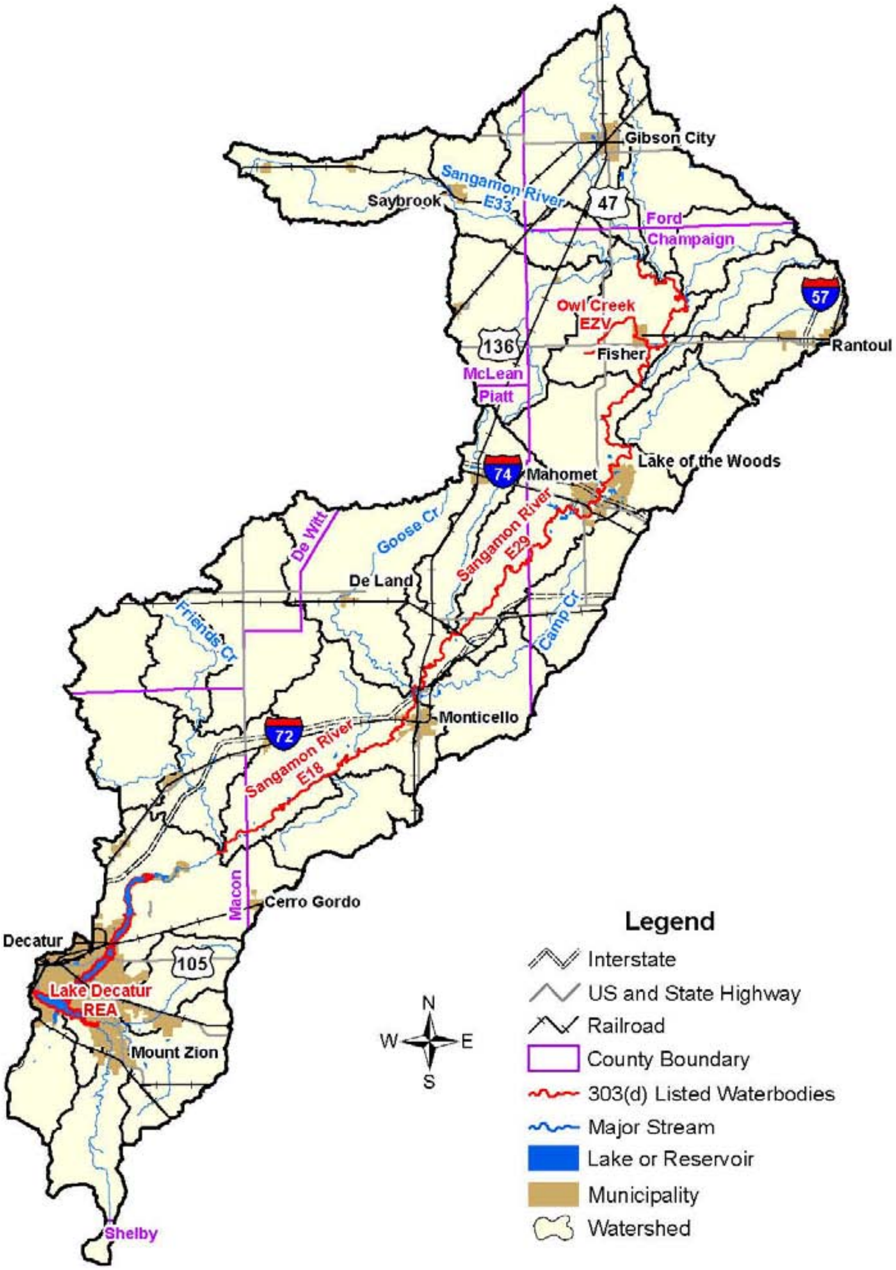
Illinois
Environmental
Protection Agency

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

August 2007

IEPA/BOW/07-017

Sangamon River/ Lake Decatur Watershed TMDL Report



Printed on Recycled Paper

Sang / Dec.

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

SEP 06 2007

REPLY TO THE ATTENTION OF:

WW-16J

RECEIVED
SEP 10 2007
Watershed Management Section
BUREAU OF WATER

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

Marcia

Dear Ms. Willhite:

The United States Environmental Protection Agency (U.S. EPA) has reviewed the final Total Maximum Daily Loads (TMDLs) submittal for the Sangamon River/Lake Decatur Watershed, including supporting documentation and follow up information. IEPA's TMDLs address the Sangamon River (IL_E-18 and IL_E-29), Owl Creek (IL_EZV), and Lake Decatur (IL_REA), in HUCs 0713000601 and 0713000602, 0713000601, and 0713000604, respectively. The Sangamon River is impaired for Primary Contact Recreational Use by fecal coliform, and Owl Creek is impaired for Aquatic Life Use by low Dissolved Oxygen and excess phosphorus. Lake Decatur is impaired for Aquatic Life Use, fish consumption, public and food processing water supplies, and aesthetic quality by phosphorus, nitrate nitrogen, aquatic algae, total suspended solids (TSS), and siltation/sedimentation. Based on this review, U.S. EPA has determined that Illinois' TMDLs for fecal coliform, phosphorus, and nitrate nitrogen meet the requirements of Section 303(d) of the Clean Water Act (CWA) and U.S. EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, U.S. EPA hereby approves Illinois' 5 TMDLs for the Sangamon River (2), Owl Creek, and Lake Decatur Watershed, addressing 12 impairments. The statutory and regulatory requirements, and U.S. EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document. IEPA also states that future plans to reduce phosphorus loading will also address other impairments, such as TSS.

Recycled/Recyclable • Printed with Vegetable Oil Based Inks on 100% Recycled Paper (50% Postconsumer)

TABLE OF CONTENTS

FINAL STAGE 1 REPORT

STAGE 2 REPORT

Stage 2 Report is a separate document on the TMDL website- http://www.epa.state.il.us/water/tmdl/report-status.html

FINAL APPROVED TMDL AND IMPLEMENTATION PLAN

This page is blank to facilitate double-sided printing.

Illinois Environmental
Protection Agency

Sangamon River/Lake Decatur Watershed
Total Maximum Daily Load
Stage One Report

October 2006

Final Report

THIS PAGE INTENTIONALLY LEFT BLANK

Contents

Section 1 Goals and Objectives for Sangamon River/Lake Decatur Watershed (0713000604, 0713000602, 0713000601)

Section 2 Sangamon River/Lake Decatur Watershed Description

Section 3 Public Participation and Involvement

Section 4 Sangamon River/Lake Decatur Watershed Water Quality Standards

Section 5 Sangamon River/Lake Decatur Watershed Characterization

Section 6 Approach to Developing TMDL and Identification of Data Needs

Appendices

Figures

THIS PAGE INTENTIONALLY LEFT BLANK

Tables

Acronyms and Abbreviations

°F	degrees Fahrenheit
ALMP	Ambient Lake Monitoring Program
BMP	best management practice
BOD	biochemical oxygen demand
$CBOD_5$	5-day carbonaceous biochemical oxygen demand
cfs	cubic feet per second
CRP	Conservation Reserve Program
CWA	Clean Water Act
DEM	Digital Elevation Model
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
DP	dissolved phosphorus
ft	foot
GIS	geographic information system
GWLF	generalized watershed loading function
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
ICLP	Illinois Clean Lakes Program
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
MBI	Macroinvertebrate Biotic Index
mg/L	milligrams per liter
MOS	margin of safety
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NRCS	National Resource Conservation Service
PO_4	phosphate
SSURGO	Soil Survey Geographic Database

Acronyms and Abbreviations (continued)

STATSGO	State Soil Geographic
STORET	Storage and Retrieval
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WLA	waste load allocation

Section 1
Goals and Objectives for Sangamon River/ Lake Decatur Watershed (0713000604, 0713000602, 0713000601)

1.1 Total Maximum Daily Load (TMDL) Overview

A Total Maximum Daily Load, or TMDL, is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards. TMDLs are a requirement of Section 303(d) of the Clean Water Act (CWA). To meet this requirement, the Illinois Environmental Protection Agency (Illinois EPA) must identify water bodies not meeting water quality standards and then establish TMDLs for restoration of water quality. Illinois EPA lists water bodies not meeting water quality standards every two years. This list is called the 303(d) list and water bodies on the list are then 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 Sangamon River/Lake Decatur 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 Stage 1 TMDL development for the Sangamon River/Lake Decatur watershed. Stage 2 and 3 will be conducted upon completion of Stage 1. Stage 2 is optional as data collection may not be necessary if additional data is not required to establish the TMDL.

Following this process, the TMDL goals and objectives for the Sangamon River/Lake Decatur watershed will include developing TMDLs for all impaired water bodies within the watershed, describing all of the necessary elements of the TMDL, developing an implementation plan for each TMDL, and gaining public acceptance of the process. Following are the impaired water body segments in the Sangamon River/ Lake Decatur watershed for which a TMDL will be developed:

- Sangamon River (E 18)
- Lake Decatur (REA)
- Sangamon River (E 29)
- Owl Creek (EZV)

These impaired water body segments are shown on Figure 1-1. There are four impaired segments within the Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur Watershed

Water Body Segment ID	Water Body Name	Size	Causes of Impairment with Numeric Water Quality Standards	Causes of Impairment with Assessment Guidelines
E 18	Sangamon River	24.20 miles	Total fecal coliform	
REA	Lake Decatur	3,093 acres	Total phosphorus, nitrogen as nitrate, dissolved oxygen(1)	Total nitrogen, sedimentation/siltation, total suspended solids (TSS), excess algal growth, chlordane, PCBs
E 29	Sangamon River	41.01 miles	Total fecal coliform	
EZV	Owl Creek	6.36 miles	Dissolved oxygen	Habitat alterations (streams), total phosphorus

(1) Data collected in 2003 indicates that Lake Decatur is no longer impaired for dissolved oxygen and the lake will no longer be on the State's 303(d) list. Therefore, a TMDL for dissolved oxygen is not being developed.

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, total phosphorus (numeric standard), nitrogen as nitrate, and dissolved oxygen impairments in the Sangamon River/Lake Decatur 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 completed during Stage 3 of the TMDL, 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 Sangamon River/Lake Decatur watershed will describe how water quality standards will be attained. This implementation plan will include 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 Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur Watershed Water Quality Standards** defines the water quality standards for the impaired water body.
- **Section 5 Sangamon River/Lake Decatur 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.

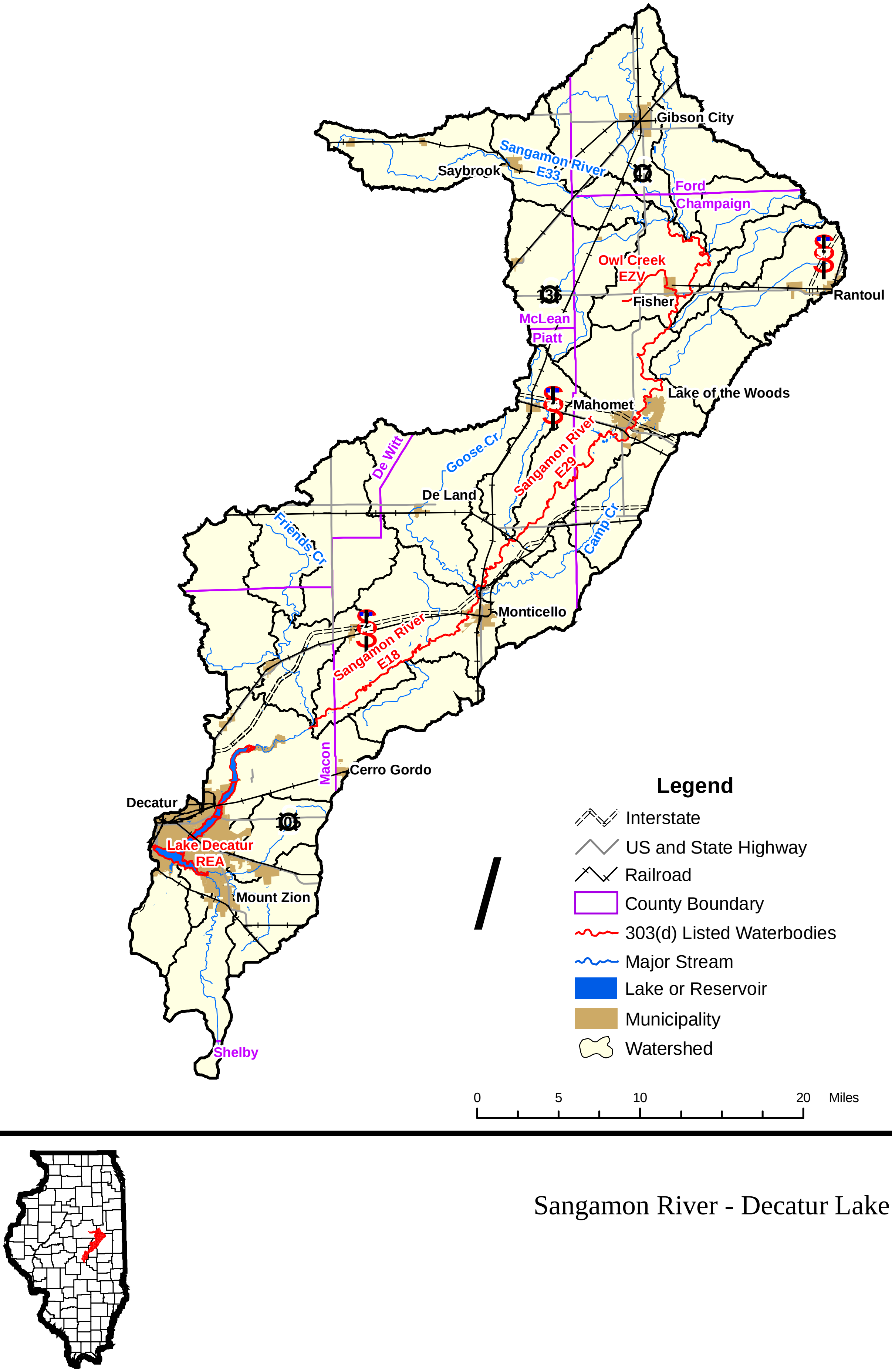


Figure 1-1
Sangamon River - Decatur Lake Watershed

THIS PAGE INTENTIONALLY LEFT BLANK

Section 2
Sangamon River/Lake Decatur Watershed Description

2.1 Sangamon River/Lake Decatur Watershed Location

The Sangamon River/Lake Decatur watershed (Figure 1-1) is located in central Illinois, flows in a southwesterly direction, and drains approximately 594,100 acres within the state of Illinois. Approximately 54,210 acres lie in southwestern Ford County, 146,325 acres lie in northwestern Champaign County, 56,960 acres lie in southeastern McLean County, 154,875 acres lie in northern Piatt County, 136,940 acres lie in eastern Macon County, 43,425 acres in southeastern De Witt County, and 1,390 acres lie in northern Shelby 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 Sangamon River/Lake Decatur watershed was obtained by overlaying the NED grid onto the GIS-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the Sangamon River/Lake Decatur watershed ranges from 954 feet above sea level in the headwaters of Sangamon River to 590 feet at its most downstream point at Decatur Lake in the southern end of the watershed. The absolute elevation change is 256 feet over the approximately 100-mile stream length of Sangamon River, which yields a stream gradient of approximately 2.6 feet per mile.

2.3 Land Use

Land use data for the Sangamon River/Lake Decatur watershed were extracted from the Illinois Gap Analysis Project (IL-GAP) Land Cover data layer. IL-GAP was started at the Illinois Natural History Survey (INHS) in 1996, and the land cover layer was the first component of the project. The IL-GAP Land Cover data layer is a product of the Illinois Interagency Landscape Classification Project (IILCP), an initiative to produce statewide land cover information on a recurring basis cooperatively managed by the United States Department of Agriculture National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data 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 Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur watershed, based on the IL-GAP land cover categories and also includes the area of each land cover category and percentage of the watershed area. Figure 2-2 illustrates the land uses of the watershed.

The land cover data reveal that approximately 535,409 acres, representing nearly 90 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for about 44 percent and 39 percent of the watershed area, respectively and rural grassland accounts for about 7 percent. Other cover types represent less than two percent of the watershed area.

Table 2-1 Land Cover and Land Use in Sangamon River/Lake Decatur Watershed

Land Cover Category	**Area (Acres)**	**Percentage**
Corn	263,128	44.3%
Soybeans	228,587	38.5%
Winter Wheat	585	0.1%
Winter Wheat/Soybeans	581	0.1%
Rural Grassland	42,528	7.2%
Upland	9,046	1.5%
Forested Areas	5,167	0.8%
High Density	11,813	2.0%
Low/Medium Density	8,222	1.4%
Urban Open Space	6,315	1.1%
Wetlands	14,326	2.4%
Surface Water	3,797	0.6%
Barren & Exposed Land	26	0.0%
Total	**594,121**	**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.

2.4 Soils

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

The Sangamon River/Lake Decatur Watershed falls within Ford, Champaign, McLean, Piatt, Macon, De Witt, and Shelby Counties. At this time, SSURGO data is only available for Champaign, Ford, and McLean Counties. STATSGO data has been used in lieu of SSURGO data for the portion of the watershed that lies within the other counties. Figure 2-3 displays the STATSGO soil map units as well as the SSURGO soil series in the Sangamon River/Lake Decatur watershed. Attributes of the spatial coverage can be linked to the STATSGO and SSURGO databases which provide information on various chemical and physical soil characteristics for each map unit and soil series. Of particular interest for TMDL development are the hydrologic soil groups as well as the K-factor of the Universal Soil Loss Equation. The following sections describe and summarize the specified soil characteristics for the Sangamon River/Lake Decatur watershed.

2.4.1 Sangamon River/Lake Decatur Watershed Soil Characteristics

Appendix B contains the STATSGO Map Unit IDs (MUIDs) for the Sangamon River/Lake Decatur Watershed as well as the SSURGO soil series. The table also contains the area, dominant hydrologic soil group, and k-factor range. Each of these characteristics is described in more detail in the following paragraphs. The predominant soil type in the STATSGO portion of the watershed are soils categorized as a fine-grained and made up of silts and clays with a liquid limit of less than 50 percent that tend toward a lean clay. The predominant soil type in the SSURGO portion of the watershed is Drummer silty clay loam on varying slopes.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms. Hydrologic soil groups B, C, and D are found within the Sangamon River/Lake Decatur 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." C 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 Sangamon River/Lake Decatur 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 87,882 people reside in the watershed. The major municipalities in the Sangamon River/Lake Decatur watershed are shown in Figure 1-1. The city of Decatur is the largest population center in the watershed and contributes an estimated 40,930 people to total watershed population.

2.6 Climate and Streamflow

2.6.1 Climate

Central Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from Decatur, Illinois (station id. 2193) in Macon County were extracted from the NCDC database for the years of 1901 through 2004. The data station in Decatur, Illinois was chosen to be representative of precipitation throughout the Sangamon River/Lake Decatur watershed.

Table 2-2 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 39 inches.

Table 2-2 Average Monthly Climate Data in Decatur, IL

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.2	36	19
February	2.0	40	22
March	3.3	52	31
April	3.9	65	42
May	4.3	75	52
June	4.1	84	61
July	3.6	89	65
August	3.6	87	63
September	3.5	80	56
October	3.0	68	44
November	2.7	53	33
December	2.5	40	23
Total	**38.7**		

2.6.2 Streamflow

Analysis of the Sangamon River/Lake Decatur watershed requires an understanding of flow throughout the drainage area. Two USGS gages within the watershed have available data (Figure 2-4). Table 2-3 summarizes the stations along with their respective information.

Table 2-3 Streamflow Gages in the Sangamon River/Lake Decatur Watershed

Gage Number	Name	POR
05570910	Sangamon River at Fisher, IL	1974-2004
05572000	Sangamon River at Monticello, IL	1909-2004

USGS gage 05570910 is located on the E 29 segment of the Sangamon River just upstream of the confluence with Owl Creek. The average monthly flows recorded at the Sangamon River at Fisher, Illinois gage range from 44 cubic feet per second (cfs) in September to 404 cfs in May with a mean annual monthly flow of 211 cfs (Figure 2-5).

USGS gage 05572000 is located on the E 28 segment of the Sangamon River, downstream of the confluence with Goose and Camp Creeks. The average monthly flows recorded at the Sangamon River at Monticello, Illinois gage range from 114 cfs in September to 802 cfs in April with a mean annual monthly flow of 422 cfs (Figure 2-5).

2.7 Watershed Photographs

The photographs shown here are of the Sangamon River/Lake Decatur watershed that were taken in the summer of 2006. Appendix D contains additional photographs of the watershed.

Lake Decatur at Williams Street Looking South

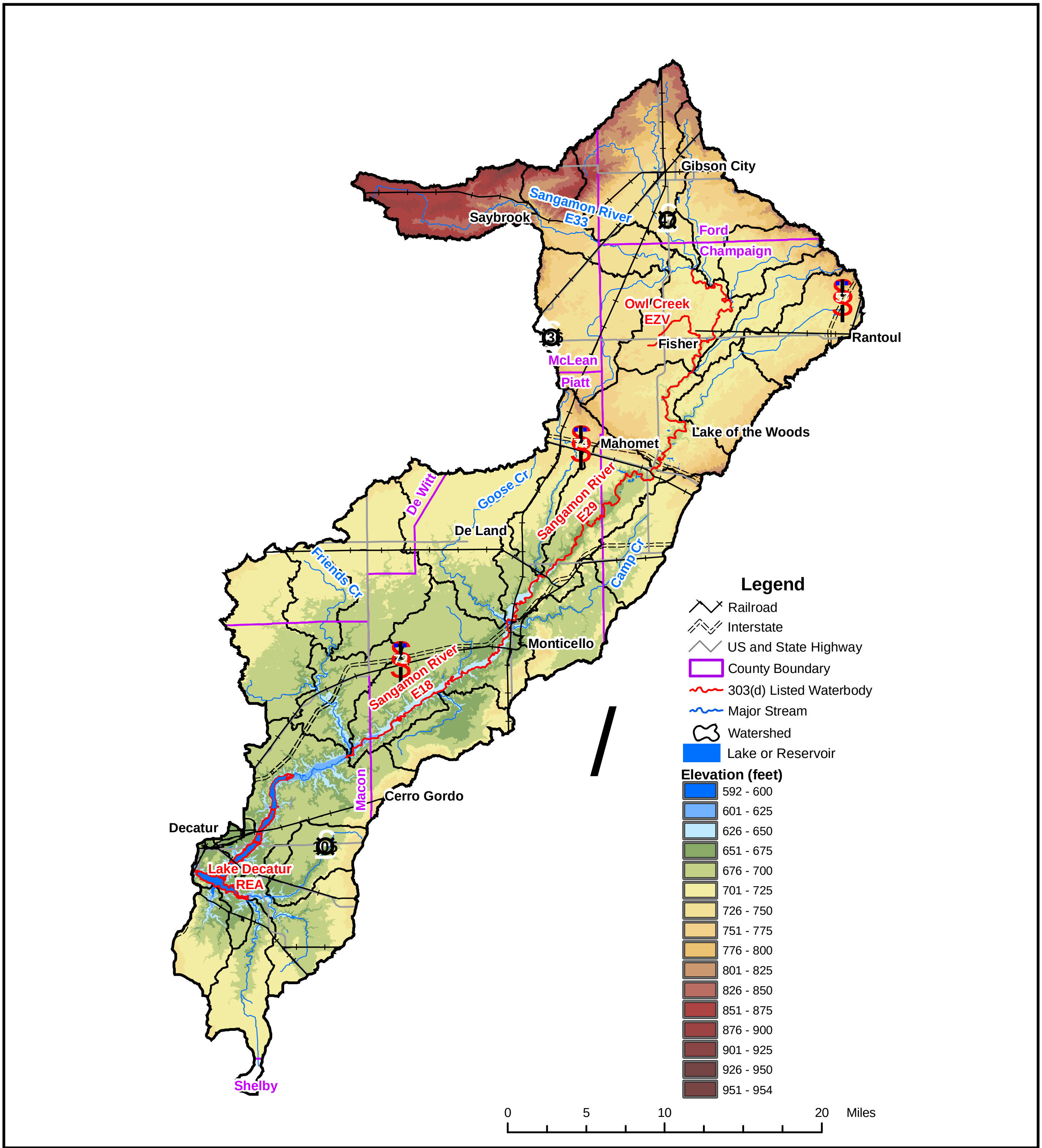
Sangamon River Segment E29 at Route 136 South Looking West

Sangamon River Segment E29 at 3000 North Road

Fisher Sanitary Treatment Plant Discharge (to Owl Creek)

Owl Creek 600 feet Downstream of Fisher Sanitary Treatment Plant

Owl Creek at 136 South Road



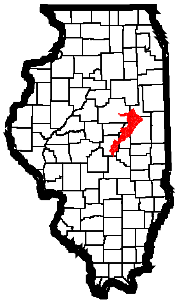
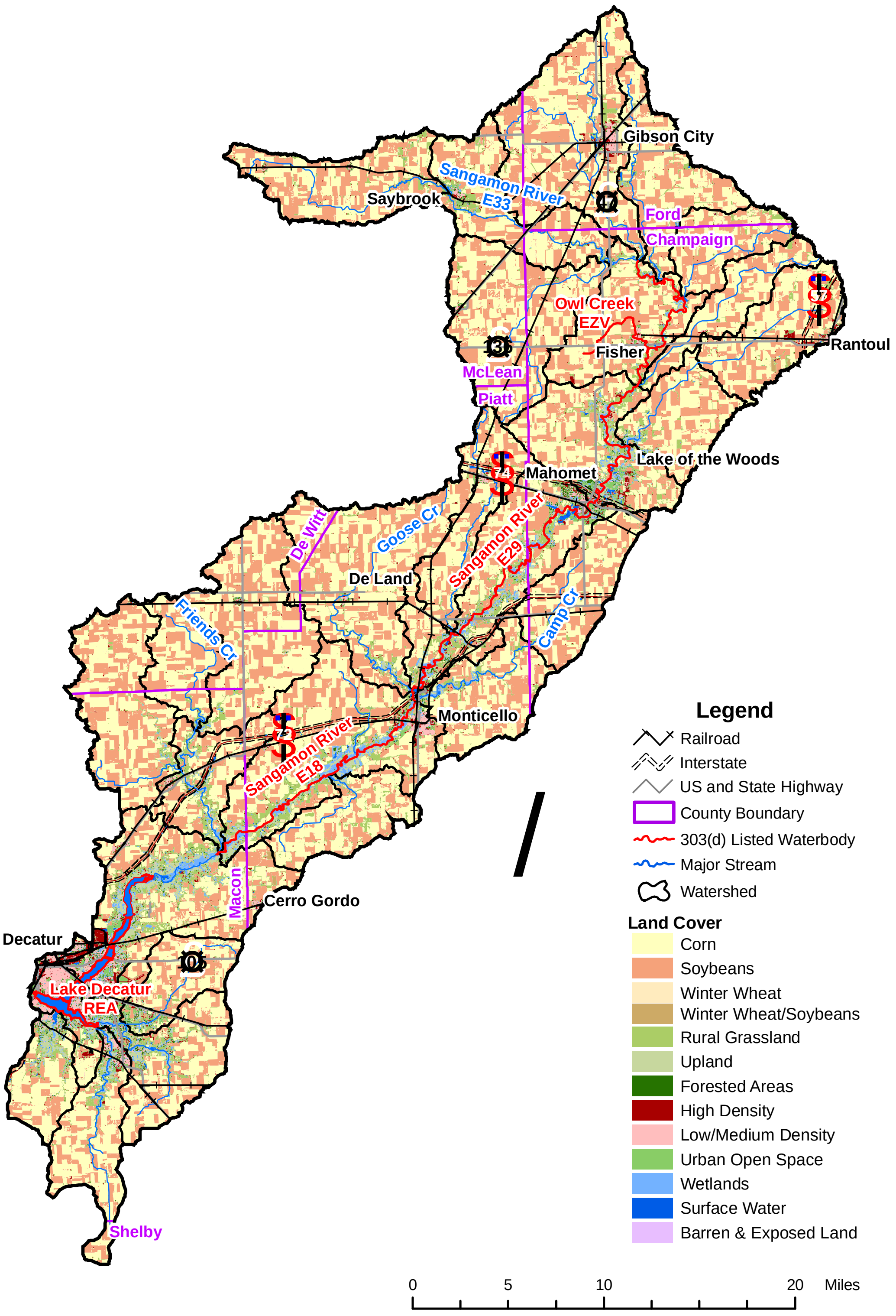


Figure 2-1
Sangamon River - Decatur Lake Watershed
Elevation

THIS PAGE INTENTIONALLY LEFT BLANK



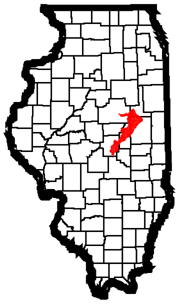
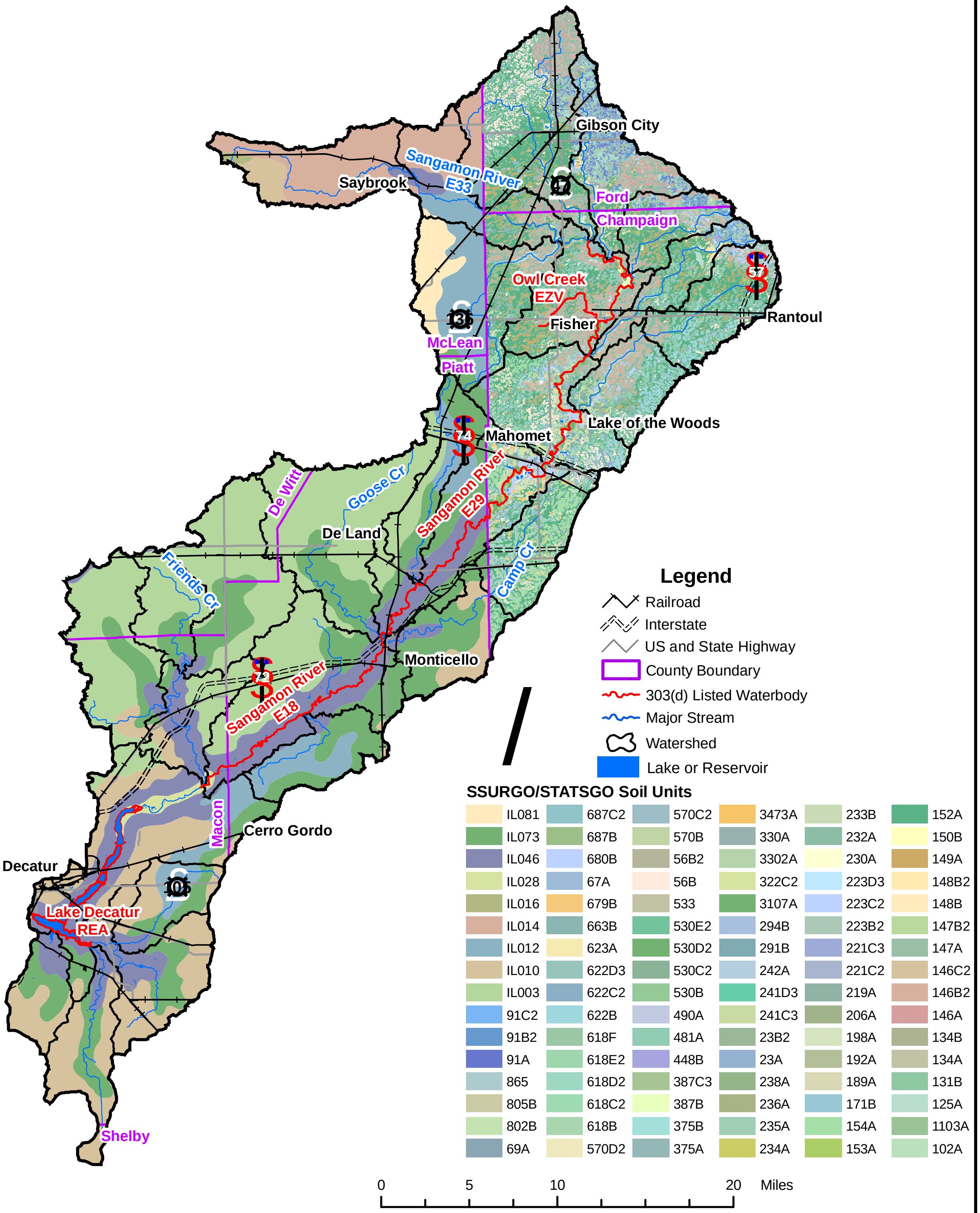


Figure 2-2
Sangamon River - Decatur Lake Watershed
Land Use

THIS PAGE INTENTIONALLY LEFT BLANK



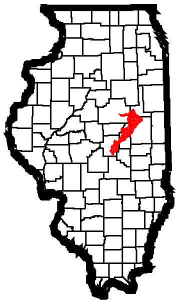
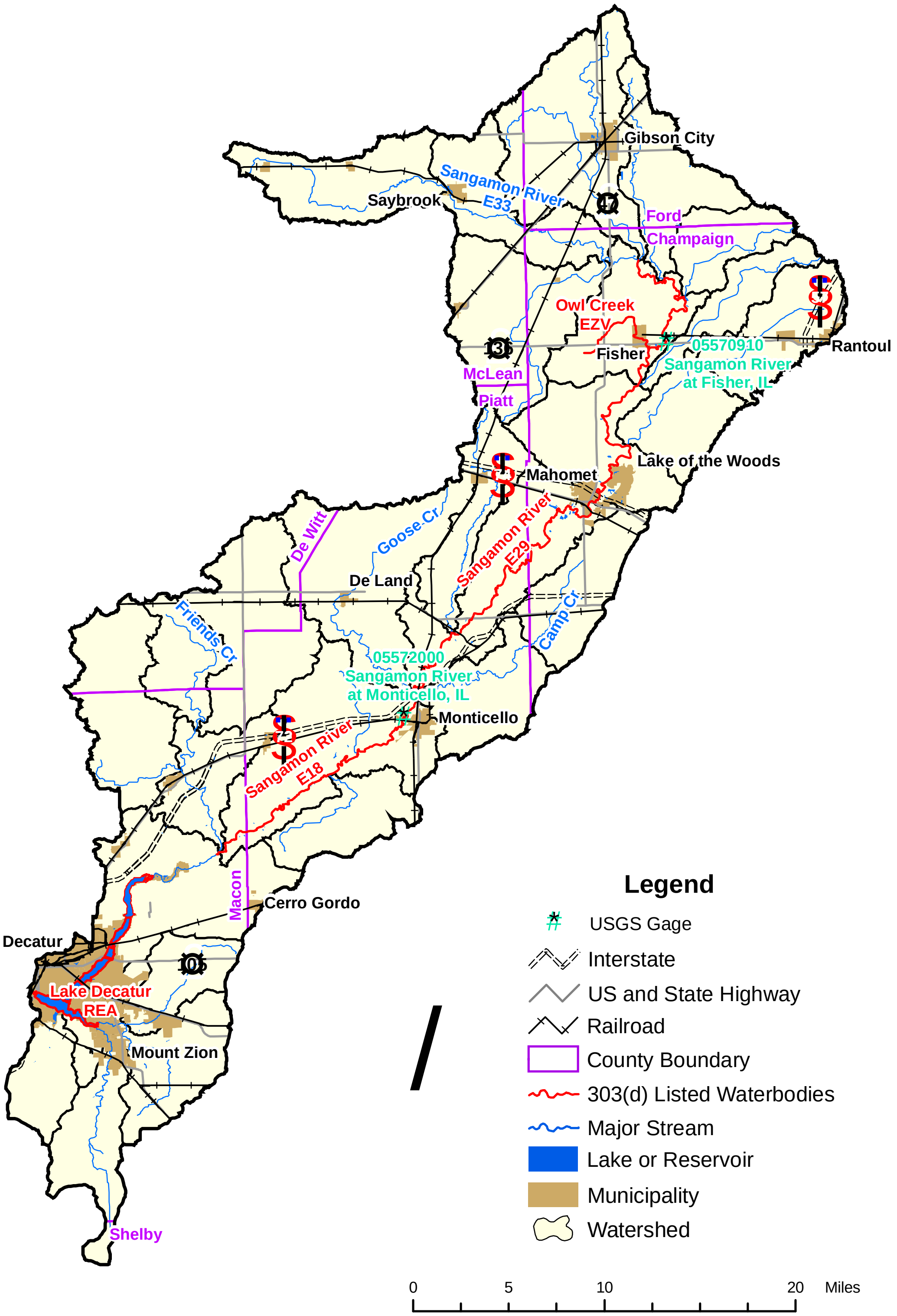


Figure 2-3
Sangamon River - Decatur Lake Watershed
Soils

THIS PAGE INTENTIONALLY LEFT BLANK



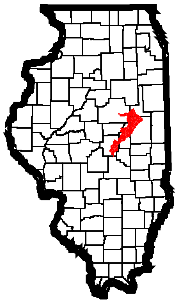
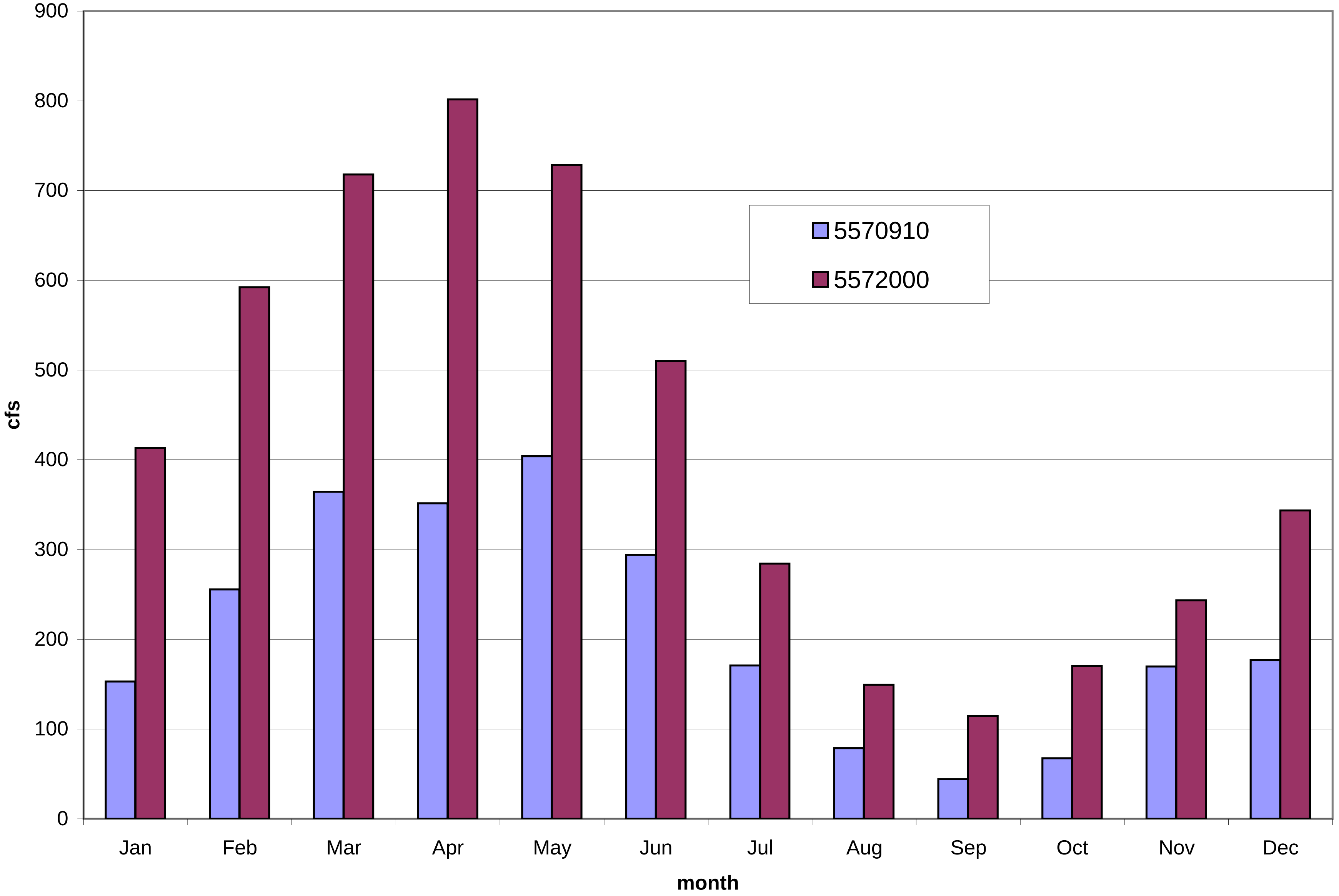


Figure 2-4
Sangamon River - Decatur Lake Watershed
USGS Gages

THIS PAGE INTENTIONALLY LEFT BLANK



CDM

Figure 2-5:
Average Total Monthly Streamflow at
USGS gages 05570910 and 05572000
Sangamon River at Fisher and Monticello, IL

T:\GIS\WRITEUP\13 Sangamon River_Decaur Lake\Data\SANGDECATUR.xlsFLOWCHART

THIS PAGE INTENTIONALLY LEFT BLANK

Section 3
Public Participation and Involvement

3.1 Sangamon River/Lake Decatur 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, will hold up to four public meetings within the watershed throughout the course of the TMDL development. A public meeting was held on May 31, 2006 at Richland Community College in Decatur, Illinois to present Stage 1 of TMDL development for the Sangamon River/Lake Decatur watershed.

THIS PAGE INTENTIONALLY LEFT BLANK

Section 4
Sangamon River/Lake Decatur 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, the Illinois Pollution Control Board (IPCB) is responsible for setting the water quality standards. Illinois is required to update water quality standards every three years in accordance with the CWA. The standards requiring modifications are identified and prioritized by Illinois EPA, in conjunction with USEPA. New standards are then developed or revised during the three-year period.

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

4.2 Designated Uses

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

4.2.1 General Use

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

4.2.2 Public and Food Processing Water Supplies

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

4.3 Illinois Water Quality Standards

To make 303(d) listing determinations for aquatic life uses, Illinois EPA first collects biological data and if this data suggests that an impairment to aquatic life exists, a comparison of available water quality data with water quality standards will then

5occur. 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 Sangamon River/Lake Decatur Watershed. TMDLs will only be developed for constituents with numeric water quality standards at this time.

Table 4-1 Summary of Water Quality Standards for Potential Sangamon River/Lake Decatur Watershed Lake Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
Chlordane - Statistical Guideline	NA	No numeric standard	No numeric standard
Excess Algal Growth	NA	No numeric standard	No numeric standard
Nitrogen, Nitrate	mg/L	No numeric standard	10
Oxygen, Dissolved	mg/L	5.0 instantaneous minimum; 6.0 minimum during at least 16 hours of any 24 hour period	No numeric standard
PCBs - Statistical Guideline	NA	No numeric standard	No numeric standard
Sedimentation/Siltation	NA	No numeric standard	No numeric standard
Total Nitrogen as N	NA	No numeric standard	No numeric standard
Total Phosphorus	mg/L	0.05(1)	No numeric standard
Total Suspended Solids	NA	No numeric standard	No numeric standard

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

1. Standard applies in particular inland lakes and reservoirs (greater than 20 acres) and in any stream at the point where it enters any such lake or reservoir.

