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**Project Manager:** Laura Bieberich

# Lower St. Joseph – Bear Creek Watershed Management Plan

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See Also the Following Documents:
The St. Joseph River Watershed Management Plan (2006)
2004 St. Joseph River Watershed Initiative Water Quality Report
2005 St. Joseph River Watershed Initiative Water Quality Report
Report  on the Bacteria Source Tracking (BST) Project, October 30, 2004

These documents are available in PDF format on the St. Joseph River Watershed Initiative website, www.sjrwi.org

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Cover photo of the St. Joseph River Dam by J. Loomis 2005.

Table of Contents

Table of Figures

## Tables

## Commonly Used Acronyms

ACE Army Corps of Engineers
ARS Agriculture Research Service

BMP Best Management Practice

CAFO Confined Animal Feeding Operations
CES Cooperative Extension Service (Purdue)
CNMP Comprehensive Nutrient Management Plan
COE Corps of Engineers, US Army
CFU Colony-forming units (bacteria)
CREP Conservation Reserve Enhancement Program
CRP Conservation Reserve Program
CSP Conservation Security Program
CTIC Conservation Technology Information Center
CWA Clean Water Act (1972)
CWI Clean Water Indiana

DC District Conservationist (NRCS)
DOT Department of Transportation
DSC Division of Soil Conservation (ISDA)

EQIP Environmental Quality Incentive Program
EPA Environmental Protection Agency

FIP Forestry Incentives Program
FOGT Field Office Technical Guide
FPP Farmland Protection Program
FSA Farm Service Agency, USDA

GLCI Grazing Lands Conservation Initiative

HEL Highly Erodible Land

IAC Indiana Administrative Code
ICP Indiana Conservation Partnership
IDEM Indiana Department of Environmental Management
IDNR Indiana Department of Natural Resources
ILMS Indiana Lakes Management Society
ISDA Indiana State Department of Agriculture
IFWOA Indiana Forest and Woodland Owners Association

LARE Lake and River Enhancement Program
LISA Low Input Sustainable Agriculture

MMP Manure Management Plan
MOA Memorandum of Agreement
MOU Memorandum of Understanding

NACD National Association of Conservation Districts
NMP Nutrient Management Plan
NPS Non-point Source
NRCS Natural Resources Conservation Service, USDA
NREC Natural Resources Education Center
NRI National Resource Inventory
NSERL National Soil Erosion Reseaarch Laboratory

PHEL Potentially Highly Erodible Land

RCA Resources Conservation Act
RC&D Resource Conservation and Development
RCWP Rural Clean Water Program
RUSLE Revised Universal Soil Loss Equation

SARE Sustainable Agriculture Research and Education
SSCB State Soil Conservation Board
SWCD Soil and Water Conservation District

TSP Technical Services Provider

USDA United States Department of Agriculture
USEPA United States Environmental Protection Agency
USFS United States Forest Service
USFWS United States Fish and Wildlife Service
USGS United States Geological Survey
USLE Universal Soil Loss Equation
WASCOB Water and Sediment Control Basin
WHIP Wildlife Habitat Incentive Program
WLEB Western Lake Erie Basin (Project)
WLTP Watershed Land Treatment Project
WQIP Water Quality Improvement Plan
WRP Wetland Reserve Program

# Lower St. Joseph – Bear Creek Watershed Management Plan

Figure 1 Walkway along the St. Joseph Greenway Trail, St. Joe, Indiana. (J. Loomis 2004)

## Vision of the Watershed

"Our vision is to improve and protect the Lower St. Joseph and Bear Creek subwatersheds to insure fishable, swimmable water by the year 2030. The river and its adjacent green space will be accessible to the general public for recreational and educational activities."

Adopted by the Lower St. Joseph – Bear Creek Watershed stakeholders on March 29, 2006

# Lower St. Joseph – Bear Creek Watershed Management Plan

Figure 2 Fort Wayne's Three Rivers Filtration Plant. (J. Loomis, 2005)

## Executive Summary

This is a management plan for two subwatersheds of the St. Joseph River – the Lower St. Joseph (Allen County), hydrologic unit code (HUC) 4100003100 and Bear Creek (Indiana) HUC 4100003070. The land of these watersheds lies in two Indiana counties, Allen and DeKalb.

The Lower St. Joseph subwatershed lies in Allen County and is predominantly urban and suburban development, encompassing a large portion of central and northern Fort Wayne north of the confluence of the three rivers at city center. There are limited rural residential and agricultural lands in the subwatershed, but these are being developed at a rapid rate.

The Bear Creek subwatershed is named for the Bear Creek, a smallish stream segment that includes flow from the Hursey Ditch system and joins the main stem of the St. Joseph River just upstream of the town of St. Joe, Indiana. The Bear Creek subwatershed includes the city of Leo-Cedarville and the town of Grabill in Allen County as well as the towns of St. Joe and Spencerville in DeKalb County. The Bear Creek subwatershed is predominantly rural and agricultural.

Together with the Lower and Upper Cedar, these two subwatersheds lie directly upstream of the City of Fort Wayne. They have the greatest impact on the quality of Fort Wayne's source water, both by virtue of their proximity to the city and by the volume of water carried by the streams and the lower portion of the St. Joseph River. The city's water intake is located within the Lower St. Joseph subwatershed at the St. Joseph River Dam near Johnny Appleseed Park in north-central Fort Wayne. (See **Figure 10**) The city's two supply reservoirs, the Cedarville Reservoir and Hurshtown Reservoir, lie within the boundaries of the Bear Creek subwatershed.

The decision to work on this watershed management plan was made in part to complete planning for the lower section of the St. Joseph River. We also recognized the need for watershed management to complement local

comprehensive planning that was being done in Allen and Dekalb counties. The increasing urbanization of northern Fort Wayne and Allen County, including areas around Leo-Cedarville and the two reservoirs, also makes the development of this plan timely.

Water quality monitoring by the City of Fort Wayne and the St. Joseph River Watershed Initiative historically has indicated that these subwatersheds exhibit some of the same problems found in the St. Joseph as a whole: noncompliance with the water quality standard (WQS) for E. coli for full-body contact, spikes in pesticides found particularly during the spring planting season, and impairment of habitat due to sedimentation and total suspended solids in the water column.

One of our main goals in this planning effort has been to identify critical areas of concern in these two subwatersheds, and to develop a ranking plan to guide us in working to restore and protect these areas. This has been done with the assistance of the City of Fort Wayne and various departments of government in Allen and DeKalb Counties. The Soil and Water Conservations Districts (SWCD), the Natural Resources Conservation Service (NRCS), and the Departments of Health (DOH) in the two counties have also been of great assistance.

Another goal has been to produce and distribute information for urban dwellers that will help them identify conservation problems in the urban core. Additionally, we have sought to provide information to those people who are moving from the city into exurban or rural areas, those who are facing landowner issues such as wells, septic systems, agricultural implement traffic, odors, and transportation issues that they may not have encountered in the city. As the small communities outside Fort Wayne grow and expand, the impact of construction activities and loss of green space continue to increase.

Public meetings with stakeholders of these two subwatersheds identified the following concerns: 1) water quality; (2) recreation and access to the water; (3) natural area/river corridor preservation and maintenance; and 4) education on watersheds and water quality issues. Stakeholder involvement has contributed to the identification of problems as well as the choice of goal and work plans for this document. Quarterly meetings and newsletters expedited the flow of information and ideas. As this document is a work in progress, we expect to continue to receive input from stakeholders and to update our progress on the plan every three to five years.

**St. Joseph River Watershed Initiative, 2006**

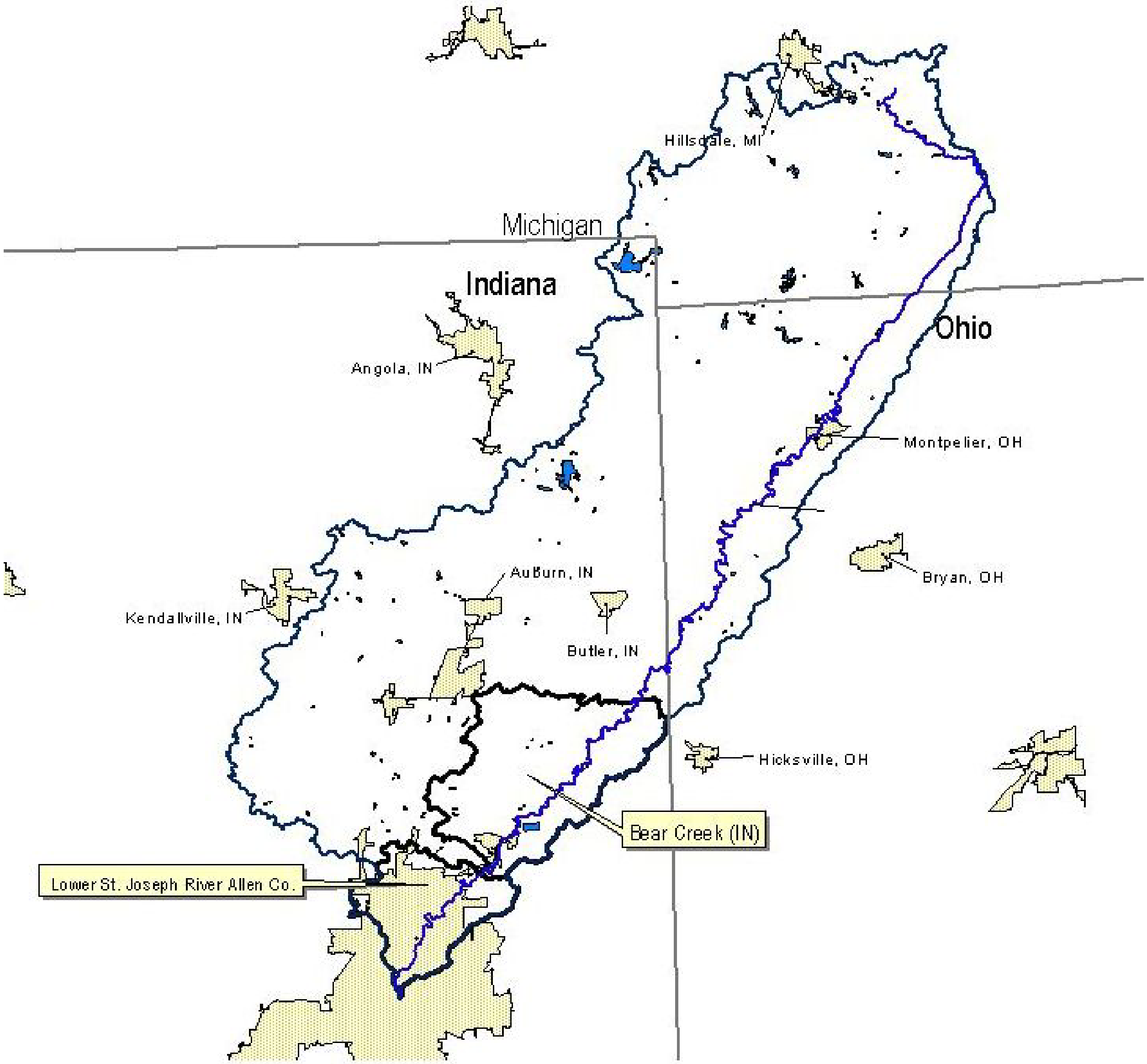



**Figure 3 The Lower St. Joseph and Bear Creek subwatersheds are part of the 3-state regional St. Joseph River Watershed. (SJRWI map)**

# Lower St. Joseph – Bear Creek Watershed Management Plan

Figure 4 Filtration Plant at the confluence of the St. Joseph, St. Marys and Maumee Rivers in Fort Wayne. (City of FW)

## Part 1: Introduction

The St. Joseph River Watershed Management Plan (WMP), written by the St. Joseph River Watershed Initiative (SJRWI), approved by the Indiana Department of Environmental Management (IDEM) in 2001 and updated 2006), outlined in its goals the ongoing effort to organize stakeholders and create watershed management plans for each of the 11-digit HUC (hydrologic unit code) subwatersheds within the St. Joseph. In 2005, the Cedar Creek WMP, encompassing the Lower and Upper Cedar Creek watersheds, was completed and approved by IDEM. This project will complete a WMP for the Lower St. Joseph and Bear Creek subwatersheds.

The Lower St. Joseph (HUC 4100003100) and Bear Creek (HUC 4100003070) comprise the southeastern portion of the 8-digit HUC St. Joseph River watershed. The Cedar Creek tributary empties into the St. Joseph River between these two subwatersheds. (See Figure 5 on page 2.) The importance of this watershed area, and that of the adjacent Cedar Creek, is their proximity to the intake Fort Wayne water supply. The water supply intake, located at the St. Joseph River Dam at Johnny Appleseed Park, lies within the Lower St. Joseph subwatershed.

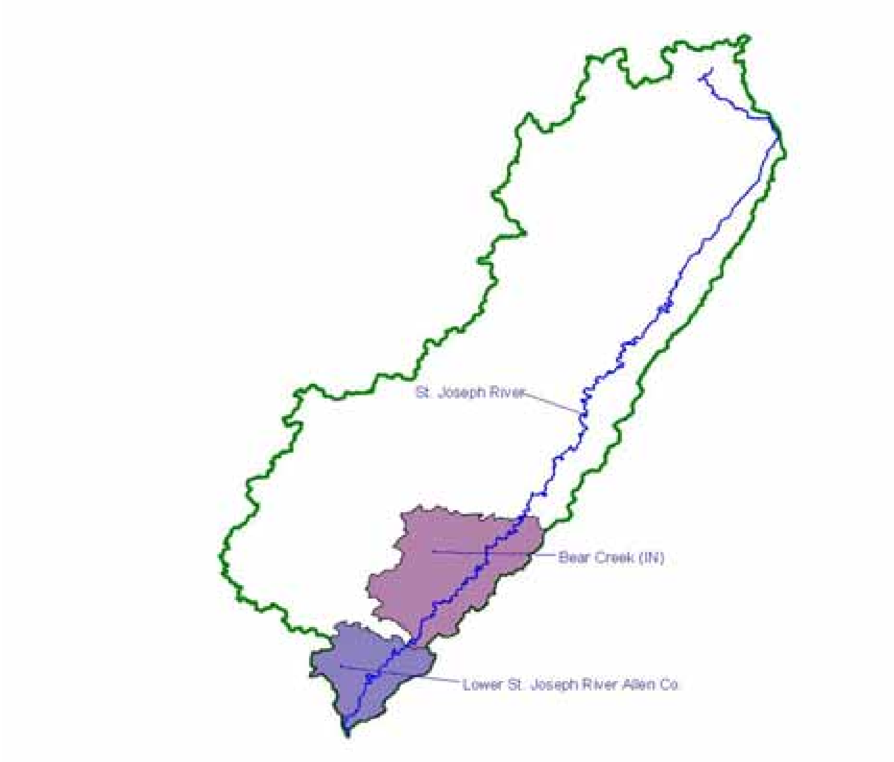



**Figure 5 The Lower St. Joseph and Bear Creek subwatersheds located in the HUC-8 St. Joseph River watershed. (SJRWI map)**

The Lower St. Joseph encompasses a large portion of northern Fort Wayne and unincorporated Allen County, and is the most urbanized subwatershed in the St. Joseph River watershed. The Bear Creek subwatershed includes Fort Wayne's two reservoirs, as well as the towns of Leo-Cedarville, Grabill, Spencerville, and St. Joe. The northern part of the Bear Creek is predominantly agricultural.

Working closely with stakeholders of this entire lower portion of the St. Joseph provided the opportunity to interact with a great number of citizens, thus improving the prospect of reducing pollutant loads close to the source water intake and improving water quality for over 200,000 residents of Fort Wayne.

Additionally, improvements in the lower watershed will impact recreational and aesthetic benefits of the river and its tributaries for these stakeholders.

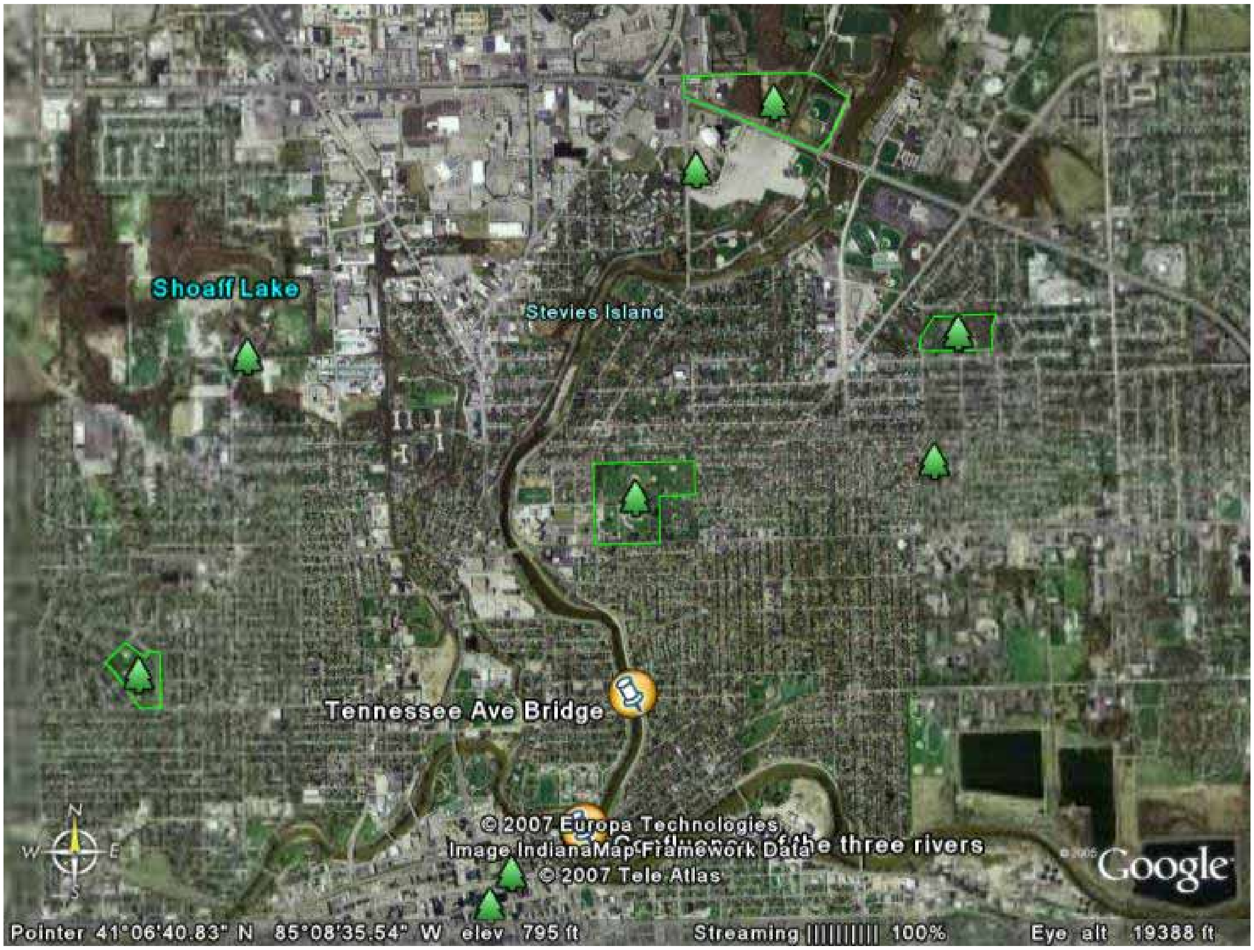



**Figure 6 Much of the Lower St. Joseph is an urban watershed.**

1.1 Partnerships and Organizations involved in this project

This Lower St. Joseph-Bear Creek (LSJ-BC) watershed management planning effort has been guided by the St. Joseph River Watershed Initiative Partnership through a subcontract with the City of Fort Wayne Water Utilities Administration, which received a Section 205(j) grant from the Indiana Department of Environmental Management for this work. The City's goals include improving the knowledge and understanding of water quality issues among urban and suburban residents, and identifying the critical areas along the river that need protection or restoration in order to impact the long-term water quality in the river.

1.1.1 The St. Joseph River Watershed Initiative Partnership

The St. Joseph River Watershed Initiative Partnership (SJRWI) is a 501©(3) not-for-profit organization that is made up of local citizens, organizations, businesses, and agencies working together to take a proactive approach to water quality problems by promoting land use practices that are both economically and environmentally compatible.

The SJRWI has been conducting water quality sampling in the St. Joseph River watershed since 1996 and maintains a water quality database and geographical information system (GIS) with mapping capability of the watershed. Information from this database has been used to help determine the baseline conditions of the watershed.

The vision of success identified by the SJRWI in its strategic plan (1997, rev. 2007 ) includes the following:

**Human Health:** In the long term, pathogens, agricultural chemicals, nutrients and turbidity will be within the capability of water treatment and filtration to maintain drinking water levels below maximum contaminant levels. The quality of water will support full body contact recreational uses year-round. Fish consumption advisories will be decreased.

**Economic Sustainability**: Residents and land users in the watershed will have a clear understanding of how their actions and operation methods affect water quality. Appropriate technology and management practices for preserving water quality will be adopted by a higher percentage of land-users. Stakeholders in the watershed will be able to maintain economic viability while giving full consideration to the environment, including land use planning and management on a watershed scale.

**Bio-Diversity:** Water quality will allow the continued presence and re-population of native wildlife and water-based species in their natural habitats, remaining above the stress level for populations living in and adjacent to waterways. Stressors will be identified, and methods of alleviation will be developed to remove or lessen the stresses threatening biological species.

**Recreation:** The water quality of the St. Joseph River will support adequate habitat for all game fish once native to the river. The water quality of the river will invite increased recreational activities, such as sport fishing, canoeing, boating and river-corridor hiking. Water clarity will improve with the reduction of sedimentation. The river and its corridor will be accessible for all recreational uses.

**Aesthetics:** The river and its corridor will become aesthetically appealing in all areas, and improve the quality of life for all citizens in the watershed.

**Drainage:** Drainage maintenance and improvement for agriculture, development, and flood control will be conducted with economically and ecologically sound methods in a manner that allows stakeholder input and two-way flow of information between county government (Drainage Boards) and stakeholders.

#### 1.1.2 Soil and Water Conservation Districts of Allen and DeKalb Counties

The Allen County Soil and Water Conservation District (SWCD) provides office space and contract personnel to handle the responsibilities of this project for the SJRWI. The DeKalb SWCD has provided significant support for the work of the Initiative, including organizational, technical and staff support.

#### 1.1.3 Local Governments of Fort Wayne and Allen County

The City of Fort Wayne Water Utilities Department has been instrumental in helping to plan and fund this effort. Additional help and support for this project has come from other city departments, including the planning and GIS department, the flood control department, the Fort Wayne-Allen County Health Department, and the Allen County I-Map project. Monthly watershed team meetings, held at the City-County Building and involving many departments of both the city and county governments, has been a helpful forum for sharing of information and ideas throughout the project.

#### 1.1.4 Other city and county offices

Additional support has come from elected and appointed officials of the towns of Leo-Cedarville and St. Joe, the DeKalb County Health Department, and the Eastern DeKalb School District.

### 1.2 Public Participation

This project was announced to local citizens through a news release on August 22, 2005. Four public stakeholder meetings were advertised via local news outlets and the quarterly newsletter St. Joseph River Review. The meetings occurred on:

September 7, Leo-Cedarville Park Pavillion, Leo-Cedarville
September 8, Our Lady of Good Hope Church, St. Joe Road, Fort Wayne
September 12, Concordia Lutheran High School, N. Anthony Blvd., Fort Wayne
September 15, Riverdale Elementary School, State Rd.1, St. Joe

A total of 27 citizens took part in these four initial stakeholder meetings. The agenda for each meeting was similar and included an overview of the watershed management process, identification of the two subwatersheds and their location, and a facilitated program by Kathy Latz, director of Wood-Land-Lakes

RC&D focused on identifying problems and concerns in the watershed, ranking the priority of those concerns, and articulating stakeholders' vision of what the watershed should be. Attendees were also asked what they hoped to accomplish and/or their reason for attending the meetings.

Additional outreach included a November 22 river boat tour of the urban portion of the City's three rivers conducted by Fort Wayne resident Dan Wire, a long-time river watcher and frequent boater who lives on the St. Joseph; others on the tour included Jane Loomis, SJRWI; a representative from the City of Fort Wayne; Dan Carmody, newly appointed president of the Downtown Improvement District; and Annie Skinner, Fort Wayne resident who was researching the use and impact of the rivers.

Two additional outreach efforts included a presentation to the St. Joe Lion's Club on November 14 and a presentation to the Northeast Area (Fort Wayne) Neighborhood Partnership on December 8, 2005.

A preliminary mailing list was created to include all stakeholders who attended the meetings listed above, as well as those who attended or responded to presentations and news articles. The list will continued to be updated as the project proceeded.

Information about this WMP project, including scheduled meetings and reports, is available on the internet at www.sjrwi.org.

Quarterly stakeholders meetings were held beginning in March, 2006.

### 1.2.1 Stakeholder-Perceived Problems

Stakeholders that attended the public meetings at Leo-Cedarville cited their reasons for attending, including the following: Drinking water protection, water quality, land quality, resources preservation, wildlife watching, and interest in seeing the St. Joseph dredged.

Those who attended the meeting at Our Lady of Good Hope Church were interested in clean water; swimmable, boatable and fishable rivers; accessible waterways- so that the public feels comfortable boating and fishing; and they wanted to know what issues and concerns will be addressed by the planning effort.

Stakeholders at the meeting at Concordia High School wanted to learn more; wanted the Cedarville reservoir cleaned up; wanted to know how to get involved, wanted to do something on the local level, and wanted to walk through the stream and not "catch anything bad." The also wanted to observe the process of watershed management; and to take time to find out more information and gain knowledge about their watershed.

Those attending the meeting at Riverdale Elementary School in St. Joe were interested in implementation of county plan and park board, riparian, riverside corridor and nature preservation; they wanted a good quality plan as a document; were interested in water quality restoration; and wanted to do anything to help. They also wanted to learn, help in the classroom and monitor water quality; to heighten community awareness and appreciation for the river; and expressed concern that the river water is dirty and should not be like that.

| | Leo-Cedarville | O L Good Hope Ch | Concordia HS | Riverdale Elem Sch |
|---|---|---|---|---|
| 1. (Highest Priority) | Recreation and erosion of streambank | Urban pollution (floatables – litter, industrial, residential, municipalities, including CSOs) | Contaminants | Public apathy |
| 2 | Sediment | Weak comprehensive development plan | Lack of recreational use of the river | Sedimentation loading |
| 3 | Riparian vegetation for wildlife migration | Loss of wildlife habitat, flood plains, wetlands and riparian corridor | Flood control issues | No government structure/unit to solve problems (park board, pollution control agency |
| 4 | Failed septic systems | Inadequate understanding of drainage system by developers and homeowners | Perception that water is contaminated | No aquatic plants |
| 5 | Increased development | | Lack of education to the public | Channelization |
| 6 | Agricultural chemicals | | Poor appearance | Poor land use management |
| 7 | Urban/suburban runoff | | | |
| 8 | Goose population | | | |
| 9 | Lack of trail along river | | | |
| 10 | Drainage | | | |

**Table 1 Stakeholder priorities by meeting location.**

Other comments and areas of concern for the stakeholders include the following, in no special order:
Lack of reservoir capacity
Reservoir maintenance
Dredge the water in Cedarville
Contaminants from animal droppings
Width of river to handle (boat) wake
River appearance – not clean looking
Health issues for swimming
Can’t swim in the river
Glass and tin cans on bottom
E. coli
Lack of planned greenway
Lack of awareness and appreciation of resources
Lack of understanding on how to address resolutions
Lack of desirable fish & clams
Fish (& clam) advisories – can’t eat fish
Too much mercury in fish
Flooding
Trash

Garbage in the water
Weak coordination between municipalities
Greenways not connected beyond Fort Wayne
Accessibility
River is not accessible from Cedarville to below the dam (portage issues)
(Lack of) access
Cormorant population increasing
Too many deer-car accidents
Parking lot runoff
Ag runoff
Hog and chicken manure spills
Detention areas in developed areas leak water to river
Pollution from lawn chemicals
Log jams
Downed trees under bridges collect debris
Sediment
Lack of erosion control
Stream maintenance
Hundreds of new septic systems in urban sprawl areas
Failing septics
Populace apathy
Public believes it's polluted
Buildup of sludge at (FW) water filtration plant
Less than adequate maintenance on river
Non-appealing smell
Loss of wetlands

### 1.2.2 Stakeholders' Visions for the Watershed

Stakeholders were asked to express their vision of the river – what they thought it should be. The following comments were expressed by the stakeholders:
River greenway
More pedestrian traffic along the river
Greenways completed to Michigan and Ohio
Green strip (filter strip) along the river
Easier access for seeing and doing
Cleaner water (both appearance and quality)
Swimmable, fishable
See my feet through clear water
Meet water quality standards
Clearer water
More recreational use (swim)
People playing in the river
Responsible use
Public regards river as something to protect and take care of
More enforcement for violators who pollute
More balance between recreation and wildlife
Promote more low-impact recreation such as fishing, canoeing and kayaking
Fish
Walleye
See the wildlife
Have a festival celebrating our waterway
Reforest the river bottomlands
Clear floodplains of development
Erect historical plaques along the greenway

Identified as scenic river designation
A "string of pearls" – historic sites, cultural sites, archeological sites, with recreational access
Educate the public
Widely recognized as an asset to community
Outdoor environment education center to attract other teachers
A string of parks
Preserve our unique heritage
More activity on navigable waters (boating)
Canoe race with trophies
Raft race
More commercial activity (restaurants) along river in urban, downtown and rural areas
More commercial, recreational usage
Hydroelectricity
Developers respect needs of the earth
Green space set aside
Respect for floodplains, wetlands – use to contain and filter water
Re-build wetlands
Respect
Use of green roofs, rain gardens to filter water
Adequate funding so that progress is continued
Aquatic biodiversity

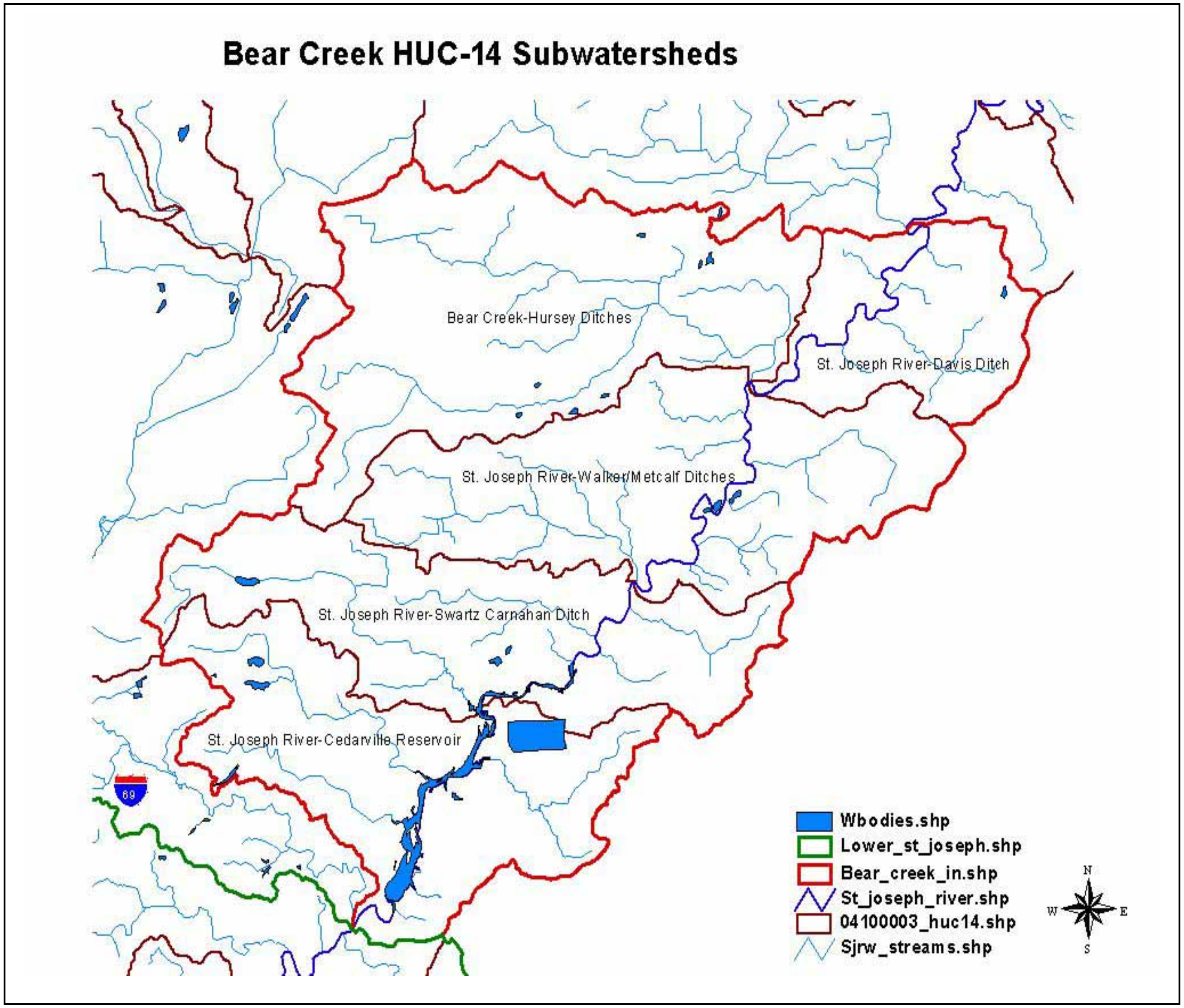
Summarizing the above, stakeholder issues were (1) water quality; (2) recreation and access; (3) river corridor/natural areas preservation and maintenance; and (4) education on watersheds and water quality issues and processes.

Figure 7 Ely Run within the boundaries of the ACRES Land Trust Popp Nature Preserve (J. Loomis, 2005)

## Part 2: The Watershed

2.1 Watershed Location and Hydrology

The Lower St. Joseph-Allen County subwatershed (Hydrologic Unit Code HUC 04010003100) is located in the lower southeastern reaches of the St. Joseph River (HUC 04010003) and encompasses the northeastern portion of the City of Fort Wayne and northeastern Allen County. The Bear Creek (HUC 04010003070) abuts the Lower St. Joseph to the north and extends into Eastern DeKalb County. Together, these two subwatersheds drain approximately 95,960 acres of land.


Bear Creek HUC-14 Subwatersheds
Bear Creek-Hursey Ditches
St. Joseph River-Davis Ditch
St. Joseph River-Walker/Metcalf Ditches
St. Joseph River-Swartz Carnahan Ditch
St. Joseph River-Cedarville Reservoir
69
Wbodies.shp
Lower_st_joseph.shp
Bear_creek_in.shp
St_joseph_river.shp
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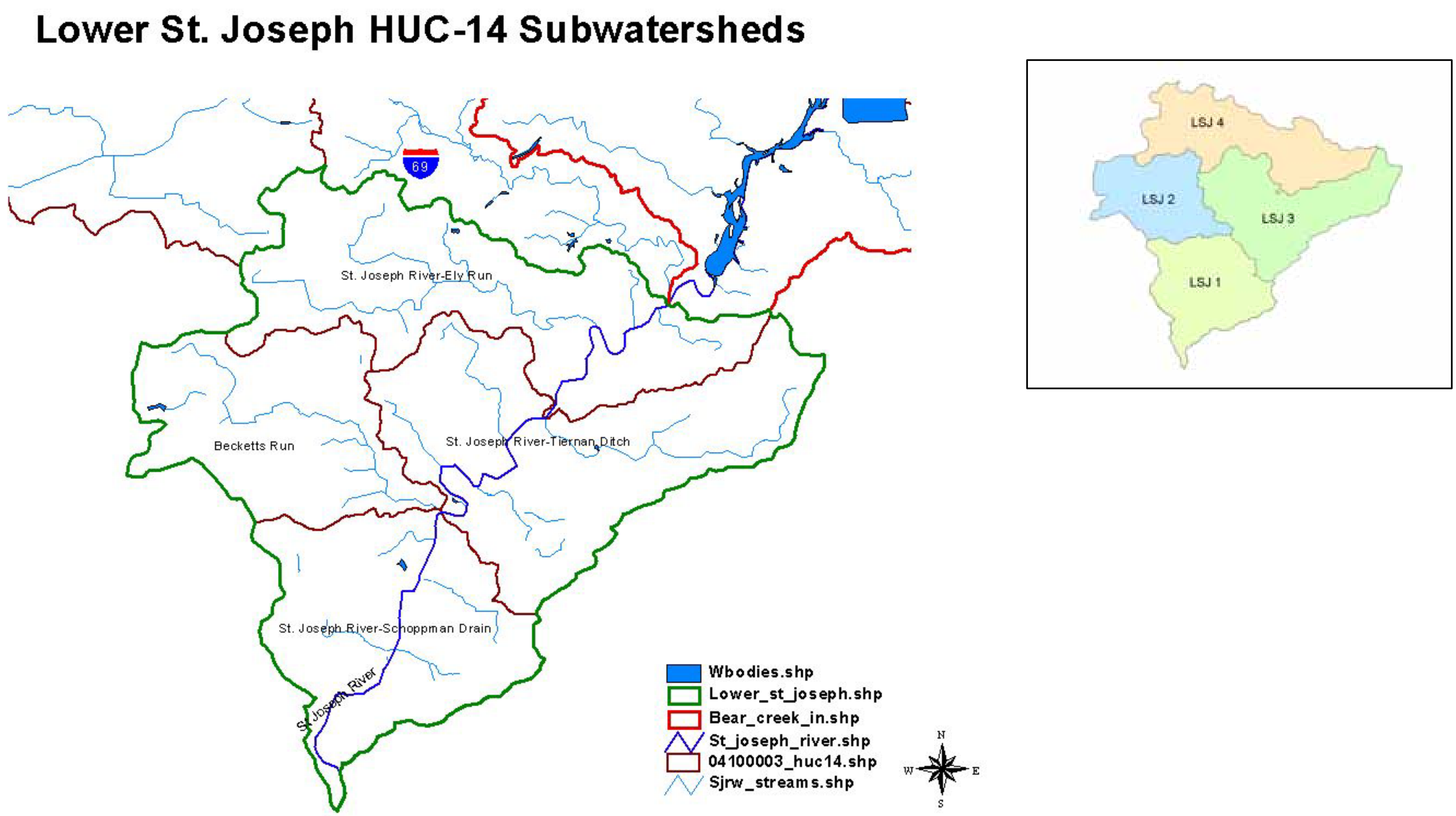



**Figure 9 The 14-digit HUC watersheds within the Lower St. Joseph subwatershed. (SJRWI)**

The HUC-11 Bear Creek (Indiana) subwatershed contains 64,619 total acres with 48.86 miles of total waterway. It contains five subwatersheds:
Bear Creek/Hursey Ditches: 17,507 acres
St. Joseph/Davis Ditch: 6,547 acres
St. Joseph/Walker-Metcalf Ditches: 14,955 acres
St. Joseph/Swartz-Carnahan Ditch: 12,698 acres
St. Joseph/Cedarville Reservoir: 12,912 acres

The HUC-11 Lower St. Joseph River (Allen) subwatershed contains approximately 31,341 total acres with 17.9 miles of total waterway. It contains four subwatersheds:
St. Joseph/Ely Run: 8,867.5 acres
St. Joseph/Tiernan Ditch: 9,336.7 acres
Beckett's Run: 6,008.5 acres
St. Joseph/Schoppman Drain: 7,127.6 acres

Many of the streams and ditches in the watershed have been channelized, deepened, straightened, and/or dredged at some time over the last 150 years to support agriculture and construction of roads and cities. Approximately 50% of the streams are part of the legal drainage system controlled by the County Drainage Boards. Drainage practices promote drainage of the land, which otherwise would be too wet to be productive. However, some drainage practices, such as dredging the bottoms of the streams, straightening streams, and increasing bank height, impact the capacity of the stream to support aquatic life, filter out sediment and chemicals, and control flow.

Table 2 shows approximate areas of the two subwatersheds in acres, stream feet and stream miles. This information was compiled by the SJRWI from its
GIS database. Maps of the streams in the Bear Creek and the Lower St. Joseph can be found in Appendices B and C at the end of this document.

| **Watershed** | **HUC** | **Area (Acres)** | **Stream Feet** | **Stream Miles** |
|---|---|---|---|---|
| Bear Creek | 4100003070 | 64,619.3 | 253,460 | 48.86 |
| Lower St. Joseph Allen Co. | 4100003100 | 31,340.93 | 94,549 | 17.9 |

Table 2 Approximate acres and stream length of 11-digit HUC Lower St. Joseph and Bear Creek subwatersheds

The St. Joseph River is dammed in two locations in these watersheds.  The St. Joseph Dam impounds the river in north central Fort Wayne in the Lower St. Joseph subwatershed. The Cedarville Dam at Leo-Cedarville has impounded the river creating the Cedarville Reservoir in the Bear Creek subwatershed.  Other dam locations on ditches and tributaries in the subwatersheds are shown in Figure 12 on page 14.

Figure 10   The St. Joseph River Dam in north central Fort Wayne.
Photo by J. Loomis 2005

Figure 11   Cedarville Dam and Reservoir at Leo-Cedarville.  (J. Loomis, 2007)

# St. Joseph River and Bear Creek Dams

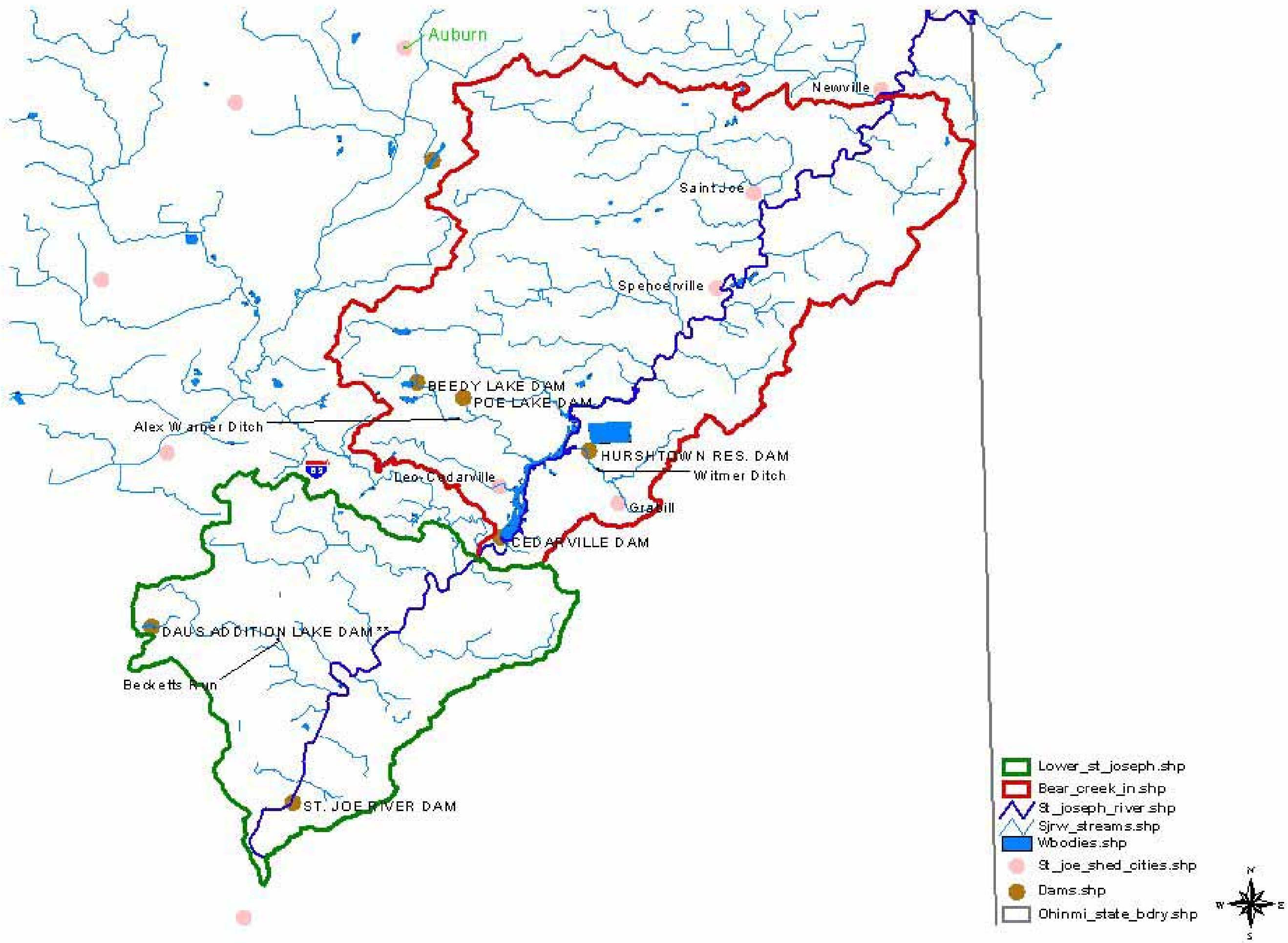



**Figure 12 Dams in the Lower St. Joseph and Bear Creek subwatersheds. SJRIW map.**

2.1.1 Water supply

In Allen County, the Fort Wayne water supply comes from surface water extracted from the St. Joseph River at the St. Joseph Dam near the intersection of Coliseum and North Anthony boulevards. It is conveyed by pipe for treatment to the Three Rivers Filtration Plant, located near downtown Fort Wayne at the confluence of the St. Joseph with the St. Mary's and Maumee rivers. The Fort Wayne plant serves more than 200,000 municipal residents in Fort Wayne and the City of New Haven. Other areas of the Lower St. Joseph and Bear Creek subwatersheds are served by private wells or water companies that extract water from wells.


**Figure 13 Location of the St. Joseph River Dam and Reservoir**

The watershed includes at least two sizeable inland lakes; both are reservoirs owned by the City of Fort Wayne (Table 3). The reservoirs provide drainage, water storage, recreation and aesthetics to residents, as well as habitat for wildlife.

| Lake Name | State | County | Drainage Area (acres) | Surface Area (acres) | Max. depth (feet) |
|---|---|---|---|---|---|
| Cedarville Res. | IN | Allen | 764.00 | 408 | 22 |
| Hurshtown Res. | IN | Allen | 0.40 | 265 | 35 |

Table 3 Lakes in the Lower St. Joseph and Bear Creek subwatersheds

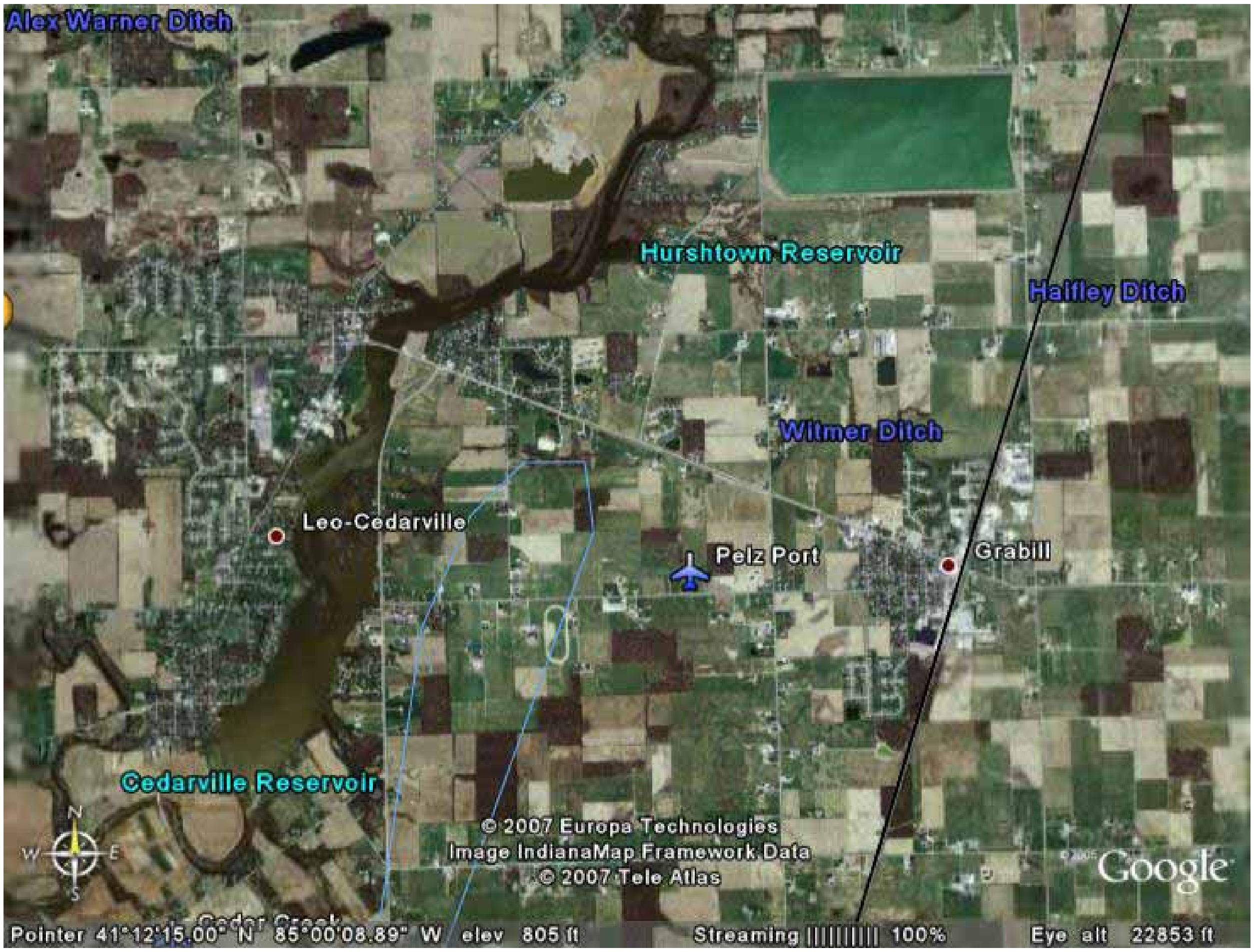



**Figure 14 The Cedarville and Hurshtown Reservoirs near Leo-Cedarville.**

### 2.2 Description and History

This section outlines the natural history, topography, land use and population, soils, climate and cultural and recreational resources of the Lower St. Joseph and Bear Creek subwatersheds.

#### 2.2.1 Natural History

The Bear and Lower St. Joseph Watersheds share a common natural history with the entire St. Joseph River Watershed and a more specific history with the southeastern portion of the larger drainage basin. The Maumee River Basin is characterized by a lobate physiography and topographically reflects the positions of various advances and retreats of ice lobes through the Pleistocene Epoch. The subwatersheds function today through a landscape defined by the most recent glacial period, the Wisconsin Age, 22,000 to 13,000 years ago.

Thickness of the glacial deposits varies within the Maumee Basin but tends generally to increase north and west away from the Maumee River headwaters in Fort Wayne. Thicknesses in the Bear/Lower St. Joseph areas range from 100 feet near Fort Wayne to 250-300 feet in Dekalb County. These glacial deposits resulted from two primary processes: glacial outwash and mass movement. Glacial outwash is deposited by high energy meltwater streams running through the ice sheet and then along the ice front. The St. Joseph River itself as it drains the Bear/Lower St. Joseph watersheds follows a course underlain by outwash deposits. Mass movement in this area describes the process of movement and deposition of fine- to medium-grained, poorly sorted sediment (till) near the base of the glacier

The Bear/Lower St. Joseph Watersheds occupy a more localized glacial terrain known as an *end moraine*. Two end moraines of the Erie Lobe are primarily responsible for the general geographic shape of the Maumee River Basin, the Fort Wayne and Wabash Moraines. These features are composed of broadly ridged uplands containing sequences of high-clay till sediments, deposited along the furthest extent of the Erie Lobe ice sheet advance (Wabash) and during a stationary period during retreat (Fort Wayne). (Fleming, 1994) The map in Figure 15 illustrates the surface geology in the region typical of such features. The silty clay-loam to clay-loam till regions border the outwash train following the course of the St. Joseph River. The Lower St. Joseph Watershed is similarly mapped, with Wabash Moraine west of the St. Joseph River and Fort Wayne Moraine to the east.

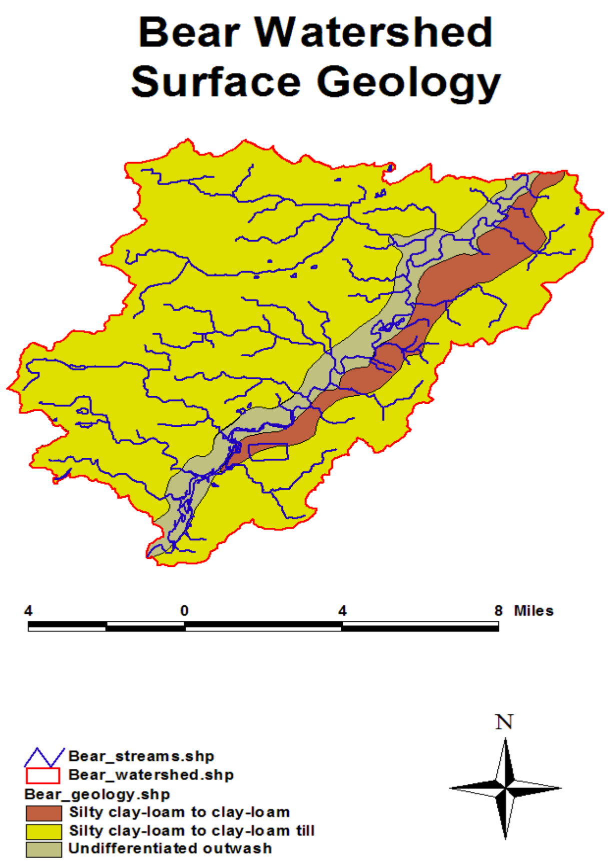



Figure 15 Surface geology of the Bear Creek subwatershed. Map by A. Wartenberg for SJRWI, 2006.

According to Anthony H. Fleming, in The Hydrogeology of Allen County, Indiana (1994), "The St. Joseph River receives a substantial amount of ground-water discharge, even during extremely dry conditions. For example, about 14 millions gallons per day are discharged to the river, mainly by the Huntertown aquifer system, between the stream gauge near Cedarville and the Fort Wayne gauging site."
Ground water below the St. Joseph River Valley has a relatively high sensitivity to contamination according to Fleming (1994). The water table almost everywhere is less than 15 feet deep, and in many places is within a foot or two of the land surface. The alluvial soils are commonly waterlogged, and the permeable character of the soil and outwash means that they are capable of receiving a large amount of direct recharge, both from precipitation and from the river.

### 2.2.2 Topography

Relief ranges in the Lower St. Joseph subwatershed range from level to rolling or strongly sloping, but is most commonly gently undulating. The areas along streams and drainage ways are more strongly dissected than other areas. Some of the most strongly dissected areas in the county are along the St. Joseph River in Cedar Creek Township. (USDA Allen Co. Indiana Soil Survey) The Bear Creek subwatershed in DeKalb County is generally flat and nearly level, drained by the St. Joseph River and its tributaries. DeKalb County's lowest elevation is in this corner of the county along the Indiana-Ohio state line, rising just 764 feet above sea level. (USDA Dekalb Co. Indiana Soil Survey)

### 2.2.3 Land Use and Population

The Lower St. Joseph subwatershed stretches from its confluence with the St. Marys River in the heart of Fort Wayne (population 215,495 at the year 2000 census) northward toward the Allen- DeKalb county line. Land use in the urban Fort Wayne area of the Lower St. Joseph subwatershed is highly developed. The Bear Creek subwatershed is predominately agricultural with isolated areas of small community development, including the towns of Leo-Cedarville, St. Joe, Spencerville, Grabill, and a small crossroads community known as Orangeville. Leo-Cedarville is the only densely urbanized area with a population of 2,782 people in 3.87 square miles. Urbanization is rapidly spreading from the northern boundary of Fort Wayne to the Leo-Cedarville area. Urban Fort Wayne the most densely populated area of the entire 694,400-acre St. Joseph Watershed; in its entirety, the St. Joseph watershed is predominantly rural, with less than 10% total urban land usage.

**Population Growing**

In Allen County, this watershed plan covers areas within Washington, St. Joseph, Perry, Cedar Creek, and Springfield townships. In DeKalb County, the watershed plan covers areas in Jackson, Spencer, Concord, and Newville townships. These townships had a combined 2005 population estimate of 145,270, an increase of 7.62% over the 2000 census.

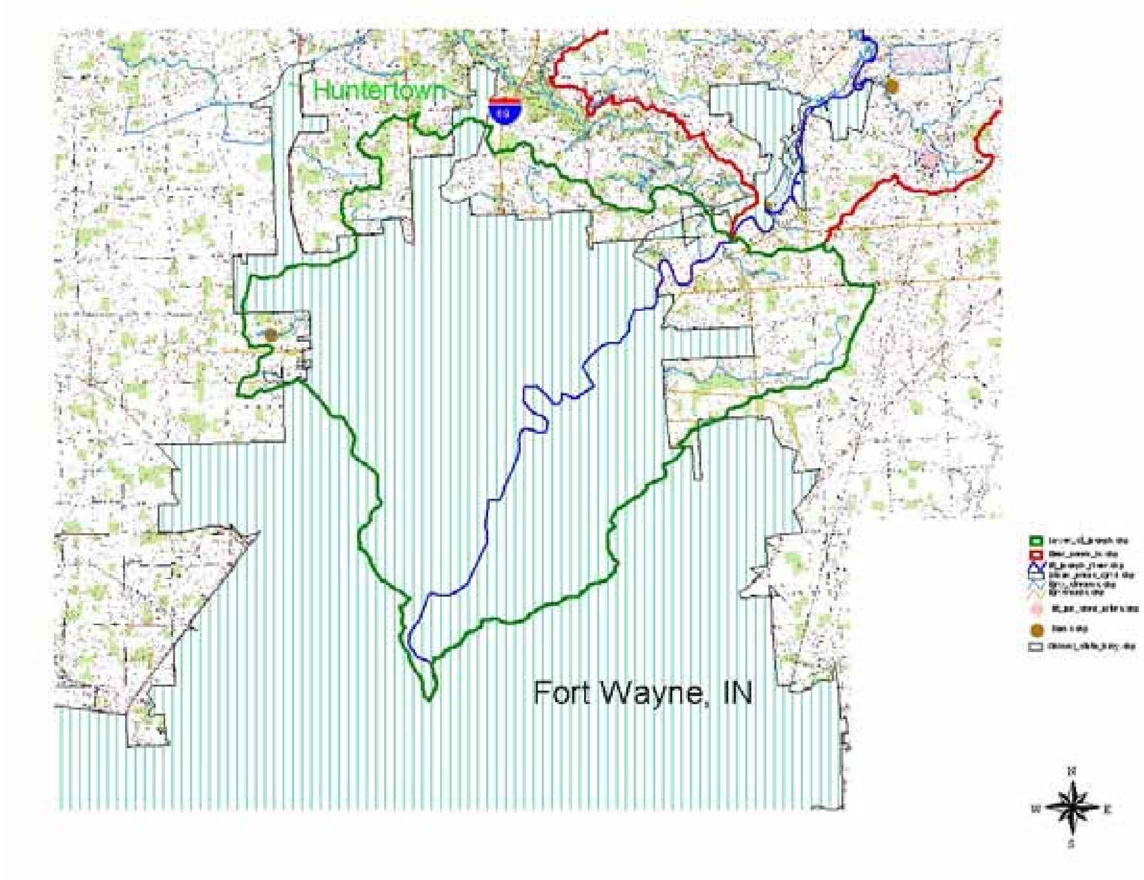



Figure 16 Urban development covers the majority of land in the Lower St. Joseph. SJRWI map.

While the majority of land in the Lower St. Joseph subwatershed is urbanized, a small northern crescent that is outside of the city limits remains. (See Figure 16.) As this area is developing rapidly, open space is becoming less available and land prices are increasing. Pockets of suburban neighborhoods that are located on large lots and contain parks or other green space are interspersed throughout the watershed. Prime farmland in this area is limited. Flash flooding along the streams within the city is occasionally a problem, particularly in areas adjacent to streams, and in those areas with a high percentage of impervious surfaces that do not drain quickly enough to handle large amounts of rain in a short duration. Some localized gully erosion is apparent along the sides of roadways and ditches.

**Public/Private Land Ownership**

The vast majority of the land within the two subwatersheds is under private ownership. However, the reservoirs and some parcels along the river are owned by the City of Fort Wayne. Additionally, easements to some parcels, particularly along the river, are held by local government.

