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Watershed Management Plan for Restoration and Protection of Bean Blossom Creek and Lake Lemon

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April, 2008

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Watershed Management Plan for Restoration and Protection of Bean Blossom Creek and Lake Lemon

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Dedicated to Ralph Reed and Joe Hailer

This watershed management plan is dedicated to the memory of two steering committee members who passed away during the course of this project.

Ralph Reed was a well-respected Brown County septic installer and an active member of the Indiana Onsite Waste Water Professionals Association. A devoted participant on our steering committee, Ralph helped educate homeowners about septic system maintenance requirements and technologies that maximize performance.

Dr. Joe Hailer was a retired hydrogeologist with a strong environmental ethic. Joe helped us describe the geology and soils in the watershed, compiled information about PCB contamination, and enthusiastically assembled a team of volunteers to monitor water quality. Eager for results, Joe stimulated in-depth discussions among steering committee members and provided valuable insights along the way.

We would like to honor these two individuals who cared deeply and spent many hours working to improve water quality in Bean Blossom Creek. Their presence is missed!

Acknowledgements

We want to express our heartfelt thanks to our steering committee members for the time and effort that they put into this project. We greatly appreciate their willingness to share their knowledge, insights, and enthusiasm for the work. Pulling together the information and ideas in this watershed management plan has reinforced for us the importance of public involvement. We had a wonderful steering committee and we couldn't have done it without them!

Many individuals and agencies contributed to this watershed planning effort. Some deserving special mention are listed here: Bill Miller with the Brown County Heritage Council initiated this effort and Natalie Stant made countless phone calls to get the ball rolling. Amy Thompson with the Purdue Cooperative Extension Service provided critical assistance early on. Janet Kramer and the Brown County League of Women Voters provided encouragement and logistical support throughout the project. Jim and Marge Faber with the Bloomington League of Women Voters were also very supportive. Ralph Reed and Richard Wise helped us plan the septic system workshops and evaluate alternative technologies for wastewater treatment. Joe Hailer and Drew Laird began monitoring water quality and worked to secure funds to implement the watershed plan.

The Lake Lemon Conservancy District was very supportive and we especially relied on the information generated in their previous studies of Lake Lemon. Richard Martin serves on the Monroe County Plan Commission and helped us coordinate planning efforts with the County Planning Department and the Comprehensive Plan review process. The Monroe County Planning Department provided excellent watershed assessments for Stout's Creek and other portions of the watershed. The entire staff at the Brown County Health Department provided assistance; John Kennard was especially helpful. The City of Bloomington Parks and Recreation Department provided assistance in a variety of ways - Angie Smith and Steve Cotter helped us understand Lake Griffy issues, and Kriste Lindberg provided technical information about karst features and helped us connect with the right people in the community. Dan Perez with the Indiana State Department of Agriculture cheerfully provided important data about agriculture in the watershed. And Tony Branam of the Natural Resource Conservation Service was very generous in providing technical assistance, information and useful insights about agriculture, septic systems and community dynamics. Nearly all our maps came from the Indiana Geographic Information Council for which we are very grateful.

We appreciate the financial support of the Indiana Department of Environmental Management and the Brown County Community Foundation. We applaud the Brown County Community Foundation for recognizing the importance of the Bean Blossom Creek and Lake Lemon as community assets. Kathleen Hagan and Bonnie Elifritz, of the Indiana Department of Environmental Management, were very helpful in providing guidance and feedback on the manuscript. We are very grateful that IDEM invested in this grassroots effort and we appreciate their patience as we completed this, our first watershed management plan.

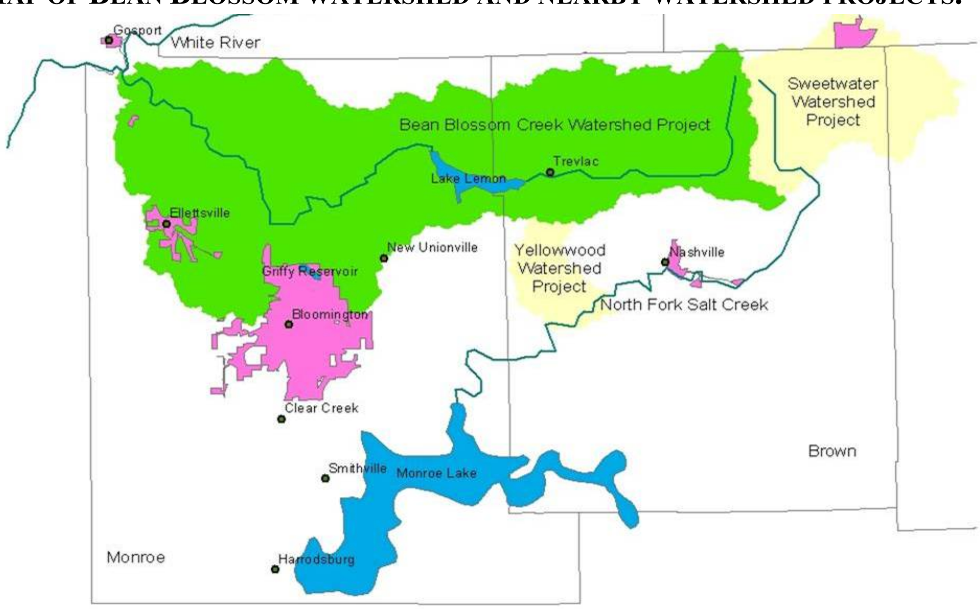
1.0 BACKGROUND AND INTRODUCTION

1.1 Introduction

The Bean Blossom Creek, sometimes written as Beanblossom Creek, is a picturesque stream that drains 192.6 square miles of land in the northern half of Indiana's Monroe and Brown counties. The Bean Blossom Creek watershed drainage area is identified by the 11-digit Hydrologic Unit Code (HUC) 05120202010. The headwaters lie in the northern part of Brown County and generally flow westward to the confluence with the West Fork of the White River in Monroe County, near Gosport. Lake Lemon (1650 acres) was created in the middle of the watershed by a dam built in the 1950s to provide flood control and drinking water for the City of Bloomington.[1] Lake Lemon was used for drinking water until the 1970s. It is now primarily valued as a recreational area but still serves as a backup water supply.[2] An earlier reservoir, Griffy Lake, is also a part of the Bean Blossom watershed. It was created in the 1920s as a drinking water reservoir, but now serves primarily recreational purposes.

Bean Blossom Creek is thought to be named for a soldier in Ketchum's Army who drowned or nearly drowned trying to ford its floodwaters between 1810 and 1812. Historical records indicate that there were at least two individuals named Beanblossom in the army at that time. It began to appear on maps as Bean Blossom Creek (with the two-word spelling preferred) by 1812.[3,4] In this document, we use the two-word spelling.

FIGURE 1: MAP OF BEAN BLOSSOM WATERSHED AND NEARBY WATERSHED PROJECTS.



[1] Lake Lemon Conservancy District website. http://msdadmin.scican.net/lakelemon1/
[2] Lake Lemon Conservancy District powerpoint presentation by Coleman Smith, biologist. http://www.agriculture.purdue.edu/fnr/cfmg/pdf/lemonlake.pdf
[3] Tales and trails of Brown County, compiled by Fran Fears, Nina Jo McDonald and Miriam Sturgeon.
[4] Counties of Morgan, Monroe, and Brown, Indiana: Historical and biographical. 1993. Charles Blanchard, editor. Chicago, IL :Windmill Publications, Inc.,

The Bean Blossom watershed is mostly forested, with scattered agricultural and rural residential land uses, and some growing urban/suburban areas near Bloomington and Ellettsville in the southwestern portion of the watershed. The Lake Lemon Conservancy District developed a Lake Lemon Watershed Management Plan [5] in 2002 but it was focused on smaller area and more narrow set of pollutant issues than this plan. Watershed planning projects took place in the nearby Sweetwater and Yellowwood drainage basins at the same time that this Bean Blossom plan was being developed, but these are part of the Salt Creek/Lake Monroe watershed system and are not connected to the Bean Blossom watershed.

Collection of new data was beyond the scope of the current watershed planning process. However, we did review and summarize a large body of data on the watershed, including information collected earlier by the Lake Lemon Conservancy District and by IDEM.

In 2006, the Indiana Department of Environmental Management (IDEM) conducted a Total Maximum Daily Load (TMDL) for *Eschericia coli* (*E. coli*) for the Bean Blossom Creek watershed, Brown and Monroe Counties, compiling data from a variety of sources[6]. TMDL is a pollution budget that sets a target for water quality goals. The TMDL was presented by IDEM to the public as a plan, leading to some confusion among the public and even among some our steering committee members about which process was which. The TMDL process is, in fact somewhat similar to the development of a watershed plan, but the TMDL did not address pollutants other than E. coli and did not include specific action steps.

1.2 Watershed Partnerships

In 2001, the Hoosier Environmental Council was asked by the Brown County Heritage Council to provide assistance in promoting awareness about water quality issues in Brown County. A steering committee was formed and it soon became obvious that the main concern was the high levels of E. coli in area streams, partly because poor water quality might negatively impact the important tourism-based economy of Brown County. In 2002, the Hoosier Environmental Council submitted a proposal to the Indiana Department of Environmental Management (IDEM) seeking funding for a watershed restoration project that focused primarily on implementing measures to address failing septic systems. That project was not funded, in part because there was no comprehensive watershed plan in place.

With no designated funding, the Brown County Heritage Council, Hoosier Environmental Council, and the steering committee worked to improve water quality in

[5] Lake Lemon Conservancy District Lake Lemon Watershed Management Plan, prepared by Malcolm Pirnie, January, 2002 http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Wtrshd_Mngmt_Plan-Lake_Lemon-Monroe-Jan02.pdf

[6] Total Maximum Daily Load for *Eschericia coli (E. coli)* in the Bean Blossom Creek Watershed, Brown and Monroe Counties, March 2006, Indiana Department of Environmental Management, Office of Water Quality, Total Maximum Daily Load Program http://www.in.gov/idem/programs/water/tmdl/documents.html

the Bean Blossom Creek and Lake Lemon. In July 2003, the Hoosier Environmental Council and the Brown County Heritage Council led a group of stakeholders to organize a watershed steering committee and a "Brown County Homeowners Septic System Workshop" with co-sponsors including Purdue Cooperative Extension, the Brown County Farm Bureau, the Brown County Health Department, the League of Women Voters and the Indiana Onsite Waste Professionals Association. The steering committee also sponsored a booth and a seminar in conjunction with Mother Earth Day in Nashville in May 2004.

In 2003, the Hoosier Environmental Council submitted a revised proposal to IDEM to develop a watershed plan for the Bean Blossom/Lake Lemon watershed. We emphasized the need to provide more background information to get the public involved in the decision-making process. We also expanded our focus from the Brown County portion of the watershed to include those living downstream in the Bean Blossom watershed portion of Monroe County, where the Hoosier Environmental Council has many members. This project was approved in March of 2005 and funded by the IDEM in June 2005.

1.3 Outreach and Stakeholder Participation

Public participation played a major role in the development and preparation of this document. An initial kickoff meeting was held on March 16, 2005 in Brown County and a second kickoff event was held in Monroe County on May 16, 2005. At these public meetings, some basic information about the watershed was presented by the Hoosier Environmental Council and local health departments. Maps were used to help people visualize the watershed and its challenges. We then led a discussion to determine the priority concerns of the people present. At the public meetings, attendees were also invited to join the steering committee or get involved in specific activities.

The steering committee felt that the survey should be extended beyond the public meetings so we began surveying people at county fairs and other forums as well. The goal was to assess public concerns about the watershed and promote interest in the project. The Monroe County Soil and Water Conservation District distributed a separate survey to determine the practices and concerns of agricultural producers.

We conducted outreach about the watershed project at a variety of forums including the Simply Living Fair at Bloomington on Sept. 17 and 18, 2005. We distributed surveys and talked with people about the watershed planning process at the Brown and Monroe County 4-H Fairs (Brown County July 29-Aug. 5, 2006). We did a presentation before the Brown County commissioners and hosted a Planning with POWER presentation at the Brown County Office Building. We presented information about the watershed planning process to the Lake Lemon Conservancy District, the Hoosier Fly Fishers, people attending the Brown County Fair in 2006, and participants in the FUNK fest (Friends Uv Nature and Knowledge) at the Bill Monroe Music Park. We also made a presentation to the Brown County Economic Development Commission.

We also met individually with watershed stakeholders. We met with staff of the Soil and Water Conservation Districts, the Monroe County Parks Dept, the Monroe and Brown County Planning offices, and the county Health Departments. We worked very closely with the Brown County Health Department, thanks to a grant from the Brown County Community Foundation.

We held two septic system workshops, one in each county. Brad Lee, Professor and Soil Scientist from Purdue addressed the group, along with Bob McCormick (Planning with P.O.W.E.R.) and Mike Market, a representative of the Presby system for wastewater treatment. We worked with the Brown County career resource center to present an educational forum about greywater and wastewater treatment. We also recruited volunteers for Riverwatch training and stream monitoring within the watershed.

As we neared the end of the watershed project, we held a public meeting at the Brown County Public Library, sponsored by the Brown County League of Women Voters. At this meeting we shared elements of the watershed plan and took participants on a virtual tour of the watershed using Google Earth. This tour is available upon request. We also made a brief presentation about the watershed plan at the Monroe County Plan Commission meeting. Since this presentation was televised it reached a much broader audience than those attending the meeting.

1.4 Steering Committee

The Steering Committee had diverse membership, but it also had constantly changing participation in that many members attended only sporadically and new people joined throughout the process. Two key members of our steering committee passed away during the course of our project and left big gaps in our collective efforts (see Dedication). Steering Committee meetings were generally held monthly or every other month. Early on, meeting summaries were posted on the Hoosier Environmental Council's website in order to keep participants abreast of the planning process, even if they were unable to attend meetings. Later steering committee meetings focused on writing and revising sections of the plan so revised versions of the plan were posted on the website instead of meeting minutes.

The steering committee reviewed public concerns expressed at various venues and evaluated existing data to determine whether perceived threats were valid problems and the approximate level of severity. In most cases there was real cause for concern, though in some instances there was very little data and we could only conclude that a precautionary approach would be appropriate, e.g. pesticides.

The table below lists the individuals and groups participating in the Steering Committee and demonstrates the diverse perspectives represented.

TABLE 1: STEERING COMMITTEE PARTICIPANTS

First Name	Last Name	Organizational Affiliation
Doug	Baird	Brown County State Park
Jacqui	Bauer	Indiana Rural Community Action Program
Debra	Beck	Resident
Tony	Branam	Natural Resource Conservation Service
Gary	Cain	Monroe County Health Department
Steve	Conard	Architect
Marge	Cook	Resident
Mark	Davis	Indiana Rural Community Action Program
Jim	Drum	Friends of Bean Blossom
Elaina	Frederick	Resident
Christian	Freitag	Sycamore Land Trust
Charles	Gaither	Farm Bureau
Joe	Hailer	Geologist, HEC member
Julie	Harris	Resident
Warren	Henegar	Monroe County Health Department
Erin	Hollinden	Sycamore Land Trust
Aunna	Huber	Lake Lemon Conservancy
Bill	Jones	IU SPEA
John	Kennard	Brown County Health Department
Janet	Kramer	League of Women Voters
Drew	Laird	Indiana Forest Alliance
Kriste	Lindberg	Bloomington Environmental Commission
Tim	Maloney	Hoosier Environmental Council
Richard	Martin	Monroe County Plan Commission
Bill	Miller	Brown County Heritage Council
Martha	Miller	Monroe County Soil and Water Conservation District
John	Milnes	Farm Bureau
Sharon	Modglin	Brown County Health Department
Judy	Morran	Resident/Teacher
Patty	Moser	Resident
Cathy	Paradise	Brown County Soil and Water Conservation District
Dan	Perez	State Department of Agriculture, Soil& Water Conservation Districts
Ralph	Reed	Septic Installer
Ernie	Reed	Septic Installer
Mike	Salem	Brown County Soil and Water Conservation District
Pauline	Schafer	CYO Camp Rancho Framosa
Robert	Schaible	Helmsburg Regional Sewer District
Rae	Schnapp	Hoosier Environmental Council
Dan	Shaver	Nature Conservancy
Angie	Smith	Bloomington Parks and Recreation
Natalie	Stant	Brown County Heritage Council and Helmsburg Regional Sewer District
Todd	Stevenson	Monroe County Highways / Surveyors Office
Amy	Thompson	Purdue Cooperative Extension
Lisa and Kenny	Wagler	Brown County livestock farmer
Jennifer	Weiss	Resident

1.5 Mission and Vision for the future

The Steering Committee spent several sessions crafting over-arching mission and vision statements to guide our work. These evolved during the course of the project.

Mission

The Bean Blossom/Lake Lemon Watershed Steering Committee will provide leadership, education and coordination that encourage public involvement in the development and implementation of a watershed management plan that will lead to improved water quality and conservation of natural resources that pertain to water quality and quantity.

Vision

Bean Blossom Creek and Lake Lemon water quality will be better than the minimum standards set by the state so that these water resources will support a healthy ecosystem, an excellent quality of life, recreational opportunities, and a local economy that balances social and environmental considerations. We envision partnerships to promote economically and environmentally compatible land uses that improve water quality in Bean Blossom Creek and Lake Lemon.

2.0 DESCRIPTION OF THE WATERSHED

The Bean Blossom Creek/Lake Lemon watershed drains 192.6 square miles of land, including 63.35 square miles in Brown County and 129.09 square miles in Monroe County. The watershed is identified by the 11 digit Hydrologic Unit Code (HUC) 05120202010. It can be divided into 10 sub-watersheds, each with a unique 14-digit hydrologic unit code as shown in Figure 2.

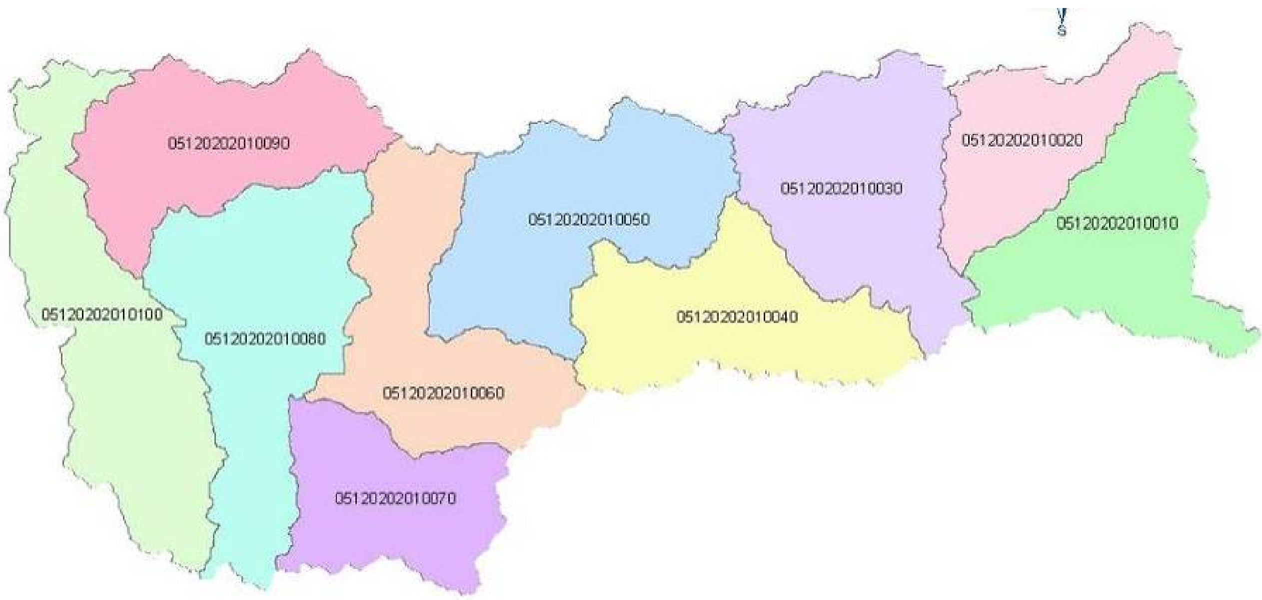


FIGURE 2: WATERSHED BOUNDARIES AND HYDROLOGIC UNITS

The Bean Blossom Creek is a tributary of the White River. The White River in turn drains to the Wabash River which flows to the Ohio River. The Ohio River drains to the Mississippi, which ultimately flows to the Gulf of Mexico. Our activities on the land in south-central Indiana can play a role in the overall health of the Mississippi Basin and the Gulf of Mexico.

The Bean Blossom Creek originates near the town of Spearsville in Brown County, and flows due south to its confluence with East Fork Bean Blossom Creek, just north of Gatesville Rd. As the channel crosses Gatesville Rd. it begins a westerly flow past the towns of Beanblossom, Helmsburg, and Trevlac on its way to Lake Lemon and Monroe County. The Bean Blossom Creek exits Lake Lemon on the northwest end and flows northward to its confluence with Honey Creek, where it turns westward, then southwest. Bean Blossom Creek then resumes a southwesterly flow towards its confluence with Muddy Fork, north of Bloomington, where it turns due west and flows under State Road 37. From there, the channel flows northwest across Monroe county to its confluence with the West Fork White River (Lower White) just south of Gosport. Major tributaries of the Bean Blossom Creek include Hopper's Branch, Lick Creek and Bear Creek in Brown County and Honey Creek, Buck Creek, Muddy Fork, Griffy Creek, Stout's Creek, Indian Creek and Jack's Defeat Creek in Monroe County.[7] Most of these waterways have been identified as having high levels of E. coli bacteria that make them unsafe for recreational use. Impaired waters show up as red in Figure 3.[8]

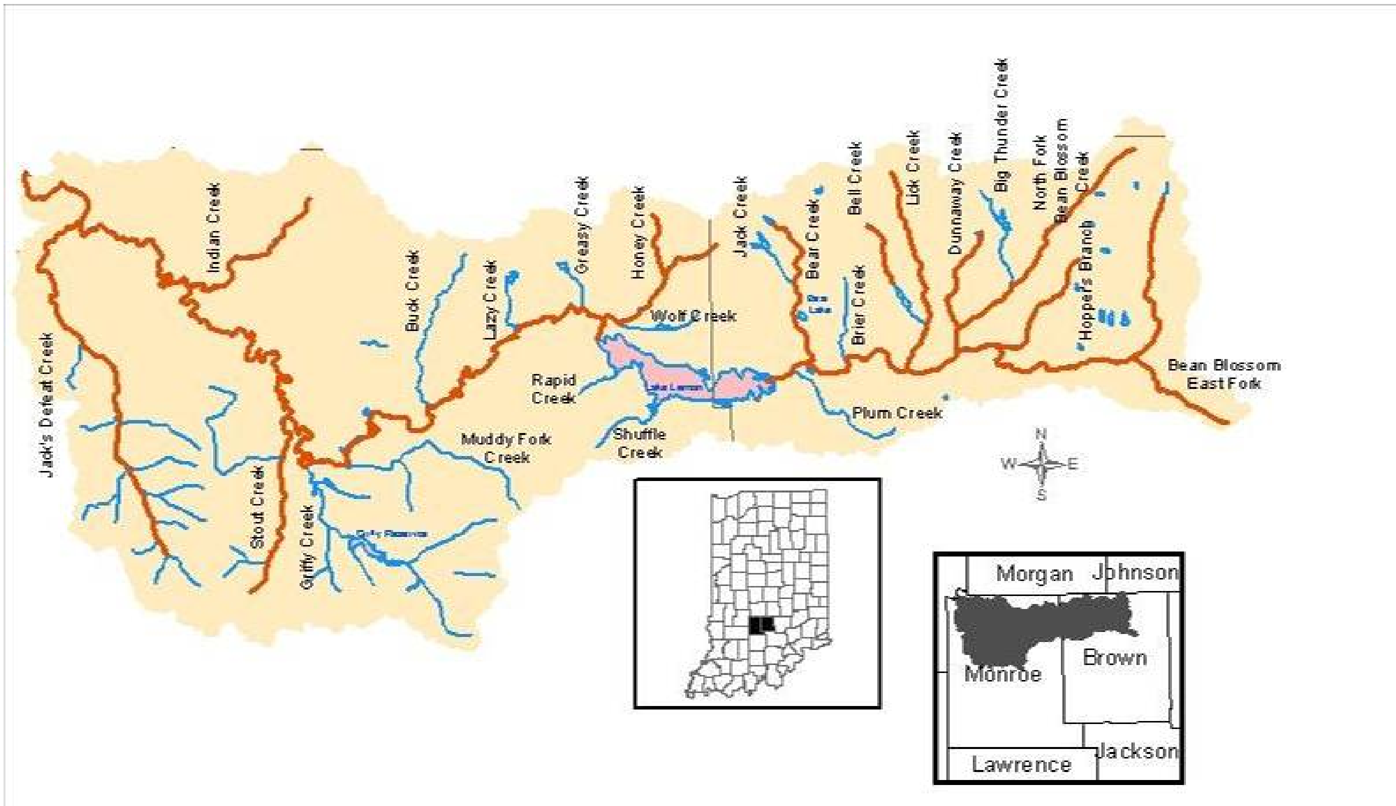


FIGURE 3: BEAN BLOSSOM AND TRIBUTARIES

2.1 Topography and Geology

The Bean Blossom Creek watershed is characterized by ridges with steep slopes and narrow valleys between them. The Mississippian age rocks that make up this spectacularly scenic region are mostly siltstone rich in silica with a shift to limestone bedrock in the western portion of the watershed.[9]

While up to 80 percent of present day Indiana was covered by ice, it was melt-water of glaciers that primarily shaped the southern regions of the state. Glacial outwash occurs only in the upper part of Bean Blossom Valley. The bedrock underlying most of the watershed is an east-to-west portion of the circular rim of a basin centered in southern Illinois. More than 330 million years ago, these rocks were part of a vast glacial delta

[7] Lower White River Watershed Restoration Action Strategy, 1991. Indiana Department of Environmental Management, Office of Water Quality http://www.in.gov/idem/programs/water/wsp/05120202part1.pdf
[8] Indiana's Final 2006 303(d) List of Impaired Waters http://www.in.gov/idem/programs/water/303d/index.html
[9] Landscape of Indiana, John R. Hill, Indiana Geological Survey

system that now makes up the bedrock known as the Borden Group, a collection of resistant rock types that form the core of the Norman Upland topographic region. Much of the Bean Blossom watershed lies within the Norman Upland which is a severely dissected plain with long narrow ridges and steep slopes that descend into v-shaped ravines.[10]

The Illinoisan glaciation peaked about 220,000 years ago, and it extended into Indiana in 2 lobes, being blocked in the center by the Knobstone escarpment which extends from Southern Johnson County to the Ohio River. Illinoisan glacial melt-waters created sluiceways through the upland area. Bean Blossom Creek and nearby Salt Creek acted as conduits for this melt-water. The lower Bean Blossom Creek was ponded by the western Illinoisan lobe. The later Wisconsonian (20,000 years ago) ice sheet did not extend as far south as the Bean Blossom watershed. [11,,12]

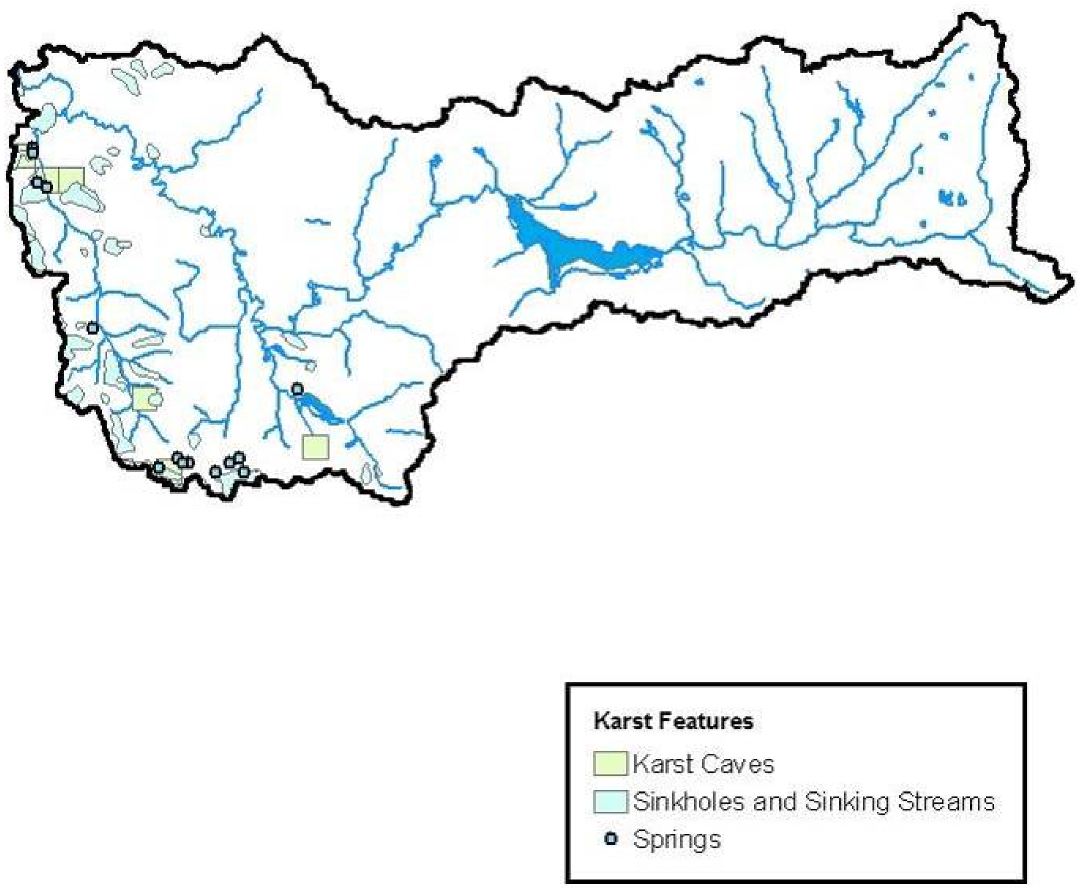


FIGURE 4: KARST FEATURES IN THE BEAN BLOSSOM WATERSHED

[10] Landscape of Indiana, John R. Hill, Indiana Geological Survey
[11] Landscape of Indiana, John R. Hill, Indiana Geological Survey
[12] Glacial Sluiceways and lacustrine plains of Southern Indiana by William D. Thornbury. Bulletin No. 4 printed by the State of Indiana Department of Conservation, Division of Geology. 1950

The topography in the eastern part of the watershed is quite rugged. In the west, the Norman Upland is joined by the Mitchell Plain, an area of relatively low relief that is pockmarked by sinkholes and underlain by cave systems developed in the Mississippian age limestone bedrock. This karst landscape develops as the bedrock limestone is dissolved by acidic groundwater. Stream erosion and dissolution of limestone by weakly acidic precipitation are the principal means of erosion that produced the Mitchell Plain.[13]

2.2 Lakes, Wetlands, Drainage and Groundwater

The watershed generally has such steep topography that there is little need for artificial drainage. Brown and Monroe Counties have no legal drains though drainage tiles occur in the Monroe county portion of the watershed. The steep topography makes for rapid runoff and wildly fluctuating stream flow conditions. For example, in 1988 streamflow averaged 30.4 cubic feet per second (cfs) in the upper Bean Blossom with a maximum of 3,200 cfs.[14]

There is little groundwater availability in the watershed, although springs do occur. In the eastern portion of the watershed there are some limestone karst features that have created springs, but these are vulnerable to contamination from the surface. Personal communication with the Brown County Health Department indicates that significant numbers of people in the Bean Blossom watershed are using springs and stream-fed ponds for drinking water. Our survey results confirm this, but most rural residents rely on private water companies that use Lake Monroe for their drinking water supply. Because of the very limited availability of groundwater, many artificial impoundments have been created over the years. Small private lakes occur throughout the watershed, especially for watering livestock but also for recreational use.

Groundwater recharge occurs mostly in wetland areas, but these are increasingly rare. Gap analysis has been performed on a state-by-state basis to identify species and habitats that are not yet represented in the existing matrix of conservation lands, i.e. gaps in habitat and species protection and to identify areas of high biodiversity that have no management plans. Most of Indiana's wetlands have been drained, farmed or otherwise disturbed. According to the 1992 Gap analysis about 2% of the Bean Blossom watershed is in wetlands.[15,16]

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[13] Landscape of Indiana, John R. Hill, Indiana Geological Survey

[14] Lake Lemon T by 200 Feasibility Study, 1992, William W. Jones and Louise Clemency. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf

[15] U.S. Geologic Survey, The Gap Analysis Program. http://gapanalysis.nbii.gov/portal/server.pt

[16] Indiana GAP Analysis Project http://www.pangaeatech.com/project_pdfs/Indiana%20GAP%20Analysis.pdf

FIGURE 5: AERIAL VIEW OF BEAN BLOSSOM BOTTOMS

Because of their biodiversity and scarcity, wetlands represent one of the most crucial areas to protect. The Beanblossom Bottoms Nature Preserve off Woodall Road just south of Bottom Road in northwest Monroe County represents a high quality hardwood wetland, and contains two great blue heron rookeries. Wetlands are important habitats because many species depend upon them for at least part of their life cycle.

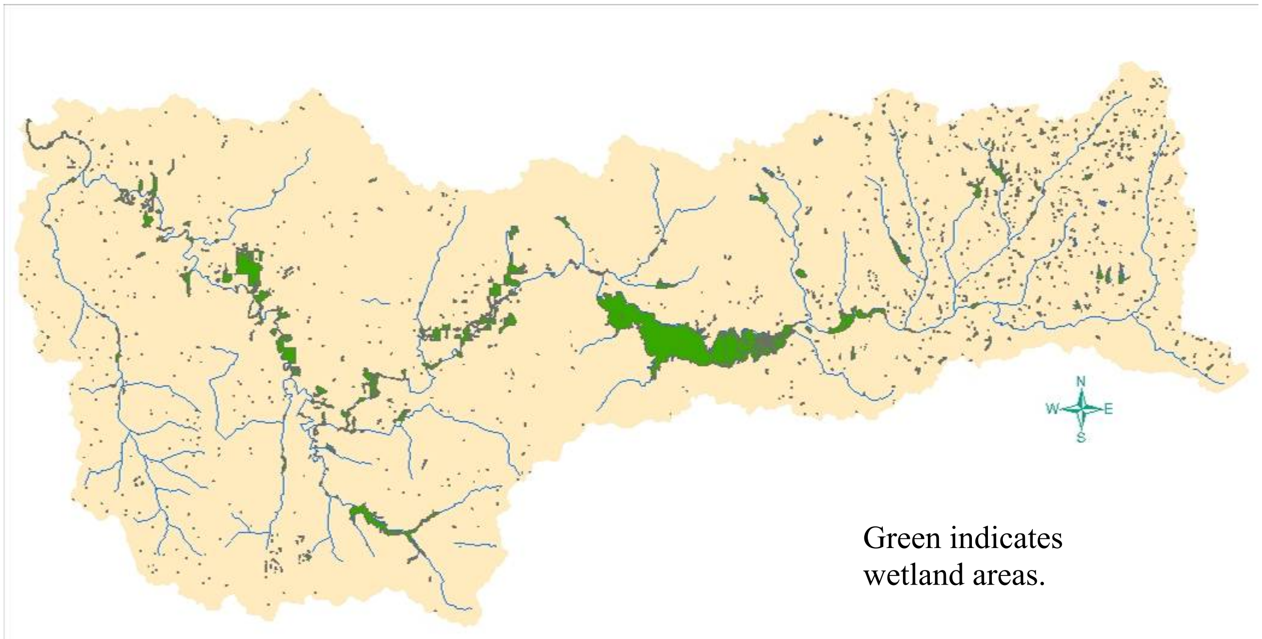

FIGURE 6: MAP OF WETLAND AREAS

2.2.1 Lake Lemon

In 1953, the City of Bloomington Utilities and the U.S. Army Corps of Engineers began damming Bean Blossom Creek to create Lake Lemon to serve as a drinking water source, and to provide flood control and recreation. Construction was completed by 1956. Lake Lemon remained a primary water source for Bloomington until Lake Monroe was constructed in the 1970s, a considerably larger human-made reservoir located to the south. Lake Lemon still serves as a back-up water source for Bloomington.[17]

By the 1990s, the City of Bloomington Utilities department began looking for an alternative way to manage the lake. A group of landowners around Lake Lemon formed the Lake Lemon Conservancy District to take over operation of the lake. In 2002, the City of Bloomington handed over operation of Riddle Point Park (located on the lake) to the Conservancy District as well.[18] The Beach at Riddle Point Park generally meets standards for safe recreational use, but sediment and aquatic weeds are big concerns of the Lake Lemon Conservancy District. They have undertaken a Sediment Removal Project to prolong the life of the lake and enhance recreational opportunities. Rip-rap has been installed at many shoreline locations to help reduce shoreline erosion.

The surface area of Lake Lemon is 1,650 acres, making it the 11th largest lake in Indiana. There are 24 miles of shoreline. The lake has an average depth of 9.7 feet at full pool level. The greatest depth is somewhat in excess of 20 feet, at the location of the

[17] Lake Lemon Conservancy District website. http://msdadmin.scican.net/lakelemon1/
[18] Lake Lemon Conservancy District website. http://msdadmin.scican.net/lakelemon1/

original creekbed.[19,20] The Lake Lemon Conservancy District developed a Lake Lemon Watershed Management Plan in 2002 that focused primarily on sediment loads.

2.2.2 Griffy Lake

Griffy Lake was originally created by the construction of a dam on Griffy Creek in the 1920s to provide a drinking water reservoir. The lake itself is about 109 acres and the watershed area upstream from the lake is roughly 4200 acres. It is mostly surrounded by managed lands but development and erosion are serious concerns as Bloomington expands and urbanization encroaches on the south fork and middle forks of Griffy Creek. The topography makes the lake very sensitive to sedimentation. The City of Bloomington has identified problems with sediment, nutrients, biotic communities, and heavy metals in Griffy Lake.[21,22]

2.3 Soils

Much of the Bean Blossom Creek watershed is too steep to be considered useful for cropland. The soils in Brown and Monroe Counties are primarily Udalfs, common in humid climates where the amount of rain in summer exceeds the amount of evapo-transpiration and water moves down through the soil at some time during most years.[23] The soil associations are shown in Figure 7 and soil characteristics are summarized in Tables 2 and 3.

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[19] Lake Lemon Conservancy District website. http://msdadmin.scican.net/lakelemon1/
[20] Bloomington Area Lakes, Fact sheet of the Monroe County Convention and Visitors Bureau http://www.geocities.com/~bloomingguide/lakes.html
[21] Griffy Lake Watershed GIS Mapping and Management Plan. Prepared by Commonwealth Biomonitoring of Indianapolis. July 1999. Prepared for the City of Bloomington Planning Department.
[22] Griffy Lake Sedimentation Survey, Prepared by School of Public and Environmental Affairs at Indiana University. March 2005. Prepared for the City of Bloomington Parks and Recreation.
[23] U.S. Department of Agriculture, Natural Resource Conservation Service, Soils Website **http://soils.usda.gov/technical/classification/orders/alfisols_map.html**

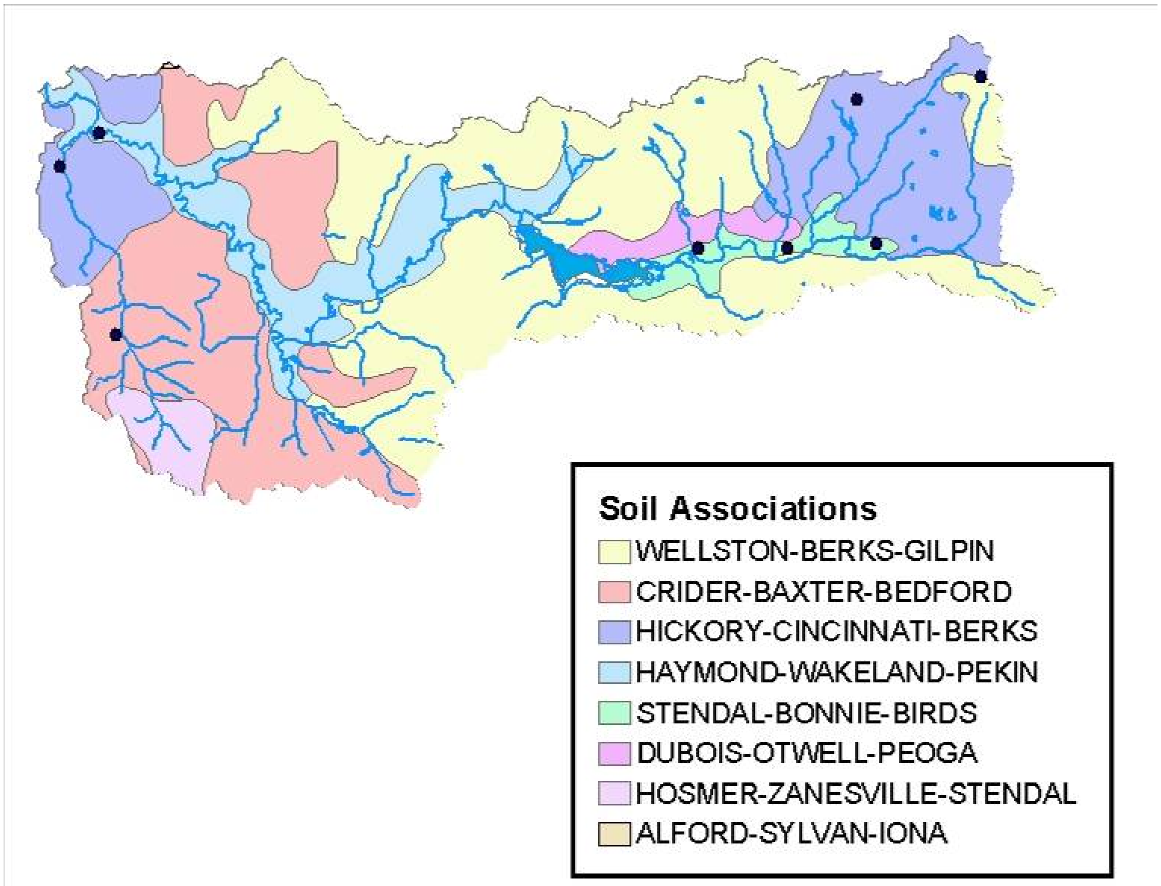

FIGURE 7: SOIL ASSOCIATIONS IN THE BEAN BLOSSOM WATERSHED

TABLE 2: SOIL CHARACTERISTICS IN THE BEAN BLOSSOM WATERSHED[24]

Symbol	Permeability	Slope %	High Water Table	Drainage	Runoff Potential
Wellston	moderate	0-50, but mostly 4-18	More than 6 feet	Well drained	Medium to rapid
Berks	Moderate or moderately rapid	0-80	More than 6 feet	Well drained	Negligible to high
Gilpin	Moderate	0-70	More than 6 feet	Well-drained	Negligible to high
Hickory	Moderate	5-70	More than 6 feet	Well-drained	Medium to very high
Cincinnati	Moderate above clay (fragipan)layer, moderately slow or slow below clay	1-18	Perched water table, 2-3 ft. Dec-April	Well-drained	Low to high depending on slope
Bonnie	Moderately slow	0-2	Intermittent Within 1 foot, October -July	Poorly drained or Very poorly drained	Low or medium
Crider	Moderate	0-30	More than 6 feet	Well drained	Low to high
Baxter	Moderate or moderately slow	2-60	More than 6 feet	Well drained	Low to high
Bedford	Permeability is moderate above the fragipan and very slow in the fragipan.	0-12	Depth to intermittent perched seasonal high water table is 1.5 to 2.5 feet in most years.	Moderately well drained	Medium or slow
Haymond	Moderate	0-3	Frequent Flooding	Well drained	Negligible to low
Wakeland	moderate	0-2	Depth to an intermittent apparent high water table ranges from 0.5 to 1.5 feet from November through May in normal years.	Somewhat poorly, drained, not dry in all parts for more than 60 cumulative days per year.	Low to negligible
Pekin	Moderate above the fragipan and slow or very slow in the	0-12	Depth to an intermittent perched seasonal high water table is 0.46	Moderately well drained	Medium to very high

[24] USDA NRCS Soil Classification Official Soil Series Description http://soils.usda.gov/technical/classification/

	fragipan.		to 0.6 meters (1.5-2 feet) most years		
Dubois	Permeability is moderate in the upper part of the subsoil and very slow in the lower part.	0-6	Depth to intermittent perched high water table is at a depth of 0.2 to 0.5 meters (0.5 to 1.5 feet) in most years.	Somewhat poorly drained	Low or medium
Otwell	very slow	0-50	Depth to an intermittent perched high water table is at 2.0 to 3.0 feet from January through April in most years.	Well-drained	Medium to very high
Peoga	Moderate in the upper part of the soil and slow or very slow in the lower part.	0-1	Depth to intermittent perched water table is 0.5 feet above the surface to 0.5 feet below surface from November to June.	Poorly drained	Low or negligible
Birds	Moderate or moderately slow in the upper part, moderately slow in the lower part	0-2	The apparent water table ranges from 2 feet above to 0.5 feet below the surface from Oct. through July	Poorly drained and very poorly drained	Negligible to medium
Stendal	moderate	0-2	Intermittent apparent seasonal high water table is 0.5 to 2.0 feet from Dec. through April most years.	Somewhat poorly drained, frequent to rare periods of flooding.	Negligible to low

2.3.1 Soil Hydrologic Groups

Most soil types vary in runoff potential depending on an array of factors including their position in the landscape. The Natural Resource Conservation Service has developed another Hydrologic Soil Groups soil classification system to better reflect soil runoff potential.[25] Generally A soils have the smallest runoff potential and D the greatest. Most of the soils in the Bean Blossom watershed are in Group B, having silt loam or loam texture with moderate infiltration rate when thoroughly wetted. However many of the soils in the bottom land areas nearest the creek are group C soils with a greater runoff potential. Thus it is crucial to provide protection for the riparian corridors. Group C soils also occur in the headwaters of Stout's Creek and along the Lake Lemon shoreline.

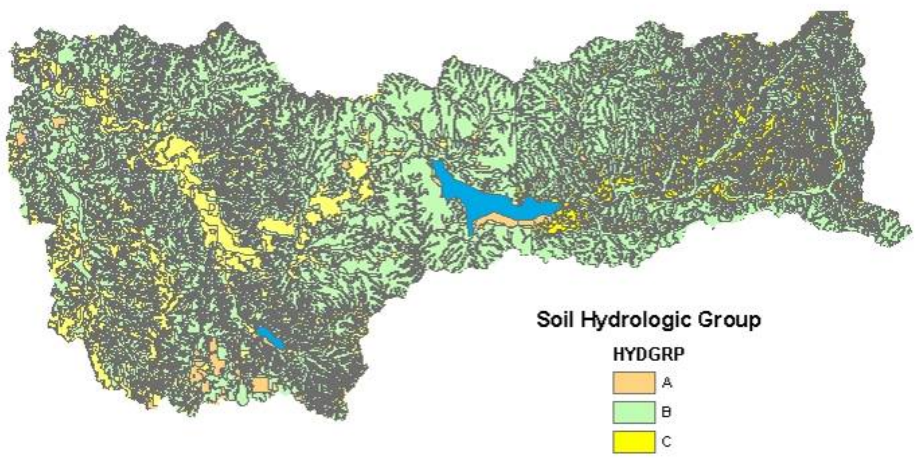

FIGURE 8: SOIL HYDROLOGIC UNITS

2.3.2 Soil Suitability for Septic Systems

Septic systems are onsite systems that use the soil as a treatment step to filter wastewater on the home site. A properly functioning septic system includes a septic tank for settling out solids and a soil absorption field (also known as leach field or finger system) to treat the wastewater. However, not all soils are suitable for septic system absorption fields. County soil surveys provide general information on whether or not a certain area is likely to be suitable for a septic system. Soil characteristics that are used to define septic suitability in a soil survey are different than those used by the Indiana State Department of Health, and soil survey information should only be used as a rough guide.

[25] U.S. Department of Agriculture, Natural Resource Conservation Service, Soil Survey Division http://ortho.ftw.nrcs.usda.gov/cgi-bin/sc/sclist.cgi

It is important to determine whether a septic system can be installed before considering the purchase of any property. Purdue University soil scientist Brad Lee, explains that soil survey classifications are done on a coarse scale and that it is still possible to find soils suitable for septic systems in an area listed as having severe limitations.[26, 27] If the soil type shown in the soil survey at your location is rated as having "severe limitations", an on-site investigation may still reveal that certain areas of the site are suitable for a conventional or modified onsite system to treat wastewater. Some sites simply are not suitable for any onsite system, but alternative onsite systems, such as mound systems, can sometimes be used on properties that are unsuitable for conventional septic systems.[15]

According to Purdue University's Census of Wastewater Disposal by Indiana County,[28] all Brown County soils have severe limitations for septic systems, yet 90 % of county residents are served by onsite systems (or an estimated 6200 onsite systems in the county). In Monroe County, 73% of soils are classified as having severe limitations for septic systems. Some 70% of the county population is served by city sewers but there are an estimated 12,000 septic systems in Monroe County.

TABLE 3: SOIL SUITABILITY FOR SEPTIC SYSTEMS[26]

County	Percent of Households with Onsite Wastewater Disposal (Septics)	Number of Households with Onsite Wastewater Disposal (Septics)	Number of Households with Sewer	County Area (acres)	Density of Septic Systems (acres per septic system)	Percent of Area with Soils Having "Severe Limitations" for Septic Systems
Brown	90%	6,317	498	201,535	31.9	100
Monroe	30%	12,566	29,152	262,070	20.9	73

Note: Percent and number of households with each wastewater disposal method are from the 1990 Census, which continues to be the most recent information available because the 2000 Census did not ask people about wastewater. Calculations of density are by Jane Frankenberger, Associate Professor of Agricultural and Biological Engineering and Joe Yahner, Professor Emeritus of Agronomy. Both serve as extension specialists for the Purdue University Cooperative Extension Service.

The soil information is based on Natural Resources Conservation Service (NRCS) Soil Survey information, calculated by Bill Hostetter, Soil Scientist in the Indiana NRCS State Office. "Severe limitations" are based on NRCS criteria, which are more restrictive than those required by the Indiana State Department of Health.

[26] Personal Communication with Brad Lee
[27] Purdue Residential Onsite Wastewater Disposal: Soil suitability for Septics http://abe.www.ecn.purdue.edu/~epados/onsiteOnline/soilsuit.htm
[28] Purdue University's Census of Wastewater Disposal by Indiana County http://abe.www.ecn.purdue.edu/~epados/onsiteOnline/census.htm

FIGURE 9: MOUND SYSTEM *Notice the elevated sand mound on-site system in this person's yard. Mound systems are one way to overcome some limitations. Photo courtesy of Purdue University*

2.4 Natural Communities and Endangered Species

The Bean Blossom Creek Watershed lies within the Brown County Hills and Mitchell Karst Plain sections of the Highland Rim Natural Region. The Brown County Hills are heavily forested with deeply dissected uplands. Forest communities consist of mainly oak-hickory forests on the drier uplands and mixed hardwoods of beech-maple and ash in the ravines and wetter areas. The Yellowwood tree is only found in Indiana in a small area of this region. A relict stand of Eastern Hemlocks is found on bluffs overlooking Bean Blossom Creek near Trevlac.

The lower reach of Bean Blossom Creek, north and west of Bloomington, flows through the Mitchell Karst Plain on its way to its confluence with the West Fork of the White River near Gosport. The Mitchell Karst Plain features flatwoods, swamp, barren and glades communities as well as upland hardwood forests.

Common wildlife species in the watershed include whitetail deer, wild turkey, squirrels, fox, and coyote. Bean Blossom Creek, its tributaries, and the ponds and lakes throughout the watershed contain a variety of warm water fish and aquatic life, such as bluegill, crappie, largemouth and smallmouth bass, and catfish.

The watershed is home to several rare and endangered species as well. Since 1985, the Indiana Department of Natural Resources has released 73 Bald Eagle chicks at nearby Lake Monroe, resulting in an increasing number of sightings of this species at Lake Lemon. The deep hardwood forests are home to a variety of forest-dependent migratory birds including songbirds such as the state-listed hooded and worm-eating warblers, and forest raptors such as the state-listed red-shouldered and broad-winged hawks. The state's largest breeding population of cerulean warblers, currently proposed for listing as a state-endangered species, is found in the Brown County Hills. Bald eagles nest at Lake Lemon. The state-endangered timber rattlesnake, and several rare plant and frog species are found in the watershed. There is a great blue heron rookery along Bean Blossom Creek west of the village of Beanblossom. The federally-endangered Indiana bat is found in the watershed's forests during the summer, and hibernates in caves in the Mitchell Karst Plain in the winter.

Rare plants such as ginseng and goldenseal also occur in the Bean Blossom watershed. These plants, listed as endangered in other states, are now on a watch list in Indiana and are of particular concern because they are commercially exploited.

