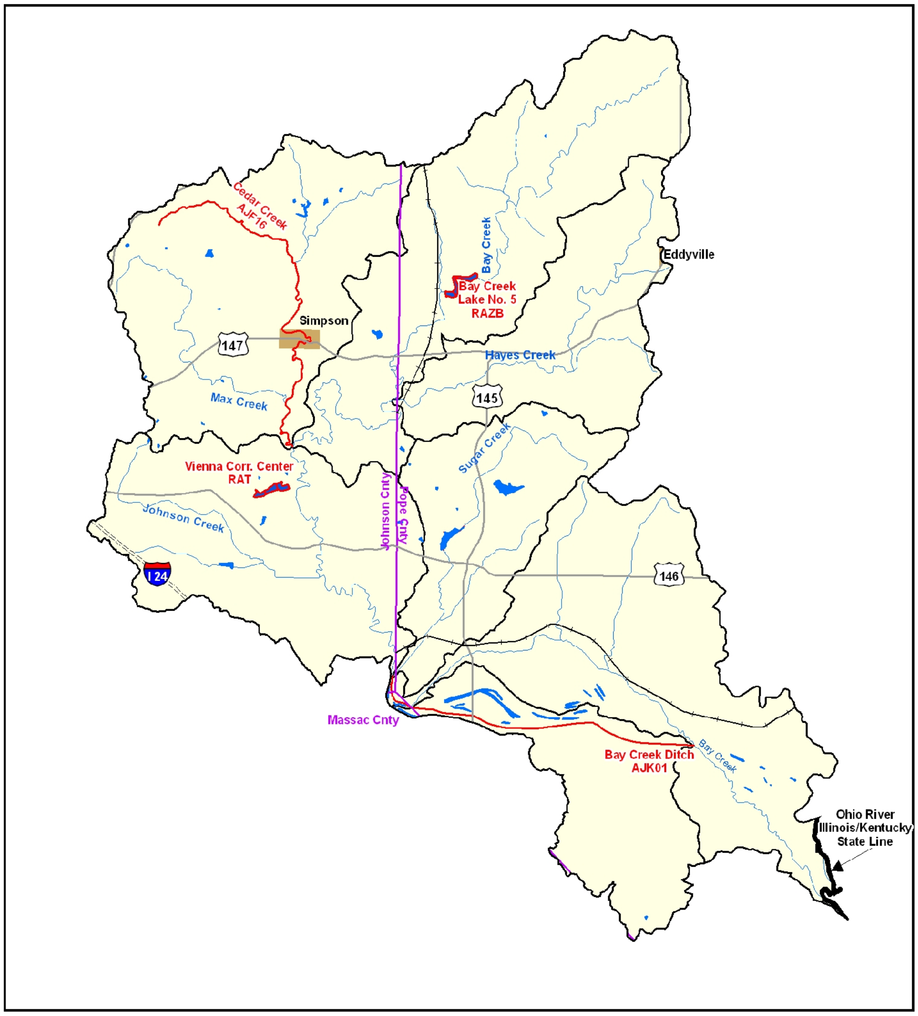
Illinois
Environmental
Protection Agency

Bureau of Water
P.O. Box 19276
Springfield, IL 62794-9276

November 2007

IEPA/BOW/07-023

Bay Creek Watershed TMDL Report



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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
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REPLY TO THE ATTENTION OF:
WW-16J

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Watershed Management Section
BUREAU OF WATER

Marcia Willhite, Chief
Bureau of Water
Illinois Environmental Protection Agency
P.O. Box 19276
Springfield, IL 62794-9276

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has reviewed the final Total Maximum Daily Loads (TMDLs) from the Illinois Environmental Protection Agency (IEPA) for the Bay Creek Watershed in Illinois. The TMDLs are for phosphorus and manganese and address phosphorus, manganese, DO, and Total Suspended Solids (TSS) impairments. Cedar Creek (AJF16), Vienna Correction Center Lake (RAT), and Bay Creek Lake No. 5 (RAZB) are the locations addressed in this TMDL that are impaired for designated uses of general use and public and food processing water supplies.

Based on this review, U.S. EPA has determined that Illinois' three TMDLs, for phosphorus in the lakes and manganese in Cedar Creek, meet the requirements of Section 303(d) of the Clean Water Act and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, U.S. EPA hereby approves three TMDLs for five impairments in the Bay Creek Watershed. The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois' effort in submitting these TMDLs and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Mr. Dean Maraldo, TMDL Program Manager, at 312-353-2098.

Sincerely yours,

Kevin M. Pierard
Acting Director, Water Division

Enclosure

cc: Mike Eppley, IEPA

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Acronyms

°F	degrees Fahrenheit
ac	acre
BOD	biological oxygen demand
BMP	best management practice
CCC	Commodity Credit Corporation
CCX	Chicago Climate Exchange
cfs	cubic feet per second
CRP	Conservation Reserve Program
CWA	Clean Water Act
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
EQIP	Environmental Quality Incentive Program
ft	Foot or feet
FSA	Forest Service Agency
GIS	geographic information system
HUC	Hydrologic Unit Code
IAH	Illinois Agronomy Handbook
ICCI	Illinois Conservation and Climate Initiative
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
IL-GAP	Illinois Gap Analysis Project
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
kg	kilogram
km	kilometer
L	liter
LA	load allocation
LC	loading capacity
lb/d	pounds per day
m	meter
mgd	million gallons per day

mg/L	milligrams per liter
Mn	manganese
MOS	margin of safety
MUID	Map Unit Identification
NA	Not applicable
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NED	National Elevation Dataset
NPDES	National Pollution Discharge Elimination System
NPS	nonpoint source
NRCS	National Resource Conservation Service
P	phosphorus
PCS	Permit Compliance System
Q2E	QUAL2E
Q2K	QUAL2K
RR	Rock Riffle Grade Control
SOD	Sediment Oxygen Demand
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic
STP	Stone Toe Protection
STORET	Storage and Retrieval
SSRP	Streambank Stabilization and Restoration Practice
SWCD	Soil Water Conservation District
TMDL	total maximum daily load
ug/L	Micrograms per liter
USACE	U.S. Army Corp of Engineers
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WASCOBs	Water and Sediment Control Basins
WHIP	Wildlife Habitat Incentives Program
WLA	waste load allocation
WRP	Wetlands Reserve Program

Section 1
Goals and Objectives for Bay Creek Watershed (0514020317)

1.1 Total Maximum Daily Load (TMDL) Overview

A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA lists water bodies not meeting water quality standards every two years. This list is called the 303(d) list and water bodies on the list are then prioritized and targeted for TMDL development.

In general, a TMDL is a quantitative assessment of water quality problems, contributing sources, and pollution reductions needed to attain water quality standards. The TMDL specifies the amount of pollution or other stressor that needs to be reduced to meet water quality standards, allocates pollution control or management responsibilities among sources in a watershed, and provides a scientific and policy basis for taking actions needed to restore a water body.

Water quality standards are laws or regulations that states authorize to enhance water quality and protect public health and welfare. Water quality standards provide the foundation for accomplishing two of the principal goals of the CWA. These goals are:

- Restore and maintain the chemical, physical, and biological integrity of the nation's waters
- Where attainable, to achieve water quality that promotes protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water

Water quality standards consist of three elements:

- The designated beneficial use or uses of a water body or segment of a water body
- The water quality criteria necessary to protect the use or uses of that particular water body
- An antidegradation policy

Examples of designated uses are recreation and protection of aquatic life. Water quality criteria describe the quality of water that will support a designated use. Water quality criteria can be expressed as numeric limits or as a narrative statement. Antidegradation policies are adopted so that water quality improvements are conserved, maintained, and protected.

1.2 TMDL Goals and Objectives for Bay Creek Watershed

The Illinois EPA has a three-stage approach to TMDL development. The stages are:

- Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection
- Stage 2 – Data Collection (optional)
- Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report addresses all stages of TMDL development for the Bay Creek watershed. Stage 2 data were collected during the fall of 2006 and the Stage 2 report is available for reference in Appendix D.

The TMDL goals and objectives for the Bay Creek watershed included developing TMDLs for all impaired water bodies within the watershed, describing all of the necessary elements of the TMDL, developing an implementation plan for each TMDL, and gaining public acceptance of the process. Following are the impaired water body segments in the Bay Creek watershed for which a TMDL was developed:

- Cedar Creek (AJF 16)
- Bay Creek Ditch (AJK 01)
- Vienna Correction Center Lake (RAT)
- Bay Creek Lake No. 5 (RAZB)

These impaired water body segments are shown on Figure 1-1. There are four impaired segments within the Bay Creek watershed. Table 1-1 lists the water body segment, water body size, and potential causes of impairment for the water body.

Table 1-1 Impaired Water Bodies in Bay Creek Watershed

Water Body Segment ID	Water Body Name	Size	Causes of Impairment with Numeric Water Quality Standards	Causes of Impairment with Assessment Guidelines
AJF 16	Cedar Creek	11.92 miles	Manganese, dissolved oxygen	
AJK 01	Bay Creek Ditch	8.49 miles	Manganese [(1)], dissolved oxygen	Sedimentation/siltation, habitat alterations (streams)
RAT	Vienna Correction Center Lake	70 acres	Manganese	
RAZB	Bay Creek Lake No. 5	118 acres	Total phosphorus	Habitat alterations (lake), total suspended solids (TSS)

(1) No TMDL was developed for this parameter because stage 2 data showed that manganese was no longer a potential cause of impairment to the Bay Creek Ditch

Illinois EPA is currently developing TMDLs for parameters that have numeric water quality standards, and therefore the remaining sections of this report will focus on the manganese, dissolved oxygen, and total phosphorus (numeric standard) impairments in the Bay Creek watershed. For potential causes that do not have numeric water quality standards as noted in Table 1-1, TMDLs were not developed at this time. However, in the implementation plan presented in section 9, many of these potential causes are addressed by implementation of controls for the pollutants with water quality standards.

The TMDLs for the segments listed above specify the following elements:

- Loading Capacity (LC) or the maximum amount of pollutant loading a water body can receive without violating water quality standards
- Waste Load Allocation (WLA) or the portion of the TMDL allocated to existing or future point sources
- Load Allocation (LA) or the portion of the TMDL allocated to existing or future nonpoint sources and natural background
- Margin of Safety (MOS) or an accounting of uncertainty about the relationship between pollutant loads and receiving water quality

These elements are combined into the following equation:

$$TMDL = LC = \Sigma WLA + \Sigma LA + MOS$$

The TMDLs also take into account the seasonal variability of pollutant loads so that water quality standards are met during all seasons of the year. Also, reasonable assurance that the TMDL will be achieved is described in the implementation plan. The implementation plan for the Bay Creek watershed describes how water quality standards will be attained. This implementation plan also includes recommendations for implementing best management practices (BMPs), cost estimates, institutional needs to implement BMPs and controls throughout the watershed, and timeframe for completion of implementation activities.

1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 Bay Creek Watershed Characteristics** provides a description of the watershed's location, topography, geology, land use, soils, population, and hydrology
- **Section 3 Public Participation and Involvement** discusses public participation activities that occurred throughout the TMDL development

- **Section 4 Bay Creek Watershed Water Quality Standards** defines the water quality standards for the impaired water body
- **Section 5 Bay Creek Watershed Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired reservoirs in the watershed, and also describes the point and non-point sources with potential to contribute to the watershed load.
- **Section 6 Approach to Developing TMDL and Identification of Data Needs** makes recommendations for the models and analysis that will be needed for TMDL development and also suggests segments for Stage 2 data collection.
- **Section 7 Model Development for the Bay Creek Watershed** provides an explanation of modeling tools used to develop TMDLs for impaired segments and potential causes of impairments within the watershed.
- **Section 8 Total Maximum Daily Loads for the Bay Creek Watershed** discusses the calculated allowable loadings to water bodies in order to meet water quality standards and the reductions in existing loadings needed to meet the determined allowable loads.
- **Section 9 Implementation Plan** includes recommendations for implementing BMPs and continued monitoring throughout the watershed
- **Section 10 References**

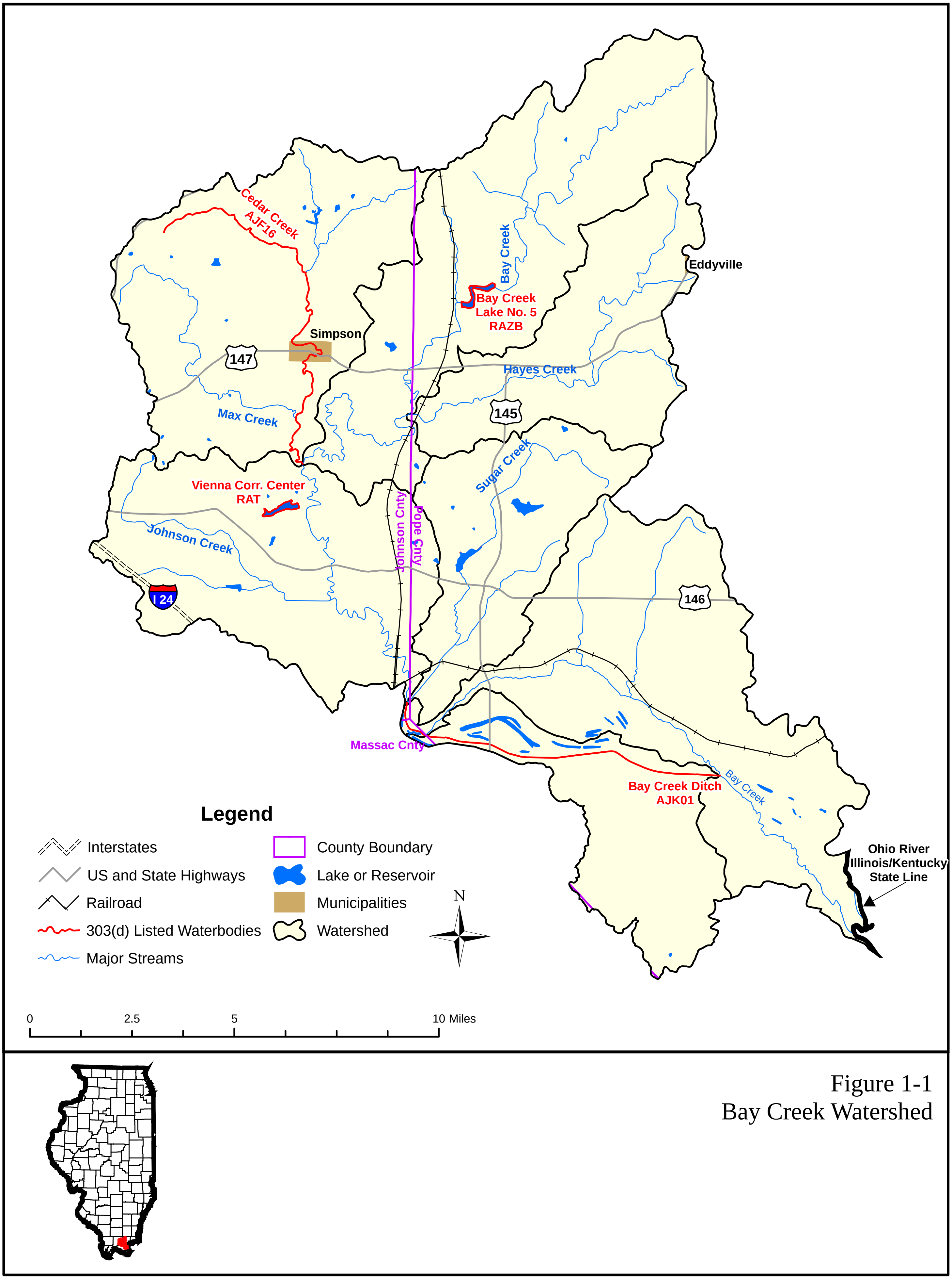

Figure 1-1
Bay Creek Watershed

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Section 2
Bay Creek Watershed Description

2.1 Bay Creek Watershed Location

The Bay Creek watershed (Figure 1-1) is located in southern Illinois, flows in a southeasterly direction, and drains approximately 144,000 acres within the state of Illinois. The watershed covers land within Pope, Johnson, and Massac Counties near the Kentucky state line.

2.2 Topography

Topography is an important factor in watershed management because stream types, precipitation, and soil types can vary dramatically by elevation. National Elevation Dataset (NED) coverages containing 30-meter grid resolution elevation data are available from the USGS for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Bay Creek watershed were obtained by overlaying the NED grid onto the GIS-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the Bay Creek watershed ranges from 823 feet above sea level in the headwaters of Bay Creek to 298 feet at its most downstream point in the southeast corner of the watershed. The absolute elevation change is 416 feet over the approximately 99-mile stream length of Bay Creek, which yields a stream gradient of approximately 4.2 feet per mile.

2.3 Land Use

Land use data for the Bay Creek watershed were extracted from the Illinois Gap Analysis Project (IL-GAP) Land Cover data layer. IL-GAP was started at the Illinois Natural History Survey (INHS) in 1996, and the land cover layer was the first component of the project. The IL-GAP Land Cover data layer is a product of the Illinois Interagency Landscape Classification Project (IILCP), an initiative to produce statewide land cover information on a recurring basis cooperatively managed by the United States Department of Agriculture National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data were generated using 30-meter grid resolution satellite imagery taken during 1999 and 2000. The IL-GAP Land Cover data layer contains 23 land cover categories, including detailed classification in the vegetated areas of Illinois. Appendix A contains a complete listing of land cover categories. (Source: IDNR, INHS, IDA, USDA NASS's 1:100,000 Scale Land Cover of Illinois 1999-2000, Raster Digital Data, Version 2.0, September 2003.)

The land use of the Bay Creek watershed was determined by overlaying the IL-GAP Land Cover data layer onto the GIS-delineated watershed. Table 2-1 contains the land uses contributing to the Bay Creek watershed, based on the IL-GAP land cover categories and also includes the area of each land cover category and percentage of the watershed area. Figure 2-2 illustrates the land uses of the watershed.

The land cover data reveal that approximately 62,072 acres, representing nearly 43 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for about 5 percent and 9 percent of the watershed area, respectively and rural grassland accounts for about 26 percent. Forested areas (including upland forests) occupy about 46 percent of the total watershed area, and wetlands cover about 9 percent. Other land cover categories represent about 1 percent or less of the watershed area.

Table 2-1. Land Use in Bay Creek Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	6,777	4.7%
Soybeans	12,768	8.8%
Winter Wheat	1,483	1.0%
Other Small Grains & Hay	1,127	0.7%
Winter Wheat/Soybeans	874	0.6%
Other Agriculture	1,132	0.8%
Rural Grassland	37,913	26.3%
Upland	51,681	35.8%
Forested Areas	14,439	10.0%
High Density	259	0.2%
Low/Medium Density	1,573	1.1%
Urban Open Space	217	0.2%
Wetlands	12,517	8.7%
Surface Water	1,596	1.1%
Barren & Exposed Land	25	0.0%
Total	**144,381**	**100%**

1. Forested areas includes partial canopy/savannah upland and coniferous.
2. Wetlands includes shallow marsh/wet meadow, deep marsh, seasonally/temporally flooded, floodplain forest, swamp, and shallow water.

2.4 Soils

Two types of soil data are available for use within the state of Illinois through the National Resource Conservation Service (NRCS). General soils data and map unit delineations for the entire state are provided as part of the State Soil Geographic (STATSGO) database. Soil maps for the database are produced by generalizing detailed soil survey data. The mapping scale for STATSGO is 1:250,000. More detailed soils data and spatial coverages are available through the Soil Survey Geographic (SSURGO) database for a limited number of counties. For SSURGO data, field mapping methods using national standards are used to construct the soil maps. Mapping scales generally range from 1:12,000 to 1:63,360 making SSURGO the most detailed level of soil mapping done by the NRCS.

The Bay Creek watershed falls within Pope, Johnson, and Massac Counties. At this time, SSURGO data is available for Pope and Massac Counties. STATSGO data has been used in lieu of SSURGO data for the portion of the watershed that lies in Johnson County. Figure 2-3 displays the STATSGO soil map units as well as the SSURGO soil series in the Bay Creek watershed. Attributes of the spatial coverage can be linked to the STATSGO and SSURGO databases which provide information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation. The following sections describe and summarize the specified soil characteristics for the Bay Creek watershed.

2.4.1 Bay Creek Watershed Soil Characteristics

Appendix B contains the STATSGO Map Unit IDs (MUIDs) for the Bay Creek watershed as well as the SSURGO soil series. The table also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characteristics is described in more detail in the following paragraphs. The predominant soil type in the STATSGO portion of the watershed are soils categorized as a fine-grained and made up of silts and clays with a liquid limit of less than 50 percent that tend toward silt. The soil type covering the most area in the SSURGO portion of the watershed is Grantsburg silt loam on varying percent slopes under varying erosion conditions.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. Hydrologic soil groups B, C, and D are found within the Bay Creek watershed with the majority of the watershed falling into category C. Category C soils are defined as "soils having a slow infiltration rate when thoroughly wet." C soils consist "chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture." These soils have a slow rate of water transmission (NRCS, 2005).

A commonly used soil attribute is the K-factor. The K-factor:

> *Indicates the susceptibility of a soil to sheet and rill erosion by water.* (The K-factor) *is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion. Losses are expressed in tons per acre per year. These estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water (NRCS 2005).*

The distribution of K-factor values in the Bay Creek watershed range from 0.02 to 0.64.

2.5 Population

Population data were retrieved from Census 2000 TIGER/Line Data from the US Bureau of the Census. Geographic shape files of census blocks were downloaded for every county containing any portion of the watersheds. The block files were clipped to each watershed so that only block populations associated with the watershed would be counted. The census block demographic text file (PL94) containing population data was downloaded and linked to each watershed and summed. City populations were taken from the US Bureau of the Census. For municipalities that are located across watershed borders, the population was estimated based on the percentage of area of municipality within the watershed boundary.

Approximately 11,200 people reside in the watershed. Municipalities in the Bay Creek watershed are shown in Figure 1-1. There are no major population centers within the watershed and future growth is expected to be limited.

2.6 Climate and Streamflow

2.6.1 Climate

Southern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation and temperature data from the Dixon Springs Agricultural Center (station id. 2353) in Pope County were extracted from the NCDC database for the years of 1967 through 2004. The data station was chosen to be representative of meteorological conditions throughout the Bay Creek watershed.

Table 2-2 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 48 inches.

Table 2-2 Average Monthly Climate Data at Dixon Springs Agricultural Center

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	3.3	42	24
February	3.2	48	29
March	4.5	59	37
April	4.7	70	47
May	5.5	78	55
June	4.2	85	63
July	3.5	89	67
August	3.5	88	65
September	3.3	82	58
October	3.4	72	47
November	4.7	58	39
December	4.5	47	30
Total	**48.3**		

2.6.2 Streamflow

Analysis of the Bay Creek watershed requires an understanding of flow throughout the drainage area. Unfortunately, there are no USGS gages within the watershed that have current, or even recent, streamflow data. Spot streamflow values were collected during Stage 2 data collection and historic values were estimated through the drainage area ratio method which assumes that the flow per unit area is equivalent in watersheds with similar characteristics. Specific information regarding streamflow estimates are discussed in detail in section 7 of this document.

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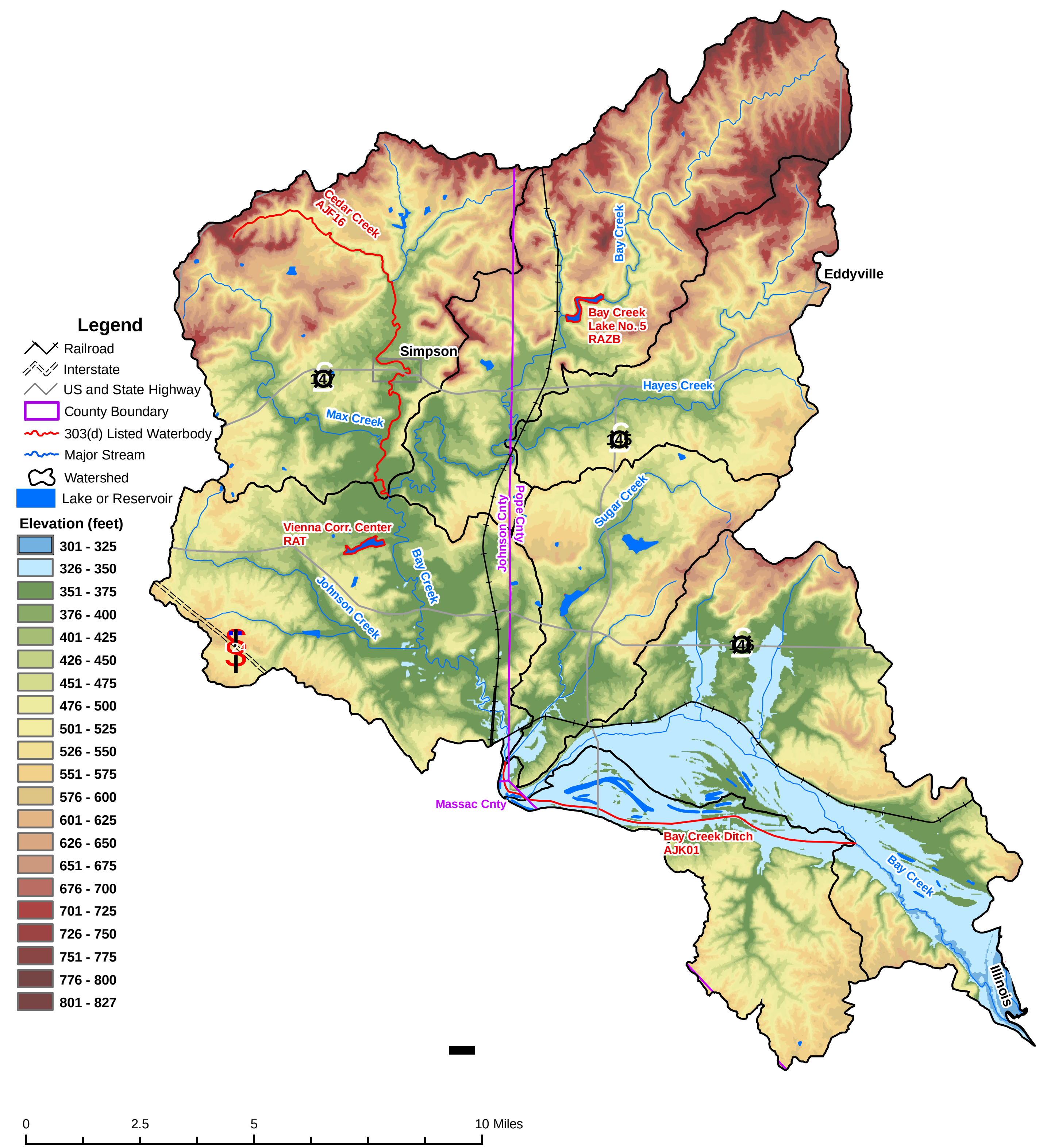

Figure 2-1
Bay Creek Watershed
Elevation

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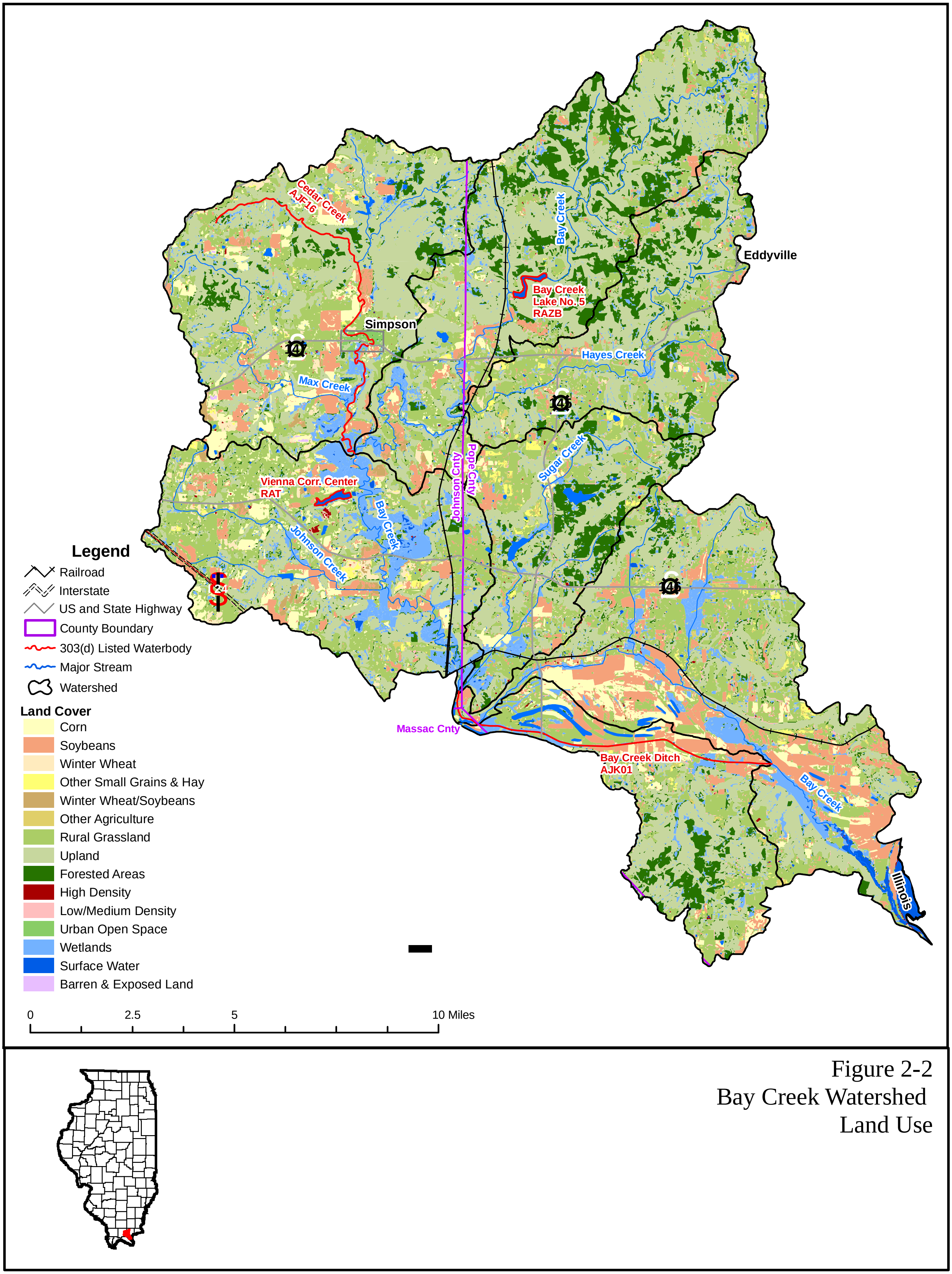

Figure 2-2
Bay Creek Watershed
Land Use

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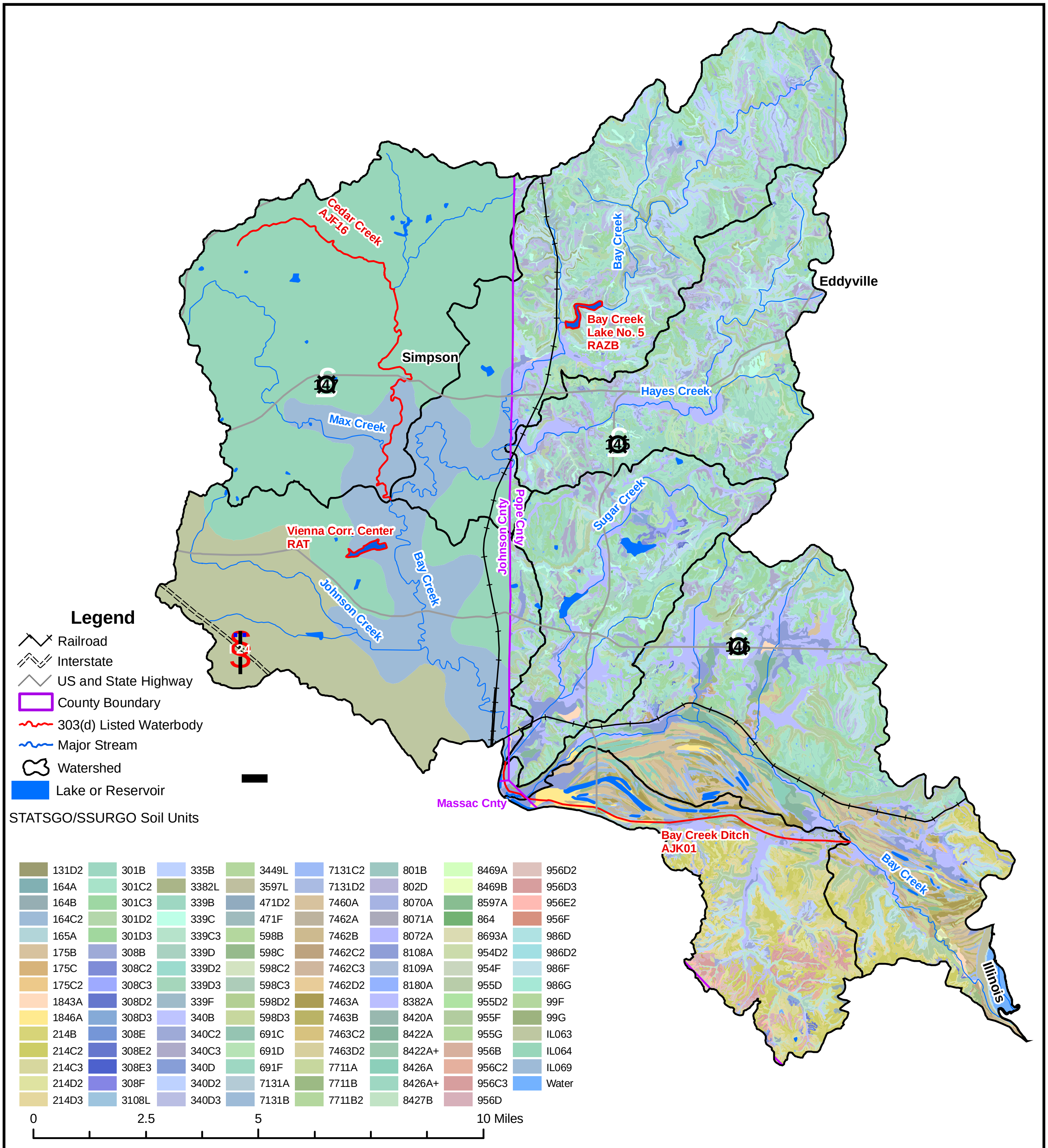

Figure 2-3
Bay Creek Watershed
Soils

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Section 3
Public Participation and Involvement

3.1 Bay Creek Watershed Public Participation and Involvement

Public knowledge, acceptance, and follow through are necessary to implement a plan to meet recommended TMDLs. It is important to involve the public as early in the process as possible to achieve maximum cooperation and counter concerns as to the purpose of the process and the regulatory authority to implement any recommendations.

Illinois EPA, along with CDM, held two public meetings within the watershed throughout the course of the TMDL development. The first public meeting was held at the Vienna Mason Lodge in Vienna, IL on September 26, 2006. Four people attended the joint Stage 1 TMDL meeting for the Bay Creek and the South Fork Saline River/Lake of Egypt watersheds. Additionally, a meeting was held at the same venue on August 8, 2007 to present the Stage 3 report and implementation plan.

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Section 4
Bay Creek Watershed Water Quality Standards

4.1 Illinois Water Quality Standards

Water quality standards are developed and enforced by the state to protect the "designated uses" of the state's waterways. In the state of Illinois, setting the water quality standards is the responsibility of the Illinois Pollution Control Board (IPCB). Illinois is required to update water quality standards every three years in accordance with the CWA. The standards requiring modifications are identified and prioritized by Illinois EPA, in conjunction with USEPA. New standards are then developed or revised during the three-year period.

Illinois EPA is also responsible for developing scientifically based water quality criteria and proposing them to the IPCB for adoption into state rules and regulations. The Illinois water quality standards are established in the Illinois Administrative Rules Title 35, Environmental Protection; Subtitle C, Water Pollution; Chapter I, Pollution Control Board; Part 302, Water Quality Standards.

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2005). The designated uses applicable to the Bay Creek watershed are the General Use and Public and Food Processing Water Supplies Use.

4.2.1 General Use

The General Use classification is defined by IPCB as standards that "will protect the state's water for aquatic life, wildlife, agricultural use, secondary contact use and most industrial uses and ensure the aesthetic quality of the state's aquatic environment." Primary contact uses are protected for all General Use waters whose physical configuration permits such use.

4.2.2 Public and Food Processing Water Supplies

The Public and Food Processing Water Supplies Use is defined by IPCB as standards that "are cumulative with the general use standards of Subpart B and must be met in all waters designated in Part 303 at any point at which water is withdrawn for treatment and distribution as a potable supply or for food processing."

4.3 Illinois Water Quality Standards

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if this data suggests that an impairment to aquatic life exists, a comparison of available water quality data with water quality standards will then occur. For public and food processing water supply waters, Illinois EPA compares available data with water quality standards to make impairment determinations. Tables 4-1 and 4-2 present the water quality standards of the potential causes of impairment for both lakes and streams within the Bay Creek watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Water Quality Standards for Potential Bay Creek Watershed Lake Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Regulatory Citation
Habitat Alterations (Lake)	NA	No numeric standard	No numeric standard	
Manganese (total)	µg/L	1000	150	302.208(g) 302.304
Total Phosphorus	mg/L	0.05[1]	No numeric standard	302.205
Total Suspended Solids	NA	No numeric standard	No numeric standard	

µg/L = micrograms per liter mg/L = milligrams per liter NA = Not Applicable
[1] Standard applies in particular inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

Table 4-2 Summary of Water Quality Standards for Potential Bay Creek Watershed Stream Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Regulatory Citation
Habitat Alterations (Streams)	NA	No numeric standard	No numeric standard	
Manganese (total)	µg/L	1000	150	302.208(g) 302.304
Oxygen, Dissolved	mg/L	5.0 instantaneous minimum; 6.0 minimum during at least 16 hours of any 24 hour period	No numeric standard	302.206
Sedimentation/ Siltation	NA	No numeric standard	No numeric standard	

µg/L = micrograms per liter mg/L = milligrams per liter NA = Not Applicable

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Bay Creek watershed, potential pollution sources must be investigated for the pollutants where TMDLs will be developed. The following is a summary of the potential sources associated with the listed causes for the 303(d) listed segments in this watershed. They are summarized in Table 4-3.

Table 4-3 Summary of Potential Sources for Bay Creek Watershed

Segment ID	Segment Name	Potential Causes	Potential Sources
AJF 16	Cedar Creek	Manganese, dissolved oxygen	Source unknown
AJK 01	Bay Creek Ditch	Sedimentation/siltation, dissolved oxygen, habitat alterations (streams)	Agriculture, crop-related sources, nonirrigated crop, hydromodification, channelization, source unknown
RAT	Vienna Correction Center Lake	Manganese	Source unknown
RAZB	Bay Creek Lake No. 5	Total phosphorus, habitat alterations (lake), total suspended solids	Forest/grassland/parkland

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Section 5
Bay Creek Watershed Characterization

Data were collected and reviewed from many sources in order to further characterize the Bay Creek watershed. Data have been collected in regards to water quality, reservoirs, and both point and nonpoint sources. This information is presented and discussed in further detail in the remainder of this section.

5.1 Water Quality Data

There are 10 historic water quality stations within the Bay Creek watershed that were used for this report. Figure 5-1 shows the water quality data stations within the watershed that contain data relevant to the impaired segments.

The impaired water body segments in the Bay Creek watershed were presented in Section 1. Refer to Table 1-1 for impairment information specific to each segment. The following sections address both stream and lake impairments. Data are summarized by impairment and discussed in relation to the relevant Illinois numeric water quality standard. The information presented in this section is a combination of USEPA Storage and Retrieval (STORET) database and Illinois EPA database data. STORET data are available for stations sampled prior to January 1, 1999 while Illinois EPA data (electronic and hard copy) are available for stations sampled after that date. The following sections will first discuss Bay Creek watershed stream data followed by lake/reservoir data.

5.1.1 Stream Water Quality Data

The Bay Creek watershed has two impaired streams. Segment AJF16 of Cedar Creek and AJK16 of Bay Creek Ditch were listed in 2004 for impairments caused by manganese and DO. The assessment methods for each segment are contained in the 2004 303(d) List. Segment AJF16 of Cedar Creek has been "monitored" while the impaired segment on Bay Creek Ditch was "evaluated." The State describes evaluated assessments as those for "which the resource-quality determinations are based on data types other than those used for monitored assessments. Other information includes: land-use information, location of known point and nonpoint potential sources, monitoring data generally more than five years old, volunteer data, or documented site-specific knowledge." Table 5-1 contains a summary of the available DO and manganese data for each impaired segment. The most recent available data for the impaired Bay Creek Ditch segment were collected in 1987 as part of an Intensive Basin Survey.

Table 5-1 Bay Creek Watershed Streams: Inventory for Impairments

Segment/Parameter	Period of Record	Number of Samples
Cedar Creek Segement AJF16; Sampling Location AJF16		
Dissolved Oxygen (DO) (mg/L)	2000	1
Manganese in Bottom Deposits (mg/kg as Mn Dry Wgt)	2000	1
Manganese, Dissolved (µg/L as Mn)	2000	1
Manganese, Total (µg/L as Mn)	2000	1
Bay Creek Ditch Segment AJK01; Sampling Location AJK01		
Dissolved Oxygen (DO) (mg/L)	1987	3
Manganesein Bottom Deposits (mg/kg as Mn Dry Wgt)	1987	2
Manganese, Dissolved (µg/L as Mn)	1987	3
Manganese, Total (µg/L as Mn)	1987	3

Table 5-2 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for manganese and DO. Other nutrient data have been collected where available.

Table 5-2 Bay Creek Watershed Data Availability for Data Needs Analysis and Future Modeling Efforts

Parameter	Period of Record	Number of Samples
Cedar Creek Segment AJF16; Sampling Location AJF16		
Carbon, Total Organic (mg/L)	2000	1
Nitrogen, Kjeldahl Sediment	2000	1
Nitrogen, Nitrite (NO2) + Nitrate (NO3) (mg/L)	2000	1
Phosphorus, Dissolved (mg/L as P)	2000	1
Phosphorus, Total (mg/L as P)	2000	1
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	2000	1
Bay Creek Ditch Segment AJK01; Sampling Location AJK01		
COD, .025N K2CR2O7 (mg/L)	1987	3
COD, Bottom Deposits, Dry Weight (mg/kg)	1987	2
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1987	3
Nitrogen Kjeldahl Total Bottom Dep Dry Wt (mg/kg)	1987	2
Nitrogen, Ammonia, Total (mg/L as N)	1987	3
Nitrogen, Kjeldahl, Total, (mg/L as N)	1987	3
Phosphorus, Dissolved (mg/L As P)	1987	3
Phosphorus, Total (mg/L as P)	1987	3
Phosphorus, Total, Bottom Deposit (mg/kg-P Dry Wgt)	1987	2

5.1.1.1 Dissolved Oxygen

The two impaired stream segments in the Bay Creek watershed are listed for use impairments caused by DO. Table 5-3 contains the available DO data. A sample was considered a violation if it was below 5.0 mg/L. Results below 5 mg/L are displayed in bold text in the table. Only DO concentrations below the standard (5.0 mg/L instantaneous minimum) have been recorded on both impaired segments.

