VFC Index - Watershed (Plan)

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Watershed Management Plan

Lower Patoka River

ARN # 19207

Gibson County Soil and Water Conservation District

Funded by the Indiana Department of Environmental Management

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EXECUTIVE SUMMARY

The overall goal and purpose of the Lower Patoka River watershed management plan is to provide data along with maps to assist local citizens with improving water quality. The major water quality concerns in the watershed and recommended management strategies are addressed in the plan. Water quality management decisions and activities are most effective and efficient when managed at a sub-watershed level; however, the impact on the whole watershed must also be considered. This watershed management plan is a tool to accomplish non-point source (NPS) pollution reductions in the Lower Patoka River watershed until target concentrations of nutrients and sediment meet state standards and streams are removed from the 303(d) list of impaired waterbodies.

WATERSHED COMMUNITY INITIATIVE

1. PROJECT INITIATION

In 2008, the Gibson County Commissioners completed a Watershed Management Plan (WMP) for the Lower Patoka River (LPR). The Gibson County Soil and Water Conservation District (SWCD) applied for and received a Section 319 implementation grant in 2013. A watershed coordinator was hired to implement the 319 grant under the 2008 WMP.

The Gibson County SWCD board of supervisors, the watershed coordinator, The Nature Conservancy's (TNC) Lower Wabash and Wetlands Program Director, the Patoka River National Wildlife Refuge manager, and the Lower Patoka Steering committee members worked together to implement the grant with the vision of ***a healthier environment with better water quality for drinking, recreation, and wildlife in the Lower Patoka River watershed*** and a mission of ***working towards a healthier environment with measurable successes by improving the water quality of the Lower Patoka River watershed through technical, financial, and educational resources and events.***

During the first-round of implementation of the current WMP, the watershed coordinator began to look forward to a second round of implementation and concluded that:

1) The 2008 WMP was not in compliance with IDEM's 2009 Checklist due to its age.
2) The watershed had experienced tremendous change with the I69 construction.

Through preliminary research, the Watershed Coordinator identified the following list of current problems in the county that are possibly impacting the Lower Patoka River (LPR) Watershed:

- Increase in agricultural acres (from 231,082 acres in 2007 to 268,146 acres in 2012) with a significant portion being (HEL) highly erodible lands. (USDA Census of Agriculture)
- As much as 79,900 acres corn (81%, 2017 spring transect data) and as much as 34,800 acres beans (43%, 2015 spring transect data) are still being conventionally tilled in Gibson County.
- Increase in population of county, potentially causing a rise in number of septic systems. (population data from 2012 U.S. Census)
- Twenty-four miles of I69 constructed through Keg and Robinson sub-watersheds, resulting in 1,680 acres impacted in the LPR watershed. (INDOT Environmental Impact Study)
- The mining of Peabody, Black Beauty and Gibson County Coal resulting in South Fork sub-watershed with sulfate and pH issues (data from IDEM testing).

The Watershed Coordinator then partnered with The Nature Conservancy (TNC) to do some modeling of the watershed. Using L-THIA modeling, TNC reported that it appeared critical areas in the watershed may have shifted due to either the first round of Best Management Practices (BMPs) implementation or the I69 impact or both. The LPR steering committee and the Gibson County SWCD then made the decision to update the current WMP through a revision process. The Gibson County SWCD applied for and received a grant from the Indiana Department of Environmental Management (IDEM) to revise the 2008 WMP for the LPR watershed.

2. LOWER PATOKA STEERING COMMITTEE

Over the course of the first round of implementation, the LPR Steering Committee members had declined to five including the watershed coordinator, IDEM's watershed specialist, the Refuge manager, TNC's Lower Wabash project director, and the writer of the 2008 WMP.

Upon the awarding of a 205j grant from IDEM, the watershed coordinator began to seek out opportunities for further assistance beyond the steering committee to revise the WMP and learned of a pilot program being offered through Purdue University called Conservation through Community Leadership (CCL). This program was to guide watershed groups in natural resource management, conservation, and agriculture and land use planning issues with facilitated action planning sessions.

With the assistance of the CCL Purdue team, a stakeholder workshop was held to gather stakeholder concerns from a wide range of citizens and county leaders. Local leaders and concerned citizens were invited from six categories: environmental, technical, social, economic, legal and political. The public, as well as a total of 100 stakeholders and community leaders, were invited to attend the stakeholder workshop led by the Purdue CCL team. The goal was to have 50 attend this meeting with 12 committed to continuing to work in the watershed as a Steering Committee Member. In addition to the original steering team, 24 stakeholders came to this kick-off session. This outreach event was held over the course of a day and stakeholders were actively involved in the discussion of resource concerns.

Key stakeholders were then asked to commit to actively engaging in the drafting of the revised WMP through LPR Steering Committee meetings with the watershed coordinator. The following table lists the LPR steering team members committed to the revision project, and their affiliations.

Table # 1	
LOWER PATOKA RIVER STEERING COMMITTEE MEMBERS	
Julie Loehr, Watershed Coordinator	Lower Patoka River Watershed
Josh Brosmer, Watershed Specialist	IDEM
Health Hamilton, acting Refuge Manager	Patoka River National Wildlife Refuge
Tom Mosley, concern citizen	Wrote the 2008 LPR WMP
Brad Smith, Lower Wabash /Wetland program director	The Nature Conservancy
S. Erica Burkemper-Fischer, District Administrator	Pike County SWCD
Tabitha Anthis, District Coordinator	Gibson County SWCD
Addie Thornley, Ag Natural Resource Program Ext. Educator	Purdue Extension
Arnie Howes, concerned citizen	BMP Cost-share Participant
Stephanie McKinney, Floodplain Administrator	Emergency Management Gibson Co.

3. NATURAL RESOURCE CONCERNS IN THE WATERSHED

On December 11, 2017, the LPR Steering Committee met with the goal of sorting through all resource concerns brought up by stakeholders at the public meetings. It was discussed that some resource concerns, such as encouraging pollinator species when doing BMPs, were valid concerns, and could be included in the WMP; however, the cost of installing a pollinator plot probably wouldn't be a part of an implementation grant. Since addressing natural resource concerns, such as non-native invasive plant species and pollinators, does not directly address water quality, they would be considered as part of the educational portion of a grant implementation. The steering team members also discussed the advantage of including non-native invasive plant species and pollinators in the WMP to apply for other grant funding opportunities such as Clean Water Indiana (CWI) or Lake and River Enhancement (LARE) grants.

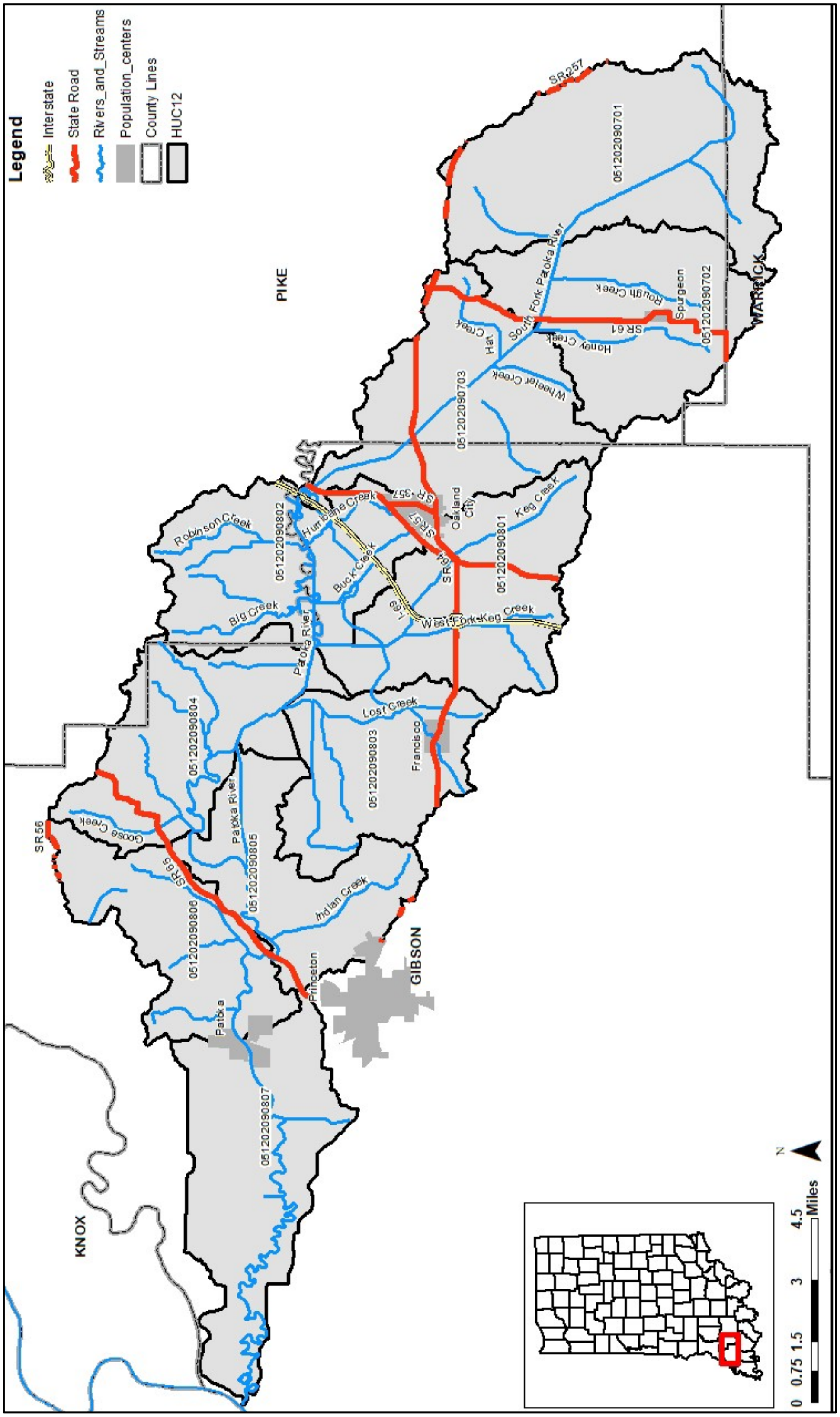
The committee further discussed stakeholder inputs that were strategies rather than resource concerns. The committee worked to reduce the list to only resource concerns. At the end of the meeting, the following list of LPR watershed natural resource concerns was compiled (listed in no order):

TABLE # 2 Stakeholder's Resource Concerns in LPR Watershed

GENERAL CONCERNS THROUGHOUT WATERSHED		DETAILS FROM DISCUSSION
1	Pollinators / beneficial insects	Planting pollinator habitats/ pollinator species during BMPs.
2	Vegetative corridors / bank stabilization	
3	Tree plantings	
4	Clean up day/ illegal dumping outreach	Ten sites in 2008 WMP have been addressed.
5	Sewer education & septic issues / maintenance / technology	
6	Lack of ag retailers' BMP promotion	Farmer's listen to and take advice from their agriculture product suppliers – find ways to actively work to involve them BMP promotion.
7	Lack of landowner peer to peer education	Producers' successfully using cover crops and no-till need to speak to those not yet adopting the technology.
8	Need farm field days / BMP demonstrations	
9	Nutrient management	Nutrient management plans, grid sampling
10	Improved waste management / recycling	
11	Manure and livestock management	
12	Soil health /soil tests / practices that promote soil health	
13	Increased cover crop and no till (decrease tillage)	Work to decrease tillage (vertical till better than conventional till), until producers use never till practices
14	Reduce nutrient and sediment loading	
15	Lawn management / rain barrels, rain gardens / urban conservation	
16	Programs @ at Patoka River National Wildlife Refuge	Utilize the Friends of Patoka River and host education, demonstrations, programs and presentations @ Refuge
17	Increase wetland conservation / restoration	
18	Increase soil organic matter (SOM)	
19	Precision ag technology	
20	Show economic return on investment that soil health through conservation / BMPS can bring	
21	Impervious surfaces / reduce run-off / slow runoff rate / reduce volume / I69 / smart growth	
22	Education regarding conservation of natural resources and outreach	
23	Invasive species (non-native and native invasive plant species)	Terrestrial and aquatic plant species
24	Increase conservation easements	
25	Improve habitat areas	
26	Gas and oil leaks	
27	Mines and mine activity / reclaimed lands	
28	Ditch maintenance (county and ag drains)	
29	Lakes and reservoirs (not private ponds)	

MAP 1 – OVERALL LOCATION OF LOWER PATOKA RIVER WATERSHED

WATERSHED BOUNDARIES, COUNTIES INVOLVED, and MAIN ROADS AND TOWNS



WATERSHED INVENTORY (Part One)

Project Location and Sub-watersheds

The LPR Watershed consists of the main branch of the Patoka River and the South Fork, Patoka River (South Fork PR). The main branch Patoka River has a Hydrologic Unit Code (HUC) of 05120209080 and is 86,688 acres. The South Fork PR is HUC 05120209070 and includes 48,814 acres. There are 10 sub-watersheds in the project area which is in far southwest Indiana in Gibson, Pike, and Warrick Counties. Map 1 below shows the location of the project.

There were thirteen 14-digit Hydrologic Unit Code (HUC) sub-watersheds in the project area during the development of the 2008 WMP. At that time, South Fork PR had 5 sub-watersheds and the main branch Patoka River had 8 sub-watersheds.

At the writing of this WMP, however, there are 10 sub-watersheds at the 12-digit HUC level encompassing the same watershed; three in South Fork PR and seven in the main branch Patoka River. Table 3 on this page shows the sub-watershed names, HUC codes, and acres for each of the ten.

The watershed has within its boundaries the incorporated communities of Francisco (population 469), and Oakland City (population 2,429) as well as the unincorporated communities of Patoka (population 735) and Spurgeon (population 207).
State highways crisscrossing the watershed include State Route 64; State Route 57; State Route 61; State Route 56; State Route 65; State Route 257 and State Route 357. Interstate I69 crosses the watershed as well. Map 1 on page 15 shows the location of major roads and communities.

Table # 3 – LPR Hydrologic Unit Codes and Names at 12-digit Level

12-digit HUC	**IDEM NAME**	**Acres**
	South Fork Patoka River	
051202090701	Houchin Ditch	19,010.4
051202090702	Honey	14,331.0
051202090703	Wheeler	15,472.4
	Main Branch Patoka River	
051202090801	Keg Creek	14,349.5
051202090802	Robinson	13,240.3
051202090803	Lost	10,635.2
051202090804	Yellow	12,736.1
051202090805	Indian	10,523.4
051202090806	Trippett	10,147.7
051202090807	Hull Ditch	15,055.5
		135,502 total acres

4. WATERSHED GEOLOGY /TOPOGRAPHY

Geologic History of Watershed

Throughout most of Indiana, the bedrock system dips gently to the southwest at an average of one-half degree into a large structural depression called the *Illinois Basin*. This means that rocks exposed at a given locality would be found buried beneath 30 feet of younger rock just one mile southwest of the outcrop. The rocks overlie one another in an imbricated sequence with the youngest found in the western part of the state and the oldest occurring at the bedrock surface in eastern Indiana. Consequently, if you drive from east to west across the southern third of the state, you would pass over rocks of progressively younger geologic age and you would also be conscious of rather abrupt changes in topographic expression. It is these changes in the lay of the land that results in the differentiation of the physiographic regions of southern Indiana. The varied topography of Indiana is a legacy of active glaciation and the inexorable forces of running water acting through geological time to erode and shape both soil and rock. This physiography has left its mark on nearly every facet of our cultural development, including the course of trails, location of modern highways and power lines, and our reservoirs.

The bedrock in the southwest part of the state is mostly shale, sandstone, limestone and coal of the Pennsylvanian System, which is covered in most areas by older glacial soils and residual soils, with some large lakebed clay deposits. However, in almost all the southwest part of the state, there is a deep surface layer of silty wind-blown loess.

The Lower Patoka project area is in the *Wabash Lowland* physiographic region, which averages about 500 feet above sea level - a full 350 feet lower than the crest of the *Crawford Upland* to the east.

The entire 8-digit HUC Patoka River Watershed (05120209) is comprised of the Upper Patoka, Middle Patoka and Lower Patoka. The headwaters of the Patoka River (Pa Toe Kah: an Indian word meaning "log on bottom") begins in Orange County in the Hoosier National Forest, just east of State Highway 37, about 8 miles southeast of Paoli, Indiana and 7 miles north east of English, Indiana. As it flows westward, it fills Patoka Reservoir, which is both a flood control project as well as a source of drinking water. The Patoka Reservoir serves as drinking water source for more than 100,000 people in 11 counties throughout southwest Indiana (2019 data from Patoka Lake Regional Water and Sewer District, https://www.plrws.net/). The lake is in the northeastern corner of Dubois County and is the source from which the City of Jasper draws its drinking water.

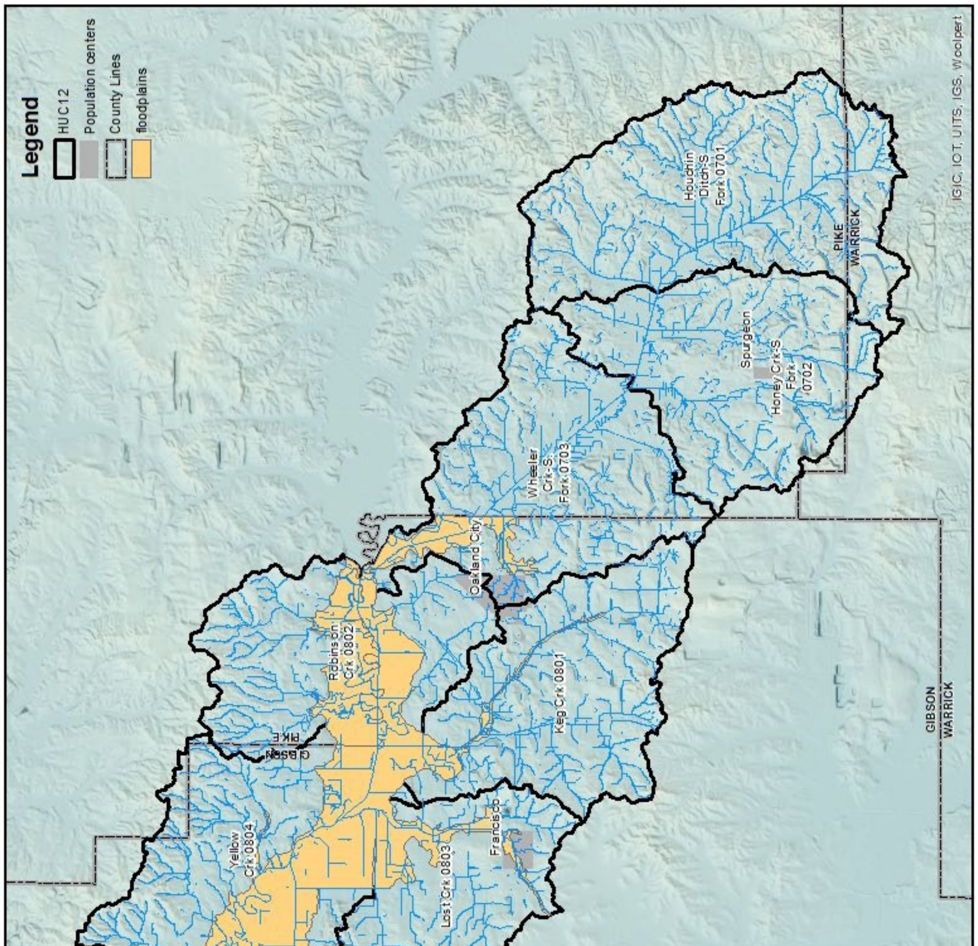
Prior to the Patoka Reservoir, we see headwaters of tributaries in Orange and Crawford counties. West of the Patoka Reservoir dam, the Patoka River watershed includes some tributary headwaters in Martin and Spencer Counties, but the main channel flows through Dubois County. The Patoka River passes through Dubois and Pike Counties before entering the Lower Patoka watershed in Pike and Gibson Counties. The South Fork PR headwaters are in far northern Warrick County at approximately 550 feet elevation and flows northwesterly some 17 miles where it enters the main stem near the Pike-Gibson line. The Patoka River continues westward through Gibson County to meet the Wabash River at 300 feet elevation. The entire journey of the Patoka is approximately 162 miles from the origin in Orange County to where it enters the Wabash River at Mt. Carmel, Illinois.

Watershed Topography Features and Drainage Patterns

The LPR project area topography (See map 2, page 18) can be described first with the South Fork PR, which is mostly in Warrick and Pike Counties. The South Fork PR has rolling hills, row crops in the lower areas, and has been severely impacted by strip mining. The South Fork PR includes the Wheeler, Honey and Houchin Ditch sub-watersheds. Waters here flow in northwesterly direction toward the main branch.

MAP 2 – LOWER PATOKA RIVER WATERSHED

TOPOGRAPHY FEATURES DEFINING DRAINAGE PATTERNS AND FLOODPLAINS



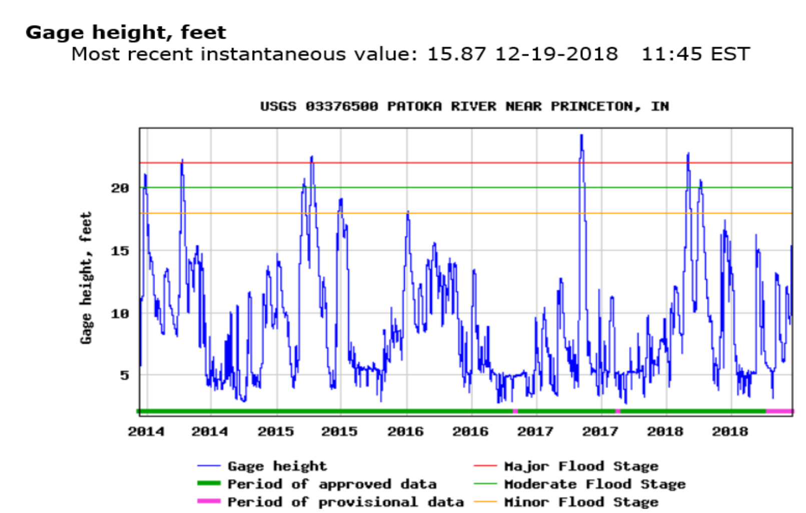
The topography of the main branch Patoka River has some tributaries with rolling hills, but the area flattens out with less relief as it nears the main channel (shown as yellow floodplains on Map 2, page 18). The main branch Patoka River includes the sub-watersheds of Keg, Robinson, Lost, Yellow, Indian, Trippett and Hull Ditch.

The Hull Ditch sub-watershed (051202090807) is the western most portion of the project area. It has an extensive floodplain as it houses the confluence of the Patoka, White, and Wabash Rivers. However, as mentioned earlier, there are portions of floodplains along the main channel as well, especially where Hurricane, Buck, Big, Robinson, Lost, Goose, Yellow and Indian creeks meet the main channel. Floodplains are a vital part of a stream's ecosystem. They are important because they act as flood buffers, water filters, and are major centers of biological life in the stream ecosystem. Floodplains are also important for maintenance of water quality because they provide fresh water to wetlands and backwaters, dilute nutrients, and improve the overall health of the habitat used by many species of birds, fish, and plants. They are vital biologically because they represent areas a variety of species use for breeding and regeneration cycles.

History of Flooding in Patoka River National Wildlife Refuge (PRNWR). The PRNWR was established to take advantage of these floodplains and prime bottomland hardwood forests. Bottomland hardwood forests are an outstanding tool in reducing downstream flooding while providing uptake of excess nutrients among other things. (See page 26 for more on the PRNWR and page 23 for more on wetlands.)

The PRNWR Manager has determined that flooding in the Oatsville Bottoms in the Robinson/Big Creeks sub-watershed occurs when the USGS in-stream gage north of Princeton reaches 12.8 feet. (http://water.usgs.gov/waterwatch). Historically, data from USGS website showed flooding in the Oatsville bottoms in the last five years tends to occur between January and July. Data shows the river was at 12.8 feet or greater:

- 70 days in 2013
- 97 days in 2014 (9 of these days were in December)
- 96 days in 2015
- 85 days in 2016
- 23 days in 2017
- 120 days in 2018
- 139 days in 2019 (as of 6-30-19)



Picture # 1 – USGS gage on Patoka River near Princeton

The data also shows that sometimes flood stage is for a day or two, and sometimes flooding may continue for 60 continuous days as in 2015 and 2019.

The fewer flood stage days in 2017 seems to be an anomaly. The 2017 flood data shows that one day the gage started at 4.3 ft. and ended the day at 14.9 ft. and continued to rise for the next 8 days to a maximum of 24.3 ft. and then stayed above flood stage for another 14 days (total of 22 days). Prior to this event, there was only one other day in 2017 when gage reached above 12.8 and that occurred a month and a half before the 22-day event. Future years' data may help explain the small number of flood stage days in 2017; but for now, it seems a random act of nature. Also of note, 2019 data shows flooding more days than the six previous years and the year is only half over.

Even though high-water helps to re-charge aquifers, flooding can be problematic. Sheet erosion is a major source of soil loss, petroleum by-products washed from roadways directly enters the water, and trash and debris may wash into the streams as well. Flooded residences present a myriad of threats as well, from septic systems, petroleum products, hazardous substances, dead animals, and other materials.

Erosion and Flood Control by the LPR Conservancy District

The Indiana Conservancy Act, I.C. 14-33, provides a vehicle by which landowners can organize a special taxing district to solve problems related to water resources management. Gibson County is served by the Lower Patoka Conservancy District (#50) headquartered in Princeton. Established in 1972 to address erosion and flood control in the lower portions of the Patoka River and its tributaries, as well as recreation and water supply, the District covers the Patoka River from the Gibson - Pike line to the Wabash River (no known map of this district, just stated as the Patoka and its tributaries). The District is empowered to remove obstructions but is prohibited from excavation in the channel. It has a stated purpose of water supply, recreation, erosion and flood control issues. Problems that can be solved through the Indiana Conservancy District are:

- Flood prevention and control
- Improving drainage
- Providing for irrigation
- Providing water supply, including treatment and distribution.
- Providing for collection, treatment, and disposal of sewage or other liquid wastes.
- Developing forests, wildlife areas, parks/recreation facilities when with water management.
- Preventing loss of topsoil from injurious water erosion
- Storage of water for augmentation of stream flow
- Operation, maintenance, and improvement for water-based recreation purposes

4. WATERSHED HYDROLOGY

Within the LPR Watershed, there are 841.91miles of tributaries, canals and streams which eventually empty into the Wabash River covering a total of 135,502 acres. The watershed is divided in two at the 10-digit level with the main branch Patoka River (86,688 acres) and the South Fork PR (48,814 acres). The South Fork has three sub watersheds – Houchin Ditch, Honey and Wheeler, while the main branch Patoka has seven – Keg, Robinson, Lost, Yellow, Indian, Trippett, and Hull Ditch. (see Table 3 on page 16).

Creeks and Tributaries

Like every watershed in the United States, there are several tributaries and streams in the project area carrying names that, though known by the locals, may not be named on a USGS or EPA map GIS layer. The names of creeks and tributaries in the South Fork PR are Clifford Creek, Hat Creek, Turkey Creek, Rough Creek and Lick Creek as well as those that name the sub watersheds: Wheeler, Honey and Houchin Ditch. The names of creeks in the main branch Patoka River are Buck Creek, Big Creek, Houchin's Ditch, Hurricane, Morrow Lateral, Indian and Goose Creek as well as those that name the sub watersheds: West

Fork Keg, East Fork Keg, Robinson, Lost, Yellow, Indian, Trippett Creeks and Hull Ditch.
At this point, there should be clarification regarding the two Houchin Ditches and the two Indian Creeks that are within the Lower Patoka River watershed.

- **Houchin Ditch** is a sub watershed (051202090701) of the South Fork Patoka.

- **Houchin's Ditch** is a part of the main branch Patoka River as a stream running through the Indian sub watershed (0512020805). This is a 3.2 mile stretch that begins at 38.404418, -87.453106 by separating from the main channel and flowing due west until 38.400315, -87.511599 where it rejoins the main channel. Many locals refer to this as the Houchin's Cutoff. See page 28 "Modifications" for more information on the history of this channel.

- **Indian Creek, south** of the main channel Patoka River, flows north across Tafttown Road and Carithers Road and is located within the Indian Creek sub watershed (051202090805). This Indian creek reaches the Patoka River at 38.391584, -87.540791.

- **Indian Creek, north** of the main channel Patoka River, flows south across county road 550 E and county road 500 N and is located within the Yellow Creek sub watershed (051202090804). This Indian creek joins with Goose Creek prior to reaching the main channel of the Patoka River.

Lakes and Open Water

The LPR watershed has 165 lakes which range in size from 7 acres to 201.8 acres, which together total approximately 3,460 acres in the watershed. There are also numerous small ponds under 7 acres in size that total an additional 2,178 acres. See map 3, page 22, for locations of lakes and open water in the watershed.

Picture # 2 – Route of historic Wabash and Erie Canal through Lower Patoka watershed.

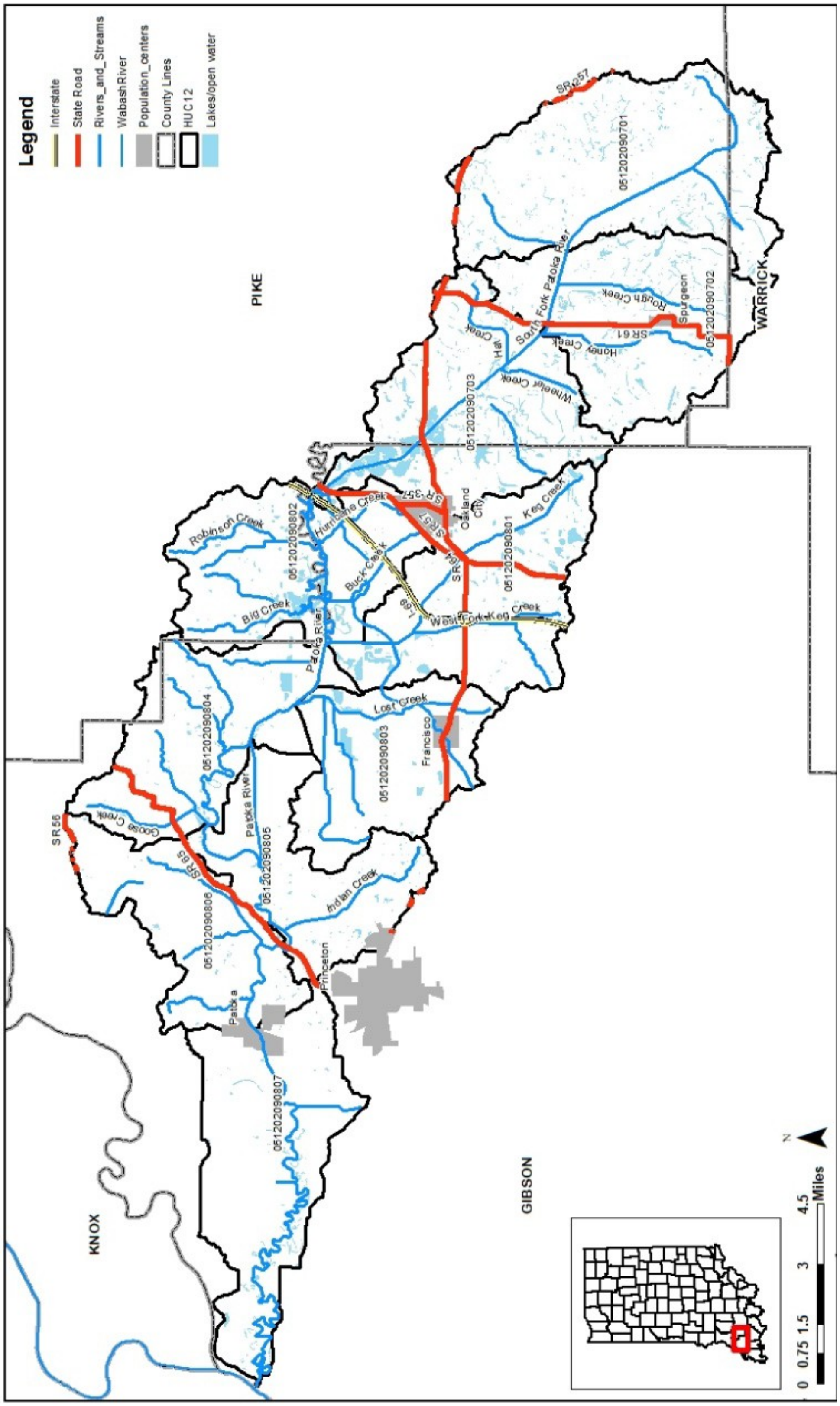
Wabash and Erie Canal

1827, Congress allotted a land grant to Indiana for building a canal to link the Great Lakes with the Ohio River. In Indiana, construction of the Wabash and Erie Canal began in 1832 in Fort Wayne, Indiana. The final section was completed in Indiana in 1853. The canal operated for seven years and in 1860, the Terre Haute to Evansville portion of the canal closed, except for some point-to-point operations between towns. The owners of the canal officially ended operations in 1874. There are some scattered physical remains of the defunct canal system still visible in southwest Indiana. These include abutments for aqueducts, remains of locks, dilapidated sections of canal earthworks, and evidence of water control structures, such as waste gates and guard locks. In general, however, little surface evidence remains of the Wabash and Erie Canal. The historic route of the canal through Gibson County is shown on Picture 2 above.

The only remaining aqueduct on the Wabash and Erie Canal in Indiana and Ohio is on County Road 500 N. This aqueduct still functions; however, due to I69 construction, it no longer can handle the water, so a secondary structure was created to help with the flow. It was originally built to take Buck Creek *under* the Wabash and Erie Canal. The entire wooden structure was built to be always, totally submerged so no oxygen could get to the wood, therefore no rot.

MAP 3 – LOWER PATOKA RIVER WATERSHED

LAKES AND OPEN WATER IN THE WATERSHED



Wetlands
Wetlands, as defined by the US Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) are "those areas that are inundated or saturated by surface or ground water at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions."

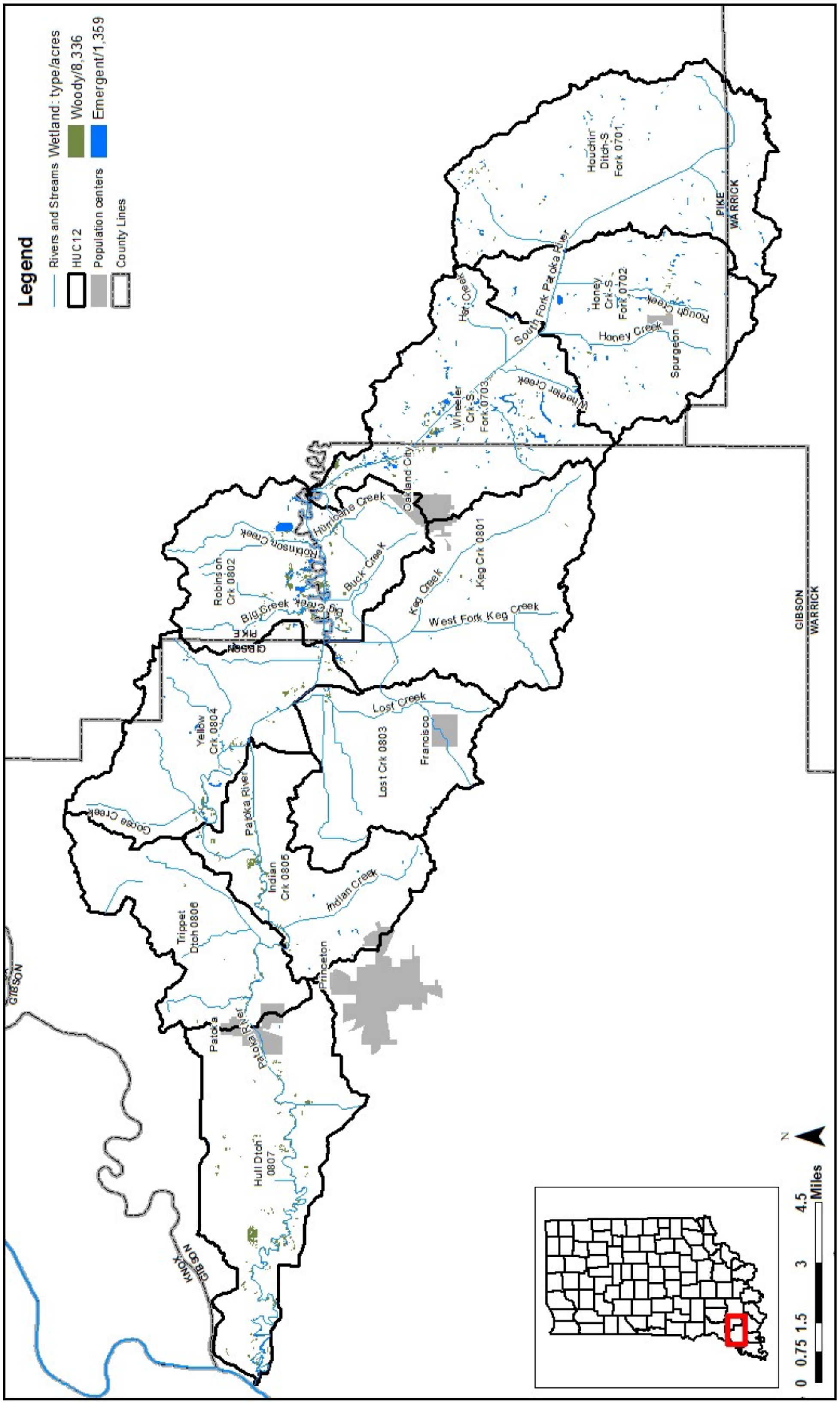
Wetlands are very important features in the landscape that provide numerous benefits to people and wildlife such as protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters and maintaining surface water flows during dry periods. In fact, the Environmental Protection Agency (EPA) states that:

> *"**Wetlands are among the most productive ecosystems in the world, comparable to rain forests and coral reefs.** An immense variety of species of microbes, plants, insects, amphibians, reptiles, birds, fish and mammals can be part of a wetland ecosystem. The combination of shallow water, high levels of nutrients and primary productivity is ideal for the development of organisms that form the base of the food web and feed many species of fish, amphibians, shellfish and insects. Many species of birds and mammals rely on wetlands for food, water and shelter, especially during migration and breeding. Wetlands' microbes, plants and wildlife are part of global cycles for water, nitrogen and sulfur. **Scientists now know that atmospheric maintenance may be an additional wetlands function.** Wetlands store carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide. Thus, wetlands help to moderate global climate conditions. Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and flood waters. Trees, root mats and other wetland vegetation also slow the speed of flood waters and distribute them more slowly over the floodplain. This combined water storage and braking action lowers flood heights and reduces erosion. Thus, wetlands within and downstream of urban areas are particularly valuable, counteracting the greatly increased rate and volume of surface-water runoff from pavement and buildings. The holding capacity of wetlands helps control floods and prevents water logging of crops. Preserving and restoring wetlands together with other water retention can often provide the level of flood control otherwise provided by expensive dredge operations and levees. Far from being useless, disease-ridden places, wetlands provide values that no other ecosystem can. These include natural water quality improvement, flood protection, shoreline erosion control, opportunities for recreation and aesthetic appreciation and natural products for our use at no cost.*

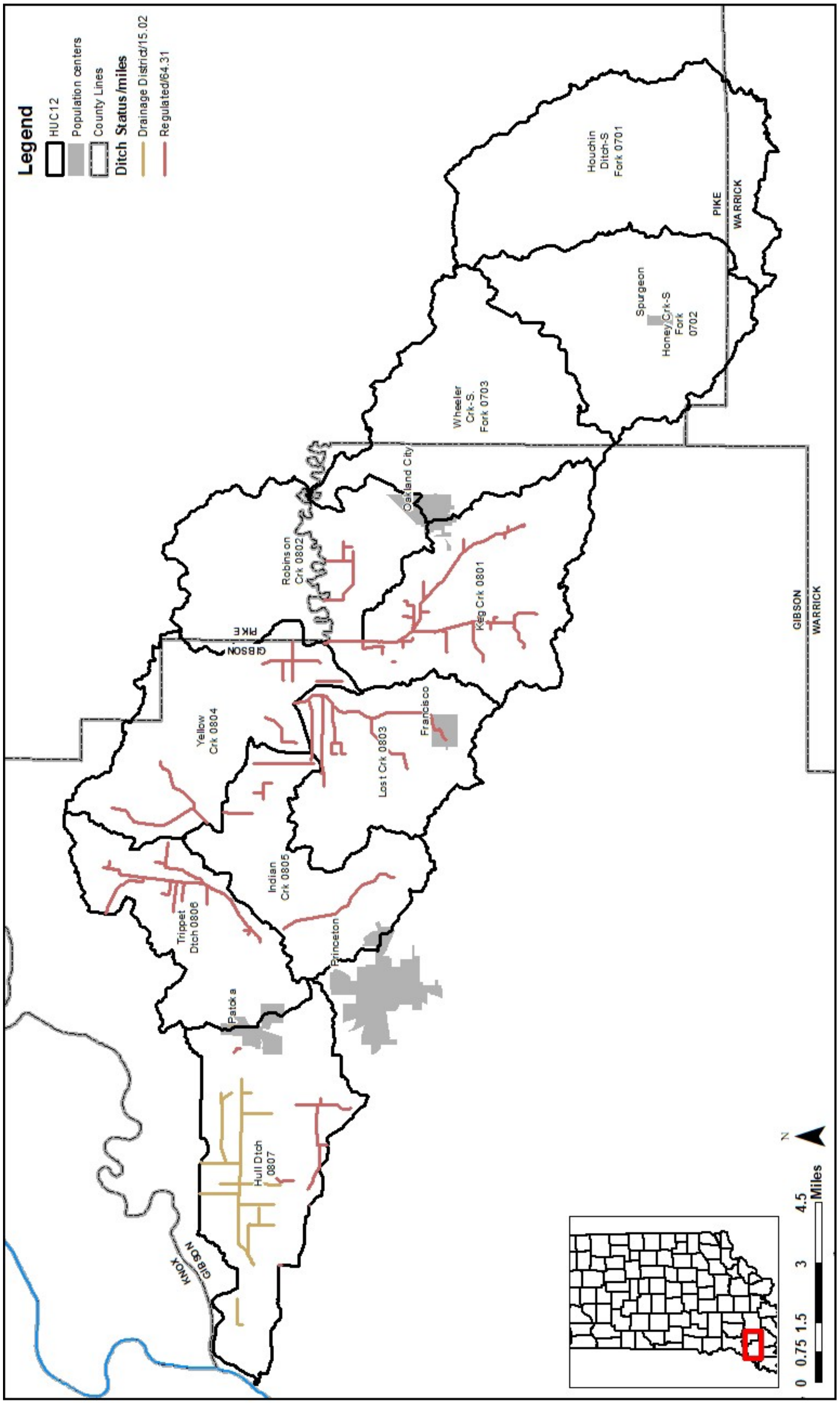
Because of their functions and values, there are several federal and state laws that regulate activities that affect wetlands. The major laws protecting wetlands include the Federal Clean Water Act, the River and Harbors Act, and Indiana's Flood Control Act.

There are 319,462.4 acres of landmass in Gibson county, with approximately 9.5% of the entire county, or 30,474 acres classified as wetlands. Within the LPR watershed, there are 8,336 acres of wooded wetlands and 1,359 acres of herbaceous emergent wetlands, for a total of 9,695 acres in the watershed. Map # 4 on page 24 shows the locations of the woody and emergent wetlands within the LPR watershed.

MAP 4 – LOWER PATOKA RIVER WATERSHED
WOODY AND EMERGENT WETLANDS IN THE WATERSHED



MAP 5 – LOWER PATOKA RIVER WATERSHED
LEGAL DRAINS IN THE WATERSHED



Roadside Ditches and Legal Drains
The Gibson County Highway Department is responsible for the maintenance of the county's approximately 1,200 miles of road, 500 bridges, and roadside ditches. Of those 1,200 miles of road, the Highway Dept. reports that about 300 miles are paved or concrete, 600 miles are rock, and 300 miles are unimproved. The entire county is 319,462.4 acres, so at 135,602 acres, the LPR watershed makes up 42.4% of the county. As roads crisscross the county in a regular pattern, it can be assumed that approximately 500 miles (42.4%) of roads run through the LPR watershed. The number of roadside ditches can be further estimated by calculating the proposed miles of road in the watershed along with the knowledge that a constructed or natural drainage ditch exists on a least one side of the length of every road. This gives us an estimate of at least 500 miles of roadside ditches in the watershed.

Within the LPR watershed, there are 15.02 miles of drainage district ditches and 64.31 miles of regulated drains. The drainage district is in the Hull Ditch sub watershed (051202090807). Regulated drains occur in all seven of the main branch Patoka River sub-watersheds. (see map 5, page 25).

We know that these roadside ditches, and legal drains are frequently used by landowners for the discharge of excess surface water. Subsurface tile drainage of cropland is a common practice throughout the watershed with tile pipes emptying directly into the drains. Pollutants in the form of applied fertilizers and pesticides can be introduced into stream waters through these tile drainage systems.

PUBLIC CONSERVATION LANDS IN WATERSHED

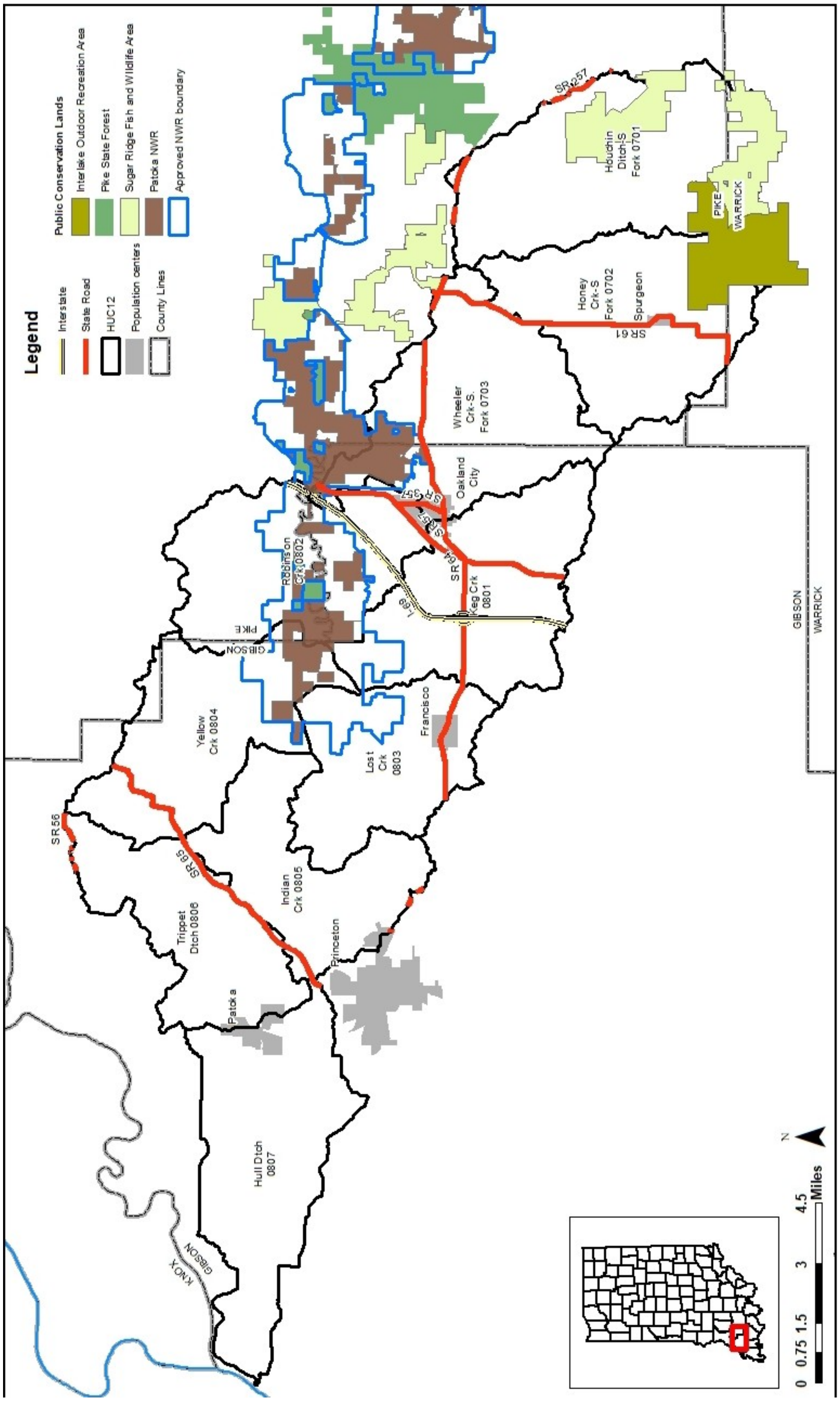
Public Access
The Indiana Division of Fish and Wildlife runs a Public Access Program which was started in 1953. The program strives to provide free access to Indiana waters. There are 169 public access sites in southern Indiana. Within the nearby Middle Patoka River Watershed, there are several Public Access Sites (PAS) for people to enjoy: Jasper, Beaver Dam Lake, Survant, Pikeville, Winslow, Stewart, and Dubois. However, within the LPR watershed, there is only one DNR public access site located on the north bank (Pike County side) of the Patoka River in the Robinson sub-watershed. This PAS just opened in September 2018 and is located at the PRNWR Oatsville Station off County Road 850 E (38.377665, -87.407849).

However, the project area also has several managed, public conservation areas including the PRNWR, Pike State Forest, Sugar Ridge and Interlake Outdoor Recreation Area. (see map 6, page 27).

The Patoka River National Wildlife Refuge and Management Area was established in 1994 as Indiana's second national wildlife refuge. Currently, there are 6,149 acres in the PRNWR along the lower third reach of the 162-mile long Patoka River. The PRNWR is recognized as an Important Bird Area by the National Audubon Society, and is home to 380 species of wildlife.

MAP 6– LOWER PATOKA RIVER WATERSHED

Public Conservation Lands in the Watershed



The refuge has many areas of trails and water access including the South Fork Trail, Snakey Point Marsh, Hugh Boyd Fishing Pier and Wildlife Observation Deck, Maxey Birding Trail and Columbia Mine Reclaimed Site. These areas are places for people to view wildlife, such as the bald eagle nest that has successfully fledged 8 eagles since 2002 on the South Fork Trail; or fish off the Boyd Pier, or hike, hunt or kayak. Snakey Point Marsh is open to public hunting, fishing and birdwatching. Maxey Birding Trail is a favorite for birders and is a great place to see migrating woodcock in the spring and fall. Columbia Mine Reclaimed Site is over 1,000 acres offering tremendous diversity of fish and wildlife habitat with over 300 acres of natural marsh and bottomland forest habitat, 11 freshwater lakes, early successional field habitats, native grass plantings, and replanted upland forests.

Pike State Forest (IN DNR Forestry Division) consists of 3,889 acres, which is interspersed through the hilly uplands down to the low bottomlands of the Patoka River. The Pike State Forest and PRNWR share similar goals in habitat protection, land conservation, and public use (i.e., fishing, hunting, photography, and bird watching). Eventually, the Pike State Forest property within the approved refuge acquisition boundary will become a part of the PRNWR.

Sugar Ridge Fish & Wildlife Area is unique in that much of the land has been strip-mined. Several Sugar Ridge acres are located just outside the LPR watershed, but are upstream, and thus can have an impact. It is made up of six separate areas, totaling approximately 8,100 acres. The portion in the Lower Patoka watershed occurs in the Houchin Ditch sub-watershed. The strip-mined land now features about 100 pits and lakes, along with rows of overburden from the mining operation. There are approximately 145 acres in 24 major pits.

Interlake State Recreation Area (ISRA), former coal mine land straddling Pike and Warrick counties, is a multi-use recreational facility focusing on off-road vehicle (ORV) recreation. Interlake is approximately 3,550 acres with nearly 100 miles of trails and 17 lakes (many of which can be accessed for fishing). The three areas of mining and reclamation create a variety of trail experiences for ORV enthusiasts, horse riders, hikers and mountain bikers. From steep spoil banks to rolling grasslands, man-made lakes and stripper pits, Interlake offers a diverse array of topography and scenic views. Trails range from beginner to experienced, with multiple miles of each skill level. All types of OHVs are allowed, 4x4, ATV, UTV, dirt bike, and home built. All trails are designed for a minimum of two user types. For example, dirt bikes and horses share trails, as do, 4x4s and ATVs. The middle of the property has several wide, easy trails with good visibility – these trails can be used by anyone. However, trails are not the only recreation available at Interlake. Fishing, hiking, mushrooming, berry picking, non-motorized or electric motor boating, dog training and more are allowed. Additionally, Interlake is open for trapping by permit only and hunting according to State regulations as published in the Indiana Hunting and Trapping Guide.

Hydrological Modifications in the Watershed

The drainage in the project area, the same as elsewhere in the state, is very much a product of human activities since settlers arrived in the area. The entire South Fork was dredged to drain low lying areas for agriculture and flood control and is referred to as the William Shy Drainage Ditch.

Likewise, portions of the main branch were dredged as well. In 1921, after 5 years of local opposition and court hearings, a local group of citizens started a drainage project known as Houchin's Ditch or Cutoff. Newspaper accounts stated their intent was to drain 100,000 acres of forested wetlands for farming. After obtaining the taking authority by court order, the group set to work dredging a straight ditch, 17 miles long, cutting through 36 miles of natural river meanders. After 3 years of steam-powered dredging from floating barges, the ditch was completed from Winslow to just west of Wheeling.

At a cost to local landowners of $580,000, the effort failed to reduce flooding on most of the bottomland intended for farming. They had failed to realize that flooding of the broad, flat floodplain of the Lower Patoka River was largely controlled by floodwater levels in the Wabash River. The dredged soil deposited on both sides of the ditch bank formed levees which trapped in overflowing floodwaters every winter and spring. This created large areas of extended seasonal flooding which transformed valuable bottomland forests into shrub-scrub swamps.

Pictures of fields not draining after floodwaters have receded due to levee along Houchin’s Cutoff.

Picture # 3– Floodwaters trapped by Houchin’s Cutofflevee.

Channeling of streams is often sought to reduce local flooding, but as we have seen in the Houchin’s Cutoff, it often doesn’t work. Even if channeling does happen to work to reduce local flooding, it always exacerbates erosion and the flooding downstream due to increased velocity.

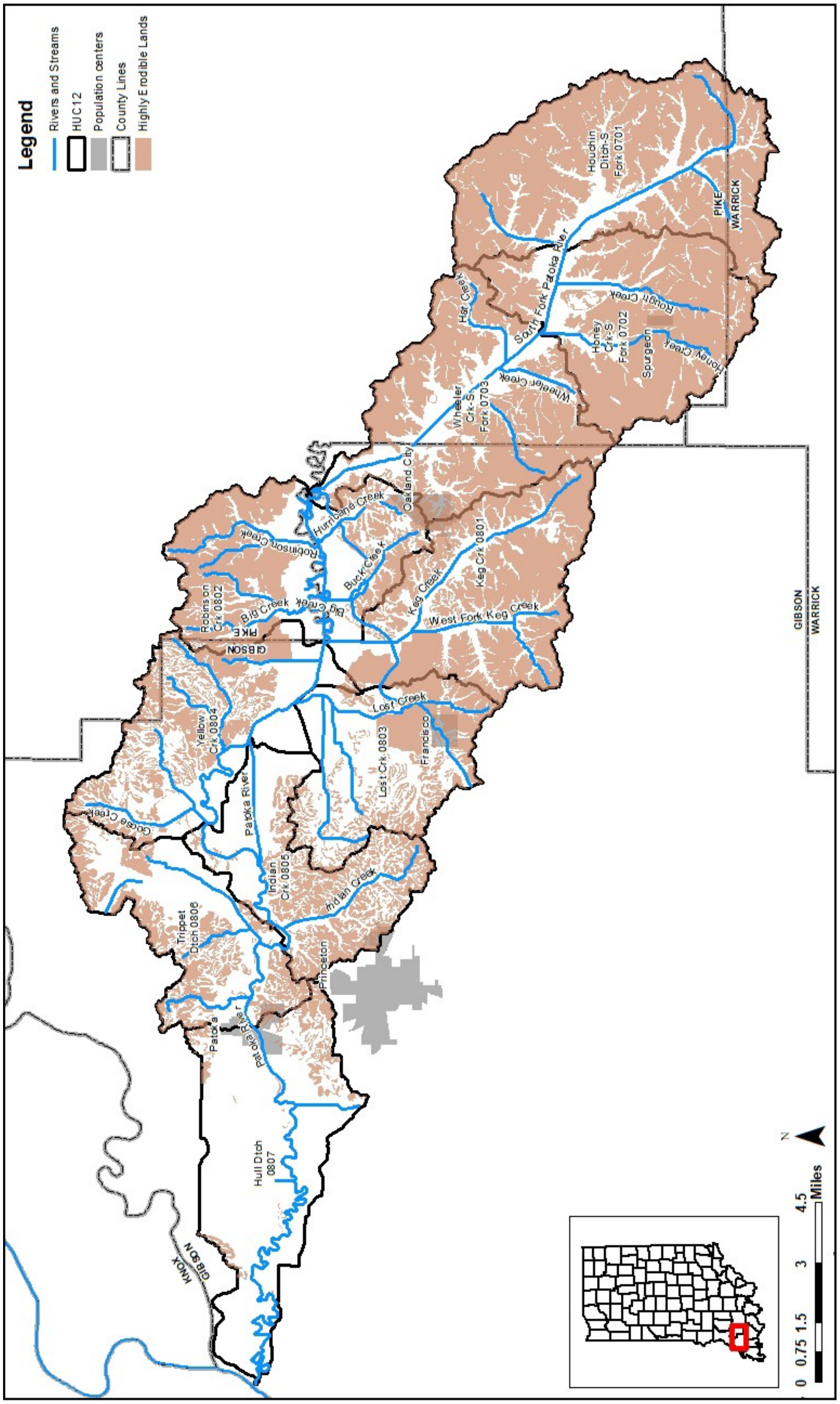
Oxbow Lakes

Because of the channelization of the Houchin’s Ditch, the natural meandering characteristics of the riverbed remained behind to form disconnected water which are called oxbow lakes. These lakes are the result of being cut off from the main flow. Even if filled with sediment, aerial photos continue to show the meandering patterns due to soil differences and are called “meander scars”. The Patoka River National Wildlife Refuge is exploring some stream channel restoration to replace lost/degraded wetland habitat among these oxbow lakes and the old meandering channel.

Picture # 4 – Satellite Picture of Patoka Meander Scars and Oxbow Lakes

During the initial stakeholder natural resource concerns meeting, hydrology related concerns included vegetated, well stabilized banks, wetland conservation and restoration and improving of habitats along the Patoka; as well as the role the reclaimed mine lands and pits play in the watershed.

MAP 7 – LOWER PATOKA RIVER WATERSHED
HIGHLY ERODIBLE LANDS IN THE WATERSHED



5. SOIL CHARACTERISTICS OF WATERSHED

The LPR watershed is comprised of a variety of soil types, many of which are perfect for growing some of the best crops in the Midwest. There are eleven major soil units in the project area as delineated by the Natural Resources Conservation Service – U.S. Department of Agriculture.