Table 4-2 Summary of Water Quality Standards for Potential Sangamon River/Lake Decatur Watershed Stream Impairments

Parameter	Units	General Use Water Quality Standard	Public and Food Processing Water Supplies
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
Total Fecal Coliform	Count/ 100 mL	May through Oct – 200(1), 400(2) Nov though Apr – no numeric standard	2000(1)
Total Phosphorus 9000	NA	No numeric standard	No numeric standard

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

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 Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur Watershed

Segment ID	**Segment Name**	**Potential Causes**	**Potential Sources**
E 18	Sangamon River	Total fecal coliform	Source unknown
REA	Decatur Lake	Total phosphorus, total nitrogen as N, nitrate nitrogen, sedimentation/siltation, total suspended solids, excess algal growth, chlordane, PCBs	Industrial point sources, agriculture, crop-related sources, nonirrigated crop production, hydromodification, flow regulation/modification, habitat modification (other than hydromodification), bank or shoreline modification/destabilization, marinas, forest/grassland/parkland, source unknown
E 29	Sangamon River	Total fecal coliform	Source unknown
EZV	Owl Creek	Dissolved oxygen, habitat alterations (streams), total phosphorus	Agriculture, hydromodification, channelization, habitat modification (other than hydromodification), removal of riparian vegetation

THIS PAGE INTENTIONALLY LEFT BLANK

Section 5
Sangamon River/Lake Decatur Watershed Characterization

Data was collected and reviewed from many sources in order to further characterize the Sangamon River/Lake Decatur 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 8 historic water quality stations within the Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur 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 is 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 is 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 Sangamon River/Lake Decatur watershed stream data followed by Sangamon River/Lake Decatur watershed lake data.

5.1.1 Stream Water Quality Data

The Sangamon River/Lake Decatur watershed has three impaired stream segments within its drainage area that are addressed in this report. There is one active water quality station on each of the Sangamon River impaired segments and three monitoring stations associated with a Facility Related Stream Survey on the impaired Owl Creek 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 is available in Appendix C.

5.1.1.1 Fecal Coliform

Sangamon River segments E 18 and E 29 are listed as impaired for 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 during the months of May through 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 Segments E 18 and E 29.

Table 5-1 Existing Fecal Coliform Data for Sangamon River/Lake Decatur Watershed Impaired Stream Segments

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)
Sangamon River Segment E 18; Sample Location E 28						
Total Fecal Coliform (cfu/100 mL)	2000-2004; 19	181	830	10	5	3
Sangamon River Segment E 29; Sample Location E 29						
Total Fecal Coliform (cfu/100 mL)	1999-2003; 39	138	2,700	2	14	8

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

5.1.1.2 Dissolved Oxygen

Owl Creek segment EZV is listed as impaired for dissolved oxygen (DO). Data from a 1998 Facility Related Stream Survey for Fisher, Illinois is the only data available for this segment. There were three available data points from the report, which are summarized in Table 5-2. A sample was considered a violation if it was below 5.0 mg/L. All samples were collected on September 24, 1998 and as shown, one of the three samples was a violation. The violating sample was collected at EZV-A1.

Table 5-2 Existing DO Data for Sangamon River/Lake Decatur Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (mg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Owl Creek Segment EZV; Sample Locations EZV-A1, EZV-E1 and EZV-C1						
DO	5.0(1)	1998; 3	5.8	8.1	3.8	1
(1) Instantaneous Minimum						

5.1.2 Lake Water Quality Data

The Sangamon River/Lake Decatur watershed has one impaired lake within its drainage area that is addressed in this report. The data summarized in this section include water quality data for the impaired constituents as well as parameters that could be useful in future modeling and analysis efforts. All historic water quality data is available in Appendix C.

5.1.2.1 Lake Decatur

Lake Decatur is listed as impaired for total phosphorous and nitrogen as nitrate. There are three active stations in Lake Decatur (see Figure 5-1). An inventory of all available data associated with impairments at all depths is presented in Table 5-3.

Table 5-3 Lake Decatur Data Inventory for Impairments

Lake Decatur Segment REA; Sample Locations REA-1, REA-2, and REA-3		
REA-1	**Period of Record**	**Number of Samples**
Dissolved Phosphorus	1991-2003	55
Total Phosphorus	1990-2003	70
Phosphorus Bottom Deposits	1991-1997	3
Nitrite plus Nitrate	1990-2003	85
REA-2		
Dissolved Phosphorus	1991-2003	24
Total Phosphorus	1991-2003	24
Nitrite plus Nitrate	1990-2003	36
REA-3		
Dissolved Phosphorus	1991-2003	24
Total Phosphorus	1991-2003	24
Phosphorus Bottom Deposits	1991-1997	3
Nitrite plus Nitrate	1990-2003	36

Table 5-4 contains information on data availability for other parameters that may be useful in data needs analysis and future modeling efforts for phosphorus and nitrogen as nitrate. The inventory presented in Table 5-4 represents data collected at varying depths.

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

Lake Decatur Segment REA; Sample Locations REA-1, REA-2, and REA-3		
REA-1	**Period of Record**	**Number of Samples**
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1991-1997	27
Ammonia, Unionized (mg/L as N)	1991-1997	27
Chlorophyll-a Corrected	1991-2003	38
Chlorophyll-a µg/L Trichromatic Uncorrected	1991-2003	38
Depth of Pond or Reservoir in Feet	1991-1997	30
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1991-1997	3
Nitrogen, Ammonia, Total (mg/L as N)	1990-2003	73
Nitrogen, Kjeldahl, Total (mg/L as N)	1991-2003	57
Oxygen, Dissolved, Percent of Saturation (%)	1991-1997	163
Temperature, Water (degrees Centigrade)	1991-2003	250
REA-2		
Depth of Pond or Reservoir in Feet	1990-1998	174
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1991-1997	15
Ammonia, Unionized (mg/L as N)	1991-1997	15
Chlorophyll-a Corrected	1991-2003	23
Chlorophyll-a µg/L Trichromatic Uncorrected	1991-2003	23
Nitrogen, Ammonia, Total (mg/L as N)	1991-2003	25
Nitrogen, Kjeldahl, Total (mg/L as N)	1991-2003	24
Oxygen, Dissolved, Percent of Saturation (%)	1991-1997	82
Temperature, Water (degrees Centigrade)	1991-2003	122
Depth of Pond or Reservoir in Feet	1990-1998	186
REA-3		
Ammonia, Unionized (Calc Fr Temp-pH-NH4) (mg/L)	1991-1997	15
Ammonia, Unionized (mg/L as N)	1991-1997	15
Chlorophyll-a Corrected	1991-2003	22
Chlorophyll-a µg/L Trichromatic Uncorrected	1991-2003	22
Nitrogen Kjeldahl Total Bottom Dep Dry Wt mg/kg	1990-1997	3
Nitrogen, Ammonia, Total (mg/L as N)	1991-2003	25

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

Lake Decatur Segment REA; Sample Locations REA-1, REA-2, and REA-3		
Continued…		
Nitrogen, Kjeldahl, Total (mg/L as N)	1991-2003	24
Oxygen, Dissolved, Percent of Saturation (%)	1991-1994	32
Temperature, Water (degrees Centigrade)	1991-2003	129
Depth of Pond or Reservoir in Feet	1990-1997	118

5.1.2.1.1 Total Phosphorus

The water quality standard for total phosphorus is a concentration less than or equal to 0.05 mg/L. Compliance with the total phosphorus standard is assessed using 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 Lake Decatur are presented in Table 5-5.

Table 5-5 Average Total Phosphorus Concentrations (mg/L) in Lake Decatur at one-foot depth

	REA-1		**REA-2**		**REA-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	0.12	NA	NA	NA	NA	6; 5	0.12
1991	5; 5	0.13	5; 5	0.15	5; 5	0.19	15; 15	0.16
1992	5; 5	0.12	NA	NA	NA	NA	5; 5	0.12
1994	5; 5	0.16	5; 5	0.18	5; 5	0.14	15; 15	0.16
1996	2; 2	0.46	NA	NA	NA	NA	2; 2	0.46
1997	5; 3	0.13	5; 5	0.15	5; 5	0.15	15; 13	0.14
2000	5; 4	0.08	5; 4	0.14	5; 2	0.07	15; 10	0.10
2003	4; 4	0.21	4; 4	0.20	4; 4	0.16	12; 12	0.19

As shown in the table, the majority of samples from 1990-2003 exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-3 shows the average annual total phosphorous concentrations in Lake Decatur.

5.1.2.1.2 Nitrite as Nitrate

Lake Decatur is a source of public water. Water from Lake Decatur that is treated at Decatur WTP violated the finished water standard for nitrogen-nitrate, and Lake Decatur was subsequently added to the 2004 303(d) list as impaired for nitrogen-nitrate. The public water supply use standard for full use support states that the maximum contaminant level for each parameter in treated water must not be exceeded in any samples taken during the most recent three sampling years. The maximum contaminant level for nitrogen-nitrate is 10 mg/L. Table 5-6 is a summary of the available finished water data from Decatur WTP. Although the nitrogen-nitrate standard was violated in past years, improvements have been made to the Decatur WTP and no violations of the standard were recorded between 2003 and 2005. Figure 5-4 shows the available nitrogen-nitrate data in the finished water at Decatur WTP.

Table 5-6 Average Nitrogen-Nitrate Concentrations (mg/L) in Decatur WTP Finished Water

Year	Data Count; Number of Violations	Average
2001	99; 12	5.8
2002	40; 15	7.3
2003	53; 0	2.1
2004	11; 0	6.6
2005	3; 0	3.5

5.2 Reservoir Characteristics

There is one impaired reservoir in the Sangamon River/Lake Decatur watershed. Reservoir information that can be used for future modeling efforts was collected from GIS analysis, the Illinois EPA, the U.S. Army Corps of Engineers, and USEPA water quality data. The following sections will discuss the available data for Lake Decatur.

5.2.1 Lake Decatur

Table 5-7 Lake Decatur Dam Information (U.S. Army Corps of Engineers)

Dam Length	64,000 feet
Dam Height	33 feet
Maximum Discharge	64,000 cfs
Maximum Storage	57,520 acre-feet
Normal Storage	18,420 acre-feet
Spillway Width	468 feet
Outlet Gate Type	B

Lake Decatur is in the City of Decatur in Macon County. The lake is approximately 3,090 acres with a shoreline length of 38 miles. In 1920, the lake was created by damming the Sangamon River and serves as a source of drinking water for the City of Decatur. Table 5-7 shows dam information for the lake while Table 5-8 contains average total depth data for each sampling location on the lake. The average maximum water depth is 15.9 feet.

Table 5-8 Average Depths (ft) for Lake Decatur Segment REA (Illinois EPA 2002 and USEPA 2002a)

Year	REA-1	REA-2	REA-3
1991	18.1	—	—
2000	14.9	6.5	6.8
2003	14.6	6.6	8.4
2005	16.0	—	—
Average	**15.9**	**6.6**	**7.6**

5.3 Point Sources

Point sources for the Sangamon River/Lake Decatur watershed have been separated into municipal/industrial sources and mining discharges. Available data has been summarized and presented in the following sections.

5.3.1 Point Sources

Permitted facilities must provide Discharge Monitoring Reports (DMRs) to Illinois EPA as part of their NPDES permit compliance. DMRs contain effluent discharge sampling results which are then maintained in a database by the State. There are 23 point sources located within the Sangamon River/Lake Decatur watershed. Figure 5-5 shows all permitted facilities that discharge to or upstream of impaired segments. 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 was not available. The impairments for each segment or downstream segment were considered when reviewing DMR data. Data has been summarized for any sampled parameter that is associated with a downstream impairment (i.e., all available nutrient and biological oxygen demand data was reviewed for segments that are impaired for dissolved oxygen). This will help in future model selection as well as source assessment and load allocation.

5.3.1.1 Lake Decatur Segment REA

There are eleven point sources with the potential to contribute discharge to Lake Decatur. Lake Decatur is listed as impaired for total phosphorus and nitrogen as nitrate. Table 5-9 contains a summary of available and pertinent DMR data for these point sources. No data was available for total phosphorus because sampling for this constituent is not typically required by the discharge permits. Nitrogen as nitrate in finished water for the Decatur WTP was discussed in Section 5.1.2.1.2.

Table 5-9 Effluent Data from Point Sources discharging to or upstream of Lake Decatur Segment REA (IEPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
PPG INDUSTRIES 1993-2005 IL0001791	Lake Decatur/Lake Decatur Segment REA	Average Daily Flow	0.2246MGD	NA
STALEY, A. E.-DECATUR SW ONLY 1996-2005 IL0002381	Lake Decatur/Lake Decatur Segment REA	Average Daily Flow	0.406 MGD	NA
ARCHER DANIEL MIDLAND-WEST 2004-2005 IL0038113	Lake Decatur/Lake Decatur Segment REA	Average Daily Flow	-	NA
ARGENTA-OREANA MIDDLE SCHOOL 1997-2005 IL0047643	Unnamed Tributary to Sangamon River/Lake Decatur Segment REA	Average Daily Flow	0.015 MGD	NA
LONG CREEK TOWNSHIP WTP 1993-2005 IL0048933	Lake Decatur/Lake Decatur Segment REA	Average Daily Flow	0.03 MGD	NA
ARCHER DANIELS MID-NORTH WTP 1993-2005 IL0060755	Lake Decatur/Lake Decatur Segment REA	Average Daily Flow	0.3 MGD	NA

Table 5-9 Effluent Data from Point Sources discharging to or upstream of Lake Decatur Segment REA (IEPA 2005) (continued)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
ARCHER DANIELS-DECATUR EAST 1993-2005 IL0061425	Fairies Pk Creek/Lake Decatur Segment REA	Average Daily Flow	0.0244 MGD	NA
WELDON WTP 1993-2005 IL0065048	Friends Creek/Lake Decatur Segment REA	Average Daily Flow	0.0034 MGD	NA
DECATUR NORTH WTP 1997-2002 ILG640170	NA/Lake Decatur Segment REA	Average Daily Flow	0.779 MGD	NA
ARGENTA WTP 1993-2005 IL0064246	Drainage Tile Tributary to Friends Creek/Lake Decatur Segment REA	Average Daily Flow	0.060 MGD	NA
OREANA WTP 1997-2005 ILG640176	Sangamon River/Lake Decatur Segment REA	Average Daily Flow	0.025 MGD	NA

5.3.1.2 Sangamon River Segments E 18 and E 29

There are 11 point sources with the potential to contribute discharge to Sangamon River segments E 18 and E 29. Segments E 18 and E 29 are listed as impaired for total fecal coliform. Table 5-10 contains a summary of available and pertinent DMR data for these point sources. Total fecal coliform data was available for three of eleven point sources.

Table 5-10 Effluent Data from Point Sources discharging to or upstream of Sangamon River Segments E 18 and E 29 (IEPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
VIOBIN USA-MONTICELLO 1998-2005 IL0005142	Unnamed Tributary to Sangamon River/ Sangamon River Segment E 18	Average Daily Flow	1.692 MGD	NA
CISCO WTP 1994-2005 IL0021571	Sangamon River/ Sangamon River Segment E 18	Average Daily Flow	0.0032 MGD	NA
GIBSON CITY WPCF 1989-2005 IL0023281	Drummer Creek/ Sangamon River Segment E 29	Average Daily Flow	0.575 MGD	NA
		Total Fecal Coliform	140.3 mg/L	-
MAHOMET STP 1989-2005 IL0024414	Sangamon River/ Sangamon River Segment E 29	Average Daily Flow	0.5 MGD	NA
		Total Fecal Coliform	45.8 mg/L	-
MONTICELLO WWTF 1989-2005 IL0029980	Unnamed Tributary to Sangamon River/ Sangamon River Segment E 18	Average Daily Flow	1.0 MGD	NA
		Total Fecal Coliform	334.6 mg/L	-
SOLAE LLC-GIBSON CITY 2004-2005 IL0035416	Drummer Creek/ Sangamon River Segment E 29	Average Daily Flow	0.116 MGD	NA

Table 5-10 Effluent Data from Point Sources discharging to or upstream of Sangamon River Segments E 18 and E 29 (IEPA 2005) (continued)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
WHITE HEATH WATERWORKS INC WTP 1987-2005 IL0051438	Sangamon River/ Sangamon River Segment E 29	Average Daily Flow	0.0016 MGD	NA
DELAND WTP 1993-2005 IL0052493	Goose Creek/ Sangamon River Segment E 18	Average Daily Flow	0.089 MGD	NA
UNIV-ALLERTON PARK & IL 4H CMP 1992-2005 IL0053325	Unnamed Tributary to Sangamon River/ Sangamon River Segment E 18	Average Daily Flow	0.056 MGD	NA
PEOPLES ENERGY-FISHER 1993-2005 IL0069248	Unnamed Tributary to Sangamon River/ Sangamon River Segment E 29	Average Daily Flow	0.032 MGD	NA
CONAIR CORPORATION 1999-2005 IL0074136	Unnamed Ditch Tributary to Sangamon River/ Sangamon River Segment E 29	Average Daily Flow	0.016 MGD	NA

5.3.1.3 Owl Creek Segment EZV

There is one permitted facility that discharges to Owl Creek segment EZV. Segment EZV is listed as impaired for dissolved oxygen. Table 5-11 contains a summary of available DMR data for this point source.

Table 5-11 Effluent Data from Point Source discharging to Owl Creek Segment EZV (IEPA 2005)

Facility Name Period of Record Permit Number	Receiving Water/ Downstream Impaired Waterbody	Constituent	Average Value	Average Loading (lb/d)
FISHER STP 1994-2005 IL0021016	Owl Creek/Owl Creek	Average Daily Flow	0.2 MGD	NA
		BOD, 5-Day	140.6 mg/L	-
		CBOD, 5-Day	3.9 mg/L	5.75
		Dissolved Oxygen	6.59 mg/L	-

5.3.2 Mining Discharges

There are no permitted mine sites or recently abandoned mines within the Sangamon River/Lake Decatur 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 Sangamon River/Lake Decatur watershed. This section will discuss site-specific cropping practices, animal operations, and area septic systems. Data was collected through communication with the local NRCS, Soil and Water Conservation District (SWCD), public health departments, and county tax department officials.

5.4.1 Crop Information

The majority of the land found within the Sangamon River/Lake Decatur watershed is devoted to crops. Corn and soybean farming account for approximately 44 percent and 39 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 Sangamon River/Lake Decatur Watershed was not available; however, the Ford, Champaign, McLean, Piatt, Macon, De Witt, and Shelby County practices were available and are shown in the following tables.

Table 5-12 Tillage Practices in Ford County

Tillage System	Corn	Soybean	Small Grain
Conventional	85%	25%	18%
Reduced - Till	8%	28%	0%
Mulch - Till	2%	10%	18%
No - Till	5%	37%	64%

Table 5-13 Tillage Practices in Champaign County

Tillage System	Corn	Soybean	Small Grain
Conventional	73%	5%	0%
Reduced - Till	21%	31%	0%
Mulch - Till	3%	32%	0%
No - Till	3%	32%	100%

Table 5-14 Tillage Practices in McLean County

Tillage System	Corn	Soybean	Small Grain
Conventional	64%	4%	0%
Reduced - Till	10%	8%	0%
Mulch - Till	14%	54%	33%
No - Till	12%	35%	67%

Table 5-15 Tillage Practices in Piatt County

Tillage System	Corn	Soybean	Small Grain
Conventional	77%	0%	67%
Reduced - Till	20%	22%	0%
Mulch - Till	3%	54%	33%
No - Till	0%	24%	0%

Table 5-16 Tillage Practices in Macon County

Tillage System	Corn	Soybean	Small Grain
Conventional	93%	34%	0%
Reduced - Till	6%	47%	0%
Mulch - Till	0%	5%	0%
No - Till	0%	14%	0%

Table 5-17 Tillage Practices in De Witt County

Tillage System	Corn	Soybean	Small Grain
Conventional	82%	10%	0%
Reduced - Till	2%	28%	0%
Mulch - Till	6%	28%	0%
No - Till	11%	34%	0%

Table 5-18 Tillage Practices in Shelby County

Tillage System	Corn	Soybean	Small Grain
Conventional	82%	23%	63%
Reduced - Till	17%	48%	37%
Mulch - Till	1%	11%	0%
No - Till	0%	18%	0%

Estimates on tile drainage were provided by the Piatt, Macon, and Ford County NRCS offices. It is estimated that for Piatt and Macon counties in the Sangamon River/Lake Decatur Watershed, 70 to 75 percent of the farms are drained by field tiles. In Ford County, the soils have decent infiltration rates and the tile drainage is limited. It is estimated that approximately 40 percent of the farms in Ford County within the watershed are drained by field tiles. Information on tile drainage was not available from other county offices in the watershed. Site-specific data will be incorporated if it becomes available. Without local information, soils data will be reviewed for information on hydrologic soil group in order to provide a basis for tile drain estimates.

5.4.2 Animal Operations

Watershed specific animal numbers were not available for the Sangamon River/Lake Decatur Watershed. Data from the National Agricultural Statistics Service was reviewed and is presented below to show countywide livestock numbers.

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

	1997	2002	Percent Change
Cattle and Calves	4,315	5,687	32%
Beef	977	594	-39%
Dairy	255	12	-95%
Hogs and Pigs	40,055	29,874	-25%
Poultry	722	NA	NA
Sheep and Lambs	460	296	-36%
Horses and Ponies	NA	93	NA

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

	1997	2002	Percent Change
Cattle and Calves	5,992	5,062	-16%
Beef	1,899	NA	NA
Dairy	78	NA	NA
Hogs and Pigs	19,479	21,158	9%
Poultry	NA	3,772	NA
Sheep and Lambs	1,046	371	-65%
Horses and Ponies	NA	522	NA

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

	1997	2002	Percent Change
Cattle and Calves	13,986	13,122	-6%
Beef	4,038	3,884	-4%
Dairy	1,003	2,840	183%
Hogs and Pigs	100,529	92,321	-8%
Poultry	772	503	-35%
Sheep and Lambs	1,517	2,179	44%
Horses and Ponies	NA	759	NA

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

	1997	**2002**	**Percent Change**
Cattle and Calves	3,116	2,294	-26%
Beef	NA	701	NA
Dairy	NA	113	NA
Hogs and Pigs	15,859	8,072	-49%
Poultry	152	177	16%
Sheep and Lambs	169	230	36%
Horses and Ponies	NA	286	NA

Table 5-23 Macon County Animal Population (2002 Census of Agriculture)

	1997	**2002**	**Percent Change**
Cattle and Calves	3,584	3,295	-8%
Beef	NA	NA	NA
Dairy	NA	NA	NA
Hogs and Pigs	11,777	6,397	-46%
Poultry	219	214	-2%
Sheep and Lambs	537	189	-65%
Horses and Ponies	NA	346	NA

Table 5-24 De Witt County Animal Population (2002 Census of Agriculture)

	1997	**2002**	**Percent Change**
Cattle and Calves	3,081	3,591	17%
Beef	1,572	NA	NA
Dairy	50	NA	NA
Hogs and Pigs	6,118	22,107	261%
Poultry	350	536	53%
Sheep and Lambs	166	111	-33%
Horses and Ponies	NA	228	NA

Table 5-25 Shelby County Animal Population (2002 Census of Agriculture)

	1997	**2002**	**Percent Change**
Cattle and Calves	19,234	20,247	5%
Beef	6,374	6,120	-4%
Dairy	2,293	2,375	4%
Hogs and Pigs	68,558	56,285	-18%
Poultry	1,067	461	-57%
Sheep and Lambs	566	768	36%
Horses and Ponies	NA	925	NA

Communications with local NRCS officials have provided more watershed-specific animal information. Piatt County estimated that 15 animal operations exist within the Sangamon River/Lake Decatur Watershed, with a total of approximately 600 cows, 50 sheep, and 70 horses. Macon County reported 73 livestock operations in the watershed, but could not provide information regarding the number of livestock per farm. Ford County indicated that within the watershed area there is only one animal operation within that county; a cattle operation that exists in the area northwest of Gibson City. Information on animal operations was not available from other county offices in the watershed. Any additional site-specific information that becomes available will be incorporated.

5.4.3 Septic Systems

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

Information on septic systems within the Sangamon River/Lake Decatur Watershed was obtained for most of the counties that have land within the watershed boundaries. Information on sewered and septic municipalities was obtained from the county health department. Piatt and Dewitt County health departments were able to estimate the number of septic systems that exist. The Macon County Health Department was unable to provide an estimate of the number of septic systems. Therefore, the tax assessor was contacted to provide estimates of the number of existing residences located in areas known to be served by septic systems. Table 5-26 is a summary of the available septic system data in the Sangamon River/Lake Decatur Watershed.

Table 5-26 Estimated Septic Systems in the Sangamon River/ Lake Decatur Watershed

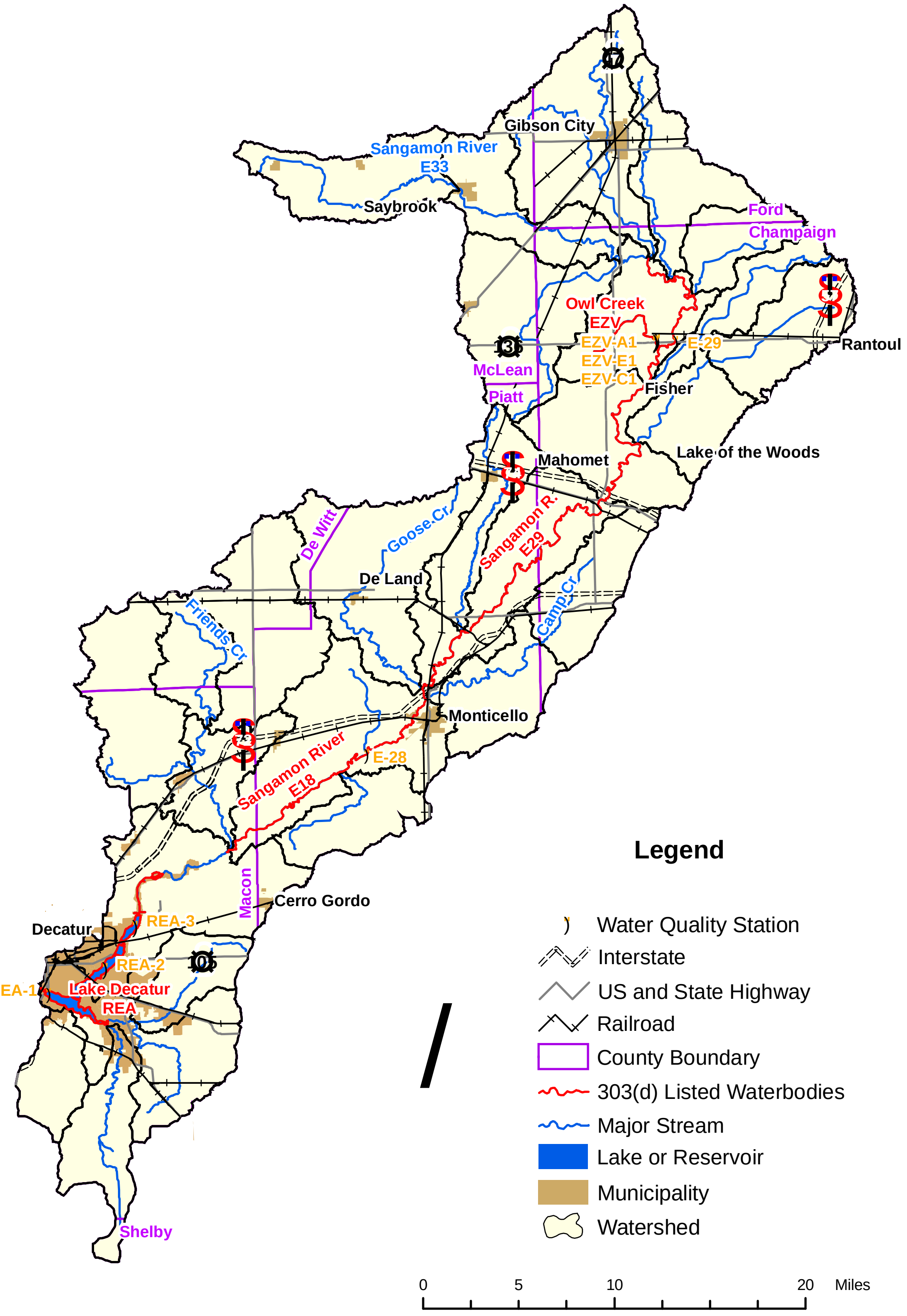
County	Estimated No. of Septic Systems	Source of Septic Areas/ No. of Septic Systems
Ford	0	Health Department
Champaign	NA	Health Department
McLean	NA	
Piatt	1,500	Health Department
Dewitt	440	Health Department
Macon	640	Health Department/ Tax Assessor
Shelby	negligible	
Total	**2,580**	

It is estimated that there are at least 2,580 septic systems in the watershed. In Macon County, where Lake Decatur is located, the municipality immediately surrounding the lake is sewered. However, there are two small municipalities, Oreana and Argenta, which are located approximately one and two miles, respectively, from Lake Decatur. Both of these communities are served by septic systems.

In Champaign County, where Lake of the Woods is located, the municipality surrounding the lake is served by septic systems. From the land use data (Section 2.1), it appears that there are residences east and south of the lake as well. Mahomet, which is the village just west of the Lake of the Woods, is sewered. Additionally, all of the rural residences outside of municipal boundaries are served by septic systems.

5.5 Watershed Studies and Other Watershed Information

The extent of previous planning efforts within the Sangamon River/Lake Decatur watershed is not known. It is assumed that this information will become available through public meetings within the watershed community. In the event that other watershed-specific information becomes available, it will be reviewed and all applicable data will be incorporated during Stages 2 and 3 of TMDL development.



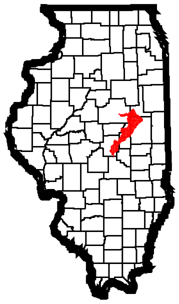
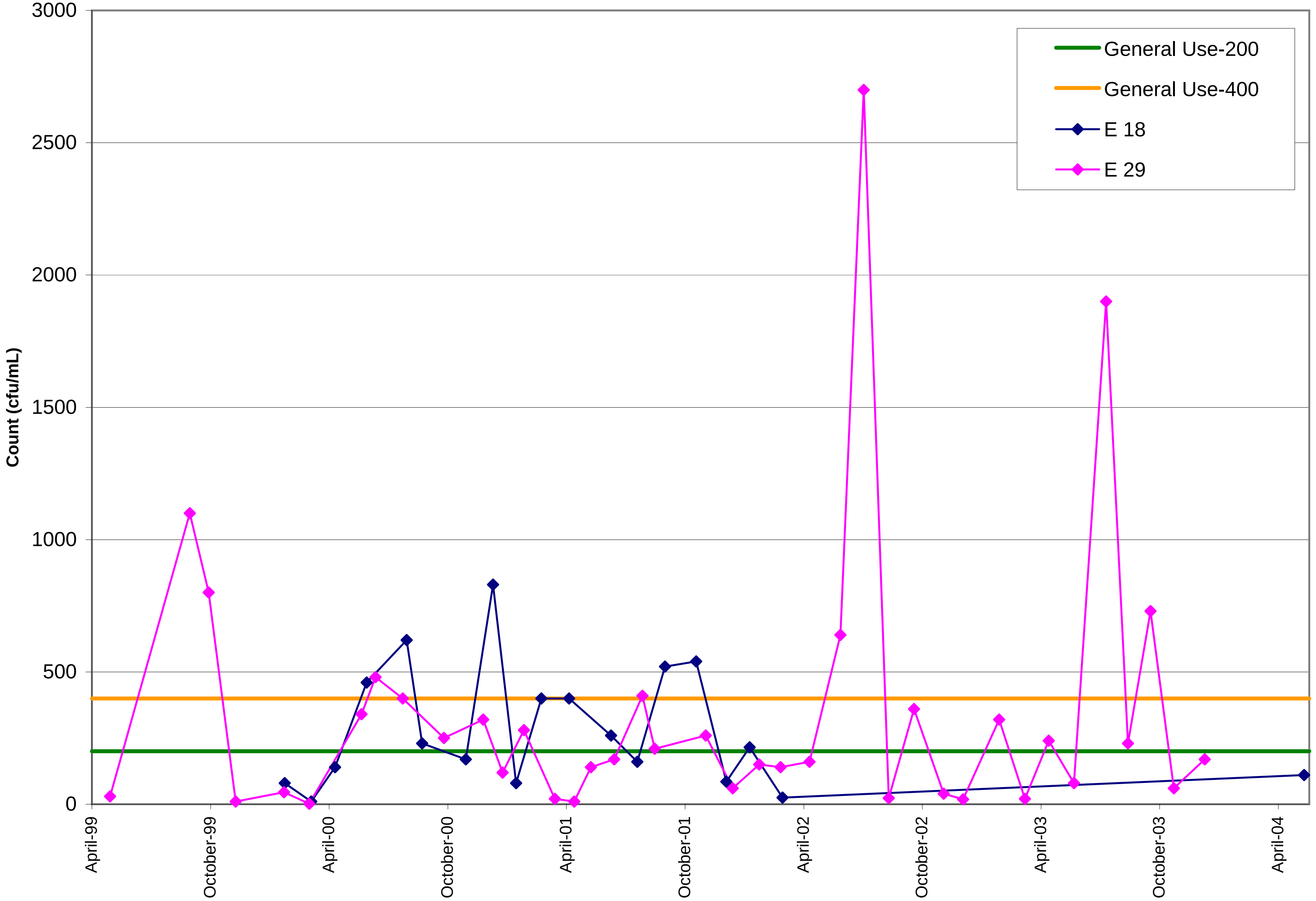


Figure 5-1
Water Quality Stations
Sangamon River - Decatur Lake Watershed

THIS PAGE INTENTIONALLY LEFT BLANK



CDM

Figure 5-2:
Sangamon River Segments E 18 and E 29
Fecal Coliform Samples

N:\13 Sangamon River_Decatur Lake\Data\SangamonR fecal summaryNEW.xlsPLT

THIS PAGE INTENTIONALLY LEFT BLANK

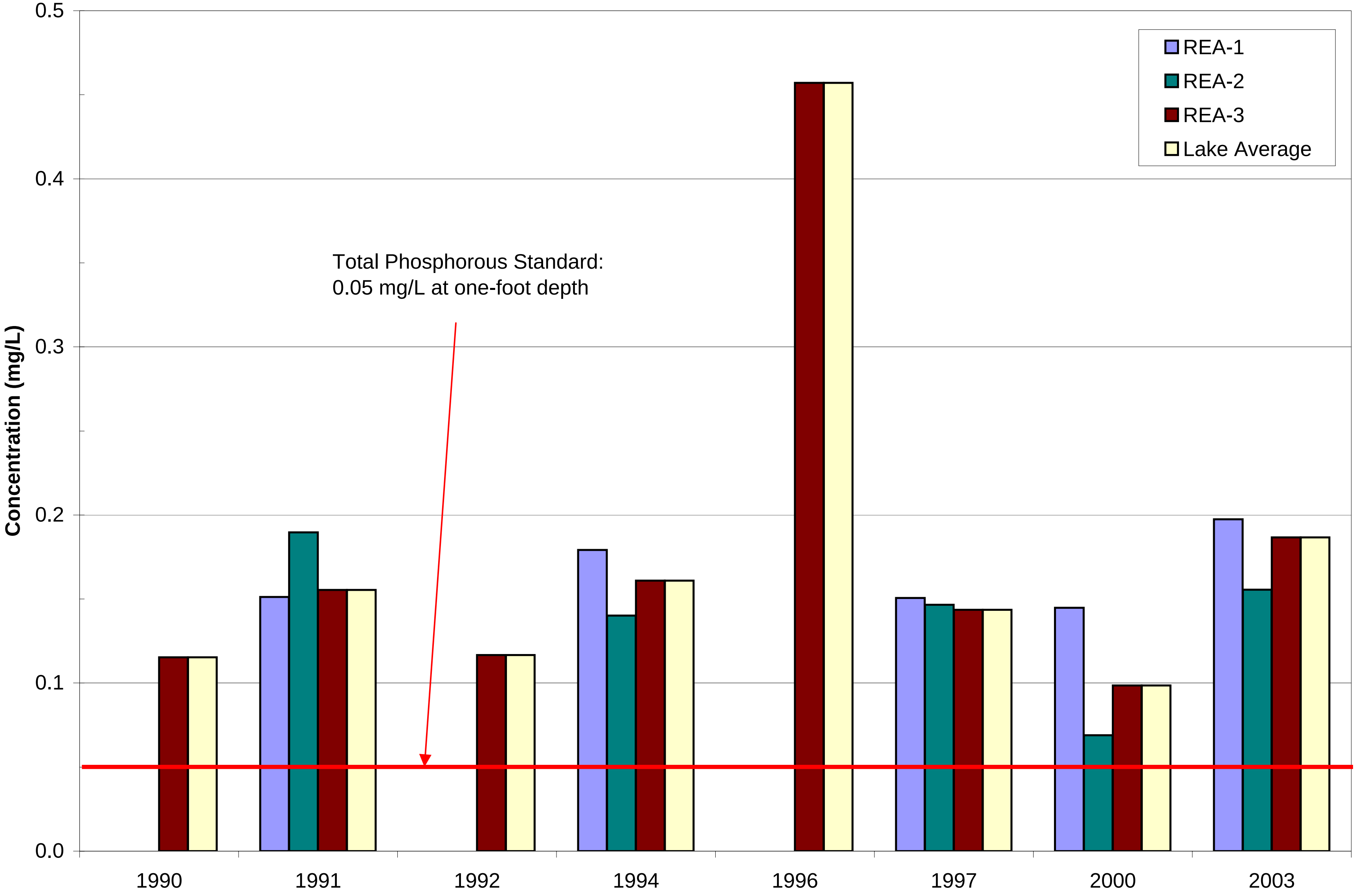
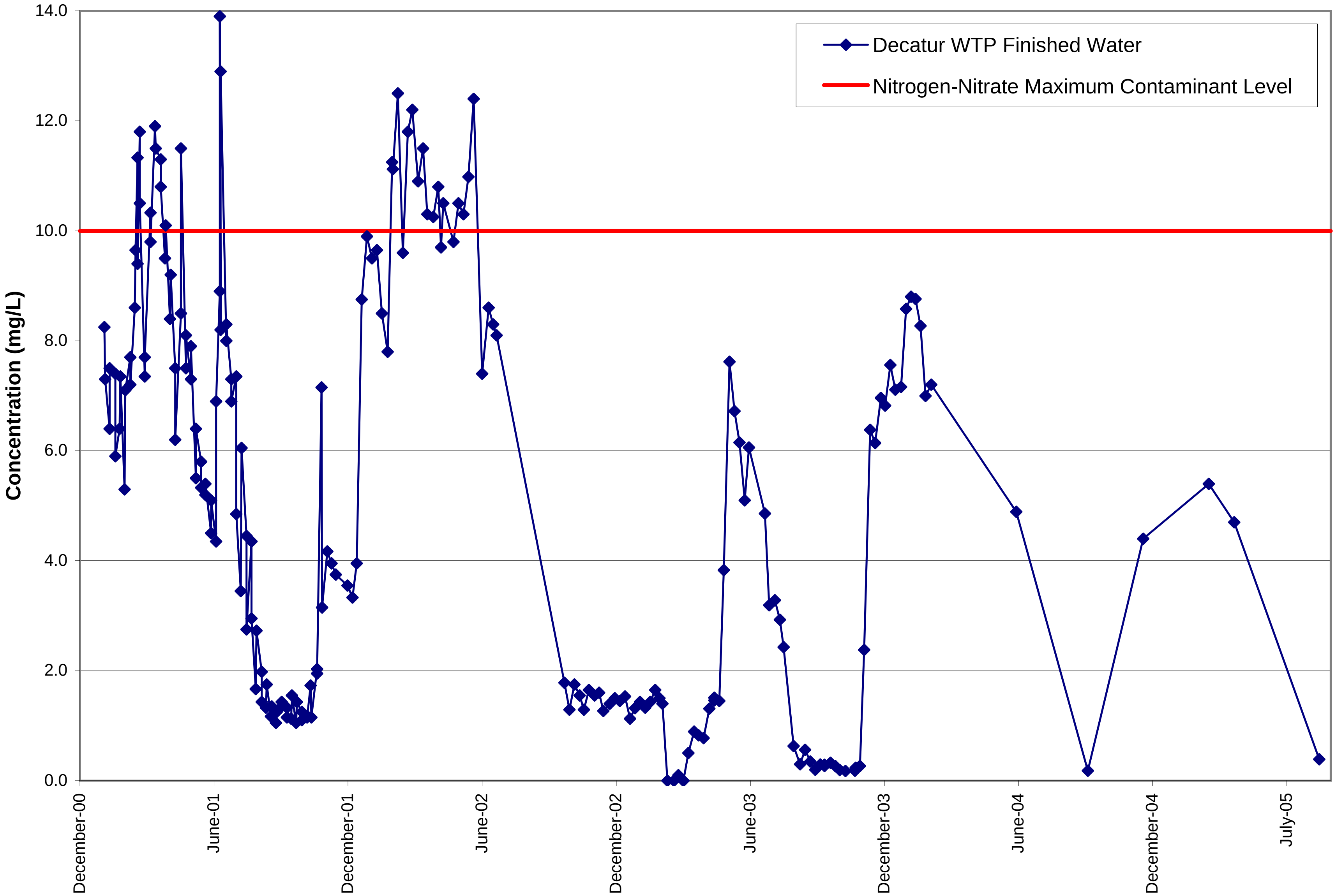


Figure 5-3:
Lake Decatur
Average Annual Total Phosphorous Concentrations
at One-Foot Depth

CDM

N:\13 Sangamon River_Decatur Lake\Data\DecaturLk TP summary.xlsPLT TP Annual

THIS PAGE INTENTIONALLY LEFT BLANK



CDM

N:\13 Sangamon River_Decatur Lake\Data\DecaturLk nitate2.xlsPLT

Figure 5-4:
Lake Decatur
Nitrogen- Nitrate Samples

THIS PAGE INTENTIONALLY LEFT BLANK

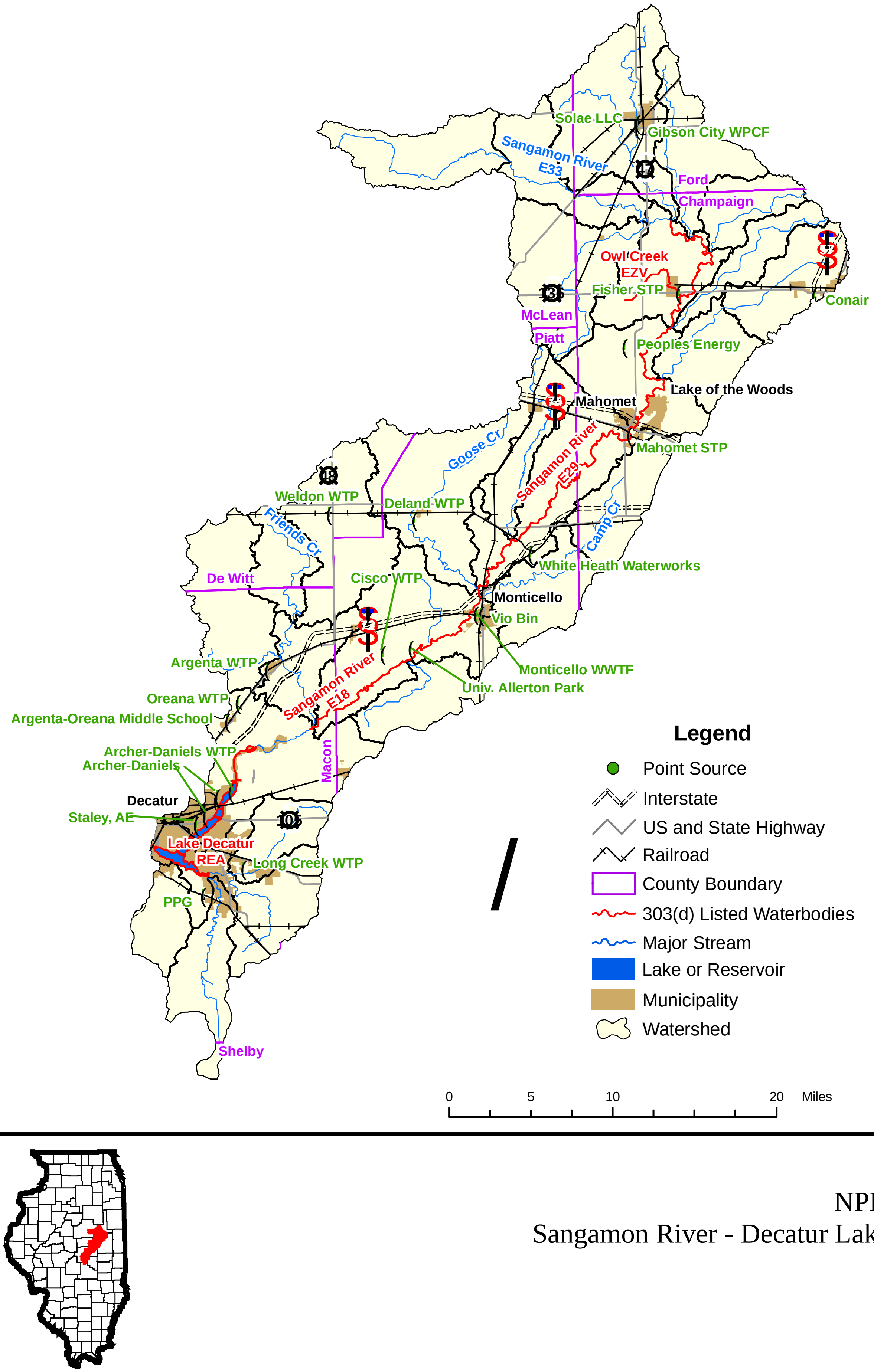


Figure 5-5
NPDES Permits
Sangamon River - Decatur Lake Watershed

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 Sangamon River/Lake Decatur watershed, total fecal coliform and dissolved oxygen are the parameters with numeric water quality standards. For lakes within the watershed total phosphorus and nitrogen as nitrate are the parameters with numeric water quality standards. Refer to Table 1-1 for a list of all segments and associated impairments. 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 a simple approach include mass-balance, load-duration, and simple watershed and receiving water models. Detailed approaches incorporate the use of complex watershed and receiving water models. Simple approaches typically require less data than detailed approaches and therefore these are the analyses recommended for the Sangamon River/Lake Decatur watershed except for stream segments with major point sources whose NDPES permit may be affected by the TMDL's WLA. Establishing a link between pollutant loads and resulting water quality is one of the most important steps in developing a TMDL. As discussed above, this link can be established through a variety of techniques. The objective of the remainder of this section is to recommend approaches for establishing these links for the constituents of concern in the Sangamon River/Lake Decatur watershed.

