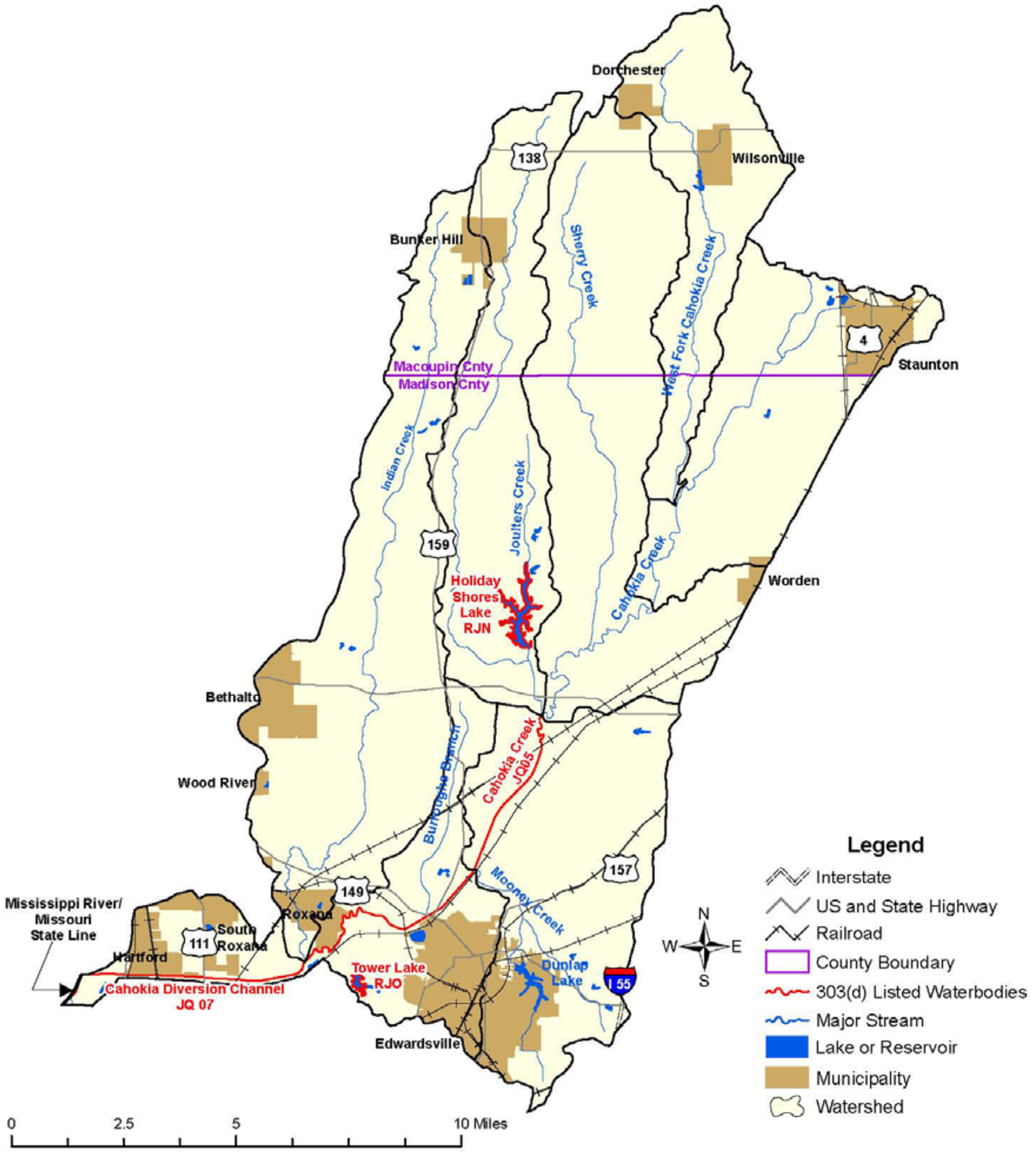
Illinois
Environmental
Protection Agency

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

August 2007

IEPA/BOW/07-019

Cahokia Creek/ Holiday Shores Lake Watershed TMDL Report



Printed on Recycled Paper

THIS PAGE INTENTIONALLY LEFT BLANK

Cah/Hol

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

RECEIVED
OCT 04 2007
Watershed Management Section
BUREAU OF WATER

SEP 28 2007

REPLY TO THE ATTENTION OF:
WW-16J

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 (TMDL) from the Illinois Environmental Protection Agency (IEPA) for Cahokia Creek/Holiday Shores Lake Watershed in Illinois. The TMDLs are for phosphorus and fecal coliform, and address several impairments in these waterbodies.

Based on this review, U.S. EPA has determined that Illinois' TMDLs for phosphorus and fecal coliform 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 three impairments for Cahokia Creek (JQ-05), Holiday Shores Lake (RJN), and Tower Lake (RJO) in Illinois. 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 this TMDL and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Dean Maraldo, TMDL Program Manager, at 312-353-2098.

Sincerely yours,

Kevin M. Pierard
Acting Director, Water Division

Enclosure

cc: Jenny Clarke, IEPA

THIS PAGE INTENTIONALLY LEFT BLANK

Contents

THIS PAGE INTENTIONALLY LEFT BLANK

Figures

THIS PAGE INTENTIONALLY LEFT BLANK

Tables

Acronyms and Abbreviations

°F	degrees Fahrenheit
µg/L	Micrograms per liter
BMP	best management practice
BOD	biochemical oxygen demand
BOD_5	5-day biochemical oxygen demand
CBOD	carbonaceous biochemical oxygen demand
CCC	Commodity Credit Corporation
CCX®	Chicago Climate Exchange
cfs	cubic feet per second
CPP	Conservation Practices Program
CRP	Conservation Reserve Program
CWA	Clean Water Act
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
EQIP	Environmental Quality Incentive Program
FSA	Farm 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
IDOT	Illinois Department of Transportation
IILCP	Illinois Interagency Landscape Classification Project
IL-GAP	Illinois Gap Analysis Project
Illinois EPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
IPCB	Illinois Pollution Control Board
LA	load allocation
lb/d	pounds per day
LC	loading capacity
mg/L	milligrams per liter
mgd	Million gallons per day
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
NRCS	National Resource Conservation Service
PCS	Permit Compliance System
SIUE	Southern Illinois University at Edwardsville
SOD	sediment oxygen demand
SSRP	Streambank Stabilization and Restoration Practice`
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic
STORET	Storage and Retrieval
STP	Sanitary Treatment Plant
SWCD	Soil and Water Conservation District
TMDL	total maximum daily load
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WASCOBs	Water and Sediment Control Basins
WHIP	Wildlife Habitat Incentives Program
WLA	waste load allocation
WRP	Wetlands Reserve Program
WTP	Water Treatment Plant

Section 1
Goals and Objectives for Cahokia Creek/ Holiday Shores Lake Watershed (071401010327)

1.1 Total Maximum Daily Load 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 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 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake watershed. Stage 2 data collection was completed during the fall of 2006 and the separate data report that was prepared for that stage is available in Appendix E.

The TMDL goals and objectives for the Cahokia Creek/Holiday Shores Lake watershed were to develop TMDLs for all impaired water bodies within the watershed, describe all of the necessary elements of the TMDL, develop an implementation plan for each TMDL, and gain public acceptance of the process. Following are the impaired water body segments in the Cahokia Creek/Holiday Shores Lake watershed for which a TMDL were developed:

- Cahokia Creek (JQ 05)
- Cahokia Diversion Canal (JQ 07)
- Holiday Shores Lake (RJN)
- Tower Lake (RJO)

These impaired water body segments are shown on Figure 1-1. There are four impaired segments within the Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake Watershed

Water Body Segment ID	Water Body Name	Size	Causes of Impairment with Numeric Water Quality Standards	Causes of Impairment with Assessment Guidelines
JQ 05	Cahokia Creek	9.89 miles	Total fecal coliform	
JQ 07	Cahokia Diversion Canal	5 miles	Copper(1), dissolved oxygen (DO)	Sedimentation/siltation, habitat alterations (streams)
RJN	Holiday Shores Lake	430 acres	Manganese, total phosphorus	Excess algal growth
RJO	Tower Lake	77 acres	Total phosphorus	Excess algal growth

(1) Data collected during Stage 2 indicated that copper is no longer a potential cause of impairment to the Cahokia Diversion Canal. Therefore, no TMDL was developed for copper.

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 total fecal coliform, DO, manganese, and total phosphorus (numeric standard) impairments in the Cahokia Creek/Holiday Shores Lake watershed. For potential causes that do not have numeric water quality standards as noted in Table 1-1, TMDLs will not be developed at this time. However, in the implementation plans available in Section 9, many of these potential causes may be addressed by implementation of controls for the pollutants with water quality standards.

The TMDL for the segments listed above will 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:

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

The TMDL developed must 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 will be described in the implementation plan. The implementation plan for the Cahokia Creek/Holiday Shores Lake watershed describes how water quality standards will be attained. This implementation plan 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 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake Watershed Water Quality Standards** defines the water quality standards for the impaired water body
- **Section 5 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake** 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**

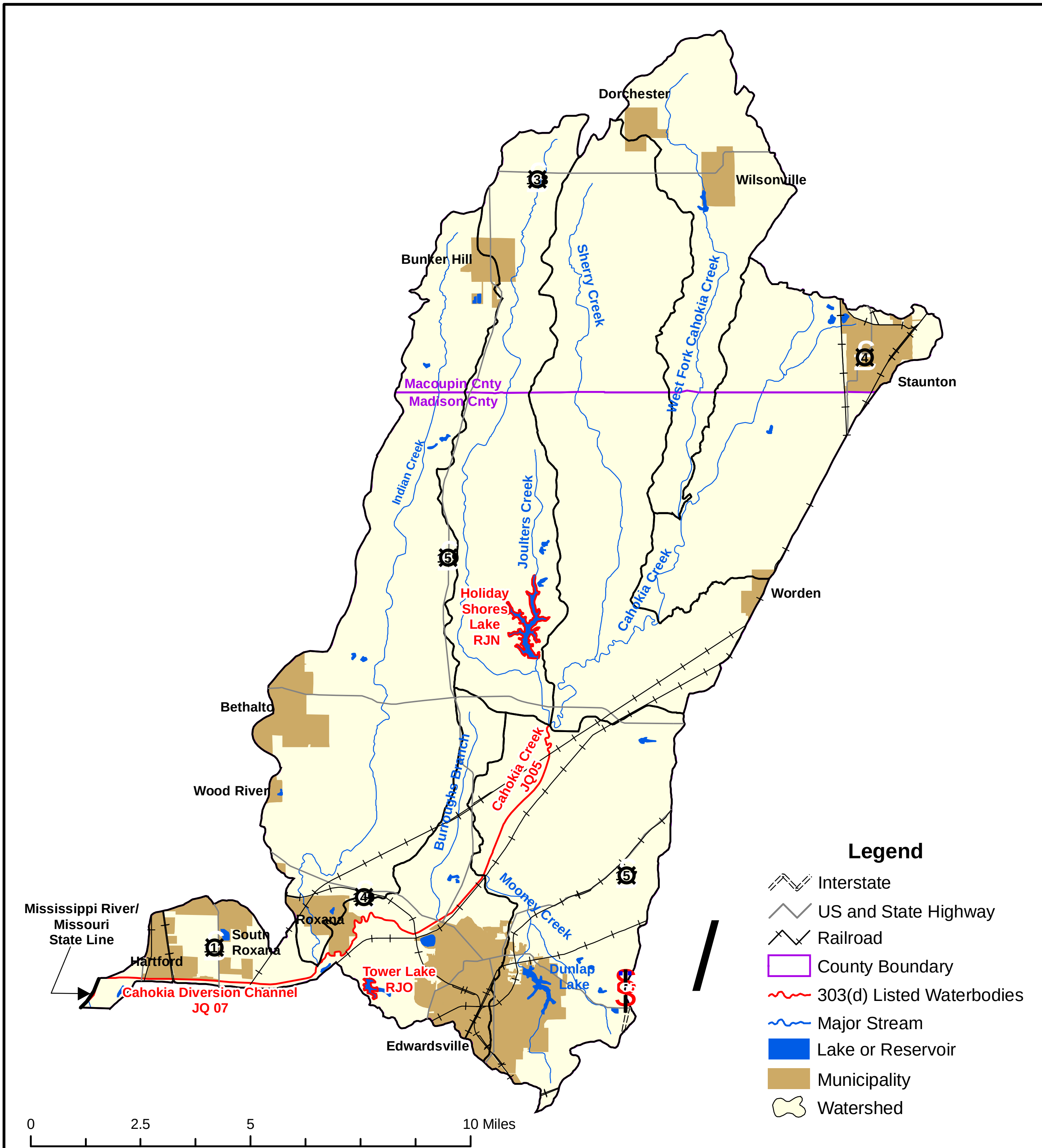


Figure 1-1
Cahokia Creek/Holiday Shores Lake Watershed

THIS PAGE INTENTIONALLY LEFT BLANK

Section 2
Cahokia Creek/Holiday Shores Lake Watershed Description

2.1 Cahokia Creek/Holiday Shores Lake Watershed Location

The Cahokia Creek/Holiday Shores Lake watershed (Figure 1-1) is located in southern Illinois, flows in a southwesterly direction, and drains approximately 126,000 acres within the state of Illinois. The watershed covers land within Macoupin and Madison counties near the Missouri state line. Approximately 36,000 acres lie in southern Macoupin County and 90,000 acres lie in northwestern Madison County.

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 U.S. Geological Survey (USGS) for each 1:24,000-topographic quadrangle in the United States. Elevation data for the Cahokia Creek/Holiday Shores Lake watershed was obtained by overlaying the NED grid onto the geographic information system (GIS)-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the Cahokia Creek/Holiday Shores Lake watershed ranges from 672 feet above sea level in the headwaters of Cahokia Creek to 390 feet at its most downstream point at the Mississippi River in the southwest tip of the watershed. The absolute elevation change is 249 feet over the approximately 24-mile stream length of Cahokia Creek, which yields a stream gradient of approximately 10.4 feet per mile.

2.3 Land Use

Land use data for the Cahokia Creek/Holiday Shores Lake 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 U.S. Department of Agriculture (USDA) National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data was 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 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake 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.

Table 2-1 Land Use in Cahokia Creek/Holiday Shores Lake Watershed

Land Cover Category	Area (Acres)	Percentage
Corn	27,391	21.7%
Soybeans	32,104	25.5%
Winter Wheat	1,928	1.5%
Other Small Grains & Hay	1,766	1.4%
Winter Wheat/Soybeans	6.387	5.1%
Other Agriculture	1,316	1.0%
Rural Grassland	11,334	9.0%
Upland	22,438	17.8%
Forested Areas	3,162	2.5%
High Density	2,649	2.1%
Low/Medium Density	6,180	4.9%
Urban Open Space	2,297	1.8%
Wetlands	5,961	4.7%
Surface Water	1,028	0.8%
Barren & Exposed Land	114	0.2%
Total	**126,055**	**100%**

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

The land cover data reveal that approximately 82,225 acres, representing nearly 65 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for approximately 22 percent and 26 percent of the watershed area, respectively; winter wheat/soybean farming accounts for roughly 5 percent; and rural grasslands account for 9 percent. Upland forests occupy approximately 18 percent of the watershed. Urban areas occupy approximately 9 percent of the watershed (about 2 percent high density, 5 percent low/medium density, and 2 percent urban open space). Wetlands occupy approximately 5 percent of the watershed. All other cover types represent less that 3 percent of the watershed area.

2.4 Soils

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 National Resource Conservation Service (NRCS) soil mapping.

The Cahokia Creek/Holiday Shores Lake watershed falls within Macoupin and Madison counties. Figure 2-3 displays the SSURGO soil series in the Cahokia Creek/Holiday Shores Lake watershed. Attributes of the spatial coverage can be linked to the SSURGO database, which provides 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 Cahokia Creek/Holiday Shores Lake watershed.

2.4.1 Cahokia Creek/Holiday Shores Lake Watershed Soil Characteristics

Appendix B contains the SSURGO soil series for the Cahokia Creek/Holiday Shores Lake. The table also contains the area, dominant hydrologic soil group, and K-factor range. Each of these characterizations is described in more detail in the following paragraphs. The soil type that covers the most area within the watershed is Hickory Loams ranging from silts to clays on 10 to 60 percent slopes.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to their infiltration rates under saturated conditions during long duration storm events. All four hydrologic soil groups (A, B, C, and D) are found within the Cahokia Creek/Holiday Shores Lake watershed with the majority of the watershed falling into category B. Category B soils are defined as "soils having a moderate infiltration rate when thoroughly wet." Category B soils "consist chiefly of moderately deep or deep, moderately well drained, or well drained soils that have moderately fine texture to moderately coarse texture." These soils have a moderate 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 Cahokia Creek/Holiday Shores Lake watershed range from 0.02 to 0.55.

2.5 Population

Population data were retrieved from Census 2000 TIGER/Line Data from the U.S. 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 U.S. 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 49,000 people reside in the watershed. The major municipalities in the Cahokia Creek/Holiday Shores Lake watershed are shown in Figure 1-1. The city of Edwardsville is the largest population center in the watershed and contributes an estimated 10,800 people to total watershed population.

2.6 Climate and Streamflow

2.6.1 Climate

Southern Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from the Edwardsville 2W (station id. 2679) in Madison County were extracted from the NCDC database for the years of 1948 through 2004. The data station in Edwardsville, Illinois was chosen to be representative of precipitation throughout the Cahokia Creek/Holiday Shores Lake watershed.

There are no stations within the watershed that have adequate temperature records. Minimum and maximum monthly temperature data were extracted for the Alton Melvin Price L&D station (station id. 137) in Madison County. Alton is just west of the watershed and was chosen to be representative of temperatures across the watershed area.

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 40 inches.

Table 2-2 Average Monthly Climate Data in the Cahokia Creek/Holiday Shores Lake Watershed

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.3	37	20
February	2.3	42	24
March	3.3	52	33
April	3.8	65	45
May	4.4	75	55
June	4.6	84	64
July	4.1	88	69
August	3.5	87	66
September	2.9	80	58
October	3.0	68	47
November	3.2	53	35
December	2.6	41	26
Total	40.0		

2.6.2 Streamflow

Analysis of the Cahokia Creek/Holiday Shores Lake watershed requires an understanding of flow throughout the drainage area. One USGS gage within the watershed has available data (Figure 2-4).

USGS gage 05587900 Cahokia Canal at Edwardsville, Illinois is located on the Cahokia Canal along segment JQ 05. The average monthly flows recorded at the gage range from 31 cubic feet per second (cfs) in August to 310 cfs in April with a mean annual monthly flow of 152 cfs (Figure 2-5).

2.7 Watershed Photographs

The photographs shown here are of the Cahokia Creek/Holiday Shores Lake watershed that were taken in the fall of 2006. Appendix D contains additional photographs of the watershed.

