St. Joseph River Watershed Management Plan

Three States, Six Counties, One Watershed

Prepared by:

The St. Joseph River Watershed Initiative

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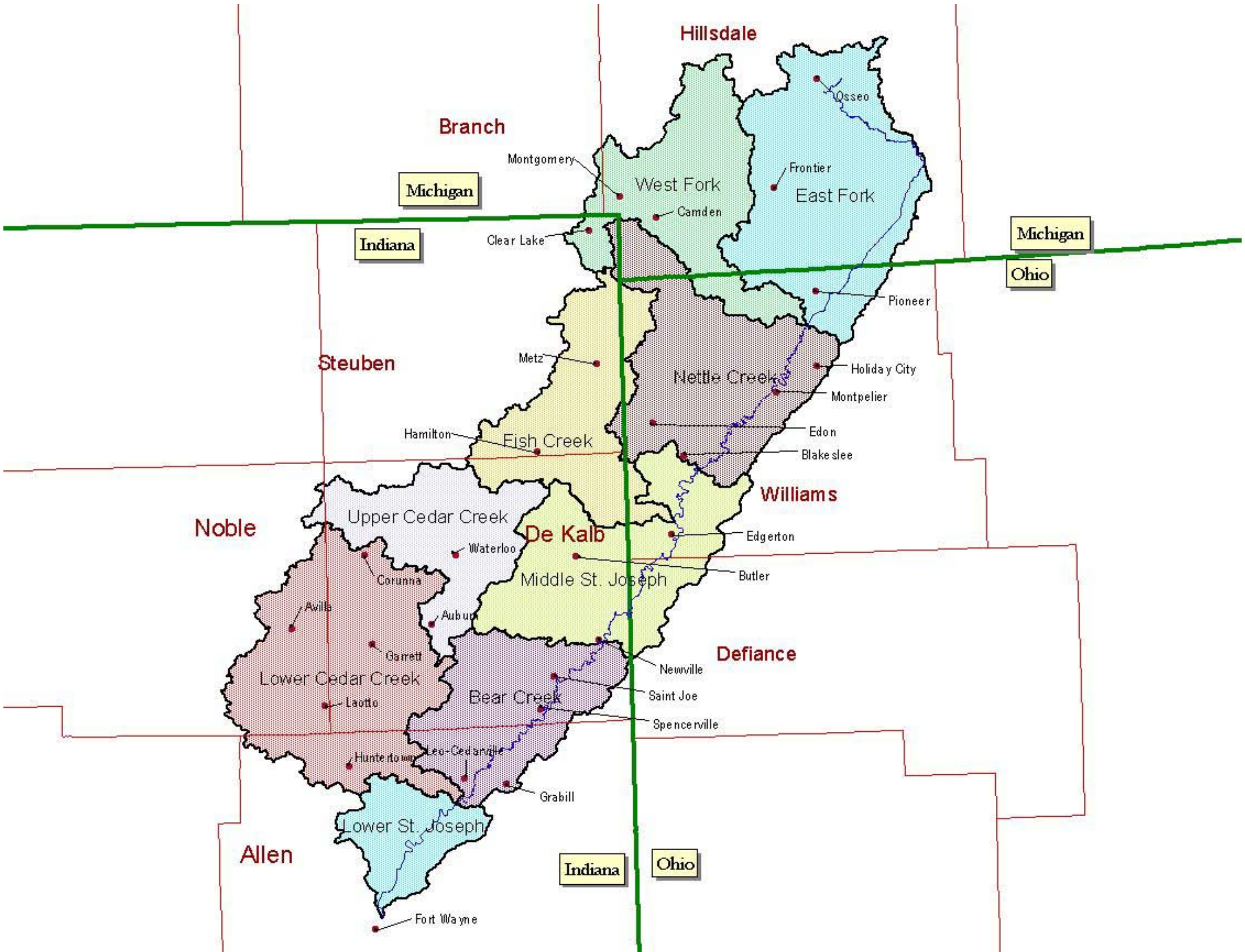

Figure 1 The St. Joseph River and its nine HUC-11 sub-watersheds

See Also the Following Documents:

The Cedar Creek Watershed Management Plan (2005)
& Attachment A: Water Quality Modeling Analysis for the Cedar Creek Watershed

2004 St. Joseph River Watershed Initiative Water Quality Report

Report on the Bacteria Source Tracking (BST) Project, October 30, 2004

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

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Executive Summary

This St. Joseph River Watershed Management Plan is a revision of the original plan prepared by the St. Joseph River Watershed Initiative and approved by the Indiana Department of Environmental Management (IDEM) in February, 2001 as a part of a Section 319 Project, ARN 98-180. In 2003, IDEM revised the requirements for planning documents in order to meet standards set forth by the U.S. Environmental Protection Agency. This document will bring the St. Joseph River Watershed Management Plan (WMP) into compliance with those requirements.

The purpose of this watershed management plan is to guide stakeholders in the St. Joseph River watershed in their efforts to protect, restore and enjoy the river and its resources. The plan provides a benchmark of the watershed, allowing us to understand where we are today. It communicates our vision, allowing us to project where we want to be in the future. It lays out a road map, allowing us to chart how we will go about moving toward our vision. And finally, it establishes our goals, so we can measure our progress.

Nine watersheds on the HUC-11 scale comprise the HUC-8 St. Joseph River watershed. Per the goals of the original plan, efforts have been underway to create management plans for several of these sub-watersheds, including Upper and Lower Cedar Creek, and the Lower St. Joseph and Bear Creek (IN) watersheds. The Fish Creek watershed has been the focus of The Nature Conservancy's Upper St. Joseph River Project for many years. The remaining sub-watersheds as yet do not have planning efforts underway.

Much of the data that support this watershed plan has been collected over the past ten years by the St. Joseph River Watershed Initiative in its effort to fulfill its mission to work with partners to promote economical and environmentally compatible land uses that improve water quality in the St. Joseph River watershed. These efforts have been supported by partners in federal, state and local government, non-profit organizations, private sector industry, and local citizens. Some of the data and information in this plan was originally gathered for the sub-watershed plans referenced above.

Public input for this updated plan has been gathered from events, meetings and conferences across the watershed over the last two years. These were local watershed planning and informational meetings; county watershed planning meetings; county comprehensive planning meetings; land use conferences; Western Lake Erie and Great Lakes water issues conferences; meetings of a partnership of local governments; and regular meetings and communication among the various partners involved in the St. Joseph River Watershed Initiative.

Information from all of these sources, as well as feedback from partners and participants in various watershed projects over the past ten years have been considered in the update of this plan. Topics emerging from this process are listed in Part 3, found on page 17.

A draft of this watershed management plan will be submitted for review and comment by the public and partners of the St. Joseph River Watershed Initiative, as well as IDEM, OEPA and MDEQ, prior to finalizing the document. The draft will be available on the Initiative's website, www.sjrwi.org. The progress of the watershed management planning and implementation effort will be reviewed by the Initiative and its partners every two years in order to review goals, evaluate progress and assess and update indicators as necessary.

Electronic (PDF) copies of this document will be distributed to all agencies and organizations on the distribution list (see page vi). It is also available on the St. Joseph River Watershed Initiative website (www.sjrwi.org). Copies of the document may be requested by contacting the Initiative at 3718 New Vision Drive, Fort Wayne, Indiana 46845, Tel. 260-484-5848 x120.

Acronyms

ACPWQ	Allen County Partnership for Water Quality
ACRES	ACRES Land Trust
ACWF	America's Clean Water Foundation
AFP	Animal Feeding Operation
ARS	Agriculture Research Service
BMP	Best management practice
BST	Bacteria Source Tracking
CAFO	Confined Animal Feeding Operations
CCWP	Cedar Creek Wildlife Project, Inc.
CEAP	Conservation Effects Assessment Program
CES	Cooperative Extension Service
CFU	Colony forming units
CRP	Conservation Reserve Program
CSO	Combined sewer overflow
CSP	Conservation Security Program
CTIC	Conservation Technology Information Center
DEM	Digital elevation model
DNR	Department of Natural Resources
EQIP	Environmental Quality Incentives Program
EPA	Environmental Protection Agency
FSA	Farm Service Agency
GIS	Geographic information system
GLC	Great Lakes Commission
HUC	Hydrologic unit code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation
IPFW	Indiana University – Purdue University Fort Wayne
LARE	Lake and river enhancement
MCL	Maximum contaminant level
MDEQ	MI Dept. Environmental Quality
MRBC	Maumee River Basin Commission
NED	National elevation dataset
NHD	National hydrography dataset
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Non-point source (pollution)
NRCS	Natural Resource Conservation Service
NRWA	National Rural Water Association
NSERL	National Soil Erosion Research Laboratory (West Lafayette, Indiana)
NTU	Nephelometric turbidity units
OEPA	OH Environmental Protection Agency
OSS	Onsite septic systems
QAPP	Quality Assurance Project Plan
RC&D	Resource Conservation and Development
RUP	Restricted use pesticide
SJRWI	St. Joseph River Watershed Initiative, Inc.
SSURGO	Soil Survey Geographic
SWAT	Soil & water assessment tool
SWCD	Soil and Water Conservation District
SWPI	Source Water Protection Initiative
TDS	Total Dissolved Solids
TMDL	Total maximum daily load
TNC	The Nature Conservancy
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Service
USF	University of Saint Francis
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
WLL	Wood-Land-Lakes RC&D
WMP	Watershed management plan
WQS	Water quality standard
WRAS	Watershed restoration action strategy
WWTP	Waste water treatment plant

Distribution List

ACRES Land Trust, Inc.
Allen County Parks Department
Allen County Partnership for Water Quality
Allen County Planning Department
Allen County Public Library
Allen County Soil & Water Conservation District
Allen County Surveyor
City of Auburn – Water Utilities
City of Fort Wayne – Water Utilities Department
Dekalb County Soil & Water Conservation District
DeKalb County Health Department
DeKalb County Planning Department
DeKalb County Surveyor
Eckhart Public Library, Auburn
Fort Wayne-Allen County Health Department
Garrett Public Library
Hillsdale (Michigan) Conservation District
Hillsdale County Drain Commission
Hillsdale County Health Department
Hillsdale College – Biology Department
Hillsdale County GIS
Indiana U – Purdue U Fort Wayne, Biology & Geology departments
Indiana Department of Natural Resources
Indiana Department of Agriculture
Indiana Department of Environmental Management
Maumee River Basin Commission
Maumee River Basin Partnership of Local Governments
Michigan Department of Environmental Quality
MSU Extension – Hillsdale County
Natural Resources Conservation Service
Noble County Soil & Water Conservation District
Noble County Health Department
Noble County Surveyor
OSU Extension – Williams County
Ohio Environmental Protection Agency
Purdue Cooperative Extension – Allen County
Purdue Cooperative Extension – DeKalb County
Purdue Cooperative Extension – Noble County
Purdue Cooperative Extension – Steuben County
Steuben County Soil & Water Conservation District
Steuben County Health Department
Steuben County Surveyor
The Nature Conservancy – Upper St. Joseph River Project Office
University of St. Francis, Biology Department
Waterloo Public Library
Wood-Land-Lakes RC&D
Williams Soil and Water Conservation District
Williams County Health Department
Williams County Surveyor

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Part 1: Introduction

Since the size of the St. Joseph River watershed (HUC 04100003) is so large, and the St. Joseph River Watershed Initiative ("the Initiative") is the only organized group working on behalf of the entire watershed, the Initiative has assumed the role as coordinator to use its resources and expertise to gather data, identify critical areas in need of conservation or action, and lead management planning in the sub-watershed areas.

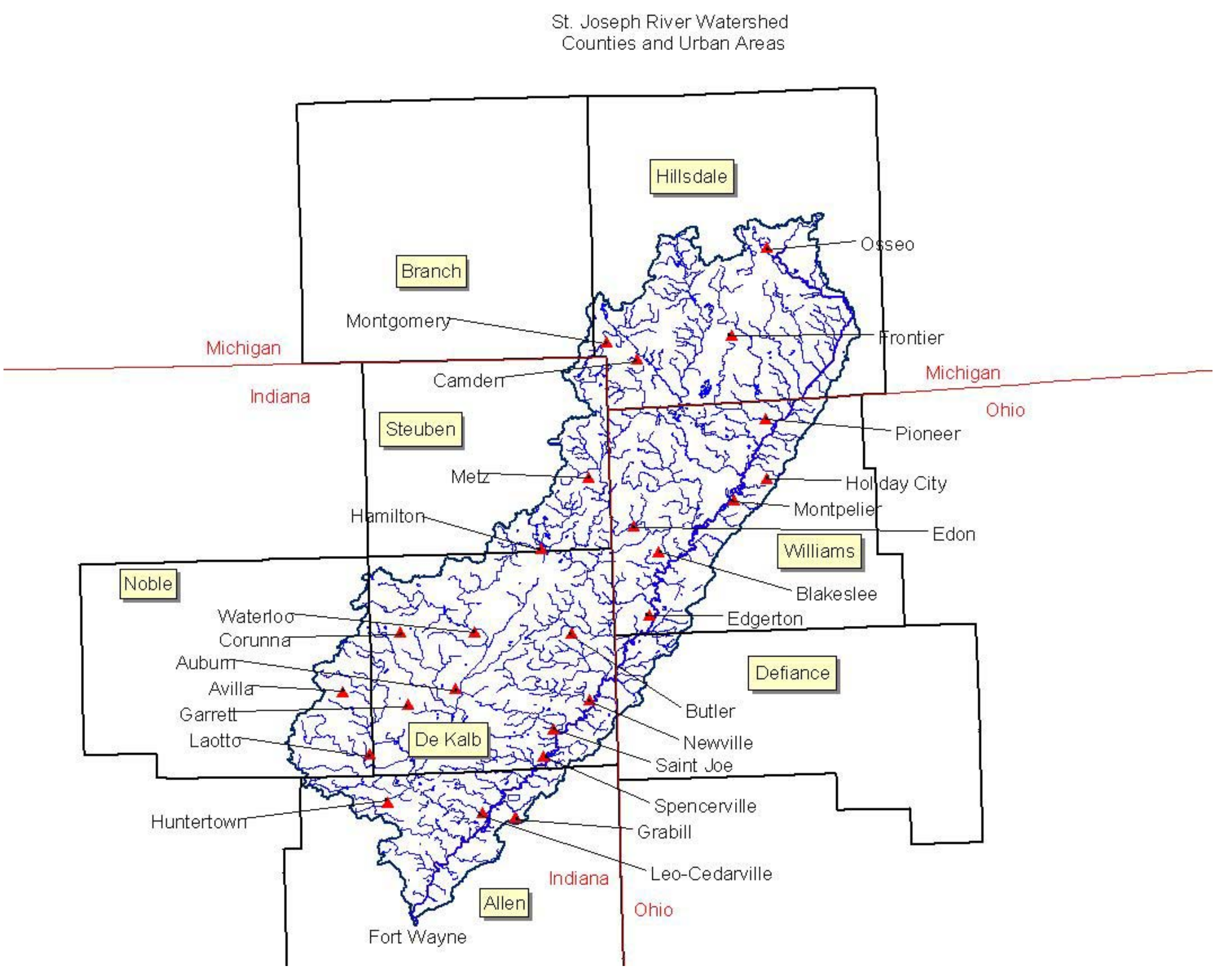


Figure 2 St. Joseph River and its watershed, covering three states and six counties

At this point in time, all nine of the 11-digit hydrologic unit code (HUC) sub-watersheds in the St. Joseph require some corrective action. Those with the most critical needs and the highest opportunity for participation from stakeholders historically have been, and will continue to be targeted first. Corrective actions which are needed in these sub-watersheds will be achieved with the assistance of citizens, partner organizations, state and federal conservation programs and grant assistance from public and private sources.

The Initiative will act as a liaison to federal/state governments and mediator to the public, coordinating fund raising, educational information, data collection and placement of best management practices (BMP). The Initiative plans to continue to monitor water quality within the watershed, as well as provide links to technical information and support needed by the various sub-watershed stakeholder groups.

As of this time, a watershed management plan (WMP) has been developed for the Upper (04100003090) and Lower (04100003080) Cedar Creek watersheds, and another is in progress for the Bear Creek (04100003070) and the Lower St. Joseph Allen County (04010003100) watersheds. The Nature Conservancy (TNC), an active partner with the Initiative, has been coordinating conservation, remediation and protection efforts since 1992 in the Fish Creek watershed (0401000350), and is beginning to work more intensely in the East Fork of the West Branch of the St. Joseph (4100003010) under its Upper St. Joseph River Watershed Project office in Angola, Indiana. More recently, a preliminary partnership effort was begun in Williams County to focus on the Nettle Creek sub-watershed, which includes Nettle Lake.

This WMP will focus on the entire 8-digit St. Joseph River watershed and as such, will be much more general in nature than the plans covering the HUC-11 sub-watersheds of the St. Joseph River.

1.1 Watershed partnerships

The St. Joseph River Watershed Initiative (SJRWI) is a 501(c)(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 St. Joseph River Watershed Initiative is governed by a Board of Directors that represent county soil and water conservation districts, local business, organizations, industry, schools and universities, local government and citizens at large. Current board members represent the City of Fort Wayne, the Maumee River Basin Commission, the Allen County SWCD, Hillsdale County Drain Commission, The Nature Conservancy, IPFW Biology Department, the Community Resource Institute, Purdue Cooperative Extension Service, Farm Bureau of Williams County, local agribusiness Custer Grain Co., private farm corporations from Hillsdale and Williams counties, and the City of Edgerton Wastewater Treatment Plant. Additional seats on the board are vacant at this time and open to new members.

The Initiative 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. Additionally, it has taken the lead in several watershed-wide projects that include bacteria source tracking, conservation tillage and erosion reduction projects, and watershed planning operations. A research project near Waterloo, Indiana, supported by America's Clean Water Foundation and the USDA Agricultural Research Service (ARS) National Soil Erosion Research Laboratory (NSERL) is another ongoing partnership for the SJRWI, which gathers and processes water samples and provides local assistance to the project. Additionally, the SJRWI and its partners have sponsored the annual Tri-State Conservation Tillage Expo since 2002.

1.2 Public participation

During the past two years, many public meetings have been convened across the St. Joseph River watershed for the purpose of gathering public input on water quality and land use issues. Information from citizens, conservation partners, educators and citizens, as well as representatives of local, state and federal government has been gathered and evaluated in the preparation of this document. Some of the more recent meetings include:

A series of three public meetings (April through July, 2004) held for the Cedar Creek watershed management planning effort
TNC's Two Stage Ditch project conference, Hillsdale County, 2004
Drainage Conference, Kendallville, February 5, 2005
Planning meeting for the Williams Soil and Water Conservation District, February 24, 2005
Hillsdale County Leadership Project, March 17, 2005
Dialogue on land use issues facing Hillsdale County, April-May 2005
Western Lake Erie Basin Convening Meeting, Toledo, OH, May 9, 2005
A series of four public meetings in September, 2005 held for the Lower St. Joseph-Bear Creek watershed management planning effort
Annual summer and winter field meetings for agricultural producers
Watershed Management Teams, monthly meetings, Fort Wayne-Allen County
Tri-State Conservation Tillage Expo, annually 2002-2005
Fort Wayne-Allen County, and DeKalb County comprehensive planning efforts
Nettle Creek- Nettle Lake WMP investigative meeting, January 2006

1.3 Topics of concern

Topics of concern gathered from these meetings include the following:

Pathogens and bacteria that keep the river out of compliance with standards for full body contact (recreational use)
Agricultural chemicals and other toxins in the water, including mercury
Animal feeding operations (AFOs)
Concentrated animal feeding operations (CAFOs)
Excessive nutrient levels in selected streams of the watershed
Urban sprawl and exurban development with the resulting loss of riparian and rural/agricultural land use
Stormwater management is not reaching small, rural communities.

Lack of uniform zoning codes among townships, cities, counties
Logjams and stream obstruction removal or lack thereof
Sedimentation of the river, streams and reservoirs
Loss of biodiversity, especially aquatic life
Not enough wetlands
Lack of adequate funding for wetland restoration
Failure to capitalize on the river as a valuable community asset
Economically and ecologically sound methods of drainage maintenance for agriculture and flood control for towns and cities
Lack of land access for hunters
Lack of filter strips and riparian corridor
Land use planning and education in rural development
Overharvesting of timber lands
Destruction of woodlots
Abandonment of wells
Development of flood plains
Lack of planning on a watershed scale
Apathy of the public regarding water and river issues
Negative perception of the quality of the river

Additional information has been compiled by the SJRWI based on feedback and data collection gathered while working with partners and citizens in various projects in the watershed over the past ten years. The Initiative maintains an informational website which makes available water quality reports, information on upcoming activities in the watershed, research results, and watershed management plans. Stakeholders are also able to contact the SJRWI via this website, www.sjrwi.org.

1.4 Visions of Success

In its Strategic Plan, developed in 1996 for the purpose of serving as a guide between various units of government, businesses, organizations, and individuals concerned for the condition of the St. Joseph River and its watershed, the St. Joseph River Watershed Initiative partners outlined target issues as sediment, pesticides, pathogens and nutrients. It further described the partnership's expectations for the next five years in a section entitled "Visions of Success." The vision included the following points:

- Human Health

At all times, pathogens, agricultural chemicals, and nutrients 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 eliminated.

- 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.

- Bio-Diversity

Water quality will allow the continued presence and repopulation of native wildlife and water-based species in their natural habitats, remaining above the stress level for populations living in and adjacent to waterways. Stresses 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, and boating. Water clarity will improve with the reduction of sedimentation.

- 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.

During the development of the first edition of this St. Joseph River Watershed Management Plan in 2000, additions that integrated issues of stakeholder input and communication, as well as access to recreational activities were included in the language of this vision.

St. Joseph River Watershed

Management Plan

Three States, Six Counties, One Watershed

Part 2: The Watershed

2.1 Watershed location

Figure 3 The St. Joseph River is part of the Maumee River and Western Lake Erie basins

The St. Joseph River Watershed, located in northeast Indiana, northwest Ohio, and south central Michigan, is an 8 digit (04100003) hydrologic unit code (HUC) watershed encompassing 694,400 acres. With its headwaters in Hillsdale County, Michigan, the St. Joseph River flows in a southwestern direction through Williams County, Ohio; Defiance County, Ohio; DeKalb County, Indiana; and Allen County, Indiana, before converging with the St. Mary's River in Fort Wayne, Indiana to form the Maumee River. Both Noble County and Steuben County contribute water to the St. Joseph River, through Cedar Creek and Fish Creek tributaries.

2.2 Description and History

(Figure 3 map courtesy of Army Corps of Engineers, Western Lake Erie Basin)

2.2.1 Natural History

The St. Joseph River was created by glaciers which scoured the region and then spread acres of sand, gravel and boulders over the surface of the land, creating lakes, ponds and marshes which fed water to the St. Joseph. The present-day river is a wide and relatively slow-flowing stream with an average bottom slope of 1.6 feet per mile, following the Fort Wayne moraine.

Anthony Fleming's 1994 The Hydrogeology of Allen County, Indiana notes that the St. Joseph River occupies a deeply entrenched valley that separates the north limbs of the Fort

Wayne and Wabash Moraines, flowing southwest for approximately 18 miles across the northern half of the county before joining the St. Marys river at the headwaters of the Maumee River in downtown Fort Wayne. Significant high-level outwash terraces mark former levels of the river prior to downcutting to the present channel level. As much as 60 feet of outwash sand is present below some of these terraces, particularly in the lowest reaches of the valley in and near Fort Wayne. Sequences of sand and silt deposited in fan-deltas that predate the latest Erie Lobe tills underlie the outwash at some places and suggest that some segments of the valley are situated over fingers or localized lake basins associated with the earliest phases of ancestral Lake Erie. (Fleming, 1994)

Regarding interchange of surface and ground water, Fleming further notes, "The St. Joseph River is the regional discharge area of the Huntertown aquifer system… There is likely to be considerable interaction between the river and shallow ground water in the outwash. The water table depth ranges from a few inches below the low-lying floodplains immediately adjacent to the river to perhaps as much as 10 to 15 feet below some of the higher outwash terraces that adjoin the floodplain within the valley. Soils are primarily formed on alluvium or reworked outwash, and are commonly very poorly developed and locally waterlogged." (Fleming, 1994 p. 78)

The St. Joseph watershed is located primarily in the Eastern Corn Belt plains ecoregion, characterized by rolling plains, with beech/maple vegetation and soils that are good for cropland. The southern portion of the watershed is located in the Huron/Erie Lake Plain ecoregion, a broad, fertile, nearly flat plain that extends into Ohio and contains highly productive farmland (US EPA 1999).

2.2.2 Land Use

Of the 694,400 acres in the watershed, Indiana occupies 56% of the watershed, while Michigan and Ohio each occupy 22%. The watershed is primarily agricultural, with approximately 64% in cropland and 15% in pasture or forage. Woodlands and wetlands are found on 10%, while the remaining 11% consist of urban, farmsteads, rural residences, airports, golf courses, and other land uses. Urbanization is spreading north from Fort Wayne and along the transportation corridors in DeKalb and Steuben counties in Indiana, but the overall percentages of land use have not changed dramatically over the last ten years across the watershed as a whole.

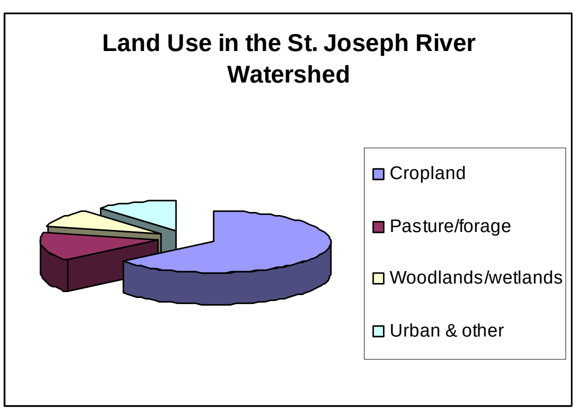


Figure 4 Land use by type in the St. Joseph River watershed

Figure 5 on page 8 is a land use map of the entire Western Lake Erie Basin. The St. Joseph River watershed lies along the northwest border of the basin. The large yellow urban area to the south represents the City of Fort Wayne and the confluence of the St. Joseph with the Maumee River. The urban area at the edge of Lake Erie is the City of Toledo, located at the mouth of the Maumee.

The predominance of farmland, not only in the St. Joseph, but in the entire basin, is obvious from this map.

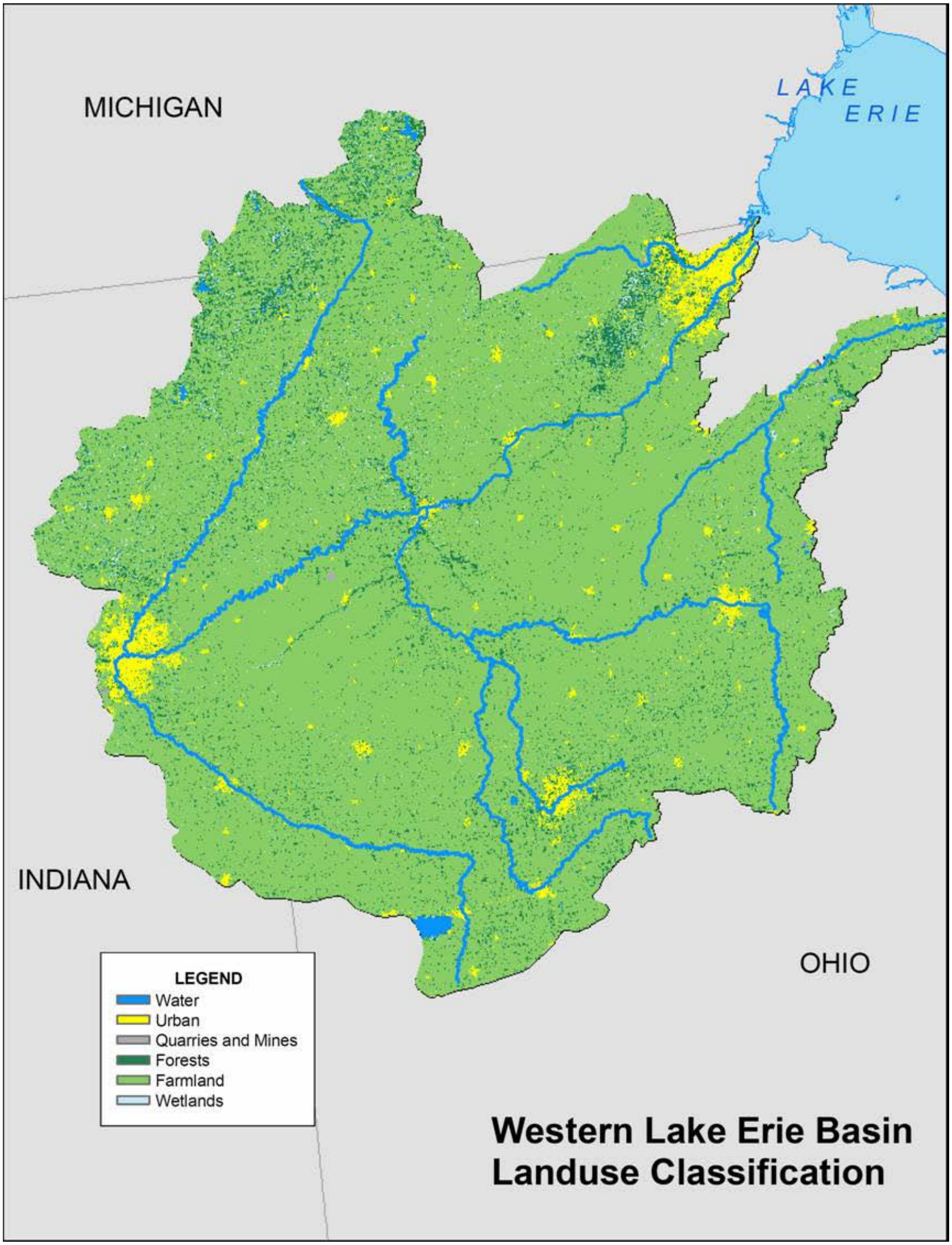


Figure 5 Land use in the Western Lake Erie Basin

2.2.3 Topography

The topography of the watershed varies from rolling hills in Hillsdale, Williams, Noble, and Steuben counties to nearly level plains in DeKalb and Allen counties.

2.2.4 Soils

Soils in the watershed were formed from compacted glacial till. The predominate soil textures are silt loam, silty clay loam, and clay loam. Soil associations include Miami-Morley, Morley-Glynwood-Blount, and Blount-Pewamo. Erosion and over-saturation are the major soil limitations.

2.2.5 Hydrology

The St. Joseph River system contains approximately 435.9 stream miles. Nine sub-watersheds on the 11-digit HUC scale form the St. Joseph, with the largest tributary, Cedar Creek, comprising the Upper Cedar Creek and the Lower Cedar Creek sub-watersheds. Other 11-digit HUC sub-watersheds in the St. Joseph are the Lower St. Joseph, Bear Creek, Middle St. Joseph, Fish Creek, Nettle Creek, East Branch St. Joseph, and West Branch St. Joseph. Approximate acres and stream length of 11-digit HUC watersheds in the St. Joseph River watershed.Table 1, below, shows approximate areas in acres and stream miles of the sub-watersheds compiled by the SJRWI from its GIS database.

Watershed	HUC	Approximate Area (Acres)	Stream Feet	Stream Miles
Bear Creek	4100003070	64,619.30	253,460	48.0
East Branch St. Joseph	4100003010	110,876.63	347,963	52.0
Fish Creek	4100003050	69,863.68	249,960	47.3
Lower Cedar Creek	4100003090	115,673.40	325,842	61.7
Lower St. Joseph Allen Co.	4100003100	31,340.93	94,549	17.9
Middle St. Joseph (IN-OH)	4100003060	85,617.41	302,083	57.2
Nettle Creek (OH)	4100003030	89,477.96	287,769	54.5
Upper Cedar Creek	4100003080	59,154.64	135,158	25.6
West Branch St. Joseph	4100003020	73,284.77	291,586	55.2

Table 1 Approximate acres and stream length of 11-digit HUC watersheds in the St. Joseph River watershed.

All streams of the St. Joseph River watershed are considered warm water streams with the exception of a portion of the East Branch of the river from Pittsford Road (T7S, R2W, Sec. 25) upstream to Trail Road (T7S, R2W, Sec 10), which is a designated trout stream (cold-water) except for the Pittsford Millpond Impoundment.

Natural streams as well as drainage ditches, some of which are regulated by local drainage boards, help to carry excess runoff water from the land in the watershed, thus supporting the use of land for agriculture, commercial, industry and residential uses. Many of the streams have been channelized and straightened to improve the flow of water downstream.

The lower 13.7 miles of the Cedar Creek, from DeKalb County Road 68 downstream to the confluence with the main stem of the St. Joseph River in Cedarville, Allen County, is designated as an Outstanding State Resource (327 IAC 2-2-2). Several natural communities, including forested, prairie, fen, bog, marsh and lake communities are included in this area (DNR, 1996). The site includes an 82-foot deep canyon cut by glacier melt. The Outstanding State Resource designation effectively protects the stream from degradation and detrimental impacts, including construction of dams, docks and bridges, excavation operations and drainage projects.

Uses of water from the St. Joseph River include public supply, industrial self-supplied (process water, waste assimilation, dewatering, sand and gravel operations, and some cooling and mineral extraction uses), agricultural water use, and energy production. Instream uses include water-based recreation, water-dependent wildlife habitat, fisheries, and discharge of treated wastewater.

The St. Joseph River serves as the drinking water supply for nearly 250,000 people in Fort Wayne and New Haven, Indiana. Fort Wayne's Three Rivers Filtration Plant processes 34 million gallons of water daily from the St. Joseph River. The filtration plant also operates two large reservoirs: Cedarville Reservoir, located in the St. Joseph River; and Hurshtown Reservoir. Both are located in the Bear Creek sub-watershed. Together these reservoirs store over 1 billion gallons of water.

The watershed includes several sizeable inland lakes (see Table 2), which provide drainage, water storage, recreation and aesthetics to residents.