Table 5-3 DO Concentrations in Bay Creek Watershed Impaired Streams

Segment	Sample Locations	Sample Date	Result (mg/L)
Cedar Creek AJF16	AJF 16	02-Oct-00	**3.0**
Bay Creek Ditch AJK01	AJK 01	6-Aug-87	**3.2**
	AJK 01	8-Sep-87	**3.5**
	AJK 01	13-Oct-87	**3.8**

5.1.1.2 Manganese

Both impaired stream segments in the Bay Creek watershed were listed for manganese impairments. The applicable water quality standard is a maximum total manganese concentration of 1,000 µg/L for general use and 150 µg/L for public water supply. Neither of the impaired streams in the Bay Creek watershed are used as a source of public water so only the general use standard of 1,000 µg/L applies. Table 5-4 summarizes the available historic manganese data for the impaired stream segments. All samples collected in 1987 violated the general use standard. The more recent data collected on Cedar Creek does not violate the general use standard.

Table 5-4 Manganese Concentrations in Bay Creek Watershed Impaired Streams

Segment	Sample Locations	Sample Date	Result (µg/L)
Cedar Creek AJF16	AJF 16	02-Oct-00	510
Bay Creek Ditch AJK01	AJK 01	6-Aug-87	2644
	AJK 01	8-Sep-87	4246
	AJK 01	13-Oct-87	1487

Additionally, Stage 2 data were collected on both segments during the fall of 2006. Newly collected data showed that manganese is no longer a potential cause of impairment to the Bay Creek Ditch.

5.1.2 Lake and Reservoir Water Quality Data

The Bay Creek watershed has two impaired lakes within its drainage area. Each lake has three active water quality stations (see Figure 5-1). Tributary data are available only for Bay Creek Lake Number 5. The data summarized in this section include water quality data for impaired constituents as well as parameters that could be useful for modeling and analysis efforts. All historic data are available in Appendix C.

5.1.2.1 Vienna Correctional Center Lake

There are three sampling locations on Vienna Correctional Center Lake. The lake is impaired for manganese. An inventory of all available manganese data at all depths is presented in Table 5-5. No manganese data have been collected at sampling location RAT-2 and only sediment samples are available at RAT-3.

Table 5-5 Vienna Correctional Center Lake Manganese Data Inventory

Vienna Correctional Center Lake Segment RAT; Sample Locations RAT-1 and RAT-3		
RAT-1	**Period of Record**	**Number of Samples**
Total Manganese	1999	5
Manganese in Bottom Deposits (mg/kg as Mn Dry Wgt)	1993-1999	4
RAT-3		
Manganese in Bottom Deposits (mg/kg as Mn Dry Wgt)	1994-1999	3

The applicable water quality standard for manganese is 1,000 µg/L for general use and 150 µg/L for public water supplies. Table 5-6 contains the total manganese data for Vienna Correctional Center Lake. Two of the five samples taken in 1999 violated the public water supply standard. These results are shown in bold text in the table. The average total manganese concentration at sampling site RAT-1 is 156 µg/L.

Table 5-6 Total Manganese Data collected on Vienna Correctional Center Lake; Sample Location RAT-1

Sample Date	Result (ug/L)	Depth (ft)
4/23/1999	**200**	12
6/4/1999	82	11
7/9/1999	30	10
8/17/1999	46	11
10/1/1999	**420**	20

5.1.2.2 Bay Creek Lake Number 5

There are three sampling locations on Bay Creek Lake Number 5. The lake is impaired by total phosphorus. An inventory of all available phosphorus data at all depths is presented in Table 5-7.

Table 5-7 Bay Creek Lake No. 5 Phosphorus Data Inventory

Sampling Location	Parameter	Period of Record	Data Count
RAZB-1	Total Phosphorus	2002	9
RAZB-2	Total Phosphorus	2002	5
RAZB-3	Total Phosphorus	2002	4

Table 5-8 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for total phosphorus. DO data at varying depths, as well as chlorophyll "a" data, have been collected where available.

Table 5-8 Bay Creek Lake No. 5 Data Availability for Data Needs Analysis and Future Modeling Efforts

Bay Creek No. 5 Segment RAZB; Sample Locations RAZB-1, RAZB-2, and RAZB-3		
RAZB-1	**Period of Record**	**Number of Samples**
Chlorophyll-a Corrected	2002	5
Chlorophyll-a Uncorrected	2002	5
Dissolved Oxygen	2002	42
RAZB-2		
Chlorophyll-a Corrected	2002	4
Chlorophyll-a Uncorrected	2002	4
Dissolved Oxygen	2002	40
RAZB-3		
Chlorophyll-a Corrected	2002	4
Chlorophyll-a Uncorrected	2002	4
Dissolved Oxygen	2002	18

Compliance with the total phosphorus standard is assessed at a one-foot depth from the lake surface. All available total phosphorus samples collected at a one-foot depth at each monitoring site in Bay Creek Lake No. 5 are presented in Table 5-9. The water quality standard for total phosphorus is a maximum concentration of 0.05 mg/L. Samples that have violated this standard are displayed in bold text within the table.

Table 5-9 Total Phosphorus Concentrations in Bay Creek Lake No. 5

Sample Date	RAZB-1	RAZB-2	RAZB-3	Lake Average
4/11/2002	0.02	0.02	**0.06**	0.03
6/4/2002	0.02	0.03	**0.06**	0.04
7/22/2002	0.04	0.04	**0.08**	**0.05**
8/13/2002	NS	**0.06**	NS	**0.06**
10/1/2002	0.02	0.03	**0.06**	0.04

Five of the samples collected during 2002 were above the total phosphorus standard. Four of the five occurred at sample location RAZB-3. All samples collected at site RAZB-1 were below the standard.

5.1.2.2.1 Bay Creek Lake Number 5 Tributary Data

Bay Creek sampling location AJ08 is located approximately five miles upstream of Bay Creek Lake Number 5. Phosphorus samples were collected twice during the year 2000. Dissolved and total phosphorus concentrations were measured on August 1 and October 2 of the year. A sediment sample was also taken on August 1.

Table 5-10 contains the phosphorus data collected at this location. There is no numeric standard for total phosphorus in stream segments, but both samples were below the applicable lake standard.

Table 5-10 Bay Creek Lake No. 5 Tributary Phosphorus Data Collected at Sampling Location AJ08

Date	Parameter	Result	Units
8/1/2000	Total Phosphorus, sediment	198	mg/kg
8/1/2000	Dissolved Phosphorus	0.01	mg/L
8/1/2000	Total Phosphorus	0.01	mg/L
10/2/2000	Dissolved Phosphorus	0.01	mg/L
10/2/2000	Total Phosphorus	0.01	mg/L

5.2 Reservoir Characteristic

There are two impaired reservoirs in the Bay Creek watershed as discussed above. Reservoir information for future modeling efforts was collected from GIS analysis, Illinois EPA, the U.S. Forest Service, the U.S. Army Corps of Engineers, and USEPA water quality data. The following sections will discuss the available data for each reservoir.

5.2.1 Vienna Correctional Center Reservoir

Table 5-11 Vienna Correctional Center Dam Information (U.S. Army Corps of Engineers)

Spillway Discharge	425 acre-feet
Maximum Storage	1,160 acre-feet
Normal Storage	1,000 acre-feet
Spillway Width	1,361 feet
Outlet Gate Type	U

Vienna Correctional Center Reservoir is located south of Simpson in Johnson County. The reservoir was built in 1944 and has a surface area of 76 acres. Drinking water for the Vienna Correctional Center (Facility No. 0875510) is supplied by the Vienna Correctional Center community water supply. The Vienna

Correctional Center Reservoir serves as the source of this drinking water. The Correctional Center operates a surface water intake in the reservoir that is drawing an average of 490,000 gallons per day. The water supply provides water to approximately 3,462 inmates and employees at Vienna and Shawnee Correctional Centers. No major cities or urban areas are located upstream of the reservoir and the contributing watershed is predominantly forested land. Table 5-11 contains U.S. Army Corps of Engineers dam data.

Table 5-12 contains depth information for each sampling location on the Vienna Correctional Center Lake. The average maximum depth in Vienna Correctional Center is 21.5 feet.

Table 5-12 Average Depths (ft) for Vienna Correctional Center Segment RAT (Illinois EPA 2002 and USEPA 2002a)

Year	RAT-1	RAT-2	RAT-3
1993	22.0	—	—
1994	21.3	15.6	10.1
1999	21.3	—	—
Average	**21.5**	**15.6**	**10.1**

5.2.2 Bay Creek Lake No. 5

Bay Creek Lake No. 5 is located northeast of Simpson in Pope County, was constructed in 1976, and has an area of 118 acres. The dam has a height of 51 feet and the reservoir has a maximum storage capacity of 13,779 acre-feet. The lake is part of the Shawnee National Forest and the Bay Creek Wilderness and is also known as Millstone Lake. Table 5-13 contains dam data.

Table 5-13 Bay Creek Lake No. 5 Dam Information (U.S. Army Corps of Engineers)

Dam Length	911 feet
Dam Height	51 feet
Maximum Discharge	NA
Maximum Storage	13,779 acre-feet
Normal Storage	1,690 acre-feet
Spillway Width	130 feet
Outlet Gate Type	U

Table 5-14 contains depth information for each sampling location on the lake. The maximum water depth is 15.6 feet.

Table 5-14 Average Depths (ft) for Bay Creek Lake No. 5 Segment RAZB (Illinois EPA 2002 and USEPA 2002a)

Year	RAZB-1	RAZB-2	RAZB-3
2002	15.6	14.9	6.1

5.3 Point Sources

Point sources for the Bay Creek watershed have been separated into municipal/ industrial sources and mining discharges. Available data have been summarized and are presented in the following sections.

5.3.1 Municipal and Industrial Point Sources

Permitted facilities must provide Discharge Monitoring Reports (DMRs) to Illinois EPA as part of their NPDES permit compliance. DMRs contain effluent discharge sampling results, which are then maintained in a database by the state. There are four point sources located within the Bay Creek watershed. Figure 5-2 shows all permitted facilities. In order to assess point source contributions to the watershed, the data have been examined by receiving water and then by the downstream impaired segment that has the potential to receive the discharge. Receiving waters were determined through information contained in the USEPA Permit Compliance System (PCS) database. Maps were used to determine downstream impaired receiving water information when PCS data was not available. The impairments for each segment or downstream segment were considered when reviewing DMR data. Data have been summarized for any sampled parameter that is associated with a downstream impairment (i.e., all available nutrient and CBOD data were reviewed for segments that are impaired for DO). This will help in future model selection as well as source assessment and load allocation.

5.3.1.1 Bay Creek Ditch AJK01

There are two point sources that discharge upstream of Bay Creek Ditch AJK01. Segment AJK01 was listed in 2004 as potentially impaired by manganese and DO. It should be noted that these facilities are located a significant distance upstream of the impaired segment. Table 5-15 contains a summary of available and pertinent DMR data for these point sources.

Table 5-15 Effluent Data from Point Sources Discharging Upstream of Bay Creek Ditch AJK01 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
IL DOC-Dixon Springs Work Camp 1999-2004 ILG551056	Hills Branch to Sugar Creek/Bay Creek Ditch AJK01	Maximum Flow	0.188 mgd	
		Design Average Flow	0.047 mgd	NA
		CBOD, 5-Day	7.82 mg/L	0.88
IL DOC-Vienna Correctional Ctr 1994-2004 IL0036757	Unnamed Tributary to Bay Creek/Bay Creek Ditch AJK01	Maximum Flow	1 mgd	
		Design Average Flow	0.42 mgd	NA
		CBOD, 5-Day	4.72 mg/L	14.0
		Nitrogen, Ammonia	3.67 mg/L	3.42

5.3.1.2 Cedar Creek Segment AJF 16

There are two permitted facilities whose discharges have the potential to reach Cedar Creek Segment AJF 16. Segment AJF 16 is listed for manganese and DO impairments. Table 5-16 contains a summary of available DMR data for these point sources. No manganese data were available.

Table 5-16 Effluent Data from Point Sources Discharging Upstream of Cedar Creek Segment AJF 16 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Patrician of Vienna 1999-2005 IL0053660	Max Creek/Cedar Creek Segment AJF 16	Maximum Flow	0.0062 mgd	
		Design Average Flow	0.0025 mgd	
		CBOD, 5-Day	24.0 mg/L	0.107
		Nitrogen, Ammonia	16.3 mg/L	0.086
Camp Ondessonk 1994-2004 IL0048381	Cedar Creek Segment AJF 16	Maximum Flow	0.01 mgd	
		Design Average Flow	.004 mgd	
		pH	6.88 su	15.5
		CBOD, 5-Day	6.12 mg/L	0.79
		Nitrogen, Ammonia	1.09 mg/L	0.035

5.3.1.3 Other Impaired Segments

There are no permitted facilities that discharge to Bay Creek Lake No. 5 or Vienna Correctional Center Lake.

5.3.2 Mining Discharges

There are no permitted mine sites or recently abandoned mines within the Bay Creek watershed.

5.4 Nonpoint Sources

There are many potential nonpoint sources of pollutant loading to the impaired segments in the Bay Creek watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems. Data were collected through communication with local NRCS, Soil and Water Conservation District (SWCD), Public Health Department, and County Tax Department officials.

5.4.1 Crop Information

A small portion of the land found within the Bay Creek watershed is devoted to crops. Corn and soybean farming account for approximately 5 percent and 9 percent of the watershed respectively. Tillage practices can be categorized as conventional till, reduced till, mulch-till, and no-till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture from County Transect Surveys. The most recent survey was conducted in 2006. Data specific to the Bay Creek watershed were not available; however, the Pope and Johnson County practices were available and shown in the following tables. Data from the 2006 survey will be used for Stage 3 if it becomes available.

Table 5-17 Tillage Practices in Pope County

Tillage System	Corn	Soybean	Small Grain
Conventional	33%	38%	0%
Reduced - Till	0%	0%	0%
Mulch – Till	5%	0%	0%
No – Till	63%	63%	100%

Table 5-18 Tillage Practices in Johnson County

Tillage System	Corn	Soybean	Small Grain
Conventional	75%	27%	0%
Reduced - Till	4%	10%	0%
Mulch – Till	0%	6%	0%
No – Till	21%	58%	100%

5.4.2 Animal Operations

Watershed specific animal numbers were not available for the Bay Creek watershed. Data from the National Agricultural Statistics Service were reviewed and are presented below to show countywide livestock numbers.

Table 5-19 Pope County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	9,139	6,983	-24%
Beef	D	D	NA
Dairy	D	D	NA
Hogs and Pigs	2,733	1,548	-43%
Poultry	110	91	-17%
Sheep and Lambs	D	67	NA
Horses and Ponies	NA	308	NA

Table 5-20 Johnson County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	18,093	17,190	-5%
Beef	8,441	9,187	9%
Dairy	56	175	213%
Hogs and Pigs	6,241	8,421	35%
Poultry	550	337	-39%
Sheep and Lambs	92	94	2%
Horses and Ponies	9	969	NA

The Illinois EPA provided a GIS shapefile illustrating the location of livestock facilities in the Bay Creek Basin. In 2001, Illinois EPA assessed the potential impact of each facility on water quality with regard to the size of the facility, the site condition and management, pollutant transport efficiency, and water resources vulnerability. This GIS data have been used as reference since the surveys were conducted at the beginning of the decade. One animal facility existed at the time of the survey. A hog farm at the Dixon Springs Agricultural Center was assessed as having a slight impact to its receiving water. Its receiving stream was listed as Sugar Creek.

5.4.3 Septic Systems

Many households in rural areas of Illinois that are not connected to municipal sewers make use of onsite sewage disposal systems, or septic systems. There are many types of septic systems, but the most common septic system is composed of a septic tank draining to a septic field, where nutrient removal occurs. However, the degree of nutrient removal is limited by soils and system upkeep and maintenance.

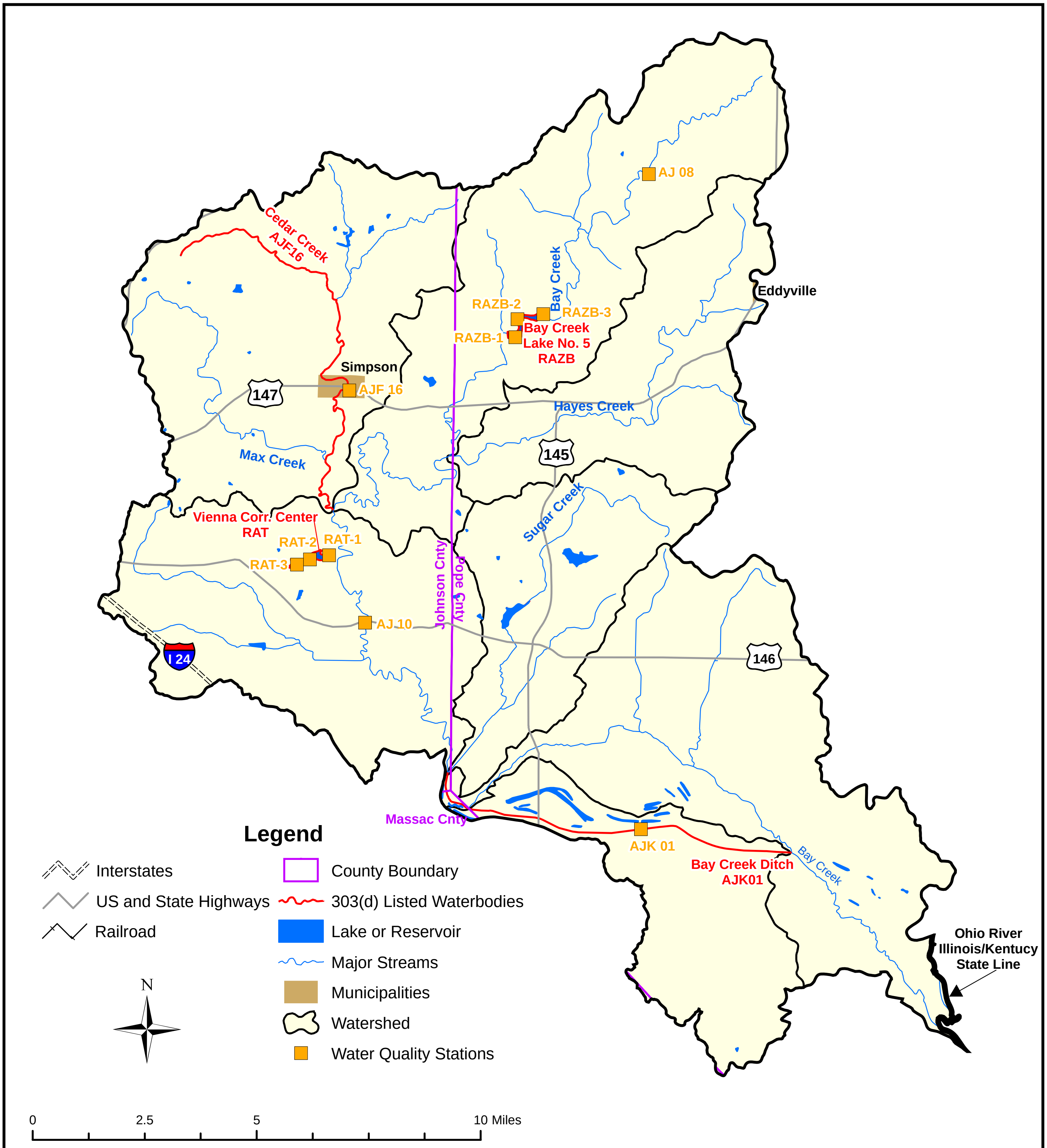
Information on septic systems was obtained for the two major counties, Johnson and Pope, within the Bay Creek watershed. Information on sewered and septic municipalities was obtained from the county health departments. However, the health departments were unable to provide estimates of the number of septic systems. Therefore, the tax assessor was contacted to provide estimates of the number of existing residences located in areas known to be served by septic systems. Table 5-21 is a summary of the available septic system data in the Bay Creek watershed. There are approximately 1,700 septic systems in the watershed.

Table 5-21 Estimated Septic Systems in the Bay Creek Watershed

County	Estimated No. of Septic Systems	Source of Septic Areas/ No. of Septic Systems
Johnson	950	Health Department/Tax Assessor, U.S. Census Bureau
Pope	790	Health Department/Tax Assessor
Massac	negligible	
Total	**1,740**	

5.5 Watershed Studies and Other Watershed Information

Previous planning efforts have been conducted within the Bay Creek watershed. An intensive survey of the Saline River/Bay Creek Basins was last conducted in the summer of 2000. Also, a diagnostic-feasibility study of Vienna Correctional Center Lake was prepared in 1997. Data from these reports have been used and incorporated in this report where appropriate.



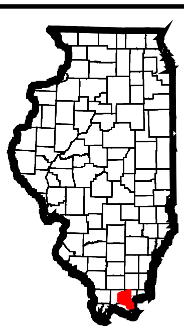


Figure 5-1
Water Quality Stations
Bay Creek Watershed

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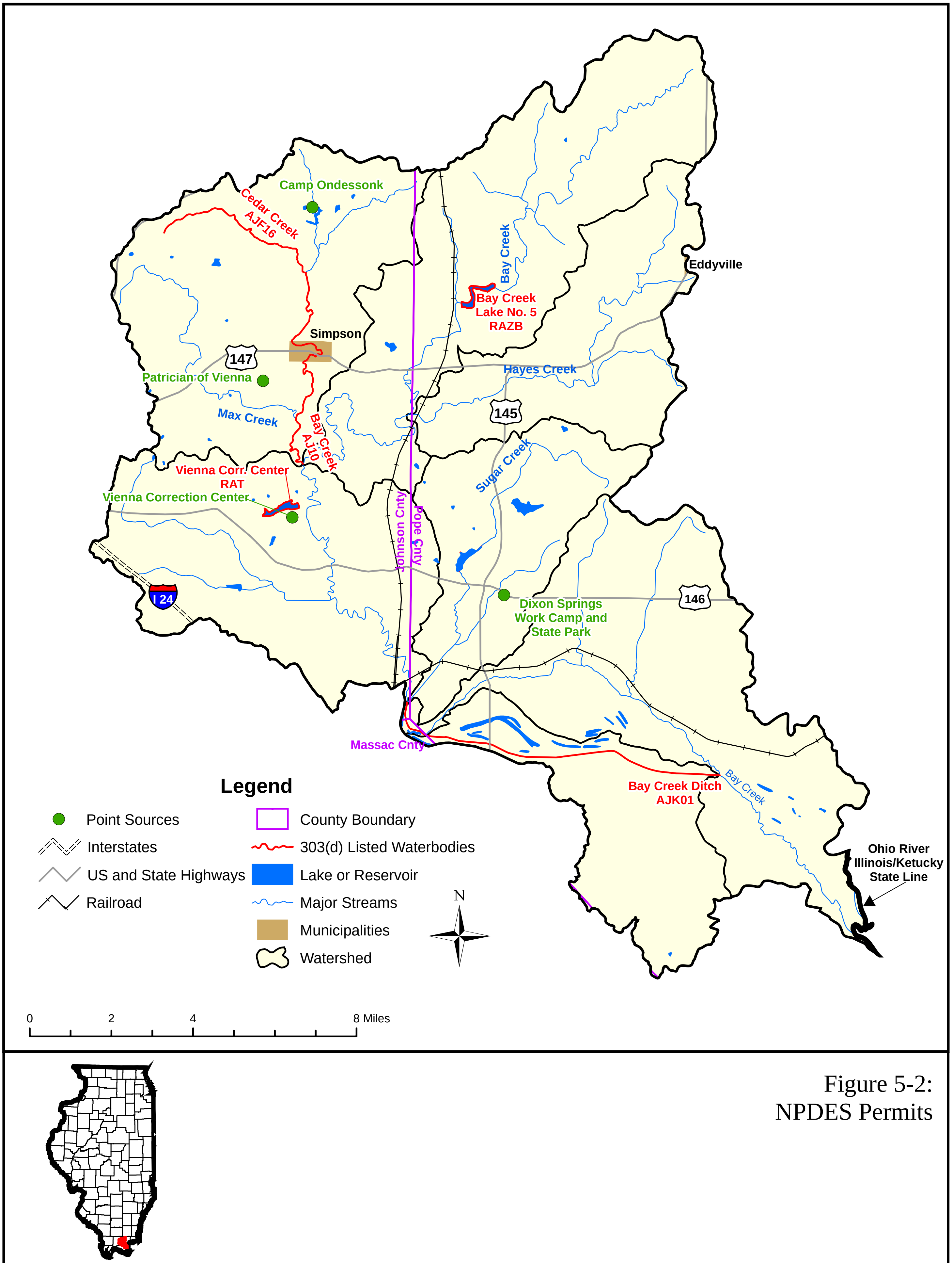

Figure 5-2:
NPDES Permits

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Section 6
Approach to Developing TMDL and Identification of Data Needs

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants impairing stream segments in the Bay Creek watershed, manganese and DO are the only parameters with numeric water quality standards. For the lakes found within the watershed, manganese and total phosphorus are the only parameters with numeric water quality standards. Illinois EPA believes that addressing these impairments should lead to an overall improvement in water quality due to the interrelated nature of the other listed pollutants. Refer to Table 1-1 for a list of all impairments within the Bay Creek watershed. Recommended technical approaches for developing TMDLs for streams and lakes are presented in this section. Additional data needs are also discussed.

6.1 Simple and Detailed Approaches for Developing TMDLs

The range of analyses used for developing TMDLs varies from simple to complex. Examples of a simple approach include mass-balance, load-duration, and simple watershed and receiving water models. Detailed approaches incorporate the use of complex watershed and receiving water models. Simple approaches typically require less data than detailed approaches and therefore these are the analyses recommended for the Bay Creek watershed except for stream segments where major point sources whose NDPES permit may be affected by the TMDL's WLA. Establishing a link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. As discussed above, this link can be established through a variety of techniques. The objective of the remainder of this section is to recommend approaches for establishing these links for the constituents of concern in the Bay Creek watershed.

6.2 Approaches for Developing TMDLs for Stream Segments in the Bay Creek Watershed

Approaches for developing TMDLs for areas without major point sources are described below.

6.2.1 Recommended Approach for DO TMDLs for Stream Segments without Major Point Sources

Segment AJF16 of Cedar Creek and segment AJK01 of the Bay Creek Ditch are impaired for dissolved oxygen. The data for these segments are limited but the collected samples do suggest impairment caused by DO. Because only one data sample has been collected on segment AJF16 since 1990 and no data have been collected since 1987 on segment AJK01, it was recommended that more data be collected in order to confirm the impairment and support model development. If further data collection indicates a DO impairment, a simplified approach that involves simulating pollutant oxidation and stream reaeration only within a spreadsheet model is recommended for DO TMDL development. This model simulates steady-state stream DO as a function of carbonaceous and nitrogenous pollutant oxidation and atmospheric reaeration. The model allows for non-uniform stream hydraulics, hydrology, and pollutant loadings at any level of segmentation. It is also free of numerical dispersion as it relies on well-known analytical solutions rather than numerical approximations of the fundamental equations. The model assumes plug flow (no hydrodynamic dispersion), which is likely an acceptable assumption for most small to medium sized streams. The model also does not incorporate the impacts of stream plant life, which generally require site-specific data for meaningful parameterization. A watershed model will not be used for these segments. Using the spreadsheet model iteratively, the BOD loads estimated to cause the DO impairments and to maintain a DO of 5.0 mg/L will be calculated. These calculated loads will become the basis for recommending TMDL reductions if necessary.

6.2.2 Recommended Approach for Manganese TMDLs

Segment AJF16 of Cedar Creek and AJK01 of Bay Creek Ditch are listed for manganese. No manganese data have been collected on the impaired segment of Bay Creek Ditch since 1987 and only one sample has been collected on Cedar Creek. It is recommended that more data be collected on these segments to confirm that manganese is causing impairment. No apparent sources of manganese have been identified to date and therefore, if more data become available and confirm impairment still exists, an empirical loading and spreadsheet analysis will be utilized to calculate this TMDL.

6.3 Approaches for Developing a TMDL for Lake Segments in the Bay Creek Watershed

Recommended TMDL approaches for the Vienna Correctional Center Lake and Bay Creek Lake Number 5 will be discussed in this section. It is assumed that enough data exists to develop a simple model for use in TMDL development.

6.3.1 Recommended Approach for Total Phosphorus TMDLs

Bay Creek Lake Number 5 is impaired for phosphorus. The BATHTUB model is recommended for phosphorus assessments in this reservoir. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that accounts for advective and diffusive transport, and nutrient sedimentation. The model relies on empirical relationships to predict lake trophic conditions and subsequent DO conditions as functions of total phosphorus and nitrogen loads, residence time, and mean depth. (USEPA 1997). Oxygen conditions in the model are simulated as meta and hypolimnetic depletion rates, rather than explicit concentrations. Watershed loadings to the lakes will be based on empirical data or tributary data available in the lake watershed.

6.3.2 Recommended Approach for Manganese TMDL

The Vienna Correctional Center Lake is a source of public water. Therefore, the applicable water quality standard for manganese in the lake is 150 µg/L. For this TMDL, manganese will not be analyzed because it is assumed that development of a total phosphorus TMDL will control the manganese concentrations. The TMDL will first investigate total phosphorus and dissolved oxygen levels throughout the water column. The lake is not impaired for total phosphorus or DO, however compliance for these parameters is assessed at one-foot depth from the surface. A preliminary review of DO concentrations at greater depths shows that DO levels in the summer have been recorded as low as 0 mg/L (sampled below 17 feet in July 1994). The manganese target will then be maintenance of hypolimnetic DO concentrations above zero, because the only controllable source of manganese to the lake is the release of manganese from lake sediments during periods when there is no DO in lake bottom waters. The cause of the lack of DO in lake bottom waters is likely caused by nutrients, it is recommended that BATHTUB be utilized to calculate this TMDL.

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Section 7
Methodology Development for the Bay Creek Watershed

7.1 Methodology Overview

Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Bay Creek watershed. Watershed characterization was discussed in Sections 1 through 5. The watershed has no major population centers, mining or major animal operations that could potentially be contributing to pollutant levels in the watershed.

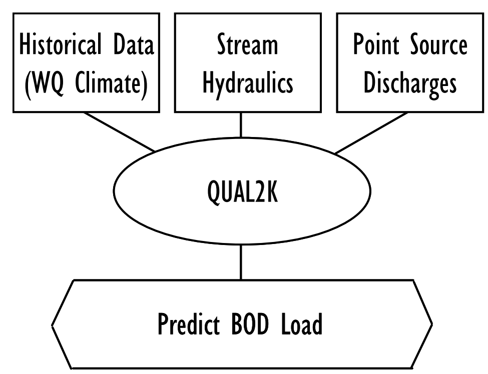
Table 7-1 Methodologies Used to Develop TMDLs in the Bay Creek Watershed

Segment Name/ID	Cause of Impairment	Methodology
Cedar Creek – AJF16	Dissolved Oxygen	QUAL2-K
Cedar Creek – AJF16	Manganese	Empirical Analysis
Bay Creek Ditch – AJK01	Dissolved Oxygen	QUAL2-K
Vienna Correction Center Lake – RAT	Manganese(1)	BATHTUB
Bay Creek Lake No. 5 – RAZB	Total Phosphorus	BATHTUB

(1) The cause of impairment for segment RAT is manganese. However, a TMDL was developed for total phosphorus in order to control manganese. More discussion is provided in Section 7.1.4

7.1.1 QUAL2K Overview

The QUAL2K model was used to develop the dissolved oxygen TMDLs for segment AJF16 of Cedar Creek and segment AJK01 of Bay Creek Ditch. QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady state hydraulics and allows for point source inputs, diffuse loading and tributary flows. Historic water quality data, observed hydraulic information, and point source discharge data were coupled with model defaults to predict steady state dissolved oxygen profiles thought the modeled system.



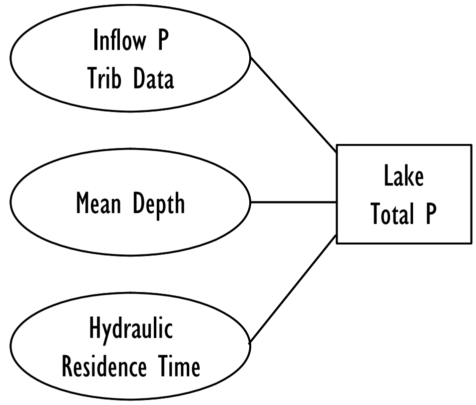
Schematic 1

7.1.2 Empirical Analysis of Manganese Overview

An empirical analysis of manganese was performed for Cedar Creek segment AJF16. Due to limited data availability, the analysis included a spreadsheet evaluation of recently collected data and one historic sample in relation to the water quality standard. As discussed in previous sections, Stage 2 data collection determined that segment AJK01 of the Bay Creek Ditch was no longer impaired by manganese and no TMDL was developed for this segment.

7.1.3 BATHTUB Overview for Bay Creek Lake No. 5

The approach taken for TMDL analysis for total phosphorus in Bay Creek Lake No. 5 included using observed data coupled with available tributary data as inputs to the BATHTUB model. This method required inputs from several sources including online databases and GIS-compatible data.



Schematic 2

Schematic 2 shows the data inputs for the BATHTUB model that were used to calculate the TMDLs. Subbasin flows were estimated using the area ratio method and phosphorus loadings to the lake from the surrounding watersheds were estimated using the historic water quality data available on Bay Creek upstream of the lake.

Once the subbasin flows and concentrations were estimated, they were used as input for the BATHTUB model. The BATHTUB model uses empirical relationships between mean reservoir depth, total phosphorus inputted to the lake, and the hydraulic residence time to determine in-reservoir concentrations (see Schematic 2).

7.1.4 BATHTUB Overview for Vienna Correctional Center Lake

The water quality standard for manganese in Illinois waters designated as public water supply is 150 µg/l, and the general use standard is 1,000 µg/l. The primary source of manganese to the lake is the release of manganese from lake sediments during periods when there is no dissolved oxygen in lake bottom waters. The lack of dissolved oxygen in lake bottom waters is presumed to be due to the effects of nutrient enrichment, as there are no significant sources of oxygen demanding materials to the lake. For this reason, release from the lake sediments is considered a controllable source, and attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target is therefore set as a total phosphorus concentration of 0.050 mg/L.

Total phosphorus assessments are made using data collected at one-foot depth only. Although the lake was not listed on the Illinois 303(d) list for impairment caused by total phosphorus, further review of available data showed that with the inclusion of data collected as part of a 1997 diagnostic-feasibility study of the lake, the average concentrations of total phosphorus at site RAT-1 were above 0.05mg/L (further discussion provided in section 7.2.5).

The approach taken for the TMDL analysis for total phosphorus in the Vienna Correctional Center Lake included using observed data coupled with available tributary data as inputs to the BATHTUB model. This method required inputs from several sources including online databases and GIS-compatible data.

Schematic 2 shows the data inputs for the BATHTUB model that were used to calculate the TMDLs. Subbasin flows were estimated using the area ratio method and phosphorus loadings to the lake from the surrounding watersheds were based on data collected during the 1995 lake study.

Once the subbasin flows and concentrations were estimated, they were used as input for the BATHTUB model. The BATHTUB model uses empirical relationships between mean reservoir depth, total phosphorus inputted to the lake, and the hydraulic residence time to determine in-reservoir concentrations (see Schematic 2).

7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine DO, manganese and total phosphorus levels in the impaired waterbodies in the Bay Creek watershed.

7.2.1 Watershed Delineations and Flow Estimations

As discussed in the Section 2, there are no USGS stream gages within the watershed that have current, or even recent, streamflow data. Therefore, the drainage area ratio method, represented by the following equation, was used to estimate flows for each impaired waterbody segment.

$$Q_{gaged}\left(\frac{Area_{ungaged}}{Area_{gaged}}\right) = Q_{ungaged}$$

where Q_{gaged} = Streamflow of the gaged basin
$Q_{ungaged}$ = Streamflow of the ungaged basin
$Area_{gaged}$ = Area of the gaged basin
$Area_{ungaged}$ = Area of the ungaged basin

The assumption behind the equation is that the flow per unit area is equivalent in watersheds with similar landuse and soil characteristics. Therefore, the flow per unit area in the gaged watershed multiplied by the area of the ungaged watershed estimates the flow for the ungaged watershed.

USGS gage 03384450 (Lusk Creek near Eddyville, Illinois) was chosen as an appropriate gage from which to estimate flows in the Bay Creek watershed. The Lusk Creek watershed is approximately 10 miles east of the Bay Creek watershed. The gage drains an area that contains similar landuses and receives comparable precipitation throughout the year. Gage 03384450 captures flow from a drainage area of 43 square miles and has an average flow rate of 60 cfs. Table 7-2 contains the watershed areas for each impaired segment as well as the estimated mean daily flows.

Table 7-2 Estimated Flow Rates for Impaired Segments in the Bay Creek Watershed

Segment Name/ID	Drainage Area (sq mile)	Estimated Average Flow Rate (cfs)
Cedar Creek – AJF16(1)	21.3	29.8
Bay Creek Ditch – AJK01(1)	167.2	233
Vienna Correction Center Lake – RAT	1.5	2.1
Bay Creek Lake No. 5 – RAZB	24.0	32.5

(1)Areas and flow rates shown are for downstream sampling location on each segment

7.2.2 QUAL2K Model

QUAL2K (Q2K) is a river and stream water quality model that is intended to represent a modernized version of the QUAL2E (Q2E) model (Brown and Barnwell 1987). The original Q2E model is well-known and USEPA-supported. The modernized version has been updated to use Microsoft Excel as the user interface and has expanded the options for stream segmentation as well as a number of other model inputs. Q2K simulates DO dynamics as a function of nitrogenous and carbonaceous oxygen demand, atmospheric reaeration, SOD, and plant photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the growth and abundance of floating (phytoplankton) and attached (periphyton) algae (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. Headwater, point source, non-point source loadings and flows are explicitly input by the user. The model simulates steady-state diurnal cycles. Model parameter default values are provided in the model based on past studies and are recommended in the absence of site-specific information.

7.2.2.1 QUAL2K Inputs

Table 7-3 contains the categories of data required for the Q2K model along with the sources of data used to analyze segments AJF16 of Cedar Creek and AJK01 of Bay Creek Ditch.

Table 7-3 Q2K Data Inputs

Input Category	Data Source
Stream Segmentation	GIS data
Hydraulic characteristics	CDM field survey and GIS analysis
Headwater water quality conditions	Stage 2 data collected at AJF16A and AJK01A
Meteorologic conditions	National Climatic Data Center
Point Source contributions	Illinois EPA

Empirical data amassed during Stage 2 of TMDL development were used to build the Q2K models for the impaired segments. In addition to the empirical data, Stage 2 observations and GIS analysis were used for the Q2K model.

7.2.2.1.1 Stream Segmentation

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Figures 7-1 and 7-2 show the stream segmentation used for the Q2K models for Cedar Creek segment AJF16 and Bay Creek Ditch AJK01, respectively.

For these models, both segments were broken into two reaches. Each reach was represented by data collected at the water quality site located in the specific reach. The headwater reaches are represented by data collected at sites AJF16A and AJK01A.

7.2.2.1.2 Hydraulic Characteristics

Stream hydraulics were specified in the model based on stream gaging performed during Stage 2, aerial photographs of the segment and site observations noted during Stage 2 data collection. Appendix D contains the Stage 2 report which also includes the photographs of Bay Creek Ditch and Cedar Creek sampling sites from the Stage 2 field survey.

7.2.2.1.3 Headwater Conditions

The headwater flow and concentrations are user-specified in the model and represent the systems' upstream boundary condition. Measured concentration data were available from sampling locations AJK01A and AJF16A, which are located within the upper reach of each impaired segment. Samples were collected during the fall of 2006.

Flows for the headwater condition were determined using historic data from USGS site 03384450 as discussed in Section 7.2.1. The average historic flows from applicable sample dates were used for headwater flow conditions.

7.2.2.1.4 Climate

Q2K requires inputs for climate. Hourly temperature and wind speed data from Paducah, Kentucky were used for the models.

7.2.2.1.5 Point Sources

A number of small point sources discharge within the Cedar Creek and Bay Creek Ditch watersheds. Two point sources (Camp Ondessonk and the Patrician of Vienna) discharge within the Cedar Creek watershed (see Figure 7-1). Additionally, two point sources (Dixon Springs and Vienna Correction Center) discharge within the Bay Creek Ditch watershed (see Figure 7-2). Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge limit data were used for model inputs. Tables 7-4 and 7-5 contain information for each facility within each watershed. Flow information was available for each discharger; however, effluent concentration data are available only for parameters that are sampled per permit requirements.

Table 7-4 Point Source Discharges within the Cedar Creek Watershed

Facility Name	Permit Number	Segment Number	Permitted Facility Flows (mgd)	Permitted DO (mg/L)	Permitted CBOD (mg/L)	Permitted Ammonia (mg/L)
Patrician of Vienna	IL0053660	2	0.0025	>6	10	2.5
Camp Ondessonk	IL0048381	1	0.004	>6	10	1.5

Table 7-5 Point Source Discharges within the Bay Creek Ditch Watershed

Facility Name	Permit Number	Segment Number	Permitted Facility Flows (mgd)	Permitted DO (mg/L)	Permitted CBOD (mg/L)	Permitted Ammonia (mg/L)
Dixon Springs Work Camp	ILG551056	1	0.047	NA	25	NA
Vienna Correctional Center	IL0036757	1	0.42	NA	10	1.5

7.2.2.1.6 Qual2K Calibration

Sufficient water quality data were not available to perform a full calibration of model kinetic and transport rates. Specifically, a spatial distribution of measured data is lacking to guide parameterization of this steady-state model. All available data are limited to two sample dates at two sampling locations on each segment. Therefore, all model rates, including key rates of BOD decay, nitrification, and algae growth, were maintained at default values. Model hydrodynamic dispersion, reaeration, and sediment oxygen demand (SOD) are calculated internally in the model based on physical, chemical, and biological conditions. "Truth checking" was performed on key model calculated parameters, such as reaeration rates, SOD fluxes, temperature, and phytoplankton concentrations using literature values and best professional judgment.

Appendix E contains the model input/output worksheets.

7.2.3 Empirical Analysis of Manganese

Table 7-6 Total Manganese Samples on Cedar Creek Segment AJF16

Site	Date	Result (µg/L)
AJF16	10/2/00	510
AJF02	7/8/05	**1100**
AJF01	7/8/05	830
AJF01	6/13/05	120
AJF16	9/25/06	250
AJF16	11/3/06	120
AJF16A	9/25/06	230
AJF16A	11/2/06	77

Load duration curves are generally used to gain understanding of the range of loads allowable throughout the flow regime of a stream. Insufficient data were available to develop a load-duration curve for segment AJF16 of Cedar Creek. Only six samples were available between the two sampling locations on the segment (Table 7-6). The load reduction needed to meet the water quality target was determined by reducing the sample that exceeded the target to bring the concentration value down to the water quality standard. Figure 7-3 shows the total manganese target (1,000 µg/L) plotted against the empirical data. The chart shows that the exceedence occurred during a time of low flow. The exceedence value is 1.1 mg/L and needs to be reduced by 9 percent in order to meet the instream water quality standard.

7.2.4 BATHTUB Development for Bay Creek Lake No. 5

Bay Creek Lake No. 5 is located northeast of Simpson in Pope County, was constructed in 1976, and has a surface area of 118 acres. The dam has a height of 51 feet and the reservoir has a maximum storage capacity of 13,779 acre-feet and a normal storage of 1,690 acre-feet. The lake is part of the Shawnee National Forest and the Bay Creek Wilderness and is also known as Millstone Lake. The BATHTUB model was used to develop a total phosphorus TMDL for this lake

BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections.

7.2.4.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in Section 2, the average annual precipitation input to the model was 48.3 inches, and the average annual evaporation input to the model was 40.71 inches (ISWS 2007). The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km^2-yr (USACE 1999b).