Cahokia Creek at Old Alton Edwards Road Looking Northeast

Holiday Shores Lake

THIS PAGE INTENTIONALLY LEFT BLANK

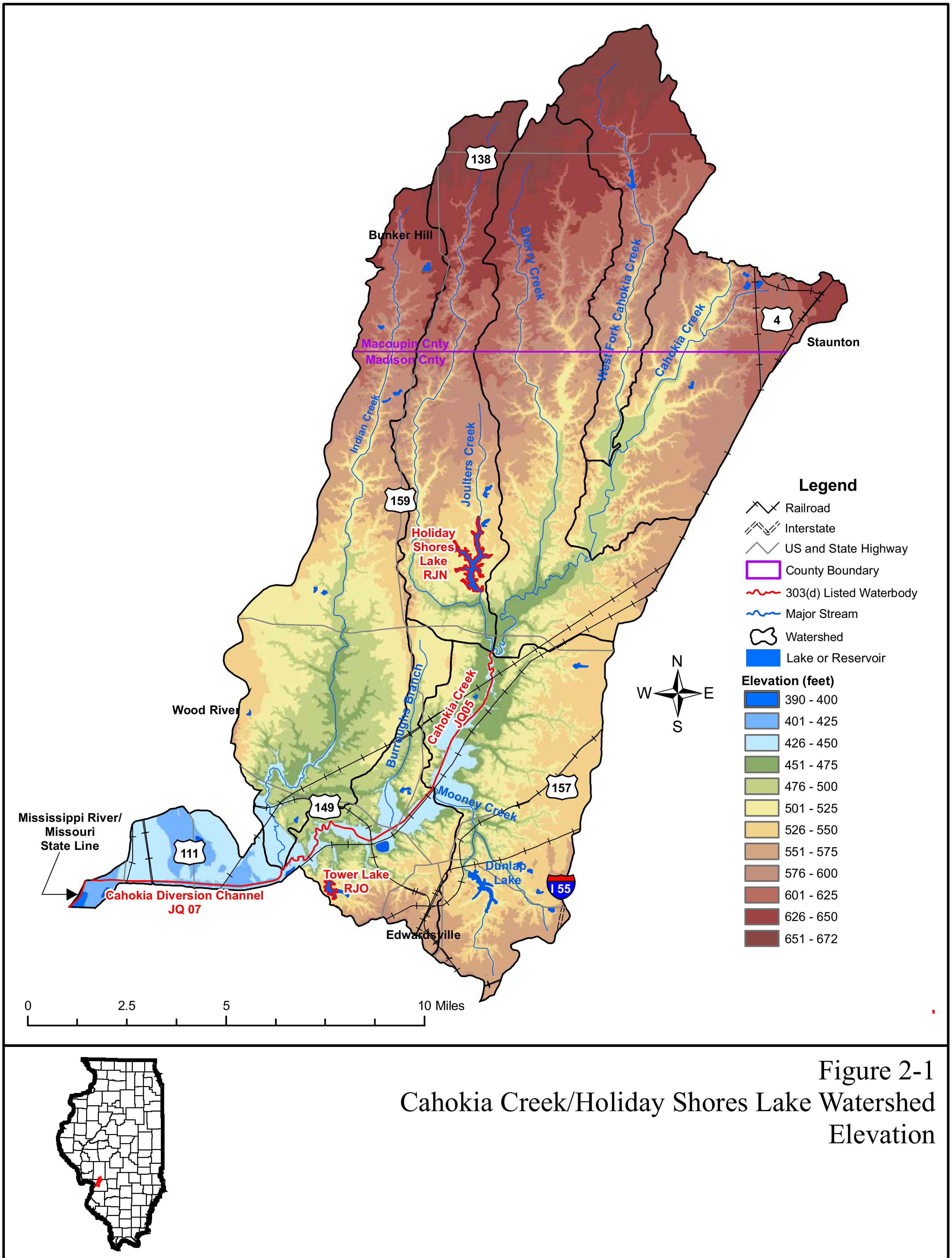


Figure 2-1
Cahokia Creek/Holiday Shores Lake Watershed
Elevation

THIS PAGE INTENTIONALLY LEFT BLANK

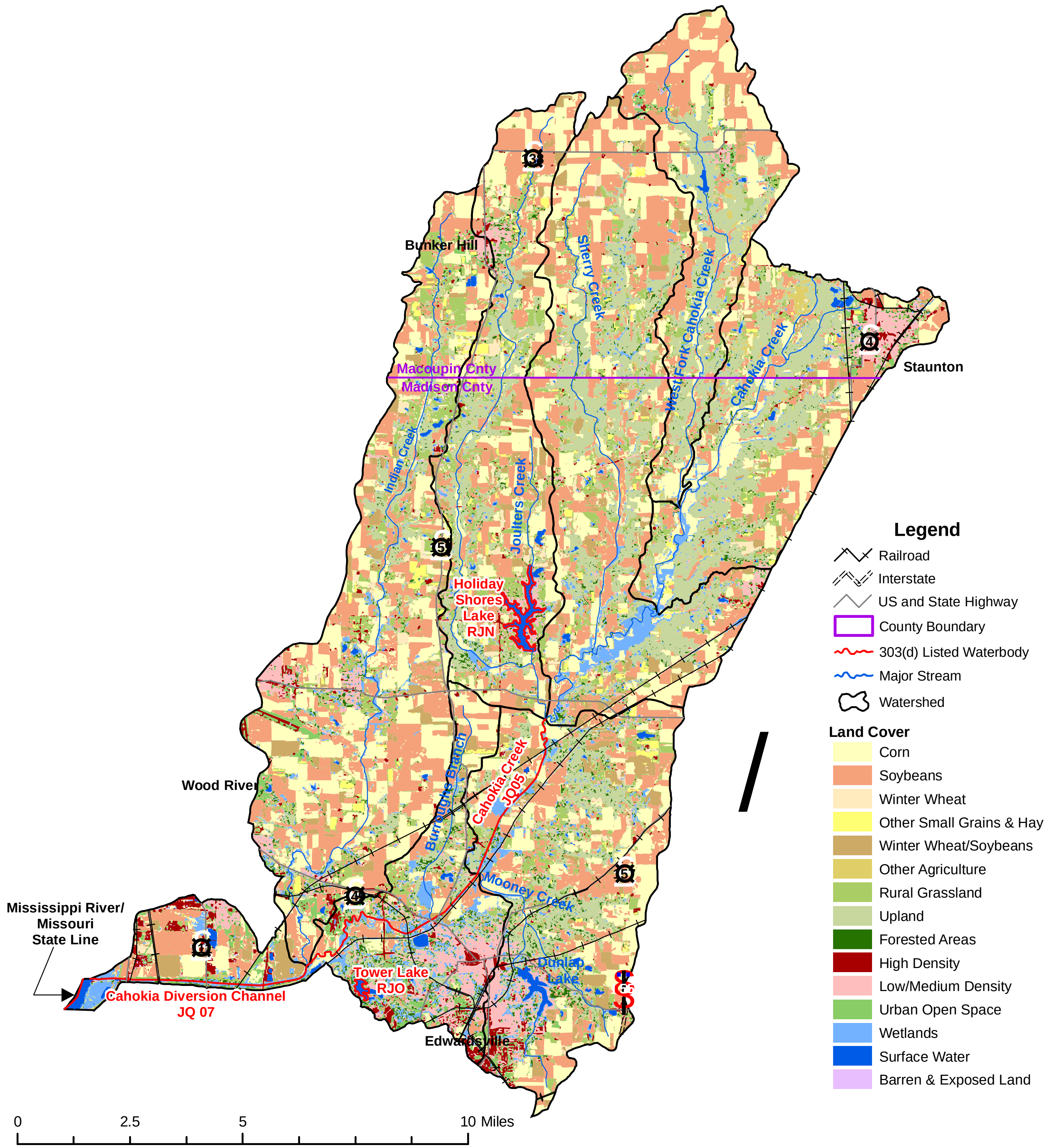


Figure 2-2
Cahokia Creek/Holiday Shores Lake Watershed
Land Use

THIS PAGE INTENTIONALLY LEFT BLANK

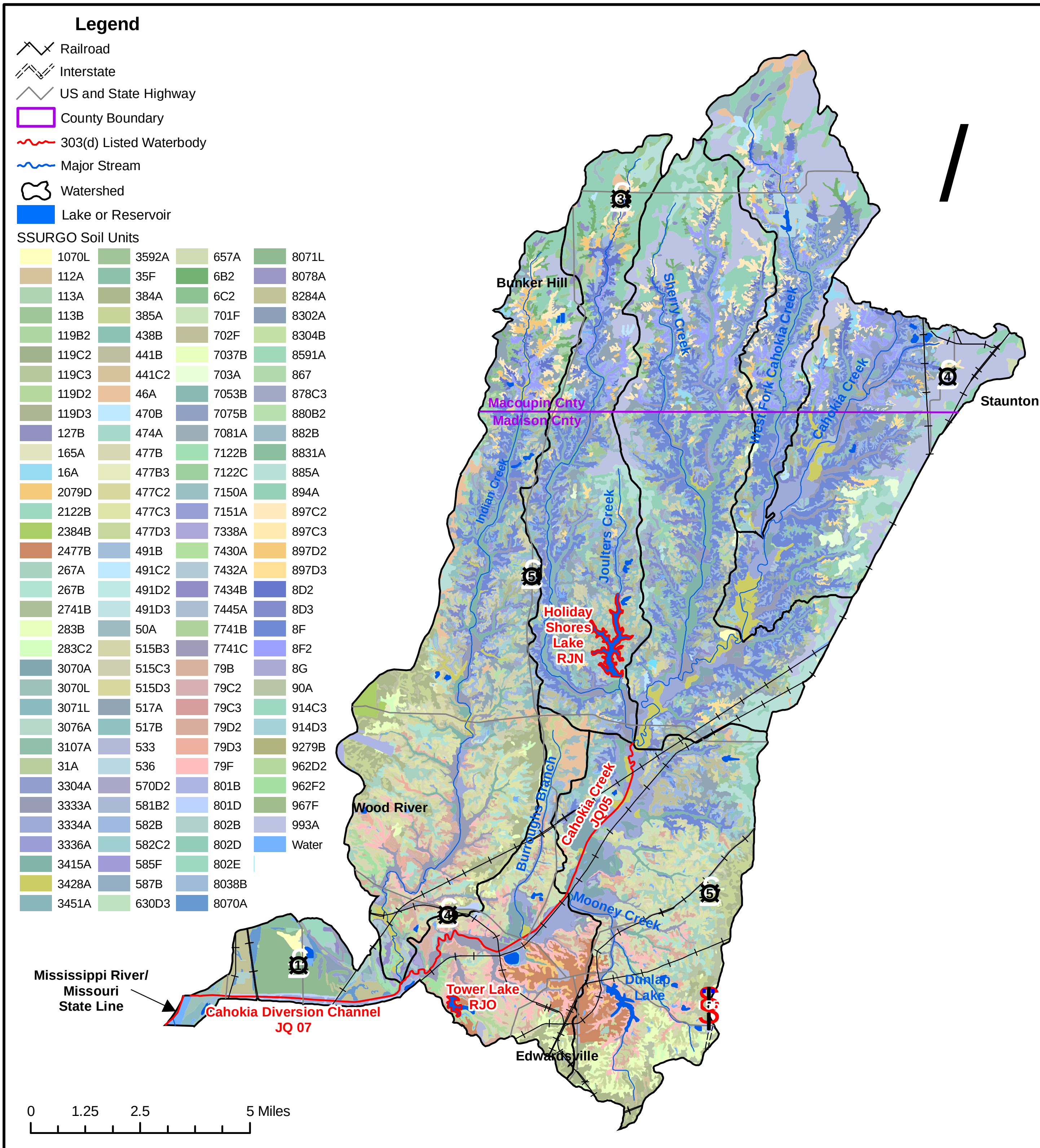


Figure 2-3
Cahokia Creek/Holiday Shores Lake Watershed
Soils

THIS PAGE INTENTIONALLY LEFT BLANK

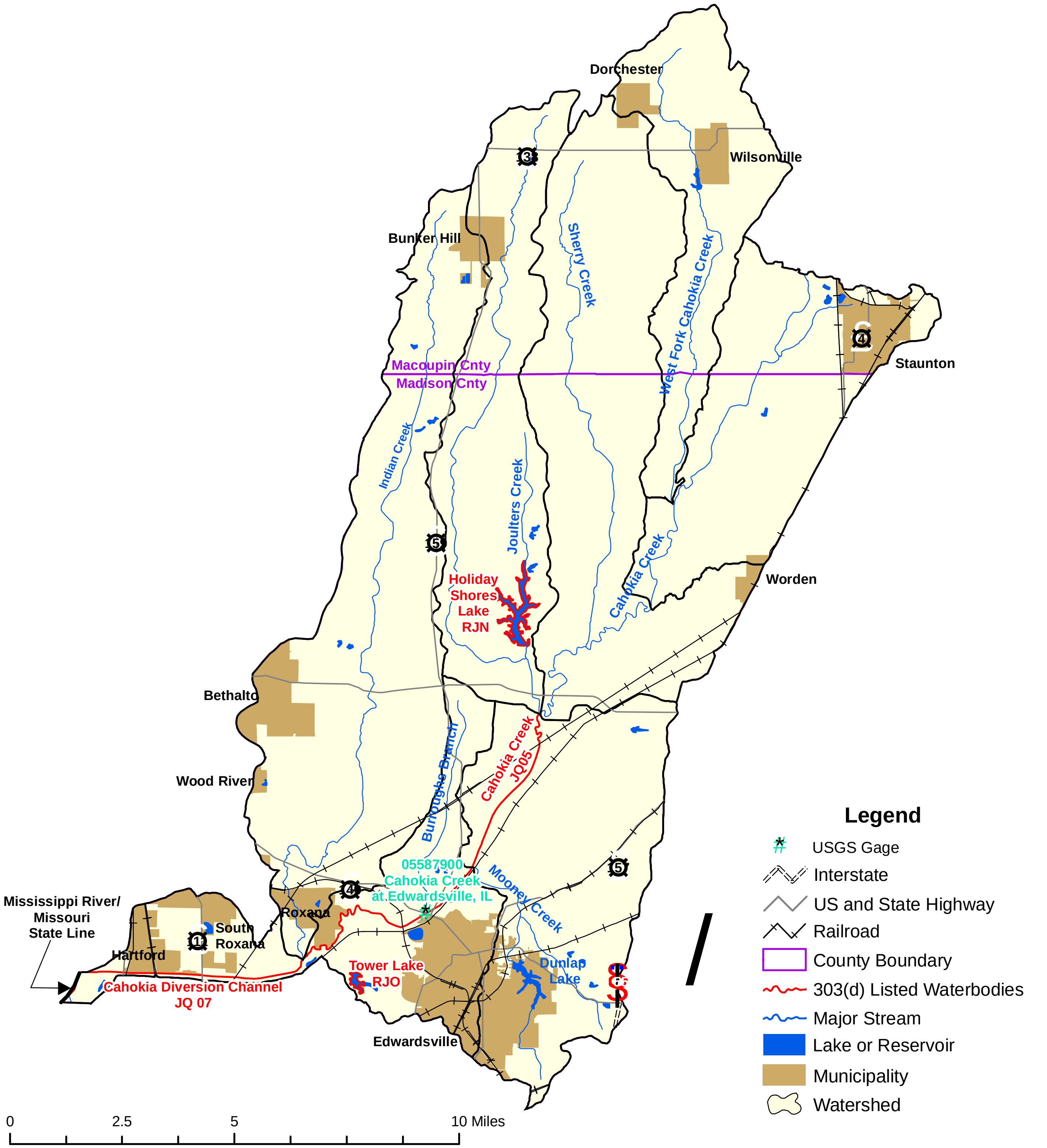


Figure 2-4
Cahokia Creek/Holiday Shores Lake Watershed
USGS Gage

THIS PAGE INTENTIONALLY LEFT BLANK

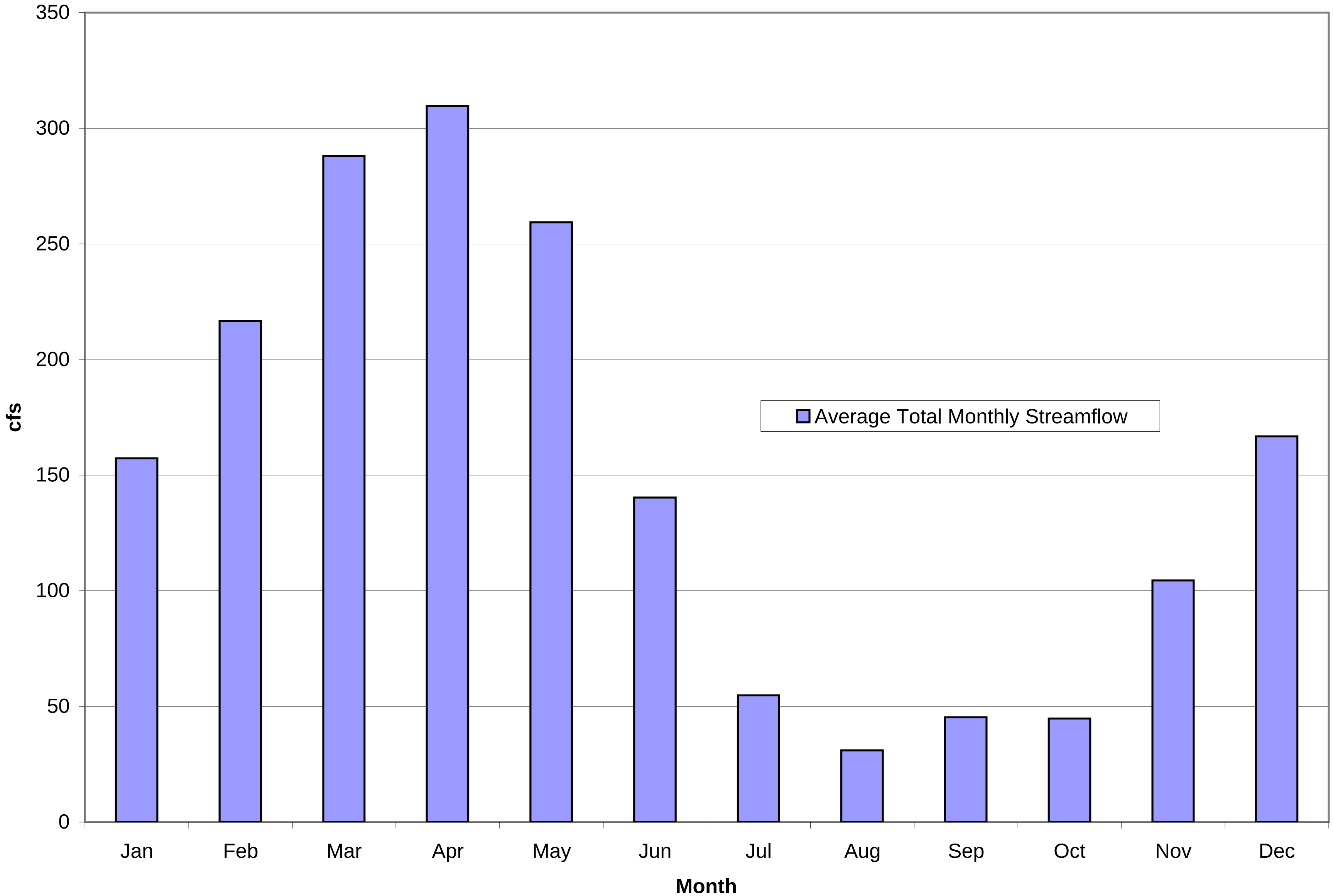


Figure 2-5:
Average Total Monthly Streamflow
at USGS gage 05587900
Cahokia Canal at Edwardsville, IL

CDM

T:\GIS\WRITEUP\14 Cahokia Creek_Holiday Shores Lake\Data\CahokiaCreek-precip-temp-flow.xlsFLow Chart

THIS PAGE INTENTIONALLY LEFT BLANK

Section 3
Public Participation and Involvement

3.1 Cahokia Creek/Holiday Shores Lake 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. A public meeting was held on June 29, 2006 at Illinois Department of Transportation (IDOT) District 8 Headquarters in Collinsville, Illinois to present Stage 1 of TMDL development for the Cahokia Creek/Holiday Shores Lake watershed. In addition, a meeting was held August 9, 2007 at the Holiday Shores Lake club house in Holiday Shores to present the Stage 3 TMDL report.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 4
Cahokia Creek/Holiday Shores Lake 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 U.S. Environmental Protection Agency (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 Cahokia Creek/Holiday Shores Lake 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: The General Use standards 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: These 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 impairment to aquatic life is occurring, then a comparison of available water quality data with water quality standards occurs.

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 Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake Watershed Lake Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Regulatory Citation 35 Ill. Adm. Code
Excess Algal Growth	NA	No numeric standard	No numeric standard	
Manganese	µg/L	1000	150	302.208g 302.304
Total Phosphorus	mg/L	0.05[(1)]	No numeric standard	302.205

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 Cahokia Creek/Holiday Shores Lake Watershed Stream Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies	Regulatory Citation 35 Ill. Adm. Code
Habitat Alterations (Streams)	NA	No numeric standard	No numeric standard	
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	
Total Fecal Coliform	Count/ 100 mL	May through Oct – 200[(1)], 400[(2)] Nov though Apr – no numeric standard	2000[(1)]	302.209

µg/L = micrograms per liter exp(x) = base natural logarithms raised to the x- power
mg/L = milligrams per liter ln(H) = natural logarithm of hardness of the receiving water in mg/L
NA = Not Applicable * = conversion factor for multiplier for dissolved metals

1. Geometric mean based on a minimum of 5 samples taken over not more than a 30 day period.
2. Standard shall not be exceeded by more than 10% of the samples collected during any 30 day period.

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake Watershed

Segment ID	Segment Name	Potential Causes	Potential Sources
Q 05	Cahokia Creek	Total fecal coliform	Source unknown
JQ 07	Cahokia Diversion Canal	Sedimentation/siltation, dissolved oxygen, habitat alterations (streams)	Agriculture, crop-related sources, nonirrigated crop production, hydromodification, channelization, habitat modification (other than hydromodofication), bank or shoreline modification/destabilization, source unknown
RJN	Holiday Shores Lake	Manganese, total phosphorus, excess algal growth	Agriculture, crop-related sources, construction, urban runoff/storm sewers, habitat modification (other than hydromodification), bank or shoreline modification/destabilization, recreation and tourism activities (other than boating), forest/grassland/parkland, source unknown
RJO	Tower Lake	Total phosphorus, excess algal growth	Source unknown

THIS PAGE INTENTIONALLY LEFT BLANK

Section 5
Cahokia Creek/Holiday Shores Watershed Characterization

Data was collected and reviewed from many sources in order to further characterize the Cahokia Creek/Holiday Shores watershed. Data has 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 six historic water quality stations within the Cahokia Creek/Holiday Shores Lake 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 Cahokia Creek/Holiday Shores Lake 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. Data analysis is focused on all available data collected since 1990. 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 Cahokia Creek/ Holiday Shores Lake watershed stream data followed by Cahokia Creek/Holiday Shores Lake watershed lake data.

5.1.1 Stream Water Quality Data

The Cahokia Creek/Holiday Shores Lake watershed has two impaired streams within its drainage area that are addressed in this report. There is one active water quality station on each impaired segment (see Figure 5-1). The data summarized in this section include water quality data for impaired constituents as well as parameters that could be useful in future modeling and analysis efforts. All historic water quality data are available in Appendix C.

5.1.1.1 Fecal Coliform

Cahokia Creek Segment JQ 05 is listed as impaired by total fecal coliform. Table 5-1 summarizes available historic fecal coliform data on the segment. The general use water quality standard for fecal coliform states that the standard of 200 per 100 mL not be exceeded by the geometric mean of at least five samples, nor can 10 percent of the samples collected exceed 400 per 100 mL in protected waters, except as provided in 35 Ill. Adm. Code 302.209(b). Samples must be collected over a 30-day period or less between the months of May and October.

There are no instances since 1990 where at least five samples have been collected during a 30-day period. The summary of data presented in Table 5-1 reflects single samples compared to the standards during the appropriate months. Figure 5-2 shows the total fecal coliform samples collected over time at JQ 05.

Table 5-1 Existing Fecal Coliform Data for Cahokia Creek JQ05

Sample Location and Parameter	Period of Record and Number of Data Points	Geometric mean of all samples	Maximum	Minimum	Number of samples > 200 [1]	Number of samples > 400 [1]
Cahokia Creek Segment JQ05; Sample Location JQ05						
Total Fecal Coliform (cfu/100 mL)	1990-2004; 114	388	590,000	5	46	34

(1) Samples collected during the months of May through October

5.1.1.2 Dissolved Oxygen

Cahokia Diversion Channel Segment JQ 07 is listed as impaired by DO. There are two DO data points available since 1990. Table 5-2 summarizes the available DO data for the impaired stream segment (raw data contained in Appendix C). The table also shows that one of the two samples did fall below the DO water quality standard of 5.0 milligrams per liter (mg/L) instantaneous minimum concentration. The violating sample was collected in 1998.

Table 5-2 Existing Dissolved Oxygen Data for Cahokia Diversion Ditch JQ07

Sample Location and Parameter	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Cahokia Canal Diversion Ditch JQ 07; Sample Location JQ 07						
DO	5.0[1]	1998-1999; 2	7.95	11.2	4.7	1

(1) Instantaneous Minimum

In 2005, a continuous monitoring device was deployed at sample location JQ07 to further monitor DO concentrations. The device logged DO concentrations every 30 minutes for three days (August 29 through September 1). Results of this sampling event are shown in Table 5-3. Figure 5-3 shows the data plotted against the standard.

Table 5-3 2005 Continuous Dissolved Oxygen Data for Cahokia Diversion Ditch JQ07

Sample Location and Parameter	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Cahokia Canal Diversion Ditch JQ 07; Sample Location JQ 07						
DO	5.0[1]	2005; 147	3.09	6.7	1.8	130

(1) Instantaneous Minimum

Table 5-4 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for DO. Where available, all nutrient and total organic carbon data have been collected for possible use in future analysis.

Table 5-4 Data Availability for DO Data Needs Analysis and Future Modeling Efforts

Sample Location and Parameter	Available Period of Record Post 1990	Number of Samples
Cahokia Canal Diversion Ditch JQ 07; Sample Location JQ 07		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1998	1
Ammonia, Unionized (mg/L as N)	1998	1
Carbon, Total Organic (mg/L as C)	1998-1999	2
Nitrite plus Nitrate, Total 1 Det. (mg/L as N)	1998-1999	2
Nitrogen, Ammonia, Total (mg/L as N)	1998-1999	2
Nitrogen, Kjeldahl, Total (mg/L as N)	1998-1999	2
Oxygen, Dissolved, Percent of Saturation (%)	1998	1
Phosphorus, Dissolved (mg/L as P)	1998-1999	2
Phosphorus, Total (mg/L as P)	1998-1999	2
Temperature, Water (degrees centigrade)	1998-1999	2

5.1.1.3 Copper

Cahokia Diversion Channel Segment JQ 07 was originally listed as impaired by copper. Table 5-5 contains a summary of copper data collected on the impaired segment. The applicable copper water quality standard is dependent on hardness. Hardness data have been collected in conjunction with copper data. The number of violations presented in Table 5-5 for copper represents violations of the general use chronic standard. As shown in the table, one of the two available data points was a violation of the water quality standard for copper. The violation occurred in 1998. The most recently collected data (three samples from 2005) were below the detection limit.

Table 5-5 Existing Copper Data for Cahokia Diversion Ditch JQ07

Sample Location and Parameter	Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Cahokia Diversion Ditch JQ 07; Sample Location JQ 07						
Dissolved Copper (µg/L)	Hardness Dependent	1998-2005; 5	17	24	10	1

In addition, further copper data was collected during late summer and fall of 2006 during Stage 2 data collection efforts. The most recent data show that copper is no longer a potential cause of impairment to the Cahokia Diversion Canal. Data are available in Appendix E.

5.1.2 Lake Water Quality Data

The Cahokia Creek/Holiday Shores Lake watershed has two impaired lakes within its drainage area that are addressed in this report. There are two active water quality stations on each of the impaired lakes (see Figure 5-1). The data summarized in this section include water quality data for the impaired constituent as well as parameters that could be useful in future modeling and analysis efforts. All historic water quality data are available in Appendix C.

5.1.2.1 Holiday Shores Lake

Holiday Shores Lake is listed as impaired for total manganese and total phosphorous. An inventory of all available phosphorous and manganese data is presented in Table 5-6. No manganese data was available for Holiday Shores Lake through the STORET database; however, manganese data was collected in 2003 and has been included in the following discussion.

Table 5-6 Holiday Shores Lake Data Inventory for Impairments

Holiday Shores Lake Segment RJN; Sample Locations RJN-1, RJN-2 and RJN-3		
RJN-1	**Period of Record**	**Number of Samples**
Total Phosphorus	1990-1998	43
Manganese	2003	5
RNJ-2		
Total Phosphorus	1990-1994	24
RNJ-3		
Total Phosphorus	1990-1994	30

Table 5-7 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for total manganese and total phosphorus at varying depths.

Table 5-7 Holiday Shores Lake Data Availability for Data Needs Analysis and Future Modeling Efforts

Holiday Shores Lake Segment RJN; Sample Locations RJN-1 and RJN-2		
RNJ-1	**Period of Record**	**Number of Samples**
Chlorophyll-a µg/L Spectrophotometric Acid. Meth	1996-1998	13
Chlorophyll-a µg/L Trichromatic Uncorrected	1996-1998	13
Depth of Pond or Reservoir in Feet	1990-1998	96
RJN-2		
Depth of Pond or Reservoir in Feet	1990-1998	96

5.1.2.1.1 Total Phosphorous

Compliance with the total phosphorus standard is based on samples collected at a one-foot depth from the lake surface. The average total phosphorus concentrations at a one-foot depth for each year of available data at each monitoring site in Holiday Shores Lake are presented in Table 5-8. The water quality standard for total phosphorus is a concentration less than or equal to 0.05 mg/L.

Table 5-8 Average Total Phosphorus Concentrations (mg/L) in Holiday Shores Lake at One-Foot Depth

	RJN-1		RJN-2		RJN-3		Lake Average	
Year	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1990	6; 5	0.14	5; 5	0.14	6; 6	0.2	17; 16	0.16
1991	6; 6	0.14	6; 6	0.13	6; 6	0.19	18;18	0.15
1992	6; 6	0.13	NA	NA	6; 6	0.14	12; 12	0.14
1993	6; 6	0.17	6; 6	0.15	6; 6	0.2	18; 18	0.17
1994	6; 6	0.2	6; 6	0.2	6; 6	0.24	18; 18	0.21
1996	6; 6	0.12	NA	NA	NA	NA	6; 6	0.12
1997	6; 6	0.13	NA	NA	NA	NA	6; 6	0.13
1998	1; 1	0.17	NA	NA	NA	NA	1; 1	0.17

As shown in the table, all the samples except for one taken at RJN-1 in 1990, exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-4 shows the average annual total phosphorous concentrations in Holiday Shores Lake.

5.1.2.1.2 Manganese

Holiday Shores Lake is a source of public water. Therefore, the applicable water quality standard for manganese is 150 micrograms per liter (µg/L). Table 5-9 summarizes available manganese data for Holiday Shores Lake. Samples were collected between May and October of 2003 at a 10-foot depth. Three of the five samples violated the public water supply standard.

Table 5-9 Manganese Concentrations in Holiday Shores Lake

Year	RJN-2			
	Water Quality Standard (µg/L)	Data Count	Number of Violations	Average (µg/L)
2003	General Use: 1000	5	0	147
	Public Water Supply: 150		3	

5.1.2.2 Tower Lake

Tower Lake is impaired for total phosphorous. There are two active stations in Tower Lake. An inventory of all available total phosphorous data at varying depths is presented in Table 5-10.

Table 5-10 Tower Lake Data Inventory for Impairments

Tower Lake Segment RJO; Sample Locations RJO-1 and RJO-3		
RJO-1	**Period of Record**	**Number of Samples**
Total Phosphorus	1990-1996	20
Dissolved Phosphorus	1990-1996	20
Phosphorus Bottom Deposits	1990-1996	2
RJO-2		
Total Phosphorus	1990-1996	10
Dissolved Phosphorus	1990-1996	10
Phosphorus Bottom Deposits	1990-1996	2
RJO-3		
Total Phosphorus	1990-1996	10
Dissolved Phosphorus	1990-1996	10
Phosphorus Bottom Deposits	1990-1996	2

Table 5-11 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for total phosphorus at varying depths.

Table 5-11 Tower Lake Data Availability for Data Needs Analysis and Future Modeling Efforts

Tower Lake Segment RJO; Sample Locations RJO-1, RJO-2, and RJO-3		
RJO-1	**Period of Record**	**Number of Samples**
Chlorophyll-a µg/L Spectrophotometric Acid. Meth	1990-1996	9
Chlorophyll-a µg/L Trichromatic Uncorrected	1990-1996	9
Depth of Pond or Reservoir in Feet	1990-1996	55

5.1.2.2.1 Total Phosphorus

Compliance with the total phosphorus standard is based on samples collected at a one-foot depth from the lake surface. The average total phosphorus concentrations at a one-foot depth for each year of available data at each monitoring site in Tower Lake are presented in Table 5-12. The water quality standard for total phosphorus is a concentration less than or equal to 0.05 mg/L.

Table 5-12 Average Total Phosphorus Concentrations (mg/L) in Tower Lake at One-Foot Depth

	RJO-1		RJO-2		RJO-3		Tower Lake	
Year	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average	Data Count; Number of Violations	Average
1990	5; 5	0.14	5; 5	0.13	5; 5	0.13	15; 15	0.13
1996	5; 5	0.09	5; 5	0.09	5; 4	0.09	15; 14	0.09
2005	2; 2	0.14	NA	NA	2; 2	0.07	4; 4	0.11

Total phosphorus data at the sites were collected in 1990, 1996 and in 2005. All of the sites had an annual average above the 0.05 mg/L standard. All samples, except for one taken at location RJO-3 in 1996, exceeded the total phosphorous standard. Figure 5-5 shows the average annual total phosphorous concentrations in Tower Lake in 1990, 1996, and 2005.

5.2 Reservoir Characteristic

There are two impaired reservoirs in the Cahokia Creek/Holiday Shores Lake watershed. Reservoir information that can be used for future modeling efforts was collected from GIS analysis, the U.S. Army Corps of Engineers (USACE), the Illinois EPA, and USEPA water quality data. The following sections will discuss the available data for each reservoir.

5.2.1 Holiday Shores Lake

Holiday Shores Lake is located in Madison County. The lake was created in 1968 by damming Joulters Creek. The lake has a surface area of 430 acres and serves as a drinking water supply for the Holiday Shores Sanitary District. Average pumpage from the lake is approximately 188,000 gallons per day to 1,080 service connections and an estimated population of 3,240 people in Madison County (Source Water Assessment Program, Illinois EPA 2002). Table 5-13 contains dam information while Table 5-14 contains depth information for the lake. The average maximum depth in Holiday Shores Lake is 27.9 feet.

Table 5-13 Holiday Shores Lake Dam Information (U.S. Army Corps of Engineers

Dam Length	960 feet
Dam Height	47 feet
Maximum Discharge	9,493 cfs
Maximum Storage	6,610 acre-feet
Normal Storage	4,605 acre-feet
Spillway Width	54 feet
Outlet Gate Type	U

Table 5-14 Average Depths (ft) for Holiday Shores Lake Segment RJN (Illinois EPA 2002 and USEPA 2002a)

Year	RJN-1	RJN -2
1990	26.5	19.2
1991	28.3	19.8
1992	28.3	20.5
1993	28.9	20.2
1994	28.1	18.8
1995	28.5	18.6
1996	27.5	18.8
1997	27.5	18.9
1998	27.8	19.0
Average	**27.9**	**19.3**

5.2.2 Tower Lake

Table 5-15 Average Depths (ft) for Tower Lake (Illinois EPA 2002 and USEPA 2002a)

Year	RJO-1	RJO -2	RJO -3
1990	37.6	19.8	17.5
1991	34.4	16.4	19.5
1993	21.4	33.7	28.8
1996	41.0	25.8	18.9
Average	**33.6**	**23.9**	**21.2**

Tower Lake is located in Madison County upstream of Cahokia Creek and has a surface area of 77 acres. The lake is located on the Southern Illinois University Edwardsville (SIUE) campus. Tower Lake was as a cooling water supply for SIUE's Heating and Refrigeration Plant, which provides air conditioning services to the buildings on campus. No recreational boating or swimming is allowed in Tower Lake although shoreline fishing is permitted. Table 5-15 contains depth information for each sampling location on the lake. The maximum water depth is 33.6 feet.

5.3 Point Sources

Point sources for the Cahokia Creek/Holiday Shores Lake watershed have been separated into municipal/industrial sources and mining discharges. Available data has 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 National Pollutant Discharge Elimination System (NPDES) permit compliance. DMRs contain effluent discharge sampling results that are then maintained in a database by the state. There are nine point sources located within the Cahokia Creek/Holiday Shores Lake watershed. Figure 5-6 shows all NPDES permitted facilities. In order to assess point source contributions to the watershed, the data has 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 were not available. Data have been summarized for any sampled parameter that is associated with a downstream impairment (i.e., all available nutrient and biological oxygen demand (BOD) data was 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 Cahokia Creek Segment JQ 05

There are four point sources with the potential to contribute discharge to Cahokia Creek segment JQ 05. Segment JQ 05 is listed as impaired for total fecal coliform. Table 5-16 contains a summary of available and pertinent DMR data for these point sources. Fecal coliform samples are only available through the Staunton Water Treatment Plant (WTP) permit. The majority of these dischargers are a considerable distance upstream of the impaired segment.

Table 5-16 Effluent Data from Point Sources Discharging Upstream of Cahokia Creek Segment JQ 05 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Holiday Shores SD STP 1998-2005 ILG580193	Cahokia Creek/Cahokia Creek Segment JQ 05	Average Daily Flow	0.25 mgd	NA
Staunton WTP 1992-2005 IL0031232	Ginseng Creek/Cahokia Creek Segment JQ 05	Average Daily Flow	0.91 mgd	NA
		Total Fecal Coliform	430 mg/L	
Wilsonville STP 1998-2005 ILG580172	Cahokia Creek/Cahokia Creek Segment JQ 05	Average Daily Flow	0.09 mgd	NA
Worden STP 1994-2005 ILG580015	Cahokia Creek/Cahokia Creek Segment JQ 05	Average Daily Flow	0.125 mgd	NA

5.3.1.2 Cahokia Diversion Canal Segment JQ 07

There are three permitted facilities whose discharge has the potential to reach Cahokia Diversion Canal Segment JQ 07. Segment JQ 07 is listed for copper and DO impairments. Table 5-17 contains a summary of available DMR data for these point sources.

Table 5-17 Effluent Data from Point Sources Discharging to or Above Cahokia Diversion Canal Segment JQ 07 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Bunker Hill STP 1996-2005 ILG580154	Indian Creek/Cahokia Diversion Canal Segment JQ 07	Average Daily Flow	0.223 mgd	NA
		BOD, 5-Day	76.0 mg/L	–
		CBOD, 5-Day	42.2 mg/L	37.1
Conoco Inc Woodriver Termtank 1997-2004 IL0071803	Cahokia Diversion Canal/Cahokia Diversion Canal Segment JQ 07	Average Daily Flow	0.0057 mgd	NA
Explorer Pipeline - Wood River 1996-2005 IL0061522	Cahokia Canal/Cahokia Diversion Canal Segment JQ 07	Average Daily Flow	0.138 mgd	NA

5.3.1.3 Tower Lake Segment RJO

There are two point sources that discharge to Tower Lake Segment RJO. Segment RJO is listed as impaired for total phosphorus. Table 5-18 contains a summary of available DMR data for these point sources.

Table 5-18 Effluent Data from Point Sources Discharging to Tower Lake Segment RJO (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Southern Illinois Univ-Pool 2002-2005 IL0075841	Tower Lake/Tower Lake Segment RJO	Average Daily Flow	0.045 mgd	NA
Southern Illinois Univ-Edwardsville 1995-2005 IL0046761	Tower Lake/Tower Lake Segment RJO	Average Daily Flow	0.6 mgd	NA
		Total Phosphorus	0.380 mg/L	0.638

5.3.1.4 Other Impaired Segments

There are no permitted facilities that discharge directly to Holiday Shores Lake Segment RJN.

5.3.2 Mining Discharges

There are no permitted mine sites or recently abandoned mines within the Cahokia Creek/Holiday Shores Lake watershed. If additional information becomes available, it will be reviewed and considered during Stage 3 of TMDL development.

5.4 Nonpoint Sources

There are many potential nonpoint sources of pollutant loading to the impaired segments in the Cahokia Creek/Holiday Shores Lake 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 percentage of the land found within the Cahokia Creek/Holiday Shores Lake watershed is devoted to crops. Corn and soybean farming account for approximately 22 percent and 26 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 2004. Data specific to the Cahokia Creek/Holiday Shores Lake watershed were not available; however, the Macoupin and Madison County practices were available and are shown in the following tables.

Table 5-19 Tillage Practices in Macoupin County

Tillage System	Corn	Soybean	Small Grain
Conventional	72%	8%	100%
Reduced - Till	19%	18%	0%
Mulch - Till	8%	26%	0%
No - Till	2%	47%	0%

Table 5-20 Tillage Practices in Madison County

Tillage System	Corn	Soybean	Small Grain
Conventional	68%	8%	6%
Reduced - Till	21%	35%	21%
Mulch - Till	7%	22%	23%
No - Till	4%	35%	49%

Communications with local county NRCS offices indicate that very little subsurface tile drainage is found in the watershed.

5.4.2 Animal Operations

Watershed specific animal numbers were not available for the Cahokia Creek/Holiday Shores Lake watershed. Data from the 2002 NASS were reviewed and are presented below to show countywide livestock numbers.

Table 5-21 Madison County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	17,690	15,809	-11%
Beef	5,890	5,931	1%
Dairy	1,774	1,683	-5%
Hogs and Pigs	46,331	29,844	-36%
Poultry	1,517	NA	NA
Sheep and Lambs	1,047	1,013	-3%
Horses and Ponies	NA	1,226	NA

Table 5-22 Macoupin County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	32,393	26,961	-17%
Beef	11,188	8,001	-28%
Dairy	1,502	1,161	-23%
Hogs and Pigs	91,755	68,030	-26%
Poultry	1,061	628	-41%
Sheep and Lambs	2,190	1,461	-33%
Horses and Ponies	NA	640	NA

The Madison County portion of this watershed is predominantly agricultural with small beef and hog operations scattered throughout the area. More detailed information was not available. No site-specific information was available for the St. Clair County portion of the watershed.