Lake Name	**State**	**County**	**Drainage Area (acres)**	**Surface Area (acres)**	**Max. depth (feet)**
Ball	IN	Steuben	11.60	87	66
Bear	MI	Hillsdale		117	50
Bird	MI	Hillsdale		113	60
Cambria Mill Pond	MI	Hillsdale		38	12
Cedarville Res.	IN	Allen	764.00	408	22
Cedar	IN	DeKalb	23.40	40	16
Clear	IN	Steuben	6.86	800	90
Cub	MI	Hillsdale		69	43
Hamilton	IN	Steuben	16.50	802	70
Hurshtown Res.	IN	Allen	0.40	265	35
Indian	IN	DeKalb	3.76	56	52
La Su Ann	OH	Wiliams		127	40
Long	IN	Steuben	2.80	154	36
Nettle	OH	Williams	12,800.00	94	28
Pioneer	OH	Williams			
Round	IN	Steuben	7.25	30	25
Seneca	OH	Williams		175	25

Table 2 Lakes in the St. Joseph River Watershed

Groundwater susceptibility to contamination is very high in areas along the natural stream/river corridors in the watershed, and considered medium risk in much of northern Allen, DeKalb and Steuben counties in Indiana. In some areas, because of the soils and the high groundwater table, it is relatively easy to contaminate groundwater (1998 Indiana State of the Environment Report).

2.2.6 Land Ownership and Population

Allen is the largest county by population in the watershed. Only about 20% of its land actually lies in the watershed; however, a majority of its population relies on the river for water supply. Table 3 , below, lists land and water area, as well as population, for the six counties that have significant land in the watershed. (See Figure 1 for a map that shows the area of each county that lies within the St. Joseph River watershed.)

County	Land Area (sq. mi.)	Water Area (sq. mi.)	Population in 2000	Est. 2004 population
Allen, Indiana	657.2	2.9	331,849	342,168
DeKalb, Indiana	362.9	1.0	40,285	41,524
Hillsdale, Michigan	598.8	8.3	46,527	47,470
Noble, Indiana	411.1	6.5	46,275	47,297
Steuben, Indiana	308.7	13.8	33,214	33,722
Williams, Ohio	421.7	1.3	39,188	38,912

Table 3 Total land area, water area, and population for six counties in the St. Joseph River watershed.

Source: Population – http://quickfacts.census.gov/qfd/state/

The majority of the St. Joseph River Watershed is rural. Fort Wayne is the largest city in the watershed with over 200,000 residents. Auburn, Indiana is the second largest city. The population is increasing throughout the watershed, especially in southern DeKalb and Noble Counties, and northern Allen County, where rural residential use is increasing dramatically. Small 5-10 acre parcels are numerous in these areas. In all three states, industry is claiming territory along interstate and major state highways.

City	Population 2000
Fort Wayne, Indiana	215,495
Auburn, Indiana	12,074
Garrett, Indiana	5,803
Montpelier, Ohio	4,320
Leo-Cedarville, Indiana	2,782
Avilla, Indiana	2,049
Waterloo, Indiana	2,200
Edgerton, Ohio	2,117
Huntertown, Indiana	1,771
Pioneer, Ohio	1,460
Grabill, Indiana	1,113
Edon, Ohio	898

Camden, Michigan	550
Newville Twp, Indiana	538
St. Joe, Indiana	478
Montgomery, Michigan	386
Corunna, Indiana	254
Clear Lake, Indiana	244
Blakeslee, Ohio	130

Table 4 Population of cities, towns and villages in the St. Joseph River watershed

Source: http://quickfacts.census.gov/qfd/states/

Approximately 95% of the land in the watershed is privately owned, with the remaining 5% owned by the government.

2.2.7 Cultural Resources

The watershed includes many park and recreational areas, nature preserves, and public recreation areas. ACRES Land Trust, The Nature Conservancy, the Izaak Walton League, the Girl Scouts, and other groups own and operate several preserves, some of which are open to the public. Several city and county parks, private campground operations, recreational lake areas, conservation clubs, and state-owned lands are also located within the watershed. Among the lands owned by the government is the Lost Nations State Game Area in Hillsdale County, and Lake La Su Ann Wildlife Area and the Fish Creek Wildlife Area in Williams County. Lost Nations is managed by the Michigan DNR, this wooded area covers five linear miles between Osseo to south of Pittsford along the east Branch of the St. Joseph River, and includes numerous small lakes and the cold-water trout stream mentioned in 2.2.5 Hydrology, above. La Su Ann and Fish Creek wildlife areas are managed by the Ohio Department of Natural Resources, Division of Wildlife.

Name	County	Acres	Subwatershed	Features
James M & Patricia D Barett Nature Preserve	Allen & DeKalb	87	Cedar Creek	Owned by ACRES Land Trust. Closed to the public.
Bicentenial Woods	Allen	80	Willow (Cedar) Creek	(ACRES) Old growth forest remnant; two miles of walking trails
Cedar Creek Bottoms Nature Preserve	Allen	36	Cedar Creek	(ACRES) Closed to the public.
Tom & Jane Dustin Nature Preserve	Allen	28.56	Cedar Creek	Closed to the public.
Tom & Jane Dustin Conservation Easement	Allen	43.78	Cedar Creek	Closed to the public

Foxfire Woods Nature Preserve	Allen	8	Cedar Creek	(ACRES) Loop trail and parking area
Jessie's Woods Nature Preserve	Allen	30	Cedar Creek	(ACRES) Closed to the public.
Robert C & Rosella C Johnson Nature Preserve	Allen	15	Cedar Creek	(ACRES) Closed to the public.
Little Cedar Creek Wildlife Sanctuary	Allen	18	Cedar Creek	(ACRES) Adjoins Barrett Oak Hill Preserve.
Dr. Frederick O Mackel Nature Preserve	Allen	11.3	Cedar & Little Cedar Creeks	(ACRES) Closed to the public.
McNabb-Walter Nature Preserve	Allen	195	St. Joseph River	(ACRES)
Mengerson Nature Preserve	Allen	36	St. Joseph River	(ACRES) Urban area, hiking trails and parking area
Men-Aki Nature Preserve	Allen	120	Cedar Creek	In Metea County Park along Cedar Creek. Open to the public.
Emanuel M. Popp Nature Preserve	Allen	40	Ely Run	(ACRES) Closed to the public.
Rodenbeck Nature Preserve	Allen	115	Cedar Creek	Bottomland forest and upland and ravine forest. Owned by FW chapter, Izaak Walton League
Vandolah Nature Preserve	Allen	47	Cedar Creek	(ACRES) Adjoins Rodenback Preserve; features upland and floodplain forest communities and a marsh; 2 mile trail w/ scenic view of ravine and bluff topography.
Douglas Woods/Fish Creek	DeKalb & Steuben	522	Fish Creek	(The Nature Conservancy) 177 acres dedicated as a State Nature Preserve. Almost 400 acres of old growth forest; active great blue heron nesting colony; reforestation project.
Fish Creek Wildlife Area	Williams	158	Fish Creek & St. Jos. River	Ohio DNR, Division of Wildlife. Public hunting and fishing area.
Lost Nations	Hillsdale		St. Jos. River, headwaters	State of Michigan parkland; hunting, fishing, hiking
La Su Ann Wildlife Area	Williams	2280	West Branch, St. Joseph	Ohio DNR, Division of Wildlife. 127 acres fishing water, 7 miles of

				shoreline; wooded wetlands
Pioneer Scout Reservation	Williams	1000	West Branch St. Joseph	Boy Scouts of America
Bodner Wetland Reserves	Williams	400		
Whitehurst Nature Preserve	Allen	4	Cedar Creek	(ACRES) Closed to the public
Metea County Park	Allen	250	Cedar Creek	Administered by Allen County Parks, located near Leo-Cedarville; newly constructed nature center

Table 5 Parks and nature preserves in the St. Joseph River watershed

Greenway construction has expanded in the St. Joseph watershed over the past several years and efforts to continue expansion and connection of these greenways are ongoing. The Fort Wayne River Greenway project within the St. Joseph watershed connects downtown to the Johnny Appleseed Park, and will be extended northward through the IPFW campus to Shoaff Park. The St. Joseph River Parks, Inc., located in St. Joe, Indiana, currently holds easements for a 1.3 mile greenway constructed along the river behind Riverdale Elementary School. This group also cooperates with DeKalb County Eastern Schools in the management of 9.1 acres (donated in 2003 for parks and recreational purposes) adjacent to their riverside greenway trail. The trail supports outdoor education during the summer as well as a community resource for walking and access to the river.

Colleges and universities in the watershed are important sources of research data, educational and technical expertise, student interns, researchers and contributors to the overall knowledge of the watershed. Additionally, several secondary schools are active in projects around the watershed.

Indiana University-Purdue University Fort Wayne has been active through the departments of Biological Sciences, Geosciences, and Public Affairs. Other post secondary institutions in the watershed that have been active in or invited to participate in watershed activities and research include: Purdue University, West Lafayette; University of St. Francis, Fort Wayne; Indiana; Hillsdale College, Hillsdale, Michigan; Tri-State University, Angola, Indiana; Indiana Institute of Technology, Fort Wayne, Indiana; University of Toledo.

Several secondary schools have been involved in water quality efforts as well, including Eastside High School and their ecology education and outdoor classroom along the St. Joseph in St. Joe Indiana. Instructors from several high schools have been trained in the Hoosier Riverwatch program and can work with students on chemical and biological assessment of the rivers and streams. Efforts to expand this cooperation with schools are underway.

2.2.8 Native Mussels

The Upper St. Joseph River watershed, a project area of The Nature Conservancy that begins in central-lower Michigan and northwestern Ohio, and ends at the confluence of Fish Creek and the St. Joseph River about 50 miles downstream, encompasses 335,000 acres. The Upper St. Joseph Project has identified 43 species of fish and 31 species of mussels, three of which are federally endangered, living in Fish Creek. Researchers recently discovered a community of mussels in the East Fork of the West Branch of the St. Joseph that is nearly as diverse as Fish Creek. These areas are the best remaining example of a river community that once was common in the western Lake Erie basin. (TNC)

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 and 15 species found in Cedar Creek. A total of 2,899 specimens of 30 native species were found, 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 1988 (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.

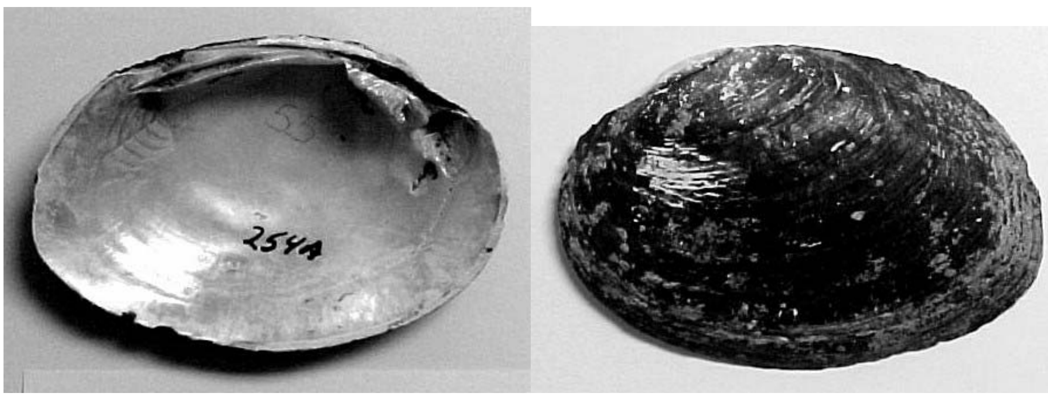


Figure 6 ***Actinonaias ligamentina*****, a mussel species found in Cedar Creek and the St. Joseph River**

(Photo courtesy W. Pryor)

More recently another source of information on mussels, the "Freshwater Mussels of the Maumee Drainage," by Jeff Garbarkiewicz of the Lucas County SWCD and Todd Crail of the University of Toledo, was published on the website http://www.farmertodd.com/musselguide/. Funding for the project was provided by OEPA's Ohio Environmental Education Fund and the Lucas County Soil and Water Conservation District.

2.2.9 Endangered Species

The 2-inch-long white cat's paw pearly mussel, listed federally in 1976 as endangered, was discovered in the Fish Creek sub-watershed and was a catalyst for formation of The Nature Conservancy's Upper St. Joseph River Project, which focuses on protection of Fish Creek and the East Branch of the St. Joseph River. The mussel, named for the shape of its shell which resembles a cat's paw-print, once lived throughout the river system but its numbers declined significantly in the early 1970s. The Fish Creek supports the last known population of the white cat's paw pearly mussel in the world.

Other endangered species living in the Fish Creek watershed include the northern rifleshell mussel (federally endangered) and the club shell mussel (federally endangered). The copperbelly water snake (federally listed as threatened and state-listed as endangered) has been discovered in the West Branch of the St. Joseph sub-watershed.

Several Indiana-listed endangered and special concern mollusks on the list were identified in the Pryor study (1997-2004) referenced above. 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 6 Endangered and special concern mussels in the St. Joseph River watershed

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

Part 3: Identifying Water Quality Problems

3.1 Point source pollution

Water quality problems that affect the St. Joseph River Watershed can be classified into point and non-point pollution problems.

Point source problems can be located at a particular point on a map. They are easily identified because pollution is discharged from the end of a pipe. Point sources account for about 25% of all pollution (IDNR Hoosier Riverwatch). Point sources are regulated through the National Pollution Discharge Elimination System (NPDES) permitting process. Permits are issued in Indiana by the Indiana Department of Environmental Management (IDEM). In Michigan and Ohio, permits are issued by the Michigan Department of Environmental Quality (MDEQ) and the Ohio Environmental Protection Agency (OEPA), respectively.

There are at least 20 industrial and 26 municipal NPDES permits in the St. Joseph watershed. A listing of NPDES permits can be found in Appendix C of this document.

Point sources may include discharge sources from factories and industries, municipal sources such as combined sewer overflows (CSO) or wastewater treatment plant (WWTP) discharge points. Other point sources may include leakage or outflow from landfills, petroleum or chemical storage facilities, and any other pollution source that can be pinpointed by a discharge pipe.

Pollutants present in the river and tributaries that may also come from point sources include toxic wastes in permitted or illegal landfills. Runoff and leaching from improperly contained dumps is a source of water pollution from various chemicals, dependent upon what is contained in the dump. One tire dump is located in Steuben County and one in northeast Allen County (1999 figures).

Mercury and PCBs, both of which are present in fish and contribute to fish consumption advisories across the watershed. Mercury is a naturally occurring metal which does not break down, but recycles between land, air and water. It is released by power plants and the burning of household, medical and industrial wastes (point and/or non-point). PCBs are synthetic oils that break down very slowly in the environment and were widely used in electrical transformers and capacitators. (IDEM State of the Environment 1999) These pollutants collect in sediment and various microscopic animals, and build up in fish and other aquatic organisms. This is the reason for fish consumption advisories, the purpose of which is to limit the ingestion of fish by humans, thereby limiting the threat of these chemicals to human health.

3.2 Non-point source pollution

Non-point sources (NPS) of pollution are those which cannot be traced to a specific point. It is the product of land use throughout the entire watershed and makes up about 75% of water pollution (IDNR Hoosier Riverwatch). Non-point sources of pollution from runoff may include agricultural fields, transportation corridors, urban streets and yards, building roofs, woodlands, parks, golf courses, and parking lots. Non-point sources also include deposition of pollutants from the atmosphere, such as mercury from power plants deposited in surface water via air pollution.

Pollution can be also be classified by type:
Organic pollution – decomposition of once-living plant and animal materials
Inorganic pollution – suspended and dissolved solids (e.g. silt, salt, minerals)
Toxic pollution – heavy metals and lethal organic compounds (e.g. iron, mercury, lead, PCB). Some of these are transferred via the atmosphere and air deposition
Thermal pollution – heated water from runoff (e.g. streets, parking lots) or point source discharges (e.g. industries, nuclear or other power plant discharges)
Biological pollution – introduction of non-native species (e.g. zebra mussels, purple loosestrife, Eurasian water milfoil) (Source: IDNR Hoosier Riverwatch)

3.2.1 Sediment

Sediment is the number one source of water pollution by volume in the watershed. Sediment increases the absorption of heat, it decreases the clarity of the water, and it may contain attached chemicals, excess organic debris, and heavy metals.

The collection of sediment in tributaries and the river disrupts life cycles, which causes loss of habitat for aquatic plants, insects, and animals. It decreases the functional capacity of drainage ditches. Further downstream, sediment decreases reservoir storage capacity and reduces recreational opportunities. And at the mouth of the river, the deposited sediment disrupts navigation and shipping activities in the river and harbor.

Suspended sediment causes turbidity, or cloudiness in the water which must be removed during treatment of water for drinking and other domestic and commercial uses.

Figure 7 on the following page shows the extent of erosive soils in the St. Joseph River watershed.

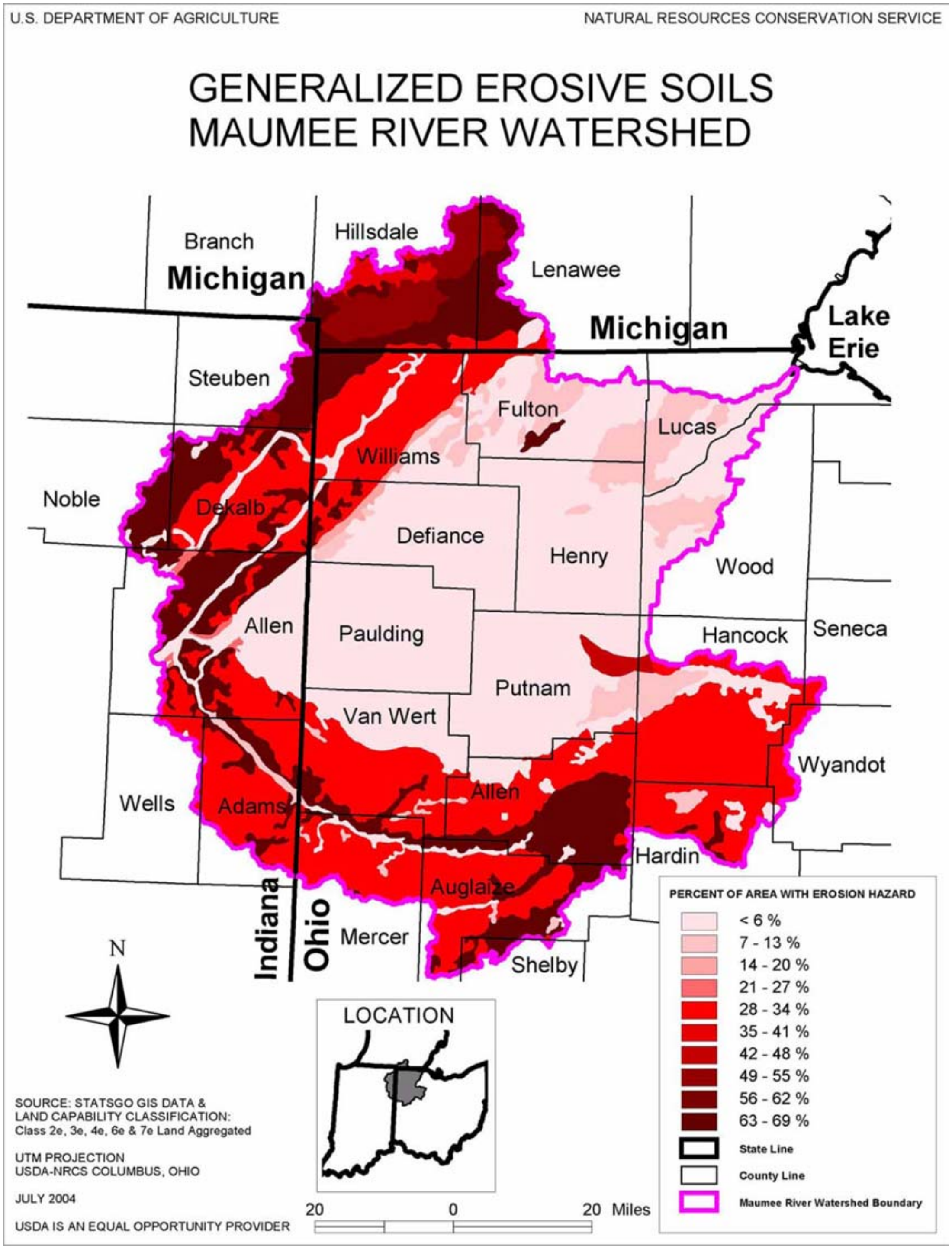


Figure 7 Erosive soils in the St. Joseph River watershed and Western Lake Erie Basin

(Map courtesy USDA)

3.2.2 Pesticides

Pesticides, like sediment, pose a threat to aquatic habitat and wildlife that rely on the river and its tributaries. Pesticides, at levels above minimum water quality standards established by EPA, are also considered a risk to human health. The cumulative effects of combinations of several types of pesticides present in water supplies are not well understood.

When levels of pesticides, fertilizers and other chemicals in raw water rise above water quality standards (WQS) for drinking, the pollutants must be removed by treatment processes in order to render the water potable for drinking and domestic use.

3.2.3 Pathogens

Pathogens, including bacteria and other microscopic organisms, pose a serious threat to both humans and animals. Analysis of water samples has found consistently high levels of E. coli, (used as an indicator of potentially harmful pathogens) throughout the recreational season in the main stem of the St. Joseph and in many of its tributaries. Flow duration curves and other models prepared for this watershed show that the majority of high level E. coli levels occur during wet weather (rain, snow melt) events. (IDEM, 2005)

Bacteria and other pathogenic organisms enter the waters of the stream through contact with the excrement of warm-blooded animals, including humans. Runoff from non-functioning septic systems, livestock pastures and feedlots, and outflow from sanitary treatment plants may contain high levels of pathogens. Additionally, wildlife in and around the stream, including birds and waterfowl, contribute to the loading of these pollutants.

High bacteria levels in water render it unsafe for drinking and for full-body recreational contact such as swimming, water skiing and wading. Drinking water can be treated by chlorination to kill bacteria and render the water safe for domestic consumption; however, this treatment process also produces by-products which are harmful and must be reduced or removed before effluent water is discharged into receiving streams.

3.2.4 Nutrients

The nutrients phosphorus and nitrogen are present in the surface waters of the St. Joseph watershed. Nutrients degrade surface water by acting as fertilizers for aquatic plants and algae. Excessive growth of these plants creates water quality problem because when they die and decompose, dissolved oxygen in the water is depleted. This condition is called *hypoxia* and can lead to fish kills. The reaction of the aquatic system to an overload of fertilizers is known as *eutrophication.*

Phosphorus does not have a gaseous phase; therefore, once it is in an aquatic system, it remains there and cycles through different forms unless physically removed.

Nitrogen occurs in water as nitrate (NO_3), nitrite (NO_2) and ammonia (NH_3). Ammonia occurs in alkaline waters; in acidic waters it occurs as ammonium (NH_4). It can enter the water by means of human and animal waste streams, decomposing organic matter, and runoff of fertilizers from lawns, gardens and agricultural fields.

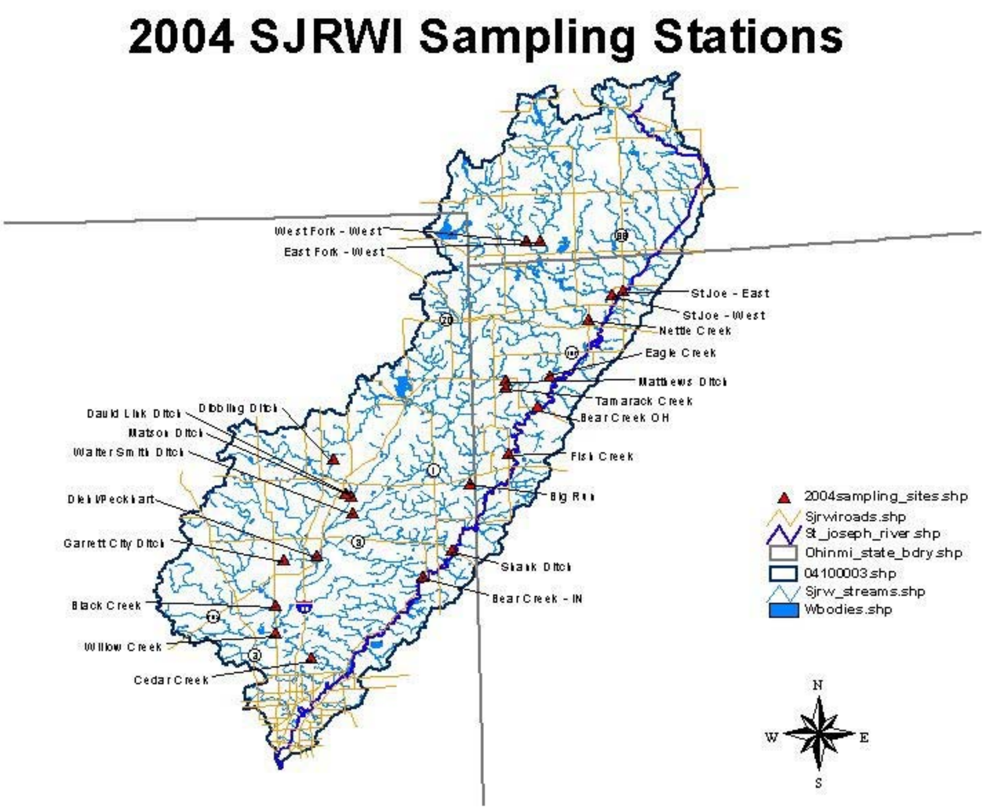
Nitrate (NO_3) levels above 4.0 ppm and nitrite levels above 3.3 ppm are considered unsafe for drinking water, posing a threat to human health. High levels of nitrates in the body inhibit the ability of blood to carry oxygen. This effect is especially noticeable in infants, and is commonly referred to as the “blue baby syndrome.”

St. Joseph River Watershed

Management Plan

Three States, Six Counties, One Watershed

Part 4: Known Water Quality Problems



Site Name	Site Number	Location	Parameters
Cedar Creek	100	Tonkel Rd, Allen Co.	Full + nutrients
Willow Creek	101	Coldwater Rd, Allen Co.	Full
Black Creek	102	CR 7A, Dekalb Co.	Full
Little Cedar Creek	103	CR 64, Dekalb Co.	Full
Diehl/Peckhart Ditch	104	SR 427, Dekalb Co.	Full + nutrients
Matson Ditch	106	CR 39, Dekalb Co.	Full + nutrients
Garrett City Ditch	117	CR 15, Dekalb Co.	Full
Shank Ditch	123	CR 75A, Dekalb Co.	Full
Fish Creek	124	SR 49, Williams Co., Ohio	Full
St. Joe - West	125	US 20, Williams Co., Ohio	Full + nutrients
St. Joe - East	126	SR 15, Williams Co., Ohio	Full
Big Run	127	CR 79, Dekalb Co.	Full
Bear Creek – IN	128	SR 1, Dekalb Co.	Full
Nettle Creek	129	SR 576, Williams Co, Ohio	Full
Eagle Creek	130	CR J, Williams Co., Ohio	Full
Bear Creek – OH	131	SR 34, Williams Co, Ohio	Full + nutrients
Matthews Ditch	132	CR 4, Williams Co., Ohio	Full
Tamarack Creek	133	CR 4, Williams Co., Ohio	Full
East Fork – West	134	Sampson Rd, Hillsdale Co., MI	Full
West Fork – West	135	Sampson Rd, Hillsdale Co., MI	Full
Walter Smith Ditch	141	CR 39, Dekalb Co.	Full + nutrients
David Link Ditch	142	CR 37, Dekalb Co.	Full
Dibbling Ditch	143	CR 18, Dekalb Co.	Full

Table 7 Site location and parameters for SJRWI sampling points in the St. Joseph watershed

4.1 Water Quality Testing in the St. Joseph

The Initiative began collecting water quality data from a grab sampling program in 1996. The Initiative currently collects water samples at 24 locations across the St. Joseph River watershed during the recreational months (April through October). Data is collected at each site for air temperature, cloud cover, water temperature, pH, conductivity, dissolved oxygen (DO), turbidity, and total dissolved solids (TDS). Sample analysis for nutrients (ammonia and phosphorus), bacteria (E. coli, heterotrophic plate count and total coliform) and pesticides (atrazine, alachlor, cyanazine, and metolochlor) is provided by the City of Fort Wayne, Water Utilities Department.

Other water quality monitoring in the watershed includes stream segment testing by the Indiana Department of Environmental Management (IDEM), Ohio Environmental Protection Agency (OEPA) and the Michigan Department of Environmental Quality (MDEQ).

On a local level, NPDES permit-holders, including wastewater treatment plants, carry out water quality testing on outflow under requirements those regulatory permits. The Fort Wayne Water Filtration Plant tests raw and finished water on a regular basis as required for their processing procedures.

Additional water quality monitoring and biological research for the Fish Creek and East Fork of the St. Joseph has been supported by The Nature Conservancy's Upper St. Joseph River Project. This project began in 1992 in an effort to protect the Fish Creek, a tributary which contains one of the most diverse assemblages of fresh water mussels in the Great Lakes Basin. Specific threats recognized by the Conservancy include siltation of the stream channel and alteration of hydrology, including tiles and ditching for drainage that reduces the groundwater reservoir available for maintaining base flow conditions during dry summer months.

Information from all of the above sources has been used to the extent available to determine the water quality problems in the St. Joseph Watershed.

4.2 Michigan DEQ St. Joseph River Biological Survey Report

The Michigan Department of Environmental Quality (MDEQ) report entitled A Biological Study of the East and West Branches of the St. Joseph River Watershed and Bean Creek Watershed in Southern Lenawee and Hillsdale Counties, July and August, 2000 includes qualitative biological and habitat results for 27 stations and water chemistry data for 18 stations. See Figure 10 for a map of the area in the study.

The MDEQ report shows macroinvertebrate communities rated acceptable or excellent at all stations. In the East Branch of the St. Joseph, habitat scored fair (moderately impaired) at all stations except Laird Creek where it was scored poor (severely impaired) due to sedimentation. In the West Branch, habitat ratings ranged from fair (moderately impaired) to good (slightly impaired). Based on macroinvertebrate communities, the overall biological quality of the East and West Branches of the St. Joseph River meet the designated use of "other indigenous aquatic life."

Fish communities were sampled at Station 17, East Branch at Tripp Road, located on a stretch of river that is a designated trout stream. No salmonid species were found during the survey; however the MDNR releases eight-inch brown trout at this station annually. A small pond immediately upstream of the sampling site is suspected of influencing water temperature at this station, making it unfavorable to trout during the high summer.

Mercury was detected at 0.2 micrograms per liter (ug/l) at the Territorial Road station on the east for of the West Branch of the St. Joseph River. Zinc was detected in Silver Creek at Territorial Road at levels exceeding 384 ug/l. These levels exceed Michigan's WQS and are scheduled to be investigated in 2005 to determine causes of the exceedences.

Phosphorus concentrations exceeded expected ranges for the Eastern Corn Belt Ecoregion at Station 25 on the West Fork of the West Branch of the St. Joseph, just north of the town of Camden. Ammonia concentrations exceeded expected ranges at Stations 25 and 27 (East Fork of the West Branch) and in Silver Creek at Station SV-3.

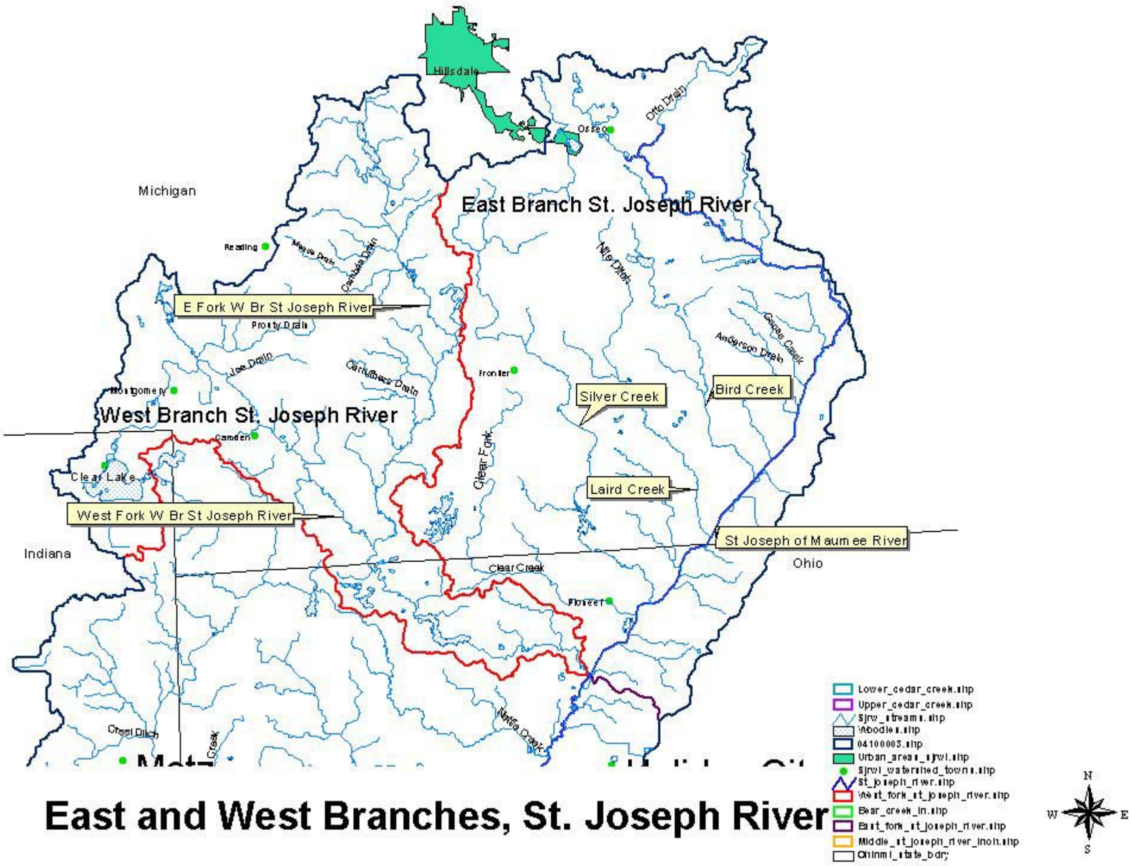


Figure 10 East and west forks of the West Branch, and the East Branch of the St. Joseph River

4.3 Ohio EPA Study of the Fish Creek

The Ohio EPA, Division of Surface Water published a report from 2002 sampling of Fish Creek entitled *Biological and Water Quality Study of Fish Creek, Steuben and DeKalb Counties, Indiana, Williams County, Ohio* on February 18, 2005. The study outlines biological community, sediment and surface water sampling of Fish Creek upstream and downstream of the location of a diesel fuel spill that occurred on September 15, 1993. Results of this study, which assessed 30 miles of the creek, indicated that 19 miles of the creek were in full support/attainment of the Indiana warmwater use and Ohio warmwater habitat use; two miles were in partial attainment of the Ohio exceptional warmwater habitat use (unique and diverse assemblage of fish and invertebrates), and nine miles were not supporting or attaining the warmwater use (typical assemblage of fish and invertebrates), primarily due to the failure of the fish community to meet biological criteria. This failure was the result of previous channel modifications negatively influencing the fish communities. The report noted a heavy silt layer covering the bottom substrates, generally causing moderate to extensive embeddedness of the stream bottom. The report also found a continued predominance of high pollution tolerant species. (Ohio EPA, 2005, p. 5)

Biological sampling from the Hiram Sweet Ditch and West Branch Fish Creek documented non-support of the Indiana warmwater use. Although macroinvertebrate communities were not impaired, fish communities in these two streams were in the poor range.

