VFC Index - Watershed (Plan)

Program: Watershed

IDEM Document Type: Plan

Document Date: 2/9/2007

Security Group: Public

Project Name: Little Cicero Creek WMP

Plan Type: Watershed Management Plan

HUC Code: 05120201 Upper White

Sponsor: Hamilton County Surveyors

Contract #: 4-140

County: Hamilton

Cross Reference ID: 16183197

Comments: Tipton

Additional WMP Information

Checklist: 2003 Checklist

Grant type: 319

Fiscal Year: 2004

IDEM Approval Date: 2/9/2007

EPA Approval Date:

Project Manager: Sky Schelle

WATERSHED MANAGEMENT PLAN

LITTLE CICERO CREEK
HAMILTON COUNTY, INDIANA

February 1, 2007

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TABLE OF CONTENTS

FIGURES

TABLES

PLATES

1.0 INTRODUCTION

1.1 Mission Statement

The stakeholders of the Little Cicero Creek watershed will develop a management plan that promotes community partnerships, education, and scientific understanding of the watershed, and will develop strategies that restore, protect, and enhance the natural resources of Little Cicero Creek, its tributaries, and downstream.

1.2 Watershed Location

This watershed management plan (WMP) addresses water quality concerns facing the Little Cicero Creek watershed, which is located mainly in east central Hamilton County (27,710 acres) with a small portion in southern Tipton County (938 acres) (Figure 1). The towns of Sheridan, Atlanta, Arcadia, and Cicero roughly outline this area. The Little Cicero Creek watershed is divided into two 14-digit hydrologic unit codes, 05120201080090 (Little Cicero Creek-Bennett Ditch/Taylor Creek, 13,449 acres), and 05120201080080 (Little Cicero Creek-Teter Branch, 13,324 acres). The watershed contains six main streams; Symons Ditch, Jay Ditch, Ross Ditch, Bennett Ditch, Taylor Creek, and Little Cicero Creek. The headwaters of the watershed begin near the northeastern boundary of the town of Sheridan and generally flow eastward, eventually draining into Morse Reservoir. Morse Reservoir is a popular recreational lake and also a backup source of drinking water for the City of Indianapolis. This WMP documents the concerns watershed stakeholders have for the Little Cicero Creek waterbodies and describes the stakeholders' vision for these waterbodies. It also outlines the goals, strategies, and action items watershed stakeholders have selected to achieve this vision. The plan concludes with methods for measuring progress toward goals and objectives outlined throughout the plan and time frames for periodic refinement of the plan.

The Little Cicero Creek watershed is located in a primarily rural area of Hamilton County, which according to the U.S. Census Bureau, is one of the fastest growing Hoosier counties. The population of the county has increased by almost 58,000 people since the year 2000 census (US Census, 2006). The growth rate between the years 2000 and 2003 was 19 percent (HCA, 2006), and from the years 2000 to 2005, was 31.7 percent (US Census, 2006).

From July 1, 2004 to July 1, 2005, Hamilton County was the 51st fastest growing county in the nation (Les, 2006). Growth projections estimate that the population of Hamilton County will increase by 30 percent or more through the year 2020 (IBRC, 2003). Along with this intense population growth will be an increase in development. In the year 2005, Hamilton County granted 4,276 residential building permits, and throughout the state was second only to Marion County, which granted 4,618 permits (STATS Indiana, 2006).

The Hamilton County Drainage Board and Surveyor's Office is concerned both with the current water quality condition as well as with potential impacts to the water quality of Little Cicero Creek due to the high potential of development in this area of Hamilton County. The Surveyor's Office understands that a change in land use, especially from a field or forest to urban development, has potential for significant impact on water quality. Such development impacts the permeability of the soil by construction compaction and causes a dramatic increase in impervious coverage from the introduction of new rooftops, driveways, and parking areas. Along with the physical impacts there is also potential for an increase of biological and chemical waste from human use entering the watershed.

This WMP was developed through a local partnership spearheaded by the Hamilton County Surveyor's office to address the existing and future potential for water quality impacts within the Little Cicero Creek watershed. Through a competitive bidding process, the Hamilton County Drainage Board selected the team of JFNew, DJCase, and The Schneider Corporation to assist with plan development and public participation. This team will also be providing the county with recommendations for addressing remedial and proactive engineering and ecological approaches to the water quality impacts identified in the plan.

One of the objectives of this plan is to identify and analyze water quality concerns that currently exist or may occur as the watershed develops. Areas of concern will be documented throughout this process and included within the plan as the county develops their stormwater management plan required by Rule 13. Rule 13 refers to stormwater permits associated with water conveyance systems that are not combined with sewage conveyances. This can include conveyances such as roads with drains, streets, storm drains, piping, channels, ditches, etc. The majority of the watershed is currently undeveloped rural farmland, and the stormwater conveyance system consists primarily of earthen drainage ditches.

Information gathered during the water quality assessment task of the watershed management planning process will provide a strong indication of existing pre-developed stormwater quantity and quality conditions, as well as existing low-flow water quality concerns. The baseline conditions of the existing watershed will assist the county in identifying future water quality improvement projects that can be targeted throughout the watershed.

This document will serve as a master plan for water quality management (or WMP) for nonpoint source (NPS) pollution control and water quality improvement in the Little Cicero Creek watershed. Specific benefits of watershed management planning for Little Cicero Creek include:

- Eligibility for implementation funds;
- Addressing *E. coli* and other impairments;
- Protection of downstream water quality; and
- Preparation for MS4 (Municipal Separate Storm Sewer Systems) stormwater management planning.

1.3 Eligibility for Implementation Funds

This WMP will meet the eligibility requirements for implementation funding from either the Indiana Department of Environmental Management (IDEM) watershed management, or the Indiana Department of Natural Resources (IDNR) administered planning funds from the Lake and River Enhancement program (LARE), or the United States Department of Agriculture Farm Service Agency Farm Bill spending prioritization. These competitive grant programs offer funding for the design and construction of soil and water conservation projects in areas that have completed an approved WMP.

1.4 Addressing *E. coli* impairments

The Clean Water Act, specifically Section 303(d), requires states to identify lakes, streams and rivers that do not meet appropriate water quality standards. These waterbodies are referred to as "impaired" waterbodies and are placed on the state's 303(d) list of impaired waterbodies.

The water quality standard for *E. coli* is 235 CFU/100ml in a single grab sample with the standard for a geometric mean of several samples set somewhat lower. For purposes of comparison, levels of *E. coli* in Indiana streams typically ranged from 133 to 1,157 CFU/100ml with an average of 645 CFU/100ml in the IDEM data from years 1991-2002.

The waterbodies on the 303(d) list are ranked according to the severity of pollution and waterbody's corresponding designated use (e.g., recreation, drinking water, biota). The state's methodology for assessing Indiana's waterbodies is described in the latest version of Indiana's 303(d) Listing Methodology for Impaired Waterbodies and Total Maximum Daily Load for Listing Cycle 2004. The 2004 IDEM published list is the most recent list available for this study; however, there is a draft listing for 2006. This was published in the October 2005 Indiana Register and is still in the public comment period and is not yet finalized. Little Cicero Creek is listed in the 2004 Indiana 303(d) list because portions of this watershed do not meet state water quality standards. Specifically, portions of the watershed are listed for impaired biotic communities and for *E. coli* (fecal coliform contamination). This was confirmed in measurements taken by the IDEM prior to development of the 303(d) list published in the year 2004. The draft 2006 listing will remove Little Cicero Creek for impaired biotic communities due to changes in the IDEM's listing methodology, but the *E. coli* listing is slated to remain. In addition, Bennett Ditch and Taylor Creek are listed for *E. coli*. Watersheds that are listed on the 303(d) list are high priority for funding through state and federal funding sources, such as Section 319 program grants.

Historic information and the year 2005 water quality sampling are used in this report to: 1) create a snap shot of how much fecal coliform is in the stream; and, 2) predict which conservation practices may be necessary to improve coliform levels and biotic communities. Additional water quality analyses of Little Cicero Creek and other waterways in the Little Cicero Creek watershed are provided in Section 3.0 of this document.

1.5 Protection of Downstream Water Resources

Land and water management in the Little Cicero Creek watershed will not only benefit the tributaries and main stem of Little Cicero Creek, but also the water quality of Morse Reservoir. Currently, Morse Reservoir is listed on the Draft 2006 303(d) list for taste, odor, and algae. Morse Reservoir is operated and maintained as a drinking water resource and recreational facility by Veolia Water Company as part of the Regional Indianapolis Metro Water Treatment and Distribution System.

Morse Reservoir flows into the West Fork of the White River, which flows into the Wabash River, the Ohio River, the Mississippi, and finally into the Gulf of Mexico. Each individual watershed project contributes incrementally to downstream water quality, whether it is local biotic community restoration or reduction of the anoxic “dead zone” in the receiving waters along the Southern Gulf Coast of the United States.

1.6 Preparation for MS4 Stormwater Management Planning

The entire area of Hamilton County, excluding the towns of Atlanta and Sheridan, is considered a MS4 community. The term “MS4” stands for Municipal Separate Storm Sewer Systems, which are federally defined conveyance systems for storm runoff. These systems typically consist of curb and gutter systems, streets, ditches, and storm drains. Rainwater generally flows from city hardscape (paved or other impermeable surfaces) into these systems and is then transported untreated directly into streams, lakes, and rivers. As designated by Rule 13 (327IAC 15-13-3), an MS4 community is one that maintains a system described above and is: 1) located within an urbanized area identified as such on Census Bureau maps; 2) has a population greater than 10,000; 3) has a population greater than 7,000 and experienced a growth rate greater than 10 percent from years 1990 to 2000; or 4) has a daily population greater than 1,000 and is associated with any of the areas listed above. Hamilton County is listed as an urbanized area by the Census Bureau and maintains a municipal separate storm sewer system, and is therefore an MS4 entity.

1.7 Watershed Partnerships

To be effective, the preparation of any WMP should include full community participation. Support, direction, and insight from individuals, groups, and/or government agencies within the planning impact areas are essential for successful short-term and long-term watershed management planning and implementation. The Little Cicero Creek WMP encouraged and provided opportunity for full community participation.

The planning process included meetings of the Steering Committee, public meetings, and availability of draft documents for review. Notes from the meetings, Frequently Asked Questions (FAQs), contact information for the Steering Committee, and a project calendar were posted to the website (http://www.djcase.com/cicerocreek/faq.htm).

1.7.1 *Local and State Project Sponsors*

Hamilton County was the local sponsor for the WMP process, contributing 25 percent of the project's costs. The County Surveyor's Office participated as a representative of the County Drainage Board, providing project leadership and direction. The remaining 75 percent of the project's costs were funded through a grant from the U.S. Environmental Protection Agency (USEPA) administered by the IDEM Watershed Management Section. These federal funds are provided by Section 319 specifically for watershed management planning.

The Hamilton County Drainage Board, the Hamilton County Surveyor's Office, DJCase, The Schneider Corporation, and JFNew developed a list of key stakeholders for the planning area. These stakeholders included Beck's Hybrids, Inc., The Town of Cicero, Indiana Farm Bureau, The Town of Sheridan, Veolia Water Company, The Hamilton County Health Department, The Friends of the White River, The Hamilton County Planning Department, The Hamilton County Parks Department, The Center for Earth and Environmental Science, and The Hamilton County Soil and Water Conservation District (SWCD). To ensure representation of the agricultural community, the stakeholders list included several key individuals who own, operate, or manage agricultural land within the watershed. These identified water management planning stakeholders were personally invited to participate in the planning process as part of the steering committee. Steering committee meetings were held to discuss watershed management planning information collected throughout the process. Stakeholders were continually provided with various outreach materials for review, comment, and/or discussion. Outreach materials included meeting notes, FAQs, and stakeholder contact information, including the planning contractor's team. Project schedule and calendars were posted for readily available access on a dedicated internet website. The website was also utilized to link directly to other local, regional, and national related websites. The stakeholder participation provided a great deal of local insight into the process of Little Cicero Creek Watershed Planning.

1.7.2 *Public Participation*

The public was invited to participate in all aspects of this project from planning to implementation. Public involvement varied according to the intensity with which each individual stakeholder wished to participate. Levels of involvement in the project varied.

Participants could be involved as a member of the steering committee, a general stakeholder, and/or a reviewer of the WMP. Public meetings were scheduled through the steering committee and held throughout the plan development. Steering committee meetings were also open to the public. The meeting information and project updates were sent in the form of news releases to local newspapers. Meeting information was posted on the project website with links from the county's website. A draft plan was available for public review and comment during the last quarter of the project.

Public participation in the planning effort was further encouraged through a series of quarterly public meetings. Public meeting notices were published in the local paper prior to the meetings. Meeting announcements were sent to all individuals on the key stakeholder list, as well as those individuals who had attended previous project meetings. All meetings were held in readily accessible public spaces within the planning area. The first meeting was held at Red Bridge Park in Cicero on June 30, 2005, the second was held at the community center in Sheridan, on March 16, 2006, and the final public meeting occurred at Red Bridge Park in Cicero on October 11, 2006.

The goal of the first public meeting was to obtain input on the watershed, water quality, and land use concerns related to the WMP. Over the course of several months from August 2005 through May 2006, facilitators interviewed individuals in the area to further develop a sense of community objectives specific to Little Cicero Creek and its stakeholders. All stakeholders and the general public were invited and encouraged to attend public meetings. All eight steering committee meetings were also open to the public. A complete draft plan was distributed to the public for review and comment in late August, 2006. A final public meeting was held on October 11, 2006, to solicit comments on the draft and discuss implementation.

Attendance at the final public meeting was good, with approximately twenty stakeholders present. The goals of the WMP were presented and a question and answer session was held. Numerous stakeholders expressed an interest in forming a watershed group to work on implementation of the Little Cicero Creek WMP.

1.8 Concerns

The first round of meetings during the summer of 2005 documented the broad range of issues that affect each group individually (e.g., farmers, lake residents, drainage board, surveyor's office, SWCD) as they manage their land or are affected by land and water management decisions of others. During the public meetings, comments were recorded for use and development of short-term and long-term strategies, guided by community input. Numerous individuals discussed concerns, issues, and potential solutions through electronic mail, individual contact, and telephone conversations both before and after steering committee and public meetings.

Stakeholder concerns were recorded as members of the community identified them. They do not necessarily represent commonly held or mutually agreed upon beliefs or understandings and have not been verified through scientific or other examination, but reflect the initial values and concerns of various individuals as stakeholders in the early stages of this planning effort.

Facilitators asked for input from many perspectives, recognizing that there would be differences of opinion. By determining community perceptions of local issues, the planning process was able to represent a broad range of perspectives to develop a sound strategy for protecting water quality and healthy land use.

During these meetings and through direct contact with team facilitators, members of the public were able to voice their concerns and receive information on the progress and preliminary results of the planning process. These comments were documented and included for consideration throughout the planning process.

Members of the community voiced initial concerns about water quality and related conditions in Little Cicero Creek and its watershed in regard to a variety of issues. These issues are loosely categorized below. Neither the category nor the order is intended to confer any relative prioritization, and many of the issues are closely interrelated. The community prioritized the concerns later in the process.

1.8.1 *Plan Development, Education, and Outreach*

- Statements about watershed conditions must be backed by scientific data
- Water quality impacts must be prioritized
- Public must be educated about human impacts on water quality
- Water quality impact assessments and solutions must be equitable
- The roles of various stakeholders in the process must be recognized
- Conflicting interests in the watershed must be resolved or accommodated in the plan
- Need a set of guidelines for plan development
- Public needs to be educated about water quality issues

1.8.2 *Development and Land Use Planning*

- Planning must be done for the long term (10-30 years) to protect watershed and improve water quality
- Solutions must accommodate both the existing economic base (agriculture) and the developing economic base
- Planning must focus on preservation of established communities and growth of new communities
- Monitor growth according to its impact on water quality
- Integration of stormwater best management practices (BMPs) into development plans
- Preservation of green space
- Impact of zoning ordinances on water quality

1.8.3 *Agricultural Practices*

- Effect of ditch maintenance (dredging, bank cutting, removal of vegetation) on sediment load of waterways
- Manure management
- Use of conservation practices by agricultural producers (no-till, grassed waterways, filter strips)
- Proper application of pesticides and fertilizers
- Livestock impact on water quality
- Wildlife impact on bacteria levels in waterways
- Pinpoint areas of highly erodible land
- Locations and causes of bank erosion

- Ditch maintenance concerns must be balanced with water quality concerns

1.8.4 *Downstream Impacts*

- Nutrient and sediment load of watershed directly impacts water downstream (i.e. Morse Reservoir)
- Recreational use is restricted by bacteria
- Fecal coliform sources need to be pinpointed
- Little Cicero Watershed is only a small portion of the drainage into Morse Reservoir

1.8.5 *Additional Concerns*

After the first public meeting, the steering committee convened to review and prioritize the concerns voiced by the watershed stakeholders. An important element that the steering committee felt was lacking in the public discussion of water quality concerns was the use of agricultural chemicals, such as Atrazine, in the watershed.

Pesticide and herbicide use in agricultural areas has changed dramatically over the past decade with introduction of new or improved chemicals, genetically modified crops, and computerized mapping of weed infestations in fields. Herbicide use has dropped with less use of residual herbicides and genetic improvement of crops.

Modern chemicals are formulated to increase their effectiveness while reducing environmental impacts. All chemicals used on farms are regulated by the U.S. Environmental Protection Agency and must be applied according to rates and uses stipulated on the chemical label. Several chemicals that were used in the past to control pests and weeds are no longer used due to persistent toxicity.

Soybean growers and pesticide applicators will be looking for signs of soybean rust during the 2005 season and in future years. Indiana maps of Federally Endangered Species do not indicate any areas within the Little Cicero Creek watershed that support either federally listed bird or mussel species that could be negatively affected by improper use of soybean rust fungicides.

1.9 Vision for the Future

As the Little Cicero watershed stakeholders listed concerns regarding the current state of water quality in their watershed, they also described their vision for the streams and reservoir in the future. Several common themes began to surface during the public meetings. Nearly all stakeholders envisioned clean streams and lake that supported multiple uses. Stakeholders unanimously voiced support for a future in which the Morse Reservoir water was clean and safe for recreation and consumption. Stakeholders also envisioned a future where more individuals have a better understanding of actions they could take to protect water quality. The following vision statement was developed using stakeholder input:

The stakeholders of the Little Cicero Creek watershed envision a healthy and stable watershed system that supports species diversity, helps protect Morse Reservoir water quality, and improves the quality of life in the Little Cicero Creek watershed while maintaining the important social, economic, and recreational uses of the area.

This vision serves as the foundation of the Little Cicero Creek WMP. Watershed stakeholders selected and recorded in this document the goals and strategies that, over time, will enable them to make this vision a reality.

2.0 DESCRIPTION OF WATERSHED

2.1 Location

The Little Cicero Creek watershed encompasses approximately 27,710 acres in northern Hamilton and approximately 938 acres in southern Tipton County, Indiana (Figure 1). The watershed lies in the headwaters of the Upper White River Watershed (HUC 05120201) (Figure 2), and is comprised of two 14-digit watersheds; Little Cicero Creek-Bennett Ditch/Taylor Creek (HUC 05120201080090) and Little Cicero Creek-Teter Branch (HUC 05120201080080) (Figure 3). The Bennett Ditch/Taylor Creek drainage area covers approximately 13,327 acres or 48 percent of the Little Cicero Creek watershed, while the Teter Branch drainage covers approximately 14,383 acres or 52 percent of the Little Cicero Creek watershed. Table 1 (below) lists the specific townships, sections, and ranges that are located at least in part in the Little Cicero Creek watershed.

Table 1. Sections, Townships, and Ranges within the Little Cicero Creek Watershed

Hamilton County, Indiana										
Adams Township				***Jackson Township***				***Washington Township***		
Section	Township	Range		Section	Township	Range		Section	Township	Range
2	19 North	3 East		2	20 North	4 East		15	19 North	3 East
3	19 North	3 East		3	20 North	4 East		16	19 North	3 East
4	19 North	3 East		4	20 North	4 East				
9	19 North	3 East		5	20 North	4 East				
10	19 North	3 East		6	20 North	4 East				
11	19 North	3 East		7	20 North	4 East				
10	20 North	3 East		8	20 North	4 East				
11	20 North	3 East		9	20 North	4 East				
12	20 North	3 East		10	20 North	4 East				
13	20 North	3 East		11	20 North	4 East				
14	20 North	3 East		14	20 North	4 East				
15	20 North	3 East		15	20 North	4 East				
16	20 North	3 East		16	20 North	4 East				
20	20 North	3 East		17	20 North	4 East				
21	20 North	3 East		18	20 North	4 East				
22	20 North	3 East		19	20 North	4 East				
23	20 North	3 East		20	20 North	4 East				
24	20 North	3 East		21	20 North	4 East				

Table 1. Sections, Townships, and Ranges - Continued

Hamilton County, Indiana						
Adams Township				***Jackson Township***		
Section	Township	Range		Section	Township	Range
25	20 North	3 East		22	20 North	4 East
26	20 North	3 East		23	20 North	4 East
27	20 North	3 East		24	20 North	4 East
28	20 North	3 East		25	20 North	4 East
29	20 North	3 East		26	20 North	4 East
30	20 North	3 East		27	20 North	4 East
31	20 North	3 East		28	20 North	4 East
32	20 North	3 East		29	20 North	4 East
33	20 North	3 East		30	20 North	4 East
34	20 North	3 East		31	20 North	4 East
35	20 North	3 East		32	20 North	4 East
36	20 North	3 East		33	20 North	4 East
				35	20 North	4 East

Tipton County, Indiana						
Cicero Township				***Jefferson Township***		
Section	Township	Range		Section	Township	Range
31	21 North	4 East		28	21 North	4 East
				29	21 North	4 East
				32	21 North	4 East
				33	21 North	4 East
				34	21 North	4 East
				36	21 North	4 East

The Little Cicero Creek watershed supports two perennial streams (Symons Ditch and Taylor Creek), a number of intermittent streams (Jay Ditch, Ross Ditch, and Bennett Ditch), roadside ditches, and other minor waterways (Figure 3). These water courses carry overland flow into Little Cicero Creek, which empties into the northwestern corner of Morse Reservoir. Water leaves the reservoir through Cicero Creek, flows south into the West Fork of the White River, and combines with the Wabash River in southwestern Indiana. Water from the Little Cicero Creek watershed eventually reaches the Ohio River in southeastern Illinois before making its way to the Gulf of Mexico.

2.2 Physical Setting

2.2.1 *Geology*

Bedrock Geology

The bedrock geology of the Little Cicero Creek watershed is composed of rocks from the Silurian and Devonian time periods (Figure 4). The area is located in the northern portion of the Cincinnati arch, which is a “gentle upward warp in the earth’s crust”, composed primarily of Silurian and Devonian rocks that extends through Indiana from the southeast to the northwest (Camp and Richardson, 1999). The majority of the watershed overlies Silurian dolomites and limestones, which are composed of the Wabash and Pleasant Mills Formations, and the Salamonie Dolomite, Cataract Formation, and Brassfield Limestone. The Brassfield Limestone, which is typically less than ten feet thick, intertwines with dolostones and shales of the Cataract Formation (Shaver et al., 1986). The Salamonie Dolomite is a mostly pure dolostone that averages about 50 feet in thickness in the vicinity of the Little Cicero Creek watershed (Shaver et al., 1986).

Only a very small area near Sheridan in the extreme western tip of the watershed overlies Devonian bedrock. The Devonian bedrock formations are composed primarily of dolomitic carbonate rocks of the Muscatatuck Group. The Muscatatuck Group is thought to be 50 to 60 feet thick in the White River Basin.

A portion of the watershed overlies the western edge of what is known as the Trenton oil and gas field. This oil is derived from Ordovician dolomite that underlies Devonian bedrock. This is an area of about one million acres that traverses into Ohio. Peak production was reached in the year 1904. This remained a viable source of oil until approximately the year 1939 (Rupp, 1997). In addition, this area is a producer of natural gas; however, amounts are limited and therefore not economically viable. A few pockets of sand and gravel production are also located in the watershed, as well as pits that have produced peat and marl.

Surficial Geology

The Little Cicero Creek watershed is located in the nearly flat to gently rolling Tipton Till Plain. The Tipton Till Plain is composed primarily of unconsolidated deposits, which are sediments that may consist of sand, silt, clay, and organic material which has not formed into solid rock, that obscure the underlying bedrock (Schneider, 1966). The plain is dominantly featureless, and the early 20th-century geographer, C.R. Dryer, described the landscape of central Indiana as so monotonous that a visitor to the region "may ride upon the railroad train for hours without seeing a greater elevation than a haystack or a pile of sawdust" (Lindsey, 1966).

Much of the topography of central and northern Indiana was shaped by the repeated advance and retreat of glaciers. Three well-known large scale glaciers moved across Indiana during the Pleistocene. These include the Illinoisan, which glaciated much of the state; the Kansan, which shared a similar boundary with the Illinoisan; and the Wisconsinan, which had a slightly more northern boundary. The Wisconsinan northern boundary lies roughly between the cities of Indianapolis and Martinsville. The Little Cicero Creek watershed was influenced by all three glacial events.

The two main advances of the Wisconsinan glacial event are marked by the location of the Shelbyville Moraine and the Crawfordsville Moraine. The till deposits left by these moraine advances are known as the Trafalgar Formation, which lies under the entirety of the Little Cicero Creek watershed (Wayne, 1956). As is typical of the Trafalgar formation, the glacial formations in the Little Cicero Creek watershed consist primarily of ground moraines, which are low-relief till deposits left behind by retreating glaciers (Camp & Richardson, 1999). These moraines lend the watershed its flat to gently rolling landscape. The ground moraines in the watershed are composed of loamy tills, which are interbedded with thin, "discontinuous to continuous layers of stratified sand and gravel" (Gray, 1989). In addition, all of the glaciated landscape, to some degree, was covered by windblown deposits, and there may be some localized deposits of loess (windblown silt) and dune sand scattered throughout the landscape (Figure 5) (Gray, 1989).

The thickness of glacial deposits in this area averages from 50 to 150 feet, though in some areas of the larger White River Basin, may be as thick as 400 feet, depending on the topography of the underlying bedrock. Glacial sediments, which include outwash sands and gravels, filled preglacial stream valleys and created buried bedrock valleys (Gray, 1989) resulting in thicker layers of unconsolidated deposits.

2.2.2 *Hydrology*

Surface Hydrology

As is characteristic of much of the glaciated portion of the state, hydrologic features including lakes, streams, wetlands, and ponds are important components of the Little Cicero Creek watershed's landscape. Morse Reservoir, although not in the watershed, was constructed between the years 1953 and 1956 to ensure the City of Indianapolis and the surrounding community had an adequate reserve of drinking water. Little Cicero Creek eventually drains into Morse Reservoir; thus the water quality of the creek can have a significant impact on the water quality of the reservoir.

Streams

A small portion of Little Cicero Creek is a regulated drain (also referred to as a legal drain) that is subject to the regulation of the county drainage board. Figure 6 shows the locations of all regulated drains in the watershed. This legal designation allows the county drainage board to generate revenue from land benefiting from drain construction, repair, evaluation or maintenance according to regulations associated with state Drainage Law (IC 36-9-27). The county surveyor, the board, or an authorized representative of the surveyor or the board acting under this chapter has the right of entry upon land lying within 75 feet of any regulated drain.

Little Cicero Creek is the longest stream in the watershed, flowing for 81,193 linear feet (LF). In total, Little Cicero Creek drains 27,710 acres covering five main inlets: Symons Ditch, Jay Ditch, Ross Ditch, Bennett Ditch, and Taylor Creek. Jay and Symons ditches form the headwaters of the Little Cicero Creek watershed. Jay Ditch drains approximately 3,105 acres at the southern tip of the headwaters, while Symons Ditch drains nearly 4,350 acres at the western tip of the headwaters of Little Cicero Creek.

Despite draining a smaller area, Jay Ditch possesses a longer stream length measuring 26,581 LF compared to 21,115 LF of Symons Ditch. Ross Ditch is the smallest of the Little Cicero Creek tributaries. In total, Ross Ditch drains approximately 1,060 acres along the southern portion of Little Cicero Creek's headwaters west of U.S. 31. Ross Ditch is also the shortest of the Little Cicero Creek tributaries measuring only 8,160 LF. Bennett Ditch's headwaters begin as roadside drainages along U.S. 31 before flowing north and east to combine with Little Cicero Creek. In total, Bennett Ditch covers 14,855 LF and drains approximately 1,795 acres.

The final tributary, Taylor Creek, drains the largest area of any of Little Cicero Creek's subwatersheds (5,350 acres) and possesses the second longest drainage covering 20,635 LF.

It is also important to note the floodplain of Little Cicero Creek. The floodplain map gives a good indication of areas within the watershed that could be prone to flooding (Figure 7). In addition, the IDNR requires a permit for any work done within the floodplain of a stream with a drainage area of over one square mile. As land use changes in the watershed, presumably to more urban uses, the number of areas prone to flooding will likely increase without the use of BMPs.

Lakes and Ponds

Morse Reservoir is a man-made lake approximately 1,375 acres in size. Although the lake is not in the watershed of study, Little Cicero Creek discharges into it. Because its water is used for public consumption, boating, swimming, fishing, and other purposes, the water quality of Morse Reservoir is a concern to the citizens of Hamilton County. Morse Reservoir was constructed to ensure an adequate water supply for the growing Indianapolis area. Construction of the reservoir was completed in the year 1956 (CEES, 2003). Water from Morse Reservoir flows south into Cicero Creek and then into the West Fork of the White River. Downstream of this is the Indianapolis Water Company White River Water Treatment Facility (CEES, 2003).

Morse Reservoir possesses a hydraulic retention time of 56 days (measured in the year 1973). This means that on average, the entire reservoir volume is replaced by inflowing water every 56 days (IDEM, 1998). This relatively short retention time suggests that the reservoir will respond fairly quickly to reductions in external nutrient inputs. The total drainage area for Morse Reservoir is approximately 212 square miles, or 135,680 acres, (IDEM, 1998) and is dependent in part on Little Cicero Creek watershed for water supply and flushing of nutrients. With an area of 27,710 acres, Little Cicero Creek accounts for approximately 20 percent of the total watershed of the reservoir.

Wetlands

Properly functioning wetlands filter sediments and nutrients in runoff, store water for future release, provide an opportunity for groundwater recharge or discharge, and serve as nesting habitat for waterfowl and spawning sites for fish. By performing these roles, healthy, functioning wetlands often improve the water quality and biological health of streams and lakes located downstream of the wetlands. Wetland habitat is scattered throughout the watershed and most of these tracts are located along the mainstem of Little Cicero Creek and Taylor Creek. Several smaller tracts are scattered throughout the watershed.

The United States Fish and Wildlife Service's (USFWS) National Wetland Inventory (NWI) map shows that wetlands cover approximately 868 acres (3 percent) of the Little Cicero Creek watershed. There are five types of wetlands in the watershed; Table 2 illustrates the acreage of each wetland type represented in the watershed and the percentage of land in the watershed that it covers, and Figure 8 illustrates the distribution of these wetlands throughout the watershed according to the NWI map. The wetlands the NWI map identified in the watershed include palustrine forested wetlands (PFO1A), palustrine emergent wetlands (PEM), palustrine scrub/shrub wetlands (PSS), lacustrine unconsolidated bottom wetlands (L1UB), and palustrine unconsolidated bottom wetlands (PUB).

Table 2. NWI Wetlands in the Little Cicero Creek Watershed

Wetland Type	Area (acres)	Percent of Watershed
Palustrine Forested (PFO1A)	760.30	2.72%
Palustrine Emergent (PEM)	47.39	0.17%
Palustrine Scrub/shrub (PSS)	20.45	0.07%
Lacustrine Unconsolidated Bottom (L1UB)	1.15	0.004%
Palustrine Unconsolidated Bottom (PUB)	38.78	0.14%
Total	**868.07**	**3.10%**

Source NWI - *GIS Data Depot (http://data.geocomm.com/)*

Palustrine forested wetlands are those that support largely woody species greater than 20 feet in height and include various hydrological regimes. This class generally possesses various layers of vegetation including canopy trees, subcanopy trees, shrubs, and ground layer herbaceous vegetation. Forested wetlands traditionally include bottomland hardwood and swamp communities. Typical canopy and shrub species found in forested wetlands include maples, elms, ash, and oaks (*Quercus bicolor, Q. palustris*).

Palustrine emergent wetlands are those that support erect, largely herbaceous perennial species and permanent water for most of the growing year, during those years of normal precipitation levels. These wetlands maintain the same appearance each year unless extreme climatic conditions cause flooding or other extreme local changes. Emergent wetlands traditionally include marsh, meadow, and fen communities. Persistent species typically identified in emergent wetlands include Cattails (*Typha* spp.), Bulrush (*Scirpus* spp.), Sedges (*Carex* spp.), Manna Grass (*Glyceria* spp.), and Smartweeds (*Polygonum* spp.). Non-persistent species found in emergent wetlands include Pickerel Weed (*Pontederia cordata*), Arrow Arum (*Peltandra virginica*), and Arrowheads (*Sagittaria* spp.). Invasive species such as Reed Canary Grass (*Phalaris arundinacea*), Common Reed (*Phragmites australis*), and Purple Loosestrife (*Lythrum salicaria*) also dominate some emergent wetlands in the Midwest and Eastern United States.

Palustrine scrub-shrub wetlands are palustrine wetlands that support largely woody species generally less than 20 feet in height and include various hydrological regimes. This class may include young woods or stunted trees due to environmental conditions and it is one of the most widespread wetland classes in the U.S.

Scrub-shrub wetlands traditionally include bog, and shrub-swamp communities. Typical woody species found in scrub-shrub wetlands include Willows (*Salix* spp.), Dogwoods (*Cornus racemosa, C. stolonifera, C. obliqua*), Buttonbush (*Cephalanthus occidentalis*), Spiraea (*Spiraea alba, S. tomentosa*), young Maples (*Acer rubrum, A. saccharinum, A. negundo*), young Ash (*Fraxinus pennsylvanica, F. nigra*), and young Elms (*Ulmus americana, U. rubra*).

Lacustrine unconsolidated bottom wetlands include wetlands or deepwater habitats that are situated in a topographic depression or a damned river channel, lack trees, shrubs, or persistent emergent vegetation with greater than 30 percent areal coverage, and are greater than 20 acres in size. Typical persistent species may include Broad-leaved Cattail (*Typha latifolia*), Arrowhead (*Sagittaria latifolia*), Swamp Buttercup (*Caltha palustris*), Southern Blue Flag Iris (*Iris virginica*), and Spatterdock (*Nuphar advena*). Similar habitats of less than 20 acres in size are also classified as lacustrine if a wave-formed or bedrock shoreline makes up all or part of the boundary, or, if at low water, the depth of the basin still exceeds two meters.

Palustrine unconsolidated bottom wetlands, also known as open-water wetlands, are deepwater habitats that tend to have water that is too deep to support upright emergent or woody vegetation. Dominant plants are submergent species such as Southern Naiad (*Najas quadalupensis*), Slender Waterweed (*Elodea nuttallii*), Eel Grass (*Vallisneria americana*), White Water Crowfoot (*Ranunculus longirostris*), Coontail (*Ceratophyllum demersum*), Pondweeds (*Potamogeton natans, P. epihydrus, P. pusillus*, and others), Bladderworts (*Utricularia vulgaris* and *U. minor*), Water Crowfoot (*Ranunculus aquatilis*), and Water Starwort (*Callitriche verna*).

Because wetlands develop under wet conditions, they require specific soil characteristics. Soils that have characteristics capable of supporting wetlands are known as hydric soils. The locations of hydric soils in the watershed are good indicators of the historical presence of wetlands. The presence of hydric soils where no wetlands exist illustrates that the Little Cicero Creek watershed has lost much of its historical wetland cover.

Comparing the total area covered by wetland (hydric) soils in the watershed (11,234 acres) to the area of existing wetland suggests that many of the wetlands throughout the watershed have been converted to other land uses, namely row crop agriculture. Only 868 acres of the 11,234 acres of wetlands historically present in the Little Cicero Creek watershed still exist. More than 90 percent of the watershed's wetlands have been filled and/or converted to a different land use. Figure 9 illustrates the locations of hydric soils in the watershed.

Groundwater

In the Little Cicero Creek watershed glacial deposits are approximately 200 feet thick and most groundwater is found in sand and gravel aquifers. The sand and gravel formations suitable for domestic wells are typically found between 100 and 150 feet below the surface (IDNR-DOW, 1971). In addition, an aquifer capable of supporting larger-capacity wells is approximated to exist at less than 150 feet deep throughout the watershed. For example, in Sheridan there are two wells, 132 feet and 153 feet deep, that can be pumped at over 200 gallons per minute (gpm). Water levels throughout the watershed are generally high, averaging approximately 25 feet below the surface. The unconsolidated aquifers in the area are estimated to have an approximate recharge rate of 19.8 million gallons per day (mgd).

Surficial sand and gravel aquifers are often found near larger streams like Little Cicero Creek, range from ten to more than 150 feet in thickness, and can support hydraulic conductivities ranging from 24 to over 1,500 feet per day (Arihood and Lapham, 1982). Yields in these aquifers can range from ten to greater than 2,000 gallons per minute (Meyer and others, 1975). These areas are of particular importance to the water quality of the Little Cicero Creek watershed, as surface aquifers related to streams and rivers often are important sources of groundwater recharge.

Bedrock aquifers in the area are Late Ordovician, Silurian, and Devonian in age (Bechert and Heckard, 1966). Wells drilled into the bedrock aquifers may go as deep as 150 feet, but only the top 100 feet of the bedrock is typically permeable enough to support productive groundwater wells (Cable et al., 1971). Figure 10 shows the location of wells drilled in the Little Cicero Creek watershed.

2.2.3 *Soils*

The Little Cicero Creek watershed's geologic history described in the previous sections determined the soil types found in the watershed and is reflected in the major soil associations that cover the Little Cicero Creek watershed. The soil types found in the watershed are a product of the original parent material deposited by the glaciers in this area 12,000 to 15,000 years ago. The main parent materials found in the watershed are glacial outwash and till, alluvium, and organic materials that were left as the glaciers receded. The interaction of these parent materials with the physical, chemical, and biological variables found in the area (climate, plant and animal life, time, landscape relief, and the physical and mineralogical composition of the parent material) formed the soils found in the Little Cicero Creek watershed today.

Major soil associations are determined at the county level. Soil scientists review the soils, relief, and drainage patterns on the county landscape to identify distinct proportional groupings of soil units. The review process typically results in the identification of 8 to 15 distinct patterns of soil units. These patterns are the major soil associations of the county. Each soil association typically consists of two or three soil units that dominate the area covered by the soil association and several soil units (minor soils) that occupy only a small portion of the soil association's landscape. Soil associations are named for their dominant components. The following paragraphs provide more detailed information on each of the major soil association covering the Little Cicero Creek watershed. The discussion relies heavily on Hostetler (1978) and readers should refer to that text for more information.

Hostetler (1978) describes three soil associations in the Little Cicero Creek watershed: the Crosby-Brookston soil association, the Miami-Crosby association, and the Shoals-Genesee association. The Crosby-Brookston soil association covers most of the western half of the watershed (the headwaters) as well as much of the downstream portion of the watershed, except in areas directly adjacent to the mainstem of Little Cicero Creek. In this association, soils developed from a thin layer of loess and glacial till parent materials. In general, Crosby soils account for 47 percent of the total soil association; Brookston soils account for 38 percent and the other 15 percent are soils of minor extent. Crosby soils occupy broad flats and slight rises, while Brookston soils are in depressional areas, swales, and narrow drainageways. As a unit, these soils tend to be located on upland till plains with swells and swales.

They are mostly level, but may be sloping along drainageways and rises. Minor soil units in this association are also found in a variety of topographic locations. Miami soils are typically found on knobs and breaks along drainageways, while Whitaker soils are on slight rises and are common near Patton soils. Patton and Houghton soils are in low lying pockets and depressions. Cultivated crops are well-suited in this soil association if properly drained; however, the potential for urban development is poor due to wetness.

The Miami-Crosby Association borders the Brookston-Crosby Association and covers the rolling till plain adjacent to Little Cicero Creek's mainstem. The parent material for the Miami-Crosby Association is the same as the Brookston-Crosby Association described above. Miami soils account for 60 percent of the Miami-Crosby Association; Crosby soils comprise 30 percent of the association, while minor soil components account for the remaining ten percent of the association. Miami soils in this association occur on flats and gently to strongly sloping knobs and breaks while Crosby soils are located on broad flats and slight rises. As a unit, this association is often dissected by drainageways, as is the case throughout the Little Cicero Creek watershed. Minor soils associated with this soil unit include Brookston, which are typically located in depressions and drainageways, Shoals and Genesee, both located on narrow floodplains, Fox, which is underlain by thin layers of sand and gravel, and Hennepin soils which occur on steep breaks. This association is classified as generally well suited for agricultural production; however, there are severe limitations for non-farm use due to slope and permeability.

Closest to the mainstem of Little Cicero Creek, the soils transition into the Shoals-Genesee Association. Soils in this association developed from alluvium on floodplains. In general, Shoals soils account for 45 percent of the total soil association, Genesee soils account for 25 percent, and the other 30 percent are soils of minor extent. The topography across these soils is mainly flat, but bisected in some areas. Minor soil units in this association are also found in a variety of topographic locations. Sloan soils occur on the lowest parts of the floodplains, Fox soils are on slightly higher terraces, Miami soils are on upland breaks, and Ross soils are on slightly higher floodplains. Cultivated crops are well suited in this soils association if properly drained and protected from flooding, but has severe limitations for all non-farm use due to flooding.

Soil types and slopes are pertinent for the purposes of this document to the extent that they affect the identification of best management practices (BMPs) to control erosion and nutrient runoff. Knowing the location and extent of major soil associations, hydric soils, septic-limited soils, and highly erodible soils can guide planning decisions as they affect runoff coefficients, erodibility and selection of appropriate measures at particular sites. A more detailed description and digitized information on soil types found in the watershed are available from the Hamilton County Soil and Water Conservation District (SWCD).

Highly Erodible Soils

Soils that erode from the landscape are transported to waterways where they degrade water quality, interfere with recreational uses, and impair aquatic habitat and biotic health. In addition, such soils carry attached nutrients, which further impair water quality by increasing plant production and algal growth. Soil-associated chemicals, like herbicides and pesticides, can kill aquatic life and damage water quality.

Highly erodible soil (HES) and potentially highly erodible soil (PHES) are classifications used by the Natural Resource Conservation Service (NRCS) to describe the potential of certain soil units to erode from the landscape. The NRCS examines common soil characteristics such as slope and soil texture when classifying soils. The NRCS maintains a list of highly erodible soil units for each county. Table 3 lists the soil units in the Little Cicero Creek watershed that the NRCS considers to be HES or PHES.

Table 3. HES and PHES Soils

Soil Symbol	Soil Name	Detail	Soil Description
FnB2	Fox loam	PHES	2-6 percent slopes, eroded
FxC3	Fox clay loam	HES	8-18 percent slopes, severely eroded
HeF	Hennepin loam	HES	18-50 percent slopes
MmB2	Miami silt loam	PHES	2-6 percent slopes, eroded
MmC2	Miami silt loam	HES	6-12 percent slopes, eroded
MmD2	Miami silt loam	HES	12-18 percent slopes, eroded
MoC3	Miami clay loam	HES	6-12 percent slopes, severely eroded
MoD3	Miami clay loam	HES	12-18 percent slopes, severely eroded
OcB2	Ockley silt loam	PHES	2-6 percent slopes, eroded

Source: NRCS, 1978

Highly erodible and potentially highly erodible soil units cover only a limited portion of the Little Cicero Creek watershed. In total, approximately 320 acres (1.1 percent of the watershed) are mapped as highly erodible soils, while 3,040 acres (10.9 percent of the watershed) are mapped as potentially highly erodible soils (Figure 11). The Hamilton County Soil Survey (Hostetler, 1978) and Tipton County Soil Survey (Neely, 1989) indicate that that majority of the highly erodible and potentially highly erodible soils lie adjacent to the mainstem of Little Cicero Creek, Taylor Creek, Symons Ditch, and Ross Ditch. Of the highly erodible and potentially highly erodible soils present within the watershed, Miami silt loam (MmC2-MmD2) and Miami clay loam (MoC3-MoD3) soils are particularly dominant.

Highly Erodible Land

Highly Erodible Land (HEL) is a designation used by the Farm Service Agency (FSA). For a field or tract of land to be labeled HEL by the FSA, at least one-third of the parcel must be situated in highly erodible soils and the soils must be used for agricultural production. Unlike the soils survey, these fields must be field checked to ensure the accuracy of the mapped soil types. Farm fields mapped as HEL are required to file a conservation plan with the FSA in order to maintain eligibility for any financial assistance from the United States Department of Agriculture (USDA). The Little Cicero Creek watershed does not have extensive tracts of highly erodible soils or potentially highly erodible soils, and therefore it is unlikely that there will be a significant number of acres of HEL in the watershed.

Soils Used for Septic Tank Absorption Fields

As is common in many areas of Indiana, septic tanks and septic tank absorption fields are utilized for on-site wastewater treatment within the Little Cicero Creek watershed. This type of wastewater treatment system relies on the septic tank for primary treatment to remove solids, and relies on the soil for secondary treatment. The soil's ability to sequester and degrade pollutants in septic tank effluent (waste discharge) will ultimately determine how well surface and groundwater is being protected.

A variety of factors can affect a soil's ability to function as a septic absorption field. Seven soil characteristics are currently used to determine soil suitability for on-site sewage disposal systems: position in the landscape, slope, soil texture, soil structure, soil consistency, depth to limiting layers, and depth to seasonal high water table. The ability of soil to treat effluent depends on four factors: the amount of accessible soil particle surface area; the chemical properties of the surfaces; soil conditions like temperature, moisture, and oxygen content; and the type of pollutants present in the effluent (Getzin, Cogger, and Bristow, 1989).

Many of the nutrients and pollutants of concern are removed safely if a septic system is sited correctly. Most soils have a large capacity to hold phosphate. On the other hand, nitrate (the end product of nitrogen metabolism in a properly functioning septic system) is very soluble in soil solution and is often leached to the groundwater. Care must be taken in locating the system to avoid well contamination. Nearly all organic matter in wastewater is biodegradable as long as oxygen is present. Pathogens can be both retained and inactivated within the soil as long as conditions are right. Bacteria and viruses are much smaller than other pathogenic organisms associated with wastewater; and therefore, have a much greater potential for movement through the soil. Clay minerals and other soil components may absorb them, but retention is not necessarily permanent.

During storm flows, they may become resuspended in the soil solution and transported in the soil profile. Inactivation and destruction of pathogens occurs more rapidly in soils containing oxygen because sewage organisms compete poorly with the natural soil microorganisms, which require oxygen for life. Sewage organisms live longer under anaerobic conditions (without oxygen) and at lower soil temperatures because natural soil microbial activity is reduced.

