0	0	321	21	2
Harrison	20,716	88	0	0	600	3	2,102	9	1
Total	31,655	79	455	1	1,282	3	6,969	17	

Source: ISDA DSC, 2004.
Note: There are 89 counties in Indiana

Table 2.24. Conservation Tillage in Indian Creek Watershed, Soybeans

County	No-Till		Mulch-Till		Reduced Till		Conventional		County Rank for % No-Till
	Acres	%	Acres	%	Acres	%	Acres	%	
Clark	15,683	73	0	0	682	3	3,637	18	14
Floyd	1,711	70	0	0	214	9	535	22	28
Harrison	15,312	93	0	0	901	5	300	2	1
Total	**32,706**	**84**	**0**	**0**	**1,797**	**5**	**4,472**	**11**	

Source: ISDA DSC, 2004.
Note: There are 89 counties in Indiana

Evidence of the success of conservation tillage in reducing chemical transport to streams is documented in the following table**.** USGS, under cooperative agreement with IDEM, monitored 149 organic chemicals in the Indian Creek near Galena (Site OBS080-004) in 2000. The following levels were detected (all were very low):

Table 2.25. Pesticides Detected in Indian Creek Watershed

Parameter	Concentration (parts per billion)
Bromacil (ug/L)	0.1
Malathion (ug/L)	0.1
Metolachlor (ug/L)	0.2
Oxadiazon (ug/L)	1.1
Simazine (ug/L)	0.08

Source: IDEM, 2006.

Clark and Floyd County have developed illicit discharge ordinances which prohibit the improper disposal of fertilizers; Harrison County is in the process of developing a similar comprehensive stormwater ordinance.

2.7 TARGET LOAD REDUCTIONS

In order to determine the overall effectiveness of recommended management measures identified in this plan, it is important to have an understanding of the target loads that result in meeting surface water quality criteria and existing pollutant loads in the watershed. Because concentrations in the impaired subwatersheds varied significantly, the target load reductions were calculated separatel for the monitored tributary subwatersheds and also for the two impaired locations on the Indian Creek mainstem. Target loads were calculated as follows:

- Research the average annual flow USGS Gaging Station 03302500 Indian Creek at State Road 335 (44.5 cubic feet per second, cfs; Drainage Area 129 square miles, 0.34 cfs/ sq.mi.)

- Where water quality criteria were not met, use water quality criteria and average monitored concentrations of bacteria from this study to estimate target loads at the water quality standard and pollutant loads for the portion of the watershed above Corydon.

Table 2.26. E.Coli Load Reduction Target Summary

Load Paramter	Site 2. Georgetown Creek above Indian Creek	Site 3. Indian Creek above Georgetown Creek	Site 4. Crandall Branch above Indian Creek	Site 5. Indian Creek below Crandall Branch
Drainage Area (sq. mi)	11.3	78.75	13.7	129
Flow-Yield (cfs/sq.mi)	0.34	0.34	0.34	0.34
Average Flow (cfs)	3.9	27	4.7	44.3
Target Average Concentration (cfu/100 ml)	125	125	125	125
Target Load (cfu/yr)	4.3 E+12	3.0 E+13	5.3 E+12	4.9 E+13
Average Concentration (cfu/100 ml)	194	147.2	779.2	268.8 cfu/100 ml
Estimated Existing Load (cfu/yr)	6.7 E+12	3.5 E+13	3.3 E+13	1.1 E+14
Estimated Load Reduction (cfu/yr)	2.4 E+12	5.4 E+12	2.8 E+13	5.7 E+13
% Load Reduction	35.5%	15.1%	84.5%	53.4%

Notes: Site 2: Georgetown Creek below Georgetown at Malinee Ott Road
Site 3: Indian Creek above Georgetown Creek, IDEM Site OBS080-0005
Site 4: Crandall Branch above SR335 Bridge
Site 5: Indian Creek above SR355 Bridge, IDEM Site OBS090-0004

The Bacterial Indicator Tool results provide insight into potential sources of bacteria in each of these subwatersheds. Results for subwatersheds above the monitoring sites were summed to develop the table below.

Table 2.27. Bacterial Loads for Target Subwatersheds

Parameter	Site 2. Georgetown Creek above Indian Creek	Site 3. Indian Creek above Georgetown Creek	Site 4. Crandall Branch above Indian Creek	Site 5. Indian Creek below Crandall Branch
Subwatersheds **(1)**	6	1-10	13	1-11, 13-14
Acres	7,240	55,907	8,803	76,847
Forest (FC/d)	1.62 E10	1.70 E11	3.22 E10	2.43 E11
Built (FC/d)	1.35 E10	4.41 E10	2.37 E9	4.69 E10
Crop (FC/d)	3.73 E12	3.03 E13	9.62 E13	5.90 E13
Pasture (FC/d)	2.44 E13	1.71 E14	4.72 E13	2.91 E14
Cattle in Stream (FC/d)	1.01 E13	7.12 E13	2.1 E13	1.19 E14
Failing Septics (FC/d)	1.88 E9	1.45 E10	5.61 E8	1.58 E10
Bacteria Yield (FC/D/Ac)	**5.29 E9**	**4.89 E9**	**8.85 E9**	**6.10 E9**

(1) Subwatersheds are shown in Table 2.16.

This table shows that bacteria from pasture and cattle in streams are likely to be important contributors to elevated bacteria in these subwatersheds. Although the bacterial contribution from failing septic systems is less than agricultural sources, exposure to pathogens from human sewage can pose a significant public health risk. Therefore, strategies that reduce bacteria from pastures, cattle in streams and septic system sources are considered to be priorities.

The per unit benefits of strategies to address these sources is summarized in the table below, based on estimates derived from the Bacterial Indicator Tool. As shown below, the anticipated load reduction from removing a single failing septic system from the watershed is 6.89 E7 FC/day. The anticipated load reduction from removing cattle from streams is 1.03 E11 FC/day per animal (assuming beef cattle). These per unit load reduction benefit values can be used to estimate the benefits of strategies as they are implmented.

Table 2.28. Load Reduction Benefits

Bacterial Source	Load Reduction Benefit
Failing Septic System	6.89 E7 FC/day/septic
Pasture	1.04 E11 FC/day/animal unit (beef cattle)
Cattle in Stream	1.03 E11 FC/day/animal unit (beef cattle)

Another important consideration for watershed improvement and watershed protection is the status of riparian areas. Healthy riparian areas serve numerous important functions:

- Reduce pollutant loads from overland runoff (bacteria, nutrients, sediment)
- Protect streambanks from erosion during high flows
- Habitat for wetland, semi-aquatic and aquatic species of plants and animals
- Shade streams, which can improve water quality during summer low –flow conditions

The status of riparian buffers in the Indian Creek watershed was estimated using the 2001 Land Cover for Indiana (USGS, 2001). A 6-meter buffer on each side of the stream was generated using GIS. Land use within that buffer is shown in Table 2.29 below. This 6-meter width was chosen because studies have shown that buffers of approximately 20 feet on each side of the stream can provide significant benefits. For example, a 75% reduction in bacteria using a 20 foot buffer was reported in "Efficacy and Economics of Riparian Buffers on Agricultural Lands" (J. Pizzimenti, 2002). Specific strategies for buffers are included in Chapter 3.

Table 2.29. Land Use Along Indian Creek Watershed Streams

Land Use	Buffer Area (Acres)	Percent
Deciduous Forest	332.08	39.7%
Evergreen Forest	9.70	1.2%
Mixed Forest	3.08	0.4%
Woody Wetland	18.95	2.3%
Emergent/Herbaceous Wetland	0.02	0.002%
	363.83	43.60%
Pasture/ Hay	322.66	38.6%
Row Crop	120.51	14.4%
Urban/Recreational Grasses	0.68	0.1%
Residential	17.97	2.2%
Mixed Urban Built-Up	3.10	0.4%
Transitional	0.05	0.01%
Open Water	7.13	0.9%
Total	**835.93**	**100.0%**

Some important considerations and opportunities arise from this analysis. Key findings are:

- With about 40% of the stream buffer areas in forest and wetland, there are significant conservation opportunities in this watershed. Maintaining these existing buffers, and re-establishing wetland buffers will help to keep this watershed intact as the area grows. This makes good economic sense because numerous studies have shown that property values are at a premium near high quality environmental features such as well-buffered, good quality streams.

- With over 50% of the stream buffer areas in agricultural uses, there are opportunities for expanding efforts to encourage farmers to establish and maintain health riparian buffers. Economic considerations are very important for the success of this practice. At a public meeting for this waterhsed plan, several farmers reported that buffer payments from agricultural agencies are not keeping pace with premiums for ethanol producing crops (e.g., corn). Drought, such as the one experienced in 2007, also results in farmers relying more on riparian areas for grazing.

It is also important to note that the USGS Landcover data provides a statewide estimate of landcover, but does not provide data on farm-specific practices.

2.8 ADDRESSING DATA GAPS: PILOT SINKHOLE INVENTORY

As discussed in Chapter 1, the geology of the Indian Creek Watershed is highly prone to development of karst features such as sinkholes, springs and caves. However, site specific data on sinkhole locations were not readily available. Sinkhole locations are an important consideration in watershed management because pollutants can be rapidly transported to groundwater systems without the benefit of soil filtration. Issues such as septic system failure may be masked because inadequately treated sewage can be transported downward into underground channels rather than surfacing, as occurs in non-karst systems.

Sinkholes that have been modified to change the flow of stormwater to the karst system are regulated under the USEPA's Underground Injection Control (UIC) program. This program is designed to protect drinking water supplies. The owners of modified sinkholes are required to provide an inventory form to USEPA. USEPA utilizes the inventory as needed to evaluate potential sources of drinking water contamination. If a discharge to a sinkhole contributes to contamination of a potable water supply, USEPA utilizes this program and requires the discharge to be treated or redirected. Additional information regarding the UIC program can be found at this website: http://www.epa.gov/safewater/uic/.

Through this watershed project, a pilot method was initiated to inventory sinkholes in the watershed using GIS analysis. The inventory consisted of compiling existing data, advanced analysis of GIS data, aerial review, field verification, and statistical analysis. These steps are described below.

The final product for the Indian Creek Watershed Pilot Sinkhole Inventory was a shapefile and Federal Geographic Data Committee (FGDC) standard metadata of GIS-predicted sinkholes. Existing data from Harrison County and the Lanesville Corridor project, as well as field inventory data collected in this project were included.

2.8.1 Existing Data

Harrison County Engineers Office: Eighteen sinkholes have been improved upon by Harrison County. The Harrison County Engineer supplied a shapefile of the locations of 18 visually plotted sinkholes (April, 2007). Eight (8) of these sinkholes lay within the Indian Creek Watershed boundaries.

Lanesville Corridor Project: FMSM conducted a project for Harrison County to evaluate routes for the proposed corridor connecting Interstate 64 and State Route 64 near Lanesville. As part of the geotechnical exploration, a field inventory of sinkholes along the proposed corridor routes was identified. Nine (9) sinkholes in the Indian Creek Watershed were mapped using GPS in this project.

Indiana Geological Survey: The Indiana Geological Survey (IGS) website was queried and the office was contacted. IGS provided a GIS shapefile of sinking stream basins and sinkhole basins. This dataset provided a general indication of the types of karst features in the Indian Creek Watershed, but did not contain specific sinkhole locations. IGS data and additional information on karst systems are available at this website: http://igs.indiana.edu/

2.8.2 Advanced Analysis of GIS Data

Sinkholes are typically characterized by bowl-shaped depressions in the earth to which water drains. In topographic data, sinkholes are represented by closed contour depressions. GIS software was used to identify closed contour depressions in contour data generated from LIDAR data. The centroid of the closed contour depression was identified using GIS data to create point locations for possible sinkholes.

Harrison County: Harrison County provided 2 foot and 4 foot contours that they generated from LIDAR data. To generate GIS locations of possible sinkholes further geoprocessing to identify the centroid of closed-depression contours was conducted. This analysis produced 14,687 possible sinkhole locations in the Harrison County region of the Indian Creek Watershed.

Floyd and Clark Counties: The USGS Kentucky Water Science Center is conducting the regional Karst Hydrology Initiative project. This multi-year effort included advanced analysis of digital elevation model (DEM) data to identify possible sinkholes. Additional information regarding the Karst Hydrology Initiative project is available at the following website: http://ky.water.usgs.gov/projects/cjt_karst/index.htm

In the Floyd and Clark County portions of the Indian Creek Watershed, the resolution of the available DEM was 10-meter (~30 feet) and 30-meter (~90 feet). USGS Kentucky Water Science Center processed DEM data in a manner similar to that described above to obtain the center of 163 closed contour depressions in the Floyd and Clark County portions of the watershed. USGS provided draft data and metadata for use in this project.

Table 2.30. GIS-Derived Sinkhole Data Summary

Data Source	Number of Closed Depression Contours Identified
Harrison County Engineers Office	8
Lanesville Corridor Project	9
Harrison County LIDAR Data	14,688
USGS Karst Hydrology Initiative	163
Total	**14,868**

2.8.3 Aerial Photography Review

Sinkholes are not the only closed contour depressions found in a typical topography. Other natural and man-made depressions are also present in most areas, including drainage features, ponds and quarries. The occurrence of non-sinkhole closed depression contours leads to over-estimation of the number of sinkholes and incorrect locations.

Conversely, identification of sinkholes in forested areas, steep terrain, and newly formed sinks may be precluded, potentially leading to under-estimation. However, despite these limitations, this dataset provides some initial planning level information regarding the potential for sinkhole locations.

A review of high resolution aerial photography was performed on a subset of the GIS-derived sinkholes to characterize the features as either probable sinkhole or probable non-sinkhole. Random sampling was used to select the GIS-derived sinkholes for aerial review.

The volume of stormwater is typically higher and the quality of stormwater is typically lower in developed areas, making sinkholes in urbanized areas of greater interest for the purposes of this watershed plan. In addition, implications for existing or new infrastructure and homes are potentially more significant and costly to manage in developed and developing areas. Therefore, USGS land use categories were used to classify the GIS-derived sinkholes into two groups: developed and undeveloped. As shown in the table below, below, 297 GIS-derived sinkholes were located in developed land uses; the remaining features were located in undeveloped land uses.

Table 2.31. GIS-Derived Sinkholes by Land Use

USGS Land Use Classification	GIS-Derived Sinkholes
Developed Land Subtotal	297
Undeveloped	14,569
Subtotal	**14,868**
Field Confirmed – Non-Sinkhole	-2
Total	**14,866**

Features were evaluated using aerial photography from the 2005 Statewide Orthophotography Project and classified as either probable sinkhole or probable non-sinkhole.

Table 2.32. Aerial Review Summary

Land Use Classification	Number of Probable Sinkholes	% of Probable Sinkholes	Number of Probable Non-Sinkholes	% of Probable Non-Sinkholes	# of GIS Derived Sinkholes Evaluated
Developed	138	50%	136	50%	274
Undeveloped	719	49%	750	51%	1,469
Total					**1,743**

2.8.4 Field Verification

Field verification using GPS was performed on 18 potential sinkholes. Of these, 2 sinkholes were confirmed non-sinkholes and removed from the final dataset.

The resulting GIS dataset, includes point locations of the 14,866 GIS-derived sinkholes with attribute fields that identify the source data (i.e., Harrison County Engineer's Office, Lanesville Project, Harrison County LIDAR, USGS Karst Hydrology Initiative), the aerial review status (yes/no), aerial review result (probable sinkhole/probable non-sinkhole), field review status (yes/no) and field review result (confirmed sinkhole/confirmed non-sinkhole). The GIS coverage and metadata are included with the CD that accompanies this watershed plan.

3.0 Goals, Decisions and Progress Measures

Setting realistic and measurable goals will contribute to the successful implementation of this Plan. A goal is the desired change or outcome as a result of the watershed planning effort. Depending on the magnitude of the problem, goals may be general, specific, long-term, or short-term. The IDEM suggests watershed groups focus on developing goals, management measures, action plans, resources, and legal matters as part of the watershed planning process.

According to the IDEM, management measures describe what needs to be controlled or changed in order to achieve the goal. The timeline or milestones to accomplish the individual management measure is identified in an action plan. In order to successfully implement the Plan, resources such as people, programs, and money need to be identified. It is important to have the support of individuals identified as resources to successfully execute the goals of the Plan. Successful implementation may require some legal matters such as obtaining permits, purchasing easements or the adoption of an ordinance (IDEM, 2002).

The watershed goals described in this chapter were formulated to directly address the water quality problems and their sources as were determined by the watershed inventory and assessment portion of this Plan which are summarized in Chapters 1 and 2. Information from stakeholders, reports, assessment tools, physical features, as well as in stream physical, chemical, and biological data were used to evaluate the current conditions of the Indian Creek Watershed and establish goals.

The current conditions have indicated three main issues - ***recreational use impairment***, ***aquatic life use impairment***, and ***flooding***. The causes of these problems are attributed to bacteria (E.Coli), low dissolved oxygen (DO), stormwater runoff, and disturbed habitat.

In the sections that follow, Action Plans for septic systems, agricultural areas, urban areas, karst and monitoring are provided. These Action Plans identify key actions needed to address the issues identified in the Indian Creek Watershed. Each action plan includes management measures, action plan strategies, resources and costs, legal matters and progress indicators. It is important to note that because strategies that reduce bacteria also provide nutrient reduction benefits, these goals and strategies were combined.

Local resources are intended to provide a list of local organizations that could potentially provide support, advice or consultation on a particular management measure. These lists are not intended to be comprehensive or to exclude other entities from participating in the development and/or implementation of a management measure. Lead agencies will vary with program directives, funding and staffing abilities and other organizations are encouraged to participate as available.

Proposed management measures are discussed and prioritized into High, Moderate and Low categories. It is recognized that each strategy is anticipated to provide some benefit. Prioritization considers a balance of anticipated benefits and ease of implementation, rather than a prescribed implementation of strategies in priority order. Adaptive implementation is likely to occur, such that if an opportunity and/or funding to implement a strategy becomes available, efforts on that strategy will be pursued. Estimated costs are shown in **Table 3.1**.

Table 3.1. Strategy Cost Estimates

Category	Estimated Cost
Low	Less than $10,000
Moderate	$10,000-$50,000
High	Greater than $50,000

Anticipated timeline dates in **Table 3.2** are provided as a reference for estimated start dates for management measure implementation.

Table 3.2. Priority Timeline

Category	Estimated Timeline
High	Within 2 years
Medium	Within 5 years
Low	Within 10 years

As a first step toward implementation, the Harrison County Regional Sewer District intends to identify and evaluate funding sources to support implementation of this watershed plan in 2008. Funding sources will be evaluated in terms of applicability to watershed priority strategies identified in the table below, funding availability and competitiveness, match requirements and other considerations. Based on these findings, one or more sources of funding may be sought to support appropriate aspects of watershed plan implementation. An initial list of potential sources to be evaluated is provided in **Appendix 3.1.** This list is not comprehensive or exclusive, and additional funding research will be conducted.

3.1 INDIAN CREEK WATERSHED PLAN AND PLANNED TMDLS

IDEM anticipates developing TMDLs the Indian Creek Watershed between 2017 and 2023. The NPS load reductions provided in this plan are initial estimates. IDEM is anticipated to conduct additional monitoring of the watershed prior to TMDL development, providing an updated snapshot of water quality conditions. The assessments and modeling conducted in support of TMDL development are anticipated to provide more refined estimates of point and nonpoint source load reductions needed to achieve water quality standards for bacteria and aquatic life. This watershed plan will be amended as needed to ensure that the strategies identified herein achieve the goals of the TMDL. Other updates to the plan will be completed on a 5 year cycle to incorporate changes in water quality, strategies and regulatory considerations.

3.2 CRITICAL AREAS

Critical areas for water quality improvement and protection were grouped and shown below by subwatershed, using monitoring data, WWTP compliance data and Bacterial Indicator Tool results. By evaluating these factors on the smaller subwatershed scale, a more detailed understanding of critical areas was gained. In addition, strategies can be focused within subwatersheds to facilitate measurable improvements. Critical areas and strategies to improve and protect water quality in these areas are shown in **Table 3.3** and additional detail is provided in **Appendix 3.2.**

Table 3.3. Critical Areas and Strategies

Site	Critical Area Subwatersheds	Strategies to Achieve Surface Water Quality Standards
Critical Area 1: Little Indian Creek North		
1	Little Indian Creek North	Sample this location during normal flow conditions; both IDEM data and this project collected data during low flow and drought conditions. Use data collected under normal flow conditions to re-assess this stream.
Critical Area 2: Indian Creek in Floyd County and Harrison County above Corydon		
2	Georgetown Creek above Indian Creek	Work with farmer near Site 2 on cattle exclusion/ alternate water supply, elsewhere in this subwatershed, repair/eliminate failing septic systems, stream buffer / streambank stabilization
3	Indian Creek above Georgetown Creek	Investigate, repair or replace improperly functioning septic systems. Work toward compliance at Woods of Lafayette WWTP
4	Crandall Branch above Indian Creek	Perform visual assessment to investigate elevated bacteria. Encourage agricultural BMPs such as cattle exclusion/ alternate water supplies, manure management plans; stream buffers & streambank stabilization.
5	Indian Creek Below Crandall Branch	Improve WWTP Compliance at Lanesville Welcome Center; Encourage agricultural BMPs such as cattle exclusion/ alternative water supplies, manure management plans; stream buffers and streambank stabilization. If septic system failures are reported, investigate with dye and smoke testing and repair or replace as needed
Critical Area 3: Indian Creek Devils Backbone Segment		
7	Indian Creek at Mathis Road bridge	Our data showed DO criteria were met; Encourage IDEM to resample this location and delist as appropriate
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	Our data showed DO criteria were met; Encourage IDEM to resample this location and delist as appropriate
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	Our data indicate that this area may be affected by Ohio River backwater and very reduced flows due to karst. If the DO violation is confirmed as being caused by natural conditions, pursue delisting and avoid TMDL development
Critical Area 4: Watershed Protection Areas		
6	Indian Creek above Little Indian Creek at Water Street	Maintain compliance at Corydon WWTP
10 & 11	Little Indian Creek	Maintain compliance at WWTPs (Corydon, Tyson); continue to monitor and assess nutrients below Lanesville.

3.3 WATER QUALITY IMPROVEMENT GOAL AND ACTION PLANS

Water Quality Improvement Goal: Reduce concentrations of bacteria and nutrients in Indian Creek Watershed streams to ensure progress toward meeting water quality standards for recreational and aquatic life designated uses.

Bacteria From Failing Septic Systems

Problem Statement: *The Bacterial Indicator Tool results indicate that there are an estimated 400 failing septic systems in the Indian Creek Watershed, contributing a total estimated load of 2.12 E10 FC/day to streams. While this loading is low relative to agricultural sources, the potential human health risk associated with exposure to sewage is relatively high. The strategies below are designed to reduce the potential human health risk associated with exposure to sewage, to improve quality of life and promote economic development through available sewer capacity.*

Table 3.4. Reduce the number of failing septic systems in Indian Creek Watershed by 10% by 2018

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Sewer commercial area near Berkshire Mobile Home Park	Provide sewage treatment to ~20 commercial entities in 2008 currently served by lagoon treatment	Harrison County Regional Sewer District Board	2008 / High – Harrison Co RSD applied for Community Development Block Grant	NA	Harrison County Regional Sewer District Annual Report describes progress

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Sewer Paul's Lane Development	Provide sewage treatment to homes in Floyd County currently served by failing septic systems	Floyd County Engineer	2008 / Cost High	NA	Floyd County Engineer
Inspect septic systems in association with real-estate transfer	Continue to inspect septic systems prior to property closings; work with buyers & sellers to repair or replace problem systems	Harrison County Health Department	2008 & ongoing / Cost Low for inspection; Moderate to High for repair/ replacement	NA	Harrison County Health Department reports problem areas to Harrison County Regional Sewer District at monthly meetings; District integrates with sewering priorities
Septic system tracking database	Continue to track failing systems, repairs & replacements in Health Dept Database	Harrison County Health Department	2008 & ongoing / Cost Low for database; Moderate to High for repair/ replacement	NA	Harrison County Health Department reports problem areas to Harrison County Regional Sewer District at monthly meetings; District integrates with sewering priorities
Identify & address problem septic systems through Stormwater (MS4) program	Continue to identify and address failing & problem systems through Illicit Discharge Detection & Elimination	Clark County MS4 Coordinator; Floyd County MS4 Coordinator	2008 & ongoing / Cost Low for inspection; Moderate to High for repair/ replacement	NA	Floyd County Annual MS4 Report Clark County Annual MS4 Report
Develop Harrison County Masterplan that identifies priority areas for addressing failing septics	Develop Masterplan by 2009	Harrison County Regional Sewer District Board	2009 / High	NA	Harrison County Regional Sewer District Annual Report describes progress

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Pursue funding to implement Masterplan	Seek Community Development Block Grants, Economic Development Funding, SRF Loans and other funds to implement priority sewering projects identified in the Masterplan	Harrison County Regional Sewer District Board	2010, after Masterplan adoption; Cost Moderate to pursue funding	NA	Harrison County Regional Sewer District Annual Report describes progress
Septic system education & outreach	Conduct septic system workshop if funding becomes available	Harrison County Health Department	By 2009 if funding becomes available / Cost Low	NA	Post workshop information to Harrison County Septic System website **(1)**
Sewer homes near Berkshire Mobile Home Park	Provide sewage treatment to ~100 homes currently served by septic systems	Harrison County Regional Sewer District Board	2010 / High	NA	Harrison County Regional Sewer District Annual Report describes progress

Notes

(1) Harrison County Septic System website: http://www.harrisoncountyhealth.com/septic_system_information.htm

Bacteria from Urban Sources

Problem Statement*: The Bacterial Indicator Tool results indicate that urban areas contribute a relatively small (0.01%) but concentrated loading of bacteria to the watershed. Many of the areas that are urbanizing rely on septic systems, and strategies to reduce bacterial loadings from this source are identified in Table 3.3. The strategies outlined below are designed to reduce bacterial loading from other (non-septic) urban sources.*

Table 3.5. Reduce urban (non-septic) sources of bacteria by 10% by 2018

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Collection system inspection and repair	Initiate inspection & repair as needed on the newly acquired Berkshire WWTP	Harrison County Regional Sewer District contractor	2008 & ongoing / Cost for inspection Low, Cost for repair Moderate to High	NA	Harrison County Regional Sewer District Annual Report describes progress
Improve WWTP Compliance	Continue to monitor, inspect and address issues non-compliant facilities	IDEM	2008 & ongoing / Cost for inspection Low, Cost for compliance Moderate to High	NA	Permit Compliance System database
Continue implementation of stormwater programs **(1)**	Continue to implement all aspects of Stormwater (MS4) programs in Clark County & Floyd County and renew permits as per IDEM requirements	Clark County MS4 Coordinator; Floyd County MS4 Coordinator	2008 & ongoing / Cost Moderate	NA	Clark County Annual Stormwater Report; Floyd County Annual Stormwater Report
WWTP upgrades and expansions	Continue to upgrade, expand and construct new facilities as per the Masterplan	Harrison County Regional Sewer District	2010 / Cost High	NA	Harrison County Regional Sewer District Annual Report describes progress

Stormwater outfall and conveyance mapping and illicit discharge screening	Continue to map and screen for illicit discharges 25% per year of MS4 systems in Clark County and Floyd County, with 100% complete by 2009	Clark County MS4 Coordinator; Floyd County MS4 Coordinator	2008 & ongoing / Cost Moderate	NA	Clark County Annual Stormwater Report; Floyd County Annual Stormwater Report
Stormwater management ordinance	Harrison County will draft and propose a basic stormwater ordinance in 2008 and will initiate implementation after adoption	Harrison County Regional Sewer District	2008 & ongoing / Cost Low	See Note 2	Harrison County Regional Sewer District Annual Report describes progress

Notes

(1) Harrison County is not densely populated enough to be required to participate in the Stormwater program.

(2) Since Harrison County is not required to participate in the Stormwater program, this initial ordinance is anticipated to focus on peak flow control and may or may not include water quality measures.

Protecting Karst Resources

Problem Statement: *Through the Sinkhole Inventory developed through this watershed planning project, approximately 15,000 sinkholes were mapped in the Indian Creek watershed. This highly developed karst system is hydrologically connected to the Blue River Watershed, a National Scenic River. Thus, water entering the karst system in the Indian Creek watershed may travel to the Blue River and impact, positively or negatively, the water quality and resources of the Blue River watershed. In addition, caves and other underground features, including Binkley Cave, Indiana's longest cave, provide habitat to rare, threatened and endangered species. Another consideration is that water travels easily between surface streams and underground environments in this watershed. The impacts of water resurfacing in Indian Creek streams, in terms of dilution and/or degradation, are not well understood, but could be significant in this highly developed karst watershed. Data were not sufficient to develop a numeric target for protecting and improving karst systems, but the group did agree on the importance of these strategies.*

Table 3.6. Improve protection of karst systems by 2018

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Karst policy development	Develop a karst policy outlining strategies to protect karst features, property adjacent to these features	Harrison County Regional Sewer District	2008 / Cost to develop Moderate; Cost to implement Moderate to High	See Note 1	Harrison County Regional Sewer District Annual Report describes progress
Karst BMP Pilot Project	Seek funding and support to conduct a pilot project to evaluate the draft karst policy, test karst BMPs locally and inform decision-making on whether an ordinance is needed	Harrison County Regional Sewer District If funding becomes available, assistance may be requested from karst experts, The Nature Conservancy, Indiana Karst Conservancy and others	2008 & ongoing/ Cost to seek grant funding is Low; Cost to implement project Moderate	NA	Harrison County Regional Sewer District Annual Report describes progress

Underground Injection Control (UIC) Program Implementation	Continue to fully implement the UIC Program by submitting inventory forms for UIC Class V wells, including modified sinkholes annually or more often as needed	Harrison County Highway Department	2008 & ongoing / Cost Low	NA	Inventory forms submitted to USEPA Region IV as required

Notes

(1) Karst policies and ordinances are not required by federal programs so this effort may encounter opposition.

Bacteria from Agricultural Sources

***Problem Statement**: The Bacterial Indicator Tool results show that bacteria from agricultural sources (pasture, cropland with manure application and cattle access to streams) is a significant source of bacteria in Indian Creek Watershed streams. This watershed is largely agricultural, so reducing agricultural sources of bacteria and managing nutrients and sediment before they become problems are important measures of success.*

Our biological and habitat monitoring was affected by the drought of 2007. However, existing data indicate that biological and habitat quality are relatively good in this watershed. Therefore the strategies below are designed to provide dual benefits: reduction of bacteria from agricultural sources and continued protection of aquatic life and habitat resources. In addition, the strategies described in Tables 3.3 to 3.6 above will provide a benefit for aquatic life and habitat by reducing pollutant inputs, protecting water quality and habitats. These strategies are incorporated by reference.

Table 3.7. Reduce bacterial loads from agricultural sources by 10% by 2018 and continue to protect aquatic life and habitat.

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Continue and expand agricultural buffers, with a target of a 10% increase (36 acres) by 2018.	Through annual farm program enrollments, continue to encourage buffers for crop and pasture lands, including identification of funding sources to alter the economic balance in favor of buffers.	Harrison County SWCD; Floyd County SWCD; Clark County SWCD	2008 & ongoing / Cost High	NA	NRCS and SWCD Annual Reports

Conduct habitat and visual assessments in Crandall Branch, Georgetown Creek and other priority areas **(1)**	Assess Crandall Branch and Georgetown Creek, and prioritize areas for stream and habitat visual assessments to identify erosion, actual buffer condition and site specific projects	Harrison County SWCD; Floyd County SWCD;	2009, if funding becomes available / Cost Moderate	NA	SWCD Annual Reports
Continue and expand cattle exclusion projects	Through annual farm program enrollments, continue to encourage cattle exclusion fencing and alternate water supplies on pasture lands, including identification of funding sources to alter the economic balance in favor of these projects.	Harrison County SWCD; Floyd County SWCD; Clark County SWCD	2008 & ongoing / Cost High	NA	NRCS and SWCD Annual Reports
Seek funding for stream buffer workshop	Seek grant funding, and if awarded, educate 20 or more landowners on the importance of buffers to water quality, habitat, and flood control.	Harrison County Regional Sewer District	2008 & ongoing/ Cost to seek grant funding is Low; Cost to implement project Moderate	NA	Harrison County Regional Sewer District Annual Report describes progress

Notes

(1) As noted in Table 3.2, Georgetown Creek and Crandall Branch were prioritized based on visual observations of cattle access in Georgetown Creek and elevated bacteria in Crandall Branch, with no obvious sources.

Reducing Risks of Flooding

***Problem Statement**: Flooding is a significant concern in this watershed. The volume and rate of stormwater flows has increased in the steep hill slopes of Floyd County and is affecting narrow valleys in this county as well as downstream Harrison County. Significant concerns related to risks associated with loss of life and property were expressed at each public meeting. New floodplain maps are being prepared by the Indiana Department of Natural Resources. These maps and associated data can be used to better understand and quantify the risks of flooding as well as to identify specific strategies to prevent and mitigate flood damage.*

It is important to highlight that many strategies that provide flood protection benefits also have water quality benefits. Stream buffers are an important example. As flood protection strategies are identified, complimentary water quality benefits will be identified.

Table 3.8. Reduce Risks of Flooding

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Reduce the number of structures affected by flooding	Work with IDNR when updated floodplain maps are released to identify number of structures affected and develop strategy, including possible applications for HMGP and PDM grants	Harrison County Planner	2008 & Ongoing/ Cost to identify affected structures Low to Moderate; Cost to mitigate Moderate to High	NA	Reduced number of repetitive loss structures in FEMA's Community Information System database
USGS Flow Gage	Pursue funding to re-instate USGS flow gage in Indian Creek watershed	USGS - Indiana Water Science Center	2010 / Cost low to identify funding; Moderate annual cost for gage	NA	USGS National Water Information System

Monitoring and Assessment

***Problem Statement**: The availability of reliable, high quality data is essential to monitoring the progress and in-stream benefits of the strategies outlined above. The entities involved in developing this plan do not currently have resources to conduct this monitoring. Therefore, this aspect of watershed plan implementation relies on ongoing data collection efforts by IDEM.*

Table 3.9. Monitoring and Assessment

Management Measure	Action Plan	Resources	Schedule / Cost	Legal Matters	Progress Indicators
Future water quality assessments	IDEM will collect additional water quality, biological and habitat data on a 5 year rotating cycle, returning again in 2012 and at the Indian Creek South of Corydon (OBS100-0004) monthly	IDEM	Ongoing / Cost Low to Moderate	NA	Report results in STORET and Integrated Report
Continue to pursue de-listing of Dissolved Oxygen in Devils Backbone segment	IDEM will collect additional dissolved oxygen data prior to developing the Dissolved Oxygen TMDL **(1)**	IDEM	Monitoring – Ongoing DO TMDL – 2017 E. Coli TMDL – 2017 to 2023 / Cost Low to Moderate	NA	Report results in STORET and Integrated Report
Collect biological data at normal flows in Indian Creek North	IDEM will collect additional biological and habitat data prior to developing the aquatic life TMDL	IDEM	Monitoring – Ongoing TMDL - 2017 / Cost Low to Moderate	NA	Report results in STORET and Integrated Report

Notes

(1) Data collected for this watershed plan indicate acceptable (above criteria) levels in the upper portion of the 17 mile long Devils Backbone segment (IDEM Segment Number INN04A3_00) with sampling during stressful summer drought conditions. Our data indicated depressed levels near the Ohio River confluence and attributed these levels to natural backwater and diminished flow due to karst geology. A letter requesting de-listing of this waterbody was submitted to IDEM in December 2007.

4.0 REFERENCES

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HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

July 26, 2006 9:30 AM to 11:00 AM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING AGENDA

1. **Introduction to Watershed Planning**

2. **IDEM's Expectations**

3. **Watershed Plan Approach**

4. **Quality Assurance Project Plan (QAPP)**

5. **Monitoring Site Selection**

6. **Next Steps**

Handouts

- ☐ **Watershed Plan Outline**
- ☐ **Draft Quality Assurance Project Plan**

Indian Creek Watershed Management Plan

Indian Creek Watershed Plan Subcommittee

July 27, 2006

Presentation Overview

- Introduction to Watershed Planning
- IDEM's Expectations
- Watershed Plan Approach
- Quality Assurance Project Plan
- Monitoring Site Selection
- Next Steps

Introduction to Watershed Planning

- Implement Feasibility Study goals in Indian Creek Watershed
  - ➢Foster economic development
  - ➢Preserve environmental integrity
  - ➢Enhance quality of life
- Approach to address water quality issues prior to IDEM TMDLs

Introduction to Watershed Planning

Indian Creek Watershed Description

- ➢Drains 256 square miles
- ➢Harrison and Floyd Counties
- ➢56 miles of impaired streams
- ➢Prone to flooding
- ➢Poised for growth
- ➢Numerous karst features, including Binkley Cave

Introduction to Watershed Planning

Indian Creek Watershed Plan – Suggested Outline

- Executive Summary
- Introduction
- Water Quality Problems
- Goals and Decisions
- Measuring Progress
- Practical Matters
- Appendices – Maps & Supporting Documentation

IDEM's Expectations

- $99,930.00 Grant §205(j)
- Major Tasks
  1. Establish Watershed Plan Committee
  2. Conduct Quarterly Public Outreach
  3. Develop Quality Assurance Project Plan
  4. Conduct Monitoring and Assessment
  5. Inventory and Map Sinkholes
  6. Develop Watershed Management Plan

IDEM's Expectations

TIMELINE

IDEM Awards Grant to Harrison County	3/2006
RFP to Hire Watershed Coordinator	3/2006
Establish Indian Creek Watershed Subcommittee	7/2006
Conduct Quarterly Public Outreach	8/2006 to 3/2008
Develop Quality Assurance Project Plan	8/2006
Conduct Monitoring & Assessment	9/2006 to 10/2007
Inventory & Map Sinkholes	10/2006 to 10/2007
Develop Watershed Management Plan	final by 3/1/2008

Watershed Plan Approach

Task 1. Establish Indian Creek Watershed Subcommittee

- **Roles**
  - Develop goals
  - Provide policy direction
  - Develop watershed strategies
- Eight quarterly meetings

Watershed Plan Approach

Task 2. Conduct Quarterly Public Outreach

- Engage watershed stakeholders & citizens
- **Roles**
  - Recommend watershed strategies
  - Implement Watershed Plan
  - Enhanced citizen involvement
- www.indiancreekwatershed.com

Watershed Plan Approach

Task 3. Develop Quality Assurance Project Plan

- IDEM approval required
- Establishes monitoring goals
- Monitoring plan
- Data analysis

Watershed Plan Approach

Task 4. Conduct Monitoring and Assessment

- Evaluate current conditions
- Identify pollution sources
- Address Data Gaps
- Support Watershed Plan Development

Tools: GIS, statistical analysis, IDEM Pollutant Load Reduction Workbook

Watershed Plan Approach

Task 5. Inventory and Map Sinkholes

- Compile existing sinkhole data
- Field verify
- Support karst policy implementation
- BMP demonstration projects

Watershed Plan Approach

Task 6. Develop Watershed Plan

Suggested Outline & Schedule

Watershed Plan Chapter	3/06	6/06	9/06	12/06	3/07	6/07	9/27	12/07	3/08
•Executive Summary									
•Introduction									
•Water Quality Problems									
•Goals and Decisions									
•Measuring Progress									
•Practical Matters									
•Appendices									

Quality Assurance Project Plan

Proposed Monitoring Goals

- **Evaluate current conditions**
  - 56 miles of impaired streams - Recreation, Aquatic Life
- **Identify pollution sources**
  - Bacteria, low dissolved oxygen, poor quality habitat
- **Address Data Gaps**
  - New monitoring locations, range of hydrologic conditions
- **Support Watershed Plan Development**
  - Identify watershed implementation strategies

Monitoring Site Selection

Site #	IDEM Site #	Location	WQ	AQL	Rationale
1	OBS080-0001	Indian Creek North between Banet Rd & Bethel Road	X	X	303(d) Segment – Aquatic Life
2	OBS090-0002	Indian Creek above Crandall Branch near Motts Rd & Adolph Rd	X		303(d) Segment – Recreation
3	OBS090-0004	Indian Creek above SR355 Bridge	X		303(d) Segment – Recreation
4	OBS090-0005	Indian Creek at Big Indian Road & Brigetta Road	X	X	303(d) Segment – Recreation
5	OBS100-0001	Indian Creek above Rocky Hollow Road Bridge	X	X	303(d) Segment – Recreation, Aquatic Life
6	OBS100-0006	Indian Creek above Lickford Road Bridge	X	X	303(d) Segment – Recreation, Aquatic Life
7		Little Indian Creek above Water Street Bridge	X	X	Major tributary
8	OBS080-0005	Indian Creek above Georgetown Creek	X		Floyd County drainage, near County boundary, developing
9		Indian Creek near Hottel Road	X	X	Upstream end of 303(d) Segment – Recreation, Aquatic Life
10		Crandall Branch above SR355 Bridge	X		303(d) Segment – Recreation (may be an artifact of mapping?)
11		Indian Creek above Little Indian Creek at Water Street	X		Downstream end of HUC, 303(d) Segment – Recreation, above WWTP, receives Corydon runoff
12		Little Indian Creek above Turley Rd Bridge	X		Mid-point of major tributary, downstream of CAFO, classified as “unassessed” by IDEM
13		Little Indian Creek below Georgetown Creek near Utz Road	X	X	Possible reference reach, downstream of impaired segments, upstream end of 303(d) Segment – Recreation

Next Steps

- Finalize QAPP & Submit to IDEM for approval
- Initiate Monitoring
- Hold Public Outreach Event
- Populate website
- Next Subcommittee Meeting

Conclusion

- Importance
  - Water Quality Issues
  - Flooding
- Implement Feasibility Study goals in Indian Creek

Questions

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

July 26 2006 9:30 AM to 11:00 AM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING SUMMARY

1. Introduction to Watershed Planning

Steve Hall and Karen Schaffer provided an overview of watershed planning. Key considerations include implementing the Regional Sewer District Feasibility Study Goals of fostering economic development, preserving environmental integrity and enhancing quality of life.