5.4.3 Septic Systems

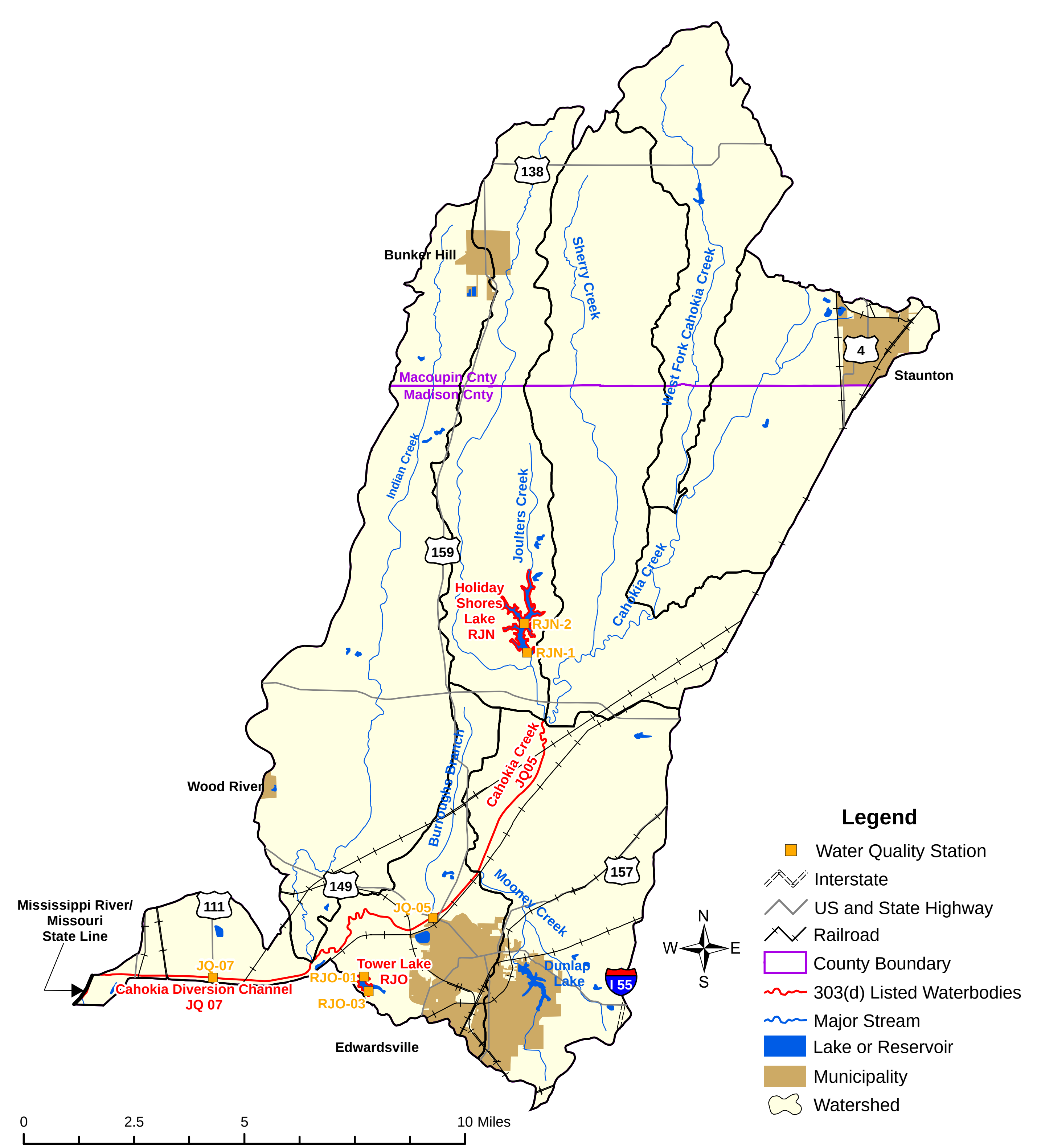
Many households in rural areas of Illinois, which are not connected to municipal sewers, make use of onsite sewage disposal systems, or septic systems. There are a variety of types of septic systems, but the most common septic system is composed of a septic tank draining to a septic field, where nutrient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

Information about the number of septic systems within the Cahokia Creek/Holiday Shores Lake watershed was not available through the Macoupin and Madison County Health Departments. However, from point source data it appears that the majority of the communities within the watershed are served by sewers. The extent of rural septic systems is not known.

5.5 Watershed Studies and Other Watershed Information

Previous planning efforts have been conducted in the Cahokia Creek/Holiday Shores watershed. In the summer of 1998, an intensive survey of the Mississippi South Central Basin was conducted. Data from this study was incorporated throughout this report.

THIS PAGE INTENTIONALLY LEFT BLANK



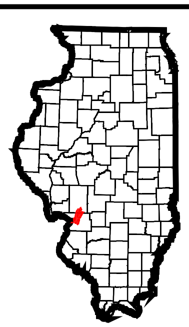
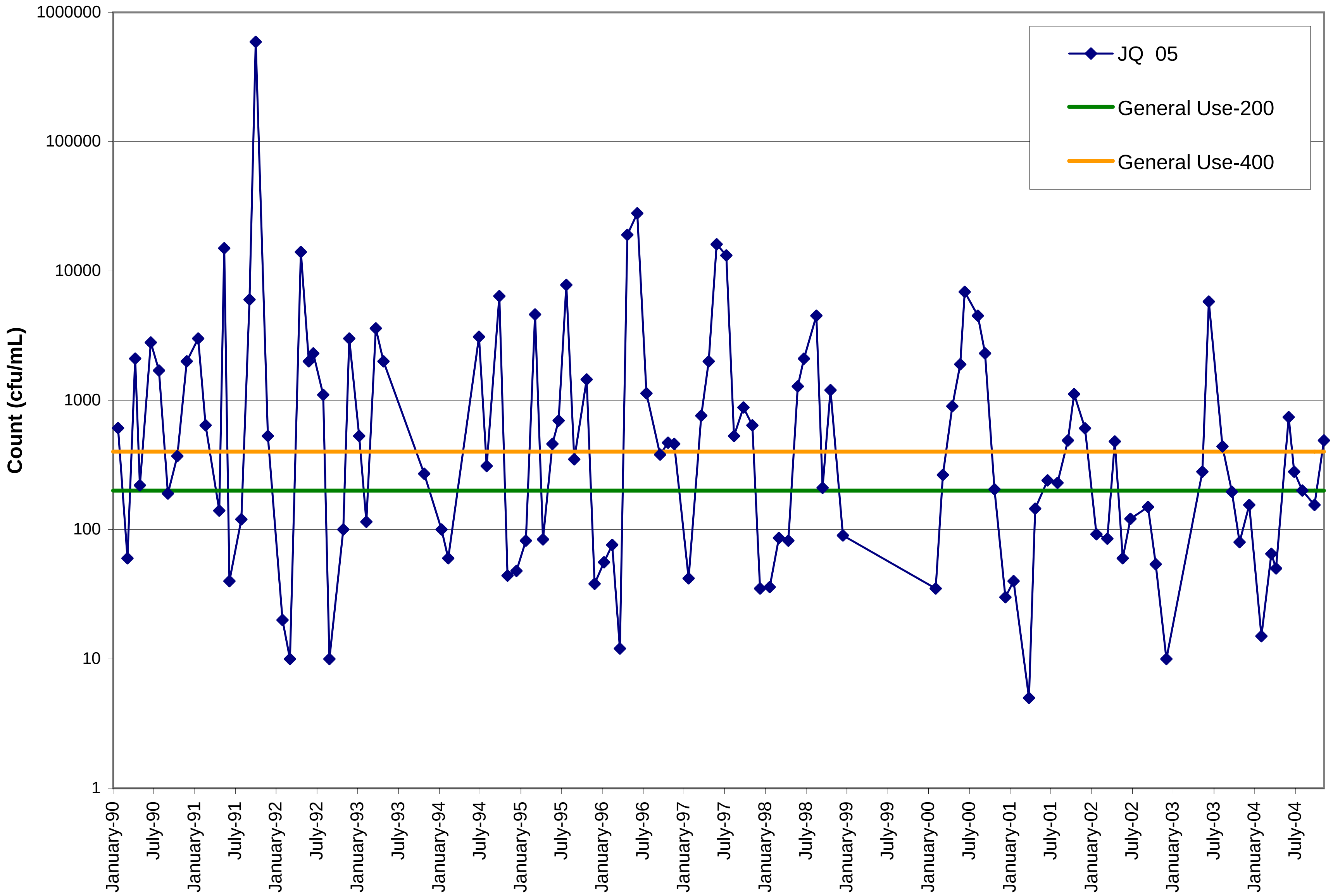


Figure 5-1
Cahokia Creek/Holiday Shores Lake Watershed
Water Quality Stations

THIS PAGE INTENTIONALLY LEFT BLANK

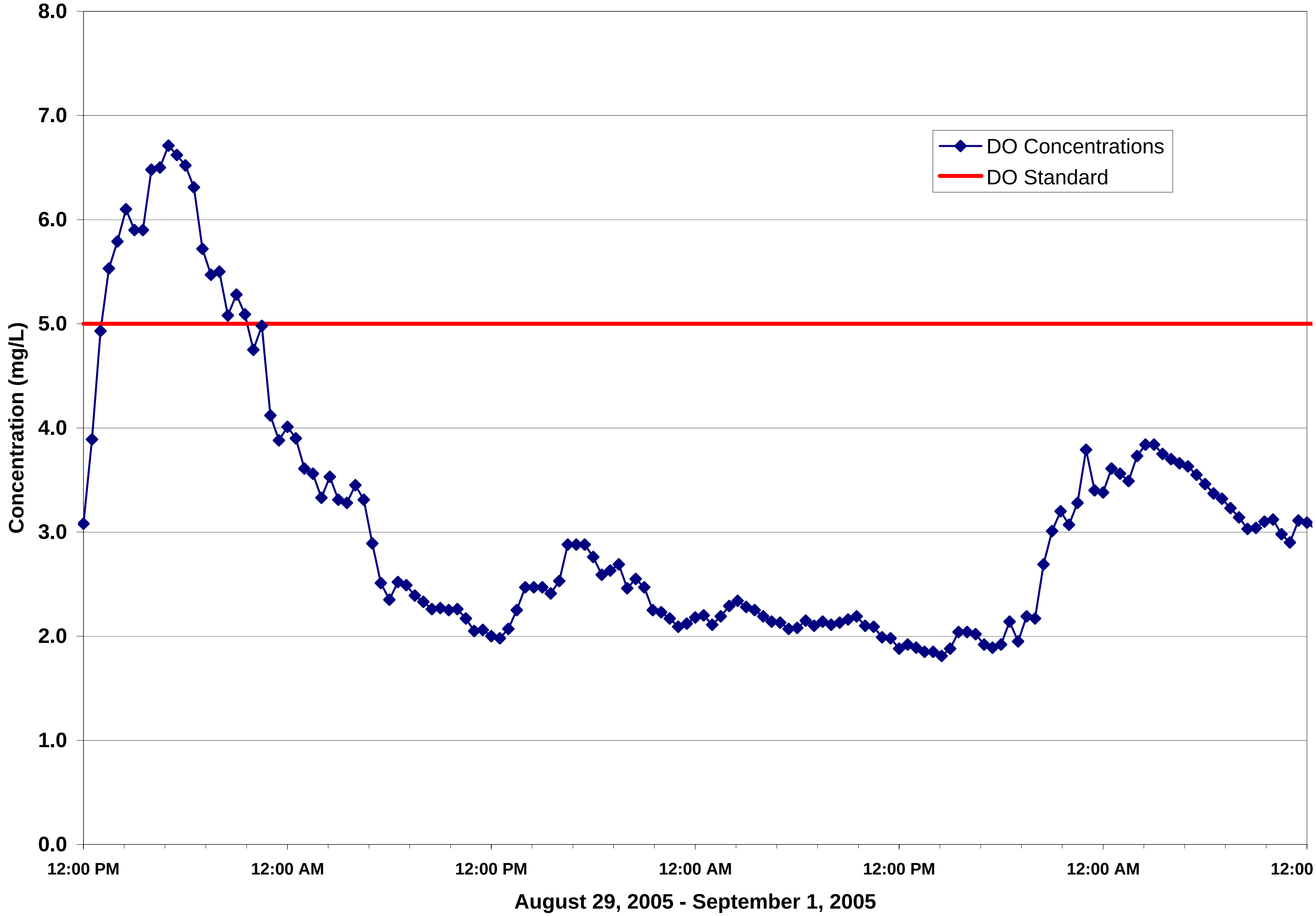


CDM

T:\GIS\14 Cahokia Creek_Holiday Shores Lake\Data\CahokiaCrk Fecal Summary.xlsPLT

Figure 5-2:
Cahokia Creek Segment JQ05
Fecal Coliform Samples

THIS PAGE INTENTIONALLY LEFT BLANK



CDM

V:\Quarterly Report Comments\CahokiaHoliday_Jenny\JQ-07 with calibration.xlsChart1

Figure 5-3:
Cahokia Diversion Ditch JQ07
Continuous DO Concentrations

THIS PAGE INTENTIONALLY LEFT BLANK

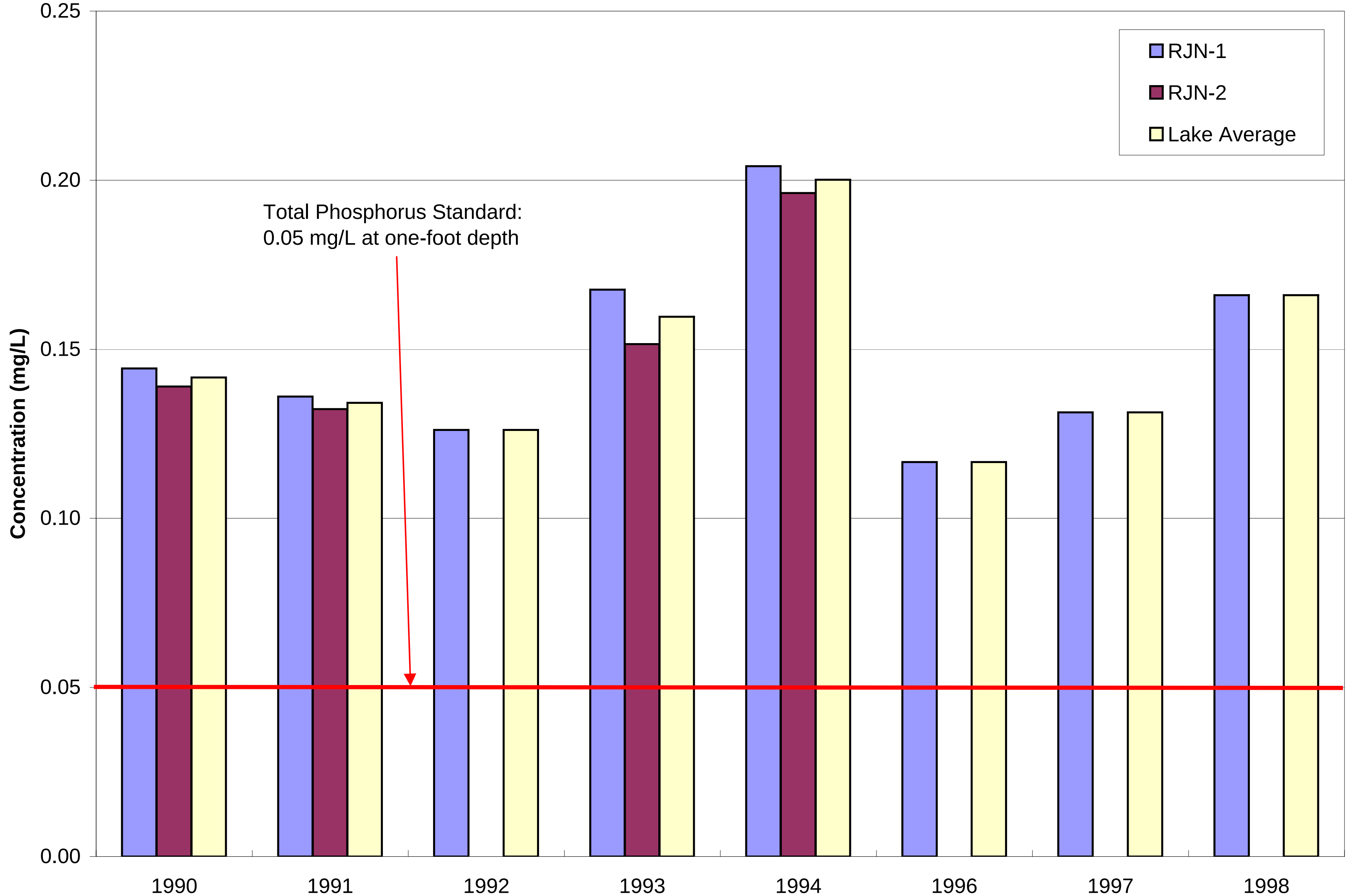


Figure 5-4:
Holiday Shores Lake
Average Annual Total Phosphorus Concentrations
at One-Foot Depth

CDM

V:\14 Cahokia Creek_Holiday Shores Lake\Data\HolidayShoresLk TP Summary.xlsPLT TP Annual

THIS PAGE INTENTIONALLY LEFT BLANK

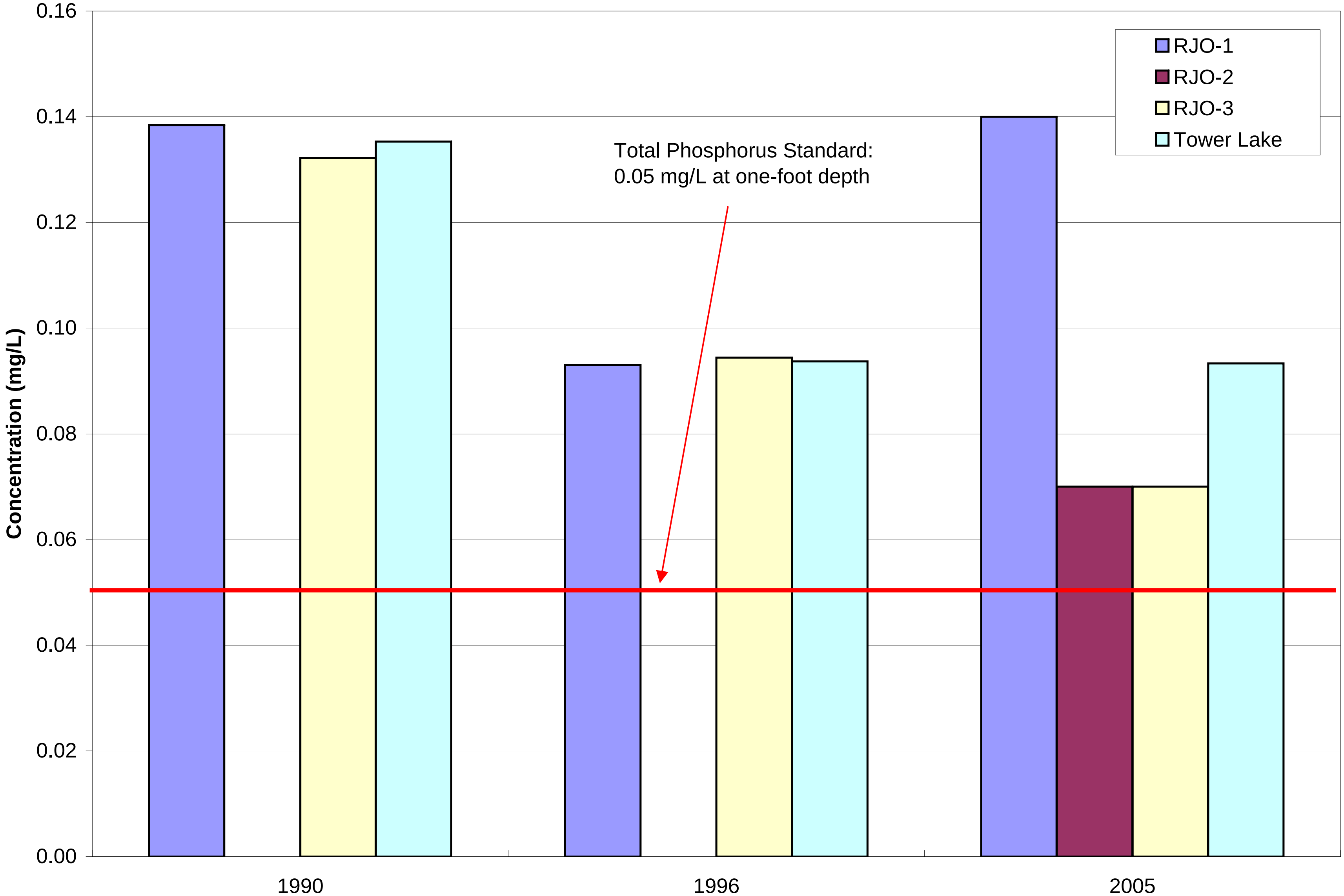
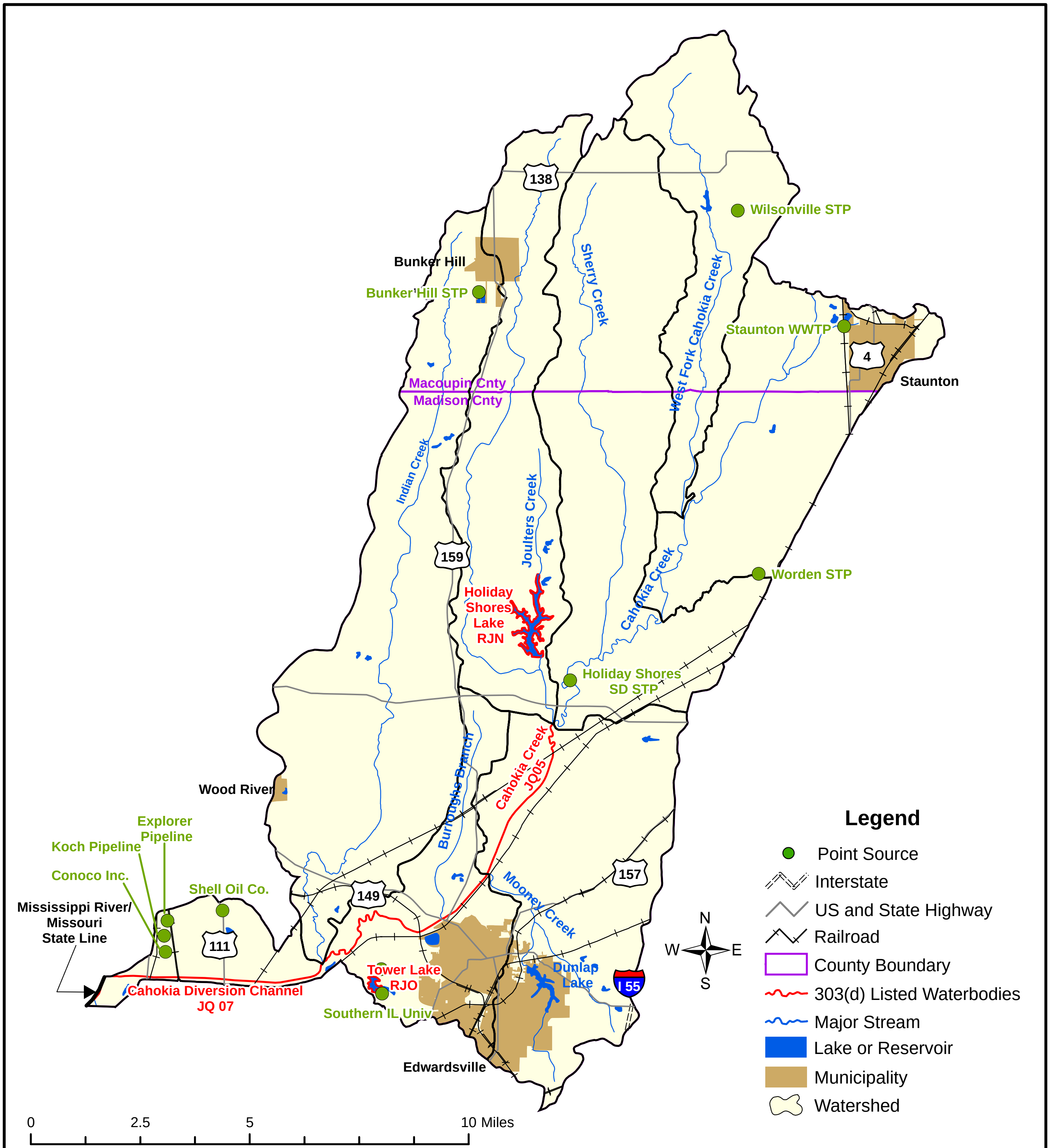


Figure 5-5:
Tower Lake
Average Annual Total Phosphorus Concentrations
at One-Foot Depth

CDM

THIS PAGE INTENTIONALLY LEFT BLANK



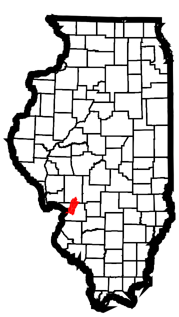


Figure 5-6
Cahokia Creek/Holiday Shores Lake Watershed
NPDES Permits

THIS PAGE INTENTIONALLY LEFT BLANK

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 Cahokia Creek/Holiday Shores Lake watershed, fecal coliform and DO are the only parameters with numeric water quality standards. For lakes in the watershed, total phosphorus and manganese 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. 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 simple approaches 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 Cahokia Creek/Holiday Shores Lake watershed except for stream segments where major point sources exist 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 Cahokia Creek/Holiday Shores Lake watershed.

6.2 Approaches for Developing TMDLs for Stream Segments in the Cahokia Creek/Holiday Shores Watershed

Both impaired segments have point sources discharging upstream of or directly to them. Approaches for developing TMDLs for parameters that could be affected by a major point source as well as TMDLs for other parameters that would not likely be affected by a point source are described below.

6.2.1 Recommended Approach for DO TMDLs for Segments with Major Point Sources

The Cahokia Diversion Channel segment JQ07 has a point source discharging upstream of it as well as directly to it. For this segment a more complicated approach that would also incorporate the impacts of stream plant activity, and possibly sediment oxygen demand (SOD), and would require a more sophisticated numerical model and an adequate level of measured data to aide in model parameterization is recommended.

Available instream water quality data for this impaired stream segment are limited, particularly spatial data. Therefore additional data collection is recommended for this segment. In 2005, continuous DO data was collected on this reach. In addition, it is recommended that another continuous sampling event take place to further support model development. Other specific data requirements include a synoptic (snapshot in time) water quality survey of this reach with careful attention to the location of the point source discharger. This survey should include measurements of flow, hydraulics, DO, temperature, nutrients, and carbonaceous biochemical oxygen demand (CBOD). The collected data will be used to support the model development and parameterization and will lend significant confidence to the TMDL conclusions.

This newly collected data could then be used to support the development and parameterization of a more sophisticated DO model for this stream and therefore, the use of the QUAL2E model (Brown and Barnwell 1985) could be utilized to accomplish the TMDL analysis for the Cahokia Diversion Channel. QUAL2E is well-known and USEPA-supported. It simulates DO dynamics as a function of nitrogenous and CBOD, atmospheric reaeration, SOD, and phytoplankton photosynthesis and respiration. The model also simulates the fate and transport of nutrients and BOD and the presence and abundance of phytoplankton (as chlorophyll-a). Stream hydrodynamics and temperature are important controlling parameters in the model. The model is essentially only suited to steady-state simulations.

In addition to the QUAL2E model, a simple watershed model such as PLOAD, Unit Area Loads or the Watershed Management Model is recommended to estimated BOD and nutrient loads from non-point sources in the watershed. This model will allow for allocation between point and nonpoint source loads and provide an understanding of percentage of loadings from point sources and nonpoint sources in the watershed.

6.2.2 Recommended Approach for Fecal Coliform TMDL

Cahokia Creek segment JQ05 is listed as impaired for total fecal coliform. The recommend approach for developing a TMDL for this segment is use of the load-duration curve method. The load-duration methodology uses the cumulative frequency distribution of streamflow and pollutant concentration data to estimate the allowable loads for a waterbody.

6.3 Approaches for Developing TMDLs for Lake Segments in Cahokia Creek/Holiday Shores Watershed

Recommended TMDL approaches for lakes within the Cahokia Creek/Holiday Shores watershed will not be separated into those lakes with or without major point source discharges. It is assumed that for the lakes in the watershed, enough data exists to develop a simple model for use in TMDL development.

6.3.1 Recommended Approach for Total Phosphorus TMDLs

Holiday Shores Lake and Tower Lake are impaired for total phosphorus. The BATHTUB model is recommended for all lake phosphorus assessments in this watershed. 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 watersheds.

6.3.2 Recommended Approach for Manganese TMDLs

Holiday Shores Lake has a manganese impairment. The applicable water quality standard for manganese is 150 µg/L. For this TMDL, manganese will not be analyzed because it is assumed that development of the phosphorus TMDL will control the manganese concentrations. The manganese target is 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 lack of DO 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, 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 for manganese is therefore set as a total phosphorus concentration of 0.050 mg-P/l.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 7
Methodology Development for the Cahokia Creek/Holiday Shores Lake Watershed

7.1 Methodology Overview

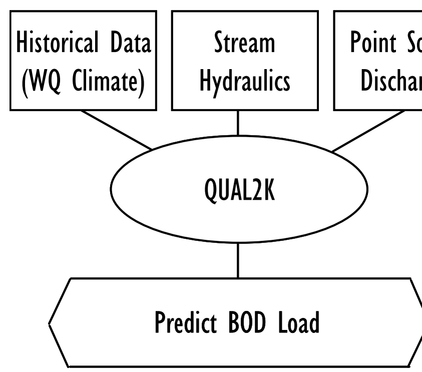
Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Cahokia Creek/Holiday Shores Lake watershed.