Sampling and studies of the creek have taken place since the 1993 spill, and reports can be found on the Ohio EPA website.

4.4 303(d) list of impaired waters

The St. Joseph River and many of its tributaries are listed as impaired on the 303(d) List of Impaired Waters in Indiana, Ohio and Michigan.

Waterbody Name	HUC-11 Sub-watershed	No. Waters on List
Bear Lake	West Branch St. Joseph	1
Fish Creek	Fish Creek	1
Black Creek	Cedar Creek	1
Cedar Creek	Upper/Lower Cedar Creek	5
Diehl Ditch	Cedar Creek	1
Dosch Ditch	Cedar Creek	1
Swartz (David Link) Ditch	Cedar Creek	1
Hamilton Lake	Fish Creek	2
Fish Creek Tribs	Fish Creek	3
St. Joseph River	Main Stem	7
Garrett Ctiy Ditch	Cedar Creek	1
Herman Sweet Ditch	SR 1, CR 65A	1
Little Cedar Creek & Trib	Cedar Creek	3
Cedar Creek Mainstem	Cedar Creek	1
St. Joseph Reservoir	Lower St. Joseph (Allen County)	1
Fish Creek – Alvarado	Fish Creek	1
Swartz-Carnahan Ditch	Bear Creek (IN)	1
Willow Creek and Trib	Cedar Creek	2
Metcalf Ditch and Tribs	Middle St. Joseph	1
Cedarville Reservoir (lower)	Bear Creek	1
West Branch Fish Creek & Tribs/ Burdick Lake	Fish Creek	2
St. Joseph River East/West (OH)	East Branch, West Branch St. Joseph	1
St. Joseph River (OH	Nettle Creek	1

Table 8 Impaired waters in the St. Joseph River watershed 2004 (EPA)

Waters listed include 35 in Indiana, one in Michigan, and three in Ohio. Of the 58 impairments in the 39 listed waters on the impaired streams listed in Table 8 (above) are pathogens (22), fish consumption advisory (FCA) for mercury (9), impaired biotic communities (9), FCA for PCBs (8), FCA (2), other habitat alterations (2), algal growth (1), mercury (1), salinity/total dissolved solids (TDS) (1), TDS (1), siltation (1) and nutrients (1).

4.4 Pollution Problems Identified

4.4.1 Pesticides

In 1995, the environmental organization, Environmental Working Group, conducted a study testing tap water in Midwest cities for commonly used herbicides. Of all the cities tested, Fort Wayne was found to have the greatest number of different pesticides and metabolites in its water. At the time of this study, the Three Rivers Filtration Plant was not testing water for farm chemicals.

Water quality monitoring data collected by the SJRWI from 1996 through 2005 indicated that on average, pesticide levels in the watershed are generally not above the drinking water standard. However, during peak application months, when spraying of agricultural chemicals coincide with soil tillage and spring rainfall, pesticide levels often spike. Concentrations in raw water at the Three Rivers Filtration plant, the lowest point of the watershed, are sometimes above the maximum contaminant levels (MCL) for drinking water set by the Environmental Protection Agency during this time. When pesticide levels in raw water are above MCL standards, the water is treated with powdered activated carbon to remove the chemicals.

Pesticide levels in upstream drainage ditches during spring rainfall events have been shown to be significantly higher. Research by the ARS at the Initiative's Source Water Protection Initiative (SWPI) project in the Matson Ditch have shown levels of Atrazine nearing 70 ppb during the first flush of rain events. Dilution and breakdown as the pollution moves downstream greatly reduces the level of the chemical, although it often remains above the 3 ppb drinking water standard at many of the Initiative's testing sites. The site nearest to Fort Wayne is Site 100 on Tonkel Road, approximately 10 miles north of the water treatment facility.

Atrazine, a water-soluble pesticide widely used for corn, has a chronic aquatic habitat contaminant level of 12 ppb, which is often exceeded across the watershed. Levels above 12 ppb can cause stress to aquatic animals and plants.

The Initiative's program analyzes water samples for atrazine, alachlor, cyanazine and metolachlor. Each of the four pesticides tested can be detrimental to human health when people exposed to excessive levels. The effects of atrazine when exposed to high levels include dermatitis, and irritation of eyes, nose and throat. Excess consumption of atrazine may lead to tremors, organ weight changes, and liver and heart damage. Some of the environmental effects include reduction of population of aquatic organisms such as mussels.

Cyanazine is in the same herbicide family as atrazine and carries some of the same characteristics. Although, cyanazine is not quite as toxic as atrazine, it has been discontinued. Cyanazine levels have decreased in recent years.

Alachlor has been classified as a possible carcinogen. Alachlor has a low acute oral toxicity with effects including hepatotoxicity and eye degeneration. Studies on rodents indicate tumor formation in lungs, stomach, thyroid, and nasal passages. Alachlor's environmental effects show it to be moderately toxic to aquatic invertebrates and fishes, and slightly toxic to waterfowl.

Metolachlor has also been classified as a possible carcinogen. Contact with metolachlor may include irritation of eyes and skin, while intoxication include cramps, nausea, anemia, methemoglobenemia, collapse, convulsions, and shock. Environmentally, metolachlor is moderately toxic to both cold and warm water fishes.

The City of Fort Wayne must remove the excess chemicals during the filtration process in order to meet safe drinking water standards. This is done by filtering with powdered activated charcoal at the Three Rivers Water Filtration Plant. The City spends an average of $165,000 annually for powdered activated carbon (Shastri, 2004).

4.4.2 Bacteria and pathogens

Escherichia Coli is a bacterium in the family *Enterobacteriaceae*. These bacteria are a family of organisms grouped together because of their role in the intestinal tract of most species of mammals. E. coli and other bacteria in the same family are essential for proper digestion, vitamin production, and heart function. A comparatively rare E. coli strain, E. coli 0157:H7, has been known to cause sickness in human beings. This strain differs from beneficial E. coli bacteria by producing a protein called Shiga-like toxin (SLT), which causes severe intestinal damage and is potentially lethal to children and elderly victims.

The IDEM Office of Water Management's Intensive Segment Survey for Cedar Creek (1992, Segment 18) listed E. coli concentrations as a major threat to water quality in the Cedar Creek watershed, the largest tributary to the St. Joseph River. Statistics from the SJRWI water quality data show that throughout the St. Joseph River Watershed, levels of E. coli are high, usually much higher than 235 colonies/100 ml set by the Indiana Department of Environmental Management as the maximum level for full body contact.

The presence of E. coli in surface waters does not necessarily indicate the presence of the harmful 0157:H7 strain of the bacteria. Regulatory agencies test for total coliform and E. coli as indicators of the amount of human and animal waste present in the waterways. High levels may indicate the presence of harmful bacterial strains and other pathogens, or the potential for such contamination.

At the time of publication of the initial St. Joseph WMP in 2000, major sources of E. coli in the St. Joseph River Watershed were believed to be failing septic systems and livestock waste. However, the SJRWI's Bacteria Source Tracking (BST) project (2001-2004), a research project funded by the Fort Wayne Community Foundation and an IDEM Section 319 grant (ARN 01-383) indicated that wildlife, particularly geese, make a significant (greater than 50%) contribution to the bacterial pollution in this watershed. The human contribution of fecal contamination was determined to be localized to particular sub-watersheds and generally low. Livestock (beef, dairy and swine) contributed little to the overall fecal pollution of the St. Joseph River watershed. Significant contribution was shown from horses; however some question arose whether there was interference with the "horse" profile from another source of contribution. It was verified by an alternative ribotyping analysis in an independent laboratory that this interference did not come from human sources.

Human and animal fecal matter in the stream brings with it a high risk for disease, and ingestion of contaminated water through swimming or other contact (recreational use) has the potential for causing serious illness in human populations. Diseases caused by sewage-contaminated water include campylobacteriosis, cryptosporidiosis, Escherichia coli diarrhea, encephalitis, gastroenteritis, giardiasis, hepatitis-A, poliomyelitis, salmonellosis, shigellosis, and typhoid fever.

Therefore, any and all sites, however localized, that indicate contamination by human or livestock sources are considered serious threats and should be addressed by BMPs as early as possible.

4.4.3 Turbidity

Turbidity, or cloudiness of the water, is caused by the sediment and attached organics (suspended solids). Measurement of water quality samples may be listed as total suspended solids (TSS).

Sediment that erodes from the land and makes its way to the streams will cause several types of problems. Sediment tends to cause embeddedness in the stream substrate – it will suffocate and bury aquatic bottom-dwellers such as mussels. It will fill in cracks and crevices around rocks, destroying homes for benthic invertebrates which are an important link in the aquatic food chain. Sediment also fills up the ditches and streams which are used for drainage and are important to the economic development and prosperity of the watershed. Sediment also carries with it pesticides and nutrients which pollute the water body and have a harmful effect on water quality as well as habitat. Moving water transports sediment with the attached chemicals to new sites downstream.

Each year, 38 million tons of topsoil erodes from U.S. cropland in the Great Lakes basin, resulting in reduced productivity and loss of nutrients valued at more than $96 billion annually (Great Lakes Commission, 2004). The St. Joseph River in Indiana, Michigan, and Ohio is one of the headwater tributaries of the Maumee River. Approximately 21% to 69% percent of the St. Joseph River watershed has soils with erosion hazard (see Figure 7). This practically guarantees that human activity on these lands will increase erosion unless careful management practices are used on site. Since the primary land use of the watershed is agricultural, erosion represents a major pollution problem for the St. Joseph River watershed.

The SJRWI water quality monitoring program has found high levels of turbidity in the river and many tributaries during sampling, particularly during and after storm events. The chart below shows turbidity levels in the Fish Creek tributary in 2003. Levels above 100 NTU are generally considered detrimental to habitat. A graph of turbidity levels in the Cedar Creek can be found in Chapter 6 of this document (see Figure 12).

Average loading of total suspended solids (TSS) at the Mayhew Bridge site sampled by the City of Fort Wayne in 2003 shows minimum TSS as 14 mg/L. The maximum at this location is 372 mg/L, while the average at this location is 72 mg/L.

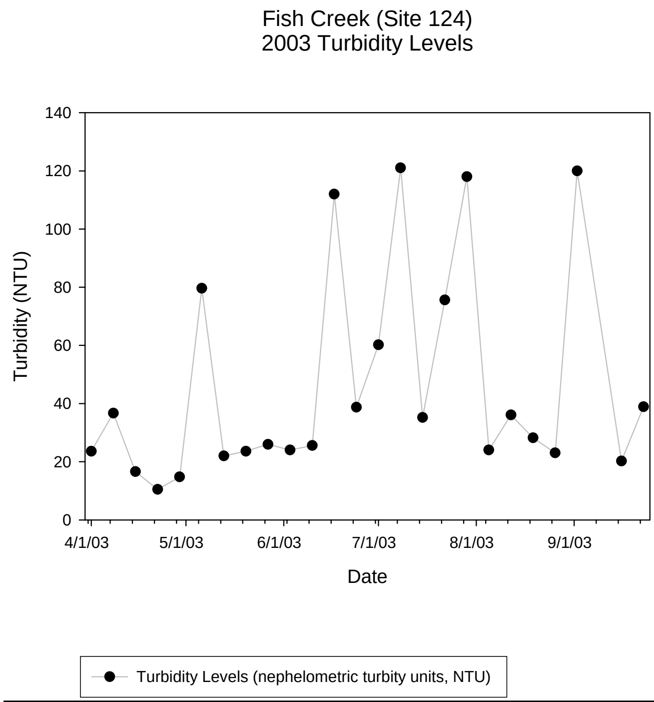


Figure 11 Turbidity in the Fish Creek, 2003

Fort Wayne's Three Rivers Filtration Plant is located at the St. Joseph River's confluence with the St. Marys River at the headwaters of the Maumee River. This plant, which processes 34 million gallons of water per day, must remove the sediment (turbidity) from the water in order to produce safe, high-quality drinking water. Turbidity levels in the raw water determine the amount of flocculants needed for clarifying the water during the treatment process. The filtration plant 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 on removal of turbidity before filtration of the water. The cost does not include upgrading and maintaining of filters. Reduction in turbidity will not necessarily reduce the city's cost of treatment by the same percentage, according to the filtration plant supervisor. The US EPA has been lowering the acceptable turbidity limits and that has impact on the cost. Reduction of turbidity in the river, however, will make the city's process more reliable and less prone to failure. (C. Shastri, personal correspondence, February 11, 2004)

Downstream of Fort Wayne, 800,000 cubic yards of sediment are dredged annually from Maumee Bay in Lake Erie to keep the Port of Toledo shipping channel open to navigation. (US Army Corps of Engineers, 2004)

4.4.4 Nutrients

Nutrients entering the waterways increase cloudiness (turbidity) in the water and support an overabundance of algae and weed growth. As the plants grow and decay, they use oxygen from the stream, reducing oxygen levels available for fish and other aquatic animals and plants. This life-death cycle can also cause discoloration and odor in the waterway, negatively affecting drinking water quality and reducing the aesthetic value of the stream.

Nutrient data (ammonia and phosphorus) is collected by the Initiative's water sampling program from six sites in the watershed throughout the recreational season. These sites include Cedar Creek at Tonkel Road (Site 100), Diehl-Peckhart Ditch (Site 104), Matson Ditch (Site 106), West Branch St. Joseph (Site 125), Bear Creek Ohio (Site 131), and Walter

Smith Ditch (Site 141). All sites except 125 and 131 are located in the Cedar Creek sub-watershed.

Although nutrient loading is not as critical a problem in this watershed as in some areas of the Midwest, there are local areas within the watershed that show elevated levels of nutrients either through water quality monitoring or through resultant overgrowth of aquatic plants and algae. Nutrients can leach from soils, but are more likely to be associated with runoff from farm fields, livestock and dairy operations, combined sewer overflows (CSO), wildlife, and failing septic systems.

Data analysis by a SWAT model produced for the Cedar Creek watershed indicates that phosphorus (P) and nitrogen (N) loading is highest during January through May, and lower during the growing season. (IDEM, 2005) Currently the Initiative samples water April through October, thus missing the projected highest loading period in the watershed.

4.4.4.1 Phosphorus

There are no federal, state or local standards concerning phosphorus in rivers, streams and lakes, but some general guidelines have been established across the country. The nutrient is considered an EPA Priority pollutant, and has had several benchmark concentrations established for it presence in fresh water. The EPA of the State of Illinois has established a level of 0.61 mg/L as capable of impairing aquatic life.

Phosphorus can enter the water via urban runoff, agricultural fertilizing operations, livestock operations, untreated wastewater and secondarily treated wastewater, as well as malfunctioning septic systems, illegal trash dumping, and residential lawn fertilizing. All are increased substantially by heavy rainfall and runoff.

Averages for phosphorus concentrations for the 2004 sampling season were well below the benchmark of 0.61 mg/L; however there were three exceedences of the benchmark, once in Bear Creek (Ohio) and twice in the Walter Smith Ditch.

4.4.4.2 Ammonia

Ammonia is the most reduced form of nitrogen and is produced by the biological decay of animal and plant material. It is introduced into rivers and streams through both urban and rural routes, and is equally represented in the sampling areas of the St. Joseph River. Urban exposure to ammonia generally comes from the discharge of sewer treatment plants and from industrial processes such as fertilizer manufacture and oil refining. In rural and agricultural areas, ammonia is often present due to fertilizer application and failing septic systems.

The toxic effects of ammonia are controlled by the pH of the stream. At higher pH (>8.0), ammonia is converted to a highly toxic (unionized) form that is fatal to aquatic life at very low levels. At a high pH, ammonia levels as low as 0.60 ppm can begin to damage fish, and levels of 0.20 ppm will begin to kill sensitive fish species. As a general rule, streams with an ammonia level of 0.10 ppm or greater should be considered to be impaired by the pollutant. The Indiana Administrative Code (IAC) recommends that ammonia concentrations in fresh waters should range between 0.00 and 0.21 ppm, depending on water temperature and pH.

Ammonia levels are measured by the Fort Wayne water pollution control plant at two locations on the St. Joseph River, the Tennessee St. and the Mayhew Road bridges. Their 2003 report shows two instances (4/14/03 and 5/05/03) at Mayhew (0.427 and 0.219) that exceed the IAC recommendation, and one instance (5/12/03) at the Tennessee site (0.313). See Appendix B for sampling results from the City of Fort Wayne.

In 2004, St. Joseph Initiative testing results for ammonia results varied widely across the watershed. While five of the six sites averaged below 0.20 ppm, several high concentration events are evident. Additionally, the high standard deviations indicate the potential at three of the sites for wide variation in ammonia values.

4.5 Fish Consumption Advisories

In Indiana, fish consumption advisories are based on the Indiana Administrative Code 317 IAC 2-1-9(45) defining toxic substances as those substances that are or may become harmful to plant or animal life or to food chains when present in sufficient concentrations or combinations. Toxic substances include but are not limited to those pollutants identified as toxic under Section 307(a)(1) of the Clean Water Act.

Toxic substances frequently encountered in Indiana streams include chlorine, ammonia, organics (including hydrocarbons and pesticides), heavy metals and pH. These materials are toxic to different organisms in varying amounts and the effects may be evident immediately or may only be manifested after long term exposure or accumulation in living tissue (IDEM 2002). Fish consumption advisories are based on data resulting from the bioaccumulation of pollutants in fish tissues (Indiana Integrated Water Quality Monitoring and Assessment Report, IDEM, 2002, p. 24).

The Indiana Fish Consumption Advisory identifies fish species that contain toxicants at levels of concern for human consumption using the Great Lakes Task Force risk-based approach (Indiana Integrated Water Quality Monitoring and Assessment Report, IDEM, 2002, p. 43). All rivers and streams in Indiana are considered to have PCB and Mercury impairments for carp (Angling in Indiana – 2003 Fish Consumption Advisory). All waters in the State of Ohio are considered impaired for mercury and PCB (Ohio EPA).

Waterbody	Species	Size (inches)	Group*
St. Joseph River, Allen Co.	Black Crappie	9-11	3
St. Joseph River, Allen Co.	Black Redhorse	13-16 16+	3 4
St. Joseph River, Allen Co.	Channel Catfish	13-14 15-20 20+	3 4 5
St. Joseph River, Allen Co.	Golden Redhorse	12-13 13+	3 4
St. Joseph River, Allen Co.	Rock Bass	7-9 9+	3 4
All Creeks and Rivers	Carp	15-20 20-25	3 4

		25+	5
Cedar Creek, Allen Co.	River Chub	4+	3
All waters (Ohio)	Channel catfish	All sizes	3
* Group: 3 = 1 meal/month	4 = 1 meal/ 2 months	5 = DO NOT EAT	

Table 9 Fish advisories in the St. Joseph River, Indiana

The fish advisory groups fish according to how often it is safe to eat the fish. Group 3 fish can be safely eaten for one meal per month; Group 4 are safe for one meal every two months. Group 5 fish should not be eaten. It is not known how many people fish in the St. Joseph River and its tributaries, nor how many people consume the fish they catch.

Ohio fish consumption advisories cover all waters of the state. Their advisories include the fish on the following chart:

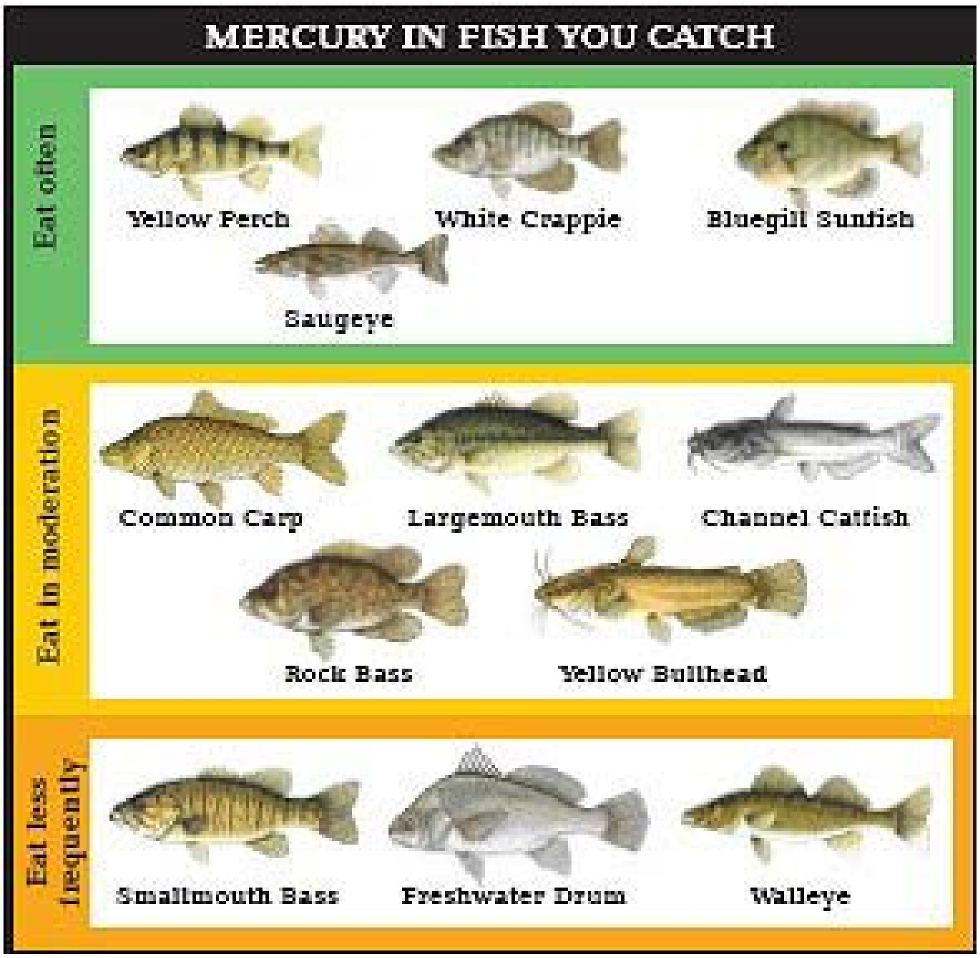


Figure 12 Ohio fish consumption advisory (ODNR, 2006)

4.6 Total Maximum Daily Load (TMDL) Schedule

Section 303(d) of the Clean Water Act requires states to identify waters that do not or are not expected to meet applicable water quality standards with federal technology-based standards alone. States are also required to develop a priority ranking for the waters taking into account the severity of the pollution and the designated uses of the waters. Once this listing and ranking of waters is completed, the states are required to develop TMDLs for these waters in order to achieve compliance with the water quality standards. (http://www.in.gove/idem/water/planbr/wqs/303d.html)

TMDL (Total maximum daily load) schedules for 303 (d) listed stream segments are listed on Table 10, below.

Waterbody	County	Parameter of Concern	TMDL development schedule
Long Lake	Steuben	FCA, Hg	2015-2020
*Cedar Creek	Allen, DeKalb	E. coli	2002-2007
Cedar Creek	Allen, DeKalb	IBC, Nutrients	2007-2014
Cedar Creek	Allen, DeKalb	FCA, PBC	2015-2020
*Garrett City Ditch	DeKalb	E. coli, TDS	2005-2010
Hamilton Lake	Steuben	FCA, Hg	2015-2020
Lower Cedarville Reservoir	Allen	E. coli	2015-2020
St. Joseph River	Allen	FCA, Hg & PBC	2015-2020
Swartz-Carnahan Ditch	Allen	IBC	2010-2017
Willow Creek & tributaries	Allen	E. coli	2010-2015
*Little Cedar, Diehl, Swartz	DeKalb	E. coli	2002-2007
Little Cedar, & tributaries	DeKalb	IBC	2005-2012
Dosch Ditch	Dekalb	IBC & algae	2005-2012
St. Joseph River	DeKalb	E. coli	2005-2010
Metcalf Ditch & tributaries	DeKalb	IBC	2010-2017
Black Creek	Steuben	IBC	2005-2012
Fish Creek & tributaries, West Branch St. Joseph	Steuben, DeKalb	E. coli	2005-2010
Herman Sweet Ditch	DeKalb	E. coli	2005-2010

Table 10 TMDL schedule and parameters of concern for Indiana streams (IDEM, 2002)

*Note that the listings for the Cedar Creek and its tributaries for parameter E. coli, scheduled to begin 2002, is being addressed by the SJRWI under the Cedar Creek WMP and Implementation Phase I grant projects.

Part 5: Sources of Water Quality Problems

Causes of water quality problems in the St. Joseph River watershed have been determined through water quality sampling and research combined with land use mapping. Land use information is available on a geographic information system (GIS) developed by the SJRWI in 2001-2003 with funding provided by the IDEM through a Section 205(j) grant to the City of Fort Wayne. This system includes aerial photo maps, soils, hydrology, and administrative boundaries, as well as land use graphics, toxic inventory maps and other tools as available at the time. Additional layers of information, including mapping of current conservation practice contracts by county across the watershed have been added since 2003, supported with funding from the Great Lakes Commission and information from NRCS and FSA. This GIS system can also integrate water quality information collected since 1996 by the SJRWI.

5.1 Point sources of pollution

Since the St. Joseph River watershed covers such a large area, sources of pollution vary widely. Several towns and cities have wastewater treatment plant discharge stations on the St. Joseph and its tributaries, including Auburn, Avilla, Butler, Corunna, Garrett, Hamilton, Hamilton Lake Conservation District, LaOtto, Steuben Lakes Regional Water District, St. Joe-Spencerville, and Waterloo in Indiana; Camden, Litchfield, North Adams, Pittsford, Reading and Waldron in Michigan; and Blakeslee, Edgerton, Montpelier, and Pioneer, in Ohio. Other areas have regional sewer treatment facilities. Some of the cities that have CSOs that empty into the river and its tributaries include Waterloo, Auburn and Fort Wayne.

Other possible point sources of pollution include in-stream discharges from commercial and industrial facilities. In-stream dischargers are required to hold NPDES permits. A listing and map of NPDES permit holders in the watershed can be found in *Appendix C* of this document.

There are several agricultural elevators and retail establishments that have large quantities of fertilizers and chemicals inventoried on the premises within the watershed. These may contribute to pollution if proper handling procedures for loading, unloading and container rinsing are not followed carefully. This type of accidental pollution would be especially noticeable if it occurred in the non-peak season.

Several large manufacturing facilities are located within the watershed, including Chase Brass & Copper Company, Nucor Fastener, Frank Sechler & Sons, Eagle Pitcher Plastics, Auburn Foundry, and Steel Dynamics, Inc.

5.2 Nonpoint sources of pollution

5.2.1 Sources from agriculture

As mentioned in the previous chapters, much of the St. Joseph watershed contains soils that are considered highly erosive. Since the vast majority of land use in the water is agricultural, the pollution from this non-point source is extensive. Conservation tillage, which reduces erosion from fields, is used on soybeans to a much greater extent than on corn within the watershed.

No-till or mulch-till practices must leave a minimum of 30% residue on the field after planting to be considered conservation tillage. The following information is taken from county transects. Note that Noble County and Hillsdale County information is from 2004*. Programs aimed at increasing conservation tillage for corn in the watershed have shown some success, but adoption has been slow and efforts continue. Conventional tillage practices in agriculture increase the amount of disturbed soils that can be moved offsite by wind and water. Conventional tillage on corn acreage contributes to both sediment pollution and chemical runoff, since the most common pesticide used for corn is atrazine, which is water-soluable.

County	Corn			Soybeans		
	No-till	Other Cons Till	Conventional	No-till	Other Cons Till	Conventional
Allen	17%	20%	63%	75%	9%	15%
DeKalb	39%	26%	35%	83%	11%	5%
Hillsdale*	35.5%	40%	24.5%	86%	13%	2%
Noble*	29%	50%	20%	70%	23%	6%
Steuben	39%	29%	32%	82%	17%	1%
Williams	33%	24%	45%	60%	15%	25%

Table 11 Conservation tillage adoption for corn and soybeans in the St. Joseph watershed 2005

Source: County SWCD offices.

According to the information in Table 11, above, conservation tillage is used on 75-99% of the soybeans in the watershed. However, conservation tillage on corn acres runs from 37% in Allen, the lowest adoption county, to 80% in Noble, the highest adoption county. It should be noted that only in DeKalb County does the majority of land lie within the St. Joseph River watershed, so other counties totals may not precisely reflect the actual adoption of conservation tillage within the St. Joseph River watershed.

Pesticides enter the waters of the St. Joseph River watershed primarily via runoff from agricultural fields and secondarily, from urban/suburban lawns. Other possible, but unconfirmed sources, include application of chemicals for ditch maintenance, and rinsing of pesticide application equipment at farm sites and agricultural chemical retail locations.

The SJRWI water quality testing program monitors the river and its tributaries for four agricultural chemicals: atrazine, alachlor, cyanazine and metolochlor. Since 1996, data has been collected tracking the level of these pesticides in the watershed. Additionally, Fort Wayne's Three Rivers Filtration Plant tests raw water for the chemicals; if levels exist in the raw water exceeding the maximum contaminant levels (MCL) the water is treated with powdered activated carbon. Water quality monitoring has shown that pesticide levels peak during April, May and June when spring rainfall, application of pesticides on farm fields and urban lawns, and disturbance of the soil by tillage and planting activities coincide. Levels of atrazine have been recorded by the Initiative's water monitoring as high as 10 ppb in the large tributaries near their confluence with the main stem of the river. These spikes generally occur during wet weather in the spring months. Research at the Source Waters Protection Initiative (SWPI) project has shown extremely high levels, above 60 ppb, recorded by the Agricultural Research Service's automated samplers in the Matson Ditch sub-watershed during rain events in peak application months.

Data collected by the SJRWI compares positively to levels of pesticides in the raw water at the filtration plant. Periods of high counts in the upper watershed coincide with dates on which the filtration plant had to filter out pesticides in the raw water obtained at the city intake near the St. Joseph River dam. Generally, pesticide levels are below water quality standards during non-peak months (July through October).

Figure 13 Dredging of drainage ditches impacts the sediment-filtering ability of the stream

Photo by Karen Griggs, 2003.

Ditches in the watershed function as drains for wet soils and quickly remove excess runoff after heavy rains. In agricultural areas, this is crucial to the production of healthy crops. However, sediment which runs off of crop fields into ditches is propelled downstream during high water, and collects in the streambed during low water periods. Removal of built up silt in the ditches, especially when dredging and straightening processes are combined, can actually increase sedimentation by increasing the velocity of the flowing water. High energy flows will carve out stream banks and lift sediment from the stream bed, moving it all downstream. Dredging of ditches also removes vegetative growth, which functions as a barrier to slow the flowing water and filter out sediment, nutrients and pesticides.

Logjams and other obstructions are common in the rural watershed areas in both the main stem of the river and the tributaries. Although high water moves many obstructions downstream, logjams become a problem for both landowners and recreational boaters when the obstructions become large and the water begins to carve new channels around the blockage. This process adds great amounts of sediment to the river.

One large dairy, Bridgewater Dairy, operates in William County. The Initiative's Bacteria Source Tracking (BST) project sampled upstream and downstream of this facility in 2004, and did not find increases in pathogens downstream of the facility. Adjacent field areas where manure from the facility may be disposed were not identified or sampled for this study. Another large dairy operation, Zeebrain, is located in DeKalb County on CR 59. The operation has approximately 700 cows and is located in the Big Run watershed. (Hines, 2005) BST analysis was performed on Big Run samples, but those samples were taken at the confluence of the creek with the St. Joseph and were not targeted specifically to the dairy operation.

Hillsdale County has a significant number of small livestock feeding operations that have the potential for bacteria and nutrient pollution. Many feeding operations are temporary and land use changes from season to season on the small farms.

Other sources of pollution from agricultural include loss of woodlands as they are converted to cropland. This change reduces wildlife habitat, and increases runoff and thermal pollution, particularly if the area is close to a ditch or stream. Woodlot management is a conservation practice that has some support from federal/state funding but in general, programs are economically only minimally supportive for landowners. The Nature Conservancy has supported reforestation efforts within the Fish Creek and West Branch sub-watersheds in recent years, as has the Initiative's St. Joseph Erosion Reduction project funded by the Great Lakes Commission, but the total amount of forested areas needs to be increased. Contiguous forested corridors with enough width and depth to support wildlife and aquatic habitat along the river and major tributaries should be increased and improved.

5.2.2 Sources from urban areas

Urban areas across the watershed contribute several kinds of pollution from several sources. However, based on acreage of land use, urban areas have a far smaller impact than agricultural areas in this watershed.