There are several waterbodies that the Indiana Department of Environmental Management (IDEM) has identified as impaired. They will be developing Total Maximum Daily Loads (TMDLs) for these waterbodies. The TMDLs have an impact on the ability to obtain wasteload allocations for new or expanded wastewater discharges.

Proactively planning for the numerous wastewater decisions to be made, and addressing impairments before IDEM develops the TMDLs are important advantages of the Watershed Plan.

2. IDEM's Expectations

IDEM's expectations for the 2-year grant include establishing a Watershed Plan Committee (accomplished through the RSD Indian Creek Subcommittee), conducting quarterly public outreach, developing a Quality Assurance Project Plan, conducting monitoring and assessment, inventory and map sinkholes, develop watershed management plan.

3. Watershed Plan Approach

FMSM was hired as the Watershed Coordinator and will be assisting the Subcommittee with implementing the project, including drafting the watershed management plan. The Indian Creek Watershed Management Plan will address the Feasibility Study goals, integrate the karst policy and identify opportunities for BMP demonstration projects. By developing the Watershed Plan, the RSD will become eligible to apply for additional grant funds to support implementation projects that are identified in the watershed plan.

FMSM has developed a website to facilitate public outreach. A password protected link will be added to the Subcommittee page. Draft documents will be available to the Subcommittee on this page. Final documents or documents available for public comment will be moved to the public page.

4. Quality Assurance Project Plan (QAPP)

The QAPP is required for all water quality (WQ) monitoring conducted through this project and must be approved by IDEM. It describes monitoring design, field data collection, laboratory analysis, quality assurance review and data analysis.

The draft QAPP was handed out and discussed. The Subcommittee was encouraged to review and provide input on the QAPP.

Review of IDEM data revealed that they have sampled few times and typically under summer low flow conditions. FMSM recommended a monitoring design that includes sampling multiple times over a range of hydrologic conditions to better understand the range of water quality. Biological (benthic invertebrates), habitat, water chemistry, bacteria and flow are recommended parameters.

FMSM will collect grab samples and measure flow using a wading rod. Through the Harrison County Health Department's participation in the project, water chemistry samples will be analyzed for free by the State Health Department laboratory in Indianapolis. A local lab will be found to analyze bacteria samples because these must be analyzed within 6 hours. Thus shipping to Indianapolis is not feasible for bacteria.

5. Monitoring Site Selection

FMSM proposed 13 monitoring locations. Site selection considerations included locations that IDEM had monitored previously, sites that are located in reaches that IDEM characterized as impaired, near county boundaries, near reaches that IDEM characterized as "unassessed" and a possible reference reach.

FMSM will incorporate the new monitoring location, recommended on the Little Indian Creek downstream of Lanesville.

6. Next Steps

- ☐ Floyd County should have an active role on the Subcommittee. In addition to Don Lopp (Planning), FMSM will work with Floyd County to engage a wastewater/ engineering representative.

- ☐ Subcommittee will provide comments on the draft QAPP

- ☐ FMSM will finalize QAPP based on input from the Subcommittee, including the recommended monitoring location on the Little Indian Creek downstream of Lanesville, and submit to IDEM for approval

- ☐ FMSM will develop a press release and schedule a public event showcasing biological monitoring

Handouts

- ☐ Presentation Slides: Indian Creek Watershed Management Plan
- ☐ Watershed Plan Outline
- ☐ Draft Quality Assurance Project Plan

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK WATERSHED PLAN SUBCOMMITTEE

JULY 26, 2006 9:30 AM to 11:00 AM

Name	Organization	Telephone	Email
Anthony Combs	Harrison County Regional Sewer District & Harrison County Health Dept.	812 738 3237	anthonycombs@hotmail.com
Chris Cunningham	Harrison County Health Dept.	812 738 3237	ccunningham20@hotmail.com
Gary Davis	Harrison County Council President	812 366 3354	gldavis@epowerc.net
Steve Hall	FMSM Engineers, Inc.	812 206 0060	shall@fmsm.com
Daniel Lee	Harrison County Regional Sewer District, & Tyson Foods	812 738 5853	daniel.lee@tyson.com
Bill Sanders	Heritage Engineering	812 280 8201	bsanders@heritageeng.com
Karen Schaffer	FMSM Engineers, Inc.	812 206 0060	kschaffer@fmsm.com
Dan Schroeder	Harrison County Health Dept.	812 738 3237	ninthschroeder@hotmail.com
Ralph Schoen	Harrison County GIS	812 738 8241	rschoen@harrisoncounty.in.gov
Tom Tucker	Harrison County Regional Sewer District	812 738 4087	tomtucker@insightbb.com
Eric Wise	Harrison County Planning Commission	812 738 8927	ewise@netpointe.com

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

August 9, 2006 9:30 AM to 11:00 AM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING AGENDA

1. **Introductions**

2. **Review and Approval of Meeting Summary**

3. **Quality Assurance Project Plan (QAPP)**

4. **Mission Statement**

5. **Brochure/Press Release**

6. **Next Meeting**

Handouts

- ☐ **Meeting Summary**
- ☐ **Draft Quality Assurance Project Plan**
- ☐ **Brochure**
- ☐ **Press Release**
- ☐ **Mission Statement**

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK WATERSHED PLAN SUBCOMMITTEE

Mission Statement

DRAFT August 8, 2006

Option 1

The Indian Creek Watershed Plan Subcommittee is a partnership of concerned citizens dedicated to fostering economic development, preserving environmental integrity and enhancing the quality of life for all who live and work here.

Option 2

The Indian Creek Watershed Plan Subcommittee is a partnership of concerned citizens dedicated to wise and sustainable use of our water resources.

Option 3

The Indian Creek Watershed Plan Subcommittee is comprised of watershed stakeholders dedicated to the preservation, protection, and improvement of the Indian Creek watershed. Our mission is to realize a long-term vision for a healthy watershed and an educated citizenry. Our goal is to educate while building partnerships to improve water quality, reduce flooding, and preserve and restore wetlands, woodlands, and other natural resources for future generations.

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

September 5, 2006 1:00 PM to 2:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING AGENDA

1. **Site Reconnaissance Results**

2. **Draft Chapter 1 of Watershed Plan**

3. **Draft Data Summaries of IDEM Data**

4. **Next Meeting**

Handouts

- ☐ **Site Reconnaissance Report**
- ☐ **Draft Chapter 1 of Watershed Plan**
- ☐ **IDEM Assessment Maps and Tables**

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

September 5, 2006 1:00 PM to 2:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING SUMMARY

1. Site Reconnaissance Results

Several members of the subcommittee expressed an interest in visiting monitoring sites. A date will be scheduled.

Dan Lee talked to Keith regarding e. coli analysis. Information regarding frequency and numbers of samples is needed.

2. Draft Chapter 1 of Watershed Plan

This chapter provides an introduction to the region and watershed. The Subcommittee was asked to provide comments by Sept 15, 2006.

3. Draft Data Summaries of IDEM Data

Draft water quality data summaries were presented. These form the basis for Watershed Plan Chapter 2. Identifying Water Quality Issues. IDEM was making impairment decisions based on very limited data in many cases. The monitoring associated with this project will greatly expand the available dataset.

Other findings include:

- e. coli levels were above criteria at all assessed stations
- Low dissolved oxygen was an issue during the summer of 2000 near the confluence with the Ohio River, where karst and low flow could influence results.
- Although not on the 303d List, elevated pH was found in the Little Indian Creek near Galena
- Un-ionized ammonia levels were well below criteria
- Comparison values were used to evaluate total phosphorus, turbidity and total Kjeldahl nitrogen.

Pollution sources will be discussed in Chapter 2 using summary statistics. The goal is to identify sources in sufficient detail to support positive action. Septic systems, agriculture and abandoned landfills will be evaluated as sources.

Wetlands and floodplains can have important roles in watershed planning. Strategies that protect water quality can provide floodplain and wetlands benefits, and vice versa. Official floodplain maps are available in paper, and unofficial digital maps are available. Because of significant karst, wetlands may not be extensive in this watershed.

Flow was also discussed as an issue. New Jersey was developing an approach to estimate flows required to support aquatic life. Indiana recognized flow as an issue in the 2004 triennial review for Surface Water Quality Standards and this topic is expected to be revisited again in the 2007 review.

There are numerous low head dams in many Indiana watersheds, including Indian Creek that influence flow. EPA has funding available to remove these dams.

4. Next Meeting

A stakeholder meeting will be scheduled. We will provide a presentation, maps on boards, brochure and live GIS. The stakeholder list will be forwarded to the Subcommittee for comment.

Handouts

- ☐ **Site Reconnaissance Report**
- ☐ **Draft Chapter 1 of Watershed Plan**
- ☐ **IDEM Assessment Maps and Tables**

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

June 21, 2007 - 2:00 PM to 3:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon, Indiana

MEETING AGENDA

1. **Watershed Plan Chapter 2 – Water Quality Problems**

2. **Sinkhole Inventory**

3. **Public Meeting**

4. **Next Meeting**

Handouts

- ☐ **Chapter 2 Water Quality Issues – 80% Draft**

Indian Creek Watershed Management Plan

Indian Creek Watershed Plan Subcommittee
June 21, 2007

Presentation Overview

- Introduction
- Watershed Plan Chapter 2 – Water Quality Problems
- Sinkhole Inventory
- Public Meeting
- Next Steps & Closing

Introduction

- Implement Goal of Indian Creek Watershed:

Foster economic development, preserve environmental quality and enhance the quality of life for all who live and work in the Indian Creek Watershed.

- Approach to address water quality issues prior to IDEM TMDLs

Introduction

Indian Creek Watershed Description

- Drains 256 square miles
- Harrison, Floyd Clark Counties
- 56 miles of impaired streams
- Prone to flooding
- Poised for growth
- Numerous karst features, including Binkley Cave

Introduction

- **Indian Creek Watershed Plan**

Executive Summary
1. Introduction
2. Water Quality Problems
3. Goals and Decisions
4. Measuring Progress
5. Practical Matters

Appendices – Maps & Supporting Documentation

Introduction
Progress to Date

- Website (298 hits)
- Public Meeting #1
- Newsletter Articles, Brochure
- Chapter 1 – Watershed Description - Final
- Chapter 2 – Water Quality Issues - 80% draft
- Sinkhole Inventory Data Compiled
- Monitoring Plan & QAPP

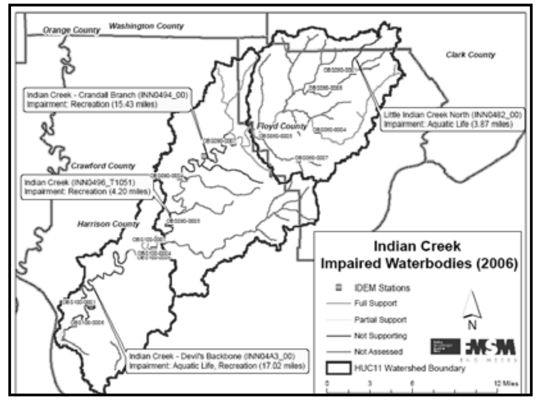
Watershed Management Plan Chapter 2 Outline

- Known Water Quality Problems
- Found Water Quality Problems
- Causes and Sources
- Addressing Data Gaps: Sinkhole Inventory
- Priority Water Quality Problems

Watershed Management Plan Chapter 2

Known WQ Problems

- **Recreational Use Support**
  - **Impaired by E. coli – 36.65 miles (TMDL 2010-2015)**
- **Aquatic Life Use Support**
  - **Low Dissolved Oxygen – 17.02 miles (TMDL 2010-15)**
  - **Impaired Biotic Communities- 3.87 miles**
    - **(TMDL 2010 – 2015)**
- **Fish Consumption Advisory**
  - **Mercury**
  - **PCB's Statewide Advisory**



Indian Creek Waterbody Assessment Results

Waterbody Segment Name	Waterbody Segment ID	Size (Miles)	Aquatic Life	Primary Contact	Fish Consumption	Category
Little Indian Creek (North)	INN0482_00	3.87	N	X	X	5A
Indian Creek-South Trib	INN0491_00	8.84	F	X	P	3A
Indian Creek-Crandall Branch	INN0494_00	15.43	F	N	P	5A
Indian Creek	INN0495_T1050	4.75	X	N	P	3A
Indian Creek	INN0496_T1051	4.20	X	N	P	5A
Indian Creek-North Karst Area	INN04A1_00	6.27	F	X	N	3A
Indian Creek-Devils Backbone	INN04A3_00	17.02	N	N	P	5A
Indian Creek-Blue Spring	INN04A4_00	4.89	X	X	P	3A

Source: IDEM, 2006.
Use Categories: F = Full Support, P = Partial Support, N = Not Supporting, X = Not Assessed.

WMP Chapter 2 Known WQ Problems

- **Recreational Use Support**
  - **Impaired by E. coli – 36.65 miles (TMDL 2010-2015)**
- **Aquatic Life Use Support**
  - **Low Dissolved Oxygen – 17.02 miles (TMDL 2010-15)**
  - **Impaired Biotic Communities- 3.87 miles**
    - **(TMDL 2010 – 2015)**
- **Fish Consumption Advisory**
  - **Mercury**
  - **PCB's Statewide Advisory**

WMP Chapter 2 Known WQ Problems

- Fish Consumption Advisory – PCB's

Table 2.5. Statewide Carp Fish Consumption Advisory

Advisory Group	Carp Size (inches)	Description: Women of childbearing years, nursing mothers and children under 15	Description: Other Adults
1		Limit to 1 meal per week	Unlimited consumption
2		One meal per month	One meal per week
3	15-20	No consumption (Do Not Eat)	One meal per month
4	20-25	No consumption (Do Not Eat)	One meal every two (2) months
5	Over 25	No consumption (Do Not Eat)	No consumption (Do Not Eat)

Source: ISDH, 2006. Note: A meal is defined as 8 ounces (before cooking) of fish for a 150-pound person or 2 ounces of uncooked fish for a 40-pound child.

WMP Chapter 2
Known WQ Problems

- Unified Watershed Assessment (2000-01)

NO DATA
- Aquatic Life Use Support
- Recreation Use Attainment
- Lake Fishery
- Eurasian Milfoil Infestation
- Lake Trophic Status

GOOD CONDITIONS
- **% Cropland**
- **Mineral Extraction**
- **Degree of Urbanization**
- **Aquifer Vulnerability**
- **Population Using Surface Water Supply**

WMP Chapter 2
Known WQ Problems

- Unified Watershed Assessment (2000-01)

ISSUES IDENTIFIED

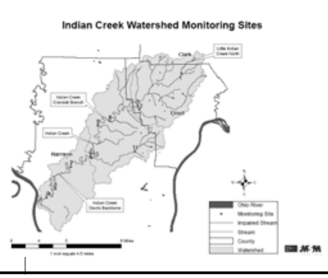
- Mussel Diversity and Occurrence – degraded or rare
- Stream Fishery - Degraded
- Critical Biodiversity Resource – T&E Reports Filed
- Residential Septic System Density - >40 / sq. mi.
- Density of Livestock – high for Indiana

WMP Chapter 2
Found WQ Problems

Water Quality Monitoring Parameters

Chemical	Physical	Biological
Total Phosphorus (TP)	Dissolved Oxygen (DO)	E. coli
Ortho-Phosphorus (PO4)	pH	Benthic Macroinvertebrate
Total Kjeldahl Nitrogen (TKN)	Temperature (T)	Habitat
Nitrate-Nitrogen (NO3)	Specific Conductivity (SC)	
Total Ammonia (NH3+NH4)	Turbidity	
Total Solids (TS)	Stream Flow	

WMP Chapter 2
Found WQ Problems



Sample Type	# Sample Events
E. Coli	5
Water Quality	6
Biological	1
Field Parms	6
Flow	11
Habitat	1

- 3 low flow
- 3 high flow

WMP Chapter 2
Causes & Sources

Possible causes and sources of the following are discussed in this section:
- Recreational use impairments
- Aquatic life use impairments
- Fish tissue contamination

WMP Chapter 2
Causes & Sources

Causes of Recreational Use Impairments

Due to elevated bacteria which is evident in IDEM sampling, 36.65 miles of streams are considered impaired for primary contact recreational use.

Primary Contact Recreation = Swimming

WMP Chapter 2
Causes & Sources

Potential Sources of E. Coli

- Human Sources
  - Wastewater treatment plants in non-compliance
  - Stormwater
  - Failing Septic Systems
- Animal Sources
  - Livestock
  - Wildlife, Pets

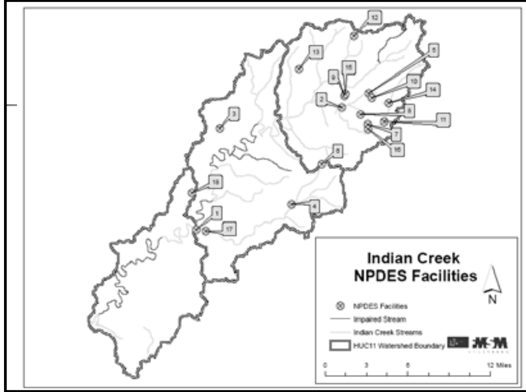


Table 2.1. National Pollution Discharge Elimination System (NPDES) Violations

Facility	NPDES #	Monitoring Location	Total # of Violations (03/2002 - 02/2007)	# of E. coli Violations (03/2002 - 02/2007)	Most Recent E. Coli Violation (03/2002-02/2007)
Chimneywood Sewage Works, Inc.	IN0050181	Effluent Outfall	16	0	N/A
Cleancar Auto Wash Corp.	IN0059803	Effluent Outfall	42	0	N/A
Corydon Municipal WWTP	IN0020893	Effluent Outfall	1	0	N/A
Country View Subdivision	IN0052159	Effluent Outfall	1	0	N/A
Dairy Dip Car Wash	IN0038385	Effluent Outfall	1	0	N/A
Daramic Incorporated	INP000153	Effluent Outfall	7	0	N/A
Woods Of Lafayette's WWTP	IN0054101	Effluent Outfall	46	12	6/30/2006
Floyd Knobs Elementary School	IN0058572	Effluent Outfall	15	0	N/A
Galena Elem & Floyd Central HS	IN0031178	Effluent Outfall	6	1	5/31/2006
Galena WWTP	IN0052019	Effluent Outfall	22	0	N/A
Greenville Elementary School	IN0058564	Effluent Outfall	55	0	N/A
Highlander Point Shopping Cent	IN0050032	Effluent Outfall	0	0	N/A
Huber Family Restaurant	IN0055794	Effluent Outfall	37	0	N/A
Jacobi's Car Wash & Store	IN0059382	Effluent Outfall	32	11	10/31/2002
Lanesville Municipal STP	IN0040215	Effluent Outfall	10	5	9/30/2006
Lanesville Welcome Center I-64	IN0045942	Effluent Outfall	81	8	5/31/2006
Tyson Foods, Inc.	INP000117	Effluent Outfall	2	0	N/A
Wymberly Sanitary Works, Inc	IN0043923	Effluent Outfall	1	0	N/A
Source: IDEM					

Number of *E. Coli* Effluent Violations in Past 5 Years

WMP Chapter 2
Causes & Sources

Potential Sources of E. Coli: Stormwater

6 Minimum Control Measures (MCMs)

- Public education and outreach
- Public participation and involvement
- Illicit discharge detection and elimination
- Construction site runoff controls
- Post-construction stormwater management
- Municipal operations pollution prevention and good housekeeping

WMP Chapter 2
Causes & Sources

Potential Sources of E. Coli: Stormwater

- **Clark & Floyd County – MS4 Programs**
- **Harrison County - Developing Stormwater Ordinance**
- **Floyd County**
  - **13.2 miles conveyance, 540 outfalls mapped**
  - **1 Potential Illicit Discharge**

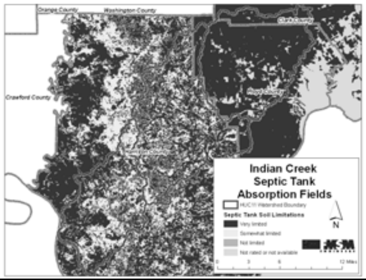
WMP Chapter 2
Causes & Sources

Potential Sources of E. Coli: Failing Septic Systems

Floyd County
- **31% of households use septic systems (~9,000 septics)**
- **81% of soils are severely limited for septic**

Harrison County
- **80% of households use septic (~10,000 septics)**
- **~70% functioning improperly (~7,000 w/ issues)**
- **67% of soils are severely limited for septic**

WMP Chapter 2
Causes & Sources



WMP Chapter 2
Causes & Sources

Potential Sources of E. Coli: Livestock

- 1 Confined Animal Feeding Operation – in compliance
- 6 Concentrated Feeding Operations – no data
- High livestock density
- Wildlife & pets?

WMP Chapter 2
Causes & Sources

Livestock, Poultry and Farms in Clark, Floyd, and Harrison Counties

	Cattle		Hogs		Horses		Poultry	
	Head	Farms	Head	Farms	Head	Farms	Head	Farms
Clark	10,972	288	2,288		10,972	288	84	29
Floyd	2,621	135	70		2,621	135	162	10
Harris-on	19,640	607	3,184		19,640	607	1.2 M	52
Total	**33,233**	**1,030**	**5,542**		**33,233**	**1,030**	**>1.2 M**	**91**

Source: ISDA DSC, 2004.

WMP Chapter 2
Causes & Sources

AQUATIC LIFE USE IMPAIRMENT

Causes and Sources…

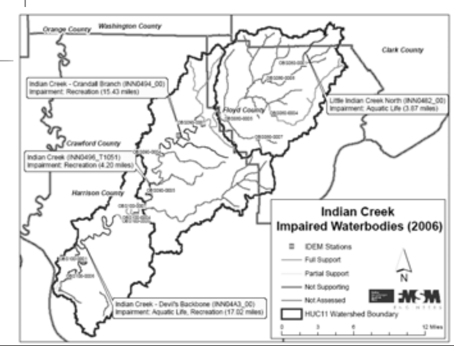
WMP Chapter 2
Causes & Sources

Causes of Aquatic Life Use Impairments

Aquatic life use is impaired at two locations:

1) **Devils Backbone – Dissolved Oxygen**
2) **Little Indian Creek North – Fish Community**

Locations of Aquatic Life Use Impairments



WMP Chapter 2
Causes & Sources

Cause of AQL Impairment: Low DO

- 5 DO readings at Indian Creek at Lickford Bridge Road (Site OBS100-006) in July and August of 2000
- Four of the 5 samples did not meet DO criteria
- IDEM listed Devil's Backbone (17.2 miles) as impaired for DO in 2006
- Data collected upstream at Indian Creek at Rocky Hollow Road (OBS100-001) indicated acceptable levels of DO

WMP Chapter 2
Causes & Sources

Possible Sources of Low DO

- **Organic enrichment (nutrients)**
  - **Not supported by upstream nutrient data**
- **Ohio River backwater &/or losing stream**
  - **Flow very slow to none**
  - **Potentially natural cause !**

WMP Chapter 2
Causes & Sources

Cause of AQL Impairment: Impaired Fish Community

- Little Indian Creek North
  - Chemical parameters – supportive of aquatic life
  - Tolerant fish species present
  - IBI score 24/60 = Impaired
  - Habitat Score – 57/100
  - Instream cover, pool/glide quality, riparian zone, erosion, channel morphology - suboptimal

WMP Chapter 2
Causes & Sources

Cause of Fish Consumption Impairment: Mercury & PCBs

- **Combustion of fossil fuels**
- **Air deposition**
- **Legacy pollution**
- **No evidence of site specific sources in Indian Creek Watershed**

Watershed Management Plan Chapter 2

Other WQ Concerns
Nutrients - phosphorus and nitrogen

- City Park South of Corydon (Site OBS1000-0004), elevated phosphorus and nitrogen
- Phosphorus: 0.015 mg/l to 3.6 mg/l
- Nitrate: 0.06 mg/l to 11.0 mg/l
- DO: 4.6 mg/l to 17.3 mg/l

WMP Chapter 2
Other WQ Concerns

Table 2.14.Estimate of 2005 Nutrient Applications in the Indian Creek Watershed

County	% County in ICW	X	Total Nutrients (tons)		X 2,000 lbs/ton	Nutrients in IWC (lbs)	
			N	P2O5		N	P2O5
Clark	2.8%	X	5646.28	6950.12	X 2000	158	194
Floyd	58.0%	X	190.46	108.75	X 2000	220,934	126,150
Harrison	32.9%	X	3588.95	2116.99	X 2000	2,361,529	1,392,979
Total						2,582,621	1,519,323

Source: OISC, 2005.

WMP Chapter 2
Other WQ Concerns

Table 2.15. Conservation Tillage in Indian Creek Watershed, Corn

County	No-Till		Mulch-Till		Reduced Till		Conventional		
	Acres	%	Acres	%	Acres	%	Acres	%	Rank
Clark	9,773	63	455	3	682	4	4,546	30	8
Floyd	1,176	79	0	0	0	0	321	21	2
Harrison	20,716	88	0	0	600	3	2,102	9	1
Total	31,655	79	455	1	1,282	3	6,969	17	

Source: ISDA DSC, 2004.

- Ag practices in place to reduce runoff !

WMP Chapter 2
Other WQ Concerns

Table 2.17.Pesticides Detected in Indian Creek Watershed

Parameter	Concentration (parts per billion)
Bromacil (ug/L)	0.1
Malathion (ug/L)	0.1
Metolachlor (ug/L)	0.2
Oxadiazon (ug/L)	1.1
Simazine (ug/L)	0.08

Source: IDEM, 2006.

- 149 other organic chemicals & pesticides – not detectable in Indian Creek Watershed !

Sinkhole Inventory

- Geology of the Indian Creek watershed is highly prone to karst features such as sinkholes, springs and caves.
- Pollutants can be rapidly transported to groundwater systems without soil filtration.
- UIC Inventory required for modified sinkholes

Sinkhole Inventory

- **Underground Injection Control (UIC) program**
- Modified sinkhole - change flow of stormwater to the karst system
- Regulated under the USEPA's UIC program
  - Inventory
  - Treat or cease discharge if drinking water supply affected

Sinkhole Inventory
Pilot Study

- Compiling existing data
- Advanced analysis of GIS data
- Prioritization
- Field inventory
- FINAL PRODUCT: Shapefile and FGDC standard metadata of field inventoried sinkholes

Sinkhole Inventory
Pilot Study

Existing Data

- **Harrison County Engineers Office –**
  - **18** visually plotted sinkholes
- **Lanesville Corridor Project**
  - **Ten (10)** sinkholes
- **Indian Geological Survey**
  - Sinkhole basins

Sinkhole Inventory
Pilot Study

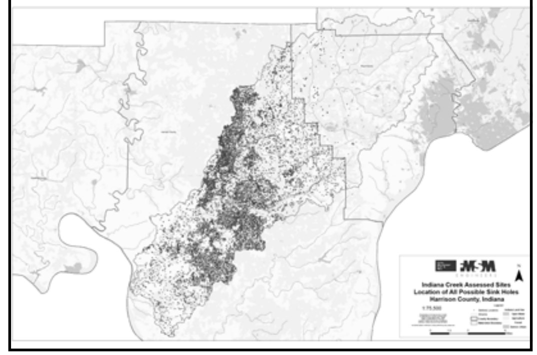
Advanced Analysis of GIS Data

- LIDAR and Digital Elevation Model (DEM) data
- Bowl-shaped depressions or closed contour depressions were identified
- The centroid of the closed contour depression was identified using GIS data to create point locations

Sinkhole Inventory
Pilot Study

- **Harrison County**
  - LIDAR data for Harrison County were obtained
  - Included 2 foot and 4 foot contours
  - **14,687 possible sinkhole locations** in Harrison Co
- **Floyd and Clark Counties** –
  - USGS used (DEM) data
  - 10-meter (~30 feet) and 30-meter (~90 feet)
  - **163 possible sinkhole locations** in the Floyd and Clark Co
  - (this method showed 6,452 in entire watershed)

14,850 Possible Sinks in Indian Creek



Sinkhole Inventory
Pilot Study

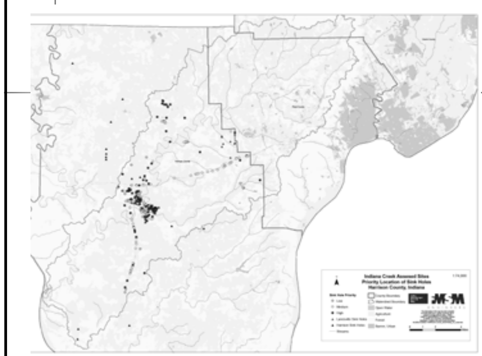
Table 2.18. Land Use and Possible Sinkhole Locations

Land Use/ Land Cover Description	Number of Possible Sinkhole Locations
Low Intensity Residential	215
High Intensity Residential	15
Commercial, Industrial, Transportation	71
Urban Recreational Grasses	14
Total	**315**

Sinkhole Inventory
Pilot Study

Table 2.19. Priority for Field Inventory

Site Description	Number of Possible Sinkhole Locations	Priority
Possible Sinkhole	152	High
Drainage	117	Medium
Construction Site	2	Low
Building, Parking Lot, Street	24	Low
Pond, Quarry	7	Low
Total	**315**	



Watershed Management Plan Chapter 2

Prioritization of Water Quality Issues

The following priorities were established at the Indian Creek Watershed Plan Public Meeting held on October 18, 2006.

- Failing/ Inadequate septic systems
- Flooding
- Other Issues
  - Coverage of drainage in Harrison County Ordinances
  - A water quality problem – foaming Corn Creek
  - Preservation and protection

Watershed Management Plan Chapter 2

Public Meeting

Week of July 9

Suggested Location & Time?

Next Steps

- Public Meeting
- Field work – sinkhole inventory
- Begin monitoring

Questions

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

June 21, 2007 2:00 PM to 3:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING SUMMARY

1. Watershed Plan Chapter 2 – Water Quality Problems

The main problems in the watershed are **recreational use impairment** caused bacteria contamination and **aquatic life use impairment** caused by low dissolved oxygen.

Members of the subcommittee informed the group of additional monitoring data on Little Indian Creek North is available at the New Albany SWCD.

There was discussion of sources of high nutrient levels. Members discussed the possibility of analyzing nutrient application rates. Larger farms would have information on locations and amounts of applied nutrients etc. It was decided, that this may be something to look into in the future, if the group decides to, the priorities now include the sources and causes of aquatic life and recreational use impairments.

2. Sinkhole Inventory

The group discussed different prioritization options for the sinkhole inventory including. Locating areas or subwatersheds with water quality problems or high potential for pollution such as areas known to have a high # of failing septic systems. Kevin Russel suggested creating a shapefile that can be used in the Karst policy of the stormwater ordinance.

The group discussed sinkhole flooding as an issue. It may be more of an issue for sinkholes that can not accept the amount of surface runoff they are receiving than sinkholes that surcharge water.

3. Public Meeting

There are several public events coming up in July that may help raise awareness of the Watershed Management Plan, such as the Floyd County Fair (July 9-14) and the Harrison County Fair (end of July). There may be a booth set up for the Indian Creek project at one or more of these events to advertise for the public meeting and raise overall awareness.

4. Next Meeting

Action Items

- ☐ The subcommittee was asked to review the 80% Draft of Chapter 2 of the watershed plan and return comments to Karen Schaffer by Friday July 20, 2007

Handouts

- ☐ **Chapter 2 Water Quality Issues – 80% Draft**
- ☐ **Article as submitted to the Corydon Democrat "Help Protect Water Quality in Your Community"**
- ☐ **Agenda**
- ☐ **PowerPoint slides**

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

November 15, 2007 - 2:00 PM to 3:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon, Indiana

MEETING AGENDA

1. **Introduction**

2. **Monitoring and Assessment Results**

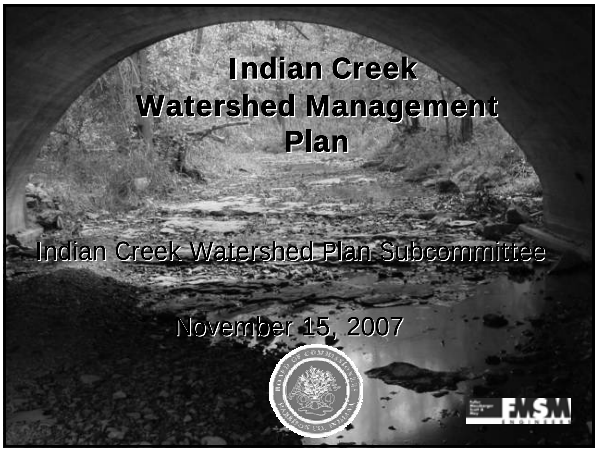
3. **Goals & Strategies Chapters**

4. **Public Meeting**

5. **Next Steps and Closing**

Handouts:

- **Chapter 2: Water Quality Issues - Draft**
- **Chapter 3: Goals and Decisions - Draft**
- **Chapter 4: Measuring Progress – Draft**
- **Newspaper Article**



Indian Creek Watershed Management Plan

Indian Creek Watershed Plan Subcommittee

November 15, 2007

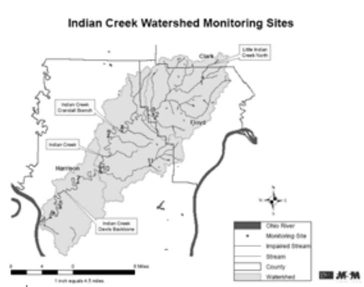
Agenda

- Introduction
- Monitoring and Assessment Results
- Goals & Strategies Chapters
- Public Meeting
- Next Steps and Closing

Introduction Progress to Date

- Monitoring completed
- Chapter 2 Water Quality Issues Revised
- Chapter 3 and 4 Drafts
- Sinkhole Inventory Data Compiled
- Public Meeting #2

Monitoring and Assessment Results



Sample Type	# Sample Events
E. Coli	5
Water Quality	6
Biological	1
Field Parms	6
Flow	11
Habitat	1

- 3 low flow
- 3 high flow

Monitoring and Assessment Results

Completed

- Sample Collection
- E. Coli Analysis
- Biological & Habitat

Pending

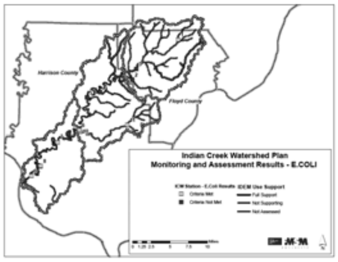
- WQ Parameters Lab Analysis

10 sites part of Indian Creek watershed testing

Monitoring and Assessment Results: E. Coli

Site	Description	Geometric Mean	Maximum Concentration	Criteria Met?
2	Georgetown Creek below Georgetown at Malinee Ott Road	194	300	No
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	147.2	430	No
4	Crandall Branch above SR335 Bridge	779.2	2,200	No
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	268.8	410	No
6	Indian Creek above Little Indian Creek at Water Street	93.3	180	Yes
7	Indian Creek at Mathis Road bridge	19.4	32	Yes
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	46.8	177	Yes
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	44.2	132	Yes
10	Little Indian Creek above Water Street Bridge	119.2	140	Yes
11	Little Indian Creek below Lanesville at State Road 62	118.8	226	Yes
Criteria: Geometric mean < 125 MPN / 100 ml and single sample maximum < 576 MPN/100 ml				

Monitoring and Assessment Results: E. Coli



- **Site 2 Georgetown Creek at Malinee Ott Road**

Monitoring and Assessment Results: Bacterial Indicator Tool

- EPA spreadsheet tool to estimate relative contribution of bacteria sources
  - Forest, Pasture, Crop, Built-up
  - Septic systems
  - Cattle in streams
  - For more information:

  http://www.epa.gov/waterscience/ftp/basins/system/BASINS3/bit.htm

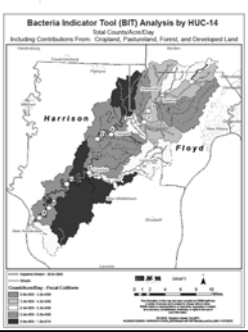
Monitoring and Assessment Results: Bacterial Indicator Tool

- Indian Creek Watershed BIT
  - 24 HUC 14 subwatersheds
  - Tool Inputs
    - Land use/ Land cover
    - Animal census
    - Animal access to streams
    - Manure application
    - Septic systems & failure rates
    - Wildlife census

Monitoring and Assessment Results: Bacterial Indicator Tool

- Bacterial Indicator Tool Outputs
  - Counts / acre / day from **land based sources**
    - Crop, pasture, built-up, forest
  - Counts / day from **"direct" inputs to water**
    - Cattle in streams
    - Failing septic systems

Monitoring and Assessment Results: Bacterial Indicator Tool



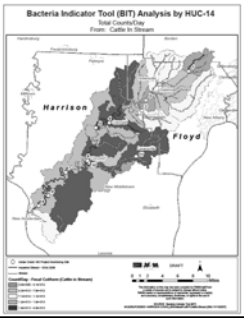
- Results indicated loadings are:
  - Lower in Floyd Co
  - Higher in western Harrison
  - Higher in lower Indian Ck
- Does not account for:
  - Cattle in streams
  - Septic systems
  - Karst system

Monitoring and Assessment Results: Bacterial Indicator Tool

Septic System Results

- Tool indicated "direct" loadings from failing septic systems are:
  - Higher in Floyd Co
  - Lower in Harrison
  - Overall lower than cattle in streams
- Caution: does not account for potential human health impacts from failing septics!