Soil types influence drainage and erodibility and are grouped into general soil associations. Unfortunately, soil associations are not generally regarded when it comes to making land management decisions. However, the NRCS does consult specific soil types when it comes to determining whether land is highly erodible, hydric, or if it is suitable for proper septic system leaching. Additionally, soil types can also be used to determine if land is to be considered 'prime farmland'. Prime farmland is defined by the U.S. Department of Agriculture as follows:

> "*Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but is not urban or built-up land or water areas. The soil quality, growing season and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied.*"

Due to the productive nature of the soils throughout the LPR watershed, much of the land is actively farmed. In some cases, wooded areas are cleared to convert the land for farming purposes. If 'acceptable farming methods' are not applied, the soil is at definite risk for erosion and nutrient degradation. Excess sediment can be transported to streams and lakes during heavy rain events, degrading habitat and transporting field applied nutrients such as phosphorus. As in all the state, prime farmland is often at risk due to encroaching urbanization. This is clear in nearby Vanderburgh Co. where prime farmland has been converted to urban sprawl of retail establishment and residential areas along Burkhardt Road and I69. For the LPR watershed, eyes should be turned toward the I69 corridor running through Gibson, and the future potential for growth in that area and that growth's impact on water quality.

During the initial stakeholder natural resource concerns meeting, soil related concerns included septic maintenance and septic system issues; soil health and the related soil testing as well as practices that promote soil health; increasing cover crops and decreasing tillage in the county; wetland restoration in hydric soils; increase of soil organic matter (SOM); and reclamation of abandoned mine land soils.

Highly Erodible Soil

Soil loss is a definite concern within the Lower Patoka River watershed, especially when it comes to soils that are classified as 'highly erodible' by NRCS. The NRCS Field Office Technical Guide (Section II) describes highly erodible land as follows:

> *"The Food Security Act of 1985 required that soil survey map units be separated into three categories based on potential erodibility due to wind erosion and sheet and rill erosion. A Highly Erodible Soil Map Unit list designates the category assigned to each map unit. It has been determined that no map units are highly erodible because of only wind erosion in Indiana. The equation for determining potential erodibility from sheet and rill erosion is:*

$$A = \frac{RK\,(LS)}{T}$$

> *(A) is the amt. of soil loss in tons per acre, (R) is rainfall factor, (K) is soil erodibility factor, and (L) and (S) are slope length and steepness factors, respectively, and (T) is the*

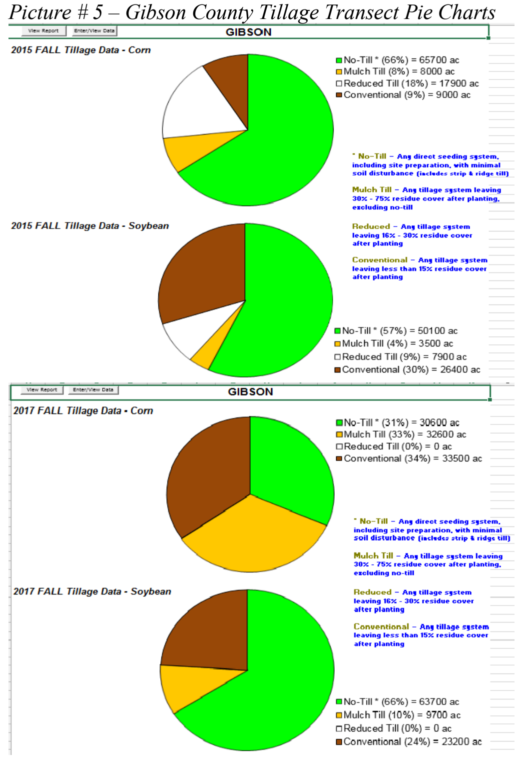
tolerable soil loss in tons per acre. A map unit is designated highly erodible (class 1) if the value (A) obtained from the equation is equal to or greater than 8 when the minimum slope length and minimum slope percent are used. A map unit is designated potentially highly erodible (class 2) if the value obtained from the equation is less than 8 when the minimum slope length and minimum slope percent are used but equal to or greater than 8 when the maximum slope length and maximum slope percent are used. A map unit is designated not highly erodible (class 3) if the value obtained from the equation is less than 8 when the maximum slope length and maximum slope % are used. The minimum and maximum slope % are obtained from the map unit name, i.e., Miami silt loam, 2 to 6 % slopes. Two is the minimum value and 6 is the maximum value. The minimum and maximum slope lengths were determined by district conservationists, soil scientists and other local people."

In the LPR Watershed, 71,529.39 acres are Highly Erodible Soils (HES) or as the NRCS calls them, Highly Erodible Lands (HEL). That equates to 52.75% of the watershed. With over half of the watershed acres being highly erodible (see map 7, page 30), it is no surprise that stakeholders cited widespread concern about soil erosion during the CCL meetings, the Steering Committee meetings, and other public venues. The watershed coordinator has seen soil erosion's impact on water quality as well, during watershed windshield surveys (see page 51) and through the water monitoring for TSS in the watershed.

Tillage Transects

Soil types and soil slopes are not the only indication of soil erosion. Land uses are also key to interpreting the potential for soil degradation. The producers (farmers and ranchers) in the watershed are asked to voluntarily incorporate soil conservation measures such as grassed waterways, no-till farming and planting of fall cover crops. Each year the local SWCD's complete soil tillage transects. The Tillage transects are completed in the spring and fall by NRCS, ISDA and SWCD staff.

Picture # 5 – Gibson County Tillage Transect Pie Charts



During the tillage transect, 543 fields are evaluated according to the current crop and tillage methods observed. This type of tillage transect data has been collected for many years. The data from 2015 and 2017 Tillage Transects in Gibson County is shown in Pictures 5 and 6. When looking at observed data such as this, one gets a picture of the variable patterns of the producers' tillage practices. The data represented showcases a range of 9% conventional till corn (fall 2015, 25 points) to 81% conventional till corn (spring 2017, 201 points) across Gibson County.

This data is not reflective of just LPR watershed, as the tillage transect data is not subdivided down into those parameters. The watershed coordinator spoke with Trevor Laureys, ISDA, after hearing that tillage transect data was available by HUC. However, Mr. Laureys stated that points were correlated to HUC division above I70; however, that data had not been input for southern Indiana yet.

Picture # 6– Gibson County Tillage Transect Tables

Year: 2015 SPRING
County: GIBSON

Percent and Number of GIBSON County fields with indicated Tillage system for each Present crop.

Present crop	No Till		Strip Till		Ridge Till		Mulch Till		Reduced Till		Conven-tional Tillage		Tillage Unknown or N/A		Cover Crops		Risers / Inlets	
	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts
Corn	55%	161	0%	0	0%	0	0%	0	27%	80	16%	46	0%	0	19%	55	0%	0
Soybeans	25%	60	0%	0	0%	0	0%	0	30%	71	43%	102	0%	0	12%	28	0%	0
Small grains	100%	4	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Hay/Pasture	18%	2	0%	0	0%	0	0%	0	0%	0	9%	1	0%	0	0%	0	0%	0
Fallow	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Specialty Crops	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
CRP and similar	43%	3	0%	0	0%	0	0%	0	14%	1	0%	0	0%	0	14%	1	0%	0
TOTALS	42%	230	0%	0	0%	0	0%	0	28%	152	27%	149	0%	0	15%	84	0%	0

Year: 2015 FALL
County: GIBSON

Percent and Number of GIBSON County fields with indicate Tillage system for each Present crop.

Present crop	No Till		Strip Till		Ridge Till		Mulch Till		Reduced Till		Conven-tional Tillage		Tillage Unknown or N/A		Cover Crops	
	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts
Corn	58%	161	8%	21	0%	0	8%	23	18%	49	9%	25	0%	0	27%	75
Soybeans	56%	113	1%	2	0%	0	4%	9	9%	18	30%	60	0%	0	14%	28
Small grains	43%	18	7%	3	0%	0	0%	0	29%	12	21%	9	0%	0	19%	8
Hay/Pasture	33%	3	0%	0	0%	0	0%	0	0%	0	0%	0	56%	5	11%	1
Fallow	100%	4	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	25%	1
Specialty Crops	83%	5	0%	0	0%	0	0%	0	0%	0	17%	1	0%	0	83%	5
CRP and similar	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	100%	3	0%	0
TOTALS	56%	304	5%	26	0%	0	6%	32	14%	79	17%	95	1%	8	22%	118

Year: 2017 SPRING
County: GIBSON

Percent and Number of GIBSON County fields with indicated Tillage system for each Present crop.

Present crop	No Till		Strip Till		Ridge Till		Mulch Till		Reduced Till		Conven-tional Tillage		Tillage Unknown or N/A		Cover Crops	
	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts
Corn	15%	37	0%	0	0%	0	4%	11	0%	0	81%	201	0%	0	9%	23
Soybeans	56%	136	0%	0	0%	0	9%	21	0%	0	35%	85	0%	0	12%	30
Small grains	100%	31	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	90%	28
Hay/Pasture	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Fallow	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Specialty Crops	0%	0	0%	0	0%	0	0%	0	0%	0	75%	6	0%	0	38%	3
CRP and similar	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
TOTALS	37%	204	0%	0	0%	0	6%	32	0%	0	54%	292	0%	0	15%	84

Year: 2017 FALL
County: GIBSON

Percent and Number of GIBSON County fields with indicated Tillage system for each Present crop.

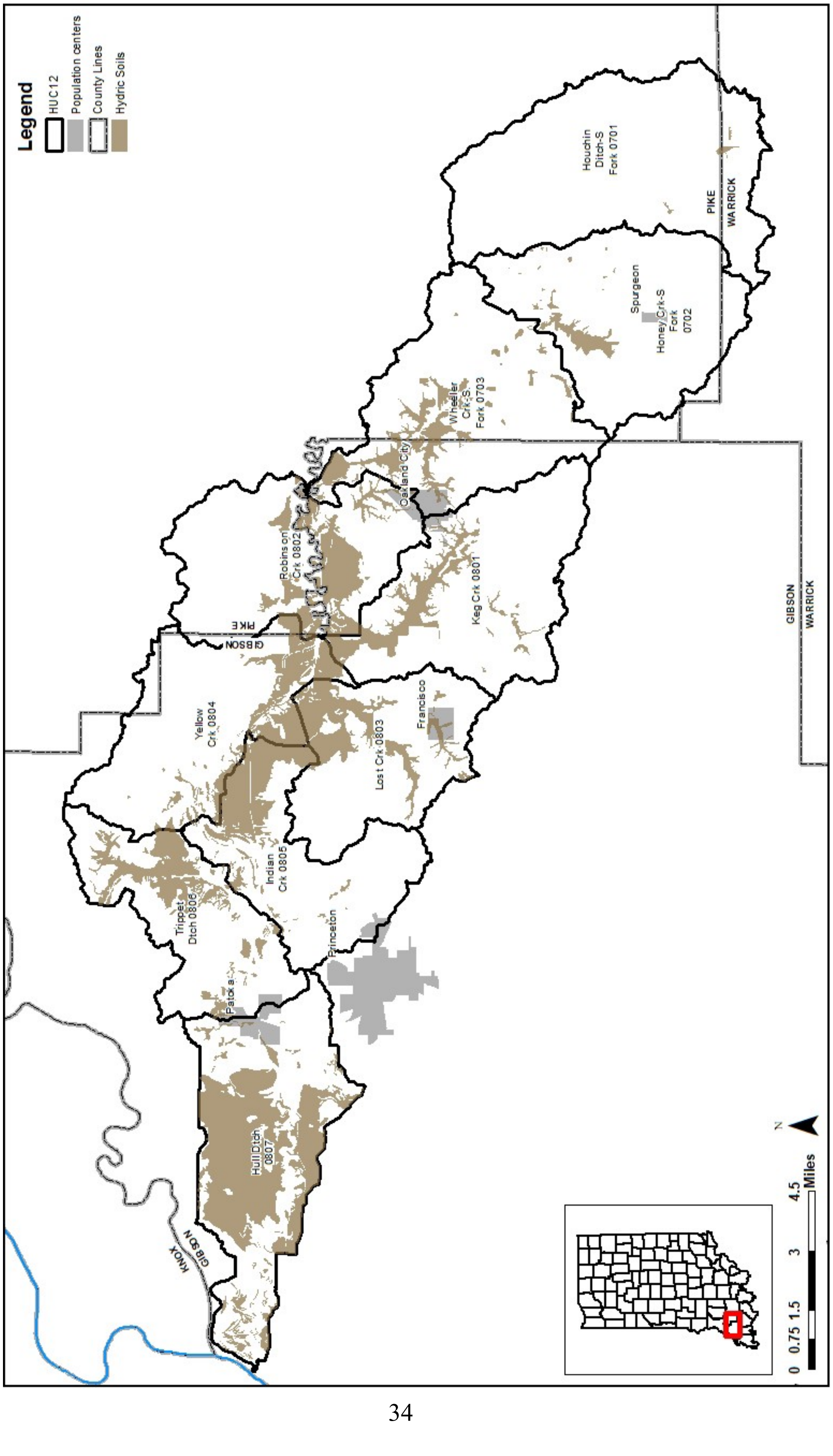
Present crop	No Till		Strip Till		Ridge Till		Mulch Till		Reduced Till		Conven-tional Tillage		Tillage Unknown or N/A		Cover Crops	
	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts	%	pts
Corn	31%	81	0%	0	0%	0	33%	87	0%	0	34%	88	0%	0	27%	70
Soybeans	65%	177	1%	2	0%	0	10%	28	0%	0	24%	64	0%	0	14%	38
Small grains	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Hay/Pasture	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Fallow	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Specialty Crops	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
CRP and similar	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
TOTALS	48%	258	0%	2	0%	0	21%	115	0%	0	28%	152	0%	0	20%	108

However, even when broadening our vision to include the whole county, we can get a glimpse of trends that are perhaps occurring within the watershed. The range is vast, and one must consider whether these differences are driven by weather patterns, variations of crop species and the timing of planting and harvest, in addition to topography and soil types. It is well documented within the SWCDs though, that there are within all watersheds, those producers who are "never till"; and as such, we may find that, when looking at data over several years, there is that % of no-till fields that we never dip below.

Likewise, we can see an overview of the change from one season to another in the pie charts (picture 5, page 32). It is important to notice that corn tillage practices fluctuate the greatest; mainly due to spring planting weather issues – whereas several soybean acres are double crop as opposed to first crop with more likely favorable weather conditions for no-till planting.

MAP 8 – LOWER PATOKA RIVER WATERSHED

HYDRIC SOILS IN THE WATERSHED



Hydric Soils
Much of the LPR Watershed's soils can be classified as 'hydric'. In fact, there are 22,104.55 acres of hydric soils in the watershed equating to 16.3 % of the total watershed. (see map 8, page 34). Hydric soils can indicate a soil's current or former propensity towards wetland characteristics and must not be disturbed for cultivation or construction. The NRCS Hydric Soils Technical Notes states:

> "*Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural* 24 *conditions, are either saturated or inundated long enough during the growing season to support growth and reproduction of hydrophytic vegetation.*"

One should take a moment here to consider the important topic of hydric soil acres compared to wetland acres in the LPR watershed. (Wetlands were discussed previously on page 23). As per NRCS definition, we know that hydric soils are formed under saturation, flooding and ponding. These hydric soils are one of the indicators used to determine past or historical wetlands. As much of Indiana has been artificially drained for agriculture, the presence of hydric soils gives us some indication of areas where wetlands might have once existed.

The LPR watershed has 22,104.55 acres of hydric soils (16.3%) and 2,208.51 acres of wetlands (1.6%). This leaves 19,896.04 acres of hydric soils that are not wetlands. These acres may have been changed by surrounding topography changes through construction or development, may still be artificially drained for agriculture use, or may be hydric for reasons other than wetland such as open water, lakes and ponds. Non-wetland hydric soil in LPR watershed equates to 14.67% of the watershed.

Unsewered Areas and Septic System Suitability
Citizens living within the LPR Watershed rely mainly on septic systems. Francisco and Oakland City do have wastewater treatment facilities, but they are the only two in the watershed. Individual homes, housing clusters and the entire towns of Patoka and Spurgeon rely on septic systems. Census shows 773 with a Patoka address, but there are only ~250 homes in the town itself (estimation from google maps). There are 199 people with a Spurgeon address. Improperly installed and maintained septic systems pose serious threats to water quality. In addition, the LPR watershed group should consider the potential for new development along the I69 corridor which could pose additional concerns.

According to the Indiana State Department of Health, there are several public health diseases involving sewage. Campylobacteriosis, for instance, is the most common diarrheal illness in the United States; and Cryptosporidiosis, which is resistant to chlorine disinfection, is the most common waterborne disease in the United States. Escherichia coli diarrhea is from E. coli bacteria found in contaminated water. There are several more listed on the ISDH website. Another one worth mentioning though, is Methemoglobinemia, also known as "blue-baby syndrome", which is a poisoning that can occur in infants during the first few months of life due to ingestion of well water high in nitrates.

Improperly designed septic systems installed in sandy soils are known to cause nitrate contamination of groundwater. The U.S. Environmental Protection Agency (EPA) has established a maximum contaminant level for nitrate in drinking water of 10 milligrams per liter, expressed as Nitrogen, or 45 milligrams per liter, expressed as Nitrate. Boiling of water does not remove nitrates; it only increases the concentration. Thus, there is a widespread concern among stakeholders about the lack of proper septic maintenance in the watershed. This concern is backed by data from monitoring that shows high E. coli concentrations in the mainstream channel and nitrate, nitrite readings taken during water monitoring.

Homeowners properly installing and maintaining their septic systems is not the only issue in the watershed. Soil types in Indiana are overwhelmingly unsuitable for septic fields. On page 37 is a map showcasing areas of limited septic suitability within the LPR watershed.

Within the LPR watershed, there are 15,495.90 acres of soils rated as somewhat limited for septic systems and 116,403.35 acres of soil rated as very limited for septic systems. The other approximately 3,700 acres are not rated. This means 85.84% of the watershed soils are rated as very limited and 97.26% are rated as either somewhat limited or very limited for septic systems and thus unsuitable, and yet the majority of those living in the watershed have septic systems.

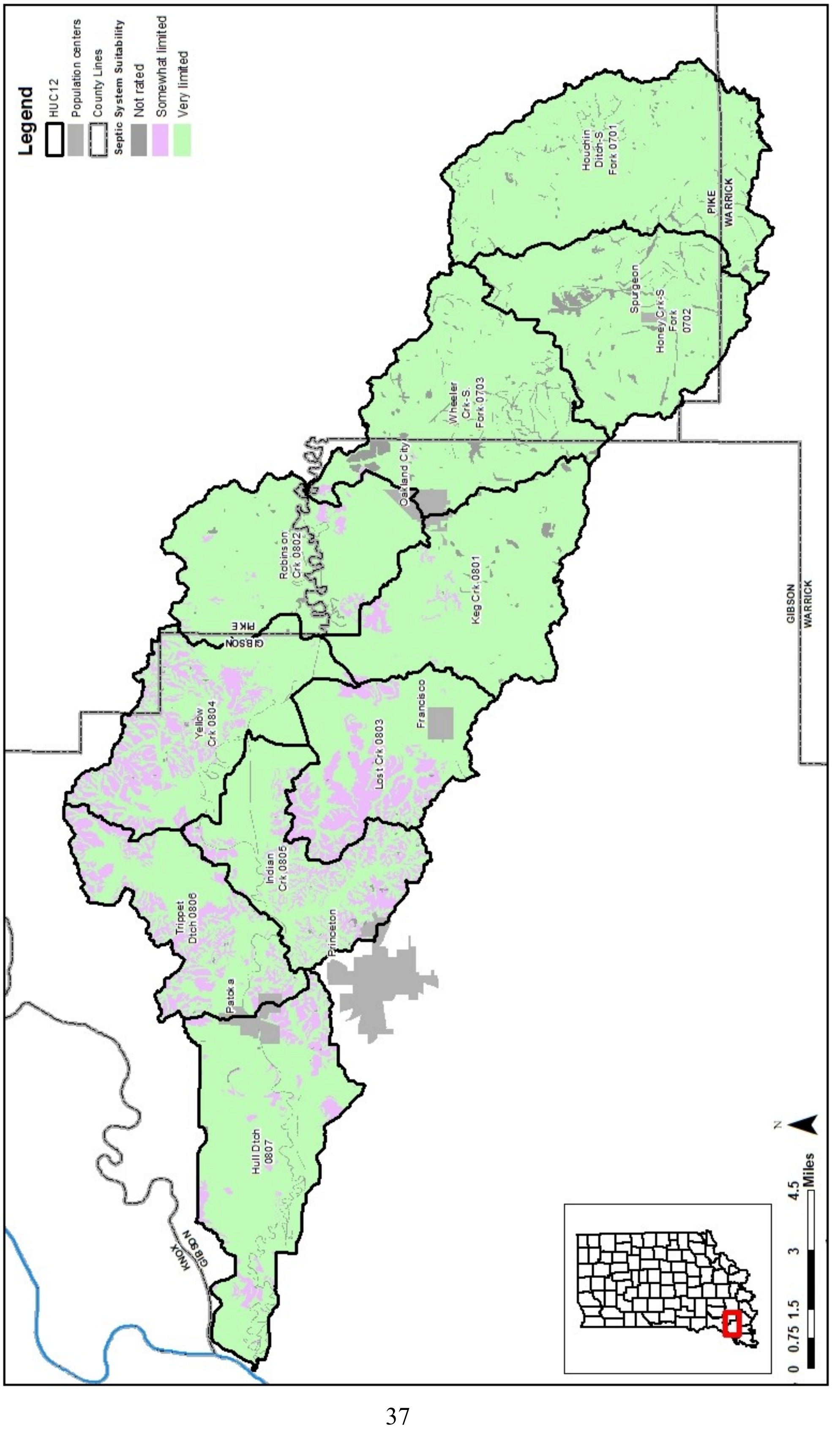
It is, thus, obvious that a very large portion of the watershed contains soils that are not ideal for septic systems. But it should also be noted that various homes and towns upstream could be contributing to the main channel high E coli counts as well as tributaries within the LPR watershed. In addition, the condition of the wastewater systems in both towns should be considered; as well as the potential for development and urban sprawl along the I69 corridor. In a report entitled "Comprehensive Plan for Gibson County, Final Draft, November 2009" it was stated that:

> *Oakland City sewage treatment plant design capacity and current flow are not known. However, Oakland City does provide sewage treatment to all residents within its corporate limits as well as a few locations in the fringe area. However, many of the older sewer lines are made of clay and need to be replaced, so recently Oakland City worked to replace sewer lines to address inflow and infiltration issues. Currently, no lines have been extended out to the future I69/SR 64 interchange. Extending sewer lines to this area would help Oakland City annex land in the future. However, Francisco recently constructed a sewage treatment facility northwest of the interchange, placing Francisco in a better position to offer services to areas adjacent to the interchange. The smaller community of Patoka has on-site septic systems. Failing septic systems have been an issue of concern, and the residents of Patoka have explored some option for centralized sewage treatment.*

Table # 4		
Septic Suitability Soil Classifications in Watershed		
CLASSIFICATION	NUMBER OF ACRES	% OF THE WATERSHED
Very limited	116,403.35 acres	85.84%
Somewhat limited	15,495.90 acres	11.43%
Not Rated	3,700.00 acres	2.7%
Null*	2.75 acres	.03%

MAP 9– LOWER PATOKA RIVER WATERSHED

SEPTIC SYSTEM SUITABILITY OF SOILS IN THE WATERSHED



6. LAND USE DESCRIPTION

The majority of the LPR Watershed is classified as rural. It is made up of several gravel roads, a few dirt roads and the occasional state highway. As mentioned previously, there are only four towns located within the watershed.

Most of the total acreage within the LPR is characterized by land being used for agricultural production (52.75%). Notable crops in the watershed are corn, soybeans, wheat, pasture and livestock. Farming practices typically lean toward more conventional methods that rely on tillage and frequent application of fertilizers and other nutrients; as well as chemicals for pest control and weed management. The recent tillage transect data (see page 32-33) confirms that most of agricultural land is not being "never-tilled"; but rather producers are making tillage decisions based on recent weather patterns. Tillage, conventional and reduced, can be a contributing factor to the amounts of sediment found in the LPR streams along with the high turbidity levels, especially after a rainfall.

Land Use Potential Impact on Water Quality / Stakeholder Concerns

Soil loss is a great concern for all stakeholders in the watershed. Turbid waters and embedded streambeds do not provide adequate habitat for fish and macroinvertebrates that contribute to a balanced ecosystem.

Additionally, producers are concerned with soil run-off as this lowers productivity and soil health significantly. Soil particles can also bind with certain additives, such as phosphorus, and transport these nutrients into the streams in excess. Soil is also lost in ditches, due to the practice of cleaning ditches periodically and not utilizing seed or erosion control measures of any type to prevent soil loss during rain events.

Table # 5 – Land Use by Acres and % in LPR Watershed

Category	Lower Patoka River Land Use	Acres	% of Watershed	Category Acres	Cat %
Developed Areas	Developed, Open Space	6,550.73	4.83	8,899.38	6.562
	Developed, Low Intensity	1,324.50	.977		
	Developed, Medium Intensity	557.74	.411		
	Developed, High Intensity	466.41	.344		
Forests and Natural Areas	Barren Land	659.12	.486	52,714.80	38.878
	Open Water	2,914.27	2.149		
	Deciduous Forest	41,094.78	30.31		
	Evergreen Forest	5,212.99	3.84		
	Mixed Forest	6.54	.004		
	Shrub/Scrub	40.07	.029		
	Grassland/Herbaceous	2,787.03	2.06		
Agricultural Production	Pasture/Hay	5,086.85	3.75	71,532.40	52.75
	Cultivated Cropland	66,445.55	49.00		
Wetlands	Woody Wetlands	1,152.86	.85	2,208.51	1.628
	Emergent Herbaceous Wetlands	1,055.65	.778		
	Unclassified/Unknown	246.91	.182	246.91	.182
TOTALS		135,602	100	135,602	100

Streambank erosion is also a primary concern when it comes to the contribution of sediment in local streams. Logjams can create blockages in streams that cause water to reroute and cleave into banks, causing much soil loss. Windshield surveys (see page 51) in the watershed have proven that, especially under bridges, there are blockages in many creeks and streams created by trash, down logs, corn stalks and other debris.

A ditch in Gibson County "cleaned out" in 2018 and same ditch after a heavy rain showcasing soil loss when there are no soil erosion control measures implemented.

Picture # 7 – Dredged ditch w/o erosion control after a heavy rain.

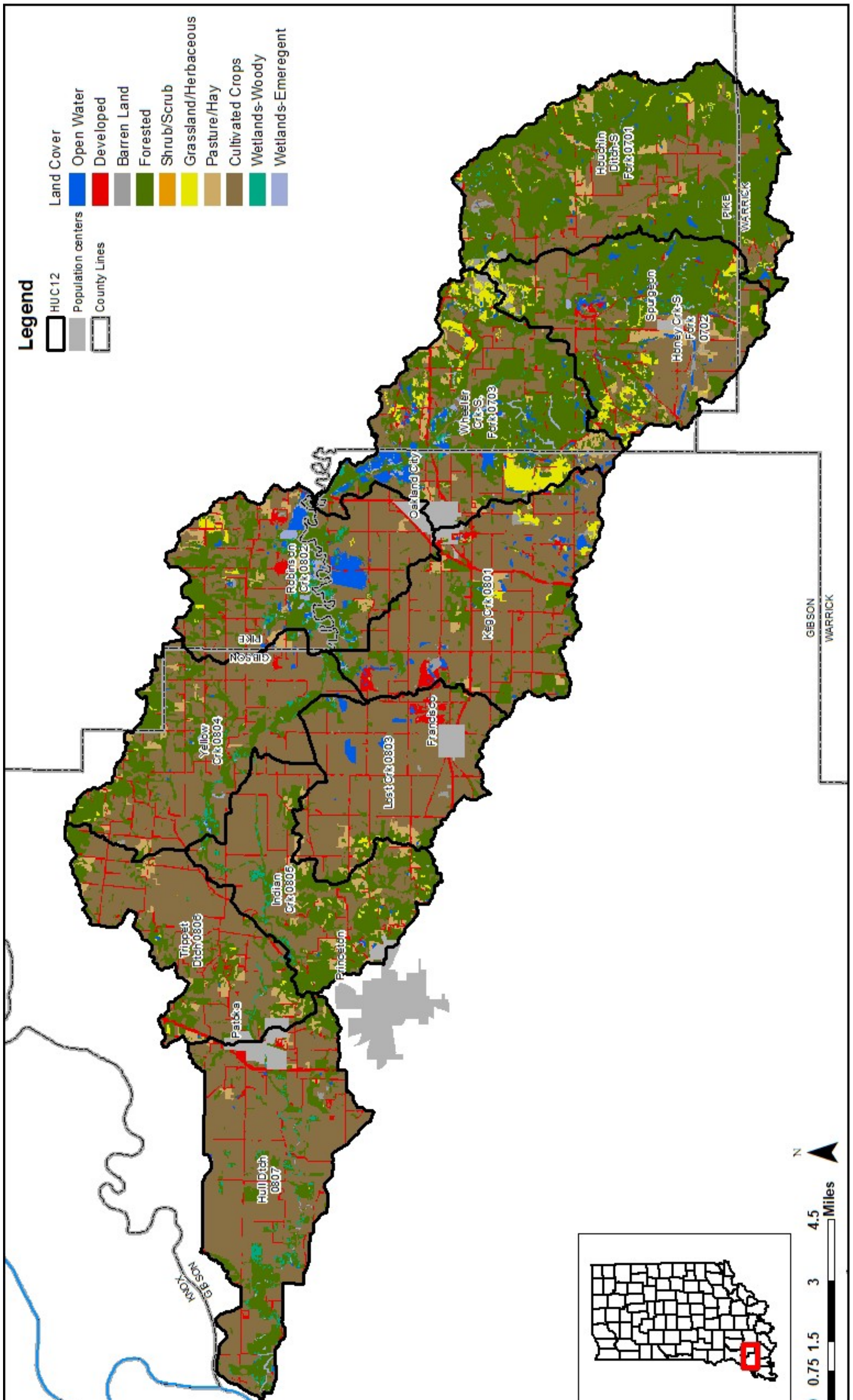
In addition, much of the agricultural land in the LPR watershed is also drained by tile systems.

Current estimates of the amount of agricultural land drained in the Midwest are unclear at this time, but ongoing research suggests that much of Indiana's original wetland areas have been deforested and drained to increase farming productivity. (See hydric soils and wetland discussion on pages 23 and 35.) It is also a cause of great concern that the overloading of local streams from excess diversion of rainwater and run-off is a major contributing factor to streambank erosion and damaging flood events.

Bottomland hardwood forests have a tremendous positive effect on down-stream flooding, nutrient uptake, and aquifer recharging. Fortunately for the LPR watershed, the Patoka River National Wildlife Refuge (PRNWR) is actively purchasing lands along the Patoka main channel and converting them back to wetlands and bottomland forests. Currently 3,056 acres are presently acquired by the refuge and are being managed. The goal is to acquire 12,000 to 13,000 acres. In addition, the PRNWR is maintaining emergent wetlands at Snakey Point and Buck's Marsh, both of which have a mixture of vegetation that includes cattail, bulrush, sedges, spatterdock, water lily and smartweeds. A future goal of the PRNWR, dependent on land acquisition, is to maintain 1,000 acres of bottomland farmland as a stopover habitat for migratory water birds. The existing 265 acres of moist soil units are being maintained with another 700 acres being converted upon acquisition. The refuge has also acquired reclaimed mine lands and converted them to grasslands and upland forests. Once the Refuge is at 13,000 acres, their presence in the watershed will represent 9.5% of the acres.

MAP 10– LOWER PATOKA RIVER WATERSHED

LAND USES IN THE WATERSHED



Fertilizer is primarily used in Lower Patoka for increasing agricultural production. It should be noted that private landowners may apply fertilizer and pesticides to gardens, landscaping and decorative plants. But it is agricultural fertilizer, typically applied as a mix of nitrogen, phosphorus and potassium, which is a resource concern among many stakeholders. Applied at the time of spring planting, over application of fertilizer can lead to increase nutrient loads. Side-dressing (after planting if the producer has the equipment to do so) is a beneficial practice as it allows the producer to apply fertilizer in a timely manner, rather than on the field prior to the crop being able to utilize it. Fertilizer applications prior to planting are more likely to be washed away with a heavy spring rain. Also, cover crop acres, which can reduce soil erosion and thus nutrient loads throughout the winter months, fluctuate each year as is evident from the soil transect data (see page 32-33). This practice could increase soil organic matter and help to reduce the need for applied fertilizer in the spring.

Several conservation programs are currently available through NRCS, FSA, DNR and ISDA to help remediate some of these resource concerns. These agencies offer cost-share programs such as EQIP with financial incentives for the implementation of conservation BMPs. Best management practices such as nutrient management, heavy use area protection, exclusion fence and rotational grazing, precision agriculture and no-till planter upgrades, water and sediment control basins (WASCOBs), cover crops, and grassed waterways have all been recognized by those in watershed work as possible remediation measures.

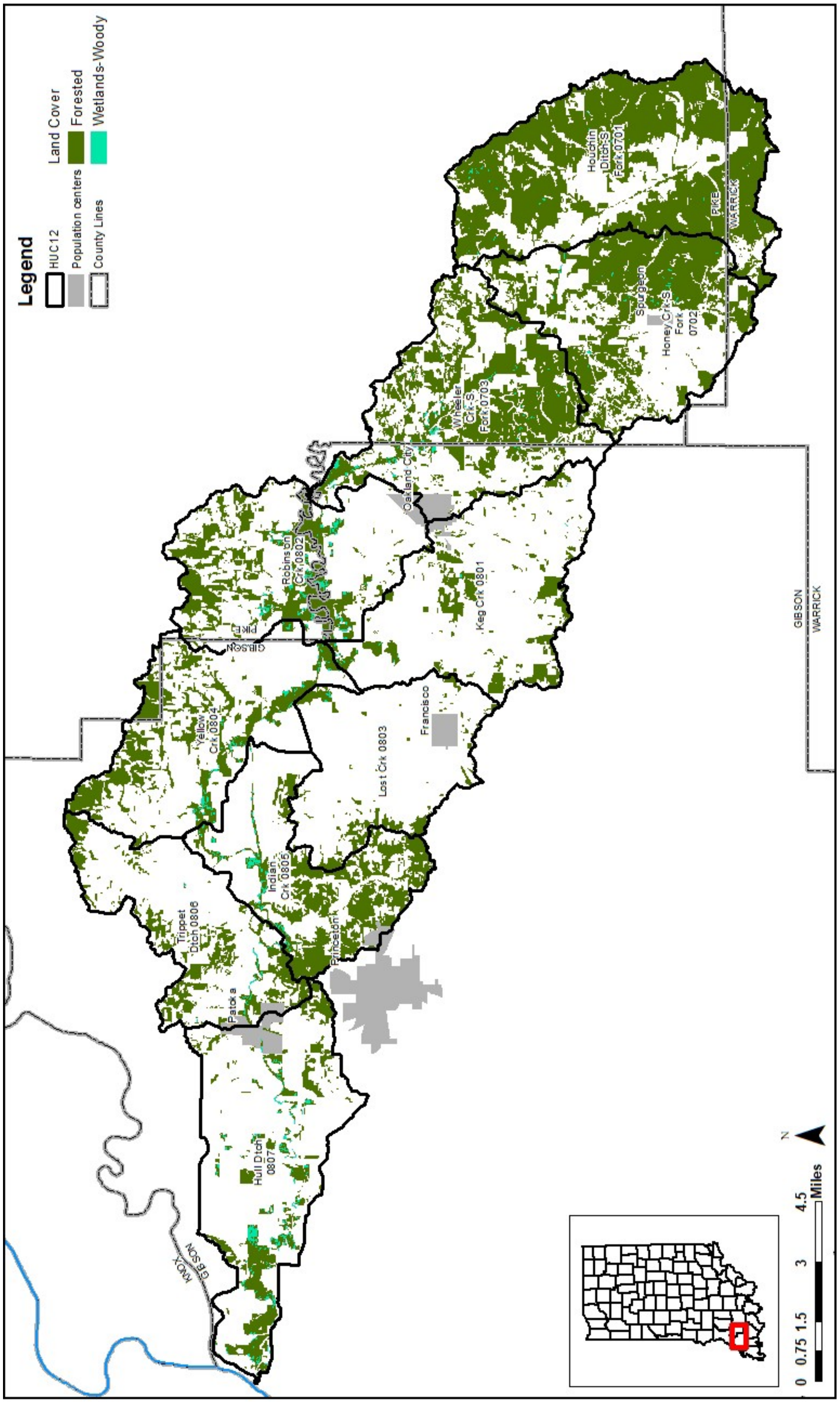
Forests. Forests are vital ecosystems that provide for maintaining riparian zones, carbon sequestration, and stabilizing hillsides. Second only to agriculture, there are significant acres of forest and natural areas in the watershed (38.87%). Map 11, page 42 show forested lands in the watershed. There are very few, if any, isolated areas of Indiana forestland where trees have never been cut. Most of these areas are thought of as small treasures and are preserved in state parks and nature preserves. The project area does not have any extensive forested areas. Rather there are "wood lots," riparian zones, and some public wildlife areas.

Sugar Ridge Fish and Wildlife Area and Pike State Forest have several non-contiguous parcels in the area that are managed for timber harvest as well as wildlife and recreational activities. Some of these parcels are located directly up-stream of the project area and have a direct influence on water quality such as that of the Patoka River National Wildlife Refuge. Conservation groups, private citizens, State, and Federal agencies all realize the importance of the remaining forests, rivers, and wetlands in the area and have undertaken projects to conserve, protect, and restore these valuable assets.

Mining. When mining activities in the project area are discussed, they fall into two very distinct groups: historical and current. Coal was discovered in Pike County in 1860 and remains one of the area's major industries. The United States government enacted the Surface Mining Control and Reclamation Act (SMCRA) in 1977, which imposed strict reclamation guidelines during and after mining operations. Prior to 1977 there were very little formal reclamation guidelines. Land was mined, which resulted in total devastation of the area, and frequently abandoned without any restoration resulting in Abandoned Mine Lands (AML).

MAP 11– LOWER PATOKA RIVER WATERSHED

FORESTED LANDS IN THE WATERSHED



Acid Mine Drainage (AMD) is caused by oxidation of pyrites during and after mining operations. AMD typically has a pH so low it is comparable to vinegar or battery acid. Obviously, nothing can live in this environment. During dry periods, the AMD collects in pools and then flushes out after a heavy precipitation event. Historically, the entire 17-mile length of the South Fork was a dead zone for many years with no fish or amphibians. Of course, most of this degrading of water quality from AMD occurred generally prior to the 1977 SMCRA. In 1996, a group was formed called the Patoka South Fork Watershed Steering Committee. They attacked the AMD problem in the South Fork Patoka River from 1996 until 2004.

Thankfully, the SMCRA imposes an extraction fee on each ton of coal mined, and with that money addresses AMD/AML problems throughout the United States. The Division of Reclamation (DOR), Indiana Department of Natural Resources is the state agency which implements the SMCRA in Indiana. Thankfully, the DOR helped fund the South Fork Steering Committee, which acted as a catalyst to catalogue, qualify, quantify, and remediate the AMD in the project area. Additional funds came directly from the Office of Surface Mining, U.S. Department of the Interior, which is the federal agency implementing the SMCRA. These kind of reclamation projects are extremely expensive, ranging from several thousands of dollars to several million.

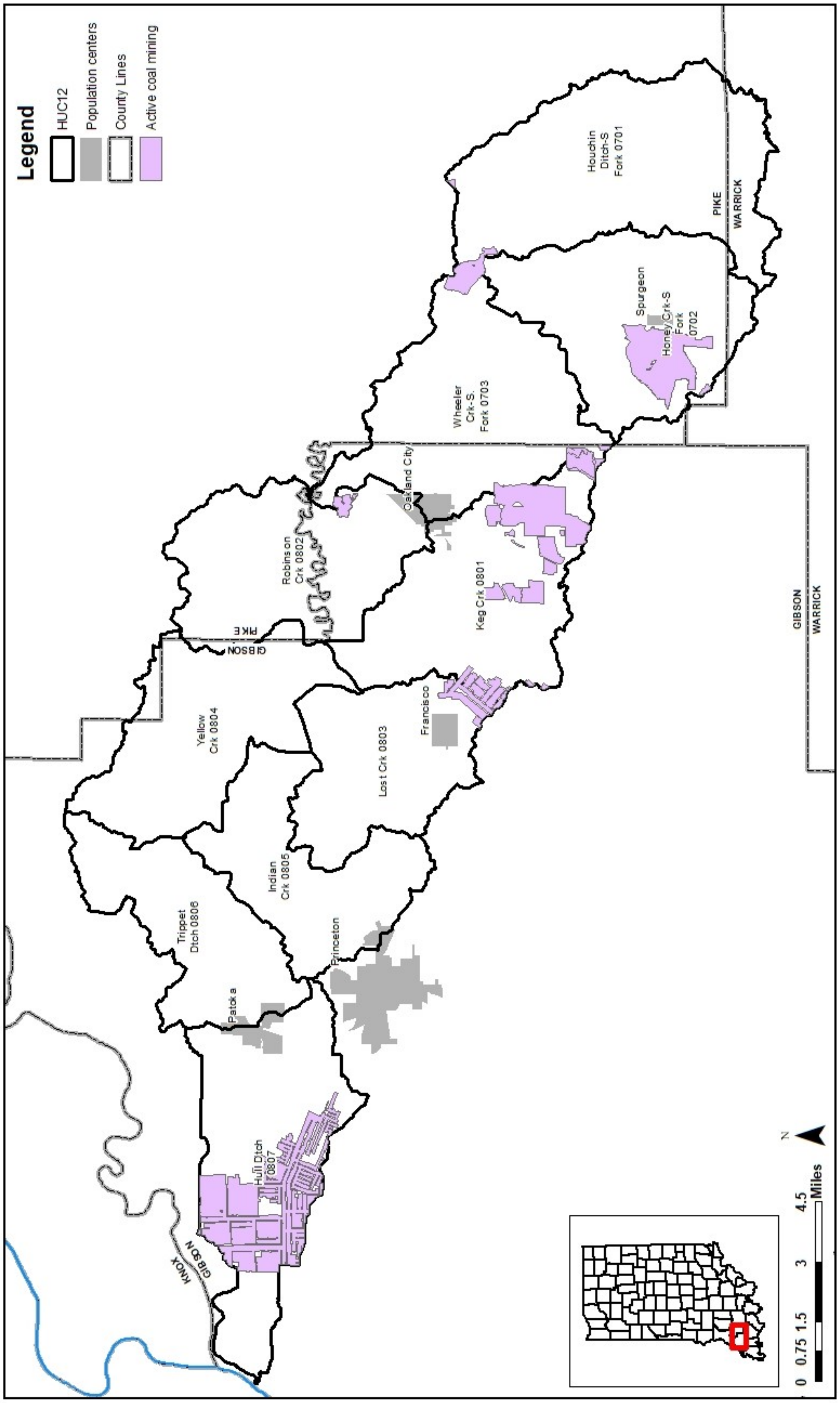
Don Corbett, a hydrologist from Indiana University, conducted water quality investigations in the region from 1965 through 1968. This data pre-dates the South Fork Steering Committee, therefore it is mentioned here merely for historical reference only. The South Fork Steering Committee received a Section 319 Grant from the Indiana Department of Environmental Management (IDEM) to provide for a Watershed Coordinator and water sampling. With the assistance of local, state, and federal agencies, the majority of AMD was eliminated by the time the South Fork Steering Committee adjourned for the last time on December 4, 2004, having done all that could be expected from a grassroots organization.

However, two major sources of AMD remain. The headwaters of the South Fork originate on the Pike-Warrick County lines, where there is severe degradation. Another site is the Durham Ditch drainage that was addressed, but still has severe contamination. The DOR spent approximately $1.2 million in 2006 for reclamation at the headwaters and is currently spending another $1.2 million to complete the project. The Durham Ditch problem is still being studied and should be addressed soon. Never-the-less, with the elimination of the AMD at the headwaters, one of the last of two major sources of contamination will be eliminated. The result of the campaign against AMD is that after many years of the pH being too low for aquatic life, the pH is now high enough to support a thriving aquatic community.

However, the project area continues to see a rapid expansion of coal mining. Surface and underground mines are routinely being opened around the project area. Map 12 on page 44 shows the extensive amount of current mining activity in the area.

Even though reclamation guidelines dictate procedures to prevent the deterioration of the watershed, vigilance is required to ensure that the guidelines are in fact being followed. Reclaimed land is extremely vulnerable to erosion. The erosion not only contributes to sedimentation in the streams, but exposes pyretic materials, which can cause AMD.

MAP 12– LOWER PATOKA RIVER WATERSHED
ACTIVE MINES IN THE WATERSHED



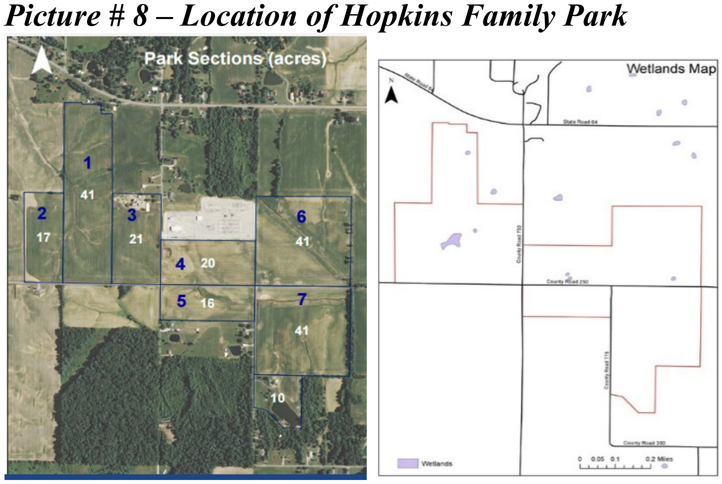
Urban and Industrial Land Use:
Gibson County is every changing, as is most of the Midwest. Actual farm numbers are decreasing, even as additional farm acres are being added. Despite the agricultural increase, manufacturing and mining industries are on the rise in both Pike and Gibson Counties as well. This development has resulted in a population growth that puts pressures on the environment. Incorporated towns, housing clusters, and individual homes all pose threats such as septic systems, illegal trash dumping, fuel leaks, and non-permitted excavation in sensitive areas such as wetlands and floodplains. The construction of Interstate 69 through the watershed has greatly changed the landscape as well. And since the corridor has been completed from Evansville to Bloomington, traffic has increased on the Interstate, and no doubt, development will increase as well in the next few years.

Pet and Wildlife Waste
Pet waste, if not properly removed and discarded, can find its way into local streams after a heavy rain event and contribute to high E. coli levels. To estimate the amount of pet waste in the LPR watershed, census records were examined. The LPR watershed is predominantly rural and on average, there are 10 people living per sq. kilometer (247 acres). The American Veterinary Medical Association states that 36.5% of households have dogs and 30.4% have cats. Since the ratio of pets to acres is very low, pet waste in the LPR watershed is insignificant to E. coli levels.

The LPR watershed does have an abundance of wildlife, especially large populations of deer and migratory birds. Urban areas with a concentrated population may be a concern, but in a balanced ecosystem, wildlife waste is not considered to be a detriment to water quality. Large flocks do stopover during migration at Snakey Point, and other wetlands on the PRNWR, but it is not a concern since the wetlands mitigate the waste pollution. In addition, many stakeholders enjoy PRNWR, with over 25,000 annually visiting to hunt, hike, fish, kayak, view wildlife, and take photos. Wildlife of any kind in a rural area is seen as a favorable indicator of good habitat and forage. Ongoing efforts will continue to monitor dense populations of wildlife that may negatively impact water quality with fecal waste.

7. OTHER PLANNING EFFORTS IN WATERSHED
Other planning efforts in the watershed include the Gibson County Comprehensive Plan and the Department of Parks and Recs Five-Year Plan; in addition to the current 2008 LPR WMP. The Comprehensive Plan for Gibson County (see map 13, page 46) was prepared for the Gibson County Board of Commissioners by Bernardin, Lochmueller and Associates, Inc. in Evansville. The final draft of this report was completed November 2009.

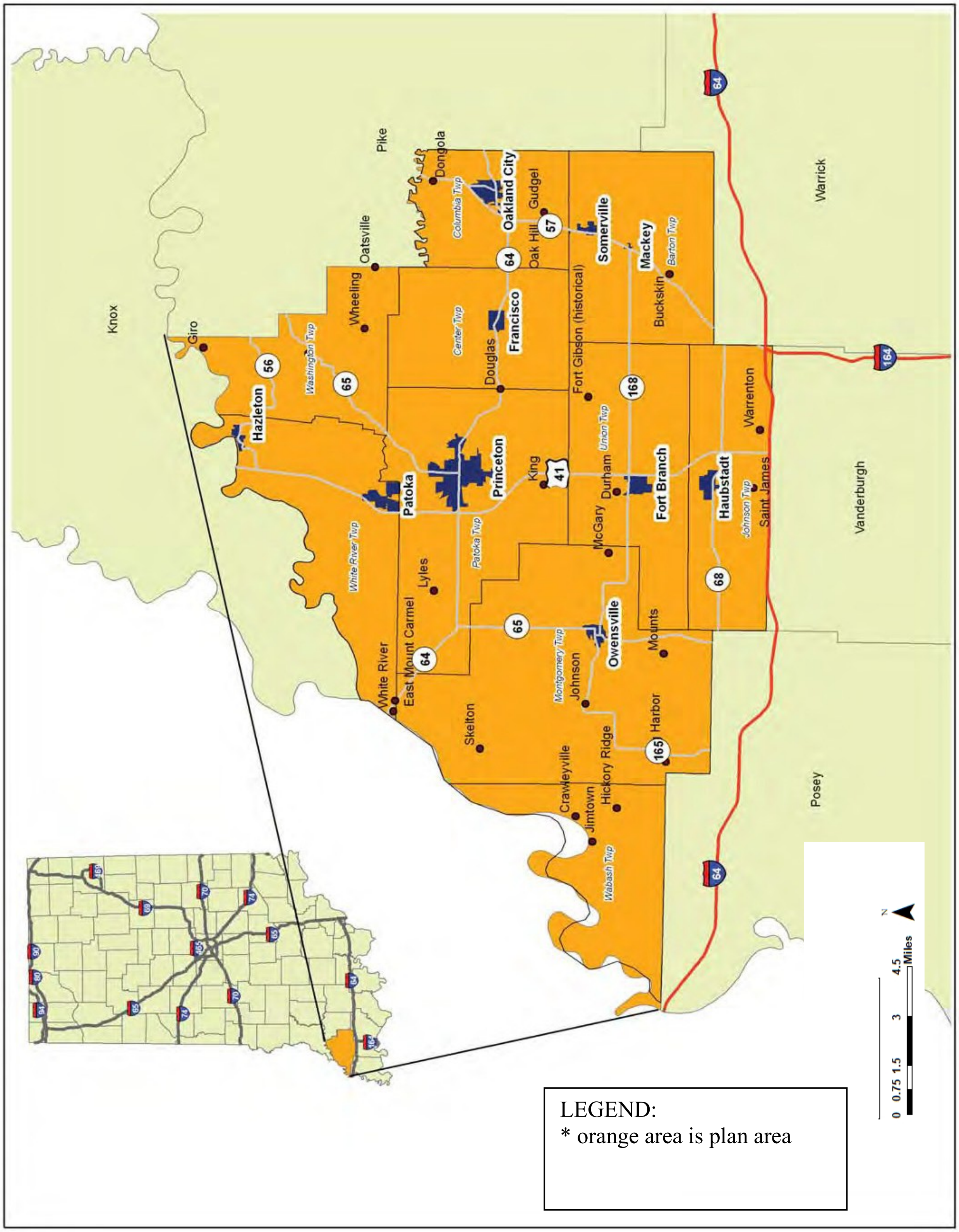
Picture # 8 – Location of Hopkins Family Park



The Gibson County Department of Parks and Recreation Five Year Plan (2017) is the master plan for development and maintenance of the Hopkins Family Park (picture 8). The park is located south of State Highway 64 near County Road 250 South and County Road 750 West. It will ultimately be a total of 200 acres or 0.0014 % of the Lower Patoka River Watershed.

MAP 13 – Gibson County Comprehensive Plan

Gibson County Comprehensive Plan



How Efforts Impacted Water Quality

The 2008 LPR WMP was used to secure a 319 grant. Several BMP cost-share and match projects were implemented during the grant, including livestock exclusions, cover crops, precision agriculture practices, a fjord-style stream crossing, cover crop seeder box purchase and WASCOBs. There was a total of 22 stakeholders / producers participating in the program either by enrolling in the cost-share program, or by obtaining designs and installing the BMPs with their own funding resulting in a cash match to the program.

The grant resulted in implementation of BMPs totaling 1,436.45 acres of cover crops, with an additional 364.46 potentially covered with a cover crop seeder box project. GIS Precision Agriculture equipment modifications impacted a total of 408.14 acres. Installed practices resulted in 6,363 tons sediment per year, 16,583.68 lbs. nitrogen per year and 5,731.70 lbs. phosphorus per year load reductions.

Planning Efforts Connected to Stakeholder Concerns

The Hopkins park five-year plan showcases the development of pollinator habitat prairie as well as protecting the area from invasive plant species, two natural resource concerns stakeholders listed that steering team members had discussed as not directly addressing water quality (see page 14), but still valid concerns.

Unmanaged Sprawl

The Gibson County Interstate 69 Economic Development Area, first designated as a 47,000-acre corridor in 2013, but modified in 2016, was created to pave the way for new Tax Increment Finance districts if needed. TIF districts would capture some of the property tax revenue raised by development in that district to fund infrastructure or other projects that benefit the district.

More recently, Gibson County considered a zoning ordinance, originated by the new construction of I69 through the county. The Gibson County Commissioners began work on a county-wide zoning ordinance in the fall of 2017. This created a backlash of citizens fighting each other, some in favor of zoning and many not in favor of zoning. After months of debate, the Gibson County Commissioners unanimously voted down the new county-wide zoning ordinance (March 2018).

Rule 5 Enforcements

The occasional housing development or other construction project in the watershed that will exceed one acre of disturbed topsoil are required by IDEM Office of Water Quality (Indiana statue 327 IAC 15-5) to submit an Erosion Control Plan and Notice of Intent to Gibson County SWCD office and are reviewed by an IDEM storm water specialist. This "disturbance" refers to any manmade change of land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting and grading. Once plans are submitted, the SWCD District Coordinator forwards them to Ron Boehm (IDEM storm water specialist) who reviews the plans / projects for compliance. At the writing of this plan, there are no enforcement / compliance issues in the Lower Patoka watershed.

8. THREATENED AND ENDANGERED SPECIES

Identify Threatened, Endangered Plants and Animals

The Indiana DNR defines potentially sensitive areas as areas where threatened or endangered species have been documented or areas that have been determined to be high quality natural areas. These areas should be considered prime candidates for preservation. There is a large concentration of these sensitive areas in and around the PRNWR. Both Gibson and Pike Counties are the home to several endangered, threatened and rare species, as well as these high-quality natural areas. The high-quality natural areas in the LPR watershed include wet-mesic floodplain forest, dry mesic upland forest, southwest lowlands and southern bottomlands and shrub swamp wetlands.

EPA: Many of the U.S. breeding bird populations-- including ducks, geese, woodpeckers, hawks, wading birds and many song-birds-- feed, nest and raise their young in wetlands. Migratory waterfowl use coastal and inland wetlands as resting, feeding, breeding or nesting grounds for at least part of the year. Indeed, an international agreement to protect wetlands of international importance was developed because some species of migratory birds are completely dependent on certain wetlands and would become extinct if those wetlands were destroyed. Unfortunately, human activities in the area have resulted in a very negative impact on flora and fauna of the watershed.

Fish: A study done by Simon, Dufour and Fisher (IU Bloomington) entitled "Changes in biological integrity of fish assemblages in the Patoka River drainage because of anthropogenic disturbance from 1888 to 2001" (published January 2005) reports the following facts

- Extirpations in watershed have resulted in local loss of 12.7% of the fish during the last century.
- Sensitive species have declined in abundance, but recent sampling has shown that they remain present in low numbers (remnant populations) due to recent water quality improvements.
- Historic and recent fish records show that 97 species were in the watershed; however, only 85 species are currently documented.
- Species collections at specific spots have fluctuated from 1888 to 2001 with both rise and fall in number of species collected; but overall diversity in the watershed has declined.
- The LPR has been environmentally impacted with mineral extraction and oil and gas exploration making an indelible image on the landscape.
- Acid mine drainage from underground / surface mining has altered the watershed's water quality.

In conclusion, the report states that the "Patoka River Watershed has endured substantial environmental changes and has exhibited significant losses in biological integrity, yet despite the local extirpation of 12.7% of the fish fauna, the watershed still maintains remnant populations of many fish species, providing a similar species composition list over the last 120 years."

Mussels: In the LPR watershed, large amounts of sediment in the streambeds create unfavorable habitat for a variety of species, including mussels. The 2016 Indiana Fish and Wildlife's Wildlife Diversity Report states that

> *Water quality in North America has been declining due to human activities for the past 200 years. As a result, the continent has lost nearly 70% of its freshwater mussels. A primary cause was that native North American mussels were harvested by the thousands for commercial button and jewelry making in the 19th and 20th centuries, especially from Midwestern rivers. Today, freshwater mussels are the Midwest's most imperiled animals. More than half of such species are federally listed as endangered, threatened, or as state species of special concern. Indiana is home to 10 federally listed freshwater mussels. Once found in virtually all rivers in Indiana, now six of Indiana's 10 species live in one river in northcentral Indiana."*

Both Pike and Gibson County are home to federally endangered Eastern Fanshell Pearlymussel, the Clubshell, the Rough Pigtoe and the Fat pocketbook mussels; and Gibson County is home to the federally endangered Tubercled Blossom mussel. Two federally endangered freshwater mussels, the Spectaclecase and the Ring Pink, are extirpated from Gibson County. See the complete list of species in Appendix A on page 142.

Picture # 9- FE Interior Least Terns on Refuge

interior Least Tern east of the Mississippi River, the Cane Ridge Unit is recognized as a Globally Important Bird Area. Over 380 species of wildlife, including a new species of burrowing crayfish verified in 2002, have been observed on the refuge.

The Interior Least Tern, the smallest tern in the world, is the only federally endangered (FE) bird that nests in Indiana. In 1985, it was listed by U.S. Fish and Wildlife Service, but in 1986 a pair was found nesting near Gibson Lake. Since then, government agencies and private industry have been working to encourage the growth of the colony. According to the 2010 DNR report, the estimated number of adult least terns in Gibson County was 150 (down from a record 220 in 2009) with an estimated 165 fledglings. There was also a reported nesting site near Rockport with 70 adults and 15 fledglings. Least terns dig shallow nest holes on islands, along riverbanks and on natural sandbars. However, with dams, locks, channelization and other human interference and modifications with the river system, the loss of historical nesting habitats (sandbars) have caused tern populations to nest along artificial dikes and sandbars and thus, interfering with infrastructure. With the hope of encouraging the terns to return to natural sites to nest, a 463-acre plot of land known as Crane Ridge was developed with two constructed islands in Tern Pond. An observation deck is near the pond for birdwatching. The PRNWR manages these lands.

