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STONY CREEK WATERSHED MANAGEMENT PLAN

February 2007

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CBBEL Project Number 02-449

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EXECUTIVE SUMMARY

Christopher B. Burke Engineering, Inc. (CBBEL) was retained by the Hamilton County Drainage Board to assist the Hamilton County Surveyor's Office with leading the investigation, development, and drafting of a Watershed Management Plan (WMP) for the Stony Creek Watershed. Interest in developing the WMP stems from both water quality and water quantity issues associated with the watershed. It is hoped that, through the implementation of this WMP, improved water quality conditions will be realized that will benefit all residents of the Stony Creek Watershed.

The Stony Creek Watershed drains portions of east-central Hamilton and west- central Madison Counties and is a tributary to the West Fork of the White River, with the confluence in the City of Noblesville, Indiana. The Stony Creek Watershed covers approximately 57 square miles, or 36, 539 acres of primarily agricultural lands.

Chapter 1: Introduction describes the planning objective, process, and participation that are pertinent to watershed planning and management. The watershed planning effort began with the organization of a Steering Committee that assessed conditions in the watershed, examined water quality issues important to the community, and made decisions as to the direction and content of the plan. **Chapter 2: Identifying Water Quality Problems and Causes** examines and discusses information that describes the current water quality conditions in the Stony Creek Watershed. To help facilitate this planning effort, CBBEL researched and compiled information on past studies, analyzed trends, and conducted a chemical monitoring program in the watershed to provide the Steering Committee with a comprehensive picture of water quality conditions in the watershed. General conclusions reported in recent and past studies showed that habitat conditions were fair to good, and the chemical monitoring study confirmed that *Escherichia coli (E. coli)* bacterium is a special concern and significant impairment exists within Stony Creek and its tributaries. **Chapter 3: Identifying Pollutant Sources** describes the potential sources and possible locations of pollutants that are causing impairment that were identified in Chapter 2. These sources of pollution included agricultural tillage practices, fertilizer and pesticide applications, inadequate septic systems and many others. **Chapter 4: Identifying Critical Areas** details general locations where these pollutant sources may be addressed to help preserve and improve water quality conditions in the Stony Creek Watershed. Results of Steering Committee discussions yielded a map of critical areas that were recognized as requiring either preservation, or improvement. **Chapter 5: Goals and Decisions** identifies specific management actions and recommendations for preserving and improving water quality in the Stony Creek Watershed. Finally, **Chapter 6: Monitoring Effectiveness** defines how the WMP will be reviewed, evaluated, and updated as a living and dynamic planning document into the future.

Additional input for this WMP was sought from the public. Two public meetings and surveys were conducted to provide a forum and conduit for review and comment on the development of the WMP. Individuals that are interested in learning more about the project or obtaining a copy of the Stony Creek WMP can contact:

Hamilton County Surveyor's Office
One Hamilton County Square, Box 188
Noblesville, IN 46060
(317) 770-8833
www.co.hamilton.in.us

This Plan is the culmination of an 18-month planning effort and is intended to be a guiding document that describes the current water quality conditions, prioritizes water resource issues, and identifies specific management actions that can be implemented to help the Stony Creek Watershed community manage their water resources into the future.

1.0 INTRODUCTION

Christopher B. Burke Engineering, Inc. (CBBEL) was retained by the Hamilton County Drainage Board to assist the Hamilton County Surveyor's Office with leading the investigation, development, and drafting of a Watershed Management Plan (WMP) for the Stony Creek Watershed. Interest in developing the WMP stems from both water quality and water quantity issues associated with the watershed. It is hoped that, through the implementation of this WMP, improved water quality conditions will be realized that will benefit all residents of the Stony Creek Watershed. This plan documents the study and its results.

1.1 WATERSHED BASED PLANNING

A watershed is an area of land that collects and drains water to a specific point. Similar to water poured into a bowl, a portion of the precipitation that falls on a watershed will move through the landscape, collecting and concentrating in low areas, creeks, and streams, until it exits through an outlet point. All water, whether in the ground or traveling over the ground surface, moves from the highest to the lowest points in an area of land. Using this definition, watersheds can be defined for any location. For planning purposes, the watershed is a measurable and practical landscape feature that is based on how water moves, interacts with, and behaves on the landscape.

Water in the form of precipitation can take several paths once it has reached the earth. Some portion of the precipitation will never reach the ground; instead it is caught by vegetation and/or ground litter and evaporates. That portion of precipitation that does reach the ground can infiltrate the ground, becoming shallow or deep groundwater, or travel over the surface as runoff. Runoff is excess rainfall that can not be absorbed or retained in the landscape. As water travels through the watershed by these pathways it interacts with the landscape, in a physical and chemical manner, that interaction determines the character of water quality in a receiving waterbody. Human activities alter the landscape and thus influence the physical and chemical interaction of water in a watershed. Recognition and an understanding of the hydrologic cycle in the context of human influence on watershed processes are fundamental to good watershed management planning.

Human interaction with the environment helps to define the characteristics of the watershed, and thus, the quality of the water. A logical way to approach water resource management is to use the watershed as the primary management unit. Since water collects and moves through the landscape via watersheds, the physical, chemical, and biological conditions of the water will be unique to each watershed. Therefore, planning and management would be most effective if they address the unique character and conditions of the watershed in question.

Watersheds, and watershed management areas, can be considered at a regional or very local level; where watersheds can be as small as a ¼ acre plot or as large as the Mississippi River Basin that covers millions of square miles. The Center for Watershed Protection classifies watersheds into five management units; these are catchment, sub-watershed, watershed, sub-basin, and basin and are listed in **Table 1-1**. The primary planning authority and suggested management focus for each of the five management units varies depending on the size of the watershed. According to this classification system the Stony Creek Watershed (approximately 57 square miles) would be considered a "Watershed" and is therefore best managed at the local or multi-local level.

Table 1-1: Watershed Management Units

Watershed Management Unit	Typical Area (Square miles)	Primary Planning Authority	Suggested Management Focus
Catchment	0.05-0.50	Local property owner	Best Management Practices (BMP)
Subwatershed	1-10	Local government	Stream Management & Classification
Watershed	10-100	Local or multi-local	Watershed-based Planning
Subbasin	100-1,000	Local, regional, and State	Basin Planning
Basin	1,000-10,000	State, multi-State, Federal	Basin Planning

(Schueler, 1995)

Watershed Planning

The Watershed Management Plan (WMP) is intended to benefit communities in the watershed by helping to improve the local economy, increase effectiveness of government, and preserve the environment through comprehensive water resource planning. Watershed planning can benefit the local economy by helping to protect drinking water supply, decrease losses related to floods, and increase property values by providing attractive and safe living and recreation areas. Good watershed planning can improve the effectiveness of government through more direct public involvement that earns the trust and support of the community and guarantees that all community interests are treated fairly. The planning effort also helps to ensure that current water quality in the community is preserved and that the community will not suffer significant financial losses due to loss of natural resource buffers and other natural resources.

The planning process is not without some complications as members of watershed communities can have competing desires for how water is used. For example, a large proportion of the Stony Creek Watershed is agricultural with many farming interests. A farmer will view water quality issues differently than will others in the community. However, the interests of that farmer must be taken into consideration if the WMP is to be a benefit to the whole community. Likewise, the homeowner near Noblesville that uses a private well for water supply has an interest in clean drinking water that is not polluted from other watershed users. Further complication of the planning process is realized when there are several government jurisdictions with different sets of ordinances and rules for water use. Nonetheless, it is imperative that the planning process formulate a workable WMP that is sensitive to the values and desires of all members of the community and is developed with the input and support of a good cross-section of the community. Input from the farmer, home-owner, government administrator, elected official and others in the community will help to ensure that there is balance and equitable distribution of responsibility for and benefits of good water quality in the watershed.

Watershed planning is especially important to help prevent future water resource problems, preserve watershed functions, and ensure future economic, political, and environmental health. Everyone in a watershed is involved in watershed management; however, there are typically no water resource specific agreements on how water should be used and managed by all users in a community. However, a WMP is a start toward a better understanding of community values and watershed processes and can provide guidance toward the betterment of watershed management and living conditions in the community.

Regulatory Context of Watershed Planning

Watershed management has been widely promoted by the Environmental Protection Agency (EPA) and other public and private organizations concerned with water quality. In fact, by developing WMPs, targeted areas become eligible for funding to implement a wide array of water quality related projects. Funding sources include, but are not limited to, the Indiana Department of Environmental Management (IDEM), the Environmental Protection Agency (EPA), the Indiana Department of Natural Resources (IDNR), and the United States Department of Agriculture (USDA).

Watershed planning can also be a response to regulatory interest in impaired water quality in the watershed. Section 303(d) of the Clean Water Act requires states to identify waters that do not, or are not expected to, meet federal water quality standards. States are also required to develop a priority ranking for these waters taking into account the severity of the pollution and state defined designated uses of the waters. For those waters identified as having impaired water quality, the states are required to develop Total Maximum Daily Loads (TMDLs) in order to achieve compliance with federal water quality standards and the Clean Water Act.

An effective watershed plan will help to address the water quality impairments identified by the IDEM, and will help to demonstrate community involvement and commitment to addressing impaired water quality in the watershed.

Stony Creek Watershed Management Plan

A WMP is a guiding document that examines the historical and existing water resource issues in a particular watershed and presents specific actions to address those water resource issues based on the values and needs of the community. The intent of the WMP is to provide better living conditions, economic viability, and environmental health benefits for those that reside in the watershed and for communities downstream. Developers of the WMP are interested stakeholders that investigated prior and existing watershed conditions, identified watershed priority areas, and formulated strategies for implementing specific actions. The WMP document represents the earnest efforts of the community to understand, analyze, and be an integral part of the solution to improve impaired water quality in the watershed. Furthermore, active community involvement in the development of the WMP helps to ensure that there is commitment by the community to implement projects identified in the WMP.

The most recent water quality data available for the Hamilton County portion of the Stony Creek Watersheds indicate:

- State water quality violations were identified for *E. coli* and Impaired Biotic Communities in Stony Creek and William Lock Ditch (IDEM 303(d) List, 2004).
- Full support for aquatic life in Stony Creek-Headwaters, William Lock Ditch, William Lehr Ditch, and the North Tributary (Noblesville); partial support for aquatic life in Stony Creek; non-support for fish consumption in Stony Creek; and non-support for primary contact in Stony Creek and its tributaries. The cause (stressor) rating is identified as moderate for biotic communities, high for PCBs, and moderate or high for pathogens (IDEM 305(b) Report, 2004).
- Elevated levels for *E. coli*, phosphate, nitrate, and turbidity were identified in water samples collected by Indiana University students as part of the "Stony Creek Watershed Stormwater Master Plan". The source of these pollutants may originate from failed septic systems, livestock, fertilizers, tile drains, sediment from construction and streambank erosion, and stormwater runoff. (CBBEL Draft Report, 2004).

- Rapid Bioassessment Protocols (RBP) and the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) prepared by Indiana University students as part of the "Stony Creek Watershed Stormwater Master Plan" indicated that most sites sampled were moderately-severely impaired. Both indices, the RBP and the QHEI, assess the quality of the biotic features of the stream system and utilize numeric ranges to determine the extent that the stream is meeting the aquatic life use standards. The study concluded that much of impairment is the result of dredging, channelization, urbanization and agricultural activities (CBBEL Draft Report, 2004).
- High levels of *E. coli* were identified in the draft "Duck Creek, Pipe Creek, Killbuck Creek, and Stony Creek TMDLs for *E. coli* Bacteria: Data Analysis and Technical Approach Report". Potential causes and sources of *E. coli* bacteria include combined sewer overflows, septic systems, livestock, and wildlife (IDEM draft TMDL report, 2004).

The Stony Creek WMP presents the overall watershed analysis and inventory conducted by Christopher B. Burke Engineering, Ltd (CBBEL), the project Steering Committee, and the public, and offers recommendations for water quality improvement, preservation, and protection. This WMP meets the requirements of the IDEM's Watershed Management Plan Checklist.

1.2 WATERSHED PARTNERSHIPS

During 2004, the draft "Stony Creek Watershed Stormwater Master Plan" which primarily addressed water quantity and flooding issues was completed. Dr. Claude Baker and his students were subcontracted to provide some water quality information for the Master Plan. In October of 2005, the Hamilton County Surveyor's Office submitted a Clean Water Act Section 319 Grant application to the IDEM in order to utilize the existing Master Plan information, further study water quality issues, and develop a IDEM approved 319 Watershed Management Plan for the Stony Creek Watershed. The Federal Clean Water Act Section 319 program provides funding for various types of projects designed to determine the nature, extent and causes of point and nonpoint source pollution problems and to develop and implement projects to resolve these problems.

The Hamilton County's section 319 grant application requesting funding to develop a Watershed Management Plan for the Stony Creek Watershed included the following statements,

> "The environmental benefits, expected achievements, and anticipated outcomes of this project is to prepare a watershed management plan that has public support, clearly defined goals, management measures, and action plan items is vital to protect and improve the water quality of Stony Creek and it's tributaries for this and future generations.

In January of 2006, the Hamilton County Surveyor's Office was awarded a Clean Water Act Section 319 grant from IDEM in the amount of $30,000 and CBBEL was selected by Hamilton County to coordinate the watershed planning project.

The Stony Creek Planning Process was led by a Steering Committee made up of local stakeholders that acted as advisors to help guide the direction of the project, as informational resources and as decision makes that recommended projects and management strategies designed to improve the water quality of Stony Creek Watershed. Steering Committee members are identified in **Table 1-2** below.

Table 1-2: Stony Creek Watershed Steering Committee

Name	Representing
John Beery	City of Noblesville, Engineering
Crist Blassaras	Madison County SWCD
Gregory Bohlander	Indiana Farm Bureau
Steve Cash	Hamilton County Surveyor
Walt Evans	Hamilton County Surveyor
Len Finchum	City of Noblesville, Street Dept
Laura Fribley	Madison County SWCD
Mike Hendricks	City of Noblesville, Wastewater Utilities
Steven Huntley	City of Noblesville Planning
Kevin Jump	City of Noblesville, Engineering
Chuck Kiphart	Hamilton County Plan Commission
Mark McCauley	Hamilton SWCD/NRCS
Barry McNulty	Hamilton County Health Department
Janelle Park	Madison County SWCD
Al Patterson	Hamilton County Parks & Recreation
Sky Schelle	IDEM
Don Seal	Noblesville Parks & Recreation
Lenore Tedesco	IUPUI CEES
Robert Thompson	Hamilton County Surveyor
Joel Thurman	Hamilton County Highway Department
Kent Ward	Hamilton County Surveyor

The Stony Creek Watershed Steering Committee met four times, during February, June, August, and October of 2006. Meeting agendas focused on discussing and identifying issues as well as areas of concern for the urban and agricultural portions of the watershed. The mission statement of the Steering Committee is, "The Stony Creek Watershed Steering Committee is committed to developing a Watershed Management Plan that will increase public awareness of water quality issues, identify water quality problems, and make economically and environmentally friendly recommendations that will improve water resources of the Stony Creek Watershed".

1.3 PUBLIC PARTICIPATION

In addition to Steering Committee meetings, 2 public stakeholder meetings were held to introduce the project to the public and surveys were conducted, to solicit their input on potential problems, and to assist with the prioritization of water quality problems.

The first Public Stakeholder meeting in February of 2006, gave citizens an opportunity to be introduced to the overall project and discuss the issues of concern within the Stony Creek Watershed. A PowerPoint presentation introduced the project, summarized water quality and natural resource data collected to date, and concluded with a question and answer session where Stakeholders could ask questions, state concerns, and make recommendations regarding the project. Detailed maps of the watershed were provided and Stakeholders were asked to indicate locations for areas of concern. Surveys (further discussed in Section 2.1) with questions about the rural portions of the watershed were distributed with 10 being completed at this meeting.

The second Public Stakeholder meeting in September of 2006 presented the draft watershed management plan to citizens. A PowerPoint presentation summarized the draft plan including watershed impairments, pollutant sources, plan recommendations, and previously identified critical areas. Stakeholders were encouraged to ask questions and review a detailed map showing the critical areas.

All Stakeholder Meetings were advertised through press releases to Hamilton and Madison County area media, and through a project web page (http://www.cbbel-in.com/StonyCk/StonyCreek.htm). The web page was developed at the beginning of the project to provide detailed project information including meeting schedules to the Steering Committee and interested citizens as well as stakeholders.

1.4 WATERSHED LOCATION

The Stony Creek WMP project area covers four 14-digit HUCs within the larger White River Watershed. These include 1) Stony Creek-North Tributary (Noblesville); 2) Stony Creek-William Lehr Ditch; 3) Stony Creek- William Lock Ditch; and finally 4) Stony Creek-Headwaters. The Stony Creek Watershed project area is identified in **Exhibit 1-1** and **Exhibit 1-2**.

The Stony Creek Watersheds drain 36,539 acres in the east-central Hamilton County and west-central Madison County. Stony Creek and its tributaries drain into the West Fork of the White River in the City of Noblesville. The land use of these watersheds is approximately 90% agriculture, 5% suburban and urban development, and 0.8% commercial development. There are approximately 47.2 miles of perennial streams and open ditches in the Stony Creek Watershed. The major streams are identified in **Exhibit 1-3**.

1.5 DESCRIPTION AND HISTORY

Natural History

The Wisconsin Glacier formed the present landscape of the Stony Creek Watershed. When the glacier receded it deposited as much as 50 to 100 feet of glacial till over the limestone bedrock. The soils found in the Stony Creek Watershed are the result of direct glacial deposits or materials carried by the streams of melting ice and snow.

Prior to settlement in the mid-1800s, much of the Stony Creek Watershed was covered in wetlands and woods. The trees removed by the early settlers to make room for farming would have consisted of upland hardwood forest species characteristic of a Maple-Beech association. Plant associations or communities are broad generalizations of vegetation based on a geographic region. The upland areas of the Stony Creek Watershed would have been densely covered in sugar maple, basswood, beech, yellow birch, American elm, ironwood, and red maple. Species such as silver maple, American elm, willow, basswood, sycamore, and ash would have been more abundant in the river corridors and low-lying marsh areas.

According to the 1992 Gap Analysis Program (GAP) datum, only 4% of the Stony Creek Watershed land use is wooded or wetland. Although nonnative and invasive species such as serviceberry now dominate much of the understory of existing wooded areas, evidence of the native hardwood forest still prevails. Fragmentation of wooded and natural areas caused by increased human settlement as well as trapping and hunting has limited the number of wildcats, bears, foxes, and poisonous snakes that once were abundant in the Stony Creek Watershed.

Climate
The climate of this region is characterized as humid continental, but the Stony Creek Watershed is also on the edge of climatic influences from the Great Lakes. The average daily summer maximum temperature is 84 degrees Fahrenheit (F) and the average daily winter minimum temperature is 20F. The annual precipitation over the watershed averages 37 inches with an average annual snowfall of 21 inches. Fifty-eight percent of the total precipitation occurs from August through September.

Land Use
As shown in **Table 1-3** and **Exhibit 1-5**, agricultural land uses dominate the current setting of the watershed. In fact, nearly 90% of the Stony Creek Watershed is involved in agricultural production. Row crops dominate the production acres with approximately 26,500 acres, or 72% of the land use.

A small portion of the Stony Creek Watershed, 1,000 acres or 2.7% is considered to be forested or shrubland, and according to the National Wetland Inventory (NWI) maps, approximately 322 acres are classified as wetlands which are shown on **Exhibit 1-4**. It is important to note that the NWI maps should only be used as a reference, and not as an indicator of whether or not wetlands exist on a particular site.

While a small portion of the Stony Creek Watershed is classified as residential, it also becomes apparent that a relatively small portion of the watershed is more urbanized. The entire Town of Lapel is located within the boundaries of the Stony Creek Watershed. Small portions of Noblesville and Anderson are also included, at the extreme western edge and extreme eastern edge respectively. As these communities continue to grow in population and expand in size, it can be expected that the percentage of agricultural land will be reduced.

Table 1-3: Stony Creek Watershed Land Use

Land Use Types	Acres	Percentage
Agriculture/Farm	32,985.16	90.27
Urban	1,790.95	4.90
Forest	999.44	2.74
Wetlands	322.03	0.88
Commercial/Industrial/Transportation	287.11	0.79
Quarries/Strip Mines/Gravel Pits	107.19	0.29
Open Water	47.15	0.13
Total	**36,539.03**	**100.00**

(USGS and USEPA (joint effort) 1999)

Soils
The soils of the Stony Creek Watershed formed primarily from Wisconsin glacial till and glacial outwash. According to the soil surveys for Hamilton and Madison Counties, and shown in **Table 1-4**, there are 5 predominant soil associations in the watershed. Near the confluence with the West Fork of the White River, the primary association is Ockley-Westland-Fox and in the upper portions of the watershed, closer to the headwaters, the primary associations are Brookston-Crosby and Fox-Eel are dominant.

Table 1-4: Soil Associations in the Stony Creek Watershed

Soil Association	Characteristics
Crosby-Brookston	Deep, nearly level, somewhat poorly drained and very poorly drained, medium textured and moderately fine textured soils that formed in a thin mantle of loess and the underlying glacial till on uplands.
Miami-Crosby	Deep, nearly level to strongly sloping, well drained and somewhat poorly drained, medium textured soils that formed in a think mantle of loess and the underlying glacial till on uplands.
Ockley-Westland-Fox	Deep and moderately deep over sand and gravel, nearly level to strongly sloping, well drained and very poorly drained, medium textured and moderately fine textured soils that formed in outwash on terraces.
Brookston-Crosby	Nearly level and gently sloping soils formed in medium-textured till on uplands.
Fox-Eel	Nearly level to strongly sloping soils on terraces and flood plains.

(USDA, 1978 and 1967)

The NRCS has assigned a soil erodibility index to each soil type. This value is based on the soil chemical and physical properties, as well as climatic conditions. Highly erodible soils are discussed in detail in Section 3. Septic systems need well-draining soils to efficiently and effectively treat household wastewater. Based on countywide date for Hamilton and Madison Counties, the soils are severely limited for septic systems. This factor will also be discussed in more detail in Section 3.

Topography

The area surrounding the Stony Creek has very little relief, as can be observed utilizing United States Geological Survey (USGS), topographical maps. With less than 100 feet of fall from the headwaters to the confluence with the West Fork of the White River, the watershed can be subjected to increased pollutant loadings from overland runoff or areas that have been subjected to systematic sub-surface drainage enhancements.

Hydrology

Within the Stony Creek Watershed, there are approximately 47.2 miles of perennial streams and open ditches that contain regular flow. The major waterways are the Stony Creek, William Lehr Ditch, and the William Lock Ditch combining to create the Stony Creek as a tributary to the West Fork of the White River. Exhibit 1-3 identifies the aforementioned waterways in the Stony Creek Watershed.

Cultural Resources

The City of Noblesville's Seminary Park was established in 1983 on one and a half acres located between Tenth and Eleventh Streets and Division and Hannibal Streets. Facilities include a gazebo, small playground and landscaped, open green space. The gazebo and green space is used many times throughout the summer for band concerts, Shakespeare in the Park, small outdoor weddings, and other organizations community events.

The Wayne-Fall Lions' Club sits on four acres of land at the corner of East 191st Street and Deshane Road. In 1969 the clubhouse was constructed. The building was a cedar log lodge kit, which had originally been purchased by company for a ski lodge. Before the building could be erected the company went bankrupt. The Wayne-Fall Lions Club purchased the log lodge kit for the remaining amount due. The members of the club assembled the lodge. The lodge contains a large meeting room with a fireplace, a kitchen that is equipped with a professional stream table and an office with a storage room. The lodge also contains a one-bedroom apartment whose rental proceeds help support club activities. The facility is also available for use by members of the community for a small rental charge.

Endangered, Threatened, and Rare Species

As shown in **Table 1-5** and **1-6**, there are a number of endangered, threatened or rare plants and animals that have been identified in both Hamilton and Madison Counties. A detailed study to verify if these plants and animals are located within the Stony Creek Watershed was not conducted.

Table 1-5: Endangered, Threatened, and Rare Species for Hamilton County

Scientific Name	Common Name	State Listing	Federal Listing
MOLLUSK			
Epioblasma torulosa rangiana	Northern Riffleshell	**Endangered**	**Endangered**
Epioblasma triquetra	Snuffbox	**Endangered**	
Lampsilis fasciola	Wavyrayed Lamp mussel	**Special Concern**	
Ligumia recta	Black Sandshell		
Obovaria subrotunda	Round Hickorynut	**Special Concern**	
Plethobasus cyphyus	Sheepnose	**Endangered**	**Candidate**
Pleurobema clava	Clubshell	**Endangered**	**Endangered**
Ptychobranchus fasciolaris	Kidneyshell	**Special Concern**	
Quadrula cylindrical cylindrical	Rabbitsfoot	**Endangered**	
Toxolasma lividus	Purple Lilliput	**Special Concern**	
Toxolasma parvum	Lilliput		
Vilosa fabalis	Rayed Bean	**Special Concern**	**Candidate**
Vilosa lienosa	Little Spectaclecase	**Special Concern**	
FISH			
Ammocrypta pellucida	Eastern Sand Darter		
AMPHIBIAN			
Necturus maculosus	Common Mudpuppy	**Special Concern**	
REPTILE			
Clemmys guttata	Spotted Turtle	**Endangered**	
Sistrurus catenatus catenatus	Eastern Massasauga	**Endangered**	**Candidate**
BIRD			
Bartramia longicauda	Upland Sandpiper	**Endangered**	

Scientific Name	Common Name	State Listing	Federal Listing
Buteo lineatus	Red-shouldered Hawk	**Special Concern**	
Certhia Americana	Brown Creeper		
Dendroica cerulean	Cerulean Warbler	**Special Concern**	
Ixobrychus exilis	Least Bittern	**Endangered**	
Nycticorax nycticorax	Black-crowned Night-heron	**Endangered**	
Thryomanes bewickii	Bewick's Wren		
MAMMAL			
Lynx rufus	Bobcat		**No Status**
Taxidea taxus	American Badger		
VASCULAR PLANT			
Armoracia aquatica	Lake Cress	**Endangered**	
Chelone oblique var. speciosa	Rose Turtlehead	**Watch List**	
Drosera intermedia	Spoon-leaved Sundew	**Rare**	
Platanthera leucophaea	Prairie White-fringed Orchid	**Endangered**	**Threatened**
HIGH QUALITY NATURAL COMMUNITY			
Forest-floodplain wet-mesic	Wet-mesic Floodplain Forest	**Significant**	
Forest-upland mesic	Mesic Upland Forest	**Significant**	

(IDNR, 2005)

Table 1-6: Endangered, Threatened, and Rare Species for Madison County

Species Name	Common Name	State Listing	Federal Listing
Epioblasma torulosa rangiana	Northern Riffleshell	**Endangered**	**Endangered**
Lampsilis fasciola	Wavyrayed Lamp mussel	**Special Concern**	
Plethobasus cyphyus	Sheepnose	**Endangered**	**Candidate**
Pleurobema clava	Clubshell	**Endangered**	**Endangered**
Ptychobranchus fasciolaris	Kidneyshell	**Special Concern**	
Quadrula cylindrical	Rabbitsfoot	**Endangered**	
Toxolasma lividus	Purple Lilliput	**Special Concern**	
Toxolasma parvum	Lilliput		
Vilosa lienosa	Little Spectaclecase	**Special Concern**	
INSECT (ODONATA)			
Cordulegaster bilineata	Brown Spiketail	**Endangered**	
BIRD			

Species Name	Common Name	State Listing	Federal Listing
Ardea Herodias	Great Blue Heron		
Lanius ludovicianus	Loggerhead Shrike	**Endangered**	**No Status**
Nycticorax nycticorax	Black-crowned Night-heron	**Endangered**	
Rallus elegans	King Rail	**Endangered**	
VASCULAR PLANT			
Deschampsia cespitosa	Tufted Hairgrass	**Rare**	
Hypericum pyramidatum	Great St Johns-wort	**Threatened**	
Juglans cinerea	Butternut	**Watch List**	
Onosmodium hispidissumum	Shaggy False-gromwell	**Endangered**	
Poa paludigena	Bog Bluegrass	**Watch List**	
Selaginella apoda	Meadow Spike-moss	**Watch List**	
Spiranthes lucida	Shining Ladies'-tresses	**Rare**	
Valerianella chenopodiifolia	Goose-foot Corn-Salad	**Endangered**	
HIGH QUALITY NATURAL COMMUNITY			
Forest-upland mesic	Mesic Upland Forest	**Significant**	
Wetland – fen	Fen	**Significant**	
Wetland – marsh	Marsh	**Significant**	

(IDNR, 2005)

2.0 IDENTIFY WATER OUALITY PROBLEMS & CAUSES

As part of the watershed planning process, an inventory and assessment of the watershed and existing water quality studies relevant to the watershed must be conducted. Examination of previous work may show that data already gathered is sufficient for determining the magnitude and extent of water quality conditions, or it may indicate that additional studies are needed to characterize the water quality problems. In either case, assessing water quality information that has already been completed is part of the initial process of building a WMP and will help to guide the identification of water quality problems and links to pollution sources in the watershed. The following section provides a summary of past and current assessments of the Stony Creek Watershed.

2.1 STAKEHOLDER CONCERNS

Individuals living and working in the Stony Creek Watershed have proven to have a wealth of knowledge as it relates to water quality, water quantity, and other natural resource issues within the watershed. Listed in **Table 2-1** are water quality issues of concern that were identified by members of the Stony Creek Steering Committee, residents, landowners, and other stakeholders in the Stony Creek Watershed throughout the planning process. The concerns identified by the Steering Committee as consistent with the findings of the study conducted by Dr. Baker, which is discussed in detail later in this chapter.

