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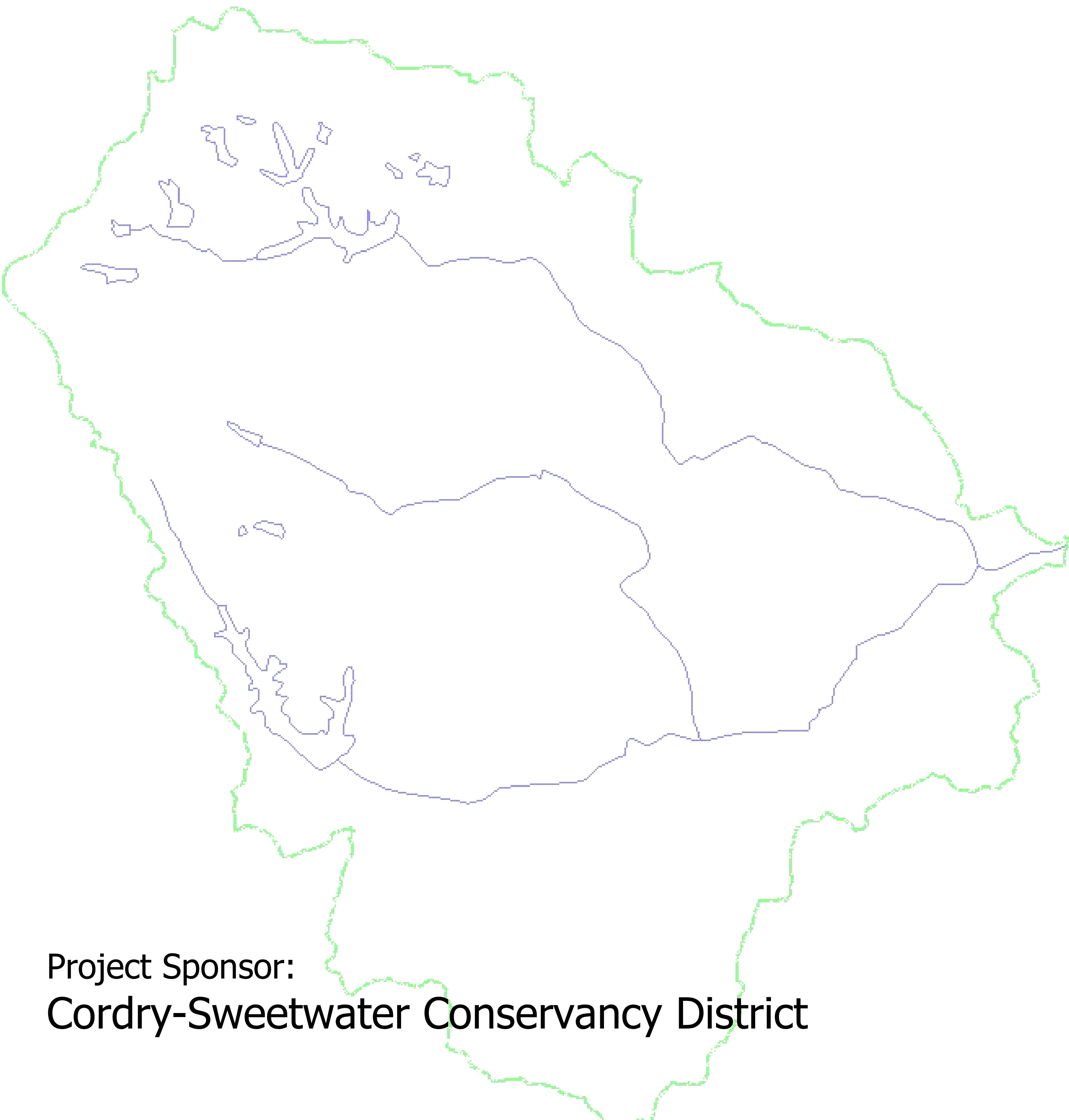
FINAL DAFT *VERSION 2* 5/30/06

A Management Plan for the Mud Creek Watershed



Project Sponsor:

Cordry-Sweetwater Conservancy District

June, 2006

Executive Summary

Area residents near the Cordry-Sweetwater Conservancy District and the Town of Princes Lakes developed this Watershed Management Plan to address long term water quality issues affecting their communities. A Watershed Team and Steering Committee, comprised of local residents, provided the locally based power source to drive the planning project. Public meetings provided the forum to identify water quality issues, investigate their sources and magnitude, and finally to develop long term goals and implementation solutions.

The Watershed Team decided to focus their efforts on what they perceived to be the top four threats to local water quality, these priority issues included failing septic systems, erosion & sedimentation, geese, and lawn chemicals.

Volunteer water quality monitoring was conducted during the summer of 2005, using established testing protocols for lake and stream sampling. This data was used to validate and/or quantify the priority issues. Information collected during this time indicates that water quality in local streams and lakes is relatively healthy, and no testing parameters exceeded the Indiana surface water quality standards.

Since no obvious water quality impairments were identified during sampling, long term goals developed by the planning team centered on maintaining or improving current water quality conditions. Implementation items to achieve these goals targeted information sharing and accessibility, coupled with expanded water quality monitoring, as the preferred mechanisms to promote the widespread use of conservation Best Management Practices. The planning team will be pursuing grant funding to develop these recommendations.

Mud Creek Watershed Management Plan

To all our volunteers, thanks for you time, your ideas, and your patience!

This project was made possible by a US Environmental Protection Agency Clean Water Act Section 205(J) grant, administered through the Indiana Department of Environmental Management, Office of Water Quality, Watershed Management Section (Grant #A305-4-51)

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Section 1. INTRODUCTION

1.1 Purpose & Objectives

The following items represent the purposes and objectives for developing a watershed management plan:

- Improve water quality in Mud Creek, it's lakes, and tributaries.
- Promote adoption of voluntary conservation.
- Provide a forum to identify and discuss watershed resources and concerns.
- Identify and seek funding to address concerns.

1.2 Vision & Mission Statements

The Watershed team developed the following Vision and Mission statements through team consensus to define the group's identity and purpose:

Vision Statement:

> "*Our watershed will be recognized as a world class environment.*"

Mission Statement:

> "*Provide input into watershed plan development.*"

1.3 Development Process

The Mud Creek watershed was selected for planning due to the interest of water quality issues among residents in the community. Because a significant portion of the population in the watershed lives along or nearby the Prince's Lakes or Cordry Lake, many of the residents are concerned about how activities in the watersheds may affect their quality of life. This watershed management plan (Plan) was developed by a stepwise process driven by local interests to reflect the water quality concerns of local stakeholders. First, a Steering Committee comprised of five members of the community was developed to provide direction and decision-making tasks. Then, a larger, more dynamic Watershed Team was assembled from members of the community and residents of the watershed in the early stages of the project. The entire local public was invited to participate in the Plan development, with the intent of having broad representation of local interests reflected in the team composition. Once the team was assembled, the following events occurred in sequential order to develop the Plan. Watershed Team and Steering Committee meetings provided the forum to undertake the process.

- Introduction of project, background of watershed resources, group dynamics, and ground-rules for participation.
- Identification of water quality concerns important to local stakeholders via Nominal Group Technique.
- Assessment of existing water quality conditions, identification of their causes, sources and critical areas.
- Development of goals, measures for improvement, and implementation and monitoring strategies to address concerns identified.
- Draft plan that incorporates all steps above.
- Implement plan; develop projects that address goals/solutions identified above.

1.4 Plan Development Partners

The following groups and organizations provided representation to the Watershed Team and/or Steering Committee and contributed to the Plan development:

Cordry/Sweetwater Conservancy District Board & Staff
Bartholomew, Brown, & Johnson County Soil & Water Conservation Districts
East Lake Committee
Clifty Creek Watershed Project
Town of Princes Lakes
CSCD- Ecology and Building Committees
US Army- Camp Atterbury
Cordry Sweetwater Lot Owners Association

1.5 Water Quality Concerns

Nominal Group Technique: At the first Watershed Team meeting, the participants identified what they perceived to be the greatest threats to water quality in the watershed. The Team accomplished this by using the Nominal Group technique, in which the first step is to brainstorm all potential water quality threats, then to rank them in terms of highest priority. The results of this process are indicated in *Table 1* below. The top four were chosen to be addressed in the watershed management plan. They are as listed follows with their primary pollutants of concern:

ISSUE	PARAMETERS OF CONCERN	RANK	# VOTES
Septic Systems	Bacteria, nutrients	1	14
Erosion- Construction Sediment, Bank Erosion	Sediment, nutrients	2	11
Geese	Bacteria, nutrients	3	8
Lawn Chemicals	Nutrients (phosphorus), herbicides	4	7
Leaf Litter	Organic sediment, nutrients	5	1
Oiling Gravel	VOC's, PAH	5	1
Graywater Lines (direct discharge)	Nutrients, bacteria	5	1
Auto Salvage Yards	VOC's, PAH, Heavy metals	*	*
Sawmills/logging	Mercury, sediment	*	*
Bombing (from Atterbury, breaks water mains)	Sediment, bacteria	*	*

Table 1 Priority Issues

(Shaded areas denote issues to be focused on in the watershed management plan.)

1.6 Outreach Efforts

Membership for the watershed planning team and community involvement were solicited in a variety of ways. The goal of the outreach process was to promote awareness of the project to as many different sectors of the community as possible to encourage broad representation and participation. Outreach efforts included:

Articles in local newsletters, including: Cordry/Sweetwater Conservancy District, Soil & Water Conservation Districts and County Extension newsletters.

Personal contacts and invitations to "key" individuals from Steering Committee members.
Personal contacts and invitations from project coordinator.
Repeated articles in local newspapers.
Educational program delivered to participants and youth at the Earth Day event.
Conducted training for Hoosier Riverwatch volunteers.
Developed a brochure for distribution at local events.
Field Day at Camp Atterbury to demonstrate conservation projects.

Section 2. WATERSHED DESCRIPTION

Physical Description

2.1 Regional Location

The watershed is located in south/central Indiana approximately 40 miles south of Indianapolis. The watershed is a headwaters of the Driftwood River, which eventually drains to the East Fork of the White River. The Hydrologic Unit Code (HUC) for this watershed is 05120204100020.

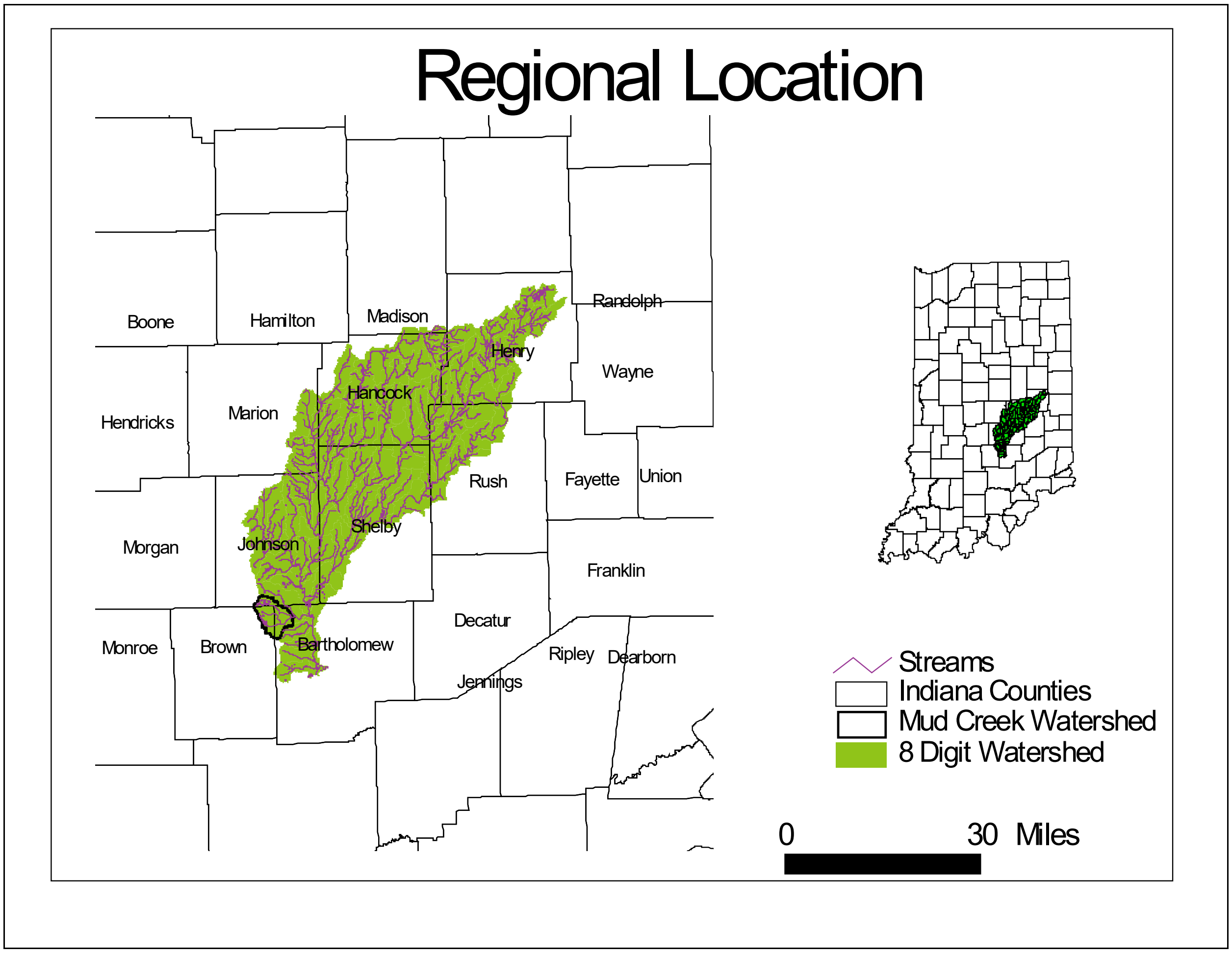

Figure 1 Regional Location Map

2.2 Watershed Location

The Mud Creek/Prince Creek watershed drains approximately 14,900 acres and encompasses portions of three counties.

*	Bartholomew-	6,431 acres	43%
*	Brown-	5,934 acres	40%
*	Johnson -	2,534 acres	17%

The watershed includes The town of Prince's Lakes, portions of the Cordry/Sweetwater Conservancy District, the eastern portion of Peoga, and a large portion of the Camp Atterbury Military Reservation.

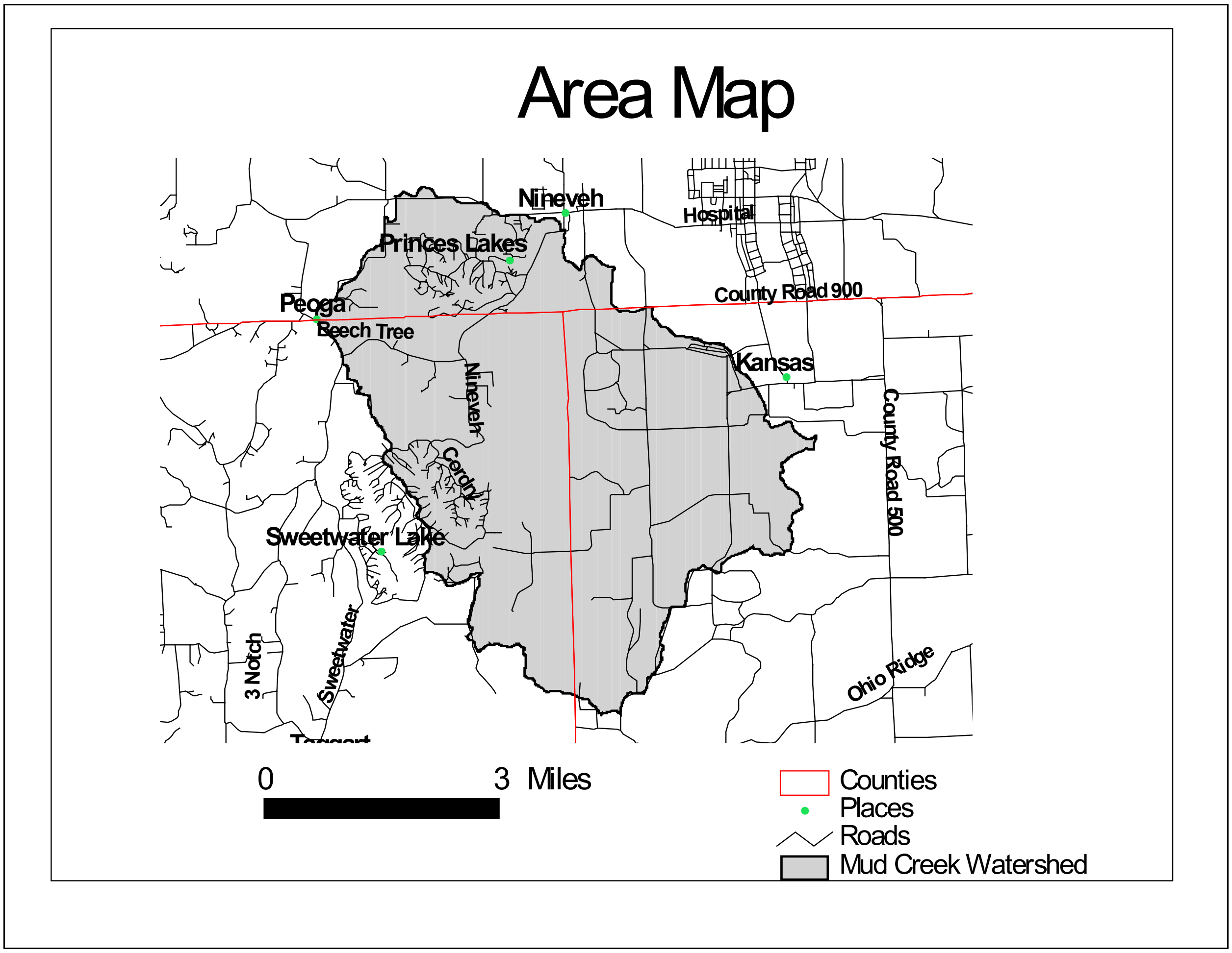

Figure 2 Watershed Location Map

2.3 Hydrology

The watershed contains approximately 15.7 miles of perennial streams, comprised of three primary arteries: Mud Creek, Saddle Creek, and Prince Creek. All are classified as first order streams with drainage areas of less than ten square miles. Mud Creek empties into Nineveh Creek, which joins with the Driftwood River, approximately 8 miles northwest of Columbus, Indiana.