The February 2018 IDNR list of Endangered, Threatened and Rare Species for Gibson County lists 2 crustaceans, 21 mussels, 2 mayflies, 1 fish, 1 amphibian, 5 reptiles, 20 birds, 9 mammals and 31 vascular plants. For Pike County, there are 13 mussels, 2 fish, 2 amphibians, 3 reptiles, 17 birds, 7 birds, and 21 vascular plants listed as endangered, threatened or rare. Appendix A lists each of these by Latin name and common name for both Gibson and Pike Counties.

9. REVIEW OF RELEVANT RELATIONSHIP

Topography and Soil Type

Most of the land (52.75%) in the Lower Patoka watershed is highly erodible soil. These types of soils are at risk for weathering and eroding, especially during heavy rains. In addition, an abundance of farm acres is at risk for soil loss due to lack of minimal tillage practices, filter strips, buffers and other conservation measures. Often tilled hill fields within the watershed can be seen with deep gullies and washouts after a heavy rain. Many farms have crop rows right up to the edge of a creek or ditch, with little or no grass buffer between the tilled acres and the waterway.

In addition, the watershed has significant floodplain acres, and hydric soils making up 16.3% of the watershed. Also, much of the farmland is drained by subsurface tile which can transmit some contaminants directly into streams and ditches with little filtration.

Soils Unsuitable for Onsite Septic Systems

Population centers within the Lower Patoka River watershed are mainly individual homes and housing clusters except for the four small towns. Two, Patoka and Spurgeon, are very small (250 or less homes each). Only Oakland City and Francisco have wastewater systems; thus, it can be stated that citizens within the watershed mainly rely on onsite septic systems for waste disposal. Many of these homes were built prior to Indiana State Department of Health's current septic system regulations (Rule 410 IAC 6-8.3) meaning they may possess a system that does not a proper drainage field, if a field is present at all. This can cause contaminated water to reach surface water and streams before harmful bacteria has been properly filtered. Evidence of this assumption is reflected in the exceedingly high E. coli counts found during water monitoring. Some sites showed high E. coli in December, which indicates a constant influx of untreated water is reaching the streams as bacteria should not survive the cold temperatures. In addition, nearly 86% of soils in the Lower Patoka watershed are classified as very limited for septic system suitability. It is evident that all these factors can be contributing to high levels of E. coli. See page 53-54 for discussion on E. coli water quality standards and page 101 for side by side comparison of high and low readings on all monitoring sites.

Hydrology and Land Use

The LPR watershed is the ending 135,502 acres of the 551,044 acres included in the 8-digit Patoka watershed; meaning the LPR is ¼ of the entire Patoka drainage basin. Due to the extremely rural nature of the watershed, stakeholders' natural resource concerns stem from land use decisions – predominantly agricultural production, wetland/hydric/floodplain areas being drained for use, and faulty, antiquated septic systems. Fortunately, the watershed has the PRNWR acquiring lands and reverting them back to wetlands to help with flood control and water quality improvements; as well as conservation practices such as cover crops and a general push for soil health being widely accepted among producers. The goal is a nutrient and sediment load reduction across the watershed through decreased tillage, improved soil health with use of cover crops and BMPs and the increase of wetland acres through restoration and conversions.

WATERSHED INVENTORY (Part Two)

10. WATER QUALITY DATA and TARGETS

Historical Data Collection

This is not the first WMP for the LPR watershed. Therefore, historical data exists that was used to draft the first WMP, as well as IDEM's presence in the watershed, including:

1) IDEM Office of Water Management completed a comprehensive report in 1996.
2) IDEM completed the *"Patoka River Watershed Restoration Action Strategy"* in June 2000.
3) Volunteers gathered data with a Hoosier Riverwatch loaner kit beginning in 2006.
4) IDEM sampled in 2009 for a proposed Patoka River TMDL that was never approved.
5) IDEM sampled in 2012 for performance monitoring on implementation efforts.

The 2009 and 2012 IDEM monitoring data, as well as historical Hoosier Riverwatch data, are summarized and listed in the Appendix for reference. However, due to the age of these reports and data, as well as the recent changes within the watershed including a round of 319 grant BMP implementation and the construction of I69, this historic data should be used only as point of reference. However, where appropriate, historical data is mentioned or reference in the 12-digit HUC subwatershed discussions.

Recent Data Collection

For this watershed management plan, the steering committee determined a more accurate representation of the watershed could be presented using the more recently collected data. This means that the load calculations and proposed load reductions, as well as critical areas will be determined using the data collected specifically for this WMP revision. Two sets of water quality inventory were gathered for this WMP. The two include the L-THIA modeling (explained below) and quarterly water monitoring data that was collected following an approved QAPP (Quality Assurance Project Plan) along with windshield and desktop surveys.

Desktop Modeling with L-THIA
First, data was compiled by TNC using the desktop L-THIA modeling.

> *"L-THIA (Long Term Hydrologic Impact Analysis) modeling is a computer-based means of determining pollutant loads based on more than 30 years of daily precipitation data. L-THIA estimates long-term average annual runoff for land use and soil combinations, based on actual long-term climate data for that area (Purdue Engineering). L-THIA will generate estimated runoff volumes and depths; and expected nonpoint source pollution loadings to waterbodies based on the information provided by the user. Results can be displayed in tables, bar graphs or pie charts. L-THIA focuses on the average impact, rather than an extreme year or storm. The L-THIA NPS Model is unlike conventional hydrologic models that address short-term runoff management issues at a limited-scale. L-THIA NPS can assess the long-term impacts of land use change within a watershed"* L-THIA NPS User's Manual Version 2.3 by Professor Bernard Engel, Purdue University.

The results from the desktop modeling are listed in Appendix F and mentioned in the 12-digit subwatershed discussion. The L-THIA results are listed by subwatershed and include subwatershed acres, lbs./acre of N, P, and TSS as well as mil col/acre of E. coli for each. This data was then used to show the % of total for each subwatershed as well as the subwatershed's ranking when compared to the others.

Windshield and Desktop Surveys
A windshield survey is an informal way to make observations in a watershed. Both major and minor roads are driven with observations made from the vehicle. At times, the watershed coordinator stopped the vehicle to record data with photographs and to record notes of observations. The windshield survey is good at showcasing a visual overview of the watershed.

In addition, a desktop survey using Google Maps was used to make observations. Street View in Google Maps is a virtual representation of surroundings with panoramic images. Google maps was used by using street views when available. This method allowed the watershed coordinator to virtually "drive" the watershed without traveling in a vehicle. Where google maps street views were available, visual data was recorded for each subwatershed.

Water Quality Monitoring
In addition, the Patoka River watershed coordinator developed a QAPP and completed water monitoring data collection. The QAPP was developed and approved with the goal of collecting up-to-date water quality data in the LPR watershed through strategic water monitoring throughout the course of a year. The water monitoring consisted of chemical, macroinvertebrate, stream flow and habitat monitoring on 12 sites located throughout the watershed. Monitoring sites are represented on maps in each subwatershed section (pages 61-100) and are indicated with a red square. The 12 monitoring sites were chosen due to their best representing of what is happening in the watershed.

A survey was completed looking at sites along bridges and lesser traveled roads for safety and convenience of collecting samples, as well as acres of watershed represented; then verified on-site.

In the Robinson watershed (051202090802), roads were closed due to mining operations, making it impossible to get to any bridges over tributaries to draw samples. Further upstream, toward headwaters, the tributaries were small and dry, apparently only running after a rainfall. Fortunately, there was a bridge over the main channel where the Patoka enters the watershed and another one where it exits the watershed. Therefore, both the pre- and post-Robinson results can be examined to determine the effect the watershed has, if any, on the main channel.

In the Lost Creek watershed (051202090803), there was a similar situation with coal mining in the area making stream access difficult at times. Also, several roads were dirt, single-file lanes through frequently flooded cornfield bottoms obviously used by farm equipment only. Moving upstream to a rock road, the watershed coordinator found dry creek beds. Therefore, the Lost Creek sample site is only representative of 57% of the sub-watershed.

In the Yellow Creek Watershed (051202090804), there were only five roadways crossing tributaries and all five were small, dry creek beds that appeared to run only after a rainfall. The only water flowing in this sub-watershed was the old Patoka River channel (most of the main channel Patoka is diverted though a straight man-made canal through Indian watershed, see page 28 for details). The only place the old channel was accessible was a bridge located just inside the Indian sub-watershed. However, it is less than a mile in, and so was chosen as the best chance of showcasing the Yellow Creek watershed.

The Indian Creek watershed (051202090805) includes both the northern channelized Patoka River area with ag field ditches draining into it and the southern portion of the watershed which is the actual Indian Creek. This watershed was given an additional site off Carither's Road (site # 13), to do the Hoosier Riverwatch monitoring on the actual Indian Creek. It was noted that sampling would be limited here, as the creek is often dry.


Picture 10 - Photo showing typical stagnant ponding in Hull sub-watershed.

The Hull watershed (051202090807) is mostly a floodplain, widely covered with flat farmlands with tile pipes emptying into ditches running alongside the fields. When checked, most of the ditches were between fields in which county roads did not cross. Also, roads in this watershed are few, and mainly just a way to reach the agricultural fields. Only one or two bridges crossed creeks; and where creeks could be checked, they were dry or stagnant ponded, apparently only running after a heavy rainfall. Therefore, the Hull test site ended up being a bridge over the main channel just miles from where the entire Lower empties into the Wabash. Thus, this sampling site is more a gage of the entire Lower Patoka than the Hull sub-watershed; although, comparing the Indian data with the Hull data can give an indication of how the subwatershed is being affected by the acres between the two sample sites.

During the water quality monitoring, the watershed coordinator was able to photo document and record data such as flooding issues, nearby construction / demolition, log jams, agricultural practices, and erosion within the watershed. In addition, habitat and biological monitoring were done at each site once; as well as stream flow each time chemical tests were performed. See pictures 11-12 on page 53.

Picture 11/12 - Photos showing typical scenario in watershed with an under-bridge log jam (Aug. 2017 looking east) allowing sediment buildup and change of stream flow (Aug. 2018 east-side of bridge).

IDEM's 303(d) List of Impaired Waters
In addition to the monitoring and L-THIA data, IDEM's 2018 Finalized 303(d) List of Impaired Waters that was submitted to EPA on August 17, 2018 was examined and included as Appendix G, as well as being referenced in the 12-digit subwatershed discussions.

Indiana Water Quality Standards
The Indiana Administrative Code Title 327 Water Pollution Control Division, Article 2 addresses water quality standards. The IDEM Office of Water Quality (WQ) uses WQ Standards as a foundation for WQ-based control programs mandated by the Clean Water Act. A standard can consist of either numeric or narrative criteria for a specific physical or chemical parameter and is used as the regulatory target for permitting, compliance, enforcement, and monitoring and assessing the quality of the state's waters. When assessments identify a waterbody as not meeting adopted WQ standards, the assessment may lead to a determination of impairment, initiating further action such as a Total Maximum Daily Load (TMDL) or other regulatory procedure aimed at addressing the impairment.

WQ Targets for the LPR watershed are state / national recommendations, or when possible, parameters used in other areas and nearby watersheds. The water quality targets for ten parameters and whether the values are required, or recommended, and the source of the standard are listed in Table #6, page 55.

WQ standards are the basis for determining whether a certain level of a contaminant such as E. coli is acceptable. Often, different levels of a contaminant are allowed for different water uses. For example, for drinking water, E. coli must be less than 1 CFU (colony forming unit) per 100 mL. Most surface water in Indiana would not meet this standard, but surface water compliance with the drinking water standard is not required because surface water drawn for drinking water use is treated before being consumed.

However, all Indiana streams and lakes are designated to meet the WQ standard for "full body contact recreation", or swimming, based on E. coli levels as recommended by the EPA. Monitoring results for E. coli are given in terms of number of E. coli CFU/100 mL of water. For water to meet the recreation standards, no sample should test higher than 235 CFU/100 mL. The lab results for E. coli in the recent water monitoring are reported as MPN/100mL or Most Probable Number of viable cells in 100mL of sample. The only difference between CFU and MPN is the way concentration of microorganisms are grown. MPN uses a liquid broth, while CFU uses a solid agar. The numbers are considered interchangeable. The E. coli lab results for the Lower Patoka range from 8 to 2,420 CFU/100 mL. Six of the twelve sites tested were over the 235 MPN/100 mL rating at least once.

MAP 14– LOWER PATOKA RIVER WATERSHED

IMPAIRED STREAMS

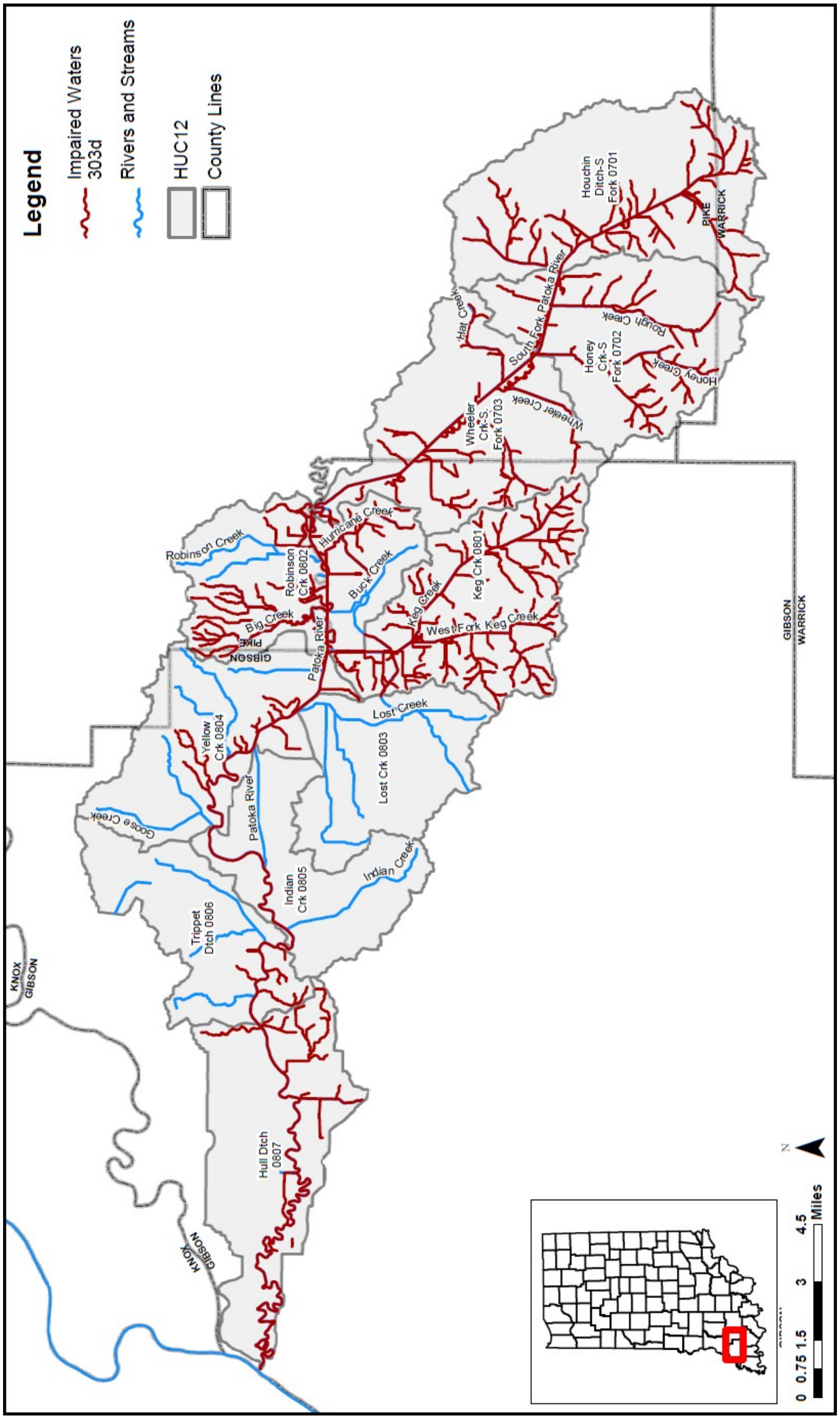


Table # 6 – Water Quality Targets for LPR Watershed			
PARAMETER	WATER QUALITY TARGETS	REQUIRED VALUE OR RECOMMENDED VALUE	SOURCE OF REQUIREMENTS OR RECOMMENDATIONS
Total Suspended Solids	10 mg/L	Recommended Value	Based on comparison of multiple regional WMPs
E. Coli	>235 cfu/100 Ml	Required Value	Indiana Administrative Code
Nitrate/Nitrite	≤ 1.0 mg/L	Recommended Value	Based on comparison of multiple regional WMPs
Total Phosphorus	≤ 0.07 mg/L	Recommended Value	U.S. EPA recommendations
Temperature	Monthly Standard	Required Value	Indiana Administrative Code
Dissolved Oxygen	Min: 4.0 mg/L Max: 12.0 mg/L	Required Value	Indiana Administrative Code
% Saturation	80-120% saturation (DO mg/L x 100% Max DO mg/L)	85-120% saturation = excellent 70-80% or 121-130% saturation = good 131%+ saturation = poor quality /dangerous to fish <70% saturation = poor water/increased toxicity	Hoosier Riverwatch
BOD^5	1-4 mg/L	1-2 mg/L BOD^5 = clean water w/ little organic waste 3-5 mg/L = fairly clean water w/ some organic waste 6-9 mg/L = lots of organic material and bacteria 10+ mg/L = very poor water quality with very large amts. of organic material in water	Hoosier Riverwatch
pH	6.0 to 9.0	Required Value	Indiana Administrative Code
Turbidity	< 10.4 NTU	Recommended Value	U.S. EPA recommendations
Water Quality Index	Excellent or Good Ratings	Excellent rating for 90-100 Good rating for 70-89 Medium rating for 50-69 Bad rating for 25-49 Very bad rating for 0-24	Hoosier Riverwatch
Citizens Qualitative Habitat Evaluation Index	≥ 60 points	Recommended Value	Hoosier Riverwatch
Macroinvertebrate Index of Biotic Integrity (Pollution Tolerance Index)	≥ 17 points	Recommended Value	Hoosier Riverwatch

The Nitrate readings in the LPR watershed ranged from none detected to 3.5 mg/L over the twelve sites sampled. The Water Quality Target is listed at equal to or less than 1.0 mg/L. In addition, the EPA states that 1.5 mg/L is the dividing line between mesotrophic and eutrophic streams. Five of the twelve sites were over the 1.0 mg/L Water Quality Target as well as over the EPA 1.5mg/L at least once during the year ranging from 1.6 mg/L to 3.5 mg/L.

However, the federal standard for nitrate in drinking water is 10 mg/L nitrate-N or 50 mg/L nitrate-NO^3 when oxygen is measured as well as the nitrogen. Unless otherwise specified, most nitrate levels are reported as amount of N present in which the federal standard of 10 mg/L is used.

11. 13. 14. WATER QUALITY, HABITAT/BIOLOGICAL AND LANDUSE INFORMATION

Watershed-Wide Descriptions and Information
While compiling information for this watershed management plan, the following items were not found for any of the 10 sub-watersheds (either in relation to water quality or habitat/biological information) and will therefore not be discussed in the following discussions of each subwatershed.

- TMDL Reports
- Office of Land Quality Data.
- Past / Ongoing LARE Studies.
- CAFOs (Combined Animal Feeding Operations).
- Combined Sewer Overflow (CSOs) or Sanitary Sewer Overflow (SSOs).
- Brownfield and Remediation Sites
- Application of Wastewater Sludge
- Non-ag Animal Operations

The following items will be addressed generally for the LPR as well as noted in each subwatershed's narrative if applicable:

- LUSTs (Leaking Underground Storage Tanks)
- Fertilizer Usage
- Hobby Farms and Animal Operations
- Confined Feeding Operations
- Stream Buffer Miles and Bank Stabilization
- Active Mines in the Watershed
- USGS flow gage data from #03376500 near Princeton.

Leaking Underground Storage Tanks (LUSTs)
The IDEM Office of Land Quality oversees the identification and remediation of LUSTs. At this time, several Underground Storage Tanks were located within the LPR watershed, however, the watershed coordinator researched the Regulatory ID # of each for reports of issues or problems and found all of them clear of any recent incidents. The web page regarding IDEM LUST program is http//www.in.gov/idem/landquality/2342.htm.

Fertilizer Usage
A large percentage of land (49%) is devoted to cultivated crops in the LPR watershed; and in order to increase productivity, fertilizer in the form of nitrogen, phosphorus and potassium, is often applied to the 66,445 acres of cultivated crops in the spring. A smaller number of producers still apply manure in the fall, though this is not typically an annual practice. In heavy rainfall events, fertilizer can be transmitted into streams via run-off and cause high nutrient loading.

Confined Feeding Operations
There are six NPDES permitted animal feeding operations, or Confined Feeding Operations (CFOs) in the Lower Patoka watershed, with each being discussed in the descriptions of the subwatershed in which they are located. IDEM defines CFO as: "*A CFO is an AFO 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. CFOs are issued a State no discharge permit. The IDEM regulates these confined feeding operations, as well as smaller operations which have violated water pollution rules or laws, under IC 13-18-10.*"

The Watershed Coordinator checked IDEM's Virtual File Cabinet databank for current or just expired permits and found six permits on file for CFO's in the Lower Patoka Watershed. There were two with expired permits that are assumed no longer be in operation. The four with permits included 2 turkey, one swine, and one dairy. Records indicated that the four CFOs in operation had not fallen out of compliance in recent years.

Hobby Farms and Non-CFO Livestock Operations

Generally, livestock does not take precedence in the LPR as pasture and hay land accounts for only 5,070 acres or 3.74% of the entire LPR watershed. The heavily cultivated crop areas in Gibson County (Hull, Trippett, Yellow, Lost and Keg sub-watersheds) have producers concentrating on row crops. Also, the "wild areas" of Pike County, including Interlake Outdoor Rec Area, Sugar Ridge FWA, Pike State Forest and PRNWR, lend themselves to hunting, fishing, ATV riding and boating more so than livestock operations.

Pike County does not have a strong 4-H program, often seeing only ½ dozen cattle or hogs being shown. The few homes that do have livestock have a backyard chicken coop, a few beehives or a few horses, but larger scale, 10+ head, livestock farms (still under CFO numbers) are nearly non-existent in LPR section of Pike County. One farm was found by the watershed coordinator (R. E. D. D. Moesner Farms, Inc.) running approximately 60 head of cattle in the Houchin's Ditch subwatershed.

Gibson County, however, does have an active 4-H program, but there are only a handful of hobby (non-CFO) livestock farms within the LPR portion of the county. Gibson County is 319,462 acres and the Lower Patoka in Gibson is estimated at 87,803 acres. This means that the LPR represents 27% of the county. Most of the active 4-H families with livestock are in other watersheds in the county. In addition, many of 4-H animals are being leased to youth that are without a farmstead.

Still, the ridges and slopes are sometimes fenced and grazed. In the 319 implementation grant, two livestock BMP projects were implemented, both installing a HUAP (heavy use area protection) and rotational grazing fencing. Still, the watershed coordinator noted that the pastures were not being heavily or tightly grazed prior to the project; but rather the cattle operation was seeking to expand numbers (from 40 head to 80 head) and would use prescribe grazing to protect the landscape. The other project had only 8 head of sheep on 20+ acre pasture.

The Steering committee discussed livestock and manure management issues in the LPR. Since the first round of implementation did have two small livestock projects, the steering committee wanted to keep livestock and manure management in the updated LPR WMP. Especially since small, hobby size livestock operations can start up relatively easily, at any time. It was decided that there is a continuing need to address potential sources and problems. In addition, the stakeholders ranked nutrient management as a high priority (Tier 1), and the steering committee realizes that livestock and manure management is a part of that concern. (see page 110-111 for stakeholder concerns).

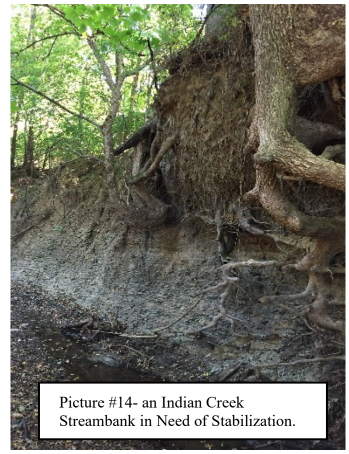
Stream Miles in Need of Buffers / Streambank Stabilization

The watershed coordinator met with John E. Howe, Gibson County GIS department director, who stated he was able to calculate "stream miles" in the Gibson County portion of the Patoka River Watershed based on the National Hydrography Dataset GIS layer. Mr. Howe stated that this was pulling from "every line" on the map, meaning even the smallest of depressions and ditches. The total "stream miles" he calculated was 838,862.77 in the county.

The watershed coordinator then used the L-THIA desktop survey stream miles which incorporated both Gibson and Pike County portions of the watershed, then focused on larger waterways than just a ditch without a high-water mark. The L-THIA desktop survey indicated 841.91 stream miles.

Obviously, it is difficult to quantify stream miles in need of buffers. However, for this WMP, the watershed coordinator incorporated observations during windshield surveys (see page 51), tillage transects, and water monitoring to determine, lack of adequate buffer width is a problem throughout the watershed. In many cases, farming practices occur much too close to streams and ditches. With over 49% of LPR being cultivated crops (66,445 acres), it is estimated that 400 miles of streams lack a good buffer, which would be a large contributing factor when it comes to sediment being transported into the watershed's streams and lakes. With nearly half of the LPR watershed's streams lacking sufficient buffer, it is easy to see why erosion and excessive sedimentation is a primary concern to the LPR steering committee.

Picture #13- an Indian Creek Streambank in Need of Stabilization.



Picture #14- an Indian Creek Streambank in Need of Stabilization.

Streambank stabilization is a complex engineering project with high construction costs and permitting often needed to successfully implement this practice. Therefore, it is difficult at best to offer solutions. During the first round of implementation, the Watershed Coordinator was contacted by a landowner regarding a section of Indian Creek that bordered his property that had severe streambank erosion (see picture 12 and 13). The massive size and cost of this engineering project deemed it unlikely that the landowner would pursue it. It was also noted that this landowner only had access to about 350 feet on the stream with the headwaters a mile upstream and the mouth a mile downstream. The entire two-mile reach needed stabilization and would be a herculean task for one landowner to try and undertake. A Lake and River Enhancement Grant was sought to help with this issue, but it was not awarded.

Log jams have also been identified as a concern as it often causes significant stream bank erosion as well as flooding. Though the PRNWR is actively planting trees in acquired riparian lands, producers in the LPR tend to opt to remove riparian buffers to create more tillable land. Loss of stabilizing roots along streams is another contributing factor to streambank erosion.

Active Mines in the Watershed

Discussion on mining activities in the watershed occurred on pages 41-43. However, there are currently 11 active mines in the watershed. IDEM's Virtual File Cabinet data was used to identify active mines based on recent water quality reports. None of the active mines were out of compliance in that past year. A surface mine layer was added to each subwatershed map to help citizens see the scope of impact from surface mining in the watershed.

USGS Gage on Patoka @ Princeton

The USGS has an in-stream gage on the Patoka River near Princeton (Gage # 03376500). This gage gives current data typically at 15-60 minute intervals, stored onsite, and then transmitted to the USGS office every 1-4 hours, depending on the data relay technique used. Recording and transmission times may be more frequent during critical events. Data from current sites are available for viewing within minutes of transmission, however, all real-time data is provisional and subject to revision after review. There is a narrative on the USGS Gage on the Patoka at Princeton on pages 19 and 20. The USGS website offers data in table or graph form for the Patoka at https://waterdata.usgs.gov/nwis/uv?site_no=03376500 for current and historical flow and water heights.

SUBWATERSHED DESCRIPTIONS AND INFORMATION

Introduction to Subwatersheds

The watershed coordinator and volunteers, as well as PRNWR staff completed several windshield surveys (driving roads through the subwatersheds) to analyze and report both good areas and positive influences as well as bad areas and negative influences. Habitat and watershed characteristics were noted in writing and by photographs during these windshield surveys. In addition, desktop "windshield" surveys were performed through google maps by the watershed coordinator. See page 51 for more details on windshield surveys.

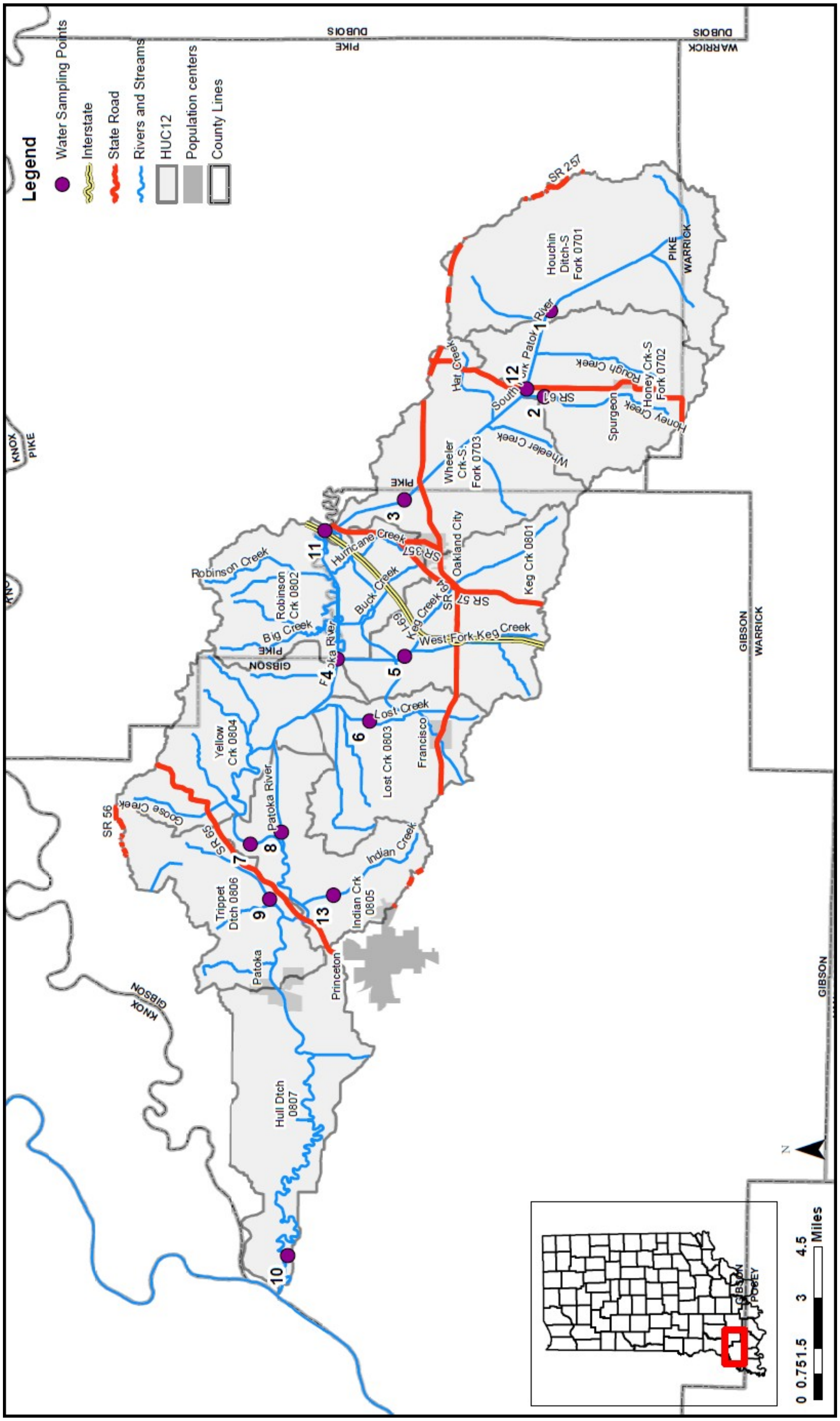
In the pages that follow, each subwatershed is described, showcasing:

- Land use data with forest and wetlands highlighted in green and cultivated crops highlighted in orange to contrast the weight of each in the watershed.
- Water quality monitoring data collected by the watershed coordinator including chemical data and stream flow.
- Indexes for each subwatershed including WQI (Water Quality Index), CCQHEI (Citizens Qualitative Habitat Evaluation Index) habitat index, and PTI (Pollution Tolerance Index) from macroinvertebrate data.
- Streams listed on the 2018 proposed 303(d) list.
- L-THIA modeling data for the subwatersheds.
- Any relevant historical data from the five data sets listed on page 50.

In the tables reporting the water quality stream sampling data, those WQ targets outside standards are highlighted in red for ease of interpretation.

MAP 15– LOWER PATOKA RIVER WATERSHED

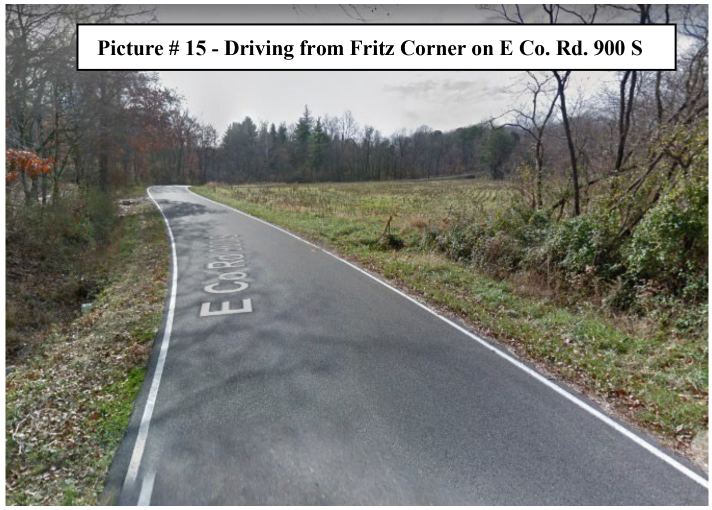
WATER MONITORING SAMPLING SITES



051202090701 – Houchin Ditch

This sub-watershed is the largest of the ten, being 19,000 acres. It is predominantly (69.31%) forest or wetlands with only 3,872 acres (20.46%) of cultivated crops. There is one permitted Confined Feeding Operation (Mark H Luff) in the watershed and that location is shown on the map 14; however, that permit expired in 2018.

Picture # 15 - Driving from Fritz Corner on E Co. Rd. 900 S



In addition, there is a significant area of surface mining or reclaimed mine lands in this watershed. The abandoned stripper pits and reclaimed lands are being utilized for recreational lands, as Sugar Ridge FWA has sizeable acres within this sub-watershed, and a portion of the Interlake Outdoor Recreation Area is present here as well.

As forested acres are dominant in this sub-watershed, the watershed coordinator found that many of the roads were tree-lined or heavily vegetated along roadside drainage ditches. However, the rocked backroads in the limited ag acres had fields right up to the roadways, with limited or non-existent drainage ditches.

Despite the land use, the water monitoring on this sub-watershed revealed a general low WQI rating except in December. The percent saturation of dissolved oxygen in the water raises concern, as well as the recently high E. coli count of 602.

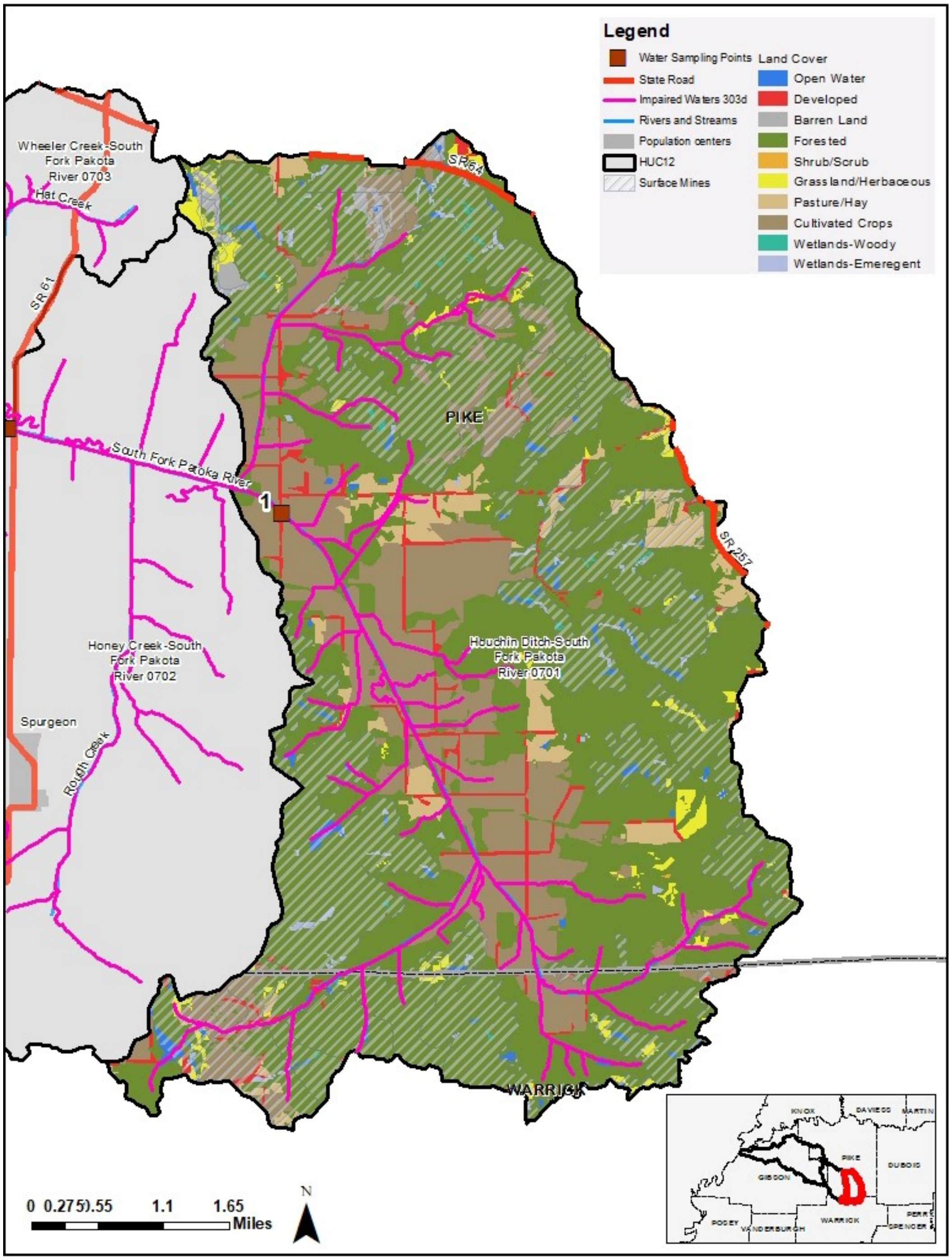
TABLE # 7		
Houchin – 51202090701		
Land Use	Acres	% Of Shed
Open Water	203.42	1.07%
Developed open space	499.01	2.64%
Developed low intensity	26.65	0.14%
Developed medium intensity	1.66	0.01%
Developed high intensity	0.79	0.00%
Barren Land	134.11	0.71%
Deciduous Forest	10,096.41	53.35%
Evergreen Forest	2858.94	15.11%
Mixed Forest	5.21	0.03%
Scrub / Shrub	2.04	0.01%
Grassland/Herbaceous	354.15	1.87%
Pasture / Hay	714.85	3.78%
Cultivated Crops	3872.3	20.46%
Woody Wetlands	34.92	0.18%
Emergent Wetlands	120.24	0.64%
Total Acres in Subwatershed	18,924.7	100.00%

Picture # 16 - Heading east on Co. Rd. 300 E – showcasing ag fields / drainage ditches alongside roadways.

The early low TSS readings seemed logical due to the high number of forested acres and general flat agricultural fields present. Perhaps the high TSS readings in August, which coincided with the high E. coli readings, could be attributed to the low flow volume at that time. However, the watershed coordinator had turbidity NTU readings of zero for all four samplings. The sampling site was notably wooded (shaded) and with rocky riffles and runs when not flooded.

MAP 16– LPR HOUCHIN'S DITCH SUBWATERSHED- 051202090701

IMPAIRED STREAMS AND NUMBERED SAMPLING SITES



While water monitoring, the watershed coordinator was approached by local landowners who stated that it wasn't that long ago when mine activity in the area had this creek segment void of all life. The watershed coordinator noted the rather large fish currently in the stream and the landowner mentioned a group that had gathered to address the damage in the South Fork that had obviously been successful. The watershed coordinator noted the landowner was referring to the South Fork Watershed Steering Committee (see page 43).

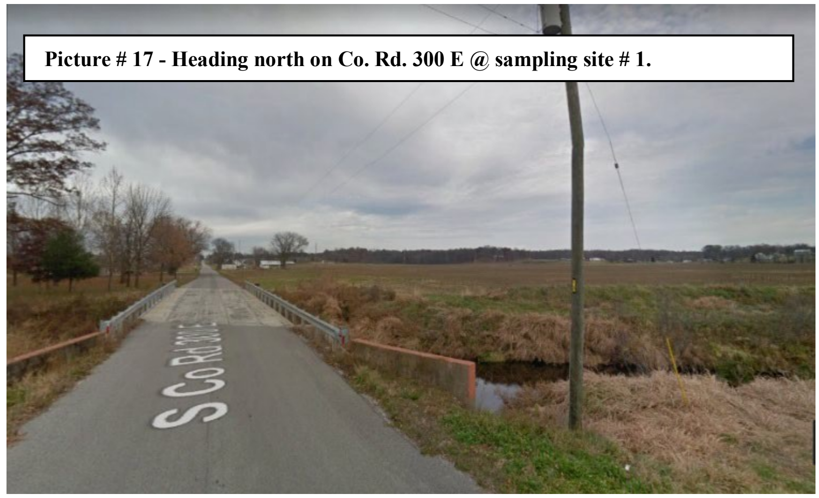

Picture # 17 - Heading north on Co. Rd. 300 E @ sampling site # 1.

TABLE # 8 – Houchin Ditch Water Monitoring Data												
NAME / HUC		**ACRES**	**LAT**	**LONG**	**% OF HUC**	EE.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 1 HOUCHINS Sf Patoka @ Scottsburg 051202090701 – HRW 2565		19,023	38.287102	87.219136	78 %							
	FLOW (cfs)	**TSS**	**Nitrate / Nitrite**	**Total P**	**E. Coli**	**Temp ° C**	**DO**	**% Sat**	**BOD^5**	**pH**	**Nitrate NO^3**	**Turbidity NTU**
9/22/2017	1.25	ND	ND	ND	86	22	5	57.47	4.5	6.5	0	0
12/19/2017	3.22	3.9	ND	ND	58	7	8	66.12	0	6	0	0
5/23/2018	14.39	4.7	3.5 / ND	ND	308	21	5	56.18	4	6.5	2.2	0
9/4/2018	0.93	20.3	ND	ND	602	24	5	59.52	4	7.0	0	0

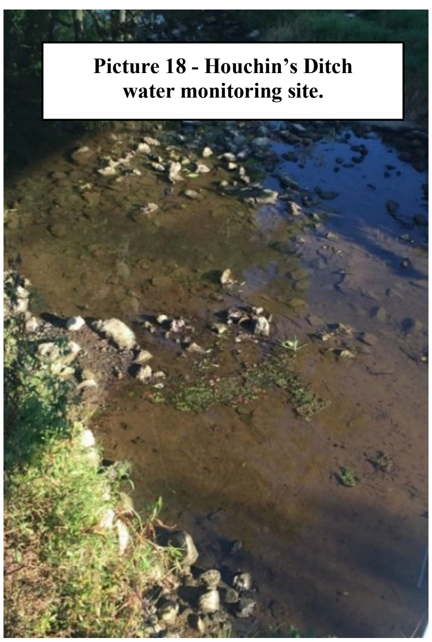

Picture 18 - Houchin's Ditch water monitoring site.

TABLE # 9					
SITE # 1 HOUCHIN DITCH @ Scottsburg 090701 HOOSIER RIVERWATCH SITE 2565					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
62.78	77.22	60.90	68.76	86.5	18

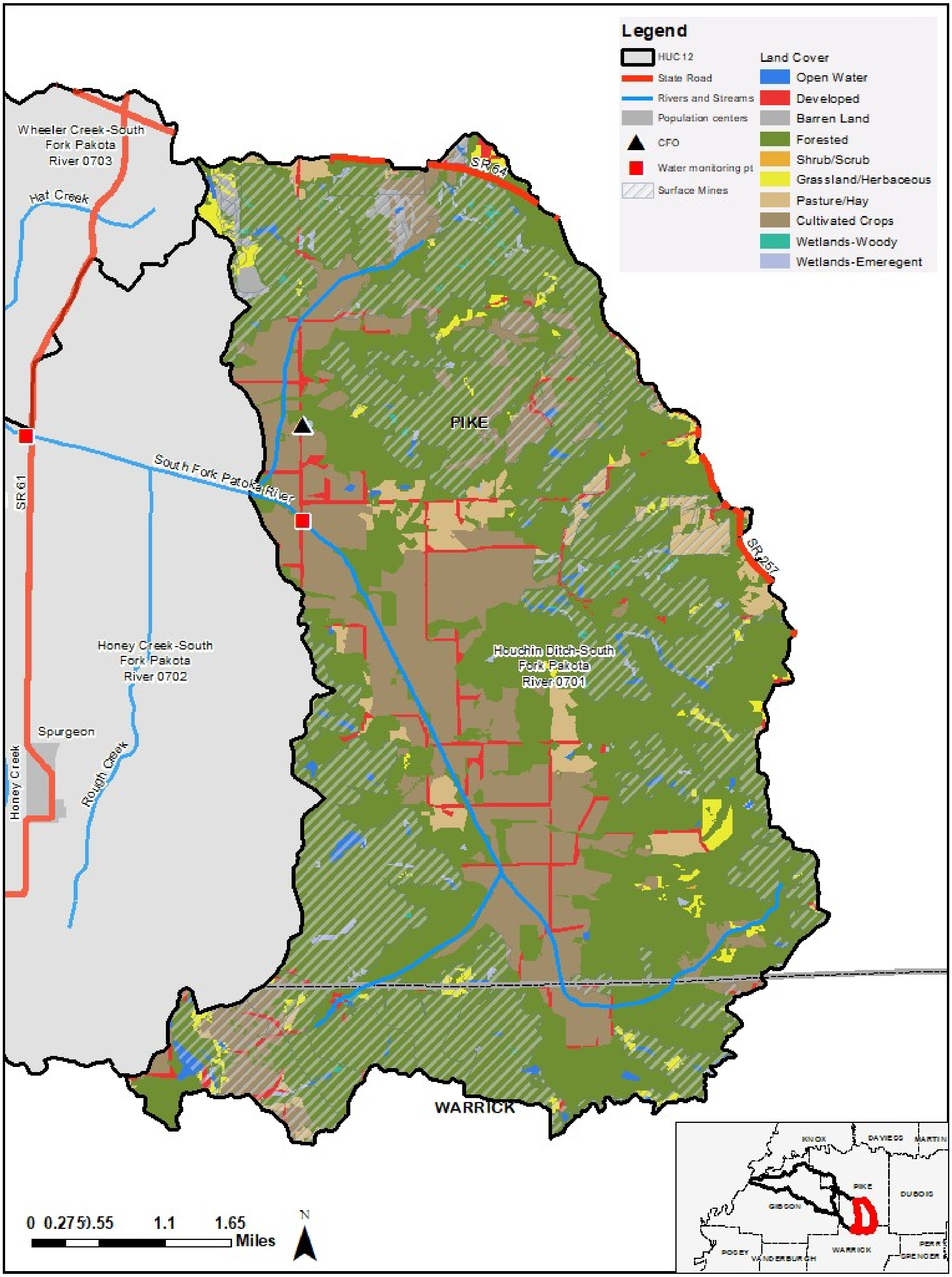
After comparing the WQ numbers, this watershed also ranked in the top three, despite the low WQI ratings. IDEM listed stream segments on 5A list at six sites for sulfates, E. coli and/or IBC. However, the watershed coordinator found several species at this monitoring site, resulting in a "good" PTI rating of 18.

The L-THIA modeling on this subwatershed showed 5% of the Lower Patoka's N load, 4% of the Lower Patoka's P load, 5% of the Lower Patoka's TSS load and 4% of the Lower Patoka's E. coli load. Ranking this subwatershed the best (lowest load contribution) out of all ten.

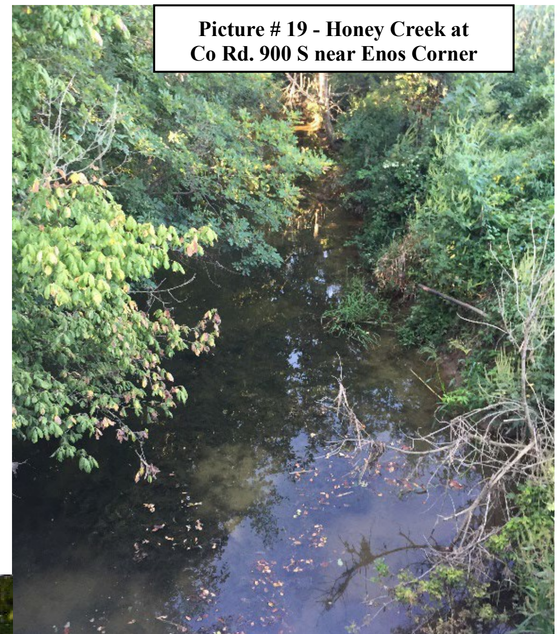
See page 101 for side by side comparisons of the 10 subwatersheds' water quality data.

MAP 17– LPR HOUCHIN'S DITCH SUBWATERSHED- 051202090701

LAND USE, WATER SITES, MINES AND CFO'S



051202090702 – Honey


Picture # 19 - Honey Creek at Co Rd. 900 S near Enos Corner

Honey sub-watershed bears a lot of resemblances to Houchin Ditch, except forested and wetland acres fall to 49.53% of the sub-watershed and cultivated crop acres increase to 4,552.09 acres or 31.78%.

There is one permitted Confined Feeding Operation (Gil Mar Farms) in the watershed shown on the map on the lower left, near Warrick County line. This is a dairy operation with no known violations.

Like Houchin watershed, there is the presence of significant surface mining and reclaimed mine lands. Also, like Houchin subwatershed, Interlake Outdoor Recreation Area utilizes the reclaimed mine lands and lakes. Interlake covers a large portion of this subwatershed, located southeast of the town of Spurgeon.

Picture # 20 – town of Spurgeon

The town of Spurgeon is in this sub-watershed, with approximately 200 people according to the 2010 US Census. Unincorporated towns of Enos Corner (about 15 homes) and Coe (about 12 homes) are also located in this sub-watershed. All three populated areas are un-sewered and reliant on onsite waste systems. Despite this, E. coli readings in this sub-watershed have remained within state standards all but one time. This could be attributed to the low population density verses the vast vegetation in the areas.

The watershed coordinator reported a red-ear slider and several small fish in the Honey creek, as well as underwater plants. Still, the low % of saturation of dissolved oxygen is a reason for concern as well as the Nitrate/Nitrite readings in Dec and May and Total P reading in Dec. May was a high flow sampling and could be reason for high TSS and NTU's, and possible reasoning behind lower WQI for the May sampling.

The watershed coordinator also reported that the substrate at site # 2 was thick, lose-your-boots-in-it sediment along the entire reach.

Table # 10

Honey 051202090702

Land Use	Acres	% of shed
Open Water	395.6	2.76%
Developed Open Space	485.62	3.39%
Developed Low Intensity	176.65	1.23%
Developed Medium Intensity	71.47	0.50%
Developed High Intensity	44.46	0.31%
Barren Land	176.71	1.23%
Deciduous Forest	5640.62	39.38%
Evergreen Forest	1263.79	8.82%
Mixed Forest	1.33	0.01%
Scrub / Shrub	5.73	0.04%
Grassland/Herbaceous	732.28	5.11%
Pasture / Hay	588.76	4.11%
Cultivated Crops	4552.09	31.78%
Woody Wetlands	42.72	0.30%
Emergent Wetlands	145.62	1.02%
Total Acres in Sub-watershed	14323.45	100.00%

MAP 18– LPR HONEY CREEK SUBWATERSHED - 051202090702

IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

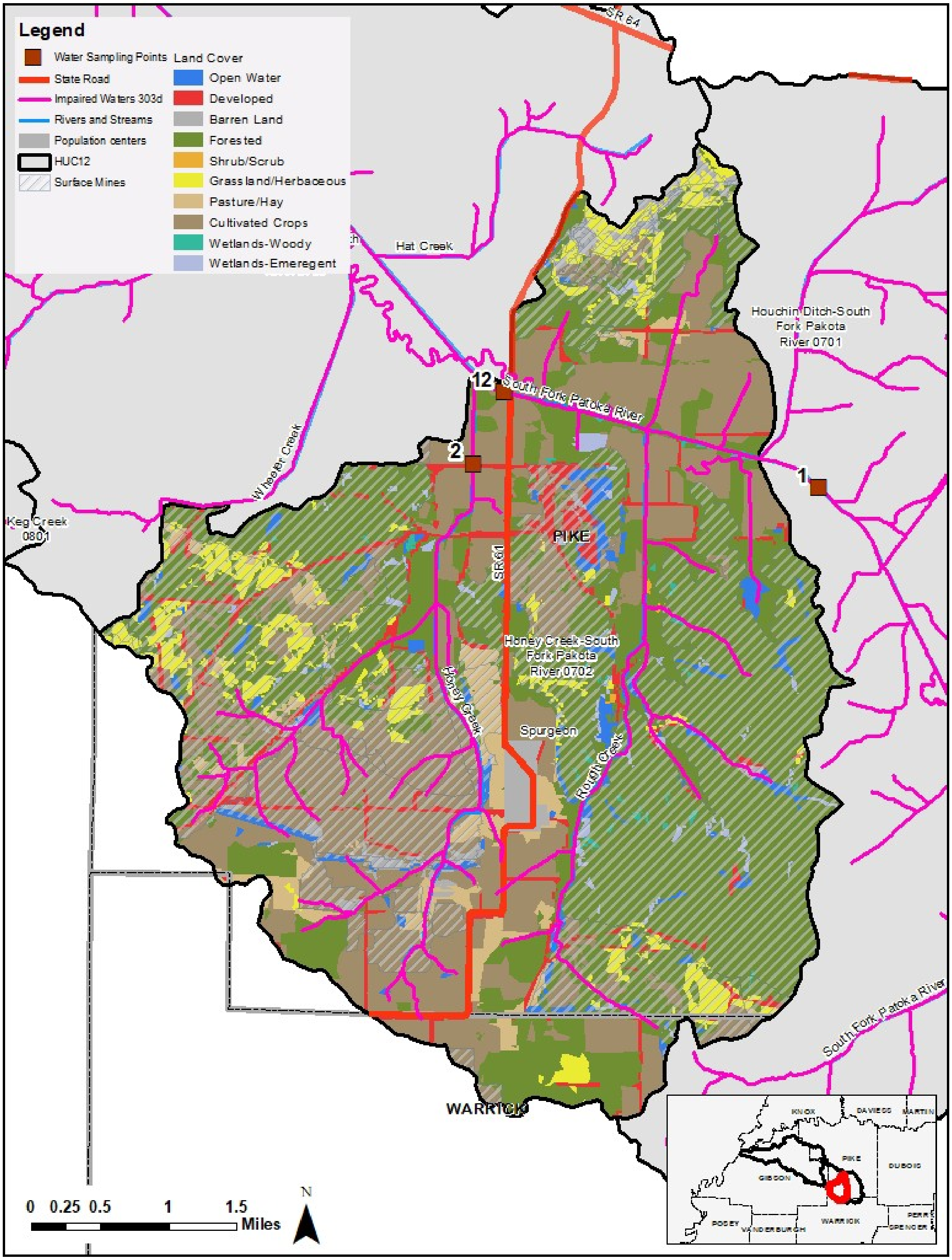
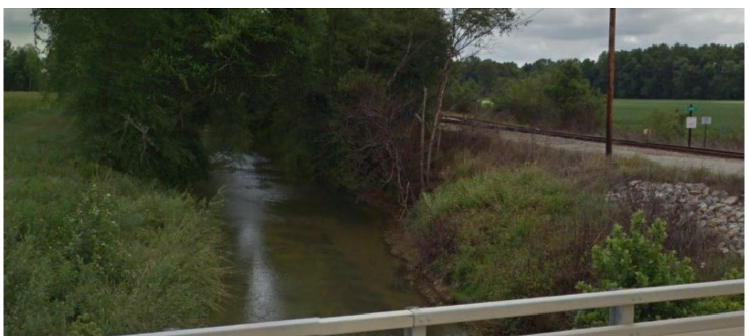
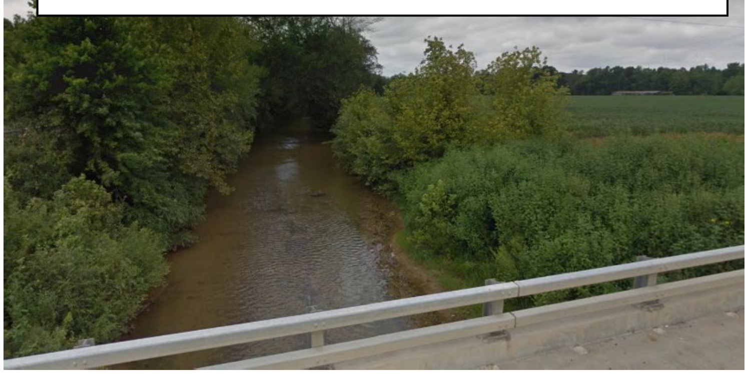


TABLE # 11 – Honey Water Monitoring Data												
NAME / HUC		**ACRES**	**LAT**	**LONG**	**% OF HUC**	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 2 HONEY @ ENOS 051202090702 – HRW 2566		14,329.50	38.289588	-87.265631	40 %							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/22/2017	4.1	3.5	ND	ND	166	22	6	68.96	2	7.5	0	0
12/19/2017	11.439	7.6	ND/1.6	0.17	44	6	8	64.0	0	6.5	0	0
5/23/2018	38.348	21.7	1.9 / ND	ND	102	22	6	68.97	3	6.5	2.2	17
9/4/2018	3.589	21.0	.201/.201	ND	152	25	5	60.24	1	7.0	0.201	0
SITE # 12 South Fork Patoka @ St. Rte. Highway 62 bridge 051202090702 – HRW 2574		14,329.50	38.297232	-87.261486	60 %							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5 DO/change	pH	Nitrate (NO^3)	Turbidity NTU
9/22/2017	49	ND	ND	ND	248	23	8	93.02	3	7	0	0
12/19/2017	6.263	3.0	ND	0.13	11	7	8	66.12	0	6.2	0	0
5/23/2018	67.39	11.0	2.7/ND	ND	91	21	6	67.42	1	6.5	2.7	0
9/4/2018	30.29	ND	ND	ND	155	25	6	72.29	1	7.0	0	0





Pictures # 21/22 - South Fork Patoka River prior to Honey Creek confluence @ St. Rte. 61 bridge. Top pic is facing east and bottom pic is

TABLE # 12					
SITE # 2 HONEY @ Enos Corner 090702 HOOSIER RIVERWATCH SITE 2566					
WQI SEPT. 2017	**WQI DEC. 2017**	**WQI MAY 2018**	**WQI SEPT. 2018**	**CQHEI**	**PTI**
78.45	73.16	66.40	76.29	71	10
SITE # 12 S. F. @ St. Rte. Highway 62 090702 HOOSIER RIVERWATCH SITE 2574					
73.92	78.86	76.63	80.45	84	26

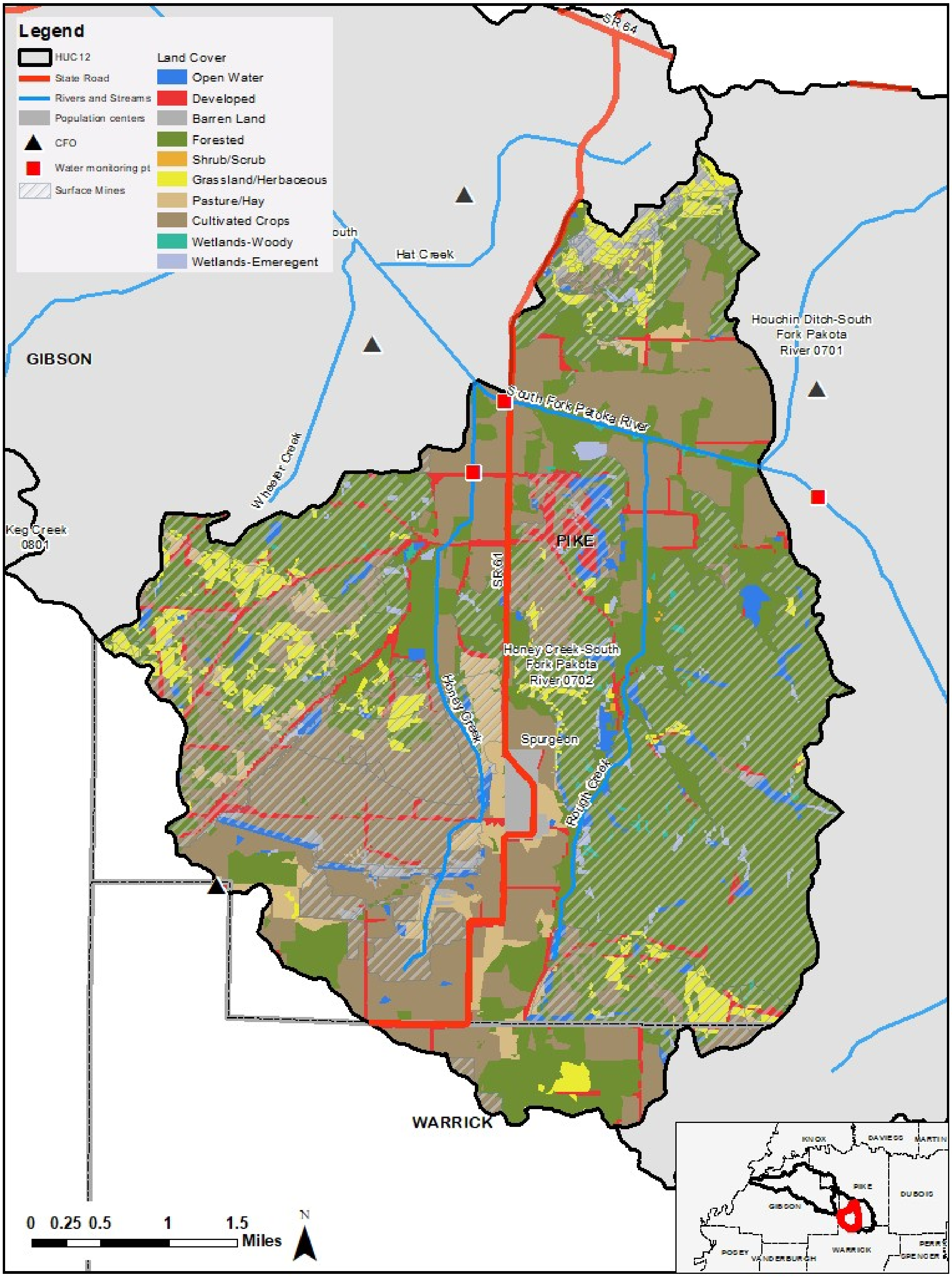
The extra site (#12) in this watershed was the South Fork Patoka as it flows under St. Rte. 61. This sampling site is prior to the Honey creek confluence. The high TSS at this site in May could also be attributed to the higher flow. The watershed coordinator noted that substrate here was small pebbles and sand with minor sediment and a much better stream bed than site #2. This site consistently kept its high WQI rating throughout the sampling events.