7.2.4.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Bay Creek Lake No. 5 is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 7-4. Segmentation was established based on available water quality and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the 2002 data from the water quality stations discussed in the Stage 1 report. Segment lengths and surface areas were determined in GIS. These data are shown below (Table 7-7) for reference. A single layer model was utilized for the analyses performed here. The depth to the metalimnion was assumed to be the average depth of the lake.

Table 7-7 Bay Creek Lake No. 5 Segment Data

Segment	Surface Area (km2)	Segment Length (km)	Average Depth (ft)
RAZB-1	0.102	0.49	15.6
RAZB-2	0.076	0.62	14.9
RAZB-3	0.136	0.96	6.1

7.2.4.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. See Figure 7-4 for subbasin boundaries. The watershed was broken up into four tributaries for purposes of the model. There is one tributary stream that flows into the Bay Creek

No. 5 Lake and three areas of direct overland flow (one for each lake segment). Bay Creek flows into segment RAZB-3.

As discussed in Section 7.2.1, there are no flow gages within the watershed and the drainage area ratio method was used to estimate flows. The total mean flow into Bay Creek Lake No. 5 was estimated to be 32.5 cfs. The flow contribution from each tributary was estimated by multiplying the average inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 7-8.

Table 7-8 Bay Creek Lake No. 5 Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (ac)	Flow Rate (cfs)
Bay Creek	Segment 1: RAZB-3	14880.7	31.52
Overland Flow to RAZB-3	Segment 1: RAZB-3	274.3	0.58
Overland Flow to RAZB-2	Segment 2: RAZB-2	66.7	0.14
Overland Flow to RAZB-1	Segment 3: RAZB-1	121.1	0.26
	TOTAL	15342.8	32.5

Bay Creek sampling location AJ08 is located approximately five miles upstream of Bay Creek Lake No. 5. Phosphorus samples were collected twice during the year 2000. Dissolved and total phosphorus concentrations were measured on August 1 and October 2 of the year. A sediment sample was also taken on August 1.

Table 7-9 contains the phosphorus data collected at this location. There is no numeric standard for total phosphorus in stream segments, but both samples were below the applicable lake standard.

Table 7-9 Bay Creek Lake No. 5 Tributary Phosphorus Data Collected at Sampling Location AJ08

Date	Parameter	Result	Units
8/1/2000	Total Phosphorus, sediment	198	mg/kg
8/1/2000	Dissolved Phosphorus	0.01	mg/L
8/1/2000	Total Phosphorus	0.01	mg/L
10/2/2000	Dissolved Phosphorus	0.01	mg/L
10/2/2000	Total Phosphorus	0.01	mg/L

A phosphorus concentration of 0.01 mg/L and the flow data provided in Table 7-8 were used to determine loadings. The phosphorus load from each tributary was determined by multiplying the total phosphorus load by the ratio of the subbasin areas. To obtain phosphorus concentrations for each tributary, the nutrient mass was divided by the volume of flow.

7.2.4.4 BATHTUB Confirmatory Analysis

Available lake historical water quality data are summarized in Section 5 of the Stage 1 report. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

The Bay Creek Lake No. 5 BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. The lake concentrations are higher than the incoming tributary concentrations indicating that sediment loading within the lake may be occurring. Therefore, in order to achieve a calibration, the model's internal loading values were adjusted for each segment. Table 7-10 shows the results of this calibration effort. Appendix G contains Bay Creek Lake No. 5 model files.

Table 7-10 Summary of Model Confirmatory Analysis- Lake Total Phosphorus (mg/L)

Lake Site	Observed	Predicted	Internal Load (mg/m3/yr)
Segment 1 : RAZB-3	0.0648	0.0641	1.66
Segment 2 : RAZB-2	0.0336	0.0477	0
Segment 3 : RAZB-1	0.0332	0.0337	0
Lake Average	0.0470	0.0503	

7.2.5 BATHTUB Development for Vienna Correctional Center Lake

Vienna Correctional Center Lake is located east of Vienna, Illinois in Johnson County, and was constructed in 1965, and has a surface area of 76.7 acres. The reservoir has a normal storage volume of 1,084 acre-feet. The lake was listed on the 2004 303(d) list for public water supply use impairment by manganese.

The BATHTUB model was used to evaluate total phosphorus levels in the Vienna Correctional Center Lake. BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections.

7.2.5.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in Section 2, the average annual precipitation input to the model was 48.3 inches, and the average annual evaporation input to the model was 40.71 inches (ISWS 2007). The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km^2-yr (USACE 1999b).

7.2.5.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Vienna Correctional Center Lake is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 7-5. Segmentation was established based on available water quality and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by an average of water quality stations collected between 1995 and 1999. In 1997 a diagnostic-feasibility study was completed for the Vienna Correctional Center Lake. The data from this study, along with the ambient data collected by Illinois EPA in 1999 were used to develop the BATHTUB model for the lake. The average of available data are shown in Table 7-11.

Segment lengths and surface areas were determined in GIS. A single layer model was utilized for the analyses performed here. The depth to the metalimnion was assumed to be the average depth of the lake.

Table 7-11 Vienna Correctional Center Lake Segment Data

Segment	Surface Area (km2)	Segment Length (km)	Average Depth (ft)
RAT-1	0.17	0.73	20.2
RAT-2	0.08	0.51	13.4
RAT-3	0.05	0.26	8.0

7.2.5.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. See Figure 7-5 for subbasin boundaries. The watershed was broken up into three tributaries for purposes of the model. There are three areas of direct overland flow (one for each lake segment).

As discussed in Section 7.2.1, there are no flow gages within the watershed and the drainage area ratio method was used to estimate flows. The total mean flow into the Vienna Correctional Center Lake watershed was estimated to be 0.06 cfs. The flow contribution from each tributary was estimated by multiplying the total mean annual inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 7-12.

The storage volume for Vienna Correctional Center Lake of 1,084 acre-feet was obtained from the Illinois State Water Survey (Contract Report 619 – July 1997). The estimated inflow from watershed runoff is 2.1 cfs. Additionally, the Vienna Correctional Center uses the lake as a drinking water supply and draws an average of 490,000 gallons per day from the lake.

Table 7-12 Vienna Correctional Center Lake Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (ac)	Flow Rate (cfs)
Overland Flow to RAT-3	Segment 1: RAT-3	669.3	1.83
Overland Flow to RAT-2	Segment 2: RAT-2	53.7	0.15
Overland Flow to RAT-1	Segment 3: RAT-1	38.6	0.11
	TOTAL	761.6	2.08

To determine phosphorus loads into the lake, a phosphorus concentration of 0.115 mg/L and the flow data provided in Table 7-11 were used to determine loadings. The concentration data was based upon concentration data from the Illinois State Water Survey (Contract Report 619 – July 1997). The phosphorus load from each tributary was determined by multiplying the total phosphorus load by the ratio of the subbasin areas. To obtain phosphorus concentrations for each tributary, the nutrient mass was divided by the volume of flow.

7.2.5.4 BATHTUB Confirmatory Analysis

Available lake historical water quality data from the 1997 lake study and ambient Illinois EPA data from 1999 were used to confirm the model. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

The Vienna Correction Center Lake BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. The lake concentrations are higher than the incoming tributary concentrations indicating that sediment loading within the lake may be occurring. Therefore, in order to achieve a calibration, the model’s internal loading values were adjusted for each segment. The results of this exercise are shown in Table 7-13.

Table 7-13 Summary of Model Confirmatory Analysis- Lake Total Phosphorus (mg/L)

Lake Site	Observed	Predicted	Internal Loading
Segment 1 : RAT-3	0.031	0.056	0
Segment 2 : RAT-2	0.033	0.057	0
Segment 3 : RAT-1	0.063	0.062	0.35
Lake Average	0.050	0.060	

Although an exact match at each site was not achieved, it is thought that the observed concentrations are likely lower than actual values because only surface samples were available at RAT-2 and RAT-3. Because RAT-1 had samples available from both surface and bottom waters, it was determined that a match at this site would lend more confidence to calibration efforts. The internal loading rates suggest that phosphorus loading from sediments is occurring near the dam where depths are greatest and the effects of low dissolved oxygen levels near the bottom are likely to be more prevalent. Appendix H contains Vienna Correctional Center Lake model files.

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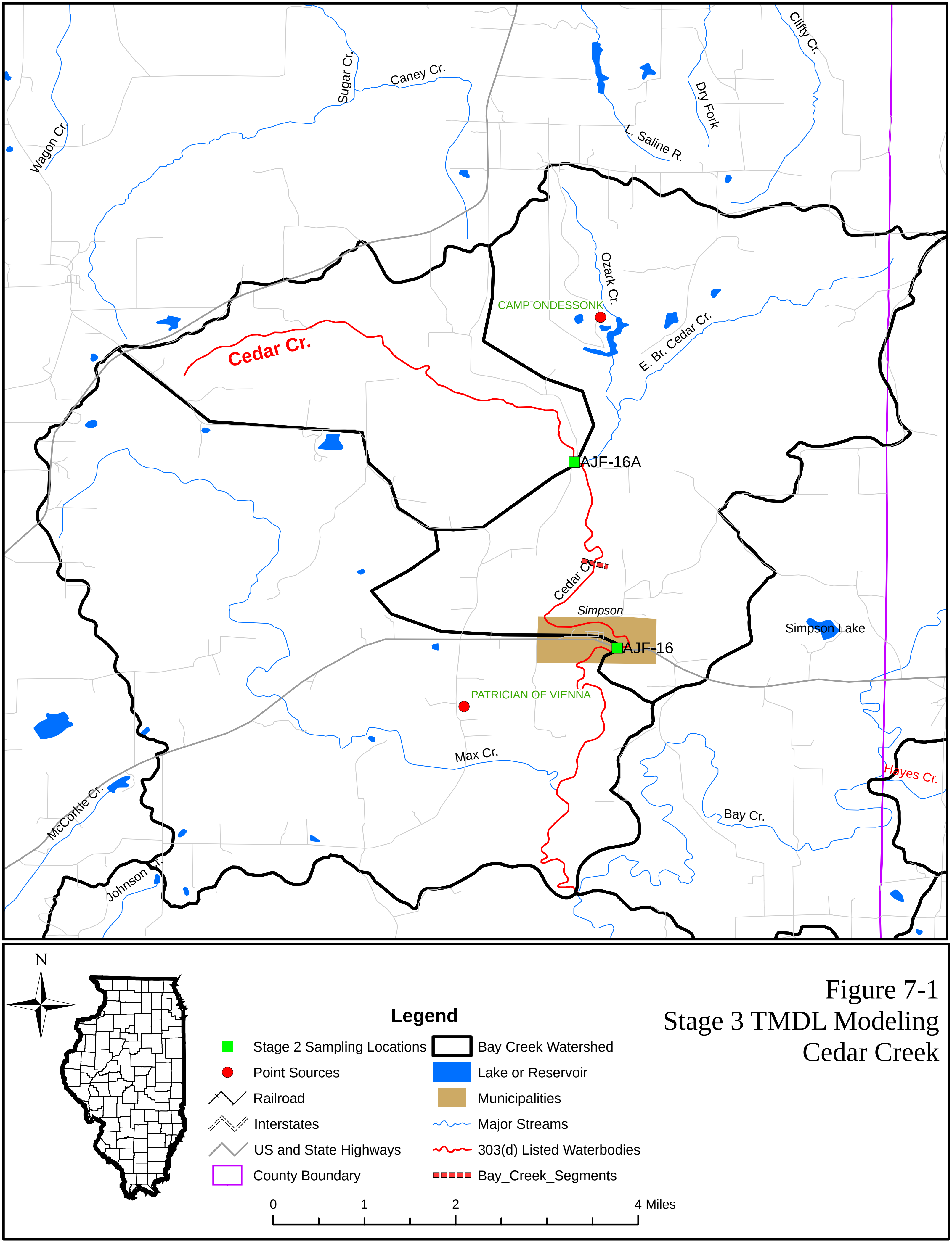

Figure 7-1
Stage 3 TMDL Modeling
Cedar Creek

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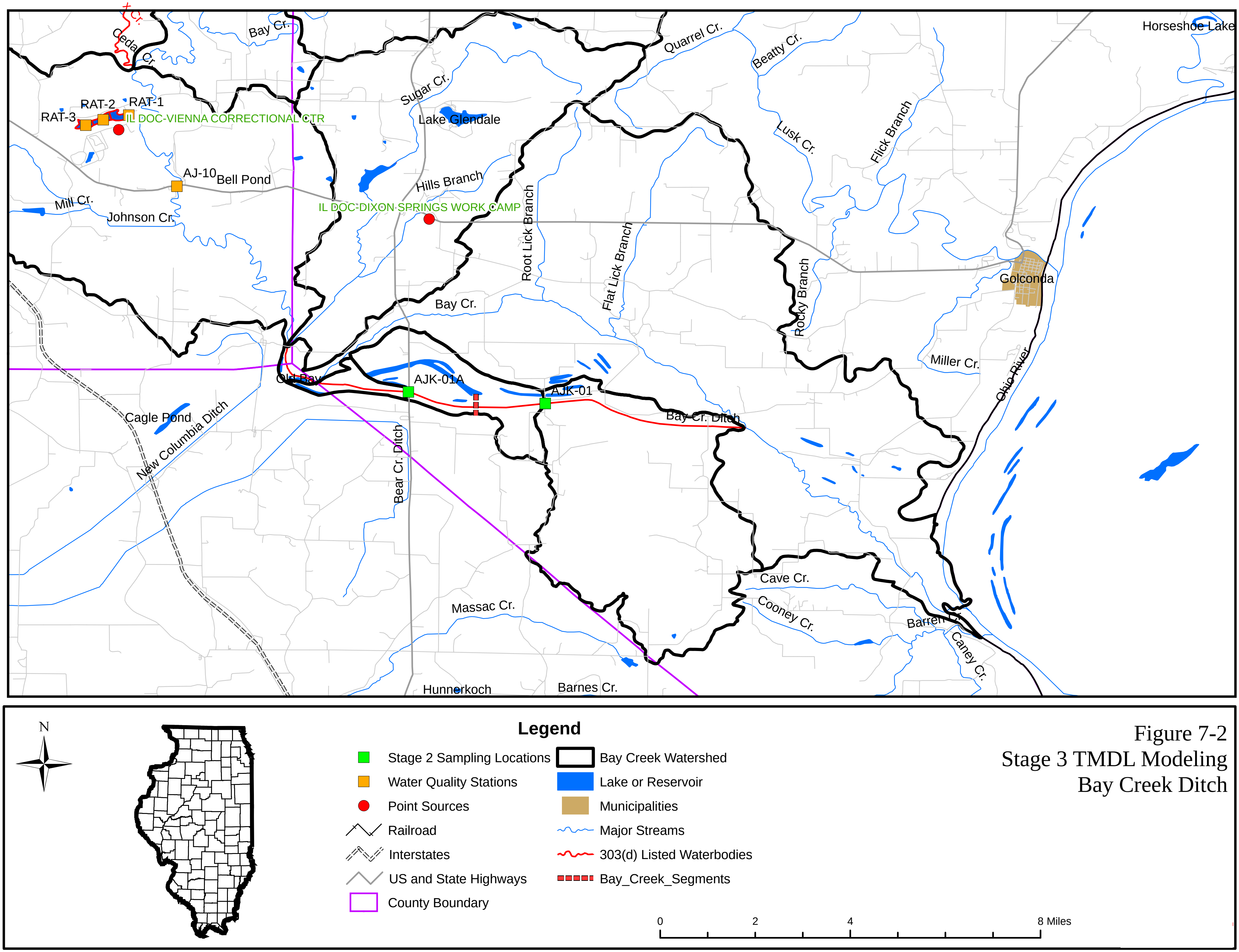

Figure 7-2
Stage 3 TMDL Modeling
Bay Creek Ditch

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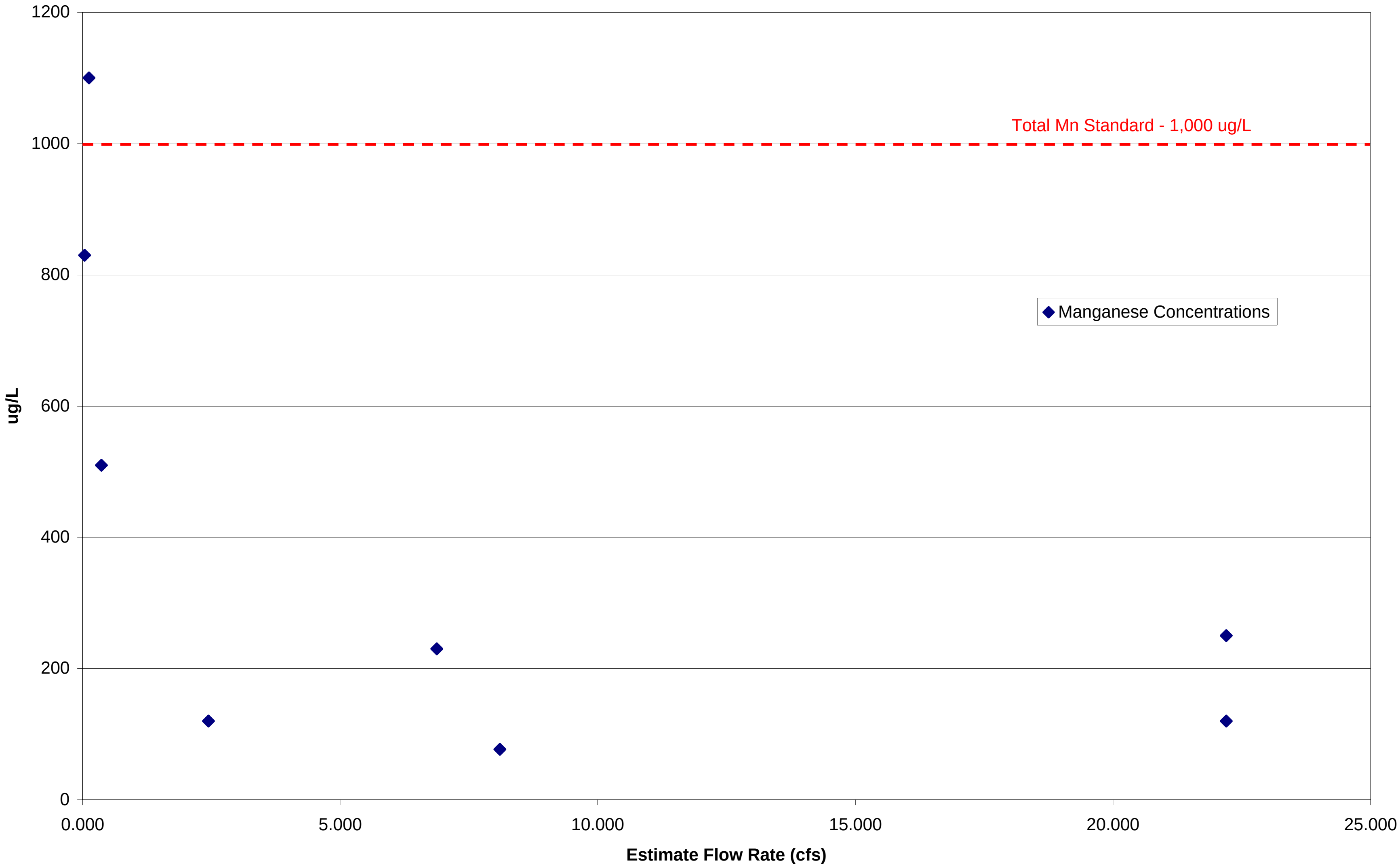

Figure 7-3:
Total Manganese Concentrations
Cedar Creek

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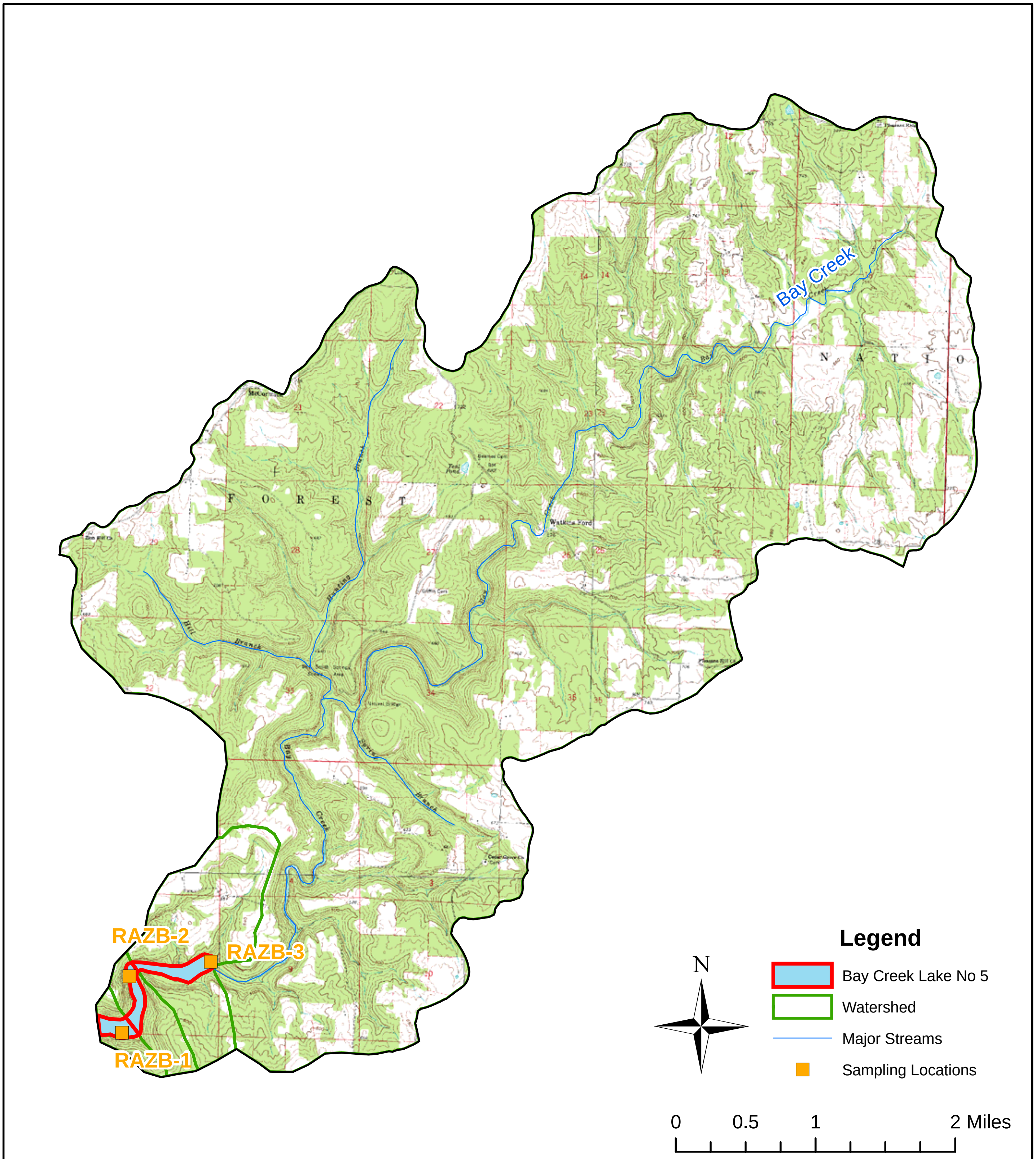

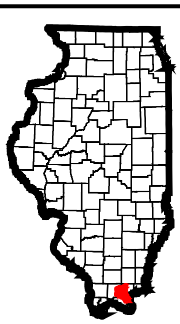

Figure 7-4:
BATHTUB Segmentation
Bay Creek Lake No. 5

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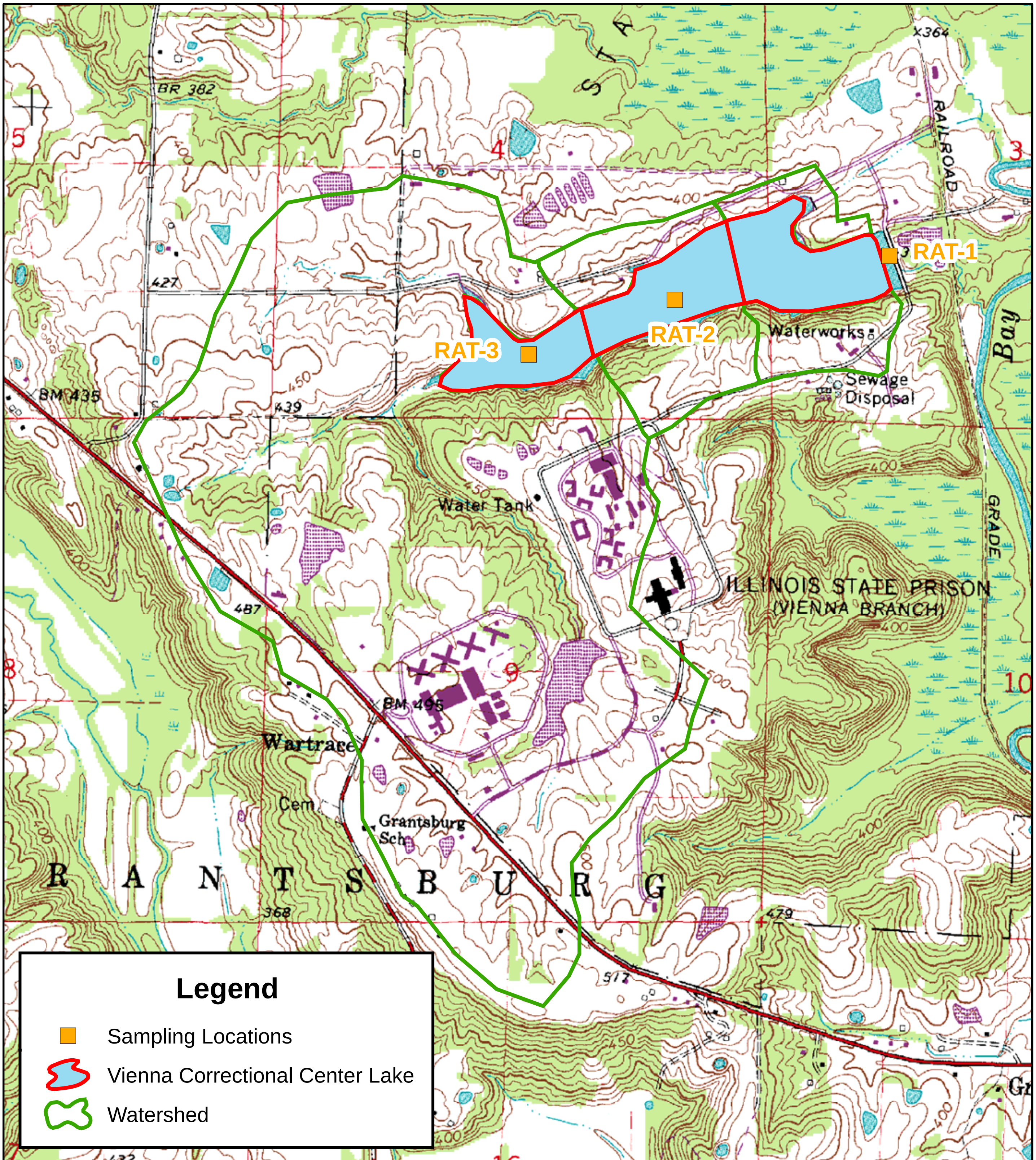

Figure 7-5:
BATHTUB Segmentation
Vienna Correctional Center Lake

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Section 8
Total Maximum Daily Load for the Bay Creek Watershed

8.1 TMDL Endpoints for the Bay Creek Watershed

The TMDL endpoints for manganese, DO and total phosphorus are summarized in Table 8-1. For manganese, the concentrations must be below the TMDL endpoint. For DO, concentrations must be greater than 6.0 mg/L for 16 hours of any 24-hour period and must never be below 5.0 mg/L. The total phosphorus endpoint is a maximum concentration of 0.05 mg/L. These endpoints are based on protection of aquatic life in the Bay Creek Ditch, Cedar Creek and Bay Creek Lake No. 5 as well as the public water supply use of Vienna Correctional Facility Lake. Some of the average concentrations, which are based on limited data sets, meet the desired endpoints. However, the data sets have maximum or minimum values, presented in Section 5 and in the Stage 2 report, that do not meet the desired endpoints and this was the basis for TMDL analysis. Further monitoring as outlined in the monitoring plan presented in Section 9, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired segments in the Bay Creek Watershed

Segment	Parameter	TMDL Endpoint (Regulatory Citation)	Average Observed Value
Bay Creek Ditch	DO	6.0 mg/L during 16 hours of any 24-hour period (302.206)	5.3 mg/L
Cedar Creek	DO	6.0 mg/L during 16 hours of any 24-hour period (302.206)	8.2 mg/L
Cedar Creek	Manganese	1,000 ug/L (302.208g)	405 ug/L
Bay Creek Lake No. 5	Total Phosphorus	0.05 mg/L (302.205)	0.047 mg/L
Vienna Correctional Center Lake	Total Phosphorus	0.05 mg/L (302.205)	0.05 mg/L

DO values represent average values of continuous monitoring performed on each segment.

8.2 Pollutant Source and Linkages

Pollutant sources for the Bay Creek watershed were identified through the existing data review described in Sections 1 through 5 as well as modeling described in Section 7. Based on the data review, the source of manganese in Cedar Creek segment AJF16 is natural background levels and potentially groundwater sources. The likely source of oxygen demanding constituents is primarily factors occurring during low flow conditions, such as slow-moving waters and increased water temperatures promoting algal growth. Nonpoint source loads in the watershed may also contribute to low DO in the streams. Sources of phosphorus to Bay Creek Lake No. 5 include nonpoint sources from tributary areas, sedimentation and resulting internal loading while sources of phosphorus to Vienna Correctional Center Lake are dominated by internal loading from nutrient rich sediments.

8.3 Allocation

As explained in the Section 1, the TMDL for impaired segments in the Bay Creek watershed will address the following equation:

$$\textbf{TMDL = LC = } \Sigma \textbf{WLA + } \Sigma \textbf{LA + MOS}$$

where:
- LC = Maximum amount of pollutant loading a water body can receive without violating water quality standards
- WLA = The portion of the TMDL allocated to existing or future point sources
- LA = Portion of the TMDL allocated to existing or future nonpoint sources and natural background
- MOS = An accounting of uncertainty about the relationship between pollutant loads and receiving water quality

Each of these elements will be discussed in this section as well as consideration of seasonal variation in the TMDL calculation.

8.3.1 Cedar Creek Manganese TMDL

8.3.1.1 Loading Capacity

The LC is the maximum amount of manganese that Cedar Creek can receive and still maintain compliance with the water quality standards. The exceedence value recorded on the segment was 1.1 mg/L and needs to be reduced by 9 percent in order to meet the instream water quality standard.

Table 8-2: Manganese Loading Capacity for Cedar Creek Segment AJF16

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	27
10	54
25	135
50	270
100	540
500	2,698
1,000	5,395
2,000	10,791

In order to determine the loading capacity at various flow conditions for Cedar Creek, a range of flows were multiplied by the water quality standard. Estimated flows in Cedar Creek range from a minimum value of 0 cfs to a maximum of 2,000 cfs with average flows of 30 cfs. Table 8-2 contains the loading capacity for manganese in Cedar Creek segment AJF16.

8.3.1.2 Seasonal Variation

Consideration to seasonality is inherent in the load duration analysis described above. The standard is not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-2). Therefore, the loading capacity represents conditions throughout the year. Similarly, by considering and addressing all flow scenarios, the critical conditions when the stream segment is most vulnerable to water quality exceedences were addressed. Critical conditions on Cedar Creek are likely during periods of low flow.

8.3.1.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The TMDL developed for Cedar Creek contains an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the TMDL.

8.3.1.4 Waste Load Allocation

There are two point sources that discharge to within the Cedar Creek watershed. The average discharge from the Patrician of Vienna facility is 0.0025mgd and the average discharge from Camp Ondessonk is 0.004mgd. The facilities are not believed to contribute significantly to manganese concentrations in Cedar Creek. Manganese loading to the creek most likely originates from natural sources such as groundwater and soils. The WLA was set to zero due to the insignificant contributions of total manganese from these facilities.

8.3.1.5 Load Allocation and TMDL Summary

Because the WLA was set to zero, the manganese load has been allocated between the LA (nonpoint sources) and the MOS. As discussed in Section 7, a simple spreadsheet analysis determined that a 9% reduction in manganese loading is needed to meet the water quality standard of 1,000µg/L. Table 8-3 shows the summary of the manganese TMDL for Cedar Creek.

Table 8-3: TMDL Summary for Manganese in Cedar Creek

Estimated Mean Daily Flow (cfs)	LC (lb/d)	WLA (lb/d)	LA (lb/d)	MOS (lb/d)
5	27	0	24	3
10	54	0	49	5
25	135	0	122	14
50	270	0	243	27
100	540	0	486	54
500	2,698	0	2,428	270
1,000	5,395	0	4,856	540
2,000	10,791	0	9,712	1,079

8.3.2 Cedar Creek DO TMDL

8.3.2.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that Cedar Creek can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the watershed and still maintain water quality standards were determined with the methodology discussed in Section 7.

The Q2K model estimated that current loads of oxygen-demanding materials cause dissolved oxygen violations during periods of low flow. The model also showed that even with the removal of external sources of oxygen-demanding materials, the segment does not meet instream water quality standards during times of low flow. It is assumed that low flows, low stream reaeration and high temperatures are causing the dissolved oxygen levels to drop below the standard on Cedar Creek. This theory is also supported by available data for the segment. During Stage 2 field surveys, higher than average flows were present in the creek and no violations of the DO standard were recorded. A historic sample, collected in October of 2000, indicated DO concentrations of 3.0mg/L. Review of the surrogate gage for the same date indicated that stream levels in the area at that time were well below average.

There are two point sources located within the watershed and none were determined to contribute significantly to low dissolved oxygen levels in the stream. The two point sources that discharge to this segment, the Patrician of Vienna nursing facility STP and Camp Ondessonk, are small facilities that discharge to tributaries of Cedar Creek that likely have little to no flow during low flow periods. Because of their negligible contribution to low dissolved oxygen levels, it was determined that permit limit reductions are not needed. Because a TMDL can not be developed for flow rates or reaeration rates, no TMDL will be developed at this time. Implementation activities to lessen diffuse loading during periods of runoff and measures to increase reaeration in the river are presented in Section 9.

8.3.3 Bay Creek Ditch DO TMDL

8.3.3.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that Bay Creek Ditch can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the watershed and still maintain water quality standards were determined with the methodology discussed in Section 7.

The Q2K model set up for the Bay Creek Ditch used available data from Stage 2 field surveys. Data collected during Stage 2 took place after a large storm event with resulting unseasonably high flows. The model showed that under higher flow conditions there are little to no dissolved oxygen problems in the ditch. This is also confirmed by field data that showed surface DO readings above 5.0mg/L and continuous monitoring that hovered near 5.0mg/L. Little to no historic data are available for the ditch. Using the available data, the model shows that with incremental reductions in flows, the DO levels in the system decreased. Again, this indicates that low DO in the stream is a result of slow moving waters with limited reaeration. In addition, low flow periods are also likely associated with high temperatures in the summer and fall which can increase the problem.

There are two point sources located within the watershed and neither were determined to contribute significantly to low dissolved oxygen levels in the stream. The two point sources that discharge upstream of this segment, the Vienna Correctional Center and the Dixon Springs work camp, are small facilities that discharge to tributaries of the Bay Creek Ditch. Because of their negligible contribution to low dissolved oxygen levels, it was determined that permit limit reductions are not needed at this time. Again, because a TMDL can not be developed for flow rates or reaeration rates, no TMDL will be developed at this time. Implementation activities to lessen diffuse loading during periods of runoff and measures to increase reaeration in the river are presented in Section 9.

8.3.4 Total Phosphorus TMDL for Bay Creek Lake No. 5

8.3.4.1 Loading Capacity

The LC of Bay Creek Lake No. 5 is the pounds of total phosphorus that can be allowed as input to the lake per day and still meet the water quality standard of 0.05-mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the model that was set up and confirmed as discussed in Section 7. To accomplish this, the loads calculated using available 2000 tributary data and 2002 lake quality data were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Bay Creek Lake No. 5. The allowable annual phosphorus load determined by reducing modeled inputs to Bay Creek Lake No. 5 through BATHTUB was determined to be **0.41 lbs/day**. This analysis is included as Appendix G.

8.3.4.2 Seasonal Variation

A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Bay Creek Lake No. 5 TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., times associated with higher runoff can increase sedimentation in the lake or months when lake stratification is occurring), the loadings for this TMDL will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

8.3.4.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Bay Creek Lake No. 5 TMDL is implicit. The analysis completed for Bay Creek Lake No. 5 is conservative because of the following:

- In the absence of site-specific data, an atmospheric loading rate of 30 kg/km2-yr total phosphorus (USACE 1999) was assumed in the BATHTUB model.
- Default values were used in the BATHTUB model, which in absence of site-specific information are assumed conservative. An example of a conservative default value is the phosphorus assimilation rate assumed in the model.

8.3.4.4 Waste Load Allocation

There are no point sources within the Bay Creek Lake No. 5 watershed. Therefore, the WLA is set to zero for this TMDL.

8.3.4.5 Load Allocation and TMDL Summary

Table 8-4 shows a summary of the TMDL for Bay Creek Lake No. 5. On average, a total reduction of 43 percent of total phosphorus loads to Bay Creek Lake No. 5 would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. The 43 percent reduction would need to come from a combination of tributary loading and internal loading. Management measures to control these types of loadings are presented in Section 9.

Table 8-4 TMDL Summary for Bay Creek Lake No. 5

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	0.40	0	0.40	0	0.7	0.3	43%

8.3.5 Total Phosphorus TMDL for Vienna Correctional Center Lake

8.3.5.1 Loading Capacity

The LC of Vienna Correctional Center Lake is the pounds of total phosphorus that can be allowed as input to the lake per day and still meet the water quality standard of 0.05-mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the model that was set up and confirmed as discussed in Section 7. To accomplish this, the loads calculated using available 1995, 1996 and 1999 data were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Vienna Correctional Center Lake. Again, it is assumed that by controlling total phosphorus loads to the lake, that dissolved oxygen levels in lake bottom waters will improve which will in turn improve total manganese concentrations. The allowable annual phosphorus load determined by reducing modeled inputs to Vienna Correctional Center Lake through BATHTUB was determined to be **0.12 lbs/day**. This analysis is included as Appendix H.

8.3.5.2 Seasonal Variation

A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Vienna Correctional Center Lake TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., higher internal loading during times of lake stratification), the loadings for this TMDL will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

8.3.5.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Vienna Correctional Center TMDL is implicit. The analysis completed for Vienna Correctional Center is conservative because of the following:

- In the absence of site-specific data, an atmospheric loading rate of 30 kg/km2-yr total phosphorus (USACE 1999) was assumed in the BATHTUB model.

- Default values were used in the BATHTUB model, which in absence of site-specific information are assumed conservative. An example of a conservative default value is the phosphorus assimilation rate assumed in the model.

8.3.5.4 Waste Load Allocation

There are no point sources within the Vienna Correctional Center watershed. Therefore, the WLA is set to zero for this TMDL.

8.3.5.5 Load Allocation and TMDL Summary

Table 8-12 shows a summary of the TMDL for Vienna Correctional Center. Because tributary contributions are thought to be minimal and loading from precipitation can not be reduced, the reductions needed to meet the water quality standard of 0.05 mg/L will come from reductions in internal loading to the lake. On average, reducing the internal loading by 50% would result in total phosphorus concentrations in the lake of 0.05 mg/L.

Table 8-12 TMDL Summary for Vienna Correctional Center Lake

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Total	0.12	0	0.12	0	0.19	0.07	36
Internal	0.065	0	0.065	0	0.13	0.065	50
Tributary & Precipitation	0.055	0	0.055	0	0.055	0	0

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Section 9
Implementation Plan for the Bay Creek Watershed

9.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Bay Creek watershed. Adaptive management is a systematic process for continually improving management policies and practices through learning from the outcomes of operational programs. Some of the differentiating characteristics of adaptive management are:

- Acknowledgement of uncertainty about what policy or practice is "best" for the particular management issue
- Thoughtful selection of the policies or practices to be applied (the assessment and design stages of the cycle)
- Careful implementation of a plan of action designed to reveal the critical knowledge that is currently lacking
- Monitoring of key response indicators
- Analysis of the management outcomes in consideration of the original objectives and incorporation of the results into future decisions (British Columbia Ministry of Forests 2000)

Implementation actions, point source controls, management measures, or BMPs are used to control the generation or distribution of pollutants. BMPs are either structural, such as wetlands, sediment basins, fencing, or filter strips; or managerial, such as conservation tillage, nutrient management plans, or crop rotation. Both types require good management to be effective in reducing pollutant loading to water resources (Osmond et al. 1995).

It is generally more effective to install a combination of point source controls and BMPs or a BMP system. A BMP system is a combination of two or more individual BMPs that are used to control a pollutant from the same critical source. In other words, if the watershed has more than one identified pollutant, but the transport mechanism is the same, then a BMP system that establishes controls for the transport mechanism can be employed (Osmond et al. 1995).

To assist in adaptive management, implementation actions, management measures, available assistance programs, and recommended continued monitoring are all discussed throughout the remainder of this section.

9.2 Implementation Actions and Management Measures for DO in the Bay Creek Ditch and Cedar Creek

DO impairments are generally addressed by focusing on organic loads that consume oxygen through decomposition and nutrient loads that can cause algal growth, which can also deplete DO. Analysis discussed in Section 7 established a relationship between low flows, oxygen-demanding materials (BOD5, ammonia-nitrogen and organic nitrogen), and DO concentrations in the Bay Creek Ditch segment AJK01, and Cedar Creek segment AJF16, therefore management measures for segments AJK01 and AJF16 will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

DO impairments in the both segments are attributed to low flow or stagnant conditions which also allows for greater sedimentation. Runoff from nonpoint sources may also contribute loading of oxygen-demanding materials in the segment. An additional contributor to low DO is increased water temperatures. Therefore, management measures for the segments will focus on reducing nonpoint source loading through sediment and surface runoff controls, reducing stream temperatures, and reducing stagnant conditions through reaeration.

9.2.1 Point Sources of Oxygen-Demanding Materials

This section discusses the point sources within the Bay Creek Ditch and Cedar Creek watersheds and their potential to contribute oxygen-demanding materials to the impaired segments. There are no municipalities within the watershed that have municipal stormwater permits.

9.2.1.1 Municipal/Industrial Sources

A number of small STPs discharge oxygen-demanding materials within the watersheds of both impaired segments. All of the facilities are located on tributaries of the impaired segments and do not directly discharge effluent to them. Tables 9-1 and 9-2 contain permit information on each of these facilities.

Table 9-1 Point Source Discharges to Bay Creek Ditch Segment AJK01

Facility Name	Permit Number	Permitted Flow (mgd)	Permit Expiration
Vienna Correction Center	IL0036757	0.42	08/31/2005
Dixon Springs Work Camp	ILG551056	0.047	02/29/2008

Table 9-2 Point Source Discharges to Cedar Creek Segment AJF16

Facility Name	Permit Number	Permitted Flow (mgd)	Permit Expiration
Camp Ondessonk	IL0048381	0.004	06/30/2010
Patrician of Vienna	IL0053660	0.0025	12/31/2010

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. The facilities are not believed to be a significant source of oxygen-demanding materials to the impaired segments. The existing permit limits are thought to be adequately protective of aquatic life uses within the impaired segments. Monitoring requirements for ammonia could be added to the Dixon Springs Work Camp permit in the future.