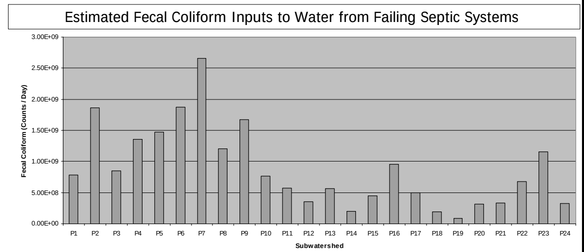
Monitoring and Assessment Results: Bacterial Indicator Tool



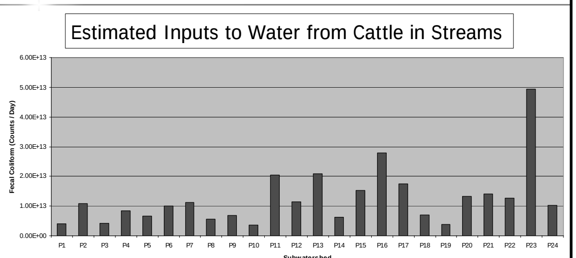
Cattle in Streams Results

- Tool indicated "direct" loadings from cattle in streams are:
  - Lower in Floyd Co
  - Higher in Harrison
  - Overall higher than septic systems
- Caution: does not account for transport to and through the karst system!

Monitoring and Assessment Results: Bacterial Indicator Tool

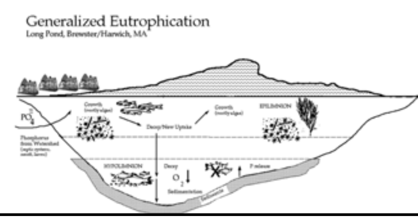


Monitoring and Assessment Results: Bacterial Indicator Tool



Monitoring and Assessment Results: Dissolved Oxygen

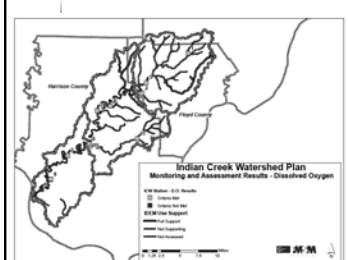
- Dissolved Oxygen Criterion
  - Instantaneous 4 mg/l, 24-hr average 5 mg/l
- IDEM 303d Assessment: >12 mg/l impaired
  - Elevated DO indicates elevated nutrients & eutrophication



Monitoring and Assessment Results: Dissolved Oxygen

Site	Description	Minimum Concentration	Criterion Met?	Maximum Concentration
2	Georgetown Creek below Georgetown at Malinee Ott Road	4.6	Yes	15.0
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	5.7	Yes	8.9
4	Crandall Branch above SR335 Bridge	6.4	Yes	10.4
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	4.5	Yes	8.7
6	Indian Creek above Little Indian Creek at Water Street	7.6	Yes	14.2
7	Indian Creek at Mathis Road bridge	5.6	Yes	9.1
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	6.3	Yes	9.1
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	3.1	No	8.9
10	Little Indian Creek above Water Street Bridge	7.7	Yes	11.1
11	Little Indian Creek below Lanesville at State Road 62	4.9	Yes	16.2

Monitoring and Assessment Results: Dissolved Oxygen



- **Site 9 - Indian Creek above Lickford Road Bridge**
- **Ohio River backwater**

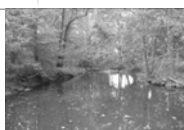
Monitoring and Assessment Results: Aquatic Life

Site	Macroinvertebrate Index of Biotic Integrity (MIBI)	Qualitative Result
Site 6 - Indian Creek above Little Indian Creek at Water Street in Corydon	40	Poor
Site 6D - Indian Creek above Little Indian Creek at Water Street in Corydon	43.9	Fair
Site 7 -Indian Creek at Mathis Road bridge	Not assessed	
Site 8 - Indian Creek above Rocky Hollow	Not assessed	
Site 10 – Little Indian Creek above the Water Street bridge	43.2	Fair

Monitoring and Assessment Results: Habitat

Site	Description	Habitat Score	Qualitative Result
1	Indian Creek North at Banet Road, IDEM Site OBS080-0001	46	Fair
2	Georgetown Creek below Georgetown at Malinee Ott Road	39.5	Poor
3	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	61	Good
4	Crandall Branch above SR335 Bridge	61.5	Good
5	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	40	Not Assessed
6	Indian Creek above Little Indian Creek at Water Street	42	Poor
7	Indian Creek at Mathis Road bridge	62	Good
8	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	55.5	Fair
9	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	63.5	Good
10	Little Indian Creek above Water Street Bridge	36	Poor
11	Little Indian Creek below Lanesville at State Road 62	58	Good

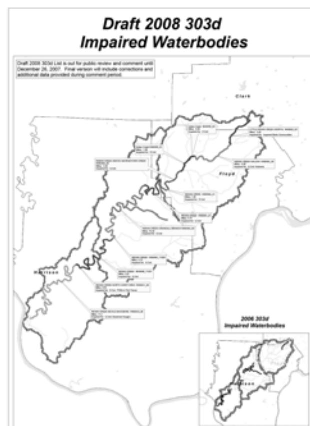
Monitoring and Assessment Results: Habitat



- Site 4: Crandall Branch above SR335 Bridge
- Good Habitat

- Site 10: Little Indian Creek above Water Street Bridge
- Poor Habitat

- Site 8: Indian Creek above Rocky Hollow Bridge
- Fair Habitat



Proposed in 2008

- New listings
  - Nutrients
  - PCBs in fish
- Additional miles
  - Bacteria
- No Change
  - Dissolved Oxygen
  - Impaired Biota

IDEM 303(d) List 2006 Final & 2008 Draft

Aquatic Life Use Support

Low Dissolved Oxygen
- **2006: 17 miles**
- **2008: 17.3 miles**

Impaired Biotic Communities
- **2006: 3.9 miles**
- **2008: 3.9 miles**

Elevated Nutrients
- **2006: 0 miles**
- **2008: 5 miles**

Recreational Use Support

Elevated E. Coli
- **2006: 36.7 miles**
- **2008: 66 miles**

Fish Consumption

PCBs in Fish Tissue

2006: 0 miles

2008: 6.4 miles

Indian Creek TMDLs scheduled 2010 - 2015

IDEM 303(d) List 2006 Final & 2008 Draft

Nutrient Assessment Method
- At least 3 sampling events
- Two or more of the following needed to classify as impaired

- Total Phosphorus: One/more measurements >0.3 mg/l
- Nitrogen: One/more measurements >10.0 mg/l
- Dissolved Oxygen (DO): < 4.0 mg/l, or in the range of 4.0-5.0 mg/l or values >12.0 mg/l
- pH: above 9.0 or in the range of 8.7- 9.0
- Algal Conditions: Algae are described as "excessive" based on field observations by trained staff.

Monitoring and Assessment Results: Next Steps

- 2008 Draft 303(d) Comment Letter to IDEM re: delisting DO
- Analyze water quality results from ISDH Laboratory
- Add WQ results to finalize Chapter 2
- Data submittal to IDEM

Chapter 3 Outline

3. Goals and Decisions

3.1.Water Quality Improvement Goal

- 3.2.Aquatic Life and Habitat Improvement Goal
- 3.3.Flooding Protection Goal

Chapter 3: Goals and Decisions
Water Quality Improvement Goal

- Action Plans
  - Septic System Action Plan
  - Agricultural Action Plan
  - Urban Areas Action Plan
  - Karst Action Plan
  - Monitoring and Assesment Action Plan

Monitoring Site – Floyd County

Site 6 Algae

Chapter 3: Goals and Decisions
Water Quality Improvement Goal

- Septic System Action Plan
  - Septic System Workshop
  - Operation & Maintenance Requirements
  - Septic Management District
  - Financial Assistance to Homeowners
  - GIS Database of Septic Systems
  - Strategy for Homeowner Associations

Chapter 3: Goals and Decisions
Water Quality Improvement Goal

- Agricultural Action Plan
  - Manure & Livestock Management Workshop
  - Financial Assistance
  - Watershed Stewardship Program

Chapter 3: Goals and Decisions
Water Quality Improvement Goal

- Urban Areas Action Plan
  - Pet waste education
  - "Pooper scooper" requirements
  - Map stormwater conveyance & outfalls
  - Dry weather screening
  - Eliminate dry weather flows
  - Sewage collection system inspection & maintenance

Chapter 3: Goals and Decisions
Water Quality Improvement Goal

- Karst Action Plan
  - Karst Protection Policy
  - Pilot BMP implementation project
  - Karst education
  - Karst inventory
  - Dye tracing

- Monitoring Action Plan
  - Water quality monitoring on a ~5 yr cycle

Chapter 3: Goals and Decisions
Aquatic Life and
Habitat Improvement Goal

- Aquatic Life & Habitat Improvement Action Plan
  - Buffer Workshop
  - Greenways Plan
  - Buffer Policy
  - Identify erosion areas
  - Identify stream protection funding sources
  - Implement pilot stream stabilization/ restoration project
  - Monitor benthic macroinvertebrates

Severely eroding stream bank near Site 1, Floyd County

Chapter 3: Goals and Decisions
Flooding Protection Goal

- Flooding Protection Action Plan
  - Stormwater Master Planning
  - Water Quality BMPs included in Flooding Capital Improvement Projects
  - Gages

Chapter 4 Outline

4: Measuring Progress

- 4.1. Progress Indicators
- 4.2. Monitoring Progress
- 4.3. Operation & Maintenance of Installed Practices
- 4.4. Plan Evaluation

Chapter 4: Measuring Progress

Indicators and Measuring Progress

Water Quality Improvement Goal

Reduce concentrations of bacteria and nutrients in Indian Creek Watershed streams to ensure progress toward meeting recreational and aquatic life designated uses.

Priority	Goal	Indicators and Progress Measures
	Reduce concentrations of bacteria and nutrients from septic systems	▪Septic System Workshop held by X ▪Operation & maintenance requirements triggered by real-estate transfer; number properties inspected and maintained ▪Septic management district feasibility study completed by X ▪Identify and educate X homeowners regarding septic system incentives and assistance programs by X ▪Build septic system GIS database by X ▪Develop wastewater management strategy for homeowner associations by X
	Reduce concentrations of bacteria and nutrients from agricultural sources	▪Manure and Livestock Management Workshop held by X ▪Identify financial incentives and assistance to encourage manure management & livestock exclusion by X; ▪Conduct feasibility study and implement a watershed stewardship program by X.

- Measurable targets needed for IDEM approval of Plan!

Chapter 4: Measuring Progress

Indicators and Measuring Progress

Water Quality Improvement Goal

Reduce concentrations of bacteria and nutrients in Indian Creek Watershed streams to ensure progress toward meeting recreational and aquatic life designated uses.

Priority	Goal	Indicators and Progress Measures
	Reduce concentrations of bacteria and nutrients from urban sources	▪Targeted and on-going education of pet-owners by X ▪GIS database of stormwater outfalls and conveyance system in Harrison County by X ▪Perform dry weather screening, illicit discharge detection and elimination in Harrison County by X ▪Inspect and repair as needed, X feet of sewer collection system per year
	Reduce concentrations of bacteria and nutrients to karst systems	▪Perform dye tracing at X locations per year ▪Sample X karst springs per year ▪Continue UIC program implementation ▪Plan and implement karst protection BMP pilot project by X ▪Develop karst protection policy by X ▪Provide karst education at X events per year ▪Continue updating Sinkhole Inventory GIS coverage
	Monitor water quality to provide the data needed to understand status and trends	▪Collect water quality data at least every 5 years

Next Steps

- Dec 13 – Subcommittee Meeting
  - Review draft plan
- Jan 15 – Public Meeting
  - Review draft plan
  - 7:00-8:30 PM, Where?
- Jan 30 – Draft Plan to IDEM
- Feb 29 – Final Plan to IDEM
- Apply for Grant Funds?
  - Implement Indian Creek Watershed Plan
  - Develop Blue River Watershed Plan
  - 319(h) Grants applications due 9/08

Questions

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

November 15, 2007 2:00 PM to 3:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING SUMMARY

1. Monitoring and Assessment Results

Monitoring events have been completed and results are being added to the watershed plan. E.Coli, dissolved oxygen, and biological monitoring results are available in the current drafts of the WMP.

The USEPA Bacteria Indicator Tool (BIT) was used in Indian Creek to compare relative contributions of bacteria in the watershed. The tool will also provide information on priority areas for bacteria management measures. Graphic representation of the results will be available on the website, and results will be summarized in the watershed plan.

2. Goals and Strategies Chapters

A preliminary draft of goals and strategies has been added to the WMP. Much more input is needed from the Subcommittee in order to finalize.

Part of the goals and strategies section includes identifying adequate funding for management measures. Floyd County provided information regarding a grant administered in Paoli Pike to assist landowners in a densely populated area pay for a pump station and convert from septic to sewers. Similarly, Karen Schaffer explained that 319 grant dollars may be available to assist with the development and implementation of selected strategies in the watershed plan. IDEM has expressed interest in a project to develop a septic system management district.

A stormwater ordinance containing a karst policy has been drafted for Harrison County. RSD is planning to move forward with the ordinance early next year. The ordinance will be added to the Strategies chapter of the WMP.

3. Public Meeting

The next public meeting is being scheduled for the week of December 17, 2007. Topics will include monitoring and assessment results, goals and strategies, sinkhole inventory, and implementation.

4. Next Steps and Closing

The next Subcommittee Meeting will be held **December 12, 2007 from 2:00 to 3:30 PM** at the Harrison County Annex Building. This meeting will focus on detailed review of Chapter 3. Goals and Strategies and Chapter 4. Measuring Progress.

Project Timeline

- Dec 12 – Draft Final Plan
- Jan 15 – Public Meeting for Draft Final Plan
- Jan 30 – Draft Final Plan to IDEM
- Feb 28 – Final Plan to IDEM
- Apply for Implementation Grant Funds (319(h) applications due Sept 08)

The presentation from today's meeting has been posted to www.indiancreekwatershed.com.

Action Items

- ☐ The subcommittee will review management strategies and provided feedback including additional strategies to consider, edits to drafted strategies, target dates for implementation, and commitments for implementation of the plan.
- ☐ FMSM will integrate the monitoring and assessment results in to the WMP
- ☐ FMSM will present a final product of the sinkhole inventory at the next Subcommittee meeting
- ☐ FMSM will add the stormwater ordinance development and implementation to chapter 3 and 4 of the WMP
- ☐ FMSM will draft a letter to IDEM requesting de-listing of the DO listing for Devil's Backbone segment of lower Indian Creek.

Handouts

- **Chapter 2: Water Quality Issues - Draft**
- **Chapter 3: Goals and Decisions - Draft**
- **Chapter 4: Measuring Progress – Draft**
- **Newspaper Article**

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK SUBCOMMITTEE

Wednesday December 12, 2007 2:00 to 3:30 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon, Indiana

MEETING AGENDA

1. **Introduction**

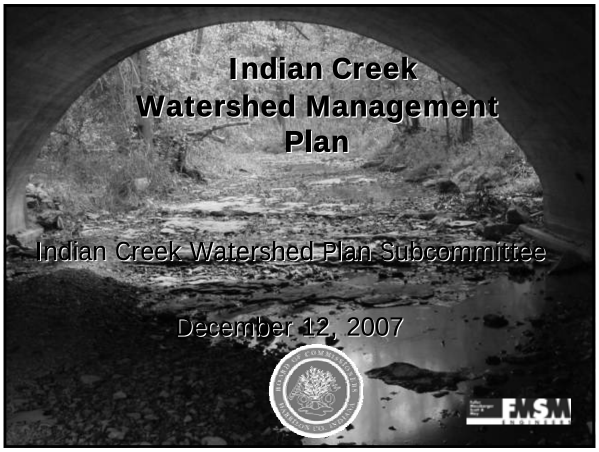
2. **Goals & Strategies Chapters**

3. **Public Meeting**

4. **Next Steps and Closing**

Handouts:

- **Section 2.4: Bacteria Indicator Tool – Draft**
- **Meeting Summary November 15, 2007**



Agenda

- Introduction
- Goals & Strategies Chapters
- Public Meeting
- Next Steps and Closing

Introduction
Progress to Date

- Monitoring completed
- Chapter 2 Bacteria Indicator Tool results entered
- Chapter 3 and 4 Drafts
- Sinkhole Inventory Data Compiled
- Public Meeting #2

Introduction
Project Timeline

- Jan 15 – Public Meeting for Draft Final Plan
- Jan 30 – Draft Final Plan to IDEM
- Feb 28 – Final Plan to IDEM
- Apply for Implementation Grant Funds (319(h) applications due Sept 08)

Introduction
Action Items (from last meeting)

The subcommittee will review management strategies and provided feedback including additional strategies to consider, edits to drafted strategies, target dates for implementation, and commitments for implementation of the plan **Underway**

FMSM will integrate the monitoring and assessment results in to the WMP **Underway**

FMSM will present a final product of the sinkhole inventory at the next Subcommittee meeting **Complete**

FMSM will add the stormwater ordinance development and implementation to chapter 3 and 4 of the WMP **Drafted**

FMSM will draft a letter to IDEM requesting de-listing of the DO listing for Devil's Backbone segment of lower Indian Creek **Complete**

Chapter 3 Outline

3. Goals and Decisions

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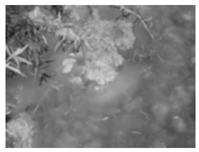
Monitoring Site – Floyd County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	Monitor water quality to provide the data needed to understand status and trends	▪Collect water quality data at least every 5 years

Next Steps

- Data submittal to IDEM
- Jan 4 - Additions and Comments from Subcommittee on Chapters 3 and 4 Due to FMSM
- Jan 15 – Public Meeting
  - Review draft of final plan
  - 7:00-8:30 PM, Where?
- Jan 30 – Draft Plan to IDEM
- Feb 29 – Final Plan to IDEM
- Apply for Grant Funds?
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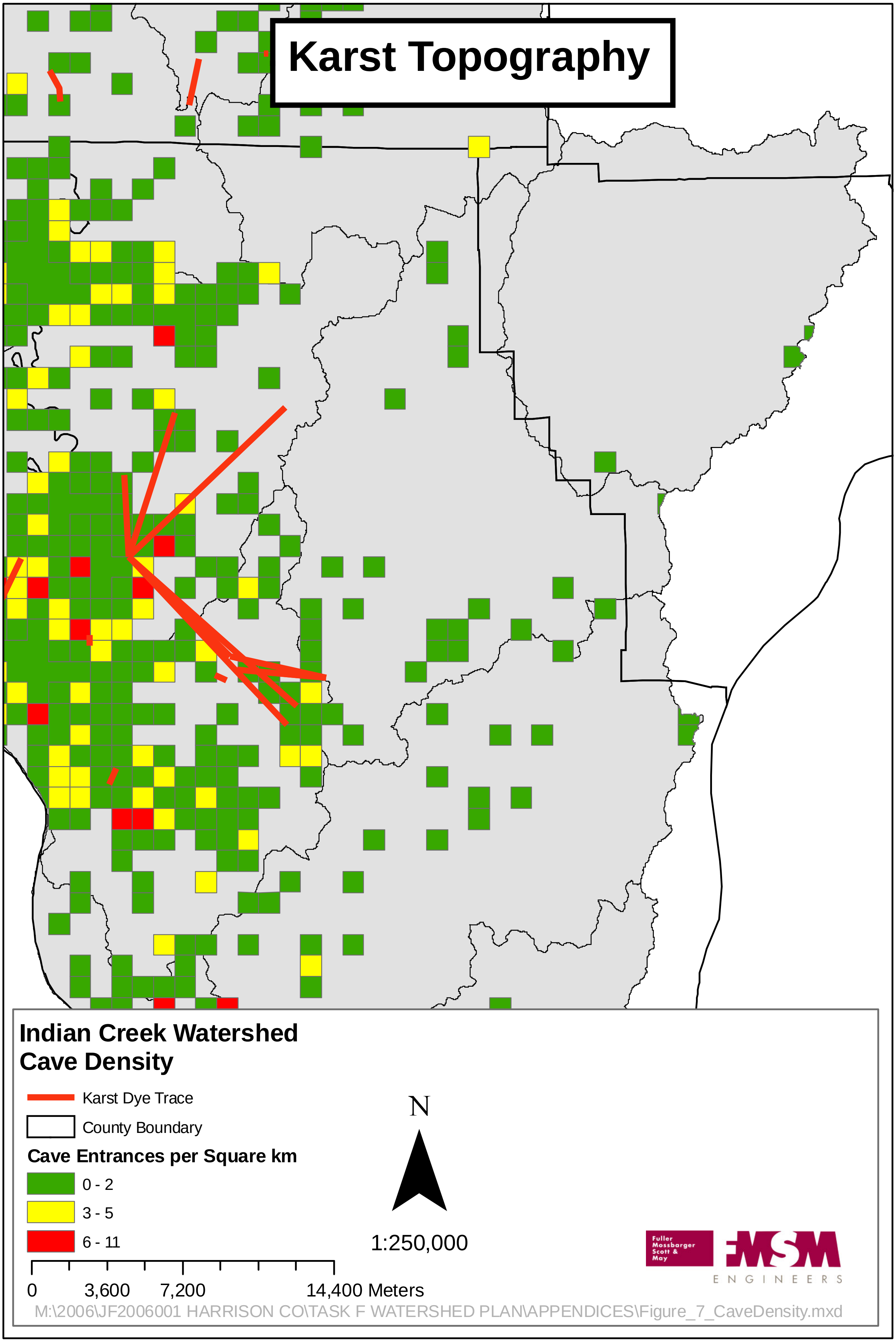
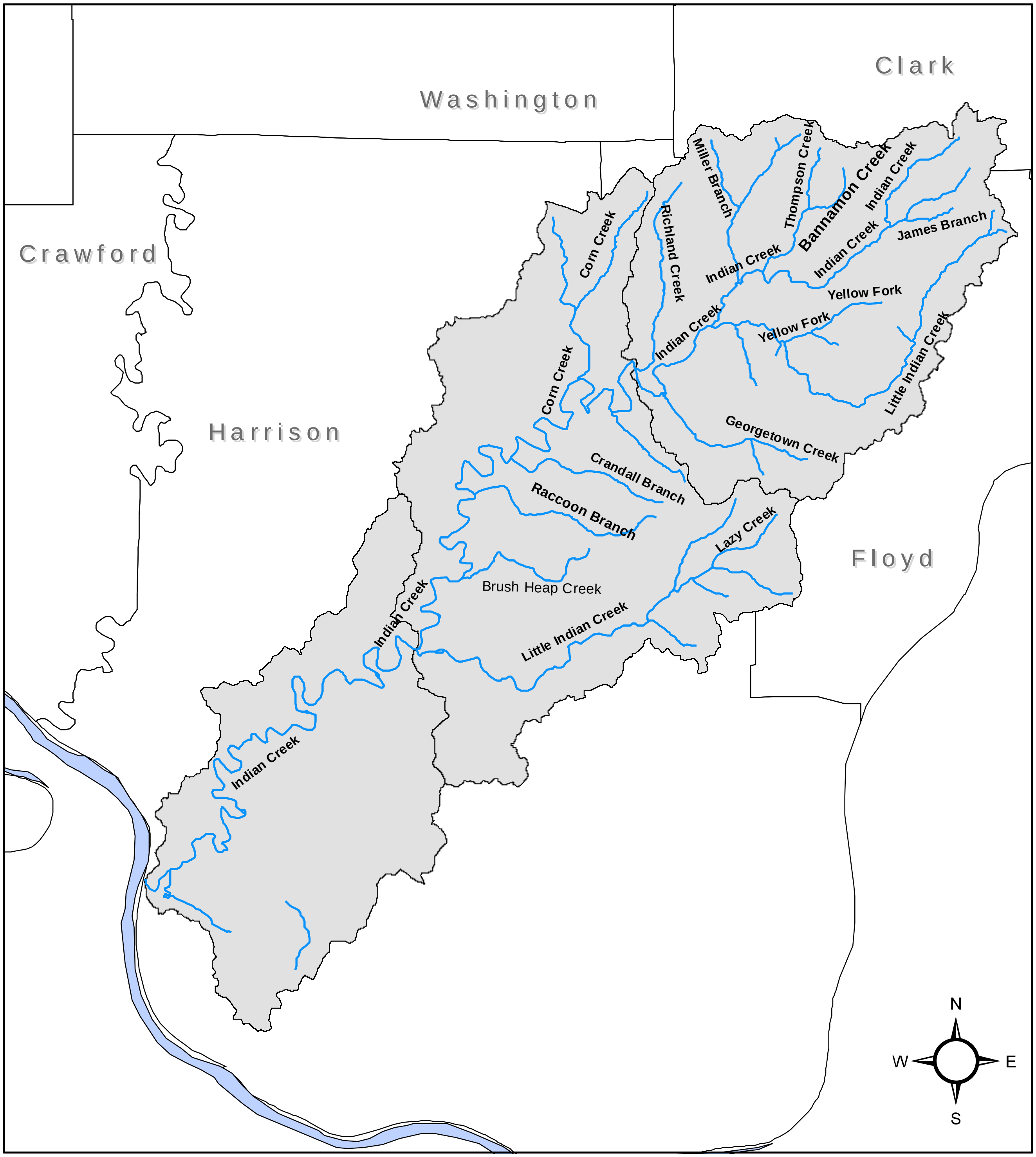


Karst Topography
Indian Creek Watershed
Cave Density
Karst Dye Trace
County Boundary
Cave Entrances per Square km
0 - 2
3 - 5
6 - 11
N
1:250,000
0
3,600
7,200
14,400 Meters
Fuller Mossbarger Scott & May
FMSM
ENGINEERS
M:\2006\JF2006001 HARRISON CO\TASK F WATERSHED PLAN\APPENDICES\Figure_7_CaveDensity.mxd



Indian Creek Watershed

Legend

- Indian Creek Stream
- Indian Creek Watershed
- Counties
- Ohio River

Fuller Mossbarger Scott & May
FMSM ENGINEERS

0 3,950 7,900 15,800 Meters

1:270,000

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Indiana County Endangered, Threatened and Rare Species List

County: Harrison

Species Name	Common Name	FED	STATE	GRANK	SRANK
Platyhelminthes (Flatworms)					
Sphalloplana chandleri	Chandler's Cave Flatworm		SE	G1G2	S1
Sphalloplana weingartneri	Weingartner's Cave Flatworm		ST	G3G4	S2
Diplopoda					
Cambala minor	A Millipede			G5	S2
Euryurus leachii	Leach's Milliped			G4	S2
Pseudotremia conservata	Tnc Cave Milliped			G1G2	S1
Pseudotremia indianae	Blue River Cave Milliped		SR	G4	S3
Scytonotus granulatus	Granulated Milliped			G5	S2
Crustacean: Malacostraca					
Crangonyx packardi	Packard's Cave Amphipod		SR	G5	S2
Miktoniscus barri	Barr's Terrestrial Isopod			G2G4	S2
Orconectes inermis inermis	A Troglobitic Crayfish			G5T3T4	S3
Crustacean: Copepoda					
Diacyclops jeanneli	Jeannel's Cave Copepod		SE	G3G4	S1
Crustacean: Ostracoda					
Sagittocythere barri	Barr's Commensal Cave Ostracod		WL	G5	S3
Mollusk: Bivalvia (Mussels)					
Alasmidonta viridis	Slippershell Mussel			G4G5	S2
Cyprogenia stegaria	Eastern Fanshell Pearlymussel	LE	SE	G1	S1
Epioblasma triquetra	Snuffbox		SE	G3	S1
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G4	S2
Lampsilis ovata	Pocketbook			G5	S2
Lampsilis teres	Yellow Sandshell			G5	S2
Ligumia recta	Black Sandshell			G5	S2
Obovaria retusa	Ring Pink	LE	SX	G1	SX
Plethobasus cooperianus	Orangefoot Pimpleback	LE	SE	G1	S1
Plethobasus cyphyus	Sheepnose	C	SE	G3	S1
Pleurobema clava	Clubshell	LE	SE	G2	S1
Pleurobema coccineum	Round Pigtoe			G4	S3
Pleurobema cordatum	Ohio Pigtoe		SSC	G3	S2
Pleurobema pyramidatum	Pyramid Pigtoe		SE	G2	S1
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula metanevra	Monkeyface			G4	S3
Quadrula nodulata	Wartyhack			G4	S3
Villosa lienosa	Little Spectaclecase		SSC	G5	S2
Mollusk: Gastropoda					
Antroselatus spiralis	Shaggy Cave Snail		ST	G3G4	S2
Carychium exile	Ice Thorn		ST	G5	S2
Fontigens cryptica	Hidden Springs Snail		SE	G1	S1
Ellipluran: Collembola					
Arrhopalites ater	Black Medusa Springtail		SE	G1G2	S1
Arrhopalites lewisi	Lewis' Cave Springtail		ST	GNR	S2
Dicyrtoma flammea	Flaming Springtail		SE	GNR	S1
Entomobrya socia	Social Springtail		ST	GNR	S2
Hypogastrura gibbosus	Humped Springtail		SE	GNR	S1
Hypogastrura helena	Helen's Springtail		SE	GNR	S1
Hypogastrura lucifuga	Wyandotte Cave Springtail		SE	GNR	S1
Hypogastrura maheuxi	Maheux Springtail		SE	GNR	S1
Hypogastrura succinea	Girded Springtail		SE	GNR	S1
Isotoma christianseni	Christiansen's Springtail		SE	GNR	S1
Isotoma truncata	Truncated Springtail		SE	GNR	S1
Isotomiella minor	Petit Springtail		ST	GNR	S2
Onychiurus casus	Fallen Springtail		ST	GNR	S2

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting
State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list
GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank
SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Indiana County Endangered, Threatened and Rare Species List

County: Harrison

Species Name	Common Name	FED	STATE	GRANK	SRANK
Onychiurus reluctus	A Springtail		SE	GNR	S1
Pseudosinella fonsa	Fountain Cave Springtail		ST	G3G4	S2
Sensillanura caeca	Blind Springtail		SE	GNR	S1
Sinella alata	Springtail		SR	G5	S3
Sinella avita	Ancestral Springtail		SE	G3G4	S1
Sinella barri	Barr's Cave Springtail		SE	G5	S1
Sinella cavernarum	A Springtail		ST	G5	S2
Sminthurides hypogramme			SE	GNR	S1
Sminthurides malmgreni	Malmgren's Springtail		ST	GNR	S2
Sminthurides weichseli	Weichsel's Springtail		SE	GNR	S1
Tomocerus elongatus	Elongate Springtail		SE	GNR	S1
Tomocerus lamelliferus	Layered Springtail		SE	GNR	S1
Tomocerus missus	Cave Springtail		SE	G4	S1
Insect: Coleoptera (Beetles)					
Aleochara lucifuga	A Beetle		SE	GNR	S1
Atheta annexa	A Beetle		SE	G2G4	S1
Catops gratiosa	A Beetle		SE	GNR	S1
Pseudanophthalmus eremita	Cave Beetle		SE	G1G2	S1
Pseudanophthalmus tenuis	Cave Beetle		ST	G3	S2
Quedius spelaeus	Spelean Rove Beetle		ST	GNR	S2
Insect: Lepidoptera (Butterflies & Moths)					
Amblyscirtes hegon	Salt-and-pepper Skipper		SR	G5	S2
Amblyscirtes vialis	Common Roadside-skipper		SR	G5	S3
Artogeia virginiensis	West Virginia White		SR	G3G4	S3
Calycopis cecrops	Red-banded Hairstreak		SR	G5	S2S3
Catocala flebilis	The Black-dashed Underwing Moth		SR	G5	S1S3
Cyllopsis gemma	Gemmed Satyr		SR	G5	S2
Erynnis martialis	Mottled Duskywing		ST	G3G4	S2S3
Grammia figurata	The Figured Grammia		SR	G5	S2S3
Grammia oithona	Oithona's Grammia		SR	G4Q	S2S3
Grammia phyllira	The Sand Barrens Grammia		SR	G4	S2S3
Hermeuptychia sosybius	Carolina Satyr		SR	G5	S1S2
Hesperia leonardus	Leonard's Skipper	No Status	SR	G4	S2
Hesperia metea	Cobweb Skipper		ST	G4G5	S2S3
Lesmone detrahens	A Moth		SR	G5	S2
Leucania inermis	A Moth		SR	G4	S2S3
Paectes abrostolella	The Barrens Paectes Moth		SR	G4	S2S3
Pagara simplex	A Moth		SR	G5	S2S3
Pangrapta decoralis	The Multicolored Huckleberry Moth		ST	G5	S2
Tampa dimediatella	Red-striped Panic Grass Moth		ST	GNR	S2S3
Thorybes pylades	Northern Cloudywing		SR	G5	S2S3
Insect: Mecoptera					
Merope tuber	Earwig Scorpionfly		SE	G3G5	S1
Insect: Odonata (Dragonflies & Damselflies)					
Aeshna mutata	Spatterdock Darner		ST	G4	S1S2
Gomphus crassus	Handsome Clubtail		ST	G3	S2
Gomphus viridifrons	Green-faced Clubtail		ST	G3	S1S2
Hagenius brevistylus	Dragonhunter		SR	G5	S2S3
Neurocordulia molesta	Smoky Shadowdragon		SE	G4	S1
Neurocordulia yamaskanensis	Stygian Shadowfly		ST	G5	S1S2
Stylogomphus albistylus	Least Clubtail		SE	G5	S1
Stylurus amnicola	Riverine Clubtail		ST	G4	S1S2
Stylurus notatus	Elusive Clubtail Dragonfly		SE	G3	S1

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County: Harrison

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Insect: Orthoptera					
Ceuthophilus brevipes	Spotted Cave Cricket		SE	GNR	S1
Melanoplus tepidus	The Fearful Barrens Locust		SR	GU	S1S3
Insect: Tricoptera (Caddisflies)					
Nectopsyche pavida	A Longhorned Casemaker Caddisfly		SR	G5	S2
Pycnopsyche rossi	A Northern Casemaker Caddisfly		SE	G3	S1
Arachnida					
Anahita punctulata	Southeastern Wandering Spider			G4	S1
Calymmaria cavicola	Cave Funnel-web Spider			GNR	S1
Chthonius virginicus	A Pseudoscorpion		SE	GNR	S1
Cicurina arcuata	A Funnel-web Weaver			GNR	S1
Dolomedes scriptus	Lined Nursery Web Spider			GNR	S1?
Dolomedes vittatus	Nursery Web Spider			GNR	S1
Erebomaster flavescens	Golden Cave Harvestman		ST	G3G4	S2
Hesperochernes mirabilis	Cave Pseudoscorpion		SE	G5	S1
Kleptochthonius packardi	Packard's Cave Pseudoscorpion		SE	G2G3	S1
Nesticus carteri	Carter's Cave Spider			GNR	S1
Fish					
Amblyopsis spelaea	Northern Cavefish		SE	G4	S1
Etheostoma camurum	Bluebreast Darter			G4	S1
Etheostoma maculatum	Spotted Darter		SSC	G2	S1
Etheostoma variatum	Variegate Darter		SE	G5	S1
Notropis ariommus	Popeye Shiner		SX	G3	SX
Typhlichthys subterraneus	Southern Cavefish			G4	S1
Amphibian					
Cryptobranchus alleganiensis alleganiensis	Hellbender		SE	G3G4T3T4	S1
Scaphiopus holbrookii holbrookii	Eastern Spadefoot		SSC	G5T5	S2
Reptile					
Agkistrodon piscivorus leucostoma	Western Cottonmouth		SE	G5T5	S1
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Crotalus horridus	Timber Rattlesnake		SE	G4	S2
Opheodrys aestivus	Rough Green Snake		SSC	G5	S3
Bird					
Accipiter striatus	Sharp-shinned Hawk	No Status	SSC	G5	S2B
Aimophila aestivalis	Bachman's Sparrow			G3	SXB
Asio otus	Long-eared Owl			G5	S2
Buteo lineatus	Red-shouldered Hawk		SSC	G5	S3
Coragyps atratus	Black Vulture			G5	S1N,S2B
Dendroica cerulea	Cerulean Warbler		SSC	G4	S3B
Haliaeetus leucocephalus	Bald Eagle	LT,PDL	SE	G5	S2
Helmitheros vermivorus	Worm-eating Warbler		SSC	G5	S3B
Lanius ludovicianus	Loggerhead Shrike	No Status	SE	G4	S3B
Wilsonia citrina	Hooded Warbler		SSC	G5	S3B
Mammal					
Corynorhinus rafinesquii	Rafinesque's Big-eared Bat		SSC	G3G4	SH
Lutra canadensis	Northern River Otter			G5	S2
Lynx rufus	Bobcat	No Status		G5	S1
Myotis grisescens	Gray Bat	LE	SE	G3	S1
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Neotoma magister	Eastern Woodrat		SE	G3G4	S2
Vascular Plant					
Acalypha deamii	Mercury		SR	G4?	S2
Agalinis auriculata	Earleaf Foxglove		ST	G3	S1
Arabis patens	Spreading Rockcress		SE	G3	S1

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Indiana County Endangered, Threatened and Rare Species List

County: Harrison

Species Name	Common Name	FED	STATE	GRANK	SRANK
Asclepias viridis	Green Milkweed		SE	G4G5	S1
Asplenium resiliens	Black-stem Spleenwort		SE	G5	S1
Asplenium ruta-muraria	Wallrue Spleenwort		SR	G5	S2
Aster oblongifolius	Aromatic Aster		SR	G5	S2
Bacopa rotundifolia	Roundleaf Water-hyssop		ST	G5	S1
Baptisia australis	Wild False Indigo		SR	G5	S2
Bumelia lycioides	Buckthorn		SE	G5	S1
Calamagrostis porteri ssp. insperata	Reed Bent Grass		ST	G4T3	S1
Carex crawei	Crawe Sedge		ST	G5	S2
Carex decomposita	Cypress-knee Sedge		ST	G3	S2
Carex eburnea	Ebony Sedge		SR	G5	S2
Carex gigantea	Large Sedge		ST	G4	S1
Carex straminea	Straw Sedge		ST	G5	S2
Ceanothus herbaceus	Prairie Redroot		SE	G5	S1
Chamaelirium luteum	Devil's-bit		SE	G5	S1
Cheilanthes lanosa	Hairy Lipfern		SR	G5	S2
Cimicifuga rubifolia	Appalachian Bugbane		SE	G3	S1
Clematis pitcheri	Pitcher Leather-flower		SR	G4G5	S2
Cornus amomum ssp. amomum	Silky Dogwood		SE	G5T5	S1
Dicliptera brachiata	Wild Mudwort		SE	G5	S1
Diodia virginiana	Buttonweed		WL	G5	S2
Eupatorium album	White Thoroughwort		ST	G5	S1
Eupatorium incarnatum	Pink Thoroughwort		ST	G5	S2
Gaura filipes	Slender-stalked Gaura		ST	G5	S2
Gentiana alba	Yellow Gentian		SR	G4	S2
Gentiana puberulenta	Downy Gentian		ST	G4G5	S2
Gentiana villosa	Striped Gentian		SE	G4	S1
Glyceria acutiflora	Sharp-scaled Manna-grass		SE	G5	S1
Gonolobus obliquus	Angle Pod		SR	G4?	S2
Heliotropium tenellum	Slender Heliotrope		ST	G5	S2
Hexalectris spicata	Crested Coralroot		SR	G5	S2
Houstonia nigricans	Narrowleaf Summer Bluets		SR	G5	S2
Hypericum denticulatum	Coppery St. John's-wort		ST	G5	S2
Hypericum dolabriforme	Straggling St. John's-wort		SR	G4	S2
Isoetes engelmannii	Appalachian Quillwort		SE	G4	S1
Itea virginica	Virginia Willow		SE	G4	S1
Juglans cinerea	Butternut		WL	G3G4	S3
Lathyrus venosus	Smooth Veiny Pea		ST	G5	S2
Lechea racemulosa	Illinois Pinweed		SE	G5	S1
Ligusticum canadense	Nondo Lovage		SE	G4	S1
Linum sulcatum	Grooved Yellow Flax		SR	G5	S2
Magnolia acuminata	Cucumber Magnolia		SE	G5	S1
Melica nitens	Three-flower Melic Grass		ST	G5	S2
Melothria pendula	Creeping Cucumber		SE	G5?	S1
Muhlenbergia capillaris	Long-awn Hairgrass		SE	G5	S1
Najas gracillima	Thread-like Naiad		ST	G5?	S1
Nothoscordum bivalve	Crow-poison		SR	G4	S2
Ophioglossum engelmannii	Limestone Adder's-tongue		SR	G5	S2
Orobanche ludoviciana	Louisiana Broomrape		SE	G5	S2
Oryzopsis racemosa	Black-fruit Mountain-ricegrass		SR	G5	S2
Oxalis illinoensis	Illinois Woodsorrel		WL	G4Q	S2
Oxydendrum arboreum	Sourwood		SR	G5	S2
Pachysandra procumbens	Allegheny Spurge		SE	G4G5	S1
Panicum bicknellii	A Panic-grass		SE	G4?Q	S1
Passiflora incarnata	Purple Passion-flower		SR	G5	S2

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Indiana County Endangered, Threatened and Rare Species List

County: Harrison

Species Name	Common Name	FED	STATE	GRANK	SRANK
Penstemon deamii	Deam Beardtongue		SR	G1	S1
Phlox amplifolia	Large-leaved Phlox		SR	G3G5	S2
Phlox bifida ssp. stellaria	Cleft Phlox		SE	G5?T3	S1
Polygala incarnata	Pink Milkwort		SE	G5	S1
Polypodium polypodioides	Resurrection Fern		SR	G5	S2
Polytaenia nuttallii	Prairie Parsley		SE	G5	S1
Prenanthes aspera	Rough Rattlesnake-root		SR	G4?	S2
Ranunculus pusillus	Pursh Buttercup		SE	G5	S1
Rhynchospora corniculata var. interior	Short-bristle Horned-rush		ST	G5TNR	S2
Rubus centralis	Illinois Blackberry		SE	G2?Q	S1
Rudbeckia fulgida var. fulgida	Orange Coneflower		WL	G5T4?	S2
Rudbeckia fulgida var. umbrosa	Coneflower		SE	G5T4T5	S1
Sanicula smallii	Small's Snakeroot		SR	G5	S2
Satureja vulgaris var. neogaea			ST	G5	S1
Saxifraga virginiensis	Virginia Saxifrage		WL	G5	S3
Scutellaria parvula var. australis	Southern Skullcap		WL	G4T4?	S2
Sedum telephioides	Allegheny Stonecrop		SR	G4	S2
Selaginella apoda	Meadow Spike-moss		WL	G5	S1
Solidago shortii	Short's Goldenrod	LE	SE	G1	S1
Sparganium androcladum	Branching Bur-reed		ST	G4G5	S2
Spiranthes vernalis	Grassleaf Ladies'-tresses		WL	G5	S2
Stenanthium gramineum	Eastern Featherbells		ST	G4G5	S1
Thalictrum pubescens	Tall Meadowrue		ST	G5	S2
Tragia cordata	Heart-leaved Noseburn		WL	G4	S2
Trichostema dichotomum	Forked Bluecurl		SR	G5	S2
Uvularia perfoliata	Bellwort		SE	G5	S1
Valerianella chenopodiifolia	Goose-foot Corn-salad		SE	G5	S1
Viola egglestonii	Eggleston's Violet		SE	G4	S1
Vitis rupestris	Sand Grape		SE	G3	S1
Waldsteinia fragarioides	Barren Strawberry		SR	G5	S2
Wisteria macrostachya	Kentucky Wisteria		SR	G5	S2
Woodwardia areolata	Netted Chainfern		SR	G5	S2
Zizia aptera	Golden Alexanders		SR	G5	S2
High Quality Natural Community					
Barrens - bedrock limestone	Limestone Glade		SG	G4	S2S3
Barrens - chert	Chert Barrens		SG	G2	S1
Forest - upland dry	Dry Upland Forest		SG	G4	S4
Forest - upland dry-mesic	Dry-mesic Upland Forest		SG	G4	S4
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3
Lake - pond sinkhole	Sinkhole Pond		SG	GU	S1
Primary - cave terrestrial	Terrestrial Cave		SG	GNR	SNR
Primary - cliff limestone	Limestone Cliff		SG	GU	S1
Primary - cliff sandstone	Sandstone Cliff		SG	GU	S3
Primary - wash gravel	Gravel Wash		SG	GU	S1
Wetland - swamp sinkhole	Sinkhole Swamp		SG	G2?	S1
Other					
Freshwater Mussel Concentration Area	Mussel Bed		SG	GNR	SNR

Indiana Natural Heritage Data Center
Division of Nature Preserves
Indiana Department of Natural Resources
This data is not the result of comprehensive county surveys.