The watershed also contains two primary lakes, Cordry Lake, which is approximately 154 acres in size, and East Lake, which is approximately 65 acres. The watershed contains approximately 82 smaller ponds or open water areas, totaling approximately 164 acres.

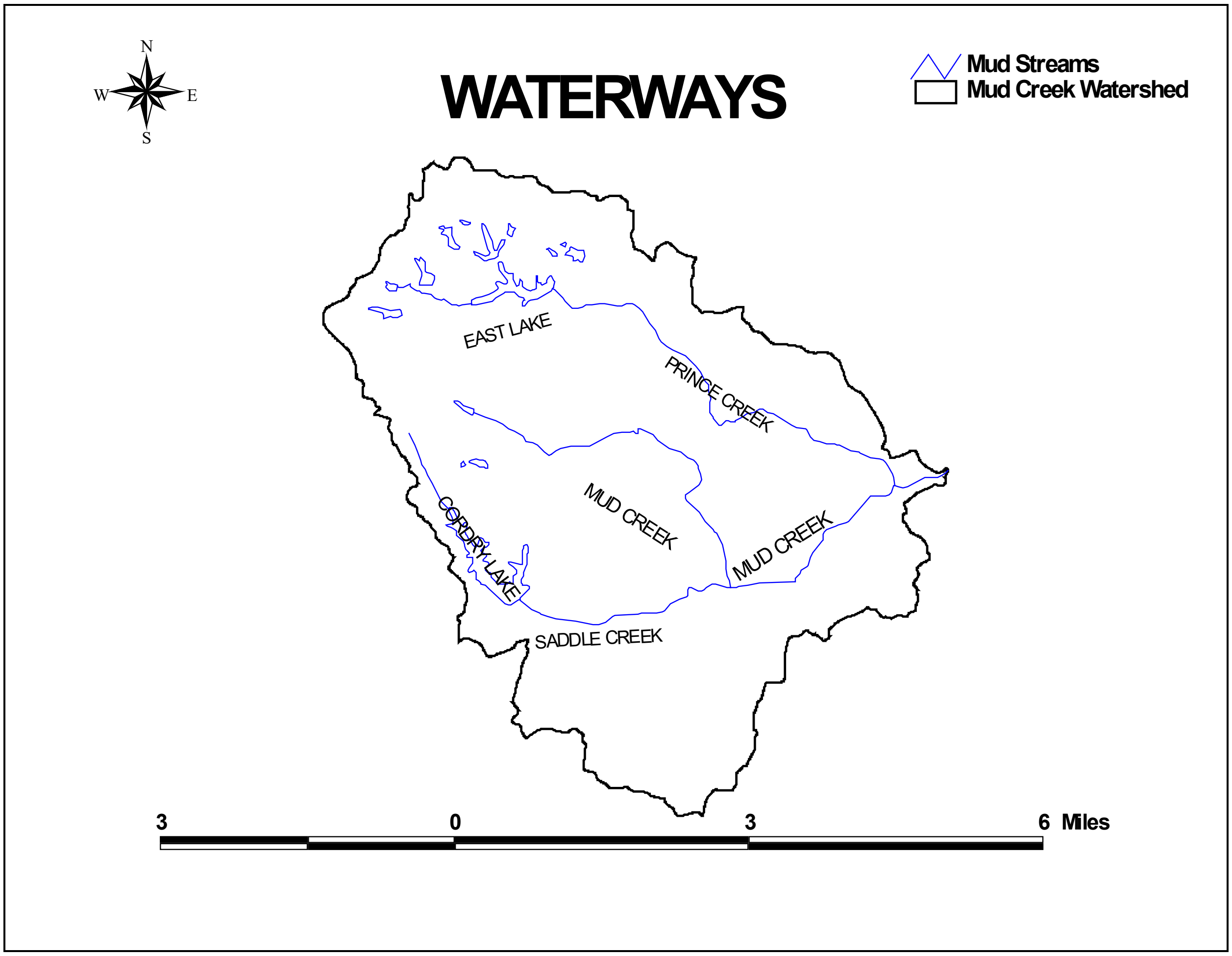

Figure 3 Map of Waterways

2.4 Physiography & Topography

The Mud Creek Watershed lies in portions of three physiographic regions (Gray, 2000) (*Figure 4*)

* The New Castle Till Plains is characterized by areas of fairly low relief with occasional terminal moraines and knolls.

* The Scottsburg Lowland is characterized by broad outwash plains and terraces that lie adjacent to rivers,

* The Norman Upland, which has westward-sloping, un-glaciated upland areas with narrow ridge tops and steep slopes.

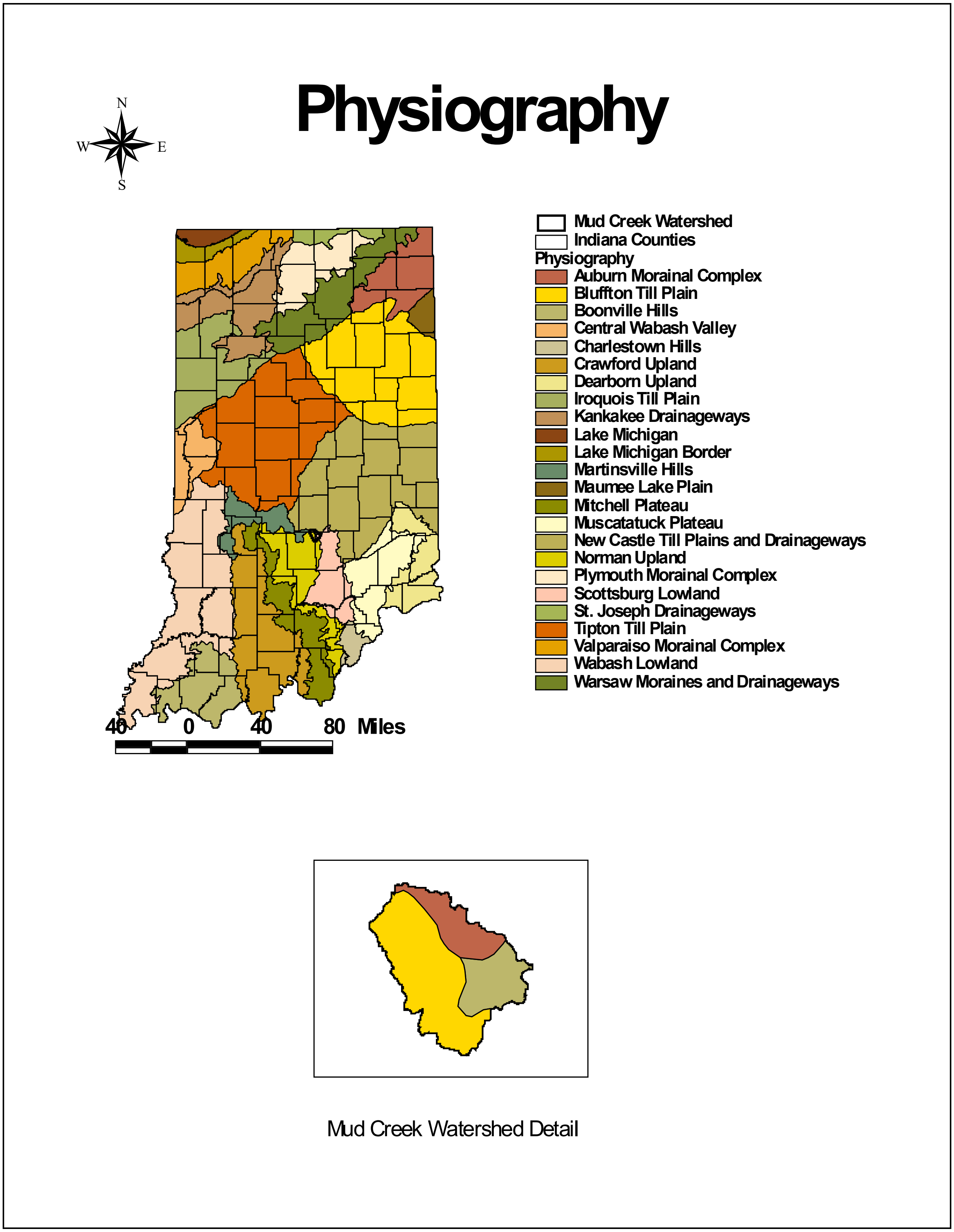

Figure 4 Physiography

The topography in the watershed transitions from areas that are very hilly with steep slopes (6-70%) to areas of broad flats with slopes ranging from 0-15% near the confluence with Nineveh Creek. Elevations above Mean Sea Level range from approximately 1,035 feet in the extreme headwaters, to approximately 672 feet near the confluence with Nineveh Creek. The following graphics depict the profiles of the major stream reaches in the watershed from the beginning to the confluence with the next larger stream. All profiles were estimated using DeLorme "X Map" topographic mapping software and are intended for reference purposes only.

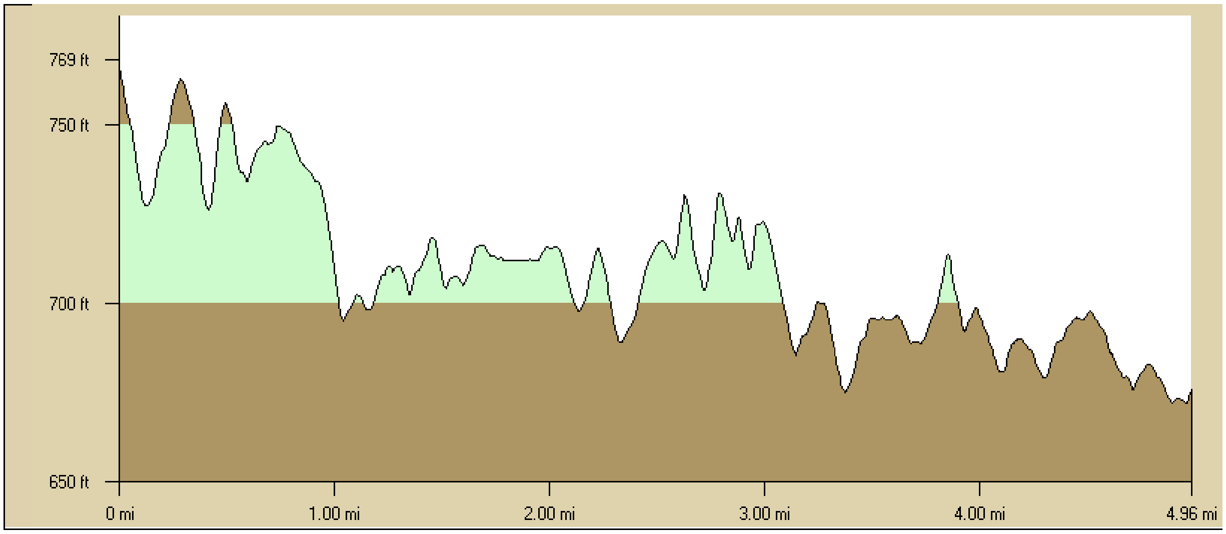

Figure 5 Prince Creek Profile
East lake outlet to Mud Creek confluence. 4.96 miles
Start Elevation: 763.7 End Elevation: 674.3
Average Grade: 3% Feet of Fall: 89.4

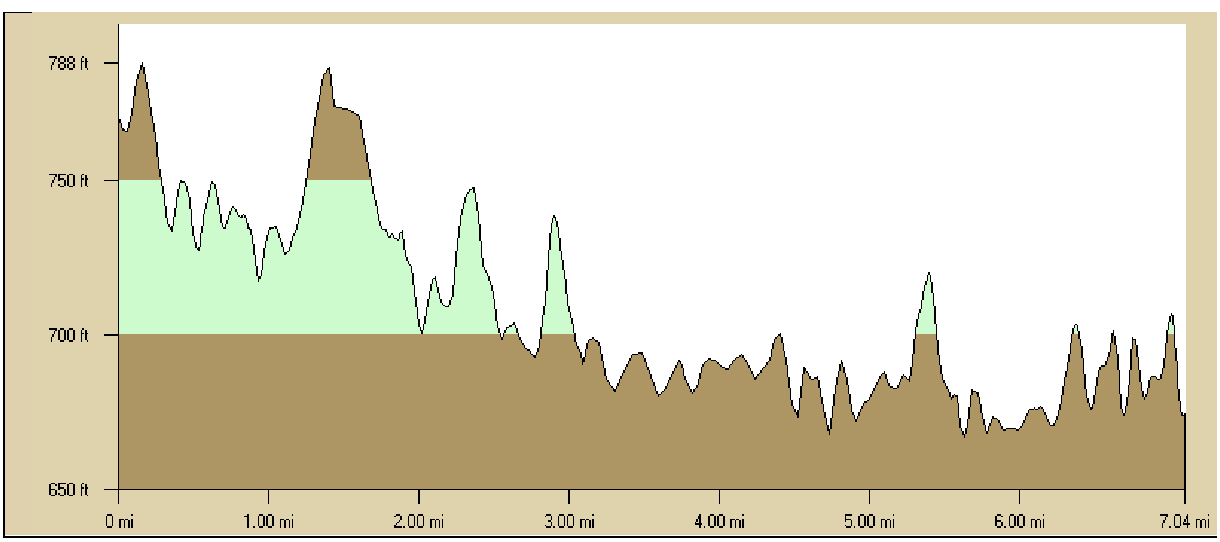

Figure 6 Mud Creek Profile

Pond outlet to Nineveh Creek confluence. 7.04 miles
Start Elevation: 766.18 End Elevation: 673.6
Average Grade: 3% Feet of Fall: 92.58

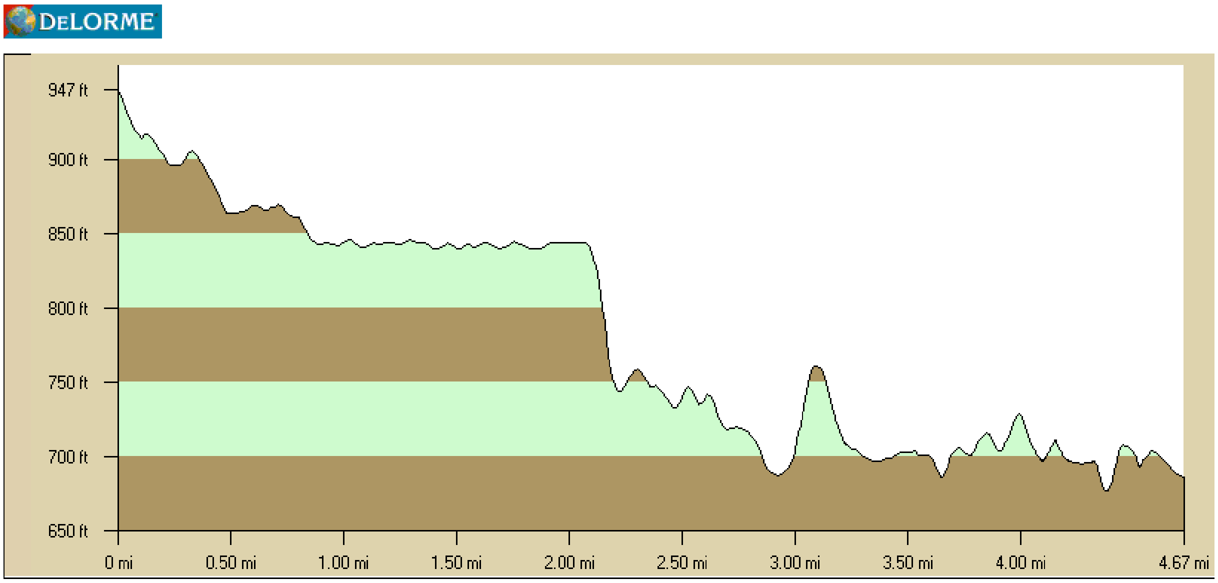

Figure 7 Saddle Creek Profile
Intermittent tributary to confluence with Mud Creek. 4.67 miles
Start Elevation: 939.2 End Elevation: 686.8
Average Grade: 3% Feet of Fall: 252.4

2.5 Groundwater & Water Supply

The Mud Creek watershed does not lie within an area of a principal aquifer. Rocks are generally poorly permeable, but may contain locally productive aquifers. *Figure 8* below depicts the statewide distribution of permeable material composing an aquifer. (USGS- National Atlas)

Potable water for area residents is provided by the Princes Lakes Water Utility for residents of Princes Lakes, and by the Cordry/Sweetwater Water Utility for residents within the Conservancy District. For residences outside of these service areas, drinking water comes from wells, ponds, or cisterns. In many areas of the Brown County portion of the watershed, water from wells is too salty or recharge rates are so slow, that surface water provides the only suitable source. (USDA- Soil Conservation Service, 1990)

The Prince's Lakes Water Department is a drinking water treatment and distribution utility permitted by IDEM (Facility #IN5241007), and serves approximately 3945 customers. Water is provided from eight wells. Princes Lakes also supplies drinking water for Camp Atterbury and to the CSCD. According to IDEM records (IDEM- Drinking Water Branch), other than a few monitoring and reporting errors, there have been no permit violations resulting from the excedence of Maximum Contaminant Levels (MCL's) for drinking water. MCLs ensure that drinking water does not pose a short-term or long-term health risk.