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

Owl Creek segment EZV receives effluent from the Fisher, Illinois facility. 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 the impaired stream segment is limited to three samples collected in conjunction with the Facility Related Stream Survey conducted in 1998. Therefore additional data collection is recommended for the segment. 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 dischargers. This survey should include measurements of flow, hydraulics, DO, temperature, nutrients, and 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 Owl Creek. QUAL2E is well-known and USEPA-supported. It simulates DO dynamics as a function of nitrogenous and carbonaceous oxygen demand, 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 nonpoint 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.

6.1.2 Recommended Approach for Fecal Coliform TMDLs

Segments E 18 and E 29 of the Sangamon River are listed as impaired for total fecal coliform. It is recommended that more data be collected on these segments. The general use water quality standard for total fecal coliform is:

- 200 cfu/100 mL geometric mean based on a minimum of five samples taken over not more than a 30 day period during the months of May through October
- 400 cfu/100 mL shall not be exceeded by more than 10 percent of the samples collected during any 30 day period during the months of May through October

As discussed in Section 5.1.1.1, there have been no instances when five or more samples have been taken within a 30 day period. More data is required in order to properly assess compliance with the standard.

If it is confirmed that the segment is impaired for total fecal coliform, the recommended approach for developing a TMDL for the segment would be to use 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.

6.2 Approaches for Developing a TMDLs for Lake Decatur

Recommended TMDL approaches for Lake Decatur will be discussed in this section. It is assumed that enough data exists to develop a simple model for use in TMDL development.

6.2.1 Recommended Approach for Total Phosphorus TMDL

Lake Decatur is listed as impaired for total phosphorus. Historic data does confirm an impairment of total phosphorus in Lake Decatur. The BATHTUB model is recommended for the 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.

6.2.2 Recommended Approach for Nitrogen-Nitrate TMDL

Lake Decatur is listed as impaired nitrogen as nitrate. The nitrogen as nitrate listing was a result of elevated concentrations in finished water discharged from the Decatur WTP in 2001 and 2002. Improvements have been made to the facility and there have been no violations recorded in the sixty-seven samples taken since 2003. Data collected prior to 2003 did indicate a nitrogen as nitrate impairment and it is recommended that an empirical loading and spreadsheet analysis be utilized to calculate this TMDL.

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

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix B: Sangamon River/Lake Decatur Watershed Soil Series Characteristics

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
533	Urban land	17.44	0.00%	NA	0.24	0.43
865	Pits, gravel	395.62	0.07%	NA	NA	NA
530E2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	197.04	0.03%	C	0.28	0.43
618E2	Senachwine silt loam, 10 to 18 percent slopes, eroded	165.98	0.03%	B	0.28	0.37
102A	La Hogue loam, 0 to 2 percent slopes	349.41	0.06%	B	0.24	0.37
1103A	Houghton muck, undrained, 0 to 2 percent slopes	12.09	0.00%	D	0.00	0.00
125A	Selma loam, 0 to 2 percent slopes	431.45	0.07%	B/D	0.17	0.43
131B	Alvin fine sandy loam, 2 to 5 percent slopes	13.50	0.00%	B	0.02	0.43
134A	Camden silt loam, 0 to 2 percent slopes	63.63	0.01%	B	0.24	0.49
134B	Camden silt loam, 2 to 5 percent slopes	446.03	0.08%	B	0.24	0.55
146A	Elliott silt loam, 0 to 2 percent slopes	4000.64	0.67%	C	0.20	0.43
146B2	Elliott silty clay loam, 2 to 4 percent slopes, eroded	15362.57	2.59%	C	0.20	0.43
146C2	Elliott silty clay loam, 4 to 6 percent slopes, eroded	1168.32	0.20%	C	0.20	0.43
147A	Clarence silty clay loam, 0 to 2 percent slopes	13.27	0.00%	D	0.20	0.37
147B2	Clarence silty clay loam, 2 to 4 percent slopes, eroded	43.61	0.01%	D	0.20	0.37
148B	Proctor silt loam, 2 to 5 percent slopes	1049.95	0.18%	B	0.28	0.43
148B2	Proctor silt loam, 2 to 5 percent slopes, eroded	30.69	0.01%	B	0.20	0.43
149A	Brenton silt loam, 0 to 2 percent slopes	9649.48	1.62%	B	0.24	0.55
150B	Onarga sandy loam, 2 to 5 percent slopes	3.26	0.00%	B	0.05	0.32
152A	Drummer silty clay loam, 0 to 2 percent slopes	63901.55	10.76%	B/D	0.24	0.37
153A	Pella silty clay loam, 0 to 2 percent slopes	271.32	0.05%	B	0.24	0.37
154A	Flanagan silt loam, 0 to 2 percent slopes	8468.31	1.43%	B	0.24	0.43
171B	Catlin silt loam, 2 to 5 percent slopes	3671.99	0.62%	B	0.24	0.43
189A	Martinton silt loam, 0 to 2 percent slopes	98.13	0.02%	C	0.20	0.43
192A	Del Rey silt loam, 0 to 2 percent slopes	29.01	0.00%	C	0.20	0.43
198A	Elburn silt loam, 0 to 2 percent slopes	2844.19	0.48%	B	0.05	0.43
206A	Thorp silt loam, 0 to 2 percent slopes	95.43	0.02%	C	0.05	0.43
219A	Millbrook silt loam, 0 to 2 percent slopes	28.24	0.00%	B	0.24	0.55
221C2	Parr silt loam, 5 to 10 percent slopes, eroded	109.76	0.02%	B	0.24	0.37
221C3	Parr clay loam, 5 to 10 percent slopes, severely eroded	228.89	0.04%	B	0.24	0.37
223B2	Varna silt loam, 2 to 4 percent slopes, eroded	2260.28	0.38%	C	0.20	0.43
223C2	Varna silty clay loam, 4 to 6 percent slopes, eroded	1399.11	0.24%	C	0.20	0.43
223D3	Varna silty clay loam, 6 to 12 percent slopes, severely eroded	699.06	0.12%	C	0.20	0.43

Appendix B: Sangamon River/Lake Decatur Watershed Soil Series Characteristics (continued)

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
230A	Rowe silty clay loam, 0 to 2 percent slopes	2.65	0.00%	D	0.20	0.37
232A	Ashkum silty clay loam, 0 to 2 percent slopes	18661.43	3.14%	C	0.20	0.43
233B	Birkbeck silt loam, 2 to 5 percent slopes	998.80	0.17%	B	0.20	0.55
234A	Sunbury silt loam, 0 to 2 percent slopes	146.90	0.02%	B	0.24	0.49
235A	Bryce silty clay, 0 to 2 percent slopes	7129.00	1.20%	D	0.17	0.37
236A	Sabina silt loam, 0 to 2 percent slopes	343.97	0.06%	C	0.20	0.55
238A	Rantoul silty clay, 0 to 2 percent slopes	101.44	0.02%	D	0.20	0.37
23A	Blount silt loam, 0 to 2 percent slopes	775.67	0.13%	C	0.20	0.43
23B2	Blount silt loam, 2 to 4 percent slopes, eroded	219.36	0.04%	C	0.20	0.43
241C3	Chatsworth silty clay, 4 to 6 percent slopes, severely eroded	182.07	0.03%	D	0.17	0.37
241D3	Chatsworth silty clay, 6 to 12 percent slopes, severely eroded	114.36	0.02%	D	0.17	0.37
242A	Kendall silt loam, 0 to 2 percent slopes	411.93	0.07%	B	0.24	0.49
291B	Xenia silt loam, 2 to 5 percent slopes	1558.74	0.26%	B	0.24	0.43
294B	Symerton silt loam, 2 to 5 percent slopes	38.77	0.01%	C	0.20	0.43
3107A	Sawmill silty clay loam, 0 to 2 percent slopes, frequently flooded	5461.04	0.92%	B/D	0.15	0.49
322C2	Russell silt loam, 5 to 10 percent slopes, eroded	1214.28	0.20%	B	0.24	0.49
3302A	Ambraw silty clay loam, 0 to 2 percent slopes, frequently flooded	844.36	0.14%	B	0.24	0.28
330A	Peotone silty clay loam, 0 to 2 percent slopes	1422.59	0.24%	C	0.24	0.43
3473A	Rossburg silt loam, 0 to 2 percent slopes, frequently flooded	438.12	0.07%	B	0.28	0.32
375A	Rutland silty clay loam, 0 to 2 percent slopes	218.12	0.04%	C	0.17	0.37
375B	Rutland silty clay loam, 2 to 5 percent slopes	1015.36	0.17%	C	0.17	0.37
387B	Ockley silt loam, 2 to 5 percent slopes	396.85	0.07%	B	0.05	0.32
387C3	Ockley clay loam, 5 to 10 percent slopes, severely eroded	153.75	0.03%	B	0.05	0.32
448B	Mona silt loam, 2 to 5 percent slopes	125.38	0.02%	B	0.17	0.37
481A	Raub silt loam, 0 to 2 percent slopes	11048.10	1.86%	B	0.24	0.49
490A	Odell silt loam, 0 to 2 percent slopes	127.90	0.02%	B	0.24	0.37
530B	Ozaukee silt loam, 2 to 4 percent slopes	446.52	0.08%	C	0.20	0.43
530C2	Ozaukee silt loam, 4 to 6 percent slopes, eroded	301.96	0.05%	C	0.20	0.43
530D2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	397.59	0.07%	C	0.20	0.43
56B	Dana silt loam, 2 to 5 percent slopes	5984.90	1.01%	B	0.24	0.55

Appendix B: Sangamon River/Lake Decatur Watershed Soil Series Characteristics (continued)

STATSGO Map Unit ID and SSURGO Soil Series Code	STATSGO Map Unit ID and SSURGO Soil Series Code Definition	Acres	Percent of Watershed	Dominant Hydrologic Soil Group	Minimum K-factor	Maximum K-factor
56B2	Dana silt loam, 2 to 5 percent slopes, eroded	148.93	0.03%	B	0.24	0.55
570B	Martinsville silt loam, 2 to 5 percent slopes	488.78	0.08%	B	0.24	0.55
570C2	Martinsville loam, 5 to 10 percent slopes, eroded	562.91	0.09%	B	0.24	0.37
570D2	Martinsville silt loam, 10 to 18 percent slopes, eroded	213.85	0.04%	B	0.20	0.37
618B	Senachwine silt loam, 2 to 5 percent slopes	47.39	0.01%	B	0.24	0.37
618C2	Senachwine silt loam, 5 to 10 percent slopes, eroded	209.74	0.04%	B	0.24	0.43
618D2	Senachwine silt loam, 10 to 18 percent slopes, eroded	355.09	0.06%	B	0.24	0.43
618F	Senachwine silt loam, 18 to 35 percent slopes	249.33	0.04%	B	0.28	0.43
622B	Wyanet silt loam, 2 to 5 percent slopes	3368.05	0.57%	B	0.24	0.37
622C2	Wyanet silt loam, 5 to 10 percent slopes, eroded	1959.05	0.33%	B	0.24	0.37
622D3	Wyanet clay loam, 10 to 18 percent slopes, severely eroded	63.46	0.01%	B	0.24	0.37
623A	Kishwaukee silt loam, 0 to 2 percent slopes	852.27	0.14%	B	0.05	0.32
663B	Clare silt loam, 2 to 5 percent slopes	2409.53	0.41%	B	0.28	0.37
679B	Blackberry silt loam, 2 to 5 percent slopes	1176.96	0.20%	B	0.24	0.37
67A	Harpster silty clay loam, 0 to 2 percent slopes	419.83	0.07%	B	0.24	0.49
680B	Campton silt loam, 2 to 5 percent slopes	1126.56	0.19%	B	0.24	0.49
687B	Penfield loam, 2 to 5 percent slopes	1133.23	0.19%	B	0.24	0.37
687C2	Penfield loam, 5 to 10 percent slopes, eroded	343.72	0.06%	B	0.24	0.43
69A	Milford silty clay loam, 0 to 2 percent slopes	925.16	0.16%	C	0.20	0.37
802B	Orthents, loamy, undulating	546.35	0.09%	B	0.24	0.49
805B	Orthents, clayey, undulating	20.77	0.00%	C	0.20	0.43
91A	Swygert silty clay loam, 0 to 2 percent slopes	2604.49	0.44%	C	0.17	0.37
91B2	Swygert silty clay loam, 2 to 4 percent slopes, eroded	2896.08	0.49%	C	0.17	0.37
91C2	Swygert silty clay loam, 4 to 6 percent slopes, eroded	131.26	0.02%	C	0.17	0.37
IL003	STATSGO	113767.50	19.15%	B	0.28	0.43
IL010	STATSGO	59280.68	9.98%	B	0.28	0.43
IL012	STATSGO	35706.78	6.01%	B	0.10	0.43
IL014	STATSGO	28021.79	4.72%	B	0.28	0.43
IL016	STATSGO	595.28	0.10%	C	0.24	0.43
IL028	STATSGO	2844.19	0.48%	B	0.20	0.43
IL046	STATSGO	62567.18	10.53%	B	0.24	0.43
IL073	STATSGO	83027.54	13.98%	B	0.28	0.43
IL081	STATSGO	7529.31	1.27%	B	0.24	0.43
W	WATER	609.61	0.10%	-	-	-
		594003.83				

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix C
Water Quality Data

THIS PAGE INTENTIONALLY LEFT BLANK

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
E 28	1/25/2000	NA	fecal coliform (cfu/100mL)	80
E 28	3/6/2000	NA	fecal coliform (cfu/100mL)	10
E 28	4/12/2000	NA	fecal coliform (cfu/100mL)	140
E 28	5/31/2000	NA	fecal coliform (cfu/100mL)	460
E 28	8/1/2000	NA	fecal coliform (cfu/100mL)	620
E 28	8/25/2000	NA	fecal coliform (cfu/100mL)	230
E 28	11/1/2000	NA	fecal coliform (cfu/100mL)	170
E 28	12/13/2000	NA	fecal coliform (cfu/100mL)	830
E 28	1/18/2001	NA	fecal coliform (cfu/100mL)	80
E 28	2/26/2001	NA	fecal coliform (cfu/100mL)	400
E 28	4/10/2001	NA	fecal coliform (cfu/100mL)	400
E 28	6/14/2001	NA	fecal coliform (cfu/100mL)	260
E 28	7/25/2001	NA	fecal coliform (cfu/100mL)	160
E 28	9/6/2001	NA	fecal coliform (cfu/100mL)	520
E 28	10/24/2001	NA	fecal coliform (cfu/100mL)	540
E 28	12/10/2001	NA	fecal coliform (cfu/100mL)	85
E 28	1/15/2002	NA	fecal coliform (cfu/100mL)	215
E 28	3/7/2002	NA	fecal coliform (cfu/100mL)	25
E 28	5/24/2004	NA	fecal coliform (cfu/100mL)	110
E 29	4/29/1999	NA	COLIFORM, TOTAL FECAL #/100ml	30
E 29	8/31/1999	NA	COLIFORM, TOTAL FECAL #/100ml	1100
E 29	9/29/1999	NA	COLIFORM, TOTAL FECAL #/100ml	800
E 29	11/10/1999	NA	COLIFORM, TOTAL FECAL #/100ml	10
E 29	1/24/2000	NA	COLIFORM, TOTAL FECAL #/100ml	45
E 29	3/3/2000	NA	COLIFORM, TOTAL FECAL #/100ml	2
E 29	5/23/2000	NA	COLIFORM, TOTAL FECAL #/100ml	340
E 29	6/14/2000	NA	COLIFORM, TOTAL FECAL #/100ml	480
E 29	7/26/2000	NA	COLIFORM, TOTAL FECAL #/100ml	400
E 29	9/28/2000	NA	COLIFORM, TOTAL FECAL #/100ml	250
E 29	11/28/2000	NA	COLIFORM, TOTAL FECAL #/100ml	320
E 29	12/28/2000	NA	COLIFORM, TOTAL FECAL #/100ml	120
E 29	1/30/2001	NA	COLIFORM, TOTAL FECAL #/100ml	280
E 29	3/19/2001	NA	COLIFORM, TOTAL FECAL #/100ml	20
E 29	4/18/2001	NA	COLIFORM, TOTAL FECAL #/100ml	10
E 29	5/14/2001	NA	COLIFORM, TOTAL FECAL #/100ml	140
E 29	6/19/2001	NA	COLIFORM, TOTAL FECAL #/100ml	170
E 29	8/2/2001	NA	COLIFORM, TOTAL FECAL #/100ml	410
E 29	8/21/2001	NA	COLIFORM, TOTAL FECAL #/100ml	210
E 29	11/8/2001	NA	COLIFORM, TOTAL FECAL #/100ml	260
E 29	12/20/2001	NA	COLIFORM, TOTAL FECAL #/100ml	60
E 29	1/30/2002	NA	COLIFORM, TOTAL FECAL #/100ml	150
E 29	3/4/2002	NA	COLIFORM, TOTAL FECAL #/100ml	140
E 29	4/18/2002	NA	COLIFORM, TOTAL FECAL #/100ml	160
E 29	6/5/2002	NA	COLIFORM, TOTAL FECAL #/100ml	640
E 29	7/11/2002	NA	COLIFORM, TOTAL FECAL #/100ml	2700
E 29	8/19/2002	NA	COLIFORM, TOTAL FECAL #/100ml	23
E 29	9/27/2002	NA	COLIFORM, TOTAL FECAL #/100ml	360
E 29	11/12/2002	NA	COLIFORM, TOTAL FECAL #/100ml	40
E 29	11/12/2002	NA	COLIFORM, TOTAL FECAL #/100ml	40
E 29	12/12/2002	NA	COLIFORM, TOTAL FECAL #/100ml	19
E 29	12/12/2002	NA	COLIFORM, TOTAL FECAL #/100ml	19
E 29	2/6/2003	NA	COLIFORM, TOTAL FECAL #/100ml	320
E 29	2/6/2003	NA	COLIFORM, TOTAL FECAL #/100ml	320
E 29	3/18/2003	NA	COLIFORM, TOTAL FECAL #/100ml	20

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
E 29	3/18/2003	NA	COLIFORM, TOTAL FECAL #/100ml	20
E 29	4/24/2003	NA	COLIFORM, TOTAL FECAL #/100ml	240
E 29	4/24/2003	NA	COLIFORM, TOTAL FECAL #/100ml	240
E 29	6/2/2003	NA	COLIFORM, TOTAL FECAL #/100ml	80
E 29	6/2/2003	NA	COLIFORM, TOTAL FECAL #/100ml	80
E 29	7/22/2003	NA	COLIFORM, TOTAL FECAL #/100ml	1900
E 29	7/22/2003	NA	COLIFORM, TOTAL FECAL #/100ml	1900
E 29	8/25/2003	NA	COLIFORM, TOTAL FECAL #/100ml	230
E 29	8/25/2003	NA	COLIFORM, TOTAL FECAL #/100ml	230
E 29	9/29/2003	NA	COLIFORM, TOTAL FECAL #/100ml	730
E 29	9/29/2003	NA	COLIFORM, TOTAL FECAL #/100ml	730
E 29	11/4/2003	NA	COLIFORM, TOTAL FECAL #/100ml	60
E 29	11/4/2003	NA	COLIFORM, TOTAL FECAL #/100ml	60
E 29	12/22/2003	NA	COLIFORM, TOTAL FECAL #/100ml	170
EAV-C1	9/24/1998	NA	Dissolved Oxygen, mg/L	8.1
EZV-A1	9/24/1998	NA	Dissolved Oxygen, mg/L	3.8
EZV-E1	9/24/1998	NA	Dissolved Oxygen, mg/L	5.5
REA-1	5/14/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
REA-1	6/11/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-1	7/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-1	9/26/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-1	10/16/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
REA-1	11/7/1990	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-1	4/29/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-1	6/3/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
REA-1	7/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
REA-1	8/13/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-1	10/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.24
REA-1	6/1/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-1	7/21/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-1	8/25/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
REA-1	9/28/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
REA-1	10/26/1992	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
REA-1	4/27/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.17
REA-1	6/15/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-1	7/13/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-1	8/5/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-1	10/14/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
REA-1	5/14/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.46
REA-1	5/14/1996	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.46
REA-1	4/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
REA-1	6/17/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
REA-1	7/18/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.03
REA-1	8/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.25
REA-1	10/15/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.22
REA-1	4/14/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
REA-1	6/13/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
REA-1	7/3/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.06
REA-1	8/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-1	10/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-1	6/17/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
REA-1	7/22/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-1	8/19/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.19
REA-1	10/7/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.29

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
REA-2	4/29/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-2	6/3/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-2	7/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-2	8/13/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
REA-2	10/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.30
REA-2	4/27/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.16
REA-2	6/15/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
REA-2	7/13/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-2	8/5/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.27
REA-2	10/14/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
REA-2	4/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
REA-2	6/17/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
REA-2	7/18/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
REA-2	8/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.26
REA-2	10/15/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
REA-2	4/14/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.39
REA-2	6/13/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.07
REA-2	7/3/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.05
REA-2	8/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-2	10/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
REA-2	6/17/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
REA-2	7/22/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-2	8/19/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-2	10/7/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
REA-3	4/29/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-3	6/3/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.11
REA-3	7/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-3	8/13/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
REA-3	10/2/1991	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.36
REA-3	4/27/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-3	6/15/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.12
REA-3	7/13/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
REA-3	8/5/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.21
REA-3	10/14/1994	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
REA-3	4/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.08
REA-3	6/17/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.14
REA-3	7/18/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.10
REA-3	8/25/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.23
REA-3	10/15/1997	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-3	4/14/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.03
REA-3	6/13/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.04
REA-3	7/3/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.03
REA-3	8/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.15
REA-3	10/18/2000	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
REA-3	6/17/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-3	7/22/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.13
REA-3	8/19/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.20
REA-3	10/7/2003	1	PHOSPHORUS, TOTAL (MG/L AS P)	0.09
Decatur WTP	1/4/2001	NA	NITRATE (AS N), MG/L	8.25
Decatur WTP	1/5/2001	NA	NITRATE (AS N), MG/L	7.30
Decatur WTP	1/11/2001	NA	NITRATE (AS N), MG/L	6.40
Decatur WTP	1/11/2001	NA	NITRATE (AS N), MG/L	7.50
Decatur WTP	1/19/2001	NA	NITRATE (AS N), MG/L	7.40
Decatur WTP	1/19/2001	NA	NITRATE (AS N), MG/L	5.90

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
Decatur WTP	1/25/2001	NA	NITRATE (AS N), MG/L	6.40
Decatur WTP	1/26/2001	NA	NITRATE (AS N), MG/L	7.35
Decatur WTP	2/1/2001	NA	NITRATE (AS N), MG/L	5.30
Decatur WTP	2/2/2001	NA	NITRATE (AS N), MG/L	7.10
Decatur WTP	2/9/2001	NA	NITRATE (AS N), MG/L	7.70
Decatur WTP	2/9/2001	NA	NITRATE (AS N), MG/L	7.20
Decatur WTP	2/15/2001	NA	NITRATE (AS N), MG/L	8.60
Decatur WTP	2/16/2001	NA	NITRATE (AS N), MG/L	9.65
Decatur WTP	2/19/2001	NA	NITRATE (AS N), MG/L	11.33
Decatur WTP	2/19/2001	NA	NITRATE (AS N), MG/L	9.40
Decatur WTP	2/22/2001	NA	NITRATE (AS N), MG/L	11.80
Decatur WTP	2/22/2001	NA	NITRATE (AS N), MG/L	10.50
Decatur WTP	3/1/2001	NA	NITRATE (AS N), MG/L	7.35
Decatur WTP	3/1/2001	NA	NITRATE (AS N), MG/L	7.70
Decatur WTP	3/9/2001	NA	NITRATE (AS N), MG/L	10.33
Decatur WTP	3/9/2001	NA	NITRATE (AS N), MG/L	9.80
Decatur WTP	3/15/2001	NA	NITRATE (AS N), MG/L	11.90
Decatur WTP	3/16/2001	NA	NITRATE (AS N), MG/L	11.50
Decatur WTP	3/23/2001	NA	NITRATE (AS N), MG/L	11.30
Decatur WTP	3/23/2001	NA	NITRATE (AS N), MG/L	10.80
Decatur WTP	3/29/2001	NA	NITRATE (AS N), MG/L	9.50
Decatur WTP	3/30/2001	NA	NITRATE (AS N), MG/L	10.10
Decatur WTP	4/5/2001	NA	NITRATE (AS N), MG/L	8.40
Decatur WTP	4/6/2001	NA	NITRATE (AS N), MG/L	9.20
Decatur WTP	4/12/2001	NA	NITRATE (AS N), MG/L	7.50
Decatur WTP	4/12/2001	NA	NITRATE (AS N), MG/L	6.20
Decatur WTP	4/20/2001	NA	NITRATE (AS N), MG/L	8.50
Decatur WTP	4/20/2001	NA	NITRATE (AS N), MG/L	11.50
Decatur WTP	4/27/2001	NA	NITRATE (AS N), MG/L	7.50
Decatur WTP	4/27/2001	NA	NITRATE (AS N), MG/L	8.10
Decatur WTP	5/4/2001	NA	NITRATE (AS N), MG/L	7.30
Decatur WTP	5/4/2001	NA	NITRATE (AS N), MG/L	7.90
Decatur WTP	5/11/2001	NA	NITRATE (AS N), MG/L	5.50
Decatur WTP	5/11/2001	NA	NITRATE (AS N), MG/L	6.40
Decatur WTP	5/18/2001	NA	NITRATE (AS N), MG/L	5.80
Decatur WTP	5/18/2001	NA	NITRATE (AS N), MG/L	5.33
Decatur WTP	5/24/2001	NA	NITRATE (AS N), MG/L	5.20
Decatur WTP	5/24/2001	NA	NITRATE (AS N), MG/L	5.40
Decatur WTP	6/1/2001	NA	NITRATE (AS N), MG/L	4.50
Decatur WTP	6/1/2001	NA	NITRATE (AS N), MG/L	5.10
Decatur WTP	6/8/2001	NA	NITRATE (AS N), MG/L	4.35
Decatur WTP	6/8/2001	NA	NITRATE (AS N), MG/L	6.90
Decatur WTP	6/13/2001	NA	NITRATE (AS N), MG/L	8.90
Decatur WTP	6/13/2001	NA	NITRATE (AS N), MG/L	13.90
Decatur WTP	6/14/2001	NA	NITRATE (AS N), MG/L	8.20
Decatur WTP	6/14/2001	NA	NITRATE (AS N), MG/L	12.90
Decatur WTP	6/22/2001	NA	NITRATE (AS N), MG/L	8.00
Decatur WTP	6/22/2001	NA	NITRATE (AS N), MG/L	8.30
Decatur WTP	6/29/2001	NA	NITRATE (AS N), MG/L	7.30
Decatur WTP	6/29/2001	NA	NITRATE (AS N), MG/L	6.90
Decatur WTP	7/6/2001	NA	NITRATE (AS N), MG/L	7.35
Decatur WTP	7/6/2001	NA	NITRATE (AS N), MG/L	4.85
Decatur WTP	7/12/2001	NA	NITRATE (AS N), MG/L	3.45
Decatur WTP	7/13/2001	NA	NITRATE (AS N), MG/L	6.05

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
Decatur WTP	7/20/2001	NA	NITRATE (AS N), MG/L	4.45
Decatur WTP	7/20/2001	NA	NITRATE (AS N), MG/L	2.75
Decatur WTP	7/27/2001	NA	NITRATE (AS N), MG/L	4.35
Decatur WTP	7/27/2001	NA	NITRATE (AS N), MG/L	2.95
Decatur WTP	8/2/2001	NA	NITRATE (AS N), MG/L	1.67
Decatur WTP	8/3/2001	NA	NITRATE (AS N), MG/L	2.73
Decatur WTP	8/10/2001	NA	NITRATE (AS N), MG/L	1.98
Decatur WTP	8/10/2001	NA	NITRATE (AS N), MG/L	1.43
Decatur WTP	8/16/2001	NA	NITRATE (AS N), MG/L	1.33
Decatur WTP	8/17/2001	NA	NITRATE (AS N), MG/L	1.75
Decatur WTP	8/23/2001	NA	NITRATE (AS N), MG/L	1.17
Decatur WTP	8/24/2001	NA	NITRATE (AS N), MG/L	1.35
Decatur WTP	8/30/2001	NA	NITRATE (AS N), MG/L	1.05
Decatur WTP	8/31/2001	NA	NITRATE (AS N), MG/L	1.25
Decatur WTP	9/7/2001	NA	NITRATE (AS N), MG/L	1.43
Decatur WTP	9/7/2001	NA	NITRATE (AS N), MG/L	1.35
Decatur WTP	9/14/2001	NA	NITRATE (AS N), MG/L	1.33
Decatur WTP	9/14/2001	NA	NITRATE (AS N), MG/L	1.15
Decatur WTP	9/20/2001	NA	NITRATE (AS N), MG/L	1.13
Decatur WTP	9/21/2001	NA	NITRATE (AS N), MG/L	1.55
Decatur WTP	9/27/2001	NA	NITRATE (AS N), MG/L	1.05
Decatur WTP	9/28/2001	NA	NITRATE (AS N), MG/L	1.43
Decatur WTP	10/5/2001	NA	NITRATE (AS N), MG/L	1.25
Decatur WTP	10/5/2001	NA	NITRATE (AS N), MG/L	1.10
Decatur WTP	10/12/2001	NA	NITRATE (AS N), MG/L	1.18
Decatur WTP	10/12/2001	NA	NITRATE (AS N), MG/L	1.15
Decatur WTP	10/17/2001	NA	NITRATE (AS N), MG/L	1.73
Decatur WTP	10/18/2001	NA	NITRATE (AS N), MG/L	1.15
Decatur WTP	10/26/2001	NA	NITRATE (AS N), MG/L	2.03
Decatur WTP	10/26/2001	NA	NITRATE (AS N), MG/L	1.95
Decatur WTP	11/1/2001	NA	NITRATE (AS N), MG/L	7.15
Decatur WTP	11/2/2001	NA	NITRATE (AS N), MG/L	3.15
Decatur WTP	11/9/2001	NA	NITRATE (AS N), MG/L	4.17
Decatur WTP	11/15/2001	NA	NITRATE (AS N), MG/L	3.95
Decatur WTP	11/21/2001	NA	NITRATE (AS N), MG/L	3.75
Decatur WTP	12/7/2001	NA	NITRATE (AS N), MG/L	3.55
Decatur WTP	12/14/2001	NA	NITRATE (AS N), MG/L	3.33
Decatur WTP	12/20/2001	NA	NITRATE (AS N), MG/L	3.95
Decatur WTP	12/27/2001	NA	NITRATE (AS N), MG/L	8.75
Decatur WTP	1/3/2002	NA	NITRATE (AS N), MG/L	9.90
Decatur WTP	1/10/2002	NA	NITRATE (AS N), MG/L	9.50
Decatur WTP	1/17/2002	NA	NITRATE (AS N), MG/L	9.65
Decatur WTP	1/24/2002	NA	NITRATE (AS N), MG/L	8.50
Decatur WTP	2/1/2002	NA	NITRATE (AS N), MG/L	7.80
Decatur WTP	2/7/2002	NA	NITRATE (AS N), MG/L	11.25
Decatur WTP	2/8/2002	NA	NITRATE (AS N), MG/L	11.12
Decatur WTP	2/15/2002	NA	NITRATE (AS N), MG/L	12.50
Decatur WTP	2/22/2002	NA	NITRATE (AS N), MG/L	9.60
Decatur WTP	3/1/2002	NA	NITRATE (AS N), MG/L	11.80
Decatur WTP	3/7/2002	NA	NITRATE (AS N), MG/L	12.20
Decatur WTP	3/15/2002	NA	NITRATE (AS N), MG/L	10.90
Decatur WTP	3/22/2002	NA	NITRATE (AS N), MG/L	11.50
Decatur WTP	3/28/2002	NA	NITRATE (AS N), MG/L	10.30
Decatur WTP	4/5/2002	NA	NITRATE (AS N), MG/L	10.25

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
Decatur WTP	4/12/2002	NA	NITRATE (AS N), MG/L	10.80
Decatur WTP	4/16/2002	NA	NITRATE (AS N), MG/L	9.70
Decatur WTP	4/19/2002	NA	NITRATE (AS N), MG/L	10.50
Decatur WTP	5/3/2002	NA	NITRATE (AS N), MG/L	9.80
Decatur WTP	5/10/2002	NA	NITRATE (AS N), MG/L	10.50
Decatur WTP	5/17/2002	NA	NITRATE (AS N), MG/L	10.30
Decatur WTP	5/24/2002	NA	NITRATE (AS N), MG/L	10.98
Decatur WTP	5/31/2002	NA	NITRATE (AS N), MG/L	12.40
Decatur WTP	6/12/2002	NA	NITRATE (AS N), MG/L	7.40
Decatur WTP	6/21/2002	NA	NITRATE (AS N), MG/L	8.60
Decatur WTP	6/27/2002	NA	NITRATE (AS N), MG/L	8.30
Decatur WTP	7/2/2002	NA	NITRATE (AS N), MG/L	8.10
Decatur WTP	10/4/2002	NA	NITRATE (AS N), MG/L	1.78
Decatur WTP	10/11/2002	NA	NITRATE (AS N), MG/L	1.29
Decatur WTP	10/18/2002	NA	NITRATE (AS N), MG/L	1.75
Decatur WTP	10/25/2002	NA	NITRATE (AS N), MG/L	1.55
Decatur WTP	10/31/2002	NA	NITRATE (AS N), MG/L	1.29
Decatur WTP	11/7/2002	NA	NITRATE (AS N), MG/L	1.65
Decatur WTP	11/15/2002	NA	NITRATE (AS N), MG/L	1.55
Decatur WTP	11/21/2002	NA	NITRATE (AS N), MG/L	1.60
Decatur WTP	11/27/2002	NA	NITRATE (AS N), MG/L	1.27
Decatur WTP	12/6/2002	NA	NITRATE (AS N), MG/L	1.40
Decatur WTP	12/13/2002	NA	NITRATE (AS N), MG/L	1.50
Decatur WTP	12/20/2002	NA	NITRATE (AS N), MG/L	1.45
Decatur WTP	12/27/2002	NA	NITRATE (AS N), MG/L	1.53
Decatur WTP	1/3/2003	NA	NITRATE (AS N), MG/L	1.13
Decatur WTP	1/10/2003	NA	NITRATE (AS N), MG/L	1.32
Decatur WTP	1/17/2003	NA	NITRATE (AS N), MG/L	1.43
Decatur WTP	1/24/2003	NA	NITRATE (AS N), MG/L	1.33
Decatur WTP	1/31/2003	NA	NITRATE (AS N), MG/L	1.43
Decatur WTP	2/7/2003	NA	NITRATE (AS N), MG/L	1.65
Decatur WTP	2/13/2003	NA	NITRATE (AS N), MG/L	1.50
Decatur WTP	2/17/2003	NA	NITRATE (AS N), MG/L	1.40
Decatur WTP	2/24/2003	NA	NITRATE (AS N), MG/L	0.00
Decatur WTP	3/5/2003	NA	NITRATE (AS N), MG/L	0.00
Decatur WTP	3/11/2003	NA	NITRATE (AS N), MG/L	0.10
Decatur WTP	3/18/2003	NA	NITRATE (AS N), MG/L	0.00
Decatur WTP	3/18/2003	NA	NITRATE (AS N), MG/L	0.00
Decatur WTP	3/25/2003	NA	NITRATE (AS N), MG/L	0.50
Decatur WTP	4/2/2003	NA	NITRATE (AS N), MG/L	0.89
Decatur WTP	4/8/2003	NA	NITRATE (AS N), MG/L	0.83
Decatur WTP	4/15/2003	NA	NITRATE (AS N), MG/L	0.77
Decatur WTP	4/23/2003	NA	NITRATE (AS N), MG/L	1.31
Decatur WTP	4/30/2003	NA	NITRATE (AS N), MG/L	1.51
Decatur WTP	4/30/2003	NA	NITRATE (AS N), MG/L	1.46
Decatur WTP	5/7/2003	NA	NITRATE (AS N), MG/L	1.45
Decatur WTP	5/13/2003	NA	NITRATE (AS N), MG/L	3.83
Decatur WTP	5/21/2003	NA	NITRATE (AS N), MG/L	7.62
Decatur WTP	5/28/2003	NA	NITRATE (AS N), MG/L	6.72
Decatur WTP	6/4/2003	NA	NITRATE (AS N), MG/L	6.15
Decatur WTP	6/11/2003	NA	NITRATE (AS N), MG/L	5.10
Decatur WTP	6/17/2003	NA	NITRATE (AS N), MG/L	6.06
Decatur WTP	7/9/2003	NA	NITRATE (AS N), MG/L	4.86
Decatur WTP	7/15/2003	NA	NITRATE (AS N), MG/L	3.19

Water Quality Data
Sangamon River/Lake Decatur Watershed

Station ID	Sample Date	Sample Depth (ft)	Parameter	Result
Decatur WTP	7/23/2003	NA	NITRATE (AS N), MG/L	3.28
Decatur WTP	7/30/2003	NA	NITRATE (AS N), MG/L	2.93
Decatur WTP	8/4/2003	NA	NITRATE (AS N), MG/L	2.43
Decatur WTP	8/18/2003	NA	NITRATE (AS N), MG/L	0.63
Decatur WTP	8/27/2003	NA	NITRATE (AS N), MG/L	0.30
Decatur WTP	9/3/2003	NA	NITRATE (AS N), MG/L	0.56
Decatur WTP	9/10/2003	NA	NITRATE (AS N), MG/L	0.35
Decatur WTP	9/17/2003	NA	NITRATE (AS N), MG/L	0.20
Decatur WTP	9/24/2003	NA	NITRATE (AS N), MG/L	0.29
Decatur WTP	9/30/2003	NA	NITRATE (AS N), MG/L	0.29
Decatur WTP	9/30/2003	NA	NITRATE (AS N), MG/L	0.27
Decatur WTP	10/8/2003	NA	NITRATE (AS N), MG/L	0.33
Decatur WTP	10/15/2003	NA	NITRATE (AS N), MG/L	0.26
Decatur WTP	10/21/2003	NA	NITRATE (AS N), MG/L	0.20
Decatur WTP	10/29/2003	NA	NITRATE (AS N), MG/L	0.18
Decatur WTP	11/11/2003	NA	NITRATE (AS N), MG/L	0.18
Decatur WTP	11/12/2003	NA	NITRATE (AS N), MG/L	0.23
Decatur WTP	11/18/2003	NA	NITRATE (AS N), MG/L	0.27
Decatur WTP	11/24/2003	NA	NITRATE (AS N), MG/L	2.38
Decatur WTP	12/2/2003	NA	NITRATE (AS N), MG/L	6.38
Decatur WTP	12/9/2003	NA	NITRATE (AS N), MG/L	6.14
Decatur WTP	12/17/2003	NA	NITRATE (AS N), MG/L	6.96
Decatur WTP	12/23/2003	NA	NITRATE (AS N), MG/L	6.82
Decatur WTP	12/30/2003	NA	NITRATE (AS N), MG/L	7.56
Decatur WTP	1/6/2004	NA	NITRATE (AS N), MG/L	7.11
Decatur WTP	1/14/2004	NA	NITRATE (AS N), MG/L	7.16
Decatur WTP	1/21/2004	NA	NITRATE (AS N), MG/L	8.58
Decatur WTP	1/28/2004	NA	NITRATE (AS N), MG/L	8.80
Decatur WTP	2/3/2004	NA	NITRATE (AS N), MG/L	8.76
Decatur WTP	2/10/2004	NA	NITRATE (AS N), MG/L	8.27
Decatur WTP	2/17/2004	NA	NITRATE (AS N), MG/L	7.00
Decatur WTP	2/25/2004	NA	NITRATE (AS N), MG/L	7.20
Decatur WTP	6/22/2004	NA	NITRATE (AS N), MG/L	4.89
Decatur WTP	9/29/2004	NA	NITRATE (AS N), MG/L	0.18
Decatur WTP	12/15/2004	NA	NITRATE (AS N), MG/L	4.40
Decatur WTP	3/16/2005	NA	NITRATE (AS N), MG/L	5.40
Decatur WTP	4/20/2005	NA	NITRATE (AS N), MG/L	4.70
Decatur WTP	8/16/2005	NA	NITRATE (AS N), MG/L	0.39

THIS PAGE INTENTIONALLY LEFT BLANK

Appendix D
Watershed Photographs

THIS PAGE INTENTIONALLY LEFT BLANK

Lake Decatur at Williams Street Looking North

Lake Decatur at Williams Street Looking Northwest

Lake Decatur at Williams Street Looking South

Fisher Sanitary Treatment Plant Discharge (to Owl Creek)

Fisher Sanitary Treatment Plant

Owl Creek at 136 South Road

Owl Creek 600 feet downstream of Fisher Sanitary Treatment Plant

Owl Creek 600 feet downstream of Fisher Sanitary Treatment Plant

Sangamon River Segment E29

Sangamon River Segment E29 at Route 136 South Looking West

Sangamon River Segment E29 at 3000 North Road

Sangamon River Segment E29 at 3000 North Road

Sangamon River Segment E29 at 3000 South

Sangamon River Segment E29 at Route 136 Looking East

Sangamon River Segment E29 at Route 136 Looking Northeast

Wildcat Slough at 700 East (Sangamon River Segment E29 Tributary)

THIS PAGE INTENTIONALLY LEFT BLANK

Sangamon River/Lake Decatur Watershed FINAL Approved TMDL

Prepared for:

Illinois Environmental Protection Agency

August 2007

Sangamon River (IL_E-18; IL_E-29): Fecal Coliform

Owl Creek (IL_EZV): Dissolved Oxygen

Lake Decatur (IL_REA): Total Phosphorus, Nitrogen as Nitrate

LimnoTech
Water | Environment | Scientists | Engineers

Ann Arbor, Michigan
www.limno.com

This page is blank to facilitate double sided printing.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

This page is blank to facilitate double sided printing.