The NRCS has ranked each soil series by its limitations for use as a septic tank absorption field. Each soil series is placed in one of three categories: slightly limited, moderately limited, or severely limited. Use of septic absorption fields in moderately or severely limited soils generally requires special design, planning, and/or maintenance to overcome the limitations and ensure proper function. Over 97 percent (27,063 acres) of the Little Cicero Creek watershed is rated as severely limited for use as septic tank effluent treatment.

Of the remaining three percent of the watershed, 2.4 percent is rated as moderately limited (675 acres) while 0.5 percent (155 acres) rates as slightly limited. Table 4 lists the specific soil types and associated suitability found in the watershed, and Figure 12 displays the location and extent of soils slightly, moderately, and severely limited for use as a septic tank absorption fields.

Table 4. Septic Field Suitability of Soil Types in the Little Cicero Creek Watershed

Soil Symbol	Soil Name	Water Table (in feet)	Suitability for Septic Absorption Field
Br	Brookston silty clay loam	0-1.0	Severe: wetness, percs slowly, flooding
CrA	Crosby silt loam	1.0-3.0	Severe: percs slowly, wetness
DeA	Del Rey, sandy substratum-Crosby silt loam	1.0-2.5	Severe: wetness, percs slowly
FnA	Fox loam	> 6	Slight
FnB2	Fox loam	> 6	Slight
FxC3	Fox clay loam	> 6	Moderate: slope
Ge	Genesee silt loam	> 6	Severe: flooding
HeF	Hennepin loam	> 6	Severe: slope, percs slowly
Ho	Houghton muck	0-1.0	Severe: wetness, flooding
MmA	Miami silt loam	> 6	Moderate: percs slowly
MmB2	Miami silt loam	> 6	Severe: percs slowly
MmC2	Miami silt loam	> 6	Severe: percs slowly
MmD2	Miami silt loam	> 6	Severe: percs slowly, slope
MoC3	Miami clay loam	> 6	Severe: percs slowly
MoD3	Miami clay loam	> 6	Severe: percs slowly, slope
OcA	Ockley silt loam	> 6	Slight
OcB2	Ockley silt loam	> 6	Slight
Or	Orthents	--	--
Pa	Palms muck	0-1.0	Severe: wetness, flooding, subsides
Pn	Patton silty clay loam (Hamilton County)	0-1.0	Severe: wetness
Pn	Patton silty clay loam, sandy substratum	0.5-2.0	Severe: ponding, percs slowly

Table 4. Septic Field Suitability of Soil Types - Continued

Soil Symbol	Soil Name	Water Table (in feet)	Suitability for Septic Absorption Field
	(Tipton County)		
Pt	Pits	--	--
Sh	Shoals silt loam	1.0-3.0	Severe: flooding, wetness
St	Sleeth loam	1.0-3.0	Severe: wetness
Sx	Sloan silty clay loam, sandy substratum	0-0.5	Severe: wetness, flooding, percs slowly
TuB2	Tuscola, till substratum-Strawn complex	2.0-4.0	Severe: wetness, percs slowly
We	Westland silty clay loam	0-1.0	Severe: wetness, flooding, percs slowly
Wh	Whitaker loam	1.0-3.0	Severe: wetness
WkB	Williamstown silt loam	1.5-3.5	Severe: wetness, percs slowly

Source: NRCS, 1978

2.2.4 *Climate*

Regional Climate

According to Koppen's "world-wide designation of climates," Indiana has what is known as a "humid, meso-thermal-microthermal, continental climate" (Koppen, 1931). While Indiana has a temperate climate that has distinct winter and summer seasons (AMS, 2006), it does not have a defined wet or dry season, and does not have a regular period annually during which average humidity drops below 50 percent. The state's climate transitions from north to south; with the northern half exhibiting a microthermal climate that is similar in temperature to the north and east and the southern half exhibiting a mesothermal climate that is similar in temperature to the south and east. The Little Cicero Creek watershed, located almost directly in the center of the state, experiences a climate that can be similar to the northern or southern half of the state according to regional conditions.

Indiana's climate, while temperate, is also transitional. Indiana natives are frequently heard responding to comments about the weather with; "if you don't like our weather, just wait a few minutes" (Lindsey, 1966). This transitional nature is not only evident in thermal differences from the north to the south of the state, but also in the variation in the length of the growing season.

The normal "frost-free growing season" varies from 150 days in the northeastern region of Indiana to well over 200 days in parts of Posey County in the extreme southwest. The growing season in the region of the Little Cicero Creek watershed can vary from 160 to 180 days per year (1966).

Annual precipitation in Indiana is generally distributed fairly evenly throughout the year. The temperate climate of the region lacks a definable wet or dry season, though the type of precipitation and its impact on local watersheds does vary seasonally. Temperature and relative humidity in the atmosphere both play a strong role in determining whether precipitation, when it hits the ground, will infiltrate into the ground, continue into surface waters as overland flow, or evaporate into the atmosphere before it can do either. During warm summers, when rainfall demand for crops is the greatest of any time of the year, so is the rate of moisture loss by evaporation. In the winter or spring, when the ground is often frozen or saturated and evaporation rates are at their lowest, about one-third of the precipitation that hits the ground exits the state as overland flow through its rivers and streams. According to Lindsey, "If it were possible to revamp our weather we would schedule more summer rain, or redistribute and do with less rain and snow in the winter" (1966).

Local Climate

Between the years 1971 and 2000 the mean temperature for Central Indiana ranged from a low of 17.6° Fahrenheit (F) in January to a high of 84.6° F in July. The average annual temperature is approximately 51.3° F. Similarly, between the years 1971 and 2000, the monthly normal precipitation ranged from a high of over 4.36 inches in July to a low of less than 1.95 inches in January and February. The average annual precipitation is approximately 37 inches. Over the year prior to the completion of water quality sampling (October 2004 to September 2005), nearly 52 inches of rain fell in Hamilton County as measured in Noblesville. This is nearly 15 inches more than the normal amounts observed in the area.

2.2.5 *Natural History*

A natural region is "a major, generalized unit of the landscape where a distinctive assemblage of natural features is present." It is part of a classification system that integrates several natural features, including climate, soils, glacial history, topography, exposed bedrock, pre-settlement vegetation, species composition, physiography, and flora (plant) and fauna (animal) distribution to identify a natural region. A section is a sub-unit of a natural region where "sufficient differences are evident such that recognition is warranted" (Jackson, 1995). Natural regions are similar to physiographic regions, but whereas physiographic regions may give information on predominant landforms, natural regions may give more information about the native plant and animal species of an area. Some natural regions may have a similar corresponding physiographic region, while some may be unique to the classification system. The Little Cicero Creek watershed occurs entirely within the Tipton Till Plain Section of the Central Till Plain Natural Region. This area possesses a largely level to gently undulating landscape that, pre-settlement, was heavily forested. Fertile glacial soils supported large forests dominated with beech, maple, oak, ash, and elm. Flatwoods (forests occurring on relatively level and often poorly drained soils) were the most common forest type present, with mesic upland and ephemeral swamps present as well. Various wetland communities also occurred along river valleys.

Presettlement, flatwood forests dominated the Tipton Till Plain section. The poorly drained soils of these forests supported Pin (*Quercus palustris*), Swamp (*Quercus bicolor*), White, Bur (*Quercus macrocarpa*), and Shumard's Oak (*Quercus shumardii*), along with Red Maple (*Acer rubrum*), Green Ash (*Fraxinus pennsylvanica*), American Elm (*Ulmus americana*), and American Sycamore (*Platanus occidentalis*). Better drained soils were dominated by American Beech (*Fagus grandiflora*), Sugar Maple (*Acer saccharum*), Tulip Tree (*Liriodendron tulipifera*), White Oak (*Quercus alba*), White Ash (*Fraxinus americana*), and Shagbark Hickory (*Carya ovata*). Trout Lily (*Erythronium americanum)*, Waterleaf (*Hydrophyllum appendiculatum*), and Bloodroot (*Sanguinaria canadensis*) were among the spring wildflowers often found in these more mesic (moderately moist) sites. Shallow depressions that were seasonally wet were common in flatwoods, and deeper, more permanent ponds often supported the growth of hydrophytic vegetation such as Buttonbush (*Cephalanthus occidentalis*) and Winterberry (*Ilex verticillata*) (Jackson, 1995).

Mesic upland forests were highly diverse plant communities found throughout the Tipton Till Plain section. Dominant trees included American Beech, Sugar Maple, Tulip Tree, White Ash, and Red Oak (*Quercus rubra*). Rich forested slopes supported a wide variety of spring wildflowers such as Yellow and White Trout Lily (*Erythronium albidum*), Bloodroot, Dutchman's Breeches (*Dicentra cucullaria*), Sharp-lobed Hepatica (*Hepatica nobilis acuta*), Celandine Poppy (*Stylophorum diphyllum*), Cut-leaved Toothwort (*Dentaria concatenate*), and Wild Geranium (*Geranium maculatum*) (Jackson, 1995).

2.2.6 *Endangered Species*

The Indiana Natural Heritage Data Center database provides information on the presence of the endangered, threatened, or rare (ETR) species, high quality natural communities, and natural areas in Indiana. The database was developed to assist in documenting the presence of special species and significant natural areas and to serve as a tool for setting management priorities in areas where special species or habitats exist. The database relies on observations from individuals rather than systematic field surveys by the IDNR. Because of this, it does not document every occurrence of special species or habitat. At the same time, the listing of a species or natural area does not guarantee that the listed species is currently present or that the listed area is in pristine condition. The database includes the date that the species or special habitat was last observed in a specific location.

According to the IDNR, a number of documented ETR animal and plant species occur in Hamilton County. Most state endangered/threatened and federally endangered species found in the county are associated with aquatic habitats. The state and federal classification guidelines are listed below.

State Classifications

Endangered: Any animal species whose prospects for survival or recruitment within the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government that occur in Indiana.

Rare: A naturally occurring living thing can be "rare" in two main ways. First, it can be rare in the sense that it is nowhere common. Usually that's because its habitat requirements are very specific, and this habitat itself is rare. The second main way an organism can be rare is for small populations of it to survive in pockets outside the area where it is considered "common."

Special Concern: Any animal species about which some problems of limited abundance or distribution in Indiana are known or suspected and should be closely monitored.

Federal Classifications

Endangered: Any species that is in danger of extinction throughout all or a significant part of its range.

Threatened: Any species that is likely to become endangered within the foreseeable future throughout all or a significant part of its range.

Appendix A presents the results from the database search for ETR species and high quality natural communities in the Little Cicero Creek watershed, and also includes a list of ETR species and high quality natural communities documented in Hamilton County for additional reference.

The ETR list for Hamilton County includes a variety of ETR plants and animals as detailed by the Indiana Natural Heritage Database, which was last updated in 2004. Additional sightings may have occurred since that time. In Hamilton County, the list includes: three vascular plants - Lake Cress (*Armoracia aquatica*), Spoon-leaved Sundew (*Drosera intermedia*), and Prairie White-fringed Orchid (*Platanthera leucophaea*); seven mollusks - Black Sandshell (*Ligumia recta*), Round Hickorynut (*Obovaria subrotunda*), Clubshell (*Pleurobema clava*), Rabbitsfoot (*Quadrula cylindica*), Lilliput (*Toxolasma parvus)*, Rayed Bean (*Villosa fabalis),* and Little Spectaclecase (*Villosa lienosa*); and one fish - the Eastern Sand Darter (*Ammocrypta pellucida*).

The list also includes one amphibian - the Mudpuppy (*Necturus maculosus*); two reptiles - the Spotted Turtle (*Clemmys guttata*) and the Eastern Massasauga rattlesnake (*Sistrurus catenatus catenatus*); five birds - the Upland Sandpiper (*Bartramia longicauda*), Red-shouldered Hawk (*Buteo lineatus*), Least Bittern (*Ixobrychus exilis*), Black-crowned Night Heron (*Nycticorax nycticorax*), and Bewick's Wren (*Thryomanes bewickii*); and two mammals - the Bobcat (*Felis rufus*) and American Badger (*Taxidea taxus jacksoni*). The county is also home to two high quality natural communities - wet-mesic floodplain forest and mesic upland forest. The ETR list for Tipton County includes only two vascular plant species, which includes the Awned Sedge (*Carex atherodes*) and Leiberg's Witchgrass (*Panicum leibergii*). It also includes one species of mollusk - Little Spectaclecase (*Villosa lienosa*) and one bird - Black Rail (*Laterallus jamaicensis*).

2.3 Land Use (Events, Deforestation, Industrial Development, Historic Sites)

The Little Cicero Creek watershed stretches across Adams and Jackson Townships in the northwest portion of Hamilton County. The county, named for Alexander Hamilton, the first Secretary of the Treasury, was organized in 1823. It was largely agricultural and sparsely populated until well after World War II when suburban development began pushing into the area from Indianapolis. The small portion of the watershed that extends into Tipton County is located in parts of Cicero and Jefferson Townships.

2.3.1 *Cities and Towns*

Towns that frame the Little Cicero Creek watershed are Arcadia, Cicero, and Sheridan. The only town that is located entirely within the watershed boundary is the small unincorporated community of Boxley. Town offices are described below as they relate to water quality impacts of land management. Refer to Figure 3 for the locations of these towns in relation to the watershed boundaries.

Cicero

The town of Cicero is located at the north end of Morse Reservoir, where Little Cicero Creek enters the reservoir. With 4,368 residents, Cicero is the largest of the three towns sharing land with the Little Cicero Creek watershed (IBRC, 2006).

Cicero's history and heritage goes back 165 years. During its early years the town prospered through the area's natural gas reserves and boasted a variety of businesses. Cicero was a progressive, bustling town, and except for Noblesville, was the largest in the county. In the early 1900s the town enjoyed the amenities afforded through the interurban line, electricity, theaters, music hall, roller skating rinks, and a racetrack. A trolley car line ran down Peru Street (Town of Cicero, 2006).

Cicero was home to the first bridge built (1838) in Hamilton County over a major stream, Cicero Creek. In 1870, the structure was converted into a covered bridge and painted red. The Red Bridge became one of the town's most memorable landmarks. It was torn down in the late 1950s to make way for construction of Morse Reservoir, which was completed in the year 1956. Today Cicero is considered a desirable place to live because of its location and the amenities provided by Morse Reservoir (2006).

Sheridan

The town of Sheridan is located at the extreme west end of the watershed, near the headwaters of Symons Ditch. Approximately half of the town's land area is located in the watershed. With 2,661 residents, Sheridan is the second largest of the four towns sharing land with the Little Cicero Creek watershed (IBRC, 2006). Sheridan has the only wastewater treatment plant located in the watershed.

In 1929, W. S. McMurtry, a local historian stated, "That about 1870 Caswell Boxley laid out an addition which he called... Sheridan, Indiana, there being four squares in that addition (located north of present day Second Street). That in 1866 Egbert Higbee had laid out an addition which called the town of Milwood. That said town of Sheridan laid off by Caswell Boxley was immediately north and adjoining the said addition laid off by Egbert Higbee. That said Millwood addition was recorded in Deed Record 5, page 444 in the Office of the Recorder of Said County and State." (SCC, 2006)

Sheridan experienced limited growth until 1882, when the Monon Railroad opened connecting Indianapolis and Chicago. With the railroad, Sheridan started to boom and many businesses moved south to the railroad.

Among these were a sorghum mill, several saw mills, a wagon and buggy shop, grist mill, a copper shop, a tile factory, clothing stores, bakeries, hardware stores, a canning factory, a hatchery, a stockyard, a poultry company, a fence company, screw products companies, a finishing tool factory, a glass washer manufacturing company, and various retail and service enterprises. (2006) The town was incorporated in the year 1886 and will celebrate its sesquicentennial in the year 2010.

Arcadia

Arcadia is located just outside the eastern edge of the watershed. A small portion of its incorporated land lies inside the watershed boundary. In the year 2005 Arcadia had a population of 1,794 people. (IBRC, 2006)

Boxley

Boxley is a small community located in the west-central portion of the Little Cicero Creek watershed. In the year 1836, Addison Boxley founded the community by dividing a portion of his property into lots and selling them. Boxley was originally known as Boxleytown, but in later years the name was abbreviated, and it became known more familiarly as Boxley. The first store in the township was owned by Addison and Thomas P. Boxley and Dr. Thomas Boxley established and served as Postmaster to the first post office. (Mensch, 2006)

Boxley was a primary stopping area on western route from Strawtown to the Wabash. Addison Boxley also owned the first tavern and received a large amount of its business from people migrating west and cattle drovers over this route. Other early enterprises in Boxley included a general store owned by T. P. Boxley, physicians' offices of Smith & Rodeman, J. M. Richardson, Dr. T. J. McMurty, and Dr. J. C. Newby; a wagon-maker; George Palmer, and blacksmiths; J. R. Ogle and Steffey Bros. (2006)

2.3.2 *Historic Structures*

There are two structures in the Little Cicero Creek watershed that are listed on the State Register of Historic Places or the National Register of Historic Places. Both are located in the town of Sheridan, and are situated almost on the watershed boundary. The Davenport-Bradfield House was built in 1875 and is noted for its Italianate architecture. It is located at 106 East 2nd Street and is included in both the State and National registers. The George Boxley Cabin is listed on the State Register of Historic Places and is located on Pioneer Hill at the intersection of 1st and Main Streets, also in Sheridan (IDNR, 2006). George Boxley built the cabin in 1828 when he brought his family from Virginia (Bush, 2006). The cabin is currently being restored.

2.3.3 *Recreational Areas*

Although the towns of Sheridan, Cicero, and Arcadia all have both publicly and privately-owned designated recreational facilities available for their communities, none of these are located inside the boundaries of the Little Cicero Creek watershed. The Town of Cicero has the White River Compound, Red Bridge Park, and Cicero Community Park. The White River Compound is a camping area that has 106 campsites along the White River, a playground, laundry, and camp store facilities. Red Bridge Park is on Morse Reservoir and includes a community building, public pool, and marina. Cicero Community Park has a playground, basketball and tennis courts, and skateboard area. Arcadia has Tecumseh Park, which offers a public swimming pool and other park facilities. Sheridan has Biddle Memorial Park, which offers playgrounds, ball diamonds, and picnic tables.

2.3.4 *Development in the Watershed*

Population increases result in a relative shrinking of land and resources available for development and agricultural uses. The agricultural industry has been productive in the county for a long period and is supported by residents as an appropriate land use. Residents expressed concern that small towns can be "bulldozed over" without planning, citing their experiences in similar large, rapidly developing communities in other parts of the nation. Residents expressed a desire for a balance of rural and urban land uses without too much development. They support management of the type of economic development (e.g., distribution centers, residential, commercial) to minimize effects on water quality.

Population

The Little Cicero Creek watershed is located in a primarily rural area of Hamilton County, which according to the U.S. Census Bureau, is one of the fastest growing Hoosier counties. The population of the county has increased by almost 58,000 people since the 2000 census (US Census, 2006). The growth rate from years 2000 to 2005 was 31.7 percent (US Census, 2006). From July 1, 2004 to July 1, 2005, Hamilton County was the 51st fastest growing county in the nation (Les, 2006). Growth projections estimate that the population of Hamilton County will increase by 30 percent or more through the year 2020 (IBRC, 2003). Along with this intense population growth will be an increase in development. In the year 2005, Hamilton County granted 4,276 residential building permits, and throughout the state was second only to Marion County, which granted 4,618 permits (STATS Indiana, 2006).

Although the portion of Hamilton County in which the Little Cicero Creek watershed is located is not yet seeing the growth of the southern half of the county where the towns of Fishers, Carmel, Noblesville, and Westfield are located (Table 5), the county's 30 percent overall growth projection through the year 2020 is a strong indicator that the northern portion of Hamilton County will soon be feeling the pressures of increased growth and development. The watershed is outlined by three towns that could see significant growth in the coming decade: Cicero, Arcadia, and Sheridan.

Table 5. Population Growth of Cities and Towns in Hamilton County

City/Town	1990 Population	2000 Population	2004 Population	Percent Increase 1990–2004
Major communities in Little Cicero Creek watershed				
Arcadia	1,468	1,747	1,809	23
Cicero	3,268	4,303	4,414	35
Sheridan	2,046	2,520	2,691	27
Major cities in Hamilton County				
Atlanta	703	761	822	17
Carmel	25,380	37,733	58,198	129
Fishers	7,508	37,835	54,330	624
Noblesville	17,655	28,590	35,438	101
Westfield	3,304	9,293	11,911	261
Other communities	47,604	59,958	62,147	31

Source: STATS Indiana, 2005

Current Land Use

The area located within the watershed currently remains largely rural. Agricultural production is the predominant use of the Little Cicero Creek watershed by land area. More than 84 percent of the watershed is managed for agriculture, while approximately 11 percent is in grass, pasture or hay production, and almost three percent is covered by forested wetlands and deciduous forest (Figure 13). Very little of the land area is in impervious cover (hard surfaces such as pavement that do not allow water to soak in). Research has consistently shown that watersheds with impervious surfaces covering more than 10-15 percent of the land area will experience degradation in water quality and ability to support fish and other animals in streams. Table 6 shows the distribution of land use types in the watershed.

Table 6. Land Use in Hamilton County

Land Use	Area (acres)	Percent Cover
Row Crop	23,562	84.30
Pasture/Hay	3,103	11.10
Woody Wetlands	418	1.49
Deciduous Forest	380	1.36
Low Intensity Residential	207	0.74
Other Grasses (Urban/parks/rec)	176	0.63
High Intensity Commercial (Industry/Transportation)	63	0.23
Open Water	16	0.06
High Intensity Residential	14	0.05
Emergent Herbaceous Wetlands	13	0.05
Total	**27,950**	**100**

Source: U.S. Geological Service. 1998. Indiana Land Cover Data Set, Version 98-12.

Zoning Ordinances

Hamilton County has established ordinances for both Adams and Jackson Townships, where the Little Cicero Creek watershed is located. Zoning maps of the watershed can be obtained from the Hamilton County Plan Commission (HCPC, 2006). The most striking feature of the zoning maps is the predominance of agricultural zoning. There are some areas, however, that have been zoned for commercial or residential land use. In addition, some parts of the watershed have been included in the Town of Sheridan or Town of Arcadia planning jurisdictions. These areas are likely to see development in the near future and thus should be a higher priority for water quality protection efforts.

Public Lands

Most of the land in Indiana is in private ownership and in the area surrounding the watershed, there are several public parks and recreational facilities. In the watershed itself, the stream and other natural resources are privately owned and managed. The county drainage board does have access to a small portion of Little Cicero Creek as a regulated drain. However, the stream is maintained on an as-needed basis.

2.3.5 *Organizational Resources*

A thorough assessment of the organizations that may be available to implement land and water conservation practices is useful in determining current organizational capacity, feasibility of various solutions and to project community needs for the future.

Governmental Organizations

Hamilton County Parks and Recreation

Hamilton County offers its residents a great variety of activities and opportunities to recreate. From Carmel to Cicero, Hamilton County abounds with parks, playhouses, museums, golf courses, and innumerable other opportunities to enjoy life.

Hamilton County and its communities have made a huge investment in recreation for its citizens. The county features 23 golf courses. Hamilton County, along with city and town governments manages more than 40 parks and recreation areas.

Several regional and local governmental organizations provide services to Little Cicero Creek watershed residents. These organizations are described in more detail below.

Hamilton County Drainage Board

The Hamilton County Drainage Board has three members who are also the Hamilton County Commissioners. The county surveyor also serves as an ex-oficio member of the drainage board. The board reviews and approves the construction, maintenance, reconstruction and vacation of regulated drains. Board approval is required when crossing a regulated drain and when outlets affect a regulated drain. The board also has the right to remove obstructions within these drains. The Hamilton County Drainage Board meets on the second and fourth Monday of each month.

The county surveyor is also a member of the County Plan Commission. As a member of the commission the county surveyor attends monthly meetings and hears and makes decisions on subdivisions and planning. The county surveyor also advises on technical review of plats for not only the Hamilton County Plan Commission but also for the Cicero, Sheridan, and Arcadia plan commissions. In addition to these duties, the county surveyor also administers the Rule 5 and Rule 13 program for the unincorporated portions of Hamilton County.

Hamilton County Soil and Water Conservation District

The Hamilton County Soil and Water Conservation District (SWCD) is a legal subdivision of state government responsible for the conservation of soil and water resources within its boundaries. It is an independent body formed under and subject only to the Indiana Soil and Water Conservation District Law.

Landowners from Adams, Clay, Delaware, Fall Creek, Jackson, Noblesville, Washington, Wayne, and White River Townships organized the SWCD in the year 1968. The district is controlled by a board of five local supervisors -- three elected by the landowners in the district and two appointed by the State Soil and Water Conservation Board. The supervisors meet monthly each year to conduct the district's business and attend other meetings in and out of the county. They serve their community without pay.

Supervisors are responsible for providing leadership in the conservation and development of soil, water, and related resources within the district's boundaries. The major purpose of the district is to analyze needs and develop and carry out both short and long range programs aimed at solving resource problems, primarily dealing with soil and water resources. The ultimate district objective is to cause soil and water conservation practices and systems to be implemented upon the land.

Supervisors and staff work with both rural and urban dwelling landowners or occupiers, groups, local agencies, and others to prevent resource problems, correct existing soil and water conservation problems and help utilize the county's natural resource capabilities. Through the district, local people are also better able to organize and coordinate their efforts in obtaining technical and financial assistance from state and federal agencies with responsibilities and expertise in natural resource use and development.

A small portion of the Little Cicero Creek watershed extends into Tipton County. Staff from the Tipton County SWCD work cooperatively with the Hamilton County SWCD office to serve residents in these areas.

Other Hamilton County Agencies

Hamilton County offices provide a number of planning and assistance services to citizens in the county. The Hamilton County Board of Commissioners and the County Plan Commission are two of these organizations. Purdue University Cooperative Extension Service maintains offices in Hamilton County with staff dedicated to the education of Indiana citizens through the application of land-grant university research and knowledge base to develop youth and strengthen agriculture, families, and communities.

State and Federal Agencies

Several state and federal agencies provide services to the watershed residents, including the IDNR, the IDEM, the NRCS, and Purdue University Cooperative Extension Service.

Nongovernmental Organizations

Upper White River Watershed Alliance

Historically, there has been no regional planning commission or river basin commission for Hamilton County or any parts of the watershed contained therein. The Upper White River Alliance provides this much needed regional river basin planning oversight for the planning area. Little Cicero Creek is located within the area served by the Upper White River Alliance, Inc. This nonprofit organization is a consortium of local governments, industry leaders, agriculture, and the regional community. Its mission to improve and protect water quality on a local watershed basis by consolidating data, integrating planning and priorities, and encouraging the development of smaller watershed partnerships that can more efficiently implement projects and plans within the larger Upper White Watershed Alliance Region.

Current priority issues include:

- Total maximum daily loads - applicability, impacts, and appropriate development;
- Stormwater phase II - local concerns, deadlines, and sharing information;
- Regional water quality monitoring - a more valuable assessment of local data;
- Local priorities;
- Achievable water quality standards; and
- Development and regional flooding

These priorities are related to the community concerns identified for the Little Cicero Creek watershed. A representative of the Upper White River Alliance participated in the development of this plan. Their website is located at: http://www.whiteriveralliance.org/.

Agricultural Organizations

A number of organizations are available to assist with issues related to agricultural production, land management and water quality. These organizations include:

- Hamilton County and Indiana Farm Bureau
- Hamilton County and Indiana Beef Cattlemen's Producers Association
- American Farmland Trust (AFT) - can provide information on development
- Indiana Department of Rural Development

Other Community Organizations

Several organizations within the county provide outreach, education, and public service related to quality of life, natural resources, and water quality. The group Friends of Cicero coordinates volunteer activities in the community, including service projects conducted by the Kiwanis and Girl Scouts. Friends of the Library assists with information needs in the community and can serve as a mechanism to provide hard copies of the WMP, as well as links on their website. Cicero Friends of the Park provides maintenance and management services to two parks located on or near Morse Reservoir. Community residents are active in the Riverwatch program, conducting volunteer water quality sampling and assisting with outreach on water quality issues. The Hamilton County Alliance serves business and community development with information on quality of life, demographics, and map resources.

In June 2005, the Morse Waterways Association held its first meeting to introduce the organization and recruit new members. The goal of the association is to promote safety as well as economic and environmental vitality on Morse Reservoir. The organization is in an early stage of development and growth. They currently have about 170 members and meet monthly at the Red Bridge Park Community Center.

The Greater Indy Chapter of Ducks Unlimited is active in Hamilton County and central Indiana. Ducks Unlimited (DU) conserves, restores, and manages wetlands and associated habitats for North America's waterfowl. Nationwide, DU supporters have raised nearly $1.6 billion for conservation since the year 1937. Habitat work for waterfowl has provided more than 9.4 million acres of valuable nesting, brood rearing, staging, migration, and wintering habitat. Scientific evaluations of DU projects have proven that habitat protection has increased the annual production of waterfowl and provided valuable resources throughout the year that increase survival and reproductive potential. Projects involving protection and restoration for waterfowl also protect water quality by controlling soil erosion, removing nutrients, and recharging groundwater.

Central Indiana Land Trust

The Central Indiana Land Trust (CILTI) is a nonprofit 501(c)(3) corporation formed in the year 1990 by a diverse group of concerned citizens acting to protect natural spaces in the face of increasing urban sprawl. Recognizing that a strong economy and a continued high quality of life in central Indiana is ultimately dependent upon and related to the state of the environment, CILTI maintains that development must be balanced with adequate greenspace. It operates in a regional capacity throughout central Indiana, and actively seeks to protect a broad array of natural areas from small urban greenspaces to pristine nature preserves of high biological integrity.

Hoosier Heartland Resource Conservation and Development

The Hoosier Heartland Resource Conservation and Development (RC&D) Council, Inc. is an organization that helps people care for, conserve, and protect natural resources in a way that will improve the area's economy, environment, and living standards. RC&D unites people in urban and rural areas who are committed to managing and utilizing our natural resources wisely and provides a framework for partnerships and alliances to develop between local citizens, governments, and technical experts to solve resource problems.

3.0 BASELINE WATER QUALITY AND WATERSHED CONDITIONS

3.1 Introduction

Data contained in this section documents current water quality conditions in Little Cicero Creek and its tributaries. Understanding the waterbodies' current conditions will help watershed stakeholders set realistic goals for future water quality conditions. This data will also serve as the benchmark against which future water quality conditions can be compared to measure stakeholder success in achieving their vision for the future of these waterbodies.

A variety of resources were reviewed to establish the existing or baseline water quality conditions within the major waterbodies in the Little Cicero Creek watershed (Little Cicero and Taylor Creeks and Symons, Jay, Ross, and Bennett Ditches). In general, few studies have been completed on the waterbodies in the Little Cicero Creek watershed. The IDEM assessed the water chemistry, biological communities, and physical habitat in Little Cicero Creek in the years 1996 and 2001. The Central Indiana Water Resources Partnership (CIWRP) sampling monitored Little Cicero Creek's water quality in the year 2003. JFNew collected additional data from each of the major streams during the summer of 2005 as part of this plan's development to supplement the existing data.

All data collected throughout this study will be used as a comparison method between streams under each condition. As water chemistry sampling occurred four times (twice during base flow, twice during storm flow), a wide variation in in-stream condition will be represented by the samples collected during this project. All data were compared within assessment events and on the whole to identify the subwatershed or drainage areas that possess the poorest water quality. The drainages or subwatershed identified with greater impairment should be targeted first for water quality improvement project implementation. Likewise, drainages or subwatersheds possessing better water quality were prioritized lower and water quality improvement projects in these areas will likely be addressed later than those areas with poorer water quality. The following paragraphs outline the findings of these assessments.

3.2 Existing Data

3.2.1 *IDEM Assessments*

State and regional reports provide benchmarks for water quality in Indiana lakes and streams by identifying how the watershed fits into the overall state and regional picture. A variety of sources were reviewed to assist in establishing baseline water quality conditions in the waterbodies of the Little Cicero Creek watershed. Every two years, the United States Environmental Protection Agency (USEPA) requires the state to submit an Indiana Water Quality 305(b) report on the status of waters in the state. The current and historical Indiana Water Quality 305(b) reports were studied (IDEM, 1989-1990; IDEM, 1992-1993; IDEM, 1995-1996; IDEM, 2002; IDEM, 2004, and IDEM, 2006). Additionally, the USEPA requires that Indiana submit a Section 303(d) List of Impaired Water Bodies for Indiana, which is named after enabling legislation in the federal Clean Water Act. This list provides a listing of waters that do not or are not expected to meet applicable water quality standards. This list was examined to determine if any portion of the Little Cicero Creek watershed was listed as impaired.

In the Indiana Water Quality 305(b) reports for years 1989-1990, 1992-1993, and 1995-1996, 16 miles of Little Cicero Creek were assessed and given a rating of fully supporting of aquatic life (IDEM, 1991; IDEM, 1994; and IDEM, 1997). In 2002, this rating was switched to partially supporting of aquatic life (IDEM, 2002). In the year 2004, the main branch of Little Cicero Creek was considered to be partially supporting for the portion located in the Little Cicero Creek–Bennett Ditch/Taylor Creek Branch (05120201080090) and non-supporting for the portion lying in the Little Cicero Creek-Teter Branch (05120201080080). All of the Little Cicero Creek tributaries possess a rating of fully supporting their aquatic life designation (IDEM, 2006).

According to the 2004 303(d) list, Little Cicero Creek in the Little Cicero Creek-Teter Branch and Little Cicero Creek-Bennett Ditch/Taylor Creek 14-digit subwatersheds possessed impaired biotic communities. Little Cicero Creek in the Little Cicero Creek-Bennett Ditch/Taylor Creek watershed is also listed as having excessive *E. coli* levels.

In the 2006 303(d) list, both segments of Little Cicero Creek have been removed from the list for impaired biotic communities. Little Cicero Creek in the Little Cicero Creek-Bennett Ditch/Taylor Creek watershed, Bennett Ditch, Taylor Creek, and other tributaries are still included on Indiana's list of impaired waterbodies for *E. coli*. Because of the high levels of *E. coli* found in these waters, this section of the Little Cicero Creek watershed will require total maximum daily load (TMDL) evaluation in the future. This process will determine the specific pollutant loading that the stream can handle and still meet water quality standards (IDEM, 2006).

The IDEM collected water chemistry samples from Little Cicero Creek at 266th Street in years 1996 and 2001 and collected water chemistry sampling at Taylor Creek in the year 1992 in association with biological sampling. Because this sampling assessment site corresponds with the most downstream sampling site during the current assessment, more comparisons can be drawn between the historic data and the current data. The IDEM sampling assessments were reviewed and the data was compared to the data collected by JFNew in the year 2005. Temperature, pH, and dissolved oxygen were all within the state standards. All but one of the *E. coli* samples was above the state standard (235 colonies/100 mL) typically measuring greater than 2,420 colonies/100 mL. These concentrations indicated that excessive amounts of *E. coli* are present within Little Cicero Creek. Fecal coliform concentrations were also high during the year 2001 event. Only three nitrate-nitrogen samples were collected with one sample above the Indiana drinking water standard (10 mg/L). The remaining nitrate-nitrogen concentrations were above the concentrations recommended by the USEPA and the Ohio EPA. One sample of total phosphorus was above the 0.3 mg/L associated with Indiana impaired waters, while all of the samples were above the USEPA standard (0.033 mg/L) and all but two were above the Ohio EPA standard (0.1 mg/L).

3.2.2 *Unified Watershed Assessment (UWA)*

In partnership with other agencies, the IDEM and the NRCS led the development of the Unified Watershed Assessment (UWA), a requirement of the Clean Water Action Plan of the year 1997. Through evaluation of water quality data, natural resource concerns, and human activities that may have the potential to impact water quality, all 11-digit hydrologic unit watersheds in the state were prioritized for restoration work. The UWA characterized the 361 watersheds in the state at the 11-digit level for 15 different parameters.

Copies of the UWA are available from the IDEM watershed management section. The Little Cicero Creek watershed was located within the priority areas outlined in the year 2001 Unified Watershed Assessment. The priority areas were classified as watersheds in need of financial or technical assistance for maintenance and improvement of water quality.

3.2.3 *Central Indiana Water Resources Partnership Sampling (CEES Sampling)*

Central Indiana Water Resources Partnership (CIWRP) is a research and development partnership between the Center for Earth and Environmental Science (CEES) through Indiana University-Purdue University, Indianapolis and USFilter and Vivendi Environment. CIWRP prepared a watershed report in the year 2003 encompassing the streams and reservoirs which are part of the Indianapolis drinking water system. This report includes the Cicero Creek and Morse Reservoir watershed as part of the long-term water quality monitoring program (Tedesco et al., 2003). Two data points were sampled within the Little Cicero Creek watershed, one located along Little Cicero Creek within the Little Cicero Creek-Teter Branch watershed (Anthony Road) and one at Little Cicero Creek's intersection with 266th Street in the Little Cicero Creek-Bennett Ditch/Taylor Creek Branch watershed. Samples were taken during the winter, spring, summer, and fall of 2003 under both base and storm flow conditions.

Data from the CIWRP report was compared to the data collected by JFNew in the year 2005. In accordance with the findings by JFNew, all the samples collected for *E. coli* and total coliform exceed the Indiana state standard (235 colonies/100 mL and 5,000 colonies/100 mL, respectively). Nitrate-nitrogen concentrations were considerably higher during the JFNew sampling following the storm events than those present during CEES sampling. Nitrate-nitrogen concentrations are a factor which was not apparent in the CEES data. Ammonia-nitrogen levels appeared to decrease during the summer and fall as compared to the winter and spring samples in the CEES data.

All ammonia-nitrogen concentrations were relatively low and were below the Indiana state standard. However, the range of ammonia-nitrogen levels was higher overall for the JFNew data. Total phosphorus concentrations increased following storm events during both the CEES and the JFNew sampling events. In both cases, total phosphorus concentrations were elevated and exceeded recommended concentrations.

3.2.4 *Veolia Water Sampling*

Discussions at early steering committee meetings indicated that Veolia Water may have data on Atrazine levels in Little Cicero Creek, but further research into the issue failed to locate any existing data on Atrazine levels in the Little Cicero Creek watershed.

3.2.5 *JFNew Watershed Stream Sampling*

To supplement the base of existing data, JFNew completed water chemistry sampling and physical habitat assessments at eight locations within the Little Cicero Creek watershed. Five of the sampling sites were located on each of the major tributaries to Little Cicero Creek including: Symons Ditch, Jay Ditch, Ross Ditch, Bennett Ditch, and Taylor Creek. Each of the tributaries was sampled at the road crossing closest to their convergence with Little Cicero Creek. Additionally, three reaches along Little Cicero Creek were also sampled. These locations occurred at Little Cicero Creek's intersection with Anthony Road, Cal Carson Road, and 266th Street. The sampling locations are shown in Figure 14.

Water Quality Parameters

JFNew measured various chemical parameters in order to create "snapshots" of water quality in the watershed throughout a one-year period. Descriptions of the parameters measured are listed below.

Temperature

Temperature can determine the form, solubility, and toxicity of a broad range of aqueous compounds. Likewise, water temperature regulates the species composition and activity of life associated with the aquatic environment. As essentially all aquatic organisms are cold-blooded, the temperature of the water regulates their metabolism and ability to survive and reproduce effectively (USEPA, 1976). The Indiana Administrative Code (IAC) (327 IAC 2-1-6) sets maximum temperature limits to protect aquatic life for Indiana streams.

For example, temperatures during the months of June and July should not exceed 90°F (23.7°C) by more than 3°F (1.7°C). The code also states that the "maximum temperature rise at any time or place… shall not exceed 5°F (2.8°C) in streams…"

Dissolved Oxygen (DO)

DO is the dissolved gaseous form of oxygen. It is essential for respiration of fish and other aquatic organisms. Fish require a DO concentration of at least three to five mg/L of DO. Cold water fish such as trout generally require higher concentrations of DO than warm water fish such as bass or bluegill. The IAC sets minimum DO concentrations at five mg/L for warm water fish. DO enters water by diffusion from the atmosphere and as a byproduct of photosynthesis from algae and plants. Excessive algae growth can over-saturate (greater than 100 percent saturation) the water with DO. Waterbodies with large populations of algae and macrophytes often exhibit supersaturation due to the high levels of photosynthesis. Dissolved oxygen is consumed by respiration of aquatic organisms, such as fish, and during bacterial decomposition of plant and animal matter.

Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions: on their total concentration, mobility, and valence (APHA, 1998). In lower flow conditions, conductivity is higher than it is following a storm because the water moves more slowly across or through ion containing soils and substrates during base flow. Carbonates and other charged particles (ions) dissolve into the slow-moving water, thereby increasing conductivity levels.

pH

The pH of stream water describes the concentration of acidic ions (specifically H^+) present in the water. The pH also determines the form, solubility, and toxicity of a wide range of other aqueous compounds. The IAC establishes a range of six to nine pH units for the protection of aquatic life.

Alkalinity

Alkalinity is a measure of the acid-neutralizing (or buffering) capacity of water. Certain substances in water, like carbonates, bicarbonates, and sulfates can cause the water to resist changes in pH. A lower alkalinity indicates a lower buffering capacity or a decreased ability to resist changes in pH. During base flow conditions, alkalinity is usually high because the water picks up carbonates from the bedrock.

Alkalinity measurements are usually lower during storm flow conditions because buffering compounds are diluted by rainwater and the runoff water moves across carbonate-containing bedrock materials so quickly that little carbonate is dissolved to add additional buffering capacity.

Turbidity

Turbidity (measured in Nephelometric Turbidity Units or NTUs) is a measure of water coloration and particles suspended in the water itself. It is generally related to suspended and colloidal matter such as clay, silt, finely divided organic and inorganic matter, plankton, and other microscopic organisms. According to the Hoosier Riverwatch, the average turbidity of an Indiana stream is 11 NTU with a typical range of 4.5-17.5 NTU (White, unpublished data). Turbidity measurements >20 NTU have been found to cause undesirable changes in aquatic life (Walker, 1978). The USEPA developed recommended water quality criteria as part of the work to establish numeric criteria for nutrients on an ecoregional basis. Recommended turbidity concentrations for the Central Corn Belt Plains, in which the Little Cicero Creek lies are 9.89 NTUs (USEPA, 2000).

Nitrogen

Nitrogen is an essential plant nutrient found in fertilizers, human and animal wastes, yard waste, and the air. About 80 percent of the air we breathe is nitrogen gas. Nitrogen gas diffuses into water where it can be “fixed”, or converted by blue-green algae to ammonia for their use. Nitrogen can also enter lakes and streams as inorganic nitrogen and ammonia. Because of this, there is an abundant supply of available nitrogen to aquatic systems. The three common forms of nitrogen are:

- Nitrate-nitrogen (NO_3-N)

Nitrate is an oxidized form of dissolved nitrogen that is converted to ammonia by algae. It is found in streams and runoff when dissolved oxygen is present, usually in the surface waters. Ammonia applied to farmland is rapidly oxidized or converted to nitrate and usually enters surface and groundwater as nitrate. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams classified as warm water habitat (WWH) was 1.0 mg/L. WWH refers to those streams which possess minor modifications and little human influence, like some areas of the mainstem of Little Cicero Creek (Plate 1).

Plate 1. Warm Water Habitat - LCC

Plate 2. Modified Warm Water Habitat - LCC

These streams typically support communities with healthy, diverse warm water fauna. The Ohio EPA (1999) found that the median nitrate-nitrogen concentration in wadeable streams classified as modified warm water habitat (MWH) was 1.6 mg/L. MWH (Plate 2) was defined as: the aquatic life use assigned to streams that have irretrievable, extensive, man-induced modification that precludes attainment of the warm water habitat use designation; such streams are characterized by species that are tolerant of poor chemical quality (fluctuating dissolved oxygen) and habitat conditions (siltation, habitat amplification) that often occur in modified streams (Ohio EPA, 1999). The USEPA developed recommended nitrate-nitrogen criterion as part of work to establish numeric criteria for nutrients on an ecoregion basis. The recommended nitrate-nitrogen concentration for the Central Corn Belt Plains, in which the Little Cicero Creek watershed lies, is 0.63 mg/L (USEPA, 2000). Nitrate-nitrogen concentrations exceeding ten mg/L in drinking water are considered hazardous to human health (IAC 2-1-6).

- Ammonia-nitrogen (NH_3-N)

Ammonia-nitrogen is a form of dissolved nitrogen that is the preferred form for algae use. Bacteria produce ammonia as they decompose dead plant and animal matter. Ammonia is the reduced form of nitrogen and is found in water where dissolved oxygen is lacking. Important sources of ammonia include fertilizers and animal manure. Both temperature and pH govern the toxicity of ammonia for aquatic life. According to the IAC, maximum ionized ammonia concentrations for the study streams should not exceed approximately 1.94 to 7.12 mg/L, depending on the water's pH and temperature.

- Organic Nitrogen

Organic nitrogen includes nitrogen found in plant and animal materials. It may be in dissolved or particulate form. In the analytical procedures, total Kjeldahl nitrogen (TKN) was analyzed. Organic nitrogen is TKN minus ammonia. The USEPA developed TKN criterion as part work to establish numeric criteria for nutrients on an ecoregion basis. The recommended TKN concentration for the Central Corn Belt Plains, in which the Little Cicero Creek watershed lies, is 0.591 mg/L (USEPA, 2000).

Phosphorus

Phosphorus is an essential plant nutrient and the one that most often controls aquatic plant (algae and macrophyte) growth. It is found in fertilizers, human and animal wastes, and yard waste. There are few natural sources of phosphorus to streams other than that which is attached to soil particles; there is no atmospheric (vapor) form of phosphorus. For this reason, phosphorus is often a limiting nutrient in aquatic systems. This means that the relative scarcity of phosphorus may limit the ultimate growth and production of algae and rooted aquatic plants. Management efforts often focus on reducing phosphorus inputs to receiving waterways because: (a) it can be managed and (b) reducing phosphorus can reduce algae production. Two common forms of phosphorus are:

- Soluble Reactive Phosphorus (SRP)

SRP is dissolved phosphorus readily usable by algae. SRP is often found in very low concentrations in phosphorus-limited systems where the phosphorus is tied up in the algae. Because phosphorus is cycled rapidly through biota, SRP concentrations of only 0.005 mg/L are enough to maintain eutrophic or highly productive conditions in lake systems (Correll, 1998). Sources of SRP include fertilizers, animal wastes, and septic systems.