Thermal pollution from runoff is common from urban areas in the watershed. Impervious surfaces including roads, rooftops, and parking lots produce storm runoff that is higher in temperature than that which runs off vegetated lands. Urban and suburban areas in the watershed have significant corridor areas along the river and tributaries that do not contain adequate buffer zones to filter runoff, protect wildlife and temper thermal pollution from the land use in the city, particularly if storm sewers drain directly to the river and/or creeks.

Roadway salts and sand from snowmelt enters the runoff stream during winter and spring seasons.

The cities of Waterloo, Auburn and Fort Wayne have combined sewer overflows (CSO) on the Cedar Creek and St. Joseph. Fort Wayne's CSOs on the St. Joseph are downstream of the city's drinking water supply intake, and are smaller and fewer in number than those on the St. Marys and Maumee, the city's other two rivers.

Storm runoff from turf and lawns carry pesticides and fertilizers, as well as wastes from domestic pets, litter, and sediment. Yard wastes and leaves that enter the storm sewer system can add to nutrient enrichment as well. Toxic household chemicals and oils, gasoline, grease and salts from driveways and roadways can enter the storm water drainage system and enter the river without treatment.

Several cities in the watershed either do not have sewage treatment plants, or they have sections of the city that remain on septic systems. Fort Wayne has been aggressive in removing septics within the city limits, and plans to connect approximately 200 homes in the Parkerdale neighborhood to central sewage treatment in 2006.

Several suburban developments in northern Allen and southern DeKalb counties rely on septic fields which are not functioning well due to soil capacity. Health department officials estimate there are as many as 5,000 failing septic systems in the Cedar Creek watershed in Allen, DeKalb and Noble counties. Some villages on the river do not have centralized sewage treatment plants; in these areas all homes are on septic systems, many of which are old and outdated, and therefore more likely to contribute to bacteria pollution during wet weather. These include Newville in DeKalb County, Edon and Blakeslee in Williams County, and Frontier in Hillsdale County.

Although sources of human contamination by sewage exist in the watershed, including CSO sites, wastewater treatment plant discharges, and failing septic systems, bacteria source tracking (BST) indicates that other sources of E. coli are influencing the surface waters. These sources include wildlife, waterfowl, livestock, domestic pets, and possibly streams themselves, which may act as a sink for E. coli in the water and streambed sediment.

5.2.3 Sources from rural development

Increasing urbanization, particularly along transportation corridors in the southern part of the watershed, is having an impact on water quality. Areas of urbanization include northern Fort Wayne, Huntertown and Leo-Cedarville, and DeKalb and Steuben counties along the I-69, US 6 and SR 8 transportation corridors. The Ohio Turnpike crosses the watershed in Williams County and the northern part of the county is experiencing increasing development from industrial and commercial sources in the Nettle Creek sub-watershed.

Much of the land change in rural areas has been from cropland to rural residential estates. Five- to ten-acre estates are replacing row crops and pasture, adding roof tops, driveways and turf grass, sometimes creating more runoff than agricultural uses. Higher density residential areas nearer to the city are generally accompanied by retail development in the form of shopping strip malls and big box stores.

Erosion from construction sites and the replacement of agricultural, woodland and pasture with impervious surfaces and turf grass lawns increases the runoff into the streams. The runoff carries the same urban pollutants listed in the section above. Increases in traffic and its accompanying pollution also come with the change from rural to urban.

Small ephemeral wetland areas and the adjacent upland woods are often destroyed during both agricultural and urban development of rural lands. Ephemeral wetlands, also called ephemeral ponds, seasonal ponds, temporary ponds or vernal pools, are depressional wetlands that temporarily hold water in the spring and early summer or after heavy rains. Periodically these wetlands dry up, often in mid to late summer. They are isolated without a permanent inlet or outlet, but may overflow in times of high water. Ephemeral wetlands are free of fish, which allows for the successful breeding of certain amphibians and invertebrates. The loss of ephemeral wetlands reduces areas available for water infiltration and storage, as well as wildlife habitat. (Center for Reptile and Amphibian Conservation and Management, 2001)

Southern DeKalb and eastern Noble counties also have soils that, like northern Allen, are unsuitable for onsite systems and these areas are increasingly under pressure for development. Comprehensive land use planning has been adopted in Dekalb County and is underway in Allen County. However, the practical effect these plans have on zoning and building may not be evident for many years, and the political will to impose zoning policies to make the plans successful has not yet been demonstrated.

5.2.4 Lake development

Land surrounding lakes has been under intensive development pressure, particularly over the last 20 years. Prices for lake-accessible real estate have increased dramatically, as has the construction and upgrade of homes. Increased construction activities from new homes and remodeling projects, both on the lakes and within their watersheds, has resulted in increasing pollution problems. Also contributing to the pollutants are increased areas of roofing, lawns and turf, non-native landscaping, sea walls which reduce shoreline vegetation and filtration opportunity, increased watercraft traffic, and increased litter and other trash. Many lake areas, once seasonal retreats, have become all-season suburban areas, complete with the problems associated with urban development. A listing of some of the larger lakes in the watershed can be found in Table 2 on page 11.

On the positive side, regional sewage treatment plants have replaced onsite septic systems around many lake areas, reducing the bacteria and nutrient input from human sources.

Part 6: Critical Areas of Concern

6.1 Development of areas of concern

Areas of concern in the St. Joseph River watershed have been assessed using a variety of databases available to and developed by the Initiative. Weekly sampling data collected by the Initiative since 1996 is the foundation for these assessments, which are further developed with the assistance of the GIS database of land use, soil types, topography, urban development, and many similarly related map layers. A recently completed database of conservation practices across the watershed is currently being used and evaluated as a further assessment tool to help determine areas requiring increased conservation methods.

While the selection of the critical locations was based on actual water quality data available, prioritization and ranking of the critical locations for goal-setting purposes involved other factors as well. These included the level of cooperation and support available in the various sub-watersheds from partners, willingness of landowners to cooperate with programs and efforts to control pollution, the availability of funding programs to help put BMPs into practice, and the historic success of programs and BMP efforts across the watershed.

6.2 Pollutants of concern

Areas with erosive soils and steep topography which are subjected to extensive and long-term disturbance, such as happens in agriculture, are at the highest risk for erosion and sediment loss. As is evident in Figure 7 on page 19, the northern and western portions of the St. Joseph Watershed are critical areas for soil loss, along with most of Allen County in the southern portion.

Nutrient loading in the St. Joseph River watershed is a greater problem in some areas than others; generally it has not been seen as a broad, high-level problem across the watershed. Nutrient levels measured by the SJRWI during the growing season (April through October) are generally within benchmark values. Based on modeling, levels are expected to be higher during winter months when crops and other plants are not growing and uptaking nutrients. The Initiative has not traditionally done any water quality testing during winter months, but plans to begin all-season water quality testing for nutrients during 2006 at a few locations to verify the output of the Cedar Creek SWAT model.

The St. Joseph River and many of its tributaries are 303(d)-listed as impaired for E. coli. This is an indication of bacterial levels in excess of water quality standards (WQS) for recreational uses. Indiana WQS for E. coli is 235 colony-forming units (CFU) per 100 ml. water. Virtually every site sampled by the SJRWI exceeds this standard during much of the recreational season (April through October) and has done so since monitoring began in 1996.

6.3 Areas of Concern

The areas of concern listed below were selected based upon water quality information gathered through the SJRWI water quality monitoring program, as well as St. Joseph River water quality data from the City of Fort Wayne, IDEM, OEPA and MDEQ. The areas of concern are listed in a priority order that is based on the extent of the water quality problem, the TMDL schedule (See Table 10 on page 33) and what we could call the "stakeholder factor." The stakeholder factor is on-the-ground knowledge of inputs that will influence the success of a project, such as the current organization of stakeholder activity, level of conservation programs already in place or planned, opportunity for partnerships with local government and conservation organizations, availability of cooperative landowners, and funding opportunities. For example, Cedar Creek is a top priority based upon the TMDL schedule, projects already in place and operating, contribution of the watershed to the pollution in the St. Joseph based on its size and land use, and the cooperative stakeholders available to work on the project.

6.3.1 Cedar Creek System and Garrett City Ditch

The Cedar Creek System is the largest tributary of the St. Joseph and has a watershed management plan (WMP) that was completed in 2005 and approved by the Indiana Department of Environmental Management. This document is available from the St. Joseph River Watershed Initiative in PDF form on the Initiative's website, www.sjrwi.org. We will not repeat the extensive documentation of the Cedar Creek area in this WMP, but will outline concerns in a general manner.

The Cedar Creek sub-watershed areas in eastern Noble and western DeKalb counties, which have rolling topography, are highly agricultural and are extensively ditched for drainage, are a concern for sedimentation. Allen County's portion of the Cedar Creek watershed is under extensive pressure from expanding urbanization.

Data show spikes in turbidity that roughly parallel stream flow, with high levels of turbidity generally corresponding to high levels of water in the stream. The graphs in Figure 12 illustrate turbidity and water levels at Site 100, Cedar Creek at Tonkel Road, the Initiative's most downstream point of sampling. The graph shows several spikes that exceeded 100 NTU during the 2003 recreational season. Upstream of Site 100, the Matson Ditch contributes water and sediment to the Cedar Creek as it drains a predominantly agricultural area around the town of Waterloo. Turbidity levels in the Matson were recorded above 250 NTU in July of 2003.

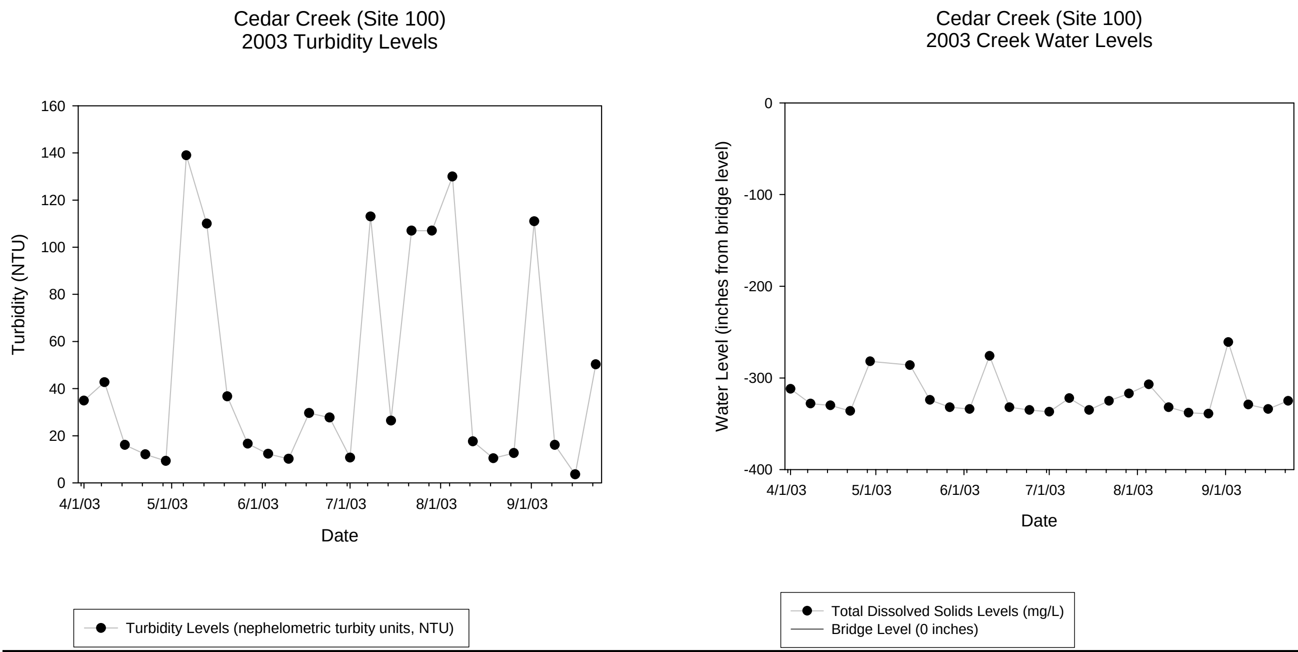


Figure 14 Turbidity and water levels in the Cedar Creek Site 100, 2003

Bacteria contamination is another concern in the Cedar Creek sub-watershed. Some sampling locations have levels recorded as high as 20,000 colony-forming units (CFU) during wet weather events. Most locations show the high levels associated with wet weather events; very few have exhibited excessive counts during moderate or dry conditions. Wet-weather loading

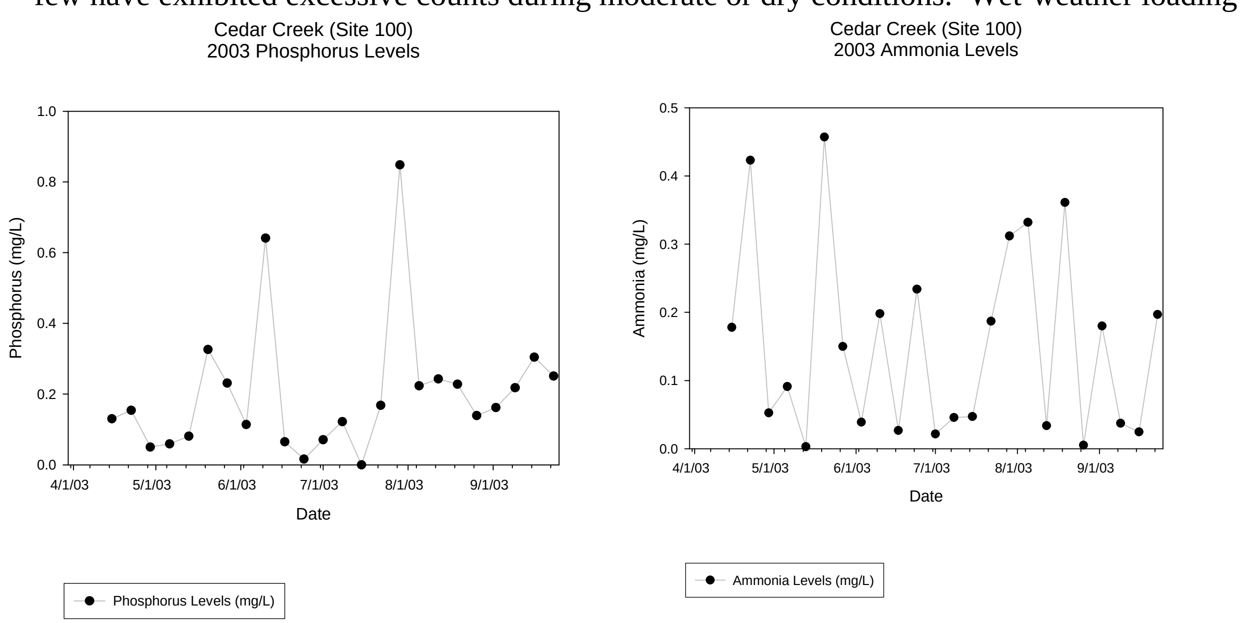


Figure 15 Phosphorus and ammonia levels in Cedar Creek (Site 100) 2003

indicates that runoff from various sources, including overloading of sanitary treatment facilities and on-site septic systems, barnyard and feedlot runoff, and flushing of riverine corridors are sources of bacterial pollution. Increased velocity of streams in the watershed, which are normally slow-flowing, could also recirculate bacteria that has settled into the streambed sediment.

Figure 13 illustrates phosphorus and ammonia levels measured at Site 100 (Cedar Creek at Tonkel Road) in 2003.

The Garrett City Ditch (Figure 16) in DeKalb County, Indiana drains 2329.4 acres with 15180.85 total feet of waterway. Cedar Creek is the receiving water for the ditch.

Garrett City Ditch is a small sub-watershed located on the eastern side of the Town of Garrett. Concerns in this sub-watershed derive from the heavily developed nature of the surrounding areas. The land-use statistics reveal a watershed characterized by high percentages of commercial and residential lands, and with a relatively high percentage of impervious surfaces. See Table 12, below.

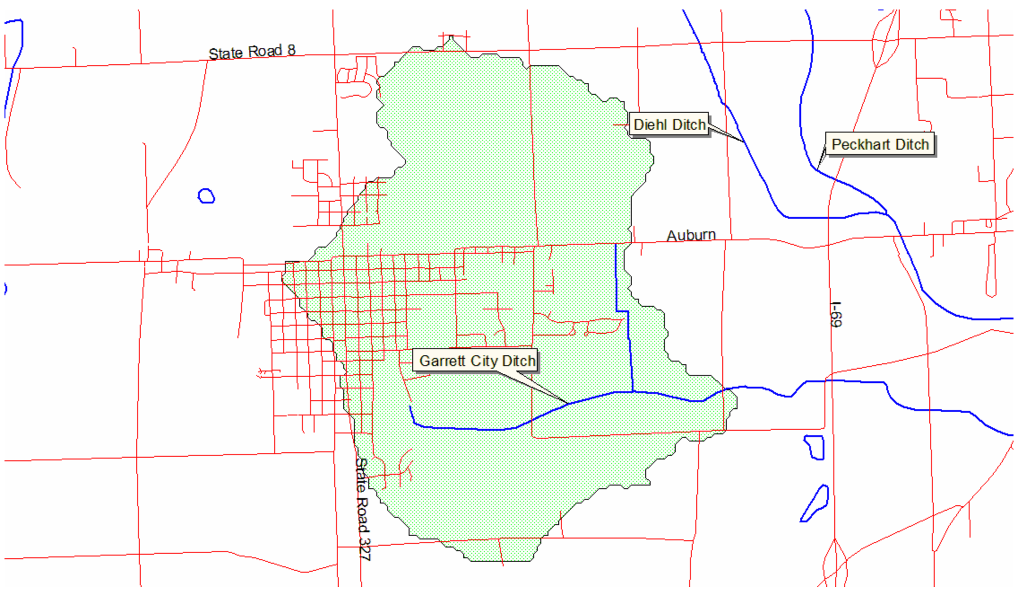


Figure 16 Garrett City Ditch sub-watershed

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Land Use	% of Total	% of Total Impervious
Water	1.6	0.0
Commercial	6.8	4.7
Agricultural	61.7	1.2
High Density Residential	3.1	1.1
Low Density Residential	12.5	1.9
Grass/Pasture	11.3	0.2
Forest	3.4	0.006
Others	0.04	0.0002

Table 12 Land use and impervious surface in Garrett Ditch sub-watershed

In addition to concerns surrounding urban and suburban development in the area, the Garrett municipal wastewater treatment plant is located at the headwaters of the ditch. A number of outlets from the Garrett storm sewer system also outfall into the ditch. As a result of these mostly urban and suburban factors, the Garrett City ditch has consistently demonstrated high bacteria and conductivity values (See figures on next page) throughout the sampling season.

Human sources of bacterial contamination in the Garrett City Ditch sub-watershed are clearly a primary concern. The Garrett wastewater treatment was rebuilt between the 2003 and 2004 sampling seasons, and while some improvement in bacterial levels has been observed, some high values were recorded during late 2004 and 2005.

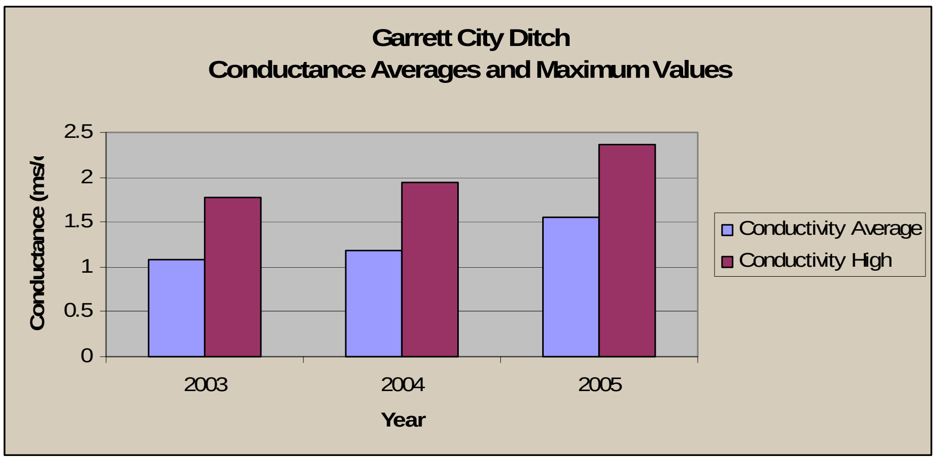


Figure 17 Conductivity averages and minimum values, Garrett City Ditch

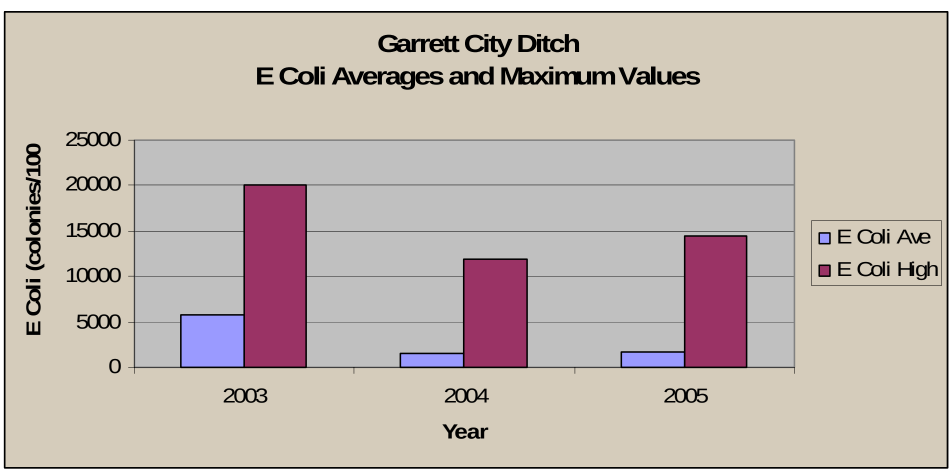


Figure 18 E. coli averages and maximum values, Garrett City Ditch

Load duration curves done for the Cedar Creek Watershed Management Plan and based on data collected from that watershed indicated that E coli impairment is related to rainfall event loading. Therefore, the greatest reductions will be made by minimizing the inputs during these high flow events. This can be done by reducing the input from failing onsite septic systems (OSS), combined sewer overflows (CSO) and sanitary sewer overflows (SSO), as well as limiting the amount of bacteria contained in storm runoff from wildlife and livestock, primarily through biofiltering.

6.3.2 Northern Allen County: Tiernan Ditch in the Lower St. Joseph-Allen Co. sub-watershed
While the topography of Allen County is generally not steep except in the Cedar Canyons area north of the City of Fort Wayne, the remainder of the northern Allen County area is at risk for erosion because it is under pressure for urbanization. Construction activity and road building has intensified since the completion of the I-469 transportation corridor linking U.S. 30 with I-69. Green spaces, including wetlands and contiguous corridor habitat for wildlife are disappearing at a rapid rate.

The Tiernan Ditch sub-watershed (3368.3 total acres / 33,894.85 feet of waterway) is typical of the areas in Allen and Dekalb counties where suburban development is encroaching on established agricultural lands. Not all of this development is connected to municipal sewers. Many areas are serviced by on-site septic systems (OSS).

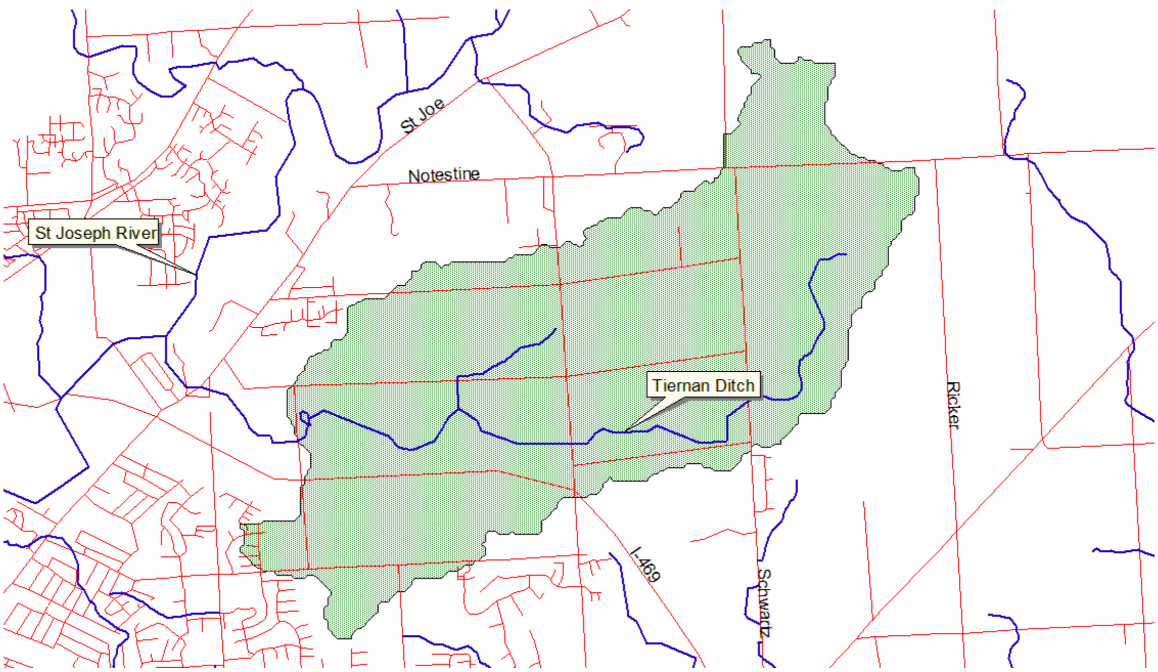


Figure 19 Tiernan Ditch sub-watershed

Source: http://pasture.ecn.purdue.edu/~watergen/ 2005

Land Use				
Type	**Acres**	**% of Total**	**Acres Impervious**	**% Impervious**
Water	29.1	0.8	0	0
Commercial	1.2	0.03	0.8	0.02
Agriculture	2196.3	65.2	41.7	1.2
High Density Residential	0.9	0.03	0.3	0.009
Low Density Residential	34.5	1.0	5.3	0.16
Grass/Pasture	750.8	22.3	6.7	0.20
Forest	354.6	10.5	6.7	0.20
Other	0.3	0.009	0	0

Table 13 Land use in the Tiernan Ditch sub-watershed

Source: http://pasture.ecn.purdue.edu/~watergen/ 2005

Sampling data from the Tiernan Ditch during 2005 indicates the presence of heavy fecal bacteria and sediment loads, illustrating the presence of competing land uses. Bacterial sampling results are charted in Table 14, below. Exceedences of the E. Coli EPA maximum contaminant level are highlighted in yellow.

Conductivity values for this sampling period was 2.64 mS/cm, which is likely indicative of a human development bacterial source, such as leaking septic systems and sewage overflows. At the same time, total suspended solids (TSS) values average over 100 mg/L for the same period, implicating the influence of agricultural runoff and erosion in the watershed as well as suburban factors. Over 16% of the sub-watershed's soil is classified as highly erodible or potentially highly erodible.

Date	E Coli	Total Coliform
4/12/2004	100	20050
4/26/2005	750	20050
5/3/2005	1640	20050
5/17/2005	530	20050
5/24/2005	20050	20050
5/31/2005	870	20050
6/14/2005	100	5040
6/28/2005	640	4060
7/5/2005	100	3840
7/19/2005	8850	20050
8/9/2005	640	4530

Table 14 E. coli values in the Tiernan Ditch sub-watershed Source: SJRWI weekly sampling database

6.3.3 Bear Creek (Indiana)

Bear Creek (IN) is located in northern Allen and southern DeKalb counties in Indiana (see Figure 1) and drains approximately 64,619.30 acres. The Bear Creek sub-watershed is another area undergoing rapid change and conflict between suburban development and existing agricultural lands. Based on mapping of government-supported conservation practices, there are relatively few fields employing BMP techniques in the watershed.

Land Use				
Type	**Acres**	**% of Total**	**Acres Impervious**	**% Impervious**
Water	481.6	2.3	0	0
Commercial	4.1	0.024	2.9	0.017
Agriculture	12948.9	75.2	246	1.4
High Density Residential	8.8	0.051	3.1	0.018
Low Density Residential	32	0.19	4.8	0.028
Grass/Pasture	2414.3	14.0	45.7	0.27
Forest	1325.6	7.7	25.1	0.15
Other	0.1	0	0	0

Table 15 Land Use acreage by type in the Bear Creek (Indiana) sub-watershed

Source: http://pasture.ecn.purdue.edu/~watergen/ 2005

Land Use Category	Impervious Cover % for Land Use
Agriculture, Pasture/Grass, Forest	1.9
Water/Wetland	0.0
Low Density Residential	15.4
High Density Residential	36.4
Industrial	53.4
Commercial	72.2

Table 16 Impervious cover for various land uses

Source: Center for Watershed Protection, 2003, www.cwp.org

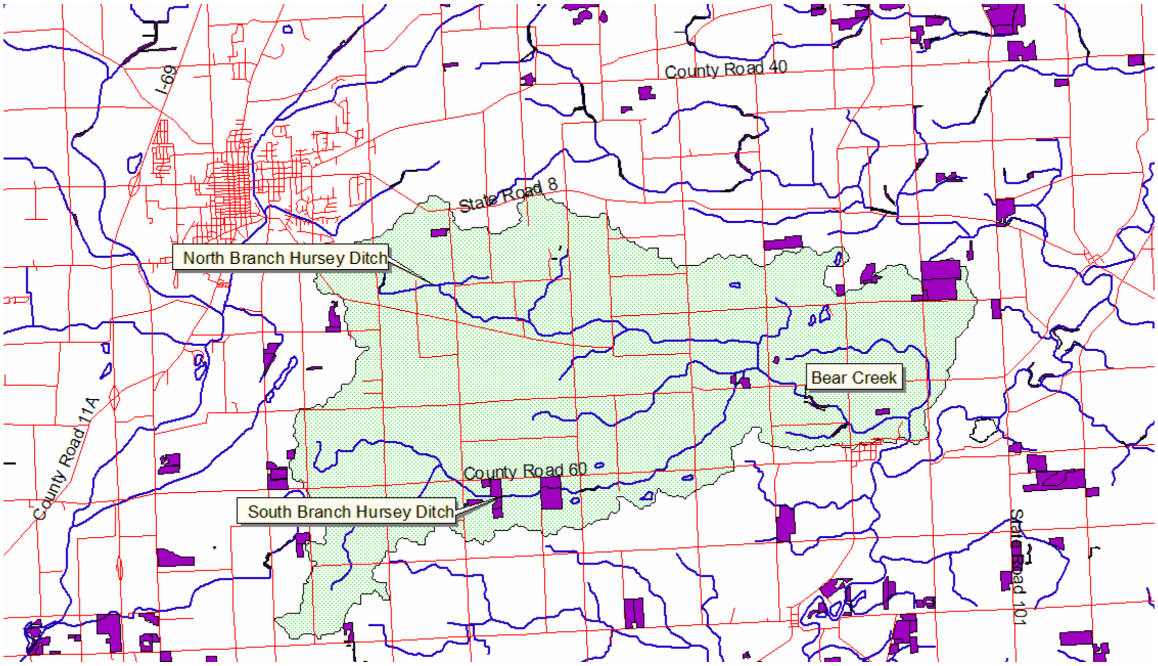


Figure 20 Best Management Practices (BMP) in the Bear Creek (IN) sub-watershed

Source: St. Joseph River Watershed Initiative GIS database, DeKalb County SWCD & FSA

The purple areas in Figure 20 show the locations of lands in the Conservation Reserve or other best management programs. While Dekalb County as a whole is very well represented in these federal, state, and local programs, the Bear Creek Watershed is not. In terms of land use, soil type, and proximity to the St. Joseph River itself, the Bear Creek watershed qualifies as a high priority sub-watershed. Figure shows the bacterial contamination in the waterway for the past two years. The water quality standard (WQS) for the State of Indiana, 235 colony forming units (CFU) per100 mL, is illustrated by the red line:

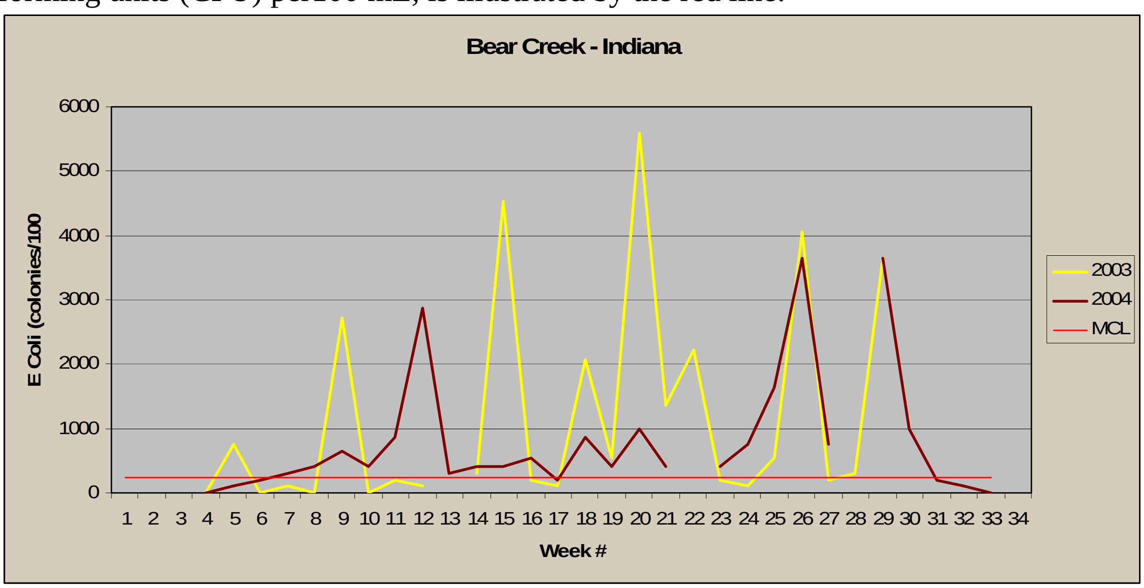


Figure 19 E. coli levels in the Bear Creek (IN) 2003-2004

The Bear Creek sub-watershed has also demonstrated high sediment levels and exceeded the drinking water quality standard for atrazine several times during each sampling year. Total loads averages remain below the critical habitat level, but are above the drinking water standard. See Figure 21, below shows lbs./day loads for Atrazine.