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Indiana County Endangered, Threatened and Rare Species List

County: Floyd

Species Name	Common Name	FED	STATE	GRANK	SRANK
Platyhelminthes (Flatworms)					
Sphalloplana chandleri	Chandler's Cave Flatworm		SE	G1G2	S1
Crustacean: Malacostraca					
Caecidotea teresae	Groundwater Isopod		SE	G1G2	S1
Crangonyx forbesi				GNR	S3
Crustacean: Copepoda					
Diacyclops jeanneli	Jeannel's Cave Copepod		SE	G3G4	S1
Mollusk: Bivalvia (Mussels)					
Ligumia recta	Black Sandshell			G5	S2
Pleurobema cordatum	Ohio Pigtoe		SSC	G3	S2
Villosa lienosa	Little Spectaclecase		SSC	G5	S2
Insect: Lepidoptera (Butterflies & Moths)					
Artogeia virginiensis	West Virginia White		SR	G3G4	S3
Celastrina nigra	Sooty Azure		ST	G4	S2
Fish					
Esox masquinongy	Ohio River Muskellunge		SSC	G5	S4?
Amphibian					
Ambystoma barbouri	Streamside Salamander			G4	S3
Cryptobranchus alleganiensis alleganiensis	Hellbender		SE	G3G4T3T4	S1
Pseudotriton ruber ruber	Red Salamander		SE	G5T5	S1
Scaphiopus holbrookii holbrookii	Eastern Spadefoot		SSC	G5T5	S2
Reptile					
Cemophora coccinea copei	Northern Scarlet Snake		SE	G5T5	S1
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Tantilla coronata	Southeastern Crowned Snake		SE	G5	S1
Bird					
Dendroica cerulea	Cerulean Warbler		SSC	G4	S3B
Helmitheros vermivorus	Worm-eating Warbler		SSC	G5	S3B
Tyto alba	Barn Owl		SE	G5	S2
Wilsonia citrina	Hooded Warbler		SSC	G5	S3B
Mammal					
Lynx rufus	Bobcat	No Status		G5	S1
Myotis grisescens	Gray Bat	LE	SE	G3	S1
Vascular Plant					
Acalypha deamii	Mercury		SR	G4?	S2
Armoracia aquatica	Lake Cress		SE	G4?	S1
Crataegus chrysocarpa	Fineberry Hawthorn		SE	G5T5	S1
Crataegus intricata	A Hawthorn		SR	G5	S2
Hexalectris spicata	Crested Coralroot		SR	G5	S2
Isoetes engelmannii	Appalachian Quillwort		SE	G4	S1
Juglans cinerea	Butternut		WL	G3G4	S3
Passiflora incarnata	Purple Passion-flower		SR	G5	S2
Penstemon deamii	Deam Beardtongue		SR	G1	S1
Plantago cordata	Heart-leaved Plantain		SE	G4	S1
Ranunculus harveyi	Harvey's Buttercup		SE	G4	S1
Rubus deamii	Deam Dewberry		SX	G4?	SX
Sagittaria australis	Longbeak Arrowhead		SR	G5	S2
Scutellaria parvula var. australis	Southern Skullcap		WL	G4T4?	S2
Uvularia perfoliata	Bellwort		SE	G5	S1
High Quality Natural Community					
Barrens - bedrock siltstone	Siltstone Glade		SG	G2	S2
Forest - upland dry	Dry Upland Forest		SG	G4	S4
Other					
Freshwater Mussel Concentration Area	Mussel Bed		SG	GNR	SNR

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Indiana County Endangered, Threatened and Rare Species List

County: Floyd

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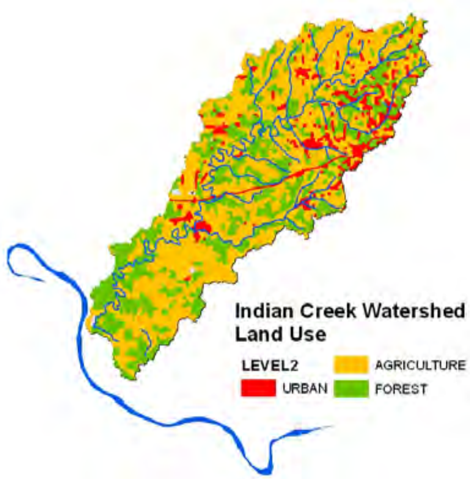
About the Indian Creek Watershed

Indian Creek is a 256-square-mile watershed located in southern Indiana. Towns include Georgetown, Greenville, Galena, Crandall, Lanesville and Corydon.

The watershed is about 48 miles long and 19 miles wide. The headwaters are located in the knobs of Clark and Floyd Counties. Indian Creek then flows through Harrison County to the Ohio River. Major tributaries include Corn Creek, Crandall Branch, Raccoon Branch, Brush Heap Creek and Little Indian Creek.

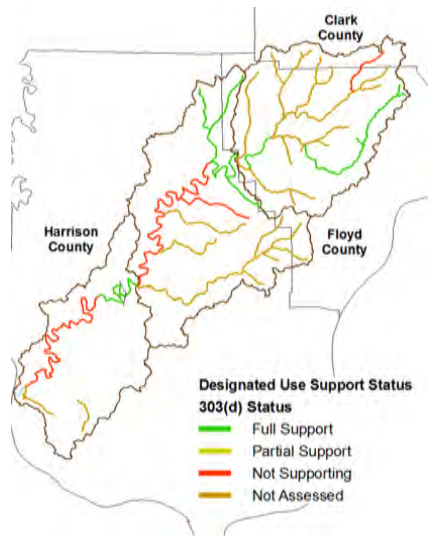
Land uses include agriculture (62%), forest (35%) and developed land (2.5%).



Indian Creek from the Floyd/Harrison County border to the Ohio River has been included on the Indiana Outstanding Rivers List due to its ecological importance.

Water Quality

The Indiana Department of Environmental Management (IDEM) monitored water quality in the Indian Creek watershed. IDEM compared the data to the State's Water Quality Standards to identify reaches with good water quality, those affected by pollution and those that need additional monitoring.



IDEM found that portions of Indian Creek and Crandall Branch have elevated levels of bacteria. Habitat and biological quality were impaired in Indian Creek and Little Indian Creek.

Through this project new monitoring data will be collected to evaluate water quality in the watershed. Results will be used to select watershed improvement and protection strategies.

Karst Features

The Indian Creek watershed includes many karst features such as caves, sinkholes and springs. Karst features are formed over centuries as rainwater dissolves limestone. Binkley Cave is an important karst feature in the watershed. At 22 miles long, it is the longest known cave in Indiana. Studies have indicated that Indian Creek feeds Binkley Cave, and the cave is connected to the Blue River.

Surface pollutants can travel underground rapidly in karst systems, where they can pollute wells. Protecting karst is important for safe water supplies. Through this project, sinkholes will be mapped and evaluated for possible pollution sources.

Watershed Goal

Foster economic development, preserve environmental quality and enhance the quality of life for all who live and work in the Indian Creek Watershed.

How can you get involved?

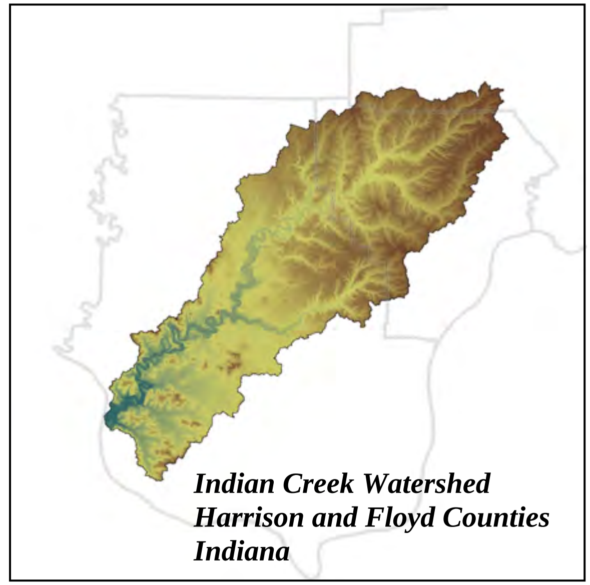
Visit our website

http://www.indiancreekwatershed.com/

Contact

Steve Hall, Watershed Coordinator
812-206-0100

Indian Creek Watershed Plan



Indian Creek Watershed
Harrison and Floyd Counties
Indiana

This project was funded by a Clean Water Act Section 205(j) grant from the US Environmental Protection Agency to the Indiana Department of Environmental Management to Harrison County, Indiana

What is a watershed?

A watershed is defined as an area of land that drains to a common point. A watershed is very much like a bowl; it has a ridge that defines its boundary and a valley that collects each drop of water that falls within its boundary.

Watersheds vary in size, and smaller watersheds exist within larger watersheds. A watershed can be a small area of land draining to a neighborhood pond or as large as the entire Mississippi River Basin.

Because we all live in a watershed, our individual and collective actions directly affect the quality of our watershed.

What is a watershed plan?

A watershed plan is a flexible framework for managing water quality and quantity within the watershed. Watershed boundaries rarely follow political boundaries. Thus, watershed planning creates a unique environment where multiple jurisdictions can work together to reduce duplication of effort and build on each other's resources and information to solve water-related problems. A multi-jurisdictional approach to addressing water quality issues often results in long-term cooperation and coordination among neighboring entities. Watershed plans identify strategies to address the most important issues currently facing the area and provide a mechanism to plan for the water resource needs of future generations.

Indian Creek Watershed Plan Subcommittee

The Harrison County Regional Sewer District formed the Indian Creek Watershed Plan Subcommittee.

Subcommittee Members

Daniel Lee, PE, Subcommittee Chair
Harrison County Regional Sewer District, & Tyson Foods

Anthony Combs
Harrison County Regional Sewer District & Harrison County Health Department

Gary Davis
Harrison County Council President

Ralph Schoen
Harrison County GIS

Tom Tucker
Harrison County Regional Sewer District

Eric Wise
Harrison County Planning Commission

Kevin Russell, PE
Harrison County Engineer

Don Lopp
Floyd County Planner

Indian Creek Watershed

Press Release

September 29, 2006

For immediate release

Contact:
Dan Lee, Harrison County Regional Sewer District (812-738-5853) daniel.lee@tyson.com

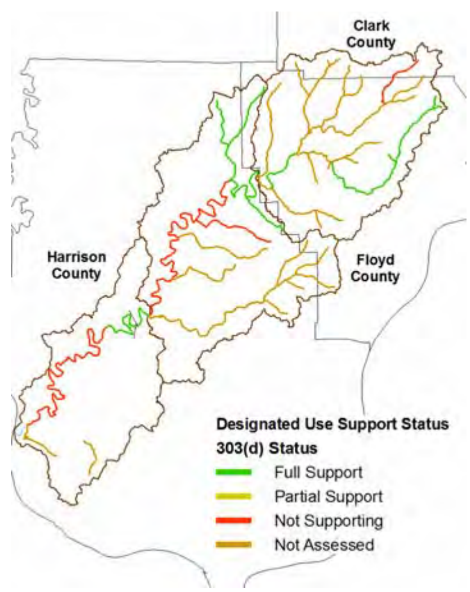
Harrison County receives grant to improve water quality
New Two-Year Project Targets Indian Creek Watershed

Corydon IN, September 22, 2006---improving water quality in the Indian Creek watershed will be the focus of a new 2-year study undertaken by the newly formed Harrison County Regional Sewer District (RSD). Through this USEPA grant-funded project, the RSD is developing a Watershed Management Plan for Indian Creek.

Indian Creek in Corydon.

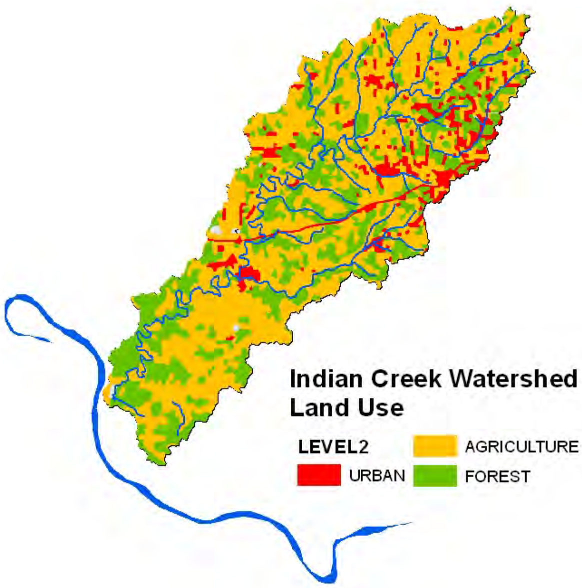
The RSD will develop a watershed management plan to provide a roadmap for protecting and improving water quality in Indian Creek. The plan will identify ways to address pollution and flooding for parts of Floyd and Harrison counties. The RSD formed the Indian Creek Watershed Subcommittee to oversee development of the Watershed Management Plan.

The project will create a resource library of water quality data, maps and other important information relevant to the watershed. In addition, project leaders will hold a series of community meetings to actively obtain input, comments and suggestions for the final watershed-based plan.



Dan Lee, Chair of the Indian Creek Watershed Subcommittee stated: “This project will produce a plan that consolidates past efforts and guides future activities to improve water quality throughout the Indian Creek watershed. The Indian Creek Watershed Management Plan grant will be a springboard to enhance future endeavors to improve Indian Creek for future generations. We are looking forward to community meetings with the public."

The Indian Creek Watershed drains portions of Floyd County and Harrison County before emptying into the Ohio River. Towns within the watershed include Greenville and Georgetown in Floyd County and Lanesville, Crandall and Corydon in Harrison County. Major tributaries to Indian Creek include Little Indian Creek, Thompson Creek, Richland Creek and Corn Creek in Floyd County, and Crandall Branch, Raccoon Branch, Brush Heap Creek and Little Indian Creek in Harrison County.



Over the past 20 years, developed land uses (i.e., commercial, industrial, residential) have increased and agricultural and forested land uses have decreased. This development has lead to increasing pressures on limited water resources and strained wastewater treatment facilities, as documented through water quality impairments. Based on state monitoring data, bacteria, siltation and low dissolved oxygen are affecting Indian Creek. Current indications are that septic systems, agricultural and urban runoff and loss of habitat are contributing to the impairments. The monitoring associated with the watershed plan development will help the RSD to better understand the pollution sources and how to manage them.

The southern portion of Indian Creek Watershed is characterized by sinkholes, springs and caves. In fact, the Indian Creek Watershed includes Indiana's largest cave system, Binkley Cave. The cave is home to bats, fish and insects that are uniquely adapted to cave habitats. Since pollutants can move rapidly from the surface to groundwater through sinkholes and caves, protecting karst systems will be an important component of the watershed plan. During the project, priority sinkhole locations will be mapped and the surrounding land uses will be characterized to identify potential pollution sources.

Tom Tucker, President, Harrison County Regional Sewer District, stated, "We believe that this watershed plan provides an opportunity for everyone to work together to maintain the wonderful quality of life that we have in Floyd and Harrison Counties, for ourselves and for our children and grandchildren."

The first community meeting is scheduled for Wednesday, October 18, 2-4 pm and will be held at the Harrison County Annex Building, 124 S. Mulberry St., Corydon. Additional information regarding this project and the meeting can be found at www.indiancreekwatershed.com or by contacting Steve Hall (shall@fmsm.com, 812-206-0100).

This work is funded by a grant from the U.S. Environmental Protection Agency under Section §205(j) of the Clean Water Act through the Indiana Department of Environmental Management to Harrison County.

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HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK WATERSHED PLAN

PUBLIC MEETING

October 18, 2006 2:00 PM to 4:00 PM

Harrison County Annex Building, 124 S Mulberry Street, Corydon

MEETING SUMMARY- FINAL

1. Introduction to Watershed Planning

Steve Hall and Karen Schaffer presented an overview of watershed planning. Highlights included a discussion of the history of the watershed plan project. An interchange for Lanesville is being planned and is anticipated to spur economic growth and associated needs for wastewater and stormwater services. Over 20 public meetings were held, and issues of concern included anticipated stormwater regulatory requirements, flooding, drainage, karst, septic systems, wastewater. A key concern was not to let growth get ahead of infrastructure. A Feasibility Study was prepared and lead to the formation of the Harrison County Regional Sewer District. The goals of the Feasibility Study and the Regional District are to foster economic development, preserve environmental integrity and enhance quality of life. These goals are also the goals of the watershed plan.

The Lanesville Interchange will bisect the Indian Creek Watershed. Alignments are along Crandall Branch and Indian Creek, which are on the State's 303(d) List of Impaired Waterbodies for *e. coli* impairments. Federal and state regulations do not allow new or expanded discharges of listed pollutants into impaired waterbodies, and IDEM has the authority to deny wasteload allocation requests for these discharges. In addition, IDEM will develop Total Maximum Daily Loads (TMDLs) – water quality clean up plans - that regulate point and nonpoint discharges into the impaired streams. These requirements pose additional regulatory burden on the District, communities and citizens. In addition, other wastewater facilities are anticipated to expand as package plants are taken out of service, and sewer service areas expand. One of the key benefits of the watershed plan is to develop a locally-driven approach to address impairments before the regulatory approaches are imposed by IDEM.

2. Watershed Plan Approach

The Watershed Plan provides an approach to coordinate the expansions to address key infrastructure needs and positions the District and watershed communities to receive additional grants to implement strategies identified in the watershed plan and provide tangible products for water resource managers and land use planners. Grants can be pursued prior to publication of a final Watershed Plan. Examples of funding sources and projects include:

- Nonpoint Source Management (319h) – 80% of available funds are targeted toward implementation projects. An example project is a review of codes and ordinances by renowned land use planning professionals to improve subdivision regulations for stormwater management. In Northern Indian, a project is underway to use thermal and infrared photography to identify failing septic systems and form a septic management district.

- Stream Restoration/ Lake Shore Stabilization

- Agricultural Cost Shares for riparian buffers – projects have resulted in reduced need for stormwater infrastructure.

- Flooding – FEMA provides HMGP (Hazard Mitigation Grant Program) and PDM (Pre-Disaster Mitigation) grants to communities to study and build solutions to flooding problems.

Monitoring and Assessment

FMSM has reviewed IDEMs 1999-2005 water quality data. Findings thus far are highlighted below.

- The 2006 303(d) List of Impaired Waterbodies does not include impairments identified through monitoring conducted by IDEM in 2005. These data will be used to develop the 2008 303(d) List.

- Based on our review of 2005 *e. coli* data, additional listings are likely in segments currently identified as meeting designated uses.

- Elevated phosphorus has also been identified in the Indian Creek below Corydon, but since IDEM is using a guideline, rather than a water quality criterion to assess phosphorus, IDEM may not list this stream segment as being impaired for phosphorus.

- IDEM found low dissolved oxygen (DO) at the bottom of the watershed that may be caused by Ohio River backwater. Because of the way that IDEM delineates waterbody “segments”, the low DO listing was applied to 17 miles of river. Through our monitoring program, we are evaluating this segment in 2 additional places. If DO is acceptable outside of the backwater area, we may work with IDEM to delist portions of this lower segment for DO.

- IDEM is developing a formal process to accept external data for the 303(d) List and initially considers our data “external”. However, since we are using a QAPP that IDEM will approve and their laboratory of choice– Indiana State Department of Health (ISDH), the RSD may want to work with them to accept our data and delist segments that meet water quality standards based on our data. Otherwise, IDEM may want to do additional monitoring themselves.

- Our monitoring program will include segments that IDEM has not sampled. It is possible that new problems will be identified. While this is a concern, it is also necessary so that the problems can be addressed proactively.

Fuller Mossbarger Scott & May FMSM ENGINEERS

3. Group Discussion

Flooding

- Flooding impacts facilities and production. The Tyson Foods facility was affected in the recent flooding event.
- Low head dams, the ford bridge and Little Indian Creek backwater are likely contributors and the problem is anticipated to worsen as the area develops.
- The system is very flashy, with floodwaters rising and receding very quickly. This may be attributed to high velocity runoff from local impervious surfaces.
- In the Blue River, agricultural buffers and stabilization projects have been implemented to mitigate flooding. Agricultural funding sources typically require significant match (up to 50%). Grants can be sought to offset the farmers match requirement.
- Contour practices can reduce agricultural runoff and soil erosion. These practices are common where rainfall is scarcer, but could be useful locally.
- FEMA HMGP and PDM grants are available to study the problem and build solutions. Data and documentation of the nature and extent of the flooding problem is critical to a successful application. Regional solutions can incorporate recreational uses such as linear parks along rivers. Lanesville has a series of parks that provide flood storage and recreational use.
- FEMA buy-outs for repetitive loss structures are also available. This has been used on 1-2 structures in Harrison County. Buy-outs compliment regional solutions by providing land.
- Floyd County involvement is very important since drainage from the knobs and developing areas is increasing. Floyd County is developing a stormwater utility that will provide a funding source for stormwater/drainage projects that could benefit Harrison County.
- The Watershed Plan should include a recommendation to identify possible flood control structures and locations.

Failing / Inadequate Septic Systems

- Failing septic systems are a problem, but are difficult to quantify. The dataset is new, complaint driven and typically arises from lack of percolation. Systems that are failing into karst features don't have percolation issues and are not being detected. Repairs can be triggered by failures or changes to the system such as expansions to handle home additions.
- New Salisbury and Laconia have more repair needs than Lanesville and Corydon.

- Projects to address this issue in other communities have included using GIS to analyze repair, failure and soils data and have resulted in identification of issues such as clay lenses and perched water tables that limit infiltration. Soil testing requirements were changed as a result.

- If septic systems failures are to be highlighted, it is important to bring solutions to homeowners. Some are not likely to have the financial means to repair failing systems.

- Some communities have implemented septic system districts that require routine inspections and pump-outs and repairs for failing systems. Fees are charged for the services, but are typically much lower than tie-on fees for sewage collection and monthly sewer bills. The RSD has the authority to address septic systems and septic education is a major charge for the RSD.

Other Issues

- Drainage is not well covered in Harrison County Ordinances

- A water quality problem – foaming – was identified in a Corn Creek cave stream near the Floyd County boundary. There is development in the area, served by septic systems that may be contributing. Existing data did not include these northern Harrison County karst features. This area could be examined further in the Sinkhole Inventory.

- The discussion so far has focused on problems, but preservation and protection are often less expensive and less onerous than remediation. Additional discussion on protection measures is needed.

4. Next Steps and Closing

- Although this was a good discussion, additional efforts to gain citizen involvement will be required in the future. Additional local advertising, non-Corydon location (e.g., Lanesville and other towns), evening time slot and refreshments were suggested as approaches to gain additional citizen involvement.

Culbertson Mansion Haunted House
Page 4

85th Year of Publication
Issue No. 47

Costume Carnival
Page 7

The Banner-Gazette

RECYCLED PAPER

Newsstand Price 25¢ Circulation 16,638 Wednesday, October 18, 2006 http://www.gbpnews.com

and the public the rest of the story.

New two-year project targets Indian Creek Watershed

Improving water quality in the Indian Creek watershed will be the focus on a new two-year study undertaken by the newly formed Harrison Count Regional Sewer District (RSD).

Through this USEPA grant-funded project, the RSD is developing a Watershed Management Plan for Indian Creek.

The RSD will develop a watershed managements plan to improve a roadmap for protecting and improving water quality in Indian Creek.

The plan will identify ways to address pollution and flooding for parts of Floyd and Harrison counties.

The RSD formed the Indian Creek Watershed Subcommittee to oversee the development of the Watershed Management Plan.

The project will create a resource library of water quality data, maps and other important information relevant to the watershed.

In addition, projects leaders will hold a series of community meeting to actively obtain, comments and suggestions for the final water-shed-based plan.

Dan Lee, Chair of the Indian Creek Watershed Subcommittee states: "This project will produce a plan that consolidates past efforts and guides future activities to improve water quality throughout the Indian Creek Watershed.

The Indian Creek Watershed Management Plan grant will be a springboard to enhance future endeavors to improve Indian Creek for future generations. We are looking forward to community meetings with the public."

The Indian Creek Watershed drains portions of Floyd County and Harrison County before emptying into the Ohio River. Towns within the watershed include Greenville and Georgetown in Floyd County and Lanesville, Crandall and Corydon on Harrison County. Major tributes to Indian Creek include Little Indiana Creek, Thompson Creek, Richland Creek, and Corn Creek in Floyd Counts and Crandall Branch, Raccoon Branch, Brush Heap Creek and Little Indian Creek in Harrison County.

Tom Tucker, President, Harrison County Regional Sewer District, states "We believe that this watershed plan provides an opportunity for everyone to work together to maintain the wonderful quality of life that we have in Floyd and Harrison Counties, for ourselves and for our children and grandchildren."

The first community meeting is scheduled for Wednesday, October 18 from 2-4 p.m. and will be held at the Harrison County Annex Building, 124 S. Mulberry street in Corydon.

For additional information regarding this project and the meeting please look at the following website www.indiancreekwatershed.com or by contacting Steve Hall at 812-206-0100.

Master Gardener training

If you have a strong interest in gardening and enjoy helping others, you are invited to enroll in the Purdue University Master Gardener training program. The Floyd County Office of the Purdue Extension will hold the 2007 Master Gardener training series on Monday afternoons from 1 to 4 p.m. beginning January 8, 2007 and continuing every Monday through March 26. The meetings will be held at the

Such services could include teaching planting and maintaining the Extension demonstration gardens, answering gardening questions from the public and more.

Training class size is limited and is based on receipt of completed application and deposit. Those accepted in the 2007 class must pay for material fees of $100 and a $25 deposit. The deposit will be refundable upon your completion of the

Help Protect Water Quality in Your Community

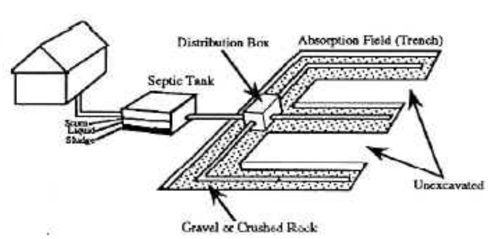
Indian Creek Watershed Management Plan

The Indian Creek watershed drains 256 square miles and includes approximately 176 miles of streams which flow to the southwest, eventually draining to the Ohio River. Towns in the watershed include Galena, Greenville and Georgetown in Floyd County and Lanesville, Crandall and Corydon in Harrison County.

A watershed management plan is being developed for Indian Creek by a Subcommittee of the Harrison County Sewer District. The watershed plan will include a description of water quality and quantity issues and identify strategies to address important issues. A strategy for measuring progress of implementation and changes in water quality and quantity will also be developed. One of the issues that has been identified in the watershed is elevated levels of bacteria, a common problem in Indiana and throughout the U.S. Elevated bacteria may come from wildlife, livestock, pets and/or malfunctioning septic systems as well as other sources.

The southern half of the Indian Creek Watershed is underlain with **karst** geology including Binkley Cave, the largest known cave in Indiana. Karst features include sinkholes, springs, and caves and underground channels. Contaminants near the surface can travel quickly into sinkholes, caves and groundwater without being broken down by soil. Therefore, water quality in this area is delicate and easily impacted. There are over 250 wells in the Indian Creek watershed used for drinking water and agricultural supplies, many in the karst region.

Septic systems need proper care and maintenance. Because of the identified problem with elevated bacteria, combined with karst geology, special attention is being paid to septic systems. Although septic systems can be a safe and effective way of treating wastewater, malfunctioning septic systems can contribute to the elevate bacteria levels in groundwater and surface water posing a threat to the environment and human health. Many households in Floyd and Harrison County use septic systems.



Conventional Septic System

A typical septic system has four main components: a pipe from the home, a septic tank, a drainfield, and the soil. These components are typically buried near the home. The septic tank holds the wastewater long enough to allow solids to settle out and oil and grease to float to the surface. It also allows partial decomposition of the solid materials. The wastewater exits the septic tank and is discharged into the drainfield for further treatment by the soil. Microorganisms in the soil provide final treatment by removing bacteria, viruses, and nutrients.

Tips for Septic System Owners

- **Don't overload your septic system** – Fix leaking faucets and toilets and use water efficiently, space out laundry loads, Route surface water drainage away from leach field - Keep gutters and basement sump pumps from draining into or near your septic system.
- **Flush responsibly** – Dental floss, feminine hygiene products, diapers, cotton swabs, cigarette butts, coffee grounds, cat litter, paper towels, etc. can clog and potentially damage septic system components.
- **Dispose of hazardous chemicals properly** – Flushing household chemicals, gasoline, oil, pesticides, antifreeze, or paint can slow or stop the biological treatment. Check with your local waste department for household hazardous waste pickup.
- **Regular Maintenance** – Have your tank pumped and inspected by a professional at least every 3 years or as recommended by the manufacturer.
- **Drainfield care** – Avoid driving or parking vehicles on your drainfield. Plant only grass over and near your septic system. Roots from nearby trees or shrubs might clog and damage the system. Do not apply manure or fertilizers over the drainfield.
- **Careful use of additives** – **Check** with your local health department before using additives since they do not eliminate the need for periodic pumping.

Ways to Know Your System in Not Functioning Properly

- Sewage surfacing over the lateral field
- Sewage backing up in the house or basement
- Mushy ground of greener grass in the area of the lateral field
- Slowly draining toilets or drains
- Sewage odors

More information

For more information regarding the Indian Creek Watershed Management Plan see www.indiancreekwatershed.com or contact Karen Schaffer at 812-206-0100.

For more information on septic systems contact: Floyd County Health Department at 812-948-4726 or http://www.floydcountyhealthdept-in.com/, Harrison County Health Department at 812-738-3237 or http://www.harrisoncountyhealth.com/index.htm or visit EPA's Septic Systems page at http://cfpub.epa.gov/owm/septic/homeowners.cfm#steps.

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK WATERSHED PLAN

PUBLIC MEETING

July 24, 2007 6:30 to 8:00 PM

Lanesville Jaycees Building

MEETING SUMMARY- DRAFT

1. Introduction to Watershed Planning

Steve Hall provided an explanation of the history of the project. RSD was formed to ensure poor water quality did not result from new development in Harrison County. Proximity to Louisville makes Harrison County an area posed for development. The proposed Lanesville corridor project north of I-64 near Lanesville is expected to be a center for new residential, commercial, and industrial development. Monitoring conducting under the watershed management plan will help to provide an understanding of baseline conditions prior to future development. The watershed plan is meant to focus on the most important issues and move forward to implement solutions. It will also help to address future water resource needs in Harrison County.

2. Draft Watershed Plan

Karen Schaffer, Watershed Coordinator gave a presentation explaining the tasks to be completed under the watershed plan and the progress made on chapters one and two.

Two of the main issues identified in the watershed are elevated bacteria and low dissolved oxygen. Indiana Department of Environmental Management sampled several locations in the watershed and the found many miles of streams to be impaired. Due to elevated bacteria, which are evident in IDEM sampling, 36.65 miles of streams are considered impaired for primary contact recreational use. Due to low dissolved oxygen (DO) and aquatic habitat scores given by IDEM, 20.89 miles of streams are considered impaired for aquatic life support.

So far one monitoring event has taken place under the Watershed Plan. *E.Coli* and flow were tested. The *E.Coli* results are not yet available from the lab. Very low flow readings were observed in the Watershed. Four of the 10 sites were observed as having 0 feet per second flow.

The sinkhole inventory is underway to map existing sinkholes. Using GIS analysis there are 14,687 possible sinkhole locations identified in the Harrison County portion of the Watershed.

3. Group Discussion

Meeting attendees discussed the following topics as they relate to Indian Creek:

- **Uses of Indian Creek:**
  - Aesthetic value
  - Recreation & Wading
  - Livestock crossing
  - Stormwater conveyance
  - Agricultural water supply
  - Indian Creek Greenway Trail
- **Water Quality Issues and Concerns:**
  - Water/ Stormwater Quality
    - Water runs red around development areas
  - Septic systems
    - State Department of Health does not approve mound septic systems although they may be a better option for a highly karst area
    - Straight pipes
    - May fail into karst systems providing little evidence from the surface
  - Stormwater quantity (Flooding)
    - We can not stop development, what can we do?
    - Can we really control floods?
    - Straightening of Indian Creek for rapid stormwater conveyance, which leads to further water quality and flooding problems
    - Erosion problems in the headwaters of Floyd County portion of the watershed effect Harrison County downstream
    - Bridge near Lanesville Jaycees building seems to be causing a flooding problem in the area because of restricted flow
    - Control of mosquito and pests in future retention/detention ponds
    - Some retention ponds will open up into karst

        - Lanesville drainage problem

- **Critical Areas for Water Quality:**
    - Upcoming meetings on stormwater ordinance with RSD and Harrison County Commissioners
- **Recommendations for Improvements or Enhancements:**
    - Stormwater quantity (flooding)
        - Create ponds on farms
        - RSD ordinance to control bridge placement (strategy to address flooding issues)
        - RSD has requested to view all new development plans to help insure smart development (no more water leaving site faster that than predevelopment)
        - Better controls for stormwater runoff needed
    - Septic systems
        - Public education on septic systems – key
        - More data on septic systems is needed
        - Septic system management district as used in Allen County to charge monthly fee for inspections, repair, and pump of septic systems
        - Research alternative septic systems
    - Water/ Stormwater Quality
        - Buffers for runoff should be used
        - Stabilize creek crossing areas with grasses
        - Cows should be kept out of the creeks
    - Overall
        - ID priorities to secure funding for implementation
        - Not all parcels are suitable for development in Harrison County; the Karst ordinance will help to control development in ill-suited areas

The following priorities were given for the Watershed Management Plan by the attendees using votes:

- Stormwater quantity (5 votes)

- Septic systems (5 votes)
- Water/ Stormwater Quality (4 votes)
- Karst issues (1 vote)

4. Next Steps and Closing

Next steps include completing water monitoring, assessing data, completing sinkhole inventory, continuing to hold Public Outreach Events, and producing Watershed Plan.

The Corydon Democrat
Corydon, Ind.
Community
October 10, 2007 Section B

Ross Schulz

Stacey Jarboe, left, and Sam Call, both of FMSM Engineers, test the waters by collecting samples of aquatic life of Indian Creek last month to determine the quality as part of the Indian Creek Watershed Management Plan. Prevalent in these waters are crayfish, clams, snails and minnows, along with many others.

10 sites part of Indian Creek watershed testing

By LINDSEY CORLEY
Staff Writer
lcorley@corydondemocrat.com

In planning for watershed management, testing the streams and determining water quality is an early step. Several engineers and a lead aquatic insect specialist sampled 10 sites last month within the Indian Creek watershed for just that reason, as part of the on-going Indian Creek Watershed Management Plan.