- Total phosphorus (TP)

TP includes dissolved and particulate phosphorus. TP concentrations greater than 0.03 mg/L (or 30µg/1) can cause algal blooms in lake systems. In stream systems, Dodd et al., 1994 suggests that streams with total phosphorus concentrations greater than 0.075 mg/L are typically characterized as productive or eutrophic. TP is often a problem in agricultural watersheds because TP concentrations required for eutrophication control can be an order of magnitude lower than those typically measured in soils used to grow crops (0.2-0.3 mg/L). The Ohio EPA (1999) found that the median TP concentration in wadeable streams that support WWH for fish was 0.10 mg/L, while wadeable streams that support MWH for fish was 0.28 mg/L. The USEPA recommended TP criterion for the Central Corn Belt Plains is 0.076 mg/L (USEPA, 2000).

Total Suspended Solids (TSS)

A TSS measurement quantifies all particles suspended in stream water. Closely related to turbidity, this parameter quantifies sediment particles and other solid compounds typically found in stream water. In general, the concentration of suspended solids is greater during high flow events due to increased overland flow. The increased overland flow erodes and carries more soil and other particulates to the stream. The State of Indiana does not have a TSS standard. In general, TSS concentrations greater than 80 mg/L have been found to be harmful to aquatic life (Waters, 1995).

Fecal Coliform

The fecal coliform group of bacteria is monitored in surface waters. These are, respectively, a subgroup of the total coliform group and a single genus and species within the fecal coliform group. If fecal coliform is found in water samples, further tests are typically performed to determine the existence of the *E. coli* bacteria. Indiana code sets a state standard for fecal coliform of 5,000 colonies/100 ml.

E. coli Bacteria

E. coli is one member of a group of bacteria that comprise the fecal coliform bacteria and is used as an indicator organism to identify the potential presence of pathogenic organisms in a water sample. Pathogenic organisms can present a threat to human health by causing a variety of serious diseases, including infectious hepatitis, typhoid, gastroenteritis, and other gastrointestinal illnesses. *E. coli* can come from the feces of any warm-blooded animal.

Wildlife, livestock, and/or domestic animal defecation, manure fertilizers, previously contaminated sediments, and failing or improperly sited septic systems are common sources of the bacteria. The IAC sets the maximum standard at 235 colonies/100 ml in any one sample within a 30-day period.

JFNew collected two sets of water chemistry samples during normal or baseline conditions (base flow) and two sets of water chemistry samples following a period of more than one inch of rain in a 24-hour period (storm flow). Each stream's physical habitat was assessed once in mid to late summer. To ensure comparability to data collected previously by the IDEM, JFNew followed similar stream sampling protocols. The stream sampling and the appropriate quality assurance/quality control procedures are referenced in the project's Quality Assurance Project Plan (QAPP). Appendix B contains the project QAPP and Appendix C contains tables of the results of field sampling performed at the eight sample sites during four base flow and four storm flow events by JFNew. The tables list the field parameters measured and the results at each sampling event, the parameter concentrations calculated for each event, the parameter loading rates, and the parameter areal loading rates (based upon watershed size) for each sample site. Base flow sampling was completed on May 31, 2005 and August 11, 2005. Storm event sampling was completed on June 13, 2005 following more than 1.5" of rain, and on September 26, 2005 following more than 2.5" of rain.

In addition to water sampling, a Qualitative Habitat Evaluation Index (QHEI) was assessed for these sites. Photos taken for the QHEI are located in Appendix D. This assessment quantifies six metrics: substrate, instream cover, channel morphology, riparian zone and bank erosion, pool/glide quality and riffle/run quality, and gradient. Numbers are assigned based on these metrics for a final QHEI score. The IDEM considers scores above 64 to be fully supporting of a balanced warm water community, while scores below 51 are considered to be non-supporting for the stream's aquatic life use designation.

Water Quality Sampling Results

Sample Site 1 - Symons Ditch

Symons Ditch (Plate 3) is the largest of the streams that form the headwaters of the Little Cicero Creek watershed; therefore, water quality impairments in this stream affect the entire watershed (Appendix D - Symons Ditch, Ross Ditch, and Jay Ditch form the Little Cicero Creek's headwaters.) In terms of its physical habitat, this stream received a QHEI score of 49. This suggests that this stream is non-supportive of aquatic life use. Although none of the samples exceeded the Indiana state standards for temperature or pH and contained acceptable levels of total suspended solids (TSS), several other parameters were of concern.

Several areas of concern were identified for Symons Ditch. Dissolved oxygen concentrations were generally good within Symons Ditch; however, the concentration was low (5.06 mg/L) during the June storm event measuring only slightly above the Indiana state standard (5 mg/L). Dissolved oxygen percent saturation levels were also relatively low during the May and August base flow and June storm flow events. Saturation levels ranged from 59.1 percent during the August base flow event to 82.1 percent during the May base flow event. These levels suggest that slow flow may be limiting DO entrainment or that decomposition may be occurring faster than DO can be replaced.

Plate 3. Sample Site 1 - Symons Ditch

Nutrient concentrations were elevated in Symons Ditch. The stream's nitrate-nitrogen concentrations were high with all concentrations exceeding the USEPA recommended criteria and the level at which the Ohio EPA indicates that biotic impairment occurs. Nitrate-nitrogen concentrations ranged from 4.3 mg/L during the August base flow event to 15.1 mg/L during the June storm event. The nitrate-nitrogen concentration present during the June storm event was in excess of the Indiana state standard.

Ammonia-nitrogen concentrations were elevated; however, none of the samples exceeded the Indiana state standard. TKN concentrations were above the USEPA recommended criteria (0.24 mg/L) for all of the samples. However, only the May base flow sample possessed organic nitrogen levels above the USEPA recommended criteria (0.591 mg/L).

Total phosphorus concentrations were also elevated in all of the samples collected. Each of the samples exceeded the USEPA recommended criteria and Ohio EPA concentration recommended for the protection of aquatic biota (0.033 mg/L and 0.08 mg/L, respectively). Biochemical oxygen demand (BOD) is a measurement of the amount of oxygen used by aerobic bacteria as they break down organic matter in the stream (Hoosier Riverwatch, 2006). Higher BOD levels indicate that large amounts of organic material are present within the stream. Only the June storm event sample for BOD exceeded the Indiana state average of 1.5 mg/L (Hoosier Riverwatch, 2006) with a BOD concentration of 2.69 mg/L. Chemical oxygen demand (COD), which measures the amount of oxygen consumed in the decomposition of organic matter through methods other than biological processes, was relatively low in Little Cicero Creek. All of the samples collected possessed COD/BOD ratios higher than the levels recommended for raw domestic wastewater of 1.5-3.0/1.0 (Bookrags.com, 2006). The ratio of COD to BOD was high for all of the samples, suggesting the presence of non-biodegradable materials in the stream (Bookrags.com, 2006).

Pathogen concentrations were also elevated in Symons Ditch. *E. coli* levels were above the state standard (235 colonies/100 mL) for all of the samples. Concentrations ranged from 771 colonies/100 mL during the May base flow event to 4,570 colonies/100 mL during the June storm event. Fecal coliform levels all exceeded the level recommended to be safe for swimming (200 colonies/100 mL; Mitchell and Stapp, 1992). The June storm, August base, and September storm samples were also above the level recommended to be safe for partial body contact (1,000 colonies/100 mL; Mitchell and Stapp, 1992). Only the September storm sample exceeded the Indiana state standard for fecal coliform (5,000 colonies/100 mL).

Compared to the other streams in the watershed, Symons Ditch exhibited high loading and areal loading rates for several of the parameters measured (Areal loading rates are the pollutant loading rate divided by drainage area. This allows for a comparison of loading rates in different sized drainages. Normally, pollutant loading rates in larger drainages are expected to be higher than the pollutant loading rates in smaller drainages.) Symons Ditch possessed the highest ammonia-nitrogen and second highest fecal coliform loading rates during the May base flow event, the second highest total phosphorus and soluble phosphorus loading rates during the August base flow event, and the second highest total phosphorus and fecal coliform loading rates during the September storm event.

This stream also possessed the highest ammonia-nitrogen, *E. coli*, and fecal coliform areal loading rates during the May base flow event, second highest organic nitrogen and soluble phosphorus areal loading rates during the June storm event, and the second highest nitrate-nitrogen and fecal coliform areal loading rates during the August base flow event. Finally, when compared with the other tributaries in the Little Cicero Creek watershed, Symons Ditch loads more nutrients, sediment, and pathogens than any of the other tributaries. This suggests that Symons Ditch may be a potential hot spot for nitrogen, phosphorus, and pathogen based pollutants and that work in the Symons Ditch subwatershed would likely produce the largest positive watershed improvement when compared to other Little Cicero Creek subwatersheds.

Sample Site 2 - Jay Ditch

Jay Ditch (Plate 4) is in the second major stream that forms the Little Cicero Creek headwaters (Appendix D). This stream possessed the lowest QHEI score in the entire watershed with a score of 40. This score indicates that this stream is non-supportive of aquatic life. This stream showed normal temperature and pH levels but exceeded standards for several other parameters.

Dissolved oxygen concentrations varied greatly within Jay Ditch. The dissolved oxygen concentration (3.7 mg/L) and the percent oxygen saturation (45.4 percent) measured during the August base flow event were the lowest levels of any sample measured during the watershed study conducted by JFNew. This concentration is below the Indiana state standard (5 mg/L).

Conversely, the May base flow sample contained the highest dissolved oxygen concentration (11.5 mg/L) measured in any of the Little Cicero Creek watershed streams during this project. This sample also contained the highest percent saturation (126 percent) measured during this project. Both the high (11.5 mg/L) and the low (3.7 mg/L) concentrations impact the biota within the stream. Low dissolved oxygen concentrations suggest that decomposition may be occurring within the stream or that slow flow limits the amount of DO that can enter the stream from the atmosphere. Conversely, the elevated dissolved oxygen saturation suggests that excessive amounts of plants or algae may be present within the stream.

Plate 4. Sample Site 2 - Jay Ditch

Pathogen concentrations were also elevated during all four sampling events that occurred in Jay Ditch. All of the *E. coli* samples exceeded the Indiana state standard (235 colonies/100 mL) ranging from 552 colonies/100 mL in the May base flow sample to 13,540 colonies/100 mL in the September storm flow sample. Additionally, fecal coliform levels all exceed the 200 colonies/100 mL standard recommended to be safe for swimming (Mitchell and Stapp, 1992). Additionally, the June storm, August base, and September storm samples were all above 1,000 colonies/100 mL, which is the recommended concentration to be safe for partial body contact (Mitchell and Stapp, 1992).

The two storm event samples also exceeded the Indiana state fecal coliform standard (5,000 colonies/100 mL). Based on the observation of cows in the stream directly upstream of the sampling site, these pathogen levels are not surprising.

Nutrient levels were high in this stream as well. Nitrate-nitrogen concentrations exceeded the USEPA recommended criteria and the level at which the Ohio EPA indicates that impairment of the aquatic community occurs during the May base and the June storm events. Ammonia-nitrogen concentrations were elevated; however, none of the concentrations exceeded the Indiana state standard.

TKN concentrations all exceeded the USEPA standard (0.24 mg/L) during all sampling events; however, only the June storm event sample was higher than typical TKN concentrations present in Indiana. The June, August, and September samples also exceeded the USEPA standard for organic nitrogen. The amount of phosphorus in the stream was also of concern. The total phosphorus concentration during the June storm event was 0.35 mg/L, which is over the level (0.3 mg/L) at which the IDEM indicates that the waters may be impaired. All of the total phosphorus samples exceeded the USEPA recommended criteria (0.033 mg/L) and the level at which the Ohio EPA indicates that impairment of the biotic community occurs (0.08 mg/L). Finally, nitrogen and phosphorus concentrations were typically higher in Jay Ditch than the other watershed tributaries. BOD levels were higher than concentrations measured at any of the other tributaries during three of the four sampling events. All three of these events exceeded the Indiana average of 1.5 mg/L (Hoosier Riverwatch, 2006). All of the samples collected possessed high COD/BOD ratios suggesting the presence of less biodegradable or non-biodegradable materials (Bookrags.com, 2006).

Jay Ditch possessed elevated loading and areal loading rates when compared with other watershed streams. Jay Ditch possessed the second highest ammonia-nitrogen, organic nitrogen, total Kjeldahl nitrogen, total suspended solids, fecal coliform, and *E. coli* loading rates during the June storm event. This stream also possessed the highest areal load for all the pollutants measured during the June storm event. It also ranked highest for TKN, TP, DP, ON, and *E. coli* areal loading rates during the September storm event. These high areal loading rates in relation to the other streams suggest that the Jay Ditch subwatershed may contribute significantly more to the poor water quality observed throughout the Little Cicero Creek watershed than other tributaries.

Sample Site 3 - Ross Ditch

Ross Ditch (Plate 5) is the smallest tributary to Little Cicero Creek and represents the third branch of the Little Cicero Creek headwaters (Appendix D). During the August assessment, the stream was dry; therefore, no water quality data is available for this sampling date. Among the three tributary streams located at the headwaters of Little Cicero Creek, Ross Ditch exhibited the best water quality during the JFNew water quality study. This stream rated a QHEI score of 56, which suggests that it is partially supportive of aquatic life. The temperature, DO, and pH were all within normal levels.

Plate 5. Sample Site 3 - Ross Ditch

Though Ross Ditch possessed better water quality than Symons Ditch and Jay Ditch, it still contains elevated pathogen, sediment, and nutrient concentrations. *E. coli* concentrations measured in the stream were elevated with all samples exceeding the Indiana state standard (235 colonies/100 mL).

The September storm sample contained the highest *E. coli* concentration measured during the study (18,600 colonies/100 mL). Fecal coliform levels were also high in all of the samples with all samples exceeding the recommended level for swimming (200 colonies/100 mL; Mitchell and Stapp, 1992). Furthermore, the June and September storm samples also exceeded the level recommended for partial body contact (1,000 colonies/100 mL; Mitchell and Stapp, 1992). Like the *E. coli* sample, the September storm sample possessed the highest fecal coliform concentration (7,083 colonies/100 mL) measured during the Little Cicero Creek project. This concentration is in excess of the Indiana state standard (5,000 colonies/100 mL). The TSS concentrations were elevated during all of the sampling events and the concentration measured during the May base flow sampling was higher than any other stream in the watershed during that assessment. Elevated pathogen and sediment concentrations can at least partially be attributed to the cows in the stream immediately upstream of this sampling site.

Nutrient concentrations were also elevated in Ross Ditch. Nitrate-nitrogen concentrations exceeded the USEPA recommended criteria (0.30 mg/L) and the level at which the Ohio EPA indicates that biotic impairment occurs (0.8 mg/L). TKN concentrations were also above the USEPA recommended criteria (0.24 mg/L) in all of the samples that were collected. Additionally, all samples were in excess of the USEPA recommended criteria (0.591 mg/L) for organic nitrogen. Total phosphorus levels were also high with all samples exceeding the USEPA recommended criteria, the level at which the Ohio EPA indicates that biota are impaired, and, in the case of the September storm sample, exceeding the level at which the IDEM suggests that impairment occurs (0.3 mg/L).

Relative to the other streams in the watershed, Ross Ditch generally possessed relatively low loading and areal loading rates. However, Ross Ditch possessed the third highest areal loading rate for ammonia-nitrogen during both the May and September storm samples. It also contained the third highest areal loading rate for TSS during the May base flow event. The relatively small watershed size and low loading rates indicates that work in the Ross Ditch subwatershed should be of lower priority than work in other tributary subwatersheds.

Sample Site 4 - Little Cicero Creek at Anthony Road

Despite possessing the highest QHEI score of any stream (tied with Little Cicero Creek at 266th Street) sampled within the watershed, there were several areas of concern raised by the 2005 sampling of Little Cicero Creek (Appendix D) at Anthony Road (Plate 6). First, the total suspended solids level measured during the June storm sampling was elevated (81.6 mg/L) exceeding the level (80 mg/L) that has been shown to negatively affect aquatic life (Waters, 1995). This stream segment also exhibited *E. coli* concentrations that exceeded the state standard (235 colonies/100 mL) during both base and storm flow conditions.

Plate 6. Sample Site 4 - Little Cicero Creek at Anthony Road

The fecal coliform concentrations were also high with the June storm, August base, and September storm samples all exceeding 200 colonies/100 mL, the level recommended to be safe for swimming (Mitchell and Stapp, 1992). The two storm samples also exceeded the level recommended to be safe for partial body contact, such as boating (1,000 colonies/100 mL; Mitchell and Stapp, 1992). However, none of the samples exceeded the Indiana state standard of 5,000 colonies/100 mL.

Dissolved oxygen concentrations were also a concern in Little Cicero Creek at Anthony Road. The oxygen saturation levels recorded during the June and September storm samples were within normal levels (80 to 90 percent), while the May base sample exhibited supersaturated conditions (113 percent) and the August base flow sample contained low saturation (53 percent). Supersaturated conditions usually indicate the presence of algae or a high density of aquatic plants within the stream. Additionally, because colder water holds more dissolved oxygen, the colder stream temperature observed during the May base flow sampling event likely increased the amount of dissolved oxygen present in the water, thereby leading to supersaturated conditions. Conversely, the August base flow event possessed a low dissolved oxygen concentration (4.5 mg/L), which was below the Indiana state standard (5 mg/L). Low DO concentrations typically occur when decomposition processes within the stream consume oxygen more quickly than it can be replaced or flow is not turbulent enough to entrain sufficient oxygen. Both of these are likely factors at this site; however, the slow flow and elevated stream temperatures likely limited the amount of dissolved oxygen that could be held by the water during the August base flow event.

Nutrient concentrations were also a concern in Little Cicero Creek at Anthony Road. Nitrate-nitrogen concentrations were high with the May base, June storm, and August base samples, which all exceeded the USEPA recommended criteria (0.30 mg/L). The May and June samples also were above the Ohio EPA recommended concentration (0.8 mg/L); however, only the June storm nitrate-nitrogen sample (14.5 mg/L) exceeded the Indiana state standard. Total Kjeldahl nitrogen (TKN) levels were relatively normal for Indiana streams during base flow; however, concentrations were elevated during all of the storm sampling events. TKN concentrations exceeded the USEPA recommended criteria (0.24 mg/L) during all of the sampling events.

Organic nitrogen concentrations were higher during the storm event samplings than those concentrations present during base flow. Organic nitrogen concentrations measured during the storm events exceeded the USEPA recommended criteria (0.591 mg/L).

Total phosphorus concentrations exceeded 0.3 mg/L, the level that IDEM suggested as a standard for declaring a waterbody to be impaired (IDEM, 2006), during both of the storm events. Total phosphorus concentrations exceeded the USEPA recommended criteria and the level at which the Ohio EPA indicates aquatic biota will be impaired in all of the samples. Dissolved phosphorus accounted for 40 percent (June storm) to 91 percent (August storm) of the phosphorus present in Little Cicero Creek at Anthony Road.

While the BOD levels for August and September were at or below the Indiana state average of 1.5 mg/L (Hoosier Riverwatch, 2006), the June storm sample was elevated possessing a concentration of 3.38 mg/L. This was the highest BOD concentration measured in any stream during the June sampling event. COD which measures the amount of oxygen consumed in the decomposition of organic matter through methods other than biological processes, was relatively low in Little Cicero Creek. All of the samples collected possessed COD/BOD ratios higher than the levels recommended for raw domestic wastewater of 1.5-3.0/1.0 (Bookrags.com, 2006). This indicates the possible presence of less biodegradable or non-biodegradable materials (Bookrags.com, 2006).

Little Cicero Creek at Anthony Road exhibited the second highest areal loading rates compared to other streams within the watershed for all pollutants including nitrate-nitrogen, ammonia-nitrogen, TKN, total phosphorus, total suspended solids, *E. coli*, and fecal coliform during the June storm event; second highest areal loading rates for ammonia-nitrogen, total Kjeldahl nitrogen, organic nitrogen, total phosphorus, dissolved phosphorus, total suspended solids, and *E. coli* during the August base flow event; and second highest areal loading rates for ammonia-nitrogen during the September storm event. Based on the input from the tributaries upstream (8,515 acres) and the limited additional drainage (5,115 acres), it is likely that dilution is not yet a large factor in reducing loading rates in the most upstream site along Little Cicero Creek.

Sample Site 5 - Bennett Ditch

Bennett Ditch (Plate 7) is a tributary to Little Cicero Creek, which flows into the creek near 276th Street (Appendix D). The temperature, DO, and pH were all within the normal levels for all of the sampling dates. This stream had a QHEI score of 44, which suggests that the stream is non-supportive of aquatic life.

There were several factors of concern in Bennett Ditch. The TSS concentration during the August sampling period was the highest (64.8 mg/L) of any stream in the watershed during this sampling event. Percent saturation of oxygen was relatively low for the June storm, August base, and September storm sampling events ranging from 73 to 81 percent saturated. *E. coli* concentrations were also high with all samples exhibiting levels above the Indiana state standard (235 colonies/100 mL). Fecal coliform concentrations exceeded 200 colonies/100 mL, which is the level recommended for swimming (Mitchell and Stapp, 1992). The June and September storm samples possessed levels above 1,000 colonies/100 mL, which is the concentration recommended for partial body contact (Mitchell and Stapp, 1992). However, none of the fecal coliform concentrations exceeded the Indiana state standard (5,000 colonies/100 mL).

Plate 7. Sample Site 5 - Bennett Ditch

Nutrient concentrations were also elevated within Bennett Ditch. All of the samples collected exhibited elevated nitrate-nitrogen concentrations which exceeded both the USEPA recommended criteria and the level at which the Ohio EPA determined that aquatic biota become impaired. During each of the sampling events, TKN concentrations exceeded the USEPA recommended criteria (0.24 mg/L). None of the ammonia-nitrogen concentrations exceeded the Indiana state standard. Organic nitrogen levels measured during the June storm, August base, and September storm events all exceeded the USEPA recommended criteria (0.591 mg/L). Total phosphorus levels exceeded both the USEPA recommended criteria and the level at which the Ohio EPA determined that aquatic biota become impaired.

The June storm (1.91 mg/L) and August base (1.85 mg/L) samples possessed BOD levels slightly greater than the Indiana state average (1.5 mg/L; Hoosier Riverwatch, 2006). COD levels were high compared to BOD levels for all of the samples.

Bennett Ditch did not possess high enough loading or areal loading rates to rank within the top three tributary contributors. In fact, Bennett Ditch tended to have the lowest loading rates of any stream within the Little Cicero Creek watershed. Based on this, work within the Bennett Ditch subwatershed should be prioritized lower than work throughout the remainder of the Little Cicero Creek watershed.

Sample Site 6 - Little Cicero Creek at Cal Carson Road

Little Cicero Creek at Cal Carson Road (Plate 8) possessed the lowest QHEI score among the sampling sites located along the mainstem of Little Cicero Creek (Appendix D). The score was 43, which suggests that the IDEM would consider the stream to be non-supporting of its aquatic life use designation. Due to an inability to safely gain access to the stream, no samples were collected during the June storm event. Temperature and pH were all within the Indiana state standards for all of the samples collected.

Plate 8. Sample Site 6 - Little Cicero Creek at Cal Carson Road

Several water quality characteristics of Little Cicero Creek at Cal Carson Road were of concern. The percent saturation of oxygen during the August base sampling was low, with levels reaching only 57.8 percent. Furthermore, the dissolved oxygen concentration was also low measuring 5.9 mg/L. Like Little Cicero Creek at Anthony Road, Little Cicero Creek at Cal Carson Road possessed supersaturated dissolved oxygen conditions (106 percent) during the May base sampling. These fluctuations are likely due to variations in the flow regime and water temperatures as described above.

TSS concentrations were elevated during the September sampling relative to the other streams within the watershed exhibiting a concentration of 64 mg/L. *E. coli* concentrations exceeded the Indiana state standard during all four sampling events ranging from 327 colonies/100 mL during the May base flow event to 4,730 colonies/100 mL during the September storm event.

August base and September storm samples for fecal coliform concentrations exceeded the recommended concentration for swimming (200 colonies/100 mL; Mitchell and Stapp, 1992). The September sample also exceeded the amount recommended for partial body contact (1000 colonies/100 mL; Mitchell and Stapp, 1992) and the Indiana state standard (5,000 colonies/100 mL).

Nutrient concentrations measured in Little Cicero Creek at Cal Carson Road varied during the four sampling events. Both of the nitrate-nitrogen base flow samples (May and August) exceeded the USEPA recommended criteria (0.3 mg/L). Furthermore, nitrate-nitrogen concentrations were higher than levels recommended by the Ohio EPA (0.8 mg/L) for the protection of aquatic biota. TKN levels also exceeded the USEPA recommended criteria (0.24 mg/L) in all collected samples. Ammonia-nitrogen concentrations were all below the Indiana state standard; however, concentrations were elevated at this site suggesting that organic material may have accumulated at this site. The August base and September storm organic nitrogen samples both exceeded the USEPA recommended criteria (0.591 mg/L). Total phosphorus concentrations within Little Cicero Creek at Cal Carson Road were elevated as well. The total phosphorus concentration during the September storm event (0.429 mg/L) exceeded the level at which the IDEM suggests that it would consider as stream impaired (0.3 mg/L). The May and August base samples were below this standard; however, they were in excess of the USEPA (0.033 mg/L) recommended criteria and the level recommended by the Ohio EPA (0.08 mg/L) for the protection of aquatic biota. BOD levels recorded during the August and September sampling events both exceeded the Indiana average (Hoosier Riverwatch, 2006). COD to BOD ratios were also high, possibly indicating the presence of non-biodegradable materials in the stream (Bookrags.com, 2006).

Little Cicero Creek at Cal Carson Road exhibited one of the three highest loads for all parameters during the May base, August base, and September storm sampling events and possessed the highest areal loads for all parameters during the August base flow sampling event.

Additionally, this stream contained the second highest organic nitrogen areal loading rate during the May base flow event and the highest ammonia-nitrogen and second highest total suspended solids areal loading rates during the September storm event. This is to be expected based on the relatively large watershed that drains to this sampling point. Water quality data suggests that during storm events dilution may be reducing the impact of the watershed on the stream at this reach.

Sample Site 7 - Taylor Creek

Taylor Creek (Plate 9) possesses the largest subwatershed of any of the Little Cicero Creek tributaries (Appendix D). The QHEI score of 51 suggests that this stream is partially supportive of aquatic life. Temperature, DO, TSS, and pH all met the recommended standards; however, the concentrations of several pollutants are of concern.

Plate 9. Sample Site 7 - Taylor Creek

Pathogen concentrations within Taylor Creek were elevated during all four sampling events. *E. coli* concentrations measured with all samples exceeded the Indiana state standard (235 colonies/100 mL). Fecal coliform levels exceeded the recommended concentration to be safe for swimming (200 colonies/100 mL; Mitchell and Stapp, 1992) with both storm events also exceeding the concentration recommended to be safe for partial body contact (1,000 colonies/100 mL; Mitchell and Stapp, 1992). However, none of the samples exceeded the Indiana state standard (5,000 colonies/100 mL).

As with all of the streams in the watershed, nutrient levels were also of concern. All of the samples possessed nitrate-nitrogen concentrations in excess of the USEPA recommended criteria and the level at which the Ohio EPA indicated that aquatic biota become impaired. TKN concentrations exceeded the USEPA recommended criteria (0.24 mg/L) during all four sampling events. Organic nitrogen concentrations measured in both storm event samples exceeded the USEPA recommended criteria (0.591 mg/L). The total phosphorus concentrations measured in the all of the samples exceeded USEPA recommended criteria and the level at which the Ohio EPA indicates that aquatic biota will become impaired.

When compared to other streams within the watershed, Taylor Creek ranked the highest for areal load of ammonia for the August base and second highest in May. It had the third highest areal load of TKN, TP, DP, and ON during the September storm sampling. Overall, Taylor Creek contained better water quality than most of the other tributary subwatersheds. Based on this information, work in the Taylor Creek subwatershed should be prioritized lower than work in other subwatersheds.

Sample Site 8 - Little Cicero Creek at 266th Street

Plate 10. Sample Site 8 - Little Cicero Creek at 266th Street

Little Cicero Creek (Appendix D) at 266th Street is the most downstream site sampled in the Little Cicero Creek watershed (Plate 10). This stream possessed a QHEI score of 63, which ties for the highest score in the watershed with Little Cicero Creek at Anthony Road. Temperature, DO, and pH levels were normal for this site. Also of note, the flow was estimated for this site during the June storm sampling date because the stream was inaccessible at the time sampling occurred.

Characteristics of concern at this sampling site include nitrate-nitrogen, ammonia-nitrogen, TKN, TP, TSS, *E. coli*, and fecal coliform concentrations. Nitrogen levels were consistently high throughout the sampling period. Nitrate-nitrogen levels exceeded both the USEPA recommended criteria (0. 30 mg/L) and levels that the Ohio EPA (0.8 mg/L) considers to be harmful for aquatic biota.

TKN levels were elevated at this sampling site ranging from 0.679 mg/L during the August base flow event to 1.78 mg/L during the June storm event. All of the samples exceeded the USEPA recommended criteria (0.24 mg/L). Organic nitrogen levels also exceeded the USEPA recommended criteria (0.591 mg/L) during the May base, June storm, and September storm sampling events. This suggests that organic material may be accumulating at this site and that decomposition of these materials is also occurring. Total phosphorus levels within the stream were high ranging from 0.129 to 0.366 mg/L with all of the samples exceeding the USEPA (0.033 mg/L) recommended criteria and the level at which the Ohio EPA (0.08 mg/L) indicates that impairment of the biotic community could occur.

Following both of the storm events, the TSS concentrations exceeded 100 mg/L. Levels this high can impair the ability of aquatic life to survive within the stream (Water, 1995). Only the BOD sample collected during the June storm event exceeded the Indiana average (1.5 mg/L) with a concentration of 2.75 mg/L (Hoosier Riverwatch, 2006). COD to BOD ratios were high for all of the samples, once again suggesting the presence of non-biodegradable materials within the stream (Bookrags.com, 2006).

Bacterial levels were also elevated during many of the sampling events. *E. coli* exceeded the Indiana state standard (235 colonies/100 mL) during all four sampling events. The samples following storm events were particularly high measuring 12,340 colonies/100 mL in June and 11,620 colonies/100 mL in September. All of the samples contained fecal coliform levels in excess of the amount recommended to be safe for swimming (200 colonies/100 mL; Mitchell and Stapp, 1992). The June, August, and September samples ranged from 1950 to 6000 colonies/100 mL, amounts considerably higher than levels recommended for partial body contact (1,000 colonies/100 mL; Mitchell and Stapp, 1992). The June fecal coliform sample was also in excess of the Indiana state standard (5,000 colonies/100 mL).

This location of Little Cicero Creek also exhibited the highest loads of all parameters during the June (with estimated storm flow) and September storm sampling events. It also possessed the highest loading rates for all parameters except ammonia-nitrogen for the May sampling.

In August, it had the highest loading rates for nitrate-nitrogen, ammonia-nitrogen, *E. coli*, and fecal coliform, and the second highest loading rates for TKN, TP, ON, and TSS. This is as expected since the site location is downstream of all of our sampling sites, and concentrations of pollutants tend to accumulate as they are moved downstream. When drainage area is taken into account, Little Cicero Creek at 266th Street possessed the highest areal loading rates for TKN, TP, ON, and TSS and second highest for nitrate-nitrogen during the May base flow event. During for the September storm event, this site contained the highest TSS areal loading rate and the second highest *E. coli* areal loading rate.

3.3 Watershed Tours

Watershed tours were conducted in order to record observations of potential water quality impacts along the mainstem of Little Cicero Creek and its tributaries. The first tour, performed in November of 2005, was attended by various members of the watershed steering committee. The second tour was performed by JFNew staff. The primary purpose of the tours was to identify areas of water quality impacts and locations for possible water quality improvement projects. Figure 14 shows areas of noted water quality impacts, or *critical areas*, such as areas of severe bank erosion, livestock access to streams, heavily tilled fields, and potential nutrient sources such as residential lawns or nursery operations. The most notable water quality impact observed during both tours was the large amount of heavily tilled land, particularly throughout the northeastern portion of the watershed. It was estimated that, based on late fall and early spring observations, roughly 5,700 acres of the Little Cicero Creek are under heavy till. Plate 11 illustrates a typical erosional feature observed in the tilled fields.

Plate 11. Erosional Features in Tilled Field

3.4 Watershed Interviews

In order to gauge general perceptions of water quality issues in the Little Cicero Creek watershed, JFNew performed phone interviews during the week of June 21, 2006, with a number of stakeholders who live and/or work in the area. While not able to speak with all of the targeted interviewees, JFNew was able to have conversations with Tom Cain - Sheridan Building and Zoning Commissioner, Charles Kiphart - Hamilton County Planner, Mark Eckstein - Sheridan Wastewater Treatment Plant (WWTP) manager, and Janette McGavic - Hamilton County Health Department official. Information gathered during the interview process was considered during the decision-making process of this WMP.

It was the general opinion of the Sheridan Building and Zoning Commissioner and the Hamilton County Planner that runoff from agricultural fields is the primary water quality problem in the watershed. When asked of their ideas of optimal water quality conditions, they responded that the goal should be to make water healthy for body contact (swimming, skiing, and other recreational activities), and fishing.

JFNew inquired if erosion is a problem in the watershed and if so, are there any areas that should be of concern. The general response was that erosion is a problem everywhere and it is due to agriculture, but not just in Little Cicero Creek watershed. When asked whether their constituents have concerns about the water quality in the watershed, they both replied no, but also mentioned that no constituents have voiced their opinions to them.

One of the most important issues that will affect the Little Cicero Creek watershed in the future is development. When asked how much of the watershed they foresee being developed for residential use in the next 20 years, the zoning commissioner responded that there will be growth around the town area of Sheridan and the planner believed that a good portion of the watershed will be developed, including large land areas that will be converted to residential areas. Areas being focused on for development are primarily around Atlanta, Arcadia, Sheridan, and Cicero in the town area. One also mentioned planning to develop large lots in the watershed.

JFNew completed the survey with the Sheridan Building and Zoning Commissioner and the Hamilton County Planner by asking what types of drainage systems they would like to see utilized. They expressed a preference for sanitary and storm sewers over septic systems.

Also mentioned was a preference for more naturalized stormwater management systems such as grassed swales, landscaped streams, and water retention ponds over stormwater pipes and outfalls. It was the general opinion that it would be hard to get developers to choose alternative stormwater BMPs.

The next interview was with the Sheridan Wastewater Treatment Plan (WWTP) manager. When asked what happens to wastewater when there is a large rain event or flooding, he responded that there are no stormwater bypasses and that all of the wastewater that goes to the WWTP is treated. He mentioned that the Sheridan WWTP has never been overloaded or overflowed. JFNew then inquired as to whether the plant has ever experienced an episode where untreated wastewater has entered a surrounding waterbody. He replied that there has not been any episode in which untreated wastewater has entered a surrounding waterbody.

JFNew completed the survey by asking if the wastewater treatment plant tested for nitrogen and phosphorus levels. The response was that, yes, they do testing for these nutrients. Mr. Eckstein mentioned that 0.1 mg/L of phosphorus is an acceptable level and removal of phosphorus after treatment is usually 95 percent, but is certainly about 85 percent removal. An acceptable level for nitrogen is 0.01 mg/L and 90-95 percent is removed. For the bacteria *E. coli* and fecal coliform he stated that there is no testing in the effluent, but the effluent is treated with chlorine to kill the bacteria before being released back into the stream.

The final interview was with Janette McGavic, County Health Department official. When asked which pollutants are of concern in the watershed, based on health department water quality sampling, she responded was that the health department does not do sampling in the Little Cicero Creek watershed, but there are three sampling sites in Morse Reservoir. She mentioned that sampling at these three sites is only done for *E. coli*. She mentioned that septic records are public record and may be reviewed for records of septic system failures or septic system complaints.

JFNew asked if the County Health Department uses die testing to find septic failures and if so, how often do they test. The Health Department's response was that yes they use dye testing when they get a complaint.

If a complaint comes in, they go to the site, collect a water sample, and test the *E. coli* level. They also collect a water sample from a yard if there is a pooling area. The homeowners are notified if a pipe is broken or leaking and needs to be replaced or repaired. If a water sample comes back high for *E. coli* they will do a dye test.

JFNew inquired whether there are areas of the county where building or the usage of septic systems is not allowed due to soil properties. She responded that there are areas that are not allowed for building or sewage systems. Contractors receive a copy of the new septic system packet owner's guide and permit procedure. They are supposed to do soil borings to test soil properties. If there are sewers within 300 feet of the property line then they must connect into the sewer system.

JFNew followed up by asking for a general opinion on the placement of septic systems in the area. Ms. McGavic replied that more complaints are filed in the more populated areas. When asked whether most septic systems are properly maintained (cleaned and functioning properly), she responded that the septic packet has instructions. Solids are removed every five years and that 2006 is the first year that the health department has sent out reminder letters or tracked system maintenance. The only problem septic area that was mentioned was Bakers Corner, which is in a separate watershed.

JFNew wrapped up the survey by asking if there is any septic data or published information on surface water or groundwater. Ms. McGavic responded that she knew of nothing published and that recreational samples will be on the county health department's website.

3.5 Water Quality Concerns

3.5.1 *E. coli*

The primary water quality concerns for the Little Cicero Creek watershed are the elevated *E. coli* and fecal coliform concentrations measured within the watershed streams. All of the water quality samples contained concentrations of *E. coli* greater than the Indiana state standard (235 colonies/100 mL). Concentrations ranged from 1.1 to more than 80 times the Indiana state standard. These concentrations are similar to results obtained during the IDEM sampling.

Fecal coliform concentrations were also high with all but two samples possessing levels greater than 200 colonies/100 mL as suggested by Mitchell and Stapp (1992) as a benchmark for good water quality. However, only six of the samples contained fecal coliform concentrations in excess of the Indiana state standard (5,000 colonies/100 mL). Concentrations of *E. coli* and fecal coliform measured in stormwater samples generally exceeded those measured in base flow samples. Possible sources of *E. coli* and fecal coliform include: runoff from agricultural fields and pastures, wildlife, or residential septic systems that surround the streams.

3.5.2 *Nutrients*

Nitrate-nitrogen and total phosphorus (TP) concentrations were elevated throughout the Little Cicero Creek watershed. Nitrate-nitrogen and total phosphorus concentrations routinely exceeded the USEPA recommended nutrient criteria and the Ohio EPA's median concentration determined for the protection of aquatic biota during both base flow and storm flow sampling events. The total nutrient load was estimated at approximately 57 tons/year and was calculated by combining the total phosphorus and total nitrogen loads. Total phosphorus in the watershed was estimated at approximately 48 tons/year, and total nitrogen was estimated at approximately 9 tons/year.

Nitrate-nitrogen concentrations also exceeded the Indiana state drinking water standard during the first storm sampling event. (Nitrate-nitrogen samples were discarded by the laboratory due to not meeting their Quality Assurance/Quality Control standards.) Like *E. coli* and fecal coliform concentrations, storm event water quality samples typically contained elevated nitrate-nitrogen and total phosphorus concentrations compared to those measured during base flow. This suggests that nitrate-nitrogen and TP concentration increases may be due to runoff from agricultural fields, animal pastures, wildlife, or faulty septic systems. These nutrients support algae and plant growth within the waterbodies.

3.5.3 *Sediment*

Also of concern are the elevated total suspended solids (TSS) concentrations measured in the Little Cicero Creek watershed. Stream reaches along the mainstem of Little Cicero Creek routinely possessed TSS concentrations in excess of levels determined to impair aquatic biota. Ross Ditch, Bennett Ditch, and Jay Ditch also possessed elevated TSS concentrations during one or more of the base flow sampling events.

In general, temperature, pH, and conductivity concentrations did not exceed the Indiana state standards during base or storm flow sampling. Dissolved oxygen (DO) concentrations at two locations were below the state standard during one of the base flow sampling events. Indiana requires that the dissolved oxygen concentration remain above 5.0 mg/L within surface waters of the state. This concentration is considered to be essential for the respiration of fish and other aquatic biota. Jay Ditch and Little Cicero Creek at Anthony Road both contained low DO levels, which were below the state standard during one of the base flow events. Symons Ditch, Jay Ditch, Little Cicero Creek at Anthony Road, and Little Cicero Creek at Cal Carson Road all possessed dissolved oxygen saturation levels that were relatively low. These low levels suggest that the decomposition of organic material or the presence of low flow which limits the amount of dissolved oxygen that can enter the stream from the atmosphere. Elevated organic and total Kjeldahl nitrogen (TKN) concentrations measured in these streams suggest that decomposition is likely one of the key factors limiting biotic communities in these streams. The majority of the samples collected during the watershed study possessed biochemical oxygen demand levels close to or slightly higher than the Indiana state average of 1.5 mg/L (Hoosier Riverwatch, 2006). However, the ratio of Chemical oxygen demand (COD) to biochemical oxygen demand was considerably high at all of the sampling sites. These high ratios may indicate the presence of less readily biodegradable or non-biodegradable substances within the waterbodies (Bookrags.com, 2006).

3.5.4 *Overall Pollutant Load*

Overall, Jay Ditch, Symons Ditch, and Ross Ditch possessed the poorest water quality of the Little Cicero Creek tributaries. These three streams also possessed the highest pollutant loads determined for the tributaries. Finally, when the pollutant loadings are normalized for drainage area, these streams contained the highest areal loading rates as well.

3.5.5 *Habitat Assessments*

The Qualitative Habitat Evaluation Index (QHEI), which assesses the quality of streams and their ability to support a balanced warm-water community, indicated that the streams within the watershed were either partially supportive or non-supportive of their aquatic life use designation.

With the exception of Little Cicero Creek at Cal Carson Road, reaches along the Little Cicero Creek mainstem possessed higher quality habitat than that present within the tributaries. This may be due to stream channelization, lack of pool and riffle development, narrow or absent riparian zones, and/or lack of high quality substrates. All of these factors contribute to the deterioration of quality habitat for aquatic organisms. Further degradation of the streams within the Little Cicero Creek watershed should be minimized. Additionally, the usage of BMPs such as buffer strips along the streams could improve water quality by slowing runoff into the stream channel.

3.5.6 *Atrazine*

Atrazine, a pesticide used to treat weeds, is used on more than 80 percent of corn grown in Midwest states. It is highly effective and relatively inexpensive. However due to its widespread use and moderately high solubility, it is widespread in surface water across the Midwest, including source water for community public water systems. Atrazine was identified in an informal survey conducted in 1998 as the top water quality concern of operators of surface water systems in Indiana. (Frankenberger, 2006)

Systems using surface water systems are much more vulnerable to pesticide contamination than systems using ground water, and small systems are more likely than large systems to have Atrazine exceeding 3 ppb (the MCL) in finished water. Although large systems that use surface water face high pesticide levels in the source water at times, most of them have the capacity to treat the water.

3.6 Results Analysis

In order to interpret the sampling results and set water quality goals for the implementation of this WMP, the data had to be converted into a useable format. Therefore, the concentrations calculated in the lab were converted into loading rates. For example, Phosphorus, Nitrate, and sediment concentrations were converted into tons/year of total load into the watershed system. Appendix C contains a table which shows the loading rates of the various water quality parameters that were measured in the sampling series.

For the purpose of this watershed plan and setting load reduction goals, annual load was calculated for sediment and nutrient concentrations measured during JFNew's eight sampling events. Based on flow and pollutant concentration calculations, the average annual load of sediment was estimated to be 2,158 tons/year. The combined nutrient load into the Little Cicero Creek watershed was estimated to be 57 tons/year.

3.7 Critical Areas

In order to meet the pollution reduction goals that will be outlined in Sections 6 and 7 of this report, the areas showing the most degraded water quality and contributing the highest pollutant loads to the watershed should be concentrated on first for the installation of BMPs and other water quality improvement measures.

In Section 3.5.4, Jay Ditch, Symons Ditch, and Ross Ditch, were highlighted as the subwatersheds with both the highest pollutant loads per tributary and the highest areal loads in the Little Cicero Creek watershed. Each of these subwatersheds begins as head water to Little Cicero Creek and flows through primarily agricultural land. In light of this, when the implementation of the Little Cicero Creek WMP begins, the subwatersheds of Jay, Symons, and Ross Ditches should be considered critical areas and thus priority areas for implementation of water quality improvement BMPs. Specific BMPs determined to help meet pollutant reduction goals set by this report will be outlined in Section 6.

One important issue to keep in mind through the implementation of this WMP is that approximately 95 percent of the soils in the watershed (Figure 9) are categorized as "severely limited" for septic system use. As critical areas are more finely tuned during the implementation of the plan, these areas of severely limited soils (particularly in the subwatersheds of Jay, Symons, and Ross Ditches) should be prioritized for septic system BMPs.

Final areas to look at in highlighting critical areas for WMP implementation are the locations of the six proposed wetland restoration sites indicated in Figure 14. These locations were primarily chosen for their suitable soil and hydrologic characteristics, but they are each located in a headwater area of Little Cicero Creek, making them critical areas for creating additional buffer zones to stop the flow of nutrients into the watershed.

4.0 CLARIFYING OUR PROBLEMS

4.1 Linking Concerns to the Existing Data

Throughout the planning process, watershed stakeholders were invited to share their concerns for the Little Cicero Creek watershed, its waterbodies, and their water quality. All of the stakeholders' concerns identified during the planning process were detailed in the Concerns Section of the Introduction (Section 1.8). The project sponsor and facilitating consultant developed a group of broad categories within which the planning process to develop problem statements, identify priority areas, and set goals for watershed and water quality improvement. The process of developing problem statements began with an investigation of stakeholder concerns and data collected during the watershed inventory process.

4.1.1 *Developing Problem Statements*

Problem statement development occurred through the planning process in an effort to tie watershed stakeholders' concerns with existing data and develop a clear pathway for future work in the Little Cicero Creek watershed. The problem statements reflect information gathered during the planning process. Details regarding stressors, pollutant sources, and identified critical areas are listed for each problem statement. Once the problem statements were approved, the stakeholders were surveyed and asked to rank the problem statements in order from the most important to the least important. The rankings were weighted and averaged, and the problem statements below are presented in the order of importance determined by the stakeholders. Critical areas identified during the watershed inventory process are identified in Figure 14.