INTRODUCTION

Section 303(d) of the 1972 Clean Water Act requires States to define impaired waters and identify them on a list, which is referred to as the 303(d) list. The State of Illinois has issued the 2006 303(d) list, which is available on the web at: http://www.epa.state.il.us/water/tmdl/303d-list.html. Section 303(d) of the Clean Water Act and EPA's Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not meeting designated uses under technology-based controls. The TMDL process establishes the allowable loading of pollutants or other quantifiable parameters for a water body based on the relationship between pollution sources and instream conditions. This allowable loading represents the maximum quantity of the pollutant that the waterbody can receive without exceeding water quality standards. The TMDL also takes into account a margin of safety, which reflects scientific uncertainty, as well as the effects of seasonal variation. By following the TMDL process, States can establish water quality-based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of their water resources (USEPA, 1991).

Two segments of the Sangamon River (IL_E-29 & IL_E-18), Owl Creek (IL_EZV) and Lake Decatur (IL_REA) are listed on the 2006 Illinois Section 303(d) List of Impaired Waters (IEPA, 2006) as waterbodies that are not meeting their designated uses and have been targeted as high priority waterbodies for TMDL development. This document presents the TMDLs designed to allow these waterbodies to fully support their designated uses. The report covers each step of the TMDL process and is organized as follows:

- Problem Identification
- Required TMDL Elements
- Watershed Characterization
- Description of Applicable Standards and Numeric Targets
- Development of Water Quality Model
- TMDL Development
- Public Participation and Involvement
- Implementation Plan

This page is blank to facilitate double sided printing.

1. PROBLEM IDENTIFICATION

The impairments in waters of the Sangamon/Lake Decatur Watershed addressed in this report are summarized below, with the parameters (causes) that they are listed for, and the impairment status of each designated use, as identified in the 303(d) list (IEPA, 2006). While TMDLs are currently only being developed for pollutants that have numerical water quality standards (indicated below with bold font), many controls that are implemented to address TMDLs for these pollutants will reduce other pollutants as well. For example, any controls to reduce phosphorus loads from watershed sources (stream bank erosion, runoff, etc.) would serve to reduce not only phosphorus, but also sediment loads to Lake Decatur, as phosphorus Best Management Practices (BMPs) are often the same or similar to sediment BMPs. Furthermore, any reduction of phosphorus loads through implementation of watershed controls is expected to work towards reducing algae concentrations, as phosphorus is the nutrient most responsible for limiting algal growth.

Sangamon River	
Assessment Unit ID	IL_E-18
Size (length miles)	24.2
Listed For	**Fecal coliform**
Use Support[1]	Aquatic life (F), Fish consumption (F), Primary contact (N), Secondary contact (X), Aesthetic quality (X)
Assessment Unit ID	IL_E-29
Size (length miles)	41.01
Listed For	**Fecal coliform**
Use Support[1]	Aquatic life (F), Fish consumption (F), Primary contact (N), Secondary contact (X), Aesthetic quality (X)

[1] F = fully supporting, N=not supporting, X = not assessed

Owl Creek	
Assessment Unit ID	IL_EZV
Size (length miles)	6.36
Listed For	**Dissolved oxygen**, habitat assessment, total phosphorus
Use Support[1]	Aquatic life (N), Fish consumption (X), Primary contact (X), Secondary contact (X), Aesthetic quality (X)

[1] F = fully supporting, N=not supporting, X = not assessed

Lake Decatur	
Assessment Unit ID	IL_REA
Size (area acres)	3,093
Listed For	**Total phosphorus, nitrogen as nitrate**, dissolved oxygen**,** sedimentation/siltation, silver, total suspended solids, total nitrogen, aquatic algae, chlordane, PCBs
Use Support[1]	Aquatic life (N), Fish consumption (N), Public and food processing water supplies (N), Primary contact (X), Secondary contact (X), Aesthetic quality (N),

[1] F = fully supporting, N=not supporting, X = not assessed

2. REQUIRED TMDL ELEMENTS

USEPA Region 5 guidance for TMDL development requires TMDLs to contain eleven specific components. Each of those components is summarized below, by waterbody.

Sangamon River (IL_E-18; IL_E-29)

1. **Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking:** The waterbody addressed is the Sangamon River, Segments IL_E-18 (HUCs 0713000601 & 0713000602) and IL_E-29 (HUCs 0713000601 & 0713000602). The pollutant of concern is fecal coliform. Potential sources include agricultural runoff, failing septic systems and permitted sewage treatment plants. Both segments are reported on the 2006 303(d) list as being in category 5, meaning available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed (IEPA, 2006). These two segments are ranked as high priority on the 303(d) list for TMDL development.
2. **Description of Applicable Water Quality Standards and Numeric Water Quality Target:** The IEPA guidelines (IEPA, 2006) for identifying fecal coliform as a cause of impairment in streams state that fecal coliform is a potential cause of impairment of the primary contact use if the geometric mean of all samples collected during May through October (minimum five samples) is greater than 200 cfu/100 ml, or if greater than 10% of all samples exceed 400 cfu/100 ml (cfu = colony forming units). For the Sangamon River TMDLs for fecal coliform, the target is set at meeting 200 cfu/100 ml across the entire flow regime during May-October.
3. **Loading Capacity – Linking Water Quality and Pollutant Sources:** Load capacity calculations were completed to determine the maximum fecal coliform loads that will maintain compliance with the fecal coliform standard for May through October under a range of flow conditions:

Segment E_18	
Sangamon River Flow (cfs)	**Fecal Coliform Load Capacity (cfu/day)**
10	4.89E+10
30	1.47E+11
100	4.89E+11
300	1.47E+12
500	2.45E+12
1000	4.89E+12
3000	1.47E+13

In Segment IL_E-18, up to a 91% reduction in fecal coliform loads is required over the range of flows observed in the river, in order to meet the TMDL target.

Segment E_29	
Sangamon River Flow (cfs)	Fecal Coliform Load Capacity (cfu/day)
5	2.45E+10
15	7.34E+10
30	1.47E+11
90	4.40E+11
272	1.33E+12
875	4.28E+12
2500	1.22E+13

In Segment IL_E-29, up to a 98% reduction in fecal coliform loads is required over the range of flows observed in the river, in order to meet the TMDL target.

4. **Load Allocations (LA):** Load allocations designed to achieve compliance with the above TMDL are calculated for the May-October period by the following equation:

Load allocation = load capacity – MOS – ΣWLAs

Segment E_18	
Sangamon River Flow (cfs)	Fecal Coliform Load Allocation (LA) (cfu/day)
10	2.82E+10
30	1.26E+11
100	4.69E+11
300	1.45E+12
500	2.43E+12
1000	4.81E+12
3000	1.46E+13

Segment E_29	
Sangamon River Flow (cfs)	Fecal Coliform Load Allocation (LA) (cfu/day)
5	1.18E+10
15	6.07E+10
30	1.34E+11
90	4.28E+11
272	1.32E+12
875	4.25E+12
2500	1.22E+13

5. **Wasteload Allocations (WLA):** The WLA for the six point source dischargers of fecal coliform in the Sangamon River (IL_E-18) watershed was calculated from the current permitted flow and a fecal coliform concentration consistent with meeting the TMDL target (200 cfu/100 ml), at the downstream end of the dischargers' exempted reaches or at the end

of the effluent pipe, as applicable (See Section 6.1.2). The WLA for these facilities equals 2.07E+10 cfu/day during periods of no CSO, excess flow, or high river stage discharge. The Gibson City CSOs, the Mahomet STP and Monticello WPCF excess flow outfalls have a combined WLA of 6.23E+10 cfu/day during periods when the CSOs and excess flow outfalls are discharging. These loads are calculated using average reported flow volumes per overflow event and a fecal coliform concentration consistent with the TMDL target (200 cfu/100 ml). In addition to these WLAs, there are two high river stage outfalls that have not discharged since 2002. When discharging, the WLA for these two outfall equals their effluent flow and a fecal coliform concentration consistent with meeting the TMDL target (200 cfu/100ml) at the end of the discharge.

The WLA for the four point source dischargers of fecal coliform in the Sangamon River (IL_E-29) watershed was calculated from the current permitted flow and a fecal coliform concentration consistent with meeting the TMDL target (200 cfu/100 ml), at the downstream end of the dischargers' exempted reaches or at the end of the effluent pipe, as applicable (See Section 6.1.2). The WLA for these facilities equals 1.27E+10 cfu/day during periods of no CSO or excess flow discharge. The Gibson City CSOs and Mahomet STP excess flow outfalls have a combined WLA of 1.79E+10 cfu/day during periods when the CSOs and excess flow outfalls are discharging. These loads are calculated using average reported flow volumes per overflow event and a fecal coliform concentration consistent with the TMDL target (200 cfu/100 ml). Because these dischargers are located within both the upstream IL_E-29 watershed and the downstream IL_E-18 watershed, they are included in the WLA calculation for both segments.

6. **Margin of Safety:** The TMDLs for segments IL_E-18 and IL_E-29 contain an implicit margin of safety for fecal coliform, through the use of multiple conservative assumptions. The TMDL target (no more than 200 cfu/100 ml at any 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). An additional implicit Margin of Safety is provided via the use of a conservative model to define load capacity. The model assumes no decay of bacteria that enter the river, and therefore represents an upper bound of expected concentrations for a given pollutant load.

7. **Seasonal Variation:** The fecal coliform TMDLs were conducted with an explicit consideration of seasonal variation. The approach used for the TMDL evaluated seasonal loads because only May through October water quality data were used in the analysis, consistent with the specification that the standard only applies during this period. The fecal coliform standard will be met regardless of flow conditions in the applicable season because the load capacity calculations specify target loads for the entire range of flow conditions that are possible to occur at any given point in the season where the standard applies.

8. **Reasonable Assurances:** In terms of reasonable assurances for point sources, Illinois EPA has the NPDES permitting program for treatment plants, stormwater permitting and CAFO permitting. The permits for the point source dischargers in the watershed will be modified if necessary as part of the permit review process (typically every 5 years), to ensure that they are consistent with the applicable wasteload allocation.
   In terms of reasonable assurances for nonpoint sources, Illinois EPA is committed to:

   - Convene local experts familiar with nonpoint sources of pollution in the watershed
   - Ensure that they define priority sources and identify restoration alternatives
   - Develop a voluntary implementation plan that includes accountability.

   Local agencies and institutions with an interest in watershed management will be important for successful implementation of this TMDL.

9. **Monitoring Plan to Track TMDL Effectiveness:** A monitoring plan will be prepared as part of the implementation plan.

10. **Transmittal Letter:** A transmittal letter is included with the TMDL.

11. **Public Participation:** Numerous opportunities were provided for local watershed institutions and the general public to be involved. A number of phone calls were made to identify and acquire data and information as part of the Stage 1 work. As quarterly progress reports were produced, the Agency posted them to their website. In May 2006, a public meeting was conducted in Decatur, Illinois to present the Stage 1 findings. A second public meeting was held on July 31, 2007 to present the results of this TMDL and Implementation Plan.

Owl Creek (EZV)

1. **Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking:**

   Owl Creek, HUC 0713000601. The impairment of concern addressed in this TMDL is dissolved oxygen. Violations of the water quality standard for dissolved oxygen are caused by large diurnal variations, driven by excessive plant productivity. The excessive plant productivity is attributed to elevated nutrient concentrations, with phosphorus being the primary nutrient of concern. Potential sources of phosphorus contributing to the listing of this segment include agricultural runoff and the Fisher Sewage Treatment Plant.

   Owl Creek is reported on the 2006 303(d) list as being in category 5, meaning available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed (IEPA, 2006). This segment is ranked as high priority on the 303(d) list for TMDL development.

2. Description of Applicable Water Quality Standards and Numeric Water Quality Target:

The IEPA guidelines (IEPA, 2006) for identifying dissolved oxygen as a cause of impairment in streams state that dissolved oxygen is a potential cause of impairment of the aquatic life use if greater than 10% of the samples are less than 5 mg/l. The TMDL target for dissolved oxygen is 5.0 mg/l. For QUAL2E model runs, a modeling target of 7.1 mg/l as a daily average was used to consider diurnal variation and ensure that the 5.0 mg/l water quality standard is met.

3. Loading Capacity – Linking Water Quality and Pollutant Sources:

Loading capacity was calculated by using the calibrated QUAL-2E model to define the maximum amount of phosphorus that could be contributed to the stream and results in algal levels that would maintain compliance with the dissolved oxygen standard. The load capacity is presented below:

IL_EZV Load Capacity

Phosphorus Load Capacity (kg/day)
1.42

4. **Load Allocations (LA):** Load allocations were based upon model prediction of the maximum amount of nonpoint source phosphorus that could be contributed to the stream and results in algal levels that would maintain compliance with the dissolved oxygen standard. QUAL2E simulations show that nonpoint source loads must be reduced by 70% to meet the TMDL target for dissolved oxygen. Load allocations designed to achieve compliance with the dissolved oxygen TMDL is as follows:

	Phosphorus (kg/day)
IL_EZV	0.02

5. **Wasteload Allocations (WLA):** The wasteload allocation for the Fisher STP was based upon prediction of the maximum amount of phosphorus that could be contributed to the stream and results in algal levels that would maintain compliance with the dissolved oxygen standard. QUAL2E simulations show that these loads must be reduced by 61% to meet the TMDL target for dissolved oxygen.

	Phosphorus (kg/day)
IL_EZV	1.26

6. **Margin of Safety:** An explicit margins of safety was incorporated into this TMDL. The TMDL for segment IL EZV contains an explicit margin of safety equal to 10% of the load allocation.

	Phosphorus MOS (lbs/day)
IL_EZV	0.14

7. **Seasonal Variation:** Seasonal variation is considered within the TMDL as described below:

   The TMDL was conducted with an explicit consideration of seasonal variation. The TMDL was evaluated for a range of flow conditions that are expected to be observed throughout the year. However, dissolved oxygen problems are predicted to be most severe during summer, low flow periods. QUAL-2E model simulations were conducted to represent the critical summer condition.

8. **Reasonable Assurances:** In terms of reasonable assurances for point sources, Illinois EPA administers the NPDES permitting program for treatment plants. The permit for the point source discharger in the watershed will be modified if necessary as part of the permit review process (typically every 5 years), to ensure that they are consistent with the applicable wasteload allocation.
   In terms of reasonable assurances for nonpoint sources, Illinois EPA is committed to:

   - Convene local experts familiar with nonpoint sources of pollution in the watershed
   - Ensure that they define priority sources and identify restoration alternatives
   - Develop a voluntary implementation plan that includes accountability.

   The involvement of local agencies and institutions with an interest in watershed management will be important for successful implementation of this TMDL. Detail on watershed activities is provided in Attachment 1 (see First Quarterly Progress Report, Watershed Characterization).

9. **Monitoring Plan to Track TMDL Effectiveness:** Monitoring of Owl Creek will continue to be conducted as part of IEPA's ambient monitoring program to track the effectiveness of the TMDL.

10. **Transmittal Letter:** A transmittal letter is included with this TMDL.

11. **Public Participation:** Numerous opportunities were provided for local watershed institutions and the general public to be involved. A number of phone calls were made to identify and acquire data and information as part of the Stage 1 work. As quarterly progress reports were produced, the Agency posted them to their website. In May 2006, a public meeting was conducted in Decatur, Illinois to present the Stage 1 findings. A second public meeting was held on July 31, 2007 to present the results of this TMDL and Implementation Plan.

Lake Decatur (REA)

1. **Identification of Waterbody, Pollutant of Concern, Pollutant Sources, and Priority Ranking:** Lake Decatur, HUC 0713000604. The pollutants of concern addressed in this TMDL are total phosphorus and nitrate. Potential sources contributing to the listing of Lake Decatur include: agricultural runoff and permitted sewage treatment plants. Lake Decatur is reported on the 2006 303(d) list as being in category 5, meaning available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed (IEPA, 2006). This waterbody is ranked as high priority on the 303(d) list for TMDL development.

2. **Description of Applicable Water Quality Standards and Numeric Water Quality Target:** The water quality standard for **total phosphorus** to protect aquatic life and aesthetic quality uses in Illinois lakes is 0.05 mg-P/l. For Lake Decatur phosphorus TMDL, the target is set at the water quality criterion for total phosphorus of 0.05 mg-P/l.

   The water quality standard for **nitrate** to protect public and food processing water supplies quality uses in Illinois lakes is 10 mg-N/l. For Lake Decatur nitrate TMDL, the target is set at the water quality criterion for nitrate of 10 mg-N/l.

3. **Loading Capacity – Linking Water Quality and Pollutant Sources:** The water quality model BATHTUB was applied to determine that the maximum phosphorus load that will maintain compliance with the phosphorus standard is 954 kg/month (31.4 kg-P/day) between July and August, with the total load not to exceed 1,908 kg over this period. This allowable load corresponds to an approximately 74% reduction from existing phosphorus loads.

   Load capacity calculations were completed to determine the maximum nitrate loads that will maintain compliance with the nitrate standard under a range of flow conditions:

Flow (cfs)	Allowable Nitrate Load (kg/day)
10	245
20	489
50	1,223
100	2,447
200	4,893
500	12,233
1000	24,466
1500	36,699
2000	48,931

These allowable loads correspond to a reduction in nitrate loads up to 28% at higher flows (613 cfs and above) and up to 13% for flows between 266 and 612 cfs. No reductions are needed during lower flow conditions (flows less than 266 cfs).

4. **Load Allocations (LA):** The Load Allocation designed to achieve compliance with the Lake Decatur total phosphorus TMDL is 858.6 kg/month (28.3 kg-P/day) for the period July-August.

   The Load Allocation designed to achieve compliance with the above nitrate TMDL is:

Flow (cfs)	Nitrate Load Allocation (kg/day)
10	115
20	336
50	996
100	2,097
200	4,299
500	10,905
1000	21,914
1500	32,612
2000	43,622

5. **Wasteload Allocations (WLA):** In the absence of effluent monitoring data, a conservative estimate of phosphorus loads from the seven sewage treatment plants in the Lake Decatur watershed was calculated assuming continuous discharge at average design flow and an effluent phosphorus concentration of 4 mg/l. Through calculation of an attenuation factor, based on observed in-stream phosphorus concentrations during dry weather, it was determined that the facilities, combined, contribute approximately 5% of the current phosphorus load to the lake. Because this contribution is insignificant, a WLA was not calculated for these facilities.

   The WLA for nitrate, which behaves more conservatively than phosphorus, and which is mobile in water, was calculated for the seven sewage treatment plants located in the Lake Decatur watershed. The facilities are: Monticello WWTP, Univ-Allerton Park and 4H Camp, Gibson City WPCF, Mahomet STP, Sangamon Valley PWD STP, Fisher STP and the Argenta-Oreana Middle School STP. The WLA was based on the average design flow for the facilities and an effluent nitrate concentration of 10 mg/l. The WLA for these facilities equals 105 kg/day during periods of no CSO and excess flow discharge. During periods of CSO and excess flow discharge, an additional WLA of 312 kg/d applies. A WLA for the two facilities with high river stage outfalls was not calculated because they have not discharged since 2002 and monitoring data are not readily available to estimate discharge flow volumes. The WLA for these two outfalls, when discharging, will be calculated from the reported overflow volume and a concentration of 10 mg/l, consistent with water quality standards.

6. **Margin of Safety:** The phosphorus TMDL contains an explicit margin of safety of 10% for total phosphorus, corresponding to 95.4 kg P/month

(3.14 kg-P/day). This value was set to reflect the uncertainty in the BATHTUB model predictions.

The nitrate TMDL contains both and implicit and explicit margin of safety. An implicit MOS is provided via the use of a conservative model to define load capacity. The model assumes no loss of nitrate that enters the lake, and therefore represents an upper bound of expected concentrations for nitrate. The TMDL also contains an explicit MOS of 10%. This 10% MOS was included in addition to the implicit MOS to address potential uncertainty in the effectiveness of load reduction alternatives.

7. **Seasonal Variation:** The phosphorus TMDL was conducted with an explicit consideration of seasonal variation. The BATHTUB model used for the phosphorus TMDL is designed to evaluate seasonal to annual loads. The seasonal loading analysis that was used is appropriate due to the long response time between phosphorus loading and biotic response. The July -August duration for the seasonal loading was determined based on a calculation of a phosphorus residence time in Lake Decatur on the order of weeks to a month.

   The nitrate TMDL was conducted with an explicit consideration of seasonal variation. The nitrate standard will be met regardless of flow conditions in the applicable season because the load capacity calculations specify target loads for the entire range of flow conditions that are possible to occur in any given point in the season where the standard applies.

8. **Reasonable Assurances:** In terms of reasonable assurances for point sources, Illinois EPA has the NPDES permitting program for treatment plants, stormwater permitting and CAFO permitting. The permits for the point source dischargers in the watershed will be modified if necessary as part of the permit review process (typically every five years) to ensure that they are consistent with the applicable wasteload allocation.

   In terms of reasonable assurances for nonpoint sources, Illinois EPA is committed to:
   - Convene local experts familiar with nonpoint sources of pollution in the watershed
   - Ensure that they define priority sources and identify restoration alternatives
   - Develop a voluntary implementation plan that includes accountability.

   Local agencies and institutions with an interest in watershed management will be important for successful implementation of this TMDL. Detail on watershed activities is provided in the Stage 1 Report.

9. **Monitoring Plan to Track TMDL Effectiveness:** A monitoring plan will be prepared as part of the implementation plan.

10. **Transmittal Letter:** A transmittal letter is included with this TMDL.

11. **Public Participation:** Numerous opportunities were provided for local watershed institutions and the general public to be involved. A number of phone calls were made to identify and acquire data and information as part of the Stage 1 work. As quarterly progress reports were produced, the Agency posted them to their website. In May 2006, a public meeting was conducted in Decatur, Illinois to present the Stage 1 findings. A second public meeting was held on July 31, 2007 to present the results of this TMDL and Implementation Plan.

3. WATERSHED CHARACTERIZATION

The Stage 1 Report (Attachment 1) presents and discusses information describing the Sangamon River/Lake Decatur Watershed. Watershed characterization activities were focused on gaining an understanding of key features of the watershed, including geology and soils, climate, land cover, hydrology, urbanization and population growth, point source discharges and watershed activities.

The Sangamon River/Lake Decatur watershed is located in central Illinois, flows in a southwesterly direction, and drains approximately 594,100 acres within the state of Illinois. Approximately 54,210 acres lie in southwestern Ford County, 146,325 acres lie in northwestern Champaign County, 56,960 acres lie in southeastern McLean County, 154,875 acres lie in northern Piatt County, 136,940 acres lie in eastern Macon County, 43,425 acres in southeastern DeWitt County, and 1,390 acres lie in northern Shelby County. The predominant land use in the watershed is agriculture, with croplands comprising 83% of the watershed. Approximately 87,882 people reside in the watershed. The city of Decatur is the largest population center in the watershed and contributes an estimated 40,930 people to the total watershed population. Between 1990 and 2000, the population in Decatur decreased by 4.2%. Between 2000 and 2006, the population also decreased by 3.3%.

Corn and soybean farming account for about 44% and 39% of the watershed area, respectively. Rural grassland accounts for about 7%. Other cover types represent approximately 10% of the watershed area, with about 2.0% forest/upland, 3.0% wetland/open water, 3.5% urban, and 1.5% other. The Stage 1 Watershed Characterization and Water Quality Analysis Report documented soil types in the watershed from two sources: State Soil Geographic (STATSGO) database and the Soil Survey Geographic (SSURGO) database. SSURGO data is available only for Champaign, Ford, and McLean Counties. STATSGO data has been used in lieu of SSURGO data for the portion of the watershed that lies within the other counties. The predominant soil type in the STATSGO portion of the watershed are soils categorized as fine-grained and made up of silts and clays with a liquid limit of less than 50 percent. The predominant soil type in the SSURGO portion of the watershed is Drummer silty clay loam on varying slopes. Figure 1 shows a map of the watershed, including impaired segments, point source dischargers, and water intakes.

Stage 2 field sampling was conducted in August-September, 2006 and October-November 2006 to collect data to support QUAL2E model calibration. Four locations on Owl Creek were sampled for BOD, chlorophyll a, TKN, nitrate, dissolved phosphorus and flow. In addition, continuous dissolved oxygen measurements were collected at four locations. Violations of the 5 mg/l dissolved oxygen criteria were observed upstream and downstream of the Fisher STP outfall in August and September, 2006. No violations were observed during deployment of the continuous monitors during November. During both periods, very large diurnal dissolved oxygen swings were observed; up to a 5 mg/l diurnal swing was observed in August and September 2006, both upstream and downstream of the Fisher STP.

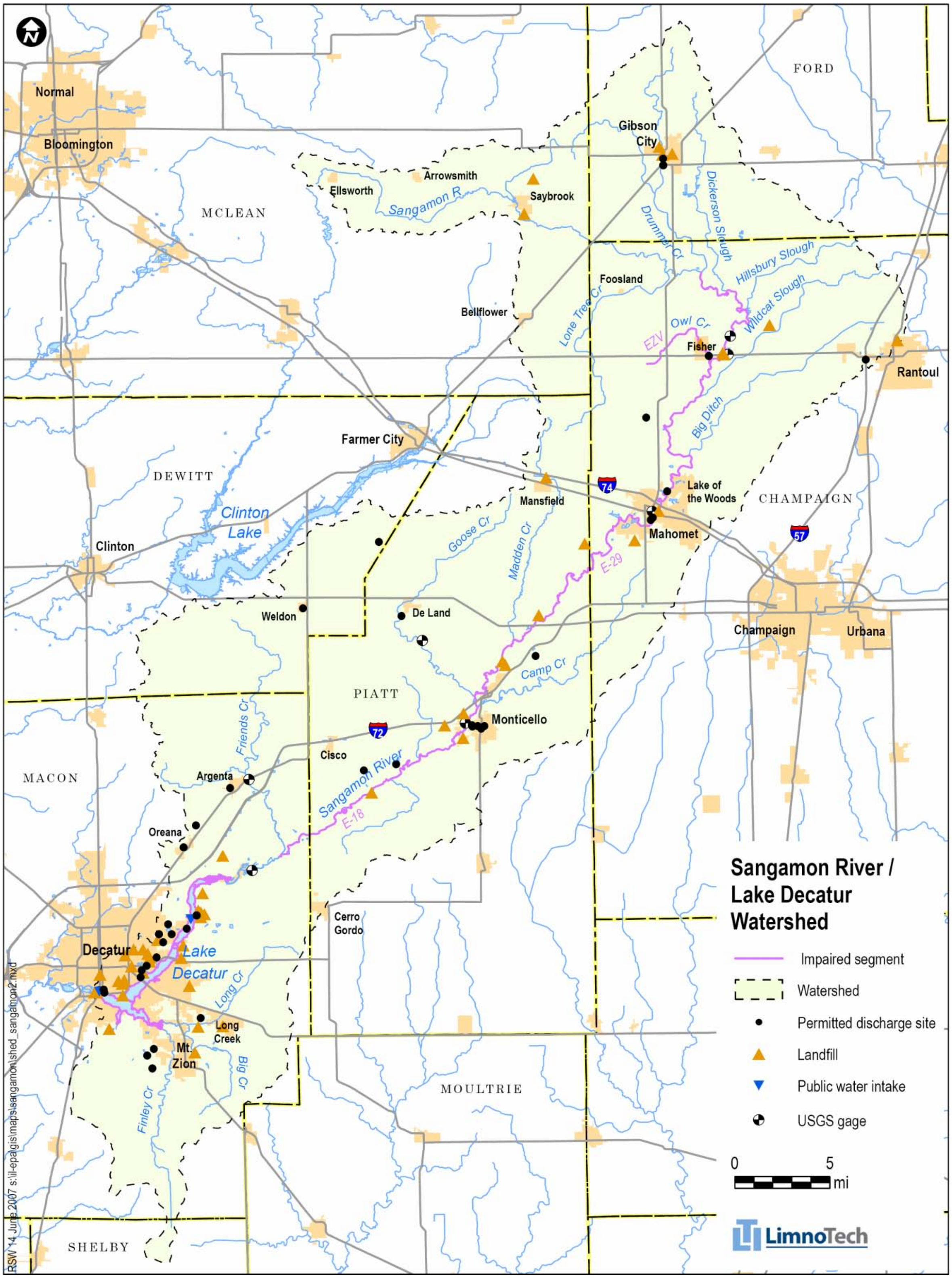


Figure 1. Sangamon River/Lake Decatur Watershed

4. DESCRIPTION OF APPLICABLE STANDARDS AND NUMERIC TARGETS

A water quality standard includes the designated uses of the waterbody, water quality criteria to protect designated uses, and an antidegradation policy to maintain and protect existing uses and high quality waters. Water quality criteria are sometimes in a form that are not directly amenable for use in TMDL development and may need to be translated into a target value for TMDLs. This section discusses the applicable designated uses, use support, criteria and TMDL targets for waterbodies in the Sangamon River/Lake Decatur watershed that are addressed in this report.

4.1 DESIGNATED USES AND USE SUPPORT

Water quality assessments in Illinois are based on a combination of chemical (water, sediment and fish tissue), physical (habitat and flow discharge), and biological (macroinvertebrate and fish) data. Illinois EPA conducts its assessment of water bodies using a set of seven designated uses: aquatic life, aesthetic quality, indigenous aquatic life (for specific Chicago-area waterbodies), primary contact (swimming), secondary contact, public and food processing water supply, and fish consumption (IEPA, 2006). For each water body, and for each designated use applicable to the water body, Illinois EPA's assessment concludes one of two possible "use-support" levels:

- Fully Supporting (the water body attains the designated use); or
- Not Supporting (the water body does not attain the designated use).

Water bodies assessed as "Not Supporting" for any designated use are identified as impaired. Waters identified as impaired based on biological (macroinvertebrate, macrophyte, algal and fish), chemical (water, sediment and fish tissue), and/or physical (habitat and flow discharge) monitoring data are placed on the 303(d) list. Potential causes and sources of impairment are also identified for impaired waters (IEPA, 2006).

Following the U.S. EPA regulations at 40 CFR Part 130.7(b)(4), the Illinois Section 303(d) list was prioritized on a watershed basis. Illinois EPA watershed boundaries are based on the USGS ten-digit hydrologic units to provide the state with the ability to address watershed issues at a manageable level and document improvements to a watershed's health (IEPA, 2006).

4.2 WATER QUALITY CRITERIA

Illinois has established water quality criteria and guidelines for allowable concentrations of fecal coliform, dissolved oxygen, total phosphorus, and nitrate under its CWA Section 305(b) program, as summarized below.

4.2.1 Fecal Coliform

The IEPA guidelines (IEPA, 2006) for identifying fecal coliform as a cause of impairment in streams state that fecal coliform is a potential cause of impairment of the primary contact use if the geometric mean of all samples collected during May through October (minimum five samples) is greater than 200 cfu/100 ml, or if greater than 10% of all samples exceed 400 cfu/100 ml.

4.2.2 Dissolved oxygen

The water quality standard for dissolved oxygen in Illinois waters designated for aquatic life is that dissolved oxygen shall not be less than 6.0 mg/l during at least 16 hours of any 24 hour period, nor less than 5.0 mg/l at any time.

The aquatic life guideline for streams indicates impairment if more than 10% of the observations measured in the last five years are below 5 mg/l.

4.2.3 Total Phosphorus

The IEPA guidelines (IEPA, 2006) for identifying total phosphorus as a cause of impairment in lakes greater than 20 acres in size, state that phosphorus is a potential cause of impairment of the aesthetic quality use if there is at least one exceedance of the applicable standard (0.05 mg-P/L) during the most recent year of data from the Ambient Lake Monitoring Program or the Illinois Clean Lakes Program.

4.2.4 Nitrate

The IEPA guidelines (IEPA, 2006) for identifying nitrate as a cause of impairment in lakes state that nitrate is a potential cause of impairment for the public and food processing supply use if 10% of observations exceed a 10 mg/l for water samples collected in 1999 or later, or for any single parameter in treated water, at least one violation of an applicable Maximum Contaminant Level occurs during the most recent three years of readily available data; or the public water supply uses a treatment approach, beyond conventional, without which a violation of at least one Maximum Contaminant Level is expected during the most recent three years of readily available data.

4.3 DEVELOPMENT OF TMDL TARGETS

The TMDL target is a numeric endpoint specified to represent the level of acceptable water quality that is to be achieved by implementing the TMDL. Where possible, the water quality criterion for the pollutant of concern is used as the numeric endpoint. When appropriate numeric standards do not exist, surrogate parameters must be selected to represent the designated use.

4.3.1 Fecal Coliform

For the Sangamon River (Segment IL_E-29 and IL_E-18) fecal coliform TMDLs, the target was set at 200 cfu/100 ml.

4.3.2 Dissolved oxygen

The water quality standard for dissolved oxygen in Illinois waters designated for aquatic life is that dissolved oxygen shall not be less than 6.0 mg/l during at least 16 hours of any 24 hour period, nor less than 5.0 mg/l at any time. For Owl Creek (IL_EZV), the target was based upon the water quality criterion for dissolved oxygen of 5 mg/l. The QUAL2E model used to calculate the TMDL predicts a daily average dissolved oxygen concentration and does not directly predict daily minimum values. QUAL2E results can be translated into a form comparable to a daily minimum, by subtracting the observed difference between daily average and daily minimum dissolved oxygen from the model output. For QUAL2E model runs, a modeling target of 7.1 mg/l was used to consider diurnal variation and ensure that the 5.0 mg/l TMDL target is met.

4.3.3 Total Phosphorus

For the Lake Decatur phosphorus TMDL, the target is set at the water quality criterion for total phosphorus of 0.05 mg-P/l.

4.3.4 Nitrate

For the Lake Decatur nitrate TMDL, the target is set at the water quality criterion for nitrate of 10 mg-N/l.

This page is blank to facilitate double sided printing.

5. DEVELOPMENT OF WATER QUALITY MODELS

Water quality models are used to define the relationship between pollutant loading and resulting water quality. A combination of modeling approaches was used for the Sangamon River/Lake Decatur watershed TMDLs. The Sangamon River TMDLs for fecal coliform and the Lake Decatur TMDL for nitrate apply the Load Duration Curve approach in conjunction with a load capacity calculation. The dissolved oxygen TMDL for Owl Creek is based on the QUAL2E model. The BATHTUB water quality model was used to define the relationship between external phosphorus loads and resulting concentrations of total phosphorus in Lake Decatur. The development of these approaches is described in the following sections, including information on:

- Model selection
- Modeling approach
- Model inputs
- Model calibration

5.1 LOAD DURATION CURVE APPROACH

A load duration curve approach was used in the fecal coliform analysis for segments IL_E-18 and IL_E-29 of the Sangamon River and in the nitrate analysis for Lake Decatur (IL_REA). A load duration curve is a graphical representation of observed pollutant load compared to maximum allowable load over a range of flow conditions. The load duration curve provides information to:

- Help identify the issues surrounding the problem and differentiate between point and nonpoint source problems, as discussed immediately below;
- Address frequency of deviations (how many samples lie above the curve vs. those that plot below); and
- Aid in establishing the level of implementation needed, by showing the magnitude by which existing loads exceed standards for different flow conditions.

5.1.1 Model Selection

The load duration curve approach was selected for fecal coliform and nitrate because it is consistent with the selected level of TMDL implementation for this TMDL and it can be applied with the existing data. The load duration curve approach identifies broad categories of sources over the entire range of flows, and the extent of control required from these source categories to attain water quality standards.

5.1.2 Approach

The load duration curve approach uses stream flows for the period of record to gain insight into the flow conditions under which exceedances of the water quality standard occur. A load-duration curve is developed by: 1) ranking the daily flow data from lowest to highest, calculating the percent of days these flows were exceeded, and graphing the results; 2) translating the flow duration curve (produced in step 1) into a load duration curve by multiplying the flows by the TMDL target; and 3) plotting observed pollutant loads (measured concentrations times stream flow) on the same graph. Observed loads that fall above the load duration curve exceed the maximum allowable load, while those that fall on or below the line, do not exceed the maximum allowable load. An analysis of the observed loads relative to the load duration curve provides information on whether the pollutant source is point or nonpoint in nature.

5.1.3 Data Inputs

The load duration curve approach requires a long-term flow record and concentration measurements that are paired to flows. Data used for the load duration curve approach are discussed below.

5.1.3.a *Fecal coliform and flow*

Segment IL_E-29:

Fecal coliform data collected by IEPA as part of IEPA's ambient water quality monitoring program between 1999 and 2003 as well as data collected by the USGS at station 05570910 were used in the analysis. Only data for the months of May-October were used because the water quality standard applies during this period.

The load duration curve approach requires a matching of flows to water quality data. Daily average flows measured at the USGS gage (05570910) in Fisher were used in the analysis. Flows are available for the period 1978-2007.

Segment IL_E-18:

Fecal coliform data collected by IEPA as part of IEPA's ambient water quality monitoring program between 2000 and 2004 at Allerton Park (Station E-28) and from 2002-2005 (Station E-18) were used in the analysis. Only data for the months of May-October were used because the water quality standard applies during this period.

The load duration curve approach requires a matching of flows to water quality data for the recent period. Daily average flows measured at the USGS gage (05572000) in Monticello were used in the analysis. Flows are available for the period 1980-2007. To estimate flows for Segment E_18, the gaged flows were adjusted for the size of the drainage area at monitoring station E-28 in Allerton Park.

5.1.3.b *Nitrate and flow*

Nitrate data collected by IEPA as part of IEPA's ambient water quality monitoring program between 2000 and 2006 at the Lake Decatur stations as well as data collected by the Decatur WTP for their finished water monitoring program between 2001 and 2005, and 2002-2003 in-lake data obtained from the Illinois State Water Survey were used in the analysis.

The load duration curve approach requires a matching of flows to water quality data. Daily average flows measured at the USGS gage (05572000) in Monticello were used in the analysis. Flows are available for the period 1908-2007. To estimate flows for Lake Decatur, the gaged flows were adjusted for the size of the drainage area. The adjustment ratio used was 1.67.

5.1.4 Analysis

5.1.4.a *Fecal coliform*

Flow duration curves for each segment were generated by ranking daily flow data from lowest to highest, calculating the percent of days these flows were exceeded, and graphing the results. Load duration curves for fecal coliform were generated by multiplying the flows in the duration curve by the TMDL target of 200 cfu/100 ml for fecal coliform bacteria. This is shown with a solid line in Figures 2 and 3. Observed pollutant loads (measured concentrations multiplied by corresponding stream flow), were plotted on the same graph. The worksheets for these analyses are provided in Attachment 3.

Segment IL_E-29:

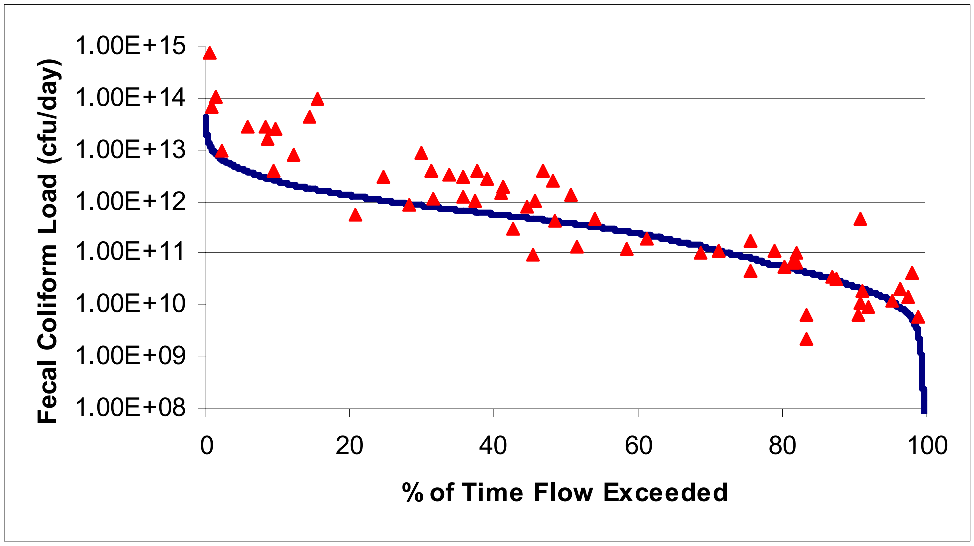


Figure 2. Fecal coliform load duration curve for Sangamon River Segment IL_E-29 with observed loads (triangles)

Fecal coliform concentration data are available for a wide range of flows and exceedances are observed over the range of flows examined. This analysis indicates that both wet and dry weather sources contribute to fecal coliform exceedances in this segment.

Segment IL_E-18:

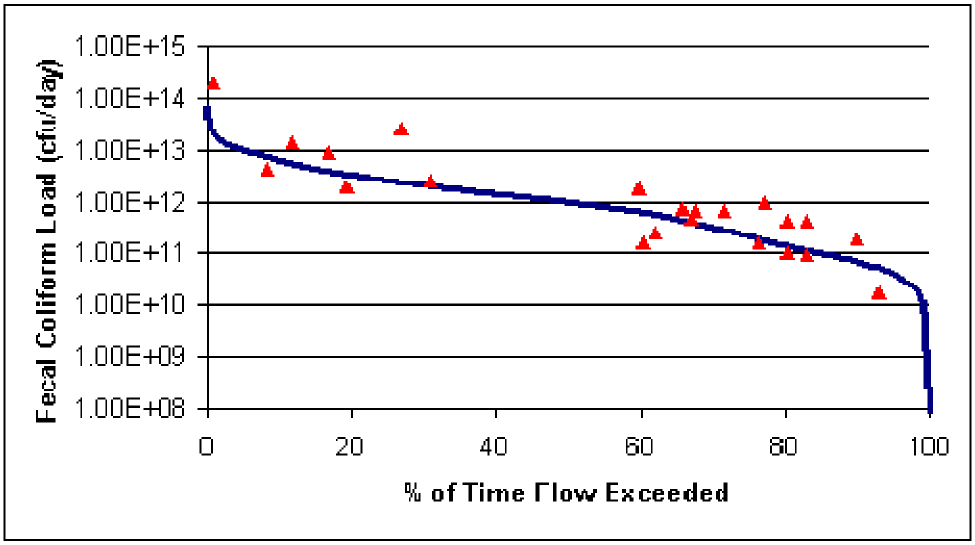


Figure 3. Fecal coliform load duration curve for Sangamon River Segment IL_E-18 with observed loads (triangles)

Fecal coliform data are available over a range of flows and exceedances are observed over the range of flows examined. This analysis indicates that both wet and dry weather sources contribute to fecal coliform exceedances in this segment.

5.1.4.b *Nitrate*

A flow duration curve for Lake Decatur was generated by ranking daily flow data (flows to the lake) from lowest to highest, calculating the percent of days these in-flows were exceeded, and graphing the results. A load duration curve for nitrate was generated by multiplying the flows in the duration curve by the TMDL target of 10 mg-N/L for nitrate. This is shown with a solid line in Figure 4. Observed pollutant loads (measured concentrations multiplied by corresponding stream flow), were plotted on the same graph. The worksheets for these analyses are provided in Attachment 4.