Stacey Jarboe, Steve Hall and Sam Call, all of Fuller, Mossbarger, Scott and May, the engineering firm in Jeffersonville behind the water management plan, spent most of Sept. 20 testing the waters in and near Harrison County. They were looking for three different things in their tests: chemical content, biologic communities and habitat assessments.

Chemicals in the water were tested through samples sent back to the lab. Biologic communities required a more hands-on approach, that's why Call was involved. Call is the lead aquatics insect specialist on the Indian Creek Watershed team. He has 25 years experience working with water issues in Kentucky and currently teaches at Bluegrass Community College in Lexington, Ky. Call said testing biologic communities can determine water quality in ways chemical testing cannot.

"Aquatic insects spend almost all their life in the water," Call said. "We get a general idea of water quality over time (by looking at them). The communities will show if it's been bad along the way."

A habitat assessment is just looking at the physical conditions of the stream to determine if those things have an impact. One obvious one in Indian Creek is the lack of shade over the water, which during summer months can elevate the temperatures of the water. Such hot water is a habitat that can be destructive to its inhabitants.

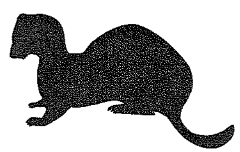
These tests, which will have results determined in about 60 days, will then be compared with a state database of information to see how they compare. In fact, some streams that the Indiana Dept. of Environmental Management has already assessed were chosen because of the information already known. That way, a comparison is "apples to apples," Hall explained. He also said they would be testing other streams to "fill in the gaps" of information.

Of the 10 sites tested, all were for water quality, chemicals or pollutants; testing for fish or bugs was also done at five of the sites.

Once the water quality information is completed, Hall said the next part of the Indian Creek Watershed Management Plan will be to make recommendations for protecting good areas and restoring areas in need, as well as planning and developing policies for growth that would help or maintain water quality.

Blue River Project Office

Allen Pursell, Project Director
Cassie Hauswald, Project Assistant
Bonnie Wolf, Land Steward
Meredith Bland, Land Protection Specialist
Phone/Fax: (812) 737-2087
www.nature.org/indiana



Don't forget to check out the new Rabbit Hash Trail

Some Volunteers/Contributors We'd Like to Thank

Jacob Beard
Bob Beck
Merle Behr
Orrie Bender
Joe Bina
Panaena Bina
Tim Brothers
Lewis Brown
Justin Conrad
Lana Cullison
Sam Cunningham
Dave Elliott
Margaret Fonda
Rick Harvey
George Herbener
Jim Isbell
Laura Lenkey
Lewis Lenkey
Mark Macomas
Jeff Ray
Ed Runden
Steve Schaftlein
Elliott Thompson
Charles Willmering

Harrison County Community Foundation
Boy Scout Troop#47 Elizabeth, IN

The newsletter for Southern Indiana's Natural Areas

Printed on Recycled Paper

Stacey Jarboe
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Jeffersonville IN 47131

Blue River Project Office
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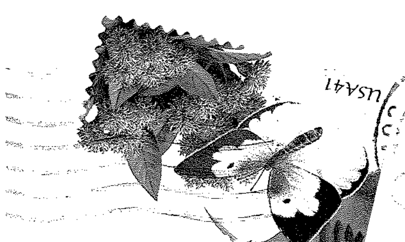
Laconia, Indiana 47135

The Nature Conservancy



The Nature Conservancy

Blue River News

Supporting the health and quality of Southern Indiana Ecosystems Issue 2, 2007

The Otter's Return to Indiana

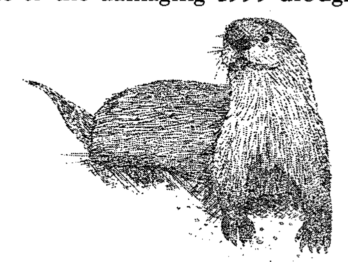
By Cassie Hauswald

Fun-loving, frisky, free-spirits of freshwater ...river otters personified. The fluid movement of a river otter embodies grace and hints at the power of this diving denizen of Indiana.

As a member of the weasel family, otters are mostly nocturnal with peak activity between midnight and dawn. Fish, crayfish, invertebrates, and small mammals make up a majority of the carnivore's diet. Otter's prefer slow-moving, clean water with plenty of small fish and ample cover. Often, beaver presence is mirrored by the appearance of otters that can use the beaver dens as cover. An otter's predatory prowess is a product of several adaptive features, including: valve-like nose and ear flaps that seal out water as it dives for several minutes, sensitive whiskers that help it to find slower-moving fish in murky water, and eyes situated atop its head so as to survey the water surface for danger while remaining unnoticed.

Ripples on the water's surface or a mud slide along a river bank are often the only clues to a river otter's presence. They shy away from humans and rightly so. Settlement of the Midwest coincided with the decline in otters as entire forests were converted to open farm ground and as early settlers realized the value of otters to the fur trade. Like all animals, otters are dependent upon a steady food supply and polluted water does not support healthy fish and aquatic invertebrates nor will it support a booming otter population. Occupying abandoned beaver dens, root wads of large streamside trees, and other equally messy tangles of vegetation, otters are most comfortable near water, preferring a forested corridor between rivers, lakes, and wetlands. As Indiana's stream corridors have slowly reforested and improvements in water quality have been made, the time was ripe for otter reintroductions.

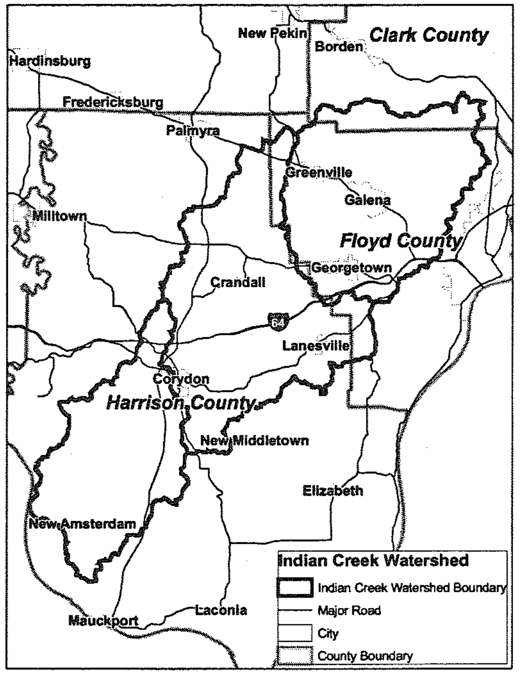
After a 50 year absence, otters were re-introduced to 6 Indiana watersheds in the late 1990's with releases on Blue River occurring in February of 1999. Coincidentally, the summer of that year was one of the worst droughts on record in this area. Studies conducted on Blue River show that the many fish are still recovering from the drought of 1999 and with the follow-up drought of 2007 fish numbers can be expected to again show a decline. So while it is true that otters eat fish, the decline in some fish species over the past several years in Blue River is most likely due to the damaging 1999 drought.



Recently removed from the state's list of endangered animals, the river otter now occupies 65 Indiana counties. In southern Indiana, they have spread out to occur in all major watersheds. From 1995 to 2005, researchers with the Indiana Division of Fish and Wildlife conducted a study in which 1328 records of sightings, accidental

Continued on page 3

Protect Community Water Quality
Indian Creek Watershed Management Plan



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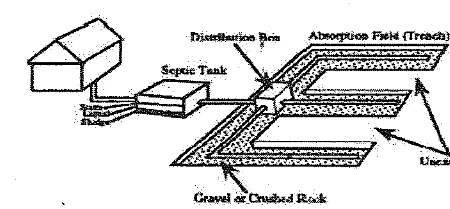

Conventional Septic System

Indian Creek Watershed

Press Release

January 25, 2008

Questions regarding publication details should be addressed to:

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For immediate release

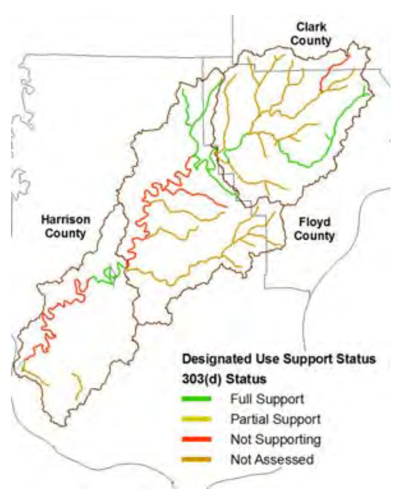
Indian Creek Watershed Management Plan Drafted
Community Input Meeting: February 5, 2008

The Harrison County Regional Sewer District (RSD) Indian Creek Subcommittee has drafted a plan to address key water quality issues in the Indian Creek Watershed. Community participation will play a crucial roll in implementing the changes needed to protect and improve the Indian Creek Watershed.

The RSD Indian Creek Subcommittee would like to invite citizens of Harrison, Floyd, and Clark Counties to attend the Indian Creek Community Meeting on Tuesday, February 05, 2008 from 7:00 to 8:30 PM at the Harrison County Annex Building, 124 S. Mulberry Street in Corydon, Indiana. Refreshments will be provided.

The meeting will focus on biological and water quality monitoring results and watershed management strategies. The evening will facilitate conversation and input regarding the Indian Creek Watershed Plan which is now in draft form. Input from the meeting will be used to finalize the plan, which will be submitted to Indiana Department of Environmental Management (IDEM) in March, 2008. The Watershed Plan will be a valuable tool to coordinate efforts and provide a timeline for steps needed to address the water quality and flooding issues.

The drainage area for the Indian Creek Watershed is 256 square miles. The Watershed drains portions of Floyd County, Harrison County, and Clark Counties before emptying into the Ohio River. Towns within the watershed include Greenville and Georgetown in Floyd County and Lanesville, Crandall and Corydon in Harrison County. Major tributaries to Indian Creek include Little Indian Creek, Thompson Creek, Richland Creek and Corn Creek in Floyd County, and Crandall Branch, Raccoon Branch, Brush Heap Creek and Little Indian Creek in Harrison County. A detailed map showing roads and impaired streams within the watershed is available at www.indiancreekwatershed.com.



IDEM monitoring results indicated that portions of the Indian Creek, Crandall Branch and Devils Backbone have elevated levels of bacteria. Habitat and biological quality were considered to be impaired in Little Indian Creek and Devils Backbone.

The Watershed is located in a karst region. Karst features include sinkholes, springs, caves and underground channels. Some of the water leaves the channel of Indian Creek travels though underground channel(s) reemerging at Harrison Spring in a separate watershed system. Due to these karst features, surface contaminants can travel quickly into sinkholes, caves and groundwater or can resurface in streams without being filtered and broken down by soils. Therefore, water quality in this area is delicate and easily impacted.

Goal: Foster economic development, preserve environmental quality and enhance the quality of life for all who live and work in the Indian Creek Watershed.

For additional information on the project visit www.indiancreekwatersed.com or contact Karen Schaffer, Watershed Coordinator, 812-206-0100; karen.schaffer@stantec.com.

This work is funded by a grant from the U.S. Environmental Protection Agency under Section §205(j) of the Clean Water Act through the Indiana Department of Environmental Management to Harrison County.

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INDIAN CREEK WATERSHED PLAN

COMMUNITY MEETING

TUESDAY FEBRUARY 5, 2008

7:00PM—8:30PM

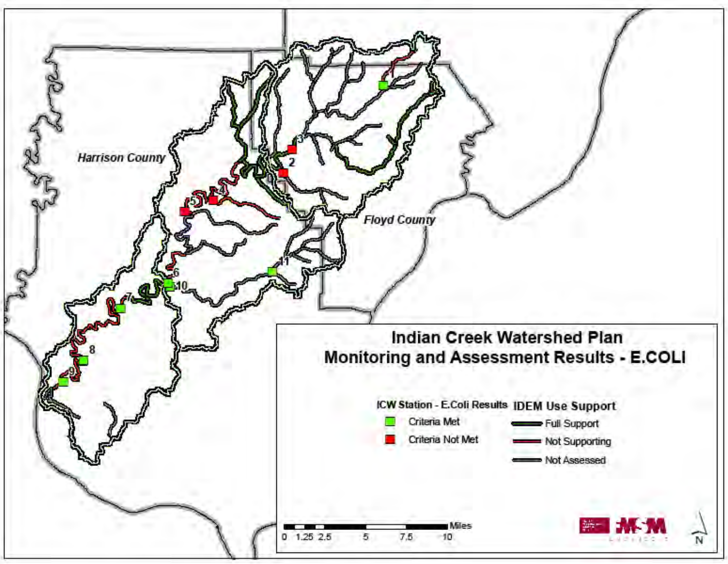
Harrison County Annex Building,
124 S Mulberry Street, Corydon, IN

Why a watershed plan?

To address water quality and quantity issues in the Indian Creek Watershed, including flooding and elevated bacteria.

Why should I get involved?

Your input is needed to help complete and implement the watershed plan.



"Foster economic development, preserve environmental quality and enhance the quality of life for all who live and work in the Indian Creek Watershed."

- **Watershed Plan Approach Overview**
- **Monitoring Approach and Results**
- **Strategy and Implementation**
- **Group Discussion**
- **Next Steps and Closing**

R E F R E S H M E N T S P R O V I D E D

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Phone: 812-206-0100
E-mail: karen.Schaffer@stantec.com

Visit us at
www.indiancreekwatershed.com

The Corydon Democrat

Accessed Website
Thu, Feb 14, 2008 02:04 PM

News
Issue of February 13, 2008

Hearings conclude on watershed plan

Lindsey Corley write the author

February 13, 2008 | 08:24 AM

In the third and final public meeting involving the Indian Creek Watershed Management Plan, Karen Schaffer, watershed coordinator, spent time with a group of citizens concerned about the future of the Indian Creek Watershed.

Schaffer first discussed results from water quality testing performed by the team from Stantec Consulting Services (formerly FMSM Engineers) last September. Ten sites were tested, and there was some overlap in areas monitored already by the Indiana Dept. of Environmental Management. Some areas, though, were completely new. Of those 10 monitored, some level of bacteria was found in four of the areas tested.

Schaffer said she and her team used a tool created by the Environmental Protection Agency called a Bacteria Indicator Tool, a spreadsheet tool used to estimate contribution of bacteria sources.

"We really honed in on bacteria problems," she said.

The results showed higher levels in western Harrison County and around lower Indian Creek. Septic system waste and potential water quality hazards due to failing systems were seen to have a greater potential for issues in Floyd County than in Harrison County. For cattle and other agricultural loadings, it was just the opposite, with the results being higher in Harrison County than in Floyd.

Dissolved oxygen content was also tested, and Schaffer said this was a good indicator of water quality as a whole.

"Actually, these looked pretty good," she said.

Only one site was designated as a problem with DO, Indian Creek above Lickford Bridge Road. IDEM had already tagged this particular site as a problem area due to the backwater from the Ohio River. Schaffer called this a "natural occurrence."

She admitted part of the testing was affected by the severe drought Harrison and Floyd counties experienced during the summer. When testing biotic integrity, or the number and kinds of insect life present in the water, two sites were unable to be tested at all.

"(There were) pretty stressed conditions out there," Schaffer said, due to the drought.

Schaffer also presented results of sinkhole testing to the audience, showing more than 14,000 possible sinkhole locations found in Harrison County and more than 150 combined found in Clark and Floyd counties.

Now, as the end of the grant for the Indian Creek Watershed Management Project is coming to a close, Schaffer also wanted to focus on goals, decisions and ways of measuring progress in the months and years to come. They want to finalize this iteration of the plan while knowing that in five or 10 years, it will be revamped, Schaffer said.

The management measures she and her team have identified are septic systems, agriculture, urban areas, karst geography, monitoring and assessment.

For septic systems, since so many local residents use them and there isn't a good database of where they are, Schaffer said she wants to find a "good pallatable, political way" to stop what could be a large problem later. That could include education workshops on how to keep the systems running cleanly and smoothly, and instating operation and maintenance requirements.

Agriculturally, since livestock waste could further impair the quality of the water, Schaffer and the audience members discussed plans like a watershed stewardship program and giving financial assistance to farmers to help create a buffer.

As for further monitoring and assessment, Schaffer said the final plan will be presented Feb. 29 to IDEM, and part of what they could begin to do is to apply for additional implementation funds for the improvements or enhancements recommended in the plan.

For more information regarding the Indian Creek Watershed Management Plan, log on to www.indiancreekwatershed.com.

IDEM Water Quality Data Summary

PARAMETER	**e. coli**									
CRITERION	April 1 to Oct 31, Geomean </= 125 CFU/100 ml and single sample max <576 CFU/100 ml									
SITE	**WATERBODY**	**LOCATION**	**START**	**STOP**	**N**	**Min**	**GEOMEAN**	**MAX**	**> 576**	**STATUS**
OBS080-0001	Little Indian Cr	Banet Rd			0					Not Assessed
OBS080-0004	Little Indian Cr	Near Galena			0					Not Assessed
OBS080-0005	Indian Cr	@ Greenville Road, NW of Georgetow	07/10/00	08/07/00	5	64	128.3	180	No	Acceptable
OBS080-0007	Georgetown	Parent Lake			0					Not Assessed
OBS080-0008	Indian Cr	Navilleton Rd	06/07/05	07/06/05	5	163.1	561.1	3255	Yes	Impaired
OBS090-0002	Indian Cr	Southern RR			0					Not Assessed
OBS090-0004	Indian Cr	@ SR 335 near Corydon Junction	07/10/00	08/07/00	5	74	417.5	2100	Yes	Impaired
OBS090-0005	Indian Cr	Landmark Way	06/08/05	07/07/05	5	72.3	308.5	1203.3	Yes	Impaired
OBS090-0007	Indian Cr	Pleasant Valley Rd	06/08/05	07/07/05	5	133.3	423.5	2602	Yes	Impaired
OBS100-0001	Indian Cr	Rocky Hollow Rd			0					Not Assessed
OBS100-0004	Indian Cr	City Park S of Corydon, SR 135	09/13/00	03/15/01	2	69	157.6	360	No	Not Assessed
OBS100-0005	Indian Cr	Corydon City Park, off SR 135 S			0					Not Assessed
OBS100-0006	Indian Cr	at Lickford Bridge Rd	07/12/00	08/09/00	5	20	162.9	833	Yes	Impaired
OBS100-0007	Indian Cr	Downstream of Little Indian Cr mouth	07/12/00	08/09/00	5	33	364.7	4500	Yes	Impaired

IDEM Water Quality Data Summary

PARAMETER	Dissolved Oxygen									
CRITERION	>/= 4.0 mg/L (instantaneous); >/= 5.0 mg/L (daily average)									
SITE	**WATERBODY**	**LOCATION**	**START**	**STOP**	**N**	**Min**	**AVG**	**MAX**	**% < 4.0 mg/L**	**STATUS**
OBS080-0001	Little Indian Cr	Banet Rd	05/18/00	09/06/00	4	8.4	9.2	10.8	0	Full Support
OBS080-0004	Little Indian Cr	Near Galena	03/28/00	08/01/00	19	8.4	10.4	12.2	0	Full Support
OBS080-0005	Indian Cr	@ Greenville Road, NW of Georgetow	07/10/00	08/07/00	5	6.5	7.6	8.9	0	Full Support
OBS080-0007	Georgetown	Parent Lake			0					Not Assessed
OBS080-0008	Indian Cr	Navilleton Rd	05/26/05	09/13/05	10	8.4	10.5	12.0	0	Full Support
OBS090-0002	Indian Cr	Southern RR	05/18/00	09/05/00	3	7.5	7.6	7.9	0	Full Support
OBS090-0004	Indian Cr	@ SR 335 near Corydon Junction	07/10/00	08/07/00	5	6.1	7.6	8.9	0	Full Support
OBS090-0005	Indian Cr	Landmark Way	05/24/05	09/13/05	10	5.2	7.9	11.5	0	Full Support
OBS090-0007	Indian Cr	Pleasant Valley Rd	06/08/05	10/12/05	9	5.5	6.7	8.3	0	Full Support
OBS100-0001	Indian Cr	Rocky Hollow Rd	05/16/00	09/06/00	3	9.9	10.3	10.7	0	Full Support
OBS100-0004	Indian Cr	City Park S of Corydon, SR 135	04/07/99	03/07/06	84	4.6	11.8	17.3	0	Full Support
OBS100-0005	Indian Cr	Corydon City Park, off SR 135 S			0					Not Assessed
OBS100-0006	Indian Cr	at Lickford Bridge Rd	07/12/00	08/09/00	5	2.5	4.3	7.8	80	Impaired
OBS100-0007	Indian Cr	Downstream of Little Indian Cr mouth	07/12/00	08/09/00	5	7.6	9.2	11.2	0	Full Support

IDEM Water Quality Data Summary

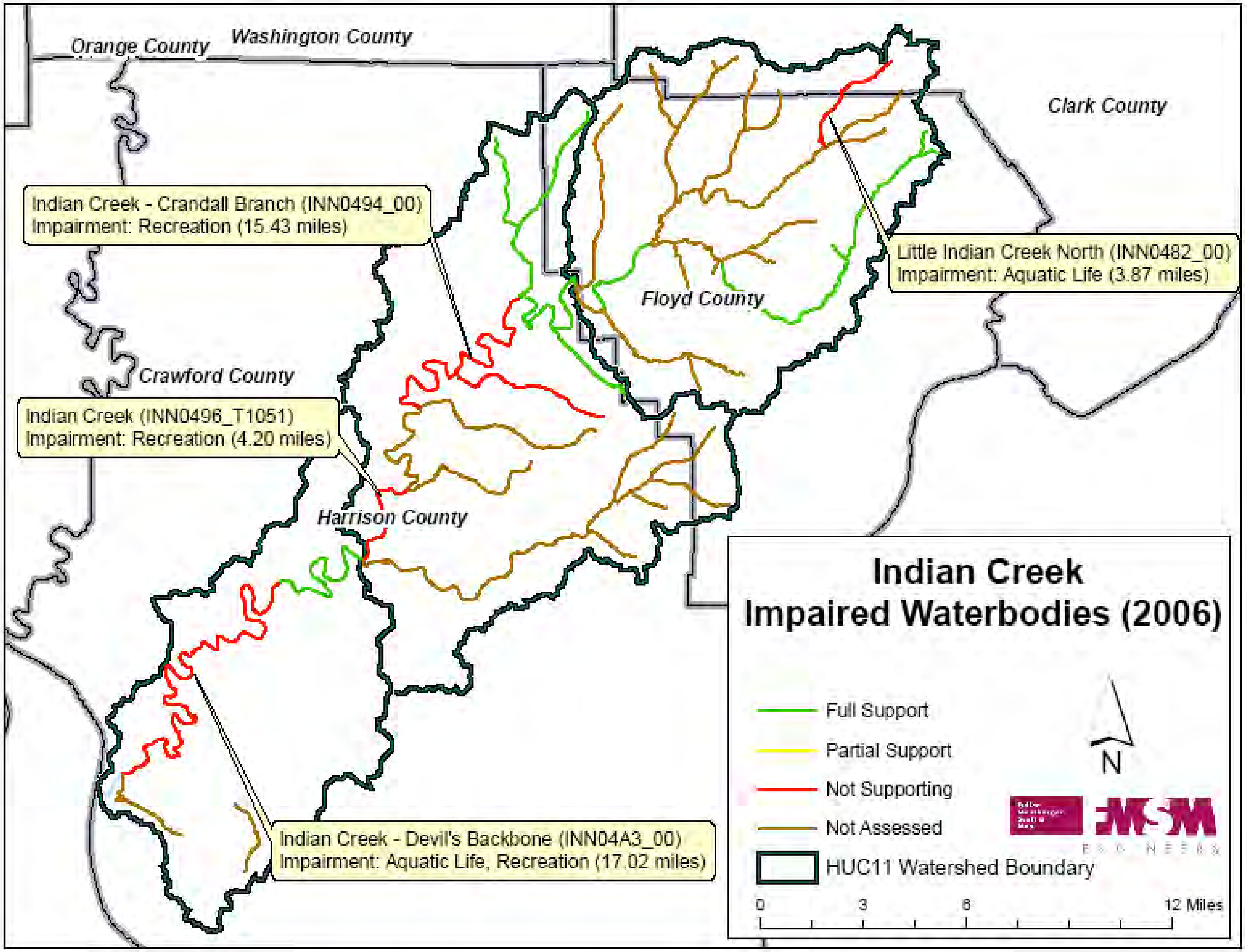
PARAMETER	pH									
CRITERION	pH between 6.0 and 9.0									
SITE	**WATERBODY**	**LOCATION**	**START**	**STOP**	**N**	**Min**	**Avg**	**MAX**	**% >9.0**	**STATIS**
OBS080-0001	Little Indian Cr	Banet Rd	05/18/00	09/06/00	4	7.57	7.92	8.42	0	Full Support
OBS080-0004	Little Indian Cr	Near Galena	03/28/00	08/01/00	19	7.9	8.74	9.26	10.0	Impaired
OBS080-0005	Indian Cr	@ Greenville Road, NW of Georgetow	07/10/00	08/07/00	5	7.34	7.53	7.59	0	Full Support
OBS080-0007	Georgetown	Parent Lake	07/22/96	07/22/96	0					Not Assessed
OBS080-0008	Indian Cr	Navilleton Rd	05/26/05	09/13/05	10	7.38	8.03	8.76	0	Full Support
OBS090-0002	Indian Cr	Southern RR	05/18/00	09/05/00	3	7.88	7.95	8.06	0	Full Support
OBS090-0004	Indian Cr	@ SR 335 near Corydon Junction	07/10/00	08/07/00	5	7.36	7.65	7.84	0	Full Support
OBS090-0005	Indian Cr	Landmark Way	05/24/05	09/13/05	10	7.11	7.66	8.21	0	Full Support
OBS090-0007	Indian Cr	Pleasant Valley Rd	06/08/05	10/12/05	9	7.3	7.49	7.66	0	Full Support
OBS100-0001	Indian Cr	Rocky Hollow Rd	05/16/00	09/06/00	3	8.25	8.48	8.77	0	Full Support
OBS100-0004	Indian Cr	City Park S of Corydon, SR 135	04/07/99	03/07/06	84	7.69	8.36	9.19	1.2	Full Support
OBS100-0005	Indian Cr	Corydon City Park, off SR 135 S			0					Not Assessed
OBS100-0006	Indian Cr	at Lickford Bridge Rd	07/12/00	08/09/00	5	7.34	7.46	7.76	0	Full Support
OBS100-0007	Indian Cr	Downstream of Little Indian Cr mouth	07/12/00	08/09/00	5	7.82	8.04	8.18	0	Full Support

IDEM Water Quality Data Summary

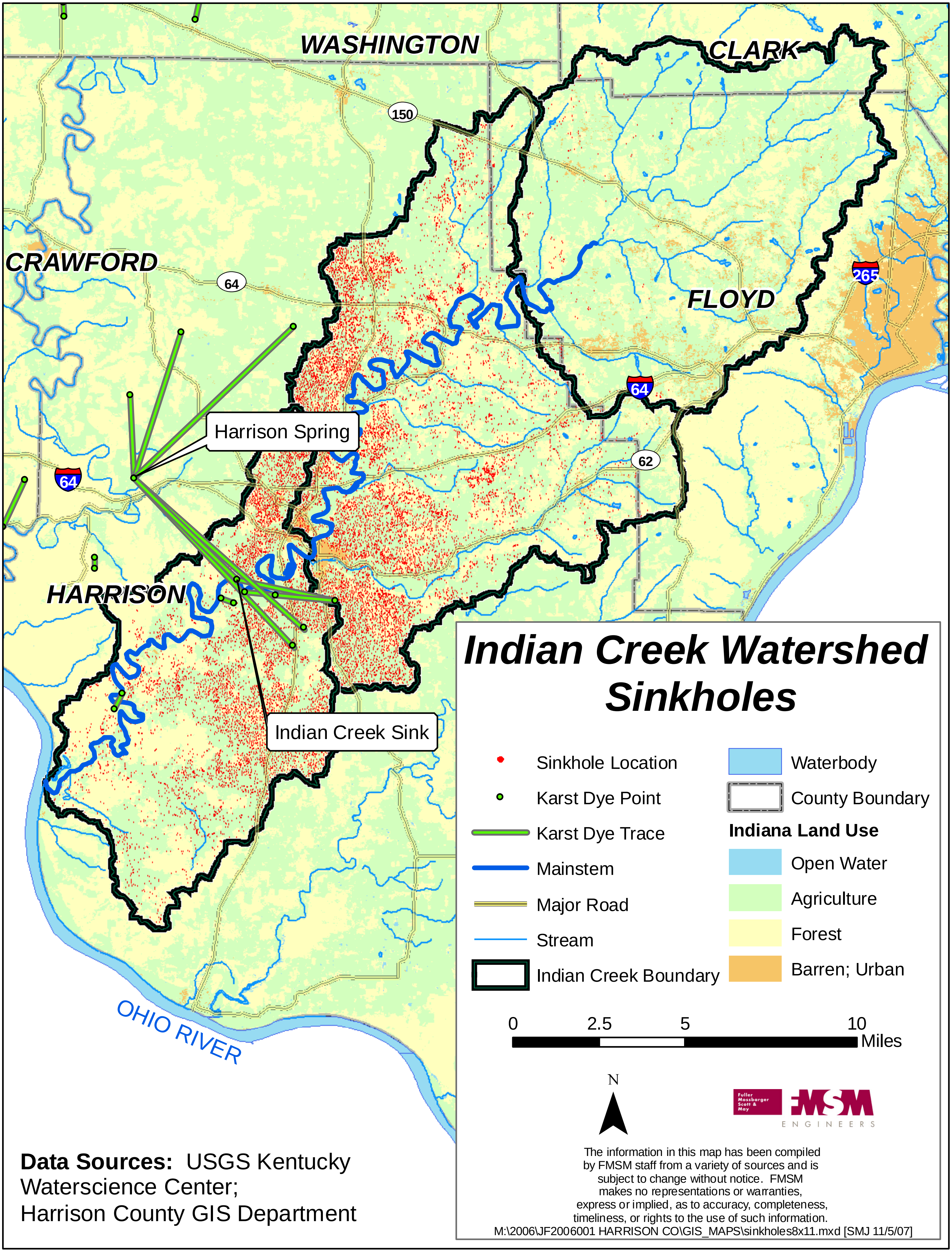
PARAMETER	Total Phosphorus									
COMPARISON	0.3 mg/L									
SITE	**WATERBODY**	**LOCATION**	**START**	**STOP**	**N**	**Min**	**AVG**	**MAX**	**% > 0.3**	**STATUS**
OBS080-0001	Little Indian Cr	Banet Rd	05/20/00	09/06/00	3	0.015	0.036	0.079	0	Acceptable
OBS080-0004	Little Indian Cr	Near Galena			0					Not Assessed
OBS080-0005	Indian Cr	@ Greenville Road, NW of Georgetown			0					Not Assessed
OBS080-0007	Georgetown	Parent Lake	07/26/96	07/22/96	2	0.055	0.067	0.079	0	Not Assessed
OBS080-0008	Indian Cr	Navilleton Rd	05/28/05	09/13/05	3	0.025	0.025	0.025	0	Acceptable
OBS090-0002	Indian Cr	Southern RR	07/11/00	09/05/00	2	0.03	0.033	0.035	0	Not Assessed
OBS090-0004	Indian Cr	@ SR 335 near Corydon Junction			0					Not Assessed
OBS090-0005	Indian Cr	Landmark Way	05/24/05	09/13/05	3	0.025	0.025	0.025	0	Acceptable
OBS090-0007	Indian Cr	Pleasant Valley Rd	06/22/05	10/12/05	3	0.025	0.025	0.025	0	Acceptable
OBS100-0001	Indian Cr	Rocky Hollow Rd	07/18/00	09/06/00	2	0.046	0.055	0.063	0	Not Assessed
OBS100-0004	Indian Cr	City Park S of Corydon, SR 135	04/07/99	02/08/06	83	0.015	0.459	3.62	34	Elevated
OBS100-0005	Indian Cr	Corydon City Park, off SR 135 S			0					Not Assessed
OBS100-0006	Indian Cr	at Lickford Bridge Rd			0					Not Assessed
OBS100-0007	Indian Cr	Downstream of Little Indian Cr mouth at Corydon			0					Not Assessed

IDEM Water Quality Data Summary

PARAMETER	Nitrate-Nitrite Nitrogen									
COMPARISON	10 mg/L									
SITE	**WATERBODY**	**LOCATION**	**START**	**STOP**	**N**	**Min**	**AVG**	**MAX**	**% > 10 mg/L**	**STATUS**
OBS080-0001	Little Indian Cr	Banet Rd	05/19/00	09/06/00	3	0.13	2	0.827	0	Acceptable
OBS080-0004	Little Indian Cr	Near Galena			0					Not Assessed
OBS080-0005	Indian Cr	@ Greenville Road, NW of Georgetown			0					Not Assessed
OBS080-0007	Georgetown	Parent Lake	07/24/96	07/22/96	2	0.022	0.024	0.023	0	Acceptable
OBS080-0008	Indian Cr	Navilleton Rd	05/27/05	09/13/05	3	0.02	0.26	0.113	0	Acceptable
OBS090-0002	Indian Cr	Southern RR	07/11/00	09/05/00	2	0.22	0.83	0.525	0	Acceptable
OBS090-0004	Indian Cr	@ SR 335 near Corydon Junction			0					Not Assessed
OBS090-0005	Indian Cr	Landmark Way	05/24/05	09/13/05	3	0.45	1.3	0.757	0	Acceptable
OBS090-0007	Indian Cr	Pleasant Valley Rd	06/22/05	10/12/05	2	0.02	0.08	0.050	0	Acceptable
OBS100-0001	Indian Cr	Rocky Hollow Rd	07/18/00	09/06/00	2	0.005	0.005	0.005	0	Acceptable
OBS100-0004	Indian Cr	City Park S of Corydon, SR 135	04/07/99	02/08/06	83	0.6	1.806	11	0	Acceptable
OBS100-0005	Indian Cr	Corydon City Park, off SR 135 S			0					Not Assessed
OBS100-0006	Indian Cr	at Lickford Bridge Rd			0					Not Assessed
OBS100-0007	Indian Cr	Downstream of Little Indian Cr mouth at Corydon			0					Not Assessed



Indian Creek 303(d) Stream Status


WASHINGTON
CLARK
CRAWFORD
FLOYD
HARRISON
OHIO RIVER
150
64
62
265
Harrison Spring
Indian Creek Sink
Indian Creek Watershed Sinkholes
Sinkhole Location
Karst Dye Point
Karst Dye Trace
Mainstem
Major Road
Stream
Indian Creek Boundary
Waterbody
County Boundary
Indiana Land Use
Open Water
Agriculture
Forest
Barren; Urban
0
2.5
5
10
Miles
N
FMSM
ENGINEERS
The information in this map has been compiled by FMSM staff from a variety of sources and is subject to change without notice. FMSM makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information.
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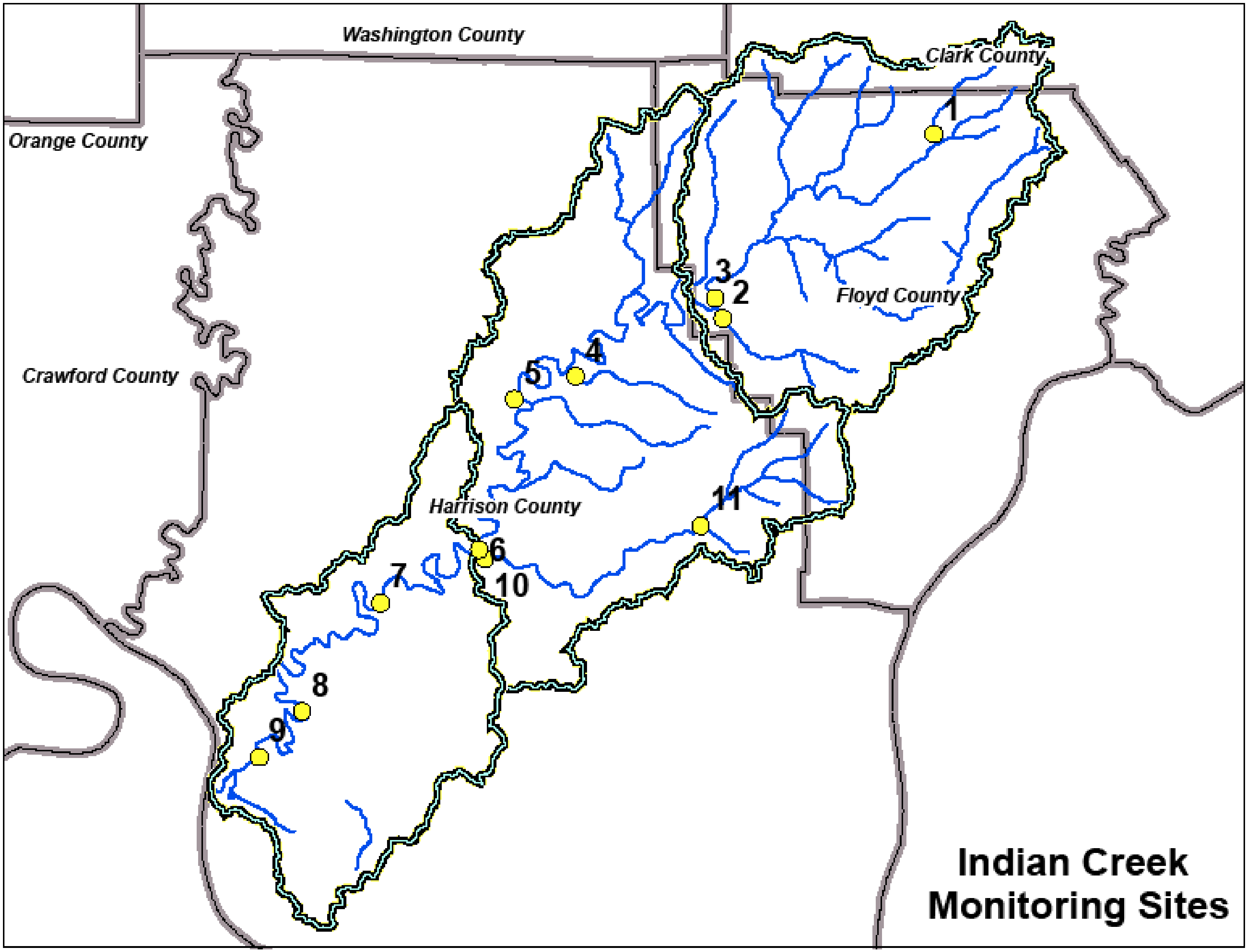
Data Sources: USGS Kentucky Waterscience Center; Harrison County GIS Department



Washington County
Clark County
Orange County
Crawford County
Floyd County
Harrison County
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11
Indian Creek
Monitoring Sites

Indian Creek Watershed Sampling Site #1

Site ID: IDEM OBS080-001
Location: Indian Creek North at Banet Road

AQL Directions: Go back down Beech St. Left on S Mulberry St. Left on Hwy 62 / Chestnut St. Right on 62 / 337 / N Capitol Ave. Right on 135 to 64-E. Take 265-E to the State St. exit. Right on State St. Right on Scottsville Rd. Right on Starlight Rd. Right on Roberts Rd. Roberts turns into Banet; the bridge is immediately past.

To get back to the office, either follow the reverse of those directions back to State St and take 265-E to 65-S to the office, or continue down Banet, left on Andres, right on Kirby, left on Campion, right on Moser Knob, left on Hausfeldt, right on Grant Line, and take 265-E to 65-S to the office.