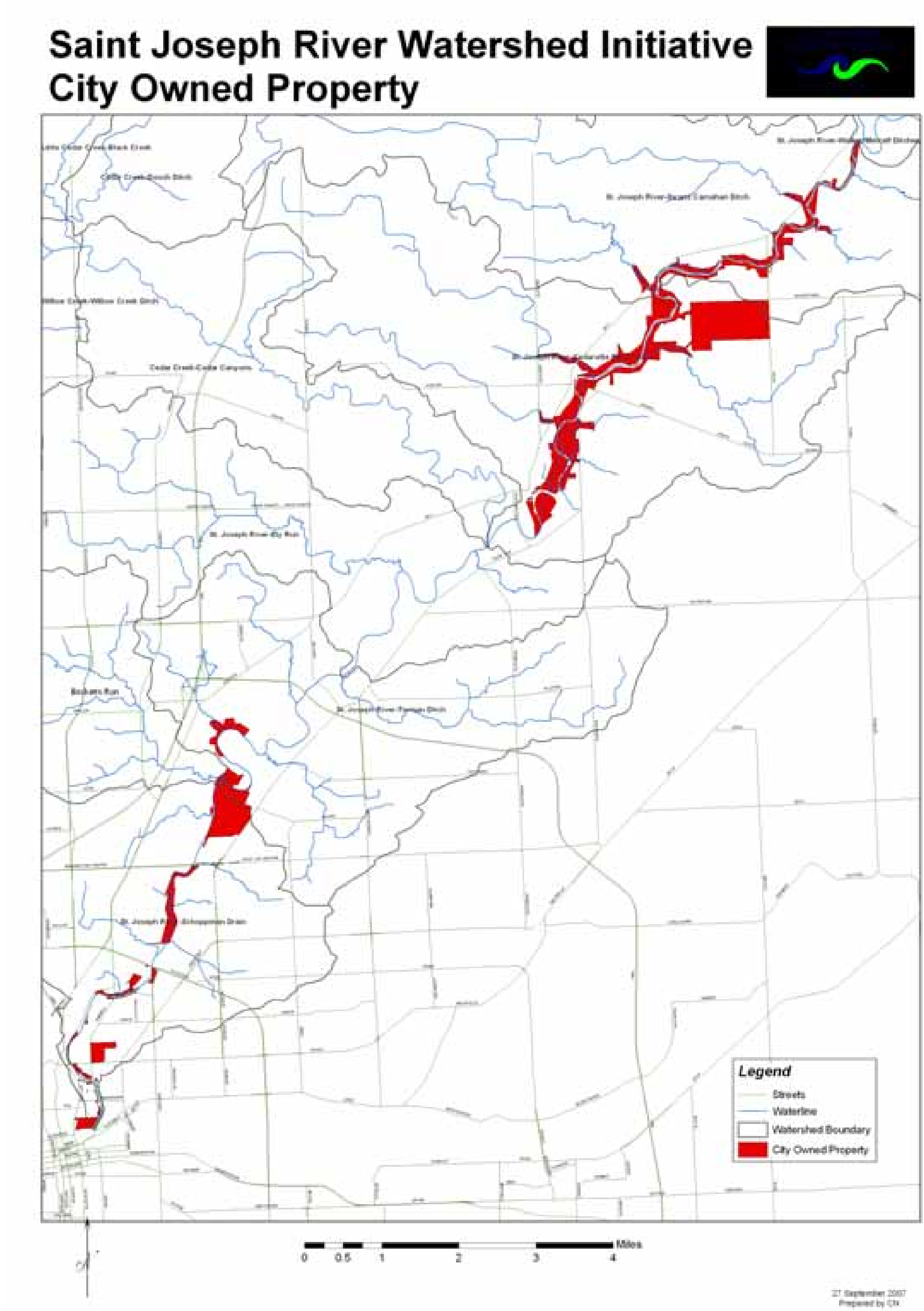



**Figure 17 Land along the St. Joseph River within Allen County owned by the City of Fort Wayne. (Allen I-map by SJRWI)**

Land use cover maps quantifying the amount of high intensity, low intensity and developed open space for the two subwatersheds are presented in the figures on the following page. These maps graphically illustrate the difference between the two areas, as well as the amount of urbanization that characterizes the Lower St. Joseph subwatershed. The GIS maps were created by Scott Gibson, using the 2001 National Land Cover Data. The data and associated information, can be found on the Multi-Resolution Land Characteristics Consortium (MRLC) website: [http://www.epa.gov/mrlc/nlcd.html](http://www.epa.gov/mrlc/nlcd.html).

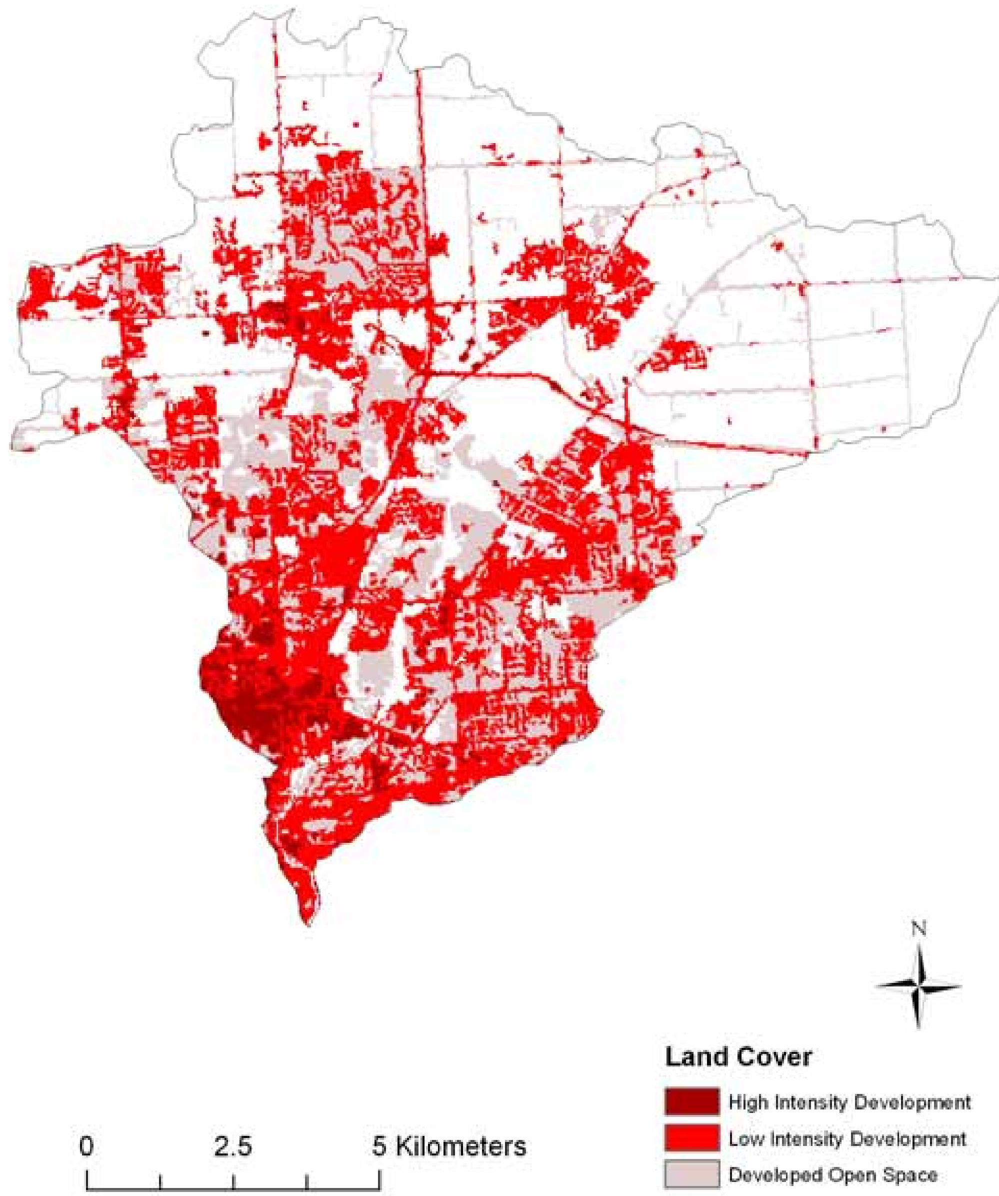



**Figure 18 Impervious surface area in the Lower St. Joseph subwatershed 2001. (S. Gibson 2007)**

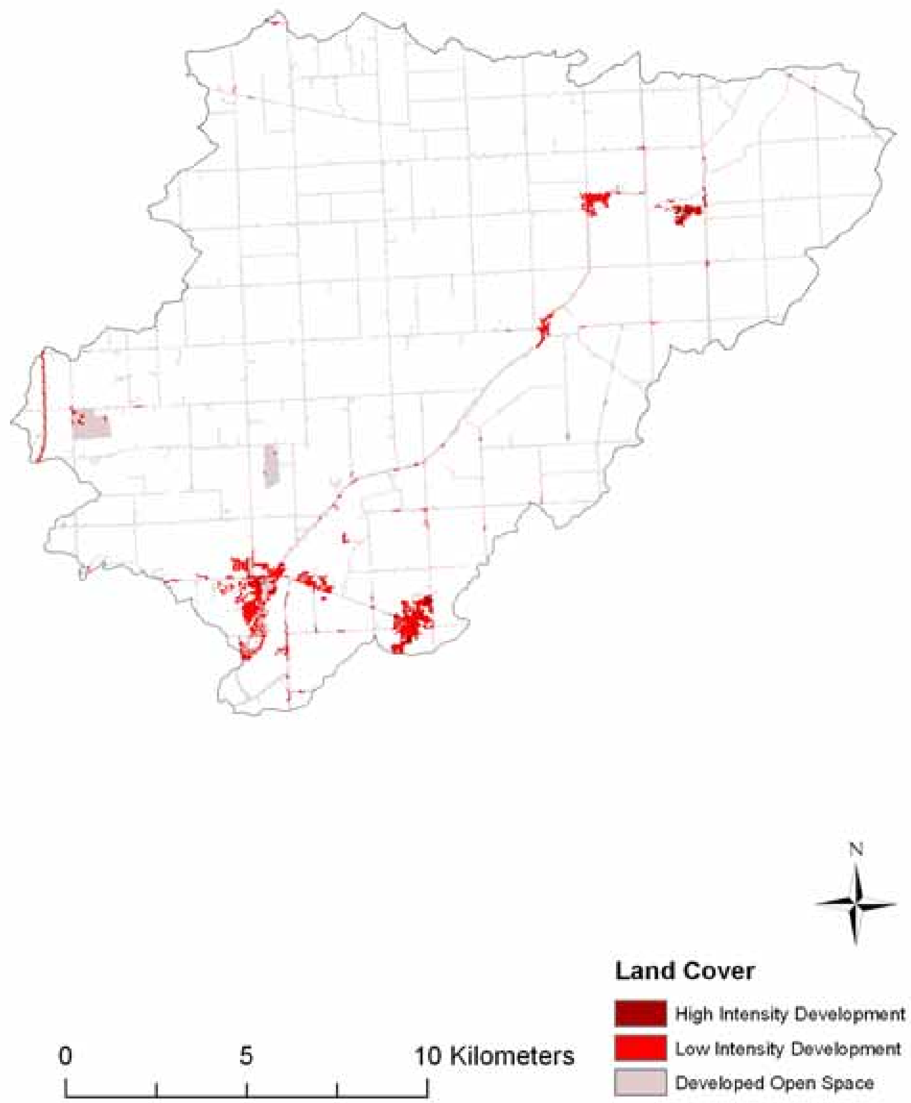



**Figure 19 Impervious surface area in the Bear Creek subwatershed, 2001. (S. Gibson 2007)**

Population varies greatly in the townships that comprise the Lower St. Joseph and Bear Creek subwatersheds. The Lower St. Joseph is contained entirely in Allen County. A small portion of the Bear Creek watershed, encompassing Leo-Cedarville is located in Allen County. With the exception of Springfield Township, Allen County is urbanized. With the exception of Jackson Township, the Bear Creek watershed in DeKalb County is rural.

| 2002 census | Allen County<br>Cedar Creek Twp. | Perry Twp. | St. Joseph Twp. | Springfield Twp. | Washington Twp. | DeKalb County<br>Concord Twp. | Jackson Twp. | Spencer Twp. | Newville Twp. |
|---|---|---|---|---|---|---|---|---|---|
| **Population** | | | | | | | | | |
| **Urban** | 4,754 | 14,875 | 67,920 | 0 | 31,288 | 0 | 111 | 0 | 0 |
| **Rural** | 5,534 | 3,295 | 986 | 3,697 | 1,817 | 1,212 | 2,448 | 1,057 | 538 |
| **% Rural** | 53.8% | 18.1% | 1.4% | 100% | 5.5% | 100% | 95.7% | 100% | 100% |
| **Housing units** | | | | | | | | | |
| **Urban** | 1,603 | 5,044 | 27,994 | 0 | 13,966 | 0 | 58 | 0 | 0 |
| **Rural** | 1,814 | 1,173 | 379 | 1,140 | 733 | 447 | 876 | 381 | 178 |
| **% Rural** | 53.1% | 18.9% | 1.3% | 100% | 5.0% | 100% | 93.8% | 100% | 100% |

Table 4 Population and housing by township, 2000 census. Provided by V. Richardson, IPFW Community Research Institute.

### 2.2.4 Soils

Soils in the Lower St. Joseph and Bear Creek subwatersheds are predominantly Morley-Blount association, which are deep, moderately well drained to somewhat poorly drained, nearly level to steep, medium-textured soils on uplands, silty, clayey and loamy soils on till plains and moraines. Along the bottomlands and flood plains, the Eel-Martinsville-Genesee association soils are deep and nearly level to moderately sloping, medium-textured and moderately fine textured, loamy soils underlain by sand and gravel. Pockets of Glynwood-Pewamo-Morley association soils, which are deep, somewhat poorly to very poorly drained, nearly level and gently sloping, moderately to moderately fine textured soils occur on uplands across the subwatersheds. (USDA Soil Survey)

Maps of the two subwatersheds that illustrate the amount of highly erodible land (HEL) and potentially highly erodible land (PHEL) in the two subwatersheds can be found in the Appendix C of this document. In the Lower St. Joseph, the Beckett's Run watershed contains the most HEL, with patches in the Eel Run watershed. In the Bear Creek subwatershed, the Swartz-Carnahan and Hursey-Bear Creek watersheds have a significant amount of HEL; the Cedarville Reservoir watershed also has substantial HEL.

### 2.2.5 Climate

Climate in the St. Joseph-Bear Creek subwatersheds is characterized by wide variations in temperature from summer to winter, and fairly uniform distribution of precipitation throughout the year. Daily changes in temperature and relative humidity are less pronounced n summer than in the other seasons. Local variations in temperature can be accounted for by differences in elevation, aspect, air drainage, ground cover, soil wetness and distance from a large body of water.

Precipitation averages around 35 inches per year.  Of this, about 60% usually falls in April through September. Droughts are most likely in midsummer, when showers are scattered, general rains are infrequent and evaporation losses are high.  The average length of the growing season is about 156 days. The sun shines 70% of the time possible in summer, and 40% of the time possible in winter.  Thunderstorms occur on about 43 days each year.  Sometimes these can be accompanied by winds strong enough to damage property.  (USDA Soil Survey)

### 2.2.6 Cultural and Recreational Resources

The Lower St. Joseph and Bear Creek subwatersheds have a significant amount of park and green space dedicated to public use.  Within the City of Fort Wayne, the Rivergreenway system follows the river from its confluence with the St. Mary's River downtown northward to Johnny Appleseed Park.  Funding has been allocated to extend the greenway northward from there across the campus of Indiana University-Purdue University Fort Wayne (IPFW) to Shoaff Park.

**Figure 20  The 0.7 mile Allen-Grabill Community Wetlands Trail includes an extra lane on the highway for Amish buggies. (J. Loomis 2007)**

Citizens from the Town of St. Joe, Indiana, (population <500) have built and maintain a 1-1/4 mile greenway along the St. Joseph River which extends from Riverdale Elementary School in the Town of St. Joe southward to County Road 64. The area includes two outdoor classrooms and a proposed 9-acre nature area. Another 0.7 mile bike/walking trail connects the towns of Grabill and Leo-Cedarville. See Figure 20.

Parks areas within the watershed include Griswold Park, Bob Arnold Northside Park, Johnny Appleseed Park, Lion's Park, Klug Park and Shoaff Park operated by the City of Fort Wayne; Riverside Gardens and Cedarville Park, operated by the City of Leo-Cedarville; the Covered Bridge park in Spencerville, and Wild Cherry Park in St. Joe.

There are several golf courses that lie along the river or within the watershed that drains to the river in these two subwatershed. Catherbury Green Golf Course, Shoaff Park golf course, and Riverbend Golf Course are on the river. Pine Valley and Autumn Country Clubs are in the Ely Run watershed; Deer Track is on SR 427 in the Hursey Ditch watershed; and Cedar Creek Golf lies in the Swartz-Carnahan watershed.

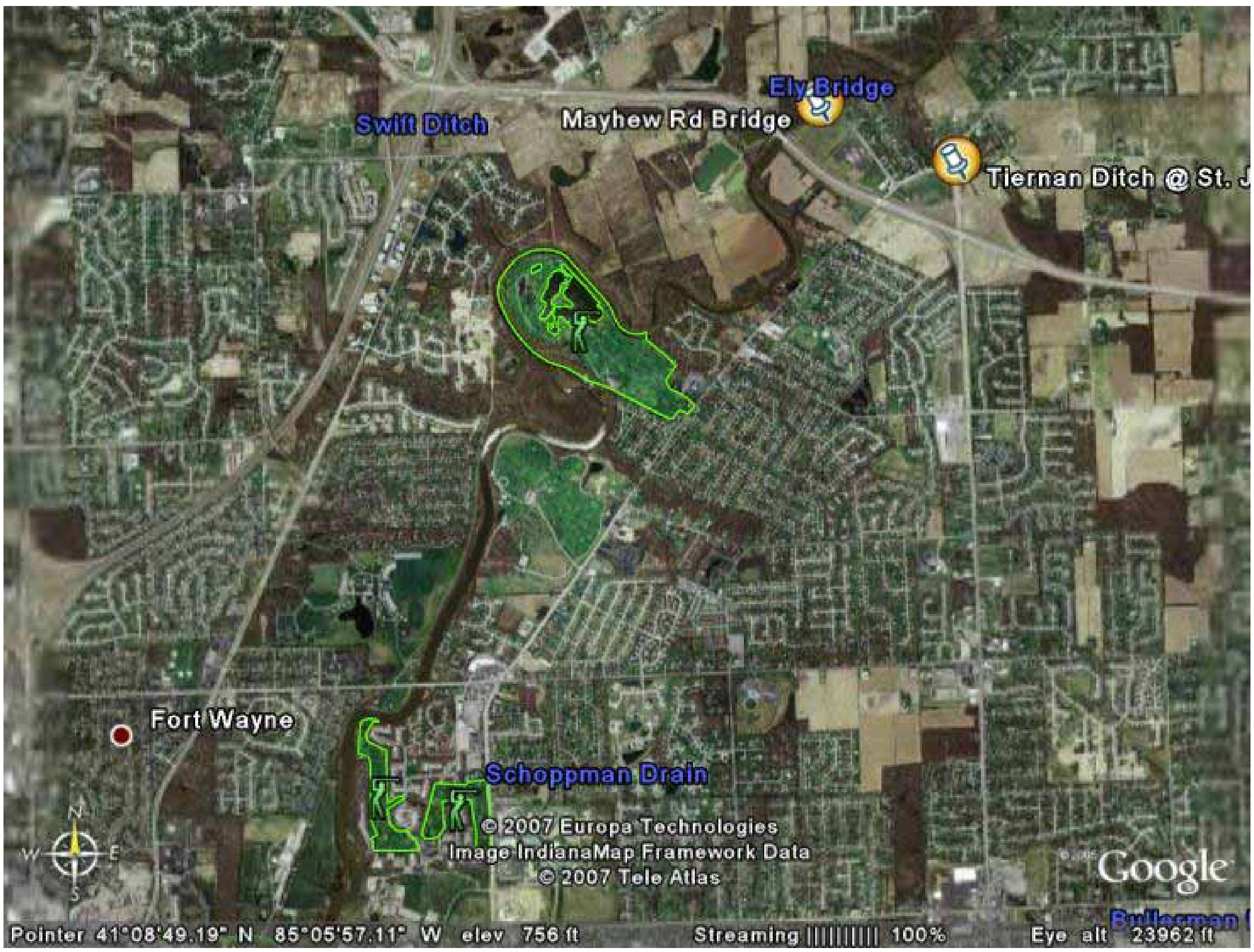



**Figure 21 Three golf courses lie along the river: Canterbury Green and River Bend Golf Clubs, and in between them, Shoaff Park.**

At least three nature preserves are located within the two subwatersheds. See Table 5, below. The preserves are owned and maintained by the ACRES Land Trust. Maps to the preserves, along with driving directions, photos, and other information is available on the ACRES website, www.acreslandtrust.org.

| Nature Preserve | Location |
|---|---|
| Emmanuel Popp Nature Preserve | North of Fort Wayne and west of Leo-Cedarville in Allen County |
| Foxfire Woods Nature Preserve | North of Leo-Cedarville in Allen County |
| McNabb-Walter Nature Preserve | Northeast of Hursh in Allen County, southwest of Spencerville |

**Table 5 Nature Preserves in the watershed. ACRES 2006.**

Other cultural points of interest located in these subwatersheds include the Memorial Coliseum and Memorial Stadium, situated adjacent to the St. Joseph River and Johnny Appleseed Park in north central Fort Wayne, as well as the Ivy Tech State College and Indiana University- Purdue University Fort Wayne (IPFW) campuses, located in the same general area.

A footbridge over the St. Joseph River is proposed at the IPFW campus, just north of the Johnny Appleseed Park and the St. Joe River Dam. Proposed development around the footbridge is to contain a wetland with a handicap-accessible overlook. (J. Kelley, IPFW, personal communication, 2007).

**Figure 22 Public Access Site at the Cedarville Reservoir. (J. Loomis 2007)**

Fishing sites in the Lower St. Joseph and Bear Creek subwatersheds include Cedarville and Hurshtown Reservoirs, the St. Joseph River from Coliseum Boulevard to the confluence of the Maumee River in Allen County, and the St. Joseph River one-half mile east of St. Joe off County Rd. 60 in DeKalb County. At these locations smallmouth bass, crappie, carp, catfish and walleye are generally caught.

A fish release project directed by Eastside High School biology teacher Tom Hollabaugh has attempted to reintroduce walleye into the river with several fish releases. The students have also utilized outdoor classrooms along the St. Joe Greenway to test the water and, with DNR permits, to catch and measure fish in the river.

Results of their efforts are shown on Table 6, below. The group released two hundred six-to-eight-inch walleyes in October, 2004, and two hundred five-to-seven-inch walleye in October of 2006. During the 2006 summer a 2.5 lb. walleye was caught about 2 mi. upriver from the release point and two 12 inch walleye were caught from a location under the State Road 101 Bridge, not far from the release point.

| Fish species | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| Blue Gill | 0 | 1 | 2 | 0 |
| Carp | 6 | 29 | 10 | 4 |
| Channel Catfish | 46 | 40 | 26 | 44 |
| Crappie | 2 | 1 | 1 | 6 |
| Largemouth Bass | 0 | 0 | 1 | 0 |
| Pike | 0 | 2 | 1 | 0 |
| Redhorse | 0 | 0 | 2 | 0 |
| Rock Bass | 2 | 15 | 7 | 10 |
| Shad | 0 | 0 | 0 | 1 |
| Sucker | 0 | 11 | 6 | 10 |

Table 6 Fish species caught and released in the St. Joseph River by Eastside High School environmental science students

The St. Joseph River is generally a slow-flowing river that provides a relaxing and scenic ride by canoe. A canoeing guide for the St. Joseph River from the Ohio line to Fort Wayne is available on the Department of Natural Resources (DNR) website, http://www.in.gove/dnr/outdoor/canoe/stjoseph.htm.
Several public access sites along the river facilitate boating with small craft (Table 7). Additional sites are available from public river greenway and park areas along the river, particularly in municipal areas. A private canoe and kayak Rental company, R & R Elk Ranch, operates along County Road 64 in St. Joe, Indiana, and offers livery and canoe rental to several locations along the St. Joseph River.

| Access | Location | | Comments |
|---|---|---|---|
| (Ohio) close to state line | CR 40 Bridge corner of bridge | Northwest corner of bridge | Limited parking |
| Newville (Indiana) | State Rd. 8 | Southeast Corner of bridge | |
| Spencerville (Indiana) | CR 68 | West of covered bridge | Private owner permits access |
| Leo- Cedarville | Grabill Road Bridge | Southwest corner of the bridge just beyond a gauging station | |
| Cedarville | Clay street off SR 1 | First street east of bridge over Cedar Creek on south side of Cedarville | Access to Cedar Creek above confluence w/ the river |
| Fort Wayne | Shoaff Park | East side of the river | |
| Fort Wayne | West side of the river above the St. Joseph dam | Across from IPFW campus | Or float an additional 200 yards downstream under the highway bridge to Johnny Appleseed Park |

**Table 7 Public access sites along the lower reaches of the St. Joseph River. (IDNR)**


**Figure 23  A Covered Bridge over the St. Joseph River in Spencerville, Indiana. (J. Loomis 2007)**

Biking trails in the watershed include those listed in Table 8, below.

| Trail | Miles | Surface | Administered by | Contact |
|---|---|---|---|---|
| Allen River Greenway | 4 | Asphalt | Allen Co Parks & Recreation | 260-449-3190 |
| River Greenway Trail | 13.95 | Asphalt | Fort Wayne Parks & Recreation | http://www.fortwayneparks.org |
| Allen Grabill Community Wetlands Trail | 0.7 | Concrete | Grabill Parks Dept | 260-627-5227 |
| St. Joe Greenway | 1.25 | Asphalt, concrete | St. Joe River Greenway Parks, Inc. | |

**Table 8  Greenway and bike trails in the Lower St. Joseph & Bear Creek subwatersheds. (IDNR)**

Figure 24 Grassed waterway and filter strips. Photo courtesy SJRWI, 2006

## Part 3: Benchmarks and Current Status of the Watershed

As outlined in Part 1, Introduction, watershed stakeholders identified four major areas of concern: 1) water quality; (2) recreation and access to the water; (3) natural area/river corridor preservation and maintenance; and 4) watershed/water quality issues education. The current status of recreational areas and points of access to the river was outlined in Part 2. The other three concerns are addressed in this chapter.

In order to establish baseline conditions for water quality, we examined data generated by the State of Indiana which supports the 303(d) list. We also examined local water quality data available for the Bear/Lower St. Joseph watersheds. The Lower St. Joseph watershed is better represented than the Bear due to its location within Fort Wayne. The majority of the data available has been collected and stored by the St. Joseph River Watershed Initiative and the City of Fort Wayne Water Utilities Department.

Additional sampling data has come from the Fort Wayne-Allen County Health Department, which has a ditch sampling program to track E. coli in the drainage ditches for the purpose of locating areas which have a high volume of failing septic systems. Two of their sampling locations are within our study area – one in the Lower St Joseph and one in the Bear Creek watersheds.

We also examined land use maps to help determine the patterns of land use both in the entire watershed and along the river and major stream corridors, which we consider the most important areas of influence on water quality. We used Arcview GIS and GIS layers from the national hydrography dataset and the 2001 national land cover dataset. The results allow us to quantify and graphically illustrate the current status of the corridors, and to identify critical areas.

A final source of data comes from volunteer water quality monitoring through the Hoosier Riverwatch program. Although not as scientifically rigorous as certified laboratory analysis, it nonetheless gives us a quality source of water quality information for some of the smaller streams that are not regularly sampled. Additionally, it has given us some biological and physical habitat information for these streams.

### 3.1 Water Quality

Water quality standards are based upon designated uses of the river in the State of Indiana. The Lower St. Joseph and Bear Creek subwatersheds are designated for warm water aquatic life, full body contact-recreational, public water supply, industrial, and agricultural uses.

#### 3.1.1 Impaired Waterways – The 303(d) list of Impaired Waterways

The St. Joseph River and several tributaries in the Bear and Lower St. Joseph watersheds are listed on the 303(d) catalogue of impaired water bodies for the State of Indiana. See Table 9, below.

| HUC Code | County | Segment ID# | Waterbody name | Parameter of concern |
|---|---|---|---|---|
| 4100003100040 | Allen Co. | INA03P1044_00 | ST. JOSEPH RESERVOIR | E. COLI, ALGAE |
| 4100003070050 | ALLEN CO | INA03P1024_00 | CEDARVILLE RESERVOIR | E. COLI, ALGAE, TASTE & ODOR |
| 4100003070040 | ALLEN CO | INA0374_T1021 | SWARTZ-CARNAHAN DITCH | IMPAIRED BIOTIC COMMUNITIES |
| 4100003070010 | DEKALB CO | INA0371_T1059 | ST. JOSEPH RIVER | E. COLI |
| 4100003060060 | DEKALB CO | INA0366_T1057 | METCALF DITCH AND TRIBS | IMPAIRED BIOTIC COMMUNITIES |

**Table 9 Impaired water bodies in the Lower St. Joseph and Bear Creek subwatersheds (IDEM, 2006)**

The impairment for the St. Joseph River, the Cedarville Reservoir, and the St. Joseph Reservoir is E. coli. The two reservoirs are also impaired by algae. Additionally, the Cedarville Reservoir is impaired for taste and odor. The impaired designated use for the Swartz-Carnahan and Metcalf Ditch is IBC (Impaired Biotic Communities (See Table 9).

The presence of algae generally indicates nutrient enrichment; and the impaired biotic communities (IBC) designation is generally a result of sediment loading, nutrient enrichment and possible pesticide contamination, as well as general physical habitat degradation. Taste and odor are often the result of algae blooms and excessive nutrient loading and are an issue for a drinking water source such as the St. Joseph River system.

#### 3.1.2 The SJRWI Water Quality Sampling Program

Water quality data is collected by the St. Joseph River Watershed Initiative (SJRWI) through its sampling program which collects grab samples from approximately 24 sites throughout the watershed once per week during the recreational season, April through October. At least four sites from the Lower St. Joseph and Bear Creek have been included in the sampling program.

The SJRWI sampling program includes data for the pesticides Atrazine, Alachlor, Metolochlor and Cyanazine; for bacteria (E. coli and total coliform); for nutrients ammonia and phosphorus; and for turbidity. Additional parameters include pH, water and air temperature, conductance, and total dissolved solids. Data collected over the years by the SJRWI have been used to help locate areas of interest, establish loads, and target load reductions for educational outreach and watershed management planning purposes.

Generally, water quality in the St. Joseph River is better than that of either the St. Marys or the Maumee. The confluence of these three rivers is in the city of Fort Wayne. However, the quality of the water in these two subwatershed is neither fishable nor swimmable, according to Indiana water quality standards.

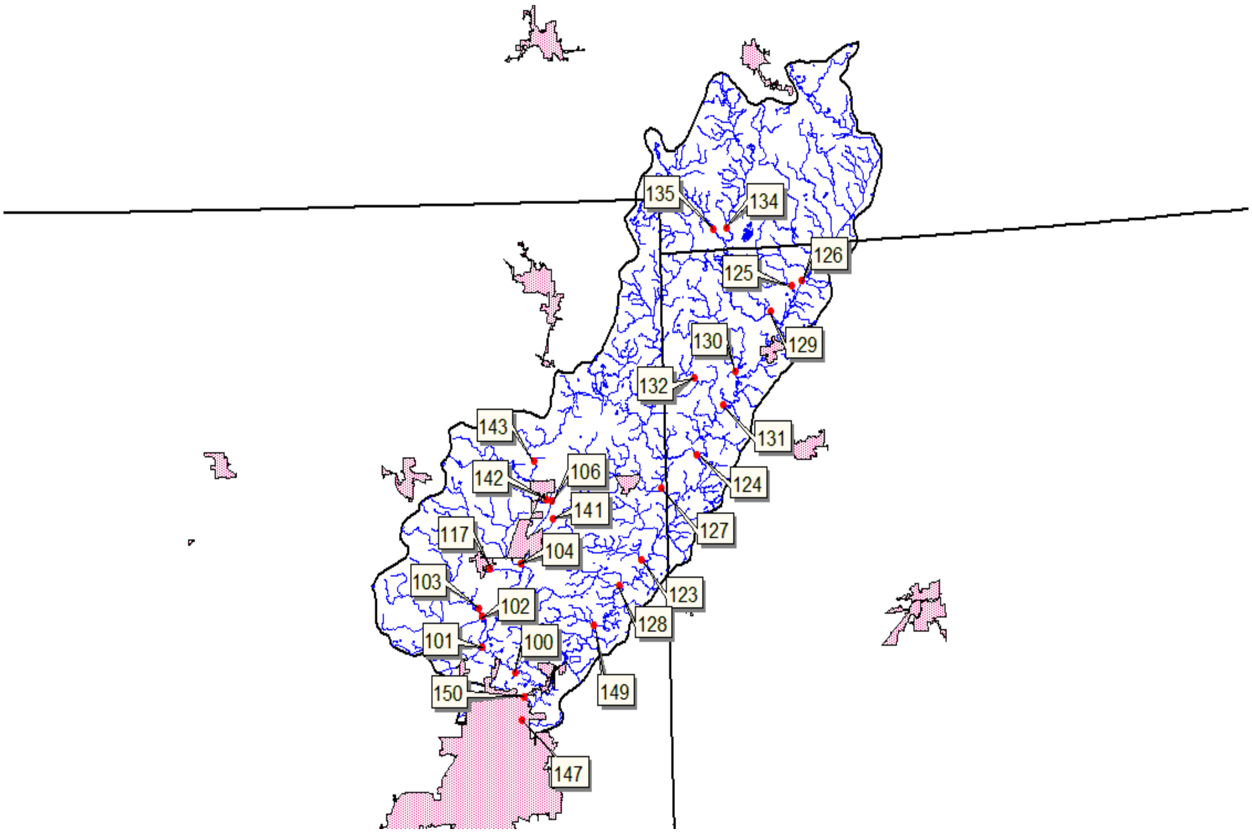



Figure 25 Sampling sites for the SJRWI weekly water monitoring program (SJRWI 2006)

The SJRWI has complete historical data (1996-2007) for the Bear Creek near its confluence with the main stem of the St. Joseph (See Site 128 in Figure 25). Sampling at other sites in the two subwatersheds was initiated to support this watershed management plan. Limited data exists for the Metcalf Ditch, Tiernan Ditch, and Ely Run sites.

Sampling sites supporting this planning effort can be located on the map in Figure 25:

- Bear Creek: **Site 128**, located on State Road 1 west of CR 63 in St. Joe, Indiana
- Metcalf Ditch: **Site 149**, located on State Road 1 north of Dekalb/Allen county line
- Tiernan Ditch: **Site 147**, located on St. Joe Rd. near the Mayhew Rd. **-** I-469 interchange
- Ely Run: **Site 150**, located on State Road 1

Witmer Ditch was sampled in 2005 at a bridge on Springfield Center Road, providing limited data. The site was discontinued in 2006 due to dry conditions and backflow from the Cedarville Reservoir.

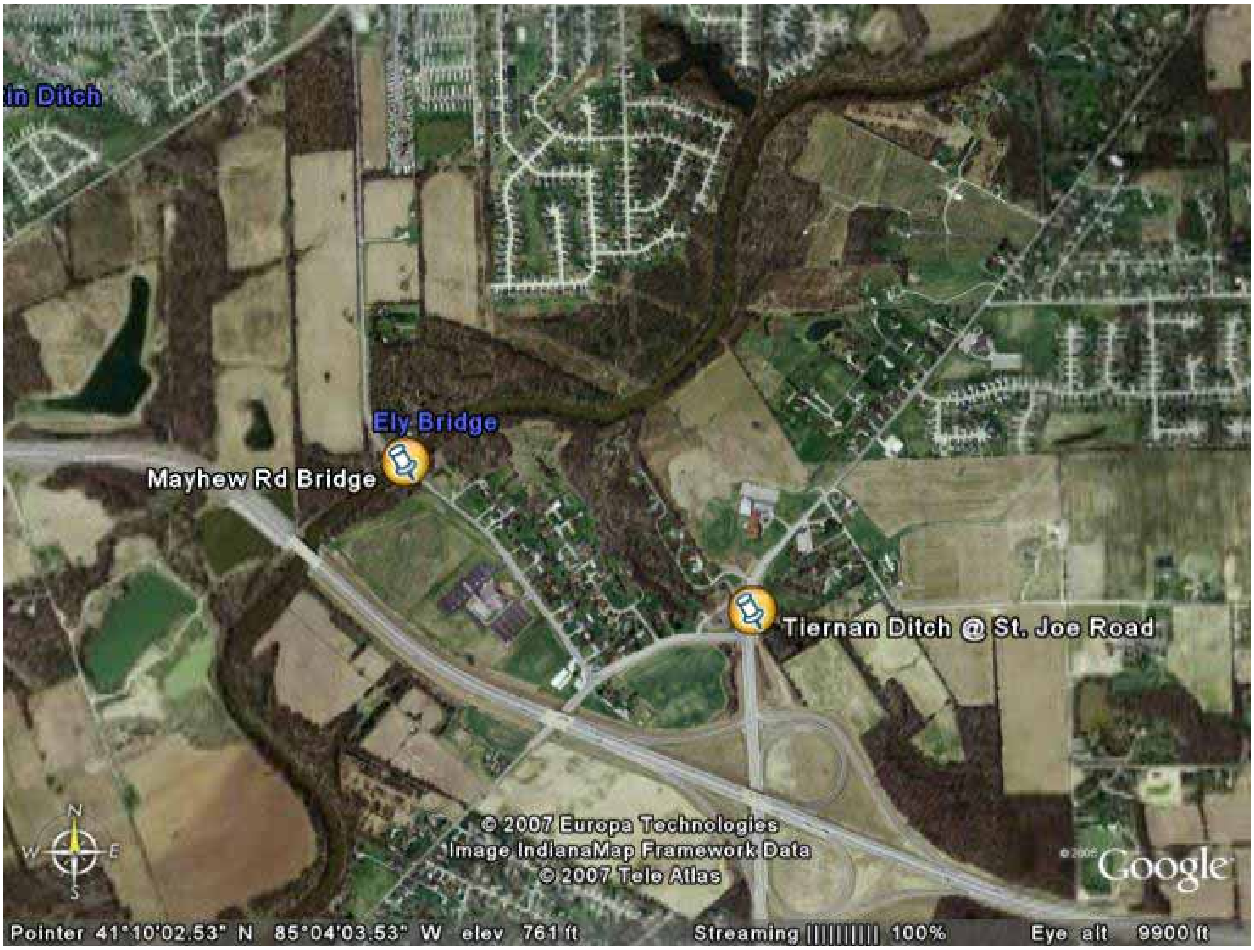



**Figure 26 Sampling locations Mayhew Road Bridge (City of FW) and Tiernan Ditch (SJRWI)**

### 3.1.3 Data Results: Contaminants of Concern

#### 3.1.3.1 Bacteria

Elevated levels of E. coli in the waters of the St. Joseph River and its tributaries have long been identified through monitoring conducted by the Indiana Department of Environmental Management, the Fort Wayne-Allen County Department of Health, and the St. Joseph River Watershed Initiative. Available water quality data indicates high levels of bacteria present in all areas of the watershed, particularly following heavy rainfall and other wet weather events.

The City of Fort Wayne water utilities department operates the city's waste water treatment plant that serves the incorporated city of Fort Wayne, as well as Grabill, Leo-Cedarville and Huntertown. There are extensive areas of the city and county which are not served by central sewer systems. The Allen County Regional Sewer District has been created and is working with stakeholders in these areas of the county in order to install centralized sewers. The Town of St. Joe, Indiana, has a wastewater treatment plant located north of County Road 64 that serves St. Joe and Spencerville. The community of Orangeville has no centralized wastewater treatment facility.

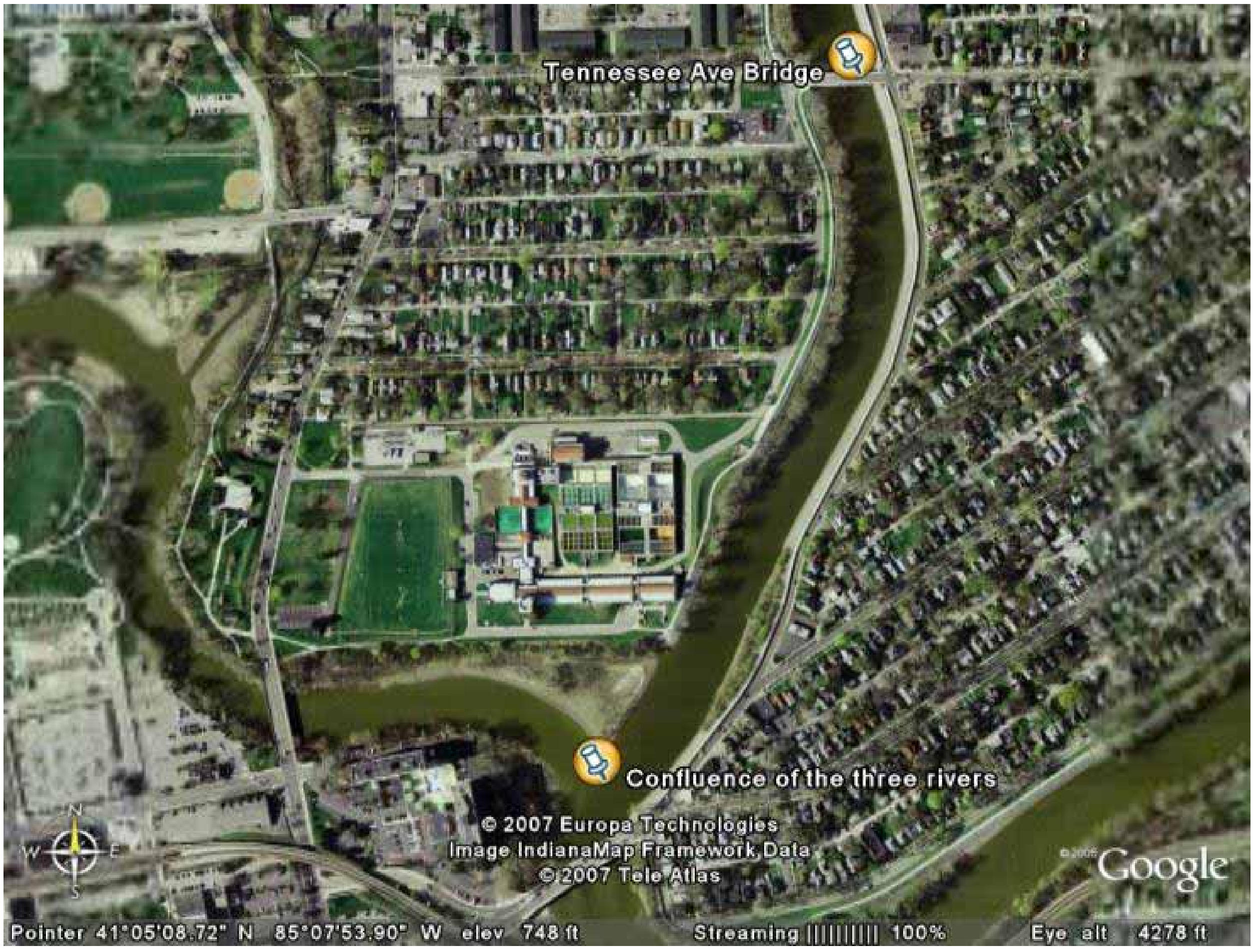



**Figure 27 Sampling location at the Tennessee Avenue bridge (City of Fort Wayne) is shown at the top of the map. This site also has a USGS streamflow gauge.**

The City of Fort Wayne tests the St. Joseph River water weekly during the recreational season at the bridges on Mayhew Road and Tennessee Avenue. Table 10 shows the average annual E. coli levels in cfu/100 mL, as well as the maximum (high) count for the year and the percentage of the samples that exceeded the Indiana water quality standard of 235 colonies per 100 mL.

| | **Mayhew Road** | | | **Tennessee Avenue** | | |
|---|---|---|---|---|---|---|
| | **Average E. coli (cfu/100 mL)** | **High** | **% samples > 235 cfu/100 mL** | **Average E. coli (cfu/100 mL)** | **High** | **% samples > 235 cfu/100 mL** |
| 2003 | 184 | 1300 | 14.28% | 145 | 700 | 17.24% |
| 2004 | 944 | 9680 | 33.3% | 1807 | 13,740 | 55.17% |
| 2005 | 213 | 2420 | 0.12% | 388 | 5200 | 19.35% |
| 2006 | 316 | 2420 | 26.67% | 397 | 3000 | 40.0% |

**Table 10 Average E. coli levels at Mayhew Road and Tennessee Avenue, 2003-2006. (City of FW)**

Data gathered by the SJRWI supports the E. coli counts that are above the state water quality standards. Annual averages for the Bear Creek (Site 128) are listed in Table 11. The Bear Creek sampling location is near the confluence of the Bear with the main stem of the St. Joseph River, upstream of the St. Joe-Spencerville wastewater treatment plant.

| | Bear Creek (Site 128) | | |
|---|---|---|---|
| | **Average E. coli count (cfu/100 mL)** | **High** | **% samples > 235 cfu/100 mL** |
| 2000 | 1186 | 11840 | 70% |
| 2001 | 604 | 1780 | 68% |
| 2002 | 415 | 2070 | 45% |
| 2003 | 1193 | 5600 | 52% |
| 2004 | 805 | 3640 | 75% |
| 2005 | 543 | 5310 | 46% |
| 2006 | 1820 | 16520 | 75% |

**Table 11 Annual E. coli averages for Bear Creek, Site 128, 2000-06. (SJRWI)**

The SJRWI data for three other regular sampling sites in the two subwatersheds is less complete; access to appropriate sampling locations and low water levels reduced the number of samples collected in some areas. A problem with Hydrolab sonde rendered some of the streamside data invalid during late 2006 and early 2007. (This malfunction did not affect the pesticide and bacteria data.)

In the Tiernan Ditch (see Figure 26), samples were taken during 2005- 2007. During the 2005 season, eight of 11 samples (73%) were above the water quality standard (WQS); the high sample reading that season was 20,050 cfu/100 mL. During 2006, five samples were recorded and all samples registered above the WQS, with a high recording of 8,850 cfu/100 mL. The first five samples taken in early 2007 recorded one sample above the WQS, at 3,840 cfu/100 mL.

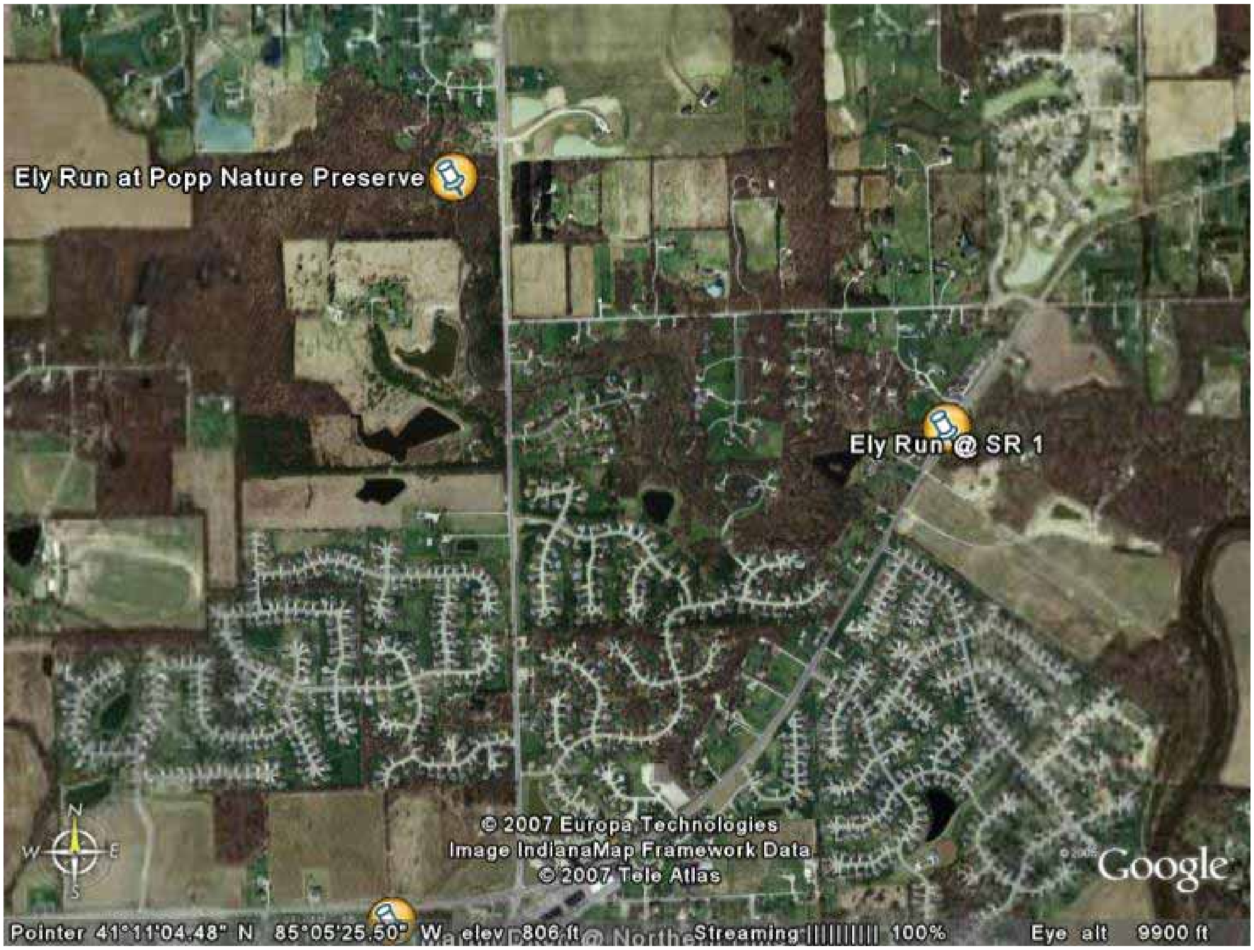



**Figure 28 Ely Run sampling sites at SR 1 (SJRWI site) and at the Popp Nature Preserve (Hoosier Riverwatch site)**

In Ely Run, samples were taken weekly by the SJRIW during the second half of 2006 and continued into 2007. During 2006, 7 of 9 samples exceeded the WQS, with a high reading of 8,310 cfu/100 mL. During the first 10 weeks of 2007, eight samples exceeded the WQS. The highest reading was 20,050 cfu/100 mL.

The Metcalf Ditch site (Figure 29, SJRWI site) recorded 4 of 12 samples (33.3%) exceeding the standard during the last half of 2006. Sampling during the first 10 weeks of 2007 resulted in a high reading of 420 cfu/100 mL, with 10% exceeding the WQS.

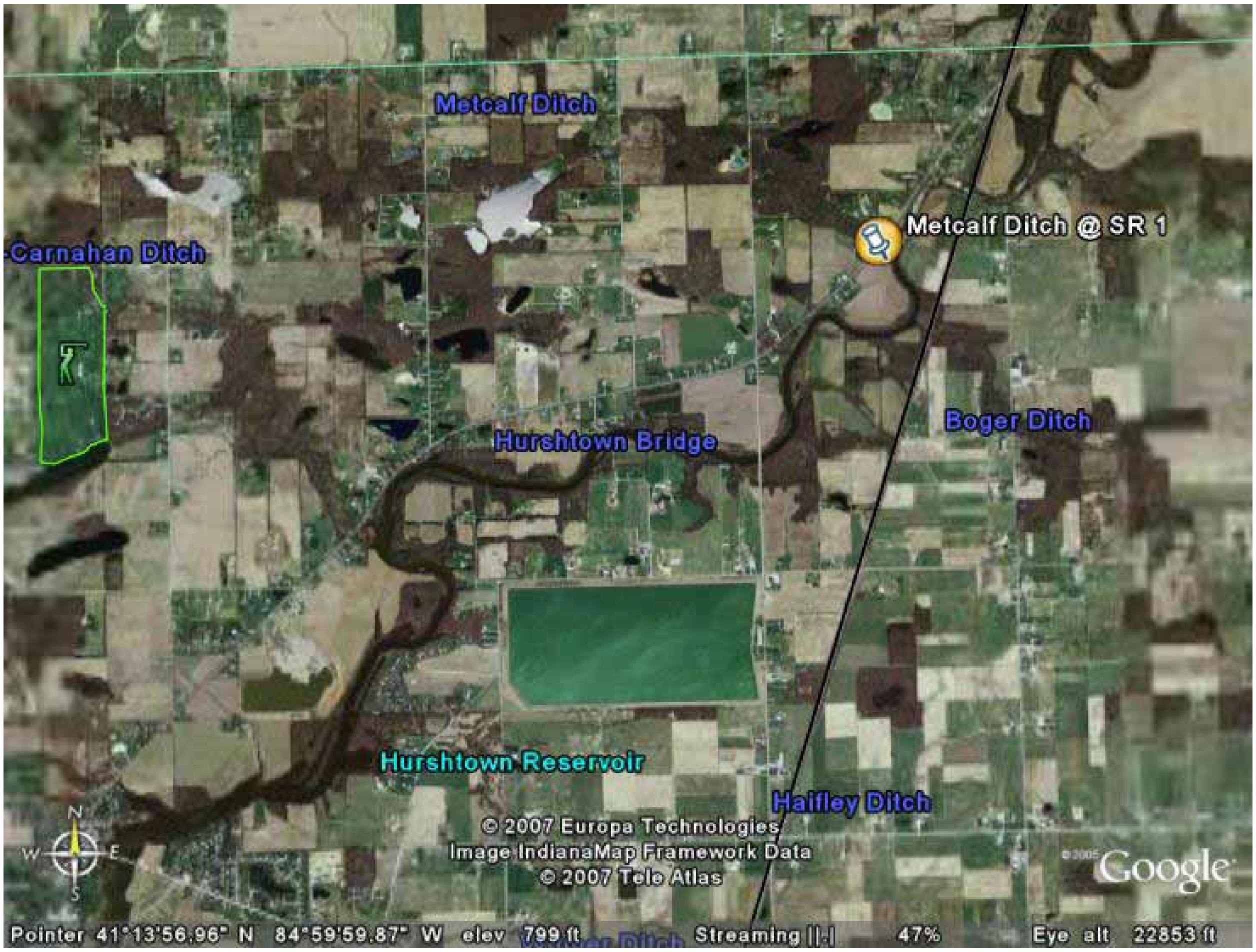



**Figure 29 Metcalf Ditch, SJRWI sampling site on State Road 1.**

**Bacteria Source Tracking**

The SJRWI's Bacteria Source Tracking project (2001-2004) identified certain trends in the sources of bacterial pollution. Livestock was rarely a significant (greater than 15%) source at the sites; nor was human a significant source. Wildlife (i.e. geese) was frequently a significant source, often representing the source of the majority of enterococci in the water sample. Horse was often significant as a source, and domestic pets were often the source of a substantial minority of the strains. (D. Ross, 2004)

This BST study included sampling in the Lower St. Joseph subwatershed in the vicinity of Grabill, Indiana. The site was selected to help measure pollutant loading in an area which has a significant Amish population and a large number of horses. Two sampling sites were selected on Fisher Ditch, one on Boger Ditch, one on Haifly Ditch and one on Witmer Ditch. The results of the testing, illustrated in Figure 30 and mapped in Figure 31) indicated that the most significant sources of fecal contamination in the area were domestic pets and horses. Livestock and human sources varied, but were not found as major sources of bacteria. (D. Ross, 2004)

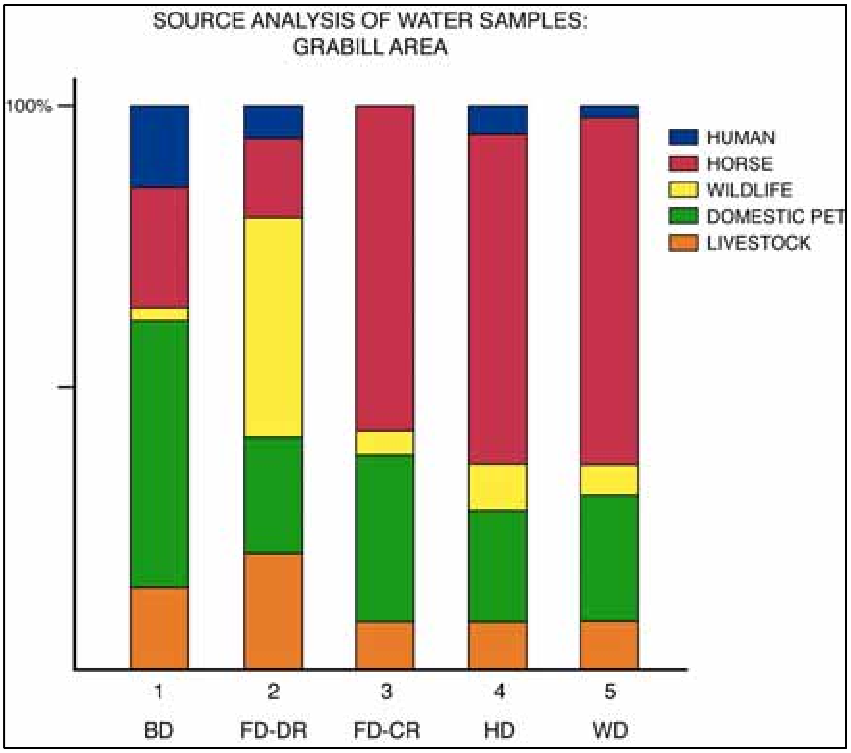



**Figure 30 Bacteria Source Tracking 2004. (D. Ross, 2004)**

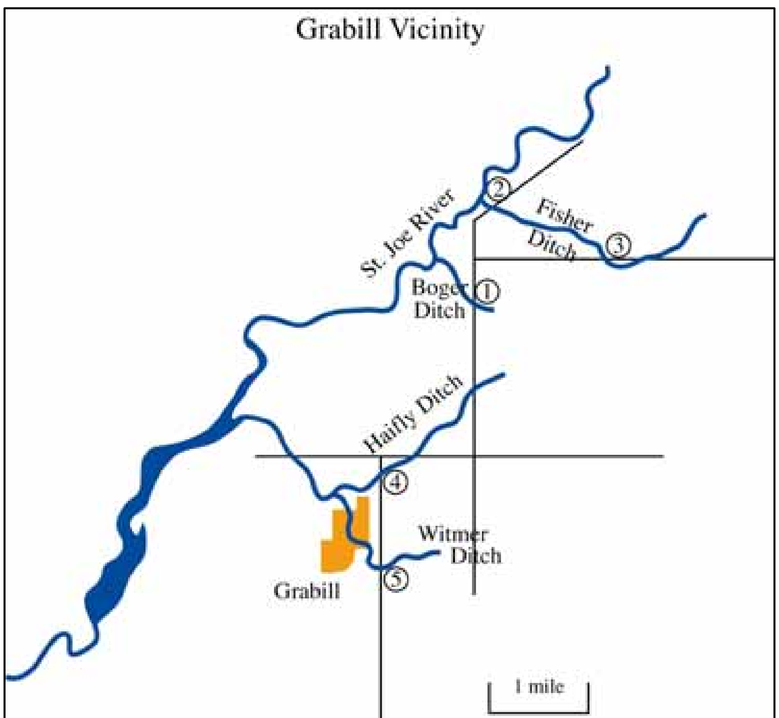



**Figure 31 Map of BST tracking in the Bear Creek watershed 2004. (D. Ross, 2004)**

## Ditch Sampling

The Fort Wayne-Allen County Health Department has conducted ditch sampling in two ditches located within the boundaries of this watershed study. Site 1, Nettlehorst Ditch at Hosler Road and Halter Roads is in the Bear Creek Watershed. Site, 2, an unnamed ditch/tributary that drains into the St. Joseph River at Porter Drive near Evard and St. Joe Roads, is in the Lower St. Joseph watershed. (See map, Figure 32)

Grab samples were taken from the streams during the recreational season, 2001 through 2004, and again in 2006. The sampling was not performed in 2005 due to lack of funding.