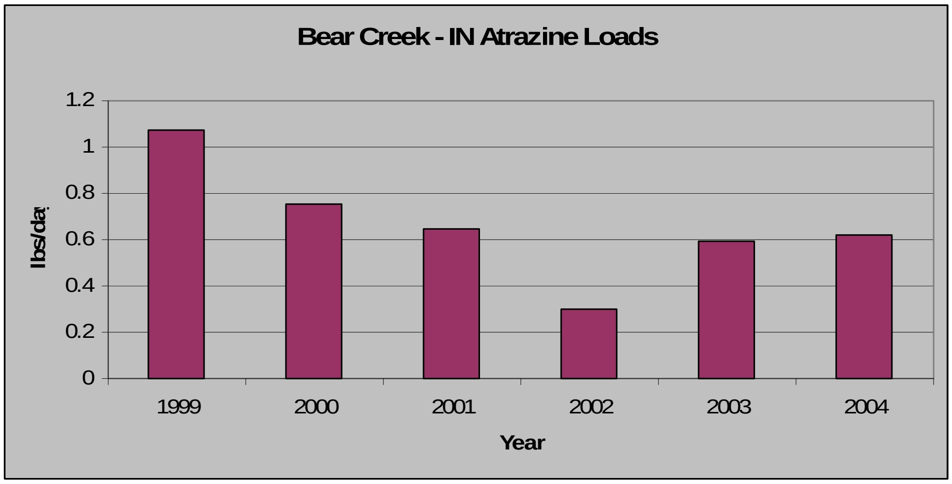


Figure 21 Historical atrazine loads in the Bear Creek (IN)

The Bear Creek sub-watershed includes Cedarville and Hurshtown reservoirs, both owned and operated by the City of Fort Wayne. The Cedarville Reservoir, located near the Town of Leo-Cedarville in northern Allen County, has lost significant capacity due to sediment from the main stem of the St. Joseph River. Residents near the reservoir report that in many places, the reservoir is barely waist-deep and these stakeholders suggest it needs to be dredged. The City Water Utilities department reports that an engineering study to determine the current capacity of the Reservoir would cost at least $100,000. (M. J. Slaton, personal communication, 2005)

Currently, a Section 205(j) grant to the City of Fort Wayne is supporting a watershed management planning effort for the Lower St. Joseph and Bear Creek (IN) sub-watersheds. The SJRWI is coordinating this effort, which is scheduled for completion June 1, 2007.

6.3.4 Nettle Creek   Subwatershed: Nettle Creek

Located in Williams County, Ohio, Nettle Creek drains approximately 89,477.96 acres, with 30,066.7 total stream feet.

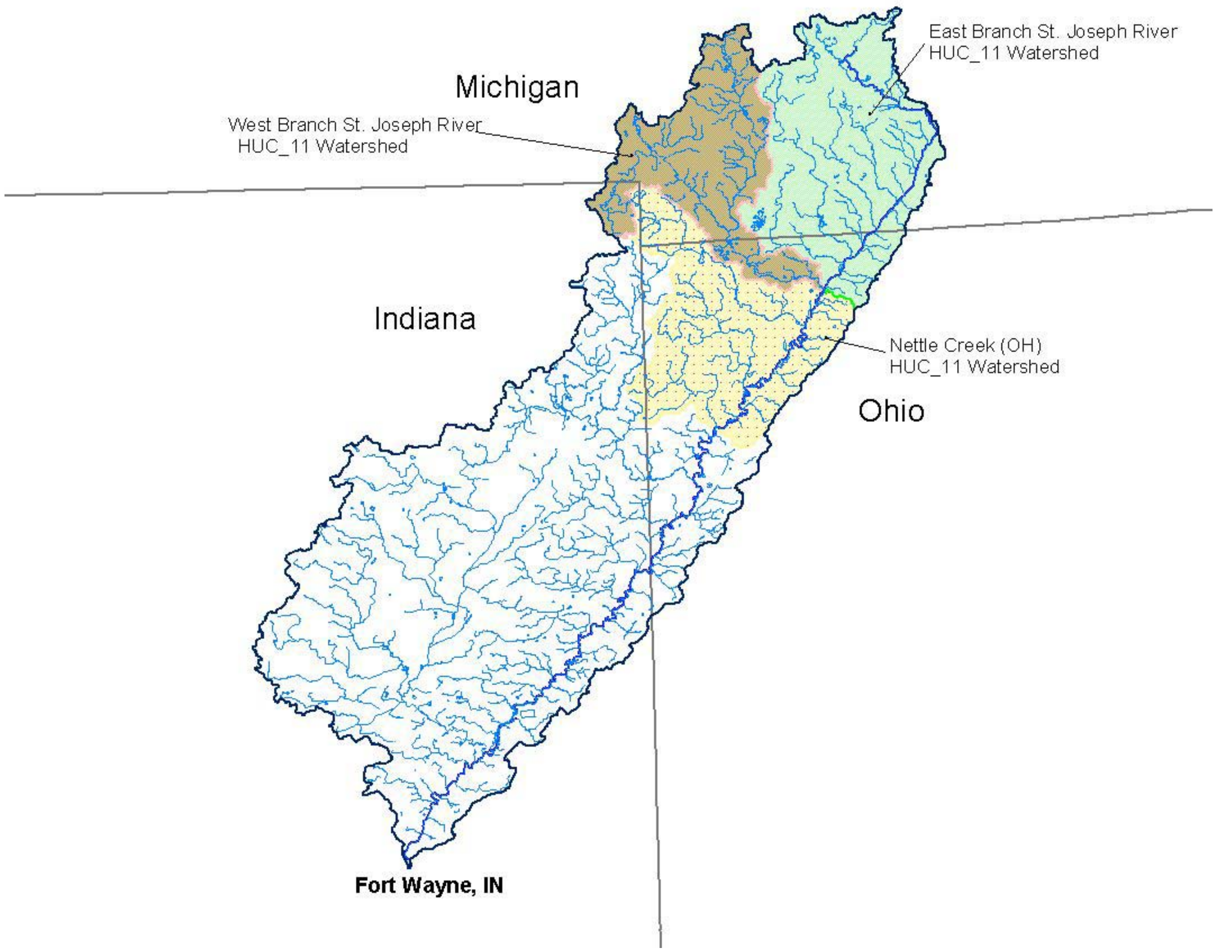


Figure 22 Nettle Creek, East Branch St. Joseph and West Branch St. Joseph watersheds

The Nettle Creek sub-watershed is located immediately south of the East and West Branches of the St. Joseph, and north of the Fish Creek sub-watershed. The map in Figure 22, above, illustrates the location of the sub-watershed.

The watershed originates near Nettle Lake in the upper left corner of the map in Figure 23, below. Conservation practices are mapped in green. Land use in the Nettle Creek sub-watershed is predominantly agricultural. Within the drainage area delineated by the Initiative's sampling point on (Ohio) State Route 576, the majority of the suburban development surrounds Nettle Lake.

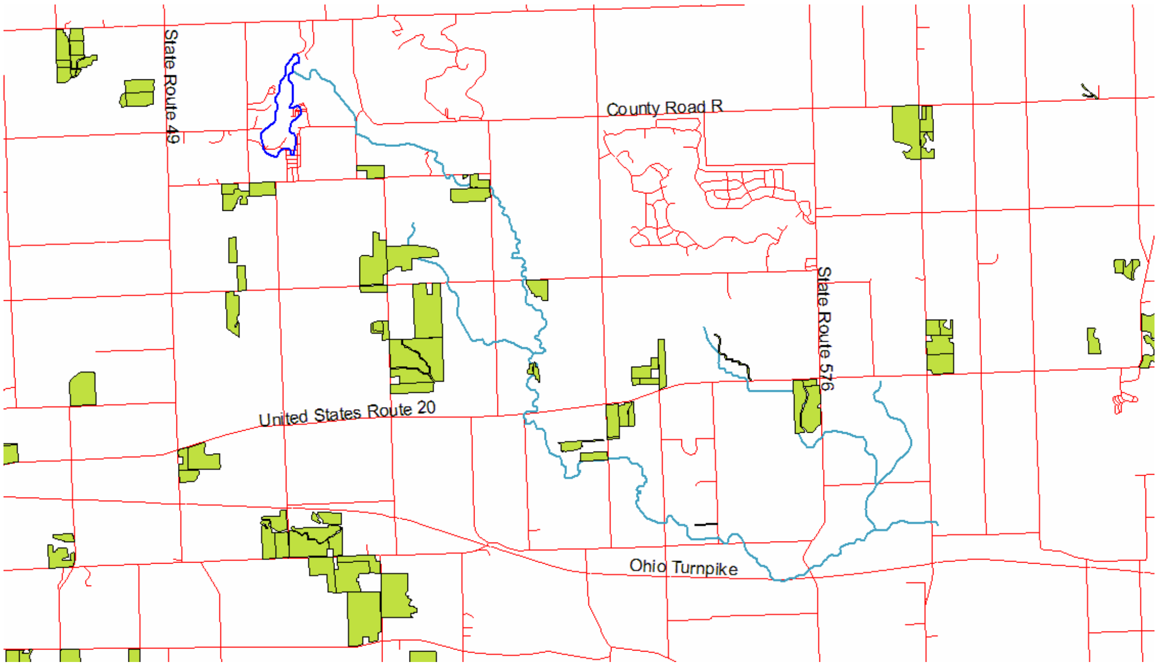


Figure 23 Conservation practices in the Nettle Creek sub-watershed

(Source: SJRWI GIS database and Williams County SWCD, FSA)

Sediment loading is the primary concern in the Nettle Creek sub-watershed. Many of the streams entering into Nettle Lake have been extensively dredged and clear-cut, as have waterways exiting the lake and into the bulk of the sub-watershed. The lake itself has had most of its natural shoreline removed, developed, and replaced with seawalls. Data from the Initiative's sampling database confirms extensive sediment loss in the area.

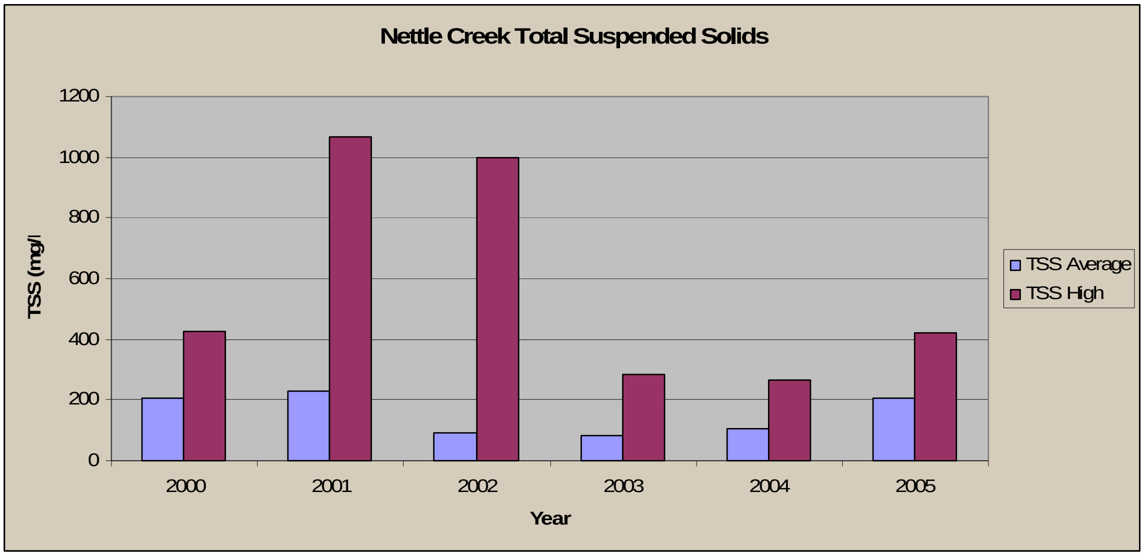


Figure 24   Total suspended solids average and high values in Nettle Creek, 2000 - 2005

While maximum contaminant levels are not established for total suspended solids, a value of 80 mg/L is widely considered to be the level at which aquatic life may become impaired. Figure 24, illustrates that the Nettle Creek averages for TSS are rising, and single year highs have exceeded the 80 mg/L value more than seven-fold average.

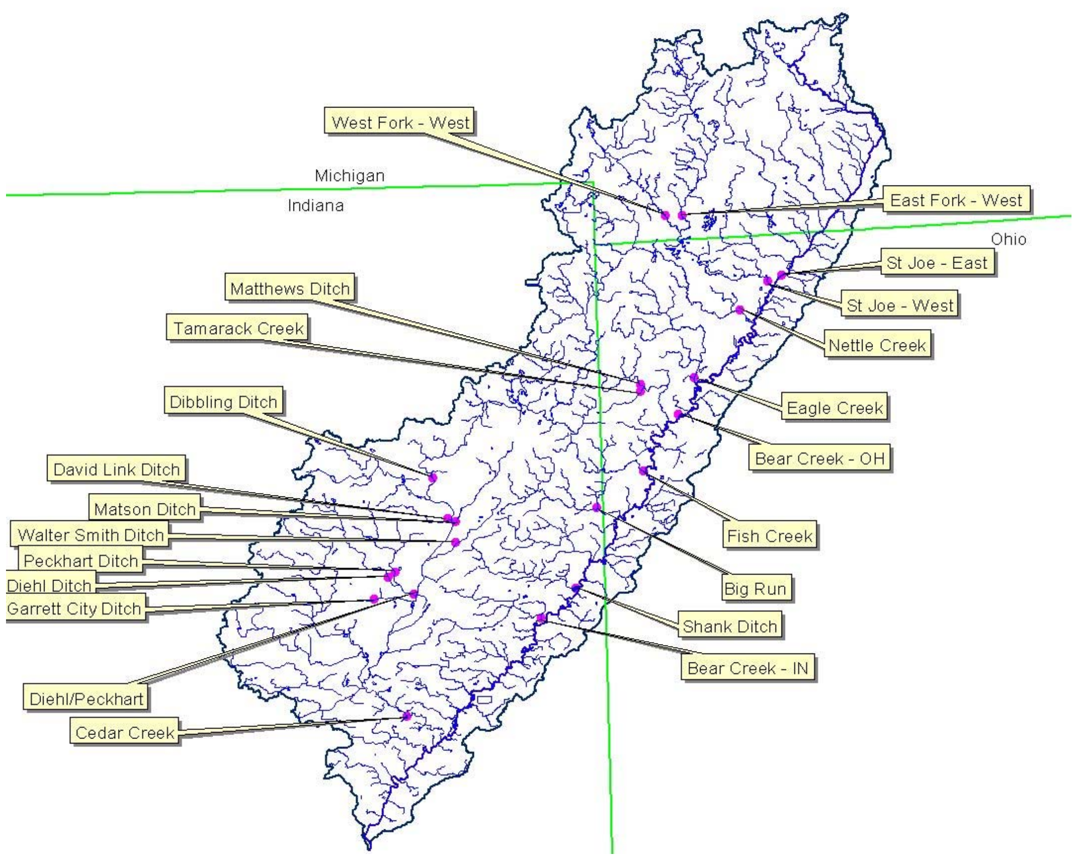


Figure 25 Sampling points of the SJRWI water quality monitoring program.

6.3.5 Bear Creek (Ohio)

High levels of phosphorus were found during the 2003 sampling season at Bear Creek (Ohio). This tributary is located in the HUC-11 Nettle Creek sub-watershed about midway along the course of the main stem of the St. Joseph River (see Figure 25, above). This site showed ammonia levels peaking in July at 1.2 ppm, nearly double the highest level found in the lower watershed. Nutrient loading may be significantly impacted by low flow values in the streams.

Low levels of dissolved oxygen (DO) were found during the summer in 2003, and high spikes of atrazine and E. coli are also a concern.

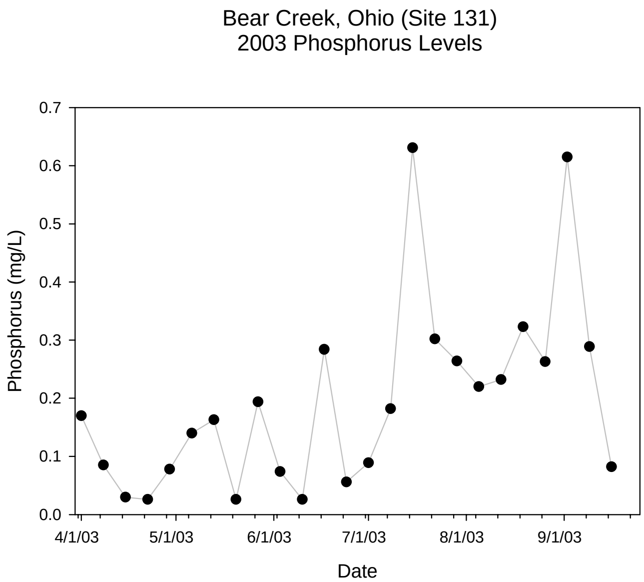


Figure 26 Phosphorus levels, Bear Creek (OH) 2003

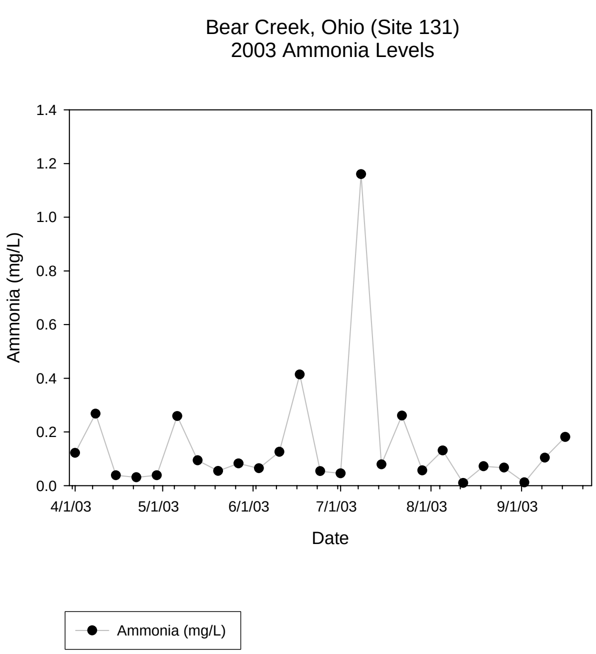


Figure 27   Ammonia levels, Bear Creek (OH) 2003

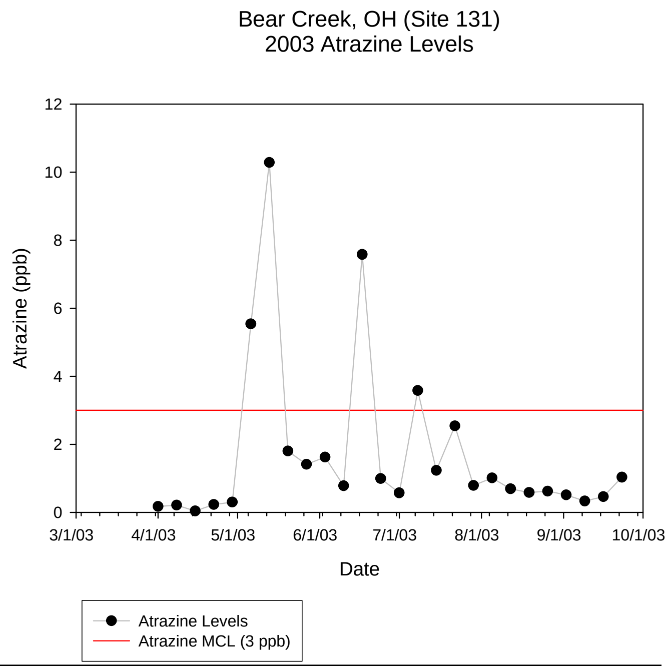


Figure 28 Atrazine levels, Bear Creek (OH) 2003

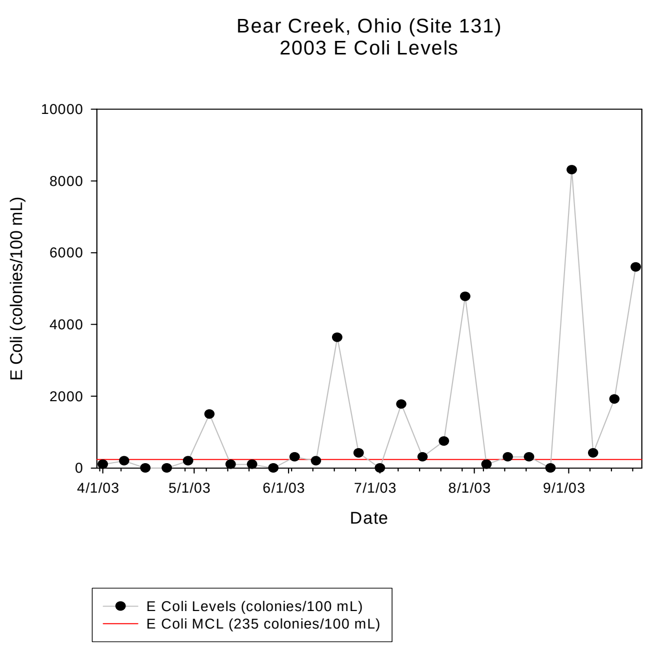


Figure 28 E. coli levels at Bear Creek (OH) 2003

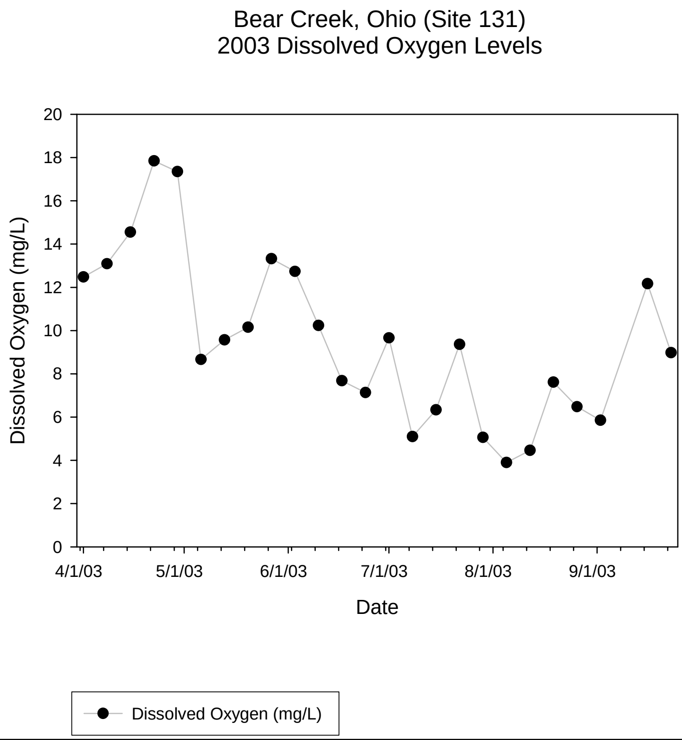


Figure 29 Dissolved oxygen levels in Bear Creek (OH) 2003

6.3.6 Big Run   Sub-watershed: Middle St. Joseph

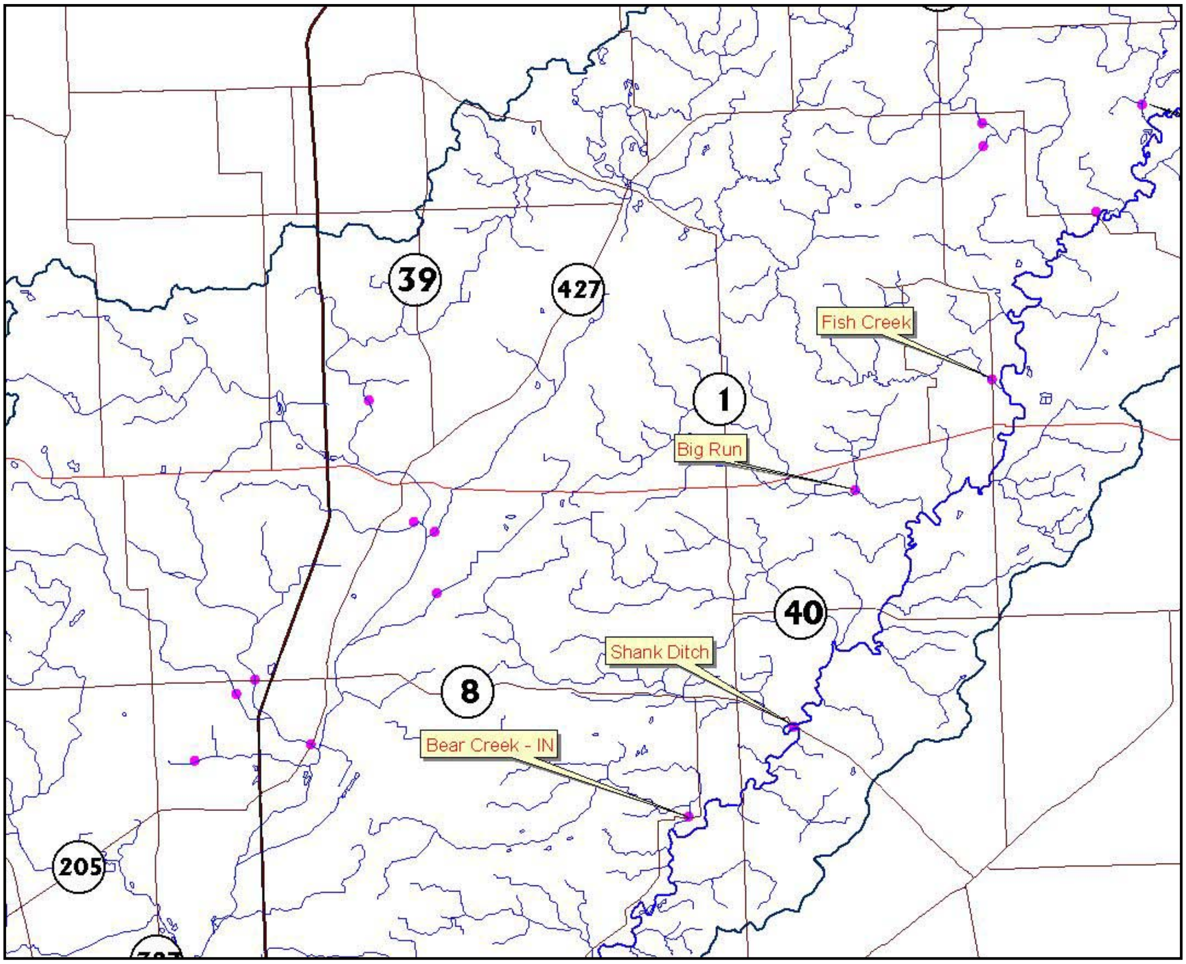


Figure 30 Big Run, Shank Ditch, Fish Creek and Bear Creek (IN) sampling locations

Big Run is located in eastern DeKalb County just south of Fish Creek in the Middle St. Joseph sub-watershed.   (See Figure 25, page 52)

E. coli counts in Big Run consistently exceed the water quality standard throughout the recreational season. Bacteria source analysis (BST) indicates that some of the load is from human sources (see Figure 33 on page 58). Livestock and domestic pets are also sources of the bacteria in the stream.

Although the Initiative has been sampling water in the Big Run tributary since 1996, no watershed planning activities have taken place to date in that area. Nor has the Initiative done extensive work in the Big Run area to promote conservation practices or to locate the probable sources of pollution.

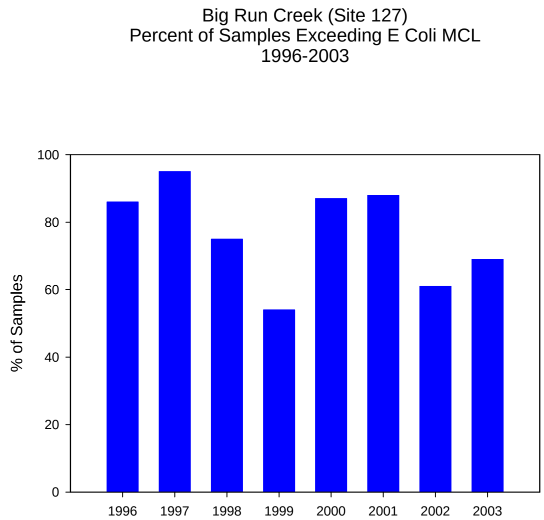


Figure 31 Percentage exceedence of E. coli standard annually in the Big Run tributary

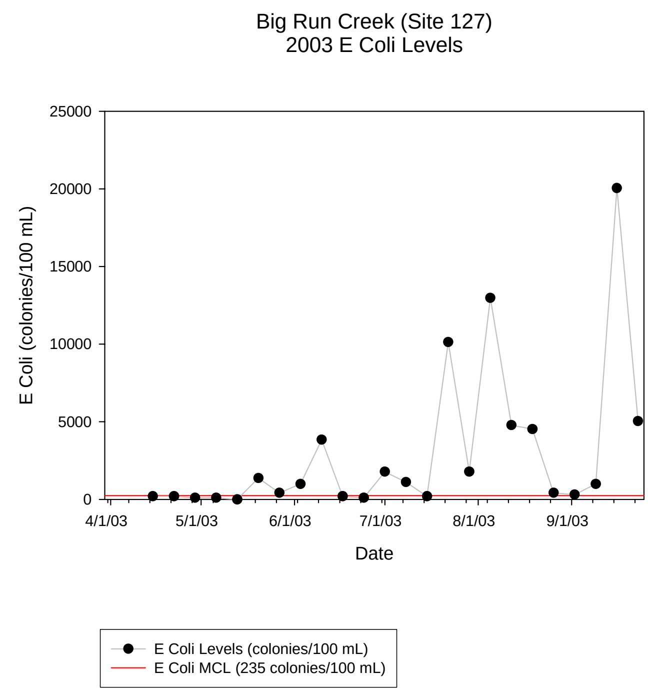


Figure 32 Big Run E. coli levels, 2003

However, Initiative Partner DeKalb County SWCD has been active in the sub-watershed and reports a high concentration of fields has been enrolled in the conservation reserve program (CRP) in the past. However, many of those contracts are now expriring and the fields are coming back into production. A number of landowners in this watershed are enrolled in the Conservation Security Program (CSP). A large dairy operation (700 head) is located in the headwaters area of the Big Run sub-watershed. (D. Hines, personal communication, October, 2005)

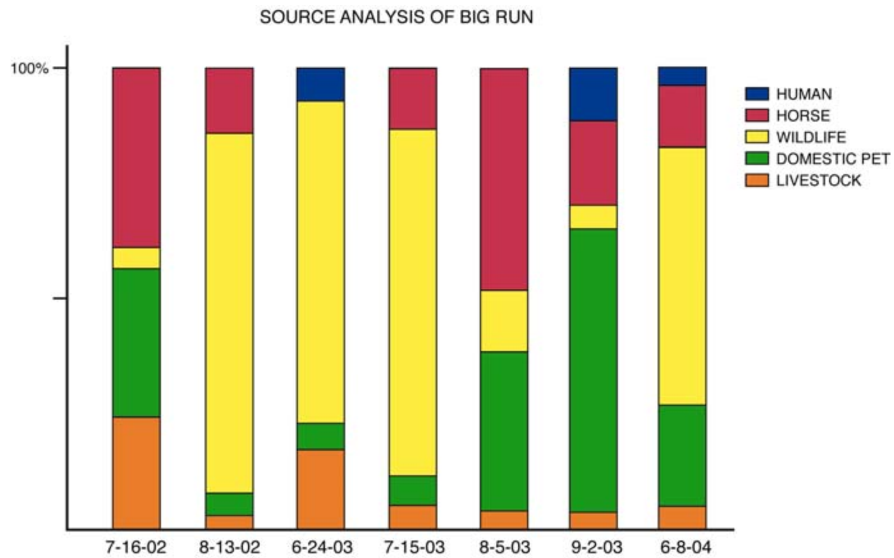


Figure 33 BST analysis results for Big Run tributary, 2002-04

Antibiotic resistance analysis done in the Big Run during the Initiative's Bacteria Source Tracking (BST) project showed human and livestock sources of E. coli were present in the water samples. This is one of the few sampling locations that showed livestock bacteria in every sample over the course of the study.

6.3.7 East Branch St. Joseph

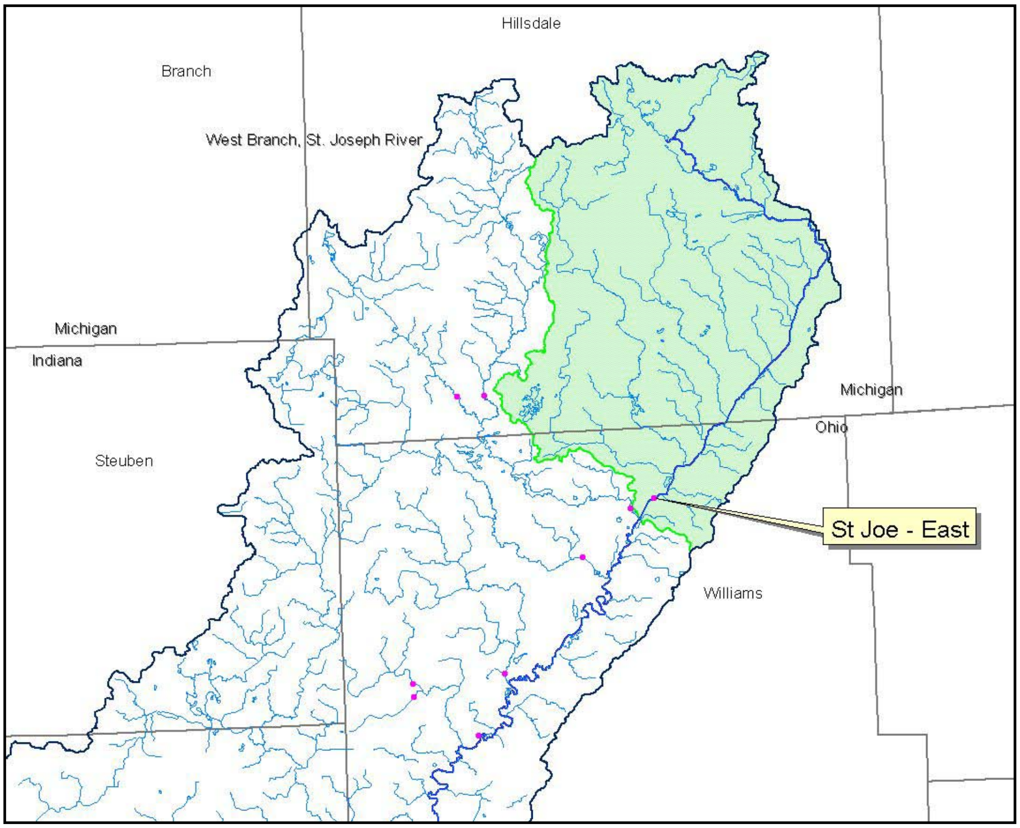


Figure 344 East Branch of the St. Joseph River

At the northern end of the St. Joseph River, the East Branch of the St. Joseph is an area of concern for contribution of sediment. (See Figure 7 on page 19) Soils in the headwaters portion are primarily very deep, well drained, sandy loams and loamy sand on outwash plains. Soils in the middle portion are very deep, well drained to somewhat poorly-drained loamy soils on moraines. The Lower portions are deep to somewhat deep, very poorly drained, clayey and loamy soils on outwash plains and ground moraines. Slopes range from nearly level to steep (USDA, 1997). The Initiative samples the East Branch of the St. Joseph in Williams County (Site 126) just upstream of its confluence with the West Branch to form the main stem of the river. The East Branch sub-watershed contains approximately 110,876 acres.