9.2.2 Nonpoint Sources of Oxygen-Demanding Materials

In addition to point sources of oxygen-demanding materials within the watershed, there are a number of potential nonpoint sources. The potential sources of nonpoint pollution to the Bay Creek Ditch include overfertilization (associated with agricultural landuses), streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Filter strips
- Reaeration/Erosion Control/Streambank Stabilization
- Nutrient Management
- Conservation Tillage
- Septic System Maintenance

9.2.2.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads, including nutrients and sediment, to Cedar Creek and the Bay Creek Ditch. Filter strips implemented along stream segments slow and filter nutrients and sediment out of runoff, help reduce stream water temperatures thereby increasing the water body DO saturation level, and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips in the Bay Creek Ditch watershed.

Organic debris in topsoil contributes to the BOD5 load to water bodies (USEPA 1997). Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of BOD5 and nutrient load associated with sediment loads to the Bay Creek Ditch. Nutrient criteria, currently being developed and expected to be adopted in the near future by the Illinois EPA, will assess the instream nutrient concentrations required for the watershed. Excess nutrients in streams can cause excessive algal growth, which can deplete DO in streams. Adoption of nutrient criteria will potentially affect this DO TMDL and help control exceedences of DO water quality criteria in the Bay Creek Ditch.

Filter strips will help control BOD5 levels by removing organic loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips can remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of BOD5 falls within this range (NCSU 2000). Riparian buffer strips also help reduce water temperatures which can in turn increase the water body DO saturation level.

Riparian vegetation, specifically shade, plays a significant role in controlling stream temperature change. The shade provided will reduce solar radiation loading to the stream. Furthermore, riparian vegetation provides bank stability that reduces sediment loading to the stream and the stream width-to-depth ratio. Research in California

(Ledwith 1996), Washington (Dong et al. 1998), and Maine (Hagan and Whitman 2000) has shown that riparian buffers effect microclimate factors such as air temperature and relative humidity proximal to the stream. Ledwith (1996) found that a 500-foot buffer had an air temperature decrease of 12°F at the stream over a zero-foot buffer. The greatest change occurred in the first 100 feet of the 500-foot buffer where the temperature decreased 2°F per 30 feet from the stream bank. A decrease in the air temperature proximal to the stream would result in a smaller convective flux to the stream during the day.

Filter strip widths for the Bay Creek Ditch TMDL were estimated based on the land slope. According to the NRCS Planning and Design Manual, the majority of sediment is removed in the first 25 percent of the width (NRCS 1994). Table 9-3 outlines the guidance for filter strip flow length by slope (NRCS 1999).

Table 9-3 Filter Strip Flow Lengths Based on Land Slope

Percent Slope	0.5%	1.0%	2.0%	3.0%	4.0%	5.0% or greater
Minimum	36	54	72	90	108	117
Maximum	72	108	144	180	216	234

GIS land use data described in Section 2 were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1, the most predominant soil type in the watershed is Grantsburg silt loam ranging from silts to clays, with less than 50 percent tending towards silt. Because slope values vary widely across the Bay Creek Ditch watershed, maximum values associated with 3% slopes were used for this analysis. Based on this slope value, filter strip widths of 180 feet could be incorporated into agricultural lands adjacent to the ditch and its tributaries. Mapping software was then used to buffer stream segments to determine the total area found within 180 feet of tributaries in the watershed. There are approximately 5,518 total acres within this buffer distance. The land use data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are an estimated 698 acres of agricultural land surrounding tributaries of the Bay Creek Ditch where filter strips and riparian buffers could potentially be installed. Landowners should evaluate their land near the Bay Creek Ditch and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 9-3. Programs available to fund the construction of these buffer strips are discussed in Section 9.5.

The same technique for evaluating available land was applied to Cedar Creek. There are 1,250 acres of land within 180 feet of Cedar Creek; of this area, 191 acres are categorized as agricultural and could potentially be converted into filter strips.

9.2.2.2 Reaeration/Streambank Stabilization

The purpose of reaeration is to increase DO concentrations in streams. Physical measures that will assist in increasing reaeration of a stream include bank stabilization, channel modifications, and the addition of riprap or pool and riffle sequences. Bank stabilization reduces erosion by planting vegetation along the bank or modification of the channel to decrease the slope of the bank. Riprap or pool and riffle sequences would increase reaeration by increasing turbulence. Turbulence creates an increase in the interaction between air and water, which draws air into the river increasing aeration. Expanding monitoring to several locations along the impaired segments could help identify reaches that would benefit the most from an increase of turbulence.

9.2.2.3 Nutrient Management

Nutrient management could result in reduced nutrient loads to the Bay Creek Ditch. A nutrient management plan should address fertilizer application rates, methods, and timing. Initial soil phosphorus concentrations are determined by onsite soil testing, which is available from local vendors. Losses through plant uptake are subtracted, and gains from organic sources such as manure application or industrial/municipal wastewater are added. The resulting phosphorus content is then compared to local guidelines to determine if fertilizer should be added to support crop growth and maintain current phosphorus levels. In some cases, the soil phosphorus content is too high, and no fertilizer should be added until stores are reduced by crop uptake to target levels.

The Illinois Agronomy Handbook (IAH) lists guidelines for fertilizer application rates based on the inherent properties of the soil (typical regional soil phosphorus concentrations, root penetration, pH, etc.), the starting soil test phosphorus concentration for the field, and the crop type and expected yield.

The overall goal of phosphorus reduction from agriculture should increase the efficiency of phosphorus use by balancing phosphorus inputs in feed and fertilizer with outputs in crops and animal produce as well as managing the level of phosphorus in the soil. Reducing phosphorus loss in agricultural runoff may be brought about by source and transport control measures, such as filter strips or grassed waterways. The Nutrient Management Plans account for all inputs and outputs of phosphorus to determine reductions. Nutrient Management Plans include:

- Review of aerial photography and soil maps;
- Regular soil testing (Illinois Agronomy Handbook recommends soil testing every 4 years);
- Review of current and/or planned crop rotation practices;
- Yield goals and associated nutrient application rates;
- Nutrient budgets with planned rates, methods, timing and form of application;
- Identification of sensitive areas and restrictions on application when land is snow covered, frozen or saturated.

Band placement should occur prior to or during corn planting, depending on the type of field equipment available. Fertilizer should be applied when the chance of a large precipitation event is low. Researchers in Iowa found that runoff concentrations of phosphorus were 60 percent lower when the next precipitation event occurred 10 days after fertilizer application, as opposed to 24 hours after application. Application to frozen ground or snow cover is strongly discouraged. Researchers studying loads from agricultural fields in east-central Illinois found that fertilizer application to frozen ground or snow followed by a rain event could transport 40 percent of the total annual phosphorus load (Gentry et al., 2007).

Recent technological developments in field equipment allow for fertilizer to be applied at varying rates across a field. Crop yield and net profits are optimized with this variable rate technology (IAH, 2002). Precision farming typically divides fields into 1- to 3-acre plots that are specifically managed for seed, chemical, and water requirements. Operating costs are reduced and crop yields typically increase, though upfront equipment costs may be high.

The effectiveness of nutrient management plans (application rates, methods, and timing) in reducing phosphorus loading from agricultural land will be site specific.

In Illinois, Nutrient Management Plans have successfully reduced phosphorus application to agricultural lands by 36-lb/acre. National reductions range from 11 to 106-lb/acre, with an average reduction of 35-lb/acre (USEPA 2003).

9.2.2.4 Conservation Tillage Practices

For the Bay Creek Ditch watershed, where a portion of the watershed consists of agricultural land uses, conservation tillage practices could help reduce nutrient loads in the lake. The ditch potentially receives nonpoint source runoff from row crops and small grain agriculture in the watershed. Total phosphorus loading from cropland is controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003); however, filter strips are less effective at removing dissolved phosphorus only. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural acres in the Bay Creek Ditch watershed.

9.2.2.5 Private Septic System Inspection and Maintenance Program

Because the information on septic systems in the watershed is not well known, it is recommended that a septic survey be completed in the area to assess the number of systems and their locations. After a survey has determined the extent of septic systems in the watershed, a program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.

To reduce the excessive amounts of contaminants from a faulty septic system, a regular maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and BOD loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

Septic system management activities can extend the life and maintain the efficiency of a septic system. Water conservation practices, such as limiting daily water use or using low flow toilets and faucets, are the most effective methods to maintain a properly functioning septic system. Additionally, the system should not be used for the disposal of solids, such as cigarette butts, cat litter, cotton swabs, coffee grinds, disposable diapers, etc. Finally, physical damage to the drainfield can be prevented by:

- Maintaining a vegetative cover over the drainfield to prevent erosion
- Avoiding construction over the system
- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drainfield (Johnson 1998)

The cost of each management measure is site specific and there is not specific data on septic systems and management practices for the watershed; therefore, costs for these practices were not outlined in Section 9.5.

Alternatively, a long-range solution to failing septic systems is a connection to a municipal sanitary sewer system. Installation of a sanitary sewer will reduce existing oxygen-demanding sources by replacing failing septic systems and will allow communities to develop without further contribution of organic loading to the impaired segments. Costs for the installation are generally paid over a period of several years (average of 20 years) instead of forcing homeowners to shoulder the entire cost of installing a new septic system. In addition, costs are sometimes shared between the community and the utility responsible for treating the wastewater generated from replacing the septic tanks. The planning process is involved and requires participation from townships, cities, counties, and citizens.

9.3 Implementation Actions and Management Measures for Manganese in Cedar Creek

One violation of the manganese standard has been recorded on Cedar Creek in the last ten years. The violating sample was collected on July 7, 2005 under low flow conditions. The only known sources of manganese to the creek are natural sources including overland runoff, soil erosion, and groundwater.

9.3.1 Nonpoint Sources of Manganese

It is likely that the main contributors to elevated manganese in Cedar Creek are natural background levels. As such, nonpoint source controls that are designed to reduce erosion are expected to provide a secondary benefit of reducing manganese that may be attached to the soil.

Following are examples of potentially applicable erosion control measures:

- Filter Strips
- Sediment Control Basins
- Streambank Stabilization/Erosion Control

The remainder of this section discusses these management options.

9.3.1.1 Filter Strips

Filter strips were discussed in Section 9.2.2.1 Again, the same technique for evaluating available land was applied to Cedar Creek. There are 1250 acres of land within 180 feet of Cedar Creek; of this area, 191 acres are categorized as agricultural and could potentially be converted into filter strips.

9.3.1.2 Sediment Control Basins

Sediment control basins are designed to trap sediments (and the pollutants bound to the sediment) prior to reaching a receiving water. Sediment control basins are typically earthen embankments that act similarly to a terrace. The basin traps water and sediment running off cropland upslope from the structure, and reduces gully erosion by controlling flow within the drainage area. The basin then releases water slowly, which also helps to decrease streambank erosion in the receiving water.

Sediment control basins are usually designed to drain an area of 30 acres or less and should be large enough to control runoff from a 10-year, 24-hour storm. Locations are determined based on slopes, tillage and crop management, and local NRCS can often provide information and advice for design and installation. Maintenance includes reseeding and fertilizing the basins in order to maintain vegetation and periodic checking, especially after large storms to determine the need for embankment repairs or excess sediment removal.

9.3.1.3 Streambank Stabilization/Erosion Control

Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Eroding soil transports pollutants, such as manganese, that can potentially degrade water quality.

Following are three available approaches to stabilizing eroding banks that could, in turn, decrease nonpoint source manganese loads:

- Stone Toe Protection (STP)
- Rock Riffle Grade Control (RR)
- Floodplain Excavation

Stone Toe Protection uses nonerodible materials to protect the eroding banks. Meandering bends found in the Cedar Creek watershed could possibly be stabilized by placing the hard armor only on the toe of the bank. STP is most commonly implemented "using stone quarry stone that is sized to resist movement and is placed on the lower one third of the bank in a windrow fashion" (STREAMS 2005).

Naturally stable stream systems typically have an alternating riffle-pool sequence that helps to dissipate stream energy. Rock Riffle Grade Control places loose rock grade control structures at locations where natural riffles would occur to create and enhance the riffle-pool flow sequence of stable streams. By installing RR in an incised channel, the riffles will raise the water surface elevation resulting in lower effective bank heights, which increases the bank stability by reducing the tractive force on the banks (STREAMS 2005).

Rather than raising the water level, Floodplain Excavation lowers the floodplain to create a more stable stream. Floodplain Excavation uses mechanical means to restore the floodplain by excavating and utilizing the soil that would eventually be eroded away and deposited in the lake (STREAMS 2005).

The extent of streambank erosion in the Cedar Creek watershed is unknown. It is recommended that further investigation be performed to determine the extent that erosion control measures could help manage nonpoint source manganese loads to the creek.

9.4 Implementation Actions and Management Measures for Phosphorus in Bay Creek No. 5 Lake and Vienna Correctional Center Lake

Phosphorus loads in the Bay Creek No. 5 Lake watershed originate from both external and internal sources while loads to Vienna Correctional Center Lake are dominated by internal sources. As discussed in previous sections, possible sources of total phosphorus in the Bay Creek No. 5 Lake watershed include runoff from the surround forest and grassland while sources of total phosphorus to the Vienna Correctional Center Lake include precipitation and internal cycling. To achieve a reduction of total phosphorus for these lakes, management measures must address loading through sediment and surface runoff controls, point source limits and internal nutrient cycling through in-lake management.

9.4.1 Point Sources of Phosphorus

There are no point sources discharging within either lake watershed.

9.4.2 Nonpoint Sources of Phosphorus

The 303(d) list identified runoff from forest/grassland/parkland as a source of total phosphorus to Bay Creek No. 5 Lake. Potential pollutant sources were not identified for the Vienna Correctional Center Lake.

BMPs available that could be utilized to treat nonpoint sources within the lake watersheds are:

- Wetlands
- Streambank Stabilization/Erosion Control
- Septic system maintenance or sanitary system
- Lake management

9.4.2.1 Wetlands

The use of wetlands as a structural control may be applicable to nutrient reduction from the surrounding areas in the Bay Creek No. 5 Lake watershed. To treat loads from watershed runoff, a wetland could be constructed on the upstream end of the reservoir. Wetlands are an effective BMP for sediment and phosphorus control because they:

- Prevent floods by temporarily storing water, allowing the water to evaporate or percolate into the ground
- Improve water quality through natural pollution control such as plant nutrient uptake
- Filter sediment
- Slow overland flow of water thereby reducing soil erosion (USDA 1996)

A properly designed and functioning wetland can provide very efficient treatment of pollutants, such as phosphorus. Design of wetland systems is very important and should consider soils in the proposed location, hydraulic retention time, and space requirements. Constructed wetlands, which comprise the second or third stage of nonpoint source treatment, can be effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates for suspended solids of greater than 90 percent, 0 to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to75 percent for nitrogen species (Johnson, Evans, and Bass 1996; Moore 1993; USEPA 1993; Kovosic et al. 2000). Although the removal rate for phosphorus is low in long-term studies, the rate can be improved if sheet flow is maintained to the wetland and vegetation and substrate are monitored to ensure the wetland is operation optimally. Sediment or vegetation removal may be necessary if the wetland removal efficiency is lessened over time (USEPA 1993; NCSU 2000).

Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff. Table 9-4 outlines estimated wetland areas for each subbasin in the Bay Creek No. 5 Lake watershed based on these recommendations. A wetland system to treat agricultural runoff from the lake subbasins could be approximately 92 acres (Denison and Tilton 1993).

Table 9-4 Acres of Wetland for Bay Creek No. 5 Lake Watershed

Subbasin	Area (acres)	Recommended Wetlands (acre)
Direct Flow RAZB-3	274	1.6
Direct Flow RAZB-2	67	0.4
Direct Flow RAZB-1	121	0.7
Bay Creek	14880	89.3
Total	**15342**	**92.0**

9.4.2.2 Streambank Stabilization/Erosion Protection

For a discussion of streambank stabilization and erosion protection management measures, refer to Section 9.3.1.3.

9.4.2.3 Septic System Maintenance and Sanitary System

The extent of septic systems within the Bay Creek Lake No. 5 watershed is not known. Depending on the number of septic systems in the watershed, they could be a potential source of nutrients to the lake.

To reduce the excessive amounts of contaminants from a faulty septic system, a regular maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and BOD loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

Septic system management activities can extend the life and maintain the efficiency of a septic system. Water conservation practices, such as limiting daily water use or using low flow toilets and faucets, are the most effective methods to maintain a properly functioning septic system. Additionally, the system should not be used for the disposal of solids, such as cigarette butts, cat litter, cotton swabs, coffee grinds, disposable diapers, etc. Finally, physical damage to the drainfield can be prevented by:

- Maintaining a vegetative cover over the drainfield to prevent erosion
- Avoiding construction over the system
- Protecting the area down slope of the system from excavation
- Landscape the area to divert surface flow away from the drainfield (Johnson 1998)

9.4.3 In-Lake Phosphorus

The Bay Creek No. 5 Lake phosphorus TMDL determined that approximately 82 percent of the current phosphorus load to Bay Creek No. 5 Lake comes from internal cycling. The Vienna Correctional Center phosphorus TMDL determined that approximately 69 percent of the current phosphorus load to Vienna Correctional Center Lake comes from internal cycling. Reduction of phosphorus from in-lake cycling through management strategies is necessary for attainment of the TMDL load allocation. Internal phosphorus loading occurs when the water above the sediments become anoxic causing the release of phosphorus from the sediment in a form which is available for plant uptake. The addition of bioavailable phosphorus in the water column stimulates more plant growth and die-off, which perpetuates the anoxic conditions and enhances the subsequent release of phosphorus into the water.

For lakes experiencing high rates of phosphorus inputs from bottom sediments, several management measures are available to control internal loading. Three BMP options for the control of internal loading include the installation of an aerator, the addition of aluminum, and dredging. Hypolimnetic (bottom water) aeration involves an aerator air-release that can be positioned at a selected depth or at multiple depths to increase oxygen transfer efficiencies in the water column and reduce internal loading by establishing aerobic conditions at the sediment-water interface. Hypolimnetic aeration effectiveness in reducing phosphorus concentration depends in part on the presence of sufficient iron to bind phosphorus in the oxygenated waters. A mean hypolimnetic iron:phosphorus ratio greater than 3.0 is optimal to promote iron phosphate precipitation (Stauffer, 1981). The iron:phosphorus ratio in the sediments should be greater than 15 to bind phosphorus (Welch, 1992).

Phosphorus inactivation by aluminum addition (specifically aluminum sulfate or alum) to lakes has been the most widely-used technique to control internal phosphorus loading. Alum forms a polymer that binds phosphorus and organic matter. The aluminum hydroxide-phosphate complex (commonly called alum floc) is insoluble and settles to the bottom, carrying suspended and colloidal particles with it. Once on the sediment surface, alum floc retards phosphate diffusion from the sediment to the water (Cooke et al.,1993).

Phosphorus release from the sediment is greatest from recently deposited layers. Dredging about one meter of recently deposited phosphorus–rich sediment can remove approximately 80 to 90 percent of the internally loaded phosphorus without the addition of potentially toxic compounds to the reservoir. However, dredging is more costly than other management options (NRCS 1992).

9.5 Reasonable Assurance

Reasonable assurance means that a demonstration is given that nonpoint source reductions in this watershed will be implemented. It should be noted that all programs discussed in this section are voluntary and some may be in practice to some degree within the watershed. The discussion in the preceding sections provided information on available BMPs for loads from nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing these practices and programs available to assist with funding.

9.5.1 Available Cost-Share Programs

Portions of the Bay Creek watershed are classified as agricultural row crop, and small grains land. There are several voluntary conservation programs established through the 2002 U.S. Farm Bill (the 2007 Farm Bill is currently being developed), which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

9.5.1.1 Illinois Department of Agriculture and Illinois EPA Nutrient Management Plan Project

The IDA and Illinois EPA are presently co-sponsoring a cropland Nutrient Management Plan project in watersheds that have or are developing a TMDL. This voluntary project supplies incentive payments to producers to have Nutrient Management Plans developed and implemented. Additionally, watersheds that have sediments or phosphorus identified as a cause for impairment (as is the case in this watershed), are eligible for cost-share assistance in implementing traditional erosion control practices through the Nutrient Management Plan project.

9.5.1.2 Conservation Reserve Program (CRP)

This voluntary program encourages landowners to plant long-term resource-conserving cover to improve soils, water, and wildlife resources. CRP is the USDA's single largest environmental improvement program and one of its most productive and cost-efficient. It is administered through the Farm Service Agency (FSA) by USDA's Commodity Credit Corporation (CCC). The program was initially established in the Food & Security Act of 1985. The duration of the contracts under CRP range from 10 to 15 years.

Eligible land must be one of the following:

1. Cropland that is planted or considered planted to an agricultural commodity two of the five most recent crop years (including field margins) and must be physically and legally capable of being planted in a normal manner to an agricultural commodity.

2. Certain marginal pastureland enrolled in the Water Bank Program.

The CCC bases rental rates on the relative productivity of soils within each county and the average of the past three years of local dry land cash rent or cash-rent equivalent. The maximum rental rate is calculated in advance of enrollment. Producers may offer land at the maximum rate or at a lower rental rate to increase likelihood of offer acceptance. In addition, the CCC provides cost-share assistance for up to 50 percent of the participant's costs in establishing approved conservation practices (USDA 2006).

Finally, CCC offers additional financial incentives of up to 20 percent of the annual payment for certain continuous sign-up practices (USDA 2006). Continuous sign-up provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land. The land must be determined by NRCS to be eligible and suitable for any of the following practices:

- Riparian buffers
- Filter strips

- Grass waterways
- Shelter belts
- Field windbreaks
- Living snow fences
- Contour grass strips
- Salt tolerant vegetation
- Shallow water areas for wildlife
- Eligible acreage within an EPA-designated wellhead protection area (FSA 1997)

9.5.1.3 Clean Water Act Section 319 Grants

Section 319 was added to the CWA to establish a national program to address nonpoint sources of water pollution. Through this program, each state is allocated section 319 funds on an annual basis according to a national allocation formula based on the total annual appropriation for the section 319 grant program. The total award consists of two categories of funding: incremental funds and base funds. A state is eligible to receive EPA 319(b) grants upon USEPA's approval of the state's Nonpoint Source Assessment Report and Nonpoint Source Management Program. States may reallocate funds through subawards (e.g., contracts, subgrants) to both public and private entities, including local governments, tribal authorities, cities, counties, regional development centers, local school systems, colleges and universities, local nonprofit organizations, state agencies, federal agencies, watershed groups, for-profit groups, and individuals.

USEPA designates incremental funds, a $100-million award, for the restoration of impaired water through the development and implementation of watershed-based plans and TMDLs for impaired waters. Base funds, funds other than incremental funds, are used to provide staffing and support to manage and implement the state Nonpoint Source Management Program. Section 319 funding can be used to implement activities which improve water quality, such as filter strips, streambank stabilization, etc (USEPA 2003).

Illinois EPA receives federal funds through Section 319(h) of the Clean Water Act to help implement Illinois' Nonpoint Source (NPS) Pollution Management Program. The purpose of the program is to work cooperatively with local units of government and other organizations toward the mutual goal of protecting the quality of water in Illinois by controlling NPS pollution. The program emphasizes funding for implementing cost-effective corrective and preventative best management practices (BMPs) on a watershed scale; funding is also available for BMPs on a non-watershed scale and the development of information/education NPS pollution control programs.

The Maximum Federal funding available is 60 percent, with the remaining 40 percent coming from local match. The program period is two years unless otherwise approved. This is a reimbursement program.

Section 319(h) funds are awarded for the purpose of implementing approved NPS management projects. The funding will be directed toward activities that result in the implementation of appropriate BMPs for the control of NPS pollution or to enhance the public's awareness of NPS pollution. Applications are accepted June 1 through August 1.

9.5.1.4 Wetlands Reserve Program (WRP)

The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. The goal of WRP is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. At least 70 percent of each project area will be restored to the original natural condition, to the extent practicable. The remaining 30 percent of each area may be restored to other than natural conditions. Landowners have the option of enrolling eligible lands through permanent easements, 30-year easements, or 10-year restoration cost-share agreements. The program is offered on a continuous sign-up basis and is available nationwide. WRP offers landowners an opportunity to establish, at minimal cost, long-term conservation and wildlife habitat enhancement practices and protection. It is administered through the NRCS (2002b).

Eligible participants must have owned the land for at least 1 year and be able to provide clear title. Restoration agreement participants must show evidence of ownership. Owners may be an individual, partnership, association, corporation, estate, trust, business, or other legal entity; a state (when applicable); a political subdivision of a state; or any agency thereof owning private land. Land eligibility is dependent on length of ownership, whether the site has been degraded as a result of agriculture, and the land's ability to be restored.

The 2002 Farm Bill reauthorized the program through 2007. The reauthorization increased the acreage enrollment cap to 2,275,000 acres with an annual enrollment of 250,000 acres per calendar year. The program is limited by the acreage cap and not by program funding. Since the program began in 1985, the average cost per acre is $1,400 in restorative costs and the average project size is 177 acres. The costs for each enrollment options follow in Table 9-5 (USDA 2006).

Table 9-5 Costs for Enrollment Options of WRP Program

Option	Permanent Easement	30-year Easement	Restoration Agreement
Payment for Easement	100% Agricultural Value	75% Agricultural Value	NA
Payment Options	Lump Sum	Lump Sum	NA
Restoration Payments	100% Restoration Cost Reimbursements	75% Restoration Cost Reimbursements	75% Restoration Cost Reimbursements

9.5.1.5 Environmental Quality Incentive Program (EQIP)

The Environmental Quality Incentive Program (EQIP) is a voluntary USDA conservation program for farmers and private landowners engaged in livestock or agricultural production who are faced with serious threats to soil, water, and related natural resources. It provides technical, financial, and educational assistance primarily in designated "priority areas." National priorities include the reduction of non-point source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds, consistent with TMDLs where available, and the reduction in soil erosion and sedimentation from unacceptable levels on agricultural land. The program goal is to maximize environmental benefits per dollar expended and provides "(1) flexible technical and financial assistance to farmers and ranchers that face the most serious natural resource problems, (2) assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourage environmental enhancement, (3) assistance to farmers and ranchers in making beneficial, cost-effective changes to measures needed to conserve and improve natural resources, and (4) for the consolidation and simplification of the conservation planning process (NRCS 2002)."

Landowners, with the assistance of a local NRCS or other service provider, are responsible for the development of an EQIP plan which includes a specific conservation and environmental objective, one or more conservation practices in the conservation management system to be implemented to achieve the conservation and environmental objectives, and the schedule for implementing the conservation practices. This plan becomes the basis of the cost-share agreement between NRCS and the participant. NRCS provides cost-share payments to landowners under these agreements that can be up to 10 years in duration.

Cost-share assistance may pay landowners up to 75 percent of the costs of conservation practices, such as grassed waterways, filter strips, manure management, capping abandoned wells, and other practices important to improving and maintaining the health of natural resources in the area. EQIP cost-share rates for limited resource producers and beginning farmers may be up to 90 percent. Total incentive and cost-share payments are limited to an aggregate of $450,000 (NRCS 2006).

9.5.1.6 Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program (WHIP) is voluntary program that encourages the creation of high quality wildlife habitat of national, state, tribal, or local significance. WHIP is administered through NRCS, which provides technical and financial assistance to landowners for development of upland, riparian, and aquatic habitat areas on their property. NRCS works with the participant to develop a wildlife habitat development plan which becomes the basis of the cost-share agreement between NRCS and the participant. Most contracts are 5 to 10 years in duration, depending upon the practices to be installed. However, longer term contracts of 15 years or greater may also funded. In addition, if the landowner agrees, cooperating State wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project.

9.5.1.7 Streambank Stabilization and Restoration Practice

Although erosion from lake tributaries is not thought to be a significant contributor of nutrients to the lake, the Streambank Stabilization and Restoration Practice (SSRP) was established to address problems associated with streambank erosion, such as loss or damage to valuable farmland, wildlife habitat, roads; stream capacity reduction through sediment deposition; and degraded water quality, fish, and wildlife habitat. The primary goals of the SSRP are to develop and demonstrate vegetative, stone structure and other low cost bio-engineering techniques for stabilizing streambanks and to encourage the adoption of low-cost streambank stabilization practices by making available financial incentives, technical assistance, and educational information to landowners with critically eroding streambanks. A cost share of 75 percent is available for approved project components; such as willow post installation, bendway weirs, rock riffles, stream barbs/rock, vanes, lunker structures, gabion baskets, and stone toe protection techniques. There is no limit on the total program payment for cost-share projects that a landowner can receive in a fiscal year. However, maximum cost per foot of bank treated is used to cap the payment assistance on a per foot basis and maintain the program's objectives of funding low-cost techniques (IDA 2000).

9.5.1.8 Conservation Practices Cost-Share Program

The Conservation Practices Program (CPP) is a 10-year program. The practices consist of waterways, water and sediment control basins (WASCOBs), pasture/hayland establishment, critical area, terrace system, no-till system, diversions, and grade stabilization structures. The CPP is state-funded through the Department of Agriculture. There is a project cap of $5,000 per landowner and costs per acre vary significantly from project to project.

9.5.1.9 Illinois Conservation and Climate Initiative (ICCI)

The ICCI is a joint project of the State of Illinois and the Delta Institute that allows farmers and landowners to earn revenue through the sale of greenhouse gas emissions credits when they use conservation practices such as no-till, grass plantings, reforestation, or manure digesters.

The Chicago Climate Exchange (CCX®) quantifies, credits and sells greenhouse gas credits from conservation practices. The credits are aggregated, or pooled, from farmers and landowners in order to sell them to CCX® members that have made voluntary commitments to reduce their greenhouse gas contributions.

ICCI provides an additional financial incentive for farmers and landowners to use conservation practices that also benefit the environment by creating wildlife habitat and limiting soil and nutrient run-off to streams and lakes.

Many farmers and landowners are already using conservation practices eligible for carbon credits on the CCX® such as no-till farming, strip-till farming, grass plantings, afforestation/reforestation, and the use of methane digesters. To be eligible, the producer or landowner must make a contractual commitment to maintain the eligible practice through 2010. CREP and CRP land is eligible for enrollment in the ICCI as long as it meets CCX® eligibility requirements for the practice (www.illinoisclimate.org).

9.5.1.10 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in Massac and Pope Counties are listed in the Table 9-6 below.

Table 9-6 Madison and Macoupin County USDA Service Center Contact Information

Contact	Address	Phone
Massac County	1438 W. 10th Street Metropolis, IL 62960	618.524.9367
Pope County	P.O. Box 27 Golconda, IL 62938	618.683.2651

9.5.2 Cost Estimates of BMPs

Cost estimates for different best management practices and individual practice prices such as filter strip installation are detailed in the following sections. Table 9-7 outlines the estimated cost of implementation measures in the Bay Creek watershed.

9.5.2.1 Wetlands

The price to establish a wetland is very site specific. There are many different costs that could be incurred depending on wetland construction. Examples of costs associated with constructed wetlands include excavation costs. NRCS estimates excavation cost at $2/cubic foot. Establishment of vegetation in critical areas including seeding and fertilizing is estimated at $230/acre. It should be noted that the larger the wetland acreage to be established, the more cost-effective the project.

9.5.2.2 Filter Strips and Riparian Buffers

Filter strips can either be seeded with grass or sodded for immediate function. The seeded filter strips cost approximately $0.30 per sq ft to construct, and sodded filter strips cost approximately $0.70 per sq ft to construct. Generally, it is assumed that the required filter strip area is 2 percent of the area drained. This means that 870 square feet of filter strip are required for each acre of agricultural land treated. The construction cost to treat one acre of land is therefore $261/ac for a seeded filter strip and $609/ac for a sodded strip. At an assumed system life of 20 years (Weiss et al., 2007), the annualized construction costs are $13/ac/yr for seeded and $30.50/ac/yr for sodded strips. Annual maintenance of filter strips is estimated at $0.01 per sq ft (USEPA, 2002b) for an additional cost of $8.70/ac/yr of agricultural land treated. In addition, the area converted from agricultural production to filter strip will result in a net annual income loss of $3.50.

Restoration of riparian areas costs approximately $100/ac to construct and $475/ac to maintain over the life of the buffer (Wossink and Osmond, 2001; NCEEP, 2004). Maintenance of a riparian buffer should be minimal, but may include items such as period inspection of the buffer, minor grading to prevent short circuiting, and replanting/reseeding dead vegetation following premature death or heavy storms.

Assuming a buffer width of 90 ft on either side of the stream channel and an adjacent treated width of 300 ft of agricultural land, one acre of buffer will treat approximately

3.3 acres of adjacent agricultural land. The cost per treated area is thus $30/ac to construct and $142.50/ac to maintain over the life of the buffer. Assuming a system life of 30 years results in an annualized cost of $59.25/yr for each acre of agricultural land treated.

9.5.2.3 Septic System Maintenance

Septic tanks are designed to accumulate sludge in the bottom portion of the tank while allowing water to pass into the drain field. If the tank is not pumped out regularly, the sludge can accumulate and eventually become deep enough to enter the drain field. Pumping the tank every three to five years prolongs the life of the system by protecting the drain field from solid material that may cause clogs and system back-ups.

The cost to pump a septic tank ranges from $250 to $350 depending on how many gallons are pumped out and the disposal fee for the area. If a system is pumped once every three to five years, this expense averages out to less than $100 per year. Septic tanks that are not maintained will likely require replacement which may cost between $2,000 and $10,000.

The cost of developing and maintaining a watershed-wide database of the onsite wastewater treatment systems in the Cedar Creek watershed depends on the number of systems that need to be inspected. A recent inspection program in South Carolina found that inspections cost approximately $160 per system (Hajjar, 2000).

Education of home and business owners that use onsite wastewater treatment systems should occur periodically. Public meetings; mass mailings; and radio, newspaper, and TV announcements can all be used to remind and inform owners of their responsibility to maintain their systems.

The costs associated with education and inspection programs will vary depending on the level of effort required to communicate the importance of proper maintenance and the number of systems in the area.

9.5.2.4 Internal Cycling

Internal cycling was identified as a source of nutrients to both Bay Creek No. 5 Lake and Vienna Correctional Center Lake. Controls of internal phosphorus cycling in lakes are costly. The in-lake controls have been converted to year 2004 dollars assuming an average annual inflation rate of 3 percent. The number and size of hypolimnetic aerators used in a waterbody depend on lake morphology, bathymetry, and hypolimnetic oxygen demand. Total cost for successful systems has ranged from $170,000 to $1.7 million (Tetra Tech, 2002). USEPA (1993) reports initial costs ranging from $340,000 to $830,000 plus annual operating costs of $60,000. System life is assumed to be 20 years.

Alum treatments are effective on average for approximately 8 years per application and can reduce internal loading by 80 percent. Treatment cost ranges from $290/ac to $720/ac (WIDNR, 2003). The surface area of Bay Creek No. 5 Lake is approximately

78 ac, so total application costs for the lake would likely range from $22,620 to $56,160. The surface area of Vienna Correctional Center Lake is approximately 75 ac, so total application costs for the lake would likely range from $21,750 to $54,000.

Dredging is typically the most expensive management practice averaging $8,000/acre. Although cost is high, the practice is 80 to 90 percent effective at nutrient removal and will last for at least 50 years (Cortell 2002; Geney 2002).

9.5.2.7 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-7. Cost estimates shown in Table 9-7 are the total estimated cost per acre and many costs could be reduced through cost share opportunities discussed in Section 9.5.1. The column labeled Program or Sponsor lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the Soil Stabilization and Restoration Practice (SSRP), Wetlands Reserve Program (WRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), Conservation Cost-Share Program (CPP), Illinois EPA, and Illinois Department of Agriculture (IDA). It should be noted that Illinois EPA 319 Grants are applicable to all of these practices.

Table 9-7 Cost Estimate of Various BMP Measures

Source	Program	Sponsor	BMP	Installation Mean $/acre
Nonpoint	CRP/CPP	NRCS and IDA	Seeded filter strip	$25
	CRP/CPP	NRCS and IDA	Sodded filter strip	$43
	CRP/CPP	NRCS and IDA	Riparian Buffer	$60
	WRP	NRCS	Wetland	varies
		NRCS	Nutrient Management Plan	$6-18
		IDA and Illinois EPA	Nutrient Management Plan	$13
	CRP/CPP/ICCI	NRCS, IDA, CCX	Conservation Tillage	varies
Internal Cycling			Dredging	$8,000
			Aerator	varies
			Alum	$290-$720

Total watershed costs will depend on the combination of BMPs selected to target non-point sources within the watershed. Regular monitoring will support adaptive management of implementation activities to most efficiently reach the TMDL goals.

9.6 Monitoring Plan

The purpose of the monitoring plan for the Bay Creek watershed is to assess the overall implementation of management actions outlined in this section. This can be accomplished by conducting the following monitoring programs:

- Track implementation of management measures in the watershed
- Estimate effectiveness of management measures
- Further monitoring of point source discharges in the watershed

- Continued ambient monitoring of all TMDL segments
- Further information gathering on area septic systems including locations and failure rates
- Storm-based monitoring of high flow events
- Tributary monitoring
- Diversion monitoring for Bay Creek Ditch

Tracking the implementation of management measures can be used to address the following goals:

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet TMDL endpoints
- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts
- Measure the extent of voluntary implementation efforts
- Further clarify the contributions from point sources
- Support work-load and costing analysis for assistance or regulatory programs
- Determine the extent to which management measures are properly maintained and operated

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed. Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency. If aeration is used to control internal loading, site-specific data could be collected to assess the effectiveness of this management measure. In addition, sampling should be performed before and after management operations employed within both lakes to determine their effects on lake nutrient levels.

IEPA monitors lakes every three years and conducts Intensive Basin Surveys every five years. Additionally, ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

Regular and more extensive monitoring of point sources in the watershed would confirm their collective contributions and provide additional information regarding oxygen-demanding materials to the Bay Creek Ditch and Cedar Creek. As permits come up for renewal, Illinois EPA NPDES program should review the permits and decide if further management measures are required.

Continued tributary monitoring is needed to further confirm the contribution of internal loading to the impaired watershed lakes. By having more knowledge on actual contributions from external loads a more precise estimate of internal loads could occur. Data on the different forms of phosphorus (dissolved, total, or orthophosphate) would also be beneficial to better assess reservoir responses to phosphorus loading.

9.7 Implementation Time Line

Implementing the actions outlined in this section for the Bay Creek watershed should occur in phases and assessing effectiveness of the management actions as improvements are made. It is assumed that it may take up to five years to secure funding for actions needed in the watershed and five to seven years after funding to implement the measures. Once improvements are implemented, it may take impaired segments 10 years or more to reach their water quality standard targets. In summary, it may take up to 20 years for impaired segments to meet the applicable water quality standards.

Section 10
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Appendix A
Land Use Categories

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File names and descriptions:

Values and class names found in the Land Cover of Illinois 1999-2000 Arc/Info GRID coverage.