Table 7-1 Methodologies Used to Develop TMDLs in the Cahokia Creek/Holiday Shores Lake Watershed

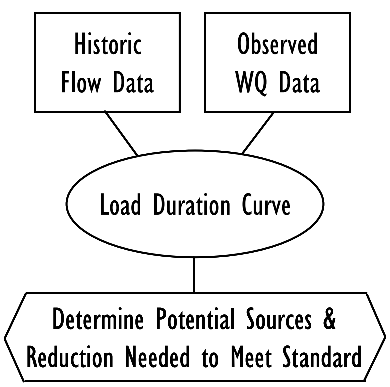
Segment Name/ID	Cause of Impairment	Methodology
Cahokia Diversion Canal/JQ07	Dissolved Oxygen	QUAL2K
Cahokia Creek/JQ05	Fecal Coliform	Load-Duration Curve
Holiday Shores Lake/RJN	Total Phosphorus/Manganese	BATHTUB
Tower Lake/RJO	Total Phosphorus	BATHTUB

7.1.1 QUAL2K Overview

The QUAL2K model was used to develop the DO TMDL for segment JQ07 of the Cahokia Diversion Canal. 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 the external oxygen-demanding load to the system.



Schematic 1



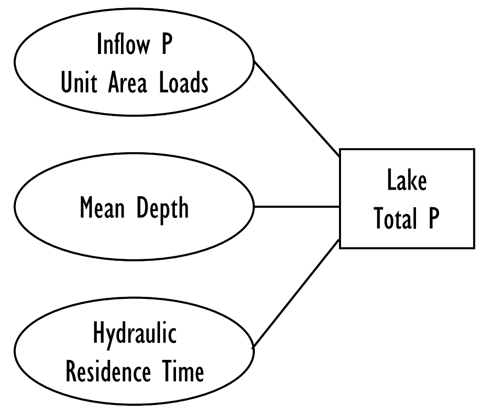
Schematic 2

7.1.2 Load-Duration Curve Overview

A loading capacity analysis was performed for Cahokia Creek (segment JQ05). A load-duration curve is a graphical representation of the maximum load of a pollutant, in this case fecal coliform, that a segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach provides useful information regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often.

7.1.3 BATHTUB Overview

The approach taken for TMDL analysis for Holiday Shores Lake and Tower Lake included using observed data coupled with unit area loads as inputs to the BATHTUB model. This method required inputs from several sources including online databases and GIS-compatible data.



Schematic 3

Schematic 3 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 both lakes from the surrounding watersheds were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). This method is based on the assumption that, on an annual basis and normalized to area, a roughly constant runoff pollutant loading can be expected for a given landuse type. This method also requires that unit area loads are not applied to watersheds that differ greatly in climate, hydrology, soils, or ecology from those from which the parameters were derived (USGS 1997).

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 3).

7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine DO, fecal coliform and total phosphorus levels in the impaired waterbodies in the Cahokia Creek/Holiday Shores Lake watershed.

7.2.1 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.

7.2.1.1 QUAL2K Inputs

Table 7-2 contains the categories of data required for the Q2K model along with the sources of data used to analyze segment JQ07 of the Cahokia Diversion Canal.

Table 7-2 Q2K Data Inputs

Input Category	Data Source
Stream Segmentation	GIS data
Hydraulic characteristics	CDM field survey and GIS analysis
Headwater conditions	Historic water quality data collected at JQ05
Meteorologic conditions	National Climatic Data Center
Point Source contributions	Illinois EPA

Empirical data amassed during Stage 1 of TMDL development (Sections 1 through 6) were used to build the Q2K model for the Cahokia Diversion Canal. In addition to the Stage 1 data, Stage 2 observations and GIS analysis were used for the Q2K model.

7.2.1.1.1 Stream Segmentation

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Figure 7-1 shows the stream segmentation used for the Q2K model.

For this model, the Cahokia Diversion Canal was broken into three reaches. Each reach was represented by data collected at the water quality site located in the specific reach. The headwaters reach is represented by data collected at site JQ05. The second reach extends from the end of the headwaters reach and is represented by data collected at site JQ07 while the final reach extends from the end of reach two to the Mississippi River. Data collected at site JQ01 were used to represent conditions on the last reach.

7.2.1.1.2 Hydraulic Characteristics

Stream hydraulics were specified in the model based on USGS data for gaging location 05587900 (Cahokia Creek at Edwardsville, Illinois), aerial photographs of the segment and site observations noted during Stage 2 data collection. Gage height and stream width were used for hydraulic data for the headwaters segment. Specific cross-section information was not available for the other reaches because each reach was not wadeable during Stage 2 site visits. Visual and aerial photograph characterization, however, were used to guide model hydraulic inputs for this downstream area. Appendix F contains the Stage 2 data report which includes photographs of sampling sites JQ07 and JQ01 from the Stage 2 field survey.

7.2.1.1.3 Headwater Conditions

The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were available from sampling location JQ05 (Cahokia Canal segment JQ05), which is located just upstream of the impaired segment of the Cahokia Diversion Canal. There have been

44 DO samples collected at station JQ05 since 1999. Of the 44 samples collected, seven resulted in DO concentrations less than 5 mg/L. The majority of violating samples were collected between the months of July through October. These months are associated with low flows in the stream. Because of this, only water quality data collected in the months of July, August, September, and October were used for this model.

Flows for the headwater condition were determined using historic data from USGS site 05587900 (Cahokia Creek at Edwardsville, Illinois). The average historic flows from July through October were used for headwater flow conditions. Data were available from 1969 through 2007.

7.2.1.1.4 Climate

Q2K requires inputs for climate. Hourly temperature and wind speed data from Lambert International Airport in St. Louis, Missouri were used for the model.

7.2.1.1.5 Point Sources

A number of point sources discharge within the Cahokia Creek/Holiday Shores Lake watershed, however, the majority of the point sources are located significantly upstream of the Cahokia Diversion Canal. Three point sources (the Explorer Pipeline - Wood River, Conoco Inc. – Wood River, and the Village of Roxana Sanitary Treatment Plant [STP]) discharge to the furthest downstream reach of the segment (see Figure 7-1). 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 input. Table 7-3 contains information for each facility. Flow information was available for each discharger; however, effluent concentration data are available only for parameters that are sampled per permit requirements.

Table 7-3 Point Source Discharges within the Cahokia Diversion Canal Watershed

Facility Name	Permit Number	Segment Number	Permitted Facility Flows (mgd)	Permitted DO (mg/L)	Permitted CBOD (mg/L)	Permitted Ammonia (mg/L)
Explorer Pipeline – Wood River	IL0061522	3	0.14	>6	10	-
Conoco Inc – Wood River	IL0071803	3	0.006	-	-	-
Wheel Ranch MHP	IL0044598	3	0.65	>6	10	6.9

7.2.1.2 QUAL2K Calibration

The QUAL2K model for the Cahokia Diversion Canal was set up and run as discussed in the preceding sections. Data collected during Stage 2 at sample locations JQ07 and JQ01 were used for model calibration. Initially, "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. SOD rates and CBOD decay rates were then adjusted until the predicted DO concentrations closely matched the observed data at both sites. Figure 7-2 shows the calibration outcome. Appendix F contains the model worksheets.

7.2.2 Load Duration Curve Development

Load duration curves are used to gain understanding of the range of loads allowable throughout the flow regime of a stream. This approach was used to characterize the current loading of fecal coliform in segment JQ05 of Cahokia Creek.

7.2.2.1 Flow Data

As discussed in the Stage 1 report, flow data were available for Cahokia Creek. USGS gage 05587900 (Cahokia Creek at Edwardsville, Illinois) is located on segment JQ05. The average monthly flows recorded at the gage range from 31 cfs in August to 310 cfs in April with a mean flow rate of 152 cfs. Historic data were downloaded from the USGS and used for the load duration analysis.

7.2.2.2 Fecal Coliform Analysis for Cahokia Creek Segment JQ05

A flow duration curve for segment JQ05 of Cahokia Creek was generated by ranking the recorded daily flow data, determining the percent of days these flows were exceeded, and then graphically plotting the results. Because the fecal coliform standard is seasonal and is only applicable between the months of May and October, only flows during this time period were used in the analysis. The flows during this duration were then multiplied by the geometric mean water quality standard of 200 cfu/100mL to generate a load duration curve. Fecal coliform data collected between May and October were compiled from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development were paired with the corresponding flow for the sampling date and plotted against the load duration curve. Figure 7-3 shows the load duration curve as a solid line and the observed pollutant load as points on the graph. Appendix G contains the spreadsheet used for this analysis.

The load duration curve shows that 13 of the 59 samples collected between May 1990 and October 2004 were below the allowable load curve. The load duration analysis shows that the standard of 200 cfu/100 mL is regularly exceeded during all flow scenarios. Exceedences during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff from precipitation and the re-suspension of fecal material in the ditch sediment. Dry weather sources of fecal coliform likely include failing septic systems, point source effluent and livestock with direct access to the ditch or its tributaries.

7.2.3 BATHTUB Development for Holiday Shores Lake

Holiday Shores Lake was listed on the 2004 303(d) for impairment caused by total phosphorus and manganese. For this TMDL, manganese will not be analyzed because it is assumed that development of the phosphorus TMDL will control the manganese concentrations. The manganese target is 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 lack of DO 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, 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 for manganese is therefore set as a total phosphorus concentration of 0.05 mg-P/L. The BATHUB model was used to determine the total phosphorus TMDL.

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.

7.2.3.1 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 40.08 inches, and the average annual evaporation input to the model was 35.3 inches. 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/km2-yr (USACE 1999b).

7.2.3.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Holiday Shores Lake 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 averaged data from the water quality stations discussed in the Stage 1 report. These data are shown below (Table 7-4) for reference. 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 7-4 Average Depths (ft) for Holiday Shores Lake Segment RJN (Illinois EPA 2002 and USEPA 2002a)

Year	RJN-1	RJN-2	RJN-3
1990	26.5	19.2	10.29
1991	28.3	19.8	11.22
1992	28.3	20.5	11.29
1993	28.9	20.2	11.27
1994	28.1	18.8	9.79
1995	28.5	18.6	9.67
1996	27.5	18.8	10.5
1997	27.5	18.9	10.09
1998	27.8	19	9.63
Average	27.9	19.3	10.43

7.2.3.3 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 six tributaries for purposes of the model. There are three tributary streams that flow into the Holiday Shores Lake and three areas of direct overland flow (one for each lake segment). Joulters Creek and an unnamed tributary northwest of the lake flow into segment RJN-3, while another unnamed tributary, also to the northwest, flows into segment RJN-2. In addition, the Holiday Shores Sanitary District pumps an average of 188,000 gallons per day from the middle lake segment (Illinois EPA, SWAP Fact Sheet, 2003).

As discussed in the Stage 1 report, there is only one USGS gage within the watershed. USGS gage 05587900 (Cahokia Creek at Edwardsville, Illinois) is located on segment JQ05 of Cahokia Creek. The average monthly flows recorded at the gage range from 31 cfs in August to 310 cfs in April with a mean flow rate of 152 cfs. Because no data specific to the Holiday Shores Lake were available, the drainage area ratio method, represented by the following equation, was used to estimate flows.

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

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 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 05587900 (Cahokia Creek at Edwardsville, Illinois) was chosen as an appropriate gage from which to estimate flows into Holiday Shores Lake. The gage drains an area of 141 square miles. The Holiday Shores Lake watershed encompasses five square miles.

The total mean flow into Holiday Shores Lake was determined to be 5.92 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 7-5.

The normal storage volume for Holiday Shores Lake of 4,605 acre-feet was obtained from the USACE National Dam Inventory data for the Holiday Shores Lake Dam. Based on this storage volume and the inflow of 5.92 cfs, the lake residence time is approximately 392 days.

Table 7-5 Holiday Shores Lake Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (ac)	Flow Rate (cfs)
Direct Flow to RJN-1	Segment 1: RJN-3	350.3	0.57
Direct Flow to RJN-2	Segment 2: RJN-2	652.4	1.07
Direct Flow to RJN-3	Segment 3: RJN-1	225.0	0.37
Joulters Creek	Segment 1: RJN-3	1637.2	2.69
Unnamed Trib -Northwest 1	Segment 3: RJN-1	379.9	0.62
Unnamed Trib - Northwest 2	Segment 2: RJN-2	362.7	0.59
	TOTAL	3607.6	5.92

Phosphorus loadings to Holiday Shores Lake from the surrounding watershed were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). For the load estimates performed for this watershed, median unit area loads were assumed by landuse from the high end of reported median ranges in the literature (USEPA 2001). Empirical data showing a full range of unit area loads were used from a small rural watershed with similar landuse and regional characteristics. All BATHTUB model files including unit area calculations for the Holiday Shores Lake watershed are provided in Appendix H.

The total watershed phosphorus loading was calculated as ranging from 2,238 to 2,660 lbs/yr, with a median of 2,449 lbs/yr or 6.7 lbs/day.

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.

Tile drainage may be present within the Holiday Shores Lake watershed. Few studies have attempted to quantify the impacts of tile drainage on watershed loadings. It can be surmised that tile drains are likely to alter both the timing and magnitude of runoff pollutant loads, particularly of dissolved phase. However, this type of analysis is beyond the scope of this study. Therefore, the unit area loads described above were not altered to account for tile drain impacts. Future studies in this watershed may desire to look more closely at this issue.

7.2.3.4 BATHTUB Confirmatory Analysis

Available lake historical water quality data are summarized in Section 5. 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 Holiday Shores Lake BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. The lake concentrations are lower than the incoming tributary concentrations indicating that the lake is a net sink of total phosphorus. Therefore, in order to achieve a calibration, the model "sedimentation" rates (nutrient removal rates) were decreased, rather than adjusting internal loads.

The model was simulated using the median phosphorus loads calculated with the unit area load method. These initial results showed that the predicted lake concentrations were consistently lower than observed lake concentrations. Therefore, the default phosphorus decay coefficient was lowered to increase predicted total phosphorus concentration. The reduction in phosphorus decay rate brought predicted phosphorus levels in line with the observed concentrations. As can be seen, an excellent match was achieved, lending significant support to the predictive ability of this simple model.

Table 7-6 Summary of Model Confirmatory Analysis- Lake Total Phosphorus (mg/L)

Lake Site	*Observed*	*Predicted*
Segment 1 : RJN -3	0.193	0.195
Segment 2 : RJN 2	0.155	0.158
Segment 3 : RJN-1	0.149	0.144
Lake Average	0.159	0.159

7.2.4 BATHTUB Development for Tower Lake

The BATHTUB model for Tower Lake 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 40.08 inches, and the average annual evaporation input to the model was 35.3 inches. 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. Tower 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 the averaged data from the water quality stations discussed in the Stage 1 report. Segment lengths and surface areas were determined in GIS. A single layer model was utilized for the analyses performed here. These data are shown below (Table 7-7) for reference.

Table 7-7 Tower Lake Segment Data

Segment	Surface Area (km2)	Segment Length (m)	Average Depth (ft)
RJO-1	0.134	447	36.25
RJO-2	0.085	720	22.07
RJO-3	0.072	512	19.62

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 7-5 for subbasin boundaries. The watershed was broken up into 4 tributaries for purposes of the model. In addition to the four tributary areas, there are three point sources that discharge into the Tower Lake. These include the Southern Illinois University at Edwardsville (SIUE) STP, SIUE cooling water facility, and the SIUE pool.

The area ratio method, as discussed in Section 7.2.3.3, was used to estimate flows in the Tower Lake watershed. The total mean flow into Tower Lake was determined to be 0.83 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 7-8. In addition, permitted discharge rates were used for point source flows. The cooling water facility was not included in the model because it draws water from the lake and discharges water to the lake at the same rate with no addition of nutrients.

Table 7-8 Tower Lake Tributary Sub basin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (ac)	Percent of Total	Flow Rate (cfs)
Direct Flow 1	RJO-1	143.80	28.5	0.23
Direct Flow 2	RJO-2	108.28	21.5	0.18
Direct Flow 3	RJO-3	63.73	12.5	0.10
Unnamed Creek	RJO-2	188.39	37.5	0.31
	TOTAL	504.2		0.82
Point Source Discharges				**(mgd)**
Southern Illinois Univ –Treatment Plant	RJO-1			0.6
Southern Illinois Univ - Pool	RJO-3			0.045
	TOTAL			0.65

Phosphorus loadings to Tower Lake from the surrounding watershed were estimated using the unit area load method, also known as the "export coefficient" method (USEPA 2001). For the load estimates performed for this watershed, median unit area loads were assumed by landuse from the high end of reported median ranges in the literature (USEPA 2001). Empirical data showing a full range of unit area loads were used from a small rural watershed with similar land use and regional characteristics. All unit area calculations for the Tower Lake watershed are provided in Appendix I.

The total watershed phosphorus loading was calculated as ranging from 138 to 262 lbs/yr, with a median of 200 lbs/yr or .55 lbs/day.

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.

Phosphorus loads from the point sources were determined from a number of sources. The SIUE treatment plant is the only facility required to sample phosphorus per permit requirements. Historic discharge monitoring report data show that the average concentration of total phosphorus from the facility is 0.38mg/L. The facility is permitted to discharge up to 1.0mg/L, which is significantly higher than the lake standard. The SIUE pool does not have permit limits for total phosphorus. In lieu of data, the pool discharge was modeled with a concentration of 0.05mg/L. As discussed above, the cooling facility uses lake water and redischarges the same water without the addition of nutrients. However, it should be noted that the cooling water reenters the lake at elevated temperatures which can encourage algal growth which also leads to decreased oxygen levels in the lake. Additionally, increased temperatures at the surface can encourage stratification which can also decrease oxygen levels at lower levels of the water column. Decreased oxygen levels in the lake promote favorable conditions for internal loading of nutrients from the lake sediments.

1.2.4.4 BATHTUB Confirmatory Analysis

Available lake historical water quality data are summarized in Section 5. 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 loadings described above were entered into the BATHTUB model and compared with available water quality data for the lake. When using these loadings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, the internal loading rates were increased. Internal loading rates reflect nutrient recycling from bottom sediments. Because the lake is relatively deep, a review of historic dissolved oxygen levels recorded at depths near the lake bottom was performed to see if there was a potential for sediment loading of phosphorus. The data show that during summer months, the lake bottom waters regularly have dissolved oxygen levels near zero, especially at site RJO-1 which is located nearest the dam in the deepest lake segment. This lends confidence to the potential for internal loading. Table 7-9 shows the results of this analysis.

Table 7-9 Summary of Model Confirmatory Analysis: Lake Total Phosphorus (µg/L)

Lake Segment	Observed Concentration	Predicted Concentration	Internal Loading Rate (mg/m^2-day)
RJO 1	119.7	119.4	17.5
RJO 2	108.8	107.3	10.5
RJO 3	113.3	112.0	10.5
Lake average	114.9	114.0	

THIS PAGE INTENTIONALLY LEFT BLANK

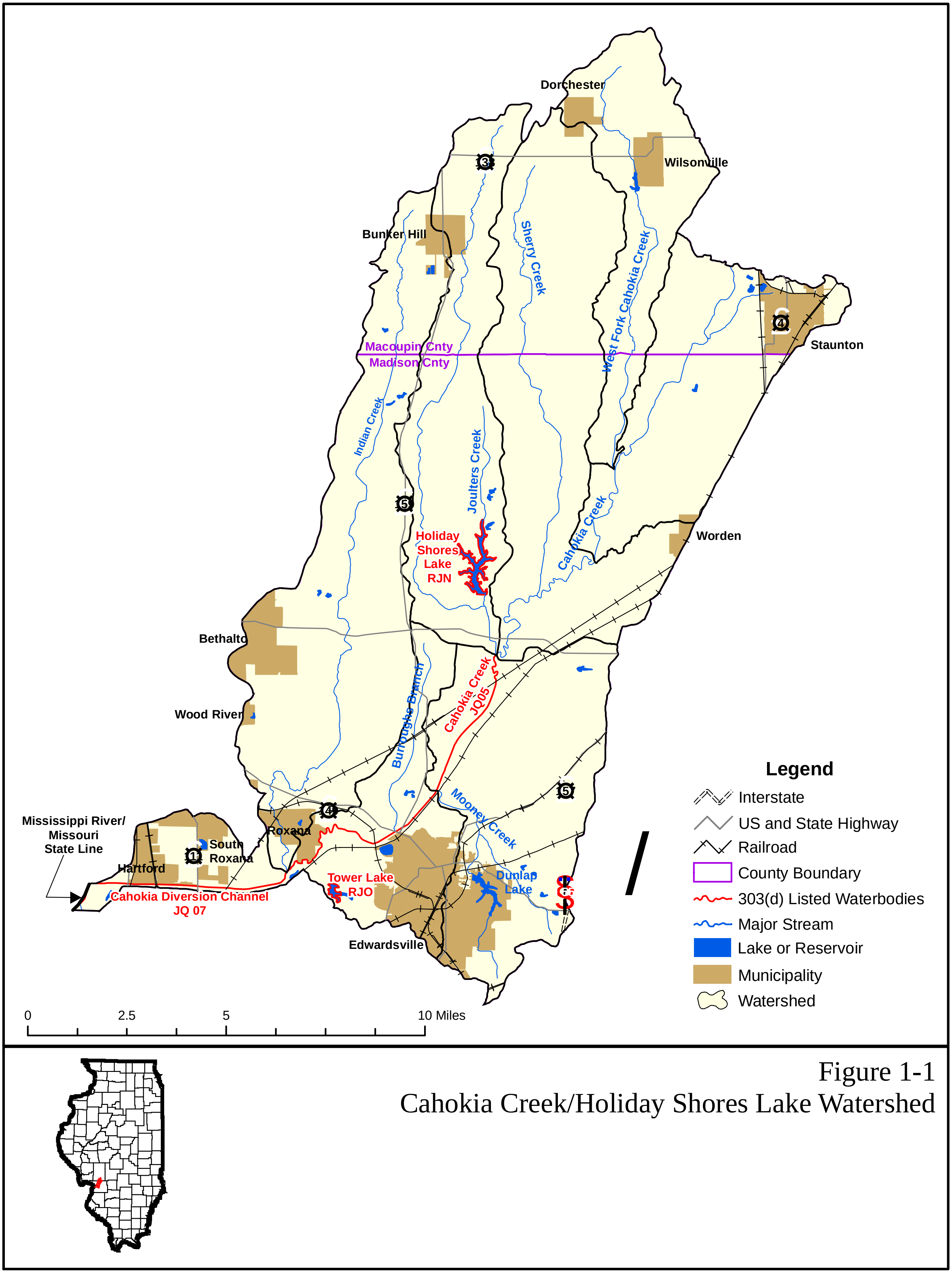
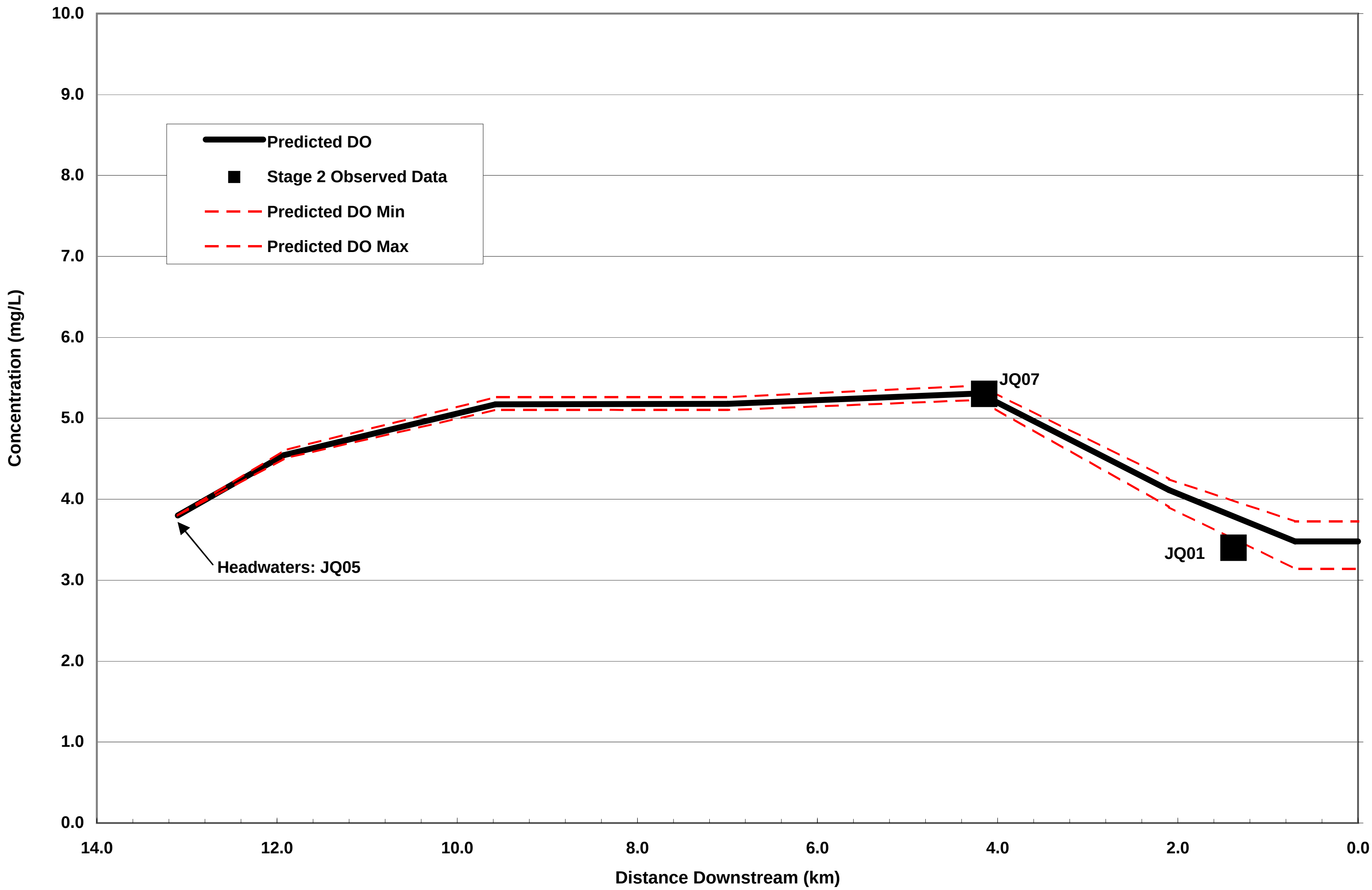