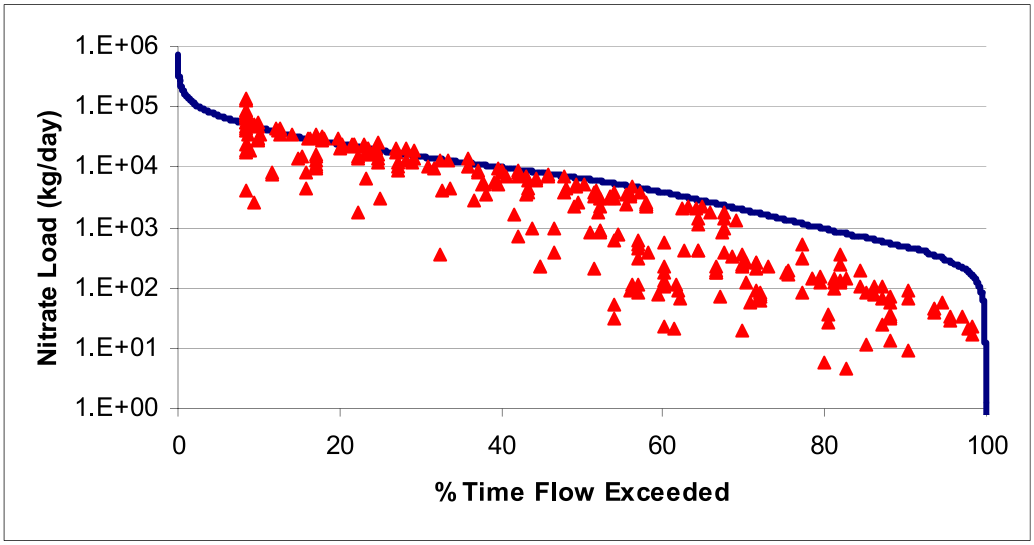


Figure 4. Nitrate load duration curve for Lake Decatur with observed loads (triangles)

Nitrate data are available over a range of flows and exceedances of the target load are observed during higher river flows. This indicates that wet weather sources are the primary contributors to nitrate exceedances in Lake Decatur.

5.2 QUAL2E MODEL

The QUAL2E water quality model was used to define the relationship between external oxygen-demanding loads and the resulting concentrations of dissolved oxygen in Owl Creek. QUAL2E is a one-dimensional stream water quality model applicable to dendritic, well-mixed streams. It assumes that the major pollutant transport mechanisms, advection and dispersion, are significant only along the main direction of flow. The model allows for multiple waste discharges, water withdrawals, tributary flows, and incremental inflows and outflows.

5.2.1 Model Selection

A discussion of the model selection process for the Owl Creek watershed is provided in the Stage 1 report (Attachment 1).

The QUAL2E model (Brown and Barnwell, 1987) was selected to address dissolved oxygen impairments in Owl Creek. QUAL2E is the most commonly used water quality model for addressing low flow conditions. An empirical approach was selected for determining watershed loads, with more detailed analysis of specific sources to be conducted during the implementation phase.

5.2.2 Modeling Approach

The approach selected for the dissolved oxygen TMDL is based upon discussions with IEPA and their Scientific Advisory Committee. The approach consists of using data collected during 2006 dry weather surveys to define current loads to the river, and using the QUAL2E model to define the extent to which loads must be reduced to meet water quality standards. This is the recommended approach presented in the Stage 1 report. The dominant land use in the watershed is agriculture and there is one permitted sewage treatment plant (Fisher STP), which is also located in this watershed. Implementation plans for nonpoint sources will consist of voluntary controls, applied on an incremental basis. The approach taken for these TMDLs will expedite these implementation efforts.

Determination of existing loading sources and prioritization of restoration alternatives may be conducted by local experts as part of the implementation process (see Section 8). Based upon their recommendations, an implementation plan could be developed that includes both accountability and the potential for adaptive management.

5.2.3 Model Inputs

This section provides an overview of the model inputs required for QUAL2E application, and how they were derived. The following categories of inputs are required for QUAL2E:

- Model options (title data)
- Model segmentation
- Hydraulic characteristics
- Reach kinetic coefficients
- Initial conditions
- Incremental inflow conditions
- Headwater characteristics
- Point source flows and loads

5.2.3.a *Model Options*

This portion of the input file defines the specific water quality parameters to be simulated. QUAL2E was set up to simulate biochemical oxygen demand, the phosphorus series, the nitrogen series, algae and dissolved oxygen.

5.2.3.b *Model Segmentation*

The QUAL2E model divides the river being simulated into discrete segments (called “reaches”) that are considered to have constant channel geometry and hydraulic characteristics. Reaches are further divided into “computational elements”, which define the interval at which results are provided. The Owl Creek QUAL2E model consists of five reaches, which are comprised of a varying number of computational elements. Computational elements have a fixed length of 0.1 miles. Reaches are defined with respect to water quality monitoring stations and tributaries. Model segmentation is presented below in Table 1.

Table 1. QUAL2E Segmentation

Reach	River miles	Number of computational elements	Other features
1	4.4 – 6.4	20	
2	2.5 – 4.4	19	
3	0.8 – 2.5	17	
4	0.2 – 0.8	6	Fisher STP
5	0.0 – 0.2	2	Unnamed trib

5.2.3.c *Hydraulic Characteristics*

A functional representation was used to describe the hydraulic characteristics of the system. For each reach, velocity and depth were specified, based on measurements taken during the August 2006 field surveys.

5.2.3.d *Reach Kinetic Coefficients*

Kinetic coefficients were set at typical values in the absence of specific data. No sediment oxygen demand (SOD) was assumed. The model reaeration rate, which was assumed to be constant over all of the reaches, was adjusted to match observed diurnal average dissolved oxygen concentrations. The decay rate for BOD, which was also assumed to be constant over all reaches, was decreased to a low value to match observed concentrations. The decay rate for ammonia was not calibrated because concentrations were generally low and uncertainty in the rate will have little effect on model predictions. Kinetic coefficients related to algal growth were left unchanged from their default values. The only adjustment to algal-related inputs was to the settling velocity, which was calibrated to match observed instream chlorophyll a data.

5.2.3.e *Initial Conditions*

Initial model conditions were based on field observations taken during the survey conducted in August 2006. Specifically, site-specific information on creek flow, velocity, morphometry, and concentrations of BOD, phosphorus, chlorophyll, and ammonia were used to specify initial conditions.

5.2.3.f *Incremental Inflow Conditions*

Incremental inflows were calculated from the measured flows. Observed increases and decreases in flows were added to each reach incrementally. Based on field measurements flow was decreasing in the reach immediately above the Fisher sewage treatment plant outfall.

5.2.3.g *Headwater Characteristics*

Headwater characteristics were based on watershed-typical values and upstream field measurements.

5.2.3.h *Point Source Flows and Loads*

The model considers two point sources: the NPDES-permitted Fisher sewage treatment plant and an unnamed tributary, which flows into Owl Creek just upstream of its confluence with the Sangamon River.

The Fisher load was considered to be equal to the August 2006 monthly average load reported on the discharge monitoring report. The flow of the unnamed tributary was based on the drainage area ratio in comparison to the upper portion (above water quality sampling station EZV01) of Owl Creek.

5.2.4 QUAL2E Calibration

QUAL2E model calibration consisted of:

1. Applying the model with all inputs specified as above
2. Comparing model results to dissolved oxygen, chlorophyll, and BOD data
3. Adjusting model coefficients to provide the best comparison between model predictions and observed dissolved oxygen data.

The QUAL2E dissolved oxygen calibration for the entire length of Owl Creek (IL_EZV) is discussed below. The QUAL2E model was initially applied with the model inputs as specified above. Observed data for the survey conducted August 29-31, 2006 were used for calibration purposes.

QUAL2E was calibrated to match the observed diurnal averages of dissolved oxygen concentrations measured along the creek. Model results initially overpredicted dissolved oxygen while underpredicting BOD data. The mismatch between model and data was minimized during the calibration process by decreasing the BOD decay rate to align model to data for BOD, and then decreasing the reaeration rate.

The resulting dissolved oxygen and chlorophyll predictions compared well to the measured concentrations, as shown in Figures 5 and 6. This comparison represents an acceptable model calibration. The QUAL2E model output files from the calibration run are included in Attachment 5.

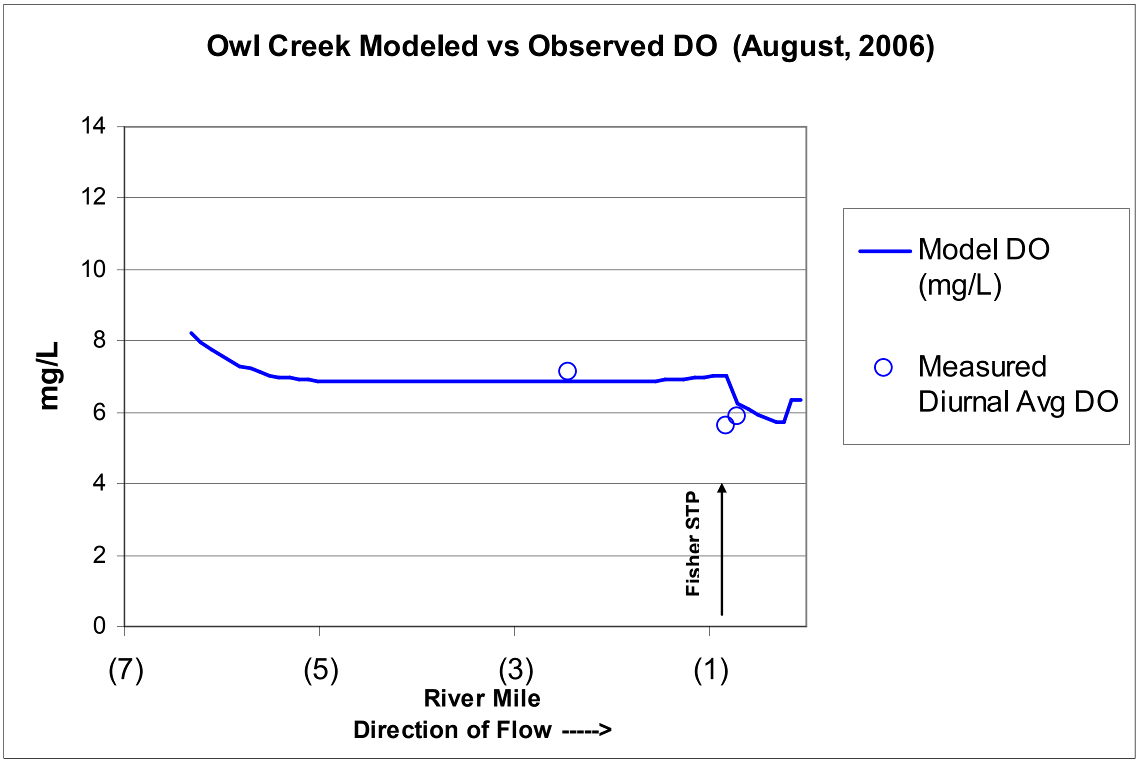


Figure 5. QUAL2E Dissolved Oxygen Calibration

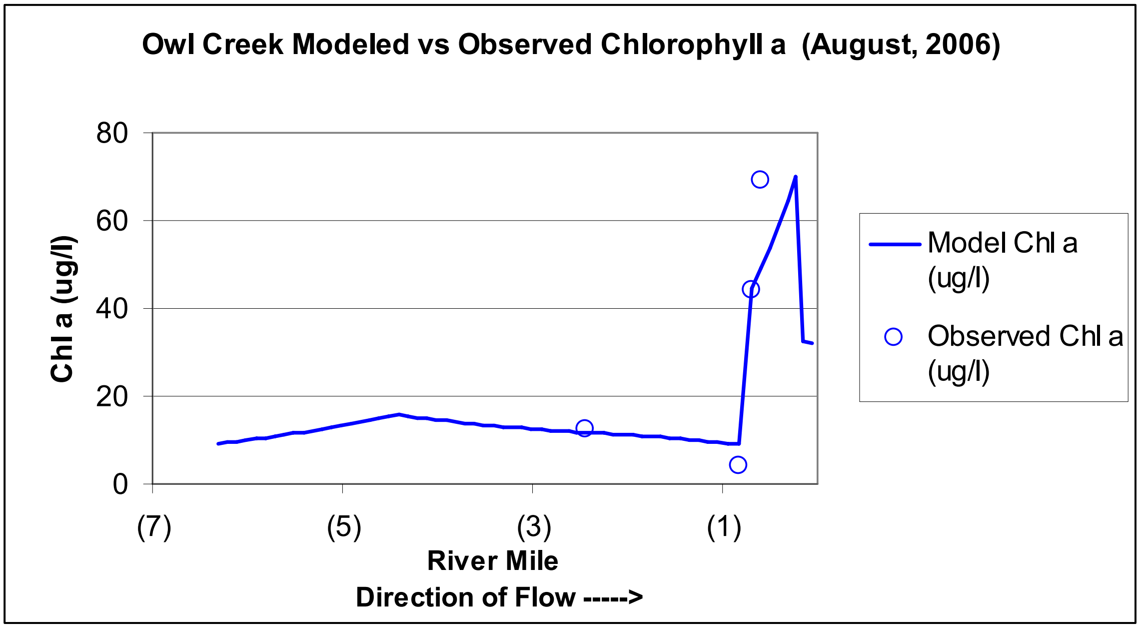


Figure 6. QUAL2E Chlorophyll Calibration

5.3 BATHTUB MODEL

The BATHTUB water quality model was used to define the relationship between external phosphorus loads and the resulting concentrations of total phosphorus in Lake Decatur.

5.3.1 Model Selection

The BATHTUB model (Walker, 1985) was selected to address phosphorus impairments to Lake Decatur. This model was selected because it does not have extensive data requirements (and can therefore be applied with existing data), yet still provides the capability for calibration to observed lake data. BATHTUB has been used previously for several reservoir TMDLs in Illinois, and has been cited as an effective tool for lake and reservoir water quality assessment and management, particularly where data are limited (Ernst et al., 1994).

The model was used to predict the relationship between phosphorus load and resulting in-lake phosphorus concentrations.

5.3.2 Modeling Approach

The approach selected for the phosphorus TMDL is based upon discussions with IEPA and the Scientific Advisory Committee. The approach consists of using existing empirical data to define current loads to the lake, and using the BATHTUB model to define the extent to which these loads must be reduced to meet water quality standards. The dominant land use in the watershed is agriculture. Implementation plans for agricultural sources will require voluntary controls, applied on an incremental basis. The approach taken for these TMDLs, which requires no additional data collection and can be conducted immediately, will expedite these implementation efforts.

Determination of existing loading sources and prioritization of restoration alternatives may be conducted by local experts as part of the implementation process (see Section 8). Based upon their recommendations, a voluntary implementation plan could be developed that includes both accountability and the potential for adaptive management.

5.3.3 Model Inputs

This section provides an overview of the model inputs required for BATHTUB application, and how they were derived. The following categories of inputs are required for BATHTUB:

- Model Options
- Global Variables
- Reservoir Segmentation
- Tributary Loads

5.3.3.a *Model Options*

BATHTUB provides a multitude of model options to estimate nutrient concentrations in a reservoir. Model options were entered as shown in Table 2, with the rationale for these options discussed below. No conservative substance was being simulated, so this option was not needed. The first order option was selected for phosphorus as the model option for BATHTUB because no additional calibration of the coefficients was necessary. Nitrogen was not simulated, because phosphorus is the nutrient of concern in the lake. Similarly, chlorophyll a and transparency were not simulated. The Fischer numeric dispersion model was selected, which is the default approach in BATHTUB for defining mixing between lake segments. Phosphorus calibrations were based on lake concentrations. The use of availability factors was not required, and estimated concentrations were used to generate mass balance tables.

Table 2. BATHTUB Model Options for Lake Decatur

MODEL	MODEL OPTION
Conservative substance	Not computed
Total phosphorus	1st order
Total nitrogen	Not computed
Chlorophyll-a	Not computed
Transparency	Not computed
Longitudinal dispersion	Fischer-numeric
Phosphorus calibration	Concentrations
Nitrogen calibration	None
Error analysis	Not computed
Availability factors	Ignored
Mass-balance tables	Use estimated concentrations

5.3.3.b *Global Variables*

The global variables required by BATHTUB consist of:

- The averaging period for the analysis
- Precipitation, evaporation, and change in lake levels
- Atmospheric phosphorus loads

BATHTUB is a steady state model, whose predictions represent concentrations averaged over a period of time. A key decision in the application of BATHTUB is the selection of the length of time over which inputs and outputs should be modeled. The length of the appropriate averaging period for BATHTUB application depends upon the nutrient residence time, which is the average length of time that phosphorus spends in the water column before settling or flushing out of the lake. Guidance for the BATHTUB model recommends that the averaging period used for the analysis be at least twice as large as the nutrient residence time for the lake of interest. For lakes with a nutrient residence time on the order of a week to a month, a monthly to seasonal (e.g. June, July, or August; Spring or Summer) averaging period is recommended. The averaging period for the Lake Decatur was selected as follows:

- The nutrient residence time of Lake Decatur was on the order of a month. Therefore the averaging period for this analysis was set to the months of July and August (a two month averaging period).

Precipitation inputs for the lakes were taken from the observed precipitation data for the calibration year, scaled to the appropriate simulation period. This resulted in a precipitation value of 7.2 inches for Lake Decatur. Evaporation was set equal to precipitation and there was no assumed increase in storage during the modeling period, to represent steady state conditions. The values selected for precipitation and change in lake levels have little influence on model predictions. Atmospheric phosphorus loads were specified using default values provided by BATHTUB.

5.3.3.c *Reservoir Segmentation*

BATHTUB provides the capability to divide the reservoir under study into a number of individual segments, allowing prediction of the change in phosphorus concentrations over the length of the reservoir. The segmentation scheme selected for the lakes was designed to provide one segment for each of the primary lake sampling stations. Lake Decatur was divided into the segments shown in Figure 7. The surface areas of each segment and the contributing watershed area for each segment were determined using a Geographic Information System (GIS).

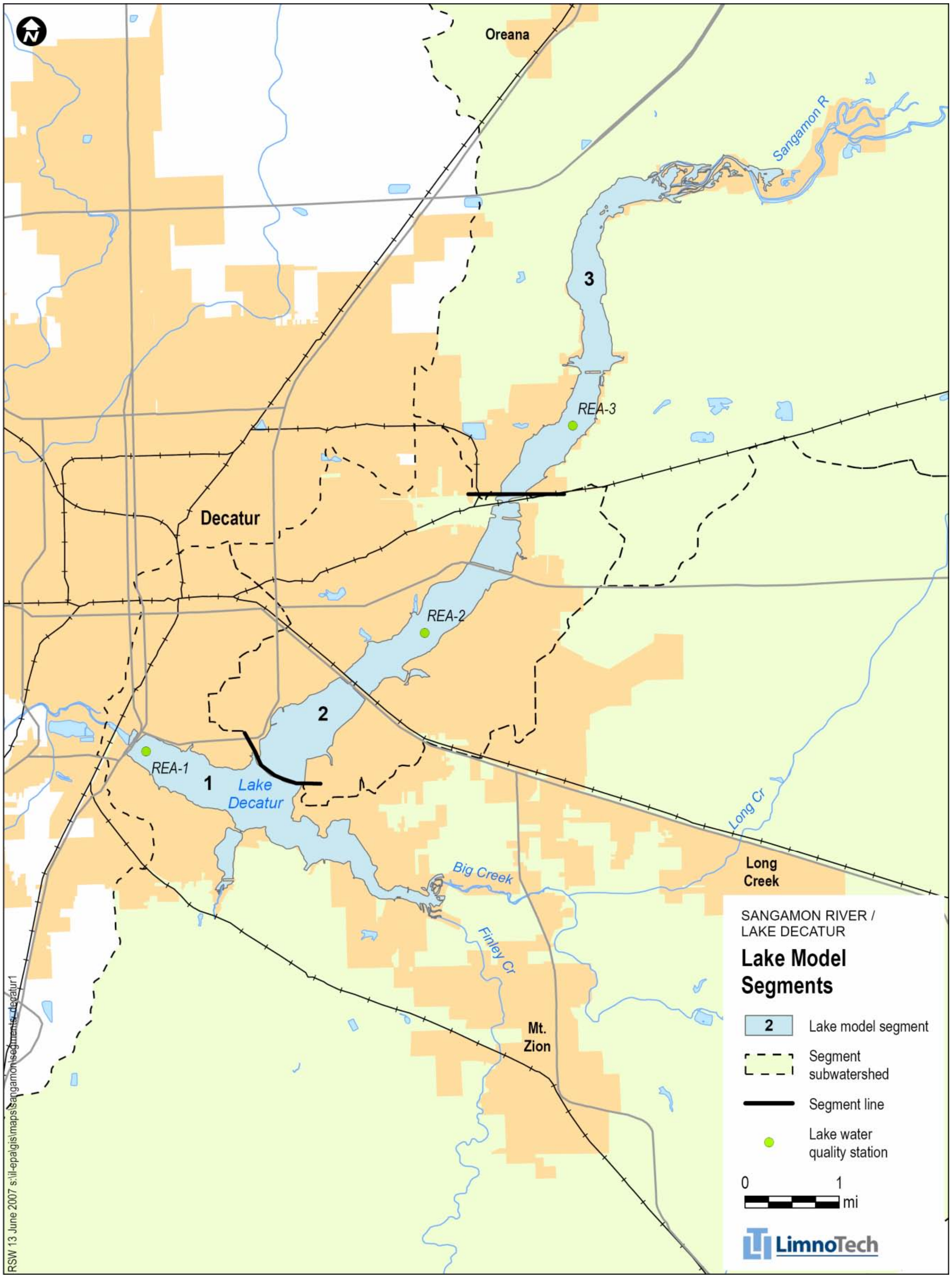


Figure 7. Lake Decatur Segmentation Used in BATHTUB

BATHTUB requires that a range of inputs be specified for each segment. These include segment surface area, length, total water depth, and depth of thermocline and mixed layer. Segment-specific values for segment depths were calculated from lake monitoring data, while segment lengths and surface areas were calculated using GIS. A complete listing of all segment-specific inputs is provided in Attachment 6.

5.3.3.d *Tributary Loads*

BATHTUB requires information describing tributary flow and nutrient concentrations into each reservoir segment. The approach used to estimate flows is discussed below. Total phosphorus concentrations for each major lake tributary were based upon Sangamon River phosphorus measurements (station E18 near Monticello) for July and August. Concentrations for small tributaries were set equal to the assumed concentration for the major tributary. A complete listing of all segment-specific flows and tributary concentrations is provided in Attachment 6.

For Lake Decatur, flows to each segment were estimated using observed flows at a USGS gaging station adjusted through the use of drainage area ratios as follows:

$$\text{Flow into segment} = \text{Flow at USGS gage} \times \text{Segment-specific drainage area ratio}$$

$$\text{Drainage area ratio} = \frac{\text{Drainage area of watershed contributing to model segment}}{\text{Drainage area of watershed contributing to USGS gage}}$$

The USGS gage on the Sangamon River at Monticello, IL (#05572000) was used in this analysis.

Segment-specific drainage area ratios were calculated using watershed boundaries provided in GIS.

5.3.3.e *Point Source Loads*

There are currently no NPDES permitted facilities in the Lake Decatur watershed that have phosphorus limits in their permits. There are, however, seven permitted sewage treatment plants (STPs), which are potential sources of phosphorus (Table 3). An analysis was conducted comparing observed dry weather phosphorus loads in the Sangamon River to expected phosphorus loads from these plants. This analysis indicated that little of the phosphorus discharged upwatershed reaches Lake Decatur. Loads from these facilities are therefore not explicitly included in the modeling because they provide an insignificant contribution to the total load. These point source loads are still implicitly considered, because the tributary loads to the lake are based on instream measurements (Sangamon River at Monticello), which reflect the inputs from point sources located upstream of this monitoring station. Point sources with outfalls located downstream of this monitoring station are included in the model by using the in-stream concentration at E18 with the drainage area ratio scaled flow for the entire watershed. This approach is conservative because the contributing area for model segments 1 and 2 is 12.4% of the total watershed area, and these segments do not have any of the listed potential phosphorus point sources.

Table 3. NPDES Point Source Discharges of Treated Wastewater in the Lake Decatur Watershed

NPDES ID	Facility name	Outfall ID	Outfall Description	Relation to Monitoring Station E18 on the Sangamon River
IL0021016	Fisher STP	001	STP outfall	Upstream
IL0023281	Gibson City WPCF	001	STP outfall	Upstream
		A01	Treated CSO	Upstream
		003	Untreated CSO	Upstream
IL0024414	Mahomet STP	001	STP outfall	Upstream
		A01	Excess flow	Upstream
IL0046141	Sangamon Valley PWD STP	001	STP outfall	Upstream
IL0029980	Monticello WWTF	001	STP outfall	Downstream
		002	High River Stage STP Outfall	Downstream
		A01	Excess flow	Downstream
		A02	High River Stage Excess Flow	Downstream
IL0053325	Allerton Park and 4H Memorial Camp	001	STP outfall	Downstream
IL0047643	Argenta-Oreana Middle School - STP	001	STP outfall	Downstream

5.3.4 BATHTUB Calibration

BATHTUB model calibration consists of:

1. Applying the model with all inputs specified as above
2. Comparing model results to observed phosphorus data
3. Adjusting model coefficients to provide the best comparison between model predictions and observed phosphorus data.

The BATHTUB model was initially applied with the model inputs as specified above. Observed data for 2002, 2004, and 2005 for the months of July and August were used for tributary loading calibration purposes, as these years provided the most robust and recent data set. The average August in-lake data from 1991, 1992, 1994, 1997, 2000 and 2003 were used for calibration, as these data best reflect the steady state conditions assumed for the BATHTUB model.

BATHTUB was first calibrated to match the observed reservoir-average total phosphorus concentrations. Model results in all three segments initially under-predicted the observed phosphorus data. The mismatch between model and data were corrected during the calibration process via a first order decay model for phosphorus. The first order option was selected for phosphorus as the model option for BATHTUB because no additional calibration of the coefficients was necessary. The resulting predicted lake average total phosphorus concentration was 194 ug-P/l, compared to an observed average of 188 ug-P/l. This comparison represents an acceptable model calibration. A complete listing of all the observed data used for calibration purposes, as well as a comparison between model predictions and observed data, is provided in Attachment 6.

This page is blank to facilitate double sided printing.

6. TMDL DEVELOPMENT

This section presents the development of the total maximum daily load for the impaired waterbodies in Sangamon River/Lake Decatur watershed. Future growth is not discussed as part of these TMDLs, because the city of Decatur, which comprises approximately half the population of the watershed, has had a declining population between 1990 and 2006.

6.1 FECAL COLIFORM (SANGAMON RIVER SEGMENTS IL_E-29 & IL_E-18)

A load capacity calculation approach was applied to support development of a fecal coliform TMDL for the Sangamon River Segments IL_E-29 and IL_E-18.

6.1.1 Calculation of Loading Capacity

The loading capacity is defined as the maximum pollutant load that a waterbody can receive and still maintain compliance with water quality standards. The loading capacity was defined over the range of observed flow conditions for each listed segment of the Sangamon River. The allowable loading capacity was computed by multiplying flow by the TMDL target (200 cfu/100 ml). The fecal coliform loading capacity for each segment is presented in Tables 4 and 5.

Table 4. Sangamon River Segment IL_E-29 Fecal Coliform Loading Capacity

Segment IL_E-29	
Sangamon River Flow (cfs)	**Fecal Coliform Load Capacity (cfu/day)**
5	2.45E+10
15	7.34E+10
30	1.47E+11
90	4.40E+11
272	1.33E+12
875	4.28E+12
2500	1.22E+13

Table 5. Sangamon River Segment IL_E-18 Fecal Coliform Loading Capacity

Segment IL_E-18	
Sangamon River Flow (cfs)	**Fecal coliform Load Capacity (cfu/day)**
10	4.89E+10
30	1.47E+11
100	4.89E+11
300	1.47E+12
500	2.45E+12
1000	4.89E+12
3000	1.47E+13

As shown previously in the Segment IL_E-29 and Segment IL_E-18 load duration curves (Figures 2 and 3), fecal coliform is observed to exceed the TMDL target over a range of flows, and the frequency of exceedances does not appear to differ significantly during wet and dry weather. The maximum fecal coliform concentration was compared to the 200 cfu/100 ml target to estimate the percent reduction needed to meet the water quality target. In Segment IL_E-29 up to 98% reduction in fecal coliform loading is required to meet the TMDL target over the range of flows observed in the river. In Segment IL_E-18 up to a 91% reduction in fecal coliform loading is required to meet the TMDL target over the range of flows observed in the river.

6.1.2 Allocation

A TMDL consists of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). This definition is typically illustrated by the following equation:

$$TMDL = WLA + LA + MOS$$

Segment IL_E-29:

There are four NPDES permitted point source dischargers of fecal coliform in the Sangamon River Segment IL_E-29 watershed. The WLA for these point sources was calculated using their permitted flow rates and a concentration consistent with meeting the TMDL target (200 cfu/100 ml) at the downstream end of their exempted reach or at the end of their effluent pipe, depending on the season and whether the disinfection exemption was applicable. Wasteload allocations for these facilities are presented in Table 6. The total WLA for these three facilities equals 1.27E+10 cfu/day.

In addition to the dischargers presented in Table 6, the Gibson City STP also has a permit for two combined sewer overflows (CSOs) that may discharge under wet weather conditions. One CSO is treated and the other is not. Furthermore, the Mahomet STP has a permit for an excess flow discharge. The WLAs for the CSOs and the excess flow discharge were calculated based on reported average overflow volumes per event and a concentration of 200 cfu/100ml, consistent with water quality standards. The WLA for the CSOs and the excess flow discharge equals 1.79E+10 cfu/day.

Table 6. Permitted Dischargers and WLAs in Sangamon River Segment IL_E-29

NPDES ID	Facility Name	Disinfection exemption	Average design flow (MGD)	Permit expiration date	WLA (cfu/day)
IL0023281	Gibson City WPCF	Year-round	0.575	6/30/2008	4.36E+09
IL0024414	Mahomet STP	Seasonal (Nov-April)	0.5	5/31/2009	3.79E+09
IL0046141	Sangamon Valley PWD STP	Seasonal (Nov-April)	0.4	12/31/2009	3.03E+09
IL0021016	Fisher STP	Year-round	0.2	3/31/2009	1.52E+09
				TOTAL	**1.27E+10**

The remainder of the loading capacity is given to the load allocation for nonpoint sources as presented in Table 7. The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources to the overall fecal coliform load.

Table 7. Fecal Coliform TMDL for Sangamon River Segment E_29[2]

Sangamon River Flow (cfs)	Fecal coliform Load Capacity (cfu/day)	WLA for Table 6 dischargers (cfu/day)	CSO and Excess flow WLA (cfu/day)[1]	Load allocation (LA) (cfu/day)
5	2.45E+10	1.27E+10		1.18E+10
15	7.34E+10	1.27E+10		6.07E+10
30	1.47E+11	1.27E+10		1.34E+11
90	4.40E+11	1.27E+10		4.28E+11
272	1.33E+12	1.27E+10		1.32E+12
875	4.28E+12	1.27E+10	1.79E+10	4.25E+12
2500	1.22E+13	1.27E+10	1.79E+10	1.22E+13

[1] For purposes of this table, CSOs and excess flow outfalls discharge only during high flows

[2] An implicit MOS is used in this TMDL

Fecal monitoring is required for the Gibson City treated CSO and the Mahomet excess flow outfall. Based on recent monitoring data (2004 – April 2007), these two outfalls are in compliance with their permit limits for fecal coliform bacteria and no WLA reductions are needed. No monitoring data were identified for the untreated CSO. No WLA reduction is required at lower flows, as the four permitted dischargers listed in Table 6 all have disinfection exemptions or are complying with their permit limits during periods when the disinfection exemption does not apply.

Segment IL_E-18:

There are six NPDES permitted point source dischargers of fecal coliform in the Sangamon River Segment IL_E-18 watershed. Dischargers located in the upstream IL_E-29 watershed are included in this tally (and discussed previously), as they are also upstream of segment IL_E-18. The WLA for these point sources was calculated using their permitted flow rates and a concentration consistent with meeting the TMDL target (200 cfu/100 ml) at the downstream end of their exempted reach or at the end of their effluent pipe, depending on the season and whether the disinfection exemption was applicable. Wasteload allocations for these facilities are presented in Table 8. The total WLA for these six facilities equals 2.07E+10 cfu/day.

In addition to the dischargers presented in Table 8, the Gibson City STP also has a permit for two combined sewer overflows (CSOs) that may discharge under wet weather conditions. One CSO is treated and the other is not. Furthermore, the Mahomet STP has a permit for an excess flow discharge and the Monticello WPCF has a permit for one excess flow outfall and two high river stage outfalls. The WLA for the Gibson City CSOs and the Mahomet and Monticello excess flow outfalls were calculated based on reported average overflow volumes per event and a concentration of 200 cfu/100ml, consistent with water quality standards. The WLA for the CSOs and the excess flow outfalls equals 6.23E+10 cfu/day. A WLA is not presented in Table 9 for the two high river stage outfalls because they have not discharged since 2002 and monitoring data are not readily available to estimate discharge flow volumes. The WLA for these two outfalls, when discharging, will be calculated from the reported overflow volume and a concentration of 200 cfu/100ml, consistent with water quality standards.

Table 8. Permitted Dischargers and WLAs in Sangamon River Segment E_18[1]

NPDES ID	Facility Name	Disinfection exemption	Average Design Flow (MGD)	Permit Expiration Date	WLA (cfu/day)
IL0029980	Monticello WWTP	Seasonal (Nov- April)	1	10/31/2010	7.58E+09
IL0053325	Univ-Allerton Park and IL 4H Cmp	Year-round	0.056	8/31/2009	4.24E+08
IL0023281	Gibson City WPCF	Year-round	0.575	6/30/2008	4.36E+09
IL0024414	Mahomet STP	Seasonal (Nov-April)	0.5	5/31/2009	3.79E+09
IL0046141	Sangamon Valley PWD STP	Seasonal (Nov-April)	0.4	12/31/2009	3.03E+09
IL0021016	Fisher STP	Year-round	0.2	3/31/2009	1.52E+09
				TOTAL	**2.07E+10**

[1] Dischargers located in the upstream IL_E-29 watershed (and presented previously in Table 6) are included in this table, as they are also upstream of segment IL_E-18.

The remainder of the loading capacity is given to the load allocation for nonpoint sources as presented in Table 9. The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources to the overall fecal coliform load.

Table 9. Fecal Coliform TMDL for Sangamon River Segment E_18[2]

Sangamon River Flow (cfs)	Fecal coliform Load Capacity (cfu/day)	WLA for Table 8 dischargers (cfu/day)	CSO and Excess flow WLA (cfu/day)[1]	Load allocation (LA) (cfu/day)
10	4.89E+10	2.07E+10		2.82E+10
30	1.47E+11	2.07E+10		1.26E+11
100	4.89E+11	2.07E+10		4.69E+11
300	1.47E+12	2.07E+10		1.45E+12
500	2.45E+12	2.07E+10		2.43E+12
1000	4.89E+12	2.07E+10	6.23E+10	4.81E+12
3000	1.47E+13	2.07E+10	6.23E+10	1.46E+13

[1] For purposes of this table, CSOs and excess flow outfalls discharge only during high flows. A WLA is not provided for the two Monticello WWTP high river stage outfalls because measured flows are not available (they have not discharged between 2002 and April 2007). The WLA for these two outfalls will be calculated from their flow volume and a concentration of 200 cfu/100ml, consistent with water quality standards.

[2] An implicit MOS is used in this TMDL

Fecal monitoring is required for the Gibson City treated CSO, the Mahomet excess flow outfall and the Monticello excess flow and high river stage outfalls. The high river stage outfalls have not discharged recently. Based on recent monitoring data (2004 – April 2007), the CSOs and excess flow outfalls are in compliance with their permit limits for fecal coliform bacteria and no WLA reductions are needed. No monitoring data were identified for the untreated Gibson City CSO. No WLA reduction is required at lower flows, as the six permitted dischargers listed in Table 8 all have disinfection exemptions or are complying with their permit limits during periods when the disinfection exemption doesn't apply.

6.1.3 Critical Condition

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. Figures 2 and 3 provide a graphical depiction of the data compared to the load capacity, showing that exceedances of the TMDL target occur over the full range of flow conditions. TMDL development utilizing the load-duration approach applies to the full range of flow conditions; therefore critical conditions were addressed during TMDL development.

6.1.4 Seasonality

This TMDL was conducted with an explicit consideration of seasonal variation. The approach used for the TMDL evaluated seasonal loads because only May through October water quality data were used in the analysis, consistent with the specification that the standard only applies during this period. The fecal coliform standard will be met regardless of flow conditions in the applicable season because the load capacity calculations specify target loads for the entire range of flow conditions that are possible to occur at any given point in the season where the standard applies.

6.1.5 Margin of Safety

Total maximum daily loads are required to contain a Margin of Safety (MOS) to account for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be either implicit (e.g., incorporated into the TMDL analysis through conservative assumptions), or explicit (e.g., expressed in the TMDL as a portion of the loading), or expressed as a combination of both. The fecal coliform TMDLs contain an implicit margin of safety, through the use of multiple conservative assumptions. First, 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). An additional implicit Margin of Safety is provided via the use of a conservative model to define load capacity. The model assumes no decay of bacteria that enter the river, and therefore represents an upper bound of expected concentrations for a given pollutant load. This margin of safety can be reviewed in the future as new data are developed.

6.2 DISSOLVED OXYGEN (OWL CREEK SEGMENT IL_EZV)

A dissolved oxygen TMDL was developed for Owl Creek (IL_EZV).

6.2.1 Calculation of Loading Capacity

The loading capacity is defined as the maximum pollutant load that a waterbody can receive and still maintain compliance with water quality standards. The pollutant of concern for Owl Creek was phosphorus, and the objective of the TMDL simulation was to define the extent that phosphorus loads would need to be reduced in order to maintain compliance with the dissolved oxygen target. The QUAL2E model was used to define the relationship between external phosphorus loading and the resulting chlorophyll a concentration. The magnitude of the diurnal dissolved oxygen variation was assumed to be directly proportional to the chlorophyll a concentration (Chapra, 1997).

The first step in determining the loading capacity was to reduce upstream sources of phosphorus to determine the maximum phosphorus load that would result in the river attaining the modeling target of 7.1 mg/l[1] upstream of the Fisher STP. Point source loads of phosphorus were then reduced at the Fisher STP to ensure compliance with the dissolved oxygen target below the plant.

Model results were used to calculate the load allocation and wasteload allocation, which is a component of the loading capacity. The load capacity was calculated as the sum of the load allocation, the wasteload allocation (section 6.1.2) and the margin of safety (section 6.1.5). The loading capacity is presented below (Table 10).

Table 10. IL_EZV Load Capacity

Phosphorus Load Capacity (kg/day)
1.42

6.2.2 Allocation

A TMDL consists of point source/waste load allocations (WLAs), nonpoint sources/load allocations (LAs), and a margin of safety (MOS). This definition is typically illustrated by the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

There is one NPDES permitted point source dischargers in the Owl Creek (IL_EZV) watershed. The allocation process dividing the allowable load between sources was discussed above in Section 6.2.1. The allocations presented below in Table 11 were reduced by 10%, which was designed to serve as a margin of safety (discussed below). The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources.

Table 11. IL_EZV Load Allocation and Wasteload Allocation for Phosphorus

Nonpoint sources			Point Sources		
Existing load (kg/day)	% Reduction	LA (kg/d)	Existing load (kg/day)	% Reduction	WLA (kg/day)
0.06	70%	0.02	3.23	61%	1.26

---

[1] This modeling target considers observed diurnal variation and ensures that the 5.0 mg/l water quality standard is met.

6.2.3 Critical Conditions

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions were taken into account in the development of this TMDL. A review of available dissolved oxygen data for Owl Creek showed that low dissolved oxygen occurs during low flow summer conditions. To effectively consider critical conditions, this TMDL is based upon the flows and temperatures measured during the August-September, 2006 low flow survey.

6.2.4 Seasonality

The TMDL was conducted with an explicit consideration of seasonal variation. The TMDL was evaluated for a range of flow conditions that are expected to be observed throughout the year. However, dissolved oxygen problems are predicted to be most severe during summer, low flow periods. QUAL-2E model simulations were conducted to represent the critical summer condition.

6.2.5 Margin of Safety

Total maximum daily loads are required to contain a Margin of Safety (MOS) to account for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be either implicit (e.g., incorporated into the TMDL analysis through conservative assumptions), or explicit (e.g., expressed in the TMDL as a portion of the loading), or expressed as a combination of both. The dissolved oxygen TMDL contains an explicit margin of safety of 10%. The 10% margin of safety is considered an appropriate value based upon the generally good agreement between the QUAL2E water quality model predicted values and the observed values. In particular, model predictions of both dissolved oxygen and chlorophyll a concentrations correctly predict the observed magnitude and spatial trends. The average error in predicted dissolved oxygen concentration is less than 0.5 mg/l. Since the model reasonably reflects the conditions in the watershed, a 10% margin of safety is considered to be adequate to address the uncertainty in the TMDL, based upon the data available. This margin of safety can be reviewed in the future as new data are developed. The resulting explicit phosphorus load allocated to the margin of safety is presented in Table 12.

Table 12. IL_EZV Margin of Safety

Phosphorus MOS (kg/day)
0.14

6.3 TOTAL PHOSPHORUS (LAKE DECATUR SEGMENT REA)

6.3.1 Calculation of Loading Capacity

The loading capacity is defined as the maximum pollutant load that a waterbody can receive and still maintain compliance with water quality standards. For Lake Decatur, the loading capacity was determined by running the BATHTUB model repeatedly, reducing the tributary nutrient concentrations for each simulation until model results demonstrated attainment of the TMDL target. The maximum tributary concentration that results in compliance with water quality standards was used as the basis for determining the lake's loading capacity. The tributary concentration was then converted into a loading rate through multiplication with the tributary flow.

BATHTUB load reduction simulations indicated that Lake Decatur phosphorus concentrations would reach the TMDL target of 50 ug-P/l when tributary phosphorus concentrations were less than 52 ug-P/l. The resulting tributary phosphorus load that led to compliance with water quality standards was 954 kg phosphorus/month (31.4 kg/day), with the total load for the July-August period not to exceed 1908 kg. This allowable load corresponds to an approximately 75% reduction from existing tributary loads (estimated as 7,538 kg for the July to August period). Loads are expressed on a two-month basis because model results indicate that the phosphorus residence time in Lake Decatur is on the order of weeks to months.

6.3.2 Allocation

A TMDL consists of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). This definition is typically illustrated by the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

The seven NPDES-permitted sewage treatment plants in the watershed are listed in Table 3. The effluent from these facilities, when discharging, is not monitored for phosphorus. In order to determine if these facilities merit a reduction or inclusion in the TMDL, a conservative estimate of the loads from these facilities was calculated. This load assumes the facilities discharge continuously at their average design flow (CSO and excess flow discharges were converted to an annual basis) and the effluent concentration was assumed to be 4 mg-P/l (Litke, 1999), which is reflective of a weak concentration in untreated domestic wastewater. An attenuation factor was applied to the loads based on observed dry weather data for the upper portion of the watershed. This calculation shows that the facilities combined contribute approximately 5% of the existing phosphorus loading, and are an insignificant source of phosphorus in the predominantly agricultural watershed. A wasteload allocation is not calculated for these facilities and the permits for these facilities will not be changed at this time. Nonpoint sources are responsible for the majority of the phosphorus load; therefore, phosphorus will not be added to the permit limits for the facilities until substantial work has been done to decrease nonpoint source loads.

The remainder of the loading capacity is given to the load allocation for nonpoint sources and the margin of safety. The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources to the overall phosphorus load. Given a loading capacity of 954 kg-P/month (31.4 kg-P/day) and an explicit margin of safety of 10% (discussed below), this results in a load allocation for Lake Decatur of 858.6 kg-P/month (28.3 kg-P/day).