Site #1 Inset Map

Upstream. Gravel bar in center, stream disturbance on left.

Downstream. Note erosion on bank in background.

Indian Creek Watershed Proposed Sampling Site #2

Site ID: FMSM008
Location: Georgetown Creek below Georgetown at Malinee Ott Road

WQ Directions: Continue down Georgetown-Greenville Rd. Right on next rd, Malinee Ott.

To get back to the office, go back to GG Rd, take a right. Left on Hwy 64 to I-64.

Site #2 Inset Map


Upstream; riffle at approximately 80 yards.


Downstream; gravel bar at approximately 65 yards.

Indian Creek Watershed Sampling Site #3

Site ID: IDEM OBS-080-0005
Location: Indian Creek above Georgetown Creek

WQ Directions: Continue down 335. Left on Hwy 64. Right on Walk Dr. Right on Whiskey Run Rd. Whiskey Run Becomes Malinee Ott / Byrneville at county line, coming down big hill; becomes Georgetown-Greenville Rd after passing GG Rd on left. Bridge is 2nd bridge past GG Rd intersection and just before Cooks Mill Rd.

Site #3 Inset Map

Upstream; no riffles to bend.

Downstream; erosion.

HARRISON COUNTY REGIONAL SEWER DISTRICT

INDIAN CREEK WATERSHED PLAN SUBCOMMITTEE

Site Directory

July 16, 2007

Order	Site #	Site ID	Location	WQ	AQL
1	11	FMSM007	Little Indian Creek below Lanesville at State Road 62	X	
2	9	OBS100-0006	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	X	X
3	8	OBS100-0001	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	X	X
4	7	FMSM002	Indian Creek at Mathis Road bridge	X	X
5	10	FMSM001	Little Indian Creek above Water Street Bridge	X	X
6	6	FMSM004	Indian Creek above Little Indian Creek at Water Street	X	
7	5	OBS090-0004	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	X	
8	4	FMSM003	Crandall Branch above SR335 Bridge	X	
9	3	OBS080-0005	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	X	
10	2	FMSM008	Georgetown Creek below Georgetown at Malinee Ott Road	X	
11	1	OBS080-0001	Indian Creek North at Banet Road, IDEM Site OBS080-0001		X

Indian Creek Watershed Sampling Site #4

Site ID: FMSM003
Location: Crandall Branch above SR 335 Bridge

WQ Directions: Continue down 335. Bridge is past cemetery and immediately past Bethlehem Rd (both on left) and before you get to Crandall.

Site #4 Inset Map

Upstream; riffle at approximately 30 yards.

Downstream.

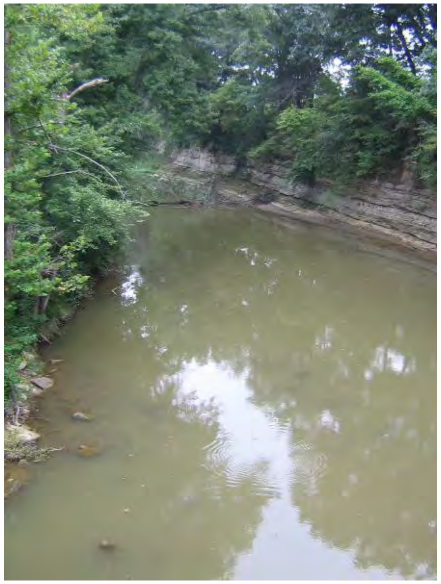
Indian Creek Watershed Sampling Site #5

Site ID: IDEM OBS090-004
Location: Indian Creek above SR 355 Bridge

WQ Directions: Continue down 62 / Walnut St. Right on 135. Right on 335. Bridge is immediately on 335.

Site #5 Inset Map


Upstream; no riffles to bend.


Downstream.

Indian Creek Watershed Proposed Site #6

Site ID: FMSM004
Location: Indian Creek above Little Indian Creek at Water Street

WQ Directions: Go back down Beech St. Left on S Mulberry St. Left on Hwy 62 / Chestnut St. Right on 62 / 337 / N Capitol Ave. Left on 62 / Walnut Street. Access is through small park entrance past bridge on right.

Site #6 Inset Map


Upstream; riffle at approximately 100 yards.


Downstream.

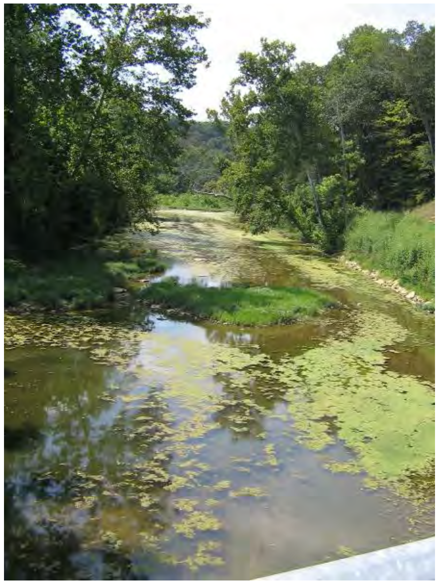
Indian Creek Watershed Sampling Site #7

Site ID: FMSM002
Location: Indian Creek at Mathis Road Bridge

WQ Directions: Continue down Rocky Hollow Rd. Right on 5 Oaks Rd. Left / straight (may appear either way) on Dixie Rd. Right on Brown Cunningham Rd. Left on Heidelberg Rd. Left on Steam Engine Rd. Left on Mathis Rd (may still appear to be Steam Engine). Bridge is just past Hottell Rd.

AQL Directions: Continue down Rocky Hollow Rd. Right on 5 Oaks Rd. Left / straight (may appear either way) on Dixie Rd. Right on Brown Cunningham Rd. Left on Heidelberg Rd. Left on Steam Engine Rd. Left on Mathis Rd (may still appear to be Steam Engine). Bridge is just past Hottell Rd.

Site #7 Inset Map


Upstream; riffle and bar.

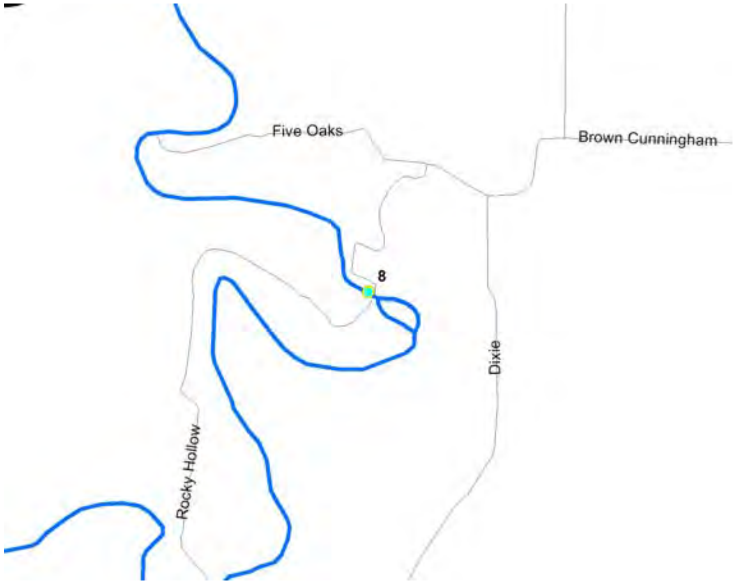

Downstream; bar with vegetation.

Indian Creek Watershed Sampling Site #8

Site ID: IDEM OBS100-0001
Location: Indian Creek above Rocky Hollow Road Bridge

WQ Directions: Go back down Lickford Bridge Rd towards Hwy 135. Left on Rocky Hollow Rd, just past church camp. 5 Oaks / Dixie is too far.

AQL Directions: Go back down Lickford Bridge Rd towards Hwy 135. Left on Rocky Hollwo Rd, just past church camp. 5 Oaks / Dixie is too far.



Site #8 Inset Map

Upstream; riffle at approximately 60 yards.

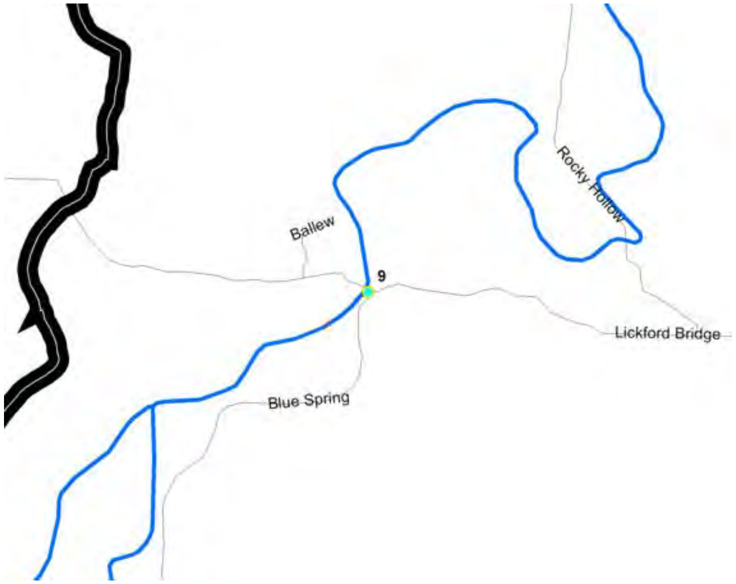
Downstream; no flow, gravel bar.

Indian Creek Watershed Sampling Site #9

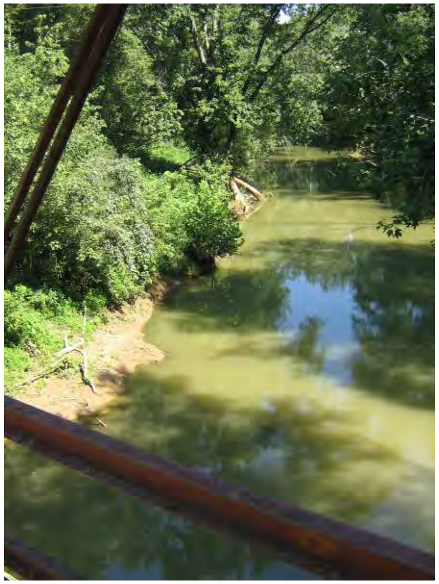
Site ID: IDEM OBS100-0006
Location: Indian Creek above Lickford Road Bridge

WQ Directions: Follow Hwy 62 E into Corydon. Left on Hwy 135. Right on Lickford Bridge Road. Road hangs a right past the church camp; bridge is immediately past turn.

AQL Directions: Take I-64 to Corydon. Right on Hwy 135. Road hangs a right past the church camp; bridge is immediately past turn.



Site #9 Inset Map



Upstream; bank erosion and blowdowns.

Downstream.

Indian Creek Watershed Sampling Site #10

Site ID:	FMSM001
Location:	Little Indian Creek above Water Street Bridge

WQ Directions: Go back down Mathis Rd, Steam Engine Rd. Left on Heidelberg Rd. Follow Heidelberg across 135. Left on Old IN 135. Straight / Right on Laconia Ave / 337. Almost immediate left on Ridley St. Left on Beech St at end of Ridley. Beech dead ends; bank and bridge access are on right.

AQL Directions: Go back down Mathis Rd, Steam Engine Rd. Left on Heidelberg Rd. Follow Heidelberg across 135. Left on Old IN 135. Straight / Right on Laconia Ave / 337. Almost immediate left on Ridley St. Left on Beech St at end of Ridley. Beech dead ends; bank and bridge access are on right.

Site #10 Inset Map


Upstream.


Downstream; 4H Club.

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Indian Creek Watershed Proposed Sampling Site #11

Site ID: FMSM007
Location: Little Indian Creek below Lanesville at SR 62

WQ Directions: Take I-64 E to Lanesville exit. Right on Crandall-Lanesville Road. Right on Hwy 62 E. Bridge is between St Peter's Church Rd (on left) and Ferree Rd (on right).

Site #11 Inset Map

Upstream; riffle at approximately 30 yards.

Downstream.

Quality Assurance Project Plan

Indian Creek Watershed Management Plan

Harrison County, Indiana

Prepared for: Harrison County Regional Sewer District

Quality Assurance Project Plan
Indian Creek Watershed Management Plan

Harrison County, Indiana

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Quality Assurance Project Plan

for

Indian Creek Watershed Management Plan

ARN # A305-6-106

Prepared by:

FMSM Engineers, Inc.

Prepared for:

Indiana Department of Environmental Management
Office of Water Management
Watershed Management Section

Version 2.0 (May 2, 2007)

Approved By:

Harrison County Regional Sewer District	Dan Lee, PE	6/21/07 Date
Watershed Coordinator	Karen Schaffer	6/21/07 Date
Project Manager:	Stephen D. Hall	6/21/07 Date
NPS/TMDL QA Manager:	Betty Ratcliff	6/26/07 Date
NPS/TMDL Section Chief:	Andrew Pelloso	6/27/07 Date
NPS/TMDL Branch Chief:	Mary Lou Renshaw	6/28/07 Date

Quality Assurance Project Plan
Indian Creek Watershed Management Plan

Harrison County, Indiana

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1. Study Description

A Section 205(j) Water Quality Management Planning Grant was awarded to Harrison County, Indiana in 2005 to develop and implement a Watershed Management Plan for the Indian Creek Watershed. One of the tasks in the project is to collect monitoring data for chemical, habitat and biological (benthic macroinvertebrate) conditions to address data gaps and improve the understanding of sources and causes of water quality impairments. The Indian Creek watershed consists of 256 square miles and drains significant portions of Harrison and Floyd Counties, as well as a small portion of Clark County.

1.1. Historical Information

Eight sites along the Indian Creek mainstem have been sampled by IDEM for e. coli bacteria. Five (5) sites were sampled in 2000 and 3 were sampled in 2005. One or more samples from each site indicated elevated levels of e. coli. IDEM attributed elevated pathogens to nonpoint sources or unknown sources. This monitoring plan will provide new information regarding bacterial contamination and potential pollution sources.

In lower Indian Creek, aquatic life impairments were attributed to low dissolved oxygen, which was measured at one location (OBS100-006). This station is located near the confluence of Indian Creek and the Ohio River and may be affected by Ohio River backwater. Dissolved oxygen (DO) was at or below 4 ppm in 4 of 5 samples collected in July and August, 2000. IDEM attributed this impairment to organic enrichment. This monitoring program includes collection of DO and nutrients at 3 locations in the impaired segment to better understand current conditions, the spatial extent of impairment and factors that may contribute to low DO.

The following water quality impairments were identified on the 2006 303(d) List 5A:

14-DIGIT HUC	COUNTY	WATERBODY SEGMENT ID	WATERBODY SEGMENT NAME	CAUSE OF IMPAIRMENT
51401040 80020	FLOYD CO	INN0482_00	LITTLE INDIAN CREEK (NORTH)	IMPAIRED BIOTIC COMMUNITIES
51401040 90040	HARRISON CO	INN0494_00	INDIAN CREEK-CRANDALL BRANCH	E. COLI
51401040 90060	HARRISON CO	INN0496_T1051	INDIAN CREEK	E. COLI
51401041 00030	HARRISON CO	INN04A3_00	INDIAN CREEK-DEVILS BACKBONE	DISSOLVED OXYGEN
51401041 00030	HARRISON CO	INN04A3_00	INDIAN CREEK-DEVILS BACKBONE	E. COLI

Impairment Category 5 was defined by IDEM as follows: (IDEM, 2006)

> **Category 5.** The water quality standard is not attained. Waterbodies may be listed in both 5A and 5B depending on the parameters causing the impairment.

Category 5A. The waterbodies are impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL. This category constitutes the Section 303(d) list of waters impaired or threatened by a pollutant(s) for which one (1) or more TMDL(s) are needed. A waterbody should be listed in this category if it is determined in accordance with the state's assessment and listing methodology that a pollutant has caused, is suspected of causing, or is projected to cause impairment. Where more than one (1) pollutant is associated with the impairment of a single waterbody, the waterbody will remain in Category 5 until TMDLs for all pollutants have been completed and approved by U.S. EPA.

IDEM uses Category 5B to list waters that do not meet Fish Consumption Designated Use and 5C to identify waters for which TMDLs are scheduled to be developed for the next listing cycle. None of the Indian Creek impaired waterbodies were included on the Category 5B or 5C lists.

To date, monitoring and assessments have focused on the middle and lower HUC watersheds. Significant percentages of stream miles in all 3 HUCs have not been assessed for one or more designated uses (aquatic life 54%; fish consumption 62%; primary contact 72%).

1.2. Study Goals

The goals of the monitoring program are outlined below:

a. Evaluate current conditions in waters on the 303(d) List
b. Identify sources and causes of impairments
c. Address data gaps
d. Support development of the Indian Creek Watershed Plan

Data will be used by the Indian Creek Watershed Plan Subcommittee to meet the goals identified above.

1.3. Study Sites

This monitoring program includes 10 sites for bacteria and water quality monitoring and 5 sites for biological monitoring. Sites are located in reaches identified as impaired for primary contact or biological uses, reaches with known or suspected pollution sources and reaches not recently sampled by IDEM or other entities to address data gaps.

Quality Assurance Project Plan
Indian Creek Watershed Management Plan

Harrison County, Indiana

Indian Creek Watershed Sampling Sites					
Site #	**IDEM Site ID**	**Location**	**WQ**	**AQL**	**Rationale**
1	OBS080-0001	Indian Creek North at Banet Road, IDEM Site OBS080-0001		X	303(d) Segment – Aquatic Life
2		Georgetown Creek below Georgetown at Malinee Ott Road	X		Unassessed reach below Georgetown
3	OBS080-0005	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	X		Floyd County drainage, near County boundary, developing
4		Crandall Branch above SR335 Bridge	X		303(d) Segment – Recreation (may be an artifact of mapping?)
5	OBS090-0004	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	X		303(d) Segment – Recreation
6		Indian Creek above Little Indian Creek at Water Street	X		Downstream end of HUC, 303(d) Segment – Recreation, above WWTP, receives Corydon runoff
7		Indian Creek at Mathis Road bridge	X	X	Upstream end of 303(d) Segment – Recreation, Aquatic Life
8	OBS100-0001	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	X	X	303(d) Segment – Recreation, Aquatic Life
9	OBS100-0006	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	X	X	303(d) Segment – Recreation, Aquatic Life
10		Little Indian Creek above Water Street Bridge	X	X	Major tributary, classified as “unassessed” by IDEM
11		Little Indian Creek below Lanesville at State Road 62	X		Upper reach of major tributary classified as “unassessed” by IDEM, downstream of Lanesville and Lanesville STP
		Number of Sites	**10**	**5**	

1.4. Sampling Design

A targeted sampling design will be used in order to meet the goals for the monitoring program identified in Section 2.2.

E. Coli: E. coli data will be collected to support calculation of geometric means; 5 evenly spaced e. coli and flow samples will be collected during a 30-day period. One set of 5 samples will be collected at each of 10 sites. Flow readings will be collected concurrently.

Water Quality: Six water quality sample events will be conducted at each of 10 sites. Samples will be collected under baseflow (3 events) and elevated flow (3 events) to evaluate water quality over a range of hydrologic conditions. Grab samples will be analyzed for Total Kjeldahl Nitrogen (TKN), Nitrate-Nitrogen (NO3), Total Ammonia (NH3+NH4), Total Phosphorus (TP), Ortho-Phosphorous (PO4), Total Solids (TS). Field parameters and flow will be collected concurrently.

Biological: Biological (benthic macroinvertebrate) data will be collected at 5 sites. Samples will be collected between July and October 2007. Field parameters and flow will be collected concurrently at each site. Water quality will be collected concurrently at 4 of 5 sites. Habitat data will be collected at 11 sites.

Field Parameters: Field parameters collected during each sample event include: pH, Dissolved Oxygen (DO), Temperature (T), Specific Conductivity (SC), Turbidity.

Flow: Flow condition (i.e. baseflow and elevated flow) for sampling will be qualitatively determined by evaluating recent precipitation data and comparing current flow to the long term daily median for the nearby USGS Gage 03302220 Buck Creek near New Middletown. Dry conditions are defined as 3 or more days of dry conditions and wet conditions are defined as 0.25 inches or greater of wet precipitation or snowmelt. Since this amount of precipitation does not always produce runoff due to soil moisture deficits, baseflow and elevated flow conditions are also defined. Baseflow is defined for this study as less than the long term daily median flow and elevated flow is greater than the 65^{th} percentile. This qualitative approach is necessary because USGS no longer operates flow gages in the Indian Creek watershed.

The sample design is summarized on the following table.

Sample Design Summary

Sample Type	# Parameters	# Sites	# Sample Events	# Results
E. Coli	1	10	5	50
Water Quality	6	10	6	360
Biological	1	5	1	5
Field Parms	5	11	6	330
Flow	1	11	11	115
Habitat	1	11	1	11

This sampling design will allow the goals of the monitoring program to be met as described below.

Goal 1. Support development of the Indian Creek Watershed Plan

Analysis of data collected in this monitoring program will be used to support identification of watershed improvement strategies to be included in the Indian Creek Watershed Plan.

Goal 2. Evaluate current conditions in waters on the 303(d) List

Each reach on the 2006 303d List will have one or more sites.

Goal 3. Identify sources and causes of impairments

Analysis of data collected under low flow and elevated flow conditions will be used to indicate relative contribution of point and nonpoint sources of pollutants. Nutrient and flow data will be used to identify possible factors contributing to low dissolved oxygen. Habitat and field parameters will be used to identify factors that may be contributing to aquatic life impairments.

Pollution source assessments will be evaluated qualitatively using IDEM's Pollutant Load Reduction Worksheet, effluent data and other pollution source information gathered through the course of the project.

Goal 4. **Address data gaps**

Reaches classified as unassessed by IDEM on Georgetown Creek and Little Indian Creek will be sampled. Three sites in Indian Creek-Devils Backbone will be used to clarify the spatial extent of impairment.

1.5. Study Schedule

The study schedule is shown on the following table. This schedule will be adjusted as necessary to accommodate unforeseen circumstances such as lack of the necessary flow conditions. IDEM approval will be sought as needed for schedule revisions.

Study Schedule

Activity	Start Date	End Date
Draft QAPP submitted to IDEM	6/2007	6/2007
IDEM Approval of QAPP	7/2007	7/2007
Water quality: field parameters, water quality and flow (6 events - 3 baseflow & 3 elevated flow, at 10 sites)	8/2007	10/2007
Benthic invertebrates: field parameters, benthic macroinvertebrates, habitat and flow (1 event, 5 sites)	8/2007	10/2007
E. coli: 5 evenly spaced samples within 30 days, 10 sites	8/2007	10/2007
QA review of data	8/2007	11/2007
Data management	8/2007	11/2007
Data assessment	8/2007	11/2007
Integrate results into Watershed Management Plan	9/2007	11/2007
Publish monitoring results to watershed website	9/2007	11/2007

2. Study Organization and Responsibility

2.1. Key Personnel

Betty Ratcliff, IDEM Quality Assurance Manager
Nonpoint Source/TMDL Section
Indiana Department of Environmental Management
Role: Review and approve QAPP, assist with quality assurance questions

Alice Rubin, IDEM Project Manager
Nonpoint Source/TMDL Section
Indiana Department of Environmental Management
Role: Assist with ensuring that monitoring design is consistent with project goals

Dan Lee, PE
Harrison County Regional Sewer District
Role: Harrison County Project Manager, final approval of monitoring locations, approval of data interpretation

Anthony Combs
Harrison County Health Department
Role: Monitoring coordinator, Coordination of field work, technical lead on monitoring locations and data interpretation

Stephen Hall
Project Manager
FMSM Engineers, Inc.

Role: Technical assistance with watershed plan, monitoring design and data interpretation

Karen Schaffer
Watershed Coordinator
FMSM Engineers, Inc.
Role: Data management and analysis team lead; develop and implement QAPP

Sam Call
Project Biologist
FMSM Engineers, Inc.
Role: Habitat and biological (benthic macroinvertebrate) sample collection and data analysis

Brian Fox
Environmental Scientist
FMSM Engineers, Inc.
Role: Field sample team lead; sample collection

Stacey Jarboe
Environmental Scientist
FMSM Engineers, Inc.
Role: Sample collection

Craig Hinshaw
Lab Director
Indiana State Department of Health
Role: Overall project coordination

Bharat Patel
Lab Supervisor, Inorganic Section
Indiana State Department of Health
Role: Oversee lab analysis

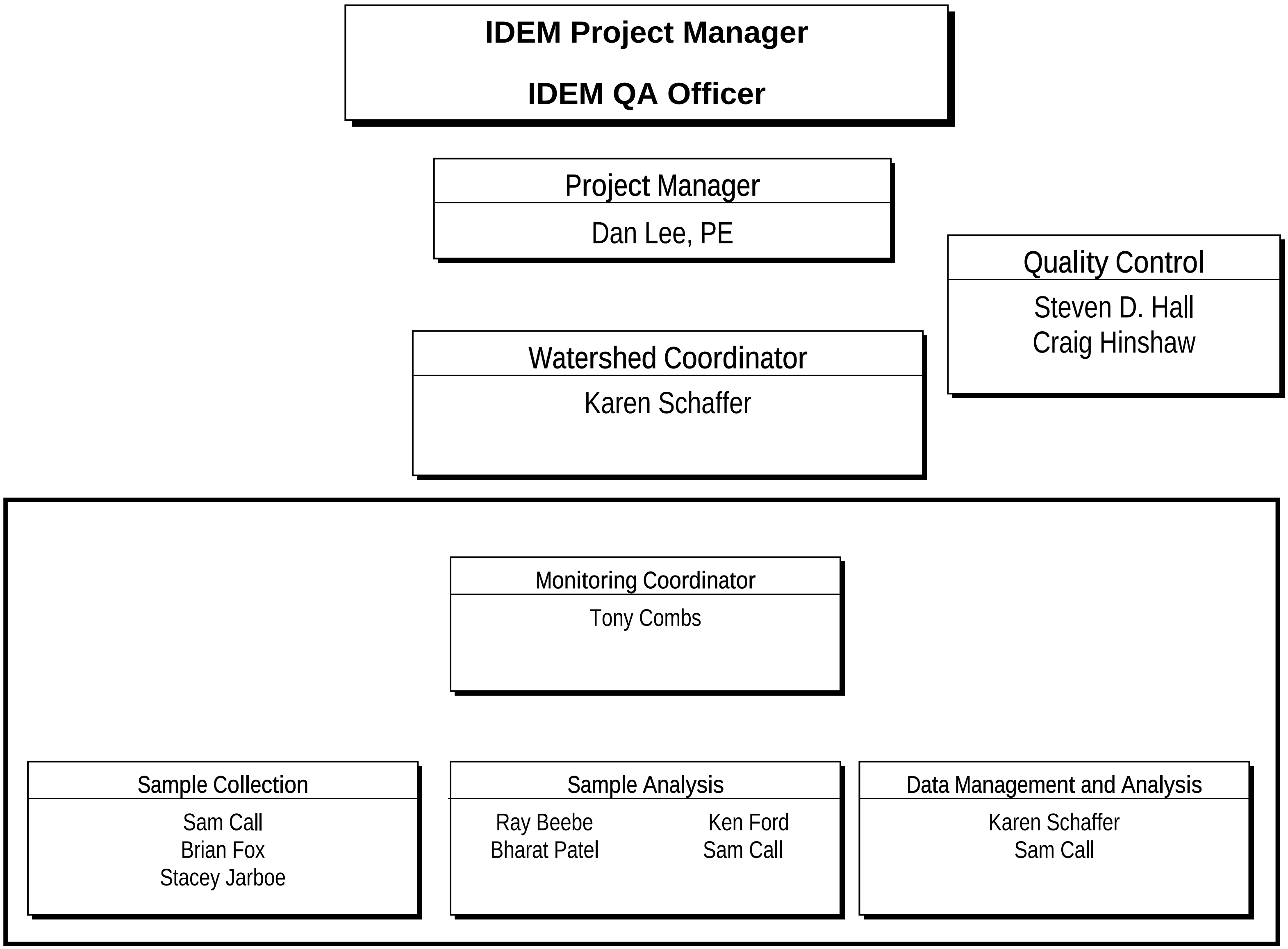
Ray Beebe
Lab Quality Assurance Coordinator
Indiana State Department of Health
Role: Oversee quality assurance review

Ken Ford
Laboratory Director
Microbac Laboratories, Inc.
Role: Oversee E. coli Analysis

2.2. Organizational Chart

An organizational chart for the Indian Creek Watershed Monitoring Program is shown on the following page.

Quality Assurance Project Plan
Indian Creek Watershed Management Plan



3. Data Quality Objectives (DQOs)

3.1. Precision

Precision measures the degree to which two or more measurments are in agreement and is often expressed as relative percent difference (RPD) between duplicates. Precision will be calculated using Equation 1. Better precision is reflected in smaller relative percent differences. Precision of the field and laboratory efforts will be measured by field and laboratory duplicates, respectively. The precision of meter readings will be estimated using duplicate readings.

Equation 1: Relative Percent Difference

$$RPD = \frac{|R_X - R_Y|}{0.5(R_X + R_Y)} \times 100$$

where:
R_X = calibrated unit
R_Y = deployed unit (pre-calibration)

Biological precision will be extimated by calculating RPD at one of five (5) stations (20%). Additionally, all biological samples will be collected by the same trained crew of experienced scientists. Except for sorting, the actual samples replicated will be chosen at random. All sample methods have built-in bias, but by using the same methods at each sampling location the bias will become a minimal problem when analyzing the data. The first sample sorted will be checked for accurrcay at the 90% level. If the sorter fails, each sample will be checked until the sorter passes. This will insure that any sorting problems are resolved at the beginning of sampling process. The goal is to achieve RPD of less that 10% for the macroinvertebrate index scores.

3.2. Accuracy

Accuracy measures the degree of agreement between an observed value and an accepted reference value. The percent recovery is calculated by comparing the concentrations of the original sample and the spiked sample using the following equation:

Equation 2. Percent Recovery

$$\%R = \frac{SSR - SR}{SA} X100$$

where:
%R = Recovery (percent)
SSR = Spike sample result (concentration units)
SR = Original sample result (concentration units)
SA = Spike added (concentration added)

%R=((SSR - SR)/(SA))*100 Excel Formula

For chemical parameters, accuracy in the field is determined through the use of field and trip blanks and through the adherence to all sample handling SOPs, preservation, and holding times. Laboratory accuracy is shown on Table 3.1.

Due to the lack of ideal, standard, or pristine biological assemblages with which to make comparisons, the accuracy of macroinvertebrate, fish and habitat sampling cannot be quantified. The accuracy of biological samples must be referred to in terms of the adherence to the quality assurance/quality control objectives.

For discharge (volume of flow per unit time), the accuracy of the method cannot be readily determined because of the fact that this is not a direct measurement. With selection of good cross-sections, and careful measurements of depth and velocity, measured flow shall be within 15% of true flow (Montana Dept. of Environmental Quality, 2002).

The accuracy of field meter readings will be measured via the calibration process.

Bias is evaluated by the use of field and laboratory blanks. To measure field bias, field blanks will be collected using deionized water from Microbac Laboratories, Inc. Lab blanks will be analyzed by Microbac (for e.coli) and ISDH Laboratory (other water chemistry parameters). Acceptable bias is less than 5 times of the method detection. If any contaminant is detected in blanks, the concentration will tagged with a “V” code (value affected by contamination) as per table 9.1. An investigation will be initiated to find the source of the contamination as per Chapter 13. Corrective Action.

To reduce systematic error in biological sampling the following controls will be used:

- Field equipment will be properly maintained and inspected before each sampling event.
- The same identification tools and references will be used for each sample.
- Twenty percent (20%) of the samples will be checked by a second person for identification accuracy.
- Sample events will occur under similar flow conditions. Periods of high flow will be avoided.

3.3. Completeness

Completeness measures the degree of valid data obtained compared to the degree of data that is expect to be obtained under normal operating conditions. Completeness may be reduced by field equipment failure, exceedence of holding times, compromised sample containers, etc. The completeness DQO for field parameters and grab sample collection is 90%; for laboratory analyses, the completeness DQO is 95%.

Equation 3. Percent Completeness

$$\%C = \frac{(M_V)}{(M_P)} \times 100$$

where
%C= completeness (percent)
MV = number of valid measurements
MP = number of planned measurements

%C=(MV/ MP)*100 Excel Formula

Data quality objectives are summarized on the table below.

Table 3.1. Data Quality Objectives

Parameter	Precision	Accuracy	Completeness
Field Parameters			
Dissolved Oxygen (DO)	0.01 mg/L	±0.2 mg/L at ≤ 20 mg/ ±0.6 mg/L at > 20 mg/L	90%
pH	0.01 units	±0.2 units	90%
Temperature (T)	0.01°C	±0.10° C	90%
Specific Conductivity (SC)	4 digits	±1%	90%
Turbidity	3 digits	±2 %	90%
Field Quality			
Dissolved Oxygen (DO)	20 % RPD	90-110%	90%
pH	20 % RPD	90-110%	90%
Temperature (T)	20 % RPD	90-110%	90%
Specific Conductivity (SC)	20 % RPD	90-110%	90%
Turbidity	20 % RPD	90-110%	90%
Laboratory Analysis			
Total Phosphorus (TP)	5%	94-101%	95%
Ortho-Phosphate (PO4)	5%	94-101%	95%
Total Kjeldahl Nitrogen (TKN)	17%	96-108%	95%
Nitrate-Nitrogen (NO3)	5%	97-110%	95%
Total Ammonia (NH4-N)	5%	91-103%	95%
Total Solids (TS)	5%	96-103%	95%
E. coli	1 CFU/ 100 ml.	46 – 119%	95%

3.4. Representativeness

Representativemess expresses the degree to which data accurately and precisely represents the population as a whole, parameter variations at a sampling point, a process condition, or an environmental condition. Monitoring sites will be established that are representative of impaired and un-impaired reaches. Water quality samples will be collected under baseflow and elevated flow conditions to represent water quality over a range of hydrologic conditions.

3.5. Comparability

Comparability expresses the confidence with which one data set can be compared to another data set. The degree to which existing and future analytical data will be comparable depends on the similarity of sampling and analytical methods.

Comparability of the sampling and analytical programs are evaluated separately.

Sampling comparability will be evaluated based on the following:

- A consistent approach to sampling was applied throughout the program
- Sampling was consistent with established methods for the media and analytical procedures
- Samples were properly handled and preserved

Analytical comparability will be evaluated based upon the following:

- Consistent methods for sample preparation and analysis
- Sample preparation and analysis was consistent with specific method requirements
- The analytical results for a given analysis were reported with consistent detection limits and consistent units of measure

4. Sampling Procedures

E. Coli: Grab samples will be collected from the center of channel from bridges using a clean bucket. Samples will be transferred into a pre-labeled, sterile sample container with sodium thiosulfate preservative and stored on ice. Samples will be delivered to Microbac Laboratories in Louisville, KY within the holding time.

Water Quality: Grab samples will be collected from the center of channel from bridges using a clean bucket. Samples will be transferred to clean, pre-labeled sample containers provided by the laboratory and stored on ice. Samples will be shipped on ice to the State Department of Health Laboratory in Indianapolis.

Benthic Macroinvertebrates: Benthic macroinvertebrates will be collected from 5 sites during the sampling period, between July and October. Macroinvertebrate sampling will be conducted during low- to moderate-flow periods. Periods of high flow will be avoided. Samples will be collected with a 500 µm dip-net and preserved in 70% ethanol. Large sticks, rocks, and leaves will be thoroughly washed and removed from the sample. The samples will be returned to the laboratory for sorting, identification, and analysis. Qualitative habitat will be measured using protocols developed by Ohio EPA (1989) and modified by IDEM.

Field Parameters: Field parameters will be collected with a calibrated Hydrolab Minisonde 4a. The instrument will be calibrated using standards that have not expired. Calibration will be perfomed on the day of sampling prior to the collection of field data. If the meter is not operating properly, it will not be used until repairs are made and proper calibration according to the manufactures instructions can be achieved.

Flow: Flow measurements will be collected with a Flow Probe flowmeter. Stream discharge will be calculated by multiplying cross sectional area by flow velocity to obtain discharge in cubic feet per second. Note that discharge data may not be obtained during high flow events due to safety considerations.

Field notebooks will be used by Field Staff to document site conditions and a digital camera will be used to document each sample event. Holding times for each parameter will be printed on each chain of custody sheet. Samples containers will be pre-labeled with a site identification number, date code and a consecutive number.

Sampling procedures for each parameter in the monitoring program are summarized on the table below.

Table 4.1. Sampling Procedures

Parameter	Sample Matrix	Sampling Frequency	Sampling Method	Sample Container	Sample Volume	Holding Time
Dissolved Oxygen (DO)	Water	~1 per month	Field Meter	NA	NA	NA
pH	Water	~1 per month	Field Meter	NA	NA	NA
Temperature (T)	Water	~1 per month	Field Meter	NA	NA	NA
Specific Conductivity (SC)	Water	~1 per month	Field Meter	NA	NA	NA
Turbidity	Water	~1 per month	Field Meter	NA	NA	NA
Total Phosphorus (TP)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	28 days
Ortho-Phosphate (PO4)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	48 hrs
Total Kjeldahl Nitrogen (TKN)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	28 days
Nitrate-Nitrogen (NO3)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	28 days
Total Ammonia (NH4-N)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	28 days
Total Solids (TS)	Water	~1 per month	Grab Sample	Two 1 liter plastic bottle	2 liters	7 days
E. coli	Water	5 per month	Grab Sample	Sterile plastic bottle w/ sodium thiosulfate preservative	4 oz.	6 hours
Benthic Macroinvertebrate	Biological	1	Dip Net	NA	NA	

5. Sample Custody Procedures

E. Coli: Samples will remain in the custody of the field staff until relinquished to the laboratory, Microbac Laboratories, Louisville, KY. Chain of Custody forms provided by the laboratory will be used to document a responsible person, date and time for each step of the custody process.

Water Quality Samples will remain in the custody of the field staff until mailed to the Indiana State Department of Health Laboratory, Indianapolis, IN. Chain of Custody forms provided by the laboratory will be enclosed with the shipment of samples and used to document a responsible person, date and time for each step of the custody process.

6. Calibration Procedures and Frequency

Each field and laboratory instrument will be calibrated once per day prior to use with calibration standards within shelf-life and according to manufacturing specifications. Calibration standards that have exceeded shelf-life will not be used. If an instrument cannot be calibrated, it will be serviced or repaired prior to use.

7. Sample Analysis Procedures

Analytical procedures are described on the table below.

Table 7.1. Analytical Procedures

Parameter	Analytical Method	Performance Range or Detection Limits/ Reporting Limits	Units
Dissolved Oxygen (DO)	Hydrolab Minisonde 4a Users Manual April 1998 EPA 360.1	0 to 50	mg/L
pH	Hydrolab Minisonde 4a Users Manual April 1998 EPA 150.1	0 to 14	S.U.
Temperature (T)	Hydrolab Minisonde 4a Users Manual April 1998 EPA 170.1	-5 to 50	°C
Specific Conductivity (SC)	Hydrolab Minisonde 4a Users Manual April 1998 EPA 120.1	0 to 100	mS/cm
Turbidity	LaMotte 2020 Turbidimeter EPA 180.1	0-1,100	NTU
Total Phosphorus (TP)	EPA 365.1	0.03 RL	mg/L
Ortho-Phosphate (PO4)	EPA 365.1	0.03 RL	mg/L
Total Kjeldahl Nitrogen (TKN)	EPA 351.2	0.1 RL	mg/L
Nitrate-Nitrogen (NO3)	EPA 353.1	0.1 RL	mg/L
Total Ammonia (NH4-N)	EPA 350.1	0.1 RL	mg/L
Total Solids (TS)	EPA 160.3	10.0 RL	mg/L
E. coli	EPA 1603	1 CFU/ 100 ml.	CFU
Habitat	QHEI	N/A	N/A
Benthic Macroinvertebrate	IDEM Macro Program SOPs Dufour, Ronda. (Undated) *Guide to Appropriate Metric Selection for Calculating the macroinvertebrate Index of Biotic Integrity (mIBI) for Indiana Rivers and Streams*.	N/A	N/A
Flow	FP101-FP201 Global Flow Probe User's Manual 2004	0.3-15	FPS

Biological: Each macroinvertebrate sample will be analyzed using the following metrics: taxa richness (TR), Ephemeroptera-Trichoptera-Plecoptera index (EPT), percent EPT (EPT%), Hilsenhoff Biotic index (HBI), and percent clingers (CL%).