Figure 1-1
Cahokia Creek/Holiday Shores Lake Watershed

THIS PAGE INTENTIONALLY LEFT BLANK

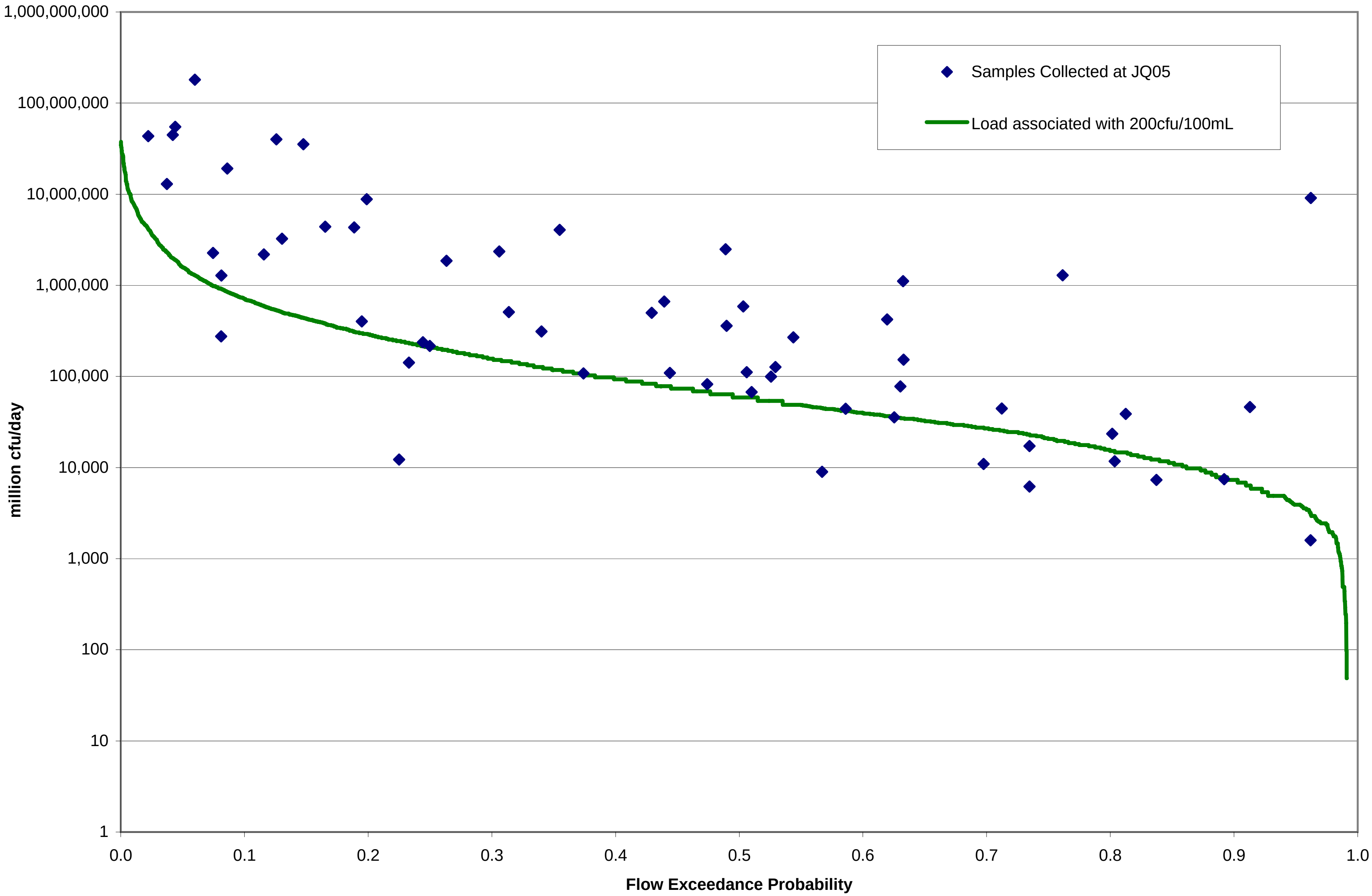


CDM

T:\GIS\Stage3\Cahokia-Holiday\DOfiles\calibration Chart.xlsDissolved Oxygen

Figure 1-2:
QUAL2K Calibration
Cahokia Diversion Canal

THIS PAGE INTENTIONALLY LEFT BLANK

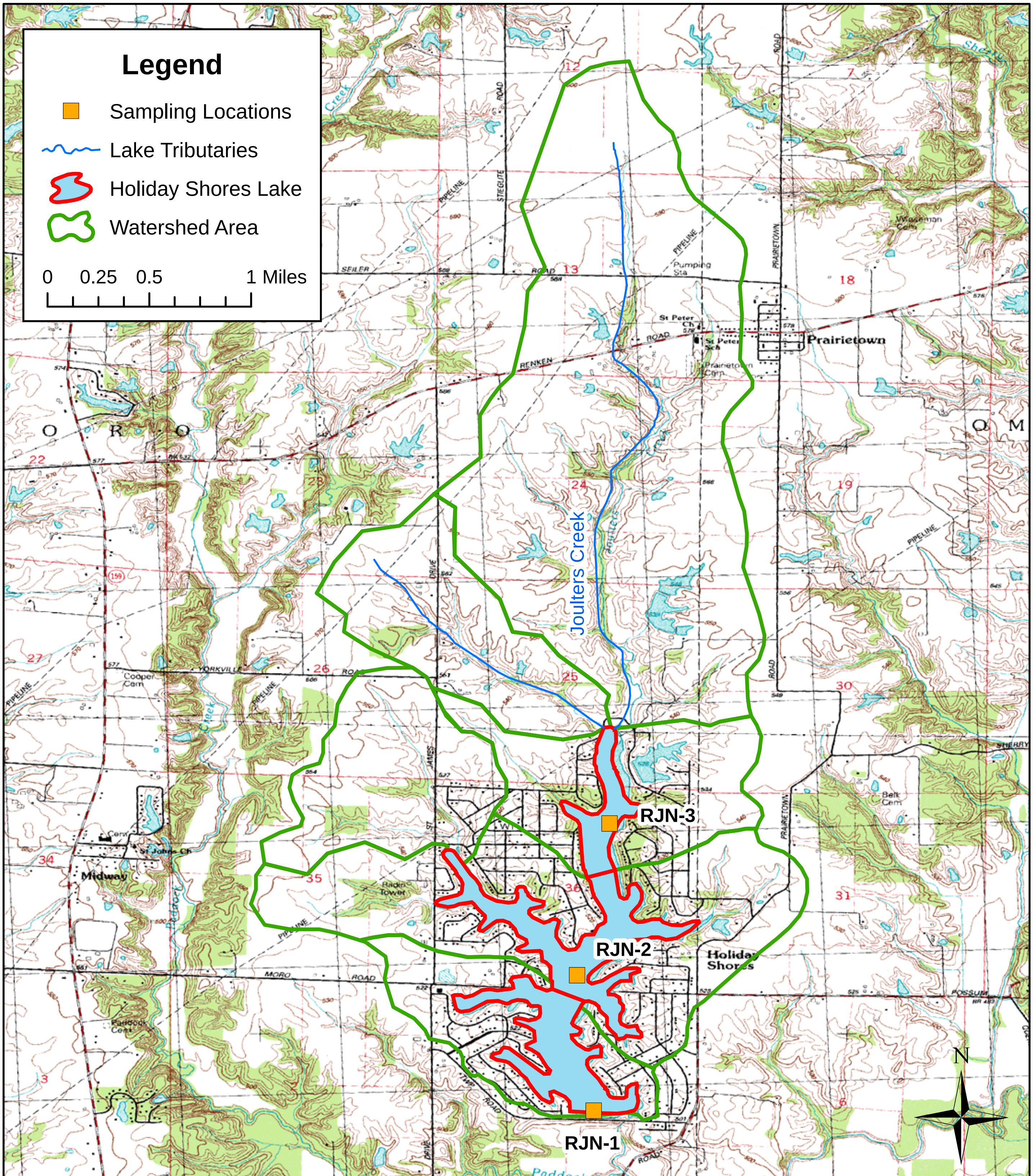


CDM

Figure 1-3:
Fecal Coliform Load Duration Curve
Cahokia Creek Segment JQ05

T:\GIS\Stage3\Cahokia-Holiday\JQ05-load-durationFECAL.xlsLoad Dur Chart

THIS PAGE INTENTIONALLY LEFT BLANK



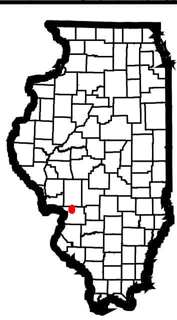
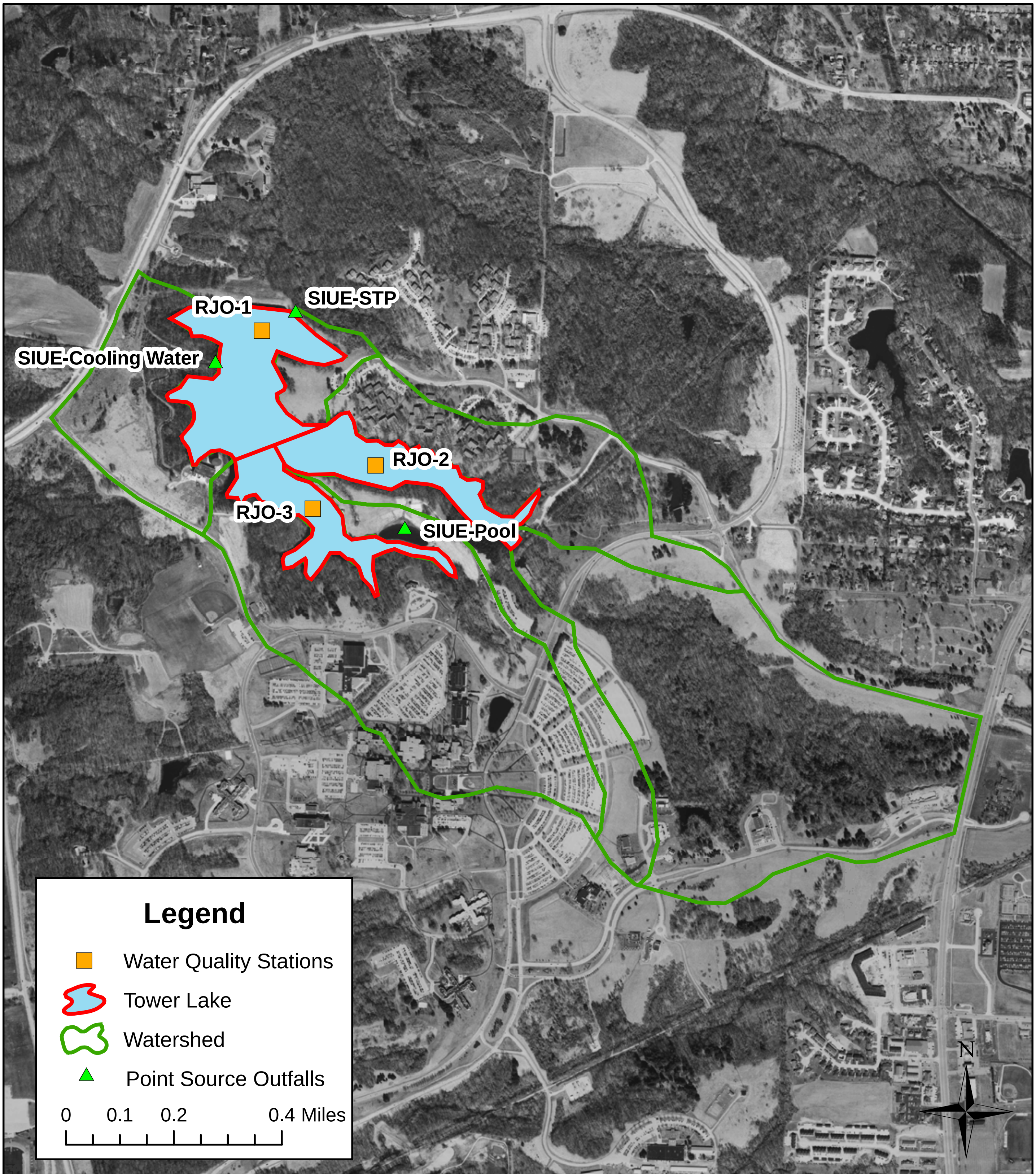


Figure 1-4:
BATHTUB Segmentation
Holiday Shores Lake

THIS PAGE INTENTIONALLY LEFT BLANK



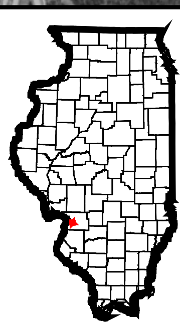


Figure 1-5:
BATHTUB Segmentation
Tower Lake

THIS PAGE INTENTIONALLY LEFT BLANK

Section 8
Total Maximum Daily Loads for the Cahokia Creek/Holiday Shores Lake Watershed

8.1 TMDL Endpoints

The TMDL endpoints for DO, fecal coliform, and total phosphorus for the impaired segments in the Cahokia Creek/Holiday Shores Lake watershed are summarized in Table 8-1. All concentrations must be below the TMDL endpoints except for DO concentrations which need to be above 6.0 mg/L during 16 hours of any 24 hour period and must never go below 5.0 mg/L. The endpoints are based on the protection of aquatic life in the Cahokia Diversion Ditch, Holiday Shores Lake and Tower Lake and the protection of the recreational uses of Cahokia Creek. Further monitoring as outlined in the monitoring plan presented in Section 9 of this report, 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 Constituents in the Cahokia Creek/Holiday Shores Lake Watershed

Impaired Segment	Constituent	TMDL Endpoint	Regulatory Citation 35 Ill Admin Code	Average Observed Value on Impaired Segment
Cahokia Creek JQ05	Fecal Coliform	200 cfu/100 mL during October - May	302.209	388 cfu/mL (geometric mean)
Cahokia Diversion Canal JQ07	DO	6.0 mg/L (16 hours of any 24-hour period), 5.0 mg/L instantaneous minimum	302.206	3.09 mg/L
Holiday Shores Lake RJN	Total Phosphorus	0.05 mg/L	302.205	0.18 mg/L
Tower Lake RJO	Total Phosphorus	0.05 mg/L	302.205	0.11 mg/L

8.2 Pollutant Source and Linkage

Potential pollutant sources for the impaired waterbodies in the Cahokia Creek/Holiday Shores Lake watershed were identified through the existing data review described in Sections 1 through 5 and the TMDL methodologies discussed and presented in Sections 6. The likely source of oxygen depletion in the Cahokia Diversion Canal is low flows. Problems are caused by slow-moving waters and increased water temperatures that promote algal growth. Sources of fecal coliform to Cahokia Creek during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the resuspension of fecal material in the ditch sediment. Dry weather sources of fecal coliform likely include point sources, failing septic systems in the watershed and livestock with direct access to the ditch or its tributaries. Nutrient sources to Holiday Shores Lake are dominated by nonpoint sources while nutrient sources to Tower Lake are likely associated with Southern Illinois University point sources and internal loading.

8.3 Allocation

As explained in Section 1, the TMDLs for the impaired segments in the Cahokia Creek/Holiday Shores Lake watershed will address the following equation:

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

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 Cahokia Diversion Canal DO TMDL

8.3.1.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that the Cahokia Diversion Canal 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 7.2.1.

The Q2K model estimated that current loads of oxygen-demanding materials cause dissolved oxygen violations during periods of low flow. To develop the TMDL for oxygen-demanding materials, non-point source loads from the headwaters and point source loads derived from effluent limits were adjusted iteratively until no violations of the standard were shown. The model showed that even with a full reduction of external loads, the in-stream standard of 5.0 mg/L was not achieved.

Based on model analysis, flow and reaeration would need to be increased during summer months. Because and TMDL can not be developed for reaeration and because stagnant water conditions can be associated with flood control measures in the area, no TMDL will be developed at this time. The Cahokia Diversion Canal is located within the urban levee district and, environmentally and economically, flood control has to be a priority over water quality in the levee district.

Further monitoring and implementation measures to increase aeration in the system are discussed in Section 9.

8.3.2 Cahokia Creek Fecal Coliform TMDL

8.3.2.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Cahokia Creek can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the water quality standard of 200 cfu/100mL were determined with the methodology discussed in Section 7.2.2. The fecal coliform loading capacity according to flow is presented in Table 8-2.

Table 8-2 Fecal Coliform Loading Capacity of Cahokia Creek

Mean Daily Flow (cfs)	Load Capacity (mil col/day)
5	24,468
10	48,937
20	97,874
50	244,685
100	489,370
200	978,739
500	2,446,848
1000	4,893,696

The mean of all the load exceedences recorded on Cahokia Creek was calculated and compared to the average allowable load for all flow conditions. By comparing these values, it was determined that a 96 percent reduction is needed to meet the standard.

8.3.2.2 Seasonal Variation

Consideration of seasonality is inherent in the load duration analysis. Because the load duration analysis used historic flow data available from 1969 through 2007, the analysis represents the full range of expected stream flows. The TMDL has been calculated to meet the standard during all flow conditions. In addition, seasonality is addressed because the TMDL has been calculated to address loading only when the seasonal standard is applicable.

Similarly, critical conditions have been addressed by considering all flow scenarios. The fecal coliform analysis discussed in Section 7 showed that exceedences of the allowable load have occurred during high, average and low flow conditions. Critical loading a fecal coliform likely occurs during high runoff events following heavy precipitation when streamflows would be highest. Again, because the analysis considered all flow scenarios, the critical condition has been incorporated into the TMDL.

8.3.2.3 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 Cahokia Creek TMDL includes both implicit and explicit safety factors. The load duration analysis performed for this TMDL is conservative because the TMDL target (no more than 200 cfu/100 ml at any point in time) is more conservative than the more restrictive portion of the fecal coliform water quality standard (geometric mean of 200 cfu/100 ml for all samples collected May through October). In addition, the load duration curve approach does not factor in the significant die-off of bacteria between the WWTP discharge points and the compliance point at JQ05. However, because the die-off rate of the bacteria is undocumented and unknown in this system, an additional explicit MOS of ten percent was reserved to protect the segment from this uncertainty.

8.3.2.4 Waste Load Allocation

There are four point sources with the potential to contribute discharge within the Cahokia Creek segment JQ 05. The average daily flows from these permitted facilities are listed in Table 8-3. The majority of these discharges are a considerable distance upstream of the impaired segment.

Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. In Illinois, a number of these treatment plants have applied for and received disinfection exemptions which allow a facility to discharge wastewater water without disinfection. All of the treatment facilities are required to comply with the geometric mean fecal coliform water quality standard of 200 cfu/100mL at the closest point downstream where recreational use occurs in the receiving water or where the water flows into a fecal-impaired segment. Because each of these facilities has a disinfection exemption, the WLA was calculated based on the discharge rate and the 200 cfu/100mL standard to apply at the point of compliance (JQ-05). Table 8-3 contains the WLA for each facility. In addition, facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. Facilities directly discharging into a fecal-impaired segment may have their year-round disinfection exemption revoked through future NPDES permitting actions.

Table 8-3 WLA for Point Sources Discharging Upstream of Cahokia Creek Segment JQ 05 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Discharge Rate	Standard (cfu/100 mL)	WLA (million cfu/d)
Holiday Shores SD STP 1998-2005 ILG580193	Cahokia Creek/Cahokia Creek Segment JQ 05	0.25 mgd	200	1893
Staunton WWTP 1992-2005 IL0031232	Ginseng Creek/Cahokia Creek Segment JQ 05	0.91 mgd	200	6891
Wilsonville STP 1998-2005 ILG580172	Cahokia Creek/Cahokia Creek Segment JQ 05	0.09 mgd	200	681
Worden STP 1994-2005 ILG580015	Cahokia Creek/Cahokia Creek Segment JQ 05	0.125 mgd	200	947

8.3.2.5 Load Allocation and TMDL Summary

The load duration analysis described in Section 7.3.2.1 determined that a 96 percent reduction in fecal coliform loading needs to occur in order to meet the TMDL endpoint of and instream concentration of 200 cfu/100mL. The LA was determined by subtracting the explicit MOS and the WLA from the determined LC. Table 8-4 shows a summary of the TMDL for Cahokia Creek.

Table 8-4 TMDL Summary for Fecal Coliform in Cahokia Creek

Estimated Mean Daily Flow (cfs)	LC (mil col/d)	WLA (mil col/d)	LA (mil col/d)	MOS (mil col/d)
5	24,468	10,412	11,610	2,447
10	48,937	10,412	33,631	4,894
20	97,874	10,412	77,675	9,787
50	244,685	10,412	209,805	24,468
100	489,370	10,412	403,021	48,937
200	978,739	10,412	870,454	97,874
500	2,446,848	10,412	2,191,751	244,685
1,000	4,893,696	10,412	4,393,915	489,370

8.3.4 Holiday Shores Lake Total Phosphorus TMDL

8.3.4.1 Pollutant Sources and Linkages

Pollutant sources and their linkages to Holiday Shores Lake were established through the BATHTUB modeling and unit area load techniques described previously (Section 7). Pollutant sources of phosphorus include nonpoint source runoff from various land use categories. The predicted median phosphorus loads from unit area load calculations, broken down by land use, are presented in Table 8-5. The loads presented in Table 8-5 were calculated from total phosphorus export coefficients taken from the literature, as described in Section 7. These median loads were then used to generate a median load from the Holiday Shores Lake watershed, which, in turn, were used to confirm the BATHTUB model and support the analyses described below. The majority of the predicted phosphorus load is from agricultural nonpoint sources (corn and soybeans).

Table 8-5 Calculated Median Total Phosphorus Loads by Source

Land Use Category	Median Phosphorus Loads lb/yr
Barren & Exposed Land	0.2
Corn	767.2
Deep Marsh	5.3
Floodplain Forest	0.9
High Density	56.1
Low/Medium Density	79.8
Other Agriculture	10.5
Other Small Grains & Hay	31.3
Partial Canopy/Savannah Upland	6.4
Rural Grassland	207.2
Seasonally/Temporarily Flood	6.1
Shallow Marsh/Wet Meadow	0.2
Shallow Water	0.2
Soybeans	808.1
Surface Water	10.2
Upland	21.5
Winter Wheat	132.5
Winter Wheat/Soybeans	305.0
TOTAL	2,448.9

The mean of loads were entered into the BATHTUB model to calculate the predicted in-lake total phosphorus concentrations in mg/L. The resulting in-lake concentrations exceed the total phosphorus target of 0.05 mg/L.

8.3.4.2 Loading Capacity

The loading capacity of Holiday Shores Lake is the total mass of phosphorus that can be assimilated by the lake 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 models that were set up and calibrated as discussed in Section 7.2.3. To accomplish this, modeled phosphorus loads 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 Holiday Shores Lake. The allowable phosphorus load was determined to be 1.6 lbs/day. A spreadsheet summary of this analysis is included as Appendix H.

8.3.4.3 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 Holiday Shores Lake TMDL as conditions were modeled on an annual basis using average annual precipitation and average annual flow into the lake. 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., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted to daily loadings 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. The critical condition for the lake is most likely high runoff periods during the agricultural season when nonpoint source phosphorus loading would be highest. By modeling on annual time scale, the periods of highest rainfall and the associated runoff are accounted for in the analysis.

8.3.4.4 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 Horseshoe Lake TMDL is implicit. The analysis completed for Holiday Shores Lake is conservative because of the following:

- Unit area loads are based on conservative assumptions over a broad geographic area and are not site-specific to the Holiday Shores Lake Watershed
- Unit area loads are likely higher than those predicted using a watershed model
- The unit area loads assumed for the percent reduction analysis are at the high end of the literature reported median loads by landuse

- In the absence of site-specific data, an atmospheric loading rate of 30 kg/km^2-yr total phosphorus (USACE 1999b) was assumed in the BATHTUB model

8.3.4.5 Waste Load Allocation

There are no point sources within the Holiday Shores Lake watershed. Therefore, the WLA is set to zero for this TMDL.

8.3.4.6 Load Allocation and TMDL Summary

Table 8-6 shows a summary of the TMDL for Holiday Shores Lake. A 76 percent reduction of total phosphorus loads to the lake would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. Table 8-6 summarizes the TMDL for Holiday Shores Lake.

Table 8-6 TMDL Summary for Total Phosphorus in Holiday Shores Lake

Load Source	Estimated Current Load (lb/day)	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
Internal	0	0	0	0	Implicit	0	0
External	6.7	1.6	0	1.6	implicit	5.1	76

8.3.5 Tower Lake Total Phosphorus TMDL

Pollutant sources and their linkages to Tower Lake were established through the BATHTUB modeling and unit area load techniques described previously (Section 7). Pollutant sources of phosphorus include point sources from SIUE, nonpoint sources for the surrounding watershed and internal loading. The predicted median phosphorus loads from unit area load calculations, broken down by land use, are presented in Table 8-7. The loads presented in Table 8-7 were calculated from total phosphorus export coefficients taken from the literature, as described earlier in this section. These median loads were then used to generate a range of potential loads from the Tower Lake watershed, which, in turn, were used to confirm the BATHTUB model and support the analyses described below. The majority of the predicted phosphorus load is from urban land associated with the university and agricultural nonpoint sources.

Table 8-7 Calculated Median Total Phosphorus Loads by Source

Land Use	Percent of Total Area	Median Load lb/yr
Deep Marsh	0%	0.28
Floodplain Forest	13%	6.69
High Density	13%	100.89
Low/Medium Density	13%	17.90
Partial Canopy/Savannah Upland	13%	6.99
Rural Grassland	0%	0.55
Seasonally/Temporarily Flooded	3%	2.62
Shallow Water	0%	0.10
Soybeans	10%	47.18
Surface Water	1%	1.02
Upland	13%	7.02
Urban Open Space	19%	8.91
TOTAL		**200.15**

The median load was entered into the BATHTUB model along with the point source contributions to calculate an in-lake total phosphorus concentrations in mg/L. The resulting in-lake concentrations exceed the total phosphorus target of 0.05 mg/L. The TMDL explained throughout the remainder of this section will examine how much the loads need to be reduced in order to meet the total phosphorus water quality standard of 0.05 mg/L in Tower Lake.

8.3.5.1 Loading Capacity

The loading capacity of Tower Lake is the total mass of phosphorus that can be assimilated by the lake 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 models that were set up and calibrated as discussed in Section 7.2.4. To accomplish this, modeled phosphorus loads 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 Tower Lake. The modeled existing conditions show that the current load to the lake is 11.3 lbs/day. Of the current load to the lake, 78 percent is from internal loading, 5 percent is from tributary contributions and 17 percent is from point sources. The allowable phosphorus load to meet in-lake standards was determined to be 3.2 lbs/day. This requires an overall total phosphorus load reduction of 71 percent. A spreadsheet summary of this analysis is included as Appendix I.

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 Tower 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., various portions of the precipitation season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted into a daily load 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. Because the majority of loading to Tower Lake is from internal cycling, the critical condition is most likely during times of stratification when internal cycling would be highest. Again, because annual average values were used to develop this model, any times of stratification would be accounted for in the TMDL.

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 Tower Lake TMDL is both implicit and explicit. The analysis completed for Tower Lake is implicitly conservative because of the following:

- The waste load allocated to point sources is much higher than actual loading to account for the high effluent limit for the SIUE STP. The waste load allocated to that facility is based on the limit of 0.5 mg/L total phosphorus at a design average flow of 0.6mgd while the facility actually discharges an average concentration of 0.38 mg/L total phosphorus and at a lower rate.

Because of the lack of information available regarding the addition of heated water from the cooling water facility, an additional explicit MOS of 10% has been included to account for this uncertainty in the analysis.

8.3.5.4 Waste Load Allocation

There are two point sources discharging nutrients within the Tower Lake watershed. The current effluent limit for the SIUE STP is 1 mg/L. With this effluent limit in place, the loading capacity will always be exceeded and the in lake standard is unachievable. For this TMDL, the effluent limit for the facility was decreased to 0.45 mg/L. The facility historically discharges at concentrations less than this limit. The WLA for the pool was determined by multiplying the target total phosphorus concentration of 0.05 mg/L by the permitted flow. Table 8-8 contains the WLA for the pool and treatment plant facilities.

Table 8-8 WLA for Total Phosphorus in Tower Lake

Point Source	Permit Number	Permitted Flow (mgd)	TP target (mg/L)	WLA (lb/day)	Current Average Discharge (lbs/day)	Reduction Needed (percent)
SIUE Treatment Plant	IL0046761	0.6	0.45	2.2	1.9	none
SIUE Pool	IL0075841	0.045	0.05	0.02	NA	NA
TOTAL				2.2		

8.3.5.5 Load Allocation and TMDL Summary

Table 8-9 shows a summary of the TMDL for Tower Lake. An overall reduction of 71% of the current load will need to be achieved in order to meet the water quality standard of 0.05mg/L total phosphorus in Tower Lake.

Table 8-9 TMDL Summary for Total Phosphorus in Tower Lake

Estimated Current Load (lb/day)	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
11.3	3.2	2.2	0.7	0.3	8.1	71%

THIS PAGE INTENTIONALLY LEFT BLANK

Section 9
Implementation Plan for the Cahokia Creek/Holiday Shores Lake Watershed

9.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Cahokia Creek/Holiday Shores Lake 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 Cahokia Diversion Canal

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 8 established a relationship between low flows, oxygen-demanding materials (BOD_5, ammonia-nitrogen and organic nitrogen), and DO concentrations in the Cahokia Diversion Canal segment JQ07, so management measures for segment JQ07 will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

DO impairments in the Cahokia Diversion Canal segment JQ07 are mostly attributed to low flow or stagnant conditions within the canal. 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 segment JQ07 watershed 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

Point sources within the Cahokia Diversion Canal watershed include both stormwater sources and municipal and industrial sources. This section discusses both sources and their potential to contribute oxygen-demanding materials to the impaired segment.

9.2.1.1 Stormwater Sources

Urban land uses are present within the Cahokia Diversion Canal watershed. Within the canal's watershed, the following municipalities have stormwater permits:

- Edwardsville
- Wood River

Illinois MS4 permits require that six minimum controls be implemented to reduce pollutants discharged. The minimum controls are:

- Public Education/Outreach
- Public Participation/Involvement
- Illicit Discharge Detection/Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These six controls should result in stormwater quality that does not affect the loads of oxygen-demanding material to the canal. Future monitoring of stormwater outfalls will help determine the efficiency of the six minimum stormwater controls and will help to gage the contributions of oxygen-demanding materials from urban storm sewers. The permitting section of Illinois EPA has the authority to review stormwater permits.

9.2.1.2 Municipal/Industrial Sources

A number of small STPs discharge oxygen-demanding materials within the Cahokia Creek/Holiday Shores watershed. All of these facilities are located a significant distance upstream of the impaired segment on segments that are not listed for DO issues. However, there are three point sources that discharge directly to or to a close tributary of the Cahokia Diversion Canal (see Figure 7-1). Table 9-1 contains permit information on each of these facilities.

Table 9-1: Point Source Discharges to Cahokia Diversion Canal Segment JQ07

Facility Name	Permit Number	Permitted Flow (mgd)	Permit Expiration
Conoco Inc.- Woodriver	IL0071803	0.0057	12/31/2007
Explorer Pipeline - Wood River	IL0061522	0.138	8/31/2007
Village of Roxanna STP	IL0077356	0.65	6/30/2013

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. Each facility is located at the downstream end of the segment and does not contribute significant flow to the system. The facilities are not believed to be a significant source of oxygen-demanding materials to the Cahokia Diversion Canal. Only the Village of Roxanna STP permit has limits for DO, BOD_5 and ammonia-nitrogen. The facility is required to discharge effluent with DO concentrations higher than 6.0 mg/L, ammonia concentrations between 2.1 and 2.8 mg/L (during low flow months), and BOD_5 concentrations of 10 mg/L. These permit limits are thought to be adequately protective of aquatic life uses within the canal. Because the other two discharges are from petroleum related facilities (Conoco and Explorer Pipeline) with relatively low discharge flows, they are not expected to contribute significant oxygen-demanding materials to the canal.

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 or potential nonpoint sources. The potential sources of nonpoint pollution to the Cahokia Diversion Canal include overfertilization (associated with both agricultural and urban landuses), streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Filter strips
- Reaeration/Erosion Control/Streambank Stabilization

Organic and nutrient loads originating from cropland can be treated with a combination of riparian buffer or grass filter strips. Streambank stabilization and erosion control can limit the oxygen-demanding material entering the stream. Instream management measures for DO focus on reaeration techniques. The Q2K model used to develop the TMDL utilizes reaeration coefficients. Increasing the reaeration coefficient by physical means will increase DO in the Cahokia Diversion Canal.

9.2.2.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads, including nutrients and sediment, to the Cahokia Diversion Canal. 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 Cahokia Creek/Holiday Shores watershed. Finally, design criteria and size selection of filter strips are detailed.

Organic debris in topsoil contributes to the BOD_5 load to water bodies (USEPA 1997). Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of BOD_5 and nutrient load associated with sediment loads to the Cahokia Diversion Canal. 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 Cahokia Diversion Canal.

Filter strips will help control BOD_5 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 BOD_5 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 Cahokia Diversion Canal 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 9-2 outlines the guidance for filter strip flow length by slope (NRCS 1999).

Table 9-2 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 5 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 Hickory Loams ranging from silts to clays on ten to 60 percent slopes. Based on these slope values, filter strip widths of 117 to 234 feet could be incorporated into agricultural lands adjacent to the canal and its tributaries. Mapping software was then used to buffer stream segments to determine the total area found within 234 feet of tributaries in the watershed. There are approximately 12,928 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 2,985 acres of agricultural land surrounding tributaries of the Cahokia Diversion Canal where filter strips and riparian buffers could potentially be installed (see Figure 9-1). Landowners should evaluate their land near the Cahokia Diversion Canal and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 9-2. Programs available to fund the construction of these buffer strips are discussed in Section 9.5.

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.

9.3 Implementation Actions and Management Measures for Fecal Coliform in Cahokia Creek

The TMDL analysis performed for fecal coliform in Cahokia Creek showed that the majority of the samples collected have exceeded the standard and that all samples collected during higher flow conditions have exceeded the standard. This indicates that potential sources are likely stormwater runoff and resuspension of instream fecal material. In addition, violations of the standard have also been recorded during lower flow scenarios. Sources of fecal coliform during low flows can potentially be attributed to point source flow and livestock with access to streams.

9.3.1 Point Sources of Fecal Coliform

9.3.1.1 Stormwater Sources

Upstream areas in the Cahokia Creek watershed are mostly rural, however the City of Edwardsville, in the southeast portion of the watershed, does have a municipal separate storm sewer, or MS4, permit for the discharge of stormwater.

Illinois MS4 permits require that six minimum controls be implemented to reduce pollutants discharged. The minimum controls are:

- Public Education/Outreach
- Public Participation/Involvement
- Illicit Discharge Detection/Elimination
- Construction Site Runoff Control
- Post Construction Runoff Control
- Pollution Prevention/Good Housekeeping

These six controls should result in stormwater quality that does not affect the loads of fecal coliform to the canal. Again, it is recommended that a storm sewer survey be performed to determine the amount of fecal coliform being contributed to the creek via urban stormwater sources. The permitting section of Illinois EPA has the ability to review stormwater permits.