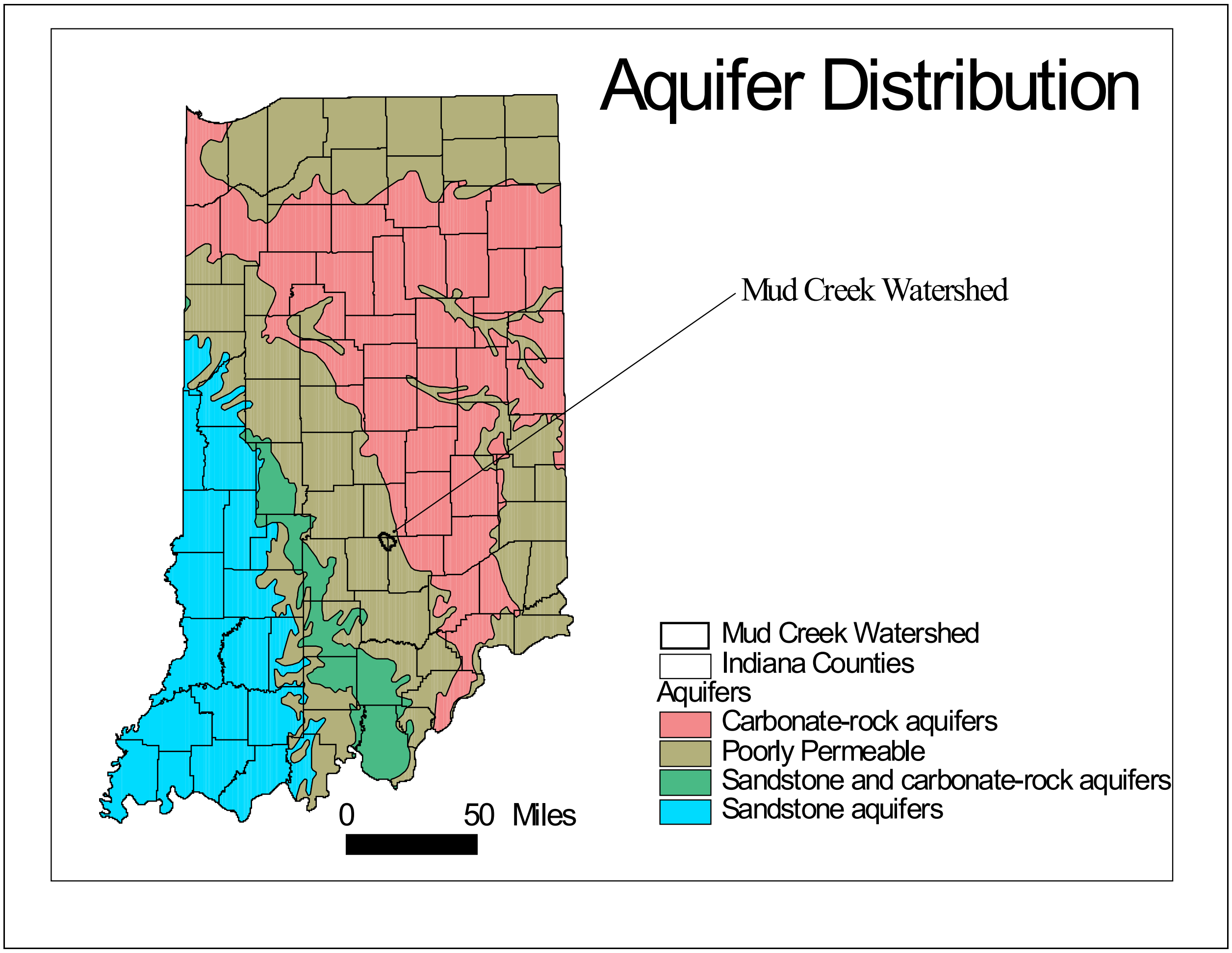

Figure 8 Map of Aquifer Distribution

2.6 Ecoregions & Climate

An ecoregion is an area with similar ecosystem functions, based on landforms, soil, vegetation, and land-use. Ecoregions are especially suited to serve as a spatial framework for environmental resource management. The Mud Creek watershed is situated in a transitional area between the Interior Plateau and the Eastern Corn Belt Plains Level 3 ecoregions.

"The Eastern Corn Belt Plains is primarily a rolling plain with local end moraines; it had more natural tree cover and has lighter colored soils than the Central Corn Belt Plains. The region has loamier and better drained soils than the Huron/Erie Lake Plain, and richer soils than the Erie/Ontario Hills and Lake Plain. Glacial deposits of Wisconsin age are extensive. They are not as dissected nor as leached as the pre-Wisconsin till which is restricted to the southern part of the region. Originally, beech forests were common on Wisconsin soils while beech forests and elm-ash swamp forests dominated the wetter pre-Wisconsin soils. Today, extensive corn, soybean, and livestock production occurs and has affected stream chemistry and turbidity.

The Interior Plateau is a diverse ecoregion extending from southern Indiana and Ohio to northern Alabama. Rock types are distinctly different from the coastal plain sands and alluvial deposits to the west, and elevations are lower than the Appalachian ecoregions to the east. Mississippian to Ordovician-age limestone, chert, sandstone, siltstone and shale compose the landforms of open hills, irregular plains, and tablelands. The natural vegetation is primarily oak-hickory forest, with some areas of bluestem prairie and cedar glades. The region has a diverse fish fauna." (USEPA- Ecoregion Descriptions)

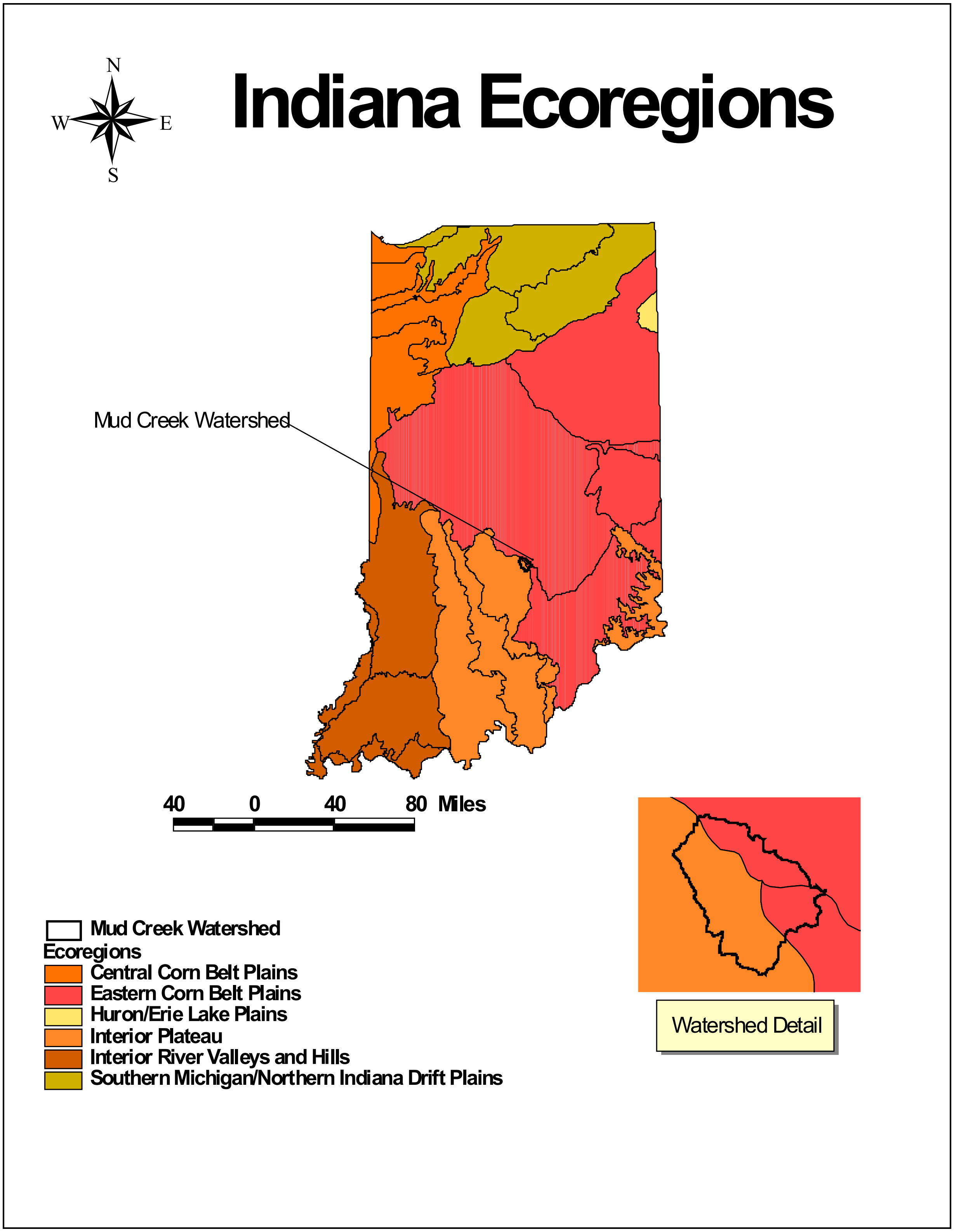

Figure 9 Map of Indiana Ecoregions

The watershed area has a continental climate, characterized by distinct summer and winter seasons with large annual temperature variations. Mean monthly temperatures at Columbus, Indiana (approx. 10 miles to the southeast of the watershed area) range from approximately 27°F in January to about 75°F in July. Mean annual precipitation is approximately 44 inches. (Risch, 2000)

The following table depicts monthly recorded averages for temperature and precipitation. The information is based on a minimum of 30 years of National Weather Service recorded data for Columbus, Indiana. (www.weather.com)

Month	Mean (°F)	Avg. Precip (in.)	Avg. High (°F)	Avg. Low (°F)	Record High (°F)	Record Low (°F)
Jan	28	2.66	37	19	77	-27
Feb	32	2.63	42	22	78	-17
Mar	42	3.66	53	31	89	-7
Apr	53	4.36	64	41	93	16
May	63	4.63	74	52	98	27
Jun	72	3.46	83	61	108	35
Jul	76	4.02	86	65	111	42
Aug	74	3.75	85	63	106	40
Sep	67	3.06	79	55	103	25
Oct	55	2.78	67	42	97	13
Nov	44	3.77	54	34	86	-2
Dec	33	3.16	42	25	73	-20

Table 2 Temperature & Precipitation (Monthly Averages)

2.7 Geology & Soils

The watershed area lies in a Mississippian age area of Bedrock known as the Borden Group, which is typified by siltstone and limestone. The surficial geology is predominantly siltstone and shale in the western portion of the watershed, with more loamy materials dominating the eastern areas, with some presence of alluvium near the confluence with Nineveh Creek. (Gray, 1989) The geographic area of the watershed is located at the southern boundary of the Wisconsin Age (latest) glacial ice sheet.

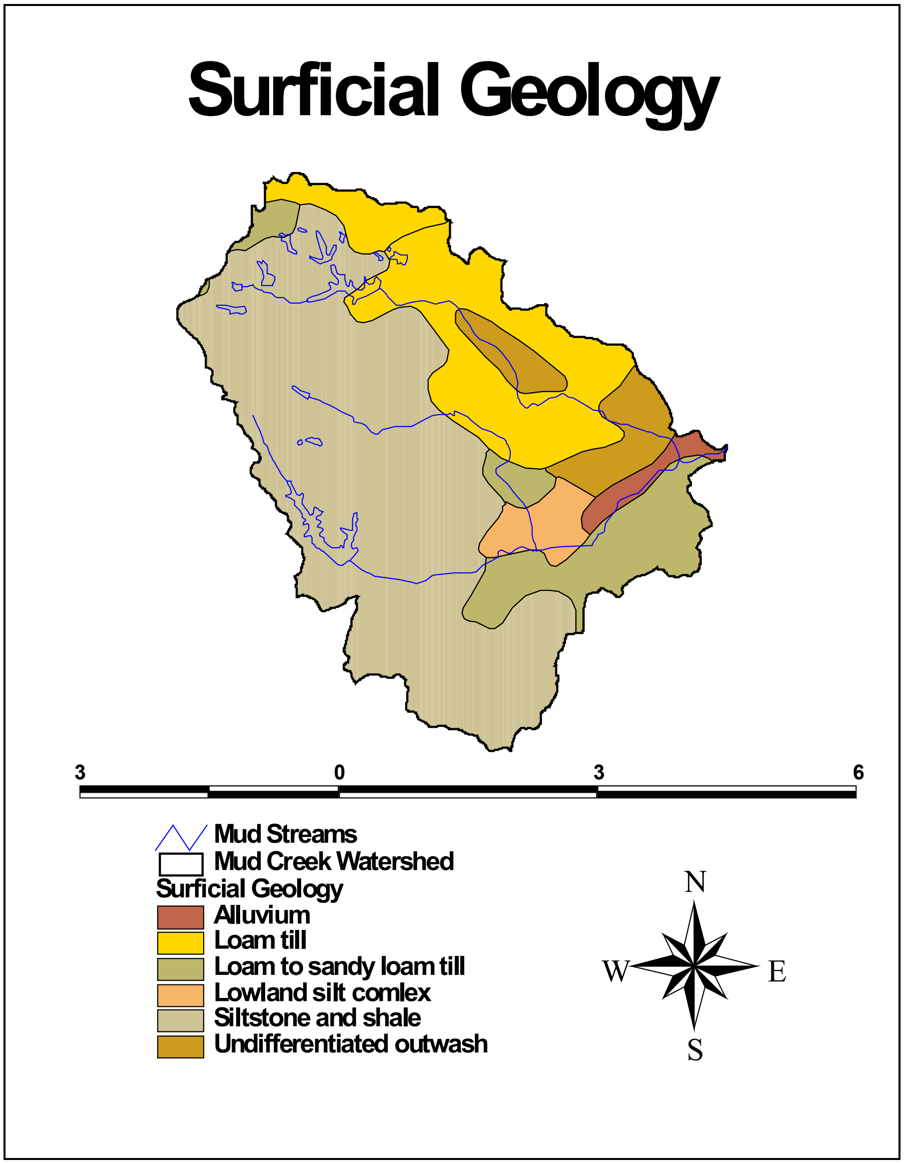

Figure 10 Surficial Geology

There are three major soil associations within the Brown & Bartholomew County portions of the Mud Creek Watershed. (USDA- Soil Conservation Service, 1990) A soil association is a broad scale representation of a distinctive pattern of soils, relief, and drainage features. Typically, an association consists of one or more major soils, and some minor soils. An association is named for the major soils.

The Berks-Wellston-Trevlac association dominates the western portion of the watershed and includes all portions in Brown County. This association is typified by moderately deep and deep, moderately well sloping to very steep, well drained soils formed in loess and in material weathered from shale, siltstone, and sandstone; on uplands. This association is used mainly for woodland. A few small areas on broad ridge-tops are used for cultivated crops, hay, or pasture. The major soils are considered poorly suited for cultivated crops, pasture, hay, urban uses, and recreational uses. The slope, hazard of erosion, and depth to bedrock are the main management concerns. The major soils are rated as 'Severe" for use as sanitary facilities, including septic tanks, lagoons, and landfills.

The Pekin-Chetwynd-Bartle association comprises much of the watershed in Camp Atterbury, from approximately the Brown/Bartholomew line, to the confluence with Nineveh Creek. This association is characterized by deep, nearly level to very steep, somewhat poorly drained to well drained soils formed in silty and loamy deposits; on terraces. Slopes range from 0-50 percent. The major soils are rated as 'Severe" for use as sanitary facilities, including septic tanks, trenches, and landfills. This association is used mainly for woodland. A few small areas on broad ridge-tops are used for cultivated crops, hay, or pasture. The major soils are considered fairly well suited for pasture and hay, and extensive recreational uses, and poorly suited for cultivated crops, urban uses, and intensive recreation uses. The slope and hazard of erosion are the main management concerns.

The Crosby-Miami-Rensselaer association comprises a small percentage of the northeast portion of the watershed, in Bartholomew and Johnson counties. This association consists of deep, nearly level to strongly sloping, somewhat poorly drained, well drained, and very poorly drained soils formed in loess and the underlying loamy glacial till, in glacial till, and in stratified loamy sediments, on uplands and terraces. Slopes range from 0-15 percent. Most areas of this association in the watershed are used as sites for military training and are idle. A few small areas are used for hay or pasture. The major soils are well suited for cultivated crops and to hay and pasture, fairly well suited for woodland and recreational uses, and poorly suited for urban uses. Wetness and restricted permeability are the main limitations. The major soils are rated as 'Severe" for use as sanitary facilities, including septic tanks, lagoons, and landfills.

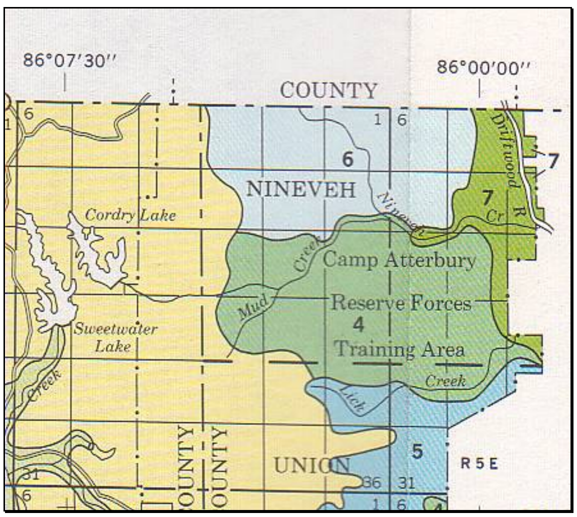

Figure 11 Soil Associations

More recent soils information from the USDA-NRCS State Soil Geographic Database (STATSGO), which includes Johnson County, indicates the presence of five soil associations within the watershed boundary.

The STATSGO data base was designed primarily for regional, multi-state, river basin, State, and multi-county resource planning, management, and monitoring. Soil maps for STATSGO are compiled by generalizing more detailed (SSURGO) soil survey maps. Where more detailed soil survey maps are not available, data on geology, topography, vegetation, and climate are assembled, together with Land Remote Sensing Satellite (LANDSAT) images. Soils of like areas are studied, and the probable classification and extent of the soils are determined.