Table 4: Rare and Endangered Species in the Bean Blossom watershed*

Name	Status	Presence
Bald eagle	Federally Threatened	Confirmed SLT
Indiana Bat	Federally Endangered	Confirmed SLT
Least Weasel	Special Concern	Confirmed INHDC
Eastern Woodrat	State Endangered	Confirmed INHDC
Northern Harrier	State Endangered	Confirmed SLT
Barn Owl	State Endangered	Confirmed SLT
Henslow's Sparrow	State Endangered	Confirmed SLT
Worm Eating Warbler	Special Concern	Confirmed SLT
Cerulean Warbler	Special Concern	Confirmed SLT
Hooded Warbler	Special Concern	Confirmed INHDC
Northern Crayfish Frog	State Endangered	Confirmed INHDC
Northern Leopard Frog	Special Concern	Confirmed INHDC
Little Brown Frog	Special Concern	Suspected
Least Bittern	State Endangered	Confirmed INHDC
Red-Shouldered Hawk	Special Concern	Confirmed INHDC
Sharp-shinned Hawk	Special Concern	Confirmed INHDC
Broad Winged Hawk	Special Concern	Confirmed INHDC
Timber Rattlesnake	State Endangered	Confirmed
Kirtland's Snake	State Endangered	Confirmed SLT
Sandhill Crane	Special Concern	migratory
Black and White Warbler	Special Concern	migratory
Little Spectaclecase	Special Concern	Confirmed INHDC
Four-toed Salamander	State Endangered	Confirmed INHDC
Tiger Beetle	State Rare	Confirmed INHDC
Salt and Pepper Skipper	State Rare	Confirmed INHDC
Gold-banded Skipper	State Rare	Confirmed INHDC
Northern Hairstreak	State Rare	Confirmed INHDC
Baltimore	State Rare	Confirmed INHDC
Great St. John's Wort	State Threatened	Confirmed INHDC
Small Sundrops	State Rare	Confirmed INHDC

Panic Grass	State Endangered	Confirmed INHDC
Illinois Blackberry	State Endangered	Confirmed INHDC
Purple Flowering Raspberry	State Threatened	Confirmed INHDC
Yellow Nodding Ladies-tresses	State Threatened	Confirmed INHDC
Clingman Hedge Nettle	State Endangered	Confirmed INHDC
Mercury	State Rare	Confirmed INHDC
Lake Cress	State Endangered	Confirmed INHDC
Northern Catalpa	State Rare	Confirmed INHDC
Narrow-leaved puccoon	State Endangered	Confirmed INHDC
Green Adders-mouth	State Endangered	Confirmed INHDC
Black-fruit Mountain Rice-grass	State Rare	Confirmed INHDC
Horned Pondweed	State Rare	Confirmed INHDC
Golden Alexanders	State Rare	Confirmed INHDC
Prairie Warbler	Partners In Flight Priority	Confirmed SLT
Louisiana Waterthrush	Partners In Flight Priority	Confirmed SLT

*Species occurring in Brown and Monroe Counties were provided by the U.S. Fish and Wildlife Service and the Indiana Department of Natural Resources.[29] The Indiana Natural Heritage Data Center (INHDC) and the Sycamore Land Trust helped confirm occurrence in the watershed.[30]

Several nuisance species are of concern in the Bean Blossom watershed. Eurasian milfoil is an aquatic plant that crowds out native vegetation and makes waterways unsuitable for boating, fishing or swimming. It is reported in more than 500 Indiana lakes and has been a severe problem in Lake Lemon for years.[31] Lake Lemon also has emerging problems with American Lotus, Spatterdock and Purple Loosestrife.[32] In Griffy Lake, another aquatic nuisance species, Brazilian elodea, appears to be overtaking populations of Eurasian watermilfoil. Authorities are attempting to isolate the problem to prevent the spread of Brazilian elodea to other lakes. An exotic aquarium fish called pacu (piranha) was confirmed in Lake Griffy in 2001. As of 2005, Zebra mussel, an invasive nuisance species, has not been observed in Lake Lemon or Griffy Lake.

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[29] http://www.fws.gov/midwest/endangered/lists/state-in.html
[30] Personal communitcation with Erin Hollinden and Christian Freitag at Sycamore Land Trust http://www.bloomington.in.us/~sycamore/
[31] Lake Lemon T by 2000 Feasibility Study. William Jones and Louise Clemency, School of Public and Environmental Affairs at Indiana University. July 1992. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf
[32] Lake Lemon Conservancy District Lake Lemon Watershed Management Plan, prepared by Malcolm Pirnie, January, 2002 http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Wtrshd_Mngmt_Plan-Lake_Lemon-Monroe-Jan02.pdf

2.5 Land Use Planning in the Bean Blossom Watershed

Water quality typically reflects land use in a watershed and land use planning is a critically important tool in watershed protection. Historically the Bean Blossom Creek watershed has been used for mineral extraction, timber harvesting and both row crop agriculture and pasture. In the early days, hunting was bountiful, with many local stories about bear hunting in the hills.[33,34] Today, about 59% of the Bean Blossom watershed is forested with much of it in public ownership – state forests, parks etc. In addition, there are several youth camps and campgrounds. The combination of scenic forested hills, large tracts of public lands, and lakeshore amenities make the watershed uniquely attractive for recreational use. In fact, the Bloomington Visitors Center estimates that over $225 million in economic impact is attributed to the travel and tourism industry in Bloomington alone.[35]

Human uses of the land can cause point source pollution discharges (e.g. pipes from wastewater treatment plans or factories) and non-point sources of pollution associated with polluted rain water runoff. These non-point sources are diffuse and inherently difficult to detect. Storm water itself can carry pollutants, particularly off impervious surfaces like parking lots. Septic systems are another example of a non-point source. While a properly functioning septic system uses the soil to treat the wastewater, some of the pollutants in the wastewater will be carried to nearby streams and/or underground water supplies. Septic system function will also vary depending on the water use habits of individual homeowners.

TABLE 5: LAND AREA IN THE BEAN BLOSSOM WATERSHED BY COUNTY

Monroe	129.09 square miles
Brown	63.35
Johnson	.15
Morgan	.003

The land in the Bean Blossom watershed lies primarily within 7 townships in northern Brown and Monroe Counties, with tiny portions in Johnson and Morgan counties. There are no large towns in the eastern half of the watershed, only small villages (Spearsville, Fruitdale, Beanblossom, Trevlac, and Helmsburg). The City of Bloomington has jurisdiction over 16.6 square miles of the watershed, particularly around Griffy Lake and Stout's Creek.[36]

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[33] Counties of Morgan, Monroe, and Brown, Indiana: Historical and biographical. 1993. Charles Blanchard, editor. Chicago, IL :Windmill Publications, Inc.,

[34] Brown County, Indiana history and families, 1836-1990 .Compiled by the Brown County Historical Society / author: Dorothy Birney Bailey. 1991. Turner Publishing Company.

[35] http://www.visitbloomington.com/static/index.cfm?contentID=274

[36] Total Maximum Daily Load for *Eschericia coli (E. coli)* in the Bean Blossom Creek Watershed, Brown and Monroe Counties, March 2006, Indiana Department of Environmental Management, Office of Water Quality, TMDL Program. http://www.in.gov/idem/programs/water/tmdl/documents.html

Figure 10 (courtesy of the Indiana Department of Environmental Management) shows the township boundaries within the watershed. It also shows stream segments are recognized by the State as impaired (polluted, primarily for E. coli but see Table 10).[37]

The Bean Blossom watershed encompasses large tracts of Morgan-Monroe and Yellowwood State Forests. In addition, Brown County State Park and Lake Monroe lie outside the watershed but near enough to help draw tourists to the area. Two reservoirs, Lake Lemon and Lake Griffy, provide recreational opportunities of a different kind. The Bean Blossom watershed is also home to Indiana's largest grape growing region. The Monroe County Convention and Visitors Bureau promotes self guided wine tours featuring two wineries in the watershed. In fact, the steering committee met at each of these wineries during the course of developing this watershed plan.

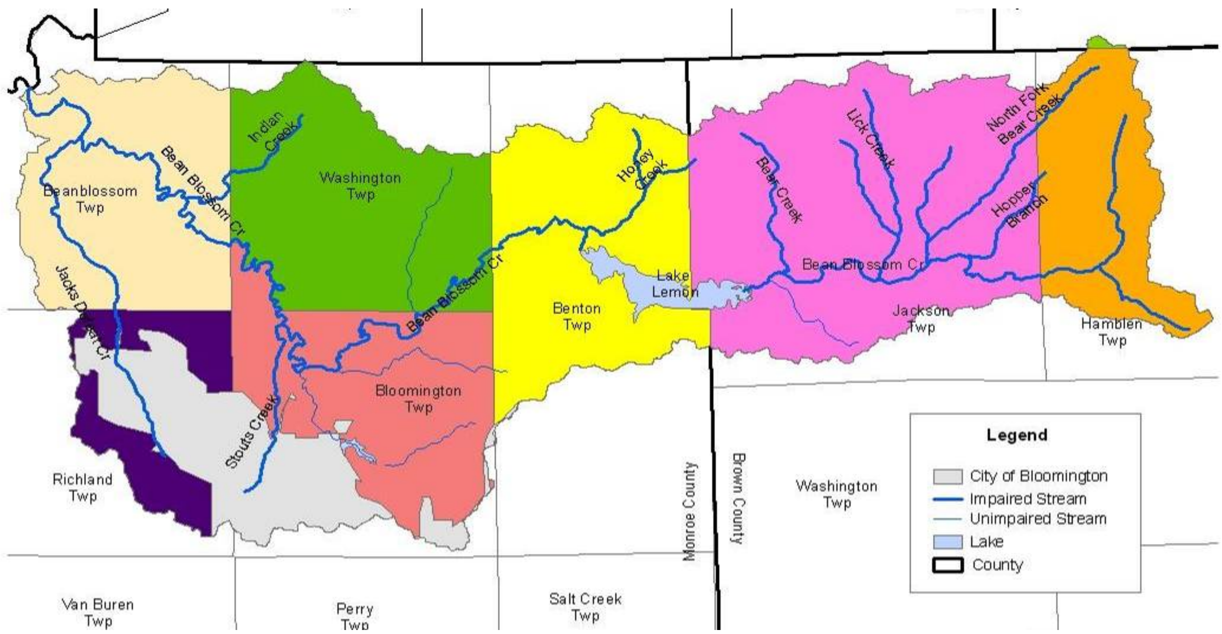

FIGURE 10: TOWNSHIP BOUNDARIES AND IMPAIRED WATERS

Land use and impervious cover play a major role in water quality. Impervious cover includes roads, parking lots, sidewalks, rooftops, and other impermeable surfaces of the landscape that prevent precipitation from soaking into the soil. Impervious cover increases rates of water runoff and is a major factor impacting water quality but the degree of causality between impervious cover and stream quality is variable, depending on other factors such as conveyance, slope, and soil types. Impervious surfaces have implications for stream shape, water quality, water temperature, and biodiversity.[38] It is generally accepted that stream degradation will occur when a watershed reaches 10%

[37] http://www.in.gov/idem/programs/water/tmdl/documents.html Note that North Fork of Bean Blossom Creek is incorrectly labeled as North Fork Bear Creek

[38] The Importance of Imperviousness, *Watershed Protection Techniques* 1(3):100-111. Available at http://www.stormwatercenter.net/Practice/1-Importance%20of%20Imperviousness.pdf and the Center for Watershed Protection http://www.cwp.org/Practice_Articles.htm

impervious cover and that above 25% impervious cover, streams are severely degraded from a physical and biological standpoint.[39]

2.5.1 Land Use Planning in Brown County

The population of Brown County increased by 6.4% from 1990 to 2000.[40] This trend is not expected to continue however, since the population is aging and job opportunities for younger people are limited. Brown County is expected to grow only 2.1% to a population of about 14,400 by 2020[41]. Most residents would like to see the county retain its rural character but many also recognize the importance of economic development opportunities.

Brown County is not actively planning for grown but struggling to ensure that rural residences meet water quality requirements. New rural homes in Brown County's Forest Reserve zoning districts must be built on a minimum of 5 acres lots in order to accommodate 2 leach fields. Brown County has 3 regional sewer districts established to try to deal with failing septic systems in older communities.

2.5.2 Land Use Planning in Monroe County

Monroe County is actively planning for growth and is projected to grow 20.3% to 131,100 in 2020. The County Comprehensive Plan is now being updated. Their "environmental constraints overlay" is a zoning ordinance designed to limit development on steep slopes near waterways. New homes may not be built on the steepest slopes within this "watershed overlay" and must generally be built on 2 acre lots to accommodate eventual septic system replacement.[42]

TABLE 6: MONROE COUNTY POPULATION OF CITIES AND TOWNS

Monroe County Cities and Towns	Population in 2006[43]	% of County
Bloomington	69,247	56.5%
Ellettsville	5,589	4.6%
Stinesville	189	0.2%

Land use is changing most rapidly in the Griffy Creek sub-watershed. Most of the land surrounding Griffy Lake is forested and owned by Indiana University, but residential development a great concern on the east end of Griffy Lake and Gramercy

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[39] Cappiella, K. and K. Brown. 2001. Land Use and Impervious Cover in the Chesapeake Bay Region.Watershed Protection Techniques, Center for Watershed Protection. p. iv

[40] Stats Indiana http://www.stats.indiana.edu/profiles/pr18013.html

[41] Lake Lemon Conservancy District Lake Lemon Watershed Management Plan, prepared by Malcolm Pirnie, Jan.2002 http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Wtrshd_Mngmt_Plan-Lake_Lemon-Monroe-Jan02.pdf

[42] Monroe County Zoning Ordinance Chapter 825 Environmental Constraints Overlay http://www.co.monroe.in.us/planning/Title8zoningordinance.html

[43] Stats Indiana http://www.stats.indiana.edu/profiles/pr18105.html

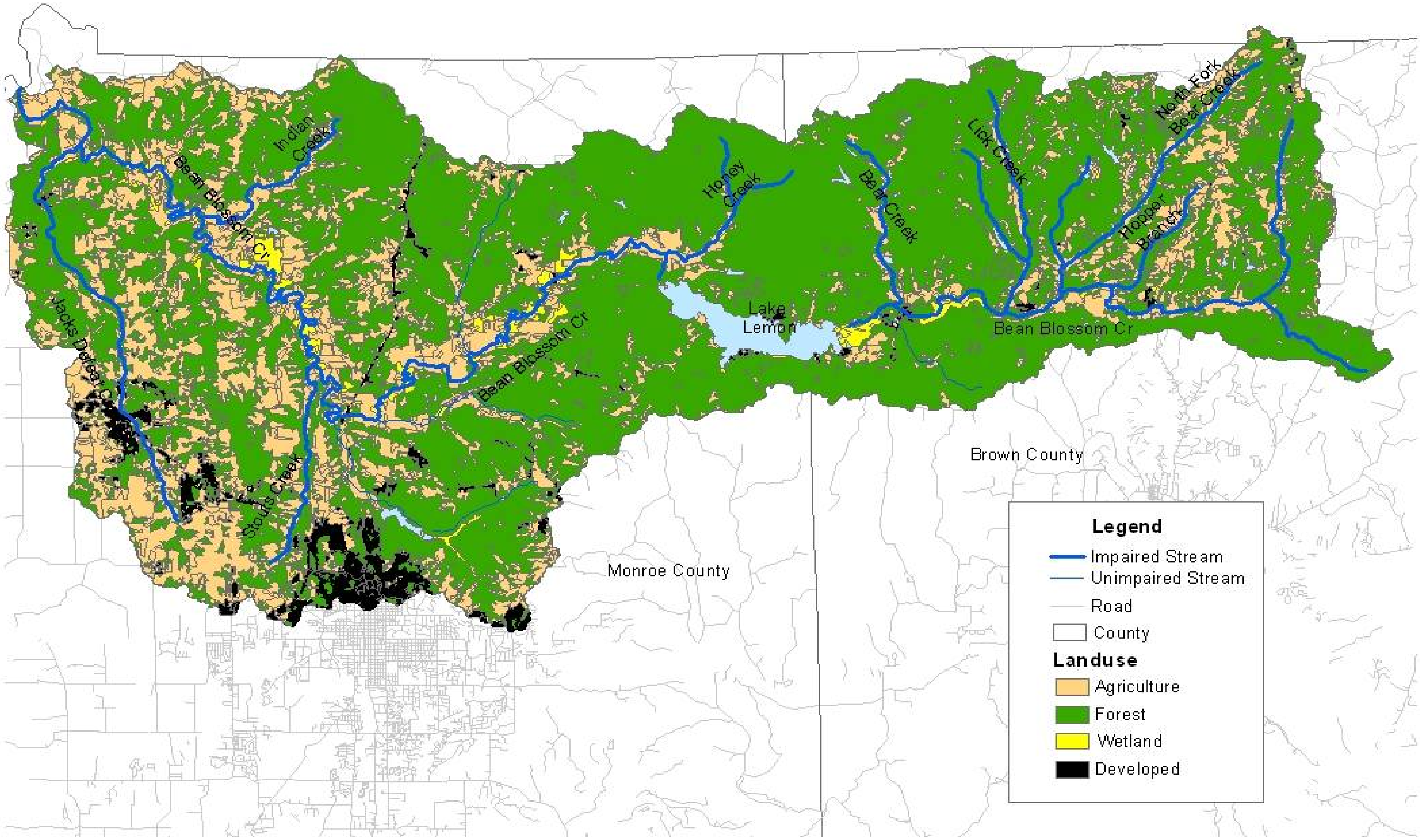

FIGURE 11: LAND USE MAP

Park areas. The area also gets heavy recreational use but there is no designated swimming areas since previous swimming areas were seriously denuded.

Lake Lemon is also attracting new residential development. It has 24 miles of shoreline and the value of lakefront property has sky-rocketed. Revised tax assessments may drive many long-time (and lower income) residents to sell to developers. The environmental constraints overlay ordinance is helpful, but probably not sufficient to protect water quality, especially if the watershed is fully built-out according to what is allowed by current zoning.

Full-body-contact recreation occurs at Cascades Park. Many parts of the stream channel were covered with concrete years ago in an attempt to control erosion, and the water is generally too shallow for swimming, but one portion in particular serves as a popular "water slide" area.

The Monroe County Parks Department is also updating their comprehensive plan. The design at Miller Showers Park is designed as a stormwater detention and treatment facility. It uses plants to clean stormwater and plans are to expand this approach. Part of the plan is to establish a multi-use path to connect Miller Showers and Cascades Parks. At Cascades Park, the concrete is crumbling in places and undercut in others. The creek is adjacent to Old State Rd. 37 and the roadway itself is threatened with undercutting in some areas. Repair of this concrete was included in a previous bond but the funds were exhausted before this portion of the project could be completed.

Monroe County has a Rule 5 ordinance in place to help minimize erosion from construction sites. However it is under-funded and there is minimal enforcement. This is being reviewed as part of the comprehensive planning process.

As a county with relatively high population, Monroe County has five entities designated as Municipal Separate Storm Sewer Systems (MS4) communities, meaning that they must have stormwater management plans in place. Bloomington, Ellettsville, and Ivy Tech are all considered MS4 communities. A county-wide storm water utility has been formed to address MS4 stormwater management requirements. The Storm Water and Environmental Education Team (SWEET) has developed a stormwater management plan[44,45] and they are in the process of developing detailed studies on catchments that are smaller than 14 digit watersheds. As a result, we have very detailed information about the Stout's Creek sub-watershed or catchment. Another outgrowth of the MS4 requirements is that Monroe County has started a Rain Garden Initiative to help mitigate the impact of impervious surfaces and minimize the impact of development and impervious surfaces by capturing runoff.

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[44] Unincorporated Monroe County Stormwater Management Plan Part B. http://www.co.monroe.in.us/stormwaterquality/Documents/PDFpartB.pdf

[45] Part C. 2005. http://www.co.monroe.in.us/stormwaterquality/Documents/part%20c%20web%20exhibits/PartCfinal%20for%20web.pdf

As a result of federal MS4 requirements,[46] Monroe County will take the following steps:

- Apply for NPDES permit coverage
- Implement the stormwater management program using appropriate controls, or best management practices (BMPs)
- Develop a stormwater management program which includes the six minimum control measures
    - Public Education and Outreach
    - Public Participation/Involvement
    - Illicit Discharge Detection and Elimination
    - Construction Site Runoff Control
    - Post-Construction Runoff Control
    - Pollution Prevention/Good Housekeeping

2.5.3 Recreational Areas and Managed Lands

The Bean Blossom Watershed encompasses large tracts of land managed by the Indiana Department of Natural Resources and private land trusts. Protecting these forested areas is critical because they capture rainwater and minimize erosion on steep slopes. Morgan Monroe State Forest, established in 1929, is the largest tract of managed land in the watershed, occupying 634 acres in the northeast Monroe County. In addition, there are numerous recreational areas in the watershed where people are likely to come into contact with the water. It is critical to establish and maintain good water quality in these areas. The nature preserves represent important habitat for endangered species so these are also critical areas to protect.

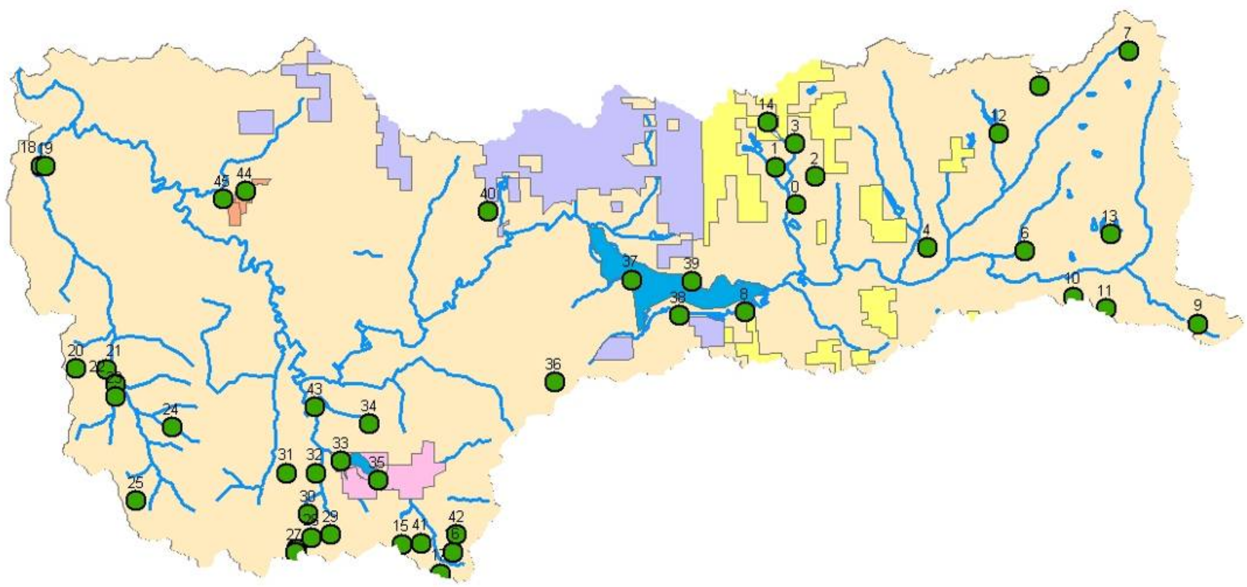

FIGURE 12: RECREATIONAL SITES AND MANAGED LANDS

[46] Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 Guidance. May 2003. Indiana Department of Environmental Management, Office of Water Quality, Urban Wet Weather Section. http://www.co.monroe.in.us/stormwaterquality/rule13.html

TABLE 7: MANAGED LANDS

Legend	Managed Lands	Managed by:
Yellow	Yellowwood State Forest	Indiana DNR
Purple	Morgan-Monroe State Forest	Indiana DNR
Pink	Griffy Lake Nature Preserve	Indiana DNR
Pink	Lilly-Dickey Woods	Indiana University
Orange	Restle Woods Nature Preserve*	Indiana DNR
Orange	Bean Blossom Bottoms*	Nature Conservancy , Sycamore Land Trust
Orange	Trevlac Bluffs	Nature Conservancy , Sycamore Land Trust, Indiana DNR
	Helmsburg Knobs	Sycamore Land Trust
	Hitz - Rhodehamel Woods	Nature Conservancy

* Restle Woods and Bean Blossom Bottoms are part of the Muscatatuck National Wildlife Refuge

TABLE 8: RECREATIONAL SITES

Legend	Recreational Sites
1	Helmsburg Elementary School
2	Hickory Ridge Senior Center
3	Little Africa Wildlife Viewing Area
4	Camp Palawopec
5	Hitz - Rhodehamel Woods
6	Trail Headquarters (Bear Wallow Hill)
7	Bear Lake Public Access Site
8	Indiana University Golf Course
9	University Elementary School
10	Stinesville Park (McGlocklin)
11	Stinesville Elementary School
12	Edgewood High School & Jr High School
13	Memorial Park
14	Ellettsville Elementary School
15	Campbell Park, Ellettsville Park
16	G3 Golf
17	Tri-North Middle School
18	Miller Showers Park
19	Arlington Heights Elementary School
20	Bloomington High School North
21	Griffy Lake Nature Preserve
22	Marlin Elementary School
23	Griffy Lake Park
24	Riddle Point Park & Lake Lemon
25	I & S Marina
26	North Shore Marina
27	Camp Hunt (Wheeler Mission)
28	Devonshire Equestrian Center
29	Bean Blossom Bottoms Nature Preserve
30	Crestmont Park
31	Cascades Golf Course & Park
32	Camp Gallahue
33	Lutheran Hills Camp
34	Bill Monroe’s Bean Blossom Festival Music Park
35	Bean Blossom Covered Bridge

3.0 LINKING PUBLIC CONCERNS AND EXISTING DATA

3.1 Public concerns

The table below indicates the concerns expressed at each of the two public meetings held at the outset of the project, listed in order of the frequency at which they were mentioned. Problem statements were developed for each of the pollutant/stressors identified in the summary table of concerns. Problems statements can be found in Chapter 4.

TABLE 9: SUMMARY OF PUBLIC CONCERNS

Concerns Expressed at Public Meetings	Number of People Expressing Each Concern
Human Sewage pollution	117
Animal manure pollution	22
Silt accumulation/ Algae and weed growth	15
Habitat Loss/Bank Erosion	15
Water Quantity Issues	14
Lack of Water Quality Awareness	12
Pesticides	7
Mercury	3
Metals, carcinogens	2
MTBE	1

Other Concerns expressed throughout the project

- Toxic algae
- Erosion from All-Terrain Vehicles
- Lead from shooting range
- PCBs from old landfill
- Coal Ash pile and community dump
- Trash, illegal dumping and old, abandoned dump sites

In order to evaluate the validity of public concerns listed in Table 9, we compiled and examined all available data pertaining to the Bean Blossom Creek watershed. The watershed has been studied a great deal, at least certain portions of it, so there is a considerable body of water quality data. In addition to parameter-specific data, indices that factor in many variables are sometimes used as an overall gauge of the health of a waterway. Examples include the Index of Biological Integrity, the Qualitative Habitat Use Evaluation Index, and the Trophic Index for lakes. These are discussed briefly in the narrative below with references provided for more information.

3.2 Baseline Conditions: Current Water Quality

The IDEM publishes a list of impaired waters to fulfill the requirements of section 303(d) of the federal Clean Water Act. Here we summarize and examine existing data to evaluate public concerns. In the next chapters, we turn valid concerns into problem statements and solutions. Overall, Bean Blossom Creek earned a very good Index of Biotic Integrity score based on 1995 data. Indiana's 303(d) list of impaired waters for 2006 indicates the following impairments in Bean Blossom Creek and its tributaries:

TABLE 10: IMPAIRED WATERS

HUC	County	Name	Parameter
5120202010010	BROWN CO	BEAN BLOSSOM CREEK-HEADWATERS	E. COLI
5120202010020	BROWN CO	NORTH BEAR FORK	E. COLI
5120202010030	BROWN CO	LICK CREEK	E. COLI
5120202010070	MONROE CO	S.F. GRIFFY CR	IMPAIRED BIOTIC COMMUNITIES
05120202010010	BROWN CO	BEAN BLOSSOM CREEK	E. COLI
05120202010030	BROWN CO	BEANBLOSSUM CREEK	E. COLI
05120202010030	BROWN CO	BELL CREEK (UPSTREAM OF EDWARD LEWIS LAKE)	E. COLI
05120202010030	BROWN CO	BEAR CREEK	E. COLI
05120202010040	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010050	MONROE CO	HONEY CREEK	E. COLI
05120202010050	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010060	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010080	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010090	MONROE CO	INDIAN CREEK	E. COLI
05120202010090	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010100	MONROE CO	BEAN BLOSSOM CREEK	E. COLI
05120202010100	MONROE CO	JACK'S DEFEAT CREEK	E. COLI
5120202010040	MONROE CO	LAKE LEMON	FCA for PCBs
05120202010040	MONROE CO	LAKE LEMON	FCA for MERCURY
5120202010070	MONROE CO	GRIFFY RESERVOIR	FCA for MERCURY
5120202010080	MONROE CO	STOUT'S CREEK	FCA for PCBs
05120202010080	MONROE CO	STOUT'S CREEK	FCA for MERCURY

3.2.1 Summary of Pollution Data

Collection of new water quality data was beyond the scope of this watershed planning process. However, we did review and summarize a large body of data on the watershed, primarily from the Indiana Department of Environmental Management (IDEM). In addition, as part of their Total Maximum Daily Load (TMDL) analysis for Bean Blossom Creek[47], the IDEM compiled data from other sources including the Brown

[47] Total Maximum Daily Load for *Eschericia coli (E. coli)* in the Bean Blossom Creek Watershed, Brown and Monroe Counties, March 2006, Indiana Department of Environmental Management, Office of Water

County Health Department and the School of Public and Environmental Affairs at Indiana University in Bloomington. This data is presented in the Appendices and summarized in the text below.

The map below shows the IDEM sampling locations for field observations and chemical water quality tests. It also shows the locations of permitted wastewater discharges.

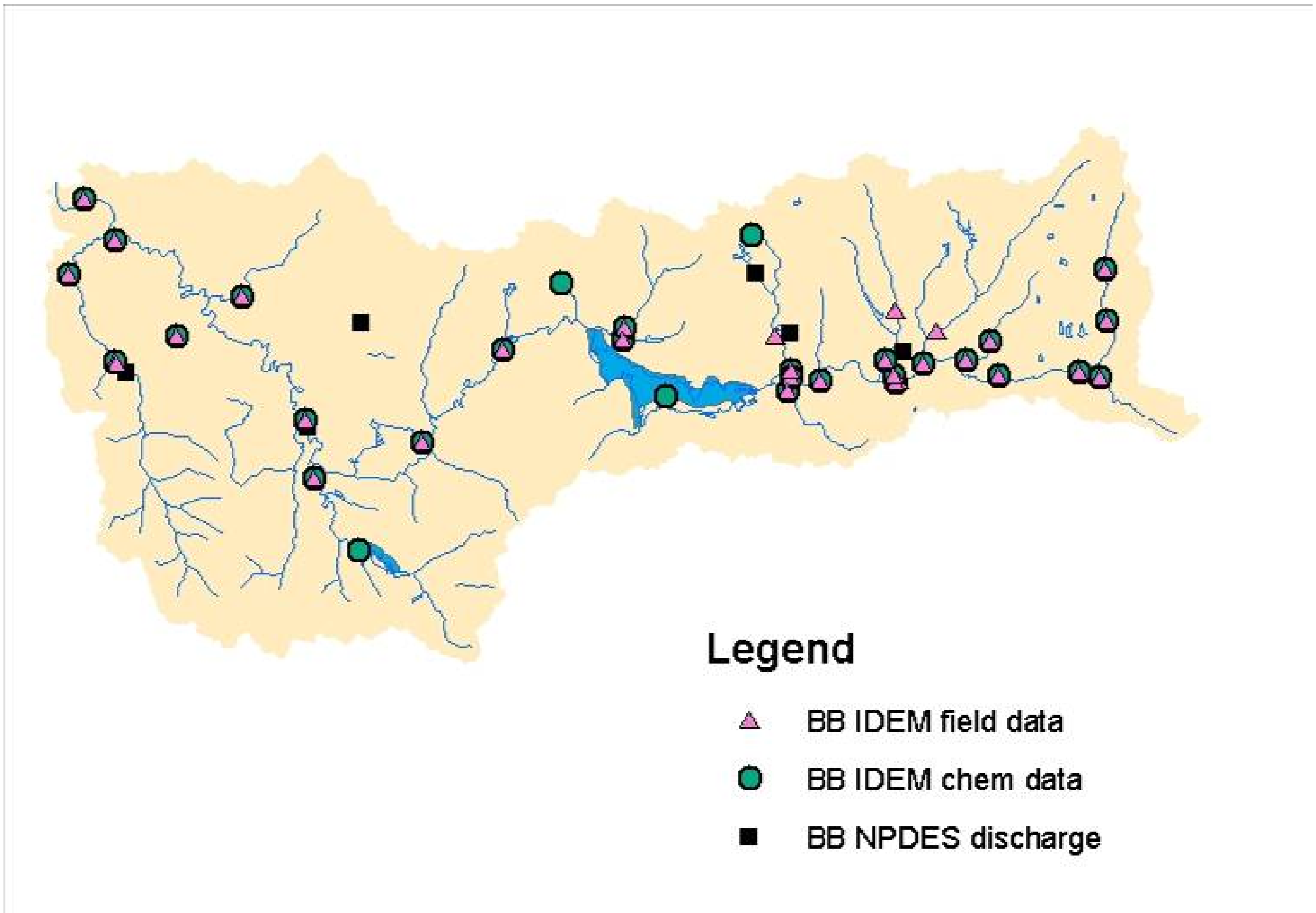

FIGURE 13: NPDES DISCHARGERS AND IDEM SAMPLING SITES

Quality, Total Maximum Daily Load Program
http://www.in.gov/idem/programs/water/tmdl/documents.html

TABLE 11: SUMMARY OF POLLUTION DATA

Parameter	Comments	Severity
Chloride		**Low severity.** Levels generally low, definitely within standards
Chlorophyll a	The concentration of chlorophyll *a* present in the water is directly related to algae growth.	**Severe.** High levels occur in some areas (lakes).
Light Transmissivity	Indicator of algae growth. Used to calculate the trophic index of lakes.	**Severe**. Both Lake Lemon and Lake Griffy have been classified as eutrophic.
Total Coliforms	No standard, but usually about 80% of total coliforms are E. coli according to the TMDL for Bean Blossom Creek.	**Severe.** Levels are very high in creeks.
E. coli	Standards say not to exceed geometric mean of 125 cfu/100 ml or 235 cfu/100 ml in a single sample.	**Severe.** Standards are routinely exceeded in most creeks but not in lakes.
Dissolved Oxygen	Standards say that daily average should be 5 mg/L and no individual sample should be less than 4 mg/L. Dissolved oxygen can decline when temperatures are high and/or when algae growth and decay use up available oxygen	**Severe.** Numerous samples from Griffy Lake and Lake Lemon have low dissolved oxygen in August 2001 and July and August 1996. Bear Creek also had some low levels. No data for other creeks.
Iron	No standards	**Moderate severity**. Iron levels are naturally high in area streams
Ammonia Nitrogen	Standard concentration depends on temperature and pH. Lakes should have less than 1 mg/L.	**Low severity.** Reported values for Lake Lemon, Griffy Lake and Bear Creek are all within standards.
Nitrate and Nitrite	Standard is 10 mg/L. Lakes should have less than 2 mg/L.	**Low severity.** All samples were well within acceptable range.
Phosphorus	No standard for phosphorus, but standard for Lake Michigan is .04 mg/L daily maximum.	**Severe.** Many samples in the Bean Blossom watershed exceed this level, particularly on Lake Lemon.
Sulfates	Standard is 250 mg/L.	**Low severity.** All samples in the Bean Blossom watershed were well below this standard.
Lead	No standard, but 5 ug/L is benchmark	**Low severity.** Levels are generally below 5 ug/L except 2 high readings at 2 different locations in 1996.
Chromium	Standard is 11 ug/L.	**Low severity**. All but one 1996 reading less than 20 ug/L, the limit of quantification.
Copper	Standard varies with hardness.	**Low severity**. All but one 1996 reading less than 20 ug/L, the limit of quantification.

Total Dissolved Solids	Standard is that 750 mg/L should never be exceeded. In Lake Michigan the standard is a 172 mg/L monthly average and a 200 mg/L daily maximum.	**Moderately severe.** Many samples in the Bean Blossom watershed exceed the Lake Michigan benchmarks, but do not approach the statewide standard.
Specific Conductance	Specific conductance is used as an indicator of dissolved solids. Benchmark is 1200 micromhos per cm 9at 25 degrees C.	**Low severity.** All samples on Lake Griffy, Lake Lemon and Bear Creek are well within standards. No data on other creeks.
MTBE	Low acute toxicity but occurs widely in underground water supplies.	**Low severity**. No data for lakes, but not expected to be a problem in lakes.

3.2.2 Pathogens and E. coli

The Bean Blossom Creek is a beautiful stream flowing through terrain that is mostly rural, rugged, and forested, especially in Brown County. In spite of this, water quality data indicates that E. coli levels exceed state standards for safe recreational use along most of the stream reaches. The water quality standards say that the geometric mean must not exceed 125 colony forming units per 100 ml.

Table 12 is a summary of E. coli data collected by the Indiana Department of Environmental Management. Most samples were collected in September and October of 2001. The Bottom Rd. and Mt. Tabor Rd. sites in Monroe County also include data collected in the spring/summer of 1996. This table is meant as a concise summary; much more detailed data is presented in Appendix B.

Geometric means are supposed to meet state standards of 125 colony forming units per 100 ml. The E. coli levels reported are geometric means of at least 5 samples. Samples that do not meet standards for safe recreational use are highlighted in Table 12. The data are presented from the uppermost reaches of the Creek moving westward and downstream to the confluence with the White River.

TABLE 12: BEAN BLOSSOM E. COLI BASELINE DATA (FROM IDEM)

Bean Blossom E. coli data From East to West (Headwaters to Downstream)	Geometric mean levels of E. coli (cfu)*/100 ml **Bold values exceed standard**
Brown County	
Upper Bean Blossom Rd.	121
Sprunica Rd.	**185**
Gatesville Rd.	**442**
SR 45 - Bean Blossom	**388**
Bean Blossom at Helmsburg Rd.	**1731**
SR 45 Bean Blossom at Lick Creek	**165**
Monroe County	
Bean Blossom Cr at Shilo Rd.	**553**
Bean Blossom Cr at Old SR 37	**1415**
Bean Blossom Cr at Bottom Rd.	**657**
Bloomington WWTP-Blucher Poole	11
Bean Blossom Cr Stream bank sample	**519**
Bean Blossom Cr at Mt. Tabor Rd.	**400**
Bean Blossom Cr at New Moon Rd.	**487**
Bean Blossom Creek Tributaries (Headwaters to Downstream)	
East Fork	**172**
Hoppers Branch	**744**
North Fork	**268**
Lick Creek	**258**
Plum Creek	**168**
Bear Creek	114
Muddy Creek	
Griffy Creek	
Stout's Creek	
Wolf Creek	**Too numerous to count***
Honey Creek	**223**
Indian Creek	**1779**
Jack's Defeat Creek	**393**

*E. coli bacteria are reported as colony-forming units (cfu) because samples are typically placed on a nutrient medium and incubated for 24 hours to allow bacteria to grow into colonies that are visible to the naked eye as discrete spots on the petri plate. Standards say not to exceed geometric mean of 125 cfu/100 ml or 235 cfu/100 ml in a single sample. If colonies are too numerous, the plate may be completely covered, making it impossible to count spots (colonies). In this situation, the next sample would typically be subjected to greater dilution before plating.

For comparison purposes, it is nteresting to note that the geometric mean data for samples collected in 2002 from the nearby Salt Creek watershed are well within standards for safe recreational use. For example, E. coli counts were 50, 36, and 3 cfu/100 ml at locations near Nashville, at the Yellowwood Lake boat ramp, and at another location in Yellowwood Lake, respectively.

3.2.3 Mercury and PCBs in Fish Tissues

IDEM's 2004 305(b) report[48] indicates that Bean Blossom Creek fully supports aquatic life, however PCBs and mercury pose a threat to those who consume fish. The Indiana Department of Environmental Management and the Indiana State Department of Health collaborate on a Fish Consumption Advisory each year. The table below provides details from the Indiana Fish Consumption Advisory.

TABLE 13 FISH CONSUMPTION ADVISORIES [49,50]

Waterbody	Fish Species	Fish size (inches)	Advisory Group*	Contaminant
Griffy Lake	Largemouth Bass	**Greater than 11 inches**	3	Mercury
Lake Lemon (Monroe County)	Black Crappie	Up to 7 inches	1	PCBs
Lake Lemon	Bluegill	Up to 6	1	PCBs
Lake Lemon	Flathead Catfish	20+	3	PCBs
Lake Lemon	Redear Sunfish	Up to 9	1	PCBs
Lake Lemon	White Crappie	Up to 9	1	PCBs
Bean Blossom Creek Monroe County	Channel Catfish	13+	3	PCBs
Stout's Creek Monroe County	Creek Chub	8+	3	PCBs
All Indiana waters	Carp	15-20 inches	3	PCBs
All Indiana waters	Carp	20-25 inches	4	PCBs
All Indiana waters	Carp	over 25 inches	5	PCBs

***Advisory Groups of the Indiana Fish Consumption Advisory**
Group 1 One meal per week for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15. Unrestricted consumption for other adults.
Group 2 One meal per month for women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15. Other adults should limit to one meal per week (52 meals per year).
Group 3 Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 are advised DO NOT EAT. Other adults should limit consumption to one meal per month (12 meals per year).

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[48] 2006 Integrated Water Quality Monitoring and Assessment Report, Indiana Department of Environmental Management http://www.in.gov/idem/programs/water/305b/index.html
[49] Indiana Fish Consumption Advisory http://www.in.gov/isdh/dataandstats/fish/2007/index.htm
[50] www.cfs.purdue.edu/extension/foodsafety/anglingindiana

Group 4 Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 are advised DO NOT EAT. Other adults should limit consumption to 1 meal every 2 months (6 meals per year) for adult males and females.
Group 5 All are advised DO NOT EAT.

3.3 Baseline Data in Tributary Sub-watersheds

There is little information about water quality in most of the tributaries of Bean Blossom Creek, however some have been studied in more detail than others.

3.3.1 Stout's Creek

The Stout's Creek sub-watershed is smaller than a 14 digit HUC and drains approximately 5,200 acres within (HUC-14: 05120202010080). Most of the drainage area lies in the MS4 regulated area. The predominant land use in the sub-watershed is agriculture (see Table 33).[51] It is generally accepted that as little as 10% impervious cover can result in stream degradation and that severe degradation occurs at 25% impervious surface. As part of their MS4 study, the Monroe County planning office determined that the Stout's Creek sub-watershed has about 17.16% impervious surfaces.[52]

Two nationally listed Superfund sites are found in the Stout's Creek sub-watershed: Bennett Stone Quarry (Bennett's Dump) and Lemon Lane Landfill. The U.S. Environmental Protection Agency cites IDEM's 2004 water quality report indicating that fish in this stream have both mercury and PCB contamination. The fish consumption advisory warns that Creek Chub from Stout's Creek greater than 8 inches long should not be eaten more than 1 time per month and should not be eaten at all by sensitive populations including women who plan to have children.[53]

Despite the presence of toxic chemicals, Stout's Creek has an exceptional score of 48 for its Index of Biological Integrity, among the highest in Monroe County, based on 1995 samples. Turbidity levels ranged from 0.08 to 0.29 with an average of 0.13 turbidity units.[54]

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[51]From Baseline Stream Characterization in Monroe County, Indiana: Stout Creek, Elizabeth Muller, Chris Gleaton for the Monroe County Planning Department, August 2006. http://www.co.monroe.in.us/planning/documents/Stout%20Stream%20Assessment_%20Final.pdf
[52] Stout Creek Impervious Cover Calculations, Appendix A http://www.co.monroe.in.us/planning/documents/Stout_Appendix%20A_IC%20calculations%20detail.pdf
[53] Indiana Fish Consumption Advisory http://www.in.gov/isdh/dataandstats/fish/2007/index.htm
[54] Bloomington Environmental Quality Indicators, Surface Water Assessments. http://www.bloomington.in.gov/beqi/waterBodies.htm

3.3.2 Lake Lemon

As a water supply reservoir and important recreational area, Lake Lemon has been the subject of a great deal of study so a large volume of water quality data is available (See Appendix). Lake Lemon has been eutrophic or hyper-eutrophic since the mid 1970s according to Carlson's Trophic Index.[55,56] Transparency is poor compared to other Indiana lakes due to algae and suspended sediments. The east end of Lake Lemon serves as a settling basin for sediments.

FIGURE 14: AERIAL VIEW OF LAKE LEMON AND SEDIMENT LOADING.
Photo courtesy of the Lake Lemon Conservancy District

Sediment carries nutrients with it that promote algae growth. The sediment also create conditions favorable for invasive species and weeds. Eurasian milfoil is an especially problematic weed in Lake Lemon, interfering with recreational boating.[57] Herbicides have been used to control the weeds for years, but this is an expensive undertaking (about $325 per acre per year)[58] and has met with limited success.

Large algae blooms can form unsightly surface scum. Blooms of blue-green algae can cause extreme day/night fluctuations in dissolved oxygen and pH of the water. These wide fluctuations can occasionally trigger fish kills. Many species of blue-green

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[55] Bloomington Environmental Quality Indicators, Surface Water Assessments. http://www.bloomington.in.gov/beqi/waterBodies.htm

[56] For general reference on Carlson's Trophic Index, see The Great American Secchi Dip-In http://dipin.kent.edu/tsi.htm#A%20Trophic%20State%20Index

[57] Bloomington Environmental Quality Indicators - Surface Water Assessments http://www.bloomington.in.gov/beqi/waterBodies.htm

[58] Lake Lemon Conservancy District Lake Lemon Watershed Management Plan, prepared by Malcolm Pirnie, January, 2002 http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Wtrshd_Mngmt_Plan-Lake_Lemon-Monroe-Jan02.pdf

algae (also known as cyano-bacteria) give the water a foul taste and odor. Some cyano-bacteria produce toxins that can cause serious problems. In humans, these toxins have been reported to cause skin and eye irritation, dermatitis, gastroenteritis, diarrhea, vomiting, liver damage, nervous system damage, damage to the kidneys and respiratory tract, nausea, headache, and even death. Livestock and wildlife may suffer skin irritation, convulsions, liver problems, paralysis, constipation, abortion, or death.[59]

Cylindrospermopsis raciborskii (Cylindro) is a toxic algae species of special concern in Indiana. The table below shows Cylindro data collected in Lake Lemon. The highest Cylindro density ever reported in the U.S., 2.1 million cells per milliliter, was from Lake Lemon in Monroe County in 2005. [60]

TABLE 14: TOXIC ALGAE POPULATIONS[61]

Location	County	Date	cells/mL
Lemon (Riddle Pt)	Monroe	7/7/2002	357,592
Lemon (Reed Pt)	Monroe	8/18/2004	315,632
Lemon (Reed Pt)	Monroe	7/7/2002	246,642
Lake Lemon	Monroe	2005	2,100,000

3.3.3 Griffy Creek and Griffy Lake

Griffy Lake sub-watershed has also been the subject of some fairly detailed studies. It consists of more than 5,000 acres, 1,169 of which belong to the city. Indiana University owns about 900 acres in the watershed. The watershed area upstream from the lake is roughly 4200 acres. The watershed is drained by Griffy Creek, which has three equally sized branches or forks. The land use in the watershed is shifting from forested to urbanized and the overall health of the watershed will face new challenges as a result. Issues such as erosion control, sedimentation, and point/non-point source pollution will have a greater likelihood of occurrence if the current development trend continues in the watershed.[62]

The Griffy Lake Watershed GIS Mapping and Management Plan[63] indicates that Griffy Lake meets state standards for safe recreational use, but the South and Middle Forks have E. coli levels that exceed state standard concentration limits. Hot spots for E. coli exist in the North, South and Middle Forks of the Griffy Creek watershed, primarily residential and agricultural areas. The South Fork is also influenced by the IU Golf Course. Sediment is a special concern because it is linked to the expanding population of rooted aquatic plants that obstruct boat traffic.

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[59] Frequently asked questions on *Cylindrospermopsis* and other potential toxin producing blue-green algae in Indiana waters. http://www.in.gov/dnr/invasivespecies/BLUEGREEN-ALGAE.pdf
[60] Aquatic Invasive Species http://www.state.in.us/dnr/fishwild/fish/cylind.htm .
[61] www.spea.indiana.edu/clp/CylindroWaterCol.doc - Invasive Algae Widespread in Indiana.
[62] Natural Features Inventory: Watersheds & Floodplains Final Report. 2003. Monroe County Planning http://www.co.monroe.in.us/planning/documents/Watersheds%20&%20Floodplains%20_NFI_.pdf
[63] Griffy Lake Watershed GIS Mapping and Management Plan, City of Bloomington http://mem.tcon.net/5012/0614/griffy.html

FIGURE 15: GRIFFY LAKE AND ENCROACHING DEVELOPMENT
(City of Bloomington Website)

The Griffy Lake study has identified problems with sediment, nutrients, biotic communities, and heavy metals. Dissolved oxygen, pH and conductivity are adequate to support aquatic life, however, high concentrations of suspended solids were recorded during storm events.[64] Griffy Lake is listed as impaired for mercury contamination. Meals of largemouth bass larger than 11 inches should be limited to one per month.[65]

Invasive species are a severe problem. Curlyleaf pondweed and Eurasian watermilfoil have inhabited Griffy Lake for over 20 years, but Brazilian elodea was first identified in 2001. Brazilian elodea is a weed that out-competes native vegetation and negatively impacts fish communities. The City of Bloomington planned to control Brazilian elodea by allowing drawdown of the lake level, but in March of 2006, the DNR commenced chemical treatment.

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64 Griffy Lake Watershed GIS Mapping and Management Plan, City of Bloomington http://mem.tcon.net/5012/0614/griffy.html
65 Indiana Fish Consumption Advisory http://www.in.gov/isdh/dataandstats/fish/2007/index.htm

3.4 Linking Concerns to Existing Data

After reviewing the available data, we revisited the concerns identified in public meetings and other venues to evaluate whether the data suggests that the concerns represent valid problems. In the table below we list concerns, benchmarks for evaluating each concern, and sources of data. The table also indicates which problem statements relate to each concern. Detailed problem statements are developed in the next chapter.

TABLE 15: LINKING CONCERNS TO EXISTING DATA

Concerns	Benchmarks	Existing Data Sources	Problem Statement
Human sewage, Animal Manure	E. coli levels, total coliform counts, dye testing, land use assessment, visual assessment	Health Departments, IDEM, Lake Lemon Conservancy District, School of Public and Environmental Affairs at IU	Data confirm problems but there are large data gaps. See Pathogen Problem Statement.
Silt accumulation/ weed growth in lakes	Total Suspended Solids, Sediment load, transmissivity	School of Public and Environmental Affairs at IU, Lake Lemon Conservancy District, IDEM .	Data confirm problems. See Sediment Problem statement.
Habitat Loss/Bank Erosion	Bank migration, visual assessment,	Hoosier Riverwatch, Visual Observations	Data confirm problems. See Sediment Problem statement.
Nutrients/Algae growth in lakes	Chlorophyll a, light transmissivity, Phosphorus, ammonia and nitrates	IDEM, Lake Lemon Conservancy District	Data confirms problems. See Nutrient Problem statement.
Mercury and metals	Mercury levels in water or fish tissues	IDEM and ISDH Fish Consumption Advisory, IDEM data on metals	Data confirm problems with mercury not other metals. See Mercury Problem statement.
Lack of Water Quality Awareness	Water quality awareness surveys	Very little existing data	Survey results confirm problems. See Water Quality Awareness Problem statement.
Pesticides	Chemical analysis, land use assessment	Very little data.	A precautionary approach is warranted. See Water Quality Awareness Problem statement.
metals, carcinogens	Chemical analysis	Very little data.	A precautionary approach is warranted. See Water Quality Awareness Problem statement.
MTBE	Chemical Analysis	Very little data on surface waters. Purdue North Central has data on ground water only.	Likely not a valid problem, but a precautionary approach may be warranted. See Water Quality Awareness Problem statement.
Trash	Visual monitoring	Very little data	A precautionary approach is warranted. See Water Quality Awareness problem statement.
Flooding	Water levels	USGS gages, many discontinued.	Data confirm problems. See Water Quantity problem statement.
Water Shortage	Water use surveys	Very little data. Indiana Onsite Waste Professionals Association	Data confirm problems. See Water Quantity problem statement.