9.3.1.2 Municipal Wastewater Sources

There are four municipal treatment plant point sources of fecal coliform to Cahokia Creek. Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. As discussed in Section 8.3.2.4, each of these facilities have disinfection exemptions meaning that they do not have to disinfect as long as the instream fecal coliform standard is being met at the downstream end of the disinfection exempt segment. However, facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. Because each facility has a disinfection exemption, the actual load of fecal coliform originating at each facility is unknown. None of the facilities are discharging directly to the impaired segment. The Holiday Shores STP is located the closest to the impaired segment of the creek. Table 9-3 contains permit information for each facility.

Table 9-3 Point Sources Discharging Upstream of Cahokia Creek Segment JQ 05 (Illinois EPA 2005)

Facility Name Period of Record Permit Number	Permit Number	Average Discharge Value	Permit Expiration
Holiday Shores SD STP	ILG580193	0.25 mgd	12/31/2007
Staunton WWTP	IL0031232	0.91 mgd	3/31/2007
Wilsonville STP	ILG580172	0.09 mgd	12/31/2007
Worden STP	ILG580015	0.125 mgd	12/31/2007

9.3.2 Nonpoint Sources of Fecal Coliform

Several management options have been identified to help reduce fecal coliform counts in Cahokia Creek. These management options focus on potential sources of fecal coliform within the basin, such as agricultural runoff, septic systems, and livestock. The alternatives that were identified are:

- Filter Strips
- Private Septic System Inspection and Maintenance Program
- Restrict Livestock Access to Cahokia Creek and Tributaries

Each alternative is discussed briefly in this section.

9.3.2.1 Filter Strips

Filter strips were discussed in Section 9.2.2.1. The same technique for evaluating available land was applied to the Cahokia Creek watershed. There are 8,309 acres of land within 234 feet of Cahokia Creek, of this area, 2,985 acres are categorized as agricultural and could potentially be converted into filter strips (see Figure 9-1).

9.3.2.2 Private Septic System Inspection and Maintenance Program

Investigation into watershed septic systems was performed during Stage 1 of TMDL development. The health departments for Macoupin and Madison County were unable to provide an estimate of septic systems in the area. Because there are a number of sanitary treatment plants in the watershed, it is thought that the number of septic systems in the watershed is limited. However, because the information is unknown, 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 9.6.

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 fecal coliform sources by replacing failing septic systems and will allow communities to develop without further contribution of fecal material to Cahokia Creek. 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.

9.3.2.3 Restrict Livestock Access to Cahokia Creek and Tributaries

Livestock are present in Madison and Macoupin Counties, which encompass the Cahokia Creek watershed. The National Agricultural Statistics Service livestock survey was reviewed for each county during Stage 1. The NASS survey showed that although livestock are present in the watershed, their numbers have steadily decreased over the last decade. It is unknown to what extent these animals have access to Cahokia Creek or its tributaries. Reduction of livestock access to streams, however, is recommended to reduce bacteria loads. The USEPA found that livestock exclusion from waterways and other grazing management measures were successful in reducing fecal coliform counts by 29 to 46 percent (2003). Fencing and alternate watering systems are effective ways to restrict livestock from streams.

9.4 Implementation Actions and Management Measures for Phosphorus in Holiday Shores Lake and Tower Lake

Phosphorus loads in the Holiday Shores Lake and Tower Lake watersheds originate from both external and internal sources. As discussed in previous sections, possible sources of total phosphorus in the Holiday Shores Lake watershed include runoff from urban and agricultural areas while sources of total phosphorus to Tower Lake include point source discharges 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

The phosphorus TMDLs for Holiday Shores Lake and Tower Lake describe waste load allocations for point source dischargers in the watershed. Holiday Shores Lake does not have any point source contributions and the associated WLA was therefore set to zero. Two facilities associated with SIUE discharge phosphorus to Tower Lake. The pool's WLA was set based on the facilities' discharge rate and the water quality standard of 0.05mg/L. The STP's effluent limit was reduced to 0.45 mg/L and the associated WLA was calculated based on that concentration and the facility's average discharge rate. It is suggested that this effluent limit be addressed during the next permit renewal for the facility. The STP's current permit (permit number IL0046761) will expire January 31, 2012.

It is recommended that effluent monitoring for total phosphorus be performed for each facility in order to further develop implementable control measures if needed.

9.4.2 Nonpoint Sources of Phosphorus

The 303(d) list did not identify sources of total phosphorus for either Holiday Shores Lake or Tower Lake. Non-point sources within the Tower Lake watershed are not considered to contribute significant nutrient loading to the lake. Potential sources of nonpoint source phosphorus pollution to Holiday Shores Lake may include septic systems, urban runoff, and agricultural sources.

BMPs available that could be utilized to treat these nonpoint sources within the Holiday Shores Lake watershed are:

- Conservation tillage practices
- Filter strips
- Wetlands
- Nutrient management
- Septic system maintenance or sanitary system

Total phosphorus originating from cropland is most efficiently treated with a combination of no-till or conservation tillage practices and grass filter strips. Wetlands located upstream of the reservoir could provide further reductions in total and dissolved phosphorus in runoff from croplands in the watershed. Nutrient management focuses on source control of nonpoint source contributions to the lake.

9.4.2.1 Conservation Tillage Practices

For the Holiday Shores Lake watershed, where a significant portion of the watershed consists of agricultural land uses, conservation tillage practices could help reduce nutrient loads in the lake. The lake 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. The 2002 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 72 percent of corn, 8 percent of soybean, and 100 percent of small grain tillage practices in Madison County, and these percentages were assumed to apply to the Holiday Shores Lake watershed as well. 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 Holiday Shores Lake watershed.

9.4.2.2 Filter Strips

Filter strips were discussed in Section 9.2.2.1. The same technique for evaluating available land was applied to the lake watershed. In the Holiday Shores Lake watershed there are 206 acres of land within 234 feet of the lake tributaries; of this area, 105 acres are categorized as agricultural and could potentially be converted into filter strips (see Figure 9-1).

9.4.2.3 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Holiday Shores Lake watershed. To treat loads from agricultural 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 Holiday Shores Lake watershed based on these recommendations. A wetland system to treat agricultural runoff from the lake subbasins could be approximately 22 acres (Denison and Tilton 1993).

Table 9-4 Acres of Wetland for Holiday Shores Lake Watershed

Subbasin	Area (acres)	Recommended Wetlands (acre)
Direct Flow RJN3	350	2.1
Direct Flow RJN2	652	3.9
Direct Flow RJN1	225	1.3
Joulters Creek	1637	9.8
Unnamed Trib - Northwest 2	363	2.2
Unnamed Trib -Northwest 1	380	2.3
Total	**3608**	**21.6**

9.4.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Holiday Shores Lake. 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).

9.4.2.5 Septic System Maintenance and Sanitary System

The extent of septic systems within the Holiday Shores Lake 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. Septic system maintenance was discussed in Section 9.3.1.2.

9.4.3 In-Lake Phosphorus

The Tower Lake phosphorus TMDL determined that a portion of the current phosphorus load to Tower 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.

As discussed in Section 7, the SIUE Cooling Water facility uses Tower Lake water for its operation. The plant redischarges lake waters from its facility at elevated temperatures. These elevated temperatures can encourage plant growth, which as discussed above, perpetuates anoxic conditions and increases the potential for internal cycling.

For lakes experiencing 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

Approximately 65 percent of the Cahokia Canal/Holiday Shores Lake watershed is 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 Macoupin and Madison Counties are listed in the Table 9-6 below.

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

Contact	Address	Phone
Madison County	7205 Marine Road Edwardsville, IL 62025	618-656-4710
Macoupin County	300 Carlinville Plaza Carlinville, IL 62626	217 854-2628 ext. 3

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 Cahokia Canal/Holiday Shores Lake 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 Nutrient Management Plan - NRCS

A significant portion of the agricultural land in the Cahokia Creek/Holiday Shores watershed is comprised of cropland. The service for developing a nutrient management plan averages $6 to $18/acre. This includes soil testing, manure analysis, scaled maps, and site specific recommendations for fertilizer management.

9.5.2.4 Nutrient Management Plan - IDA and Illinois EPA

The costs associated with development of Nutrient Management Plans co-sponsored by the IDA and the Illinois EPA is estimated as $10/acre paid to the producer and $3/acre for a third party vendor who develops the plans. There is a 200 acre cap per producer. The total plan development cost is estimated at $13/acre.

9.5.2.5 Conservation Tillage

Conservation tillage practices generally require fewer trips to the field, saving on labor, fuel, and equipment repair costs, though increased weed production may result in higher pesticide costs relative to conventional till (USDA, 1999). In general, conservation tillage results in increased profits relative to conventional tillage (Olson and Senjem, 2002; Buman et al., 2004; Czapar, 2006). The HRWCI (2005) lists the cost for conservation tillage at $0/ac.

Hydrologic inputs are often the limiting factor for crop yields and farm profits. Conservation practices reduce evaporative losses by covering the soil surface. USDA (1999) reports a 30 percent reduction in evaporative losses when 30 percent ground cover is maintained. Harman et al. (2003) and the Southwest Farm Press (2001) report substantial yield increases during dry years on farms managed with conservation or no-till systems compared to conventional till systems.

Depending on the type of equipment currently used, replacing conventional till equipment with no-till equipment can either result in a net savings or slight cost to the producer. Al-Kaisi et al. (2000) estimate that converting conventional equipment to no-till equipment costs approximately $1.25 to $2.25/ac/yr, but that is for new equipment..

Other researchers report a net gain when conventional equipment is sold to purchase no-till equipment (Harman et al., 2003).

9.5.2.6 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 Cahokia Creek/Holiday Shores Lake 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.

9.5.2.7 Internal Cycling

Internal cycling was identified as a source of nutrients to Tower 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 Tower Lake is approximately 72 ac, so total application costs for the lake would likely range from $21,000 to $52,000.

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).

9.5.2.8 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-6. Cost estimates shown in Table 9-6 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 9-6 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 Cahokia Creek/Holiday Shores Lake 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
- Investigation of tile line flow and associated water quality from agricultural land
- Further information gathering on area septic systems including locations and failure rates
- Storm-based monitoring of high flow events
- Tributary monitoring
- Storm Sewer surveys to monitor outfall concentration of parameters of concern

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 Cahokia Diversion Canal, fecal coliform to Cahokia Creek and total phosphorus to Tower Lake. As permits come up for renewal, Illinois EPA NPDES program should review the permits and decide if further management measures are required.

Stormwater outfall monitoring will also confirm stormwater contributions throughout the watershed. Urban stormwater is a potential pollutant source for each impaired waterbody segment in the watershed. Outfall monitoring for parameters of concern is suggested.

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 Cahokia Creek/Holiday Shores Lake 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.

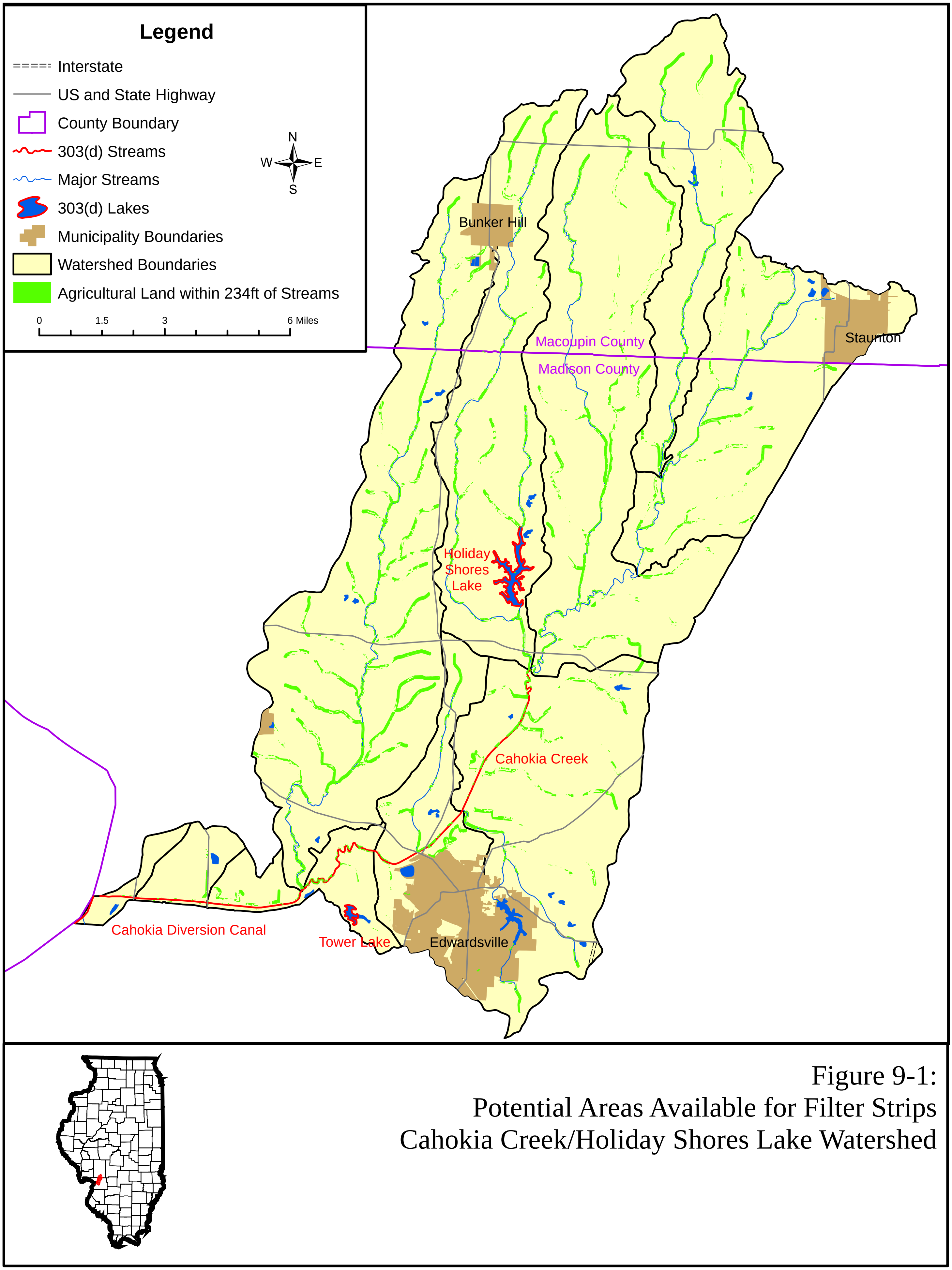


Figure 9-1:
Potential Areas Available for Filter Strips
Cahokia Creek/Holiday Shores Lake Watershed

THIS PAGE INTENTIONALLY LEFT BLANK

Section 10
References

Bogner, William C., Lin, Shun D., Hullinger, David L., and Raman, Raman K. 1997. Diagnostic-Feasibility Study of Vienna Correctional Center Lake, Johnson County, Illinois. ISWS Contract Report 619.

British Columbia Ministry of Forests. 2000. Definitions of Adaptive Management. (http://www.for.gov.bc.ca/hfp/amhome/Amdefs.htm)

Chapra, S.C., Pelletier, G.J. and Tao, H. 2005. QUAL2K: A Modeling Framework for Simulating River and Stream Water Quality, Version 2.04

Cooke, G.D., E.B. Welch, S.A. Peterson, and P.R. Newroth. 1993. Restoration and management of lakes and reservoirs. Lewis Publishers, Boca Raton, FL. 548 pp.

Denison, D. and D. Tilton. 1993. Rouge River National Wet Weather Demonstration Program: Technical Memorandum. Rouge River Project: RPO-NPS-TM-12.01. August.

Dong, J., J. Chen, K.D. Brosofske, and R.J. Naiman. 1998. "Modelling Air Temperature Gradients Across Managed Small Streams in Western Washington." *Journal of Environmental Management*. 53:309-321.

FSA (Farm Service Agency). 1997. *Conservation Reserve Program: Continuous Sign-Up for High Priority Conservation Practices*. USDA. February.

Gentry, L.E., M.B. David, T.V. Royer, C.A. Mitchell, and K.M. Starks. 2007. Phosphorus Transport Pathways to Streams in Tile-Drained Agricultural Watersheds. *Journal of Environmental Quality* Volume 36: 408:415, American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America.

Hagan, J.M. and A.A. Whitman, 2000. Microclimate changes across upland and riparian clearcut-forest boundaries in Maine. Mosaic Science Notes #2000-4. November 30. http://www.manometmaine.com/MSN2000-4.pdf

Hajjar, L.M. 2000. Final Report for Section 309 – Cumulative and Secondary Impacts Task 2 – Model Septic System Maintenance Program. Office of Ocean and Coastal Resource Management South Carolina Department of Health and Environmental Control.

IAH. 2002. Illinois Agronomy Handbook, 23rd Edition. University of Illinois Extension, College of Agricultural, Consumer, and Environmental Sciences.

Illinois Department of Agriculture (IDA). 2004. 2004 Illinois Soil Conservation Transect Survey Summary.

Illinois Department of Natural Resources (IDNR), Illinois Natural History Survey (INHS), Illinois Department of Agriculture (IDA), United States Department of Agriculture (USDA) National Agricultural Statistics Survey (NASS)'s 1:1000,000 Scale Land Cover of Illinois 1999-2000. Raster Digital Data. Version 2.0, Sept 2003. *http://www.inhs.uiuc.edu/cwe/gap/landcover.htm*

Illinois EPA (Illinois Environmental Protection Agency). 2005a. Point source discharge information, Illinois Environmental Protection Agency.

________.2005b. Water Quality Data.

________.2004a. Illinois Water Quality Report, 2004. IEPA/BOW/04-006.

________. 2004b. Clean Water Act Section 303(d) List -Illinois' Submittal for 2004.

ISWS (Illinois State Water Survey). 2007. Pan Evaporation in Illinois. Download: Pan Evaporation in Illinois.http://www.sws.uiuc.edu/atmos/statecli/Pan_Evap/Panevap.htm

Kinney, W. 2005. STREAMS (Stream Technical Resource Evaluation and Management Service): *Watershed Evaluation – Evergreen Lake*. May.

Kovacic, D.A., M.B. David, L.E. Gentry, K.M. Starks and R.A. Cooke. 2000 *Effectiveness of constructed wetlands in reducing nitrogen and phosphorus export from agricultural tile drainage*. J. Environ. Qual. 29:1262-1274.

Ledwith, Tyler. 1996. Effects of Buffer Strip Width on Air Temperature and Relative Humidity in a Stream Riparian Zone. Watershed Management Council Networker; 6(4):6-7. http://www.watershed.org/news/sum_96/buffer.html

NCDC (National Climatic Data Center). 2005. Weather stations

NCEEP. 2004. North Carolina Ecosystem Enhancement Program Annual Report 2003-2004. North Carolina Department of Environment and Natural Resources.

NCSU. 2002. Riparian Buffers and Controlled Drainage to Reduce Agricultural Nonpoint Source Pollution. Departments of Soil Science and Biological and Agricultural Engineering, North Carolina Agricultural Research Service, North Carolina State University, Raleigh, North Carolina. Technical Bulletin 318, September 2002.

NCSU (North Carolina State University) Water Quality Group. 2000. National Management Measures to Control Nonpoint Source Pollution from Agriculture. United States Environmental Protection Agency: Contract # 68-C99-249.

NRCS (Natural Resources Conservation Service). 2006. EQIP Fact Sheet. http://www.nrcs.usda.gov/PROGRAMS/EQIP/

________. 2004. Wetland Reserves Program. http://www.nrcs.usda.gov/programs/ WRP/

________. 2002. Natural Resources Conservation Service Conservation Practice Standard Field Border (Feet) Code 386.

________. 1999. Illinois Urban Manual: PRACTICE STANDARD -FILTER STRIP (acre) CODE 835. http://www.il.nrcs.usda.gov/technical/engineer/urban/standards/ urbst835.html

Osmond, D.L., J. Spooner, and D.E. Line. 1995. Systems of Best Management Practices for Controlling Agricultural Nonpoint Source Pollution: The Rural Clean Water Program Experience. North Carolina State University Water Quality Control Group: brochure 6. March.

Stauffer, R.E. 1981. Sampling strategies for estimating the magnitude and importance of internal phosphorus supplies in lakes. U.S. EPA 600/3-81-015. Washington, D.C.

Tetra Tech. 2005. TMDL Development for the Lake Oakland and Walnut Point Lake Watersheds. Stage One Report: Watershed Characterization and Water Quality Analysis.

USGS (United States Geological Survey). 1998. National Elevation Dataset. EROS Data Center, Sioux Falls, SD. *http://gisdata.usgs.net/ned/*

________. 2007. Streamflow data for gage 03384450 Lusk Creek near Eddyville, IL.
USACE (United States Army Corps of Engineers) in cooperation with FEMA's National Dam Safety Program. 2005. National Inventory of Dams. *http://www.tec.army.mil/nid*

________. 1999. *Simplified Procedures for Eutrophication and Assessment and Prediction: User Manual.* William Walker. Instruction Report W-96-2. Waterways Experiment Station. USACE Headquarters.

U.S. Census Bureau. 2000. Geography Division Cartographic Operations Branch. *Census 2000 TIGER/Line Data.*

USDA (U.S. Department of Agriculture), NRCS (Natural Resources Conservation Service).2006. Soil Survey Geographic (SSURGO) database for Pope and Massac Counties, Illinois. *http://www.ftw.nrcs.usda.gov/ssur_data.html*

________. 2002. National Agricultural Statistics Survey (NASS) 2002 Census of Agriculture. *http://www.nass.usda.gov/census/census02/volume1/index2.htm*

________.2005. National Soil Survey Handbook, title 430-VI. [Online] Available: *http://soils.usda.gov/technical/handbook/*

________.1994. State Soil Geographic (STATSGO) data base for Illinois. *http://www.ncgc.nrcs.usda.gov/products/datasets/statsgo/*

USDA (United States Department of Agriculture). 2006. Farm Service Agency Online: Conservation Reserve Program Fact Sheet. http:/www.fsa.usda.gov/pas/publications/ facts/html/crp06.htm.October

________. 2002. National Agricultural Statistics Survey (NASS) 2002 Census of Agriculture. *http://www.nass.usda.gov/census/census02/volume1/index2.htm*

________. 1994. Natural Resource Conservation Service Online: Planning and Design Manual for the Control of Erosion, Sediment, and Stormwater. http://www.abe. msstate.edu/ Tools/csd/p-dm/index.html

USEPA (U.S. Environmental Protection Agency). 2007. Permit Compliance System Data. http://www.epa.gov/enviro/html/pcs/pcs_query_java.html

________. 2004a. *BASINS - Better Assessment Science Integrating Point and Nonpoint Sources*. Download: BASINS Data. http://www.epa.gov/OST/BASINS/

________. 2004b. *STORET – Storage and Retrieval*. Download: Water Quality Data. http://www.epa.gov/storet/

________. 2003. Air Toxics and the Great Lakes: What Are We Doing About Air Deposition of Pollutants to the Great Lakes? March. http://www.epa.gov/region5/air/glakes/gl2.htm.

________. 1999. Draft Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition). Office of Water. EPA 841/D/99/001.

________. 1997. Compendium of Tools for Watershed Assessment and TMDL Development. Office of Water. EPA/841/B/97/006.

________. Office of Water. 1983. *Final Report of the Nationwide Urban Runoff Program*. Washington, D.C. Wetzel, R. G. 1983. *Limnology*. Saunders College Publishing. Orlando, Florida. pp. 289–297.

WIDNR. 2003. Alum Treatments to Control Phosphorus in Lakes. Wisconsin Department of Natural Resources, March 2003.

Wossink, A., and D. Osmond. 2001. Cost and Benefits of Best Management Practices to Control Nitrogen in the Piedmont. North Carolina Cooperative Extension Service.

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix A
Land Use Categories

THIS PAGE INTENTIONALLY LEFT BLANK

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

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B
Soil Characteristics

Appendix B: Cahokia Creek/Holiday Shores Lake 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	Maximum K-factor	Minimum K-factor
533	Urban land	141.72	0.11%	NA	0.24	0.43
536	Dumps	310.12	0.25%	NA	0.32	0.32
867	Oil waste land	3.50	0.00%	NA	0.00	0.00
1070L	Beaucoup silty clay loam, undrained, 0 to 2 percent slopes, occasionally flooded	155.01	0.12%	D	0.28	0.32
112A	Cowden silt loam, 0 to 2 percent slopes	220.25	0.17%	D	0.37	0.49
113A	Oconee silt loam, 0 to 2 percent slopes	809.77	0.64%	C	0.32	0.49
113B	Oconee silt loam, 2 to 5 percent slopes	1555.78	1.23%	C	0.32	0.49
119B2	Elco silt loam, 2 to 5 percent slopes, eroded	6.45	0.01%	B	0.28	0.43
119C2	Elco silt loam, 5 to 10 percent slopes, eroded	40.90	0.03%	B	0.28	0.43
119C3	Elco silty clay loam, 5 to 10 percent slopes, severely eroded	1262.71	1.00%	B	0.28	0.37
119D2	Elco silt loam, 10 to 18 percent slopes, eroded	566.86	0.45%	B	0.17	0.43
119D3	Elco silty clay loam, 10 to 18 percent slopes, severely eroded	1642.51	1.30%	B	0.28	0.37
127B	Harrison silt loam, 2 to 5 percent slopes	247.60	0.20%	B	0.24	0.49
165A	Weir silt loam, 0 to 2 percent slopes	119.01	0.09%	D	0.37	0.55
16A	Rushville silt loam, 0 to 2 percent slopes	709.44	0.56%	D	0.37	0.55
2079D	Menfro-Orthents-Urban land complex, 8 to 15 percent slopes	219.75	0.17%	0	0.37	0.49
2122B	Colp-Orthents-Urban land complex, 2 to 5 percent slopes, rarely flooded	170.31	0.14%	0	0.32	0.49
2384B	Edwardsville-Orthents-Urban land complex, 1 to 4 percent slopes	227.04	0.18%	0	0.28	0.49
2477B	Winfield-Orthents-Urban land complex, 2 to 8 percent slopes	1518.46	1.20%	0	0.37	0.49
267A	Caseyville silt loam, 0 to 2 percent slopes	1596.30	1.27%	B	0.37	0.55
267B	Caseyville silt loam, 2 to 5 percent slopes	1292.61	1.03%	B	0.37	0.49
2741B	Oakville-Psamments-Urban land complex, 2 to 5 percent slopes, rarely flooded	0.19	0.00%	0	0.02	0.28
283B	Downsouth silt loam, 2 to 5 percent slopes	1402.33	1.11%	B	0.24	0.49
283C2	Downsouth silt loam, 5 to 10 percent slopes, eroded	196.72	0.16%	B	0.24	0.49
3070A	Beaucoup silty clay loam, 0 to 2 percent slopes, frequently flooded	1145.83	0.91%	B/D	0.28	0.32
3070L	Beaucoup silty clay loam, 0 to 2 percent slopes, frequently flooded, long duration	115.52	0.09%	B/D	0.28	0.32
3071L	Darwin silty clay, 0 to 2 percent slopes, frequently flooded, long duration	102.25	0.08%	D	0.24	0.28
3076A	Otter silt loam, 0 to 2 percent slopes, frequently flooded	31.46	0.02%	B/D	0.32	0.49
3107A	Sawmill silty clay loam, 0 to 2 percent slopes, frequently flooded	18.97	0.02%	B/D	0.15	0.32

Appendix B: Cahokia Creek/Holiday Shores Lake 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	Maximum K-factor	Minimum K-factor
31A	Pierron silt loam, 0 to 2 percent slopes	98.74	0.08%	D	0.37	0.55
3304A	Landes fine sandy loam, 0 to 2 percent slopes, frequently flooded	428.48	0.34%	B	0.02	0.32
3333A	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	4450.37	3.53%	C	0.28	0.55
3334A	Birds silt loam, 0 to 2 percent slopes, frequently flooded	3350.75	2.66%	C/D	0.37	0.49
3336A	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded	49.03	0.04%	B	0.43	0.49
3415A	Orion silt loam, 0 to 2 percent slopes, frequently flooded	2587.20	2.05%	C	0.28	0.55
3428A	Coffeen silt loam, 0 to 2 percent slopes, frequently flooded	1778.67	1.41%	B	0.28	0.55
3451A	Lawson silt loam, 0 to 2 percent slopes, frequently flooded	3190.14	2.53%	B	0.28	0.49
3592A	Nameoki silty clay loam, 0 to 2 percent slopes, frequently flooded	7.74	0.01%	D	0.24	0.32
35F	Bold silt loam, 18 to 35 percent slopes	66.13	0.05%	B	0.43	0.55
384A	Edwardsville silt loam, 0 to 2 percent slopes	2957.86	2.35%	B	0.24	0.49
385A	Mascoutah silty clay loam, 0 to 2 percent slopes	1321.77	1.05%	B	0.24	0.49
438B	Aviston silt loam, 2 to 5 percent slopes	28.59	0.02%	B	0.24	0.49
441B	Wakenda silt loam, 2 to 5 percent slopes	178.93	0.14%	B	0.28	0.49
441C2	Wakenda silt loam, 5 to 10 percent slopes, eroded	27.33	0.02%	B	0.28	0.49
46A	Herrick silt loam, 0 to 2 percent slopes	1238.99	0.98%	B	0.24	0.49
470B	Keller silt loam, 2 to 5 percent slopes	166.18	0.13%	C	0.28	0.37
474A	Piasa silt loam, 0 to 2 percent slopes	123.45	0.10%	D	0.24	0.49
477B	Winfield silt loam, 2 to 5 percent slopes	4712.31	3.74%	B	0.37	0.49
477B3	Winfield silty clay loam, 2 to 5 percent slopes, severely eroded	64.99	0.05%	B	0.37	0.49
477C2	Winfield silt loam, 5 to 10 percent slopes, eroded	608.62	0.48%	B	0.37	0.49
477C3	Winfield silty clay loam, 5 to 10 percent slopes, severely eroded	1912.35	1.52%	B	0.37	0.49
477D3	Winfield silty clay loam, 10 to 18 percent slopes, severely eroded	1509.07	1.20%	B	0.37	0.49
491B	Ruma silt loam, 2 to 5 percent slopes	104.30	0.08%	B	0.37	0.43
491C2	Ruma silt loam, 5 to 10 percent slopes, eroded	111.91	0.09%	B	0.37	0.43
491D2	Ruma silt loam, 10 to 18 percent slopes, eroded	70.33	0.06%	B	0.37	0.43
491D3	Ruma silty clay loam, 10 to 18 percent slopes, severely eroded	9.97	0.01%	B	0.37	0.37
50A	Virden silty clay loam, 0 to 2 percent slopes	763.06	0.61%	B/D	0.24	0.49
515B3	Bunkum silty clay loam, 2 to 5 percent slopes, severely eroded	1048.72	0.83%	C	0.37	0.49
515C3	Bunkum silty clay loam, 5 to 10 percent slopes, severely eroded	1825.62	1.45%	C	0.37	0.49
515D3	Bunkum silty clay loam, 10 to 18 percent slopes, severely eroded	657.30	0.52%	C	0.37	0.49
517A	Marine silt loam, 0 to 2 percent slopes	7227.84	5.73%	C	0.32	0.55
517B	Marine silt loam, 2 to 5 percent slopes	5280.65	4.19%	C	0.32	0.55