Value	Class Names
0	Background
	AGRICULTURAL LAND
11	Corn
12	Soybeans
13	Winter Wheat
14	Other Small Grains & Hay
15	Winter Wheat/Soybeans
16	Other Agriculture
17	Rural Grassland
	FORESTED LAND
21	Upland
25	Partial Canopy/Savannah Upland
26	Coniferous
	URBAN & BUILT-UP LAND
31	High Density
32	Low/Medium Density
35	Urban Open Space
	WETLAND
41	Shallow Marsh/Wet Meadow
42	Deep Marsh
43	Seasonally/Temporally Flooded
44	Floodplain Forest
48	Swamp
49	Shallow Water
	OTHER
51	Surface Water
52	Barren & Exposed Land
53	Clouds
54	Cloud Shadows

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Appendix B
Soil Characteristics

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Appendix B: Bay Creek Watershed Soil Series Characteristics

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
131D2	Alvin fine sandy loam, 10 to 18 percent slopes, eroded	10.10	0.01%	B	0.24	0.24
164A	Stoy silt loam, 0 to 2 percent slopes	0.93	0.00%	C	0.37	0.55
164B	Stoy silt loam, 2 to 5 percent slopes	63.68	0.04%	C	0.37	0.55
164C2	Stoy silt loam, 5 to 10 percent slopes, eroded	6.53	0.00%	C	0.37	0.55
165A	Weir silt loam, 0 to 2 percent slopes	1.21	0.00%	D	0.37	0.55
175B	Lamont fine sandy loam, 2 to 5 percent slopes	136.20	0.09%	B	0.17	0.24
175C	Lamont fine sandy loam, 5 to 10 percent slopes	7.49	0.01%	B	0.17	0.24
175C2	Lamont fine sandy loam, 5 to 10 percent slopes, eroded	69.41	0.05%	B	0.17	0.24
1843A	Bonnie and Petrolia soils, undrained, 0 to 2 percent slopes, frequently flooded	166.77	0.12%	D	0.32	0.49
1846A	Karnak and Cape silty clays, undrained, 0 to 2 percent slopes, frequently flooded	511.01	0.35%	D	0.24	0.32
214B	Hosmer silt loam, 2 to 5 percent slopes	1556.52	1.08%	C	0.43	0.43
214C2	Hosmer silt loam, 5 to 10 percent slopes, eroded	2404.34	1.67%	C	0.43	0.43
214C3	Hosmer silt loam, 5 to 10 percent slopes, severely eroded	1047.73	0.73%	C	0.43	0.43
214D2	Hosmer silt loam, 10 to 18 percent slopes, eroded	438.86	0.30%	C	0.43	0.43
214D3	Hosmer silt loam, 10 to 18 percent slopes, severely eroded	938.51	0.65%	C	0.43	0.43
301B	Grantsburg silt loam, 2 to 5 percent slopes	8473.26	5.87%	C	0.37	0.43
301C2	Grantsburg silt loam, 5 to 10 percent slopes, eroded	12165.02	8.43%	C	0.37	0.49
301C3	Grantsburg silt loam, 5 to 10 percent slopes, severely eroded	5772.39	4.00%	C	0.37	0.43
301D2	Grantsburg silt loam, 10 to 18 percent slopes, eroded	1522.67	1.06%	C	0.37	0.49
301D3	Grantsburg silt loam, 10 to 18 percent slopes, severely eroded	3237.09	2.24%	C	0.37	0.49
308B	Alford silt loam, 2 to 5 percent slopes	117.35	0.08%	B	0.37	0.55
308C2	Alford silt loam, 5 to 10 percent slopes, eroded	131.66	0.09%	B	0.37	0.55
308C3	Alford silt loam, 5 to 10 percent slopes, severely eroded	135.09	0.09%	B	0.37	0.55
308D2	Alford silt loam, 10 to 18 percent slopes, eroded	69.81	0.05%	B	0.37	0.55
308D3	Alford silt loam, 10 to 18 percent slopes, severely eroded	90.32	0.06%	B	0.37	0.55
308E	Alford silt loam, 18 to 25 percent slopes	5.65	0.00%	B	0.37	0.55
308E2	Alford silt loam, 18 to 25 percent slopes, eroded	15.28	0.01%	B	0.37	0.55
308E3	Alford silt loam, 18 to 25 percent slopes, severely eroded	18.62	0.01%	B	0.37	0.55
308F	Alford silt loam, 25 to 35 percent slopes	8.45	0.01%	B	0.37	0.55
3108L	Bonnie silt loam, 0 to 2 percent slopes, frequently flooded, long duration	38.57	0.03%	C/D	0.37	0.49
335B	Robbs silt loam, 1 to 4 percent slopes	190.59	0.13%	D	0.43	0.43

Appendix B: Bay Creek Watershed Soil Series Characteristics (continued)

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
3382L	Belknap silt loam, 0 to 2 percent slopes, frequently flooded, long duration	70.89	0.05%	C	0.28	0.49
339B	Wellston silt loam, 2 to 5 percent slopes	116.16	0.08%	B	0.37	0.43
339C	Wellston silt loam, 5 to 10 percent slopes	1218.97	0.84%	B	0.37	0.43
339C3	Wellston silt loam, 5 to 10 percent slopes, severely eroded	8.20	0.01%	B	0.37	0.43
339D	Wellston silt loam, 10 to 18 percent slopes	2718.16	1.88%	B	0.37	0.55
339D2	Wellston silt loam, 10 to 18 percent slopes, eroded	72.15	0.05%	B	0.37	0.43
339D3	Wellston silt loam, 10 to 18 percent slopes, severely eroded	92.05	0.06%	B	0.37	0.55
339F	Wellston silt loam, 18 to 35 percent slopes	1474.97	1.02%	B	0.37	0.55
340B	Zanesville silt loam, 2 to 5 percent slopes	249.33	0.17%	C	0.32	0.43
340C2	Zanesville silt loam, 5 to 10 percent slopes, eroded	1077.13	0.75%	C	0.32	0.43
340C3	Zanesville silt loam, 5 to 10 percent slopes, severely eroded	2532.83	1.75%	C	0.32	0.43
340D	Zanesville silt loam, 10 to 18 percent slopes	0.77	0.00%	C	0.32	0.43
340D2	Zanesville silt loam, 10 to 18 percent slopes, eroded	2898.55	2.01%	C	0.32	0.43
340D3	Zanesville silt loam, 10 to 18 percent slopes, severely eroded	3852.38	2.67%	C	0.32	0.43
3449L	Armiesburg-Sarpy complex, 0 to 2 percent slopes, frequently flooded, long duration	5.96	0.00%	B	0.02	0.49
3597L	Armiesburg silty clay loam, 0 to 2 percent slopes, frequently flooded, long duration	206.56	0.14%	B	0.28	0.49
471D2	Clarksville gravelly silt loam, 10 to 18 percent slopes, eroded	11.47	0.01%	B	0.28	0.43
471F	Clarksville gravelly silt loam, 25 to 35 percent slopes	10.53	0.01%	B	0.28	0.43
598B	Bedford silt loam, 2 to 5 percent slopes	4.17	0.00%	C	0.28	0.43
598C	Bedford silt loam, 5 to 10 percent slopes	6.92	0.00%	C	0.28	0.43
598C2	Bedford silt loam, 5 to 10 percent slopes, eroded	100.18	0.07%	C	0.28	0.43
598C3	Bedford silt loam, 5 to 10 percent slopes, severely eroded	66.35	0.05%	C	0.28	0.43
598D2	Bedford silt loam, 10 to 18 percent slopes, eroded	54.76	0.04%	C	0.28	0.43
598D3	Bedford silt loam, 10 to 18 percent slopes, severely eroded	18.75	0.01%	C	0.28	0.43
691C	Beasley silt loam, 5 to 10 percent slopes	128.96	0.09%	C	0.28	0.43
691D	Beasley silt loam, 10 to 18 percent slopes	558.95	0.39%	C	0.28	0.43
691F	Beasley silt loam, 18 to 35 percent slopes	258.72	0.18%	C	0.28	0.43
7131A	Alvin fine sandy loam, 0 to 2 percent slopes, rarely flooded	63.95	0.04%	B	0.24	0.24
7131B	Alvin fine sandy loam, 2 to 5 percent slopes, rarely flooded	578.97	0.40%	B	0.24	0.24
7131C2	Alvin fine sandy loam, 5 to 10 percent slopes, eroded, rarely flooded	381.53	0.26%	B	0.24	0.24

Appendix B: Bay Creek Watershed Soil Series Characteristics (continued)

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
7131D2	Alvin fine sandy loam, 10 to 18 percent slopes, eroded, rarely flooded	12.96	0.01%	B	0.24	0.24
7460A	Ginat silt loam, 0 to 2 percent slopes, rarely flooded	1898.02	1.32%	D	0.24	0.37
7462A	Sciotoville silt loam, 0 to 2 percent slopes, rarely flooded	508.30	0.35%	C	0.24	0.49
7462B	Sciotoville silt loam, 2 to 5 percent slopes, rarely flooded	833.73	0.58%	C	0.32	0.49
7462C2	Sciotoville silt loam, 5 to 10 percent slopes, eroded, rarely flooded	367.20	0.25%	C	0.32	0.49
7462C3	Sciotoville silt loam, 5 to 10 percent slopes, severely eroded, rarely flooded	20.84	0.01%	C	0.32	0.49
7462D2	Sciotoville silt loam, 10 to 18 percent slopes, eroded, rarely flooded	20.03	0.01%	C	0.32	0.49
7463A	Wheeling silt loam, 0 to 2 percent slopes, rarely flooded	622.71	0.43%	B	0.05	0.32
7463B	Wheeling silt loam, 2 to 5 percent slopes, rarely flooded	748.73	0.52%	B	0.05	0.32
7463C2	Wheeling silt loam, 5 to 10 percent slopes, eroded, rarely flooded	218.86	0.15%	B	0.05	0.32
7463D2	Wheeling silt loam, 10 to 18 percent slopes, eroded, rarely flooded	15.26	0.01%	B	0.05	0.32
7711A	Hatfield silt loam, 0 to 2 percent slopes, rarely flooded	927.64	0.64%	C	0.24	0.49
7711B	Hatfield silt loam, 2 to 5 percent slopes, rarely flooded	495.45	0.34%	C	0.32	0.49
7711B2	Hatfield silt loam, 2 to 5 percent slopes, eroded, rarely flooded	11.27	0.01%	C	0.32	0.49
801B	Orthents, silty, undulating	23.20	0.02%	C	0.24	0.43
802D	Orthents, loamy, hilly	44.90	0.03%	B	0.32	0.43
8070A	Beaucoup silty clay loam, 0 to 2 percent slopes, occasionally flooded	74.70	0.05%	B	0.28	0.32
8071A	Darwin clay, 0 to 2 percent slopes, occasionally flooded	8.35	0.01%	C/D	0.24	0.24
8072A	Sharon silt loam, 0 to 3 percent slopes, occasionally flooded	1487.58	1.03%	B	0.37	0.37
8108A	Bonnie silt loam, 0 to 2 percent slopes, occasionally flooded	2171.81	1.50%	C/D	0.37	0.49
8109A	Racoon silt loam, 0 to 2 percent slopes, occasionally flooded	567.35	0.39%	C/D	0.37	0.49
8180A	Dupo silt loam, 0 to 2 percent slopes, occasionally flooded	8.38	0.01%	C	0.24	0.55
8382A	Belknap silt loam, 0 to 2 percent slopes, occasionally flooded	5399.26	3.74%	C/D	0.28	0.49
8420A	Piopolis silty clay loam, 0 to 3 percent slopes, occasionally flooded	1.23	0.00%	C/D	0.32	0.32
8422A	Cape silty clay loam, 0 to 2 percent slopes, occasionally flooded	1114.94	0.77%	C/D	0.28	0.32
8422A+	Cape silt loam, overwash, 0 to 2 percent slopes, occasionally flooded	342.49	0.24%	C/D	0.28	0.43
8426A	Karnak silty clay, 0 to 2 percent slopes, occasionally flooded	538.44	0.37%	C/D	0.24	0.28
8426A+	Karnak silt loam, overwash, 0 to 2 percent slopes, occasionally flooded	85.75	0.06%	C/D	0.24	0.32

Appendix B: Bay Creek Watershed Soil Series Characteristics (continued)

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
8427B	Burnside silt loam, 1 to 4 percent slopes, occasionally flooded	2212.09	1.53%	B	0.24	0.37
8469A	Emma silty clay loam, 0 to 2 percent slopes, occasionally flooded	23.45	0.02%	C	0.24	0.37
8469B	Emma silty clay loam, 2 to 5 percent slopes, occasionally flooded	14.10	0.01%	C	0.37	0.37
8597A	Armiesburg silty clay loam, 0 to 2 percent slopes, occasionally flooded	29.48	0.02%	B	0.28	0.49
864	Pits, quarries	9.80	0.01%	NA	0.17	0.49
8693A	Hurst silty clay loam, 0 to 2 percent slopes, occasionally flooded	22.22	0.02%	D	0.24	0.37
954D2	Alford-Baxter complex, 10 to 18 percent slopes, eroded	41.86	0.03%	B	0.17	0.55
954F	Alford-Baxter complex, 18 to 35 percent slopes	8.41	0.01%	B	0.17	0.55
955D	Muskingum and Berks soils, 10 to 18 percent slopes	563.90	0.39%	C	0.24	0.37
955D2	Muskingum and Berks soils, 10 to 18 percent slopes, eroded	5.48	0.00%	C	0.24	0.37
955F	Muskingum and Berks soils, 18 to 35 percent slopes	2760.17	1.91%	C	0.24	0.37
955G	Muskingum and Berks soils, 35 to 70 percent slopes	233.12	0.16%	C	0.24	0.37
956B	Brandon-Saffell complex, 2 to 5 percent slopes	9.70	0.01%	B	0.28	0.43
956C2	Brandon-Saffell complex, 5 to 10 percent slopes, eroded	104.43	0.07%	B	0.28	0.43
956C3	Brandon-Saffell complex, 5 to 10 percent slopes, severely eroded	177.82	0.12%	B	0.28	0.43
956D	Brandon-Saffell complex, 10 to 18 percent slopes	360.28	0.25%	B	0.28	0.43
956D2	Brandon-Saffell complex, 10 to 18 percent slopes, eroded	119.72	0.08%	B	0.28	0.43
956D3	Brandon-Saffell complex, 10 to 18 percent slopes, severely eroded	327.17	0.23%	B	0.28	0.43
956E2	Brandon-Saffell complex, 18 to 25 percent slopes, eroded	73.66	0.05%	B	0.28	0.43
956F	Brandon-Saffell complex, 25 to 35 percent slopes	8.56	0.01%	B	0.28	0.43
986D	Wellston-Berks complex, 10 to 18 percent slopes	1739.13	1.21%	B	0.24	0.43
986D2	Wellston-Berks complex, 10 to 18 percent slopes, eroded	68.70	0.05%	B	0.24	0.43
986F	Wellston-Berks complex, 18 to 35 percent slopes	4265.05	2.96%	B	0.24	0.64
986G	Wellston-Berks complex, 35 to 70 percent slopes	100.99	0.07%	C	0.24	0.64
99F	Sandstone and Limestone Rock Land, 18 to 35 percent slopes	233.91	0.16%	NA	0.24	0.43
99G	Sandstone and Limestone Rock Land, 35 to 90 percent slopes	432.68	0.30%	NA	0.24	0.32
IL063	STATSGO	9585.23	6.64%	C	0.17	0.43
IL064	STATSGO	31580.12	21.88%	C	0.17	0.43
IL069	STATSGO	11520.07	7.98%	B	0.20	0.43
W	Water	931.34	0.65%	-	-	-
	TOTAL	144322.43			0.02	0.64

Appendix C
Water Quality Data

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Appendix C:
Water Quality Data
Bay Creek Watershed

STATION	SAMPLE DATE	SAMPLE DEPTH	PARAMETER	RESULT
AJ 10	8/6/1987		MANGANESE, TOTAL (UG/L AS MN)	2465.00
AJ 10	9/8/1987		MANGANESE, TOTAL (UG/L AS MN)	2120.00
AJ 10	10/13/1987		MANGANESE, TOTAL (UG/L AS MN)	1067.00
AJF 16	10/2/2000		MANGANESE, TOTAL (UG/L AS MN)	510.00
AJK 01	8/6/1987		MANGANESE, TOTAL (UG/L AS MN)	2644.00
AJK 01	9/8/1987		MANGANESE, TOTAL (UG/L AS MN)	4246.00
AJK 01	10/13/1987		MANGANESE, TOTAL (UG/L AS MN)	1487.00
AJ 10	8/6/1987		DISSOLVED OXYGEN (DO) mg/l	4.70
AJ 10	9/8/1987		DISSOLVED OXYGEN (DO) mg/l	5.30
AJ 10	10/13/1987		DISSOLVED OXYGEN (DO) mg/l	7.00
AJF 16	10/2/2000		DISSOLVED OXYGEN (DO) mg/l	3.00
AJK 01	8/6/1987		DISSOLVED OXYGEN (DO) mg/l	3.20
AJK 01	9/8/1987		DISSOLVED OXYGEN (DO) mg/l	3.50
AJK 01	10/13/1987		DISSOLVED OXYGEN (DO) mg/l	3.80
RAT-1	4/23/1999	12	Total Manganese (ug/L)	200.00
RAT-1	7/9/1999	11	Total Manganese (ug/L)	30.00
RAT-1	8/17/1999	10	Total Manganese (ug/L)	46.00
RAT-1	6/4/1999	11	Total Manganese (ug/L)	82.00
RAT-1	10/1/1999	10	Total Manganese (ug/L)	420.00
RAT-1	7/12/1993	22	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	2800.00
RAT-1	6/7/1994	22	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	4700.00
RAT-1	6/7/1994	22	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	2600.00
RAT-3	6/7/1994	11	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	1000.00
RAT-3	6/7/1994	11	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	869.00
RAT-1	8/17/1999	20	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	2600.00
RAT-3	8/17/1999	10	MANGANESE IN BOTTOM DEPOSITS (MG/KG AS MN DRY WGT)	570.00
RAT-1	7/12/1993	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.90
RAT-1	7/12/1993	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.00
RAT-1	7/12/1993	2	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.00
RAT-1	7/12/1993	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.00
RAT-1	7/12/1993	4	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.00
RAT-1	7/12/1993	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.10
RAT-1	7/12/1993	6	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.10
RAT-1	7/12/1993	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.10
RAT-1	7/12/1993	8	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.50
RAT-1	7/12/1993	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.10
RAT-1	7/12/1993	10	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.20
RAT-1	7/12/1993	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.10
RAT-1	7/12/1993	12	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	3.10
RAT-1	7/12/1993	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	14	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	16	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	18	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	19	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	20	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	21	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	7/12/1993	22	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.20
RAT-1	4/14/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.70
RAT-1	4/14/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.60
RAT-1	4/14/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.50
RAT-1	4/14/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.10
RAT-1	4/14/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.80
RAT-1	4/14/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.80
RAT-1	4/14/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.60
RAT-1	4/14/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.30
RAT-1	4/14/1994	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.20
RAT-1	4/14/1994	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.30
RAT-1	4/14/1994	19	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	4.30
RAT-1	4/14/1994	21	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	1.80
RAT-1	6/7/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.50
RAT-1	6/7/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.50

Appendix C:
Water Quality Data
Bay Creek Watershed

STATION	SAMPLE DATE	SAMPLE DEPTH	PARAMETER		RESULT
RAT-1	6/7/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.30
RAT-1	6/7/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.70
RAT-1	6/7/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.00
RAT-1	6/7/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	6.40
RAT-1	6/7/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	1.90
RAT-1	6/7/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	6/7/1994	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	6/7/1994	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.00
RAT-1	6/7/1994	19	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.00
RAT-1	6/7/1994	20	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.00
RAT-1	7/19/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.90
RAT-1	7/19/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.90
RAT-1	7/19/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.00
RAT-1	7/19/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.50
RAT-1	7/19/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.30
RAT-1	7/19/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	2.50
RAT-1	7/19/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	7/19/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	7/19/1994	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.30
RAT-1	7/19/1994	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	7/19/1994	19	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	7/19/1994	19.5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.00
RAT-1	8/22/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.60
RAT-1	8/22/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.60
RAT-1	8/22/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.20
RAT-1	8/22/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.00
RAT-1	8/22/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	6.70
RAT-1	8/22/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	5.40
RAT-1	8/22/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.50
RAT-1	8/22/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	8/22/1994	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	8/22/1994	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	8/22/1994	18	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-1	10/17/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	6.20
RAT-1	10/17/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	6.20
RAT-1	10/17/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	5.80
RAT-1	10/17/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	5.00
RAT-1	10/17/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	4.80
RAT-1	10/17/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	4.50
RAT-1	10/17/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	4.40
RAT-1	10/17/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	4.00
RAT-1	10/17/1994	15	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.20
RAT-1	10/17/1994	17	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-2	4/14/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.60
RAT-2	4/14/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.60
RAT-2	4/14/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.50
RAT-2	4/14/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.40
RAT-2	4/14/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.30
RAT-2	4/14/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.80
RAT-2	4/14/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.30
RAT-2	4/14/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.30
RAT-2	4/14/1994	14.5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.10
RAT-2	6/7/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.60
RAT-2	6/7/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.60
RAT-2	6/7/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	8.70
RAT-2	6/7/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.80
RAT-2	6/7/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	7.50
RAT-2	6/7/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	4.60
RAT-2	6/7/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.30
RAT-2	6/7/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-2	6/7/1994	14	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	0.10
RAT-2	7/19/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.00
RAT-2	7/19/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE	MG/L	9.00

Appendix C:
Water Quality Data
Bay Creek Watershed

STATION	SAMPLE DATE	SAMPLE DEPTH	PARAMETER	RESULT
RAT-2	7/19/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.00
RAT-2	7/19/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.90
RAT-2	7/19/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.40
RAT-2	7/19/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.60
RAT-2	7/19/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.10
RAT-2	7/19/1994	13	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.10
RAT-2	7/19/1994	14.5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.10
RAT-2	8/22/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.70
RAT-2	8/22/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.40
RAT-2	8/22/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.50
RAT-2	8/22/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.30
RAT-2	8/22/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.10
RAT-2	8/22/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.50
RAT-2	8/22/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.80
RAT-2	8/22/1994	12.5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.10
RAT-2	10/17/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.00
RAT-2	10/17/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.00
RAT-2	10/17/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.70
RAT-2	10/17/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	5.70
RAT-2	10/17/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	5.00
RAT-2	10/17/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	4.70
RAT-2	10/17/1994	11	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	3.50
RAT-3	4/14/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.80
RAT-3	4/14/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.70
RAT-3	4/14/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.60
RAT-3	4/14/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.40
RAT-3	4/14/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.20
RAT-3	4/14/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.60
RAT-3	6/7/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.60
RAT-3	6/7/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.60
RAT-3	6/7/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.30
RAT-3	6/7/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.20
RAT-3	6/7/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.70
RAT-3	6/7/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	2.00
RAT-3	7/19/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.90
RAT-3	7/19/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.90
RAT-3	7/19/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	9.00
RAT-3	7/19/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	8.60
RAT-3	7/19/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	5.90
RAT-3	7/19/1994	9	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	0.10
RAT-3	8/22/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.70
RAT-3	8/22/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.60
RAT-3	8/22/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.40
RAT-3	8/22/1994	5	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.20
RAT-3	8/22/1994	7	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.50
RAT-3	10/17/1994	0	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.30
RAT-3	10/17/1994	1	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	7.20
RAT-3	10/17/1994	3	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	6.80
RAT-3	10/17/1994	4	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	5.90
AJ 08	8/1/2000		PHOSPHORUS AS P	198.00
AJ 08	8/1/2000		PHOSPHORUS AS P,Dissolved mg/l	0.01
AJ 08	10/2/2000		PHOSPHORUS AS P,Dissolved mg/l	0.01
AJ 08	8/1/2000		PHOSPHORUS AS P,Total mg/l	0.01
AJ 08	10/2/2000		PHOSPHORUS AS P,Total mg/l	0.01
RAZB-1	4/11/2002	15	PHOSPHORUS AS P,Total mg/l	0.02
RAZB-1	4/11/2002	1	PHOSPHORUS AS P,Total mg/l	0.02
RAZB-1	6/4/2002	1	PHOSPHORUS AS P,Total mg/l	0.02
RAZB-1	6/4/2002	16	PHOSPHORUS AS P,Total mg/l	0.03
RAZB-1	7/22/2002	1	PHOSPHORUS AS P,Total mg/l	0.04
RAZB-1	7/22/2002	12	PHOSPHORUS AS P,Total mg/l	0.06
RAZB-1	8/13/2002	11	PHOSPHORUS AS P,Total mg/l	0.06
RAZB-1	10/1/2002	1	PHOSPHORUS AS P,Total mg/l	0.02
RAZB-1	10/1/2002	13	PHOSPHORUS AS P,Total mg/l	0.02

Appendix C:
Water Quality Data
Bay Creek Watershed

STATION	SAMPLE DATE	SAMPLE DEPTH	PARAMETER	RESULT
RAZB-2	4/11/2002	1	PHOSPHORUS AS P,Total mg/l	0.02
RAZB-2	6/4/2002	1	PHOSPHORUS AS P,Total mg/l	0.03
RAZB-2	7/22/2002	1	PHOSPHORUS AS P,Total mg/l	0.04
RAZB-2	8/13/2002	1	PHOSPHORUS AS P,Total mg/l	0.06
RAZB-2	10/1/2002	1	PHOSPHORUS AS P,Total mg/l	0.03
RAZB-3	6/4/2002	1	PHOSPHORUS AS P,Total mg/l	0.06
RAZB-3	7/22/2002	1	PHOSPHORUS AS P,Total mg/l	0.06
RAZB-3	8/13/2002	1	PHOSPHORUS AS P,Total mg/l	0.08
RAZB-3	10/1/2002	1	PHOSPHORUS AS P,Total mg/l	0.06

Appendix D
Stage 2 Report

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CDM

Illinois Environmental
Protection Agency

Stage 2 Data Report

March 2007

Final Report

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Contents

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Figures

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Tables

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Section 1
Introduction

The Illinois Environmental Protection Agency (Illinois EPA) has a three-stage approach to total maximum daily load (TMDL) development. The stages are:

Stage 1 – Watershed Characterization, Data Analysis, Methodology Selection

Stage 2 – Data Collection (optional)

Stage 3 – Model Calibration, TMDL Scenarios, Implementation Plan

This report addresses data collection associated with Stage 2 TMDL development for the following watersheds:

- Bay Creek
- Cahokia Creek/Holiday Shores Lake
- Cedar Creek/Cedar Lake
- Crab Orchard Creek/Crab Orchard Lake
- Crooked Creek
- Little Wabash River
- Mary's River/North Fork Cox Creek
- Sangamon River/Lake Decatur
- Shoal Creek
- South Fork Saline River/Lake of Egypt
- South Fork Sangamon River/Lake Taylorville

Sampling has been completed based on the recommendations presented in Section 6 of each watershed's Stage 1 TMDL report and the sampling plan described within the quality assurance project plan (QAPP). The Stage 2 data will supplement existing data collected and assessed as part of Stage 1 of TMDL development and will support the development of TMDLs under Stage 3 of the process. Where adequate supporting data exist, data collected during Stage 2 activities may also be used to support the delisting of certain parameters from the state 303(d) list.

The remaining sections of this report contain:

- **Section 2 Field Activities** includes information on sampling locations as well as field parameter, grab sample and continuous monitoring data
- **Section 3 Quality Assurance Review** discusses changes in the sampling plan from the original QAPP, data verification and validity, and conformance to the data quality objectives
- **Section 4 Conclusions** summarizes the Stage 2 work and makes recommendations for moving forward

Section 2
Field Activities

TMDL streams were sampled by CDM twice during the fall of 2006 to collect data needed to support water quality modeling and TMDL development. The first round of Stage 2 data collection took place between August 28 and September 29, 2006. The second round of Stage 2 data collection took place between October 16 and November 17, 2006. In addition, three segments within the Little Wabash River watershed were sampled by Illinois EPA between April and August of 2006. Over the course the sampling project, 32 streams (out of a possible 33) and one lake were sampled within the eleven Stage 2 watersheds. Table 2-1 contains data collection dates for each watershed.

Table 2-1: Stage 2 Data Collection Field Dates

Watershed	First Round Dates (2006)	Second Round Dates (2006)
Bay Creek	9/25-9/29	10/30-11/6
Cahokia Creek/Holiday Shores Lake	8/28-9/6	10/16-10/20
Cedar Lake	9/5-9/14	10/30-11/6
Crab Orchard Lake	9/5-9/14	10/30-11/6
Crooked Creek	9/5-9/14	10/16-10/20
South Fork Saline River/Lake of Egypt	9/25-9/29	10/30-11/6
Little Wabash River - CDM	9/5-9/14	10/30-11/16
Little Wabash River – Illinois EPA	4/18-8/8	
Mary's River	9/5-9/14	10/16-10/20
Sangamon River/Lake Decatur	8/28-9/6	10/30-11/3
Shoal	8/28-9/6	10/16-10/20
South Fork Sangamon River/Lake Taylorville	8/28-9/6	10/30-11/3

Sampling was conducted in accordance with the QAPP by CDM personnel at stream and lake locations with sufficient water and access. When time permitted, alternate locations were investigated if water and/or access were limited at original locations. Figures 2-1 through 2-11 show sampling locations used for Stage 2 data collection for each watershed. Refer to section 3.1 for further information related to sampling location changes from the original QAPP. Appendix A contains pictures of each sampling location. The sampling and analysis activities conducted at each sampling location included:

- In-stream field parameterization
- Grab samples for laboratory analysis
- Continuous monitoring
- Stream gaging

2.1 Instream field parameters

Water quality measurements for pH, temperature, dissolved oxygen (DO), conductivity, and turbidity were taken at each accessible sampling location where water was present using an In-Situ 9500 Profiler water quality meter. In-Situ 9500 Profilers were calibrated each morning of field activity. Water quality readings were taken at each accessible site with adequate water at the center of flow and values were recorded in field books. These values are presented in Table 2-2. Table 2-2 also contains sample location latitude and longitude as well as explanatory information as to why a limited number of sites were not sampled.

At each site with adequate and safely wadeable streamflow, flow measurements were recorded using a Marsh McBirney 2000 flow meter. Appendix B contains flow meter data and stream discharge analysis for these sites.

2.2 Grab Samples

Grab samples were collected based on the causes of impairment identified in the 303(d) list as well as data needed to support TMDL development under Stage 3. Samples collected on Owl Creek and South Fork Sangamon River were analyzed by Prairie Analytical Laboratories in Springfield, IL and all other samples collected by CDM were analyzed by ARDL, Inc in Mt. Vernon, IL. Samples were delivered in person to the laboratory or exchanged with laboratory personnel in the field. Select segments in the Little Wabash watershed (Elm River segment CD01, and Little Wabash River segments C09 and C33) were sampled by Illinois EPA and analyzed by the Illinois EPA Laboratory in Champaign, IL.

Table 2-3 contains data collected at each location associated with impairment status. Values shown in bold face with gray background violated the applicable water quality standard. All data analyzed by the laboratories are contained in Appendix C. This appendix includes the data shown in Table 2-3 as well as all other parameters that were sampled in order to support Stage 3 TMDL development. In addition, Appendix C shows data qualifiers as well as detection limits for all samples.

2.3 Continuous Monitoring

In-Situ 9500 Professional XP multi-parameter data-logging sondes were used for continuous data measurements on streams impaired by low DO and/or pH. The sondes were calibrated prior to deployment then deployed for at least 3 days at select locations with adequate water and access. DO, pH, conductivity and temperature data were recorded at 15 minute intervals during sonde deployment, after which the sonde was removed and data were downloaded to a laptop computer. The continuous data associated with impairment causes are presented in Appendix D. Because sondes were not field checked at the time of retrieval, there is a possibility that some experienced times of drying or build-up of sedimentation during deployment. A column was added to the data presented in Appendix D to estimate acceptable or "suspect" data. Data were deemed suspect when low conductivity or high temperature values indicate that the meter was likely out of the water or also at times when field log books indicated that the sonde had not yet been deployed or had been pulled from the stream. The data that were deemed acceptable were plotted on Figures D-1 through D-26. The charts are grouped by watershed and show data collected during the first and second round of sampling at each location.

Violations of the instantaneous DO standard (5.0 mg/L minimum) were not recorded during either monitoring period on the following segments that are currently listed for impairment caused by low DO:

- Cedar Creek AJF16 (Figure D-1)
- Big Muddy River N99 (Figure D-4)
- Shoal Creek OI05 (Figures D-22 and D-23)
- South Fork Saline River ATH08 (Figure D-24)

According to Table B-2 of the Illinois Integrated Water Quality Report (2006), the aquatic life use may also be impaired if DO concentrations are below 6.0 mg/L for more than 16 hours of any 24 hour period. Appendix D also contains this analysis for the segments that did not violate the instantaneous minimum standard. The number of values recorded below 6.0 mg/L during any 24 hour period were counted and if any count was above 64 (64 values equates to 16 hours worth of data), the stream was considered to be potentially impaired by low DO. The following segments did not experience a violation of either the 5.0 mg/L instantaneous standard or the 6.0 mg/L standard as described above:

- Cedar Creek AJF16 (Figure D-1)
- Shoal Creek OI05 (Figures D-22 and D-23)
- South Fork Saline River ATH08 (Figure D-24)

Violations of the pH standard (6.5 minimum, 9.0 maximum) were not recorded during either monitoring period on the following segments that are currently listed for impairment caused by pH:

- Crab Orchard Creek ND12 (Figure D-5)
- Briers Creek ATHS01 (Figure D-25)

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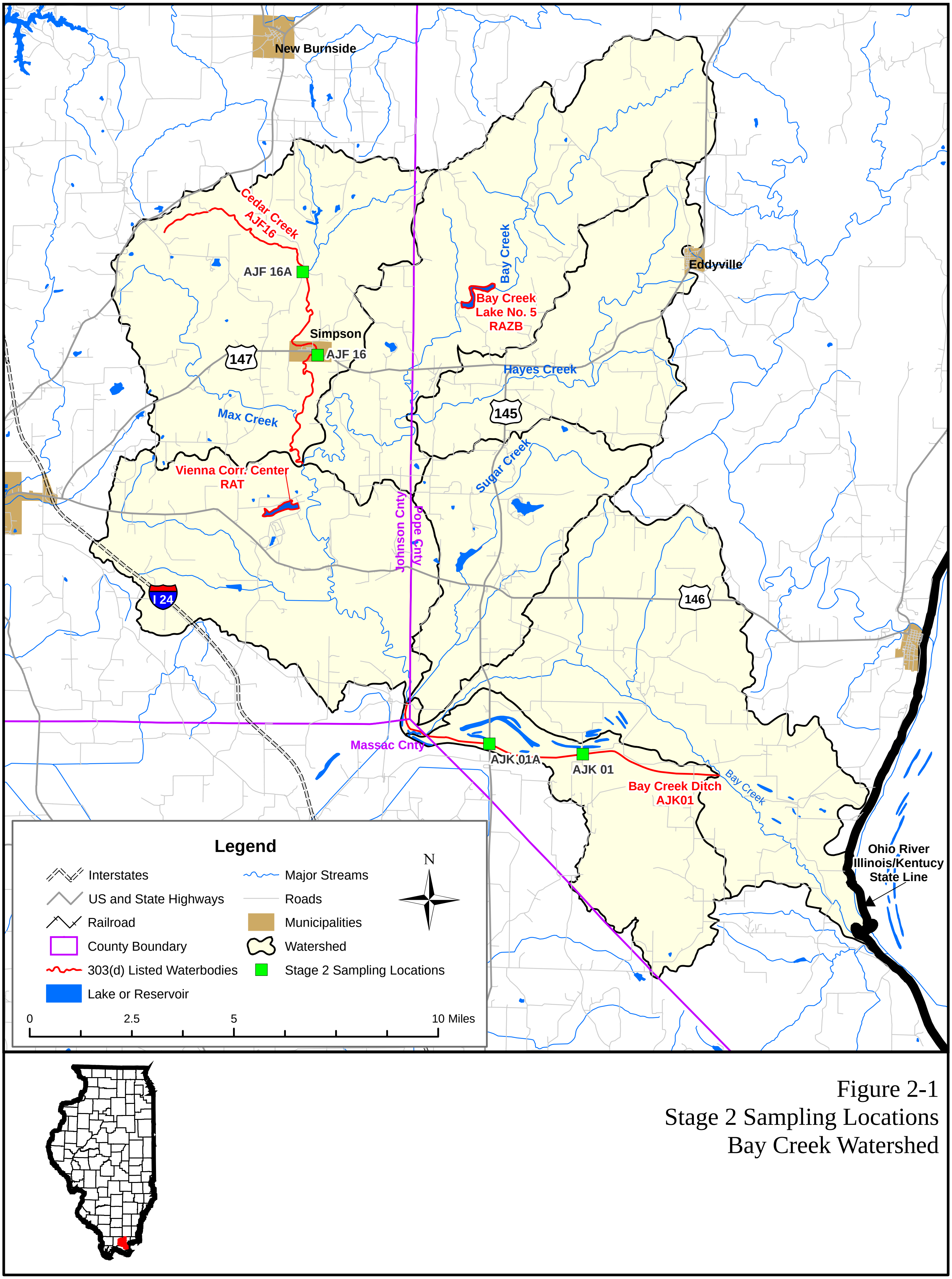

Figure 2-1
Stage 2 Sampling Locations
Bay Creek Watershed

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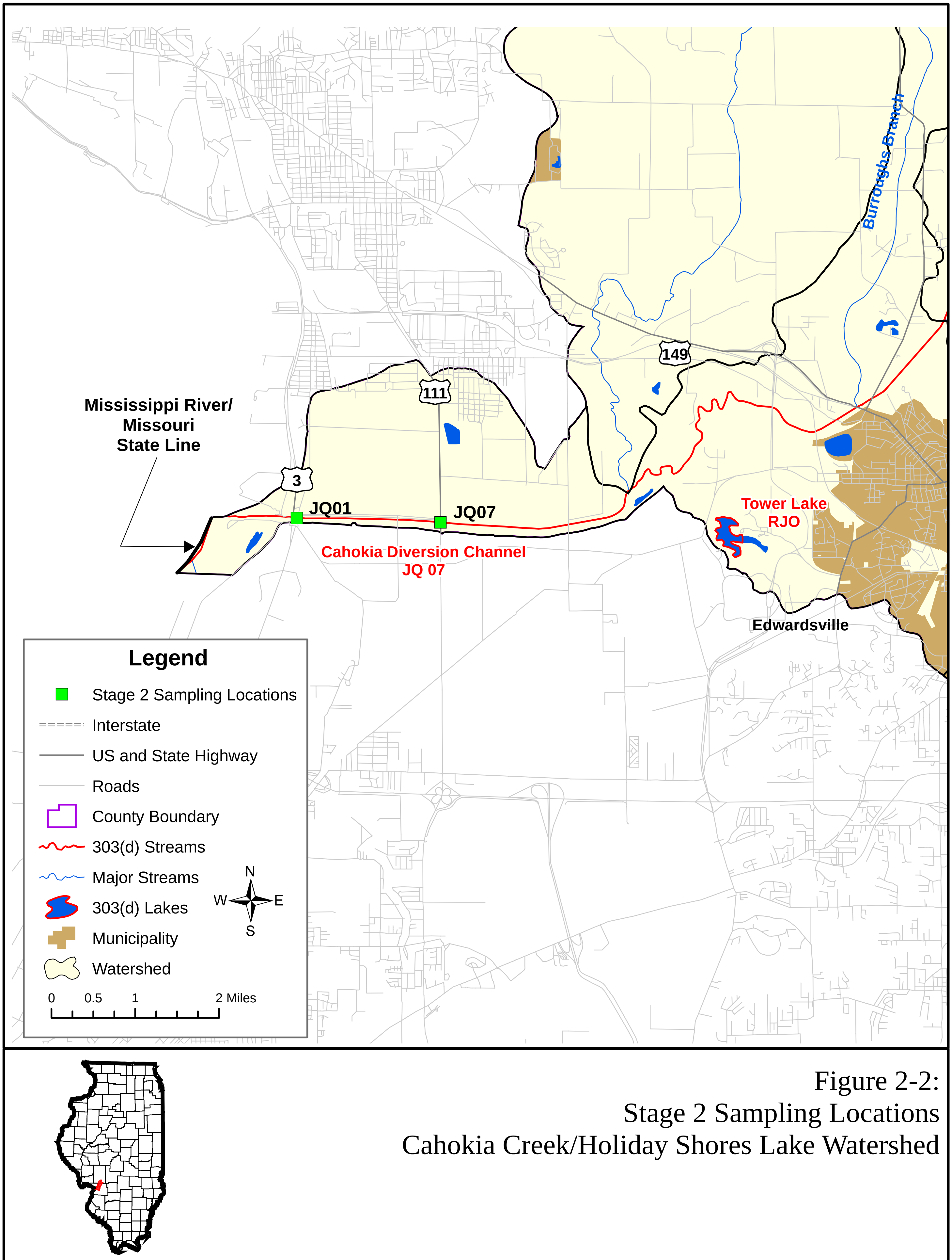

Figure 2-2:
Stage 2 Sampling Locations
Cahokia Creek/Holiday Shores Lake Watershed

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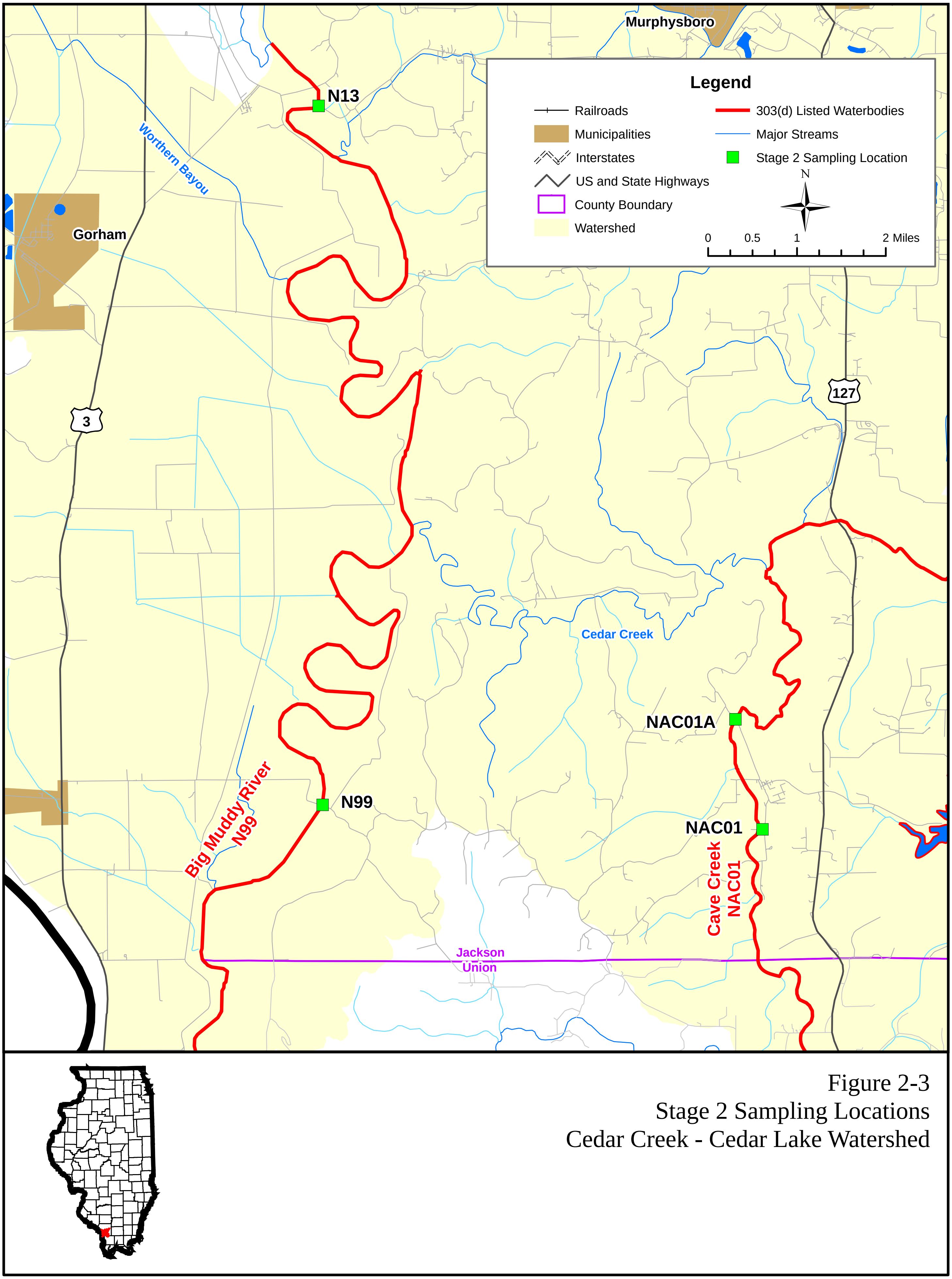

Figure 2-3
Stage 2 Sampling Locations
Cedar Creek - Cedar Lake Watershed

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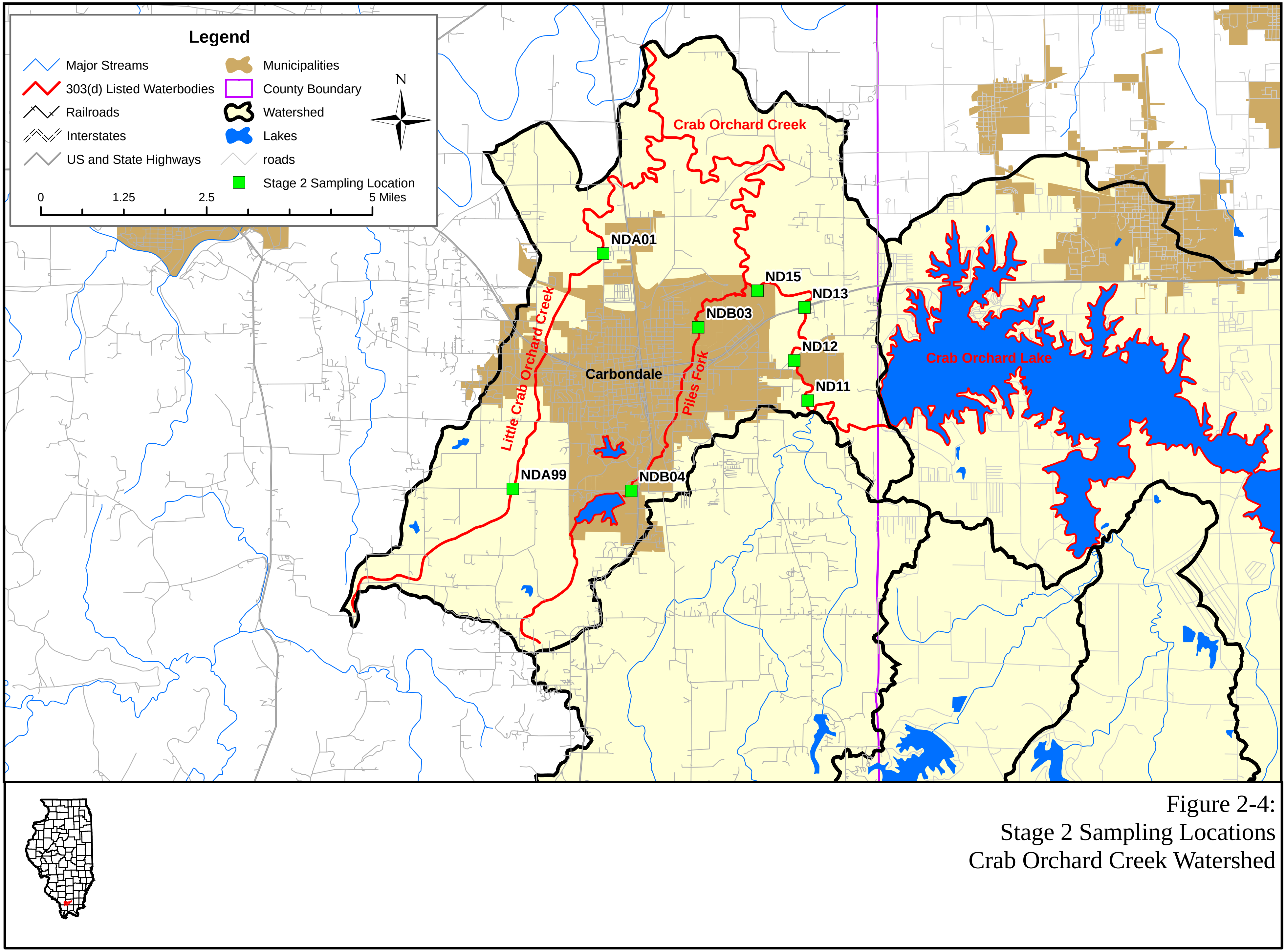