4.0 Water Quality Problems and their Causes

In this section we identify pollution problems that are likely contributing to the water quality problems in Bean Blossom Creek and associated lakes and tributaries. Problem statements were developed to address the concerns identified in the previous section. We examine both point sources and non-point sources of pollution. Point source pollution originates from identifiable "points" such as a discharge pipe from a factory or wastewater treatment plant. Non-point sources represent polluted runoff from land use activities.

Non-point source pollution, unlike pollution from an industrial discharge, comes from diffuse sources. Non-point source pollution is caused by rainwater or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries pollutants, often depositing them into lakes, rivers, wetlands, and even underground sources of drinking water. Examples of non-point source pollution include:

- Deposition of airborne contaminants such as mercury from power plant smokestacks;
- Bacteria and nutrients from livestock, pet wastes, and faulty septic systems;
- Excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas;
- Oil, grease, and toxic chemicals from urban runoff roads, rooftops, and parking lots; and
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks.

In urban areas, stormwater may be treated (as required by the federal MS4 program) but in small communities and rural areas stormwater flow is seldom treated. It is inherently difficult to identify the exact sources of non-point source pollution, due to its diffuse nature. Much of this watershed plan is devoted to identifying factors that contribute to non-point source pollution.

4.1 Pathogen Problem Statement:

The presence of bacteria is potentially dangerous to humans who come into contact with the water. High E. coli levels are the primary reason that the IDEM has included the Bean Blossom Creek on the 303(d) list of impaired waters. *Escherichia coli* occurs in the intestines of warm-blooded animals and serves as an indicator of the presence of human or animal feces. It is technically very challenging and expensive to distinguish between animal and human sources of E. coli.

E coli levels are elevated from the headwaters throughout the length of the creek, with the exception of Lake Lemon and Griffy Lake. Apparently the E. coli bacteria do not survive well under lake conditions, possibly due to competition with other lake organisms. Possibly bacteria settle out in slow moving lake waters but are re-suspended in faster moving creeks.

Human sewage and animal manure can come from either point or non-point sources. The high levels of bacteria in rural headwaters suggest mostly non-point sources but there are several permitted point source wastewater discharges along the creek that may also contribute to pathogen loads. Permitted discharges may cause water quality problems if their permits are inadequate or if they operate in violation of their permits.

Septic systems may fail due to nonexistent system components, improper installation, improper operations and maintenance, inadequate soils and inappropriate use. Septics that discharge directly to waterways are illegal, but difficult to detect. Livestock operations may contribute to bacterial load if animals are allowed to stand in streams and deposit waste directly into waterways, if manure runs off from pasture or paddock areas, or if manure runs off from manure storage areas or farm fields where it has been applied to the land as a soil amendment.

It is important to recognize that *E. coli* is an indicator that other pathogenic organisms may be present in the water as well. Chronically high levels of E. coli in area streams can cause illness in humans who come in contact with the water, interfering with safe recreational use and tourism. High pathogen levels can also cause dissolved oxygen levels to decline in the water column, affecting the survival of aquatic species.

4.2 Sediment Problem Statement

Large amounts of sediment runoff in this watershed destroy in-stream habitat and interfere with aesthetic enjoyment and recreation. Sediment overload causes poor clarity, elevated turbidity and is often associated with high concentrations of nutrients and total suspended solids concentrations.

The removal of vegetation is a primary factor in soil erosion; removal of vegetative cover increases the potential for soil to erode away. (It also destroys wildlife habitat.) The vegetative cover right along the stream corridor is especially important. Forested buffers are preferable because the tree roots help hold the soil to a greater depth and the trees also provide shade to minimize temperature fluctuations.

Vegetative cover is routinely removed in construction, forestry, and row crop agriculture. Overgrazing and intensive use of all-terrain vehicles (ATVs) can also denude the landscape and expose soils. Impermeable surfaces such as rooftops and roads can increase runoff velocity and exacerbate erosion problems.

Sediment overload in this watershed is due to a variety of factors including erodible soils and steep slopes, inadequate riparian buffers, and inadequate use of conservation practices in forestry, construction, and agriculture. There are a number of Best Management Practices (BMPs) that can help minimize erosion for each of these land uses, but most are not required by law; implementation is mostly voluntary. While many BMPs have been identified, the effectiveness of a given practice depends on site specific factors in a given situation.

There are several areas in the Bean Blossom watershed where the removal of vegetative cover is a significant factor. Highly erodible areas that are disturbed by farming, logging or construction are especially vulnerable to erosion. Highly erodible soils are defined by NRCS as follows:

> A soil map unit with an erodibility index of 8 or greater is considered to be highly erodible land (HEL) as set forth in the regulation 7 CFR 610, Subpart B. [66]The erodibility index is based on soil characteristics and climatic conditions and the Highly Erodible Soil Map Unit List is published in the NRCS Field Office Technical Guide. The definition is based on Erosion Indexes derived from certain variables of the Universal Soil Loss Equation and the Wind Erosion Equation. The indexes are the quotient of tons of soil loss by erosion predicted for bare ground divided by the sustainable soil loss (T factor).[67]

Highly erodible soils occur in the Bean Blossom watershed in the East Fork (northern part), much of Hoppers Branch, and the northern half of the North Fork drainage area.

4.3 Nutrient Problem Statement

Factors influencing nutrient runoff are similar to those for sediment and pathogens because nutrients are often associated with sewage (the pathogen path) or soil particles (the sediment path). Nutrients can also come more or less directly from fertilizer application, especially in areas where manicured lawns are preferred. These areas, including both residential neighborhoods and golf courses, tend to apply fertilizer at rates higher than necessary, thus favoring runoff of excess nutrients. Commercial fertilizers are often mixtures that may contain nutrients that are not needed. The growth of most land plants is limited by nitrogen availability; they grow faster with the addition of nitrogen and may not use additional phosphorus. Most aquatic plants are phosphorus limited, so when excess phosphorus runs into waterways it stimulates the growth of algae and aquatic weeds. We estimate that the combined P load from livestock and septics is about 46,466 lbs of phosphorus per year. See Section 6.3.

Algae populations and aquatic weeds limit the recreational and aesthetic use of Lake Lemon and Griffy Lake. Most lake homeowners attribute the presence of weeds to accumulation of sediment, but nutrients are also an important factor. Lake Lemon Conservancy District uses herbicides to control weed growth on the lake. However, the herbicides are expensive and it is not possible to eradicate weeds completely; the goal is just to control weeds near docks, beaches and other recreational areas. In fact, the use of herbicide to kill weeds can exacerbate algal growth by making more nutrients available

[66] According to the National Food Security Act Manual, Fourth Edition, Part 511 — Highly Erodible Land Determinations, Subpart A — Developing Soil Data for HEL Determinations
[67] http://soils.usda.gov/technical/manual/print_version/complete.html

for algae. Thus it is important to address nutrients and sediment, weeds and algae in a coordinated manner.

Griffy Lake has a Trophic State Index within the range of 40-50 in the 1990s (a range of 47-75 was found in the 1970s)[68]. Based on this and other data, Griffy Lake can be classified as mesotrophic to eutrophic. Lake Lemon has also been classified as eutrophic.

4.4 Water Quality Awareness Problem Statement

We conducted a survey to assess the awareness of area residents about watershed issues. There is certainly a lack of awareness about how rivers work and how land use activities impact water quality. Our surveys indicate that there is a general lack of understanding about water quality, and factors that influence it. Many watershed stakeholders were unaware of the watershed planning group and the planning process. Many believed that they did not live in a watershed. This confusion is likely exacerbated by the fact that the Monroe County Watershed Zoning Overlay district is sometimes referred to as if it were the watershed. In fact it encompasses parts of both the Salt Creek/Lake Monroe and the Bean Blossom/Lake Lemon watershed. People living outside the zoning overlay district sometimes had the mistaken impression that they do not live in any watershed.

There is a lack of general knowledge about the interplay between water quality and water quantity. Water quantity is an issue in this watershed. While flooding is frequent in certain areas, groundwater is scarce. Onsite wastewater treatment (e.g. septic systems) is more expensive and less effective when larger volumes of water are generated, potentially overloading the system. Many stakeholders lack knowledge about how to manage their individual properties in a manner that protects water quality.

People in this watershed are concerned about pollution from toxic chemicals and carcinogens, especially mercury, PCBs, and pesticides because of their widespread occurrence and/or perceived risks. For example, residents may not be aware that pathogens can pose a much more immediate health hazard than low levels of pesticides. Further, many people are not used to thinking of soil as a pollutant and do not recognize the serious impacts of sediment on aquatic life.

Another widely dismissed problem is that of trash disposal. There are a number of poorly documented old dump sites in the watershed. These dumps can contain hazards such as leaking pesticide containers or equipment that can leak PCBs. Many of these are on private property, often in ravines. Dumps also contribute to a general notion that dumping is an acceptable practice. There is also an ongoing problem with litter, especially in heavily used recreational areas. The Environmental Management Association at IU cleans up trash around Griffy Lake on a regular basis.

[68] Griffy Lake Watershed GIS Mapping and Management Plan, City of Bloomington http://mem.tcon.net/5012/0614/griffy.html

4.4.1 Mercury and Other Metals

There are fish consumption advisories in place on the Bean Blossom Creek. These advisories recommend that individuals should limit the amount of fish they eat due to mercury (and PCB) contamination in the fish tissues. Area residents should be able to eat the fish they catch. It is difficult to identify sources of metals in the watershed, though their use is certainly widespread. There is no indication that other metals pose a water quality problem in this watershed.

4.4.2 Pesticides

Pesticides are poisons and should always be used with care. There is little data about pesticide use practices in this watershed. However, agricultural and residential areas are expected to have some pesticide use. There is significant corn and soybean production in the watershed with associated pesticide use. Most of this takes place in bottomland areas near larger waterways. Pesticides may also be used around livestock and on golf courses. The large acreage of pasture in this watershed is not likely to have much pesticide use and pesticide use on forested lands is very limited. Pesticides are commonly used on both Lake Lemon and Griffy Lake to control aquatic weeds. The non-target impacts of this practice are not known. Residents need information about the relative risks of using pesticides and the effectiveness of alternative pest control strategies.

4.4.3 PCBs, Carcinogens and Toxics

Landfills are thought to be the primary source of PCBs in the watershed. PCBs are very stable in the environment and unfortunately have already been disbursed through parts of the watershed. Cleanup expenses are enormous. Residents need information about how to avoid risks and how to prevent such disastrous contamination from occurring in the future.

Agricultural practices that included carcinogenic pesticides are probably the most widespread source. There is little data available on these parameters, but their presence cannot be ruled out. Collection of data on pesticide levels is beyond the scope of this project, however, residents need information about how to minimize risks.

MTBE was listed as a concern at our first public meeting. It is used as a gasoline additive in some parts of the United States, but Indiana refineries use ethanol as a gasoline additive instead of MTBE. Any MTBE entering Indiana comes from gasoline from other states or incidental cross contamination of gasoline being hauled in trucks or pipelines that previously contained gas with MTBE. Concern about MTBE was expressed at the public meeting due to media reports about MTBE contamination of drinking water in other areas. The concern was that the cumulative impact of small gasoline spills from recreational boating could contaminate the drinking water reservoirs at Lake Lemon and/or Monroe.

In spite of the very limited use of MTBE in Indiana, Purdue University North Central professor of chemistry Reynaldo Barreto, reports that MTBE is detectable in groundwater almost everywhere in the state. There is no data on MTBE in surface waters in Indiana, however, MTBE is heavier than water so it tends to sink and has much greater potential to contaminate underground water supplies than surface waters. While there is no evidence to support an MTBE contamination problem in Lake Lemon or the Bean Blossom Creek watershed, recreational users can be educated about ways to minimize fuel spills.

4.4.4 Trash and Litter

Concerns expressed at the public meeting included illegal dumping and litter in this area that relies heavily on tourism dollars. While the problem is not severe in most of the watershed, we felt that it was important to address it because it seems to reflect a general attitude about water resources.

4.5 Water Quantity Problem Statement

Flooding and water shortages are flip sides of the same coin, especially in a watershed with such steep topography. Steep slopes lead to rapid runoff, causing flash flood conditions for some and water scarcity for others. Impervious surfaces, such as rooftops and roads, tend to exacerbate these effects. Flooding prevents some landowners from fully utilizing their property. Construction of homes or other structures in floodways can worsen flooding and put people and property at risk. Stormwater retention areas and wetlands can be used to mitigate these problems.

The Bean Blossom watershed has few productive wells and few natural lakes. Reservoirs are the primary source of drinking water in the area, with Lake Monroe being the main source, but with Griffy Lake and Lake Lemon reservoirs serving as backup drinking water supplies. Water conservation can help ensure that the reservoirs meet the needs of a growing community far into the future.

Water conservation can help reduce peak flows, to minimize flooding. It can also can also prolong the life of a residential septic system and reduce wastewater treatment costs at treatment plants in sewered areas.

5.0 Estimating Pollutant Sources and Loads

The data presented in Chapter 3 help identify hot spots that are not meeting water quality standards, however the data are not detailed enough to pinpoint specific sources and the loads they contribute. In chapter 4 we develop problem statements, to help clarify potential sources. In this chapter we estimate pollutant loads in a couple of different ways. First, we estimate current pollutant loading based on available concentration and flow information. Then we use the Long Term Hydrologic Impact Assessment model known as L-THIA to estimate pollutant load from each of the major tributaries based on runoff estimates associated with existing land use patterns.

5.1 Estimating Load from Streamflow Extrapolation

To approximate flow in Bean Blossom Creek, we used flow data for the nearest USGS gauging station, located Centerton on the West Fork of the White River. The USGS gauge 03354000 at Centerton is located upstream from the mouth of Bean Blossom Creek. This location was used by the Indiana Department of Environmental Management to construct load duration curves as part of the Total Maximum Daily Load development.

Table 16: Pollutant Load estimates based on Streamflow Extrapolation

Parameter	Method	Existing Avg. Conc	Estimated Loading	Maximum Desired Conc	Target Load	Load Reduction Goal	Percent Reduction Needed
Total P	Flow Extrapolation	.06194 mg/L	12.20 tons/year	.04 mg/L	7.86 tons per year	4.34 tons per year	35.6 %
Total N	Flow Extrapolation	.80405 mg/L	158.41 tons/year	10 mg/L	1965 tons per year	N.A.	N.A.
TSS	Flow Extrapolation	88.42 mg/L	17,381.15 tons/year	11 mg/L	2162 tons per year	15,218.88 tons per year	87.56 %
E. coli	Flow Extrapolation	1277 CFU/100 ml	$2.28\text{x}10^{15}$ CFU/year	235 CFU/100 ml (125 CFU geometric mean)	4.20×10^{14} CFU/ year	1.86×10^{15} CFU/year	81.6%

The flow rate of the Bean Blossom Creek watershed, with a drainage area of 192 square miles, was determined by extrapolating from the West Fork White River (2521 square miles).[69] Since the drainage area of the Bean Blossom Creek is 8% that of the White River drainage, the flow of the White River was multiplied by 8% to estimate the average annual stream flow for the Bean Blossom Creek at **200 cubic feet per second.** Certainly the eastern portion of the Bean Blossom watershed has much more steep topography than that of the White River and its flow conditions may differ. Load

[69] USGS Streamflow data. http://waterdata.usgs.gov/in/nwis/current?type=flow

calculations are critically sensitive to flow estimates, so we compared this estimate with historic flow data collected from discontinued gaging stations on Bean Blossom Creek, and found it a reasonable estimate (See Appendix C).

To estimate average annual load for each pollutant, we multiplied average pollutant concentrations (from appendix) by average streamflow. The resulting estimates of pollutant load are very rough, depending on a limited dataset, and a variety of assumptions including an aggregation or generalization of conditions over time and over an area exceeding 190 square miles. .

5.2 Runoff Estimates using Long Term Hydrologic Impact Assessment Model – L-THIA

In order to get more specific information about the geographic sources of pollutant loading we estimated pollutant loading using Purdue University Long-Term Hydrologic Impact Assessment model (L-THIA).[70] This model estimates runoff volume and pollutant concentration based on soil characteristics, land use, and rainfall data. Land use data is from the 1992 National Land Cover Database from Land Sat TM imagery, which is the latest available for the L-THIA tool. The L-THIA model uses standard coefficients for runoff from each of these land uses. The L-THIA model computes runoff, pollutant loads and concentrations based on land use, area, impervious surfaces and long term climatic data.

We ran the L-THIA analysis on each of the major tributaries to the Bean Blossom Creek. The watershed boundaries for each tributary were determined using HYMAPS online watershed delineation tool. The L-THIA model relies on land use data, soil characteristics and rainfall data to calculate runoff rates, pollutant loads and concentrations. The concentrations predicted by the L-THIA tool do not match very well with the available field data, however we felt that the L-THIA model was useful for estimating the relative contributions to pollutant load from each sub-watershed even if the absolute values were off.

Figure 16 shows the major tributaries of the Bean Blossom Creek and the HUC boundaries. Note that some 14 digit HUCs are comprised of several tributaries. Tributary watersheds were determined using the HYMAPs tool associated with L-THIA. The sub-watershed maps are presented in Figures 17-35, again in upstream to downstream (east to west) order.

[70] Long Term Hydrologic Impact Assessment Tool, Purdue University. Choi, J.Y., B. Engel and L. Theller. 2005. Online Watershed Delineation. http://pasture.ecn.purdue.edu/~watergen/hymaps/

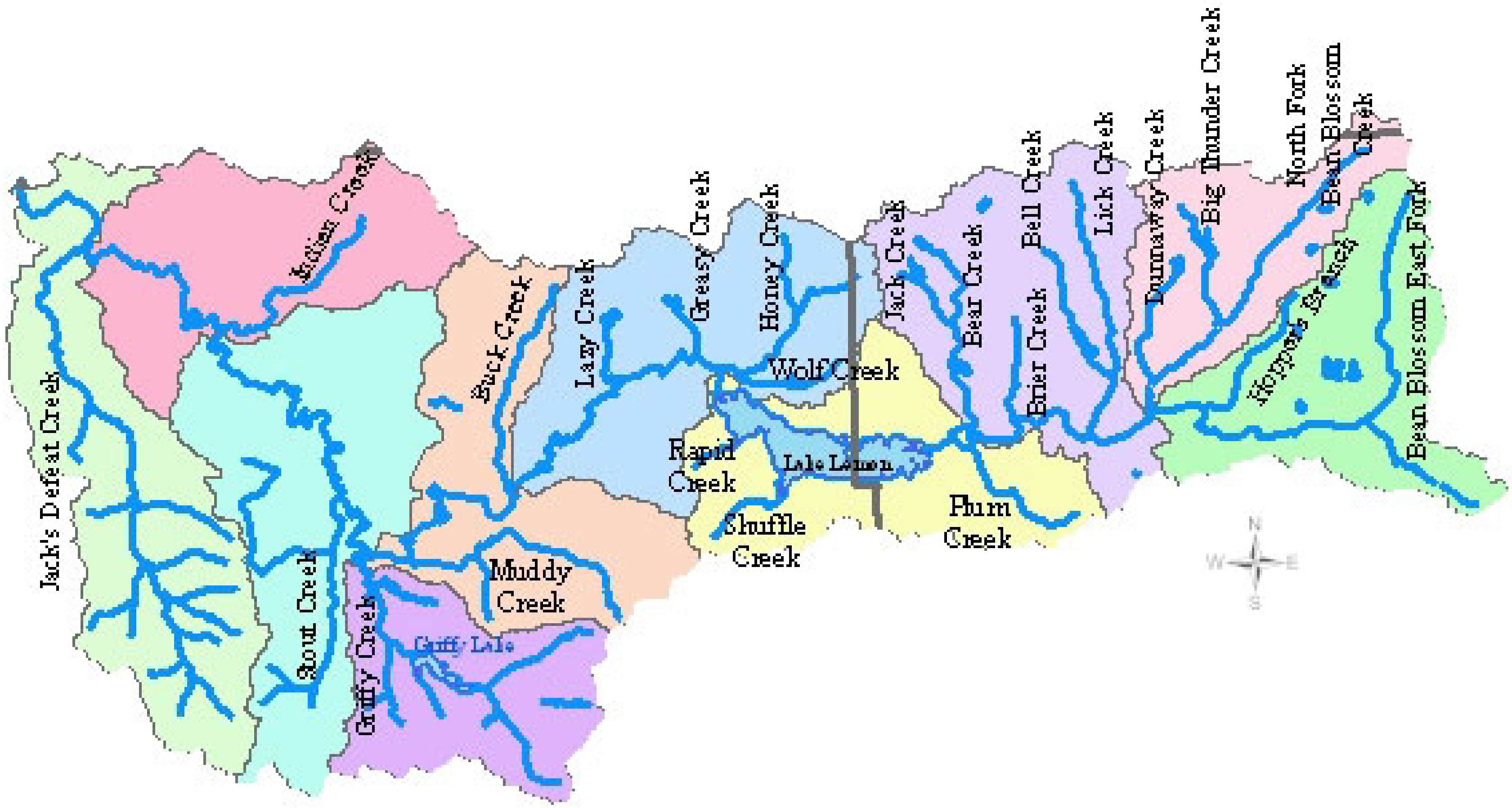

Figure 16: Bean Blossom Tributaries The multi-colored polygons represent 14 digit hydrologic units. Some hydrologic units include several tributaries. (Refer to the following pages or Figure 2 on page 7 for hydrologic unit codes.)

HUC 05120202010010 has 2 major tributaries, the East Fork of Bean Blossom Creek and a stream known as Hoppers Branch.

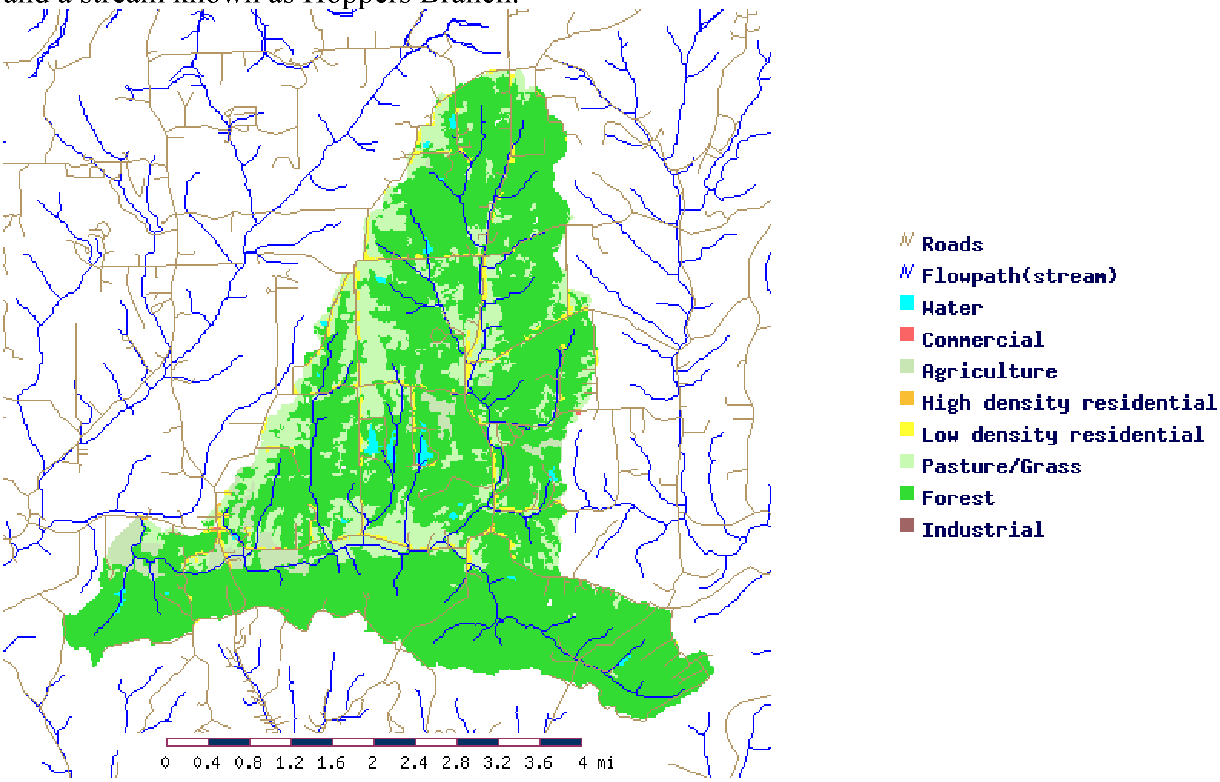

FIGURE 17: BEAN BLOSSOM EAST FORK

The total area of the Bean Blossom East Fork sub-watershed is 11121 acres and impervious cover is 261.3 acres or 2.34 % of the watershed. The estimated annual flow is 3135.77 acre-feet.

TABLE 17: BEAN BLOSSOM EAST FORK POLLUTANT LOAD

	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	88	0	0	0	0	0	0
Commercial	C	3	21	5	890	369	1861	11074
Agricultural	C	396	2976	879	72390	2706	0	1759027
High Density Residential	C	18	104	32	2360	1468	2850	115164
Low Density Residential	C	321	859	269	19362	12042	23376	944490
Grass/Pasture	C	2006	1266	18	1809	904	0	36191
Forest	C	8290	3932	56	5617	2808	0	112349
Total		**11121**	9158	1259	102428	20297	28087	2978295
Avg Annual Concentration (ppm)			1.09	0.15	12.18	2.41	3.34	7703

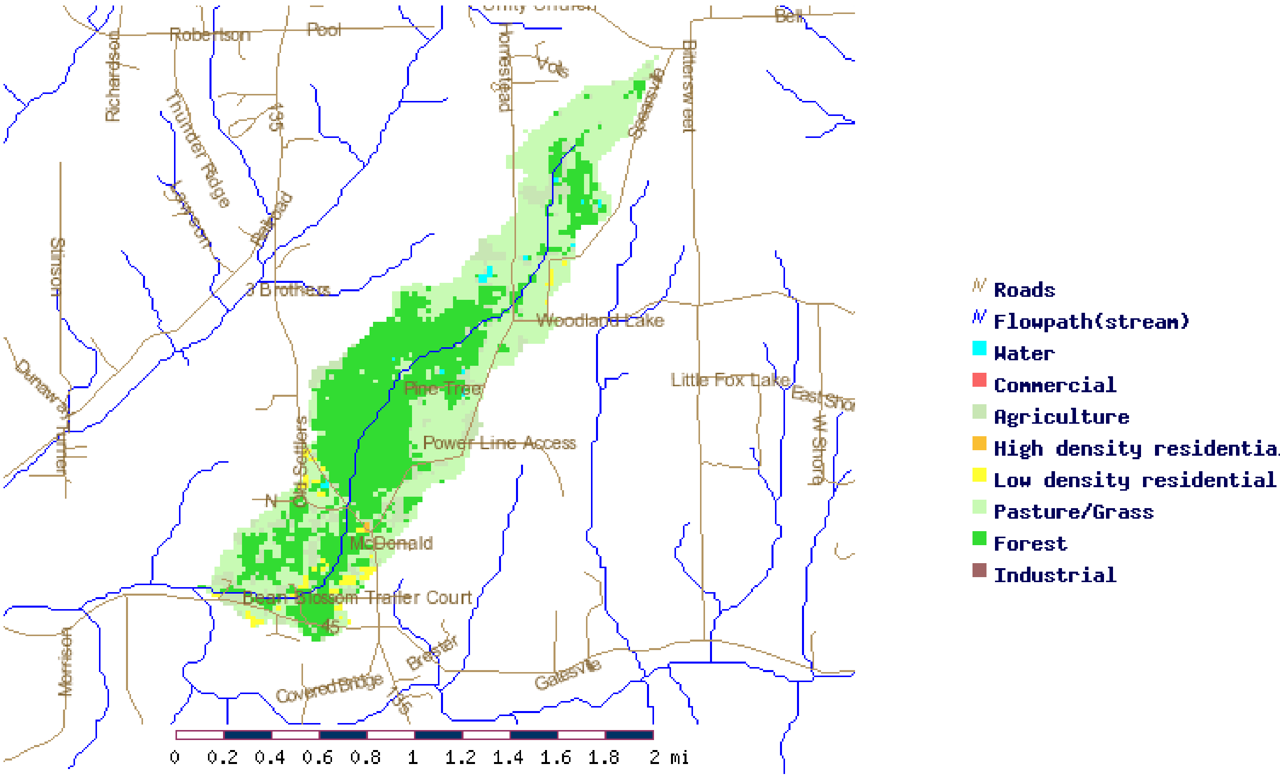

FIGURE 18: HOPPERS BRANCH

The total area of the Hopper's Branch sun-watershed is 849.9 and impervious cover is 261.3 acres or 2.34 % of the watershed. The estimated annual flow is 273 acre-feet.

TABLE 18: HOPPERS BRANCH POLLUTANT LOAD

		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	4.6	0	0	0		0	0
Agricultural	C	83.4	627	185	15261		0	370836
High Density Residential	C	0.4	2	1	53		64	2602
Low Density Residential	C	14.5	38	12	875		1056	42690
Grass/Pasture	C	365	230	3	329		0	6584
Forest	C	381.3	180	2	258		0	5167
Total		849.9	1077	203	16776		1120	427879
Estimated annual Average Concentration (ppm)			1.47	0.28	22.93		1.53	12713.312

HUC 05120202010020 consists of the North Fork of Bean Blossom Creek and Big Thunder Creek. Since these two creeks join before they reach the confluence with the Bean Blossom Creek mainstem, we treat them as a single tributary. The total area of the North Fork Bean Blossom Creek and Big Thunder sub-watershed is 8282 and impervious cover is 160.5 acres or 1.93 % of the watershed. The annual flow is 2572 acre-feet.

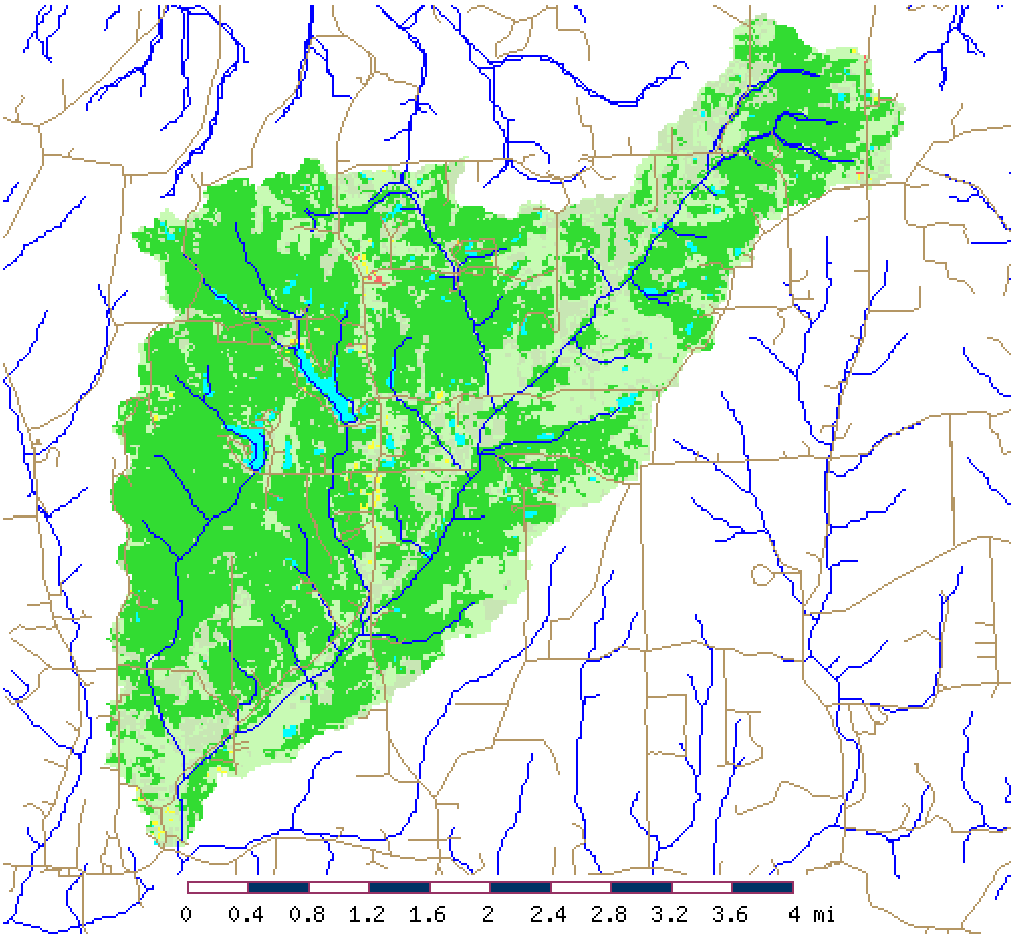

FIGURE AND TABLE 19: NORTH FORK/ BIG THUNDER CREEK

North Fork BB/ Big Thunder Crk

Land Use	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	156.8	0	0	0	0	0	0
Commercial	C	3.9	24	5	1021	423	2135	12703
Agricultural	C	1090.5	8205	2424	199550	7459	0	4848886
High Density Residential	C	0.4	2	1	53	33	64	2602
Low Density Residential	C	25.6	68	21	1545	960	1865	75370
Grass/Pasture	C	1896.7	1197	17	1710	855	0	34217
Forest	C	5108.2	2423	34	3461	1730	0	69232
Total		8282.4	11919	2502	207340	11460	4064	5043010
Avg Annual Concentration (ppm)			1.73	0.36	30.07	1.66	0.59	15901

HUC 05120202010030 is made up of several tributaries, including Lick Creek, Brier Creek, Jack Creek and Bear Creek. Since Bear and Jack Creeks join before the confluence with Bean Blossom Creek, they are treated as a single tributary.

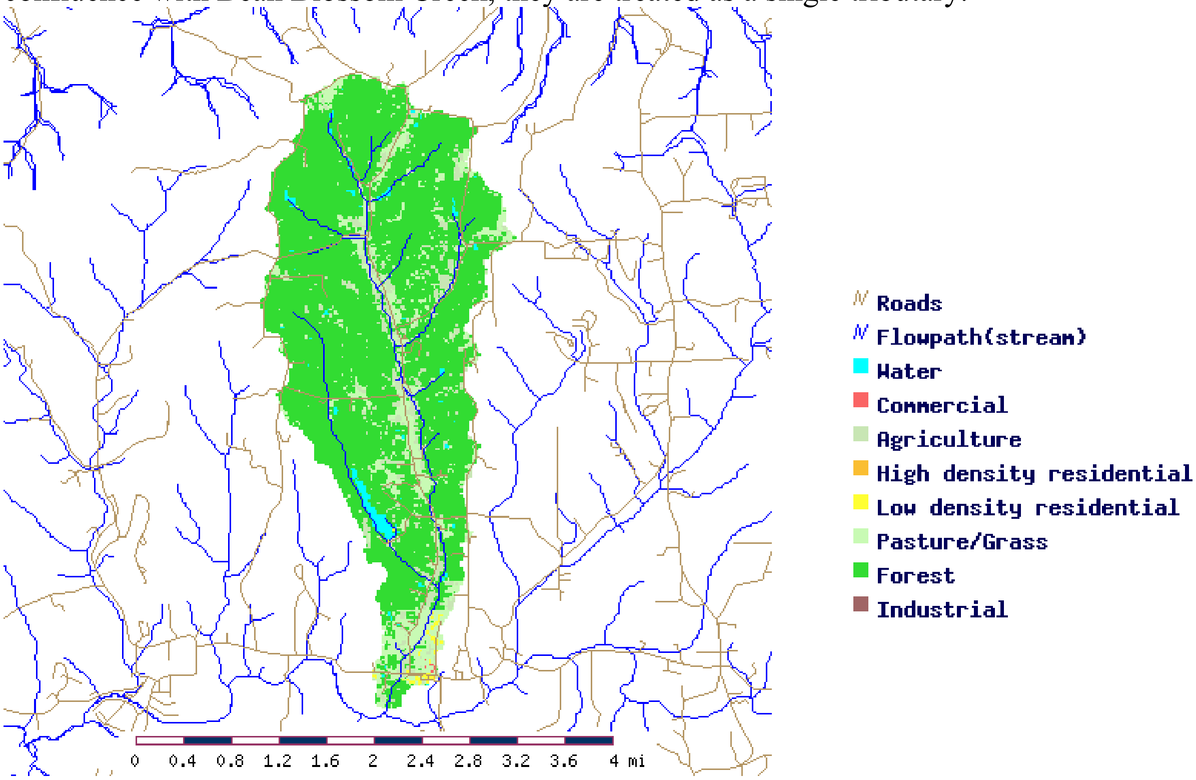

FIGURE 20: LICK CREEK

The total area of the Lick Creek sub-watershed is 4097 acres and impervious cover is 79.9 acres or 1.95 % of the watershed. The estimated annual flow is 1142 acre-feet.

TABLE 20: LICK CREEK POLLUTANT LOAD

Lick Creek

Land Use	**Soils**	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	62	0	0	0	0	0	0
Commercial	C	1	8	2	366	152	766	4560
Agriculture	C	275	2070	611	50340	1881	0	1223226
High Density Residential	C	0	2	1	53	33	64	2602
Low Density Residential	C	17	45	14	1026	638	1238	50050
Grass/Pasture	C	494	311	4	445	222	0	8902
Forest	C	3247	1540	22	2200	1100	0	44000
Industrial	C	0	1	0	42	9	31	675
Total		4097	3977	654	54472	4035	2099	1334015
Avg Annual Concentration (ppm)			1.30	0.21	17.80	1.32	0.69	9476

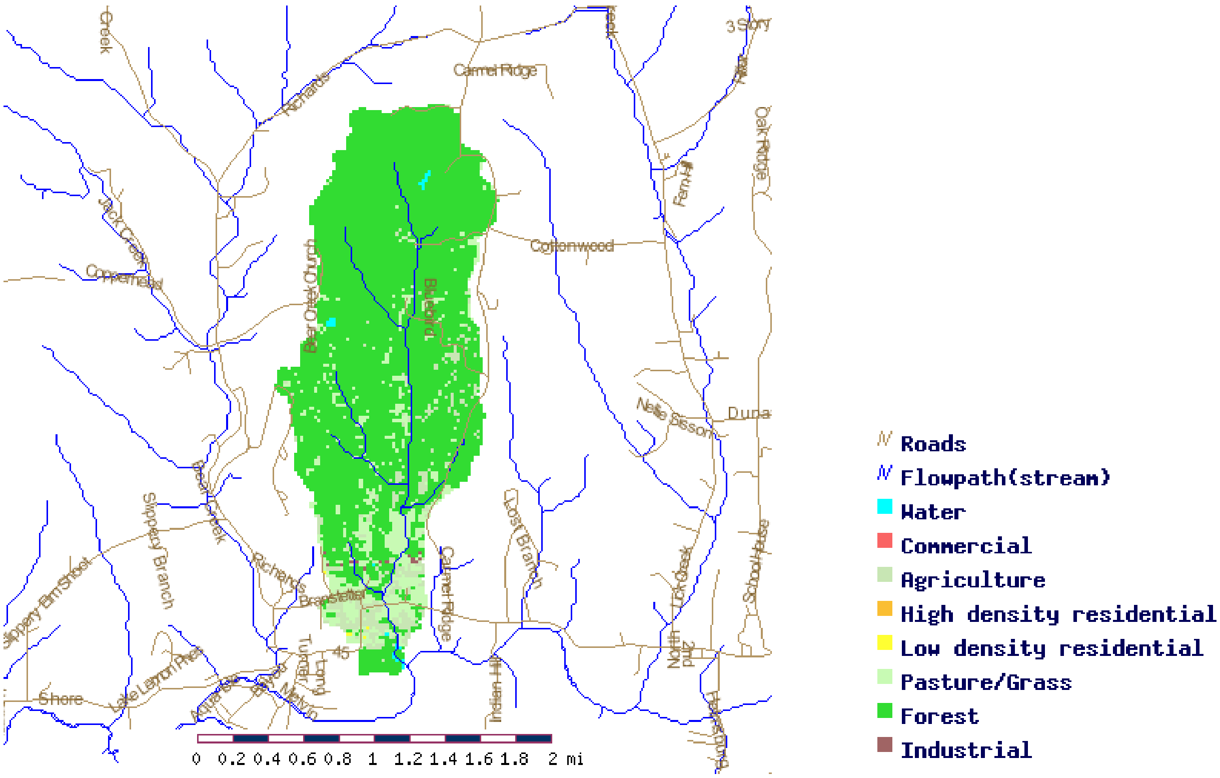

FIGURE 21: BRIER CREEK

The total area of the Brier Creek sub-watershed is 1670 and impervious cover is 33.4 acres or 1.99 % of the watershed. The estimated annual flow is 460 acre-feet.

TABLE 21: BRIER CREEK POLLUTANT LOAD

Brier Creek								
	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	6.1	0	0	0	0	0	0
Agricultural	C	89.6	674	199	16395	612	0	398404
Low Density Residential	C	0.9	2	1	54	33	65	2649
Grass/Pasture	C	174.1	109	1	157	78	0	3140
Forest	C	1396	662	9	946	473	0	18920
Industrial	C	3.4	14	3	715	165	538	11476
Total		1670.4	1461	213	18267	1361	603	434589
Avg Annual Concentration (ppm)			1.18	0.17	14.81	1.10	0.49	7658

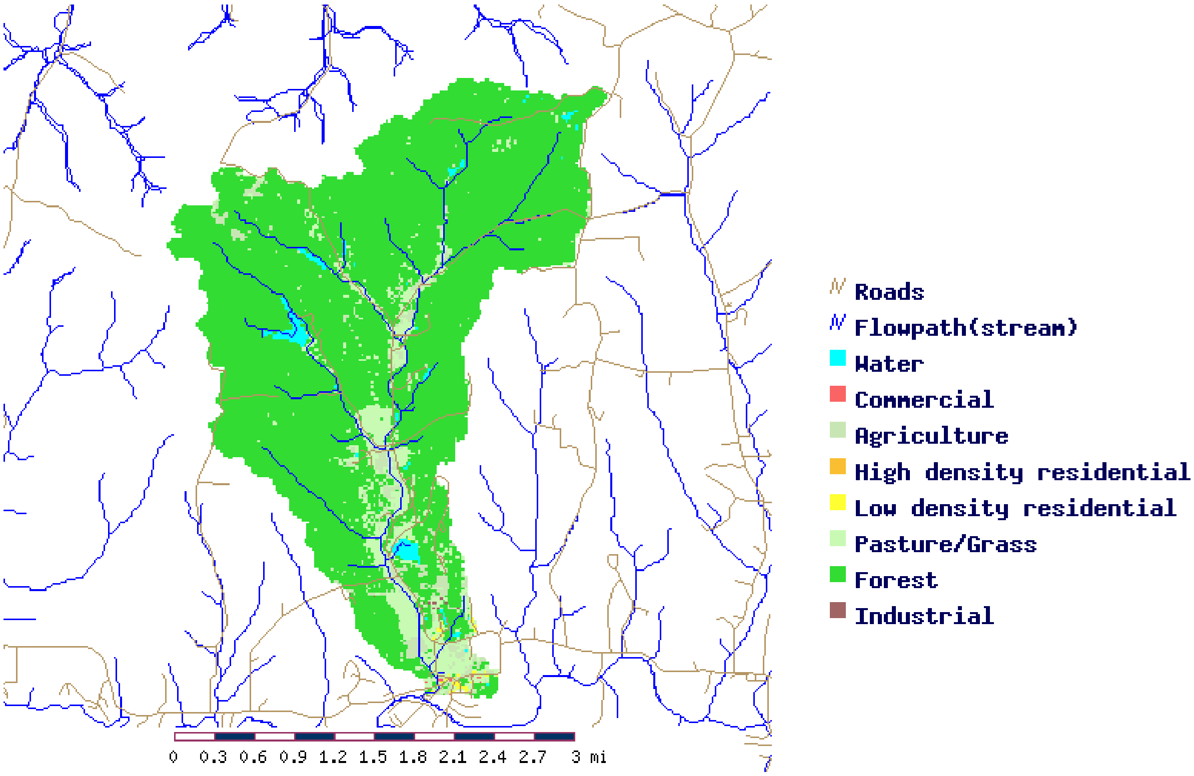

FIGURE 22: JACK/BEAR CREEK

The total area of the Jack Creek/Bear Creek sub-watershed is 4949 acres and impervious is 96.9 acres or 1.95 % of the watershed. The estimated annual flow is 1313 acre-feet.

TABLE 22: JACK/BEAR CREEK POLLUTANT LOAD

Jack Creek/Bear Creek								
	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	1.9	0	0	0	0	0	0
Commercial	C	186.9	12	2	497	206	1040	6188
Agricultural	C	12.1	1406	415	34200	1278	0	831047
Low Density Residential	C	421.3	32	10	730	454	881	35624
Grass/Pasture	C	4257	266	3	380	190	0	7600
Forest	C	2.9	2019	28	2884	1442	0	57696
Industrial	C	0.3	12	2	610	141	459	9788
Total		4948.6	3747	460	39301	3711	2380	947943
Avg Annual Concentration (ppm)			1.06	0.13	11.17	1.05	0.68	5856

HUC 05120202010040 includes Plum Creek, Shuffle Creek and Rapid Creek as well as Lake Lemon itself. Plum Creek flows into Bean Blossom Creek on the east (upstream) end of Lake Lemon while Shuffle and Rapid Creek drain directly into the western part of Lake Lemon.

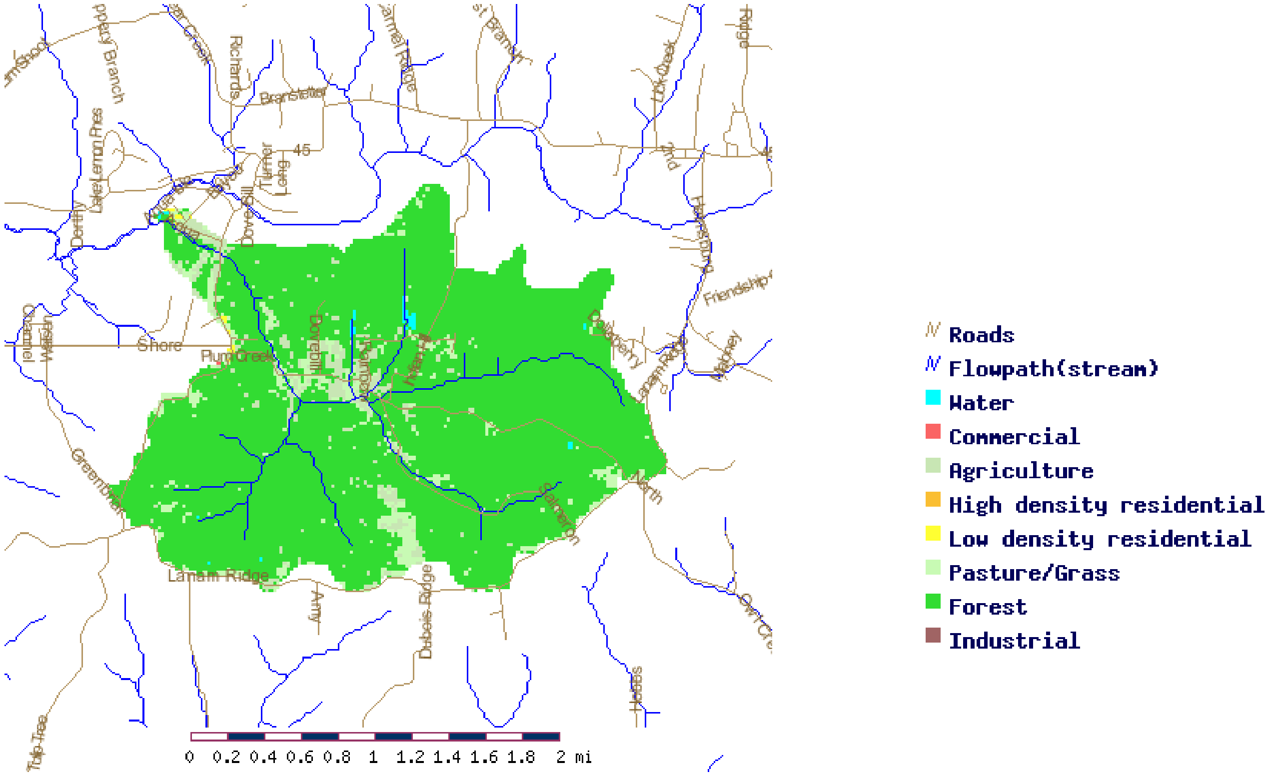

FIGURE 23: PLUM CREEK The total area of the Plum Creek sub-watershed is 2688 acres and impervious cover is 51.2 acres or 1.9 % of the watershed. The estimated annual runoff is 717 acre-feet.

TABLE 23: PLUM CREEK POLLUTANT LOAD

	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	9	0	0	0	0	0	0
Commercial	C	0	1	0	52	21	109	651
Agricultural	C	121	910	269	22141	827	0	538024
Low Density Residential	C	4	9	3	223	138	269	10893
Grass/Pasture	C	151	95	1	136	68	0	2731
Forest	C	2402	1139	16	1627	813	0	32559
Total		**2688**	2154	289	24179	1867	378	584858
Avg Annual Concentration (ppm)			1.12	0.15	12.58	0.97	0.20	6615

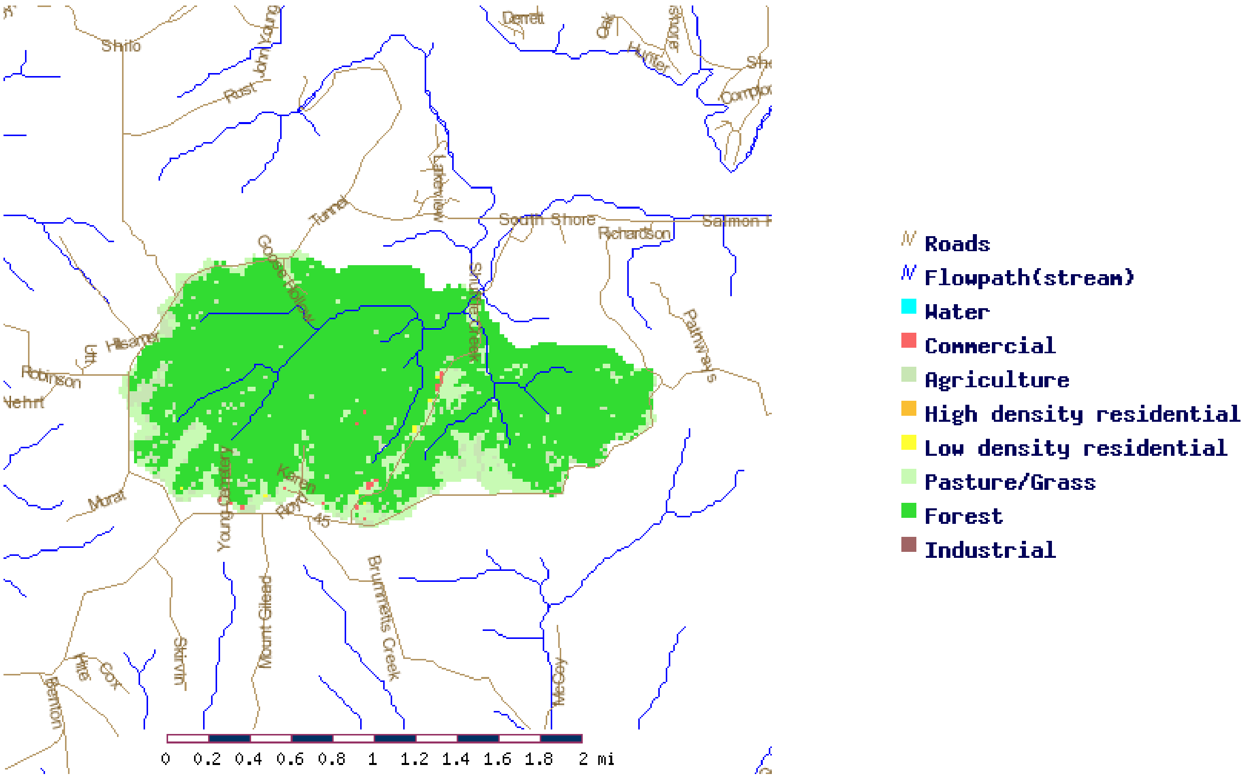

FIGURE 24: SHUFFLE CREEK

The total area of the Shuffle Creek sub-watershed is 1540 acres. The impervious cover is 32 acres or 2.07 %. Total annual runoff volume is estimated at 427.9acre-feet.