Table 12 shows the average annual counts and the annual high counts from these two locations. The extremely high levels of E. coli and indicate likely contamination from failed septic systems.

| | **Nettlehorst Ditch** | | | **Evard Road - St. Joe Road (unnamed ditch)** | | |
|---|---|---|---|---|---|---|
| | **Average E. coli (cfu/100 mL)** | **High** | **% > 235 cfu /100 mL** | **Average E. coli (cfu/100 mL)** | **High** | **% > 235 cfu/100 mL** |
| **2001** | 2135 | 11,000 | 82.1% | 108,851 | 580,000 | 100% |
| **2002** | 1432 | 25000 | 51.4% | 87,703 | 650,000 | 82.3% |
| **2003** | 2707 | 29,000 | 78.6% | 29,265 | 130,000 | 96.2% |
| **2004** | 8444 | 80,000 | 80% | 72,276 | 250,000 | 90% |
| **2005** | * | * | * | * | * | * |
| **2006** | 2461 | 25,000 | 80% | 83,618 | 203,000 | 100% |

**Table 12 Sampling data results from Fort Wayne-Allen County Health Department ditch sampling 2001-2004, 2006. (G. Chapple)**

The Evard Road-St. Joe Road site shown in Figure 34 on page 42 is in the location of a sewer project which will disconnect approximately 118 houses from private septic systems and connect them to the Fort Wayne central sewer system. This sewer project is expected to remove significant amounts of bacteria from the river, and will continue to be monitored.

# FW-Allen Co. Ditch Sampling Sites

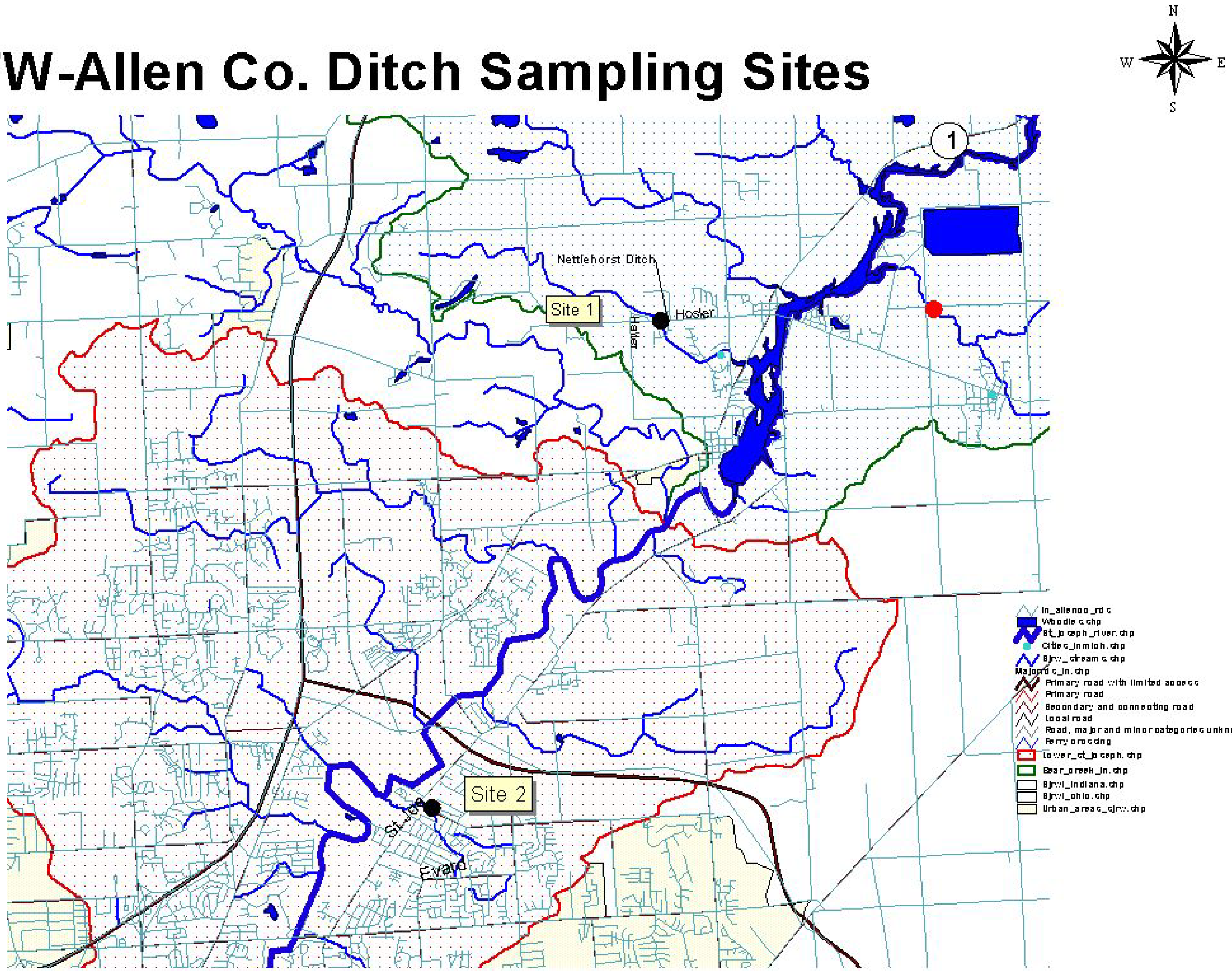



**Figure 32 Fort Wayne-Allen Co. Health Dept. ditch sampling sites. (SJRWI map)**

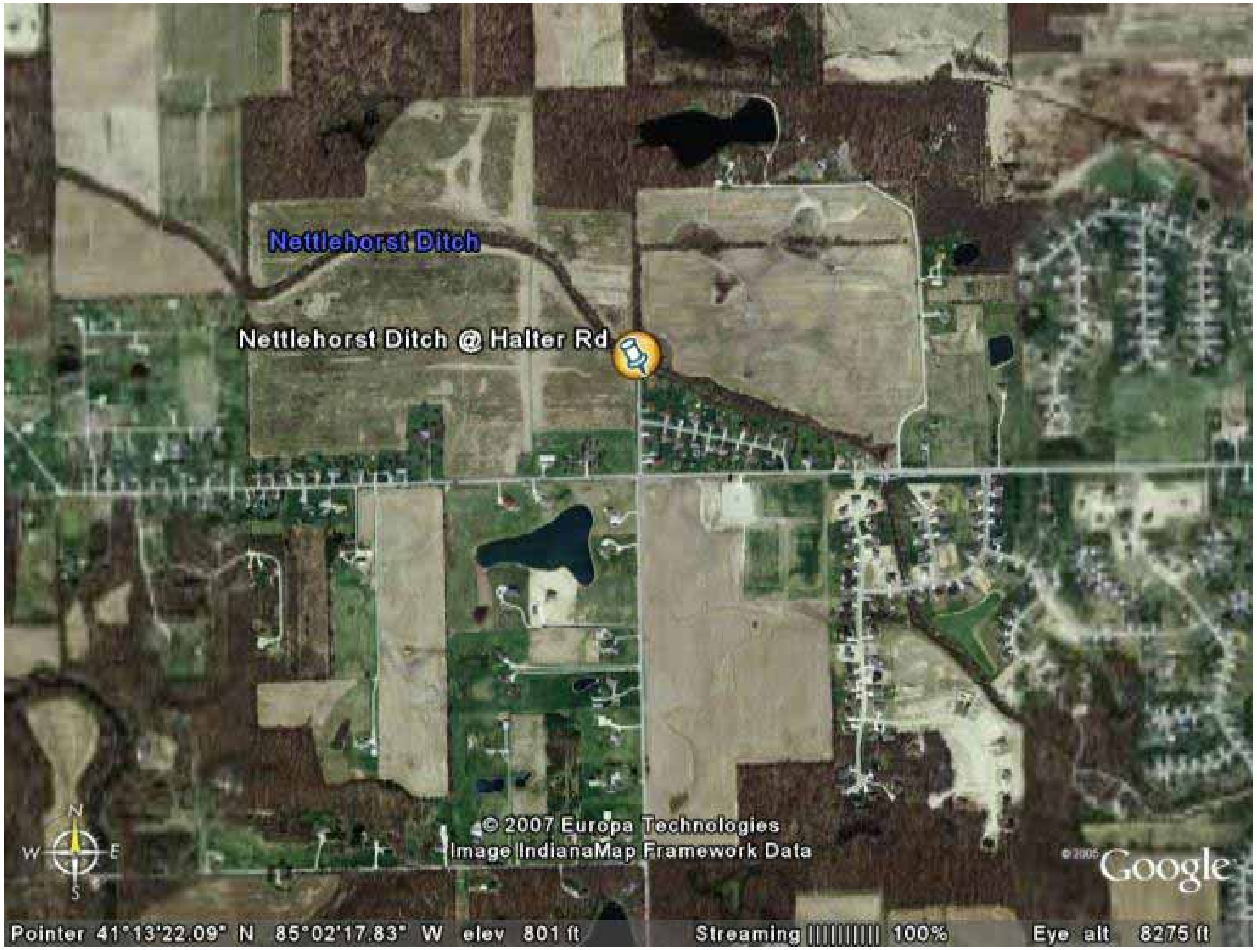



**Figure 33 Nettlehorst Ditch sampling site.**

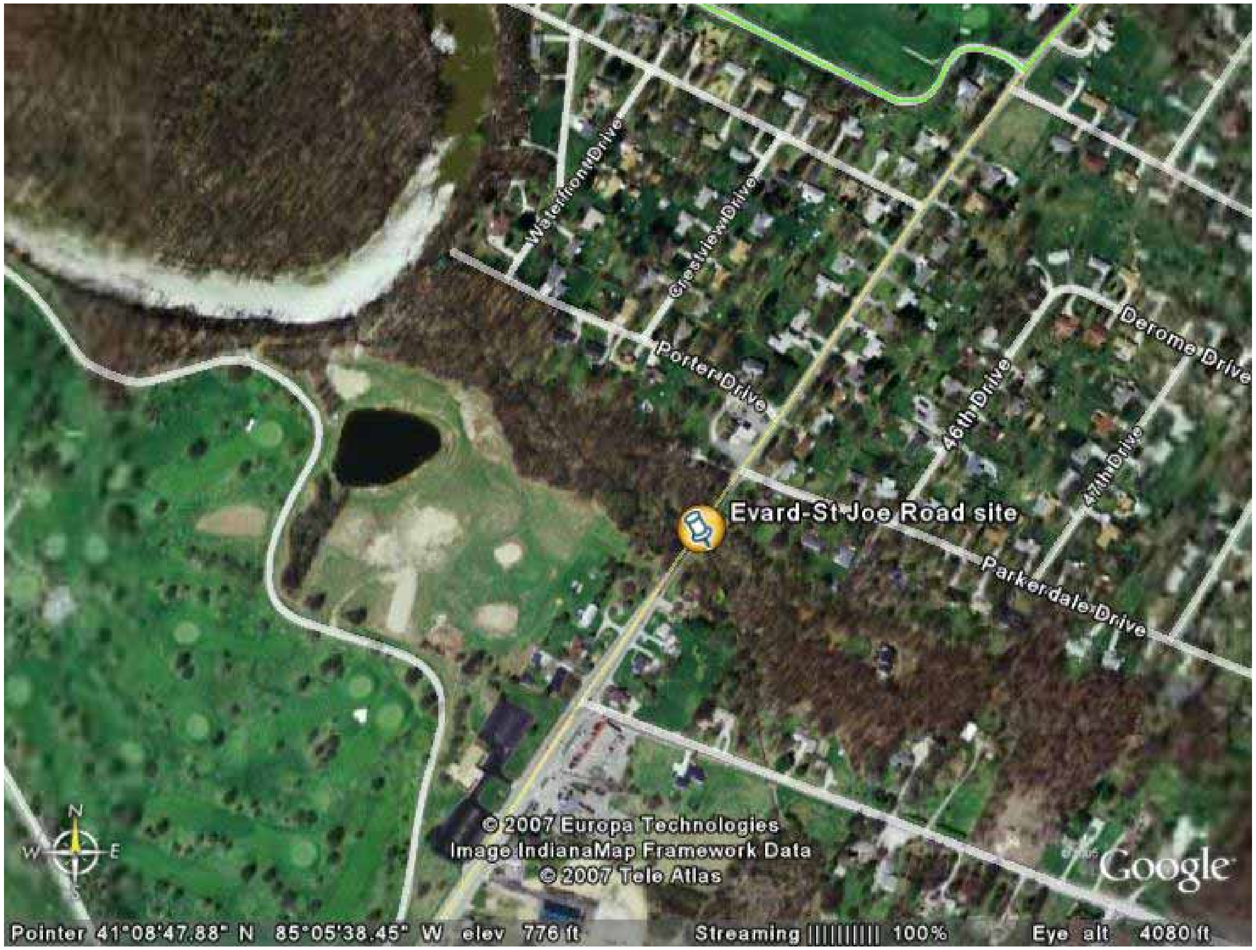



**Figure 34 Sampling site on unnamed ditch near Evard & St. Joe Road.**

**Hoosier Riverwatch sampling**

The Hoosier Riverwatch sampling procedure for E. coli uses the EZ Gel Coliscan with 24 hr. incubation. Riverwatch data is available several locations in these subwatersheds. None of these site indicate particularly significant problems.

| Site | Subwatershed | Date | E. coli (cfu/100mL) |
|---|---|---|---|
| St. Joseph River @ SR 101 bridge | Bear Creek | 8/31/2006 | 200 |
| St. Joseph River near Orangeville | Bear Creek | 7/8/2007 | 0 |
| Bear Creek @ Wild Cherry Park | Bear Creek | 8/31/2006 | 233 |
| Bear Creek @ Wild Cherry Park | Bear Creek | 5/23/2007 | 467 |
| Hilkey Ditch @ Garman & Amstutz | Bear Creek | 8/31/2006 | 500 |
| Ely Run @ Diebold Rd. | Lower St. Joseph | 10/17/06 | 0 |
| Ely Run @ Diebold Rd. | Lower St. Joseph | 5/8/07 | 400 |
| Ely Run @ Popp Nature Preserve | Lower St. Joseph | 7/19/2006 | 400 |

**Table 13 Hoosier Riverwatch E. coli data for various streams and dates. (HR database)**

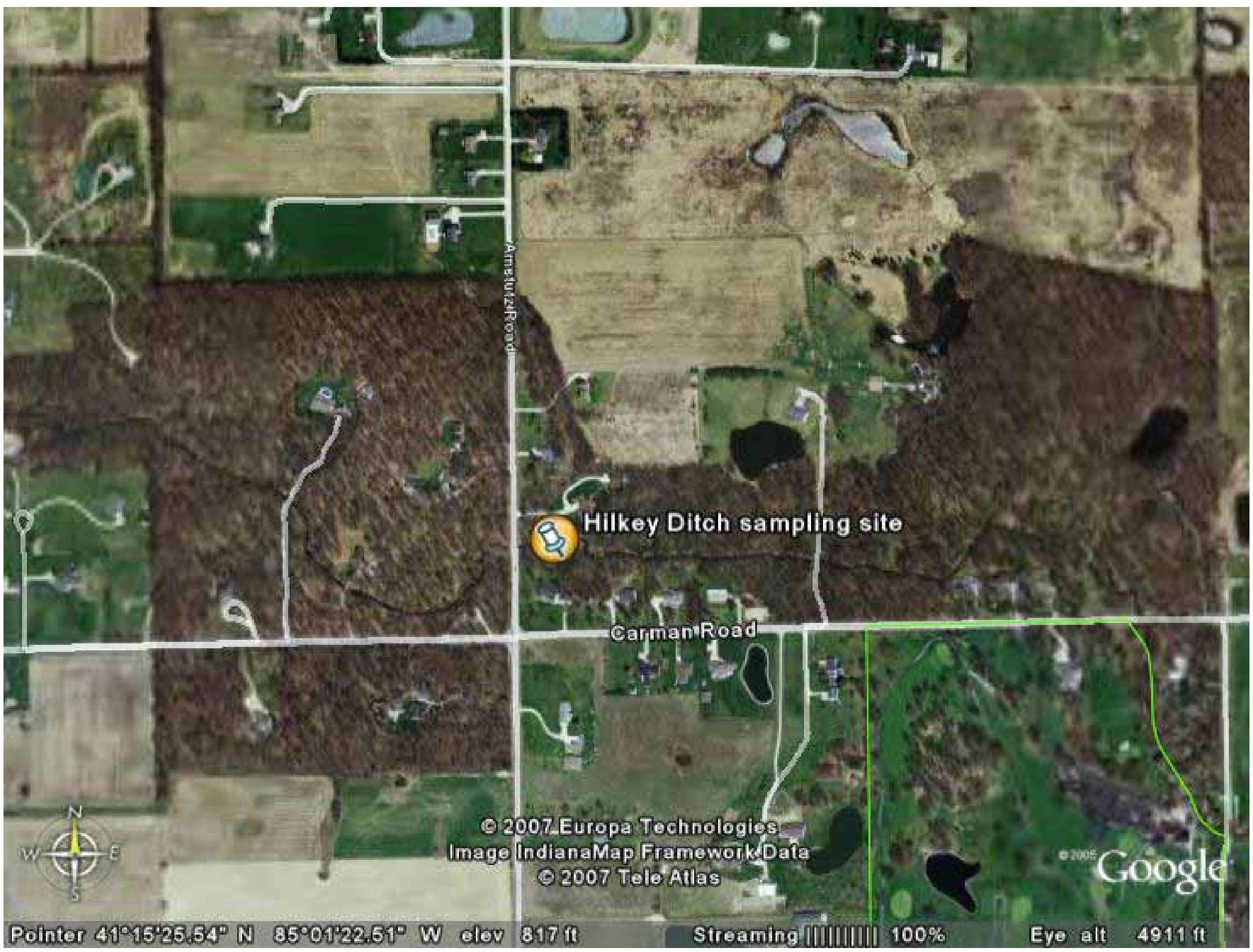



**Figure 35 Hilkey Ditch sampling location. Hilkey is a tributary of the Swartz-Carnahan.**

3.1.3.2 Sediment

Sediment loading is generally a major problem in the watershed. The Lower St. Joseph and the Bear Creek subwatersheds have some of the most highly erosive soils in the Western Lake Erie Basin (See Figure 36), These subwatersheds have been highly modified by human activities, including agriculture and construction.

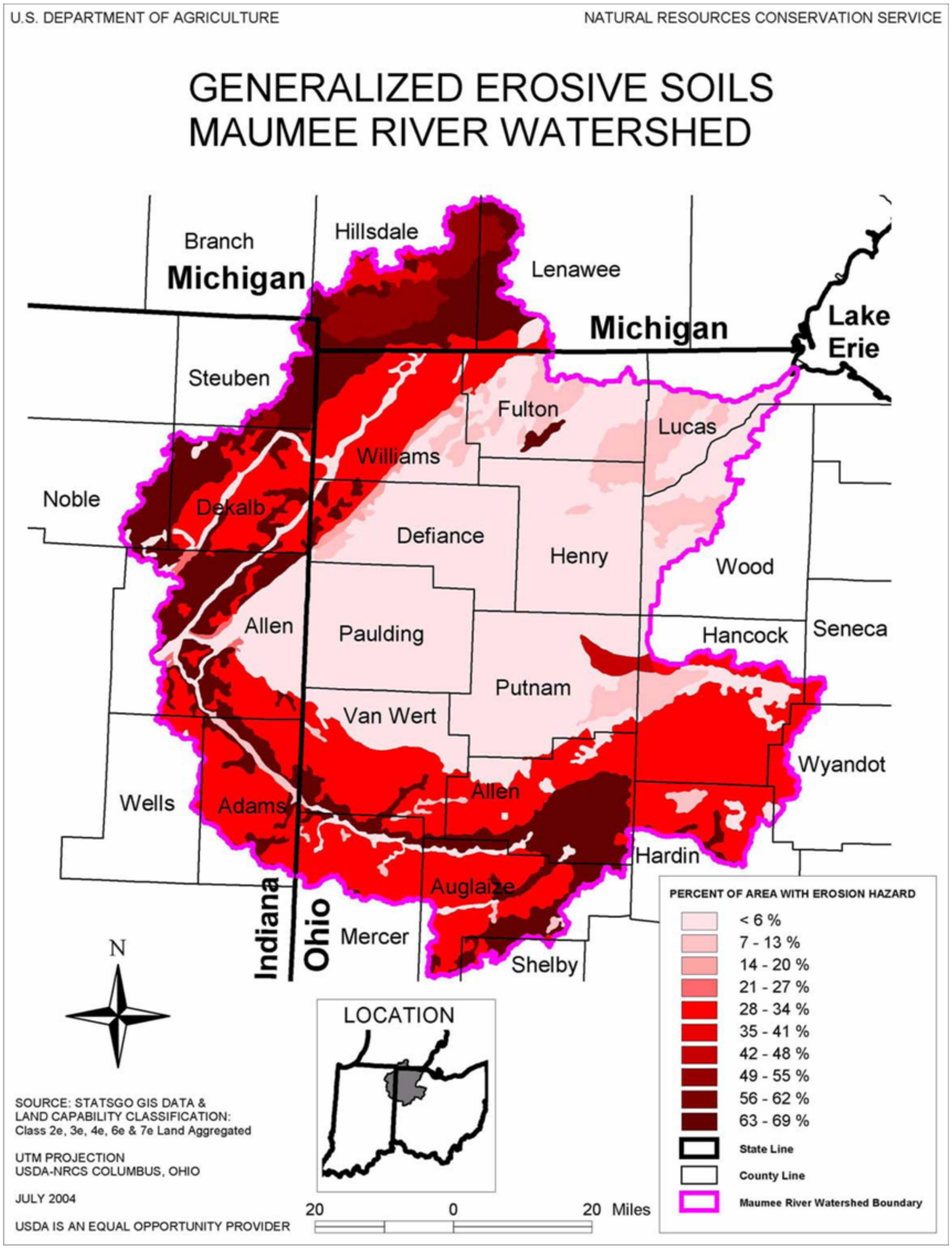



**Figure 36 Western Lake Erie Basin watershed with erosion hazard. (Photo courtesy NRCS)**

Each year, 38 million tons of topsoil erodes from U.S. cropland in the Great Lakes Basin (Great Lakes Commission, 2004). Figure 36 illustrates that the St. Joseph River in Allen County (Indiana) is in the 63% - 69% erosive soils range. Human activity on these lands will increase erosion unless careful management practices are employed.

Maps of the highly erodible land (HEL) in the watershed are located in the Appendix C of this document. Sediment is considered the number one source of pollution by volume to Indiana waterways. Sediment is soil particles (clay and silt) which wash off the land and into ditches, streams, lakes and rivers.

Sediment has reduced the capacity of the water bodies to carry and hold the water. Capacity of the Cedarville Reservoir, an 8-mile, 245-acre impoundment on the St. Joseph River at the towns of Cedarville and Leo, about 12 miles northeast of Fort Wayne, has decreased over the years since its creation in 1954. The reservoir is part of the City of Fort Wayne's municipal water supply; water from the reservoir is contained and then released as needed to flow down the river and help keep the water impounded at the city's water intake located at the St. Joseph dam at a constant level.

Much of the Cedarville Reservoir is 4 feet deep, with a maximum depth of 16 feet. In 2006 the Cedarville Reservoir was lowered for work on the tainer gates. According to a city engineer working on the project, the flow through the reservoir had formed two channels, with sediment deposited in between the two, directly upstream of the dam. (N. Baggett, personal communication, 2006) The reservoir was drained again in 2007 to check on repairs.

**Figure 37 The Cedarville Reservoir was drained in 2006 to facilitate repairs on the dam. (J. Loomis 2006)**

Sediment and attached organics (suspended solids) causes turbidity, or cloudiness of the water. High turbidity in the streams can be a sign of several important water quality problems, including the risk of developing gastrointestinal diseases if the water is ingested because bacteria and viruses can be attached to the suspended solids. Although disinfecting water with chlorine will kill coliform bacteria, it will not always control organisms such as Cryptosporidium and Giardia. Cryposporidiosis from surface water contamination sickened 400,000 people in Milwaukee in 1993.

Turbidity is measured in Nephelometric Turbidity Units (NTUs). The EPA has established a Maximum Contaminant Level (MCL) of 0.5 NTU for treated water. The Fort Wayne Filtration Plant has committed to maintaining a turbidity level at 0.3 NTU or better. The plant uses an outside laboratory to monitor raw water from the river and finished water at the end of the treatment process for Cryptosporidium and Giardia. Suspended sediment in the stream can also contain nutrients such as phosphorus as well as pesticides. These affect aquatic species as well as drinking water supply. High algae growth is caused by high nutrient levels; and can also be a cause of increasing turbidity.

Turbidity in the Lower St. Joseph and Bear Creek increases the cost of water treatment for the Fort Wayne water filtration plant. Since the municipal water supply for the cities of Fort Wayne and New Haven is drawn from the St. Joseph River, the turbidity of the river has an effect on the cost of drinking water treatment. The Three Rivers Water Filtration Plant, which treats an average of 34 million gallons per day, uses ferric sulfate as a coagulant to remove turbidity from the water. Together with operational costs that include electricity and maintenance, the City of Fort Wayne spends approximately $300,000 annually to remove turbidity before the filtration process of the water even begins. (C. Shastri, personal communication, 2005)

The filtration plant uses powdered activated carbon (PAC) to control taste and odor. The plant operators begin increasing the amount of PAC used in the treatment process as soon as weather conditions indicate that a taste and odor problem could occur. Tastes and odors in the water are caused by organic material in the river and tend to be worse in the spring, fall and during run-off events after heavy rains and thaws.

Turbidity also negatively affects aquatic habitat. Many aquatic plants require clear water in order to receive enough sunlight to grow and reproduce. Cloudy and muddy waters limit the species of aquatic plants that can live in the river and streams. Aquatic animals that rely on visual cues for reproduction are likewise negatively affected by turbid waters. Sediment which settles out of the water column and deposits layers of silt on the streambed will suffocate mussels and other aquatic animals with limited mobility. Sediment can also negatively affect the food sources and feeding habits of fish that live in the streams, limiting their growth and development, and ultimately their populations.

Stakeholders in this watershed have expressed particular concern about the muddiness of the river (brown color) and siltation of the Cedarville Reservoir. The increasingly shallow water of the reservoir negatively affects recreational boating and fishing activities and can contribute to the growth of algae.

Turbidity readings taken by the SJRWI water sampling program at several sites in the Bear and Lower St. Joseph subwatersheds over the last few years are shown below.

| | **Bear Creek (128)** | | **Tiernan Ditch (147)** | | **Metcalf Ditch (149)** | | **Ely Run (150)** | |
|---|---|---|---|---|---|---|---|---|
| | **Range (NTU)** | **Average (NTU)** | **Range (NTU)** | **Average (NTU)** | **Range (NTU)** | **Average (NTU)** | **Range (NTU)** | **Average (NTU)** |
| **2004** | 9.2 - 218 | 56.2 | n/a | n/a | n/a | n/a | n/a | n/a |
| **2005** | 12.7 - 183 | 56.2 | 33.6 - 103 | 46.38 | 12.4 - 167 | 50.33 | n/a | n/a |
| **2006** | 10.7 - 292 | 71.8 | n/a | n/a | n/a | n/a | 16.0 - 102 | 61.1 |

**Table 14 Turbidity Readings in Bear Creek, Tiernan Ditch, Metcalf Ditch, and Ely Run 2004-06. (SJRWI)**

Hoosier Riverwatch analysis for turbidity uses a 60 cm tube secchi disk and a conversion chart to calculate NTU. The following turbidity readings were taken for this watershed plan using the 60 cm tube.

| **Site** | **Subwatershed** | **Date** | **Turbidity (NTU)** |
|---|---|---|---|
| St. Joseph River near Orangeville | Bear Creek | 7/8/2007 | 38 |
| Bear Creek @ Wild Cherry Park | Bear Creek | 8/31/2006 | 51 |
| Bear Creek @ Wild Cherry Park | Bear Creek | 5/23/2007 | 15.01 |
| Hilkey Ditch @ Garman & Amstutz | Bear Creek | 8/31/2006 | 15.01 |
| Ely Run @ Diebold Rd. | Lower St. Joseph | 10/17/2006 | 70 |
| Martin Ditch near Leo Crossing | Lower St. Joseph | 10/17/2006 | 95 |
| Ely Run @ Popp Nature Preserve | Lower St. Joseph | 7/19/2006 | 27 |

**Table 15 Hoosier Riverwatch sampling data for turbidity. (HR database)**

The readings at the Roy Delagrange Ditch, a section of Ely Run near Diebold Rd., and the Martin Ditch tributary are reflective of a rain event and construction activities without proper erosion control. See Figure 38 on page 48 for a map of this site. The area north of the sampling site, directly across State Road 1, was developed to a commercial retail site beginning in 2006, resulting in extreme increases in sediment to the Martin Ditch during construction phase.

Total suspended solids (TSS)

TSS is the residue remaining when the sample water is filtered. The particulate matter which does not pass through the filter is weighed and reported in mg/L or in parts per million (ppm). Although turbidity measures the same water quality property as TSS, TSS gives an actual measurement. TSS can be calculated from turbidity measurements, but because of the variation in size, shape and color of the particulate matter, the calculation must be figured for each site via a comparison of several measurements of TSS and turbidity. TSS calculations are not performed for samples at the SJRWI or Hoosier Riverwatch sampling sites, although turbidity measurements are available.

In the Lower St. Joseph subwatershed, the City of Fort Wayne Water Pollution Control Plant (WPCP) monitors the St. Joseph River from bridges at Mayhew Road (Figure 26) and Tennessee Avenue (Figure 27). The Tennessee Bridge location is in the heart of the city; Mayhew Road is in the northern part of Allen County which is much less intensely urbanized but which drains agricultural land and intense development. Measurements from the Tennessee site are being used for load and reduction calculations in this watershed management plan since this location has a USGS flow gauge as well.

| | **Mayhew Road** | | **Tennessee Street** | |
|---|---|---|---|---|
| | **Average TSS (mg/L)** | **Min-Maximum (mg/L)** | **Average TSS (mg/L)** | **Min-Maximum (mg/L)** |
| 2003 | 72 ppm | 14-372 | 56 ppm | 9-236 |
| 2004 | 57 ppm | 14-312 | 56 ppm | 8-434 |
| 2005 | 34 ppm | 8-116 | 19 ppm | 7-72 |
| 2006 | 49 ppm | 20-122 | 34 ppm | 16-59 |

**Table 16 Annual total suspended solid (TSS) averages and ranges (mg/L) in the St. Joseph 2003-06. (City of FW data)**

Stream water quality standards do not exist in Indiana for sediment. The target level of <30 mg/L (equal or less than 30) for TSS has been chosen for the target based on TMDL targets for wastewater discharge in the State of Indiana (IDEM).

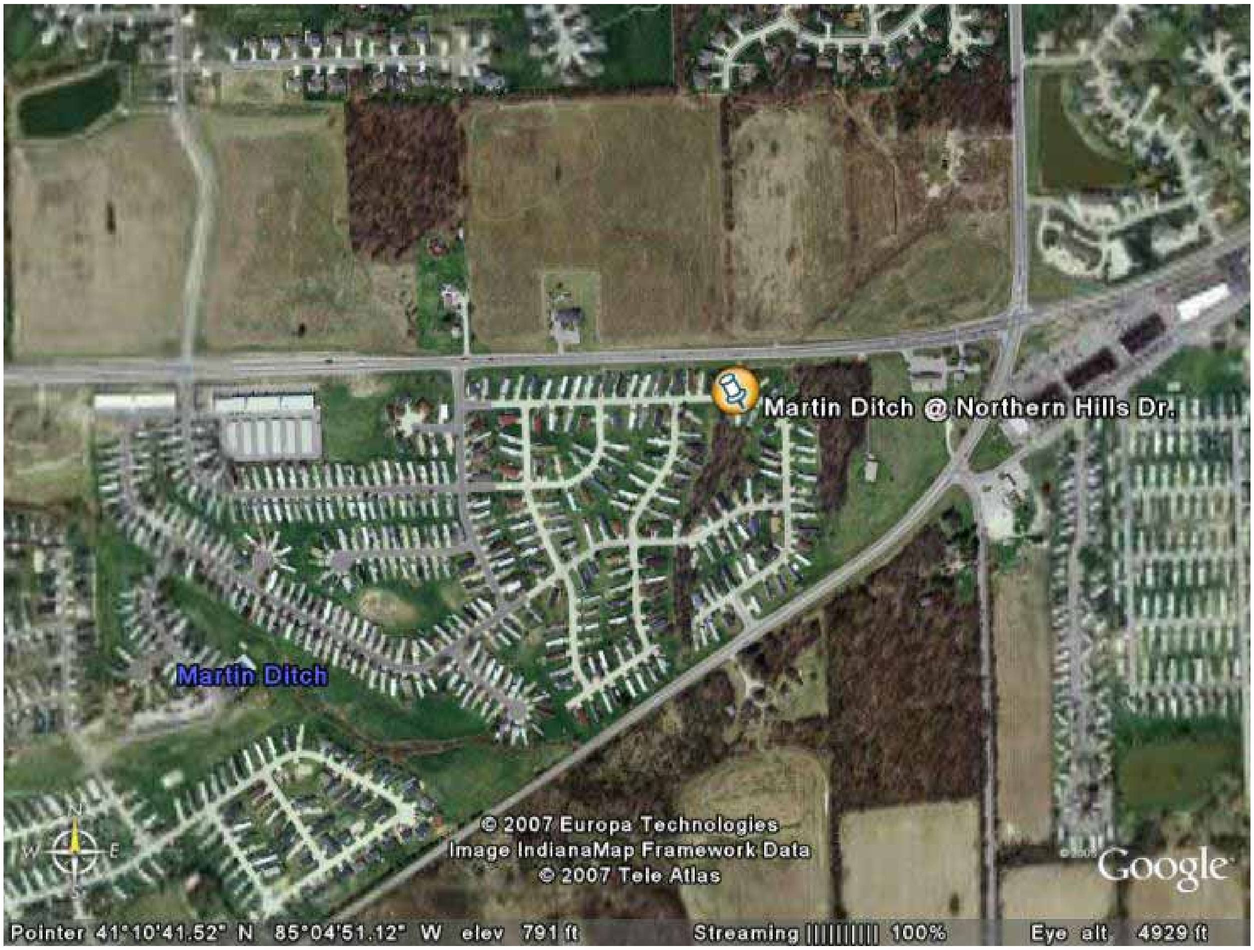



**Figure 38 Sampling site on Martin Ditch tributary.**

### 3.1.3.3 Nutrients

Nutrient sampling in the watershed has generally been performed during the recreational season, so nutrient loads do not reflect possible higher loads during the non-growing season when nutrients are less tied up in plant life.

303 (d) Listings of the St. Joseph and Cedarville Reservoirs for algae, and the Swartz-Carnahan and Metcalf Ditches for impaired biotic communities (IBC) indicate that nutrients could be a water quality issue in the Lower St. Joseph and Bear Creek subwatersheds. Nutrients in the water can increase the growth of algae. Algae can cause of increased levels of total suspended solids (TSS) in the water, as well as imparting taste and odor to the water, which must be addressed in the drinking water treatment process.

Nutrient samples (total phosphorus and ammonia NH3-N) were taken by the SJRWI at Metcalf Ditch (see Figure 29) and Ely Run (see Figure 28) weekly during August through October in 2006. The results are shown in Table 17. Ammonia remained below the 0.1 mg/L detection limit for the Ely Run site, and showed only slight variation from the detection limit at Metcalf Ditch.

| **2006 - Metcalf Ditch (Site 149)** | | | | **2006 - Ely Run (Site 150)** | | | |
|---|---|---|---|---|---|---|---|
| **Ammonia NH3-N (ppm/ mg/L)** | | **Total Phosphorus (ppm / mg/L)** | | **Ammonia NH3-N (ppm / mg/L)** | | **Total Phosphorus (ppm / mg/L)** | |
| **Average** | **Range** | **Average** | **Range** | **Average** | **Range** | **Average** | **Range** |
| 0.146 | <.01-0.418 | 0.24 | .048-1.18 | n/a | < 0.1 detection limit | 0.17 | 0.07 - 0.617 |

**Table 17 Total Phosphorus (P) and ammonia levels (NH3-N), Metcalf Ditch and Ely Run, 2006. (SJRWI)**

Fort Wayne's two St. Joseph River sampling sites (Mayhew Road and Tennessee Street) include data for ammonia (NH3-N) and phosphorus (Total P).

| | **Mayhew Road** | | **Tennessee Street** | |
|---|---|---|---|---|
| | **Average Total P (ppm)** | **Average $NH_3$-N (ppm)** | **Average Total P (ppm)** | **Average $NH_3$-N (ppm)** |
| 2003 | 0.264 | 0.089 | 0.193 | 0.066 |
| 2004 | 0.17 | 0.062 | 0.15 | 0.059 |
| 2005 | 0.14 | 0.072 | 0.10 | 0.081 |
| 2006 | 0.23 | 0.06 | 0.6 | 0.18 |

**Table 18 Annual average values for phosphorus and ammonia at Mayhew Road and Tennessee Avenue, 2003-06. (City of FW data)**

Water Quality Standards have not been set for nutrients in the State of Indiana. Our target level for Total P is 0.3 mg/L and our target level for NH3-N is 1.0 mg/L. These target criteria were selected for planning purposes only and are based on studies done for the Cedar Creek subwatersheds. The target criteria are not meant to be used to set any discharge limitations on any point source or identify any water quality violation, but are used simply as a benchmark to achieving improved water quality from the current observed levels. (N. Rice, 2005) Averages smooth out the spikes in the data. Still the annual average for 2006 at the Tennessee Avenue site (0.6) exceeded that 0.3 mg/L target for P.

3.1.3.4 Pesticides

The SJRWI samples for four agricultural pesticides, Atrazine, Alachlor, Metolachlor and Cyanizine. All are soluble in water. The maximum contaminant level (MCL) for drinking water for Atrazine is 3 ppb (parts per billion). The other three chemicals tend to follow the Atrazine lead: if Atrazine is present in the water, it is likely that the other chemicals may also be present. Standards have not been established by the US Environmental Protection Agency (EPA) for all the chemicals; therefore we are using Atrazine as the chemical of concern in most instances.

Elevated levels and/or spike events of pesticides are generally present during the spring months due to the spring application of chemicals on agricultural fields and residential lawns paired with the spring rainfall. Levels in particular ditches, particularly in the upper part of the watershed, depends primarily on the amount of agricultural land draining into the waterway, as well as the amount and timing of the rainfall.
Atrazine levels at the Initiative's Bear Creek sampling location showed a steady decline through 2005; however the 2006 average increased again. Average Atrazine in the first 10 weeks of 2007 was 0.443 ppb, well below the 3.00 ppb maximum contaminant level (MCL) set by the EPA for Atrazine.

Despite general improvements in the average levels, exceedences of the standard remain a strong concern for the watershed due to spring spikes. Samples from the Bear Creek exceeded the 3 ppb water quality standard (WQS) twice during 2003 and 2004, and once during 2005. In 2006, the Atrazine level exceeded the WQS three times:11.83 ppb on April 16; 7.24 ppb on April 23; and 4.83 ppb on April 30. No exceedences were recorded during the first 10 weeks of 2007. Seasonal averages were below the 3 ppb standard for drinking water. (See Figure 39)

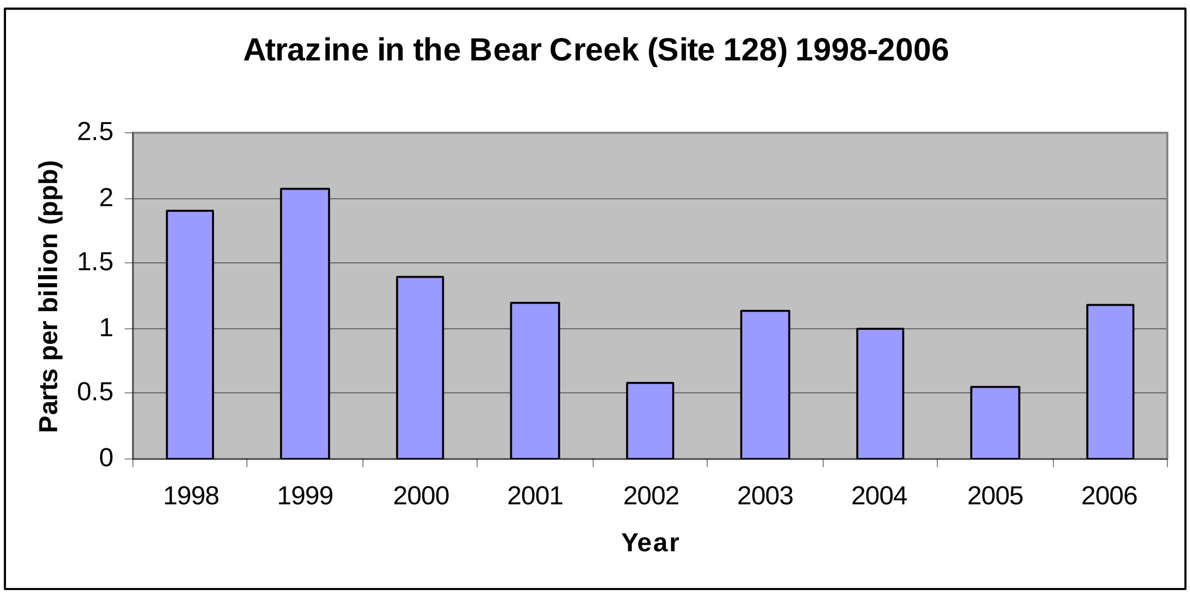



**Figure 39 Average annual Atrazine levels (ppb) in the Bear Creek at Site 128, 1998-2006. (SJRWI)**

Data for the Tiernan Ditch (Site 147) is limited. Of eight samples analyzed for Atrazine drawn from this site during the growing season, one exceedence (4.18 ppb) was recorded in June, 2005. The average level of Atrazine in the ditch for 2005 was 1.76 ppb. Only two samples were taken at the Tiernan during 2006; neither exceeded the 3.0 MCL; a reading of 2.27 ppb was recorded the third week of May.

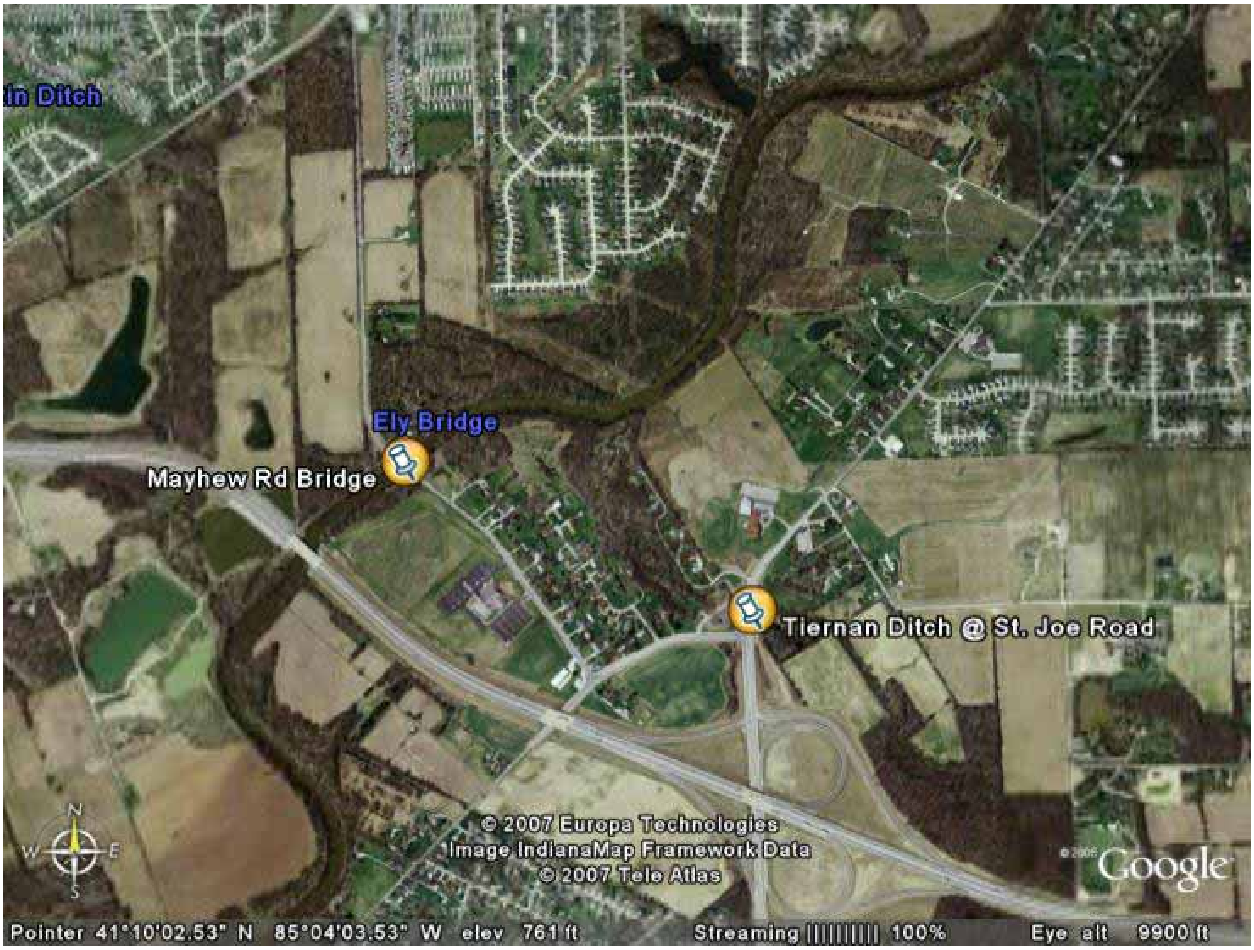



**Figure 40 Tiernan Ditch sampling site.**

Samples were taken from Ely Run (Site 150) during the second half of 2006. Of nine samples, 0.19 ppb Atrazine was the highest reading; the average for the year was 0.115 ppb. None of the samples taken at the site during the first ten weeks of 2007 exceeded the 3 ppb standard. The average during that period was 0.657 ppb. Samples were taken from the Metcalf Ditch (Site 149) during the same time period in late 2006 and early 2007. None of the samples exceeded the drinking water quality standard of 3 ppb Atrazine; the average counts for the years were 0.076 ppb and 0.138 ppb respectively.

### 3.2 Land usage in Flood Plains

The following tables show the land usage in the Lower St. Joseph and Bear Creek watersheds within the flood plain in 2001.

| LOWER ST. JOE - habitat within the flood plain | | | | |
|---|---|---|---|---|
| **Habitat** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
| Open Water | 700934.8 | 70.1 | 173.2 | 9.60 |
| Developed, Open Space | 1595804.3 | 159.6 | 394.3 | 21.86 |
| Developed, Low Intensity | 939974.6 | 94.0 | 232.3 | 12.88 |
| Developed, Medium Intensity | 195257.5 | 19.5 | 48.2 | 2.67 |
| Developed, High Intensity | 84635.0 | 8.5 | 20.9 | 1.16 |
| Decidous Forest | 1326090.9 | 132.6 | 327.7 | 18.16 |
| Evergreen Forest | 14081.5 | 1.4 | 3.5 | 0.19 |
| Shrub/scrub | 105730.2 | 10.6 | 26.1 | 1.45 |
| Grassland/Herbaceous | 26882.2 | 2.7 | 6.6 | 0.37 |
| Pasture/Hay | 80346.5 | 8.0 | 19.9 | 1.10 |
| Cultivated Crops | 1513150.3 | 151.3 | 373.9 | 20.73 |
| Woody Wetlands | 384509.3 | 38.5 | 95.0 | 5.27 |
| Emergent Herbaceous Wetlands | 332951.2 | 33.3 | 82.3 | 4.56 |
| **TOTAL** | 7300348.1 | 730.0 | 1803.9 | |

**Table 19 Flood plain land use, 2001, within the Lower St. Joseph watershed. (S. Gibson, 2007)**

Within the flood plain of the Lower St. Joseph (Table 19) land use percentages indicate that developed open space occupies 21.86% of the flood zone and cultivated crops occupy 20.73% of the flood zone. Natural vegetation (including deciduous and evergreen forest, shrub/scrub, grassland/herbaceous, woody wetlands, and emergent herbaceous wetland) occupies 30.44% of the floodplain zone. If cultivated crops within the flood zone were replaced by conservation practices including wetlands, forests and vegetated buffers, that could improve the natural vegetation area to 51.17% of the floodway area, potentially improving the range and diversity of habitat for wildlife and aquatic species, as well as improving the water storage and filtration capacity of the floodplain. In the absence of complete land use change, improving conservation tillage of the cropland in the flood zone could result in substantial reduction in soil and nutrient loss.

| BEAR CREEK - habitat within the flood plain | | | | |
|---|---|---|---|---|
| **Habitat** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
| Open Water | 976644.5 | 97.7 | 241.3 | 6.67 |
| Developed, Open Space | 710816.5 | 71.1 | 175.6 | 4.85 |
| Developed, Low Intensity | 95880.3 | 9.6 | 23.7 | 0.65 |
| Developed, Medium Intensity | 12574.2 | 1.3 | 3.1 | 0.09 |
| Developed, High Intensity | 5707.5 | 0.6 | 1.4 | 0.04 |
| Decidous Forest | 2878957.1 | 287.9 | 711.4 | 19.66 |
| Evergreen Forest | 31442.3 | 3.1 | 7.8 | 0.21 |
| Shrub/scrub | 178314.7 | 17.8 | 44.1 | 1.22 |
| Grassland/Herbaceous | 9221.8 | 0.9 | 2.3 | 0.06 |
| Pasture/Hay | 803762.3 | 80.4 | 198.6 | 5.49 |
| Cultivated Crops | 7165596.3 | 716.6 | 1770.7 | 48.93 |
| Woody Wetlands | 1389557.6 | 139.0 | 343.4 | 9.49 |
| Emergent Herbaceous Wetlands | 386492.9 | 38.6 | 95.5 | 2.64 |
| **TOTAL** | 14644967.9 | 1464.5 | 3618.8 | |

**Table 20 Flood plain land use, 2001, within the Bear Creek watershed. (S. Gibson, 2007)**

Within the 30 meter flood plain buffer of the Bear Creek watershed (Table 20) land use percentages indicate that developed open space occupies just 5.63% while cultivated crops occupy nearly half of the zone (48.93%). Agricultural BMPs such as conservation tillage, buffers, field borders and grassed waterways, as well as conservation practices such as wetland restoration and tree planting could have a significant impact on both habitat and water quality in this watershed.

### 3.3 Fish Consumption Advisories

The fish consumption advisory issued by the State of Indiana is not a ban on eating fish from lakes and streams. Rather, it is a tool to help people make the right choice about how much fish to eat and why type of fish to eat.

The advisory is based on tissue data that are collected every year at new sites or at sites previously sampled. New information is available from the Indiana State Department of Health, Environmental Epidemiology, 2 N. Meridian St., Section 5D, Indianapolis, IN 46204.

Table 21 lists the waterbodies in the Bear/Lower St. Joseph watersheds are listed on the 303(d) list for fish consumption advisories:

| HUC Code | County | Segment ID # | Waterbody Name | Parameter of Concern |
|---|---|---|---|---|
| 04100003070040 | ALLEN CO | INA0374_T1022 | ST. JOSEPH RIVER-MAINSTEM | FCA for PCBs and Hg |
| 04100003070050 | ALLEN CO | INA0375_T1025 | ST. JOSEPH RIVER-MAINSTEM | FCA for PCBs and Hg |
| 04100003100010 | ALLEN CO | INA03A1_M1038 | St Joseph River – main stem | FCA for PCBs and Hg |
| 04100003100010 | ALLEN CO | INA03A2_M1040 | St Joseph River – main stem | FCA for PCBs and Hg |
| 04100003100040 | ALLEN CO | INA03A4_M1042 | ST. JOSEPH RIVER | FCA for PCBs and Hg |
| 04100003070050 | ALLEN CO | INA03P1024_00 | Cedarville Reservoir - lower | FCA for PCBs and Hg |
| 4100003100040 | ALLEN CO | INA03P1044_00 | ST. JOSEPH RESERVOIR | FCA for PCBs and Hg |

**Table 21 Fish Consumption Advisory (FCA) for the Lower St. Joseph and Bear Creek subwatersheds (IDEM, 2006)**

Fish consumption advisories serve as a warning that certain fish, particularly bottom-feeders, should not be consumed or consumption should be limited. Generally, you can assume that any fish you catch is a group 2 if it is not listed in the advisory. And unless noted otherwise, all carp from rivers and streams fall under Group 3 if they are 15-20 inches in length, Group 4 if they are 20-25 inches in length, or Group 5 if they are over 25 inches in length. An explanation of the groupings and the amount of fish in each group that is recommended for consumption by different age groups is included in Appendix E of this document.

### 3.4 Exotic and Invasive Species

Exotic species are those plants and animals not native to the area or watershed. Sometimes exotic species are introduced and, because they have no predators or population limitations, become invasive, crowding out native plant and animal populations. There are several invasive species in the Lower St. Joseph and Bear Creek. Most are plants, including garlic mustard, purple loosetrife, and bush honeysuckle. The Emerald Ash Borror, an exotic insect that destroys ash trees, has been identified in surrounding states and counties. The invasive zebra mussel has been located in many of the state's lakes, but none were found in the St. Joseph

River during an 8-year mussel study by local biologist Warren Pryor. (Pryor 2005) Rusty crayfish have been identified in the Cedar Creek by Hoosier Riverwatch citizen volunteer monitors. Cedar Creek empties into the St. Joseph River just downstream of the river's confluence with the Bear Creek.

Great care is needed to limit the spread of invasive species and efforts continue to educate the public about invasives. In Indiana, it is illegal to possess live fish and mussels listed in Table 22, below. If any are caught, they must be killed immediately and not returned to the water. (DNRecreation 2006 Fishing Guide). This watershed planning effort did not include a quantification of the various invasive species; however, zebra mussels have not been found in the St. Joseph River, although they are present in several northwest Indiana lakes (W. Pryor, 2005).

| *Asiatic clam* | *Snakeheads of the family Channidae* |
|---|---|
| Bighead carp | Quagga mussel |
| Black carp | Tubenose goby |
| Round goby | Walking catfish of the family Clariidae |
| Rudd | White perch (not freshwater drum) |
| Ruffe | Zebra mussel |
| Silver carp | |

Table 22 Invasive fish and mussel species that are illegal to possess in Indiana

### 3.5 Endangered Species

Freshwater mussels are one of the most endangered groups of animals in North America. The decline of this group over the last hundred years has been attributed to direct and indirect impacts to aquatic ecosystems. Habitat and water quality degradation, including changes in water temperature and flow, the introduction of heavy metals, organic pollution, dredging, and increased sedimentation due to excessive erosion, have caused declines in native populations of mussels. These factors, as well as barriers to fish migration, such as dams and degraded habitat, have also negatively impacted the fish species that mussels rely on as hosts.

*Lampsilis siliquoidea. Photo by Warren Pryor.*

Freshwater unionid mussels are native to North America. Unionid mussels require a fish host to complete their life cycle. After eggs are fertilized and develop into larvae (glochidia) within the marsupial gills of the female, they are released into the water and must attach to a suitable fish host to survive and transform into the adult. Because adults are relatively stationary, transport of glochidia by fish hosts allow mussels to migrate to new habitat and exchange individuals among populations. Individuals of many species live to be 20 to 30 years of age, with some reaching 50 years or more. (P. Badra, Michigan State University Extension, 2005)

Unionid mussels are useful habitat and water quality indicators because most species are long-lived and generally spend their lives within a small section of stream. They are filter feeders and are sensitive to and accumulate contaminants. Empty shells remain intact for many years after the mussels' death and can reveal which species were present at a particular site in the past. Without the presence of healthy fish host populations, unionid mussels are unable to reproduce.

Live unionids and empty shells provide habitat for aquatic insects. Empty shells also provide habitat for crayfish. Mussels often constitute the highest percentage of biomass relative to other benthic stream animals. They are a key link in the food chain between aquatic microorganisms and large animals that eat unionids. Mussel species richness and fish species richness are related. (P. Badra, Michigan State University Extension, 2005)
A study of the distribution of native freshwater mussels in the rivers of Allen County by Warren W. Pryor between 1997 and 2004 reports 29 species found in the St. Joseph River. A total of 2,899 specimens of 30

native species were found in the county, of which 169 live specimens were observed. Pryor reports that mussel species diversity has fluctuated but remained high in the St. Joseph River from 25 species in 1908 (Clark & Wilson, 1912) to 22 species in 1998 (Watters, 1998) and 29 species during the 1997-2002 study. Watters (1988) reported 10 species in 1988. The mussel species that dominated the community in Allen county in 1908 (*A. ligamentina, A. plicata, F. flava and L. costata*) have maintained strong presences in both Cedar Creek and the St. Joseph River (main stem) (Pryor, 2005). The Pryor study can be found at the St. Joseph River Watershed Initiative website, www.sjrwi.org.

Several Indiana-listed endangered and special concern mollusks were identified in a study of the mussels of Allen County (1997-2004) by Warren Pryor, University of St. Francis, Fort Wayne. These include:

| **Common Name** | **Species** | **Listing** | **Location** |
|---|---|---|---|
| Clubshell | Pleurobema clava | Endangered | St. Joseph (Allen) |
| Rabbitsfoot | Quadrula cylindrical | Endangered | St. Jospeh (Allen) |
| White catspaw | Epioblasma obliquata | Endangered | St. Joseph (Allen) |
| Kidneyshell | Ptychobranchus fasciolaris | Special concern | Cedar Creek & St. Joseph (Allen) |
| Rayed bean | Villosa fabalis | Special concern | St. Joseph (Allen) |
| Round hickorynut | Obovaria subrotunda | Special concern | St. Joseph (Allen) |
| Wavyrayed lampmussel | Lampsilis fasciola | Special concern | St. Joseph (Allen) |

**Table 23 Endangered and special concern mussels in the St. Joseph River watershed**

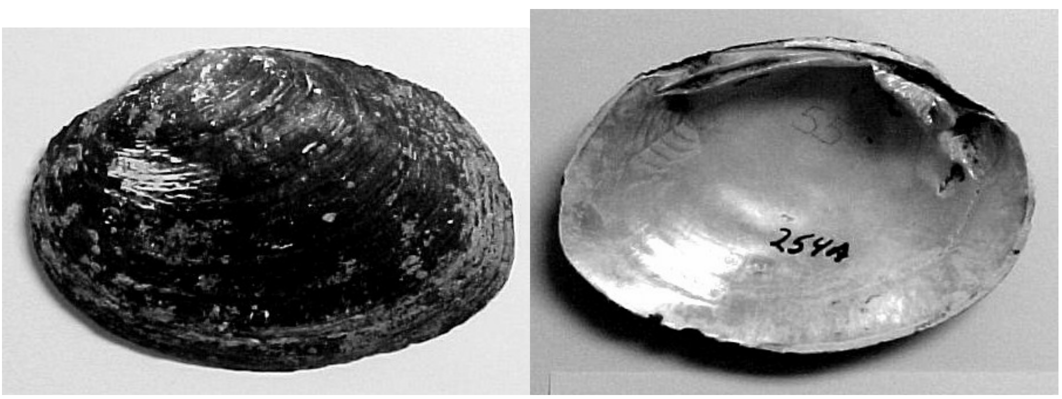


Figure 41 Actinonaias ligamentina, a mussel species found in the St. Joseph River (W. Pryor, 2004)

During the summer of 2006, a mussel study was conducted by Michael A. Hoggarth, Ph.D., for the Board of Public Works of the City of Fort Wayne. That study found no federal or Indiana endangered species, although in the past, three federal endangered species (*P. clava, E. t. rangiana, and E. o. perobliqua*) have been found in the St. Joseph River in and immediately downstream of Johnny Appleseed Park. All three are considered to be extirpated from this reach by the U.S. Fish and Wildlife Service (USFWS). Another mussel, the rayed bean (*V. fabilis*) is listed by Indiana as a species of Special Concern, and is a candidate for listing as a federal endangered species by the USFWS. Hogarth concedes that the population of this species, if it is still extant in this reach of the River, must be very low. Other species of concern for the St. Joseph River include the kidneyshell (*P. fasciolaris*), purple lilliput (*T. lividus*), round hickorynut (*O. subrotunda*), salamander mussel (*S. ambigua*), and the wayv-rayed lampmussel (*L. fasciola*). He reported that none were found during the 2005 survey, although low numbers of the kidneyshell were found by Watters (1988) and Freiteg (1991). (Hoggarth, 2005)

Additionally, Hogarth reported that his survey found “numerous specimens of the pointed campeloma (*Campeloma decisum*) a snail listed by Indiana as a species of Special Concern. They were found from the

Parnell Avenue Bridge to Stevie's Island. (Hoggarth, 2005 pp. 3-6)  Stevie's Island is shown in the center of the map in Figure 42.