Table 2-1: Stakeholder Concerns in the Stony Creek Watershed

Rural Issues/Agricultural Impacts

- Improved Crop and Manure Management
- Livestock with Waterway Access and Pasture Management
- Unbuffered Waterways
- Sub-surface Drainage Tile and Ditch Maintenance
- Eroded Streambanks and Log Jams
- Failing Septic Systems
- Improper Solid Waste Disposal

Urban Issues/Development Impacts

- Failing Septic Systems
- Urban Stormwater Pollution
- Pet and Wildlife Waste
- Rapid Development and Changing Land Uses
- Residential Lawn Care
- Improper Solid Waste Disposal
- Floodplain Management/Open Space

Public Opinion Questionnaire

Approximately 75 Public Opinion Questionnaires were distributed to stakeholders and made available on the project web site at the beginning of the planning process. A total of 25 questionnaires were returned; 21 from residents in rural portions of the watershed and 4 from residents in urban portions of the watershed. The goal of the questionnaire was to gain an accurate understanding of how local stakeholders use and perceive Stony Creek and its tributaries. Forty-eight percent of respondents agree that Stony Creek is a valuable resource, while 28% of respondents agree that Stony Creek is polluted. The leading contributor to pollution in the Stony Creek Watershed according to 44% of the respondents was fertilizer and chemical application while contributions from raw sewage, erosion, flooding, and construction activity were ranked evenly. **Appendix 2** includes the questionnaires utilized and identifies the cumulative results from those questionnaires.

2.2 WATER QUALITY BASELINE STUDIES

The following section provides a summary of baseline water quality conditions present in the Stony Creek Watershed.

2006 Indiana Integrated Water Quality Report

The Indiana Department of Environmental Management (IDEM) is the primary agency involved in surface water quality monitoring and assessment in the State of Indiana. In conjunction with the requirements of the Clean Water Act and the State's goals for protecting its natural and recreational resources, the IDEM operates several monitoring programs designed to monitor and assess the chemical, physical, and biological conditions of Indiana's rivers, streams, and lakes.

The IDEM's Office of Water Quality's surface water quality basin strategy is designed to describe the overall environmental quality of each major river basin in the state and to identify monitored water bodies that do not fully support designated uses. The IDEM's surface water monitoring was revised in 2001 to meet the goals of assessing all waters of the state within five years.

The 305(b) report provides a compilation and summary of all of the IDEM's water quality monitoring and assessment data (compiled from AIMS database and other datasets/reports within the IDEM). Each subwatershed is given a water quality rating relative to its streams status in meeting Indiana's Water Quality Standards (WQS). WQS are set at levels necessary for protecting a waterway's designated use(s), such as swimmable, fishable, or drinkable. Each subwatershed is given a rating of fully, partially, or not supportive of its designated uses.

Chapter 303(d) of the Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards with technology based standards alone. States are also required to develop a priority ranking for these waters, taking into account the severity of the pollution and the designated use of the waters. Once this listing and ranking of waters is completed, States are required to develop Total Maximum Daily Loads for these waters in order to achieve water quality standards. Stony Creek was listed on both the 2002, 2004, and 2006 303(d) List of Impaired Waters due to *E. coli* and impaired Biotic Communities.

In an attempt to ensure greater consistencies between the 305(b) report and 303(d) list, the two reports are now submitted together as an integrated report to U.S. EPA every two years.

Table 2-2 below identifies Stony Creek's impairments as identified by the 2006 Integrated Water Quality report.

Table 2-2: Stony Creek 2006 Integrated Water Quality Report

Watershed Name	HUC	Use Support	Cause (stressor) Rating
Stony Creek – Headwaters	05120201070040	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Moderately Impaired- Pathogens
Stony Creek – William Lock Ditch Tributaries	05120201070050	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Highly Impaired- Pathogens
Stony Creek	05120201070050	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Highly Impaired- Pathogens, PCBs
William Lehr Ditch and Other Tributaries	05120201070060	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Highly Impaired- Pathogens
Stony Creek	05120201070060	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Highly Impaired- Pathogens, PCBs
North Tributary (Noblesville)	05120201070070	Fully Supporting- Aquatic Life	
		Not Supporting- Full Contact Recreations	Moderately Impaired- Pathogens
Stony Creek	05120201070070	Partially Supporting- Aquatic Life	Moderately Impaired- Pathogens, Biotic Communities
		Not Supporting- Full Contact Recreations	Highly Impaired – PCBs

(IDEM, 2006)

Fish Consumption Advisory (FCA)

Each year since 1972, three agencies have collaborated to create the Indiana Fish Consumption Advisory. These agencies include the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and the Indiana State Board of Health (ISBH). Each year, members from these agencies meet to discuss the findings of recent fish monitoring data and to develop the new statewide fish consumption advisory.

The 2004 advisory is based on levels of polychlorinated biphenyls (PCBs) and mercury found in fish tissue. In each area, samples were taken of bottom-feeding fish, top-feeding fish, and fish feeding in between. Fish tissue samples were analyzed for polychlorinated biphenyls (PCBs), pesticides, and heavy metals. Of those samples, the majority contained at least some mercury. However, not all fish tissue samples had mercury at levels considered harmful to human health. If they did, they are listed in the fish consumption advisory. There is a fish consumption advisory listing for the entire Stony Creek due to *E. coli* levels and the proximity of a Superfund site, and a statewide PCB advisory for carp in all Indiana streams, the Indiana portion of Lake Michigan, and inland lakes is in effect.

United States Fish and Wildlife Service Survey of Fish Communities and Habitat Quality

In 2002, the United States Fish and Wildlife (USFW) Service, under the direction of the IDNR conducted a water quality assessment of the West Fork of the White River. The study was conducted as a result of the 1999 fish kill that resulted in the death of more than 180 tons of fish, aquatic organisms, and riparian wildlife.

The study included fish sampling, habitat assessments, and chemical sampling. In all, 77 sites were studied, including Stony Creek. Electrofishing methods were utilized to sample fish assemblages, with scoring based on the Index of Biotic Integrity (IBI). The Qualitative Habitat Evaluation Index (QHEI) served as the scoring mechanism for habitat assessments. Water quality sampling was completed during two separate events measuring the levels of dissolved oxygen, temperature, specific conductivity, pH, oxidation-reduction potential, turbidity, salinity, nitrate and ammonia.

The Stony Creek Watershed sites consistently scored among the lowest for both the IBI and the QHEI indices. Possible reasons for this degradation in this area can be attributed to channelization, removal of riparian corridors, sedimentation, and the loss of instream cover. Stony Creek is also designated as a receiving water for the Hamilton County and City of Noblesville's Municipal Separate Storm Sewer System (MS4), a source for high levels of nutrient loadings.

IDEM's Draft TMDL Report for Duck, Pipe, Killbuck, and Stony Creeks dated March 30, 2005

IDEM is finishing their final TMDL report which addresses the *E. coli* pollution in Stony Creek. Findings in this TMDL report are discussed later in this document. **Exhibit 2-1** shows the sampling points for the IDEM TMDL Study and **Appendix 3** includes data from the report. More information on the IDEM Draft TMDL will be presented in Section 4.3 to present *E. coli* loadings for the Stony Creek Watershed.

Chemical Water Quality Monitoring

In November of 2002, the Hamilton County Drainage Board hired Christopher B. Burke Engineering, Ltd. (CBBEL) to assist the Surveyor's Office with conducting a study of the Stony Creek Watershed in Hamilton County, Indiana. The project included both water quality and water quantity studies of which CBBEL subcontracted water quality monitoring tasks to Dr. Claude Baker of Indiana University. Dr. Baker, of the New Albany campus, and his students conducted water quality tasks, including chemical monitoring, habitat assessments, and bio-monitoring at nine sites within the Stony Creek Watershed during the months of May, June, and October of 2003.

Samples were collected to characterize high, base and low flow conditions. Parameters evaluated during collections included temperature, dissolved oxygen, pH, alkalinity, turbidity, conductivity, total dissolved solids, nitrate, nitrite, ammonia-nitrogen, total nitrogen, orthophosphate, total phosphate, and fecal coliform bacteria. The sampling sites can be found illustrated in **Exhibit 2-2** and a narrative description is provided in **Table 2-3**.

Table 2-3: Stony Creek Monitoring Sites

Site Number	Waterbody Name	Site Description
1	Stony Creek	At Atlantic Rd, near the Town of Fishersburg
2	Stony Creek	At Pilgrim Rd, b/n 191st and 196th Streets
2A	Wm Lock Ditch	Near 191st Street
3	Wm Lock Ditch	Above Stony Creek at 196th Street and Mystic Rd
4	Stony Creek	Highway 38 near IMI Quarry
5	Wm Lehr Ditch	At 166th Street near Boden Rd
6	Stony Creek	At Cumberland Road
7	Stony Creek	At Greenfield Rd
8	Stony Creek	At Allisonville Rd near confluence with White River

Dissolved Oxygen

Indiana WQS state that dissolved oxygen levels shall average at least five milligrams per liter per day and shall not be less than four milligrams at any time. Dissolved oxygen concentrations are affected by numerous factors. Physical conditions, such as lower temperatures generally result in higher concentrations of dissolved oxygen. Turbulent water action, associated with in stream riffles also result in increased dissolved oxygen concentrations, by injecting air into the water column.

Table 2-4 identifies examples of dissolved oxygen concentrations in natural waterways and classifications associated with each range of concentrations. Dissolved oxygen concentrations below 3.0 mg/L are considered to be stressful to fish and levels below 2.0 mg/L will not typically support aquatic life.

Table 2-4: Dissolved Oxygen Concentrations and Waterway Classification

Dissolved Oxygen Concentration (mg/L)	Waterway Classification
5.4 to 14.8	Typical Range of healthy waterway
5.0 to 6.0	Optimal Range for Aquatic Growth
0.1 to 5.0	Low Range in Natural Waterways

Sampling results observed by Dr. Baker, et al. indicate that dissolved oxygen concentrations in the Stony Creek Watershed remained above the 5.0 mg/L level during the three collection events at all nine sites. In fact, none of the samples taken were below the threshold for the typical range of a healthy waterway.

Turbidity and Total Dissolved Solids

Turbidity is defined as cloudiness or opacity in the appearance of a liquid caused by solids, particles and other pollutants. Measuring turbidity provides an indication of the clarity of water and water quality. Increased turbidity affects a stream and the organisms that live in it in many ways and if the water becomes too turbid, it loses the ability to support a wide variety of plants and other aquatic organisms. The total dissolved solids (TDS) measurement refers to inorganic salts and small amounts of organic matter that are dissolved in water. The principal

constituents are usually the cations calcium, magnesium, sodium and potassium and the anions carbonate, bicarbonate, chloride, sulphate and, particularly in groundwater, nitrate (from agricultural use).
Neither turbidity nor TDS is a clear indicator of the amount of sediment that is present in samples taken from the monitoring sites. Therefore, the LTHIA Model will be used in Section 4.3 to determine sediment loadings for the Stony Creek Watershed.

Nutrients
The term "nutrients" primarily refers to the two major plant macronutrients, phosphorus, and nitrogen. These nutrients are common components of fertilizers, animal and human wastes, vegetation, and some industrial processes. Nutrients up to certain levels are both necessary and beneficial to water bodies. However, an overabundance of nutrients can stimulate the occurrence of algal blooms and excessive plant growth, which can result in the reduction of dissolved oxygen concentrations in surface water through respiration and the decomposition of dead algae.

Total Phosphorus
Nonpoint discharges are the major sources of phosphorus in most watersheds. Phosphorus can be present as organic matter and can be either dissolved or suspended in the water column. Phosphorus may also occur in inorganic compounds released from various minerals, fertilizers, and detergents, which may also be either dissolved or suspended in the water column. Phosphorus is the primary nutrient associated with the production of algae and aquatic plants, as it is often a limiting nutrient in aquatic environments.

There are not currently published water quality standards in Indiana for total phosphorus, however, it should be noted that levels above 0.03 mg/L encourages plant growth, which may lead to eutrophication of the waterbody. According to the IDEM Wabash River TMDL and IDEM 303(d) listing methodology, total phosphorous levels of 0.30 mg/L are used as an indication of impaired water quality so this will be used this as the basis for comparison in the Stony Creek Watershed including the concentration basis for calculating the target load. Using 0.30 mg/L as an impairment indicator, the collected samples from the Stony Creek Watershed would all indicate impairments for total phosphorus. Average levels ranged from 0.35 mg/L at Site 5 to the highest average of 0.79 mg/L at Site 2A, closely followed by Site 1 with an average total phosphorus level of 0.74 mg/L. **Table 2-5** provides a more in depth review of the total phosphorus results for the Stony Creek Watershed sampling events. The May sampling event followed a significant rainfall, the June sampling is considered a base flow monitoring event and the fall sampling event took place in October. This data and the Region 5 Model will be used in Section 4.3 to determine phosphorous loadings for the Stony Creek Watershed.

Table 2-5: Total Phosphorous Concentrations (mg/L)

Date	Site 1	Site 2	Site 2A	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
05/13/03 (flood stage)	0.78	1.09	1.24	1.05	1.01	0.70	0.84	0.86	0.59
06/27/03 (base flow)	1.00	0.30	0.67	0.15	0.35	0.23	0.33	0.26	0.29
10/03/03 (fall flow)	0.45	0.40	0.47	0.18	0.30	0.13	0.23	0.30	0.32
Average	**0.74**	**0.60**	**0.79**	**0.46**	**0.55**	**0.35**	**0.47**	**0.47**	**0.40**

It was noted at several points in the report put forth by Dr. Baker that cattle were observed in waterways. Increased erosion of streambanks, overland erosion of crop fields, human inputs from household wastewaters and animal manures are all potential sources for total phosphorus loadings.

Nitrogen (Nitrates, Nitrites, Ammonia Nitrogen, and Total Nitrogen)
Point source discharges, such as wastewater treatment plants can be a significant source of ammonia in surface waters; however, nonpoint discharges such as untreated effluent from septic systems, decaying organisms, and bacterial decomposition of organic waste from improper disposal or over-application of fertilizers in stormwater runoff can also contribute to the level of nitrogen in a waterbody.

The levels of Ammonia-Nitrogen that were observed in the Stony Creek Watershed are not considered to be hazardous to aquatic life. According to the IDEM Wabash River TMDL and IDEM 303(d) listing methodology, total nitrogen levels of 10.0 mg/L are used as an indication of impaired water quality so this will be used this as the basis for comparison in the Stony Creek Watershed including the concentration basis for calculating the target load. Using 10.0 mg/L as an impairment indicator, the collected samples from the Stony Creek Watershed would not indicate impairments for total nitrogen. Although the levels of total nitrogen present in the samples do not indicate an urgent need for implementation of Best Management Practices (BMPs) designed to reduce nitrogen loadings to the streams and tributaries, the implementation of such BMPs would provide further total nitrogen reductions to the Stony Creek Watershed. For example, livestock exclusion fencing, precision nutrient management on crop fields and septic system maintenance can all be investigated for potential impacts on reduction of total nitrogen in the Stony Creek Watershed. The monitoring completed following the significant rain event in May indicated levels of total nitrogen nearing 10 mg/L, and base flow levels averaging 3.5 mg/L. **Table 2-6** provides a more in depth review of the total nitrogen results for the Stony Creek Watershed sampling events. The May sampling event followed a significant rainfall, the June sampling is considered a base flow monitoring event and the fall sampling event took place in October. This data and the Region 5 Model will be used in Section 4.3 to determine total nitrogen loadings for the Stony Creek Watershed.

Table 2-6: Total Nitrogen Concentrations (mg/L)

Date	Site 1	Site 2	Site 2A	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
05/13/03 (flood stage)	9.00	8.00	7.00	9.00	8.00	5.00	8.00	8.00	7.00
06/27/03 (base flow)	5.70	3.70	5.10	3.60	3.50	1.40	3.00	2.50	2.90
10/03/03 (fall flow)	3.20	3.40	2.70	3.40	2.70	1.90	3.20	3.10	3.40
Average	**5.97**	**5.03**	**4.93**	**5.33**	**4.73**	**2.77**	**4.73**	**4.53**	**4.43**

Fecal Coliform Bacteria
Fecal Coliforms are a type of bacteria that originate from the digestive tracts of warm blooded animals. One specific strain of the bacteria, *E. coli*, is used as an indicator of raw sewage and/or manure pollutant loadings into streams and waterways. This potential raw sewage contamination could also contain other disease causing bacteria or viruses.

E. coli is also used as an indicator because it is easier and less costly to monitor for and detect than the actual pathogenic organisms such as Giardia, Cryptosporidium, and Shigella, which require special sampling protocols and sophisticated laboratory techniques in order to measure.

The presence of waterborne disease causing organisms can cause outbreaks of diseases such as typhoid fever, dysentery, cholera, and chrypotsporidiosis.

The Indiana Water Quality Standard (WQS) for *E. coli* has been established in order to ensure safe use of surface waters for recreation and drinking water. The standard for *E. coli* states that sample concentration shall not exceed 125 per 100 milliliters as a geometric mean based on not less than 5 samples equally spaced over a 30 day period nor exceed 235 per 100 milliliters in any 1 sample in a 30 day period.

Stony Creek is impaired by fecal coliform, and more specifically, *E. coli*, as indicated in IDEM's Integrated Water Quality Report. In addition to the listings in both the 303(d) and the 305(b) reports, IDEM also placed a Fish Consumption Advisory for all fish caught in Stony Creek in 2003.

Recent sampling events conducted in 2005 by the Hamilton County Health Department also indicate the presence of *E. coli* at levels higher than the standard. During the recreational season, April to October, Stony Creek at the Greenfield Avenue Bridge was sampled twice for *E. coli*, once during June, and once during August. This site, one of 19 total, was selected based on the probability of full body contact with the water, and the sample collection ability. The June sampling event resulted in 1400 cfu/100ml, exceeding the Indiana State standard of no more than 235 cfu/100ml in any one sample.

Stony Creek Bioassessment

Dr. Baker and associates also performed several layers of bioassessment on the 9 stations within the Stony Creek Watershed. Macroinvertebrate assemblages were evaluated utilizing many qualitative metrics, and the habitat potential was compared against a Qualitative Habitat Evaluation Index (QHEI) to assist with determining an overall rating for each station monitored. Once the collective values had been tabulated for each site, they were compared against a reference segment of high quality. Limits were then set whereas above 88% of the reference value was determined to be indicative of optimal habitat. The range between 88% and 58% of the reference value is indicative potentially supportive, and less than 58% indicates habitat that is less than optimal to support aquatic life.

Based on these determinations, none of the sampled locations were comparable to the reference segment regarding habitat and macroinvertebrate assemblages. Three of the 9 stations were within the potentially supportive limits, while the remaining 6 stations were below the 58% level, indicating that several of the sites have situations that are adverse for aquatic organisms.

It was noted during the study that beginning at Station 4, and progressing downstream, RBP values moved closer toward the supporting range when compared to the reference site. At the same time, in-stream structure begins to show signs of improvement in regards to riffle/pool sequences, vegetation, and substrate materials. This may lead one to believe that overall improvements to the condition of the stream can be achieved by implementing BMPs within the Stony Creek Watershed to reduce non-point source pollution loadings to the stream system.

2.3 BASELINE WATER QUALITY: CONCERNS, CAUSES, AND PROBLEMS

Linking stakeholder concerns with known and discovered water quality issues in the watershed helps to validate initial observations and provides evidence to dismiss others. Thus, a review of existing water quality studies can help to guide the planning process towards management actions that are most appropriate and efficient for improving water quality conditions. The following descriptions detail water quality baseline conditions that have been established by prior studies as they relate to stakeholder concerns. These descriptions are organized by the general stakeholder concerns shown in Section 2.1, and provide the foundations for the watershed management strategies identified in the WMP. Specific concerns within each category and potential measures to address those concerns will be provided in later sections.

The water quality studies listed in the previous section indicate there are water quality problems within the Stony Creek Watershed. Those problems are primarily associated with elevated levels of nutrients and potential pathogens, both of which can be directly impacted by human behaviors and awareness. Steering Committee members and stakeholders indicated early on in the planning process that there is a need to educate citizens on the impacts that their day-to-day activities have on water quality. The Steering Committee believes that increased education and outreach efforts will have a positive effect on water quality in the Stony Creek Watershed.

Rural and Urban Impacts

Numerous studies have indicated that *E. coli* concentrations in the Stony Creek Watershed are consistently exceeding the Indiana State Standards. This issue is not only important in regard to aquatic organisms and the health of the streams, it is also inherently important to the stakeholders who come into contact with the water source on a regular basis. Prior studies and projects indeed support the need for investigation into the impacts that failing septic systems, improperly treated wastewater, and agricultural manures have on the Stony Creek and the tributaries.

The studies described earlier do; in fact, indicate that agricultural activities have a significant impact on the water quality status of the Stony Creek and its tributaries. Pathogen impairments are likely related to the amount of livestock observed within the water courses and on-farm manure management activities such as application and storage. From Dr. Baker's study, the elevated nitrogen (above 10.0 mg/L) and phosphorous levels (above 0.30 mg/L) also indicate that farm applied manure and/or chemicals such as fertilizers are impacting the streams by loading nutrients into them. Therefore, the studies do support the concerns of the Steering Committee regarding nutrient impacts stemming from agricultural sources. Wildlife and pet waste are also potential sources of pathogens that were discussed by the Steering Committee. Atrazine testing was also discussed since it is not clear if such pesticides are a concern for this watershed.

New development has the potential to increase runoff volumes and peak discharge flows in a watershed through the creation of impervious surfaces and the installation of stormwater collection systems. Additionally, new development can increase the amount of soil that is delivered to a waterway through ground disturbing activities. During the water quality studies, streambeds were noted to be covered with sediments, and boulders, cobbles and pebbles were absent from the stream bed materials, indicating increased sediment loading from somewhere in the watershed. If new development is not required to install measures that are designed to limit soil erosion and control increases in stormwater runoff, conditions in the waterways will likely continue to degrade.

3.0 IDENTIFYING POLLUTANT SOURCES

A number of substances including nutrients, bacteria, metals, and toxic substances, cause water impairments. Sources of these pollutants are divided into two broad categories: point sources and non-point sources. Prior sections of the WMP have identified stakeholder concerns, presented historic evidence of impairment, and discussed whether that evidence supports or negates those stakeholder concerns. This section attempts to present, in detail, possible sources of pollution to the waterways that have been identified as issues or concerns. Where possible, the magnitude and extent of pollutant sources are supported by pollutant loading estimates.

3.1 POINT SOURCES OF POLLUTION

Point source pollution refers to discharges that enter surface waters through a pipe, ditch, or other well-defined point of discharge. The term applies to wastewater and stormwater discharges from a variety of sources. The primary pollutants associated with point source discharges are oxygen demanding wastes, nutrients, sediment, toxic substances, ammonia, and metals.

It is important to note that based on evaluation of IDEM records, there have not been any major enforcement action taken on these facilities, and they are believed to be in general compliance with their permit requirements. It is also important to identify that these facilities exist in the watershed, but that identification is not intended to indicate that these facilities are negatively impacting water quality.

3.1.1 POINT SOURCES FROM INDUSTRIAL FACILITIES

Wastewater point source discharges include municipal (city, town, or county) and industrial wastewater treatment plants and small domestic wastewater treatment systems that may serve schools, commercial offices, residential subdivisions, and individual homes. Stormwater point source discharges include stormwater discharges associated with industrial activities and stormwater discharges from municipal separate storm sewer systems (MS4s) operated by municipalities and counties.

Industrial point source dischargers in Indiana must apply for and obtain a National Pollutant Discharge Elimination System (NPDES) permit from the state. Discharge permits are issued under the NPDES program, which is delegated to IDEM by the US EPA. Within the boundaries of the Stony Creek Watershed, there are 7 active NPDES permitted facilities outlined in **Table 3-1**, and **Exhibit 3-1**.

Table 3-1: NPDES Facilities in the Stony Creek Watershed

Permit Number	Facility Name	City	County	Receiving Stream
INR230111	Bridgestone/Firestone, Inc.	Noblesville	Hamilton	Wilson Ditch
ING490030	IMI (Irving Materials Inc.) Noblesville	Noblesville	Hamilton	Stony Creek
IN0020087	Lapel Municipal STP	Lapel	Madison	West Fork White River Via Stony Creek
IN0025526	Tall Timber Mobile Home Park	Noblesville	Hamilton	Stony Creek

Permit Number	Facility Name	City	County	Receiving Stream
				via unnamed trib
INR00E045	E&B Paving, Inc.	Noblesville	Hamilton	Stony Creek
INR210048	Owens Brockway Glass Containers Inc.	Lapel	Madison	Stony Creek
INR500015	Waste Management of Hamilton County-Transfer Station	Noblesville	Hamilton	Stony Creek

(IDEM, 2006)

3.1.2 POINT SOURCES FROM LEAKING UNDERGROUND STORAGE TANKS

Another point source of pollution is the Leaking Underground Storage Tank (LUST) used to store substances such as used oil, gasoline, gases or even food products. Approximately 95% of the Underground Storage Tanks (USTs) contain some form of petroleum products and are placed underground to reduce the possibility of explosion. Other common uses include dry cleaning facilities for storage of chemicals, vehicle service stations for storage of used motor oil, and residences equipped with heating oil tanks either located in the basement or buried in the yard. Residential tanks are not regulated by IDEM but may pose a higher risk as heating oil systems are replaced by more modern heating systems. In many cases, the heating oil tanks are not removed and may continue to leak contents and residue with water table fluctuations.

Prior to 1998, many of the tanks and associated piping utilized were constructed of unprotected steel. Depending on the soil conditions, water table, and other groundwater conditions the underground systems began to show signs of rust and potential leaks after 10 years. Facilities with new tanks installed or replaced after 1998 were required to utilize liners composed on non-rusting materials. IDEM has prioritized LUST areas into high, medium, and low categories based on the risk posed to the general population, environmentally sensitive areas or other infrastructure. Those areas considered to be of a high priority include those where drinking water sources may be impacted, surface pooling of the substance is observed, utility lines (sewer) may be affected, environmentally sensitive areas are endangered or where vapors are present in buildings in use. Moderate priority LUST areas are those where no aforementioned conditions exist and there is a potential for groundwater contamination due to leaking contents. Low priority areas are those where only the soil surrounding the LUST may become impacted.

According to IDEM's Office of Land Quality, there are currently 8 LUST sites within the Stony Creek Watershed. Within Madison County, there are 2 and within Hamilton County there are 6. Those LUSTs identified within the watershed boundaries are included in Exhibit 3-1.

3.1.3 POINT SOURCES FROM CONFINED FEEDING OPERATIONS

Confined Feeding Operations (CFOs) are also considered to be a potential point source discharger and are required by IAC 16-2-5 and 327 IAC 16 to obtain an NPDES permit from IDEM's Office of Land Quality and Office of Water Quality for operation. According to IDEM's records, there are 10 permitted facilities in the Stony Creek Watershed. Of these 10, 8 or 80% are located in Hamilton County, while the remaining 2 (20%) are located in Madison County. CFOs within the boundaries of the watershed are included in Exhibit 3-1. The concern surrounding these operations is the increased amount of manure and nutrient production yearly and the potential for leaching or overland runoff of those nutrients into nearby streams and tributaries. Manure contains nutrients such as nitrogen and phosphorus that are beneficial for crop production but in large quantities, are detrimental to water quality. These nutrients, if allowed to enter the water system will cause increased algal growth leading to increased turbidity and lower levels of dissolved oxygen as the algae and plants decompose. Due to size or historical compliance issues some confined feeding operations are defined as concentrated animal feeding operations (CAFOs). The general permit CAFO regulation, 327 IAC 15-15, covers these types of operations.

Livestock operations with at least 300 cattle, 600 swine, 600 sheep, or 30,000 fowl for at least 45 days within a 1-year period are designated as a CFO and must complete the permitting process prior to construction of the facilities. Furthermore, any existing operation with fewer animals but wishing to expand to the numbers listed above must apply for and obtain an NPDES permit. Smaller operations with a previous water quality violation may also be designated as a CFO. In order to successfully obtain the NPDES permit, a facility must prove the following: a minimum of 120 days storage for manure, adequate acreage for application of manure, minimum distances from wells and surface waters, a Manure Management Plan has been completed and sufficient levels of record keeping regarding the facility and associated activities. **Table 3-2** from IDEM's Draft TMDL Report for Duck, Pipe, Killbuck, and Stony Creeks dated March 30, 2005, shows the daily *E. coli* loading rates per animal using Manure Production Rates, Animal Masses, and Bacterial Loading Rates for Cows, Pigs, and Sheep.