TABLE 24: SHUFFLE CREEK POLLUTANT LOAD

Shuffle Creek								
Land Use	**Soils**	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Commercial	C	4	24	5	1021	423	2135	12703
Agricultural	C	72	538	159	13102	489	0	318367
Low Density Residential	C	2	4	1	102	63	123	5005
Grass/Pasture	C	203	128	1	183	91	0	3665
Forest	C	1260	597	8	853	426	0	17073
Total		**1540**	1291	174	15261	1492	2258	356813
Avg Annual Concentration (ppm)			1.13	0.15	13.30	1.30	1.97	6763

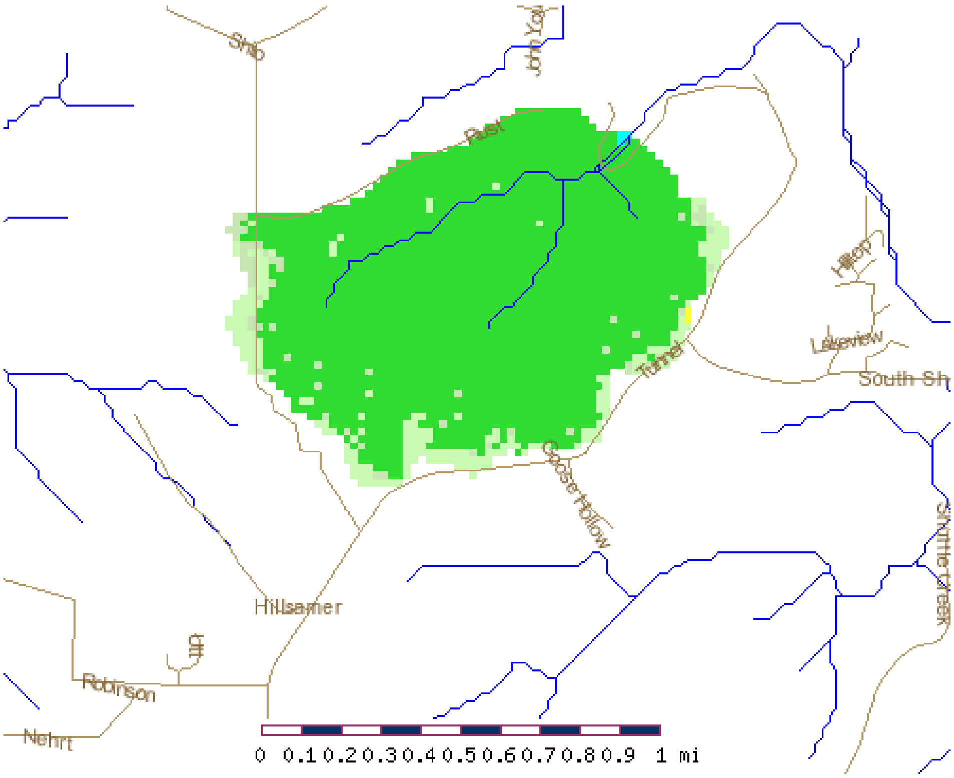

FIGURE 25: RAPID CREEK

The total area of the Rapid Creek sub-watershed is 510 acres. The impervious cover is 9.5 acres or 1.86 %. Total annual runoff volume is estimated at 133.82 acre-feet.

TABLE 25: RAPID CREEK POLLUTANT LOAD

Rapid Creek								
	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	1	0	0	0	0	0	0
Agricultural	C	13	100	29	2433	90	0	59138
Low Density Residential	C	0	1	0	24	15	29	1177
Grass/Pasture	C	46	28	0	41	20	0	828
Forest	C	449	213	3	304	152	0	6088
Total			342	33	2802	277	29	67231
Avg Annual Concentration (ppm)			0.95	0.09	7.81	0.77	0.08	4074

HUC 05120202010050 includes Wolf and Honey Creek (treated as one tributary since they join before the confluence with Bean Blossom Creek), Greasy Creek and Lazy Creek, as well as an un-named tributary near Coyle that flows into Bean Blossom Creek from the South.

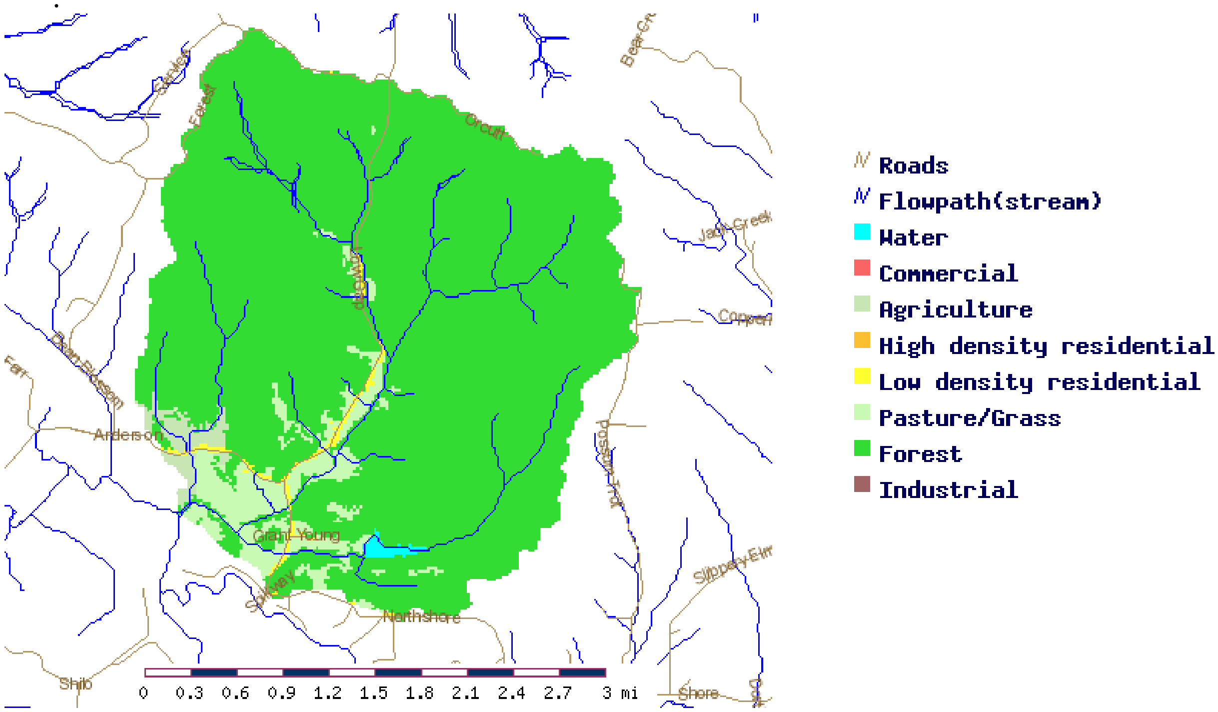

FIGURE 26: WOLF CREEK/HONEY CREEK

The total area of the Wolf Creek/Honey Creek sub-watershed is 5472 acres. Impervious cover is 109.7 acres or 2 %. Total Annual Runoff volume is 1214.7 acre-feet.

TABLE 26: WOLF CREEK/HONEY CREEK POLLUTANT LOAD

Wolf/Honey Crk

	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	20.9	0	0	0	0	0	0
Agricultural	B	79.5	348	102	8471	316	0	205850
Agricultural	C	2.7	20	6	494	18	0	12005
Low Density Residential	B	37.2	45	14	1033	642	1247	50418
Low Density Residential	C	10.8	28	9	651	405	786	31797
Grass/Pasture	B	236.8	54	1	77	38	0	1550
Grass/Pasture	C	127.6	80	1	115	57	0	2301
Forest	B	661.2	85	1	122	61	0	2453
Forest	C	4294.8	2037	29	2910	1455	0	58208
Total		5472	2697	163	13873	2992	2033	364582
Avg Annual Concentration (ppm)			0.83	0.05	4.26	0.92	0.62	2434

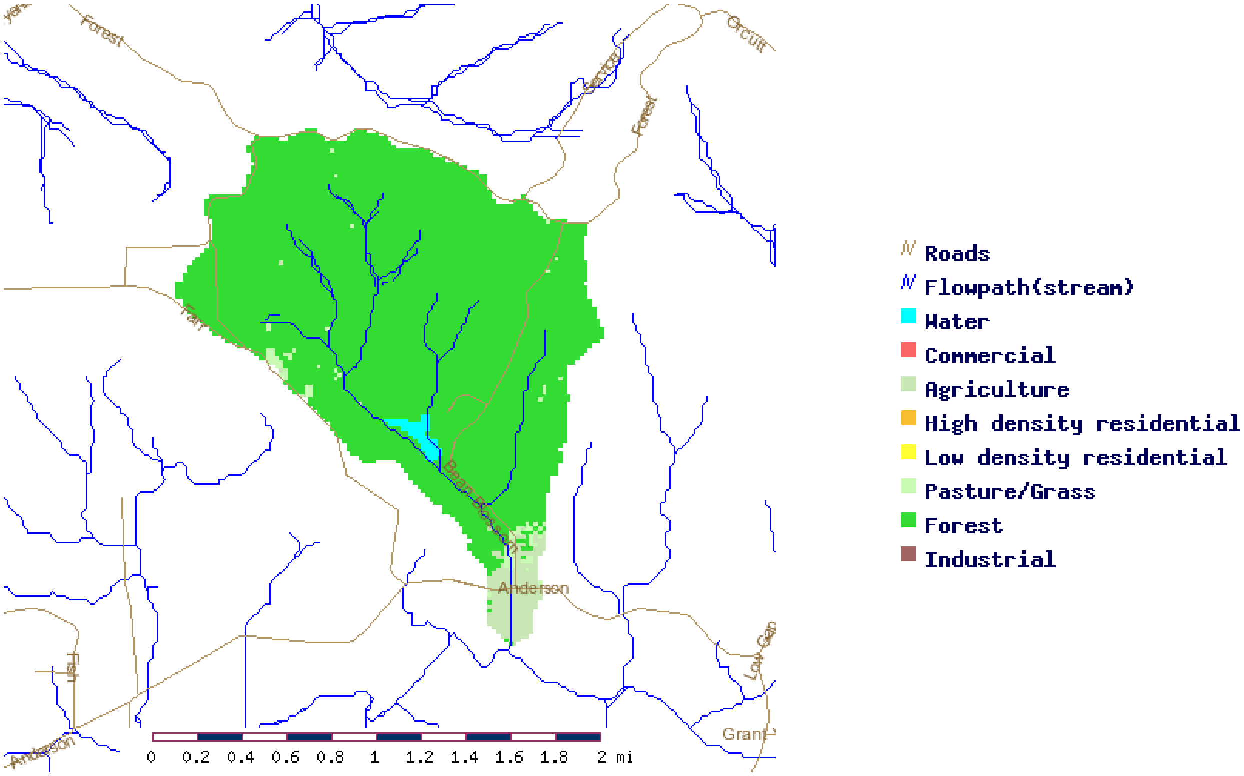

FIGURE 27: GREASY CREEK

The total area of the Greasy Creek sub- watershed **is** 1473 acres. The impervious cover is 27.5 acres or 1.86 %. Total annual runoff volume is estimated at 360.72 acre-ft.

FIGURE 26: GREASY CREEK POLLUTANT LOAD

Greasy Creek								
		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	C	12.5	0	0	0	0	0	0
Agricultural	B	51.3	224	66	5466	204	0	132831
Agricultural	C	0.9	6	2	164	6	0	4001
Grass/Pasture	B	7.6	1	0	2	1	0	49
Grass/Pasture	C	11.8	7	0	10	5	0	212
Forest	B	24.2	3	0	4	2	0	89
Forest	C	1364.6	647	9	924	462	0	18494
Total		1472.9	888	77	6570	680	0	155676
Avg Annual Concentration (ppm)			0.92	0.08	6.79	0.70	0.00	3500.03

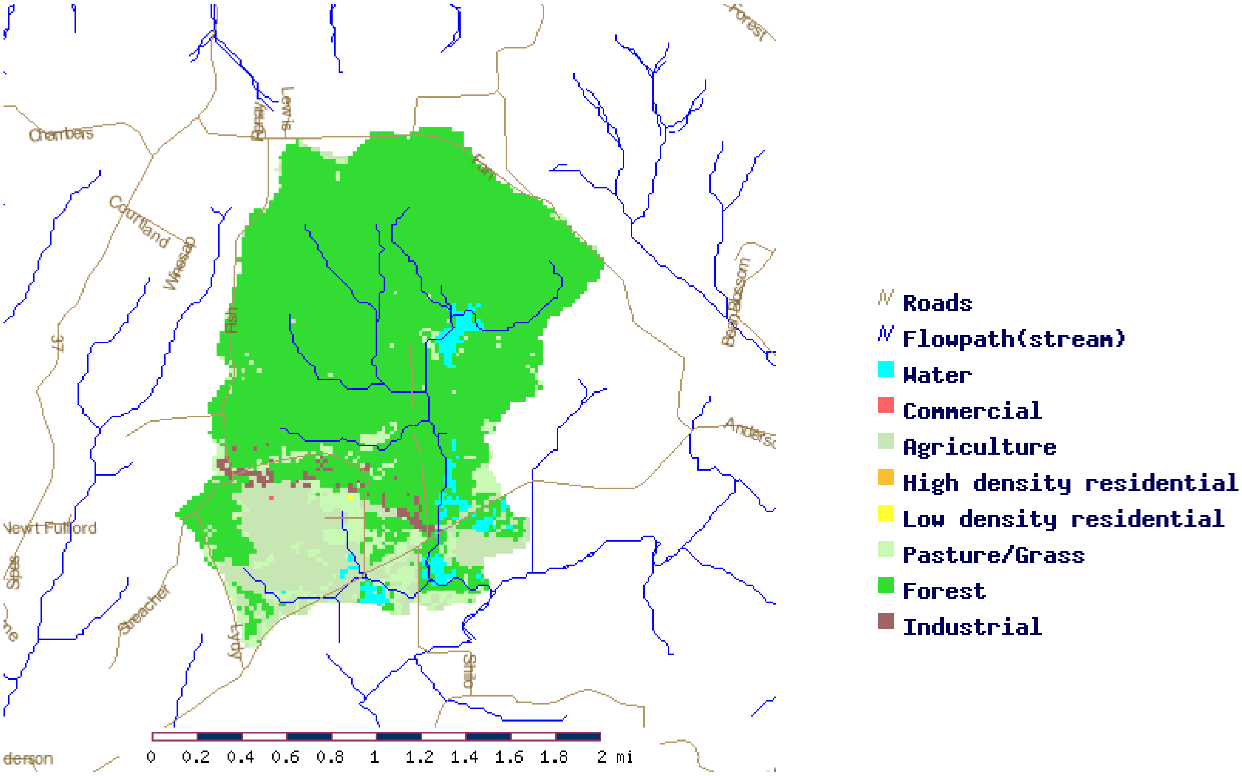

FIGURE 28: LAZY CREEK

The total area is 1850 acres. The impervious cover is 45.1 acres or 2.43 % of the watershed. Total annual runoff volume is estimated at 338.72

TABLE 28: LAZY CREEK POLLUTANT LOAD

		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	39.2	0	0	0	0	0	0
Water/Wetlands	C	6.4	0	0	0	0	0	0
Commercial	B	0.2	1	0	43	17	90	537
Agricultural	B	220.8	967	285	23528	879	0	571720
Agricultural	C	4.4	33	9	805	30	0	19564
Low Density Residential	B	0.2	0	0	5	3	6	271
Grass/Pasture	B	124.2	28	0	40	20	0	813
Grass/Pasture	C	8.3	5	0	7	3	0	149
Forest	B	745.9	96	1	138	69	0	2766
Forest	C	678.7	321	4	459	229	0	
Industrial	B	21.7	75	16	3603	833	2710	57779
		1850	1526	316	28628	2083	2806	662797
			1.68	0.35	31.53	2.29	3.09	15869

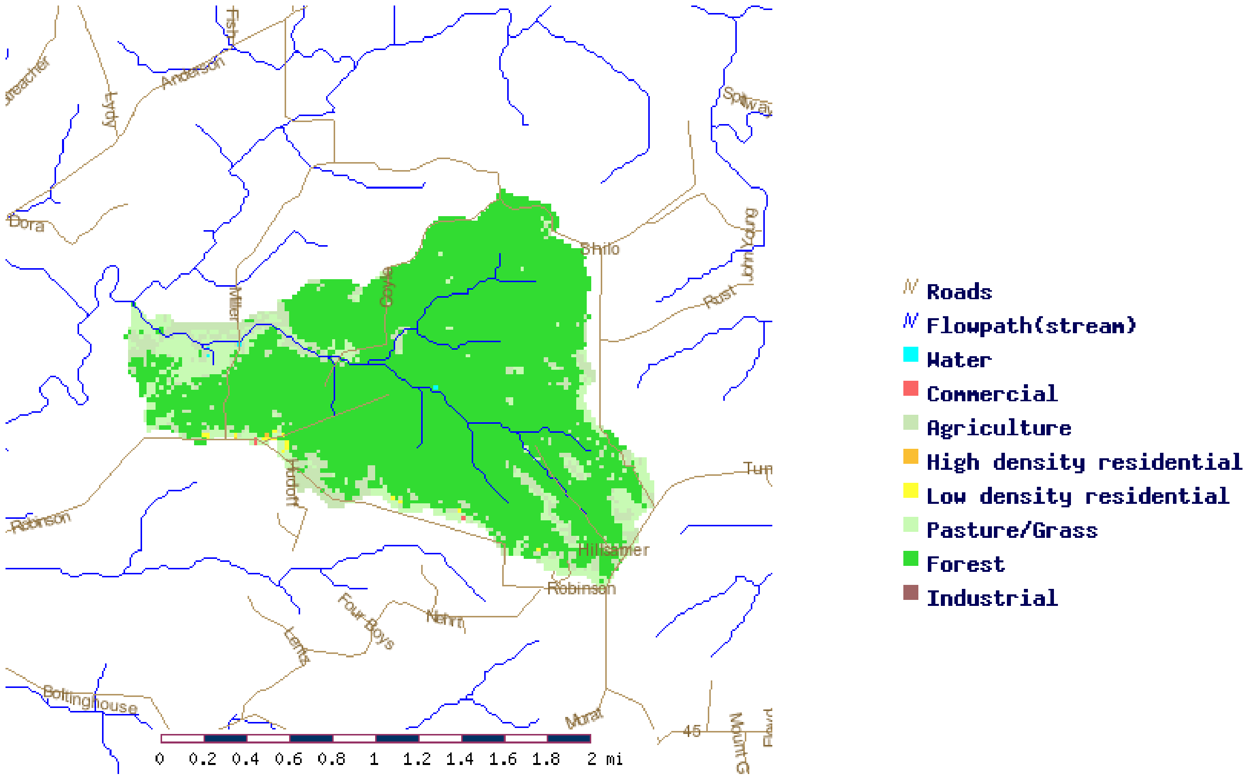

FIGURE 29: UNNAMED TRIBUTARY (NEAR COYLE)

The total area of this un-named tributary is 1595 acres. The impervious cover is 31 acres or 1.94 %. Total annual runoff volume is estimated at 437.43

TABLE 29: UNNAMED TRIBUTARY (NEAR COYLE) POLLUTANT LOAD

Unnamed Trib near Coyle								
	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	0	0	0	0	0	0	0
Water/Wetlands	C	0	0	0	0	0	0	0
Commercial	C	1	4	1	183	76	383	2280
Agricultural	B	34	146	43	3569	133	0	86742
Agricultural	C	106	799	236	19433	726	0	472216
High Density Residential	B	0	2	1	53	33	64	2602
Low Density Residential	C	4	9	3	223	138	269	10893
Grass/Pasture	B	44	10	0	14	7	0	289
Grass/Pasture	C	112	70	1	101	50	0	2022
Forest	B	21	2	0	3	1	0	76
Forest	C	1272	603	8	862	431	0	17242
Total		1595	1645	293	24441	1595	716	594362
Avg Annual Concentration (ppm)			1.40	0.25	20.84	1.36	0.61	11020

HUC 05120202010060 includes Buck Creek flowing southward to the Bean Blossom Creek and Muddy Creek (and Muddy Fork) flowing northward.

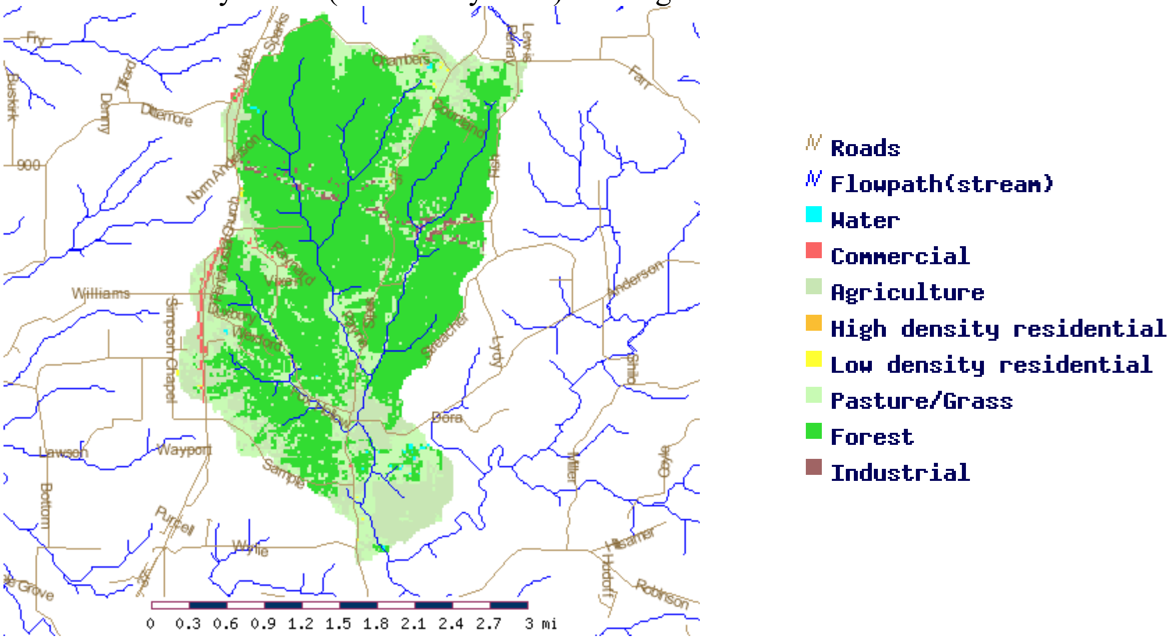

FIGURE 30: BUCK CREEK

The total area of Buck Creek is 4496 acres. The impervious cover is 123 acres or 2.73 % of the watershed. Total annual runoff volume is estimated at 1259.29 acre-ft.

TABLE 30: BUCK CREEK POLLUTANT LOAD

Buck Creek								
Land Use	**Soils**	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	5.4	0	0	0	0	0	0
Water/Wetlands	C	3.9	0	0	0	0	0	0
Commercial	B	22.9	119	28	4949	2051	10344	61533
Commercial	C	2.4	15	3	628	260	1314	7817
Agricultural	B	445.3	1951	576	47451	1773	0	1153022
Agricultural	C	226.7	1705	504	41483	1550	0	1008016
High Density Residential	B	0.2	1	0	17	10	20	842
Low Density Residential	B	2.7	3	1	75	46	90	3659
Low Density Residential	C	4.1	10	3	247	153	298	12071
Grass/Pasture	B	296.4	67	1	97	48	0	1940
Grass/Pasture	C	501.9	316	4	452	226	0	9054
Forest	B	289	37	1	53	26	0	1071
Forest	C	2657	1260	18	1800	900	0	36009
Industrial	B	3	10	2	481	111	362	7721
Industrial	C	35	153	34	7368	1705	5541	118142
Total		4495.6	5647	1175	105101	8859	17969	2420897
Avg Annual Concentration (ppm)			1.67	0.35	31.13	2.62	5.32	15590.908

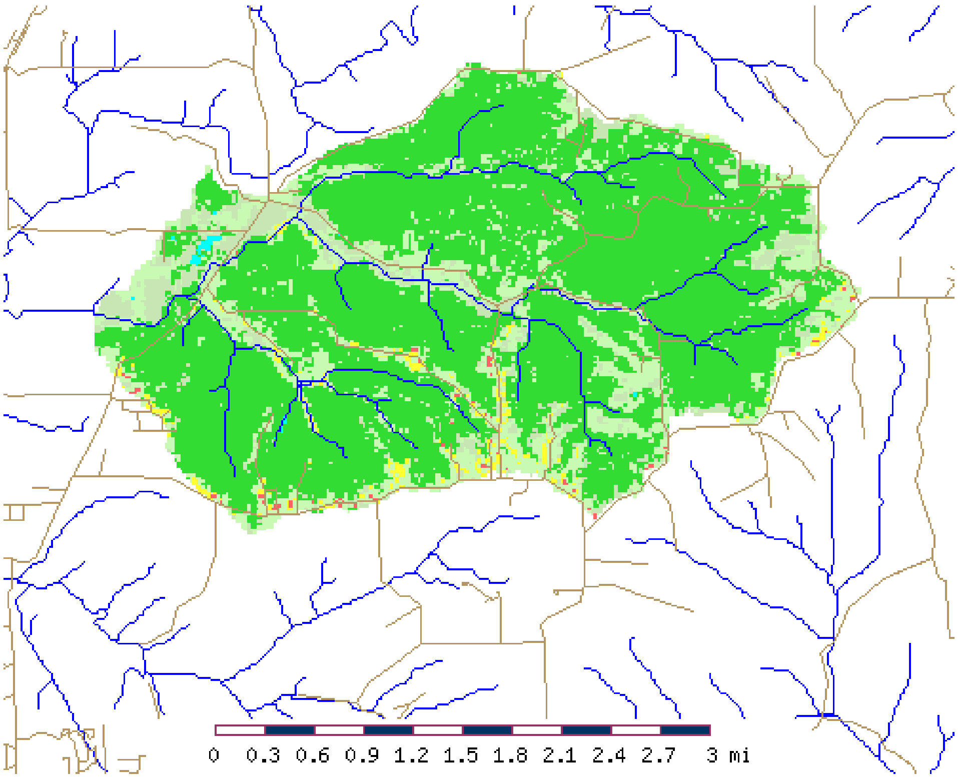

FIGURE 31: MUDDY CREEK

The total area is 5521 acres. The impervious cover is 127.9 acres or 2.31 %. Total annual runoff volume is estimated at 1561.28 acre-feet

TABLE 31: MUDDY CREEK POLLUTANT LOAD

Muddy Creek								
		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	0	0	0	0	0	0	0
Water/Wetlands	C	10	0	0	0	0	0	0
Commercial	B	6	29	6	1210	501	2529	15047
Commercial	C	12	77	18	3222	1335	6735	40065
Agricultural	B	32	141	41	3441	128	0	83634
Agricultural	C	433	3257	962	79216	2961	0	1924881
Low Density Residential	B	18	21	6	486	302	587	23718
Low Density Residential	C	65	175	54	3947	2454	4765	192548
Grass/Pasture	B	96	21	0	31	15	0	627
Grass/Pasture	C	881	556	7	794	397	0	15890
Forest	B	342	44	1	63	31	0	1266
Forest	C	3625	1719	24	2456	1228	0	49136
Total			6040	1119	94866	9352	14616	2346812
Avg Annual Concentration (ppm)			1.44	0.27	22.66	2.23	3.49	12190

HUC 5120202010070 consists of

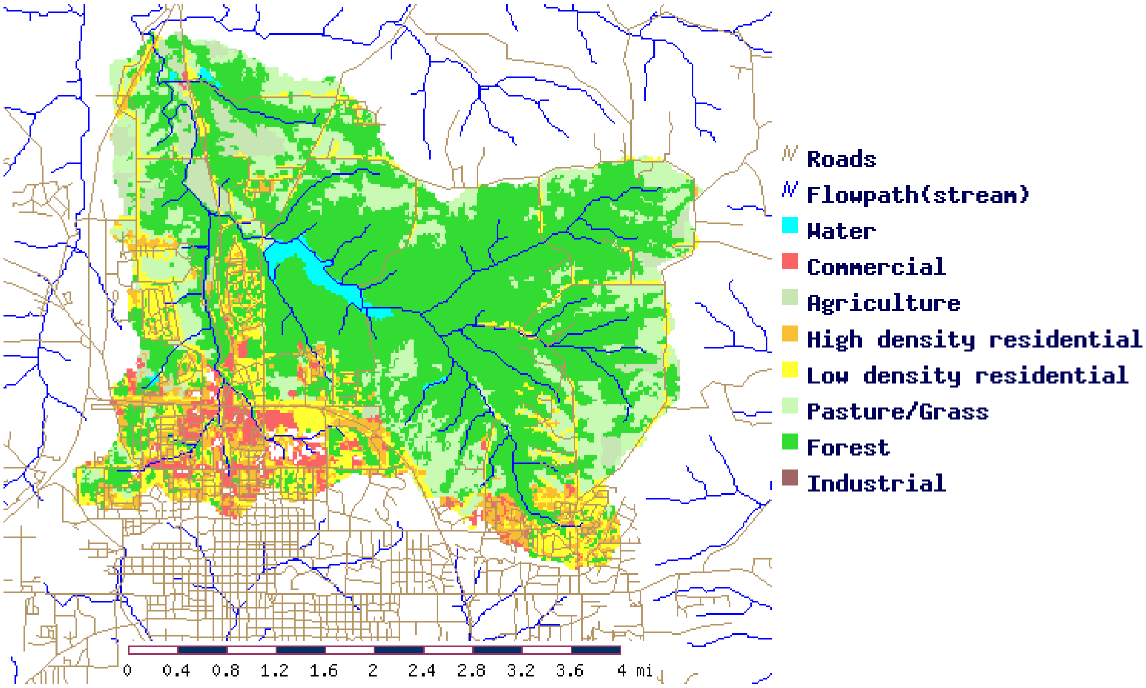

FIGURE 32: GRIFFY CREEK

The total area is 8920 acres. The impervious cover in the watershed is 774.1 acres or 8.67 % of the watershed. Total annual runoff volume is estimated at 2449.3 acre-feet.

TABLE 32: GRIFFY CREEK POLLUTANT LOAD

Griffy								
		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	44	0	0	0	0	0	0
Water/Wetlands	C	79	0	0	0	0	0	0
Commercial	B	322	1681	401	69659	28867	145594	866036
Agricultural	B	303	1327	392	32287	1207	0	784562
Agricultural	C	64	484	143	11784	440	0	286353
High Density Residential	B	663	2543	796	57288	35630	69165	2794574
High Density Residential	C	10	56	17	1280	796	1545	62462
Low Density Residential	B	976	1204	377	27125	16870	32749	1323205
Low Density Residential	C	125	335	105	7568	4707	9137	369199
Grass/Pasture	B	989	226	3	323	161	0	6478
Grass/Pasture	C	573	361	5	516	258	0	10331
Forest	B	2558	332	4	474	237	0	9487
Forest	C	2213	1049	14	1499	749	0	29987
Total		**8920**	9598	2257	209803	89922	258190	6542674
Avg Annual Concentration (ppm)			1.46	0.34	31.950	13.693	39.319	21663.598

HUC 05120202010080 is the Stout's Creek tributary. The total area is 5144 acres. The impervious cover is 324.9 acres or 6.31 %. Total annual runoff volume is estimated at 1302.8 acre-feet.

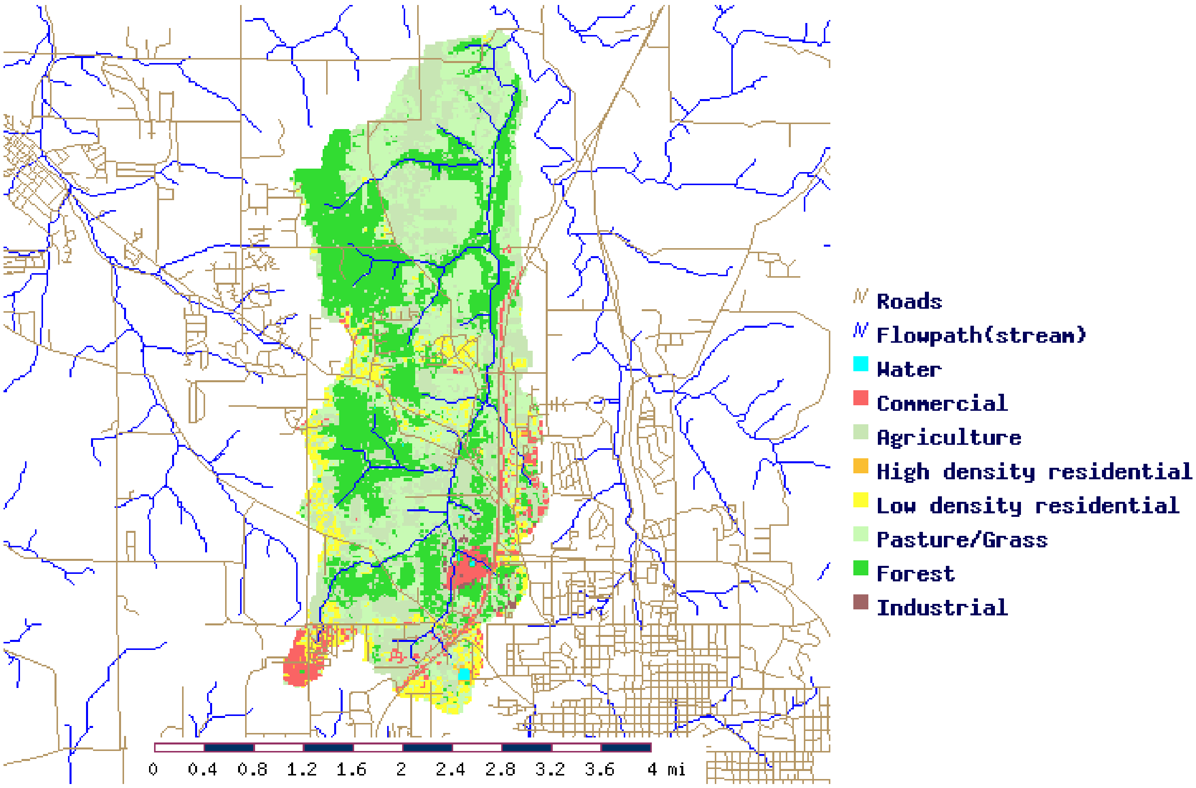

FIGURE AND TABLE 33: STOUT'S CREEK WATERSHED AND POLLUTANT LOAD

Stout's Creek								
		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	8	0	0	0	0	0	0
Water/Wetlands	C	0	0	0	0	0	0	0
Commercial	B	189	987	235	40892	16946	85468	508389
Commercial	C	42	263	62	10925	4527	22835	135830
Agricultural	B	1290	5652	1670	137462	5138	0	3340216
Agricultural	C	62	464	137	11290	422	0	274347
High Density Residential	B	17	63	19	1424	886	1720	69506
High Density Residential	C	2	13	4	293	182	354	14314
Low Density Residential	B	282	347	108	7835	4873	9459	382202
Low Density Residential	C	72	193	60	4351	2706	5253	212274
Grass/Pasture	B	1468	336	4	480	240	0	9614
Grass/Pasture	C	55	34	0	49	24	0	992
Forest	B	1559	202	2	289	144	0	5783
Forest	C	76	36	1	51	25	0	1030
Industrial	B	22	75	16	3603	833	2710	57779
Total		**5144**	8665	2318	218944	36946	127799	5012276
Avg Annual Concentration (ppm)			2.48	0.66	62.68	10.58	36.59	31201

HUC 05120202010090 is the Indian Creek watershed.

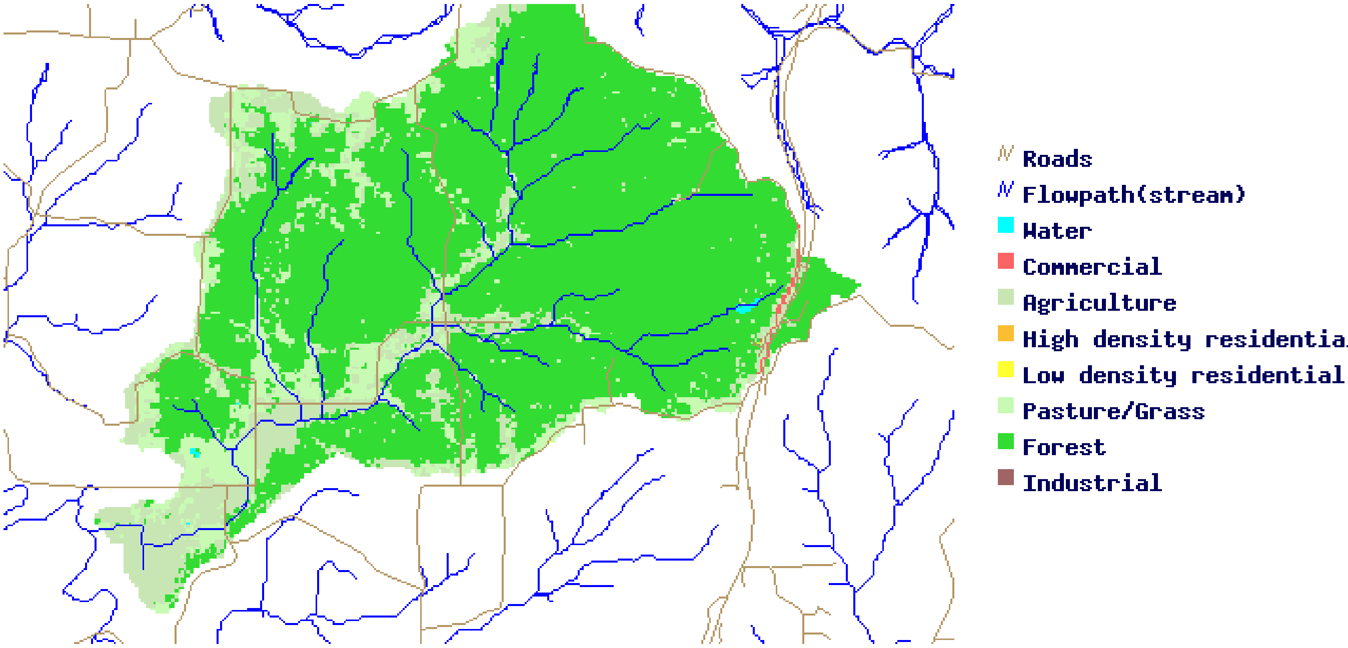

FIGURE 34: INDIAN CREEK

The total area is 5653 acres. The impervious cover is 114.4 acres or 2.02 % of the watershed. Total annual runoff volume is estimated at 1344.26 acre-feet.

TABLE 34: INDIAN CREEK POLLUTANT LOAD

Indian Creek								
	Soils	Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	2	0	0	0	0	0	0
Water/Wetlands	C	3	0	0	0	0	0	0
Commercial	B	3	14	3	583	241	1219	7255
Commercial	C	8	51	12	2122	879	4435	26384
Agricultural	B	553	2421	715	58874	2200	0	1430596
Agricultural	C	223	1674	494	40715	1522	0	989341
Low Density Residential	B	0	0	0	11	6	13	542
Low Density Residential	C	0	1	0	12	7	14	588
Grass/Pasture	B	444	101	1	145	72	0	2907
Grass/Pasture	C	221	139	1	199	99	0	3983
Forest	B	935	121	1	173	86	0	3467
Forest	C	3261	1546	22	2209	1104	0	44198
Total			6068	1249	105043	6216	5681	2509261
Avg Annual Concentration (ppm)			1.68	0.35	29.15	1.72	1.58	15139

HUC 05120202010100. The total area is 13548 acres. The impervious cover is 636.1 acres or 4.69 % of the watershed. Total annual runoff volume is estimated at 4161.81 acre-feet.

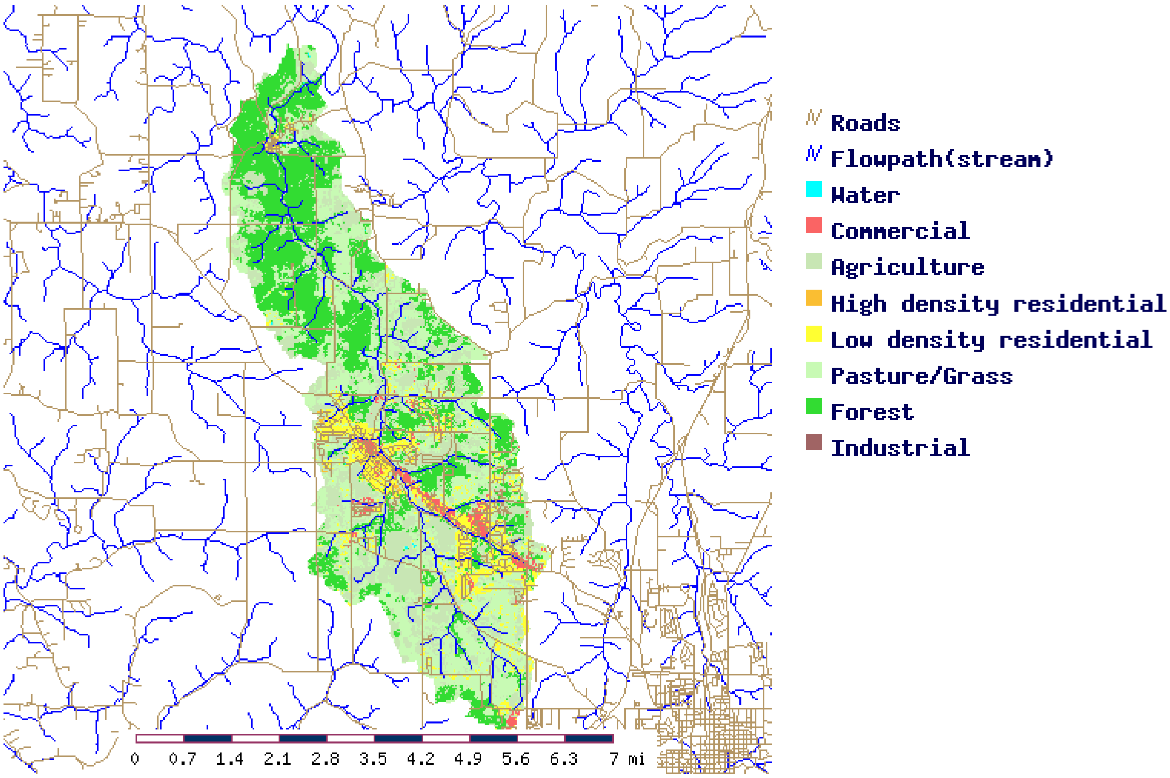

FIGURE 35: JACK'S DEFEAT CREEK

TABLE 35: JACK'S DEFEAT CREEK POLLUTANT LOAD

Jack's Defeat Creek								
		Area (acres)	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
Water/Wetlands	B	10.1	0	0	0	0	0	0
Water/Wetlands	C	2.7	0	0	0	0	0	0
Commercial	B	252	1315	314	54486	22580	113882	677405
Commercial	C	35	218	52	9039	3745	18892	112377
Agricultural	B	1841	8067	2383	196188	7334	0	4767188
Agricultural	C	1477	11112	3283	270239	10102	0	6566561
High Density Residential	B	59	224	70	5051	3142	6099	246431
High Density Residential	C	1	8	2	186	116	225	9109
Low Density Residential	B	858	1057	331	23824	14817	28764	1162192
Low Density Residential	C	308	825	258	18589	11561	22443	906805
Grass/Pasture	B	2291	524	7	749	374	0	14998
Grass/Pasture	C	2212	1396	19	1994	997	0	39898
Forest	B	1583	205	2	293	146	0	5871
Forest	C	2620	1242	17	1775	887	0	35504
Avg Annual Concentration (ppm)			2.35	0.60	52.20	6.79	17.06	28342

TABLE 36A: LAND USE ACREAGE BY TRIBUTARY SUB-WATERSHED

Land Use	Water/ Wetlands	Forest	Grass/ Pasture	Agri-culture	Low Density Res-idential	High Density Res-idential	Comm ercial	Indus trial	Acres
BB East Fork (N&S)	87.6	8289.5	2006.1	395.6	320.8	17.7	3.4	0	11121
Hoppers Branch	4.6	381.3	365.0	83.4	14.5	0.4	0	0	850
North Fork BB Crk	156.8	5108.2	1896.7	1090.5	25.6	0.4	3.9	0	8282
Lick/Bell Creek	62.4	3246.5	493.5	275.1	17.0	0.4	1.4	0.2	4097
Brier Creek	6.1	1396.0	174.1	89.6	0.9	0	0	3.4	1670
Jack /Bear Creek	65.9	4257.0	421.3	186.9	12.1	0	1.9	2.9	4949
Plum Creek	9.1	2402.3	151.4	121.0	3.7	0	0.2	0	2688
Shuffle Creek	0.0	1259.7	203.2	71.6	1.7	0	3.9	0	1540
Rapid Creek	0.7	449.2	45.9	13.3	0.4	0	0	0	510
Wolf/Honey Creek	20.9	4956.0	364.4	82.2	48.0	0	0	0	5472
Greasy Creek	12.5	1388.8	19.4	52.2	0.0	0	0	0	1473
Lazy Creek	45.6	1424.6	132.5	225.2	0.2	0	0.2	21.7	1851
Unnamed Trib	0.8	1292.9	156.3	139.7	3.7	0.4	0.7	0	1595
Buck Creek	9.3	2945.8	798.3	672.0	6.8	0.2	25.3	37.9	4496
Muddy Creek	10.7	3967.0	976.6	465.2	82.9	0	17.9	0	5521
Griffy Creek	122.9	4770.7	1562.1	367.4	1101.7	673.0	322.3	0	8920
Stout's Creek	8.1	1635.3	1523.4	1351.7	354.1	18.7	230.9	21.7	5144
Indian Creek	5.3	4195.9	664.9	775.0	0.6		10.8	0	5653
Jack's Defeat Creek	12.8	4202.6	4502.2	3317.9	1165.5	59.9	286.6	0	13548
	642.1	57569.3	16457.3	9775.5	3160.2	771.1	909.4	87.8	

TABLE 36B: LAND USE PERCENTAGE IN TRIBUTARY SUB-WATERSHEDS

	Water/ Wetland	% Forest	% Grass/ Pasture	% Agric	% Low Density Res-idential	% High Density Res-idential	% Comm ercial	% Industri al
BB East Fork (N&S)	0.8	74.5	18.0	3.6	2.9	0.2	0.0	0.0
Hoppers Branch	0.5	44.9	42.9	9.8	1.7	0.0	0.0	0.0
North Fork BB Crk	1.9	61.7	22.9	13.2	0.3	0.0	0.0	0.0
Lick/Bell Creek	1.5	79.2	12.0	6.7	0.4	0.0	0.0	0.0
Brier Creek	0.4	83.6	10.4	5.4	0.1	0.0	0.0	0.2
Jack /Bear Creek	1.3	86.0	8.5	3.8	0.2	0.0	0.0	0.1
Plum Creek	0.3	89.4	5.6	4.5	0.1	0.0	0.0	0.0
Shuffle Creek	0.0	81.8	13.2	4.6	0.1	0.0	0.3	0.0
Rapid Creek	0.1	88.1	9.0	2.6	0.1	0.0	0.0	0.0
Wolf/Honey Creek	0.4	90.6	6.7	1.5	0.9	0.0	0.0	0.0
Greasy Creek	0.8	94.3	1.3	3.5	0.0	0.0	0.0	0.0
Lazy Creek	2.5	77.0	7.2	12.2	0.0	0.0	0.0	1.2
Unnamed Trib	0.1	81.1	9.8	8.8	0.2	0.0	0.0	0.0
Buck Creek	0.2	65.5	17.8	14.9	0.2	0.0	0.6	0.8
Muddy Creek	0.2	71.9	17.7	8.4	1.5	0.0	0.3	0.0
Griffy Creek	1.4	53.5	17.5	4.1	12.4	7.5	3.6	0.0
Stout's Creek	0.2	31.8	29.6	26.3	6.9	0.4	4.5	0.4
Indian Creek	0.1	74.2	11.8	13.7	0.0	0.0	0.2	0.0
Jack's Defeat Creek	0.1	31.0	33.2	24.5	8.6	0.4	2.1	0.0

Table 36A presents the actual acreage in each land use, whereas Table 36B presents the same information as a percentage of the sub-watershed acreage in each land use category. As forest land is converted to other uses, water quality impacts are expected to increase. A small but growing portion of the watershed is becoming urbanized. As discussed previously, impervious surface has a tremendous impact on runoff rates and water quality.

Table 37 below summarizes the predicted pollutant load from each land use, totaled over all the major tributary sub-watersheds of Bean Blossom Creek. The results reflect the amount of land devoted to each land use in the watershed, but they also reflect the inherent assumptions of the L-THIA model which assigns load per acre for each land use based on literature values. Most of the watershed is devoted to forest, but the second most common land use is agricultural and it has a proportionately large impact on water quality. Residential uses account for only a small percentage of the watershed area, but have a large impact on fecal coliform levels.

In Figure 36 below, the land use of tributary sub-watersheds is presented graphically from east to west, upstream to downstream order. All of the watersheds retain significant forested areas. Only the Griffy Creek watershed has appreciable high density residential area, but Griffy, Stout's and Jack's Defeat all have relatively high percentages of land are devoted to low density rural residential areas.

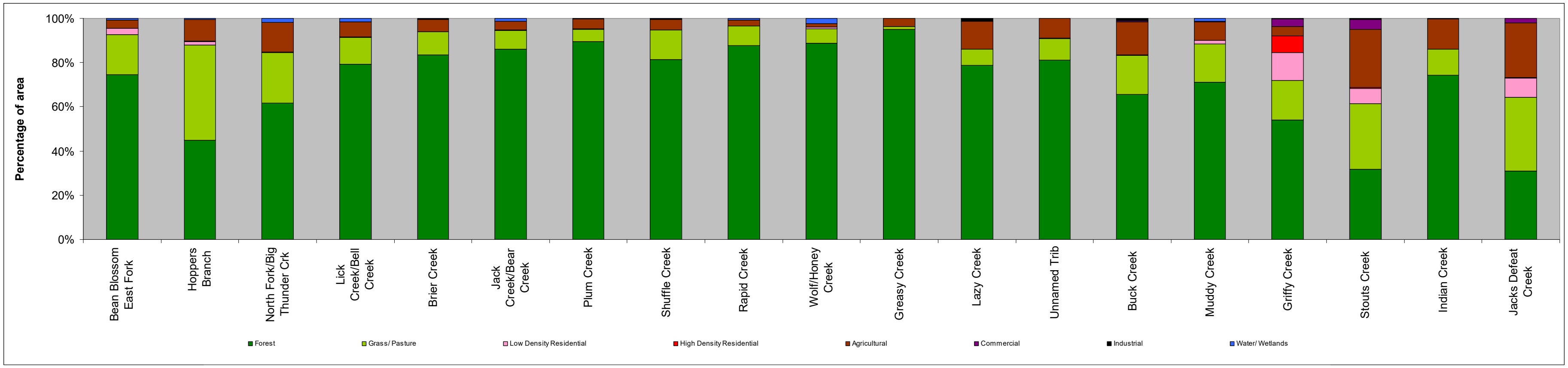

FIGURE 36: BAR CHART COMPARING LAND USE IN TRIBUTARY SUB-WATERSHEDS.

TABLE 37: IMPERVIOUS ACREAGE BY TRIBUTARY SUB-WATERSHED

	Acres	Acres Impervious	% Impervious Surface
BB East Fork	11121	261.3	2.3
Hoppers Branch	850	17.9	2.1
North Fork/Big Thunder	8282	160.5	1.9
Lick Creek/Bell Creek	4097	79.9	2.0
Brier Creek	1670	33.4	2.0
Jack Creek/Bear Creek	4949	96.9	2.0
Plum Creek	2688	51.2	1.9
Shuffle Creek	1540	32.0	2.1
Rapid Creek	510	9.5	1.9
Wolf Creek/Honey Creek	5472	109.7	2.0
Greasy Creek	1473	27.5	1.9
Lazy Creek	1851	45.1	2.4
Unnamed Trib near Coyle	1595	31.0	1.9
Buck Creek	4496	123.0	2.7
Muddy Creek	5521	127.9	2.3
Griffy Creek	8920	774.1	8.7
Stout's Creek	5144	324.9	6.3
Indian Creek	5653	114.4	2.0
Jack's Defeat Creek	13548	636.1	4.7
Totals	89380	3056	3.4

Impervious surface has major impacts on stormwater runoff and water quality. Table 37 shows the estimated impervious surface in each tributary sub-watershed based on typical imperviousness for each land use. At 10% imperviousness, water quality impairments are expected. Rapid Creek, Indian Creek and Jack's Defeat Creek (highlighted) have the highest percentage of impervious surface but none has yet reached the critical 10% imperviousness according to this analysis. Note that L-THIA may be underestimating impervious surfaces since the data are based on 1992 Land Sat data. For comparison, the 2006 Stout's Creek study found more than 11% impervious surface. The Griffy Creek watershed, with the largest land area devoted to high density residential use, has the highest impervious cover.