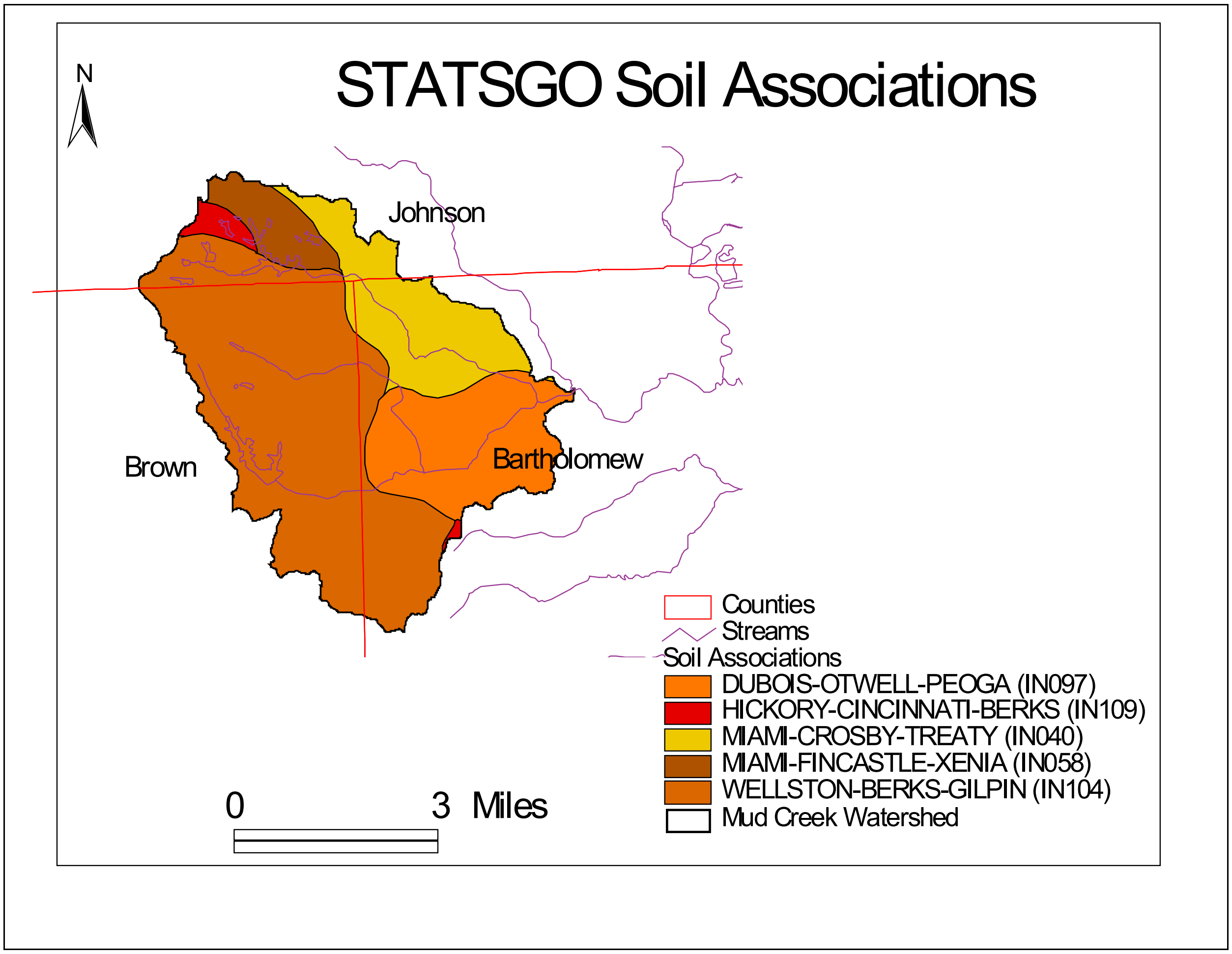

Figure 12 STATSGO Soil Associations

2.8 Wetlands

The current federal (33 CFR Part 328.3 b) and state (IC 13-18) definition of wetlands are: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas."

The US Fish & Wildlife Service National Wetland Inventory (NWI) maps provide a basic framework for the location, extent, and characteristics of wetlands. The maps are based on the USGS topographic quad maps and are compiled by collaborating other existing data from aerial photographs, soil mapping, and remote sensing. Wetland areas are classified according to their geomorphology, predominant vegetation type and hydrologic regime. Based on this information, the Mud Creek watershed contains the following distribution of wetlands:

TYPE	SYMBOL	COUNT	ACRES
Palustrine Emergent	PEM	8	5.1
Palustrine Forested	PFO	27	282.3
Palustrine Scrub-Shrub	PSS	6	76.2
Palustrine Unconsolidated Bottom (Open Water)	PUB	82	164.7
Lacustrine Unconsolidated Bottom (Lake)	L1UB	2	218

Table 3 Wetland Distribution

Nearly all of the wetlands appear to be associated with streams or are the result of pond construction via excavation and/or damming small drainageways.

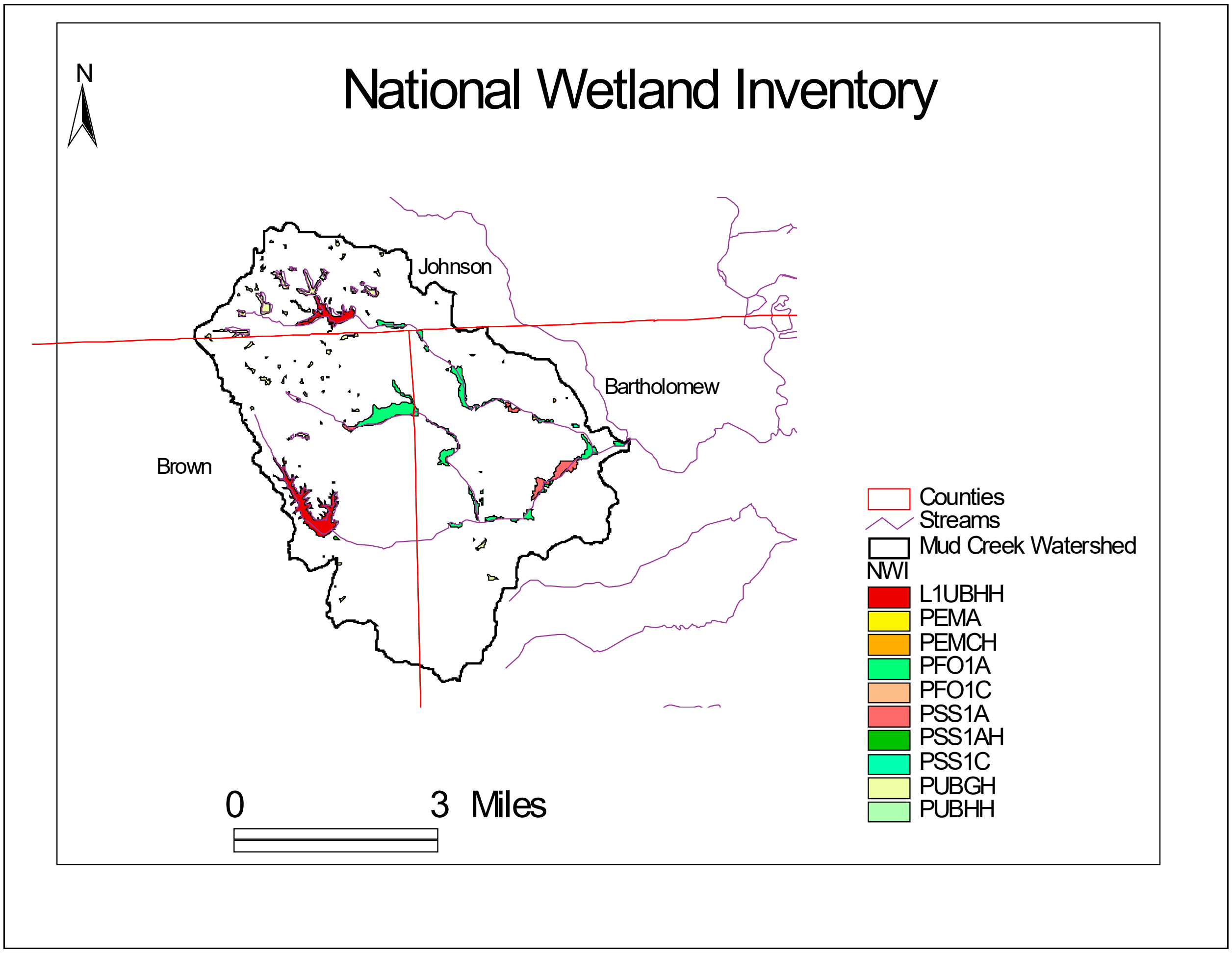

Figure 13 Wetland Distribution Map

2.9 Threatened/Endangered Species

Several endangered, threatened, or rare species, high quality natural communities, and natural resources are documented within the watershed. The following table of information from the Indiana Natural Heritage Data Center was provided by the Indiana Department of Natural Resources Division of Nature Preserves.

TYPE	SPECIES NAME	COMMON NAME	STATE	FED	LOCATION	DATE
Bird	Ammodramus henslowii	Henslow's Sparrow	SE	**	T10NR04E 03 SWQ SWQ NEQ & SEQ SWQ NEQ &SEQ	1997
Fish	Fundulus catenatus	Northern Studfish	SSC	**	T10NR04E 03 SWQ	1990
Forest	Forest-Upland Dry-Mesic	Dry-Mesic Upland Forest	SG	**	T10NR04E 27 SWQ	1990

Forest	Forest upland-Mesic	Mesic Uplanld Forest	SG	**	T10NR04E 27 SWQ	1990
Mammal	Myotis sodalis	Indiana Bat or Social Myotis	SE	LE	T10NR04E 15 NEQ SEQ SEQ	1997
Mammal	Myotis sodalis	Indiana Bat or Social Myotis	SE	LE	T10NR04E 15 NEQ SEQ SWQ	1997
Mammal	Taxidea taxus	American Badger	SE	**	T10NR04E 12	1985
Vascular Plant	Onethera perennis	Small Sundrops	ST	**		2001
Vascular Plant	Panax quinquefolius	American Ginseng	**	**	T10NR04E 27 SWQ	1993
Vascular Plant	Sparganium androcladum	Branching Bur-Reed	ST	**	T10NR04E 22 NEQ NEQ	1993
Vascular Plant	Spiranthes ochroleuca	Yellow Nodding Ladies-Tresses	ST	**	T10NR04E 15 NEQ	1993
Vascular Plant	Spiranthes ochroleuca	Yellow Nodding Ladies-Tresses	ST	**		2001
Vascular Plant	Spiranthes ochroleuca	Yellow Nodding Ladies-Tresses	ST	**		2001
Vascular Plant	Spiranthes ochroleuca	Yellow Nodding Ladies-Tresses	ST	**		2001
Vascular Plant	Spiranthes ochroleuca	Yellow Nodding Ladies-Tresses	ST	**		2001
	STATE:	SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC=special concern, WL=watch list, SG=significant, **=no status but rarity warrants concern				
	FEDERAL:	LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, ESA=appearance similar to LE species, **=not listed				

Table 4 Threatened/Endangered Species

Most of the listed species and communities are located on US Army property at Camp Atterbury. The large number of listed species encountered in the area may simply be the result of increased survey, sampling, and inventory work conducted on federal property.

2.10 Cultural Resources

There are no historically/culturally significant areas listed on either the *National Register of Historic Places* or the *Indiana Register of Historic Sites & Structures* located within the Mud Creek watershed area.

Two cemeteries are located in the watershed. Mt. Moriah and Anderson cemeteries are located on Camp Atterbury property approximately one mile east of Cordry Lake dam.

2.11 Natural History

In the early 1800's, the area of the watershed was rich in exotic wildlife, including bears, panthers, and wolves. The county provided a bounty for these "nuisance" animals, leading to their subsequent eradication from the area. Various hardwoods, including oak, walnut, hickory, and cherry, covered the ridges and were harvested for timber. A substantial amount of gold, quartz, and jasper was discovered and mined in the area. (Ball State University, 1998)

The Mud Creek Watershed area is situated in the northern extent of the Brown County Hills unit of the Highland Rim Natural Region. The Highland Rim Natural Region is a large, mostly forested landscape extending from the Ohio River northward to approximately the Wisconsinan glacial maximum. The Rim is a rugged, botanically rich portion of the state defined by its distinctive un-glaciated topography shaped by exposed bedrock. (Jackson. 1997)

The Brown County Hills section is typified by its shale, siltstone, and sandstone bedrock that have eroded over the ages to form a complex of steep, V-shaped valleys and ravines which separate prominent ridges. Approximately one half of the region was glaciated early in the Pleisocene, but the later Wisconsin age ice sheets occurred only along the northern fringe of Brown County Hills. Natural waterbodies and wetland were scarce in the Brown County Hills, and were limited to creeks and small intermittent streams. On the crests of several ridges in Brown County , a few small depressional wetlands or ephemeral ponds occur, often referred to by local residents as "bear wallows". (Jackson, 1997)

Spiranthes ochroleuca - yellow nodding ladies'-tresses
Jim Stasz @ USDA-NRCS PLANTS Database

The Brown County Hills are characterized by a diverse mix of natural vegetation. Black Walnut, wild cherry, and sycamore occur along stream-sides. Adjacent lower slopes and sheltered north-facing slopes harbor a mesic forest and understory community. On drier, sunny slopes, white, black, and chestnut oak and shagbark hickory dominate. Vegetation is heavily influenced by topography, slope and aspect. Few rare or unusual plant communities exist within the oak-hickory forests, but species of interest include small stands of eastern hemlock, flowering raspberry, trailing arbutus, whorled pogonia, and green adders mouth orchid. The nodding yellow ladies-tresses orchid is restricted in Indiana only to the Brown County Hills area. Several rare animal species exist in the Brown County area, including the Timber Rattlesnake, once found throughout the state, is now listed as a state endangered species. Forest interior birds, including, the wood thrush, ovenbird, worm-eating warbler, Kentucky warbler, black & white warbler, and Acadian flycatcher occupy some of the last unbroken forest areas in Indiana. Owing to the large portion of publicly owned forestlands, the Brown County Hills presently retain more of the unbroken natural character of the original pre-settlement landscape than any other natural region in the state, and will continue to provide a glimpse of Indiana's original wilderness for generations to come. (Jackson, 1997)

Land Use

2.12 History

Brown County was established in 1836. It was once part of Bartholomew, Monroe, and Jackson Counties. It was named after Major General Jacob Brown, a soldier in the War of 1812. The first permanent settlers arrived in Brown County around 1820. Nashville, the County seat, was founded in 1836. (USDA- Soil Conservation Service, 1990)

In southern Johnson County, early settlers from northern Kentucky settled along the two rivers in Blue River Township for the abundance of timber and rich soil. In 1820, John Campbell became the first settler in the area near present day Edinburgh. In 1821, Amos Durin settled west of Sugar Creek near what is now Nineveh. (Johnson County Interim Report, 1985)

Hamblen Township, in which Cordry/Sweetwater is located, was the first part of Brown County to be settled. The first water mill in Brown County was established on Salt Creek in 1827, which gave rise to recreational activities, such as log-rolling contests and barn raising through the turn of the century.

In 1942, Camp Atterbury was established as a training area for the United States Army on an approximately 40,320 acre parcel, near Edinburgh, Indiana. The installation was a troop-training, military hospital, and prisoner-of-war facility during World War II. In 1968 and 1969, approximately 7,000 acres of the property was sold and the remaining property was re-designated as Atterbury Reserve Forces Training Area, under the control of the Indiana Army National Guard. (Risch, 2004)

In 1948, Mr. Howard Prince began plans for the development of a large lake in Sweetwater Valley. (Ball State University, 1998) Promoted by the Brown County Lakes Development Corporation as a recreation and resort housing area, construction on Cordry and Sweetwater dams was started in 1950. Due to financial problems, the construction was delayed until the dams were finally completed in the mid-late 1960's. The Cordry/Sweetwater Conservancy District was established in June 1959, by the Brown County Circuit Court under the Indiana Conservancy Act. The stated purposes of the district were to be:

* To provide water supply, including treatment and distribution, for domestic, industrial, and public use.
* To provide for the collection, treatment, and disposal of sewage and other liquid wastes produced within the district.
* To develop forests, wildlife areas, and park and recreational facilities, where feasible, in connection with beneficial water management.

2.13 Demographics

There are portions of ten US Census Block Groups contained within the geographic area of the Mud Creek Watershed. (*Figure 14*) Some interesting statistics from the 2000 Census for this set of block groups are:

Total Population- 13,807
Percent with High School Degree- 43%
Percent with Bachelors Degree- 5.5%
Percent Below Poverty Level- 18%

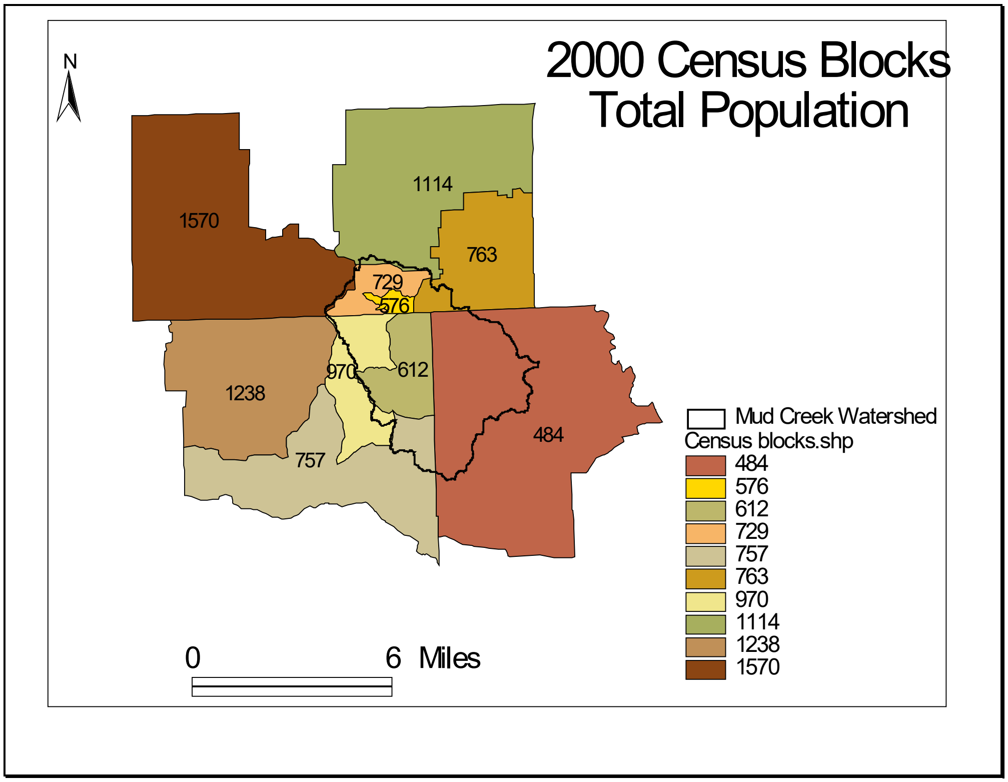

Figure 14 Census Block Total Population

Population trend data from the Indiana Business Research Center, by county, shows a similar slow growth pattern in each county (IBRC), until about 1950, when populations began to rise dramatically. (*Figure 15*) Population growth in Johnson County has recently far outpaced the others.

County	1950 Pop.	2000 Pop.	2035 (Projected)
Bartholomew	36,108	71,435	76,129
Brown	6,209	14,957	16,051
Johnson	26,183	115,209	166,518

Table 5 Population Trends

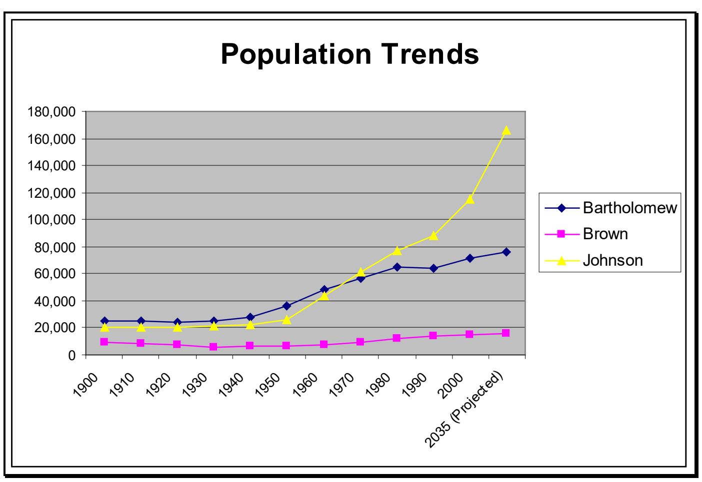

Figure 15 Population Trends

2.14 Land Ownership

There are three principal land holdings within the Mud Creek Watershed, Camp Atterbury, the Cordry/Sweetwater Conservancy District, and the Town of Prince's Lakes.