IDEM listed stream segments on Category 5 list at 7 sites for IBC, E. coli and /or sulfates. Still, the L-THIA modeling ranked Honey in the top three (lowest load contribution) with 8% N load, 8% P, 7% TSS and 8% E. coli load in the entire Lower Patoka.

See page 101 for side by side comparisons of the 10 subwatersheds' water quality data.

MAP 19– LPR HONEY CREEK SUBWATERSHED - 051202090702

LAND USE, WATER SITES, MINES AND CFO'S



051202090703 – Wheeler

This sub-watershed encompasses over 15,000 acres with 48.07% being forested or wetlands, as the PRNWR has a significant number of acres in the northern portion of this sub-watershed. Cultivated crops equal 4,199 acres or 27.17% of the sub-watershed. There is one CFO in this subwatershed (Lecocq Farms). This is a turkey operation with a current permit with no known violations.

The town of Oakland City is in this sub-watershed. The population was recorded as 2,429 in the 2010 U.S. Census. The town is home to Oakland City University as well as the PRNWR office. Homes in Oakland City are connected to a sewer system.

The map clearly shows the evidence of surface mining in this watershed, which may be indicative of the high percentage of open water (5.76%); the highest of all ten subwatersheds.

What is interesting about the water quality data collected in this subwatershed, is one site is located near the South Fork's entrance into the PRNWR, and the other sampling site is located at where the South Fork is exiting the PRNWR. The data clearly indicates that the wetlands and marshes the South Fork flows through improved the water quality of the creek. The dissolved oxygen and the % of saturation increased in all four samples, and the one high turbidity reading in the May sample was lowered after the water passed through the PRNWR lands.

TABLE # 13		
WHEELER - 051202090703	ACRES	% of shed
Open Water	890.94	5.76%
Developed open space	651.37	4.21%
Developed low intensity	289.08	1.87%
Developed medium intensity	70.34	0.46%
Developed high intensity	23.58	0.15%
Barren Land	116.71	0.76%
Deciduous Forest	6003.7	38.84%
Evergreen Forest	899.61	5.82%
Mixed Forest	0	0.00%
Scrub / Shrub	13.34	0.09%
Grassland/Herbaceous	1137.49	7.36%
Pasture / Hay	635.65	4.11%
Cultivated Crops	4199.22	27.17%
Woody Wetlands	157.32	1.02%
Emergent Wetlands	368.92	2.39%
Total Acres in Sub-watershed	15457.27	100.00%

In a 2014 EPA blog, Marguerite Huber stated wetlands are "Earth's kidneys", playing a significant part in our water's health. The same way our kidneys filter and remove wastes from our blood, wetlands absorb wastes such as nitrogen and phosphorous. As "Earth's kidneys", wetlands retain nutrients and treat non-point source pollutants.

The water sampling results from site 3 can be compared with site 14 to confirm that EPA statement; as WQI scores increased every time. This WMP water monitoring data supports the theory that wetlands are efficient in water quality improvements.

It is possible that the N and P readings were from this sub-watershed or from upstream, as both sampling sites were located on the South Fork itself, rather than tributaries. There is some concern for the low % saturations, but the watershed coordinator noted that both sites had few riffles/runs and that the South Fork was mainly wide and deep heading into the wetlands.

MAP 20– LPR WHEELER SUBWATERSHED 051202090703
IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

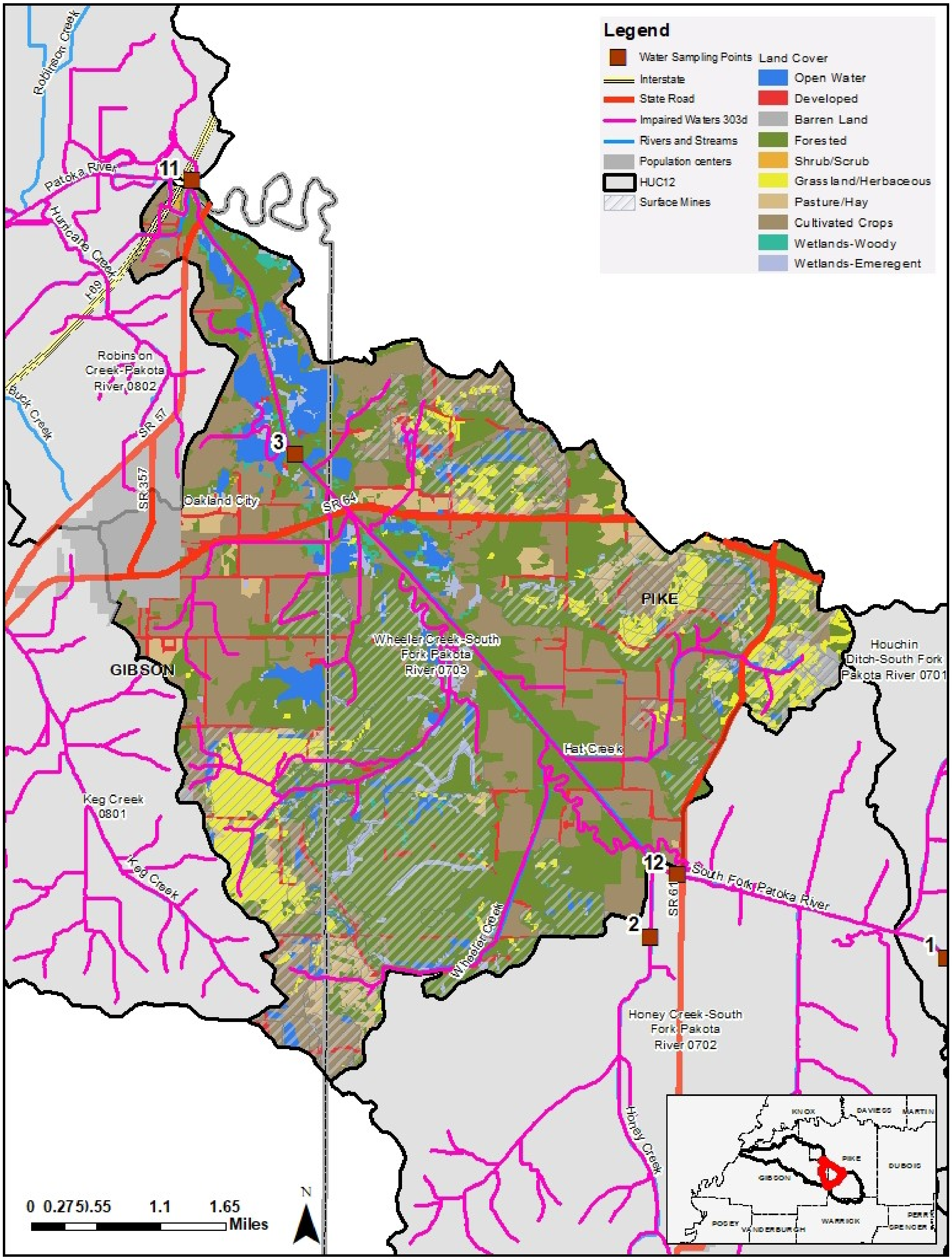


TABLE # 14					
SITE # 3 WHEELER - SF Patoka @ Refuge 090703 HOOSIER RIVERWATCH SITE 2567					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
72.42	73.80	66.40	74.61	75	19
SITE # 14 SF leaving Refuge @ Dongola Station 090703 HOOSIER RIVERWATCH SITE 1260					
87.58	84.52	78.75	87.08	78	19


Picture # 24 -Wheeler water monitoring site #14

The L-THIA modeling showed 8% of N load, 8% of P load, 8% of TSS and 8% of E. coli loads for the entire Lower Patoka; ranking this subwatershed 4th in the watershed for lowest load contribution; just behind Honey (090702).

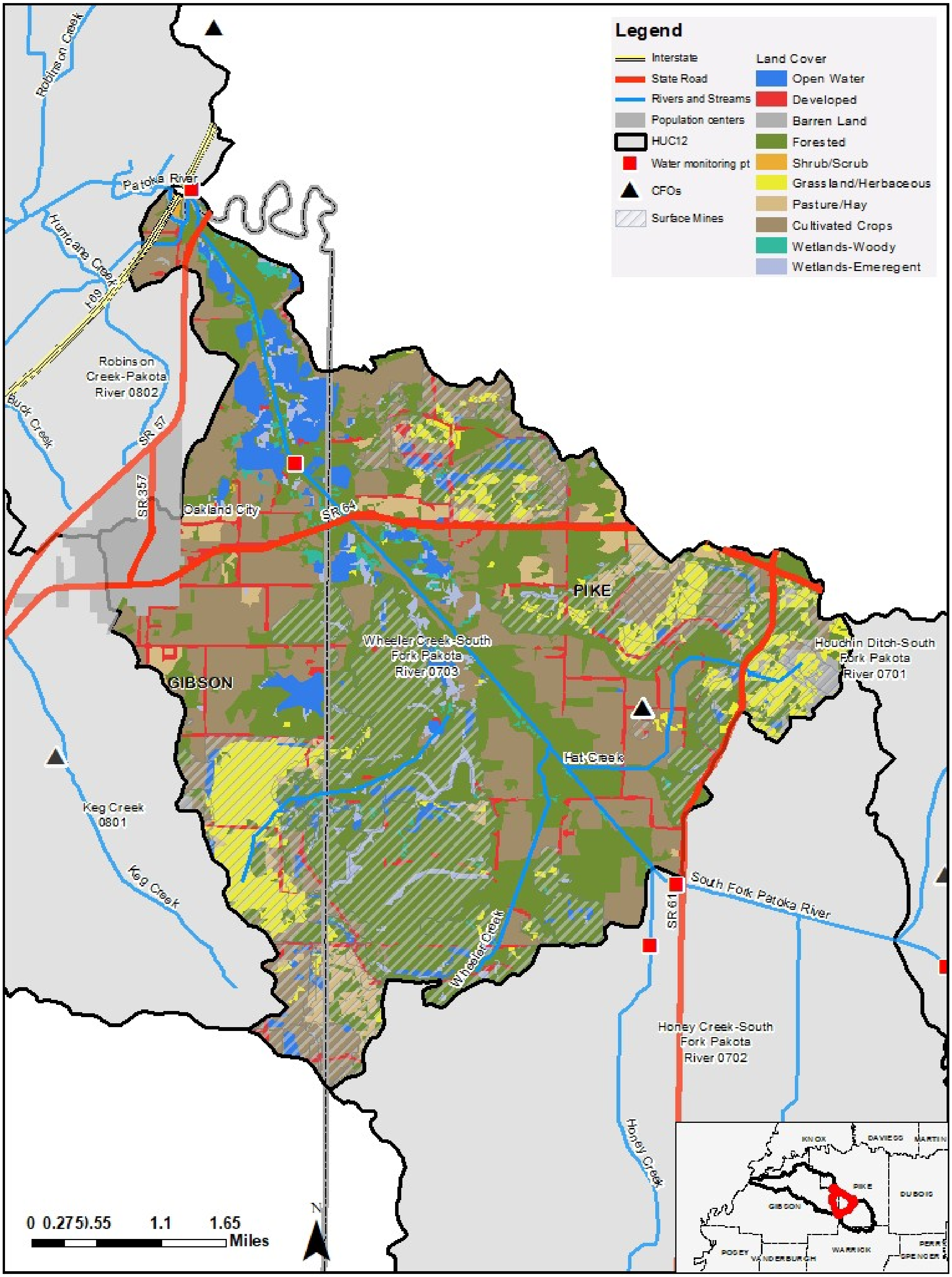
IDEM listed six stream segments on the 303(d) category 5 list for sulfates, IBC and/or E. Coli. However, the watershed coordinator collected macroinvertebrates resulting in a "good" PTI rating of 19 and the E. coli results stayed below state standards all four sampling events.

See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

TABLE # 15												
NAME / HUC		**ACRES**	**LAT**	**LONG**	**% OF HUC**	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 3 WHEELER SF PATOKA @ REFUGE 051202090703 – HRW 2567		15,470.5	38.349097	-87.321606	90%							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/22/2017	27	5.2	ND	ND	143	24	5	59.52	2	6.5	0	0
12/19/2017	13.98	3.5	ND	0.20	34	6	8	64.0	0	6.5	0	0
5/23/2018	91.29	23.5	2.7/ND	ND	172	22	5	57.47	4	7	2.7	18.3
9/4/2018	23.58	8.6	ND	ND	73	26	5	61.73	3	7.0	0	0
SITE # 14 S.F. out of Refuge @ Dongola Station Bridge 051202090703– HRW 1260			38.3792	-87.3395								
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/26/2017	24.3	No Labs @ this site.	No Labs @ this site.	No Labs @ this site.	No Labs @ this site.	23	6	69.7	1	7	0	0
12/21/2017	4.8					5	10	78.13	2	6.5	0	0
5/18/2018	83.12					24	6	71.4	4	6.75	0	17
9/27/2018	32.9					24	6	71.43	2	7	0	0

MAP 21– LPR WHEELER SUBWATERSHED 051202090703

LAND USE, WATER SITES, MINES AND CFO'S



051202090801 – Keg

There are 15,000 acres in this sub-watershed with cultivated crops being the predominant land use at 66.94%

There are two permitted Confined Feeding Operations in this sub-watershed: Morning Star Farms (turkeys) and Keg Creek Farms (swine). Both have no known violations.

Picture # 25 - Typical view in Keg with cultivated crops on either side of county road.

Picture # 26 - View from I69 of surface coal mining operation in Keg subwatershed.

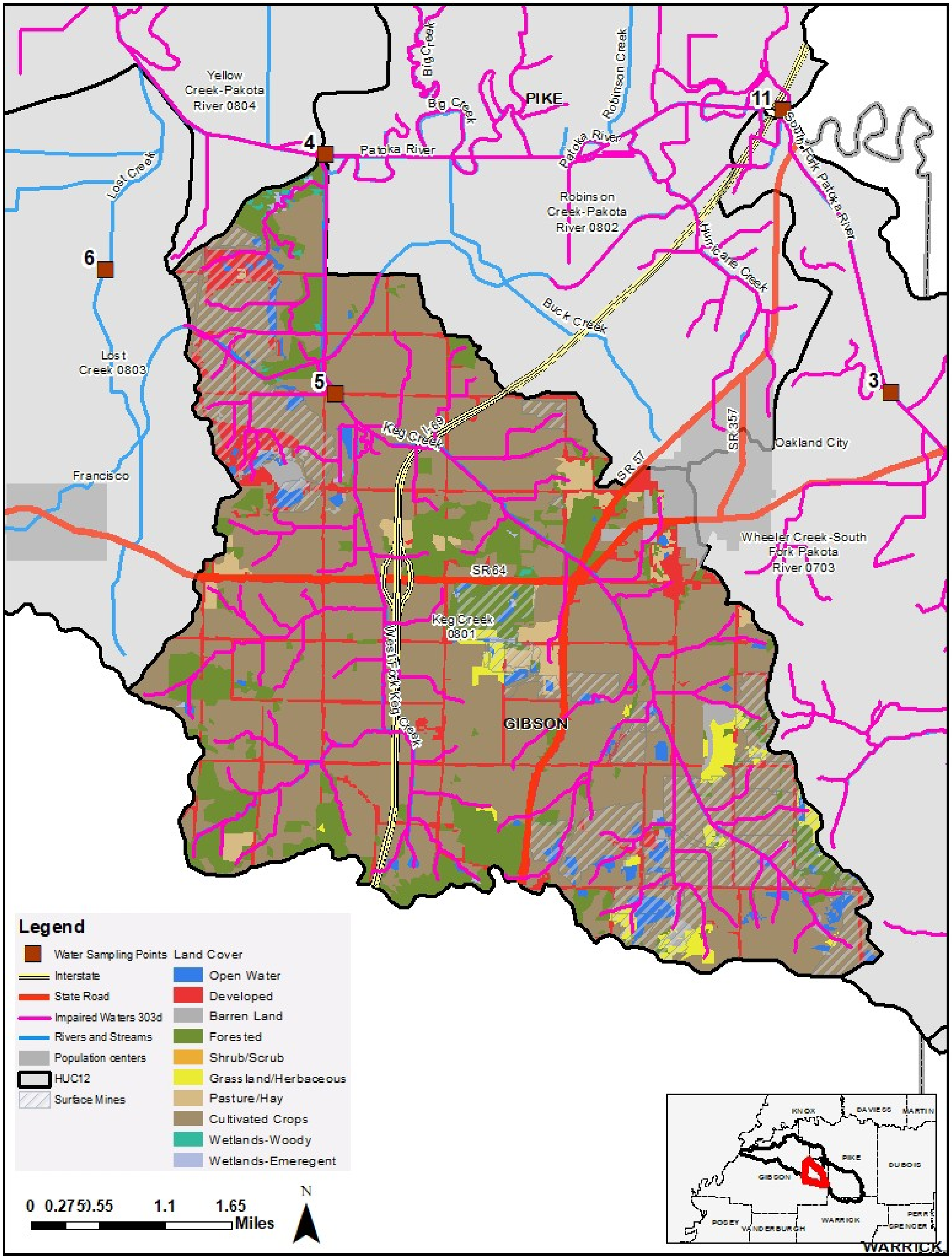
Table # 16		
KEG -51202090801		
Land Use	Acres	% of shed
Open Water	371.07	2.59%
Developed open space	936.93	6.53%
Developed low intensity	262.79	1.83%
Developed medium intensity	156.92	1.09%
Developed high intensity	172.9	1.21%
Barren Land	137.52	0.96%
Deciduous Forest	1952.4	13.61%
Evergreen Forest	124.05	0.87%
Mixed Forest	0	0.00%
Scrub / Shrub	0	0.00%
Grassland/Herbaceous	262.36	1.83%
Pasture / Hay	309.92	2.16%
Cultivated Crops	9599.46	66.94%
Woody Wetlands	26.97	0.19%
Emergent Wetlands	27.14	0.19%
Total Acres in Subwatershed	14340.43	100.00%

Over 14% of the sub-watershed is forested or wetland acres and there are significant acres of reclaimed mine lands. In addition, there is an active surface mining operation (Peabody, Francisco) within this sub-watershed, as well as I69 which impacts 211 acres as it transects the area.

The sampling site chosen for this watershed represented 90% of the drainage acres and is located after the confluence of the west and east fork of the Keg Creek and nearby to the mouth of the main stem of the Patoka. The Keg flows north toward the main branch of the Patoka.

While water monitoring, the watershed coordinator saw significant changes in the water levels at the sample site. The level would rise, not just after a significant rainfall in the area, but also when the main branch of the Patoka would rise. The stream flow at this sample site was directly influenced by the height of the Patoka River. At times, the water would flow southward as Patoka River flood waters from the main branch would push back into the Keg subwatershed.

MAP 22– LPR KEG CREEK SUBWATERSHED - 051202090801
IMPAIRED STREAMS AND NUMBERED SAMPLING SITES



Picture # 27/28 of water monitoring site # 5 – Drastic water levels and flow changes based on upstream flooding. Left: water is 10” deep; Right: water is 10’ deep and backing up from Patoka main branch.

The dissolved oxygen readings dropped from a high of 10 in Dec. to a reading of 3 ppm in May 2018. The BOD^5 however remained low to non-existent, so bacteria loads were low, leading to conclusion that low dissolved oxygen readings were probably due to this site’s flow becomes relatively slow or even “reversed” when the main channel is at flood stage. Concern is raised with the high P readings at all four sample events, the high turbidity at 3 and high N twice. TSS was high in August as well. The E. coli readings were increased at two events but were not a lot over the state standard.

TABLE # 17

NAME / HUC		ACRES	LAT	LONG	% OF HUC	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 5 KEG 051202090801 – HRW 2569		14,352.50	38.348695	-87.405975	90%							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/22/2017	2.49	8.9	ND	0.09	236	26	8	98.76	3	7	0	19
12/21/2017	0.693	3.8	1.6 / 1.6	0.16	60	5	10	78.13	0	6.5	0	0
5/18/2018	1.718	7.7	3.0/ND	0.13	276	21	3	33.7	0	7.0	2.2	15
8/30/2018	5.69	75.3	.36/.36	0.10	44	24	4	47.62	0	7.0	0.36	17.5

IDEM 303(d) list had stream segments impaired for IBC, E. coli, nutrients, ammonia and/or pH at 31 different sites. The L-THIA modeling showed this subwatershed contributed 17% of the N; 17% of the P; 17% of the TSS and 17% of the E. coli load of the Lower Patoka showing this to be the most critical subwatershed.

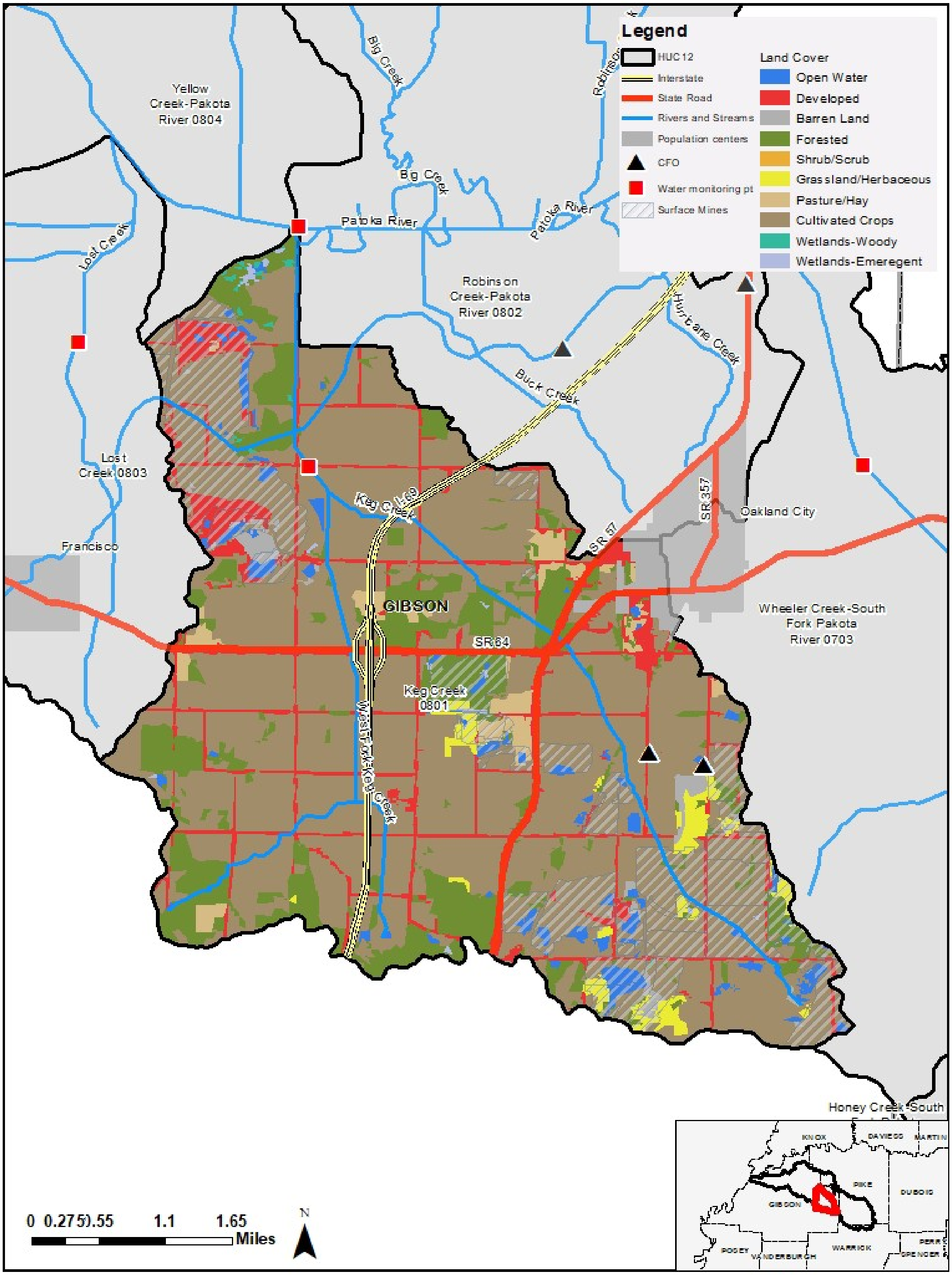
See page 101 for side by side comparisons of the 10 subwatersheds’ water quality data.

TABLE # 18

SITE # 5 KEG - @ Confluence of East and West Fork 051202090703 - HOOSIER RIVERWATCH SITE 2567					
WQI SEPT. ‘17	WQI DEC. ‘17	WQI MAY ‘18	WQI SEPT. ‘18	QHEI	PTI
74.18	77.09	64.27	73.15	62	10

MAP 23– LPR KEG CREEK SUBWATERSHED - 051202090801

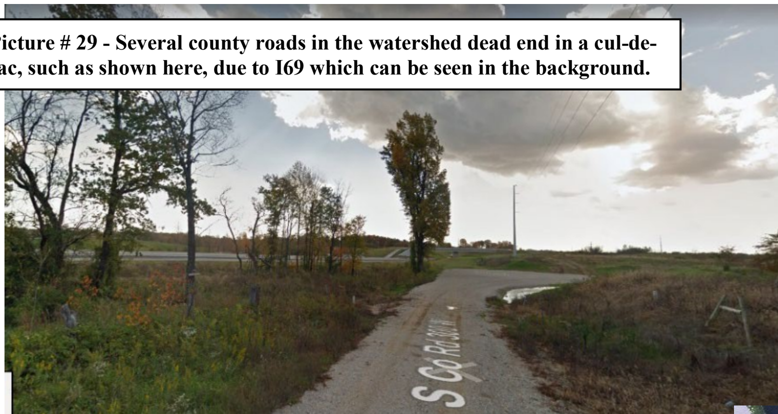
LAND USE, WATER SITES, MINES AND CFO'S



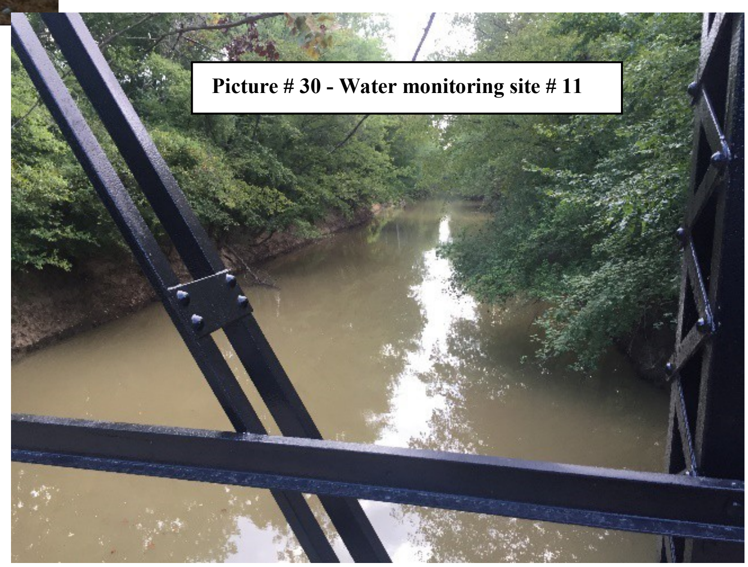
051202090802 – Robinson

The Robinson sub-watershed is 13,240 acres. The main channel Patoka River dissects this sub-watershed and is also the Pike / Gibson county line. The watershed is divided by the main channel, with only three bridges crossing the Patoka. All three bridges are part of the PRNWR which is on either side of the main channel and occupies approximately 4,570 acres of the sub-watershed (34.5%). Thus, it's not surprising to find that 34% of Robinson is forested or wetland acres with an additional 5.46% of open water. Cultivated crops account for 47.58% or 6,293.51 of the acres. There are no permitted CFOs in this subwatershed. Mining activity is present. There is an unincorporated town, Oatsville (≈20 homes), and a placed called Chandler (not Warrick County's Chandler) which is home to the Pike Co. Bird Hunter's Club on CR325 W @ 38,417475, -87,338729.

Picture # 29 - Several county roads in the watershed dead end in a cul-de-sac, such as shown here, due to I69 which can be seen in the background.



The water samples were drawn from the main channel at the Dongola Bridge (where Patoka enters Robinson) and at the Oatsville Bridge (where the Patoka exits Robinson). The comparison of both sites can be interpreted to determine the impact the sub-watershed has on the water quality of the main channel Patoka.



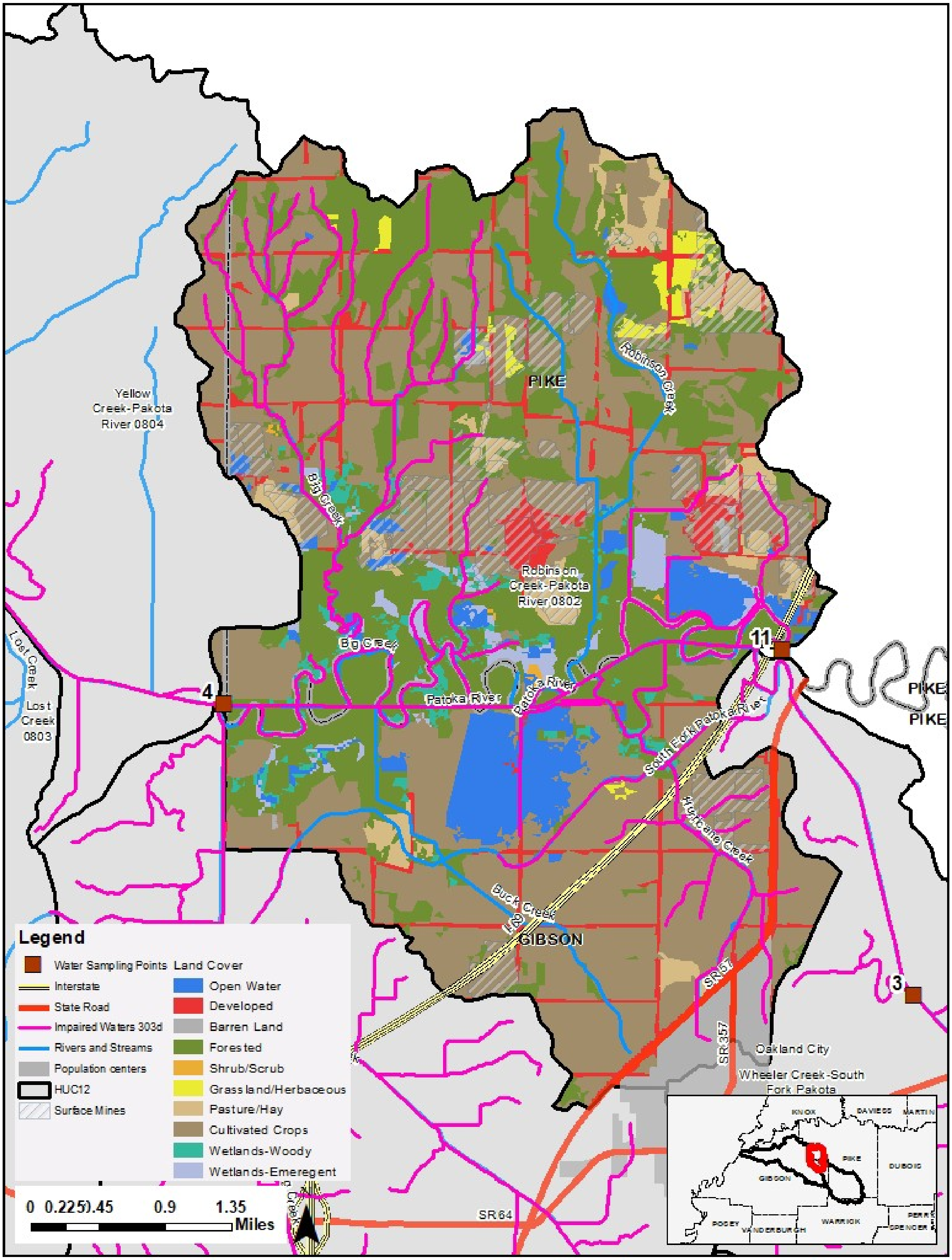
Picture # 30 - Water monitoring site # 11

Table # 19		
ROBINSON -51202090802		
Land Use	ACRES	% of shed
Open Water	721.79	5.46%
Developed open space	707.84	5.35%
Developed low intensity	109.19	0.83%
Developed medium intensity	78.98	0.60%
Developed high intensity	87.8	0.66%
Barren Land	26.73	0.20%
Deciduous Forest	3979.64	30.09%
Evergreen Forest	22.72	0.17%
Mixed Forest	0	0.00%
Scrub / Shrub	9.71	0.07%
Grassland/Herbaceous	128.35	0.97%
Pasture / Hay	558.02	4.22%
Cultivated Crops	6293.51	47.58%
Woody Wetlands	263.22	1.99%
Emergent Wetlands	238.88	1.81%
Total Acres in Subwatershed	13226.37	100.00%

The WQI ratings for Robinson hovered around the 70 mark, due in part to high TSS and turbidity, high P and low % DO saturation. Comparing data between Dongola and Oatsville, N, P, TSS and turbidity were higher 68.75% of the time at Oatsville. This indicates that the Robinson sub-watershed is negatively impacting the water quality of the main channel Patoka.

MAP 24– LPR ROBINSON CREEK SUBWATERSHED - 051202090802

IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

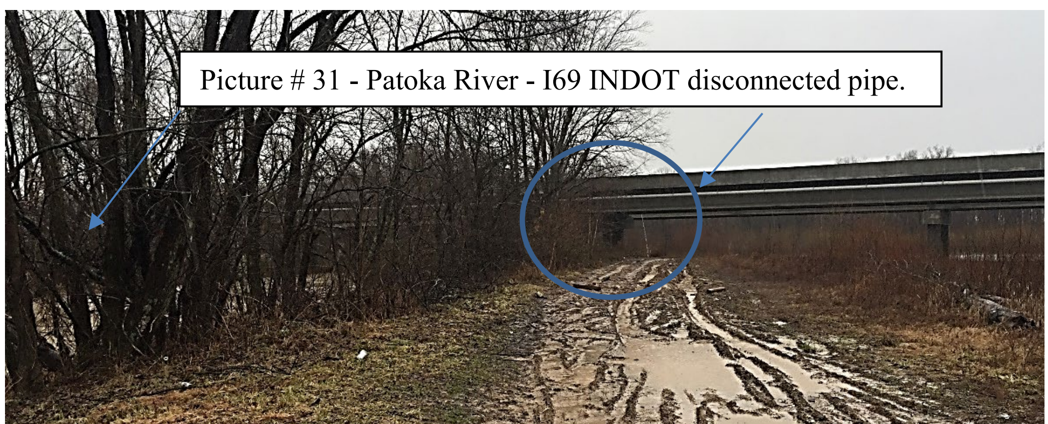


The watershed coordinator also was concerned at the consistent low % of DO saturation; but noted that wide and deep and channelized does not conduce itself to riffles and runs that can increase DO % of saturation. The E. coli counts remained below state standards at both sites for all four samples. IDEM's 303(d) Category 5 list has no stream segments impairments. The watershed coordinator reported PTI of 9 which is poor, however macro collection on the main stem is difficult at best.

TABLE # 20 – Robinson Water Monitoring Data

NAME / HUC		ACRES	LAT	LONG	% OF HUC	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 11 ROBINSON @ Dongola (pre-watershed) 051202090802 – HRW 2573		13,244.0	38.382954	-87.338095	0 %							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5 DO/change	pH	Nitrate (NO^3)	Turbidity NTU
9/26/2017	689	51.0	.514 /.514	0.15	158	23	6	69.76	2	6.5	0	38
12/21/2017	1268.2	19.2	0.48/.48	0.12	32	5	10	78.125	2	6.0	0	19
5/18/2018	485.5	43.6	3.0/ND	0.19	48	21	6	67.4	5	6.5	3.0	31
8/30/2018	1728	55.0	ND	ND	9	23	6	69.77	1.5	6.0	0	42
SITE # 4 ROBINSON @ OATSVILLE (post watershed) 051202090802 – HRW 2568		13,244.0	38.377410	-87.407623	100%							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5 DO/change	pH	Nitrate (NO^3)	Turbidity NTU
9/26/2017	810	66.9	.534/ .534	0.17	133	22	6	68.96	2	6.5	0	46
12/21/2017	1250.8	16.2	0.51/0.51	0.10	50	5	8	62.5	2	6	0	67
5/18/2018	522	49.0	2.7/ND	0.17	27	22	6	68.96	4	6.5	0	30
8/30/2018	972	76.1	.309/.309	0.14	29	24	6	71.43	1	6.2	0.309	43

The I69 bridge crossing the Patoka could also be contributing to poor water quality, as INDOT has not yet fixed the disconnected piping. When it rains, stormwater runoff is dropped right into the Patoka, rather than being diverted as was originally planned. The watershed coordinator has reported this issue repeatedly to INDOT and IDEM.



Picture # 31 - Patoka River - I69 INDOT disconnected pipe.

TABLE # 21

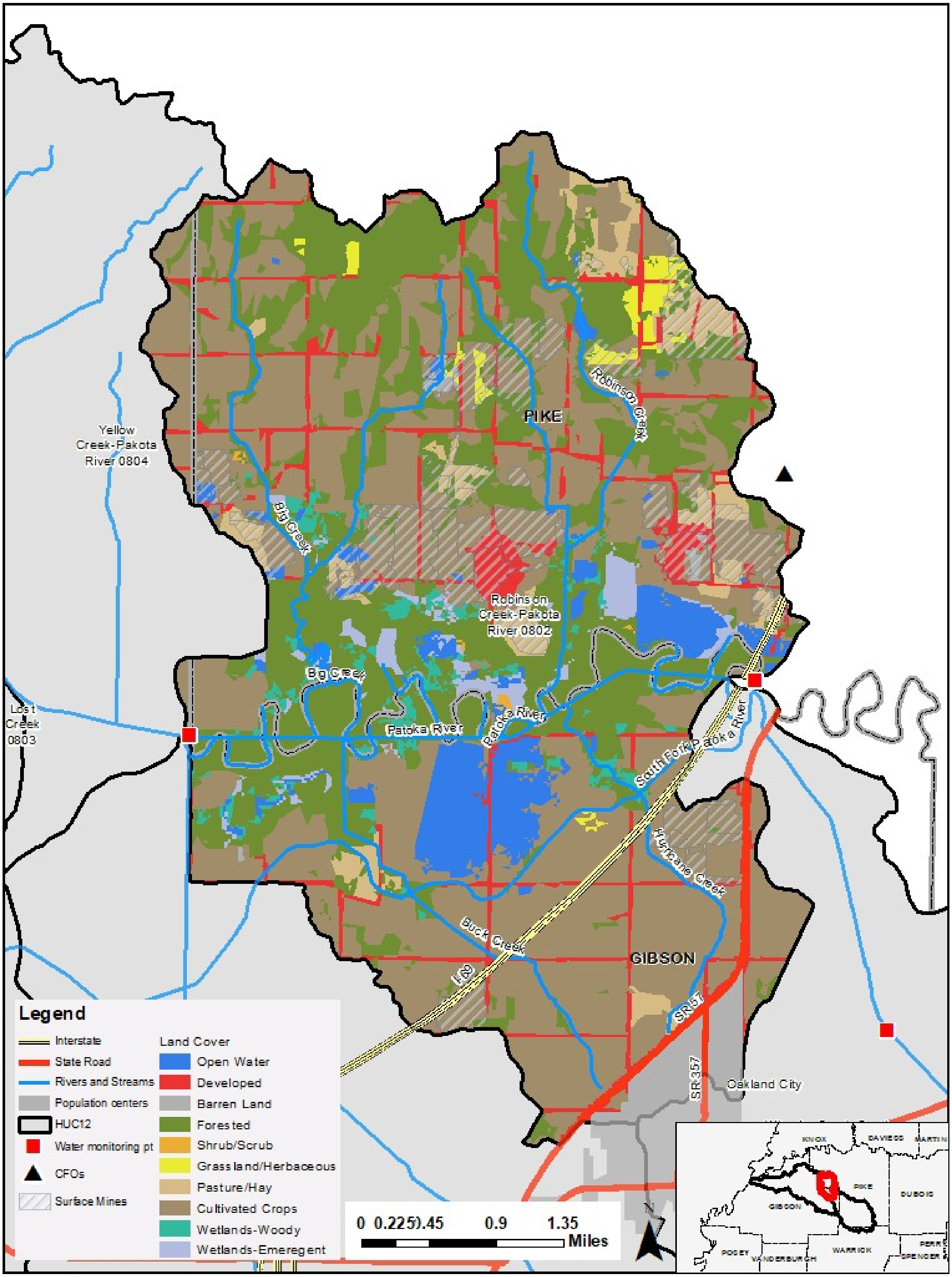
SITE # 4 ROBINSON - Main channel @ Oatsville Station 051202090703 HOOSIER RIVERWATCH SITE 2568					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
66.46	68.99	70.90	74.72	58	9
SITE # 11 ROBINSON - Main channel @ Dongola Station 051202090703 HOOSIER RIVERWATCH SITE 2573					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
66.96	72.78	67.87	75.28	47	16

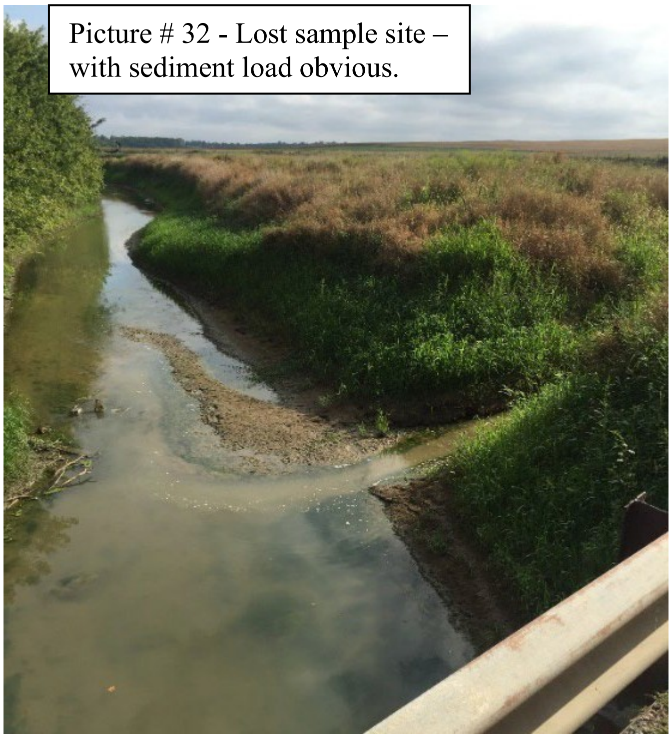
The L-THIA modeling showed 12% N, 11% P, 11% TSS, and 12% E.coli of the entire Lower Patoka load as coming from this watershed; ranking this subwatershed as 2nd critical next to 09050801 (Keg).

See page 101 for side by side comparisons of the 10 subwatersheds' water quality data.

MAP 25– LPR ROBINSON CREEK SUBWATERSHED - 051202090802

LAND USE, WATER SITES, MINES AND CFO'S





Picture # 32 - Lost sample site – with sediment load obvious.

051202090803 – Lost

The Lost sub-watershed has 10,635 acres. Only 8.56% is forested and wetland acres and over 76% is cultivated crops; however, there are no permitted confined feeding operations in this sub-watershed. Land use alone, though, would have one believe that this sub-watershed would be more critical than the previous ones discussed.

The town of Francisco, with a population of 469, is in this sub-watershed; and Peabody Frisco Mine is operating a surface mine here as well. Homes in Francisco are connected to a sewer system.

Water monitoring did reveal that the TSS and turbidity readings on this site were high during high flow events. Picture to the left is of Lost Creek, facing north, showcasing a field drainage ditch entering Lost Creek and bringing a sediment load that is evident in both the color of the effluvium and in the sediment "island" being formed in the creek.

The farm fields in this subwatershed are often farmed right up to the edge of the road with little to no ditches as seen in picture to the right.

Picture # 33 - Lost subwatershed.

Table # 22

LOST CREEK – 051202090803		
Land Use	ACRES	% of shed
Open Water	189.25	1.78%
Developed open space	575.09	5.41%
Developed low intensity	162.59	1.53%
Developed medium intensity	120.53	1.13%
Developed high intensity	111.31	1.05%
Barren Land	38.18	0.36%
Deciduous Forest	893.00	8.40%
Evergreen Forest	2.89	0.03%
Mixed Forest	0.00	0.00%
Scrub / Shrub	0.00	0.00%
Grassland/Herbaceous	31.88	0.30%
Pasture / Hay	312.89	2.94%
Cultivated Crops	8178.85	76.94%
Woody Wetlands	7.90	0.07%
Emergent Wetlands	6.14	0.06%
Total Acres in Subwatershed	10630.50	100.00%

MAP 26– LPR LOST CREEK SUBWATERSHED -051202090803
IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

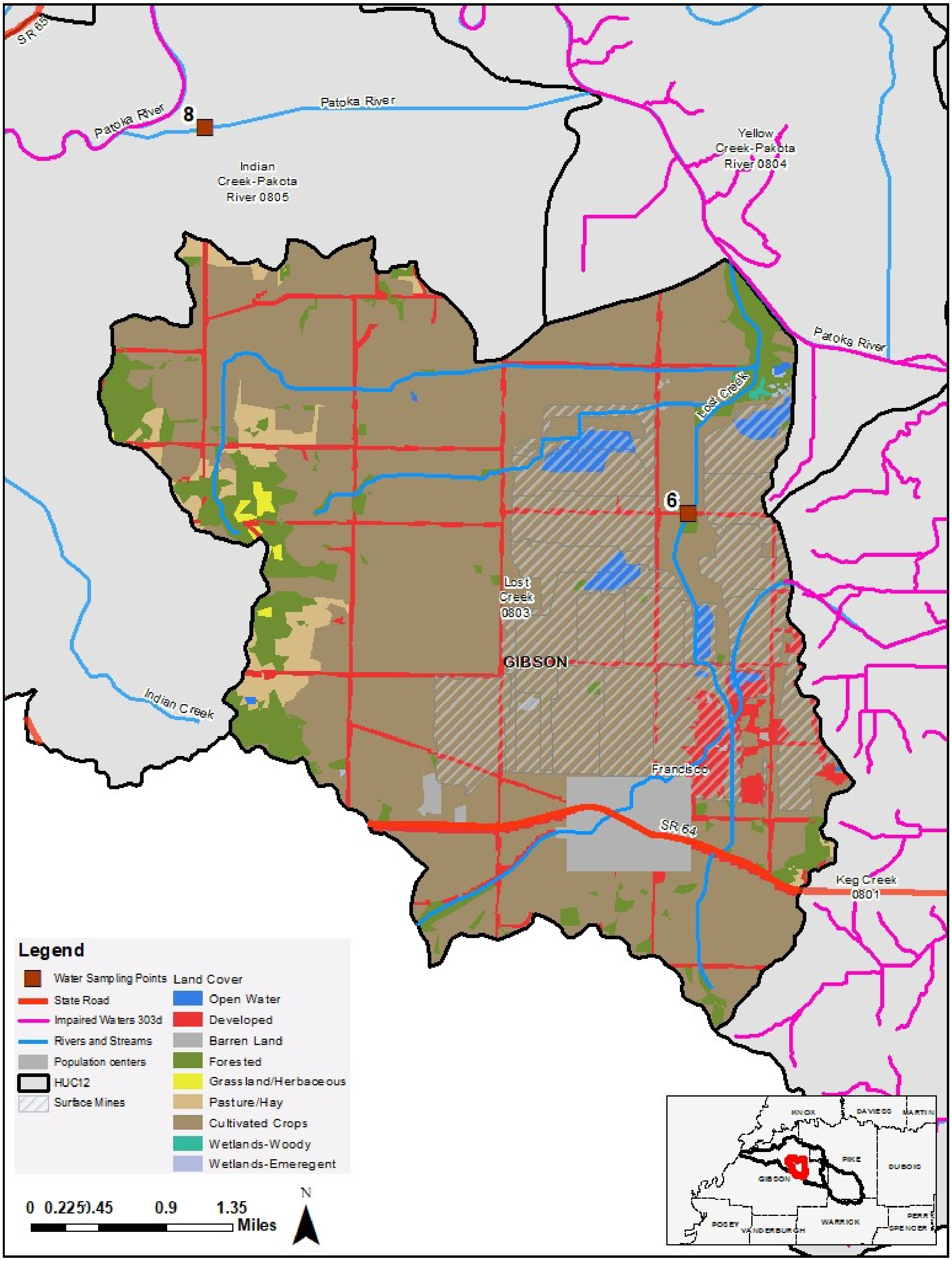


Table # 23 – Lost Water Monitoring Data												
NAME / HUC		ACRES	LAT	LONG	% OF HUC	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 6 LOST CREEK – 051202090803 – HRW 2570		10,635.3	38.363462	-87.441141	57%							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/26/2017	2.6	42.2	ND	ND	64	22	5.5	63.22	1.5	8	0	18.5
12/21/2017	0.405	5.1	0.17/0.17	ND	8	2	8	57.97	2	7.5	0	0
5/18/2018	5.89	31.2	ND/ND	0.15	47	22	6	68.9	5.5	7.5	0	40
9/4/2018	1.607	12.3	ND	ND	70	24	8	95.24	3	8.75	0	30

Multiple times, while working on the first round of implementation for the LPR, the watershed coordinator was asked by concerned stakeholders to water test in this subwatershed, particularly for pH levels. It was assumed that some water quality issues were resulting from the mining operations located around the sampling site. However, the watershed coordinator did not find any pH levels below 6 in this subwatershed. (Acid mine drainage is caused by the oxidation of metallic compounds often present in coal mine slag and most streams affected by coal mine drainage are acidic with pH reading between 2.5 and 6).


Picture # 34 – Water monitoring site # 6.

The month of May had a high P reading along with high BOD^5. There was also low % saturation on three of the samples. However, the WQI ratings were stable throughout the monitoring regime.

The L-THIA modeling data gives this subwatershed a rating of 10% of the entire LPR load for N, P, TSS and E.coli ranking Lost fourth most critical.

IDEM's 303(d) Category 5 list did not have any stream segments listed as impaired.

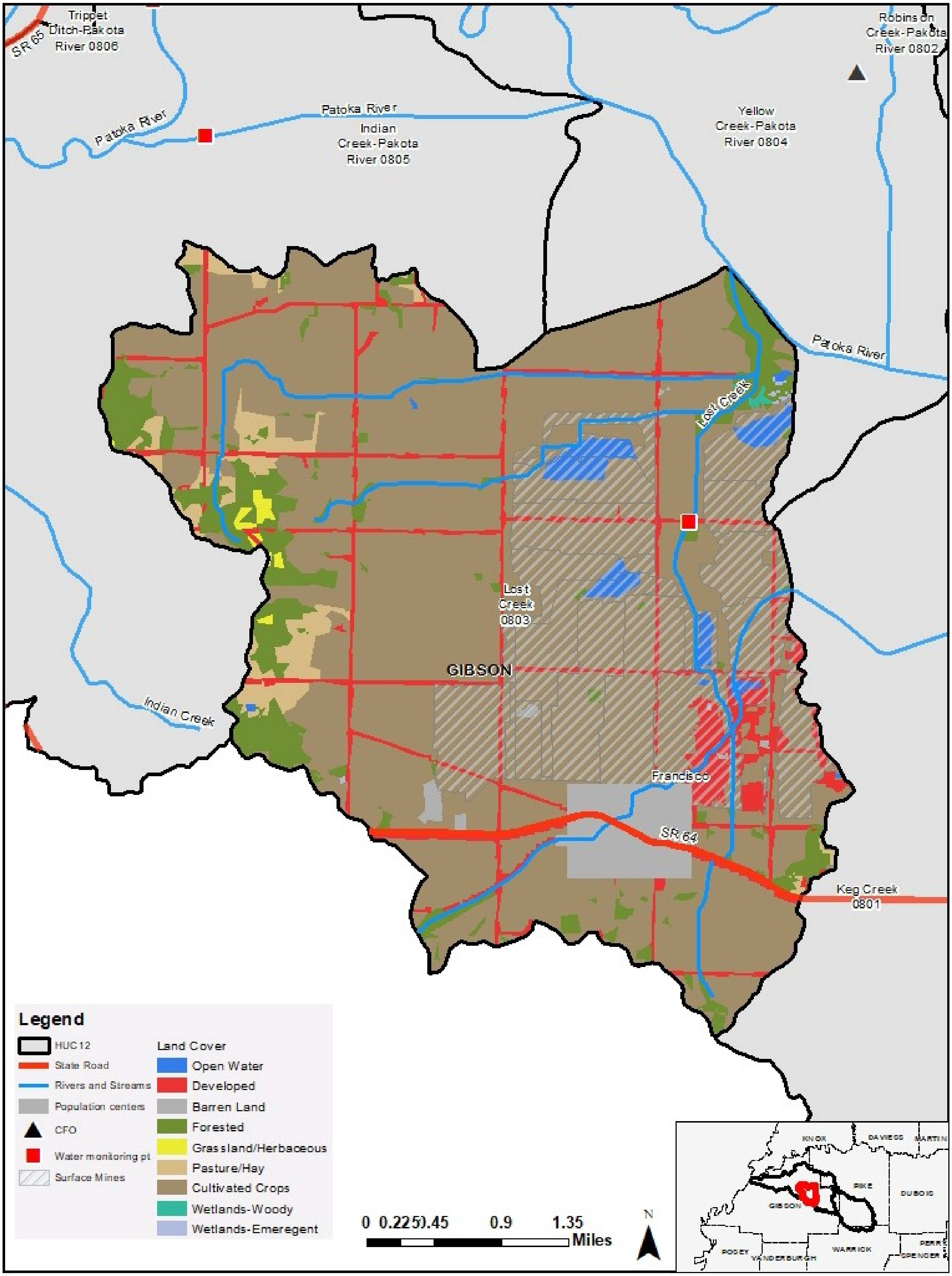
Though E. coli counts were low during this sampling, the watershed coordinator noted that IDEM had performed E. coli testing on this site in 2009 with readings above state standards 5 out of 5 times. (see Appendix E for historical IDEM data).

See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

TABLE # 24					
SITE # 6 LOST CREEK- 51202090803 - HOOSIER RIVERWATCH SITE 2570					
WQI SEPT. '17	WQI DEC. '17	WQI MAY '18	WQI SEPT. '18	CQHEI	PTI
71.39	78.35	71.91	73.82	65	16

MAP 27– LPR LOST CREEK SUBWATERSHED -051202090803

LAND USE, WATER SITES, MINES AND CFO'S



051202090804 – Yellow

The Yellow subwatershed is 12,736 acres with 29.86% of those acres being forested or wetlands. Cultivated crops make up 60% of the sub-watershed, or 7,640 acres. This subwatershed has populated areas such as Mt. Olympus and Wheeling, each having about 30 homes. There is a Confined Feeding Operations in this sub-watershed (Odessa Winds Incorporated, swine), with no known violations.

Picture # 35 - Yellow sample site # 7

There is a small section of surface mining located near Lost and Robinson, as mines in Lost and Robinson have crossed watershed lines.

As the Patoka flows northerly at the beginning of this watershed, one can find on the map the location where the main stem is made to move straight west across the landscape in a man-made channelized ditch, rather than continuing its meandering path north. The main channel Patoka River now cuts straight across the Indian subwatershed, bypassing the old channel that looped around to the north.

The sampling site for this watershed is in the Indian subwatershed; but was the best scenario for capturing the subwatershed (see page 52). Because the main flow waters bypass this old channel, the site had little to no flow, except after heavy rains. After rains, however, not only did the creek flood, but the surrounding fields and roadways did too. Still, almost 8,000 acres drain to this point, so it is interesting to note that there isn't much flow here other than after rainfall.