TABLE 38: POLLUTANT LOAD BY LAND USE

	Acres	Nitrogen (Lbs)	Phosphorus (Lbs)	TSS (Lbs)	BOD (Lbs)	COD (Lbs)	Fecal (per 100 ml)
Commercial	909.4	4864	1155	201788	83619	421766	2,508,834
Agricultural	16,457.3	58,304	17,219	1,418,172	52,976	0	34,460,601
High Density Residential	771.1	3020	943	68111	42329	82234	3,322,810
Low Density Residential	3160.2	5311	1660	119923	74033	144782	5,850,330
Grass/Pasture	9775.5	7962	105	11385	5520	0	227,955
Forest	57569.3	24112	334	34449	17217	0	680,054
Industrial	87.8	340	73	16422	3797	12351	263,360
Total		103913	21489	1870250	278946	661133	47,313,944

In Table 38, we record the L-THIA estimates for pollutant load by land use activity for the entire Bean Blossom watershed. These results indicate that agricultural land use is likely to be responsible for the largest impacts in terms of nitrogen, phosphorus, total suspended solids (TSS), and fecal contamination while residential land uses are likely having the greatest impacts in terms of biological oxygen demand (BOD). Chemical oxygen demand (COD) is contributed by both commercial and low density residential development. Low density residential land use is also a major factor in fecal coliform loading.

TABLE 39: ESTIMATED POLLUTANT LOAD BY TRIBUTARY SUB-WATERSHED

	Acres	Nitrogen (lbs)	Phosphorus (lbs)	TSS (lbs)	BOD (lbs)	COD (lbs)	Fecal (millions of coliform)
BB East Fork	11120	9158	1259	102428	20297	28087	2978295
Hoppers Branch	850	1077	203	16776	3110	1120	427879
North Fork BB/Big Thunder	8282	11919	2502	207340	11460	4064	5043010
Lick Creek/Bell Creek	4097	3977	654	54472	4035	2099	1334015
Brier Creek	1670	1461	213	18267	1361	603	434589
Jack Creek/Bear Creek	4949	3747	460	39301	3711	2380	947943
Plum Creek	2688	2154	289	24179	1867	378	584858
Shuffle Creek	1540	1291	174	15261	1492	2258	356813
Rapid Creek	510	342	33	2802	277	29	67231
Wolf Creek/Honey Creek	5472	2697	163	13873	2992	2033	364582
Greasy Creek	1473	888	77	6570	680	0	155676
Lazy Creek	1851	1526	316	28628	2083	2806	662797
Unnamed Trib near Coyle	1595	1645	293	24441	1595	716	594362
Buck Creek	4496	5647	1175	105101	8859	17969	2420897
Muddy Creek	5521	6040	1119	94866	9352	14616	2346812
Griffy Creek	8920	9598	2257	209803	89922	258190	6542674
Stout's Creek	5144	8665	2318	218944	36946	127799	5012276
Indian Creek	5653	6068	1249	105043	6216	5681	2509261
Jack's Defeat Creek	13548	26193	6738	582413	75801	190305	14544339
Total	89380	104093	21491	1660705	189024	402943	37936859

We used the L-THIA to estimate pollutant loads and concentrations by sub-watershed, as shown in Tables 39 and 40. Highest nitrogen loads are predicted from the North Fork of Bean Blossom and from Jack's Defeat. These also have the highest phosphorous loading, along with Griffy and Stout's Creek. Total suspended solids contribution above Lake Lemon is highest in the East Fork and the North Fork of Bean Blossom Creek, the two largest sub-watersheds. Below Lake Lemon, several tributaries contribute high TSS loads to the White River. In the upper watershed, the East Fork has the highest contribution of BOD, COD and Fecal coliform while in the lower watershed, Griffy Stout's Creek and Jack's Defeat stand out with high BOD and COD but all the sub-watersheds Buck Creek on downstream are expected to have high fecal coliform counts.

TABLE 40: POLLUTANT LOAD CORRECTED FOR SUB-WATERSHED SIZE

	Nitrogen lbs/acre	Phosphorus lbs/acre	TSS/ Acre	BOD /Acre	COD/ Acre	Fecal coliform (millions) /acre
BB East Fork	0.82	0.11	9.21	1.83	2.53	268
Hoppers Branch	1.27	0.24	19.74	1.32	1.32	503
North Fork BB/Big Thunder Crk	1.44	0.30	25.03	1.38	0.49	609
Lick Creek/Bell Creek	0.97	0.16	13.29	0.98	0.51	326
Brier Creek	0.87	0.13	10.94	0.81	0.36	260
Jack Creek/Bear Creek	0.76	0.09	7.94	0.75	0.48	192
Plum Creek	0.80	0.11	8.99	0.69	0.14	218
Shuffle Creek	0.84	0.11	9.91	0.97	1.47	232
Rapid Creek	0.67	0.06	5.50	0.54	0.06	132
Wolf Creek/Honey Creek	0.49	0.03	2.54	0.55	0.37	67
Greasy Creek	0.60	0.05	4.46	0.46	0.00	106
Lazy Creek	0.82	0.17	15.47	1.13	1.52	358
Unnamed Trib near Coyle	1.03	0.18	15.33	1.00	0.45	373
Buck Creek	1.26	0.26	23.38	1.97	4.00	538
Muddy Creek	1.09	0.20	17.18	1.69	2.65	425
Griffy Creek	1.08	0.25	23.52	10.08	28.95	733
Stout's Creek	1.68	0.45	42.56	7.18	24.84	974
Indian Creek	1.07	0.22	18.58	1.10	1.00	444
Jack's Defeat Creek	1.93	0.50	42.99	5.60	14.05	1074

In Table 40, we report pollutant load per acre to determine if some sub-watersheds contribute a disproportionate share of the overall load when corrected for size. This gives an idea of which watersheds may be contributing a larger share of pollutant load for their size, but it must be remembered that these figures represent an averaging over all the land uses (and land area) in the sub-watershed.

Results indicate that watersheds for the North Fork Bean Blossom Creek, Griffy Creek, Stout's Creek and Jack's Defeat Creek have highest coliform contributions per acre (loads). In the North Fork watershed this can be attributed to high percentage of land in row crops on steep slopes. Stout's Creek and Jack's Defeat watersheds have a high percentage of land converted from forest to agriculture while in the Griffy Creek watershed forested land has bee converted to low density residential use.

Even when corrected for size, the largest sediment loads above Lake Lemon are from the North Fork of Bean Blossom Creek and Hoppers Branch, consistent with earlier reports using the Agriculture Nonpoint Source Model (AGNP) to predict stormwater runoff from a given storm event.[71] That study reported lowest sediment yields from Big Thunder Creek, Possum Trot Creek, Bear Creek and Plum Creek, even though Plum Creek and Possum Trot Creek are reported to have severe streambank erosion problems. Tributaries downstream from Lake Lemon were not included in that study.

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[71] Lake Lemon T by 2000 Feasibility Study. 1992. William W. Jones and Louise Clemency. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf

Table 41: ESTIMATED POLLUTANT CONCENTRATION BY SUB-WATERSHED

	Nitrogen ppm	Phos phorus ppm	TSS ppm	BOD ppm	COD ppm	Fecal coliform per 100 ml
BB East Fork	1.09	0.15	12.18	2.41	3.34	7703
Hoppers Branch	1.47	0.28	22.93	2.42	1.53	12713
North Fork BB/Big Thunder	1.73	0.36	30.07	1.66	0.59	15901
Lick Creek/Bell Creek	1.30	0.21	17.80	1.32	0.69	9476
Brier Creek	1.18	0.17	14.81	1.10	0.49	7658
Jack Creek/Bear Creek	1.06	0.13	11.17	1.05	0.68	5856
Plum Creek	1.12	0.15	12.58	0.97	0.20	6615
Shuffle Creek	1.13	0.15	13.30	1.30	1.97	6763
Rapid Creek	0.95	0.09	7.81	0.77	0.08	4074
Wolf Creek/Honey Creek	0.83	0.05	4.26	0.92	0.62	2434
Greasy Creek	0.92	0.08	6.79	0.70	0.00	3500
Lazy Creek	1.68	0.35	31.53	2.29	3.09	15869
Unnamed Trib near Coyle	1.40	0.25	20.84	1.36	0.61	11020
Buck Creek	1.67	0.35	31.13	2.62	5.32	15591
Muddy Creek	1.44	0.27	22.66	2.23	3.49	12190
Griffy Creek	1.46	0.34	31.95	13.69	39.32	21664
Stout's Creek	2.48	0.66	62.68	10.58	36.59	31201
Indian Creek	1.68	0.35	29.15	1.72	1.58	15139
Jack's Defeat Creek	2.35	0.60	52.20	6.79	17.06	28342

L-THIA predicts concentrations based on calculated runoff volumes, which are in turn estimated from rainfall, soil type and % imperviousness associated with a given land use. While the watershed modeling of pollutant loads predicts high levels of fecal coliform, it is difficult to compare these with E. coli standards. According to the TMDL for Bean Blossom Creek, about 80% of total coliforms are E. coli. Instead, the L-THIA numbers for fecal coliforms are an order of magnitude higher than the E. coli sampling data. This emphasizes the importance o f using the L-THIA tool as a tool for comparison of relative pollutant contributions only.

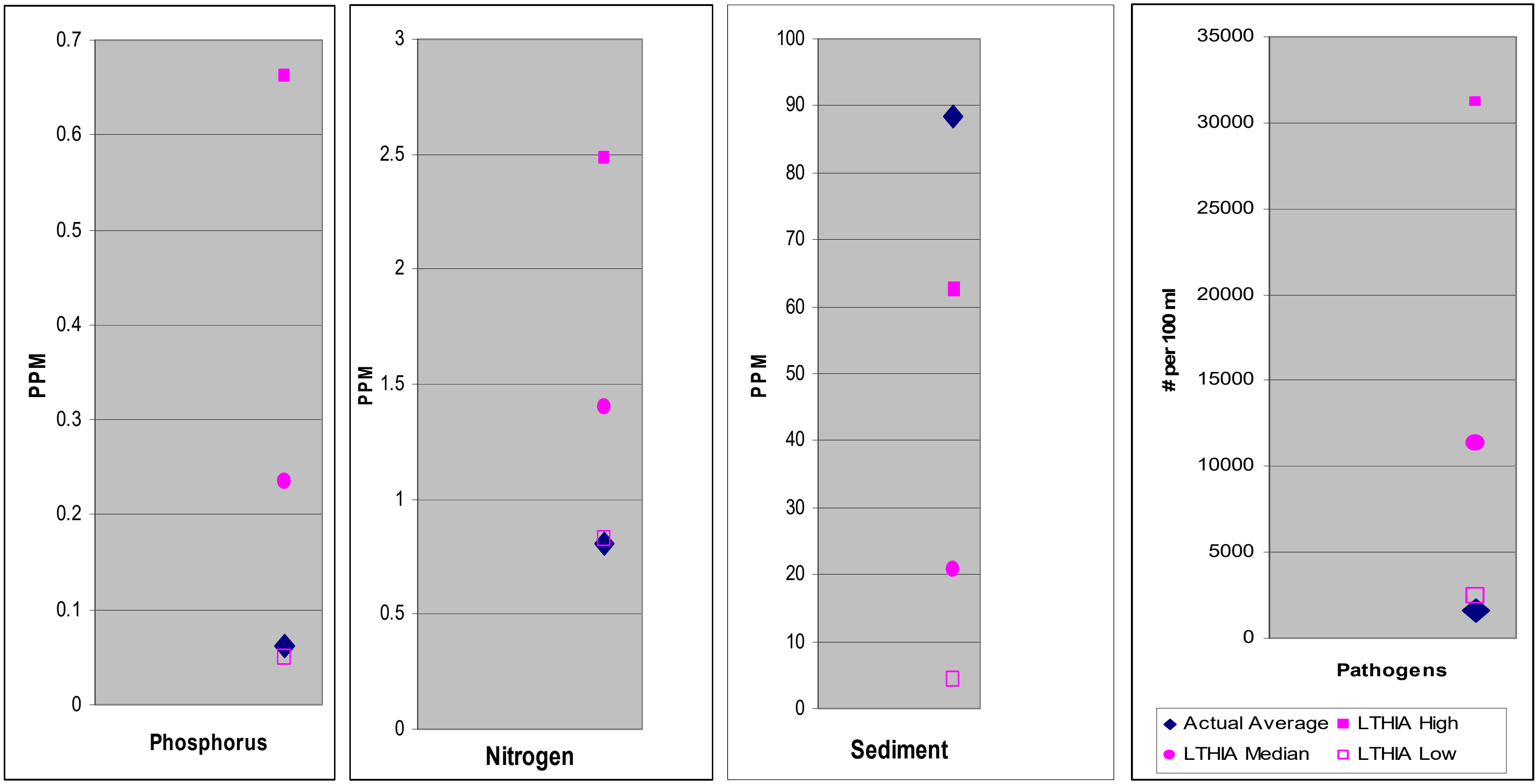

FIGURE 37: COMPARING L-THIA PREDICTIONS WITH MEDIAN VALUES TO REAL-WORLD DATA FROM WATER QUALITY MONITORING. This figure shows the range of values that L-THIA predicts in the tributary sub-watersheds (pink symbols) superimposed on the average concentrations from the water quality monitoring data (dark diamonds). L-THIA results seem to over-estimate phosphorus, nitrogen and pathogens but underestimate sediment loads. In spite of this, the L-THIA tool seems useful for comparing relative contributions from sub-watersheds based on land use.

6.0 Identifying Specific Pollution Sources and Critical Areas

The steering committee reviewed available data and identified pollution sources and critical areas or audiences for each of the identified problem. It should be noted that there is far more data available for some sub-watersheds than for others. For example, both Griffy Lake and Lake Lemon have been the subject of some fairly detailed studies. As part of their MS4 planning, the Monroe County Planning Department has done a detailed watershed analysis for Stout's Creek. They did a land use assessment of each parcel, so there is more, up-to-date information on land use in this sub-watershed than any other. For most of the tributary sub-watersheds of Bean Blossom Creek, this level of detail does not exist.

A visual tour of the watershed complemented the water quality data and the L-THIA model. As part of our watershed assessment, we also developed a virtual tour of the watershed using Google Earth. The aerial photography is particularly useful for identifying areas where riparian buffers might be useful. The table below summarizes some of our findings based on the virtual tour and observations made on the ground through windshield surveys of the watershed. For more detailed information, please see the sections on critical areas below and take the virtual tour of the watershed at www.hecweb.org.

TABLE 42: VISUAL ASSESSMENT OF THE BEAN BLOSSOM WATERSHED

Site	Location	Observations
1	Robinson Rd.	Privately owned logging site with sediment runoff
2	Gatesville Rd. Just east of Bean Blossom	cattle in stream
3	Gatesville Rd. Just east of Bean Blossom	small lake with septics
4	Gatesville Rd. Just east of Bean Blossom	erosion
5	Upper Bean Blossom Rd. near Parsley Rd.	32 cattle in creek
6	Upper Bean Blossom Rd. near Parsley Rd.	New homes on 2.5 acre lots
7	Upper Bean Blossom Rd. after Webber Rd.	large dump in ravine
8	Spearsville Rd. through Spearsville	lots of small ponds, pasture
9	Hurdle Rd. intersection	lots of bare soil from ATV tracks
10	Hurdle Rd. intersection	3 horses
11	Homestead Rd.	Cattle operation
13	Lick Creek Rd	more row crops
14	Lick Creek Rd	creek has streambank erosion, undercut banks
15	Branstrator Rd	Camp Waycross
16	Trevlac	Flooding/old homes on small lots next to creek
17	South Shore Drive after Riddle Point Park	Sheep and horses
18	East Robinson Rd. before Murat Rd.	Cows in Creek
19	Muddy Fork	50+ cows in creek
20	Dolan Rd.	10 cows in creek
21	Bottom Rd.	Cropping right up to streambank
22	Bottom Rd.	narrow treeline on banks (1 row of trees)
23	Bottom Rd.	Erosion
24	Bottom Rd.	cornfields
25	Bottom Rd after 90degree turn	overgrazing
26	Bottom Rd after 90degree turn	Cows in Creek
27	Bottom Rd after 90degree turn	Cows in Creek
28	Prather Rd	Logging
30	Jack's Defeat	Oolitic Park
31	Texas Ridge Rd	Junk yard
31	46 west of Smithville	buffalo, horses
32	37 north by Oliver Winery	junk yard
34	Monroe County, Cowden Rd. at Delap Rd.	Horses
35	Monroe County, Cowden Rd. at Delap Rd.	Erosion
38	Anderson Rd.	Cows in Creek
39	Anderson Rd at Fish Rd.	50 cows in Creek
41	N Old 37 North	20 cows in creek
42	Miller Rd. btwn Anderson Rd and Shilo	pasture and wetland
43	Lentz Rd.	horses right next to creek
44	Earl Young Rd.	Erosion - Driving through creek
45	Boltinghouse Rd.	Creek runs right through cattle feeding area.
46	Boltinghouse Rd.	No trees on north side of creek.
47	Old 37 at Muddy Fork just N. of Old Meyers Rd.	Erosion
48	Little Horse Rd.	pasture and wetland
49	Upstream of Cascades	quarry

FIGURE 38: COWS IN THE CREEK AERIAL VIEW. Cows in the creek are a common site in the Bean Blossom watershed, a situation that contributes to pathogen and erosion problems. This aerial view shows cows standing in creek (center), cow paths leading to creek and bank erosion at access points (upper portion of photo).

FIGURE 39: FEEDLOT PATHOGENS AND SEDIMENT. Tributary runs through barnyard area. It is heavily trampled and completely devoid of vegetation. About 30 cows were visible in the distance when this photo was taken. This is a critical area for pathogens and sediment.

FIGURE 40: FEEDLOT PATHOGENS AND SEDIMENT AERIAL VIEW. This aerial view of the previous image location shows the intermittent stream running through barnyard area, creating a pathogen contamination problem as well as erosion issues.

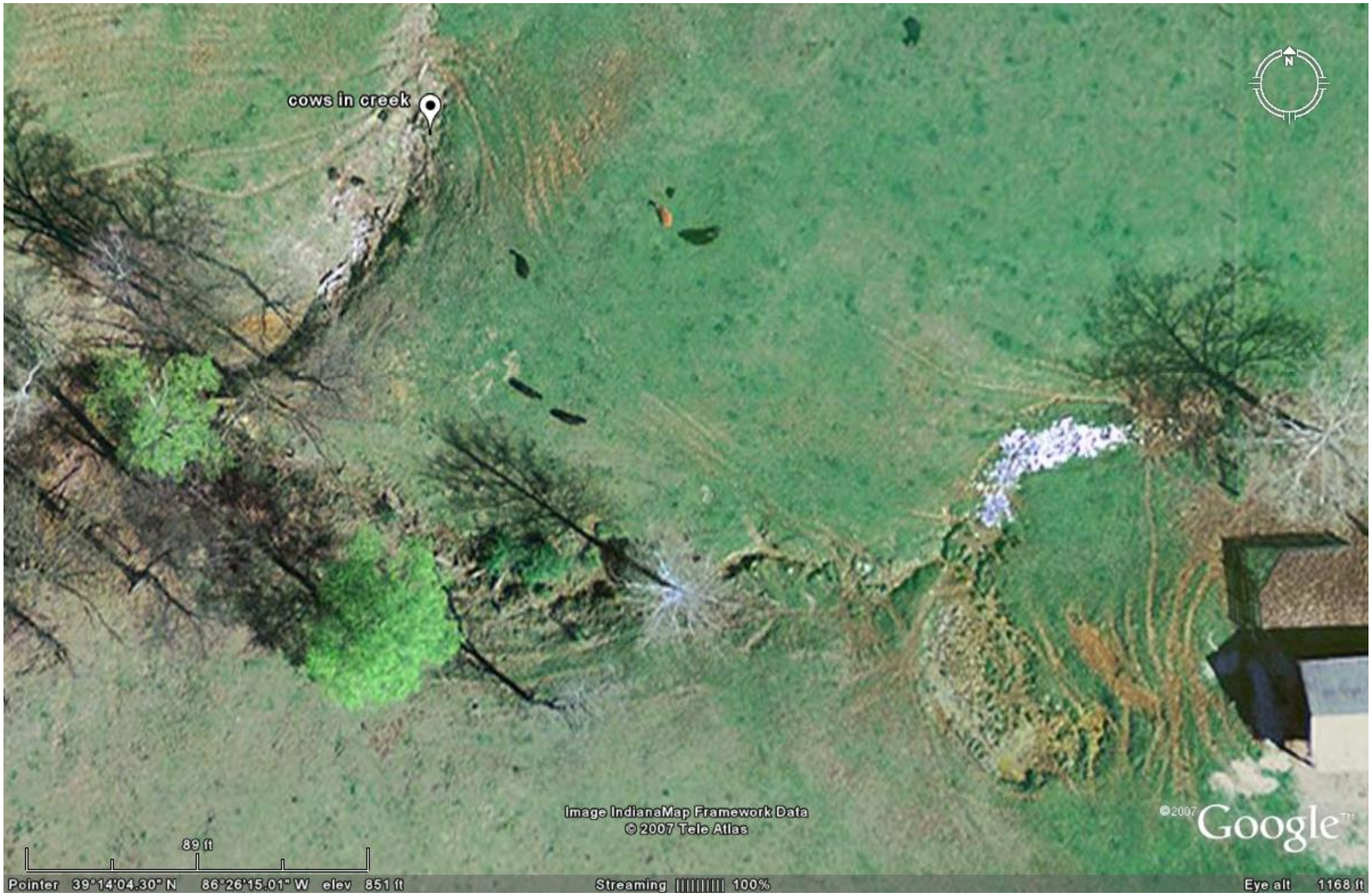

FIGURE 41: COWS IN THE CREEK CAUSE EROSION. Cows have clearly contributed to streambank erosion in this location.

FIGURE 42: STREAMBANK EROSION ON BEAN BLOSSOM CREEK. This view of Bean Blossom Creek near the village of Bean Blossom clearly shows streambank erosion. Note exposed tree roots and leaning tree. This is very common along Bean Blossom mainstem.

FIGURE 43: THE VILLAGE OF BEANBLOSSOM. A regional Sewer District has been formed to address failing septic systems in the village of Beanblossom and the Beanblossom Trailer Court. The Bill Monroe Music Campground hauls wastewater away from the site; waste is treated with lime to reduce pathogens before spreading on nearby farmland.

FIGURE 44: EAST END OF LAKE LEMON. Intense residential use includes the Chitwood Addition, Aqua Isle, and Trevlac. The small lots and high water tables make this a critical area for septic systems. Erosion is a serious problem here too.

FIGURE 45: AQUA ISLE. A closer view of small lots along the Aqua Isle portion of Bean Blossom Creek.

FIGURE 46: DEVELOPMENT ENCROACHES ON GRIFFY LAKE.

FIGURE 47: STREAMBANK EROSION ON JACK'S DEFEAT CREEK. Jack's Defeat Creek lacks tree canopy near Ellettsville. Note streambank erosion developing on the left bank.

FIGURE 48: CONSTRUCTION DEBRIS ON JACK'S DEFEAT CREEK. Construction debris has been used to help stop bank erosion on Jack's Defeat Creek. This common practice is unsightly and creates hazards for recreational users.

FIGURE 49: SEDIMENT ENTERING JACK'S DEFEAT CREEK. In the foreground, gravel and soil from this church parking lot are washing down the bank to Jack's Defeat Creek.

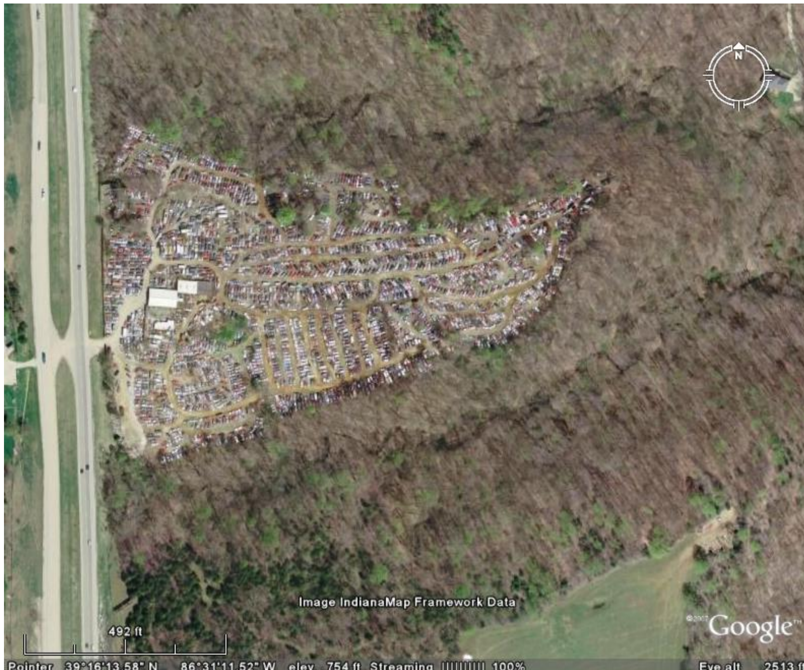

FIGURE 50 A AND B: AUTO SALVAGE OPERATION. This auto salvage yard is on 37 north of Bloomington. Note waterways half-hidden by trees on either side. Car parts contain mercury, hydrocarbons and other toxics that can impact water quality.

Figure 51: Blucher Poole Wastewater Treatment Plant. This facility on Bottom Rd. is one of two plants that treat waste from the City of Bloomington.

FIGURE 52: DOG PARK JUST BELOW THE DAM ON GRIFFY LAKE.

6.1 Pathogen Sources:

E. coli bacteria can cause illness, but E. coli is also a common indicator that other pathogens may be present. Sources of E. coli in the Bean Blossom watershed include animal manure and human sewage. Rural residential areas are an important source of pollutant loading in this watershed, including failing wastewater treatment plants, failing septic systems, and homes that have illegal discharges of wastewater known as straight pipes (with no septic system in place). Animal waste can be significant wherever animals occur in high densities, including pets and wildlife. The dog park beneath the Griffy Lake dam and equestrian communities raise concerns similar to those surrounding livestock operations. Wildlife sources are exempt from meeting water quality standards, but wildlife is likely to be a significant contributor to E. coli levels. This is difficult to quantify though since we are not aware of any estimates of wildlife populations in the watershed.

The Indiana Department of Environmental Management conducted a Total Maximum Daily Load analysis on the Bean Blossom Creek watershed.[72] The target for this TMDL is 125 cfu as a geometric mean based on a minimum of 5 samples equally spaced over a 30 day period. The load allocation (for point sources) and the wasteload allocation (for nonpoint sources) are that same number. IDEM's TMDL concluded that achieving water quality standards in the watershed depends on:

1) Incorporating E. coli limits for all sanitary waste dischargers (some currently only monitor for Chlorine
2) Confined feeing Operations (livestock facilities) not violating their permits
3) Non-point sources of E. coli being controlled by implementing best management practices
4) The issuance of MS4 permits for Bloomington and Monroe County.

Human sewage and animal wastes contribute to nutrient loading as well as pathogens. Management efforts aimed at reducing bacteria loading to the watershed should also reduce nutrient loading.

6.1.1 Point Sources: Permitted Discharges

Sewer collection systems and wastewater treatment facilities can be a source of E. coli, particularly when they are not in compliance with their permits. Combined sewer systems that combine both stormwater and sewage are prone to overflows, but no combined sewers are known to occur in the watershed. Occasional violations of permit conditions do occur within the Bean Blossom watershed. Violations may occur at wastewater treatment facilities in conjunction with equipment failure or heavy rains that overwhelm the treatment capability resulting in bypasses. When this occurs, they may discharge inadequately treated wastewater directly to streams.

[72] Total Maximum Daily Load for *Eschericia coli (E. coli)* in the Bean Blossom Creek Watershed, Brown and Monroe Counties, March 2006, Indiana Department of Environmental Management, Office of Water Quality, Total Maximum Daily Load Program.
http://www.in.gov/idem/programs/water/tmdl/documents.html

TABLE 43: POINT SOURCE DISCHARGES IN THE BEAN BLOSSOM CREEK WATERSHED

Facility	Permit Number	Receiving Water
Facilities with *E. coli* Limits		
Camp Gallahue	IN0053899	Jack Creek Tributary
Bloomington North (Blucher Poole)	IN0035726	Bean Blossom Creek
Ellettsville Municipal STP	IN0021083	Jack's Defeat Creek
Camp Hunt's WWTP	IN0060321	Lazy Creek
Facilities with Total Residual Chlorine Limits		
Helmsburg Regional Sewer District	IN0058416	Bean Blossom Creek
Star of Indiana	IN0037605	Unnamed Tributary to Bean Blossom Creek
Lutheran Hills Camp	IN0039110	Bear Creek
Facilities with no Total Residual Chlorine or *E. coli* Limits		
Stinesville RSD	IN0050105	Bean Blossom Creek
Speedway Station #6013	IN0080181	Unnamed Creek to Jack's Defeat Creek

Point source discharges are permitted under the National Pollutant Discharge Elimination System (NPDES), but NPDES permit-holders are required to monitor and/or limit pollutant concentrations to levels deemed to meet water quality standards. Some of these dischargers are required to monitor E. coli levels in their discharge and some are currently required to monitor residual chlorine instead (as a surrogate for E. coli levels). In the TMDL document for Bean Blossom Creek, IDEM recommends that these permits be revised to include more direct measurement of E. coli levels when they come up for renewal in 2010.[73]

Blucher Poole wastewater treatment plant is located on the north side of Bloomington and was recently upgraded to treat up to 6 million gallons per day though it currently treats about 1.5-2 mgd.[74] Water quality violations were reported by Blucher Poole. Since the IDEM has taken no enforcement action, the state considers the plant to be in compliance. Nevertheless, their exceedances represent a source of E. coli contamination in the Bean Blossom Creek.

Many small communities that experience problems with septic system failure are encouraged to form regional sewer districts and convert to package wastewater treatment plants. This can lead to new problems as small communities may lack the resources and expertise to manage such plants properly. Sparsely populated Brown County has 3 small regional sewer districts – Helmsburg, Gnaw Bone and the newly established Bean

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[73] Total Maximum Daily Load for *Eschericia coli (E. coli)* in the Bean Blossom Creek Watershed, Brown and Monroe Counties, March 2006, Indiana Department of Environmental Management, Office of Water Quality, Total Maximum Daily Load Program.
http://www.in.gov/idem/programs/water/tmdl/documents.html

[74] Utility and Transportation Characteristics of Monroe County Indiana 2003.
http://www.co.monroe.in.us/planning/documents/Utilities.pdf

Blossom sewer district. Gnaw Bone discharges to the Salt Creek watershed (not part of Bean Blossom drainage) but Helmsburg RSD discharges to Bean Blossom Creek and the Bean Blossom Regional Sewer district may follow suit. It does not yet have a permit to discharge. The Bean Blossom Regional Sewer District is considering systems other than conventional package treatment plants, including the Algae Wheel[75] and/or final discharge to a soil absorption system rather than a direct permitted discharge to the Creek.

The Helmsburg Regional Sewer District permit was issued 1995. This minor, municipal wastewater treatment plant discharges 0.025 million gallons per day of treated sanitary wastewater into Bean Blossom Creek upstream from Lake Lemon in Brown County. Effluent parameters to be limited and/or monitored are: flow, pH, $CBOD_5$, total suspended solids, ammonia-nitrogen, dissolved oxygen and total residual chlorine. The Helmsburg Regional Sewer District has violated their permit when they failed to meet the effluent limitations for Total Suspended Solids (TSS), ammonia nitrogen and Total Residual Chlorine (TRC) for months in 1999 and 2000. They also failed to submit required monitoring reports in 2001 and reported a bypass of 3000 gallons in 2006 due to equipment failure. [76]

Due to widespread septic system failure and small lots that prevented septic system replacement, the IDEM recommended that the unincorporated area of Bean Blossom connect to the Helmsburg wastewater treatment plant. It was also expected that the Helmsburg plant would operate better with additional flow. However, local people rejected this recommendation and formed the Bean Blossom Regional Sewer District in 2007.

Stinesville has a population of about 200 people and wastewater treatment is handled by the Monroe County Regional Sewer District through a contract with Bynum Fanyo. In Stinesville, each house has a primary treatment area (septic system), but the effluent is collected and treated through aerated lagoons before being discharged to Bean Blossom Creek.[77,] It discharges about .039 million gallons per day. [78]

Most wastewater treatment permits do not require disinfection during winter months (outside the recreational season), but emerging research suggests that year-round disinfection may be necessary in order to achieve water quality standards. Historically it has been thought that E. coli bacteria do not survive long outside the intestines of their host. It was further assumed that sunlight would help kill the bacteria. New results indicate that E. coli bacteria can survive and multiply outside their hosts. This can occur in soils amended with manure or in stream sediments that are laden with E. coli. Thus residual bacteria in the water column or stream sediments can be a source of E. coli.

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[75] http://www.algaewheel.com/
[76] www.state.in.us/idem/compliance/water/wastewater/compeval/ssobp/byp2006.xls
[77] Monroe County Drainage Board minutes from Feb. 5, 2004
http://www.co.monroe.in.us/drainageboard/Forms/minutes/2004/Feb5min.pdf
[78] Personal Communication with Rick Coppock at Bynum-Fanyo.

6.1.2 Non-point Sources: Stormwater Runoff

Stormwater can also carry pollutants, including E. coli. This occurs because rainwater may fall or run onto contaminated surfaces and washes into storm drains. Cities and other institutions with a large population of occupants must comply with Municipal Separate Storm Sewer (MS4) requirements. Brown County does not have any MS4 communities, but Monroe County has several.

Under Storm Water Phase II requirements, the municipal separate storm sewer system (MS4) for Bloomington and the surrounding urbanized area meaning that they must obtain a permit under the National Pollutant Discharge Elimination System (NPDES) for their storm water discharges and develop a management plan to minimize pollutant runoff.[79,80,81] The MS4 plan led to formation of the Storm Water and Environmental Education Team (SWEET). This MS4 Plan details characterization of urban watersheds, and aggressive capture and treatment measures including the Cascades Park facility. The MS4 characterizations carried out to date for Stout's Creek and Griffy Creek are included in this plan.

6.1.3 Non-point Sources: Septics

While rural residences with failing septic systems are a likely major source of E. coli and nutrient loading of nitrogen and phosphorus into area streams and lakes, there is very limited data about septic system failure. Also, there are very few alternative technologies available. Most communities with failing septic systems are encouraged by IDEM to install package treatment plants. This approach can convert non-point source pollution to point sources that can be monitored by the state, but it is a very expensive solution that requires ongoing maintenance by experienced personnel. It is often difficult for a small community to ensure adequate maintenance of a package treatment plant, as noted in the Helmsburg example above.

Health Department have limited information about numbers of failing septic systems. Based on 2000 census figures, and correcting for people who live in sewered areas, we estimated the number of septic systems as shown in the table below.

TABLE 44: NUMBER OF SEPTIC SYSTEMS IN THE BEAN BLOSSOM WATERSHED

County	Rural homes/sq. mi	Square miles in watershed	# septics in watershed
Monroe	46.16	129.09	5959
Brown	17.88	63.35	1133
Total			7092

79 NPDES Storm Water Program for Regulated Small MS4s. May 2004. U.S. Environmental Protection Agency. Available at: http://cfpub.epa.gov/npdes/stormwater/phase2.cfm

80 A map of the regulated area, as defined by the 2000 Census, is provided at: http://cfpub.epa.gov/npdes/stormwater/urbanmapresult.cfm?state=IN).

81 http://www.co.monroe.in.us/stormwaterquality/index.htm

The effectiveness of septic systems at removing pollutants from wastewater varies depending on the type of system used and the conditions at the site. Even properly operating conventional septic systems have relatively low nutrient removal capability, and can release more than 10 pounds of nitrogen per year to the groundwater for each person using it.

TABLE 45: AVERAGE EFFECTIVENESS OF ON-SITE SYSTEMS (PERCENT REDUCTIONS)[82]

Onsite Wastewater Disposal Practice	TSS (%)	BOD (%)	Total N (%)	Total P (%)	Pathogens (%)
Conventional System	72	45	28	57	3.5
Mound System	NA	NA	44	NA	NA
Anaerobic Upflow	44	62	59	NA	NA
Intermittent Sand	92	92	55	80	3.2
Recirculating Sand	90	92	64	80	2.9
Water Separation	60	42	83	30	3.0
Constructed Wetlands	80	81	90	NA	4.0

Table 45 gives an overview of the average effectiveness for seven types of on-site systems. Table 46 shows the typical characteristics of septage. The nutrients from septics can be a cause of eutrophication in lakes. Communities may elect to require homeowners installing new septic systems to use more advanced treatment technologies to address pollutant concerns.[83] One alternative treatment system that is gaining popularity in Monroe County is the Presby system. Presby systems have above-ground treatment occurring in pipe-like chambers before discharge to soil. County health department staff must have training before the state Department of Health will delegate approval for Presby systems to the county level. Installers must have a training course too.[84]

[82] Non-Stormwater Fact Sheet: Septic Systems, The Stormwater Center http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool7-Non_Stormwater/SepticSystems.htm
[83] Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. USEPA, Office of Water, Washington, DC. http://www.epa.gov/nps/MMGI/
[84] Presby Environmental Innovative Septic Technology http://www.presbyeco.com/indiana.html

TABLE 46: TYPICAL CHARACTERISTICS OF SEPTAGE[85]

Parameter (mg/L unless otherwise noted)	Minimum	Maximum	Median
Total solids	1,132	130,475	65,804
Total volatile solids	353	71,402	35,878
Total suspended solids	310	93,378	46,844
Volatile suspended	95	51,500	25,798
Biochemical oxygen demand	440	78,600	39,520
Chemical oxygen demand	1,500	703,000	352,250
Total Kjeldahl nitrogen	66	1,060	563
Ammonia nitrogen	3	116	60
Total phosphorus	20	760	390
Alkalinity	522	4,190	2,356
Grease	208	23,368	11,788
pH	1.5	12.6	7
Total coliform	10^7/100 ml	10^9/100 ml	5,050,000,000
Fecal coliform	10^6/100 ml	10^8/100 ml	505,000,000

Note: The measurements above are in mg/L unless otherwise

The table above indicates the broad range of pollutant levels that may be found in a septic system discharge. In addition, septic system failure is often undetected. These factors make it difficult to quantify pollutant loads originating from septic systems, however we can estimate loads based on the number of systems present and using literature values. According to EPA's protocol for developing pathogen TMDLs[86], we can estimate septic system discharges of fecal coliform as follows:

10^6 counts/100 ml x 70 gallons/person-day x 2.5 people/household x 3785.2 ml/gallon

= 6,624,100,000 counts fecal coliform per septic system per day.

Based on health department estimates that 30% of septic systems discharge to the surface, we surmise that at least 2128 of the watershed's 7092 septic systems are likely to be failing:

6,624,100,000 counts fecal coliform x 2128 = 14,093,435,160,000
= 1.4×10^{13} fecal coliform counts per day
1.4×10^{13} x 365 days/year = 5.14×10^{15} fecal coliform counts per year

Total Septic Load = 5.14×10^{15} fecal coliform counts per year

[85] Decentralized Systems Technology Fact Sheet Septage Treatment/Disposal http://www.epa.gov/OWM/mtb/septage.pdf
[86] Protocol for developing pathogen TMDLs. 2001 EPA. http://www.epa.gov/owow/tmdl/pathogen_all.pdf On page 5-6 they cite Metcalf and Eddy Ecoli in raw sewage is 10-100 mpn/ml.

6.1.3.1 Septics in Brown County

Dye testing of septic systems can help detect failures. Dye testing involves placing fluorescein dye in toilets and drains and letting the water run. Usually the water volume is designed to simulate a full day's typical water use. Some communities promote voluntary dye testing programs and we compiled information on these. We offered voluntary dye testing to the Lake Lemon Conservancy District, but they declined.

There is no requirement to do dye testing at point of sale in either Brown or Monroe County, but some realtors and septic repair companies use dye testing as a diagnostic tool. In nearby Bartholomew County, the health department does surprise dye testing inspections, but Brown and Monroe Counties do not. The Brown County Health Department has been working closely with realtors to conduct dye tests in response to complaints or requests. Typically requests come in at the time of property transfer (prior to sale of a home). If the home is occupied, dye testing may involve normal household water use thereby avoiding concerns about flooding the system or forcing it into failure.[87,88]

The Brown County Health Department typically gathers information about septic systems in response to the following situations:

- Citizen complaints
- Homeowner-initiated construction/expansion or repair
- Inspections related to real estate sales
- Routine well-testing for bacteria (most properties do not have wells)

Brown County Health Department has some dye test results - fewer in 2004 than in previous years because home sales were down. They conducted 16 dye tests between January and June 2004 and 4 failed. They conducted 19 dye tests between July and December and 6 failed. Some rural residences, especially older homes may have no septic system at all, just "straight pipes" that carry wastewater directly to area waterways. The Brown County Health Department also has data indicating E. coli hot spots in streams flowing through residential areas indicating residential sources – either failing septic systems or straight pipes.

In Brown County, a completed septic permit is required in order to obtain a building permit. Conventional septic systems are the norm.[89] We estimate that there are approximately 1133 septic systems in the Brown County portion of the Bean Blossom watershed. At the outset of this project, the Brown County Health Department had a large file listing 156 applications for septic system modification (repair or enlargement) that had not been finalized or inspected. This backlog of work occurred because the health department did not have the resources to follow up to find out if repairs were actually made. With support from the Brown County Community Foundation, the

[87] Hoosier Environmental Council's Watershed Restoration Toolkit http://www.hecweb.org/ProgramsandInitatives/Watershed/watershed-toolkit.pdf
[88] Personal communication with Health Department staff, particularly John Kennard.
[89] Personal communication with Health Department staff, particularly John Kennard.

Hoosier Environmental Council updated those records in an effort to assist the health department and facilitate the watershed planning process.

Our intention was to locate each septic system failure on a GIS map layer, but there were technical and political barriers to getting this level of specificity. Brown County Health Department records remain in paper form only, not electronic. These records are filed by the name of the owner at the time of system installation, not necessarily the current owner. They are not easily cross-referenced with county parcel maps to find current owners. Brown County odes have a GIS system, ThinkMap, but the health department does not have access to the tax assessors parcel map layer and is very reluctant to develop any cross-referencing system until the tax assessor's records are updated. The Health Department is also concerned about security issues related to confidential health records if computer linkages are established. This can be addressed through installation of appropriate firewalls by an information technology specialist, but this has not been recognized as a priority. The lack of communication between computer systems in different departments within county government remains a serious obstacle to any realistic planning for future growth.[90]

Of the original backlog of 155 permit applications, 70 were in the Bean Blossom watershed. Of those, 18 cases were discovered in which the lot was never developed so the permit was never finalized. 27 reported that the work was done as planned, 2 are in progress and 8 have not done the work. Those last 11 are the ones that warrant a close look by the health department. Another 13 were never resolved because it proved impossible to locate the owner.

TABLE 47: RESULTS FROM BROWN COUNTY SEPTIC SYSTEM FOLLOWUP

Never developed, no permit needed	18
Did the work as planned	28
Did the work, need inspection	8
Installation in progress, need inspection	2
Unable to contact, unresolved	14
Total	70

6.1.3.2 Septic Systems in Monroe County

The population of Monroe County increased by 10% between 1990 and 2000. The Monroe County health department started septic record keeping in 1965 but records since 1980 are considered more reliable. There are about 25,000 conventional septic systems in Monroe County, 400 mounds and 40 Presby systems. The health department oversees installation to help ensure that the systems are installed properly to minimize failure. They have more than 100 approved installers. The Monroe County Building Department requires a septic permit before construction can begin. There is a $3000 fine for installation without a permit and it is enforced.

[90] Personal communication with Health Department staff, particularly John Kennard.

The Monroe County Health Department promotes mound systems and Presby systems as secondary treatment for new installation or repairs. Since 1990, Monroe County Health Department has required installation of 100a filters on new systems and repairs. The filter protects the soil absorption field by removing particles greater than $1/16^{th}$ inch in diameter. Filters are accessed through a riser and flow shuts off when the filter is removed to prevent tampering. The filter needs cleaning every 3 years. Filters are not required on Presby systems.

Communication and consistency between departments can be a challenge in Monroe County too. Monroe County Health Department regulations require a minimum 1 acre lot for a new septic system, but the Monroe County Planning Department requires 2.5 acres in most cases. Monroe County has a watershed overlay zoning district that requires dosing pumps for septic systems in the lake regions unless using a Presby system. This helps ensure consistent wastewater treatment by minimizing system overload at times of peak usage. Health Department regulations require a setback of at least 100 feet from a slope of 12% slope or more. An above ground system (Presby or mound) must have 35 ft. setback buffer from a slope of 12% or greater.

Septic system failure is notoriously difficult to detect. Monroe County doesn't do routine dye testing because of concerns that it can flood the system, i.e. the test itself may cause failure. A visual inspection is considered more informative; it can ensure that a complete system is present and in working order.

The Monroe County Health Department conducted a survey of septic systems installed between 1994 and 2004 and found less than 5% with water on the surface. They expect that many older homes may have septic failure. They would like to initiate inspection at the time of property transfer, in order to ultimately inspect all properties in the county. They have funding for this and could handle the workload. They feel that this would be a huge step toward updating their records and identifying pollution sources.

Monroe County Commissioners are considering an ordinance that would require septic inspection at point of sale, but this has not yet passed. So far, there has been no consensus about who will be responsible for the inspection. Realtors and private home inspectors are concerned about the potential liability of inspecting septic systems, but this issue could likely be worked out by amending the draft ordinance and/or working with the County Recorders office.

In the absence of point-of-sale inspections that would provide more complete information about each property, the Monroe County Health Department assembles data through routine practices including:

- Citizen complaints
- Homeowner-initiated construction/expansion or repair
- Subdivision of a property and inspection of the original homestead
- Inspections related to real estate sales
- Analysis of aerial photos from the county GIS system (areas with greener grass)
- Routine well-testing for bacteria (most properties do not have wells)

6.1.4 Non-Point Sources: Livestock Agriculture Operations

About 20% of the Bean Blossom watershed is devoted to pasture. Most of these pastures support grazing with free livestock access to waterways. The IDEM regulates livestock operations with more than 300 cattle and those that have had a documented direct discharge to waterways. Livestock operations are regulated under IDEM rules for confined feeding operations and/or concentrated animal feeding operations, depending on size, but there is only one regulated livestock facility in the watershed. In this case, the cows are not actually confined indoors; it is a pasture-based herd.

Manure and septage applied to cropland as fertilizer may also be a factor, especially since there is a commercial manure and septage hauler located in the watershed, but no information is available about how much manure is imported into the watershed. IDEM rules treat this as proprietary and do not require disclosure of information about how much manure is land-applied in a given watershed or a given field. There is no local ordinances that requires reporting on this either, though it would give decision-makers valuable information.

USDA records for 2005 indicate that there are about 2000 cattle in Brown County and 9600 in Monroe. Using interpolation based on the watershed acreage in each county, we estimate that there are about 3505 cattle in the Bean Blossom watershed. Many horses are penned near creek banks as well, but we could find no statistics on the numbers of horses in the watershed. While cows will tend to stand in the stream more than horses, the latter will destroy riparian vegetation by browsing.

- Monroe Co. portion of Bean Blossom watershed
  9600 cattle/411 sq. mi. = x/129.09 sq. mi. so x=3105 cattle

- Brown Co. portion of Bean Blossom watershed
  2000 cattle/317 sq. mi. = x cattle / 63.35 sq. mi. so x= 400 cattle

  Total Cattle = 3505

Assuming all these are beef cattle and an E. coli production rate of 6.3×10^{10} CFU/animal/day[91], we estimate the total E. coli loading from these animals at E. coli.

Total Livestock Load = 3.45×10^{11} colony forming units

[91] Total Maximum Daily Load for Pathogens Beeds Lake Franklin County, Iowa. 2006. Iowa Department of Natural Resources. http://www.iowadnr.com/water/watershed/tmdl/files/final/beeds.pdf

6.1.5 Pathogen Critical Areas and Audiences:

First, we identified critical areas to protect for recreational use including public parks and greenways, as well as private camps, where recreational use of the waterways is most likely to occur. Next, we considered those hot spots or critical problem areas with the highest E. coli concentrations.

Lake Lemon is a critical area to protect as the most popular recreational site in the watershed, providing opportunities for swimming, sailing, rowing, and water skiing. The Lake Lemon Conservancy District has been collecting data at various locations on Lake Lemon for years, and these data generally indicate that E. coli levels are acceptable within the lake, but the Conservancy District would like to do more localized testing. There are two publicly accessible parks located on Lake Lemon. The largest is Riddle Point Park operated by the Lake Lemon Conservancy district. The beach at Riddle Point generally tests low for E. coli. The other park is Little Africa Wildlife Viewing Area, which covers 24 acres (97,000 m^2) on a peninsula on the east end of the lake and features a nature trail. Other recreational centers on Lake Lemon include the Lake Lemon Marina on the north shore, and the Bloomington Yacht Club and the Indiana University Aquatic Center on the south shore.

Griffy Lake also gets a great deal of recreational use. Swimming is prohibited but there is a boat house and trails with ample opportunity for people to come in contact with the water. Data indicate that the lake is within bounds for safe recreational use but it is important to maintain this condition. High levels of E. coli were found in the Middle and South Fork of Griffy Creek.

Other critical recreational areas to protect include the children’s camps north of Trevlac on Bear Creek Road including Camp Gallahue Girl Scout camp, Lutheran Hills Camp, and Waycross Episcopal Camp. They serve hundreds of children every summer and include water play in the creek. There is also Walnut Hills Retreat Center on W. Bear Creek Church Road. Bean Blossom Covered Bridge is another important site located on the main stem of Bean Blossom creek at Covered Bridge Road. Downstream in Monroe County, another recreational area is Cascades Park (part of the Cascade Creek watershed). Many parts of the stream channel were covered with concrete years ago. One portion in particular serves as a popular improvised “water slide’ area.

TABLE 48: CRITICAL AREAS TO PROTECT FROM PATHOGENS

Lakes	Griffy Lake
	Lake Lemon
	Crestview Lake
	Smith Lake
	Little Fox Lake
	Happy Landing Lake
	Woodland Lake
	Echo Lake
	Lake Gallahue
	Bear Lodge Lake
	Lutheran Hills Lake
	LaSalle Lake
	Shady Oaks Lake
Other Recreational Areas	Cascades Park
	Little Africa Wildlife Viewing Area
	Camp Palawopec
	Hitz - Rhodehamel Woods
	Trail Headquarters (Bear Wallow Hill)
	Bear Lake Public Access Site
	Stinesville Park (McGlocklin)
	Memorial Park
	Campbell Park, Ellettsville Park
	Miller Showers Park
	Griffy Lake Nature Preserve
	Marlin Elementary School
	Griffy Lake Park
	Riddle Point Park & Lake Lemon
	I & S Marina
	North Shore Marina
	Camp Hunt (Wheeler Mission)
	Devonshire Equestrian Center
	Bean Blossom Bottoms Nature Preserve
	Crestmont Park
	Cascades Golf Course & Park
	Camp Gallahue
	Lutheran Hills Camp
	Bill Monroe’s Bean Blossom Music Park
	Bean Blossom Covered Bridge

Critical problem areas were identified in a variety of ways. Those areas with highest concentrations of E. coli were considered, and the Purdue model for Long-Term Hydrologic Impact Assessment was used to prioritize based on predicted pollutant load for each tributary as well as predicted pollutant load per acre and predicted pollutant concentration in runoff. We also relied on personal communication with staff at county health departments, water quality studies conducted the City of Bloomington and visual observations.

Critical problem areas include residential areas with failing septic systems – particularly those adjacent to waterbodies. These are primarily older subdivisions with small lots (See Table 49). The Griffy Lake Watershed GIS Mapping and Management Plan[92] indicates that Griffy Lake meets state standards for safe recreational use, but the South and Middle Forks of Griffy Creek have E. coli levels that exceed state standard concentration limits, particularly on the south fork.

The City of Bloomington's Stout's Creek study reports that all sites tested on Stout's Creek had *E. coli* readings above the state water quality standard for safe recreational use. While there have been some isolated septic system failures in the Stout's sub-watershed in recent years, requiring repair and department inspection, no concentration of system failures has been found. This study suggests that sanitary sewer overflows are a greater concern than septic systems on the Stout's Creek.[93] (Sanitary sewer overflows occur when storm water infiltration and infrastructure failure cause sewage systems to discharge untreated.) Pollution control systems found within the City of Bloomington (Aqua-Swirl, Stormceptor, Vortechnics) claim at least an 80% annual total suspended solids (TSS) removal efficiency, but there is no active or proposed storm water filtering system within the Bloomington portion of the Stout's Creek sub-watershed.