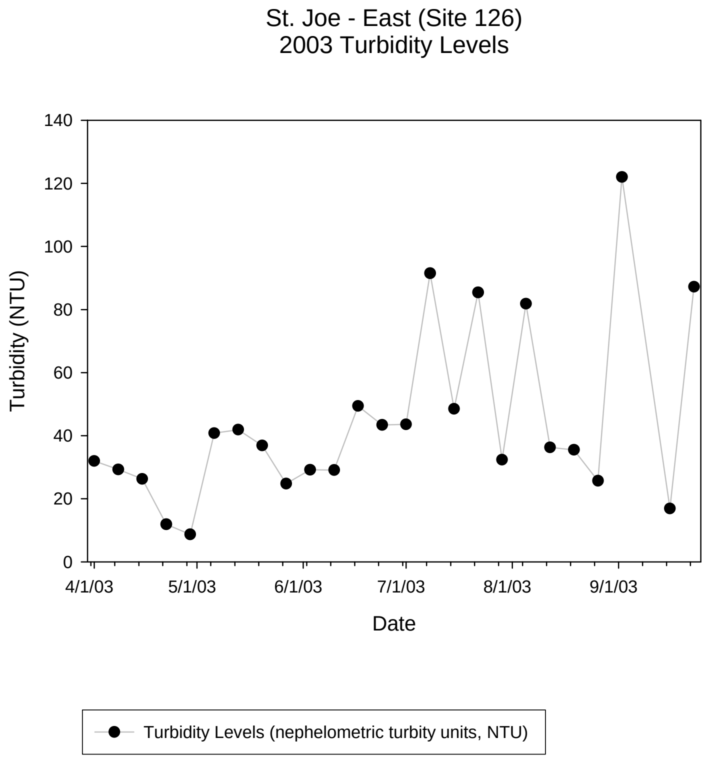


Figure 35 Turbidity levels in the East Branch of the St. Joseph River 2003

6.3.8 West Branch St. Joseph

The Initiative monitors two sites in Hillsdale County: West Fork of the West Branch, and East Fork of the West Branch. The West Branch sub-watershed contains approximately 73,284 acres.

The 2004 MDEQ biological study found high levels of ammonia in the East Fork of the West Branch of the St. Joseph River and in Silver Creek, and phosphorus exceedences in the East Fork of the St. Joseph. Causes of these exceedences have not been determined.

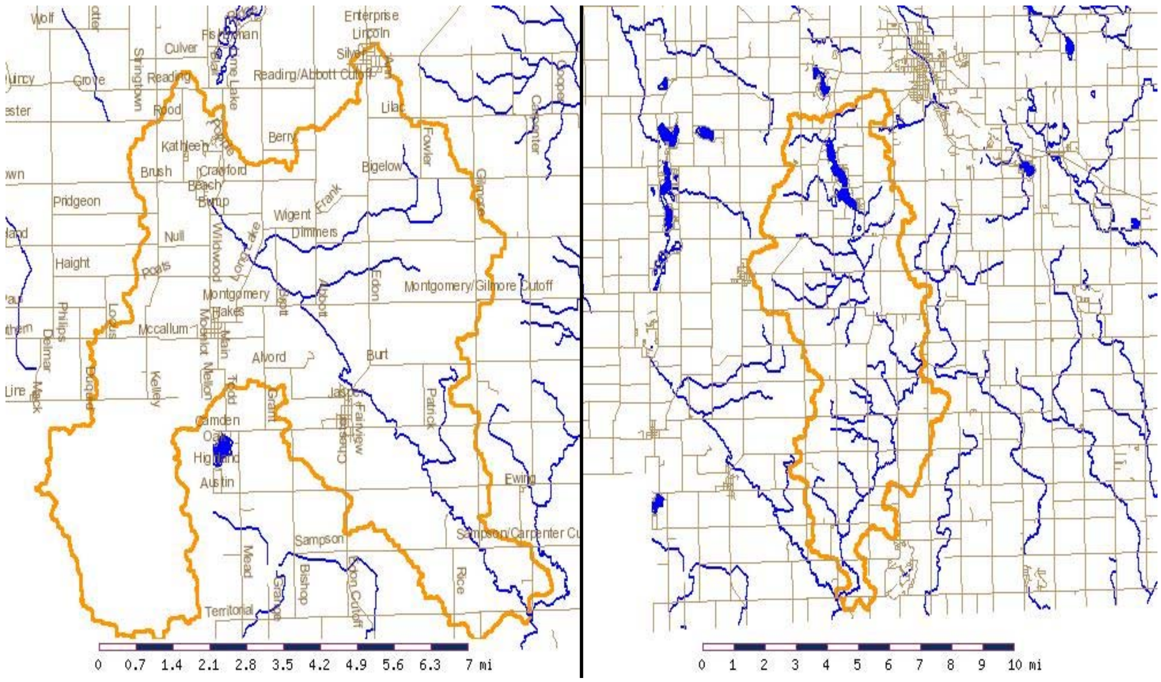


Figure 36 West and East Forks of the West Branch of the St. Joseph River

West Fork – West Branch East Fork – West Branch

Although the East and West Fork sub-watersheds are directly adjacent to one another, they are characterized by differing land use and contamination issues. The West Fork is a sub-watershed of concern to the State of Michigan for mercury, zinc, phosphorus, and ammonia concentrations. The State has noted potential ammonia contamination in the East Fork, while the Initiative's sampling program has targeted the East Fork for elevated bacteria levels. Land use differences can be noted on the maps in Figure 37.

Recently the Nature Conservancy has uncovered a community of mussels in the East Fork of the West Branch of the St. Joseph River that is quite diverse. The watershed is also home to the copperbelly water snake, a federally threatened species.

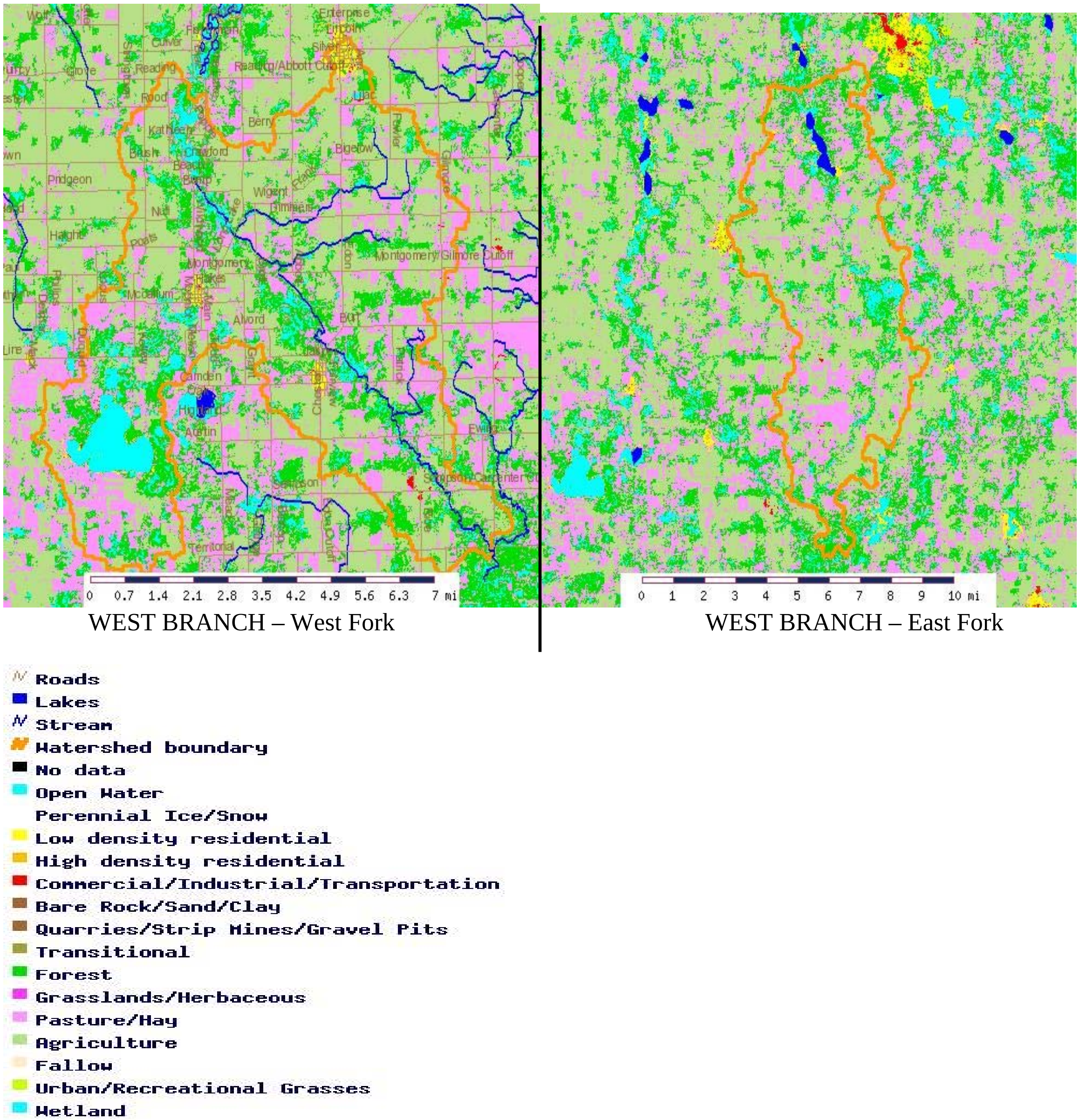


Figure 377 Land usage in the East and West Forks of the West Branch of the St. Joseph River

The West Fork contains more developed land-use than the East Fork, as well as the associated industrial and residential area. Both watersheds are nearly identical in acreage, but land use statistics are very different. Commercial land comprises 0.21% of the West Fork, and 0.09% of East Fork. Residential properties account for 1.2% of West Fork, compared to 0.49% in the East Fork.

Bacteria concentrations in the East Fork – West Branch sub-watershed have consistently exceeded the EPA maximum contaminant level of 235 colonies/100 mL at a rate between 30% and 50% of the sampling days since the Initiative has begun sampling that site (see Figure). It should be noted that the Initiative's sampling site for the East Fork is located adjacent to a farm which allows cattle access to the stream, and this may increase the bacteria counts for this location. So far, efforts to encourage the farmer to fence the cattle from the stream have not been successful.

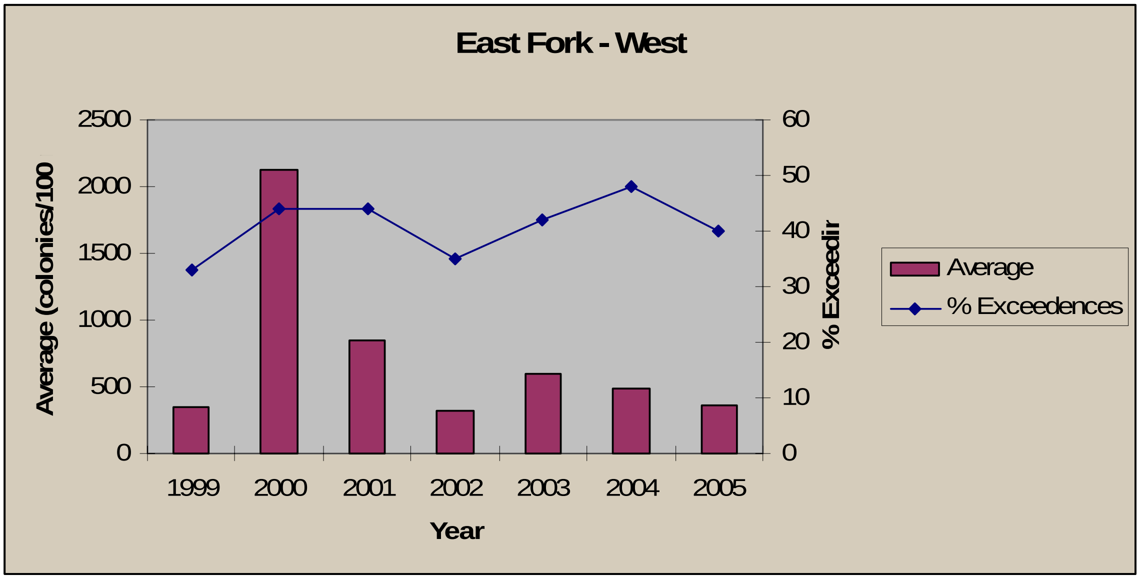


Figure 38 E. coli levels in the East Fork of the West Branch of the St. Joseph, 1999-2005

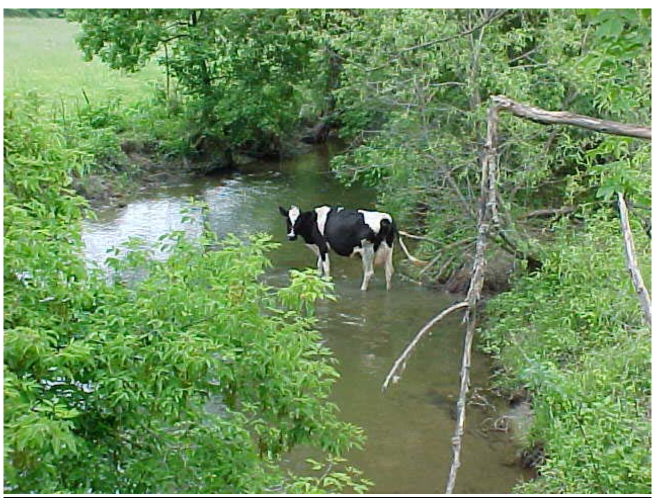


Figure 39 Cattle have access to the stream along the East Fork of the West Branch of the St. Joseph

Photo by J. K. Thompson

St. Joseph River Watershed

Management Plan

Three States, Six Counties, One Watershed

Part 7: Goals and Decisions

7.1 Focus, goal selection and design

As stated in Chapter 1, the focus of St. Joseph River WMP is to organize and manage the watershed planning effort on a large scale so as not to lose sight of the overall connection among all the stakeholders in this 8-digit HUC watershed.

Therefore, goal selection and design is based on the necessity to organize efforts across the entire 8-digit HUC St. Joseph River watershed as a whole. As was stated in the previous St. Joseph plan approved in 2001, focusing on entire watershed will help to regionalize the effort to improve the watershed, and to coordinate the efforts in each of the sub-watersheds which will concentrate on the smaller areas and more specific BMPs. Working with the entire 8-digit HUC area also allows us to represent the area as a functioning part of the Western Lake Erie Basin (WLEB), an area which is gaining national scrutiny in the last few years as a result of efforts by Ohio Representative Marcy Kaptur who represents the Toledo area.

Goals and implementation schedules are based upon the input of partner organizations and their experiences of working with stakeholders over the past ten years. These partners include the following:
- SWCD staff and board of supervisors in each of the six counties
- SJRWI staff
- NRCS staff
- Cedar Creek WMP work group
- Lower St. Joseph-Bear Creek stakeholders
- City of Fort Wayne water utilities department
- The Nature Conservancy's Upper St. Joseph River Project staff
- county Cooperative Extension Service personnel
- Wood-Land-Lakes R C & D
- Maumee River Basin Commission
- representatives from county and municipal offices such as GIS departments, health - departments and surveyors
- scientists at the National Soil Erosion Research Laboratory at Purdue University faculty and students of the biology and geosciences departments at Indiana-Purdue University Fort Wayne
- faculty and students at University of St. Francis
- representatives from local environmental groups including Cedar Creek Wildlife Project, ACRES Land Trust, Izaak Walton League in Allen and DeKalb counties
- Allen County Partnership for Water Quality

- Edon Co-op
- Williams County Farm Bureau
- Staff from the wastewater treatment plants in Edgerton, Auburn and Fort Wayne

Some of these representatives serve on the Board of Directors for the Initiative, or work with the Initiative as technical advisors. Most have participated in sub-watershed planning and BMP placement projects.

Other citizen input has been gathered at public meetings and presentations, via surveys such as the conservation tillage expo survey of participants (2002-2004) and the Fort Wayne water customer survey, and through personal contacts such as phone calls, event feedback comments, and requests for service and/or water quality data. (See also 1.2).

Some projects have worked better than others; landowners in some areas are more willing to cooperate and become involved in programs and projects. Their feedback has helped tailor projects to fit specific areas for better results.

The Initiative's water sampling program and the GIS mapping of current conservation practices in the watershed have helped us identify our water quality goals and target areas.

7.2 Overall Vision and Goals

The overall vision this effort is to reduce the loads of sediment, pesticides, pathogens, and nutrients in the St. Joseph River so as to meet EPA Water Quality Standards or target loads throughout the entire year, thus protecting human health, watershed biodiversity and aesthetic and economic value of the river.

The main goal of the St. Joseph River watershed plan which will help to achieve this vision is to organize the stakeholders in each of the nine 11-digit HUC sub-watersheds and create watershed plans for each of these units. Each of the sub-watershed management plans will then set goals and reduction strategies depending upon local interest and capabilities. This is reflected in Goal No. 1. Since the approval of the original St. Joseph WMP in 2001 which aimed at creating seven sub-watershed groups over five years, a WMP has been completed for the Upper and Lower Cedar Creek sub-watersheds, and a WMP effort is underway in the Lower St. Joseph and Bear Creek (Indiana) sub-watersheds. Additionally, preliminary efforts at organization are underway in the Nettle Creek sub-watershed.

Goals 2 through 5 reflect the pollutants of concern in the watershed and list some of the types of action items that will be taken *on the sub-watershed level* to reduce these pollutants. These actions will be taken in each sub-watershed as those areas are organized and their plans implemented.

Because we cannot guarantee the implementation on the sub-watershed scale, we have calculated loads and estimated load reductions based upon 2003 sampling results from the main stem of the St. Joseph at the Mayhew Road bridge in northern Allen County.

Goal 1: By 2020, organize stakeholders and produce watershed plans for the HUC-11 sub-watersheds which have not yet been completed, based upon priorities of critical areas (see Chapter 6).

Goal 2: Reduce bacteria in the river to meet the EPA recreational season WQS by 2025, based on sampling of the St. Joseph River at the Mayhew Road bridge site.

Goal 3: Meet and maintain nutrient target levels in the St. Joseph watershed to meet target levels year-round by 2025. (P <0.6 ppm; NH_3 <0.10 ppm with pH <8.0)

Goal 4: Decrease pesticide loading in sub-watersheds during application season so that raw water meets the drinking water quality standards at the Mayhew Road bridge site and remediation by the Fort Wayne filtration plant is unnecessary (>3.0 ppb for atrazine; 2.0 ppb for alachlor; 700 ppb for glyphosate).

Goal 5: Reduce sediment (TSS) in the river at the Mayhew Road bridge site 30% by the year 2025.

St. Joseph River Watershed

Management Plan

Three States, Six Counties, One Watershed

Part 8: Meeting Our Goals

8.1 Resources

The St. Joseph River Watershed Initiative will continue its efforts with local citizens and partners across the watershed such as Wood-Land-Lakes (WLL), Department of Natural Resources (DNR), Agricultural Research Service (ARS), Natural Resource Conservation Service (NRCS), The Nature Conservancy (TNC), US Fish and Wildlife Service (USFWS), and local soil and water conservation districts (SWCD), county departments of health, county drainage boards, colleges and universities. The City of Fort Wayne has and is committed to continue in the near future, in-kind support of Initiative water quality monitoring activities.

Financial support to the Initiative and landowners from other federal, state and private organizations must be utilized to support the watershed activities necessary to realize our goal. These programs and sources include the Great Lakes National Program Office (GLNPO), Great Lakes Commission (GLC), Conservation Reserve Program (CRP), Environmental Protection Agency (EPA) Targeted Watersheds, Conservation Security Program (CSP), Environmental Quality Incentive Program (EQIP), Wetland Reserve Program (WRP), and Forestry Incentive Program (FIP). State-funded programs such as Section 319 and 205(j) grants, Conservation Reserve Enhancement Program (CREP), and Lake& River Enhancement (LARE) programs are also sources of support.

Private-sector support may come from grass root citizen organizations as well as foundations, such as the Foelinger Foundation, Wal-mart Foundation, the Fort Wayne Community Foundation, county foundations in DeKalb, Noble and Steuben counties, America's Clean Water Foundation, and others.

Efforts of the Initiative and individual watershed groups toward meeting the goals listed in Part 7 are largely dependent upon funding to support staff and activities; lack of funding will obviously impede the progress toward our goals.

8.2 Load Data Source

The City of Fort Wayne measures bacteria, phosphorus, nitrogen and total suspended solids in the St. Joseph River at the Mayhew Bridge in northern Fort Wayne. Measurements from this location are being used in this plan as a basis for loads and reductions because this downstream sampling point includes all major tributaries and has USGS flow data available. The location is upstream of the city's drinking water intake facility at the St. Joseph dam at

Johnny Appleseed Park. This location is also upstream of the Fort Wayne combined sewer outfalls (CSOs) on the St. Joseph so will not include the city's input from these CSOs. The Mayhew Bridge is also upstream of the approximately 120 septic systems in the Parkerdale neighborhood scheduled to be connected to the Fort Wayne WWTP during 2006, so sampling will not show the effects of that remediation project.

Table 17, below, shows the sampling results from the river survey of 2003, the most recent data available to us. Because pollutant loads and flow vary widely across the watershed and action items will be implemented in many different areas upstream of this location, it is virtually impossible to accurately predict how the combined efforts will affect loads and load reductions for the river as a whole. Although we have collected and present some loading data from critical sub-watersheds, the targeted loads and reductions for the goals in this plan are based upon samples and flow at the Mayhew Road Bridge (E. coli, nutrients, sediment) and Three Rivers Filtration Plant (pesticides).

It should be noted that levels of pollutants at the Mayhew location also vary widely, based primarily on rainfall and flow in the river. An example: in 2003, 86% of samples met the WQS for E. coli (235 CFU/100 mL). In 2002, only 51.6% of samples met the WQS. The average depth of the river for the two years at this location varied by only 0.89 ft. See Appendix E for 2002 sample results.

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

Table 17 Water quality samples from the St. Joseph River at Mayhew Road bridge, 2003.

Pesticide loads are generally measured by the City of Fort Wayne water utilities department in raw water at the water filtration plant intake site to determine whether reduction efforts are needed to meet drinking water standards. Measurements are not taken at the Mayhew Bridge site. Average annual pesticide concentrations are generally below the maximum contaminant level for drinking water throughout the watershed. However, spikes during application season (April through June) are not uncommon in raw water tests at the plant and in upstream tributaries and drainage ditches.

8.3 Action Items, Timelines, Indicators and Reductions

Goals	Action Items	Cooperators	Start/End	Measurable Milestones*	Cost Estimate	Load Reduction
8.2.1 By 2020, organize stakeholders and produce watershed plans for the HUC-11 sub-watersheds which have not yet been completed, based on priorities of critical areas of concern.	1. Upper and Lower Cedar Creek WMP implementation in place	All watershed stakeholders. See Cedar Creek WMP for complete information	2005 -2012	Phase I implementation is funded beginning 2005 through 2008; Phase II expected 2009-2012	Phase I: $685,000 Phase I: est. $700,000	See Cedar Creek WMP
	2. Lower St. Joseph-Bear Creek WMP completed by 2007; begin implementation 2008.	All watershed stakeholders, including DeKalb and Allen Co gov't and agencies, IPFW, Cities of FW, Leo-Cedarville, St. Joe, Spencerville, Grabill	2006-2012	WQ and land use data collected; critical areas identified and ranked. By 2011, first implementation phase will be completed.	$500,000	N/A
	3. Organize stakeholders in Nettle Creek sub-watershed by 2008 and begin implementation of BMPs by 2009	All watershed stakeholders, including Williams Co. gov't and agencies, University of Toledo faculty, and Nettle Lake landowners.	2006-2013	Stakeholders are organized and WMP completed by 2009; by 2013, first implementation phase will be completed.	$700,000	N/A
	4. Organize stakeholders in the Middle St. Joseph sub-watershed by 2010	All sub-watershed stakeholders, including Dekalb Co. gov't and agencies, Cities of Butler and Newville, local industries	2008-2015	Stakeholders are organized and WMP completed by 2011; by 2015 first implementation phase will be completed	$700,000	N/A
	5. Organize stakeholders in the	All sub-watershed stakeholders, including	2010-2017	Stakeholders are organized and WMP	$800,000	N/A

	East Branch St. Joseph and Fish Creek sub-watershed by 2011	Steuben, Williams and Hillsdale Co gov't and agencies, Indiana, Ohio and Michigan state gov't agencies, landowners		completed by 2013; first implementation phase completed by 2017		
	6. Organize stakeholders in the West Branch sub-watershed by 2012	All sub-watershed stakeholders, including Hillsdale and Williams Co. agencies and gov't., landowners, lake associations, The Nature Conservancy	2010 – 2018	Stakeholders are organized and WMP completed by 2014; first implementation phase completed by 2019	$800,000	N/A

Goal	Action Item	Cooperators	Start/End	Measurable Milestones*	Cost Estimate	Load Reduction
8.2.2 Reduce bacteria in the river to meet the EPA recreational season WQS by 2025, based on sampling of the St. Joseph River at the Mayhew Rd. Bridge site. Target load is 3.19669E+12	1. Reduce failing OSS by 25%; support local government efforts to reduce impact of CSOs and SSOs	Landowners, local government, local health departments; septic system maintenance retailers; local universities; NFP groups	2006 – 2025	Septic maintenance information will be distributed across the watershed by 2010; By 2015, failing septic systems will be reduced by 15%	$2M	2.53584E+13 (~3%)
	2. Reduce sources and impact of wildlife domestic pet bacteria inputs	Landowners, local government, local health departments; park agencies; home and garden retailers, landscape companies; conservation organizations; golf courses, homeowner and neighborhood associations; hunters; DNR, NRCS, SWCDs	2006 - 2025	Riparian buffers and filters will be increased by 25% by year 2020; Education and demonstration sites for goose-proof landscaping in place by 2012; 15 workshops focused on landscaping for bacteria reduction by 2012; proper pet waste management information distributed in all towns and cities by 2010;	$500,000 plus federal farm program dollars from CCRP, WHP, EQIP, CREP, others	3.043301E+14 (~30%)
	3. Reduce sources and impact of livestock bacteria inputs	Landowners, livestock producers; state agencies; county SWCD, NRCS, ag retailers	2006 - 2025	Buffers and filters, manure containment around livestock grazing and feed areas will be increased by 25% by year 2018 and by 30% by year 2025	$500,000 plus federal farm program dollars	3.04301E+13 (~3%)

Goal	Action Items	Cooperators	Start/ End	Measurable Milestones*	Cost Estimate	Load Reduction
8.2.3 Meet and maintain nutrient target levels year-round by 2025. Targets are (P =0.6 ppm (460.43 lb/day); NH_3 =0.10 ppm with pH <8.0) (299.82 lb/day)	1. Increase bioswale, wetland and filter/buffer acres by 20%	Landowners, County drainage boards and surveyors, SWCDs, NRCS, ARS, farmers and livestock producers	2006 - 2020	Increase acres of buffer, filter, bioswales and wetlands 10% by 2012.		P: 4.186301 lb/day N: 8.15 lb/day
	2. Water quality monitoring for nutrients will continue across the watershed year-round	City of Fort Wayne; Hoosier Riverwatch, SWCDs, citizen volunteer water quality monitoring corps; landowners; NSERL; local secondary schools, colleges and universities	2006 – 2020	Monitoring efforts will continue with appropriate equipment and staffing; Database will be maintained to house results of all sampling efforts and results will be distributed to the public	$40,000	N/A
	2. Introduce and demonstrate new technologies (tools and equipment) to improve conservation tillage outcomes	SWCDs, NRCS, ag retailers and equipment dealers, landowners, ag producers	2006 – 2010	Host annual technology workshop for precision application and conservation tillage	$60,000	N/A
			2006-2020	Continue cost-share and risk-reduction program for increased use of conservation tillage, impacting 50% of currently conventionally tilled corn acreage in S J	$500,000	P: 116.64 lb/day; N: 232.95 lb/day.

				watershed		
	4. See goal #1 under 8.2.2: reducing failing septic systems and CSO inputs					

Goal	Action Items	Cooperators	Start/End	Measurable Milestones*	Cost Estimate	Load Reduction
8.2.4 Decrease pesticide load in sub-watersheds during application season so that raw water meets drinking water MCL and redediation by the Fort Wayne filtration plant is unnecessary. Target levels: (<3.0 ppm for atrazine; <2.0 ppm for alachlor; <700 ppm for glyphosate)**	1. Continue outreach efforts to farm operators to increase conservation tillage and precision chemical application across the watershed	Landowners, farmers, SWCDs, NRCS, CES, ag retailers and equipment dealers; local sponsors and advertisers; TNC	2006-2012	Host annual technology workshop for precision application and conservation tillage	$60 K	*N/A
				Continue cost-share and risk-reduction program for increased use of conservation tillage, impacting 76,739 acres	$150 K	*N/A
	2. Create cost-share program for increasing filter and buffer areas	Landowners, farmers, SWCDs, NRCS, CES, ag chemical and equipment dealers; rural residential and urban landowners; lake associations	2006 - 2015	Increase filter/buffer acreage adjacent to ditches, streams, river, reservoirs, lakes, drainage tiles and tile risers by 20%	See nutrient, sediment goals	*N/A
	3. Increase educational efforts and outreach to rural residential and urban dwellers	Landscape and garden, ag retail stores; rural residential and urban–suburban landowners; CES, NRCS, SWCDs; neighborhood and lake associations	2006 – 2025	Sponsor at least 1 workshop in each HUC-11 sub-watershed annually focusing on pesticide safety and application, effects, alternatives and environmental implications of usage.	$20 K	*N/A

*Note: Since we have no way of determining exactly when farmers will apply pesticides and how close application will coincide with rainfall events, which can be quite scattered, we cannot calculate a load reduction for the action items in this goal. ** There is no MCL established for metolochlor and cyanazine. A limited amount of testing for glyphosate has been performed in the upper watershed; up to this point, contamination from this pollutant has not been characterized as a problem downstream.