Table # 25		
YELLOW – 51202090804		
Land Use	Acres	% of shed
Open Water	49.81	0.39%
Developed open space	659.26	5.18%
Developed low intensity	46.63	0.37%
Developed medium intensity	18.82	0.15%
Developed high intensity	13.31	0.10%
Barren Land	14.32	0.11%
Deciduous Forest	3624.44	28.49%
Evergreen Forest	1.33	0.01%
Mixed Forest	0	0.00%
Scrub / Shrub	1.01	0.01%
Grassland/Herbaceous	34.16	0.27%
Pasture / Hay	446.8	3.51%
Cultivated Crops	7639.91	60.05%
Woody Wetlands	126.68	1.00%
Emergent Wetlands	46.41	0.36%
Total Acres in Subwatershed	12722.89	100.00%

The WQI ratings were low on all four samples. The TSS and turbidity values were outside targets, as well, on all four samples. However, with little to no flow, there is reason to believe the high readings are not from effluvium, but from lack of a fresh water source. The old saying "Dilution is the solution to the pollution" perhaps applies in reverse here, as non-moving, stagnant waters with no fresh supply will evaporate, heat-up, and concentrate chemical parameters. Thus, it is likely that the N, P, DO and % saturation readings were all affected by the lack of flow.

Of note, though, is the high E. coli readings in December when the water temperature was 4^0 C.

MAP 28– LPR YELLOW CREEK SUBWATERSHED – 051202090804

IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

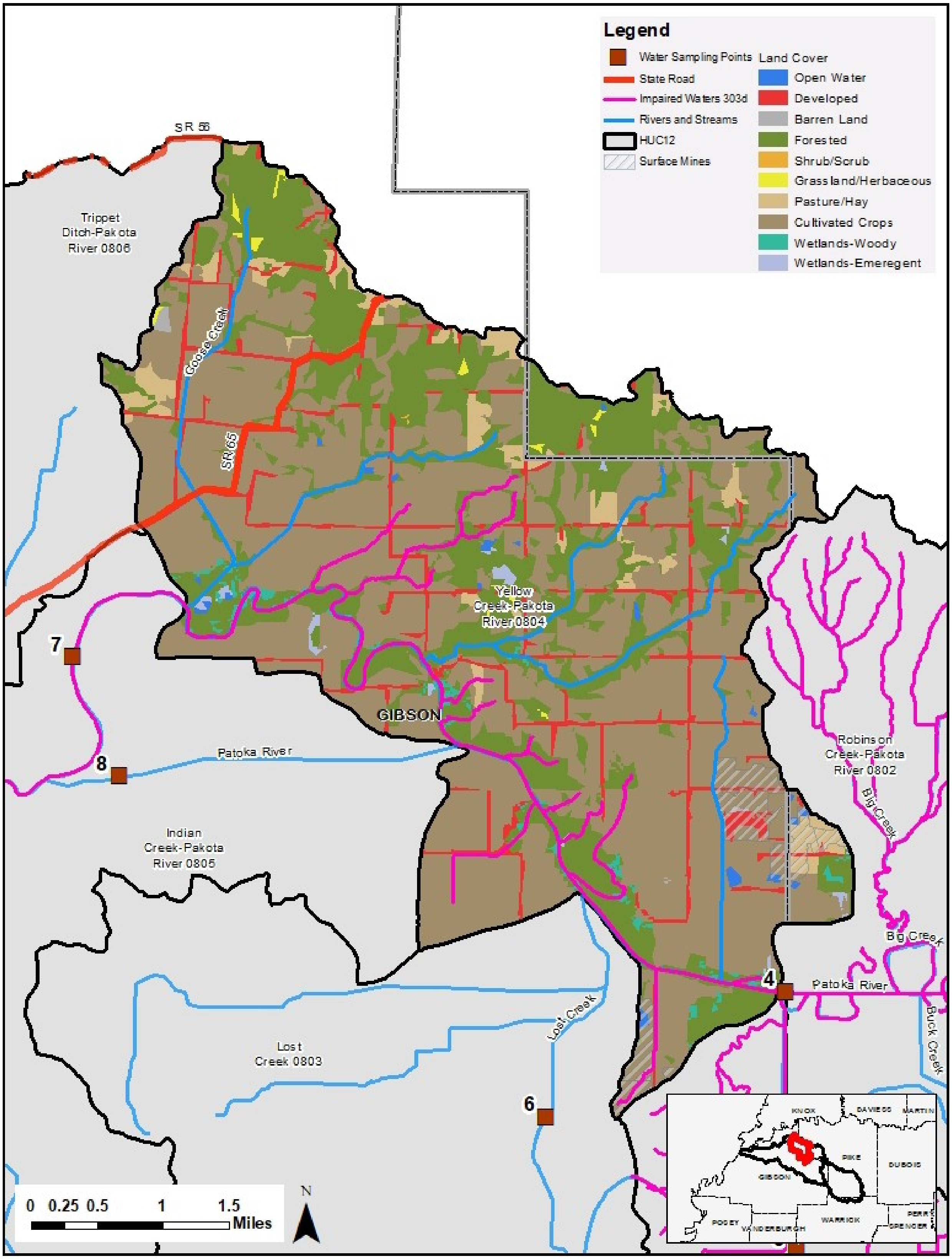


TABLE # 26 – Yellow Water Monitoring Data												
NAME / HUC		**ACRES**	**LAT**	**LONG**	**% OF HUC**	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 7 YELLOW @ EMBREE 051202090804 – HRW 2571		12,736.9	38.413968	-87.507714	100 %							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/18/2017	0	29.7	.553/.553	0.2	129	22	5	57.47	0	7	0	40
12/26/2017	0	15.1	1.8 / ND	0.22	365	4	5	38.17	4	6	3.3	19
5/21/2018	1.133	74.3	4.7/ND	0.18	210	23	3	34.89	2.5	6.5	4.7	24
8/28/2018	0	52.6	.406/.121	.2	61	25	2	24.09	1.5	6.5	0.41	54

Picture # 36 - Typical view in Yellow watershed, facing east from Hwy 65.

The LTHIA modeling results showed this subwatershed contributing 11% of the N load, 11% of the P load, 11% of the TSS load and 11% of the E. coli load of the entire Lower Patoka. The watershed noted that this site had low PTI and WQI readings from data collected in this study.

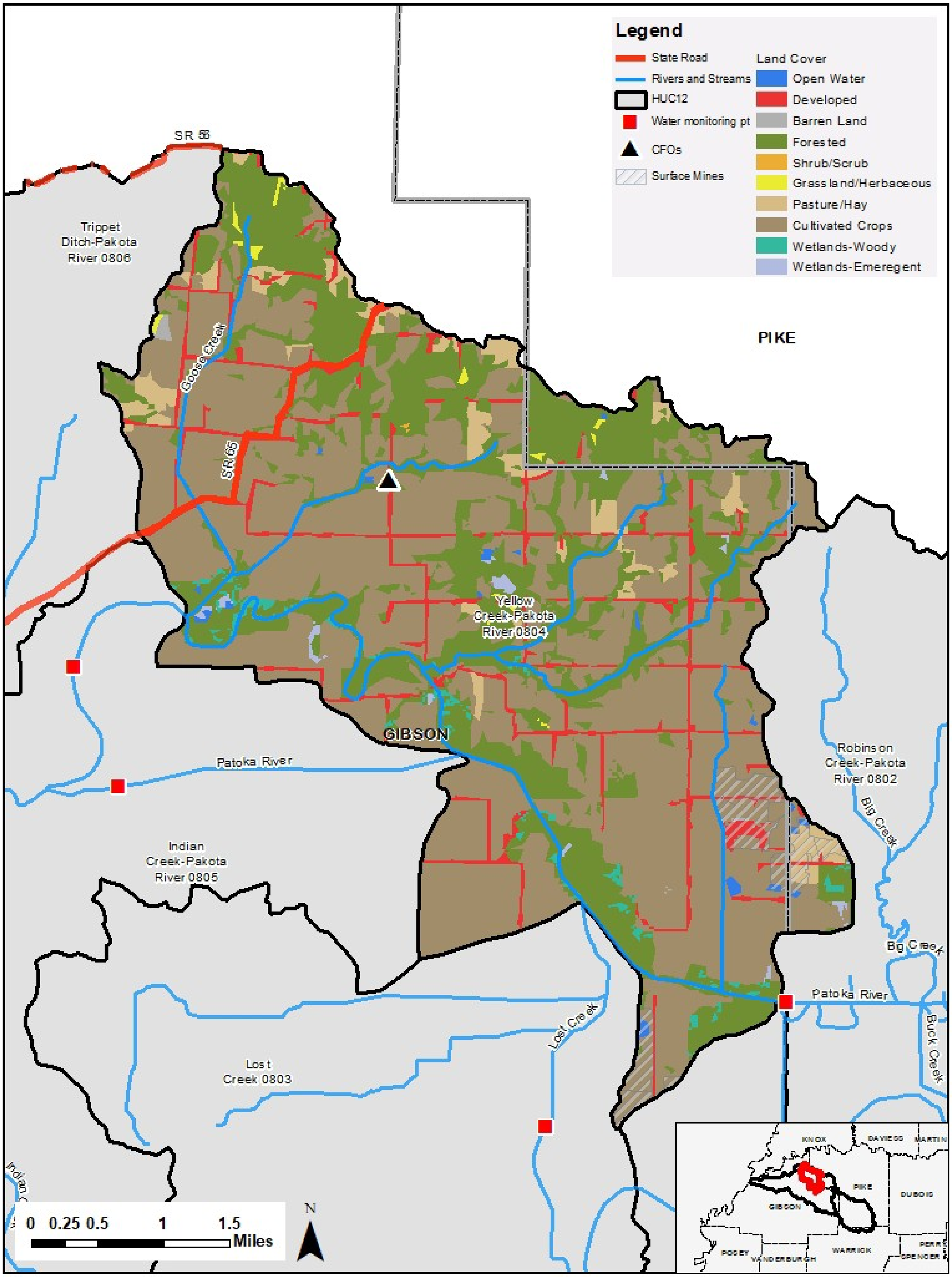
The IDEM 2018 303(d) list showed no stream segments listed as impaired.

See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

TABLE # 27					
SITE # 7 YELLOW CREEK- @ Embree's Farm 51202090804 - HOOSIER RIVERWATCH SITE 2571					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
68.10	56.71	55.51	60.56	51.5	10

MAP 29– LPR YELLOW CREEK SUBWATERSHED – 051202090804

LAND USE, WATER SITES, MINES AND CFO'S



051202090805 – Indian

Picture # 37 - Carither's Road sampling site – dry as was often the case.

There are 10,523 acres in the Indian sub-watershed. Approximately 39.1% are forested and wetland acres. There are 5,002 acres of cultivated crops equating to 47.56% of the sub-watershed. There are no permitted Confined Feeding Operations and no active mining.

The first sampling site is the main channel Patoka River, only 2.6 miles into the Indian watershed. Thus, it only represents 27% of the watershed. Because of this, a second site was chosen along Carither's Road. However, this site ran dry throughout most of the year; and didn't have much flow when there was water present. Approximately 3,500 acres drains to this site on Carither's Road; but, although it has the appearance of a natural stream, it is obviously just a large drainage ditch, running only after a rain event.

Turbidity is a problem in this watershed, as TSS and turbidity readings were high all four sampling events. Phosphorous was high at all four readings and N high in Dec and May. May had an extremely low DO reading as well, and % saturation was never within targets.

This sampling site was at the end of the man-made channelized stretch across many cultivated crops and just prior to the confluence of the old channel from the north. Low quality could be attributed to agricultural activities in the subwatershed as well as upstream loads.

Table # 28		
INDIAN -51202090805		
Land Use	Acres	% of shed
Open Water	46.55	0.44%
Developed open space	536.76	5.10%
Developed low intensity	36.41	0.35%
Developed medium intensity	0.77	0.01%
Developed high intensity	0.15	0.00%
Barren Land	0	0.00%
Deciduous Forest	3932.33	37.39%
Evergreen Forest	20.5	0.19%
Mixed Forest	0	0.00%
Scrub / Shrub	1.92	0.02%
Grassland/Herbaceous	65.22	0.62%
Pasture / Hay	715.51	6.80%
Cultivated Crops	5002.01	47.56%
Woody Wetlands	142.01	1.35%
Emergent Wetlands	17.92	0.17%
Total Acres in Subwatershed	10518.06	100.00%

Interestingly, E. coli readings were super high in December 2017. The watershed coordinator sought reasoning behind such high readings with water temps at 3ºC. Upon examination, both this location and the Hull location (page 97) had a 2,420 E. coli reading the same day.

It was noted that the December samples for the LPR were taken December 19th, December 21st and December 26th; but that there was a rain event between 21st and 26th. The USGS Patoka gage # 03376500 discharge and stream height readings showed under 1000 cfs and under 8ft on the 19th; under 1000 cfs and under 7.5 ft on the 21st; but was over 1,300 cfs and over 9.5 ft on the 26th. The watershed coordinator is convinced the 2,420 c/ml E. coli reading was from the Patoka main channel as it entered the LPR watershed. The other three E. coli readings in the Indian sub-watershed are within WQ targets. Likewise, the other samples collected on the 26th in the Trippett and Yellow subwatersheds were within target that day. The watershed coordinator also noted that all other E. coli readings in the LPR had never been this high throughout the entire year of monitoring. Since the Lower Patoka has both the Upper and Middle Patoka river load contribution prior to reaching this watershed, it is possible that the flood waters from upstream (Upper and Middle Patoka) brought the high E. coli load in that day. In hindsight, it is clear to see that the best-case scenario would have been to collect a sample the same day at Dongola (site 14, page 71) to prove the load was present as waters entered the Lower Patoka watershed. Unfortunately, the Dongola reading was taken days prior to the rain event.

MAP 30– LPR INDIAN CREEK SUBWATERSHED -051202090805

IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

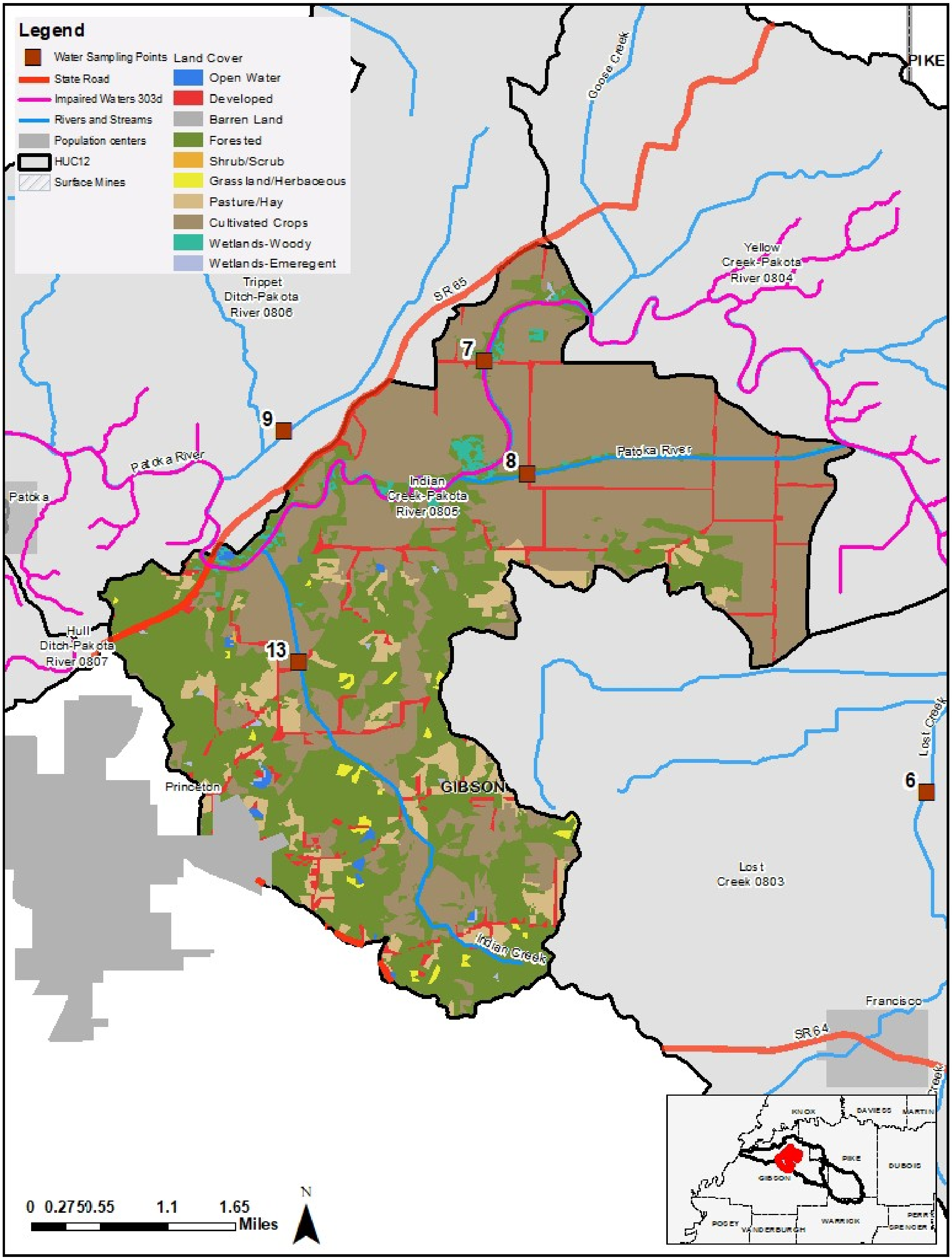
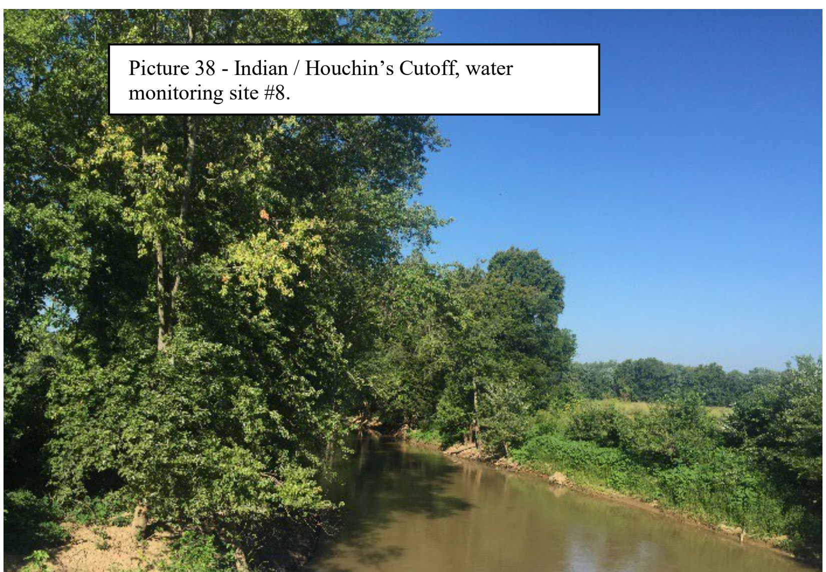


TABLE # 29 Indian Water Monitoring Data

NAME / HUC		ACRES	LAT	LONG	% OF HUC	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards						
SITE # 8 INDIAN / CUTOFF 051202090805 – HRW 1065		10,515.1	38.400782	-87.501198	27%							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/18/2017	510	91.7	.518/.518	0.18	62	21	6	67.42	0	6.5	0	36
12/26/2017	167.67	84.3	3.5 / ND	0.56	2420	3	6	44.44	2	5	8.8	59
5/21/2018	466.94	78.7	2.9/ND	0.13	61	21	3	33.71	1	6.5	2.9	42
8/28/2018	619.77	107	.347/.347	0.16	44	24	6	71.42	1	6.5	0.347	48
SITE # 13 Additional INDIAN SITE @ Carither's Road 051202090805 – HRW 2575		10,515.1	38.378414	-87.535259	62 %							
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/18/2017	No water	No Labs @ this site.	No Labs @ this site.	No Labs @ this site.	No Labs @ this site.	No water to sample– stream bed dry						
12/26/2017	0					1	6	42.25	1	6	0	0
5/21/2018	1.028					22	4	45.98	1	6.5	0	0
8/28/2018	No water					No water to sample– stream bed dry						



Picture 38 - Indian / Houchin's Cutoff, water monitoring site #8.

This sampling site on the main channel had water quality results significantly outside the state standards and completely off this WMP's goals. However, one must realize that this sub-watershed only contributed slightly here (27% of drainage area), and the rest of the pollution is possibly a result of upstream pollutant loads.

L-THIA modeling showed this watershed contributed 7% of the entire load in the LPR for each N, P, TSS and E.coli.

IDEM's 303(d) list for Category 5 had stream segments impaired for IBC and/or PCBS (fish tissue) on two sites.

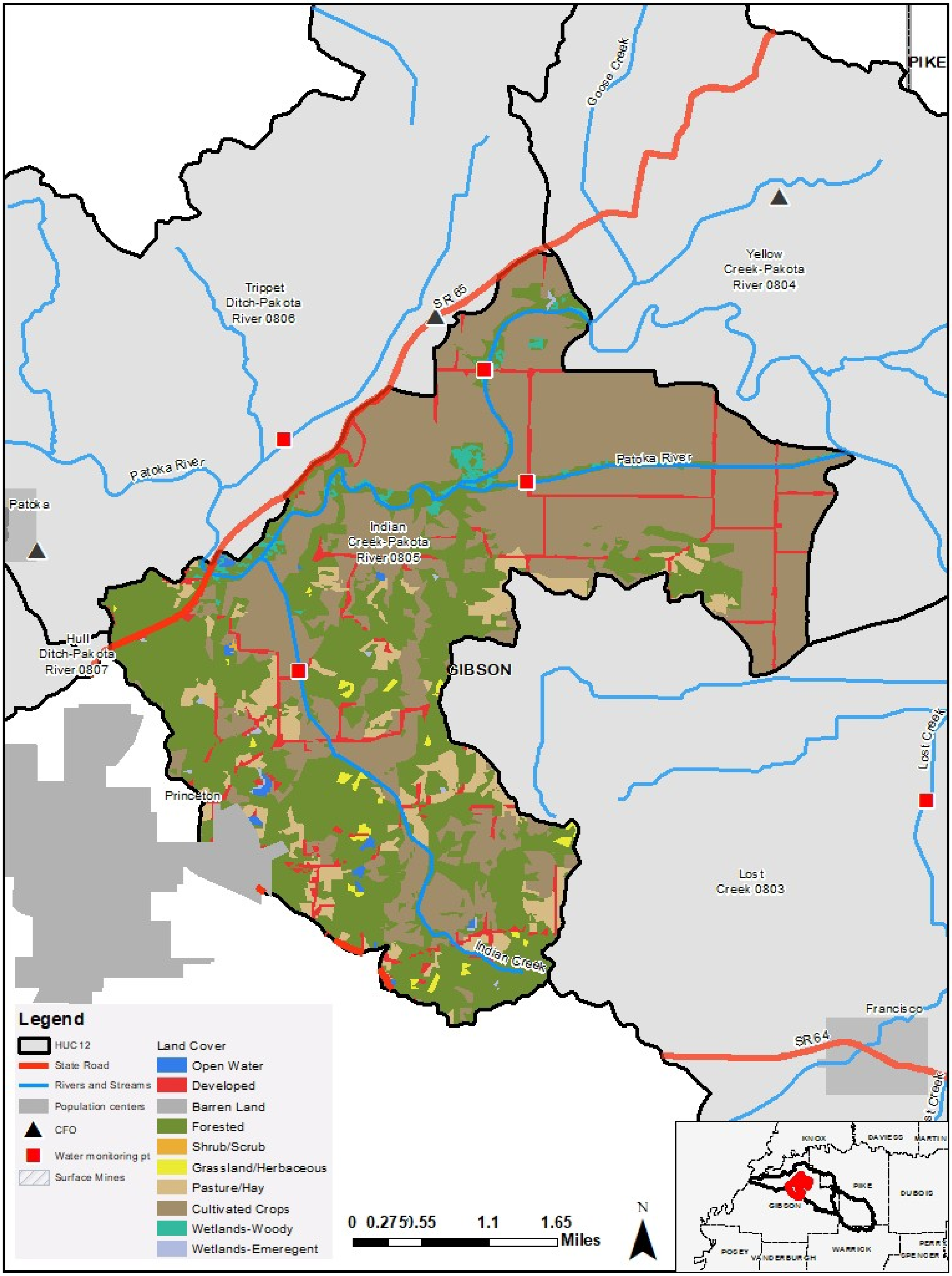
See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

TABLE # 30

SITE # 8 INDIAN CREEK- @ Cut-off Bridge 51202090805 - HOOSIER RIVERWATCH SITE 1065					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
70.77	48.54	62.13	74.94	58	10
SITE # 13 INDIAN CREEK- @ Carither's Road 51202090805 - HOOSIER RIVERWATCH SITE 2575					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
No water	69.03	77.22	No water		NA

MAP 31– LPR INDIAN CREEK SUBWATERSHED -051202090805

LAND USE, WATER SITES, MINES AND CFO'S



051202090806 – Trippett

This sub-watershed is the smallest with only 10,147 acres. The majority is cultivated crops with 63.2% or 6,402 acres. Forested and wetland acres equate to approximately 23% of the watershed. There are no CFO's or active mines in this subwatershed.

Trippett shares the town of Patoka with Hull subwatershed. The 2010 US Census states that the population of Patoka was 773. The entire town does not have a wastewater treatment facility, and the towns folk rely on onsite septic systems. There are approximately 250 homes in the town itself based on an estimation from google maps.

The sampling site represented 60% of the subwatershed. The watershed coordinator found the site to be running quickly throughout most of the year although not very deep. Substrate was sandy gravel with riffles and runs except during the December sampling in which there was no flow.

Table # 31		
Trippett 051202090806		
Land Use	ACRES	% of shed
Open Water	10.91	0.11%
Developed open space	678.48	6.70%
Developed low intensity	56.15	0.55%
Developed medium intensity	6.90	0.07%
Developed high intensity	0.44	0.00%
Barren Land	0.04	0.00%
Deciduous Forest	2276.91	22.48%
Evergreen Forest	4.96	0.05%
Mixed Forest	0.00	0.00%
Scrub / Shrub	6.31	0.06%
Grassland/Herbaceous	29.19	0.29%
Pasture / Hay	606.49	5.99%
Cultivated Crops	6402.65	63.20%
Woody Wetlands	48.82	0.48%
Emergent Wetlands	2.25	0.02%
Total Acres in Subwatershed	10130.50	100.00%

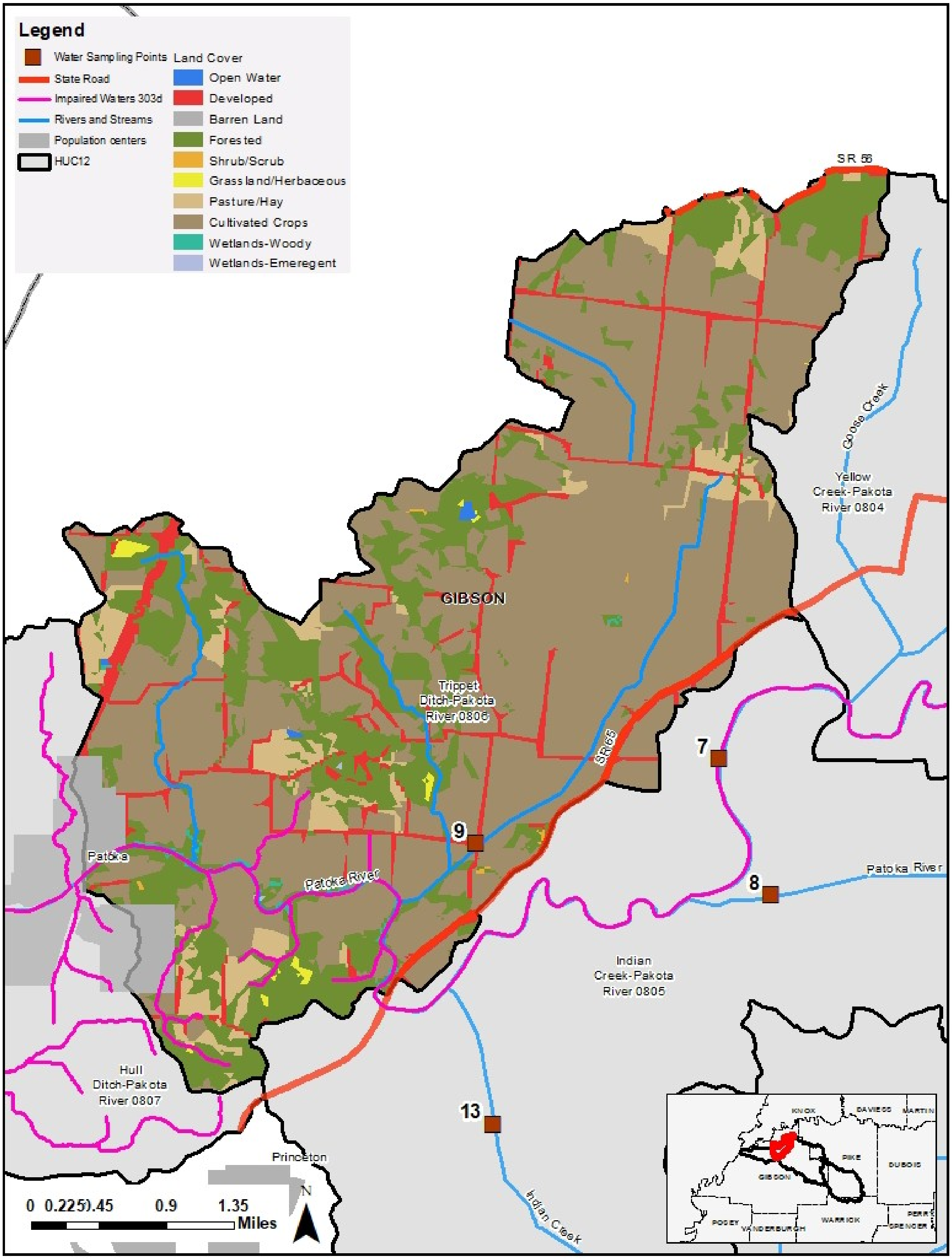
Picture # 39 – Water monitoring Site # 9

The TSS and turbidity readings were high except in December when there was no flow. Either N or P readings, or both, were high every sample; and E. coli was above target in Sept. and May. Although DO seemed normal across the sampling, the % of saturation was below target 3 of 4 times. The watershed coordinator attributed the high DO to the riffles and runs, and the low % of saturation due to the warm temperature of the water. When the flow increased, so did the % of saturation.

Although only above target once, the BOD was only zero when water temps were low; indicating that bacteria are present when the water temp are such to sustain them.

This sub-watershed generally had low WQI ratings. The one time it was in the "green" target range, it was only 0.23 points out of the "red".

MAP 32– LPR TRIPPETT SUBWATERSHED -051202090806
IMPAIRED STREAMS AND NUMBERED SAMPLING SITES



Picture # 40 - Typical view while driving through Trippett subwatershed.

TABLE # 32 – Trippett Water Monitoring Data													
NAME / HUC		**ACRES**	**LAT**	**LONG**	**% OF HUC**	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards							
SITE # 9 TRIPPETT DITCH 051202090806 – HRW 2572		10,147.0	38.405613	-87.537581	60%								
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU	WQI
9/26/2017	0.8	27.0	ND	0.10	276	23	5	58.14	5	6.5	0	17	59.49
12/26/2017	0	8.5	3.0 / ND	ND	172	1	8	56.34	0	6.75	4.4	0	69.78
5/21/2018	1.128	24.1	7.1/ND	0.11	276	20	8	87.79	3	6.5	7.1	17	68.88
8/28/2018	0.1498	19.3	.284/.284	0.12	69	24	5	59.52	4	7.0	0.284	16	70.22

The Trippett subwatershed was listed as a critical zone in the old watershed management plan and stakeholders in the subwatershed were offered a cost-share program through the first round of implementation with a 319 grant. Though producers and landowners were anticipated and sought, very few desired to participate in the 319 cost-share programs.

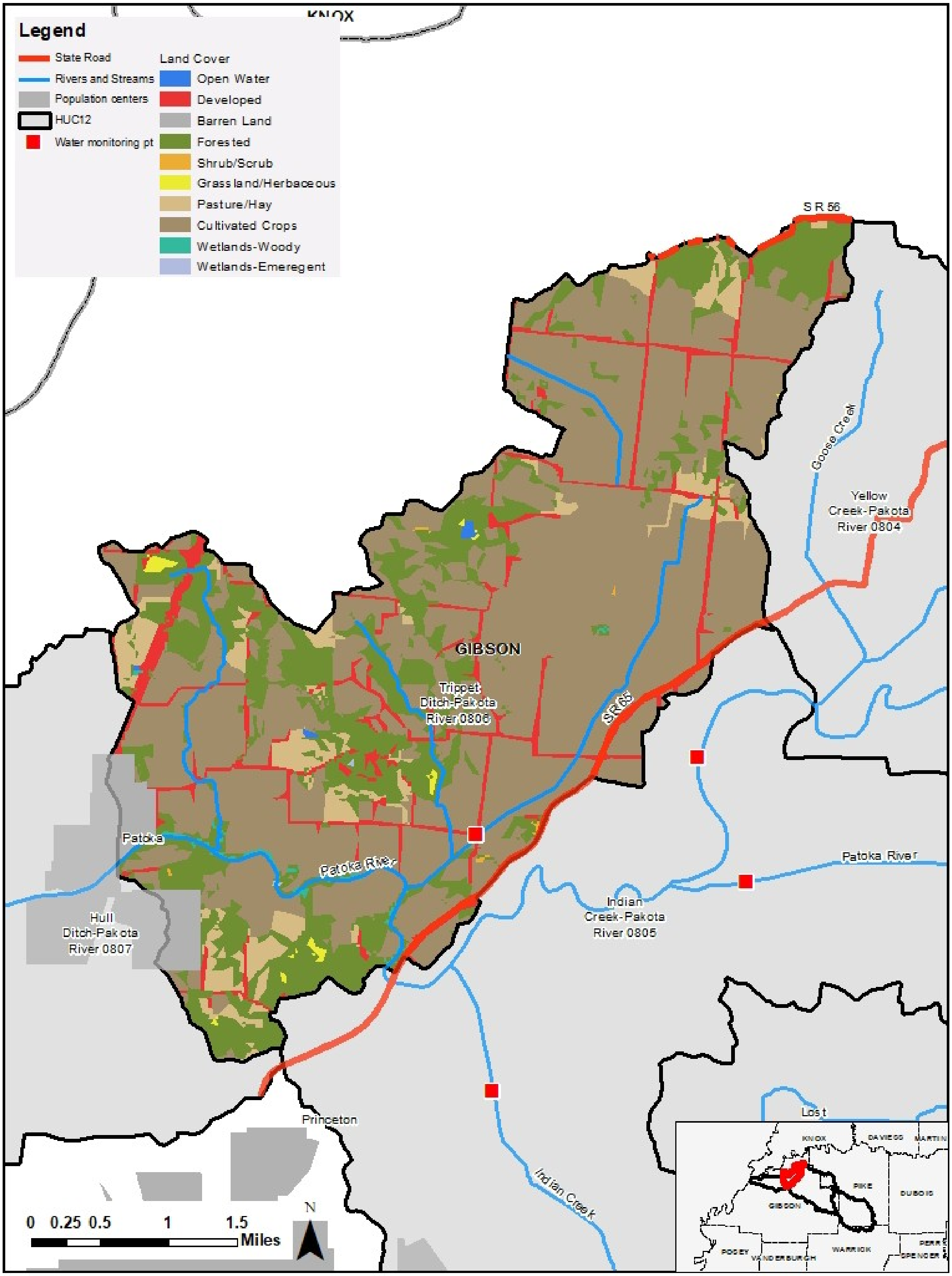
The L-THIA modeling listed this subwatershed as contributing 8% of each of the N, P, TSS, and E. coli loads in the Lower. IDEM's 303(d) Category 5 list had stream segments impaired for IBC and/or PCBS (fish tissue) from 1 site.

See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

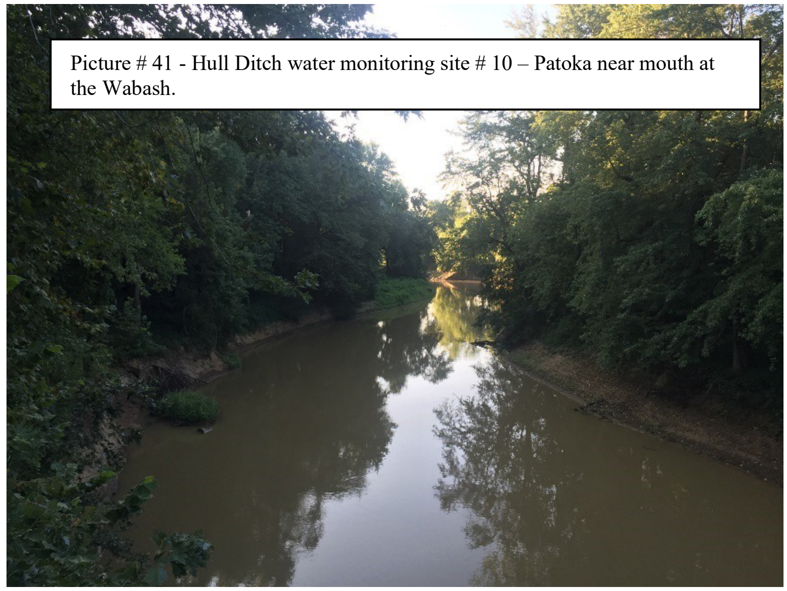
TABLE # 33					
SITE # 9 TRIPPETT DITCH 090806 HOOSIER RIVERWATCH SITE 2572					
WQI SEPT. '17	**WQI DEC. '17**	**WQI MAY '18**	**WQI SEPT. '18**	**CQHEI**	**PTI**
59.49	69.78	68.88	70.22	71	17

MAP 33– LPR TRIPPETT SUBWATERSHED -051202090806

LAND USE, WATER SITES, MINES AND CFO'S



051202090807 – Hull Ditch



Picture # 41 - Hull Ditch water monitoring site # 10 – Patoka near mouth at the Wabash.

There are 15,055 acres in this sub-watershed. Approximately 20% of the sub-watershed is forested or wetland acres, but 71% of the sub-watershed is cultivated crops. There are no permitted Confined Feeding Operations in this sub-watershed and no active mining.

Hull shares the town of Patoka with Trippett subwatershed. The 2010 US Census states that the population of Patoka was 773. The entire town does not have a wastewater treatment facility, and the towns folk rely on onsite septic systems. There are approximately 250 homes in the town itself based on an estimation from google maps.

This sub-watershed is predominantly a floodplain, as this is the final stage of the river as it approaches the confluence of the Wabash River. As stated earlier, there were few options for water sampling other than the one chosen which is representative of the entire Patoka (Upper, Middle and Lower) as well as the Hull sub-watershed. However, the high number of cultivated crop acres in a floodplain should also have bearing on the lab results. Unfortunately, floodplain producers predominantly work their fields prior to planting to "air them out" and aid in or speed up the drying process. Lack of no-till and frequent and expansive flooding can cause nutrient and sediment loads to rise.

Table # 34		
HULL -51202090807		
Land Use	Acres	% of shed
Open Water	34.93	0.23%
Developed open space	820.36	5.46%
Developed low intensity	158.37	1.05%
Developed medium intensity	31.34	0.21%
Developed high intensity	11.66	0.08%
Barren Land	14.79	0.10%
Deciduous Forest	2695.34	17.94%
Evergreen Forest	14.21	0.09%
Mixed Forest	0	0.00%
Scrub / Shrub	0	0.00%
Grassland/Herbaceous	5.29	0.04%
Pasture / Hay	181.18	1.21%
Cultivated Crops	10677.13	71.06%
Woody Wetlands	297.73	1.98%
Emergent Wetlands	82.14	0.55%
Total Acres in Subwatershed	15024.47	100.00%

It is noted that TSS and turbidity were high on all four readings as well as P. Nitrates were high twice; once in May when nitrogen applications prior to planting could be the culprit and once in December when manure spreading on frozen ground could be the culprit.

The low % DO saturation could be interpreted as due to the deep and wide river without much riffles/runs to increase DO saturation; as well as sediment loads.

The high E. coli count in December was probably due to a rain event that increased the level due to upstream contributions. (see narrative on page 89).

MAP 34– LPR HULL DITCH SUBWATERSHED - 051202090807
IMPAIRED STREAMS AND NUMBERED SAMPLING SITES

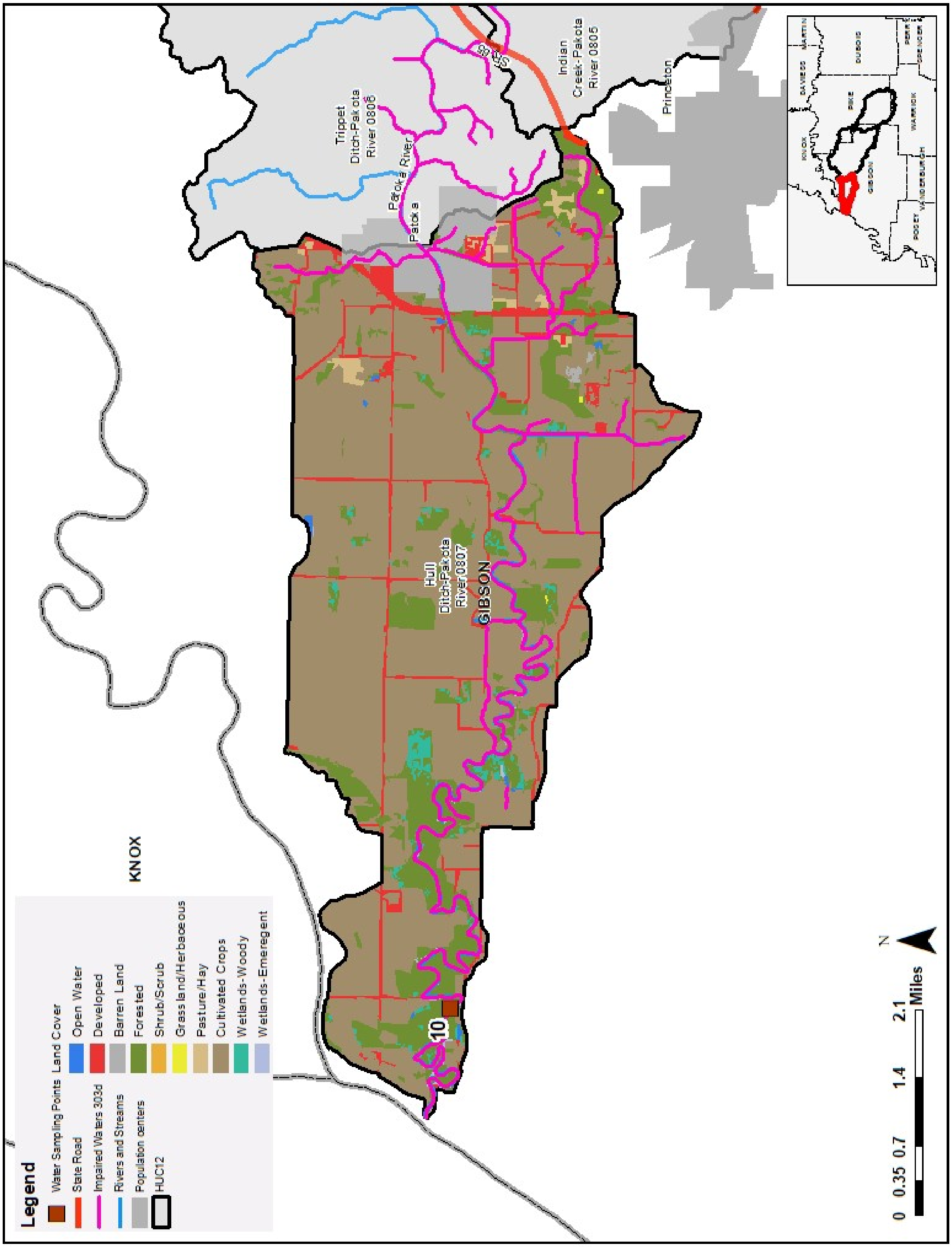


Table # 35 – Hull Ditch Water Monitoring Data											
NAME / HUC		ACRES	LAT	LONG	% OF HUC	E.C. Labs results for TSS / N / P / E. Coli in light green = within standards and in red are outside of standards. Hoosier Riverwatch results for Temp/DO/ % Sat/ BOD^5/pH/Nitrate (NO^3)/Transparency / NTU in light yellow = within standards and in red are outside standards					
SITE # 10 HULL @ mouth 051202090807 – HRW 1262		15,058.7	38.396948	-87.729999	98%						
	FLOW (cfs)	TSS	Nitrate / Nitrite	Total P	E. Coli	Temp	DO	% Sat	BOD^5	pH	Nitrate (NO^3)	Turbidity NTU
9/18/2017	400	70.0	.647/.647	.22	58	21	7	78.65	6	6.5	0	38
12/26/2017	1350	34.4	2.7 / ND	0.8	2420	3	7	51.85	7	6	8.8	79
5/21/2018	522	81.3	2.8/ND	0.13	96	22	6	68.97	4	6.5	2.8	40
8/28/2018	475	90.3	.352/.352	.17	114	24	6	71.42	1	6.5	0.352	50

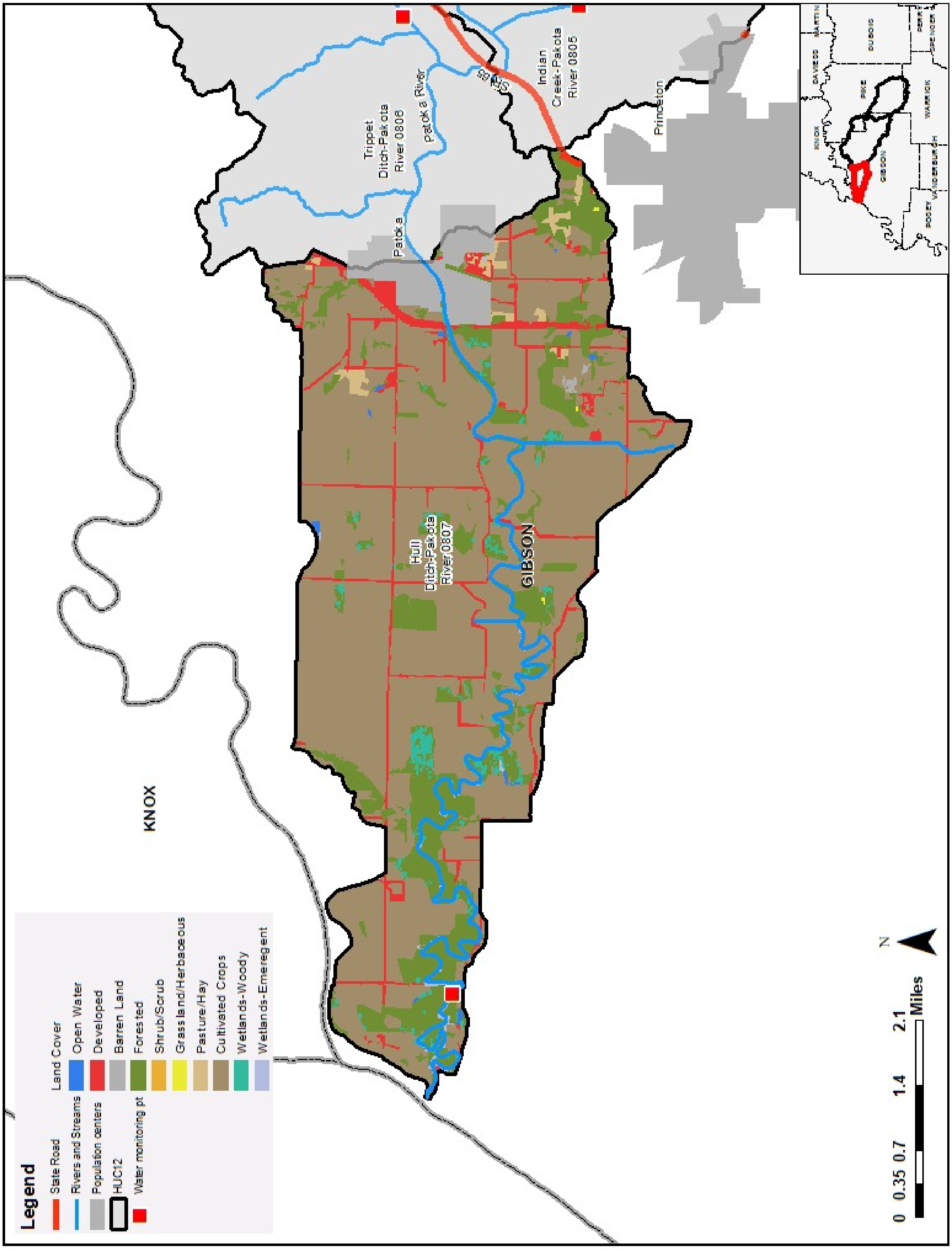
TABLE # 36					
SITE # 10 HULL @ mouth 090807 HOOSIER RIVERWATCH SITE 2572					
WQI SEPT. '17	WQI DEC. '17	WQI MAY '18	WQI SEPT. '18	CQHEI	PTI
64.47	46.07	67.19	72.70	57	18

The Hull subwatershed was listed as contributing 15% of the N load, 16% of the P load, 15% of the TSS load and 15% of the E. coli load in the Lower Patoka. One may think that is because this subwatershed is at the tail end of a 167-mile reach and carries the weight of all that landmass NPS pollution. However, L-THIA calculates the loads based on land use, soil types and rainfall and does not consider upstream sources. So, while ranked as the 2nd most critical by the L-THIA modeling, it is also well suited to conservation practices that can reduce those loads.

Picture # 42 - Field tile drainage ditch along backroad of Hull subwatershed.

See page 101 for side by side comparisons of the 10 subwatersheds water quality data.

MAP 35– LPR HULL DITCH SUBWATERSHED - 051202090807
LAND USE, WATER SITES, MINES AND CFO'S



WATERSHED INVENTORY (PART THREE)

15. Watershed Inventory Summary

After reviewing each of the ten subwatersheds individually, one may consider the data collected too massive and complicated to organize in such a way to extrapolate possible problems and causes, calculate loads and define critical areas; all of which is necessary to discuss measures to address the load reduction goals.

However, as with all number crunching, sometimes the best way to “see” results is to visually represent the data side by side as shown in Table 37. In this table, highest concentration or ranges are listed. This does not incorporate stream flow data or loads. For more on flow and how loads are calculated, see pages 115-120.

Table # 37 Side by Side Comparison of Subwatersheds’ Data

HUC	Site 0#	Name	Highest mg/L		Range of Low-High For Each			CQHEI	PTI
			N	P	TSS	E. Coli	WQI		
0701	1	Houchin	3.5	0	0.0 - 20.3	58 - 602	61 - 77	86.5	18
0702	2	Honey	1.9	0.17	3.5 - 21.7	44 - 166	66 - 78	71	10
0702	12	Honey	2.7	0.13	0.0 - 11.0	11 - 248	77 - 84	84	26
0703	3	Wheeler	2.7	0.20	3.5 - 23.5	34 - 172	66 - 75	75	19
0703	14	Wheeler	No labs	No labs	No labs	No labs	79 - 88	78	19
0801	5	Keg	3.0	0.16	3.8 - 75.3	44 - 276	64 - 77	62	10
0802	4	Robinson	2.7	0.17	16.2 - 76.1	27 - 133	66 – 75	58	9
0802	11	Robinson	3.0	0.19	19.2 - 55.0	9 - 158	67 - 75	47	16
0803	6	Lost	0.17	0.15	5.1 - 42.2	8 - 70	71 - 78	65	16
0804	7	Yellow	4.7	0.22	15.1 - 74.3	61 - 365	56 - 68	51.5	10
0805	8	Indian	3.5	0.56	78.7 - 107.0	44 - 2,420	49 - 75	58	10
0805	13	Indian	No labs	No labs	No labs	No labs	69 - 77	NA	NA
0806	9	Trippett	7.1	0.12	8.5 - 27.0	69 - 276	60 - 70	71	17
0807	10	Hull	2.8	0.8	34.4 - 90.3	58 - 2,420	65 - 73	57	18

Site 1, 2, 5, 6, 7 and 9 are representative of the individual subwatersheds, with data collected from water monitoring sites that were prior to a confluence with the main channel. Site 3 represents most of South Fork Patoka prior to entering the PRNWR. Site 4 (shaded pink) captures where the main channel enters the Lower Patoka and thus has zero LPR drainage acres represented in the data. Sites 8, 10 and 11 are also on the main channel and those indices and data should be considered as representative of LPR as well as upstream pollutant loads from Middle and Upper Patoka. The water monitoring data, L-THIA and LOADEST computer models were used to calculate annual loads for each subwatershed (see page 115-120 for detailed information). However, on the following pages, a series of maps are used to visualize the data by showcasing “hot spots” in the LPR. The maps interpret the collected data into “hot spots” which have high readings for TSS, Nitrates/Nitrites, Total Phosphorus, and E. coli; as well as low CQHEI and PTI scores. These “hot spots” are not rendered to any type of scale and merely serve to offer a quick visual representation of regions where certain pollutant readings were elevated. The circles were drawn based on drainage area to the site, analysis of the data and comparison of pollutant loads. The maps were created to assist the Steering Committee with discussion and decisions; as well as future citizens working with this WMP.

Turbidity and TSS Collection

Turbidity data was collected during the monitoring project using the Hoosier Riverwatch turbidity tube method and TSS data was collected with lab samples. The results typically showed high TSS lab data along with high turbidity readings on the three sites with water sampling coming off the main branch of the Patoka: Robinson 0802 , Indian 0805 and Hull 0807. The Yellow 0804 showed high TSS/turbidity all four times, but 3 of 4 samples had no flow. In the Lost 0803 subwatershed, TSS and turbidity spiked only when stream flow increased.

Turbidity and TSS Findings

All methods of collecting turbidity data supported the concern that sediment in surface water is, in fact, a very serious problem in the LPR watershed. Sediment is a widespread and serious problem throughout the entire LPR watershed. As shown on Map 36 on page 103, there are several hot spots where sediment loads are high. This does not reflect the target load or reduction needed in each subwatershed, but merely highlights high loads. (See table #47 on page 118 for TSS loads on all subwatersheds.)

The land in the LPR watershed is often utilized for growing crops with over 49% of the streams not properly buffered; as well as some producers still using conventional tillage, especially in the floodplains; all of which could be contributing to TSS loads. When sites had high flow, corresponding increases in TSS and turbidity were often seen.

Table # 38 - TSS Pollution Hot Spots per Data					
Circle Color	Data Calculations Used	HUC / Data	HUC / Data	HUC / Data	HUC / Data
	L-THIA modeling	**051202090801 / 2,009,156 lbs.**	**051202090807 / 1,782,738 lbs.**	**051202090802 / 1,336,163 lbs.**	**051202090804 / 1,251,771 lbs.**
	WQ data calculations	**051202090805 / 86,968,470 lbs.**	**051202090807/ 75,462,596 lbs.**	**051202090802 / 58,009,639 lbs.**	**051202090702 / 46,115,821 lbs.**
	LOADEST calculations	**051202090807 / 2,200,391 lbs.**	**051202090802 / 1,503,661 lbs.**	**051202090805 / 847,134 lbs.**	**051202090703 / 408,471 lbs.**

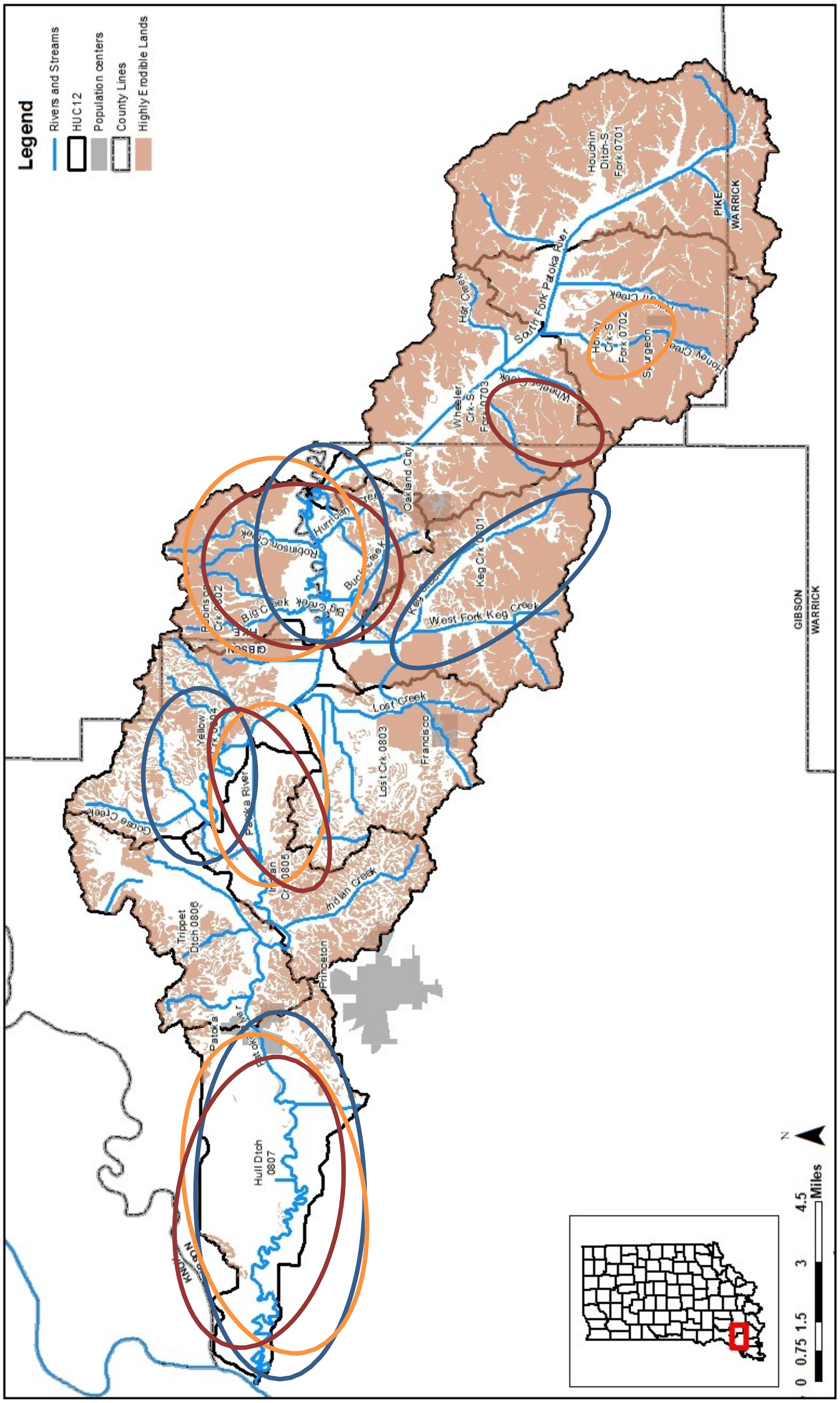
L-THIA and LOADEST calculations are computer models (see page 117 for details). For the WQ monitoring calculations, the following method was used to convert the daily concentrations into daily loads. TSS samples are reported as milligrams per liter (mg/L) from the laboratory. Pollutant loads and load reduction calculations are reported as pounds per year (lbs./yr.). To convert mg/L to lbs./yr. samples were multiplied by stream flow of cubic feet per second (cfs) and then by 196.4610806. This number is derived as follows:

$$\square\,\frac{mg}{L} \;\text{X}\; \square\,\frac{cf}{sec} \;\text{X}\; \frac{3{,}153{,}600\ sec}{year} \;\text{X}\; \frac{28.317\ L}{cf} \;\text{X}\; \frac{0.0000022\ lbs.}{mg} = \square\ lbs.\ /\ yr.$$

This results in a daily load calculation. Pounds are converted to tons by dividing by 2000 (2,000 lbs. in each ton). Then the average of all daily loads x 365 equals annual load.