TABLE 49: CRITICAL AREAS FOR PATHOGEN REDUCTION

Critical Area	Problem	Priority
Bean Blossom East Fork	L-THIA predicts large E. coli loading due to large acreage devoted to agriculture and residential density. Visual confirmation of livestock in streams and septics on small lots near Spearsville.	2
Hoppers Branch	L-THIA indicates high fecal coliform/acre. Large percentages of the watershed devoted to agriculture and residential. Visual confirmation of livestock in streams and many homes on small lots, especially in unincorporated area of Bean Blossom.	1
North Fork Bean Blossom	L-THIA indicates large percentage of land devoted to agriculture and pasture.	1
Lick Creek	Large percentage or watershed in ag and pasture	2

[92] Griffy Lake Watershed GIS Mapping and Management Plan, City of Bloomington http://mem.tcon.net/5012/0614/griffy.html
[93] Baseline Stream Characterization in Monroe County, Indiana: Stout Creek, Elizabeth Muller, Chris Gleaton for the Monroe County Planning Department, August 2006. http://www.co.monroe.in.us/planning/documents/Stout%20Stream%20Assessment_%20Final.pdf

Brier Creek	Large percentage or watershed in ag and pasture	2
Lazy Creek	Large percentage or watershed in ag and pasture	2
Unnamed trib near Coyle	Large percentage or watershed in ag and pasture	2
Buck Creek	Small watershed with relatively low overall load, but disproportionately high levels of when corrected for size. LTHIA indicates large percentage of land in ag and pasture.	1
Griffy Creek	L-THIA indicates about 50% of forest cover has been converted from forest. The % devoted to grass and pasture is similar to East Fork but expected load is twice as high due to high density residential development. Septics are an issue on South and Middle forks.	1
Stout's Creek	Largely deforested. Large percentage is devoted to grass and pasture, twice as much as in similarly sized North Fork. In addition there is significant low density residential and commercial development. Stout's Creek study indicates sanitary sewer overflows.	1
Indian Creek	Very little residential but total load of fecal coliform is expected to be high because it is a large watershed with nearly 25% deforested for row crops and pasture.	1
Jack's Defeat Creek	Largest sub-watershed with very high percentage of land area devoted to agriculture and pasture as well as low density residential development. Many homes on septics.	1
Bean Blossom Mainstem	Many septics on small lots, especially in Helmsburg, Trevlac, and Aqua Isle areas.	1
Throughout the watershed	Livestock access to creeks	1
Throughout the watershed	Small towns and unincorporated areas with dense residential development on small lots.	1
Throughout the watershed	Older homes with no records of septic system installation or upgrade, including Fairwood Terrace (Prairie Drive), Audubon Hills, Merlin Hills off old 37.	1
Throughout the watershed	Septic Systems in areas with high water tables, i.e. lakefronts.	1
Throughout the watershed	Permitted discharges with no E. coli limits	1

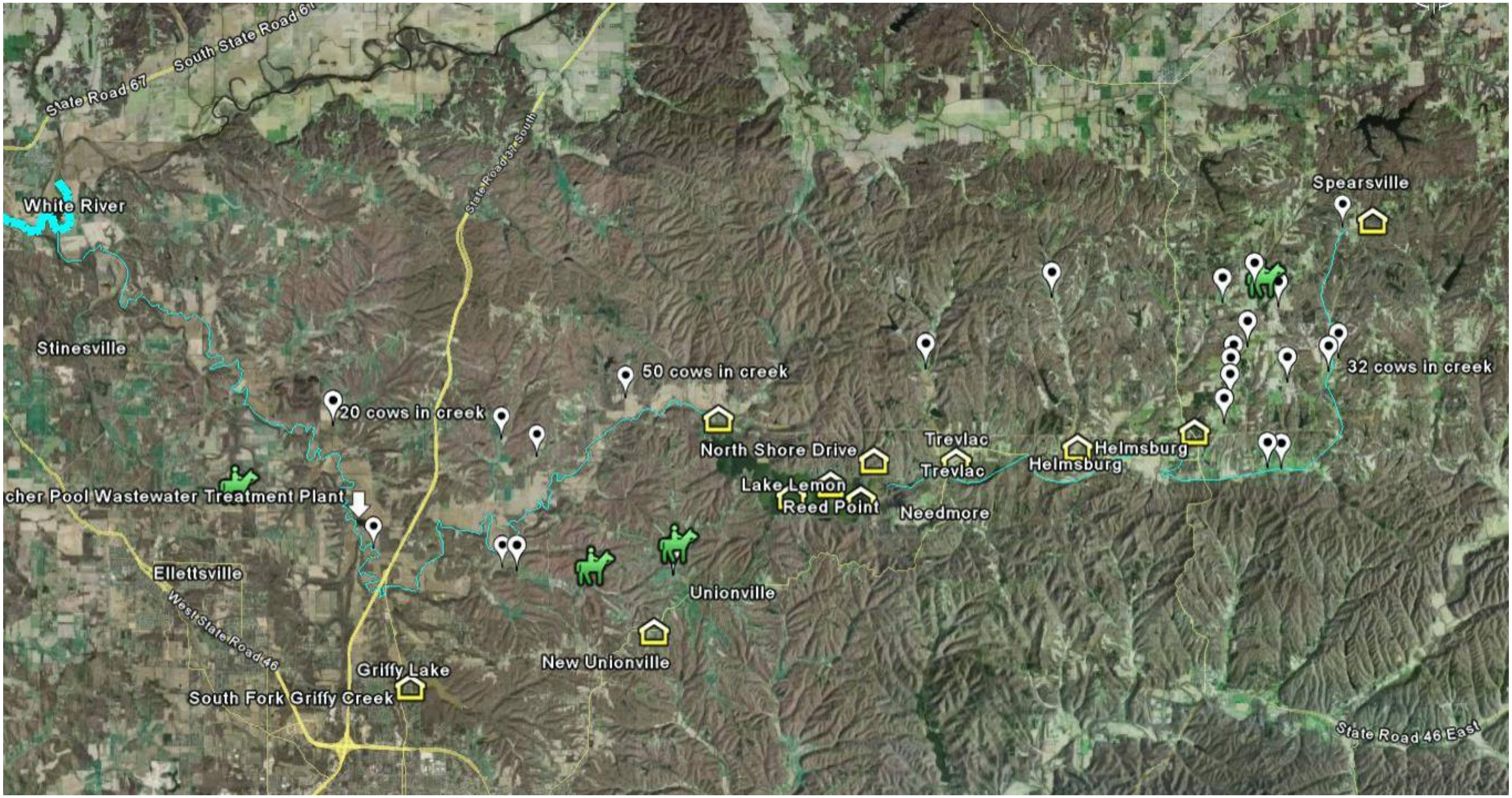

FIGURE 53: CRITICAL AREAS FOR PATHOGENS IN THE BEAN BLOSSOM WATERSHED

This aerial photograph shows the rugged topography in the eastern part of the watershed and the more developed nature of the western portion with Lake Lemon roughly dividing the two. The black and white pins indicate areas where cows occur. In a few cases the number of cows in the creek is, we were actually able to count cows in the creek. Horses are also shown. Areas where septic systems are thought to be critical are indicated by house symbols.

6.2 Silt/Sediment Sources:

The public is not necessarily accustomed to thinking of soil as a pollutant, but displaced soil particles have a big impact on water quality. In streams, suspended solids impair visibility and make it difficult for predator species to find their prey. These particles can also smother eggs and adults of some species.

Sediment is a particular concern in lakes because it reduces the capacity of the reservoirs, carries nutrients that promote algae growth, and provides a substrate for rooted aquatic plants that obstruct boat traffic. The topography of this watershed makes the lakes very sensitive to sedimentation. Both Griffy Lake and Lake Lemon have a large delta of sediment that is continually expanding.

The L-THIA model predicts that the North Fork of Bean Blossom Creek, Lazy Creek, Buck Creek and Griffy Creek have elevated levels of sediment. Downstream from the lakes, Stout's Creek, Jack's Defeat, and Indian Creek contribute high concentrations of Total Suspended solids to the Bean Blossom Creek.

A 1998 study of Griffy Lake showed that DO, pH and conductivity are adequate to support aquatic life, but high concentrations of suspended solids were recorded during storm events.[94] IBI scores indicate slight to moderate impairments. The South Fork also tested positive for Polycyclic Aromatic Hydrocarbons which can reduce IBI scores and be toxic to aquatic life. Overall the South Fork of Griffy Creek was the most severely impacted, mostly due to development in the northeast part of Bloomington. Erosion from construction sites and decreasing forest cover are responsible. In 2004, sampling revealed high levels of sediment in the South and Middle Forks compared to the relatively pristine North Fork. Suspended solids on the Middle Fork exceeded 141 mg/l during a severe storm event. On Griffy Lake, heavy recreational use is also contributing sediment as the trails on steep slopes are denuded.

The Stout's Creek study indicates that bank erosion along Stout's Creek was mostly non-severe, although in some cases this erosion extended for the entire 200 foot stream reach evaluated. Turbidity levels ranged from 0.08 to 0.29 with an average of 0.13 turbidity units.[95] There were two sites where stream buffers were small enough to potentially increase erosion. Another site showed damming and debris deposition that can cause banks to be cut.

6.2.1 Agriculture

Sediment sources in the Bean Blossom watershed include agriculture, timber harvesting, mining/quarrying, and residential/commercial development. Farms using conventional tillage tend to have greater soil erosion contributing to nutrient and sediment loads. In Monroe County, 51 percent of the corn acreage and 16 % of the soybean acreage use conventional tillage. Data is not available on Brown County tillage practices.

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[94] Griffy Lake Watershed GIS Mapping and Management Plan, City of Bloomington http://mem.tcon.net/5012/0614/griffy.html

[95] ibid.

Conventional tillage of farm fields can increase the sediment load in stormwater runoff. The presence of grass filter strips or forested buffers along streams can mitigate this effect by slowing the water down and allowing the soil particles to settle out. Farm Bill programs provide a great incentive for adoption of conservation practices, such as reduced tillage, grass filter strips or forested buffers. The following information about implementation of such practices is provided by a personal communication from Tony Branam of the Natural Resource Conservation Service:

Currently, there are 20.5 acres (Monroe County) of pasture land under contract through the Grassland Reserve Program (GRP). The focus of the GRP is to maintain existing grasslands with a healthy vegetative cover, and to protect these areas from conversion and development.

The Conservation Reserve Program (CRP) has the largest enrollment of acreage through the USDA as either general sign-up contracts, or continuous sign-up contracts. The general sign-up CRP contracts will enroll entire crop fields due to their vulnerability to erosion as a result of extreme slope (highly erodible land, HEL), or floodplains prone to scouring during flood events. The total enrollment for general sign-up is 410.3 acres (85.5 acres Brown County, 324.8 acres Monroe County). These lands are typically planted to a vegetative cover using cool season grasses and legumes.

The continuous sign-up CRP enrollments targets riparian buffers along environmentally sensitive areas (wetlands, streams, lakes, sinkholes) of pastures and crop fields. Historically, cool season grasses and legumes have been the vegetative cover of choice, however, newer program applicants have been more likely to plant trees and shrubs with occasional native warm season prairie grasses and wildflowers. The total acreage of CRP buffers is 111.4 acres (1.9 acres Brown County, 109.5 acres Monroe County). In addition to buffers, there are 65.8 acres of CRP bottomland timber establishment adjacent to Bean Blossom Creek in Monroe County.

Forest riparian buffers and filter strips adjacent to Bean Blossom Creek and its tributaries have also been established through the Environmental Quality Incentives Program (EQIP) and Wildlife Habitat Incentives Program (WHIP). A total of 3.7 acres of streamside buffers have been installed in Monroe County and one stream crossing with livestock exclusion from riparian corridor in Brown County have been funded through EQIP. The WHIP program has funded 11.5 acres of riparian buffers in Monroe County headwater streams using native trees, shrubs, and warm season grasses and forbs.

The WHIP has also funded the planting of 60.2 acres of wildlife habitat in the watershed on floodplains and uplands to enhance habitat diversity and reduce habitat fragmentation. Currently, there are 20.5 acres of wetland restoration and five wildlife watering facilities under construction on the Bean Blossom Creek floodplain in Monroe County with funding through WHIP. The EQIP program has provided incentive payments for winter cover crops 102 acres of crop land in Monroe County to protect the land surface from flood events and encourage deposition of silt on the floodplain rather than in the stream channel.

Local cost-share assistance programs have also contributed to water quality enhancement in the Bean Blossom Creek watershed. A Clean Water Indiana grant sponsored by the Brown

County SWCD provided construction design and cost-share assistance for a streambank stabilization project on North Fork Bean Blossom Creek. An additional 7.0 acres of wetland restoration in Monroe County was completed with funding through the Partners for Wildlife program sponsored by U.S. Fish & Wildlife Service. The Monroe County SWCD has sponsored 123.1 acres of cover crops to stabilize topsoil on crop fields and immobilize nutrients from leaching into groundwater or drainage tiles discharging into surface waters.

In summary, there are 126.6 acres of riparian buffers and filter strips, 193.3 acres of restoration of wetlands & bottomland forests, 60.2 acres of wildlife habitat creation, 430.8 acres of upland soil loss protection, 224.1 acres of cover crops, 5 wildlife watering facilities, one streambank stabilization project, and one livestock stream crossing.

The use of winter cover crops as part of typical tillage operation can reduce expected soil loss by one half, and reduce demand for nitrogen fertilizers during spring planting. Cover crops are a cost-effective means to reduce soil erosions and reduce nutrient loading into ground and surface water supplies, and should be a priority for any watershed planning on agricultural and non-agricultural lands.

6.2.2 Development

The removal of vegetation and soil during any type of construction can cause increased erosion. While there is a rule on the books that requires construction sites to use best management practices to minimize soil erosion and runoff, there is little or no enforcement. Enforcement was de-funded at the state level. Currently Rule V permits go to the Soil and Water Conservation District office but there is no staff person to review or enforce them.[96]

Development can increase erosion, not only during the construction phase, but also in the long term due to an increase in impervious surface. Impervious surfaces contribute to erosion by increasing runoff flow and velocity, which then increases streambank cutting. In addition, dirt deposited on hard surfaces such as streets and parking lots often washes directly to storm drains. Gravel roads can also add sediment to nearby waterways.

As the Bean Blossom/Lake Lemon watershed becomes more populated, especially in the western section, impervious surfaces become more of an issue. It is a generally accepted rule of thumb that 10% impervious surface will cause degradation of a watershed, and 25% may cause such sever impairment that aquatic life will not be supported Monroe County's Storm Water and Environmental Education Team (SWEET) has started a Rain Garden Initiative to help increase stormwater infiltration/retention and reduce sediment runoff. For more information, visit http://www.co.monroe.in.us/stormwaterquality/bioretention.html and http://www.co.monroe.in.us/RainGarden/home.htm

Using Ellettsville's estimates that 26,448 lbs of sediment enter Jack's Defeat Creek each year from Ellettsville's 30 acres of impervious surface, we can predict that the overall sediment load from the 3691 acres of impervious surfaces in the Bean Blossom watershed would yield

[96] Personal communication with County employees.

about 3,253,986 lbs of sediment in the stream each year. Areas of changing land use are particularly important since this is where most construction takes place.

6.2.3 Forestry

Forestry practices, including road construction and logging on steep slopes may contribute to erosion and sediment loading. In theory, DNR requires timber harvesters are supposed to employ best management practices to minimize runoff but enforcement is spotty at best. Monroe County requires a permit for timber harvesting through the County Building inspectors, but there is no mechanism to enforce best management practices. Past practices can continue to cause sediment runoff for many years.

The Indiana Department of Natural Resources has adopted a new State Forest Management Plan (IDNR Division of Forestry Strategic Plan 2005-07)[97] calling for up to a five-fold increase in logging on state forests including the Morgan-Monroe State Forest and Yellowwood State Forest lands within the watershed. Logging contractors need to strictly follow best management practices in order to minimize sediment loads in Bean Blossom Creek and its tributaries.

Five new timber harvests were approved in Morgan Monroe State Forest in 2007. Road building to accommodate logging trucks can have a big impact. More sustainable forestry practices would improve the local economy in the long term. In some areas in Kentucky, integrated forest management practices are used in which all logging is done by horses to minimize the impact of road building. Portable saw mills also reduce heavy traffic.

Timber stand improvement should help make forestry on private lands more profitable. The Soil and Water Conservation districts have made timber stand improvement, hardwood tree planting and forestry Best Management Practices their top priorities. Monroe County Parks Comprehensive plan includes greenways and canoe trails that should help protect and expand riparian protection.[98]

6.2.4 Road building

Both timber harvesting and residential development involve road building. This road building can have a major impact on waterways, especially when building on steep slopes. Transportation infrastructure and construction of highways is another form of road building that can have a major impact on water quality. It is especially important to implement erosion control measures at stream crossings.

The proposed construction/extension of I-69 poses a potential threat to water quality in the Bean Blossom Creek. In the I-69 Tier I Final Environmental Impact Statement, there are 2 new potential interchanges on SR 37/new I-69 in the Bean Blossom watershed, along with possible changes to the existing SR 37/Walnut St. interchange. There are likely to be water quality impacts from a proposed bridge over Bean Blossom Creek. There are also possible

[97] http://www.indianaforestalliance.org/pdf/SF_mgmt_plan2005-2007.pdf
[98] Personal Communication with Steve Cotter, Bloomington Parks Department

effects from I-69 on Stout's Creek (just west of SR 37) and Griffy Creek, since they are bridged by SR 37.

6.2.5 Sediment Critical Areas and Audiences

Critical areas to protect include existing well-buffered waterways, and especially lands that are currently in the Farm Bill Conservation Programs as outlined above. Many of these areas are up for renewal soon and it will be important to re-enroll as much acreage as possible. It is especially important to maintain and increase buffers along the Bean Blossom Creek mainstem.

Critical areas to protect include all forested areas within the watershed as these help slow runoff and protect soils. Future development should strive to retain as much forest cover as possible. Critical areas to protect and restore include lakes, especially Griffy Lake and Lake Lemon but also the numerous smaller lakes in the area. The steep topography of the Bean Blossom watershed makes area lakes especially susceptible to sedimentation. Steep slopes shed water quickly resulting in few productive aquifers so reservoirs were constructed at great public expense to supply drinking water, provide flood control and offer recreational opportunities. It is important to the local economy and culture to maintain lake capacity by minimizing sediment runoff.

Since its construction, the Lake Lemon Conservancy District estimates that Lake Lemon has accumulated as much as 520,000 cubic yards of sediment have accumulated, mostly at the eastern end.[99] They estimate that 8,000,000 to 10,000 cubic yards are being deposited each year, meaning that the lake is losing capacity at about .17 % each year, but the loss is 10 times higher at the eastern end. Another study indicates that 1066 tons of sediment may enter Lake Lemon in a single storm event.[100] Sediment is currently being removed from the eastern portion by dredge and barge operation.

<u>Shoreline erosion</u>

Lakes are inherently sensitive to sediment accumulation, but they can also be a source, especially where wave action from wind or boat traffic causes shoreline erosion. In 1999 the Lake Lemon Conservancy District received a grant through IDEM's 104 (b)(3) grant program for a sedimentation/restoration study. They identified 9 sites in need of shoreline restoration. Most of this eroding shoreline is owned by the City of Bloomington Utilities. A total of 3,779 linear feet of shoreline have been stabilized with funding through the Lake and River Enhancement (LARE) program. As of 2002, Lake Lemon expenditures reached the LARE cap of $300,000 so no more dollars can be allocated from that program, but shoreline erosion remains a challenge.

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[99] Lake Lemon Conservancy District Lake Lemon Watershed Management Plan, prepared by Malcolm Pirnie, January, 2002 http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Wtrshd_Mngmt_Plan-Lake_Lemon-Monroe-Jan02.pdf

[100] Lake Lemon T by 2000 Feasibility Study, 1992, William W. Jones and Louise Clemency. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf

Overland erosion

Another source of sediment is streambank erosion that occurs when seasonal high waters erode and gouge banks. Dramatic fluctuations in streamflow exacerbate this effect. For example, in 1988 streamflow averaged 30.4 cubic feet per second (cfs) in the upper Bean Blossom with a maximum of 3,200 cfs.[101]

FIGURE 54: POTENTIAL DEMONSTRATION SITE FOR STREAMBANK STABILIZATION

Streambank erosion is a visible problem along much of the Bean Blossom from the confluence of the North Fork east of Helmsburg all the way to Lake Lemon. Cut banks occur up to 20 feet high and silt deposits on floodplain terraces can be up to one foot thick following spring floods. Streambank erosion is also evident along Plum Creek and Possum Trot Creek (a small tributary on the north side of Lake Lemon between Bear Creek and Wolf Creek. A streambank stabilization demonstration project has been suggested at one particularly visible location where erosion threatens State Rd. 45 midway between Trevlac and Helmsburg. [102]

[101] Lake Lemon T by 2000 Feasibility Study, 1992, William W. Jones and Louise Clemency. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf
[102] ibid

Sheet and Rill Erosion

Cropland is another important source of sediment. The L-THIA model predicts that the North Fork of Bean Blossom, Lazy Creek, Buck Creek and Griffy Creek have highest levels of Total Suspended Solids. Downstream from the major lakes, LTHIA predicts that Stout's Creek, Jack's Defeat, and Indian Creek contribute extremely high concentrations of Total Suspended solids to the Bean Blossom Creek.

The Lake Lemon T by 2000 Feasibility study used the Agricultural Nonpoint Source Model to estimate sediment load from a simulated storm event and found the largest sediment yields per acre originating from the North Fork of Bean Blossom Creek above Big Thunder Creek and Hopper's Branch with highest losses reported at .071 tons per acre (142 lbs/A) and 076 tons per acre (152 lbs/Acre), respectively.[103] They report the lowest sediment yields from Big Thunder Creek, Bear Creek, Possum Trot Creek and Plum Creek, even though visible streambank erosion appears serious on Possum Trot and Plum creeks.

[103] ibid

TABLE 50: CRITICAL AREAS FOR SEDIMENT LOAD REDUCTION

Critical Area	Problem	Priority
Lake Lemon, Lake Griffy, and lakes throughout the watershed	Lakes are sinks for sediment accumulation, but shoreline erosion can also be a source of sediment, especially where there is wave action from wind or boat traffic.	2
Bean Blossom East Fork	L-THIA predicts large sediment load due to large watershed and steep slopes. Livestock create some streambank erosion problems too.	2
Hoppers Branch	Small watershed but large sediment load due to high percentage of land in pasture and row crops. Livestock create some streambank erosion problems too.	1
North Fork Bean Blossom	L-THIA indicates high Total Suspended Solids. Steep topography and Highly Erodible Soils.[104]	1
Lick Creek	Steep topography and Highly Erodible Soils.	2
Brier Creek	Steep topography and Highly Erodible Soils.	2
Lazy Creek	Steep topography and Highly Erodible Soils.	2
Unnamed Trib near Coyle	Steep topography and Highly Erodible Soils.	2
Bear Creek	Steep topography and Highly Erodible Soils.	2
Plum Creek	Visible streambank erosion	2
Possum Trot Creek	Visible streambank erosion	2
Buck Creek	TSS load is high even though it is a small watershed. Load per acre is high due to land converted from forest to row crops, pasture, and low density development.	1
Muddy Creek	TSS load is high due to row crop production on sensitive soils.	2
Griffy Creek	L-THIA indicates TSS load is high as well as load per acre because about 50% of land has been converted from forest. High percentage of impervious surface exacerbates runoff problems.	1
Stout's Creek	Largely deforested. Total load and load per acre are high.	1
Indian Creek	L-THIA indicates high Total Suspended Solids.	2
Jack's Defeat Creek	TSS load very high and load per acre is high too due to very high percentage of land area devoted to agriculture and pasture as well as low density residential development.	1
Throughout watershed	Livestock access locations where animals denude and erode streambanks. Most critical to install buffers along mainstem.	1
Throughout watershed	Inadequately buffered stream banks, especially areas with streambank erosion where there is no buffer present. Especially eroded bank on mainstem. See map.	1
Throughout watershed	Steep slopes and highly erodible lands that are disturbed by farming, logging or construction.	1
Throughout watershed	Active construction sites and areas of changing land use (future development), especially South Fork of Griffy Creek where rapid development is taking place	1
Throughout watershed	Conventionally tilled cropland especially where no buffer is present.	2
Throughout watershed	Clearcuts on state forests or private lands where inadequate BMPs are in place	1
Throughout watershed	Gravel quarries contribute TSS, including one on Jack's Defeat in Ellettsville, one just upstream of Cascades Park and several on north side of Bloomington.	2
Throughout watershed	Road construction sites, especially stream crossings	1
Throughout watershed	Urban areas with high degree of impervious pavement, namely Bloomington and Ellettsville. These are to be addressed by MS4 plans.	1
Critical audiences	Livestock owners, Developers, Property owners with creek frontage, Landowners with forested acreage.	1

[104] from SCS Map of Highly erodible soils

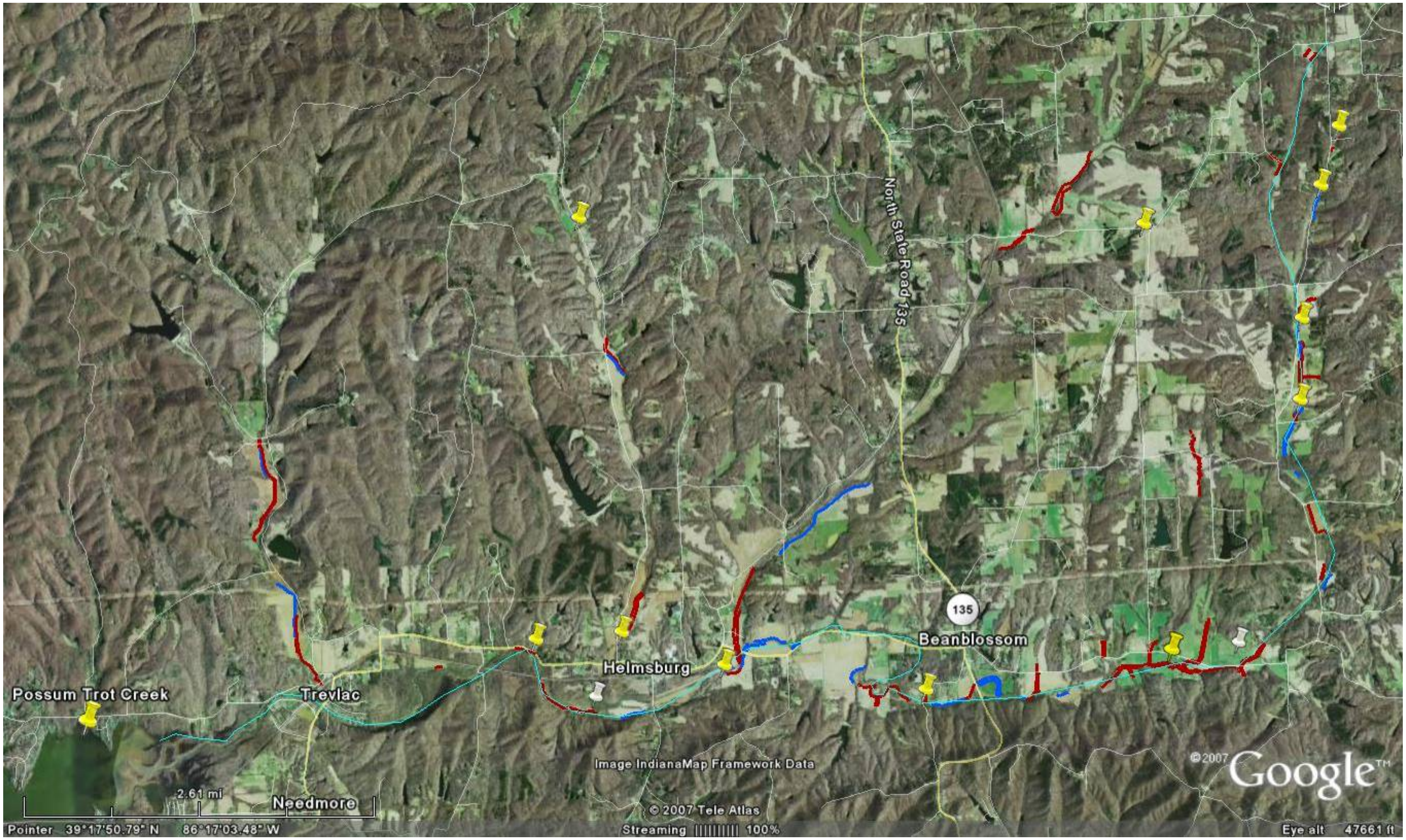

FIGURE 55: CRITICAL AREAS FOR SEDIMENT IN THE UPPER BEAN BLOSSOM WATERSHED The red lines indicate areas with absent buffers, blue lines indicate inadequate buffers. This is a very conservative estimate, using 35 ft. buffer as adequate. Yellow pins indicate areas where erosion is visible. In this steep topography erosion can be observed in the very headwaters.

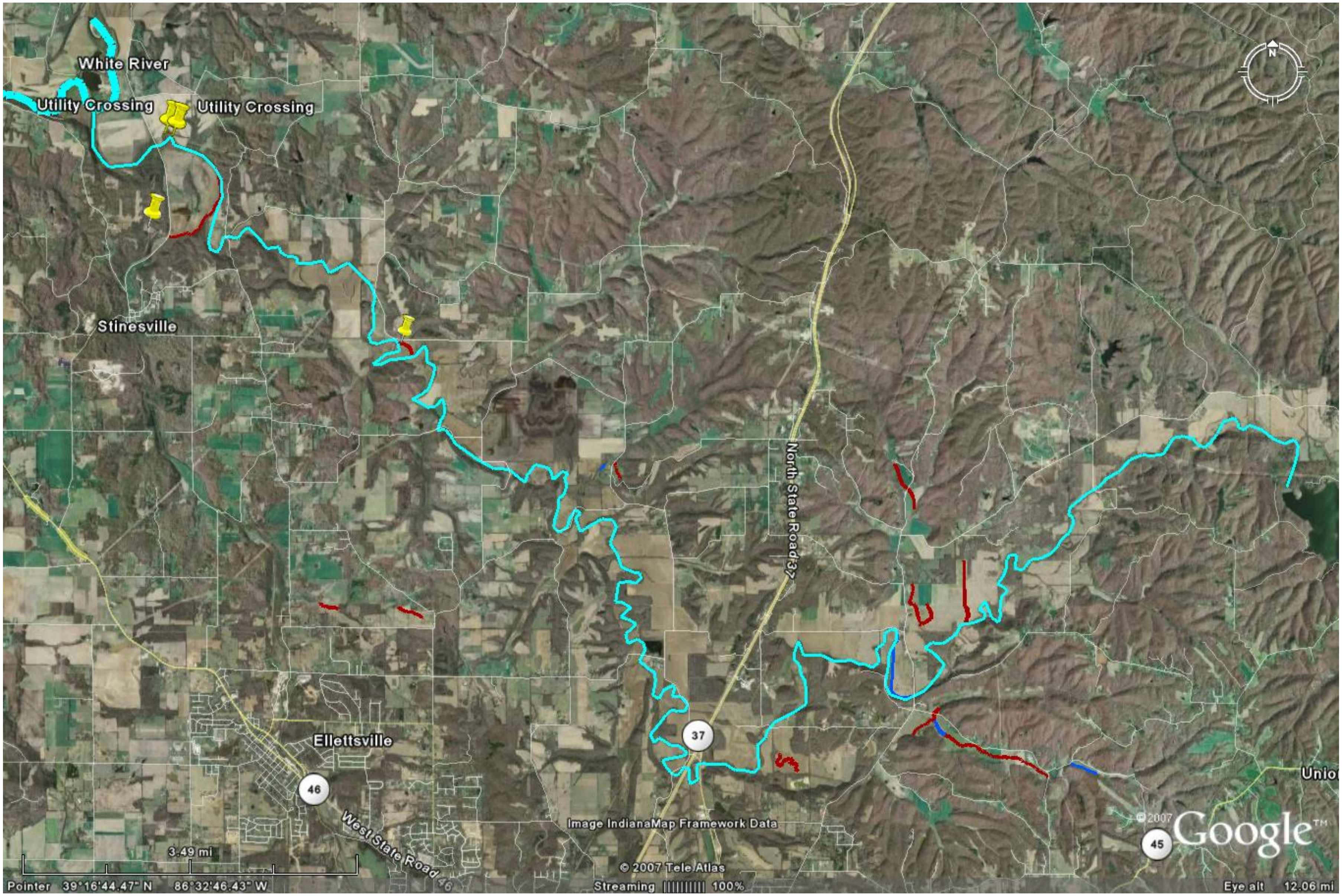

FIGURE 56: CRITICAL AREAS FOR SEDIMENT IN THE LOWER BEAN BLOSSOM WATERSHED

The red lines indicate areas with absent buffers, blue lines indicate inadequate buffers. This is a very conservative estimate, using 35 ft. buffer as adequate. Erosion is much less noticeable downstream from Lake Lemon.

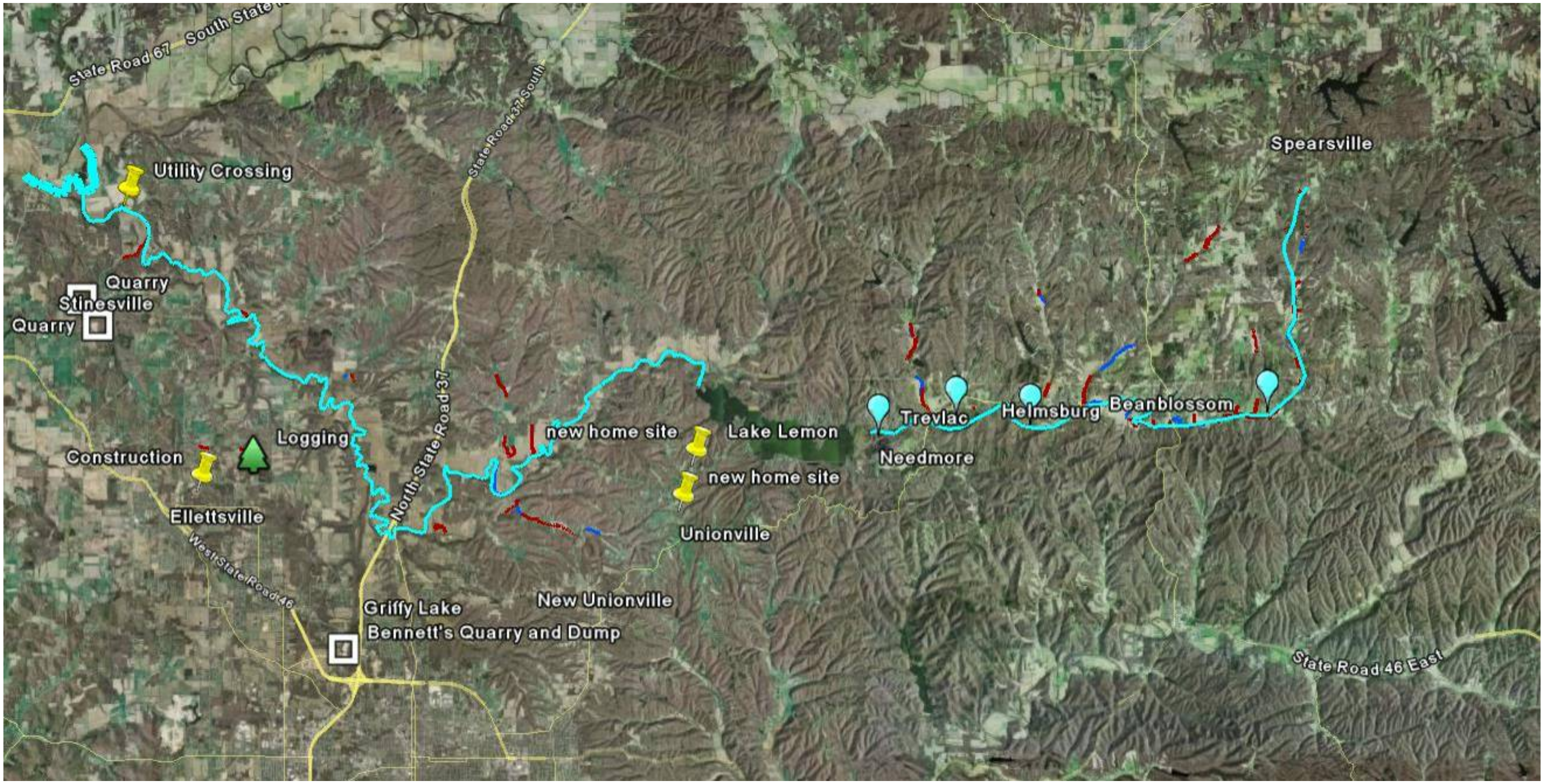

FIGURE 57: OTHER CRITICAL AREAS FOR SEDIMENT IN THE BEAN BLOSSOM WATERSHED

The light blue pointers indicate areas where wetland enhancement may be feasible for trapping sediments before they reach Lake Lemon. The downstream portion of the watershed has less steep topography and more buffers in place, but it also has several quarries and more construction of new homes. The red lines indicate areas with absent buffers, blue lines indicate inadequate buffers. This is a very conservative estimate, using 35 ft. buffer as adequate.

6.3 Nutrient Sources

Nutrients are a problem because they stimulate the growth of algae and aquatic weeds that can deplete oxygen when they respire in the night. Nutrients are often associated with sediment runoff, but nutrient loading can also be more directly related to the use of phosphorus-containing fertilizers and detergents. For example, fertilizers used on agricultural crops, residential lawns and golf courses are often applied at high rates that promote runoff.

Since algae growth in lakes is usually linked to phosphorus levels, particular attention has been paid to this nutrient. The Lake Lemon T by 2000 Feasibility Study storm event simulation indicates high levels of phosphorus associated with sediment from North Fork of Bean Blossom (but not Big Thunder Creek) and Hoppers Branch. Soluble-phosphorus (not associated with sediment) was a problem almost exclusively in the North Fork.[105]

Livestock with direct access to creeks and illegal or failing septic can deposit nutrients (as well as pathogens) directly into waterways. Measures undertaken to control sediment should also reduce nutrient load. Animal exclusion and septic maintenance will address both nutrient and pathogen problems. Riparian buffers help trap sediment and nutrients to enter streams in either residential or agricultural settings.

Nutrient loads from livestock and septics
According to the Indiana Census of Agriculture there are 3505 cows in the watershed.

Assume 43.585 lbs. P per animal per year from [106]
3505 beef cows x 43.585 lbs. P per animal per year x 30% = 153,694 lbs per year
Assuming 30% reaches streams:
Livestock P load = 46,108 lbs P per year

390 mg Phosphorus /L of septage from Table 46[107]
390 mg P/L x 1 lb/460,000mg x 3.7852 L/gallon = .0032 lbs/gallon septage
.0032 lbs/gallon x 70 gallons/day/person x 2128 septics x 2.5 ppl/home = 1195 lbs P/year
Assuming 30% reaches streams:
Septic P Load = 358 lbs/year

Combined P load from livestock and septics = 46,466 lbs per year

6.3.1 Nutrient Critical areas:

[105] Lake Lemon T by 2000 Feasibility Study, 1992, William W. Jones and Louise Clemency. http://www.state.in.us/dnr/fishwild/lare/pdf/Lake_Lemon-Monroe/Lake_Lemon_Feasibility_Study-Monroe-July92.pdf
[106] ftp://ftp-fc.sc.egov.usda.gov/NWMC/manurecharactertable.xls from Using Manure Characteristics to Determine Land-Based Utilization http://wmc.ar.nrcs.usda.gov/technical/WQ/manurechar.html#TBL1
[107] Decentralized Systems Technology Fact Sheet Septage Treatment/Disposal http://www.epa.gov/OWM/mtb/septage.pdf

According to L-THIA results, nutrient runoff is greatest in Stout's Creek and Jack's Defeat Creek. Griffy Creek, Lazy Creek and the North Fork of Bean Blossom also contribute high levels of nutrients. Areas that are critical for human or animal waste are also critical areas for nutrient loading. Similarly, areas where sediment loading is critical will be critical for nutrients as well. Failing septic systems, cows in the creek and streams with inadequate riparian buffers should all be considered critical areas for nutrient loading, particularly in the sub-watersheds identified by L-THIA.

In addition to agricultural fertilizer, golf courses and lawns should be considered a critical area/audience because they tend to use high rates of fertilizer. It was beyond the scope of this project to determine fertilizer use but there are 3 golf courses in the Bean Blossom watershed, all on the northeast side of Bloomington.

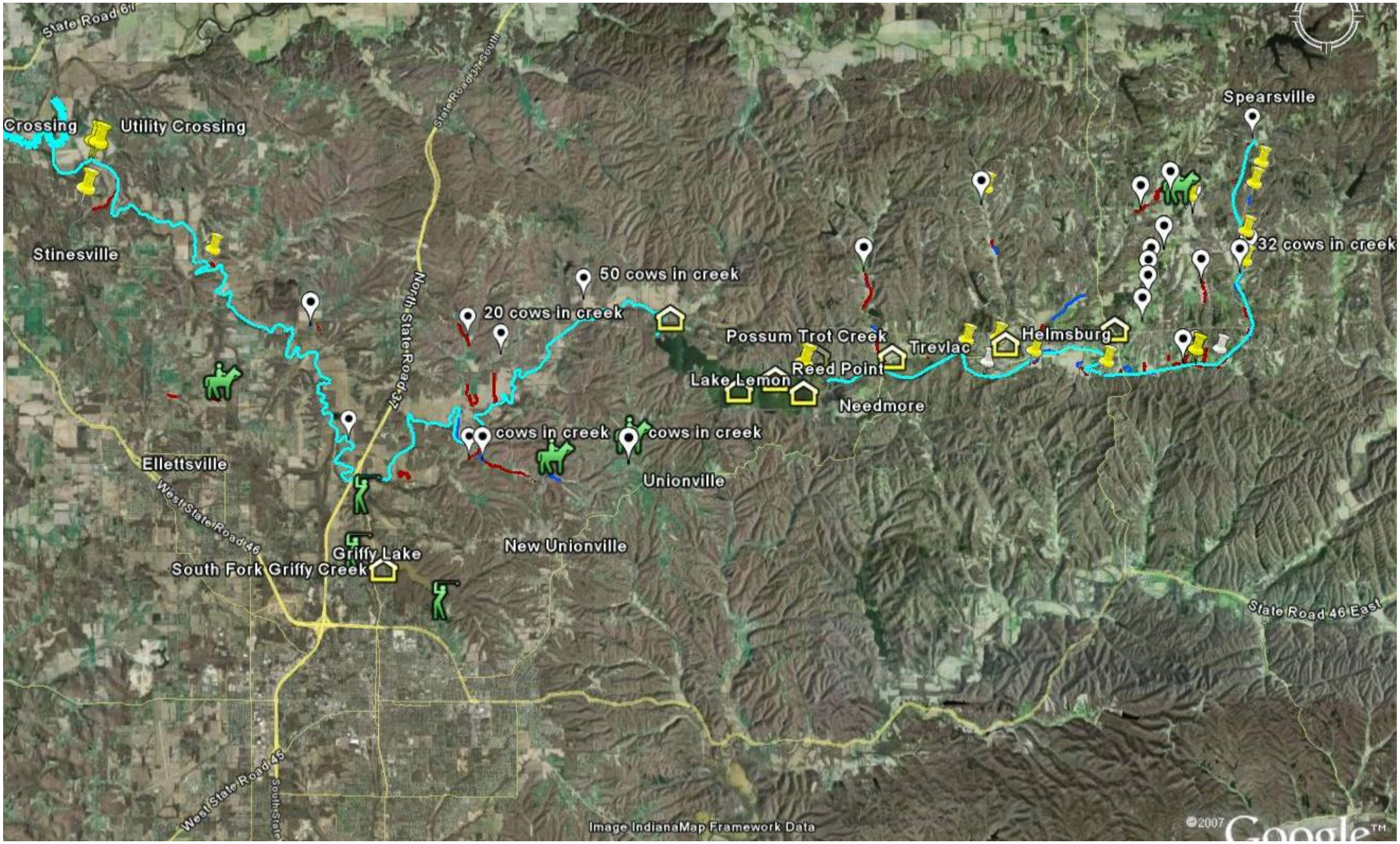

FIGURE 58: CRITICAL AREAS FOR NUTRIENTS IN THE BEAN BLOSSOM WATERSHED
Critical areas for nutrients include golf courses as well as failing septic systems, livestock manure, and eroding areas. The blue and red lines indicate inadequate or absent buffers as in Fig. 55.

TABLE 51: CRITICAL AREAS FOR NUTRIENT LOAD REDUCTION

Critical Area	Problems	Priority
Lake Lemon, Lake Griffy	Shoreline erosion contributes nutrients and lakefront homes on septics contribute to nutrient load.	1
Bean Blossom East Fork	Nutrient loads associated with sediment runoff. Livestock and homes on septics contribute to nutrients too.	2
Hoppers Branch	Small watershed but large nutrient load per acre mostly associated with agriculture and residential development on slopes and sensitive soils Livestock and homes on septics contribute to nutrient loads.	1
North Fork Bean Blossom/ Big Thunder Creek	Agricultural and pasture land uses on steep topography and highly erodible soils are a factor too. [108]	1
Buck Creek	Load from this small watershed is high due to amount of land converted from forest to row crops, pasture, and low density residential use, including septics.	1
Muddy Creek	Nutrient loading is high due to sensitive soils in row crops and pasture	2
Griffy Creek	TSS load is high because about 50% of land has been converted from forest. High percentage of impervious surface exacerbates runoff problems. Septics are a contributing factor as well as fertilizer use at 3 public Golf Courses in the Griffy Creek sub-watershed. • Cascades Golf Course, 3550 Kinser Pike, Bloomington, • Indiana University Golf Course St. Rd. 46 Bypass Bloomington • Taylor's Par Three Golf Course , 4975 N Hwy 37 Bloomington	1
Stout's Creek	Largely deforested. High total load and load per acre of nutrients.	1
Jack's Defeat Creek	Nutrient load is high due to very high percentage of land area devoted to agriculture and pasture as well as low density residential development.	1
Indian Creek	Agriculture and pasture runoff contribute nutrients.	2
Bean Blossom Mainstem	Many acres along the mainstem are devoted to high intensity row crop agriculture. These are close to creek so maximizing chances for nutrient runoff.	1
Throughout watershed	Livestock access locations where animals denude and erode streambanks and deposit nutrients directly into waterways.	1
Throughout watershed	Inadequately buffered stream banks. Most critical to install buffers along mainstem and where streambank erosion is present. See map Fig. 40& 41.	1
Throughout watershed	Steep slopes and highly erodible lands that are disturbed by farming, logging or construction, especially where there is no buffer present.	1
Throughout watershed	Active construction sites and areas of changing land use (future development), especially South Fork of Griffy Creek where rapid development is taking place	1
Throughout watershed	Conventionally tilled cropland especially where no buffer is present.	2
Throughout watershed	Small towns and unincorporated areas with dense residential development on small lots.	1
Throughout watershed	Older homes with no records of septic system installation or upgrade, including Fairwood Terrace (Prairie Drive), Audubon Hills, Merlin Hills off old 37.	1
Throughout watershed	Septic Systems in areas with high water tables, i.e. lakefronts.	1
Throughout watershed	Permitted discharges with no Phosphorus limits	1

[108] (from SCS Map)

6.4 Critical Areas for Water Quality Awareness

One of the over-arching problems identified in the watershed management plan is the lack of water quality awareness. We conducted an informal survey and found that area residents know little about how land use impacts water quality. We also found that most rural residents rely on septic systems but have little information about how their septic systems function.

Many of the concerns that were expressed during this project are real problems, but do not lend themselves to a conventional load reduction approach for a variety of reasons. A typical load reduction analysis looks at sources in the watershed and then attempts to minimize those sources through implementation of various practices. However, many pollutants defy classic load reduction approaches. In the case of mercury, data indicates that sources are actually outside the watershed. For PCBs, there are sources within the watershed but management practices to reduce loads are extremely expensive. For other pollutants, there are sources within the watershed but they are so diffuse or widespread that it is easier to identify a specific audience than to pinpoint geographic sources. We classify all these pollutants under the heading of water quality awareness because pollution prevention approaches seem the best way to minimize pollutant load. We outline critical areas and audiences as much as possible. .

6.4.1 Mercury and other Metals

While mercury is certainly a widespread problem throughout Indiana, there is no indication that other metals pose a serious water quality concern in this watershed. Metals are certainly present in the watershed, however, and public awareness of proper use and disposal is key to preventing water pollution.

It is difficult to identify sources of mercury within the watershed. Coal-burning power plants are a primary source of mercury deposition since mercury occurs as a contaminant in coal and older power plants are not required to remove it. With many old coal burning plants, Indiana is 4th in the nation in mercury emissions with about 7000 lbs per year of mercury emissions![109] Most of the population of the Bean Blossom watershed is using electric power generated by burning coal, a source of mercury, yet little coal is actually burned in the watershed, with the exception of the Indiana University Physical Plant.

Sources of mercury include dental offices, homeowners, hospitals, auto salvage operations, junkyards and dumps, and wastewater treatment plants.[110] Wastewater treatment plants have little control over what comes into their collection systems and wastewater treatment does not capture mercury it will end up in the river or in the sludge (biosolids) which are spread on the land and can also end up in waterways. Awareness of pollution prevention options and proper disposal methods is key.

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[109] http://www.cleartheair.org/dirtypower/map.html
[110] http://www.in.gov/recycle/topics/mercury/index.html

Mercury is used in some medicines (as a preservative), contact lens solutions, and in silver amalgam dental fillings. It is found in many consumer products, most notably fever thermometers, thermostats, fluorescent light bulbs, some novelty items that light up. Mercury is found in auto parts, including car headlamps and trunk light switches, but its use has been phased out by law and the state is offering a bounty on switches that are turned in for mercury recovery.[111] There is at only one auto salvage operation that we are aware of in the watershed, located on State Rd. 37 north of Bloomington.

A word about fluorescent bulbs – they do contain mercury vapor but dramatically reduce the amount of mercury put into the environment by reducing energy needs compared to the use of low efficiency incandescent bulbs. Fluorescent bulbs should be collected, protected from breakage, and recycled through your solid waste district. See http://www.in.gov/recycle/topics/mercury/index.html for more information about handling products containing mercury.

Brown County SWMD
176 Old State Road 46
P.O. Box 1308
Nashville, IN 47448
Phone: (812) 988-0140
E-mail: recycle@bcswmd.org
Internet: http://www.bcswmd.org

Monroe County SWMD
3400 Old State Road 37 South
Bloomington, IN 47401
Phone: (812) 349-2020
E-mail: bstrauss@mcswmd.org
Internet: http://www.mcswmd.org

TABLE 52: CRITICAL AREAS/AUDIENCES FOR MERCURY REDUCTION

Critical Area/Audience	Priority
Consumers of electric power	1
Junkyards and automobile shredders	1
Hospitals, clinics and dental offices	2
Consumers of cars, light bulbs, novelty items	2

[111] See Indiana's Auto Salvage Facilities Manual online at http://www.in.gov/idem/programs/land/autosalvage/manual/docs/auto_salvage_manual.pdf or contact Steve Mojonnier at IDEM's Office of Land Quality at (317) 233-1655 or smojonnier@idem.in.gov.

6.4.2 Pesticides

In a nationwide study of pesticides and water quality, at least one pesticide was detected in water from all streams studied and at least one pesticide was detected more than 90 percent of the time in water from streams draining agricultural, urban, or mixed land uses.[112] Identification of specific geographic locations where pesticides are used is beyond the scope of this project, in part because pesticide use is so widespread. However, we can identify some critical audiences for information about minimizing pesticide use, especially around children.

TABLE 53: CRITICAL AREAS/AUDIENCES FOR PESTICIDE REDUCTION

Critical Area/Audience	Priority
Increased awareness about pesticide drift	1
Schools, especially grounds and building maintenance staff	1
Park Departments staff charged with grounds maintenance	2
Farmers, especially those near schools and waterways	2
Homeowners	2

6.4.3 PCBs, Carcinogens and Toxics

While we have established that MTBE is not a serious concern in this watershed, fuel and hydrocarbons are certainly in widespread use and awareness of their potential impacts to water quality is the key to preventing them. Critical audiences include gas stations and boaters who might spill fuel directly into waterways.

The Stout's Creek watershed has landfills that are clearly a source of Poly-Chlorinated Biphenyls (PCB) contamination. PCB's are a class of chemicals known to include carcinogens. Cleanup is underway but is controversial and expensive. The South Fork of Griffy Creek tested positive for Polycyclic Aromatic Hydrocarbons (PAHs). PAHs are a class of chemicals known to include some that are very toxic and that have endocrine disrupting activity. PAHs are especially toxic to aquatic life. Sources of PAHs are treated wood and asphalt often associated with urban development.