Table 3-2: Calculation of Daily *E.coli* Loading Rates (per animal)

Statistic	Beef	Milk	Other Cow	Swine	Sheep
Total Manure Production (kg/1,000 kg animal-d)	58	86	72	84	40
Typical Animal Mass (kg)	360	640	500	61	27
Total Manure Produced (kg/animal-d)	20.88	55.04	36	5.124	1.08
Fecal Coliform Rate (col/1,000 kg animal)	2.8E+11	1.6E+11	2.2E+11	1.8E+11	4.5E+11
Fecal Coliform Rate (col/kg manure)	4.83E+09	1.86E+09	3.056E+09	2.14E+09	1.13E+10
E. coli Rate (col/kg manure)	4.34E+09	1.67E+09	2.75E+09	1.93E+09	1.01E+10
E. coli Load (col/animal-day)	9.07E+10	9.22E+10	9.9E+10	9.88E+09	1.09E+10

(ASAE, 1999)

To prepare an accurate representation of the amount of manure and selected nutrients (e.g. Nitrogen and Phosphorous) generated in each 14-digit HUC, a more detailed livestock inventory will need to be completed. This inventory should include the number of animals of each species for appropriate weight or production classifications, the type of manure storage facility being utilized, and the location within the 14-digit HUC. To provide the best information possible, a future livestock inventory should also account for the amount of manure generated in other areas and applied within these specific watersheds. Similarly, manure generated within these watersheds and applied to acreage outside of the watershed boundaries should be accounted for.

3.2 NONPOINT SOURCES OF POLLUTION

Nonpoint source (NPS) pollution refers to runoff that enters surface waters by stormwater runoff, contaminated groundwater, snowmelt, or atmospheric deposition. There are many types of common activities that can serve as sources of nonpoint source pollution including the presence of impervious surfaces, land development, construction, mining operations, crop production, animal feeding lots, subsurface drainage tiles, timber harvesting, failing septic systems, landfills, roads and paved areas, and wildlife. These sources may contribute a single pollutant or a combination of pollutants such as *E. coli* bacteria, heavy metals, pesticides, oil and grease, nutrients, and any other substance that may be washed off the ground or removed from the atmosphere and carried into surface waters.

3.2.1 NONPOINT SOURCES FROM AGRICULTURAL AND RURAL LANDS

In 2002, the National Water Quality Inventory (NWQI), sponsored by the EPA, reports that agricultural NPS is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and a major contributor to ground water contamination and wetlands degradation.

NPS pollutants that result from agricultural activities are nutrients, pesticides, bacteria, and sediment. These pollutants can migrate from the land to surface and/or ground waters through overland runoff, erosion, and infiltration. It is important to note that these pollutants do not only originate from agricultural activities and can also be attributed to residential and urban lands as well. **Table 3-3** identifies common agricultural nonpoint source pollutants and their associated sources.

Table 3-3: NPS Pollution and Agriculture

Pollutants	Agriculture Sources
Nutrients	Commercial Fertilizers and Manure
Toxic Chemicals	Herbicides, Insecticides, Fungicides
Sediment	Tillage, Sheet, Rill, Gully, and Streambank Erosion
Animal Waste	Manure Runoff from Fields, Pastures, and Feedlots

(EPA, 2002)

There are a number of activities associated with agriculture and rural areas that can serve as potential sources of water pollution.

Agriculture is the predominant land use in the Stony Creek Watershed. According to the 2002 Indiana Agricultural Census, approximately 55% or 140,448 acres of land in Hamilton County are used for crop and livestock production, and approximately 84% or 243,597 acres of land in Madison County are used for crop and livestock production. Approximately 90% (32,985 acres) of the Stony Creek Watershed is involved in agricultural production.

Like most of Indiana, corn and soybeans dominate the crops grown in both Hamilton and Madison Counties. In 2002, Hamilton County producers planted 55,535 acres of corn, 60,999 acres of soybeans, and 1,951 acres of wheat. The County ranks 47th in the State for corn production and 48th in the State for soybean production. In 2002, Madison County producers planted 93,388 acres of corn, 118,575 acres of soybeans, and 3,578 acres of wheat. The County ranks 12th in the State for corn production and 5th in the State for soybean production.

Table 3-4 contains the harvested area acres, production bushels, and state production rank for Hamilton and Madison Counties.

Table 3-4: Hamilton and Madison County Harvested Area and Production

	Hamilton	**Madison**
Corn - Grain		
Harvested	55,535 (acres)	93,388 (acres)
Production	6,885,294 (bushels)	11,051,126 (bushels)
Rank in State (of 92)	47th	12th
Soybeans		
Harvested	60,999 (acres)	118,575 (acres)
Production	3,000,977 (bushels)	5,716,127 (bushels)
Rank in State (of 92)	48th	5th
Hay (dry) Tons		
Harvested	4,319 (acres)	3,578 (acres)
Production	10,663 (tons, dry)	9,606 (tons, dry)
Rank in State (of 92)	56th	67th
Wheat (all)		
Harvested	1,951 (acres)	1,829 (acres)
Production	120,450 (bushels)	108,982 (bushels)
Rank in State (of 92)	55th	57th

(National Agricultural Statistics Service, 2002)

Improved Crop and Manure Management
Nutrients such as phosphorus and nitrogen in the form of commercial fertilizers, manure, land applied sludge, legumes, and crop residue are utilized to enhance crop production. In small amounts, nitrogen and phosphorous are beneficial and necessary to aquatic life. However, in excessive amounts, they can stimulate the occurrence of algal blooms and plant growth.

Algal blooms and excessive plant growth often reduce the dissolved oxygen content of surface waters through plant respiration and decomposition of dead algae and other plants. This situation is accelerated in hot weather and low flow conditions due to the reduced capacity of the water system to retain dissolved oxygen. When the dissolved oxygen levels reach severely low limits, fish kills occur and the aquatic ecosystem is disrupted. Pesticides and fertilizers (including synthetics and animal manures) can be washed from fields or facilities with inadequate storage facilities.

The Office of Indiana State Chemist (OISC) annually publishes the total tonnages of commercial fertilizers sold in each Indiana County. The list includes single nutrient fertilizers, multi-nutrient fertilizers, as well as organic and micronutrient fertilizers. **Table 3-5** estimates the annual commercial nutrient application within the watershed. Total countywide application rates for Hamilton and Madison counties were multiplied by the percent of each county's land area in the Stony Creek Watershed to estimate application within the boundaries of the watershed.

Table 3-5: Estimate of Commercial Nutrient Application

County	% of county in watershed	X	Total Nutrients (T)		X 2000 lbs/ton	Nutrients in watershed (lbs)	
			N	P_2O_5		N	P_2O_5
Hamilton	9	X	4713.88	2050.39	X 2000	848,498	369,070
Madison	4		9762.69	6057.57	X 2000	781,015	484,605

(OISC, 2005)

The table shown above describes an estimate of the amount of fertilizer applied in the Stony Creek Watershed and is not an estimate of loading to waterways. It is expected that only a portion of the applied fertilizer nutrients would be mobilized to local waterways as a majority of the macronutrients would be utilized by the crop to which it was applied.

Excess nutrient laden runoff may also stem from the numerous, non-regulated livestock operations throughout the watershed. While only 10 livestock operations are regulated, there are approximately 74 hog farms, 325 cattle farms, 70 sheep farms, and 45 poultry farms in Hamilton and Madison Counties. These totals are provided by each county and therefore, not all of these facilities are within the boundaries of the watershed. Livestock farms may be included in one or more of the categories if, for example, there are both cattle and hogs present at the same farm. Several landowners have reported owning horses as a hobby but their numbers tend to be spread throughout the watershed and not in concentrated operations. It becomes evident that the majority of the livestock operations in Hamilton and Madison Counties are not regulated and therefore, do not have a permit. This increases the risk for contamination of the nearby streams and rivers with potentially high levels of nutrient and bacteria.

Crop management includes the responsible use of pesticides, a broad array of chemicals used to control plant growth (herbicides), insects (insecticides), and fungi (fungicides). These chemicals have the potential to enter and contaminate water through direct application, runoff, wind transport, and atmospheric deposition. They can kill fish and wildlife, contaminate food and drinking water sources, and destroy the habitat that animals use for protective cover.

While some pesticides undergo biological degradation by soil and water bacteria, others are very resistant to degradation. Such non-biodegradable compounds may become “fixed” or bound to clay particles and organic matter in the soil, making them less available. However, many pesticides are not permanently fixed by the soil. Instead they collect on plant surfaces and enter the food chain, eventually accumulating in wildlife such as fish and birds. Many pesticides have been found to negatively affect both humans and wildlife by damaging the nervous, endocrine, and reproductive systems or causing cancer.

The OISC does not track the overall pesticide sales within individual Indiana counties. Since background levels of pesticides in the watershed are not known, the Steering Committee believes there is a need to potentially study these chemicals. According to IUPUI CEES, Atrazine and Triazine herbicides, which have health effects to both humans and wildlife, are widely used by corn producers and are contaminants of concern for drinking water supplies locally and nationally. Other herbicides and pesticides used on corn, soybeans and for pest control on livestock also have the potential to impact surface water.

Erosion and sedimentation occur when wind or water runoff carries soil particles from an area, such as a farm field or streambank, and transports them to a waterbody, such as a stream or a lake. Eroded soil particles may become suspended within the water column, clouding the water and reducing the amount of sunlight reaching aquatic vegetation and obstructing the gills of aquatic organisms. Particles of silt and sand may precipitate out of the water column, settling on the streambed effectively covering fish spawning areas and smothering food supplies. Land clearing and conventional tillage makes soils susceptible to erosion, which can then cause stream and ditch sedimentation.

Furthermore, pollutants such as phosphorus, pathogens, and heavy metals move through the landscape attached to microscopic soil and organic particles; these same microscopic particles are easily transported in overland flow and are stored in and carried by streams throughout the watershed.

Areas with highly erodible soils, if not managed properly, can erode at an accelerated rate and may lead to excessive soil deposition in waterways. Highly Erodible Lands (HELs) are determined based on a mathematical equation called the Universal Soil Loss Equation (USLE). This equation, and subsequent versions, considers the average rainfall, erodibility of the soil type, allowable loss for that soil type and the length and the slope of the area. According to the USDA, the soil of an entire farm tract is considered HEL if at least one third of the tract has highly erodible soils.

HEL erosion has been identified as a problem caused by poor crop management which are activities involving land disturbance such as conventional tillage methods, intensive livestock grazing with stream accessibility, and removal of wooded areas are likely to increase sediment loadings to the watershed. The HEL classified soils in the Stony Creek Watershed are illustrated in **Exhibit 3-2.**

According to the 2003 Cropland Tillage Data from Purdue University, 23% of corn and 77% of soybeans acreage in Hamilton County and 9% of corn and 70% of soybeans in Madison County was in no-till or mulch till. No till refers to any direct seeding system including strip preparation, with minimal soil disturbance. Mulch till refers to any tillage system leaving greater than 30% crop residue cover after planting, excluding no-till. No-till and mulch till are often grouped together into conservation tillage. **Table 3-6** was created to compare various tillage methods utilized within the watershed. It is clear that while no-till soybeans seems to be an accepted practice throughout the watershed, no-till corn has not been widely established. Resistance to utilizing conservation tillage in corn production can be attributed to several rationale including the needed acreage for manure application and associated incorporation methods, increased moisture attributed to the combination of poorly draining soils and excess fodder, and the concern of inconsistent plant populations and yield reductions. Reduced tillage, with 15-30% residue remaining following the harvest and present during the critical erosion period, utilized for corn production does seem to be a more operator-accepted practice.

Increases in conservation tillage methods, including reduced till, mulch till, and no-till, for crop production could significantly reduce the sediment loads to streams and waterways in the Stony Creek Watershed. Since specific tillage data is not available for the watershed, according to the Hamilton County SWCD, there are no significant differences between the agricultural fields in the watershed when compared to the rest of the County. Therefore, the overall County data could be utilized to draw conclusions about the Stony Creek Watershed. For a more detailed view of these critical areas, a tillage inventory should be completed within the watershed and those results should be cross-referenced with NRCS HEL determinations.

Table 3-6: Percent of Crop Acres in Conservation Tillage

County	Crop	% No Till	% Mulch Till	% Reduced Till	% Conventional Till	State Rank
Hamilton	Corn	19	4	6	70	32 of 92
	Soybeans	70	7	4	20	18 of 92
Madison	Corn	7	2	1	89	53 of 92
	Soybeans	63	7	13	17	26 of 92

(Purdue University, 2003)

The benefits of reducing sediment loss are numerous, not only in terms of water quality, but also in regards to drainage issues and overall soil health. When less sediment is delivered to the streams and ditches, routine maintenance or dredging of these water systems may be lessened. This situation would help to maintain the flow capacity of the stream or drainage ditch, sub-surface drainage tile mains and lines will also be less likely to become choked with sediments also requiring less maintenance.

Land application of manure was perceived to be a concern of the Steering Committee, but according to the Regional USDA office, this is not a problem in the Stony Creek Watershed since most producers follow guidelines. The practice is often beneficial to the health of the soil, the health of the crop, and also serves as a useful method of disposal. Guidelines are provided by the NRCS in Standard 633 to assist landowners in the reduction of the potential for manure laden water to leave the field. Setbacks from streams and open waters, application rates, seasonal timing of the application and various other techniques are outlined in this Standard. While this information cannot be considered a law or regulation, it does encourage landowners to demonstrate their stewardship for the watershed in which they operate. Land application of manure is not the only potential source of bacteria to waterways associated with agricultural lands.

Livestock with Waterway Access and Pasture Management

Manure, whether applied for crop nutrition or the by-product of grazing, is a water quality concern in the Stony Creek Watershed. The nitrogen and phosphorus that make the manure so productive on farm fields can create on over-fertilized “soup” when they run off into waterways, leading to increased algal blooms.

Grazing livestock and pasture lands can also provide a significant contribution of bacteria especially when livestock are allowed direct access to a ditch or creek. In the Stony Creek Watershed, 18% of the land use is in pasture while 72% of the land is used for row crop production. Exhibit 1-5 shows the various land uses for the watershed. Several land owners in the Stony Creek Watershed, utilize the creek as their drinking water source for their livestock. According to Dr. Baker’s study, on all occasions when water quality sampling occurred, cattle were observed in the water using the stream as a water source. The Steering Committee vocalized a general concern regarding livestock in streams and waterways. Committee members and other stakeholders present for public meetings agreed with Dr. Baker’s observations that cattle are more often than not provided access to streams within the Stony Creek Watershed.

Hamilton County ranks 64th in the State for hog production with approximately 10,500 head of hog and 72nd in the State for cattle production with approximately 3,900 head of cattle. Hamilton County does rank high in the state for both horses, 7th of 92, and poultry, 12th of 92. Madison County ranks 44th in the State for hog production with approximately 26,900 head, and 71st in the State for cattle production with approximately 4,300 head.

In addition to those regulated facilities mentioned in Section 3.1.3, there are numerous small (hobby) farms in the Stony Creek Watershed with small numbers of horse, sheep, and/or poultry below the permit level.

Pasture management can be an effective management measure to reduce any water quality impacts that livestock operations have on water quality. Pasture management leads to better weed control, better soil structure, increased productivity over longer periods of time, and healthier animals. It also helps the soil absorb excess water, manure, nutrients, and other pollutants and ultimately protects water quality by reducing the amount and improving the quality of runoff.

Pastures can be grazed intensively during peak periods of growth, but they need regular attention. Rest periods are critical to proper pasture growth. A grazing rotation that allows 21 to 28 days of regrowth between grazing periods is usually best. Pasturing too many animals on a given parcel of land or allowing them to graze for too long in the same area reduces plant vigor and compacts the soils, reducing absorption capacity and pasture recovery. Overgrazing can lead to additional runoff and a poorer quality of runoff.

NRCS provides regions with a Grazing Land Specialist. Plans have been provided to operators and landowners through the NRCS and SWCDs in the area. While there are numerous acres of pasture lands for horse grazing, it is felt that many of these operations have personally secured land management personnel to provide them with insight and guidance on the grazing needs of the operation.

According to Dr. Baker's study, he and his students believed that a major bacteria source in the Stony Creek Watershed is from cattle in the stream and the amount of bacteria could be reduced significantly by the use of exclusionary fencing. However, the IDEM TMDL study suggests that after comparing more possible sources, that the application of manure to row crops and pasture lands constitutes the largest percentage of *E. coli* loads to the watershed.

Unbuffered Waterways
Vegetated buffers are corridors along natural waterways and drainage ditches are an integral part of the form and function of a healthy waterway system. Although the appearance of buffers differs between natural streams and drainage ditches, the functions remain the same – to improve water quality by filtering and trapping sediments and pollutants carried by stormwater, to store large quantities of stormwater and decrease velocity to receiving waterways, and to create important aquatic and terrestrial habitats. Vegetated buffers along natural streams usually consist of a natural and dense network of grasses, shrubs, and trees. Conversely, buffers along agricultural drainage ditches usually consist of swaths of mowed grasses that are regularly maintained to prevent the establishment of woody plants. **Exhibit 3-3 and Exhibit 4-1** illustrate areas where buffers and filter strips are needed.

Along the streams and tributaries within the Stony Creek Watershed, there are approximately 47.2 miles of streams. Based on 2005 aerial photography, it is estimated that 19.3 miles or 41%

of these have less than 30 feet of vegetated buffer on one or both of the streambanks. Many of these same stream miles are centered in row crop land use. With little to no protection and filtering capabilities, these streams have a greater risk potential of being subjected to overland runoff contaminated with excess nutrients, bacteria, and soil particles. Fields in Stony Creek are often tilled and planted to the edge of a drainage ditch or the creek. Many of the trees and other vegetation have been removed as land was prepared to raise crops.

Funds are available through the Hamilton and Madison County SWCDs and NRCS to assist with the implementation of a conservation buffer initiative. When Hamilton County reconstructs a legal drain, 20 foot wide buffers are automatically incorporated into the design of the project based on Surveyor's standards. These buffers are required for access purposes and do provide some water quality benefits.

Sub-surface Drainage Tile and Ditch Maintenance

Tile drainage systems, ditching, and channelization were necessary for a successful agricultural industry in the watershed. However, construction of drainage ditches and systematic subsurface tiling in poorly draining soils enhances the movement of oxygen consuming wastes, sediment and soluble nutrients into ground and surface waters. If tiles and ditches are not maintained, flooding of agricultural lands increases sediment and nutrient loadings as flood waters inundate increased acreages and potentially cause holding ponds, lagoon and other manure storage facilities to overflow. In Dr. Baker's study, he observed that some ditches in the Stony Creek Watershed need maintenance work that would remove sediment and clean out debris. This would help the drainage system to work more efficiently. Dr. Baker also noted that habitat in the watershed has been marginalized by previous dredging followed by the filling of the stream with sediments. He suggests that Stony Creek has lost a significant portion of its meandering riffle and pool character that is necessary for stream health and ample fish habitat.

In Hamilton County, the Surveyor's Office is responsible for ditch maintenance which must be done in accordance with their "Standard Detail Drawings for Drain Design". These uniform standards ensure that practices are in place to help minimize sedimentation when necessary maintenance work is performed. The standards may be viewed by visiting the County's web site:
http://www.co.hamilton.in.us/upload/images/survey/docs/HCSO_Design_Standard_Details.pdf.

The Stony Creek Watershed Stormwater Master Plan recommends that the full reach of Stony Creek and William Locke Ditch be added to the Hamilton County Surveyor's Regulated Drain rolls for on-going maintenance. This would allow the office to collect funds to provide routine ditch maintenance ensuring flow conveyance capacity is maintained. Residents requested that maintenance be completed on the William Locke Ditch downstream of 211th Street to remove existing logjams, sandbars, and other areas of sediment accumulation and vegetation. Without on-going maintenance, the stream will continue to degrade.

Failures in subsurface drainage tiles can cause varied amounts of sediment to erode into outlet streams and waterways. Utilizing the average dry density of silty clay loam, silty clay soils from the Region 5 Model User's Manual, it has been estimated that by repairing an average tile failure, creating a void approximately the size of one cubic foot, as much as 0.04 tons of sediment can be kept from being eroded. The landowner provides the best defense against increased and continued delivery of sediment via subsurface drainage tiles. At the first sight of a failure, proper actions must be taken to repair the damage, not only for the benefit of water quality, but also to protect and retain the productive top soil.

Eroded Streambanks and Log Jams
Streambank erosion often results from increased stream flows associated with heavy rainfall events. When stream flow rates exceed the resistance ability of nearby soils and vegetation, bank erosion occurs. Streambank erosion can have numerous negative impacts ranging from increased turbidity, loss of in stream habitat, loss of conveyance volume, and damage to public infrastructure such as roads and bridges. Localized streambank problems, primarily in association with log jams, have been identified by the Steering Committee primarily in William Lock Ditch as a water quality issue in the Stony Creek Watershed that needs to be addressed in more detail. According to the Dr. Baker study, "previous ditching, tile drains, and channel straightening have resulted in a watershed designed to move water quickly." Higher stream velocities have eroded streambanks and caused log jams.

Flooding events are not only damaging to homes, but also to the agricultural community as well. Operators may need to replant crop that have been damaged by flooding, or the entire field could become inundated, zeroing out the productivity for that crop season. Furthermore, livestock facilities that are located in the floodway or the 100-year floodplain are at a higher risk of loss of animals.

Failing Septic Systems
Septic systems can be a safe and effective method for treating wastewater if they are sized, sited, and maintained properly. However, in Hamilton County, 93% of the soils have severe limitations for conventional septic systems, and 99% of soils in the Madison County portion of the Stony Creek Watershed are unsuitable for conventional septic systems. High clay content within the soil structure does not allow adequate percolation of the wastewater through the underlying soil layers. Therefore, many of the bacteria, pathogens and other waste components can not be effectively removed from the effluent, and in several instances, the contaminated wastewater will not drain in a downward fashion, but either rise to the surface, or drain in a lateral pattern until it reaches an area suitable for percolation or an outlet such as a stream.

In rural areas of the Stony Creek Watershed, septic systems are the primary source of wastewater treatment. According to Purdue University's Residential Onsite Wastewater Disposal data, there are 11,716 households using septic systems in Hamilton County and 15,914 households using septic systems in Madison County. The number of actual systems per county has the potential to be significantly higher, possibly three times as high per county, as permitting procedures began to develop in the late 60's and were not mandatory until the early 1990s when the Indiana State Department of Health adopted a rule establishing statewide guidelines for construction and repair of septic systems. Information provided by Purdue University Extension suggests that there are more than 800,000 residential septic systems in the State of Indiana. Of those, it is estimated that approximately 200,000 systems are failing to properly treat household wastewater. Further estimates provide that from these failing systems, 15.3 billon gallons of raw sewage are discharged into local streams and rivers annually.

To further agitate the issue, homeowners may be largely unaware of the components of their septic systems, how septic systems function, the location of the septic system, or how to properly maintain their system. In addition, many residential septic systems have been by-passed all-together and the effluent is directed into nearby agricultural drainage tiles with a direct route to a stream or open ditch. This by-pass may have seemed logical to the original homeowner as a means to avoid the on-going maintenance and the aforementioned potential problems associated with poorly draining soils. Elevated loadings of bacteria, nutrients, toxic substances, and oxygen consuming wastes are associated with improperly treated residential wastewater. The combination of most homeowners not performing routine maintenance on these systems and poor soil conditions lead to system failure. **Exhibit 3-4** identifies know areas of septic system clusters.

Improper Solid Waste Disposal

Waste such as litter, large appliances, and animal carcasses are routinely dumped in the rural areas of the Stony Creek Watershed. Stormwater runoff carries pollutants such as bacteria and viruses associated with that trash into the waterways. Solid waste, considered to be discarded materials other than fluids and a form of pollution, must be disposed of properly to avoid contaminating the land and water. Plastics are particularly hazardous since they are not easily biodegradable, will take years to decompose, and may leach harmful chemicals into the environment. Trash in water bodies can threaten the health of people who use them for wading or swimming and of animals that use the waterways as a drinking water source.

The main area of concern for illegal dumping activities identified by the Steering Committee is the William Lehr Ditch Subwatershed. Public education efforts should be focused in this area to highlight available alternatives for waste disposal such as Tox-Drops and recycling programs. Existing programs offered by the Hamilton County and East Central Solid Waste Management Districts could be utilized for this purpose.

3.2.2 NONPOINT SOURCES FROM URBAN DEVELOPMENT

A change in land use, especially from field or forest to urban development, has a significant impact on water quality. Not only is the permeability of the soil affected by construction compaction and impervious coverage such as rooftops, driveways, and parking areas, but there is an increase of biological and chemical waste from human use. There are a number of activities associated with urban land areas that can serve as potential sources of water pollution.

Failing Septic Systems

Many homes in the urban area of the Stony Creek Watershed are still utilizing a septic system. Sewer service areas do not always offer contiguous service area resulting in unsewered “donut hole” areas. The reason for this is that connection to sanitary sewers is usually driven by developers, development, and/or annexation. Within the City of Noblesville’s jurisdictional area, the Hamilton County Health Department is responsible for septic systems and they currently have educational materials for homeowners. If a major interceptor is constructed in close proximity to homes with septic systems, then the City will approach them about connecting to their sanitary lines. The City’s policy is to not force connection to sanitary sewers since there is such a high cost to the individual homeowner to do this. Usually the City will do their best to reduce sanitary connection fees since the resulting connection and treatment of sewage improves the overall quality of life.

As mentioned in the previous discussion on rural septic systems, the same problems such as unsuitable soils not allowing the proper function of systems and lack of routine maintenance apply to the urban portion of the watershed. Even in urban areas, many residential septic systems have been by-passed all-together and the effluent is directed into nearby drainage ditches with a direct route to a stream or open ditch. In the Stony Creek Watershed, using the best available data, it is estimated that 1,100 septic systems are in the Hamilton County portion and 700 are in the Madison County portion. Since 5% of the watershed is urbanized land use, approximately 90 septic systems would be located in the urban portions. Recognizing this is not the most accurate way to estimate the distribution of septic systems; further investigation is needed to exactly locate the systems.

Urban Stormwater Pollution

Many activities associated with urban or residential land uses can generate NPS pollution. In most urbanized areas, large quantities of impervious or hard surfaces such as roads, driveways, parking lots, and rooftops, cause an increase in stormwater runoff resulting in flash floods and streambank erosion.

Managing NPS pollution in urban areas typically includes practices for managing water quantity, as well as water quality. In urban environments, NPS pollutants carried by stormwater typically include *E.coli* bacteria, sediments, nutrients, heavy metals, oil and grease, and pesticides.

The amount of imperviousness in a watershed can be directly related to the health of the receiving streams. As shown in **Table 3-7**, the Center for Watershed Protection has developed a classification system for managing headwater streams based on the percent of impervious land in the watershed. According to the Center for Watershed Protection, watersheds with more than 10% imperviousness are considered impaired and pose an additional challenge to achieve water quality standards.

In the Stony Creek Watershed there are approximately 1,791 acres of land classified as high and low density urban. In order to calculate imperviousness in the Stony Creek Watershed it was assumed that three-quarters of high density urban and half of low density urban is impervious. The estimated overall imperviousness of the Stony Creek Watershed is 1.6%. However, the percent of impervious area would be higher in more urban areas such as the Stony Creek-North Trib (Noblesville) Subwatershed. While these areas may be possible sources of urban pollution, the Steering Committee felt that the EPA and IDEM NPDES Stormwater Program would already address these sources.

According to Table 3-7, the streams in the Stony Creek Watershed fall overall into the most protective category known as "Sensitive Stream". In order to prevent further degradation of these waterways, the Center for Watershed Protection suggests strict zoning, site impervious restrictions, stream buffers, and stormwater practices designed to protect current infiltration rates.

Table 3-7: Stream Classification Based on Imperviousness in Watershed

Urban Stream Classification	Sensitive Stream (0-10% Impervious)	Impacted Stream (11-25% Impervious)	Non-supporting Stream (26-100% Impervious)
Channel stability	Stable	Unstable	Highly Unstable
Water quality	Good	Fair	Fair-Poor
Stream biodiversity	Good-Excellent	Fair-Good	Poor
Resource objective	Protect biodiversity and channel stability	Maintain critical elements of stream quality	Minimize downstream pollutant loads
Water quality objectives	Sediment and temperature	Nutrient and metal loads	Control bacteria
Stormwater	Secondary	Removal efficiency	Removal efficiency

Urban Stream Classification	Sensitive Stream (0-10% Impervious)	Impacted Stream (11-25% Impervious)	Non-supporting Stream (26-100% Impervious)
practice selection factors	environmental impacts		
Land use controls	Watershed-wide	Site limits	Additional infill and redevelopment
Monitoring and enforcement	GIS mapping of impervious areas and biomonitoring	GIS mapping of impervious areas and biomonitoring	Pollutant load modeling
Development rights	Transferred out	None	Transferred in
Riparian buffers	Widest buffer network	Average buffer width	Greenways

(Schueler, 2000)

Pet and Wildlife Waste

As areas urbanize, an increased number of homeowners results in an increased number of pets. Wildlife and pet wastes can contribute significantly to the concentrations of bacteria and organic matter in stormwater runoff. Open manicured lawn areas attract geese and other wildlife. Ducks and geese nest in colonies located in trees and bushes around rivers, streams, and lakes. The presence of waterfowl has been shown to result in elevated levels of ammonia, organic nitrogen, and *E.coli* bacteria. In addition, waterfowl activity can increase sediment loadings by pulling up grasses and sprouts and trampling emergent vegetation along streambanks and shorelines, significantly impacting erosion causing and sedimentation of the waterbodies. According to the IDEM TMDL study for Stony Creek, the predominant wildlife species in this watershed are deer, raccoon, and Canada goose. Free-ranging wildlife can deposit fecal matter directly into waterways or it can be transported in runoff from woods, pastureland, and cropland. Deer populations can impact streambanks by trampling grasses with their hooves and eating vegetation.