Figure 2-4:
Stage 2 Sampling Locations
Crab Orchard Creek Watershed

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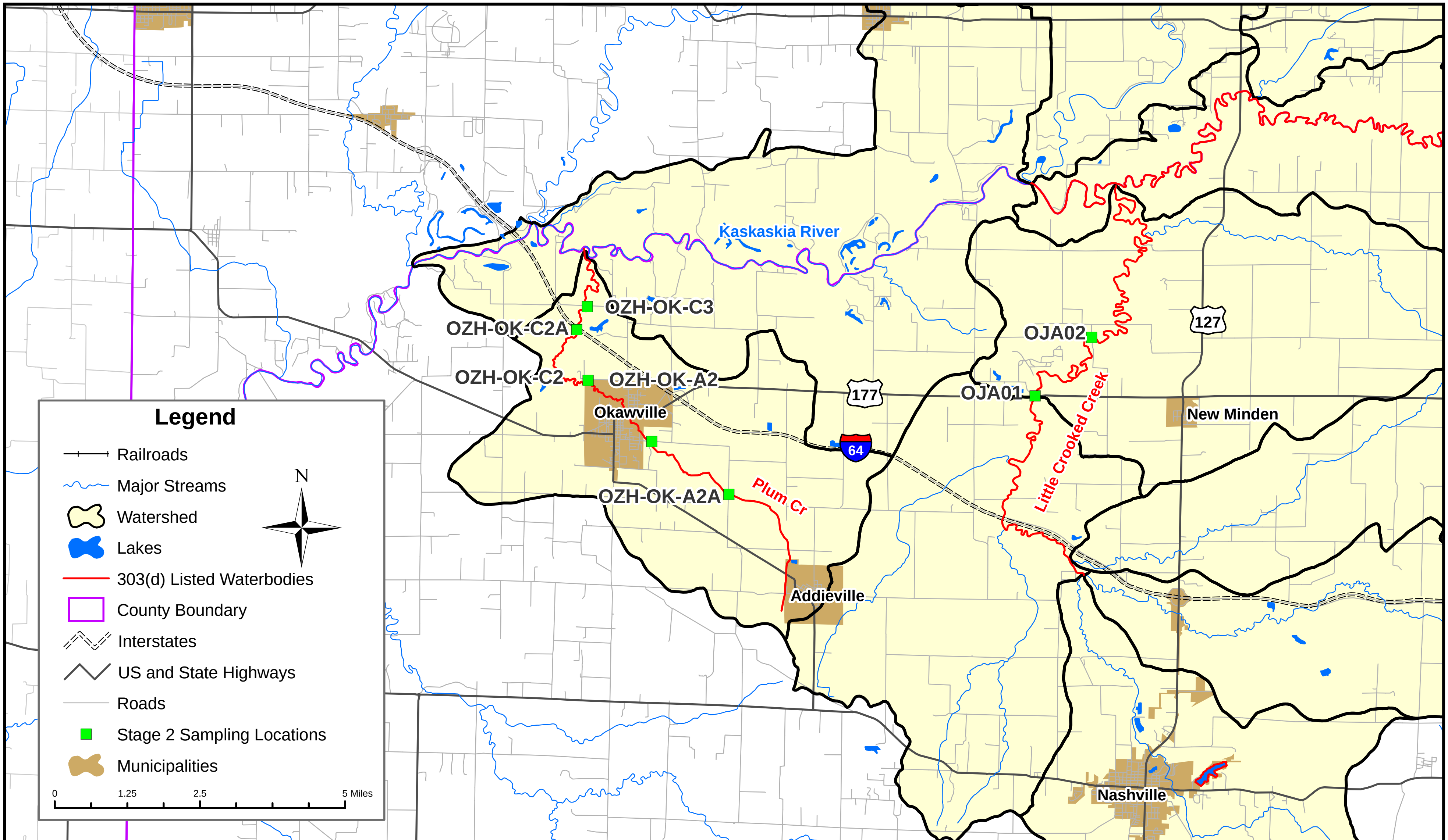

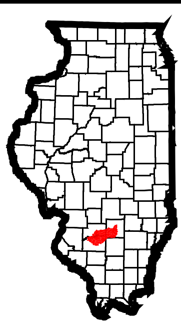

Figure 2-5
Stage 2 Sampling Locations
Crooked Creek Watershed

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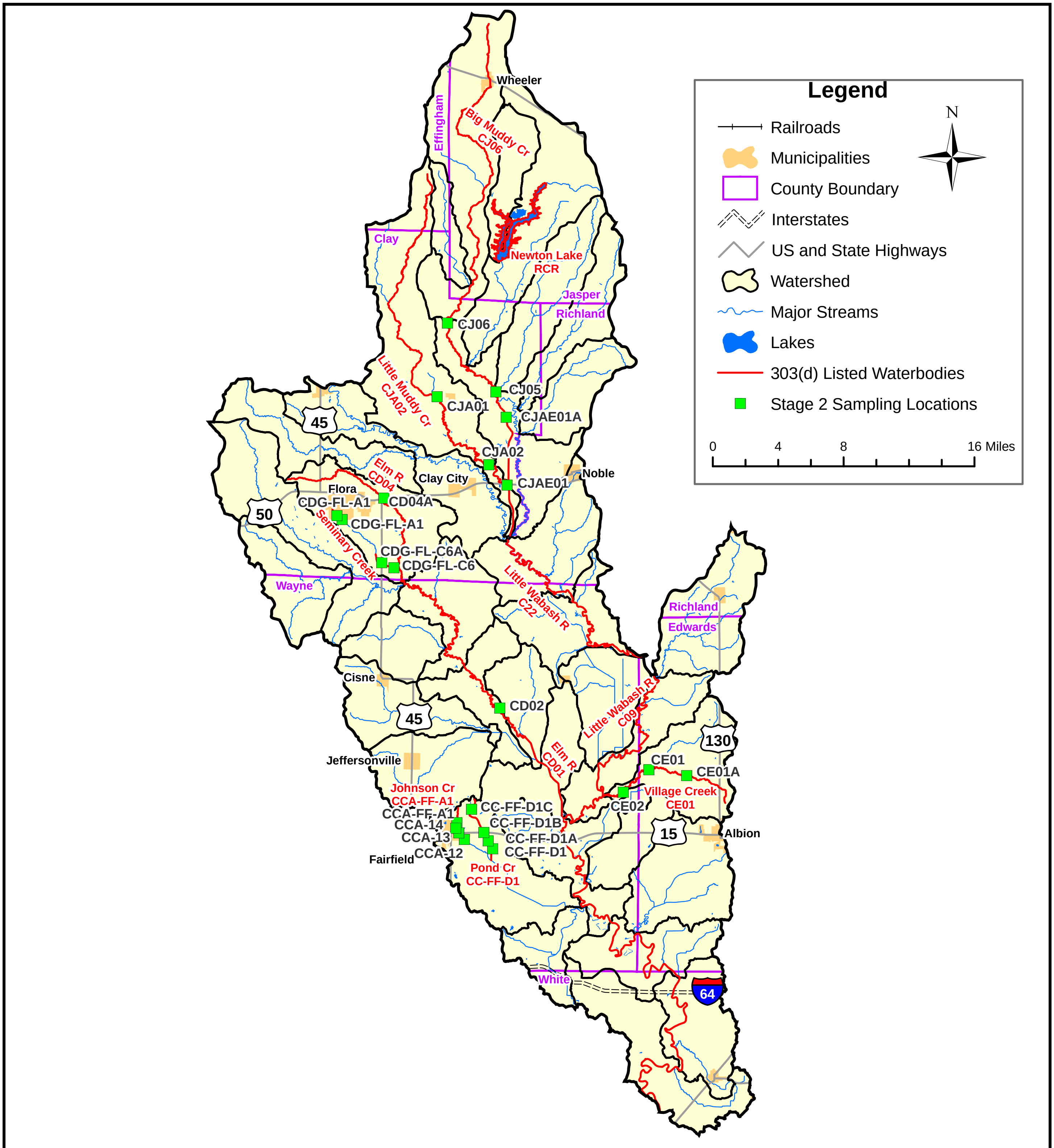

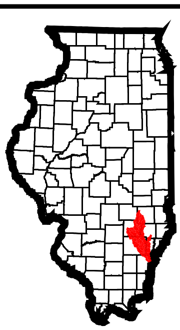

Figure 2-6:
Stage 2 Sampling Locations
Little Wabsash River Watershed

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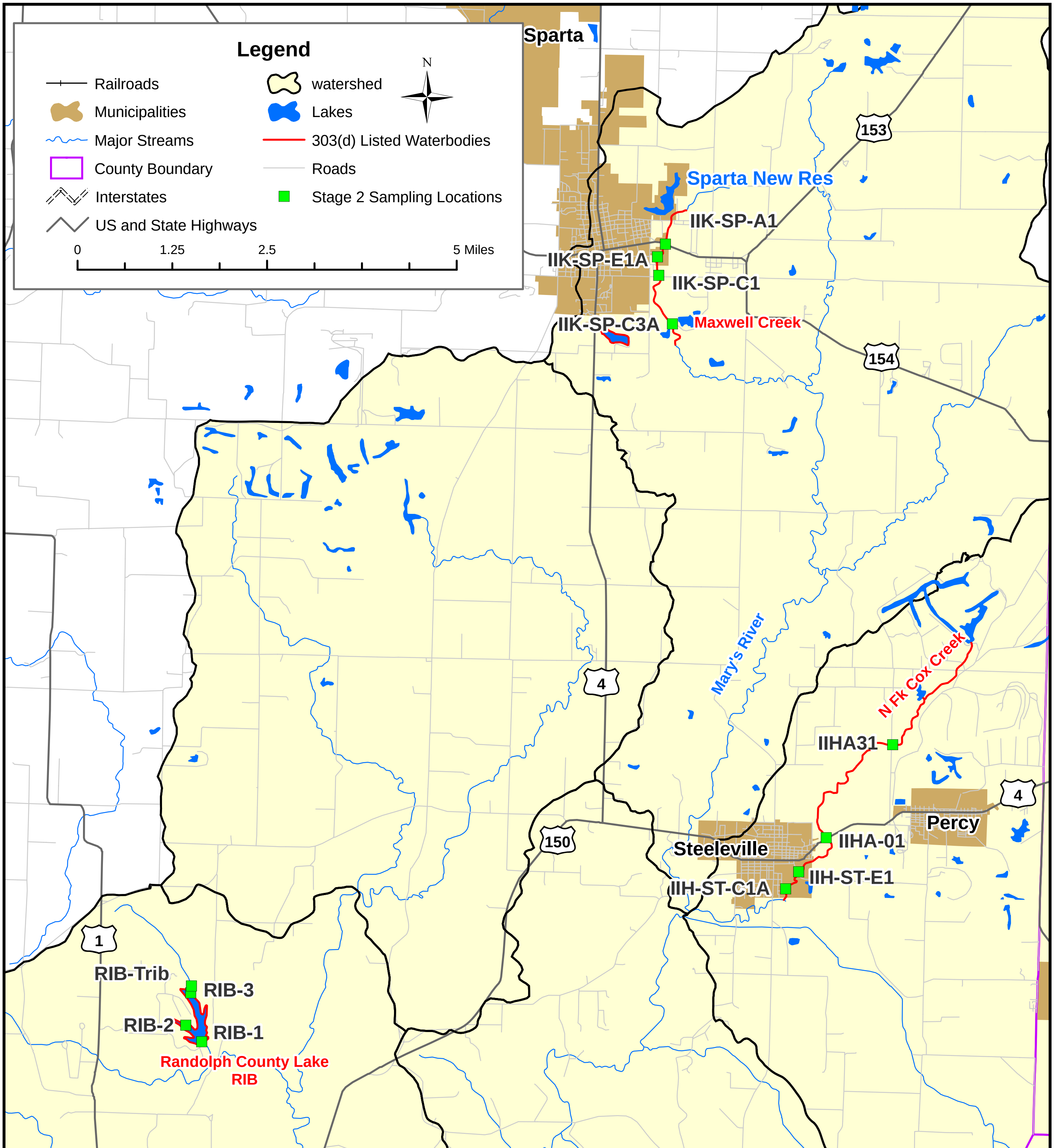

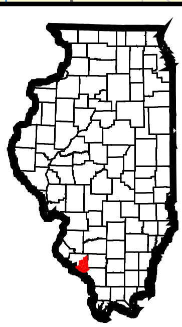

Figure 2-7:
Stage 2 Sampling Locations
Marys River - North Fork Cox Creek Watershed

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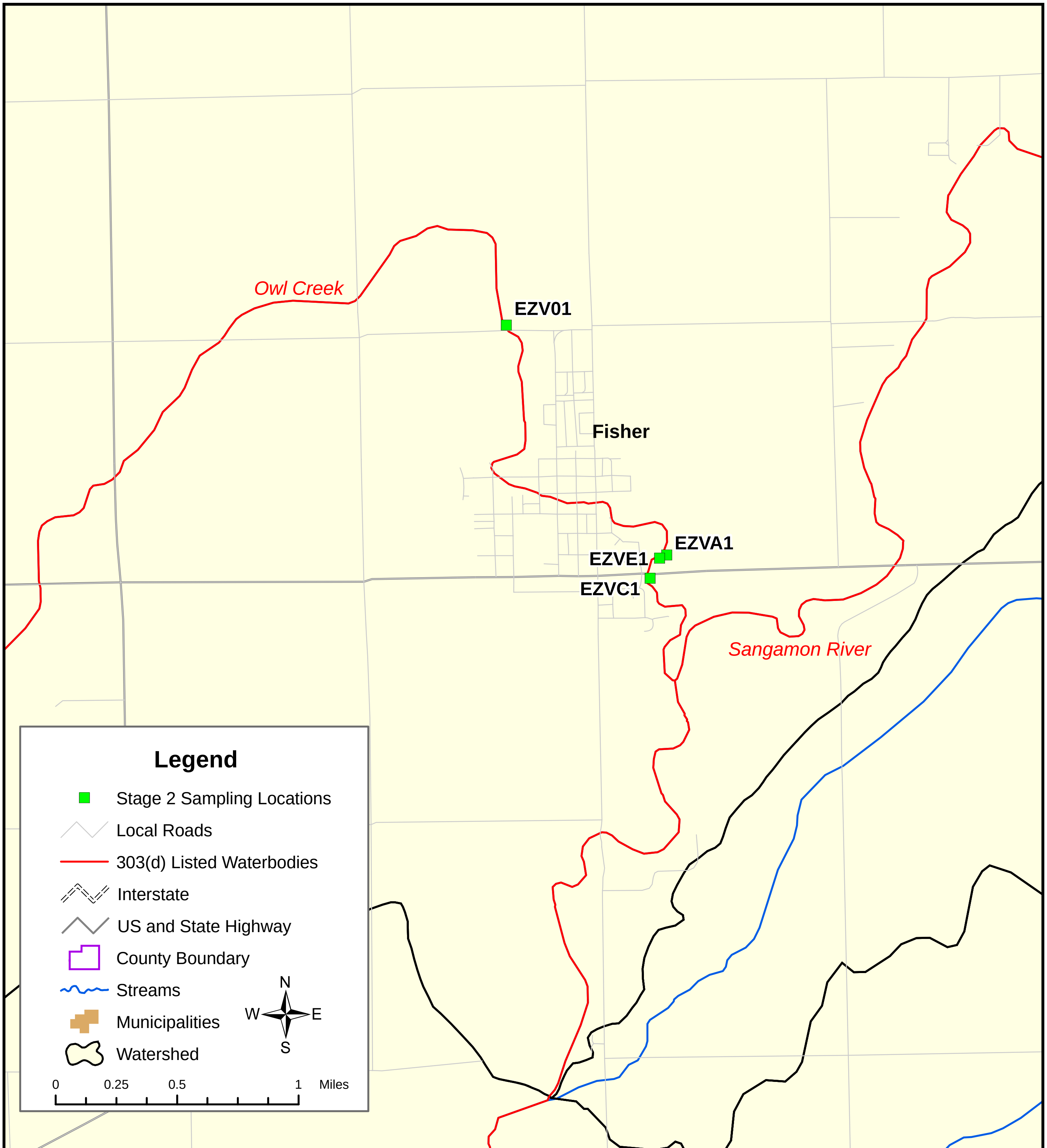

Figure 2-8:
Stage 2 Sampling Locations
Sangamon River - Lake Decatur Watershed

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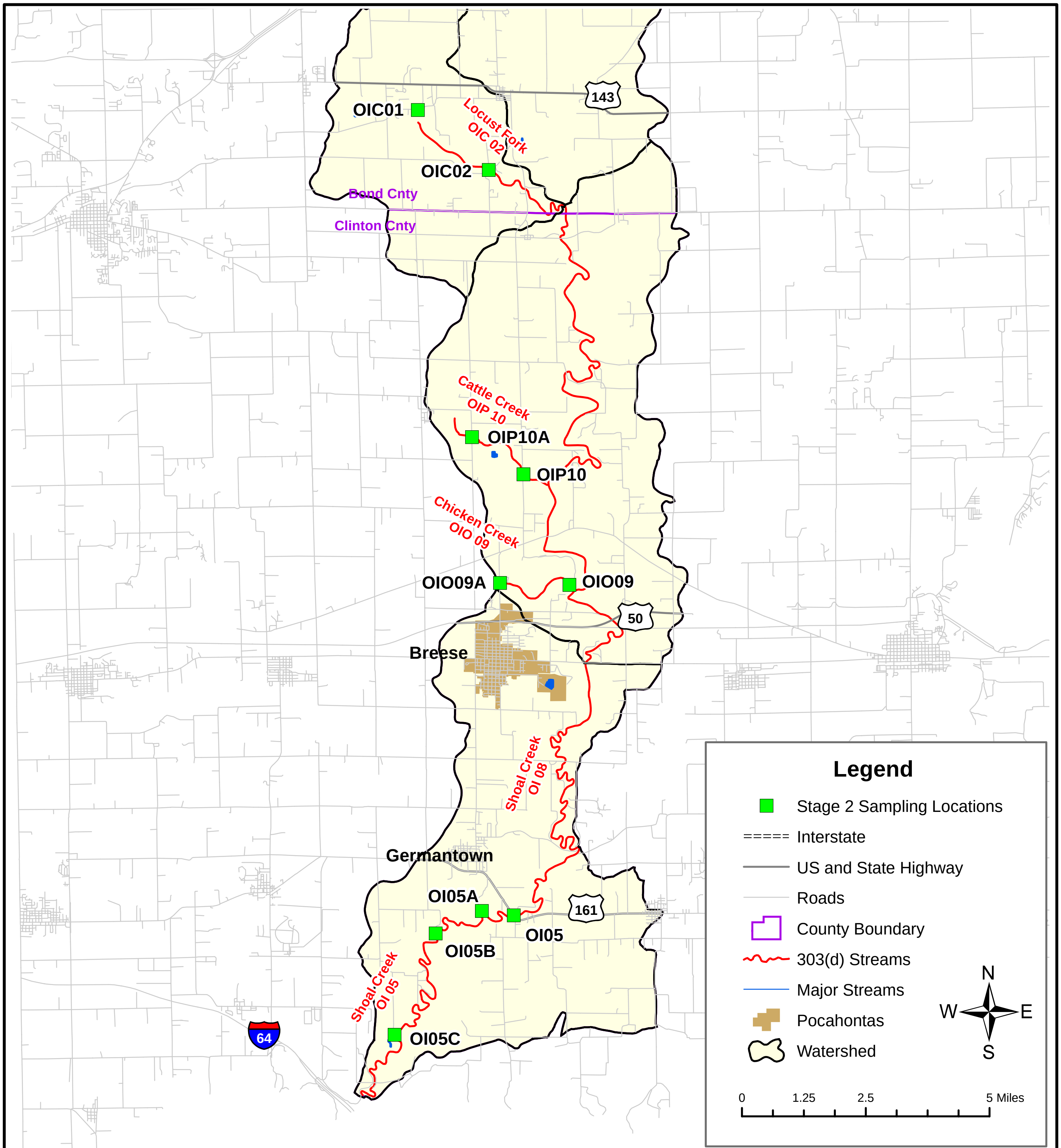

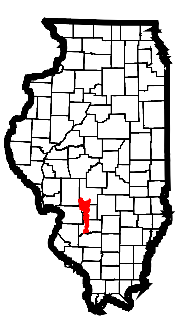

Figure 2-9:
Stage 2 Sampling Locations
Shoal Creek Watershed

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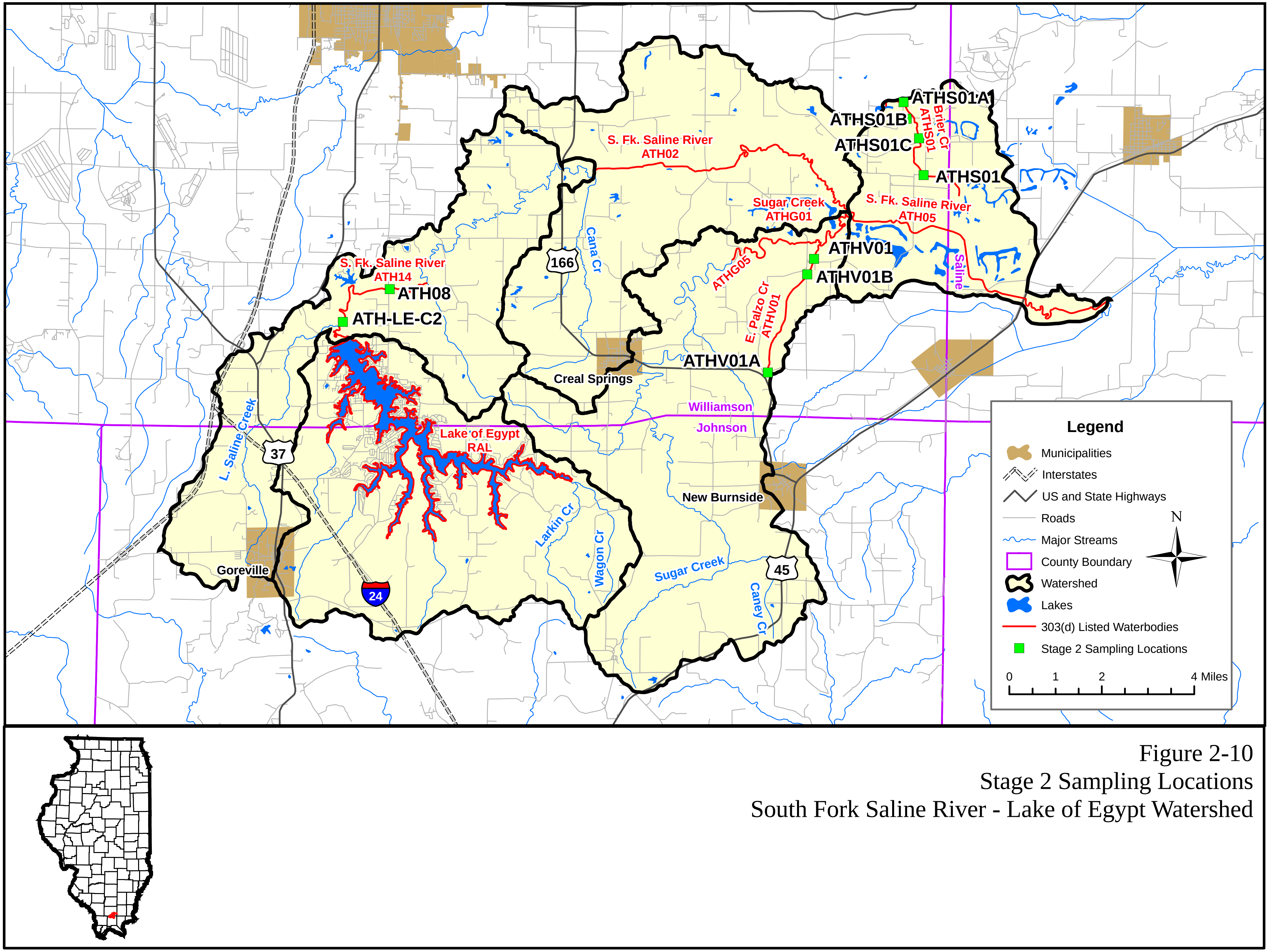

Figure 2-10
Stage 2 Sampling Locations
South Fork Saline River - Lake of Egypt Watershed

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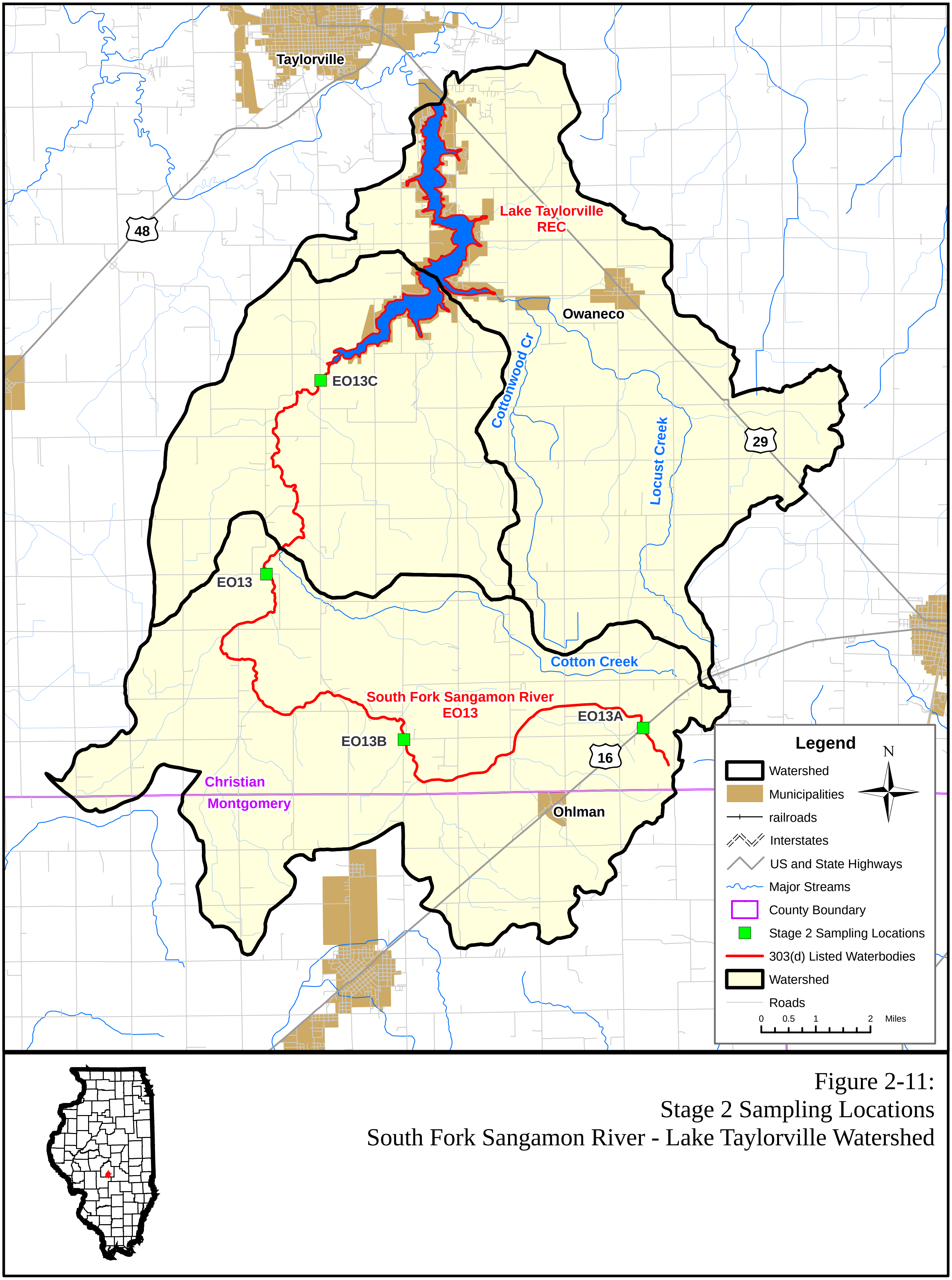

Figure 2-11:
Stage 2 Sampling Locations
South Fork Sangamon River - Lake Taylorville Watershed

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Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Bay Creek	Cedar Creek	AJF16	37.4661	88.7508	9/25/2006	18:00	6.5	117.0	7.8	8.9	63.9	NA
	Cedar Creek	AJF16	37.4661	88.7508	11/3/2006	11:05	7.2	164.5	8.6	11.0	7.0	NA
	Cedar Creek	AJF16A	37.4954	88.7592	9/25/2006	18:15	6.6	81.0	15.6	9.4	64.0	NA
	Cedar Creek	AJF16A	37.4954	88.7592	11/2/2006	13:30	7.3	101.8	5.4	11.6	9.2	NA
	Bay Creek Ditch	AJK01	37.3245	88.6337	9/25/2006	15:58	6.3	74.0	17.2	5.6	66.6	NA
	Bay Creek Ditch	AJK01	37.3245	88.6337	10/31/2006	8:15	7.2	91.6	20.4	8.2	12.8	NA
	Bay Creek Ditch	AJK01A	37.3282	88.6747	9/25/2006	NOT SAMPLED *Site flooded over banks into surrounding fields with no access/alternate site not located*						NA
	Bay Creek Ditch	AJK01A	37.3282	88.6747	10/31/2006	8:45	7.1	91.1	44.5	6.1	13.2	NA
Cahokia Creek/Holiday Shores Lake	Cahokia Diversion Ditch	JQ01	38.8054	90.1023	8/31/2006	13:40	7.4	606.7	62.3	3.4	23.9	NA
	Cahokia Diversion Ditch	JQ01	38.8054	90.1023	10/17/2006	14:45	8.3	459.8	92.9	9.6	12.6	NA
	Cahokia Diversion Ditch	JQ07	38.8050	90.0673	8/31/2006	14:45	7.4	498.6	68.0	5.3	23.0	NA
	Cahokia Diversion Ditch	JQ07	38.8050	90.0673	10/17/2006	14:15	8.3	427.0	115.8	9.4	12.8	NA
Cedar Creek	Big Muddy River	N13	37.7392	89.4284	9/7/2006	11:15	7.6	646.1	45.5	8.1	29.9	NA
	Big Muddy River	N13	37.7392	89.4284	11/1/2006	10:45	7.1	319.1	258.5	8.2	11.2	NA
	Big Muddy River	N99	37.6252	89.4284	9/7/2006	12:15	7.7	749.5	40.2	10.1	23.6	NA
	Big Muddy River	N99	37.6252	89.4284	11/1/2006	9:45	7.4	333.4	188.4	7.8	11.5	NA
	Cave Creek	NAC01	37.6154	89.3395	9/11/2006	11:45	7.8	288.4	N/A	7.6	20.4	NA
	Cave Creek	NAC01	37.6154	89.3395	11/1/2006	11:45	7.8	213.2	24.0	10.6	9.8	NA
	Cave Creek	NAC01A	37.6380	89.5660	9/11/2006	11:15	7.5	330.3	N/A	4.9	20.5	NA
	Cave Creek	NAC01A	37.6380	89.5660	11/1/2006	12:15	7.7	227.7	20.6	10.1	10.2	NA
Crab Orchard Creek	Crab Orchard Creek	ND11	37.7198	89.1717	9/6/2006	12:15	7.3	385.9	N/A	5.2	20.1	NA
	Crab Orchard Creek	ND11	37.7198	89.1717	11/1/2006	14:00	7.7	229.6	26.7	10.1	11.7	NA
	Crab Orchard Creek	ND12	37.7286	89.1753	9/6/2006	13:15	7.3	502.7	N/A	6.4	24.2	NA
	Crab Orchard Creek	ND12	37.7286	89.1753	11/1/2006	15:00	7.7	233.4	52.2	10.4	11.7	NA
	Crab Orchard Creek	ND13	37.7402	89.1723	9/6/2006	15:00	7.4	494.1	N/A	6.0	22.2	NA
	Crab Orchard Creek	ND13	37.7402	89.1723	11/1/2006	15:45	7.3	234.7	19.0	11.1	11.8	NA
	Crab Orchard Creek	ND15	37.7440	89.1852	9/6/2006	16:30	7.0	470.0	N/A	6.8	22.4	NA
	Crab Orchard Creek	ND15	37.7440	89.1852	11/1/2006	NOT SAMPLED *Site located behind Walmart parking lot and not accessible due to large chain link fence/no available alternate sites*						NA
	Little Crab Orchard Creek	NDA01	37.7525	89.2276	9/6/2006	18:00	7.3	242.5	N/A	2.1	19.2	NA
	Little Crab Orchard Creek	NDA01	37.7525	89.2276	11/2/2006	8:30	7.0	225.5	30.4	8.2	6.3	NA
	Little Crab Orchard Creek	NDA99	37.7011	89.2531	9/9/2006	NOT SAMPLED *Site dry and road crossings in the vacinity of site were also dry*						NA
	Little Crab Orchard Creek	NDA99	37.7011	89.2531	11/2/2006	10:30	8.7	190.5	17.0	12.3	5.5	NA
	Piles Fork	NDB03	37.7361	89.2016	9/7/2006	10:00	7.3	404.0	7.4	1.6	18.5	NA
	Piles Fork	NDB03	37.7361	89.2016	11/2/2006	9:15	7.7	240.7	25.5	10.3	7.3	NA
	Piles Fork	NDB04	37.7004	89.2205	9/9/2006	7:40	7.7	753.7	7.8	3.6	17.6	NA
	Piles Fork	NDB04	37.7004	89.2205	11/2/2006	11:00	8.1	154.9	56.5	11.5	10.2	NA
Crooked Creek	Little Crooked Creek	OJA-01	38.4416	89.4170	9/7/2006	17:45	7.0	274.0	22.5	3.7	20.3	NA
	Little Crooked Creek	OJA-01	38.4416	89.4170	10/19/2006	14:05	7.5	335.4	84.1	4.7	12.0	NA
	Little Crooked Creek	OJA-02	38.4564	89.3992	9/8/2006	11:15	7.0	284.8	20.2	3.1	19.7	NA
	Little Crooked Creek	OJA-02	38.4564	89.3992	10/19/2006	14:35	7.3	332.5	48.1	3.8	12.4	NA
	Plum Creek	OZH-OK-A2	38.4290	89.5387	9/8/2006	14:00	7.9	663.3	10.4	6.8	23.9	NA
	Plum Creek	OZH-OK-A2	38.4290	89.5387	10/19/2006	10:50	7.6	390.6	51.8	5.3	11.2	NA
	Plum Creek	OZH-OK-A2A	38.4160	89.5140	9/8/2006	16:45	7.8	503.2	56.9	8.5	22.3	NA
	Plum Creek	OZH-OK-A2A	38.4160	89.5140	10/19/2006	11:20	7.8	341.6	74.7	9.0	9.8	NA
	Plum Creek	OZH-OK-C2	38.4441	89.5592	9/8/2006	12:45	7.3	367.1	11.2	1.1	18.8	NA
	Plum Creek	OZH-OK-C2	38.4441	89.5592	10/19/2006	10:15	7.4	361.7	66.4	2.5	12.0	NA
	Plum Creek	OZH-OK-C2A	38.4568	89.5630	9/8/2006	17:30	7.8	977.9	13.4	4.6	20.7	NA
	Plum Creek	OZH-OK-C2A	38.4568	89.5630	10/19/2006	13:40	7.7	433.1	48.8	3.2	11.5	NA
	Plum Creek	OZH-OK-C3	38.4626	89.5598	9/8/2006	15:00	7.7	983.2	38.5	4.1	21.2	NA
	Plum Creek	OZH-OK-C3	38.4626	89.5598	10/19/2006	9:35	7.5	384.1	556.5	5.2	11.7	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash	Little Wabash River	C09	38.4407	88.2581	1/25/2005	14:00	7.3	415	42	12.1	1.1	NA
	Little Wabash River	C09	38.4407	88.2581	3/17/2005	8:00	8.3	700	23	14.9	7	NA
	Little Wabash River	C09	38.4407	88.2581	4/19/2005	14:30	7.8	535	50	7.3	18.8	NA
	Little Wabash River	C09	38.4407	88.2581	5/9/2005	10:30	7.3	738	60	6.7	19.7	NA
	Little Wabash River	C09	38.4407	88.2581	6/23/2005	7:30	7.7	690	47	5.1	26	NA
	Little Wabash River	C09	38.4407	88.2581	8/23/2005	13:00	7.2	290	70	4.2	27.1	NA
	Little Wabash River	C09	38.4407	88.2581	9/27/2005	16:00	7.8	533	25	7.5	24.6	NA
	Little Wabash River	C09	38.4407	88.2581	10/27/2005	14:00	7.8	550	11	8.7	11.7	NA
	Little Wabash River	C09	38.4407	88.2581	12/6/2005	13:00	7.6	375	70	11.8	1.6	NA
	Little Wabash River	C09	38.4407	88.2581	2/1/2006	13:00	7.6	390	200	9.3	6.8	NA
	Little Wabash River	C09	38.4407	88.2581	3/15/2006	10:00	6.6	150	130	6.2	12.4	NA
	Little Wabash River	C09	38.4407	88.2581	4/18/2006	16:00	7.9	572	40	8.1	20.1	NA
	Little Wabash River	C09	38.4407	88.2581	4/26/2006	10:00	7.8	580	59	7.2	17.7	NA
	Little Wabash River	C09	38.4407	88.2581	5/1/2006	9:45	7.5	543	75	6.4	16.2	NA
	Little Wabash River	C09	38.4407	88.2581	5/10/2006	10:00	7.4	475		6.2	18.5	NA
	Little Wabash River	C09	38.4407	88.2581	5/17/2006	11:00	7.4	421	70	7.4	14.7	NA
	Little Wabash River	C09	38.4407	88.2581	5/24/2006	9:45	7.5	473		6.6	18.9	NA
	Little Wabash River	C09	38.4407	88.2581	5/31/2006	10:20	7.2	352		4	25.3	NA
	Little Wabash River	C09	38.4407	88.2581	6/7/2006	10:15	7.2	345		4.3	23.3	NA
	Little Wabash River	C09	38.4407	88.2581	6/15/2006	8:50	7.4	536	55	5.2	23.9	NA
	Little Wabash River	C09	38.4407	88.2581	6/22/2006	10:05	7.5	608	65	4.4	28.4	NA
	Little Wabash River	C09	38.4407	88.2581	6/27/2006	10:40	7.44	462	64	4.9	24.17	NA
	Little Wabash River	C09	38.4407	88.2581	7/5/2006	10:30	7.2	321		4.4	27.5	NA
	Little Wabash River	C09	38.4407	88.2581	7/12/2006	10:30	7.3	456		3.8	25.3	NA
	Little Wabash River	C09	38.4407	88.2581	7/20/2006	10:00	7.4	372		4.8	29.4	NA
	Little Wabash River	C09	38.4407	88.2581	7/27/2006	10:00	7.2	239		4.8	26.4	NA
	Little Wabash River	C09	38.4407	88.2581	8/1/2006	8:30	7.3	306	65	4.5	30.3	NA
	Little Wabash River	C09	38.4407	88.2581	8/8/2006	11:05	7.3	392	55	4.75	28.4	NA
	Little Wabash River	C33	38.2699	88.1377	4/18/2006	11:00	7.1	418	35	4.4	19.8	NA
	Little Wabash River	C33	38.2699	88.1377	4/26/2006	12:15	7.7	607	56	6	19	NA
	Little Wabash River	C33	38.2699	88.1377	5/1/2006	11:45	7.7	597	58	6.8	16.8	NA
	Little Wabash River	C33	38.2699	88.1377	5/10/2006	12:20	7.3	409		5.3	18.7	NA
	Little Wabash River	C33	38.2699	88.1377	5/17/2006	14:00	7.4	462	90	7.2	15.5	NA
	Little Wabash River	C33	38.2699	88.1377	5/24/2006	12:15	7.4	494		6.4	19.9	NA
	Little Wabash River	C33	38.2699	88.1377	5/31/2006	12:40	7.2	449		3.9	25.4	NA
	Little Wabash River	C33	38.2699	88.1377	6/7/2006	12:30	6.8	286		3	23.01	NA
	Little Wabash River	C33	38.2699	88.1377	6/15/2006	11:05	7.5	511	45	8.1	25.1	NA
	Little Wabash River	C33	38.2699	88.1377	6/22/2006	12:00	7.2	546	38	3	29.8	NA
	Little Wabash River	C33	38.2699	88.1377	6/27/2006	11:50	7.4	548	61	4.8	26.17	NA
	Little Wabash River	C33	38.2699	88.1377	7/5/2006	13:00	7.3	334		5.8	29	NA
	Little Wabash River	C33	38.2699	88.1377	7/12/2006	12:30	7.1	326		3.4	25.3	NA
	Little Wabash River	C33	38.2699	88.1377	7/20/2006	12:20	6.9	247		3.4	29.9	NA
	Little Wabash River	C33	38.2699	88.1377	7/27/2006	12:10	7.5	308		6.4	27.4	NA
	Little Wabash River	C33	38.2699	88.1377	8/1/2006	10:30	7.3	296	40	4.7	30.8	NA
	Little Wabash River	C33	38.2699	88.1377	8/8/2006	13:30	7.3	361	40	4.9	29.8	NA
	Johnson Creek	CCA12	38.3732	88.3449	9/9/2006	13:05	8.2	1402.0	13.4	14.2	28.4	NA
	Johnson Creek	CCA12	38.3732	88.3449	11/14/2006	9:45	7.5	651.4	645.5	7.7	7.0	NA
	Johnson Creek	CCA13	38.3789	88.3511	9/9/2006	14:30	8.6	1517.0	3.1	14.9	25.4	NA
	Johnson Creek	CCA13	38.3789	88.3511	11/14/2006	10:15	7.7	649.4	19.0	12.8	8.1	NA
	Johnson Creek	CCA14A	38.3830	88.3546	9/9/2006	15:25	7.6	836.0	3.6	5.7	21.6	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash (cont.)	Johnson Creek	CCA14A	38.3830	88.3546	11/14/2006	10:25	7.7	694.2	2.4	12.5	8.0	NA
	Johnson Creek	CCAFFA1A	38.3881	88.3535	9/10/2006	10:50	7.4	788.0	5.9	3.8	19.8	NA
	Johnson Creek	CCAFFA1A	38.3881	88.3535	11/14/2006	10:45	7.4	789.8	4.3	12.3	7.5	NA
	Pond Creek	CCFFD1	38.3648	88.3130	9/9/2006	10:30	7.7	576.0	8.6	7.1	19.5	NA
	Pond Creek	CCFFD1	38.3648	88.3130	10/31/2006	10:10	7.6	8719.7	29.2	8.2	3.8	NA
	Pond Creek	CCFFD1A	38.3720	88.3181	9/9/2006	NOT SAMPLED *Site Dry/no available alternate sites*						NA
	Pond Creek	CCFFD1A	38.3720	88.3181	11/9/2006	12:15	7.3	742.5	9.1	11.2	13.6	NA
	Pond Creek	CCFFD1B	38.3793	88.3230	9/9/2006	11:45	7.5	784.0	10.0	8.6	22.9	NA
	Pond Creek	CCFFD1B	38.3793	88.3230	11/9/2006	11:35	7.3	827.9	4.1	12.1	12.7	NA
	Pond Creek	CCFFD1C	38.3999	88.3370	9/10/2006	12:10	8.0	3941.0	17.8	11.9	19.3	NA
	Pond Creek	CCFFD1C	38.3999	88.3370	10/31/2006	11:20	8.8	1394.0		14.4	4.4	NA
	Elm River	CD01	38.5184	88.1320	1/26/2005	13:00	7.1	388	36	9.1	1.4	NA
	Elm River	CD01	38.5184	88.1320	3/15/2005	11:30	8.4	950	7.2	14.6	6.2	NA
	Elm River	CD01	38.5184	88.1320	4/20/2005	11:30	7.4	670	60	6.7	20.1	NA
	Elm River	CD01	38.5184	88.1320	5/5/2005	13:00	7.5	625	27	7.6	13.8	NA
	Elm River	CD01	38.5184	88.1320	6/23/2005	10:00	7.5	1050	22	5.2	24.7	NA
	Elm River	CD01	38.5184	88.1320	8/18/2005	11:00	7.6	730	34	3.6	24.6	NA
	Elm River	CD01	38.5184	88.1320	9/29/2005	11:30	7.6	700	17	3.6	18.5	NA
	Elm River	CD01	38.5184	88.1320	10/18/2005	11:30	7.5	680	8.2	5.9	15	NA
	Elm River	CD01	38.5184	88.1320	12/8/2005	10:30	7.4	321	65	9.6	0.3	NA
	Elm River	CD01	38.5184	88.1320	2/1/2006	15:00	7.5	430	80	9.1	7	NA
	Elm River	CD01	38.5184	88.1320	3/1/2006	13:30	7.4	840	42	10.2	9.1	NA
	Elm River	CD01	38.5184	88.1320	4/6/2006	11:00	7.3	440	90	8.6	13.5	NA
	Elm River	CD01	38.5184	88.1320	4/18/2006	14:30	7.3	670	40	5.6	20.9	NA
	Elm River	CD01	38.5184	88.1320	4/26/2006	11:15	7.5	860		6.2	15.9	NA
	Elm River	CD01	38.5184	88.1320	5/1/2006	11:00	7.4	958		5.9	15.2	NA
	Elm River	CD01	38.5184	88.1320	5/10/2006	11:10	7.2	489		5	18.2	NA
	Elm River	CD01	38.5184	88.1320	5/17/2006	9:30	7.1	484	35	7	13.8	NA
	Elm River	CD01	38.5184	88.1320	5/24/2006	11:20	7.2	594		5.7	18.5	NA
	Elm River	CD01	38.5184	88.1320	5/31/2006	11:30	7.2	605		3.8	25.7	NA
	Elm River	CD01	38.5184	88.1320	6/7/2006	11:25	7	346		4.5	23.4	NA
	Elm River	CD01	38.5184	88.1320	6/15/2006	9:50	7.1	622		4.6	22.5	NA
	Elm River	CD01	38.5184	88.1320	6/22/2006	11:15	7.1	443		4.6	27.9	NA
	Elm River	CD01	38.5184	88.1320	6/27/2006	9:15	6.77	229	91	5	21.95	NA
	Elm River	CD01	38.5184	88.1320	7/5/2006	11:50	7.2	588		3.6	26.6	NA
	Elm River	CD01	38.5184	88.1320	7/12/2006	11:30	7.2	569		4.2	23.9	NA
	Elm River	CD01	38.5184	88.1320	7/20/2006	11:15	7	285		2.8	28.2	NA
	Elm River	CD01	38.5184	88.1320	7/27/2006	11:05	7.1	346		3.5	25.8	NA
	Elm River	CD01	38.5184	88.1320	8/1/2006	9:20	7.3	382		4	27.8	NA
	Elm River	CD01	38.5184	88.1320	8/8/2006	12:20	7.1	425		4.1	26.3	NA
	Elm River	CD02	38.6751	88.4362	9/8/2006	17:45	7.5	344.0	15.9	8.1	23.2	NA
	Elm River	CD02	38.6751	88.4362	11/8/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	Elm River	CD02A	38.4894	88.3051	9/12/2006	12:51	7.2	404.0	15.7	3.8	22.0	NA
	Elm River	CD02A	38.4894	88.3051	11/8/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	Seminary Creek	CDFGLC6	38.6180	88.4384	9/8/2006	12:25	7.7	708.0	4.2	6.6	19.5	NA
	Seminary Creek	CDFGLC6	38.6180	88.4384	11/8/2006	17:00	7.5	527.6	17.5	10.5	12.4	NA
	Seminary Creek	CDFGLC6A	38.6135	88.4245	9/8/2006	11:10	7.7	720.0	201.2	7.0	20.1	NA
	Seminary Creek	CDFGLC6A	38.6135	88.4245	11/8/2006	16:45	7.3	561.7	15.1	12.0	13.5	NA
	Seminary Creek	CDGFLA1	38.6561	88.4832	9/8/2006	15:40	7.9	558.0	7.0	10.0	22.0	NA
	Seminary Creek	CDGFLA1	38.6561	88.4832	11/8/2006	14:45	7.3	385.0	12.5	14.3	12.7	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Little Wabash (cont.)	Seminary Creek	CDGFLA1A	38.6595	88.4890	9/8/2006	13:45	7.4	362.0	22.7	2.6	19.0	NA
	Seminary Creek	CDGFLA1A	38.6595	88.4890	11/8/2006	15:50	7.2	429.8	16.8	15.1	12.7	NA
	Village Creek	CE01	38.4348	88.1369	9/6/2006	17:30	8.1	610.0	11.4	9.9	24.9	NA
	Village Creek	CE01	38.4348	88.1369	11/14/2006	8:45	7.5	697.9	8.0	10.6	6.8	NA
	Village Creek	CE01A	38.4294	88.0943	9/12/2006	17:05	7.2	327.0	145.2	5.8	22.6	NA
	Village Creek	CE01A	38.4294	88.0943	11/9/2006	13:45	7.2	607.2	8.7	11.2	14.2	NA
	Village Creek	CE02	38.4150	88.1659	9/6/2006	15:20	7.8	568.0	15.7	7.9	25.0	NA
	Village Creek	CE02	38.4150	88.1659	11/9/2006	12:55	7.5	587.4	14.1	10.7	13.1	NA
	Big Muddy Creek	CJ05	38.7693	88.3093	9/7/2006	16:45	8.2	63.1	11.4	10.5	23.6	NA
	Big Muddy Creek	CJ05	38.7693	88.3093	11/8/2006	11:30	7.4	457.0	32.5	12.4	8.3	NA
	Big Muddy Creek	CJ06	38.8298	88.3642	9/7/2006	18:10	7.5	588.0	34.6	4.9	21.8	NA
	Big Muddy Creek	CJ06	38.8298	88.3642	11/8/2006	11:00	7.3	455.1	15.8	11.6	10.6	NA
	Little Muddy Creek	CJA01	38.7647	88.3760	9/12/2006	10:20	7.0	321.0	9.5	3.4	20.9	NA
	Little Muddy Creek	CJA01	38.7647	88.3760	11/13/2006	12:00	7.0	267.9	113.2	10.1	7.4	NA
	Little Muddy Creek	CJA02	38.7047	88.3174	9/7/2006	14:20	6.8	554.0	45.9	2.8	20.4	NA
	Little Muddy Creek	CJA02	38.7047	88.3174	11/8/2006	12:30	7.0	497.0	35.8	9.3	10.4	NA
	Big Muddy Diversion Ditch	CJAE01	38.6865	88.2967	9/7/2006	12:10	7.1	1946.0	26.9	9.1	22.2	NA
	Big Muddy Diversion Ditch	CJAE01	38.6865	88.2967	11/8/2006	13:05	7.3	478.2	30.8	10.8	11.7	NA
	Big Muddy Diversion Ditch	CJAE01A	38.7467	88.2977	9/7/2006	15:45	8.1	908.0	6.5	10.3	24.3	NA
	Big Muddy Diversion Ditch	CJAE01A	38.7467	88.2977	11/13/2006	12:30	7.6	452.9	37.8	9.8	8.2	NA
Mary's River/North Fork Cox Creek	North Fork Cox Creek	IIHA01	38.0114	89.6460	9/9/2006	17:40	7.9	2073.0	N/A	10.0	22.0	NA
	North Fork Cox Creek	IIHA01	38.0114	89.6460	10/18/2006	14:25	8.3	2995.0	13.5	8.1	15.4	NA
	North Fork Cox Creek	IIHA31	38.0293	89.6303	9/9/2006	17:10	8.2	3491.0	N/A	9.6	23.9	NA
	North Fork Cox Creek	IIHA31	38.0293	89.6303	10/18/2006	14:45	8.4	3215.0	8.5	8.6	15.5	NA
	North Fork Cox Creek	IIHA-STC1	38.0015	89.6557	9/9/2006	16:15	7.8	3019.0	N/A	7.1	21.9	NA
	North Fork Cox Creek	IIHA-STC1	38.0015	89.6557	10/18/2006	14:00	8.1	1990.0	20.0	7.0	14.9	NA
	North Fork Cox Creek	IIHA-STE1	38.0048	89.6526	9/9/2006	15:45	7.8	3422.0	N/A	6.9	20.7	NA
	North Fork Cox Creek	IIHA-STE1	38.0048	89.6526	10/18/2006	13:40	8.0	2505.0	16.3	6.0	14.7	NA
	Maxwell Creek	IIKSPA1	38.1242	89.6870	9/7/2006	NOT SAMPLED						NA
	Maxwell Creek	IIKSPA1	38.1242	89.6870	10/17/2006	*Site dry during both visits/available alternate locations also dry*						NA
	Maxwell Creek	IIKSPC1	38.1182	89.6885	9/7/2006	15:30	7.3	968.1	4.8	2.0	24.3	NA
	Maxwell Creek	IIKSPC1	38.1182	89.6885	10/17/2006	8:20	7.1	561.5	22.3	20.2	18.4	NA
	Maxwell Creek	IIKSPC3A	38.1090	89.6850	9/7/2006	15:00	7.5	997.0	4.4	2.6	21.6	NA
	Maxwell Creek	IIKSPC3A	38.1090	89.6850	10/17/2006	8:45	7.5	457.8	19.2	6.5	15.4	NA
	Maxwell Creek	IIKSPE1A	38.1218	89.6889	9/7/2006	NOT SAMPLED						NA
	Maxwell Creek	IIKSPE1A	38.1218	89.6889	10/17/2006	*Site dry during both visits/available alternate locations also dry*						NA
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:00	9.1	279.7	N/A	13.9	25.6	1
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:02	9.1	279.5	N/A	13.9	24.9	2
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:04	9.1	279.2	N/A	13.8	24.7	3
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:06	9.1	278.8	N/A	13.9	24.6	4
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:08	9.0	279.3	N/A	13.2	24.4	5
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:10	9.0	279.7	N/A	12.6	24.3	6
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:12	8.9	280.4	N/A	11.8	24.2	7
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:14	8.2	286.0	N/A	6.2	23.9	8
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:16	7.8	287.4	N/A	4.4	23.7	9
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:18	7.6	288.9	N/A	2.5	23.5	10
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:20	7.3	290.3	N/A	0.3	23.1	11
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:22	7.3	296.0	N/A	0.1	22.7	12
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:24	7.1	317.6	N/A	0.0	21.2	13
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:26	7.1	332.7	N/A	0.0	18.5	14
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:28	7.1	330.3	N/A	0.0	17.1	15