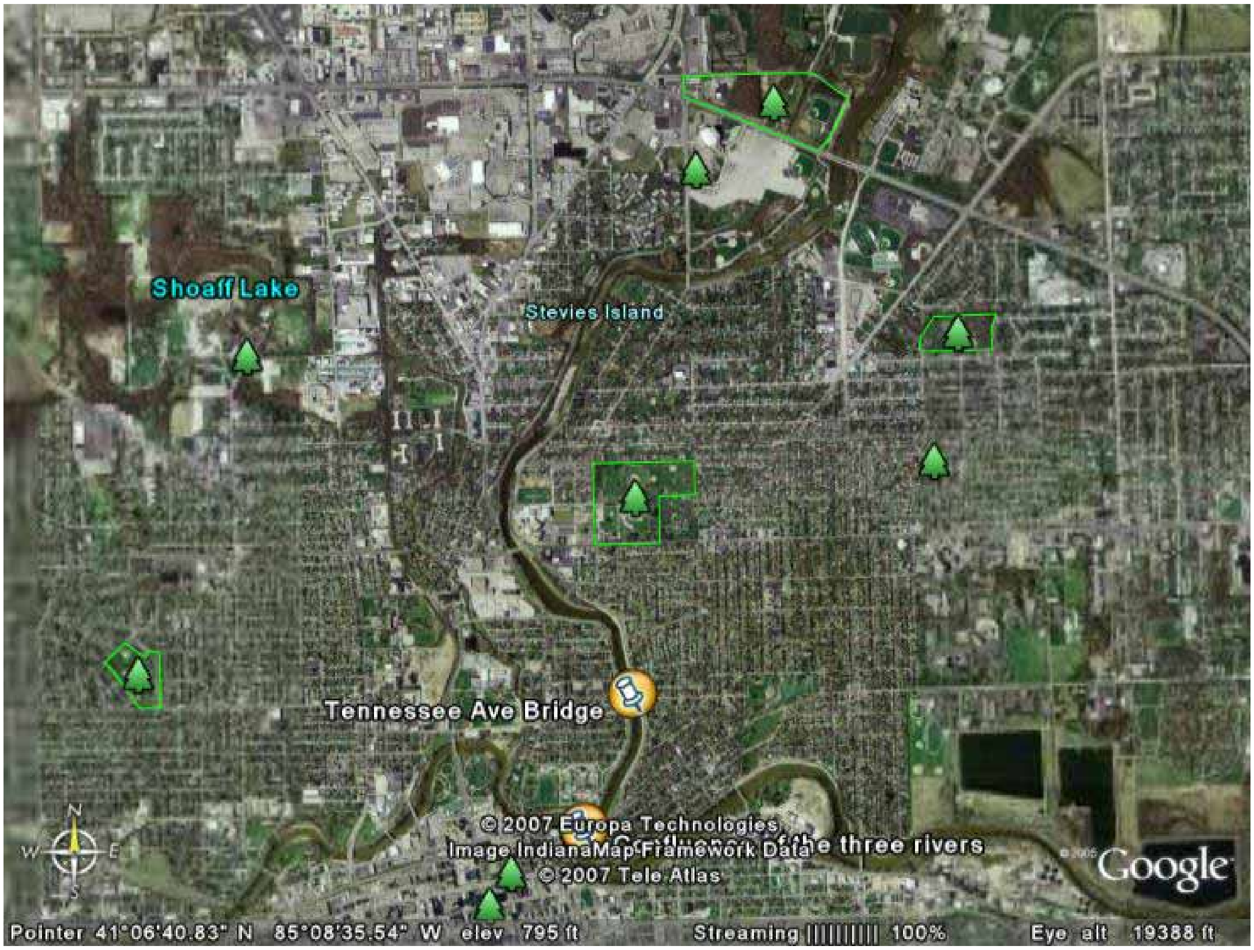



**Figure 42 Stevie's Island is located between the confluence and the St. Joe dam.**

Indiana's full list of endangered species can be found in Appendix K of this document.

### 3.6  Wetlands

Wetlands are areas where water is at or above the surface of the soil for a long enough time of the year to significantly influence the types of plants and soils that occur in that area. Seasonally wet, or *ephemeral wetlands* are transition zones, where the flow of water, sunlight, and nutrient cycling produce unique ecosystems.  Wetlands that stand alone and not near a body of water are called isolated wetlands. (IDEM http://www.in.gov/idem/who/media/factsheets/wetlands.html)

Wetlands naturally store and filter nutrients as the water cycles in and through the wetland.  They store and slowly release floodwaters. Wetlands that occur along streams, lakes and rivers act as sediment traps, controlling erosion and absorbing the energy of moving water.

Wetlands also provide shelter and nursery for fish and wildlife.  More than one-third of America's endangered species live only in wetlands.  More than 200 species of birds rely on wetlands for feeding, nesting, foraging and roosting.  Recreational activities such as fishing, birdwatching, hunting and wildlife photography rely on wetlands.

A complete assessment of wetlands in the two subwatersheds was created for the SJRWI by Aaron Wartenberg using ArcView GIS. The resulting maps for the Bear Creek and the Lower St. Joseph subwatersheds are shown in Appendix D of this document. This assessment reveals a wide-ranging variety of wetland resources in both watersheds.

According to this study, there are 5537.9 total acres of wetlands on the National Wetlands Inventory in the two subwatersheds. Roughly one-third of these are pond or stream bottom habitats. There are 2,160 acres of forested palustrine wetland, the most ecologically sensitive and valuable Indiana wetland. Additionally, there are 954.3 acres of emergent palustrine, an ecological precursor to forested wetlands. There is indication of valuable wetlands along the St. Joseph main branch, in isolated areas, and along the tributaries.

Because wetlands serve as recharge areas for aquifers, loss of wetlands affects the water supply for many watersheds. Approximately 20% of the flow of the St. Joseph River is provided by its underground aquifer, underscoring the importance of wetland areas to our watershed. (A. Fleming, 1994)

The majority of the wetland area is located in the Bear Creek subwatershed. There are seven major classes of wetlands in this subwatershed:

- Lacustrine-Limnetic-Unconsolidated-Permanent = 749.5 acres
- Palustrine-Aquatic Bed-Permanent = 21.9 acres
- Palustrine-Emergent = 954.3 acres
- Palustrine-Forested = 2160.0 acres
- Palustrine-Shrub/Scrub = 43.9 acres
- Palustrine-Unconsolidated = 403.1 acres
- Riverine-Lower-Unconsolidated = 1205.2 acres

Thee table below shows the percentage of land by township located within the Lower St. Joseph and Bear Creek subwatersheds which is actually under water.

| | ***Cedar Creek Twp.*** | ***Perry Twp.*** | ***St. Joseph Twp.*** | ***Springfield Twp.*** | ***Washington Twp.*** | ***Concord Twp.*** | ***Jackson Twp.*** | ***Spencer Twp.*** | ***Newville Twp.*** |
|---|---|---|---|---|---|---|---|---|---|
| **% Water** | 3.4% | 0.3% | 0.1% | 0.2% | 0.2% | 0.2% | 0.3% | 0.3% | 0.1% |

Table 24 Percentage of surface area under water by township in the Lower St. Joseph & Bear Creek subwatersheds. (Data courtesy IPFW Community Research Institute)

According to the U.S. Fish and Wildlife Service (USFWS), just one project supporting wetland development and restoration in this area of the St. Joseph River watershed was funded by their grant programs between 2002 and 2006. The USWFS *Partners* program is a valuable funding resource which had been underutilized in this area of the watershed but is now being promoted by local conservation offices. The SJRWI received a $45,000 grant from the USFWS Private Stewardship Grant Program (PSGP) in the Spring of 2007 for tree planting and wetland creation. This grant is expected to fund some projects in the Bear and Lower St. Joseph watersheds during the next two to three years.

### 3.7 Natural Communities and Conservation Practices

There are four natural communities listed with the State of Indiana in the Bear Creek Watershed totaling 142.1 acres.

- 30.6 acre *upland forest* along Nettlehorst Ditch.
- 72.4 acre *flatwoods central till plain forest* along north side of Fisher Ditch just prior to its joining the St. Joseph River.
- 26.9 acre *floodplain forest* along the south side of Fisher Ditch along the same segment as above listed community.
- 11.99 acre *floodplain forest* adjacent to St. Joseph River in the St. Joseph/Walker-Metcalf watershed.

In 2005, the SJRWI compiled a digital GIS layer of conservation practices that had been installed in the two subwatersheds to that point in time. These include best management practices (BMPs) that are part of the NRCS conservation practices, including the Conservation Reserve Program (CRP), Environmental Quality Incentives Program (EQIP), and Wetland Reserve Program (WRP), and recorded by the Farm Service Agency (FSA) in each county. Privately-financed BMPs are not included in this inventory.

| Practice Code | Practice | Acres |
|---|---|---|
| CP1 | Establishment of Permanent Introduced Grasses and Legumes | 18 |
| CP2 | Establishment of Permanent Native Grasses | 19.3 |
| CP3 | Tree Planting | 89.7 |
| CP4 | Permanent Wildlife Habitat | 51.2 |
| CP5 | Field Windbreak Establishment | 15.8 |
| CP7 | Erosion Control Structure | 2 |
| CP8 | Grass Waterways | 6.6 |
| CP10 | Vegetative Cover - Grass | 1895 |
| CP11 | Vegetative Cover – Trees | 11.4 |
| CP21 | Filter Strips | 170.6 |
| Total | | 2279.6 |

**Table 26 Conservation practices installed in Allen County. (NRCS)**

| Code | Practice | Acres | % of CRP |
|---|---|---|---|
| CP-1 | Permanent Introduced Grasses/Legumes | 286.8 | 4.93 |
| CP-2 | Permanent Native Grasses | 25.5 | 0.44 |
| CP-3A | Hardwood Tree Planting | 151.6 | 2.6 |
| CP-4D | Permanent Wildlife Habitat | 507.6 | 8.72 |
| CP-5A | Field Windbreak | 5.1 | 0.09 |
| CP-8A | Grassed Waterway | 12.7 | 0.22 |
| CP-10 | Established Grass | 3565.7 | 61.25 |
| CP-11 | Established Trees | 117.9 | 2.03 |
| CP-21 | Filter Strips | 582.8 | 10.01 |
| CP-23 | Wetland Restoration | 54.8 | 0.94 |
| CP-4D/12 | Permanent Wildlife Habitat / Wildlife Food Plot | 26 | 0.45 |
| CP-4D/23 | Permanent Wildlife Habitat / Wetland Restoration | 55.5 | 0.95 |
| CP-10/12 | Established Grass / Wildlife Food Plot | 304.8 | 5.24 |
| CP-10/23 | Established Grass / Wetland Restoration | 70.1 | 1.2 |
| CP-11/23 | Established Trees / Wetland Restoration | 54.2 | 0.93 |
| Total | | 5821.1 | |

**Table 25 Conservation practices installed in DeKalb County. (NRCS)**

Conservation practices within the Bear Creek subwatershed are more prevalent in Allen County than in DeKalb County (see Figure 43). The red line on the map indicates the Allen-DeKalb county line. A large number of the practices mapped just below the county line are located within the 14-digit HUC Cedarville

Reservoir watershed (Bear Creek 1 on map), with a smaller number of practices located in the Swartz-Carnahan watershed (Bear Creek 2 on map). Both watersheds have significant amounts of highly erodible land (HEL). (See HEL maps in Appendix C of this document.)

Conservation practices are very limited in the Lower St. Joseph subwatershed, primarily due to the urban land cover. Figure 44 illustrates the conservation practices in the Lower St. Joseph subwatershed. The conservation practices are shown as light-colored shapes outlining the fields where the practices are located.

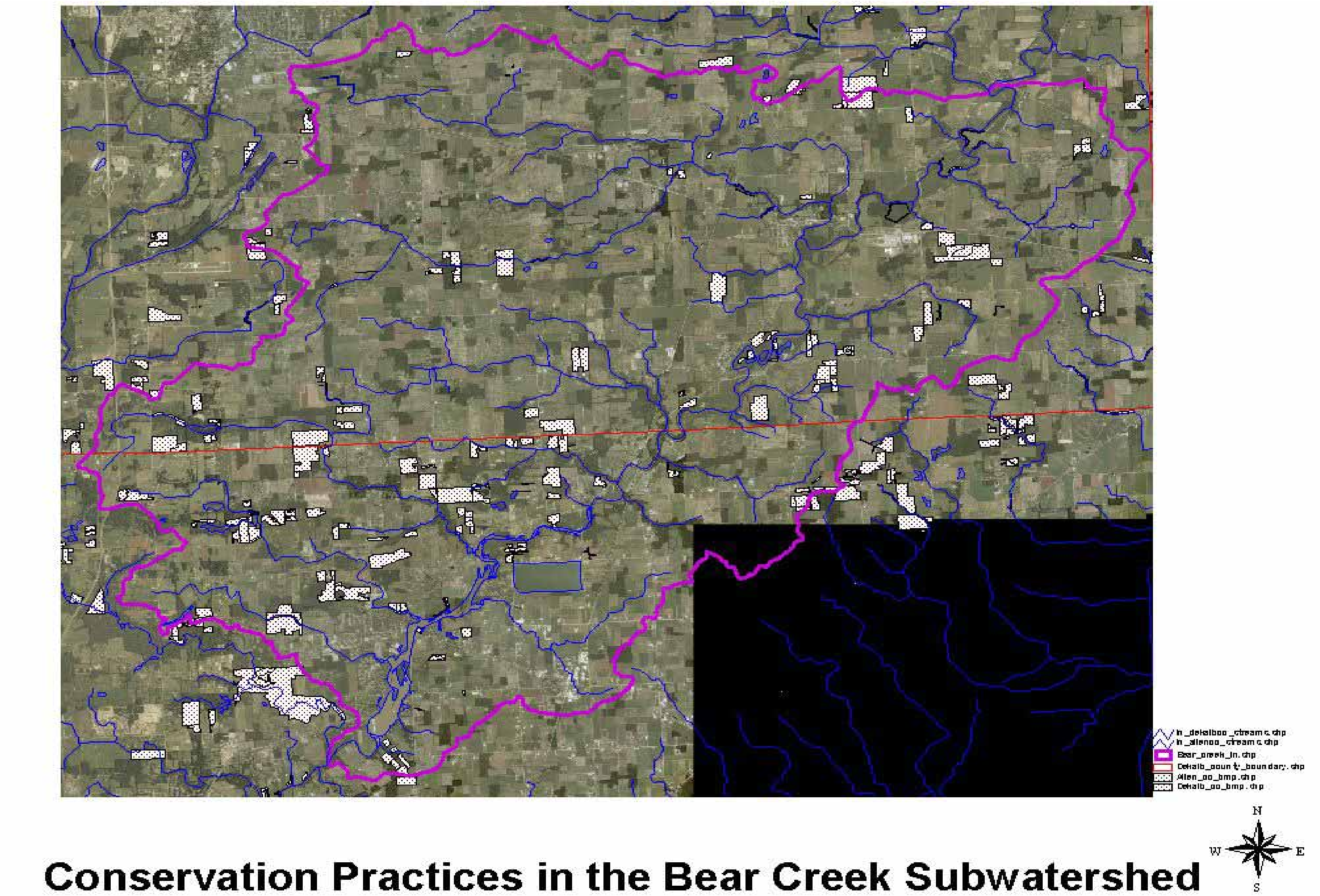



**Figure 43 Conservation Practices in the Bear Creek subwatershed (SJRWI 2005)**

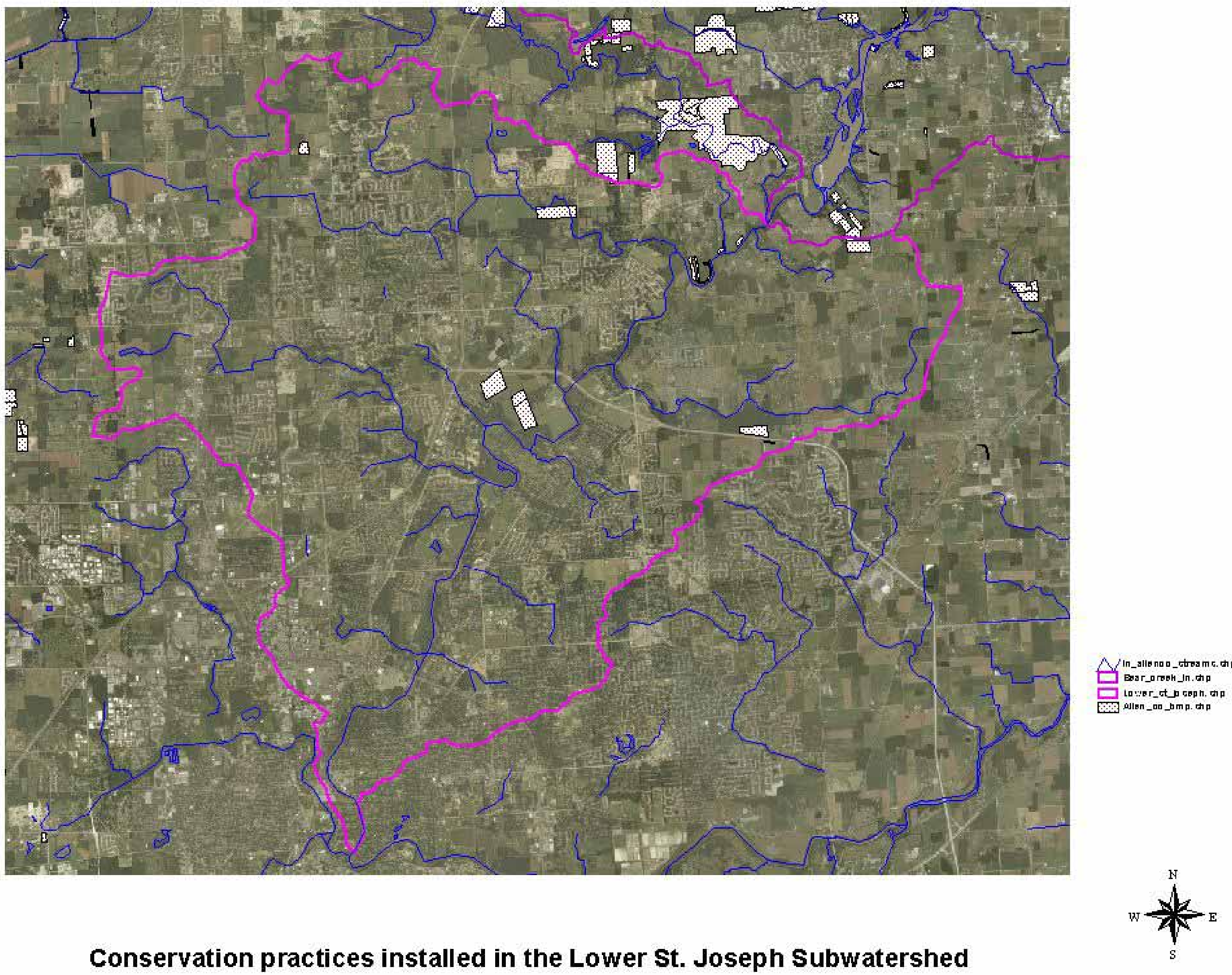



**Figure 44 Conservation Practices in the Lower St. Joseph subwatershed (SJRIW 2005)**

### 3.8 Neighborhood Drainage Problems

In the lower reaches of the St. Joseph, flooding of neighborhoods is a public health and welfare issue as well as an economic drain. Although flooding is generally considered a water *quantity* rather than a water *quality* problem, storm and flood waters can carry large amounts of sediment, toxic or hazardous chemicals, nutrients, bacteria and pathogens. Thus, flooding can increase water quality problems, pose health and property hazards in the neighborhood, and contribute to negative economic growth.

Approximately 30 areas and neighborhoods have been identified within the City of Fort Wayne by the Department of Public Works as drainage problem areas and ranked according to severity. Several of these locations lie within the Lower St. Joseph subwatershed. These include Ludwig Park (1), Royal Oaks (2), Buesching & Stellhorn (12), Cranston Lane at Sunny Lane (18), Ann Hackley Road (19), Billy Drive at Danny Drive (26), Wallen Road east of Lima Road (27), and Concordia Gardens at Riverton Drive (28). Numbers in parentheses refer to their ranking. (See Figure 45)

The City of Fort Wayne is interested in public education projects that focus on what is reasonable drainage time for standing water after a heavy rain. A paradigm shift from "getting rid of water as fast as possible" to "slowing storm water down and letting it percolate into the soil" is needed. Water quality issues surrounding this problem include installation of areas that store water and clean up the water, such as rain gardens and wetlands.

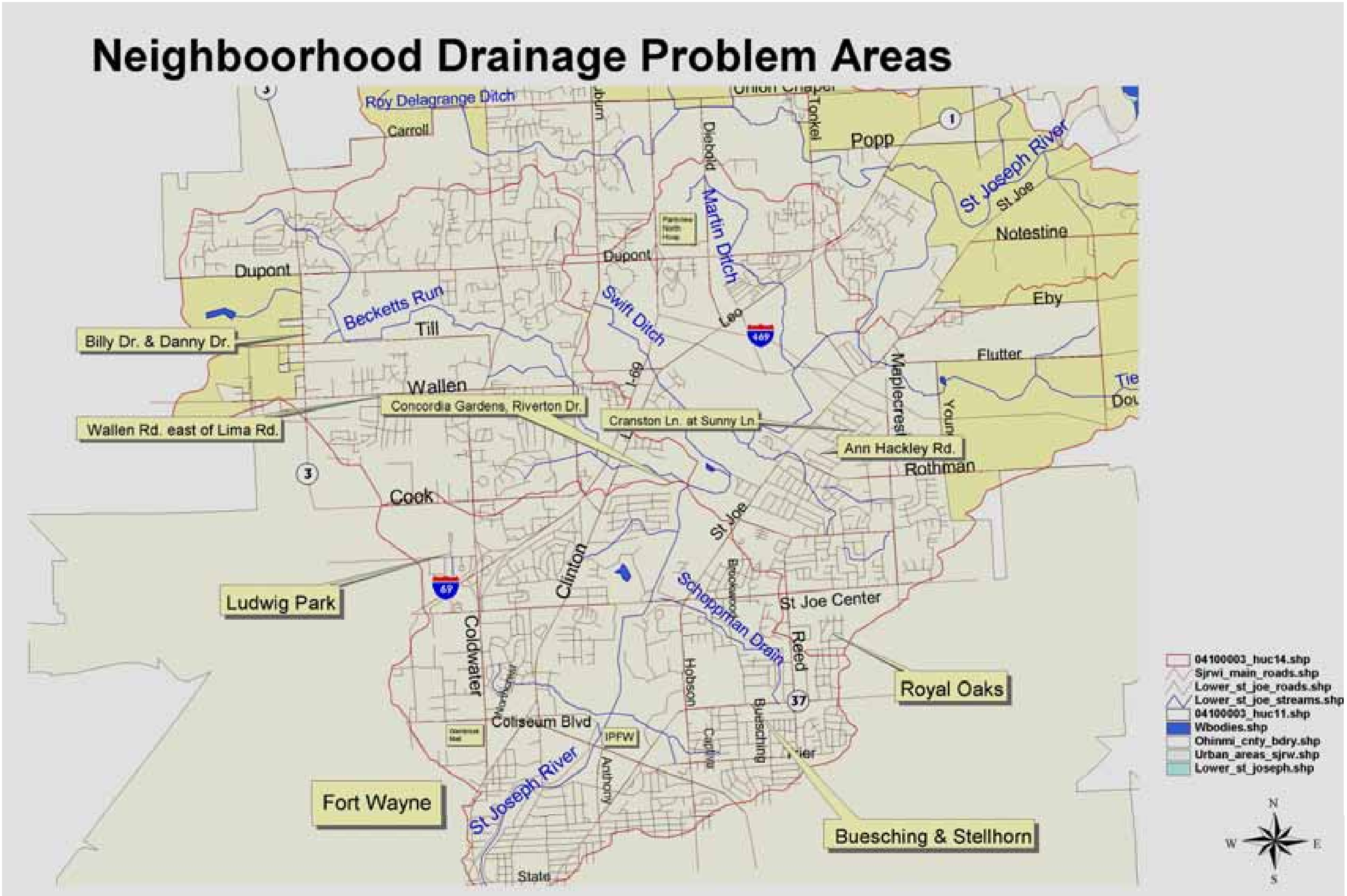



**Figure 45  Fort Wayne neighborhoods in the Lower St. Joseph subwatershed with drainage concerns.  (SJRWI map)**

## 3.9 Habitat and Biological Monitoring Results

Monitoring of macroinvertebrates and habitat evaluation was performed at four locations in the two watersheds using the Hoosier Riverwatch methodology. The evaluations generally showed a significant number of pollution-intolerant macroinvertebrates at each of the sites

Habitat was evaluated using the Hoosier Riverwatch guidelines, which employ the Citizens Qualitative Habitat Evaluation Index (CQHEI) rating. CQHEI is an index developed by the Ohio EPA as a “citizens” companion to the Qualitative Habitat Evaluation Index (QHEI) used by the state’s professional staff. The purpose of the index is to provide a measure of the stream habitat and riparian health that generally corresponds to physical factors affecting fish and other aquatic life such as macroinvertebrates. The stream is evaluated for substrate, fish cover, stream shape and human alterations, stream forests and wetlands and erosion, stream depth and velocity, and riffles and runs.

Maximum total points for CQHEI is 114. Scores above 60 are generally conducive to the existence of warmwater fauna. Of the sites listed below, the Hilkey Ditch and the St. Joseph River at the SR 101 bridge scored below 60. The Hilkey Ditch site is in a rural residential area and the SR 101 bridge is an area of highly changed natural environment (concrete highway bridge and supporting structures).
There is some historical data for biological data at the St. Joseph River at the Covered Bridge near Spencerville (CR 68), HR Site 299. The location was not resampled for this study.

| | |
|---|---|
| May 21, 2002 | Score 72 |
| June 13, 2002 | Score 73 |
| August 22, 2002 | Score 64 |
| October 22, 2002 | Score 62 |
| July 15, 2003 | Score 61 |

St. Joseph River bridge on SR 101, HR Site 1087

| | |
|---|---|
| August 31, 2006 | Score 49 |

Hilkey Ditch at Garman and Amstutz Road intersection, HR site 1086

| | |
|---|---|
| August 31, 2006 | Score 40 |
| May 23, 2007 | Score 40 |

Ely Run, HR site 1070

| | |
|---|---|
| July 19, 2006 | Score 86 |

Bear Creek at Wild Cherry Park, HR site 1088

| | |
|---|---|
| August 31, 2006 | Score 66 |
| May 23, 2007 | Score 66 |

## 3.10 Education

A survey of water utilities costumers conducted by the City of Fort Wayne in 2004 indicated a significant need for education of watershed stakeholders.

- 80% of the 2,202 respondents did not know what watershed they lived in;
- 65% of the respondents admitted that they were not sure what a watershed is;
- 28% of respondents believed that storm water that runs down a storm drain is treated before it reaches the river;
- 87% of respondents agreed that the three rivers are a valuable resource for Fort Wayne; and
- 80% agreed that the rivers are polluted.

During the initial stakeholder meetings for this watershed management plan, stakeholders of the Lower St Joseph and Bear Creek expressed the belief that more watershed education is needed. Fort Wayne's 2004 survey supports that belief.
In presentations to various stakeholder groups since 2002, the SJRWI has found that many people in the watershed are interested in the river and are concerned about it. However, their level of knowledge about the river, its receiving waters, its state of pollution, and how they impact the river and water quality is quite limited.

The Town of St. Joe, Indiana, has established outdoor classrooms for environmental education at their St. Joe River Greenway Trail, used by Eastside High School and Riverdale Elementary School. Concordia High School, located along the St. Joseph River near the St. Joseph River Dam, also has established an outdoor environmental education area. The Indiana University-Purdue University Fort Wayne (IPFW) campus, which is located along the St. Joseph River, also has extensive educational opportunities for students interested in the River and watershed issues.

In response to the need for watershed education, the SJRWI has established a local training effort for the IDNR's Hoosier Riverwatch citizen volunteer monitoring program, and has offered basic training as well as advanced E. coli training since 2004. The trained citizens can sample the streams in their neighborhood and enter their data on the Hoosier Riverwatch database. The focus of the SJRWI in offering this program remains to educate the public about water quality issues, and through education, to change behaviors.

Figure 46  A Combined Sewer Outfall (CSO) on the St. Joseph River in the Northside neighborhood area. (J. Loomis, 2005)

## Part 4: Known Water Quality Problems, Sources and Areas of Concern

As outlined in the Introduction to this document (Part 1), watershed stakeholders identified four major areas of concern: 1) water quality; (2) recreation and access to the water; (3) natural area/river corridor preservation; and 4) education.  Data gathered for this watershed management plan has helped to determine the general health of the Lower St. Joseph and Bear Creek subwatersheds and to validate the concerns of the stakeholders. As a general rule, the problems identified in the St. Joseph River WMP (SJRWI, 2006) and particularly in the Cedar Creek WMP (SJRWI, 2005) are present in these subwatersheds as well. Those problems are:

- high bacteria counts (E. coli) - Concern #1;
- sediment loading (TSS) - Concern #1;
- pesticide spikes, particularly during spring application season (Atrazine) – Concern #1;
- impaired biotic communities and algae blooms on waterways (Nutrients) - Concern #1;
- degradation of the riparian corridor and aquatic habitat - Concern #3; and
- lack of watershed education - Concern #4.

As in the neighboring watersheds, problems with degradation of the natural stream corridor and changes to the natural hydrology cause some wildlife and aquatic habitat concerns and contribute to water quality problems.

Particular to this watershed management plan is the amount of urban land use concentrated in the Lower St. Joseph subwatershed. In this area, the extent of impervious surface negatively affects water and habitat quality. The southern portion of the Bear Creek subwatershed in Allen County is becoming increasingly urbanized as well, and land use change is spreading northward into Dekalb County. Sprawling development increases the concern over loss of natural river corridor and farmland and the impact of increasing impervious surfaces (Concerns #1 and #3).

Also unique to this watershed is the concern of access to the river for recreational activities (Concern #2). This concern did not surface as a major issue during our work with either the larger St. Joseph (HUC-8) or the Cedar Creek watershed management plans.

Areas of Concern and sources are outlined in the remainder of this chapter. Critical areas for each of the concerns and Maps 1 through 5 locating those areas can be found in Chapter 5.

## 4.1 Water Quality Issues

Water quality issues are the most important to stakeholders based on public meetings. The quality of water is also a major concern of the City of Fort Wayne Water Utilities as the St. Joseph River is the source of drinking water for the City. Objective ES3 in the Allen County Comprehensive Plan (adopted 2007) is “Preserve and improve the quality of groundwater and surface water resources.” Objective ES3.B reads “Support and collaborate in the establishment of watershed management plans that recommend actions to address major sources of surface water contamination.” (Plan-it Allen, A Plan for Land and Living, Allen County-Fort Wayne, Section 5)

Four pollutants of concern are addressed here: Bacteria, sediment, pesticides and nutrients.

### 4.1.1 Bacteria

Full-body contact in the St. Joseph River is not generally recommended after storm events as the E. coli count often exceeds the water quality standard of 235 colonies/100 mL. Recreational use of the river in the Fort Wayne urban area is considered incidental. Recreational use of the river upstream of the St. Joseph Dam and in the Cedarville Reservoir is more important to stakeholders. Boating and fishing are quite popular among local citizens during the recreational season (April-October). Some full-body recreational use of the river, such as water skiing and use of personal watercraft (jet-ski) occurs, mostly upstream of the city limits nearer the Cedarville Reservoir. Use of motor boats, pontoons, row boats, canoes and kayaks is common. Hunting and fishing are also popular throughout the year. Walking, hiking and biking trails are increasing in popularity.

The following areas of concern focus on four main sources of bacterial contamination: Combined sewer overflows (CSO); failing on-site septic systems (OSS); wildlife, in particular nuisance geese; and livestock/domestic pets and their manure.

**Area B-1: Northside neighborhood to Downtown (Map 1)**
**Source: CSOs**
Appearance and odors are major barriers to greater appreciation of the rivers by the public. There are 42 CSO locations in Fort Wayne which overflow on 105 days per year, spilling nearly 1 billion gallons of sewage. Six of the CSOs are in the St. Joseph River; all six are downstream of the drinking water intake located at the St. Joseph dam. The City is working with EPA Region V to agree on a long-term control plan that will eventually reduce the number of overflow events from 105 to approximately 4 days per year. (G. Meszaros, presentation to stakeholders, 2007)

**Area B-2: Urban and Suburban Fort Wayne (Map 1, Map 2, Map 3)**
**Source: Failing OSS**
Soils in these subwatersheds generally are not very supportive of well-functioning septic systems. Additionally, many housing lots are too small to adequately host an on-site septic system given the soil properties. DeKalb County estimates about 4,000 septic systems exist with a failure rate of around 40%. In 2005, the Fort Wayne-Allen County Health Department counted 1,083 permitted septic system in the Bear Creek subwatershed and 742 in the Lower St. Joseph subwatershed. The number of septics installed before

current record-keeping efforts, many of which are likely failing, is unknown, but estimated to be at least equal to the number of permitted systems.

The goal of the City of Fort Wayne is to remove all septic systems from the city limits and get the homes connected to central sewers. Newly annexed areas are of particular concern. Tiernan Ditch, Ely Run and Beckett's Run subwatersheds contain many septic systems which are within city limits. Availability of central sewer service for areas of these subwatersheds which fall outside of the city limits is less certain.

Estimates of septic system failure rate are estimated at around 40% statewide. Estimates of failure for the neighboring Cedar Creek watershed reached 75%. (Rice, 2005) For the purposes of this project, we selected a 50% failure rate which includes failure of non-permitted or non-recorded systems. Maps of the permitted septic systems in Allen County within the two subwatersheds can be found in Appendix J of this document. No maps are available for DeKalb County.

**Area B-3: Orangeville and area north of St Joe, DeKalb County (Map 5)**
**Source: Failing OSS**
The community of Orangeville and the town of Newville do not have centralized sewage systems according to the DeKalb County Board of Health. The town of St. Joe, Indiana, has an award-winning wastewater treatment plant (WWTP) which handles waste from St. Joe and Spencerville and discharges into the St. Joseph River north of County Road 64. Sewage from the City of Leo-Cedarville and the Town of Grabill is piped to the Fort Wayne Wastewater Treatment Plant. (Fort Wayne's plant outflows to the Maumee River downstream of its confluence with the St. Joseph.)

The Bear Creek subwatershed, which includes the large Hursey Ditch system, has shown high levels of bacteria in the SJRWI sampling program. The SJRWI site (128) is upstream of the town of St. Joe and downstream of Orangeville. In 2006, the site average was 1820 cfu/100 mL, with the highest reading at 16,520 and 75% of samples exceeding the water quality standard of 235 cfu/100 mL. Hoosier Riverwatch sampling at several selected sites in 2006 and 2007 did not validate this data, but this was a more random sampling of small tributary sites.

**Area B-4: St. Joseph River-Cedarville Reservoir and Swartz-Carnahan subwatersheds (Map 3)**
**Sources: Failing OSS, Livestock, pets, horses, wildlife (geese)**
Although livestock is not believed to be a major source of E. coli based on the BST project, recent reports from Soil and Water districts indicate that small feedlot operations operate "under the radar" within the Cedarville and Swartz-Carnahan subwatersheds - that is, they are not large enough to require State controls for CAFOs, and their numbers fluctuate, often from month to month, particularly in the Amish community. (Personal communication SWCD, NRCS of DeKalb and Allen counties 2006) A 2008 livestock survey being undertaken for the Western Lake Erie Basin Project indicates that there may be significantly more pleasure horses and other small livestock numbers than previously thought. The area around the Cedarville Reservoir is also home to small estates with limited numbers of domestic livestock; education about the impact of animals on water quality is becoming more important in this area. Additionally, there are a significant number of septic systems in the area and based on the soils, it is expected that a significant number of them are failing. BST tracking at Boger and Fisher Ditches indicated human, livestock, domestic pet, horses and wildlife (geese) as sources of bacteria.

**Area B-5: IPFW campus & urban parks and greenspace (Map 1)**
**Source: Nuisance geese**
Populations of Canada geese have inhabited the IPFW campus and its lawns, sports fields and greenspace for many years. The campus, which straddles the St. Joseph River in Fort Wayne, has struggled with controlling the geese and their droppings. Additional areas along the river which have goose populations include Canterbury Green, Shoaff Park, Concordia University, and River Bend golf course. Other parks and neighborhoods with open detention/retention ponds and similar water features are also experiencing problems with nuisance geese. Removal and control of nuisance geese is a high priority for the City of Fort Wayne.

### 4.1.2 Sediment

Based on turbidity and TSS data outlined in Part 3, erosion and sedimentation are water quality problems in the Lower St. Joseph and Bear Creek subwatersheds. Sediment has increased the cost of water treatment for the City of Fort Wayne, costing the City approximately $300,000 per year (Shastri). It has decreased the capacity of the reservoirs. It negatively affects aquatic habitat and recreational enjoyment of the river by stakeholders, who indicated that muddy water of the river is a problem in the watershed.

Turbidity in the Bear Creek and Lower St. Joseph subwatersheds is caused by agriculture (tillage and other land disturbance); loss of stabilized and vegetated banks on the river and its tributaries; and construction activities, particularly large land development such as suburban residential and commercial site developments.

Since the majority of the land in the watershed is rural/agricultural, erosion from this land remains a great source of sediment in the water. Conservation tillage reduces land disturbance and erosion because the soil is not plowed and disked. In 2007, although conservation tillage for soybeans was 90% in Allen County and 94% in DeKalb County, conservation tillage for corn lagged behind at 66% in Allen County and 63% in DeKalb County. Tillage transect data is available in the Appendix L of this document. DeKalb County reported that nearly 7,000 acres were returned to production from the Conservation Reserve Program (CRP) in the spring of 2004. With the increasing price of commodity grains, it is expected that conservation practices that take land out of production will become harder to sell as producers weigh long-term conservation contracts against the possibility of larger profit margins on grant production.

**Area S-1: Northern Allen County (Map 2, Map 3)**
**Source: Construction and development**

Allen County covers over 400,000 acres. Approximately 1/3 of that is urban Fort Wayne. The urban footprint has been increasing in the watershed. Allen is the largest county in the State of Indiana and ten years ago it had the most acres of cropland in the State. In the past ten years urban development has increased substantially. Allen County now ranks third in the State for acres of cropland. (S. Liechty, NRCS Allen County, personal communication 2007) This area of the watershed has high erosion hazard based on soil types and HEL (highly erodible land) maps. The increased number of construction sites, which often includes new utility infrastructure) along with the lack of erosion control on many of these sites, is contributing to erosion and sedimentation in the St. Joseph watershed. Additionally, the development has increased the amount of impervious surface and decreased the number of wetlands which could function as sediment traps.

**Area S-2: Agricultural Fields: DeKalb Co. upstream of reservoirs (Map 3, Map 4, Map 5)**
**Soruces: Conventional tillage, lack of cover crops, livestock access to streams**

The rural/agricultural area of the Bear Creek watershed is particularly vulnerable to sediment from farming activities based on the preponderance of land dedicated to agriculture. Increasing conservation tillage, increasing winter cover crops, reduction of row crops on marginal land and fencing to reduce livestock access to stream banks, and protection/restoration of wetlands are key practices for reducing sediment and TSS.

**Area S-2: Flood Plain (Riparian) Corridor of both subwatersheds (Maps 1-5)**
**Sources: Row crops, disturbance of soil, lack of permanent vegetation**

Within the flood plain of the river and its main tributaries, cultivated crops occupy 30.7% of the land in the Lower St. Joseph subwatershed and 66% of the land in the flood plain of the Bear Creek subwatershed, based on 2001 land use maps. Although fertile, these disturbed areas are particularly prone to erosion during high water events. Restoration of wetlands and forest land will reduce sediment and TSS.

Approximately one half of the streams in these two subwatersheds are established legal drains and undergo periodic maintenance. Maintenance is dependent upon the availability of assessment fees, so actual work on problem drainage or erosion areas may be delayed until enough fees are collected to finance the work. If permits are required, additional time is required. Dredging maintenance on streams and drains can result in increased erosion if the stream banks are not protected and revegetated immediately. The removal of woody vegetation, including trees and shrubs, also contributes to thermal pollution of the streams, thus increasing the impact on water quality.

**Area S-3: Transportation corridors I-69, I-469, SR 1 (Map 2)**
**Sources: Construction of new roads; winter season road sanding**

Transportation corridor construction and improvement adds to sediment levels in the watershed. In 2007, observation of Interstate 69 construction at its intersection of I-469 and Dupont Road showed greatly increased the sediment load, although there was no actual sampling done in the construction area. This land is subject to erosion during the construction period and is often not revegetated quickly.

Sand/salt mixtures spread on roadways to reduce driving hazard during winter season will increase the particulate matter that get into streams. The amount used across the two counties depends upon winter weather conditions. Reduction of the use of this material is a safety and economic decision made by the municipal government. Bioretention and biofilters can help to reduce the amount of particulate matter that reaches the streams.

### 4.1.3 Pesticide Spikes

Pesticides, at levels above minimum water quality standards established by EPA, are considered a risk to human health. Additionally, the cumulative effect of even low levels of combinations of several types of pesticides that may be present in water supplies is not well understood. The City of Fort Wayne tracks pesticides in both the raw (incoming) water and in finished (tap) water provided by the city's drinking water utility. If levels of pesticides in the raw water exceed the maximum contaminant load (MCL) set by the EPA, the chemicals are removed by treatment with powdered activated charcoal (PAC). The City spends an average of $165,000 annually for PAC (C. Shastri, 2004).

The largest source of pesticides in the St. Joseph watershed is generally considered to be agricultural, based upon the substantial percentage of the agricultural land use in the northern portion of the Lower St. Joseph and the majority of the Bear Creek subwatershed.

Atrazine, which is water-soluble, is widely used across the watershed for corn production. Atrazine has a chronic aquatic habitat contaminant level of 12 ppb. Although the SJRWI has not encountered such high levels at our weekly sampling station in the Bear Creek near the confluence of the main stem of the river, research by the Agricultural Research Service in the Upper Cedar Creek subwatershed showed Atrazine levels near 60 ppb in the drainage ditches adjacent to farm fields.

In non-agricultural areas, pesticides can enter the water through storm water runoff from treated lawns, golf courses (see Figure 21 on page 26) and other recreational areas, plant nurseries and garden centers, and domestic gardens. Urban landowners in the Lower St. Joseph subwatershed have an important effect on water quality in three important ways: Pesticides are widely available for purchase and use, as are lawn and garden services; the average urban homeowner has less of an economic incentive to apply pesticides conservatively based on number of acres treated; and impervious surfaces speed up the travel time from lawn to waterbody.

Water quality sampling by the Initiative shows an overall decline in the amount of pesticides in the raw water over the last ten years in most subwatersheds. However, the river still exhibits high levels of contamination by pesticides in the spring, when application of agricultural chemicals and heavy spring rains coincide. Pesticides are washed off the fields, either because the chemicals are water soluble, or because they bind to the soil particles and are carried to the stream with sediment.

**Area P-1: Floodplain (Maps 1-5)**
**Sources: Agriculture, urban lawns, ditch maintenance**

Within the flood plain of the river and its main tributaries, cultivated crops occupy 30.7% of the land in the floodplain of the Lower St. Joseph subwatershed and 66% of the land in the flood plain of the Bear Creek subwatershed. Pesticides used on these farm fields have a greater possibility of drifting and leaching into the waters of the river and its tributaries. Along the main stem of the St. Joseph and in areas surrounding the reservoirs, residential and parkland lawns are sources for pesticides. Ditch maintenance that may occur along legal drains and tributaries often includes the use of herbicides to control woody vegetation. Because of the proximity of all of these practices to open water, the rate of contamination of the water is magnified.

**Area P-2: Bear Creek-Hursey Ditch System (Map 4)**
**Source: Agriculture**

The Bear Creek-Hursay Ditch subwatershed is 77.2% cropland (13520.5 acres) with 536.5 of those acres located within the 30 meter buffers either side of the streams. Conservation practices in this subwatershed have been limited (See the DeKalb County conservation practices map in Figure 43 of this document.) Critical times for pesticide reduction and control is during the spring planting season, and particularly along small streams and ditches.

**Area P-3: Davis Ditch (Map 5)**
**Source: Agriculture**

The Davis Ditch subwatershed is 66.8% cropland (4371.8 acres) with 119.1 of those acres located with the 30-meter buffers either side of the stream. Conservation practices in this subwatershed have been limited (See the DeKalb County conservation practices map in Figure 43. Critical times for pesticide reduction and control is during spring planting season, and particularly along small streams and ditches.

**Area P-4: Schoppman Drain and Beckett's Run (Map 1, Map 2)**
**Soruces: Agriculture, parkland, urban lawns**

According to 2001 land-use maps, the Beckett's Run subwatershed has a significant amount of cropland (1,245.9 acres) including 52 acres within the 30-meter riparian buffer zone. Additionally, urban parcels along the river banks include residential lawns and several golf courses and parks. The total amount of pesticides used in these areas is unknown, but is expected to be significant and to have direct runoff into the river. An education outreach effort to homeowners, parks and green space owners, and agricultural producers will be required to decrease the use of pesticides entering the Fort Wayne drinking water system.

### 4.1.4 Nutrients

Nutrients enter the waterways in the two subwatersheds through various sources; chief among them are agriculture, failing septic systems, CSOs, urban lawns, golf courses, livestock (manure), domestic animals and wildlife, and stream dredging operations.

Nutrients in the river functions as a fertilizer and contribute to growth of algae, which decreases dissolved oxygen in the water, as well as contributes to taste and odor problems. Phosphorus is the limiting nutrient for plant and algal growth in the waterways since nitrogen is generally available in the atmosphere. Algae mats are not aesthetically pleasing and some species can secrete toxins which are deadly to fish and other animals.

The practice of dredging ditches can increase the amount of phosphorus in the streams. A laboratory study on the sediments collected during the dredging of the Walter Smith Ditch in northern DeKalb County by the USDA Agricultural Research Service in 2006 concluded that transport of soluble phosphorus (P) increases immediately after dredging. Phosphorus is normally bound to sediment particles in the stream bed and water column. The experiment did not determine how long the reduction in P removal by the sediment particles lasts. (Smith et al, 2006)

No studies have been done to quantify the amounts of nutrients entering the streams originating from the various possible sources. However, the large number of failing septic systems could be a source. And the Initiative's Bacteria Source Tracking (BST) project (2002-04) showed that a large amount of bacteria (and therefore, nutrients) could be identified as originating from geese. Large populations of nuisance geese, which overwinter in Northeast Indiana, are common in both rural and urban areas of these subwatersheds, particularly on parklands and fallow farm fields and around retention/detention basins and ponds.

**Area N-1: Swartz-Carnahan Ditch and Cedarville Reservoir (Map 3)**
**Sources: Agriculture, residential lawns, failing OSS**

The Cedarville Reservoir is 303d-listed as impaired for algae, taste and odor. Algae growth contributes to taste and odor and is particularly relevant in drinking water sources. Fertilizer and manure drainage from agricultural areas and rural homes with failing septic systems are possible sources for nutrients contributing to the algal problems on the reservoir. Highly erodible land (HEL) maps indicate significant HEL pockets in the Cedarville Reservoir watershed and the Swartz-Carnahan Ditch watershed. The Ditch drains to the Reservoir. These areas could be contributing to the phosphorus loading since phosphorus binds to the soil particles.

**Area N-2: St. Joseph Reservoir (Map 1)**
**Sources: Urban lawns and parkland; nuisance geese, failing OSS**
The St. Joseph Reservoir is 303d-listed as impaired for algae. This reservoir lies downstream of several green spaces along the river, including the IPFW campus and athletic fields, Canterbury Green, Shoaff Park, River Bend Golf Course, and Concordia University. Fertilizers leaching into the river from these greenspace areas is a possible source of nourishment for algae. Another source of nutrients feeding the algae is the residential community along the river upstream of the reservoir. The upstream drainage area includes land with a large number of homes serviced by on-site septic systems, 50% of which are potentially failing. Septic system failure can add significant amounts of phosphorus and nitrogen to the river and its tributaries.

**Area N-3: Flood Plain Corridor (Maps 1-5)**
**Source: Agriculture**
Within the flood plain of the river and its main tributaries, cultivated crops occupy 30.7% of the land in the floodplain of the Lower St. Joseph subwatershed and 66% of the land in the flood plain of the Bear Creek subwatershed. Fertilizers used on these farm fields have a greater possibility of leaching into the waters of the river and its tributaries.

**Area N-4: Legal Drains, ditch and stream corridors (Maps 1-5)**
**Source: Streambed disturbance**
Approximately one half of the streams in these two subwatersheds are established legal drains and undergo periodic maintenance. Although it happens relatively infrenquently on any given stream, dredging maintenance on streams and drains can result in increased levels of phosphorus which is released from the stream bed soils during and after operations. Reduction of wetlands and stream overflow areas associated with drain maintenance may also decrease the ability of the stream to naturally filter out nutrients from the water column.

## 4.2 Access to the River and Recreation

Stakeholders, particularly those in Fort Wayne and Leo-Cedarville, have indicated that better access to the river is desirable. Complaints of too few public access points, as well as poorly-accessible access points were common discussion points in several of the public meetings. Access points were defined as areas for both boat launch facilities and pedestrian access for walking, fishing, hiking and bird watching. Seven public access points are described in Table 7.

Figure 47 An Army Corps of Engineers flood control project removed vegetation and added rip-rap to the banks of the St. Joseph in the Northside neighborhood of Fort Wayne (J. Loomis, 2005)

**Area A-1: Northside Neighborhood (Map 1)**
**Sources: St. Joseph Flood Project**

Within the urban Fort Wayne area, stakeholders complain that the river is "out of sight" and not easily enjoyed by the population. A flood control project in the 1990s added an earthen flood protection wall with rip-rap and cleared vegetation from the banks of the St. Joseph River in Fort Wayne in order to reduce flooding to homes in the Northside area of the city. Although there is a concrete walkway along the river along part of this area, residents are generally unhappy with the aesthetics of the project, lack of greenery and the limited access to the water. Planting "pots" that were installed to add vines and other green plants are currently empty and need a green-up effort by the neighborhood or the city to improve aesthetics.

Figure 48 Public access to the St. Joseph River in Johnny Appleseed Park, just downstream of the St. Joseph Dam. (J. Loomis 2005)

**Area A-2: Johnny Appleseed Park and IPFW campus (Map 1)**
**Sources: Access sites not user friendly**

The public access sites to the river at both the park (below the dam) and IPFW (above the dam) are limited facilities that exhibit eroding banks and large geese populations (IPFW). Rocks and boulders in the river near the St. Joseph park public access site severely hamper boating activities (D. Wire, 2006). Water levels fluctuate due to the season and upon the construction work and water supply required by the City of Fort Wayne. Greenway paths along the river invite users but connectivity, maintenance and improvement are continuing concerns.

**Area A-3: Cedarville Reservoir and**

**surrounding area (Map 3)**
**Source: Access sites limited, water levels fluctuate**
The level of the Cedarville Reservoir was lowered at least two times during the preparation of this watershed management plan for repair and maintenance of the dam and for further inspection of the repairs. While maintenance of the dam and the reservoir are undeniably important for the community, significantly lowering water levels in the reservoir during the recreational season affects water quality by changing water temperature (thermal pollution) and reducing dilution of pollutants. It also negatively affects the habitat of aquatic species that inhabit the reservoir and its perimeter, including mussels, amphibians and fish, as well as native flora. Although siltation of the Reservoir has been exhibited during the dam maintenance, there are currently no plans to assess the amount of sediment in the reservoir or to dredge the reservoir due to prohibitive costs.

4.3 Riparian Corridor and Natural Areas Preservation
Riparian zones are the vegetated ecosystems along a water body through which energy, materials and water pass. These areas characteristically have high water tables and are subject to periodic flooding and influence from the adjacent water body. They may encompass wetlands or uplands or some combination of both. (http://ww.epa.gov/owow/nps/facts/point11.htm)

Loss of natural vegetation on these riparian corridors affects the terrestrial wildlife as well as the aquatic species in the river and its tributaries. Changes in the vegetation along streams affects the pollutant load entering the streams, as well as the water temperature, shade, and natural habitat features of the stream. Pollutants, including sediment and chemicals entering the stream from the riparian corridor, affect fish and mussel species as well as their food sources.

Development has greatly impacted these two subwatersheds. Agricultural and urban development has often included filling wetlands, building of drainage ditches and adding subsurface drainage. Historically, many streams and drainage ditches have been straightened, deepened and otherwise channelized, encouraging runoff water to move more quickly downstream. Smaller first and second order streams are often cleared of woody vegetation that might interfere with stream flow. The main stem of the river and its major tributaries have lost much of the original riparian buffer through agricultural and urban development.

Development of urban areas replaces pervious surface with impervious surfaces – roofs, roadways, parking lots and turf – and often adds additional drainage infrastructure. These activities increase both the volume (amount) and the velocity (energy) of storm water runoff, promoting erosion and increasing the pollutants and contaminants entering the stream. (See impervious surfaces maps, Figure 18 and Figure 19.)

Loss of storm water storage upstream in the form of wetlands, oxbows, pervious surfaces, and slow-moving streams increases the quantity and decreases the quality of water moving downstream. The main stem of the river and its tributaries have lost much of their riparian buffers in the Bear Creek subwatershed. Limited natural corridor remains in the urbanized areas downstream of the Cedarville dam. Urban sprawl and intense development of the northern Allen County and Leo-Cedarville areas is increasing the impervious surface and non-native landscaping cover in the two subwatersheds.

**Area R-1: Beckett's Run Subwatershed (Map 2)**
**Source: Urban/suburban Development**
As of 2001, the subwatershed included approximately 70.6 acres of wetlands and 106 acres of woodland. The remaining non-urbanized land in the Beckett's Run watershed is being developed at a rapid rate. Currently at least three neighborhoods in this watershed have documented drainage problems. Additional loss of wetlands, woodlands and natural vegetation in the northwest with the resultant increase in impervious surfaces will further threaten water quality.

**Area R-2: Tiernan Ditch Subwatershed ( Map 2)**
**Source: Urban/suburban Development**
As of 2001, the subwatershed included 63.8 acres of wetlands and 106.7 acres of woodland. Expansion of transportation corridors I-69, I469 and Dupont Road (SR 1) are substantially impacting the pace of

development of this watershed. Loss of wetlands and woodlands in the northern section will further impact neighborhood drainage problems in the central and southern portions. It will also negatively impact water quality through increases in sediment, heat, inorganic and toxic chemicals.

**Area R-3: Ely Run Subwatershed (Map 2)**
**Source: Urban/suburban Development**
As of 2001, the subwatershed included 65.5 acres of wetlands and 90.9 acres of woodland. Expansion of transportation corridors I-69, Dupont Road (SR 1) and Tonkel Road are substantially impacting the pace of development of this watershed. Loss of woodlands and wetlands and the native vegetation will be significant in their impact on water quality. These changes will further intensify the decline of native aquatic and fish species and increase the drainage problems in urban Fort Wayne.

**Area R-4: St. Joseph-Cedarville Subwatershed (Map 3)**
**Source: Urban/suburban Development**
As of 2001, the St. Joseph-Cedarville Reservoir subwatershed included 42.7 acres of wetlands and 92.5 acres of woodland. Development around Leo-Cedarville, Grabill and Spencerville along the SR 1 corridor is increasing the threat to this natural land cover and will further impact water quality in the reservoir and the river.

**Area R-5: Bear Creek – Hursey Ditch Subwatershed (Map 4)**
**Source: Limited conservation practices installed; remaining wetland areas need protection**
As of 2001, the Bear Creek-Hursey Ditch Subwatershed included 53 acres of open water, mostly in the form of small streams and ditches, 13520 acres of row crops, and only 382 acres of wetlands. Forested areas are fragmented.

## 4.4 Habitat and Biological Diversity

The loss of mussels in species and diversity in the St. Joseph River is of concern, since this indicates underlying problems in water quality, available habitat, and possibly fish diversity. Of particular interest is protection of areas that have currently identified mussel beds which are in decline, including Johnny Appleseed Park (Map 1 in Chapter 5) and Cedarville Reservoir (Map 3 in Chapter 5). Improving the populations in these sites is dependent upon improvement in water quality and habitat upstream.

## 4.5 Watershed Education

Based on the survey and feedback from stakeholder outreach, education of the general public on watersheds and water quality issues, as well as conservation practices, needs to be a focus in these two subwatersheds. (See Section 3.10) Both municipal and agricultural agencies are interested in increasing outreach education to achieve water quality goals.

**Figure 49 Undercut banks along the Ely Run. (J. Loomis 2006)**

## Part 5: Critical Areas in the Watershed

In the process of determining where to begin implementation of the goals of this watershed plan, we have identified critical areas that should be addressed sooner rather than later. Improvement of problem areas could have an immediate impact on water quality. Some areas are identified for protection – these are areas that are threatened by loss of wetlands and permanent vegetation such as woodland. Developing or farming these areas could negatively impact the current quality of the water.

The 30-meter riparian zones along either side of the river and its tributaries are considered critical areas. As these land use areas are closest to the flowing water, they have a greater impact on the quality of the water and the riparian and aquatic habitat. Likewise, when these areas are improved through placement of Best Management Practices (BMPs) or changes in land use, they have a significant effect on improvement of water quality, reduction of flooding, and wildlife diversity, particularly on first and second-order streams.

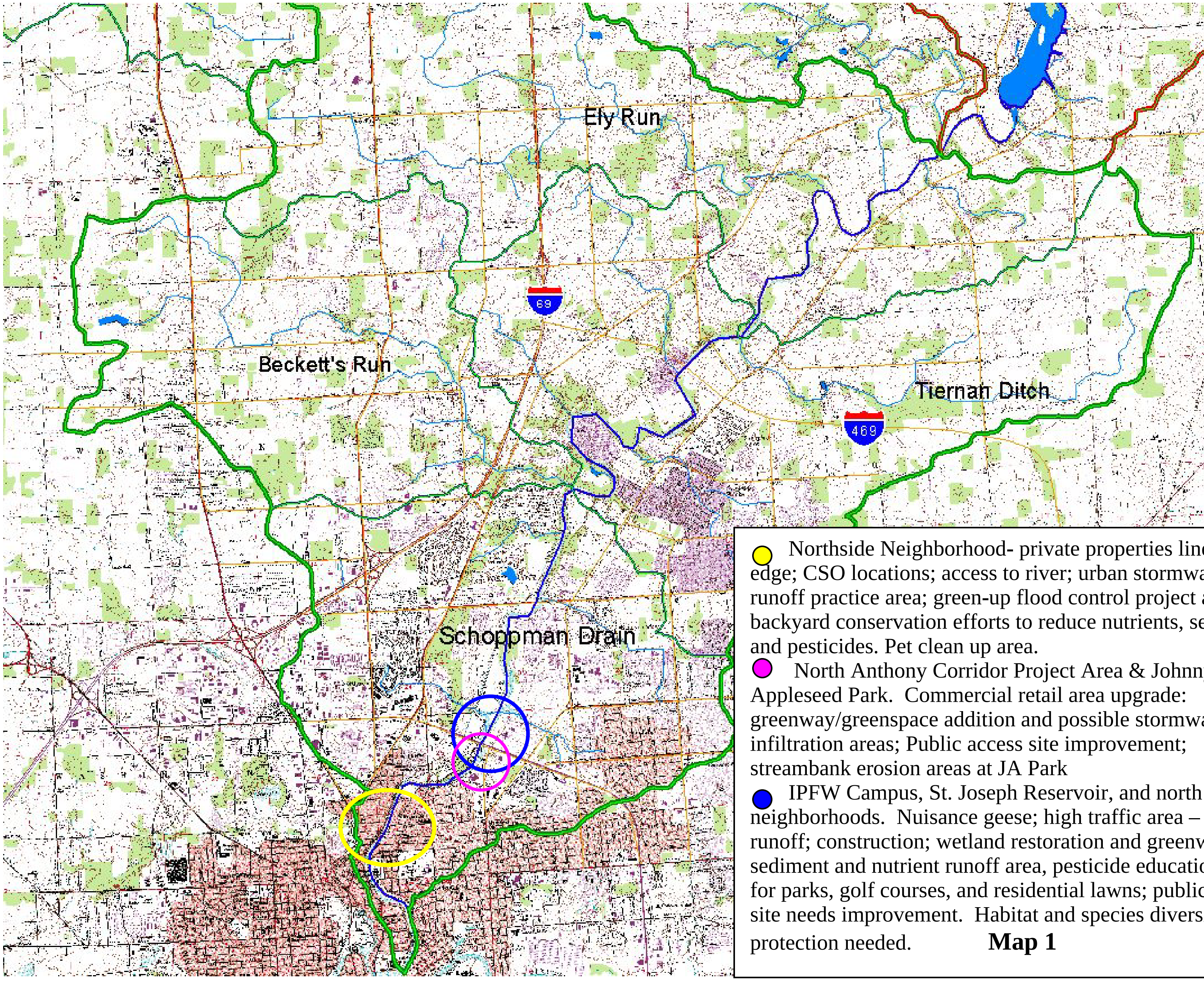
Land cover maps based on 2001 land use data for each of the seven subwatersheds in this section are located in Appendices M and N of this document. These maps were used to identify land use acreage across the subwatersheds as well as within the 30-meter riparian zones.