Recent studies have shown that pet waste is among the top 5 sources of bacteria in contaminated waters, and in some areas, more of a coliform contributor than humans. Pet wastes can be partially controlled through municipal ordinances requiring collection and removal of the waste from curbsides, yards, parks, roadways and other areas where the waste can be washed directly into receiving waters and/or stormdrains. However, even when ordinances such as leash and pooper-scooper laws are in place, some pet owners neglect to collect the wastes left behind. When the waste is improperly disposed of or simply left where it was deposited, aquatic organisms, other pets and humans may come into contact with several transmittable disease causing bacteria and parasites. The disease that can be transmitted from pet to human include Campylobacteriosis (frequently causes diarrhea in humans), Salmonellosis (fever, vomiting, diarrhea, headache), and Toxocariasis (loss of vision, rash, fever). It is crucial that pet owners pick up their pet waste to prevent these diseases and stormwater pollution. The Steering Committee agreed that ordinances requiring this within the Stony Creek Watershed would be too difficult to enforce if they were in place. Therefore, public education and voluntary cooperation would be the best approach.

Rapid Development and Changing Land Uses

Nationwide, more than 1.5 million acres of land is developed each year. As rural landscapes are turned into more urban uses, the result is a significant lowering of water quality and an increase in water quantity. Development practices and encroachment directly impact water quality and should be considered a potential source of pollution. Land use planning and development practices are effective methods to control not only where development occurs but also the means by which it occurs, and the overall impact the development will have on water quality for many years. In the March 16, 2006, Indianapolis Star newspaper, an article appeared titled "Outside Indy, growth spurts go on". The article stated that Hamilton County was the 18th fastest-growing county in U.S. from 2000 to 2005 because Hamilton County's population increased 32 percent. "An awful lot of this is coming from what we call suburban flight," said Vince Thompson, an economic research analyst with the Indiana Business Research Center in Bloomington. The suburban flight is a result of homeowners leaving the Indianapolis area for better schools and other benefits. This phenomenon is anticipated to continue all over Hamilton County and Noblesville during the next several years. According to the Planning Department, growth in the Madison County and Anderson area is anticipated to remain constant at a much slower pace. Population growth is expected to occur primarily in the Hamilton County portion of the Stony Creek Watershed to the north and east of Noblesville.

Comprehensive Plans, Zoning Ordinances, and Subdivision Control Ordinances are documents that almost every community uses to guide growth and development. These same documents can also be used to effectively protect natural resources and improve water quality. The Hamilton and Madison County Plan Commissions as well as the City of Noblesville's Planning Department have proactively worked to control haphazard and unplanned growth outside of designated urban areas. Their Master Plans include areas to conserve as open space. Both counties, Noblesville and Anderson have policies and procedures in place that aid the prevention of pollution and flooding to water bodies.

Soil erosion from construction activities can contribute to the filling of nearby waterways affecting water quality, aquatic habitats, and recreational opportunities. Hamilton County, Noblesville, Madison County, and Anderson as Phase II Stormwater entities require best management practices (BMPs) including silt fencing, straw bales, and turf seeding, that when installed and maintained properly, can successfully limit sediment from leaving the site.

Residential Lawn Care

In order to apply the recommended amount of fertilizer to a residential lawn, a soil test must first be performed in order to accurately calculate the type and amount of fertilizer needed. Most homeowners do not have this soil test performed so the result tends to be an overapplication of fertilizers. Other chemicals such as pesticides and herbicides tend to be overapplied too. Every home, regardless of size or age, has potential pollution sources that can impact ground and surface water quality. These may include the use, storage and disposal of pesticides, fertilizers, and pesticides commonly used around the home. Common chemicals applied to flowerbeds and small gardens can have a major impact to local streams and tributaries. Urban activities may create conditions that result in higher-than-normal concentrations of ammonia and phosphorus in water bodies downstream. While professional lawn and garden chemical applicators receive training and are required to maintain application records, the average homeowner does not. This often results in over-application of lawn and garden chemicals and contributes significant nutrient loads to adjacent waterbodies. It is advisable to have residential lawns sampled for available nutrient levels prior to application of additional fertilizers and/or nutrients. These samples will outline the specific needs of the lawn and will reduce the potential for over-application and contaminated runoff entering the local water courses.

Yard wastes can also be a pollutant stream if they are not properly managed. Yard waste such as grass clippings, leaves, and dead plants are high in organic matter and if piled or dumped on nearby streambanks can result in the smothering of the vegetation that is naturally stabilizing the back and preventing soil erosion. Depleted dissolved oxygen level of nearby waterways as the vegetation decomposes can also be an outcome of importer disposal of lawn and brush clippings. Composting of the accumulated brush and lawn trimmings can be more valuable to the homeowner as a nutrient rich, organic material for flower beds and gardens and less damaging to the flora and fauna of the watershed.

Improper Solid Waste Disposal

In urban areas, it is especially important to properly dispose of solid waste due to the large volume of waste generated. Existing Hamilton County and East Central Solid Waste Management District programs are not utilized to their capacity even though they serve as an important community resource. Stormwater runoff carries trash and pollutants associated with that trash to the Stony Creek waterways. The mission of the Hamilton County Solid Waste Management District is to promote recycling, waste reduction, and responsible waste management within Hamilton County. They offer residential, business, and teacher education and outreach. Their website (www.hcdoes.org) contains detailed information about their services. Madison County is served by the East Central Solid Waste Management District. Their objective is to provide the most up-to-date information on waste reduction, recycling, and composting in east central Indiana. Their programs are also described in detail at their web site (www.eciswd.org).

Floodplain Management/Open Space

As land uses become more urbanized, water quantity is increased due to factors such as less water infiltration, channelization of waterways, and modification of the floodplain. Increased water quantity results in increased pollutants loadings and property destruction. Flooding and associated flood damage is most likely to occur during the spring because of heavy rains combined with melting snow. However, provided the right saturated conditions, intense rainfall of short duration during summer rains storms are capable of producing damaging flash flood conditions.

The standard for flooding is a 1% chance of flooding or a 100-year flood. This is a benchmark used by the Federal Emergency Management Agency (FEMA) to establish a standard of flood protection in communities throughout the country. The 100-year flood is referred to as the "regulatory" or "base" flood. The term 100-year flood is often incorrectly used and can be misleading. It does not mean that only one flood of that size will occur every 100 years. What it actually means is that there is a 1% chance of a flood of that intensity and elevation happening in any given year. In other words, the regulatory flood elevation has a 1% chance of being equaled, or exceeded, in any given year and it could occur more than once in a relatively short period.

Along Stony Creek from 186th Street to the confluence with the White River, has detailed flood stream studies outlining the floodway and 100 year floodplain. However, the remaining streams and tributaries are unnumbered Zone A streams without detailed floodway and 100 year floodplain delineations.

Stony Creek begins in Madison County and travels through the watershed into rural Hamilton County where it eventually meets the White River in Noblesville. The Stony Creek watershed between the City of Anderson and the City of Noblesville is continuing to experience rapid development pressure from the west to the east. Historical flooding events in both Hamilton and Madison Counties have caused over $120 million in property and crop damages since 1993. Areas prone to regional flooding may become more susceptible to flooding as rural land uses are changed to a more urban setting. Currently Hamilton County has an ordinance which requires no filling of floodplain areas. Also, they have an ordinance requiring subdivision planning so that lot lines are not located in floodplain areas and any such areas must be set aside as common area.

As high water events, both large scale and smaller scale floods, occur, there are many possibilities for pollutants to enter the stream systems. Debris from infrastructure and buildings damaged by flood events, oils, grease and toxins from submerged vehicles and septic systems, and common chemicals and solvents that are present in nearly every home can all become mobile when flooding occurs. These substances can be severely harmful to aquatic life, other wildlife and humans that come into contact with the contaminated water, and can pose long term problems for saturated soils in the flood area.

General damage debris, either from the destruction of buildings or from general washing away of materials on the ground can also have effect on the severity of the event. When materials are trapped in the stream, water is impeded and can potentially cause an enlarged area to become affected and adding to the potential for pollutants to enter the water course and surrounding lands.

4.0 IDENTIFYING CRITICAL AREAS

Water quality data, trends in land use development, and comments from stakeholders in the watershed were utilized to identify critical areas within the Stony Creek Watershed. Critical areas include both areas that are of benefit to water quality and storage within the watershed as well as areas that are suspected of degrading water quality and impeding the natural drainage and infiltration of the watershed. Areas that are considered to be beneficial in the Stony Creek Watershed should be protected or enhanced, and those areas or activities suspected of degrading water quality or increasing the risk of flooding should be targeted for implementation of management measures.

4.1 BENEFICIAL CRITICAL AREAS

Identifying land uses and activities that have a negative impact on water quality or the assimilation of increased water quality is often the primary focus of watershed planning. While managing the impacts of these activities can and does improve water quality and assimilation, it is equally important to identify the existing land use conditions and activities in a watershed that currently enhance or protect water quality and reduce the risk of flood related damages.

Well Buffered Stream Reaches

The term buffer includes those areas with permanent vegetation with the intention of trapping pollutant and managing other natural resource concerns, such as field wind breaks, vegetated fence rows, filter strips, and riparian buffers. Buffered stream reaches can be beneficial to the watershed in many ways. Loadings of sediments, nutrients, and pesticides can be significantly reduced after passing through a vegetated buffer adjacent to the stream or ditch. These corridors are also important to the wildlife of the ware as they provide habitat and food sources perhaps not found elsewhere. Overhanging vegetation, even if only tall grasses, allow the water course to be shaded in areas, thus creating a cooler environment, maintaining more consistent Dissolved Oxygen levels within the water and providing a conducive habitat for aquatic organisms.

Within the Stony Creek Watershed, there are approximately 47.2 miles of streams, and of that, approximately 19.3 miles, or 41% have 30 feet or less of vegetated buffer on one or both of the streambanks. NRCS Practice Standard 393 suggests that a minimum average flow length of 30 feet is necessary to reduce the dissolved contaminants and suspended sediments in the overland runoff. In the Stony Creek Watersheds, the following buffer miles are needed; 2.5 miles in Stony Creek Headwaters, 7 miles in William Lehr Ditch, 6 miles in William Lock Ditch, and 2.5 miles in Stony Creek North Trib near Noblesville. Exhibit 3-3 highlights the areas of the streams and tributaries to Stony Creek that have less than 30 feet of vegetation on either streambank.

These buffers provide a valuable water quality benefit and should be protected from encroaching development or neighboring land uses and stretches lacking sufficient cover should be buffered. Areas of reaches considered critical and in need of long-term protection include those reaches of Stony Creek with greater than 75 feet of riparian corridor. Smaller streams and tributaries with greater than 50 feet of buffered streambank should also be provided protection. In total there are approximately 13 miles with adequately sized buffers in need of protection. These areas not only provide habitat for land and aquatic species, they also provide crucial protection and enhancement capabilities for overall water quality and provide storage areas for high water events, reducing potential monetary damages due to flooding. Dr. Baker's study confirms that there are existing vegetated filter strips currently in place in the watershed as an appropriate BMP but he concludes that buffers should be expanded in terms of width and length.

A method of protecting these well buffered areas is to adopt a basin wide ordinance requiring a setback for new construction and redevelopment along Stony Creek, ensuring that the riparian area will be maintained and protected from encroachment. Other effective measures include developing a Greenways Plan, purchasing floodplain and/or conservation easements along the main-stem and other currently established riparian buffers, and continual outreach and educational efforts to inform individual landowners of the importance and value of the riparian buffers. If buffers are enrolled in federally funded programs, landowners need to contact the NRCS to establish an invasive species maintenance program. Currently existing ordinances and policies effectively prevent any new development in the floodplain in Hamilton and Madison Counties, which also helps to maintain a necessary buffer area. Along Stony Creek, the approximate floodway and 100-year floodplain from 186th Street to the White River confluence (FEMA studied area) is 1000 feet. It is generally less in unstudied areas of the watershed.

Sanitary and Treatment Facilities

Residential areas that are serviced by a centralized wastewater facility such as a WWTP or an operational package plant have reduced the potential for sewage or other household effluent to enter a nearby drainage ditch, stream, or river. While there are risks and impacts associated with such services, the benefits far outweigh the detriments regarding the protection and enhancement of water quality. Treatment facilities have the ability to efficiently and effectively treat household wastewater while discharging significantly cleaner water.

Areas serviced by centralized treatment facilities in the watershed include the City of Noblesville, the City of Anderson, and the Town of Lapel. These service areas are shown on **Exhibit 3-5**. The largest municipal discharge, the Lapel Municipal WWTP has a maximum permitted flow of 0.36 MGD. None of the dischargers in the Stony Creek Watershed have *E. coli* limits but these limits will be introduced during each facility's next NDPES permit cycle. As these incorporated areas continue to grow in population, it may eventually become necessary to extend the service areas for the WWTPs. This may provide the opportunity for several residences to abate with current on-site septic systems, thus reducing the overall potential for untreated household wastewater to enter the streams and tributaries in the Stony Creek Watershed. To further illustrate this point, within the last 2 years the area near Lapel known as Fishersburg with approximately 75 homes was connected to Lapel's sanitary sewer system. Madison County Health Department sampling has confirmed significant *E. coli* reductions in Stony Creek since the connection occurred.

The City of Noblesville has a program to add existing and new development to their sanitary sewer service area. For existing residential subdivisions, if 60% or more of homeowners in that subdivision sign a petition requesting connection, the City will connect them.

Hamilton Southeastern (HSE) Utilities, Inc. currently has a Master Plan on their website (http://hseutilities.com/ftp/Standards/MasterPlan.pdf) identifying their potential expansion of sanitary sewer services for the southern portion of Wayne Township. During 2007, they will add a Master Plan detailing expanding services into the northern portion of Wayne Township. HSE owns a 42 acre site at the confluence of Stony Creek and William Lehr Ditch, on the north side of State Road 38. Their plan is to build a 15 MGD WWTP which will have the capacity to serve most of Wayne Township and bring new sanitary sewer lines into the Stony Creek Watershed. The timeframe for when this occurs is dependent upon how quickly new development is constructed in this fairly rural area. HSE anticipates that most of the land in this area will eventually be annexed in by the City of Noblesville.

According to IDEM records, the Lapel Municipal WWTP and Tall Timber Mobile Home Park discharge into the Stony Creek Watershed. The Lapel WWTP does have a total residual chlorine limit in their permit and chlorine is used for sewage disinfection. NPDES records show no violations at either plant so overall they are considered to be a benefit to water quality in the watershed.

Parks, Floodplains, and Wetlands

Parks, recreational areas and open spaces areas allow for the increased potential for infiltration or stormwater, uptake of nutrients and entrapment of solids such as sediment, thus reducing the loadings to streams, rivers, and ditches. These low development areas, if placed in sensitive locations can also reduce monetary damages caused by frequent flooding. Damages to the open space or recreational areas could be far lower than damages to residences or other structures routinely found along a water course.

Protected lands in the Stony Creek Watershed include Seminary Park and the South 10^{th} Street Wetland Mitigation Project. Seminary Park is owned and operated by the City of Noblesville sits on one and a half acres located between Tenth and Eleventh Streets and Division and Hannibal Streets. The South 10^{th} Street Wetland Mitigation Project was created by the City of Noblesville to mitigate for wetlands lost during the exit 10 corporate campus development in Wayne Township along Sand Creek. This constructed wetland project contains a total of 17 acres with 13 or 14 being used currently as wetlands.

Restrictions on developing in floodplain areas contained in Hamilton and Madison County ordinances results in those areas being protected. Having a minimum of 75' setback for new construction and redevelopment along Stony Creek, ensures that the riparian area will be maintained and protected from encroachment. Because of these restrictions, flooding potential is reduced and overall water quality is increased. Allowing development in the floodway, residential or otherwise, is to allow the lives and property of citizens to be placed in harms way and creates potential liability for governmental entities. The flood conveyance capacity of affected floodways should be maintained and restored to safe and satisfactory levels. Development in floodplains negatively impacts the watercourse.

Wetlands have the ability to serve several functions in regard to the protection and enhancement of water quality. Water flowing into, or stored in a wetland may be retarded allowing increased time for the uptake of nutrients, settling of suspended solids and evaporation or infiltration of excess water. Nearly 330,000 gallons of water can be retained by a 1 acre-foot wetland. If this wetland did not exist, this water would be directed to the nearest open water system, pollutants included. The ability to recharge the surrounding area with slowly released water helps provide a more consistent soil moisture level in an agricultural setting, while allowing for groundwater recharge at the same time. Wetlands also serve the watershed as wildlife habitat areas providing cover from predators while also serving as a food source. The project listed above involved restoration or protection of critical wetlands and this area will be beneficial to the functioning of the natural landscape as well as the historical heritage of the area. Exhibit 1-4 shows the estimated 322 acres of wetlands located within the Stony Creek Watershed. The source of the exhibit is the National Wetland Inventory (NWI) maps which should only be used as a reference, and not as an indicator of whether or not wetlands exist on a particular site. NWI maps show the potential for wetlands to exist based on ideal conditions.

Therefore, a field verification study would need to be conducted to determine where exactly these critical areas would be located.

Comprehensive Planning and Development Ordinances

Comprehensive planning and development ordinances in place are integral not only for the protection of water resources, but also for the protection of citizens and personal property in the communities in which they are located. These measures pair long-range planning and natural resource planning to ensure that future generations of citizens will have well developed communities along with preserved natural resources.

Hamilton and Madison Counties have each prepared Comprehensive Land Use Plans describing areas to be protected such as river corridors, wetlands, farmland and open spaces. Hamilton County's June 2006 draft Comprehensive Plan Update outlines several policies and strategies to preserve and protect environmental and natural resources including water resources and waterbodies. The Stony Creek Watershed would benefit from implementing the outlined strategies including stabilizing failing and eroding streambanks, preserving and restoring native riparian vegetation along the edges of water resources, creating natural buffer zones and setbacks, and prohibiting stream channelization.

Surface water, 100-yr floodplain, woodlands, and soils are identified in the City of Noblesville's Comprehensive Master Plan "Respecting Environmental Resources" Chapter as constraints to development or areas that need preservation. Chapter 3 – Natural Resources in the City of Anderson's 2005 Comp Plan outlines several policies that would support addressing some of the issues outlined in this plan. Policies such as promoting protection of wetlands, elimination of potentially hazardous septic systems, promoting the protection and enhancement of local land-based resources, such as floodplains, riparian areas, woodlands, and soils, would benefit the Stony Creek Watershed.

Methods to provide this protection include the development of specific ordinances or other policies by which the citizens of the counties and city must abide. Furthermore, each county and the city has recognized the importance of Stony Creek and tributaries to the local setting and have taken measures to reduce construction and development within the floodplain and corridor areas via ordinance language and construction plan reviews. Reviewing these construction plans not only protects the natural resources of the area, but prevents future flooding damages and expenses during high water events.

4.2 <u>CRITICAL AREAS AS POTENTIAL SOURCES OF POLLUTION</u>

Critical areas identified below are considered to be potential sources of pollution in the watershed. In order to minimize the water quality impacts associated with these areas, it will be important to target the implementation of management measures identified in **Table 5-1, Table 5-2**, and **Table 5-3** toward these critical areas. The following areas were ranked as being of highest priority by the Steering Committee members.

Unbuffered Stream Reaches

Unbuffered streams and tributaries are highly exposed to overland runoff and the non-point source pollutants that are carried with it. Large quantities of runoff with high velocities lead to erosion of the streambank itself. Without the protection of several feet of vegetated buffer, pollutants such as sediment, nutrients and chemicals can be directly delivered to the stream system. In addition to reductions in pollutant loadings, vegetated buffers also provide a shading effect that can provide a more habitable environment for aquatic organisms regarding temperature and Dissolved Oxygen. Exhibit 3-3 highlights the areas of the streams and tributaries to Stony Creek that have less than 25 feet of vegetation on either streambank. The most critical are those areas are bordered by agricultural fields utilizing conventional tillage methods during crop production. There are approximately 47.2 miles of streams within the watershed, and of it is estimated that 19.3 miles, or 41%, of streams have less than 25 feet of vegetated buffer on one or both of the streambanks. A more detailed assessment, including a tillage survey and buffer survey should be completed to provide a more accurate overview of the watershed.

The promotion of existing federal incentive programs such as Conservation Reserve Program (CRP), Conservation Security Program (CSP), and Environment Quality Incentive Program (EQIP) can lead to the establishment of various forms of stream buffers providing benefits not only to Stony Creek, but also to the individual landowners. As stated in Dr. Baker's study, although water quality parameters did not exceed published standards, the creek had elevated phosphate and nitrate nutrients which produced an exuberant eutrophic growth of water plants and algae. Adequately sized stream buffers would reduce the amount of nutrients going into Stony Creek. Sampling sites 1, 2, and 2A in the William Lock Ditch subwatershed shown on Exhibit 2-2 should be prioritized for buffer implementation based on the sampling results. Both William Lock Ditch and William Lehr Ditch are completely without adequately sized buffers. These areas, shown on Exhibit 3-3, are considered critical.

Agricultural Tillage Practices

Conventional tillage of crop land allows the soil to remain exposed to the elements for extended periods of time. The majority of conventional tillage is completed following the crop harvest in the fall and no crop residue remains on the surface of the field. Thus the topsoil is exposed to the snow and more importantly during the spring snow melts and rain events. As the snow melts and the rain falls, the potential for soil erosion is greatly increased and nearly guaranteed.

Within the Stony Creek Watershed, the primary tillage method for corn production (148,923 acres) remains to be conventional tillage. The average percentage of corn conventional tillage is 84% or 125,095 acres. According to IDEM's Region 5 Model, if conservational tillage for corn production were increased by 10% (12,509 acres), it is estimated that there will be a reduction in phosphorous loadings in the watershed by as much as 19,906 lbs/year and nitrogen loadings by as much as 39,390 lbs/year. It does seem that soybean production has moved away from conventional tillage as the average percentage of soybean conventional tillage is 27%. Fields utilizing conventional tillage for crop production on HEL soils within 500 feet of a stream or tributary are to be considered critical areas due to the increased erosion and pollution potential. HEL erosion has been identified as a primary concern, and activities involving land disturbance such as conventional tillage methods are likely to increase sediment loadings to the watershed. The HEL classified soils in the Stony Creek Watershed are illustrated in Exhibit 3-2.

For a more detailed view of these critical areas, a tillage inventory should be completed within the watershed and those results should be cross-referenced with NRCS HEL determinations. Owners of farm fields in the Stony Creek William Lock Ditch Subwatershed especially those adjacent to Dr. Baker's sampling sites 1, 2, 2A, and 3, which are considered to have water quality data of greater concern and are shown on Exhibit 2-2, should be considered priority areas for implementation of conservation practices.

HEL determinations, made by NRCS, are based on a mathematical equation, USLE, the Universal Soil Loss Equation. This equation takes into account the rainfall factor, erodibility of the soil type, allowable loss for that soil type and the length and the slope of the area. Soil map units may also be classified as Potentially Highly erodible (PHEL) based on a varying range of length/slope values. In such instances, the final determination of erodibility must be made through an onsite investigation.

Within the Stony Creek Watershed, there are approximately 5,400 acres (15% of all soils) of HEL classified soils, with the predominant soil type being Miami. These HEL soils need proper management to reduce the increased potential for soil erosion. Proper management of the soils can reduce the potential for adverse effects such as field gully erosion. Thus, areas of HEL soils currently in production and adjacent to a tributary stream of Stony Creek are considered critical. These areas will need to be investigated in order to produce a conservation plan outlining potential BMPs and management techniques to reduce erosion. Management measures addressing highly erodible soils will target owners of cropped fields located on HELs.

Flooding and Streambank Erosion

Areas prone to flooding can also be sensitive to other issues related to water or habitat quality degradation. Poorly managed floodplains where increased construction or other land use changes have occurred not only creates vulnerabilities to the new structures, but also to downstream areas as well. If water is not allowed to infiltrate the soil layers due to increased impervious surfaces, runoff volumes and downstream loadings will be increased. These increased volumes of water may mobilize trees and other near stream debris creating the potential for in stream obstructions or log jams. The term "log-jam" is defined by the Indiana Administrative Code as the accumulation of lodged trees, root wads, or other debris that impedes the ordinary flow of water through a waterway.

As these log jams are created areas of significant erosion and streambank destabilization are created further degrading water quality through sedimentation. Some areas in the Stony Creek Watershed are sensitive to log jams and associated debris deposition and/or increased streambank erosion. The full reach of Stony Creek and William Locke Ditch downstream of 211th Street have existing logjams, sandbars, and other areas of sediment accumulation and vegetation. Therefore, these areas are considered to be critical.

Detailed stream studies can decrease the risks to structural damages and streambanks. Utilizing the associated information will provide better knowledge regarding the stream and allow for proper floodplain management. Furthermore, the installation of stream gages designed to monitor water quality, elevation and flow will provide the necessary baseline information as well as information regarding periods of low water and periods of high water. The combination of information obtained through detailed stream studies and long term monitoring can be invaluable when proposing methods to prevent repeated flood events as well as reducing the impacts of flooding to water quality and personal property. Areas sensitive to repeated flooding, property damages and the locations of existing and proposed stream gages are identified on Exhibit 4-1.

Failing Septic Systems

A source of the elevated pathogen bacteria in the watershed may be associated with improperly functioning or failed septic systems. Many factors can lead to the failure of residential septic systems; the age of the system, lack of regular maintenance to the systems, and heavy clay soils. Within the Stony Creek Watershed, the unincorporated areas lack a centralized sewage treatment system, limiting homeowners to on-site septic systems. It is crucial that these homeowners are equipped with the necessary information and knowledge as to the proper maintenance of the system to prevent failure. As the more populated areas of the City of Noblesville, the City of Anderson and the Town of Lapel grow in size, it will become more feasible to provide sanitary sewer services to those residences in close proximity to these areas. The most critical are those areas within the watershed where a clustered of 20 or more residential septic systems installed more than 10 years ago in soils with NRCS defined severe limitation for onsite wastewater disposal or treatment.

Utilizing digital aerial photography, 13 clusters of septic systems were identified and are shown on Exhibit 3-4 and 4-1. These clusters are all located near Stony Creek or associated tributary streams and may provide concentrated loadings of nutrients and/or bacteria if several of these systems are failing to adequately treat the household wastes. Water quality monitoring should be initiated immediately upstream as well as immediately downstream of these areas to further assess the impact on water quality and macro-invertebrate communities. Areas where several residential septic systems are clustered in close proximity to each other are considered to be a critical area. As the number of aging systems or systems located in severely limited soils increases, so does the potential for increased nutrients and bacteria to enter the water system. For purposes of this watershed management plan, clusters of 20 or more residences outside the areas serviced by centralized sewer were identified as critical.

Livestock and Pasture Management

Livestock with access to the stream, feedlots, and pastures bordering streams can have a direct impact on water quality. Loadings of bacteria, such as *E. coli*, are directly deposited through fecal matter and sediment is delivered to the stream via erosion of worn entrance paths and degraded streambanks. Livestock need to be excluded from the open streams and/or feedlots and pastures with exclusionary fencing and alternative watering systems. A vegetated buffer will further reduce the potential of the above mentioned pollutants entering the stream system.

All areas where livestock have unrestricted access to open streams and tributaries, or where feedlots and pastures are within 500 feet of the open stream or tributary without a vegetated buffer are considered critical areas for the purpose of this plan. Furthermore, these areas would be considered extremely critical areas should they also be located in an area with HEL classified soils. Several small, unregulated livestock operations were identified in the watershed. The extent of the water quality impacts associated with these facilities is not clear without having a detailed animal inventory of the watershed. The Steering Committee did identify most of the smaller livestock operations as being in the Stony Creek-William Lock Ditch Subwatershed so this area will be considered as critical.

Development Practices

Hamilton County is experiencing rapid development in the watershed due to a 32% population increase in the last 5 years and land uses are being quickly altered from rural to urban landscape. As areas become paved surfaces resulting in higher volumes of runoff creating increased potential for flooding and streambank scouring conditions. Hamilton and Madison Counties as well as the Cities of Anderson and Noblesville are now required by EPA and IDEM via an NPDES permit to address the quality of stormwater runoff. Their programs must include activities to address pollution sources such as illicit discharges (illegally dumped motor oil, paint, sewage) and sediment from construction site runoff. The Counties are also required to have new development install practices to help manage the overall volume and amount of pollutants coming off of the development. As land areas in the Stony Creek Watershed change, it will be important to monitor the effects such changes have on overall water quality and quantity in order to determine program effectiveness.

4.3 ESTIMATING POLLUTANT LOADS

In order to determine the overall effectiveness of recommended management measures identified in this plan, it is important to have an understanding of the existing pollutant loads in the watershed.

Existing E. coli Loads

Existing pollutant loads for *E. coli* were calculated using data from 17 sites sampled within the Stony Creek Watershed. Values from various sources at each of the 17 sites range from a low of 9.44E+10 to a high of 1.08E+11. This data and the calculation results were taken from IDEM's Draft TMDL Report for Duck, Pipe, Killbuck, and Stony Creeks dated March 30, 2005. Appendix 3 includes data from the report. Appendix 3, **Table 1** contains the existing *E. coli* loads from within each of the 17 subwatershed sampling sites as well as the various source categories. Subwatersheds highlighted in yellow are part of the headwaters. Appendix 3, **Table 2** shows the existing load percentages associated with each source category. According to the draft IDEM report, domestic pets were identified as a main contributor to increased *E. coli* loads in the 166^{th} Street Noblesville and Allisonville Road subwatersheds. CFOs and the CSOs in Noblesville are also believed to contribute significant sources of *E. coli* load.

Target E. coli Loads

Target pollutant loads for *E. coli* were in the Stony Creek Watershed were also taken from IDEM's Draft TMDL Report for Duck, Pipe, Killbuck, and Stony Creeks dated March 30, 2005. Appendix 3, **Table 3** shows the percentage of *E. coli* load reduction required in each subwatershed in order to achieve water quality standards.