Camps Atterbury is a US military installation who's mission is to support individual and unit training of the National Guard, as well as active and reserve forces. Camp Atterbury occupies approximately 33,760 acres, of which, approximately 9,693 acres is located within the Mud Creek Watershed, a comprising approximately 65% of the watershed.

The Cordry/Sweetwater Conservancy District was established in 1959 and includes approximately 2,300 acres, of which, approximately half are located within the Mud Creek Watershed. Cordry Lake is the primary waterbody of the Conservancy District located within the Mud Creek Watershed. The Conservancy District is governed by a board of locally elected officials, which oversees District operations and services.

The Town of Prince's Lakes covers approximately 1.3 square miles, all of which is located in the Mud Creek Watershed.

2.15 GAP Landuse Data

The National Gap Analysis Project (GAP) is a joint venture between the US Geological Survey- Biological Resources Division and the US Fish & Wildlife Service to identify and quantify the extent and location of habitat and land-use in order to identify priority areas for conservation. (USGS, 2002)

The Indiana Gap Analysis Project began in October, 1994 and has now completed the development of a geographic information system with layers for the state's land cover, vertebrate species, and land management information. The land cover map for Indiana was developed at the Center for Remote Sensing and Geographic Information Systems in conjunction with the Department of Geography, Geology, and Anthropology at Indiana State University using a minimum of two dates of Landsat digital Thematic Mapper (TM) data per scene, with triple date coverage for over sixty percent of the state. A total of seventeen land cover classes have been distinguished. (ISU, 1999)
Figure 16 below depicts the GAP land cover distribution for the Mud Creek Watershed and Table 6 summarizes land cover occurrences.

Land-Cover	GAP Code	Description	Number	Acres
Developed- Other	2	Strip-mines, Some developed/urban areas, Some bare agricultural fields, Transportation (roads and airports)	2	8.1
Urban- High Density	3	Industrial, Commercial, Mixed urban/built-up	3	12.5
Urban- Low Density	4	Residential, Mixed urban/built-up	22	196
Ag- Wet	5	Row crop fields with standing water during at least 1 image date, NWI classified lands in agricultural areas	7	34
Ag- Row Crop	6	Corn fields, Soybean fields, Other crops, Unplanted/bare agricultural fields at time of imagery	84	662
Ag- Pasture, Grassland	7	Pasture, CRP lands, Recently abandoned agricultural old fields, Golf courses, Mowed recreational areas, Revegetated strip-mines, natural grasslands- prairie remnants	82	818
Deciduous Woodland	9	Late-immature old fields, successional woods (sassafras, oaks, cherry, poplar, etc...)	34	322

Deciduous Forest	10	Closed canopy mixed hardwood successional forest (sassafras, oaks, cherry, tulip poplar, etc...)	28	12,055
Evergreen Forest	11	Planted pine stands	13	66.7
Forested Wetland	13	Floodplain forest, Swamp Forest, Deciduous forest bog	22	374
Shrub Wetland	15	River bar complex, Swamp/bog series	8	26
Water	18	Lakes, ponds, rivers, streams	18	322.5

Table 6 GAP Landuse

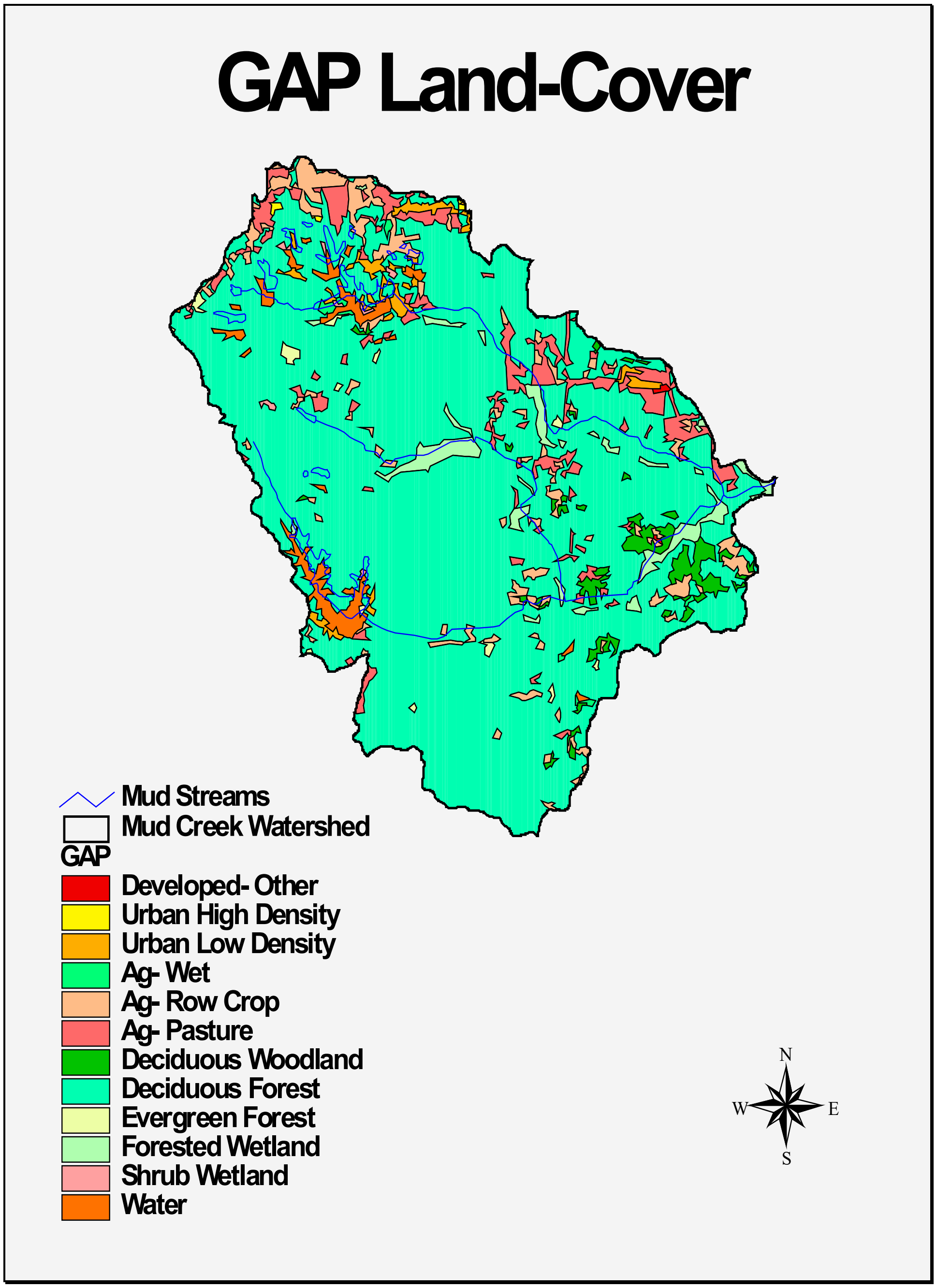

Figure 16 GAP Landuse Distribution

2.16 Recreation

Recreational use in the Mud Creek watershed is centered primarily on lakes use. Boating, fishing, swimming, dominate recreational uses on Cordry Lake and Prince's Lakes. Area residents are mostly concerned with maintaining and/or improving the quality of water to ensure continued recreational uses of the lakes.

Other recreational uses include hunting, fishing, wildlife viewing, hiking, horseback riding, and numerous other outdoor activities at the Johnson County Park and the Indiana Department of Natural Resources controlled portion of Camp Atterbury. Although this area does not lie within the boundaries of the Mud Creek watershed, the recreational property is adjacent.

2.17 Urban/Residential

The town of Prince's Lakes is the only urban center located in the watershed, although Camp Atterbury operates as a quasi-town with it's own governing structure. Prince's Lakes is predominantly a residential community with a handful of commercial facilities located along Nineveh Road, which include real estate offices, liquor store, pizzeria, and barber shop. There are no industrial or institutional facilities located within the watershed.

Residential development is centered around Cordry Lake and Princes Lakes, with scattered dwellings located in un-incorporated areas of Johnson and Brown Counties along Nineveh Road. Camp Atterbury provides quarters for its permanent staff and rotational troops. Princes Lakes and Camp Atterbury utilize municipal sewer systems, while all other residential dwellings rely on on-site septic systems.

2.18 Agriculture

There is little agricultural production in the watershed, due to steep, forested areas within Brown County and the large percentage of acreage contained within US Army property. The few tillable acres that area in production are located in the extreme northern portion of the watershed in Johnson County, where the topography is flatter. According to estimates from aerial photography, approximately 300-400 acres of agricultural lands exist along the south side of County Road 750 South, in Johnson County.

2.18.1 Tillage Systems

According to observations noted during a field reconnaissance conducted in May of 2005, tillage in planted areas was dominated by conventional tilled corn. No fields using no-till or reduced/minimum till were observed during the inspection. The crops planted were nearly all corn, with the remaining agricultural fields enrolled in pasture/hay.

Figure 17 Agricultural Photo

2.18.2 Existing Conservation Practices

No "on-the-land" conservation practices were observed during the field inspection.

2.18.3 Livestock Operations

There does not appear to be any significant production of livestock occurring in the watershed area. No large scale production facilities were noted during the field inspection, and there are no permitted Confined Animal Feeding Operations (CAFO) located in the watershed, according to IDEM records (IDEM- CAFO Permits). A few grazing cattle were observed and a few homesteads appear to raises horses.

Section 3. WATER QUALITY BENCHMARKS

3.1 IDEM 305(b) Water Quality Report

Section 305(b) of the federal Water Pollution Control Act (the Clean Water Act most recently amended in 1987) requires states to prepare and submit to the U.S. Environmental Protection Agency (U.S. EPA) a water quality assessment report of state water resources every two years. The Indiana Department of Environmental Management (IDEM), Office of Water Quality (OWQ) has prepared the 2004 Indiana Integrated Water Quality Report following the guidelines provided by U.S. EPA (1997a and 2004) and U.S. EPA Region 5 (2004). This report is intended to meet the reporting requirements of Sections 106, 303(d), 305(b), 314, and 319 of the Clean Water Act.

Designated Uses

The Indiana Department of Environmental Management, within the framework of the state's water quality monitoring strategy, monitors and assesses Indiana's surface waters to ensure they meet the state water quality standards for designated uses. The water quality standards are designed to ensure that all waters of the state, unless specifically exempted, are safe for full body contact recreation and are protective of aquatic life, wildlife, and human health.

Water Quality Assessment Methodology
Use Support/Impairment status is determined for each stream waterbody using the assessment guidelines provided in the U.S. EPA documents Guidelines for Preparation of the State Water Quality Assessments (305[b] Reports) and Electronic Updates: Report Contents. Washington, DC: U. S. Environmental Protection Agency. (EPA-841-B-97-002A.) and Guidance for 2004 Assessment, Listing, and Reporting Requirements Pursuant to Sections 303(d) and 305(b) of the Clean Water Act, July 21, 2003, Watershed Branch, U. S. Environmental Protection Agency. Available results from six monitoring result types listed below are integrated to provide an assessment for each stream waterbody for 305(b) reporting and 303(d) listing purposes.*

- Physical/chemical water results;
- Fish community assessment;
- Benthic aquatic macroinvertebrate community assessments;
- Fish tissue and surficial aquatic sediment contaminant results,
- Habitat evaluation; and
- *E. coli* monitoring results.

The following table is an excerpt that illustrates the basin-wide assessment of Aquatic Life Use. This basin includes the Driftwood River (highlighted), of which, the Mud Creek-Prince Creek watershed is a subset.

APPENDIX C: COMPREHENSIVE BASIN AQUATIC LIFE USE ASSESSMENTS

Attainment Results Calculated Using the Probabilistic Monitoring Design

BASIN ASSESSED	TARGET POP.1	BASIN SIZE (MILES)	DESIGNATED USE ASSESSED	YEAR ASSESSED	DATA USED IN ASSESSMENT		% ATTAINING	% NOT ATTAINING	CONFIDENCE LEVEL (%)	CONFIDENCE INTERVAL (%)
WHITE RIVER, EAST FORK BASIN	05120204 05120205 05120206 05120207 05120208	4856	Aquatic Life Use	1999	Biological		80%	20%	95%	14%

Table 7 Aquatic Life Use Assessment (Indiana 305b Report)

According to the Site Specific Waterbody Assessments of the 305(b) report, the Mud Creek-Prince Creek is listed as Fully Supportive of Aquatic Life Use. The parameters of Fish Consumption Use and Primary Contact (recreational use) were not assessed.

3.2 IDEM 303(d) Impaired Waters List

Section 303(d) of the 1972 Federal Clean Water Act (CWA) requires each state to identify those waters that do not meet the state's water quality standards for designated uses. For these impaired waters, states are required to establish total maximum daily loads (TMDLs) to meet the state water quality standards.

According to the Final 2004 303(d) List of Impaired Waterbodies, published by IDEM, no stream segments in the Mud Creek watershed are listed as "impaired". Mud Creek-Prince Creek segment is listed as a "Category 2", which means:

"Attaining some of the designated uses; no use is threatened; and insufficient or no data and information are available to determine if the remaining uses are attained or threatened. Waterbodies should be listed in this category if there are data and information which meet the requirements of the state's assessment and listing methodology to support a determination that some, but not all, designated uses are attained and none are threatened."

3.3 Watershed Restoration Action Strategy

The Driftwood River Watershed Restoration Action Strategy, (WRAS) developed by IDEM in May of 2001, is intended to serve as a reference point and a map to assist local citizens with improving water quality. The WRAS accumulates existing water quality information and uses it to formulate priority issues and recommended management strategies, based on the 8-digit HUC level, in this case, the Driftwood River watershed.

As a primary source of water quality information used to develop strategies in the WRAS, the Unified Watershed Assessment (UWA) combines water quality data layers that are ranked and scored. The following table represents the UWA scores for each parameter in the Driftwood River Watershed. The parameters are listed according to the 11-digit HUC's contained within the Driftwood River watershed. The highlighted HUC is the 11-digit watershed that contains the Mud Creek watershed.

Hydrologic Unit Scores for Each Parameter Used in the UWA (2000-2001)															
11 Digit HUC	Mussel Diversity & Occurrence	Aquatic Life Use Support	Recreational Use Attainment	Stream Fishery	Lake Fishery	Eurasion Milfoil Infestation Status	Lake Trophic Status	Critical Biodiversity Resource	Aquifer Vulnerability	Population Using Surface water for Drinking	Residential Septic System Density	Degree of Urbanization	Density of Livestock	% Cropland	Mineral Extraction Activities
05120204010	nd	3	3	3	1	nd	1	3	4	2	4	2	2	4	2
05120204020	1	3	nd	3	nd	nd	nd	2	4	2	3	2	3	5	3
05120204030	3	1	4	2	nd	nd	nd	4	4	2	2	2	3	5	3
05120204040	4	1	1	2	nd	nd	nd	4	3	2	4	2	3	5	3
05120204050	1	4	1	2	nd	nd	nd	2	2	2	3	2	3	4	3
05120204060	5	1	5	4	nd	nd	nd	4	4	2	4	2	3	5	3
05120204070	2	1	5	1	nd	nd	nd	2	4	2	5	2	2	2	2
05120204080	5	1	5	2	nd	nd	nd	4	3	2	4	2	3	4	3
05120204090	5	1	5	1	nd	nd	nd	3	4	2	4	2	2	3	1
05120204100	nd	1	5	nd	nd	nd	nd	3	4	2	4	2	2	3	1

Table 8 Unified Watershed Assessment

Note: The UWA scores range from 1 to 5, with a score of 1 indicating good water quality and a score of 5 indicating severe impairment. nd = No Data.

According to the above UWA data, it appears the most significant water quality concerns the Mud Creek watershed area result from impairments to Recreational Use Attainment, Aquifer Vulnerability, and Residential Septic System Density.

According to the WRAS, the Priority Issues and Recommended Action Strategies for the Driftwood River Watershed are summarized as follows:

Priority Issue	Management Strategy 1	Management Strategy 2	Management Strategy 3
Data/Information Targeting	Use data from ongoing collection efforts	Develop TMDL's for Impaired waterbodies	
Streambank Erosion & Stabilization	Comprehensive approach to drainage, stream flows, energy.		
Failing Septic Systems & Straight Pipe Discharges	Characterize impacts of direct discharges by local communities.	Enforcement of existing and adoption of new local ordinances to address new systems.	Education/outreach of health and environmental risks.
Water Quality-General	Complete required TMDL's		
Nonpoint Source Pollution-General	Identify, assess, & quantify nonpoint pollutants via TMDL	Utilization of existing funding sources to promote conservation practices.	Land use planning 7 site design for urban sources.
Nonpoint Source Pollution-Education/Outreach	Field days to promote conservation.		
Point Sources- General	Regulatory correction of illegal and non-compliant point sources.		

Table 9 Watershed Restoration Action Strategy, Driftwood River

3.4 NPDES Dischargers

According to the USEPA Envirofacts Warehouse on-line database, only two National Pollutant Discharge Elimination Permit System (NPDES) permit holders are present in the Mud Creek watershed. No violations from either permit holder are documented. (USEPA- Envirofacts)

The Princes Lakes Lift Station #1 (#INR000024612) facility, located at 14 East Lakeview Drive, Nineveh, and the Dream Maker Bath & Kitchen (#INR000102277) facility, located at 8458 South Christian Drive, Nineveh, are listed as a Hazardous Waste permitees. There are no Water, Superfund, Toxic Waste, or Air dischargers listed as NPDES permit holders within the watershed.   (USEPA- Envirofacts)

The State of Indiana's efforts to control the direct discharge of pollutants to waters of the State were inaugurated by the passage of the Stream Pollution Control Law of 1943. The vehicle currently used to control direct discharges to waters of the State is the NPDES (National Pollutant Discharge Elimination System) Permit Program. This was made possible by the passage of the Federal Water Pollution Control Act Amendments of 1972 (also referred to as the Clean Water Act). These permits place limits on the amount of pollutants that may be discharged to waters of the State by each discharger. These limits are set at levels protective of both the aquatic life in the waters which receive the discharge and protective of human health.