Problem Statement 1

Pathogen levels in the watershed regularly exceed the state standard of 235 colonies/100mL, and often even exceed safety standards for partial human contact with the water (1,000 colonies/100mL)

Stressor: *E. coli* bacteria
Source: Animal waste
Human waste

Critical Areas:	Livestock access to streams
	Failing septic systems
	Agricultural fields where manure application is used
	Symons Ditch, Jay Ditch, and Ross Ditch

Problem Statement 2

Excessive nutrient levels, documented in historic and recent water quality sampling, are negatively affecting the quality of downstream surface waters such as Morse Reservoir

Stressor:	Nutrients
Sources:	Residential use of lawn fertilizer
	Agricultural use of crop fertilizer
	Organic materials
	Soil erosion
	Livestock access to streams
	Improper disposal of yard waste
	Future residential development sites
	Runoff from livestock pasture
	Manure application to agricultural fields
Critical Areas:	Crop fields
	Residential lawns, particularly those close to surface water bodies (streams or ponds)
	Any areas where yard waste may be disposed
	Livestock operations (either pastured or confined)
	Nursery operations
	Symons Ditch, Jay Ditch, and Ross Ditch

Problem Statement 3

Sediment load carried through the watershed is degrading and filling waterbodies in the watershed and limiting their use for drainage, wildlife habitat, recreational, and aesthetic purposes

Stressor:	Silt/sediment
	Pollutants that bind to sediment

Sources:	Bank erosion
	Mismanagement of erosion control practices at construction sites
	Lack of soil conservation practices in agricultural fields
	Changes in land use
	Livestock access to streams
	Application of agricultural herbicides, pesticides, and fertilizers
Critical Areas:	Crop fields that are intensively tilled
	New development areas
	Eroding streambanks and channels that have been cleared of stabilizing vegetation and root systems
	Areas where livestock can trample streambanks
	Symons Ditch, Jay Ditch, and Ross Ditch

Problem Statement 4

It is important to form a WMP that equitably accommodates the individual interests of stakeholders in the watershed and downstream

Stressor:	Diverse values and lifestyles
Sources:	A diversity of water usage needs
	Various land use practices throughout the watershed
Critical Areas:	Agricultural producers
	Existing communities
	New developments

Problem Statement 5

Residents in the watershed are not knowledgeable about their daily impact on the watershed and its water quality

Stressor:	Lack of public education
Source:	Today's lifestyle is not conducive to daily analysis of the consequences of everyday activities

Critical Areas:	Residential lawn care - application of fertilizer, lawn/garden watering
	Residential septic maintenance
	Outdoor water usage - car washing
	Privately owned pond and/or streambank management

Problem Statement 6

It is important to provide stakeholders the support and resources needed to implement the WMP and ensure the continuity of the watershed planning group into the future

Stressor:	Lack of continuity in linking the WMP with implementation
Sources:	Changes in political leadership
	Lack of interest among watershed stakeholders
	Lack of funding
Critical Areas:	Local government
	Local non-profit or environmental interest groups
	Schools

Problem Statement 7

Residents in the watershed are largely unaware of the watershed planning process or the existence of the watershed group

Stressor:	Lack of public education
Source:	Lack of interest in watershed issues due to lack of education
Critical Areas:	Schools
	Neighborhood associations
	Local interest groups
	Agricultural property owners

4.1.2 *Linking Problem Statements to Concerns*

Each problem statement had to be linked to at least one stakeholder concern. Table 7 reflects the stakeholders' concerns, any existing data identified that supports or refutes those concerns, and identifies the problem statement linked to that particular concern.

Table 7. Linking Stakeholder Concerns with Existing Data

Concern	Existing Data	Problem Statement
Education, Outreach, and Plan Development		
Stakeholders need to be better informed with respect to the health of their watershed	Discussions with local stakeholders confirm that they could be better educated with respect to water quality and how to manage the watershed to improve water quality	5
The watershed management needs to be developed using a clear set of guidelines	In order to be eligible for implementation funds, the watershed plan must follow a set format and be approved by the IDEM	7
Statements made regarding the current conditions in the watershed must be backed by scientific data	No data was available to confirm or refute the concern	7
Water quality impacts to be addressed in the plan must be prioritized	In order to be eligible for implementation funds, the watershed plan must follow a set format and be approved by the IDEM	7
Stakeholders need to be educated with respect to their daily impact on the watershed	Discussions with local stakeholders confirm that they could be better educated with respect to how their daily activities impact the watershed in which they reside	5
Impact assessments and solutions must be equitable	No data was available to confirm or refute the concern, but in order for the watershed plan to be successful, there must be buy-in and support from all stakeholders	4
Land Use Planning and Development		
Watershed plan must address long term land use planning and development (10-30 years)	No data was available to confirm this concern, but short term solutions will not provide for a healthy watershed in the future	6
Planning must focus on preserving existing communities and accommodating the growth of new communities	Discussions with stakeholders confirmed their concerns about future development impacting changing the character/quality of life of existing communities	6
The effect of future growth on water quality needs to be monitored over time	Discussions with stakeholders confirmed their desire to track the water quality impacts of future planning efforts in the watershed	6

Table 7. Linking Stakeholder – Continued

Concern	Existing Data	Problem Statement
Stormwater BMPs should be integrated into future management plans	Research on pollutant runoff suggests that stormwater BMPs can increase infiltration, slow overland flow, and provide pollutant uptake from runoff before it enters the waterways	6
Existing green space must be preserved, and future planning must allow the creation of additional green space	No data was available to verify this, but green space offers aesthetic, wildlife habitat, and recreational value to communities	6
Zoning ordinances should be developed with respect to their impacts on water quality	No data was available to verify this, but zoning determines land use, which impacts the type and amount of pollutants entering surface waters from a site	5
Construction practices must be monitored to protect water quality	No data was available to verify this, but research on pollutant runoff suggests that significant erosion occurs on active construction sites	3
Illicit discharges and pipes may carry excess levels of sediment, nutrients, and pollutants to Little Cicero Creek.	The Hamilton County Surveyor's office will be mapping these areas over the next four years.	1, 2, 3
Agricultural Practices		
Ditch maintenance (dredging, bank cutting, removal of vegetation) impacts the sediment load of waterways	Numerous areas of bank clearing, channel cutting, and severe bank erosion were identified during the November 2005 watershed tour and a subsequent stream crossing survey performed in April 2006.	3
The use of conservation practices by agricultural producers needs to be continued and increased	Filter strips and no-till agriculture are used in some areas of the watershed, but numerous areas in the watershed were identified during the watershed tour and stream crossing survey where no conservation practices are being used. It was estimated that approximately 5,700 acres of the watershed were tilled.	6
Overuse of fertilizers contribute to nutrient loading in the watershed	Discussions with stakeholders confirm a concern about residential use of fertilizers over use by agricultural producers	2

Table 7. Linking Stakeholder – Continued

Concern	Existing Data	Problem Statement
The impact of Atrazine use in the watershed is not known at this time	There is currently no data on Atrazine levels in the watershed, but the toxicity of the chemical indicates a strong need for further study. In addition, Atrazine binds to soil particles and the high rate of sediment loading in the watershed indicates that Atrazine may be entering Morse Reservoir from Little Cicero Creek	3
Wildlife impacts bacteria levels in waterways	Discussions with stakeholders confirmed their concern about the impact of large populations of Canada Geese on water quality	1
Areas of highly erodible soils (HES) and potential highly erodible soils (PHES) can contribute a significant amount of sediment load to the watershed	While not dominant, there are some areas of HES and PHES in the watershed where soil conservation practices are not being used	3
Bank erosion can contribute a significant amount of sediment load to the watershed	During the watershed tour and stream crossing survey, numerous areas of bank erosion were identified	3
Ditch maintenance concerns must be balanced with water quality concerns	Conversations with stakeholders confirmed a concern that water quality/habitat issues not take precedence over drainage issues	4
Livestock in the stream can cause streambank erosion and provide nutrients, sediment, and pathogens to the stream	During the watershed land inventory, numerous areas where livestock have access to Little Cicero Creek or its tributaries were documented.	1, 2, 3
Downstream Impacts		
The quality of the water flowing from Little Cicero Creek has a direct impact on the water quality of Morse Reservoir	No data is available to verify this concern, but Little Cicero Creek does comprise 20 percent of the reservoir's total watershed, which means it likely impacts Morse Reservoir	4
Recreational use of the reservoir is restricted by bacterial levels	Residents reported incidents of ear infections after contact with the water. Water sampling revealed frequent levels of fecal coliform above that of state standards	1
Morse Reservoir experiences algae blooms which may be a symptom of high nutrient levels	Little Cicero Creek contributes elevated volumes of nitrogen and phosphorus to Morse Reservoir. A triathlon event was cancelled in the year 2005 due to an algae bloom.	2

Table 7. Linking Stakeholder – Continued

Concern	Existing Data	Problem Statement
Water quality within Morse Reservoir is declining	No data is available to verify this concern. Additional work on the health of Morse Reservoir needs to be completed.	1, 2
Water depth is declining within Morse Reservoir, especially on the north end where sediment drops out of the water as it hits the lake	No data is available to verify this concern. Additional work on the health of Morse Reservoir needs to be completed.	3
Sources of fecal coliform need to be pinpointed	Discussions with stakeholders confirmed that they want to know specific sources of pathogens in order to more effectively manage them. Areas to pinpoint in an investigation include aging septic systems, areas where livestock have access to streams, and the possibility of wildlife as a source of fecal coliform.	1
Little Cicero Creek contributes only a small portion of the total inflow to Morse Reservoir	Watershed area calculations revealed that Little Cicero Creek is 20 percent of Morse Reservoirs total inflow	4
Disposal of waste oil and household hazardous waste is impacting the water quality of Morse Reservoir	No data is available to verify this concern, but many stakeholders who pour household waste into sewers do not understand that they are polluting the watershed	2
Remaining concerns are not concerns for which specific information can be gathered to confirm or refute the issue. Therefore, these concerns are not included.		

5.0 SETTING GOALS

5.1 Potential Goals and Techniques

To address the problem statements, goals were developed and techniques identified for accomplishing the goals. Initial goals were derived from the stakeholder concerns and resulting problem statements. During the May 11, 2006, stakeholder meeting, steering committee members reviewed and refined the potential goals, and then prioritized them according to the problem statements to which they applied. The potential goals and techniques listed below were refined and then used as a basis for the final goals, objectives, and action items developed later in the planning process. The potential goals are listed below in the order that they were developed; and hereafter will be listed in the order to which they apply to the prioritized problem statements. The number in parentheses listed with each potential goal is the problem statement(s) to which that goal applies.

Potential Goal 1

Reduce the concentrations of *E. coli* in the watershed to meet the state standard of 235 colonies/100mL by 2030. (1)

Potential Techniques:

- Determine specific sources of *E. coli* (anthropogenic, wildlife, livestock)
- Replace failing septic systems, connect with city sewers where available
- Restrict livestock access to streams
- Proper disposal of waste
- Monitor the outfall of the Sheridan Wastewater Treatment Plant for *E. coli*

Potential Goal 2

Reduce the nutrient load entering Morse Reservoir from Little Cicero Creek by 25 percent by the year 2010 and 60 percent by the year 2015. (2)

Potential Techniques:

- Watershed land management (develop riparian buffers, use phosphorous-free fertilizers, proper yard and pet waste disposal, restricting car washing)
- Wetland restoration projects (for uptake of nutrients before water enters streams)

- Enforce erosion control ordinances
- Monitor the outfall of the Sheridan Wastewater Treatment Plant for nitrogen and phosphorus

<u>Potential Goal 3</u>

Reduce the sediment load during storm events to Little Cicero Creek and its tributaries by 50 percent over the next five years. (3)

Potential Techniques:

- Restrict cattle access to streams
- Streambank stabilization (biolog installation along non-regulated drains, Palmiter techniques, soil encapsulated lifts)
- Enforcement of erosion control ordinances
- Ditch buffers/ grassed waterways
- Open space ordinance
- Wetland restoration (to reduce stress on streambeds and banks)
- Place the watershed on a regulated drain maintenance program
- Further assess watershed for sediment binding pollutants such as Atrazine

<u>Potential Goal 4</u>

Increase stakeholder participation in implementation of the Little Cicero Creek WMP by forming a watershed group (4, 5, 6, and 7)

Potential Techniques:

- Outreach (newsletters, newspaper articles, website, demonstration projects)
- Coordination with local community groups or units of local government (Hamilton County Drainage Board/Surveyor's Office, Hamilton County Parks Department, Upper White River Alliance, lake and neighborhood associations)
- Public education (clean-up/field days, volunteer monitoring through schools and community groups)
- Engage a diverse group of stakeholders to ensure equitable distribution of responsibilities and costs associated with plan implementation

5.2 Final Goals and Objectives

The following goals and action plan are a result of several public and steering committee meetings. Once the watershed assessment was complete and the baseline water quality data reviewed, stakeholders identified the issues of greatest concern in the watershed, developed problem statements, identified sources of watershed impairment, and set goals to address those issues. The following action plan is designed to address the identified sources of impairment. The plan also includes the means to identify and pinpoint additional sources where sufficient data could not be identified.

The stakeholders identified their primary watershed concerns in the first public meeting on June 30, 2005 (Section 1.8). Once the concerns were identified, problem statements were developed to address each concern (Section 4.1.1) and then prioritized by importance. Critical areas where these watershed concerns should be first addressed were determined by the results of JFNew's water sampling analysis. These areas, based on total pollutant load and areal loading rates, were determined to be the subwatersheds of Jay Ditch, Symons Ditch, and Ross Ditch.

Stakeholders considered the environmental, economic, and social impacts of the proposed WMP, and the action plan was designed to target the specific issues of concern (*E. coli*, nutrients, sediment, and stakeholder participation) and improve the water quality in the Little Cicero Creek watershed and downstream. Stakeholders took economic concerns into consideration by creating a management plan that for the most part could be implemented by active volunteers (Section 6.0). Most of the action items that cannot be completed by a volunteer work force may be eligible for outside funding. This might include funding to hire a consultant to complete work that volunteers are not able to do. The social impact of the plan was considered in Goal 4, as it was important to stakeholders that the responsibility for implementing the management plan be equitably distributed among landowners in the watershed. Stakeholders also agreed that increased public involvement in the watershed management process will be integral to the successful implementation of the plan. The action plan also includes a number of action items designed to increase public awareness of the value of the natural resources in the Little Cicero Creek watershed. Many of the action items and objectives listed with specific goals will be applicable to other goals, for example, a BMP action listed under sediment load reduction goal will also address the issues of reducing nutrient and/or pathogenic pollution.

The following are the prioritized goals and respective action plans for the Little Cicero Creek watershed:

Goal 1: Increase stakeholder participation in implementation of the Little Cicero Creek WMP by forming a watershed group or joining an existing watershed group such as the Upper White River Watershed Alliance (UWRWA).

Goal time frame: Other than continuous or annual tasks, this is a goal which should be achieved by the summer of 2007.

Goal notes: As a small but somewhat consistent group of individuals have attended most of the watershed planning meetings to date, these individuals will likely be charged with maintaining the current attendance standard and will work with other community members to boost interest and participation in the implementation phase of the Little Cicero Creek WMP. Meeting this goal will require that a core group of individuals begin implementation of this plan and meet at least on a quarterly basis. A number of stakeholders who attended the October 11 public meeting expressed an interest in forming a watershed group and pursuing implementation of the WMP.

Associated costs: With the exception of personnel time, there are no real costs associated with this goal. The watershed group would likely be able to borrow Hoosier Riverwatch sampling equipment for use during stream monitoring.

Estimated load reduction: A direct load reduction cannot be calculated for this goal or any of its objectives or action items.

Potential targets: This goal targets the entire Little Cicero Creek watershed and all those who reside within it. This goal is designed to help form partnerships among community members, county officials, and community groups in the watershed. Any efforts toward forming an active, cohesive group directed at improving water quality in the watershed will provide longevity for the Little Cicero Creek WMP.

With no action: If a watershed group is not formed, there will be no system for implementing the WMP and none of the water quality benefits associated with plan implementation will be realized.

Objective 1a: Establish a core group of individuals willing to work together to generate interest in the WMP, coordinate implementation of the plan, and discuss watershed management issues and water quality concerns in the watershed.

Action Items:

- Contact potential core group members including the local IDNR conservation officer, high school biology teacher, Morse Waterway Association Members, UWRWA members, Hamilton County SWCD, or other community and conservation groups active in the watershed.
- Advertise the formation of the group in local newspapers and mailing to stakeholders, using the existing stakeholder database.
- Host regular water quality meetings in various locations throughout the watershed.
- Biannually, invite local, regional, and state natural resources professionals to attend watershed group meetings. Hold discussions dealing with local and state efforts/events highlighting water quality (including regulatory efforts) and resources available to assist watershed groups.
- Publish meeting minutes via an email list, newsletter, and/or website. These publications should include information detailing current and future efforts at improving water quality, the aesthetic value of a healthy watershed, and information on how stakeholders may get involved in these efforts.

Objective 1b: Develop a volunteer monitoring network through Hoosier Riverwatch.

Action Items:

- Identify groups (local schools, Girl/Boy Scouts, 4-H groups, other community groups) that may be interested in participating in volunteer monitoring.
- Identify landowners along Little Cicero Creek and its tributaries who may be willing to allow a group of volunteers to perform water quality monitoring on their property. Target property owners at the eight sites sampled during the watershed inventory phase of the WMP.

- Attend Riverwatch training sessions.
- Advertise results of sampling to the community through various media outlets mentioned in Objective 4a.
- Enter results of the sampling efforts into the Hoosier Riverwatch online database.

Objective 1c: Apply for implementation funds for the Little Cicero WMP.

Action Items:

- Apply for Section 319 implementation funds during the 2007 application period.
- Investigate additional funding sources listed in Appendix E for eligibility and funding availability.

Objective 1d: Once funding is obtained, hire a watershed coordinator who will be overseen by the watershed group and responsible for coordinating the implementation of the WMP.

Action Items:

- The watershed group will create a list of potential duties of the watershed coordinator, using the Little Cicero Creek WMP as a guide.
- Develop list of duties and job description for the watershed coordinator position.

Goal 2: In two years, the watershed group will develop a better understanding of the processes involved in identifying the sources of *E. coli* (i.e. failing septic systems, wildlife, domestic pets, etc.) and educate stakeholders on BMPs available to reduce pathogenic contamination of Little Cicero Creek and its tributaries. The ultimate goal will be to reach the state standard of 235 col/100 mL by the year 2030.

Goal notes: As part of sampling done during the development of the WMP, it was determined that *E. coli* concentrations are of concern throughout the watershed, particularly during storm events. In addition, Little Cicero Creek and many of its tributaries are included in the 2006 303(d) list as impaired for *E. coli*. Identification of the sources of the *E. coli* will be necessary to direct the management of this pollutant and setting a goal for reduction of *E. coli* in the watershed.

The current average concentration of *E. coli* in the watershed for the four sampling events performed by JFNew is 4,177.7 col/100mL. This average is slightly misleading, for while samples taken during base flow were slightly elevated in most places, the storm sample concentrations were so high in some parts of the watershed that it drove the average up very high.

Once the processes involved in identifying the sources of *E. coli* are better understood, the watershed group will be able to target management efforts appropriately in the subwatersheds of concern and set a realistic reduction goal. This goal will be continually revisited during subsequent revisions to the WMP.

Following guidance included in the draft 2006 303(d) list, Little Cicero Creek in the Little Cicero Creek-Bennett Ditch/Taylor Creek watershed, Bennett Ditch, Taylor Creek, and other tributaries will be included on Indiana's list of impaired waterbodies for *E. coli*. Because of the high levels of *E. coli* found in these waters, these areas of the Little Cicero Creek watershed will require Total Maximum Daily Load (TMDL) evaluation in the future. This process will determine the specific pollutant loading that the stream can handle and still meet water quality standards (IDEM, 2006).

Many of the objectives and action items listed for Goals 3 and 4 may also help reduce the concentration of *E. coli* in the Little Cicero Creek watershed. Completing specific tasks targeting the identification of *E. coli* sources, identification and management of failing septic systems and/or the promotion of septic system maintenance, establishment of riparian buffers and vegetated waterways, and restriction of cattle access to streams, will increase the likelihood of this happening as well. Other potential tasks should target education of watershed residents and participation in development of the *E. coli* TMDL for the Little Cicero Creek watershed and initiating a cost share program for implementing BMPs for *E. coli* throughout the watershed.

Associated costs: Tasks associated with this goal will primarily involve personnel time. Actual dollar costs associated with the educational tasks are low, totaling less than $5,000 over the next ten years.

Estimated load reduction: As the pathogen levels are estimated as concentrations, not as loads, load reductions were not calculated for this goal.

Goal time frame: Except for annual/biannual/continuous tasks, the goal should be reached by the year 2030.

Objective 2a: Perform research to better pinpoint the presence and locations of possible sources of *E. coli* contamination.

Action Items:

- Search health department public records for recorded septic system failures or maintenance records.
- Collect information on the location and number of livestock (cattle, swine, goats, or sheep) that are either housed or grazed in the watershed.
- Identify the areas of the watershed where manure is applied to agricultural fields and determine the amounts that are applied.
- Continue to monitor the load of *E. coli* in Little Cicero Creek and its tributaries. Monitoring should be continued monthly during the growing season (May to October) and quarterly during the remainder of the year.
- Establish additional sampling locations in order to help narrow down possible sources of *E. coli* and their locations (near the outfall of the Sheridan wastewater treatment plant, downstream of cattle operations, downstream of possible septic outfalls).
- Use Hoosier Riverwatch volunteers to perform sampling.
- Track results in a water quality sampling database.
- Compare results throughout the lifetime of sampling.
- Publish sampling results to the watershed group (Goal 1) and in the local newspaper.
- Publish a newspaper article targeting the list or summarizing BMPs available to reduce the risk of pathogenic contamination in the Little Cicero Creek watershed.
- Host an annual information booth at the Hamilton County Fair.

Objective 2b: Work with county sanitary officials to identify any failing septic systems and promote proper septic system maintenance in the watershed.

Objective notes: Figure 9 shows that almost the entire watershed is covered by soils that are severely limited for septic system use; thus, focusing on any part of the watershed for addressing failing septic systems would prove beneficial. Because a priority area needs to be determined, the subwatersheds with the highest levels of pathogenic contamination will be targeted first. These areas include the subwatersheds of Symons, Jay, and Ross Ditches (see 3.5.4 Overall Pollutant Load).

During the interview process the Sheridan wastewater treatment plant (WWTP) was contacted. According to Mark Eckstein, Sheridan WWTP manager, no releases of *E. coli* occur at the plant because all water is treated with chlorine before being released into Symons Ditch.

Action Items:

- Work with the Hamilton County Health Department to identify any failing septic systems in the watershed, targeting the areas noted above first.
- Develop a summary of BMPs available to reduce the risk of pathogenic contamination of waterbodies in the Little Cicero Creek watershed. The list should include management techniques to address contamination from all potential sources. In addition, the list should be written to target a non-technical audience.
- Distribute the BMP summary list via email, a newsletter, or a link on a county website.
- Start a cost share program to help stakeholders in the watershed implement BMPs for *E. coli* control such as cattle exclusion, development and implementation of manure management plans for livestock operations, and septic systems BMPs.
- Work with the Hamilton County Plan Commission (HCPC) to develop a local ordinance that all properties sold with existing septic systems be required to perform septic system tests at the time of sale.
- Work with the HCPC to require that property owners installing new septic systems provide proof that the systems are installed correctly and according to code.
- Work with the HCPC and Hamilton County Health Department to explore wastewater management options other than septic systems for new construction in the watershed.

Objective 2c: Work with the Hamilton County SWCD to implement a cost share program for the application of BMPs to reduce pathogenic contamination of Little Cicero Creek and its tributaries.

- Develop a summary of BMPs available to reduce the risk of pathogenic contamination of waterbodies in the Little Cicero Creek watershed. The list should include management techniques to address contamination from all potential sources. In addition, the list should be written to target a non-technical audience.
- Distribute the BMP summary list via email, a newsletter, or a link on a county website; along with possible funding sources (see Appendix E).
- Host a field day highlighting the installation of various BMPs such as cattle exclusion fencing, proper manure management, and septic system maintenance.

Goal 3: By the year 2015, reduce the nutrient load entering Morse Reservoir from the watershed 60 percent along Little Cicero Creek and its tributaries.

Goal notes: The draft version of Goal 3 was written with a general reduction range (25-50 percent) in mind because load reduction calculations had not yet been completed to determine an appropriate load reduction goal percentage. Upon completing the calculations, it was estimated that a 60 percent reduction could actually be reached. It was decided that striving to meet the greatest reduction possible was desirable, so the final goal was set at 60 percent. Load reduction calculations were calculated using the IDEM/USEPA Region V Pollutant Load Reduction Model.

The acreage and condition of existing riparian buffers in the Little Cicero Creek watershed is not known at this time. Habitat sampling and walking tours of Little Cicero Creek and its tributaries conducting as a part of this plan's development provide a rough estimate of buffer coverage. Enough detailed information was gathered to set a target condition for riparian buffers, but a large amount of the filter strips were placed based on study of aerial photos, which is not a perfect way to lay out BMPs.

Ground studies will also be necessary to further assess appropriate areas for filter strip installation. The action plan described below includes a complete survey of the riparian zone of Little Cicero Creek and its tributaries so that stakeholders can refine this goal in future revisions to the WMP.

The Hamilton County Parks Department has shown interest in acquiring additional natural areas for park properties. The survey of the riparian zone in the watershed should take note of any areas to set aside as conservation or preservation areas.

Goal time frame: Other than continuous or annual tasks, this is a long-term goal which should be achieved by the year 2015.

Goal notes: Figure 14 shows critical areas of water quality concern as they are related to land use. The map shows numerous areas where nutrient loading is believed to occur in greater amounts than in other parts of the watershed (areas in pink such as nursery operations or fertilized lawns). Of particular concern are areas along streams or in headwater areas.

According to the manager of the Sheridan WWTP, nutrients are monitored at the outfall from the treatment plant and no sample results showing elevated levels of nitrogen or phosphorus coming from the treatment plant are documented.

The watershed inventory phase of this management plan allowed the steering committee to create a general idea of the condition of riparian buffers in the watershed, but the total acreage and condition of existing riparian buffers was not explored in detail. Habitat sampling and driving tours of Little Cicero Creek and its tributaries conducted as a part of this plan's development provided a rough estimate of buffer coverage, but a more detailed survey of the buffer coverage is necessary to set a target condition for riparian buffers. The action plan described below includes a complete survey of the riparian zone of Little Cicero Creek and its tributaries so that stakeholders can refine this goal in future revisions to the WMP. Figure 15 shows proposed areas of concentration for the installation of riparian buffer/filter strips.

Associated costs: All the tasks associated with this goal will utilize personnel time. Actual dollar costs associated with educational tasks are low; likely totaling less than $5,000 over the next ten years.

Livestock restriction is estimated to cost approximately $2 per linear foot, installing a vegetated filter strip for a demonstration project should cost approximately $3,000 to $10,000, and a wetland restoration project can range from a few thousand dollars up to $5,000 per acre.

Costs associated with converting to no-till are wrapped primarily in a one-time cost of converting farm equipment for no-till. The main challenge is how to manage the tillage system and the additional management improvements that make it a successful system. With no-till, the costs of carrying tillage equipment are eliminated.

Converting to no-till typically means (for most producers) the addition of heavier down-pressure springs, row cleaners, and possibly a coulter on each planter row unit. The actual cost of converting existing equipment ranges between $300 and $400 per planter row, which for many producers, amounts to a nominal additional production cost of approximately $1 or $2 per acre per year. (Al-Kaisi and Tidman, 2002)

The cost of establishing filter or buffer strips varies according to equipment, labor costs, grading, seed, and fertilizer used. Landowners may be eligible for CRP or EQIP funding assistance (See Appendix E) and may also receive technical or financial assistance from federal, state, or local sources. The local USDA Service Center has information on specifically what technical and financial help is available to help design and establish buffers, including assistance from state and local programs.

Congress created the Clean Water State Revolving Fund (CWSRF) program to provide reduced-rate loan funding for water quality projects of all kinds, including agricultural BMPs. All 50 states and Puerto Rico manage CWSRF programs that are similar to banks. Federal and state contributions have established CWSRF programs, and states use these assets to provide low or no-interest loans to important water quality projects. As borrowers repay CWSRF loans, states use the loan repayments to fund other important water quality projects.

CWSRF programs nationwide have more than $34 billion in assets and fund $3-4 billion in water quality projects each year. Many states have used their CWSRF programs to fund agricultural BMPs. States have provided funding for a wide variety of projects, including waste management systems, manure spreaders, conservation tillage equipment, irrigation equipment, filter strips, and streambank stabilization. A comprehensive list of possible funding sources for water quality improvement projects is included in Appendix E.

Estimated load reduction: It is estimated that the current nutrient load in the Little Cicero Creek watershed averages approximately 57 tons/year (48 tons/year of total phosphorus and 9 tons/year of nitrogen). As land use changes within the watershed and individuals implement water quality improvement projects, the nutrient load can be re-estimated and load reduction re-calculated. Most of the objectives listed under this goal are education and assessment related.

BMPs that will most significantly reduce the nutrient load over time are agricultural and focus on conservation practices such as installing filter strips and converting to no-till. BMPs such as streambank stabilization show nominal impacts on nutrient loading and are very cost restrictive. Objectives and action items listed for other goals, specifically Goal 4 may possess associated load reductions, if applicable. Refer to these objectives for the anticipated reduction in nutrient loading in the Little Cicero Creek watershed.

In order to meet the goal of a 60 percent reduction in nutrient load by the year 2015, approximately 1,826 acres of currently tilled agricultural fields will need to be converted to no-till and approximately 305 acres of filter/buffer strips (with a buffer width of 75 LF) will need to be installed. Over a period of eight years (2007 through 2015), 305 acres of filter strips will reduce the nutrient load by 1.24 tons/year and 1,826 acres of no-till will reduce the nutrient load by 3.15 tons/year. The total reduction in nutrient load in the year 2015 will equal approximately 35.12 tons, which is 60 percent of the current nutrient load of 57 tons/year.

Potential targets: Specific target associated with this goal include educating stakeholders regarding the use of conservation agricultural practices (such as no-till) and restricting livestock access to Little Cicero Creek and its tributaries. All watershed residents and user groups are targeted by this goal.

With no action: If water quality improvement projects, such as cattle exclusion, septic system improvements, and agricultural BMPs are not implemented it is anticipated that sediment and nutrient loading will likely remain at current levels or increase as erosion continues, existing septic systems continue aging, and population levels increase throughout the watershed.

Objective 3a: Map the zone extending approximately 150 feet from the edge of each creek bank along Little Cicero Creek and its tributaries.

Action Items:

- Identify all property owners along Little Cicero Creek and its tributaries using plat maps and information from the county assessor's office.
- Identify which portions of Little Cicero Creek and its tributaries are legal drains on which the county might hold easements to access the waterbody.
- Develop a spreadsheet/database containing all property owners and their addresses.
- Obtain permission to survey the entire length of Little Cicero Creek and its tributaries.
- Survey the entire length of Little Cicero Creek and its tributaries. The survey area should include the zone extending approximately 150 feet from the edge of each creek bank.
- Map the results of the survey in a GIS or similar system. Attributes such as the type of vegetation, width of each vegetation zone, presence of invasive species, and condition of vegetation should be included with the geographical data.
- Work with the Hamilton County Parks Department and the Central Indiana Land Trust to develop a plan for protecting and preserving existing riparian buffers along Little Cicero Creek and its tributaries.

Objective 3b: Educate watershed landowners on the importance of riparian buffers to protect water quality and biotic life in Little Cicero Creek and its tributaries.

Action Items:

- Meet with county drainage board representatives to identify which "Best Management Practices" (BMPs) are recommended along legal drains to protect, enhance, and manage riparian buffers and how landowners may obtain permission to implement these practices.

- Once the database documenting where buffer restoration or improvement should be targeted is available, work cooperatively with the NRCS on agricultural properties to encourage landowners to use available funds to restore or improve buffer zones.
- Work cooperatively with the county drainage board on properties that lie adjacent to legal drains (some overlap with agricultural properties noted above is likely) to encourage landowners to implement BMPs to restore and protect buffer zones.
- Identify non-agriculturally oriented funding sources to assist residential and commercial property owners with restoring riparian zones.
- Organize and hold two annual demonstration days with the NRCS, the IDNR, county drainage board, or private landowners to demonstrate a healthy, functioning riparian buffer. One demonstration day will occur in an agricultural setting, while the second demonstration day will occur in a residential/commercial setting.
- Publish brochure/newsletter containing information on the importance of riparian buffers for protecting water quality and biotic life in Little Cicero Creek and its tributaries and how to receive funding to restore riparian buffers.
- Add information on the Little Cicero Creek website documenting the importance of riparian buffers for protecting water quality and biotic life in Little Cicero Creek and its tributaries and how to receive funding to restore riparian buffers.
- Publish biannual columns for the local newspaper emphasizing the importance of riparian buffers for protecting water quality and biotic life in Little Cicero Creek and its tributaries and how to receive funding to restore riparian buffers.

Objective 3c: Educate watershed stakeholders regarding what they can do to reduce nutrient loading to the watershed.

Action Items:

- Identify potential techniques that individual stakeholders can do personally to improve water quality in the watershed. These techniques may include establishing riparian buffers along non-regulated drains, installing filter strips, using less fertilizer, establishing a protocol for yard and pet waste disposal, or encouraging homeowners to wash cars in lawn areas away from existing drains that carry water into nearby streams.
- Work with the SWCD and the IDEM project managers to locate or develop educational materials addressing BMPs and distribute them to stakeholders.

- Host one annual demonstration day highlighting BMP activities that watershed residents can complete on their own.
- Identify business operations in the watershed that use fertilizers (such as nursery operations or farming operations either using fertilizers or practicing manure application) and find out what kind of nutrient management plans, if any, are in place.
- Develop a county ordinance requiring nursery and livestock operations to implement nutrient management plans.

Objective 3d: Work with the Hamilton County SWCD to educate users to reduce sediment and nutrient loading into Little Cicero Creek and its tributaries.

Action Items:

- Investigate and obtain funding to install a demonstration filter strip in the watershed.
- Host a volunteer day to complete installation of a filter strip.
- Educate agricultural producers in the watershed on the benefits of installing filter strips and the use of other agricultural BMPs.
- Identify a location, find funding, complete a design, and complete construction of a vegetated swale and/or rain garden for demonstration somewhere in the Little Cicero Creek watershed.
- Work with the Hamilton County Surveyor's Office to place more regulated drains on maintenance, which will make them eligible for funding to install BMPs such as filter strips.

Objective 3e: Restore wetlands in the Little Cicero Creek watershed, where feasible.

Objective notes: In general, restoring wetlands will increase storage potential in the watershed. In addition to providing flood control, wetlands also slow overland flow and allow sediment to settle, serve as groundwater recharge sites, act as nutrient traps through the uptake of nitrogen and phosphorus by wetland vegetation, and contribute to the maintenance of the natural hydrologic regime of the Little Cicero Creek watershed. This helps prevent bed and bank erosion in streams by storing water during high flow events and protecting streams from the energy associated with high flow.

Plate 12. Wetland Restoration Area B

Plate 13. Wetland Restoration Area F

Six potential wetland restoration projects (Wetland Restoration Areas A through F on Figure 14) were identified during the watershed inventory process. Plates 12 and 13 show two of the possible restoration areas identified during the watershed tour.

Individual landowners will need to be contacted to assess their interest and willingness to participate in a wetland restoration project. Additional restoration possibilities may be located by using the hydric soils map (Figure 9) which shows extensive areas of hydric soils (soils which developed under wetland conditions) throughout the watershed. Primary areas targeted by this objective are the potential wetland restoration sites mapped in Figure 15, but additional wetland restoration opportunities should not be ruled out.

Restoring wetlands can range from several thousand dollars to remove drainage tile up to $5,000 per acre if additional excavation is required and/or the area must be planted to promote the growth of native species. As plans have not yet been developed for the potential wetland restoration areas and final cost estimates are not available. The final cost of any restoration projects is included as an action item for this objective.

Action Items:

- Finalize location(s) of wetland restoration areas (proposed areas shown in Figure 15) and seek funding for a demonstration restoration project (funding opportunities are list in Appendix E).
- Work with a NRCS District Conservationist to determine the expected hydrology in a restored or constructed wetland.

- Contact landowners where potential restoration projects may be located to determine their interest in participating in a restoration project.
- Work with the IDNR, the NRCS, the local SWCD, and/or other wetland restoration experts to develop a restoration plan and cost estimates for the wetlands.
- Design the size, placement, and construction methods required for creating or restoring a wetland.
- Determine if control of exotic/invasive plant species will be necessary and decide on appropriate control mechanisms.
- Procure funding sources for wetland restoration projects.
- Obtain any necessary permits and permissions needed to complete a wetland restoration/creation project.
- Work with the Hamilton County SWCD and/or the UWRWA to develop and maintain a database of possible wetland restoration areas for mitigation or conservation areas.

Objective 3f: Promote a reduction in fertilizer use.

Action Items:

- Distribute information regarding the impact of fertilizers on water quality and the importance of reducing fertilizer use in the watershed via a newsletter, email list, or a possible link to a county website.
- Residential stakeholders should be provided information on how to test their soils to determine the need for fertilizers.
- Encourage residents to apply phosphorus-free fertilizers to lawns.

Objective 3g: Restrict livestock access to streams and install filter strips along reaches of stream where livestock are grazed.

Estimated cost: It is estimated that livestock fencing will cost approximately $2 per linear foot of fencing installed. Additional potential costs may include seeding, gate installation, and construction of alternate watering resources for livestock. Cost estimates for these items are not listed here as associated costs will depend upon the landowners' preferences. Targeted areas in the watershed for potential livestock exclusion are shown in Figure 15.

Action Items:

- Work with the NRCS and landowners in the watershed to identify cost effective solutions for restricting livestock access to Little Cicero Creek and its tributaries.
- Identify alternate watering solutions for livestock.
- Obtain funding for construction of alternate water sources and installation of livestock exclusion fencing.
- The Drainage Board can exercise its authority under Indiana Code (IC) 36-9-27 to restrict cattle from regulated drains.

Objective 3h: Encourage the use of no-till and other agricultural BMPs throughout the watershed.

Estimate load reduction: As this objective will deal primarily with educating landowners about how they can reduce nutrient loading, no specific loading calculations were made for this objective. It is anticipated that an increase in conservation BMPs used by stakeholders will help meet Goal 2.

Objective notes: In order to meet the goal of a 60 percent reduction in nutrient loading by the year 2015, a large amount of land will need to be put into conservation tillage and filter strips.

Action Items:

- Work with the SWCD to educate agricultural producers in the watershed regarding conservation BMPs such as no-till, crop rotation, pasture rotation, conservation cover, critical area planting, ridge-till planting and fertilization, or strip-cropping.
- Educate watershed stakeholders regarding the economic benefits of conservation tillage. Studies have shown that costs can be significantly lower per bushel produced using some conservation practices (Rehm, 2004).

Objective 3i: Convert 1,826 acres of tilled agricultural fields to no-till and install 305 acres of filter strips where appropriate (focusing on fields adjacent to streams and headwaters).

Estimate load reduction: During the watershed tours, approximately 5,700 acres of tilled agricultural fields were observed. The current nutrient load into the Little Cicero Creek watershed is approximately 57 tons/year. According to the IDEM Region V Loading Model, for every ten acres of agricultural field that is converted to no-till, the annual nutrient load will be reduced by 29 pounds. The use of filter strips associated with fields that are converted to no-till (particularly those fields adjacent to surface waters) significantly increases the load reduction.

In order to meet the goal of a 60 percent reduction in nutrient load by the year 2015, approximately 1,826 acres of currently tilled agricultural fields will need to be converted to no-till and approximately 305 acres of filter/buffer strips (with a buffer width of 75 LF) will need to be installed. Over a period of eight years (2007 through 2015), 305 acres of filter strips will reduce the nutrient load by 1.24 tons/year and 1,826 acres of no-till will reduce the nutrient load by 3.15 tons/year. The total reduction in nutrient load in the year 2015 will equal approximately 35.12 tons, which is 60 percent of the current nutrient load of 57 tons/year.

Objective notes: In order to meet the goal of a 60 percent reduction in nutrient loading by the year 2015, a large amount of land will need to be put into conservation tillage and filter strips. In order to best achieve this goal, agricultural fields near streams and headwaters will be prioritized (see Figure 15).

Action Items:

- Publicize the availability of funding assistance for installing filter strips and implementing agricultural conservation BMPs.
- Use the riparian zone map created under Objective 2a to prioritize areas for installation of filter strips and use of no-till agricultural practices.

Objective 3j: Continue to monitor the nutrient load in Little Cicero Creek and its tributaries. Monitoring should be continued monthly during the growing season (May to October) and quarterly during the remainder of the year.

Action Items:

- Identify volunteers to participate in Hoosier Riverwatch Training.
- Complete Hoosier Riverwatch monitoring on a monthly or quarterly basis.
- Maintain a water quality sampling database to track results.
- Compare results throughout the lifetime of sampling.
- Publish sampling results to the watershed group (Goal 1) and in the local newspaper.
- Publish a newspaper article targeting the list or summarizing BMPs available to reduce nutrient loading in the Little Cicero Creek watershed.

Objective 3k: Promote the use of phosphorus-free fertilizers or a reduction in fertilizer use in both residential and agricultural areas.

Objective notes: Garn (2002) estimated that the use of phosphorus-free fertilizer may reduce phosphorus runoff from lawns by as much as 57 percent.

Action Items:

- Distribute information regarding the impact of fertilizers on water quality and the importance of reducing fertilizer use in the watershed via a newsletter, email list, or a possible link to a county website. Residential stakeholders should be provided information on how to test their soils to determine the need for phosphorus in residential fertilizer applications and how to obtain phosphorus-free fertilizer.
- Investigate the market potential for phosphorus-free fertilizer in the Little Cicero Creek watershed.
- Work with the Hamilton County SWCD to promote tools for better nutrient management for agricultural operations.

Objective 3l: Encourage county officials to maintain vegetated filter strips along legal drains and to reduce the use of chemical applications along Little Cicero Creek and its tributaries.

Action Items:

- Meet with the Hamilton County Surveyor to determine the maintenance schedule for regulated drains in the Little Cicero Creek watershed.
- Attend at least one Hamilton County Drainage Board meeting annually.

Goal 4: Reduce the sediment load to Little Cicero Creek and its tributaries by 50 percent over the next ten years.

Goal time frame: Other than continuous or annual tasks, this is a goal which should be achieved within ten years of project implementation.

Goal notes: The results of TSS concentrations in the Little Cicero Creek watershed showed sediment load exceeding recommended standards primarily during storm events. Therefore, Goal 3 sediment load reductions will target storm events as well.

Associated costs: All the tasks associated with this goal will utilize personnel time. Actual dollar costs associated with educational tasks are low; likely totaling less than $5,000 over the next ten years. Cost estimates for streambank stabilization can range from $5/LF installed and $75/LF installed, depending upon the method of streambank stabilization installed and the type of labor (volunteer versus paid labor) to installed the BMPs. Total cost estimates for streambank stabilization may range around $60,000 and up. Cost estimates for wetland restoration and buffer installation projects are discussed in detail under Goal 3. Approximately 19,000 LF of stream were observed to have cattle access during the two watershed tours. Areas where cattle accessed streams consistently showed moderate to severe streambank erosion.

Estimated load reduction: The average sediment load in the watershed was calculated to be approximately 2,158 tons per year (T/yr). Goal 3, Objective 3i detailed the amount of no-till and filter strips necessary to reduce the nutrient load 60 percent by the year 2015.

The BMPs proposed in Objective 3i included 1,826 acres of no-till and 305 acres of filter/buffer strips. The associated nutrient load reduction as a result was a total of 35.12 tons over eight years (2007 through 2015). The sediment load reduction associated with these BMPs was estimated by the IDEM Region V Model to be approximately 2,369 tons per year, which more than meets the proposed 50 percent reduction in sediment load by the year 2015.

Potential targets: Specific targets associated with this goal include converting tilled agricultural fields to no-till, installing filter strips along fields adjacent to water bodies and near headwaters, and implementing livestock exclusion along Little Cicero Creek and its tributaries (see Figure 15). Six wetland restoration possibilities were located and discussed in Goal 3, Objective 3e. All watershed residents and user groups are also targeted by this goal.

With no action: If water quality improvement projects, wetland restoration, livestock exclusion, and buffer enhancement, are not implemented it is anticipated that sediment loading will likely remain at current levels or increase as erosion continues throughout the watershed. If BMPs to reduce sedimentation are not implemented, it is likely that erosion and sediment transport will continue from these and other sites in the watershed. In addition, the transport of sediment-born pollutants such as phosphates and Atrazine will increase as sediment load increases.

Objective 4a: Implement streambank stabilization techniques along non-regulated reaches of Little Cicero Creek and its tributaries.

Estimated load reduction: Sediment load calculations were taken at eight sampling sites in the watershed during four sampling events (two during base flow and two during storm flow) and the average sediment load in the watershed was calculated to be approximately 2,158 tons per year (T/yr). According to calculations derived from the IDEM USEPA Pollutant Load Reduction Model (Steffen, 1982), the amount of streambank stabilization necessary to attain Goal 4 (a 50 percent reduction in sediment load over the next ten years) will be dependent upon the soil types at the specific sites proposed for erosion control.

Areas targeted as sediment load "hot spots" (livestock access areas and streambank erosion areas highlighted in Figure 14) were dominated by either silt loam soils or silty clay loam soils. If erosion control BMPs are used in areas of primarily silt loam soils, approximately 25,036 LF of streambank erosion control will need to be installed in order to reduce the sediment load into the watershed by 50 percent in five years. If BMPs are installed in areas with dominantly silty clay loam soils (such as areas along Symons Ditch and Ross Ditch), approximately 26,600 LF of streambank erosion control will need to be installed. Stabilizing larger eroded banks will likely result in larger reductions in sediment load. It should be noted that the measured total of suspended solids is an estimate of the annual load rather than a calculation of it. As the current annual sediment load in the watershed was based on only four sampling events, there is likely error associated with the results. Regardless, it is reasonable to expect a reduction in sediment load if the banks along the eroding portions of the creeks are stabilized.

The streambank stabilization load reductions achieved by simply implementing the nutrient load reduction BMPs demonstrate the importance of treating the source of sediment carried into waterbodies as nonpoint source pollution. Streambank stabilization is often considered a "band-aid" solution to controlling sediment loss from watersheds. Even though the sediment load reduction goal will be met by simply implementing the recommended nutrient load reduction BMPs, streambank stabilization BMPs should still be considered for the additional load reduction that will result. Because of the expense associated with installing streambank stabilization BMPs, any techniques installed should be considered secondary BMPs for sediment load reduction that while important, should not be prioritized above the nutrient control BMPs.

During the watershed inventory process, approximately 19,000 LF of streambanks in need of stabilization were observed. Because of this, and also due to the high cost associated with streambank stabilization it is not feasible to install over 25,000 LF of streambank stabilization BMPs. In addition, streambank stabilization techniques do not reduce sediment transport from the source, so it is important to consider other methods for addressing the sediment load in the Little Cicero Creek watershed.

In Goal 3, approximately 305 acres of filter strips and 1,826 acres of no-till were proposed. In addition to reducing the nutrient load to the watershed, these BMPs also offered sediment reduction benefits of approximately 2,369 tons per year, which more than meets the 50 percent sediment load reduction described in Goal 4.

While streambank stabilization will not solve the sediment and nutrient load issue in the Little Cicero Creek watershed, smaller scale streambank demonstration projects may be useful as educational tools for watershed stakeholders.