According to the IDEM report, "high reductions (75 to 99%) in *E. coli* loads associated with manure application and free-ranging livestock are required across the Stony Creek Watershed to achieve the water quality standard". Load reductions from failing septic systems, wildlife, and domestic animals are next highest (60 to 99%). The CFO load reduction is 60% and the Noblesville CSOs are 50%.

Existing Nitrogen and Phosphorous Loads

Existing pollutant loads for total nitrogen and total phosphorus in the Stony Creek Watershed were determined by:

- Identifying the closest USGS stream gauging station: which was located on the Stony Creek at Noblesville, Indiana.
- Determining the Stony Creek's average annual discharge rate at that site (61 cubic feet/second)
- Multiplying the average annual discharge rate of 61 cubic feet/second, by the mean pollution concentrations for nitrate and phosphorus based on samples collected as a component of the Stony Creek Master Plan in 2002 by Dr. Baker. Calculations for all sites utilize a flow rate of 61 cubic feet/second; however monitoring sites upstream of the USGS gauge actually would have a lower average annual flow.

Target Nitrogen and Phosphorous Loads

Target pollutant loads were then determined by multiplying the average annual discharge rate (61 cubic feet/ second) by a target concentration set for each pollutant. The targets utilized for this method were also utilized to develop the Total Maximum Daily Loads (TMDL) for Stony Creek. Target load reductions were then determined by subtracting the targeted loadings from the estimated existing loadings. Based on these calculations, the existing pollutant loads, targets, and target reductions were developed for Total Phosphorus and Total Nitrogen. Reductions needed to achieve attainment status in Indiana are provided in **Table 4-1**.

Table 4-1: Estimated Pollutant Loads and Load Reductions

Sampling Site	Parameter	Mean Flow	Existing Average Concentration	Estimated Existing Loadings	Target Concentration	Targeted Loadings	Target Load Reduction	Percent Reduction Needed
1	Total Phosphorus	61 cfs	0.74 mg/L	44.41 tons/year	0.30 mg/L	18.00 tons/year	26.40 tons/year	59.5%
	Total Nitrogen	61 cfs	5.97 mg/L	358.26 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
2	Total Phosphorus	61 cfs	0.60 mg/L	36.01 tons/year	0.30 mg/L	18.00 tons/year	18.00 tons/year	50.0 %
	Total Nitrogen	61 cfs	5.03 mg/L	301.85 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
2A	Total Phosphorus	61 cfs	0.79 mg/L	47.41 tons/year	0.30 mg/L	18.00 tons/year	29.40 tons/year	62.0%
	Total Nitrogen	61 cfs	4.93 mg/L	295.85 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
3	Total Phosphorus	61 cfs	0.46 mg/L	27.60 tons/year	0.30 mg/L	18.00 tons/year	9.60 tons/year	34.8%
	Total Nitrogen	61 cfs	5.33 mg/L	319.85 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
4	Total Phosphorus	61 cfs	0.55 mg/L	33.01 tons/year	0.30 mg/L	18.00 tons/year	15.00 tons/year	45.5%
	Total Nitrogen	61 cfs	4.73 mg/L	283.84 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
5	Total Phosphorus	61 cfs	0.35 mg/L	21.00 tons/year	0.30 mg/L	18.00 tons/year	3.00 tons/year	14.3%
	Total Nitrogen	61 cfs	2.77 mg/L	166.23 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
6	Total Phosphorus	61 cfs	0.47 mg/L	28.20 tons/year	0.30 mg/L	18.00 tons/year	10.20 tons/year	36.2%
	Total Nitrogen	61 cfs	4.73 mg/L	283.84 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
7	Total Phosphorus	61 cfs	0.47 mg/L	28.20 tons/year	0.30 mg/L	18.00 tons/year	10.20 tons/year	36.2%

Sampling Site	Parameter	Mean Flow	Existing Average Concentration	Estimated Existing Loadings	Target Concentration	Targeted Loadings	Target Load Reduction	Percent Reduction Needed
	Total Nitrogen	61 cfs	4.53 mg/L	271.84 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A
8	Total Phosphorus	61 cfs	0.40 mg/L	24.00 tons/year	0.30 mg/L	18.00 tons/year	6.00 tons/year	25.0%
	Total Nitrogen	61 cfs	4.43 mg/L	265.84 tons/year	10.0 mg/L	600.09 tons/year	Below Target	N/A

Following the estimation of current pollutant loadings and the reductions needed to reach target levels of Total Phosphorus and Total Nitrogen, various scenarios were developed to predict pollutant load reductions realized by implementing BMPs throughout the watershed. It should be noted that several BMPs may need to be implemented in combination to provide adequate reductions in loadings in order to meet Indiana target levels.

Utilizing information found in Schueler's "The Practice of Watershed Protection", calculations to determine phosphorus and nitrogen loadings and potential load reductions were also produced utilizing estimated septic system inputs from household wastewater per person, per day, using an estimate of 3,000 households within the watershed. (According to 1990 data from Purdue University, all of Hamilton County had 11,716 homes and all of Madison County had 15,914 homes utilizing septic systems.) Estimates were then produced to determine septic system outputs for systems that are failing, or non-existent, as well as systems that are efficiently and effectively treating the household wastewater. These values are identified in **Table 4-2**. It can be further estimated that with septic system pumping, routine maintenance, and system replacements, approximately 11.92 tons of phosphorus and 50.05 tons of nitrogen per 3,000 homes can be reduced from the current loadings.

Table 4-2: Estimated Loadings and Reductions for 3,000 Septic Systems

Nutrient	Failing Septic Systems	Functional Septic Systems
Nitrogen	50.17 tons/year	0.12 tons/year
Phosphorus	16.88 tons/year	4.96 tons/year

Existing and Target Watershed Sediment Loads

The LTHIA Model was used with the land use acreage contained in Table 1-3 to estimate current and target sediment loads for the Stony Creek Watershed since no sediment monitoring was conducted in Dr. Baker's study. The estimated current sediment load for the watershed according to the LTHIA model is about 1,205 tons per year. When calculating the target load using 80 milligrams per liter for the target concentration in accordance with Waters, 1995 and the estimate of flow at 61 cfs, the result is 4,800 tons per year. The calculations result in a lower current load than target load. Since the current load estimate is less than the target load, it appears that sediment is not a substantial problem in the watershed based on average load conditions. Therefore, remediation measures for controlling sediment within the Stony Creek Watershed should not be a priority at this time. Sediment monitoring in the watershed should be conducted to more accurately characterize the sediment load in Stony Creek before expending resources to mange sediment reductions.

Existing and Target Row Crop Sediment Loads

Since no sediment monitoring was conducted in Dr. Baker's study, no existing and target pollutant loads for sediment from Row Crop production in the Stony Creek Watershed were determined. However, management measures should be taken to reduce the potential sediment loadings to the watershed since conventional tillage practices are still being utilized. The individual, 100 acre farm load reduction for sediment described below could be utilized to determine a target goal for the watershed.

Load Reduction on an Individual, 100 acre Farm for Sediment, Phosphorous, and Nitrogen

Load reduction spreadsheets (Region 5 Model) accepted by IDEM, Ohio Department of Natural Resources (ODNR), Michigan Department of Environmental Quality (MDEQ), and the Illinois Environmental Protection Agency (IEPA), along with the RUSLE2 predicted annual soil loss (ton/year) were utilized to produce estimated load reductions for sediment, phosphorus, and nitrogen as a result of implementing agricultural field practices and/or filter strips on a 100 acre farm in 2 different soil types. This spreadsheet is better utilized with field specific information, but is beneficial in this application as it provides estimates of how various BMPs can reduce pollutant loadings. The Region 5 Model assumes that all of the runoff from the 100 acres is being treated by the BMPs used in the calculation.

The NRCS RUSLE2 Worksheet Erosion Calculation Record was utilized with general local information provided by the Hamilton County NRCS District Conservationist and these records can be found in **Appendix 5**. RUSLE2, the Revised Universal Soil Loss Equation, is a mathematical equation which considers a rainfall factor, erodibility of individual soil types, allowable loss for that soil type and the length and the slope of the area.

Regarding the Stony Creek Watershed, 72% of land use, or 26,500 acres, is classified as row crop production occurring predominantly in Brookston and Miami soils. The assumption can be made that with high agricultural, row crop land use, significant load reductions should be achieved by implementing row crop BMPs, such as conservation tillage and filter strips, throughout the watershed. Based on information derived from local sources and the spreadsheets mentioned, the estimated reductions in phosphorus loadings by implementing conservation tillage and filterstrips on a single 100 acre, row crop farm would range from approximately 68 lbs/year to 549 lbs/year. In regard to nitrogen, the reductions range from approximately 130 lbs/year to 1,055 lbs/year. Sediment reductions range from approximately 34 tons to 464 tons. **Table 4-3** was produced outlining these findings and demonstrates the potential reductions based on 2 different soil types and the Region 5 Model Worksheets to produce these findings can be found in Appendix 5. The Region 5 Model assumes that all 100 acres would have conservation tillage and filterstrips.

Livestock with direct access to a nearby stream or drainage way can provide significant inputs of nutrients and bacteria. Pasture lands or feedlots without a proper filter strip, within 500 feet of a tributary stream or open ditch may also provide considerable amounts of excess nutrients and bacteria. Following the estimation of current pollutant loadings and the reductions needed to reach target levels of Total Phosphorus, Total Nitrogen and *E. coli*, various scenarios were developed to predict pollutant load reductions realized by implementing BMPs throughout the watershed. It should be noted that several BMPs may need to be implemented in combination to provide adequate reductions in loadings in order to meet Indiana target levels.

Calculations within the load reduction spreadsheets previously mentioned were utilized to determine potential load reductions associated with installation of livestock exclusion fencing and/or filterstrips along feedlot and pasture areas. These estimated reductions will vary based on species or combinations of species per operation, number of operations implementing livestock exclusion and/or feedlot setbacks. The average animal unit estimates were confirmed by the Hamilton County SWCD as being representative of conditions in the Stony Creek Watershed. Values ranging from 0.003 tons phosphorus reductions through 0.44 tons phosphorus reductions per operation are identified in **Table 4-4** and the Region 5 Model Worksheets to produce these findings can be found in Appendix 5. No BMP efficiency data was available for nitrogen removal through livestock exclusion and/or feedlot setbacks.

Table 4-3: Average Individual Row Crop Farm Load Reductions

EST. LOAD REDUCTIONS	Brookston			Miami		
Based on a single Farm; 100 acres in size	Conservation tillage	Filter Strips	**TOTAL**	Conservation tillage	Filter Strips	**TOTAL**
Sediment (tons/year)	15	19	**34**	244	220	**464**
Phosphorus (lbs/year)	24	44	**68**	230	319	**549**
Nitrogen (lbs/year)	48	82	**130**	461	594	**1055**

(IDEM Region 5 Model, October 2003)

Table 4-4: Estimated Phosphorus Loadings and Reductions from Feedlots, Pastures and Access Areas

Species	Average Animal Units	Est. Phosphorus Loadings without Filterstrip	Est. Phosphorus Loadings with Filterstrip
Beef	115	0.14 tons/year	0.02 tons/year
Dairy	400	0.44 tons/year	0.07 tons/year
Horse	5	0.003 tons/year	0.00 tons/year
Sheep	100	0.01 tons/year	0.00 tons/year
Swine	1000	0.34 tons/year	0.05 tons/year

(IDEM Region 5 Model, October 2003)

In total, it is estimated that the implementation of management measures for buffer strips, streambank stabilization, and buffers with exclusionary fencing may reduce nitrogen loadings in the watershed by approximately 13.18 tons/year ranging to 106.66 tons/year and phosphorus loadings by approximately 6.9 tons/year ranging to 55.52 tons/year. Based on this estimate, the implementation of these management measures at specific sites would greatly reduce the pollutant loadings potentially meeting the targeted phosphorus load reduction at the individual sampling sites, as shown in Table 4-1. All target load reduction numbers for nitrogen were below reduction target values so theoretically no management measures for nitrogen would even need to be implemented in the watershed.

Table 4-5 identifies the predicted load reductions associated with implementing some of the management measures discussed above.

Table 4-5: Potential Load Reductions and Critical Area Management Measures

Management Measure	Total Phosphorous Reduction	Total Sediment Reduction	Total Nitrogen Reduction
Septic System Improvements (per single home)	0.007 tons/year	N/A	0.017 tons/year
Implementation of Filter/Buffer Strips (per mile of buffer)	0.15 to 1.18 tons/year	125.6 to 1716.3 tons/year	0.28 to 2.26 tons/year
Implementation of Agricultural Conservation Measures (per 100 acre farm)	0.012 to 0.115 tons/year	0.0075 to 0.122 tons/year	0.024 to 0.230 tons/year
Streambank Stabilization/Restoration (per each 200 feet long X 50 high streambank with a recession rate of 0.75 feet per year*)	0.097 tons/year	195 tons/year	0.195 tons/year

(*Region 5 Model example, see Appendix 5)

In order to reduce total phosphorous loadings in the Stony Creek Watershed, target load reductions could be achieved by implementing various individual BMPs or combinations of various BMPs near each of the sampling sites from Dr. Baker's study as outlined in **Table 4-6**. The potential number of BMPs column assumes that only that particular, individual BMP would be implemented to achieve the reduction needed; however, it would be most appropriate to implement a combination of BMPs. Therefore, the table is provided to give readers an idea of the scale of BMP implementation that is needed to reach target load reductions. For BMP load reductions with a range of values, to be conservation the lower number was utilized.

Table 4-6: Implementation of BMPs to Reach Potential Phosphorous Load Reductions

Sampling Site	Target Load Reduction	BMP[1]	BMP Phosphorous Load Reduction	Potential # of BMPs Needed
1	26.40 tons/year	Septic System Improvements	0.007 tons/year	3,771 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	176 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	2,200 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	272 streambanks
2	18.00 tons/year	Septic System Improvements	0.007 tons/year	2,571 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	120 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	1,500 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	185 streambanks
2A	29.40 tons/year	Septic System Improvements	0.007 tons/year	4,200 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	196 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	2,450 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	303 streambanks
3	9.60 tons/year	Septic System Improvements	0.007 tons/year	1,371 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	64 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	800 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	99 streambanks
4	15.00 tons/year	Septic System Improvements	0.007 tons/year	2,143 homes with Septic

Sampling Site	Target Load Reduction	BMP[1]	BMP Phosphorous Load Reduction	Potential # of BMPs Needed
				Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	100 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	1,250 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	155 streambanks
5	3.00 tons/year	Septic System Improvements	0.007 tons/year	428 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	20 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	250 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	31 streambanks
6	10.20 tons/year	Septic System Improvements	0.007 tons/year	1,457 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	68 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	850 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	105 streambanks
7	10.20 tons/year	Septic System Improvements	0.007 tons/year	1,457 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	68 miles of filter strips and/or buffers
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	850 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	105 streambanks
8	6.00 tons/year	Septic System Improvements	0.007 tons/year	857 homes with Septic Improvements
		Implementation of Filter/Buffer Strips	0.15 to 1.18 tons/year	40 miles of filter strips and/or buffers

Sampling Site	Target Load Reduction	BMP[1]	BMP Phosphorous Load Reduction	Potential # of BMPs Needed
		Implementation of Agricultural Conservation Measures	0.012 to 0.115 tons/year	500 (100 acre) farms
		Streambank Stabilization/Restoration	0.097 tons/year	62 streambanks

[1] Information from Table 4-5

It is important that the established pollutant reduction targets be utilized as reference points and not as hard and fast indicators through which to evaluate the long term success of this watershed management plan. Both existing pollutant loadings and pollutant reduction targets are subject to a wide variety of assumptions, and are based on the best data currently available. The overall success of the watershed management plan should not only be evaluated by whether or not target load reductions or instream standards are achieved, but also on the basis of whether or not water quality improves as a result of implementing the watershed management plan. If existing pollutant loads are estimated too high, achieving target pollutant load reductions may not result in achieved in-stream pollutant concentrations. Alternatively, if existing pollutant loadings are estimated too low with goals that are easily achieved, in-stream target concentrations may be fulfilled prior to reaching target pollutant load reductions resulting in an inadequate number of BMPs to effectively improve overall water quality.

Nevertheless, it is believed that by implementing the full range of management measures discussed in detail in **Section 5** that water quality in the Stony Creek Watershed will be greatly enhanced.

5.0 GOALS AND DECISIONS

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

According to the IDEM, management measures describe what needs to be controlled or changed in order to achieve the goal. The anticipated timeline for implementing individual management measures is identified in **Section 5.1**. In order to successfully implement the plan, resources such as people, programs, and money need to be identified. It is important to have the support of individuals identified as resources to successfully execute the goals of the plan. Successful implementation may require some legal matters such as obtaining permits, purchasing easements, or the adoption of an ordinance. The Stony Creek Steering Committee decided to focus on goals that improve both water quality issues and water quantity issues in the Stony Creek Watershed based on education, water quantity, agriculture, land use planning, and *E. coli* reduction.

The Stony Creek Steering Committee represents the population of the watershed since it is made up of a diverse group of local leaders who are familiar with water quality issues in the watershed. The following goals were identified and agreed upon by the Stony Creek Steering Committee during their Steering Committee meetings with consideration of comments received during the 2 public meetings:

Education Goal: *Improve water quality through targeted education and outreach efforts to change stakeholders' habits and behaviors.*

Public education efforts will be wide spread and will likely reach all landowners in the watershed. However, specific management measures and action plans identified in the following tables will need to be targeted toward relative landowners. For example, workshops and educational brochures focusing on buffer initiatives should target landowners along open creeks and ditches as well as discuss total phosphorous loading reduction actions.

Flooding Goal: *Improve water quality by reducing in stream and private property damages associated with increased water quantity through collaborative efforts basin-wide.*

Flood reduction management measures and action items will most likely need to be implemented by the Hamilton and Madison County Surveyors' Offices. Implementing the recommendations from the Stony Creek Master Plan, Dr. Baker's study, as well as this plan will reduce water quantity which will also improve water quality. For example, increasing the number of miles of regulated drains which are maintained to provide better drainage will enhance this endeavor.

Water Quality Goal: *Improve water quality by implementing BMPs throughout the watershed in an effort to reduce E. coli, nutrient, and sediment loadings to the Stony Creek and tributaries.*

BMPs include proper management of agricultural nutrients, on-site household wastewater treatment (septic) systems, pet waste, manure, and livestock access to waterways within the Stony Creek Watershed.

Agricultural management measures and action strategies identified in the following tables will need to be targeted toward relevant landowners. For example, brochures promoting cost share programs available for land owners on highly erodible lands should be targeted only to the owners of highly erodible lands, and brochures promoting cost share programs to implement exclusionary fencing and alternative watering systems should be targeted only to landowners known to have livestock on their property. Additionally, numerous landowners along creeks and ditches in the watershed expressed interest in implementing conservation measures on their property if financial assistance were made available. These landowners should be targeted for priority implementation.

As discussed in Section 4, areas have been identified as potential priority areas for implementation of septic system management measures in the watershed. Where appropriate, these areas should be considered first during the implementation of management measures relating to septic systems. However, some of the management measures are broader and will require implementation efforts that target all landowners with septic systems in the watershed and in some cases the management measures will require county-wide participation.

Ideally, management measures would be implemented until *E. coli,* nutrient, and sediment loadings would reach the target reduction goals stated in Section 4.3.

Land Use/Future Development and Planning Goal: *Improve water quality and reduce damages associated with water quantity in the Stony Creek Watershed through basin-wide land use planning and ordinance development for the protection of agricultural activities and floodplain management.*

Urban development is currently occurring at a rapid rate within the watershed, and the current rate of development does seem to be posing a large threat to water quality in the watershed. However, by implementing the management measures identified in this plan potential future water quality impacts associated with urban development in the watershed can be minimized.

Tables 5-1, 5-2, and 5-3 located on the following pages identify management measures, action plane, resources/cost, legal matters, and progress indicators associated with addressing education, wastewater treatment systems, agriculture, and land use planning in the Stony Creek Watershed. Table 5-1 identifies all management measures and action strategies considered high priorities, Table 5-2 identifies all management measures considered medium priorities, and Table 5-3 identifies all management measures considered low priorities.

In order to determine the relative priorities of management measures listed in the tables, each measure was evaluated in terms of its ability to improve water quality within 5-years, the relative ease at which it could be implemented, and the overall public sentiment expressed towards a given measure. It is important to note that regardless of their overall ranking, all management measures listed in these tables are considered priorities. Priority placement areas for these BMPs should be performed in accordance with the Critical Areas discussion (Section 4.0).

It is important to note that originally in early discussions the Steering Committee identified two of the management measures; 1) increasing nutrient management and pest management practices among crop producers and 2) improving pasture management techniques including rotational grazing and fencing livestock from waterways, as medium priorities. The rationale behind this was that many of these practices are already being encouraged by NRCS and the SWCD. Also, livestock exclusionary fencing would require a funding source for fence installation which would most likely not include funds for on-going maintenance as well as an alternative drinking water source. Upon further evaluation and consideration, the Steering Committee agreed to identify these two measures as high priorities due to the findings in Dr. Baker's Study and the IDEM TMDL study identifying manure management as the largest contributor of *E. coli* in the Stony Creek watershed. When these two management measures are implemented, it will be important to consider the opinions and concerns of the producers that are affected by them. Currently under IC 36-9-27-46, the Hamilton County Drainage Board has the authority to require exclusionary livestock fencing along regulated drains.

Estimated costs in the tables are identified as either Low, Moderate, or High. Those activities, materials, or programs estimated to cost less than $1,000 will be considered low cost. Those activities, materials, and programs that are estimated to cost between $1,001 and $10,000 are considered Moderate cost. Activities, materials, and programs that are estimated to cost more than $10,000 are considered High cost.

"Local Resources" in the tables are intended to provide a list of local organizations that could potentially provide support, advice, or consultation on a particular management measure. These lists are not intended to be comprehensive and are not intended to exclude non-listed organizations from participating in the development or implementation of a particular management measure. Other non-listed organizations are encouraged to participate as available.

It is most likely that the Hamilton County Surveyor will apply for Supplemental 319 funding to implement many of the management measures and action items identified in this plan. If awarded, this type of grant will provide funding for implementation of many of the priority issues identified in this plan. Additional funding sources, such as those listed in the IDEM's Indiana Watershed Planning Guide will need to be pursued in order to ensure successful long-term implementation of the Stony Creek Watershed Management Plan.

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators

Establish buffer along natural streams and artificial drainage ditches. 19.3 miles need buffered of the total 47.2 miles in the watershed. Goal is to establish 10 miles of buffers in 5 years.	• Identify landowners and stretches of natural waterways that need buffered.
	• Conduct a workshop and/or develop educational materials on the benefits of implementing riparian buffers along natural streams and filter strips along drainage ditches.
	• Develop a cost share program to assist landowners with implementing buffers and filter strips.
	• Use GIS to maintain a graphical database of the installation of buffers. Use the images to illustrate the success of this effort and display at local events.
		• Local Resources
		  ◦ Hamilton and Madison County SWCDs
		  ◦ Hamilton and Madison County Surveyor's Office
		  ◦ NRCS
		  ◦ Department of Agriculture
		  ◦ Purdue Extension Service
		  ◦ Nature Conservancy Easements
		• Section 319 grant
		• High cost
			Indiana Filter Strip Program	Installation of filter and buffer strips throughout the watershed.

Increase the number of acres in no-till or mulch till practices. Goal is to increase corn production in conservation tillage by 10% and soy bean production in conservation tillage by 5% in 5 years.	• Provide educational materials to farmers at SWCD annual meetings, Ag Days, County Fairs, and other events.
	• Research and promote incentive programs to improve participation in conservation tillage practices.
	• Develop a cost share program to assist landowners with implementing conservation tillage.
		• Local Resources
		  ◦ Hamilton and Madison County SWCDs
		  ◦ NRCS
		  ◦ Department of Agriculture
		  ◦ Purdue Extension Service
		  ◦ Hamilton and Madison County Surveyor's Office
		• CORE 4
		• EQIP funds
		• 319 Grant
		• High cost
				Future surveys and correspondence indicate that stakeholders have changed behaviors and/or practices.

Promote use of grassed waterways, concentrated flow areas, and critical seedings to reduce erosion and sedimentation within the watershed. Goal is to establish grassed waterways on 20 Farm Operations in 5 years.	• Provide informational materials regarding benefits to water quality and soil savings through establishing grassed waterways, concentrated flow areas, and critical seeding areas.
	• Obtain funding and provide economic incentives to landowners to stabilize areas of concern.
	• Complete pre and post implementation load reductions based on spreadsheets provided by IDEM and RUSLE 2 calculations.
		• Local Resources
		  ◦ Hamilton and Madison County SWCDs
		  ◦ NRCS
		  ◦ Department of Agriculture
		  ◦ Purdue Extension
		• CTIC/Core 4 programs
		• Federal incentive programs
				• Reduced sediment loadings to nearby streams and waterways
				• Enhanced water quality in stream segments near to participants.

Investigate possible funding sources beyond regulated drain rolls to remove log jams and remediate streambank erosion areas of concern within 3 years.	• Inventory locations prone to log jams and streambank erosion • Determine need for DNR permit for mitigation activities at each site • Prioritize areas for removal or	• Hamilton and Madison County Surveyor's Offices • Hamilton and Madison County SWCDs • Property owners along River and	• Easements or agreements need to be obtained for private property entrance. • Funding mechanisms may include ditch assessments, maintenance fees or other means involving public input.	• Inventory and GIS mapping of logjams and destabilized streambanks completed and utilized to determine areas in greatest need of maintenance.

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	stabilization activities • Obtain funding for removal of log jams or streambank stabilization activities	tributaries. • Moderate Cost		• Various sources of funding have been identified, landowners in assessed areas are aware of the issues and the completed inventory is being utilized to determine maintenance schedule.

Implement streambank stabilization techniques that utilize a combination of vegetation, soil bioengineering, and structural systems. Goal is to implement 1 project annually of approximately 500 to 1,000 linear feet.	• Inventory waterways for erosion problems through field work and property owner outreach.
	• Create and distribute educational materials to landowners on streambank stabilization.
	• Develop a cost share program to assist landowners with conducting streambank stabilization.
	• Identify additional funding sources to assist with stabilizing eroded banks
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • NRCS
		  • DNR
		  • Hamilton and Madison County Surveyor's Office
		• 319 Grant
		• High cost
			N/A	Future water quality sampling indicates a reduction of sediment, phosphorus, and nitrogen loadings and concentrations, within the Stony Creek Watershed.

Continue to distribute an educational brochure about proper septic system operation and maintenance as part of on-going program.	• Utilize existing educational brochure on proper septic system operation and maintenance.
	• Identify landowners and distribute brochure. Target known residents and landowners in the watershed with existing septic systems.
	• Distribute educational brochures to all landowners applying for a septic system permit.
		• Local Resources
		  • Hamilton and Madison County Health Departments
		  • Area Plan Commissions
		• Low cost
			N/A	Follow up contact indicates that stakeholders receiving brochures have changed their behaviors and/or practices.

Conduct a Bacterial Source Tracking (BST) Study to determine the sources of fecal bacteria in waterways (e.g. from human, pets, livestock, or wildlife origins) and provide education to pet owners within 4 years.	• Investigate the latest advancements in BST technology
	• Identify localized sources of fecal coliform within the Stony Creek Watershed
	• Select sampling locations in watershed for investigation
	• Conduct BST Study
	• Conduct education and outreach highlighting water quality impacts associated with pet waste
		• Local Resources
		  • Hamilton and Madison County Health Departments
		  • Hamilton and Madison County Surveyor's Offices
		  • IUPUI, IU, Purdue
		• 319 Grant
		• High cost for study; moderate cost for education and outreach
			N/A	• Identification of percentages of fecal bacteria used to target *E. coli* mitigation efforts.
				• Increase hunting bag limits of numbers of animals that can be taken

Maintain existing gauging stations and increase the overall number of gauging stations in the watershed that monitor flow data; evaluate within 3 years.	• Determine activity levels of stream gauges currently in the watershed. • Determine locations where new, additional stream gauges are needed. • Explore necessary steps to establish new gauges and local sponsorship. • Maintain central repository or	• United States Geological Survey • Indiana Geological Survey • Hamilton and Madison County Surveyor's Offices	N/A	• Number of stream gauges increased due to local interest and efforts. • Data from gauges utilized to guide land use decision making in Hamilton and Madison Counties and Local Communities within those counties.

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	electronic database for all stream gauges in the watershed.			
Increase frequency of maintenance, number of miles maintained, and debris removal for Stony Creek, William Lock Ditch, and William Lehr Ditch to prevent flooding within 4 years.	• Update inventory annually. Prioritization may also need to be addressed annually. • As new areas are reported, they should be inspected and added to the inventory. • Determine if additional personnel are needed to adequately address the maintenance needs of the area. • If additional personnel are required, explore options for partnerships with other County or Municipal offices.	• Hamilton and Madison County Surveyor's Offices • Hamilton and Madison County Commissioners • Low Cost unless additional personnel are required.		• Inventory of areas in need is updated annually and utilized as a fluid document. • Personnel needs have been addressed. • Increased maintenance, either visual or mechanical, is occurring.