Goal	Action Items	Cooperators	Start/End	Measurable Milestones*	Cost Estimate	Load Reduction
8.2.5 Reduce sediment to TSS concentration = 80 Target load is 239,853.10 lb/day	1. Create cost-share program for buffers & filter strips	Landowners, farmers, SWCDs, NRCS, CES, equipment dealers; rural residential and urban landowners; lake associations	2006 – 2020	Increase filter/buffer acreage adjacent to ditches, streams, river, reservoirs, lakes, drainage tiles and tile risers by 25%	$100,000	5,298.63 lb/day
	2. Introduce and demonstrate new technologies (tools and equipment) to improve conservation tillage outcomes	SWCDs, NRCS, ag retailers and equipment dealers, landowners, ag producers	2006 – 2010	Host annual technology workshop for precision application and conservation tillage	$60,000	N/A
			2006-2020	Continue cost-share and risk-reduction program for increased use of conservation tillage, impacting 50% of currently conventionally tilled corn acreage in S J watershed	$500,000	151,893.15 lb/day
	3. Water quality monitoring for sediment and turbidity will continue across the watershed year-round	City of Fort Wayne; Hoosier Riverwatch, SWCDs, citizen volunteer water quality monitoring corps; landowners; NSERL; local secondary schools, colleges and universities	2006 – 2025	Monitoring efforts will continue with appropriate equipment and staffing; Database will be maintained to house results of all sampling efforts and results will be distributed to the public	$40,000	N/A
	4. Work with county drainage boards and	County drainage boards and surveyors, landowners, TNC, university	2007 – 2025	Hold two drainage workshops/conferences by 2013; create at least	$75,000	N/A

	surveyors to investigate and improve maintenance methods for drainage system while improving filtering capacity of streambeds and riparian corridors	researchers, conservation organizations, SWCDs, NRCS, ARS, farmers		two demonstration sites within the watershed by 2015; information and results will be presented to interested groups, surveyors and general public		

Part 9: Loads and Targeted Load Reductions

St. Joseph River @ Mayhew Rd. Loads					
Date	**E Coli Load (colonies/day)**	**Phos Load (lbs/day)**	**NH3-N Load (lbs/day)**	**TSS Load (lbs/day)**	Flow
4/7/2003		5247.056112	3115.439566	1213751.898	3040
4/14/2003	3.71836E+13	0	2125.796671	149398.9601	923
4/21/2003	8.67903E+12	227.2393853	206.5812593	82657.71283	383
4/28/2003	3.19263E+12	324.86656	5.129472001	39337.94936	317
5/5/2003	6.34498E+13	6983.03988	3720.889863	6322343.857	3150
5/12/2003	1.70207E+16	7376.515151	4880.279986	4040084.554	5200
5/19/2003	2.45087E+14	1354.91416	846.8213503	482835.4257	1570
5/27/2003	1.08872E+14	597.9529611	243.6472231	96793.69244	460
6/2/2003	2.86279E+13	447.6880184	6.132712581	71570.14104	379
6/9/2003	4.71795E+13	37.43273994	12.53996788	33699.74376	347
6/16/2003	2.09989E+14	479.8294734	599.7868417	134993.2099	556
6/23/2003	4.84938E+13	240.6644702	63.88862555	102183.7091	321
6/30/2003	4.85945E+13	194.666429	102.6422989	30198.12133	193
7/7/2003	1.52139E+15	388.5885182	372.9196263	363629.1915	581
7/15/2003	1.00714E+14	3076.604447	51.56440833	125173.5599	400
7/21/2003	9.67358E+14	2437.982486	609.4956215	1499816.646	1130
7/28/2003	4.30552E+13	4556.330366	582.9151399	1808326.308	1710
8/4/2003	5.69538E+15	7742.7519	941.6437664	1392555.854	2900
8/11/2003	3.41571E+14	866.5085982	113.2237902	134831.3475	714

8/18/2003	4.15042E+13	188.08064	170.9824	59862.09686		317
8/25/2003	2.51155E+13	124.5151011	41.81247839	21527.69414		285
9/2/2003	2.85524E+13	15841.81602	3639.336113	3150974.6		5670
9/8/2003	1.03212E+14	690.9414966	215.5737469	119799.7295		854
9/15/2003	1.77236E+14	192.0989961	50.17173781	99469.81682		419
9/22/2003	1.33275E+14	259.548047	216.2900391	60579.68666		401
9/29/2003	1.11672E+15	4499.048565	708.1583995	883768.4962		2520
10/6/2003	1.21129E+14	617.9800163	174.4683914	105874.1709		633
10/13/2003	9.47467E+13	252.7519011	7.659148518	36775.12863		355
10/27/2003	2.04852E+13	273.0540384	42.90849176	42677.70943		452
Average	1.01434E+15	2259.32643	823.0585909	782947.9659	Median	556
High	1.70207E+16	15841.81602	4880.279986	6322343.857		5670
Low	3.19263E+12	0	5.129472001	21527.69414		193
Standard Deviation	3.32317E+15	3560.360112	1324.135625	1447659.909		1459.59364
Target Concentration	235	0.6	0.1	80		
Target Load (same units as above)	3.19669E+12	1798.898286	299.816381	239853.1048		
Reduction needed to meet WQS(%)	99.68484934	20.3790005	63.57289939	69.36538375		
Reduction needed (value)	1.01114E+15	460.4281445	523.2422099	543094.8611		

E. coli concentration is cfu/100 ml
other pollutant concentrations are mg/l

N. Rice, IDEM 2006

Table 18 Contaminant loads for the St. Joseph River Watershed, 2003

9.1.Attaining Targeted Load Reductions

9.1.1 Bacteria

The amount of reduction of E. coli bacteria needed to meet our target of 235 CFU is 99.68% (See Table 18, above). This will not be an easy task, and the calculations show that our action items will reduce loads by only about 36% and will not meet the WQS goal.

Bacteria contamination of the river and tributaries, as well as some lakes, is probably the most publicized concern of stakeholders in the watershed. Most stakeholders within cities have now heard about combined sewer overflows because of the sewer rate hikes that have been initiated by cities. Storm water issues are also being publicized as requirements to treat municipal storm water are enforced. Again, this requires utility rate hikes for the urban dwellers.

Many citizens are so concerned about bacteria contamination that they refused to go near the river, especially in the Fort Wayne area. The highly popular Three Rivers Festival raft race was discontinued several years ago due to liability issues, often characterized as relating to bacteria-laden water. Although many people canoe or boat in the St. Joseph and the Cedarville Reservoir, participation in these recreational activities are much lower than would be expected for a water resource of this size.

Modeling done by SJRWI and IDEM for the Cedar Creek Watershed Management Plan indicated that removing septic systems may have a very minimal effect on total loads in the tributary. The Initiative's BST project (See Appendix G) indicated that human source bacteria in the Upper watershed is highly localized and contributed <10% of the concentration of fecal coniform to our samples. However, human source pollution is an important public health concern for stakeholders, and the incidence of disease based on E. coli concentration is the basis for the water quality standards set by the State. Therefore, this is one of the first steps that is scheduled to reduce bacteria. The Cedar Creek WMP Implementation includes funding for cost-sharing failing septic replacement as well as education about maintenance of septic systems. The current load (1.01434E+15) x 10% human source x remediation of 25% of failing septics & CSOs equals 2.53584E+13 or ~3% reduction.

Other steps that we are suggesting include the addition of filtration areas (buffers, filters, wetlands) and reduction in the number of nuisance geese through landscaping changes, to help to reduce the amount of bacteria from wildlife that enters the water way. Based on the BST project, contribution from wildlife sources makes up nearly 60% of fecal coliform in some locations, so these BMPs have the potential of reducing a much greater amount of bacteria. However, we have no data to determine how effective our suggested BMPs will be. We have used as a measuring stick, that BMPs will cut the contribution in half over the period of time allocated to the project (2006-2025). This is based on the ballooning number of nuisance geese over the past 10 years in the watershed. The current average load (1.01434E+15) x 60% wildlife x 50% reduction through changes in wildlife management and BMPs equals 3.043301E+14 or ~30% reduction.

Finally, working with livestock operations to contain manure and reduce runoff will help to eliminate approximately one-third of the 10% of bacteria contribution in certain watersheds based on the BST livestock contribution calculation. The current load (1.01434E+15) x 10% from livestock sources x 30% improvements in manure handling equals 3.04301E+13 or ~3% reduction.

Load reduction based on 100% adoption of conservation tillage for corn				
County	**Acres affected**	**Phosphorus (lb/yr)**	**Nitrogen (lb/yr)**	**Sediment (tons/yr)**
Allen	14,076.8	8,278	16,527	4,859
DeKalb	56,350	29,957	59,834	19,705
Hillsdale	24,428.80	19,229	38,414	13,351
Noble	5095.5	3,233	6,459	2,223
Steuben	14,031.10	11,861	23,699	8,762
Williams	43,971.80	16,055	32,051	9,042
Total	153,478.10	85,145	170,057	55,441

Table 19 Load reduction by county that would be expected if 100% of corn acres are no-tilled.

9.1.2 Nutrients and Sediment

Sediment and nutrient loads were calculated by Nathan Rice (IDEM, 2006) and are reflected in Table 18, above.

The current daily average load is 2259.32643 lb/day; the target daily load for phosphorus (P) is 1798.898286 lb/day based on 0.6 ppm. (The EPA of the State of Illinois has established a level of 0.61 mg/L as capable of impairing aquatic life.) Our reduction target is 460.4281445 lb/day, or 20.379%.

Our action items in Chapter 8 include increasing bioswale, wetland and filter/buffer acres by 20% and increasing conservation tillage for corn acreage by 50% by year 2020.

For filter strips and buffers, we used DeKalb County as a model, since the number of stream miles and conservation practices is known for that county, having been calculated via GIS for a previous project. Approximately 20% of the county's 780 stream miles are protected by CRP, buffers, filters or woodlots. That leaves 80% of the stream miles available for protection. When converting this to acres, we used 20 ft. wide buffers. From the remaining possible acres of possible buffers, we targeted an additional 20% for filter strips and buffers. In DeKalb County, this resulted in 1,890.91 streamside acres available for buffers. We made the assumption that the remaining counties in the watershed were similar to DeKalb's stream mile percentage and adoption of the practices, and calculated the acres for the remaining five counties in the watershed.

Meeting the targeted 20% of possible buffer acres installed would reduce P by 1,528 lb/year (4.186301 lb/day) across the watershed. We did not calculate changes in wetland acres separately.

Load reductions for conservation tillage were calculated with the help of the IDEM load reduction calculator for agricultural fields. We started with the total acres in each county that lies in the watershed, multiplied by the percentage of watershed land generally classified as cropland (64%), and finally, used the percentage of that cropland in each county that is classified as using conventional tillage for corn based on county transect data for 2004-2005. These calculations resulted in the total acres affected for each county, reflected in , above.

Load reductions for nutrients P and N were calculated based on adoption of conservation tillage by county, using total cropland acres (~64% of total area in the watershed is cropland) times the percentage of corn under conventional tillage in that county. Our action items reflect a positive change of 50% of those corn acres moving to conservation tillage by 2020. The calculator figured the reduction of nutrients annually. See .

The change to conservation tillage for corn on 50% of the conventionally tilled land will reduce the P load 42,572.5 lb/yr (116.6356 lb/day). These combined changes in filter/buffers and conservation tillage for corn will result in a reduction of 120.8199 lb/day, about 26% of the target amount needed to reach the reduction goal of 460.428 lb/day.

The same tools were used to calculate reductions for nitrogen (N). According to the load and reduction calculations (Table 18), the average daily load of nitrogen at Mayhew Bridge is 823.059 lb/day. Our target load, based on concentration of 0.1 ppm of ammonia is 299.816 lb/day. That requires a reduction of 63.5% or 523.242 lb/day.

Action items include installing filter strips on 20% of the possible land adjacent to streams and changing 50% of the corn acreage from conventional to conservation tillage. The filter/buffer BMPs applied to a total of 999.83 acres will reduce nitrogen 2,976 lb/year (8.15 lb/day). The conservation tillage BMP applied to a total of 76,739 acres will reduce nitrogen 85,028.5 lb/yr (232.96 lb/day). Total reduction for both practices is 241.11 lb/day, approximately 80.4% of what is required to meet the target.

[Note: Current and target loads refer to NH_3 ammonia. Nitrogen load reductions for filter strips and conservation tillage, calculated with the help of IDEM's load reduction model, refer to Total N. Total reduction for these practices may be slightly less than the calculated amounts listed below based on the differences of these measurements.]

Sediment reduction was calculated in the same fashion as P and N. According to the load and reduction calculations (Table 18) the average daily load of sediment at Mayhew Bridge is 782,947.97 lb/day. Our target total suspended solids (TSS) concentration is 80, which calculates to 239,853.10 lb/day. Installation of filters and buffers on 20% of the possible streamside land (999.83 acres) would result in a reduction of 967 tons/yr. (5,298.63 lb/day). The conservation tillage BMP applied to a total of 76,739 acres will reduce sediment by 27,720.5 tons/yr (151,893.15 lb./day). Total reduction for both practices is 157,191.78 lb/day or 65.54% of what is required to meet the target.

9.1.3 Pesticides

Targeted load reduction for pesticides was calculated based on atrazine concentrations taken at the Three Rivers Filtration Plant in Fort Wayne, 2003, using flow data from the Mayhew Road Bridge site. The average atrazine load was 10.6 lb/day. Of the 172 days data was measured, 29 had loads in excess of the target condition (3 ppb.) The average load excess for these days was 11.58 lb/day. All exceedences of the target condition occurred in application months of May, June and July. (N. Rice, IDEM, 2006)

Although these calculations were performed using 2003 data, a study by G. Vasquez Amabile, *Modeling and Risk Analysis of Non Point Source Pollution caused by Atrazine Using SWAT* (2004) showed similar trends for other years (see Figure 39 on page 85).

Research by the Agricultural Research Service (ARS) National Soil Erosion Research Laboratory at the Initiative's Source Water Protection Initiative project near Waterloo in the Upper Cedar Creek sub-watershed shows the effect of rainfall in ditches where pesticides have been applied to farm fields. The graph in Figure 38 is the record of samples taken by an automated sampler, showing water and pesticide levels during a rain event in June of 2003 on the David Link (formerly Swartz) Ditch in DeKalb County.

Based upon the loads measured at the Filtration Plant and data collected from upstream sampling sites, it is clear that the majority of the loading in this watershed occurs on agricultural land during the application/heavy rainfall season. Our actions will focus, therefore, on reducing the pesticide loading that enters the runoff stream during these months. Our efforts will include education efforts regarding application amounts and timing, as well as support of research and demonstration of BMPs that will help to block the flow of pesticides into the waterways.

Since we have no way of determining exactly when farmers will apply pesticides and how close application will coincide with rainfall events, which can be quite scattered, we cannot calculate a load reduction for the action items in Goal 8.2.4. See Appendix A, for pollutant loads in several of the critical watershed areas.

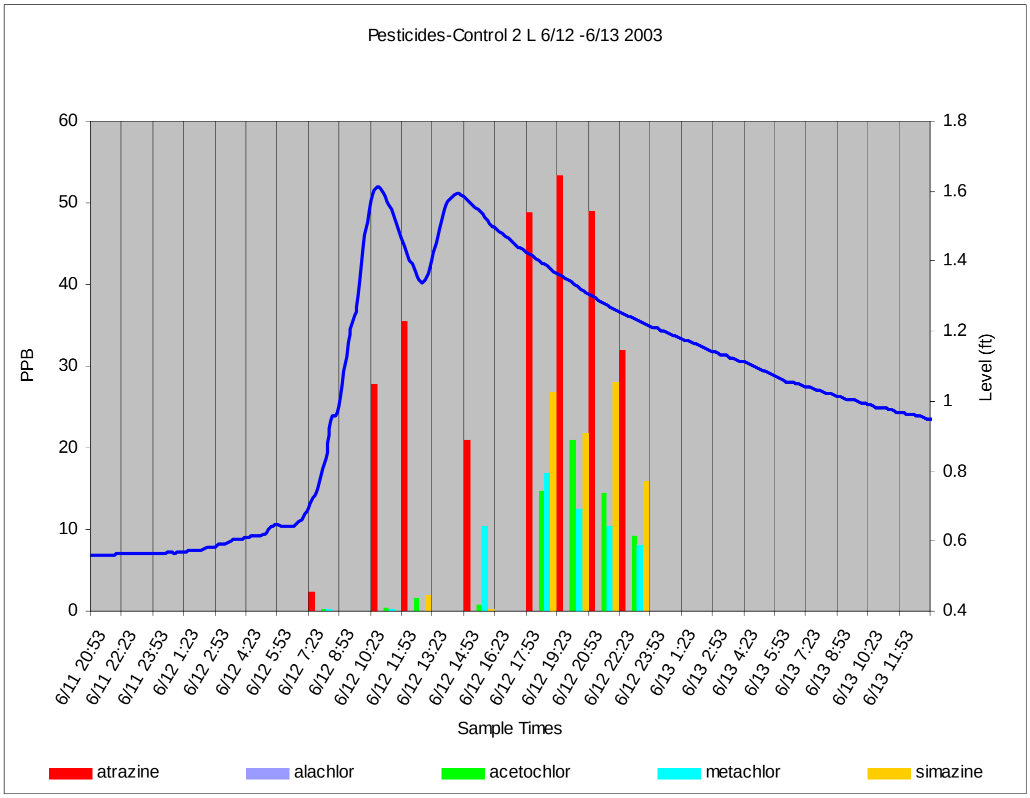
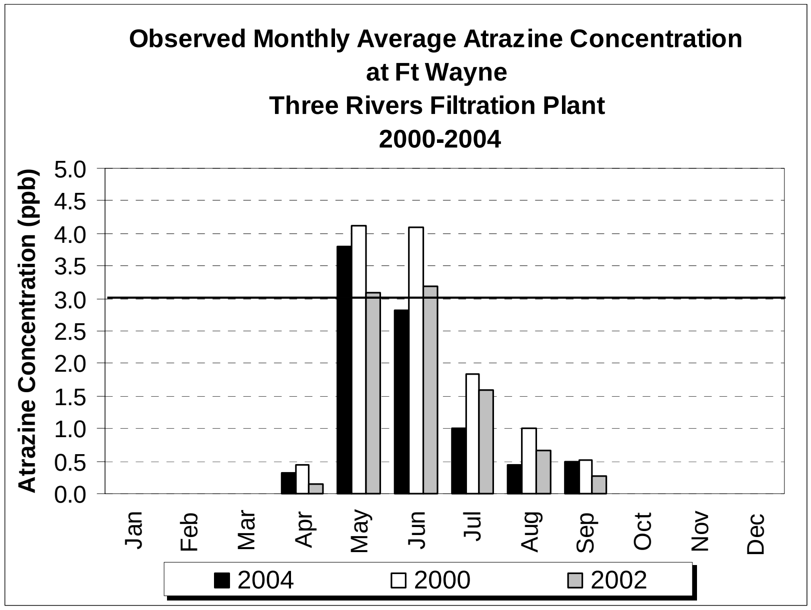


Figure 38 Effect of a rainfall event and resulting runoff on water and pesticide levels in the Swartz (David Link) Ditch, 2003

(Source: USDA-ARS, Source Water Protection Initiative project, 2004)



Observed monthly average atrazine concentration at Fort Wayne, recorded by personnel of the Three Rivers Filtration Plant during the period 2000-2004 (2004: early application; 2000: intermediate application; 2002: late application).

Figure 39 SWAT model output for atrazine, St. Joseph River watershed

9.2 Progress Indicators for this watershed plan

The St. Joseph River Watershed Initiative will measure progress toward goals by the number of successful sub-watershed groups formed, and the completion of watershed management plans.

The St. Joseph River Watershed Initiative will continue to assist with watershed improvement implementation efforts of each of the sub-watershed groups.

The St. Joseph River Watershed Initiative will continue to exist as a viable NFP entity that represents the sub-watershed groups in the larger, regional effort of the Western Lake Erie Basin.

9.3 Monitoring Progress

Annual progress can be monitored in several ways. To measure progress toward load reductions and water quality targets, the Initiative will continue water quality monitoring, as well as biological assessment (as appropriate) in each sub-watershed in order to measure the effectiveness of BMP placement.

We will also measure the effects of outreach education efforts (newsletters, web sites, workshops, conferences, other watershed activities, and active volunteer watershed citizen monitors) through survey instruments and feedback from stakeholders. This will help us to measure how much impact our outreach efforts have in understanding issues and changing behaviors of stakeholders.

The number and progress of cooperative efforts with county departments of health, surveyors and drainage boards will tell us how successfully we are working with those agencies.

We will also track the number of programs and participation in watershed conservation and protection programs such as SWPI, buffer and filter strip signups, conservation tillage equipment rentals, cost share and incentive programs, and conservation tillage based on county transects. In urban and suburban areas, surveys, cooperation and participation in outreach projects by residents, land developers and residential and commercial builders can help us measure how well we are reaching those stakeholders.

Part 10: Plan Evaluation

This watershed plan will be reviewed by the St. Joseph River Watershed Initiative and its various sub-watershed partners as sub-watershed groups are organized and management plans are written; and as implementation begins and progresses in each sub-watershed. We expect these reviews will be required approximately every two years. As they are completed, all sub-watershed plans will be referenced in this master St. Joseph River Watershed Management Plan.

Updated contact listings of each sub-watershed group and the various partners in the Initiative will be maintained by the St. Joseph River Watershed Initiative. Water quality data will continue to be collected according to Quality Assurance Project Plans (QAPP) and stored in digital format at the office of the Initiative. All water quality data is available to the public.

Appendices

Appendix A: Pollutant loads in some critical areas, 2004

The Initiative's weekly grab samples are analyzed by the Fort Wayne Filtration Plant laboratory for atrazine, alachlor, metolochlor and cyanazine, all reported in units of parts per billion. These tables show atrazine loads in several of the sampling locations. The loading of other pesticides rarely exceed maximum contaminant load (MCL) levels, and tend to follow the same pattern as does atrazine.

	Bear Creek - IN			
Date	Bear (IN) Flow (cf/s)	E Coli Load (colonies/day)	Atrazine Load (lbs/day)	TSS Load (lb/day)
4/6/2004	14.98320331		0.059349533	
4/13/2004	9.649778292	2.36087E+12	0.167257774	444.4533067
4/20/2004	8.756739684	4.28476E+12	0.167257774	265.0397648
4/27/2004	7.56602154	5.73831E+12	0.005395412	0
5/4/2004	14.31342436	1.47078E+13	0.99275582	4558.266106
5/11/2004	25.30276056	3.96189E+13	1.80206763	0
5/18/2004	16.69486064	1.71548E+13	0.037767884	2125.565703
5/25/2004	79.62927588	1.69491E+14	3.674275616	7204.207795
6/1/2004	125.2734714	8.82686E+14	1.888394223	73772.23037
6/8/2004	18.13364507	1.37531E+13	0.782334749	13005.35991
6/15/2004	126.5138028	1.3E+14	2.37937672	16607.01494
6/22/2004	49.36518972	5.07253E+13	0.582704503	
6/29/2004	14.23900447	1.84633E+13	0.318329312	
7/6/2004	10.44359039	5.11016E+12	0.36688802	
7/13/2004	10.24513736	2.18068E+13	0.609681563	
7/20/2004	12.89944656	1.32549E+13	0.604286151	
7/27/2004	11.98160132	2.90205E+13	0.798520986	
8/3/2004	7.367568516	7.57056E+12	0.15646695	
8/10/2004	4.489999668	0	0.107908241	
8/17/2004	3.448121292	3.54312E+12	0.097117417	
8/24/2004	5.33342502	9.78638E+12	0.102512829	
8/31/2004	8.781546312	3.52346E+13	0.070140357	
9/7/2004	5.978397348	5.32403E+13	0.242793543	
9/14/2004	4.489999668	8.23876E+12	0.032372472	
9/21/2004	3.745800828	0	0.043163297	
9/28/2004	3.15907E+13		0.010790824	

	Nettle			
Date	Nettle Flow (cf/s)	E Coli Load (colonies/day)	Atrazine Load (lbs/day)	TSS Load (lbs/day)
4/6/2004	12.1278676	2.96723E+12	4.370283772	
4/13/2004	7.810828639	0	1.618623619	
4/20/2004	7.087975603	0	3.507017842	
4/27/2004	6.124171555	0	3.399109601	
5/4/2004	11.58572783	5.66918E+12	2.373981308	
5/11/2004	20.48083602	5.56208E+13	0.80931181	
5/18/2004	13.51333592	1.75229E+13	1.402807137	
5/25/2004	64.45439571	1.18272E+14	0.701403568	
6/1/2004	101.4002176	2.75378E+14	0.053954121	

6/8/2004	14.67793248	1.50828E+13	1.348853016
6/15/2004	102.4041801	1.05229E+14	9.603833475
6/22/2004	39.95770949	1.95523E+13	0.593495327
6/29/2004	11.52549007	2.11489E+13	10.25128292
7/6/2004	8.453364671	1.55116E+13	10.46709941
7/13/2004	8.292730663	2.51586E+13	10.25128292
7/20/2004	10.44121052	1.07292E+13	17.26531861
7/27/2004	9.698278233	1.65384E+14	13.5964384
8/3/2004	5.963537547	1.26938E+13	9.981512319
8/10/2004	3.634344431	4.02802E+13	11.11454885
8/17/2004	2.791015889	1.36571E+12	10.73687001
8/24/2004	4.317038965	6.75978E+12	7.769393373
8/31/2004	7.108054854	1.11301E+13	1.402807137
9/7/2004	4.839099491	1.77592E+13	7.067989805
9/14/2004	3.634344431	1.77837E+12	7.49962277
9/21/2004	3.031966901	7.41808E+11	10.35919116
9/28/2004	2.871332893	2.95053E+12	7.49962277

`	**West Fork - West Branch**			
Date	Flow (cf/s)	E Coli Load (colonies/day)	Atrazine Load (lbs/day)	TSS Load (lbs/day)
4/6/2004	27.16355127	0	0.555727443	2868.615565
4/13/2004	17.49440636	0	0.205025658	3602.91747
4/20/2004	15.87538675	3.88411E+12	0.021581648	788.6458679
4/27/2004	13.71669394	3.35596E+12	0.005395412	789.7111457
5/4/2004	25.94928656	6.34881E+12	0.334515548	1835.458851
5/11/2004	45.87222234	2.3232E+14	0.118699065	3863.407482
5/18/2004	30.26667219	1.76242E+14	0.205025658	866.292783
5/25/2004	144.3625821	0	0.064744945	10068.65066
6/1/2004	227.1124734	3.55621E+14	0.15646695	10385.71876
6/8/2004	32.87509268	8.04329E+12	0.037767884	2282.076568
6/15/2004	229.3611117	9.20302E+14	0.02697706	65044.08691
6/22/2004	89.49580633	4.37925E+13	0.043163297	40925.90164
6/29/2004	25.81436826	4.04211E+13	0.102512829	6870.538752
7/6/2004	18.93353491	1.94557E+13	0.118699065	4086.168906
7/13/2004	18.57375277	1.9086E+13	0.086326593	2939.175424
7/20/2004	23.38583884	5.72163E+12	0.010790824	792.4483179
7/27/2004	21.72184646	1.6475E+13	0.043163297	1786.559641
8/3/2004	13.3569118	0	1.694159388	641.5635541
8/10/2004	8.140070827	3.98313E+12	0.091722005	313.3248325
8/17/2004	6.251214613	3.05887E+12	0.674426508	
8/24/2004	9.669144905	7.33359E+12	1.165409006	
8/31/2004	15.92035952	3.89511E+12	0.215816483	
9/7/2004	10.83843685	1.40543E+13	0.701403568	
9/14/2004	8.140070827	3.98313E+12	0.188839422	
9/21/2004	6.790887817	6.97819E+12	0.059349533	
9/28/2004	6.431105681	6.60848E+12	0.264375191	

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	East Fork - West Branch			
Date	Flow (cf/s)	E Coli Load (colonies/day)	Atrazine Load (lbs/day)	TSS Load (lbs/day)
4/6/2004	27.38670028	6.70049E+12	0.663635684	2892.181288
4/13/2004	17.63812319	0	0.134885302	3632.515494
4/20/2004	16.00580331	1.21396E+13	0.086326593	795.1246063
4/27/2004	13.8293768	3.38353E+12	0.145676126	796.1986354
5/4/2004	26.16246036	6.40096E+12	0.199630246	1850.537175
5/11/2004	46.24906338	7.24185E+13	0.248188955	3895.145437
5/18/2004	30.51531339	3.95695E+13	0.161862362	873.4093921
5/25/2004	145.548523	0	0.118699065	10151.36478
6/1/2004	228.978206	4.87394E+14	0.534145794	10471.0376
6/8/2004	33.14516209	3.40593E+13	0.140280714	2300.823864
6/15/2004	231.2453169	4.9222E+14	0.12948989	65578.42512
6/22/2004	90.23101581	0	0.323724724	41262.10858
6/29/2004	26.02643371	2.67443E+13	0.043163297	6926.980338
7/6/2004	19.0890742	1.44782E+13	0.124094477	4119.736849
7/13/2004	18.72633645	9.16325E+12	0.037767884	2963.320797
7/20/2004	23.57795388	1.15373E+13	0	798.9582935
7/27/2004	21.90029178	0	0.064744945	1801.236257
8/3/2004	13.46663904	0	0.749962277	646.834009
8/10/2004	8.206941639	8.4333E+12	0.107908241	315.898801
8/17/2004	6.302568441	3.084E+12	1.429784197	808.6543892
8/24/2004	9.748577085	1.52647E+13	1.375830076	833.8642383
8/31/2004	16.05114553	7.85422E+12	0.215816483	3648.924272
9/7/2004	10.92747478	5.34708E+12	1.143827358	1089.289236
9/14/2004	8.206941639	9.09591E+13	0.550332031	1401.294681
9/21/2004	6.846675069	2.07715E+13	0.188839422	340.1241234
9/28/2004	6.483937317	1.01528E+13	0.188839422	1049.505409

Appendix B. Endangered, Special Concern, and Extirpated Species in Indiana

(Source: Indiana Department of Natural Resources)

AMPHIBIANS

Endangered

Four-toed salamander	*Hemidactylium scutatum*
Green salamander	*Aneides aeneus*
Hellbender	*Cryptobranchus alleganiensis alleganiensis*
Northern crawfish frog	*Rana areolata circulosa*
Northern red salamander	*Pseudotriton ruber ruber*

Special Concern

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

BIRDS

Endangered

American bittern	*Botaurus lentiginosus*
Bachman's sparrow	*Aimophila aestivalis*
Bald eagle	*Haliaeetus leucocephalus*
Barn owl	*Tyto alba*
Bewick's wren	*Thryomanes bewickii*
Black rail	*Laterallus jamaicensis*
Black tern	*Chlidonias niger*
Black-crowned night-heron	*Nycticorax nycticorax*
Golden-winged warbler	*Vermivora chrysoptera*
Henslow's sparrow	*Ammodramus henslowii*
Interior least tern	*Sterna antillarum athalassos*
King rail	*Rallus elegans*
Kirtland's warbler	*Dendroica kirtlandii*
Least bittern	*Ixobrychus exilis*
Loggerhead shrike	*Lanius ludovicianus*
Marsh wren	*Cistothorus palustris*
Northern harrier	*Circus cyaneus*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Piping plover	*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	*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*
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*
Worm-eating warbler	*Helmitheros vermivorus*

Extirpated

Common loon	*Gavia immer*

Common raven	*Corvus corax*
Double-crested cormorant	*Phalacrocorax auritus*
Greater prairie-chicken	*Tympanuchus cupido*
Swallow-tailed kite	*Elanoides forficatus*
Wilson's phalarope	*Phalaropus tricolor*

FISH

Endangered

Bluebreast darter	*Etheostoma camurum*
Gilt darter	*Percina evides*
Greater redhorse	*Moxostoma valenciennesi*
Harlequin darter	*Etheostoma histrio*
Lake sturgeon	*Acipenser fulvescens*
Northern cavefish	*Amblyopsis spelaea*
Redside dace	*Clinostomus elongatus*
Southern cavefish	*Typhlichthys subterraneus*
Spottail darter	*Etheostoma squamiceps*
Southern cavefish	*Typhlichthys subterraneus*
Spottail darter	*Etheostoma squamiceps*
Spotted darter	*Etheostoma maculatum*
Tippecanoe darter	*Etheostoma tippecanoe*
Variegate darter	*Etheostoma variatum*

Special Concern

Bantam sunfish	*Lepomis symmetricus*
Blue sucker	*Cycleptus elongatus*
Cisco	*Coregonus artedi*
Crystal darter	*Crystallaria asprella*
Eastern sand darter	*Ammocrypta pellucida*
Northern studfish	*Fundulus catenatus*
Ohio river muskellunge	*Esox masquinongy ohioensis*
River redhorse	*Moxostoma carinatum*

Extirpated

Alabama shad	*Alosa alabamae*
Blackfin cisco	*Coregonus nigripinnis*
Great Lakes muskellunge	*Esox masquinongy masquinongy*
Harelip sucker	*Lagochila lacera*
Popeye shiner	*Notropis ariommus*
Shortnose cisco	*Coregonus reighardi*
Stargazing darter	*Percina uranidea*

MAMMALS

Endangered

Allegheny woodrat	*Neotoma magister*
American badger	*Taxidea taxus*
Bobcat	*Lynx rufus*
Evening bat	*Nycticeius humeralis*
Franklin's ground squirrel	*Spermophilus franklinii*
Gray bat	*Myotis grisescens*
Indiana bat	*Myotis sodalis*
Northern river otter	*Lutra canadensis*
Southeastern bat	*Myotis austroriparius*
Swamp rabbit	*Sylvilagus aquaticus*

Special Concern

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

Extirpated

American bison	*Bos bison*
Black bear	*Ursus americanus*
Black rat	*Rattus rattus*
Common porcupine	*Erethizon dorsatum*
Eastern spotted skunk	*Spilogale putorius*
Elk	*Cervus elaphus*
Fisher	*Martes pennanti*
Gray wolf	*Canis lupus*
Lynx	*Lynx lynx*
Mountain lion	*Felis concolor*
Red wolf	*Canis rufus*
Wolverine	*Gulo gulo*

MOLLUSKS

Endangered

Clubshell	*Pleurobema clava*
Fanshell	*Cyprogenia stegaria*
Fat pocketbook	*Potamilus capax*
Longsolid	*Fusconaia subrotunda*
Northern riffleshell	*Epioblasma torulosa rangiana*
Orangefoot pimpleback	*Plethobasus cooperianus*
Pink mucket	*Lampsilis abrupta*
Pyramid pigtoe	*Pleurobema rubrum*
Rabbitsfoot	*Quadrula cylindrica cylindrica*
Rough pigtoe	*Pleurobema plenum*
Sheepnose	*Plethobasus cyphyus*
Snuffbox	*Epioblasma triquetra*
Tubercled blossom	*Epioblasma torulosa torulosa*
White catspaw	*Epioblasma obliquata perobliqua*
White wartyback	*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	*Villosa fabalis*
Round hickorynut	*Obovaria subrotunda*
Salamander mussel	*Simpsonaias ambigua*
Swamp lymnaea	*Lymnaea stagnalis*
Wavyrayed lampmussel	*Lampsilis fasciola*

Extirpated

Cracking pearlymussel	*Hemistena lata*
Leafshell	*Epioblasma flexuosa*
Catspaw	*Epioblasma obliquata obliquata*
Ring pink	*Obovaria retusa*
Round combshell	*Epioblasma personata*
Scaleshell	*Leptodea leptodon*
Spectaclecase	*Cumberlandia monodonta*
Tennessee riffleshell	*Epioblasma propinqua*
Wabash riffleshell	*Epioblasma sampsonii*
Winged mapleleaf	*Quadrula fragosa*

REPTILES

Endangered

Alligator snapping turtle	*Macroclemys temminckii*
Blanding's turtle	*Emydoidea blandingii*
Butler's garter snake	*Thamnophis butleri*
Eastern massasauga	*Sistrurus catenatus catenatus*
Eastern mud turtle	*Kinosternon subrubrum subrubrum*
Hieroglyphic river cooter	*Chrysemys concinna hieroglyphica*
Kirtland's snake	*Clonophis kirtlandii*