Also found in the Appendix is water quality data collected from the St. Joseph River Watershed Initiative, the City of Fort Wayne, and the Fort Wayne –Allen County Health Department, the DeKalb County Health Department.

Part 4 of this document highlighted areas of concern across the Lower St. Joseph and Bear Creek subwatersheds. This chapter contains a series of maps identifying more specific locations considered critical for improvement or protection during the next five years. Some of these areas are already being addressed or are under consideration for attention. A table with further information on each location follows the maps. We expect that high priority items will be addressed in years 1-2; Medium in years 3-4; and Low in years 4-5. Total time for completing the projects may extend beyond year five.

In selecting these critical areas for improvement, we relied on water quality data, land use data, aerial maps, stakeholder input from public meetings, and direct correspondence from many stakeholders at various meetings during the preparation of this plan. We also used input from watershed stakeholder partners including the city and county government offices as well as regional and federal agencies, and private environmental organizations.

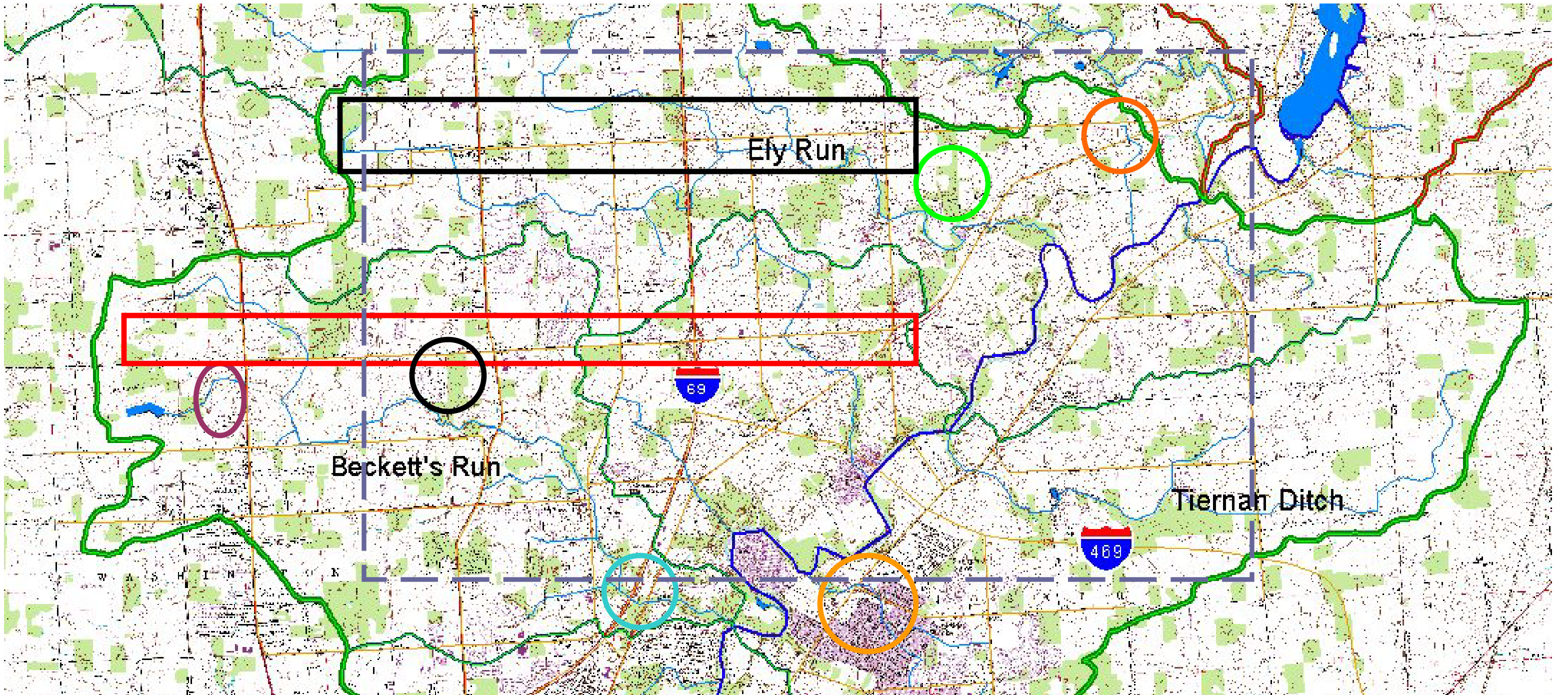
Outreach education supporting general watershed information and particular BMP activities is considered part of all practices identified to solve water quality problems and will be implemented as each project moves forward.




Northside Neighborhood- private properties line river's edge; CSO locations; access to river; urban stormwater runoff practice area; green-up flood control project and backyard conservation efforts to reduce nutrients, sediment and pesticides. Pet clean up area.

North Anthony Corridor Project Area & Johnny Appleseed Park. Commercial retail area upgrade: greenway/greenspace addition and possible stormwater infiltration areas; Public access site improvement; streambank erosion areas at JA Park

IPFW Campus, St. Joseph Reservoir, and north river neighborhoods. Nuisance geese; high traffic area – highway runoff; construction; wetland restoration and greenway area; sediment and nutrient runoff area, pesticide education area for parks, golf courses, and residential lawns; public access site needs improvement. Habitat and species diversity protection needed. **Map 1**




Interstate 69 crosses Beckett's Run; Construction adding sediment to the stream. Highway runoff contributes pollution.

Commercial construction area: increase in impervious surface area here will affect downstream pollution and flooding in this watershed.

Dupont Road Corridor. High traffic; commercial building area; road widening, increased impervious surfaces.

Union Chapel Road is also a major east-west corridor.

Solomon Farm City Park; nuisance geese; area of protection for wetland and greenspace.

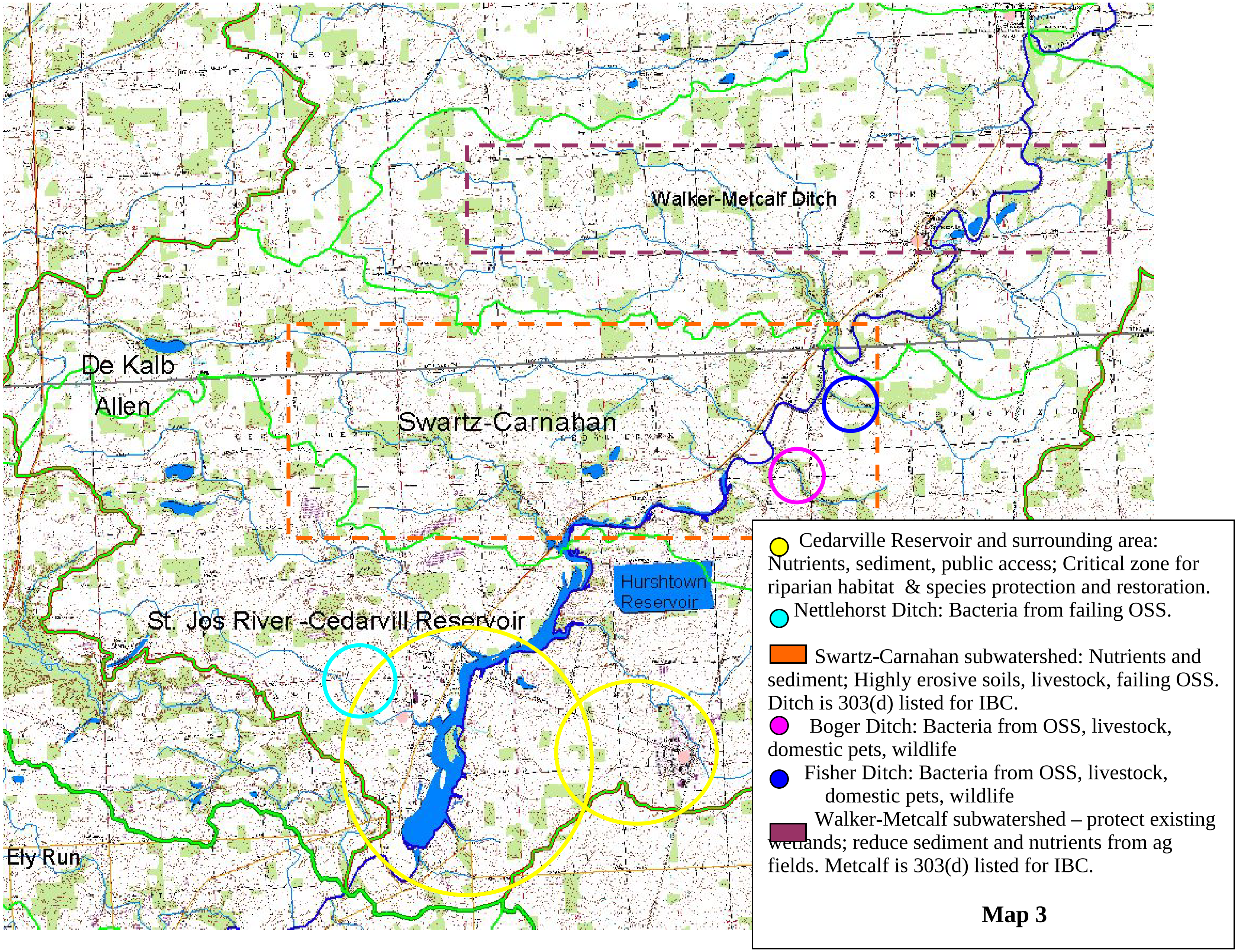
Parkerdale Neighborhood area: Septic to central sewer project for City of Fort Wayne. Continued monitoring needed to track improvements

Bank erosion/restoration projects on Ely Run; also surrounding areas of Martin Ditch and tribs.

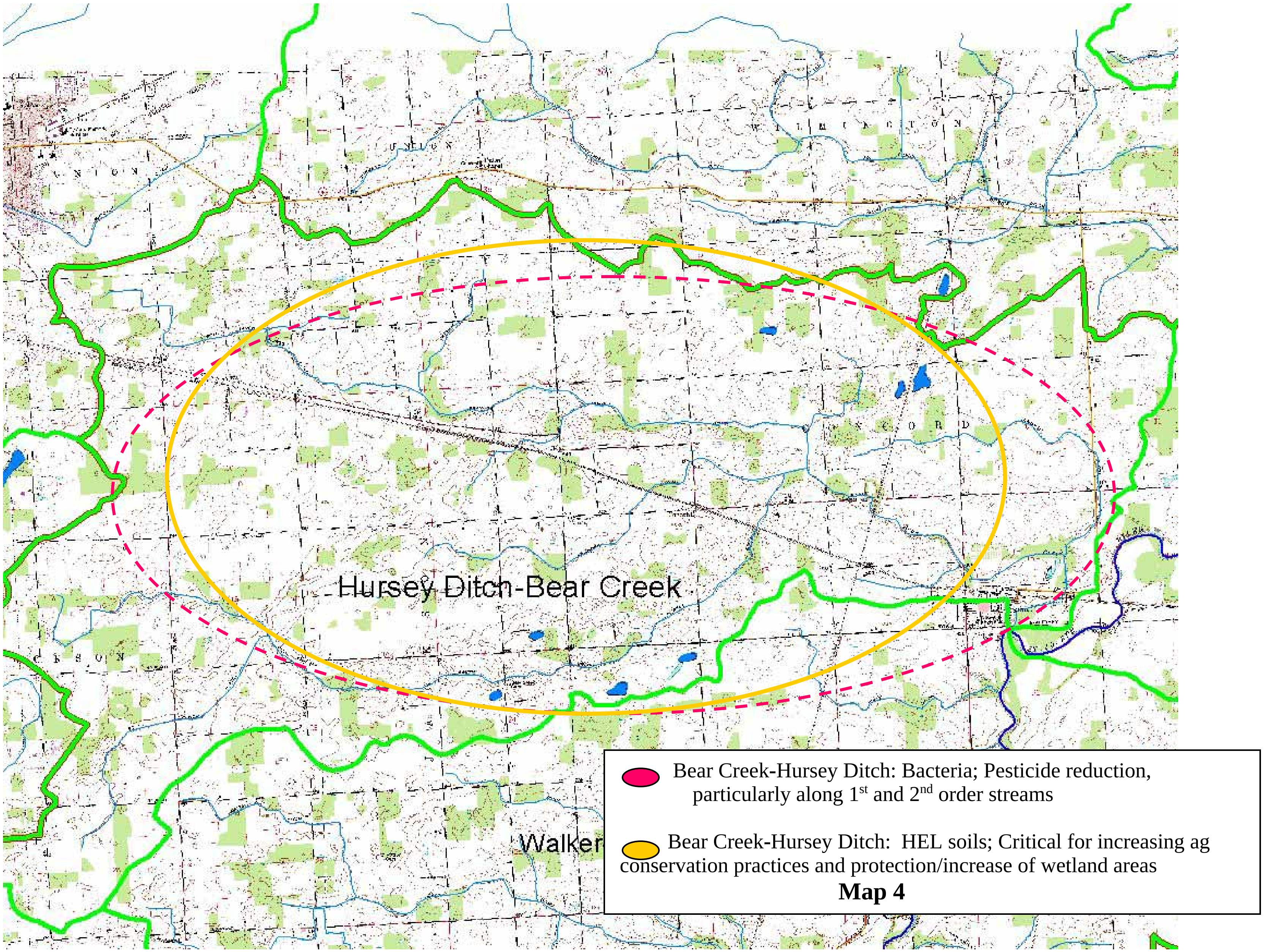
Heavy construction area – Dupont & Tonkel Rds.

Beckett's Run: pesticides from remaining ag land, lawns. Beckett's Run, Ely Run & Tiernan Ditch: Failing On-site Septic Systems (OSS).

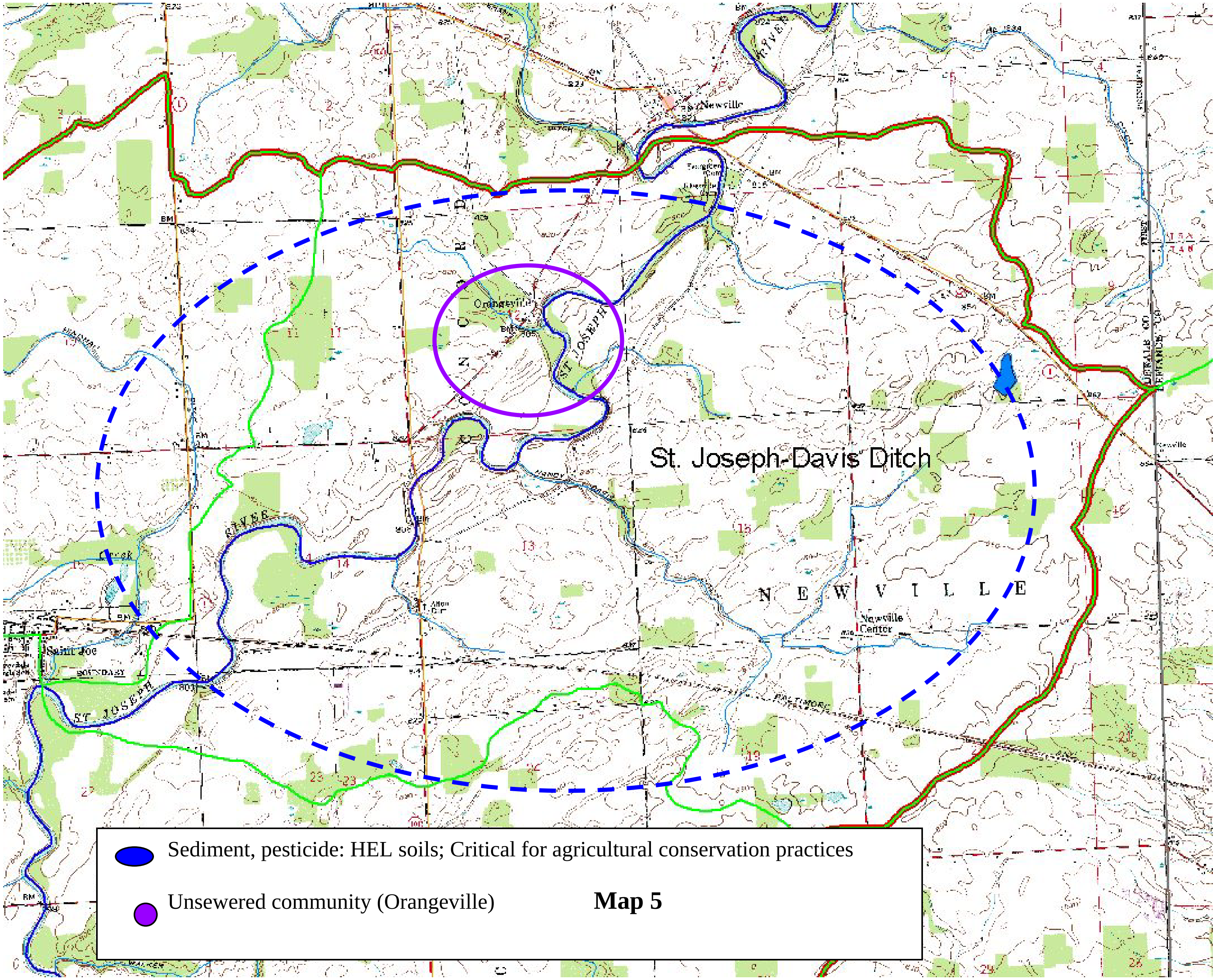
**Map 2**


Walker-Metcalf Ditch
De Kalb
Allen
Swartz-Carnahan
Hurshtown Reservoir
St. Jos River -Cedarvill Reservoir
Ely Run
Cedarville Reservoir and surrounding area: Nutrients, sediment, public access; Critical zone for riparian habitat & species protection and restoration.
Nettlehorst Ditch: Bacteria from failing OSS.
Swartz-Carnahan subwatershed: Nutrients and sediment; Highly erosive soils, livestock, failing OSS. Ditch is 303(d) listed for IBC.
Boger Ditch: Bacteria from OSS, livestock, domestic pets, wildlife
Fisher Ditch: Bacteria from OSS, livestock, domestic pets, wildlife
Walker-Metcalf subwatershed – protect existing wetlands; reduce sediment and nutrients from ag fields. Metcalf is 303(d) listed for IBC.

**Map 3**


Hursey Ditch-Bear Creek
Walker
Bear Creek-Hursey Ditch: Bacteria; Pesticide reduction, particularly along 1st and 2nd order streams
Bear Creek-Hursey Ditch: HEL soils; Critical for increasing ag conservation practices and protection/increase of wetland areas

**Map 4**


St. Joseph-Davis Ditch
Orangeville
Newville
N E W V I L L E
Newville Center
Saint Joe
Sediment, pesticide: HEL soils; Critical for agricultural conservation practices
Unsewered community (Orangeville)
Map 5

Areas highlighted on Maps 1 through 5 in this chapter are considered problems that can and should be addressed within the next five years. These areas are listed on the table (below), along with the leading causes of the problems, possible solutions to those problems, and priority ranking. It is recognized that list is broad and requires support from many communities and stakeholders across the two subwatersheds.

| Map # | Area/Location | WQ Problems | Leading Cause(s) | Other issues | Solution(s) | Priority |
|---|---|---|---|---|---|---|
| 1 | Northside Neighborhood | Bacteria, nutrients, sediment | CSOs and pet waste; residential lawns; construction and road runoff | Access to river<br>Green-up along flood control project | Removal of CSOs (City of FW)<br>Backyard conservation, education<br>Pet waste cleanup<br>No-phosphate fertilizer project | Medium<br>High<br>High<br>Medium |
| 1 | North Anthony Corridor, Johnny Appleseed Park area | Sediment, nutrients, toxics and heat (thermal) | Highway/road storm runoff; High % Impervious surface; sediment | Public access | Increase greenspace/stormwater infiltration areas<br>Increase tree cover in urban area; tree sales & education workshops<br>Improve public access area to reduce erosion | Medium (city funding)<br>High<br>Medium |
| 1 | IFPW Campus, St. Joseph Reservoir and north river neighborhhoods | Sediment, Bacteria and Nutrients; toxic and heat (thermal) | High traffic and impervious surface area; nuisance geese; Lawn fertilizers; construction activities | Critical area for protection/creation of wetlands, stormwater infiltration, buffers and educational-demonstration site | Increase landscape practices that deter nuisance geese<br>Increase stormwater bio retention and filtration areas<br>No-phosphate fertilizer projects to reduce algae<br>Buffer highway runoff | High<br>High<br>High<br>High |
| 2 | I-69 corridor-Beckett's Run | Sediment, Toxics, heat | Highway construction activities at bridge, bank erosion and increased runoff velocity along the stream. | | Improve sediment control at construction site<br>Improve bio filtration between highway and stream | High<br>Medium (Reliant on Highway Dept.) |
| 2 | Commercial construction area at Dupont Road and Lima Rd (SR 3) | Sediment, toxics, solid waste (trash), heat (thermal), Increased velocity of stream | Construction activities; increased auto and truck traffic; increased solid waste; increased impervious surface | Possible increase in neighborhood flooding during heavy storm events | Enforce Rule 5 and Rule 13<br>Increase green infiltration areas<br>Increase urban tree cover<br>Promote rain gardens and other bioretention practices | High<br>High<br>Med<br>High |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Dupont Rd & Union Chapel Rd Corridors | Toxics, heat, sediment | Greatly increased road traffic; construction activities | Possible increase in neighborhood flooding during storm events | Enforce Rule 5 and Rule 13<br>Promote rain gardens and other bioretention practices on residential and commercial lots | High<br>High<br>High |
| 2 | Solomon Farm and other parkland and urban open space | Bacteria, nutrients | Nuisance geese | | Promote landscaping changes to deter geese; Promote goose reduction practices | Medium high. Some efforts already underway. |
| 2 | Parkerdale Neighborhood area | Bacteria, nutrients | Failing septic systems | Sediment from construction activities (temporary) | Protect area from sediment during construction<br>Continue water monitoring to verify reduction of bacteria | High<br>High |
| 2 | Ely Run – Bank erosion projects | Sediment | At least two areas identified needing bank restoration: Popp Nature preserve and M Eschlebach property | Martin Ditch and tribs also show stress | Design and implement technical practices to restore stream bank | Medium- high |
| 2 | SR1 (Dupont) & Tonkel Road Commercial Development | Sediment, thermal pollution | Construction activities, increased impervious surfaces | Loss of wetlands and area for storm water infiltration | Enforce Rule 5 and Rule 13<br>Protect existing wetlands<br>Increase permanent vegetation cover along downstream waterway to River | High<br>High<br>High |
| 3 | Cedarville Reservoir | Sediment, nutrients | Runoff from agricultural activities, construction; OSS and wildlife | Wetlands – critical protection areas | Increase conservation tillage upstream<br>Improve OSS management<br>Increase wetlands and biofiltration around reservoir<br>Begin no-P fertilizer program | High<br>High<br>Med<br>High |
| 3 | Nettlehorst Ditch | Bacteria | Failing septic systems | | Replace failing septic systems or provide sanitary sewer connection to area | Med |
| 3 | Swartz-Carnahan subwatershed | Nutrients, sediment | Highly erodible soils, livestock and manure; lawn and garden nutrients; failing OSS | Wetlands – critical protection areas | Increase conservation tillage and other ag BMPs<br>Improve OSS management<br>Increase comprehensive nutrient management | High<br>High<br>Med |
| 3 | Boger Ditch | Bacteria | BST project | Nutrients | Improve failing OSS | Med |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | indicated OSS, livestock, domestic pets and wildlife | | Increase comprehensive nutrient/manure management | High |
| 3 | Fisher Ditch | Bacteria | BST project indicated OSS, livestock, domestic pets and wildlife | Nutrients | Improve failing OSS<br>Increase comprehensive nutrient/manure management | Med<br>High |
| 3 | Walker-Metcalf Ditch | | | Wetlands – critical protection areas | Protect and increase wetland and bioretention areas along riparian corridor | Medium |
| 4 | Bear Creek-Hursey | Bacteria | Failing OSS based on SJRWI data – Site 128. 75% of samples exceed WQS | Nutrients | Reduce number of failed OSS<br>Educate homeowners about OSS maintenance<br>Improve livestock manure management | Medium<br>High<br><br>Medium-high |
| 4 | Bear Creek-Hursey Ditch | | | Wetlands- critical protection and restoration area | Protect and increase wetland and bioretention areas along riparian corridor; increase forest land | Medium |
| 5 | Davis Ditch | Sediment, pesticides, nutrients | Agricultural BMPs | Highly erodible land | Increase conservation tillage<br>Increase use of cover crops<br>Promote pesticide BMPs | High<br>Medium-high<br>Medium |
| 5 | Davis Ditch | Bacteria | Unsewered community at Orangeville | Nutrients | Educate homeowners about OSS maintenance<br><br>Remove failing OSS | High<br><br>Low- funding a huge barrier |

**Table 27 Critical area practices**

## Part 6: Goals and Decisions

A broad array of management solutions to the watershed problems outlined in Parts 4 and 5 were considered. These solutions arose from suggestions by the stakeholder groups in quarterly meetings, examination of what other watershed groups are doing, information gathered from municipal government, information gathered from local, federal and state agencies, and communication with the watershed's other various working partners regarding their ongoing projects. In the end, our objectives and action steps were selected based on both need and opportunity: Projects (objectives and action items) that both addressed important problems and could utilize a partner or matching services were given a higher ranking and priority. Also, projects that were particularly economical because they could be "adopted" from other watersheds' projects and/or easily replicated in several subwatershed communities, were given higher priority. This kind of project might include educational outreach programs, farmer-to-farmer meetings, tree planting workshops, and distribution of informational packets.  Suggestion solutions that were not currently cost-effective or that were lacking broad support may be re-examined as the watershed plan is updated.

In order to address the water quality problems, particularly in the critical areas listed in Chapter 5, the following broad goals and decisions have been formulated. These goals support our vision of making the Lower St. Joseph and Bear Creek subwatersheds fishable and swimmable by the year 2030, and that the river and its adjacent green space will be accessible to the general public for recreational and educational activities. Our goals include:

- To eventually reduce E. coli contamination by 95% in the watershed so that the River meets full body contact standard of 235 cfu/100 ml.
- To reduce total suspended solids (TSS) 63% by reducing erosion from agricultural operations, urban and suburban lawns and gardens, and construction sites based on a target load of 30 mg/L.
- To reduce Atrazine runoff by 50% in order to maintain Atrazine at <12 ppm in all tributaries and <3 ppm at the Fort Wayne water intake (St. Joseph River Dam), and to effect similar reductions for other common pesticides.

- To reduce phosphorus by 2.6% so that phosphorus levels do not exceed WQ target of 0.3 mg/L, thus reducing algae blooms and preventing eutrophication in the reservoirs, lakes, streams and river.
- To increase the natural land cover in the riparian buffer zone by 10% in order to improve water quality and habitat, thereby improving aesthetics and access to the stream, increasing wildlife and aquatic diversity, and reducing the impact of stream velocity and seasonal flooding.

To reach our goals, we needed to determine what the current pollutant loading is in the watershed, and to determine what kinds of remedial actions can reduce those loads. Calculations of pollutant loads and reductions can be found in Chapter 7.

6.1 Goal 1: To eventually reduce E. coli contamination by 95% in the watershed so that the River meets full body contact standard of 235 cfu/100 ml.

Indicator for this goal: water quality monitoring for E. coli

| Objectives | Milestones | Action Steps | Champion |
|---|---|---|---|
| 6.1.1. Increase the public awareness of problems of bacterial contamination of the river | Number of brochures, PSAs, videos, and other outreach efforts produced to educate about proper septic system placement and maintenance | Make water quality information accessible to stakeholders via the Internet<br><br>Mount a public outreach campaign to educate homeowners, developers and public officials about proper placement and maintenance of their septic systems and alternatives to onsite septic systems | SJRWI, City of FW, county Health Departments, Allen Co. Regional Sewer Task Force, IDEM, Cities/towns along the River. |
| 6.1.2 Replace and or remove failing septic systems from the watershed | Number of failed onsite septic systems replaced, repaired or moved to central sewage treatment | Secure funding for cost-share to help replace failing septic systems and/or to connect homes to central sewage systems<br><br>Evaluate use of native plant installation on septic system distribution fields and if useful, promote adoption | SJRWI, City of FW, Health Departments, Allen Co. Regional Sewer Task Force, Cities/towns along the River. |
| 6.1.3. Reduce the number and/or impact of the Combined Sewer Overflows (CSO) | Number of CSOs removed or loads reduced from the St. Joseph River | Partner with municipalities to educate stakeholders about the impact of CSOs and other overflows and secure their removal or reduce their impact on the river. | City of Fort Wayne, FW AC Health Dept., SJRWI. EPA, IDEM |
| 6.1.4 Insure pet waste and equine, poultry and livestock waste is handled properly to prevent contamination of the river and its tributaries | CNMP plans created<br><br>Number of producers adopting rotational grazing practices and fencing livestock from streams | Educate stakeholders about the impact of livestock, pet, and other domestic animal wastes on water quality<br><br>Promote neighborhood efforts to clean up after pets<br><br>Promote rotational grazing and CNMPs for confined animal operations<br><br>Obtain funding to cost-share BMPs for waste handling and nutrient management plans for livestock operations | SJRWI, ACPWQ, SWCD, NRCS, Urban neighborhood associations. |
| 6.1.5 Reduce populations and the contamination impact of nuisance wildlife in the watershed | Number of landowners adopting alternative landscaping practices<br><br>Number of educational events held and number of participants in each. | Support efforts by DNR and others to control nuisance wildlife, i.e. geese<br><br>Obtain funding to support efforts to encourage landscaping to deter nuisance geese | SJRWI, DNR, municipal government and urban/suburban neighborhood associations |

6.2 Goal 2: To reduce total suspended solids (TSS) 63% by reducing erosion from agricultural operations, urban and suburban lawns and gardens, and construction sites based on a target load of 30 mg/L.
Indicator for this goal: water quality monitoring for TSS

| Objectives | Milestones | Action Steps | Champion |
|---|---|---|---|
| 6.2.1. Increase use of low impact development in the watershed | Land use mapping of type and extent of developed areas<br><br>Adoption of low impact planning zoning ordinances | Support low impact development through educational forums and demonstration sites | SJRWI, Municipal gov't planning departments, Purdue University, private foundations/sources |
| 6.2.2. Improve the diversity and viability of native species in the watershed | Land-use mapping of natural vegetation<br><br>Number of planting workshops/ educational events and number of participants | Educate landowners about natural plant and animal species and their relationship with the watershed and water quality. | SJRWI, IDNR, USFWS, NRCS, SWCD, other environmental organizations such as TNC, PF and DU; and local colleges and universities. |
| 6.2.3. Improve compliance with storm water rules and erosion controls in the watershed | Percentage of construction sites compliant with Rule 5 and Rule 13 | Educate the public and municipal officials about the negative effects of sediment and erosion on water quality and encourage compliance with erosion control requirements | SJRWI, IDEM, Municipal government including County Surveyor, SWCD, ACPWQ. |
| 6.2.4. Increase the adoption of conservation tillage methods, perennial crops and cover crops | Number of acres in cover crops<br><br>Number of acres in conservation tillage | Publicize the results of tillage transects<br><br>Secure funding for cost-share of appropriate BMPs aimed at sediment reduction, such as conservation tillage, cover crops, and other related erosion controls | NRCS, SWCD, SJRWI, USFWS |
| 6.2.5. Increase buffers by 75% along the river and open bodies of water | Number of acres of buffers and grassed waterways installed | Secure funding for cost-share of appropriate BMPs aimed at sediment reduction, such as installation of buffers, grassed waterways, reforestation, and other related erosion controls | NRCS, SWCD, SJRWI, USFWS, PF and DU |
| 6.2.6. Increase wetlands and other bioinfiltration areas throughout the watershed | Number of acres of wetlands installed or restored<br><br>Number/acres of rain gardens and bioswales installed | Support installation of rain gardens and bioswales through education, demonstration sites, and cost-sharing.<br><br>Secure funding for cost-share of appropriate BMPs aimed at sediment reduction, rain gardens, vegetated swales and related erosion controls | NRCS, SWCD, SJRWI, USFWS, City of Fort Wayne, County SWCDs, PF and DU |

6.3 Goal 3: To reduce Atrazine runoff by 50% in order to maintain Atrazine at <12 ppm in all tributaries and <3 ppm at the Fort Wayne water intake (St. Joseph River Dam), and to effect similar reductions for other common pesticides.
Indicator for this goal: Water quality monitoring for atrazine.

| Objectives | Milestones | Action Steps | Champion |
|---|---|---|---|
| 6.3.1. Reduce pesticide contamination from agricultural areas of the watershed | Reduce pesticide usage in agricultural areas<br><br>Number of buffers and filters installed along water courses, tile inlets and drainage areas | Educate stakeholders about the impact and danger of pesticides on water quality of the river.<br><br>Obtain cost share for pesticide management planning<br><br>Educate/demonstrate the proper application, handling and disposal of pesticides | SJRWI, NRCS, SWCD |
| 6.3.2. Increase buffering capability of flood plains and riparian corridors | Land use mapping: Increased natural vegetation along stream corridors and flood zone | Obtain funding for cost-sharing agricultural BMPs, such as variable rate sprayers, filtered drainage and tile risers, wider field and stream buffers, and GPS-guidance to reduce contamination by pesticides | SWCD, NRCS, SJRWI, USFWS, TNC, Purdue University CES |
| 6.3.3. Reduce pesticide contamination from storage areas, container disposal and equipment rinsing | Number of educational events and participants | Obtain funding to support continued monitoring of water quality, biological diversity and habitat by professionals and volunteers<br><br>Support agricultural pesticide handling licensing and certification | SJRWI, Hoosier Riverwatch, TNC, Local government, Purdue University, certified crop consultants, State Chemist Office |
| 5.3.4. Reduce the amount of pesticides applied to urban lawns, parks and recreational areas | Number of homeowners, parks, golf courses pledging to reduce/adjust pesticide applications on their land | Educate urban and rural landowners, lake and neighborhood associations, and lawn care companies about the proper use of more environmentally friendly pesticides<br><br>Create “pledge” for lawn care companies to encourage proper notification to homeowners, proper type, amount, application and storage of pesticides; and publicize list of companies which take the pledge for cleaner water. | SJRWI, SWCD, Purdue CES, ACPWQ, Neighborhood Association groups, local lawn care retailers |

6.4 Goal 4: To reduce phosphorus entering the river by 2.6% so that phosphorus levels do not exceed WQ target of 0.3 mg/L in order to reduce algae blooms and prevent eutrophication in the reservoirs, lakes, streams and river.
Indicator for this goal: Water quality monitoring for phosphorus

| Objectives | MIlestones | Action Items | Champion |
|---|---|---|---|
| 6.4.1. Reduce the number and intensity of algal blooms in the Cedarville and St. Joseph Reservoirs | Number and extent of algal blooms | Educate farmers, homeowners and lawn contractors about the impact of nutrient runoff on water quality and aquatic organisms<br><br>Encourage homeowners and restaurants to us non-phosphate detergents for their dishwashers<br><br>Obtain funding for cost share program to promote use of no-P fertilizers on lawns and gardens surrounding the lakes and river. | SJRWI, SWCD, ACPWQ, IDNR, USFWS, DU, City of FW, Hoosier Riverwatch. Private retailers. |
| 6.4.2. Increase the buffering capability of the flood plain and the river/stream corridors | Increase acres of riparian buffers and wetlands | Obtain funding to continue WQ, biological and habitat monitoring<br><br>Obtain funding to cost-share BMPs to reduce nutrient load such as planting cover crops, wetland installation/restoration, buffers and filter strips, fencing. | SJRWI, NRCS, SWCD, IDNR, USFWS, DU, PF, City of FW. |
| 6.4.3. Decrease the number of failing septic systems in the watershed | Number of systems replaced, repaired or moved to central sewage. | Educate rural homeowners about septic system installation, maintenance and failure; obtain cost share money to help support removal of failing septic systems. | SJRWI, County health departments, City of FW, Allen Co. Regional Sewer District |
| 6.4.4. Decrease the amount of nutrients entering the stream from agricultural and urban land | Number of CNMPs developed and implemented<br><br>Number of homeowners, lawn care companies, parks, golf courses pledging to reduce/adjust fertilizer applications on their land | Promote rotational grazing and use of CNMPs for confined animal operations<br><br>Obtain cost-share money and encourage adoption of new technology for nutrient stabilization for agricultural crops and urban turf areas.<br><br>Create “pledge” and cost-share program for lake and riverside property owners to use zero-P fertilizers.<br><br>Create “pledge” for lawn care companies to encourage proper notification to homeowners, proper type, amount, application and storage of fertilizers; and publicize list of companies which take the pledge for cleaner water. | SWCD, NRCS, Purdue University CES, SJRWI, Municipal and county government departments, City of FW Water Utilities, lake and neighborhood associations |

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| 6.4.5. Decrease the impact of nuisance geese in the watershed | Number of parks, homeowners and commercial landowners which adopt landscaping practices to reduce nuisance geese. | Obtain cost-share support for and demonstrate environmentally friendly landscaping that deters nuisance geese | SJRWI, IDNR, SWCD, NRCS, local government parks and recreation departments |

6.5 Goal 5: To increase the natural land cover in the riparian buffer zone by 10% in order to improve water quality and habitat, thereby increasing wildlife and aquatic diversity, improving aesthetics and access to the stream, and reducing the impact of stream velocity and seasonal flooding.

Indicator for this goal: miles of contiguous forested areas along the river/stream corridors.

| Objectives | Milestones | Action Items through 2010 | Champion |
|---|---|---|---|
| 6.5.1. Reduce the acreage of row crops in 30-meter riparian buffer zone. | Land use mapping; number of row crop acres of riparian land use changed to permanent vegetation | Create land use maps and target areas for reduction of cropping;<br><br>Increase adoption of conservation tillage in acres where cropping persists by partnering with other agencies to promote BMPs;<br><br>Obtain funding to cost-share appropriate BMPs | NRCS, SWCDs, SJRWI, FWS, IDEM, landowners. |
| 6.5.2. Increase net wetland and natural vegetation area, particularly within the 30-meter riparian buffer zone | Land use mapping: Number of acres of natural vegetation, including trees, planted in the buffer zone.<br><br>Number of contiguous acres of woodland connected in each HUC-14 watershed<br><br>Lack of invasive species in streams and riparian areas | Map wetlands and woodlands; target areas that connect fragmented forest, target wetland restoration areas, particularly along river corridor where habitat is imperiled.<br><br>Obtain funding to cost-share appropriate BMPs such as reforestation, wetland restoration, bank stabilization in the river and its corridors<br><br>Educate landowners and river users about the value of floodplains, wetlands and contiguous wildlife corridors and the impact of human activity such as farming and construction on the floodplains.<br><br>Work with drainage boards and surveyors to improve methods used for maintenance of legal drains<br><br>Support municipal and other community efforts to improve greenways with natural vegetation along the river and its tributaries | SJRWI, NRCS, SWCD, IDNR; City of Fort Wayne; The Nature Conservancy; canoe, boating and fishing groups; USFWS, neighborhood or lake associations, county parks, Izaak Walton League, Ducks Unlimited and Pheasants Forever. |
| 6.5.3. Reduce inorganic and toxic pollution from litter and dumping activities along river | Lack of visible erosion, trash, and other negative WQ indicators.<br><br>Number of outreach events | Sponsor/support and encourage river and stream clean-up activities, including eradication of invasive species and planting of native species<br><br>Install educational signage that promotes proper | SJRWI, City and County government, IDEM, IDNR; canoe, boating and fishing groups; neighborhood or lake associations, city and county |

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| and stream banks, greenways and access points to the river | and press releases<br><br>Number of stream or access point clean-ups and restoration events; number of stakeholders participating in each event | environmental behavior and activity at river trails and access points.<br><br>Promote education through feature articles and press coverage of stream clean-up activities.<br><br>Obtain funding to cost-share appropriate BMPs such as bank stabilization and natural plantings along the stream banks and at public access sites, to reduce the impact of erosion due to land/water traffic; | parks |
| 6.5.4. Support watershed improvement projects located adjacent to or near the river and tributaries that are designed to improve water quality and support conservation of local water resources | Number of BMPs or environmentally -friendly improvements to riverside properties | Communicate with municipal planning officials to insure that riverside projects will improve and not negatively impact water quality<br><br>Work with drainage boards and surveyors to improve methods used for maintenance of legal drains | SJRWI, SWCD, NRCS, IDNR, IDEM; City of Fort Wayne, City of Leo-Cedarville; Town of Grabill; Counties of Allen and DeKalb; FW Downtown Improvement District |
| 6.5.5. Increase public knowledge about land use and its effect on water quality | Biological monitoring: improvements in QHEI / CQHEI scores<br><br>Number of volunteers participating in water quality training and monitoring<br><br>Number of people attending workshops and other educational events | Obtain funding to continue to monitor improvement in water quality, biological diversity and habitat<br><br>Support corps of volunteers to help educate, monitor water quality, and "patrol" river and tributaries for water quality problems. | SJRWI, SWCD, NRCS, IDEM, IDNR, Hoosier Riverwatch; canoe, boating and fishing organizations, City water utilities; City and county parks naturalists, other environmental organizations including Ducks Unlimited, Izaak Walton League. |


(Photo by K. Thompson, SJRWI)

## Part 7: Pollutant Loads and Reductions

7.1 Discharge Data
Discharge data for the St. Joseph River was acquired from the USGS website for the gauging station on the lower reaches of the St. Joseph River at Fort Wayne located at the Tennessee Avenue Bridge. The flow data was selected for dates that correspond to sampling dates.

7.2 Pollutant Load Calculations

Current pollutant loads and reduction targets for E. coli, phosphorus and TSS were calculated from years 2005 and 2006 using a pollutant load and reduction calculation tool provided by IDEM and water quality data supplied by the City of Fort Wayne water pollution control plant for the Tennessee Bridge location.

Loads and reduction targets for Nitrogen were not calculated because the water quality data available is for ammonia NH3-N, and the available tools used for N calculation use nitrite/nitrate. Ammonia toxicity varies based on pH and water temperature. Our water quality data indicated that ammonia levels were consistently below the target 1.0 for this pollutant.

Water quality data for pesticides, particularly the indicator chemical Atrazine, is available for most of the main tributaries of the St. Joseph, including Bear Creek and Ely Run. A significant historical record is available from the SJRWI water quality monitoring program. Generally, our data indicates that exceedences of the drinking water standard (3 ppm) for Atrazine have occurred infrequently, and these occurred mainly during the spring season during heavy precipitation events. However, since USGS flow data is not available for the tributaries and efforts to secure estimated flow for the sampling locations were unsuccessful, we were not able to calculate pollutant loads for these sampling sites.

### 7.2.1 E. coli Loads and Targets

Load calculations for E. coli were performed using data acquired from the City of Fort Wayne Pollution Control Plant during 2005 and 2006 (See Appendix I) and discharge data (cfs/s) provided by the USGS for corresponding sampling dates. The load calculator used was provided by IDEM. Results of the calculations for each year were sorted by flow regimes.

Results indicated that loading above and below the water quality standard (WQS) of 235 colony forming units (cfu) were distributed during both high and low flow regimes, indicating that a variety of sources are responsible for the loads. Results of the calculations are shown in Appendix G of this document, and show a target load reduction of 95% in 2005 and 92% in 2006. A target load reduction of 95% is being adopted for this plan.

Reduction of E. coli to the targeted goal will be difficult and will take a substantial amount of time. Reductions will be made through improvements in CSO removal from the St. Joseph River and its tributaries; through the removal of failing septic systems in the watershed; through improved manure management for agricultural operations and pet waste control in urban neighborhoods, and through reduction of the number of nuisance geese in the watershed. Currently there is no cost-share program to help homeowners defray the cost of connecting to central sewage, and in some areas, no ordinance requiring that they must connect if the sewer is available. There is also a lack of funding for repair/replacement of failed septic systems.

### 7.2.2 Total Suspended Solids (TSS)

Load calculations for Total Suspended Solids (TSS) were performed using data acquired from the City of Fort Wayne Pollution Control Plant during 2005 and 2006 (See Appendix G) and discharge data (cfs/s) provided by the USGS for corresponding sampling dates. The load calculator used was provided by IDEM. Results of the calculations for each year were sorted by flow.

The target adopted for TSS for this plan is 30 mg/L (equal to 30 parts per million (ppm)) based on required levels for Total Maximum Daily Load (TMDL) plans. Results of the calculations indicated that TSS loading was more of a problem in 2006 than it was in 2005. During 2005, only two samples exceeded the targeted load and both were at higher flow (discharge) levels. Maximum reduction indicated to meet the target during 2005 was 58%.

During 2006, a substantially higher number of samples exceeded the target loading level, and although they occurred across both low and high flow dates, the majority of overloads occurred in high flow regimes. The maximum targeted reduction for 2006 was 63.2%, which is adopted for the targeted reduction for this plan.

This magnitude of reduction will be difficult to reach and may take many years. Reductions will be realized through enforcement of pre and post-construction erosion control practices in the construction and development zones, through increases in agricultural BMPS, including conservation tillage, use of cover crops, and replacement of row crops with perennial vegetation in the 30-meter stream buffer zones using USDA Farm programs such as Continuous CRP, EQIP, CREP and others, and cost-share plans financed through Section 319 grants, LARE, USFWS, and private funding sources. We will also work with county drainage boards to improve installation of stream side buffers following stream dredging operations.

Since TSS can also be caused by algae, reduction of nutrients will also affect the TSS loads. Practices utilized to reduce E. coli, phosphorus and nitrogen will also support reductions in TSS.

### 7.2.3 Phosphorus

Load calculations for Phosphorus were performed using total phosphorus (P) data acquired from the City of Fort Wayne Pollution Control Plant during 2005 and 2006 (See Appendix I) and discharge data (cfs/s) provided by the USGS for corresponding sampling dates. The load calculator used was provided by IDEM. Results of the calculations for each year were sorted by flow.

A target of 0.3 mg/L (ppm) was adopted for this plan based on studies done for the neighboring Cedar Creek watershed. Calculations indicated that in 2005, the load did not exceed the 0.3 ppm target; ranging from 16% to hundreds of percentage points below the target. However, in 2006, phosphorus levels exceeded the target load three times. Two of these times are considered outliers, with exceedences at 66.7% and 51.6%. A third sample, at 2.59% is considered more in line with the general data for the watershed and is being used as out target reduction. All the positive load reduction percentages for 2006 occurred during low to mid-level flows.

The target load reduction for this plan for phosphorus (P) is 2.6%. This reduction will be realized through reduction/removal of failed septic systems, by increased use of non-phosphorus fertilizers, and by changing land use within the 30-meter stream buffer zones from row crop to perennial vegetation, including trees and wetlands.

### 7.2.4 Atrazine and related pesticides

Loads and targets for Atrazine were calculated from 2007 sampling data supplied by the Fort Wayne pollution control plant from the Indiana State Department of Health Chemistry Laboratory for just three dates in 2007: April 17, June 19, and August 21. Results of these calculations are located in Appendix H and show that no reduction is required to meet the target.

According to our research conducted late in the production of this plan, the Fort Wayne Water Filtration Plant has Atrizine data which is collected at the St. Joe Dam water intake upstream of the Tennessee Avenue Bridge. That data was not available in electronic form in time for inclusion in this plan; however, it is expected to be available in electronic format in early 2008. The data will be assessed (and this plan will be updated) at that time.

Based on data collected by the SJRWI from the tributaries including Bear Creek, Metcalf Ditch, Tiernan Ditch and Ely Run, these load and reduction figures do not reflect a complete picture for pesticide pollution in the watershed. First, the data from the City was delayed and the dataset available to us is very limited. Although it may capture the pollutant from residential and commercial lawns, urban parks and recreational areas, the Tennessee Bridge is a substantial distance downstream from any agricultural land use. The values likely are a more accurately reflection of drinking water treatment requirements than the impact of pesticides on aquatic and stream habitat in the upper reaches of the watershed.

Analysis of the water quality monitoring data collected by the SJRWI and reported in the 2005 Annual Water Quality Report for the St. Joseph River Watershed suggests that Atrazine continues to be a pollutant of concern in most subwatersheds, particularly during the spring months when application of the chemical and rain is plentiful. The 2006 and 2007 water quality reports have not been released to date, but based on the reported increase in the number of acres planted to corn, we would not expect Atrazine loads to be reduced. The area received below-normal levels of precipitation in the late spring and early summer months of 2007, which would influence both runoff and in-stream concentration of this water-soluble pollutant.

As an interim target, the plan has adopted a 50% reduction goal for the watershed. It is expected that this can be accomplished primarily through placement of agricultural BMPs, continued reduction in rates of use by farmers based on continuing education of the impact of pesticides, and changes in land use in the 30-meter stream buffer zones from row crops to perennial vegetation.

## 7.3 Achieving Reduction Goals

Reduction of pollutants will be achieved through a multitude of best management practices. Many of these BMPs will have an effect on several pollutants. Following are some of the reduction results that could be expected by implementation of BMPs in the watershed.

### 7.3.1 Removal of failing septic systems

Based on reports from local health departments in Allen County alone, the number of permitted systems in these two watersheds is estimated at 1,825. An equal number of unpermitted systems (those installed prior to record-keeping) is estimated to exist in the watershed. These are generally considered to be failing systems. Based on work done for watershed planning and TMDLs in this region, population served by these systems average 2.5 persons per household, with loads estimated to be 12 grams of nitrogen per day per person and 2.5 grams of total phosphorus per day per person (Haith, et al., 1992, received by communication from A. Brown, IDEM, 2007)

Based on these estimates, removing or repairing half of the failed systems would result in removal of pollutants from 2,281 people, equating to 2,081,641 g of P per year (4,589.2 lb/ year), and 9,991,875 g of N per year (22,028.1 lb/year). This is far more than the total reduction needed based on load calculations. However, the probability of removing 50% of the failing systems in the next 20 years is very low, given the very high cost of replacement, low interest on the part of landowners, and almost non-existent funding support for this type of project.

### 7.3.2 Agricultural BMPs in 14-digit HUCs

**Land use changes in the flood plain:**
Using the 2001 Land use map acres outlined in Chapter 3 (see page 52), generalized soils information, and crop sequencing information provided by USDA, the following table was created with results from an erosion and nutrient reduction spreadsheet calculator provided by IDEM and the Region V Pollutant Load Reduction Model. The table shows reductions that could occur if we were able to convert 50% of the land in the flood plain from row crops to permanent vegetation.

Calculations used C-factor change of 0.34 (corn after soybeans, fall mulch till <10% cover) to 0.02 (first-year meadow with 50% cover) for 187 acres in the Lower St. Joseph and 885 acres in the Bear Creek subwatersheds.

| Watershed | Acres treated | Sediment Reduction tons/yr | Sediment Reduction tons/da | Phosphorus Reduction lbs/yr | Phosphorus Reduction lbs/da | Nitrogen Reduction lbs/yr | Nitrogen Reduction lbs/da |
|---|---|---|---|---|---|---|---|
| Lower St. Joseph | 187 | 296 | 0.81 | 385 | 1.05 | 769 | 2.11 |
| Bear Creek | 885 | 10383 | 28.45 | 9542 | 26.14 | 19093 | 52.31 |
| **Total** | **1072** | **10679** | **29.26** | **9927** | **27.20** | **19862** | **54.42** |
| **Total reduction needed** | | | **389.00** | | **1162** | | N/A |
| **% reduction realized** | | | **7.5%** | | **2.3%** | | N/A |

**Table 28 Reduction of pollutants based on reducing acreage of crops planted in riparian buffer zones**

**Improving use of Conservation Tillage:**
Using the 2001 Land use map acres and generalized soils information for each 14-digit HUC (see Appendix M), the following table was created using an erosion and nutrient reduction calculator provided by IDEM and the Region V Pollutant Load Reduction Model. The table shows reductions that could occur if 100% no-till for corn could be accomplished in the watersheds. Based on 2006 transects, Allen County currently has 53% conventional tillage and DeKalb has 34% conventional tillage.

Calculations used C-factor change of 0.36 (corn after soybeans, conventional fall tillage) to 0.05 (no-till, 50% cover after planting) for 75% of the corn currently conventionally tilled in each of the subwatershed, based on current transect data for Allen and DeKalb counties.

| Subwatershed | Acreage: (75% of acres currently conventionally tilled) | Sediment Reduction tons/yr | Sediment Reduction tons/da | Phosphorus Reduction lbs/yr | Phosphorus Reduction lbs/da | Nitrogen Reduction lbs/yr | Nitrogen Reduction lbs/da |
|---|---|---|---|---|---|---|---|
| Beckett's Run | 475 | 716 | 1.96 | 944.00 | 2.59 | 1886.00 | 5.17 |
| Tiernan | 1467 | 1920 | 5.26 | 2604.00 | 7.13 | 5203.00 | 14.25 |
| Ely Run | 1717 | 2204 | 6.04 | 3000.00 | 8.22 | 5995.00 | 16.42 |
| Cedarville Res | 2459 | 3018 | 8.27 | 4145.00 | 11.36 | 8282.00 | 22.69 |
| Swartz-Carnahan | 1895 | 19582 | 53.65 | 17554.00 | 48.09 | 35126.00 | 96.24 |
| Walker-Metcalf | 2552 | 25408 | 69.61 | 22947.00 | 62.87 | 45916.00 | 125.80 |
| Bear-Hursey | 3311 | 31909 | 87.42 | 29007.00 | 79.47 | 58041.00 | 159.02 |
| St. Jos-Davis | 1085 | 12021 | 32.93 | 10627.00 | 29.12 | 21266.00 | 58.26 |
| **Total** | **14960** | **96778** | **265** | **90828** | **249** | **181715** | **498** |
| **Total reduction needed** | | | **389** | | **1162** | | N/A |
| **% reduction realized** | | | **68%** | | **21%** | | N/A |

**Table 29 Reduction of pollutants based on improving adoption of conservation tillage**

**Cover Crops:**
Another agricultural BMP that will help with reduction of pollutants in the watershed is the use of cover crops. Cover crops are plants grown during the off season when cash crops are not being produced. Cover crops can hold soil in place and when prudently selected, improve soil tilth, and reduce the amount of fertilizer and pesticides used on cash crops.

The predominant rotation of crops in the watershed is a corn-soybean rotation, with a smaller amount of producers adding wheat to the rotation. Conservation tillage for soybeans is high in the watershed; however, soybean stubble is light and deteriorates over the winter season. Adding a cover crop to the soybean rotation can reduce pollution from sediment, phosphorus and nitrogen.  Calculations of pollutant reductions that are outlined in the following table were based on adding cover crops to 75% of the soybeans, which account for approximately 50% of the row crops in each subwatershed. We used a C factor of .15 (corn following soybeans with 20% residue) improving to a C factor of .03 (corn following soybeans with 80% residue) with the addition of a cover crop.

| Subwatershed | Sow cover crop on 75% of Soybean acres | Sediment tons/yr | Sediment tons/da | Phosphorus lbs/yr | Phosphorus lbs/da | Nitrogen lbs/yr | Nitrogen lbs/da |
|---|---|---|---|---|---|---|---|
| Beckett's Run | 467 | 273 | 0.75 | 421.00 | 1.15 | 841.00 | 2.30 |
| Tiernan | 1437 | 730 | 2.00 | 1157.00 | 3.17 | 2312.00 | 6.33 |
| Ely Run | 1688 | 840 | 2.30 | 1338.00 | 3.67 | 2672.00 | 7.32 |
| Cedarville Res | 2441 | 1161 | 3.18 | 1865.00 | 5.11 | 3724.00 | 10.20 |
| Swartz-Carnahan | 2908 | 11026 | 30.21 | 11688.00 | 32.02 | 23374.00 | 64.04 |
| Walker-Metcalf | 3928 | 14344 | 39.30 | 15320.00 | 41.97 | 30636.00 | 83.93 |
| Bear-Hursey | 5070 | 17933 | 49.13 | 19276.00 | 52.81 | 38546.00 | 105.61 |
| St. Jos-Davis | 1639 | 6676 | 18.29 | 6976.00 | 19.11 | 13952.00 | 38.22 |
| **Total** | **19579** | **52983** | **145** | **58041** | **159** | **116057** | **318** |
| **Total reduction needed** | | | **389** | | **1162** | | N/A |
| **% reduction realized** | | | **37%** | | **14%** | | N/A |

**Table 30  Reduction of pollutants based on use of cover crops**

### 7.3.3 Urban BMPs

**Construction BMP enforcement**

The population in the townships that comprise the Lower St. Joseph and Bear Creek subwatersheds increased 7.62% from 2000 to 2005 ( V. Richardson, 2006). Using that percentage of increase and applying it to housing units, the 55,768 units counted in these townships in the year 2,000 would have increased to 60,037 in 2005 and would be expected to increase by 4,575 new units by year 2010. In the Midwest, it is estimated that one acre of land under construction contributes almost 30 tons of sediment to nearby lakes, rivers and streams (http://www.in.gov/idem/stormwater/index.html) (2007, p. 8) Using the 30-ton estimate, those 4,575 new houses build over five years (915 per year) each on a half-acre lot, would contribute 13,725 tons of sediment per year. Proper implementation and enforcement of construction and post-construction storm water BMPs will thus prevent an estimated 13,725 tons of sediment from entering the river over the first five years of implementation.

**Rain Gardens**

A study in Madison, Wisconsin, showed that lawns and streets are the largest contributors of suspended solids, total phosphorus and dissolved phosphorus in their urban residential lake basin. (Waschbusch, 2000) In urban Fort Wayne, including particularly the Schoppman Drain, Beckett's Run and Tiernan Ditch, lawn and street runoff is likely the greatest source of several types of pollutants based on the percentage of development in these subwatersheds. This pollution can be reduced through BMPs such as increased street sweeping, pet waste management, and reduction in the use of lawn care chemicals.

Studies at the University of Maryland have shown that rain gardens are also very effective in removing pollutants from storm water runoff. Average pollution reduction at a depth of 3 feet under a variety of flow rates and pollutant concentrations include the following. (Cofferman, 2000)

| Pb | Zn | P | TKN | NH4 | NO3 | TN |
|---|---|---|---|---|---|---|
| 99% | 99% | 81% | 68% | 79% | 23% | 43% |

As part of its long term control agreement, the City of Fort Wayne's storm water utility has agreed to help fund 1,000 rain gardens in the city. The goal of the project is to help improve the quality and quantity of storm water runoff from urban residential and commercial lots. (The Jorunal Gazette 03/02/08) Assuming that one-third of these will be installed in the St. Joseph River watershed, and that the average rain garden will treat 600 square feet of surface (rooftop), a total of 4.601 acres would be treated by this type of water infiltration system. Using an urban pollutant load reduction worksheet provided by IDEM, treatment of a total of 4.60 acres would result in reduction of

- 1,422 lb/yr of total suspended solids (TSS)
- 2,006 lb/year of total dissolved solids (TDS)
- 15 lb/yr of Total Kjendahl Nitrogen (TKN)
- 4 lb/yr of total phosphorus (P).

Hoosier Riverwatch photo

## Part 8: Implementation

8.1 Timeline for Implementation

Based on water quality monitoring results and tracking of conservation practices over many years, we know that the changes in land use and social behavior that result in water quality improvement take many years to implement and many more years to register positive changes. The slow rate of positive change should also be considered as an absence of negative change: What problems would watershed communities be facing had they not made efforts to improve watersheds and water quality.

Changes indicated in this plan may be accomplished in 10 to 25 years, depending upon the practices. Removing failing septic systems may take considerably longer than removing or controlling nuisance geese (cheaper) or decommissioning the CSOs (required by EPA). The rate of success in reducing erosion from agricultural land may depend upon commodity prices for corn and soybeans and the amount of funding available from federal farm programs.