Appendix B: Cahokia Creek/Holiday Shores Lake 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	Maximum K-factor	Minimum K-factor
570D2	Martinsville sandy loam, 10 to 18 percent slopes, eroded	3.38	0.00%	B	0.20	0.37
581B2	Tamalco silt loam, 2 to 5 percent slopes, eroded	6.10	0.00%	D	0.37	0.55
585F	Negley loam, 18 to 35 percent slopes	26.09	0.02%	B	0.28	0.32
587B	Terril loam, 2 to 5 percent slopes	11.72	0.01%	B	0.32	0.32
630D3	Navlys silty clay loam, 10 to 18 percent slopes, severely eroded	25.82	0.02%	B	0.37	0.49
657A	Burksville silt loam, 0 to 2 percent slopes	138.92	0.11%	D	0.37	0.55
6B2	Fishhook silt loam, 2 to 5 percent slopes, eroded	897.49	0.71%	D	0.28	0.43
6C2	Fishhook silt loam, 5 to 10 percent slopes, eroded	277.75	0.22%	D	0.28	0.43
701F	Menfro-Hickory silt loams, 18 to 35 percent slopes	1465.09	1.16%	B	0.28	0.49
702F	Ruma-Hickory silt loams, 18 to 35 percent slopes	1135.70	0.90%	B	0.28	0.43
7037B	Worthen silt loam, 2 to 5 percent slopes, rarely flooded	4.10	0.00%	B	0.32	0.49
703A	Pierron-Burksville silt loams, 0 to 2 percent slopes	459.12	0.36%	D	0.37	0.55
7053B	Bloomfield loamy fine sand, 2 to 5 percent slopes, rarely flooded	69.34	0.06%	A	0.02	0.15
7075B	Drury silt loam, 2 to 5 percent slopes, rarely flooded	46.85	0.04%	B	0.32	0.49
7081A	Littleton silt loam, 0 to 2 percent slopes, rarely flooded	12.74	0.01%	B	0.28	0.49
7122B	Colp silt loam, 2 to 5 percent slopes, rarely flooded	105.46	0.08%	C	0.32	0.49
7122C	Colp silty clay loam, 5 to 10 percent slopes, severely eroded, rarely flooded	131.98	0.10%	C	0.32	0.37
7150A	Onarga sandy loam, 0 to 2 percent slopes, rarely flooded	79.25	0.06%	B	0.02	0.32
7151A	Ridgeville fine sandy loam, 0 to 2 percent slopes, rarely flooded	26.24	0.02%	B	0.02	0.28
7338A	Hurst silty clay loam, 0 to 2 percent slopes, rarely flooded	92.29	0.07%	D	0.28	0.49
7430A	Raddle silt loam, 0 to 2 percent slopes, rarely flooded	64.91	0.05%	B	0.32	0.49
7432A	Geff silt loam, 0 to 2 percent slopes, rarely flooded	310.36	0.25%	C	0.24	0.49
7434B	Ridgway silt loam, 2 to 5 percent slopes, rarely flooded	281.95	0.22%	B	0.17	0.43
7445A	Newhaven loam, 0 to 2 percent slopes, rarely flooded	90.24	0.07%	B	0.24	0.32
7741B	Oakville fine sand, 2 to 5 percent slopes, rarely flooded	36.79	0.03%	A	0.02	0.28
7741C	Oakville fine sand, 5 to 10 percent slopes, rarely flooded	71.98	0.06%	A	0.02	0.28
79B	Menfro silt loam, 2 to 5 percent slopes	991.14	0.79%	B	0.37	0.55
79C2	Menfro silt loam, 5 to 10 percent slopes, eroded	484.33	0.38%	B	0.37	0.49
79C3	Menfro silty clay loam, 5 to 10 percent slopes, severely eroded	2.82	0.00%	B	0.37	0.49
79D2	Menfro silt loam, 10 to 18 percent slopes, eroded	1138.17	0.90%	B	0.37	0.49
79D3	Menfro silty clay loam, 10 to 18 percent slopes, severely eroded	365.22	0.29%	B	0.37	0.49
79F	Menfro silt loam, 18 to 35 percent slopes	1876.77	1.49%	B	0.37	0.55
801B	Orthents, silty, undulating	264.40	0.21%	C	0.24	0.43

Appendix B: Cahokia Creek/Holiday Shores Lake 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	Maximum K-factor	Minimum K-factor
801D	Orthents, silty, hilly	308.88	0.25%	C	0.43	0.43
802B	Orthents, loamy, undulating	144.51	0.11%	C	0.24	0.49
802D	Orthents, loamy, hilly	113.27	0.09%	B	0.32	0.43
802E	Orthents, loamy, hilly	9.12	0.01%	B	0.43	0.43
8038B	Rocher loam, 2 to 5 percent slopes, occasionally flooded	33.56	0.03%	B	0.24	0.32
8070A	Beaucoup silty clay loam, 0 to 2 percent slopes, occasionally flooded	262.92	0.21%	B	0.28	0.32
8071L	Darwin silty clay, 0 to 2 percent slopes, occasionally flooded, long duration	1220.70	0.97%	D	0.24	0.28
8078A	Arenzville silt loam, 0 to 2 percent slopes, occasionally flooded	12.87	0.01%	B	0.43	0.49
8284A	Tice silty clay loam, 0 to 2 percent slopes, occasionally flooded	589.10	0.47%	B	0.24	0.32
8302A	Ambraw silty clay loam, 0 to 2 percent slopes, occasionally flooded	163.26	0.13%	B/D	0.24	0.28
8304B	Landes very fine sandy loam, 2 to 5 percent slopes, occasionally flooded	14.71	0.01%	B	0.20	0.32
8591A	Fults silty clay, 0 to 2 percent slopes, occasionally flooded	13.27	0.01%	D	0.24	0.32
878C3	Coulterville-Grantfork silty clay loams, 5 to 10 percent slopes, severely eroded	470.24	0.37%	D	0.28	0.49
880B2	Coulterville-Darmstadt silt loams, 2 to 5 percent slopes, eroded	538.94	0.43%	D	0.37	0.49
882B	Oconee-Coulterville-Darmstadt silt loams, 2 to 5 percent slopes	410.44	0.33%	D	0.37	0.55
8831A	Fluvaquents, clayey, 0 to 2 percent slopes, occasionally flooded	114.06	0.09%	0	0.32	0.32
885A	Virden-Fosterburg silt loams, 0 to 2 percent slopes	3120.95	2.48%	B/D	0.28	0.49
894A	Herrick-Biddle-Piasa silt loams, 0 to 2 percent slopes	5846.52	4.64%	B	0.28	0.49
897C2	Bunkum-Atlas silt loams, 5 to 10 percent slopes, eroded	2240.01	1.78%	C	0.28	0.43
897C3	Bunkum-Atlas silty clay loams, 5 to 10 percent slopes, severely eroded	120.59	0.10%	C	0.28	0.37
897D2	Bunkum-Atlas silt loams, 10 to 18 percent slopes, eroded	794.94	0.63%	C	0.28	0.43
897D3	Bunkum-Atlas silty clay loams, 10 to 18 percent slopes, severely eroded	529.79	0.42%	C	0.28	0.49
8D2	Hickory loam, 10 to 18 percent slopes, eroded	1174.99	0.93%	C	0.24	0.43
8D3	Hickory clay loam, 10 to 18 percent slopes, severely eroded	2140.43	1.70%	C	0.24	0.49
8F	Hickory silt loam, 18 to 35 percent slopes	10509.41	8.34%	C	0.24	0.37
8F2	Hickory loam, 18 to 35 percent slopes, eroded	1940.77	1.54%	C	0.28	0.37
8G	Hickory silt loam, 35 to 60 percent slopes	147.30	0.12%	C	0.24	0.49

Appendix B: Cahokia Creek/Holiday Shores Lake 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	Maximum K-factor	Minimum K-factor
90A	Bethalto silt loam, 0 to 2 percent slopes	1223.42	0.97%	B	0.24	0.49
914C3	Atlas-Grantfork silty clay loams, 5 to 10 percent slopes, severely eroded	249.58	0.20%	D	0.28	0.43
914D3	Atlas-Grantfork silty clay loams, 10 to 18 percent slopes, severely eroded	207.69	0.16%	D	0.28	0.37
9279B	Rozetta silt loam, terrace, 2 to 5 percent slopes	23.74	0.02%	B	0.28	0.49
962D2	Sylvan-Bold silt loams, 10 to 18 percent slopes, eroded	194.82	0.15%	B	0.37	0.55
962F2	Sylvan-Bold silt loams, 18 to 35 percent slopes, eroded	357.31	0.28%	B	0.37	0.55
967F	Hickory-Gosport silt loams, 18 to 35 percent slopes	14.01	0.01%	C	0.28	0.43
993A	Cowden-Piasa silt loams, 0 to 2 percent slopes	7677.58	6.09%	D	0.37	0.49
M-W	Miscellaneous water	72.70	0.06%	-	-	-
W	Water	1784.10	1.42%	-	-	-
		126063.03				

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix C
Water Quality Data

THIS PAGE INTENTIONALLY LEFT BLANK

Water Quality Data
Cahokia Creek/Holiday Shores Lake Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
JQ 05	1/23/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	610
JQ 05	3/6/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	60
JQ 05	4/10/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2100
JQ 05	5/1/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	220
JQ 05	6/19/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2800
JQ 05	7/26/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1700
JQ 05	9/4/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	190
JQ 05	10/16/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	370
JQ 05	11/27/1990	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2000
JQ 05	1/17/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	3000
JQ 05	2/20/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	640
JQ 05	4/22/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	140
JQ 05	5/14/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	15000
JQ 05	6/6/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	40
JQ 05	7/30/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	120
JQ 05	9/4/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	6000
JQ 05	10/2/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	590000
JQ 05	11/26/1991	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	530
JQ 05	1/30/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	20
JQ 05	3/4/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	10
JQ 05	4/21/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	14000
JQ 05	5/27/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2000
JQ 05	6/16/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2300
JQ 05	7/30/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1100
JQ 05	8/27/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	10
JQ 05	10/28/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	100
JQ 05	11/24/1992	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	3000
JQ 05	1/7/1993	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	530
JQ 05	2/9/1993	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	115
JQ 05	3/23/1993	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	3600
JQ 05	4/27/1993	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2000
JQ 05	10/26/1993	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	270
JQ 05	1/11/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	100
JQ 05	2/10/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	60
JQ 05	6/28/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	3100
JQ 05	8/2/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	310
JQ 05	9/27/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	6400
JQ 05	11/3/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	44
JQ 05	12/13/1994	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	48
JQ 05	1/24/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	82
JQ 05	3/7/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	4600
JQ 05	4/11/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	84
JQ 05	5/23/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	460
JQ 05	6/20/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	695
JQ 05	7/25/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	7800
JQ 05	8/29/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	350
JQ 05	10/24/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1450
JQ 05	11/28/1995	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	38
JQ 05	1/9/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	56
JQ 05	2/15/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	76
JQ 05	3/21/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	12
JQ 05	4/23/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	19000
JQ 05	6/6/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	28000
JQ 05	7/18/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1130
JQ 05	9/17/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	380
JQ 05	10/22/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	470
JQ 05	11/19/1996	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	460
JQ 05	1/22/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	42
JQ 05	3/20/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	760
JQ 05	4/22/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2000
JQ 05	5/28/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	16100
JQ 05	7/10/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	13200
JQ 05	8/14/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	530
JQ 05	9/25/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	880
JQ 05	11/4/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	640
JQ 05	12/9/1997	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	35
JQ 05	1/21/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	36
JQ 05	3/3/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	86

Water Quality Data
Cahokia Creek/Holiday Shores Lake Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
JQ 05	4/14/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	82
JQ 05	5/27/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1280
JQ 05	6/23/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	2100
JQ 05	8/18/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	4500
JQ 05	9/15/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	210
JQ 05	10/20/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	1200
JQ 05	12/15/1998	NA	FECAL COLIFORM,MEMBR FILTER,M-FC BROTH,44.5 C, count/100mL	90
JQ 05	2/3/2000	NA	Total Fecal Coliform, count/100mL	35
JQ 05	3/7/2000	NA	Total Fecal Coliform, count/100mL	265
JQ 05	4/18/2000	NA	Total Fecal Coliform, count/100mL	900
JQ 05	5/23/2000	NA	Total Fecal Coliform, count/100mL	1900
JQ 05	6/13/2000	NA	Total Fecal Coliform, count/100mL	6900
JQ 05	8/10/2000	NA	Total Fecal Coliform, count/100mL	4500
JQ 05	9/12/2000	NA	Total Fecal Coliform, count/100mL	2300
JQ 05	10/24/2000	NA	Total Fecal Coliform, count/100mL	205
JQ 05	12/12/2000	NA	Total Fecal Coliform, count/100mL	30
JQ 05	1/17/2001	NA	Total Fecal Coliform, count/100mL	40
JQ 05	3/27/2001	NA	Total Fecal Coliform, count/100mL	5
JQ 05	4/24/2001	NA	Total Fecal Coliform, count/100mL	145
JQ 05	6/19/2001	NA	Total Fecal Coliform, count/100mL	240
JQ 05	8/2/2001	NA	Total Fecal Coliform, count/100mL	230
JQ 05	9/18/2001	NA	Total Fecal Coliform, count/100mL	490
JQ 05	10/16/2001	NA	Total Fecal Coliform, count/100mL	1115
JQ 05	12/4/2001	NA	Total Fecal Coliform, count/100mL	607
JQ 05	1/24/2002	NA	Total Fecal Coliform, count/100mL	92
JQ 05	3/14/2002	NA	Total Fecal Coliform, count/100mL	85
JQ 05	4/16/2002	NA	Total Fecal Coliform, count/100mL	480
JQ 05	5/21/2002	NA	Total Fecal Coliform, count/100mL	60
JQ 05	6/25/2002	NA	Total Fecal Coliform, count/100mL	121
JQ 05	9/12/2002	NA	Total Fecal Coliform, count/100mL	150
JQ 05	10/16/2002	NA	Total Fecal Coliform, count/100mL	54
JQ 05	12/3/2002	NA	Total Fecal Coliform, count/100mL	10
JQ 05	5/13/2003	NA	Total Fecal Coliform, count/100mL	280
JQ 05	6/11/2003	NA	Total Fecal Coliform, count/100mL	5800
JQ 05	8/11/2003	NA	Total Fecal Coliform, count/100mL	440
JQ 05	9/22/2003	NA	Total Fecal Coliform, count/100mL	196
JQ 05	10/27/2003	NA	Total Fecal Coliform, count/100mL	80
JQ 05	12/9/2003	NA	Total Fecal Coliform, count/100mL	155
JQ 05	2/2/2004	NA	Total Fecal Coliform, count/100mL	15
JQ 05	3/17/2004	NA	Total Fecal Coliform, count/100mL	65
JQ 05	4/7/2004	NA	Total Fecal Coliform, count/100mL	50
JQ 05	6/3/2004	NA	Total Fecal Coliform, count/100mL	740
JQ 05	6/28/2004	NA	Total Fecal Coliform, count/100mL	280
JQ 05	8/3/2004	NA	Total Fecal Coliform, count/100mL	200
JQ 05	9/27/2004	NA	Total Fecal Coliform, count/100mL	155
JQ 05	11/8/2004	NA	Total Fecal Coliform, count/100mL	490
JQ 07	3/2/1999	NA	HARDNESS, CA,MG mg/l	357
JQ 07	9/18/1998	NA	HARDNESS, TOTAL (MG/L AS CACO3)	128
JQ 07	9/18/1998	NA	COPPER, DISSOLVED (UG/L AS CU)	24
JQ 07	3/2/1999	NA	COPPER, DISSOLVED (UG/L AS CU)	10
JQ 07	9/18/1998	NA	COPPER, TOTAL (UG/L AS CU)	28
JQ 07	3/2/1999	NA	DISSOLVED OXYGEN (DO) mg/l	11.2
JQ 07	9/18/1998	NA	OXYGEN ,DISSOLVED, ANALYSIS BY PROBE MG/L	4.70
RJN-1	5/22/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.281
RJN-1	6/3/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.132
RJN-1	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.033
RJN-1	8/6/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.128
RJN-1	9/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.157
RJN-1	10/6/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.135
RJN-1	5/29/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.084
RJN-1	6/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.114
RJN-1	7/14/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.135
RJN-1	8/11/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.130
RJN-1	9/9/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.145
RJN-1	10/6/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.208
RJN-1	5/30/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.092
RJN-1	6/29/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.089
RJN-1	7/12/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.096

Water Quality Data
Cahokia Creek/Holiday Shores Lake Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
RJN-1	8/15/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.183
RJN-1	9/27/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJN-1	10/25/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.113
RJN-1	5/25/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.083
RJN-1	6/8/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.095
RJN-1	7/26/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.154
RJN-1	8/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.238
RJN-1	9/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.286
RJN-1	10/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.150
RJN-1	5/10/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.266
RJN-1	6/12/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.145
RJN-1	7/10/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.193
RJN-1	8/14/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.233
RJN-1	9/12/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.204
RJN-1	10/9/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJN-1	5/22/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.102
RJN-1	6/19/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.105
RJN-1	7/16/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.116
RJN-1	8/18/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.122
RJN-1	9/22/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.160
RJN-1	10/27/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.095
RJN-1	5/21/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.072
RJN-1	6/30/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.076
RJN-1	7/28/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.140
RJN-1	8/30/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.163
RJN-1	9/21/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.194
RJN-1	10/18/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.143
RJN-1	7/25/1998	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.166
RJN-2	5/8/2003	10	Total Manganese, ug/L	55
RJN-2	7/1/2003	10	Total Manganese, ug/L	180
RJN-2	7/24/2003	10	Total Manganese, ug/L	150
RJN-2	8/27/2003	10	Total Manganese, ug/L	170
RJN-2	10/23/2003	10	Total Manganese, ug/L	180
RJN-2	5/22/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJN-2	6/3/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.145
RJN-2	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.100
RJN-2	8/6/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.137
RJN-2	9/10/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.173
RJN-2	10/6/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.140
RJN-2	5/29/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.094
RJN-2	6/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.091
RJN-2	7/14/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.146
RJN-2	8/11/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.128
RJN-2	9/9/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.143
RJN-2	10/6/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.192
RJN-2	5/25/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.094
RJN-2	6/8/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.090
RJN-2	7/26/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.167
RJN-2	8/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.214
RJN-2	9/21/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.198
RJN-2	10/24/1993	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.146
RJN-2	5/10/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.182
RJN-2	6/12/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.143
RJN-2	7/10/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.212
RJN-2	8/14/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.251
RJN-2	9/12/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.205
RJN-2	10/9/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.184
RJO-1	4/23/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.140
RJO-1	6/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.125
RJO-1	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.074
RJO-1	8/14/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.167
RJO-1	10/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.186
RJO-1	5/7/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.112
RJO-1	6/20/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.059
RJO-1	7/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJO-1	8/29/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.066
RJO-1	10/7/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.159
RJO-1	8/15/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.058

Water Quality Data
Cahokia Creek/Holiday Shores Lake Watershed

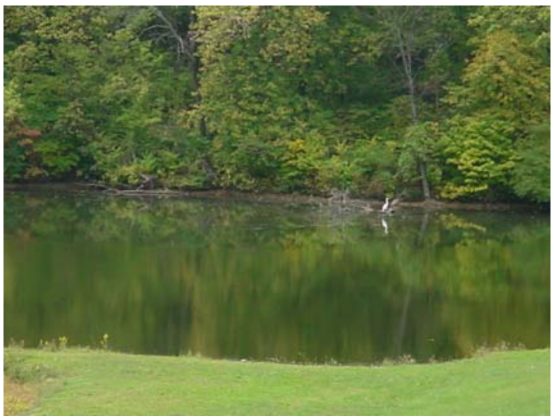
Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
RJO-1	10/4/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.221
RJO-2	8/15/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJO-2	10/4/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJO-3	4/23/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.115
RJO-3	6/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.127
RJO-3	7/9/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.065
RJO-3	8/14/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.150
RJO-3	10/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.204
RJO-3	5/7/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.114
RJO-3	6/20/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.046
RJO-3	7/30/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.069
RJO-3	8/29/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.064
RJO-3	10/7/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.179
RJO-3	8/15/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.064
RJO-3	10/4/2005	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.076

Appendix D
Watershed Photographs

THIS PAGE INTENTIONALLY LEFT BLANK


Cougar Lake at Southern Illinois University


Cougar Lake at Southern Illinois University


Cougar Lake at Southern Illinois University


Holiday Shores Lake


Holiday Shores Lake


Holiday Shores Lake

Holiday Shores Lake

Holiday Shores Lake

Holiday Shores Lake Dam

Holiday Shores Lake Watershed

Cahokia Creek at Old Alton Edwards Road Looking Northeast

Cahokia Creek at Old Alton Edwards Road Looking Southwest

Appendix E
Stage Two Report

THIS PAGE INTENTIONALLY LEFT BLANK

STAGE 2 REPORT AVAILABLE BY REQUEST
CONTACT ILLINOIS EPA AT:
217-782-3362
OR DOWNLOAD DOCUMENT FROM ILLINOIS EPA WEBSITE:
http://www.epa.state.il.us/water/tmdl/report-status.html

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix F
QUAL2K Inputs

THIS PAGE INTENTIONALLY LEFT BLANK

MODEL INPUTS

Headwaters - JQ-05	Min	Max	Mean	July-Oct Min	July-Oct Max	July-Oct Mean	Units needed for mode
Flow	0.000	218.040	4.190	0.000	116.382	1.199	m3/second
Temperature	0.8	28.0	15.2	10.8	27.2	20.9	C
DO	3.8	14.0	8.1	3.8	8.7	6.5	mg/L
CBOD	2	2	2	2	2	2	mgO2/L
Organic Nitrogen	360.0	1300.0	764.0	N/A	N/A	N/A	ugN/L
Ammonia	10.0	14000.0	4695.2	10.0	270.0	75.5	ugN/L
Nitrate* (NO3+NO2)	10.0	2000.0	645.2	10.0	730.0	309.1	ugN/L
Organic Phosphorus	30.0	310.0	105.3	30.0	196.0	99.6	ugP/L
Inorganic Phosphorus	10.0	258.0	73.9	40.0	258.0	100.7	ugP/L
Chlorophyll-a	N/A	N/A	N/A	N/A	N/A	N/A	ugA/L

	Location				Elevation	
Reach	Upstream (km)	Downstream (km)	Segment Length	Segment Slope	Upstream (m)	Downstream (m)
RJQ-05	13.10	8.40	4.7	0.000574468	129.5	126.8
RJQ-07	8.40	2.80	5.6	0.0005	126.8	124
RJQ-01	2.80	0.00	2.8	0.000428571	124	122.8

Downstream					
Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds
38	48	36.7	-90	1	31.6
38	48	19.6	-90	5	11.1
38	48	20.1	-90	6	51.8

Point Source Data: http://www.epa.gov/enviro/html/pcs/pcs_query_java.html (downloaded July 16-17, 2007)

Point Sources	Permit Number						
Conoco Inc. Woodriver	IL0071803	Location (km)	1.95				
	Permit Limit	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.00025	0.0000	0.0789	0.0159	N/A	N/A	N/A
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	N/A	N/A	N/A	N/A	N/A	N/A	N/A
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
Explorer Pipeline - Wood River	IL0061522	Location (km)	1.95				
	Permit Limit	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.006	0.0000	0.1047	0.0149	0.0000	0.0013	0.0005
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	20 (BOD)	N/A	N/A	N/A	N/A	N/A	N/A
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
Village of Roxanna STP	IL0077356	Location (km)					
	Permit Limit	**Min**	**Max**	**Mean**	**July-Oct Min**	**July-Oct Max**	**July-Oct Mean**
Flow (cms)	0.028	N/A	N/A	N/A	N/A	N/A	N/A
Temperature	N/A	N/A	N/A	N/A	N/A	N/A	N/A
DO	6 (MIN)	N/A	N/A	N/A	N/A	N/A	N/A
CBOD	20	N/A	N/A	N/A	N/A	N/A	N/A
Organic N	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ammonia	15000	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	<2000	N/A	N/A	N/A	N/A	N/A	N/A
Inorganic P	<2000	N/A	N/A	N/A	N/A	N/A	N/A

Sampling Location	Lat - Degrees	Lat - Minutes	Lat - Seconds	Long - Degrees	Long - Minutes	Long - Seconds	Location (km)
JQ-05	38	49	27.48	-89	58	27.84	13.1
JQ-07	38	48	18	-90	4	2.28	4.15
JQ-01	38	48	19.44	-90	6	8.28	1.38

Sampling Location	Min Flow	Max Flow	Avg. Flow	July-Oct Min Flow	July-Oct Max Flow	July-Oct Avg. Flow	Estimated Depth
JQ-07	0.000	287.058	5.516	0.000	153.222	1.578	1.800
JQ-01	0.000	291.486	5.601	0.000	155.586	1.603	2.500

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix G
Fecal Coliform Analysis

THIS PAGE INTENTIONALLY LEFT BLANK

Date	Result (cfu/100mL)	Flow (cfs)	Load (million cfu/day)	Geometric mean load (million cfu/day)	Exceeded Geometric mean load (million cfu/day)
10/2/1991	590000.00	0.63	9094934	3083	3083
10/28/1992	100.00	0.65	1590	3181	
10/24/1995	1450.00	1.3	46123	6362	6362
9/4/1990	190.00	1.6	7438	7830	
7/30/1991	120.00	2.5	7341	12234	
8/14/1997	530.00	3	38905	14681	14681
8/2/1994	310.00	3.1	23514	15170	15170
9/27/2004	155.00	3.1	11757	15170	
7/10/1997	13200.00	4	1291936	19575	19575
9/12/2002	150.00	4.7	17250	23000	
10/16/2002	54.00	4.7	6210	23000	
8/29/1995	350.00	5.2	44533	25447	25447
10/27/2003	80.00	5.6	10962	27405	
9/27/1994	6400.00	7.1	1111848	34745	34745
9/25/1997	880.00	7.1	152879	34745	34745
8/11/2003	440.00	7.2	77516	35235	35235
9/22/2003	196.00	7.4	35489	36213	
6/16/1992	2300.00	7.5	422081	36703	36703
9/15/1998	210.00	8.6	44190	42086	42086
6/6/1991	40.00	9.2	9004	45022	
7/30/1992	1100.00	10	269153	48937	48937
10/16/1990	370.00	11	99587	53831	53831
10/22/1996	470.00	11	126502	53831	53831
5/27/1992	2000.00	12	587244	58724	58724
9/17/1996	380.00	12	111576	58724	58724
8/2/2001	230.00	12	67533	58724	58724
7/25/1995	7800.00	13	2481104	63618	63618
7/18/1996	1130.00	13	359442	63618	63618
6/19/2001	240.00	14	82214	68512	68512
7/26/1990	1700.00	16	665543	78299	78299
6/28/2004	280.00	16	109619	78299	78299
10/20/1998	1200.00	17	499157	83193	83193
8/3/2004	200.00	22	107661	107661	
6/13/2000	6900.00	24	4051980	117449	117449
9/18/2001	490.00	26	311728	127236	127236
6/20/1995	695.00	30	510168	146811	146811
6/28/1994	3100.00	31	2351421	151705	151705
5/23/2000	1900.00	40	1859604	195748	195748
10/24/2000	205.00	43	215690	210429	210429
5/1/1990	220.00	44	236855	215323	215323
6/25/2002	121.00	48	142113	234897	
8/27/1992	10.00	50	12234	244685	
9/4/1991	6000.00	60	8808653	293622	293622
10/26/1993	270.00	61	402996	298515	298515
6/19/1990	2800.00	63	4316240	308303	308303
9/12/2000	2300.00	78	4389645	381708	381708
5/28/1997	16100.00	90	35454828	440433	440433
5/27/1998	1280.00	104	3257244	508944	508944
5/14/1991	15000.00	109	40005965	533413	533413
6/3/2004	740.00	121	2190908	592137	592137
8/10/2000	4500.00	174	19158820	851503	851503
5/21/2002	60.00	187	274536	915121	
5/13/2003	280.00	187	1281170	915121	915121
5/23/1995	460.00	202	2273611	988527	988527
6/6/1996	28000.00	263	180185887	1287042	1287042
6/11/2003	5800.00	388	55063867	1898754	1898754
8/18/1998	4500.00	407	44814021	1991734	1991734
10/16/2001	1115.00	474	12931836	2319612	2319612
6/23/1998	2100.00	846	43470702	4140067	4140067

AVERAGE = **433702**

Number of exceedences = 46

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix H
BATHTUB Files
Holiday Shores Lake

THIS PAGE INTENTIONALLY LEFT BLANK

Title: Holidayshores Lake

Notes:

	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	40.08	inches	1.01803	meters
Evaporation	35.3	inches	0.89662	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		

	inches to meters
Conversions:	0.0254

Total Lake Segments		3	CONVERSIONS	ft to m	
				0.3048	
Segment Name:	Segment 1: RJN-3				
Outflow Segment:	Segment 2: RJN-2				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.193	km	0.193	km2	
Mean Depth	10.43	ft	3.179064	meters	Total Depth
Length	1.2254	km	1.2254	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.1931	mg/L	193.1	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment Name:	Segment 2: RJN-2				
Outflow Segment:	Segment 3: RJN-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.544	km2	0.544	km2	
Mean Depth	19.3	ft	5.88264	meters	Total Depth
Length	1.0982		1.0982	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.1548	mg/L	154.8	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name:	Segment 3: RJN-1				
Outflow Segment:	Out of Reservoir				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.4142	km2	0.4142	km2	
Mean Depth	27.9	ft	8.50392	m	Total Depth
Length	1.1779	km	1.1779	km	Length in GIS
Mixed Layer Depth		ft		m	Depth where DO changes
Hypolimnetic Depth		ft		m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity	1		1	1/m	
Total Phosphorus	0.1490	mg/L	149.0	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model
Segment 1: RJN-3					
Segment 2: RJN-2					
Segment 3: RJN-1					

GNIS_Name	Shape_Perime	Shape_Are	Area (km2)	Segment
Holiday Lake	3	48	0.193	Segment 1
Holiday Lake	9	134	0.544	Segment 2
Holiday Lake	6	102	0.414	Segment 3

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	6	
Total area of the watershed =	3607.6	acres
Total annual estimated flow in the watershed =	5.2842408	mil m^3/yr

Tributary Name:	Direct Flow 1				
Segment:	Segment 1: RJN-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	350.3	acres	1.4	km2	
Flow Rate	0.795752106	cfs	0.7106067	million meters3/yr	
TP Conc		mg/L	210.21	ug/L	

Tributary Name:	Direct Flow 2				
Segment:	Segment 2: RJN-2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	652.4	acres	2.6	km2	
Flow Rate	1.481996915	cfs	1.32342337	million meters3/yr	
TP Conc		mg/L	210.21	ug/L	

Tributary Name:	Direct Flow 3				
Segment:	Segment 3: RJN-1				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	225.0	acres	0.9	km2	
Flow Rate	0.51109527	cfs	0.45640812	million meters3/yr	
TP Conc		mg/L	210.21	ug/L	

Tributary Name:	Joulters Creek				
Segment:	Segment 1: RJN-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	1637.2	acres	6.626	km2	
Flow Rate	3.71926047	cfs	3.32129992	million meters3/yr	
TP Conc		mg/L	210.21	ug/L	

Tributary Name:	Unnamed Trib -Northwest 1				
Segment:	Segment 1: RJN-3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	362.7	acres	1.468	km2	
Flow Rate	0.823989477	cfs	0.73582267	million meters3/yr	
TP Conc		mg/L	210.21	ug/L	

Tributary Name:	Unnamed Trib - Northwest 2				
Segment:	Segment 2: RJN-2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	379.9	acres	1.537	km2	
Flow Rate	0.863057123	cfs	0.77071009	million meters3/yr	

Lake Segment	Area (ac)	Area (km2)	Percent of To	Estimated Flow
RJN-3	350.3	1.418	13%	0.7106067
RJN-2	652.4	2.640	25%	1.32342337

Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area	0.0	acres	0.000	km2	
Flow Rate	0.292137057	cfs	0.26087842	million meters3/yr	
TP Conc		mg/L		ug/L	

Tributary Name					
Direct Flow 1					
Direct Flow 2					
Direct Flow 3	RJN-1	225.0	0.910	9%	0.456408
Joulters Creek	RJN-3	1637.2	6.626	63%	3.3213
Unnamed Trib - Northwest	RJN-2	362.7	1.468	14%	0.735823
Unnamed Trib -Northwest	RJN-3	379.9	1.537	15%	0.77071
TOTAL		**2604.9**	**10.5**		

Unit Conversions:

1 acre= 0.004046856 square kilometer

1cfs = 0.893000087 mil m^3/yr

CDM	Client:	Illinois EPA	Job No.	1681-41548	Computed By:
	Project:	TMDL Holiday Shores Lake Watershed	Dated Checked:		Date:
	Calculations:	**Total Phosphorus Loads**	Checked By:		Page No.