Conduct flood protection studies for areas that frequently flood including hydraulic analyses of unstudied/understudied streams to determine exact flood boundaries within 6 years.	• FIRMs for White River being updated next 1-2 years through FEMA Map Modernization Program but does not include Stony Creek or William Lock Ditch	• Local Resources
		  • DNR Division of Water
		  • IDHS
		  • Hamilton and Madison County Surveyor's Office
		• FEMA Grant
		• High cost		

Minimize soil erosion and sediment in waterways with better construction management and practices by continuing to implement on-going Rule 13 construction runoff program.	• Implement an educational program focusing on the benefits of implementing construction site BMPs into new development.
	• Work with local Storm Water Phase II communities to create and distribute a handbook for developers, contractors, engineers, and decision-makers identifying appropriate BMPs for controlling pollution associated with construction sites.
		• Local Resources
		  • Hamilton County Stormwater Phase II Communities
		  • Hamilton and Madison County SWCDs
		  • Area Plan Commissions, Surveyors, Town Councils, and Drainage Boards
		  • Local Builders Associations
		  • Purdue Planning with POWER
		• Moderate cost
			Approval and adoption of updated planning documents and ordinances.
			
			Enforcement of existing fines for construction violations.
				Post construction practices implemented in 100% of developments greater than or equal to one acre in the Stony Creek Watershed.

Improve water quantity and quality management through effective storage and treatment of urban, suburban, and rural stormwater runoff by continuing to implement on-going Rule 13 post-construction runoff program.	• Review Hamilton and Madison County and Noblesville drainage ordinances and make recommendations for improvement to the Drainage Board and City Council.
	• Implement an educational program focusing on the benefits of implementing stormwater BMPs into new development including Field Tour Workshops of existing Low Impact Development (LID) techniques.
		• List of definitions suggested language, and model ordinances.
		• Local Resources
		  • Hamilton County Stormwater Phase II Communities
		  • Hamilton County and Madison County SWCDs
		  • Area Plan Commissions, Surveyors, Town Councils, and Drainage Boards
		  • Local Builders Associations
			Approval and adoption of updated planning documents and ordinances.	Post-construction practices implemented in 100% of developments greater than or equal to one acre in the Stony Creek Watershed.

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	• Create and distribute a handbook for developers, contractors, engineers and decision-makers identifying appropriate stormwater BMPs. • Develop a cost share program to provide financial assistance to developers implementing stormwater BMPs such as pervious pavement, bioretention swales, rain gardens, etc. (For developments subject to Stormwater Phase II standards, cost share dollars would be used to fund BMPs in addition to minimum Phase II requirements.)	◦ Organization of Green Builders • 319 Grant • High cost		
Incorporate water quality BMPs into all future municipal and county-owned flood control projects designed and implemented in the watershed by continuing to implement on-going Rule 13 program.	• Update existing Comp Plans, Zoning Ordinances, and Subdivision Control Ordinances.	• Local Resources ◦ Area Plan Commissions, Surveyors, Town Councils, and Drainage Boards ◦ Hamilton County and Madison County SWCDs • Moderate Cost	Approval and adoption of updated planning documents and ordinances.	Updated ordinances and comprehensive plans address water quality issues.
Increase detection and enforcement of illicit discharges by continuing to implement on-going Rule 13 program.	• Build GIS database to track operational status of septic systems in Madison and Hamilton County. • Review existing records to compare the number of known septic systems in the watershed with the total number of homes in the watershed. • Conduct volunteer dye testing of septic systems to identify failing systems and illicit connections. • Require septic system contractors to be certified. • Require residents to provide proof that their septic system has been cleaned and inspected every five years by a licensed inspector/hauler.	• Local Resources ◦ Hamilton County and Madison County Health Departments ◦ Hamilton and Madison County Surveyor's Office ◦ Purdue Extension Service • Secure additional funds to develop and amend a watershed wide GIS database. • Moderate-High cost	County Health Departments and Commissioners will need to decide how to enforce proof of cleaning and inspection. Develop and adopt an ordinance requiring homeowners to document proof of septic system maintenance.	Future water quality sampling indicates a reduction in *E.coli* and nutrient concentrations and loadings in the Stony Creek Watershed.
Secure funding or cost-share assistance to assist interested landowners with connecting to local wastewater treatment plants within 7 years.	• Work with Regional Sewer District and Noblesville City Council to ensure political support and identify priority landowners. • Research all available private and public sources of funds for providing landowners with financial assistance	• Local Resources ◦ Hamilton County Commissioners ◦ Noblesville City Council ◦ Regional Sewer District ◦ Hamilton County and Madison County Health Departments ◦ USDA RCAP	N/A	Secure funding or cost-share assistance to assist interested landowners with connecting to local wastewater treatment plants.

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	in connecting to local treatment plants. • Secure a funding mechanism to provide financial support and incentives to encourage landowners to connect to local wastewater treatment plants. • Develop and conduct an education and marketing campaign educating priority landowners on the benefits associated with connecting to wastewater treatment plants. • Begin connecting interested landowners to wastewater treatment plants.	• Section 319 grant. • State Revolving Loan Funds. • High cost		

Establish a Septic System Management (Conservancy) District (also referred to as Onsite Wastewater Management District) for outreach & education efforts, inspection and maintenance programs and enforcement actions within 7 years.	• Investigate preferred mechanisms for establishing District as well as administration (e.g. formation of Board) including meeting with other counties and visiting other areas in Indiana that currently have an established District
	• Develop fees for District services
	• Establish legal authority for District rules and regulations
	• Locate all septic systems in District service area/develop database
	• Establish Programs for Inspection
		• Local Resources
		  • Hamilton and Madison County Health Departments
		  • DNR
		  • IDEM
		• High cost
			Develop and adopt an ordinance to establish District rules and regulations as well as fees.	Clusters of residences utilizing septic systems.

Improve pasture management techniques including rotational grazing and fencing livestock from waterways. Goal is to improve techniques on approximately 1,600 acres in 5 years.	• Create educational materials for livestock landowners about pasture management and limiting access to waterways.
	• Develop a cost-share program to fence livestock from waterways and provide alternative watering mechanisms.
	• Extensively test *E.coli* bacteria sources in the watershed to determine whether the bacterial indicators are in fact the result of animal or human waste.
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • NRCS
		  • Department of Agriculture
		  • Purdue Extension
		  • Hamilton and Madison County Surveyor's Office
		• Section 319 grant
		• High cost
				Future water quality sampling indicates a reduction in *E.coli* and phosphorus concentrations in the Stony Creek Watershed.

Increase nutrient management and pest management practices among crop producers. Goal is to develop 100	• Identify landowners and evaluate current manure, nutrient, and /or pest management practices.	• Local Resources • Hamilton and Madison County SWCDs	N/A	Follow up contact indicates that stakeholders attending workshops have changed behaviors and/or practices since

Table 5-1: High Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
Nutrient Management Plans (NMP) and/or Pest Management Plans (PMP) within the next 5 years.	• Conduct a workshop/and or develop a brochure for crop and livestock producers addressing manure, nutrient, and pest management. • Develop a cost-share program to provide land-owners with assistance in developing nutrient and pest management plans.	• NRCS • Department of Agriculture • Purdue Extension • Hamilton and Madison County Surveyor's Office • CORE 4 • EQIP funds • Section 319 Grant • High cost		attending the workshops. Future water quality sampling indicates a reduction in *E.coli*, phosphorus, and ammonia concentrations in the Stony Creek Watershed.

Table 5-2: Medium Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators

Promote use of winter cover crops to reduce erosion and sedimentation within the watershed. Goal is to establish an additional 500 acres of winter cover crops annually.	• Target fall plowed fields within the watershed.
	• Provide informational materials regarding benefits to water quality and soil health through establishing winter cover crops.
	• Obtain funding and provide economic incentives to landowners incorporating winter cover crops.
	• Complete pre and post implementation load reductions based on spreadsheets provided by IDEM and RUSLE 2 calculations.
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • NRCS
		  • Department of Agriculture
		  • Purdue Extension
		• CTIC/Core 4 programs
		• Federal incentive programs
		• Low Cost
				• Reduced sediment loadings to nearby streams and waterways.
				• Enhanced water quality in stream segments near to participants.

Continue on-going Rule 13 education and outreach highlighting the water quality impacts associated with the over application of fertilizers and pesticides to urban and rural residential lawnscapes.	• Coordinate education campaign among various departments and agencies
	• Distribute educational materials to landowners
	• Provide funding for soil testing of lawns
	• Conduct stakeholder workshop utilizing the Extension service
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • Purdue Extension
		  • Office of the Indiana State Chemist (OISC)
		  • Commercial Applicators
		  • Hamilton and Madison County Surveyor's Office
		  • Veolia Water Company
		• Section 319 Grant
		• Moderate cost
				Conduct before and after surveys of those having their soil tested

Secure funding for low-income landowners that may need financial assistance in installing, repairing, or operating and maintaining their septic systems within 7 years.	• Research all available private and public sources of funds for addressing septic systems issues including sewer extensions and private WWTP.
	• Seek funding and assistance from funding sources identified and researched in 2006.
		• Local Resources
		  • Hamilton County and Madison County Health Departments.
		  • Purdue Extension Service
		  • USDA RCAP
		• High cost
			N/A	

Investigate and address atrazine levels in the watershed within 6 years.	• Develop and conduct monitoring study of Atrazine levels in soils, ground, and surface water throughout the watershed
	• Offer funding assistance to crop producers to implement BMPs such as field boundaries, filter strips, & grass plantings to reduce Atrazine runoff
	• Develop Atrazine remediation pilot project to investigate potential for new technologies such as
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • NRCS
		  • Department of Agriculture
		  • Purdue Extension
		  • Hamilton and Madison County Surveyor's Office
		  • Hamilton and Madison County Health Departments
		  • IUPUI, IU, Purdue
		• Section 319 grant
				• BMPs implemented by 100% of crop producers participating in remediation pilot project utilizing atrazine in the Stony Creek Watershed.
				• Future water quality sampling indicates a reduction in atrazine concentrations in the Stony Creek Watershed.

Table 5-2: Medium Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	bioremediation of soils and wetland uptake for surface water	• High cost		

Conduct on-going education and outreach to home owners' associations regarding buffers and filter strips.	• Provide home owners with existing brochures
	• Conduct public workshops targeting developers of new subdivisions and property owners along Stony Creek
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • NRCS
		  • Purdue Extension
		  • Hamilton and Madison County Surveyor's Office
		  • Builders' Associations
		• Low cost
			Ordinance language for residential set aside	Conduct survey before & after workshops

Evaluate urban areas subject to repetitive flooding for existing structural relocation, buy out and flood-proofing as on-going activity.	• Investigate repetitive loss properties. • Determine critical areas based on previous flooding and land uses within the 100 year floodplain. • Inform landowners of programs and funding mechanisms available for proposed activities. • Create upland areas for increased storage, and develop passive land uses that would experience little monetary damage if flooded	• Hamilton and Madison County Surveyor's Offices • Hamilton and Madison County SWCDs • Hamilton and Madison County EMA Directors		Repetitive Loss properties mitigated to reduce future flood damages.

Conduct septic system workshops and tours of existing septic system demonstration projects at Strawtown and Baker's Corner to promote onsite wastewater treatment systems resulting in improved water quality as an on-going activity.	• Conduct educational workshops on proper septic system operation and maintenance and tours of demonstration projects.
	• Identify landowners and distribute brochure. Target known residents and landowners in the watershed with existing septic systems.
	• Distribute educational brochures to all landowners applying for a septic system permit.
		• Local Resources
		  • Hamilton and Madison County Health Departments
		  • Area Plan Commissions
		  • Landowners
		• Section 319 grant
		• Low cost
				• Follow up contact indicates that stakeholders attending workshops and receiving brochures have changed their behaviors and/or practices.
				• Future water quality sampling indicates a reduction of *E.coli* concentrations in the Stony Creek Watershed.

Table 5-3: Low Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators

Secure funding for livestock and crop producers that may need financial and technical assistance with implementing conservation measures such as conducting alternative plantings on highly erodible soils, implementing manure management BMPs, or conservation easements as on-going activity.	• Research available financial assistance opportunities and incentives to assist livestock and crop producers with implementing BMPs.
	• Develop a cost share program to assist landowners with implementing BMPs.
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • Hamilton and Madison County Surveyor's Office
		  • NRCS
		  • DNR
		  • Purdue Extension
		• CRP and EQIP funds
		• 319 Grant
		• High cost
			N/A	Future water quality sampling indicates a reduction in *E.coli* and nutrient concentrations and loadings in the Stony Creek Watershed.
				
				Increased watershed wide participation in conservation programs.

Investigate the water quality impacts from "hobby" farms and the resources to assist them to implement BMPs related to improving and protecting water resources.	• Inventory properties including numbers and types of animals
	• Determine which farms are eligible for federal programs
	• Conduct BMP workshops
	• Offer incentives to provide BMPs such as exclusionary fencing, long-term fence maintenance, and alternative water sources for livestock
		• Local Resources
		  • Hamilton and Madison County SWCDs
		  • Hamilton and Madison County Surveyor's Office
		  • NRCS
		  • DNR
		  • Purdue Extension
		  • Indiana Farm Bureau
		• CRP and EQIP funds
		• High cost
				Type and number of BMPs installed by hobby farms.

Promote and encourage participation in Hamilton County and East Central Solid Waste Management District Tox-Drop and Recycling Programs.	• Include pollution prevention information in published or distributed materials and at local events and workshops.	• Local Resources • Hamilton County and East Central Solid Waste Management Districts • Low cost	N/A	• Future surveys indicate changes in stakeholder attitudes and behaviors as they relate to pollution prevention. • Increased number of pounds, etc. collected • Number of days drop off centers are open • Outreach activities conducted

Improve the planning process to minimize impacts of septic systems on water quality.	• Ensure that Health Departments continue to participate in development review and approval process.
	• Build a GIS layer that identifies land suitable for septic systems.
	• Include language in updated Comprehensive Plans that addresses potential impacts of septic systems on water quality.
	• Promote existing financial assistance programs to assist homeowners in replacing and repairing inadequate septic systems.
		• Local Resources
		  • Hamilton and Madison County Commissioners
		  • Clarks Hill Town Board
		  • Hamilton County and Madison County Health Departments
		  • Purdue Extension Service
		  • USDA RCAP
		• Secure additional funds to provide economic incentives for repairing failing septic systems.
		• Moderate cost
			Will need to gain legal authority to require landowners to provide documentation that their septic systems are working properly prior to selling their property.	Secure funding for low-income landowners that may need financial assistance in installing, repairing, or operating and maintaining their septic systems.
				
				Future water quality sampling indicates a reduction in *E.coli* and nutrient concentrations and loadings in the Stony Creek Watershed.

Table 5-3: Low Priority Management Measures

Management Measures	Action Plan	Resources/Cost	Legal Matters	Progress Indicators
	• Provide economic incentives and assistance to homeowners to repair or replace aging septic systems. • Require homeowners to document that their septic system is functioning properly prior to selling their property.			

5.1 POTENTIAL IMPLEMENTATION TIMELINE

Management measures listed in the tables above as high priorities are likely to provide the greatest long term benefit to water quality in the watershed. However, these activities are not always the easiest measures to implement. Likewise some of the measures that may be considered medium or low priorities may be relatively easy to implement. Therefore, implementation of certain medium priority measures may occur prior to certain high priority measures, and implementation of certain low priority measures may occur prior to certain medium priority measures. Additionally, new information or changes in political and economic circumstances may result in a change in the implementation schedule shown below.

While a variety of circumstances may influence when, where, and how a given measure is implemented, **Table 5-4** details the anticipated timeline for when each management measure will be implemented. This table is not intended to provide an overall indication of when implementation of a management measure is likely to begin.

Table 5-4: Potential Timeline for Implementation

Management Measures	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Establish buffer along natural streams and artificial drainage ditches. 19.3 miles need buffered of the total 47.2 miles in the watershed.		H	H	H	H	H	H	H	H	H
Increase the number of acres in no-till or mulch till practices.		H	H	H	H	H	H	H	H	H
Promote use of grassed waterways, concentrated flow areas, and critical seedings to reduce erosion and sedimentation within the watershed.		H	H	H	H	H	H	H	H	H
Investigate possible funding sources beyond regulated drain rolls to remove log jams and remediate streambank erosion areas of concern.	H	H	H							
Implement streambank stabilization techniques that utilize a combination of vegetation, soil bioengineering, and structural systems.	H	H	H	H						
Continue to distribute an educational brochure about proper septic system operation and maintenance.	H	H	H	H	H	H	H	H	H	H
Conduct a Bacterial Source Tracking (BST) Study to determine the sources of fecal bacteria in waterways (e.g. from human, pets, livestock, or wildlife origins) and provide education to pet owners.		H	H	H						
Maintain existing gauging stations and increase the overall number of gauging stations in the watershed that monitor flow data	H	H	H							

Management Measures	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Increase frequency of maintenance, number of miles maintained, and debris removal for Stony Creek, William Lock Ditch, and William Lehr Ditch to prevent flooding.		H	H	H						
Conduct flood protection studies for areas that frequently flood including hydraulic analyses of unstudied/understudied streams to determine exact flood boundaries		H	H	H	H	H				
Minimize soil erosion and sediment in waterways with better construction management and practices.	H	H	H	H	H	H	H	H	H	H
Improve water quantity and quality management through effective storage and treatment of urban, suburban, and rural stormwater runoff	H	H	H	H	H	H	H	H	H	H
Incorporate water quality BMPs into all future flood control projects designed and implemented in the watershed.	H	H	H	H	H	H	H	H	H	H
Increase detection and enforcement of illicit discharges.	H	H	H	H	H	H	H	H	H	H
Secure funding or cost-share assistance to assist interested landowners with connecting to local wastewater treatment plants.			H	H	H	H	H			
Establish a Septic System Management (Conservancy) District (also referred to as Onsite Wastewater Management District) for outreach & education efforts, inspection and maintenance programs and enforcement actions.			H	H	H	H	H			
Improve pasture management techniques including rotational grazing and fencing livestock from waterways.		H	H	H						

Management Measures	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Increase nutrient management and pest management practices among crop producers.		H	H	H						
Promote use of winter cover crops to reduce erosion and sedimentation within the watershed.		M	M	M						
Education and Outreach highlighting the water quality impacts associated with the over application of fertilizers and pesticides to urban and rural residential lawnscapes.	M	M	M	M	M	M	M	M	M	M
Secure funding for low-income landowners that may need financial assistance in installing, repairing, or operating and maintaining their septic systems.			M	M	M	M	M			
Investigate and Address Atrazine Levels in Watershed	M	M	M	M	M	M				
Conduct education and outreach to home owners' associations regarding buffers and filter strips.	M	M	M	M	M	M	M	M	M	M
Evaluate urban areas subject to repetitive flooding for existing structural relocation, buy out and flood-proofing.	M	M	M	M	M	M	M	M	M	M
Conduct septic system workshops and tours of existing septic system demonstration projects to promote onsite wastewater treatment systems resulting in improved water quality.	M	M	M	M	M	M	M	M	M	M
Secure funding for livestock and crop producers that may need financial and technical assistance with implementing conservation measures such as conducting alternative plantings on highly erodible soils, implementing manure management BMPs, or conservation easements.	L	L	L	L	L	L	L	L	L	L

Management Measures	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Investigate the water quality impacts from "hobby" farms and the resources to assist them to implement BMPs related to improving and protecting water resources.		L	L							
Promote and encourage participation in Hamilton County and East Central Solid Waste Management District Tox-Drop and Recycling Programs.	L	L	L	L	L	L	L	L	L	L
Improve the planning process to minimize impacts of septic systems on water quality.	L	L	L	L	L	L	L	L	L	L

6.0 MONITORING EFFECTIVENESS

Progress indicators are used to gauge the progress and success of the watershed planning effort. Indicators may be administrative, such as language added to an ordinance, or programmatic, indicating the total acreage added to a filter strip program. Alternatively, monitoring describes how the above mentioned indicators will be evaluated to determine the level of success reached toward achieving the goal. Monitoring progress can be general, or very specific, such as increasing the number of participants at quarterly meetings or through improvements observed in biological or chemical measurements.

Goal Monitoring

For each goal, it is suggested that progress toward meeting each indicator be documented on a biannual basis. Biannual tracking of progress for each milestone will help to maintain focus on goal objectives and progress, but also to troubleshoot issues where it is clear that tasks may need to be adjusted or modified in order to achieve the goal objective.

Plan Evaluation

The Hamilton County Drainage Board and Surveyor's Office in partnership with the Stony Creek Watershed Steering Committee will be responsible for the regular review and update of the Stony Creek Watershed Management Plan. This plan should be evaluated on a biannual basis to document and celebrate progress; assess effectiveness of efforts; modify activities to better target water quality issues; and keep implementation of the plan on schedule. The plan should be revised as needed to better meet the needs of the watershed stakeholders and to meet water quality goals.

Chemical Monitoring Re-evaluation

In order to evaluate if management measures are having a beneficial impact on water quality, chemical monitoring of the watershed should be conducted at the same monitoring locations that Dr. Baker used for the Master Plan as funding allows. This data will be used to measure the effectiveness of all measures implemented in achieving goals of improving water quality, reducing concentrations of nutrients and *E.coli*, and reaching targeted load reductions as identified in Section 4.3.

By identifying existing pollutant loads and targeting future pollutant loads, the Stony Creek Steering Committee has created a framework through which the overall success of individual management measures and goals identified in this plan can be evaluated. Results of future water quality monitoring efforts will identify the relative success and short comings associated with implemented management measures, and can be used to adjust and revise certain portions of the plan as necessary.

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APPENDIX 1

ACRONYMS

BMP	Best Management Practice
CBBEL	Christopher B. Burke Engineering, Ltd.
CFO	Confined Feeding Operation
CFU	Colony Forming Unit
CSO	Combined Sewer Overflow
EPA	United States Environmental Protection Agency
FCA	Fish Consumption Advisory
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HEL	Highly Erodible Lands
HSE	Hamilton Southeastern Utilities, Inc.
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
LUST	Leaking Underground Storage Tank
MGD	Million Gallons per Day
MS4	Municipal Separate Storm Sewer System
NDPES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source Pollution
NRCS	Natural Resource Conservation Service
NWI	National Wetlands Inventory
NWQI	National Water Quality Inventory
OISC	Office of the Indiana State Chemist
QHEI	Qualitative Habitat Evaluation Index
PCB	Poly-Chlorinated Biphenyls
RBP	Rapid Bioassessment Protocols
SWCD	Soil & Water Conservation District
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USFW	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
WMP	Watershed Management Plan
WQS	Water Quality Standards
WWTP	Wastewater Treatment Plant

APPENDIX 2

APPENDIX 3

Table 1: Existing Condition *E. coli* Loads within Stony Creek Subwatersheds

Source Category	CR 650 W	CR 825 W	CR 925 W	SR 132/13	CR 1000 W	Cyntheanne Rd	70-0026	Wm Lock E206th/ Durbin Rd	Wm Lock Ditch @ E196th
Manure Application	6.16E+10	1.47E+11	5.05E+11	3.20E+11	6.30E+11	5.11E+11	5.20E+11	3.15E+11	2.49E+11
Active CAFOs	0	0	1.57E+11	0	0	0	0	4.51E+10	0
Domestic Animals	1.40E+09	1.60E+09	1.83E+10	1.90E+11	5.42E+10	1.18E+10	7.69E+09	4.62E+09	3.50E+09
NPDES	0	0	0	2.25E+09	4.42E+07	0	1.22E+07	0	0
Non-CAFO Livestock	6.41E+09	1.25E+10	4.07E+10	2.58E+10	3.44E+10	4.07E+10	2.68E+10	7.80E+09	1.08E+10
Failing Septic	5.70E+09	7.35E+09	3.04E+10	9.33E+10	4.77E+10	4.11E+10	3.48E+10	2.06E+10	1.56E+10
CSOs	0	0	0	0	0	0	0	0	0
Wildlife	5.24E+09	1.26E+10	4.38E+10	8.50E+10	6.11E+10	5.64E+10	4.72E+10	2.80E+10	2.15E+10
Upstream Load	0	4.58E+09	1.60E+10	1.29E+11	1.67E+11	8.81E+10	4.13E+10	0	3.45E+10
Subwatershed Sum	8.04E+10	1.81E+11	7.96E+11	7.16E+11	8.28E+11	6.61E+11	6.36E+11	4.21E+11	3.01E+11
Cumulative Sum	8.04E+10	1.86E+11	8.12E+11	8.46E+11	9.95E+11	7.49E+11	6.78E+11	4.21E+11	3.35E+11

Source Category	E 196th St	Wm Lehr Ditch @ 166th	Wm Lehr @ Private Dr /SR 38	SR 38	Union Chapel Rd	Cumberland Rd Gage	North Trib @ 166th Noblesville	Allisonville Rd.
Manure Application	3.35E+11	7.21E+11	8.22E+11	5.41E+10	1.46E+11	1.50E+11	5.33E+10	4.45E+10
Active CAFOs	0	0	0	0	0	0	0	0
Domestic Animals	5.28E+09	1.18E+10	5.01E+10	5.72E+09	1.01E+10	2.54E+09	2.01E+10	9.42E+09
NPDES	0	0	0	0	0	0	2.66E+05	0
Non-CAFO Livestock	2.23E+10	5.19E+10	7.91E+10	9.35E+09	1.28E+10	1.36E+10	2.92E+09	4.87E+09
Failing Septic	2.40E+10	7.71E+10	5.72E+10	1.28E+10	1.51E+10	1.06E+11	1.19E+10	3.02E+10
CSOs	0	0	0	0	0	0	1.35E+10	0
Wildlife	2.91E+10	6.55E+10	8.68E+10	4.91E+09	1.27E+10	1.33E+10	6.34E+09	5.38E+09
Upstream Load	1.41E+11	0	1.35E+11	3.78E+11	2.97E+10	2.13E+10	0	1.71E+10
Subwatershed Sum	4.15E+11	9.27E+11	1.09E+12	8.69E+10	1.96E+11	2.86E+11	1.08E+11	9.44E+10
Cumulative Sum	5.57E+11	9.27E+11	1.23E+12	4.65E+11	2.26E+11	3.07E+11	1.08E+11	1.11E+11

Table 2: Percentages of Existing Condition Loads within Stony Creek Subwatersheds

Source Category	CR 650 W	CR 825 W	CR 925 W	SR 132/13	CR 1000 W	Cyntheanne Rd	70-0026	Wm Lock E206th/ Durbin Rd	Wm Lock Ditch @ E196th
Manure Application	76.7%	79.2%	62.3%	37.9%	63.3%	68.2%	76.7%	74.8%	74.4%
Active CAFOs	-----	-----	19.3%	-----	-----	-----	-----	10.7%	-----
Domestic Animals	1.7%	0.9%	2.3%	22.4%	5.5%	1.6%	1.1%	1.1%	1.0%
NPDES	-----	-----	-----	0.3%	0.0%	-----	0.0%	-----	-----
Non-CAFO Livestock	8.0%	6.7%	5.0%	3.1%	3.5%	5.4%	4.0%	1.9%	3.2%
Failing Septic	7.1%	3.9%	3.7%	11.0%	4.8%	5.5%	5.1%	4.9%	4.7%
CSOs	-----	-----	-----	-----	-----	-----	-----	-----	-----
Wildlife	6.5%	6.8%	5.4%	10.1%	6.1%	7.5%	7.0%	6.7%	6.4%
Upstream Load	-----	2.5%	2.0%	15.3%	16.8%	11.8%	6.1%	-----	10.3%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