At this point in time, however, there is a significant amount of momentum in the St. Joseph River watershed moving toward conservation practices and it continues to build. There are many partnerships and they are actively working. This is an important factor in increasing the rate of improvement in this watershed. We would expect that the first 25 percent of reduction for all targets could be accomplished in the first 5 to 10 years if funding is available. The remaining 75 percent will take increasingly more time and money as the marginal cost rises.

Since outreach education and BMP installation are ongoing throughout the larger St. Joseph River watershed, implementation of this plan has already begun on a limited basis. Programs currently available in this watershed include an SJRWI cost-share program for conservation tillage (available through ARN A305-6-108 through March, 2009), and a cost-share program for reforestation and wetlands offered through the St. Joseph River Watershed Initiative with grant support from the USFWS Private Stewardship Grants Program to support wildlife and habitat diversity (available through December, 2008). Additionally, the SJRWI is committed to outreach education through its mission to improve the quality of the St. Joseph River and continues to disseminate watershed information to community groups and organizations.

Additional work is being done to implement the plan's educational and information goals through the outreach efforts of the Allen County Partnership for Water Quality (ACPWQ) which is a partnership created by Fort Wayne, Allen County and New Haven to implement the storm water requirements of Rule 13.

## 8.2 Funding

Based on the cost of similar projects in the St. Joseph River Watershed, the cost of implementing this watershed management plan over the next 15 to 20 years is expected to be substantial. Much of the cost burden will be shared by partners and their existing conservation programs, particularly those funded under the USDA farm and conservation programs. However, education, cost sharing, technical assistance and incentives will be needed to entice landowners to give up agricultural production in floodway zones. There are 2,145 acres of cultivated crops in the flood zone. Cash incentive costs to add BMPs and/or take this land out of production could range from $100,000 to one million dollars, not including technical assistance or funding under farm bill programs.

Urban BMPs will need to be applied to at least 900 developed acres in the flood zone. Much of this will be absorbed by landowners, but the cities and towns will also have to lend considerable support for this effort. Outreach education and technical assistance will be necessary, along with cost share incentives, which might be estimated at $400 to $1,000 per acre. Within the urban areas, a significantly greater amount of land will need to be improved with urban BMPs. Wages and benefits for educational outreach staff are estimated at $75,000 per year per employee.

A significant amount of the funding to reduce E. coli in the watershed will come from homeowners in the form of rate increases that will pay for removal of CSO and connection to central sewer within the City of Fort Wayne. Regional sewer districts will also fund a significant portion of connection to sewer and removal of septic systems; the regional districts are significantly funded by landowners themselves. The removal, maintenance and repair of 300 to 500 failing septic systems at an average cost of $8,000 will cost two to four million dollars. Creation of sewer infrastructure and hook up to central sewage will be significantly more expensive. The City of Fort Wayne is facing costs of nearly $250 million over 20 years to clean up storm water, including the storm water-induced combined sewer overflow (CSO) problem. Outreach education efforts and program administration will increase the annual cost to any bacteria-reduction project.

The SJRWI expects to apply to IDEM for Section 319 funding during the 2008 grant funding cycle to work on Phase I of the implementation of this grant, focusing on the first 25% of the targeted goals during the first five years of implementation. That implementation would begin in 2009. It is possible that the SJRWI will lead this effort, with cooperation and support from many partners within the St. Joseph River watershed. In addition to funding to support BMP installation, it will require at least one full-time staff person to lead the implementation effort for a minimum of two to three years.

## 8.3 Technical Assistance

Technical assistance and stakeholder support required for implementation may be requested from some or all of the following agencies, institutions, organizations and persons:

- Soil and Water Conservation Districts of Allen and DeKalb counties
- NRCS of Allen and DeKalb counties
- City of Fort Wayne, water utilities department
- Health departments of Allen and DeKalb counties
- Surveyors of Allen and DeKalb counties
- The Nature Conservancy with its funding from the Joyce Foundation
- US Fish and Wildlife Service
- Western Lake Erie Basin Project
- Pheasants Forever
- Ducks Unlimited

- Allen County Parks Department
- Fort Wayne Parks Department
- Indiana University-Purdue University Fort Wayne
- North Anthony Corridor Improvement Association
- Downtown Improvement District
- Northside Neighborhood Association
- Dan Wire
- Allen County Regional Sewer District
- PBS- WFWA
- Northeast Indiana Greenbuild Coalition
- Young Leaders of Northeast Indiana (YLNI)

## 8.4 Milestones and Measurements

At least 25% of the targeted reduction goals should be targeted for improvement in the first five years of the approval of this watershed management plan and the start of implementation. Since the easiest changes are expected to be made first, the remaining 75% of the targeted reduction goals are expected to take an additional 10 to 20 years to accomplish.

Water quality monitoring by the City of Fort Wayne at its Mayhew Road and Tennessee Street locations is expected to continue. Additionally, since the SJRWI is committed to continuing its work in the watershed, we expect that our weekly water quality sampling program will continue in this watershed and will help us to monitor progress throughout the implementation phase.

The SJRWI is currently implementing an effort supported by a Section 319 grant (ARN A305-7-170) to create a web-accessible database system that will put the water quality data collected by the SJRWI, the Allen County Health Department, and the City of Fort Wayne online, making it much more readily available to researchers and to the general public. With easy access to this historical data, it will be possible to track progress over time to measure our impact on each of the pollutants of concern.

Other efforts in the entire St. Joseph River watershed include a livestock survey (livestock numbers are currently unavailable by watershed, only by county), a habitat conservation planning effort, and continuation of cooperation with conservation efforts taking place across the Western Lake Erie Basin.

With support from this current planning grant, the SJRWI has established a Hoosier Riverwatch citizen volunteer monitoring program that has trained many volunteers, some of whom expect to remain active in the watershed. They will also help with measuring results through chemical, biological and habitat evaluation. The SJRWI expects to continue to train volunteers and supply monitoring loaner kits to those volunteers.

## 8.5 Updating the WMP

The Lower St. Joseph – Bear Creek Watershed Management Plan is a living document that should be reviewed and updated at least every five years in order to measure progress and maintain focus on our goals. As it is a part of the mission of the SJRWI to continue work with stakeholders across the watershed, the organization will be expected to lead this evaluation and revision effort.

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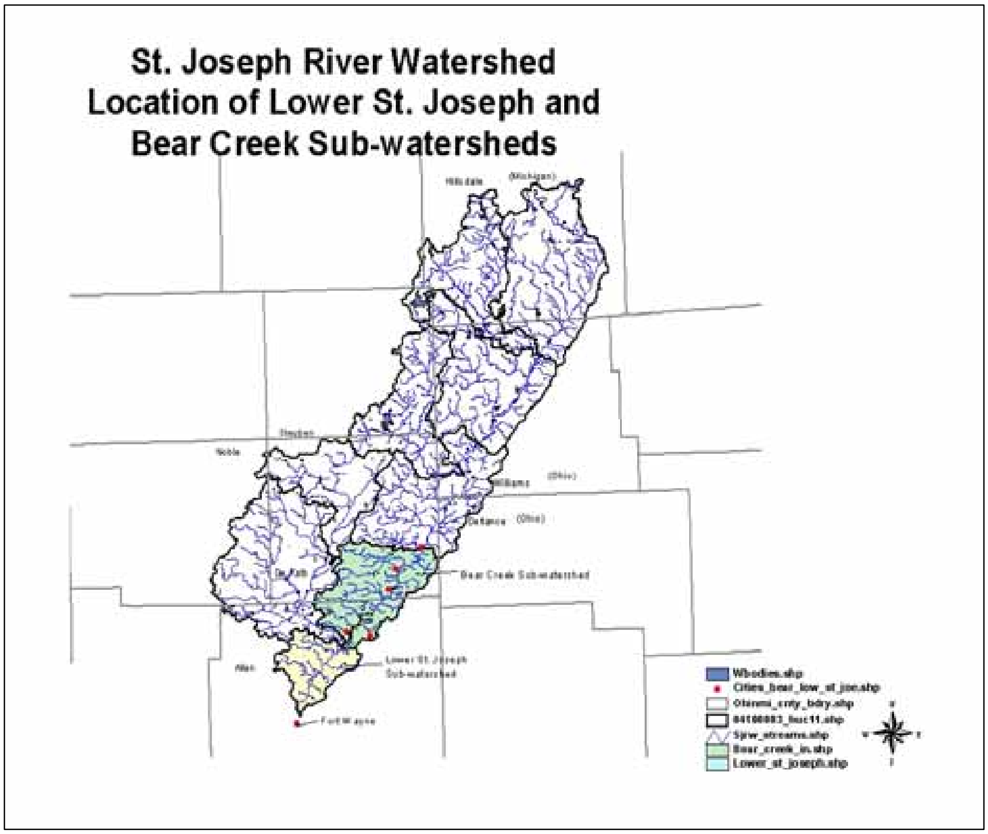
# Appendices

## Table of Contents

# *A call to Action*: What can your neighborhood do?

**River Clean-up Days ☼ Volunteer water monitoring ☼ Storm drain marking
Riverside beautification efforts ☼ Erosion reduction ☼
Rain garden demonstrations ☼ Native plant & landscaping workshops ☼
Awareness Projects: Lawn & garden chemical pollution ☼ Pet-waste
☼ (Home) Car wash runoff ☼ Watershed education
☼ National Drinking Water Week (May) ☼
National water quality monitoring day (October) ☼ Earth Day (April)**

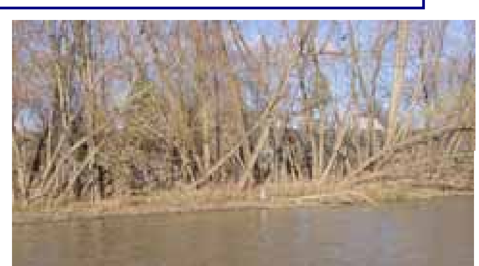



| | | | |
|---|---|---|---|
| St. Joseph River | HUC | 04100003 | (8 digit) |
| Lower St. Joseph River watershed | HUC | 04100003100 | (11 digit) |
| Bear Creek watershed | HUC | 04100003070 | (11 digit) |

**St. Joseph River Watershed Initiative**
**3718 New Vision Drive Fort Wayne, IN 46845**
**260-484-5848 x120** **Fax 260-484-5080** www.sjrwi.org

Our Mission:
To develop partnerships to promote economical and environmentally compatible land uses that improve water quality in the St. Joseph River Watershed.

6 Industry & commerce
7 Agriculture
8 Aquatic/wildlife habitat
9 Transportation



**Environmental Alphabet Soup**

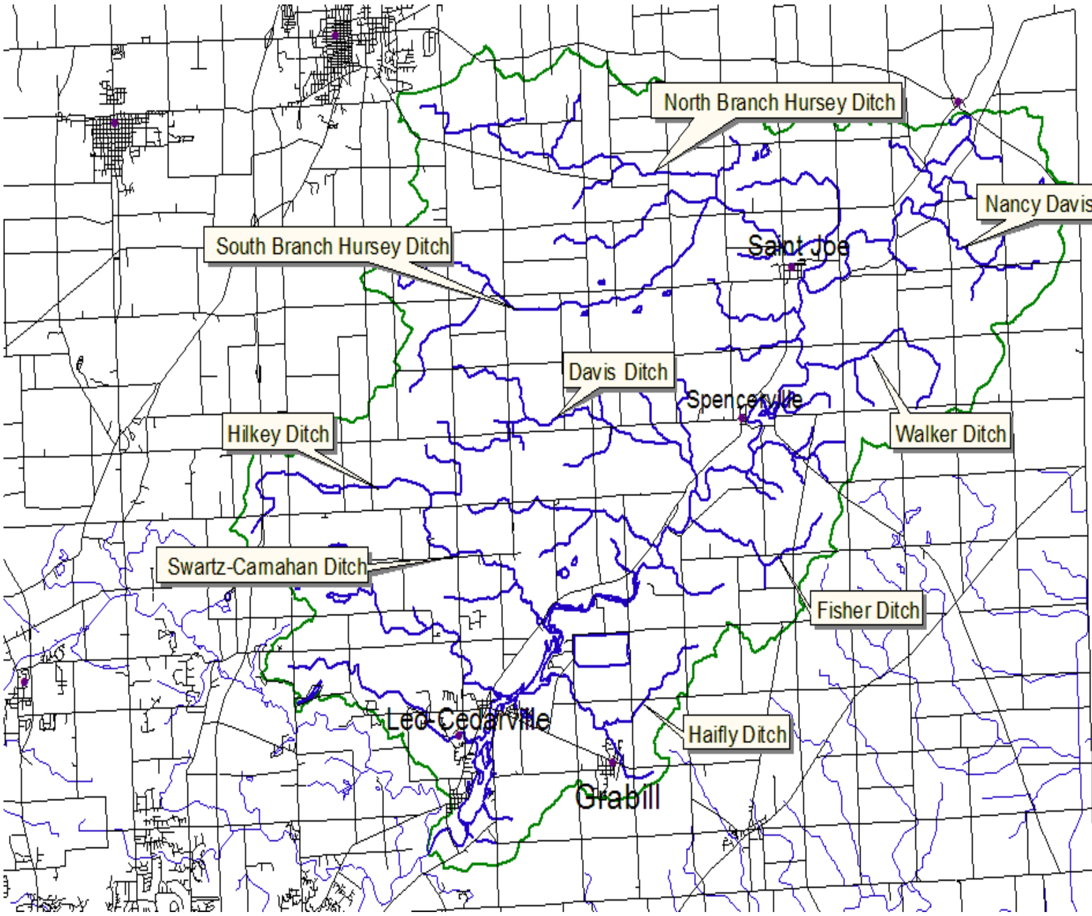
| | |
|---|---|
| ARS | Agricultural Research Service; part of USDA |
| CES | Cooperative Extension Service |
| CWA | Clean Water Act |
| EPA | Environmental Protection Agency |
| Groundwater | Underground water sources; occurs in aquifers |
| HUC | Hydrologic Unit Code. A way of cataloguing portions of the landscape according to their drainage |
| IDEM | Indiana Department of Environmental Management |
| IDNR | Indiana Department of Natural Resources |
| ISDA | Indiana Department of Agriculture |
| NFP | Not-for-profit (organization) |
| NGO | Non-governmental organization |
| NPS | Non-point source pollution. Widespread & diffuse, not from a single point or pipe |
| NRCS | Natural Resource Conservation Service (Part of USDA) |
| Point source | (pollution) Identifiable source or location of pollution, end of a pipe |
| SDWA | Safe Drinking Water Act |
| SJRWI | St. Joseph River Watershed Initiative |
| Stakeholders | Anyone who lives, works, recreates, or has other interest in the watershed area. |
| Steering Committee | Small group of stakeholders that helps to guide the watershed management process |
| SWPI | Source Water Protection Initiative |
| SWCD | Soil & Water Conservation District |
| TMDL | Total Maximum Daily Load – the amount of pollution a water body can absorb without violating water quality standards |
| TNC | The Nature Conservancy |
| USDA | U.S. Department of Agriculture |
| USFS | U.S. Forest Service |
| USFWS | U.S. Fish & Wildlife Service |
| USGS | U.S. Geological Survey |
| Watershed | All of the landscape that drains to a specific point (surface water body) |
| WMP | Watershed Management Plan |
| WMS | Watershed Management Section (IDEM) |

**Top 10 reasons for developing a watershed plan:**

10 To be able to use grant funds to leverage existing programs
9 To provide the partners with a tangible success story
8 To make it easier to obtain grant funds
7 To empower the local community to create change
6 To enable the community to get additional agency support
5 To provide a way to track progress with measurable results
4 To help the project grow bigger and last longer
3 To inform the community, and market the project to new partners
2 To record the group's decisions; and
**#1 To improve the quality of life for people in the watershed by helping ensure clean water and healthy natural resources!**

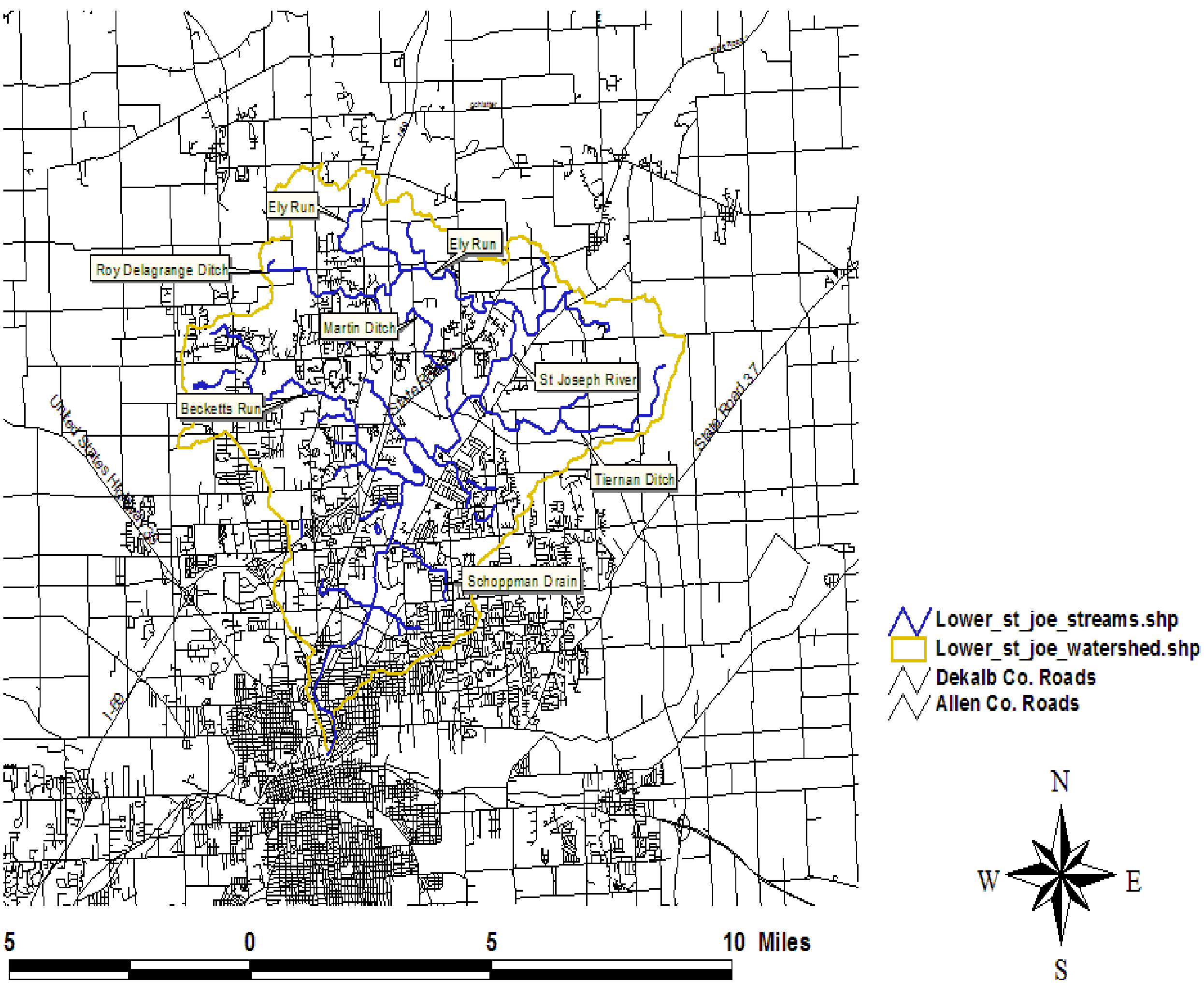
Indiana Watershed Planning Guide, IDEM, Office of Watershed Management Section, 2003

Appendix B Stream Maps
Stream map of the Bear Creek (IN) Watershed

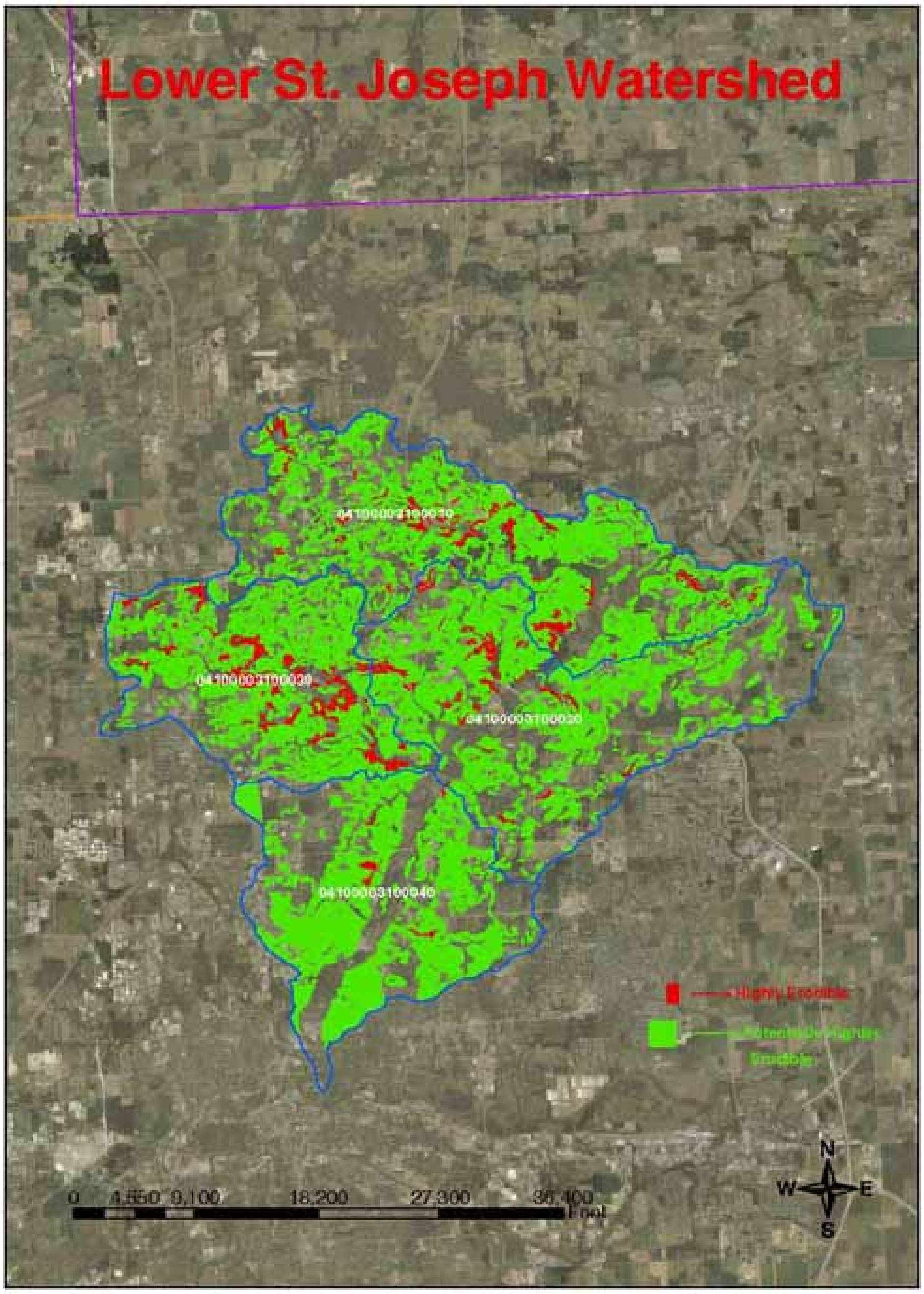


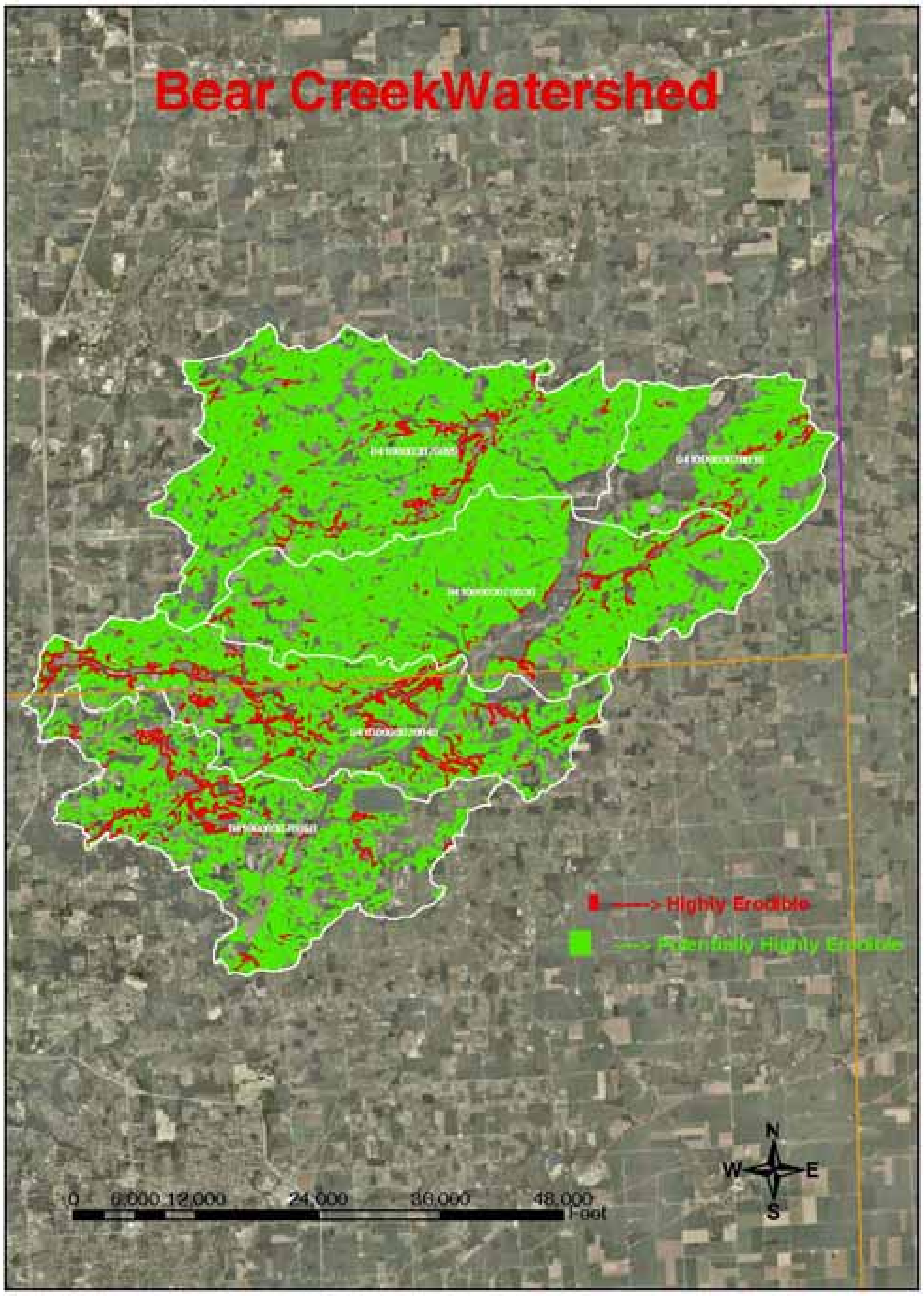
Stream map of the Lower St. Joseph (Allen) Watershed

# Lower St. Joseph River Watershed

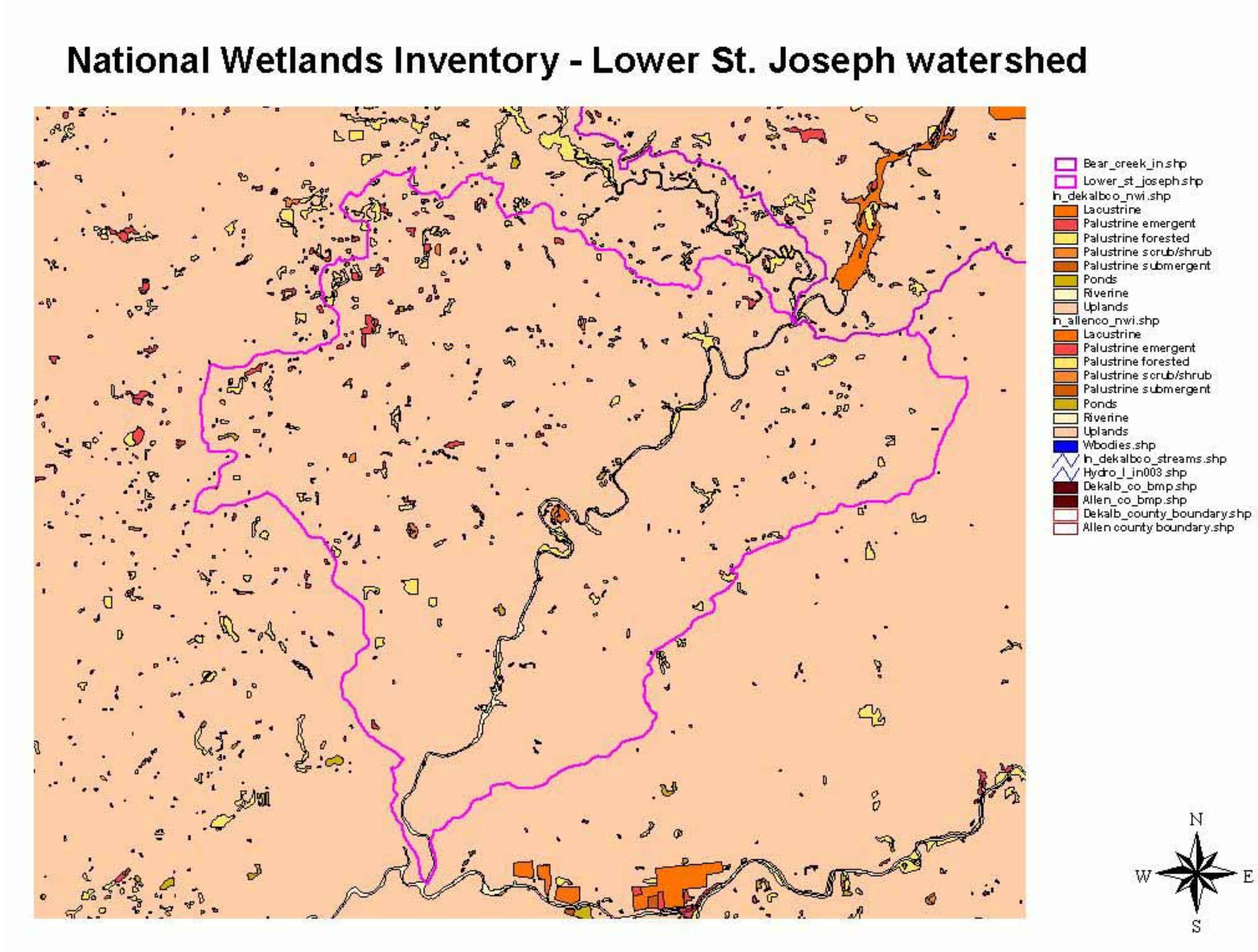


Appendix C  Highly Erodible Soils

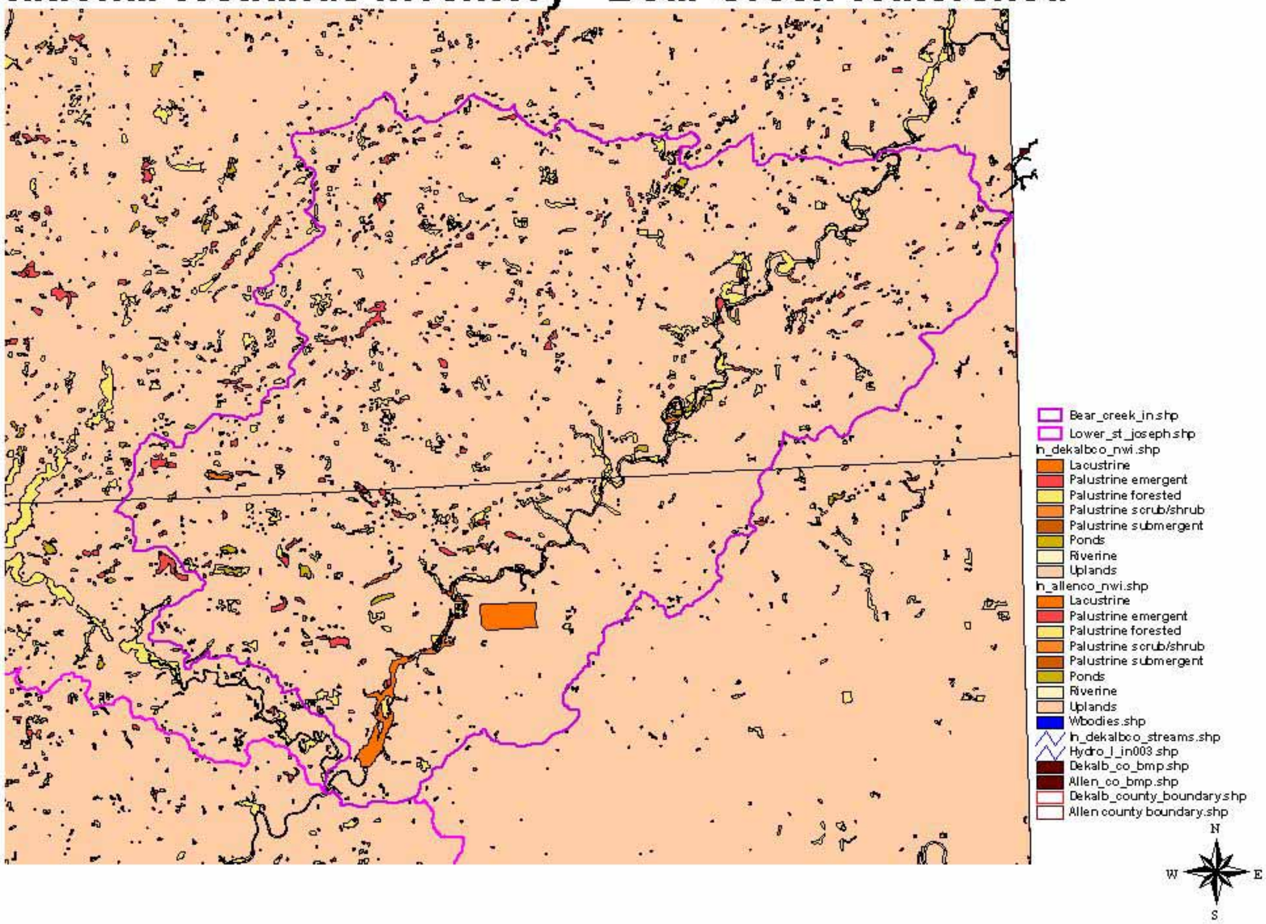



Bear CreekWatershed
Highly Erodible
Potentially Highly Erodible
0
6,000
12,000
24,000
36,000
48,000
Feet
N
W
E
S

Appendix D     Wetland Inventory
Maps created by Aaron Wartenberg, 2006



# National Wetlands Inventory - Bear Creek Watershed



## Appendix E Indiana Fish Consumption Advisory

| Group 1 | Group 2 | Group 3 | Group 4 | Group 5 |
|---|---|---|---|---|
| Unrestricted consumption<br>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. | Limit to one meal per week (52 meals per year) for adult males and females.<br>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. | Limit to one meal per month (12 meals per year) for adult males and females.<br>Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15 do not eat. | Limit to one meal every 2 months (6 meals per year) for adult males and females.<br>Women who are pregnant or breast-feeding, women who plan to have children, and children under the age of 15, do not eat | No consumption (DO NOT EAT). |

Appendix F LSJ-BC sub-watershed discharge on local sampling dates

SJRWI sampling dates

| dv_dt | Discharge Fort Wayne |
|---|---|
| 10d | 12n |
| 4/3/2001 | 530 |
| 4/10/2001 | 2220 |
| 4/17/2001 | 1120 |
| 4/24/2001 | 1560 |
| 5/1/2001 | 636 |
| 5/8/2001 | 389 |
| 5/15/2001 | 373 |
| 5/22/2001 | 1300 |
| 5/29/2001 | 2390 |
| 6/5/2001 | 1760 |
| 6/12/2001 | 926 |
| 6/19/2001 | 519 |
| 6/26/2001 | 737 |
| 7/3/2001 | 306 |
| 7/10/2001 | 237 |
| 7/17/2001 | 185 |
| 7/24/2001 | 279 |
| 7/31/2001 | 204 |
| 8/7/2001 | 74 |
| 8/14/2001 | 128 |
| 8/21/2001 | 153 |
| 8/28/2001 | 195 |
| 9/4/2001 | 144 |
| 9/11/2001 | 208 |
| 9/18/2001 | 149 |
| 9/25/2001 | 223 |
| 10/2/2001 | 153 |
| 10/9/2001 | 394 |
| 10/16/2001 | 5370 |
| 10/23/2001 | 4980 |
| 10/30/2001 | 1820 |
| 4/2/2002 | 3870 |
| 4/9/2002 | 4810 |
| 4/16/2002 | 2880 |
| 4/23/2002 | 1390 |
| 4/30/2002 | 877 |
| 5/7/2002 | 700 |
| 5/14/2002 | 4370 |
| 5/21/2002 | 2250 |
| 5/28/2002 | 897 |
| 6/4/2002 | 710 |
| 6/11/2002 | 487 |
| 6/18/2002 | 372 |
| 6/25/2002 | 380 |
| 7/2/2002 | 265 |
| 7/9/2002 | 188 |
| 7/16/2002 | 149 |
| 7/23/2002 | 131 |
| 7/30/2002 | 524 |
| 8/6/2002 | 104 |
| 8/13/2002 | 83 |
| 8/20/2002 | 150 |
| 8/27/2002 | 86 |
| 9/3/2002 | 75 |
| 9/10/2002 | 60 |
| 9/17/2002 | 45 |
| 9/24/2002 | 98 |
| 10/1/2002 | 42 |
| 10/8/2002 | 105 |
| 10/15/2002 | 94 |
| 10/22/2002 | 90 |
| 10/29/2002 | 100 |
| 4/1/2003 | 1460 |
| 4/8/2003 | 3060 |
| 4/15/2003 | 788 |
| 4/22/2003 | 475 |
| 4/29/2003 | 314 |
| 5/6/2003 | 3920 |
| 5/13/2003 | 4850 |
| 5/20/2003 | 1160 |
| 5/27/2003 | 460 |
| 6/3/2003 | 372 |
| 6/10/2003 | 287 |
| 6/17/2003 | 469 |
| 6/24/2003 | 260 |
| 7/1/2003 | 184 |
| 7/8/2003 | 786 |
| 7/15/2003 | 400 |
| 7/22/2003 | 956 |
| 7/29/2003 | 1410 |
| 8/5/2003 | 3590 |
| 8/12/2003 | 756 |
| 8/19/2003 | 305 |
| 8/26/2003 | 283 |
| 9/2/2003 | 5670 |
| 9/9/2003 | 835 |
| 9/16/2003 | 352 |
| 9/23/2003 | 757 |
| 9/30/2003 | 2140 |
| 10/7/2003 | 618 |
| 10/14/2003 | 364 |
| 10/21/2003 | 814 |
| 10/28/2003 | 467 |
| 4/6/2004 | 604 |
| 4/13/2004 | 389 |

| | |
|---|---|
| 4/20/2004 | 353 |
| 4/27/2004 | 305 |
| 5/4/2004 | 577 |
| 5/11/2004 | 1020 |
| 5/18/2004 | 673 |
| 5/25/2004 | 3210 |
| 6/1/2004 | 5050 |
| 6/8/2004 | 731 |
| 6/15/2004 | 5100 |
| 6/22/2004 | 1990 |
| 6/29/2004 | 574 |
| 7/6/2004 | 421 |
| 7/13/2004 | 413 |
| 7/20/2004 | 520 |
| 7/27/2004 | 483 |
| 8/3/2004 | 297 |
| 8/10/2004 | 181 |
| 8/17/2004 | 139 |
| 8/24/2004 | 215 |
| 8/31/2004 | 354 |
| 9/7/2004 | 241 |
| 9/14/2004 | 181 |
| 9/21/2004 | 151 |
| 9/28/2004 | 143 |
| 10/5/2004 | 207 |
| 10/12/2004 | 140 |
| 10/19/2004 | 129 |
| 10/26/2004 | 126 |
| 4/5/2005 | 722 |
| 4/12/2005 | 492 |
| 4/19/2005 | 384 |
| 4/26/2005 | 618 |
| 5/3/2005 | 487 |
| 5/10/2005 | 353 |
| 5/17/2005 | 571 |

| | |
|---|---|
| 5/24/2005 | 713 |
| 5/31/2005 | 243 |
| 6/7/2005 | 157 |
| 6/14/2005 | 285 |
| 6/21/2005 | 146 |
| 6/28/2005 | 118 |
| 7/5/2005 | 111 |
| 7/12/2005 | 85 |
| 7/19/2005 | 231 |
| 7/26/2005 | 235 |
| 8/2/2005 | 260 |
| 8/9/2005 | 121 |
| 8/16/2005 | 171 |
| 8/23/2005 | 121 |
| 8/30/2005 | 92 |
| 9/6/2005 | 68 |
| 9/13/2005 | 77 |
| 9/20/2005 | 129 |
| 9/27/2005 | 267 |
| 10/4/2005 | 215 |
| 10/11/2005 | 162 |
| 10/18/2005 | 94 |
| 10/25/2005 | 110 |
| 4/4/2006 | 1990 |
| 4/11/2006 | 723 |
| 4/18/2006 | 757 |
| 4/25/2006 | 367 |
| 5/2/2006 | 443 |
| 5/9/2006 | 434 |
| 5/16/2006 | 5040 |
| 5/23/2006 | 1530 |
| 5/30/2006 | 639 |
| 6/6/2006 | 371 |
| 6/13/2006 | 343 |
| 6/20/2006 | 217 |

| | |
|---|---|
| 6/27/2006 | 474 |
| 7/4/2006 | 347 |
| 7/11/2006 | 328 |
| 7/18/2006 | 1720 |
| 7/25/2006 | 509 |
| 8/1/2006 | 1090 |
| 8/8/2006 | 285 |
| 8/15/2006 | 226 |
| 8/22/2006 | 228 |
| 8/29/2006 | 674 |
| 9/5/2006 | 228 |
| 9/12/2006 | 162 |
| 9/19/2006 | 155 |
| 9/26/2006 | 203 |
| | |

Appendix G Load calculations for pollutants at the Tennessee Avenue Bridge

E. coli 2005 Sorted by flow

| E. Coli | WQS = | 235 | cfu/100ml | = Criteria * Flow * ((28317/100)*60*60*24) | | |
|---|---|---|---|---|---|---|
| Date | USGS FLOW CFS | TMDL (cfu/day) | Actual Data (cfu/100 mL) | Actual Load (cfu/day) | Difference | % Reduction |
| 4/4/2005 | 695 | 4.00E+12 | 19 | 3.23E+11 | -3.67E+12 | -1136.84 |
| 4/11/2005 | 570 | 3.28E+12 | 20 | 2.79E+11 | -3.00E+12 | -1075.00 |
| 4/18/2005 | 405 | 2.33E+12 | 40 | 3.96E+11 | -1.93E+12 | -487.50 |
| 4/25/2005 | 577 | 3.32E+12 | 387 | 5.46E+12 | 2.15E+12 | 39.28 |
| 5/2/2005 | 490 | 2.82E+12 | 70 | 8.39E+11 | -1.98E+12 | -235.71 |
| 5/9/2005 | 373 | 2.14E+12 | 18 | 1.64E+11 | -1.98E+12 | -1205.56 |
| 5/18/2005 | 570 | 3.28E+12 | 110 | 1.53E+12 | -1.74E+12 | -113.64 |
| 5/23/2005 | 855 | 4.92E+12 | 111 | 2.32E+12 | -2.59E+12 | -111.71 |
| 5/31/2005 | 243 | 1.40E+12 | 192 | 1.14E+12 | -2.56E+11 | -22.40 |
| 6/6/2005 | 186 | 1.07E+12 | 5200 | 2.37E+13 | 2.26E+13 | **95.48** |
| 6/13/2005 | 226 | 1.30E+12 | 1986 | 1.10E+13 | 9.68E+12 | 88.17 |
| 6/20/2005 | 154 | 8.85E+11 | 109 | 4.11E+11 | -4.75E+11 | -115.60 |
| 6/27/2005 | 104 | 5.98E+11 | 50 | 1.27E+11 | -4.71E+11 | -370.00 |
| 7/5/2005 | 111 | 6.38E+11 | 87 | 2.36E+11 | -4.02E+11 | -170.11 |
| 7/11/2005 | 110 | 6.32E+11 | 157 | 4.23E+11 | -2.10E+11 | -49.68 |
| 7/18/2005 | 118 | 6.78E+11 | 210 | 6.06E+11 | -7.22E+10 | -11.90 |
| 7/25/2005 | 224 | 1.29E+12 | 34 | 1.86E+11 | -1.10E+12 | -591.18 |
| 8/1/2005 | 258 | 1.48E+12 | 99 | 6.25E+11 | -8.58E+11 | -137.37 |
| 8/8/2005 | 208 | 1.20E+12 | 921 | 4.69E+12 | 3.49E+12 | 74.48 |
| 8/15/2005 | 196 | 1.13E+12 | 249 | 1.19E+12 | 6.71E+10 | 5.62 |
| 8/22/2005 | 122 | 7.01E+11 | 140 | 4.18E+11 | -2.84E+11 | -67.86 |
| 8/29/2005 | 99 | 5.69E+11 | 45 | 1.09E+11 | -4.60E+11 | -422.22 |
| 9/6/2005 | 68 | 3.91E+11 | 35 | 5.82E+10 | -3.33E+11 | -571.43 |
| 9/13/2005 | 77 | 4.43E+11 | 14 | 2.64E+10 | -4.16E+11 | -1578.57 |
| 9/19/2005 | 108 | 6.21E+11 | 28 | 7.40E+10 | -5.47E+11 | -739.29 |
| 9/26/2005 | 427 | 2.46E+12 | 1300 | 1.36E+13 | 1.11E+13 | 81.92 |
| 10/3/2005 | 188 | 1.08E+12 | 68 | 3.13E+11 | -7.68E+11 | -245.59 |
| 10/10/2005 | 145 | 8.34E+11 | 40 | 1.42E+11 | -6.92E+11 | -487.50 |
| 10/17/2005 | 93 | 5.35E+11 | 67 | 1.52E+11 | -3.82E+11 | -250.75 |
| 10/24/2005 | 101 | 5.81E+11 | 199 | 4.92E+11 | -8.90E+10 | -18.09 |
| 10/31/2005 | 85 | 4.89E+11 | 16 | 3.33E+10 | -4.55E+11 | -1368.75 |

E. coli 2006 Sorted by Flow

| **E. Coli** | WQS = | 235 | cfu/100ml | *= Criteria * Flow * ((28317/100)*60*60*24)* | | |
|---|---|---|---|---|---|---|
| Date | USGS FLOW CFS | TMDL (cfu/day) | Actual Data (cfu/100 mL) | Actual Load (cfu/day) | Difference | % Reduction |
| 08/21/06 | 110 | 6.32443E+11 | 365 | 9.82305E+11 | 3.49862E+11 | 35.61643836 |
| 09/11/06 | 165 | 9.48665E+11 | 201 | 8.11411E+11 | -1.37254E+11 | -16.9154229 |
| 09/26/06 | 203 | 1.16715E+12 | 261 | 1.29628E+12 | 1.29131E+11 | 9.961685824 |
| 09/18/06 | 207 | 1.19014E+12 | 3000 | 1.51933E+13 | 1.40032E+13 | **92.16666667** |
| 08/28/06 | 222 | 1.27639E+12 | 240 | 1.30354E+12 | 27157135680 | 2.083333333 |
| 09/05/06 | 228 | 1.31088E+12 | 133 | 7.41904E+11 | -5.68979E+11 | -76.6917293 |
| 08/14/06 | 246 | 1.41437E+12 | 58 | 3.49079E+11 | -1.06529E+12 | -305.172414 |
| 10/02/06 | 251 | 1.44312E+12 | 2420 | 1.48611E+13 | 1.34179E+13 | 90.2892562 |
| 07/06/06 | 322 | 1.85133E+12 | 66 | 5.19949E+11 | -1.33138E+12 | -256.060606 |
| 06/19/06 | 359 | 2.06406E+12 | 228 | 2.00258E+12 | -61482776544 | -3.07017544 |
| 08/07/06 | 371 | 2.13306E+12 | 81 | 7.35224E+11 | -1.39783E+12 | -190.123457 |
| 07/10/06 | 379 | 2.17905E+12 | 45 | 4.17266E+11 | -1.76179E+12 | -422.222222 |
| 10/09/06 | 387 | 2.22505E+12 | 205 | 1.941E+12 | -2.84049E+11 | -14.6341463 |
| 06/12/06 | 391 | 2.24805E+12 | 126 | 1.20534E+12 | -1.04271E+12 | -86.5079365 |
| 04/24/06 | 396 | 2.2768E+12 | 100 | 9.68849E+11 | -1.30795E+12 | -135 |
| 05/08/06 | 402 | 2.31129E+12 | 45 | 4.42588E+11 | -1.8687E+12 | -422.222222 |
| 05/01/06 | 411 | 2.36304E+12 | 308 | 3.09709E+12 | 7.3405E+11 | 23.7012987 |
| 06/05/06 | 454 | 2.61027E+12 | 184 | 2.04378E+12 | -5.66483E+11 | -27.7173913 |
| 07/24/06 | 460 | 2.64476E+12 | 96 | 1.08041E+12 | -1.56435E+12 | -144.791667 |
| 06/26/06 | 564 | 3.24271E+12 | 122 | 1.68345E+12 | -1.55926E+12 | -92.6229508 |
| 05/30/06 | 639 | 3.67392E+12 | 86 | 1.3445E+12 | -2.32942E+12 | -173.255814 |
| 04/10/06 | 680 | 3.90965E+12 | 70 | 1.16458E+12 | -2.74507E+12 | -235.714286 |
| 10/16/06 | 762 | 4.38111E+12 | 411 | 7.66228E+12 | 3.28117E+12 | 42.82238443 |
| 04/17/06 | 863 | 4.9618E+12 | 866 | 1.82848E+13 | 1.3323E+13 | 72.86374134 |
| 10/23/06 | 1130 | 6.49692E+12 | 36 | 9.95272E+11 | -5.50164E+12 | -552.777778 |
| 04/03/06 | 1640 | 9.42915E+12 | 517 | 2.07441E+13 | 1.1315E+13 | 54.54545455 |
| 07/31/06 | 1700 | 9.77412E+12 | 488 | 2.02969E+13 | 1.05228E+13 | 51.8442623 |
| 05/22/06 | 1780 | 1.02341E+13 | 86 | 3.74524E+12 | -6.48884E+12 | -173.255814 |
| 07/17/06 | 2070 | 1.19014E+13 | 372 | 1.88397E+13 | 6.93828E+12 | 36.82795699 |
| 05/15/06 | 4190 | 2.40903E+13 | 687 | 7.04258E+13 | 4.63355E+13 | 65.79330422 |

TSS 2005 Tennessee BridgeSorted by Flow

| Date | USGS FLOW CFS | TMDL (tons/day) | Actual Data (mg/L) | Actual Load (tons/day) | Difference (tons/day) | % Reduction |
|---|---|---|---|---|---|---|
| 9/6/05 | 68 | 5.50239 | 12 | 2.200956 | -3.301434 | -150 |
| 9/13/05 | 77 | 6.2306475 | 13 | 2.69994725 | -3.53070025 | -130.7692308 |
| 10/31/05 | 85 | 6.8779875 | 12 | 2.751195 | -4.1267925 | -150 |
| 10/17/05 | 93 | 7.5253275 | 20 | 5.016885 | -2.5084425 | -50 |
| 8/29/05 | 99 | 8.0108325 | 14 | 3.7383885 | -4.272444 | -114.2857143 |
| 10/24/05 | 101 | 8.1726675 | 21 | 5.72086725 | -2.45180025 | -42.85714286 |
| 6/27/05 | 104 | 8.41542 | 8 | 2.244112 | -6.171308 | -275 |
| 9/19/05 | 108 | 8.73909 | 8 | 2.330424 | -6.408666 | -275 |
| 7/11/05 | 110 | 8.900925 | 32 | 9.49432 | 0.593395 | 6.25 |
| 7/5/05 | 111 | 8.9818425 | 18 | 5.3891055 | -3.592737 | -66.66666667 |
| 7/18/05 | 118 | 9.548265 | 20 | 6.36551 | -3.182755 | -50 |
| 8/22/05 | 122 | 9.871935 | 17 | 5.5940965 | -4.2778385 | -76.47058824 |
| 10/10/05 | 145 | 11.7330375 | 15 | 5.86651875 | -5.86651875 | -100 |
| 6/20/05 | 154 | 12.461295 | 24 | 9.969036 | -2.492259 | -25 |
| 6/6/05 | 186 | 15.050655 | 26 | 13.043901 | -2.006754 | -15.38461538 |
| 10/3/05 | 188 | 15.21249 | 18 | 9.127494 | -6.084996 | -66.66666667 |
| 8/15/05 | 196 | 15.85983 | 11 | 5.815271 | -10.044559 | -172.7272727 |
| 8/8/05 | 208 | 16.83084 | 14 | 7.854392 | -8.976448 | -114.2857143 |
| 7/25/05 | 224 | 18.12552 | 12 | 7.250208 | -10.875312 | -150 |
| 6/13/05 | 226 | 18.287355 | 8 | 4.876628 | -13.410727 | -275 |
| 5/31/05 | 243 | 19.6629525 | 20 | 13.108635 | -6.5543175 | -50 |
| 8/1/05 | 258 | 20.876715 | 38 | 26.443839 | 5.567124 | **21.05263158** |
| 5/9/05 | 373 | 30.1822275 | 13 | 13.0789653 | -17.10326225 | -130.7692308 |
| 4/18/05 | 405 | 32.7715875 | 28 | 30.586815 | -2.1847725 | -7.142857143 |
| 9/26/05 | 427 | 34.5517725 | 72 | 82.924254 | 48.3724815 | **58.33333333** |
| 5/2/05 | 490 | 39.649575 | 14 | 18.503135 | -21.14644 | -114.2857143 |
| 4/11/05 | 570 | 46.122975 | 14 | 21.524055 | -24.59892 | -114.2857143 |
| 5/18/05 | 570 | 46.122975 | 25 | 38.4358125 | -7.6871625 | -20 |
| 4/25/05 | 577 | 46.6893975 | 16 | 24.901012 | -21.7883855 | -87.5 |
| 4/4/05 | 695 | 56.2376625 | 7 | 13.1221213 | -43.11554125 | -328.5714286 |
| 5/23/05 | 855 | 69.1844625 | 22 | 50.7352725 | -18.44919 | -36.36363636 |

Based on 30 mg/L TSS target

TSS 2006 Tennessee BridgeSorted by Flow

| Date | USGS FLOW CFS | TMDL (tons/day) | Actual Data (mg/L) | Actual Load (tons/day) | Difference (tons/day) | % Reduction |
|---|---|---|---|---|---|---|
| 8/21/06 | 110 | 8.900925 | 18 | 5.340555 | -3.56037 | -66.67 |
| 9/11/06 | 165 | 13.3513875 | 35 | 15.5766188 | 2.22523125 | 14.29 |
| 9/26/06 | 203 | 16.4262525 | 31 | 16.9737943 | 0.54754175 | 3.23 |
| 9/18/06 | 207 | 16.7499225 | 36 | 20.099907 | 3.3499845 | 16.67 |
| 8/28/06 | 222 | 17.963685 | 33 | 19.7600535 | 1.7963685 | 9.09 |
| 9/5/06 | 228 | 18.44919 | 23 | 14.144379 | -4.304811 | -30.43 |
| 8/14/06 | 246 | 19.905705 | 27 | 17.9151345 | -1.9905705 | -11.11 |
| 10/2/06 | 251 | 20.3102925 | 29 | 19.6332828 | -0.67700975 | -3.45 |
| 7/6/06 | 322 | 26.055435 | 31 | 26.9239495 | 0.8685145 | 3.23 |
| 6/19/06 | 359 | 29.0493825 | 16 | 15.493004 | -13.5563785 | -87.50 |
| 8/7/06 | 371 | 30.0203925 | 40 | 40.02719 | 10.0067975 | 25.00 |
| 7/10/06 | 379 | 30.6677325 | 42 | 42.9348255 | 12.267093 | 28.57 |
| 10/9/06 | 387 | 31.3150725 | 34 | 35.4904155 | 4.175343 | 11.76 |
| 6/12/06 | 391 | 31.6387425 | 20 | 21.092495 | -10.5462475 | -50.00 |
| 4/24/06 | 396 | 32.04333 | 37 | 39.520107 | 7.476777 | 18.92 |
| 5/8/06 | 402 | 32.528835 | 28 | 30.360246 | -2.168589 | -7.14 |
| 5/1/06 | 411 | 33.2570925 | 28 | 31.039953 | -2.2171395 | -7.14 |
| 6/5/06 | 454 | 36.736545 | 28 | 34.287442 | -2.449103 | -7.14 |
| 7/24/06 | 460 | 37.22205 | 24 | 29.77764 | -7.44441 | -25.00 |
| 6/26/06 | 564 | 45.63747 | 34 | 51.722466 | 6.084996 | 11.76 |
| 5/30/06 | 639 | 51.7062825 | 20.5 | 35.3326264 | -16.37365613 | -46.34 |
| 4/10/06 | 680 | 55.0239 | 42 | 77.03346 | 22.00956 | 28.57 |
| 10/16/06 | 762 | 61.659135 | 52 | 106.875834 | 45.216699 | 42.31 |
| 4/17/06 | 863 | 69.8318025 | 28 | 65.176349 | -4.6554535 | -7.14 |
| 10/23/06 | 1130 | 91.436775 | 46 | 140.203055 | 48.76628 | 34.78 |
| 4/3/06 | 1640 | 132.7047 | 30 | 132.7047 | 0 | 0 |
| 7/31/06 | 1700 | 137.55975 | 35 | 160.486375 | 22.926625 | 14.29 |
| 5/22/06 | 1780 | 144.03315 | 46 | 220.85083 | 76.81768 | 34.78 |
| 7/17/06 | 2070 | 167.499225 | 59 | 329.415143 | 161.9159175 | 49.15 |
| 5/15/06 | 4190 | 339.044325 | 54.4 | 614.800376 | 275.756051 | 44.85 |
| 5/15/06 | 4190 | 226.02955 | 54.4 | 614.800376 | 388.770826 | **63.24** |

Phosphorus 2005 Sorted by flow

| Phosphorous | Your Target = | 0.3 | mg/L | ***Load (lb/day) = Criteria * Flow * (5.3945)*** | | |
|---|---|---|---|---|---|---|
| Date | USGS FLOW CFS | TMDL Lbs/Day | Actual Data (mg/L) | Actual Load (lbs/day) | Difference (lbs/day) | % Reduction |
| 9/6/05 | 68 | 110.0478 | 0.258 | 94.641108 | -15.406692 | -16.27906977 |
| 9/13/05 | 77 | 124.61295 | 0.107 | 44.4452855 | -80.1676645 | -180.3738318 |
| 10/31/05 | 85 | 137.55975 | 0.023 | 10.5462475 | -127.0135025 | -1204.347826 |
| 10/17/05 | 93 | 150.50655 | 0.09 | 45.151965 | -105.354585 | -233.3333333 |
| 8/29/05 | 99 | 160.21665 | 0.105 | 56.0758275 | -104.1408225 | -185.7142857 |
| 10/24/05 | 101 | 163.45335 | 0.077 | 41.9530265 | -121.5003235 | -289.6103896 |
| 6/27/05 | 104 | 168.3084 | 0.024 | 13.464672 | -154.843728 | -1150 |
| 9/19/05 | 108 | 174.7818 | 0.1 | 58.2606 | -116.5212 | -200 |
| 7/11/05 | 110 | 178.0185 | 0.155 | 91.976225 | -86.042275 | -93.5483871 |
| 7/5/05 | 111 | 179.63685 | 0.05 | 29.939475 | -149.697375 | -500 |
| 7/18/05 | 118 | 190.9653 | 0.129 | 82.115079 | -108.850221 | -132.5581395 |
| 8/22/05 | 122 | 197.4387 | 0.112 | 73.710448 | -123.728252 | -167.8571429 |
| 10/10/05 | 145 | 234.66075 | 0.116 | 90.73549 | -143.92526 | -158.6206897 |
| 6/20/05 | 154 | 249.2259 | 0.09 | 74.76777 | -174.45813 | -233.3333333 |
| 6/6/05 | 186 | 301.0131 | 0.089 | 89.300553 | -211.712547 | -237.0786517 |
| 10/3/05 | 188 | 304.2498 | 0.073 | 74.034118 | -230.215682 | -310.9589041 |
| 8/15/05 | 196 | 317.1966 | 0.14 | 148.02508 | -169.17152 | -114.2857143 |
| 8/8/05 | 208 | 336.6168 | 0.088 | 98.740928 | -237.875872 | -240.9090909 |
| 7/25/05 | 224 | 362.5104 | 0.13 | 157.08784 | -205.42256 | -130.7692308 |
| 6/13/05 | 226 | 365.7471 | 0.102 | 124.354014 | -241.393086 | -194.1176471 |
| 5/31/05 | 243 | 393.25905 | 0.05 | 65.543175 | -327.715875 | -500 |
| 8/1/05 | 258 | 417.5343 | 0.135 | 187.890435 | -229.643865 | -122.2222222 |
| 5/9/05 | 373 | 603.64455 | 0.078 | 156.947583 | -446.696967 | -284.6153846 |
| 4/18/05 | 405 | 655.43175 | 0.06 | 131.08635 | -524.3454 | -400 |
| 9/26/05 | 427 | 691.03545 | 0.185 | 426.138528 | -264.8969225 | -62.16216216 |
| 5/2/05 | 490 | 792.9915 | 0.09 | 237.89745 | -555.09405 | -233.3333333 |
| 4/11/05 | 570 | 922.4595 | 0.075 | 230.614875 | -691.844625 | -300 |
| 5/18/05 | 570 | 922.4595 | 0.1 | 307.4865 | -614.973 | -200 |
| 4/25/05 | 577 | 933.78795 | 0.006 | 18.675759 | -915.112191 | -4900 |
| 4/4/05 | 695 | 1124.75325 | 0.196 | 734.83879 | -389.91446 | -53.06122449 |
| 5/23/05 | 855 | 1383.68925 | 0.096 | 442.78056 | -940.90869 | -212.5 |