Estimated cost: The total cost for streambank stabilization BMPs varies with the specific techniques used. Techniques applied will be determined on a site-specific basis, according to the degree and location of erosion. The following list details typical costs per linear foot for different bank stabilization techniques:

- Palmiter methods - $45/linear foot installed, $10/linear foot if installed by volunteer laborers
- Coir fiber logs (with native plants) - $55/linear foot installed, $20/linear foot if installed by volunteer laborers
- Willow staking, fascines, or mats - $35/linear foot installed, $5/linear foot or less if installed by volunteer laborers
- Bank reshaping, erosion control blanket and seeding - $25/linear foot installed, $10/linear foot if installed by volunteer laborers
- Soil encapsulated lifts - $75/linear foot installed, $35/linear foot if installed by volunteer laborers

Costs associated with installing filter/buffer strips and converting agricultural land to no-till are outlined under Goal 3.

Action Items:

- Contact respective landowners to assess their interest in participating in streambank stabilization projects on their properties.
- Apply for the IDEM Section 319 Supplemental funds or the IDNR Lake and River Enhancement (LARE) grants to implement stabilization BMPs.
- Once funding is obtained, hire a consultant to finalize stabilization designs.

- Hire a contractor or organize volunteers to install a stabilization BMP demonstration project.

Objective 4b: Reduce erosion from active construction sites.

Objective notes: This objective focuses on both the education of the watershed group and of developers in the area. Specific on-the-ground implementation tasks are not a part of this objective.

Action Items:

- Become familiar with typical erosion control practices used at both small (1 acre) and large (>5 acres) construction sites.
- Work with county officials to require erosion control on all construction sites regardless of whether it is required by the state under Rule 5.
- Work with county officials to enforce erosion control ordinances that include provisions requiring site clearing to be done in phases, eliminating the possibility of complete site clearing.
- Work with state or county officials to ensure that Rule 5 is being enforced at all sites to which it is applicable.
- Develop a system of recognition for county builders and developers actively implementing effective erosion control practices on active construction sites.

Objective 4c: Encourage the use of soil conservation practices in rural and agricultural areas of the Little Cicero Creek watershed including conservation tillage, grassed waterways, vegetated stream buffers, or other structural BMPs as needed.

Objective notes: The specific items that are identified and implemented will determine the implementation cost and sediment load reduction. As this objective is again targeted at cataloging and educating stakeholders rather than specifically installing BMPs, there is no specific load reduction associated with this objective.

Action Items:

- Identify agricultural producers who are using no-till and other conservation practices.

- Facilitate interaction between those producers using conservation practices and other landowners interested in adopting conservation practices by hosting one demonstration day annually.
- Apply for cost-share funding to install practices.

Objective 4d: Continue to monitor the sediment load in Little Cicero Creek and its tributaries. Monitoring should be continued monthly during the growing season (May to October) and quarterly during the remainder of the year.

Action Items:

- Identify volunteers to participate in Hoosier Riverwatch Training.
- Complete Hoosier Riverwatch monitoring on a monthly or quarterly basis.
- Maintain a water quality sampling database to track results.
- Compare results throughout the lifetime of sampling.
- Publish sampling results to the watershed group (Goal 1) and in the local newspaper.
- Publish a newspaper article targeting the list or summarizing BMPs available to reduce sediment loading in the Little Cicero Creek watershed.

Objective 4e: Continue to work with Hamilton County officials to increase awareness of any proposed development in the Little Cicero Creek watershed.

Action Items:

- Although the Little Cicero Creek area is not yet experiencing significant development, the rapid rate of growth in other parts of Hamilton County indicates that development will be increasing in the near future. In light of this, it is recommended that the Little Cicero Creek watershed group establish and maintain a good working relationship with Hamilton County Planning officials.
- Attend at least one Hamilton County Planning meeting annually.
- Work with the Hamilton County SWCD to develop a recognition/reward program for developers using “smart practices” such as alternative stormwater or green building principals in new developments.

Objective 4f: Restrict livestock access to all regulated drains in the watershed and install filter strips along historically grazed portions of Little Cicero Creek and its tributaries.

Estimated load reduction: Over 19,000 LF of stream were estimated to have cattle access during the two watershed tours. Areas where cattle accessed streams consistently showed moderate to severe streambank erosion. The average sediment load in the watershed was calculated to be approximately 2,157.84 tons per year (T/yr).

Earlier sediment load reduction calculations showed that BMPs proposed for nutrient load reductions (no-till and filter strips under Goal 3) provide more than enough sediment load reductions needed to meet the sediment load reduction outlined in Goal 4. Due to cost restrictions, large-scale streambank stabilization projects are not feasible at this time. If streambank stabilization BMPs are installed only along non-regulated reaches of stream where cattle have access, approximately 9,000 LF of stream will be stabilized. This will reduce the sediment load in the Little Cicero Creek watershed by an additional approximately 108 tons/year.

Objective 4g: Create an Atrazine monitoring network to assess whether Little Cicero Creek is contributing unsafe levels (greater than 3 ug/mL or 0.003 mg/L) of Atrazine to Morse Reservoir.

Objective notes: Protecting drinking water sources such as Morse Reservoir from the risk of pesticide runoff is difficult. The complexity of the task is one of the reasons a detailed susceptibility analysis to agricultural pesticides is not included in most source water assessments. The purpose of an Atrazine monitoring network will be to:

- Determine the amount of Atrazine entering Morse Reservoir from Little Cicero Creek
- Assess potential water quality impacts of changes to pesticide application and management practices in watersheds used by small community water systems
- Make the information gathered during the monitoring available to the public
- Educate pesticide applicators and the public about watersheds used by community water supply systems, and the importance of knowing about these watersheds in making pesticide applications.

Action Items:

- Develop a database on Atrazine application rates specific to agricultural land in the Little Cicero Creek watershed
- Include Atrazine sampling in the on-going water quality monitoring to be performed at the eight sampling sites used during the planning phase of the Little Cicero WMP.
- Create a list of Atrazine alternatives showing their associated costs and benefits
- Develop an Atrazine informational brochure and distribute to watershed stakeholders
- Publish sampling results to the watershed group (Goal 1) and in the local newspaper.
- Publish a newspaper article targeting the list or summarizing BMPs available to reduce Atrazine loading in the Little Cicero Creek watershed.

6.0 MEASURING SUCCESS

Measuring the success at achieving the stakeholders' goals and assessing the progress toward realizing their vision for the Little Cicero Creek watershed is an important component of this plan. The following describes milestones for stakeholders to reach tangible deliverables produced while working toward each goal. Where appropriate, monitoring plans designed to help stakeholders evaluate their progress are also included below. Because some of the goals are long-term (ie. they will take more than five years to attain), regular monitoring will be essential to ensure that the actions of the stakeholders are helping them reach their goals. Monitoring will allow stakeholders to make necessary adjustments to their strategy if the monitoring results indicate that changes are needed. Possible funding sources for implementing watershed projects are listed in Appendix E. Interim measures or indicators of success, which will help stakeholders evaluate their progress toward their goals, are included in the Action Register in Appendix F.

Goal 1: Increase stakeholder participation in implementation of the Little Cicero Creek WMP by forming a watershed group or joining an existing watershed group such as the UWRWA.

Milestones:

- Formation of an independent, permanent watershed group.
- Funding obtained for the hiring of a watershed coordinator and implementation of the WMP.
- Identification of a watershed coordinator to lead the implementation of the plan.
- Watershed group meetings held.
- Minutes from watershed group meetings published.
- Watershed group website developed and maintained.
- Hoosier Riverwatch volunteer monitoring training attended.
- Hoosier Riverwatch data collected and submitted.

Goal attainment: This goal lacks a specific water quality target similar to that which the other goals possess. Rather than being attained, this goal will be a continuous effort by watershed stakeholders.

Goal 2: In two years, the watershed group will develop a better understanding of the processes involved in identifying the sources of *E. coli* (i.e. failing septic systems, wildlife, domestic pets, etc.) and educate stakeholders on BMPs available to reduce pathogenic contamination of Little Cicero Creek and its tributaries. The ultimate goal will be to reach the state standard of 235 col/100 mL by the year 2030.

Milestones:

- Record searches at health department completed and septic system failures in the watershed recorded and mapped.
- Specific data on the number and location of livestock in the watershed collected and mapped.
- Areas of concern for *E. coli* narrowed down to more specific locations (ie. near a cluster of septic outfalls, immediately downstream of a livestock operation, or immediately downstream from the Sheridan WWTP).
- Additional sampling sites established at areas of concern (see above), continued monitoring of *E. coli* levels, and results tracked in a database.
- Development of a list of pathogenic BMPs.
- BMPs list distributed to the general public.
- Cost share program to help stakeholders finance the installation of *E. coli* BMPs, focusing first on Jay, Symons, and Ross Ditches.
- Local ordinance developed to require that all properties sold with septic systems have septic systems tests at the time of sale.
- Local ordinance developed to require that all newly installed septic systems have proof of proper installation.

Goal attainment: This goal will be attained when the watershed group has gathered sufficient information regarding septic failures, livestock operations, and additional water quality data to determine from where in the watershed the majority of pathogenic contamination is originating.

A quantitative goal for the establishment of BMPs will be set by the watershed group and progress toward meeting this goal will be tracked. The BMPs installed will be compared to changes in water quality over time, to develop at least a rough idea of how effective the BMPs are at reducing pathogenic contamination.

Indicator to be monitored: The level of *E. coli* in the watershed and the total amount of BMPs installed.

Parameter assessed: *E. coli* concentrations and more specific locations of areas of concern for *E. coli* contamination.

Frequency of monitoring: Monthly during the growing season and quarterly during the rest of the year.

Location of monitoring: Existing eight sampling locations and at least four additional sites as determined by the watershed group. Existing stream sampling points are shown on Figure 14.

Length of monitoring: Monitoring will occur over a period of five years.

Protocol: Monitoring will be conducted according to the Quality Assurance Project Plan (QAPP) developed for this project (Appendix B) or it will follow the Hoosier Riverwatch protocol for measuring *E. coli* (Crighton and Hosier, 2004).

Monitoring equipment: Equipment required for *E. coli* analysis following the QAPP protocol is identified in Appendix B. For equipment requirements for *E. coli* measurement using the Hoosier Riverwatch method, see the Hoosier Riverwatch Training Manual (2004).

Data entry: The monitors will maintain data forms in a binder and share results with the watershed group during meetings. The monitors will also track *E. coli* concentrations in an electronic database and into the Hoosier Riverwatch online sampling database.

Data evaluation: The local Health Department staff can provide assistance in interpreting data as needed. Additionally, Hoosier Riverwatch staff or local instructors may also be available to provide assistance with data analysis.

Goal 3: By the year 2015, reduce the nutrient load entering Morse Reservoir from the watershed 60 percent by installing a network of riparian buffers and filter strips along Little Cicero Creek and its tributaries.

Milestones:

- One demonstration day (bank stabilization, filter strip, conservation agricultural practices) held.
- A demonstration vegetated filter funded, designed, built, and highlighted at the demonstration day.
- At least one wetland restoration project is funded and constructed.
- Livestock access restricted along all regulated drains in the watershed.
- Over the next five years, convert at least 300 acres per year to no-till. At the end of five years, at least 1,826 acres of tilled agricultural land near streams and headwaters (see Figure 15) will have been converted to no-till.
- At least 305 acres of filter/buffer strips installed where appropriate.
- Nutrient load monitoring continued at eight original sample sites.
- Market for phosphorus-free fertilizer assessed and a ban on phosphorus-containing fertilizers in the watershed is proposed to county officials.
- Information on the importance of riparian buffers and how to receive funding for buffer restoration added to the Little Cicero Creek website.
- Regulated drains that are currently not maintained are placed on a maintenance schedule with the Surveyor's office, making them eligible for BMP funding.

Goal attainment: This goal will be attained when the nutrient load entering Morse Reservoir from Little Cicero Creek is reduced by 60 percent.

Indicator to be monitored: The levels of phosphorus and nitrogen in water samples over the next eight years.

Parameter assessed: Total phosphorus (TP) and total Kjeldahl nitrogen (TKN).

Frequency of monitoring: Monthly during the growing season and quarterly through the remainder of the year.

Location of monitoring: Eight stream sampling points are shown on Figure 14.

Length of monitoring: Monitoring will occur over a period of five years.

Protocol: Monitoring will be conducted according to the QAPP developed for this project (Appendix B) or it will follow the Hoosier Riverwatch protocol for measuring total phosphorus and nitrate+nitrite (Crighton and Hosier, 2004).

Monitoring equipment: Equipment required for nutrient analysis following the QAPP protocol is identified in Appendix B. For equipment requirements for nutrient measurement using the Hoosier Riverwatch method, see the Hoosier Riverwatch Training Manual (2004).

Data entry: The monitor will maintain data forms in a binder and share results with the watershed group during meetings. The monitor will also track nutrient concentrations in an electronic database and into the Hoosier Riverwatch online sampling database.

Data evaluation: The local Health Department staff can provide assistance in interpreting data as needed. Additionally, Hoosier Riverwatch staff or local instructors may also be available to provide assistance with data analysis.

Goal 4: Reduce the sediment load during storm events to Little Cicero Creek and its tributaries by 50 percent over the next five years.

Milestones:

- Landowners (using list developed in Goal 1 milestones) contacted regarding streambank stabilization opportunities and funding sources.
- Funding obtained for a streambank stabilization demonstration project and field day.
- Streambank stabilization demonstration and field day completed.

- Development of recognition program for builders who use sediment control BMPs.
- Cost-share funding identified for conservation program implementation.
- Livestock access restricted along all regulated drains in the watershed.
- At least 1,826 acres of tilled agricultural land near streams and headwaters (see Figure 15) converted to no-till.
- At least 305 acres of filter/buffer strips installed where appropriate.
- Cost share program developed for installation of water quality BMPs (possible funding sources included in Appendix E).
- Sediment load monitoring continued at eight original sample sites.
- A mailing or newspaper article outlining BMPs available for reducing sediment load is distributed to stakeholders.
- The watershed group practices continued coordination with the Hamilton County Planning Commission.
- A database of Atrazine loading rates (calculated from samples collected by volunteer monitors) in the watershed is created and maintained.
- A list of BMPs for reducing Atrazine levels is distributed to stakeholders.

Goal attainment: This goal will be attained when the sediment load entering Morse Reservoir from Little Cicero Creek is reduced by half. This will be measured using either total suspended solids (TSS) or turbidity.

Indicator to be monitored: Average sediment load (in tons/year) is reduced by half and the annual load of Atrazine entering Morse Reservoir from Little Cicero Creek is determined.

Parameter assessed: TSS and Atrazine

Frequency of monitoring: Monthly during the growing season and quarterly through the remainder of the year.

Location of monitoring: Eight stream sampling points are shown on Figure 14.

Length of monitoring: Monitoring will occur over a period of five years.

Protocol: Monitoring will be conducted according to the QAPP developed for this project (Appendix B) or it will follow the Hoosier Riverwatch protocol (Crighton and Hosier, 2004).

Monitoring equipment: Equipment required for TSS analysis following the QAPP protocol is identified in Appendix B. For equipment requirements for TSS measurement using the Hoosier Riverwatch method, see the Hoosier Riverwatch Training Manual (2004). Appropriate equipment for testing Atrazine will be determined by the Little Cicero Watershed Group, with consultation from Veolia Water.

Data entry: The monitor will maintain data forms in a binder and share results with the watershed group during meetings. The monitor will also track TSS concentrations in an electronic database and into the Hoosier Riverwatch online sampling database.

7.0 CONCLUSION

Little Cicero Creek, with a watershed of approximately 28,000 acres, is a large area in which to implement a comprehensive management plan. In order to create a manageable watershed plan, specific sources of water quality impairments had to be explicitly targeted: pathogens, nutrients, sediment, and public education. Even in trying to keep a narrow vision of the water quality problems in the Little Cicero Creek watershed, it was found that in order to attain the goals of the plan, extremely large areas of BMPs such as streambank stabilization and filter strips would need to be installed throughout the watershed. For this reason, further investigation of available BMPs for control of nonpoint source (NPS) pollution and more specific pinpointing of sources of NPS pollution in the watershed will need to be performed. Below (Tables 8 and 9) are summary tables of the average pollutant values across the watershed as calculated by JFNew's eight sampling events and the areas and types of BMPs being recommended to help attain the reduction in pollutant loads and concentrations as delineated in Goals 1, 2, and 3 of this plan.

Table 8. Average Pollutant Values and Goal Pollutant Values

	E. coli **(col/100mL)**	**Total Nutrient Load (tons/year)**	**Sediment Load (tons/year)**
Average Values across the Watershed	4,177.70	57*	2,158
Goal Value	N/A	22.9	1,079

** Total nutrient load is sum of 48 tons/year of total phosphorus and 9 tons/year of total nitrogen*

Table 9. BMPs (in Acres) Needed to Attain Goals

Best Management Practice Used	**Nutrient Load**	**Sediment Load**
No-Till (300 acres/year over 5 years)	1,826 acres	1,826 acres
Filter Strips	305 acres	305 acres
No-till and Filter Strips Combined	2,131 acres	2,131 acres

In the water quality analysis, it was noted that the tributaries to Little Cicero Creek that showed the poorest water quality, and thus highlighted as "critical areas," were Symons Ditch, Jay Ditch, and Ross Ditch. Although nonpoint pollution BMPs are recommended throughout the watershed, the watershed group should consider these three tributaries "priority areas" where BMPs such as filter strips, cattle exclusion, and no-till farming should be implemented first.

As more water quality data is collected through the implementation of this plan, the type and amount of appropriate BMPs or action items may need to change. In light of this, it will be important to remember throughout the implementation stages that this WMP is meant to be a "living document" that will be subject to revision as progress toward attaining goals one through four is tracked over the next five or ten years. Additional BMPs will also need to be considered that can achieve similar results to those proposed in lesser quantities and with lower associated costs.

The Little Cicero Creek Watershed Group (LCCWG), when formed, will be responsible for holding and revising the Little Cicero Creek WMP as appropriate, based on stakeholder feedback. To assist with record keeping and to ensure that action items outlined in the plan are completed, stakeholders should complete the simple Action Register form provided in Appendix F. This form should be returned to the LCCWG, which will keep completed action registers to ensure that tasks are being completed. The forms will also help document the success of actions taken in the watershed.

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APPENDIX A

ENDANGERED SPECIES

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

APPENDIX B

QUALITY ASSURANCE PROJECT PLAN

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

APPENDIX C

RESULTS OF FIELD WATER QUALITY SAMPLING

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

APPENDIX D

QHEI SITE PHOTOGRAPHS

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

APPENDIX E

FUNDING SOURCES

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

APPENDIX F

ACTION REGISTER

LITTLE CICERO CREEK WATERSHED MANAGEMENT PLAN
HAMILTON COUNTY, INDIANA

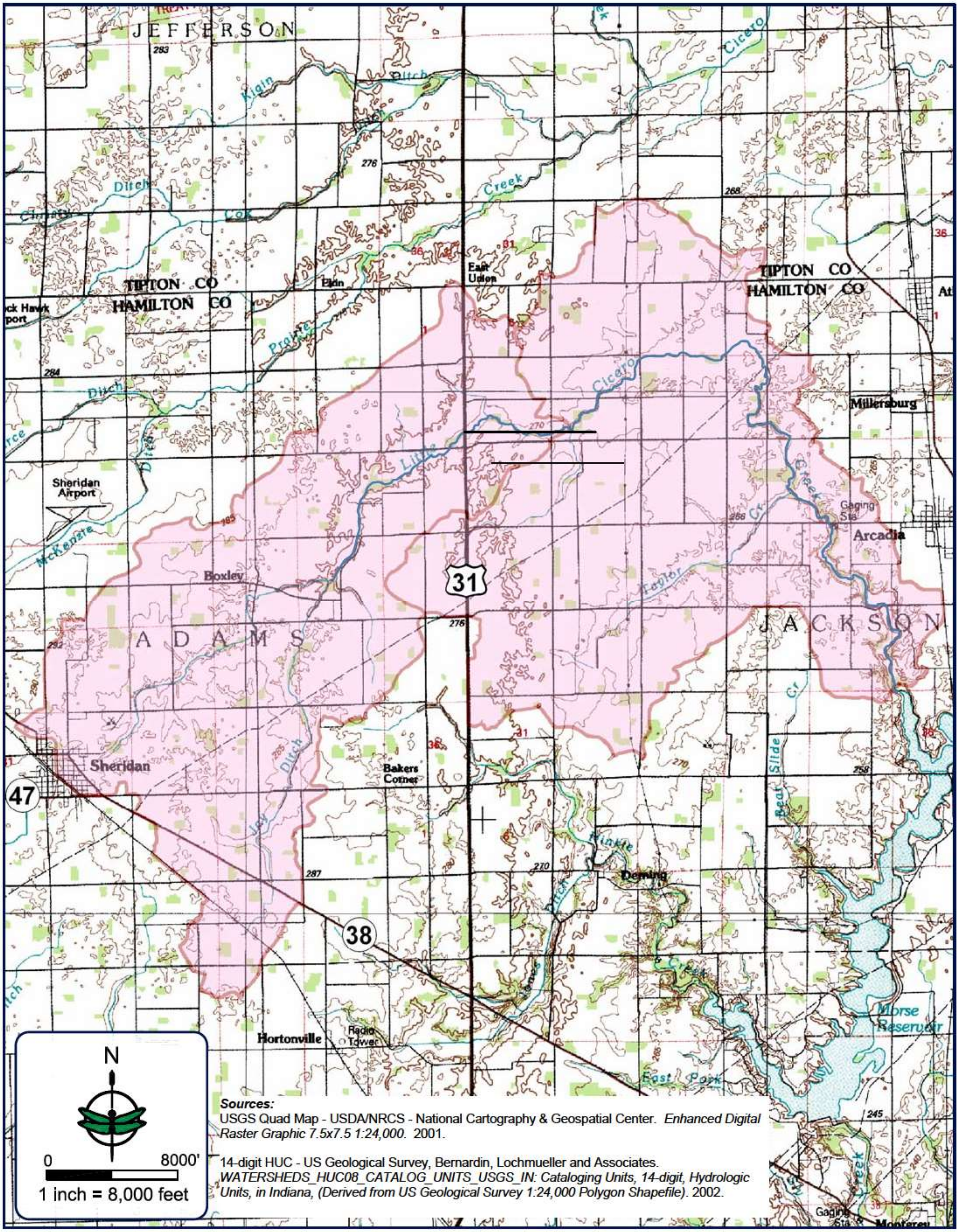
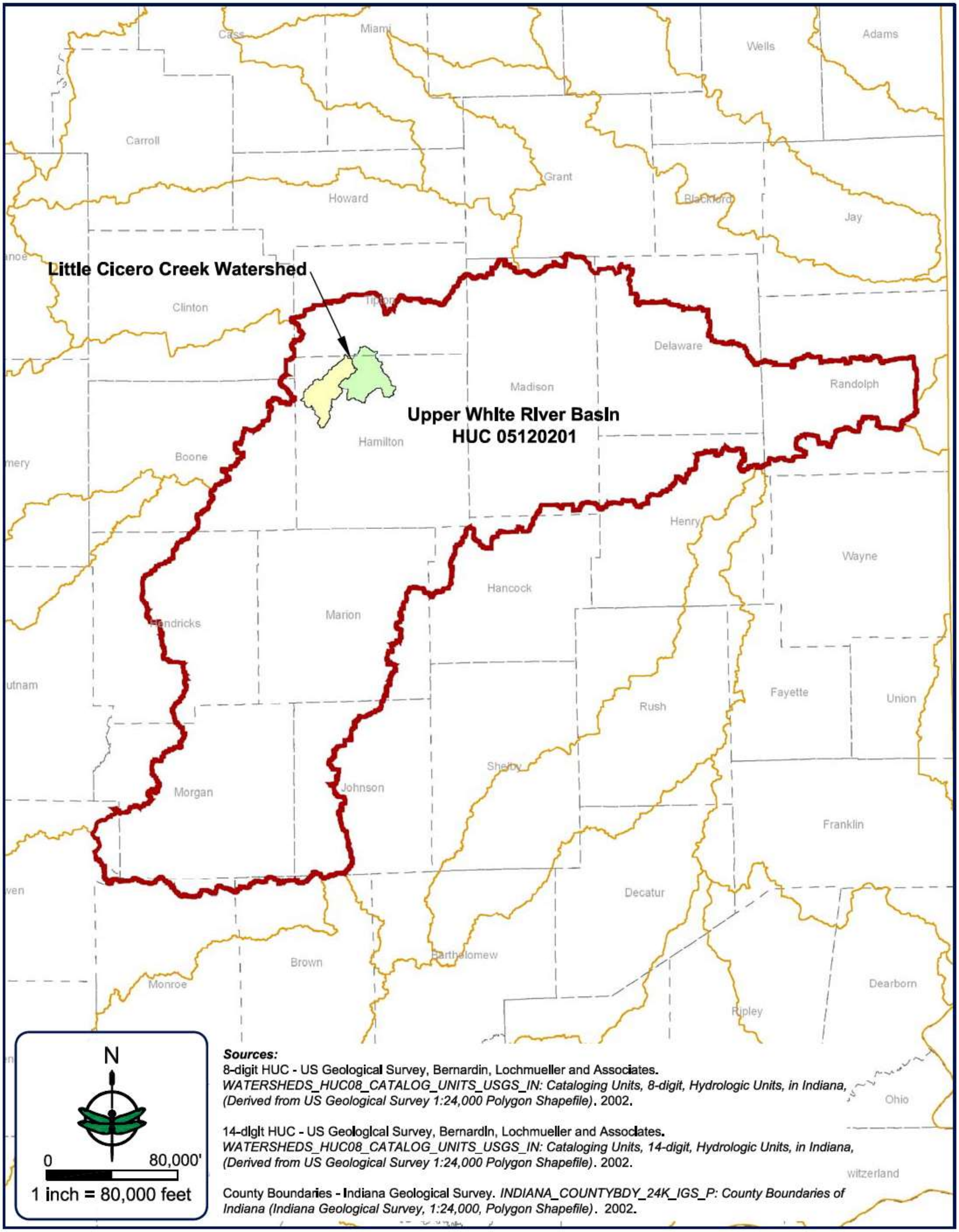


Figure 1. Little Cicero Creek Watershed Location



Sources:

8-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 8-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

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County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Figure 2. Upper White River Basin

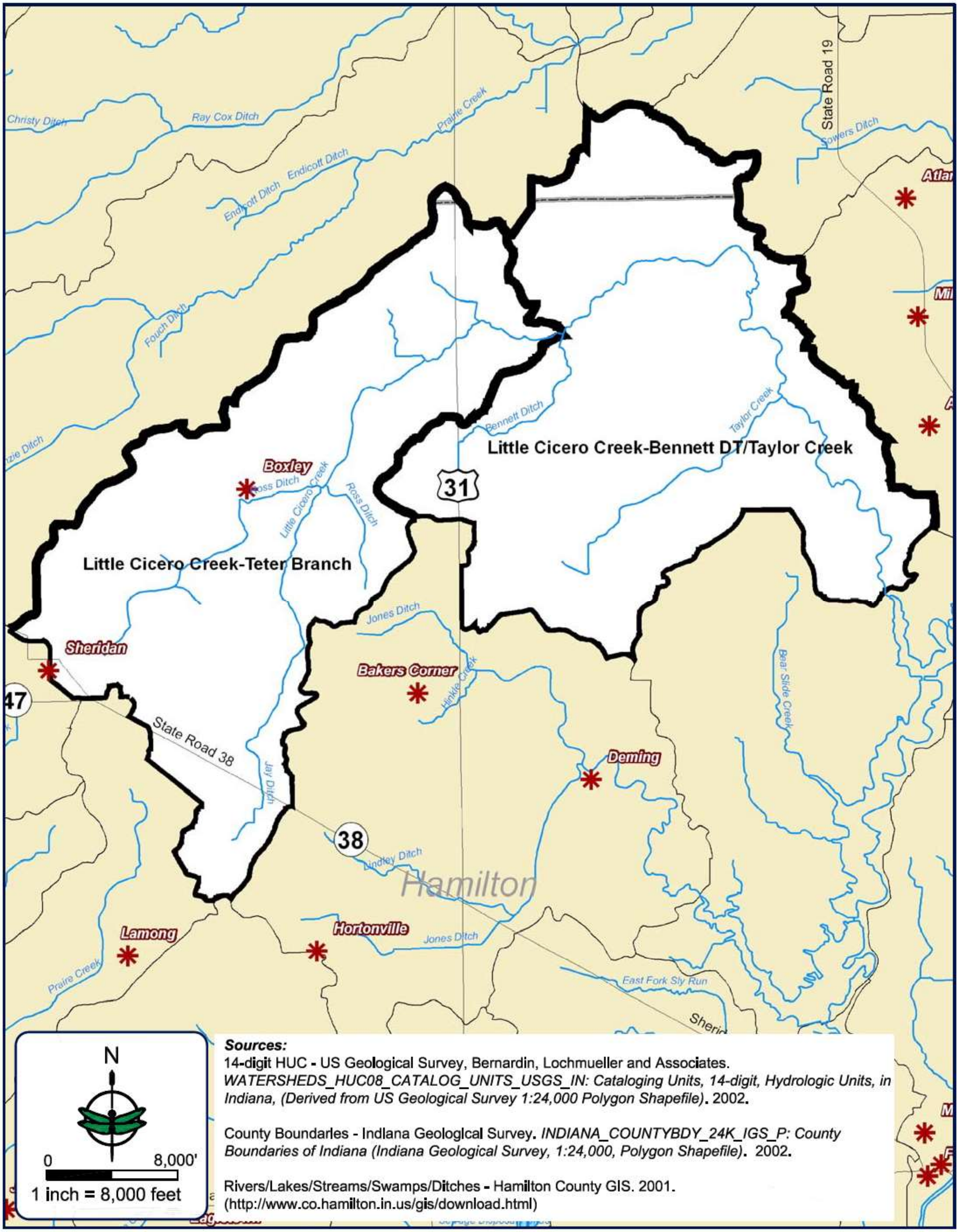
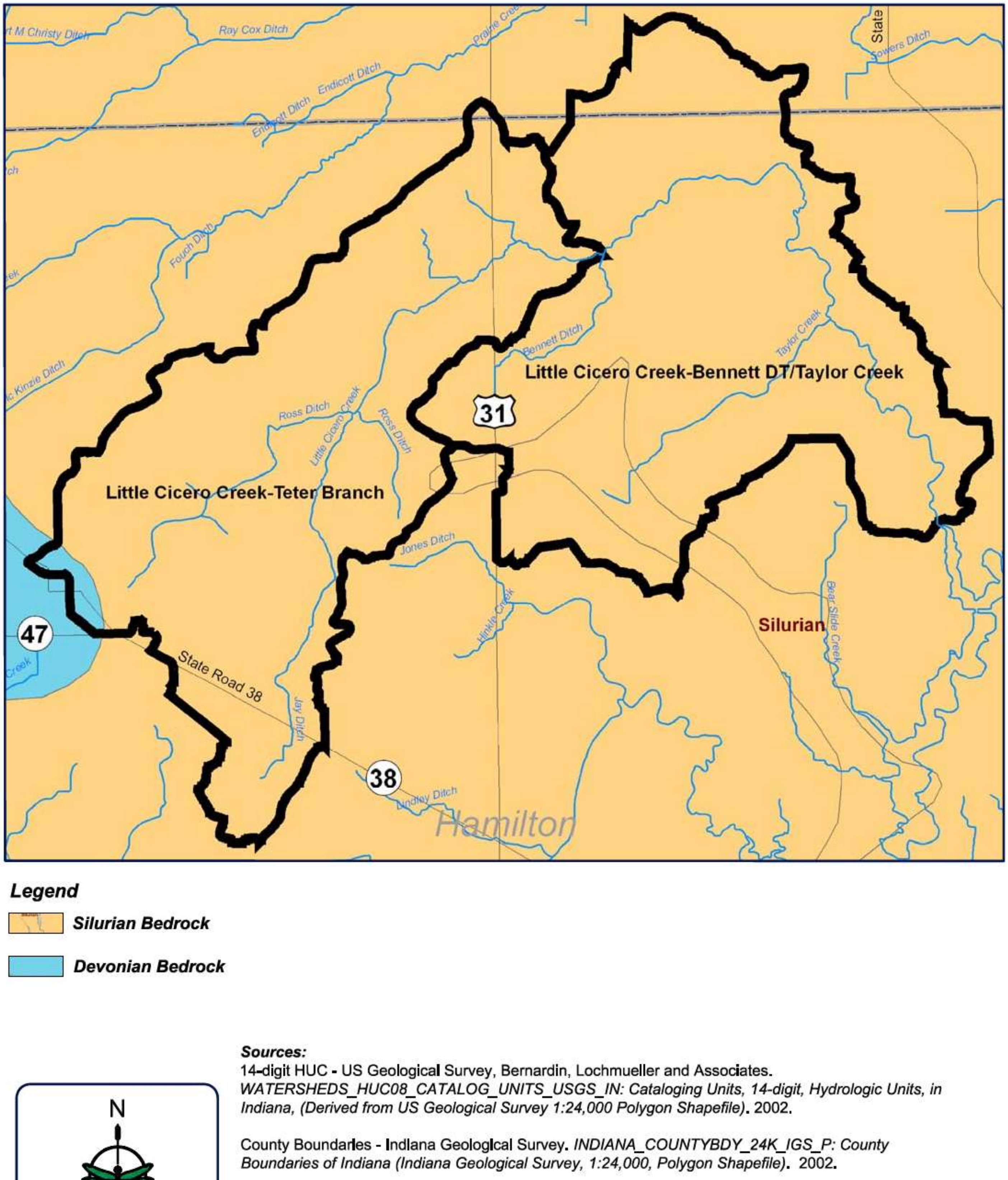


Figure 3. Streams of the Little Cicero Creek watershed



Sources:

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(http://www.co.hamilton.in.us/gis/download.html)
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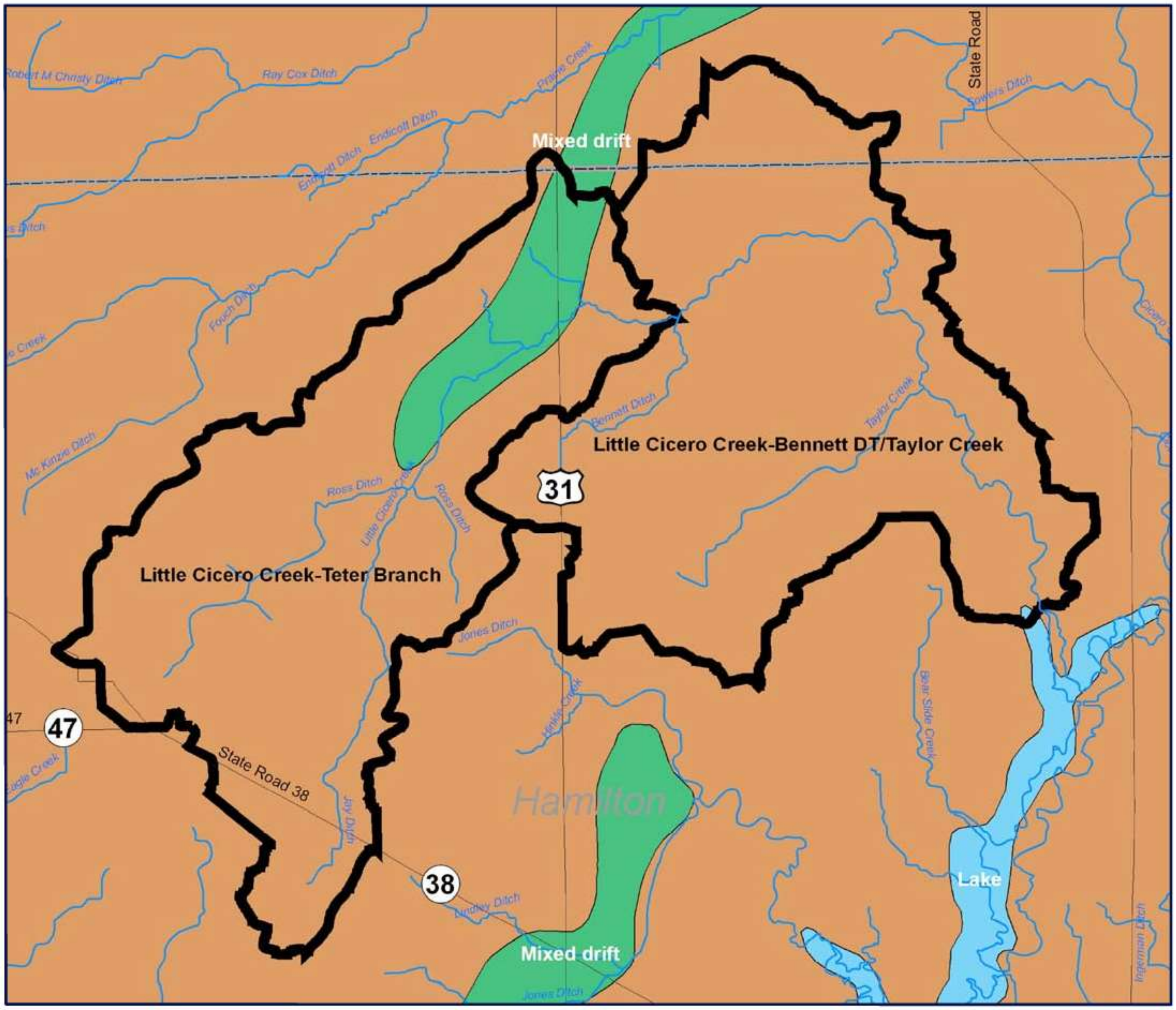
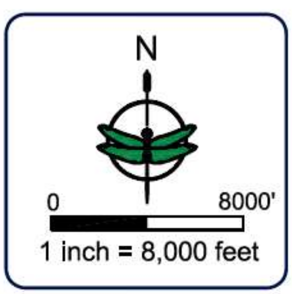
Figure 4. Bedrock of the Little Cicero Creek Watershed



Legend

Trafalgar Formation

Mixed Drift Ground Moraines



Sources:

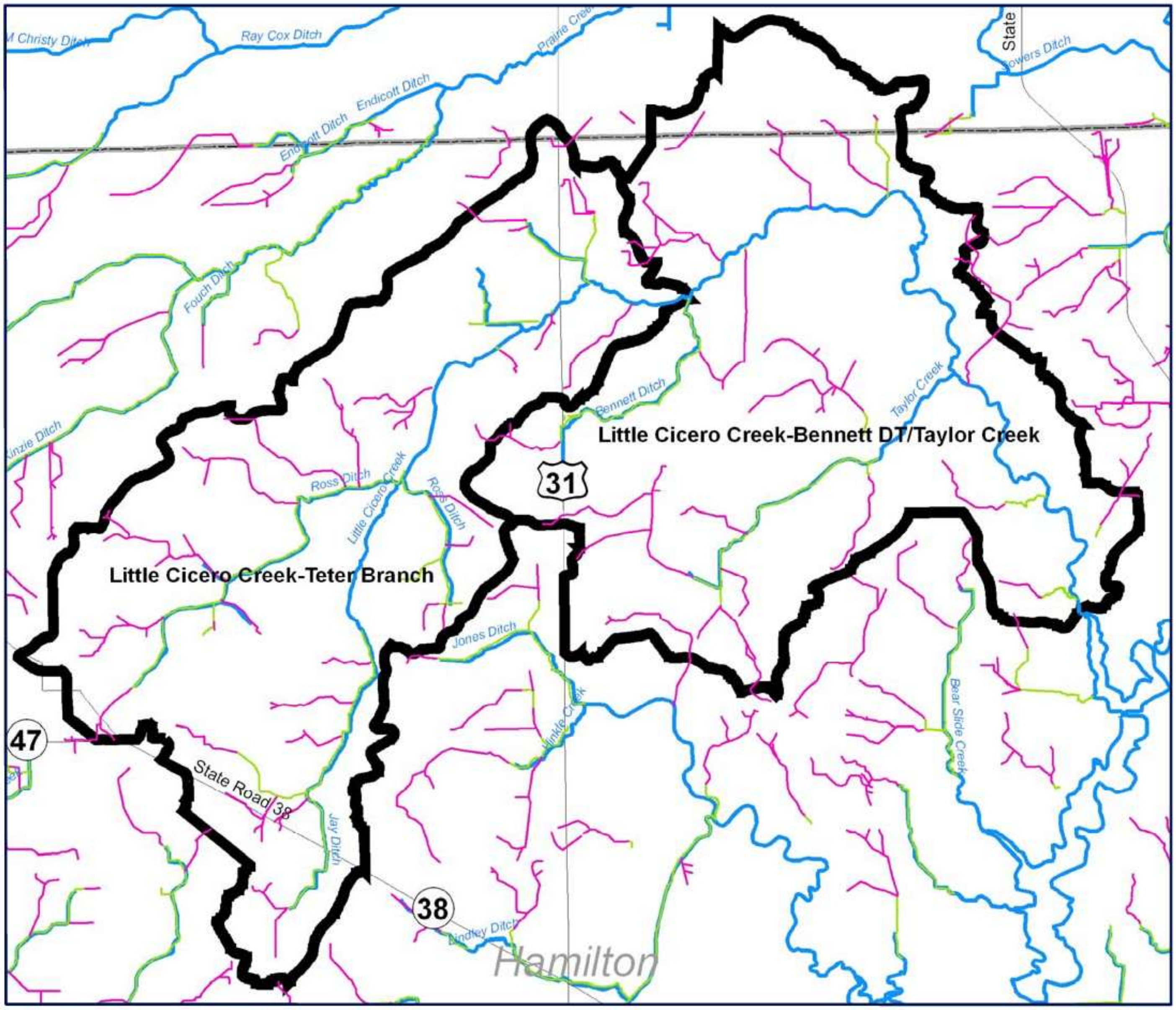
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Glacial Deposits - Indiana Geological Survey. *SURFICIAL_GEOL_MM49_IN: Quaternary Geologic Map of Indiana (Indiana Geological Survey, 1:500,000, Polygon Shapefile)*. 2002. (http://igs.indiana.edu/arcims/statewide/download.html)

Figure 5. Glacial Deposits



Legend

Open Regulated Drains

Tiled Regulated Drains

Non-regulated Drains

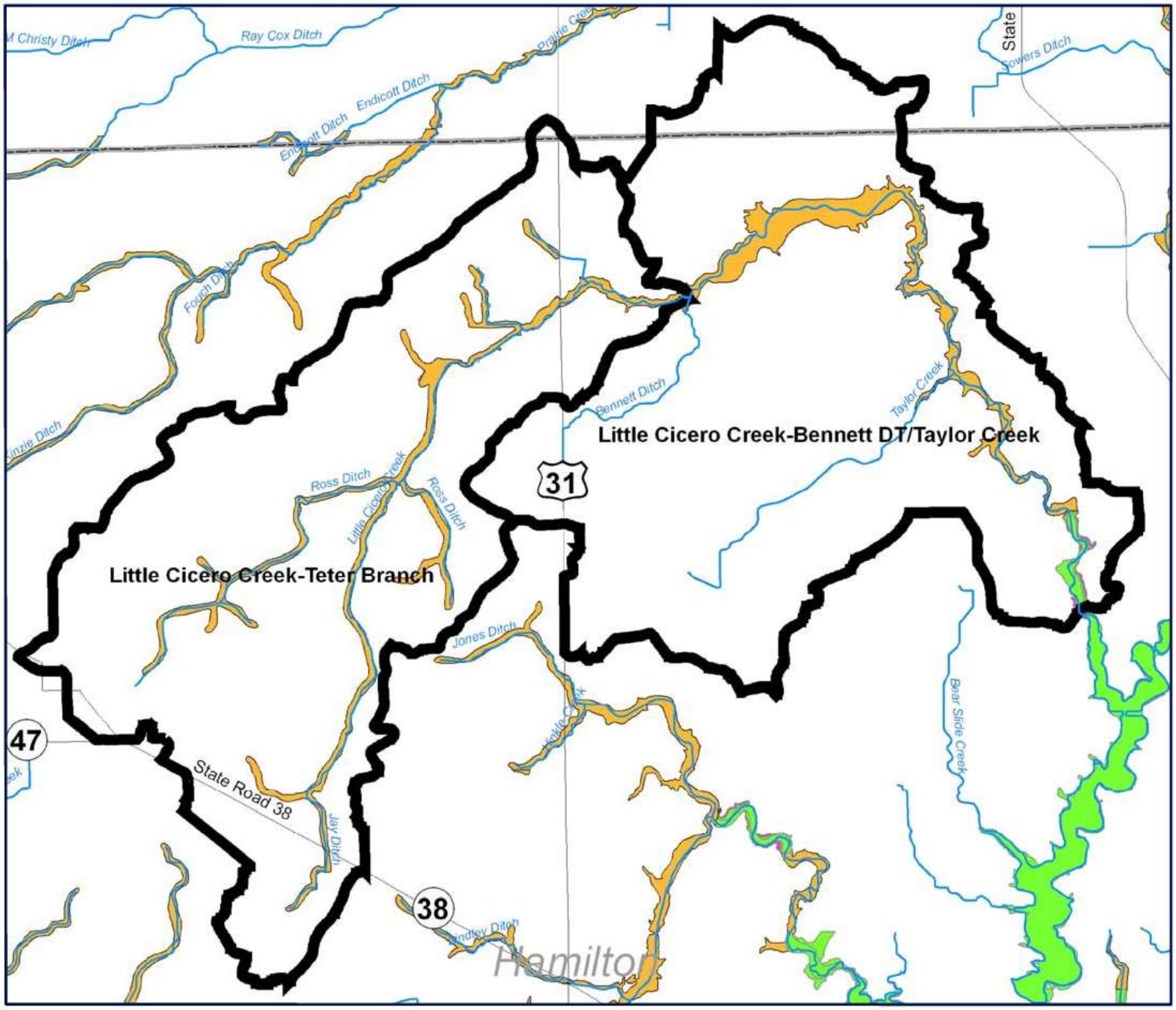
N
0 8000'
1 inch = 8,000 feet

Sources:
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Figure 6. County Regulated Drains

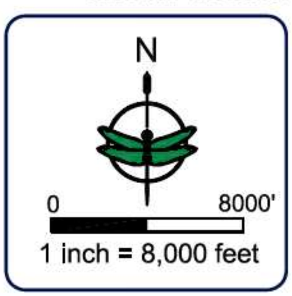


Legend

Flood Zone A - *Where flood insurance rate zones correspond to the 100-year floodplain that is determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no Base Flood Elevations (BFEs) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.*

Flood Zone AE - *Where flood insurance rate zones correspond to the 100-year floodplain that is determined in the the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.*

Flood Zone X - *Where flood insurance rate zones correspond to areas outside the 100-year floodplain, areas of 100-year sheet flow flooding where average depths are less than 1 foot, areas of 100-year stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 100-year flood by levees. No BFEs or depths are shown in this zone.*



Sources:

14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

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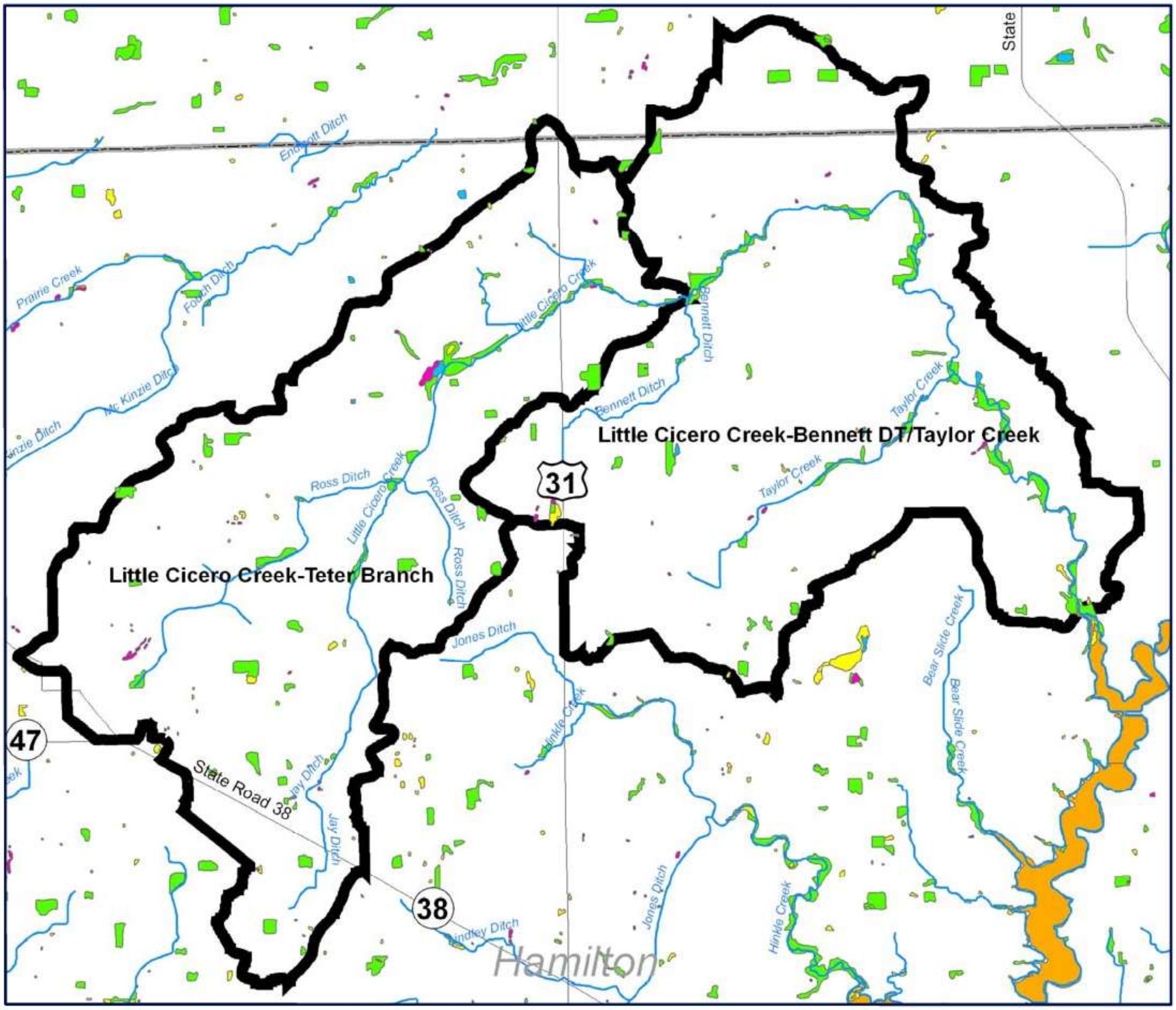
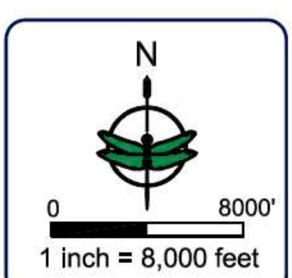
Figure 7. Floodplains



Legend

- **PEM - Palustrine Emergent Wetlands**
- **L1UB - Lacustrine Limnetic Unconsolidated Bottom Wetlands**
- **PFO1A - Palustrine Forested, Broad-leaf Deciduous Wetlands, Temporarily Flooded**
- **PSS - Palustrine Scrub-shrub Wetlands**
- **PUB - Palustrine Unconsolidated Bottom Wetlands**



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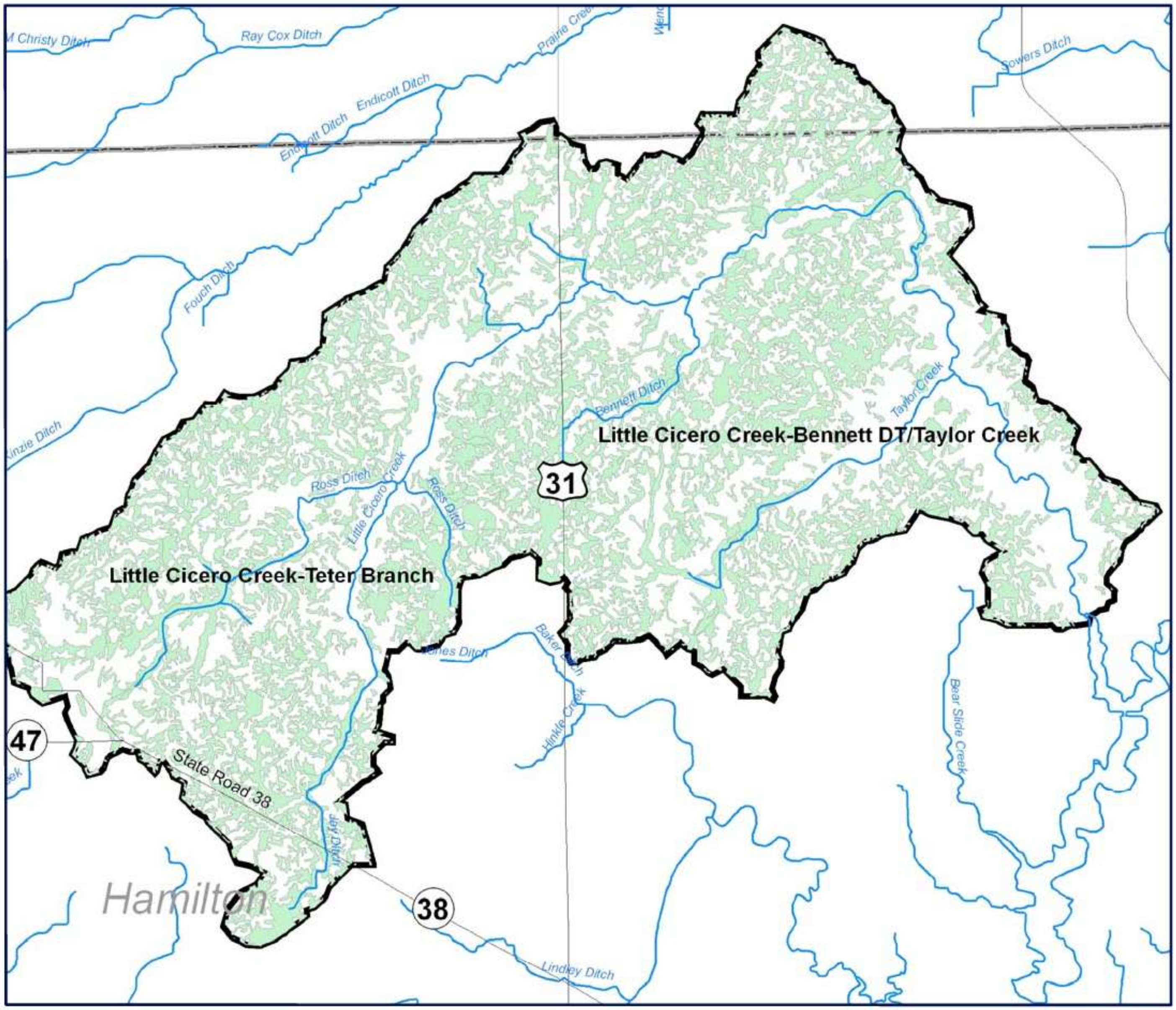
County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

NWIs - US Fish and Wildlife Service. Bernardin, Lochmueller and Associates. *WETLANDS_NWI_POLY_IN: National Wetland Inventory Polygons by County in Indiana (US Fish and Wildlife Service, 1:2M, Polygon Shapefile)*. 2001. (http://igs.indiana.edu/arcims/statewide/download.html)

Figure 8. National Wetland Inventory (NWI) Map

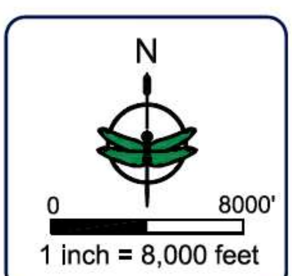
JFNew



Legend

Hydric Soils

Non-Hydric Soils



Sources:

14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

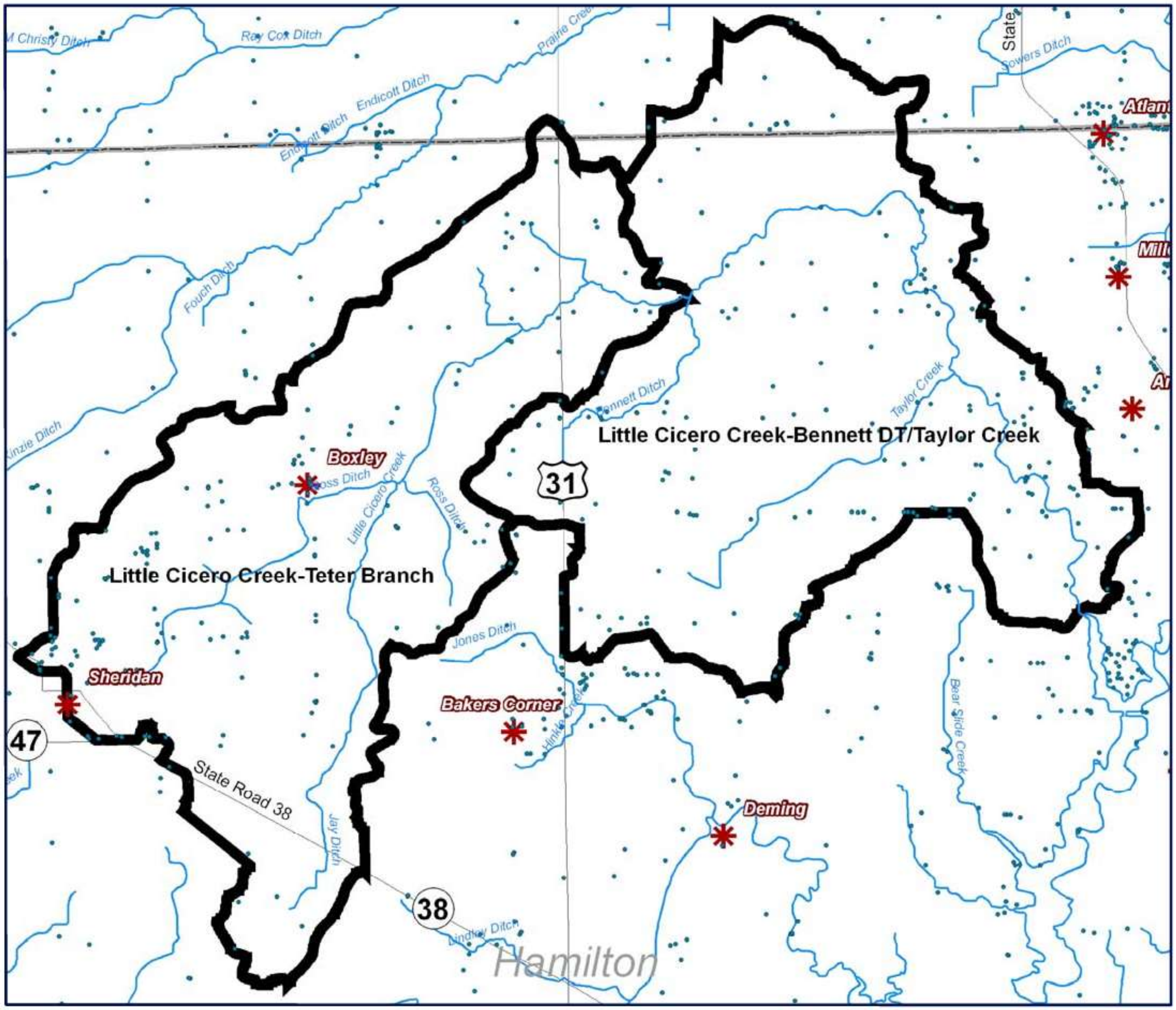
County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Hydric Soils - U.S. Department of Agriculture, Natural Resources Conservation Service. *Soil Survey Geographic (SSURGO) database for Hamilton County, Indiana*. 2004. (URL:http://SoilDataMart.nrcs.usda.gov/)

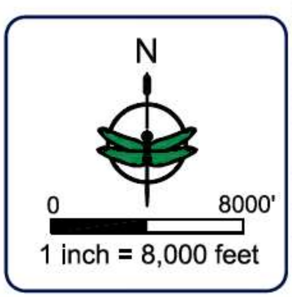
Figure 9. Hydric Soils

JFNew



Legend

Individual Groundwater Wells



Sources:

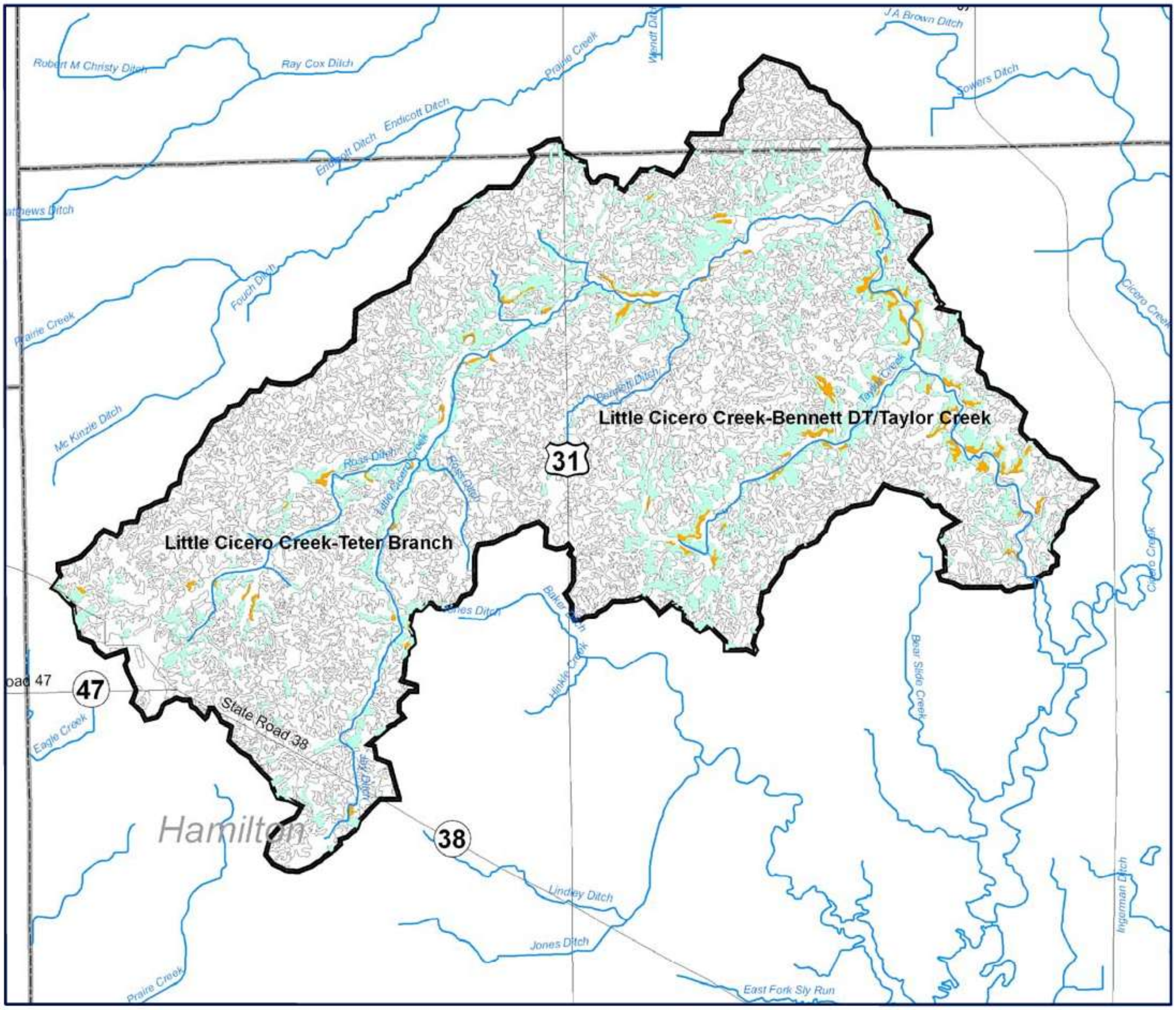
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates.
WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile). 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Wells - Indiana Geological Survey. *WATERWELLS_ILITH_IN: Water-well and Borehole Locations from Version 1.03 4-12-01 of the iLITH Database (Indiana Geological Survey, Point Shapefile)*. 2001. (http://igs.indiana.edu/arcims/statewide/download.html)

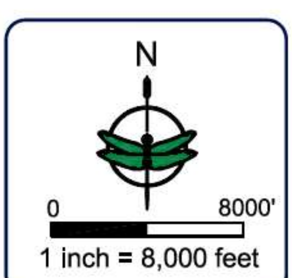
Figure 10. Individual Groundwater Well Locations



Legend

Potential Highly Erodible Soils (PHES)

Highly Erodible Soils (HES)



Sources:

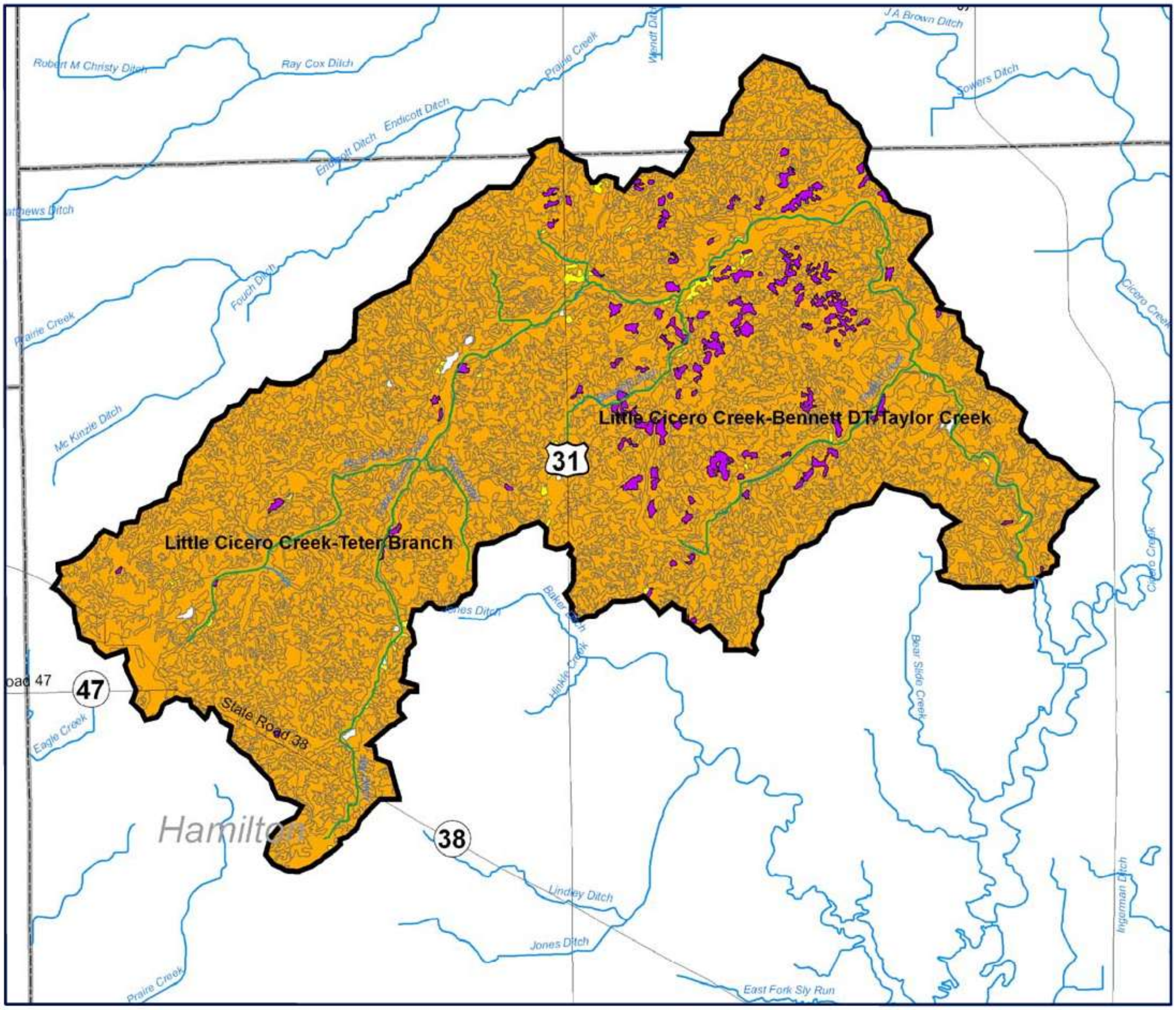
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

HES and PHES Soils - U.S. Department of Agriculture, Natural Resources Conservation Service. *Soil Survey Geographic (SSURGO) database for Hamilton County, Indiana*. 2004. (URL:http://SoilDataMart.nrcs.usda.gov/)

Figure 11. Highly Erodible and Potential Highly Erodible Soils

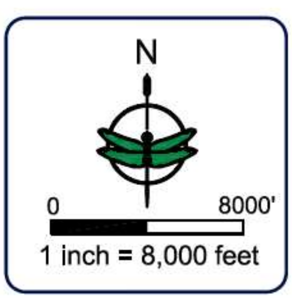


Legend

Severely Limited for Septic Field Suitability

Moderately Limited for Septic Field Suitability

Slightly Limited for Septic Field Suitability



Sources:

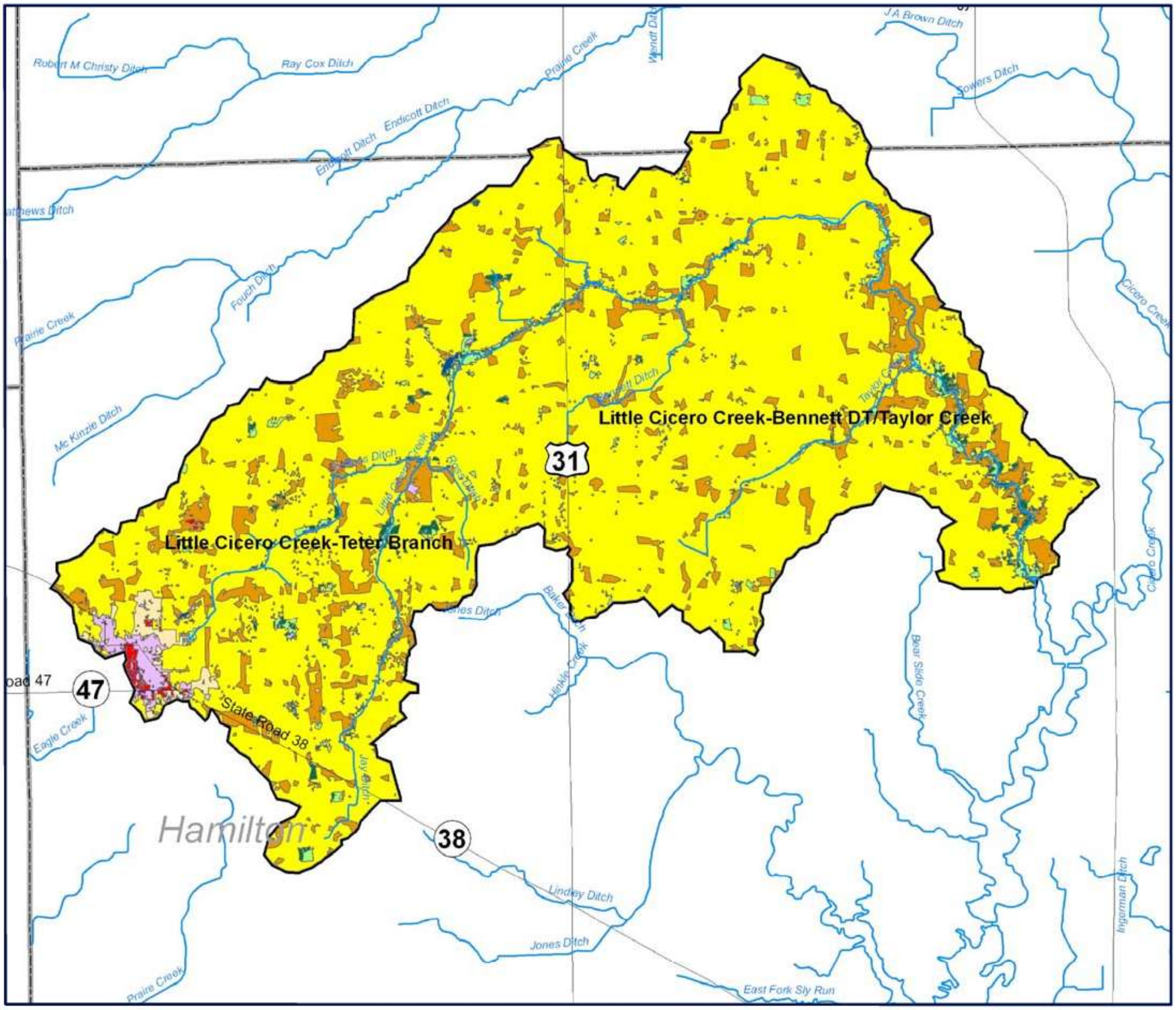
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

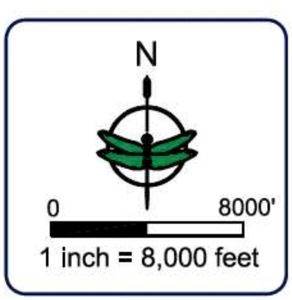
Septic Soils - U.S. Department of Agriculture, Natural Resources Conservation Service. *Soil Survey Geographic (SSURGO) database for Hamilton County, Indiana*. 2004. (URL:http://SoilDataMart.nrcs.usda.gov/)

Figure 12. Septic Fields Suitability of Soils



Legend

Row Crops (+84.30%)	***Other Grasses (Urban/parks/recreation) (+0.63%)***
Pasture/Hay (+11.10%)	***High Intensity Commercial (Industry/Transportation) (+0.23%)***
Woody Wetlands (+1.49%)	***Open Water (+0.06%)***
Deciduous Forest (+1.36%)	***High Intensity Residential (+0.05%)***
Low Intensity Residential (+0.74%)	***Emergent Herbaceous Wetlands (+0.05%)***



Sources:

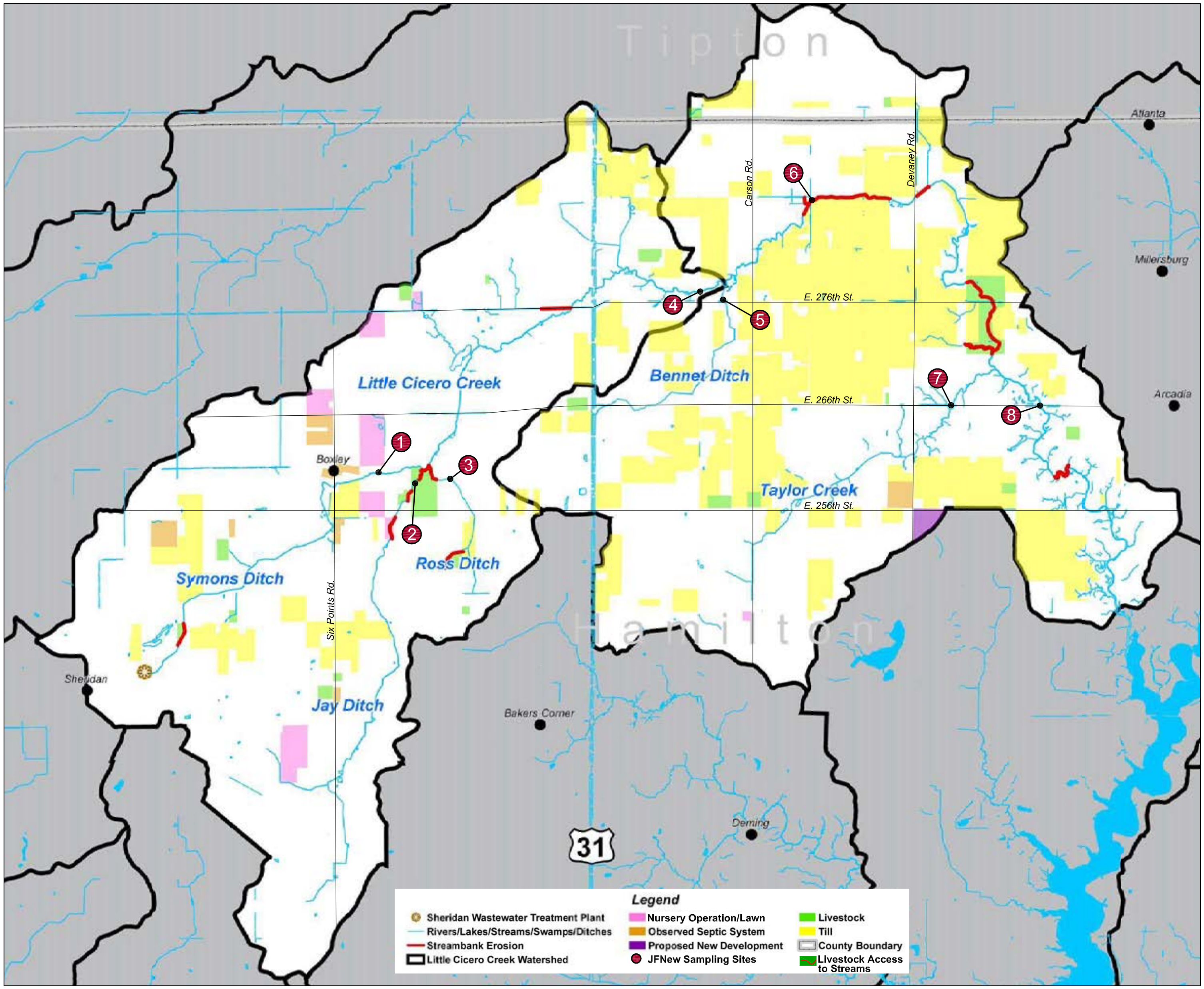
14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile)*. 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)*. 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Land Use - National Cartography & Geospatial Center. *National Land Cover Dataset.* 1993.

Figure 13. Land Use



SKL - March 2006 - #041231 - WtrShed-landuse E.mxd

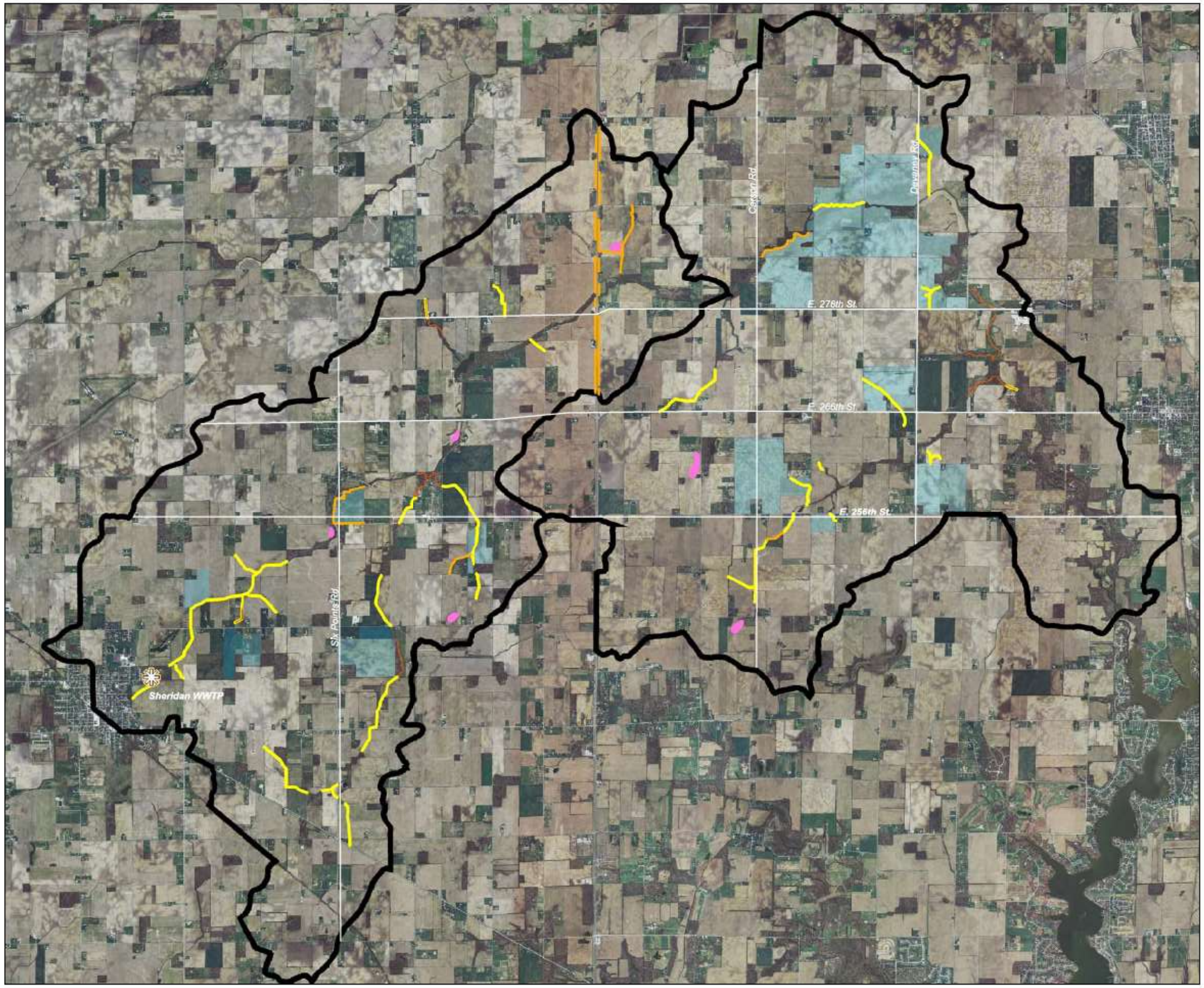
Coordinate System: NAD_1983_StatePlane_Indiana_East_FIPS_1301

Source:
GNIS Populated Places - USDA/NRCS Geospatial Data Gateway (2004)
(http://datagateway.nrcs.usda.gov/)
Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County Geographic Information System (2001)
(http://www.co.hamilton.in.us/gis/download.html)
County - Indiana Geological Survey
(http://igs.indiana.edu/arcims/statewide/dload_page/reference.html)
USGS HUC14 Subwatersheds - Indiana Geological Survey
(http://igs.indiana.edu/arcims/statewide/download.html)

N
Not to Scale

JFNew

Figure 14. Critical Areas



Legend

- No-till Agricultural Fields (±1,826 Acres Proposed)
- Filter Strip on Both Banks (±245 Acres Proposed)
- Filter Strip on One Bank (±60 Acres Proposed)
- Livestock Exclusion (±19,547 Linear Feet Proposed)
- Wetland Restoration Opportunities (Six Areas Proposed)

Sources:

14-digit HUC - US Geological Survey, Bernardin, Lochmueller and Associates. *WATERSHEDS_HUC08_CATALOG_UNITS_USGS_IN: Cataloging Units, 14-digit, Hydrologic Units, in Indiana, (Derived from US Geological Survey 1:24,000 Polygon Shapefile).* 2002.

County Boundaries - Indiana Geological Survey. *INDIANA_COUNTYBDY_24K_IGS_P: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile).* 2002.

Rivers/Lakes/Streams/Swamps/Ditches - Hamilton County GIS. 2001. (http://www.co.hamilton.in.us/gis/download.html)

Aerial Images - USDA/NRCS Geospatial Data Gateway. 2005. (http://datagateway.nrcs.usda.gov/)

N

Not to Scale

JFNew

Figure 15. Proposed BMPs

Species Name	Common Name	Status	Found in Aquatic habitats
Vascular plants			
Armoracia aquatica	Lake Cress	State: endangered	Yes
Drosera intermedia	Spoon-leaved sundew	State: rare	Yes
Platanthera leucophaea	Prairie white-fringed orchid	State: endangered Federal: threatened	Yes
Mollusca			
Ligumia recta	Black sandshell	State: not listed but rarity warrants concern	Yes
Obovaria subrotunda	Round hickorynut	State: species of special concern	Yes
Pleurobema clava	Clubshell	State: endangered Federal: endangered	Yes
Quadrula cylindrica cylindrica	Rabbitsfoot	State: endangered	Yes
Toxolasma parvum	Lilliput	State: not listed but rarity warrants concern	Yes
Villosa febalis	Rayed bean	State: species of special concern	Yes
Villosa lienosa	Little spectaclecase	State: species of special concern	Yes
Fish			
Etheostoma pellucidum	Eastern sand darter	State: species of special concern	Yes
Amphibians			
Necturus maculosus	Mudpuppy	State: species of special concern	Yes
Reptiles			
Clemmys guttata	Spotted turtle	State: endangered	Yes
Sistrurus catenatus catenatus	Eastern massasauga	State: endangered	Yes
Birds			
Bartramia longicauda	Upland sandpiper	State: endangered	No
Buteo lineatus	Red-shouldered hawk	State: species of special concern	No
Ixobrychus exilis	Least bittern	State: endangered	Yes
Nycticorax nycticorax	Black-crowned night heron	State: endangered	Yes
Thryomanes bewickii	Bewick’s wren	State: endangered	No

Mammals			
Lynx rufus	Bobcat	State: endangered	No
Taxidea taxus	American badger	State: endangered	No
High quality natural community			
Forest – Floodplain wet-mesic	Wet-mesic floodplain forest	State: significant	Yes
Forest – Upland mesic	Mesic upland forest	State: significant	No

Quality Assurance Project Plan
for
Little Cicero Creek Watershed Management Plan
in
Hamilton and Tipton Counties, Indiana

A305-4-140

Prepared by:

JFNew
Hamilton County Surveyor's Office

Prepared for:

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

Final Draft
May 10, 2005

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TABLE OF CONTENTS

PAGE

List of Appendices

List of Figures

List of Tables

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Section 1: Study Description

Historical Information

The Little Cicero Creek watershed includes all of the land that drains to Little Cicero Creek. The Little Cicero Creek watershed encompasses all of two 14-digit watersheds including the Little Cicero Creek-Bennett Ditch/Taylor Creek (HUC 05120201080080) and Little Cicero Creek-Teter Branch (HUC 05120201080090) watersheds within the larger Upper White River basin (HUC 05120201). The watershed includes nearly 26,775 acres or 41.8 square miles of Hamilton and Tipton Counties (Figure 1). Drainage from the watershed includes the towns of Sheridan, Atlanta, and Arcadia. Water drains from Little Cicero Creek into Morse Reservoir, a major drinking water supply for Hamilton and Marion County residents. Water flows from Morse Reservoir to the West Fork White River, which eventually combines with the Wabash River in southwest Indiana.

State and local agencies have conducted a limited number of water quality assessments that focus on water bodies in the Little Cicero Creek watershed. These studies indicate that water quality is moderately poor throughout the watershed. The Indiana Department of Environmental Management sampled Little Cicero Creek at 266th Street on numerous occasions from 1992 to 2004. In general, nutrient concentrations were typical of levels observed throughout Indiana. However, *E. coli* concentrations exceeded the state standard during the 2004 assessment. Additionally, sampling of the aquatic biota within the watershed indicated that the streams were only partially supporting for their aquatic life use designation (IDEM, 2004). For these reasons, Little Cicero Creek is listed on the 2004 list of impaired waterbodies for *E. coli* and impaired biotic communities.

Additional reasons for completing a watershed management plan for the Little Cicero Creek watershed are that the stream drains one of the remaining rural areas of Hamilton County and because the county's population increased by 58% from 1990 to 1999. Pro-active planning on the part of Hamilton County should help to prevent the decline in water quality typically associated with sharp increases in community growth and development. Furthermore, planned growth will hopefully minimize the impact of development in the Little Cicero Creek watershed to the stream and its water quality. To this end, the Hamilton County Surveyor's office, along with watershed stakeholders, will develop a watershed management plan for Little Cicero Creek and its watershed. Once completed, the plan will help prevent further ecological degradation of the watershed and guide future watershed management efforts to ensure the area's ecological health.

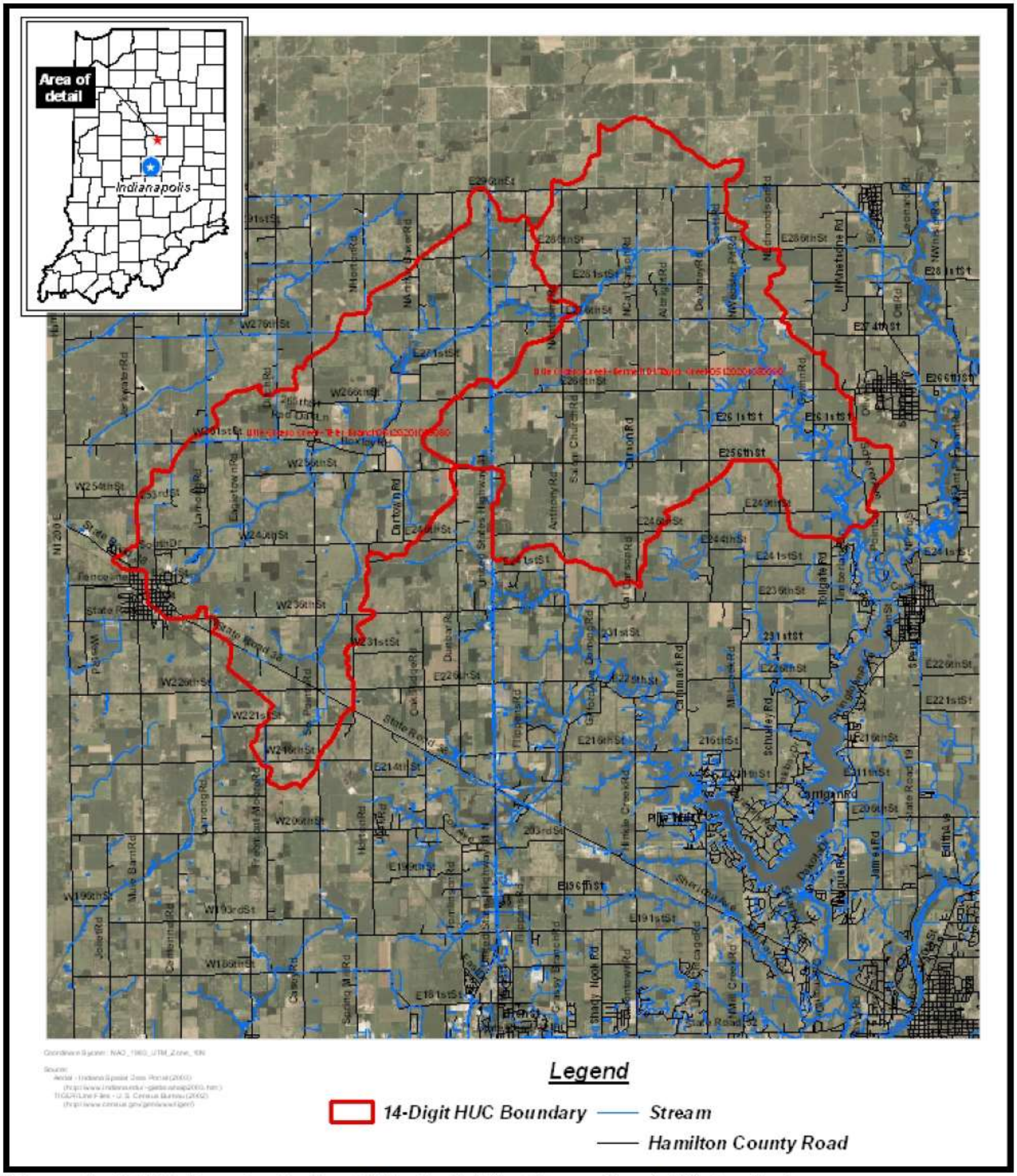


Figure 1. 14-Digit watersheds within the Little Cicero Creek Watershed.

Study Goals

The goal of the sampling/water quality collection portion of this study is to determine the quality of water in the major tributaries to Little Cicero Creek and Little Cicero Creek itself. Chemical and physical conditions of the selected streams will be documented. The collection of this data will allow for the identification of problem areas, characterization of the watershed, and implementation of broad management decision making for the development of a watershed management plan for the Little Cicero Creek watershed. This information will be supplemented with historical data documenting the conditions of the watershed such as land use, soils, and cultural resources and stakeholder concerns and issues discussed through watershed meetings. Data collected during this sampling will be combined with previously collected data to determine changes in the watershed and will serve as baseline data for the tracking of water quality improvement success.

In summary, the goal of the sampling/water quality collection portion of this study is to determine the quality of water in the major streams in the Little Cicero Creek watershed. This goal will be achieved with the following actions:
Action 1: Field and laboratory water chemistry data collection at each of the eight sites will include dissolved oxygen, temperature, pH, total dissolved solids, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total organic nitrogen, dissolved phosphorus, total phosphorus, turbidity, total suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), fecal coliform, and *E. coli*.

Action 2: Collect discharge measurements at each sampling site for each of the four sampling events to use in the calculation of pollutant loading.

Action 3: Conduct habitat assessment at each of the eight sample sites to assess physical stream conditions.

Action 4: Analyze chemical and physical data to allow for comparison with historical data and to provide baseline water quality information.

Action 5: Use chemical and physical data to evaluate and rank priority areas in the watershed and to develop recommendations for appropriate Best Management Practices to improve watershed water quality.

To achieve the goal of evaluating and ranking priority areas within the watershed, standardized data collection methodology and analysis will be used for each of the sampling stations. Consistencies in methodology will ensure sampling stations can be compared to one another, enabling the Technical Project Manager to determine which sites are most degraded relative to others in the watershed. Methodologies will follow those established and accepted by the scientific community and regulatory agencies (Indiana Department of Environmental Management (IDEM), Ohio Environmental Protection Agency (Ohio EPA), and U.S. Environmental Protection Agency (USEPA)). For example, habitat will be analyzed using a protocol developed by the Ohio EPA. Habitat data will be analyzed using Ohio EPA's Qualitative Habitat Evaluation Index (QHEI). This index is also used by the IDEM throughout the state to assess Indiana's stream habitat. Standardized methodology and analysis will also allow comparisons to be made to past studies within and outside of the Little Cicero Creek watershed that have used these methodologies.