MAP 36 – LOWER PATOKA RIVER WATERSHED

TSS / TURBIDITY HOT SPOTS – ON HIGHLY ERODIBLE LANDS MAP



Nutrient Findings (NO_2/NO_3 and Total Phosphorus)

Interestingly, Nitrogen was discovered to be the most minor when it came to pollutant loads. In fact, concentrations were never over the state drinking water standards of 10.0 mg/L. However, the LPR WMP target is much lower at <1.0 mg/L to facilitate better biological populations. Still, only 15 of 48 samples had Nitrate concentrations outside the target; and only 2 of 48 Nitrite concentrations was outside the target. Unfortunately, 9 of the 10 watersheds had a sample that was over the LPR WMP target at least once during the water monitoring. (See table 48 and 49 on pages 119-120 for nutrient loads on all subwatersheds.)

Total Phosphorus loads, however, were much higher. In fact, 30 of the 48 water samples were over the <0.07 mg/L water quality target for this WMP. This could be due to Phosphorus' ability to bind with soil particles and persist in the environment longer than Nitrogen. In fact, high Phosphorus loads in the LPR are often observed in relation to high TSS loads; as in Robinson 0802, Yellow 0804, Indian 0805, Trippett 0806 and Hull 0807. When considering both Nitrogen and Phosphorus collectively as 'nutrients', it is easy to see that there are areas within the LPR watershed that routinely fail to meet water quality targets. More investigation will be needed to better correlate the nutrient data with current land use, though it may be assumed that agricultural activities, malfunctioning septic systems, livestock access to streams, and/or decomposing organic matter could all be contributing factors to these high nutrient loads.

Table # 39 - Nutrient Pollution Hot Spots per Loads					
Circle Color	Data Calculations Used	HUC / LOAD	HUC / LOAD	HUC / LOAD	HUC / LOAD
	L-THIA modeling	**051202090801 24,084 lbs. P 83,144 lbs. N**	**051202090807 21,677 lbs. P 74,278 lbs. N**	**051202090802 16,042 lbs. P 57,085 lbs. N**	**051202090804 15,211 lbs. P 52,812 lbs. N**
	WQ data calculations	**190,206 lbs. P (0802) 4,200,281 lbs. N (0702)**	**151,595 lbs. P (0807) 2,730,058 lbs. N (807)**	**88,894 lbs. P (702) 2,168,545 lbs. N (0805)**	**78,028 lbs. P (0805) 1,453,171 lbs. N (0703)**
	LOADEST calculations	**8,840 lbs. P (0805) 75,073 lbs. N (0807)**	**4,792 lbs. P (0807) 47,089 lbs. N (0802)**	**4,556 lbs. P (0802) 39,811 lbs. N (0703)**	**3,640 lbs. P (0702) 27,912 lbs. N (0702)**

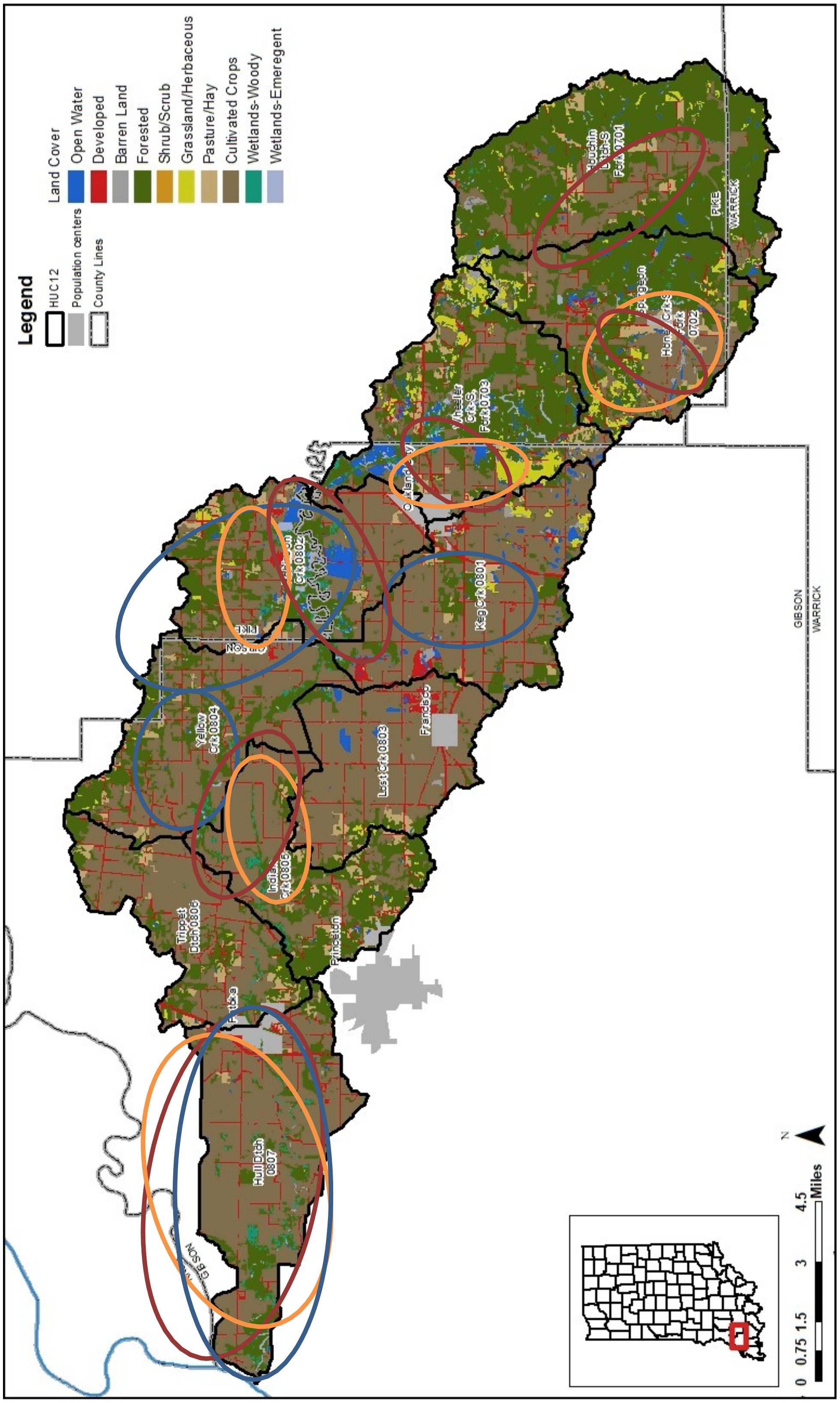
L-THIA and LOADEST calculations are computer models (see page 117 for details). For the WQ monitoring calculations, the following method was used to convert concentrations to loads. N and P samples are reported as milligrams per liter (mg/L) from the laboratory. Pollutant load and load reduction calculations are reported as pounds per year (lbs./yr.). To convert mg/L to lbs./yr. samples are multiplied by stream flow of cubic feet per second (cfs) and then by 196.4610806. This number is derived as follows:

$$\frac{\square\,mg}{L} \times \frac{\square\,cf}{sec} \times \frac{3{,}153{,}600\ sec}{year} \times \frac{28.317\ L}{cf} \times \frac{0.0000022\ lbs.}{mg} = \square\ \text{lbs. / yr.}$$

This results in a daily load calculation. The average of all daily loads x 365 equals annual load.

MAP 37– LOWER PATOKA RIVER WATERSHED

NUTRIENT POLLUTION HOT SPOTS – ON LAND USE MAP



Habitat/Macroinvertebrate Findings and Water Quality Index

Scores for Water Quality Index (WQI) were greater than 70 at least once on all 12 monitoring sites and greater than a score of 70 on average 60% of the time. (See WQ Targets table on page 55). Only once did the WQI fall below 50 (a rating of bad) and that was in December on site 8 in the Indian Creek subwatershed.

Scores for habitat (CCQHEI) were solidly good throughout the watershed. Our target was ≥40. (see WQ Targets table on page 55). Most of the sampling sites (10 of the 12) scored 58 or higher with some scoring in the high 70's and 80's. Robinson 0802 had the lowest habitat score with 47; followed by Yellow with a low score of 52.

Scores for macroinvertebrates (PTI) were relatively high throughout the LPR sampling sites. (See WQ Targets table on page 55). Out of 13 macroinvertebrate samplings, only 5 fell below our target of ≥17 PTI.

At some sites where the PTI or CQHEI was low, it was mainly due to the sampling site being the main channel of the Patoka and not a tributary. In the case of the Yellow subwatershed, the low readings were due to the man-made changes to the watershed (see pages 28 and 52).

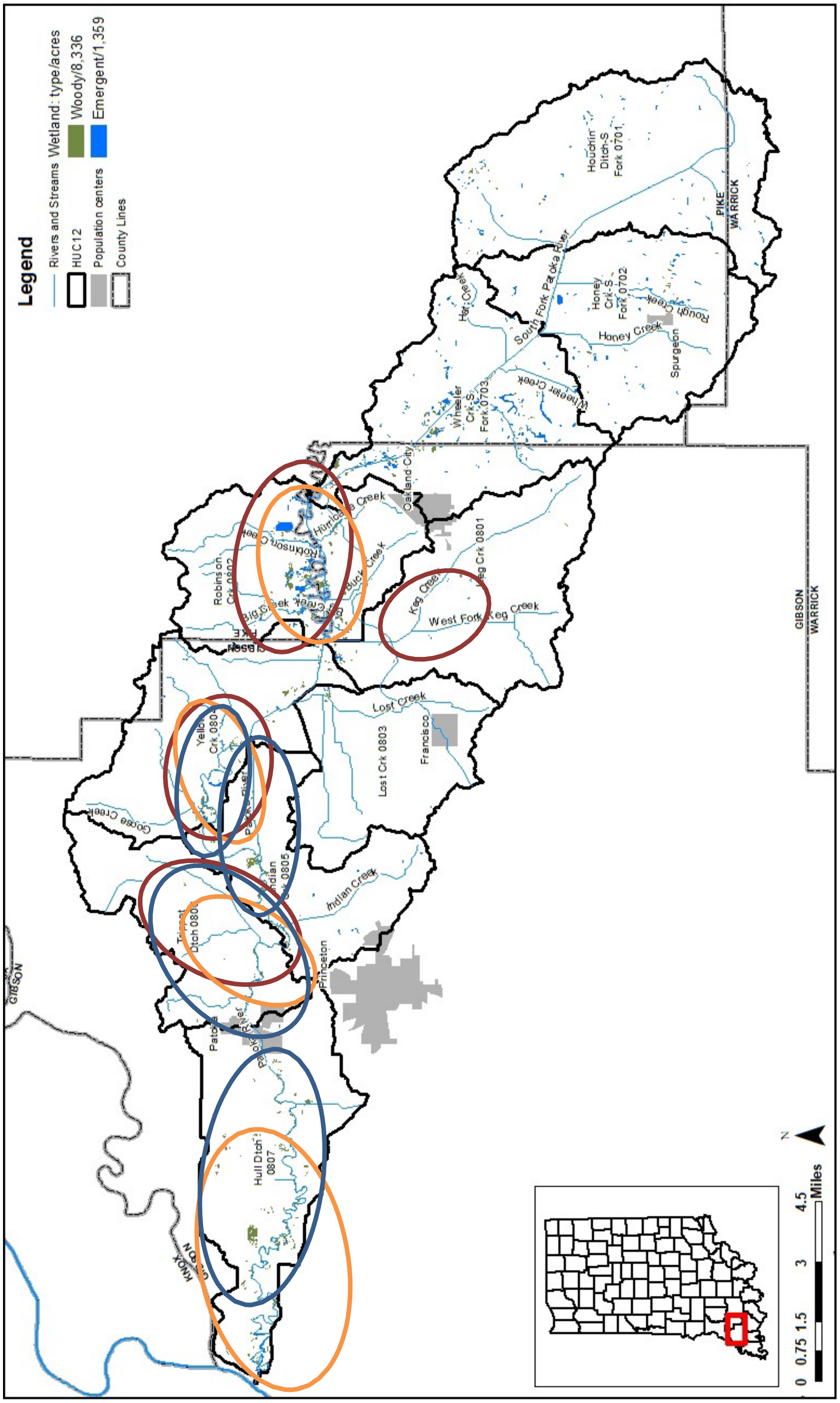
Based on visual observations, it seems that where stream habitat and macroinvertebrate populations were greatly impacted, it was due to the excess amounts of sediment and embedding of features that would typically offer cover for spawning and hiding. On the map, areas where scores were low for CQHEI, WQI or macroinvertebrate PTI are circled. (There was no particular reason for using the wetland layer map.)

Table # 40 - Habitat, Macroinvertebrates and Water Quality Indexes

Circle Color	Index	HUC / INDEX	HUC / INDEX	HUC / INDEX	HUC / INDEX
(blue)	**WQI**	**051202090804 / 60.22**	**051202090807 / 62.6**	**051202090805 / 64.1**	**051202090806 / 67.1**
(orange)	**CQHEI**	**051202090802 / 47**	**051202090804 / 52**	**051202090807 / 57**	**051202090805 / 58**
(red)	**PTI**	**051202090802 / 9**	**051202090801 / 10**	**051202090804 / 10**	**051202090806 / 10**

MAP 38 – LOWER PATOKA RIVER WATERSHED

Habitat, Macroinvertebrate and WQ HOT SPOTS – ON WOODY AND EMERGENT WETLANDS MAP



E.coli Findings

In general, E.coli was found to be a pervasive problem throughout the entire LPR watershed, which is the case for most other watersheds in the state of Indiana. However, after routine data collection, some sites were noticeably worse than others, even showing high pollutant loads in the middle of winter when all live bacteria should feasibly be unable to persist. High E.coli samples collected in winter could indicate that a stream is receiving regular inputs of bacteria, perhaps from livestock with stream access. Other high levels of E.coli bacteria could be introduced due to older, malfunctioning septic systems. With the poor septic suitability of many soils in the watershed, it is likely that septic systems are not able to properly leach all harmful substances out before effluent reaches surface streams and groundwater. In some cases, private landowners have been reported to configure their septic systems for 'straight-piping' to local ditches and streams, especially found to be true in many homes built prior to 1970's.

This map is a representation (not to scale) of areas throughout the watershed where E.coli concentrations were routinely high, especially in comparison with other monitoring sites. Though E.coli loads were a problem throughout the watershed, the zones below represent those drainage areas where a distinct 'spike' in pollutant loads was noted. This visual depiction simply outlines areas within the watershed that should be considered a priority when it comes to E.coli. (See Table # 50 on page 120 for E. coli loads on all subwatersheds.)

Table # 41 – E. Coli Hot Spots per Data

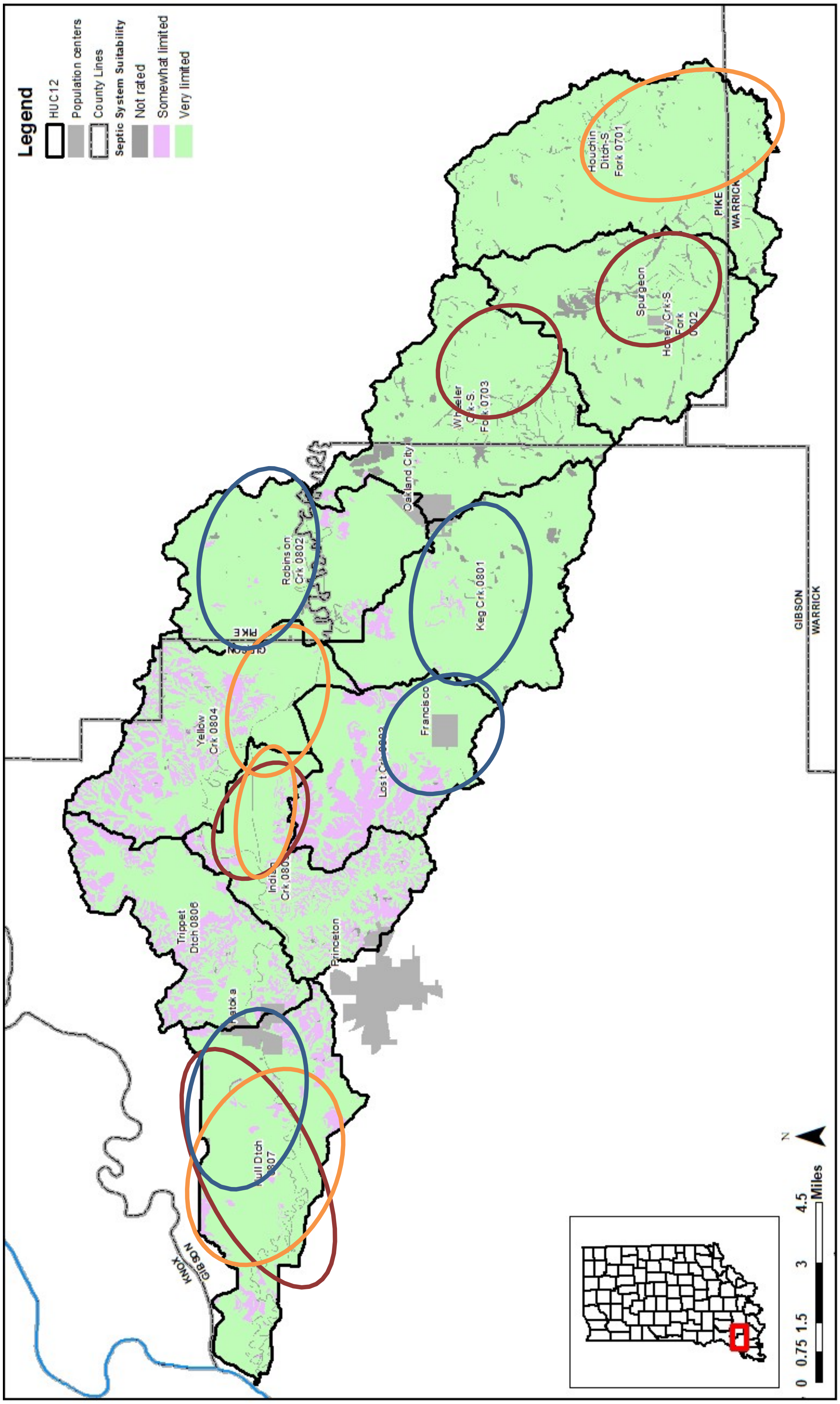
Data Calculations Used	HUC / DATA	HUC / LOAD	HUC / LOAD	HUC / LOAD
L-THIA modeling	**051202090801** **160.49 mil co/acre**	**051202090807** **134.25 mil co/acre**	**051202090803** **121.02 mil col/acre**	**051202090802** **115.79 mil col/acre**
WQ Data highest reading	**051202090807** **2,420 cfu/100ML**	**051202090805** **2,420 cfu/100ML**	**051202090701** **602 cfu/100ML**	**051202090804** **365 cfu/100ML**
WQ Data trillion colonies / day	**051202090807** **168.19**	**051202090805** **34.89**	**051202090702** **32.11**	**051202090703** **15.98**

Currently, U.S. EPA requires pollutant levels be reported in terms of loads, however, there is no EPA-approved means of converting colonies/mL to loads (as E. coli has no mass). Lab results are expressed in cfu/100mL as well as the Indiana State water quality targets. However, L-THIA reports E. coli as million colonies per acre, which is not a format that is easily converted for reduction calculations. Rather than just use cfu/mL which is an instantaneous reading, and which does not incorporate stream flow into the equation, colonies per day were calculated. This number can be further calculated into colonies per year, but these numbers become astronomically large. Colonies per day can be figured with samples multiplied by stream flow and then by 24,465,888. This number is derived as follows:

$$\frac{\square\ \text{colonies}}{100\ \text{mL}} \times \frac{\square\ \text{cf}}{\text{sec}} \times \frac{1{,}000\ \text{mL}}{\text{L}} \times \frac{28.317\ \text{L}}{\text{cubic ft}} \times \frac{86{,}400\ \text{sec}}{1\ \text{day}} = \square\ \text{colonies per day}$$

MAP 39– LOWER PATOKA RIVER WATERSHED

E. coli Pollutant Hot Spots – on Septic Suitable Soils Map



16. ANALYSIS OF STAKEHOLDER CONCERNS

The LPR steering committee was able to develop a list of natural resource concerns, voiced by several local stakeholders, producers, county officials, contractors and conservation-minded citizens. Many of these concerns were identified by landowners possessing an extensive knowledge of the historical and recent land uses, while other concerns were observed by the watershed coordinator during water monitoring events, tillage transects and windshield surveys (see page 51).

On February 7, 2018, the LPR steering committee met to prioritize and refine the list of natural resource concerns. There were 6 people attending this meeting. The committee worked together to rank the natural resource concerns in the watershed. To simplify the prioritizing of the natural resource concerns, the committee determined to place the concerns into three Tier Groups with Tier one ranking the highest, emphasizing the importance of the concern, or the ability of BMP implementation to address the concern. For instance, increase wetlands is placed in Tier Three due to NRCS programs currently available to assist landowners.

After lengthy discussion regarding each individual resource concerns, the final ranking was determined as represented in Table # 42. This table shows priority ranking of the stakeholder concerns and explanations from that evening's discussions. Notice that some of the original concerns were grouped into categories.

Table # 42 Natural Resource Concerns in Lower Patoka River Watershed		
Ranked into Three Priority Tiers		
TIER ONE	TIER TWO	TIER THREE
1. **Reduce Nutrient and Sediment Loading.** (Promote practices that improve soil health. Promote precision ag technology, field days, BMP demonstrations, involve ag retailers, use peer to peer education.)	**1. Promote Pollinators / Beneficial Insects.** (Plant pollinator habitats and promote pollinator species during BMPs, promote beneficial insects.)	1. **Increase Wetlands** (Wetland conservation and restoration is a priority. Work to convert priors back to wetlands on hydric soils. Tier 3 due to NRCS programs already available.)
2. Increase Cover Crop and No Till. (Work to decrease tillage -vertical till better than conventional -until producers use never till practices. Increase SOM/ improve soil health. Show $ return on investment.)	**2. Address Invasive Plant Species.** (Non-native and native invasive species, both terrestrial and aquatic plant species through education and support of local eradication efforts. Promote planting of native species.)	**2. Mines and Reclaimed Lands.** (Three active mines in watershed, so mining activity's effect on water quality a priority as well as soil health on reclaimed lands. Tier 3 due to NRCS programs already available.)
3. Improve Nutrient Management. (Promote use of nutrient plans and grid sampling. Promote 4Rs – Right time, right rate, right product, right place. Educate on proper livestock and manure management, such as rotational grazing and incorporation instead of spreading.)	**3. Address Illegal Dumping and Waste Management.** (Host clean up days, educational outreach on effects of trash and illegal dumping, improve waste management, promote recycling and recycling drives or championships, partner with solid waste, promote amnesty days, promote available county dumpster sites.)	**3. Educational Programs @ Refuge.** (Partner with the Friends of the Patoka River as education events, demonstrations, programs and presentations are held @ the Patoka River National Wildlife Refuge.)
4. Sewer/Septic Education. (Promote septic maintenance and innovative sewer / septic technology. No BMPs $ can be spent on this priority, so focus on educating regarding water cycle, water treatment, effects of sewage.)	**4. Storm water Planning.** (County maintenance of legal drains, ag drain maintenance / impervious surfaces / slow run-off / reduce volume / I69 growth and zoning – water management in county not just spot treat. BMP $ can only be for water quality related to runoff.)	**4. Urban Conservation.** (Home conservation such as lawn management, use of rain barrels and rain gardens, native plantings are needed to address storm water and water quality. Tier 3 due to lack of urban areas in watershed.)
5. Improve Riparian Zones. (Increase and enhance vegetation on riparian corridors. Increase bank stabilization, improve habitats, tree plantings.)	**5. Natural Resources and Conservation Education.** (Use education programs already available in print and online, such as US FWS, NRCS, DNR as well as universities and other websites and online resources. Develop programs and brochures as)	**5. Increase Conservation Easements.** (Tier 3 due to NRCS programs already available.)
	6. Address Gas and Oil Well Leaks. (Over 100 orphan wells in which no one is responsible anymore. Many old wells not even on maps, people need to report leaking wells. Contact IDEM if leaking well is found. State doesn't have budget for this but will take care of it if causing issues. DNR contact is Rusty Rutherford.)	**6. Public Lakes and Reservoirs.** (This is not regarding private ponds. Tier 3 due to low number of public lakes in watershed. Patoka Refuge taking care of public water on their lands. Lakes do help to address erosion in the watershed.)

These concerns were looked at individually to determine whether each concern was supported by data, quantifiable, and whether the concern was outside the project's scope. If there was data to support that concern, the evidence was indicated. The group then decided whether they wanted to focus on the concern. There were four concerns the group does not wish to focus on: gas and oil leaks, mines and reclaimed lands, urban conservation and public lakes and reservoirs.

TABLE # 43 - ANALYSIS OF STAKEHOLDER CONCERNS					
Tier 1 Natural Resource Concerns					
Concern	**Supported by Data?**	**Evidence**	**Quantifiable?**	**Outside Scope of Project?**	**Group wants to focus on?**
Sediment and Nutrient Loading	Yes	Water monitoring, tillage transects, data, windshield surveys.	Yes	No	Yes
Soil Erosion	Yes	Water monitoring, tillage transects, data, windshield surveys.	Yes	No	Yes
Nutrient Management / Livestock Management	Yes	Water monitoring, tillage transects, data, windshield surveys.	Yes	No	Yes
Failing Septic Systems Septic Maintenance	Yes	Water monitoring data.	No	No – but adult education only.	Yes, in form of education
Degraded Riparian Zones	Yes	CQHEI and PTI scores, tillage transects, windshield surveys.	Yes	No	Yes
Tier 2 Natural Resource Concerns					
Concern	**Supported by Data?**	**Evidence**	**Quantifiable?**	**Outside Scope of Project?**	**Group wants to focus on?**
Lack of Pollinators and Beneficial Insects and Habitats	Yes	Stakeholder and PRNWR staff reports at meetings.	Yes	No	Yes
Invasive plant species	Yes	Stakeholder and PRNWR staff reports at meetings.	Yes	No – adult education only.	Yes, in form of education
Illegal Dumping / Litter and Trash /Waste Management	Yes	Stream cleanup volunteers and highway dept. reports, stakeholder and PRNWR staff reports.	Yes	No	Yes
Storm Water Run-off	Yes	Highway dept. reports, stakeholder input, windshield surveys, PRNWR staff.	Yes	No	Yes
Natural Resource and Conservation Education	Yes	Observations during public outreach, stakeholder input, PRNWR staff, citizen surveys.	No	No	Yes
Gas and Oil Leaks	Yes	Observations while water monitoring and during windshield surveys, reports from PRNWR staff.	Yes	Yes	No
Tier 3 Natural Resource Concerns					
Concern	**Supported by Data?**	**Evidence**	**Quantifiable?**	**Outside Scope of Project?**	**Group wants to focus on?**
Increase Wetlands	Yes	Desktop survey, water monitoring data, reports from PRNWR staff, flooding, nutrient loads.	Yes	No	Yes
Mines and Reclaimed Lands	Yes	Tillage transect data, windshield surveys, stakeholder input, reports from PRNWR staff.	Yes	Yes	No
Educational Programs @ Refuge	Yes	Stakeholder input reports from PRNWR staff, observations during current public outreach, citizen surveys.	Yes (# of programs)	No (adult education only).	Yes
Urban Conservation	No	Lack of urban areas in the watershed.	No	Yes	No
Increase Conservation Easements	Yes	Stakeholder input, # of program acres.	Yes	No	Yes
Public Lakes and Reservoirs	No	Few public lakes, except for PRNWR which is address concerns already.	No	Yes	No

Working closely with PRNWR staff and volunteers, along with IDEM watershed specialist, it was determined that the gas and oil leaks and mines and reclaimed lands do not have IDEM funding for BMPs available; and the two concerns are being addressed by the PRNWR when the Refuge has funds available to do so. The Columbia Mine Preserve is an example of PRNWR working to restore reclaimed mine lands. There were no data and evidence to support the need for urban conservation or public lakes and reservoirs protection and was deemed outside the scope of the project. The results of the analysis of stakeholder concerns is found in Table #43 on page 111.

The Steering Committee noted that even though certain concerns are supported by data (i.e. failing or antiquated septic systems and the E. coli rate), this WMP will not focus on them financially due to funding constraints; but would actively promote adult education in the matter. So, even though in some cases, the solutions lie outside the boundaries of a 319 cost-share program (as in failing septic systems), continued education and outreach (i.e. septic maintenance workshops) will be used as a method to initiate improvements throughout the watershed.

17. IDENTIFYING PROBLEMS

Specific problems were identified relating to each concern the group wished to focus on. As each natural resource concern was discussed and potential problems listed, the committee noticed that several concerns could be grouped together since they shared potential problems. The committee felt that this grouping would help those who seek to implement the WMP in the future. Potential problems are defined as issues that exist due to a concern. Identified problems help clarify which contributing factors can be changed, improved upon, or investigated further. Table 44 lists the concerns with corresponding 'problem' explanations.

TABLE # 44 POTENTIAL PROBLEMS FROM NATURAL RESOURCE CONCERNS

CONCERNS	PROBLEMS
Sediment and Nutrient Loading Soil Erosion Nutrient Management Livestock Management Stormwater Runoff Lack of Sufficient Wetlands Increase Conservation Easements	• High turbidity • Large amounts of sediment transported into streams • Degraded habitats. • Exceeded Water Quality Targets for TSS, N, P • Impaired biological populations. • Lack of consistent cover crop and no-till practices • Cattle allowed stream excess and lack of rotational grazing • Lack of soil health /fertility education • Lack of soil health benefits awareness • Lack of ed regarding 4Rs (right product, right time, right rate, right place).
Failing Septic Systems Lack of Septic Maintenance Livestock Management	• E. Coli loads exceeding water quality targets • Lack of public awareness on septic system maintenance. • Older homes without leach field or with pipes directly to ditch. • Antiquated systems prohibitively expensive to repair / replace.
Degraded Riparian Zones Invasive Plant Species Lack of Pollinator Habitat Lack of Beneficial Insects Illegal Dumping / Litter Waste Management	• Farming up to edge of stream/lack of field borders/filter strips. • Streambanks needing stabilization. • Impaired biological populations. • High turbidity and degraded habitats. • Invasive plant species being sold at local retail outlets. • Illegal dumpsites noted during windshield surveys. • Disregard of actions' consequences on water, such as litter
Natural Resource Education Conservation Education Educational Programs at Refuge	• Lack of public awareness • Lack of high-quality educational workshops and opportunities • Lack of attendance at workshops and programs during first round implementation. • Disregard of consequences of actions such as roadside litter

18. IDENTIFYING CAUSES

After identifying specific problems, the potential causes for each specific problem was determined. Table # 45 links stakeholder concerns to known water quality problems and their potential causes. For this watershed management plan; a "cause" is an event, agent, or series of actions that can produce a problem.

TABLE # 45 IDENTIFICATION OF POTENTIAL CAUSES IN RELATION TO PROBLEMS

Problem	***Potential Cause(s)***
High turbidity / sediment transported to streams	Water quality target for Total Suspended Solids (TSS) exceeded, soil erosion; need for streambank stabilization, need for field borders and grassed waterways.
Degraded habitat	Water quality target for Total Suspended Solids (TSS) exceeded, lack of field buffers, riparian areas, wetlands; need for streambank stabilization.
Water quality targets for TSS exceeded	Excess run-off occurs, transporting sediment into streams, land management methods need improvement
Water quality targets for NO_2/NO_3 exceeded	Excess run-off occurs, transporting nutrients into streams, land and livestock management methods need improvement, substandard septic systems.
Water quality targets for Total Phosphorus exceeded	Excess run-off occurs, transporting nutrients into streams, land and livestock management methods need improvement, substandard septic systems
Impaired biological populations	Water quality targets for Total Suspended Solids (TSS) exceeded, lack of buffers, riparian areas, wetlands
Cover crops and no till not utilized	Lack of information, lack of soil health education, lack of seed availability, adverse weather conditions, producer doesn't own no-till equipment, prohibitive costs of cover crops, fear of cover crop termination difficulty.
Cattle with stream access and lack of rotational grazing	Producers use ditch / stream to water / cool cattle; prohibitive cost of fencing cattle out of stream and building HUAP; prohibitive cost of additional fencing and watering system with rotational grazing.
Water quality targets for E.coli exceed	Excess untreated run-off occurs from unmaintained septic systems, land and livestock management methods need improvement, public lacks awareness. Septic system updates/repairs are cost prohibitive.
Lack of frequent high-quality outreach and public education / lack of stakeholder attendance at such events.	Holding a soil health expo is not enough, high quality, nationally known speakers are required to draw producers and stakeholders to the event. Venues are often difficult to secure. Food (cost-prohibitive) is often needed to ensure high numbers attending. Stakeholders such as ag retailers often don't attend due to getting time off work. Producers only attend when PARP credits are offered which lengthens the meeting, raising the cost of the meeting and requires partnership with Purdue extension staff.
Lack of public awareness on soil health, benefits of soil health, 4 R's, invasive plant species, septics, pollinator / beneficial insects.	Information is not as available/visible as it could be at this time; funding for outreach is lacking. Invasive plant species are sold at retail outlets (such as callary pear, burning bush and Japanese honeysuckle). If producer adds grass waterway, pollinator species are not considered or planted as part of the plan. Same with field borders.
Disregard of consequences of actions and the effect on water quality.	Roadside litter and illegal dumping of household trash is rampant throughout this watershed. Planting of invasive species that are being sold at local retail outlets.

19. IDENTIFYING POTENTIAL SOURCES FOR EACH POLLUTION PROBLEM

In this section, the identified problems and causes are paired with potential sources and specific subwatersheds where these issues are most prevalent.

TABLE # 46 – POTENTIAL SOURCES AND SUSPECT WATERSHEDS			
Problem	***Potential Cause(s)***	***Potential Source(s)***	***Watershed(s)***
High Turbidity / Sediment transported into streams	WQ target for TSS exceeded, soil erosion; need for streambank stabilization, field borders and grassed waterways.	Up to 81% of ag land still conventional tilled, roadside ditches not seeded after maintenance, removal of riparian areas, 49% streams lack sufficient buffers, HEL acres.	All watersheds, most notably: Keg, Robinson, Yellow, Indian, and Hull
Degraded habitat	WQ target for TSS exceeded, lack of field buffers, riparian areas, wetlands; need for bank stabilization.	Lack of high-quality riparian and wetland areas, embedded stream substrate (from excess sediment), 54% CQHEI scores were 65 or below	All watersheds, most notably; Keg, Robinson, Lost, Yellow, Indian, Hull.
WQ targets for TSS exceeded	Run-off transporting sediment, land management methods need improvement	Up to 81% of agricultural land still conventional tilled, roadside ditches not seeded after maintenance, removal of riparian areas, 49% streams lack sufficient buffers.	All watersheds, most notably: Keg, Robinson, Yellow, Indian, and Hull
WQ targets for NO^2/NO^3 Exceeded	Run-off transporting nutrients into streams, land and livestock management methods need improvement, substandard septic systems.	Agricultural fertilizer used without NMP, antiquated septics, lack of buffers on 49% of streams, livestock with access to streams, 30% of samples exceeded WQ target.	All watersheds except Lost
WQ targets for Total Phosphorus exceeded	Run-off transporting nutrients into streams, land and livestock management methods need improvement, substandard septic systems	Agricultural fertilizer used without NMP, lack of buffers on 49% of streams, livestock with access to streams, antiquated septics, 56% of samples exceeded WQ target.	All watersheds, most notably; Keg, Robinson, Yellow, Indian, Trippett, and Hull
Impaired biological populations	Water quality targets for TSS exceeded, lack of buffers, riparian areas, wetlands	Embedded stream substrates, 49% of streams lack buffer; lack of shade/cover; removal of riparian areas, lack of wetlands.	All watersheds, most notably; Honey, Keg, Robinson, Yellow, Indian
Cover crops and no till not utilized	Lack of information, soil health ed and seed availability, adverse weather conditions, producer doesn't own no-till equipment, prohibitive costs of cover crops, fear of termination difficulty.	Lack of education, lack of resources such as no-till equipment availability, poor weather conditions, preventative planting, prohibitive costs and fear of difficulty terminating cover crops.	All watersheds.
Water quality targets for E.coli exceed	Run-off from unmaintained septic, land and livestock management methods need improvement, public lacks awareness. Septic updates/repairs are cost prohibitive.	Manure used as fertilizer without NMP, livestock with access to stream, antiquated septics, lack of buffers and wetlands for filtering, 58% of sites exceeded WQ targets.	All watersheds, most notably; Houchins, Honey, Keg, Yellow, Indian, Trippett, Hull
Cattle with stream access and lack of rotational grazing	Producers use ditch or stream to water / cool cattle; prohibitive cost of fencing out of stream and building HUAP; prohibitive cost of additional fencing and watering system with rotational grazing.	Lack of watering systems and shelter for drinking / cooling in summer; prohibitive costs of fencing and watering systems. Lack of education regarding benefits of rotational grazing.	All watersheds, most notably; Houchins, Yellow, Trippett and Indian.
Lack of education / stakeholder attendance.	High quality, nationally known speakers / venues often difficult to secure. Food (cost-prohibitive) needed to ensure high #s attending. Ag retailers not involved. Producers only attend for PARP credits.	N/A	All watersheds
Lack of issue awareness such as soil health, invasive plants, septics, pollinators and beneficial insects.	Information is not as available/visible as it could be at this time; funding for outreach is lacking. Invasive plant species are sold at retail outlets. If producer adds practice, pollinator species are not considered / planted as part the plan.	N/A	All watersheds
Disregard of consequences of actions on water quality.	Roadside litter and illegal dumping of household trash is rampant throughout this watershed. Planting of invasive species that are being sold at local retail outlets.	N/A	All watersheds

20. CURRENT LOADS

Load Calculations Introduction

IDEM states that "*a load, in terms of water quality, is the amount of a pollutant carried by a particular waterbody within a particular timeframe such as 'tons of nitrogen per year'. A loading of pollutants may be caused by humans or occur naturally, entering the water from run-off, ground water, pipes or the air in the form of wet deposition, such as rain or snow, as well as dry deposition.*

IDEM further differentiates between loads and concentrations stating "*pollutant concentration refers to the amount of a pollutant in a defined volume of water (such as milligrams of nitrogen per liter of water); whereas loads are an equalizer that addresses how much pollution is being contributed by one stream compared to another. This is important, especially when pollutants are being contributed by both large and small streams that can be flowing fast or slow. Waterbodies carrying the same concentration of pollutant, but that differing in hydrology, may have drastically different loadings.*

This makes sense when one realizes the difference between Stream A with 500 ppm nitrogen but no flow, and Stream B with 5 ppm nitrogen and 38 cfs flow. Stream A may have a higher concentration, but it has no load; whereas Stream B has a low concentration but does have a load of 5,380 ppm/sec. As IDEM states, "*Load calculations can be obtained by multiplying concentration by discharge (flow).*"

Loads are important in watershed management plans, because U.S. EPA requires pollutant levels be reported in terms of loads. Even so, concentrations are generally used as thresholds because water samples are reported in terms of concentrations with a known level of precision and accuracy. IDEM further states that "*loads can help us to compare dissimilar streams to determine which stream segment or tributary is contributing the most pollution in a system. This allows restoration efforts to be focused in areas that are in most need. When examined seasonally or under various flow conditions, pollutant loads can help to identify sources of pollutants.*"

Estimating current loading using recent data is as simple as multiplying concentration x flow. This, of course, is an instantaneous reading and needs to be calculated periodically throughout the year and under various flow conditions to gain a more reliable estimate of load for the year. It is also interesting to consider the points along the watershed where monitoring is occurring. In the LPR monitoring, there were some subwatersheds that had samples drawn from the main stem flow, where others were taken prior to a confluence with the main stem.

As the bottom 1/4 reach of the entire watershed, the Lower Patoka has received loading from both the Upper and Middle Patoka watersheds, both in concentrations and in flow. The entire 8-digit HUC is 861 square miles, with the Lower Patoka being only 211.7 square miles. This fact affects load calculations; as water entered the LPR watershed already carrying pollutant loads. For example, the monitoring for the Hull subwatershed, taken from the main stem of the channel and at the mouth of the entire reach of the Upper, Middle and Lower Patoka, more fully represents the whole 8-digit Patoka (HUC 05120209) and not just that of the Hull subwatershed.

LPR Load Calculations

The fact that the Lower Patoka represents the lower ¼ of the entire Patoka 8-digit HUC and has pollutant loads from upstream; as well as the fact that water grab samples were analyzed only 4 times (once a quarter); resulted in load calculations being figured multiple ways to confirm load reductions are accurate and truly representative of where action is needed in the watershed.

STREAM FLOW @ SAMPLE SITES
The first step in determining subwatershed loads, was to calculate stream flow for each site. Actual stream flow readings were taken the same day as the grab samples by measuring depth, width and velocity per Hoosier Riverwatch techniques. These four flow readings were averaged together to obtain a mean for each site.

STREAM FLOW @ USGS GAGE
Data was then downloaded from the USGS in-stream gage # 003376500 just north of Princeton (38.2325; -87.3256) where the Patoka River moves under Highway 65. Stream flow data from the gage, on the same day as grab samples, was downloaded and recorded for each site. This gage represents Upper and Middle Patoka as well as 8 of the 10 Lower Patoka subwatersheds. Thus, this in-stream gage has a drainage basin of 822 square miles or 526,080 acres. Trippett (site 9) and Hull (site 10) are both located downstream from the USGS stream gage and together are 39 square miles or 25,025 acres. Upstream of gage and downstream of gage combined, total the entire reach of the HUC 8 Patoka which is 861 square miles.

While downloading USGS in-stream gage # 03376500 stream flow data, it was noticed that the gage has historic daily discharge (cf/s) readings totaling 31,144 records; 85 years of daily readings from 1935 through end of 2019. The historic mean (85 years) is 1,094.9 cf/s. The decade mean (last 10 years) is 1,375.6 cf/s and the average of the sampling years (2017 and 2018) is 1,223.2 cf/s. The historical data shows that the lowest annual average discharge was 330.1 cf/s in 1992 and the highest annual average discharge was 2,110 cf/s in 2019.

COMPARISON OF THE TWO
Once the drainage basin per site was calculated, the percent represented at the stream gage was calculated by dividing drainage acres by USGS gage drainage acres. The resulting percentage is representative of the % of the USGS gage stream flow that could be attributed mathematically as coming from each subwatershed. This % was multiplied by each of the USGS flow data readings and then averaged for a mean.

The two means (average of water sampling stream flow data and average of USGS stream flow data) were then compared to see which might better represent the actual stream flow from each 12-digit HUC subwatershed at each site. The results showed that the actual stream flow readings taken during the grab samples correctly represented the subwatersheds contribution to the main stem.

STREAM FLOW X CONCENTRATION = DAILY LOADS
To convert daily stream flow and daily concentrations into a daily load is merely a mathematical calculation. The stream flow taken day of sample x that days' pollutant concentration gave four daily load readings (one for each sampling event). These daily loads were calculated using the water monitoring data from the water study done as outlined by the QAPP. The daily loads were averaged together to determine an annual daily mean. A variable was used to concert mg/L to lbs./yr. (see pages 102-108 for details on the mathematical calculations used).

DAILY LOADS INTO ANNUAL LOADS
It must be noted that there are several ways to figure the annual load from the daily loads. One method is to average the four concentrations and multiply with the average stream flow. However, this skews the results especially since several samples had either no flow, or no traceable amount of pollutant. So, to best represent what is happening in the watershed, the flow x the concentration was calculated first resulting in four amounts (once a quarter) showcasing the daily load on the day the sample was ran.

Those four daily loads were calculated into annual loads using two methods to help ensure accuracy. First all four were averaged together and multiplied by 365 days for annual load. Then each of the four were multiplied by # of days in that quarter the reading represented. Then those four totals were averaged. The results for both methods were identical.

SITE'S DRAINAGE ACRES AND WEIGHTED LOADS

Each monitoring site was then examined to determine the number of drainage acres represented at the water monitoring site. Some sites represented part of the subwatershed they were in; other sites were on the main stem of the Patoka and represented upstream flow as well as subwatershed flow. Acres of subwatershed, draining to each site, were calculated using the Indiana Map acres tool.

The drainage area of the sampling site was compared to the actual subwatershed acres and the annual loads were weighted to correctly represent the 12-digit HUC and not just the sampling site's drainage acres. The weighted annual loads from water monitoring was then placed in a table.

For instance, Site 2 (Honey 0702) represents only 5,620 acres of Honey that drain to that site. (See Honey subwatershed Map 18 on page 66 for visual clarification of the two sites). However, Site 12 (Honey 0702) includes drainage from Houchin (0701), but none of the drainage acres from Site 2 as it is prior to the confluence. Site 12 has 27,552 drainage acres. Therefore, to correctly report pollutant and stream flow data per 12-digit HUC, results are weighted. By calculating the % of HUC represented at the site and finding a per acre amount, results can be figured that truly represent the entire 12-digit HUC.

LOADEST MODEL

Next, those same water quality data and stream flow data (for TSS, N and P) were input into the LOADEST model. This is a computer-generated loads calculation based on TSS, N and P concentrations and stream flow collected during water monitoring for each site. Stream flow data and pollutant concentrations along with dates and time of samples were entered into the program. Then target concentration (recommended values or standards, complete list is on page 55) and the watershed acres represented at the site are entered. The result is a computer-generated load which shows estimated annual load in lbs./yr. and lbs./ac/yr. The anomaly here is that funding was only available for the 4 water monitoring events (once a quarter) and the LOADEST model required at least 12 samples for load calculations. Per the watershed specialist's suggestion, the quarterly data was input repeatedly so that the 4 samples were entered as 12.

Because the LPR is near the mouth and is main stem driven, several sites represent upstream acres / concentrations. For instance, on site 4 (Robinson 802), site 8 (Indian 805) and site 10 (Hull 807) WQ samples were pulled from the main stem. In other subwatersheds, such as site 6 (Lost 803), the site represents only 58% of the entire 803 HUC. Therefore, to calculate LOADEST loads per subwatershed, the lbs./ac/yr. result was multiplied by the HUC acres in each subwatershed to more accurately represent each subwatershed's load.

L-THIA MODEL

L-THIA is a computer-generated calculation of loads based on acres, land use and rainfall of each subwatershed. An anomaly here is that stream flow is not incorporated into the totals. Some subwatersheds have little to no flow. At times, when the main stem was flooded, waters actually flowed backwards on some sites. It seems that L-THIA loads should incorporated stream flow into the equation to be accurate. However, as stream flow often is dictated by rainfall, the L-THIA data is reliable in terms of showcasing subwatersheds most negatively impacting the LPR.

E. COLI LOADS
E. coli data was collected, but as E. coli has no mass, its "load" is expressed in concentration of colony forming units (cfu). The stream flow data was used to determine daily "loads" of cfu/second which were converted to cfu/day. This number can be further calculated into colonies per year, but these numbers become astronomically large and for this WMP, comparison of subwatersheds was done with the average cfu/day.

TARGET LOADS
The target load is the pollutant load of a stream which meets the applicable water quality standard or water quality target. Water quality standards / targets are listed on Table 6, page 55. Target loads are figured the same way loads are calculated, except the acceptable standard or recommended value is used instead of the WQ monitoring concentrations. Stream flow x the standard for the pollutant gives us the daily target load for the subwatershed, which can then be calculated into the annual target load. The LOADEST computer program also gave a maximum annual load to meet targets for TSS, N and P when the WQ monitoring and stream flow data was entered. The maximum annual load was reported in both lb./yr. and lb./ac/yr. This data was compared to the WQ monitoring target for subwatershed prioritizing.

The following tables will showcase the results from the various load calculation methods by listing those loads per subwatershed as well as target loads. For review of how stream flow, averages and loads were calculated, see page 115-117.

TSS LOADS
Table 47 shows TSS loads from the water monitoring samples, LOADEST computer model and L- THIA computer model; as well as annual target loads from water monitoring samples and LOADEST. Annual target load was calculated using the water quality standard (10 mg/L) x avg stream flow x 196.46108064. This variable was used to convert mg/L to lbs./yr. (See page 102 for details on math calculations.) Pounds per year were converted to tons per year for Table 47. Page 116 gives details on how average stream flow was calculated.

Table # 47 - LPR CALCULATED LOADS AND TARGET LOADS FOR TSS (tons/yr.)							
HUC	Site #	Annual Load (WQ data)	Annual Target Load (WQ data)	Annual Load (LOADEST)	Target Load (LOADEST)	Annual Load (L-THIA)
51202090701 Houchin	1	1,145	2,287	43.7	62.35	267.2
51202090702 Honey	2	23,058	13,137	107.12	195.77	431.2
51202090703 Wheeler	3	7,480	4,594	204.2	126.13	449.6
51202090801 Keg	5	4,770	1,024	130.9	28.12	1,004.5
51202090802 Robinson	4	29,005	6,477	751.8	169.21	668.1
51202090803 Lost	6	4,916	1,637	136.1	45.34	574.8
51202090804 Yellow	7	1,004	135	21.0	2.85	626.6
51202090805 Indian	8	43,484	4,909	423.6	136.16	428.5
51202090806 Trippett	9	856	344	24.86	10.03	470.7
51202090807 Hull	10	37,731	6,450	1,100.2	188.42	891.4

PHOSPHORUS LOADS

Table 48 shows Phosphorus loads from the water monitoring samples, LOADEST computer model and L-THIA computer model; as well as annual target loads from water monitoring samples and LOADEST. Annual target load from water monitoring samples was calculated using the water quality standard (0.07 mg/L) x average stream flow x 196.46108064. This variable was used to convert mg/L to lbs./yr. (see page 104 for details on calculations.). Page 116 gives details on how average stream flow was calculated.

Table # 48- LPR CALCULATED LOADS AND TARGET LOADS FOR P (lbs./yr.)						
HUC	**Site #**	**Annual Load (WQ data)**	**Annual Target Load (WQ data)**	**Annual Load (LOADEST)**	**Annual Target Load (LOADEST)**	**Annual Load (L-THIA)**
51202090701 Houchin	1	0	32,015	414.4	872.6	5,914.8
51202090702 Honey	2	88,894	183,915	3,639.9	4,949.9	10,484.4
51202090703 Wheeler	3	16,484	64,318	1,566.3	1,757.5	10,894.9
51202090801 Keg	5	21,119	14,341	563.2	381.1	24,084.1
51202090802 Robinson	4	177,047	90,674	4,556.3	2,371.4	16,042.1
51202090803 Lost	6	27,553	22,922	1,728	633.3	13,633.3
51202090804 Yellow	7	4,867	1,893	102	38.97	15,211.4
51202090805 Indian	8	82,457	16,502	8,839.7	1,836.3	10,228.9
51202090806 Trippett	9	4,972	4,819	220.2	138.7	11,413.8
51202090807 Hull	10	143,739	78,384	4,792.2	2,637.12	21,676.6

NITROGEN LOADS

Table 49 shows N loads from the water monitoring samples, LOADEST computer model and L-THIA computer model; as well as annual target loads from water monitoring samples and LOADEST. Annual target load was calculated using the water quality standard (1.0 mg/L) x average stream flow x 196.46108064. This variable was used to convert mg/L to lbs./yr. (see page 104 for details on mathematical calculations.). Page 116 gives details on how average stream flow was calculated.

Table # 49- LPR CALCULATED LOADS AND TARGET LOADS FOR N (lbs./yr.)						
HUC	Site #	Annual Load (WQ data)	Annual Target Load (WQ data)	Annual Load (LOADEST)	Annual Target Load (LOADEST)	Annual Load (L-THIA)
51202090701 Houchin	1	581,869	457,362	31,804	12,486	24,549
51202090702 Honey	2	2,116,629	2,627,364	27,912	14,714	37,878
51202090703 Wheeler	3	726,585	2,793,934	39,811	25,109	40,321
51202090801 Keg	5	97,346	204,865	4,797	5,450	83,144
51202090802 Robinson	4	860,199	1,295,347	47,089	33,841	57,085
51202090803 Lost	6	2,145	327,462	326	9,068	46,798
51202090804 Yellow	7	63,540	27,038	2,682	5,728	52,812
51202090805 Indian	8	1,218,508	981,814	24,809	26,234	35,802
51202090806 Trippett	9	134,094	68,847	6,734	2,030	39,245
51202090807 Hull	10	9,070,384	1,539,727	75,073	37,674	74,278

E. COLI LOADS

Table 50 reports highest E. coli reading during sampling per subwatershed, as well as colonies per day from the water monitoring data. Target Load was calculated using average stream flow data x water quality standard of 235 colonies per mL, converted to colonies per day. See page 108 for details on mathematical calculations, L-THIA modeling E. coli results, conversion of colonies/mL to colonies / day, and information regarding lack of EPA-approved methods of converting colonies/mL to loads since E. coli has no mass.

TABLE # 50 - LPR CALCULATED AND TARGET LOADS FOR E COLI (colonies / day)				
HUC	Site #	Highest E. coli reading during sampling	WQ Data E. coli colonies / day	Target colonies / day
51202090701 - Houchin	1	602 cfu/100mL	15.2 trillion	13.3 trillion
51202090702 - Honey	2	166 cfu/100mL	32.1 trillion	76.89 trillion
51202090703 - Wheeler	3	172 cfu/100mL	15.9 trillion	26.89 trillion
51202090801 - Keg	5	276 cfu/100mL	3.37 trillion	6.0 trillion
51202090802 - Robinson	4	133 cfu/100mL	9.08 trillion	37.9 trillion
51202090803 - Lost	6	70 cfu/100mL	2.17 trillion	9.58 trillion
51202090804 - Yellow	7	365 cfu/100mL	0.7 trillion	0.79 trillion
51202090805 - Indian	8	2420 cfu/100mL	34.9 trillion	6.9 trillion
51202090806 - Trippett	9	276 cfu/100mL	2.2 trillion	2.02 trillion
51202090807 - Hull	10	2420 cfu/100mL	86.3 trillion	32.77 trillion

ANALYSIS OF DATA

When comparing loads and targets from these three methods, results did differ; however, overall, the results showed a very similar picture in terms of which subwatersheds were contributing higher loads (see pages 101-109 for discussion on "hot spots"). Hull (0807) and Robinson (0802) consistently were shown to be top culprits. However, there were several other subwatersheds that seemed to be needed attention also, but not consistently. The LPR steering committee discussed the loads and targets from the water monitoring data, LOADEST model and L-THIA model and worked to compare subwatersheds to gain insight as to which ones were more negatively affecting the Lower Patoka.

The LPR steering committee began to discuss ways to prioritize goals by focusing on a few subwatersheds in short-term goals (to be Tier 1 subwatersheds). Then, once efforts and resources are exhausted and there is a loss of return in time and investment, move to the next few subwatersheds with mid-term goals (to be Tier 2 subwatersheds). Subsequently, efforts should move to the long-term goals (Tier 3 subwatersheds).

The LPR steering committee discussed the L-THIA modeling data which incorporates land uses in each subwatershed. The extreme fluctuations recognizably seen from only water monitoring once a quarter and the fact that the LPR is main stem driven and near the mouth, were discussed in comparison to the L-THIA modeling. It was agreed that though the loads seemed low when compared to the WQ monitoring loads; the L-THIA modeling corrected represented the extent each subwatershed was contributing (TSS, N and P) to the LPR based on windshield surveys throughout the watershed and the "boots on the ground" observations during water monitoring. See more on L-THIA on page 51.

To help visualize how the L-THIA loads pinpoint the worse-case scenarios in the LPR, Table 51 below was created with % of total for TSS, N, P and Fecal Coliform instead of loads. In this way, the table shows the % each subwatershed is contributing rather than lbs. per acre or lbs. per year. This visual tool helped pinpoint which subwatersheds are impacting the Lower Patoka based on the L-THIA data. The three highest % for each of the pollutants is highlighted in yellow for ease of interpretation of those subwatershed that require our attention. However, there is a tie for P and TSS between Robinson (0802) and Yellow (0804). The watershed coordinator explained that the Yellow subwatershed had no flow 75% of the time and only 1.133 cf/s when flow was noted. Even if a high pollutant concentration was found at Yellow (0804) site, with no flow, there would be no load. In this way, experience in the watershed helped the LPR steering committee interpret the L-THIA modeling correctly.

TABLE # 51 L-THIA MODELING – % of Load Contribution per Subwatershed

HUC	Size (acres)	N (as % of total)	P (% of total)	TSS (as % of total)	Fecal Coliform (as % of total)
051202090701	19,010.4	0.05	0.04	0.05	0.04
051202090702	14,331.0	0.08	0.08	0.07	0.08
051202090703	15,457.4	0.08	0.08	0.08	0.08
051202090801	14,3449.5	0.17	0.17	0.17	0.17
051202090802	13,240.3	0.12	0.11	0.11	0.12
051202090803	10,630.2	0.10	0.10	0.10	0.10
051202090804	12,736.1	0.11	0.11	0.11	0.11
051202090805	10,523.4	0.07	0.07	0.07	0.07
051202090806	10,147.7	0.08	0.08	0.08	0.08
051202090807	15,055.5	0.15	0.16	0.15	0.15
Totals	135,502	1.00	1.00	1.00	1.00

21. LOAD REDUCTION GOALS

Once loads and targets are figured for each subwatershed, the reductions needed to reach target loads is merely a subtraction of target load from current loads. Table 52, page 124, lists each subwatershed with loads for N, P, TSS, and E. coli followed by the target load and then the load reduction needed to meet the target. For each subwatershed and each pollutant, the worse-case scenario was used to report current loads. The intention was to accurately portray what is occurring in the watershed and where best management practice funding should be targeted to ensure the best results. The Lower Patoka is mainstem driven and has an extension public conservation lands presence in several subwatersheds, with wetlands working to reduce pollutant loads. In addition, several water monitoring sites indicated little to no flow. For this reason, all the data was compared in a way that the worse-case scenario could be addressed and so implementation of the WMP could do the most good.

SET GOALS AND IDENTIFY CRITICAL AREAS

22. Water Quality Improvement or Protection Goal Statements

The LPR steering committee and the Gibson County SWCD have developed this WMP and it is assumed that the Gibson County SWCD will pursue a 319 grant to implement this plan. However, it is possible that another entity may seek and secure grant or private funding to implement this plan. When speaking of goals and management of future implementation of LPR WMP, this document will use the language of "grant administrator" to refer to the point person or entity.

The following goals are arranged in various steps, based on the list of Stakeholder Concerns (page 111); along with the collected water monitoring data and pollutant loads. The goals represented in this WMP reflect an adaptive resource management approach to load reductions throughout the entire LPR watershed by first focusing on three subwatersheds in a Tier One category for more short-term load reduction goals. Mid-term goals will focus on Tier One and Tier Two subwatersheds; while long-term goals will focus on the remainder of the LPR watershed.