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Mary's River/North Fork Cox Creek (cont.)	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:30	7.1	329.6	N/A	0.0	16.1	16
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:32	7.1	329.9	N/A	0.0	14.7	17
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:34	7.1	330.0	N/A	0.0	13.6	18
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:36	7.1	332.4	N/A	0.0	12.4	19
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:38	7.1	335.4	N/A	0.0	11.8	20
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:40	7.1	341.7	N/A	0.0	11.3	21
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:42	7.1	347.9	N/A	0.0	10.9	22
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:44	7.1	350.1	N/A	0.0	10.8	23
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:46	7.1	352.6	N/A	0.0	10.6	24
	Randolph County Lake	RIB-1	37.9707	89.7962	9/9/2006	12:48	7.0	363.8	N/A	0.0	10.2	25
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	8.0	306.1	5.6	7.1	15.8	0
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	305.0	6.7	5.4	15.7	3.28
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	304.9	5.9	5.4	15.7	6.56
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.8	303.6	6.6	5.3	15.6	9.84
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.7	303.5	7.1	5.3	15.6	13.12
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.6	304.0	11.9	4.5	13.3	16.4
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.5	371.4	9.8	0.6	12.7	19.68
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.6	392.9	8.3	0.5	10.9	22.96
	Randolph County Lake	RIB-1	37.9707	89.7962	10/18/2006	10:25	7.5	435.0	63.4	0.3	10.1	26.24
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:00	9.0	286.4	N/A	13.3	27.0	1
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:02	9.0	282.2	N/A	13.8	26.8	2
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:04	9.1	279.7	N/A	14.7	25.0	3
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:06	9.0	280.2	N/A	14.3	24.7	4
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:08	8.9	282.2	N/A	12.5	24.4	5
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:10	8.6	286.3	N/A	9.0	24.1	6
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:12	8.1	290.2	N/A	6.0	24.0	7
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:14	7.8	292.2	N/A	4.0	23.9	8
	Randolph County Lake	RIB-2	37.9738	89.8000	9/9/2006	14:16	7.7	292.7	N/A	3.1	23.8	9
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	8.0	304.9	10.3	7.1	16.0	0
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.9	304.5	7.0	6.7	15.9	3.28
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.8	304.5	6.6	6.4	15.9	6.56
	Randolph County Lake	RIB-2	37.9738	89.8000	10/18/2006	12:05	7.8	304.5	6.3	6.3	15.8	9.84
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:00	9.0	283.0	N/A	13.2	26.4	1
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:02	9.0	283.3	N/A	12.9	26.5	2
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:04	9.0	281.0	N/A	12.8	25.8	3
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:06	9.0	280.4	N/A	12.9	25.0	4
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:08	9.0	279.7	N/A	12.9	24.6	5
	Randolph County Lake	RIB-3	37.9800	89.7990	9/9/2006	13:10	9.0	279.7	N/A	12.6	24.5	6
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	8.0	305.0	8.8	7.9	16.0	0
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	7.9	304.7	8.7	7.1	16.0	3.28
	Randolph County Lake	RIB-3	37.9800	89.7990	10/18/2006	11:15	7.8	304.7	10.4	6.7	16.0	6.56
	Randolph County Lake Tributary	RIB-Trib	37.9813	89.7988	9/9/2006	13:20	9.0	284.0	N/A	12.9	28.4	NA
	Randolph County Lake Tributary	RIB-Trib	37.9813	89.7988	10/18/2006	11:45	8.1	341.7	46.3	8.3	16.2	NA
Sangamon River/Lake Decatur	Owl Creek	EZV01	40.3254	88.3531	8/30/2006	12:50	7.4	669.0	50.8	8.5	21.2	NA
	Owl Creek	EZV01	40.3254	88.3531	11/2/2006	9:25	8.2	856.7		12.2	5.1	NA
	Owl Creek	EZVA1	40.3115	88.3409	8/30/2006	11:05	7.7	606.9	52.3	6.5	19.0	NA
	Owl Creek	EZVA1	40.3115	88.3409	11/2/2006	10:33	8.2	856.3		11.8	4.7	NA
	Owl Creek	EZVC1	40.3101	88.3423	8/30/2006	10:25	7.3	1450.0	25.6	5.0	21.0	NA
	Owl Creek	EZVC1	40.3101	88.3423	11/2/2006	12:20	8.1	990.7		11.7	6.0	NA
	Owl Creek	EZVE1	40.3113	88.3415	8/30/2006	10:45	7.5	1497.0	20.3	11.1	21.5	NA
	Owl Creek	EZVE1	40.3113	88.3415	11/2/2006	12:59	8.3	859.8		12.5	6.1	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
Shoal Creek	Shoal Creek	OI05	38.5361	89.5213	9/1/2006	12:35	7.5	563.4	38.7	9.1	22.9	NA
	Shoal Creek	OI05	38.5361	89.5213	10/17/2006	11:30	7.9	604.4	39.7	8.5	12.0	NA
	Shoal Creek	OI05A	38.5370	89.5330	9/1/2006	NOT SAMPLED *Site located at end of private road with chained fence/alternate location not located*						NA
	Shoal Creek	OI05A	38.5370	89.5330	10/17/2006							NA
	Shoal Creek	OI05B	38.5333	89.5496	9/1/2006	14:20	7.8	542.2	43.0	10.8	26.2	NA
	Shoal Creek	OI05B	38.5333	89.5496	10/17/2006	11:15	7.9	542.4	72.7	8.7	12.3	NA
	Shoal Creek	OI05C	38.5020	89.5661	9/1/2006	15:40	7.8	535.3	43.5	10.2	23.5	NA
	Shoal Creek	OI05C	38.5020	89.5661	10/16/2006	10:30	8.0	578.9	46.0	9.4	12.1	NA
	Locust Fork	OIC01	38.7715	89.5556	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Locust Fork	OIC01	38.7715	89.5556	10/19/2006	12:20	7.8	401.1	24.3	3.8	10.0	NA
	Locust Fork	OIC02	38.7536	89.5288	8/31/2006	17:50	8.0	499.6	23.2	9.4	24.2	NA
	Locust Fork	OIC02	38.7536	89.5288	10/17/2006	13:00	7.7	422.2	26.9	5.2	14.2	NA
	Chicken Creek	OIO09	38.6407	89.5025	9/1/2006	NOT SAMPLED *Sites dry during both visits/sites located at only two road crossings on segment*						NA
	Chicken Creek	OIO09	38.6407	89.5025	10/17/2006							NA
	Chicken Creek	OIO09A	38.6373	89.5260	9/1/2006							NA
	Chicken Creek	OIO09A	38.6373	89.5260	10/17/2006							NA
	Cattle Creek	OIP10	38.6649	89.5170	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Cattle Creek	OIP10	38.6649	89.5170	10/17/2006	12:05	7.9	928.0	105.6	2.0	14.2	NA
	Cattle Creek	OIP10A	38.6744	89.5359	8/31/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	Cattle Creek	OIP10A	38.6744	89.5359	10/17/2006							NA
South Fork Saline River/Lake of Egypt	South Fork Saline River	ATH08	37.6399	88.9281	9/26/2006	10:20	7.1	165.0	0.6	8.7	23.6	NA
	South Fork Saline River	ATH08	37.6399	88.9281	10/31/2006	11:15	6.6	213.1	10.0	8.8	19.0	NA
	South Fork Saline River	ATH14	NA	NA	9/26/2006	NOT SAMPLED *Sites located on private property and/or not accessible by roads* *No other road crossings available on segment*						NA
	South Fork Saline River	ATH14	NA	NA	10/31/2006							NA
	South Fork Saline River	ATHLEC1	NA	NA	9/26/2006							NA
	South Fork Saline River	ATHLEC1	NA	NA	10/31/2006							NA
	South Fork Saline River	ATHLEC2	37.6295	88.9465	9/26/2006	9:45	6.6	81.0	15.6	9.4	18.1	NA
	South Fork Saline River	ATHLEC2	37.6295	88.9465	10/31/2006	12:00	6.8	137.7	11.6	9.6	17.1	NA
	Briers Creek	ATHS01	37.6766	88.7178	9/11/2006	11:30	7.6	1997.0	2.0	9.1	21.3	NA
	Briers Creek	ATHS01	37.6766	88.7178	9/27/2006	9:00	7.3	1392.0	3.4	10.2	15.5	NA
	Briers Creek	ATHS01	37.6766	88.7178	10/30/2006	16:30	7.1	1281.0	19.6	9.4	13.7	NA
	Briers Creek	ATHS01	37.6766	88.7178	11/15/2006	10:25	7.0	700.1	185.3	4.6	9.4	NA
	Briers Creek	ATHS01A	37.6995	88.7257	9/11/2006	10:00	7.1	765.0	5.6	9.7	17.9	NA
	Briers Creek	ATHS01A	37.6995	88.7257	9/27/2006	11:30	7.5	817.0	1.9	9.7	17.0	NA
	Briers Creek	ATHS01A	37.6995	88.7257	11/2/2006	12:00	8.0	862.8	3.0	8.5	9.5	NA
	Briers Creek	ATHS01A	37.6995	88.7257	11/15/2006	11:10	6.8	226.1	36.3	5.4	10.2	NA
	Briers Creek	ATHS01B	37.6943	88.7245	9/11/2006	10:25	7.2	507.0	6.2	9.5	17.8	NA
	Briers Creek	ATHS01B	37.6943	88.7245	9/27/2006	10:35	6.7	500.0	0.5	9.7	17.3	NA
	Briers Creek	ATHS01B	37.6943	88.7245	11/2/2006	12:20	7.4	726.7	2.9	9.9	9.5	NA
	Briers Creek	ATHS01B	37.6943	89.7640	11/15/2006	11:30	6.8	198.9	69.1	4.0	10.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	9/11/2006	12:55	6.8	2071.0	21.5	6.3	19.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	9/27/2006	9:30	7.0	1571.0	2.2	9.8	15.1	NA
	Briers Creek	ATHS01C	37.6882	88.7195	10/31/2006	14:30	7.4	1296.0	4.5	9.4	12.0	NA
	Briers Creek	ATHS01C	37.6882	88.7195	11/15/2006	10:45	7.0	848.6	90.7	8.8	9.5	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	9/11/2006	10:40	6.9	375.0	16.4	6.7	22.7	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	9/27/2006	NOT SAMPLED *Site flooded over road with no safe access/no other road crossings on segment*						NA
	East Palzo Creek	ATHV01	37.6502	88.7608	10/31/2006	13:40	6.5	490.6	14.2	7.6	12.4	NA
	East Palzo Creek	ATHV01	37.6502	88.7608	11/15/2006	10:00	6.3	554.5	200.0	5.1	9.4	NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	9/11/2006	8:25	7.2	1878.0	1.7	6.6	18.8	
	East Palzo Creek	ATHV01A	37.6143	88.7788	9/27/2006	NOT SAMPLED *Site dry/no other road crossings on segment*						NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	10/31/2006							NA
	East Palzo Creek	ATHV01A	37.6143	88.7788	11/15/2006	9:05	6.8	158.9	81.9	9.0	9.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	9/11/2006	8:55	6.9	481.0	28.8	6.0	19.1	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	9/26/2006	12:30	6.2	405.0	4.6	10.9	17.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	10/31/2006	13:00	6.4	498.2	23.8	8.7	12.4	NA
	East Palzo Creek	ATHV01B	37.6452	88.7635	11/15/2006	9:35	6.1	435.0	243.8	5.6	9.4	NA

Table 2-2: Field Measurements

Watershed	Water body	Sample Site	Latitude	Longitude	Date	Time	pH (s.u.)	Conductivity (uS/cm)	Turbidity (NTU)	DO (mg/l)	Temp. °C	Depth (ft)
South Fork Sangamon River/ Lake Taylorville	South Fork Sangamon River	EO13	39.4072	89.3164	8/30/2006	18:10	7.3	719.3	7.2	6.3	20.4	NA
	South Fork Sangamon River	EO13	39.4072	89.3164	11/2/2006	16:50	7.7	528.5		6.5	6.1	NA
	South Fork Sangamon River	EO13A	39.2700	89.1880	8/30/2006	19:55	7.3	754.7	7.6	9.7	21.6	NA
	South Fork Sangamon River	EO13A	39.2700	89.1880	11/2/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	South Fork Sangamon River	EO13B	39.3630	89.2700	8/30/2006	19:25	7.6	1112.0	60.1	8.3	21.6	NA
	South Fork Sangamon River	EO13B	39.3630	89.2700	11/2/2006	NOT SAMPLED *Miscommunication between field crews caused error in sampling*						NA
	South Fork Sangamon River	EO13C	39.4590	89.2970	8/30/2006	18:55	7.0	56.9	96.0	3.8	21.1	NA
	South Fork Sangamon River	EO13C	39.4590	89.2970	11/2/2006	16:25	8.2	954.1		5.8	6.4	NA

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Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc [6]	Dissolved Iron	Total Silver	Dissolved Copper [6]	TP	Atrazine [5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Bay Creek	Cedar Creek	AJF16	9/25/2006	18:00		8.9	0.25										
			11/3/2006	11:05		11.0	0.12										
		AJF16A	9/25/2006	18:15		9.4	0.23										
			11/2/2006	13:30		11.6	0.08										
	Bay Creek Ditch	AJK01	9/25/2006	15:58		5.6	0.16										
			10/31/2006	8:15		8.2	0.05										
		AJK01A	10/31/2006	8:45		6.1	0.06										
Cahokia Creek/Holiday Shores Lake	Cahokia Diversion Ditch	JQ07	10/4/2006	16:35		5.3								ND			
			10/17/2006	14:15		9.4								ND			
		JQ01	10/4/2006	16:20		**3.4**								ND			
			10/17/2006	14:45		9.6								ND			
Cedar Creek	Big Muddy River	N99	9/7/2006	12:15		10.1		186									
			11/1/2006	9:45		7.8		75									
		N13	9/7/2006	11:15		8.1		144									
			11/1/2006	10:45		8.2		68									
	Cave Creek	NAC01	9/11/2006	11:45		7.6											
			11/1/2006	11:45		10.6											
		NAC01A	9/11/2006	11:15		**4.9**											
			11/1/2006	12:15		10.1											
Crab Orchard Lake	Crab Orchard Creek	ND11	9/6/2006	12:15	7.3	5.2	1.00										
			11/1/2006	14:00	7.7	10.1	0.26										
		ND12	9/6/2006	13:15	7.3		0.17										
			11/1/2006	15:00	7.7		ND										
		ND13	9/6/2006	15:00		6.0											
			11/1/2006	15:45		11.1											
		ND15	9/6/2006	16:30		6.8											
	Little Crab Orchard Creek	NDA01	9/6/2006	18:00		**2.1**	**2.00**										
			11/2/2006	8:30		8.2	0.20										
		NDA99	11/2/2006	10:30		12.3	0.03										
	Piles Fork	NDB03	9/7/2006	10:00		**1.6**											
			11/2/2006	9:15		10.3											
		NDB04	9/9/2006	7:40		**3.6**											
			11/2/2006	11:00		11.5											
Crooked Creek	Plum Creek	OZH-OK-A2	9/8/2006	14:00		6.8	0.65										
			10/19/2006	10:50		5.3	0.33										
		OZH-OK-A2A	9/8/2006	16:25		8.5	0.20										
			10/19/2006	11:20		9.0	0.22										
		OZH-OK-C2	9/8/2006	12:45		**1.1**											
			10/19/2006	10:15		**2.5**											
		OZH-OK-C2A	9/8/2006	17:30		**4.6**											
			10/19/2006	13:40		**3.2**											
		OZH-OK-C3	9/9/2006	15:00		**4.1**	0.30										
			10/19/2006	9:35		5.2	0.77										
	Little Crooked Creek	OJA-01	9/7/2006	17:45		**3.7**	0.14										
			10/19/2006	14:05		**4.7**	0.17										
		OJA-02	9/8/2006	11:15		**3.1**	0.14										
			10/19/2006	14:35		**3.8**	0.17										

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH(1)	DO(1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Village Creek	CE01	9/6/2006	17:30		9.9	0.17										
			11/14/2006	8:45		10.6	0.10										
		CE02	9/6/2006	15:20		7.9	0.80										
			11/9/2006	12:55		10.7	0.11										
		CE01A	9/12/2006	17:05		5.8	0.41										
			11/9/2006	13:45		11.2	0.08										
	Johnson Creek	CCAFFA1A	9/10/2006	10:50		**3.8**											
			11/14/2006	10:45		12.3											
		CCA12	9/9/2006	13:05		14.2											
			11/14/2006	9:45		7.7											
		CCA13	9/9/2006	14:30		14.9											
			11/14/2006	10:15		12.8											
		CCA14A	9/9/2006	15:25		5.7											
			11/14/2006	10:25		12.5											
	Pond Creek	CCFFD1	9/9/2006	10:30		7.1											
			10/31/2006	10:10		8.2											
		CCFFD1A	11/9/2006	12:15		11.2											
		CCFFD1B	9/9/2006	11:45		8.6											
			11/9/2006	11:35		12.1											
		CCFFD1C	9/10/2006	12:10		11.9											
			10/31/2006	11:20		14.4											
	Seminary Creek	CDGFLA1	9/8/2006	15:40		10.0											
			11/8/2006	14:45		14.3											
		CDGFLA1A	9/8/2006	13:45		**2.6**											
			11/8/2006	15:50		15.1											
		CDFGLC6	9/8/2006	12:25		6.6											
			11/8/2006	17:00		10.5											
		CDFGLC6A	9/8/2006	11:10		7.0											
			11/8/2006	16:45		12.0											
	Big Muddy Creek	CJ06	9/7/2006	18:10		**4.9**	0.54										
			11/8/2006	11:00		11.6	0.39										
		CJ05	9/7/2006	16:45		10.5	0.04										
			11/8/2006	11:30		12.4	0.07										
	Little Muddy Creek	CJA02	9/7/2006	4:20		**2.8**	**1.30**										
			11/8/2006	12:30		9.3	0.39										
		CJA01	9/12/2006	10:20		**3.4**	**1.30**										
			11/13/2006	12:00		10.1	0.17										
	Big Muddy Diversion Ditch	CJAE01	9/7/2006	12:10		9.1											
			11/8/2006	13:05		10.8											
		CJAE01A	9/7/2006	15:45		10.3											
			11/13/2006	12:30		9.8											

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc [6]	Dissolved Iron	Total Silver	Dissolved Copper [6]	TP	Atrazine [5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Elm River	CD02A	9/12/2006	12:51		**3.8**											
		CD02	9/8/2006	17:45		8.1											
		CD01	4/18/2006	14:30												0.12	
			4/26/2006	11:15												0.16	
			5/1/2006	11:00												0.27	
			5/17/2006	9:30												**19.00**	
			5/24/2006	11:20												**15.00**	
			5/31/2006	11:30												8.30	
			6/7/2006	11:25												5.70	
			6/15/2006	9:50												2.80	
			6/22/2006	11:15												1.20	
			6/27/2006	9:15												4.20	
			7/5/2006	11:50												2.40	
			7/12/2006	11:30												0.92	
			7/20/2006	11:15												2.40	
			7/27/2006	11:05												2.60	
			8/1/2006	9:20												2.60	
			8/8/2006	12:20												1.60	
	Little Wabash River	C33 [4]	4/18/2006	11:00												0.55	
			4/26/2006	12:15			**0.35**									1.10	
			5/1/2006	11:45			**0.50**									0.71	
			5/10/2006	12:20			**0.41**										
			5/17/2006	14:00												**19.00**	
			5/24/2006	12:15			**0.38**									8.10	
			5/31/2006	12:40			**0.37**									**13.00**	
			6/7/2006	12:30			**0.44**									6.30	
			6/15/2006	11:05												5.30	
			6/22/2006	12:00			**0.76**									2.60	
			6/27/2006	11:50												2.50	
			7/5/2006	13:00			**0.50**									1.70	
			7/12/2006	12:30			**0.54**									1.00	
			7/20/2006	12:20			**0.46**									2.30	
			7/27/2006	12:10												0.64	
			8/1/2006	10:30												0.66	
			8/8/2006	13:30												0.50	

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH (1)	DO (1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Little Wabash	Little Wabash River	C09	3/17/2005	8:00		14.9											
			4/19/2005	14:30		7.3											
			5/9/2005	10:30		6.7											
			6/23/2005	7:30		5.1											
			8/23/2005	13:00		**4.2**											
			9/27/2005	16:00		7.5											
			10/27/2005	14:00		8.7											
			12/6/2005	13:00		11.8											
			2/1/2006	12:30		9.3											
			3/15/2006	10:00		6.2											
			4/18/2006	16:00												0.27	
			4/26/2006	10:00									ND			0.62	
			5/1/2006	9:45									ND			0.59	
			5/10/2006	10:00									ND				
			5/17/2006	11:00									ND			**20.00**	
			5/24/2006	9:45									ND			6.30	
			5/31/2006	10:20									ND			**24.00**	
			6/7/2006	10:15									ND			4.20	
			6/15/2006	8:50									ND			1.80	
			6/22/2006	10:05									ND			1.20	
			6/27/2006	10:40									ND			1.50	
			7/5/2006	10:30									ND			1.20	
			7/12/2006	10:30									ND			0.96	
			7/20/2006	10:00									ND			1.60	
			7/27/2006	10:00									ND			0.72	
			8/1/2006	8:30									ND			0.63	
			8/8/2006	11:05									ND			0.40	
			8/18/2006	16:00									ND				
Mary's River/North Fork Cox Creek	North Fork Cox Creek	IIHA31	9/9/2006	17:10				**1610**	**3110**								
			10/18/2006	14:45				**1830**	**2830**								
		IIHA01	9/9/2006	17:40				**1850**	**3090**								
			10/18/2006	14:25				**1630**	**2540**								
		IIHA-STE1	9/9/2006	15:40					**3090**								
			10/18/2006	13:40					**1340**								
		IIHA-STC1	9/9/2006	16:15					**2530**								
			10/18/2006	14:00					**1400**								
	Maxwell Creek	IIKSPC1	9/7/2006	15:30		**2.0**											
			10/17/2006	8:20		20.2											
		IIKSPC3A	9/7/2006	15:00		**2.6**											
			10/17/2006	8:45		6.5											
	Randolph County Lake	RIB-1 (3)	9/9/2006	12:00											0.04		
			10/18/2006	10:45											**0.130**		
		RIB-2 (3)	9/9/2006	14:00											0.04		
			10/18/2006	12:05											**0.053**		
		RIB-3 (3)	9/9/2006	13:00											0.04		
			10/18/2006	11:15											**0.100**		

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH[1]	DO[1]	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc[6]	Dissolved Iron	Total Silver	Dissolved Copper[6]	TP	Atrazine[5]	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
Sangamon River/ Lake Decatur	Owl Creek	EZV01	8/30/2006	12:50		8.5											
			11/2/2006	9:25		12.2											
		EZVA1	8/30/2006	11:05		6.5											
			11/2/2006	10:33		11.8											
		EZVE1	8/30/2006	10:45		11.1											
			11/2/2006	12:59		12.5											
		EZVC1	8/30/2006	10:25		**5.0**											
			11/2/2006	12:20		11.7											
Shoal Creek	Shoal Creek	OI05	9/1/2006	12:35		9.1											
			10/17/2006	11:30		8.5											
		OI05B	9/1/2006	14:20		10.8											
			10/17/2006	11:15		8.7											
		OI05C	9/1/2006	15:40		10.2											
			10/16/2006	10:30		9.4											
	Locust Fork	OIC01	10/19/2006	12:20		**3.8**	0.18										
		OIC02	8/31/2006	17:50		9.4	0.35										
			10/17/2006	13:00		5.2	0.08										
	Cattle Creek	OIP10	10/17/2006	12:05		**2.0**			928[2]					0.021			5.8
South Fork Saline River/ Lake of Egypt	Briers Creek	ATHS01	9/11/2006	11:30	7.6	9.1	0.65	**1250**	**1960**		0.020	0.310	ND				
			9/27/2006	9:00	7.3	10.2	**2.00**	**951**	**1490**		0.022	ND	ND				
			10//2006	11:30							ND	ND					
			10/30/2006	16:30			**1.50**	**656**	**1120**		0.035	ND	ND				
			11/15/2006	10:25			**1.40**	281	469		0.028	**1.10**	ND				
		ATHS01A	9/27/2006	11:30	7.5	9.7	0.10	294	678		ND	**1.10**	ND				
			10/4/2006	10:50							ND	ND					
			11/2/2006	12:00	8.0	8.5	0.11	219	597		0.012	ND	ND				
			11/15/2006	11:10	6.8	5.4	0.12	65	213		ND	**1.40**	ND				
		ATHS01B	9/13/2006	10:40			0.18	143	418			ND	ND				
			9/27/2006	10:35	6.7	9.7	0.17	196	414		ND	ND	ND				
			10/4/2006	11:05							0.013	ND					
			11/2/2006	12:20	7.4	9.9	0.22	373	608		0.018	ND	ND				
			11/15/2006	11:30	6.8	**4.0**						**2.10**					
		ATHS01C	9/11/2006	12:55			**8.70**	**1290**	**2150**			**5.00**	ND				
			9/27/2006	9:30	7.0	9.8	**4.10**	**1100**	**1660**		ND	0.78	ND				
			10/4/2006	11:20							ND	**2.20**					
			10/31/2006	14:30	7.4	9.4	**1.90**	**691**	**1190**		ND	0.17	ND				
			11/15/2006	10:45	7.0	8.8	0.93	338	667		ND	0.470	ND				

Table 2-3: Data Associated with Impairment Status

Watershed	Water body	Sample Site	Date	Time	Causes of Impairment												
					pH(1)	DO(1)	Total Mn	Sulfates	TDS	Total Boron	Dissolved Zinc (6)	Dissolved Iron	Total Silver	Dissolved Copper (6)	TP	Atrazine (5)	Ammonia
					s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L
South Fork Saline River/ Lake of Egypt	East Palzo Creek	ATHV01A	9/11/2006	10:40	6.9	6.7	**1.40**		**1560**			ND					
			10/31/2006	13:40	6.5	7.6	**1.80**		375			0.160		ND			
			11/15/2006	10:00	**6.3**	5.1	0.09		211			**2.60**		ND			
		ATHV01	9/11/2006	10:40	6.9	6.7	0.38		262			ND					
			10/4/2006	12:30								0.13		ND			
			10/31/2006	13:40	6.5	7.6	**1.80**		375			0.16		ND			
			11/15/2006	10:00	**6.3**	5.1	**2.10**		324			0.340		ND			
		ATHV01B	9/11/2006	8:55	6.9	6.0	0.41		388			ND					
			9/26/2006	12:30	**6.2**	10.9	1.00		323			ND		ND			
			10/4/2006	11:50								ND		ND			
			10/31/2006	13:00	**6.4**	8.7	**1.60**		341			ND		ND			
			11/15/2006	9:35	**6.1**	5.6	**1.60**		225			0.100		ND			
	South Fork Saline River	ATHLEC2	9/26/2006	9:45		9.4											
			10/31/2006	12:00		9.6											
		ATH08	9/26/2006	10:20		8.7											
			10/31/2006	11:15		8.8											
South Fork Sangamon River/ Lake Taylorville	South Fork Sangamon River	EO13A	8/30/2006	19:55		9.7	0.61			0.05							
		EO13	8/30/2006	18:10		6.3	0.49			0.20							
			11/2/2006	16:50		6.5	0.33			0.08							
		EO13B	8/30/2006	19:25		8.3	**1.18**			0.20							
		EO13C	8/30/2006	18:55		**3.8**	**5.49**			0.27							
			11/2/2006	16:25		5.8	0.38			0.13							

Shaded cells indicate exceedances of the applicable water quality standard

1 pH and DO values in this table represent field parameters sampled using the In-Site 9500 Profiler. Continuous DO and pH data are available in Appendix D.

2 Value shown is for conductivity. TDS standard corresponds to 1667 uS/cm specific conductance

3 Values shown were collected at one-foot depth.

4 Segment C33 is a source of public water. Therefore the applicable manganese standard is 150 ug/L.

5 Chronic criteria for atrazine is 9 ug/L and a single exceedance of this value indicates a potential cause of impairment

6 Corresponding hardness values were used to calculate standards. Analytical data can be found in Appendix C.

Section 3
Quality Assurance Review

A review was conducted to assess the quality and usability of data generated from Stage 2 work activities and to review compliance with the original sampling plan and objectives developed for the QAPP. Field and laboratory methods were deemed in accordance with the QAPP. Minor deviations from the original plan occurred and all are discussed below.

3.1 Deviations from original Sampling Plan (QAPP)

The following issues and/or concerns developed during the sampling events:

- Sampling during the week of September 25th followed a heavy precipitation event which resulted in high stream flows and flooding at Bay Creek Ditch segment AJK01A and East Palzo Creek segment ATHV01.
- In-field filtering was not performed for dissolved phosphorus or dissolved metal samples. Illinois EPA requested additional information on this procedure. CDM along with ARDL, Inc drafted text for Illinois EPA to validate this sampling practice. Total versus dissolved samples are discussed further in section 3.2.2.
- All locations on Chicken Creek (OIO09) were dry during both sample periods; therefore no samples were collected for this segment.
- The following sites had no water during either sampling event: Maxwell Creek IIKSPA1 and IIKSPE1A, and Cattle Creek OIP10A. Alternate locations were not found.
- Access was not available to the following sites during either sampling event: Shoal Creek OIO5A, South Fork Saline River sites ATH14 and ATHLEC1. Alternate locations were not found.
- Site EZVA1 on Owl Creek was moved from the location proposed in the QAPP to the intersection of Owl Creek and County Road 3100 due to better stream flow.
- Only one round of sampling was conducted at the following sites due to access or water volume issues (refer to Table 2-2 for specific dates and issues): Locust Fork OIC01, Cattle Creek OIP10, Crab Orchard Creek ND15, Little Crab Orchard Creek NDA99, Pond Creek CCFFD1A, East Palzo Creek ATHV01 and ATHV01A, and Bay Creek Ditch AJK01A.
- Due to field crew error only one round of sampling was conducted at South Fork Sangamon River EO13A and EO13B and Elm River locations CD02 and CD02A.

3.2 Data Verification and Validation

A data quality review was performed on all laboratory data. The review consisted of an evaluation of laboratory QC and field QC samples. Laboratory QC included an evaluation of method blanks, matrix spikes, matrix spike duplicates, laboratory control samples and holding times. Field QC included an evaluation of field duplicates. No decontamination rinsate blanks were collected.

No laboratory violation resulted in the qualification of CDM collected data. While some matrix spikes had percent recoveries outside of the established limits, all other QC associated with the samples were acceptable. When a matrix spike was reported outside of the control limits, the laboratory control samples had percent recoveries within the established control limits, indicating a matrix effect on the sample analysis and no need to qualify the data. All samples were analyzed within the control limits.

An evaluation of the phosphorus data (total versus dissolved) was performed to determine the effects of filtering the samples immediately versus waiting up to 48 to 64 hours. All samples were received by the laboratories on ice and at 4^0C (+/-). A total of 161 samples have been analyzed for both total and dissolved phosphorus by method 365.2. Of the 161 samples, a total of 10 samples sets had a phosphorus concentration of greater than 1 mg/L (100 times higher than the reporting limit and considered significant when controlling based on RPDs). One of these samples had relative percent difference (RPD) between the total and dissolved fraction of the sample of greater than 100. Precision values of less that 25 % RPD are considered acceptable for sample results reported significantly above the reporting limit. Sample EO13C had total phosphorus measured at 2.09 mg/L and dissolved phosphorus measured at 0.52 mg/L. The TSS measured in this sample was 159 mg/L. The suspended solids contained in this sample may have absorbed the available phosphorus, but all other results in samples with phosphorus concentrations above 1mg/L show that this reaction is not taking place. Sampling or analytical variations may explain the elevated RPD between the sample and the duplicate. Total phosphorus and dissolved phosphorus results for samples with phosphorus concentrations above 1 mg/L are not significantly different.

Looking at all other results, there does not appear to be a correlation between the difference of total and dissolved phosphorus and the TSS concentration. Suspended solids absorbing dissolved phosphorus would be the likely mechanism for lowering the dissolved phosphorus concentrations. Based on the lack of this correlation, dissolved phosphorus concentration would not be significantly different if the samples were filtered immediately versus filtering at the laboratory 48-hours after collection.

Finally, field and laboratory quality control data were collected to assess bias associated between field and laboratory methods. Positive sample results and relative percent difference (RPD) are presented in Table 3-1.