The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the State such that the quality of the water of the State is maintained in accordance with the standards contained in 327 IAC 2. The NPDES permit requirements must ensure that the minimum amount of control is imposed upon any new or existing point source through the application of technology-based treatment requirement contained in 327 IAC 5-5-2. According to 327 IAC 5-2-2, "Any discharge of pollutants into waters of the State as a point source discharge, except for exclusions made in 327 IAC 5-2-4 is prohibited unless in conformity with a valid NPDES permit obtained prior to discharge." This is the most basic principal of the NPDES permit program.

3.5 Indiana Clean Lakes Program

The Indiana Clean Lakes Program (ICLP) was created in 1989 as a program within the Indiana Department of Environmental Management's (IDEM) Office of Water Management. The program is administered through a grant to Indiana University's School of Public and Environmental Affairs (SPEA) in Bloomington. The Indiana Clean Lakes Program (ICLP, 2006) is a comprehensive, statewide public lake management program having five components:

1. Public information and education
    a. produce and distribute the quarterly Water Column newsletter
    b. sponsor the annual Indiana Lake Management Conference
    c. prepare informational brochures prepare lake assessment reports
    d. conduct training and informational workshops

2. Technical assistance
    a. assist lake associations with interpreting water quality data
    b. attend lake association meetings
    c. present programs to lake associations

3. Volunteer lake monitoring
    a. citizen volunteers monitor water transparency on 80 Indiana lakes
    b. volunteers in an expanded program collect monthly samples for total phosphorus and chlorophyll a analysis

4. Lake water quality assessment
    a. conduct routine assessments of water quality on Indiana lakes
    b. identify regional and/or temporal patterns in lake data
    c. identify lake conditions that warrant further attention

5. Coordination with other state and federal lake programs
    a. work with other state and federal agencies to coordinate efforts and enhance the protection of Indiana lakes

In 2005, Cordry Lake and East Lake were monitored according to the Expanded Monitoring protocols of the Indiana Clean Lakes Program, with the addition of *E. coli* bacteria sampling at two sites on the lake. Results of the monitoring efforts are summarized in the tables below and the site specific data is included in **Appendix 2.**

Volunteers on Cordry Lake and East Lake have been collecting data as part of the ICLP for several years, although no data was collected for East Lake during 2004. Volunteers collect water clarity data using a Secchi disk. The weighted black & white colored disk is lowered into the water column until no longer visible. This depth is recorded. The measurement gives us an idea about the transparency of the water, which is a function of the amount of suspended sediment, algae, and other material. Secchi disk transparency has been linked to lake eutrophication, which is a measure of how productive the lake is. Eutrophication is a natural process by which a waterbody slowly accumulates sediments and nutrients, begins to support abundant plant life, and eventually disappears. Eutrophication of waterbodies can be rapidly accelerated by human interference, such as excessive sedimentation from runoff or from the addition of nutrients that accelerate plant growth. *Table 10 & 11* below depict results of the Secchi disk collection over the past seven years. According to interpretations from ICLP, the trend for water clarity in indicates a slight improvement over the seven year data collection period in Cordry Lake. The Indiana statewide average Secchi depth reading in 2005 was 7.8 feet; Cordry Lake was well above the state average. Although the trend data for East Lake is not quite as comprehensive over the seven year period, the trend indicates a slight decrease in clarity in East Lake. The 2005 average for East Lake was only slightly below the statewide average.

Secchi Disk Data- Cordry Lake	Mean Feet (Jul.-Aug.)
2005	20.0
2004	22.4
2003	21.2
2002	21.4
2001	16.6
2000	13.7
1999	18.4

Table 10 Cordry Lake Secchi Data

Secchi Disk Data- East Lake	Mean Feet (Jul.-Aug.)
2005	7.2
2004	No data
2003	9.4
2002	No data
2001	14.1
2000	7.1
1999	No data

Table 11 East Lake Secchi Data

Volunteers also collect samples for Total Phosphorus and Chlorophyll a. Volunteers send the collected samples to the SPEA laboratory at IU for analysis. Phosphorus is often the key nutrient in determining the amount of phytoplankton (algae) in a lake, and is usually the first element to limit biological productivity, or limiting nutrient, since it is unavailable from the atmosphere and is rapidly recycled and converted to other forms unavailable to plants. Any addition of phosphorus from outside sources, such as waste discharge, lawn fertilizer or agricultural runoff, or even from failing septic systems, can stimulate or over-stimulate algae and plant growth, which leads to eutrophication.

Cholorophyll a is the photosynthetic pigment that causes the green color in algae and plants. The concentration of Chlorophyll a is directly related to the amount of algae living in the water; lakes with high nutrient levels typically support larger numbers of algae. *Tables 12 & 13* below depicts results of Total Phosphorus and Chlorophyll *a* over the past four years. According to interpretations from ICLP, the trend indicates a decrease in Total Phosphorus over the sampling period, while Chlorophyll a levels remained fairly consistent in Cordry Lake and decrease in both parameters for East Lake. Indiana statewide averages for Total Phosphorus and Chlorophyll a in 2005 were 36.3 and 6.49, respectively. Cordry Lake was well below these averages and East Lake was also significantly lower.

Cordry Lake		
Year	**Total Phosphorus *ug*/L (Mean)**	**Chlorophyll a ug/L (Mean)**
2005	23	.7
2004	27	.6
2003	28	.6
2002	39	.6

Table 12 Cordry Lake Total Phosphorus & Chlorophyll Data

East Lake		
Year	**Total Phosphorus *ug*/L (Mean)**	**Chlorophyll a ug/L (Mean)**
2005	32.2	3.8
2004		
2003	13	2.1
2002		

Table 13 East Lake Total Phosphorus & Chlorophyll Data

The Carlson TSI index is used as a measurement of lake productivity based on Secchi readings, Chlorophyll a, and Total Phosphorus. According to the Carlson TSI ratings, Cordy Lake can be considered an Oligotrophic to slightly Mesotrophic lake, indicative of a low to moderately productive lake, while East Lake scored in the Mesotrophic to slightly Eutrophic range, indicative of greater productivity. (ICLP, 2006)

3.6 USGS Study- Camp Atterbury

A comprehensive study of water quality (Water Resources Investigations Report 03-4149) was conducted for Camp Atterbury by the US Geological Survey (USGS). In 2000 and 2001, the USGS conducted a base-wide assessment of surface water quality at 27 sampling sites on Camp Atterbury property, including nine sampling sites within the Mud Creek watershed. *E. coli* concentrations were sampled at six of the nine sites within the Mud Creek watershed. Of these six sites, all exceeded the 30-day (5 sample) geometric mean Indiana water quality standard of 125 colonies per 100 milliliters and all sites recorded at least one excedence of the single-sample Indiana water quality standard of 235 colonies per 100 milliliters. Three of these sample sites also contained wastewater tracers, such as beta-sitosterol, caffeine, cholesterol, or phenol, which can be indicative of elevated E. coli levels as a result of a sewer or other human wastewater source. However, the data at these three sites were inconclusive to determine a source.

Benthic-macroinvertebrate communities were assessed at five sites within the Mud creek watershed, and scores ranged from “Fair” to “Good” at all sites. Fish community integrity was also evaluated at three of the nine sites in the watershed using the Index of Biotic Integrity (IBI). IBI scores ranged from “Fair” at two sites, to “Poor” at one sample location, which was listed as only “Partial Support” of the aquatic-life use criteria. Qualitative Habitat Evaluation Index (QHEI) scores for these three sites indicated a “Full-Support” for aquatic life use.

Other than the ubiquitous elevated levels of *E. coli* at all sites, and one sample location that scored a “Poor” fish community IBI rating, no other water quality concerns were documented for the Mud Creek watershed portion of the Camp Atterbury study. (Risch, 2004)

3.7 Volunteer Water Quality Monitoring

In May of 2005, local volunteers from the watershed team initiated a sampling program to monitor and assess the quality of the surface water in the lakes and streams of the Mud Creek watershed. Monitoring of two stream sites within the watershed occurred monthly beginning in May of 2005 and ran through September, 2005. Special thanks goes out to our stalwart volunteers- Margaret Bruce, Sean Michel, Barb & Pat Kuachak, Buzz Settles, and Herb Clark, who donated a considerable amount of time toward the collection and analysis of our monitoring efforts! Sample sites were chosen to represent conditions in major stream segments of the watershed, and included locations at Prince Creek below the outlet of Princes Lakes, and Saddle Creek, below the outlet at Cordry Lake. The following map displays sampling site locations.

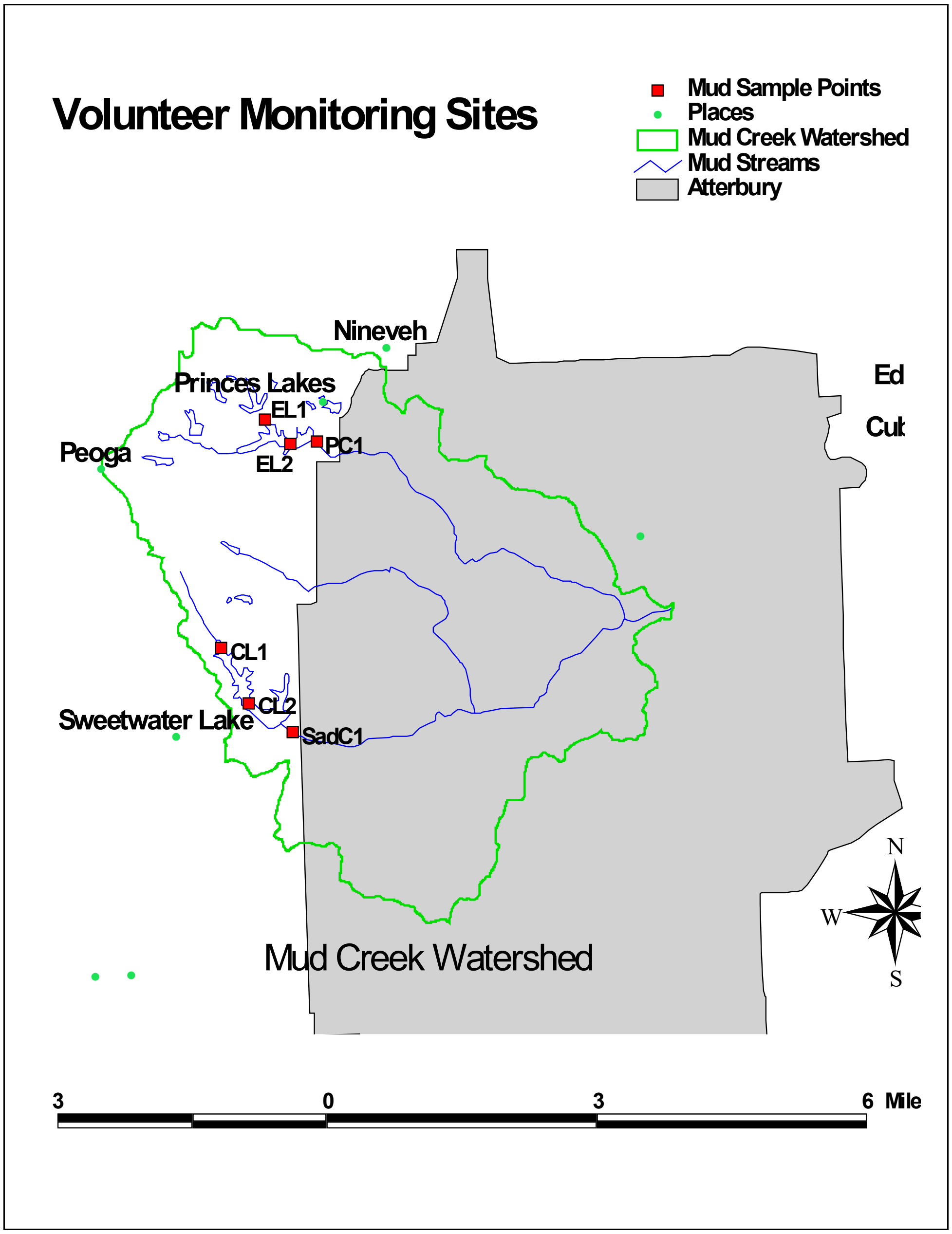

Figure 18 Volunteer Monitoring Site Map

Volunteers collected data according to the *Hoosier Riverwatch* protocols and included the following monitoring parameters:

- Dissolved Oxygen
- Biological Oxygen Demand (BOD 5-day)
- *E. coli* bacteria
- pH
- Water Temperature
- Orthophosphate
- Nitrate & Nitrite
- Turbidity
- Flow

- Citizens Qualitative Habitat Evaluation Index
- Macroinvertebrates

The *Hoosier Riverwatch* program evaluates water quality based on the habitat, chemical, and biological conditions of the waterbody. (IDNR- Hoosier Riverwatch)

The **habitat** component is evaluated using the *Citizens Qualitative Habitat Evaluation Index* (CQHEI) procedure. CQHEI rates a variety of the stream's physical characteristics pertinent to the support of a healthy population of fish and wildlife, including: bottom type, cover, stream shape, adjacent land use, and stream configuration. A weighted score is assigned to each of the parameters, which are totaled to give an overall CQHEI total rank. The maximum total points available is 114. A set of ranges for *Excellent, Medium, Poor,* & *Very Poor* have not yet been developed for the index. However, QHEI scores *greater than 60* have been found to be "generally conducive to the existence of warmwater fauna."

The **chemical** component is assessed by using a series of analytical tests considered by the National Sanitation Foundation to be the most useful in determining stream water quality. The analytical results of each parameter are assigned a weighted value and are totaled to give an overall *Water Quality Index Rating* (WQI), expressed as a percentage. The percentage values are used to rate the water quality according to the following:

Excellent- 90-100% *Good*- 70-89% *Medium*- 50-69%
Bad- 25-49% *Very Bad*- 0-24%

The **biological** component is evaluated through the assessment of the benthic macroinvertebrate community present in the stream. *Benthic macroinvertebrates* are insects and animals large enough to be seen with the naked eye, and live in or on the stream bottom, such as nymphs, beetles, worms, crayfish, snails, clams, etc. Different species of macroinvertebrates can tolerate water pollution in different ways. Some species, such as mayflies, are intolerant to water pollution and can only survive in streams with little or no pollution. Some species, such as bloodworms, are pollution tolerant, and can survive where water quality is very poor. And of course, some species fall in the middle. Biological monitoring data is particularly useful in evaluating water quality because the animal community present of a stream is indicative of conditions *over time*, whereas, chemical monitoring data is only representative of that particular sampling instance. A *Pollution Tolerance Index Rating* (PTI) is formed by adding the number of different species found, multiplied by a weighting factor based on pollution tolerance level. The PTI rating can then be used to compare water quality based on the following scale:

Excellent- 23 or more *Good*- 17-22 *Fair*- 11-16 *Poor*- 10 or less

Stream flow is also monitored at each site in order to provide a frame of reference for both stream size and weather conditions at the sampling event. Oftentimes, many chemical monitoring parameters are heavily influenced by stream flow, both in terms of dilution (e.g. more water in the stream) or by runoff from surrounding lands (e.g. heavy rains wash sediment into the stream). Flow is expressed in cubic feet per second, which measures stream discharge.

Results of the monitoring efforts are summarized below and the site specific data is included in **Appendix 2.**

Site ID	Site Description	WQI *(mean May-August)*	QHEI	PTI	Flow *(mean May-August)*
PC1	Prince Creek below East Lake outlet	84.23	46	22	2.06 cfs
Sad1	Saddle creek below Cordry Lake outlet	84.16	90	29	1.475 cfs

Table 14 Stream Monitoring Summary

Figure 19 Photo- Shawn measuring flow on Saddle Creek

Figure 20 Photo- Prince Creek at site PC1

In summary, water quality sampled at both Prince Creek and Saddle Creek had "Good" ratings for *Chemical* and *Biological* monitoring components. Prince Creek scored substantially lower in the *Habitat* component, due mostly to the sampling site located adjacent to Nineveh Road that showed signs of significant human alteration to the channel.

A Quality Assurance Project Plan (QAPP) was developed to ensure quality data collection and was approved by the Indiana Department of Environmental Management.

Of particular interest to the members of the Watershed Team was the collection of *E. coli* data at the stream and lake sampling sites. *E. coli* found in substantial quantities could be a direct indicator of serious problems from septic systems and/or geese infestation. At the outset of the monitoring program, we fully expected to record samples in excess of state water quality standards (235 colonies per 100 mL). However, much to our surprise and delight, no samples in excess of the state standard were recorded at any sampling site in the watershed. Results of the *E. coli* monitoring are summarized below.

E. coli- colonies per 100 ML						
SITE ID	**May**	**June**	**July**	**August**	**Sept**	**MEAN**
PC1	0	100	0	50	33	36.6
Sad1	100	66.5	0	0	0	33.3
CL1	66	0	0	0	No data	16.5
CL2	66	20	0	60	No data	36.5
EL1	33	20	0	20	0	14.6
EL2	33	0	0	20	0	10.6

Table 15 *E. coli* Monitoring Results

It is important to note that *E. coli* samples were collected at only two locations on the lakes; one location representative of the deeper, main body of the lake, and one representative of the shallower, cove areas. The potential for dilution of *E. coli* levels in these large bodies of water is great. *E. coli* levels can vary greatly depending on the proximity of the sampling point to potential sources, such as failing septic systems. For this reason, it is important to realize that the data collected above may not be truly representative of all potential *E. coli* sources in the lakes.

Section 4. PROBLEMS & STRESSORS

At a public meeting held on July 20, 2005, Watershed team participants developed the following "problem statements", through group consensus, to further refine the critical issues identified earlier in the process.

4.1 Problem Statement #1

ISSUE	PARAMETERS OF CONCERN	PROBLEM STATEMENT
Septic Systems	Bacteria, nutrients	Septic systems are a problem because they fail, which is caused by abuse, lack of maintenance, and grandfathered installations. The worst location is lakeside. The extent of the problem is minimal at this time.

4.2 Problem Statement #2

ISSUE	PARAMETERS OF CONCERN	PROBLEM STATEMENT
Erosion- Construction Sediment, Bank	Sediment, nutrients	Erosion is a problem because sediment is the number one pollutant in streams. The problem is caused by nature, construction, and people who

Erosion		don't understand soil migration. The worst locations are the north ends of Cordry Lake, East Lake, and Prince's Lakes coves. The useable surface of the lakes are shrinking and the problem is serious.