<u>Short Term Load Reduction Goals for Tier One Subwatersheds</u> would include:

1. Reduce sediment loads by at least 5% in Tier One subwatersheds within the next 5 years.
2. Reduce nitrogen loads by at least 5% in Tier One subwatersheds within the next 5 years.
3. Reduce phosphorus loads by at least 5% in Tier One subwatersheds within the next 5 years.
4. Reduce E. coli loads by 2% in Tier One subwatersheds within the next 5 years.

<u>Mid-Term Load Reduction Goals for Tier One and Tier Two Subwatersheds</u> would include:

1. Review past work and assess for changes that need to be made. Make adjustments as needed.
2. Reduce sediment loads by at least 10% in Tier One and Two subwatersheds within the next 10 years.
3. Reduce nitrogen loads by at least 10% in Tier One and Two subwatersheds within the next 10 years.
4. Reduce phosphorus loads by at least 10% in Tier One and Two subwatersheds within the next 10 years.
5. Reduce E. coli loads by 4% in Tier One and Two subwatersheds within the next 10 years.

Long-Term Load Reduction Goals for Lower Patoka Watershed

1. Review past work and assess for changes that need to be made. Make adjustments as needed.
2. Research funding opportunities to implement BMPs and update WQ monitoring data.
3. Reduce sediment loads by at least 15% in LPR within the next 10-25 years.
4. Reduce nitrogen loads by at least 15% in LPR within the next 10-25 years.
5. Reduce phosphorus loads by at least 15% in LPR within the next 10-25 years.
6. Reduce E. coli loads by 6% in LPR within the next 10-25 years.

Habitat and Biological Goals

1. Continue to promote programs and conservation practices that establish riparian corridor, wetland habitat and field buffers and filter strips.
2. Document CQHEI and PTI score improvements on 80% of sites in the next 20 years.

Administrative Goals

1. Continue to pursue advantageous partnerships and additional funding sources in order to make improvements throughout LPR and surrounding watersheds in the future.
2. Continue to promote a variety of BMPs that will help bring about long-term behavioral changes, better land management, and continued conservation throughout the region.

ADAPTIVE RESOURCE MANAGEMENT OF LPR WMP

As with any goal-based project, an adaptive resource management approach should be used for the LPR WMP. The grant administrator should work to implement the WMP by aggressively pursuing the goals of the WMP with an adaptive management perspective. This means looking periodically and repetitively at past decisions and adjusting course as deemed necessary. Adaptive resource management means decisions should meet one or more resource management objective (either passively or actively); while obtaining information needed to improve future management decisions. Thus, this tool gives those working on the implementation of the WMP a way to reach short-term goals and milestones while also gaining knowledge to improve management in the future.

This is one reason mid-term goals start with review and adjust. The first 5 years of implementation of the WMP should enlighten grant administrators through success and failures as to the most pressing needs or changes in the watershed that are not evident (and can't be predicted) at the writing on this WMP. Likewise, for long-term goals, since there is a greater stretch of time (10-25 years), there should be an interim review process around the 15-year mark to further adapt to the needs of the LPR. It is even likely that there will be a need to revise the WMP prior to long-term goals being implemented. Implementation of the WMP is a learning process in which the grant administrator will have to grow and adjust each year of implementation to best meet long-term goals and outcomes. Adaptive resource management allows the project to proceed in the face of uncertainty, with an aim to reduce uncertainty over time through frequent review and examination. In this way, there is an increase likelihood that the LPR project will achieve full success.

TABLE # 52 LOAD TARGETS AND REDUCTION NEEDED				
HUC	**N (lbs./yr.)**	**P (lbs./yr.)**	**TSS (tons/yr.)**	**Fecal Coliform (col/day)**
051202090701				
Current Load	31,804	5,914.8	1,145	15.2 trillion
Target Load	12,486	872.6	62.35	13.3 trillion
Reduction Needed	19,318	5,042.2	1,083	1.9 trillion
051202090702				
Current Load	37,878	10,484.4	431.2	32.1 trillion
Target Load	14,714	4,949.9	195.77	76.9 trillion
Reduction Needed	23,164	5,534.5	235.4	0
051202090703				
Current Load	40,321	10,894.9	7,480	15.9 trillion
Target Load	25,109	1,757.5	4,594	26.9 trillion
Reduction Needed	15,212	9,137.4	2,886	0
051202090801				
Current Load	97,346	24,071	4,770	3.37 trillion
Target Load	5,450	14,341	1,024	6.0 trillion
Reduction Needed	91,896	9,743.1	3,746	0
051202090802				
Current Load	57,085	177,047	29,005	9.08 trillion
Target Load	33,841	90,674	6,477	37.9 trillion
6Reduction Needed	23,244	86,373	22,528	0
051202090803				
Current Load	2,145	27,553	4,916	2.17 trillion
Target Load	9,068	20,922	1,637	9.58 trillion
Reduction Needed	0	6,631	3,279	0
051202090804				
Current Load	2,682	4,867	1,004	.707 trillion
Target Load	5,728	1,893	135	.791 trillion
Reduction Needed	0	2,974	869	.0
051202090805				
Current Load	24,809	8,839.7	423.6	34.9 trillion
Target Load	26,234	1,836.3	136.2	6.9 trillion
Reduction Needed	0	7,003.4	287.4	28 trillion
051202090806				
Current Load	6,734	4,972	856	2.2 trillion
Target Load	2,030	4,819	344	2.02 trillion
Reduction Needed	4,704	153	512	0.18 trillion
051202090807				
Current Load	75,073	143,739	37,731	86.3 trillion
Target Load	37,674	78,384	6,450	32.77 trillion
Reduction Needed	37,399	65,355	31,281	53.53 trillion

As stated previously, the short-term load reduction goals in the first five years will be focused on Tier One subwatersheds. Mid-term goals and long-term goals will focus on Tier Two and Tier Three respectively. See page 129 for discussion on critical areas and how they were defined.

Table 53 below shows the calculated load reductions to achieve the WMP's goals. The current load for each subwatershed was used for N, P and TSS and multiplied by 5%. The result is 5% of the current load and the load reduction needed to obtain proposed goals. The current load for E. coli for each subwatershed was multiplied by 2% resulting in load reduction needed to obtain proposed goals.

TABLE # 53 LOAD REDUCTIONS NEEDED TO ACCOMPLISH GOALS

	HUC	N (lbs./yr.)	P (lbs./yr.)	TSS (tons/yr.)	Fecal Coliform (trillion col/day)	Time Frame
Tier One	051202090807 – Hull	1,869.95	3,267.75	1,564.05	1.0706	Short-Term Goals First 5 years
	051202090802 – Robinson	1,162.2	4,318.65	1,126.4	0.0	
	051202090801 - Keg	4,594.8	487.16	187.3	0.0	
Tier One Totals		7,626.95	8,073.56	2,877.75	1.0706	
Tier Two	051202090803 – Lost	0	331.55	163.95	0	Mid-Term Goals 5-10 years
	051202090804 – Yellow	0	148.7	43.45	0	
	051202090805 – Indian	0	350.17	14.37	0.56	
Tier Two Totals		0	830.42	221.77	0.56	
Tier Three	051202090701 – Houchin	965.9	887	54.15	0.038	Long -Term Goals 10-25 years
	051202090703 – Wheeler	760.6	1,634	144.33	0	
	051202090702 – Honey	1,158.2	1,573	11.77	0	
	051202090806 - Trippett	235.2	1,712	25.6	0.0036	
Tier Three Totals		3,119.9	5,806	235.85	0.416	

EXPERIENCE IN WATERSHED VERSES DATA ANOMALIES

As mentioned previously, there were several anomalies in the data collection that makes it invaluable to have experience in the watershed to help correlate data with what is actually happening in each subwatershed. As TSS loads increase, often N and P loads also increase, especially with agricultural lands and lack of cover crops and no-till practices. Consistently, the Tier One subwatersheds rose to the surface during discussions of where BMPs could most readily and positively impact water quality in LPR. For example, Hull (0807) subwatershed has extensive farmland (over 71%) and is at the mouth of the LPR and thus has extensive floodplains. Conversely, the South Fork Patoka (subwatersheds Houchin 0701, Honey 0702, and Wheeler 0703) enters the PRNWR wetlands prior to confluence with the main channel; and although water sampling in the South Fork showed some areas of concern, by the time the water reaches the main stem on the other side of the PRNWR wetlands, mitigation has occurred. The vast wetlands of the PRNWR have done what wetlands do. There is a drop in N and TSS prior to the confluence as well as increase in dissolved oxygen. (See page 69 for more details). As water quality improves as it moves through the PRNWR wetlands, it deems it unlikely that the South Fork would be the best target for short-term goals in the watershed. For more details on how critical areas were defined, see page 129.

23. ACHIEVEMENT INDICATORS

To achieve these goals within the stated time frames, objectives have been highlighted. These objectives will provide a clear outline for the best methods to be utilized to accomplish the previously stated goals. Success will be measured by monitoring the indicators listed in the tables below.

TABLE #54 – REDUCE TSS LOADS BY
5% IN 5 YRS in Tier 1 Critical Subwatersheds
10% IN 10 YRS in Tier 1 and 2 Critical Subwatersheds
15% IN 15-20 YEARS across entire LPR

OBJECTIVES	INDICATORS
Implement 319, LARE, CWI and other cost-share programs to put erosion-reducing BMPs in place.	▪ Tabulate # of BMPs implemented using cost-share program ▪ Measure sediment load reductions for each installed BMP using StepL or Region 5 model. ▪ Continue monitoring turbidity at each site in both high and low flow events, to track improvements. ▪ Continue annual macroinvertebrate monitoring to track success. ▪ Conduct CQHEI at each monitoring site no less than every 3 years to track improvements ▪ Track number of event attendees. ▪ Tillage transects will show increased acreage utilizing cover crops and / or no-till practices.
Promote CRP, WRP, CREP, and programs designed to establish buffers.	
Educate the public about the amount of soil that can be lost from land if reduced tillage is not practiced; promote conservation practices.	
Continue to conduct annual spring tillage transects and fall cover crop transect in Gibson and Pike Counties.	
Work with partners to pool resources for BMP implementation, future water monitoring, and / or widespread public education.	

<table>
<tr><th colspan="2">TABLE #55 REDUCE NO^2/NO^3 LOADS BY
5% IN 5 YRS in Tier 1 Critical Subwatersheds
10% IN 10 YRS in Tier 1 and 2 Critical Subwatersheds
15% IN 15-20 YEARS across entire LPR</th></tr>
<tr><th>OBJECTIVES</th><th>INDICATORS</th></tr>
<tr><td>Implement 319, LARE, CWI and other cost-share programs to put erosion-reducing BMPs in place.</td><td rowspan="5">▪ Tabulate # of BMPs implemented using cost-share program
▪ Measure nitrogen load reductions for each installed BMP using StepL or Region 5 model.
▪ Continue monitoring nitrogen using Hoosier Riverwatch methods or lab analysis to track improvements.
▪ Continue annual macroinvertebrate monitoring to track success.
▪ Conduct CQHEI at each monitoring site no less than every 3 years to track improvements
▪ Track number of event attendees.
▪ Tillage transects will show increased acreage utilizing cover crops and / or no-till practices.</td></tr>
<tr><td>Promote CRP, WRP, CREP, and programs designed to establish buffers.</td></tr>
<tr><td>Educate the public about nutrient management strategies, promote voluntary N analysis and conservation practices.</td></tr>
<tr><td>Continue to conduct annual spring tillage transects and fall cover crop transect in Gibson and Pike Counties.</td></tr>
<tr><td>Work with partners to pool resources for BMP implementation, future water monitoring, and / or widespread public education.</td></tr>
</table>

<table>
<tr><th colspan="2">TABLE #56 REDUCE Total Phosphorus LOADS BY
5% IN 5 YRS in Tier 1 Critical Subwatersheds
10% IN 10 YRS in Tier 1 and 2 Critical Subwatersheds
15% IN 15-25 YEARS across entire LPR</th></tr>
<tr><th>OBJECTIVES</th><th>INDICATORS</th></tr>
<tr><td>Implement 319, LARE, CWI and other cost-share programs to put erosion-reducing BMPs in place.</td><td rowspan="5">▪ Tabulate # of BMPs implemented using cost-share program
▪ Measure phosphorus load reductions for each installed BMP using StepL or Region 5 model.
▪ Collect total phosphorus samples using Hoosier Riverwatch methods or lab analysis to indicate improvements.
▪ Continue annual macroinvertebrate monitoring to track success.
▪ Conduct CQHEI at each monitoring site no less than every 3 years to track improvements
▪ Track number of event attendees.
▪ Tillage transects will show increased acreage utilizing cover crops and / or no-till practices.</td></tr>
<tr><td>Promote CRP, WRP, CREP, and programs designed to establish buffers.</td></tr>
<tr><td>Educate the public about nutrient management strategies; promote conservation practices.</td></tr>
<tr><td>Continue to conduct annual spring tillage transects and fall cover crop transect in Gibson and Pike Counties.</td></tr>
<tr><td>Work with partners to pool resources for BMP implementation, future water monitoring, and / or widespread public education.</td></tr>
</table>

TABLE #57 REDUCE E. coli LOADS BY 2% IN 5 YRS in Tier 1 Critical Subwatersheds 4% IN 10 YRS in Tier 1 and 2 Critical Subwatersheds 6% IN 15-25 YEARS across entire LPR	
OBJECTIVES	INDICATORS
Implement 319, LARE, CWI and other cost-share programs for BMPs that emphasize livestock management such as restricting access to streams and rotational grazing / pasture improvements.	▪ Tabulate # of BMPs implemented using cost-share program ▪ Measure load reductions for each installed BMP using StepL or Region 5 model. ▪ More producers restricting livestock from stream access. ▪ Collect E coli samples using Hoosier Riverwatch methods or lab analysis to track improvements. ▪ Track number of event attendees. ▪ Number of residences upgrading on-site septic systems as indicated by permitting trends.
Promote CRP, WRP, CREP, and programs designed to establish buffers.	
Work with Health Dept. to educate the public regarding septic system maintenance and to promote awareness of impacts of failing systems.	
Continue to conduct annual spring tillage transects and fall cover crop transects in Gibson and Pike Counties.	
Work with partners to pool resources for BMP implementation, future water monitoring, and / or widespread public education.	

TABLE #58 PROMOTE BMPs AND EDUCATE PUBLIC	
OBJECTIVES	INDICATORS
Promote CRP, WRP, CREP, and programs designed to establish buffers.	▪ Track participants in programs such as CRP, CREP, WRP. ▪ Track number of attendees at events and field days as well as social media and website traffic. ▪ Secure continued funding for increased BMP implementation.
Educate the public about buffers, filter strips, grassed waterways, wetlands; promote conservation practices that enhance stream habitat.	
Create, maintain and frequently update a website for the watershed; use Facebook, twitter, Flickr and other social media sites to promote the project and increase attendance at educational events.	
Work with partners to pool resources for workshops, field days, and other public education events.	

TABLE #59 HABITAT AND BIOLOGICAL MPROVEMENTS	
OBJECTIVES	INDICATORS
Implement 319, LARE, CWI and other cost-share programs for BMPs that address water quality and improved habitat.	▪ Tabulate # of BMPs implemented using cost-share program ▪ Measure load reductions for each installed BMP using StepL or Region 5 model. ▪ More producers restricting livestock from stream access. ▪ Track number of event attendees. ▪ Tillage transects will show habitat improvements throughout watershed.
Promote CRP, WRP, CREP, and programs designed to establish buffers.	
Educate the public about no-till and cover crop practices and streambank protection; promote conservation practices that enhance stream habitat.	
Continue to conduct annual spring tillage transects and fall cover crop transect in Gibson and Pike Counties.	

24. CRITICAL AREAS DEFINED

The Lower Patoka River Watershed Steering Committee met January 7, 2019 to discuss the data collected (historical and recent) and to determine those subwatersheds that should be targeted in the watershed as most critical and most likely to lend themselves to BMPs that could positively affect the water quality in the Lower Patoka.

First discussed was the L-THIA modeling which gave a ranking of the top three "culprits" to the nonpoint source pollution impacting the LPR (see chart on page 121). These three watersheds were Keg, Hull, and Robinson, respectively.

Next, the committee discussed the chemical, habitat and biological data recently collected by the watershed coordinator. It was noted that all 10 subwatersheds had data outside the Indiana Water Quality Standards at least once throughout the year. However, it seemed that Hull, Indian, Trippett, Yellow, Keg and Robinson, respectively, were in greater need for intervention as they had the greatest number of "fails" or concentrations outside the water quality targets.

The watershed coordinator stressed the experiences of the windshield surveys and observations while water monitoring (boots on the ground) to help guide the LPR steering committee, especially when data did not agree with what was actually happening in the watershed. There was discussion regarding the Hull watershed with over 70% farmland and extensive floodplains; as well as the fact that the South Fork Patoka (Houchin 0701, Honey 0702, Wheeler 0703) passed through PRNWR wetlands prior to confluence with the main channel. (see page 125 "Experience verses Anomalies".)

The steering committee then discussed the need for two or three "top" critical areas to be placed in a Tier 1 priority and two or three "second place" critical areas to be placed in Tier 2 priority, with the other subwatersheds listed as Tier 3. This tiered system complies with EPA's expectations of a WMP.

RANKING BASED ON WEIGHTED DATA

As stated earlier, initial review of data collected showed Hull 0807 and Robinson 0802 consistently outside of targets, but which subwatershed should join them in Tier 1 Critical was harder to pinpoint. A ranking system was developed to categorize subwatershed by assigning points based on data collection and ranking with other subwatersheds. Points were assigned to weight the data and to help rank the data in terms of high importance (greater need of intervention) to low importance. Critical areas were then determined based on this ranking system. Points were awarded in three areas and then added up for a grand total per subwatershed.

1) L-THIA modeling data for loads were ranked. Highest load placed last, lowest load ranked first. First place received a 1, second place a 2, and so on with tenth place receiving a 10. Thus, the largest number represented the highest need for intervention.

2) Monitoring data load reductions were ranked. Highest load reduction needed placed last, lowest reduction needed placed first. First place received a 1, second place a 2, and so on with tenth place receiving a 10. Thus, the largest number represented the highest need for intervention.

3) WQ Index, PTI and CQHEI were ranked. In this situation, since high numbers equaled better quality, first place was given to the highest data index numbers. Highest WQI, PTI and CQHEI numbers were placed first, and lowest index numbers placed last. First place received a 1, second place a 2, and so on with tenth place receiving a 10. Thus, the largest number represented the highest need for intervention.

The ranking points were totaled to give an overall score for each subwatershed. Table # 60 shows the scoring and ranking of the subwatersheds.

Table # 60 Ranking System for Critical Areas and Subwatersheds Ranking Scores

	0701 Houchin	0702 Honey	0703 Wheeler	0801 Keg	00802 Robinson	0803 Lost	0804 Yellow	0805 Indian	0806 Trippett	0807 Hull
L-THIA TSS	1	3	4	10	8	6	7	2	5	9
L-THIA N	1	3	5	10	8	6	7	2	4	9
L-THIA P	1	3	4	10	8	6	7	2	5	9
L-THIA E. coli	1	3	5	10	8	6	7	2	4	9
Reduction TSS needed	5	1	6	8	9	7	4	2	3	10
Reduction N needed	6	7	5	10	8	2	1	3	4	9
Reduction P needed	3	4	7	8	10	5	2	6	1	9
Reduction E coli needed	8	2	2	2	2	2	1	9	7	10
WQ Index	6	2	1	4	5	3	10	8	7	9
PTI Index	3	1	2	10	7	6	8	9	5	4
CQHEI Index	1	2	4	3	8	9	6	7	5	8
Ranking Total	36	31	45	85	81	58	60	52	50	95

The LPR steering committee noticed three subwatersheds scored above 80, reflecting the greatest need for intervention. Lowest ranking (and less stressed subwatersheds) included the South Fork Patoka and Trippett, each scoring 50 or less. The middle ranking subwatersheds scored 52-60.

Based on this data and ranking system, the steering committee concluded that the subwatersheds should be ranked as follows:
TIER 1 = 1) Hull 2) Keg 3) Robinson
TIER 2 = 4) Lost 5) Indian 6) Yellow
TIER 3 = 7) Trippett 8) South Fork Patoka

In Tier 3, the South Fork Patoka includes Houchin 0701, Honey 0702 and Wheeler 0703 (see pages 69 and 125 for PRNWR wetlands improving WQ here). Map 40 on page 133 shows the location of the Tier 1 subwatersheds. Tier 1 subwatersheds are colored to help visualize their location in the LPR. Hull 0807 is orange; Keg 0801 is blue; and Robinson 0802 is pink. Tier 2 and Tier 3 subwatersheds are all green.

The steering committee determined that Lost subwatershed (score of 58) should be placed in Tier 2 slightly in front of Indian (score of 52) and Yellow (score of 60) since Indian and Yellow have already undergone a round of implementation during a 319 grant awarded in the fall of 2013, as well as Yellow having little to no flow most of the year. The grant funding had been directed toward and offered to stakeholders in Indian, Yellow and Trippett. However, it was difficult to find landowners, producers and stakeholders willing to participate in the cost-share program. Some of the reasoning behind this lack of participation included: not wanting to participate in a government program; not wanting to use cover crops and no-till; lack of interest in conservation practices. However, there was several stakeholders outside these three subwatersheds who wanted to participate in the cost-share program. It is the hope of the steering committee that the LPR watershed be positively impacted through stakeholders learning about and participating in conservation practices such as cover crops and no-till to lessen the nutrient and sediment loads impacting the Patoka River. The steering committee knows this ranking and tier system is the best way to positively impact the watershed. It is also anticipated that Clean Water Indiana and Lake and River Enhancement grants will be pursued to supplement any 319 grant implementation secured using this document. CWI and LARE grant funds will not be limited to the Tier 1 areas as defined by this WMP and will address nutrient and sediment loads in the rest of the LPR.

25. MEASURES AND BMPs TO ADDRESS THE GOALS

There are several IDEM-approved BMP's that would be appropriate to address the goals of this WMP and to address pollutant load reductions desired. Numerous agricultural BMPs are ideal conservation practices for the problems cited in the Tier 1 subwatersheds and include, but are not limited to:

- cover crops and critical area seeding
- nutrient management
- exclusion fence, HUAP, and prescribed grazing
- filter strips, grassed waterways, and WASCOBs
- precision agriculture upgrades, no-till planter upgrades

Many of these BMPs include secondary associated practices, such as subsurface drainage or underground outlets. These practices are also designed to be implemented in conjunction with other similar BMPs as a part of a comprehensive systems approach to conservation throughout the watershed.

The NRCS practice numbers for these related practices are listed under the main BMP description (Table 62, first column) . Detailed descriptions and specifications can be found in the NRCS FOTG (Field Office Technical Guide) for Gibson and Pike Counties @ https://efotg.sc.egov.usda.gov/#/details.

IDEM-approved BMPs had load reductions estimated using the Region 5 and Step L pollutant load tools, with minor adjustments made to reflect the soil loss estimated for the watershed area according to the NRCS RUSLE soil loss equation and current tillage transect data which estimates soil loss per acre to be in the range of 1.2 to 6.8 tons/acre/year, depending on land use.

As conservation practices are implemented throughout the watershed, grant administrators can calculate pollutant load reductions quarterly or annually using the Step L and Region 5 load reduction tools. A

319 grant requires quarterly reports to IDEM as well as monthly updates to stakeholders and SWCD board of supervisors. A final report is due at the end of all 319 grants that gives a total pollutant load reduction achieved. Pollutant loads can be tabulated into a comprehensive format so that progress can be tracked and to verify when pollutant load reduction goals are achieved. The verifying of load reductions plays into the adaptive resource management process described earlier on page 123. As stakeholders review pollutant load reductions from BMP implementation, they are obtaining the information needed to improve future management decisions. Grant administrators and stakeholders can learn from successes, failures, challenges and triumphs and make adaptive resource management decisions based on knowledge gain to best work toward the WMP goals. As short-term (5 year) goals are reached, grant administrators and stakeholders can move toward mid-term and long-term goals, adapting decisions based on what has been learned.

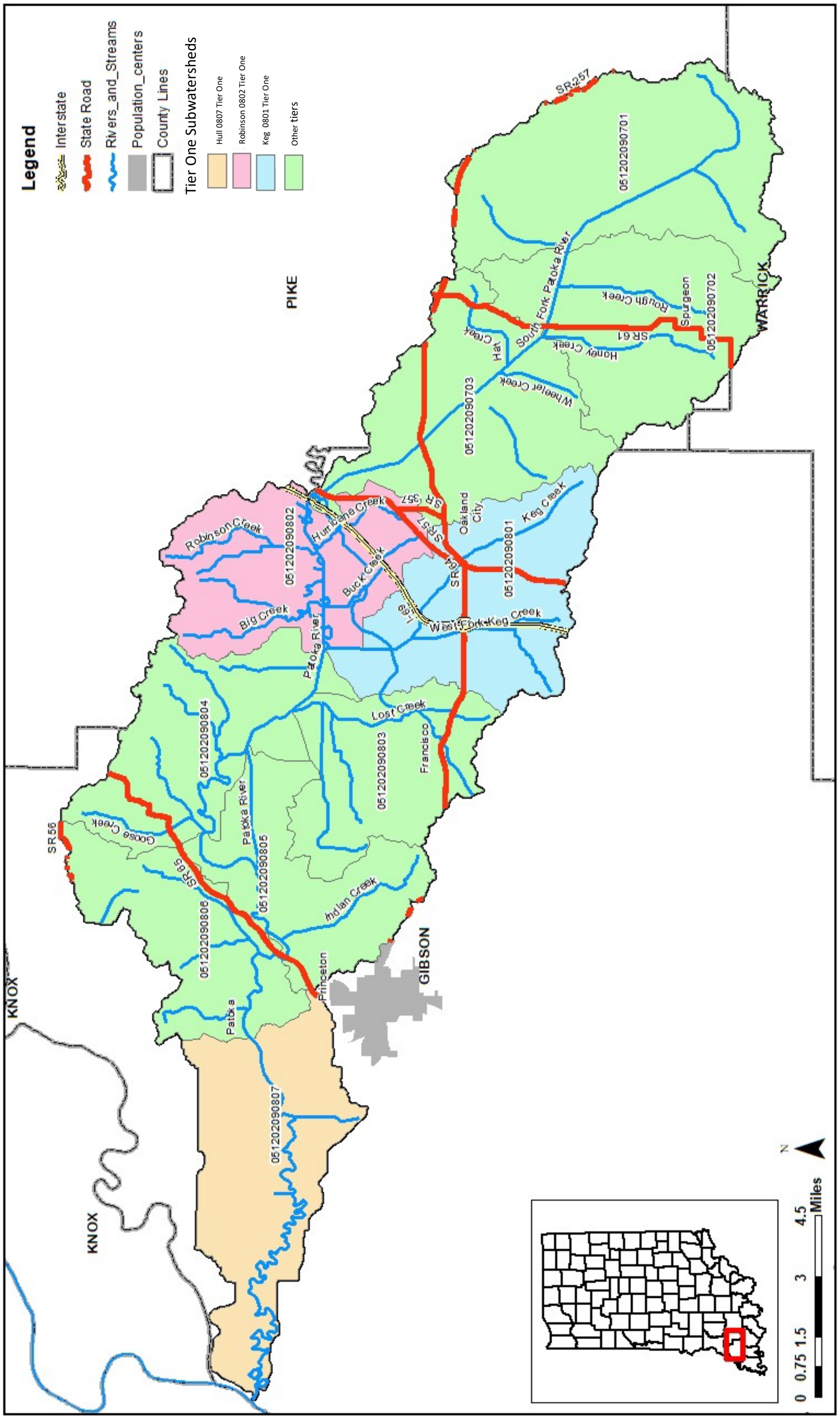
26. LOAD REDUCTION EXPECTED FOR EACH BMP

There are several BMPs approved by IDEM that result in load reductions and improved water quality. Table 62 on page 135 is a list of potential IDEM-approved BMPs and the potential load reductions for each. The LPR steering committee discussed this list and selected those that had the greatest potential for adoption by producers in the Tier One subwatersheds. Those proposed Tier 1 BMPs are listed in Table 61 on page 134. The selection decisions were possible due to previous work in the LPR and contact with stakeholders and producers interested in improving water quality through conservation measures. For the short-term goals, BMPs will be targeted at the three critical subwatersheds in Tier One. As work in the watershed continues, mid-term goals in Tier Two subwatershed can be implemented along with continuing work in Tier One. For long-term goals, the entire LPR watershed may be considered.

All load reductions and cost-estimates in Tables 61 and 62 were calculated using the best approved methods and tools. At this time, there is no approved tool for accurately calculating E.coli load reductions resulting from BMP installation, so reduction goals for E.coli loads could not be generated. Step L and Region 5 do include reduction efficiencies for septic system maintenance, livestock access restriction, or pasture management. It is possible that applicable tools for estimating and calculating E.coli load reductions will be available in the future, in which case, this WMP should be reevaluated and updated accordingly.

The BMP's proposed for achieving load reductions on Table 61 are not required to be implemented exactly as the quantities suggest. These are merely suggestions based on the experience and knowledge of the LPR steering committee who volunteer and work in the watershed. With "boots on the ground", the LPR steering committee are knowledgeable of portions of subwatersheds that are lacking certain conservation practices. These BMPs are simply proposed solutions for achieving the WMP's goals and will act as a guideline. These BMPs were chosen based on the likelihood of adoption as well as current stakeholder interest, and the local expertise of the watershed coordinator and the LPR steering committee. Practices such as cover crops, no-till planter upgrades, forage and biomass planting, and WASCOBs have been adopted by local producers in past 319 programs in adjacent watersheds and continue to generate interest throughout the LPR watershed. The proposed combinations of BMPs in Table 61, could lead to pollutant load reductions that the grant administrators find are reaching the short-term goals. As mentioned earlier, adaptive resource management techniques will help grant administrators adjust and tweak the program. It may be deemed necessary to stray from the proposed list on Table 61 and seek other IDEM-approved BMPs from Table 62.

MAP 40– LOWER PATOKA RIVER WATERSHED
CRITICAL SUBWATERSHEDS



The ultimate BMP promotion would be a conservation "systems approach". Several practices, such as prescribed grazing and equipment modifications will have load reductions every year after implementation; however, for the purposes of these estimates, will only be counted singly. Likewise, a reduced-till producer who purchase no-till equipment and begins a systematic change to no-till farming will have a life-long effect on the watershed, as the same acreage year after year is no longer disturbed. However, for the purposes of these estimates, BMP practices such no-till equipment will only be counted singly. Thus, in Table 61, when cover crops are listed as potential BMP and a set number of acres are listed, those acres can be planted at any time in the 5-year spread, such as 400 acres a year or 1,000 acres in two years.

BMP adoption and success is closely tied to the participation of local producers. Continued promotion and conservation planning with a 'systems approach' will be necessary for the successful installation of load-reducing BMPs in the future. Many of the proposed conservation practices are popular or easy to implement and are listed on the suggested BMP table (Table 61 on page 134). However, WMP implementation is not limited to these few suggestions. Table 62 on page 135 is a more extensive listing of IDEM approved BMPs.

Long-term strategies for BMP implementation throughout the LPR watershed are highly dependent on continued promotion of conservation practices in the future. An adaptive resource management approach will need to be applied, starting with Tier One critical areas first. Initial implementation efforts during the first five years of the project will also help encourage widespread continuous adoption of many beneficial cropping practices such as cover crops, no-till, filter strips, and nutrient management. In this expansive manner, goals can realistically be achieved, though difficult to track with exactitude. Future water monitoring may be necessary to verify the extent to which pollutant loads have been reduced.

Table 61 below shows suggested BMPs that may be considered for the Tier One critical subwatersheds of Hull Ditch 0807, Keg 0801 and Robinson 0802.

Table # 61 – Short-Term Goals: Reduce Sediment and Nutrient Loads by 5% in 5 years					
To be implemented in Tier One Critical HUCs			Hull Ditch 0807 / Robinson 0802 / Keg 0801		
Suggested BMP	**UNIT**	**Estimated COST**	**N Reduction lbs./yr.**	**P Reduction lbs. / yr.**	**Sediment Reduction tons/ yr.**
Cover Crops	2,000 acres	$80,000	16,800	19,200	1,000
Tillage Management / Upgrades	2,000 acres	$80,000	24,000	6,000	2,000
WASCOBs	1 structure	$25,000	50	50	50
Forage and Biomass Planting	50 acres	$12,500	650	350	25
Livestock Watering Facility	one structure	$1,500	340	60	1.35
HUAP	100 sq. ft.	$500	400	200	5
Conservation Cover	100 acres	$4,000	840	960	50
Wetland Restoration	100 acres *	$10,000	900	500	200
TOTAL REDUCTION WITH IMPLEMENTED BMPS			**43,980**	**27,320**	**3,331.35**

* *The wetland restoration goal is possible in this watershed due to the presence of the Patoka River National Wildlife Refuge which is still actively purchasing farmland and converting it back to wetlands or planting bottomland hardwood forests.*

Table # 62 IDEM-Approved BMPs Information						
NRCS Practice Number and BMP or Measure	Critical Areas	WQ Concern (Reason Critical	Estimated Load Reduction for BMP			Estimated Cost / Unit
			Nitrogen lbs./yr.	Phosphorus lbs./yr.	Sediment tons/yr.	
472 - Access Control **382 -** Fence (linear feet)	(All) Hull, Robinson, Keg	TSS, Nutrients, E. Coli, Habitat, Bio	8.9	3.1	0.1	$2 / linear ft.
528 / 516 / 558 - Prescribed Grazing, Pasture Seeding (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, E. coli, Habitat, Bio.	40	30	0.6	$26 / acre
575 / 578– Animal Trails and Walkways (linear feet)	(All) Hull, Robinson, Keg	TSS, Nutrients, E. coli, Habitat, Bio.	8.9	3.1	0.1	$2 / linear ft.
340 – Cover Crops (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	8.4	9.6	0.5	$40 / acre
327 / 635 – Conservation Cover (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	8.4	9.6	0.5	$40 / acre
342 – Critical Area Planting (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	23.5	8.2	1.0	$500-$2,000 / acre
362 / 606 - Diversion (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	11	4.3	0.2	$ 4 / ft.
386 / 393 / 332 – Field Border / Filter Strip (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	23.5	8.2	0.3	$ 600 / ft.
512 - Forage and Biomass Planting (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	13	7	0.5	$ 100 - $250 / acre
410 – Grade Stabilization Structure (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	2	1	1	$ 50 - $650 / structure
412 – Grassed Waterway (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	0.1	0.1	0.1	$ 6 / ft.
560 / 561 HUAP /Access Protection (sq. ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	4	2	0.05	$ 500 - $2,500 / structure
590- Nutrient Management Plan (single plan / per acre)	(All) Hull, Robinson, Keg	Nutrients, Habitat, Bio	12	n/a	n/a	$ 11 - $30 / acre
345 / 585 – Residue and Tillage Management - Mulch /Strip Till (per acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	10	2	1	$ 40 / acre
329 / 585 – Residue and Tillage Management - No-till (per acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	12	3	1	$ 40 / acre
391 / 390 / 395 Riparian Buffer, Forest, Herbaceous (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	12	6	1	$ 700 - $2,000 / acre
580- Streambank and Shoreline Protection (linear ft.)	(All) Hull, Robinson, Keg	TSS, Habitat, Bio	8.9	3.1	.2	$ 50 / ft.
554 / 587 / 606 / 620 – Drainage Water Management and Water Control Structure (single structure)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	.52	.41	.96	$ 2,000 / structure
600 / 606 / 620 – Terrace (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	26.5	10.4	0.2	$ 3 / ft.
612 / 338 – Tree and Shrub Establishment (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	11.4	4.4	0.5 / acre	$ 700 / acre
638 / 606 / 620 WASCOB (linear ft.)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	0.1	.01	.01	$ 2,000-$25,00 per WASCOB system
614 / 533 / 516 / 574 / 642 – Watering Facility (single structure)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	340	60	1.35	$ 1,500-$8,000 per structure
656 / 658 / 659 / 657 – Wetland Creation, Enhancement, Restoration (acre)	(All) Hull, Robinson, Keg	TSS, Nutrients, Habitat, Bio	9	5	2	$ 400-$5,000 per acre

The BMPs suggested in Table 61 can be implemented relatively easily in Tier One subwatersheds of Hull 0807, Keg 0801 and Robinson 0802. The cover crops and tillage management can be focused on the Hull and Keg subwatersheds where extensive agricultural fields are planted. Cover crops and reduced tillage practices can assist producers in managing nutrient and pesticide applications as fields stay green throughout the winter months, and producers determine to plant their cash crops into the cover crops rather than till prior to planting. The Robinson subwatershed is home to PRNWR which is actively purchasing lands to restore to wetland or to plant to conservation cover. The PRNWR is also actively planting trees on reclaimed land along the Patoka River which would benefit water quality as well as improve CQHEI and PTI scores in the subwatershed. Livestock and HUAP can be targeted to conservation minded livestock producers in the Keg subwatershed.

27. ACTION REGISTER AND SCHEDULE

To make successful strides toward accomplishing the WMP's goals, and to help lead in the implementation of the WMP, a list of objectives needed have been described in the following action register. The LPR steering committee and other interested parties can use this Action Register as a tool to track progress. It will also serve as a reference document to periodically consult throughout the project to ensure that all goals will be met in a timely fashion.

GOALS

Short Term Load Reduction Goals for Tier One Subwatersheds would include:

5. Reduce sediment loads by at least 5% in each subwatershed within the next 5 years.
6. Reduce nitrogen loads by at least 5% in each subwatershed within the next 5 years
7. Reduce phosphorus loads by at least 5% in each subwatershed within the next 5 years
8. Reduce E. coli loads by 2% in each subwatershed within the next 5 years

Mid Term Load Reduction Goals for Tier One and Two Subwatersheds would include:

1. Review past work and assess for changes that need to be made. Make adjustments as needed.
2. Reduce sediment loads by at least 10% in each subwatershed within the next 10 years.
3. Reduce nitrogen loads by at least 10% in each subwatershed within the next 10 years
4. Reduce phosphorus loads by at least 10% in each subwatershed within the next 10 years
5. Reduce E. coli loads by 4% in each subwatershed within the next 10 years

Long-Term Load Reduction Goals for LPR Subwatershed

1. Review past work and assess for changes that need to be made. Make adjustments as needed.
2. Seek funding opportunities to implement BMPs and update WQ monitoring data.
3. Reduce TSS loads by 15% in each subwatershed within the next 10-25 years.
4. Reduce Nitrogen loads by 15% in each subwatershed within the next 10-25 years.
5. Reduce Phosphorus loads by 15% in each subwatershed within the next 10-25 years.
6. Reduce E. coli loads by 6% in each subwatershed within the next 10-25 years.

Habitat and Biological Goals

1. Continue to promote programs and conservation practices that establish riparian corridor, wetland habitat and field buffers and filter strips.
2. Document CQHEI and PTI score improvements on 80% of sites in the next 20 years.

Administrative Goals

1. Continue to pursue advantageous partnerships and additional funding sources in order to make improvements throughout LPR and surrounding watersheds in the future.
2. Continue to promote a variety of BMPs that will help bring about long-term behavioral changes, better land management, and continued conservation throughout the region.

Organizations and partners listed below are not technically obligated to fulfill requirements as stated. This list is intended to serve as a guideline for current and future steering committee members and other project associates. This Action Register is based on the likelihood of a partnership as well as the group's current interest and involvement at the time of this writing.

Table # 64 – LPR Watershed Action Register for TSS					
Goals 1 and 5 – Reduce TSS by 5% in the next 5 years and 15% within the next 20-25 years.					
Problem Statement: TSS pollutant loads exceed water quality targets.					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Implement cost-share program to implement BMPs.	Landowners, Stakeholders, Agricultural Producers, General Public	Develop cost-share program as well as potential participants contact list. Achieve short-term load reduction goal for Tier 1 critical areas. (5% in 5 yrs.) Achieve mid-term load reduction goal for Tier 1 /Tier 2 critical areas. (10% in 10 yrs.) Achieve long-term load reduction goal in all watersheds (15% in 20-25 yrs.)	2,000 to promote; $200,000 to implement	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff	Number of BMPs implemented and participating producers. Sediment load reductions calculated for each BMP. Continued turbidity monitoring; macro, CQHEI and WQI monitoring.
Seek funding source to promote buffer establishment.		Acquire funding and match sources through grant applications and cross-promotion of programs. (5 and 10 year goals)	$100-$500 per acre		Increased # BMPs implemented throughout watershed; increased load reductions; movement toward goal.
Conduct spring and fall tillage transects.		Record tillage transect data and compare records each year. (5, 10, 15, 20, 25 year goal).	$500		Transects reflecting increased cover crop and no-till acres; fewer conventional tilled acres.
Educate public about soil erosion and conservation practices.		Newsletter articles, website updates, brochures distributed, advertise cost-share program, workshops and field days. (Annual goal of 3 x per year)	$2,500		Number of publications distributed, number of individuals on contact list, increased web traffic, attendance at events.
Pool resources with partners for BMP, monitoring and education.		Field day to highlight BMPs, assist with partner workshops and events, acquire additional funding through partnerships. (5-10 year goals)	$1,500		Track attendance at events, observe social media traffic, additional funding secured through CWI, LARE or other sources.

Table # 65 – LPR Watershed Action Register for N					
Goals 2 and 6 – Reduce N Loads by 5% in the next 5 years and 15% within the next 20-25 years.					
Problem Statement: Nitrate / Nitrite pollutant loads exceed water quality targets.					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Implement cost-share program to implement BMPs.	Landowners, Stakeholders, Agricultural Producers, General Public	Develop cost-share program as well as potential participants contact list. Achieve short-term load reduction goal for Tier 1 critical areas. (5% in 5 yrs.) Achieve mid-term load reduction goal for Tier 1 /Tier 2 critical areas. (10% in 10 yrs.) Achieve long-term load reduction goal in all watersheds (15% in 20-25 yrs.)	2,000 to promote; $200,000 to implement	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff	Number of BMPs implemented and participating producers. Nitrate/Nitrite load reductions calculated for each BMP. Continued water monitoring; macro, CQHEI and WQI monitoring.
Seek funding source to promote buffer establishment.		Acquire funding and match sources through grant applications and cross-promotion of programs. (5 and 10 year goals)	$100-$500 per acre		Increased # BMPs implemented throughout watershed; increased load reductions; movement toward goal.
Conduct spring and fall tillage transects.		Record tillage transect data and compare records each year. (5, 10, 15, 20, 25 year goal).	$500		Transects reflecting increased cover crop and no-till acres; fewer conventional tilled acres.
Educate public about soil erosion and conservation practices.		Newsletter articles, website updates, brochures distributed, advertise cost-share program, workshops and field days. (Annual goal of 3 x per year)	$2,500		Number of publications distributed, number of individuals on contact list, increased web traffic, attendance at events.
Pool resources with partners for BMP, monitoring and education.		Field day to highlight BMPs, assist with partner workshops and events, acquire additional funding through partnerships. (5-10 year goals)	$1,500		Track attendance at events, observe social media traffic, additional funding secured through CWI, LARE or other sources.

Table # 66 – LPR Watershed Action Register for P					
Goals 3 and 7 – Reduce P Loads by 5% in the next 5 years and 15% within the next 20-25 years.					
Problem Statement: Total Phosphorus pollutant loads exceed water quality targets.					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Implement cost-share program to implement BMPs.	Landowners, Stakeholders, Agricultural Producers, General Public	Develop cost-share program as well as potential participants contact list. Achieve short-term load reduction goal for Tier 1 critical areas. (5% in 5 yrs.) Achieve mid-term load reduction goal for Tier 1 /Tier 2 critical areas. (10% in 10 yrs.) Achieve long-term load reduction goal in all watersheds (15% in 20-25 yrs.)	2,000 to promote; $200,000 to implement	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff	Number of BMPs implemented and participating producers. Total P load reductions calculated for each BMP. Continued water monitoring; macro, CQHEI and WQI monitoring.
Seek funding source to promote buffer establishment.		Acquire funding and match sources through grant applications and cross-promotion of programs. (5 and 10 year goals)	$100-$500 per acre		Increased # BMPs implemented throughout watershed; increased load reductions; movement toward goal.
Conduct spring and fall tillage transects.		Record tillage transect data and compare records each year. (5, 10, 15, 20, 25 year goal).	$500		Transects reflecting increased cover crop and no-till acres; fewer conventional tilled acres.
Educate public about soil erosion and conservation practices.		Newsletter articles, website updates, brochures distributed, advertise cost-share program, workshops and field days. (Annual goal of 3 x per year)	$2,500		Number of publications distributed, number of individuals on contact list, increased web traffic, attendance at events.
Pool resources with partners for BMP, monitoring and education.		Field day to highlight BMPs, assist with partner workshops and events, acquire additional funding through partnerships. (5-10 year goals)	$1,500		Track attendance at events, observe social media traffic, additional funding secured through CWI, LARE or other sources.

Table # 67 – LPR Watershed Action Register for E. coli					
Goals 4 and 8 – Reduce E. coli Loads by 2% in the next 5 years and 6% within the next 20-25 years.					
Problem Statement: E. coli pollutant loads exceed water quality targets.					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Promote, and when possible fund, conservation practices that emphasize livestock management and implement suggested BMPs when possible.	Landowners, Stakeholders, Agricultural Producers, General Public	Develop cost-share program as well as potential participants contact list. Achieve short-term load reduction goal for Tier 1 critical areas. (2% in 5 yrs.) Achieve mid-term load reduction goal for Tier 1 /Tier 2 critical areas. (4% in 10 yrs.) Achieve long-term load reduction goal in all watersheds (6% in 20-25yrs.)	2,000 to promote; $200,000 to implement	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff, soil scientist, Health Dept. staff	Number of BMPs implemented and participating producers. When possible, calculate E. coli loads and compare to baseline data. Continued water monitoring; macro, CQHEI and WQI monitoring.
Seek funding source to promote buffer establishment.		Acquire funding and match sources through grant applications and cross-promotion of programs. (5 and 10 year goals)	$100-$500 per acre		Increased BMPs implemented throughout watershed; increased load reductions; movement toward goal.
Work with contractors and Health Dept. to promote septic system education		Produce and distribute septic maintenance brochures at events, county fairs, and field days. (Annual goal of 3 x year).	$500		Increased number of residences with upgraded septic systems as indicated per permits.
Educate stakeholders about livestock and pasture management and applicable conservation practices.		Newsletter articles, website updates, brochures distributed, advertise cost-share program, workshops and field days. (Annual goal of 3 x per year)	$2,500		Number of publications distributed, number of individuals on contact list, increased web traffic, attendance at events.
Pool resources with partners for BMP, monitoring and education.		Field day to highlight BMPs, assist with partner workshops and events, acquire additional funding through partnerships. (5-10 year goals)	$1,500		Track attendance at events, observe social media traffic, additional funding secured through CWI, LARE or other sources.

Table # 68– LPR Watershed Action Register for Riparian and Macros					
Goals 9 and 10 – Promote Riparian and Wetland Habitat to Improve CQHEI and PTI Scores					
Problem Statement: Lack of quality riparian areas with CQHEI and PTI scores below targets.					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Implement 319, CWI and other cost-share programs to implement BMPs that enhance riparian and wetland habitat.	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	Develop cost-share program as well as potential participants contact list. (5-10 year goals) Achieve goal for improved CQHEI and PTI scores within next 20 years.	2,000 to promote; $100,000 to implement	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff, soil scientist, Health Dept. staff	Number of BMPs implemented and participating producers. Continued sediment monitoring to show reduction; macro, CQHEI and WQI scores improve.
Promote CRP, WRP, CREP and other cost-share programs designed to improve riparian and wetland habitat.		New landowners enroll in buffer programs, implement over 2,000 ft. new filter strips in watershed. (5-10 year goals)	$5,000		Sediment load reductions as a result of BMP implementation; macro, CQHEI and WQI scores improve.
Pool resources with partners and pursue additional funding for BMPs monitoring and education.		Assist with partner field days, acquire additional funding sources through partnerships. (5,10,15,20,25 year goals)	$1,500		Track attendance at events, observe social media traffic, additional funding secured through CWI, LARE or other sources, additional BMPs implemented.
Educate public and stakeholders about wetlands, buffers, and streambank conservation.		Newsletter articles, website updates, brochures distributed, advertise cost-share program, workshops and field days. (Annual goal of 3 x per year)	$2,500		Number of publications distributed, number of individuals on contact list, increased web traffic, attendance at events.
Conduct tillage transect in spring and fall.		Record tillage transect data and compare records each year. (5,10,15,20,25 year goalsl)	$500		Transects reflecting increased cover crop and no-till acres; fewer conventional tilled acres.

Table # 69 – LPR Watershed Action Register for BMP Funding and Partnerships					
Goals 11 and 12 – Purse Partnerships and Additional Funding to Promote BMPs					
Problem Statement: Lack of conservation awareness; need for continued funding to promote BMPs					
Objective(s)	Target Audience	Milestone(s)	Cost	Partners and Technical Assistance	Goal Indicator
Improve WQ through better habitats and land management; target non-point sources	Landowners, Stakeholders, Agricultural Producers, General Public, County Officials	Update social media and website with information and statistics to encourage stakeholders to "follow" and to increase "hits". (Quarterly goal)	$250	Partners include steering committee, SWCD board of supervisors, DNR, ISDA, TNC, Hoosier Riverwatch volunteers, Refuge and Friends of Patoka, seed and implement dealers, and NRCS. Technical Assistance includes NRCS, ISDA, TNC, local agronomist, Purdue Extension, Hoosier Riverwatch staff, soil scientist, Health Dept. staff	Increased traffic on website and social media; public interest in land management solutions.
Encourage new producers to enroll in cost-share program.		Promote cost-share programs and conservation practices at workshops, field days, county fairs and meetings. (annual goal of 3 x year)	$200		New BMPs installed, pollutant load reductions tabulated, new farmers develop new land management habits.
Pursue mutually beneficial partnerships with local organizations.		Recruit additional steering committee members; stay connected with Friends of Patoka River. (Quarterly goal)	$250		New stakeholders attend meetings.
Educate producers about the benefits of BMPs and conservation.		Organize small group (coffee shop) meetings of producers to discuss BMP challenges and successes and new technology. (Annual goal of 2 x year)	$2,000 to promote; $100,000 for BMPs		Number of small group meetings; number attending the meetings; new BMP installation and pollutant load reductions tabulated.

28. INTERIM MILESTONES

As grant administrators work toward accomplishing the WMP's goals through BMP implementation and education and outreach, adaptive resource management techniques will be used to measure goals and milestones and adjust accordingly. Measurable milestones can be found for each goal in Tables on pages 137-142. After the short-term goals are targeted in the first 5 years of implementing the WMP, stakeholders in the watershed will focus on mid-term milestones of 10 years, and then move toward long-term goals of 15-25 years. Interim review of goals at 15 years as part of the adaptive resource management approach is critical to the success of the project. Decisions based on past experiences will help stakeholders adjust mid-term, interim and long-term goals. For more on adaptive resource management, see page 123.

29. ESTIMATE OF FINANCIAL COST FOR EACH OBJECTIVE

Objectives to help reach the goals of the WMP will be accomplished with grant funding such as 319 grants, CWI grants, LARE grants or foundation grants secured through partners such as TNC or Friends of Patoka River. Stakeholders, partners and producers as well as staff will provide match dollars and in-kind services. The estimated cost of each objective is listed in the tables on pages 137-142.

The cost of each BMP is listed as an estimated cost. Table 61 on page 134 lists a selection of BMPs costing an estimated $213,500. Part of the BMPs listed include wetland restorations. The LPR is fortunate to have the PRNWR in the watershed. The PRNWR is actively purchasing farmland and converting it back to wetlands and bottomland hardwood forests and are seeking grants and federal funding to implement these practices. The PRNWR successfully secured Toyota, Duke Energy, Walton Foundation and US FWS grants in 2018 and 2019. It is anticipated that grant resources for the PRNWR will continue to positively impact the LPR.

30. DETERMINE POSSIBLE PARTNERS

Possible partners for LPR watershed goals include Gibson County SWCD board of supervisors and office staff; Pike County SWCD board of supervisors and office staff; faithful Lower Patoka steering committee members particularly Tom Mosley and Bill McCoy; The Nature Conservancy and Brad Smith; the Patoka River National Wildlife Refuge staff and the Friends of the Patoka River; Mike Stillwell and Gibson County Solid Waste Department; Chuck Lewis and Gibson County Highway Department; Duke Energy and Toyota Foundation who offer grant funding opportunities in the watershed; concerned involved citizens and conservation minded stakeholders. Finding the right group of people who are committed to improving water quality and who are willing to volunteer themselves to the effort is the key to the success of this project.

31. TECHNICAL ASSISTANCE NEEDED TO IMPLEMENT THE PLAN

Indiana is unique in that it has the Indiana Conservation Partnership which is comprised of eight Indiana agencies and organizations that share a common goal of promoting conservation. The mission of the ICP is to provide technical, financial, and educational assistance needed to implement economically and environmentally compatible land and water stewardship decisions, practices and technologies. Those eight agencies include the USDA Natural Resource Conservation Service, USDA Farm Service Agency, Indiana State Dept. of Agriculture, IDEM, Indiana Dept. of Natural Resources, State Soil Conservation Board, the Indiana Association of Soil and Water Conservation, and Purdue University Extension. These eight have a formal memorandum of agreement signed January 2010, which ensures collaboration and assistance between each.

Through the ICP, technical assistance needed to implement the WMP is ensured from NRCS technical staff, NRCS District Conservationist, ISDA and ISDA resource specialist, Purdue Extension staff, and the IDEM watershed specialist. In addition, Gibson County and Pike County SWCDs have solid working relationships with soil scientists, Health Dept. staff, The Nature Conservancy, local agronomists, and Hoosier Riverwatch staff. Having this kind of expertise and commitment to improve water quality in each partner is key to the success of this project.

32. STRATEGY TO TRACK GOAL INDICATORS AND EVALUATE EFFECTIVENESS

To determine the overall success and effectiveness of the LPR Watershed Management Plan over time, milestones must be recorded for future reference.

Tracking Effectiveness of BMPs

To tabulate total load reductions, each BMP associated with 319 funding or other watershed initiative funded projects will be tracked and evaluated by the grant administrator. Depending on the type of

BMP installed, a load reduction calculation will be determined using programs such as StepL, Region5, or another approved option. Gibson County SWCD or whomever is implementing the WMP will be responsible for calculating and recording the load reductions for each installed BMP as well as overall load reductions for each critical area as time passes. Typically, load reduction summaries will be provided in annual updates at LPR steering committee meetings and the Gibson and Pike SWCD monthly board of supervisors as well as at the IASWCD Annual Meetings usually held in January in Indianapolis. In addition, load reduction accomplishments will be highlighted in the 319 final report.

Table 62 on page 135 in this WMP provides information regarding the cost per unit for implementing each BMP, as well as the calculable load reduction for each practice. The load reductions listed are estimates ran through the Region 5 Model. They can only be considered estimates as variables such as soil types for cover crops and slopes / lengths of grassed waterways and WASCOBs are not known and were therefore estimated. The actual load reduction for a project can vary once the project's true and accurate numbers are put into the Region 5 model; or if another load reduction calculation model is used. However, for this WMP, an average was used to provide a fair representation of an estimate load reduction for each BMP. The cost of each BMP is listed as well and is estimated costs per unit. However, the BMPs provided are merely suggestions for guidance when working towards reducing pollutant loads in tier one critical areas (short-term) as well as throughout the entire LPR watershed (long- term).

The grant administrators can hire a watershed coordinator to oversee the cost-share aspect of any 319 implementation grant secured, though NRCS District Conservationist, NRCS Conservation Technical Team, ISDA Resource Specialists, and other partner personnel may assist with conservation planning, inventory and evaluations, engineering designs, and verification of proper installation.

IDEM 319 funding requirements state that grant applications can only be considered from a municipality, county government, state government, federal government, college/university or a nonprofit 501(c)3. Whether a 319 grant is pursued by Gibson or Pike SWCDs or some other entity is yet to be known; however, whomever pursues the grant will be the entity to issue payments and track financial records accordingly.

Water Quality Monitoring

IDEM does have plans to monitor in the Patoka watershed in 2021. However, ongoing water monitoring involving laboratory analysis is often cost-prohibitive. Stakeholders in the watershed can seek out partnerships with agencies such as Duke Energy, Toyota and The Nature Conservancy to obtain additional funding for periodic lab analyses of water samples in the LPR. Performance monitoring by IDEM will occur as warranted based on likelihood of seeing improvements in water quality due to BMP implementation.

If funding is lacking, HRW techniques can be used to track macroinvertebrate populations, CQHEI scores, and flow as well as measure N, turbidity and E. coli. And although Hoosier Riverwatch techniques cannot measure total phosphate, it can measure orthophosphates which help indicate potential for algae blooms. The HRW techniques can also measure DO, BOD^5, pH and water temperature. When all measurements are coupled together, the result is a water quality index (WQI) that can be compared to other streams in the watershed, as well as compared to the WQ index baseline data collected for each subwatershed at the writing of this WMP.

The Hoosier Riverwatch loaner kit is available and can be utilized on a regular basis. Monitoring using the HRW loaner kit has been occurring in this watershed since 2006 and no doubt will continue, on a routine basis, with those in the community who are already trained and who understand the program. These dedicated volunteers will continue monitoring for the foreseeable future, as long as HRW continues to offer the free testing supplies.

If a 319 grant is awarded to implement this WMP, then those administering the grant can ensure the continued routine monitoring of the 13 sites in this WMP. Water quality monitoring, assessment of macroinvertebrates and update of CQHEI scores will be a means to assist in management of goals, including establishment of milestones and adaptively changing goals accordingly.

If monitoring ceases, it can be resumed, with comparisons being drawn from the baseline data collected for this WMP. Additionally, other agencies may be monitoring in the area, and partnerships can be cultivated that will result in the sharing of mutually beneficial data.

Social Indicators

Social indicators are difficult milestones as they are often gradual and vague in nature. However, the LPR watershed has the PRNWR and the Friends of the Patoka River that are dedicated to fostering positive changes when it comes to conservation. Attendance is already being tracked at PRNWR events and first-time attendee numbers to the Refuge are noted.

Other tangible ways to observe social indicators include periodic windshield surveys and the fall and spring tillage transects. Attendance at conservation field days, events, fair booths, planter clinics, and annual meetings can indicate interest in conservation as well as social media and online activity observed by ‘hits’ as well as the number of ‘followers’ on Facebook, Twitter, and Flickr. A database of contacts can be maintained, and periodic email updates may be sent. Traffic and inquiries in the USDA service center will also be noted when it comes to specific inquiries related to LPR watershed resource concerns.

Tracking of Administrative Successes

Administrative successes can be tracked by the goals and milestones clearly outlined in tables in this WMP. Those implementing the WMP can use the Action Register as a guideline when devising strategies for achieving the stated LPR watershed goals.

If funding for implementation is secured, the grant administrator will be chiefly responsible for tracking and reporting all administrative successes, including load reductions, number of BMPs successfully installed, match/in-kind contributions, database of contacts, online media, and event participation/attendance. The grant administrator will also be responsible for the comprehensive final report expected at the conclusion of each 319 grant.