Phosphorus 2006 Sorted by flow

| Phos | Your Target = | 0.3 | mg/L | Load (lb/day) = Criteria * Flow * (5.3945) | | |
|---|---|---|---|---|---|---|
| Date | USGS FLOW CFS | TMDL Lbs/Day | Actual Data (mg/L) | Actual Load (lbs/day) | Difference (lbs/day) | % Reduction |
| 8/21/06 | 110 | 178.0185 | 0.13 | 77.14135 | -100.87715 | -130.7692308 |
| 9/11/06 | 165 | 267.02775 | 0.156 | 138.85443 | -128.17332 | -92.30769231 |
| 9/26/06 | 203 | 328.52505 | 0.102 | 111.698517 | -216.826533 | -194.1176471 |
| 9/18/06 | 207 | 334.99845 | 0.1 | 111.66615 | -223.3323 | -200 |
| 8/28/06 | 222 | 359.2737 | 0.093 | 111.374847 | -247.898853 | -222.5806452 |
| 9/5/06 | 228 | 368.9838 | 0.081 | 99.625626 | -269.358174 | -270.3703704 |
| 8/14/06 | 246 | 398.1141 | 0.209 | 277.352823 | -120.761277 | -43.54066986 |
| 10/2/06 | 251 | 406.20585 | 0.162 | 219.351159 | -186.854691 | -85.18518519 |
| 7/6/06 | 322 | 521.1087 | 0.25 | 434.25725 | -86.85145 | -20 |
| 6/19/06 | 359 | 580.98765 | 0.9 | 1742.96295 | 1161.9753 | **66.66666667** |
| 8/7/06 | 371 | 600.40785 | 0.162 | 324.220239 | -276.187611 | -85.18518519 |
| 7/10/06 | 379 | 613.35465 | 0.095 | 194.228973 | -419.1256775 | -215.7894737 |
| 10/9/06 | 387 | 626.30145 | 0.62 | 1294.35633 | 668.05488 | **51.61290323** |
| 6/12/06 | 391 | 632.77485 | 0.063 | 132.882719 | -499.8921315 | -376.1904762 |
| 4/24/06 | 396 | 640.8666 | 0.14 | 299.07108 | -341.79552 | -114.2857143 |
| 5/8/06 | 402 | 650.5767 | 0.308 | 667.925412 | 17.348712 | **2.597402597** |
| 5/1/06 | 411 | 665.14185 | 0.175 | 387.999413 | -277.1424375 | -71.42857143 |
| 6/5/06 | 454 | 734.7309 | 0.057 | 139.598871 | -595.132029 | -426.3157895 |
| 7/24/06 | 460 | 744.441 | 0.138 | 342.44286 | -401.99814 | -117.3913043 |
| 6/26/06 | 564 | 912.7494 | 0.188 | 571.989624 | -340.759776 | -59.57446809 |
| 5/30/06 | 639 | 1034.12565 | 0.025 | 86.1771375 | -947.9485125 | -1100 |
| 4/10/06 | 680 | 1100.478 | 0.113 | 414.51338 | -685.96462 | -165.4867257 |
| 10/16/06 | 762 | 1233.1827 | 0.15 | 616.59135 | -616.59135 | -100 |
| 4/17/06 | 863 | 1396.63605 | 0.1 | 465.54535 | -931.0907 | -200 |
| 10/23/06 | 1130 | 1828.7355 | 0.191 | 1164.29494 | -664.440565 | -57.06806283 |
| 4/3/06 | 1640 | 2654.094 | 0.045 | 398.1141 | -2255.9799 | -566.6666667 |
| 7/31/06 | 1700 | 2751.195 | 0.192 | 1760.7648 | -990.4302 | -56.25 |
| 5/22/06 | 1780 | 2880.663 | 0.12 | 1152.2652 | -1728.3978 | -150 |
| 7/17/06 | 2070 | 3349.9845 | 0.21 | 2344.98915 | -1004.99535 | -42.85714286 |
| 5/15/06 | 4190 | 6780.8865 | 0.293 | 6622.66582 | -158.220685 | -2.389078498 |

# Appendix H Atrazine Loads and Targets, Tennessee Avenue Bridge

Atrazine Loads, Targets and Reduction based on Tennessee Bridge sampling by City of Fort Wayne
April 17, 2007

Load Calculation Tool *

**mass based pollutants**

| input | |
|---|---|
| Atrazine (mg/l) | 0.00028 |
| Flow (cfs) | 1140 |
| | |
| Target Concentration 3 ppb | |
| (mg/l) | *0.003* |

| output | |
|---|---|
| Current Load (lb/day) | 1.72 |
| Current Load (ton/year) | 0.31 |
| Target Load (lb/day) | 18.44 |
| Target Load (ton/year) | 3.36 |

| load reduction needed | |
|---|---|
| (ton/year) | -3.05 |
| % reduction | -971.4 |

Atrazine 6/19/07 Tennessee Ave Bridge

Load Calculation Tool *

**mass based pollutants**

| input | |
|---|---|
| Atrazine (mg/l) | 0.0018 |
| Flow (cfs) | 153 |
| | |
| Target Concentration 3 ppb | |
| (mg/l) | *0.003* |

| output | |
|---|---|
| Current Load (lb/day) | 1.48 |
| Current Load (ton/year) | 0.27 |
| Target Load (lb/day) | 2.47 |
| Target Load (ton/year) | 0.45 |

| load reduction needed | |
|---|---|
| (ton/year) | -0.18 |
| % reduction | -66.7 |

Atrazine 8/21/07 Tennessee Ave Bridge

Load Calculation Tool *

**mass based pollutants**

| input | |
|---|---|
| Atrazine (mg/l) | 0.00056 |
| Flow (cfs) | 6230 |
| | |
| Target Concentration 3 ppb | |
| (mg/l) | *0.003* |

| output | |
|---|---|
| Current Load (lb/day) | 18.81 |
| Current Load (ton/year) | 3.43 |
| Target Load (lb/day) | 100.75 |
| Target Load (ton/year) | 18.39 |

| load reduction needed | |
|---|---|
| (ton/year) | -14.95 |
| % reduction | -435.7 |

# Appendix I  Water Quality Data – City of Fort Wayne

**City of Fort Wayne River Survey 2003**
**St. Joseph River @ Mayhew Road**

| Wk | Date | ECOLI | Depth(ft) | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|
| 1 | 04/07/03 | Test Failed | 6.52 | 0.320 | 0.190 | 74 |
| 2 | 04/14/03 | 16 | 3.41 | No Sample | 0.427 | 30 |
| 3 | 04/21/03 | 9 | 2.88 | 0.110 | 0.100 | 40 |
| 4 | 04/28/03 | 4 | 1.91 | 0.190 | 0.003 | 23 |
| 5 | 05/05/03 | 8 | 7.58 | 0.411 | 0.219 | 372 |
| 6 | 05/12/03 | 1300 | 9.58 | 0.263 | 0.174 | 144 |
| 7 | 05/19/03 | 62 | 4.19 | 0.160 | 0.100 | 57 |
| 8 | 05/27/03 | 94 | 3.06 | 0.241 | 0.098 | 39 |
| 9 | 06/02/03 | 30 | 2.73 | 0.219 | 0.003 | 35 |
| 10 | 06/09/03 | 54 | 3.01 | 0.020 | 0.007 | 18 |
| 11 | 06/16/03 | 150 | 3.34 | 0.160 | 0.200 | 45 |
| 12 | 06/23/03 | 60 | 2.69 | 0.139 | 0.037 | 59 |
| 13 | 06/30/03 | 100 | 2.37 | 0.187 | 0.099 | 29 |
| 14 | 07/07/03 | 1040 | 12.57 | 0.124 | 0.119 | 116 |
| 15 | 07/15/03 | 100 | 2.97 | 1.426 | 0.024 | 58 |
| 16 | 07/21/03 | 340 | 5.04 | 0.400 | 0.100 | 246 |
| 17 | 07/28/03 | 10 | 5.08 | 0.494 | 0.063 | 196 |
| 18 | 08/04/03 | 780 | 6.52 | 0.495 | 0.060 | 89 |
| 19 | 08/11/03 | 190 | 3.66 | 0.225 | 0.029 | 35 |
| 20 | 08/18/03 | 52 | 2.42 | 0.110 | 0.100 | 35 |
| 21 | 08/25/03 | 35 | 3.09 | 0.081 | 0.027 | 14 |
| 22 | 09/02/03 | 2 | 10.54 | 0.518 | 0.119 | 103 |
| 23 | 09/08/03 | 48 | 3.55 | 0.150 | 0.047 | 26 |
| 24 | 09/15/03 | 168 | 3.44 | 0.085 | 0.022 | 44 |
| 25 | 09/22/03 | 132 | 3.15 | 0.120 | 0.100 | 28 |
| 26 | 09/29/03 | 176 | 5.98 | 0.331 | 0.052 | 65 |
| 27 | 10/06/03 | 76 | 3.49 | 0.181 | 0.051 | 31 |
| 28 | 10/13/03 | 106 | 1.67 | 0.132 | 0.004 | 19 |
| 29 | 10/27/03 | 18 | 2.38 | 0.112 | 0.018 | 18 |
| | Max. | 1300 | 12.57 | 1.426 | 0.427 | 372 |
| | Min. | 2 | 1.67 | 0.020 | 0.003 | 14 |
| | Avg. | 184 | 4.44 | 0.264 | 0.089 | 72 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l,
TSS = Total Suspended Solids mg/l

Jim Cornell

**City of Fort Wayne River Survey 2003**

**St. Joseph River @ Tennessee Street**

| Wk | Date | ECOLI | Depth(ft) | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|
| 1 | 04/07/03 | 8 | 13.53 | 0.348 | 0.181 | 90 |
| 2 | 04/14/03 | 34 | 11.69 | No Sample | 0.081 | 25 |
| 3 | 04/21/03 | 5 | 11.55 | 0.130 | 0.100 | 9 |
| 4 | 04/28/03 | 3 | 11.31 | 0.079 | 0.003 | 26 |
| 5 | 05/05/03 | 12 | 14.12 | 0.174 | 0.062 | 124 |
| 6 | 05/12/03 | 700 | 18.73 | 0.358 | 0.313 | 176 |
| 7 | 05/19/03 | 78 | 12.27 | 0.140 | 0.100 | 39 |
| 8 | 05/27/03 | 76 | 11.01 | 0.225 | 0.027 | 28 |
| 9 | 06/02/03 | 38 | 11.30 | 0.057 | 0.003 | 27 |
| 10 | 06/09/03 | 80 | 11.32 | 0.021 | 0.003 | 14 |
| 11 | 06/16/03 | 130 | 13.38 | 0.100 | 0.100 | 22 |
| 12 | 06/23/03 | 40 | 11.92 | 0.120 | 0.018 | 35 |
| 13 | 06/30/03 | 190 | 11.29 | 0.131 | 0.053 | 26 |
| 14 | 07/07/03 | 360 | 15.36 | 0.136 | 0.047 | 54 |
| 15 | 07/15/03 | 500 | 13.91 | 0.793 | 0.011 | 42 |
| 16 | 07/21/03 | 440 | 14.37 | 0.350 | 0.100 | 236 |
| 17 | 07/28/03 | 60 | 12.95 | 0.192 | 0.023 | 72 |
| 18 | 08/04/03 | 640 | 14.46 | 0.316 | 0.077 | 87 |
| 19 | 08/11/03 | 120 | 12.01 | 0.145 | 0.012 | 31 |
| 20 | 08/18/03 | 54 | 11.51 | 0.100 | 0.100 | 28 |
| 21 | 08/25/03 | 20 | 11.20 | 0.126 | 0.155 | 13 |
| 22 | 09/02/03 | 8 | 15.51 | 0.541 | 0.076 | 200 |
| 23 | 09/08/03 | 96 | 12.16 | 0.110 | 0.029 | 20 |
| 24 | 09/15/03 | 92 | 12.07 | 0.009 | 0.024 | 38 |
| 25 | 09/22/03 | 92 | 11.93 | 0.110 | 0.100 | 25 |
| 26 | 09/29/03 | 184 | 14.30 | 0.279 | 0.043 | 63 |
| 27 | 10/06/03 | 104 | 11.96 | 0.153 | 0.039 | 22 |
| 28 | 10/13/03 | 20 | 11.58 | 0.107 | 0.009 | 18 |
| 29 | 10/27/03 | 23 | 11.69 | 0.062 | 0.034 | 22 |
| | Max. | 700 | 18.73 | 0.793 | 0.313 | 236 |
| | Min. | 3 | 11.01 | 0.009 | 0.003 | 9 |
| | Avg. | 145 | 12.77 | 0.193 | 0.066 | 56 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l,

TSS = Total Suspended Solids mg/l

Jim Cornell

**City of Fort Wayne River Survey 2004**

**St. Joseph River @ Mayhew Road**

| Wk | Date | ECOLI | Depth(ft) | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|
| 1 | 04/05/04 | 74 | 1.74 | 0.17 | 0.009 | 25 |
| 2 | 04/12/04 | 24 | 3.00 | 0.09 | 0.009 | 28 |
| 3 | 04/19/04 | 25 | 2.73 | 0.12 | 0.100 | 43 |
| 4 | 04/26/04 | 58 | 1.97 | 0.17 | 0.060 | 68 |
| 5 | 05/03/04 | 1298 | 3.41 | 0.10 | 0.110 | 48 |
| 6 | 05/11/04 | 839 | 3.46 | 0.19 | 0.150 | 79 |
| 7 | 05/17/04 | 152 | 3.51 | 0.16 | 0.060 | 45 |
| 8 | 05/24/04 | 9680 | 10.24 | 0.50 | 0.200 | 312 |
| 9 | 06/01/04 | 7740 | 10.44 | 0.45 | 0.160 | 180 |
| 10 | 06/07/04 | 346 | 3.22 | 0.39 | 0.030 | 62 |
| 11 | 06/14/04 | 2324 | 12.47 | 0.18 | 0.210 | 108 |
| 12 | 06/21/04 | 312 | 6.15 | 0.21 | 0.100 | 73 |
| 13 | 06/28/04 | 107 | 2.95 | 0.08 | 0.010 | 36 |
| 14 | 07/06/04 | 126 | 4.38 | 0.08 | 0.008 | 20 |
| 15 | 07/12/04 | 104 | 4.43 | 0.14 | 0.008 | 60 |
| 16 | 07/19/04 | 537 | 3.35 | 0.16 | 0.100 | 55 |
| 17 | 07/26/04 | 214 | 3.42 | 0.27 | 0.090 | 77 |
| 18 | 08/02/04 | 62 | 3.52 | 0.10 | 0.010 | 24 |
| 19 | 08/09/04 | 40 | 2.65 | 0.16 | 0.009 | 52 |
| 20 | 08/16/04 | Failed | 3.87 | 0.08 | 0.020 | 47 |
| 21 | 08/23/04 | 422 | 3.50 | 0.16 | 0.100 | 44 |
| 22 | 08/30/04 | 196 | 3.87 | 0.08 | 0.030 | 36 |
| 23 | 09/07/04 | 786 | 4.05 | 0.09 | 0.009 | 29 |
| 24 | 09/13/04 | 220 | 3.92 | 0.10 | 0.008 | 34 |
| 25 | 09/21/04 | 146 | 3.87 | 0.12 | 0.014 | 19 |
| 26 | 09/27/04 | 166 | 3.56 | 0.14 | 0.100 | 29 |
| 27 | 10/04/04 | 110 | 3.50 | 0.09 | 0.020 | 26 |
| 28 | 10/11/04 | 88 | 2.95 | 0.17 | 0.026 | 22 |
| 29 | 10/18/04 | 53 | 1.91 | 0.10 | 0.100 | 14 |
| 30 | 10/25/04 | 99 | 1.93 | 0.13 | 0.016 | 21 |
| | Max. | 9680 | 10.44 | 0.50 | 0.210 | 312 |
| | Min. | 24 | 1.74 | 0.08 | 0.008 | 14 |
| | Avg. | 909 | 4.13 | 0.17 | 0.062 | 57 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l,

TSS = Total Suspended Solids mg/l

**City of Fort Wayne River Survey 2004**

**St. Joseph River @ Tennessee Street**

| Wk | Date | ECOLI | Depth(ft) | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|
| 1 | 04/05/04 | 20 | 11.62 | 0.13 | 0.009 | 22 |
| 2 | 04/12/04 | 21 | 11.70 | 0.12 | 0.009 | 25 |
| 3 | 04/19/04 | 14 | 11.73 | 0.09 | 0.100 | 30 |
| 4 | 04/26/04 | 36 | 11.87 | 0.10 | 0.040 | 21 |
| 5 | 05/03/04 | 1454 | 12.09 | 0.08 | 0.070 | 30 |
| 6 | 05/11/04 | 238 | 12.18 | 0.10 | 0.110 | 39 |
| 7 | 05/17/04 | 93 | 12.03 | 0.15 | 0.160 | 33 |
| 8 | 05/24/04 | 9680 | 14.61 | 0.57 | 0.200 | 434 |
| 9 | 06/01/04 | 6520 | 15.57 | 0.44 | 0.120 | 230 |
| 10 | 06/07/04 | 218 | 12.01 | 0.33 | 0.030 | 48 |
| 11 | 06/14/04 | 3309 | 20.83 | 0.17 | 0.190 | 180 |
| 12 | 06/21/04 | 126 | 13.22 | 0.20 | 0.100 | 8 |
| 13 | 06/28/04 | 190 | 11.92 | 0.08 | 0.008 | 34 |
| 14 | 07/06/04 | 20 | 11.57 | 0.08 | 0.008 | 22 |
| 15 | 07/12/04 | 1288 | 11.78 | 0.13 | 0.008 | 66 |
| 16 | 07/19/04 | 85 | 11.56 | 0.13 | 0.100 | 31 |
| 17 | 07/26/04 | 320 | 12.18 | 0.15 | 0.080 | 50 |
| 18 | 08/02/04 | 82 | 12.12 | 0.13 | 0.010 | 16 |
| 19 | 08/09/04 | 104 | 11.71 | 0.11 | 0.009 | 33 |
| 20 | 08/16/04 | Failed | 11.30 | 0.05 | 0.020 | 33 |
| 21 | 08/23/04 | 190 | 11.95 | 0.12 | 0.100 | 30 |
| 22 | 08/30/04 | 1488 | 13.27 | 0.11 | 0.010 | 30 |
| 23 | 09/07/04 | 840 | 12.74 | 0.09 | 0.009 | 13 |
| 24 | 09/13/04 | 82 | 11.74 | 0.12 | 0.008 | 24 |
| 25 | 09/21/04 | 85 | 6.68 | 0.17 | 0.023 | 32 |
| 26 | 09/27/04 | 66 | 5.83 | 0.12 | 0.100 | 41 |
| 27 | 10/04/04 | 110 | 6.35 | 0.15 | 0.020 | 35 |
| 28 | 10/11/04 | 58 | 11.72 | 0.21 | 0.022 | 31 |
| 29 | 10/18/04 | 39 | 11.74 | 0.10 | 0.100 | 23 |
| 30 | 10/25/04 | 613 | 8.75 | 0.11 | 0.008 | 28 |
| | Max. | 9680 | 20.83 | 0.57 | 0.200 | 434 |
| | Min. | 14 | 5.83 | 0.05 | 0.008 | 8 |
| | Avg. | 944 | 11.81 | 0.15 | 0.059 | 56 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l,

TSS = Total Suspended Solids mg/l

**City of Fort Wayne   River Survey 2005**

**St. Joseph River @ Mayhew Road**

| Wk | Date | Depth(ft) | ECOLI | DO | Temp(F) | pH | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04/04/05 | 3.29 | 37 | 12.27 | 47.2 | 6.87 | 0.15 | 0.020 | 8 |
| 2 | 04/11/05 | 2.92 | 37 | 10.53 | 56.9 | 7.28 | 0.09 | 0.024 | 28 |
| 3 | 04/18/05 | 2.54 | 32 | 11.7 | 58.4 | 7.72 | 0.05 | 0.100 | 32 |
| 4 | 04/25/05 | 2.95 | 179 | 12.71 | 45.7 | 7.01 | 0.03 | 0.061 | 16 |
| 5 | 05/02/05 | 2.39 | 40 | 12.18 | 49.6 | 7.06 | 0.07 | 0.020 | 17 |
| 6 | 05/09/05 | 2.14 | 43 | 10.74 | 61.1 | 7.34 | 0.07 | 0.020 | 19 |
| 7 | 05/18/05 | 3.06 | 73 | 9.31 | 59.7 | 7.47 | 0.70 | 0.100 | 37 |
| 8 | 05/23/05 | 3.96 | 68 | 5.46 | 62.0 | 8.16 | 0.14 | 0.020 | 30 |
| 9 | 05/31/05 | 3.02 | 44 | No Data | 65.2 | 8.12 | 0.11 | 0.027 | 26 |
| 10 | 06/06/05 | 3.03 | 96 | No Data | 70.3 | 7.92 | 0.08 | 0.080 | 18 |
| 11 | 06/13/05 | 3.22 | 727 | No Data | 75.5 | 7.74 | 0.09 | 0.181 | 38 |
| 12 | 06/20/05 | 2.23 | 73 | 8.32 | 70.0 | 8.12 | 0.12 | 0.100 | 37 |
| 13 | 06/27/05 | 2.35 | 62 | 6.48 | 78.0 | 7.86 | 0.03 | 0.050 | 17 |
| 14 | 07/05/05 | 2.31 | 96 | 5.68 | 76.0 | 7.97 | 0.03 | 0.002 | 32 |
| 15 | 07/11/05 | 2.57 | 57 | 5.34 | 76.6 | 7.93 | 0.13 | 0.002 | 23 |
| 16 | 07/18/05 | 1.59 | 548 | 5.07 | 76.4 | 7.68 | 0.15 | 0.002 | 30 |
| 17 | 07/25/05 | 3.46 | 43 | 9.44 | 81.3 | 8.04 | 0.21 | 0.100 | 47 |
| 18 | 08/01/05 | 1.43 | 88 | 5.14 | 74.3 | 7.82 | 0.16 | 0.092 | 53 |
| 19 | 08/08/05 | 2.23 | 61 | 7.31 | 78.1 | 7.92 | 0.13 | 0.100 | 16 |
| 20 | 08/15/05 | 2.70 | 119 | 5.03 | 74.5 | 7.79 | 0.15 | 0.100 | 26 |
| 21 | 08/22/05 | 1.46 | 158 | 7.51 | 73.5 | 7.76 | 0.19 | 0.100 | 34 |
| 22 | 08/29/05 | 2.14 | 79 | 7.53 | 73.1 | 7.86 | 0.17 | 0.100 | 33 |
| 23 | 09/06/05 | 1.49 | 88 | 7.21 | 70.6 | 7.89 | 0.21 | 0.030 | 20 |
| 24 | 09/13/05 | 1.98 | 727 | 6.86 | 71.8 | 7.89 | 0.13 | 0.100 | 37 |
| 25 | 09/19/05 | 2.09 | 162 | 7.53 | 67.2 | 7.95 | 0.14 | 0.100 | 32 |
| 26 | 09/26/05 | 1.86 | 2420 | 7.92 | 69.1 | 7.68 | 0.32 | 0.100 | 116 |
| 27 | 10/03/05 | 2.46 | 87 | 8.31 | 64.2 | 7.57 | 0.12 | 0.100 | 87 |
| 28 | 10/10/05 | 3.18 | 67 | 9.19 | 57.8 | 7.52 | 0.14 | 0.100 | 25 |
| 29 | 10/17/05 | 1.36 | 115 | 9.52 | 54.9 | 8.09 | 0.10 | 0.100 | 30 |
| 30 | 10/24/05 | 1.12 | 120 | 10.01 | 50.2 | 7.97 | 0.12 | 0.100 | 75 |
| 31 | 10/31/05 | 0.07 | 46 | 10.64 | 49.2 | 7.69 | 0.05 | 0.100 | 17 |
| | Max. | 3.96 | 2420 | 12.71 | 81.30 | 8.16 | 0.70 | 0.181 | 116 |
| | Min. | 0.07 | 32 | 5.03 | 45.70 | 6.87 | 0.03 | 0.002 | 8 |
| | Avg. | 2.34 | 213 | 8.39 | 65.70 | 7.73 | 0.14 | 0.072 | 34 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l, DO = Dissolved Oxygen mg/l

TSS = Total Suspended Solids mg/l

City of Fort Wayne River Survey 2005

St. Joseph River @ Tennessee Street

| Wk | Date | Depth(ft) | ECOLI | DO | Temp(F) | pH | PHOS | NH3-N | TSS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04/04/05 | 12.09 | 19 | 12.45 | 47.5 | 6.76 | 0.20 | 0.020 | 7 |
| 2 | 04/11/05 | 11.74 | 20 | 10.84 | 57.3 | 7.27 | 0.08 | 0.020 | 14 |
| 3 | 04/18/05 | 8.39 | 40 | 12.45 | 57.8 | 7.84 | 0.06 | 0.100 | 28 |
| 4 | 04/25/05 | 12.74 | 387 | 12.29 | 47.1 | 6.62 | 0.01 | 0.030 | 16 |
| 5 | 05/02/05 | 11.11 | 70 | 12.49 | 51.0 | 6.62 | 0.09 | 0.020 | 14 |
| 6 | 05/09/05 | 8.50 | 18 | 11.18 | 62.8 | 7.46 | 0.08 | 0.020 | 13 |
| 7 | 05/18/05 | 8.89 | 110 | 9.93 | 59.0 | 7.56 | 0.10 | 0.100 | 25 |
| 8 | 05/23/05 | 9.38 | 111 | 6.45 | 62.4 | 8.06 | 0.10 | 0.020 | 22 |
| 9 | 05/31/05 | 7.94 | 192 | 5.54 | 65.5 | 8.23 | 0.05 | 0.026 | 20 |
| 10 | 06/06/05 | 7.11 | 5200 | No Data | 69.8 | 7.87 | 0.09 | 0.045 | 26 |
| 11 | 06/13/05 | 8.44 | 1986 | No Data | 76.7 | 7.48 | 0.10 | 0.103 | 8 |
| 12 | 06/20/05 | 6.96 | 109 | 8.01 | 69.7 | 8.03 | 0.09 | 0.100 | 24 |
| 13 | 06/27/05 | 10.53 | 50 | 14.38 | 82.3 | 8.37 | 0.02 | 0.020 | 8 |
| 14 | 07/05/05 | 6.59 | 87 | 5.41 | 76.7 | 7.85 | 0.05 | 0.002 | 18 |
| 15 | 07/11/05 | 5.05 | 157 | 6.02 | 77.5 | 7.82 | 0.16 | 0.002 | 32 |
| 16 | 07/18/05 | 10.73 | 210 | 7.08 | 78.5 | 8.13 | 0.13 | 0.002 | 20 |
| 17 | 07/25/05 | 11.21 | 34 | 9.78 | 81.9 | 7.98 | 0.13 | 0.100 | 12 |
| 18 | 08/01/05 | 10.94 | 99 | 6.07 | 76.1 | 7.88 | 0.14 | 0.148 | 38 |
| 19 | 08/08/05 | 10.14 | 921 | 8.41 | 79.9 | 8.66 | 0.09 | 0.100 | 14 |
| 20 | 08/15/05 | 6.51 | 249 | No Data | 77.6 | 7.78 | 0.14 | 0.100 | 11 |
| 21 | 08/22/05 | 10.70 | 140 | 7.44 | 77.3 | 7.93 | 0.11 | 0.100 | 17 |
| 22 | 08/29/05 | 10.17 | 45 | 7.20 | 76.5 | 8.18 | 0.11 | 0.100 | 14 |
| 23 | 09/06/05 | 10.50 | 35 | 8.79 | 73.5 | 7.92 | 0.26 | 0.421 | 12 |
| 24 | 09/13/05 | 10.43 | 14 | 12.71 | 75.8 | 8.16 | 0.11 | 0.100 | 13 |
| 25 | 09/19/05 | 10.89 | 28 | 8.58 | 70.1 | 8.00 | 0.10 | 0.100 | 8 |
| 26 | 09/26/05 | 11.54 | 1300 | 8.50 | 70.7 | 8.82 | 0.19 | 0.100 | 72 |
| 27 | 10/03/05 | 11.26 | 68 | 9.13 | 71.6 | 8.95 | 0.07 | 0.100 | 18 |
| 28 | 10/10/05 | 11.23 | 40 | 8.16 | 60.8 | 7.16 | 0.12 | 0.100 | 15 |
| 29 | 10/17/05 | 11.20 | 67 | 10.29 | 58.4 | 8.19 | 0.09 | 0.100 | 20 |
| 30 | 10/24/05 | 10.34 | 199 | 8.41 | 53.2 | 7.78 | 0.08 | 0.103 | 21 |
| 31 | 10/31/05 | 11.29 | 16 | 11.77 | 50.7 | 7.49 | 0.02 | 0.100 | 12 |
| | Max. | 12.74 | 5200 | 14.38 | 81.90 | 8.82 | 0.260 | 0.421 | 72 |
| | Min. | 5.05 | 14 | 5.41 | 47.10 | 6.62 | 0.01 | 0.002 | 7 |
| | Avg. | 9.82 | 388 | 9.28 | 67.60 | 7.83 | 0.10 | 0.081 | 19 |

E.Coli = colonies per 100 mls, yellow indicates >235

PHOS = Total Phosphorus mg/l, NH3-N = Ammonia-Nitrogen mg/l, DO = Dissolved Oxygen mg/l

TSS = Total Suspended Solids mg/l

City of Fort Wayne River Survey 2006

St. Joseph River @ Mayhew Road

| Wk | Date | Depth(ft) | pH | DO | Temp(F) | ECOLI | NH3-N | PHOS | TSS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04/03/06 | 4.13 | 7.28 | 11.45 | 49.97 | 613 | 0.05 | 0.15 | 72 |
| 2 | 04/10/06 | 3.23 | 7.32 | 10.99 | 50.65 | 88 | 0.05 | 0.15 | 38 |
| 3 | 04/17/06 | 3.16 | 7.46 | 10.34 | 57.11 | 579 | 0.05 | 0.13 | 62 |
| 4 | 04/24/06 | 2.63 | 7.65 | 9.46 | 58.95 | 100 | 0.05 | 0.03 | 45 |
| 5 | 05/01/06 | 1.55 | 7.27 | 9.88 | 56.71 | 124 | 0.05 | 0.15 | 31 |
| 6 | 05/08/06 | 1.72 | 7.87 | 9.64 | 60.75 | 63 | 0.05 | 0.62 | 32 |
| 7 | 05/15/06 | 8.32 | 7.30 | 10.17 | 52.50 | 1986 | 0.22 | 0.18 | 70 |
| 8 | 05/22/06 | 5.47 | 7.29 | 9.85 | 56.48 | 126 | 0.05 | 0.15 | 62 |
| 9 | 05/30/06 | 3.43 | 7.80 | 8.48 | 73.52 | 54 | 0.05 | 0.03 | 31 |
| 10 | 06/05/06 | 3.54 | 7.10 | 8.53 | 67.62 | 104 | 0.05 | 0.03 | 56 |
| 11 | 06/12/06 | 3.46 | 7.42 | 8.41 | 65.86 | 105 | 0.05 | 0.23 | 21 |
| 12 | 06/19/06 | 1.91 | 7.43 | 6.53 | 71.57 | 36 | 0.05 | 0.12 | 27 |
| 13 | 06/26/06 | 3.81 | 6.81 | 9.46 | 73.64 | 108 | 0.05 | 0.23 | 63 |
| 14 | 07/06/06 | 2.80 | 7.80 | 9.16 | 72.12 | 72 | 0.05 | 0.29 | 47 |
| 15 | 07/10/06 | 3.56 | 7.47 | 7.11 | 74.15 | 112 | 0.05 | 0.41 | 80 |
| 16 | 07/17/06 | 6.16 | 6.90 | 7.28 | 75.22 | 238 | 0.05 | 0.28 | 122 |
| 17 | 07/24/06 | 3.61 | 7.40 | 7.31 | 74.27 | 71 | 0.05 | 0.12 | 20 |
| 18 | 07/31/06 | 5.68 | 7.24 | 7.45 | 76.31 | 387 | 0.05 | 0.21 | 63 |
| 19 | 08/07/06 | 3.67 | 6.93 | 7.09 | 77.93 | 345 | 0.05 | 0.25 | 56 |
| 20 | 08/14/06 | 2.45 | 7.52 | 7.03 | 71.91 | 62 | 0.05 | 0.30 | 31 |
| 21 | 08/21/06 | 2.23 | 7.91 | 6.70 | 71.53 | 99 | 0.05 | 0.14 | 38 |
| 22 | 08/28/06 | 2.19 | 7.65 | 6.21 | 74.56 | 172 | 0.05 | 0.29 | 40 |
| 23 | 09/05/06 | 2.77 | 7.13 | 8.17 | 66.40 | 219 | 0.05 | 0.17 | 33 |
| 24 | 09/11/06 | 2.91 | 7.26 | 7.39 | 65.82 | 50 | 0.05 | 0.18 | 21 |
| 25 | 09/18/06 | 2.61 | 7.68 | 7.16 | 68.00 | 206 | 0.05 | 0.11 | 30 |
| 26 | 09/26/06 | 2.43 | 7.63 | 10.63 | 59.58 | 485 | 0.05 | 0.16 | 54 |
| 27 | 10/02/06 | 2.16 | 7.27 | 9.07 | 58.51 | 2420 | 0.05 | 0.21 | 38 |
| 28 | 10/09/06 | 2.15 | 6.75 | 9.49 | 57.25 | 145 | 0.05 | 0.37 | 36 |
| 29 | 10/16/06 | 3.02 | 6.76 | 7.91 | 48.45 | 159 | 0.30 | 0.91 | 856/59 |
| 30 | 10/23/06 | 3.03 | 6.61 | 9.60 | 48.50 | 145 | 0.05 | 0.33 | 82 |
|  | Max. | 8.32 | 7.91 | 11.45 | 77.93 | 2420 | 0.30 | 0.91 | 122 |
|  | Min. | 1.55 | 6.61 | 6.21 | 48.45 | 36 | 0.05 | 0.03 | 20 |
|  | Avg. | 3.33 | 7.33 | 8.60 | 64.53 | 316 | 0.06 | 0.23 | 49 |

DO = Dissolved Oxygen mg/l, E.Coli = colonies per 100 mls (yellow indicates >235)
NH3-N = Ammonia Nitrogen mg/l, PHOS = Total Phosphorus mg/l
TSS = Total Suspended Solids mg/l
Original TSS value of 856 mg/l on 10/16/06 was caused by short-term maintenance at the Cedarville Dam.
TSS value of 59 mg/l (average of 10/09/06 and 10/23/06) was used for Max., Min., and Avg. calculations.

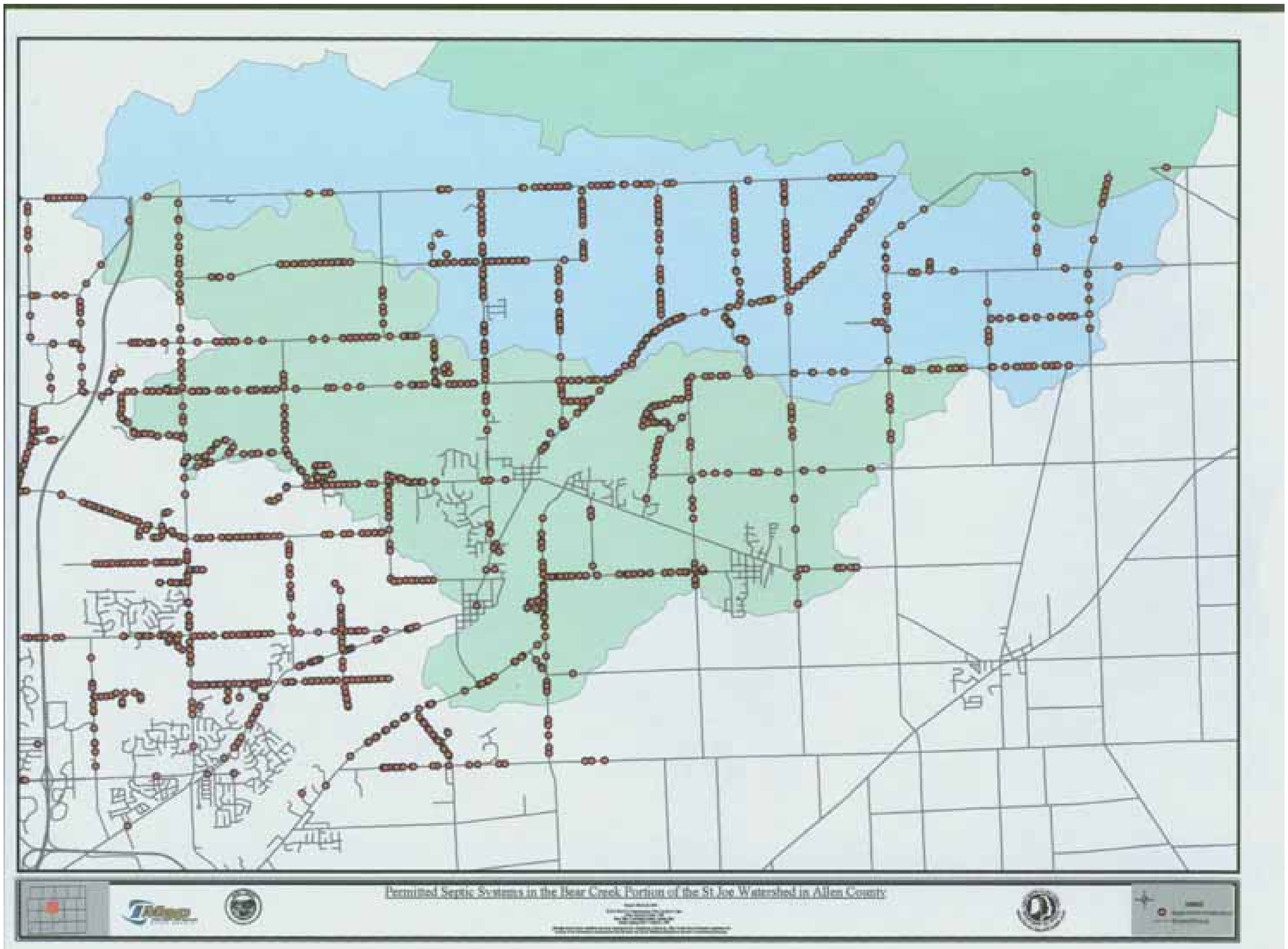
City of Fort Wayne River Survey 2006

St. Joseph River @ Tennessee Street

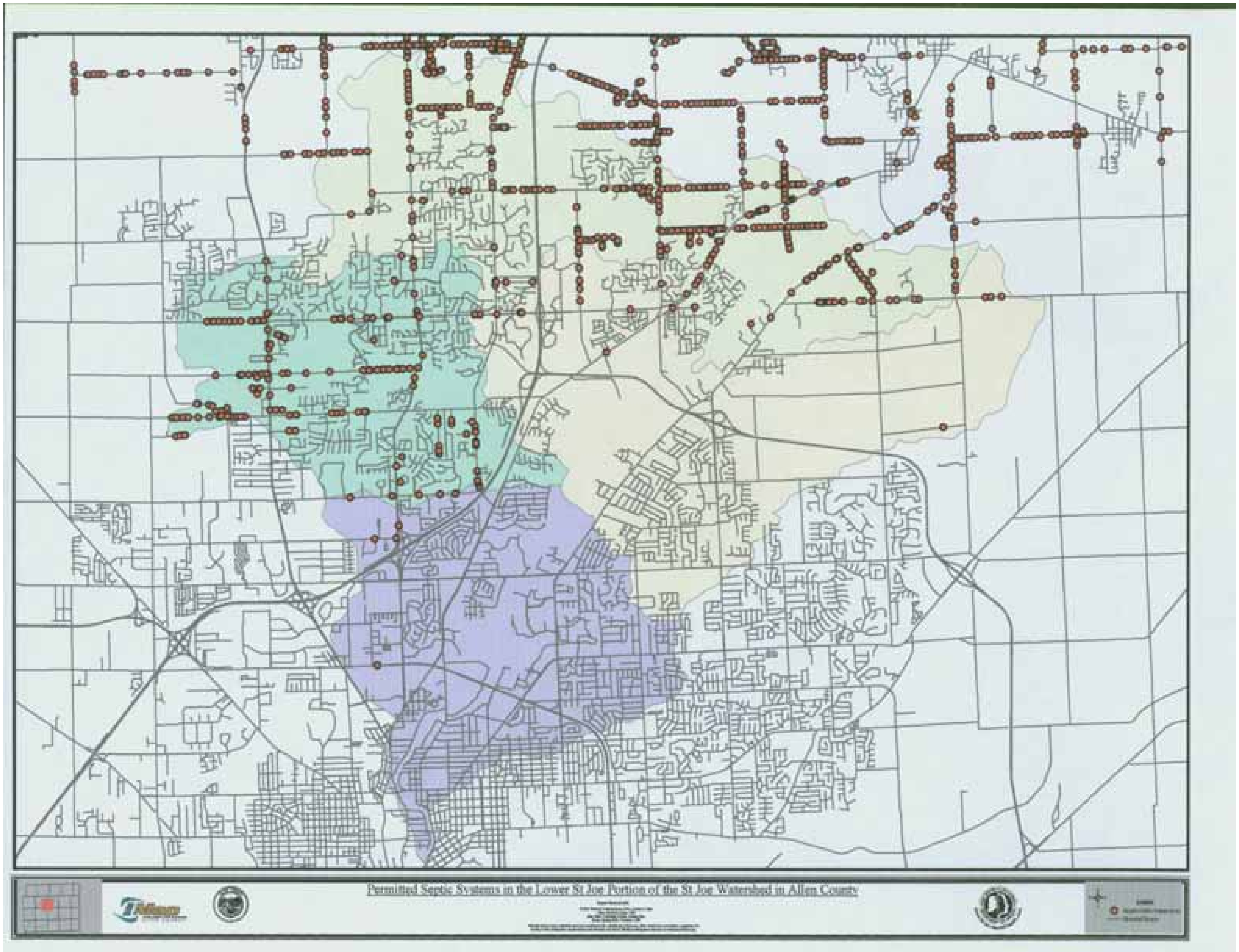
| Wk | Date | Depth(ft) | pH | DO | Temp(F) | ECOLI | NH3-N | PHOS | TSS |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 04/03/06 | 11.56 | 7.25 | 12.19 | 50.28 | 517 | 0.05 | 0.05 | 30 |
| 2 | 04/10/06 | 10.66 | 7.43 | 11.51 | 51.09 | 70 | 0.05 | 0.11 | 42 |
| 3 | 04/17/06 | 12.9 | 7.48 | 10.40 | 60.07 | 866 | 0.05 | 0.10 | 28 |
| 4 | 04/24/06 | 9.92 | 7.51 | 9.69 | 60.61 | 100 | 0.05 | 0.14 | 37 |
| 5 | 05/01/06 | 8.48 | 7.43 | 9.67 | 57.68 | 308 | 0.05 | 0.18 | 28 |
| 6 | 05/08/06 | 9.32 | 8.07 | 10.45 | 62.44 | 45 | 0.05 | 0.31 | 28 |
| 7 | 05/15/06 | 13.97 | 7.38 | 10.60 | 52.80 | 687 | 0.24 | 0.29 | 54 |
| 8 | 05/22/06 | 12.78 | 7.47 | 10.28 | 59.29 | 86 | 0.05 | 0.12 | 46 |
| 9 | 05/30/06 | 11.02 | 7.99 | 9.65 | 73.64 | 86 | 0.05 | 0.03 | 21 |
| 10 | 06/05/06 | 11.14 | 7.21 | 8.80 | 68.74 | 184 | 0.05 | 0.06 | 28 |
| 11 | 06/12/06 | 10.97 | 7.49 | 8.65 | 67.46 | 126 | 0.05 | 0.06 | 20 |
| 12 | 06/19/06 | 10.81 | 7.61 | 6.84 | 73.81 | 228 | 0.05 | 0.90 | 16 |
| 13 | 06/26/06 | 11.54 | 7.28 | 7.51 | 74.57 | 122 | 0.05 | 0.19 | 34 |
| 14 | 07/06/06 | 10.89 | 7.91 | 9.88 | 73.45 | 66 | 0.05 | 0.25 | 31 |
| 15 | 07/10/06 | 11.48 | 7.36 | 7.53 | 74.55 | 45 | 0.05 | 0.10 | 42 |
| 16 | 07/17/06 | 12.56 | 7.12 | 8.16 | 76.76 | 372 | 0.05 | 0.21 | 59 |
| 17 | 07/24/06 | 10.19 | 7.56 | 7.48 | 75.88 | 96 | 0.05 | 0.14 | 24 |
| 18 | 07/31/06 | 11.35 | 7.49 | 7.74 | 78.00 | 488 | 0.05 | 0.19 | 35 |
| 19 | 08/07/06 | 8.29 | 7.19 | 7.10 | 78.86 | 81 | 0.05 | 0.16 | 40 |
| 20 | 08/14/06 | 5.24 | 7.84 | 6.66 | 73.73 | 58 | 0.05 | 0.21 | 27 |
| 21 | 08/21/06 | 6.92 | 7.91 | 7.37 | 73.73 | 365 | 0.05 | 0.13 | 18 |
| 22 | 08/28/06 | 4.19 | 7.67 | 6.27 | 75.03 | 240 | 0.05 | 0.09 | 33 |
| 23 | 09/05/06 | 6.50 | 7.27 | 8.64 | 69.15 | 133 | 0.05 | 0.08 | 23 |
| 24 | 09/11/06 | 5.62 | 7.53 | 8.96 | 67.34 | 201 | 0.05 | 0.16 | 35 |
| 25 | 09/18/06 | 7.61 | 7.60 | 8.06 | 68.09 | 3000 | 0.05 | 0.10 | 36 |
| 26 | 09/26/06 | 10.75 | 7.80 | 11.27 | 61.14 | 261 | 0.05 | 0.10 | 31 |
| 27 | 10/02/06 | 11.48 | 7.50 | 10.99 | 60.40 | 2420 | 0.05 | 0.16 | 29 |
| 28 | 10/09/06 | 11.13 | 7.17 | 9.58 | 57.94 | 205 | 0.05 | 0.62 | 34 |
| 29 | 10/16/06 | 11.44 | 7.08 | 11.55 | 49.70 | 411 | 0.05 | 0.15 | 52 |
| 30 | 10/23/06 | 12.30 | 6.87 | 11.03 | 49.20 | 36 | 0.05 | 0.19 | 46 |
| | Max. | 13.97 | 8.07 | 12.19 | 78.86 | 3000 | 0.24 | 0.90 | 59 |
| | Min. | 4.19 | 6.87 | 6.27 | 49.20 | 36 | 0.05 | 0.03 | 16 |
| | Avg. | 10.10 | 7.48 | 9.15 | 65.85 | 397 | 0.06 | 0.18 | 34 |

DO = Dissolved Oxygen mg/l, E.Coli = colonies per 100 mls (yellow indicates >235)
NH3-N = Ammonia Nitrogen mg/l, PHOS = Total Phosphorus mg/l
TSS = Total Suspended Solids mg/l

Appendix J Permitted Septic Systems, Allen County




Permitted septic systems in the Bear Creek sub-watershed within Allen county are shaded blue and green in this map. (Allen Co. I-Map)




Permitted septic systems in the Lower St. Joseph sub-watershed, Allen County are shown in the lavender, dark green, light green and yellow sections of this map. (Allen Co. I-Map)

# Rare and Endangered Animals of Indiana

Revised 09/04

The Wildlife Diversity Section protects and manages over 700 animal species in Indiana including those on this list. You can support these efforts by donating to the Indiana Nongame Fund on the Indiana State income tax form or through a direct donation.

## Indiana Protection

Vertebrates, mollusks and crustaceans classified as endangered in Indiana are protected from taking pursuant to the Nongame and Endangered Species Act of 1973 (IC 14-22-34) and Fish and Wildlife Administrative Rules (312 IAC).

## Indiana Classifications

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

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

## Federal Classifications

**Endangered-** Any species that is in danger of extinction throughout all or a significant portion of its range. Federal-endangered species are designated with "FE."

**Threatened-** Any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Federal-threatened species are designated with "FT."

**Candidate-** Any species that has been submitted for review for protection under the Federal Endangered Species Act. If added to the federal list, it will automatically be considered a state-endangered species in Indiana. Candidates for the Federal list are designated with "FC."

### AMPHIBIANS

Endangered

| | |
|---|---|
| Crawfish frog | *Rana areolata* |
| Four-toed salamander | *Hemidactylium scutatum* |
| Green salamander | *Aneides aeneus* |
| Hellbender | *Cryptobranchus alleganiensis* |
| Red salamander | *Pseudotriton ruber* |

Special Concern

| | |
|---|---|
| Blue-spotted salamander | *Ambystoma laterale* |
| Eastern spadefoot | *Scaphiopus holbrookii* |
| Common mudpuppy | *Necturus maculosus* |
| Northern leopard frog | *Rana pipiens* |
| Plains leopard frog | *Rana blairi* |

### BIRDS

Endangered

| | |
|---|---|
| American bittern | *Botaurus lentiginosus* |
| Bald eagle (FT) | *Haliaeetus leucocephalus* |
| Barn owl | *Tyto alba* |
| Black rail | *Laterallus jamaicensis* |
| Black tern | *Chlidonias niger* |
| Black-crowned night-heron | *Nycticorax nycticorax* |
| Common moorhen | *Gallunula chloropus* |
| Golden-winged warbler | *Vermivora chrysoptera* |
| Henslow's sparrow | *Ammodramus henslowii* |
| King rail | *Rallus elegans* |
| Kirtland's warbler (FE) | *Dendroica kirtlandii* |

### BIRDS (cont.)

| | |
|---|---|
| Least bittern | *Ixobrychus exilis* |
| Least tern (FE) | *Sterna antillarum* |
| Loggerhead shrike | *Lanius ludovicianus* |
| Marsh wren | *Cistothorus palustris* |
| Northern harrier | *Circus cyaneus* |
| Osprey | *Pandion haliaetus* |
| Peregrine falcon | *Falco peregrinus* |
| Piping plover (FE) | *Charadrius melodus* |
| Sedge wren | *Cistothorus platensis* |
| Short-eared owl | *Asio flammeus* |
| Trumpeter swan | *Cygnus buccinator* |
| Upland sandpiper | *Bartramia longicauda* |
| Virginia rail | *Rallus limicola* |
| Whooping crane (FE) | *Grus americana* |
| Yellow-crowned night-heron | *Nyctanassa violacea* |
| Yellow-headed blackbird | *Xanthocephalus xanthocephalus* |

Special Concern

| | |
|---|---|
| Black-and-white warbler | *Mniotilta varia* |
| Broad-winged hawk | *Buteo platypterus* |
| Cerulean warbler | *Dendroica cerulea* |
| Common nighthawk | *Chordeiles minor* |
| Great egret | *Ardea alba* |
| Hooded warbler | *Wilsonia citrina* |
| Mississippi kite | *Ictinia mississippiensis* |
| Red-shouldered hawk | *Buteo lineatus* |
| Sandhill crane | *Grus canadensis* |
| Sharp-shinned hawk | *Accipiter striatus* |
| Western meadowlark | *Sturnella neglecta* |
| Whip-poor-will | *Caprimulgus vociferus* |
| Worm-eating warbler | *Helmitheros vermivorum* |

## FISHES

### Endangered

| | |
|---|---|
| Bantam sunfish | *Lepomis symmetricus* |
| Channel darter | *Percina copelandi* |
| Gilt darter | *Percina evides* |
| Greater redhorse | *Moxostoma valenciennesi* |
| Lake sturgeon | *Acipenser fulvescens* |
| Northern brook lamprey | *Ichthyomyzon fossor* |
| Northern cavefish | *Amblyopsis spelaea* |
| Pallid shiner | *Hybopsis amnis* |
| Redside dace | *Clinostomus elongatus* |
| Variegate darter | *Etheostoma variatum* |

### Special Concern

| | |
|---|---|
| Banded pygmy sunfish | *Elassoma zonatum* |
| Bigmouth shiner | *Notropis dorsalis* |
| Cisco | *Coregonus artedi* |
| Cypress darter | *Etheostoma proeliare* |
| Lake whitefish | *Coregonus clupeaformis* |
| Longnose dace | *Rhinichthys cataractae* |
| Longnose sucker | *Catostomus catostomus* |
| Northern madtom | *Noturus stigmosus* |
| Ohio River muskellunge | *Esox masqinongy ohioensis* |
| Pugnose shiner | *Notropis anogenus* |
| Slimy sculpin | *Cottus cognatus* |
| Spotted darter | *Etheostoma maculatum* |
| Tippecanoe darter | *Etheostoma tippecanoe* |
| Trout-perch | *Percopsis omiscomaycus* |
| Western sand darter | *Ammocrypta clara* |

## MAMMALS

### Endangered

| | |
|---|---|
| Allegheny woodrat | *Neotoma magister* |
| Badger | *Taxidea taxus* |
| Bobcat | *Lynx rufus* |
| Evening bat | *Nycticeius humeralis* |
| Franklin's ground squirrel | *Spermophilus franklinii* |
| Gray myotis (FE) | *Myotis grisescens* |
| Indiana myotis (FE) | *Myotis sodalis* |
| River otter | *Lontra canadensis* |
| Southeastern myotis | *Myotis austroriparius* |
| Swamp rabbit | *Sylvilagus aquaticus* |

### Special Concern

| | |
|---|---|
| Eastern pipistrelle | *Pipistrellus subflavus* |
| Eastern red bat | *Lasiurus borealis* |
| Hoary bat | *Lasiurus cinereus* |
| Least weasel | *Mustela nivalis* |
| Little brown myotis | *Myotis lucifugus* |
| Northern myotis | *Myotis septentrionalis* |
| Plains pocket gopher | *Geomys bursarius* |
| Pygmy shrew | *Sorex hoyi* |
| Rafinesque's big-eared bat | *Corynorhinus rafinesquii* |
| Silver-haired bat | *Lasionycteris noctivagans* |
| Smoky shrew | *Sorex fumeus* |
| Star-nosed mole | *Condylura cristata* |

## MOLLUSKS

### Endangered

| | |
|---|---|
| Clubshell (FE) | *Pleurobema clava* |
| Eastern fanshell (FE) | *Cyprogenia stegaria* |
| Fat pocketbook (FE) | *Potamilus capax* |
| Longsolid | *Fusconaia subrotunda* |
| Northern riffleshell (FE) | *Epioblasma torulosa rangiana* |
| Orangefoot pimpleback (FE) | *Plethobasus cooperianus* |
| Pink mucket (FE) | *Lampsilis abrupta* |
| Pyramid pigtoe | *Pleurobema rubrum* |
| Rabbitsfoot | *Quadrula cylindrica cylindrica* |

## MOLLUSKS (cont.)

| | |
|---|---|
| Rough pigtoe (FE) | *Pleurobema plenum* |
| Sheepnose (FC) | *Plethobasus cyphyus* |
| Snuffbox | *Epioblasma triquetra* |
| Tubercled blossom (FE) | *Epioblasma torulosa torulosa* |
| White catspaw (FE) | *Epioblasma obliquata perobliqua* |
| White wartyback (FE) | *Plethobasus cicatricosus* |

### Special Concern

| | |
|---|---|
| Ellipse | *Venustaconcha ellipsiformis* |
| Kidneyshell | *Ptychobranchus fasciolaris* |
| Little spectaclecase | *Villosa lienosa* |
| Ohio pigtoe | *Pleurobema cordatum* |
| Pointed campeloma | *Campeloma decisum* |
| Purple lilliput | *Toxolasma lividus* |
| Rayed bean (FC) | *Villosa fabalis* |
| Round hickorynut | *Obovaria subrotunda* |
| Salamander mussel | *Simpsonaias ambigua* |
| Swamp lymnaea | *Lymnaea stagnalis* |
| Wavyrayed lampmussel | *Lampsilis fasciola* |

## REPTILES

### Endangered

| | |
|---|---|
| Alligator snapping turtle | *Macrochelys temminckii* |
| Blanding's turtle | *Emydoidea blandingii* |
| Butler's garter snake | *Thamnophis butleri* |
| Copperbelly water snake (FT*) | *Nerodia erythrogaster neglecta* |
| Cottonmouth | *Agkistrodon piscivorus* |
| Eastern mud turtle | *Kinosternon subrubrum* |
| Hieroglyphic river cooter | *Pseudemys concinna* |
| Kirtland's snake | *Clonophis kirtlandii* |
| Massasauga (FC) | *Sistrurus catenatus* |
| Ornate box turtle | *Terrapene ornate* |
| Scarlet snake | *Cemophora coccinea* |
| Smooth green snake | *Liochlorophis vernalis* |
| Southeastern crowned snake | *Tantilla coronata* |
| Spotted turtle | *Clemmys guttata* |
| Timber rattlesnake | *Crotalus horridus* |
| Western mud snake | *Farancia abacura* |

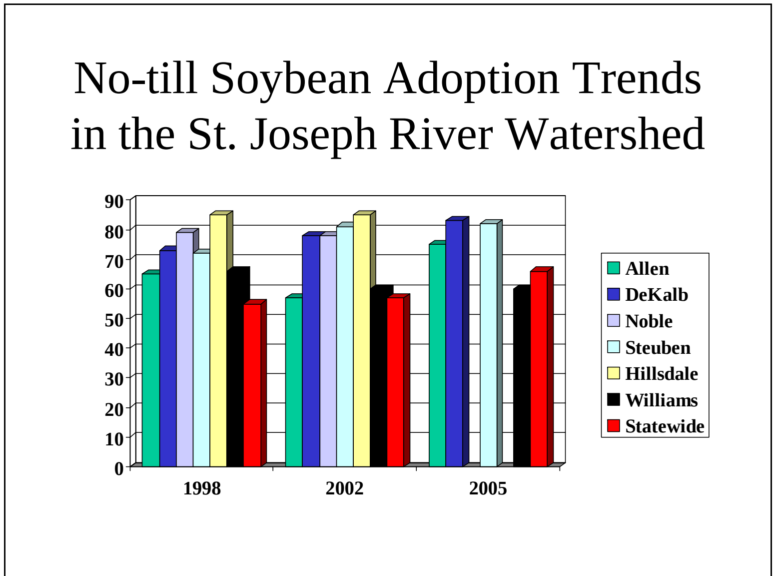
### Special Concern

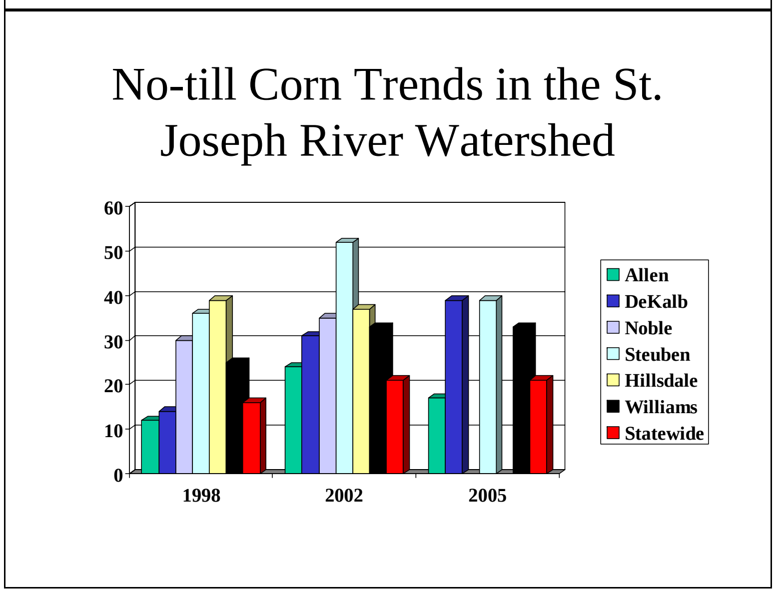
| | |
|---|---|
| Rough green snake | *Opheodrys aestivus* |
| Western ribbon snake | *Thamnophis proximus* |

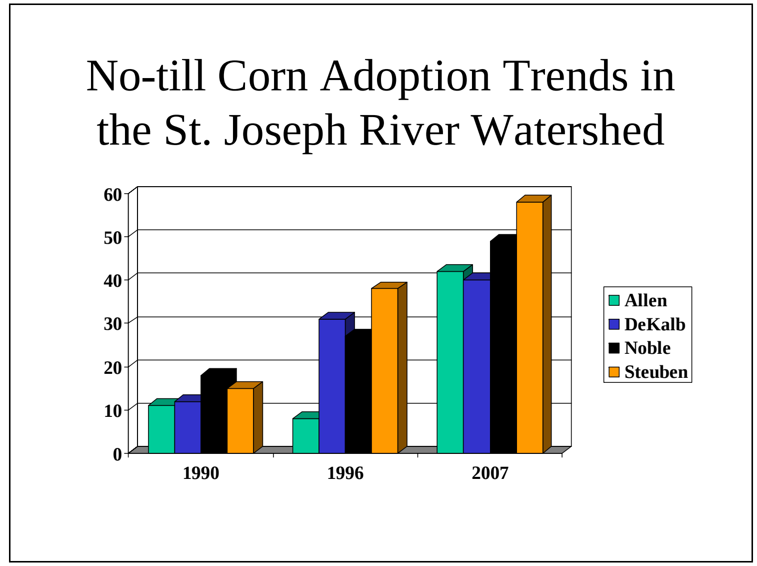
*Northern population only

Wildlife Diversity Section
Division of Fish and Wildlife
402 W. Washington St., W273
Indianapolis, IN 46204
317-232-4080

www.IN.gov/dnr/fishwild/endangered/



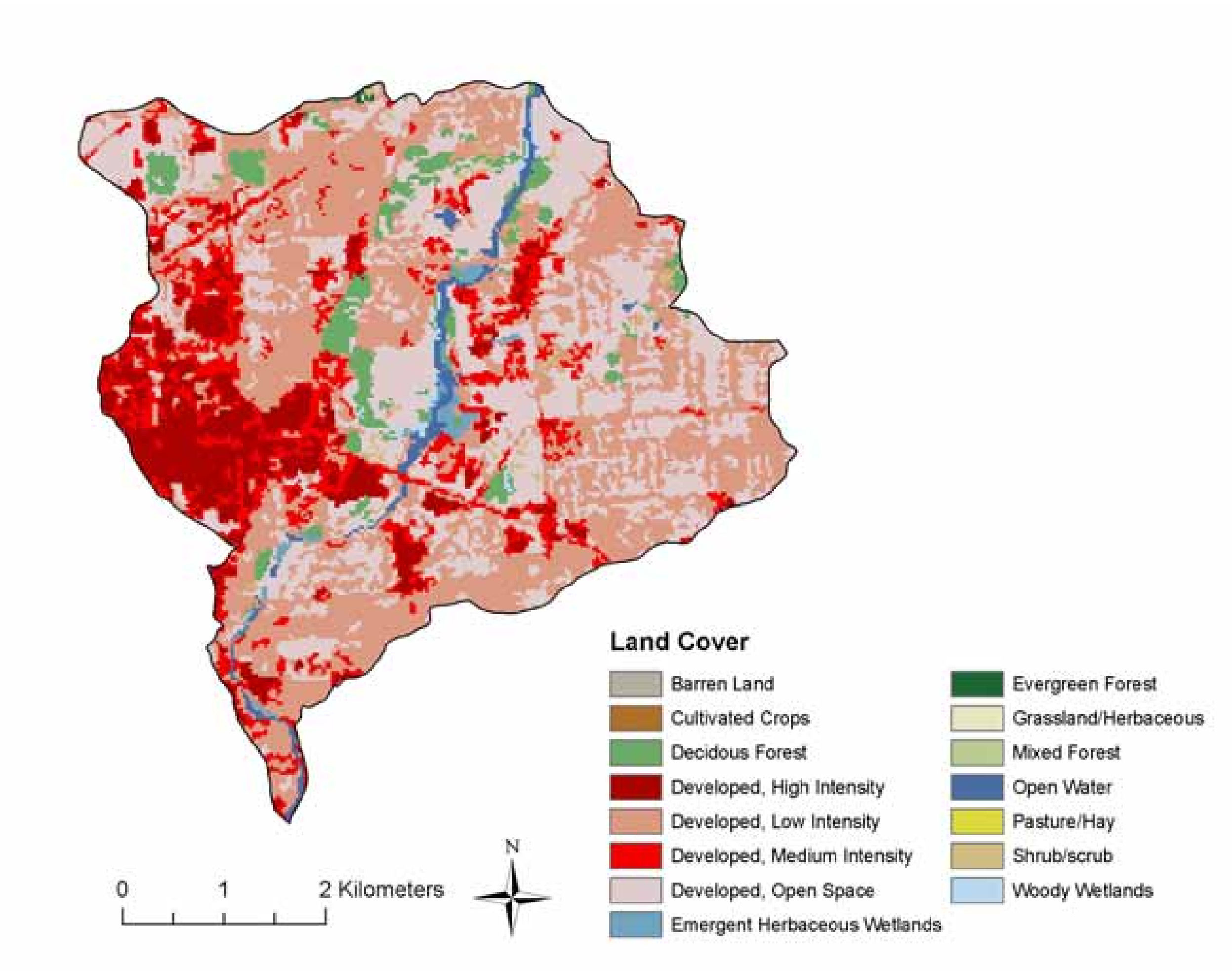




Source: J. Lake, Indiana State Department of Agriculture, 2007.