6.3.3 Critical Condition

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. Critical conditions were taken into account in the development of this TMDL. In terms of loading, the period with the greatest nutrient residence time (seasonal period of low flow conditions) was chosen because the in-lake concentrations of phosphorus were determine to be the greatest at this time according to available data. The Lake Decatur TMDL is based upon a seasonal period that takes into account both summer low flows and summer water quality in order to effectively consider these critical conditions.

6.3.4 Seasonality

The Lake Decatur TMDL was conducted with an explicit consideration of seasonal variation. The BATHTUB model used for this TMDL is designed to evaluate loads over the critical seasonal summer period. Model results indicate that the phosphorus residence time in Lake Decatur is on the order of weeks to a month. Loads entering the lake in the fall through early spring period do not directly affect summer phosphorus concentrations because of the shorter nutrient residence time in the lake, and therefore were excluded from the TMDL analysis.

6.3.5 Margin of Safety

The phosphorus TMDL contains an explicit margin of safety of 10%. The 10% margin of safety is considered an appropriate value based upon the generally good agreement between the BATHTUB water quality model predicted values and the observed values. Since the model reasonably reflects the conditions in the watershed, a 10% margin of safety is considered to be adequate to address the uncertainty in the TMDL, based upon the data available. This margin of safety can be reviewed in the future as new data are developed. The resulting explicit phosphorus load allocated to the margin of safety is 95.4 kg-P/month (3.14 kg-P/day) for Lake Decatur

6.4 NITRATE (LAKE DECATUR SEGMENT REA)

6.4.1 Calculation of Loading Capacity

The loading capacity is defined as the maximum pollutant load that a waterbody can receive and still maintain compliance with water quality standards. The loading capacity was defined over the range of observed inflows to the lake. The allowable loading capacity was computed by multiplying flow to the lake by the TMDL target (10 mg-N/L). The nitrate loading capacity for Lake Decatur is presented in Table 13.

Table 13. Lake Decatur (REA) Nitrate Loading Capacity

Flow (cfs)	Load Capacity (kg/day)
10	245
20	489
50	1,223
100	2,447
200	4,893
500	12,233
1000	24,466
1500	36,699
2000	48,931

The maximum nitrate concentrations were examined for different flow intervals for Lake Decatur (Table 14) and compared to the 10 mg-N/L target to estimate the percent reduction needed to meet the water quality target. In Lake Decatur a reduction of 13%-28% in nitrate loading is required to meet the TMDL target over the range of flows observed in the river. No reduction is needed during low flow conditions.

Table 14. Lake Decatur (REA) Nitrate Loading Reduction

% Time Flow Exceeded Percentile Interval	Flow (cfs)	# samples > 10 mg/L per # samples	Maximum Nitrate Concentration (mg/L)	Percent Reduction to Meet Target
0-30	613 - 32,000	30/98	13.9	28%
30-60	612 - 266	2/99	11.5	13%
60-100	0 - 265	0/109	8.25	-

6.4.2 Allocation

A TMDL consists of waste load allocations (WLAs) for point sources, load allocations (LAs) for nonpoint sources, and a margin of safety (MOS). This definition is typically illustrated by the following equation:

$$\text{TMDL} = \text{WLA} + \text{LA} + \text{MOS}$$

There are seven NPDES permitted sewage treatment plants in the Lake Decatur watershed, some of which have multiple outfalls. None of these dischargers have a permit requirement to monitor nitrate. The WLA for these point sources was calculated using their permitted flow rates and a concentration consistent with meeting the TMDL target (10 mg/l) at the end of their effluent pipe. Wasteload allocations for these facilities are presented in Table 15. The total WLA for these facilities equals 105 kg/day.

In addition to the dischargers presented in Table 15, the Gibson City STP also has a permit for two combined sewer overflows (CSOs) that may discharge under wet weather conditions. One CSO is treated and the other is not. Furthermore, the Mahomet STP has a permit for an excess flow discharge and the Monticello WPCF has a permit for one excess flow outfall and two high river stage outfalls. The WLA for the Gibson City CSOs and the Mahomet and Monticello excess flow outfalls were calculated based on reported average overflow volumes per event and a concentration of 10 mg/l, consistent with water quality standards. The WLA for the CSOs and the excess flow outfalls equals 312 kg/day. A WLA for the two high river stage outfalls is not presented in Table 16 because they have not discharged since 2002 and monitoring data are not readily available to estimate discharge flow volumes. The WLA for these two outfalls, when discharging, will be calculated from the reported overflow volume and a concentration of 10 mg/l, consistent with water quality standards.

Table 15. Permitted Dischargers and Nitrate WLAs[1] in the Lake Decatur Watershed

NPDES ID	Facility Name	Average Design Flow (MGD)	Permit Expiration Date	WLA (kg/day)
IL0029980	Monticello WWTP	1	10/31/2010	37.9
IL0053325	Univ-Allerton Park and IL 4H Camp	0.056	8/31/2009	2.1
IL0023281	Gibson City WPCF	0.575	6/30/2008	21.8
IL0029980	Mahomet STP	0.5	5/31/2009	18.9
IL0046141	Sangamon Valley PWD STP	0.4	12/31/2009	15.1
IL0021016	Fisher STP	0.2	3/31/2009	7.6
IL0047643	Argenta-Oreana Middle School STP	0.038	7/31/2009	1.4

[1] These facilities do not currently have nitrate permit limits. The WLAs are calculated based on a target nitrate concentration of 10 mg/l.

The remainder of the loading capacity is given to the load allocation for nonpoint sources as presented in Table 16. The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources to the overall nitrate load.

The load duration curve (Figure 4) shows no exceedances of the TMDL target (10 mg-N/L) during low flow conditions, the period during which the impact from point sources would be largest. This indicates point sources are not significant contributors to nitrate exceedances in Lake Decatur during low flow periods. The permits for these facilities will not be changed at this time. Non-point sources are responsible for the majority of the nitrate load; therefore, nitrate will not be added to the permit limits for the facilities until substantial work has been done to decrease non-point source loads.

The remainder of the loading capacity is given to the load allocation for non-point sources and the margin of safety. The load allocation is not divided into individual source categories for purposes of this TMDL, as it is the intent of the implementation plan to provide detail on the contributions of specific sources to the overall nitrate load.

Table 16. Lake Decatur (REA) Nitrate TMDL Allocations

Flow (cfs)	Allowable Load (kg/day)	WLA for Table 15 dischargers (kg/day)	WLA CSOs and excess flow outfalls (kg/day)[1]	MOS (explicit) (kg/day)	Load Allocation (LA) (kg/day)
10	245	105		24	115
20	489	105		49	336
50	1,223	105		122	996
100	2,447	105		245	2,097
200	4,893	105		489	4,299
500	12,233	105		1,223	10,905
1000	24,466	105		2,447	21,914
1500	36,699	105	312	3,670	32,612
2000	48,931	105	312	4,893	43,622

1 For purposes of this table, CSOs and excess flow outfalls discharge only during high flows. A WLA is not provided for the two Monticello WWTP high river stage outfalls because measured flows are not available (they have not discharged between 2002 and April 2007). The WLA for these two outfalls will be calculated from their flow volume and a concentration of 10 mg/l, consistent with water quality standards.

6.4.3 Critical Condition

TMDLs must take into account critical environmental conditions to ensure that the water quality is protected during times when it is most vulnerable. The nitrate load duration curve (Figure 4) provides a graphical depiction of the data compared to the load capacity, showing that exceedances of the TMDL target occur during higher flow conditions. TMDL development utilizing the load-duration approach applies to the full range of flow conditions; therefore critical conditions were addressed during TMDL development.

6.4.4 Seasonality

This TMDL was conducted with an explicit consideration of seasonal variation. The nitrate standard will be met regardless of flow conditions in the applicable season because the load capacity calculations specify target loads for the entire range of flow conditions that are possible to occur in any given point in the season where the standard applies.

6.4.5 Margin of Safety

TMDLs are required to contain a Margin of Safety (MOS) to account for any uncertainty concerning the relationship between pollutant loading and receiving water quality. The MOS can be either implicit (e.g., incorporated into the TMDL analysis through conservative assumptions), or explicit (e.g., expressed in the TMDL as a portion of the loading), or expressed as a combination of both. The nitrate TMDL contains a combination of both types. An implicit Margin of Safety is provided via the use of a conservative model to define load capacity. The model assumes no loss of nitrate that enters the river, and therefore represents an upper bound of expected concentrations for a given pollutant load. The TMDL also contains an explicit margin of safety of 10%. This 10% margin of safety was included in addition to the implicit margin of safety to address potential uncertainty in the effectiveness of load reduction alternatives. This margin of safety can be reviewed in the future as new data are developed.

This page is blank to facilitate double sided printing.

7. PUBLIC PARTICIPATION AND INVOLVEMENT

The TMDL process included numerous opportunities for local watershed institutions and the general public to be involved. A number of phone calls were made to identify and acquire data and information (see the Stage 1 Report). As quarterly progress reports were produced during the first stage of the TMDL process, the Agency posted them to their website for public review.

A public meeting was held on May 31, 2006 at Richland Community College in Decatur, Illinois to present Stage 1 of TMDL development for the Sangamon River/Lake Decatur watershed. A second meeting was also held at Richland Community College in Decatur, Illinois on July 31, 2007 to present the Draft TMDL and Implementation Plan.

This page is blank to facilitate double sided printing.

8. IMPLEMENTATION PLAN

Total Maximum Daily Loads (TMDLs) have been developed for the Sangamon River (IL_E-18; IL_E-29) to address water quality impairments due to fecal coliform; for Owl Creek (IL_EZV) to address water quality impairments due to dissolved oxygen; and for Lake Decatur (IL_REA) to address water quality impairments due to total phosphorus and nitrate. These TMDLs determined that significant reductions in existing pollutant loadings were needed to meet water quality objectives. The next step in the TMDL process is to develop an implementation plan that includes both accountability and the potential for adaptive management. This section identifies a number of alternative actions to be considered by local stakeholders for TMDL implementation; these alternative actions are summarized, and recommendations are presented for implementation actions and additional monitoring.

8.1 EXISTING CONTROLS

The local Natural Resource Conservation Service (NRCS), Farm Service Agency (FSA), and Soil and Water Conservation District (SWCD) offices have information on existing best management practices within the watershed, and can be contacted to understand what efforts have been made or are planned to control nonpoint sources. Discussions with local NRCS staff indicated that no large-scale BMPs have been implemented in the watershed within the last several years, although several streambank stabilization/restoration projects have been undertaken. The NRCS has been working with individual landowners to implement small-scale BMPs (e.g., filter strips) on individual properties. However, it is difficult to quantify the impact of these individual property BMPs over the entire watershed.

Several small Land and Water Reserves have been established in the Sangamon River/Lake Decatur watershed, including the 143.77 acre Jasmine Hollow Land and Water Reserve, located southwest of Allerton Park and Monticello, and the 28-acre Shady Rest Land and Water Reserve north of the City of Monticello. These Land and Water Reserves, both of which are in Piatt County in the Grand Prairie Section of the Grand Prairie Natural Division, are two of the nine protected natural areas that, taken together, preserve over 8.5 miles of the Sangamon River and over 3,100 acres of forest and other natural land along the Sangamon River corridor in Piatt and Champaign counties (Illinois Nature Preserves Commission, 2006).

There have also been several CWA Section 319 nonpoint source grants in the Sangamon River/Lake Decatur watershed within the last ten years, including the Upper Sangamon River Basin Water Quality Improvement Project, which funded local soil and water conservation districts to provide technical and educational assistance directly to landowners in the watershed. Cost-share funds were used to implement agricultural BMPs on over 40,000 acres, including nutrient management using GIS/GPS with fertilizer monitors; and the restoration of two small wetlands (total of 3 acres) (IEPA, 2006b). The Conservation Reserve Enhancement Program (CREP) Assistance project facilitated landowners enrolling in the CREP program, including landowners in all of the counties in the watershed.

The watershed also received a Targeted Watershed Grant from EPA in 2004. This 3-year, $1.29M grant was used to assess and demonstrate agricultural BMPs addressing the use of crop nutrients, specifically nitrogen and phosphorus. The grant reflects a partnership between the Agricultural Watershed Institute, based in Decatur, local SWCDs, and the University of Illinois, plus individual landowners. One project is using GIS-based software and precision agriculture technology in on-farm trials to optimize nitrogen management. A second study is demonstrating drainage water management and subsurface bioreactors to reduce movement of nitrates through drainage tiles to surface water. The third study is examining the economic and environmental benefits from soil testing and variable rate technology to improve phosphorus management. In addition, some of the grant money is used to provide risk insurance to farmers who use management practices that reduce the amount of nutrients lost to the streams (EPA, 2004).

The City of Decatur implemented a massive dredging project for Lake Decatur in 2004. The $25M project, which is projected to last for 12 years, is intended to remove approximately 10,000,000 cubic yards of sediment from the lake and move it to a 400-acre impoundment that was formerly used for a previous dredging project. The project has been initiated at the north end of the lake where the Sangamon River enters the lake. Flow velocities from the Sangamon decrease as the river enters the lake, allowing large volumes of transported sediment to deposit at the entrance to the lake. The goal of the dredging project is to remove sediment and virgin soil to a depth of 10.5 feet below the current lake level. Project managers anticipate that dredging operation will remain in the northern part of the lake through 2007, and then will be moved to the southern part of the lake to begin operation there (Dredging Supply Co., Inc., 2004).

8.2 IMPLEMENTATION APPROACH

The approach to be taken for TMDL development and implementation is based upon discussions with Illinois EPA and its Scientific Advisory Committee. The approach consists of the following steps, with the first three steps corresponding to TMDL development and the latter two steps corresponding to implementation:

1. Use existing data to define overall existing pollutant loads, as opposed to developing a watershed model that might define individual loading sources.
2. Apply relatively simple tools (e.g., load duration curve) to define the load-response relationship and define the maximum allowable pollutant load that the waterbody can assimilate and still attain water quality standards.
3. Compare the maximum allowable load to the existing load to define the extent to which existing loads must be reduced in order to meet water quality standards.
4. Develop a voluntary implementation plan that includes both accountability and the potential for adaptive management.
5. Carry out adaptive management through the implementation of a long-term monitoring plan designed to assess the effectiveness of pollution controls as they are implemented, as well as progress towards attaining water quality standards.

This approach is designed to accelerate the pace at which TMDLs are being developed for sites dominated by nonpoint sources, which will allow implementation activities (and water quality improvement) to begin sooner. The approach also places decisions on the types of nonpoint source controls to be implemented at the local level, which will allow those with the best local knowledge to prioritize sources and identify restoration alternatives. The Association of Illinois SWCDs, using Section 319 grant funding, have made available a Watershed Liaison to provide educational, informational, and technical assistance to local agencies and communities. The liaison can assist in establishing local watershed planning groups, as well as acting as an overall facilitator for coordination between local, state, and Federal agencies.

The adaptive management approach to be followed recognizes that models used for decision-making are approximations, and that there is never enough data to completely remove uncertainty. The adaptive process allows decision-makers to proceed with initial decisions based on modeling, and then to update these decisions as experience and knowledge improve.

Steps One through Three described above have been completed, as described previously in this report. This plan represents Step Four of the process. Step Five is briefly described in the last section of this document, and will be conducted as implementation proceeds.

8.3 IMPLEMENTATION ALTERNATIVES

Based on the objectives for the TMDLs and experience in other watersheds, a number of alternatives have been identified for the implementation phase of these TMDLs. As discussed earlier in this plan, a number of BMPs, including streambank stabilization/restoration, wetlands restoration, sediment control structures, conservation buffers, and conservation tillage, have been implemented in this watershed. No comprehensive inventory of BMPs was identified in preparing this plan.

For fecal coliform in Sangamon River segments E-29 and E-18, implementation alternatives focused on livestock, failing septic systems, and permitted point sources:

- Point Source Controls
- Private Sewage Disposal System Inspection and Maintenance Program
- Restriction of Livestock Access
- Conservation Buffers
- Wetland Restoration

For the dissolved oxygen TMDL, violations of the water quality standard for dissolved oxygen are caused by large diurnal variations, driven by excessive plant productivity. The excessive plant productivity is attributed to elevated nutrient concentrations, with phosphorus being the primary nutrient of concern. Potential sources of phosphorus contributing to the listing of this segment include agricultural runoff and the Fisher Sewage Treatment Plant. Implementation alternatives are therefore focused on reducing nonpoint source phosphorus loads, point source phosphorus loads and also on improving aeration, improving flow rate and decreasing water temperature. The alternatives include:

- Point Source Controls
- Conservation Buffers
- Streambank Enhancement and Protection
- Nutrient Management
- Conservation Tillage
- Conservation Buffers
- Private Sewage Disposal System Inspection and Maintenance Program
- Restriction of Livestock Access
- Sediment Control Structures
- Streambank and Shoreline Enhancement and Protection
- Wetland Restoration
- Grassed Waterways

For the total phosphorus TMDL, the primary source of high phosphorus concentrations was determined to be nonpoint source runoff. Recently-collected dissolved oxygen data indicate the lake does not go anoxic and therefore sediment phosphorus release was not identified as a source. Therefore, implementation alternatives are focused on reducing pollutant loading from nonpoint source runoff, particularly agricultural runoff. The alternatives include:

- Nutrient Management
- Conservation Tillage
- Conservation Buffers
- Private Sewage Disposal System Inspection and Maintenance Program
- Restriction of Livestock Access
- Sediment Control Structures
- Streambank and Shoreline Enhancement and Protection
- Wetland Restoration
- Grassed Waterways

For the nitrate TMDL, the primary cause of high nitrate was determined to be nonpoint source runoff during wet weather. Implementation alternatives are therefore focused on reducing pollutant loading from nonpoint source runoff, particularly agricultural runoff. The alternatives include:

- Nutrient Management
- Conservation Tillage

- Conservation Buffers
- Restriction of Livestock Access

Each of these alternatives is described briefly in this section, including information about their costs and effectiveness in reducing pollutant loadings. Costs have been updated from their original sources, based on literature citations, to 2007 costs using the Engineering News Record Construction Cost Index, as provided by the NRCS (http://www.economics.nrcs.usda.gov/cost/priceindexes/index.html).

It should be noted that there is usually a wide range in the effectiveness of the various practices; this is largely due to variations in climate, soils, topography, design, construction, and maintenance of the practices (NRCS, 2006).

8.3.1 Nutrient Management

Nutrient management plans are designed to minimize nutrient losses from agricultural lands, and therefore minimize the amount of phosphorus and nitrogen transported into the watershed. Because agriculture is the most common land use in the watershed, controls focused on reducing phosphorus and nitrogen loads from these areas are expected to help reduce phosphorus and nitrogen loads delivered to the watershed. The focus of a nutrient management plan is to increase the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface and ground waters (EPA, 2003). The majority of phosphorus lost from agricultural land is transported via surface runoff, mostly in particulate form attached to eroded soil particles, while nitrogen generally leaches through the soil. A nutrient management plan identifies the amount, source, time of application, and placement of each nutrient needed to produce each crop grown on each field each year, to optimize efficient use of all sources of nutrients (including soil reserves, commercial fertilizer, legume crops, and organic sources) and minimize the potential for losses that lead to degradation of soil and water quality (UIUC, 2005).

Steps in developing a nutrient management plan include (UIUC, 2005):

- Assess the natural nutrient sources (soil reserves and legume contributions).
- Identify fields or areas within fields that require special nutrient management precautions.
- Assess nutrient needs for each field by crop.
- Determine quantity of nutrients that will be available from organic sources, such as manure or industrial or municipal wastes.
- Allocate nutrients available from organic sources.
- Calculate the amount of commercial fertilizer needed for each field.
- Determine the ideal time and method of application.
- Select nutrient sources that will be most effective and convenient for the operation.

A Pennsylvania State University study on the relative effectiveness of nutrient management in controlling nitrogen and phosphorus indicated that total phosphorus loads can be reduced by 35% with nutrient management, while total nitrogen loads can achieve a 15% reduction (EPA, 2003). Nutrient management is generally effective, but for phosphorus, most fertilizer is applied to the surface of the soil and is subject to transport (NRCS, 2006). In an extensively cropped watershed, the loss of even a small fraction of the fertilizer-applied phosphorus can have a significant impact on water quality.

Costs of developing nutrient management plans have been estimated at $6 to $20/acre (EPA, 2003). These costs are often offset by the savings associated with using less fertilizer. For example, a study in Iowa showed that improved nutrient management on cornfields led to a savings of about $3.60/acre (EPA, 2003).

The Agricultural Water Institute (AWI) has been evaluating several forms of nutrient management in the Sangamon River/Lake Decatur watershed using its 2004 Targeted Watershed Grant. Historically, Illinois farmers have applied fertilizer according to methods outlined in the University of Illinois Agronomy Handbook. However, under the 2004 Targeted Watershed Grant, AWI developed curves that optimized the amount of fertilizer to be used for corn crops based on the price of corn versus the price of fertilizer. The curve evaluated the cost effectiveness of improving corn yield by adding more fertilizer while also evaluating the additional cost of using more fertilizer. This practice was piloted in the watershed in the 2005 and 2006 growing seasons, and resulted in approximately a 20-lb reduction in nitrogen applied per acre of corn per season. However, as corn prices began rising during the 2007 growing season, many farmers abandoned these curves as a guide for fertilizer application and began applying fertilizer at the original application rates (AWI, 2007).

The Piatt County SWCD indicates that the majority of farmers in the Sangamon River watershed in the County have implemented nutrient management plans and are using variable rate technology (VRT) to optimize fertilizer addition to their land. Piatt County indicates that approximately 500 acres of farmland along the Sangamon River have employed this practice (Piatt County SWCD, 2007).

The Macon County SWCD also indicates that use of nutrient management plans is prevalent in the County. The Macon County SWCD has successfully used the state Environmental Quality Incentives Program (EQIP) to fund development of nutrient management plans in the County (Macon County SWCD, 2007). DeWitt County indicates its nutrient management practices are similar to those in Piatt and Macon Counties (Dewitt County SWCD, 2007). Although there is no specific data on nutrient management in other counties in the watershed, it is likely that nutrient management is widespread, given the success and scope of these various state and Federal programs.

8.3.2 Conservation Tillage

The objective of conservation tillage is to provide profitable crop production while minimizing soil erosion (UIUC, 2005). This reduction in erosion also reduces the amount of nutrients, particularly phosphorus, lost from the land and delivered to the watershed. The NRCS has replaced the term conservation tillage with the term crop residue management, or the year-round management of residue to maintain the level of cover needed for adequate control of erosion. This often requires more than 30% residue cover after planting (UIUC, 2005). Conservation tillage/crop residue management systems are recognized as cost-effective means of significantly reducing soil erosion and maintaining productivity. The most recent Illinois Soil Transect Survey (IDOA, 2006) suggests that a large percentage of cropland in the watershed is farmed using reduced till, mulch till, or no till methods. For example, 95%, 87% and 63% of the land under soybean production in Champaign, Piatt, and Macon Counties (the three counties with the largest percentage of their land in the watershed) use these methods. The percentages for corn production using these methods are 27%, 22%, and 11%, respectively, for Champaign, Piatt, and Macon Counties, and 100%, 67%, and 0%, respectively, for small grain fields. Additional conservation tillage measures should be considered as part of this implementation plan, particularly for cornfields.

Conservation tillage practices have been reported to reduce total phosphorus loads by 45%, and total nitrogen (including organic nitrogen, ammonia, and nitrate) loads by 55% (EPA, 2003). In general, conservation tillage and no-till practices are moderate to highly effective at reducing particulate phosphorus, but exhibit low or even negative effectiveness in reducing dissolved phosphorus (NRCS, 2006). A wide range of costs has been reported for conservation tillage practices, ranging from $12/acre to $83/acre in capital costs (EPA, 2003). For no-till, costs per acre provided in the Illinois Agronomy Handbook for machinery and labor range from $36 to $66 per acre, depending on the farm size and planting methods used (UIUC, 2005). In general, the total cost per acre for machinery and labor decreases as the amount of tillage decreases and farm size increases (UIUC, 2005).

8.3.3 Conservation Buffers

Conservation buffers are areas or strips of land maintained in permanent vegetation to help control pollutants (NRCS, 1999), generally by slowing the rate of runoff, while filtering sediment and nutrients. Additional benefits may include the creation of wildlife habitat, improved aesthetics, and potential economic benefits from marketing specialty forest crops (Trees Forever, 2005). This category of controls includes buffer strips, field borders, filter strips, vegetative barriers, riparian buffers, etc. (NRCS, 1999).

Filter strips and similar vegetative control methods can be very effective in reducing nutrient transport. The relative gross effectiveness of filter strips in reducing total phosphorus has been reported as 75% (EPA, 2003). Reduction of particulate phosphorus is moderate to high, while effectiveness for dissolved phosphorus is low to negative (NRCS, 2006). Vegetated filter strips and riparian buffers can also be used to reduce bacteria; riparian buffer zones have bacteria removal efficiencies of 43-57% (Commonwealth of Virginia, 2003). Riparian buffers can work to improve instream dissolved oxygen concentrations by promoting increased infiltration and baseflow and lowering stream temperature.

Costs of conservation buffers vary from about $200/acre for filter strips of introduced grasses or direct seeding of riparian buffers, to approximately $360/acre for filter strips of native grasses or planting bare root riparian buffers, to more than $1,030/acre for riparian buffers using bare root stock shrubs (NRCS, 2005).

The Conservation Practices Cost-Share Program (CPP), part of the Illinois Conservation 2000 Program, provides cost sharing for conservation practices including field borders and filter strips (http://www.agr.state.il.us/Environment/conserv/index.html). The Department of Agriculture distributes funding for the cost-share program to Illinois' SWCDs, which prioritize and select projects. The Illinois Buffer Partnership offers cost sharing for installation of streamside buffer plantings at selected sites. An additional program that may be of interest is the Visual Investments to Enhance Watersheds (VIEW), which involves a landscape design consultant in the assessment and design of targeted BMPs within a watershed. Sponsored by Trees Forever (www.treesforever.org), VIEW guides a committee of local stakeholders through a watershed landscape planning process (Trees Forever, 2005). Additional funding for conservation buffers may be available through other sources such as the Conservation Reserve Program (CRP).

The Champaign County SWCD is completing an effort to put 472 acres on the Big Ditch, a tributary to the Sangamon, into a conservation buffer under the state's CPP. The SWCD has also added conservation buffers through CREP. For example, 450 acres of conservation buffer along the Sangamon River were placed under CREP in 2003. The Nature Conservancy is currently beginning a project to encourage additional enrollment of conservation buffers in CREP in Champaign County (Champaign County SWCD, 2007).

Piatt County has approximately 2,000-3,000 acres along the floodplain of the Sangamon under CREP, and they are protecting additional acreage under CRP and under the Illinois Landowner Incentive Program run by the Illinois Department of Natural Resources (IDNR) (Piatt County SWCD, 2007).

Ford County has preserved conservation buffers under multiple programs, including CRP, CREP, and the Conservation Security Program (CSP) under USDA's NRCS, which are all Federal programs; and the state EQIP (Ford County SWCD, 2007).

The State of Illinois has also undertaken a large effort to restore native grasses. This program can help to stabilize soils and also provide filtration of pollutants running off through overland flow. 55 acres in Allerton Park and 200 acres at Rock Springs Center were restored in the late 1990s, and projects have also been undertaken in Sand Creek Recreation Area, Fort Daniel Conservation Area, and Friends Creek Regional Park in Macon County (IDNR, undated).

Recent research by the Agricultural Watershed Institute under the 2004 Targeted Watershed Grant has evaluated methods to intercept nutrient flowing off cropland through subsurface tile drains. Much of the Sangamon River/Decatur Lake watershed is agricultural cropland that is drained through these tile drains, and therefore conservation buffers such as buffer strips, filter strips, riparian buffers, etc., may not be effective in mitigating nutrient loading from cropland runoff, because the drains run under the buffers and empty directly to surface waters. AWI is evaluating the potential for subsurface bioreactors to denitrify tile drainage. These subsurface bioreactors consist of pits or trenches dug to intercept tile drain flow before it reaches surface water. These ditches contain denitrifying bacteria in a carbon substrate such as woodchips, and denitrify the tile flow before it enters the surface water. AWI currently has six demonstration subsurface bioreactors in the watershed, including three near its facility and three on farms within the watershed (AWI, 2007).

8.3.4 Sediment Control Basins

Sediment control basins trap sediments (and nutrients bound to that sediment) before they reach surface waters (EPA, 2003). Basins could be installed throughout the watershed, in areas selected to minimize disruption to existing croplands. In addition to controlling sediment, these basins would reduce phosphorus loads to the watershed. Costs for these basins can vary widely depending on location and size; estimates prepared for another Illinois watershed range from $1,200 to more than $200,000 per basin (Zahniser Institute, undated). This same study estimated a trapping efficiency for sediment of 75%.

Storm water detention wetlands might also warrant consideration. These wetlands would trap sediments and nutrients; a study prepared for another Illinois watershed provides an estimated phosphorus removal rate of 45% (Zahniser Institute, undated). Wetlands generally have low to moderate effectiveness at reducing particulate phosphorus, and low to negative effectiveness at reducing dissolved phosphorus (NRCS, 2006).

Information from Piatt County (Piatt County SWCD, 2007) indicated that a sediment catch basin had been recently been installed on the Sangamon using CPP funding.

8.3.5 Streambank and Shoreline Enhancement and Protection

Representatives from the Champaign and Ford County SWCDs indicated that there was minimal stream bank restoration activity in the respective counties (Champaign County SWCD, 2007; Ford County SWCD, 2007). However, Piatt County has indicated that it has submitted an application for one streambank restoration on the Sangamon River under the IDOA’s Streambank Stabilization and Restoration Program (SSRP). This project is expected to receive funding in Fall 2007. Piatt County is also preparing applications for streambank restoration on two tributaries of the Sangamon River under the same program. There is also a planned project to re-build terraces on a tributary to the Sangamon northeast of Monticello (Piatt County SWCD, 2007). Macon County has completed two large streambank restoration projects in Friends and Big Creeks and has submitted grant applications to the state for two smaller streambank restoration projects on these same creeks (Macon County SWCD, 2007).

The Friends Creek restoration project is typical of the types of projects done in this watershed. The project targeted a stretch of the bank which was being severely eroded where the streambed meandered. This section of the creek, which had banks 8 to 10 feet high, consisted of easily-erodible soft glacial till. The local Illinois NRCS and the Lake Decatur Watershed Staff from the Macon County SWCD teamed with the landowner to install a series of stone piles, called bendway weirs, that jut into the current, redirecting the stream's flow so that it will not undercut the bank (IDNR, undated).

8.3.6 Grassed Waterways

Grassed waterways are another alternative to consider for this watershed. A grassed waterway is a natural or constructed channel that is planted with suitable vegetation to reduce erosion (NRCS, 2000). Grassed waterways are used to convey runoff without causing erosion or flooding, to reduce gully erosion, and to improve water quality. They may be used in combination with filter strips, and are effective at reducing soil loss, with typical reductions between 60 and 80 percent (Lin et al, 1999). Grassed waterways cost approximately $1,800/acre, not including costs for tile or seeding (Madison County SWCD, 2006).

8.3.7 Private Septic System Inspection and Maintenance Program

A number of municipal wastewater treatment plants exist in the Sangamon River/Lake Decatur watershed, however, private septic systems are common in rural areas and around lakes; these may contribute pollutants, particularly if they are not properly maintained. A more proactive program to maintain functioning systems and address nonfunctioning systems could be developed to minimize the potential for releases from private sewage disposal systems. The U.S. EPA has developed guidance for managing private sewage disposal systems (EPA, 2005). This guidance includes procedures for assessing existing conditions, assessing public health and environmental risks, selecting a management approach, and implementing a management program (including funding information).

This alternative would require the commitment of staff time for Health Department personnel in the affected Counties; cost depends on whether the additional inspection activities could be accomplished by existing staff or would require additional personnel.

8.3.8 Combined Sewer Overflow Controls

The Gibson City sewage treatment plant has a permit for two combined sewer overflows (CSOs) that may discharge under wet weather conditions. One of these is treated and one is not. Recent data indicate the treated CSO is in compliance with its permit limits for fecal coliform. The untreated CSO does not have monitoring requirements for fecal coliform and is a source of fecal coliform to the Sangamon River and a source of nitrate and phosphorus to Lake Decatur during wet weather. The City is required to submit a Long-Term Control Plan (LTCP) to Illinois EPA by July 28, 2007. This plan is required to comply with the National CSO Control Policy and reduce pollutant loadings.

8.3.9 Point Source Controls

An evaluation of the permitted point source dischargers into segments IL_E-29 and IL_E-18 of the Sangamon River indicated that six dischargers are municipal wastewater treatment plants, and are therefore potential sources of fecal coliform. The remaining seven facilities are industrial dischargers that are not expected to discharge fecal coliform, nitrate or phosphorus. The six municipal NPDES-permitted point source dischargers of fecal coliform in the Sangamon River watershed are: Fisher STP, Gibson City WPCF, Mahomet STP, and Sangamon Valley PWD STP in Segment E-29, and Monticello WWTP and Allerton Park and Illinois 4H Camp in Segment E-18. The Argenta-Oreana Middle School STP is located within the Lake Decatur watershed, but discharges downstream of the fecal coliform-impaired Sangamon River segments.

The Mahomet STP, Monticello WWTP, and Sangamon Valley PWD STP have seasonal waivers for disinfection from November through April, and the Fisher STP, Gibson City WPCF, and the Allerton Park and Illinois 4H Camp have year-round disinfection waivers, and are not required to remove fecal coliform from their discharges. A review of recent fecal coliform measurements in the effluent of the dischargers with monitoring requirements found no violations of the fecal coliform permit limits. Illinois EPA is currently reviewing disinfection exemptions for facilities in this watershed and will evaluate the need for additional point source controls through the NPDES permitting program; permits might need to be modified to ensure consistency with the WLA.

Current fecal coliform permit limits and disinfection exemptions are presented for the six sewage treatment plants in the Sangamon River watershed. None of these facilities have permit limits for phosphorus or nitrate. A seventh permitted STP is located in the Lake Decatur watershed, but discharges downstream of the impaired Sangamon River segments (Argenta-Oreana Middle School STP (IL0047643)). This facility does not have a permit limit for phosphorus or nitrate.

Table 17. Summary of Point Sources

NPDES ID	Facility Name	Outfall	Disinfection exemption	Permit limit Fecal coliform (cfu/100ml)	Permit Expiration Date
IL0029980	Monticello WWTP	001 – STP outfall	Seasonal (Nov-April)	May - October: Daily max not to exceed 400	10/31/2010
		002 – High river stage STP outfall	Seasonal (Nov-April)	May - October: Daily max not to exceed 400	
		A01 – Excess flow	No	Daily max not to exceed 400	
		A02 – High river stage excess flow	No	Daily max not to exceed 400	
IL0053325	Univ-Allerton Park and IL 4H Camp	001 – STP outfall	Year-round		8/31/2009
IL0023281	Gibson City WPCF	001 – STP outfall	Year-round		6/30/2008
		A01 – Treated CSO		Daily max not > 400/100ml	
		003 – Untreated CSO			
IL0029980	Mahomet STP	001 – STP outfall	Seasonal (Nov-April)	May - October: Daily max not to exceed 400	5/31/2009
		A01 – Excess flow	No	Daily max not > 400/100ml	
IL0046141	Sangamon Valley PWD STP	001- STP outfall	Seasonal (Nov-April)	May - October: Daily max not to exceed 400	12/31/2009
IL0021016	Fisher STP	001 – STP outfall	Year-round		3/31/2009

Violations of the dissolved oxygen water quality standard in Owl Creek are caused by large diurnal variations, driven by excessive plant productivity. The excessive plant productivity is attributed to elevated nutrient concentrations, with phosphorus being the primary nutrient of concern. Violations are currently observed upstream and downstream of the Fisher STP. If nonpoint source controls are implemented upstream of the Fisher STP such that dissolved oxygen meets water quality standards, an additional 62%

reduction in TP will be needed at the Fisher STP to ensure the DO standard is met downstream of the discharge. IEPA will evaluate the need for additional point source controls through the NPDES permitting program; permits might need to be modified to ensure consistency with the WLA.

8.3.10 Restrict Livestock Access to Lake and Tributaries

Livestock are a potential source of nutrients and fecal coliform that are the focus of these TMDLs. In addition, livestock can cause or exacerbate streambank erosion and trample riparian buffers. While there are few livestock operations in the watershed, restricting their access to the Sangamon River, its tributaries, and Lake Decatur may help to reduce fecal coliform and nutrient loading into the watershed. This could be accomplished by fencing and installation of alternative systems for livestock watering. This BMP could be targeted for DeWitt County, which has a larger percentage of livestock operations than do the other counties in the watershed (DeWitt County SWCD, 2007).

Livestock exclusion and other grazing management measures have been shown to reduce phosphorus loads on the order of 49% (EPA, 2003). The principal direct costs of providing grazing practices vary from relatively low variable costs of dispersed salt blocks to higher capital and maintenance costs of supplementary water supply improvements. Improving the distribution of grazing pressure by developing a planned grazing system or strategically locating water troughs, salt, or feeding areas to draw cattle away from riparian zones can result in improved utilization of existing forage, better water quality, and improved riparian habitat. Fencing costs are estimated as $3,500 to $4,000 per mile (EPA, 2003). Capital costs for pipeline watering range from $0.32 to $2.60 per foot, while watering tanks and troughs range from $291 to $1,625 each (EPA, 2003).

8.4 IDENTIFYING PRIORITY AREAS FOR CONTROLS

Priority areas for locating controls were identified through a review of available information. Information reviewed included: tributary water quality data, previous reports and GIS-based information. This information, along with recommendations for additional data collection, is discussed below to help focus control efforts.

8.4.1 Tributary Monitoring

Available water quality data obtained as part of the Stage 2 Watershed Characterization work were reviewed. There was no recent tributary monitoring data for segments IL_E-29 and IL_E-18 of the Sangamon River or for Lake Decatur. Samples were taken at four sites along Owl Creek in August and November, 2006. These data were used to support QUAL2E model calibration and it was concluded that the low in-stream dissolved oxygen in Owl Creek is caused by excess plant productivity that is caused by high nutrient concentrations.

Additional tributary monitoring data would help target particular areas for implementation efforts. Specific data collection recommendations are provided in the Monitoring and Adaptive Management Section later in this Implementation Plan.

8.4.2 Previous Reports

The Illinois State Water Survey (ISWS) has published a technical report that presents ten years of streamflow and nitrate monitoring (May 1993-April 2003) in the Lake Decatur watershed (Keefer and Bauer, 2005). Nitrate was measured at 8 stations in the watershed and one in the lake. In the most recent project years, nitrate concentrations had maximum values above 10 mg/l at all stations. In general mean nitrate concentrations were higher at tributary stations; concentrations decreased at river and lake stations as drainage areas increased. Annual nitrate-nitrogen loads varied from year to year for all stations and generally corresponded with variation in runoff. The study found that the 10-year mean annual nitrate-Nitrogen loads at each station varied little, ranging from 21-24 lbs/acre, with a weighted annual yield to Lake Decatur of 22 lbs/acre and a range of 10-32 lbs/acre. These results indicate that nitrate is prevalent throughout the watershed.

Cited within this report, is a 1987 study (Fitzpatrick et al., 1987) that presents the estimated proportion of total lake sediment and sediment yield by source area. This information is presented below (Table 18). Watersheds with higher sediment loading rates are also likely candidate areas for targeting phosphorus controls, as phosphorus is often bound to sediment.

Table 18. Sources of Sediment to Lake Decatur: Estimated Proportion of Total Lake Sediment and Sediment Yield by Source Area

Source	Lake watershed area (percent)	Total lake sediment (percent)	Yield to lake (tons/acre/year)
All sources	*100*	*100*	*0.27*
Sangamon River above Monticello	59	22	0.10
Sangamon River below Monticello and above the lake	25	27	0.29
Bluff watersheds	6	29	1.25
Big/Long and Sand Creeks	9	19	0.56
Lakeshore erosion	--	2	--

(Fitzpatrick et al., 1987 as cited in Keefer and Bauer, 2005).

8.4.3 GIS Analysis

GIS soils, land use and topography data were analyzed to identify areas that are expected to generate the highest sediment and associated phosphorus loads. Within the GIS, maps were generated to show areas with steep slopes (Figure 8), highly erodible soils (Figure 9), and finally, priority areas for best management practices (BMPs). Priority areas are defined as agricultural areas that have both steep slopes and highly erodible soils (Figure 10). These maps serve as a good starting point for selecting areas to target for implementing control projects, to maximize the benefit of the controls. Note that this watershed has few areas of steep slopes; thus, Figure 10 shows relatively few high priority areas. However, the Figure 9 shows larger areas having highly erodible soils, which will also benefit from controls.

GIS analysis was also used to investigate the presence of hydric soils in the watershed to determine whether wetland restoration or creation is a viable option within this watershed. To support this analysis, areas having hydric soils, which are not already developed, forested, or covered by water or wetlands were identified. A significant proportion of the Sangamon River watershed was identified as being potentially suitable for wetland restoration or creation. These areas are shown in Figure 11. Note that GIS soils data for Macon County were not available.