Northern copperbelly water snake	*Nerodia erythrogaster neglecta*
Northern scarlet snake	*Cemophora coccinea copei*
Ornate box turtle	*Terrapene ornata*
Smooth green snake	*Opheodrys vernalis*
Southeastern crowned snake	*Tantilla coronata*
Spotted turtle	*Clemmys guttata*
Timber rattlesnake	*Crotalus horridus*
Western cottonmouth	*Agkistrodon piscivorus leucostoma*

Special Concern

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

Extirpated

Western mud snake	*Farancia abacura reinwardtii*

Appendix C: NPDES Permitted Facilities in the St. Joseph River Watershed

Industrial Permits - Indiana

Permit Type	Plant_Name	County	Owner Type	State	Receiving Waters
GEN	MERIDIAN AUTOMOTIVE SYSTEMS	ALLEN	PRIVATE	IN	ST. JOSEPH R VIA WITMER HAIFLEY D
STD	CITATION BOHN ALUMINUM	DE KALB	PRIVATE	IN	BIG RUN CR VIA TEUTSCH DITCH
STD	AUBURN FOUNDRY, INC. PLANT 1	DE KALB	PRIVATE	IN	CEDAR CR / PECKHART D / STORM SEWER
STD	AUBURN GEAR INC.	DE KALB	PRIVATE	IN	CEDAR CR TO ST JOSEPH RIVER
STD	RIEKE CORPORATION	DE KALB	PRIVATE	IN	CEDAR CR TO ST JOSEPH RIVER
GEN	EATON CORPORATION, CLUTCH DIV.	DE KALB	PRIVATE	IN	CEDAR CR VIA CITY STORM SEWERS
STD	AUBURN FOUNDRY, CR 50 LANDFILL	DE KALB	PRIVATE	IN	CEDAR CR VIA GARRETT DRAIN
STD	SPX - CONTECH DIVISION	DE KALB	PRIVATE	IN	CEDAR CR VIA GRANDSTAFF DITCH
STD	TOWER AUTOMOTIVE, INC.	DE KALB	PRIVATE	IN	CEDAR CR VIA GRANDSTAFF DITCH
GEN	MARATHON ASHLAND, WATERLOO ASP	DE KALB	PRIVATE	IN	CEDAR CR VIA UNNAMED TRIBUTARY
STD	AUBURN FOUNDRY, INC. PLANT 2	DE KALB	PRIVATE	IN	CEDAR CR/ DIEHL D/ WETLAND/ POND
GEN	STAFFORD GRAVEL, WASHLER PIT	DE KALB	PRIVATE	IN	ST JOSEPH R VIA CHRISTOFFEL DITCH
STD	RALPH SECHLER & SONS, INC.	DE KALB	PRIVATE	IN	ST JOSEPH R VIA HINDMAN DITCH
STD	STEEL DYNAMICS, INC.	DE KALB	PRIVATE	IN	ST JOSEPH R VIA SOL SHANK DITCH
GEN	EASTSIDE H.S. & BUTLER ELEMENT	DE KALB	PRIVATE	IN	ST JOSEPH R/BIG RUN CR/STORM SEWER

Municipal Permits - Indiana

STD	BUTLER MUNICIPAL STP	DE KALB	PUBLIC	IN	BIG RUN CR TO ST JOSEPH RIVER
CSO	AUBURN CSS	DE KALB	PUBLIC	IN	CEDAR CR AND JOHN DIEHL DRAIN
STD	AUBURN MUNICIPAL STP	DE KALB	PUBLIC	IN	CEDAR CR TO ST JOSEPH RIVER
STD	WATERLOO MUNICIPAL STP	DE KALB	PUBLIC	IN	CEDAR CR TO ST JOSEPH RIVER
STD	GARRETT MUNICIPAL STP	DE KALB	PUBLIC	IN	CEDAR CR VIA GARRETT CITY DITCH
STD	CORUNNA MUNICIPAL STP	DE KALB	PUBLIC	IN	CEDAR CR VIA JOHN DIEHL DITCH
STD	ST. JOE - SPENCERVILLE RSD	DE KALB	PUBLIC	IN	ST JOSEPH R
STD	AVILLA MUNICIPAL STP	NOBLE	PUBLIC	IN	CEDAR CR (LITTLE) VIA UNNAMED DITCH
STD	LAOTTO REGIONAL SEWER DISTRICT	NOBLE	PUBLIC	IN	CEDAR CR VIA BLACK CREEK
STD	HAMILTON WATER TREATMENT PLANT	STEUBEN	PUBLIC	IN	FISH CR VIA WILLIAM EGBERT DITCH
STD	HAMILTON LAKE CONS. DIST.	STEUBEN	PUBLIC	IN	FISH CREEK TO ST. JOSEPH RIVER

STD	STEUBEN LAKES RWD	STEUBEN	PUBLIC	IN	LM/ST JOSEPH/PIGEON R/PIGEON CREEK

Michigan Permits

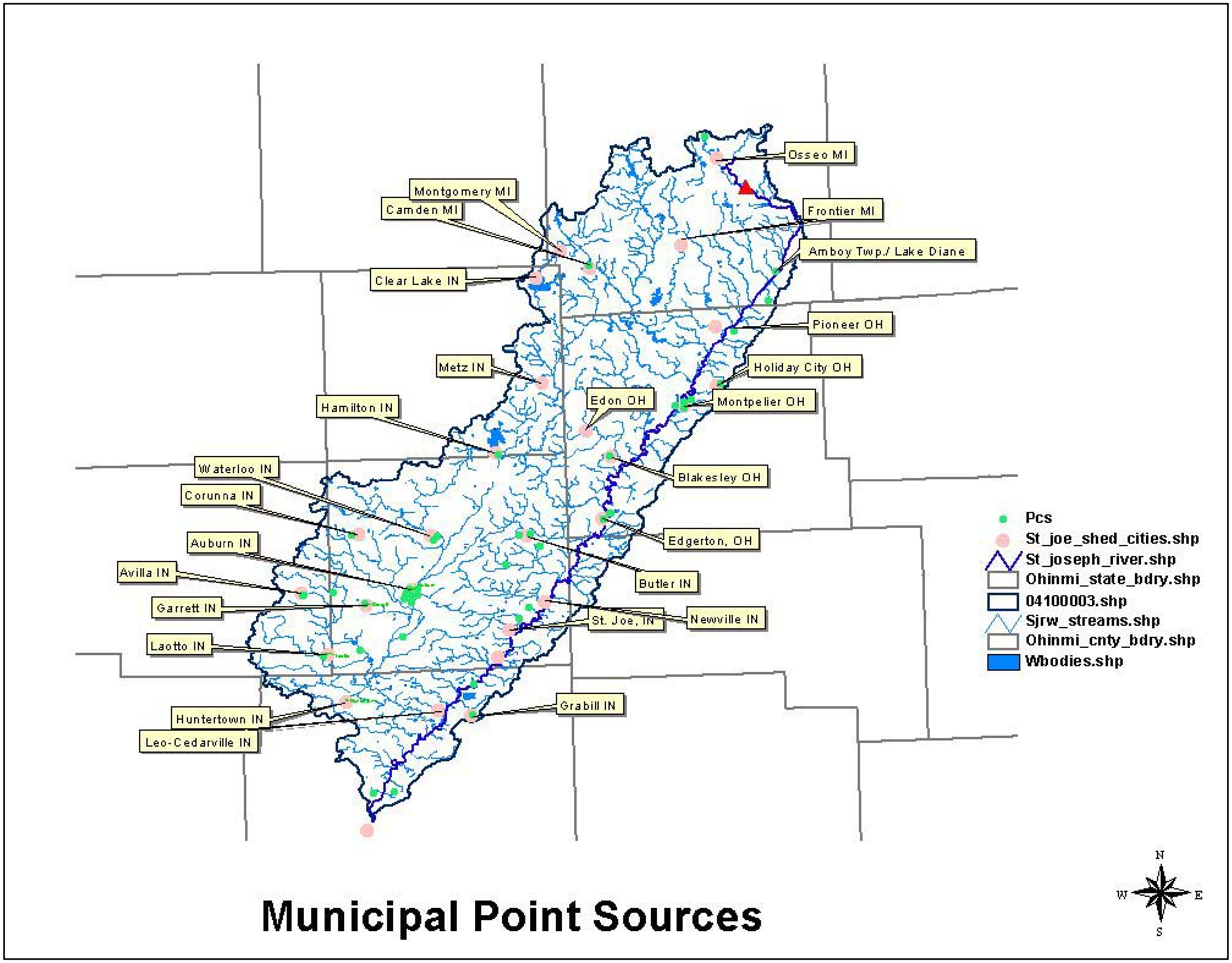
Amboy Township	Waldron	MI	St. Joseph River
Amboy Township	Camden	MI	St. Joseph River
Village of Camden	Camden	MI	St. Joseph River
Camp Michindoh Ministries Camp and Conference Center	Hillsdale	MI	St. Joseph River
Hillsdale Power Plant	Hillsdale	MI	St. Joseph River
Litchfield WWSL	Litchfield	MI	St. Joseph River
North Adams WWSL	North Adams	MI	St. Joseph River
Pittsford SSDS WWSL	Pittsford	MI	St. Joseph River
R. C. Plastics, Incorporated	Osseo	MI	St. Joseph River
Reading WWSL	Reading	MI	St. Joseph River
Schilling Farm Site	Hillsdale	MI	St. Joseph River
Waldron WWSL	Waldron	MI	St. Joseph River

Williams County Individual NPDES Permits

facility	county name	location	ohio_epa_no	us_epa_no
Williams Co South Central SD	Williams	NWDO	2PH00018*AD	OH0126641
Harvard Industries - Trim Trends *	Williams	NWDO	2IC00039*GD	OH0034380
Ohio Turnpike Commission Kunkle Maintenance Blgd	Williams	NWDO	2PP00047*AD	OH0126438
Montpelier WTP	Williams	NWDO	2IW00170*ED	OH0030546
Edon Village WTP 1	Williams	NWDO	2PA00031*ED	OH0095141
Ohio Turnpike Comm Indian Meadows Tiffin R Plaza	Williams	NWDO	2PP00002*ED	OH0035815
Edgerton WWTP	Williams	NWDO	2PB00047*ID	OH0021164
Spangler Candy Co	Williams	NWDO	2IH00107*BD	OH0116254
Tru Fast Corp	Williams	NWDO	2PR00105*BD	OH0122254
West Unity STP	Williams	NWDO	2PB00021*HD	OH0020303
Montpelier STP	Williams	NWDO	2PD00003*ID	OH0021831
Nettle Lake Area STP	Williams	NWDO	2PG00046*CD	OH0053376
Williams County - Norlick Sewer District No 1	Williams	NWDO	2PG00067*ED	OH0058831
Williams County - Durham Estates Subsewer District	Williams	NWDO	2PG00085*CD	OH0079081
Stryker STP	Williams	NWDO	2PB00009*FD	OH0022497
Lakeland Woods WWTP	Williams	NWDO	2PG00087*DD	OH0079103

Edgerton WTP	Williams	NWDO	2IZ00040*ED	OH0030562
BP Amoco Oil Corp Bulk Plant Bryan	Williams	NWDO	2IN00177*BD	OH0122661
Williams County - Hickory Hills Subsewer District	Williams	NWDO	2PG00084*DD	OH0079073
Williams County - Hillside Nursing Home *	Williams	NWDO	2PG00086*DD	OH0079090
Exit One	Williams	NWDO	2PR00108*BD	OH0122351
Bryan WWTP	Williams	NWDO	2PD00018*LD	OH0020532
Chase Brass and Copper Co Inc	Williams	NWDO	2IC00007*HD	OH0002941
Pioneer WWTP	Williams	NWDO	2PB00006*HD	OH0022535
Bryan WTP	Williams	NWDO	2IY00002*FD	OH0030481
Kunkle Schoolhouse	Williams	NWDO	2PR00129*BD	OH0125709
Manufactured Housing Enterprises *	Williams	NWDO	2PR00141*BD	OH0126683

Note: Not all the permits from Williams County are within the St. Joseph River watershed.



Appendix D: Municipal Point Sources in the SJR Watershed

Appendix E. Reduction calculations for nutrients and sediment

Watershed Acres, Total St. Joseph River Watershed: 694,400

County	Predominant Soil type	% of total watershed	~Acres in w'shed	~Cropland Acres (64%)	Conventionally-tilled (corn) acres
Allen	BmA	--	34,912.6	22,344.1	14,076.8
DeKalb	GnB_3	--	--	161,000	56,350
Hillsdale	Miami	22%	152,680	97,715.2	24,428.8
Noble	BLA	--	39,526	25,296.64	5059.33
Steuben	GnB_2	--	29,859.84	29,859.84	9555.2
Williams	BmA	22%	152,680	97,715.2	43971.84

For Filter Strips and Buffers, the following calculations were used.

Dekalb has ~780 stream miles of buffer strips possible; approximately 20 % is buffered

=	1890.909	Acres possible	1512.727	Acres not yet buffered = 80% of total possible

Assume 20% of area in each county is buffered. Target an additional 20% of area for buffers and filters

County	**Watershed Cropland ac**	**% of DeK**	**Est. possible buff**	**Est. 20%**	**Remaining Acres**	**Target addtnl 20% acres**	**Calculated reduction in P lb/yr.**	**Calculated reduction in N lb/yr**	**Calculated reduction of sediment tons/yr**
Allen	22344.1	75%	1414.97	282.99	1131.97	226.39	262	515	154
DeKalb	161000.0	100%	1890.91	378.18	1512.73	302.55	481	933	302
Hillsdale	97715.2	61%	1147.64	229.53	918.12	183.62	376	732	253
Noble	25296.6	16%	297.10	59.42	237.68	47.54	85	166	55
Steuben	29859.8	19%	350.70	70.14	280.56	56.11	146	283	104
Williams	97715.2	61%	1147.64	229.53	918.12	183.62	178	347	99
						999.83	1528.00	2976.00	967.00

City of Fort Wayne River Survey 2002

St. Joseph River @ Mayhew Road

Wk	Date	ECOLI	Depth(ft)	PHOS	NH3-N	TSS
1	04/01/02	548	7.71	0.279	0.206	96
2	04/08/02	1280	6.47	0.177	0.041	64
3	04/15/02	200	7.89	0.280	0.100	105
4	04/22/02	620	5.27	0.188	0.055	66
5	04/29/02	500	2.68	0.139	0.125	176
6	05/06/02	100	1.55	0.072	0.020	40
7	05/13/02	3300	9.08	0.470	0.120	208
8	05/20/02	100	5.69	0.150	0.100	41
9	05/29/02	350	4.42	0.156	0.002	76
10	06/03/02	180	2.84	0.145	0.019	34
11	06/10/02	380	2.41	0.165	0.002	36
12	06/17/02	120	2.73	0.130	0.100	45
13	06/24/02	510	2.57	0.135	0.010	30
14	07/01/02	740	2.09	0.188	0.006	60
15	07/08/02	240	11.08	0.191	0.002	44
16	07/05/02	240	1.51	0.130	0.100	44
17	07/22/02	80	2.66	0.179	0.187	32
18	07/29/02	240	3.57	0.210	0.002	120
19	08/05/02	20	2.04	0.144	0.043	24
20	08/12/02	265	2.07	0.108	0.032	42
21	08/19/02	360	2.94	Test failed	Test failed	44
22	08/26/02	100	2.21	0.164	0.005	36
23	09/03/02	90	2.76	0.088	0.024	35
24	09/09/02	90	2.83	0.139	0.071	25
25	09/06/02	70	1.86	0.140	0.100	38
26	09/23/02	200	2.74	0.158	0.058	36
27	09/30/02	195	1.70	0.207	0.006	23
28	10/07/02	270	1.71	0.243	0.147	15
29	10/14/02	110	3.00	0.102	0.048	19
30	10/21/02	80	1.09	0.050	0.100	15
31	10/28/02	35	0.89	0.015	0.056	70
	Max.	3300	11.08	.0.470	0.206	208
	Min.	20	0.89	0.015	0.002	15
	Avg.	375	3.55	0.164	0.063	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

Appendix F   Atrazine loads in critical areas 1999-2003

Date	Atrazine	Flow	Load	Target Load (based on 3ppb)	Load exceeds target	Excess
	ppb	cfs	lb/day	lb/day	1= true	lb/day
4/21/2003	0.39	383	0.80546	6.195845714		
4/22/2003	0.62	475	1.588056	7.684142857		
4/23/2003	0.9	376	1.824782	6.082605714		
4/28/2003	0.14	340	0.256677	5.500228571		
4/29/2003	0.09	435	0.211112	7.037057143		
4/30/2003	0.08	355	0.153144	5.742885714		
5/1/2003	0.15	321	0.259643	5.192862857		
5/2/2003	0.22	317	0.376065	5.128154286		
5/3/2003	0.31	314	0.524894	5.079622857		
5/4/2003	2.71	305	4.457072	4.934028571		
5/5/2003	1.82	405	3.974724	6.551742857		
5/6/2003	4.44	694	16.61587	11.22693714	1	5.38893
5/7/2003	4.83	751	19.55995	12.14903429	1	7.410911
5/8/2003		464				
5/9/2003		3150				
5/10/2003	4.39	3920	92.79641	63.4144	1	29.38201
5/11/2003	5.01	2630	71.05163	42.54588571	1	28.50574
5/12/2003	4.5	2090	50.71534	33.81022857	1	16.90511
5/13/2003	4.5	4660	113.0782	75.38548571	1	37.69274
5/14/2003	4.19	6230	140.7611	100.7836	1	39.97749
5/15/2003	4.19	6210	140.3092	100.4600571	1	39.84916
5/16/2003	3.96	5200	111.0399	84.12114286	1	26.91877
5/17/2003	3.38	4850	88.3973	78.45914286	1	9.938158
5/18/2003	3.06	4070	67.15779	65.84097143	1	1.316819
5/19/2003	2.99	3590	57.88236	58.07594286		
5/20/2003	4.6	3290	81.60829	53.2228	1	28.38549
5/21/2003	2.3	2460	30.51009	39.79577143		
5/22/2003	2.36	1890	24.05218	30.5748		
5/23/2003	2.28	1570	19.30257	25.39811429		
5/24/2003	1.87	1160	11.69715	18.76548571		
5/25/2003	1.88	1110	11.25282	17.95662857		
5/26/2003	1.5	872	7.053234	14.10646857		
5/27/2003	1.69	726	6.616128	11.74460571		
5/28/2003	1.51	723	5.887024	11.69607429		
5/29/2003	1.27	678	4.643164	10.96810286		
5/30/2003	1.53	570	4.702695	9.220971429		
5/31/2003	1.8	460	4.464891	7.441485714		
6/1/2003	1.6	493	4.25351	7.975331429		
6/2/2003	1.18	473	3.009704	7.651788571		
6/3/2003	1.47	401	3.178647	6.487034286		
6/4/2003	1.33	416	2.983497	6.729691429		
6/5/2003	0.3	407	0.65841	6.584097143		
6/6/2003	1.28	379	2.615952	6.131137143		

6/7/2003	1.23	372	2.467338	6.017897143		
6/8/2003	1.21	366	2.38807	5.920834286		
6/9/2003	1.04	345	1.934786	5.581114286		
6/10/2003	1.04	311	1.744112	5.031091429		
6/11/2003	1.13	264	1.608655	4.270765714		
6/12/2003	0.98	321	1.696335	5.192862857		
6/13/2003	1.09	347	2.03956	5.613468571		
6/14/2003	2.64	287	4.085699	4.64284		
6/15/2003	4.26	253	5.8118	4.092817143	1	1.718983
6/16/2003	5.75	439	13.61172	7.101765714	1	6.509952
6/17/2003	6.52	801	28.16182	12.95789143	1	15.20393
6/18/2003	6.52	661	23.23965	10.69309143	1	12.54656
6/19/2003	4.2	489	11.07487	7.910622857	1	3.164249
6/20/2003	3.66	556	10.97328	8.994491429	1	1.978788
6/21/2003	3.26	469	8.244627	7.58708	1	0.657547
6/22/2003	4.88	600	15.78889	9.706285714	1	6.082606
6/23/2003	4.07	742	16.28467	12.00344	1	4.281227
6/24/2003	4.8	558	14.44295	9.026845714	1	5.416107
6/25/2003	4.8	364	9.421568	5.88848	1	3.533088
6/26/2003	3.81	360	7.39619	5.823771429	1	1.572418
6/27/2003	3.39	321	5.867935	5.192862857	1	0.675072
6/28/2003	3.08	260	4.318219	4.206057143	1	0.112162
6/29/2003	2.89	236	3.67782	3.817805714		
6/30/2003	3.25	233	4.08338	3.769274286	1	0.314106
7/1/2003	2.37	230	2.939387	3.720742857		
7/2/2003	2.29	197	2.432665	3.186897143		
7/3/2003	2.14	198	2.28486	3.203074286		
7/4/2003	1.93	193	2.008608	3.122188571		
7/5/2003	1.43	184	1.418843	2.976594286		
7/6/2003	1	187	1.008375	3.025125714		
7/7/2003	1.3	179	1.254807	2.895708571		
7/8/2003	2.03	176	1.92659	2.847177143		
7/9/2003	1.64	301	2.661895	4.86932		
7/10/2003	2.35	397	5.030822	6.422325714		
7/11/2003	3.1	581	9.712217	9.39892	1	0.313297
7/12/2003	3.06	786	12.96954	12.71523429	1	0.254305
7/13/2003	2.33	1690	21.23358	27.33937143		
7/14/2003	2.24	1610	19.44708	26.0452		
7/15/2003	1.99	1170	12.55508	18.92725714		
7/16/2003	1.81	708	6.910228	11.45341714		
7/17/2003	2.41	549	7.134605	8.881251429		
7/18/2003	2.07	466	5.201599	7.538548571		
7/19/2003	1.88	400	4.05507	6.470857143		
7/20/2003	1.88	310	3.14268	5.014914286		
7/21/2003	1.21	285	1.859563	4.610485714		
7/22/2003	1.16	263	1.645108	4.254588571		
7/23/2003	0.79	235	1.001096	3.801628571		
7/24/2003	0.99	195	1.040999	3.154542857		
7/25/2003	0.87	1130	5.30125	18.28017143		
7/26/2003	0.98	956	5.052014	15.46534857		

7/27/2003	1.04	1350	7.570903	21.83914286
7/28/2003	0.89	996	4.780022	16.11243429
7/29/2003	0.95	627	3.211972	10.14306857
7/30/2003	1.05	389	2.202518	6.292908571
7/31/2003	1.21	306	1.996583	4.950205714
8/1/2003	0.65	1710	5.993631	27.66291429
8/2/2003	1.12	1410	8.515648	22.80977143
8/3/2003	1.28	1340	9.249012	21.67737143
8/4/2003	1	653	3.521225	10.56367429
8/5/2003	0.63	783	2.660008	12.66670286
8/6/2003	0.77	3820	15.86115	61.79668571
8/7/2003	0.73	3040	11.96677	49.17851429
8/8/2003	0.89	2900	13.91774	46.91371429
8/9/2003	0.85	3590	16.45485	58.07594286
8/10/2003	0.89	3020	14.49364	48.85497143
8/11/2003	0.8	1990	8.58467	32.19251429
8/12/2003	0.64	1430	4.935107	23.13331429
8/13/2003	0.96	1320	6.833225	21.35382857
8/14/2003	0.49	778	2.055683	12.58581714
8/15/2003	0.66	714	2.541106	11.55048
8/16/2003	0.54	756	2.201386	12.22992
8/17/2003	0.61	723	2.378202	11.69607429
8/18/2003	0.76	578	2.368765	9.350388571
8/19/2003	0.69	400	1.488297	6.470857143
8/20/2003	0.95	505	2.586995	8.169457143
8/21/2003	0.62	460	1.537907	7.441485714
8/22/2003	0.58	317	0.991443	5.128154286
8/23/2003	0.7	305	1.151273	4.934028571
8/24/2003	0.51	365	1.003792	5.904657143
8/25/2003	0.54	304	0.885213	4.917851429
8/26/2003	0.48	302	0.78168	4.885497143
8/27/2003	0.46	247	0.612682	3.995754286
8/28/2003	0.38	241	0.493834	3.898691429
8/29/2003	0.7	285	1.07578	4.610485714
8/30/2003	0.29	283	0.442553	4.578131429
8/31/2003	0.36	406	0.78815	6.56792
9/1/2003	0.36	298	0.578495	4.820788571
9/2/2003	0.53	248	0.708775	4.011931429
9/3/2003	0.58	360	1.125929	5.823771429
9/4/2003	0.47	306	0.775532	4.950205714
9/5/2003	0.36	2320	4.503717	37.53097143
9/6/2003	0.49	5670	14.98165	91.7244
9/7/2003	0.64	4840	16.70344	78.29737143
9/8/2003	0.58	3550	11.10291	57.42885714
9/9/2003	0.33	2960	5.267278	47.88434286
9/10/2003	0.41	2110	4.664949	34.13377143
9/11/2003	0.39	1260	2.649816	20.3832
9/12/2003	0.47	854	2.164394	13.81528
9/13/2003	0.32	835	1.440844	13.50791429
9/14/2003	0.35	710	1.340007	11.48577143

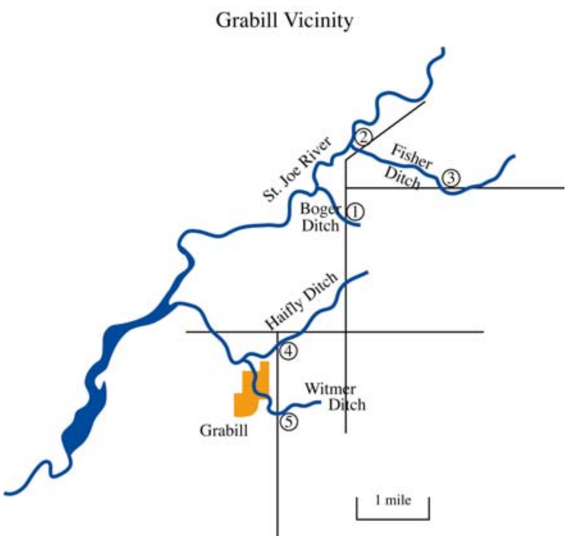
9/15/2003	0.46	493	1.222884	7.975331429
9/16/2003	0.35	437	0.824765	7.069411429
9/17/2003	0.58	453	1.416794	7.328245714
9/18/2003	0.32	365	0.62983	5.904657143
9/19/2003	0.34	419	0.768199	6.778222857
9/20/2003	0.34	352	0.64536	5.694354286
9/21/2003	0.37	307	0.612521	4.966382857
9/22/2003	0.38	352	0.721285	5.694354286
9/23/2003	0.41	295	0.652208	4.772257143
9/24/2003	0.26	230	0.322464	3.720742857
9/25/2003	0.34	243	0.445519	3.931045714
9/26/2003	0.39	401	0.843314	6.487034286
9/27/2003	0.29	757	1.183789	12.24609714
9/28/2003	0.3	576	0.931803	9.318034286
9/29/2003	0.34	1580	2.896787	25.55988571
9/30/2003	0.36	1950	3.785451	31.54542857
10/1/2003	0.25	3390	4.570043	54.84051429
10/2/2003	0.4	3150	6.7944	50.958
10/3/2003	0.27	2520	3.668976	40.7664
10/4/2003	0.16	2140	1.846351	34.61908571
10/5/2003	0.28	1680	2.536576	27.1776
10/6/2003	0.36	1250	2.426571	20.22142857
10/7/2003	0.2	861	0.928568	13.92852
10/8/2003	0.24	856	1.107811	13.84763429
10/9/2003	0.52	576	1.615126	9.318034286
10/10/2003	0.15	633	0.512007	10.24013143
10/11/2003	0.5	618	1.666246	9.997474286
10/12/2003	0.22	442	0.524355	7.150297143
10/13/2003	0.21	680	0.770032	11.00045714
10/14/2003	0.19	364	0.372937	5.88848
10/15/2003	0.14	246	0.185714	3.979577143
10/16/2003	0.28	413	0.623575	6.68116

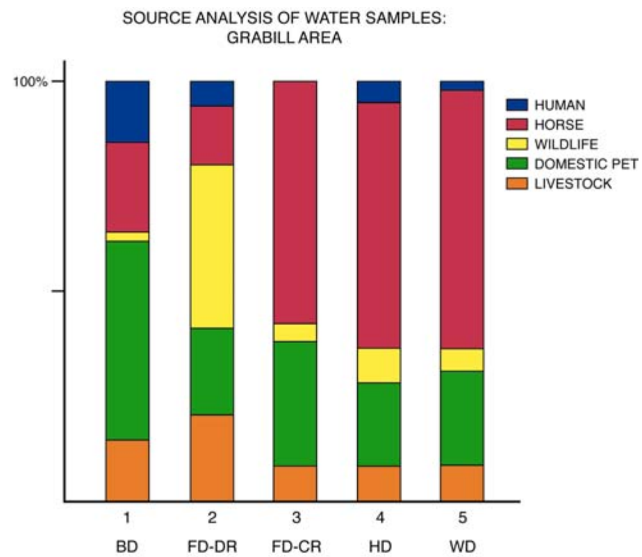
min	0.153144	days load exceeds target	29	11.5864
mean	10.6247	(all in May, June & July)		
max	140.7611	% days exceeded	16.9	
may-june avg	23.86121			average load excess

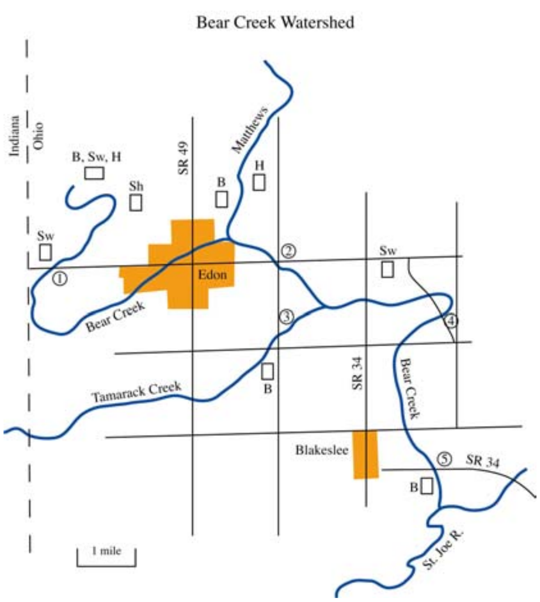
N. Rice
(IDEM 2006)

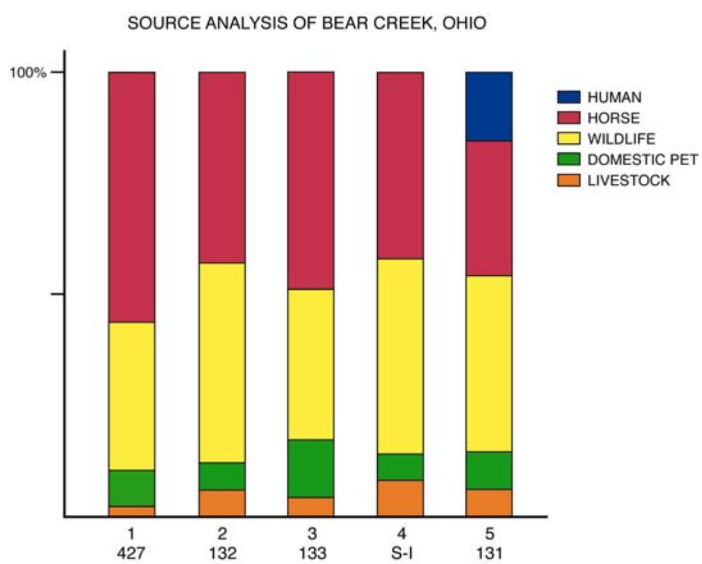
Appendix G: BST Data

The Initiative's Bacteria Source Tracking Project indicated that overall, human contribution was localized and was generally <10% of the total. The "horse" marker was proven to be an animal source, and is suspected to be part of the wildlife category. Contribution from livestock (dairy, beef, swine) was also localized and contributed less than expected to the total pollution. (D. Ross, IPFW)

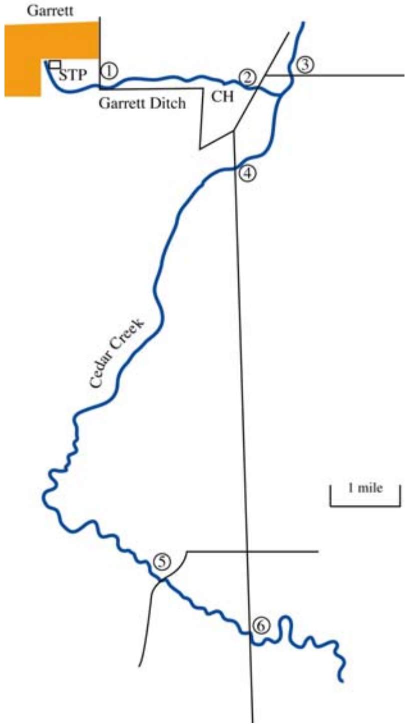


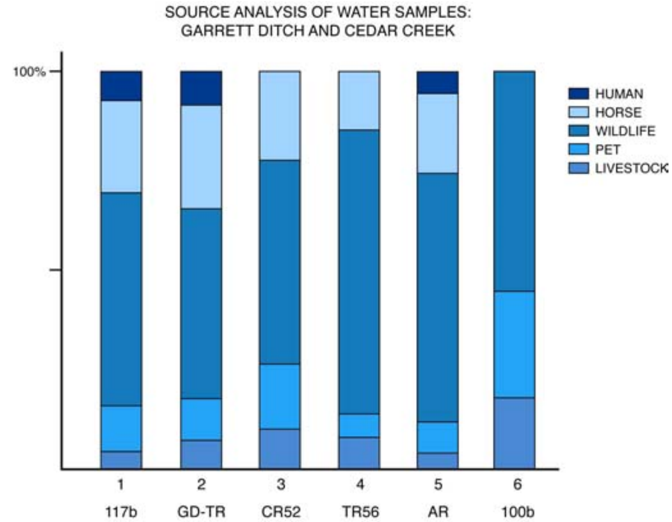






Garrett Ditch and Cedar Creek





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