4.3 Problem Statement #3

ISSUE	PARAMETERS OF CONCERN	PROBLEM STATEMENT
Geese	Bacteria, nutrients	Geese are a problem because there are so many and they have stopped migrating. The problem is excessive waste running into lakes and streams and because there are no natural predators. The worst location is along lakeshores and the extent of the problem is critical.

4.4 Problem Statement #4

ISSUE	PARAMETERS OF CONCERN	PROBLEM STATEMENT
Lawn Chemicals	Nutrients (phosphorus), herbicides	Lawn chemicals are a problem because of phosphorus and run-off into the lakes. The worst location is the north end of the lakes and from lawns closest to the lake. The extent of the problem is not serious at this time.

Section 5. SOURCES

5.1 Residential Septic Systems

Improperly functioning and/or poorly maintained septic systems can lead to pollution of surface and shallow groundwater. *E. coli* bacteria and nutrient contamination of waterbodies can result if the on-site effluent treatment facility (eg. absorption filed, trenches, mound, sand filter, or other media) cannot efficiently treat the volume of effluent prior to entry into surface/groundwater.

5.1.1 Source Description

A typical residential septic system contains several components; a septic tank to settle the solids, a distribution tank which collects liquids, and treatment field for final filtering/treatment of the liquid effluent prior to discharge to groundwater. Systems that discharge directly to surface waters are typically not permitted for residential use. A common misconception is to refer to the system as simply a *septic tank*, which ignores the other equally important components of the *system*.

The septic tank collects the solid waste, which is slowly digested by microbial and enzymatic action. However, excess solid material should be pumped out and removed regularly (annually or bi-annually) to prevent possible damage to the other components of the septic system, particularly clogging up the treatment field. Additionally, excessive inputs of oils, grease, or harsh chemicals can inhibit the enzymatic digestion of the solids and warrant more frequent pumping.

Once the liquids are separated from the solids, they can either gravity flow directly to the treatment field, or be collected in a distribution tank for pumping or flowing to the treatment field. For systems that rely on pumps to move the liquid effluent, this can be another source of maintenance or potential for malfunction.

The treatment field is the final step in the system. This is typically made up of a system of constructed trenches (fingers) known as an absorption field. However, other methods for treatment can be used, such as a mound system, sand filter, or even a constructed wetland. At this stage in the process, the effluent is treated by physical and biological actions during slow percolation through the media, (soil profile, sand filter, etc.) and ultimately enters the groundwater table prior to entering any surface water. Particulate matter is filtered out through contact with soil material and biological action digests bacteria and reduces nutrients.

Potential sources of bacterial/nutrient contamination from septic systems may include the following:

- Septic systems with treatment fields that are undersized for the volume of effluent discharged to the system.. This is a common problem for older systems that serve multi-bedroom homes on lots less than one acre in size.
- Septic systems with treatment fields situated in areas with unsuitable soil types. Unsuitable soil types are typically those soils that contain a high clay content, which prevents percolation through soil layers, and contributes to less than adequate treatment of effluent.. Additionally, soil types that are mostly sand often allow rapid infiltration to groundwater tables without adequate treatment time within a soil profile.
- Septic systems that are situated in close proximity to surface waters and/or shallow groundwater tables.
- Septic systems situated on areas with slopes exceeding 15%. This generally contributes to accelerated runoff to down-slope receiving waters.
- Septic systems that have not been properly maintained. The build-up of solids within an absorption field or other treatment media can cause effluent to discharge at or near the ground surface.
- Septic systems without any secondary treatment component, e.g.. the “straight pipe” discharge.

5.1.2 Areas

The majority of septic systems in the watershed are located in and around the Cordry-Sweetwater Conservancy District. The town of Princes Lakes and Camp Atterbury both are serviced by a sanitary sewer system and a municipal treatment facility, which is permitted under the National Pollutant Discharge Elimination System (NPDES) by IDEM.

There are approximately 500 homes in the Cordry Lake area, which represents the largest concentration of residential septic systems in the watershed.

5.1.3 Magnitude

Based on the results of the volunteer water quality monitoring conducted in the summer of 2005 (*see Section 3.7*), there does not appear to be a significant threat to water quality resulting from septic systems. Both E. coli and nutrient levels were well within the Indiana Water Quality Standards limits, at sample sites in area lakes and streams. This is most likely due to the large volume of water stored in the lakes that dilute pollutant concentration prior to discharging to receiving streams. However, due to the limited scope of the sampling conducted, it should be noted that the monitoring results collected may not be representative of all pollution situations occurring in the watershed.

Additionally, the following factors also contribute heavily toward the magnitude of the problem, in spite of water quality monitoring results:

- Heavy concentration of single family homes adjacent to and near Cordry Lake
- Small lot size of existing homes
- High clay content of local soils
- Steep slopes near lakes and streams
- Age of the majority of existing systems.

5.2 Erosion & Sedimentation

Erosion of topsoil by wind and particularly water, can lead to excessive sedimentation of waterways. Sediment entering streams and lakes can smother substrate used by aquatic life and can reduce depth and volume of lakes and ponds. Sedimentation can lead to decreased water clarity, which inhibits light penetration and retards aquatic plant growth. In addition to the physical problems caused by sedimentation, nutrients, bacteria, and other harmful chemicals are often bound to sediment particles, and therefore, are introduced to waterbodies as the sediment enters.

Sedimentation occurs naturally and contributes to eutrophication of lakes and ponds. Eutrophication is the natural process by which lakes and ponds are ultimately converted to dry land through the physical process of sedimentation and the biological process of plant growth. The eutrophication process can be dramatically accelerated if erosion is increased due to human induced activities such as construction, agriculture, logging, etc.

Erosion and sedimentation are also natural processes in streams. Through bank erosion and bedload movement of sediments, stream channels are continually formed and re-formed following heavy flow events. Additionally, out-of-bank flooding causes deposition of sediment in floodplains that leads to topographical and soil changes, as well as the distribution of nutrients, which is a key function for plant and animal life. Again, this natural process can be disrupted if sediment inputs are disproportionately increased due to human activity, and/or if the streams have been channelized. Stream channelization directs stream flow energy onto itself, rather than spreading energy over a broad floodplain area. Streambanks can become unstable and start to erode, which leads to additional sediment contribution. Oftentimes in channelized streams, the sediment that is normally deposited in floodplain areas during flow events, winds up being deposited in the downstream receiving water, be it Lake Monroe or the Gulf of Mexico.

5.2.1 Source Description

Sources of erosion in the Mud Creek watershed originate primarily from construction activity and from bank/shoreline erosion, as there is little agriculture present in the watershed area. Erosion from construction sites in which soil has been disturbed by excavation activities can lead to sedimentation of waterways unless Best Management Practices (BMP's) are installed correctly and adequately maintained. Bank erosion along shorelines is caused from wave action induced by wind, but can be exacerbated by waves induced from boating activity. Shoreline erosion is of particular concern to property owners along lakes because it may threaten the integrity of home and dock structures and may limit access to the lakes.

5.2.2 Areas

Residential development near Princes Lakes and Cordry Lake appear to be the primary areas of construction site related erosion. There is little or no commercial or institutional site development located within the Mud Creek watershed.

Shoreline erosion is evident in areas of Princes Lakes and Cordry Lake in which there are no existing bank protection, such as rip-rap or seawalls. Sedimentation in the upstream portions (north ends) and cove areas of Cordry Lake and Princes Lakes is also present and is a major concern to property owners and users of the lakes. Much of this sedimentation is caused by leaf litter entering the lakes which leads to the rapid accumulation of organic sediment on the lake bottoms.

Streambank erosion on Saddle Creek, Price Creek, and Mud Creek is present, but is due mostly to natural processes because the surrounding riparian areas are relatively un-disturbed by human activity.

5.2.3 Magnitude

The magnitude of the problem is viewed as severe because continued, un-checked sedimentation of the lakes will result in loss of recreational use and will thwart lake access by property owners. Shoreline erosion is also viewed as severe because property is threatened and continued erosion will reduce water clarity. Streambank erosion on Saddle Creek, Price Creek, and Mud Creek is slight, and is due mostly to natural processes because the surrounding riparian areas are relatively un-disturbed by human activity. Water quality monitoring data does not indicate severe problems related to sedimentation at this time.

5.3 Geese

The Canada Goose (*Branta canadensis*) was once an uncommon bird and was thought nearly extirpated in the 1960's. Over-hunting and destruction of wetlands had nearly driven the species to the brink of extinction. Improved game management, protection of wetlands, and particularly the outlawing of lead shot for waterfowl hunting introduced in 1986, has contributed to the dramatic rebound of the species. (GPNC, 2006)

Figure 21   Goose Photo

Of particular note is the phenomenon of the "urban goose" that has become quite noticeable over the last few decades. The species appears to have developed a great tolerance, preference even, for wintering in urban areas. Several factors contribute to this phenomenon:

- More than other goose species, the Canada Goose has a high tolerance for people.
- The habitat is right. Golf courses and the typical suburban housing development that includes a pond of some sort are ideal for the birds. For sleeping at night and loafing during the day, they prefer the combination of water and grassy areas with open sightlines between the two.
- In cities they are protected from predators. Loose dogs are about their only concern.
- People bring them food. Feeding the geese is an activity that many people find enjoyable. (Of course, the geese enjoy this too!) The green lawns in the areas described above are consumed with gusto by the geese also.
- The geese find other food in abundance within a short flight from town. Waste grain and new green wheat in farm fields nearby are consumed with relish by the birds on their daily foraging trips.

- And the social nature of the birds can be greatly credited for this phenomenon. When one family of geese discovers that the city life is a good deal, they will remember and return the following year along with their youngsters and any flockmates they travel with. (GPNC, 2006)

5.3.1 Source Description

The Canada Goose is a voracious forager, and therefore, what goes in must come out! The feces is extremely rich in nutrients and is also a source of fecal bacteria, such as *E. coli* and other pathogens such as Salmonella. Scientists have recently discovered that the birds can also carry and transmit anti-biotic resistant strains of bacteria, called "Superbugs". (Cole et al., 2005) Excessive amounts of feces entering waterbodies can lead to both degraded water quality and health/safety concerns.

5.3.2 Areas

The geese frequent the open water areas of Cordry Lake and Princes Lakes, and forage along adjacent lawns and mowed areas. They also appear to prefer congregating along the dams, which gives them a clear line of sight from which to view possible predators. The geese also will roost and forage around and on piers and docks.

5.3.3 Magnitude

The extent of the problem is perceived to be critical because of health and safety concerns and possible loss of recreational opportunities of the lakes. Additionally, the excessive nutrients associated with the droppings can lead to decreased water clarity and excessive algal growth. Water quality monitoring data does not indicate a severe threat at this time.

5.4 Lawn Chemicals

Fertilizers, herbicides, and insecticides applied to residential lawns can pose a threat to surface waters if they are washed from lawns into receiving waters during rainfall events. Of particular concern to water quality in lakes, is phosphorus, which is often the "limiting nutrient" in freshwater systems, since it is unavailable from the atmosphere and is rapidly converted to forms unavailable to algae. Excessive algal growth can contribute to reduced water clarity, eutrophication, and reduced dissolved oxygen.

Figure 22 Fertilizer Photo *Image courtesy of the Washington State Water Quality Consortium*

Remember, when you're fertilizing the lawn, you MAY NOT just be fertilizing the lawn!

Fertilizing is an important lawn care practice, as it influences grass color, ability to recover from stress, and helps prevent weed invasions and disease. There are important features to consider when choosing lawn fertilizers at the local garden center.   Nitrogen (N), phosphorus (P), and potassium (K) are the three major nutrients needed by lawns. Nitrogen is the nutrient required most, although too much nitrogen can cause excessive topgrowth, leading to assorted problems. Percent nitrogen (by weight) is always the first of three numbers on the fertilizer bag, followed by phosphorus and potassium. For example, a 18-6-12 fertilizer contains 18 percent nitrogen. This number is important because it determines how much fertilizer is needed. In most cases, a rate of 1 pound of nitrogen per 1,000 square feet is suggested for each fertilizer application to the lawn. If high percentage nitrogen fertilizers are used, then less actual fertilizer product is needed to supply that one pound compared to fertilizers with low percent nitrogen. Recommended ratios of N-P-K for lawn fertilizers include 3:1:2 or 4:1:2.

Phosphorus (P) is an essential nutrient contained in every living grass plant cell. The amount of P needed by the grass plant is significantly less than nitrogen or potassium. It has positive effects on turfgrass establishment, rooting, and root branching. Phosphorus is particularly important during early grass seedling growth and development stages. However, there is much debate as to the benefits to lawns provided by phosphorus fertilizer versus the potential for water quality degradation, particularly in lakes. (UI- Lawn Talk) In fact, the State of Minnesota has enacted a law, effective January 1, 2005, prohibiting the use of phosphorus fertilizers applied to lawns within the state.   (MDA, 2006)

5.4.1 Source Description

Any inputs of phosphorus from outside sources (such as fertilizer of detergents) can stimulate excessive algae growth. Phosphorus is most often bound to soil particles, and therefore, is introduced to receiving waters from soil erosion and sedimentation

5.4.2 Areas

Areas of concern are those lawns which are directly adjacent to lakes and/or streams. Additionally, any areas that are subject to erosion can be a significant source of phosphorus.

5.4.3 Magnitude

The extent of the problem is perceived to be not serious at this time, since water quality monitoring results do not show signs of excessive nutrients in waterbodies. However, given the density of residential lawns located adjacent to area lakes, the potential for lawn chemical runoff to waterbodies exists and could lead to water quality degradation over time.

Section 6. CRITICAL AREAS & EXISTING LOADS

6.1 Failing Septic Systems

As there are municipal sewer systems serving the Prince's Lakes area and the Camp Atterbury property, the critical area within the Mud Creek watershed is limited to the residential community around Cordry Lake. Of this area, homes situated within approximately 200 feet of the lake shoreline and/or other waterbodies appear to be the most critical areas of potential water quality pollution resulting from failed or inadequate septic systems. There are approximately 500 homes located within this area.

Existing loading rates of *E. coli* contributed to Cordry Lake from failing septic systems was calculated by using the "Bacterial Indicator Tool" (USEPA-Bacterial Tool) which was modified by the Indiana Department of Environmental Management to provide *E. coli* values. According to estimates from staff at the Cordry-Sweetwater Conservancy District, approximately 500 homes are estimated to be located within 200 feet of the lake, with an average of 2.5 people per septic system, with an estimated septic system failure rate of 12.5% (this number is somewhat low due to the seasonal occupancy of the lake homes) . Based on this information, approximately 5.96E+ 11 cfu per day of *E. coli* are being loaded into the lake from failing systems. No target load is available for lakes, since flow and dilution cannot be determined.

Existing loads of *E. coli* to streams in the watershed were estimated using the water quality data collected during the summer of 2005. The estimated loading rate was well within water quality standards. The estimated loads and target maximum loads, per sample site, are presented in the table below. The loading rates are based on the mean of six *E. coli* sample collections and four flow data collections.

SITE	***E. coli* Estimated Load (cfu/day)**	***E. coli* Target Max Load cfu/day** *(Based on water quality standard of 235 cfu/100 mL)*
PC 1	3.17E + 09	1.18E + 10
Sad 1	1E + 09	8.48E + 09

Table 16 *E. coli* Estimated & Target Stream Loads

Since estimated current loads are below target loads, no load reduction is required.

6.2 Erosion & Sedimentation

Residential development near Princes Lakes and Cordry Lake appear to be the most critical areas of construction site related erosion, since there is little or no commercial or institutional site development located within the Mud Creek watershed. Land disturbing construction activities located adjacent to, or within approximately 200 feet of the lakes or stream channels, appear to pose the greatest potential for direct sediment pollution of the waterbodies.

Sedimentation in the upstream portions (north ends) and cove areas of Cordry Lake and Princes Lakes is also present and is a major concern to property owners and users of the lakes. Much of this sedimentation is caused by leaf litter entering the lakes which leads to the rapid accumulation of organic sediment on the lake bottoms.

Existing loading of sediment to streams was estimated using the water quality data collected during the summer of 2005. Since Total Suspended Solids (TSS) was not collected as part of the sampling procedure, Mg/l of TSS was estimated by converting NTU turbidity, based on the conversion rate of 1.25 mg/L TSS * NTU's. Estimated TSS loading and the Target Max loads, per sample site, are presented in the table below. The loading rates are based on the mean of four turbidity and flow sample collections.

SITE	TSS Estimated Load (lbs/day)	**TSS Target Max Load (lbs/day)** *(based on 80 mg/L TSS)*
PC 1	175	888
Sad 1	149	636

Table 17 Estimated & Target Total Suspended Solids Stream Loads

Using the STEPL model to calculate existing loads for the watershed, approximately 3368.9 tons of sediment enter the waterways per year. (USEPA-STEPL) Since estimated current loads are below target loads, no load reduction is required.

6.3 Geese

Critical areas for goose congregation and subsequent concentration of droppings are along the shorelines of the lake dams and adjacent lawn areas. Estimates from local residents indicate numbers of approximately 20-60 resident geese throughout the year and migratory flocks of up to 200 birds during the winter months.

Lake Access, based in Duluth Minnesota, provides the following information concerning the "contributions" of geese:

> "The scoop on goose poop":
>
> - The average Canada goose dropping has a dry weight of 1.2 g (~ 0.04 ounces)
> - Average droppings per day ~ 82 g/day (dry weight), that's 2.6 ounces/day (about 1/3 cup)
> - Each dropping contains 76 % carbon, 4.4 % nitrogen, and 1.3 % phosphorus
> - Geese can defecate as many as 92 times a day (numbers reported range from 28-92)
> - What goes into a goose generally comes from within the watershed and what comes out also stays in the watershed (at least for resident Giant Canada geese). (Lake Access, 2006)

Based on these estimates, phosphorus contributions from geese to area lakes was estimated to be approximately 39 lbs per year, using the conservative figure of 45 resident geese.

Assuming the average concentration of fecal coliform bacteria per gram in Canada geese feces is 1.53 x $10^{4,}$ (Alderisio & DeLuca) loading rates of fecal coliform bacteria to area lakes from an estimated resident goose population of 45 birds would be 5.65 x 10^{7} colonies of bacteria per day. No target loads for lakes are available.

6.4 Lawn Chemicals

The Watershed Team has identified residential lawns serviced by private lawn care companies as critical areas. No information on how many lawns are serviced or where they are located is available at this time. Existing loads for phosphorus were not calculated for streams since no detectable levels were observed in water quality monitoring.