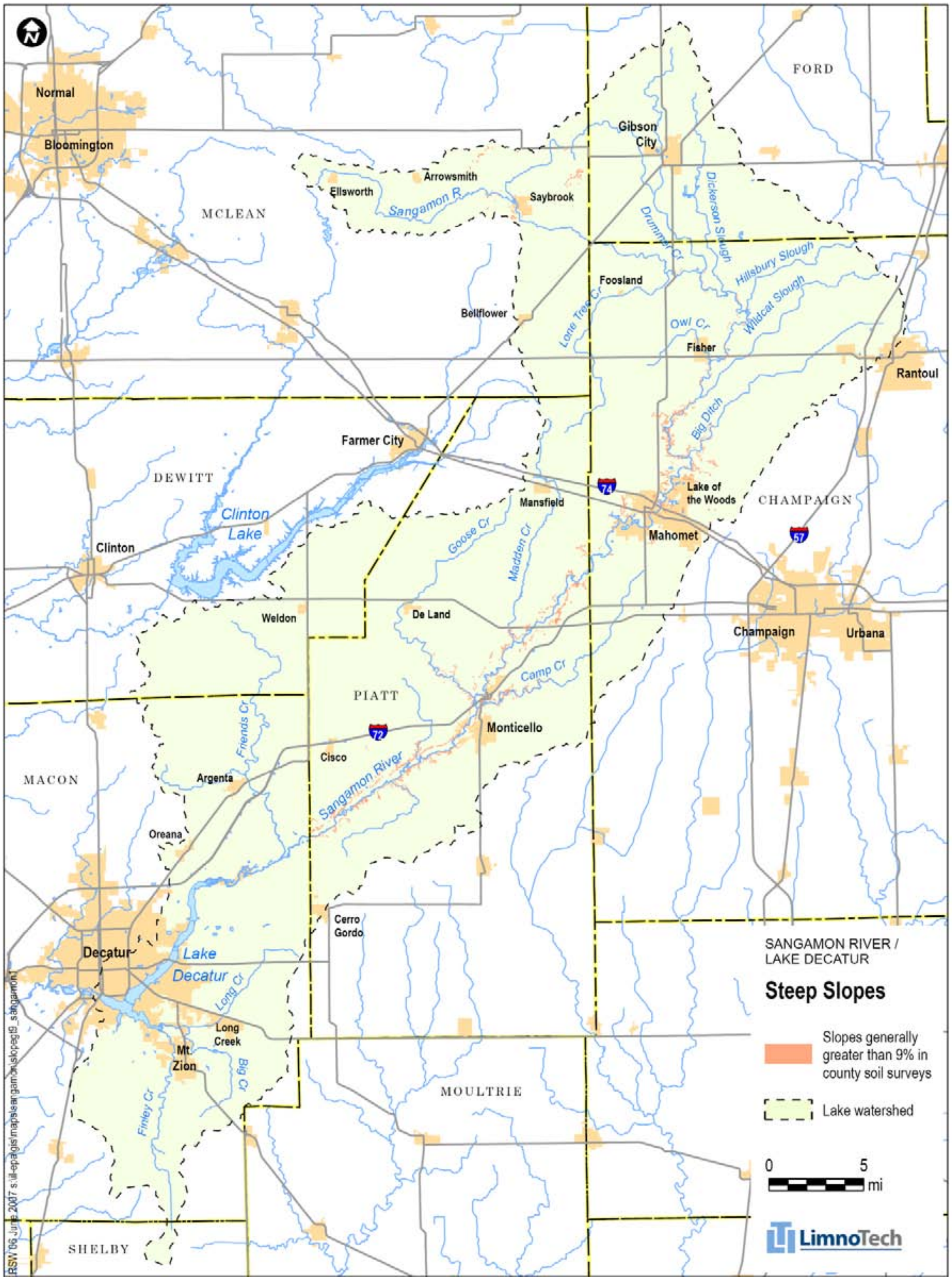


Figure 8. Areas with Steep Slopes

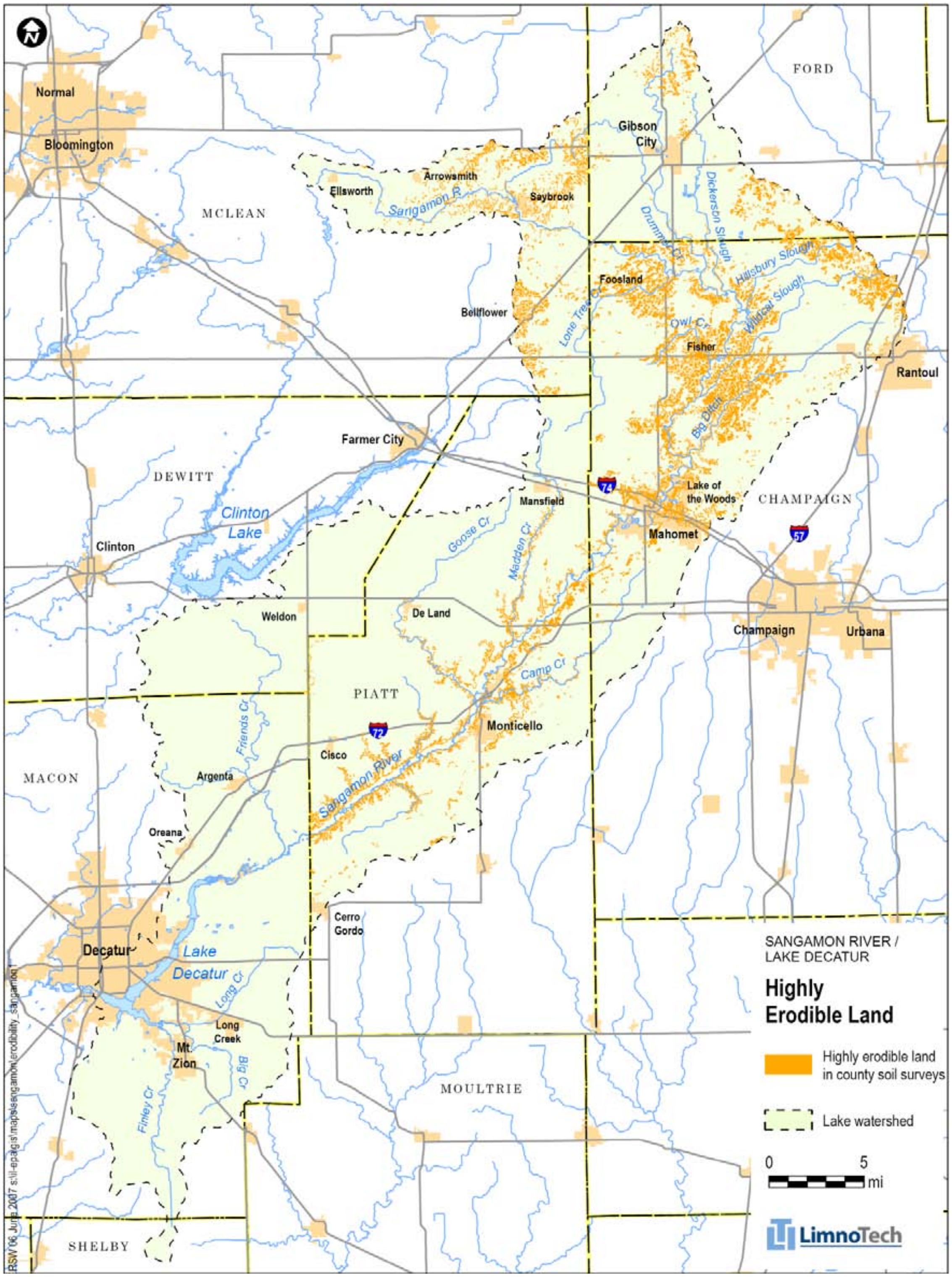


Figure 9. Areas of Highly Erodible Land

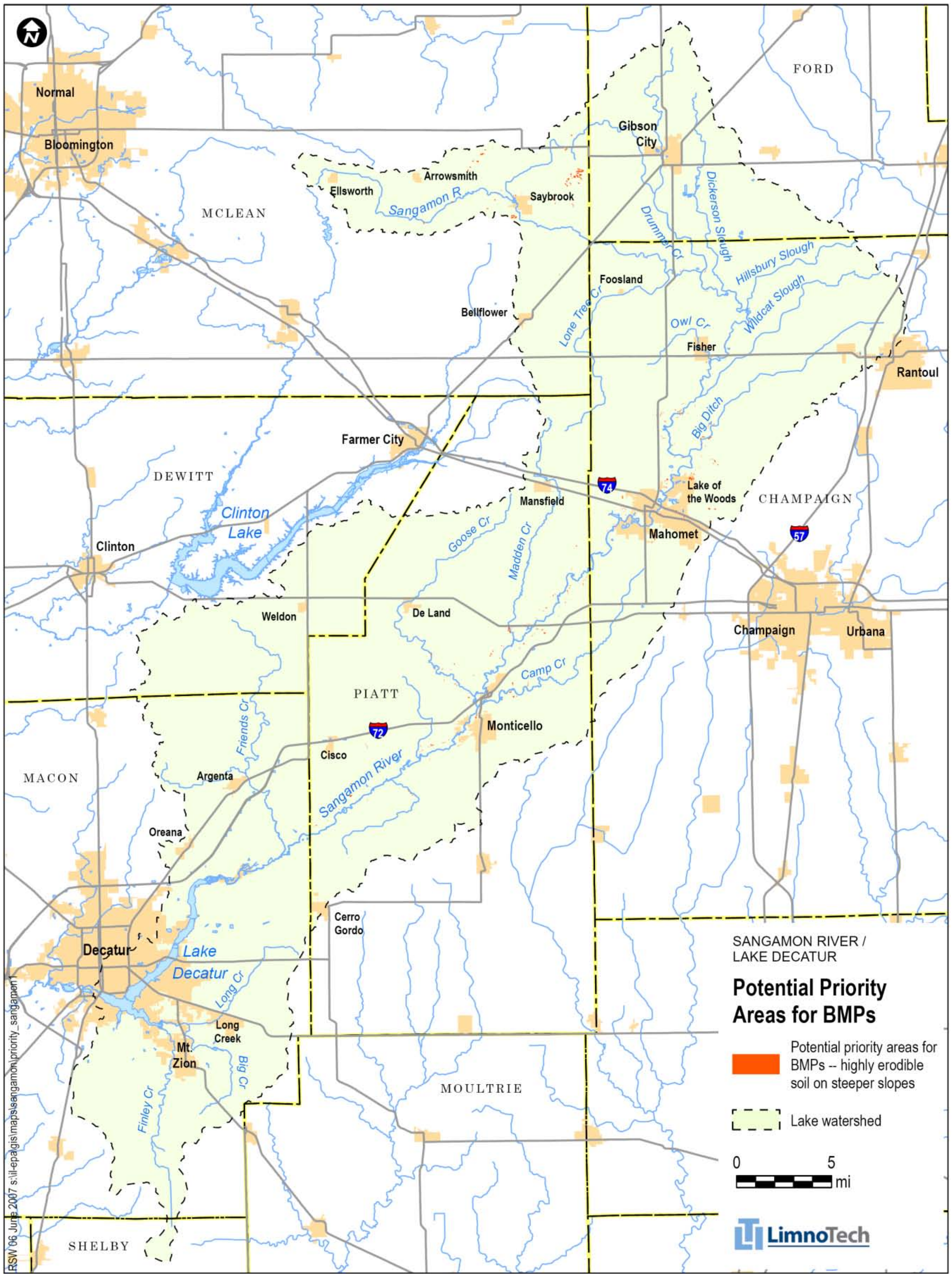


Figure 10. Potential Priority Areas for BMPs

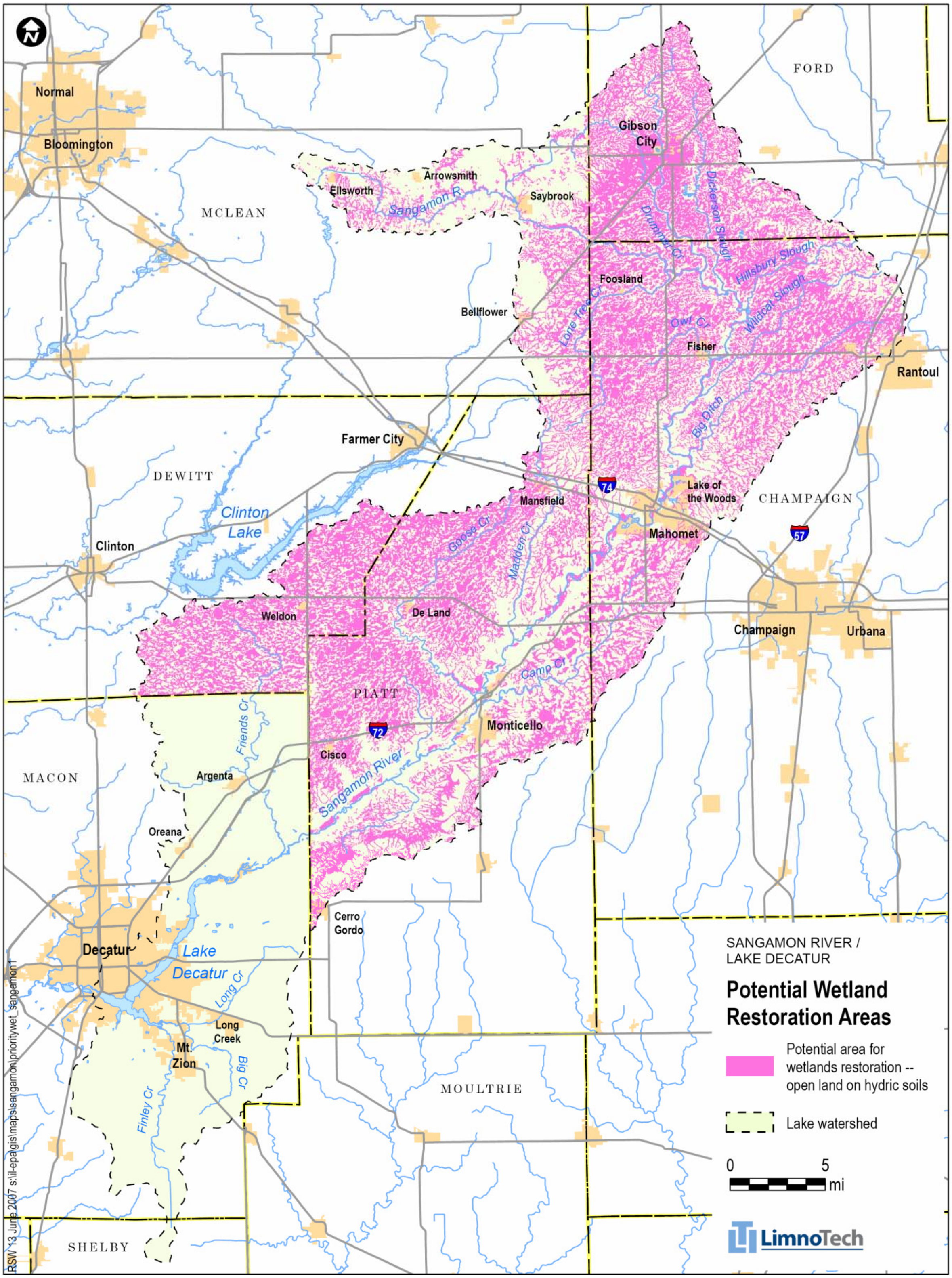


Figure 11. Potential Wetland Restoration Areas

8.5 REASONABLE ASSURANCE

The U.S. EPA requires states to provide reasonable assurance that the load reductions identified in the TMDL will be met. In terms of reasonable assurance for point sources, Illinois EPA administers the NPDES permitting program for treatment plants, stormwater permitting, and CAFO permitting. Reasonable assurance for point sources means that NPDES permits will be consistent with any applicable wasteload allocation contained in the TMDL. The permit for point source dischargers in the watershed will be modified if necessary to ensure it is consistent with the applicable wasteload allocation.

For nonpoint sources, which are the focus of this work, reasonable assurance means that nonpoint source controls are specific to the pollutant of concern, implemented according to an expeditious schedule and supported by reliable delivery mechanisms and adequate funding (EPA, 1999).

One of the most important aspects of implementing non-point source controls is obtaining adequate funding to implement voluntary or incentive-based programs. Funding is available from a variety of sources, including those listed below. It should be noted that the Federal programs listed are based on the 2002 Farm Bill, which expires on September 30, 2007. It is currently unknown what conservation programs will be included in a future farm bill.

- *Illinois Nutrient Management Planning Program,* cosponsored by the IDOA and IEPA (http://www.agr.state.il.us/Environment/LandWater/tmdl.html). This program targets funding to Soil and Water Conservation Districts (SWCDs) for use in impaired waters. The nutrient management plan practice cost share is only available to landowners/operators with land in TMDL watersheds. The dollar amount allocated to each eligible SWCD is based on their portion of the total number of cropland acres in eligible watersheds.
- *Clean Water Act Section 319 grants* to address nonpoint source pollution (http://www.epa.state.il.us/water/financial-assistance/non-point.html). Section 319 of the Clean Water Act provides Federal funding for states for the implementation of approved NPS management programs. Funding under these grants has been used in Illinois to finance projects that demonstrate cost-effective solutions to NPS problems. Projects must address water quality issues relating directly to NPS pollution. Funds can be used for the implementation of watershed management plans, including the development of information/education programs, and for the installation of best management practices.
- *Conservation 2000* (http://www.epa.state.il.us/water/conservation-2000/), which funds nine programs across three state natural resource agencies (IEPA, IDOA, and the Department of Natural Resources). Conservation 2000 is a multi-year, $100 million initiative designed to take a broad-based, long-term ecosystem approach to conserving, restoring, and managing Illinois' natural lands, soils, and water resources while providing additional high-quality opportunities for outdoor recreation.
- *Conservation Practices Cost-Share Program* (http://www.agr.state.il.us/Environment/conserv/index.html). Another component of Conservation 2000, the CPP focuses on conservation practices, such as terraces, filter

strips and grass waterways, which are aimed at reducing soil loss on Illinois cropland. IDOA distributes funding for the cost-share program to Illinois' SWCDs, which prioritize and select projects. Construction costs are divided between the state and landowners.

- *Conservation Reserve Program* administered by the Farm Service Agency (http://www.nrcs.usda.gov/programs/crp/). The CRP provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost-effective manner. CRP participants may enroll in 10 and 15-year contracts. CRP is administered by the Farm Service Agency, with NRCS providing technical land eligibility determinations, conservation planning and practice implementation.
- *Wetlands Reserve Program* (http://www.nrcs.usda.gov/programs/wrp/). NRCS's Wetlands Reserve Program (WRP) is a voluntary program offering landowners the opportunity to protect, restore, and enhance wetlands on their property. The NRCS provides technical and financial support to help landowners with their wetland restoration efforts. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection. Figure 5 shows potential wetland restoration areas. These are areas with hydric soils that are not currently developed, covered by water or forested.
- *Environmental Quality Incentive Program* sponsored by NRCS (general information at http://www.nrcs.usda.gov/PROGRAMS/EQIP/; Illinois information and materials at http://www.il.nrcs.usda.gov/programs/eqip/). The Environmental Quality Incentives Program (EQIP) provides a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical assistance to eligible participants to install or implement structural and management practices on eligible agricultural land. EQIP may cost-share up to 75 percent of the costs of certain conservation practices (e.g., grassed waterways, nutrient management, riparian buffers, and wetland restoration). Incentive payments may be provided for up to three years to encourage producers to carry out management practices they may not otherwise use without the incentive.
- *Wildlife Habitat Incentives Program (WHIP)* (http://www.il.nrcs.usda.gov/programs/whip/index.html). WHIP is a NRCS program for developing and improving wildlife habitat, primarily on private lands. It provides both technical assistance and cost-share payments to help establish and improve fish and wildlife habitat.

In terms of reasonable assurances for nonpoint sources, Illinois EPA is committed to:

- Convene local experts familiar with nonpoint sources of pollution in the watershed
- Ensure that they define priority sources and identify restoration alternatives
- Develop a voluntary implementation plan that includes accountability
- Using the results of future monitoring to conduct adaptive management

8.6 MONITORING AND ADAPTIVE MANAGEMENT

Future monitoring is needed to assess the effectiveness of the various restoration alternatives and conduct adaptive management. The Illinois EPA conducts a variety of water quality monitoring programs (IEPA, 2002). Lake Decatur is one of the core lakes on Illinois EPA's ambient lake monitoring program. These lakes are sampled by the Illinois EPA field biologists on a 3-year rotational basis; Lake Decatur was last sampled in 2006. In addition, ongoing stream monitoring programs include: a statewide 213-station Ambient Water Quality Monitoring Network (AWQMN); an Intensive Basin Survey Program that covers all major watersheds on a five-year rotation basis; and a Facility-Related Stream Survey Program that conducts approximately 20-30 stream surveys each year. Local agencies and watershed organizations are encouraged to conduct additional monitoring to assess sources of pollutants and evaluate changes in water quality in the Sangamon River watershed.

In particular, the following monitoring is recommended:

- Fecal coliform monitoring in the Upper Sangamon River segments IL_E-29 and IL_E-18 and major tributaries. This monitoring should be conducted primarily during wet weather. Sites should be selected to include locations downstream of potential fecal coliform loads, such as livestock operations or areas that have higher concentrations of septic systems.
- Dry weather fecal coliform monitoring is also recommended upstream and downstream of WWTP outfalls. For facilities with exemptions for disinfection, the downstream monitoring should be conducted at the downstream end of the disinfection exemption reach. This monitoring will help assess the contributions of these sources to the fecal coliform impairment.
- Periodic low flow dissolved oxygen and water temperature monitoring of Owl Creek is also recommended, to provide feedback on the effect that improvement projects have on instream dissolved oxygen.
- Wet and dry weather monitoring of total phosphorus and nitrogen as nitrate at several locations in Lake Decatur to assess water quality improvement as BMPs are implemented. It is recommended that nitrate monitoring be conducted at the locations previously sampled by the ISWS (Keefer and Bauer, 2005), which are presented below.
    - Long/Big Creek near Twin Bridge Road, Long Creek, IL
    - Friends Creek at Rt. 48 near Argenta, IL
    - Goose Creek near Deland, IL
    - Camp Creek near White Heath, IL
    - Sangamon River at Shively Bridge near Mahomet, IL
    - Big Ditch near Fisher, IL
    - Sangamon River at Monticello, IL
    - Sangamon River at Fisher, IL

Monitoring will provide additional information to identify or confirm potential sources of pollutants, and assist in targeting implementation efforts.

Continued monitoring efforts will provide the basis for assessment of the effectiveness of the TMDLs, as well as future adaptive management decisions. As various alternatives are implemented, the monitoring will determine their effectiveness and identify which alternatives should be expanded, and which require adjustments to meet the TMDL goals.

9. REFERENCES

Agricultural Watershed Institute, 2007. Personal communication with Steve John, Executive Director. May 24, 2007

Champaign County SWCD, 2007. Personal communication with Bruce Stikkers, Resource Conservationist. May 25, 2007.

Chapra, S., 1997. Surface Water-Quality Modeling. The McGraw-Hill Companies, Inc. New York, New York.

Commonwealth of Virginia, 2003. *Guidance Manual for Total Maximum Daily Load Implementation Plans*. Department of Conservation and Recreation, Department of Environmental Quality. http://www.deq.state.va.us/tmdl/implans/ipguide.pdf

DeWitt County SWCD, 2007. Personal communication with Shelley Finfrock, Resource Conservationist. June 7, 2007.

Dredging Supply Company, Inc., 2004. *City of Decatur, Illinois Commences Massive Water Supply Lake Dredging Project*. Press release posted on company website at http://www.dscdredge.com/article-lake-dredging-project.html

Ernst, M. R., W. Frossard, and J. L. Mancini. 1994. Two Eutrophication Models make the Grade. *Water Environment and Technology* 6 (11), pp 15-16.

Fitzpatrick, W.P., W.C. Bogner, and N.G. Bhowmik, 1987. Sedimentation and Hydrologic Processes in Lake Decatur and its Watershed. Illinois State Water Survey Report of Investigation 107. Champaign, IL.

Ford County SWCD, 2007. Personal communication with Debra Slade, Administrative Coordinator. May 30, 2007.

Illinois Department of Agriculture (IDOA), 2006. *2006 Illinois Soil Conservation Transect Survey Summary.* http://www.agr.state.il.us/darts/References/transect/transect06.pdf

Illinois Department of Natural Resources (IDNR), undated. *The Heart of the Sangamon: An Inventory of the Region's Resources, 2000.* Illinois Department of Natural Resources Office of Realty and Environmental Planning. Available at http://dnr.state.il.us/orep/c2000/assessments/upper_sangamon/toc.htm

Illinois Environmental Protection Agency (IEPA), 2002. *Water Monitoring Strategy 2002-2006*. Bureau of Water, Springfield, IL. IEPA/BOW/02-005. (Available at http://www.epa.state.il.us/water/water-quality/monitoring-strategy/2002-2006/monitoring-strategy-2002-2006.pdf)

Illinois Environmental Protection Agency (IEPA), 2006. Illinois Integrated Water Quality Report and Section 303(d) list-2006. Illinois EPA Bureau of Water. April 2006. IEPA/BOW/04-005 http://www.epa.state.il.us/water/watershed/reports/303d-report/2006/303d-report.pdf

Illinois Environmental Protection Agency (IEPA), 2006b. State of Illinois Section 319 Biannual Report. Illinois EPA Bureau of Water. March 2006. Available at www.epa.state.il.us/water/watershed/reports/biannual-319/2006/marchappendix.pdf

Illinois Nature Preserves Commission, 2006. Illinois Nature Preserves Commission Agenda, May 2, 2006 (Available at http://www.dnr.state.il.us/inpc/agendas/190.htm).

Keefer, L. and E. Bauer, 2005. Watershed Monitoring for the Lake Decatur Watershed, 2000-2003. Illinois State Water Survey, Champaign, IL.

Lin, S.D., W.C. Bogner and R.K. Raman, 1999. Phase I Diagnositc-Feasibility Study of Otter Lake, Macoupin County, IL. Contract Report 652, Illinois State Water Survey, Champaign, IL.

Litke, D. 1999. Review of Phosphorus Control Measures in the United States. U.S. Geological Survey. Water-Resources Investigations Report 99-4007, Denver, CO.

Macon County SWCD, 2007. Personal communication with Shannon Allen, Watershed Specialist. May 31, 2007.

Madison County Soil and Water Conservation District, 2006. LimnoTech personal communication with Rick Macho, Resource Conservationist. March 29, 2006.

Natural Resources Conservation Service (NRCS), 1999. *CORE4 Conservation Practices Training Guide. The Common Sense Approach to Natural Resource Conservation.* U.S. Department of Agriculture. Available at http://www.nrcs.usda.gov/technical/ECS/agronomy/core4.pdf

Natural Resources Conservation Service (NRCS), 2000. *Natural Resources Conservation Service Conservation Practice Standard, Grassed Waterway, Code 412*. Available at http://www.age.uiuc.edu/clmt/Workbook/WK_FILES/NRC_WATR.DOC

Natural Resources Conservation Service (NRCS), 2005. LimnoTech personal communication with Montgomery County District Conservationist. November 3, 2005.

Natural Resources Conservation Service (NRCS), 2006. LimnoTech personal communication with Don Pitts, State Water Quality Specialist. March 28, 2006.

Piatt County SWCD, 2007. LimnoTech personal communication with Jonathon Manuel, Resource Conservationist. May 30, 2007.

Trees Forever, 2005. Available at http://www.treesforever.org/content.asp?ID=2142. Accessed October 2005.

U.S. Environmental Protection Agency (EPA), 1991. *Guidance for Water Quality-based Decisions: The TMDL Process.* EPA 440/4-91-001. Office of Water, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1999. *Protocol for Developing Nutrient TMDLs*. EPA 841-B-99-007. Office of Water, Washington, DC. Available at http://www.epa.gov/owow/tmdl/nutrient/pdf/nutrient.pdf

U.S. Environmental Protection Agency (EPA), 2003. *National Management Measures to Control Nonpoint Source Pollution from Agriculture*. EPA 841-B-03-004. Office of Water, Washington, DC. Available at http://www.epa.gov/owow/nps/agmm/index.html

U.S. Environmental Protection Agency (EPA), 2004. 2004 Watershed Project Summaries, Sangamon River, Illinois. Website at http://www.epa.gov/twg/2004/04selectsumm.html#UpperSangamon

U.S. Environmental Protection Agency (EPA), 2005. *Handbook for Managing Onsite and Clustered (Decentralized) Wastewater Treatment Systems*. EPA 832-B-05-001. Office of Water, Washington, DC. Available at http://www.epa.gov/owm/septic/pubs/onsite_handbook.pdf

University of Illinois at Urbana-Champaign (UIUC), 2005. *Illinois Agronomy Handbook*. Online version, accessed October 2005. http://www.aces.uiuc.edu/iah/index.php?ch=smap.content.html

Walker, W. W., 1985. *Empirical Methods for Predicting Eutrophication in Impoundments; Report 3, Phase III: Model Refinements*. Technical Report E-81-9, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Zahniser Institute for Environmental Studies (undated; believed 2004). *Clean Lakes Program Phase 1 Diagnostic Feasibility Study, Glenn Shoals Lake, City of Hillsboro, Montgomery County, Illinois*. Prepared for the City of Hillsboro in cooperation with the Illinois Environmental Protection Agency.

This page is blank to facilitate double sided printing.

Attachment 1

This page is blank to facilitate double sided printing.

Data for Fecal Coliform Load Duration Curve

Sangamon River IL_E-18 (cfs)	% of Time Exceeded	Fecal load (cfu/day)
0.00	100.0	0.00E+00
4.79	97.9	2.35E+10
5.8	96.9	2.86E+10
7.0	95.8	3.42E+10
8.4	94.8	4.13E+10
9.9	93.8	4.84E+10
11.5	92.8	5.61E+10
12.5	91.8	6.12E+10
13.5	90.8	6.63E+10
14.6	89.8	7.14E+10
15.6	88.8	7.65E+10
16.7	87.8	8.16E+10
18.8	86.7	9.18E+10
19.8	85.7	9.69E+10
20.8	84.7	1.02E+11
22.9	83.7	1.12E+11
24.0	82.7	1.17E+11
26.1	81.7	1.27E+11
28.1	80.7	1.38E+11
30.2	79.7	1.48E+11
33.3	78.6	1.63E+11
35.4	77.6	1.73E+11
38.6	76.6	1.89E+11
41.7	75.6	2.04E+11
45.8	74.6	2.24E+11
50.0	73.6	2.45E+11
55.2	72.6	2.70E+11
58.4	71.6	2.86E+11
62.5	70.5	3.06E+11
67.7	69.5	3.31E+11
72.9	68.5	3.57E+11
78.2	67.5	3.82E+11
85.4	66.5	4.18E+11
91.7	65.5	4.49E+11
99.0	64.5	4.84E+11
106.3	63.5	5.20E+11
113.6	62.4	5.56E+11
120.9	61.4	5.92E+11
128.2	60.4	6.27E+11
135.5	59.4	6.63E+11
140.7	58.4	6.88E+11
146.9	57.4	7.19E+11
154.2	56.4	7.55E+11
160.5	55.4	7.85E+11
166.7	54.3	8.16E+11
175.1	53.3	8.57E+11
182.4	52.3	8.92E+11
190.7	51.3	9.33E+11
199.0	50.3	9.74E+11
208.4	49.3	1.02E+12
216.7	48.3	1.06E+12
226.1	47.3	1.11E+12
235.5	46.2	1.15E+12
240.7	45.2	1.18E+12
250.1	44.2	1.22E+12
260.5	43.2	1.27E+12
269.9	42.2	1.32E+12
278.2	41.2	1.36E+12
289.7	40.2	1.42E+12
301.1	39.2	1.47E+12
311.6	38.1	1.52E+12
323.0	37.1	1.58E+12
335.5	36.1	1.64E+12
350.1	35.1	1.71E+12
363.7	34.1	1.78E+12
378.2	33.1	1.85E+12
392.8	32.1	1.92E+12

Observed Data

Date	Sangamon River IL_E-18 (cfs)	Concentration (cfu/100 ml)	Percentile	Fecal load (cfu/day)
5/31/2000	789.8	460	16.97	8.89E+12
8/1/2000	29.2	620	80.34	4.43E+11
8/25/2000	82.3	230	67.03	4.63E+11
6/14/2001	414.7	260	30.93	2.64E+12
7/25/2001	24.0	160	83.17	9.38E+10
9/6/2001	14.6	520	90.00	1.86E+11
10/24/2001	132.3	540	59.88	1.75E+12
5/24/2004	702.3	110	19.31	1.89E+12

Data for Fecal Coliform Load Duration Curve

Sangamon River IL_E-18 (cfs)	% of Time Exceeded	Fecal load (cfu/day)
412.6	31.1	2.02E+12
428.3	30.0	2.10E+12
448.1	29.0	2.19E+12
467.9	28.0	2.29E+12
486.6	27.0	2.38E+12
509.5	26.0	2.49E+12
532.5	25.0	2.61E+12
561.6	24.0	2.75E+12
587.7	23.0	2.88E+12
622.1	21.9	3.04E+12
649.2	20.9	3.18E+12
677.3	19.9	3.31E+12
714.8	18.9	3.50E+12
753.4	17.9	3.69E+12
793.0	16.9	3.88E+12
836.7	15.9	4.09E+12
886.7	14.9	4.34E+12
955.5	13.8	4.68E+12
1042.0	12.8	5.10E+12
1135.8	11.8	5.56E+12
1219.1	10.8	5.97E+12
1344.2	9.8	6.58E+12
1479.6	8.8	7.24E+12
1604.7	7.8	7.85E+12
1750.6	6.8	8.57E+12
1917.3	5.8	9.38E+12
2094.4	4.7	1.02E+13
2365.3	3.7	1.16E+13
2667.5	2.7	1.31E+13
3344.8	1.7	1.64E+13
4709.8	0.7	2.30E+13

Data for Fecal Coliform Load Duration Curve

			Observed Data				
Sangamon River IL_E-29 (cfs)	**% of Time Exceeded**	**Fecal load (cfu/day)**	**Date**	**Sangamon River IL_E-29 (cfs)**	**Concentration (cfu/100 ml)**	**Percentile**	**Fecal load (cfu/day)**
-	99.99	0.00E+00	5/7/1979	434.0	800	12.12	8.50E+12
0.56	98.94	2.74E+09	6/12/1979	132.0	320	37.40	1.03E+12
1.20	97.97	5.87E+09	7/20/1979	114.0	700	41.34	1.95E+12
1.60	97.00	7.83E+09	8/8/1979	174.0	2100	29.94	8.94E+12
2.00	96.03	9.79E+09	9/18/1979	17.0	110	75.63	4.58E+10
2.50	95.07	1.22E+10	10/26/1979	9.0	10	83.47	2.20E+09
3.00	94.10	1.47E+10	10/26/1979	9.0	30	83.47	6.61E+09
3.40	93.13	1.66E+10	9/22/1980	6.8	210	86.90	3.49E+10
3.80	92.16	1.86E+10	10/21/1980	4.3	190	91.13	2.00E+10
4.20	91.19	2.06E+10	5/7/1981	535.0	310	9.53	4.06E+12
4.70	90.23	2.30E+10	5/22/1981	1350.0	300	2.27	9.91E+12
5.20	89.26	2.54E+10	7/23/1981	591.0	1200	8.47	1.74E+13
5.80	88.29	2.84E+10	10/22/1981	163.0	280	31.57	1.12E+12
6.40	87.32	3.13E+10	5/12/1982	108.0	110	42.74	2.91E+11
7.00	86.36	3.43E+10	6/15/1982	101.0	330	44.52	8.16E+11
7.60	85.39	3.72E+10	8/24/1982	6.3	220	87.65	3.39E+10
8.20	84.42	4.01E+10	9/29/1982	2.4	210	95.33	1.23E+10
9.00	83.45	4.40E+10	5/3/1983	2100.0	1300	0.96	6.68E+13
9.50	82.49	4.65E+10	6/21/1983	1800.0	2400	1.34	1.06E+14
10.00	81.52	4.89E+10	8/17/1983	13.0	350	78.96	1.11E+11
11.00	80.55	5.38E+10	10/20/1983	4.4	4200	90.90	4.52E+11
12.00	79.58	5.87E+10	5/1/1984	263.0	90	20.73	5.79E+11
13.00	78.62	6.36E+10	6/20/1984	140.0	900	35.65	3.08E+12
14.00	77.65	6.85E+10	7/19/1984	24.0	200	71.10	1.17E+11
15.00	76.68	7.34E+10	8/23/1984	4.0	100	91.93	9.79E+09
16.00	75.71	7.83E+10	5/22/1985	87.0	200	48.50	4.26E+11
18.00	74.75	8.81E+10	7/1/1985	523.0	2000	9.78	2.56E+13
19.00	73.78	9.30E+10	8/20/1985	80.0	700	50.57	1.37E+12
21.00	72.81	1.03E+11	9/17/1985	17.0	420	75.63	1.75E+11
22.00	71.84	1.08E+11	10/17/1985	4.4	100	90.90	1.08E+10
24.00	70.88	1.17E+11	5/1/1986	348.0	12000	15.61	1.02E+14
26.00	69.91	1.27E+11	6/18/1986	150.0	900	33.85	3.30E+12
28.00	68.94	1.37E+11	7/16/1986	166.0	1000	31.17	4.06E+12
30.00	67.97	1.47E+11	9/11/1986	1.2	1500	98.01	4.40E+10
32.00	67.01	1.57E+11	10/7/1986	88.0	1200	48.30	2.58E+12
34.00	66.04	1.66E+11	6/3/1987	370.0	5000	14.54	4.53E+13
36.00	65.07	1.76E+11	7/21/1987	10.0	280	82.03	6.85E+10
39.00	64.10	1.91E+11	9/10/1987	2.0	420	96.28	2.06E+10
42.00	63.13	2.06E+11	10/27/1987	10.0	430	82.03	1.05E+11
44.00	62.17	2.15E+11	5/18/1988	77.0	70	51.45	1.32E+11
47.00	61.20	2.30E+11	6/22/1988	11.0	250	81.32	6.73E+10
50.00	60.23	2.45E+11	8/10/1988	0.7	350	98.81	5.99E+09
52.00	59.26	2.54E+11	9/14/1988	0.0	20	99.99	0.00E+00
56.00	58.30	2.74E+11	5/10/1989	115	520	41.09	1.46E+12
58.00	57.33	2.84E+11	6/19/1989	98	430	45.70	1.03E+12
61.00	56.36	2.99E+11	8/1/1989	29	150	68.69	1.06E+11
63.00	55.39	3.08E+11	9/13/1989	131	1200	37.57	3.85E+12
67.00	54.43	3.28E+11	5/8/1990	186	190	28.19	8.65E+11
70.00	53.46	3.43E+11	7/2/1990	802	1500	5.68	2.94E+13
73.00	52.49	3.57E+11	8/1/1990	123	900	39.19	2.71E+12
76.00	51.52	3.72E+11	9/25/1990	12	190	80.31	5.58E+10
80.00	50.56	3.91E+11	10/31/1990	99	40	45.38	9.69E+10
82.00	49.59	4.01E+11	5/23/1991	595	1900	8.44	2.77E+13
86.00	48.62	4.21E+11	6/27/1991	48	160	61.08	1.88E+11
90.00	47.65	4.40E+11	8/22/1991	1.5	400	97.42	1.47E+10
94.00	46.69	4.60E+11	10/1/1991	4.5	60	90.71	6.61E+09
97.00	45.72	4.75E+11	6/4/1992	56	90	58.33	1.23E+11
100.00	44.75	4.89E+11	7/14/1992	216	560	24.77	2.96E+12
104.00	43.78	5.09E+11	8/13/1992	69	280	53.95	4.73E+11

Data for Fecal Coliform Load Duration Curve

Sangamon River IL_E-29 (cfs)	% of Time Exceeded	Fecal load (cfu/day)
107.00	42.82	5.24E+11
111.00	41.85	5.43E+11
115.00	40.88	5.63E+11
120.00	39.91	5.87E+11
124.00	38.95	6.07E+11
130.00	37.98	6.36E+11
133.00	37.01	6.51E+11
138.00	36.04	6.75E+11
142.00	35.07	6.95E+11
148.00	34.11	7.24E+11
153.00	33.14	7.49E+11
160.00	32.17	7.83E+11
165.00	31.20	8.07E+11
171.00	30.24	8.37E+11
179.00	29.27	8.76E+11
185.00	28.30	9.05E+11
191.00	27.33	9.35E+11
201.00	26.37	9.84E+11
210.00	25.40	1.03E+12
220.00	24.43	1.08E+12
231.00	23.46	1.13E+12
242.00	22.50	1.18E+12
251.00	21.53	1.23E+12
266.00	20.56	1.30E+12
280.00	19.59	1.37E+12
294.00	18.63	1.44E+12
312.00	17.66	1.53E+12
327.00	16.69	1.60E+12
345.00	15.72	1.69E+12
362.00	14.76	1.77E+12
389.00	13.79	1.90E+12
411.00	12.82	2.01E+12
443.00	11.85	2.17E+12
479.00	10.89	2.34E+12
518.00	9.92	2.53E+12
565.00	8.95	2.76E+12
623.00	7.98	3.05E+12
693.00	7.01	3.39E+12
769.00	6.05	3.76E+12
867.00	5.08	4.24E+12
988.00	4.11	4.83E+12
1,170.00	3.14	5.73E+12
1,370.00	2.18	6.70E+12
1,890.00	1.21	9.25E+12
3,340.00	0.24	1.63E+13

Observed Data

Date	Sangamon River IL_E-29 (cfs)	Concentration (cfu/100 ml)	Percentile	Fecal load (cfu/day)
5/25/1993	140	380	35.65	1.30E+12
6/29/1993	2450	13000	0.62	7.79E+14
8/19/1993	94	1800	46.69	4.14E+12
9/29/1993	733	1900	6.51	3.41E+13
7/1/1994	31	490	67.57	3.72E+11
8/16/1994	17	540	75.63	2.25E+11
9/7/1994	4.8	260	90.09	3.05E+10
9/27/1994	4.8	310	90.09	3.64E+10
6/15/1995	234	360	23.18	2.06E+12
9/8/1995	15	1400	77.31	5.14E+11
9/22/1995	6.5	420	87.29	6.68E+10
10/17/1995	3.9	140	92.09	1.34E+10
5/21/1996	340	300	16.05	2.50E+12
7/19/1996	30	110	68.10	8.07E+10
8/27/1996	7.5	190	85.62	3.49E+10
10/28/1996	5.3	40	89.22	5.19E+09
5/1/1997	92	540	47.12	1.22E+12
4/29/1999	261	30	20.86	1.92E+11
8/31/1999	3.2	1100	93.66	8.61E+10
9/29/1999	7.3	800	85.95	1.43E+11
5/23/2000	66	340	54.80	5.49E+11
6/14/2000	67	480	54.56	7.87E+11
7/26/2000	6.7	400	87.02	6.56E+10
9/28/2000	1.3	250	97.87	7.95E+09
5/14/2001	67	140	54.56	2.30E+11
6/19/2001	118	170	40.52	4.91E+11
8/2/2001	9.1	410	83.20	9.13E+10
8/21/2001	6.2	210	87.77	3.19E+10
6/5/2002	232	640	23.43	3.63E+12
7/11/2002	44	2700	62.48	2.91E+12
8/19/2002	52	23	59.65	2.93E+10
9/27/2002	8.3	360	84.37	7.31E+10
6/2/2003	72	80	52.91	1.41E+11
7/22/2003	261	1900	20.86	1.21E+13
8/25/2003	7.7	230	85.37	4.33E+10
9/29/2003	49	730	60.71	8.75E+11

Attachment 2

This page is blank to facilitate double sided printing.