8. Quality Control Procedures

Quality control procedures are summarized on the table below.

Table 8.1. Quality Control Procedures

Quality Control Procedures	Frequency
Field sampling technique documentation	QAPP approved prior to initial sampling
Laboratory Accuracy and Precision Capability	As per Laboratory QAPP and SOP
Field Blanks	E. Coli – one blank Water Quality – one (1) blank, analyzed for six (6) parameters
Field Duplicate	Bacteria – five (5) field duplicate samples (10%) Water Quality- 1 low flow field duplicate, 2 elevated flow field duplicates, each analyzed for 6 parameters (36 results, 10%) Habitat – 1 field duplicate (20%) Biological – one (1) sample (20%) will be identified by two scientists
Equipment / Instrument Calibration	Day of use according to manufacturer's instructions
Laboratory Method Blank	As per Laboratory QAPP and SOP
Laboratory Duplicate	As per Laboratory QAPP and SOP
Laboratory Matrix Spike	As per Laboratory QAPP and SOP
Laboratory Control Standard	As per Laboratory QAPP and SOP
Laboratory Quality Control Standard	As per Laboratory QAPP and SOP
System Audit	To be performed if DQOs are not met

9. Data Review, Reduction, Analysis, and Reporting

9.1. Data Review

After each sample event, field data sheets, chain of custody and laboratory records will be reviewed by the project Quality Control officers for adherence to this Quality Assurance Project Plan. Raw data will be compared to data quality objectives identified in Chapter 3 and data that do not meet the specified DQOs will be identified with a data flag.

Field data and chain of custody review will occur after each sample event. Laboratory data review will occur as each batch of data is received. Investigation of data quality issues will occur prior to the next sample event.

The USGS National Water Information System (NWIS) codes will be used to identify result values that may require additional consideration from a quality assurance perspective. Data Qualifier Codes are shown on the table below. The NWIS codes can be found at: http://waterdata.usgs.gov/nwis/help?codes_help

Table 9.1. Data Qualifier Codes

Code	Definition	Notes
<	Actual value known to be less than the value shown	Measured value is less than the Method Detection Limit (MDL) and the MDL is reported
>	Actual value is known to be greater than the value shown	Measured value is greater than the analytical range and the highest measurable concentration is reported
A	Arithmetic Mean	
E	Estimated value	Use if holding time is exceeded
G	Geometric Mean	
K	Colony count is outside the accepted range for the analytical method	
V	Value affected by contamination	Analyte was detected in both the environmental sample and associated blanks

9.2. Data Reduction

For each parameter, basic summary statistics will be calculated, including number of measurements, minimum, maximum, average, median, number and percent of values meeting and exceeding water quality criteria or other non-regulatory water quality comparison value (See **Appendix B**).

The percent saturation of dissolved oxygen (% DO saturation) and concentration of un-ionized ammonia will be calculated.

9.3. Data Analysis

The percent (%) difference between baseflow and elevated flow samples will be evaluated using t-test. Results from stations with statistically significant differences will be used to evaluate relative importance of point source and nonpoint source contributions to in-stream concentrations. To the extent possible, sources of e. coli will be identified through watershed assessments using GIS data.

Data will be analyzed using IDEM protocols specified in *Appendix C: Indiana's 305(b) Assessment and 303(d) Listing Methodology, 2006*, or most recent update as appropriate. If data indicate that water quality has improved, the Project Manager will work cooperatively with IDEM to pursue de-listing.

9.4. Data Reporting

Data will be presented in a water quality monitoring report to be developed as a component of the Indian Creek Watershed Management Plan. Reporting will include sample results, quality assurance review and data interpretation.

10. Performance and System Audits

Performance and System Audits will be conducted if the Data Quality Objectives in Chapter 3 are not met on a consistent basis. Audits will be conducted by the Quality Control Officer and assistance from IDEM may be requested. IDEM reserves the right to conduct external performance and/or systems audits of any component of this study.

The audit reviews, but is not limited to, the following items:

1. Calibration procedures and documentation;
2. Data review and validation procedures;
3. Data storage, filing, and record keeping procedures;
4. Chain of custody procedures;
5. Standard Operating Procedures;
    a. Sample collection
    b. Chain of Custody sample login
    c. Sample preparation
    d. Analytical Procedures
    e. Quality Assurance/Quality Control Procedures
    f. Sample Container Preparation
6. Documentation;
    a. Bench Sheets
    b. Computer Entry for Sample Login
    c. Sample Analysis
7. Sample Storage;
    a. Adequate storage space (refrigerator, freezer, etc.) to store samples
    b. Stock or Quality Control Standards stored separately from samples
8. QA/QC procedures in the laboratory;
    a. Corrective actions or approved changes made to existing data
9. Maintenance Records:
    a. Provide documentation of all routine and non-routine maintenance on equipment and instruments
    b. Instruction/Vendor Manuals on file for equipment and instruments
10. Proficiency Documentation maintains records to demonstrate analysts have been trained in the analytical procedures;
11. Training includes maintaining records relating to additional training and attendance at workshops/seminars by personnel
12. Worksheet Review
13. On-site Analyst Work Review

14. Quality Control Standard Review
15. Annual Review by the Indiana Water Pollution Control Association Laboratory Committee
16. Unknown Sample Accuracy

11. Preventative Maintenance

Preventative maintenance procedures for field equipment are designed to minimize maintenance issues in the field and include the following:

- Perform a calibration check of the hydrolab sonde and flow meter prior to each sample event

- Maintain sufficient parts for equipment as per manufacturer's recommendation, including DO meter membranes and filling solutions.

- Order new replacement parts upon use of in-house replacement parts

Preventative maintenance procedures for laboratory instrument are designed to minimize maintenance issues in the laboratory.

Laboratory instruments will be maintained as per the requirements of the Indiana State Board of Health Laboratory Quality Control Plan and Standard Operating Procedures.

12. Data Quality Assessment

All data will be screened to ensure that it is valid in terms of precision, accuracy and completeness and that it meets the data quality objectives stated in Chapter 3.

12.1. Precision

The Relative Percent Difference of field and laboratory duplicate samples will be used to evaluate precision. The equation and data quality objectives for precision of each parameter are provided in Chapter 3. See Table 3.1 Data Quality Objectives. If precision falls out of limits in table 3.1 corrective action wil be triggered.

The same scientists will perform all habitat assessments.

12.2. Accuracy

The percent recovery of spiked samples will be used to calculate accuracy. The equation and Data Quality Objectives for accuracy are provided in Chapter 3.

Accuracy in macroinvertebrate analysis is dependent on maintenance of standard procedures for sample processing, labeling, sorting, identification, and counts. A definitive measurement of accuracy in biological assessments cannot be made because there is not a "true" value for reference. However, by stressing conformance with the procedures outlined in this plan, we expect to achieve a high degree of accuracy.

See Table 3.1 Data Quality Objectives. If accuracy falls out of limits in table 3.1 corrective action wil be triggered.

12.3. Completeness

Completeness will be assessed by comparing the number of field samples and laboratory results to the Data Quality Objectives contained in this QAPP. The equation and Data Quality Objectives for completeness are provided in Chapter 3.

See Table 3.1 Data Quality Objectives. If completeness is not achieved as required in table 3.1 corrective action wil be triggered.

13. Corrective Action

Quality control issues identified by the field or laboratory teams will be reported immediately to the Quality Control Officers. Corrective action to address identified quality assurance or quality control problems includes performance of a system audit to clearly identify the source of the problem, developing measures to address the problem, communicating the measures through a meeting and written documentation and post-assessments to ensure that data quality objectives are met. Corrective actions (as necessary) will be initiated prior to the next sample event.

14. Quality Assurance Reports

The status of the data with respect to data quality objectives will be discussed in a section of each data report. The report section will discuss the results of the data quality assessment conducted as per Chapter 12 and Corrective Actions if needed, as per Chapter 13 of the most recent Quality Assurance Project Plan.

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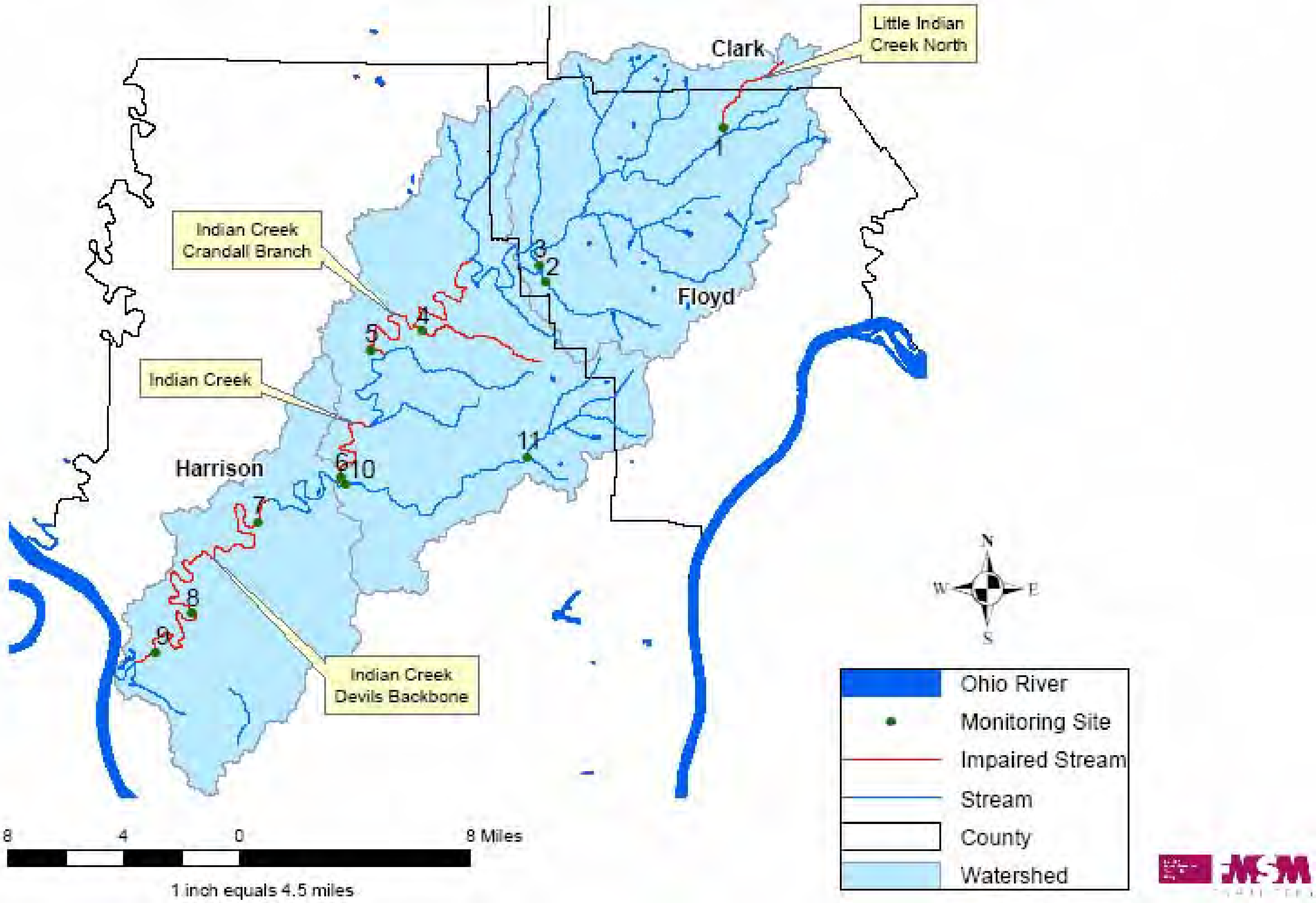
Appendix A

Indian Creek Sampling Sites

Indian Creek Watershed Monitoring Sites



Appendix B

Water Quality Criteria and Other Comparison Values

Parameter (Units)	Warm Water Aquatic Habitat Acute Criterion	Warm Water Aquatic Habitat Chronic Criterion	Domestic Water Supply Source	Other Comparison Value	Notes
Dissolved Oxygen (DO) (mg/L)	≥ 4.0 instantaneous	≥5.0 daily avg.	NA	>12 mg	**Comparison Value:** From IDEM, 2006 Integrated Report, Appendix C.
% DO Saturation	NA	NA	NA	<60% or >120%	% DO Saturation less than 60% or greater than 120% generally indicates eutrophication
pH (pH units)	≥ 6.0 and ≤ 9.0	NA	NA		
Temperature (°C)	See Table Below				
Specific Conductance (µS/cm @ 25 °C)	1,200	NA	NA		
Turbidity (NTU)	NA	NA	NA	5 – 25 NTU	**Comparison Value:** 5 NTU was recommended by AWWA, 1990 for recreation and 25 NTU was recommended by Harvey, 1989 for aquatic life
Total Solids (TS) (mg/L)	NA	NA	NA	261 mg/L	**Comparison Value:** Median of 99 results from the Indian Creek Watershed (4/7/99 to 2/8/06). Data collected by IDEM.
E. coli (CFU/100 ml)	**April 1 – Oct 31:** Geomean ≤ 125 / 100 ml and no single sample can exceed 576 / 100 ml		NA	NA	Geometric mean (geomean) based on a minimum of 5 samples in 30 days.
Total Kjeldahl Nitrogen (TKN) (mg/L)				0.26 – 0.50 mg/L	**Comparison Value:** < 0.25 mg/L was recommended by NHDES as ideal, with 0.26 – 0.50 mg/L recognized as an average value.
Nitrate-Nitrogen (NO3-N) (mg/L)	10	NA	NA	5 mg/L	**Comparison Value:** Concentrations greater than 5 mg/L trigger additional monitoring in finished drinking water.

Parameter (Units)	Warm Water Aquatic Habitat Acute Criterion	Warm Water Aquatic Habitat Chronic Criterion	Domestic Water Supply Source	Other Comparison Value	Notes
Ammonia-Nitrogen (NH4-N)					Un-ionized ammonia concentration is calculated using the equation below and compared to criteria tables in 327 IAC 2-1-6
Total Phosphorus (TP) (mg/L)	NA	NA	NA	0.3 mg/L	**Comparison Value:** From IDEM, 2006 Integrated Report, Appendix C.

Table 6-4

	Ohio River Main Stem °F(°C)	Other Indiana Streams °F(°C)
January	50 (10.0)	50 (10.0)
February	50 (10.0)	50 (10.0)
March	60 (15.6)	60 (15.6)
April	70 (21.1)	70 (21.1)
May	80 (26.7)	80 (26.7)
June	87 (30.6)	90 (32.2)
July	89 (31.7)	90 (32.2)
August	89 (31.7)	90 (32.2)
September	87 (30.7)	90 (32.2)
October	78 (25.6)	78 (25.5)
November	70 (21.1)	70 (21.1)
December	57 (14.0)	57 (14.0)

***To calculate total ammonia, divide the number in the table by the value determined by: $1/(10^{pK_a-pH} + 1)$.

Where: $pK_a = 0.09018 + (2729.92/(T + 273.2))$

pH = pH of water

T = °C

DO at 100% saturation based on temperature is shown on the table below. % DO saturation is also affected by barometric pressure. More detailed tables that include this effect have been published by USGS, 1998.

DO (mg/L) at 100% Saturation

$$\text{DO (percent saturation)} = \frac{\text{measured DO (mg/L)}}{\text{DO (mg/L at 100 percent saturation)}} \times 100$$

Temperature (°C)	DO (mg/l)	Temperature (°C)	DO (mg/l)
0	14.60	23	8.56
1	14.19	24	8.40
2	13.81	25	8.24
3	13.44	26	8.09
4	13.09	27	7.95
5	12.75	28	7.81
6	12.43	29	7.67
7	12.12	30	7.54
8	11.83	31	7.41
9	11.55	32	7.28
10	11.27	33	7.16
11	11.01	34	7.16
12	10.76	35	6.93
13	10.52	36	6.82
14	10.29	37	6.71
15	10.07	38	6.61
16	9.85	39	6.51
17	9.65	40	6.41
18	9.45	41	6.41
19	9.26	42	6.22
20	9.07	43	6.13
21	8.90	44	6.04
22	8.72	45	5.95

Appendix C

Microbac Laboratories, Inc., KTL Division, Standard Operating Procedures and Registration

E. coli MF (using modified mTEC agar)

PREPARED BY:	Alison Schleck
APPROVED BY:	Dee Cutrera
SUPERCEDES:	
REFERENCES:	EPA 1603
APPLICATION:	Ambient Water and Wastewater
CONC. RANGE:	N/A

1. PRELIMINARY COMMENTS

This method is approved for LT2 testing. Method 1603 describes a membrane filter (MF) procedure for the detection and enumeration of Escherichia coli in ambient waters and disinfected wastewater. This method is a single-step modification of EPA method 1103.1.

2. PRESERVATION & HOLDING TIMES

Samples should be held at <10°C. Sample analysis is preferably begun within 2 hours of collection. The maximum transport time to the laboratory is 6 hours, and samples should be processed within 2 hours of receipt at the lab.

3. INTERFERENCES

4. SAFETY CONSIDERATIONS

All samples should be handled as if they contain pathogens.

5. CLEANING CONSIDERATIONS

Disinfect work area before and after handling each sample.

6. APPARATUS AND EQUIPMENT

6.1 Autoclave
6.2 Water bath capable of maintaining 44.5 ± 0.2°C
6.3 Water bath for tempering agar
6.4 Vacuum source
6.5 Filter flask
6.6 Forceps
6.7 Sterile filtration apparatus
6.8 Magnifying lens or stereoscope
6.9 Thermometer, checked against a NIST certified thermometer, graduated to 0.1 °C.

7. REAGENTS AND SUPPLIES

7.1 Sterile phosphate buffered rinse water with MgCl
7.2 mTEC agar, modified (laboratory or commercially prepared)
  7.2.1 Prepare according to directions on container. Adjust volumes to amount of media needed
  7.2.2 Sterilize by autoclaving
  7.2.3 pH should be 7.3 ± 0.2
  7.2.4 Pour 4-6ml of tempered agar into petri dishes
  7.2.5 Allow to solidify and dry completely. Refrigerate for up to two weeks.
7.3 Sterile disposable plastic petri dishes (50x11mm)
7.4 Sterile borosilicate pipettes (1.00 & 10.0ml)
7.5 Membrane filters, sterile, gridded, 47mm, with 0.45 micron pore size
7.6 Ethanol for flame-sterilizing equipment

8. STANDARDS

8.1 Positive control culture: *Escherichia coli*, ATCC traceable
8.2 Negative control culture: *Enterobacter aerogenes*, ATCC traceable

9. SAMPLE PREPARATION

10. INSTRUMENT CALIBRATION

Refer to SOP Balances Operation and Calibration Program, SOP Thermometers Operation and Calibration Program, SOP Autoclave Market Forge Operation and SOP Thermo pH Meter Operation for specific instrument calibration indications.

11. PROCEDURE

11.1 Place bottom portion of filtration unit on vacuum flask.
11.2 Using sterile forceps, place membrane filter on bottom portion of filtration unit.
11.3 Carefully place top portion of filtration unit on top of filter (do not wrinkle filter) and attach clamp.
11.4 Shake the sample at least 25 times to distribute the bacteria uniformly.
11.5 Measure the desired volume into the funnel and filter under low vacuum. Select sample volumes that will yield counts between 20 and 80 *E.coli* per membrane. A minimum of three dilutions is recommended to ensure that a countable plate is obtained. For volumes of 20ml or less, add 20-30ml sterile buffered rinse water to the filter prior to adding sample aliquot. When sample is completely filtered rinse filter with (2) 20-30ml aliquots of sterile phosphate buffered rinse water with MgCl.
11.6 Turn off the vacuum and remove the top portion of the filtration apparatus.
11.7 Using sterile forceps, transfer filter to petri dish with modified mTEC agar, ensuring that no bubbles are trapped.
11.8 To rejuvenate stressed or injured cells, invert, and incubate for 2 ± 0.5 hours @ 35 ± 0.5°C.
11.9 After a 2 ± 0.5 hour incubation at 35 ± 0.5°C, transfer the plates to a Whirl-Pak® bag, seal and submerge in a 44.5 ± 0.2°C water bath for 22 ± 2 hours.
11.10 Remove plates from the water bath, and count and record the number of red or magenta colonies with the aid of a magnifying lens or stereoscope.
11.11 If required, verify a portion of typical and atypical colonies using Enterotube II, a commercially available multi-test identification system.

12. CALCULATIONS

Colonies per 100ml = C*100/S

Where: C = Colonies Counted
S = Sample Volume (ml)

13. QUALITY ASSURANCE

13.1 Analyst must be trained per DW and LT2 requirements and SOP Training
13.2 Check each batch of media for performance with positive and negative control organisms.
13.3 Each lot of membrane filters is checked for sterility by placing one filter in a non-selective broth and checking for growth (turbidity) after 24 hours incubation at 35±0.5°C.
13.4 Once per month repeat counts will be performed on at least one positive sample and compared with the counts of other analysts. Replicate counts for the same analyst should agree within 5% and those between analysts agree within 10%.
13.5 Each batch of Buffered Rinse water is checked for sterility by adding 50 ml of buffer water to 50 ml TSB 2X and checking for growth (turbidity) after 48 hours incubation at 35 ± 0.5°C.
13.6 All media and supplies shall be checked for sterility and documented in the Sterility Log and/or the Micro Working Reagents Log. Results and date read must be included with the data.
13.7 Each lot of pipets or autoclave batch of pipet tips is checked for sterility by placing one tip in TSB 1X or by repeatedly pipetting TSB through the pipet and checking for growth (turbidity) after 48 hours incubation at 35 ± 0.5°C.
13.8 The filter apparatus is checked for sterility for each filtration series by an initial blank, performing a blank after every 10 samples, and performing a final blank. If a control indicates contamination, the data shall be rejected and a new sample requested.
13.9 Each analyst on record will perform a set of PE or Blind studies every six months.

13.10 An IPR (Initial precision and recovery) study should be conducted by the laboratory prior to running client samples.

14. MAJOR SOURCES OF UNCERTAINTY

14.1. Holding temperature and time
14.2. Interference from other species
14.3. Interference from colloidal or suspended particulate material
14.4. Homogeneity of sample

Help

Logout

LT2 *E. coli* Lab Registration

Thank you for registering your organization as a participating *E. coli* lab for the LT2 Data Collection System. Below is a summary of the information you submitted to the system. Please click the edit link at the bottom of the screen to edit the information, or click the continue link to complete the registration process.

The LT2 Data Collection System has record of the following information for your *E. coli* lab:

Lab ID	KY00074
Lab Name	Microbac Laboratories, Inc. Kentucky Testing Division
Lab Type	*E. coli*, Membrane Filtration
Primary User Name	Delores Cutrera
Mailing Address	3323 Gilmore Industrial Blvd.
City	Louisville
State	KY
Zip Code	40213
Phone Number	5029626400
Fax Number	(502) 962-6411
E-mail	dcutrera@microbac.com

Please send the certification information to LT2ESWTR and Stage 2 DBPR by fax: (937) 586-6557, or by mail: to LT2ESWTR and Stage 2 DBPR ATTN: E. coli LT2 Data Collection and Tracking System Laboratory Registration, P.O. Box 98, Dayton, OH 45401. After certification is verified, the system administrator is notified to activate your laboratory in the system.

Edit Information   Continue with Registration

Revised: June 2006
LT2 Technical Support: stage2mdbp@epa.gov

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
002	**Indian Creek above Georgetown Creek @ Hamby Rd**						
		Dissolved oxygen (DO)	mg/L	6	4.6	7.42	15
		E. Coli	CFU / 100 ml	5	110	194.00	300
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	0.80	3.2
		Orthophosphate	mg/L	6	0.03	0.04	0.1
		pH	su	6	7.32	7.70	8.57
		Phosphorus, total	mg/L	6	0.03	0.04	0.05
		Solids, total	mg/L	6	281	379.33	475
		Specific conductance	us/cm	6	367	563.67	666
		Stream Flow	ft/sec	9	0	0.37	0.99
		Temperature, water	C	6	14.1	20.82	26
		Total Ammonia	mg/L	6	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	263	297.50	338
		Total Kjeldahl Nitrogen	mg/L	6	0.3	0.63	1.5
		Turbidity	NTU	6	4.2	10.33	22.9
003	**Indian Creek above Georgetown Creek, IDEM Site OBS080-0005**						
		Dissolved oxygen (DO)	mg/L	7	5.74	6.98	8.78
		E. Coli	CFU / 100 ml	5	12	147.20	430
		Nitrogen - nitrate+nitrite	mg/L	6	0.1	0.37	1.7
		Orthophosphate	mg/L	7	0.03	0.03	0.06
		pH	su	7	7.19	7.41	7.69
		Phosphorus, total	mg/L	7	0.03	0.04	0.08
		Solids, total	mg/L	7	217	235.86	264
		Specific conductance	us/cm	7	304	347.61	400
		Stream Flow	ft/sec	11	0	0.21	1.99
		Temperature, water	C	7	13.5	20.33	27.24
		Total Ammonia	mg/L	7	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	5	147	182.00	201
		Total Kjeldahl Nitrogen	mg/L	7	0.2	0.47	1
		Turbidity	NTU	7	6.14	10.58	14.3

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
004	**Crandall Branch above SR335 Bridge**						
		Dissolved oxygen (DO)	mg/L	7	6.41	8.14	10.4
		E. Coli	CFU / 100 ml	5	196	779.20	2200
		Nitrogen - nitrate+nitrite	mg/L	6	0.2	0.93	3.6
		Orthophosphate	mg/L	7	0.03	0.03	0.04
		pH	su	7	7.26	7.56	7.97
		Phosphorus, total	mg/L	7	0.03	0.04	0.05
		Solids, total	mg/L	7	265	331.86	376
		Specific conductance	us/cm	7	426	515.27	673.9
		Stream Flow	ft/sec	11	0	0.12	1.06
		Temperature, water	C	7	13.9	20.09	25
		Total Ammonia	mg/L	7	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	5	207	245.40	260
		Total Kjeldahl Nitrogen	mg/L	7	0.3	0.46	0.6
		Turbidity	NTU	7	2.16	4.54	7.11
005	**Indian Creek above SR355 Bridge, IDEM Site OBS090-0004**						
		Dissolved oxygen (DO)	mg/L	6	4.5	6.30	8.66
		E. Coli	CFU / 100 ml	5	84	268.80	410
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	0.48	1.9
		Orthophosphate	mg/L	6	0.03	0.04	0.09
		pH	su	6	7.3	7.48	7.66
		Phosphorus, total	mg/L	6	0.03	0.05	0.13
		Solids, total	mg/L	6	225	255.00	274
		Specific conductance	us/cm	6	310	375.43	448
		Stream Flow	ft/sec	10	0	0.59	4.85
		Temperature, water	C	6	13.9	20.37	25.2
		Total Ammonia	mg/L	6	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	171	200.00	215
		Total Kjeldahl Nitrogen	mg/L	6	0.3	0.63	1.3
		Turbidity	NTU	6	3.79	11.18	29

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
006	**Indian Creek above Little Indian Creek at Water Street**						
		Dissolved oxygen (DO)	mg/L	7	7.58	10.17	14.2
		E. Coli	CFU / 100 ml	8	19	94.63	200
		Nitrogen - nitrate+nitrite	mg/L	7	0.1	0.64	1.9
		Orthophosphate	mg/L	8	0.03	0.05	0.1
		pH	su	7	7.62	8.01	8.53
		Phosphorus, total	mg/L	8	0.03	0.06	0.16
		Solids, total	mg/L	8	244	264.13	288
		Specific conductance	us/cm	6	305	362.43	444
		Stream Flow	ft/sec	10	0.12	2.41	18.78
		Temperature, water	C	7	14.2	21.24	29.8
		Total Ammonia	mg/L	8	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	5	152	182.00	223
		Total Kjeldahl Nitrogen	mg/L	8	0.2	0.68	1.2
		Turbidity	NTU	7	1.13	15.58	46.6
007	**Indian Creek at Mathis Road bridge**						
		Dissolved oxygen (DO)	mg/L	6	5.6	7.27	9.04
		E. Coli	CFU / 100 ml	5	10	19.40	32
		Nitrogen - nitrate+nitrite	mg/L	6	0.1	0.55	2.6
		Orthophosphate	mg/L	7	0.03	0.04	0.1
		pH	su	6	7.43	7.82	8.39
		Phosphorus, total	mg/L	7	0.03	0.05	0.18
		Solids, total	mg/L	7	162	200.43	287
		Specific conductance	us/cm	6	222.8	293.97	340
		Stream Flow	ft/sec	10	0	1.10	6.6
		Temperature, water	C	6	14.4	20.07	28.2
		Total Ammonia	mg/L	7	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	156	160.75	168
		Total Kjeldahl Nitrogen	mg/L	7	0.3	0.57	1.1
		Turbidity	NTU	6	2.01	10.69	45

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
008	**Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001**						
		Dissolved oxygen (DO)	mg/L	6	0.08	5.73	7.73
		E. Coli	CFU / 100 ml	6	4	40.17	177
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	0.62	2.5
		Orthophosphate	mg/L	6	0.03	0.06	0.14
		pH	su	6	7.27	7.88	8.24
		Phosphorus, total	mg/L	6	0.06	0.11	0.22
		Solids, total	mg/L	6	199	226.67	299
		Specific conductance	us/cm	6	190	288.32	330
		Stream Flow	ft/sec	10	0	0.21	2.01
		Temperature, water	C	6	13	19.82	27
		Total Ammonia	mg/L	6	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	145	151.50	156
		Total Kjeldahl Nitrogen	mg/L	6	0.4	0.90	1.2
		Turbidity	NTU	6	10.1	23.52	63.1
009	**Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006**	Dissolved oxygen (DO)	mg/L	6	3.09	4.91	8.9
		E. Coli	CFU / 100 ml	5	4	44.20	132
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	0.60	2.5
		Orthophosphate	mg/L	6	0.03	0.05	0.15
		pH	su	6	6.91	7.40	7.58
		Phosphorus, total	mg/L	6	0.03	0.08	0.24
		Solids, total	mg/L	6	279	310.17	341
		Specific conductance	us/cm	5	331	452.36	520
		Stream Flow	ft/sec	10	-0.72	0.15	1.91
		Temperature, water	C	6	14.9	21.01	26.98
		Total Ammonia	mg/L	6	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	166	230.50	260
		Total Kjeldahl Nitrogen	mg/L	6	0.2	0.57	1.2
		Turbidity	NTU	6	5.62	17.51	68.9

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
010	**Little Indian Creek above Water Street Bridge**						
		Dissolved oxygen (DO)	mg/L	6	7.74	9.87	11.1
		E. Coli	CFU / 100 ml	5	100	119.20	140
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	1.22	5.1
		Orthophosphate	mg/L	6	0.03	0.06	0.16
		pH	su	6	7.61	7.89	8.08
		Phosphorus, total	mg/L	6	0.03	0.07	0.21
		Solids, total	mg/L	6	201	267.67	319
		Specific conductance	us/cm	6	267	397.17	510
		Stream Flow	ft/sec	10	0.1	3.37	28.3
		Temperature, water	C	6	13.8	22.47	29.3
		Total Ammonia	mg/L	6	0.1	0.10	0.1
		Total Dissolved Solids	mg/L	4	176	233.00	268
		Total Kjeldahl Nitrogen	mg/L	6	0.5	0.70	1.1
		Turbidity	NTU	5	1.3	6.04	20.9
011	**Little Indian Creek below Lanesville at State Road 62**						
		Dissolved oxygen (DO)	mg/L	6	4.9	10.63	16.2
		E. Coli	CFU / 100 ml	6	20	136.67	420
		Nitrogen - nitrate+nitrite	mg/L	5	0.1	1.60	5.9
		Orthophosphate	mg/L	6	0.1	0.66	2.15
		pH	su	6	7.52	8.24	8.88
		Phosphorus, total	mg/L	6	0.12	0.74	2.88
		Solids, total	mg/L	6	285	391.00	453
		Specific conductance	us/cm	6	406	572.83	720
		Stream Flow	ft/sec	10	0.02	2.23	18.4
		Temperature, water	C	6	14.2	21.80	26.2
		Total Ammonia	mg/L	6	0.1	0.22	0.8
		Total Dissolved Solids	mg/L	4	230	322.25	362
		Total Kjeldahl Nitrogen	mg/L	6	0.6	0.92	1.4
		Turbidity	NTU	6	1.9	17.17	80.2

Indian Creek Watershed Plan
Water Quality Monitoring Data Summary

Station ID	Location	Characteristic Name	Units	Number of Samples	Minimum	Average	Maximum
Blank							
		E. Coli	CFU / 100 ml	1	1	1.00	1
		Nitrogen - nitrate+nitrite	mg/L	1	0.1	0.10	0.1
		Phosphorus, total	mg/L	1	0.03	0.03	0.03
		Total Ammonia	mg/L	1	0.1	0.10	0.1
		Total Kjeldahl Nitrogen	mg/L	1	0.1	0.10	0.1

Indian Creek Watershed
Benthic Macroinvertebrate Data
Station List

Station ID	Station Name	Sample Date	Parameters	Notes
001	Indian Creek North at Banet Road, IDEM Site OBS080-0001	09/20/07	QHEI	Drought, insufficient water to sample benthic
002	Georgetown Creek below Georgetown at Malinee Ott Road	09/20/07	QHEI	
003	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	09/20/07	QHEI	
004	Crandall Branch above SR335 Bridge	09/20/07	QHEI	
005	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	09/20/07	QHEI	
006	Indian Creek above Little Indian Creek at Water Street, Corydon	09/20/07	Benthic, QHEI	Duplicate Sample
007	Indian Creek at Mathis Road Bridge	09/20/07	Benthic, QHEI	
008	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	09/20/07	Benthic, QHEI	
009	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	09/20/07	QHEI	
010	Little Indian Creek above Water Street Bridge	09/20/07	Benthic, QHEI	
011	Little Indian Creek below Lanesville at State Road 62	09/20/07	QHEI	

Indian Creek Watershed
Benthic Macroinvertebrate Data
Species List

Order	Genus	Species	Tol Val.	FFG	HABIT	Site 6 Quantitative	Site 6 Qualitative	Site 6 Duplicate Quantitative	Site 6 Duplicate Qualitative	Site 7 Qualitative	Site 8 Qualitative	Site 10 Quantitative	Site 10 Qualitative
Epheneroptera	*Acerpenna*	*pygmaenus*	3.88	CG		21		4		3		4	
	Baetis	*intercalaris*	4.99	CG		17		7		3		1	
	Callibaetis	*sp.*	9.84	CG			4			5			
	Caenis	*lattapennis*	7.4	CG		5		3		5		22	
	Caenis	*sp.*	7.4	CG							1		
	Choropterpes	*basalis*	2.3	SC	Clinger			1		1			
	Ephemera	*sp.*	1.1	CG				1	1				
	Isonychia	*sp.*	3.45	CF						1			
	Maccaffertium	*sp.*	4.1	SC	Clinger	2							
	Procloeon	*sp.*	5	CG						1			
	Stenacron	*sp.*	4	CG	Clinger					8		14	
	Stenonema	*femoratum*	7.18	SC	Clinger					6	16	3	
	Tricorythodes	*sp.*	5.06	CG		1						1	
Plecoptera	*Acroneuria*	*frisoni*	4	PR	Clinger							1	
	Acroneuria	*sp.*	1.4	PR	Clinger					1			
Tricoptera	*Cheumatopsyche*	*sp.*	6.22	CF	Clinger	2				29			
	Helicopsyche	*borealis*	5	SC	Clinger	8		2					
	Hydroptila	*sp.*	6.22	PH	Clinger			1					
	Hydropsyche	*venularis*	4	CF	Clinger	1		1					
	Neophylax	*sp.*	2.2	SC	Clinger							1	
	Triaenodes	*sp.*	4.46	PR							6		
Odonata	*Argia*	*fumipennis*	8.2	PR			2		2	1			
	Argia	*moesta*	8.2	PR		1		3		1		7	3
	Argia	*sedula*	8.46	PR					1	1			1
	Argia	*tibalis*	8.17	PR				1					2
	Argia	*sp.*	8.2	PR		1	1		1				
	Enallagma	*sp.*	8.91	PR			25			10	19		2
	Hetaerina	*sp.*	5.61	PR						7		1	
	Basiaeschna	*janata*	7.35	PR			1			2			1
	Boyeria	*vinosa*	5.89	PR							1		
	Epitheca	*priceps*	5.6	PR			2						
	Somatochlora	*sp.*	9.15	PR			3		5	1	1		
Coleoptera	*Ancyronyx*	*variegata*	6.49	SC	Clinger					1			
	Berosus	*sp.* (larvae)	8.43	PH		1	1						
	Dubiraphia	*vittata*	4.05	SC	Clinger			1		8	2	1	
	Helichus	*lithophilis*	4.6	SC	Clinger					7			
	Lutrochus	*laticeps*	5	SC	Clinger	2		5		1		2	2
	Macronychus	*glabratus*	4.58	CG	Clinger						5		
	Optioservus	*trivittatus*	2.36	SC	Clinger					1			
	Optioservus	*sp.* (larvae)	2.36	SC	Clinger			2					
	Peltodytes	*duodecipunctatus*	8.7	PH			2						
	Peltodytes	*sexmaculatus*	8.7	PH			1						
	Psephenus	*herricki*	2.35	SC	Clinger	2		12		19	13	10	6
	Stenelmis	*crenata*	5.1	SC	Clinger	1		2			1	8	1
	Stenelmis	*sexlineata*	5.1	SC	Clinger			1		29		12	
	Stenelmis	*sp.* (larvae)	5.1	SC	Clinger	5		22		4		143	1
	Tropisternus	*collaris striolatus*	9.7	CG							1		
	Tropisternus	*sp.*	9.7	CG						4			1
Hemiptera	*Belostoma*	*sp.*	9.8	PR									1
	Notonecta	*irrorata*	9	PR							1		
	Mesovelia	*sp.*	9.8	PR						1			
	Microvelia	*sp.*	9	PR						3			
Lepidoptera	*Parapoynx*	*sp.*	3	SH	Clinger							1	
	Petrophila	*sp.*	1.8	SH	Clinger	1							

Indian Creek Watershed
Benthic Macroinvertebrate Data
Species List

Order	Genus	Species	Tol Val.	FFG	HABIT	Site 6 Quantitative	Site 6 Qualitative	Site 6 Duplicate Quantitative	Site 6 Duplicate Qualitative	Site 7 Qualitative	Site 8 Qualitative	Site 10 Quantitative	Site 10 Qualitative
Diptera	*Anopheles*	*sp.*	8.58	CF							2		
	Chironominae		7	CG						1			
	Chironomus	*sp.*	9.63	CG									1
	Cryptochironomus	*sp.*	6.4	PR		7		1				2	
	Dicrotendipes	*sp.*	8.1	CG		3		1		1			
	Nanocladius	*sp.*	7.07	CG				1					
	Polypedilum	*sp.*	6.8	SH		11		1		1			
	Sphaeromias	*sp.*	6.9	PR									1
	Tanytarsus	*sp.*	6.7	CF	Clinger			3					
	Thienemannella	*sp.*	5.86	CG						1			
	Thienemannimyia	*gp.sp.*	5.9	PR		11		3					
	Zavrelia	*sp.*	5.3	CG		3		2					
Turbellaria	Unident. Flat worm		5	CG						16			
Oligochaeta	Lumbricudae		5	CG								4	
Hirudinea	*Helobdella*	*triserialis*	9.2	PC								1	
	Mooreobdella	*melanostoma*	7.8	CG						1		1	3
Gastropoda	*Campeloma*	*sp.*	5	SC					1				
	Elimia	*semicarinata*	2.5	SC		153	17	28	11	21	8	265	6
	Ferrissia	*rivularis*	6.55	SC						1			
	Physella	*sp.*	8.84	SC			2	1		2			
Pelecypoda	*Corbicula*	*fluminea*	6.12	CF		1	8	9	6	3		9	1
	Pisidium	*sp.*	6.48	CF								3	
	Sphaerium	*striatinum*	7.6	CF			4		5			1	1
Amphipoda	*Hyalella*	*azteca*	7.75	CG			5		1	5			
Isopoda	*Lirceus*	*sp.*	7.85	CG						1			
Decapoda	*Orconectes*	*juvinilis*	5.99	CG			4			5	8	4	4
		Total # Individuals				260(132)		116(113)		223	85	522(164)	
		Taxa Richness (TR)				35(31)		34(28)		42	15	34(30)	
		EPT				9		8		11	3	8	
		mHBI				4.8353		4.6168				5.0216	
		m%EPT				22		17				9	
		% Clingers				9		46				38	
		% Chir+Olig				13		10				1	
		MBI				**38.2**	**Poor**	**44.1**	**Fair**			**43.2**	**Fair**

Indian Creek Watershed
Benthic Macroinvertebrate Data
Qualitative Habitat Evaluation Index (QHEI)

Station ID	Station Name	Stream Size	1-Substrate	2-Instream Cover	3-Channel Morphology	4-Bank Erosion and Riparian Zone	5a-Pool/Glide Quality	5b-Riffle/Run Quality	6-Stream Gradient	Total QHEI Score	Habitat Quality Result
001	Indian Creek North at Banet Road, IDEM Site OBS080-0001	Headwater	12	12	14	4	0	0	4	46	Fair
002	Georgetown Creek below Georgetown at Malinee Ott Road	Headwater	13	6	10	4.5	2	0	4	39.5	Poor
003	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005	Larger Steam	13	13	14	9	8	0	4	61	Good
004	Crandall Branch above SR335 Bridge	Headwater	13	14	15	9.5	2	4	4	61.5	Good
005	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004	Larger Steam	16	13	11					40	Not Assessed
006	Indian Creek above Little Indian Creek at Water Street, Corydon	Larger Steam	5	6	11	7	5	4	4	42	Poor
007	Indian Creek at Mathis Road Bridge	Larger Steam	14	13	15	9	2	5	4	62	Good
008	Indian Creek above Rocky Hollow Road Bridge, IDEM Site OBS100-0001	Larger Steam	15	11	11	8.5	2	4	4	55.5	Fair
009	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006	Larger Steam	14	13	17	9.5	6	0	4	63.5	Good
010	Little Indian Creek above Water Street Bridge	Larger Steam	12	3	9	5	3	0	4	36	Poor
011	Little Indian Creek below Lanesville at State Road 62	Headwater	12	13	14	9	1	5	4	58	Good
	Maximum Score		**20**	**20**	**20**	**10**	**12**	**8**	**10**	**100**	

Notes

Stream Size: Headwaters Stream - less than or equal to 20 square miles

QHEI Scoring

Narrative Ranges	Headwaters	Large Streams
Excellent	70-100	75-100
Good	55-69	60-74
Fair	43-54	45-59
Poor	30-42	30-44
Very Poor	0-30	0-30

Site 5 Incomplete data

Appendix 3.1 Funding Sources

1. Indiana Department of Environmental Management Grants and Loans

1.1. Section 205(j) Grants

These grants are for water quality management planning, and can be used to determine the nature, extent and causes of point and nonpoint source pollution problems as well as develop plans to resolve these problems.