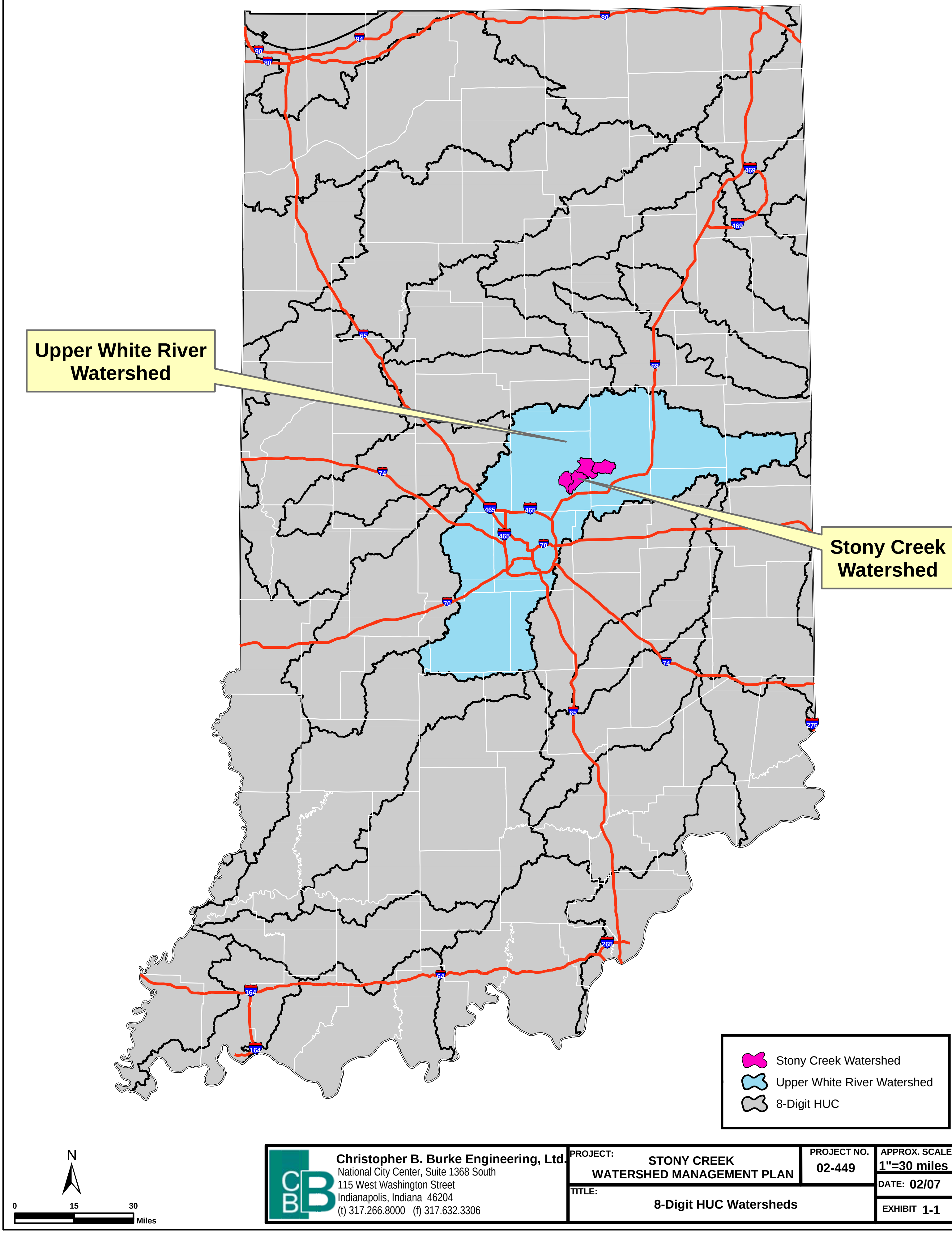
Source Category	E 196th St	Wm Lehr Ditch @ 166th	Wm Lehr @ Private Dr /SR 38	SR 38	Union Chapel Rd	Cumberland Rd Gage	North Trib @ 166th Noblesville	Allisonville Rd.
Manure Application	60.1%	77.8%	66.8%	11.6%	64.4%	49.0%	49.3%	39.9%
Active CAFOs	-----	-----	-----	-----	-----	-----	-----	-----
Domestic Animals	0.9%	1.3%	4.1%	1.2%	4.5%	0.8%	18.6%	8.5%
NPDES	-----	-----	-----	-----	-----	-----	0.0%	-----
Non-CAFO Livestock	4.0%	5.6%	6.4%	2.0%	5.7%	4.4%	2.7%	4.4%
Failing Septic	4.3%	8.3%	4.6%	2.8%	6.7%	34.5%	11.0%	27.1%
CSOs	-----	-----	-----	-----	-----	-----	12.5%	-----
Wildlife	5.2%	7.1%	7.1%	1.1%	5.6%	4.3%	5.9%	4.8%
Upstream Load	25.4%	-----	11.0%	81.3%	13.1%	6.9%	-----	15.3%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3: Percent TMDL Load Reductions Applied to Source Categories within Each Stony Creek Subwatershed

Source Category	CR 650 W	CR 825 W	CR 925 W	SR 132/13	CR 1000 W	Cyntheanne Rd	70-0026	Wm Lock E206th/ Durbin Rd	Wm Lock Ditch @ E196th
Manure Application	**75%**	**89%**	**99%**	**93%**	**92%**	**92%**	**86%**	**95%**	**87%**
Active CAFOs	-------	-------	**60%**	-------	-------	-------	-------	**60%**	-------
Domestic Animals	**60%**	**70%**	**99%**	**90%**	**91%**	**70%**	**80%**	**95%**	**70%**
NPDES	-------	-------	-------	0%	0%	-------	0%	-------	-------
Non-CAFO Livestock	**75%**	**89%**	**99%**	**93%**	**92%**	**92%**	**86%**	**95%**	**87%**
Failing Septic	**60%**	**70%**	**99%**	**91%**	**91%**	**75%**	**80%**	**95%**	**70%**
CSOs	-------	-------	-------	-------	-------	-------	-------	-------	-------
Wildlife	**60%**	**70%**	**99%**	**90%**	**91%**	**70%**	**80%**	**95%**	**70%**

Source Category	E 196th St	Wm Lehr Ditch @ 166th	Wm Lehr @ Private Dr /SR 38	SR 38	Union Chapel Rd	Cumberland Rd Gage	North Trib @ 166th Noblesville	Allisonville Rd.
Manure Application	**91%**	**92%**	**93%**	**95%**	**95%**	**86%**	**82%**	**85%**
Active CAFOs	-------	-------	-------	-------	-------	-------	-------	-------
Domestic Animals	**82%**	**80%**	**80%**	**80%**	**87%**	**75%**	**80%**	**60%**
NPDES	-------	-------	-------	-------	-------	-------	0%	-------
Non-CAFO Livestock	**91%**	**92%**	**93%**	**95%**	**95%**	**86%**	**82%**	**85%**
Failing Septic	**85%**	**80%**	**85%**	**85%**	**87%**	**75%**	**80%**	**70%**
CSOs	-------	-------	-------	-------	-------	-------	**50%**	-------
Wildlife	**82%**	**80%**	**80%**	**80%**	**87%**	**75%**	**80%**	**60%**

APPENDIX 4



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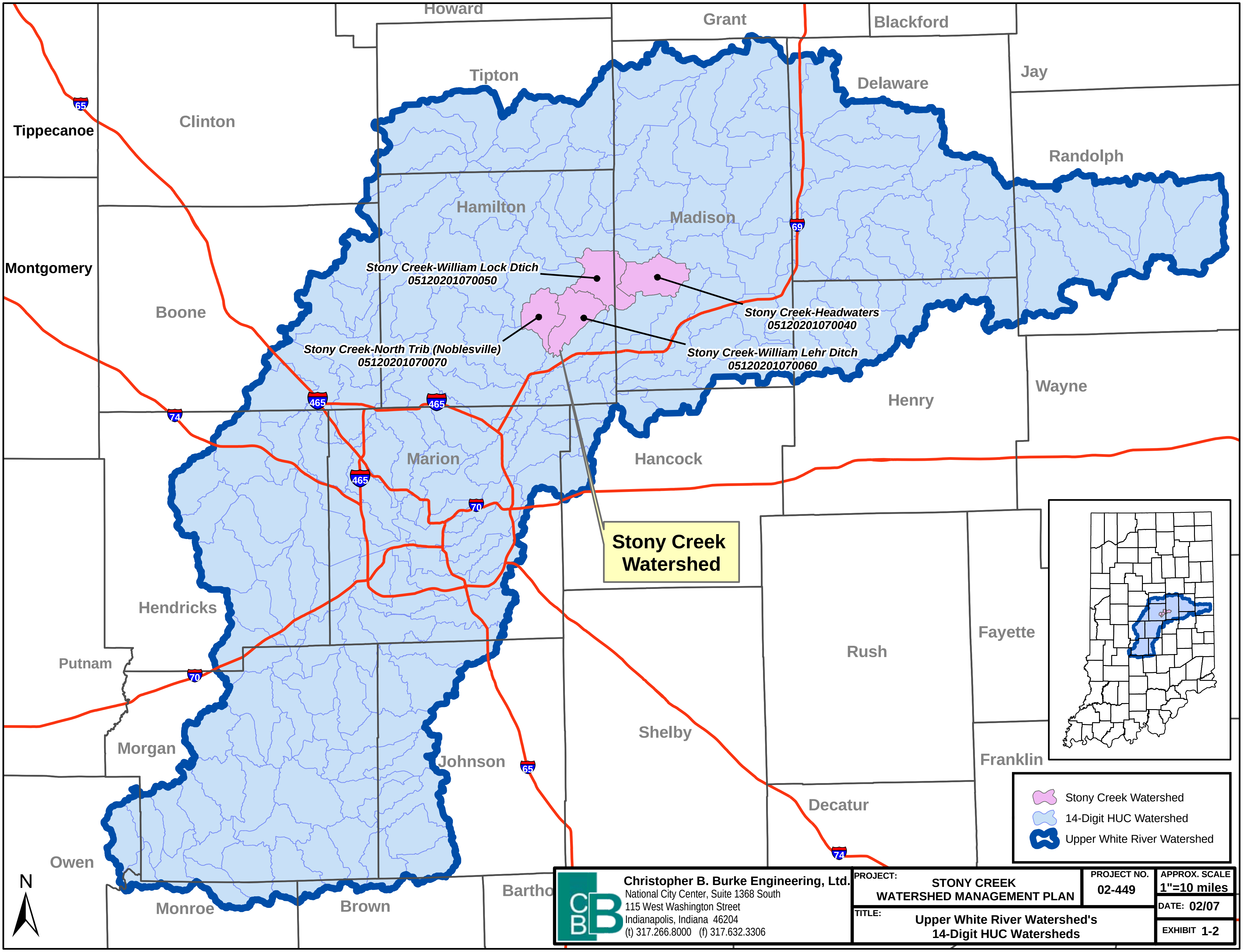
PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN	PROJECT NO. 02-449	APPROX. SCALE 1"=30 miles	
TITLE: 8-Digit HUC Watersheds		DATE: 02/07	EXHIBIT 1-1


Howard
Grant
Blackford
Tipton
Delaware
Jay
Tippecanoe
Clinton
Randolph
Hamilton
Madison
Montgomery
Boone
Stony Creek-William Lock Dtich
05120201070050
Stony Creek-Headwaters
05120201070040
Stony Creek-North Trib (Noblesville)
05120201070070
Stony Creek-William Lehr Ditch
05120201070060
Wayne
Henry
Marion
Hancock
Stony Creek Watershed
Hendricks
Putnam
Fayette
Rush
Shelby
Morgan
Johnson
Franklin
Decatur
Owen
Monroe
Brown
Bartho
N
65
74
465
70
69
Stony Creek Watershed
14-Digit HUC Watershed
Upper White River Watershed
Christopher B. Burke Engineering, Ltd.
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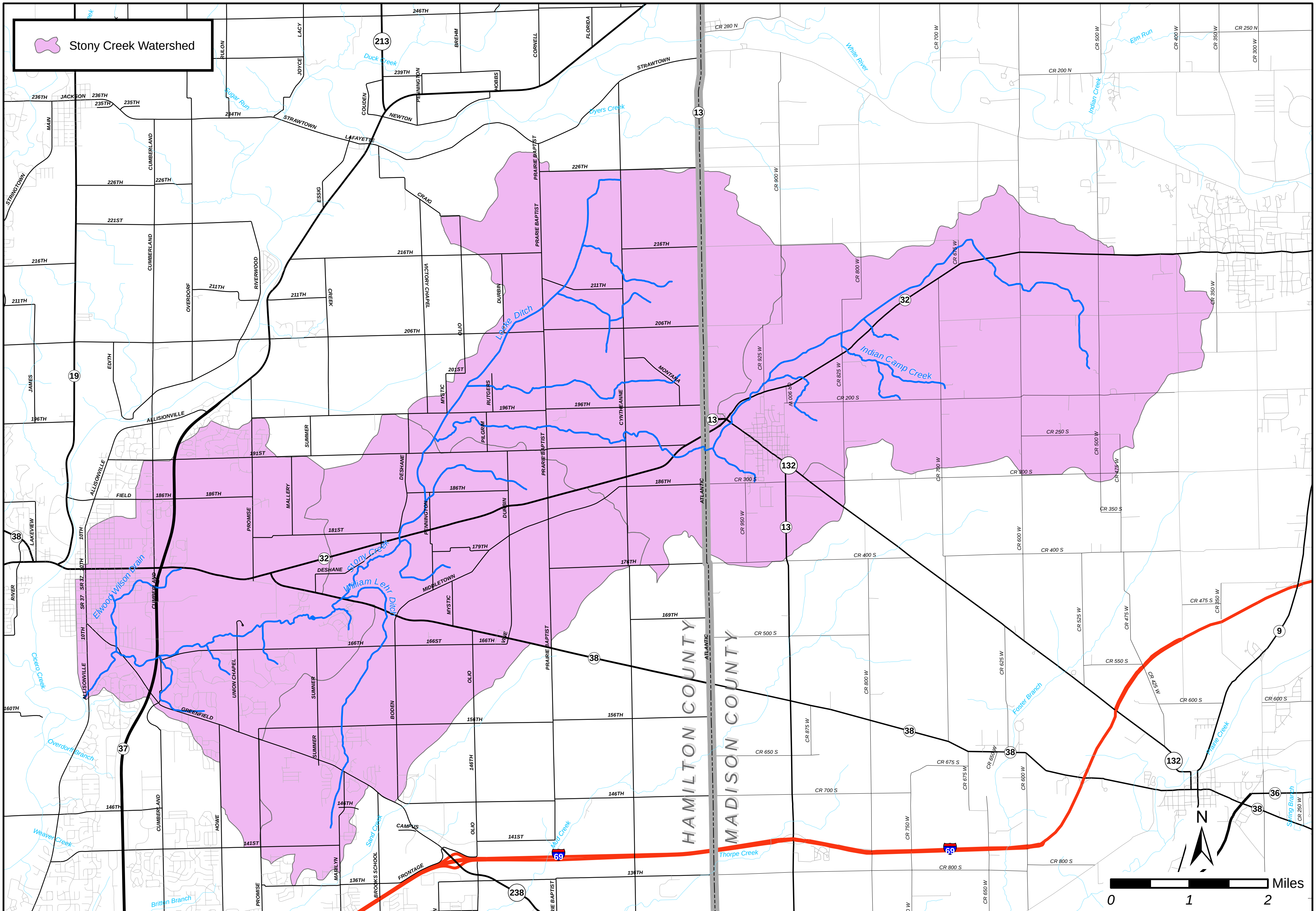
PROJECT:
STONY CREEK
WATERSHED MANAGEMENT PLAN
PROJECT NO.
02-449
APPROX. SCALE
1"=10 miles
DATE: 02/07
TITLE:
Upper White River Watershed's
14-Digit HUC Watersheds
EXHIBIT 1-2



Sources of Data:

1. *Hamilton County Roads: Hamilton County GIS, 2006*
2. *Madison County Roads: US Bureau of the Census TIGER files, 2005*
3. *Streams: National Hydrography Dataset, 2006*
4. *Watershed Boundary: United States Geological Survey, 2004*

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PROJECT: **STONY CREEK WATERSHED MANAGEMENT PLAN**

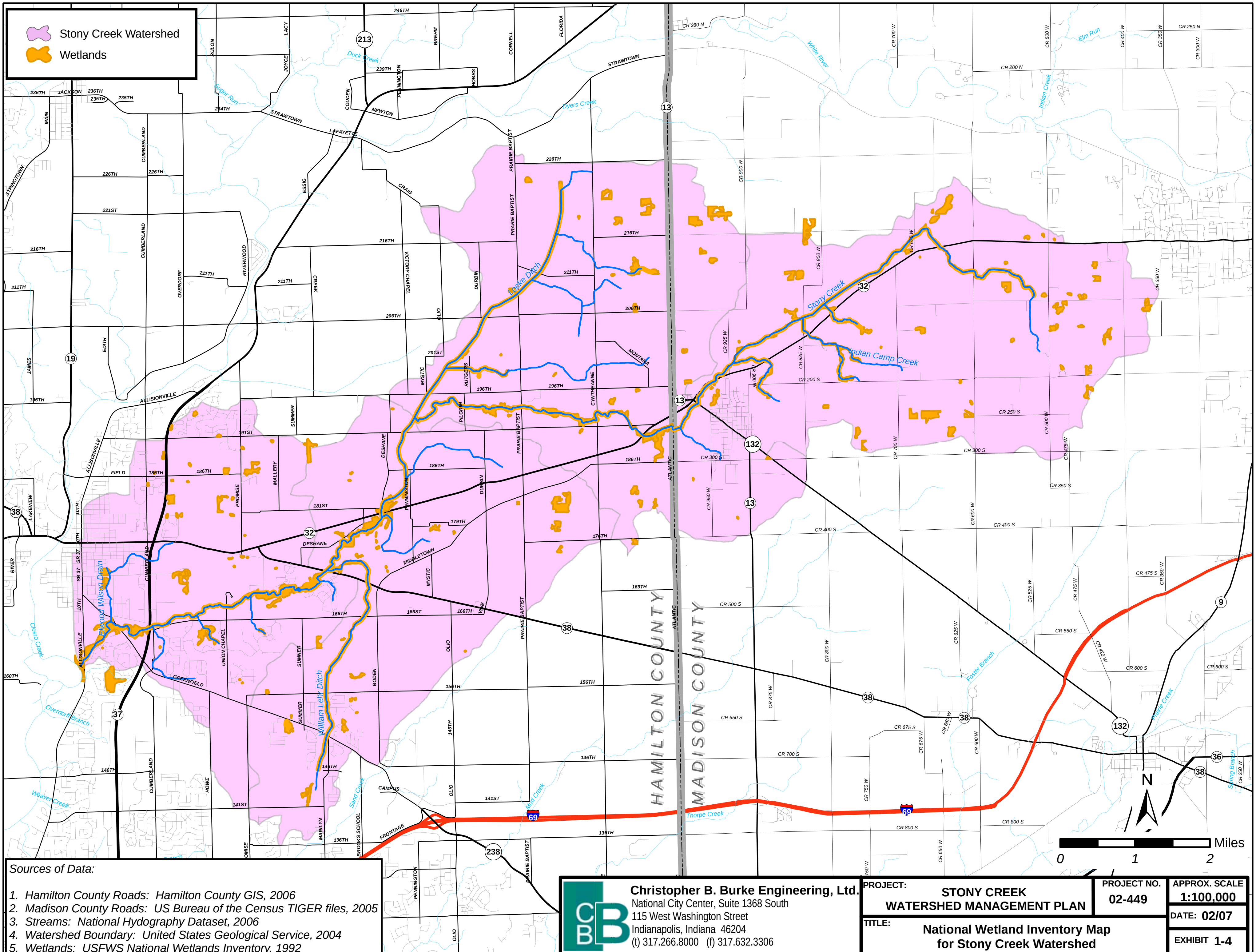
PROJECT NO. **02-449**

APPROX. SCALE **1:100,000**

DATE: **02/07**

TITLE: **Major Streams and Drainage Ditches in the Stony Creek Watershed**

EXHIBIT **1-3**



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004
5. Wetlands: USFWS National Wetlands Inventory, 1992

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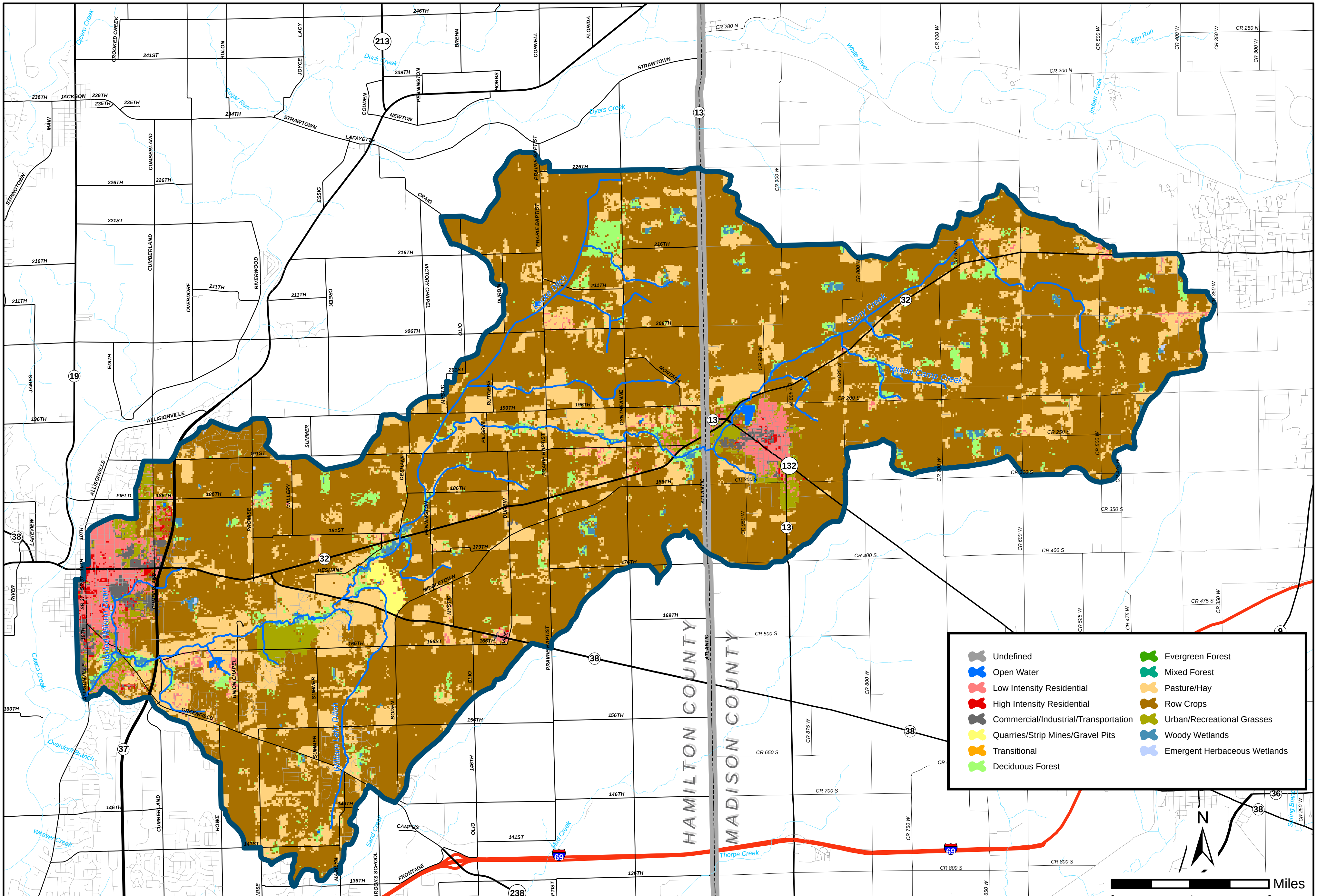
PROJECT:	PROJECT NO.	APPROX. SCALE
STONY CREEK WATERSHED MANAGEMENT PLAN	02-449	1:100,000
		DATE: 02/07
TITLE: National Wetland Inventory Map for Stony Creek Watershed		EXHIBIT 1-4



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004
5. Land Use: USGS National Land Cover Data Set, 1993

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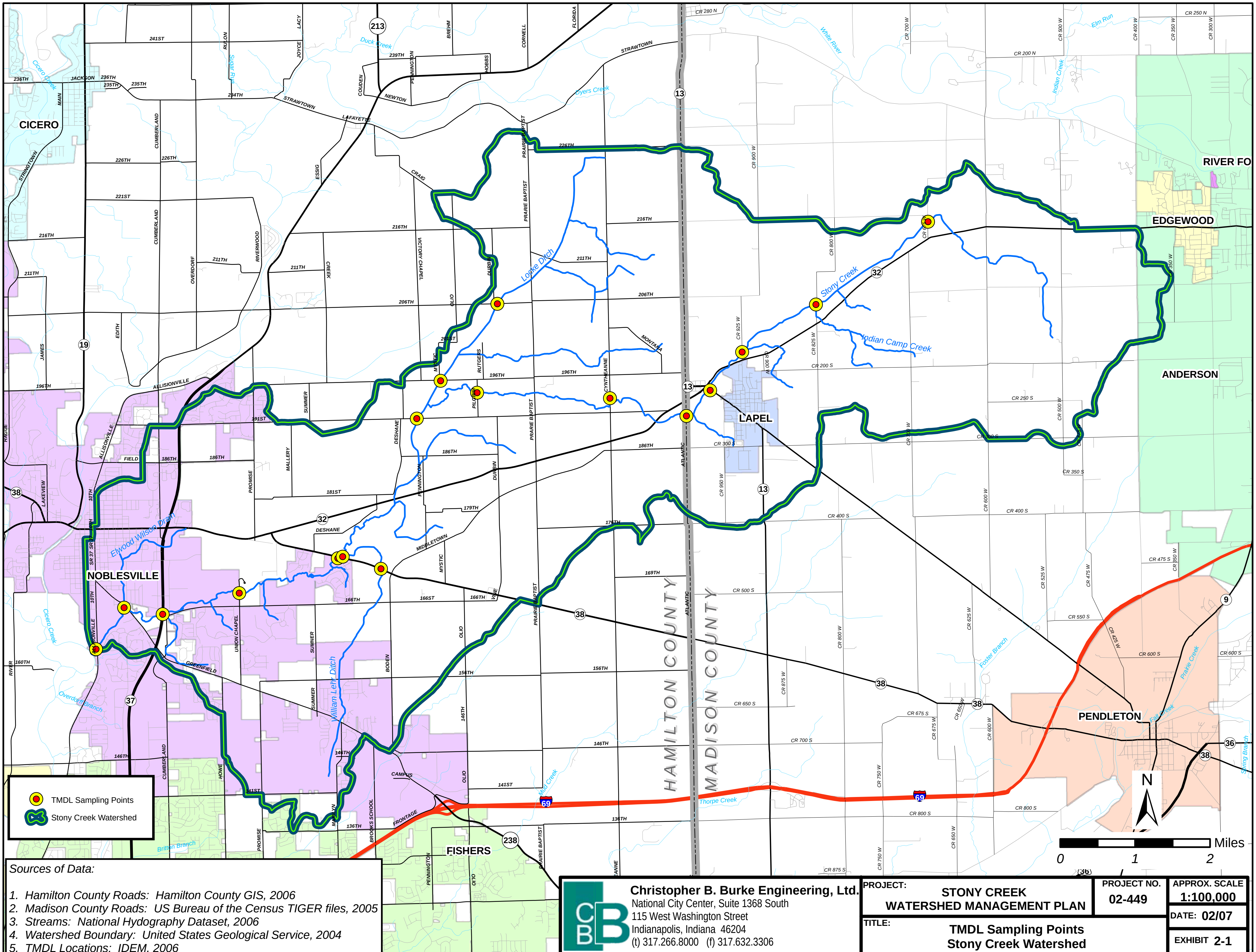
PROJECT:	STONY CREEK WATERSHED MANAGEMENT PLAN	PROJECT NO. 02-449	APPROX. SCALE 1:100,000
TITLE:	Land Use in the Stony Creek Watershed		DATE: 02/07
			EXHIBIT 1-5


CICERO
NOBLESVILLE
FISHERS
LAPEL
EDGEWOOD
RIVER FO
ANDERSON
PENDLETON
HAMILTON COUNTY
MADISON COUNTY
Stony Creek
Indian Camp Creek
Locke Ditch
Elwood Wilson Drain
William Lehr Ditch
Cicero Creek
Duck Creek
Dyers Creek
White River
Indian Creek
Elm Run
Overdorf Branch
Britton Branch
Mud Creek
Thorpe Creek
Foster Branch
Prairie Creek
Fall Creek
Spring Branch
TMDL Sampling Points
Stony Creek Watershed
N
0
1
2
Miles
Sources of Data:
1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004
5. TMDL Locations: IDEM, 2006
CBB
Christopher B. Burke Engineering, Ltd.
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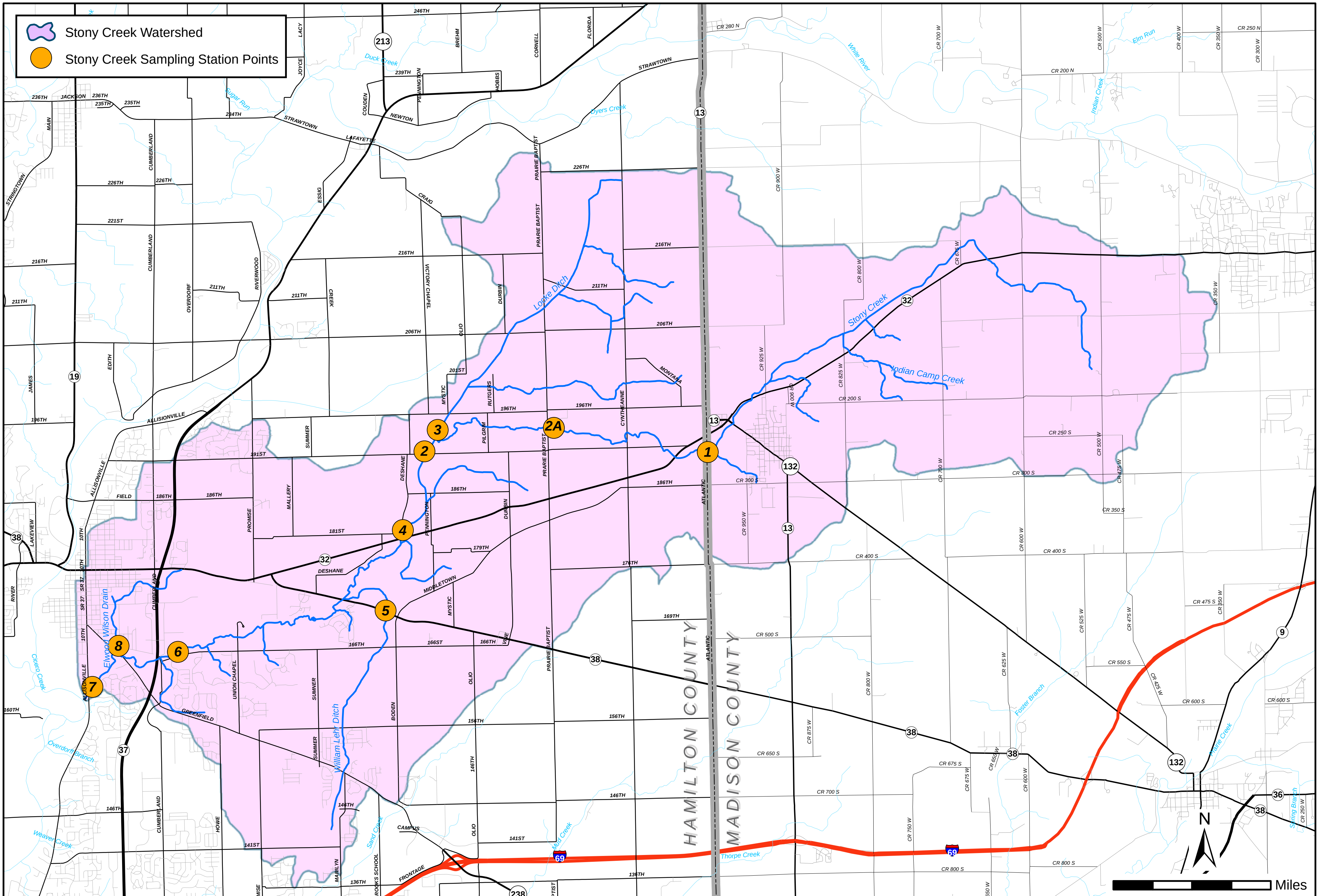
Indianapolis, Indiana 46204
(t) 317.266.8000 (f) 317.632.3306
PROJECT:
STONY CREEK
WATERSHED MANAGEMENT PLAN
PROJECT NO.
02-449
APPROX. SCALE
1:100,000
DATE: 02/07
TITLE:
TMDL Sampling Points
Stony Creek Watershed
EXHIBIT 2-1