PCB contamination in the Stout's Creek sub-watershed has been confirmed. The use of PCBs has been minimized in recent years, but historic sources are still present. Westinghouse plant made capacitors containing PCBs from 1957 to 1977. The plant changed hands to Viacom and CBS before going out of business.[113] During its operation, PCBs that spilled during manufacture were washed down the drain into the Bloomington

[112] **Pesticides in the Nation's Streams and Ground Water, 1992–2001**
Jeffrey D. Martin, USGS Indiana Water Science CenterPreseented at Indiana Water Resource Association meeting 2006. http://cobweb.ecn.purdue.edu/~frankenb/iwra2006/IWRA_Proceedings.pdf or http://ca.water.usgs.gov/pnsp/pubs/circ1291

[113] New study sees more deaths from certain types of cancer among former factory workers exposed to PCBs by Steve Hinnefeld Herald Times February 26, 2006 http://copa.org/2006/news/ht_2_26.html

sewer system. Gardeners and farmers who accepted sewage sludge during this period got more than they bargained for, and few records exist.

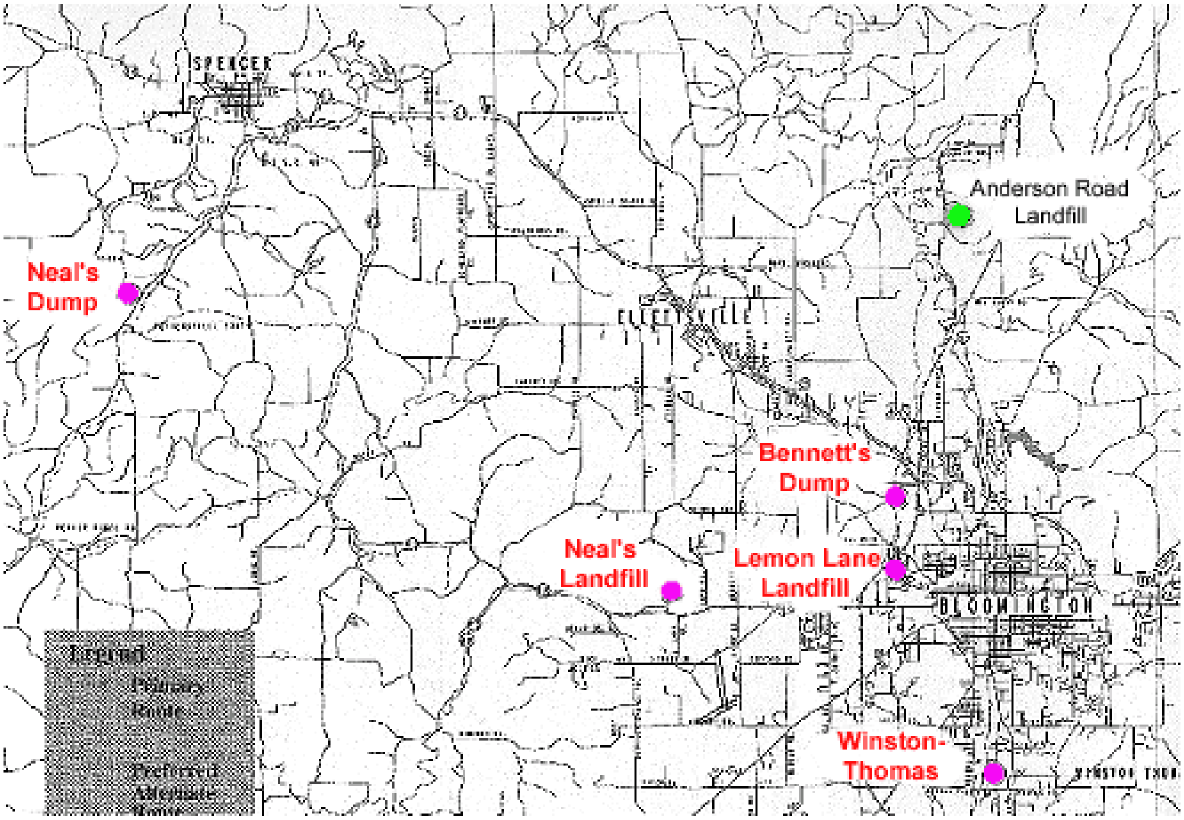

FIGURE 59: KNOWN PCB CONTAMINATION SITES

Defective capacitors were hauled to local landfills: Lemon Lane, Bennett's Quarry/Dump, Neal's Landfill, Neal's Dump, and Anderson Road Landfill and Winston Thomas sewage treatment plant. Of these, only Lemon Lane, Anderson Road and Bennett's Quarry are in the Bean Blossom watershed. The Bennett's Quarry and the original Westinghouse site drain into Stout's Creek while the Lemon Lane Landfill drains to both Stout's Creek and Clear Creek (not a Bean Blossom tributary).

The plan for remediation was memorialized in a Consent Decree that was entered by the United States District Court for the Southern District of Indiana in 1985. The Consent Decree called for construction of an incinerator to destroy PCB-contaminated soils and materials excavated from six sites. Public opposition to the incinerator arose before and after the Consent Decree and the Indiana State Legislature passed several laws which prevented any immediate consideration of incinerator permit applications.

Anderson Road Landfill

The Anderson Road Landfill is an 80-acre sanitary landfill serving Monroe County. In the 1960s and 1970s, part of the landfill was used for the disposal of PCB waste from the Westinghouse plant. In 1987, the PCB-contaminated waste was excavated and placed into a storage facility constructed for that purpose at the Winston-Thomas Treatment Plant, another PCB-contaminated site in Bloomington. Water from a contaminated pond near the Anderson Road Landfill was transferred to a contaminated lagoon at the Winston-Thomas Treatment Plant. [114] Today this site is considered remediated except that some low wooded areas nearby were found to have low level PCBs.

Lemon Lane

In 1987, interim remedial measures were implemented to minimize any immediate threat to public health and the environment. Surface capacitors were removed and eroded slopes were graded and stabilized. Clean fill was placed over the landfill surface followed by a 36-mil Hypalon geomembrane cover. The interim cover was maintained by Viacom until 2000, when Lemon Lane was excavated and capped. [115]

Even though removal and consolidation activities have been completed at the Lemon Lane Landfill, PCBs continue to be released from the Landfill to the Illinois Central Springs, where the EPA has built a 1000 gallon per minute water treatment plant. Viacom, the responsible party, refused to pay for the treatment plant, preferring to reduce the flow of PCBs to the springs. When pumping was conducted in 2001 at a quarry site known as MW-21 the PCB levels actually rose at Illinois Central Springs. Lowering the amount of water getting to the Springs actually caused the concentrations of PCBs to go up. Dye tests indicate that water is flowing through karst features (caves) from the area where there are high PCB levels towards the southwest (towards the Springs) although there may be layers where the water moves to the northeast as well. The travel time to Illinois Central Springs was 21 hours at 170 gallon per minute average flow rate.

Bennett's Quarry[116]

During the 1960s, a portion of the Bennett's Stone Quarry, located 2.5 miles northwest of Bloomington, was used as an uncontrolled dump for electrical parts and capacitors containing PCB dielectric fluid. Monroe County first discovered Bennett's dump contaminated site in 1983. Initial remedial measures included:

- Installation of a locked, 8-foot high chain link and barbed wire security fence
- Removal of 252 visible capacitors and excavation of 20 cubic yards of stained soil
- A clay cap at least 16" thick was installed over the main site.

In 1999, CBS began excavation at the site and disposed of a total of 36,172 tons of PCB-contaminated material in an off-site landfill permitted to accept PCBs. During excavation activities in 1999, three deep quarry pits filled with rubble and fill were discovered. Capacitor parts and PCB contaminated soils were found above the rubble and groundwater at these locations had a light, oily sheen.

[114] Citizens Opposed to PCB Ash website http://www.copa.org/studies/scind/anderson/intro.htm
[115] *Lemon Lane Cap Inspection and Maintenance Plan* http://www.copa.org/2001/llcap/final-cap.html
[116] Citizens Opposed to PCB Ash http://www.copa.org/2006/bennetts/Benn_Rod_06.pdf

Although Bennett's Quarry has been fully excavated to bedrock, PCBs are still being released to Stout's Creek from springs near the Bennett's Quarry site. After completion of the remediation, a series of periodic flowing springs and seeps developed at the Bennett's Dump Site containing PCBs. These springs discharge directly into Stout's Creek, which flows along the western edge of the Site. These springs are the headwaters of Stout's Creek. Historical analysis of aerial photographs shows springs on the Site, but not at the location of the current springs. It is felt that the quarrying operation, the remedial excavation, and the nearby construction of the State Rd. 46/37 overpass may have changed the water flow patterns over the years.

There are four springs within the Bennett's Dump Site and an additional spring is located within the channel of Stout's Creek referred to as Rusty Spring. None of these springs flow continuously and the PCB content in the water ranges from 0.57 ppb to 7.3 ppb, with a median value of 1 ppb.

In 2004, Viacom released the Final Report for the Groundwater Investigation Plan. Unlike the Illinois Central Springs, which releases large slugs of PCBs with each storm, Bennett's Springs release PCBs at a steady rate, indicating that the springs are not fed by conduits in the karst bedrock and that releases are not related to storm events. Viacom proposed lowering the water level in adjacent quarries to reduce movement of PCBs to the springs via installation of a passive quarry drain to reduce groundwater flow and construction of groundwater interceptor trench with carbon adsorption treatment for the PCB contaminated groundwater. Because this remedy will leave PCBs on-site above levels deemed safe for unlimited use and unrestricted exposure, a statutory review will be conducted within five years to ensure that the remedy is, or will be, protective of human health and the environment.

Table 54: Critical Areas/Audiences for Toxics

Critical Area/Audience	**Priority**
Fishermen especially for PCBs	1
Stout's Creek especially for PCBs	1
South Fork Griffy Creek especially for PAHs	1
Boaters especially for fuel and other hydrocarbons	2
Gas stations, especially those near waterways	2

6.4.4 Trash and Litter

Trash and litter problems in the watershed are limited. There are few data available, but we observed some dump sites in ravines on private property. These were often hidden by vegetation and difficult to detect, but they can be a source of water pollution, especially if they include pesticide containers and appliances that may contain PCBs. Litter is observed in the more populated portions of the watershed, including more popular recreational areas. An Indiana University student group regularly picks up litter at Griffy Lake. The litter generally includes bait cups used by fishermen, as well as fast food wrappers and beverage containers. While the problem is not severe in most of the watershed, we felt that it was important to address it because it seems to reflect a general attitude about water resources.

Table 55: Critical Areas/Audiences for Trash and Litter

Critical Area/Audience	**Priority**
Stout's Creek	1
Griffy Lake	1
Fishermen	1
Recreational users	1

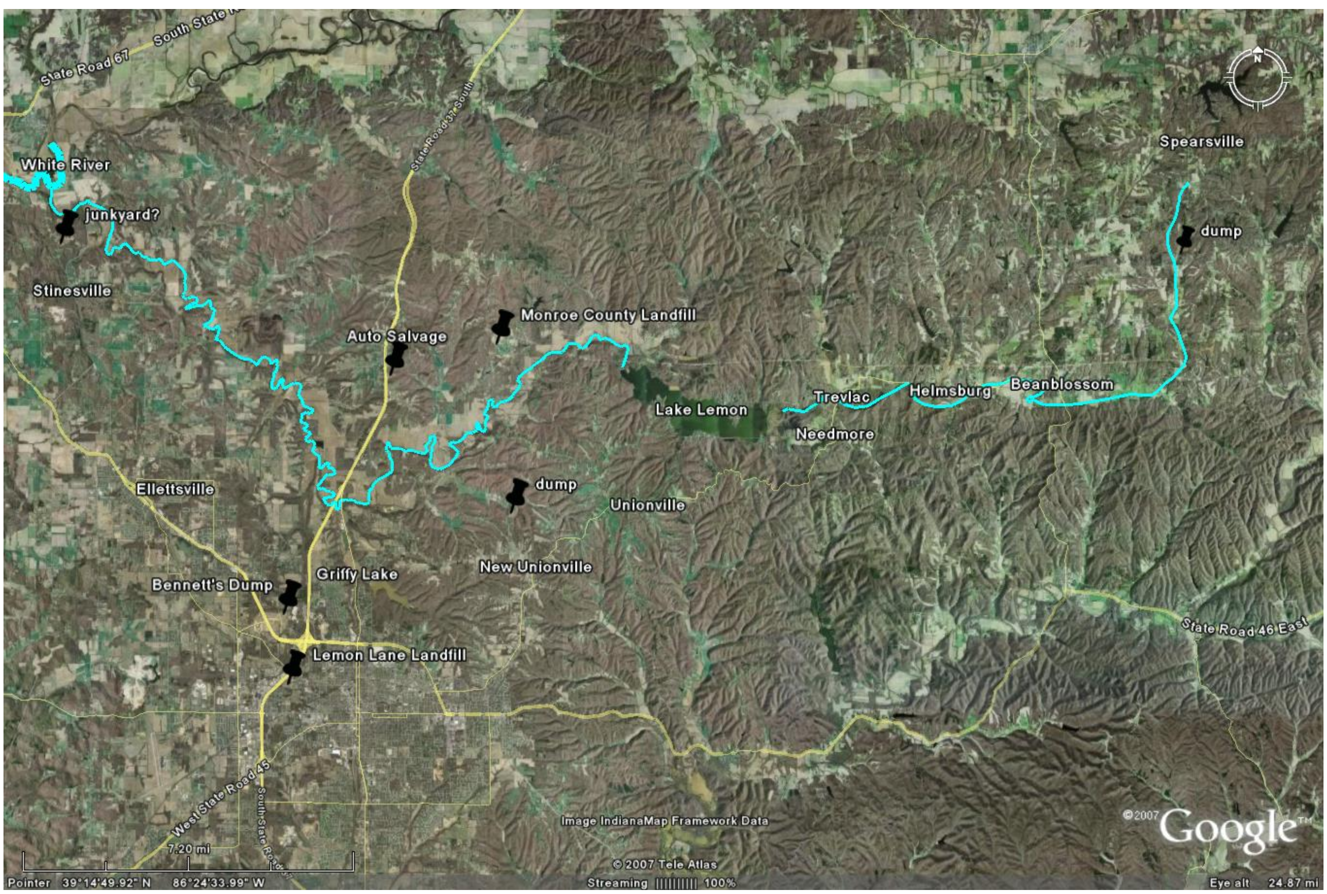

FIGURE 60: CRITICAL AREAS FOR DUMP SITES.

6.4.5 Water Quantity, Flooding and Water Conservation

The steep slopes, narrow valleys of the Bean Blossom watershed lead to rapid water runoff and rapid flooding of downstream areas. Impervious surfaces such as rooftops and roadways exacerbate this effect, especially those near waterbodies. The se effects can be mitigated by measures and practices that retain stormwater on the land, including wetlands, stormwater retention basins, green roofs and rain gardens.

Table 56: Critical Areas/Audiences for Water Quantity Issues

Critical Area/Audience	Priority
County employees and officials responsible for drainage and land use decisions	2
Establishment of ordinances that prevent building/filling in flood plain	2
Helmsburg	2
Trevlac	2
Unincorporated area of Bean Blossom	2
Jack's Defeat Creek	2
Ellettsville	1
Residential property owners	1

7.0 ACTION PLANS FOR WATERSHED RESTORATION

In this chapter we present action plans for each of our problem areas. After the watershed steering committee had reviewed concerns, pollutant sources, and critical areas, we set goals and decided on action items to address those problems. These action plans include measures that encompass agricultural, forested, rural residential, and urban land use settings. The action plans also includes mechanisms to continue to identify and refine information about pollution sources where existing data were limited, sources of funding for implementation and measures to assess progress toward goals.

Our action steps are designed to target specific pollutants (E. coli, nutrients, sediment, etc.) to improve water quality of streams and lakes in the watershed. Stakeholders evaluated environmental, economic, and social impacts of the recommendations. Some of the actions recommended will require policy changes while others can be accomplished immediately under existing policies. Some of the action items can be carried out right away by volunteers with minimal funding, including much of the ongoing monitoring for success. Other recommendations will require professional assistance and significant funding.

Setting realistic and measurable goals is crucial to the successful implementation of this watershed management plan and ultimate stream restoration. The successful implementation also depends on expanded stakeholder involvement. The steering committee has provided core leadership, but real ownership will require more public involvement. The number of stakeholders participating in plan development is not enough to implement the plan. Future watershed management efforts will make this the first priority before efforts to achieve other watershed goals.

The stakeholders prioritized the goals at steering committee meetings. Our top priorities are to engage more people in the watershed protection process and address those areas in the watershed with the highest E. coli concentration and the highest likelihood for human contact.

This action plan is meant to be a “living” document. Action items are subject to change in response to funding availability and shifts in priorities of the partner organizations.

7.1 Pathogen Action Plan

Goal: Restore safe E. coli levels in the Bean Blossom Creek and tributaries throughout the year by 2020. Maintain safe E. coli levels in Lake Lemon and Lake Griffy. Currently E. coli levels exceed safe values all along the Bean Blossom Creek except in Lake Lemon. Safe E. coli levels are defined in the TMDL for Bean Blossom Creek as a geometric mean of 125 E. coli per 100 ml during the recreational season. In light of new data about survival of E. coli in the environment, the goal of this watershed management plan is to see that geometric mean of 125 cfu/100 ml be met year-round. It is our further goal that the single sample standard of 235 E. coli per 100 ml be met at all times.

Many of the objectives and action items below involve providing communities with more options for rural wastewater treatment. Composting toilets, the Presby system and other alternative systems can solve many problems for communities with poor soils, high water tables or small lots and failing septics, but the current policy framework does not facilitate the use of these alternatives.

7.1.1 Pathogen Load Reduction Objectives and Indicators

The primary indicator of progress toward this goal is E. coli levels in area streams. To achieve the water quality goals above, we need to reduce current load by 81.6% or 1.86×10^{15} CFU/year (See Table 16 on page 47).

Pathogen Reduction Objective 1. **Ensure that all onsite wastewater treatment systems are functional and non-polluting.** Many of the action items below involve providing communities with more options for rural wastewater treatment. Composting toilets, the Presby system and other alternative systems can solve many problems for communities with poor soils, high water tables or small lots and failing septics, but the current policy framework does not facilitate the use of these alternatives. Based on our estimate of 7092 septic systems in the watershed (from Section 6.1.3, pg 99) and an assumption that at least 30% of septic systems are failing, we estimate that we can reduce loads by at least 5.14×10^{15} fecal coliform counts per year if we ensure that all septic system are inspected and maintained.

Pathogen Reduction Objective 2: **Ensure that all communities in the watershed have properly functioning wastewater treatment facilities at all times, especially in critical areas. .** This objective is likely to result in significant load reduction, but the results are difficult to quantify. At a minimum, accomplishing this objective should ensure that permitted discharges are meeting the target E. coli levels during warmer months.

Pathogen Reduction Objective 3: **Work with livestock owners to promote widespread implementation of livestock Best Management Practices in watershed, especially minimizing livestock access to streams.** From Section 6.1.4, page 103, we estimate that Total Cattle = 3505. Assuming all these are beef cattle and an E. coli production rate of 6.3×10^{10} CFU/animal/day[117], we estimate the total E. coli loading

[117] Total Maximum Daily Load for Pathogens Beeds Lake Franklin County, Iowa. 2006. Iowa Department of Natural Resources. http://www.iowadnr.com/water/watershed/tmdl/files/final/beeds.pdf

from these animals at 3.45 x 10^{11}. If the cattle stand in the stream about 30% of the time, then we have a loading rate of 6.62x10^{13}. Livestock exclusion from streams would be expected to eliminate nearly this entire load.

Pathogen Reduction Objective 4: **Engage more public participation and monitor progress** This action item is not likely to result in load reduction in itself but it will help engage the community, pinpoint sources and track progress.
Taken together, the E. coli load reductions we have identified in this section are expected to eliminate at least 2.43 x 10^{16} CFU/year, more than enough to reach the goals.

TABLE 57: PATHOGEN REDUCTION ACTION STEPS

Pathogen Objective 1	**Ensure that all onsite wastewater treatment systems are functional and non-polluting.**	**Cost**	**Potential Partners**	**Potential Funding Sources**	**Time frame/ Priority**	**Interim benchmarks**
Action #						
PTHN 1-1	Develop educational materials for realtors and home inspectors, preferably via distance learning modules.	25,000	HEC, Realtors	Realtors Association, Homebuyers could pay fee for service	Very High. 2008-2010	Production of video or webcast
PTHN 1-2	Pass ordinance requiring septic system inspection at point of sale in Brown and Monroe counties to ensure that a proper septic system exists.	10,000	*Health Departments,* County Commissioners, Realtors, HEC	Monroe County Health Dept. can cover staff costs. Brown County Health Dept. needs funding.	High, 2010-2012	# inspections performed; number of repairs made.
PTHN 1-3	Step up enforcement and repair of failing septic systems, especially in critical areas identified.	10,000/yr ongoing	HEC, SWCDs, Health Departments, USDA	SWCD, Stormwater utility fees could be used in Monroe County. USDA Rural Utilities Service Programs in Brown Co.	High. 2008-2010	# inspections; # repairs
PTHN 1-4	Offer cost share assistance and/or low interest loans.	50,000	SWCDs, HEC	Brown County SWCD will offer 50% cost share for repair or replacement.	High. 2008-2010	# repairs, # applicants for cost-share
PTHN 1-5	Prepare and distribute outreach brochure to home-owners and prospective home-buyers on responsible septic system maintenance. Promote water conservation measures that improve performance of septic systems.	30,000	HEC, SWCDs, Health Departments, Lake Lemon Conservancy District, SWEET, Septic Haulers	Community Foundations, EPA Targeted Watershed Program	High. 2008-2010	Community survey responses
PTHN 1-6	Establish framework to ensure that all septic systems are maintained properly. This could be done by the existing county-wide regional sewer district in Monroe County. In Brown County, a county wide Regional Sewer District could be established or the health department could be authorized and funded to accomplish this task.	50,000	County Commissioners, County Health Departments, SWCDs, RCAP HEC, Septic Haulers	Community Foundations, USDA, Brown County SWCD, EPA Targeted Watershed Program	High. 2010-2015	Record keeping system in place, # systems maintained

Pathogen Objective 1 Continued	**Ensure that all onsite wastewater treatment systems are functional and non-polluting.**		**Potential Partners**	**Potential Funding Sources**	**Priority/Time frame**	**Interim benchmarks**
PTHN 1-7	Develop ordinance to facilitate alternative residential wastewater treatment systems, including secondary treatment and Presby systems, especially in areas where conventional septics function poorly, e.g. areas with high water table or poor soils.	6,000	RCAP, HEC, Health Departments, County Commissioners, SWCDs, Developers, LLCD	Developers, Septic System Manufacturers	High. Ongoing. review ordinances in 2008	Ordinance in place to facilitate alternatives; # alternatives installed
PTHN 1-8	Where several homes have failing septic systems, develop community cluster systems with sewer collection and soil discharge, as explored by the Rural Wastewater Task Force. It is less expensive initially, requires less maintenance, is more reliable and aesthetically pleasing than package treatment plants.	Cost per unit will be high but not so high as package treatment plants.	RCAP, Bean Blossom Regional Sewer District, Health Departments, HEC, IDEM	Homeowners, USDA, SRF, EPA Targeted Watershed, USDA Self Help Housing Loans or Waste Disposal Grants	High. 2012-2020.	Cluster systems established
PTHN 1-9	Establish infrastructure for water conserving systems such as composting toilets and other alternatives. There is a great deal of interest based on attendance at a Brown County Workshop on this topic.	10,000	County Health Depts. ISDH, Septic Haulers HEC RCAP? IOWPA		High, but requires policy changes. 2009-2011	Adoption of policies that facilitate alternatives
PTHN 1-10	Ensure that county decision makers (planning offices, tax assessors and health departments) are sharing parcel information, GIS systems and requirements for new construction.	15,000	County staff & Commissioners, Chamber of Commerce Economic Development groups	Existing county budget, community foundations	High. 2008-2012, ongoing	Information sharing, Unique identifier for each parcel shared by departments

Pathogen Reduction Objective 2	Ensure that all communities in the watershed have properly functioning wastewater treatment facilities at all times, especially in critical areas.	Relative Cost	Potential Partners	Potential Funding Sources	Priority	Interim benchmarks
Action #						
PTHN 2-1	Develop policy document to promote alternatives to conventional package treatment plants. Conventional package plants have a high failure rate, especially when not properly maintained. Alternative systems will need oversight.	5,000	RCAP, Bean Blossom Regional Sewer District, Health Departments, HEC, IDEM	USDA, SRF, EPA Targeted Watershed	High. 2008 for BB RSD, 2010 and beyond for others	Cluster systems established
PTHN 2-2	Convert the unincorporated area of Bean Blossom to a sewer collection system with treatment, preferably an alternative treatment system such as a cluster system with a constructed wetland for secondary treatment prior to soil based treatment.	Cost per unit will be high but not so high as package treatment plants.	RCAP, Bean Blossom Regional Sewer District, Health Departments, HEC, IDEM	USDA, SRF, EPA Targeted Watershed, Individual households could pay fee for service	High. 2008-1012	Number of alternative systems installed and monitored; # developers participating
PTHN 2-3	Incorporate E. coli limits into direct discharge permits. Achieve year round disinfection and de-chlorination of discharge from all permitted outfalls.	Within existing budgets	IDEM, HEC	Individual dischargers	High. As permit renewals come up.	Permits modified with year round E. coli limits
PTHN 2-4	Establish routine annual inspection for all package treatment plants.	??	IDEM, HEC	Permit fees?	2009 onward	# Inspections
PTHN 2-5 (same as PTHN 1-8)	Where several homes have failing systems, develop community cluster systems with sewer collection and soil discharge, as explored by the Rural Wastewater Task Force. It is less expensive initially, requires less maintenance, is more reliable and aesthetically pleasing than package treatment	Cost per unit will be high but not so high as package treatment plants.	RCAP, Bean Blossom Regional Sewer District, Health Departments, HEC, IDEM	USDA, SRF, EPA Targeted Watershed	2010 – 2015	Cluster systems established

Pathogen Reduction Objective 3	**Work with livestock owners to promote widespread implementation of livestock Best Management Practices in watershed, especially minimizing livestock access to streams in critical areas.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Time frame/ Priority**	**Interim benchmarks**
Action #						
PTHN 3-1	Ensure that confined feeding operations are not violating their permits which specify zero discharge.	1000	IDEM, volunteers, HEC, Hoosier Riverwatch	Hoosier Riverwatch, IDEM fees	High. 2008-ongoing	# inspections, volunteer data
PTHN 3-2	Develop local ordinance and framework for oversight of responsible manure management that includes reporting how much manure is spread where.	5000	County Commissioners, HEC, NRCS, volunteers	HEC	High. 2010 for oversight, 2009 for ordinance	Ordinance passed
PTHN 3-3	Promote cost-share for best management practices that exclude livestock from streams, providing alternative water source.	20,000	Landowners, NRCS, SWCDs, HEC	USDA, IDEM 319	High. Expanded 2008-2010	BMPs installed
PTHN 3-4	Promote prescribed grazing and pasture improvement to minimize over-grazing and runoff.	25,000	NRCS	USDA, IDEM 319	High. Expanded 2008-2010.	Acres of prescribed grazing
PTHN 3-5	Develop marketing of BMPs and cost share opportunities that target owners of small herds of cattle and horses.	6000	NRCS, SWCDs, Trail Riders Assn, 4-H, HEC	IDEM 319	High. 2008-2012	Marketing materials produced/distributed.

Pathogen Reduction Objective 4	**Conduct regular coordinated testing of streams, possibly testing for laundry brighteners and caffeine as well as E. coli.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Time frame/ Priority**	**Interim benchmarks**
	Action Items:					
PTHN 4-1	Form Bean Blossom Guardians group and promote adoption of stream segments.	2000	DNR Adopt-A-River; HEC	HEC, Community Foundation	High. Riverwatch group started 06, Guardians formed by June, 2008.	Volunteers participating in monitoring
PTHN 4-2	Recruit volunteers on an ongoing basis	2000	Hoosier Riverwatch, HEC	HEC, Community Foundation	High. Ongoing	Volunteers participating in Riverwatch
PTHN 4-3	Host workshops to train volunteers on monitoring for E. coli, caffeine and laundry brighteners as well as sediment and nutrients	2000	Hoosier Riverwatch, HEC,	Riverwatch, HEC, Bloomington Parks	High. 2008-2009	Workshop conducted, Attendance, Follow through monitoring

SWCD = Soil and Water Conservation District
HEC = Hoosier Environmental Council
LLCD = Lake Lemon Conservancy District
SWEET = Storm Water Environmental Education Team
RCAP = Rural Community Assistance Program
ISDH = Indiana State Dept. of Health
IDEM = Indiana Dept. of Environmental Management
IOWPA = Indiana Association of Onsite Waste Professionals
NRCS = Natural Resource Conservation Service
319 = IDEM's Section 319 grant program
DNR = Department of Natural Resources

7.2 *Sediment Reduction Action Plan*

Goal: ***Achieve sediment load of 2162 tons per year by 2020.*** (See Table 16 on page 47).

7.2.1 Sediment Reduction Objectives and Indicators

The primary indicators for load reduction are Total Suspended Solids and Secchi Disc readings. Sediment load needs to be reduced by 87.6% or 15,219 tons per year (See Table 16 on page 47).

Sediment Reduction Objective 1: **Enhance riparian corridors**
Sediment Reduction Objective 2: **Promote mechanisms that minimize stormwater runoff.**
Sediment Reduction Objective 3: **Implement Bank Stabilization along eroding areas.**
Sediment Reduction Objective 4: **Minimize soil erosion in agricultural areas.**
Sediment Reduction Objective 5: **Minimize soil erosion in developing areas**
Sediment Reduction Objective 6: **Minimize soil erosion in forested areas.**
Sediment Reduction Objective 7: **Engage more public participation and monitor progress**

There are about 8.6 miles of stream with inadequate or absent riparian buffer. Using Google Earth aerial photography, we identified 130,898 linear feet of streams that had no buffer present and 45,339 that had inadequate buffer present (less than the minimum width of 35 feet). Thirty five foot wide forested buffers installed in the areas indicated will amount to about 123 acres of riparian buffer. Installation of buffers to treat runoff from 3000 acres will reduce sediment load by **14,497 tons per year**. Installation of 4 wetland areas totaling about 300 acres will reduce sediment load by 35,691 lbs/year or **17.84 tons/year**.

Streambank erosion is an issue throughout the watershed, especially in the steeper eastern headwaters. Streambank stabilization at 5 critical sites totaling 4568 linear feet of streambank would reduce sediment load by an estimated **776.6 tons per year.** Gully stabilization measures along 12,000 linear feet of waterways would reduce sediment load by **1147 tons per year.**

Implementing this action plan will reduce sediment load by about 16,438 tons, more than enough to achieve the necessary load reductions.

TABLE 58: SEDIMENT REDUCTION ACTION STEPS

Sediment Reduction Objective 1	Install practices that trap sediment	Relative Cost	Potential Partners	Potential Funding Sources	Priority/ Timeframe	Interim Benchmarks
	Action Items					
SDMT1-1	Review plat maps to identify key land owners to install riparian buffers and other BMPs. Promote existing cost-share programs and develop new ones as appropriate for streambank stabilization measures, forested, shrub, or grass buffers.	20,000	NRCS, SWCDs, HHRC&D, SWEET, HEC, Landowners	319, Community Foundations	Very high. 2008-2010, ongoing	Acres of buffers installed.
SDMT 1-2	Educate homeowners and landowners about the benefits of buffers through workshops. Identify willing landowners and improve riparian (river) and lacustrine (lake shoreline) buffers.	5000	NRCS, SWCDs, HHRC&D, HEC, Landowners	319, Community Foundations	Very high 2008-2010	Acres of buffers installed.
SDMT 1-3	Organize volunteers to help plant buffers. Partner with the Hoosier Heartland Resource Conservation & Development "Plant A Million" tree-planting program.	3000	HHRC&D, HEC, Sycamore Land Trust?	Community Foundations	High. 2008-2010.	# Trees Planted, # volunteers, # landowners, acres planted
SDMT 1-4	Explore the feasibility of restoring 4 wetlands in appropriate areas, especially around Trevlac and Aqua Isle	6000	NRCS, Nature Conservancy, Sycamore Land Trust, IU SPEA	319, Community Foundations, EPA Targeted Watershed, WRP	High. 2009-2010.	Acres of wetland restored
SDMT 1-5	Promote urban forested buffers that can serve double duty as greenways	Within existing budget	Parks Departments, HHRC&D, HEC, SWEET	Parks Departments, 319, Community Foundations, EPA Targeted Watershed	High. 2008-2020.	# trees planted, acres buffer installed
SDMT 1-6	Provide conservation easements to create/retain a forested buffer boundary between residential development and waterways, especially lakes.	20,000	Planning Depts, Developers, NRCS, SWCDs, HEC, Parks Departments	319, Community Foundations, EPA Targeted Watershed	High. 2008-2009 Monroe Co. Comp Plan	Acres buffered

Sediment Reduction Obj. 2	**Promote mechanisms that minimize stormwater runoff.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
SDMT 2-1	Develop projects to showcase rain gardens Green Roofs, Permeable Pavement, etc.	20,000	IU SPEA, Bloomington Parks Dept. SWEET, CSI	319, EPA Targeted Watershed, Community Foundation	High. 2008-2012.	Demonstration projects in place
SDMT2-2	Develop tax credits and other incentives for stormwater retention	10,000	County Commissioners, Planning with POWER, County Surveyors, SWEET, SWCD	319, EPA Targeted Watershed, Community Foundation	High. 2009-2012.	Ordinance passed

Sediment Reduction Objective 3	**Implement Bank Stabilization along eroding areas.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
Action #						
SDMT3-1	Identify landowners along eroding areas and use parcel maps to contact landowners and promote bank stabilization BMPs and cost share opportunities in critical areas.	20,000	NRCS, SWCD, HEC,	319, EPA Targeted Watershed	Very High. 2008-2010.	Streambank stabilization projects installed
SDMT3-2	Develop bank stabilization demonstration area along SR 45 between Bean Blossom and Helmsburg at prominent location.	100,000	NRCS, SWCD, HEC, INDOT, County Surveyors	319, EPA Targeted watershed, Community Foundation	Very high. 2008-2012.	Demonstration site developed
SDMT3-3	Identify adjoining landowners suffering from erosion and encourage them to join forces for stream channel restoration. This may be especially appropriate at the east end of Lake Lemon.	5000	Landowners, NRCS, Sycamore Land Trust, Steve Hall,	319. Private landowners, Land trust	Medium. 2010-2015	Stream restoration projects

Sediment Reduction Objective 4	**Minimize soil erosion in agricultural areas.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Indicators**
Action #						
SDMT 4-1	Identify inadequately buffered fields for BMPs. Provide cost-share to establish residue management or field border buffers on fields with highly erodible soils	12,000	NRCS, SWCDs, HEC	319, WHIP, LARE	Very High. 2008-2010	Acres buffered or improved
SDMT 4-2	Provide cost-share to convert row crops on highly erodible lands to hay or cover crops.	10,000	NRCS, SWCDs,	319, Farm Bill, LARE	Very High. 2008-2010	Acres converted to cover crops
SDMT 4-3	Improve pasture management, especially for small-holdings. Minimize over-grazing, especially on steep slopes. Establish good pasture rotation and implement pasture improvements. Ensure that a pasture management plan is in place.	20,000	NRCS, SWCDs,	319, Farm Bill, LARE	High. Presently ongoing.	Pasture acreage improved

Sediment Reduction Objective 5	**Minimize soil erosion in developing areas**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
SDMT 5-1	Develop and recommend ordinances to restrict building on slopes, restrict building in intermittent waterways and mitigate impervious surfaces with rain gardens.	2000	Planning with POWER, Planning Departments, SWCDs HEC	319, Private Donors, Targeted watershed	Very High. 2008-2010.	Ordinance passed
SDMT 5-2	Establish a mitigation bank for development impacts to wetlands.	8000	Developers, Sycamore Land Trust, Nature Conservancy, HEC	Developers?, 319?	High. 2009-2011	Bank established
SDMT 5-3	Develop educational materials and review ordinances to promote permeable pavement	6000	Developers, homeowners, SWEET, SWCD's HEC, Center for Sustainable Living	319, existing budgets	High. Presently ongoing, expanded 2008-2012	Track sales, Adoption
SDMT 5-4	Develop a mechanism for Rule 5 enforcement (currently there is no staff person to enforce.).	25,000	SWCDs, Planning Departments, NRCS??, HEC	Unknown	Very High. 2008-2010.	Mechanism in place

Sediment Reduction Objective 6	Minimize soil erosion in forested areas.	Relative Cost	Potential Partners	Potential Funding Sources	Priority/ Timeframe	Interim Benchmarks
SDMT 6-1	Host sustainable forestry workshop for private landowners to promote sustainable forestry in general and the project's cost share opportunities in particular. Help landowners understand how they can develop a steady income stream from forested land while protecting water quality for future generations.	5000	HHRC&D, CSL, HEC, Native Forest Council, Heartwood, Indiana Woodland Owners Association	Native Forest Council, Community Foundations, 319, Private Donors	Very high. 2008-2009.	# participants
SDMT 6-2	Establish a Sustainable Forestry Certification Program	20,000	HHRC&D, CSL, HEC, Native Forest Council, Heartwood, Indiana Woodland Owners	Native Forest Council, Community Foundations, 319, Private Donors	Very high. 2008-2010.	Certification program in place
SDMT 6-3	Make timber harvest BMPs mandatory with inspection and enforcement. State Forestry Management plan includes spot checks, but this is insufficient Legislation has been considered to require BMPs on private lands but this has not yet passed.	3000	Native Forest Council, DNR, HEC, legislators, Indiana Woodland Owners Association	Native Forest Council, Community Foundations, Private Donors	High, but requires legislation 2008-2012.	Law passed

NRCS = Natural Resource Conservation Service
SWCD = Soil and Water Conservation District
HEC = Hoosier Environmental Council
IDEM = Indiana Dept. of Environmental Management
319 = IDEM's Section 319 grant program
DNR = Department of Natural Resources
INDOT Indiana Dept. of Transportation
Hoosier Heartland RC&D = Hoosier Heartland Resource Conservation and Development
IU SPEA = Indiana University School of Public and Environmental Affairs
SWEET = Storm Water Environmental Education Team
CSL = Center for Sustainable Living
WRP = Wetlands Reserve Program
WHIP = Wildlife Habitat Improvement Program

7.3 Nutrient Action Plan Goal - Reduce phosphorus load to 7.86 tons per year over the next 5 years. (See Table 16 on page 47).

7.3.1 Nutrient Load Reduction Objectives and Indicators

To achieve this goal, phosphorus loads need to be reduced by 35.6% or 4.34 tons/year. (See Table 16 on page 47). The most direct way to reduce phosphorus load is to reduce fertilizer inputs. However, it is difficult to predict the load reduction achievable by this means since it will be dependent on availability and perceived desirability of P-free fertilizers. It is easier to predict the outcome of other measures. The installation of stream buffers that filter runoff from 3000 acres will reduce phosphorus load by 17,905 lbs/year or **8.95 tons per year**. Removing 3505 cattle from creeks year as described in the section on Pathogen Reduction, will result in P load reduction of **1,005 lbs or 0.5 tons per year**. Repair or replacement of 2127 failing septic systems (30% of all septics) will reduce phosphorus load by 65,804 pounds per household per year for a total reduction of **1134 lbs or .56 tons of phosphorus per year**. [118] Altogether this action plan will reduce phosphorus loading by **almost 11 tons per year**.

Nutrient Reduction Objective 1: **Promote phosphorus pollution prevention through the use of P-free alternatives – fertilizer and dishwashing detergents.**

Nutrient Reduction Objective 2: **Ensure that all onsite wastewater treatment systems are functional and non-polluting.** (See PTHN 1.)

Nutrient Reduction Objective 3: **Ensure that all communities in the watershed have properly functioning wastewater treatment facilities with phosphorus limits, especially in critical areas.** (See PTHN 2.)

Nutrient Reduction Objective 4: **Work with livestock owners to promote widespread implementation of livestock Best Management Practices in watershed, especially minimizing livestock access to streams.** (See PTHN 3.)

Nutrient Reduction Objective 5: **Install practices that trap sediment (and nutrients**). (SDMT1.)

Nutrient Reduction Objective 7: **Minimize soil erosion in agricultural areas**. (See SDMT4.)

Nutrient Reduction Objective 8: **Engage more public participation and monitor progress**. See Action Plan for Water Quality Awareness.)

[118] Decentralized Systems Technology Fact Sheet Septage Treatment/Disposal http://www.epa.gov/OWM/mtb/septage.pdf

TABLE 59: NUTRIENT LOAD REDUCTION ACTION STEPS

Nutrient Reduction Objective 1	**Promote phosphorus pollution prevention through the use of P-free alternatives – fertilizer and dishwashing detergents.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Indicators**
NTRT 1-1	Develop educational materials to promote more responsible use of fertilizer through Nutrient Management Plans for golf courses and farms.	10,000	SWCDs, Parks, Purdue Cooperative Extension, LLCD,	319	High. 2008-2015	# farms and golf courses with nutrient management plans
NTRT 1-2	Ask farm coops, garden shops, lawn care companies to get them to stock P-free fertilizer.	1000	SWCDs, Purdue Cooperative Extension, LLCD,	Community Foundation and private donors	High. 2008-2010.	Track fertilizer availability and sales
NTRT 1-3	Promote benefits of P-free fertilizer to homeowners and farmers, including potential cost savings[119]. Parks could serve as demonstration areas.	2000	SWCDs, Parks, Purdue Cooperative Extension, LLCD,	Community Foundation and private donors	High. 2008-2010.	Track fertilizer availability and sales
NTRT 1-4	Develop brochure about importance of soil testing for responsible fertilizer use.	2000	SWCDs, Purdue extension, Private firms	Community Foundation and private donors	Medium. 2008-2010.	
NTRT 1-5	Ask retailers to stock P-free detergents. Promote the sale and use of P-free dishwasher detergents in the watershed, especially among lake-front communities.	1000	SWCDs, Purdue Cooperative Extension, LLCD,	319	High. 2008-2010	Track detergent availability and sales
NTRT 1-6	Promote legislation banning dishwasher detergents containing phosphorus. (Laundry detergents containing phosphorus have already been banned.)	500	SWCDs, Purdue Cooperative Extension, LLCD,	Community Foundation and private donors	High but requires legislation. Done - 2008	Legislation

[119] Effects of Lawn Fertilizer on Nutrient Concentration in Runoff from Lakeshore Lawns, Lauderdale Lakes, Wisconsin http://wi.water.usgs.gov/pubs/wrir-02-4130/wrir-02-4130.pdf

Nutrient Objective 2	**Ensure that all onsite wastewater treatment systems are functional and non-polluting.**	**Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim benchmarks**
	Action Items:					
NTRT 2-1	Same as PTHN 1-1					
NTRT 2-2	Same as PTHN 1-2					
NTRT 2-3	Same as PTHN 1-3					
NTRT 2-4	Same as PTHN 1-4					
NTRT 2-5	Same as PTHN 1-5					
NTRT 2-6	Same as PTHN 1-6					
NTRT 2-7	Same as PTHN 1-7					

Nutrient Objective 3	**Ensure that all communities in the watershed have properly functioning wastewater treatment facilities with phosphorus limits, especially in critical areas.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim benchmarks**
	Action Items:					
NTRT 3-1	Same as PTHN 2-1					
NTRT 3-2	Incorporate Phosphorus limits into direct discharge permits.	Within current budget	IDEM, HEC	Individual dischargers	High. 2008-2015 as permit renewals come up.	Permits modified with year P limits
NTRT 3-3	Same as PTHN 2-4					
NTRT 3-4	Same as PTHN 1-8					

Nutrient Reduction Objective 4	**Work with livestock owners to promote widespread implementation of livestock Best Management Practices in watershed, especially minimizing livestock access to streams in critical areas.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim benchmarks**
	Action Items:					
NTRT 4-1	Same as PTHN 3-1					
NTRT 4-2	Same as PTHN 3-2					
NTRT 4-3	Same as PTHN 3-3					
NTRT 4-4	Same as PTHN 3-4					
NTRT 4-5	Same as PTHN 3-5					
Nutrient Reduction Obj. 5	**Install practices that trap nutrients**					
NTRT 5-1	Same as SDMT 1-1					
NTRT 5-2	Same as SDMT 1-2					
NTRT 5-3	Same as SDMT 1-3					
NTRT 5-4	Same as SDMT 1-4					
NTRT 5-5	Same as SDMT 1-5					
NTRT 5-6	Same as SDMT 1-6					
Nutrient Reduction Obj. 6	**Promote mechanisms that minimize stormwater runoff.**					
NTRT 6-1	Same as SDMT 2-1					
NTRT 6-2	Same as SDMT 2-2					

Nutrient Reduction Objective 7	**Engage more public participation and monitor progress.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim benchmarks**
	Action Items:					
NTRT7-1	Form an expanded watershed group to build on the work of steering committee and help ensure implementation of the watershed plan. Promote adoption of stream segments. Similar to PTHN 4-1	Same as PTHN 4-1	DNR Adopt-A-River; HEC	HEC, Community Foundation	Group formed by June, 2008.	Volunteers participating
NTRT7-2	Same as PTHN 4-2					
NTRT7-3	Host workshops to train volunteers on monitoring for phosphorus as well as pathogens and sediment. Similar to PTHN 4-3.	Same as PTHN 4-3	Hoosier Riverwatch, HEC	Riverwatch, HEC, Bloomington Parks	High. 2008-2010.	Attendance, Follow up monitoring

7.4 Action Plan for Pollution Prevention Water Quality Awareness - *Mercury, Pesticides, PCBs , Toxics and Trash.*

Goal: Increase Public Involvement in the watershed to help address mercury and other metals, pesticides, PCBs, carcinogens, toxics, trash and water quantity issues. A load reduction cannot be estimated for this goal, but the steering committee feels this is a very important over-arching goal to ensure implementation of the other recommendations in this plan. One of the action items is to promote compact fluorescent bulbs which do contain some mercury but dramatically reduce overall energy needs and the amount of mercury put into the atmosphere from power plants .

Water Quality Awareness Objective 1. **Form an expanded watershed group to build upon the work of the steering committee, help ensure implementation of the watershed plan, and monitor progress.**
Water Quality Awareness Objective 2: **Expand Pollution Prevention efforts and promote awareness about mercury and other metals and toxics.**
Water Quality Awareness Objective 3: **Promote Pollution Prevention approaches to pesticides**
Water Quality Awareness Objective 4: **Promote awareness about PCBs and other carcinogens and toxics**
Water Quality Awareness Objective 5: **Promote awareness about trash and litter.**
Water Quality Awareness Objective 6: **Expand Riverwatch to monitor progress on many fronts. A Riverwatch test kit has already been acquired along with two pairs of hip waders**

TABLE 60: WATER QUALITY AWARENESS ACTION STEPS

WQA Objective 1	**Form an expanded watershed group to build upon the work of the steering committee, help ensure implementation of the watershed plan, and monitor progress.**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
	Action Items					
WQA 1-1	Develop marketing/outreach campaigns to engage the public in restoration efforts and promote pollution prevention approaches.	6000	SWCDs, Parks, Power companies, citizen groups, HEC	Private foundations and businesses	2008-2015	Community survey responses
WQA1-2	Find volunteers to help with marketing campaign	1000	Citizen groups	Private foundations	2008-2010	# participants
WQA1-3	Host a watershed tour/ canoe outings	500	Citizen groups, Parks, private companies	Private entities, community foundations	2008-2010, ongoing	# participants
WQA1-4	Host trash cleanups to engage people in watershed protection	500	Citizen groups, Parks, private entities	Community Foundations, Retailers	2008-2010, and ongoing	# participants

WQA Objective 2	Objective 2: Expand Pollution Prevention efforts and promote awareness about mercury and other metals and toxics.	Relative Cost	Potential Partners	Potential Funding Sources	Priority/ Timeframe	Interim Benchmarks
	Action Items					
WQA3-1	Develop materials to educate consumers about what they can do to reduce mercury emissions, from installing energy conserving fluorescent light bulbs to advocating pollution controls on existing power plants.	3000	Power plants, consumer groups, churches, fishing groups, HEC	Private foundations	High. 2008-2012	Consumer survey responses, laws
WQA3-2	Develop materials to promote purchase of green power options	1000	Power companies, consumer groups, HEC	Private foundations	High. 2008-2012	Track use of green power
WQA3-3	Develop education program encouraging consumers to avoid products that contain mercury where good substitutes exist.	1000	Power companies, consumer groups, HEC	Private foundations, consumer groups	High. 2008-2012	Track sales?
WQA3-4	Develop campaign to urge dentists and consumers to choose ceramic fillings whenever possible.	5000	Dental industry, consumer groups, HEC	Private foundations	High. 2009-2012	Survey dentists
WQA 3-5	Promote proper disposal of products containing toxic substances, including mercury or PCBs and metals.	1000	Solid Waste Districts, HEC	Private foundations, Retailers	Medium. 2009-2012	Track recycling
WQA 3-6	Expand educational programs concerning disposal of toxic and hazardous substances.	6000	Solid Waste Districts, Consumer groups, HEC	Community foundations, private foundations	Medium. 2009-2012	Community survey responses or focus groups

WQA Objective 4	: **Promote Pollution Prevention approaches to pesticides**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
	Action Items					
WQA 4-1	Promote alternatives to pesticide use in schools through pest/pesticide management plans	800	Pesticide Review Board, IU-SPEA, HEC, PANNA	Private Foundations	Very high. 2008-2012	Pesticide plans for schools
WQA 4-2	Promote pesticide management plans for all farms and golf courses	1000	NRCS, PANNA, Golf industry, ISCO	Private Foundations	Very high. 2008-2012	Plans in place
WQA4-3	Promote sustainable farming practices and sustainable consumer choices	2000	Sustainable Earth, HOME, HEC	Farm Aid, Private Foundations, Kellogg Fndn.	High. 2008-2012	Growth in Farmers Markets?
WQA4-4	Conduct survey of homeowners to learn more about their pesticide use practices.	3000	Consumer groups, Pesticide Action Network	Community Foundation, Private Foundations	Medium. 2010 - 2015	Community Survey or Focus Group
WQA Objective 5	**Promote proper disposal of products containing toxic substances, including PCBs, mercury and metals.**					
	Action Items					
WQA5-1	Expand educational programs concerning disposal of toxic and hazardous substances.	3000	Solid Waste Districts, HEC	Private Foundations, others	Medium. 2009-2012	Track use of Solid Waste District programs
WQA5-2	Determine feasibility of expanded hours for collection of toxic materials.	500	Solid Waste Districts	Unknown	Medium. 2009-2012.	Track use

WQA Objective 6	Establish ongoing monitoring program to measure progress	Relative Cost	Potential Partners	Potential Funding Sources	Priority	Interim Benchmarks
	Action Items					
WQA6-1	Same as PTHN 4-1					
WQA6-2	Same as PTHN 4-3					

7.5 Action Plan for Water Quantity Issues, Flooding and Water Shortages

Goal: Minimize flooding and water shortages in the watershed.

Flooding and Water Shortage Objective 1: Minimize runoff and provide water storage capacity.
Flooding and Water Shortage Objective 2: Promote Water Conservation

Water quantity has a big impact on water quality. Flooding and water shortages can also have major economic consequences. A small percentage of the watershed is in urban land use, yet this use can have significant impacts because impervious surfaces contribute to increased rates of stormwater runoff, potentially contributing to flooding and erosion from increased hydraulic flow. To prevent flood damage and promote water conservation, it is crucial to restrict building in flood prone areas and promote water retention on the land. The restoration of wetlands can help minimize flooding downstream. Use of rain gardens and permeable paving materials should help alleviate this problem in developed areas.

TABLE 61: WATER QUANTITY ACTION PLAN.