3.3 Data Quality Objectives

The data generated during the Stage 2 investigation conformed to the data quality objectives established in the QAPP. A completeness criterion of 90% was established and easily achieved. No data have been qualified that were collected by CDM personnel and analyzed by ARDL, Inc or Prairie Analytical laboratories. Data qualifiers were applied to some of the data collected by Illinois EPA personnel. All qualifiers are included with the laboratory data contained in Appendix C.

Table 3-1: Duplicate Pair Sample Results

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
AJK01-DUP	Solids, total suspended	24.2	MG/L	9/25/2006	
AJK01	Solids, total suspended	25	MG/L	9/25/2006	3.252033
ATHS01A-DUP	Hardness (CA/MG)	435.1	MG CACO3/L	11/2/2006	
ATHS01A	Hardness (CA/MG)	445	MG CACO3/L	11/2/2006	2.249744
ATHS01A-DUP	Solids, total dissolved	604	MG/L	11/2/2006	
ATHS01A	Solids, total dissolved	597	MG/L	11/2/2006	-1.1657
ATHS01A-DUP	Chloride	5.13	MG/L	9/27/2006	
ATHS01A	Chloride	5.1	MG/L	9/27/2006	-0.64556
ATHS01A-DUP	Solids, total dissolved	675	MG/L	9/27/2006	
ATHS01A	Solids, total dissolved	678	MG/L	9/27/2006	0.443459
ATHS01A-DUP	Sulfate	290.63	MG/L	9/27/2006	
ATHS01A	Sulfate	294	MG/L	9/27/2006	1.154242
ATHS01C-DUP	Chloride	5.38	MG/L	9/11/2006	
ATHS01C	Chloride	5.4	MG/L	9/11/2006	0.388903
ATHS01C-DUP	Sulfate	1297.83	MG/L	9/11/2006	
ATHS01C	Sulfate	1290	MG/L	9/11/2006	-0.60514
ATHS01-FIELDDUP	Alkalinity	113	MG/L	10/30/2006	
ATHS01	Alkalinity	108	MG/L	10/30/2006	-4.52489
ATHS01-FIELDDUP	Chloride	4.9	MG/L	10/30/2006	
ATHS01	Chloride	4.9	MG/L	10/30/2006	0
ATHS01-FIELDDUP	Hardness (CA/MG)	673	MG CACO3/L	10/30/2006	
ATHS01	Hardness (CA/MG)	668	MG CACO3/L	10/30/2006	-0.74571
ATHS01-FIELDDUP	Iron	68200	MG/KG	10/30/2006	
ATHS01	Iron	93800	MG/KG	10/30/2006	31.60494
ATHS01-FIELDDUP	Manganese	1130	MG/KG	10/30/2006	
ATHS01	Manganese	1480	MG/KG	10/30/2006	26.81992
ATHS01-FIELDDUP	Manganese	1.5	MG/L	10/30/2006	
ATHS01	Manganese	1.5	MG/L	10/30/2006	0
ATHS01-FIELDDUP	Nitrate-Nitrite	0.06	MG/L	10/30/2006	
ATHS01	Nitrate-Nitrite	0.06	MG/L	10/30/2006	-11.9658
ATHS01-FIELDDUP	Phosphorus, diss	0.05	MG/L	10/30/2006	
ATHS01	Phosphorus, diss	0.05	MG/L	10/30/2006	8.163265
ATHS01-FIELDDUP	Phosphorus, total	0.04	MG/L	10/30/2006	
ATHS01	Phosphorus, total	0.03	MG/L	10/30/2006	-26.8657
ATHS01-FIELDDUP	Solids, total	69.7	%	10/30/2006	
ATHS01	Solids, total	74.5	%	10/30/2006	6.65742
ATHS01-FIELDDUP	Solids, total dissolved	1040	MG/L	10/30/2006	
ATHS01	Solids, total dissolved	1070	MG/L	10/30/2006	2.843602
ATHS01-FIELDDUP	Solids, total suspended	4.3	MG/L	10/30/2006	
ATHS01	Solids, total suspended	5.6	MG/L	10/30/2006	26.26263
ATHS01-FIELDDUP	Sulfate	662	MG/L	10/30/2006	
ATHS01	Sulfate	604	MG/L	10/30/2006	-9.16272
ATHS01-FIELDDUP	Zinc	106	MG/KG	10/30/2006	
ATHS01	Zinc	116	MG/KG	10/30/2006	9.009009
ATHS01-FIELDDUP	Zinc, diss	0.02	MG/L	10/30/2006	
ATHS01	Zinc, diss	0.03	MG/L	10/30/2006	8.333333
ATHS01-DUP	Alkalinity	60.9	MG/L	11/15/2006	
ATHS01	Alkalinity	56.8	MG/L	11/15/2006	-6.96686
ATHS01-DUP	Hardness (CA/MG)	340.14	MG CACO3/L	11/15/2006	
ATHS01	Hardness (CA/MG)	337	MG CACO3/L	11/15/2006	-0.92743
ATHS01-DUP	Solids, total dissolved	481	MG/L	11/15/2006	

Table 3-1: Duplicate Pair Sample Results (continued)

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
ATHS01	Solids, total suspended	151	MG/L	11/15/2006	-104.43
ATHS01-DUP	Hardness (CA/MG)	1035.17	MG CACO3/L	9/27/2006	
ATHS01	Hardness (CA/MG)	1030	MG CACO3/L	9/27/2006	-0.50069
ATHV01B-DUP	Alkalinity	15.3	MG/L	9/26/2006	
ATHV01B	Alkalinity	15.3	MG/L	9/26/2006	0
ATHV01B-DUP	Solids, total	72.5	%	9/26/2006	
ATHV01B	Solids, total	71.9	%	9/26/2006	-0.83102
CCFFD1-DUP	Chlorophyll	5.5	MG/CU.M.	9/9/2006	
CCFFD1	Chlorophyll	5	MG/CU.M.	9/9/2006	-9.52381
CE01A-DUP	Solids, total suspended	134	MG/L	9/12/2006	
CE01A	Solids, total suspended	137	MG/L	9/12/2006	2.214022
CJA02-DUP	Biological Oxygen Demand	4	MG/L	11/8/2006	
CJA02	Biological Oxygen Demand	3.7	MG/L	11/8/2006	-7.79221
EO13-DUP	Biological Oxygen Demand	6.3	MG/L	11/2/2006	
EO13	Biological Oxygen Demand	6.3	MG/L	11/2/2006	0
EO13-DUP	Solids, total suspended	8.4	MG/L	11/2/2006	
EO13	Solids, total suspended	7.6	MG/L	11/2/2006	-10
IIAA01-DUP	Chloride	21.71	MG/L	9/9/2006	
IIAA01	Chloride	21.7	MG/L	9/9/2006	-0.0258
IIAA01-DUP	Sulfate	1832.11	MG/L	9/9/2006	
IIAA01	Sulfate	1850	MG/L	9/9/2006	0.971725
IIHA01-DUP	Chloride	21.71	MG/L	9/9/2006	
IIHA01	Chloride	21.7	MG/L	9/9/2006	-0.0258
IIHA01-DUP	Sulfate	1832.11	MG/L	9/9/2006	
IIHA01	Sulfate	1850	MG/L	9/9/2006	0.971725
IIHA31-DUP	Hardness (CA/MG)	1290.87	MG CACO3/L	9/9/2006	
IIHA31	Hardness (CA/MG)	1300	MG CACO3/L	9/9/2006	0.704783
IIHA31-DUP	Hardness (CA/MG)	1306.27	MG CACO3/L	10/18/2006	
IIHA31	Hardness (CA/MG)	1280	MG CACO3/L	10/18/2006	-2.0315
IIHA31-DUP	Chloride	19.5	MG/L	10/18/2006	
IIHA31	Chloride	19.4	MG/L	10/18/2006	-0.51363
IIHA31-DUP	Solids, total dissolved	2850	MG/L	10/18/2006	
IIHA31	Solids, total dissolved	2830	MG/L	10/18/2006	-0.70423
IIHA31-DUP	Sulfate	1783.35	MG/L	10/18/2006	
IIHA31	Sulfate	1830	MG/L	10/18/2006	2.582091
IIHA-STE1-DUP	Solids, total dissolved	3100	MG/L	9/9/2006	
IIHA-STE1	Solids, total dissolved	3090	MG/L	9/9/2006	-0.3231
IIKSPC3A-DUP	Biological Oxygen Demand	11	MG/L	9/7/2006	
IIKSPC3A	Biological Oxygen Demand	11	MG/L	9/7/2006	0
JQ01-DUP	Chlorophyll	11.8	MG/CU.M.	8/31/2006	
JQ-01	Chlorophyll	13.2	MG/CU.M.	8/31/2006	11.2
JQ01-DUP	Hardness (CA/MG)	221.3	MG CACO3/L	8/31/2006	
JQ-01	Hardness (CA/MG)	221	MG CACO3/L	8/31/2006	-0.13565
ND11-DUP	Solids, total suspended	16.2	MG/L	11/1/2006	
ND11	Solids, total suspended	15	MG/L	11/1/2006	-7.69231
ND11-DUP	Alkalinity	90.2	MG/L	9/6/2006	
ND11	Alkalinity	90.2	MG/L	9/6/2006	0
NDA01-DUP	Solids, total suspended	18.2	MG/L	9/6/2006	
NDA01	Solids, total suspended	16.6	MG/L	9/6/2006	-9.1954
NDB04-DUP	Chlorophyll	26.9	MG/CU.M.	11/2/2006	
NDB04	Chlorophyll	25.7	MG/CU.M.	11/2/2006	-4.56274
OI05C-DUP	Biological Oxygen Demand	4.6	MG/L	9/1/2006	
OI05C	Biological Oxygen Demand	5.1	MG/L	9/1/2006	10.30928
OIC02-DUP	Solids, total suspended	14	MG/L	8/31/2006	
OIC02	Solids, total suspended	13.7	MG/L	8/31/2006	-2.16606
OIC02-DUP	Solids, total suspended	18.5	MG/L	10/17/2006	

Table 3-1: Duplicate Pair Sample Results (continued)

SampleLocation	Parameter	Result	Units	Collection Date	RPD(%)
OIC02	Solids, total suspended	16.8	MG/L	10/17/2006	-9.63173
OIP10-DUP	Hardness (CA/MG)	278.52	MG CACO3/L	10/17/2006	
OIP10	Hardness (CA/MG)	286	MG CACO3/L	10/17/2006	2.650039
OZH-OK-A2A-DUP	Chlorophyll	155.4	MG/CU.M.	9/8/2006	
OZH-OK-A2A	Chlorophyll	126	MG/CU.M.	9/8/2006	-20.8955

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Section 4
Conclusions

Data collected during Stage 2 have been deemed adequate and usable for Stage 3 TMDL development (see discussion in Section 3). Table 4-1 contains information for each segment sampled during Stage 2 with regards to its impairment status. The table contains information on the number of historic samples available prior to Stage 2 data collection, the number of historic violations as well as the date of the last recorded violation. The intention of this table is to assist any future determination on the impairment status of the Stage 2 stream segments.

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Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Bay Creek	Cedar Creek	AJF16	Dissolved Oxygen	1	1	2000	Continuous	0	Delist
			Manganese	1	0	-	4	0	Delist
	Bay Creek Ditch	AJK01	Dissolved Oxygen	3	3	1987	Continuous	Multiple	Impaired
			Manganese	3	3	1987	3	0	Delist
Cahokia Creek/ Holiday Shores Lake	Cahokia Diversion Ditch	JQ07	Dissolved Oxygen	147	130	2005	Continuous	Multiple	Impaired
			Copper	5	1	1998	4	0	Delist
Cedar Creek	Big Muddy River	N99	Dissolved Oxygen	3	1	2002	Continuous	*	Impaired
			Sulfates	3	0	-	4	0	Delist
	Cave Creek	NAC01	Dissolved Oxygen	2	1	1995	Continuous	1	Impaired
Crab Orchard Lake	Crab Orchard Creek	ND11	Dissolved Oxygen	2	1	2000	Continuous	Multiple	Impaired
			Manganese	2	2	2000	2	0	Delist
			pH	3	2	2004	Continuous	Multiple	Impaired
	Crab Orchard Creek	ND12	pH	3	1	2004	Continuous	0	Delist
			Manganese	2	1	2000	2	0	Delist
	Crab Orchard Creek	ND13	Dissolved Oxygen	4	4	2000	Continuous	Multiple	Impaired
	Little Crab Orchard Creek	NDA01	Dissolved Oxygen	2	1	1995	Continuous	Multiple	Impaired
			Manganese	2	1	1995	3	1	Impaired
	Piles Fork	NDB03	Dissolved Oxygen	2	1	1995	Continuous	Multiple	Impaired
Crooked Creek	Plum Creek	OZH-OK-A2	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek		Manganese	1	1	2002	4	0	Delist
	Plum Creek	OZH-OK-C2	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek	OZH-OK-C3	Dissolved Oxygen	1	1	2002	Continuous	Multiple	Impaired
	Plum Creek		Manganese	1	1	2002	2	0	Delist
	Little Crooked Creek	OJA-01	Dissolved Oxygen	5	4	2002	Continuous	Multiple	Impaired
			Manganese	5	2	2002	4	0	Delist

Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Little Wabash	Little Wabash River	C09	Dissolved Oxygen	43	7	2003	Continuous	Multiple	Impaired
			Silver	43	1	2002	18	0	Delist
			Atrazine	2	1	1991	16	2	Impaired
		C33	Dissolved Oxygen	5	3	2002	Continuous	Multiple	Impaired
			Manganese	5	5	2002	10	10	Impaired
			Atrazine	NA	NA	NA	16	2	Impaired
	Village Creek	CE01	Dissolved Oxygen	1	0	NA	Continuous	Multiple	Impaired
			Manganese	1	1	2002	6	0	Delist
	Johnson Creek	CCAFFA1	Dissolved Oxygen	1	1	1997	Continuous	Multiple	Impaired
	Pond Creek	CCFFD1	Dissolved Oxygen	1	1	1997	Continuous	Multiple	Impaired
	Elm River	CD01	Atrazine	8	3	2002	16	2	Impaired
		CD02	Dissolved Oxygen	3	2	2003	Continuous	Multiple	Impaired
	Seminary Creek	CDGFLA1	Dissolved Oxygen	1	1	1998	Continuous	Multiple	Impaired
	Seminary Creek	CDFGLC6	Dissolved Oxygen	1	1	1998	Continuous	Multiple	Impaired
	Big Muddy Creek	CJ06	Dissolved Oxygen	3	1	2002	Continuous	Multiple	Impaired
			Manganese	2	1	2002	6	0	Delist
	Little Muddy Creek	CJA02	Dissolved Oxygen	4	3	2002	Continuous	Multiple	Impaired
			Manganese	4	3	2002	4	2	Impaired
	Big Muddy Diversion Ditch	CJAE01	Dissolved Oxygen	1	0	2000	Continuous	Multiple	Impaired
Mary's River/ North Fork Cox Creek	North Fork Cox Creek	IIHA31	Sulfates	2	2	1995	4	4	Impaired
			TDS	2	2	1995	4	4	Impaired
	North Fork Cox Creek	IIHA-STC1	TDS	1	1	1995	4	2	Impaired
	Maxwell Creek	IIKSPC1A	Dissolved Oxygen	2	2	19999	Continuous	Multiple	Impaired
	Randolph County Lake	RIB	Total Phosphorus	11	3	1993	6	2	Impaired
Sangamon River/ Lake Decatur	Owl Creek	EZV	Dissolved Oxygen	3	1	1998	Continuous	Multiple	Impaired

Table 4-1: Impairment Status

Watershed	Stream Name	Segment	Parameter of Concern	Historic Data Count	Number of Historic Violations	Date of Last Recorded Violation	Stage 2 Data Count	Number of Violations	Suggested Status
Shoal Creek	Shoal Creek	OI05	Dissolved Oxygen	3	1	2002	Continuous	0	Delist
	Locust Fork	OIC01	Dissolved Oxygen	3	1	1991	Continuous	Multiple	Impaired
			Manganese	3	1	1991	2	0	Delist
	Chicken Creek	OIO09	Dissolved Oxygen	2	1	1991	0	0	No Water
	Cattle Creek	OIP10	Dissolved Oxygen	3	2	1991	Continuous	Multiple	Impaired
			Ammonia	3	1	1991	1	0	Delist
			TDS	3	1	1991	1	0	Delist
South Fork Saline River/ Lake of Egypt	Briers Creek	ATHS01	Zinc	2	2	1993	13	0	Delist
			Iron	3	3	1993	16	3	Impaired
			Manganese	3	3	1993	8	4	Impaired
			Silver	3	1	1993	12	0	Delist
			Sulfates	3	3	1993	16	6	Impaired
			TDS	2	1	1993	16	9	Impaired
			pH	3	3	1993	Continuous	0	Delist
			Dissolved Oxygen	2	1	1993	Continuous	1	Impaired
	East Palzo Creek	ATHV01	Copper	3	2	1993	5	0	Delist
			Iron	3	3	1993	7	1	Impaired
			Manganese	3	3	1993	7	3	Impaired
			TDS	0		-	7	1	Impaired
			pH	3	3	1993	Continuous	Multiple	Impaired
	South Fork Saline River	ATH14	Dissolved Oxygen	8	1	2000	Continuous	0	Delist
South Fork Sangamon/ Lake Taylorville	South Fork Sangamon River	EO13	Dissolved Oxygen	1	1	1989	Continuous	Multiple	Impaired
			Boron	1	1	1989	6	0	Delist
			Manganese	1	1	1989	6	2	Impaired

* Continuous data did not violate the 5.0 mg/L instantaneous DO standard, however, continuous data collected at site N13 experienced more than 16 hours below 6.0 mg/L in a 24 hour period

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STAGE 2 APPENDICES AVAILABLE UPON REQUEST
CONTACT Illinois EPA at 217-782-3362

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Appendix E
QUAL2K Inputs

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APPENDIX E: CEDAR CREEK QUAL2K INPUT DATA

	Results						
Headwaters - AFJ16A	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**	**Units needed for model**
Flow	0.000	20.208	0.261	0.000	20.208	0.045	m3/second
Temperature	N/A	N/A	N/A	9.240	17.761	13.501	C
DO	N/A	N/A	N/A	9.396	11.610	10.503	mg/L
CBOD ***(BOD)**	N/A	N/A	N/A	1.05	2.10	1.58	mgO2/L
Organic Nitrogen	N/A	N/A	N/A	210.0	580.0	395.0	ugN/L
Ammonia	N/A	N/A	N/A	N/A	N/A	N/A	ugN/L
Nitrate ***(NO2&NO3)**	N/A	N/A	N/A	30.0	220.0	125.0	ugN/L
Organic Phosphorus	N/A	N/A	N/A	37.0	60.0	48.5	ugP/L
Inorganic Phosphorus	N/A	N/A	N/A	17.0	50.0	33.5	ugP/L
Chlorophyll-a	N/A	N/A	N/A	2500.0	2500.0	2500.0	ugA/L

	Location		**Elevation**	
Reach	Upstream (km)	Downstream (km)	Upstream (m)	Downstream (m)
Headwaters	19.19	9.63	213.4	115.2
AJF16	9.63	0.00	115.2	108.2

Downstream					
Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds
37	28	48.1	-88	45	20.6
37	25	38.5	-88	45	31.4

Point Source Data: Orignal data downloaded from: http://www.epa.gov/enviro/html/pcs/pcs_query_java.html (July 24,2007)

Point Sources	**Permit Number**						
Camp Ondessonk	IL0048381	Location (km)	11.57				
Parameter	**NPDES Limit**	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.0002	0.0000	0.0001	0.0001	0.0000	0.0001	0.0001
Temperature	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DO	Min. 6	6.1	6.9	6.48	6.6	6.9	6.75
CBOD	Max. 12, Avg. 10	0.15	9.40	6.02	0.15	9.40	4.75
Organic N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	Max. 3000, Avg. 1500	700.00	1400.00	1123.75	700.00	1400.00	1038.00
NO2+NO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Organic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Point Sources	**Permit Number**						
Patrician of Vienna	IL0053660	Location (km)	2.38				
Parameter	**NPDES Limit**	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.00011	0.00004	0.00004	0.00004	0.00004	0.00004	0.00004
Temperature	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DO	Min. 6	N/A	N/A	N/A	N/A	N/A	N/A
CBOD	Max. 20, Avg. 10	4.10	17.40	9.36	4.10	17.40	8.62
Organic N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	Max. 6500, Avg. 2500	6910.00	25600.00	13662.73	8940.00	25600.00	15735.00
NO2+NO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Organic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX E: CEDAR CREEK QUAL2K INPUT DATA

Sampling Location	Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds	Location (km)
AJF16	37	27	57.96	-88	45	2.88	6.25
AFJ16A	37	29	43.44	-88	45	33.12	11.71

Sampling Location	**Min Flow**	**Max Flow**	**Avg. Flow**	**(July-Oct) Min Flow**	**(July-Oct) Max Flow**	**(July-Oct) Avg. Flow**
AJF16	0.000	65.233	0.844	0.000	65.233	0.144
AJF16A	0.000	20.208	0.261	0.000	20.208	0.045

	Results						
Headwaters - AJK01A	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**	**Units needed for model**
Flow	0.000	500.241	6.472	0.000	500.241	1.102	m3/second
Temperature	N/A	N/A	N/A	13.150	13.150	13.150	C
DO	N/A	N/A	N/A	6.120	6.120	4.156	mg/L
CBOD ***(BOD)**	N/A	N/A	N/A	2.40	2.40	2.40	mgO2/L
Organic Nitrogen	N/A	N/A	N/A	680.0	680.0	680.0	ugN/L
Ammonia	N/A	N/A	N/A	N/A	N/A	N/A	ugN/L
Nitrate ***(NO2&NO3)**	N/A	N/A	N/A	49.0	49.0	49.0	ugN/L
Organic Phosphorus	N/A	N/A	N/A	63.0	63.0	63.0	ugP/L
Inorganic Phosphorus	N/A	N/A	N/A	97.0	97.0	97.0	ugP/L
Chlorophyll-a	N/A	N/A	N/A	2500.0	2500.0	2500.0	ugA/L

	Location		**Elevation**	
Reach	Upstream (km)	Downstream (km)	Upstream (m)	Downstream (m)
Headwaters	13.66	6.92	106.1	105.2
AJK01	6.92	0.00	105.2	103

Downstream					
Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds
37	19	25.5	-88	39	22.2
37	19	2.7	-88	34	22.6

Point Source Data: Orignal data downloaded from: http://www.epa.gov/enviro/html/pcs/pcs_query_java.html (July 24,2007)

Point Sources	**Permit Number**						
Vienna Correction Center	IL0036757	Location (km)	13.66				
Parameter	**NPDES Limit**	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.0184	0.0065	0.0305	0.0169	0.0126	0.0289	0.0184
Temperature	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CBOD	Max 20, Avg. 10	1.00	22.80	4.99	1.20	20.00	4.62
Organic N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	Max 3000, Avg. 1500	190.00	18000.00	2217.44	250.00	10500.00	1970.80
NO2+NO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Organic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Point Sources	**Permit Number**						
Dixon Springs Work Camp	ILG551056	Location (km)	13.66				
Parameter	**NPDES Limit**	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.0021	0.0004	0.0027	0.0008	0.0004	0.0014	0.0008
Temperature	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DO	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CBOD	Max. 40, Avg. 25	1.90	43.00	9.75	1.90	15.00	6.39
Organic N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NO2+NO3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Organic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic P	N/A	N/A	N/A	N/A	N/A	N/A	N/A

APPENDIX E: BAY CREEK DITCH QUAL2K INPUTS

Sampling Location	Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds	Location (km)
AJK01	37	19	28.2	-88	38	1.32	5.56
AJK01A	37	19	41.52	-88	40	28.92	9.34

Sampling Location	**Min Flow**	**Max Flow**	**Avg. Flow**	**(July-Oct) Min Flow**	**(July-Oct) Max Flow**	**(July-Oct) Avg. Flow**	Width
AJK01	0.000	511.704	6.620	0.000	511.704	1.127	40
AJK01A	0.000	500.241	6.472	0.000	500.241	1.102	66

Appendix F
Manganese Analysis
Cedar Creek

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APPENDIX F: Manganese Analysis - Cedar Creek

Sample Location	Date	value	Surrogat Gage	Gaged Area	Ungaged Area	Flow	Standard
AJF16	10/2/2000	510	0.74	111.90	55.20	0.365	1000
AJF02	7/8/2005	**1100**	0.25	111.90	55.20	0.123	1000
AJF01	7/8/2005	830	0.25	111.90	17.10	0.038	1000
AJF01	6/13/2005	120	16	111.90	17.10	2.445	1000
AJF16	9/25/2006	250	45	111.90	55.20	22.198	1000
AJF16	11/3/2006	120	45	111.90	55.20	22.198	1000
AJF16A	9/25/2006	230	45	111.90	17.10	6.877	1000
AJF16A	11/2/2006	77	53	111.90	17.10	8.099	1000

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Appendix G
BATHTUB Files
Bay Creek Lake No. 5

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APPENDIX G: BAY CREEK LAKE NO. 5
BATHTUB FILES

Title: Bay Creek Lake No. 5
Notes:

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	48.3	inches	1.22682	meters
Evaporation	40.71	inches	1.03403	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	30	kg/km2-yr		
	inches to meters			
Conversions:	0.0254			

APPENDIX G: BAY CREEK LAKE NO. 5
BATHTUB FILES

Total Lake Segments	3		CONVERSIONS	ft to m	
				0.3048	
Segment Name:	Segment 1: RAZB-3				
Outflow Segment:	Segment 2: RAZB-2				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.136	km	0.136	km2	
Mean Depth	6.1	ft	1.85928	meters	Total Depth
Length	0.96	km	0.96	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.06475	mg/L	64.75	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment Name:	Segment 2: RAZB-2				
Outflow Segment:	Segment 3: RAZB-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.076	km2	0.076	km2	
Mean Depth	14.9	ft	4.54152	meters	Total Depth
Length	0.62	km	0.62	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.0336	mg/L	33.6	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name: Segment 3: RAZB-1
Outflow Segment: Out of Reservoir

	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.102	km2	0.102	km2	
Mean Depth	15.6	ft	4.75488	29.5	Total Depth
Length	0.49	km	0.49	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity	1		1	1/m	
Total Phosphorus	0.0322	mg/L	32.2	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment 1: RAZB-3					
Segment 2: RAZB-2					
Segment 3: RAZB-1					

Data may need to be generated from Unit Area Loads sheet if no trib concentration data are available
Flow data may need to be calculated if no gage data exists - use surrogate gage tab

Number of Tributaries 4

Tributary Name:	Bay Creek				
Segment:	Segment 1: RAZB-3				
Tributary Type:	Monitored Inflow				
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			60.22	km2	
Flow Rate		cfs	28.12659043	million meters3/yr	
TP Conc	0.01	mg/L	10	ug/L	

Tributary Name:	Overland Flow to RAZB-3				
Segment:	Segment 2: RAZB-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			1.11	km2	
Flow Rate		cfs	0.518440973	million meters3/yr	
TP Conc	0.01	mg/L	10	ug/L	

Tributary Name:	Overland Flow to RAZB-2				
Segment:	Segment 3: RAZB-2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			0.27	km2	
Flow Rate		cfs	0.126107264	million meters3/yr	
TP Conc	0.01	mg/L	10	ug/L	

Tributary Name:	Overland Flow to RAZB-1				
Segment:	Segment 4: RAZB-1				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			0.49	km2	
Flow Rate		cfs	0.22886133	million meters3/yr	
TP Conc	0.01	mg/L	10	ug/L	

APPENDIX G: BAY CREEK LAKE NO. 5
BATHTUB FILES

Tributary Name	Area	Area (km2)	Percent of Total Area	Estimated Flow
Bay Creek		60.22	97.0%	28.12659043
Overland Flow to RAZB-3		1.11	1.8%	0.518440973
Overland Flow to RAZB-2		0.27	0.4%	0.126107264
Overland Flow to RAZB-1		0.49	0.8%	0.22886133
	Total Area	62.09	Total Flow	29

Internal Loads	
Segment 1	1.66
Segment 2	0
Segment 3	0

Loadings	Observed	Predicted
Segment 1-RAZB-3	64.8	64.1
Segment 2-RAZB-2	33.6	47.7
Segment 3-RAZB-1	33.2	33.7
Area-Wtd Mean	47.0	50.3

Current Load **Predicted**
File: **T:\GIS\Stage3\BayCreek\Bay Creek Lake #5\BATHTUB Model\BayCreekNo5-Existing.btb**

Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Bay Creek	60.2	0.00E+00	0.00	0.01
2	1	1	RAZB-3	1.1	0.00E+00	0.00	0.01
3	1	2	RAZB-2	0.3	0.00E+00	0.00	0.01
4	1	3	RAZB-1	0.5	0.00E+00	0.00	0.01
PRECIPITATION				0.3	0.00E+00	0.00	1.23
TRIBUTARY INFLOW				62.1	0.00E+00	0.00	0.01
***TOTAL INFLOW				62.4	0.00E+00	0.00	0.02
ADVECTIVE OUTFLOW				62.4	0.00E+00	0.00	0.01
***TOTAL OUTFLOW				62.4	0.00E+00	0.00	0.01
***EVAPORATION					0.00E+00	0.00	

Overall Mass Balance Based Upon Component: **Predicted TOTAL P** **Outflow & Reservoir Concentrations**

Trb	Type	Seg	Name	Load kg/yr	%Total	Load Variance $(kg/yr)^2$	%Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	Bay Creek	8.0	7.9%	0.00E+00		0.00	10.0	0.1
2	1	1	RAZB-3	0.1	0.1%	0.00E+00		0.00	10.0	0.1
3	1	2	RAZB-2	0.0	0.0%	0.00E+00		0.00	10.0	0.1
4	1	3	RAZB-1	0.1	0.1%	0.00E+00		0.00	10.0	0.1
PRECIPITATION				9.4	9.4%	2.22E+01	100.0%	0.50	24.5	30.0
INTERNAL LOAD				82.5	82.4%	0.00E+00		0.00		
TRIBUTARY INFLOW				8.2	8.2%	0.00E+00		0.00	10.0	0.1
***TOTAL INFLOW				29.5	100.0%	2.22E+01	100.0%	0.05	83.0	1.6
ADVECTIVE OUTFLOW				29.7	29.7%	5.71E+01		0.25	33.7	0.5
***TOTAL OUTFLOW				29.7	29.7%	5.71E+01		0.25	33.7	0.5
***RETENTION				70.4	70.3%	6.82E+01		0.12		

Overflow Rate (m/yr)	2.8	Nutrient Resid. Time (yrs)	0.5442
Hydraulic Resid. Time (yrs)	1.2300	Turnover Ratio	1.8
Reservoir Conc (mg/m3)	50	Retention Coef.	0.703

	Percent Reduction													
Tributary Concentrations		10	15	20	25	30	35	40	45	50	55	60	65	70
	64.8	58.32	55.08	51.84	48.6	45.36	42.12	38.88	35.64	32.4	29.16	25.92	22.68	19.44
Internal Loading														
	1.66	1.494	1.411	1.328	1.245	1.162	1.079	0.996	0.913	0.83	0.747	0.664	0.581	0.498

Change Segment Concentrations to 50

Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Bay Cre	60.2	0.00E+00	0.00	0.01
2	1	1	RAZB-3	1.1	0.00E+00	0.00	0.01
3	1	2	RAZB-2	0.3	0.00E+00	0.00	0.01
4	1	3	RAZB-1	0.5	0.00E+00	0.00	0.01
PRECIPITATION				0.3	0.00E+00	0.00	1.23
TRIBUTARY INFLOW				62.1	0.00E+00	0.00	0.01
***TOTAL INFLOW				62.4	0.00E+00	0.00	0.02
ADVECTIVE OUTFLOW				62.4	0.00E+00	0.00	0.01
***TOTAL OUTFLOW				62.4	0.00E+00	0.00	0.01
***EVAPORATION					0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	Load %Total	Load Variance $(kg/yr)^2$	Load Variance %Total	CV	Conc mg/m^3	Export $g/km^2/yr$
1	1	1	Bay Cre	8.0	11.8%	0.00E+00		0.00	10.0	0.1
2	1	1	RAZB-3	0.1	0.2%	0.00E+00		0.00	10.0	0.1
3	1	2	RAZB-2	0.0	0.1%	0.00E+00		0.00	10.0	0.1
4	1	3	RAZB-1	0.1	0.1%	0.00E+00		0.00	10.0	0.1
PRECIPITATION				9.4	14.0%	2.22E+01	100.0%	0.50	24.5	30.0
INTERNAL LOAD				49.7	73.8%	0.00E+00		0.00		
TRIBUTARY INFLOW				8.2	12.2%	0.00E+00		0.00	10.0	0.1
***TOTAL INFLOW				67.3	100.0%	2.22E+01	100.0%	0.07	55.8	1.1
ADVECTIVE OUTFLOW				24.9	37.1%	3.31E+01		0.23	28.3	0.4
***TOTAL OUTFLOW				24.9	37.1%	3.31E+01		0.23	28.3	0.4
***RETENTION				42.4	62.9%	4.21E+01		0.15		

Overflow Rate (m/yr)	2.8	Nutrient Resid. Time (yrs)	0.6215
Hydraulic Resid. Time (yrs)	######	Turnover Ratio	1.6
Reservoir Conc (mg/m3)	39	Retention Coef.	0.629

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Appendix H
BATHTUB Files
Vienna Correction Center Lake

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APPENDIX H: VIENNA CORRECTIONAL CENTER LAKE
BATHTUB FILES

Title: Vienna Correctional Center Lake
Notes:

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	48.3	inches	1.22682	meters
Evaporation	40.71	inches	1.03403	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	30	kg/km2-yr		

	inches to meters
Conversions:	0.0254

APPENDIX H: VIENNA CORRECTIONAL CENTER LAKE
BATHTUB FILES

Total Lake Segments	3		CONVERSIONS	ft to m	
				0.3048	
Segment Name:	Segment 1: RAT-3				
Outflow Segment:	Segment 2: RAT-2				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	2.843	km	0.0486588	km2	
Mean Depth	8.033	ft	2.4484584	meters	Total Depth
Length	0.26	km	0.26	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.031	mg/L	31	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment Name:	Segment 2: RAT-2				
Outflow Segment:	Segment 3: RAT-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.419	km2	0.0848187	km2	
Mean Depth	13.433	ft	4.0943784	meters	Total Depth
Length	0.51	km	0.51	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.033	mg/L	33	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

APPENDIX H: VIENNA CORRECTIONAL CENTER LAKE
BATHTUB FILES

Segment Name: Segment 3: RAT-1
Outflow Segment: Out of Reservoir

	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.288	km2	0.1709085	km2	
Mean Depth	20.152	ft	6.1423296	m	Total Depth
Length	0.73	km	0.73	km	Length in GIS
Mixed Layer Depth	0	ft	0	m	Depth where DO changes
Hypolimnetic Depth	0	ft	0	m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity	1		1	1/m	
Total Phosphorus	0.063	mg/L	63	ug/L	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment 1: RAZB-3			15		
Segment 2: RAZB-2			15		
Segment 3: RAZB-1			15		

Data may need to be generated from Unit Area Loads sheet if no trib concentration data are available
Flow data may need to be calculated if no gage data exists - use surrogate gage tab

Number of Tributaries 3

Tributary Name: Overland Flow to RAT-3
Segment: Segment 1: RAT-3
Tributary Type:

	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			2.843	km2	
Flow Rate		cfs	1.82797083	million meters3/yr	
TP Conc	0.09	mg/L	90	ug/L	

Tributary Name: Overland Flow to RAT-2
Segment: Segment 2: RAT-2
Tributary Type:

	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			0.419	km2	
Flow Rate		cfs	0.14664376	million meters3/yr	
TP Conc	0.09	mg/L	90	ug/L	

Tributary Name: Overland Flow to RAT-1
Segment: Segment 3: RAT-1
Tributary Type:

	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area			0.288	km2	
Flow Rate		cfs	0.1053854	million meters3/yr	
TP Conc	0.09	mg/L	90	ug/L	

Tributary Name	Acres	Area (km2)	Percent of To	Estimated Flow
Overland Flow to RAT-3	669.3351	2.708703	87.9%	1.83
Overland Flow to RAT-2	53.69546	0.217298	7.1%	0.15
Overland Flow to RAT-1	38.58821	0.156161	5.1%	0.11
	Total Area	3.082162	Total Flow	2.08

Internal Loads	
Segment 1	0
Segment 2	0
Segment 3	0.35

Loadings	Observed	Predicted
RAT-3	55.8	31.0
RAT-2	56.7	33.0
RAT-1	62.4	63.0
Area-Wtd Mean	59.8	49.5

Current Load **Predicted**
File: **T:\GIS\Stage3\BayCreek\Vienna Correctional Center Lake\ViennaCCLake-Existing.btb**

Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	RAT-3	2.7	0.00E+00	0.00	0.02
2	1	2	RAT-2	0.2	0.00E+00	0.00	0.02
3	1	3	RAT-1	0.2	0.00E+00	0.00	0.02
PRECIPITATION				0.3	0.00E+00	0.00	1.23
TRIBUTARY INFLOW				3.1	0.00E+00	0.00	0.02
***TOTAL INFLOW				3.4	0.00E+00	0.00	0.13
ADVECTIVE OUTFLOW				3.4	0.00E+00	0.00	0.03
***TOTAL OUTFLOW				3.4	0.00E+00	0.00	0.03
***EVAPORATION					0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	Load %Total	Load Variance $(kg/yr)^2$	Load Variance %Total	CV	Conc mg/m^3	Export $kg/km^2/yr$
1	1	1	RAT-3	0.5	1.6%	0.00E+00		0.00	11.5	0.2
2	1	2	RAT-2	0.0	0.1%	0.00E+00		0.00	11.5	0.2
3	1	3	RAT-1	0.0	0.1%	0.00E+00		0.00	11.5	0.2
PRECIPITATION				9.1	28.9%	2.08E+01	100.0%	0.50	24.5	30.0
INTERNAL LOAD				21.8	69.2%	0.00E+00		0.00		
TRIBUTARY INFLOW				0.6	1.8%	0.00E+00		0.00	11.5	0.2
***TOTAL INFLOW				31.6	100.0%	2.08E+01	100.0%	0.14	74.5	9.3
ADVECTIVE OUTFLOW				6.8	21.5%	1.97E+00		0.21	62.4	2.0
***TOTAL OUTFLOW				6.8	21.5%	1.97E+00		0.21	62.4	2.0
***RETENTION				24.8	78.5%	1.80E+01		0.17		

Overflow Rate (m/yr)	0.4	Nutrient Resid. Time (yrs)	2.8711
Hydraulic Resid. Time (yrs)	13.9507	Turnover Ratio	0.3
Reservoir Conc (mg/m3)	60	Retention Coef.	0.785

50% Reduction in Internal Loading

File: **T:\GIS\Stage3\BayCreek\Vienna Correctional Center Lake\ViennaCCLake-TMDL.btb**

Overall Water & Nutrient Balances

Overall Water Balance — **Averaging Period = 1.00 years**

Trb	Type	Seg	Name	Area km^2	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	RAT-3	2.7	0.00E+00	0.00	0.02
2	1	2	RAT-2	0.2	0.00E+00	0.00	0.02
3	1	3	RAT-1	0.2	0.00E+00	0.00	0.02
PRECIPITATION				0.3	0.00E+00	0.00	1.23
TRIBUTARY INFLOW				3.1	0.00E+00	0.00	0.02
***TOTAL INFLOW				3.4	0.00E+00	0.00	0.13
ADVECTIVE OUTFLOW				3.4	0.00E+00	0.00	0.03
***TOTAL OUTFLOW				3.4	0.00E+00	0.00	0.03
***EVAPORATION					0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**
Component: **TOTAL P**

Trb	Type	Seg	Name	Load kg/yr	Load %Total	Load Variance (kg/yr)^2	Load Variance %Total	CV	Conc mg/m^3	Export g/km^2/yr
1	1	1	RAT-3	0.5	2.4%	0.00E+00		0.00	11.5	0.2
2	1	2	RAT-2	0.0	0.2%	0.00E+00		0.00	11.5	0.2
3	1	3	RAT-1	0.0	0.1%	0.00E+00		0.00	11.5	0.2
PRECIPITATION				9.1	44.3%	2.08E+01	100.0%	0.50	24.5	30.0
INTERNAL LOAD				10.9	53.0%	0.00E+00		0.00		
TRIBUTARY INFLOW				0.6	2.8%	0.00E+00		0.00	11.5	0.2
***TOTAL INFLOW				20.6	100.0%	2.08E+01	100.0%	0.22	48.7	6.1
ADVECTIVE OUTFLOW				5.3	25.6%	1.40E+00		0.22	48.6	1.6
***TOTAL OUTFLOW				5.3	25.6%	1.40E+00		0.22	48.6	1.6
***RETENTION				15.3	74.4%	1.63E+01		0.26		

Overflow Rate (m/yr)	0.4	Nutrient Resid. Time (yrs)	3.4751
Hydraulic Resid. Time (yrs)	13.9507	Turnover Ratio	0.3
Reservoir Conc (mg/m3)	47	Retention Coef.	0.744

	Load kg/yr	%Total	Load Variance	CV	Conc	Export
ADVECTIVE OUTFLOW	5.1	25.6%	1.37E+00	0.23	46.8	1.3
***TOTAL OUTFLOW	5.1	25.6%	1.37E+00	0.23	46.8	1.3
***RETENTION	14.8	74.4%	1.62E+01	0.27		

Overflow Rate (m/yr)	0.4	Nutrient Resid. Time (yrs)	3.5782
Hydraulic Resid. Time (yrs)	13.9507	Turnover Ratio	0.3
Reservoir Conc (mg/m3)	47	Retention Coef.	0.744

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Appendix I
Responsiveness Summary

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Appendix I
Responsiveness Summary
Bay Creek

Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from August 8, 2007 through August 17, 2007 postmarked, including those from the August 8, 2007 public meeting discussed below.

What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. The Bay Creek TMDL report contains a plan detailing the actions necessary to reduce pollutant loads to the impaired water bodies and ensure compliance with applicable water quality standards. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations thereunder.

Background

The watershed targeted for TMDL development is Bay Creek is located in Pope, Johnson, and Massac Counties near the Kentucky State line. The watershed encompasses an area of approximately 144,000 acres. Land use in the watershed is predominately agriculture. The water body is listed on the Illinois EPA 2006 Section 303(d) List as being impaired for total phosphorus and total suspended solids. The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) List. Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Therefore, a TMDL was developed for total phosphorus, Manganese, dissolved oxygen. The summary of the impaired segments for Bay Creek Watershed are as follows: Cedar Creek – Manganese and Dissolved Oxygen; Bay Creek Ditch – Dissolved Oxygen; Vienna Correction Center Lake – Total Phosphorus; Bay Creek Lake No. 5 – Total Phosphorus. The Illinois EPA contracted with Camp Dresser & McKee (CDM) to prepare a TMDL report for the Bay Creek watershed.

Public Meetings

Public meetings were held in the Village of Vienna on September 26, 2006 and on August 8, 2007. The Illinois EPA provided public notice for both meetings by placing display ads in the Vienna Times. This notice gave the date, time, location, and purpose of the meeting. The notice also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. Approximately 92 individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review at the Vienna Times and also on the Agency's web page at http://www.epa.state.il.us/water/tmdl .

The public meeting started at 6:00 p.m. on Wednesday, August 8, 2007. No attendees were at the meeting and the meeting concluded at 6:15 p.m. with the meeting record remaining open until midnight, August 17, 2007

No Public Comments were received after the meeting on August 8, 2007.