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004

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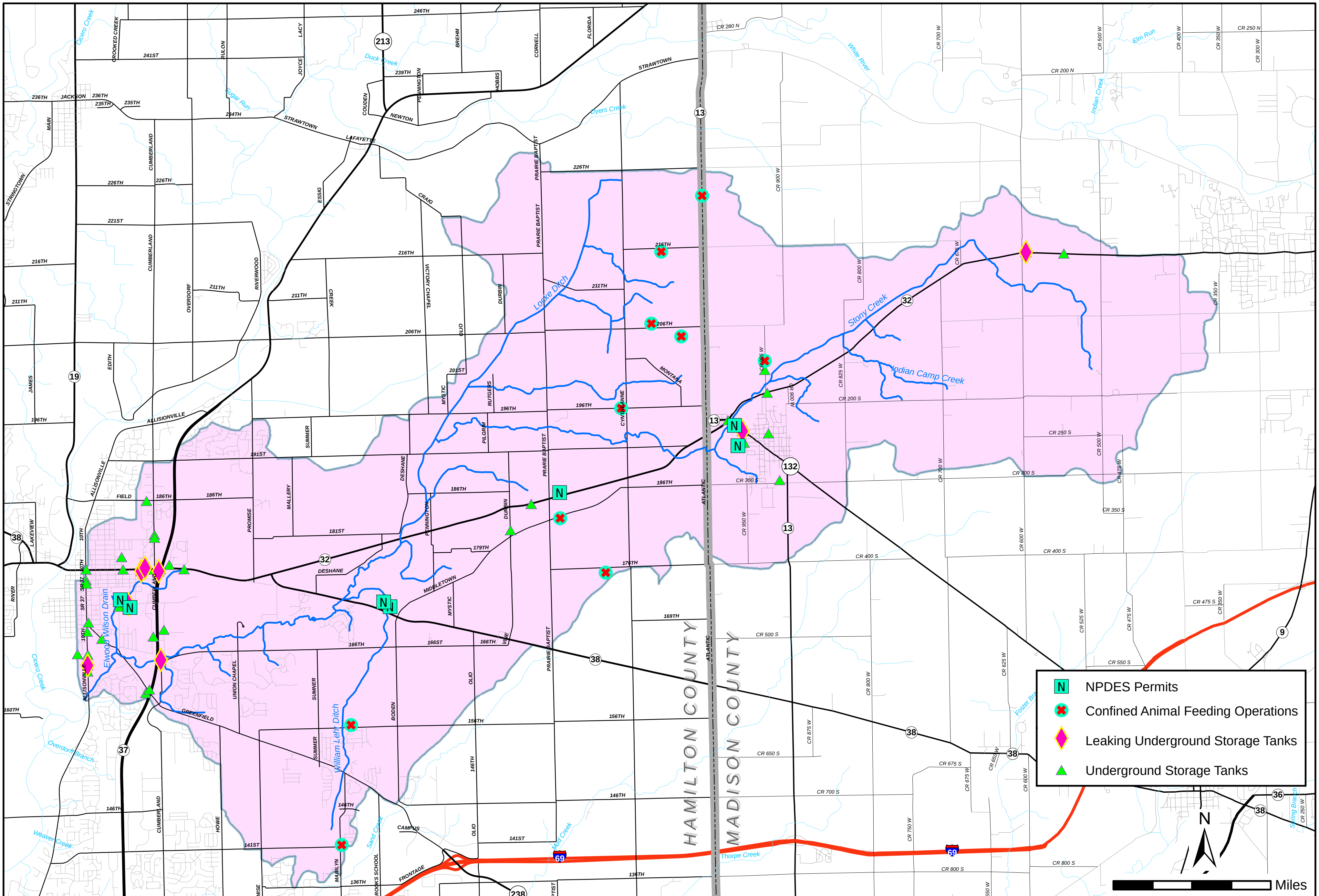
PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN	PROJECT NO. 02-449	APPROX. SCALE 1:100,000
TITLE: Sampling Sites in the Stony Creek Watershed		DATE: 02/07
		EXHIBIT 2-2



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004
5. Land Use: USGS National Land Cover Data Set, 1993

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PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN

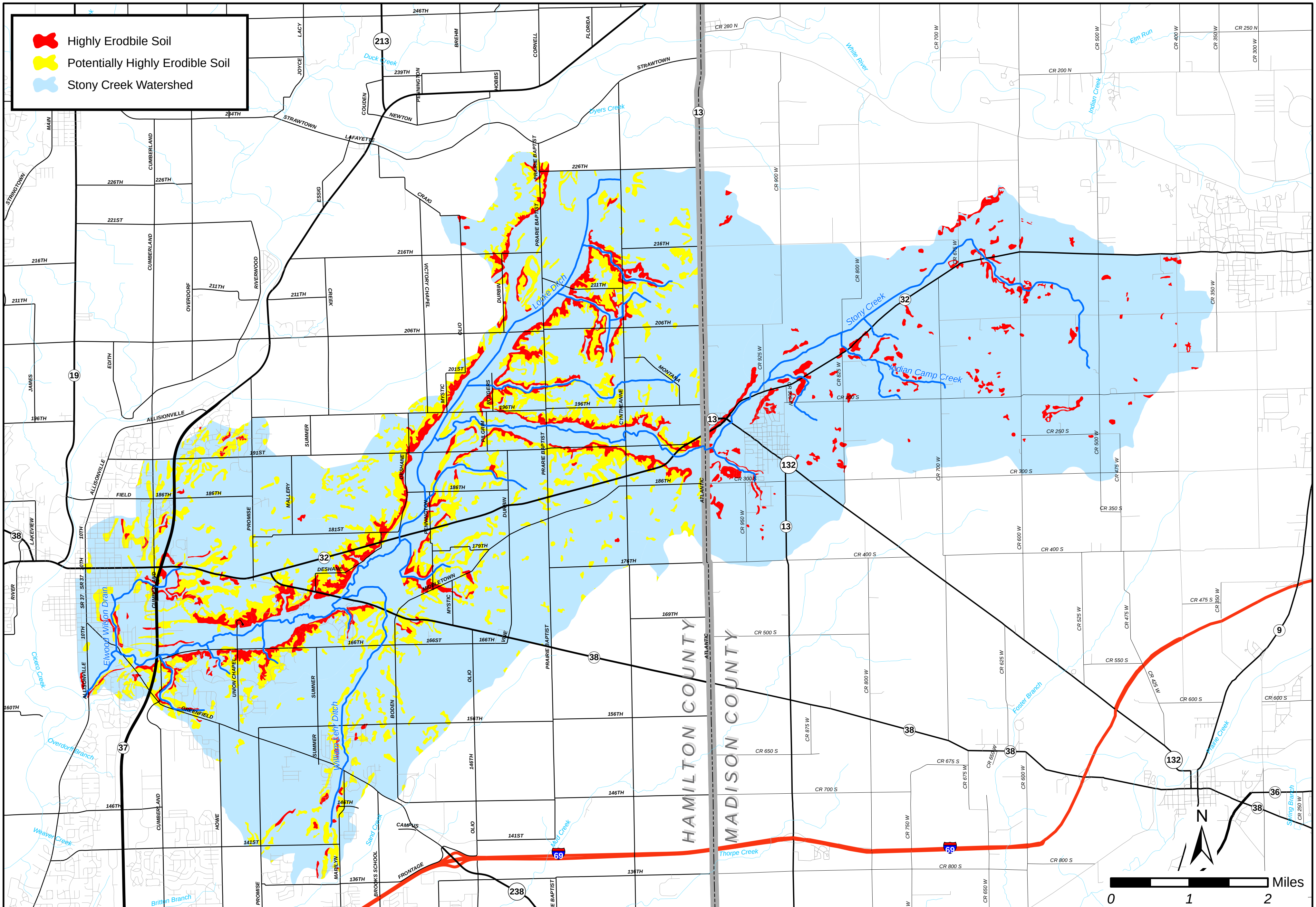
PROJECT NO. 02-449

APPROX. SCALE 1:100,000

DATE: 02/07

TITLE: Potential Sources of Pollution in the Stony Creek Watershed

EXHIBIT 3-1



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004
5. Soils: Madison County and Hamilton County Farm Service Agencies, 2006

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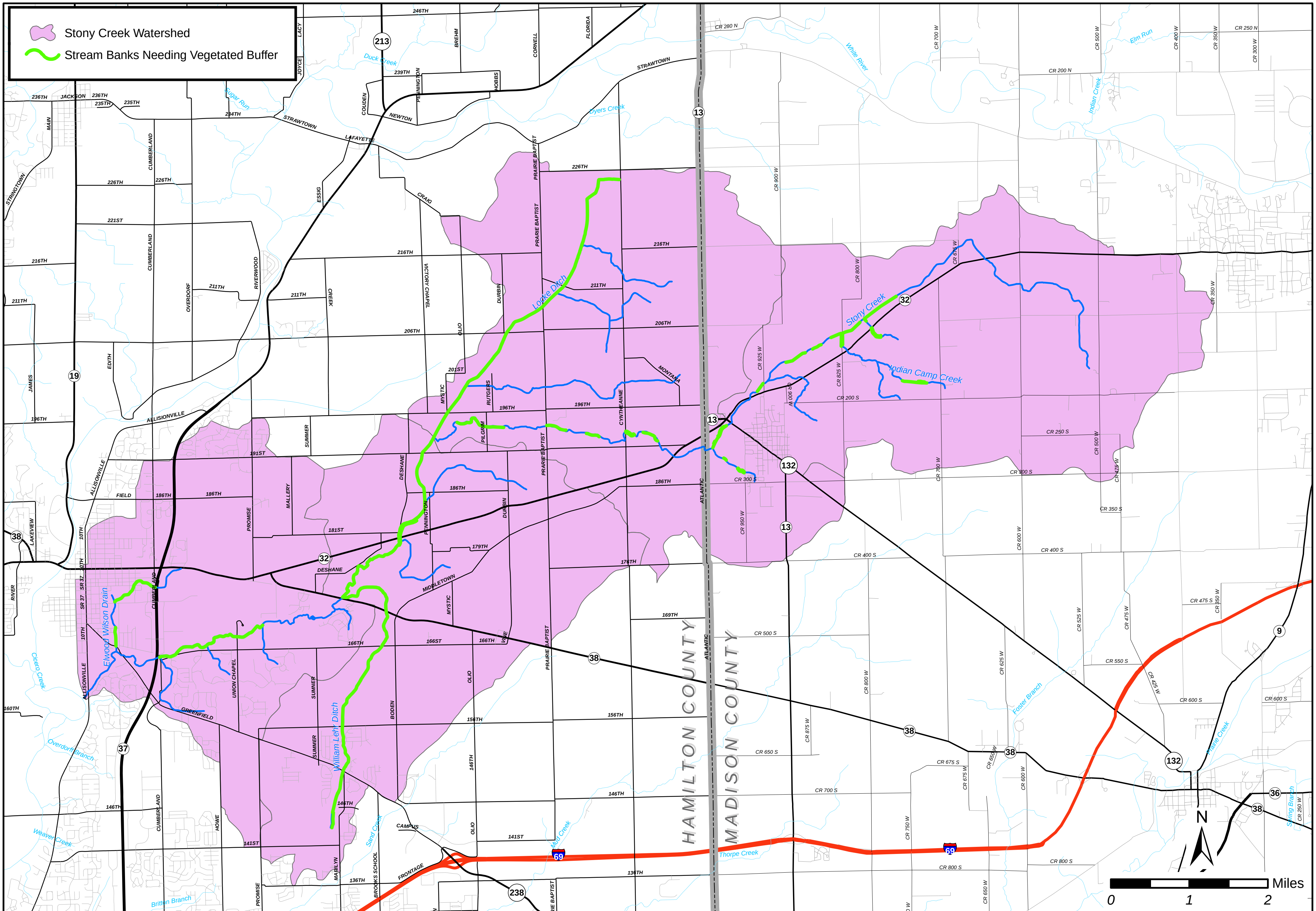
PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN	PROJECT NO. 02-449	APPROX. SCALE 1:100,000
TITLE: Highly Erodible Lands in the Stony Creek Watershed		DATE: 02/07
		EXHIBIT 3-2



Sources of Data:

1. *Hamilton County Roads: Hamilton County GIS, 2006*
2. *Madison County Roads: US Bureau of the Census TIGER files, 2005*
3. *Streams: National Hydrography Dataset, 2006*
4. *Watershed Boundary: United States Geological Survey, 2004*

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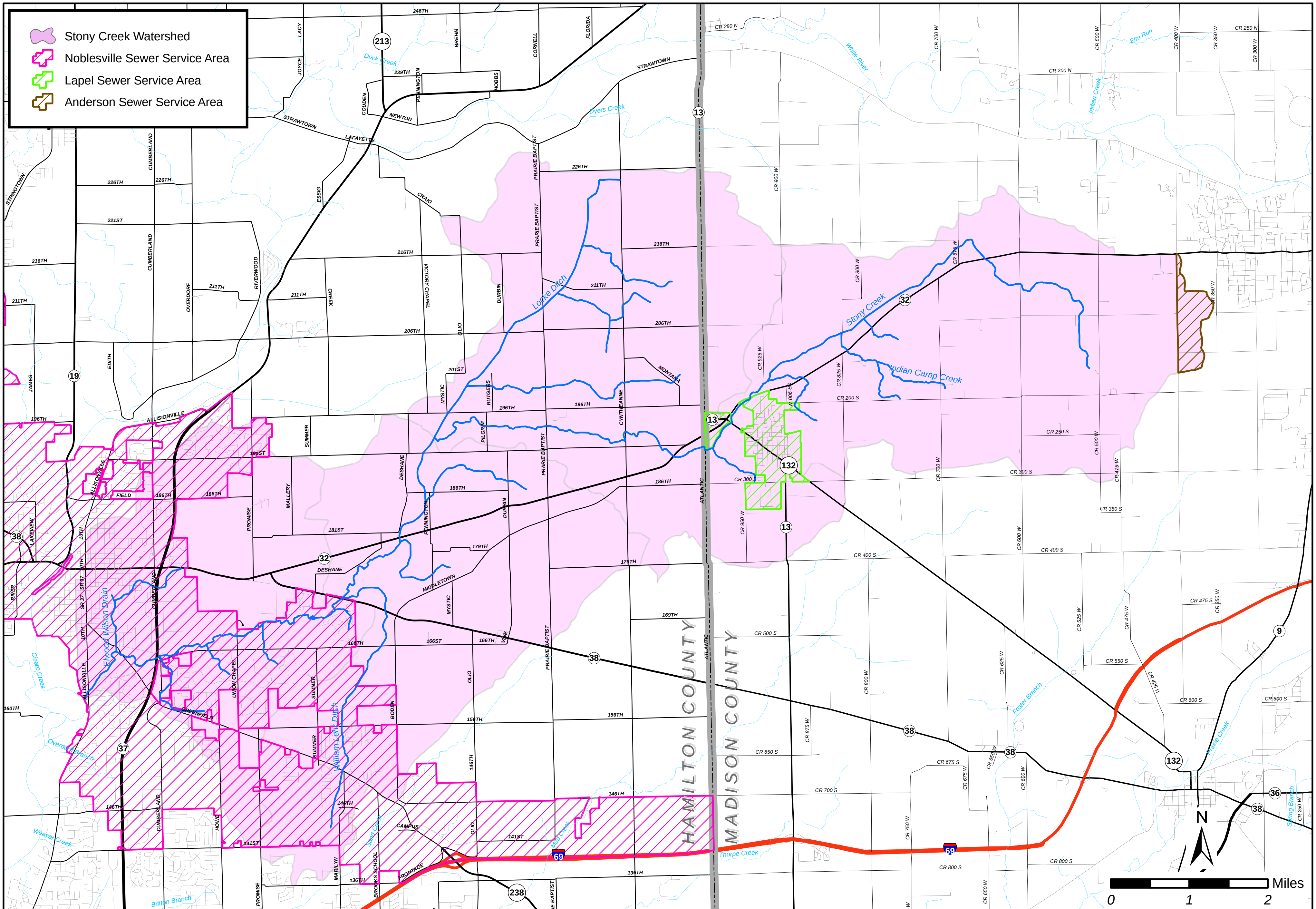
PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN	PROJECT NO. 02-449	APPROX. SCALE 1:100,000	DATE: 02/07
TITLE: Areas in Need of Buffers/Filter Strips in the Stony Creek Watershed		EXHIBIT 3-3	



Sources of Data:

1. Hamilton County Roads: Hamilton County GIS, 2006
2. Madison County Roads: US Bureau of the Census TIGER files, 2005
3. Streams: National Hydrography Dataset, 2006
4. Watershed Boundary: United States Geological Service, 2004

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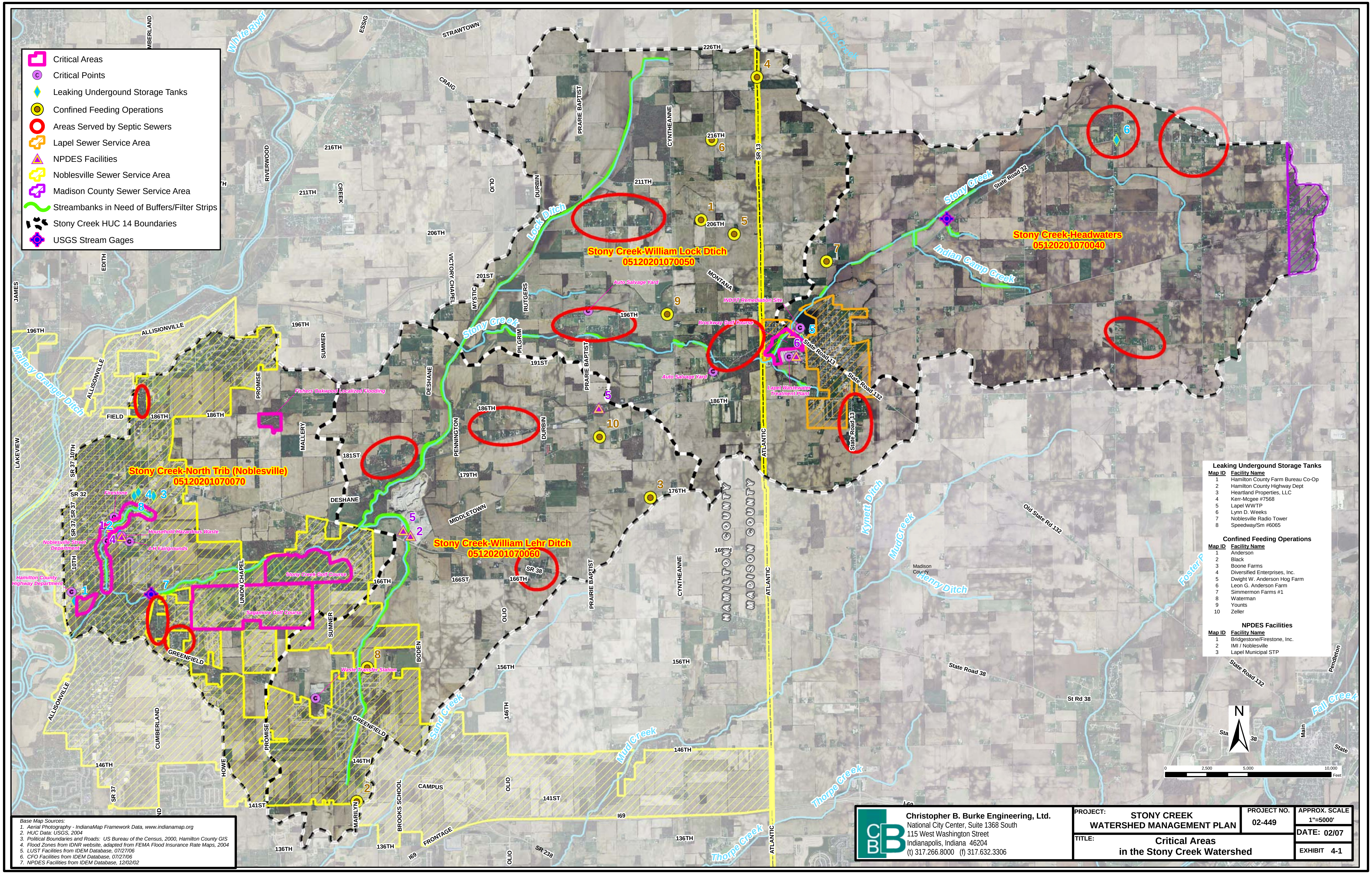
PROJECT:	STONY CREEK WATERSHED MANAGEMENT PLAN
PROJECT NO.	02-449
APPROX. SCALE	1:100,000
DATE:	02/07
TITLE:	Municipal Sewer Service Areas in the Stony Creek Watershed
EXHIBIT	3-5



Critical Areas
Critical Points
Leaking Undergound Storage Tanks
Confined Feeding Operations
Areas Served by Septic Sewers
Lapel Sewer Service Area
NPDES Facilities
Noblesville Sewer Service Area
Madison County Sewer Service Area
Streambanks in Need of Buffers/Filter Strips
Stony Creek HUC 14 Boundaries
USGS Stream Gages
Stony Creek-William Lock Dtich
05120201070050
Stony Creek-Headwaters
05120201070040
Stony Creek-North Trib (Noblesville)
05120201070070
Stony Creek-William Lehr Ditch
05120201070060
Auto Salvage Yard
INDOT Remediation Site
Brockway Golf Course
Lapel Wastewater Treatment Plant
Fishers Oakwood Localized Flooding
Firestone
Household Hazardous Waste
4-H Fairgrounds
Noblesville Street Department
Hamilton County Highway Department
Stony Creek Golf Course
Sagamore Golf Course
Waste Transfer Station
HAMILTON COUNTY
MADISON COUNTY
White River
Stony Creek
Indian Camp Creek
Lock Ditch
Mallery Granger Ditch
Sand Creek
Mud Creek
Thorpe Creek
Kynett Ditch
Henry Ditch
Fall Creek
Leaking Undergound Storage Tanks
Map ID | Facility Name
1 Hamilton County Farm Bureau Co-Op
2 Hamilton County Highway Dept
3 Heartland Properties, LLC
4 Kerr-Mcgee #7568
5 Lapel WWTP
6 Lynn D. Weeks
7 Noblesville Radio Tower
8 Speedway/Sm #6065
Confined Feeding Operations
Map ID | Facility Name
1 Anderson
2 Black
3 Boone Farms
4 Diversified Enterprises, Inc.
5 Dwight W. Anderson Hog Farm
6 Leon G. Anderson Farm
7 Simmermon Farms #1
8 Waterman
9 Younts
10 Zeller
NPDES Facilities
Map ID | Facility Name
1 Bridgestone/Firestone, Inc.
2 IMI / Noblesville
3 Lapel Municipal STP
N
0 2,500 5,000 10,000 Feet
Base Map Sources:
1. Aerial Photography - IndianaMap Framework Data, www.indianamap.org
2. HUC Data: USGS, 2004
3. Political Boundaries and Roads: US Bureau of the Census, 2000, Hamilton County GIS
4. Flood Zones from IDNR website, adapted from FEMA Flood Insurance Rate Maps, 2004
5. LUST Facilities from IDEM Database, 07/27/06
6. CFO Facilities from IDEM Database, 07/27/06
7. NPDES Facilities from IDEM Database, 12/02/02
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(t) 317.266.8000 (f) 317.632.3306
PROJECT: STONY CREEK WATERSHED MANAGEMENT PLAN
PROJECT NO. 02-449
APPROX. SCALE 1"=5000'
DATE: 02/07
TITLE: Critical Areas in the Stony Creek Watershed
EXHIBIT 4-1

ACRONYMS

BMP	Best Management Practice
CBBEL	Christopher B. Burke Engineering, Ltd.
CFO	Confined Feeding Operation
CFU	Coliform Forming Unit
CSO	Combined Sewer Overflow
FCA	Fish Consumption Advisory
HEL	Highly Erodible Land
HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
ISDH	Indiana State Department of Health
MS4	Municipal Separate Storm Sewer Systems
NPS	Non Point Source (Pollution)
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWQI	National Water Quality Inventory
PCB	Poly-Chlorinated Biphenyls
QHEI	Qualitative Habitat Evaluation Index
USDA	United States Department of Agriculture
UWA	Unified Watershed Assessment
WMP	Watershed Management Plan
WQS	Water Quality Standards
WWTP	WasteWater Treatment Plant

Stony Creek Watershed Rural Survey

Question	Response
1. How would you best describe your situation?	• Livestock Producer • Row Crop Producer • Non-Ag Rural Resident • Hobby Farm • Other
2. What sub-watershed do you live in?	• Stony Creek - Headwaters • Stony Creek – William Lock Ditch • Stony Creek – William Lehr Ditch • Stony Creek – North Tributary • Do Not Know
3. Do you have a waterway (stream/ditch) on your property?	• Yes • No
4. If yes, have you installed buffer/filter strips?	• Yes • No
5. If you have not installed buffer/filter strips, what has prevented you from doing so?	• Cost of Installation • Inability to mow strip • Noxious Weeds • Other
6. Does your household wastewater drain to a septic tank?	• Yes • No • Do Not Know
7. If you do have a septic tank, have you had it pumped & inspected in the last 3 years?	• Yes • No • Do Not Know
8. If you have livestock, do they have direct access to waterways (stream/ditch)?	• Yes • No
9. The waterways (stream/ditches) in the Stony Creek Watershed are polluted?	• Agree • Agree Somewhat • Disagree
10. How concerned are you about the water quality in Stony Creek and the tributaries?	• Very Concerned • Somewhat Concerned • Not Concerned
11. The water quality of Stony Creek should be protected and enhanced	• Agree • Somewhat Agree • Disagree
12. Please rank the following **sources** of pollutants from 1-8 (1=greatest impact)	• Failing Septic Systems • Fertilizer/Chemical Application • Animal Waste (manure) • Littering/Dumping • Erosion • Flooding

Question	Response
	• Construction • Other
13. Please rank the following **pollutants** from 1-4 (1=greatest impact).	• Bacteria • Nutrients • Sediment • Toxins (Oil & Grease)
14. I am interested in learning more about the water quality of Stony Creek.	• Agree • Disagree

Stony Creek Watershed Urban Survey

Question	Response
1. In which Community do you live in?	• Noblesville • Lapel • Anderson • Unincorporated Hamilton County • Unincorporated Madison County • Other
2. What sub-watershed do you live in?	• Stony Creek - Headwaters • Stony Creek – William Lock Ditch • Stony Creek – William Lehr Ditch • Stony Creek – North Tributary • Do Not Know
3. How familiar are you with the stormwater drainage system for your area?	• Very Familiar • Somewhat Familiar • Not Familiar
4. Where does the stormwater in your area drain?	• Sewage treatment plant • Local water bodies • Other • Do Not Know
5. Do you apply fertilizer or chemicals to your lawn?	• Yes • No
6. If yes, do you have your soil tested prior to application?	• Yes • No
7. Does your household wastewater drain to a septic tank?	• Yes • No • Do Not Know
8. If you do have a septic tank, have you had it pumped & inspected in the last 3 years?	• Yes • No • Do Not Know
9. Does your household wastewater drain to a sanitary sewer?	• Yes • No • Do Not Know
10. The waterways (streams/ditches) in the Stony Creek watershed are polluted.	• Agree • Agree Somewhat • Disagree
11. How concerned are you about the water quality of Stony Creek and the tributaries?	• Very Concerned • Somewhat Concerned • Not Concerned
12. The water quality of Stony Creek should be protected and enhanced.	• Agree • Agree Somewhat • Disagree
13. Please rank the following **sources** of pollutants from 1-8 (1=greatest	• Failing Septic Systems • Fertilizer/Chemical Application

Question	Response
impact).	• Animal Waste (manure) • Littering/Dumping • Erosion • Flooding • Construction • Other
14. Please rank the following **pollutants** from 1-4 (1=greatest impact).	• Bacteria • Nutrients • Sediment • Toxins (Oil & Grease)
15. I am interested in learning more about the water quality of Stony Creek.	• Agree • Disagree