References:
1. "Illinois EPA Total Maximum Daily Load Holiday Shores Lake/Cahokia Creek Watershed" prepared by CDM dated 2006
2. USEPA PLOAD Version 3.0 User's Manual dated January 2001

3. USGS Fact Sheet FS-195-97: "Unit-Area Loads of Suspended Sediment, Suspended Solid, And Total Phosphorus From Small Watersheds in Wisconsin" prepared by Corsi, Graczik, Owens, and Bannerman

Methodology:
Holiday shores Lake Watershed is predominantly rural. (Reference 1, pg. 2-1)
Therefore, the export coefficient method described on Page 3 of Reference 2 is used to calculate median total phosphorus loads.
The minimum and maximum phosphorus loads are calculated using the procedure described in "Estimating Loads" section of Reference 3.

1. Calculate Median Total Phosphorus Load
Assumptions:

Export coefficients per land use (lb/ac/yr) are given in Appendix IV of Reference 2. The export coeffients for the Wisconsin area located in Appendix IV are most appropriate for the Holiday shores Lake watershed due to similar climate characteristics. The land use distribution for Holiday Shores watershed is given on page 5-7 of Reference 1. Export coeficients were assumed for the Holidayshores lake Land Use categories that are not listed in the Wisconsin categories. Assumed values are indicated with bold and italics.

Holiday Shores Lake Watershed Information		Total Phosphorus Export Coefficients		Phosphorus Loads		
Land Use	Area	High*	Low*	High	Low	
	acres	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	
Barren & Exposed Land	1.3344	0.16	0.16	0.2	0.2	0.2
Corn	833.9605	0.92	0.92	767.2	767.2	767.2
Deep Marsh	35.2738	**0.22**	***0.08***	7.8	2.8	5.3
Floodplain Forest	8.4426	**0.13**	0.08	1.1	0.7	0.9
High Density	37.3836	**2**	1	74.8	37.4	56.1
Low/Medium Density	284.9592	0.52	0.04	148.2	11.4	79.8
Other Agriculture	11.4248	0.92	0.92	10.5	10.5	10.5
Other Small Grains & Hay	34.0573	0.92	0.92	31.3	31.3	31.3
Partial Canopy/Savannah Upland	61.1508	0.13	0.08	7.9	4.9	6.4
Rural Grassland	627.9985	0.5	**0.16**	314.0	100.5	207.2
Seasonally/Temporarily Flood	40.5131	0.22	0.08	8.9	3.2	6.1
Shallow Marsh/Wet Meadow	1.511	**0.22**	***0.08***	0.3	0.1	0.2
Shallow Water	1.5652	**0.22**	***0.08***	0.3	0.1	0.2
Soybeans	878.3576	0.92	0.92	808.1	808.1	808.1
Surface Water	68.3251	**0.22**	***0.08***	15.0	5.5	10.2
Upland	204.5874	**0.13**	0.08	26.6	16.4	21.5
Winter Wheat	144.0521	0.92	0.92	132.5	132.5	132.5
Winter Wheat/Soybeans	331.4873	0.92	0.92	305.0	305.0	305.0
TOTAL	**3,606**			**2,660**	**2,238**	2448.9

*Export coefficient valuus listed in Appendix IV are MEDIAN values. The ranges for each land use are assumed.
Bold: No category for this land use in Wisconsin unit area loads. Use Florida unit area loads
Bold Italic: No category for this land use in Appendix IV. Use forest land use value.

Results:

The export coefficient values lised in Appendix IV of Reference 2 are median values. Therefore, the range calculated with this method is a range for the median, rather than a range between the minimum and maximum loads. The results show that the Holiday shores Lake watershed median Phosphorus load ranges between 2,238-2,660 lb/yr.

KAW
6/21/2005
1 of

Trib Name	Trib Area (acres)	Percent of Total	Trib Flow (mil m^3/yr)	Trib Concentration(lbs/yr)	Trib Concentration(ug/L)
Direct Flow 1	350.2945426	10%	0.513101658	237.7848481	210.21
Direct Flow 2	652.3833584	18%	0.955592914	442.8469729	210.21
Direct Flow 3	224.9870057	6%	0.329554679	152.7243348	210.21
Jouters Creek	1637.23933	45%	2.3981824218	1,111.381018	210.21
Unnamed Trib - Northwest 2	362.7247918	10%	0.5313091395	246.222676	210.21
Unnamed Trib -Northwest 1	379.9225886	11%	0.5564999917	257.896781	210.21
	3607.551617				

Unit Conversions:

1 cu m = 1000 liters
l pound = 453.59237 grams or 10^6 ug
(1 lb/yr) **/** (1 mil m^3/yr) = 0.45359237 ug/L

Median phosphorous load in the watershed = 2448.856631 lb/yr
Total average annual estimated flow in the watershed = 5.284240804 mil m^3/yr

Internal Loads	mg/m^2-day
Segment 1	14.2
Segment 2	16.7
Segment 3	21.3

Loadings	Observed	Predicted
Segment 1-RJN-3	193.1	193.3
Segment 2-RJN-2	154.8	155.0
Segment 3- RJN-1	149.0	148.2
Area-Wtd Mean	159.1	159.0

Holiday Shores Lake - Existing Conditions

File: C:\BATHTUB\Holiday Shores Lake - EXISTING.btb

Overall Water & Nutrient Balances

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

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	Direct Flow 1	1.4	0.5	0.00E+00	0.00	0.37
2	1	2	Direct Flow 2	2.6	1.0	0.00E+00	0.00	0.37
3	1	3	Direct Flow 3	0.9	0.3	0.00E+00	0.00	0.37
4	1	1	Joulters Creek	6.6	2.4	0.00E+00	0.00	0.36
5	1	1	Unnamed Trin - Northwest 1	1.5	0.5	0.00E+00	0.00	0.36
6	1	2	Unnamed Trin - Northwest 2	1.5	0.6	0.00E+00	0.00	0.36
7	4	3	Water Supply Outflow		0.3	0.00E+00	0.00	
PRECIPITATION				1.2	1.2	0.00E+00	0.00	1.02
TRIBUTARY INFLOW				14.5	5.3	0.00E+00	0.00	0.36
***TOTAL INFLOW				15.7	6.5	0.00E+00	0.00	0.41
GAUGED OUTFLOW					0.3	0.00E+00	0.00	
ADVECTIVE OUTFLOW				15.7	5.2	0.00E+00	0.00	0.33
***TOTAL OUTFLOW				15.7	5.4	0.00E+00	0.00	0.35
***EVAPORATION					1.0	0.00E+00	0.00	

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

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	Direct Flow 1	107.9	1.2%	0.00E+00		0.00	210.2	77.0
2	1	2	Direct Flow 2	200.9	2.3%	0.00E+00		0.00	210.2	77.3
3	1	3	Direct Flow 3	69.3	0.8%	0.00E+00		0.00	210.2	77.0
4	1	1	Joulters Creek	504.1	5.8%	0.00E+00		0.00	210.2	76.1
5	1	1	Unnamed Trin - Northwest 1	111.7	1.3%	0.00E+00		0.00	210.2	76.1
6	1	2	Unnamed Trin - Northwest 2	117.0	1.3%	0.00E+00		0.00	210.2	76.1
7	4	3	Water Supply Outflow	38.7		1.37E-01		0.01	148.2	
PRECIPITATION				34.5	0.4%	2.98E+02	100.0%	0.50	29.5	30.0
INTERNAL LOAD				7541.6	86.8%	0.00E+00		0.00		
TRIBUTARY INFLOW				1110.8	12.8%	0.00E+00		0.00	210.2	76.4
***TOTAL INFLOW				8687.0	100.0%	2.98E+02	100.0%	0.00	1345.5	553.9
GAUGED OUTFLOW				38.7	0.4%	1.37E-01		0.01	148.2	
ADVECTIVE OUTFLOW				765.0	8.8%	5.37E+01		0.01	148.2	48.8
***TOTAL OUTFLOW				803.7	9.3%	5.93E+01		0.01	148.2	51.2
***RETENTION				7883.3	90.7%	3.30E+02		0.00		

Nutrient Resid. Time (yrs)	0.1343
Turnover Ratio	7.4
Retention Coef.	0.907

	Percent Reduction						
Tributary Concentrations	80	85	86	87	88	89	90
210.21	42.041	31.531	29.429	27.327	25.225	23.123	21.021
Internal Loading							
14.2	2.84	2.13	1.988	1.846	1.704	1.562	1.42
16.7	3.34	2.505	2.338	2.171	2.004	1.837	1.67
21.3	4.26	3.195	2.982	2.769	2.556	2.343	2.13

Change Segment Concentrations to 50

Overall Mass Balance Based Upon Component:

Trb	**Type**	**Seg**	**Name**	**Predicted TOTAL P Load kg/yr**	**%Total**
1	1	1	Direct Flo\	10.8	1.0%
2	1	2	Direct Flo\	20.1	1.9%
3	1	3	Direct Flo\	6.9	0.7%
4	3	1	Joulters C	50.4	4.8%
5	3	1	Unnamed	11.2	1.1%
6	3	2	Unnamed	11.7	1.1%
7	4	3	Water Sup	12.9	
PRECIPITATION				34.5	3.3%
INTERNAL LOAD				905.0	86.1%
TRIBUTARY INFLOW				37.8	3.6%
POINT-SOURCE INFLOW				73.3	7.0%
***TOTAL INFLOW				1050.6	100.0%
GAUGED OUTFLOW				12.9	1.2%
ADVECTIVE OUTFLOW				255.5	24.3%
***TOTAL OUTFLOW				268.4	25.5%
***RETENTION				782.2	74.5%

Overflow Rate (m/yr)	4.7
Hydraulic Resid. Time (yrs)	1.3533
Reservoir Conc (mg/m3)	48

Appendix I
BATHTUB Files
Tower Lake

THIS PAGE INTENTIONALLY LEFT BLANK

Title:	Tower Lake			
Notes:				
	Historic Data	Units	Model Input	Model units
Averaging Period:	NA		1	yr
Precipitation	40.08	inches	1.01803	meters
Evaporation	35.3	inches	0.89662	meters
Increase in Storage	NA	NA		meters
Atmospheric Loads	NA	NS		
	inches to meters			
Conversions:	0.0254			

Total Lake Segments	3		CONVERSIONS	ft to m	
				0.3048	

Segment Name:	Segment 1: RJO-3				
Outflow Segment:	RJO-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.0720	km	0.0720	km2	
Mean Depth	19.6222	ft	5.9809	meters	Total Depth
Length	501.2500	km	0.5013	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			0.08	1/m	
Total Phosphorus	0.106083325	mg/L	106.083325	ug/L or ppb	
Dissolved Phosphorus	0.0602	mg/L	60.2	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name:	Segment 2: RJO-2				
Outflow Segment:	Segment 1: RJO-1				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.0851	km2	0.0851	km2	
Mean Depth	22.456	ft	6.8445888	meters	Total Depth
Length	734.8000	m	0.7348	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.102	mg/L	102.1666667	ug/L or ppb	
Dissolved Phosphorus	0.0684	mg/L	68.4	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

Segment Name:	Segment 2: RJO-1				
Outflow Segment:	Out of Reservoir				
	Historic Data	Units	Model Input	Model units	Notes
MORPHOMETRY					
Surface Area	0.1342	km	0.1342	km2	
Mean Depth	36.25	ft	11.049	meters	Total Depth
Length	437.7500		0.4378	km	Length in GIS
Mixed Layer Depth				m	Depth where DO changes
Hypolimnetic Depth				m	Leave Blank
OBSERVED WQ					
Non-Algal Turbidity			1	1/m	
Total Phosphorus	0.11966665	mg/L	119.66665	ug/L or ppb	
Dissolved Phosphorus	0.0637	mg/L	63.7	ug/L or ppb	
Internal Load	NA	NA		mg/m2-day	Adjust after initial run to calibrate model

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	6	
Total area of the watershed =	3607.6	acres
Total annual estimated flow in the watershed =	0.73852773	mil m^3/yr

Tributary Name:	Direct Flow 1				
Segment:	Segment 3: RJO - 1				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area		acres	0.25788	km2	
Flow Rate		cfs	0.09334867	million meters3/yr	
TP Conc		mg/L	122.93	ug/L	

Tributary Name:	Direct Flow 2			
Segment:	Segment 2: RJO - 2			
Tributary Type:				
	Historic Data	Units	Model Input	Model units
Total Watershed Area		acres	0.438	km2
Flow Rate		cfs	0.158603	million meters3/yr
TP Conc		mg/L	122.93	ug/L

Tributary Name:	Direct Flow 3				
Segment:	Segment 1: RJO - 3				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area		acres	0.582	km2	
Flow Rate		cfs	0.210636	million meters3/yr	
TP Conc		mg/L	122.93	ug/L	

Tributary Name:	Unnamed Creek				
Segment:	Segment 2: RJO - 2				
Tributary Type:					
	Historic Data	Units	Model Input	Model units	Notes
Total Watershed Area		acres	0.7624	km2	
Flow Rate	0.309003621	cfs	0.275940	million meters3/yr	
TP Conc		mg/L	122.93	ug/L	

Tributary Name:	Southern Illinois Univ - Edwardsville					
Segment:	Segment 3: RJO - 1					
Tributary Type:						
	Historic Data		Units	Model Input	Model units	Notes
Total Watershed Area		0.0	acres	0.000	km2	
Flow Rate		0.928401664	cfs	0.82906277	million meters3/yr	
TP Conc		0.38	mg/L	380.00	ug/L	*Permitted to discharge 1 mg/L - 0.38 from DMRs

Tributary Name:	Southern Illinois Univ - Pool					
Segment:	segment 1: RJO3					
Tributary Type:						
	Historic Data		Units	Model Input	Model units	Notes
Total Watershed Area		0.0	acres	0.000	km2	
Flow Rate		0.069630125	cfs	0.06217971	million meters3/yr	
TP Conc		0.05	mg/L	50.00	ug/L	*Estimated Concentration

Tributary Name	Lake Segment	Acres	Area (km2)	Percent of To	Estimated Flow
Direct Flow 1	Segment 3 - RJO 1	63.730	0.258	13%	0.093349
Direct Flow 2	Segment 2 - RJO 2	108.279	0.438	21%	0.158603
Direct Flow 3	Segment 1 - RJO 3	143.803	0.582	29%	0.210636
Unnamed Creek	Segment 2 - RJO 2	188.387	0.762	37%	0.275940
TOTAL		**504.2**	**2.040**		0.738528

Unit Conversions:

1 acre=	0.004046856	square kilometer
1cfs =	0.893000087	mil m^3/yr

CDM	Client:	Illinois EPA	Job No.	1681-41548	Computed By:	KAW
	Project:	TMDL Tower Lake Watershed	Dated Checked:		Date:	6/21/2005
	Calculations:	**Total Phosphorus Loads**	Checked By:		Page No.	1 of

References:
1. "Illinois EPA Total Maximum Daily Load Cahokia Creek/Holiday Shores Lake Watershed" prepared by CDM dated April 2006
2. USEPA PLOAD Version 3.0 User's Manual dated January 2001

3. USGS Fact Sheet FS-195-97: "Unit-Area Loads of Suspended Sediment, Suspended Solid, And Total Phosphorus From Small Watersheds in Wisconsin" prepared by Corsi, Graczik, Owens, and Bannerman

Methodology:

The export coefficient method described on Page 3 of Reference 2 is used to calculate median total phosphorus loads.
The minimum and maximum phosphorus loads are calculated using the procedure described in "Estimating Loads" section of Reference 3.

1. Calculate Median Total Phosphorus Load
Assumptions:

Export coefficients per land use (lb/ac/yr) are given in Appendix IV of Reference 2. The export coeffients for the Wisconsin area located in Appendix IV are most appropriate for the TowerLake watershed due to similar climate characteristics. The land use distribution for Tower Lake watershed is given on page 5-7 of Reference 1. Export coeficients were assumed for the Tower lake Land Use categories that are not listed in the Wisconsin categories. Assumed values are indicated with bold and italics.

Tower Lake Watershed Information		**Total Phosphorus Export Coefficients**		**Phosphorus Loads**			
Land Use	Area	High*	Low*	High	Low		
	acres	lb/ac/yr	lb/ac/yr	lb/yr	lb/yr	Percent of watershec	median
Deep Marsh	1.8589	**0.22**	***0.08***	0.4	0.1	0%	0.28
Floodplain Forest	63.7313	**0.13**	0.08	8.3	5.1	13%	6.69
High Density	67.2585	**2**	1	134.5	67.3	13%	100.89
Low/Medium Density	63.9172	0.52	0.04	33.2	2.6	13%	17.90
Partial Canopy/Savannah Upland	66.543	0.13	0.08	8.7	5.3	13%	6.99
Rural Grassland	1.6798	0.5	**0.16**	0.8	0.3	0%	0.55
Seasonally/Temporarily Flooded	17.4371	**0.22**	***0.08***	3.8	1.4	3%	2.62
Shallow Water	0.6672	**0.22**	***0.08***	0.1	0.1	0%	0.10
Soybeans	51.2797	0.92	0.92	47.2	47.2	10%	47.18
Surface Water	6.8158	**0.22**	***0.08***	1.5	0.5	1%	1.02
Upland	66.895	**0.13**	0.08	8.7	5.4	13%	7.02
Urban Open Space	93.8255	**0.16**	0.03	15.0	2.8	19%	8.91
TOTAL	**501.9**			**262**	**138**		200.15

*Export coefficient valuus listed in Appendix IV are MEDIAN values. The ranges for each land use are assumed.
Bold: No category for this land use in Wisconsin unit area loads. Use Florida unit area loads
Bold Italic: No category for this land use in Appendix IV. Use forest land use value.

Results:

The export coefficient values lised in Appendix IV of Reference 2 are median values. Therefore, the range calculated with this method is a range for the median rather than a range between the minimum and maximum loads. The results show that the Tower Lake watershed median Phosphorus load ranges between 138 lb/yr.

Trib Calcs

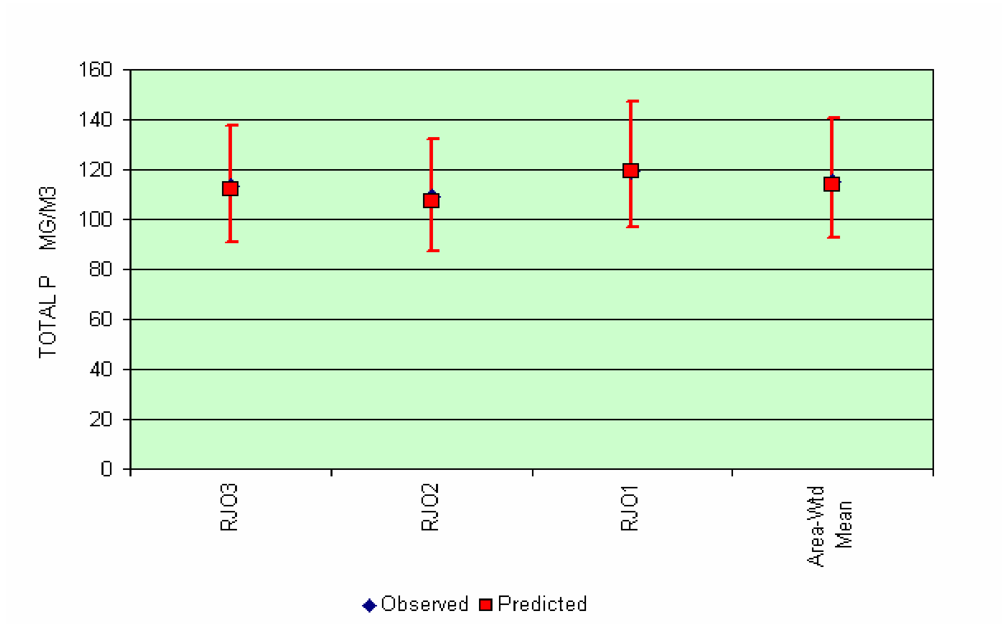
Trib Name	Trib Area (acres)	Percent of Total	Trib Flow (mil m^3/yr)	Trib Concentration(lbs/yr)	Trib Concentration(ug/L)
Direct Flow 1	63.730	13%	0.093348947	25.2987635	122.93
Direct Flow 2	108.279	21%	0.158602597	42.98334096	122.93
Direct Flow 3	143.800	29%	0.210631397	57.08381391	122.93
Unnamed Creek	188.387	37%	0.27594026	74.78335463	122.93
	504.2	1	**0.738523201**		

Unit Conversions:

1 cu m = 1000 liters
l pound = 453.59237 grams or 10^6 ug
(1 lb/yr) **/** (1 mil m^3/yr) = 0.45359237 ug/L

Median phosphorous load in the watershed = 200.149273 lb/yr
Total average annual estimated flow in the watershed = 0.738527729 mil m^3/yr

SCENARIO: NO COOLING WATER, STP AT HISTORIC DMR VALUES



INTERNAL LOAD	mg/m2/day
RJO1	17.5
RJO2	10.5
RJO3	10.5

File: **C:\BATHTUB\TowerLake-nocooling-existing.btb**
Variable: **TOTAL P MG/M3**

Segment	Predicted Mean	CV	Observed Mean	CV
RJO3	112.0	0.21	113.3	0.00
RJO2	107.3	0.21	108.8	0.00
RJO1	119.4	0.21	119.7	0.00
Area-Wtd Mean	114.0	0.21	114.9	0.00

File: **C:\BATHTUB\TowerLake-nocooling-existing.btb**

Overall Water & Nutrient Balances

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

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	3	Direct Flow to RJO1	0.3	0.1	0.00E+00	0.00	0.36
2	1	2	Direct Flow to RJO2	0.4	0.2	0.00E+00	0.00	0.57
3	1	2	Unnamed Creek to RJO2	0.8	0.2	0.00E+00	0.00	0.21
4	1	1	Direct Flow to RJO3	0.6	0.2	0.00E+00	0.00	0.36
5	3	3	SIUE-STP		0.8	0.00E+00	0.00	
6	3	1	SIUE-Pool		0.1	0.00E+00	0.00	
PRECIPITATION				0.3	0.3	0.00E+00	0.00	1.02
TRIBUTARY INFLOW				2.0	0.7	0.00E+00	0.00	0.35
POINT-SOURCE INFLOW					0.9	0.00E+00	0.00	
***TOTAL INFLOW				2.3	1.9	0.00E+00	0.00	0.81
ADVECTIVE OUTFLOW				2.3	1.6	0.00E+00	0.00	0.70
***TOTAL OUTFLOW				2.3	1.6	0.00E+00	0.00	0.70
***EVAPORATION					0.3	0.00E+00	0.00	

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

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	3	Direct Flow to RJO1	11.5	0.6%	0.00E+00		0.00	122.9	44.5
2	1	2	Direct Flow to RJO2	30.5	1.6%	0.00E+00		0.00	122.9	69.5
3	1	2	Unnamed Creek to RJO2	19.5	1.0%	0.00E+00		0.00	122.9	25.6
4	1	1	Direct Flow to RJO3	25.9	1.4%	0.00E+00		0.00	122.9	44.5
5	3	3	SIUE-STP	315.0	16.8%	0.00E+00		0.00	380.0	
6	3	1	SIUE-Pool	3.1	0.2%	0.00E+00		0.00	50.0	
PRECIPITATION				8.7	0.5%	1.91E+01	100.0%	0.50	29.5	30.0
INTERNAL LOAD				1460.3	77.9%	0.00E+00		0.00		
TRIBUTARY INFLOW				87.3	4.7%	0.00E+00		0.00	122.9	42.8
POINT-SOURCE INFLOW				318.2	17.0%	0.00E+00		0.00	357.0	
***TOTAL INFLOW				1874.5	100.0%	1.91E+01	100.0%	0.00	987.5	804.0
ADVECTIVE OUTFLOW				195.5	10.4%	1.66E+03		0.21	119.4	83.8
***TOTAL OUTFLOW				195.5	10.4%	1.66E+03		0.21	119.4	83.8
***RETENTION				1679.0	89.6%	1.68E+03		0.02		

Overflow Rate (m/yr)	5.6	Nutrient Resid. Time (yrs)	0.1518
Hydraulic Resid. Time (yrs)	1.5247	Turnover Ratio	6.6
Reservoir Conc (mg/m3)	114	Retention Coef.	0.896

	LBS/DAY
EXISTING LOAD	**11.32**

SCENARIO: NO COOLING WATER
60% REDUCTION IN TRIB CONCENTRATIONS, 95% REDUCTION IN INTERNAL LOADING

File: **C:\BATHTUB\TowerLake-nocooling-TMDL.btb**

Overall Water & Nutrient Balances

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

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	3	Direct Flow to RJO1	0.3	0.1	0.00E+00	0.00	0.36
2	1	2	Direct Flow to RJO2	0.4	0.2	0.00E+00	0.00	0.57
3	1	2	Unnamed Creek to RJO2	0.8	0.2	0.00E+00	0.00	0.21
4	1	1	Direct Flow to RJO3	0.6	0.2	0.00E+00	0.00	0.36
5	3	3	SIUE-STP		0.8	0.00E+00	0.00	
6	3	1	SIUE-Pool		0.1	0.00E+00	0.00	
PRECIPITATION				0.3	0.3	0.00E+00	0.00	1.02
TRIBUTARY INFLOW				2.0	0.7	0.00E+00	0.00	0.35
POINT-SOURCE INFLOW					0.9	0.00E+00	0.00	
***TOTAL INFLOW				2.3	1.9	0.00E+00	0.00	0.81
ADVECTIVE OUTFLOW				2.3	1.6	0.00E+00	0.00	0.70
***TOTAL OUTFLOW				2.3	1.6	0.00E+00	0.00	0.70
***EVAPORATION					0.3	0.00E+00	0.00	

Overall Mass Balance Based Upon **Predicted** **Outflow & Reservoir Concentrations**

Component: **TOTAL P**

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	3	Direct Flow to RJO1	4.6	0.9%	0.00E+00		0.00	49.2	17.8
2	1	2	Direct Flow to RJO2	12.2	2.3%	0.00E+00		0.00	49.2	27.8
3	1	2	Unnamed Creek to RJO2	7.8	1.5%	0.00E+00		0.00	49.2	10.2
4	1	1	Direct Flow to RJO3	10.4	1.9%	0.00E+00		0.00	49.2	17.8
5	3	3	SIUE-STP	414.5	77.6%	0.00E+00		0.00	500.0	
6	3	1	SIUE-Pool	3.1	0.6%	0.00E+00		0.00	50.0	
PRECIPITATION				8.7	1.6%	1.91E+01	100.0%	0.50	29.5	30.0
INTERNAL LOAD				73.0	13.7%	0.00E+00		0.00		
TRIBUTARY INFLOW				34.9	6.5%	0.00E+00		0.00	49.2	17.1
POINT-SOURCE INFLOW				417.6	78.2%	0.00E+00		0.00	468.6	
***TOTAL INFLOW				534.3	100.0%	1.91E+01	100.0%	0.01	281.5	229.2
ADVECTIVE OUTFLOW				115.3	21.6%	5.07E+02		0.20	70.5	49.5
***TOTAL OUTFLOW				115.3	21.6%	5.07E+02		0.20	70.5	49.5
***RETENTION				419.0	78.4%	5.24E+02		0.05		

Overflow Rate (m/yr)	5.6	Nutrient Resid. Time (yrs)	0.2282
Hydraulic Resid. Time (yrs)	1.5247	Turnover Ratio	4.4
Reservoir Conc (mg/m3)	49	Retention Coef.	0.784

EXISTING LOAD	LC	WLA	LA	MOS	REDUCTION
11.3	3.2	2.2	0.7	0.3	71%

lbs/day	L/million gallons	mg/lbs	mgd		mg/L	
2.2	3785412	453592.4		0.6		0.45

Appendix J
Responsiveness Summary

THIS PAGE INTENTIONALLY LEFT BLANK