- **Who's Eligible:** Municipal governments, county governments, regional planning commissions, and other public organizations. For-profit entities, nonprofit organizations, private associations, universities, and individuals are not eligible to receive this assistance.
- **Matching Contribution Required:** No match is required.
- **Who to Call:** Doug Campbell, NPS/TMDL Section, (317) 233-8491.
- **More Information:** http://www.IN.gov/idem/resources/grants_loans/205j/

1.2. Section 319(h) Grants

These grants are for projects that reduce documented nonpoint source water quality impairments.

Funds may be used to conduct assessments, develop and implement watershed and surface water monitoring plans, provide technical assistance, demonstrate new technology and provide education and outreach.

- **Who's Eligible:** Nonprofit organizations, universities, and federal, state, and local governmental units.
- **Matching Contribution Required:** 40% of the total project cost, federal funds cannot be used.
- **Who to Call:** Laura Bieberich, NPS/TMDL Section, (317) 233-1863.
- **More Information:** http://www.IN.gov/idem/resources/grants_loans/319h/

1.3. Household Hazardous Waste Grants

These grants are designed to help start or expand household hazardous waste (HHW) recycling programs involving the collection, recycling, or disposal of HHW, and conditionally exempt small quantity generator waste (CESQGW).

Funds may be used to support educational and outreach programs that inform the public of substitutes for typical household hazardous products, product reuse and exchange programs that help reduce HHW, and the establishment of permanent facilities for the proper handling, collection, storage, recycling or disposal of HHW and CESQGW.

- **Who's Eligible:** Solid waste management districts, counties, municipalities and townships. Joint applications between two or more units of government are encouraged.
- **Matching Contribution Required:** 50% of the total project cost. See web site for further information.
- **Who to Call:** Office of Pollution Prevention and Technical Assistance (OPPTA), at (800) 988-7901
- **More Information:** http://www.in.gov/recycle/funding/hhwg.html

1.4. Waste Tire Recycling Grants

These grants are designed to help start or expand waste tire recycling programs in Indiana, and target new and innovative projects that reuse or recycle waste tires.

Funds may be used for IDEM approved civil engineering field projects that utilize waste tire material, research and development efforts that explore the use of waste tire material in high value-added products, projects that involve the beneficial reuse of waste tires in the construction of sports and other recreational fields, and trial and implementation efforts aimed at converting waste tires into fuel alternatives or supplements for energy generation applications.

- **Who's Eligible:** Indiana businesses, units of local government, schools and nonprofit organizations with 501(c) status.
- **Matching Contribution Required:** 50% of the total project cost. See web site for further information.
- **Who to Call:** Office of Pollution Prevention and Technical Assistance (OPPTA), at (800) 988-7901
- **More Information:** http://www.in.gov/recycle/funding/wtf.html

1.5. Recycling Grants

Each of these grants is intended to create sustainable projects with no state funding for ongoing program costs.

- **Who's Eligible:** Solid waste management districts, counties, municipalities, townships, schools, and nonprofit organizations with 501(c) status.
- **Matching Contribution Required:** 50% of the total project cost. See web site for further information.
- **Who to Call:** Office of Pollution Prevention and Technical Assistance (OPPTA), at (800) 988-7901
- **More Information:** http://www.in.gov/recycle/funding/

1.6. Indiana Brownfields Program

The Indiana Finance Authority administers the following grant and loan incentives with environmental technical support from IDEM staff:

- Stipulated Site Assessment Grants
- Stipulated Remediation Grants
- Petroleum Remediation Grants

- Federal Matching Grants
- Brownfields Low-Interest Loans
- Voluntary Remediation Tax Credits

Brownfields are abandoned, idled or underused properties where environmental contamination, either real or potential, hampers expansion and redevelopment.

In addition to site assessment and cleanup grants, which help pay for environmental investigation and remediation costs at identified brownfield sites, low-interest loans are also available under this program.

These loans are designed to help cover costs associated with brownfield remediation and redevelopment. Some of the eligible activities include soil and ground water cleanup, demolition, asbestos and lead based paint abatement, as well as further investigation.

- **Who's Eligible:** Political subdivisions.
- **Rates:** Call for current interest rates and additional information.
- **Who to Call:** Financial Resources Coordinator, Indiana Brownfields Program, (317) 234-1688

More Information: http://www.in.gov/ifa/brownfields/

1.7. Wastewater (WWSRF) and Drinking Water (DWSRF)

SRF loans are designed to fund projects that improve drinking water and wastewater infrastructure in order to maintain water quality or provide other public health benefits.

Funds are available for improvements to wastewater plants, sewer line extension projects, corrections to sewage overflow problems, water storage facilities, and water line extension projects. Funds are also available for the costs associated with non-point source water pollution abatement projects such as wetland restoration/protection, erosion control measures, stormwater best management practices, and wellhead and source water protection measures.

Contact SRF staff to see if your project is eligible for a Small System Technical Assistance Fund (SSTAF) grant.

- **Who's Eligible:** Political subdivision including incorporated cities, towns, counties, regional sewer/water districts, conservancy districts and water authorities. Private and not-for-profit facilities are eligible only for drinking water SRF loans.
- **Rates:** Below market rates are adjusted quarterly and are based on median household income (2000 census data) and current user rates. Call for current interest rates and additional information.
- **Who to Call:** Drinking Water SRF Administrator, (317) 232-8663 or the Wastewater SRF Administrator, (317) 232-4396
- **More Information:** http://www.in.gov/ifa/srf/

1.8. Boating Infrastructure Grant Program (BIG P)

This program is intended to provide funding (on a reimbursement basis) for the construction of facilities that will enhance boating for non-trailerable, (26 feet or over in length) transient recreational boats. "Transient" is defined as passing through or by a place, and staying 10 days or less.

Funding could be used for such projects as slips for transient boaters, mooring buoys, navigational aids to direct safe entry to facilities, and initial dredging to provide transient vessels with safe channel depths. These funds are subject to certain limitations and requirements. Call for additional information.

Boating facilities constructed under this program must be open to the public, designed to last for at least 20 years, continue to be used for their original stated grant purpose, and be maintained throughout their useful life.

- **Who's eligible:** All public marinas in Indiana which are situated along the shorelines of Lake Michigan and the Ohio River.
- **Matching Contribution Required:** 25% of the project cost, federal funds cannot be used.
- **Who to Call:** Office of Pollution Prevention & Technical Assistance, (317) 232-8172
- **More Information:** http://www.in.gov/idem/resources/grants_loans/bigp/index.html

1.9. Clean Vessel Act Grant Program

The primary goal of the Clean Vessel Act (CVA) is to reduce overboard sewage discharge from recreational boats. Boat sewage dumped into our waters may affect aquatic plants, fish, and other animals. The nutrients, microorganisms, and chemicals contained in human waste discharged from boats have a negative impact on coastal and inland waters, particularly in sheltered or shallow areas not naturally flushed by tide or current.

This program provides funding (on a reimbursement basis) for the construction, renovation, operation and maintenance of pump-out stations for holding tanks and dump stations for portable toilets. These funds are subject to certain limitations and requirements. Call for additional information.

- **Who's eligible:** All public marinas in Indiana which support recreational boats which are 26 feet and over in length and have portable or permanent on-board toilets.
- **Matching Contribution Required:** 25% of the project cost, federal funds cannot be used.
- **Who to Call:** Office of Pollution Prevention & Technical Assistance, (317) 232-8172
- **More Information:** http://www.in.gov/idem/resources/grants_loans/cva/index.html

Clean Vessel Act Public Notices:

- East Chicago Marina located at 3301 Aldis Avenue, East Chicago, Indiana 46312
- Rivercrest Marina located at 1200 W. 2nd Street, Madison, Indiana 47250
- Turtle Creek Harbor located at 206 6th Street, Florence, Indiana 47020

2. Indiana Department of Natural Resources Grants

2.1. Best Management Practices (BMP) Cost-Share Program

Logging operations in the State of Indiana are eligible to apply for cost-share dollars that will help defray the expense of BMP installations on harvest sites, depending on the location and timing of the harvest.

2.2. Community Forestry Grant Programs

Trees make our communities better places to live and work. Cities, towns and non-profit organizations can receive funding to enhance urban trees and forests. The Indiana DNR, Division of Forestry offers four grant programs that help improve, protect, maintain and increase the number of trees in Indiana communities. This federal and state funding is provided on an annual basis by the Indiana Department of Natural Resources and the U.S.D.A.

2.3. Develop a Shooting Range

The Indiana Shooting Range grant program provides assistance with the development of rifle, handgun, shotgun, and archery facilities. The main objective of this program is to provide the citizens of Indiana with additional and safer places to fire their guns, and train hunter education students.

2.4. Development of a New Park or Recreation Area

The Land and Water Conservation Fund grant program is to assist eligible governmental units in the provision of new park areas. Participation in outdoor recreation activities is expanding so rapidly that park agencies often face a real financial burden in attempting to provide enough facilities to keep up with the demand.

2.5. Fire Fighting Assistance for Rural Community Fire Departments

There are a number of programs aimed at assisting rural fire departments with needs ranging from equipment to training. Fire departments may serve either incorporated communities or unincorporated rural areas.

2.6. Forest Management Cost Share Programs

Many landowners may not be reaping their full benefits or providing adequate long term protection of forestlands. Cost share assistance is available to provide maximum watershed protection and erosion control, encourage abundant, healthy populations of wildlife, and maximum yields on timber harvests.

2.7. Historic Preservation and Archaeology

Each year the Division of Historic Preservation and Archaeology receives over $500,000 in federal funding under the Historic Preservation Fund (HPS) Program, which helps promote the U.S. Department of the Interior, National Park Service. The HPF Program helps promote historic preservation and Archaeology in Indiana by providing assistance to projects that will aid the State in meeting its goals for cultural resource management.

2.8. Hoosier Riverwatch

Hoosier Riverwatch has awarded grants to volunteer groups since 1996. These grant recipients form the foundation of the Hoosier Riverwatch volunteer stream monitoring network. Each grant provides up to $500 of water monitoring equipment. In return, grant recipients agree to monitor their selected stream or river segments at least four times per year for two years.

2.9. Lake and River Enhancement

The Lake and River Enhancement Program (LARE) was developed to ensure the continued viability of public-access lakes and streams. The program's goal is to utilize a watershed approach to reduce non-point source sediment and nutrient pollution of Indiana's and adjacent states' surface waters to a level that meets or surpasses state water quality standards. To accomplish this goal, grants are available for technical and financial assistance for qualifying projects.

2.10. Recreational Trails Program (RTP)

The Recreational Trails Program is a matching assistance program that provides funding for the acquisition and/or development of multi-use recreational trail projects. Both motorized and non-motorized projects may qualify for assistance. The assistance program is sponsored by the U.S. Department of Transportation’s Federal Highway Administration (FHWA). **..**

http://www.in.gov/dnr/assistance/grantresources.html

3. Indiana Office of Federal Grants & Procurement

Message from the Governor

I created the Office of Federal Grants and Procurement (OFGP) by Executive Order on my first day in office in order to increase significantly the amount of federal dollars coming to our state. Indiana ranks at or near the bottom among states in terms of our success in bringing federal funds back from Washington, and now the state is determined to move quickly to improve our performance and our ranking.

The OFGP will serve as a valuable resource in helping agencies of state government identify and win competitive federal grants, provide them with training and technical assistance to improve their grant skills, and measure and track federal grant funding to the state. In order to leverage resources and increase Indiana's capacity to pursue and secure federal grants, the Office will also provide grant assistance and support to Hoosier universities, non-for-profits, and the business community.

To ensure that Indiana receives its fair share of federal funding in the future, the OFGP will work closely with the State's Washington D.C. Office and our strong Congressional Delegation to advocate for fair adjustments in federal grant formulas, and to develop strong relationships with key federal agencies that are best able to provide direct grant assistance to the state.

In addition to coordinating federal grant activity, the OFGP is dedicated to keeping Indiana businesses informed of opportunities to sell their products and services to the federal government. The Office will work closely with the business community to find ways for the federal government to "Buy Indiana" whenever possible.

Hoosier taxpayers deserve to know that we are making every effort to ensure that a fair portion of the monies they send to Washington each year come back to Indiana to help us meet the challenges we face in building infrastructure, training workers for new job opportunities, and caring for the sick and disabled. The OFGP will be the central focus of this Administration's efforts to obtain federal support wherever possible to support our goal of improving the lives Hoosier citizens and communities as we "Aim Higher" for Indiana's future.

Sincerely,

Mitch Daniels

http://www.in.gov/ofgp/

4. Federal Emergency Management Agency (FEMA) Grants

4.1. Buffer Zone Protection Program (BZPP)

Total Funding Available in FY 2008: $48.5 million

Purpose: BZPP provides grants to build security and risk-management capabilities at the State and local level in order to secure pre-designated Tier I and Tier II critical infrastructure sites, including chemical facilities, financial institutions, nuclear and electric power plants, dams, stadiums, and other high-risk/high-consequence facilities.

Eligible Applicants: Specific BZPP sites within 45 States have been selected based on their level of risk and criticality. Each State with a BZPP site is eligible to submit applications for its local communities to participate in and receive funding under the program. Therefore, BZPP funding allocated to any given State or territory is a function of the number, type, and character of the pre-identified sites within that State or territory.

http://www.fema.gov/government/grant/bzpp/index.shtm

4.2. FY 2008 Emergency Management Performance Grant

The principal priority for the FY 2008 EMPG funds is to sustain and enhance catastrophic planning capabilities, to include addressing the findings of the FEMA gap analysis program and similar capability assessment efforts, and assisting state and local jurisdictions to address national and regional catastrophic planning needs. State and local jurisdictions should also continue to focus on addressing state-specific planning issues identified through the 2006 Nationwide Plan Review. In FY 2008, specific planning focus areas of evacuation planning, logistics and resource management, continuity of operations (COOP) / continuity of government (COG) planning, and recovery planning have been identified as national planning focus areas.

Total Funding Awarded in FY 2008: $291,450,000

http://www.fema.gov/emergency/empg/empg.shtm

4.3. Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act.

4.4. Flood Mitigation Assistance (FMA)

Provides funding to assist States and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP.

4.5. Pre-Disaster Mitigation Grant Program (PDM)

Provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event.

4.6. Repetitive Flood Claims (RFC)

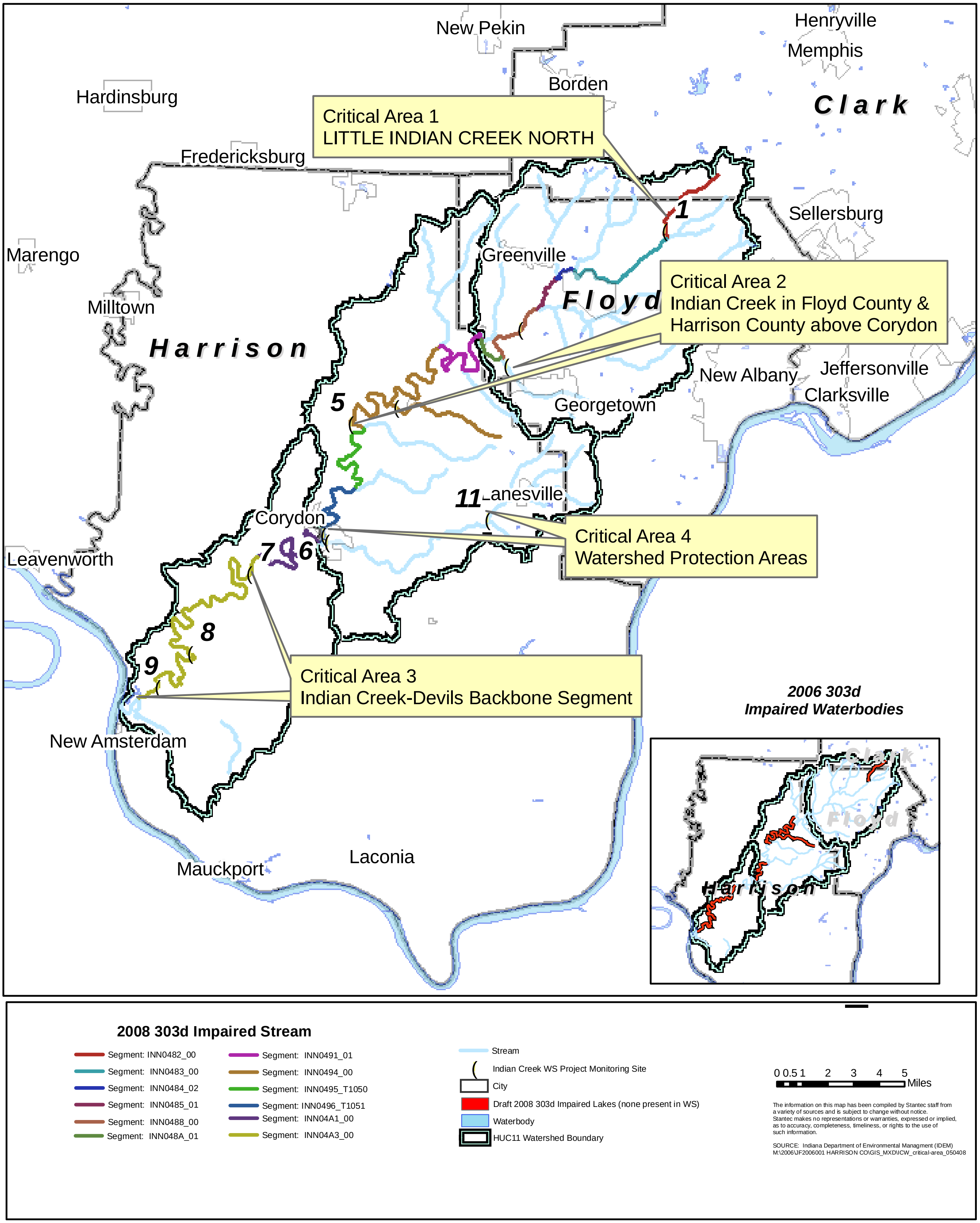
Provides funding to States and communities to reduce or eliminate the long-term risk of flood damage to structures insured under the NFIP that have had one or more claims for flood damages, and that can not meet the requirements of the Flood Mitigation Assistance (FMA) program for either cost share or capacity to manage the activities.

4.7. Severe Repetitive Loss (SRL)

Provides funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss (SRL) structures insured under the National Flood Insurance Program (NFIP).

http://www.fema.gov/government/grant/hmgp/index.shtm

Indian Creek Watershed -- Critical Areas



Critical Area 1. Little Indian Creek North

Critical Area 1: Little Indian Creek North

Item	Description
Monitoring Site	001
Location	Indian Creek North at Banet Road, IDEM Site OBS080-0001
Site Selection Rationale	303(d) Segment – Aquatic Life Impairment
Biological Monitoring Result	Not sampled due to severe drought conditions. Habitat assessment result was Fair (score 46) and indicated bank erosion and poor riparian zone.
Interpretation	Data gap
Cause of Impairment	
Load Reduction Required	
Pollution Source(s)	
Strategies - High Priority	
Strategies - Medium Priority	Sample this location during normal flow conditions; both IDEM data were collected during low flow and it was not possible to collect benthic data during this project Use data collected under normal flow conditions to re-assess this stream.
Strategies - Low Priority	Bank stabilization and riparian vegetation would be beneficial.

Monitoring Site 001: These photographs were taken on September 20, 2007 during the biological sampling event. Due to lack of water, this site was not sampled. The very small drainage area may contribute to biological impairment since this site is easily affected by both droughts and floods.

Critical Area 2: Indian Creek in Floyd County and Harrison County above Corydon

This critical area includes the Indian Creek mainstem, Georgetown Creek and Crandall Branch. Information to support the critical area assessment was derived from monitoring data collected at Sites 002, 003, 004 and 005.

Critical Area 2: Georgetown Creek

Item	Description
Monitoring Site	002
Location	Georgetown Creek below Georgetown at Malinee Ott Road
Site Selection Rationale	Unassessed reach below Georgetown
Bacteria Result (CFU/100 ml)	Geomean: 194; Maximum: 300 Estimated Existing Load: 6.7 E+12 CFU/year
Interpretation	Recreational Use Impaired
Cause of Impairment	Elevated e. coli
Load Reduction Estimates	Estimated Load Reduction: 2.4 E+12 CFU/year 35.5%
Pollution Source(s)	Cattle in creek (field observation, see photos below). Possible pasture sources and septic systems (BIT result)
Strategies - High Priority	Cattle exclusion/ alternate water supply, stream buffer / streambank stabilization
Strategies - Medium Priority	Evaluate septic systems as a possible pollution source in Georgetown Creek; address through maintenance, repair, and replacement as needed.
Strategies - Low Priority	




Monitoring Site 2. Georgetown Creek below Georgetown at Malinee Ott Road. These field photos document cattle access to the creek, which could be addressed by cattle exclusion fencing and alternate water supplies. The photos also show poor riparian buffer. This site was not included in the benthic macroinvertebrate sampling, but clearly riparian buffer and bank stabilization would be beneficial here.

Critical Area 2: Indian Creek above Georgetown Creek

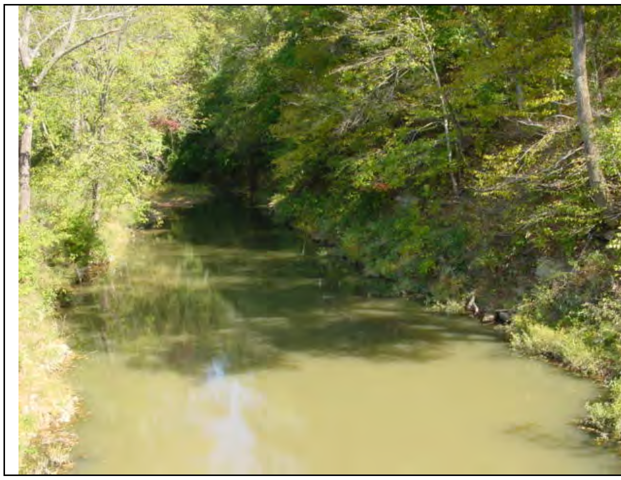
Item	Description
Monitoring Site	003
Location	Indian Creek above Georgetown Creek, IDEM Site OBS080-0005
Site Selection Rationale	Floyd County drainage, near County boundary, developing
Bacteria Result (CFU/100 ml)	Geomean: 147; Maximum: 430 Estimated Existing Load: 3.5 E+13 CFU/year
Interpretation	Recreational Use Impaired
Cause of Impairment	Elevated e. coli
Load Reduction Required	Estimated Load Reduction: 5.4 E+12 CFU/ year 15.1%
Pollution Source(s)	Septic systems (BIT Result for subwatersheds 1-10 indicates that the area draining to Site 3 had the highest potential for septic contribution in Indiana Creek Watershed due to poor soil conditions for septic systems and higher population density. Non-compliance at Woods of Layfayette WWTP– See Table below.
Strategies - High Priority	WWTP Compliance at Woods of Layfayette, historical compliance issues at Jacobi's Car Wash seem to be addressed; maintain compliance at WWTPs above Site 003.
Strategies - Medium Priority	Evaluate septic systems as a potential source of bacterial pollution using methods such as dye and smoke testing, fecal coliform / fecal strep ratios, optical brighteners.
Strategies - Low Priority	

Wastewater Treatment Facilities above Monitoring Site 3

Facility	Map Reference ID Number (1)	NPDES #	Monitoring Location	Total # of Violations (03/2002 - 02/2007)	# of E. coli Violations (03/2002 - 02/2007)	Most Recent E. Coli Violation (03/2002-02/2007)
Galena Elem & Floyd Central HS	2	IN0031178	Effluent Outfall	6	1	5/31/2006
Wymberly Sanitary Works, Inc	5	IN0043923	Effluent Outfall	1	0	N/A
Highlander Point Shopping Cent	7	IN0050032	Effluent Outfall	0	0	N/A
Chimneywood Sewage Works, Inc.	8	IN0050181	Effluent Outfall	16	0	N/A
Galena WWTP	9	IN0052019	Effluent Outfall	22	0	N/A
Country View Subdivision	10	IN0052159	Effluent Outfall	1	0	N/A
Woods Of Lafayette's WWTP	**11**	**IN0054101**	**Effluent Outfall**	**46**	**12**	**6/30/2006**
Huber Family Restaurant	12	IN0055794	Effluent Outfall	37	0	N/A
Floyd Knobs Elementary School	14	IN0058572	Effluent Outfall	15	0	N/A
Jacobi's Car	**15**	**IN0059382**	**Effluent**	**32**	**11**	**10/31/2002**

Facility	Map Reference ID Number (1)	NPDES #	Monitoring Location	Total # of Violations (03/2002 - 02/2007)	# of E. coli Violations (03/2002 - 02/2007)	Most Recent E. Coli Violation (03/2002-02/2007)
Wash & Store			**Outfall**			
Cleancar Auto Wash Corp.	16	IN0059803	Effluent Outfall	42	0	N/A

Note: Map ID # refers to Figure 2.10 Indian Creek NPDES Facility Compliance



Site 003 Upstream and Downstream. This site as a well-forested buffer and little evidence of disturbance near the sampling site.

Critical Area 2: Crandall Branch above SR335 Bridge

Item	Description
Monitoring Site	004
Location	Crandall Branch above SR335 Bridge
Site Selection Rationale	303(d) Segment – Recreation (may be an artifact of mapping?)
Bacteria Result	Geomean: 779; Maximum: 2,200 Estimated existing load: 3.3 E+13 CFU/year
Interpretation	Recreational Use Impaired
Cause of Impairment	Elevated e. coli
Load Reduction Estimate	Estimated Load Reduction: 2.8 E+13 CFU/year 84.5%
Pollution Source(s)	BIT result for Watershed 13 indicated crop, pasture and cattle as potential sources. BIT result ranked septic systems as relatively low impact in this watershed compared to other Indian Creek subwatersheds, discharges into the well developed karst system from septic systems and/or agricultural sources could contribute to impairments as could bacterial regrowth. Currently, no WWTPs discharge into Crandall Branch.
Strategies - High Priority	
Strategies - Medium Priority	Perform visual and habitat assessments to evaluate agricultural sources of bacteria in this subwatershed.
Strategies - Low Priority	Evaluate septic systems as a potential source of bacterial pollution using methods such as dye and smoke testing, fecal coliform / fecal strep ratios, optical brighteners.

Site 4. Crandall Branch Above Indian Creek, Upstream and Downstream. The impacts of the drought can be seen in this picture. Otherwise, this area has a well forested buffer near the sampling site.

Critical Area 2: Indian Creek above SR355 Bridge

Item	Description
Monitoring Site	005
Location	Indian Creek above SR355 Bridge, IDEM Site OBS090-0004
Site Selection Rationale	303(d) Segment – Recreation
Bacteria Result	GeoMean: 268.8; Maximum: 410 Estimated Existing Load: 1.1 E+14 CFU/year
Interpretation	Recreational Use Impaired
Cause of Impairment	Elevated e. coli
Load Reduction Estimate	Load Reduction Estimate: 5.7 E+13 CFU/year 53.4%
Pollution Source(s)	BIT results indicate crop, pasture and cattle as potential sources of bacteria in Watershed 15; Septic systems were ranked lower than other Indian Creek subwatersheds in the BIT analysis; WWTP Compliance, discharges into the well developed karst system from septic systems and/or agricultural sources could contribute to impairments; bacterial regrowth?
Strategies - High Priority	Improve WWTP Compliance at Lanesville Welcome Center
Strategies - Medium Priority	Encourage agricultural BMPs such as cattle exclusion/ alternative water supplies, manure management plans
Strategies - Low Priority	If septic system failures are reported, investigate with dye and smoke testing and repair or replace as needed

Wastewater Treatment Facilities above Monitoring Site 5

Facility	Map Reference ID Number (1)	NPDES #	Monitoring Location	Total # of Violations (03/2002 - 02/2007)	# of E. coli Violations (03/2002 - 02/2007)	Most Recent E. Coli Violation (03/2002-02/2007)
Dairy Dip Car Wash	3	IN0038385	Effluent Outfall	1	0	N/A
Lanesville Welcome Center I-64	**6**	**IN0045942**	**Effluent Outfall**	**81**	**8**	**5/31/2006**

Note: Map ID # refers to Figure 2.10 Indian Creek NPDES Facility Compliance

Site 5 Indian Creek above SR355 Bridge Looking Upstream and Downstream. This site has a relatively well vegetated riparian area, but there is evidence of some areas needing tree plantings. This area is highly influenced by karst and water was very still during the drought. This hot, dry condition promotes regrowth of bacteria.

Critical Area 3: Indian Creek Devils Backbone Segment

This critical area includes the Indian Creek mainstem from the Mathis Road Bridge to the Ohio River Confluence. Information to support the critical area assessment was derived from monitoring data collected at Sites 007, 008 and 009.

Critical Area 3: Indian Creek Devils Backbone Segment

Item	Description
Monitoring Site	007, 008
Location	Indian Creek at Mathis Road Bridge and Indian Creek above Rocky Hollow Road Bridge (IDEM Site OBS100-0001)
Site Selection Rationale	303(d) Segment – Aquatic Life impairment due to low dissolved oxygen
Dissolved Oxygen Result (mg/l)	Minimum: 5.6 mg/l Average: 7.3 mg/l
Interpretation	Aquatic Life Use Met
Cause of Impairment	NA
Load Reduction Required	NA
Pollution Source(s)	NA
Strategies - High Priority	
Strategies - Medium Priority	Our data showed DO criteria were met. Encourage IDEM to resample this location and delist as appropriate.
Strategies - Low Priority	

Site 007: Indian Creek at Mathis Road Bridge

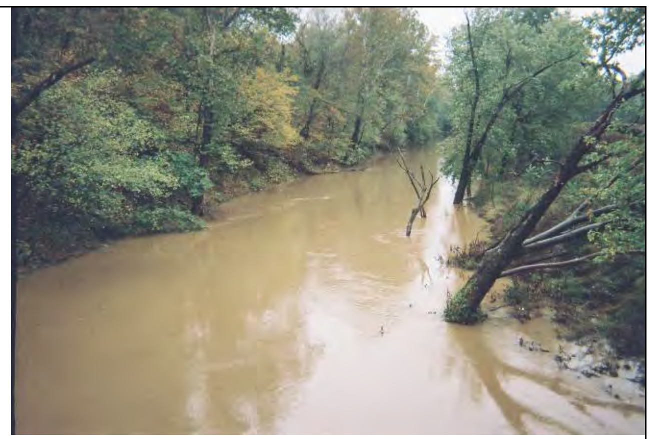
Site 008: Indian Creek above Rocky Hollow Road Bridge (IDEM Site OBS100-0001)

These monitoring sites are located in an agricultural / undeveloped part of the watershed. This area is heavily influenced by karst and other than the mainstem Indian Creek, there is relatively little surface water in this area. The photographs show a well developed and stable riparian buffer in this area. The sediment load from upstream sources in these high flow photographs is clearly visible.

Critical Area 3: Indian Creek Devils Backbone Segment

Item	Description
Monitoring Site	009
Location	Indian Creek above Lickford Road Bridge, IDEM Site OBS100-0006
Site Selection Rationale	303(d) Segment – Aquatic Life impairment due to low dissolved oxygen
Dissolved Oxygen Result (mg/l)	Minimum: 3.1 mg/l Average: 4.9mg/l
Interpretation	Aquatic Life Use Not Met
Cause of Impairment	Our data indicate that this area may be affected by Ohio River backwater and very reduced flows due to karst. If the DO violation is confirmed as being caused by natural conditions, pursue delisting and avoid TMDL development
Load Reduction Required	NA
Pollution Source(s)	NA
Strategies - High Priority	
Strategies - Medium Priority	Encourage IDEM to resample this location and delist as appropriate.
Strategies - Low Priority	

Site 009 under base flow conditions.



Site 009 under elevated flow conditions.

During four (4) sample events, flows were 0 feet/ second and during three (3) sample events, flows were reversed and ranged from -0.5 ft/s to -0.72 ft/s. These very low and reverse flows indicate the important influence of the Ohio River and it's backwater in this area.

This monitoring site is located in an agricultural / undeveloped part of the watershed. This area is heavily influenced by karst and other than the mainstem Indian Creek, there is relatively little surface water in this area. The photographs show a well developed and stable riparian buffer in this area. The sediment load from upstream sources in the elevated flow condition photograph is clearly visible.

Critical Area 4: Watershed Protection Areas

This critical area includes the Indian Creek mainstem near Corydon and Little Indian Creek. The watershed in this area has relatively good water quality, thus watershed protection was identified as an important strategy here. Information to support the critical area assessment was derived from monitoring data collected at Sites 006, 010 and 011.

Critical Area 4: Watershed Protection Areas

Item	Description
Monitoring Site	006
Location	Indian Creek above Little Indian Creek at Water Street
Site Selection Rationale	Downstream end of HUC, 303(d) Segment – Recreation, above WWTP, receives Corydon runoff
Bacteria Result (CFU/100ml)	Geomean: 93.3; Maximum: 180
Interpretation	Recreational use met
Cause of Impairment	NA
Load Reduction Required	NA
Pollution Source(s)	NA
Strategies - High Priority	
Strategies - Medium Priority	Maintain compliance at Corydon WWTP.
Strategies - Low Priority	Consider riparian habitat improvements.

Site 006 – Looking upstream

Site 006- Looking downstream

While recreational criteria for bacteria were met, this location has poor habitat. Sedimentation is occurring and elevated nutrients may be contributing to algal proliferation seen in the downstream photograph.

Indian Creek Watershed Plan
Appendix 3.2. Critical Areas Issues and Strategies

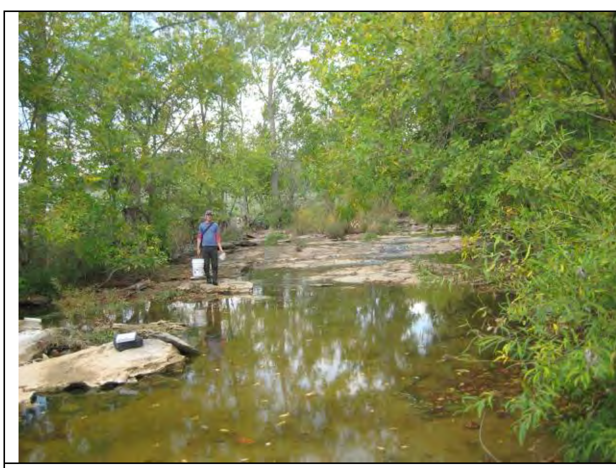
Critical Area 4: Watershed Protection Areas

Item	Description
Monitoring Site	010 and 011
Location	Little Indian Creek
Site Selection Rationale	Major tributary, classified as “unassessed” by IDEM
Bacteria Result (CFU/100 ml)	Site 010: Geomean: 119.2; Maximum: 140 Site 011: Geomean: 118; Maximum: 226
Interpretation	Recreational use met
Cause of Impairment	NA
Load Reduction Required	NA
Pollution Source(s)	NA
Strategies - High Priority	
Strategies - Medium Priority	Maintain compliance at Corydon WWTPs (Corydon, Tyson).
Strategies - Low Priority	Continue to monitor and assess nutrients below Lanesville. Consider flood protection and riparian habitat improvements near the confluence with Indian Creek (Site 010).

Site 010 – Low flow condition

Site 010- Elevated flow condition

The poor quality habitat is documented in the low flow condition photograph and potential for flooding is seen in the elevated flow photograph.



Site 11 – Biological sampling under low flow conditions

Site 11 – nearby sinkhole

Site 11 on Little Indian Creek near Lanesville had good quality habitat that should be maintained. The influence of karst and its ability to transport water through underground channels is depicted in the sinkhole photograph.