Using the STEPL model to calculate existing loads for the watershed, approximately 26447.8 pounds of nitrogen and 7736.6 pounds of phosphorus enter the waterways per year. (USEPA- STEPL)

Section 7. GOALS & INDICATORS

At public meetings held on January 25 and February 15, 2006, the Watershed Team participated in facilitated strategic planning sessions to develop water quality goals for the priority water quality issues. The goals were developed based on water quality monitoring information collected the previous summer and the Problem Statements developed earlier in the process. The goals were developed as a result of group consensus.

7.1 Goal #1- Failing Septic Systems

“Current water quality will be maintained or improved indefinitely.”

7.1.1 Indicators to Track Progress

E. coli levels, as sampled in area lakes and streams during the summer of 2005, will be the standard to which the goal will be measured. Further *E. coli* monitoring will be required to track changes.

7.2 Goal #2- Erosion & Sedimentation

“By 2015, eliminate sources of sedimentation and restore original (lake bed) water configuration.”

7.2.1 Indicators to Track Progress

Sources of sedimentation in the watershed, including construction site runoff, shoreline erosion, and organic leaf litter will be monitored to determine attainment of goal. Original lake bed configuration, as determined by depth to solid bottom, will be the standard to which any dredging or removal of accumulated sediment will be measured.

7.3 Goal #3- Geese

“By 2010, resident geese populations (along lakes) will be eliminated.”

7.3.1 Indicators to Track Progress

Presence of resident geese in congregation areas along lakeshores will be monitored by visual observations of birds during the nesting months when migratory species have departed.

7.4 Goal #4- Lawn Chemicals

“Current water quality will be maintained or improved indefinitely.”

7.4.1 Indicators to Track Progress

Water quality monitoring data from the Indiana Clean Lakes Program and Hoosier Riverwatch will continue to provide the means to which nutrient levels in area lakes and streams are tracked.

Section 8. MEASURES TO BE IMPLEMENTED

At public meetings held on January 25 and February 15, 2006, the Watershed Team participated in facilitated strategic planning sessions to develop action items to achieve the water quality goals stated in the previous section. The following measures were developed as a result of group brainstorming and consensus.

8.1 Measures to Address Failing Septic Systems

- Education
- Monitoring programs
- Use newest technology
- Identify threatened areas and prioritize
- Improve health dept. communications and cooperation with CSCD board
- Inform people
- Develop committees: research, identification, liaison, etc.
- Improve septic inspection system through realtor and CSCD board communication
- Feasibility study for sewers on Cordry/Sweetwater

8.2 Measures to Address Erosion & Sedimentation

- Education- contractors and residents
- Rules & regulations for shoreline stabilization and technical specifications.
- Ground covers- make available to residents at wholesale prices.
- Hold lot owners responsible for erosion occurring on their property (more accountability for contractors).
- Long term dredging program
- More/improved enforcement of existing regulations.
- Better coordination with agencies (IDNR, IDEM, Corps of Engineers, etc.)
- Install rip-rap, plantings, sediment barriers on eroding shorelines.
- Purchase leaf-vac truck; compost leaves.
- Arrange for pontoon boat pick-up of bagged leaves at shorelines.
- Leaf barrier structures in valleys.

8.3 Measures to Address Geese

- Continue/expand hunting efforts.
- Continue/expand application of deterrent chemicals (Flight Control) in priority areas.
- Plant deterrent vegetation in geese access/nesting/forage areas.
- Conduct multi-year relocation program.
- Educate residents on "No-Feed".
- Egg removal/shaking.
- Dog harassment.
- Electric fencing in priority areas.
- Molt round-up, to slaughter house, donate meat to charity food programs.

8.4 Measures to Address Lawn Chemicals

- Publish list of approved fertilizers and application methods; include appropriate application techniques for boat dock stains & paint.
- Post "Non-Phosphorus" Conservancy District/Lakes
- Incorporate approved list and application methods into local rules & regulations. Conduct enforcement on improper application.

Section 9. MEASURE IMPLEMENTATION

Subsequent to the development of measures to address watershed goals by the Watershed Team, the smaller Steering Committee refined the ideas developed by the large group in terms of specific projects.

9.1 Measure #1- Local Workshop

Task- Conduct a local education/information sharing workshop targeting local board officials, property owners, area realtors, soil scientists, builders & contractors, and health department officials. Program agenda will focus on the following:

- Septic Systems-
    - Existing rules and regulations (local & state)
    - Suitable site requirements
    - Maintenance
    - New technology alternatives
- Erosion & Sedimentation-
    - Shoreline stabilization options (have vendors with display materials and/or materials for purchase available)
    - Ground cover/plant material options (have wholesale vendors)
    - Construction site practices/maintenance/regulations
    - Leaf management alternatives
- Lawn Chemicals-
    - Lawn nutrient requirements
    - Vendors with "phosphorus free" products
- Geese-
    - Migratory vs. resident goose identification
    - State permitting requirements
    - Management options

Completion Date- September, 2008

Responsibility- CSCD Ecology Commission/East Lake Committee, CSLOA

Resources- A program committee shall be developed to secure financial resources, develop program content, arrange for speakers/vendors, secure a venue, and conduct advertising. Approximately $10,000 will be required to provide for cost associated with program planning and implementation.

Technical Assistance- Local Soil & Water Conservation Districts, Health Departments, and area lawn care providers may be solicited for technical assistance.

Permits- No permits are required.

Reporting Dates- January, 2009

9.2 Measure #2- Informational Website

Task- Develop a CSCD website. Site will content focus on the following:

- Technical and regulatory contact information for septic systems and erosion control
- Technical specifications for locally approved/preferred conservation practices
- Materials providers for erosion control, approved lawn chemicals
- Links to local, state, and federal resources
- Goose control information

- On-line availability of Watershed Management Plan
- Voluntary distribution list of local property owners to receive emails of important notices
- On-line availability of local rulemaking processes and outcomes
- Permit requirements/guidelines
- Water quality monitoring data
- Links/information sharing with Prince's Lakes website
- Announce website at local workshop (See Measure #1)

Completion Date- June, 2007

Responsibility- CSCD Board, CSCD Ecology Committee, CSLOA, East Lake Committee, Town of Princes Lakes

Resources- Develop a committee to outline site content. Hire contractor to develop site content and build website. Estimated cost for development- $15,000.

Technical Assistance- Local Soil & Water Conservation Districts and Health Departments may be solicited for technical assistance.

Permits- No permits are required.

Reporting Dates- June, 2008

9.3 Measure #3- Comprehensive Water Quality Monitoring

Task- Develop a comprehensive water quality monitoring program of local lakes and streams in order to document attainment of specified goals. Will include utilization and expansion of existing *Indiana Clean Lakes Program* and *Hoosier Riverwatch* volunteer monitoring programs. Monitoring will center on tracking *E. coli* and nutrient levels in waterbodies. Will include development of comprehensive plan and Quality Assurance/Quality Control plan.

Completion Date- Develop program by March, 2007. Monitoring will be on-going.

Responsibility- CSCD Ecology Committee, East Lake Committee, CSLOA

Resources- Develop committee to outline needs and solicit volunteers. Hire contractor to develop plan and QA/QC. Purchase additional sampling materials and replenish existing supplies. Estimated cost- $10,000.

Technical Assistance- IDNR- *Hoosier Riverwatch*, IU-SPEA

Permits- No permits are required.

Reporting Dates- Report as required by *Hoosier Riverwatch* and ICLP. On-going reporting to local officials and public via website (See Measure #2).

9.4 Measure #4- Alternative Technology Demonstration Sites

Task- Install a minimum of two alternative technology on-site residential sewage treatment systems. Sites will be used for demonstration purposes to educate and inform local health & planning officials and area residents on the potential for non-traditional septic systems. Site selection and technology employed will be chosen based on conventional system limiting factors, such as lot size, proximity to lakes, soil type, high water table, steep slope, etc. Cost share assistance will be provided to property owners to off-set cost of design, installation, monitoring and maintenance.

Completion Date- January, 2009

Responsibility- CSCD Board, CSCD Ecology Commission, CSLOA

Resources- Project will require identification of priority sites and agreements with willing landowners. Hire contractor to design, install, and monitor systems. Estimated cost- $35,000.

Technical Assistance- Local Health Department, Indiana State Department of Health

Permits- Approval from County Health Department and ISDH is required for experimental systems.

Reporting Dates- To be determined by project monitoring and reporting requirements. Report to public via website (See Measure #2).

9.5 Measure #5- Sewer Feasibility Study

Task- Conduct comprehensive study of CSCD to determine potential and cost of sanitary sewer and Sewage Treatment Plant installation and maintenance. Explore alternatives for non-traditional treatment and collection .

Completion Date- January 2010

Responsibility- CSCD Board, CSCD Ecology Committee

Resources- Develop committee to solicit bids from qualified firms. Estimated cost- $50,000 - $100,000,

Technical Assistance- IDEM, ISDH

Permits- No permits are required.

Reporting Dates- January, 2011

9.6 Measure #6- Erosion Control Technical Specifications

Task- Develop a list of approved/preferred technical specifications for shoreline and construction site erosion control. Incorporate list into local rules and regulations. Develop website based (See Measure #2) practice descriptions, typical detail drawings, material suppliers, costs, and permitting requirements.

Completion Date- January 2008

Responsibility- CSCD Ecology Committee, East Lake Committee, CSCD Board

Resources- Form a committee to develop list of approved practices. Hire contractor to draft specifications for inclusion in website. Estimated cost- $10,000.

Technical Assistance- Local Soil & Water Conservation Districts, Indiana Department of Environmental Management.

Permits- No permits are required.

Reporting Dates- January 2009

9.7 Measure #7- Leaf Litter Management

Task- Develop comprehensive program to reduce the amount of leaf litter material entering lakes. Program includes:

- Purchase a leaf vacuum truck and develop a local composting facility.
- Develop a program to provide for pick-up and disposal of bagged leaves from lake docks via pontoon boat and trucking to compost facility.
- Develop distribution of compost material to local residents and/or a "for sale" program.
- Develop and install three leaf barrier structures in ravines as demonstration sites.

Completion Date- January 2009

Responsibility- CSCD Board, CSCD Ecology Committee, East Lake committee, Town of Princes Lakes, CSLOA

Resources- Form a committee to research logistics of truck purchase, compost facility, and boat pick-up alternatives. Identify leaf barrier demonstration sites. Estimated costs: $60,000 - $75,000.

Technical Assistance- local Solid Waste Management Districts and Soil & Water Conservation Districts.

Permits- No permits are required.

Reporting Dates- January, 2010

9.8 Measure #8- Geese Management

Task- In addition to current, on-going management techniques, develop and implement:

- Woody vegetation plantings in target goose access areas.
- Annual spring egg/nest destruction to reduce new resident population.
- Relocation of young individuals to a protected environment prior to the geographic "imprinting" of perennial nesting areas along lakes.

Completion Date- June, 2008

Responsibility- CSCD Board, CSCD Ecology Committee, East Lake committee

Resources- Develop committee of volunteers to conduct egg/nest destruction and relocation. Purchase and install woody vegetation in target areas. Estimated cost: $1,000.

Technical Assistance- IDNR Division of Fish & Wildlife

Permits- Egg/Nest Destruction Permit (IDNR), Trap/Transport Permit (IDNR)

Reporting Dates- January, 2009

9.9 Measure #9- List of Approved Lawn Chemicals

Task- Develop a list of approved/preferred lawn chemicals. Incorporate list into local rules and regulations. Develop website based (See Measure #2) listing, including material suppliers, application instructions, and costs. Develop example sites on area lawns to demonstrate the effectiveness of approved chemicals. Post signs in yards and photos on website.

Completion Date- January 2007

Responsibility- CSCD Ecology Committee, East Lake Committee, CSLOA

Resources- Volunteers to develop specifications and host demonstration lawns. Estimated cost: $1,000.

Technical Assistance- Lawn chemical applicators and suppliers, Indiana Office of State Chemist

Permits- No permits are required.

Reporting Dates- June 2007

Section 10. LOAD REDUCTIONS & MONITORING

Load reductions for water quality parameters of concern resulting from measure implementation were not calculated since long term goals center on maintaining essentially "good" water quality that was documented through monitoring efforts. Additionally, existing loading information did not document any loads in excess of water quality standards, therefore, since estimated current loads are below target loads, no load reduction is required.

10.1 Measure #1- Local Workshop

Monitoring Indicators

- Method- The success of the local workshop will be measured by the number of attendees.
- Monitoring Plan- A list of workshop attendees will be compiled during registration for the workshop.

10.2 Measure #2- Informational Website

Monitoring Indicators

- Method- The success of the website will be determined by usage levels and by the number of local residents that sign up for list serves, notices, bulletins, etc.
- Monitoring Plan- A site usage counter will be built in to the website to track number of "hits". A database of voluntary recipients will be kept as part of site management.

10.3 Measure #3- Comprehensive Water Monitoring

Monitoring Indicators

- Method- Water quality of area lakes and streams will be continued to be monitored using the Indiana Clean Lakes Program and Hoosier Riverwatch procedures.
- Monitoring Plan- A Quality Assurance Project Plan (QAPP) will be developed prior to initiating the comprehensive monitoring plan to dictate monitoring specifics.

10.4 Measure #4- Alternative Technology Demonstration Sites

Monitoring Indicators

- Method- Success will be judged based on site size requirements, cost effectiveness, maintenance requirements, and pollution reduction effectiveness.

- <u>Monitoring Plan</u>- Alternative technology septic systems will be monitored for effectiveness based on the requirements of the individual systems proposed.
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10.5 Measure #5- Sewer Feasibility Study

Monitoring Indicators

- <u>Method</u>- The sewer feasibility study will be completed according to contract and/or bid specifications and will be reviewed for applicability by CSCD Board.

10.6 Measure #6- Erosion Control Specifications

Monitoring Indicators

- <u>Method</u>- Erosion control specifications will be compiled and submitted for approval by local groups/boards according to contract and/or bid specifications.

10.7 Measure #7- Leaf Litter Management

Monitoring Indicators

- <u>Method</u>- Leaf removal activities will be measured based on amount of leaf litter removed and hauled to compost/disposal sites. Demonstration sites will be monitored for effectiveness by annually measuring the amount of leaf litter debris impounded behind structures.
- <u>Monitoring Plan</u>- Records of material removed will be kept and reported annually. Demonstration sites will be measured using rods or measuring staffs to record accumulated material.

10.8 Measure #8- Geese Management

Monitoring Indicators

- <u>Method</u>- Geese management techniques will be monitored for effectiveness by conducting annual visual inspections of target areas to document numbers of resident geese and note any population change trends.

10.9 Measure #9- List of Approved Lawn Chemicals

Monitoring Indicators

- <u>Method</u>- Approved chemical list will be compiled and submitted for approval by local groups/boards according to contract and/or bid specifications.

Section 11. EVALUATION & EVOLUTION

11.1 Record Keeping

The Cordry Sweetwater Conservancy District will be the primary record-keeper and responsible entity for the watershed management plan. The document will be reviewed <u>biennially</u> by the CSCD to determine if established goals are being met according to the specified schedule and to make any adjustments or updates based on new information. This Watershed Management Plan is intended to be a “living document” and should be updated to reflect new information or trends. The results of the biennial evaluation will be made available to stakeholders in the watershed via CSCD Board and/or Committee meetings, newsletters, direct mailings, and/or articles in local press.

11.2 Contact Information

For more information about the content of this plan, please contact:

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randy@aquaterracons.net

or

Cordry Sweetwater Conservancy District
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Nineveh, IN 46164-9679
317/ 933-2893

11.3 Distribution List

Hard copies and/or electronic copies are available for viewing at the following locations:

Cordry Sweetwater Conservation District
Town of Prince's Lakes
East Lake Committee
CSCD Library
US Army, Camp Atterbury

Section 12. TABLES & APPENDICES

12.1 Table of Acronyms

ACRONYM	DEFINITION
BMP	Best Management Practice
CES	Cooperative Extension Service
CRP	Conservation Reserve Program
CSCD	Cordry Sweetwater Conservancy District
EQIP	Environmental Quality Incentives Program
HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
LARE	Lake and River Enhancement
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
SWCD	Soil & Water Conservation District
USFWS	United States Fish & Wildlife Service
USGS	United States Geological Service
WMP	Watershed Management Plan

Table 18 Table of Acronyms

12.2 Table of Potential Funding Sources

SOURCE	CONTACT INFO.
Section 319- Nonpoint Source pollution	IDEM. (317) 232-0019 http://www.in.gov/idem/water/planbr/wsm/319main.html
Section 205(j)- Watershed Planning	IDEM. (317) 232-0019 http://www.in.gov/idem/water/planbr/wsm/205jmain.html
IPALCO Golden Eagle Grants	(317) 736-8994 www.ipalco.com/aboutipalco/news/03-30-99.html
Five Star Restoration Program (Wetlands)	USEPA- http://www.epa.gov/owow/wetlands/restore/5star/index.html
Watershed Funding (General Information)	USPA- http://www.epa.gov/owow/funding.html

Partners for Fish & Wildlife Program (Wetlands)	USFWS- http://cfpub.epa.gov/fedfund/program.cfm?prog_num=46
Environmental Quality Incentives Program (EQIP)	NRCS. (317) 290-3200 www.in.nrcs.usda.gov
Conservation Reserve Program (CRP)	NRCS. (317) 290-3200 www.in.nrcs.usda.gov
Lake & River Enhancement (LARE)	(317) 233-3870 http://www.in.gov/dnr/fishwild/lare/
State Revolving Fund (SRF)	IDEM. (317) 232-0019
Water Quality Special Research Grants	Cooperative State Research Education & Extension Service (CSREES). USDA. (202) 401-5971
Chemical Emergency Preparedness & Prevention Technical Assistance Grants	USEPA- (202) 260-0030 www.epa.gov/ceppo
Pesticide Environmental Stewardship Grants	USEPA. (703) 308-7035 www.pesp.org
Watershed Protection & Flood Prevention Program	USDA, NRCS (202) 720-3534 www.ftw.nrcs.usda.gov/programs.html
Watershed Assistance Grants	USEPA (202) 260-4538 www.epa.gov/owow/wag.html
Water Quality Cooperative Agreements	USEPA (202) 260-9545 www.epa.gov/owm/wm042000.htm

Table 19 Potential Funding Sources

12.3 Appendices

1. Bibliography
2. Volunteer Water Quality Monitoring Data

12.4 Key Words

watershed management planning, Indiana, Cordry Lake, Princes Lakes, Mud Creek, Driftwood River, volunteer monitoring.