Flooding and Water Shortage Objective 1	**Minimize runoff and provide water storage capacity**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
WQFS1-1	Where possible, restore riparian habitat and wetlands	50,000	Landowners, hunting groups, land trusts	NRCS, Hunting groups, DNR HeritageTrust, land trusts, Private and Community Foundations	High 2010-2020	Wetland Restoration acreage
WQFS 1-2	Strengthen ordinances to preclude filling wetlands and building in floodplains	5000			High, 2008-2012	Ordinances
WQFS1-3	Develop outreach program to encourage protection of riparian corridors and wetlands by parks, greenways and land trusts through Comprehensive Plan and other arenas.	2000	Parks Depts, Planning Depts.	Community & Private Foundations	High 2008-2009 Monroe Co., Brown Co.?	Riparian buffers protected
WQFS 1-4	Promote awareness about the connections between water conservation and water quality	2000-10,000	Citizen groups, land trusts, Co. Commissioners, Planners, SWCDs, Health Depts.	Community & Private Foundations, water companies, retailers	High. 2008-2015	Community surveys or focus groups

Flooding & Water Shortage Objective 2	**Promote Water Conservation**	**Relative Cost**	**Potential Partners**	**Potential Funding Sources**	**Priority/ Timeframe**	**Interim Benchmarks**
WQFS2-1	Promote awareness that water conservation can improve the life and performance of septic systems.	2-10,000	Homeowners, Health Depts. Citizen groups, land trusts, Co. Commissioners, Planners, Realtors, SWCDs, Health Depts., HEC	Community & Private Foundations, Targeted Watershed Program	High. 2008-2012	Community surveys, focus groups
WQFS2-2	Develop materials to promote low flow toilets and showers	600	Consumer groups, schools, Realtors, HEC, Retailers, Water Companies	Manufacturers, Community & Private Foundations, Targeted Watershed Program	High, 2008-2012	Adoption, Community surveys, focus groups
WQFS2-3	Establish infrastructure for composting toilets and other alternative systems.	35,000	Health Departments, Septic Haulers, ISDH, HEC	Fee for service, Targeted Watershed Program	High, 2010-2015	Infrastructure in place

8.0 SUMMARY AND FUTURE CONSIDERATIONS

We completed this Watershed Management Plan for Restoration and Protection of Bean Blossom Creek and Lake Lemon to identify activities that will bring the Bean Blossom Creek into compliance with applicable water quality standards and targets set by the Steering Committee. This plan identifies the following priorities:

- livestock exclusion from streams; septic system inspection and maintenance;
- enhanced riparian buffers; better implementation of best management practices in forestry, construction and agriculture;
- improved public awareness about factors affecting water quality and pollution prevention options, better consideration of water quality impacts associated with urbanization; and
- better coordination between local government agencies, economic development and water quality interests.

Implementation of this plan will depend on the availability of funds and the enthusiasm of local agencies and individuals. The steering committee recognized early on that there would be a need for additional funds and worked to identify ways to sustain our work beyond the completion of this planning process and into the implementation phase. Many of the recommendations in our watershed action plan have already been identified as priorities by local agencies and organizations represented on our steering committee, and some of the action items are covered in existing budgets. For example, the Brown County Soil and Water Conservation District plans to use its district funds to offer 50% cost share for septic system repair or replacement. The steering committee identified other potential sources of funding for action items as well. These are included in the Action Plan in the previous chapter.

Volunteers have also written a proposal for $5000 for education and testing to implement portions of the plan. This will help collect data about water quality indicators and measure progress toward achieving water quality goals. We will also be monitoring water quality improvements over time including sampling done by county and state government as well as the Lake Lemon Conservancy District.

This Watershed Management Plan for Restoration and Protection of Bean Blossom Creek and Lake Lemon is intended to be a living document. It will be revised and updated as needed to take new developments into account. Questions, comments and suggestions for revision should be directed to the Hoosier Environmental Council.

8.1 Monitoring Plan

Effectiveness will be monitored in a variety of ways. First, monitoring for water quality will be conducted at several levels. IDEM will continue to conduct water quality assessment as part of its ongoing assessment effort. Health departments will continue to collect water quality samples. In addition, volunteer monitoring efforts will be expanded to track progress on watershed restoration.

In addition to monitoring water quality changes over time, members of the watershed steering committee will track interim benchmarks as outlined in the Watershed Restoration Action Plan in the previous chapter. Tacking will be subject to change in response to funding availability and shifts in priorities of the partner organizations.

Table 62: Monitoring Plan

Interim benchmarks to track	**Action #**	**Who will track progress**
Production of video or webcast on septics	PTHN 1-1, NTRT 2-1	HEC
Number of septic inspections performed; number of repairs made.	PTHN 1-2, PTHN 1-3, NTRT 2-2, NTRT 2-3	Health Departments
# applicants for cost-share	PTHN 1-4, NTRT 2-4	SWCD
Community survey responses	PTHN 1-5, NTRT 2-5, WQA 1-1, WQA3-1, WQA 3-3, WQA 3-6, WQA 4-4, WQFS 1-4, WQFS2-1, WQFS2-2	HEC
Record keeping system in place	PTHN 1-6, NTRT 2-6	HEC
Septic systems maintained	PTHN 1-6, NTRT 2-6	Regional Sewer District and/or county health departments
Ordinance in place to facilitate alternative onsite systems	PTHN 1-7, NTRT 2-7	HEC
# alternative onsite systems installed	PTHN 1-7, PTHN 2-2,	Health Departments
# Cluster systems established	PTHN 1-8, PTHN 2-1, PTHN 2-5, NTRT 3-1, NTRT 3-4	IDEM, RCAP
Adoption of policies that facilitate alternatives	PTHN 1-9, WQFS 2-3	HEC
Information sharing, Unique identifier for each parcel shared by departments	PTHN 1-10	HEC
# developers participating in cluster system development	PTHN 2-2	Health Department
Permits modified with year round E. coli limits	PTHN 2-3	IDEM

# Inspections of package treatment plants	PTHN 2-4, NTRT 3-3	IDEM
# CFO inspections	PTHN 3-1, NTRT 4-1	IDEM
Ordinance in place to ensure responsible manure management	PTHN 3-2, NTRT 4-2	HEC
Livestock BMPs	PTHN 3-3, NTRT 4-3	SWCD
Acres of prescribed grazing	PTHN 3-4, NTRT 4-4	NRCS
Marketing materials produced/distributed to small herd owners.	PTHN 3-5, NTRT 4-5	SWCD
Volunteers participating in monitoring and sites being monitored	PTHN 4-1, PTHN 4-2, NTRT 7-1, NTRT 7-2, WQA 6-1,	HEC
Workshops conducted, # participants	PTHN 4-3, NTRT 7-3, WQA6-2	HEC
Acres of buffers installed.	SDMT1-1, SDMT 1-2, NTRT 5-1, NTRT 5-2	NRCS, SWCD
# Trees Planted, # volunteers	SDMT1-3, SDMT1-5, NTRT 5-3	Hoosier Heartland RC&D Plant a Million
# landowners, acres planted in buffer	SDMT1-3, SDMT1-5, SDMT1-6, NTRT 5-5, NTRT 5-6	SWCD
Acres of wetland restored	SDMT1-4, NTRT 5-4	NRCS, SWCD
Green Roof demonstration projects in place	SDMT 2-1, NTRT 6-1	SWEET
Permeable Pavement demo projects in place	SDMT 2-1, NTRT 6-1	SWEET
Ordinance - incentives for stormwater retention	SDMT 2-2, NTRT 6-2	HEC
Streambank stabilization projects installed	SDMT3-1	SWCD, HEC
Bank stabilization demonstration project	SDMT3-2	SWCD, HEC
Stream channel restoration projects	SDMT3-3	HEC
Acres with residue management or buffer	SDMT 4-1	SWCD
Acres converted to cover crops	SDMT 4-2	NRCS, SWCD
Pasture acreage improved	SDMT 4-3	NRCS, SWCD
Ordinances to restrict building on slopes	SDMT 5-1	HEC
Wetland Mitigation Bank established	SDMT 5-2	HEC and SLT
Track sales of permeable pavement	SDMT5-3	HEC
Rule 5 Enforcement	SDMT5-4	HEC

# Participants in sustainable forestry workshop	SDMT6-1	HEC
Certification program in place	SDMT6-2	HEC
Legislation to require forestry BMPs	SDMT6-3	HEC
# farms with nutrient management plans	NTRT 1-1	NRCS
# golf courses with nutrient management plans	NTRT 1-1	HEC
Track availability and sales of P free fertilizer	NTRT 1-2, NTRT 1-3	HEC
Brochure about responsible fertilizer use	NTRT 1-4	HEC
Track detergent availability and sales	NTRT 1-5	HEC
Legislation banning P-detergent	NTRT 1-6	HEC
Permits modified with year P limits	NTRT 3-2	IDEM
# participants in marketing campaign	WQA1-2	HEC
# participants in watershed outings & cleanups	WQA1-3, WQA1-4	HEC
Laws eliminating mercury sources	WQA3-1	HEC
Track use of green power	WQA3-2	HEC
Survey dentists about mercury use	WQA 3-4	HEC
Track recycling	WQA 3-5, WQA 5-1, WQA 5-2	Solid Waste District
Track schools with pesticide management plans	WQA 4-1	HEC with State Chemist office
Track farms and golf courses with pesticide plan	WQA 4-2	NRCS with State Chemist office
Track growth in farmers markets	WQA4-3	HEC with ISDA
Wetland restoration acreage	WQFS 1-1	NRCS, SLT
Ordinance to preclude floodplain filling	WQFS 1-2	HEC
Riparian buffers protected in urban areas	WQFS 1-3	Parks Dept.

APPENDIX A: CONCISE BIBLIOGRAPHY OF STUDIES ON LAKE LEMON, GRIFFY LAKE , AND BEAN BLOSSOM CREEK TRIBUTARY WATERSHEDS

Lake Lemon

Sedimentation in Lake Lemon, Monroe County, Indiana June-74
http://www.state.in.us/dnr/fishwild/lare/lare_reports.html

Lake Lemon Diagnostic/Feasibility Study, Environmental Systems Applications Center, School of Public and Environmental Affairs, Indiana University. April 1986.
http://www.state.in.us/dnr/fishwild/lare/lare_reports.html

Lake Lemon Diagnostic Feasibility Study Draft Report. School of Public and Environmental Affairs at Indiana University. May 1983 and Jun 1989.

Lake Lemon T by 2000 Feasibility Study. William Jones and Louise Clemency , School of Public and Environmental Affairs at Indiana University. July 1992. cited
http://www.state.in.us/dnr/fishwild/lare/lare_reports.html

[Lake Lemon] Feasibility Study for a Biotechnical Shoreline Stabilization Project February-97
Biotechnical Shoreline Stabilization Project June-97
Lake Lemon Shoreline Stabilization-Project Manuals 2000-2001

Lake Lemon Sedimentation/Restoration Project Public Presentation, Brown County Library, December 18, 2001.

Lake Lemon Watershed Management Plan, Prepared by Malcolm Pirnie of Columbus Ohio. January 2002. Prepared for the Lake Lemon Conservancy District.
http://www.state.in.us/dnr/fishwild/lare/lare_reports.html

Lake Lemon Aquatic Vegetation Management Plan 2000-2003 February-
Lake Lemon Aquatic Vegetation Management Plan February-05
Lake Lemon Aquatic Vegetation Management Plan-2006 Update February-06
Lake Lemon Aquatic Vegetation Management Plan Update 2006 Feb-07

Griffy Lake

Griffy Lake Watershed GIS Mapping and Management Plan. Prepared by Commonwealth Biomonitoring of Indianapolis. July 1999. Prepared for the City of Bloomington Planning Department.

Griffy Lake Sedimentation Survey, Prepared by School of Public and Environmental Affairs at Indiana University. March 2005. Prepared for the City of Bloomington Parks and Recreation. cited

Griffy Lake Aquatic Vegetation Management Plan February-05
Griffy Lake Aquatic Vegetation Management Plan Update 2006 Feb-07

Bean Blossom Creek and its Tributaries

Bloomington MS4 plan. http://www.co.monroe.in.us/stormwaterquality/rule13.html

Ellettsville Urban Stormwater Improvement Project. Prepared by Commonwealth Biomonitoring. May 2000.

APPENDIX B: BEAN BLOSSOM CREEK FLOW DATA

Gage	Years	Extrapolation		units
USGS 03357000		White River at Spencer drains	2988	square miles
	1931-1971	Avg Annual Flow is	2798	cubic feet
		Bean Blossom Creek drains	193	square miles
		Flow rate is estimated to be	181	cfs
USGS 03356000				
		Bean Blossom at Dolan	100	square miles
	1952-1978	Avg Annual Flow is	101	cubic feet
		Bean Blossom Creek drains	193	square miles
		Flow rate is estimated to be	195	cfs
USGS 03356500				
		Bean Blossom near Bloomington	118	square miles
	1957-1993	Avg Annual Flow is	145	cubic feet
		Bean Blossom Creek drains	193	square miles
		Flow rate is estimated to be	238	cfs
USGS 03355000				
		Bear Creek Near Trevlac	7	square miles
	1958-1973	Avg Annual Flow is	7	cubic feet
		Bean Blossom Creek drains	193	square miles
		Flow rate is estimated to be	194	cfs

APPENDIX C: BEAN BLOSSOM CREEK WATER QUALITY DATA

DESCRIPTION	LSITE	HUCTO14	CTYNAME	SAMPLEDATE	XPARAMETER	CONC	AVG CONC
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Nitrogen, Ammonia (mg/L)	1.634	0.29
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Nitrogen, Ammonia (mg/L)	0.038	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Nitrogen, Ammonia (mg/L)	0.158	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Nitrogen, Ammonia (mg/L)	0.544	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Nitrogen, Ammonia (mg/L)	2.109	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Nitrogen, Ammonia (mg/L)	0.381	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Nitrogen, Ammonia (mg/L)	0.745	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Nitrogen, Ammonia (mg/L)	0.02	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Nitrogen, Ammonia (mg/L)	0.022	
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Nitrogen, Ammonia (mg/L)	0.018	
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Nitrogen, Ammonia (mg/L)	0.018	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	0.06
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Nitrogen, Nitrate+Nitrite (mg/L)	0.105	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Nitrogen, Nitrate+Nitrite (mg/L)	0.221	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Nitrogen, Nitrate+Nitrite (mg/L)	0.119	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Nitrogen, Nitrate+Nitrite (mg/L)	0.116	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Nitrogen, Nitrate+Nitrite (mg/L)	0.022	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Nitrogen, Nitrate+Nitrite (mg/L)	0.022	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Nitrogen, Nitrate+Nitrite (mg/L)	0.114	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Nitrogen, Nitrate+Nitrite (mg/L)	0.095	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Nitrogen, Nitrate+Nitrite (mg/L)	0.013	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Nitrogen, Nitrate+Nitrite (mg/L)	0.051	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Nitrogen, Nitrate+Nitrite (mg/L)	0.053	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Nitrogen, Nitrate+Nitrite (mg/L)	0.073	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Nitrogen, Nitrate+Nitrite (mg/L)	0.072	
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Nitrogen, Nitrate+Nitrite (mg/L)	0.064	
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Nitrogen, Nitrate+Nitrite (mg/L)	0.068	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TKN (mg/L)	0.6 (B)	0.80
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	TKN (mg/L)	0.62 (B)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TKN (mg/L)	0.98 (BJ)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	TKN (mg/L)	0.66 (BQ)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	TKN (mg/L)	0.36	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	TKN (mg/L)	0.54	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TKN (mg/L)	0.79 (B)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	TKN (mg/L)	0.81 (B)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TKN (mg/L)	0.67 (BJ)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	TKN (mg/L)	3.1 (BQ)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	TKN (mg/L)	0.62	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	TKN (mg/L)	0.52	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TKN (mg/L)	1.4 (B)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	TKN (mg/L)	0.62 (B)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TKN (mg/L)	0.96 (BJ)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	TKN (mg/L)	1.1 (BQ)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	TKN (mg/L)	0.71	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	TKN (mg/L)	0.42	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TKN (mg/L)	0.5 (B)	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	TKN (mg/L)	0.64 (B)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TKN (mg/L)	1.1 (BJ)	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	TKN (mg/L)	0.37 (BQ)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	TKN (mg/L)	0.43	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	TKN (mg/L)	0.28	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	TKN (mg/L)	2.466	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	TKN (mg/L)	0.388	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	TKN (mg/L)	0.518	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	TKN (mg/L)	0.353	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	TKN (mg/L)	< 0.23	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	TKN (mg/L)	< 0.23	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	TKN (mg/L)	0.26	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	TKN (mg/L)	3.537	

PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	TKN (mg/L)	0.971
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	TKN (mg/L)	0.478
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	TKN (mg/L)	0.412
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	TKN (mg/L)	< 0.23
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	TKN (mg/L)	< 0.23
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	TKN (mg/L)	0.726
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	TKN (mg/L)	0.303
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	TKN (mg/L)	0.296
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	TKN (mg/L)	0.242
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	TKN (mg/L)	< 0.23
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	TKN (mg/L)	< 0.23
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	TKN (mg/L)	< 0.23
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	TKN (mg/L)	< 0.23

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Ortho-P (Dissolved,mg/L)	0.028
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Ortho-P (Dissolved,mg/L)	0.01
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Ortho-P (Dissolved,mg/L)	0.003
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Ortho-P (Dissolved,mg/L)	0.003
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Ortho-P (Dissolved,mg/L)	0.003
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Ortho-P (Dissolved,mg/L)	0.409
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Ortho-P (Dissolved,mg/L)	0.01
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Ortho-P (Dissolved,mg/L)	0.019
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Ortho-P (Dissolved,mg/L)	0.005
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Ortho-P (Dissolved,mg/L)	0.053
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Ortho-P (Dissolved,mg/L)	0.003
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Ortho-P (Dissolved,mg/L)	0.01
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Ortho-P (Dissolved,mg/L)	0.02
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Ortho-P (Dissolved,mg/L)	0.005
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Ortho-P (Dissolved,mg/L)	0.005
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Ortho-P (Dissolved,mg/L)	0.008
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Ortho-P (Dissolved,mg/L)	0.008
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Ortho-P (Dissolved,mg/L)	0.009
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Ortho-P (Dissolved,mg/L)	0.008

Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Phosphorus, Total (mg/L)	0.075	0.06
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Phosphorus, Total (mg/L)	0.022	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Phosphorus, Total (mg/L)	< 0.01	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Phosphorus, Total (mg/L)	0.076	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Phosphorus, Total (mg/L)	0.059	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Phosphorus, Total (mg/L)	0.061	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Phosphorus, Total (mg/L)	0.91	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Phosphorus, Total (mg/L)	0.096	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Phosphorus, Total (mg/L)	0.075	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Phosphorus, Total (mg/L)	0.15	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Phosphorus, Total (mg/L)	0.3	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Phosphorus, Total (mg/L)	0.14	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Phosphorus, Total (mg/L)	0.024	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Phosphorus, Total (mg/L)	0.14	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Phosphorus, Total (mg/L)	0.013	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Phosphorus, Total (mg/L)	0.34	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Phosphorus, Total (mg/L)	0.55	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Phosphorus, Total (mg/L)	0.17	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Phosphorus, Total (mg/L)	0.01	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Phosphorus, Total (mg/L)	0.022	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Phosphorus, Total (mg/L)	0.03	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Phosphorus, Total (mg/L)	0.044	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Phosphorus, Total (mg/L)	0.053	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Phosphorus, Total (mg/L)	0.06	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Phosphorus, Total (mg/L)	0.062	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Phosphorus, Total (mg/L)	0.02	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Phosphorus, Total (mg/L)	0.063	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Phosphorus, Total (mg/L)	0.06	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Phosphorus, Total (mg/L)	0.042	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Phosphorus, Total (mg/L)	0.013	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Phosphorus, Total (mg/L)	0.032	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Phosphorus, Total (mg/L)	0.43	

PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Phosphorus, Total (mg/L)	0.055
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Phosphorus, Total (mg/L)	0.058
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Phosphorus, Total (mg/L)	0.049
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Phosphorus, Total (mg/L)	0.089
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Phosphorus, Total (mg/L)	0.022
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Phosphorus, Total (mg/L)	0.043
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Phosphorus, Total (mg/L)	0.01
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Phosphorus, Total (mg/L)	0.025
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Phosphorus, Total (mg/L)	0.022
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Phosphorus, Total (mg/L)	0.037
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Phosphorus, Total (mg/L)	0.036
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Phosphorus, Total (mg/L)	0.046
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Phosphorus, Total (mg/L)	0.046

Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	E. Coli (CFU/100mL)	450 (JH)	1273
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	E. Coli (CFU/100mL)	120 (JH)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	E. Coli (CFU/100mL)	180 (JH)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	E. Coli (CFU/100mL)	270	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	E. Coli (CFU/100mL)	150 (JH)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	E. Coli (CFU/100mL)	5200 (JH)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	E. Coli (CFU/100mL)	280 (JH)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	E. Coli (CFU/100mL)	280	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	E. Coli (CFU/100mL)	130	
Bottom Rd	WWL010-0001	05120202010080	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Bottom Rd	WWL010-0001	05120202010080	Monroe	9/17/2001	E. Coli (MPN/100mL)	340	
Bottom Rd	WWL010-0001	05120202010080	Monroe	9/24/2001	E. Coli (MPN/100mL)	920	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/1/2001	E. Coli (MPN/100mL)	370	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/2001	E. Coli (MPN/100mL)	440	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	9/17/2001	E. Coli (MPN/100mL)	370	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	9/24/2001	E. Coli (MPN/100mL)	520	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/1/2001	E. Coli (MPN/100mL)	260	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/2001	E. Coli (MPN/100mL)	85	
SR 45	WWL010-0004	05120202010030	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
SR 45	WWL010-0004	05120202010030	Brown	9/17/2001	E. Coli (MPN/100mL)	100	
SR 45	WWL010-0004	05120202010030	Brown	9/24/2001	E. Coli (MPN/100mL)	920	
SR 45	WWL010-0004	05120202010030	Brown	10/1/2001	E. Coli (MPN/100mL)	37	
SR 45	WWL010-0004	05120202010030	Brown	10/9/2001	E. Coli (MPN/100mL)	15	
Sprunica Rd	WWL010-0014	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	2400	
Sprunica Rd	WWL010-0014	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	54	
Sprunica Rd	WWL010-0014	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	920	
Sprunica Rd	WWL010-0014	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	60	
Sprunica Rd	WWL010-0014	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	30	
Gatesville Rd or Beanblossom Rd.	WWL010-0015	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Gatesville Rd or	WWL010-0015	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	520	

Beanblossom Rd.							
Gatesville Rd or Beanblossom Rd.	WWL010-0015	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	> 2400	
Gatesville Rd or Beanblossom Rd.	WWL010-0015	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	99	
Gatesville Rd or Beanblossom Rd.	WWL010-0015	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	56	
Bear Wallow Rd	WWL010-0016	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	1100	
Bear Wallow Rd	WWL010-0016	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	51	
Bear Wallow Rd	WWL010-0016	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	2400	
Bear Wallow Rd	WWL010-0016	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	38	
Bear Wallow Rd	WWL010-0016	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	29	
SR 135	WWL010-0017	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
SR 135	WWL010-0017	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	> 2400	
SR 135	WWL010-0017	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	> 2400	
SR 135	WWL010-0017	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	150	
SR 135	WWL010-0017	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	110	
SR 45	WWL010-0018	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
SR 45	WWL010-0018	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	45	
SR 45	WWL010-0018	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	24000	
SR 45	WWL010-0018	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	120	
SR 45	WWL010-0018	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	28	
SR 45	WWL010-0019	05120202010020	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
SR 45	WWL010-0019	05120202010020	Brown	9/17/2001	E. Coli (MPN/100mL)	130	
SR 45	WWL010-0019	05120202010020	Brown	9/24/2001	E. Coli (MPN/100mL)	820	
SR 45	WWL010-0019	05120202010020	Brown	10/1/2001	E. Coli (MPN/100mL)	58	
SR 45	WWL010-0019	05120202010020	Brown	10/9/2001	E. Coli (MPN/100mL)	93	
Helmsburg Rd	WWL010-0020	05120202010030	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Helmsburg Rd	WWL010-0020	05120202010030	Brown	9/17/2001	E. Coli (MPN/100mL)	770	
Helmsburg Rd	WWL010-0020	05120202010030	Brown	9/24/2001	E. Coli (MPN/100mL)	37000	
Helmsburg Rd	WWL010-0020	05120202010030	Brown	10/1/2001	E. Coli (MPN/100mL)	610	
Helmsburg Rd	WWL010-0020	05120202010030	Brown	10/9/2001	E. Coli (MPN/100mL)	370	
SR 45	WWL010-0021	05120202010040	Brown	9/10/2001	E. Coli (MPN/100mL)	730	

SR 45	WWL010-0021	05120202010040	Brown	9/17/2001	E. Coli (MPN/100mL)	37	
SR 45	WWL010-0021	05120202010040	Brown	9/24/2001	E. Coli (MPN/100mL)	> 2400	
SR 45	WWL010-0021	05120202010040	Brown	10/1/2001	E. Coli (MPN/100mL)	27	
SR 45	WWL010-0021	05120202010040	Brown	10/9/2001	E. Coli (MPN/100mL)	76	
n Low Gap Rd	WWL010-0022	05120202010050	Monroe	9/10/2001	E. Coli (MPN/100mL)	650	
n Low Gap Rd	WWL010-0022	05120202010050	Monroe	9/24/2001	E. Coli (MPN/100mL)	> 2400	
n Low Gap Rd	WWL010-0022	05120202010050	Monroe	10/1/2001	E. Coli (MPN/100mL)	> 2400	
n Low Gap Rd	WWL010-0022	05120202010050	Monroe	10/9/2001	E. Coli (MPN/100mL)	> 2400	
N Low Gap Rd	WWL010-0023	05120202010050	Monroe	9/10/2001	E. Coli (MPN/100mL)	1400	
N Low Gap Rd	WWL010-0023	05120202010050	Monroe	9/17/2001	E. Coli (MPN/100mL)	56	
N Low Gap Rd	WWL010-0023	05120202010050	Monroe	9/24/2001	E. Coli (MPN/100mL)	1700	
N Low Gap Rd	WWL010-0023	05120202010050	Monroe	10/1/2001	E. Coli (MPN/100mL)	110	
N Low Gap Rd	WWL010-0023	05120202010050	Monroe	10/9/2001	E. Coli (MPN/100mL)	38	
Shilo Rd	WWL010-0024	05120202010050	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Shilo Rd	WWL010-0024	05120202010050	Monroe	9/17/2001	E. Coli (MPN/100mL)	160	
Shilo Rd	WWL010-0024	05120202010050	Monroe	9/24/2001	E. Coli (MPN/100mL)	690	
Shilo Rd	WWL010-0024	05120202010050	Monroe	10/1/2001	E. Coli (MPN/100mL)	490	
Shilo Rd	WWL010-0024	05120202010050	Monroe	10/9/2001	E. Coli (MPN/100mL)	150	
Old SR 37	WWL010-0025	05120202010060	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Old SR 37	WWL010-0025	05120202010060	Monroe	9/17/2001	E. Coli (MPN/100mL)	1200	
Old SR 37	WWL010-0025	05120202010060	Monroe	9/24/2001	E. Coli (MPN/100mL)	> 2400	
Old SR 37	WWL010-0025	05120202010060	Monroe	10/1/2001	E. Coli (MPN/100mL)	820	
Old SR 37	WWL010-0025	05120202010060	Monroe	10/9/2001	E. Coli (MPN/100mL)	1000	
Bloomington WWTP	WWL010-0026	05120202010080	Monroe	9/10/2001	E. Coli (MPN/100mL)	18	
Bloomington WWTP	WWL010-0026	05120202010080	Monroe	9/17/2001	E. Coli (MPN/100mL)	6	
Bloomington WWTP	WWL010-0026	05120202010080	Monroe	9/24/2001	E. Coli (MPN/100mL)	15	
Bloomington WWTP	WWL010-0026	05120202010080	Monroe	10/1/2001	E. Coli (MPN/100mL)	13	
Bloomington WWTP	WWL010-0026	05120202010080	Monroe	10/9/2001	E. Coli (MPN/100mL)	7	
Stream Bank Sample	WWL010-0027	05120202010080	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Stream Bank Sample	WWL010-0027	05120202010080	Monroe	9/17/2001	E. Coli (MPN/100mL)	440	
Stream Bank Sample	WWL010-0027	05120202010080	Monroe	9/24/2001	E. Coli (MPN/100mL)	770	
Stream Bank Sample	WWL010-0027	05120202010080	Monroe	10/1/2001	E. Coli (MPN/100mL)	330	
Stream Bank Sample	WWL010-0027	05120202010080	Monroe	10/9/2001	E. Coli (MPN/100mL)	140	

N Moon Rd	WWL010-0029	05120202010100	Monroe	9/11/2001	E. Coli (MPN/100mL)	2000	
N Moon Rd	WWL010-0029	05120202010100	Monroe	9/20/2001	E. Coli (MPN/100mL)	1400	
N Moon Rd	WWL010-0029	05120202010100	Monroe	9/25/2001	E. Coli (MPN/100mL)	290	
N Moon Rd	WWL010-0029	05120202010100	Monroe	10/2/2001	E. Coli (MPN/100mL)	240	
N Moon Rd	WWL010-0029	05120202010100	Monroe	10/10/2001	E. Coli (MPN/100mL)	140	
N Moon Rd	WWL010-0029	05120202010100	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
N Moon Rd	WWL010-0029	05120202010100	Monroe	9/17/2001	E. Coli (MPN/100mL)	550	
N Moon Rd	WWL010-0029	05120202010100	Monroe	9/24/2001	E. Coli (MPN/100mL)	490	
N Moon Rd	WWL010-0029	05120202010100	Monroe	10/1/2001	E. Coli (MPN/100mL)	150	
N Moon Rd	WWL010-0029	05120202010100	Monroe	10/9/2001	E. Coli (MPN/100mL)	140	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/1/2001	E. Coli (MPN/100mL)	307.6	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/8/2001	E. Coli (MPN/100mL)	307.6	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/15/2001	E. Coli (MPN/100mL)	123.6	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/22/2001	E. Coli (MPN/100mL)	517.2	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/29/2001	E. Coli (MPN/100mL)	1553.07	
Bottom Rd	WWL010-0033	05120202010090	Monroe	9/10/2001	E. Coli (MPN/100mL)	> 2400	
Bottom Rd	WWL010-0033	05120202010090	Monroe	9/17/2001	E. Coli (MPN/100mL)	1400	
Bottom Rd	WWL010-0033	05120202010090	Monroe	9/24/2001	E. Coli (MPN/100mL)	> 2400	
Bottom Rd	WWL010-0033	05120202010090	Monroe	10/1/2001	E. Coli (MPN/100mL)	920	
Bottom Rd	WWL010-0033	05120202010090	Monroe	10/9/2001	E. Coli (MPN/100mL)	> 2400	
Upper Beanblossom Rd	WWL010-0034	05120202010010	Brown	9/10/2001	E. Coli (MPN/100mL)	160	
Upper Beanblosson Rd	WWL010-0034	05120202010010	Brown	9/17/2001	E. Coli (MPN/100mL)	170	
Upper Beanblosson Rd	WWL010-0034	05120202010010	Brown	9/24/2001	E. Coli (MPN/100mL)	1200	
Upper Beanblosson Rd	WWL010-0034	05120202010010	Brown	10/1/2001	E. Coli (MPN/100mL)	65	
Upper Beanblosson Rd	WWL010-0034	05120202010010	Brown	10/9/2001	E. Coli (MPN/100mL)	12	
Helmsburg WWTP	WWL010-0035	05120202010030	Brown	9/17/2001	E. Coli (MPN/100mL)	25	
Helmsburg WWTP	WWL010-0035	05120202010030	Brown	9/24/2001	E. Coli (MPN/100mL)	1	
Helmsburg WWTP	WWL010-0035	05120202010030	Brown	10/1/2001	E. Coli (MPN/100mL)	9	
SR 45	WWL010-0036	05120202010030	Brown	9/10/2001	E. Coli (MPN/100mL)	> 2400	

SR 45	WWL010-0036	05120202010030	Brown	9/17/2001	E. Coli (MPN/100mL)	60	
SR 45	WWL010-0036	05120202010030	Brown	9/24/2001	E. Coli (MPN/100mL)	690	
SR 45	WWL010-0036	05120202010030	Brown	10/1/2001	E. Coli (MPN/100mL)	180	
SR 45	WWL010-0036	05120202010030	Brown	10/9/2001	E. Coli (MPN/100mL)	61	
N. Shore Dr.	WWL010-0037	05120202010030	Brown	9/10/2001	E. Coli (MPN/100mL)	550	
N. Shore Dr.	WWL010-0037	05120202010030	Brown	9/17/2001	E. Coli (MPN/100mL)	42	
N. Shore Dr.	WWL010-0037	05120202010030	Brown	9/24/2001	E. Coli (MPN/100mL)	1300	
N. Shore Dr.	WWL010-0037	05120202010030	Brown	10/1/2001	E. Coli (MPN/100mL)	13	
N. Shore Dr.	WWL010-0037	05120202010030	Brown	10/9/2001	E. Coli (MPN/100mL)	35	
Melvin Rd.,E. of SR45	WWL010-0045	05120202010030	Brown	5/31/2006	E. Coli (MPN/100mL)	307.6	
Melvin Rd.,E. of SR45	WWL010-0045	05120202010030	Brown	6/6/2006	E. Coli (MPN/100mL)	387.3	
Melvin Rd.,E. of SR45	WWL010-0045	05120202010030	Brown	6/13/2006	E. Coli (MPN/100mL)	1046.2	
Melvin Rd.,E. of SR45	WWL010-0045	05120202010030	Brown	6/20/2006	E. Coli (MPN/100mL)	3282	
Melvin Rd.,E. of SR45	WWL010-0045	05120202010030	Brown	6/27/2006	E. Coli (MPN/100mL)	1413.6	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/1/2001	Coliforms (Total) (MPN/100mL)	> 2419.2	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/8/2001	Coliforms (Total) (MPN/100mL)	> 2419.2	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/15/2001	Coliforms (Total) (MPN/100mL)	> 2419	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/22/2001	Coliforms (Total) (MPN/100mL)	> 2419.2	
Old Dutch Church Rd - Thru Stinesville	WWL010-0032	05120202010100	Monroe	8/29/2001	Coliforms (Total) (MPN/100mL)	> 2419	
Melvin Rd., E. of SR45	WWL010-0045	05120202010030	Brown	5/31/2006	Coliforms (Total) (MPN/100mL)	> 2420	
Melvin Rd. E. of SR45	WWL010-0045	05120202010030	Brown	6/6/2006	Coliforms (Total) (MPN/100mL)	> 2420	
Melvin Rd. E. of SR45	WWL010-0045	05120202010030	Brown	6/13/2006	Coliforms (Total) (MPN/100mL)	> 2420	
Melvin Rd. E. of SR45	WWL010-0045	05120202010030	Brown	6/20/2006	Coliforms (Total) (MPN/100mL)	> 24200	
Melvin Rd. E. of SR45	WWL010-0045	05120202010030	Brown	6/27/2006	Coliforms (Total) (MPN/100mL)	10462	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Hardness (as CaCO3) (mg/L)	100	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Hardness (as CaCO3) (mg/L)	73	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Hardness (as CaCO3) (mg/L)	79	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Hardness (as CaCO3) (mg/L)	130	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Hardness (as CaCO3) (mg/L)	150	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Hardness (as CaCO3) (mg/L)	99	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Hardness (as CaCO3) (mg/L)	130	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Hardness (as CaCO3) (mg/L)	64	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Hardness (as CaCO3) (mg/L)	130	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Hardness (as CaCO3) (mg/L)	160	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Hardness (as CaCO3) (mg/L)	150	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Hardness (as CaCO3) (mg/L)	120	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Hardness (as CaCO3) (mg/L)	220	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Hardness (as CaCO3) (mg/L)	150	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Hardness (as CaCO3) (mg/L)	160	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Hardness (as CaCO3) (mg/L)	200	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Hardness (as CaCO3) (mg/L)	210	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Hardness (as CaCO3) (mg/L)	250	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Hardness (as CaCO3) (mg/L)	92	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Hardness (as CaCO3) (mg/L)	49	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Hardness (as CaCO3) (mg/L)	88	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Hardness (as CaCO3) (mg/L)	110	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Hardness (as CaCO3) (mg/L)	110	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Hardness (as CaCO3) (mg/L)	93	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Hardness (as CaCO3) (mg/L)	130	

Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Alkalinity (as CaCO3) (mg/L)	50 (Q)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Alkalinity (as CaCO3) (mg/L)	53	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Alkalinity (as CaCO3) (mg/L)	60	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Alkalinity (as CaCO3) (mg/L)	120	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Alkalinity (as CaCO3) (mg/L)	140	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Alkalinity (as CaCO3) (mg/L)	90	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Alkalinity (as CaCO3) (mg/L)	40 (Q)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Alkalinity (as CaCO3) (mg/L)	80	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Alkalinity (as CaCO3) (mg/L)	84	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Alkalinity (as CaCO3) (mg/L)	130	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Alkalinity (as CaCO3) (mg/L)	150	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Alkalinity (as CaCO3) (mg/L)	100	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Alkalinity (as CaCO3) (mg/L)	120 (Q)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Alkalinity (as CaCO3) (mg/L)	170	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Alkalinity (as CaCO3) (mg/L)	120	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Alkalinity (as CaCO3) (mg/L)	170	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Alkalinity (as CaCO3) (mg/L)	200	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Alkalinity (as CaCO3) (mg/L)	220	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Alkalinity (as CaCO3) (mg/L)	30 (Q)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Alkalinity (as CaCO3) (mg/L)	50	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Alkalinity (as CaCO3) (mg/L)	68	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Alkalinity (as CaCO3) (mg/L)	110	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Alkalinity (as CaCO3) (mg/L)	110	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Alkalinity (as CaCO3) (mg/L)	80	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Alkalinity (as CaCO3) (mg/L)	183	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Alkalinity (as CaCO3) (mg/L)	95	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Alkalinity (as CaCO3) (mg/L)	122.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Alkalinity (as CaCO3) (mg/L)	106	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Alkalinity (as CaCO3) (mg/L)	130	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Alkalinity (as CaCO3) (mg/L)	134	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Alkalinity (as CaCO3) (mg/L)	78	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Alkalinity (as CaCO3) (mg/L)	86.9	

PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Alkalinity (as CaCO3) (mg/L)	73.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Alkalinity (as CaCO3) (mg/L)	52	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Alkalinity (as CaCO3) (mg/L)	36.5	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Alkalinity (as CaCO3) (mg/L)	36.1	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Alkalinity (as CaCO3) (mg/L)	29	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	pH (SU)	8.65	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	pH (SU)	7.4	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	pH (SU)	7.32	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	pH (SU)	8.19	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	pH (SU)	7.3	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	pH (SU)	8.25	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	pH (SU)	7.43	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	pH (SU)	8.4	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	pH (SU)	7	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	pH (SU)	8.1	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	pH (SU)	6.92	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	pH (SU)	7.91	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	11	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	11.6	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	13.2	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	16.6	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	21.9	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.1	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.2	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.4	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.4	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.7	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Temperature (°C)	26.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	13.9	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	14	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	16	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	18.2	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	22.2	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	28	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	28.7	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	28.7	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	28.7	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Temperature (°C)	28.5	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	21.1	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	22.9	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	25.3	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	25.5	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	25.6	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	25.7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	25	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	26	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Temperature (°C)	26.2	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	21.1	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	22	

PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	24.3	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	25.7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	26	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	26.2	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	26.2	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	26.3	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Temperature (°C)	26.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	17.7	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	22.8	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	26.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	27.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	27.8	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	28.2	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Temperature (°C)	28.4	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	12.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	15.2	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	21.9	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	26	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	26.6	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	26.7	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	26.9	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Temperature (°C)	28	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	0.63	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	0.72	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	0.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	0.95	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	7.65	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	9.66	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	9.75	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	9.98	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	10.07	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	10.21	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	DO (mg/L)	10.05	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	0.1	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	0.5	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.5	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.9	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	6.6	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.7	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	DO (mg/L)	7.7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	0.68	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	0.81	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	5.69	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	6.34	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	5.91	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	6.41	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	6.55	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	6.92	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	DO (mg/L)	7.04	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	0.03	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	0.04	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	0.06	

PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	1.95	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	5.71	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	6.12	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	6.81	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	7.76	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	DO (mg/L)	8.38	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	1.11	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	9.71	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	7.43	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	7.31	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	7.19	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	7.22	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	DO (mg/L)	7.15	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	0.4	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	1.3	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	4.4	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	7.4	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	7.5	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	7.7	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	7.9	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	DO (mg/L)	7.9	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	% Sat (%)	125.4	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	% Sat (%)	100.6	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	% Sat (%)	129	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	% Sat (%)	80.7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	% Sat (%)	84	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	% Sat (%)	90	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	% Sat (%)	91.6	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	% Sat (%)	12.9	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	% Sat (%)	96.8	
PARENT LAKE SITE - Dam gone, lake dry	WWL010-0043	05120202010050	Monroe	6/30/1992	% Sat (%)	68.3	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TS (mg/L)	160	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TS (mg/L)	200	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	TS (mg/L)	190	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	TS (mg/L)	220	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	TS (mg/L)	250	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	TS (mg/L)	170	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TS (mg/L)	300	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TS (mg/L)	170	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	TS (mg/L)	1400	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	TS (mg/L)	280	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	TS (mg/L)	270	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	TS (mg/L)	200	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TS (mg/L)	300	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TS (mg/L)	260	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	TS (mg/L)	300	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	TS (mg/L)	290	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	TS (mg/L)	310	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	TS (mg/L)	350	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TS (mg/L)	140	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TS (mg/L)	570	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	TS (mg/L)	130	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	TS (mg/L)	160	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	TS (mg/L)	170	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	TS (mg/L)	150	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	TS (mg/L)	180	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TSS (mg/L)	40	88.43
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TSS (mg/L)	110	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	TSS (mg/L)	60	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	TSS (mg/L)	24	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	TSS (mg/L)	13	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	TSS (mg/L)	16	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TSS (mg/L)	140	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TSS (mg/L)	59	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	TSS (mg/L)	1100	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	TSS (mg/L)	48	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	TSS (mg/L)	21	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	TSS (mg/L)	11	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	TSS (mg/L)	< 4 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	TSS (mg/L)	< 4 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TSS (mg/L)	38	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TSS (mg/L)	74	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	TSS (mg/L)	50	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	TSS (mg/L)	8	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	TSS (mg/L)	< 4 (U)	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	TSS (mg/L)	< 4 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TSS (mg/L)	20	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TSS (mg/L)	520	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	TSS (mg/L)	5	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	TSS (mg/L)	8	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	TSS (mg/L)	4	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Specific Conductance (Field) (umho/cm)	281	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Specific Conductance (Field) (umho/cm)	245	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Specific Conductance (Field) (umho/cm)	251	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Specific Conductance (Field) (umho/cm)	238	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Specific Conductance (Field) (umho/cm)	200	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Specific Conductance (Field) (umho/cm)	218	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Specific Conductance (Field) (umho/cm)	198	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Specific Conductance (Field) (umho/cm)	172	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Specific Conductance (Field) (umho/cm)	210	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TDS (mg/L)	69 (B)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TDS (mg/L)	92	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	TDS (mg/L)	150	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	TDS (mg/L)	200	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	TDS (mg/L)	270	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	TDS (mg/L)	140	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TDS (mg/L)	190 (B)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TDS (mg/L)	79	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	TDS (mg/L)	160	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	TDS (mg/L)	240	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	TDS (mg/L)	280	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	TDS (mg/L)	170	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TDS (mg/L)	300 (B)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TDS (mg/L)	180	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	TDS (mg/L)	200	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	TDS (mg/L)	290	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	TDS (mg/L)	340	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	TDS (mg/L)	420	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TDS (mg/L)	160 (B)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TDS (mg/L)	84	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	TDS (mg/L)	120	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	TDS (mg/L)	160	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	TDS (mg/L)	190	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	TDS (mg/L)	130	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	TDS (mg/L)	170	

Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Chromium (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Chromium (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Chromium (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Chromium (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Chromium (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Chromium (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Chromium (Total) (ug/L)	31	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Chromium (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Chromium (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Chromium (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Chromium (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Chromium (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Chromium (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Chromium (Total) (ug/L)	< 20 (U)	

Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Copper (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Copper (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Copper (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Copper (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Copper (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Copper (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Copper (Total) (ug/L)	30	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Copper (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Copper (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Copper (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Copper (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Copper (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Copper (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Copper (Total) (ug/L)	< 20 (U)	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Iron (Total) (ug/L)	2500	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Iron (Total) (ug/L)	4800	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Iron (Total) (ug/L)	2700	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Iron (Total) (ug/L)	818	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Iron (Total) (ug/L)	1100	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Iron (Total) (ug/L)	1100	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Iron (Total) (ug/L)	4600	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Iron (Total) (ug/L)	4300	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Iron (Total) (ug/L)	33000	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Iron (Total) (ug/L)	1660	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Iron (Total) (ug/L)	1000	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Iron (Total) (ug/L)	910	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Iron (Total) (ug/L)	2000	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Iron (Total) (ug/L)	2600	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Iron (Total) (ug/L)	2800	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Iron (Total) (ug/L)	97.7	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Iron (Total) (ug/L)	44	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Iron (Total) (ug/L)	590	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Iron (Total) (ug/L)	1700	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Iron (Total) (ug/L)	15000	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Iron (Total) (ug/L)	700	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Iron (Total) (ug/L)	550	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Iron (Total) (ug/L)	590	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Iron (Total) (ug/L)	620	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Iron (Total) (ug/L)	636	

Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Lead (Total) (ug/L)	< 5 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Lead (Total) (ug/L)	< 5 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Lead (Total) (ug/L)	< 5 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Lead (Total) (ug/L)	< 5 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Lead (Total) (ug/L)	< 5 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Lead (Total) (ug/L)	< 5 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Lead (Total) (ug/L)	24	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Lead (Total) (ug/L)	< 5 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Lead (Total) (ug/L)	< 5 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Lead (Total) (ug/L)	< 5 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Lead (Total) (ug/L)	< 5 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Lead (Total) (ug/L)	< 5 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Lead (Total) (ug/L)	< 5 (U)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Lead (Total) (ug/L)	8.2	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Lead (Total) (ug/L)	< 5 (U)	

Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Sulfate (mg/L)	23 (B)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Sulfate (mg/L)	36 (B)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Sulfate (mg/L)	23	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Sulfate (mg/L)	25	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Sulfate (mg/L)	31	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Sulfate (mg/L)	22	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Sulfate (mg/L)	33 (B)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Sulfate (mg/L)	23 (B)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Sulfate (mg/L)	17	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Sulfate (mg/L)	27	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Sulfate (mg/L)	30	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Sulfate (mg/L)	27	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Sulfate (mg/L)	27 (B)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Sulfate (mg/L)	23 (B)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Sulfate (mg/L)	18	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Sulfate (mg/L)	31	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Sulfate (mg/L)	35	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Sulfate (mg/L)	78	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Sulfate (mg/L)	31 (B)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Sulfate (mg/L)	21 (B)	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Sulfate (mg/L)	21	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Sulfate (mg/L)	20	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Sulfate (mg/L)	32	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Sulfate (mg/L)	26	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Sulfate (mg/L)	13	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Chloride (mg/L)	13	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Chloride (mg/L)	6.1	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Chloride (mg/L)	6.2	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Chloride (mg/L)	16	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Chloride (mg/L)	26	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Chloride (mg/L)	9.1	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Chloride (mg/L)	17	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Chloride (mg/L)	5.4	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Chloride (mg/L)	4.9	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Chloride (mg/L)	18	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Chloride (mg/L)	26	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Chloride (mg/L)	11	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Chloride (mg/L)	24	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Chloride (mg/L)	7.2	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Chloride (mg/L)	9.6	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Chloride (mg/L)	22	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Chloride (mg/L)	31	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Chloride (mg/L)	50	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Chloride (mg/L)	12	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Chloride (mg/L)	3.7	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Chloride (mg/L)	6.6	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Chloride (mg/L)	8.4	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Chloride (mg/L)	9.6	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Chloride (mg/L)	9.9	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Chloride (mg/L)	17	

Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TOC (mg/L)	4.1	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TOC (mg/L)	4.2	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	TOC (mg/L)	3	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	TOC (mg/L)	3.8	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	TOC (mg/L)	3.3	
Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	TOC (mg/L)	3.4	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TOC (mg/L)	3.8	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TOC (mg/L)	5.2	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	TOC (mg/L)	6	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	TOC (mg/L)	4.3	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	TOC (mg/L)	3.6	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	TOC (mg/L)	3.2	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TOC (mg/L)	4.3	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TOC (mg/L)	2.9	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	TOC (mg/L)	5	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	TOC (mg/L)	4	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	TOC (mg/L)	3.2	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	TOC (mg/L)	1.9	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TOC (mg/L)	4.4	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TOC (mg/L)	4.4	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	TOC (mg/L)	3	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	TOC (mg/L)	3.7	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	TOC (mg/L)	4.3	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	TOC (mg/L)	2.5	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	TOC (mg/L)	4.4	

Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	TPH - IR (mg/L)	< 1 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	TPH - IR (mg/L)	< 1 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	TPH - IR (mg/L)	< 1 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	TPH - IR (mg/L)	< 1 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	TPH - IR (mg/L)	< 1 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	TPH - IR (mg/L)	< 1 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	TPH - IR (mg/L)	< 1 (U)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	TPH - IR (mg/L)	< 1 (U)	

Bottom Rd	WWL010-0001	05120202010080	Monroe	11/18/1996	Zinc (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	10/9/1996	Zinc (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	7/16/1996	Zinc (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	4/29/1996	Zinc (Total) (ug/L)	< 20 (U)	
Bottom Rd	WWL010-0001	05120202010080	Monroe	2/27/1996	Zinc (Total) (ug/L)	22	
Bottom Rd	WWL010-0001	05120202010080	Monroe	6/6/1996	Zinc (Total) (ug/L)	49	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	11/19/1996	Zinc (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	10/9/1996	Zinc (Total) (ug/L)	< 20 (U)	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	2/28/1996	Zinc (Total) (ug/L)	26	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	4/29/1996	Zinc (Total) (ug/L)	24	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	6/6/1996	Zinc (Total) (ug/L)	150	
Mt Tabor Rd	WWL010-0002	05120202010090	Monroe	7/16/1996	Zinc (Total) (ug/L)	20	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	11/18/1996	Zinc (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	10/9/1996	Zinc (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	2/28/1996	Zinc (Total) (ug/L)	< 20 (U)	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	4/29/1996	Zinc (Total) (ug/L)	26	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	6/6/1996	Zinc (Total) (ug/L)	82	
Old Dutch Church Rd	WWL010-0003	05120202010100	Monroe	7/16/1996	Zinc (Total) (ug/L)	27	
SR 45	WWL010-0004	05120202010030	Brown	6/6/1996	Zinc (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	11/18/1996	Zinc (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	10/9/1996	Zinc (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	7/16/1996	Zinc (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	2/27/1996	Zinc (Total) (ug/L)	< 20 (U)	
SR 45	WWL010-0004	05120202010030	Brown	4/29/1996	Zinc (Total) (ug/L)	54	
SR 45	WWL010-0038	05120202010010	Brown	8/13/1996	Zinc (Total) (ug/L)	< 20 (U)	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	% Water Column Oxic (%)	56	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	% Water Column Oxic (%)	77.8	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	% Water Column Oxic (%)	75	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	% Water Column Oxic (%)	71	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	% Water Column Oxic (%)	67	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	% Water Column Oxic (%)	67	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	% Water Column Oxic (%)	100	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	% Water Column Oxic (%)	100	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	% Water Column Oxic (%)	100	
PARENT LAKE SITE - Dam gone, lake dry	WWL010-0043	05120202010050	Monroe	6/30/1992	% Water Column Oxic (%)	100	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	1% Light Level (feet)	10.5	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	1% Light Level (feet)	27.5	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	1% Light Level (feet)	5	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	1% Light Level (feet)	9	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	1% Light Level (feet)	16	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	1% Light Level (feet)	15.4	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Secchi Depth (meters)	2.5	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Secchi Depth (meters)	5	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Secchi Depth (meters)	4.1	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Secchi Depth (meters)	0.4	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Secchi Depth (meters)	0.7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Secchi Depth (meters)	0.9998	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Secchi Depth (meters)	3.6	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Secchi Depth (meters)	4.27	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Secchi Depth (meters)	3.3	
PARENT LAKE SITE - Dam gone, lake dry	WWL010-0043	05120202010050	Monroe	6/30/1992	Secchi Depth (meters)	1.9	

PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Chlorophyll a (ug/L)	0.93	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Chlorophyll a (ug/L)	0.94	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Chlorophyll a (ug/L)	4.9	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Chlorophyll a (ug/L)	6.89	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Chlorophyll a (ug/L)	2.26	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Chlorophyll a (ug/L)	0.97	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	8/20/2001	Light Trans @ 3 ft. (%T)	16	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/22/1997	Light Trans @ 3 ft. (%T)	52	
PARENT LAKE SITE	WWL010-0005	05120202010070	Monroe	7/24/1990	Light Trans @ 3 ft. (%T)	62	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/20/2001	Light Trans @ 3 ft. (%T)	7	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	8/27/1996	Light Trans @ 3 ft. (%T)	27	
PARENT LAKE SITE	WWL010-0041	05120202010040	Monroe	7/24/1990	Light Trans @ 3 ft. (%T)	32	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	7/18/2001	Light Trans @ 3 ft. (%T)	45	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	8/19/1996	Light Trans @ 3 ft. (%T)	19	
PARENT LAKE SITE	WWL010-0042	05120202010030	Brown	6/30/1992	Light Trans @ 3 ft. (%T)	57	
PARENT LAKE SITE	WWL010-0043	05120202010050	Monroe	6/30/1992	Light Trans @ 3 ft. (%T)	55	