Study Site

The project site is the Little Cicero Creek watershed encompassing approximately 41.8 square miles in northern Hamilton and southern Tipton Counties, Indiana. Because the project's goal is to document the ecological conditions in the Little Cicero Creek watershed, the study will examine and/or identify the following parameters: 1.Water chemistry (dissolved oxygen, temperature, pH, total dissolved solids, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total organic nitrogen, dissolved phosphorus, total phosphorus, turbidity, total suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), fecal coliform, and *E. coli*) and 2. Riparian/stream habitat quality in the watershed.

Sampling Design

All parameters (water chemistry and habitat) will be collected and analyzed at each of the eight sample sites. Sample sites were selected to achieve an accurate representation of the variety of stream habitat types found within the watershed. Preliminary site selection was based on map analysis. The map analysis consisted of locating tributaries with relatively large watersheds and accessible sampling points (road crossings). This approach was also taken in an attempt to have sampling stations that may be able to indicate which subwatersheds are contributing the most pollutants to the Little Cicero Creek watershed. The sampling stations selected based on this map analysis were then field checked by the Project Manager for confirmation of site accessibility and appropriateness for the physical assessment protocol (QHEI). Following the field inspection, eight sampling stations were selected for water chemistry and habitat assessment. Approximate locations of these sites are shown in Figure 2 and will be georeferenced during the course of the study. Appendix A provides additional details on the site locations. Landowners at these sampling stations will be contacted to obtain permission to conduct sampling in those areas. Should permission be denied, acceptable substitute stations will be selected using the same criteria outlined above. Any changes in sampling locations will be submitted as an addendum to this QAPP.

JFNew will collect baseline stream water chemistry data at eight sites within the Little Cicero Creek watershed (Figure 2). Specifics detailing sample site selection are included in Section 3. Details about each sample site including location and stream name is included in Appendix A. Water chemistry parameters to be sampled include dissolved oxygen, temperature, pH, total dissolved solids, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total organic nitrogen, dissolved phosphorus, total phosphorus, turbidity, total suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), fecal coliform, and *E. coli*. Dissolved oxygen, temperature, pH, and total dissolved solids will be analyzed *in situ* with field equipment. Discharge will be measured at each site to allow loading calculations and comparison of relative contributions of each of the tributaries.

Water chemistry samples will be collected four times during the study period. Samples will be taken two times during base flows and two times during storm (peak) flow events. Water chemistry sampling events will be timed to capture samples from base flow and peak flow (1" or more of rain in a 24-hour period) events. If soils are saturated by previous storm events, a storm event releasing 0.75" of rain may be sufficient to produce runoff and will be used as a storm event sample. JFNew will use best professional judgment to determine if a rain event of less than 1" qualifies as a storm event. This timing allows collection during a wide range of temporal and seasonal factors that may impact water quality. The water chemistry sampling schedule is flexible to prevent sampling during inappropriate weather or when equipment is not working. Following each sampling event, water chemistry samples will be delivered to the appropriate, contracted laboratory. JFNew will deliver nitrate-nitrogen, ammonia-nitrogen, total suspended solids, fecal coliform, and *E. coli* samples to Veolia Water Indianapolis in Indianapolis, Indiana. The total phosphorus, dissolved phosphorus, total Kjeldahl nitrogen, BOD, and COD samples will be delivered to ESG Laboratories in Indianapolis, Indiana. Water chemistry data gathered during this study will be compared to state and USEPA recommended criteria.

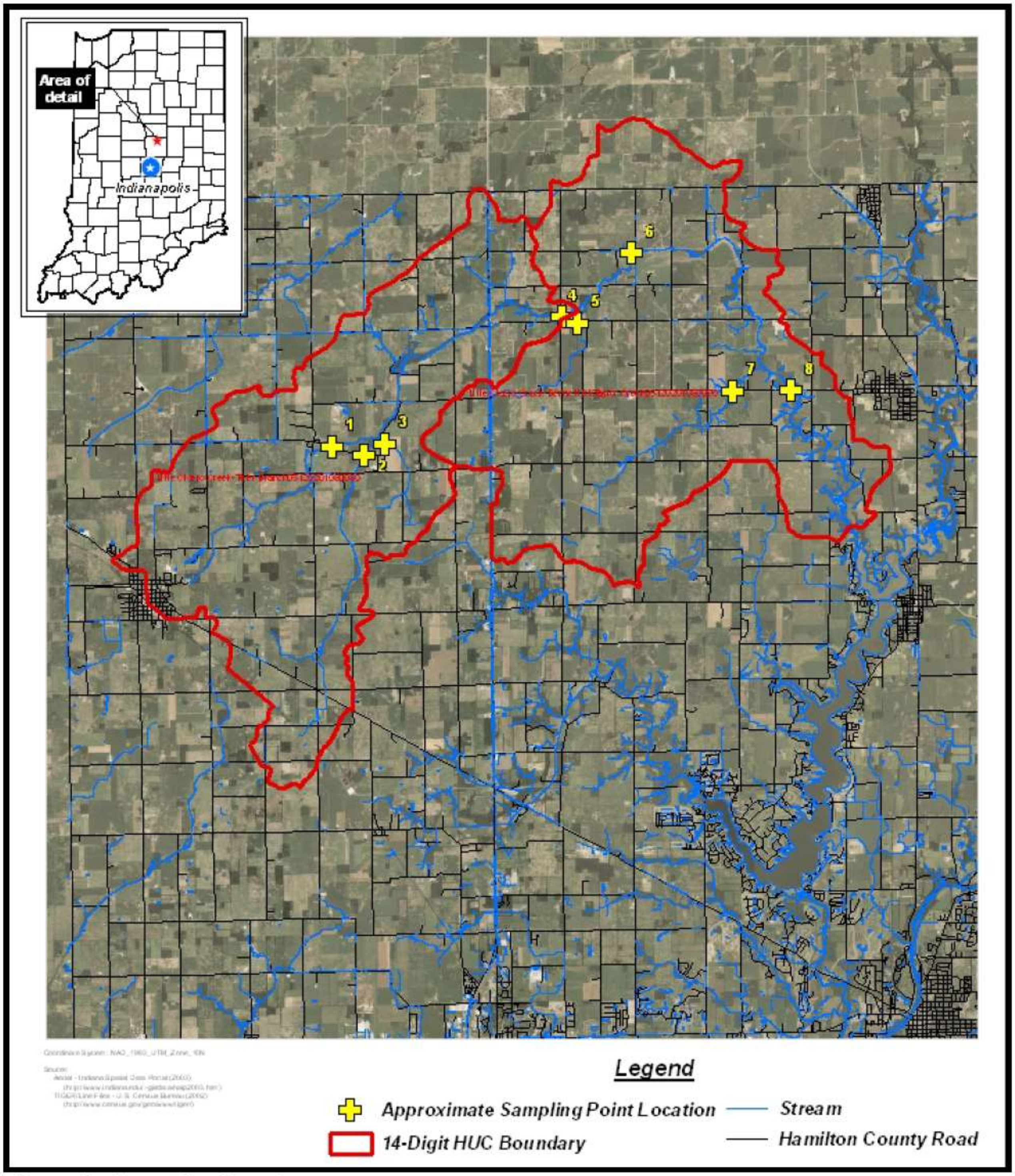


Figure 2. Sampling locations. Appendix A contains detailed sample site information.

Habitat sampling will occur once during the study period. The habitat sampling event will take place during low flow conditions in the summer to provide information on habitat availability during the highest period of stress for in-stream biota. Habitat quality will be assessed using Ohio Environmental Protection Agency (OEPA) Qualitative Habitat Evaluation Index (QHEI) protocol (OEPA, 1989).

This sampling design reflects our sampling goals. Furthermore, the design allows JFNew to meet the goals to determine the quality of water in the major streams in the Little Cicero Creek watershed and to evaluate and rank the conditions of the Little Cicero Creek watershed streams for subwatershed prioritization.

Study Schedule
Sampling station specific chemical and physical parameters will be sampled periodically throughout the project (Table 1). Habitat sampling will occur once during the summer, while chemical sampling will occur four times during a variety of conditions (base flow during spring, summer, and fall and storm flow during the growing season). Geolocation of sample sites will occur once during the sampling period.

Table 1. Parameters studied.

	Type of Sample/ Parameter	Number of Sampling Stations	Sampling Event Frequency	Sampling Period
Physical	Habitat	8	1	Summer 2005
Chemical	Water Chemistry*	8	4	Spring-Fall 2005
	Discharge	8	4	Spring-Fall 2005
Geolocation	GPS	8	1	Spring-Fall 2005

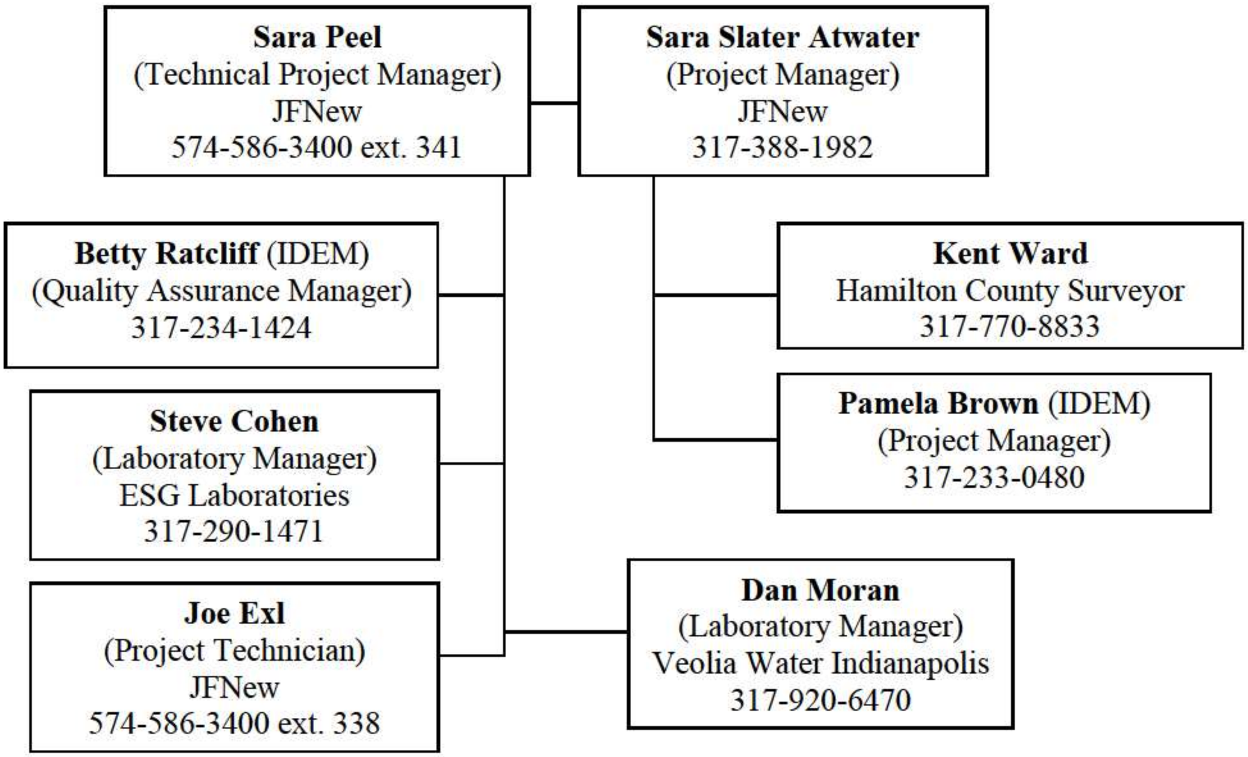
*Water chemistry samples will be analyzed for dissolved oxygen, temperature, pH, total dissolved solids, nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total organic nitrogen, dissolved phosphorus, total phosphorus, turbidity, total suspended solids, biological oxygen demand (BOD), chemical oxygen demand (COD), fecal coliform, and *E. coli*.

Section 2: Study Organization and Responsibility

Key Personnel
In general, JFNew will be responsible for the design, planning, execution, analysis and documentation of technical aspects of the project. JFNew will also assist with coordination of public input and development of the watershed plan. The water-testing laboratories (Veolia Water Indianapolis and ESG Laboratories) will be responsible for chemical water quality analysis. The Hamilton County Surveyor's office will be responsible for providing forums for public input and documenting the public's concerns and goals. Indiana Department of Environmental Management (IDEM) will provide the overall project guidance and assistance. Specific duties and responsibilities are outlined below.

In general, the Project Technicians report to the Technical Project Manager. The Technical Project Manager coordinates with the laboratories (Veolia Water Indianapolis and ESG Laboratories), the IDEM Quality Assurance Manager, and the JFNew Project Manger. The

JFNew Project Manger coordinates with the IDEM Project Manager and the Hamilton County Surveyor's office.



Project Organization
Project Technician is responsible for:
- Collection of general watershed parameters
- Collection of historical water quality data
- Water chemistry sampling
- Habitat sampling
- Data entry for water chemistry, macroinvertebrate, and habitat samples

Project Manager is responsible for:
- Selection of sampling site locations
- Implementation of QAPP
- Water chemistry sampling
- Coordination with IDEM and the Hamilton County Surveyor's office

Technical Project Manager is responsible for:
- QAPP development
- Review of general watershed parameters
- Review of historical data
- Geolocation of sampling sites
- Water chemistry sampling

Technical Project Manager responsibilities (cont.):

- Habitat sampling
- Oversight of Project Technician's duties listed above
- Review water chemistry and habitat field data sheets prior to leaving sampling site
- Review of water chemistry and habitat data entry for completeness and accuracy
- Implementation of QAPP
- Analysis of collected information

Section 3: Data Quality Objectives for Measurement of Data

The project goal is to obtain an overview of water quality in the Little Cicero Creek watershed from which a watershed management plan can be developed. Like many projects, this project has financial, temporal, and other constraints. For examples, we will collect physical and chemical data from each of the major streams in the Little Cicero Creek watershed. Sites sampled on each of the streams will provide information on the relative pollutant inputs of each subwatershed. This information will prioritize one subwatershed over another subwatershed when evaluating where to spend limited funding. Likewise, samples collected along the mainstem of Little Cicero Creek will allow for the determination of which portion of the watershed (Upper, Middle, or Lower) carries the greatest pollutant load. The sampling design will not; however, provide representative data for the whole watershed. Specificity will be sacrificed in order to obtain a greater quantity of general information on the entire watershed, rather than specific information on a portion of it. Based on this, the general data quality objectives are to gather representative information on the ecosystem's health at a watershed scale, collect broad, watershed scale data to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future.

Like any project, this project has financial and temporal constraints. The project goal is to document the ecological conditions of the watershed with special emphasis on water quality from which a watershed management plan can be developed. The project's data quality goals are based on this overall project goal. Based on this, the general data quality objectives for measurement of data are to gather representative information on the ecosystem to make broad conclusions, and perform collection by accepted protocols to ensure the effort can be repeated in the future. The data quality objectives for measurement of data are precision, accuracy, representativeness, comparability, and completeness.

DQO: Precision and Accuracy

Field Water Chemistry Parameters

Field equipment will be calibrated in accordance with manufacturer's specifications as detailed in Section 6. Replicate field measurements will be taken with the following field equipment: the Hanna Instruments HI 98129 pH, EC/TDS and temperature meter; the YSI Model 55 temperature and dissolved oxygen meter; and Marsh McBirney model 2000 portable flow meter. One replicate will be taken in every eight measurements or once per sampling event. Precision will be calculated using the Relative Percent Difference equation:

$$RPD = \frac{(C - C') \times 100\%}{(C + C')/2}$$

Where:
C = the larger of the two values
C' = the smaller of the two values

The acceptable relative percent difference for field water chemistry parameters is detailed in Table 2. Regular, scheduled maintenance will occur in accordance with manufacturer's instructions and will be used to insure equipment precision and accuracy.

Field equipment will be calibrated following manufacturers specifications on the day of sample collection. Field equipment use will follow recommended usage by the equipment manufacturer. Expected accuracy measurements for field equipment measurements are those listed by the equipment manufacturers and are displayed in Table 2.

Laboratory Water Chemistry Parameters
The Technical Project Manager and Project Manager (or Technical Project Manager and Project Technician if the Project Manager is not available) will collect samples in accordance with the contracted laboratories' Quality Assurance/Quality Control (QA/QC) requirements. For all parameters analyzed by ESG Laboratories and Veolia Water Indianapolis this will include the collection of one duplicate sample in every eight samples collected, or one duplicate sample per sampling event. One set of field blank samples (one sample per parameter) will be collected during each sampling trip. Duplicate and field blank sample analysis will occur following the laboratory procedure detailed in the laboratory QA/QC plans (Appendices B and C). The contracted laboratories will implement QA/QC measures to ensure data quality as detailed in the laboratories' QA/QC documents (Appendices B and C). Section 7 of ESG Laboratories Quality Management Plan provides information on the procedures followed for these DQO's. Likewise, Section 7 of Veolia Water Indianapolis Quality Management Plan provides information on the procedures followed for these DQO's. The laboratory standards are sufficient to meet the stated goals of this project. Table 2 summarizes the data quality objectives for measurement of data for the water chemistry parameters. Data not meeting laboratory standards for duplicates or field blanks will be removed from the sample set and will not be used for watershed prioritization.

Habitat Parameters
To ensure precision, all sampling protocols will be carried out as required in the procedural documentation by qualified individuals. The same field crew, consisting of the Technical Project Manager and Project Manager (or Project Technician and Technical Project Manager if the Project Manager is not present) will sample each site using the same procedure to maintain consistency among sites. The consistency of field personnel and procedural organization will enhance precision by minimizing sampling variability.

Habitat evaluation will be conducted by an experienced/trained Technical Project Manager and Project Manager. Habitat will be evaluated on an individual basis then compared. Any discrepancies in habitat scoring will be noted and discussed in order to obtain an accurate and precise habitat score through collaboration. If a score can not be determined through collaboration, then the Technical Project Manager's will be used for scoring purposes. Table 2 outlines the parameters, measurement range, accuracy, and precision of habitat evaluation.

Global Positioning System Parameters
Location coordinate data precision is expected to be high, while accuracy is submeter. Table 2 lists detailed precision and accuracy information for the Trimble Pro XRS GPS.

Table 2. Data quality objectives for measurement of data for field and laboratory methods.

Parameter	Precision	Accuracy	Completeness
pH	RPD<5%	± 0.01	75%
Temperature	RPD<5%	± 2%	75%
Dissolved Oxygen	RPD<5%	± 0.3 mg/l	75%
Total Dissolved Solids	RPD<5%	± 2% f.s.	75%
Flow	RPD <5%	±2% + zero stability zs=±0.03 ft/sec	75%
Ammonia	See Appendix C.	See Appendix C.	75%
Biological Oxygen Demand	See Appendix B.	See Appendix B.	75%
Chemical Oxygen Demand	See Appendix B.	See Appendix B.	75%
E. coli	See Appendix C.	See Appendix C.	75%
Fecal Coliform	See Appendix B.	See Appendix B.	75%
Nitrate+nitrite	See Appendix C.	See Appendix C.	75%
Dissolved phosphorus	See Appendix B.	See Appendix B.	75%
Total Kjeldahl Nitrogen	See Appendix B.	See Appendix B.	75%
Total Organic Nitrogen	See Appendix B.	See Appendix B.	75%
Total Phosphorus	See Appendix B.	See Appendix B.	75%
Total Suspended Solids	See Appendix C.	See Appendix C.	75%
GPS	High	50 cm ± 1 ppm	100%
Habitat Analysis	High	High	100%

DQO: Completeness
In the event that some catastrophic event (i.e. weather anomaly, chemical spill, or other event that would prohibit access to sampling sites) were to take place, the first action taken would be to delay the sampling to a later time that year, in hopes that sampling would occur under more representative conditions. There is flexibility built into the project schedule to allow sampling to occur during favorable conditions, preserving data quality.

Field and Laboratory Water Chemistry Parameters
One hundred percent (100%) collection of field and laboratory water chemistry samples is expected. Sampling locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. However, climatic or other changes beyond the project's control may alter conditions in the watershed. Refusal of landowners to grant access to the property may also limit the sample collection. Equipment malfunction or problems during sample collection and analysis could also limit the amount of water chemistry data over the term of the project. Sites 4, 6, and 8 are all located along Little Cicero Creek's mainstem. Samples

collected at Site 8 would provide information on the pollutant concentration and loads carried by Little Cicero Creek. The loss of Sites 4 and 6 would still enable watershed stakeholders to prioritize subwatersheds. Therefore, loss of two sample sites would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) for water chemistry samples will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{24 \times 100\%}{32} = 75\ \%$$

Habitat Parameters
Again, one hundred percent (100%) collection of habitat samples is expected. Sampling will occur at the same sites as those utilized for water chemistry sample collected. Sample locations have been field checked to ensure sampling access and proper sampling hydrology is present at each site. Climatic or other changes beyond the project's control may alter the condition of the watershed; however, since habitat data is being collected once over the lifetime of the project sample collection could be rescheduled to allow for data collection. Still, the refusal of landowners to grant access to the property may limit the sample collection at the selected sites. Again, the loss of the first two sample sites along Little Cicero Creek's mainstem would not prevent the project from attaining its goal of developing a watershed management plan. Based on this 75% completeness (see equation below) will be acceptable for completion of the project.

$$\% \text{ completeness} = \frac{(\text{number of valid measurements}) \times 100\%}{(\text{number of valid measurements expected})} = \frac{6 \times 100\%}{8} = 75\ \%$$

Global Positioning System Parameters
The geolocation of the sample sites is not dependent upon the weather or other climatic situations (barring the loss of satellites). Since GPS data can be collected over the length of the project, 100% completeness should be achieved.

DQO: Representativeness
Representativeness is the most important data quality metric in the project since the project objective is to provide watershed scale data. Representativeness of sampling sites was achieved by performing a desktop review of potential sampling sites. Because the number of watershed streams draining to Little Cicero Creek exceeds the number of sites that can be sampled by this project given the limited resources, not all streams could be sampled. The following criteria were used to narrow the set of potential sites. Potential sites were selected based on accessibility (proximity to a road) and location in the watershed (ensuring that all major streams draining Little Cicero Creek are sampled). Potential sites were then field checked by the Project Manager to ensure accessibility to sampling stations and that the variety of physical, riparian, and in-stream habitats in the watershed were all represented in the sampling stations. Landowner permission will confirm potential sampling locations usability as sampling sites. An additional criterion for choosing sites is whether it has been used in historical studies to which this project's data may be compared. IDEM sampled macroinvertebrates and water chemistry at two of the selected sample sites.

DQO: Comparability
Water chemistry parameters are expected to be comparable to other studies if sampling and laboratory protocols and data quality objectives for measurement of data are similar. Results of this study can be compared to other studies that use this protocol and similar data quality objectives. All laboratory water chemistry analysis will be conducted using common, EPA-approved methods. All chemical data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability. As noted in the Sampling Design section, any non-analogous historical data (data collected under a different protocol with different data quality objectives) used in the study will be cited as such in the final product.

The habitat samples are expected to be comparable because the project will follow habitat assessment procedures set forth by Ohio EPA's Quality Habitat Evaluation Index (QHEI). Results of this study can be compared to other studies using these protocols. All habitat data to be used for direct comparison with the data collected during the present study will be reviewed prior to its use to ensure comparability.

Section 4: Sampling Procedures

The sampling methods and equipment are summarized in Table 2.

Water Chemistry Sampling
Water chemistry samples will be taken at each station to test the parameters listed in Table 2. Temperature, dissolved oxygen, pH, total dissolved solids, and flow measurements will be made in the field using the following instruments: YSI Model 55 dissolved oxygen/temperature meter; Hanna Instruments HI 98129 pH, EC/TDS, and temperature meter; and the Marsh McBirney Model 2000 portable flow meter. All measurements will be taken according to the standard operating procedures provided by the manufacturer of the equipment. Project biologists will record water chemistry field measurements on standardized field log data sheets (Appendix D). Sampling location, sample number/field ID, date, time, weather, Universal Transverse Mercantor (UTM) coordinates (North American Descent 1983, Zone 16), and any additional field notes will also be recorded on the field sheet.

Flow measurements will be taken utilizing protocols outlined in Marsh-McBirney (1990). A tape measure will be staked across the width of the channel prior to any measurements being taken. If the stream is less than two inches (2") deep, then multiple point velocity measurements will be taken throughout the width of the channel. Channel depths will be measured at a minimum of five points across the channel. Discharge will be calculated using the following formula:

$$\text{Discharge} = \frac{\left(\sum d_i\right)}{(n+1)}\ w*v$$

where d equals stream depth, n equals the number of streams depths measured, w equals the width of the stream, and v equals the velocity of the stream (0.9 times the fastest velocity recorded). This equation has been modified from EPA (1997).

If the stream is greater than two inches in depth, then the trapezoid channel method will be utilized to calculate stream discharge. The interval width, thus the number of flow measurements recorded across the channel, is determined by the channel width. If the channel width is less than fifteen feet, then the interval width will be equal to the stream width divided by five. If the channel is greater than fifteen feet wide, then the interval width will be equal to the channel width multiplied by 0.1. Stream depths will be recorded at the right and left edges of the predetermined trapezoid (SI_o and SI_1). Flow measurements will be recorded at the midpoint of each trapezoid ($SI_{1/2}$). All data will be recorded on the data sheet included in Appendix D. Discharge will be calculated using a calibrated Excel spreadsheet to minimize data errors involved in performing hand calculations.

Grab samples will be collected for the remaining water chemistry parameters (nitrate+nitrite, ammonia, total Kjeldahl nitrogen, total organic nitrogen, total phosphorus, dissolved phosphorus, total suspended solids, BOD, COD, fecal coliform, and *E. coli)*. Samples will be placed in prepared containers supplied by ESG Laboratories, Indianapolis, Indiana and Veolia Water Indianapolis, LLC in Indianapolis, Indiana (Table 3). The laboratories will provide the appropriate preservative in the pre-packaged containers as necessary. Sample collection will proceed in a manner similar to that outlined in *EPA Volunteer Stream Monitoring: A Methods Manual* (1997). One member of the field crew will wade to the center of the stream's thalweg to collect the water sample. The crewmember will invert a clean sample bottle (an extra one, not one used for sample storage) from the laboratory into the stream's thalweg. At a depth of approximately 8 to 12 inches below the water surface, the crewmember will turn the bottle into the current to allow for collection of water. (If the stream at the sampling station is shallower than 16 inches, water collection will occur mid-way between the water's surface and the stream bottom.) Once the bottle is full, the crewmember will scoop the bottle up toward the surface. Water in this bottle will be poured into the sample containers provided by the analytical laboratories.

The sample containers will be labeled as outlined in the proceeding section, stored on ice and transported to the appropriate laboratory for analysis. Nitrate-nitrogen, ammonia-nitrogen, total suspended solids, and *E. coli* samples will be stored on ice and transported to Veolia Water Indianapolis in Indianapolis. Required chain of custody procedures as outlined in Veolia's Laboratory Quality Assurance Plan (Appendix C) will be followed. All other samples including total phosphorus, dissolved phosphorus, total Kjeldahl nitrogen, total organic nitrogen, BOD, COD, and fecal coliform will be stored on ice and transported to ESG Laboratories in Indianapolis, Indiana. Required chain of custody procedures as outlined in the laboratory's QA/QC plan (Appendix B) will be followed. Water chemistry samples will be processed at both labs using the laboratory's standard operating protocol (see Table 3). All four water chemistry samples collection events will follow this protocol for each of the eight sample sites, duplicates, and field blanks. Analytical results from the water quality labs will be based on their schedule, but are anticipated within 2-3 weeks of sample collection.

Table 3. Sampling procedures.

Parameter	Sample Frequency	Sample Container*	Sample Volume	Holding Time
pH	4	N/A	N/A	N/A
Temperature	4	N/A	N/A	N/A
Dissolved Oxygen	4	N/A	N/A	N/A
Total Dissolved Solids	4	N/A	N/A	N/A
Flow	4	N/A	N/A	N/A
Ammonia	4	HDPE Nalgene	See Appendix C.	28 days
BOD	4	HDPE Nalgene	See Appendix B.	24 hours
COD	4	HDPE Nalgene	See Appendix B.	24 hours
E. coli	4	HDPE Nalgene	See Appendix C.	6 hours†
Fecal Coliform	4	HDPE Nalgene	See Appendix B.	6 hours†
Nitrate+nitrite	4	HDPE Nalgene	See Appendix C.	28 days
Dissolved phosphorus	4	HDPE Nalgene	See Appendix B.	48 hours
Total Kjeldahl Nitrogen	4	HDPE Nalgene	See Appendix B.	28 days
Total Organic Nitrogen	4	HDPE Nalgene	See Appendix B.	28 days
Total Phosphorus	4	HDPE Nalgene	See Appendix B.	28 days
Total Suspended Solids	4	HDPE Nalgene	See Appendix C.	7 days
GPS	1	N/A	N/A	N/A
Habitat Analysis	1	N/A	N/A	N/A

*Sample containers will be provided and preserved by the contracted laboratory. ESG Laboratories will provide and preserve containers for BOD, COD, dissolved phosphorus, total phosphorus, total Kjeldahl nitrogen, total organic nitrogen, and fecal coliform sampling. Veolia Water Indianapolis will provide and preserve sample bottles for all remaining laboratory parameters.

†This value refers to the maximum time between sample collection and analysis, not the holding time from the time the sample arrives at the lab. That holding time is 2 hours.

Habitat Evaluation

Habitat evaluation will be conducted at each station using Ohio EPA's Quality Habitat Evaluation Index (QHEI). The field crew will adhere to OEPA QHEI standard procedures. Assessments will be made by the field crew and noted on QHEI data sheets (Appendix E).

Section 5: Custody Procedures

Field sampling data and data sheets used for water chemistry field sampling will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

The field crew consisting of the Technical Project Manager and Project Manager (or Project Technician and Technical Project Manager if the Project Manager is not present) will collect the water chemistry samples using the procedure outlined in Section 4. Samples will be labeled with the sampling location, sample number (same as "Field ID" on the laboratory Chain of Custody Record), date and time of collection, sample parameters, and sampler name(s). This information along with the project name and project number will be recorded on the laboratories' Chain of Custody Records (Appendices B and C). Appendices B and C contain blank Chain of Custody Records for ESG Laboratories and Veolia Water Indianapolis, respectively.

E. coli samples will be stored on ice and transported within 6 hours to Veolia Water Indianapolis laboratory. Nitrate-nitrogen, ammona-nitrogen, and total suspended solids samples will be stored on ice and transported to the Veolia Water Indianapolis laboratory within 24 hours of sample collection. The Technical Project Manager will sign the Chain of Custody Record in the presence of the laboratory technician when samples are released to the laboratory. Veolia Water Indianapolis personnel will review sample labels and remove any samples from the dataset that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on laboratory bench sheets after all checks have been completed. A copy of the chain of custody form will accompany sample result documents from Veolia Water Indianapolis. The report from Veolia Water Indianapolis is expected within 2-3 weeks of sampling.

Fecal coliform samples will be stored on ice and transported to ESG Laboratories within 6 hours of collection. All other water chemistry samples (BOD, COD, total Kjeldahl nitrogen, organic nitrogen, total phosphorus, and dissolved phosphorus) will be analyzed by ESG Laboratories. These samples will be stored on ice and transported to the laboratory within 24 hours of sample collection. The Technical Project Manager will sign the Chain of Custody form in the presence of the laboratory technician when samples are released to the laboratory. ESG Laboratories personnel will review sample labels and remove any samples from the dataset that cannot be attributed to specific samplers, have not been properly preserved, or that exceed the maximum holding time. The laboratory manager will also sign-off on laboratory bench sheets after all checks have been completed. A copy of the chain of custody form will accompany sample result documents from ESG Laboratories. The report from ESG Laboratories is expected within 2-3 weeks of sampling.

Habitat measurements will be noted on the QHEI data sheet located in Appendix E. Samples are not collected as part of this procedure. Habitat assessment data sheets will remain in JFNew's custody; therefore, chain of custody does not apply to these measurements.

Section 6: Calibration Procedures and Frequency

Calibration measures will be performed on all field equipment to be used (where appropriate) based upon the manufacturers recommendations as outlined in the users manual for each individual piece of equipment. Field equipment that cannot be calibrated, such as a tape measure, will not be calibrated. Field equipment calibration will be performed the day of sampling prior to its use in the field. The YSI Model 55 oxygen and temperature probe is auto-calibrated based on the altitude and salinity of the sample prior to time of use. The Hanna Instruments HI 98129 pH, EC/TDS, and temperature meter is calibrated using Fisher pH calibration buffer (pH 4.0 and 7.0) and Oakton calibration solution (1413 μS). The Marsh McBirney Model 2000 flow meter is calibrated by the manufacturer prior to shipping. If equipment cannot be properly calibrated, then sampling will be rescheduled. If the GPS can not be properly calibrated, then GPS measurements will be recorded at a later date following proper calibration and all other sampling will proceed as scheduled. See Appendix B for ESB Laboratories and Appendix C for Veolia Water Indianapolis calibration procedures and frequency.

Section 7: Sample Analysis Procedures

Table 4 summarizes the analytical procedures for each water chemistry parameter. Each laboratory has the capability, as shown in their respective Quality Assurance documents (Appendices B and C), to analyze the water samples according to the procedures listed in Table 4.

All procedures that will be used to analyze the macroinvertebrate samples and QHEI assessments will strictly adhere to the OEPA QHEI protocol, respectively. Because this tool was designed to make rapid assessments at large scales, the use of this tool will enable the achievement of project goals. In general, detection limits are not applicable to the physical habitat assessment used in this project.

Table 4. Analytical procedures.

Matrix	Parameter	Method	Detection Limits
Water	pH	Hanna Instruments HI 98129	0.1
Water	Temperature	YSI Model 55	1°C
Water	Dissolved Oxygen	YSI Model 55	0.1 mg/l
Water	Total Dissolved Solids	Hanna Instruments HI 98129	
Water	Flow	Marsh McBirney Model 2000 portable flow meter	0.1 ft/s
Water	Ammonia	EPA 350.2 or 350.3	0.1 mg/l
Water	Biological Oxygen Demand	EPA 405.1	1.0 mg/l
Water	Chemical Oxygen Demand	EPA 410.4	10 mg/l
Water	*E. coli*	SM 9223	N/A
Water	Fecal Coliform	SM 9224 D	N/A
Water	Nitrate+nitrite	EPA 353.3	0.1 mg/l
Water	Dissolved phosphorus	EPA 365.2	0.25 mg/l as PO_4*
Water	Total Kjeldahl Nitrogen	EPA 351.3 or 350.3	0.10 mg/l
Water	Total Organic Nitrogen	EPA 351.3 or 350.3	0.10 mg/l
Water	Total Phosphorus	EPA 365.2	0.10 mg/l*
Water	Total Suspended Solids	EPA 160.2	1.0 mg/l
Geolocation	GPS	Trimble Pathfinder Pro XRS	submeter
Habitat	Habitat Analysis	Ohio EPA QHEI	N/A

*ESG Laboratories will provide phosphorus reporting levels at 0.01 mg/l for total phosphorus and 0.03 mg/l for dissolved phosphorus and PO_4.

Section 8: Quality Control Procedures

Quality control will be achieved by strict adherence to written protocol. To achieve precision in field measurements, replicate measurements will be taken. Replicate measurements for each field parameter will be taken at one of the eight sampling sites for each sampling event. To achieve accuracy in field measurements, equipment will be properly maintained and equipment calibration will occur as detailed in Section 6. To achieve precision in laboratory measurements, duplicate samples will be collected one time in eight samples or once per sampling trip. The contracted laboratories have established control limits for all quality control checks established by their protocols (Appendices B and C). To achieve accuracy in laboratory measurements, field blanks collected concurrently with sample collection will be analyzed. Field blank collection will ensure that no outside contamination occurs during the process of sample bottle preparation or sample collection. Additional laboratory QA/QC checks for accuracy and precision will be implemented by ESG Laboratories and Veolia Water Indianapolis (Appendices B and C). Field work will be performed by the same crew at each site. The Technical Project Manger will ensure consistency in sample collection and field work. This quality control procedure will allow for comparison to be made among sampling sites, and thus, achieve the project's goals of identifying hot spots within the watershed for more targeted intensive management.

Quality control in the field will be obtained by adherence to procedures detailed in Sections 3 and 4. This quality control includes replicate samples, equipment calibration, and adherence to procedures as detailed in Section 3. Quality control of laboratory water chemistry analysis will be performed as outlined in the respective laboratories' QA/QC plans (Appendices B and C). This quality control includes use of field replicates, lab duplicates, split samples, field blanks, reference standards, and method blanks where appropriate. This level of quality control is sufficient to achieve project goals.

Independent QHEI assessments will be made by each member of the field crew to ensure precision and accuracy of habitat assessment. Any differences in assessments will be averaged, if possible, based on the metric. Where averaging of a metric is not possible, the value given by the Technical Project Manager will be accepted. Fieldwork will be performed by the same crew at each site. The Technical Project Manager will ensure consistency in sample collection and fieldwork.

Section 9: Data Reduction, Analysis, Review, and Reporting

Data Reduction

Field data sheets will be inspected for completeness and signed by the Technical Project Manager before leaving the site. The Technical Project Manager will calculate the RPD before leaving the site to ensure the precision data quality objectives for measurement of data for the field measurements are met. It will be assumed that accuracy data quality objective of field measurements are met if there is no problem with equipment calibration. The field data sheet contains fields showing whether the RPD met the data quality objective, if calibration was completed, if the measurement was taken (completeness), and if protocol was followed (comparability). Data from the field data sheets will be used to calculate a QHEI score to indicate the habitat quality of the aquatic system at the specific sites studied. Field measurements using electronic instrumentation need no further reduction. Data reduction in the laboratory will be done in accordance with ESG Laboratories and Veolia Water Indianapolis QA/QC protocol (Appendices B and C).

Data Analysis

Discharge and loadings will be calculated using an electronic spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Hamilton County Surveyor's office to minimize errors involved with performing hand calculations. Once the raw data has been reviewed by the Technical Project Manger, discharge will be calculated using methodology detailed in Section 4 (Marsh McBirney, 1990). Once discharge has been calculated, the pollutant load will be calculated by multiplying the specific site discharge by the concentration of a pollutant found at that site. Pollutant loads among sites will be compared to identify which sites provide the greatest load of pollutant to the Little Cicero Creek watershed.

Data Review

The Project Technician will enter all data into a computerized spreadsheet/database program designed for this project and compatible with software used by JFNew, IDEM, and the Hamilton County Surveyor's office. The Technical Project Manager will review data entry for completeness and errors.

Data Reporting

ESG Laboratories and Veolia Water Indianapolis will provide sample results with qualifying information for any results which fall outside of the control limits. A copy of the chain of custody form will accompany laboratory results.

The Technical Project Manager will be responsible for report production and distribution. The Project Technician will provide assistance in these tasks. The report will contain the data results, interpretation of the data, Best Management Practice proposals for existing watershed conditions, a compilation of watershed stakeholders' concerns and goals, and proposals for future development in the watershed.

Section 10: Performance and System Audits

Specific audits such as those conducted on the contracting laboratories by outside auditors are not applicable to this type of project. Such audits are not necessary to achieve the project goals given the scope of this study and the intended use of the data. However, the following checks and oversight will be utilized to ensure data quality:

- The Technical Project Manager will provide oversight to all technical staff ensuring strict adherence to all protocols.
- Field data sheets will be reviewed for completeness prior to leaving the field.
- Two individuals will make QHEI assessments at each site.

Both ESG Laboratories and Veolia Water Indianapolis have built in audits (Appendices B and C). The Project staff is open to IDEM's audits upon IDEM's request. The Technical Project Manager will conduct a system audit following the first sampling event and at the end of the project to ensure data quality objectives for measurement of data are met.

Section 11: Preventative Maintenance

JFNew will utilize a dissolved oxygen meter/thermometer (YSI Model 55), pH/total dissolved solids meter (Hanna Instruments HI 98129), flow meter (Marsh McBirney Model 2000 portable flow meter), global positioning system (Trimble Pathfinder Pro XRS), and tape measure for water quality sampling. To keep these instruments and equipment in proper working order, all maintenance will be performed as outlined in the users manuals provided with the equipment where appropriate. Additional batteries for the dissolved oxygen meter and GPS, a separate thermometer, and replacement dissolved oxygen membranes will be present in the field for any necessary field repairs. An additional set of collection bottles and nets will be taken along on each sampling trip (where applicable). Preventative maintenance in each respective laboratory is covered in Appendices B and C.

Section 12: Data Quality Assessment

DQO: Precision and Accuracy

As stated in the Study Goals in Section 1, the goal of the project is to document the physical and chemical condition of the Little Cicero Creek watershed. Collected data will be utilized to identify priority areas in the watershed that may be contributing more non-point source pollutants to the Little Cicero Creek watershed. Data quality controls outlined in the sections above will be sufficient to meet the objectives of the study. Data quality assessments conducted by the contracting laboratories will be sufficient to meet the objectives of the project (Appendices B and C). Laboratory analysis of precision and accuracy checks, including control levels for duplicate and replicate samples and field and laboratory blanks, will be kept on file in the contract laboratories. All laboratory data will be assessed by ESG Laboratories and Veolia Water Indianapolis to determine if data quality falls within the required precision and accuracy levels specified by each laboratory (Appendices B and C). The laboratories will follow established protocols to determine if data is valid. Any data that is determined to not meet laboratory quality control guidelines will not be reported or used for subwatershed prioritization. All QA/QC measures for each run of the samples will be included with the lab's final data analysis and will be included as an appendix in the final report.

Field measurements and habitat data will be accepted as valid provided no significant problems occur during calibration and sampling. Field water chemistry measurements will be repeated if precision failures are observed (RPD>5%). Data that does not meet precision goals will not be included in sample analysis and subwatershed prioritization. The accuracy of field measurements and habitat data will not be quantified. However, the data will be acceptable provided that no significant problems occurred during equipment calibration or sampling. Sampling will be rescheduled if problems occur during equipment calibration. Field measurements will be repeated if difficulties occur during sampling.

DQO: Completeness

All data determined to be accurate and precise will be considered valid and will be reported even if completeness objectives are not met. Due to flexibility in scheduling of sampling events, 75-100% completeness is anticipated. If for some reason (such as ones outlined in previous sections) 100% collection of samples is not possible, the data will be evaluated to determine whether the watershed has been sufficiently represented in the data collection to date.

DQO: Representativeness

Meeting the goal of representation is of primary importance since it is one of the study's goals. Data will be evaluated for representativeness based primarily on the following criteria: all sampling stations have been sampled at least once and water chemistry samples have been collected during storm and base flow events. Those criteria are listed in order of importance.

The first one listed will have more importance in deciding whether the project is complete despite not having collected 100% of the samples. Any decisions to deem the project complete without 100% collection of data will be made by the Technical Project Manager. The IDEM Project Manager will be included in all such decisions.

DQO: Comparability

Data collected during this study will meet comparability requirements if standard operating procedures as outlined in Section 4 are followed. Water chemistry data will be comparable with other data collected using the same protocol. Likewise, macroinvertebrate and habitat data will be comparable to IDEM data only if the standard operating procedures are followed. If problems occur during sample collection that requires the use of non-standardized operating procedures, then that data will be evaluated for comparability. This will likely result in the removal of this data from the data set.

Section 13: Corrective Action

Should extraordinary events occur that could adversely affect the collection of accurate, representative data (extreme climatic conditions, chemical spill, etc.) testing shall be rescheduled during the same year when conditions are more favorable. The data can then be analyzed so that reports can be written. Since water chemistry sampling is to be done four times and macroinvertebrate and habitat one time during the study period, it is feasible to schedule sampling at a time when conditions permit within the project's timeframe. If, for reasons beyond the project's control, samples cannot be collected during the project's timeframe, the prohibitive conditions will be noted and discussed with the IDEM Project Manager.

ESG Laboratories and Veolia Water Indianapolis corrective actions that will be taken for the chemical water quality analysis are noted in Appendices B and C. Although it is not anticipated, should data received from the ESG Laboratories and Veolia Water Indianapolis be unusable given the project's data goals, another sampling event will occur to replace effected data. Assurance from the ESG Laboratories and/or Veolia Water Indianapolis that similar problems in data quality will not be repeated will be obtained prior to submission of any samplings.

Less than 75% accuracy of the checked portion (10%) of the macroinvertebrate sample will trigger corrective actions for the macroinvertebrate identification. Such corrective actions could include discussion with sampler and identifier to determine the source of error, re-identification of part of or the entire sample, and/or discarding an unusable sample where appropriate. Any habitat data collected according to standard operating protocols will meet the data collection objectives. Corrective actions are not applicable to this form of assessment.

Section 14: Quality Assurance Reports

Quality Assurance reports will be submitted to IDEM's Watershed Management Section every three months as part of the Quarterly Progress Report and/or Final Report. Any problems that are found with the data will be documented in the quarterly reports. Quality assurance issues that may be addressed in the quarterly report include, but are not limited to the following:

- Assessment of such items as data accuracy and completeness
- Results of performance and/or systems audit
- Significant QA/QC problems and recommended solutions
- Discussion of whether the QA objectives were met and the resulting impact on decision making
- Limitations on use of the measurement data

If no QA/QC problems arise, this will be noted in the report.

References

APHA et al. 1995. Standard Methods for the Examination of Water and Wastewater, 19th edition. American Public Health Association, Washington, D.C.

ESG Laboratories. 2005. Quality Management Plan. Loose-leaf publication. Indianapolis, Indiana.

Indiana Department of Environmental Management. 2004. Indiana 303(d) List of Impaired Waterbodies. Indianapolis, Indiana.

Marsh-McBirney. 1990. Model 2000 Installation and Operations Manual.

Ohio Environmental Protection Agency. 1989. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Monitoring and Assessment, Columbus, Ohio.

U.S. Environmental Protection Agency. 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79/020.

U.S. Environmental Protection Agency. 1997. Volunteer Stream Monitoring: A Methods Manual. EPA-841-B-97-003.

Veolia Water Indianapolis, LLC. 2004. Laboratory Quality Assurance Plan. Loose-leaf publication. Indianapolis, Indiana.