33. FUTURE WMP ACTIVITY

This WMP is intended to be a resource for interested parties, now and in the future. Data collected via monitoring is funding-dependent; the data collected for this LPR Watershed Management Plan was to establish baseline pollutant loads that would allow the LPR Steering Committee to prioritize critical areas and make decisions regarding the most efficient courses of action. Monitoring, using Hoosier Riverwatch, should continue on a routine basis, along with an annual macroinvertebrate assessment and the CQHEI updated every three years. Additional water monitoring with lab analysis may take place in the future, if funding permits.

A previous 319 implementation grant was awarded and completed. However, a second round of implementation could not be completed without a WMP written and approved following the 2009 checklist. Therefore, the LPR steering committee and Gibson County SWCD board of supervisors undertook the task of updating the LPR WMP with the goal of seeking implementation dollars.

This plan is designed to provide a comprehensive overview of the resource concerns observed within the LPR watershed at the time of this writing. It may be adapted as future needs require and should be revised when critical areas, load reductions, and/or land uses are believed to have changed significantly in any way. This WMP should be reevaluated every three years and revised after a maximum of 25 years have elapsed. All grant administrators should use adaptive resource management techniques to properly implement this WMP and should look to revise this Watershed Management Plan when changes in the LPR (or changes in EPA or IDEM rules) deem it necessary to do so.

Any questions regarding this document may be directed to:

Gibson County SWCD
229 S Second Avenue
Princeton, IN 47670
812.385.5033 ext. 3

APPENDIX A: Indiana, Gibson County's Endangered, Threatened and Rare Species

Species Name	Common Name	Federal	State
Crustacean: Malacostraca			
Caecidotea beattyi	An Isopod		critically imperiled in state
Orconectes indianensis	Indiana Crayfish		Rare
Mollusk: Bivalvia (Mussels)			
Cumberlandia monodonta	Spectaclecase	Endangered	Extirpated
Cyprogenia stegaria	Eastern Fanshell Pearlymussel	Endangered	Endangered
Epioblasma flexuosa	Leafshell		Extirpated
Epioblasma propinqua	Tennessee Riffleshell		Extirpated
Epioblasma torulosa torulosa	Tubercled Blossom	Endangered	Endangered
Epioblasma triquetra	Snuffbox	Endangered	Endangered
Fusconaia subrotunda	Longsolid	Candidate	Endangered
Lampsilis abrupta	Pink Mucket	Endangered	Endangered
Lampsilis ovata	Pocketbook		imperiled in state
Obovaria retusa	Ring Pink	Endangered	Extirpated
Obovaria subrotunda	Round Hickorynut	Candidate	Endangered
Plethobasus cicatricosus	White Wartyback	Endangered	Endangered
Plethobasus cooperianus	Orangefoot Pimpleback	Endangered	Endangered
Plethobasus cyphyus	Sheepnose	Endangered	Endangered
Pleurobema clava	Clubshell	Endangered	Endangered
Pleurobema cordatum	Ohio Pigtoe		Species Special Concern
Pleurobema plenum	Rough Pigtoe	Endangered	Endangered
Pleurobema pyramidatum	Pyramid Pigtoe		Endangered
Potamilus capax	Fat Pocketbook	Endangered	Endangered
Ptychobranchus fasciolaris	Kidneyshell		Species Special Concern
Quadrula cylindrica cylindrica	Rabbitsfoot	Threatened	Endangered
Insect: Ephemeroptera (Mayflies)			
Homoeoneuria ammophila	A sand-filtering Mayfly		Endangered
Pseudiron centralis	White Crabwalker Mayfly		Endangered
Fish			
Etheostoma squamiceps	Spottail Darter		imperiled in state
Amphibian			
Acris blanchardi	Northern Cricket Frog		Species Special Concern
Reptile			
Kinosternon subrubrum subrubrum	Eastern Mud Turtle		Endangered
Nerodia erythrogaster neglecta	Copperbelly Water Snake	Threatened	Endangered
Opheodrys aestivus	Rough Green Snake		Species Special Concern
Pseudemys concinna concinna	Eastern River Cooter		Endangered
Terrapene carolina Carolina	Eastern Box Turtle		Species Special Concern
Bird			
Accipiter striatus	Sharp-shinned Hawk		Species Special Concern
Ammodramus henslowii	Henslow's Sparrow		Endangered
Botaurus lentiginosus	American Bittern		Endangered
Buteo lineatus	Red-shouldered Hawk		Species Special Concern
Circus hudsonius	Northern Harrier		Endangered
Cistothorus platensis	Sedge Wren		Endangered
Falco peregrinus	Peregrine Falcon		Species Special Concern
Haliaeetus leucocephalus	Bald Eagle		Species Special Concern
Ixobrychus exilis	Least Bittern		Endangered
Lanius ludovicianus	Loggerhead Shrike		Endangered
Mniotilta varia	Black-and-white Warbler		Species Special Concern
Nyctanassa violacea	Yellow-crowned Night-heron		Endangered
Nycticorax nycticorax	Black-crowned Night-heron		Endangered
Phalaropus tricolor	Wilson's Phalarope		Species Special Concern
Rallus elegans	King Rail		Endangered
Setophaga cerulean	Cerulean Warbler		Endangered
Sternula antillarum athalassos	Interior Least Tern	Endangered	Endangered
Thryomanes bewickii	Bewick's Wren		critically imperiled in state
Tyto alba	Barn Owl		Endangered
Vermivora chrysoptera	Golden-winged Warbler	Candidate	Endangered
Mammal			
Lasiurus borealis	Eastern Red Bat		Species Special Concern
Mustela nivalis	Least Weasel		Species Special Concern
Myotis lucifugus	Little Brown Bat	Candidate	Species Special Concern
Myotis septentrionalis	Northern Long Eared Bat	Threatened	Species Special Concern
Myotis sodalist	Indiana Bat or Social Myotis	Endangered	Endangered
Nycticeius humeralis	Evening Bat		Endangered
Perimyotis subflavus	Tri-colored Bat		Species Special Concern
Sylvilagus aquaticus	Swamp Rabbit		Endangered

Taxidea taxus	American Badger		Species Special Concern

Indiana, Pike County's Endangered, Threatened and Rare Species

Species Name	Common Name	Federal	State
Mollusk: Bivalvia (Mussels)			
Cyprogenia stegaria	Eastern Fanshell Pearlymussel	Endangered	Endangered
Epioblasma torulosa torulosa	Tubercled Blossom	Candidate	Endangered
Fusconaia subrotunda	Longsolid	Candidate	Endangered
Obovaria subrotunda	Round Hickorynut	Candidate	Endangered
Pleurobema clava	Clubshell	Endangered	Endangered
Pleurobema cordatum	Ohio Pigtoe		Species of Special Concern
Pleurobema plenum	Rough Pigtoe	Endangered	Endangered
Pleurobema pyramidatum	Pyramid Pigtoe		Endangered
Potamilus capax	Fat Pocketbook	Endangered	Endangered
Ptychobranchus fasciolaris	Kidneyshell		Species of Special Concern
Quadrula cylindrica cylindrica	Rabbitsfoot	Threatened	Endangered
Simpsonaias ambigua	Salamander Mussel	Candidate	Species of Special Concern
Insect: Ephemeroptera (Mayflies)			
Pseudiron centralis	White Crabwalker Mayfly		Endangered
Siphloplecton interlineatum	Flapless Cleft-footed Minnow Mayfly		Endangered
Fish			
Ammocrypta clara	Western Sand Darter		Species of Special Concern
Etheostoma Tippecanoe	Tippecanoe Darter	Candidate	Species of Special Concern
Amphibian			
Acris blanchardi	Northern Cricket Frog		Species of Special Concern
Lithobates areolatus circulosus	Northern Crawfish Frog		Endangered
Reptile			
Nerodia erythrogaster neglecta	Copperbelly Water Snake	**Ps lt**	Endangered
Opheodrys aestivus	Rough Green Snake		Species of Special Concern
Terrapene carolina Carolina	Eastern Box Turtle		Species of Special Concern
Bird			
Accipiter striatus	Sharp-shinned Hawk		Species of Special Concern
Asio flammeus	Short-eared Owl		Endangered
Buteo lineatus	Red-shouldered Hawk		Species of Special Concern
Buteo platypterus	Broad-winged Hawk		Species of Special Concern
Circus hudsonius	Northern Harrier		Endangered
Falco peregrinus	Peregrine Falcon		Species of Special Concern
Haliaeetus leucocephalus	Bald Eagle		Species of Special Concern
Ictinia mississippiensis	Mississippi Kite		Species of Special Concern
Ixobrychus exilis	Least Bittern		Endangered
Lanius ludovicianus	Loggerhead Shrike		Endangered
Mniotilta varia	Black-and-white Warbler		Species of Special Concern
Nyctanassa violacea	Yellow-crowned Night-heron		State Endangered
Yellow-crowned Night-heron	Black-crowned Night-heron		State Endangered
Rallus elegans	King Rail		State Endangered
Setophaga cerulean	Cerulean Warbler		State Endangered
Tyto alba	Barn Owl		State Endangered
Vermivora chrysoptera	Golden-winged Warbler	**Candidate**	State Endangered
Mammal			
Lasiurus borealis	Eastern Red Bat		Species of Special Concern
Myotis septentrionalis	Northern Long Eared Bat	**Threatened**	Species of Special Concern
Myotis sodalist	Indiana Bat or Social Myotis	**Endangered**	State Endangered
Nycticeius humeralis	Evening Bat		State Endangered
Perimyotis subflavus	Tricolored Bat		Species of Special Concern
Sylvilagus aquaticus	Swamp Rabbit		State Endangered
Taxidea taxus	American Badger		Species of Special Concern

APPENDIX B: Sampling Sites and Parameters Studied

NAME	12 DIGIT HUC	ACRES	LAT	LONG	% OF HUC	PARAMETERS	BY WHOM
SITE # 1 HOUCHINS DITCH SF PATOKA SCOTTSBURG	051202090701	19,023	38.287102	87.219136	78 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 2 HONEY ENOS CORNER	051202090702	14,329.50	38.289588	-87.265631	40 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 3 WHEELER SF PATOKA @ REFUGE	051202090703	15,470.5	38.349097	-87.321606	90%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 4 ROBINSON (POST) 850 E N OF 50 N @ OATSVILLE	051202090802	13,244.0	38.377410	-87.407623	100 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 5 KEG @ CONFLUENCE OF E/W FORKS – OFF 50S E 850	051202090801	14,352.50	38.348695	-87.405975	90%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 6 LOST CREEK – OFF 50 N E OF 650 E	051202090803	10,635.3	38.363462	-87.441141	57%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 7 YELLOW NEAR EMBREE	051202090804	12,736.9	38.413968	-87.507714	100 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 8 INDIAN HOUCHINS CUTOFF	051202090805	10,515.1	38.400782	-87.501198	27%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 9 TRIPPETT DITCH 350 N @ 175E (TRIANGLE)	051202090806	10,147.0	38.405613	-87.537581	60%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 10 HULL – last bridge before Wabash @ E. Mt. Carmel	051202090807	15,058.7	38.396948	-87.729999	98%	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 11 2ND ROBINSON (PRE) Patoka @ Dongola bridge E of I69	051202090802	13,244.0	38.382954	-87.338095	0 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 12 Additional HONEY SITE – Kenny Page's place	051202090702	14,329.50	38.297232	-87.261486	60 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
						E.Coli, TSS, Nutrients	E.C. Labs
SITE # 13 Additional INDIAN SITE @ Carither's Road E of 150 E, S of 200 N	051202090805	10,515.1	38.378414	-87.535259	62 %	Temp, DO, BOD, pH, Nutrients, Turbidity	Watershed Coordinator
No E.C. Labs at this site.							

The 13 sites chosen are listed above. Some explanation regarding the sites:

- Robinson watershed 051202090802 has roads closed due to mining operation making it impossible to get to any bridges to draw samples from downstream. I traveled upstream to the next open road and those tributaries were dry. So, I went to where the Patoka exits the watershed. A bridge there makes access possible. I then added the second site to Robinson at the bridge located exactly where the Patoka enters the watershed. This should give a good report of the entire watershed.
- I attempted two sites in Lost Creek 051202090803 watershed and found similar situation with coal mining in the area making stream access difficult at times. Several roads were dirt single-file lanes through the frequently flooded cornfield bottoms obviously used by farm equipment only. Moving downstream to a rock road, I found dry creek beds.
- Yellow Creek Watershed 051202090804 has only five roadways crossing tributaries. I checked all five and found dry creek beds. The only water flowing is in the old Patoka River channel (most of the Patoka water is diverted though a straight channelized man-made canal through Indian watershed) and is only accessible by one bridge which is actually located just inside the Indian. However, it is less than a mile in. This site will be the best chance of showcasing the Yellow Creek watershed.
- Indian Creek watershed 051202090805 has the northern channelized Patoka River area with ag field ditches draining into it. The southern portion of the watershed is the actual Indian Creek. I decided to add one more site (not in the QAPP), site # 13 just to do the Hoosier Riverwatch monitoring on the actual Indian Creek, but may not be able to get sampling done in September due to flow restrictions. Hopefully we can get a spring rain reading here. Lack of flow was why I decided not to include it in the original documented 12.
- The final watershed, Hull (051202090807) will be tested just miles from where the entire Lower empties into the Wabash and will be a good gage of the entire Lower Patoka.

APPENDIX C

2001-2009 IDEM WATER QUALTY DATA - Escherichia coli

PROTOCOL Escherichia coli (Method: SM9223B| Medium: Water| T/D: T)
SUMMARY TYPE: Single Result
WATER QUALITY STANDARD: 235 MPN/100mL

STATION NAME	WATERBODY	SUMMARY RESULT	RESULT UNIT	PERCENT EXCEEDANCE	DISP DATE
WPA080-0002	Patoka River	870.4	MPN/100mL	270.38	4/24/2001 13:40
WPA080-0035	Patoka River	2419.2	MPN/100mL	929.45	4/24/2001 14:10
WPA080-0008	East Fork Keg Creek	1413.6	MPN/100mL	501.53	4/24/2001 14:30
WPA080-0008	East Fork Keg Creek	866.4	MPN/100mL	268.68	5/8/2001 13:25
WPA080-0036	Patoka River	579.4	MPN/100mL	146.55	5/22/2001 11:15
WPA080-0002	Patoka River	547.5	MPN/100mL	132.98	5/22/2001 13:05
WPA080-0035	Patoka River	1046.24	MPN/100mL	345.21	5/22/2001 13:25
WPA080-0008	East Fork Keg Creek	1299.65	MPN/100mL	453.04	5/22/2001 13:50
WPA080-0061	Lost Creek	1732.9	MPN/100mL	637.4	7/7/2009 10:25
WPA080-0061	Lost Creek	547.5	MPN/100mL	132.98	7/14/2009 10:15
WPA080-0061	Lost Creek	344.8	MPN/100mL	46.72	7/21/2009 10:00
WPA080-0061	Lost Creek	547.5	MPN/100mL	132.98	7/28/2009 9:55
WPA080-0062	Patoka River	866.4	MPN/100mL	268.68	7/28/2009 10:05
WPA080-0061	Lost Creek	488.4	MPN/100mL	107.83	8/4/2009 10:00
WPA080-0062	Patoka River	547.5	MPN/100mL	132.98	8/4/2009 10:15

WPA080-002 is located @ 38.3897222, -87.5488889 @ Severn's Bridge in watershed 051202090805
WPA080-0035 is located @ 38.4120833, -87.45713889 @ Wheeling in watershed 051202090804
WPA080-0008 is located @ 38.34, -87.38694444 in watershed 051202090801
WPA080-0036 is located @ 38.3908528, -87.63678056 in watershed 051202090807
WPA080-0061 is located @ 38.3634469, -87.4410075 in watershed 051202090803
WPA080-0062 is located @ 38.3774178, -87.40751056 @ Oatsville in watershed 051202090802

APPENDIX D

IDEM WATER QUALITY DATA - Macroinvertebrates
1993-2012

DATE	HUC CODE	WATERBODY NAME	LAT	LONG	CO.	AUID	MACROs Collected	HBI	PTI	CQHEI
7/24/2012	51202090703	Wheeler Creek	38.30780111	-87.28198306	Pike	INP0973_ T1002	Left handed snail; crayfish; Dragonfly; damselfly;water strider; aquatic bug; crawling water beetle; whirligig beetle; net spinning caddisfly	5.3 (fair rating)	21 (good rating)	35 (poor rating)
10/17/1996	51202090701	South Fork Patoka River	38.25169444	-87.19327778	Pike	INP0971_ 01	sowbug; damselfly; Alderfly; non-biting midge; dance fly; biting midges; aquatic worm	6.09 (fairly poor rating)	9 (poor rating)	65 (good rating)
7/24/2012	51202090701	South Fork Patoka River	38.28724	-87.21935833	Pike	INP0971_ 01	aquatic worm; left handed snail; mayfly; dragonfly; damselfly; water strider; crawling water beetle; water scavenger beetle; riffle beetle; micro caddisfly; biting midge; non-biting midge	6.23 (fairly poor rating)	22 (good rating)	48 (fair rating)
7/24/2012	51202090701	Tributary of South Fork Patoka River	38.29291361	-87.22401861	Pike	INP0972_ T1004	damselfly; alderfly; netspinning caddisfly; non-biting midge group	4.75 (good rating)	9 (poor rating)	28 (very poor rating)
7/24/2012	51202090702	Honey Cr	38.28950806	-87.26560639	Pike	INP0972_ T1003	roundworm, left handed snail; springtail; dragonfly; damselfly; aquatic bug; crawling water beetle; whirligig beetle; water scavenger beetle; riffle beetle; non-biting midge; non-biting midge; horsefly	6.42 (fairly poor rating)	16 (fair rating)	32 (poor rating)
7/10/2012	51202090703	Turkey Creek	38.33830722	-87.33048139	Gibson	INP0973_ T1005	aquatic worm; sludge worm; left handed snail; fingernail clams; isopod; crayfish; water boatman; common backswimmer; crawling water beetle; non-biting midge; biting midge; soldier fly	7.74 (very poor rating)	12 (fair rating)	42 (poor rating)
7/10/2012	51202090703	South Fork Patoka River	38.37792583	-87.33679389	Gibson	INP0973_ 01	Left handed snail; clam; dragonfly; water scorpion; waters strider; riffle beetle; alderfly; netspinning caddisfly; micro caddisfly; non-biting midge; dance fly	4.54 (good rating)	17 (good rating)	56 (fair rating)
10/10/2001	51202090805	Patoka River	38.420577	-87.493553	Gibson	INP0985_ 01	non-biting midge; mayfly; planaria; worm;	5.8 (fairly poor rating)	9 (poor rating)	
10/10/2001	51202090806	Patoka River	38.401798	-87.549271	Gibson	INP0986_ 03	non-biting midge; biting midge; riffle beetle; crawling water beetle; water scavenger beetle; mayfly; common netspinner caddis; micro caddisfly; tubemaking caddis; damselfly; water mites; sand flea; worm	5.87 (fairly poor rating)	21 (good rating)	
10/10/2001	51202090807	Patoka River	38.386436	-87.661199	Gibson	INP0987_ 01	non-biting midge; biting midge; riffle beetle; mayfly; tubemaking caddis; damselfly; sand flea; fingernail clams; worm	6.1 (fairly poor rating)	20 (good rating)	
10/10/2001	51202090804	Patoka River	38.379587	-87.423892	Gibson	INP0984_ 01	non-biting midge; mayfly; common netspinner caddis; micro caddisfly; damselfly; sand flea; sowbug; worm; dance fly	6.11 (fairly poor rating)	20 (good rating)	
10/16/1996	51202090801	East Fork Keg Creek	38.34005556	-87.38694444	Gibson	INP0981_ 01	mayfly; damselfly; common netspinner caddis; water scavenger beetle; riffle beetle; non-biting midge; dance fly; biting midge; worm	6.21 (fairly poor rating)	18 (good rating)	24 (very poor rating)
10/16/1996	51202090802	Patoka River	38.37952778	-87.36308333	Gibson	INP0982_ 01	mayfly; damselfly; common netspinner caddis; riffle beetle; non-biting midge; dance fly; biting midge; fingernail clams	5.25 (fair rating)	20 (good rating)	39 (poor rating)
10/14/1993	51202090806	Patoka River	38.39194444	-87.54888889	Gibson	INP0986_ 03	mayfly; fingernet caddisflies; micro caddisflies; common netspinner caddis; riffle beetle; non-biting midge; dance fly; worm	5.11 (fair rating)	15 (fair rating)	52 (fair rating)
10/16/1996	51202090802	Robinson Creek	38.40638889	-87.35283333	Pike	INP0982_ T1002	sowbug; mayfly; damselfly; riffle beetle; non-biting midge; biting midge; worm; left-handed snail; fingernail clams	6.24 (fairly poor rating)	21 (good rating)	54 (fair rating)

APPENDIX E

IDEM WATER QUALITY DATA FROM 1996-2012

AUID	STATION NAME	DATE	HUC	LAT	LONG	HUC NAME	IMPAIRMENT	DO mg / L	pH	S. C. umho/cm	Temp °C	% Sat	Turb. NTU	E. Coli MPN / 100 mL
INP0971_01	WPA070-0011	10/17/1996	51202090701	38.25169	-87.1933	Houchin Ditch-S F	E. coli, DO, IBC, pH, Sulfate	7.47	8.23	2660	13.8			
INP0971_01	WPA070-0026	7/24/2012	51202090701	38.28724	-87.2194	Houchin Ditch-S F	E. coli, DO, IBC, pH, Sulfate	6.73	7.83	3200	28.99	87.6	182	
INP0971_01	WPA070-0026	7/24/2012	51202090701	38.28724	-87.2194	Houchin Ditch-S F	E. coli, DO, IBC, pH, Sulfate	6.5	7.83	3200	28.9	84.7	13.2	
INP0972_T1004	WPA070-0029	7/24/2012	51202090701	38.29291	-87.224	Houchin Ditch-S F		10.81	7.17	3200	36.56	160.8	14.4	
INP0972_T1004	WPA070-0029	7/24/2012	51202090701	38.29291	-87.224	Houchin Ditch-S F		10.95	7.21	3200	36.56	162.9	12.9	
INP0972_T1003	WPA070-0034	7/24/2012	51202090702	38.28951	-87.2656	Honey Creek	E. coli, IBC	4.66	7.78	3990	26.54	58.4	24.6	
INP0972_T1003	WPA070-0034	7/24/2012	51202090702	38.28951	-87.2656	Honey Creek	E. coli, IBC	4.75	7.79	3990	26.54	59	18.1	
INP0973_01	WPA070-0012	5/22/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC	8.72	7.3	2180	20.78		8.21	84.5
INP0973_01	WPA070-0012	5/15/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC							
INP0973_01	WPA070-0012	5/15/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC	9.05	7.63	3220	25.46		2.29	18.3
INP0973_01	WPA070-0012	5/8/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC							
INP0973_01	WPA070-0012	5/8/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC	8.84	7.69	3110	24.29		4.01	35.9
INP0973_01	WPA070-0012	5/1/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC	10.69	7.82	2920	23.87		3.28	8.4
INP0973_01	WPA070-0012	4/24/2001	51202090703	38.30796	-87.2751	Wheeler Creek	IBC	9.37	7.67	2680	20.03		16	43.5
INP0973_T1005	WPA070-0039	7/10/2012	51202090703	38.33831	-87.3305	Wheeler Creek		6.91	7.82	519	26.45	88.1	17.4	
INP0973_T1005	WPA070-0039	7/10/2012	51202090703	38.33831	-87.3305	Wheeler Creek		6.93	7.83	516	26.47	88	12.8	
INP0973_01	WPA070-0040	7/10/2012	51202090703	38.37793	-87.3368	Wheeler Creek	IBC	6.01	7.75	3010	26.42	76.7	3.4	
INP0973_01	WPA070-0040	7/10/2012	51202090703	38.37793	-87.3368	Wheeler Creek	IBC	5.92	7.69	3330	27.15	74.5	0	
INP0973_T1002	WPA-07-0009	7/24/2012	51202090703	38.3078	-87.282	Wheeler Creek	IBC	9.69	8.04	4240	29.75	127.9	1.6	
INP0973_T1002	WPA-07-0009	7/24/2012	51202090703	38.3078	-87.282	Wheeler Creek	IBC	10.4	8.06	4250	29.77	120.1	0	
INP0981_01	WPA080-0008	5/22/2001	51202090801	38.34	-87.3869	Keg Creek	E. coli, IBC, Nutrients	7.67	7.46	936	19		110	1299.65
INP0981_01	WPA080-0008	5/15/2001	51202090801	38.34	-87.3869	Keg Creek	E. coli, IBC, Nutrients	6.6	7.59	1202	26.81		15.89	133.3
INP0981_01	WPA080-0008	5/8/2001	51202090801	38.34	-87.3869	Keg Creek	E. coli, IBC, Nutrients	6.1	7.67	965	23.37		74.09	866.4
INP0981_01	WPA080-0008	5/1/2001	51202090801	38.34	-87.3869	Keg Creek	E. coli, IBC, Nutrients	8.58	7.86	1247	23.53		31.5	57.3
INP0981_01	WPA080-0008	4/24/2001	51202090801	38.34	-87.3869	Keg Creek	E. coli, IBC, Nutrients	8.98	7.92	1223	18.9		82.69	1413.6
INP0981_01	WPA080-0030	10/16/1996	51202090801	38.34006	-87.3869	Keg Creek	E. coli, IBC, Nutrients	7.18	8.53	1590	20.29			
INP0982_01	WPA080-0031	10/16/1996	51202090802	38.37953	-87.3631	Robinson Creek	PCB_FT	7.85	8.53	492	15.52			
INP0982_T1002	WPA080-0033	10/16/1996	51202090802	38.40639	-87.3528	Robinson Creek		5.36	8.52	1095	16.37			
INP0982_01	WPA080-0062	8/4/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT		7.92		23.4		71.2	547.5
INP0982_01	WPA080-0062	7/28/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT			337	22.82			866.4
INP0982_01	WPA080-0062	7/21/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT		7.78	613	22.08			54.8
INP0982_01	WPA080-0062	7/14/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT		7.57	658	24.75			19.9
INP0982_01	WPA080-0062	7/14/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT							18.5
INP0982_01	WPA080-0062	7/7/2009	51202090802	38.37742	-87.4075	Robinson Creek	PCB_FT		8.03	586	22.51			90.9
INP0983_01	WPA080-0061	8/4/2009	51202090803	38.36345	-87.441	Lost Creek			8.25		25.3		53.2	488.4
INP0983_01	WPA080-0061	7/28/2009	51202090803	38.36345	-87.441	Lost Creek				516				547.5
INP0983_01	WPA080-0061	7/21/2009	51202090803	38.36345	-87.441	Lost Creek			7.89	836	20.54			344.8
INP0983_01	WPA080-0061	7/14/2009	51202090803	38.36345	-87.441	Lost Creek			7.91	2199	21.68			547.5
INP0983_01	WPA080-0061	7/7/2009	51202090803	38.36345	-87.441	Lost Creek			8.13	1047	21.66			1732.9
INP0984_01	WPA080-0035	5/22/2001	51202090804	38.41208	-87.4571	Yellow Creek	PCB_FT	8.15	7.36	615	17.57		27.5	1046.24

INP0984_01	WPA080-0035	5/8/2001	51202090804	38.41208	-87.4571	Yellow Creek	PCB_FT	8.21	7.84	1082	24.31		24.39	206.3
INP0984_01	WPA080-0035	5/1/2001	51202090804	38.41208	-87.4571	Yellow Creek	PCB_FT	8.56	7.76	856	20.76		9.44	101.7
INP0984_01	WPA080-0035	4/24/2001	51202090804	38.41208	-87.4571	Yellow Creek	PCB_FT	9.16	8.19	1025	17.01		45	210.5
INP0984_01	WPA080-0035	4/24/2001	51202090804	38.41208	-87.4571	Yellow Creek	PCB_FT	7.75	7.78	680	16.62		36.09	2419.2
INP0986_03	WPA080-0002	5/22/2001	51202090805	38.38972	-87.5489	Indian Creek	E. coli, IBC	6.05	7.17	849	20.39		111	547.5
INP0986_03	WPA080-0002	5/15/2001	51202090805	38.38972	-87.5489	Indian Creek	E. coli, IBC	7.55	7.69	1104	23.3		85	45.7
INP0986_03	WPA080-0002	5/8/2001	51202090805	38.38972	-87.5489	Indian Creek	E. coli, IBC	6.83	7.65	1335	22.55		88.5	53.7
INP0986_03	WPA080-0002	5/1/2001	51202090805	38.38972	-87.5489	Indian Creek	E. coli, IBC	8.84	7.88	1171	20.78		61.7	41.9
INP0986_03	WPA080-0002	4/24/2001	51202090805	38.38972	-87.5489	Indian Creek	E. coli, IBC	9.3	7.98	1050	18.45		53.2	870.4
INP0987_01	WPA080-0036	5/22/2001	51202090807	38.39085	-87.6368	Hull Ditch	PCB_FT	6.04	7.34	1088	20.36		153	579.4
INP0987_01	WPA080-0036	5/15/2001	51202090807	38.39085	-87.6368	Hull Ditch	PCB_FT	7.54	7.69	1464	21.77		82.4	96
INP0987_01	WPA080-0036	5/8/2001	51202090807	38.39085	-87.6368	Hull Ditch	PCB_FT	6.85	7.69	1345	21.44		74.59	101.7
INP0987_01	WPA080-0036	5/8/2001	51202090807	38.39085	-87.6368	Hull Ditch	PCB_FT							127.4
INP0987_01	WPA080-0036	5/1/2001	51202090807	38.39085	-87.6368	Hull Ditch	PCB_FT	8.9	7.86	1115	20.01		59.9	42.4

APPENDIX F

TNC L-THIA Modeling Results

HUC	Size (acres)	N (lb)	P (lb)	TSS (lb)	Fecal Coliform (mil col)
051202090701	18,981.13	24,549.18	5,914.82	534,456.26	569,223.24
051202090702	14,323.45	37,877.50	10,484.42	862,420.00	1,006,290.00
051202090703	15,457.26	40,321.00	10,894.93	899,334.00	1,073,500.00
051202090801	14,340.43	83,144.20	24,084.11	2,009,156.00	2,301,560.00
051202090802	13,226.35	57,085.11	16,042.11	1,336,163.25	1,531,462.22
051202090803	10,630.50	46,797.91	13,633.31	1,149,555.00	1,286,458.00
051202090804	12,722.90	52,812.34	15,211.40	1,251,771.00	1,421,326.00
051202090805	10,518.06	35,801.54	10,228.88	856,434.15	958,870.14
051202090806	10,130.50	39,245.09	11,413.76	941,423.52	1,066,978.48
051202090807	15,024.46	74,278.28	21,676.57	1,782,738.40	2,017,025.36
Totals	135,355.04	491,912.14	139,584.32	11,623,451.57	13,232,693.43
HUC	Size (acres)	N (lb/ac)	P (lb/ac)	TSS (lb/ac)	Fecal Coliform (mil col/ac)
051202090701	18,981.13	1.29	0.31	28.16	29.99
051202090702	14,323.45	2.64	0.73	60.21	70.25
051202090703	15,457.26	2.61	0.70	58.18	69.45
051202090801	14,340.43	5.80	1.68	140.10	160.49
051202090802	13,226.35	4.32	1.21	101.02	115.79
051202090803	10,630.50	4.40	1.28	108.14	121.02
051202090804	12,722.90	4.15	1.20	98.39	111.71
051202090805	10,518.06	3.40	0.97	81.43	91.16
051202090806	10,130.50	3.87	1.13	92.93	105.32
051202090807	15,024.46	4.94	1.44	118.66	134.25
Totals	135,355.04	37.44	10.66	887.21	1,009.44
HUC	N (% of total)	P (% of total)	TSS (% of total)	Fecal Coliform (% of total)	RANKING by LOAD CONTRIBUTION (lowest = 1; highest = 10)
051202090701	0.05	0.04	0.05	0.04	1
051202090702	0.08	0.08	0.07	0.08	3
051202090703	0.08	0.08	0.08	0.08	4
051202090801	0.17	0.17	0.17	0.17	10
051202090802	0.12	0.11	0.11	0.12	8
051202090803	0.10	0.10	0.10	0.10	6
051202090804	0.11	0.11	0.11	0.11	7
051202090805	0.07	0.07	0.07	0.07	2
051202090806	0.08	0.08	0.08	0.08	4
051202090807	0.15	0.16	0.15	0.15	9
Totals	1.00	1.00	1.00	1.00	

APPENDIX G

Lower Patoka WQ Monitoring Data Loads, Target Loads and Reductions Needed for TSS

HUC	HUC Acres	Site #	DATE	TSS mg/L	Stream Flow cfs	Daily Load TSS lb/yr	Annual Load TSS lb /yr. @ site	HUC Acres @ Site	Weighted Constant	Actual HUC Load (lbs.)	Actual HUC Load (tons)	Daily Target TSS constant x flow	Annual Target TSS avg. lb / yr @ site	Annual HUC Target TSS tons / yr	Reduction Needed	HUC
51202090701		1	Sept. 2017	0	1.25	-						2,456				51202090701
51202090701		1	Dec. 2017	3.9	3.2225	2,469						6,331				51202090701
51202090701		1	May. 2018	4.7	14.386	13,284						28,263				51202090701
51202090701	19,010.0	1	Aug. 2018	20.3	0.93	3,709	1,775,873	14,745.0	3.457210	2,289,545	1,145	1,827	3,547,499	2,286.81	(1,142)	51202090701
51202090702		2	Sept. 2017	3.5	4.1	2,819						8,055				51202090702
51202090702		2	Dec. 2017	7.6	11.439	17,080						22,473				51202090702
51202090702		2	May. 2018	21.7	38.348	163,485						75,339				51202090702
51202090702	14,331.0	2	Aug. 2018	21	3.589	14,807	18,084,957	5,620.1	0.645180	46,115,821	23,058	7,051	10,303,765	13,137.07	9,921	51202090702
51202090703		3	Sept. 2017	5.2	27	27,583						53,044				51202090703
51202090703		3	Dec. 2017	3.5	13.98	9,613						27,465				51202090703
51202090703		3	May. 2018	23.5	91.29	421,471						179,349				51202090703
51202090703	15,472.4	3	Aug. 2018	8.6	23.58	39,840	45,488,748	13,706.5	0.328868	14,959,777	7,480	46,326	27,939,344	4,594	2,886	51202090703
51202090801		5	Sept. 2017	8.9	2.49	4,354						4,892			-	51202090803
51202090801		5	Dec. 2017	3.8	0.0693	52						136				51202090803
51202090801		5	May. 2018	7.7	1.71789	2,599						3,375				51202090803
51202090801	14,349.5	5	Aug. 2018	75.3	5.69	84,175	8,320,118	12,515.6	6.824581	9,539,258	4,770	11,179	1,786,825	1,024.32	3,745	51202090803
51202090802		4	Sept. 2017	66.9	439	5,769,885						862,464				51202090802
51202090802		4	Dec. 2017	16.2	918	2,921,691						1,803,513				51202090802
51202090802		4	May. 2018	49	526	5,063,588						1,033,385				51202090802
51202090802	13,240.3	4	Aug. 2018	76.1	457	6,832,465	1,878,621,068	13,240.0	0.030879	58,009,639	29,005	897,827	419,493,522	6,477	22,528	51202090802
51202090803		6	Sept. 2017	42.2	2.6	21,556						5,108			-	51202090803
51202090803		6	Dec. 2017	5.1	0.40478	406						795				51202090803
51202090803		6	May. 2018	31.2	5.89221	36,117						11,576				51202090803
51202090803	10,635.2	6	Aug. 2018	12.3	1.607	3,883	5,653,974	6,115.8	1.353233	9,832,097	4,916	3,157	1,883,058	1,637.29	3,279	51202090803
51202090804		7	Sept. 2017	29.7	0	-						-				51202090804
51202090804		7	Dec. 2017	15.1	0	-						-				51202090804
51202090804		7	May. 2018	74.3	1.1327	16,534						2,225				51202090804
51202090804	12,736.1	7	Aug. 2018	52.6	0	-	1,508,736	9,564.9	3.016177	2,008,950	1,004	-	203,060	135.19	869	51202090804
51202090805		8	Sept. 2017	91.7	446	8,034,905						876,216				51202090805
51202090805		8	Dec. 2017	84.3	1260	20,867,703						2,475,410				51202090805
51202090805		8	May. 2018	78.7	460	7,112,284						903,721				51202090805
51202090805	10,523.4	8	Aug. 2018	107	464	9,753,900	4,176,402,215	2,774.6	0.020824	86,968,470	43,484	911,579	471,482,035.80	4,909	38,575	51202090805
51202090806		9	Sept. 2017	27	0.8	4,244						1,572				51202090806
51202090806		9	Dec. 2017	8.5	0	-						-				51202090806
51202090806		9	May. 2018	24.1	1.128	5,341						2,216				51202090806
51202090806	10,147.7	9	Aug. 2018	19.3	0.1498	568	926,398	5,490.3	1.178834	1,712,258	856	294	372,488.74	344.23	512	51202090806
51202090807		10	Sept. 2017	70	446	6,133,515						876,216				51202090807
51202090807		10	Dec. 2017	34.4	1260	8,515,409						2,475,410				51202090807
51202090807		10	May. 2018	81.3	460	7,347,251						903,721				51202090807
51202090807	15,055.5	10	Aug. 2018	90.3	464	8,231,562	2,758,281,057	14,315.0	0.027359	75,462,596	37,731	911,579	471,482,035.80	6,450	31,282	51202090807
51202090702		12	Sept. 2017	0	49	-						96,266				51202090702
51202090702		12	Dec. 2017	3	6.263	3,691						12,304				51202090702
51202090702		12	May. 2018	11	67.39	145,635						132,395				51202090702
51202090702	15,472.4	12	Aug. 2018	0	30.29	-	13,625,992	3,882.0	0.561571	37,890,058	18,945	59,508	27,418,204	7,699	11,246	51202090702

APPENDIX G

Lower Patoka WQ Monitoring Data Loads, Target Loads and Reductions Needed for N

HUC	HUC Acres	Site #	DATE	Nitrate Nitrite	Steam Flow cfs	Daily Load N lb/yr	Annual Load N lb /yr. @ site	HUC Acres @ Site	Weighted Constant	Actual Subwatershed Load	Target N constant x flow	Annual Target N lb / yr @ site	Annual HUC Target N avg. lb / yr	Reduction Needed
51202090701		1	Sept. 2017	0	1.25	-					246			
51202090701		1	Dec. 2017	0	3.2225	-					633			
51202090701		1	May. 2018	1.75	14.386	4,946					2,826			
51202090701	19,010.0	1	Aug. 2018	0	0.93	-	451,323	14,745	3.4572	581,869	183	354,750	457,362	124,507
51202090702		2	Sept. 2017	0	4.1	-					805			
51202090702		2	Dec. 2017	0.8	11.439	1,798					2,247			
51202090702		2	May. 2018	0.95	38.348	7,157					7,534			
51202090702	14,331.0	2	Aug. 2018	0.201	3.589	142	830,081	5,620	0.6452	2,116,629	705	1,030,376	2,627,364	(510,736)
51202090703		3	Sept. 2017	0	27	-					5,304			
51202090703		3	Dec. 2017	0	13.98	-					2,747			
51202090703		3	May. 2018	1.35	91.29	24,212					17,935			
51202090703	15,472.4	3	Aug. 2018	0	23.58	-	2,209,359	13,707	0.3289	726,585	4,633	2,793,934	918,833	(192,247)
51202090801		5	Sept. 2017	0	2.49	-					489			-
51202090801		5	Dec. 2017	1.6	0.0693	22					14			
51202090801		5	May. 2018	1.5	1.71789	506					337			
51202090801	14,349.5	5	Aug. 2018	0.36	5.69	402	84,905	12,516	6.8246	97,346	1,118	178,683	204,865	(107,519)
51202090802		4	Sept. 2017	0.534	439	46,056					86,246			
51202090802		4	Dec. 2017	0.51	918	91,979					180,351			
51202090802		4	May. 2018	1.35	526	139,507					103,339			
51202090802	13,240.3	4	Aug. 2018	0.309	457	27,743	27,857,220	13,240	0.0309	860,199	89,783	41,949,352	1,295,347	(435,149)
51202090803		6	Sept. 2017	0	2.6	-					511			-
51202090803		6	Dec. 2017	0.17	0.40478	14					80			
51202090803		6	May. 2018	0	5.89221	-					1,158			
51202090803	10,635.2	6	Aug. 2018	0	1.607	-	1,234	6,116	1.3532	2,145	316	188,306	327,462	(325,316)
51202090804		7	Sept. 2017	0.553	0	-					-			
51202090804		7	Dec. 2017	0.9	0	-					-			
51202090804		7	May. 2018	2.35	1.1327	523					223			
51202090804	12,736.1	7	Aug. 2018	0.121	0	-	47,719	9,565	3.0162	63,540	-	20,306	27,038	36,502
51202090805		8	Sept. 2017	0.518	446	45,388					87,622			
51202090805		8	Dec. 2017	1.75	1260	433,197					247,541			
51202090805		8	May. 2018	1.45	460	131,040					90,372			
51202090805	10,523.4	8	Aug. 2018	0.347	464	31,632	58,514,614	2,775	0.0208	1,218,508	91,158	47,148,203.58	981,814	236,694
51202090806		9	Sept. 2017	0	0.8	-					157			
51202090806		9	Dec. 2017	1.5	0	-					-			
51202090806		9	May. 2018	3.55	1.128	787					222			
51202090806	10,147.7	9	Aug. 2018	0.284	0.1498	8	72,550	5,490	1.1788	134,094	29	37,248.87	68,847	65,247
51202090807		10	Sept. 2017	0.647	446	56,691					87,622			
51202090807		10	Dec. 2017	1.35	1260	334,180					247,541			
51202090807		10	May. 2018	1.4	460	126,521					90,372			
51202090807	15,055.5	10	Aug. 2018	0.352	464	32,088	50,140,053	14,315	0.0274	1,371,782	91,158	47,148,203.58	1,289,928	81,854
51202090702		12	Sept. 2017	0	49	-					9,627			
51202090702	15,472.4	12	Dec. 2017	0	6.263	-					1,230			
51202090702		12	May. 2018	2.7	67.39	35,747					13,240			

APPENDIX G

Lower Patoka WQ Monitoring Data Loads, Target Loads and Reductions Needed for P

HUC	HUC Acres	Site #	DATE	Total P	Steam Flow cfs	Daily Load P lb/yr	Annual Load P lb /yr. @ site	Acres @ Site	Weighted Constant	Actual Subwatershed Load	Daily P constant x flow	Annual Target P lb / yr @ site	Annual HUC Target P avg. lb / yr	Reduction Needed
51202090701		1	Sept. 2017	0	1.25	-					17			
51202090701		1	Dec. 2017	0	3.2225	-				-	44			
51202090701		1	May. 2018	0	14.386	-					198			
51202090701	19,010.0	1	Aug. 2018	0	0.93	-	-	14,745	3.4572	-	13	24,832	32,015	(32,015)
51202090702		2	Sept. 2017	0	4.1	-					56			
51202090702		2	Dec. 2017	0.17	11.439	382					157			
51202090702		2	May. 2018	0	38.348	-					527			
51202090702	14,331.0	2	Aug. 2018	0	3.589	-	34,862	5,620	0.6452	88,894	49	72,126	183,915	(95,022)
51202090703		3	Sept. 2017	0	27	-					371			
51202090703		3	Dec. 2017	0.2	13.98	549					192			
51202090703		3	May. 2018	0	91.29	-					1,255			
51202090703	15,472.4	3	Aug. 2018	0	23.58	-	50,124	13,707	0.3289	16,484	324	195,575	64,318	(47,834)
51202090801		5	Sept. 2017	0.09	2.49	44					34			-
51202090801		5	Dec. 2017	0.16	0.0693	2				21,120	1			
51202090801		5	May. 2018	0.13	1.71789	44					24			
51202090801	14,349.5	5	Aug. 2018	0.1	5.69	112	18,420	12,516	6.8246	21,119	78	12,508	14,341	6,779
51202090802		4	Sept. 2017	0.17	439	14,662					6,037			
51202090802		4	Dec. 2017	0.1	918	18,035					12,625			
51202090802		4	May. 2018	0.17	526	17,568					7,234			
51202090802	13,240.3	4	Aug. 2018	0.14	457	12,570	5,733,616	13,240	0.0309	177,047	6,285	2,936,455	90,674	86,373
51202090803		6	Sept. 2017	0	2.6	-					36			-
51202090803		6	Dec. 2017	0	0.40478	-					6			
51202090803		6	May. 2018	0.15	5.89221	174					81			
51202090803	10,635.2	6	Aug. 2018	0	1.607	-	15,845	6,116	1.3532	27,553	22	13,181	22,922	4,631
51202090804		7	Sept. 2017	0.2	0	-					-			
51202090804		7	Dec. 2017	0.22	0	-					-			
51202090804		7	May. 2018	0.18	1.1327	40					16			
51202090804	12,736.1	7	Aug. 2018	0.2	0	-	3,655	9,565	3.0162	4,867	-	1,421	1,893	2,974
51202090805		8	Sept. 2017	0.18	446	15,772					6,134			
51202090805		8	Dec. 2017	0.56	1260	138,623					17,328			
51202090805		8	May. 2018	0.13	460	11,748					6,326			
51202090805	10,523.4	8	Aug. 2018	0.16	464	14,585	16,491,474	2,775	0.0050	82,457	6,381	3,300,374.25	16,502	65,955
51202090806		9	Sept. 2017	0.01	0.8	2					11			
51202090806		9	Dec. 2017	0	0	-					-			
51202090806		9	May. 2018	0.11	1.128	24					16			
51202090806	10,147.7	9	Aug. 2018	0.12	0.1498	4	2,690	5,490	1.1788	4,972	2	2,607.42	4,819	153
51202090807		10	Sept. 2017	0.22	446	19,277					6,134			
51202090807		10	Dec. 2017	0.08	1260	19,803					17,328			
51202090807		10	May. 2018	0.13	460	11,748					6,326			
51202090807	15,055.5	10	Aug. 2018	0.17	464	15,497	6,052,180	14,315	0.0238	143,739	6,381	3,300,374.25	78,384	65,355
51202090702		12	Sept. 2017	0	49	-					674			
51202090702		12	Dec. 2017	0.13	6.263	160					86			
51202090702		12	May. 2018	0	67.39	-					927			
51202090702		12	Aug. 2018	0	30.29	-	14,596	3,882	1.4756	24,488	417	191,927	283,208	(258,720)

APPENDIX G

Lower Patoka WQ Monitoring Data Loads, Target Loads and Reductions Needed for E. coli

HUC	HUC Acres	Site #	DATE	E. coli	Steam Flow cfs	Daily Load Colonies per Day	Annual Load @ site	Acres @ Site	Weighted Constant	Actual HUC Load	Daily Target constant x flow	Annual Target avg. @ site	Annual HUC Target avg.	Reduction Needed / trillion colonies per day
51202090701		1	Sept. 2017	86	1.25	2.63E+09					7.19E+09			
51202090701		1	Dec. 2017	58	3.2225	4.57E+09				15.21	1.85E+10		13.384	1.83
51202090701		1	May. 2018	308	14.386	1.08E+11				15.21 trillion	8.27E+10		13.384 trillion	
51202090701	19,010.0	1	Aug. 2018	602	0.93	1.37E+10	11,799,168,974,179	14,745	3.4572	15,212,095,323,299	5.35E+09	1.04E+13	13,384,810,023,797	1.83E+12
51202090702		2	Sept. 2017	166	4.1	1.67E+10					2.36E+10			
51202090702		2	Dec. 2017	44	11.439	1.23E+10				32.11	6.58E+10		76.89	(44.78)
51202090702		2	May. 2018	102	38.348	9.57E+10				32.11 trillion	2.20E+11		76.89 trillion	
51202090702	14,331.0	2	Aug. 2018	152	3.589	1.33E+10	12,593,467,820,743	5,620	0.6452	32,112,171,820,655	2.06E+10	3.02E+13	76,890,484,401,099	-4.48E+13
51202090703		3	Sept. 2017	143	27	9.45E+10					1.55E+11			
51202090703		3	Dec. 2017	34	13.98	1.16E+10				15.98	8.04E+10		26.89	(10.91)
51202090703		3	May. 2018	172	91.29	3.84E+11				15.98 trillion	5.25E+11		26.89 trillion	
51202090703	15,472.4	3	Aug. 2018	73	23.58	4.21E+10	48,578,440,257,151	13,707	0.3289	15,975,845,912,049	1.36E+11	8.18E+13	26,889,877,385,611	-1.09E+13
51202090801		5	Sept. 2017	236	2.49	1.44E+10					1.43E+10			
51202090801		5	Dec. 2017	60	0.0693	1.02E+08				3.369	3.98E+08		5.995	-2.63
51202090801		5	May. 2018	276	1.71789	1.16E+10				3.369 trillion	9.88E+09		5.995 trillion	
51202090801	14,349.5	5	Aug. 2018	44	5.69	6.13E+09	2,938,646,180,410	12,516	6.8246	3,369,242,285,737	3.27E+10	5.23E+12	5,995,417,058,605	-2.63E+12
51202090802		4	Sept. 2017	133	439	1.43E+12					2.52E+12			
51202090802		4	Dec. 2017	50	918	1.12E+12				9.08	5.28E+12		37.908	(28.83)
51202090802		4	May. 2018	27	526	3.47E+11				9.08 trillion	3.02E+12		37.908 trillion	
51202090802	13,240.3	4	Aug. 2018	29	457	3.24E+11	294,115,632,791,760	13,240	0.0309	9,081,949,566,476	2.63E+12	1.23E+15	37,908,670,481,736	-2.88E+13
51202090803		6	Sept. 2017	64	2.6	4.07E+09					1.49E+10			
51202090803		6	Dec. 2017	8	0.40478	7.92E+07				2.170	2.33E+09		9.583	-7.41
51202090803		6	May. 2018	47	5.89221	6.78E+09				2.170 trillion	3.39E+10		9.583 trillion	
51202090803	10,635.2	6	Aug. 2018	70	1.607	2.75E+09	1,248,113,025,858	6,116	1.3532	2,170,454,901,307	9.24E+09	5.51E+12	9,583,251,127,523	-7.41E+12
51202090804		7	Sept. 2017	129	0	0.00E+00					0.00E+00			
51202090804		7	Dec. 2017	365	0	0.00E+00				0.707	0.00E+00		0.791	(0.08)
51202090804		7	May. 2018	210	1.1327	5.82E+09				0.707 trillion	6.51E+09		0.791 trillion	
51202090804	12,736.1	7	Aug. 2018	61	0	0.00E+00	531,040,998,507	9,565	3.0162	707,103,924,873	0.00E+00	5.94E+11	791,282,963,549	-8.42E+10
51202090805		8	Sept. 2017	62	446	6.77E+11					2.56E+12			
51202090805		8	Dec. 2017	2420	1260	7.46E+13				34.89	7.24E+12		6.899	27.99
51202090805		8	May. 2018	61	460	6.87E+11				34.89 trillion	2.64E+12		6.899 trillion	
51202090805	10,523.4	8	Aug. 2018	44	464	4.99E+11	6,977,333,139,027,840	2,775	0.0050	34,886,665,695,139	2.67E+12	1.38E+15	6,899,021,073,270	2.80E+13
51202090806		9	Sept. 2017	276	0.8	5.40E+09					4.60E+09			
51202090806		9	Dec. 2017	172	0	0.00E+00				2.238	0.00E+00		2.02	0.22
51202090806		9	May. 2018	276	1.128	7.62E+09				2.238 trillion	6.49E+09		2.015 trillion	
51202090806	10,147.7	9	Aug. 2018	69	0.1498	2.53E+08	1,211,057,987,960	5,490	1.1788	2,238,423,094,815	8.61E+08	1.09E+12	2,014,849,909,000	2.24E+11
51202090807		10	Sept. 2017	58	446	6.33E+11					2.56E+12			
51202090807		10	Dec. 2017	2420	1260	7.46E+13				168.19	7.24E+12		32.77	135.42
51202090807		10	May. 2018	96	460	1.08E+12				168.19 trillion	2.64E+12		32.77 trillion	
51202090807	15,055.5	10	Aug. 2018	114	464	1.29E+12	7,081,805,783,682,720	14,315	0.0238	168,192,887,362,465	2.67E+12	1.38E+15	32,770,350,098,033	1.35E+14
51202090702		12	Sept. 2017	248	49	2.97E+11					2.82E+11			
51202090702		12	Dec. 2017	11	6.263	1.69E+09				86.33	3.60E+10		118.4	(32.07)
51202090702		12	May. 2018	91	67.39	1.50E+11				86.33 trillion	3.87E+11		118.4 trillion	
51202090702		12	Aug. 2018	155	30.29	1.15E+11	51,455,686,456,029	3,882	1.4756	86,326,712,788,388	1.74E+11	8.02E+13	118,402,253,969,694	-3.21E+13

APPENDIX H

IDEM'S 2018 303(d) LIST OF IMPAIRED STREAMS CATEGORY 5

HUC	County	Unit ID's	Name	Impairment Cause
051202090701	PIKE	INP0971_01 / INP0971_02	Patoka River, South Fork	Sulfate, IBC, E coli
051202090701	PIKE	INP0971_03 / INP0971_04	Patoka River, South Fork	Sulfate, IBC, E coli
051202090701	PIKE	INP0971_T1001	South Fork Unnamed Trib	IBC
051202090701	PIKE	INP0971_T1004	Houchin Ditch	IBC
051202090702	PIKE	INP0972_01 / INP0972_02	Patoka River, South Fork	IBC, E coli
051202090702	PIKE	INP0972_T1001	Rough Creek	Sulfate, IBC
051202090702	PIKE	INP0972_T1001B / INP0972_T1001C	Rough Creek	Sulfate, IBC
051202090702	PIKE	INP0972_T1003	Honey Creek	IBC, E. coli
051202090702	PIKE	INP0972_T1004	Honey Creek	IBC
051202090702	PIKE	INP0972_T1006 / INP0972_T1007	Honey Creek	IBC, Sulfate
051202090702	PIKE	INP0972_T1008 / INP0972_T1009	South Fork, Patoka River	IBC, E. Coli
051202090703	PIKE	INP0973_01	Patoka River, South Fork	IBC, E. Coli
051202090703	GIBSON/PIKE	INP0973_T1001	Hat Creek	Sulfate, IBC
051202090703	PIKE	INP0973_T1002	Wheeler Creek	IBC
051202090703	PIKE	INP0973_T1004	Lick Creek	IBC
051202090703	PIKE	INP0973_T1005	Turkey Creek	IBC
051202090703	PIKE	INP0973_T1006	Hat Creek	Sulfate, IBC
051202090801	GIBSON	INP0981_01 / INP0981_02	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_03 / INP0981_04	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_05 / INP0981_06	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_07 / INP0981_08	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_09	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_10 / INP0981_11	Keg Creek	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1001	Keg Creek, West Fork	Ammonia, IBC, Nutrients
051202090801	GIBSON	INP0981_T1002 / INP0981_T1003	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1004 / INP0981_T1005	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1006 / INP0981_T1007	Keg Creek, East Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1008	Keg Creek	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1009 / INP0981_T1010	Keg Creek,West Fork	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1011 / INP0981_T1012	Keg Creek,West Fork	Ammonia, IBC, Nutrients
051202090801	GIBSON	INP0981_T1013	Keg Creek,West Fork	Ammonia, IBC, Nutrients
051202090801	GIBSON	INP0981_T1014	Keg Creek,West Fork	Ammonia, IBC, Nutrients, pH
051202090801	GIBSON	INP0981_T1015	Keg Creek	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1016 / INP0981_T1017	Wabash and Erie Canal	IBC, E coli, Nutrients
051202090801	GIBSON	INP0981_T1019	Keg Creek, Unnamed Trib	IBC, E coli, Nutrients
051202090801	GIBSON	INP0982_T1005	Hurricane Creek	Nutrients
051202090801	GIBSON	INP0982_T1008	Wabash and Erie Canal	Ammonia
051202090805	GIBSON	INP0985_03 / INP0985_04	Patoka River	IBC, PCBS (fish tissue)
051202090806	GIBSON	INP0986_03	Patoka River	IBC, PCBS (fish tissue)
051202090807	GIBSON	INP0987_01 / INP0987_02	Patoka River	IBC, PCBS (fish tissue)
051202090807	GIBSON	INP0987_03 / INP0987_04	Patoka River	IBC, PCBS (fish tissue)
051202090807	GIBSON	INP0987_05 / INP0987_06	Patoka River	IBC, PCBS (fish tissue)
051202090807	GIBSON	INP0987_T1002 / INP0987_T1003	Patoka River, Unnamed Trib	IBC, PCBS (fish tissue)
051202090807	GIBSON	INP0987_T1004 / INP0987_T1005	Patoka River, Unnamed Trib	IBC, PCBS (fish tissue)

RESOURCES and REFERENCES:

Indiana State Department of Health – Environmental Public Health, Diseases Involving Sewage, Rev. 10/5/09 on the web @ http://www.in.gov/isdh/22963.htm

Indiana State Department of Health – Epidemiology Resource Center, Quick Facts on E coli. For more information, refer to http://www.cdc.gov/ecoli/.

https://engineering.purdue.edu/watersheds/tools.html; the Web-Based Load Calculation Using LOADEST program.

2012 Census of Agriculture, Gibson County, Indiana profile @ www.agcensus.usda.gov.

Watershed Management Plan for Turtle Creek Watershed, Turman Creek Watershed and Kelly Bayou Watershed; West Central Indiana Watershed Alliance, Sullivan County SWCD, Sullivan, Indiana, December 2015.

Patoka Lake Source Water Protection Plan

Estimation of Pollutant Loads in Rivers and Streams: A Guidance Document for NPS Programs; R. Peter Richards, Water Quality Laboratory, Heidelberg College, Tiffin, OH; US EPA Region 8, David Rathke, Project Officer. 1998.

"Establishing the Relationship between Turbidity and Total Suspended Sediment Concentration," C. P. Holliday, Todd C. Rasmussen and Williams P. Miller, University of Georgia, 2003.

Acronyms List

BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CFU	Colony Forming Unit
CRP	Conservation Reserve Program
CWI	Clean Water Indiana
DO	Dissolved Oxygen
DOR	Division of Reclamation
EQIP	Environmental Quality Incentives Program
FOTG	Field Office Technical Guide
FSA	Farm Service Agency
FWA	Fish and Wildlife Area
GIS	Geographical Information System
HRW	Hoosier RiverWatch
HUC	Hydrological Unit Code
IAC	Indiana Administrative Code
IASWCD	Indiana Association of Soil and Water Conservation Districts
IBC	Impaired Biotic Community
ICP	Indiana Conservation Partnership
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
ISDA	Indiana State Department of Agriculture
ISDH	Indiana State Department of Health
LARE	Lake and River Enhancement Program
L-THIA	Long-Term Hydrological Impact Analysis Tool
NH_3	Chemical formula for ammonia
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NMP	Nutrient Management Plan
ppm	Parts per Million
PRNWR	Patoka River National Wildlife Refuge
QAPP	Quality Assurance Project Plan
CQHEI	Citizens Qualitative Habitat Evaluation Index
SWCD	Soil and Water Conservation District
TMDL	Total Maximum Daily Loads
TNC	The Nature Conservancy
TSS	Total Suspended Solids
USACE	United States Army Corp of Engineers
USDA	United States Department of Agriculture
US EPA	United States Environmental Protection Agency
US FWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WASCoB	Water and Sediment Control Basin
WMP	Watershed Management Plan
WQ	Water Quality