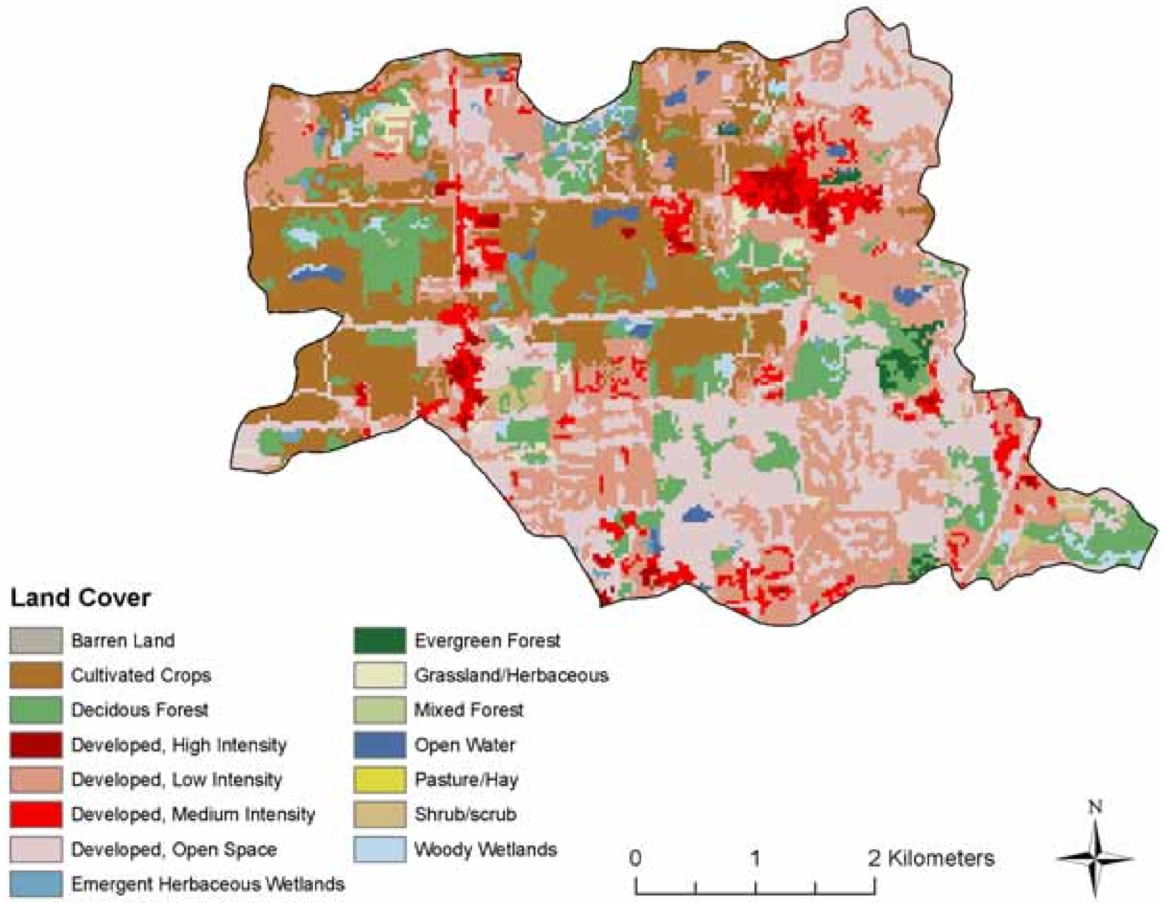
Appendix M    Land use maps and tables, 14-Digit HUC areas

M-1    Land Use 2001, Schoppman Drain



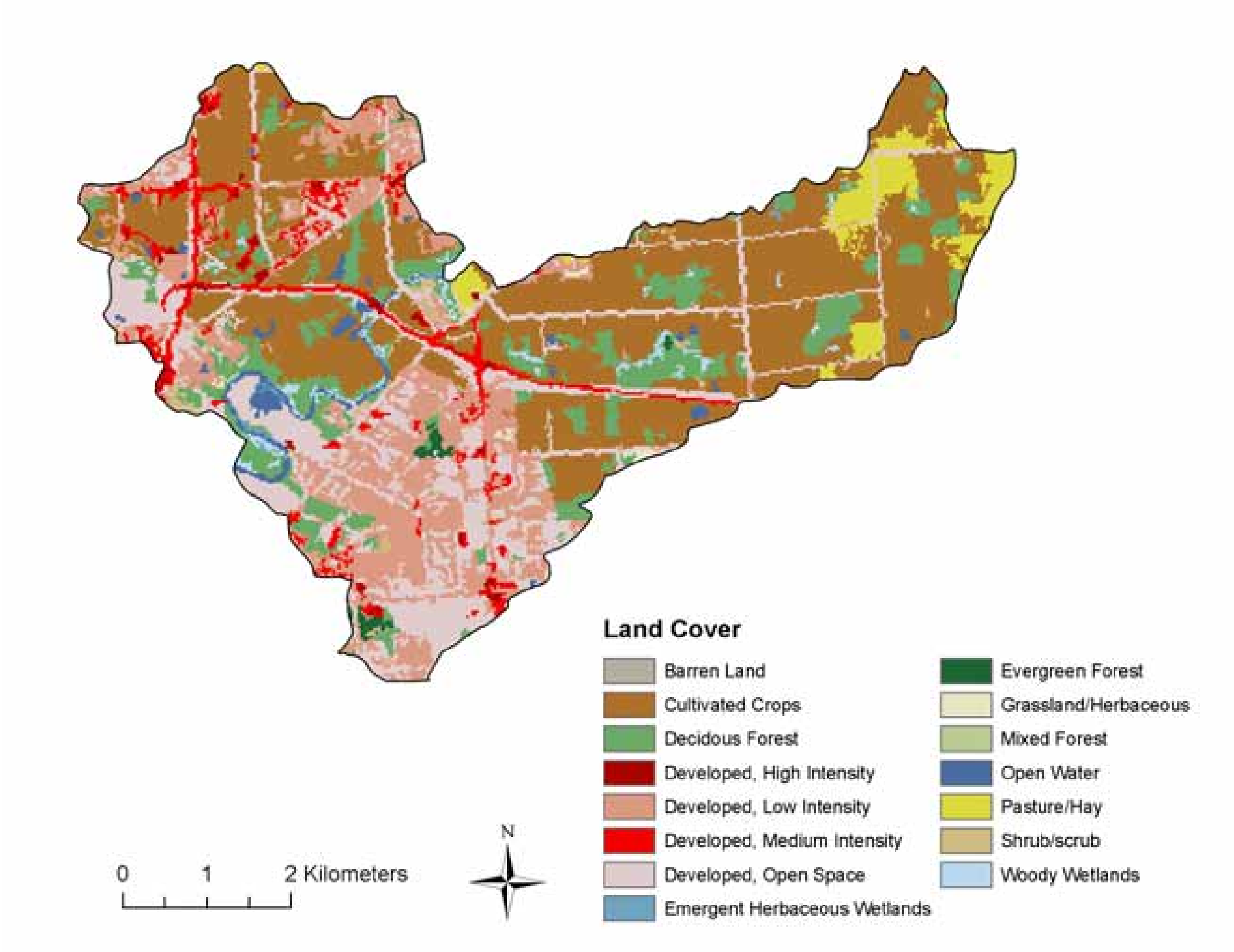

| **HABITAT within the Schoppman Drain Subwatershed** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
|---|---|---|---|---|
| Open Water | 549900.0 | 55.0 | 135.9 | 1.9 |
| Developed, Open Space | 8575200.0 | 857.5 | 2119.0 | 29.7 |
| Developed, Low Intensity | 11544300.0 | 1154.4 | 2852.7 | 40.0 |
| Developed, Medium Intensity | 3475800.0 | 347.6 | 858.9 | 12.0 |
| Developed, High Intensity | 2793600.0 | 279.4 | 690.3 | 9.7 |
| Decidous Forest | 1299600.0 | 130.0 | 321.1 | 4.5 |
| Evergreen Forest | 18000.0 | 1.8 | 4.4 | 0.1 |
| Shrub/scrub | 241200.0 | 24.1 | 59.6 | 0.8 |
| Woody Wetlands | 115200.0 | 11.5 | 28.5 | 0.4 |
| Emergent Herbaceous Wetlands | 238500.0 | 23.9 | 58.9 | 0.8 |
| **TOTAL** | 28851300.0 | 2885.1 | 7129.3 | |

M-2 Land Use 2001- Beckett's Run



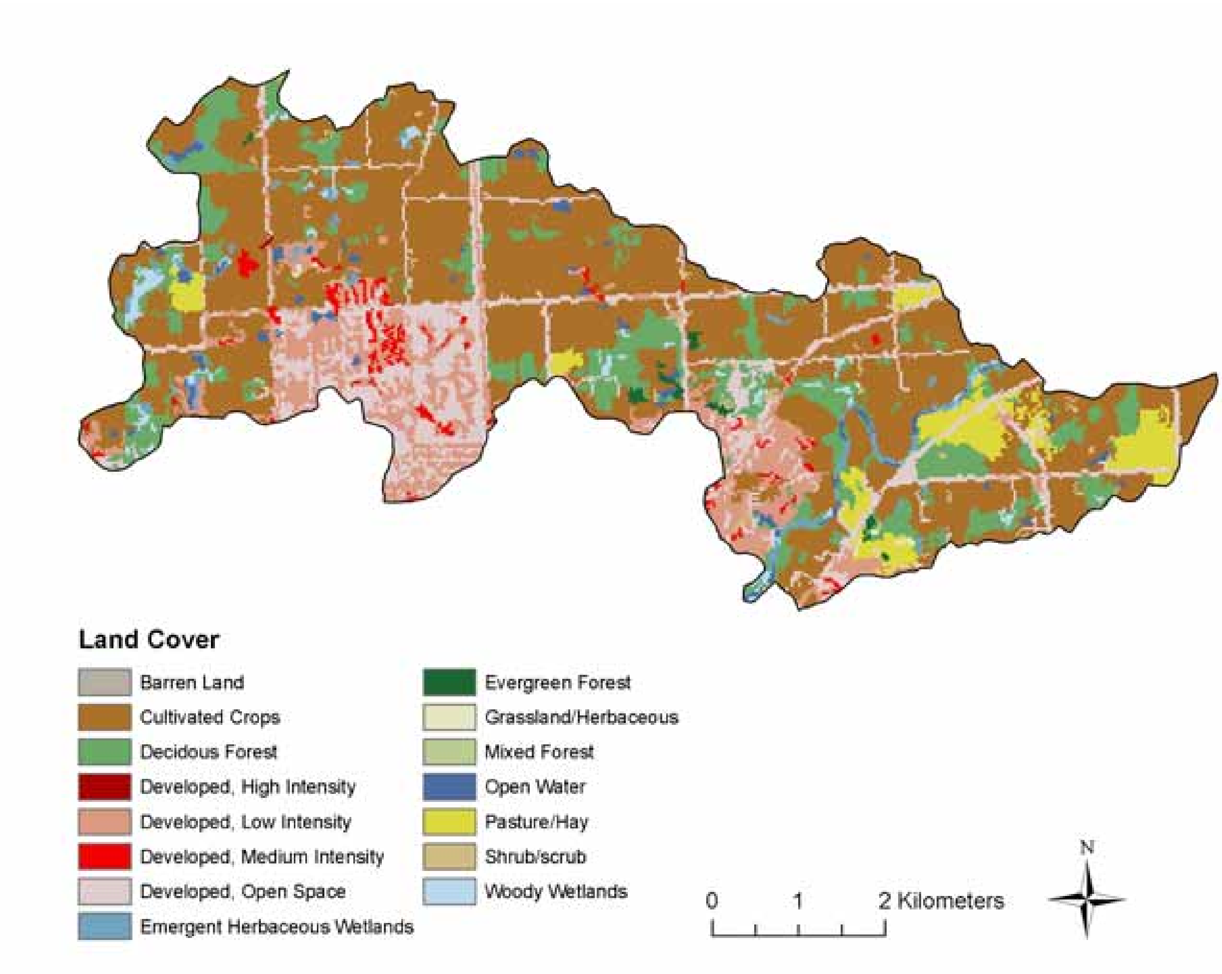

| **HABITAT within the Beckett's Run Subwatershed** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
|---|---|---|---|---|
| Open Water | 268200.0 | 26.8 | 66.3 | 1.1 |
| Developed, Open Space | 6298200.0 | 629.8 | 1556.3 | 25.9 |
| Developed, Low Intensity | 6804000.0 | 680.4 | 1681.3 | 28.0 |
| Developed, Medium Intensity | 1255500.0 | 125.6 | 310.2 | 5.2 |
| Developed, High Intensity | 334800.0 | 33.5 | 82.7 | 1.4 |
| Decidous Forest | 3024900.0 | 302.5 | 747.5 | 12.4 |
| Evergreen Forest | 162900.0 | 16.3 | 40.3 | 0.7 |
| Shrub/scrub | 398700.0 | 39.9 | 98.5 | 1.6 |
| Grassland/Herbaceous | 207000.0 | 20.7 | 51.2 | 0.9 |
| Cultivated Crops | 5041800.0 | 504.2 | 1245.9 | 20.7 |
| Woody Wetlands | 311400.0 | 31.1 | 76.9 | 1.3 |
| Emergent Herbaceous Wetlands | 208800.0 | 20.9 | 51.6 | 0.9 |
| **TOTAL** | 24316200.0 | 2431.6 | 6008.7 | |

M-3 Land Use 2001 - Tiernan Ditch



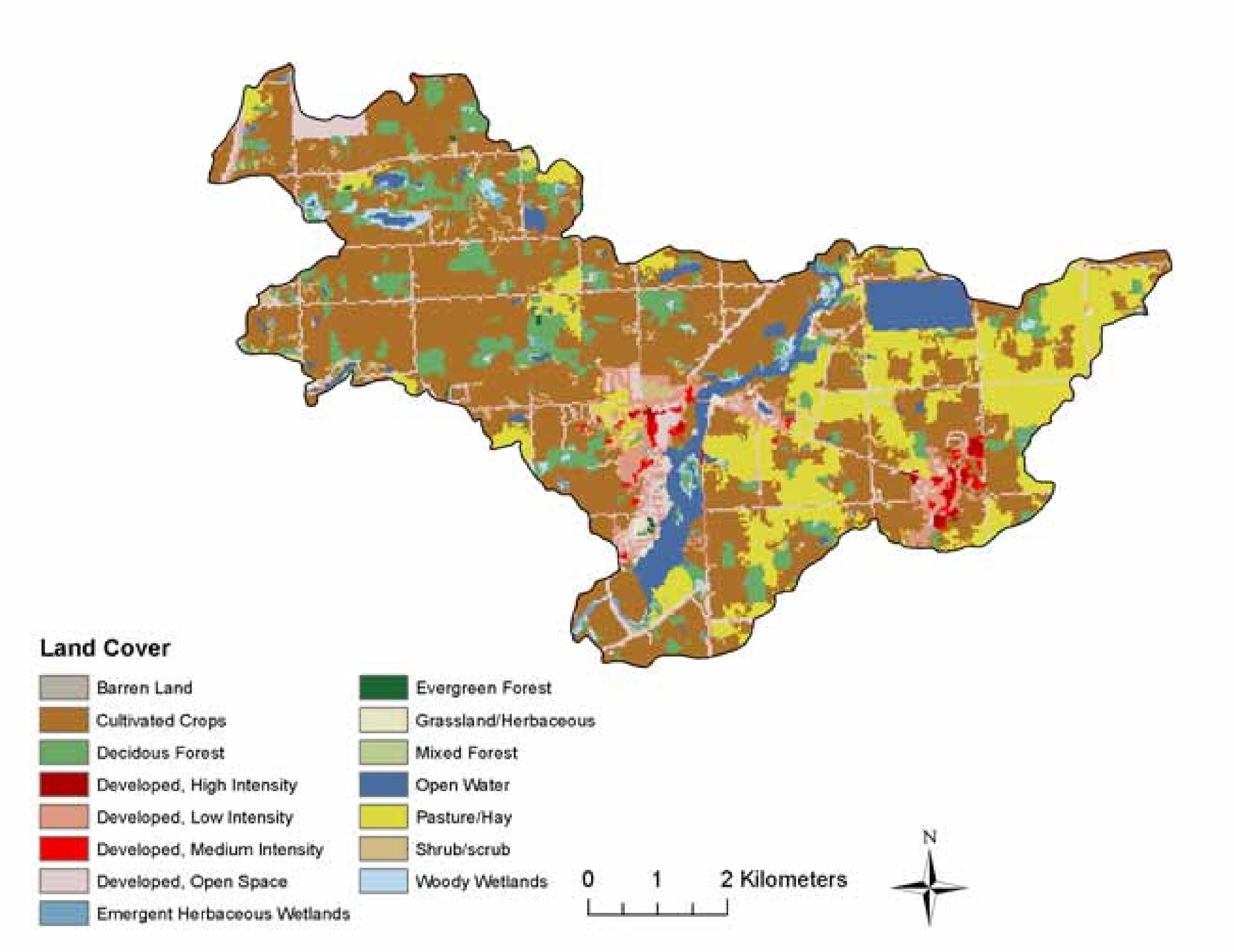

| HABITAT within the Tiernan Ditch Subwatershed | Square Meters | Hectares | Acres | % of total |
|---|---|---|---|---|
| Open Water | 657000.0 | 65.7 | 162.3 | 1.7 |
| Developed, Open Space | 6411600.0 | 641.2 | 1584.3 | 17.0 |
| Developed, Low Intensity | 6474600.0 | 647.5 | 1599.9 | 17.1 |
| Developed, Medium Intensity | 1602900.0 | 160.3 | 396.1 | 4.2 |
| Developed, High Intensity | 263700.0 | 26.4 | 65.2 | 0.7 |
| Decidous Forest | 4227300.0 | 422.7 | 1044.6 | 11.2 |
| Evergreen Forest | 177300.0 | 17.7 | 43.8 | 0.5 |
| Shrub/scrub | 392400.0 | 39.2 | 97.0 | 1.0 |
| Grassland/Herbaceous | 92700.0 | 9.3 | 22.9 | 0.2 |
| Pasture/Hay | 1432800.0 | 143.3 | 354.1 | 3.8 |
| Cultivated Crops | 15502500.0 | 1550.3 | 3830.8 | 41.0 |
| Woody Wetlands | 408600.0 | 40.9 | 101.0 | 1.1 |
| Emergent Herbaceous Wetlands | 147600.0 | 14.8 | 36.5 | 0.4 |
| **TOTAL** | 37791000.0 | 3779.1 | 9338.4 | |

M-4 Land Use 2001 - Ely Run



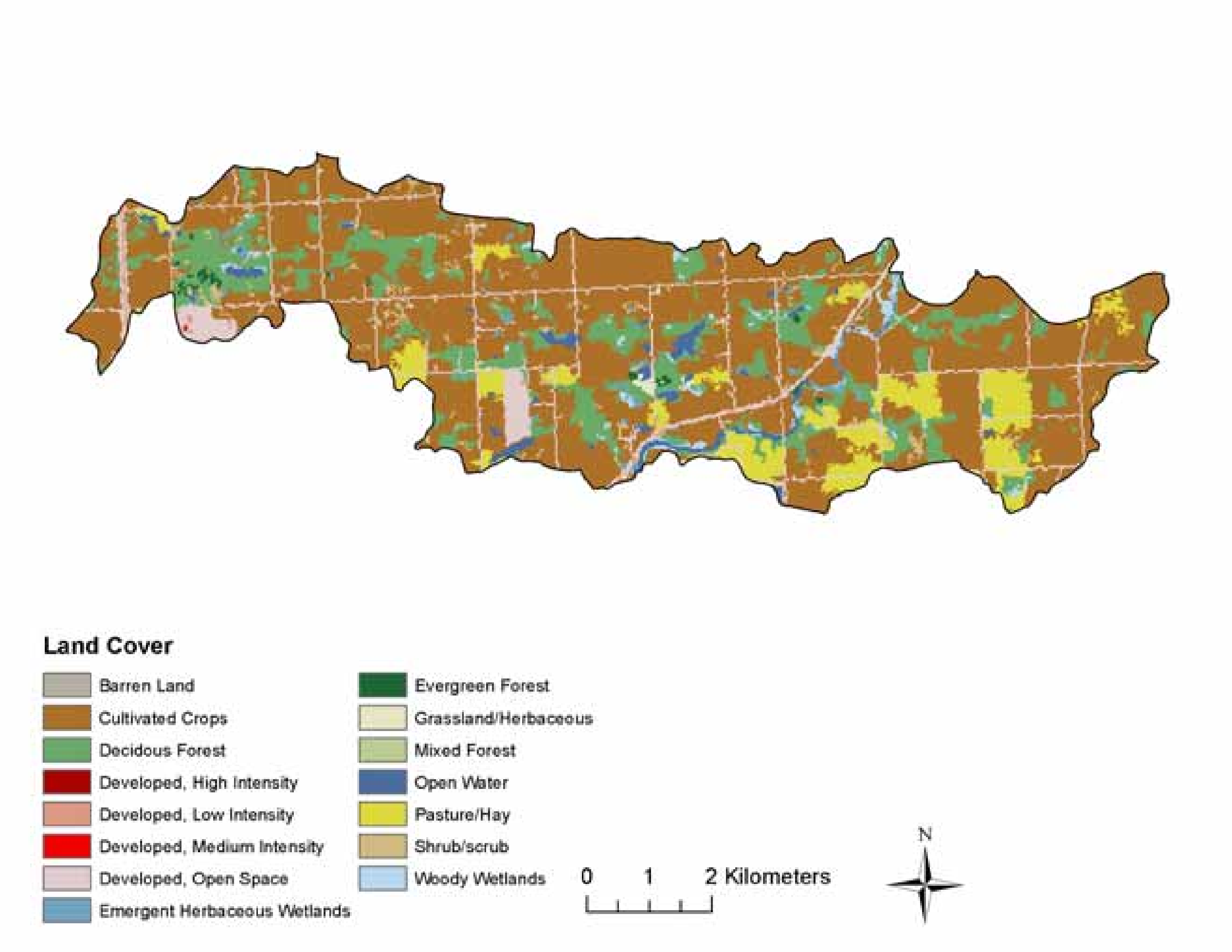

| **HABITAT within the Ely Run Subwatershed** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
|---|---|---|---|---|
| Open Water | 522900.0 | 52.3 | 129.2 | 1.5 |
| Developed, Open Space | 4543200.0 | 454.3 | 1122.6 | 12.7 |
| Developed, Low Intensity | 4064400.0 | 406.4 | 1004.3 | 11.3 |
| Developed, Medium Intensity | 496800.0 | 49.7 | 122.8 | 1.4 |
| Developed, High Intensity | 14400.0 | 1.4 | 3.6 | 0.0 |
| Decidous Forest | 4941000.0 | 494.1 | 1220.9 | 13.8 |
| Evergreen Forest | 152100.0 | 15.2 | 37.6 | 0.4 |
| Shrub/scrub | 256500.0 | 25.7 | 63.4 | 0.7 |
| Grassland/Herbaceous | 67500.0 | 6.8 | 16.7 | 0.2 |
| Pasture/Hay | 1649700.0 | 165.0 | 407.6 | 4.6 |
| Cultivated Crops | 18216000.0 | 1821.6 | 4501.3 | 50.8 |
| Woody Wetlands | 438300.0 | 43.8 | 108.3 | 1.2 |
| Emergent Herbaceous Wetlands | 510300.0 | 51.0 | 126.1 | 1.4 |
| **TOTAL** | 35873100.0 | 3587.3 | 8864.4 | |

M-5 Land Use -St. Joseph River -Cedarville Reservoir



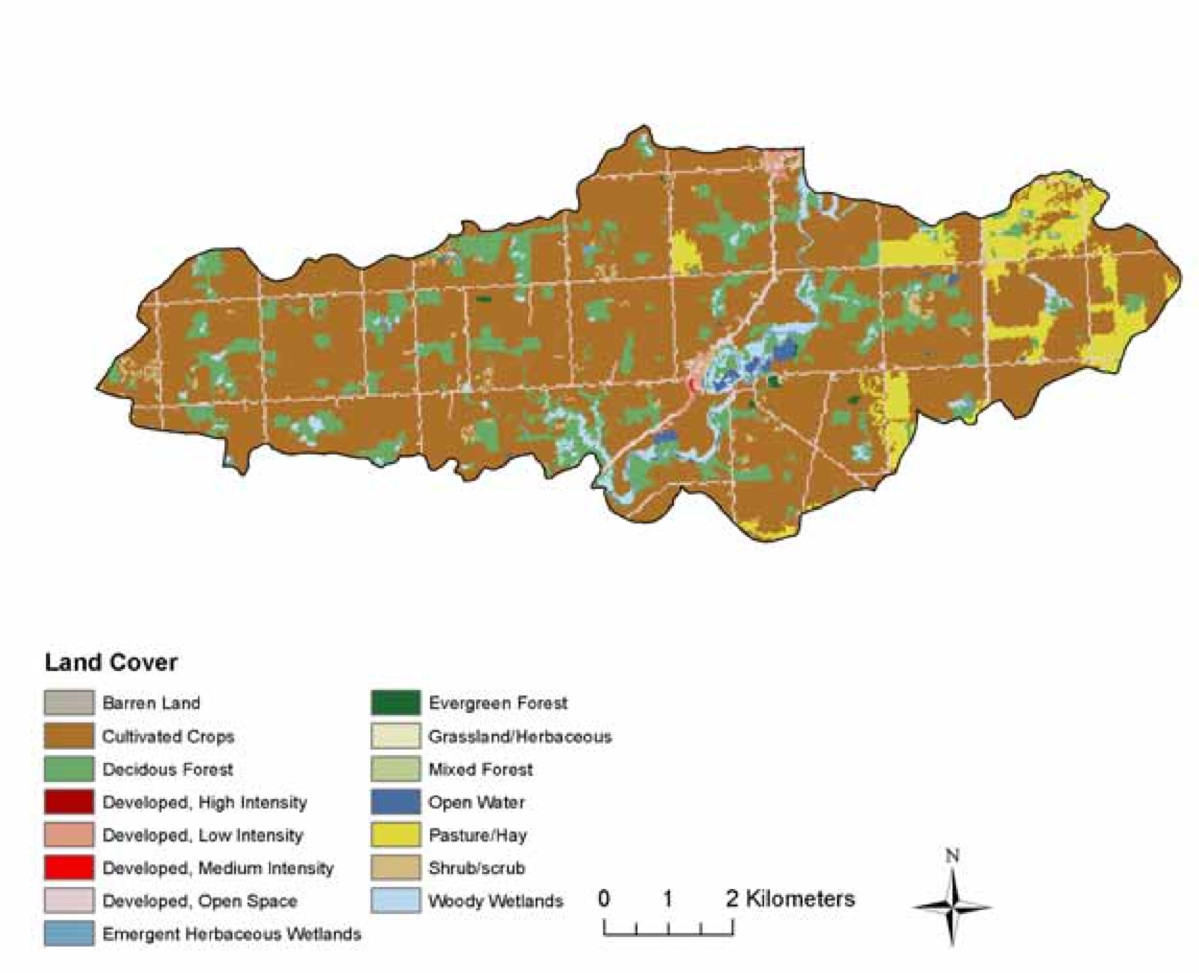

| HABITAT within the Cedarville Reservoir subwatershed | Square Meters | Hectares | Acres | % of total |
|---|---|---|---|---|
| Open Water | 3131100.0 | 313.1 | 773.7 | 6.0 |
| Developed, Open Space | 3783600.0 | 378.4 | 934.9 | 7.2 |
| Developed, Low Intensity | 2007900.0 | 200.8 | 496.2 | 3.8 |
| Developed, Medium Intensity | 383400.0 | 38.3 | 94.7 | 0.7 |
| Developed, High Intensity | 187200.0 | 18.7 | 46.3 | 0.4 |
| Decidous Forest | 5229000.0 | 522.9 | 1292.1 | 10.0 |
| Evergreen Forest | 53100.0 | 5.3 | 13.1 | 0.1 |
| Shrub/scrub | 947700.0 | 94.8 | 234.2 | 1.8 |
| Grassland/Herbaceous | 225900.0 | 22.6 | 55.8 | 0.4 |
| Pasture/Hay | 8917200.0 | 891.7 | 2203.5 | 17.1 |
| Cultivated Crops | 26344800.0 | 2634.5 | 6509.9 | 50.4 |
| Woody Wetlands | 699300.0 | 69.9 | 172.8 | 1.3 |
| Emergent Herbaceous Wetlands | 341100.0 | 34.1 | 84.3 | 0.7 |
| **TOTAL** | 52251300.0 | 5225.1 | 12911.6 | |

M-6 Land Use 2001 Swartz-Carnahan Ditch



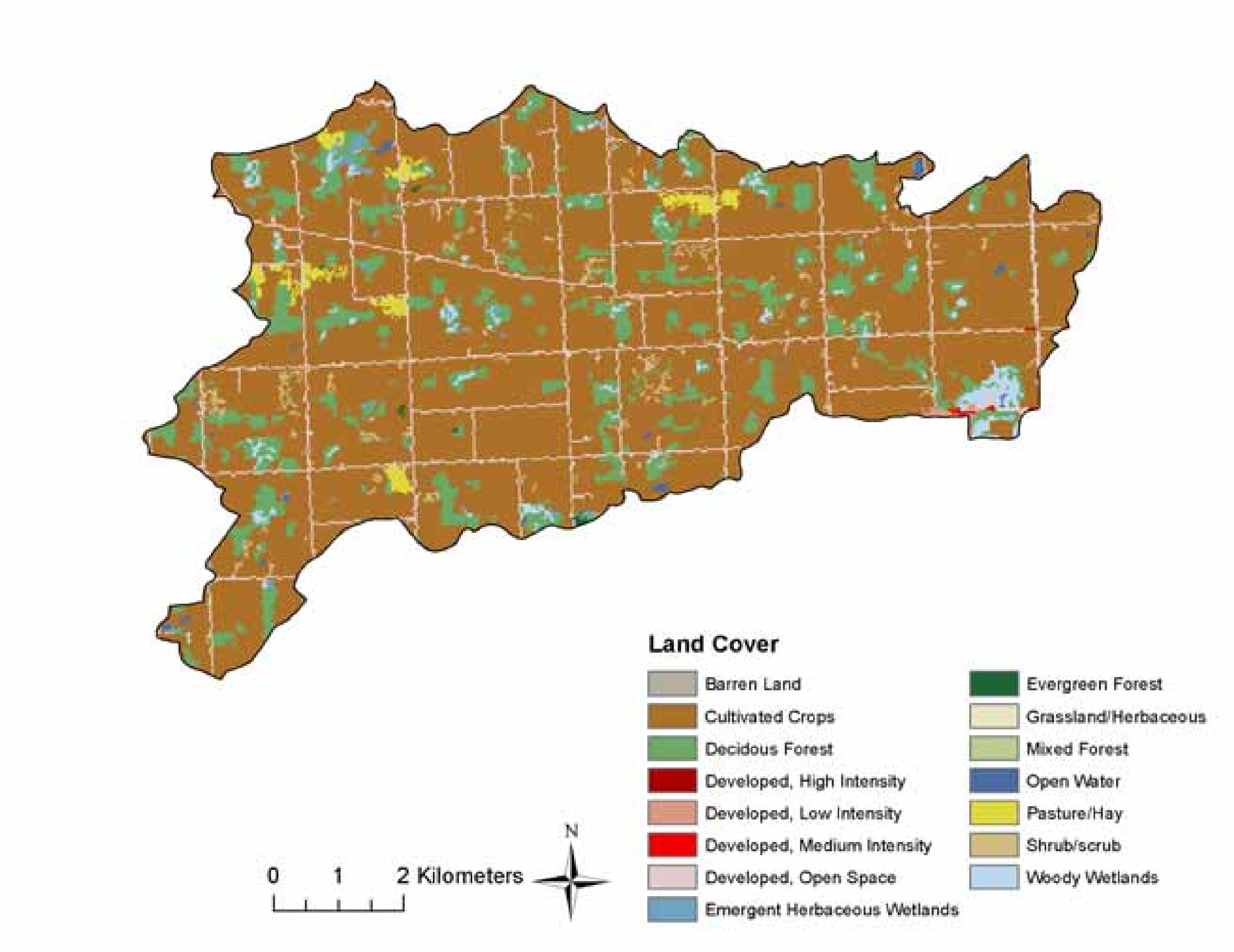

| **HABITAT within Swartz-Carnahan Subwatershed** | **Square Meters** | **Hectares** | **Acres** | **% of total** |
|---|---|---|---|---|
| Open Water | 1032300.0 | 103.2 | 255.1 | 2.0 |
| Developed, Open Space | 3707100.0 | 370.7 | 916.0 | 7.2 |
| Developed, Low Intensity | 212400.0 | 21.2 | 52.5 | 0.4 |
| Developed, Medium Intensity | 6300.0 | 0.6 | 1.6 | 0.0 |
| Decidous Forest | 8429400.0 | 842.9 | 2083.0 | 16.4 |
| Evergreen Forest | 200700.0 | 20.1 | 49.6 | 0.4 |
| Shrub/scrub | 969300.0 | 96.9 | 239.5 | 1.9 |
| Grassland/Herbaceous | 106200.0 | 10.6 | 26.2 | 0.2 |
| Pasture/Hay | 4227300.0 | 422.7 | 1044.6 | 8.2 |
| Cultivated Crops | 31384800.0 | 3138.5 | 7755.4 | 61.1 |
| Woody Wetlands | 591300.0 | 59.1 | 146.1 | 1.2 |
| Emergent Herbaceous Wetlands | 521100.0 | 52.1 | 128.8 | 1.0 |
| **TOTAL** | 51388200.0 | 5138.8 | 12698.3 | |

M-7 Land Use 2001 - Walker-Metcalf Ditches



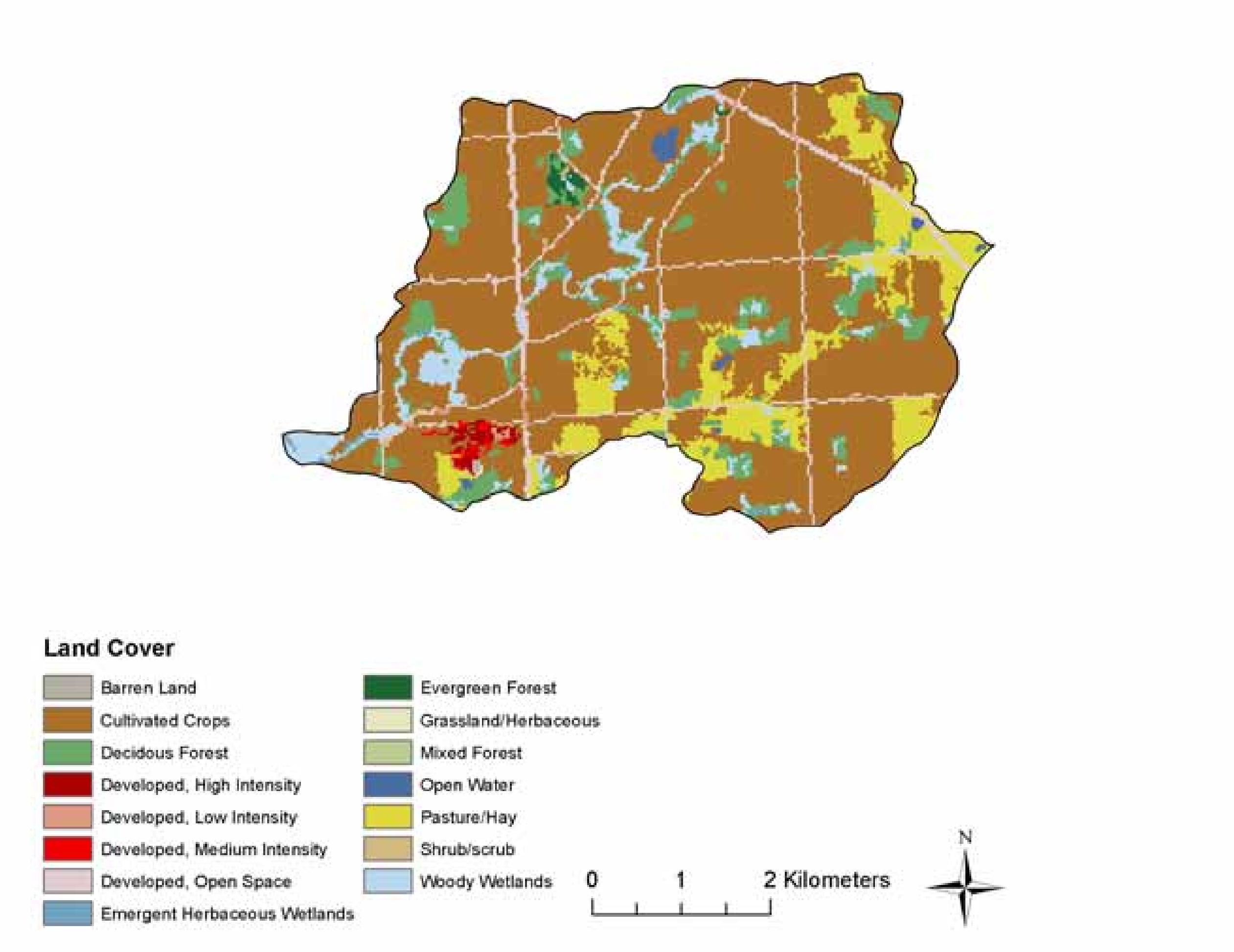

| HABITAT within the Walker-Metcalf Subwatershed | Square Meters | Hectares | Acres | % of total |
|---|---|---|---|---|
| Open Water | 357300.0 | 35.7 | 88.3 | 0.6 |
| Developed, Open Space | 2918700.0 | 291.9 | 721.2 | 4.8 |
| Developed, Low Intensity | 288900.0 | 28.9 | 71.4 | 0.5 |
| Developed, Medium Intensity | 19800.0 | 2.0 | 4.9 | 0.0 |
| Decidous Forest | 7937100.0 | 793.7 | 1961.3 | 13.1 |
| Evergreen Forest | 90000.0 | 9.0 | 22.2 | 0.1 |
| Shrub/scrub | 684900.0 | 68.5 | 169.2 | 1.1 |
| Pasture/Hay | 3846600.0 | 384.7 | 950.5 | 6.4 |
| Cultivated Crops | 42390000.0 | 4239.0 | 10474.8 | 70.0 |
| Woody Wetlands | 1722600.0 | 172.3 | 425.7 | 2.8 |
| Emergent Herbaceous Wetlands | 280800.0 | 28.1 | 69.4 | 0.5 |
| **TOTAL** | 60536700.0 | 6053.7 | 14958.9 | |

M-8 Land Use 2001 - St. Joseph River - Hursey Ditches




| HABITAT within the Hursey Ditches Subwatershed | Square Meters | Hectares | Acres | % of total |
|---|---|---|---|---|
| Open Water | 215100.0 | 21.5 | 53.2 | 0.3 |
| Developed, Open Space | 3643200.0 | 364.3 | 900.3 | 5.1 |
| Developed, Low Intensity | 135000.0 | 13.5 | 33.4 | 0.2 |
| Developed, Medium Intensity | 35100.0 | 3.5 | 8.7 | 0.0 |
| Developed, High Intensity | 5400.0 | 0.5 | 1.3 | 0.0 |
| Decidous Forest | 8596800.0 | 859.7 | 2124.3 | 12.1 |
| Evergreen Forest | 54900.0 | 5.5 | 13.6 | 0.1 |
| Shrub/scrub | 986400.0 | 98.6 | 243.7 | 1.4 |
| Grassland/Herbaceous | 3600.0 | 0.4 | 0.9 | 0.0 |
| Pasture/Hay | 920700.0 | 92.1 | 227.5 | 1.3 |
| Cultivated Crops | 54715500.0 | 5471.6 | 13520.5 | 77.2 |
| Woody Wetlands | 1201500.0 | 120.2 | 296.9 | 1.7 |
| Emergent Herbaceous Wetlands | 346500.0 | 34.7 | 85.6 | 0.5 |
| **TOTAL** | 70859700.0 | 7086.0 | 17509.8 | |

M-9 Land Use 2001 - St. Joseph River - Davis Ditch

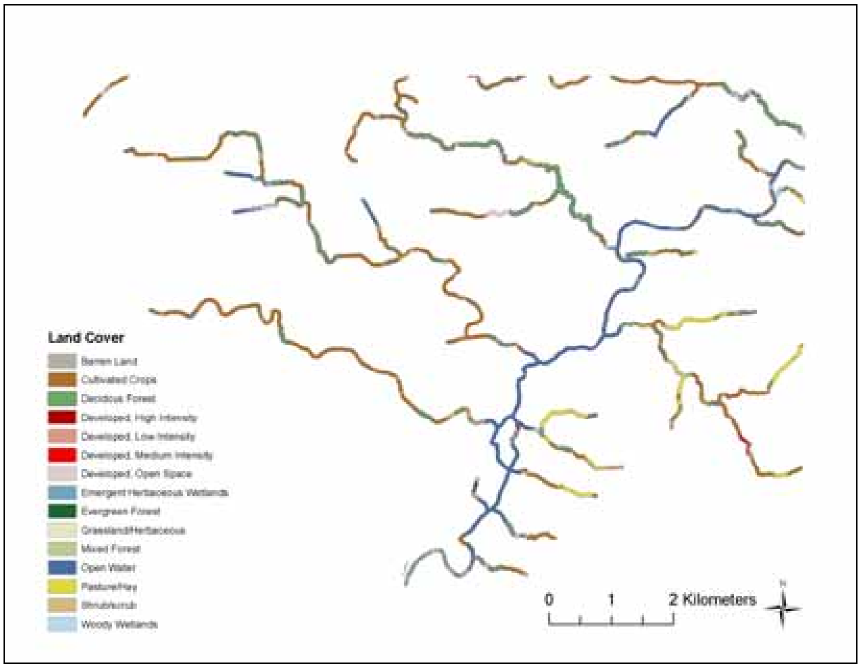



| HABITAT within the Davis Ditch Subwatershed | Square Meters | Hectares | Acres | % of total |
|---|---|---|---|---|
| Open Water | 141300.0 | 14.1 | 34.9 | 0.5 |
| Developed, Open Space | 1398600.0 | 139.9 | 345.6 | 5.3 |
| Developed, Low Intensity | 100800.0 | 10.1 | 24.9 | 0.4 |
| Developed, Medium Intensity | 74700.0 | 7.5 | 18.5 | 0.3 |
| Developed, High Intensity | 135900.0 | 13.6 | 33.6 | 0.5 |
| Barren Land | 15300.0 | 1.5 | 3.8 | 0.1 |
| Decidous Forest | 2203200.0 | 220.3 | 544.4 | 8.3 |
| Evergreen Forest | 108900.0 | 10.9 | 26.9 | 0.4 |
| Shrub/scrub | 32400.0 | 3.2 | 8.0 | 0.1 |
| Grassland/Herbaceous | 6300.0 | 0.6 | 1.6 | 0.0 |
| Pasture/Hay | 3129300.0 | 312.9 | 773.3 | 11.8 |
| Cultivated Crops | 17692200.0 | 1769.2 | 4371.8 | 66.8 |
| Woody Wetlands | 1386000.0 | 138.6 | 342.5 | 5.2 |
| Emergent Herbaceous Wetlands | 76500.0 | 7.7 | 18.9 | 0.3 |
| **TOTAL** | 26501400.0 | 2650.1 | 6548.6 | |

## Appendix N  Land use in the Buffer Zones

Land use in the buffer zones of the Bear Creek and Lower St. Joseph sub-watersheds

The tables in this section were created by Scott Gibson (2007) using Arcview GIS and a stream layer from the national hydrography dataset. All streams were buffered by 30m on each side, then those buffers were overlaid on top of the 2001 national land cover dataset and clipped. Acreage for all land uses within the riverine corridor on all streams in each of the HUC-14 sub-watersheds were compiled into these tables.  The map below is an exmple of the clipped buffers with their land usage.




**Bear Creek Southwest: Land Use in the buffer zone (S. Gibson, 2007)**

N-1  Schoppman Drain: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 326194.5 | 80.6 | 32.6 | 19.8 |
| Developed, Open Space | 481905.7 | 119.1 | 48.2 | 29.3 |
| Developed, Low Intensity | 389491.7 | 96.2 | 38.9 | 23.7 |
| Developed, Medium Intensity | 113658.5 | 28.1 | 11.4 | 6.9 |
| Developed, High Intensity | 73500.5 | 18.2 | 7.4 | 4.5 |
| Decidous Forest | 111647.5 | 27.6 | 11.2 | 6.8 |
| Shrub/scrub | 35247.6 | 8.7 | 3.5 | 2.1 |
| Woody Wetlands | 36357.0 | 9.0 | 3.6 | 2.2 |
| Emergent Herbaceous Wetlands | 75650.7 | 18.7 | 7.6 | 4.6 |
| TOTAL | 1643653.5 | 406.2 | 164.4 | |

N-2 Beckett's Run: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 12929.7 | 3.2 | 1.3 | 0.9 |
| Developed, Open Space | 428208.8 | 105.8 | 42.8 | 28.7 |
| Developed, Low Intensity | 223262.3 | 55.2 | 22.3 | 15.0 |
| Developed, Medium Intensity | 25785.5 | 6.4 | 2.6 | 1.7 |
| Developed, High Intensity | 3190.0 | 0.8 | 0.3 | 0.2 |
| Decidous Forest | 416366.1 | 102.9 | 41.6 | 27.9 |
| Evergreen Forest | 12624.4 | 3.1 | 1.3 | 0.8 |
| Shrub/scrub | 33674.5 | 8.3 | 3.4 | 2.3 |
| Grassland/Herbaceous | 19659.2 | 4.9 | 2.0 | 1.3 |
| Cultivated Crops | 210685.4 | 52.1 | 21.1 | 14.1 |
| Woody Wetlands | 74876.1 | 18.5 | 7.5 | 5.0 |
| Emergent Herbaceous Wetlands | 31618.5 | 7.8 | 3.2 | 2.1 |
| TOTAL | 1492880.5 | 368.9 | 149.3 | |

N-3 Tiernan Ditch: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 244220.2 | 60.3 | 24.4 | 11.3 |
| Developed, Open Space | 370213.0 | 91.5 | 37.0 | 17.1 |
| Developed, Low Intensity | 210061.0 | 51.9 | 21.0 | 9.7 |
| Developed, Medium Intensity | 45804.6 | 11.3 | 4.6 | 2.1 |
| Developed, High Intensity | 7944.5 | 2.0 | 0.8 | 0.4 |
| Decidous Forest | 430551.8 | 106.4 | 43.1 | 19.9 |
| Evergreen Forest | 1022.8 | 0.3 | 0.1 | < 0.1 |
| Shrub/scrub | 12285.7 | 3.0 | 1.2 | 0.6 |
| Grassland/Herbaceous | 4720.9 | 1.2 | 0.5 | 0.2 |
| Pasture/Hay | 39056.6 | 9.7 | 3.9 | 1.8 |
| Cultivated Crops | 566828.2 | 140.1 | 56.7 | 26.2 |
| Woody Wetlands | 171304.2 | 42.3 | 17.1 | 7.9 |
| Emergent Herbaceous Wetlands | 62796.5 | 15.5 | 6.3 | 2.9 |
| TOTAL | 2166810.0 | 535.4 | 216.7 | |

N-4 Ely Run: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 117590.5 | 29.1 | 11.8 | 5.9 |
| Developed, Open Space | 315476.9 | 78.0 | 31.5 | 15.8 |
| Developed, Low Intensity | 117159.6 | 29.0 | 11.7 | 5.9 |
| Developed, Medium Intensity | 10008.9 | 2.5 | 1.0 | 0.5 |
| Decidous Forest | 367525.5 | 90.8 | 36.8 | 18.4 |
| Evergreen Forest | 434.3 | 0.1 | < 0.1 | < 0.1 |
| Shrub/scrub | 24522.4 | 6.1 | 2.5 | 1.2 |
| Grassland/Herbaceous | 2502.0 | 0.6 | 0.3 | 0.1 |
| Pasture/Hay | 41289.9 | 10.2 | 4.1 | 2.1 |
| Cultivated Crops | 735636.7 | 181.8 | 73.6 | 36.8 |
| Woody Wetlands | 101972.0 | 25.2 | 10.2 | 5.1 |
| Emergent Herbaceous Wetlands | 162885.5 | 40.3 | 16.3 | 8.2 |
| TOTAL | 1997004.2 | 493.5 | 199.7 | |

N-5 Lower St. Joseph-Cedarville Reservoir: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 619815.9 | 153.2 | 62.0 | 19.7 |
| Developed, Open Space | 122056.5 | 30.2 | 12.2 | 3.9 |
| Developed, Low Intensity | 73709.4 | 18.2 | 7.4 | 2.3 |
| Developed, Medium Intensity | 12574.2 | 3.1 | 1.3 | 0.4 |
| Developed, High Intensity | 5707.5 | 1.4 | 0.6 | 0.2 |
| Decidous Forest | 364633.3 | 90.1 | 36.5 | 11.6 |
| Evergreen Forest | 9681.5 | 2.4 | 1.0 | 0.3 |
| Shrub/scrub | 41739.1 | 10.3 | 4.2 | 1.3 |
| Grassland/Herbaceous | 5043.1 | 1.2 | 0.5 | 0.2 |
| Pasture/Hay | 419294.0 | 103.6 | 41.9 | 13.3 |
| Cultivated Crops | 1307127.8 | 323.0 | 130.7 | 41.4 |
| Woody Wetlands | 101074.9 | 25.0 | 10.1 | 3.2 |
| Emergent Herbaceous Wetlands | 71624.1 | 17.7 | 7.2 | 2.3 |
| TOTAL | 3154081.3 | 779.4 | 315.4 | |

N-6 Swartz-Carnahan Ditch: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 294461.9 | 72.8 | 29.4 | 9.6 |
| Developed, Open Space | 174839.7 | 43.2 | 17.5 | 5.7 |
| Developed, Low Intensity | 12988.2 | 3.2 | 1.3 | 0.4 |
| Decidous Forest | 834389.5 | 206.2 | 83.4 | 27.2 |
| Evergreen Forest | 1525.0 | 0.4 | 0.2 | 0.0 |
| Shrub/scrub | 48198.5 | 11.9 | 4.8 | 1.6 |
| Grassland/Herbaceous | 4178.6 | 1.0 | 0.4 | 0.1 |
| Pasture/Hay | 128699.7 | 31.8 | 12.9 | 4.2 |
| Cultivated Crops | 1316523.7 | 325.3 | 131.7 | 43.0 |
| Woody Wetlands | 144216.3 | 35.6 | 14.4 | 4.7 |
| Emergent Herbaceous Wetlands | 103176.7 | 25.5 | 10.3 | 3.4 |
| TOTAL | 3063197.7 | 756.9 | 306.3 | |

N-7 St. Joseph River-Walker-Metcalf Ditch: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 60765.3 | 15.0 | 6.1 | 1.6 |
| Developed, Open Space | 181585.1 | 44.9 | 18.2 | 4.7 |
| Developed, Low Intensity | 1195.3 | 0.3 | 0.1 | 0.0 |
| Decidous Forest | 878507.3 | 217.1 | 87.9 | 22.9 |
| Evergreen Forest | 177.1 | 0.0 | 0.0 | 0.0 |
| Shrub/scrub | 21826.7 | 5.4 | 2.2 | 0.6 |
| Pasture/Hay | 115681.3 | 28.6 | 11.6 | 3.0 |
| Cultivated Crops | 1888777.4 | 466.7 | 188.9 | 49.2 |
| Woody Wetlands | 534556.6 | 132.1 | 53.5 | 13.9 |
| Emergent Herbaceous Wetlands | 152745.4 | 37.7 | 15.3 | 4.0 |
| TOTAL | 3835817.568 | 947.845 | 383.585 | |

N-8 Bear Creek-Hursey Ditches: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Open Water | 1601.5 | 0.4 | 0.2 | 0.1 |
| Developed, Open Space | 143045.8 | 35.3 | 14.3 | 4.6 |
| Developed, Low Intensity | 1523.5 | 0.4 | 0.2 | 0.0 |
| Decidous Forest | 612058.5 | 151.2 | 61.2 | 19.6 |
| Shrub/scrub | 65822.2 | 16.3 | 6.6 | 2.1 |
| Cultivated Crops | 2171235.5 | 536.5 | 217.1 | 69.4 |
| Woody Wetlands | 123502.7 | 30.5 | 12.4 | 3.9 |
| Emergent Herbaceous Wetlands | 10422.9 | 2.6 | 1.0 | 0.3 |
| TOTAL | 3129212.5 | 773.2 | 312.9 | |

N-9 St. Joseph River-Davis Ditch: Land use within 30-meter stream buffers

| Habitat | Square Meters | Acres | Hectares | % of total |
|---|---|---|---|---|
| Developed, Open Space | 89289.6 | 22.1 | 8.9 | 6.1 |
| Developed, Low Intensity | 6463.8 | 1.6 | 0.6 | 0.4 |
| Decidous Forest | 189368.6 | 46.8 | 18.9 | 12.9 |
| Evergreen Forest | 20058.6 | 5.0 | 2.0 | 1.4 |
| Shrub/scrub | 728.1 | 0.2 | 0.1 | <0.1 |
| Pasture/Hay | 140087.3 | 34.6 | 14.0 | 9.6 |
| Cultivated Crops | 481931.9 | 119.1 | 48.2 | 32.9 |
| Woody Wetlands | 486207.2 | 120.1 | 48.6 | 33.2 |
| Emergent Herbaceous Wetlands | 48523.7 | 12.0 | 4.9 | 3.3 |
| TOTAL | 1462658.8 | 361.4 | 146.3 | |