APPENDIX A

Sampling Station Locations

	Location	Width	Substrate	Comments
1	Symons Ditch/Little Cicero Creek at Boxley	~25-30'	Silt/Mud	Upstream mowed to edge, tree lined downstream, est. 2' deep.
2	Jay Ditch/Teeter Branch at Boxley	~15-20'	Sand/Silt	Fence surrounding stream, cattle, may be homeowner issues, est. 1-3' deep.
3	Ross Ditch at Meridian	~10'	Silt/Mud	Culverted. Fences in and around stream, may be homeowner issues.
4	Little Cicero Creek at Anthony Rd.	~30-35'	Sandy with few large rocks or rip-rap	Rocky under bridge, est. 2' deep, but deeper downstream.
5	Bennet Ditch at 276th	~5-6'	Sand/Silt	Est. 4" deep.
6	Little Cicero Creek at Cal Carson	~30'	Sandy with few large rocks or rip-rap	
7	Taylor Creek at 266th	~20'	Silt mud with rip-rap	
8	Little Cicero at 266th	~40'	Silt and large rocks	Difficult to see substrate due to water depth and cloudiness

APPENDIX B

ESG Laboratories
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX C

Veolia Water Indianapolis
Laboratory QA/QC Plan and Chain of Custody Form

APPENDIX D

Water Quality Sampling Data Sheets

WATER QUALITY SAMPLING FIELD LOG SHEET

SITE NUMBER AND LOCATION: ____

DATE: ____________________ PROJECT NAME: ______________________________

TIME: _____________

FIELD CREW: _________________________________

WEATHER CONDITIONS: ____

OTHER OBSERVATIONS: ____

EQUIPMENT CALIBRATION (Date): _____________________

FIELD PARAMETERS	REPLICATE (if taken)	
pH: ___________	pH: ___________	RPD = _______
Temperature: ______________	Temperature: ___________	RPD = _______
Dissolved Oxygen: ___________	Dissolved Oxygen: _______	RPD = _______
DO % Saturation: ____________	DO % Saturation: _______	RPD = _______
Total Dissolved Solids: _________	TDS: ______	RPD= _______
Calculated Flow: _____________		

Relative Percent Difference (RPD)= $\frac{(sample_1 - sample_2)}{((sample_1 + sample_2)/2)}$

LAB PARAMETERS

E. Coli: ____
Ammonia: ____
Nitrate: ____
Total Suspended Solids: ____
Total Kjeldahl Nitrogen: ____
Orthophosphorus Phosphorus: ____
Total Phosphorus: ____
Total Organic Nitrogen: ____
BOD: ____
COD: ____
Fecal Coliform:____

Field Crew Leader Signature: _____________________

Discharge Measurement

Site:______________________________ Date:___________ Time:__________
Project #:__________________________ Project Name:___________________
Crew Members:____________________ Equipment:_____________________
Physical Site Description:____
GPS Coordinates:___________________________

If the stream is <2" deep:
Stream Width:_____feet
Stream Depths: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____feet
U: _____, _____, _____, _____, _____, _____, _____, _____, _____, _____ft/s
U_{max}:_____ft/s

If the stream is >2" deep:
Stream Width (W):_____feet
Interval Width (IW) (If W<15', then IW=W/5. If W>15, then IW=W*0.1):_____feet

Segment	**SI_0** Location	**SI_0** Depth (ft)	**SI_1** Location	**SI_1** Depth (ft)	**½ IW** Location	**½ IW** Depth (ft)	**$U_{0.4}$** Set Depth	**$U_{0.4}$** Rate (ft/s)
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Field Crew Leader Signature: ______________________

APPENDIX E

Qualitative Habitat Evaluation Index (QHEI) Data Sheets

STREAM: ______________ **RIVER MILE:** ________ **DATE:** __________ **QHEI SCORE** [ ]

1) SUBSTRATE: (Check ONLY Two Substrate Type Boxes: Check all types present) **SUBSTRATE SCORE** [ ]

TYPE	POOL	RIFFLE		POOL	RIFFLE	SUBSTRATE ORIGIN (all)		SILT COVER (one)	
BLDER/SLAB(10)	___	___	GRAVEL(7)	___	___	LIMESTONE(1)	RIP/RAP(0)	SILT-HEAVY(-2)	SILT-MOD(-1)
BOULDER(9)	___	___	SAND(6)	___	___	TILLS(1)	HARDPAN(0)	SILT-NORM(0)	SILT-FREE(1)
COBBLE(8)	___	___	BEDROCK(5)	___	___	SANDSTONE(0)		Extent of Embeddedness (check one)	
HARDPAN(4)	___	___	DETRITUS(3)	___	___	SHALE(-1)		EXTENSIVE(-2)	MODERATE(-1)
MUCK/SILT(2)	___	___	ARTIFIC(0)	___	___	COAL FINES(-2)		LOW(0)	NONE(1)

TOTAL NUMBER OF SUBSTRATE TYPES: [ ] >4(2) [ ] <4(0)

NOTE: (Ignore sludge that originates from point sources: score is based on natural substrates)

COMMENTS: ______________________

2) INSTREAM COVER: **COVER SCORE** [ ]

TYPE (Check all that apply)

- [ ] UNDERCUT BANKS(1)
- [ ] OVERHANGING VEGETATION(1)
- [ ] SHALLOWS (IN SLOW WATER)(1)
- [ ] DEEP POOLS(2)
- [ ] ROOTWADS(1)
- [ ] BOULDERS(1)
- [ ] OXBOWS(1)
- [ ] AQUATIC MACROPHYTES(1)
- [ ] LOGS OR WOODY DEBRIS(1)

AMOUNT (Check only one or Check 2 and AVERAGE)

- [ ] EXTENSIVE >75%(11)
- [ ] MODERATE 25-75%(7)
- [ ] SPARSE 5-25%(3)
- [ ] NEARLY ABSENT <5%(1)

COMMENTS: ______________________

3) CHANNEL MORPHOLOGY: (Check ONLY ONE per Category or Check 2 and AVERAGE) **CHANNEL SCORE** [ ]

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATION/OTHER	
HIGH(4)	EXCELLENT(7)	NONE(6)	HIGH(3)	SNAGGING	IMPOUND
MODERATE(3)	GOOD(5)	RECOVERED(4)	MODERATE(2)	RELOCATION	ISLAND
LOW(2)	FAIR(3)	RECOVERING(3)	LOW(1)	CANOPY REMOVAL	LEVEED
NONE(1)	POOR(1)	RECENT OR NO RECOVERY(1)		DREDGING	BANK SHAPING
				ONE SIDE CHANNEL MODIFICATION	

COMMENTS: ______________________

4) RIPARIAN ZONE AND BANK EROSION: (Check ONE box or Check 2 and AVERAGE per bank) **RIPARIAN SCORE** [ ]

River Right Looking Downstream

RIPARIAN WIDTH (per bank) L R (per bank)	EROSION/RUNOFF-FLOODPLAIN QUALITY L R (most predominant per bank)	L R (per bank)	BANK EROSION L R (per bank)
WIDE >150 ft.(4)	FOREST, SWAMP(3)	URBAN OR INDUSTRIAL(0)	NONE OR LITTLE(3)
MODERATE 30-150 ft.(3)	OPEN PASTURE/ROW CROP(0)	SHRUB OR OLD FIELD(2)	MODERATE(2)
NARROW 15-30 ft.(2)	RESID.,PARK,NEW FIELD(1)	CONSERV. TILLAGE(1)	HEAVY OR SEVERE(1)
VERY NARROW 3-15 ft.(1)	FENCED PASTURE(1)	MINING/CONSTRUCTION(0)	
NONE(0)			

COMMENTS: ______________________

5) POOL/GLIDE AND RIFFLE/RUN QUALITY **NO POOL = 0** **POOL SCORE** [ ]

MAX.DEPTH (Check 1)	MORPHOLOGY (Check 1)	POOL/RUN/RIFFLE CURRENT VELOCITY (Check all that Apply)	
>4 ft.(6)	POOL WIDTH>RIFFLE WIDTH(2)	TORRENTIAL(-1)	EDDIES(1)
2.4-4 ft.(4)	POOL WIDTH=RIFFLE WIDTH(1)	FAST(1)	INTERSTITIAL(-1)
1.2-2.4 ft.(2)	POOL WIDTH<RIFFLE WIDTH(0)	MODERATE(1)	INTERMITTENT(-2)
<1.2 ft.(1)		SLOW(1)	
<0.6 ft.(Pool=0)(0)			

COMMENTS: ______________________

RIFFLE SCORE [ ]

RIFFLE/RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS	
GENERALLY >4 in. MAX.>20 in.(4)	STABLE (e.g., Cobble,Boulder)(2)	EXTENSIVE(-1)	NONE(2)
GENERALLY >4 in. MAX.<20 in.(3)	MOD.STABLE (e.g., Pea Gravel)(1)	MODERATE(0)	NO RIFFLE(0)
GENERALLY 2-4 in.(1)	UNSTABLE (Gravel, Sand)(0)	LOW(1)	
GENERALLY <2 in.(Riffle=0)(0)	NO RIFFLE(0)		

COMMENTS: ______________________

6) GRADIENT (FEET/MILE): ______ **% POOL** ______ **% RIFFLE** ______ **% RUN** ______ **GRADIENT SCORE** [ ]

Field Parameters

ID	Stream	Date	Timing	Flow (cfs)	Temperature (degrees C)	Dissolved Oxygen (mg/L)	Percent Saturation	pH	Conductivity (mmhos/cm)	TSS (mg/L)	BOD (mg/L)	COD (mg/L)
1	Symons Ditch at Boxley Road	5/31/2005	base	2.09	15.9	8.12	82.1	8	716	3.6	<4	<10
		6/13/2005	storm	36.5	19.3	7.09	76.6	7.29	448	20.4	2.69	19.7
		8/11/2005	base	0.82	23.1	5.06	59.1	8.13	941	9.2	1.17	<10.0
		9/26/2005	storm	2.9	19.9	9.13	100.8	7.97	657	15.2	<1.00	15.7
2	Jay Ditch at Boxley Road	5/31/2005	base	1.41	19.1	11.75	126.2	8.27	607	14.4	<4	<10
		6/13/2005	storm	35.7	20.1	7.6	83.9	7.54	413	54.8	3.28	28.4
		8/11/2005	base	0.24	23.1	3.7	45.4	8.03	671	20.4	3.34	12.2
		9/26/2005	storm	18.38	19.5	8.45	92.1	7.77	451	29.2	1.57	25
3	Ross Ditch at Meridian	5/31/2005	base	0.43	20.2	10.5	114.3	8.09	570	34.8	<4	12.2
		6/13/2005	storm	7.79	20.6	7.45	84.1	7.61	469	27.2	1.84	12.2
		8/11/2005	base	Stream was dry; no sample collected.								
		9/26/2005	storm	2.76	19.7	7.68	84.4	7.58	451	24.4	1.24	26.1
4	Little Cicero at Anthony	5/31/2005	base	6.86	19.3	10.61	113	8.27	588	11.2	<4	<10
		6/13/2005	storm	126.6	20.2	7.58	82.1	7.45	435	81.6	3.38	23.2
		8/11/2005	base	0.95	23.4	4.55	53.2	7.97	688	3.6	1.51	<10.0
		9/26/2005	storm	38.76	19.7	8.81	96.8	7.79	460	36.4	1.21	19.2
5	Bennett Ditch at 276th	5/31/2005	base	0.85	18.2	9.24	97.8	8.1	601	21.51	<4	<10
		6/13/2005	storm	9.98	18.7	7.48	78.3	7.27	507	18.8	1.91	15.1
		8/11/2005	base	0.05	21.6	7.15	81.2	8.18	780	64.8	1.85	<10.0
		9/26/2005	storm	6.35	19.2	6.81	73.9	7.51	524	8.8	<1.00	14.5
6	Little Cicero at Cal Carson	5/31/2005	base	9.63	18.7	9.79	104.6	8.25	603	14	<4	<10
		6/13/2005	storm	Unsafe water level, no sample collected								
		8/11/2005	base	1.51	23.1	5.9	57.8	7.86	653	14	1.68	18.6
		9/26/2005	storm	49.82	19.7	6.96	76	7.68	450	64	1.65	23.2
7	Taylor Creek at 266th	5/31/2005	base	2.7	17.2	9.37	97.4	8.15	567	16.4	<4	<10
		6/13/2005	storm	33.8	19.3	7.56	82.8	7.65	489	52.8	1.86	14.5
		8/11/2005	base	0.97	22.1	8.18	96.4	8.23	645	2.8	1.08	<10.0
		9/26/2005	storm	37.31	19.5	6.45	70	7.44	462	12.9	<1.00	22.1
8	Little Cicero at 266th	5/31/2005	base	14.9	20.7	10.93	122.8	8.35	597	36	<4	11
		6/13/2005	storm	275	20.9	7.6	83.5	7.46	442	108.8	2.75	24.4
		8/11/2005	base	1.75	24.9	6.02	70.9	8.15	662	10	1.16	<10.0
		9/26/2005	storm	135.12	20.1	6.65	73.6	7.66	480	104.4	1.24	24.4

Parameter Areal Loading Rates

ID	Stream	Date	Timing	Nitrate-N Aerial Load (Kg/ha-yr)	Ammonia-N Aerial Load (Kg/ha-yr)	TKN Aerial Load (Kg/ha-yr)	TP Aerial Load (Kg/ha-yr)	DP Aerial Load (Kg/ha-yr)	ON Aerial Load (Kg/ha-d)	TSS Aerial Load (Kg/ha-yr)
1	Symons Ditch at Boxley Road	5/31/2005	base	6.84	0.34	0.89	0.16	bdl	0.46	3.82
		6/13/2005	storm	280.25	6.82	32.95	7.03	4.18	20.36	377.59
		8/11/2005	base	1.83	0.11	0.37	0.1	0.08	0.27	3.81
		9/26/2005	storm	--	0.19	3.2	0.55	0.49	2.91	22.31
2	Jay Ditch at Boxley Road	5/31/2005	base	4.55	0.11	0.86	0.13	bdl	0.39	14.4
		6/13/2005	storm	403.07	12.85	53.5	8.92	5.37	30.42	1389.37
		8/11/2005	base	bdl	0.03	0.22	0.05	0.03	0.18	3.52
		9/26/2005	storm	--	bdl	22.19	5.22	3.81	20.75	381.07
3	Ross Ditch at Meridian	5/31/2005	base	4.29	0.14	0.8	0.09	bdl	0.59	30.92
		6/13/2005	storm	239.78	1.05	18.76	2.49	1.34	15.07	439.82
		8/11/2005	base	Stream was dry; no sample collected.						
		9/26/2005	storm	--	0.26	10.03	2.85	2.29	9.23	139.89
4	Little Cicero at Anthony	5/31/2005	base	5.71	0.09	0.7	0.11	bdl	0.51	12.43
		6/13/2005	storm	303.61	8.87	37.48	7.31	2.99	23.96	1671.14
		8/11/2005	base	0.11	0.03	0.1	0.03	0.03	0.07	0.55
		9/26/2005	storm	--	0.27	9.78	2.46	1.74	9.15	228.24
5	Bennett Ditch at 276th	5/31/2005	base	8.8	0.1	0.54	0.11	bdl	0.33	22.4
		6/13/2005	storm	186.5	2.86	14.6	1.89	0.91	10.45	230.67
		8/11/2005	base	0.14	0	0.17	0.01	0.01	0.16	4.3
		9/26/2005	storm	--	0	9.76	2.57	2.32	9.3	68.74
6	Little Cicero at Cal Carson	5/31/2005	base	7.38	0.12	0.78	0.14	bdl	0.64	17.51
		6/13/2005	storm	No sample collected.						
		8/11/2005	base	0.47	0.04	0.17	0.05	0.03	0.13	2.74
		9/26/2005	storm	--	0.35	9.91	2.78	1.66	9.13	414.4
7	Taylor Creek at 266th	5/31/2005	base	9.9	0.07	0.71	0	bdl	0.46	18.4
		6/13/2005	storm	253.53	6.01	19.09	2.75	1.07	10.3	735.89
		8/11/2005	base	2.01	0.02	0.18	0	0	0.14	1.12
		9/26/2005	storm	--	0	20.61	4.49	3.22	19.38	198.46
8	Little Cicero at 266th	5/31/2005	base	8.88	0.05	0.91	0.23	bdl	0.77	45.48
		6/13/2005	storm	345.28	9.96	41.5	7.32	2.94	27.28	2536.36
		8/11/2005	base	0.48	0.03	0.1	0.02	0.01	0.08	1.49
		9/26/2005	storm	--	bdl	17.64	4.19	1.97	16.72	1195.8

Parameter Concentrations

ID	Stream	Date	Timing	Nitrate-Nitrogen (mg/L)	Ammonia-Nitrogen (mg/L)	TKN (mg/L)	TP (mg/L)	Dissolved P (mg/L)	Org. N (mg/L)	*E. coli* (col/100 mL)	Fecal Coliform (col/100 mL)
1	Symons Ditch at Boxley Road	5/31/2005	base	6.445	0.321	0.839	0.154	<0.1	0.432	771	705
		6/13/2005	storm	15.141	0.3684	1.78	0.38	0.226	1.1	4,570	3,200
		8/11/2005	base	4.433	0.2655	0.892	0.249	0.2	0.664	1,220	1,700
		9/26/2005	storm	--	0.1298	2.18	0.377	0.332	1.98	4,520	5,100
2	Jay Ditch at Boxley Road	5/31/2005	base	4.551	0.1133	0.859	0.132	<0.1	0.395	552	240
		6/13/2005	storm	15.898	0.5068	2.11	0.352	0.212	1.2	7,470	7,000
		8/11/2005	base	<1.0	0.1506	1.29	0.283	0.16	1.03	1,080	1,096
		9/26/2005	storm		<0.040	1.7	0.4	0.292	1.59	13,540	5,400
3	Ross Ditch at Meridian	5/31/2005	base	4.828	0.153	0.904	0.103	<0.1	0.666	583	330
		6/13/2005	storm	14.829	0.0652	1.16	0.154	0.083	0.932	7,940	2,300
		8/11/2005	base	Stream was dry; no sample collected.							
		9/26/2005	storm	--	0.046	1.75	0.497	0.4	1.61	18,600	7083
4	Little Cicero at Anthony	5/31/2005	base	5.141	0.0824	0.629	0.103	<0.1	0.457	275	116
		6/13/2005	storm	14.825	0.4331	1.83	0.357	0.146	1.17	6,700	4,500
		8/11/2005	base	0.715	0.1697	0.668	0.2	0.183	0.482	750	530
		9/26/2005	storm	--	0.0435	1.56	0.392	0.277	1.46	5,650	1290
5	Bennett Ditch at 276th	5/31/2005	base	8.455	0.0966	0.519	0.103	<0.1	0.32	744	370
		6/13/2005	storm	15.2	0.2327	1.19	0.154	0.074	0.852	4,950	2,200
		8/11/2005	base	2.088	<0.04	2.56	0.149	0.097	2.44	720	550
		9/26/2005	storm		<0.040	1.25	0.329	0.297	1.19	3,640	3000
6	Little Cicero at Cal Carson	5/31/2005	base	5.903	0.0951	0.626	0.111	<0.1	0.508	327	107
		6/13/2005	storm	Stream was dry; no sample collected.							
		8/11/2005	base	2.424	0.1962	0.855	0.254	0.143	0.674	970	840
		9/26/2005	storm	--	0.0535	1.53	0.429	0.257	1.41	4,730	5833
7	Taylor Creek at 266th	5/31/2005	base	8.826	0.064	0.635	<.100	<0.1	0.408	285	210
		6/13/2005	storm	18.191	0.4314	1.37	0.197	0.077	0.739	3,410	1,500
		8/11/2005	base	5.027	0.062	0.443	<0.100	<0.050	0.361	1,210	410
		9/26/2005	storm		<0.040	1.34	0.292	0.209	1.26	2,950	3800
8	Little Cicero at 266th	5/31/2005	base	7.028	0.0363	0.723	0.183	<0.1	0.608	464	260
		6/13/2005	storm	14.811	0.4274	1.78	0.314	0.126	1.17	12,340	6,000
		8/11/2005	base	3.208	0.2064	0.679	0.129	0.077	0.568	2,750	1,950
		9/26/2005	storm	--	<0.040	1.54	0.366	0.172	1.46	11,620	3900

Parameter Loading Rates

ID	Stream	Date	Timing	Nitrate-N Load (Kg/day)	Ammonia-N Load (Kg/day)	TKN Load (Kg/day)	TP Load (Kg/day)	DP Load (Kg/day)	Org. N Load (Kg/day)	TSS Load (Kg/day)	E. coli Load (bil col/day)	Fecal Coliform (bil col/day)
1	Symons Ditch at Boxley Road	5/31/2005	base	33	1.6	4.3	0.8	bdl	2.2	18.4	1,116.60	1,021.00
		6/13/2005	storm	1,351.30	32.9	158.9	33.9	20.2	98.2	1,820.60	115,423.90	80,822.00
		8/11/2005	base	8.8	0.5	1.8	0.5	0.4	1.3	18.4	688.9	959.9
		9/26/2005	storm	--	0.9	15.4	2.7	2.4	14	107.6	9,054.70	10,216.60
2	Jay Ditch at Boxley Road	5/31/2005	base	15.7	0.4	3	0.5	bdl	1.4	49.6	537.8	233.8
		6/13/2005	storm	1,387.70	44.2	184.2	30.7	18.5	104.7	4,783.50	184,533.60	172,923.00
		8/11/2005	base		0.1	0.8	0.2	0.1	0.6	12.1	181.6	184.3
		9/26/2005	storm	--	bdl	76.4	18	13.1	71.4	1,312.00	172,169.50	68,664.40
3	Ross Ditch at Meridian	5/31/2005	base	5.1	0.2	0.9	0.1	bdl	0.7	36.4	172.7	97.7
		6/13/2005	storm	282.5	1.2	22.1	2.9	1.6	17.8	518.1	42,800.10	12,398.00
		8/11/2005	base	Stream was dry; no sample collected.								
		9/26/2005	storm	--	0.3	11.8	3.4	2.7	10.9	164.8	35,548.70	13,537.20
4	Little Cicero at Anthony	5/31/2005	base	86.2	1.4	10.6	1.7	bdl	7.7	187.9	1,305.60	550.7
		6/13/2005	storm	4,589.10	134.1	566.5	110.5	45.2	362.2	25,259.50	586,941.90	394,214.70
		8/11/2005	base	1.7	0.4	1.5	0.5	0.4	1.1	8.3	490.4	346.6
		9/26/2005	storm	--	4.1	147.9	37.2	26.3	138.4	3,449.90	151,544.90	34,600.50
5	Bennett Ditch at 276th	5/31/2005	base	17.5	0.2	1.1	0.2	bdl	0.7	44.5	436.1	216.9
		6/13/2005	storm	370.9	5.7	29	3.8	1.8	20.8	458.8	34,184.00	15,192.90
		8/11/2005	base	0.3	bdl	0.3	0	0	0.3	8.6	26.9	20.6
		9/26/2005	storm	--	bdl	19.4	5.1	4.6	18.5	136.7	16,004.20	13,190.30
6	Little Cicero at Cal Carson	5/31/2005	base	138.9	2.2	14.7	2.6	bdl	12	329.5	2,178.10	712.7
		6/13/2005	storm	No sample collected.								
		8/11/2005	base	8.9	0.7	3.1	0.9	0.5	2.5	51.6	1,010.80	875.4
		9/26/2005	storm	--	6.5	186.4	52.3	31.3	171.8	7,796.70	163,071.30	201,098.30
7	Taylor Creek at 266th	5/31/2005	base	58.7	0.4	4.2	bdl	bdl	2.7	109.1	536.6	395.4
		6/13/2005	storm	1,503.40	35.7	113.2	16.3	6.4	61.1	4,363.70	79,755.00	35,082.80
		8/11/2005	base	11.9	0.1	1.1	bdl	bdl	0.9	6.6	813	275.5
		9/26/2005	storm	--	bdl	122.2	26.6	19.1	114.9	1,176.80	76,159.20	98,103.30
8	Little Cicero at 266th	5/31/2005	base	256.1	1.3	26.3	6.7	bdl	22.2	1,311.70	4,784.60	2,681.00
		6/13/2005	storm	No flow collected; estimated for comparison purposes only.								
		8/11/2005	base	13.8	0.9	2.9	0.6	0.3	2.4	42.9	3,335.80	2,365.40
		9/26/2005	storm	--	bdl	508.8	120.9	56.8	482.4	34,491.40	1,086,432.50	364,637.40

S1-Symons Ditch looking downstream.

S1-Symons Ditch looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

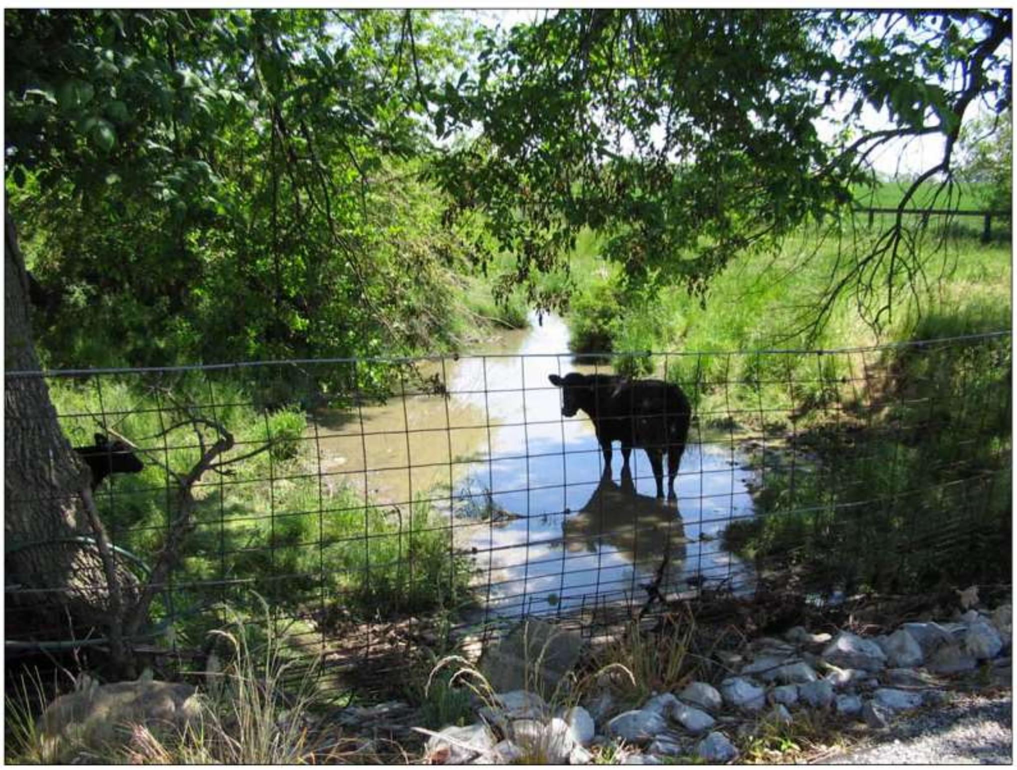
JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S2-Jay Ditch looking downstream.

S2-Jay Ditch looking upstream.

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S2-Cows in stream.



S3-Cows in stream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
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www.jfnew.com

S3-Cows in stream (2).

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S3-Ross Ditch looking downstream.

S3-Ross Ditch looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S4-Little Cicero Creek looking downstream.

S4-Little Cicero Creek looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
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www.jfnew.com

S5-Bennet Ditch looking downstream.

S5-Bennet Ditch looking upstream.

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S6-Little Cicero Creek looking downstream.

S6-Little Cicero Creek looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S7-Taylor Creek looking downstream.

S7-Taylor Creek looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

S8-Little Cicero Creek looking downstream.

S8-Little Cicero Creek looking upstream.

Site Photographs
May 31, 2005
Little Cicero Creek
Hamilton County Surveyor
Hamilton County, Indiana

JFNew # 04-12-31

JFNew
708 Roosevelt Road, Walkerton, IN 46574
Phone 574-586-3400 / Fax 574-586-3446
www.jfnew.com

Program Name	Overview	FY 2006 Funding Levels
Regulated Drain Assessments	Information available at http://www.co.hamilton.in.us	Contact Hamilton County Drainage Board at (317) 776-9627
Wildlife Habitat Incentives Program (WHIP)	The Wildlife Habitat Incentives Program is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed. More information is available at http://www.in.nrcs.usda.gov/programs/whip/whip.html.	Contact local NRCS office
Bring Back the Natives Grant Program	This National Fish and Wildlife Foundation (NFWF) program provides funds to restore damaged or degraded riverine habitats and their native aquatic species through watershed restoration and improved land management. More information available at: www.nfwf.org/programs/bbn.cfm	Not available
Clean Water State Revolving Fund	EPA awards grants to states to capitalize their Clean Water State Revolving Funds (CWSRFs). The states, through the CWSRF, make loans for high-priority water quality activities. As loan recipients make payments back into the fund, money is available for new loans to be issued to other recipients. More information available at: www.epa.gov/owm/cwfinance/cwsrf/	$5 billion
Community Development Block Grant Program	The Department of Housing and Urban Development sponsors this program, intended to develop viable communities by providing decent housing and a suitable living environment and by expanding economic opportunities primarily for persons of low and moderate income. Specific activities may provision of public facilities and improvements, such as new or improved water and sewer facilities. More information available at: www.hud.gov/offices/cpd/communitydevelopment/programs/index.cfm	$3.75
Community-based Restoration Program	The NOAA Community-based Restoration Program (CRP) provides funds for small-scale, locally driven habitat restoration projects that foster natural resource stewardship within communities. Partnerships are sought at the national and local level to contribute funding, land, technical assistance, workforce support, or other in-kind services. More information available at: http://www.nmfs.noaa.gov/habitat/restoration/funding_opportunities/funding.html	$3 million
Conservation Reserve Program	CRP is a voluntary program that offers long-term rental payments and cost-share assistance to establish long-term, resource-conserving cover on environmentally sensitive cropland or, in some cases, marginal pastureland. The protective cover reduces soil erosion, improves water quality, and enhances or establishes wildlife habitat. Increased rental payments are available on certain land areas (e.g., land within a wellhead protection area may receive an additional 10 percent payment). More information available at: http://www.fsa.usda.gov/dafp/cepd/crp.htm	$1.9 billion

Program Name	Overview	FY 2006 Funding Levels
Conservation Security Program	The Conservation Security Program (CSP) is a voluntary conservation program that supports ongoing stewardship of private lands by providing payment for maintaining and enhancing natural resources. CSP identifies and rewards those farmers and ranchers who are meeting the highest standards of conservation and environmental management on their operations. More information available at: www.nrcs.usda.gov/programs/csp	$259 million
Environmental Education Grants	EPA awards grants to states to capitalize their Drinking Water State Revolving Fund (DWSRF) programs. States use a portion of their capitalization grants to set up a revolving fund from which loans are provided to eligible public water utilities (publicly- and privately-owned) to finance the costs of infrastructure projects. States may also use up to 31 percent of their capitalization grants to fund set-aside activities that help to prevent contamination problems of surface and ground water drinking water supplies, as well as enhance water system management through source water protection, capacity development, and operator certification programs. More information available at: www.epa.gov/safewater/dwsrf.html	$837.5 million
Environmental Quality Incentives Program	The USDA Natural Resources Conservation Service's Emergency Watershed Protection (EWP) program helps protect lives and property threatened by natural disasters such as floods, hurricanes, tornadoes, droughts, and wildfires. EWP provides funding for such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks. The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner. EWP can provide up to 90 percent cost share in limited resource areas as determined by the US Census. More information available at: www.nrcs.usda.gov/programs/ewp/	$300 million
Farm and Ranch Lands Protection Program (FRPP)	This program provides funding for the following educational priorities: (1) Capacity Building for developing and delivering coordinated environmental education programs (2) Education Reform by utilizing environmental education as a catalyst to advance state, local, or tribal education reform goals; (3) Community Issues such as designing and implementing model projects to educate the public about environmental issues and/or health issues (4) Health Issues such as educating	$3 million
Five-Star Restoration Program	The USDA Natural Resources Conservation Service's Environmental Quality Incentives Program (EQIP) was established to provide a voluntary conservation program for farmers and ranchers to address significant natural resource needs and objectives. Nationally, it provides technical, financial, and educational assistance, sixty percent of it is targeted to livestock-related natural resource concerns and the rest to more general conservation priorities. EQIP is available primarily in nationwide where there are significant natural resource concerns and objectives. More information available at: www.nrcs.usda.gov/programs/eqip	$695 million

Program Name	Overview	FY 2006 Funding Levels
Forest Land Enhancement Program	The USDA Natural Resources Conservation Service's Farmland Protection Program (FPP) is a voluntary program that helps farmers and ranchers keep their land in agriculture and prevents conversion of agricultural land to non-agricultural uses. The program provides matching funds to organizations with existing farmland protection programs that enable them to purchase conservation easements. More information available at: www.nrcs.usda.gov/programs/frpp	$72 million
Forest Legacy Program	The EPA supports the Five-Star Restoration Program by providing funds to the National Fish and Wildlife Foundation and its partners, the National Association of Counties, NOAA's Community-based Restoration Program and the Wildlife Habitat Council. These groups then make subgrants to support community-based wetland and riparian restoration projects. More information available at: www.epa.gov/owow/wetlands/restore/5star/	$500,000
Freshwater Mussel Fund	The Forest Service's Forest Land Enhancement Program (FLEP) replaces the Forestry Incentives Program and Steward Incentives Program. The program provides financial, technical, educational, and related assistance to State Foresters or equivalent agencies to assist private landowners in sustainable forest management to enhance production of timber, fish and wildlife habitat, soil and water quality, wetland, recreational resources, and aesthetic values. More information available at: www.stateforesters.org/SFlist.html	$5 million
Grassland Reserve Program	Through its Forest Legacy Program (FLP), the USDA Forest Service supports state efforts to protect environmentally sensitive forest lands from the conversion to non-forest uses through the use of conservation easements and fee-simple purchase. More information available at: http://www.fs.fed.us/spf/coop/programs/loa/flp.shtml	$56.5 million
Land and Water Conservation Fund	The National Fish and Wildlife Foundation and the U.S. Fish and Wildlife Service are administering a fund to enhance and protect freshwater mussel resources. Funds are available for the enhancement and protection of the mussel resource and for the restoration and cultivation of mussel shell populations allegedly affected by illegal acts. More information available at: http://www.nfwf.org/	Not available
Landowner Incentive Program (Non-Tribal)	The 2002 Farm Bill established the Grassland Reserve Program (GRP) for the purpose of restoring and conserving two million acres of grassland, rangeland, and pastureland. GRP will do this through the use of up to 30-year rental agreements and 30-year or permanent easements. Total funding through 2007 is authorized at $254 million in easements, rental agreements, and cost-share payments for enrolling up to 2 million acres. The current value of unfunded backlog is $898 million. More information at: http://www.nrcs.usda.gov/programs/GRP/	none
Learn and Serve America Program	LWCF uses offshore oil leasing revenues to support grants to States, and through States, local units of government for the acquisition and development of state and local park and recreation areas that guarantee public use in perpetuity. More information available at: http://www.nps.gov/lwcf	$28 million

Program Name	Overview	FY 2006 Funding Levels
Migratory Bird Conservancy	The U.S. Fish and Wildlife Service's Landowner Incentive Program (LIP) grant program provides competitive matching grants to states, territories, and the District of Columbia to establish or supplement landowner incentive programs. These programs provide technical and financial assistance to private landowners for projects that protect and restore habitats of listed species or species determined to be at-risk. More information available at: http://offices.fws.gov/statelinks.html	$21,660,902 million
National Fish and Wildlife Foundation General Matching Grants	Learn and Serve America provides students and youth with opportunities to serve America by connecting community service with academic learning, personal growth, and civic responsibility. Typical projects address local needs in the areas of education, public safety, the environment, and other human needs. More information available at: http://www.learnandserve.org/	$37 million
National Wildlife Refuge Friends Group Grant Program	The National Fish and Wildlife Foundation's (NFWF) Migratory Bird Conservancy (MBC) program is a bird conservation grant fund supported by donations from birding businesses and their customers, and matched by NFWF. The MBC will fund projects that directly address conservation of priority bird habitats in the Western Hemisphere. Acquisition, restoration, and improved management of habitats are program priorities. Education, research, and monitoring will be considered only as components of actual habitat conservation projects. More information available at: www.conservebirds.org	$63,500
Native Plant Conservation Initiative	The National Fish and Wildlife Foundation operates a conservation grants program that awards challenge grants, on a competitive basis, to eligible grant recipients. Grants are awarded to projects that: (1) address priority actions promoting fish and wildlife conservation and the habitats on which they depend; (2) work proactively to involve other conservation and community interests; (3) leverage available funding; and (4) evaluate project outcomes. More information available at: www.nfwf.org/guidelines.cfm	Not available
Natural Resources Conservation Service: Conservation on Private Lands	The National Fish and Wildlife Foundation provides grants for projects that help organizations to be effective co-stewards of our Nation's important natural resources within the National Wildlife Refuge System. More information available at: www.nfwf.org/programs/nwrgp.cfm	$200,000
Nonpoint Source Implementation Grants (319 Program)	The National Fish and Wildlife Foundation's Native Plant Conservation Initiative (NPCI) supports on-the-ground conservation projects that protect, enhance, and/or restore native plant communities on public and private land. This program is funded by the Bureau of Land Management, Forest Service, Fish and Wildlife Service, and National Park Service. More information available at: http://www.nfwf.org/programs/npci.cfm	Not available

Program Name	Overview	FY 2006 Funding Levels
North American Wetlands Conservation Act Grants Program	The goal of the partnership is to support high quality projects that engage private landowners, primarily farmers and ranchers, in the conservation and enhancement of wildlife and natural resources on their lands. Successful projects will address conservation practices in ongoing agriculture, ranching, and forestry operations (at the watershed or landscape scale); offer value for fish and wildlife; include partnerships; and have a strong "on-the-ground" component. More information available at: http://www.nfwf.org/programs/nrcsnacd.cfm	Not available
Partners for Fish and Wildlife Program	Through its 319 program, EPA provides formula grants to the states and tribes to implement nonpoint source projects and programs in accordance with section 319 of the Clean Water Act (CWA). Nonpoint source pollution reduction projects can be used to protect source water areas and the general quality of water resources in a watershed. Examples of previously funded projects include installation of best management practices (BMPs) for animal waste; design and implementation of BMP systems for stream, lake, and estuary watersheds; basinwide landowner education programs; and lake projects previously funded under the CWA section 314 Clean Lakes Program. More information available at: www.cfda.gov (search on program 66.460)	$206 million
Pesticide Environmental Stewardship Grants	The U.S. Fish and Wildlife Service's Division of Bird Habitat Conservation administers this matching grants program to carry out wetlands and associated uplands conservation projects in the United States, Canada, and Mexico. Grant requests must be matched by a partnership with nonfederal funds at a minimum 1:1 ratio. Conservation activities supported by the Act in the United States and Canada include habitat protection, restoration, and enhancement. Mexican partnerships may also develop training, educational, and management programs and conduct sustainable-use studies. Project proposals must meet certain biological criteria established under the Act. Visit the program web site for more information. (Click on the hyperlinked program name to see the listing for "Primary Internet".) More information available at: http://www.fws.gov/birdhabitat/index.shtm	$71.6 million
Presidents Environmental Youth Award	The Partners for Fish and Wildlife Program provides technical and financial assistance to private landowners to restore fish and wildlife habitats on their lands. More information available at: http://ecos.fws.gov/partners/viewContent.do?viewPage=home	$50 million
Private Stewardship Grants Program	EPA's Pesticide Environmental Stewardship Program (PESP) offers grants to support the reduction of risks from pesticides in agricultural and non-agricultural settings, and to implement pollution prevention measures. More information available at: http://www.epa.gov/oppbppd1/PESP/	$470,000

Program Name	Overview	FY 2006 Funding Levels
Science to Achieve Results	The U.S. Fish and Wildlife Service's Private Stewardship Grants Program (PSGP) provides grants and other assistance on a competitive basis to individuals and groups engaged in private conservation efforts that benefit species listed or proposed as endangered or threatened under the Endangered Species Act of 1973, as amended, candidate species, or other at-risk species on private lands within the United States. More information available at: http://www.fws.gov/endangered/grants/private_stewardship/	$7.3 million
Small Watershed Rehabilitation Program	The National Fish and Wildlife Foundation's Pulling Together Initiative (PTI) provides a means for federal agencies to partner with state and local agencies, private landowners, and other interested parties to develop long-term weed management projects within the scope of an integrated pest management strategy. More information available at: http://www.nfwf.org/programs/pti.cfm	$1.6 million
State Wildlife Grant Program (Non-Tribal)	The Science to Achieve Results (STAR) program is designed to improve the quality of science used in EPA's decision-making process. STAR funds are provided for research in the following six areas: (1) Safe Drinking Water (includes source water protection), (2) High Priority Air Pollutants, (3) Research to Improve Human Health Risk Assessment, (4) Research to Improve Ecological Risk Assessment, (5) Emerging Issues, and (6) Pollution Prevention and New Technologies. More information available at: http://es.epa.gov/ncer/rfa/	$60,300,000
Sustainable Agriculture Research and Education	This program provides essential funding for the rehabilitation of aging small watershed impoundments that have been constructed over the past 50 years. This funding program helps communities rehabilitate dams to address critical public health and safety issues. More information available at: http://www.nrcs.usda.gov/programs/WSRehab/	$31.5 million
Targeted Watershed Grants Program	The U.S. Fish and Wildlife Service's (USFWS) State Wildlife Grant (SWG) program provides grants to states, territories, and the District of Columbia for wildlife conservation. The SWG program provides funds to help develop and implement programs that benefit wildlife and their habitat, including species that are not hunted or fished. More information available at: http://www.fws.gov/offices/statelinks.html	$60,335
Transportation Equity Act for the 21st Century Funding Programs	SARE funds scientific investigation and education to reduce the use of chemical pesticides, fertilizers, and toxic materials in agricultural production; to improve management of on-farm resources to enhance productivity, profitability, and competitiveness; to promote crop, livestock, and enterprise diversification and to facilitate the research of agricultural production systems in areas that possess various soil, climatic, and physical characteristics; to study farms that have are managed using farm practices that optimize on-farm resources and conservation practices; and to promote partnerships among farmers, nonprofit organizations, agribusiness, and public and private research and extension institutions. More information available at: www.sare.org	$12.3 million

Program Name	Overview	FY 2006 Funding Levels
Urban and Community Forestry Challenge Cost-Share Grants	EPA is asking the nation's Governors, Tribal Leaders, and leading watershed organizations to apply for the next round of funding to support collaborative partnerships to protect and restore the nation's water resources. More information available at: http://www.epa.gov/owow/watershed/initiative/	$16.6 million
Water and Waste Disposal Systems for Rural Communities	The Transportation Equity Act for the 21st Century (TEA-21) funds numerous transportation programs (Surface Transportation Program (STP), National Highway System, etc.) to improve the nation's transportation infrastructure, enhance economic growth, and protect the environment. States may spend up to 20 percent of the STP dollars used on certain projects to rehabilitate existing transportation facilities for environmental restoration and pollution abatement projects, including the construction of stormwater treatment systems. Additionally, each state sets aside 10 percent of STP funds for transportation enhancement projects, which can include acquisition of conservation and scenic easements and the mitigation of highway stormwater runoff water quality, as well as scenic beautification, pedestrian and bicycle trails, archaeological planning, and historic preservation. These varied project types can be used to protect source water areas during construction of transportation corridors. More information available at: www.fhwa.dot.gov/tea21/	Not available
Watershed Processes and Water Resources Program	The U.S. Forest Service's Urban and Community Forestry Challenge Cost-Share Grant Program seeks to establish sustainable urban and community forests by encouraging communities to manage and protect their natural resources. More information available at: www.treelink.org/nucfac/	$1 million
Watershed Protection and Flood Prevention Program	This USDA Rural Utilities Service program provides monies to provide basic human amenities, alleviate health hazards, and promote the orderly growth of the rural areas of the nation by meeting the need for new and improved rural water and waste disposal facilities. Funds may be used for the installation, repair, improvement, or expansion of a rural water facility including costs of distribution lines and well pumping facilities. Funds also support the installation, repair, improvement, or expansion of a rural waste disposal facility, including the collection and treatment of sanitary waste stream, stormwater, and solid wastes. More information available at: www.usda.gov/rus/water/programs.htm	Grants: $380.5 million; Loans: $1 billion; Guaranteed Loans: $75 million

Program Name	Overview	FY 2006 Funding Levels
Wetlands Program Development Grants	The Watershed Processes program sponsors basic and mission-linked research that address two areas: (1) Understanding fundamental processes controlling a) source areas and flow pathways of water, b) the transport and fate of water, sediment, nutrients, dissolved matter, and organisms (including water-borne pathogens), within forest, rangeland, and agricultural environments as influenced by watershed characteristics and contaminant origin, and c) water quality. (2) Developing appropriate technology and management practices for improving the effective use of water (consumptive and non-consumptive) and protecting or improving water quality for agricultural and forestry production, including the evaluation of management policies that affect the quantity and quality of water resources. More information available at: www.csrees.usda.gov/funding/rfas/nri_rfa.html	$4.3 million
Wetlands Reserve Program	Also known as the 'Watershed Program' or the 'PL 566 Program,' this program provides technical and financial assistance to address water resource and related economic problems on a watershed basis. Projects related to watershed protection, flood mitigation, water supply, water quality, erosion and sediment control, wetland creation and restoration, fish and wildlife habitat enhancement, agricultural water conservation, and public recreation are eligible for assistance. Technical and financial assistance is also available for planning new watershed surveys. More information available at: http://www.nrcs.usda.gov/programs/watershed/	Not available
	The EPA's Wetland Program Development Grants are intended to encourage comprehensive wetlands program development by promoting the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution. More information available at: http://www.epa.gov/owow/wetlands/grantguidelines/	$19.5 million
	Through this voluntary program, the USDA Natural Resources Conservation Service (NRCS) provides landowners with financial incentives to restore and protect wetlands in exchange for retiring marginal agricultural land. To participate in the program landowners may sell a conservation easement or enter into a cost-share restoration agreement (landowners voluntarily limit future use of the land, but retain private ownership). Landowners and the NRCS jointly develop a plan for the restoration and maintenance of the wetland. More information available at: www.nrcs.usda.gov	The national budget is sufficient to enroll 150,000 acres nationwide.

Action Register

Date: ___________________

Goal (choose from goals listed below): ____

Task completed: ____

Type of task (circle appropriate task type):

Meeting Who attended by: ____
____
____
____

Education Number attended: _____ Number distributed: _____

Distributed to: ____

Investigation Sources of information: ____
____

Field Work Description of Activity: ____
____
____

Other Description of Activity: ____
____
____

Please describe to which goal(s) or objective(s) this task applies, a listing of other actions required based on this task, and any suggested future actions.

____
____
____
____
____

Task completed by: ____________________________________

Goals:

Goal 1: Increase stakeholder participation
Goal 2: Identify and begin to address *E. coli* issues
Goal 3: Reduce nutrient load
Goal 4: Reduce sediment load