Data for Nitrate Load Duration Curve

Inflow to Lake Decatur (cfs)	% of Time Exceeded	Nitrate load (kg/day)
0.00	100.00	0.00
5.34	98.85	130.70
20.03	90.16	490.13
20.03	89.88	490.13
20.03	89.60	490.13
20.03	89.32	490.13
21.70	89.04	530.97
21.70	88.76	530.97
21.70	88.48	530.97
21.70	88.20	530.97
23.37	87.92	571.82
23.37	87.64	571.82
23.37	87.36	571.82
23.37	87.08	571.82
25.04	86.80	612.66
25.04	86.52	612.66
25.04	86.24	612.66
26.71	85.96	653.50
26.71	85.68	653.50
26.71	85.40	653.50
28.38	85.12	694.35
28.38	84.84	694.35
28.38	84.56	694.35
30.05	84.28	735.19
30.05	84.00	735.19
30.05	83.72	735.19
31.72	83.44	776.04
31.72	83.16	776.04
31.72	82.88	776.04
33.39	82.60	816.88
33.39	82.32	816.88
33.39	82.04	816.88
35.06	81.76	857.72
35.06	81.48	857.72
35.06	81.20	857.72
36.73	80.92	898.57
36.73	80.64	898.57
38.40	80.36	939.41
38.40	80.08	939.41
40.07	79.80	980.25
40.07	79.52	980.25
41.74	79.24	1021.10
41.74	78.96	1021.10
41.74	78.68	1021.10
43.41	78.40	1061.94
43.41	78.12	1061.94
45.07	77.84	1102.79
46.74	77.55	1143.63
46.74	77.27	1143.63
48.41	76.99	1184.47
50.08	76.71	1225.32
50.08	76.43	1225.32
50.08	76.15	1225.32
51.75	75.87	1266.16
53.42	75.59	1307.01
53.42	75.31	1307.01
55.09	75.03	1347.85
56.76	74.75	1388.69
58.43	74.47	1429.54
58.43	74.19	1429.54
60.10	73.91	1470.38
61.77	73.63	1511.23
63.44	73.35	1552.07
63.44	73.07	1552.07
65.11	72.79	1592.91
66.78	72.51	1633.76
68.45	72.23	1674.60
70.12	71.95	1715.45

Observed Data

Date	Inflow to Lake Decatur (cfs)	Concentration (mg/l)	Percentile	Nitrate load (kg/day)
1/4/01	113.5	8.3	64.9	2,291.3
1/5/01	118.5	7.3	64.2	2,116.9
1/11/01	93.5	6.4	67.6	1,463.8
1/11/01	93.5	7.5	67.6	1,715.4
1/19/01	217.0	7.4	54.0	3,929.2
1/19/01	217.0	5.9	54.0	3,132.7
1/25/01	133.6	6.4	62.3	2,091.2
1/26/01	126.9	7.4	63.1	2,281.5
2/1/01	3,338.9	5.3	8.4	43,294.6
2/2/01	3,171.9	7.1	8.4	55,098.5
2/9/01	2,220.4	7.7	8.4	41,828.3
2/9/01	2,220.4	7.2	8.4	39,112.2
2/15/01	3,272.1	8.6	8.4	68,846.6
2/16/01	3,405.7	9.7	8.4	80,405.4
2/19/01	1,500.8	11.3	12.6	41,602.3
2/19/01	1,500.8	9.4	12.6	34,515.6
2/22/01	848.1	11.8	23.0	24,483.5
2/22/01	848.1	10.5	23.0	21,786.2
3/1/01	4,774.6	7.4	8.4	85,858.1
3/1/01	4,774.6	7.7	8.4	89,946.6
3/9/01	906.5	10.3	21.5	22,910.2
3/9/01	906.5	9.8	21.5	21,734.7
3/15/01	631.0	11.9	29.3	18,372.4
3/16/01	699.5	11.5	27.0	19,680.7
3/23/01	891.5	11.3	21.9	24,646.1
3/23/01	891.5	10.8	21.9	23,555.5
3/29/01	550.9	9.5	32.5	12,804.6
3/30/01	534.2	10.1	33.3	13,200.8
4/5/01	404.0	8.4	40.1	8,302.8
4/6/01	410.7	9.2	39.5	9,243.8
4/12/01	774.6	7.5	24.7	14,213.7
4/12/01	774.6	6.2	24.7	11,750.0
4/20/01	477.5	8.5	36.0	9,929.2
4/20/01	477.5	11.5	36.0	13,433.6
4/27/01	338.9	7.5	44.2	6,218.5
4/27/01	338.9	8.1	44.2	6,716.0
5/4/01	273.8	7.3	49.2	4,889.8
5/4/01	273.8	7.9	49.2	5,291.7
5/11/01	247.1	5.5	51.4	3,324.7
5/11/01	247.1	6.4	51.4	3,868.7
5/18/01	225.4	5.8	53.4	3,198.1
5/18/01	225.4	5.3	53.4	2,938.9
5/24/01	292.2	5.2	47.8	3,716.8
5/24/01	292.2	5.4	47.8	3,859.8
6/1/01	350.6	4.5	43.3	3,859.8
6/1/01	350.6	5.1	43.3	4,374.4
6/8/01	2,053.4	4.4	8.7	21,853.6
6/8/01	2,053.4	6.9	8.7	34,664.3
6/13/01	773.0	8.9	24.8	16,830.6
6/13/01	773.0	13.9	24.8	26,285.9
6/14/01	664.4	8.2	28.2	13,329.8
6/14/01	664.4	12.9	28.2	20,970.1
6/22/01	357.3	8.0	43.0	6,992.5
6/22/01	357.3	8.3	43.0	7,254.7
6/29/01	198.7	7.3	55.8	3,548.1
6/29/01	198.7	6.9	55.8	3,353.7
7/6/01	202.0	7.4	55.4	3,632.5
7/6/01	202.0	4.9	55.4	2,396.9
7/12/01	96.8	3.5	67.2	817.3
7/13/01	85.1	6.1	68.9	1,260.2
7/20/01	46.7	4.5	77.1	508.9
7/20/01	46.7	2.8	77.1	314.5
7/27/01	33.4	4.4	81.9	355.3
7/27/01	33.4	3.0	81.9	241.0
8/2/01	33.4	1.7	81.9	136.4
8/3/01	28.4	2.7	84.3	189.6
8/10/01	18.4	2.0	90.2	89.0
8/10/01	18.4	1.4	90.2	64.2

Data for Nitrate Load Duration Curve

Inflow to Lake Decatur (cfs)	% of Time Exceeded	Nitrate load (kg/day)
71.79	71.67	1756.29
73.46	71.39	1797.13
75.12	71.11	1837.98
75.12	70.83	1837.98
76.79	70.55	1878.82
78.46	70.27	1919.67
80.13	69.99	1960.51
81.80	69.71	2001.35
83.47	69.43	2042.20
85.14	69.15	2083.04
86.81	68.87	2123.89
88.48	68.59	2164.73
345.57	43.90	8454.70
350.58	43.62	8577.23
352.25	43.34	8618.07
357.26	43.05	8740.61
363.94	42.77	8903.98
367.28	42.49	8985.67
370.62	42.21	9067.36
375.62	41.93	9189.89
380.63	41.65	9312.42
383.97	41.37	9394.11
387.31	41.09	9475.80
390.65	40.81	9557.49
395.66	40.53	9680.02
400.67	40.25	9802.55
407.34	39.97	9965.93
409.01	39.69	10006.77
415.69	39.41	10170.15
419.03	39.13	10251.83
424.04	38.85	10374.37
429.05	38.57	10496.90
434.05	38.29	10619.43
439.06	38.01	10741.96
442.40	37.73	10823.65
449.08	37.45	10987.02
452.42	37.17	11068.71
459.10	36.89	11232.09
464.10	36.61	11354.62
470.78	36.33	11518.00
475.79	36.05	11640.53
482.47	35.77	11803.90
487.48	35.49	11926.44
494.15	35.21	12089.81
499.16	34.93	12212.34
500.83	34.65	12253.19
505.84	34.37	12375.72
515.86	34.09	12620.78
520.86	33.81	12743.31
529.21	33.53	12947.53
537.56	33.25	13151.75
540.90	32.97	13233.44
545.91	32.69	13355.97
555.92	32.41	13601.04
562.60	32.13	13764.41
565.94	31.85	13846.10
574.29	31.57	14050.32
584.30	31.29	14295.38
587.64	31.01	14377.07
594.32	30.73	14540.45
602.67	30.45	14744.67
609.35	30.17	14908.04
614.35	29.88	15030.58
624.37	29.60	15275.64
631.05	29.32	15439.02
637.73	29.04	15602.39
647.74	28.76	15847.46
657.76	28.48	16092.52

Observed Data

Date	Inflow to Lake Decatur (cfs)	Concentration (mg/l)	Percentile	Nitrate load (kg/day)
8/16/01	14.0	1.3	93.6	45.6
8/17/01	13.0	1.8	94.4	55.8
8/23/01	35.1	1.2	81.2	100.4
8/24/01	21.7	1.4	88.1	71.7
8/30/01	21.7	1.1	88.1	55.8
8/31/01	26.7	1.3	85.1	81.7
9/7/01	41.7	1.4	78.5	146.0
9/7/01	41.7	1.4	78.5	137.8
9/14/01	14.2	1.3	93.6	46.2
9/14/01	14.2	1.2	93.6	39.9
9/20/01	7.7	1.1	97.7	21.2
9/21/01	8.7	1.6	97.0	32.9
9/27/01	6.5	1.1	98.3	16.7
9/28/01	6.3	1.4	98.4	22.2
10/5/01	11.0	1.3	95.5	33.7
10/5/01	11.0	1.1	95.5	29.7
10/12/01	23.4	1.2	87.1	67.5
10/12/01	23.4	1.2	87.1	65.8
10/17/01	380.6	1.7	41.6	1,611.0
10/18/01	345.6	1.2	43.9	972.3
10/26/01	1,607.7	2.0	11.7	7,984.5
10/26/01	1,607.7	2.0	11.7	7,669.9
11/1/01	589.3	7.2	30.9	10,308.8
11/2/01	549.2	3.2	32.6	4,232.9
11/9/01	355.6	4.2	43.1	3,627.8
11/15/01	270.4	4.0	49.5	2,613.6
11/21/01	237.1	3.8	52.3	2,174.9
12/7/01	522.5	3.6	33.7	4,538.4
12/14/01	435.7	3.3	38.2	3,549.9
12/20/01	1,986.6	4.0	9.0	19,198.7
12/27/01	631.0	8.8	29.3	13,509.1
1/3/02	317.2	9.9	45.8	7,682.7
1/10/02	293.8	9.5	47.7	6,829.1
1/17/02	195.3	9.7	56.2	4,611.5
1/24/02	183.6	8.5	57.1	3,818.9
2/1/02	4,073.4	7.8	8.4	77,734.2
2/7/02	1,919.9	11.3	9.4	52,841.9
2/8/02	1,552.6	11.1	12.0	42,239.2
2/15/02	986.6	12.5	19.9	30,173.5
2/22/02	5,409.0	9.6	8.4	127,041.0
3/1/02	1,497.5	11.8	12.6	43,231.7
3/7/02	2,570.9	12.2	8.4	76,737.6
3/15/02	2,120.2	10.9	8.4	56,540.3
3/22/02	1,083.5	11.5	18.1	30,483.9
3/28/02	1,093.5	10.3	17.9	27,555.4
4/5/02	1,193.6	10.3	16.2	29,933.5
4/12/02	1,340.6	10.8	14.2	35,421.5
4/16/02	971.6	9.7	20.2	23,058.0
4/19/02	786.3	10.5	24.4	20,199.4
5/3/02	2,637.7	9.8	8.4	63,242.8
5/10/02	2,938.2	10.5	8.4	75,479.6
5/17/02	4,958.2	10.3	8.4	124,945.7
5/24/02	1,532.5	11.0	12.3	41,169.2
5/31/02	1,091.8	12.4	17.9	33,122.8
6/12/02	2,604.3	7.4	8.4	47,150.3
6/21/02	975.0	8.6	20.1	20,513.5
6/27/02	836.4	8.3	23.2	16,984.1
7/2/02	450.7	8.1	37.2	8,932.6
10/4/02	31.7	1.8	82.7	138.1
10/11/02	25.0	1.3	86.1	79.0
10/18/02	25.0	1.8	86.1	107.2
10/25/02	28.4	1.6	84.3	107.6
10/31/02	25.0	1.3	86.1	79.0
11/7/02	35.1	1.7	81.2	141.5
11/15/02	33.4	1.6	81.9	126.6
11/21/02	40.1	1.6	79.4	156.8
11/27/02	40.1	1.3	79.4	124.5
12/6/02	35.1	1.4	81.2	120.1

Data for Nitrate Load Duration Curve			Observed Data				
Inflow to Lake Decatur (cfs)	% of Time Exceeded	Nitrate load (kg/day)	Date	Inflow to Lake Decatur (cfs)	Concentration (mg/l)	Percentile	Nitrate load (kg/day)
664.44	28.20	16255.89	12/13/02	33.4	1.5	81.9	122.5
672.78	27.92	16460.11	12/20/02	153.6	1.5	60.1	544.9
682.80	27.64	16705.18	12/27/02	88.5	1.5	68.5	331.2
689.48	27.36	16868.55	1/3/03	217.0	1.1	54.0	600.0
696.16	27.08	17031.93	1/10/03	131.9	1.3	62.6	425.9
709.51	26.80	17358.68	1/17/03	76.8	1.4	70.4	268.7
716.19	26.52	17522.06	1/24/03	51.8	1.3	75.6	168.4
722.87	26.24	17685.43	1/31/03	63.4	1.4	73.0	221.9
734.55	25.96	17971.34	2/7/03	93.5	1.7	67.6	377.4
741.23	25.68	18134.72	2/13/03	51.8	1.5	75.6	189.9
751.25	25.40	18379.78	2/17/03	53.4	1.4	75.2	183.0
761.26	25.12	18624.84	2/24/03	166.9	-	58.7	-
767.94	24.84	18788.22	3/5/03	93.5	-	67.6	-
782.97	24.56	19155.82	3/11/03	217.0	0.1	54.0	53.1
794.65	24.28	19441.72	3/18/03	245.4	-	51.6	-
804.67	24.00	19686.79	3/18/03	245.4	-	51.6	-
816.36	23.72	19972.69	3/25/03	305.5	0.5	46.6	374.5
826.37	23.44	20217.76	4/2/03	173.6	0.9	58.2	378.9
836.39	23.16	20462.82	4/8/03	879.8	0.8	22.2	1,775.8
856.42	22.88	20952.95	4/15/03	372.3	0.8	42.1	704.1
863.10	22.60	21116.33	4/23/03	253.8	1.3	50.9	813.3
874.79	22.32	21402.23	4/30/03	213.7	1.5	54.4	789.4
886.47	22.04	21688.14	4/30/03	213.7	1.5	54.4	763.3
894.82	21.76	21892.36	5/7/03	1,212.0	1.5	15.9	4,299.6
914.85	21.48	22382.49	5/13/03	2,587.6	3.8	8.4	24,247.0
924.87	21.20	22627.55	5/21/03	639.4	7.6	29.0	11,920.1
938.22	20.92	22954.30	5/28/03	352.3	6.7	43.3	5,791.3
951.58	20.64	23281.06	6/4/03	287.1	6.2	48.1	4,320.5
963.27	20.36	23566.96	6/11/03	409.0	5.1	39.6	5,103.5
978.29	20.08	23934.56	6/17/03	1,836.4	6.1	10.0	27,226.6
989.98	19.80	24220.47	7/9/03	439.1	4.9	38.0	5,220.6
1003.33	19.52	24547.22	7/15/03	2,454.1	3.2	8.4	19,153.0
1018.36	19.24	24914.81	7/23/03	829.7	3.3	23.4	6,658.2
1035.05	18.96	25323.25	7/30/03	240.4	2.9	52.1	1,723.3
1051.75	18.68	25731.69	8/4/03	464.1	2.4	36.6	2,759.2
1065.10	18.40	26058.44	8/18/03	76.8	0.6	70.4	118.2
1078.46	18.12	26385.20	8/27/03	36.7	0.3	80.5	27.0
1098.49	17.84	26875.32	9/3/03	1,919.9	0.6	9.4	2,630.4
1115.18	17.56	27283.76	9/10/03	245.4	0.3	51.6	208.3
1130.21	17.28	27651.36	9/17/03	135.2	0.2	62.2	65.5
1145.23	16.99	28018.95	9/24/03	98.5	0.3	67.0	70.8
1168.61	16.71	28590.77	9/30/03	332.2	0.3	44.8	234.1
1178.62	16.43	28835.83	9/30/03	332.2	0.3	44.8	218.6
1200.33	16.15	29366.81	10/8/03	140.2	0.3	61.6	111.5
1212.01	15.87	29652.71	10/15/03	136.9	0.3	61.9	88.1
1237.05	15.59	30265.37	10/21/03	161.9	0.2	59.4	77.7
1252.08	15.31	30632.97	10/29/03	187.0	0.2	56.9	81.4
1277.12	15.03	31245.63	11/11/03	198.7	0.2	55.8	88.5
1293.81	14.75	31654.07	11/12/03	193.7	0.2	56.3	110.9
1320.53	14.47	32307.57	11/18/03	554.3	0.3	32.4	363.4
1338.89	14.19	32756.85	11/24/03	3,055.1	2.4	8.4	17,789.2
1363.93	13.91	33369.51	12/2/03	874.8	6.4	22.3	13,654.6
1388.97	13.63	33982.17	12/9/03	689.5	6.1	27.3	10,357.3
1415.68	13.35	34635.68	12/17/03	567.6	7.0	31.7	9,665.3
1440.73	13.07	35248.33	12/23/03	883.1	6.8	22.2	14,735.6
1480.79	12.79	36228.59	12/30/03	1,819.7	7.6	10.1	33,657.1
1502.49	12.51	36759.56	1/6/04	3,188.6	7.1	8.4	55,466.5
1545.90	12.23	37821.50	1/14/04	689.5	7.2	27.3	12,077.9
1575.95	11.95	38556.70	1/21/04	480.8	8.6	35.8	10,092.7
1612.68	11.67	39455.26	1/28/04	402.3	8.8	40.2	8,662.2
1654.41	11.39	40476.36	2/3/04	317.2	8.8	45.8	6,798.1
1686.13	11.11	41252.40	2/10/04	262.1	8.3	50.2	5,303.1
1736.22	10.83	42477.72	2/17/04	243.7	7.0	51.7	4,174.3
1769.60	10.55	43294.59	2/25/04	454.1	7.2	37.1	7,998.9
1819.69	10.27	44519.91	6/22/04	1,248.7	4.9	15.4	14,939.6
1836.38	9.99	44928.35	9/29/04	26.7	0.2	85.1	11.8
1886.47	9.71	46153.67	12/15/04	1,292.1	4.4	14.8	13,909.8
1919.85	9.43	46970.55	3/16/05	420.7	5.4	39.0	5,558.0

Data for Nitrate Load Duration Curve

Inflow to Lake Decatur (cfs)	% of Time Exceeded	Nitrate load (kg/day)
1969.94	9.15	48195.87
2020.02	8.87	49421.19
2086.80	8.59	51054.95
2120.19	8.31	51871.83
2170.27	8.03	53097.14
2237.05	7.75	54730.90
2287.13	7.47	55956.22
2370.60	7.19	57998.42
2420.69	6.91	59223.74
2504.16	6.63	61265.94
2554.24	6.35	62491.25
2621.02	6.07	64125.01
2687.80	5.79	65758.77
2771.27	5.51	67800.97
2871.43	5.23	70251.61
2971.60	4.95	72702.24
3055.07	4.67	74744.44
3155.24	4.39	77195.08
3255.41	4.11	79645.72
3355.57	3.82	82096.35
3472.43	3.54	84955.43
3589.29	3.26	87814.51
3789.63	2.98	92715.78
4006.65	2.70	98025.50
4173.60	2.42	102109.89
4457.40	2.14	109053.37
4757.90	1.86	116405.28
5141.87	1.58	125799.39
5592.62	1.30	136827.26
6227.01	1.02	152347.96
7128.50	0.74	174403.70
8347.19	0.46	204219.78
11869.71	0.18	290400.53

Observed Data

Date	Inflow to Lake Decatur (cfs)	Concentration (mg/l)	Percentile	Nitrate load (kg/day)
4/20/05	445.7	4.7	37.6	5,125.5
8/16/05	36.7	0.4	80.5	35.0
4/14/00	116.9	1.5	64.4	428.9
4/14/00	116.9	1.5	64.4	431.7
6/13/00	819.7	8.0	23.6	16,043.5
7/3/00	370.6	8.0	42.2	7,253.9
7/3/00	370.6	7.9	42.2	7,163.2
8/18/00	21.7	0.7	88.1	34.5
8/18/00	21.7	0.7	88.1	36.1
10/18/00	80.1	1.2	69.8	231.3
10/18/00	80.1	1.3	69.8	247.0
4/25/03	237.1	1.5	52.3	875.8
4/25/03	237.1	1.5	52.3	870.0
6/17/03	1,836.4	6.6	10.0	29,428.1
6/17/03	1,836.4	6.8	10.0	30,686.1
7/22/03	1,140.2	3.6	17.1	9,931.1
7/22/03	1,140.2	3.8	17.1	10,684.3
8/19/03	68.4	0.4	72.0	73.0
8/19/03	68.4	0.5	72.0	75.5
10/7/03	155.3	0.3	60.0	129.1
10/7/03	155.3	0.3	60.0	119.3
4/20/06	3,121.9	9.8	8.4	74,774.3
4/20/06	3,121.9	9.7	8.4	73,705.0
6/16/06	175.3	5.7	58.0	2,423.1
6/16/06	175.3	5.3	58.0	2,290.1
7/17/06	185.3	1.0	57.0	452.0
7/17/06	185.3	1.1	57.0	503.2
8/16/06	71.8	1.5	71.5	263.4
8/16/06	71.8	1.5	71.5	259.9
10/6/06	100.2	0.7	66.6	179.9
10/6/06	100.2	0.7	66.6	174.7
4/14/00	116.9	1.5	64.4	423.1
6/13/00	819.7	8.0	23.6	16,043.5
7/3/00	370.6	8.0	42.2	7,253.9
8/18/00	21.7	0.6	88.1	32.9
10/18/00	80.1	1.2	69.8	233.3
4/25/03	237.1	1.5	52.3	846.8
6/17/03	1,836.4	6.4	10.0	28,933.9
7/22/03	1,140.2	3.5	17.1	9,847.4
8/19/03	68.4	0.4	72.0	71.2
10/7/03	155.3	0.3	60.0	106.4
4/20/06	3,121.9	9.9	8.4	75,538.0
6/16/06	175.3	5.8	58.0	2,470.2
7/17/06	185.3	0.7	57.0	312.4
8/16/06	71.8	1.5	71.5	263.4
10/6/06	100.2	0.7	66.6	176.0
4/14/00	116.9	4.0	64.4	1,143.6
6/13/00	819.7	10.0	23.6	20,054.4
7/3/00	370.6	9.1	42.2	8,251.3
8/18/00	21.7	0.6	88.1	30.3
10/18/00	80.1	0.1	69.8	19.6
4/25/03	237.1	5.2	52.3	3,027.5
6/17/03	1,836.4	10.2	10.0	45,826.9
7/22/03	1,140.2	5.5	17.1	15,454.6
8/19/03	68.4	0.5	72.0	83.9
10/7/03	155.3	0.5	60.0	183.8
4/20/06	3,121.9	9.6	8.4	72,941.2
6/16/06	175.3	5.2	58.0	2,217.2
7/17/06	185.3	0.2	57.0	110.6
8/16/06	71.8	1.2	71.5	214.3
10/6/06	100.2	0.8	66.6	191.1
4/14/00	116.9	5.1	64.4	1,458.1
6/13/00	819.7	10.0	23.6	20,054.4
7/3/00	370.6	10.0	42.2	9,067.4
8/18/00	21.7	0.3	88.1	13.3
10/18/00	80.1	1.8	69.8	354.9
4/25/03	237.1	5.0	52.3	2,911.5
6/17/03	1,836.4	11.9	10.0	53,464.7

Data for Nitrate Load Duration Curve			Observed Data				
Inflow to Lake Decatur (cfs)	% of Time Exceeded	Nitrate load (kg/day)	Date	Inflow to Lake Decatur (cfs)	Concentration (mg/l)	Percentile	Nitrate load (kg/day)
			7/22/03	1,140.2	6.0	17.1	16,654.2
			8/19/03	68.4	0.4	72.0	62.5
			10/7/03	155.3	0.6	60.0	218.8
			4/20/06	3,121.9	8.9	8.4	68,129.4
			6/16/06	175.3	6.2	58.0	2,671.8
			7/17/06	185.3	1.3	57.0	598.4
			8/16/06	71.8	0.5	71.5	91.2
			10/6/06	100.2	0.9	66.6	222.3
			5/14/02	8,113.5	7.1	8.4	140,446.2
			5/28/02	1,145.2	12.0	17.0	33,488.2
			6/11/02	1,205.3	10.2	16.0	30,019.7
			6/25/02	697.8	10.3	27.0	17,570.2
			7/16/02	106.8	6.6	65.8	1,717.1
			7/30/02	93.5	4.2	67.6	959.1
			8/14/02	23.4	1.8	87.1	104.8
			8/27/02	2,404.0	0.7	8.4	4,082.0
			9/10/02	75.1	0.3	70.8	59.1
			9/24/02	46.7	0.7	77.1	84.8
			10/8/02	23.4	0.4	87.1	24.4
			10/22/02	18.4	0.2	90.2	8.9
			11/6/02	31.7	0.1	82.7	4.7
			11/19/02	38.4	0.1	80.0	5.6
			12/23/02	155.3	0.1	60.0	22.8
			2/25/03	141.9	0.1	61.3	20.8
			3/11/03	217.0	0.1	54.0	31.9
			3/25/03	305.5	1.2	46.6	929.0
			4/7/03	764.6	1.6	25.0	3,032.7
			4/22/03	275.5	3.4	49.1	2,266.1
			5/6/03	1,218.7	2.8	15.8	8,467.1
			5/20/03	781.3	9.9	24.6	18,992.3
			6/10/03	223.7	5.9	53.6	3,234.6
			6/24/03	392.3	7.5	40.7	7,227.5
			7/8/03	689.5	5.1	27.3	8,535.5
			7/22/03	1,140.2	4.6	17.1	12,804.5

Attachment 3

This page is blank to facilitate double sided printing.

```
TITLE01              Owl Creek TMDL
TITLE02              Calibration -- 6/21/07
TITLE03   NO         CONSERVATIVE MINERAL   I
TITLE04   NO         CONSERVATIVE MINERAL  II
TITLE05   NO         CONSERVATIVE MINERAL III
TITLE06   NO         TEMPERATURE
TITLE07  YES         5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08  YES         ALGAE AS CHL-A IN UG/L
TITLE09  YES         PHOSPHORUS CYCLE AS P IN MG/L
TITLE10                (ORGANIC-P; DISSOLVED-P)
TITLE11  YES         NITROGEN CYCLE AS N IN MG/L
TITLE12                (ORGANIC-N; AMMONIA-N; NITRITE-N;' NITRATE-N)
TITLE13  YES         DISSOLVED OXYGEN IN MG/L
TITLE14   NO         FECAL COLIFORM IN NO./100 ML
TITLE15   NO         ARBITRARY NON-CONSERVATIVE
ENDTITLE
LIST DATA INPUT
NOWRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
NO TRAPEZOIDAL CHANNELS
NO PRINT LCD/SOLAR DATA
NO PLOT DO AND BOD
FIXED DNSTM CONC (YES=1)=        0.          5D-ULT BOD CONV K COEF  =     0.023
INPUT METRIC            =        0.          OUTPUT METRIC           =        0.
NUMBER OF REACHES       =        5.          NUMBER OF JUNCTIONS     =        0.
NUM OF HEADWATERS       =        1.          NUMBER OF POINT LOADS   =        2.
TIME STEP (HOURS)       =        1.          LNTH. COMP. ELEMENT (MI)=      0.10
MAXIMUM ROUTE TIME (HRS)=       60.          TIME INC. FOR RPT2 (HRS)=       1.0
LATITUDE OF BASIN (DEG) =   40.3254          LONGITUDE OF BASIN (DEG)=   88.3531
STANDARD MERIDIAN (DEG) =        0.          DAY OF YEAR START TIME  =      241.
EVAP. COEF.,(AE)        =   0.00068          EVAP. COEF.,(BE)        =   0.00027
ELEV. OF BASIN (ELEV)   =     683.2          DUST ATTENUATION COEF.  =      0.06
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)=  3.43   O UPTAKE BY NO2 OXID(MG O/MG N)=   1.14
O PROD  BY ALGAE (MG O/MG A)   =   1.8   O UPTAKE BY ALGAE (MG O/MG A)  =   1.90
N CONTENT OF ALGAE (MG N/MG A) =   0.09  P CONTENT OF ALGAE (MG P/MG A) =  0.014
ALG MAX SPEC GROWTH RATE(1/DAY)=   2.0   ALGAE RESPIRATION RATE (1/DAY) =  0.105
N HALF SATURATION CONST (MG/L) =   0.03  P HALF SATURATION CONST  (MG/L)=  0.005
LIN ALG SHADE CO (1/H-UGCHA/L) =  0.003  NLIN SHADE (1/H-(UGCHA/L)**2/3)=  0.000
LIGHT FUNCTION OPTION (LFNOPT) =    2.0  LIGHT SATURATION COEF (INT/MIN)=   0.66
DAILY AVERAGING OPTION (LAVOPT)=    2.0  LIGHT AVERAGING FACTOR  (INT)  =    0.9
NUMBER OF DAYLIGHT HOURS (DLH) =   14.2  TOTAL DAILY SOLAR RADTN (INT)  =  1500.
ALGY GROWTH CALC OPTION(LGROPT)=    2.0  ALGAL PREF FOR NH3-N (PREFN)   =    0.1
ALG/TEMP SOLR RAD FACTOR(TFACT)=   0.45  NITRIFICATION INHIBITION COEF  =    0.6
ENDATA1A
THETA    SOD RATE  1.060
ENDATA1B
STREAM REACH     1. RCH= Upstream 1        FROM         6.36    TO          4.36
STREAM REACH     2. RCH= Upstream 2        FROM         4.36    TO          2.50
STREAM REACH     3. RCH= 01 to Fisher      FROM         2.50    TO          0.75
STREAM REACH     4. RCH= Fisher to trib    FROM         0.75    TO          0.20
STREAM REACH     5. RCH= trib to conflu    FROM         0.20    TO          0.00
ENDATA2
ENDATA3
FLAG FIELD RCH=  1.        20.          1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
FLAG FIELD RCH=  2.        19.          2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
```

```
FLAG FIELD RCH=  3.        17.          2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
FLAG FIELD RCH=  4.         6.          6.2.2.2.2.2.
FLAG FIELD RCH=  5.         2.          6.5.
ENDATA4
HYDRAULICS RCH=  1.     100.0     0.2054     1.00      0.482   0.000    0.020
HYDRAULICS RCH=  2.     100.0     0.2054     1.00      0.482   0.000    0.020
HYDRAULICS RCH=  3.     100.0     0.1765     1.00      0.508   0.000    0.020
HYDRAULICS RCH=  4.     100.0     0.1548     1.00      0.659   0.000    0.020
HYDRAULICS RCH=  5.     100.0     0.4252     1.00      0.280   0.000    0.020
ENDATA5
TEMP/LCD          1.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          2.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          3.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          4.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          5.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
ENDATA5A
REACT COEF RCH=   1.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   2.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   3.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   4.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   5.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
ENDATA6
N AND P COEF   RCH=  1.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  2.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  3.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  4.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  5.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
ENDATA6A
ALG/OTHER COEF RCH=  1.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  2.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  3.0   50.0    .44    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  4.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  5.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ENDATA6B
INITIAL COND-1 RCH=   1.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   2.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   3.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   4.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   5.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
ENDATA7
INITIAL COND-2 RCH=   1.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   2.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   3.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   4.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   5.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
ENDATA7A
INCR INFLOW-1  RCH=   1.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   2.  0.135  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   3. -0.216  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   4.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   5.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
ENDATA8
INCR INFLOW-2  RCH=   1.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   2.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   3.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   4.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   5.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
```

```
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1. Owl Creek Upstr    0.146 70.00  8.50  6.00  0.0   000    000
ENDATA10
HEADWTR-2 HDW=   1.   0.00   0.0  9.00  0.25  0.25  0.00  0.00  0.11  0.11
ENDATA10A
POINTLD-1 PTL=   1. Fisher STP  0.00 0.08900  77.0   6.1  12.5   0.0   000   000
POINTLD-1 PTL=   2. unnamed tr  0.00 0.16700  77.0   7.0   6.0   0.0   0.0   0.0
ENDATA11
POINTLD-2 PTL=   1.   0.00   0.0  64.0  0.00  0.60  0.00  0.00  2.17   2.1
POINTLD-2 PTL=   2.   0.00   0.0  0.00  0.25  0.25  0.00  0.00  0.00   0.0
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
```

```
                                              * * * QUAL-2E  STREAM QUALITY
ROUTING MODEL * * *
                                                           Version 3.22  --  May
1996

          $$$ (PROBLEM TITLES) $$$

         CARD TYPE                                     QUAL-2E PROGRAM TITLES
         TITLE01              Owl Creek TMDL
         TITLE02              Calibration -- 6/21/07
         TITLE03   NO         CONSERVATIVE MINERAL   I
         TITLE04   NO         CONSERVATIVE MINERAL  II
         TITLE05   NO         CONSERVATIVE MINERAL III
         TITLE06   NO         TEMPERATURE
         TITLE07  YES         5-DAY BIOCHEMICAL OXYGEN DEMAND
         TITLE08  YES         ALGAE AS CHL-A IN UG/L
         TITLE09  YES         PHOSPHORUS CYCLE AS P IN MG/L
         TITLE10                (ORGANIC-P; DISSOLVED-P)
         TITLE11  YES         NITROGEN CYCLE AS N IN MG/L
         TITLE12                (ORGANIC-N; AMMONIA-N; NITRITE-N;' NITRATE-N)
         TITLE13  YES         DISSOLVED OXYGEN IN MG/L
         TITLE14   NO         FECAL COLIFORM IN NO./100 ML
         TITLE15   NO         ARBITRARY NON-CONSERVATIVE
         ENDTITLE

          $$$ DATA TYPE 1 (CONTROL DATA) $$$

         CARD TYPE                                            CARD TYPE
         LIST DATA INPUT             0.00000
0.00000
         NOWRITE OPTIONAL SUMMARY    0.00000
0.00000
         NO FLOW AUGMENTATION        0.00000
0.00000
         STEADY STATE                0.00000
0.00000
         NO TRAPEZOIDAL CHANNELS     0.00000
0.00000
         NO PRINT LCD/SOLAR DATA     0.00000
0.00000
         NO PLOT DO AND BOD          0.00000
0.00000
         FIXED DNSTM CONC (YES=1)=   0.00000          5D-ULT BOD CONV K COEF  =
0.02300
         INPUT METRIC            =   0.00000          OUTPUT METRIC           =
0.00000
         NUMBER OF REACHES       =   5.00000          NUMBER OF JUNCTIONS     =
0.00000
         NUM OF HEADWATERS       =   1.00000          NUMBER OF POINT LOADS   =
2.00000
         TIME STEP (HOURS)       =   1.00000          LNTH. COMP. ELEMENT (MI)=
0.10000
         MAXIMUM ROUTE TIME (HRS)=  60.00000          TIME INC. FOR RPT2 (HRS)=
1.00000
         LATITUDE OF BASIN (DEG) =  40.32540          LONGITUDE OF BASIN (DEG)=
88.35310
```

```
         STANDARD MERIDIAN (DEG) =   0.00000          DAY OF YEAR START TIME  =
241.00000
         EVAP. COEF.,(AE)        =   0.00068          EVAP. COEF.,(BE)        =
0.00027
         ELEV. OF BASIN (ELEV)   = 683.20001          DUST ATTENUATION COEF.  =
0.06000
         ENDATA1                     0.00000
0.00000

          $$$ DATA TYPE 1A (ALGAE PRODUCTION AND NITROGEN OXIDATION CONSTANTS)
$$$

         CARD TYPE                                              CARD TYPE
         O UPTAKE BY NH3 OXID(MG O/MG N)=    3.4300          O UPTAKE BY NO2
OXID(MG O/MG N)=    1.1400
         O PROD  BY ALGAE (MG O/MG A)   =    1.8000          O UPTAKE BY ALGAE
(MG O/MG A)  =    1.9000
         N CONTENT OF ALGAE (MG N/MG A) =    0.0900          P CONTENT OF ALGAE
(MG P/MG A) =    0.0140
         ALG MAX SPEC GROWTH RATE(1/DAY)=    2.0000          ALGAE RESPIRATION
RATE (1/DAY) =    0.1050
         N HALF SATURATION CONST (MG/L) =    0.0300          P HALF SATURATION
CONST  (MG/L)=    0.0050
         LIN ALG SHADE CO (1/FT-UGCHA/L=)    0.0030          NLIN SHADE(1/FT-
(UGCHA/L)**2/3)=    0.0000
         LIGHT FUNCTION OPTION (LFNOPT) =    2.0000          LIGHT SAT'N COEF
(BTU/FT2-MIN) =    0.6600
         DAILY AVERAGING OPTION (LAVOPT)=    2.0000          LIGHT AVERAGING
FACTOR  (INT)  =    0.9000
         NUMBER OF DAYLIGHT HOURS (DLH) =   14.2000          TOTAL DAILY SOLR
RAD (BTU/FT-2)= 1500.0000
         ALGY GROWTH CALC OPTION(LGROPT)=    2.0000          ALGAL PREF FOR NH3-
N (PREFN)   =    0.1000
         ALG/TEMP SOLR RAD FACTOR(TFACT)=    0.4500          NITRIFICATION
INHIBITION COEF  =    0.6000
         ENDATA1A                            0.0000                 0.0000

          $$$ DATA TYPE 1B (TEMPERATURE CORRECTION CONSTANTS FOR RATE
COEFFICIENTS) $$$

         CARD TYPE     RATE CODE     THETA VALUE

         THETA( 1)      BOD DECA        1.047     DFLT
         THETA( 2)      BOD SETT        1.024     DFLT
         THETA( 3)      OXY TRAN        1.024     DFLT
         THETA( 4)      SOD RATE        1.060     USER
         THETA( 5)      ORGN DEC        1.047     DFLT
         THETA( 6)      ORGN SET        1.024     DFLT
         THETA( 7)      NH3 DECA        1.083     DFLT
         THETA( 8)      NH3 SRCE        1.074     DFLT
         THETA( 9)      NO2 DECA        1.047     DFLT
         THETA(10)      PORG DEC        1.047     DFLT
         THETA(11)      PORG SET        1.024     DFLT
         THETA(12)      DISP SRC        1.074     DFLT
         THETA(13)      ALG GROW        1.047     DFLT
         THETA(14)      ALG RESP        1.047     DFLT
         THETA(15)      ALG SETT        1.024     DFLT
```

```
         THETA(16)      COLI DEC        1.047     DFLT
         THETA(17)      ANC DECA        1.000     DFLT
         THETA(18)      ANC SETT        1.024     DFLT
         THETA(19)      ANC SRCE        1.000     DFLT
         ENDATA1B

          $$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

         CARD TYPE           REACH ORDER AND IDENT               R. MI/KM  R.
MI/KM
         STREAM REACH     1.0  RCH= Upstream 1        FROM          6.4    TO
4.4
         STREAM REACH     2.0  RCH= Upstream 2        FROM          4.4    TO
2.5
         STREAM REACH     3.0  RCH= 01 to Fisher      FROM          2.5    TO
0.8
         STREAM REACH     4.0  RCH= Fisher to trib    FROM          0.8    TO
0.2
         STREAM REACH     5.0  RCH= trib to conflu    FROM          0.2    TO
0.0
         ENDATA2          0.0                                       0.0    0.0

          $$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

         CARD TYPE                  REACH  AVAIL HDWS TARGET     ORDER OF AVAIL
SOURCES
         ENDATA3                     0.         0.       0.0   0.   0.   0.   0.
0.   0.

          $$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

         CARD TYPE        REACH ELEMENTS/REACH             COMPUTATIONAL FLAGS
         FLAG FIELD        1.       20.
1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
         FLAG FIELD        2.       19.
2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.
         FLAG FIELD        3.       17.
2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.0.0.
         FLAG FIELD        4.        6.
6.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
         FLAG FIELD        5.        2.
6.5.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
         ENDATA4           0.        0.
0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.

          $$$ DATA TYPE 5 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH)
$$$

         CARD TYPE        REACH  COEF-DSPN  COEFQV    EXPOQV    COEFQH   EXPOQH
CMANN
         HYDRAULICS        1.    100.00     0.205     1.000     0.482     0.000
0.020
         HYDRAULICS        2.    100.00     0.205     1.000     0.482     0.000
0.020
         HYDRAULICS        3.    100.00     0.176     1.000     0.508     0.000
0.020
```

```
         HYDRAULICS        4.    100.00     0.155     1.000     0.659     0.000
0.020
         HYDRAULICS        5.    100.00     0.425     1.000     0.280     0.000
0.020
         ENDATA5           0.      0.00     0.000     0.000     0.000     0.000
0.000

          $$$ DATA TYPE 5A (STEADY STATE TEMPERATURE AND CLIMATOLOGY DATA) $$$

         CARD TYPE                            DUST     CLOUD   DRY BULB  WET
BULB     ATM              SOLAR RAD
                        REACH   ELEVATION     COEF     COVER     TEMP      TEMP
PRESSURE     WIND   ATTENUATION
         TEMP/LCD          1.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          2.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          3.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          4.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          5.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         ENDATA5A          0.        0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND
REAERATION) $$$

         CARD TYPE        REACH     K1         K3        SOD         K2OPT     K2
COEQK2    OR   EXPQK2
                                                         RATE
TSIV COEF  OR    SLOPE

FOR OPT 8      FOR OPT 8
         REACT COEF        1.      0.02      0.00      0.000         1.      0.70
0.000       0.00000
         REACT COEF        2.      0.02      0.00      0.000         1.      0.70
0.000       0.00000
         REACT COEF        3.      0.02      0.00      0.000         1.      0.70
0.000       0.00000
         REACT COEF        4.      0.02      0.00      0.000         1.      0.70
0.000       0.00000
         REACT COEF        5.      0.02      0.00      0.000         1.      0.70
0.000       0.00000
         ENDATA6           0.      0.00      0.00      0.000         0.      0.00
0.000       0.00000

           $$$ DATA TYPE 6A (NITROGEN AND PHOSPHORUS CONSTANTS) $$$

         CARD TYPE           REACH    CKNH2    SETNH2     CKNH3      SNH3
CKNO2     CKPORG   SETPORG     SPO4
         N AND P COEF          1.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          2.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
```

```
         N AND P COEF          3.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          4.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          5.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         ENDATA6A              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 6B (ALGAE/OTHER COEFFICIENTS) $$$

         CARD TYPE           REACH    ALPHAO    ALGSET    EXCOEF      CK5
CKANC    SETANC    SRCANC
                                                                    CKCOLI
         ALG/OTHER COEF        1.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        2.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        3.     50.00      0.44      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        4.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        5.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ENDATA6B              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

         CARD TYPE           REACH    TEMP       D.O.      BOD       CM-1
CM-2      CM-3       ANC      COLI
         INITIAL COND-1        1.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        2.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        3.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        4.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        5.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         ENDATA7               0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 7A (INITIAL CONDITIONS FOR CHOROPHYLL A, NITROGEN, AND
PHOSPHORUS) $$$

         CARD TYPE           REACH    CHL-A     ORG-N     NH3-N     NO2-N
NO3-N     ORG-P     DIS-P
         INITIAL COND-2        1.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        2.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        3.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        4.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
```

```
         INITIAL COND-2         5.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         ENDATA7A               0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 8 (INCREMENTAL INFLOW CONDITIONS) $$$

         CARD TYPE            REACH     FLOW      TEMP      D.O.       BOD
CM-1      CM-2      CM-3        ANC      COLI
         INCR INFLOW-1          1.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1          2.     0.135     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1          3.    -0.216     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1          4.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1          5.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         ENDATA8                0.     0.000      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00

          $$$ DATA TYPE 8A (INCREMENTAL INFLOW CONDITIONS FOR CHLOROPHYLL A,
NITROGEN, AND PHOSPHORUS) $$$

         CARD TYPE            REACH    CHL-A     ORG-N     NH3-N     NO2-N
NO3-N     ORG-P     DIS-P
         INCR INFLOW-2          1.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2          2.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2          3.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2          4.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2          5.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         ENDATA8A               0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

         CARD TYPE               JUNCTION ORDER AND IDENT         UPSTRM
JUNCTION    TRIB
         ENDATA9                 0.                                 0.        0.
0.

          $$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

         CARD TYPE    HDWTR     NAME               FLOW      TEMP      D.O.
BOD      CM-1      CM-2      CM-3
                      ORDER
         HEADWTR-1      1.   Owl Creek Upstr      0.15     70.00      8.50
6.00      0.00      0.00      0.00
         ENDATA10       0.                        0.00      0.00      0.00
0.00      0.00      0.00      0.00
```

```
          $$$ DATA TYPE 10A (HEADWATER CONDITIONS FOR CHLOROPHYLL, NITROGEN,
PHOSPHORUS,
                             COLIFORM AND SELECTED NON-CONSERVATIVE CONSTITUENT)
$$$

         CARD TYPE     HDWTR     ANC     COLI    CHL-A    ORG-N    NH3-N    NO2-
N    NO3-N    ORG-P    DIS-P
                       ORDER
         HEADWTR-2       1.     0.00 0.00E+00     9.00     0.25     0.25
0.00     0.00     0.11     0.11
         ENDATA10A       0.     0.00 0.00E+00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 11 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) $$$

                       POINT
         CARD TYPE      LOAD    NAME              EFF     FLOW     TEMP     D.O.
BOD     CM-1     CM-2     CM-3
                       ORDER
         POINTLD-1      1.   Fisher STP          0.00     0.09    77.00     6.10
12.50     0.00     0.00     0.00
         POINTLD-1      2.   unnamed tr          0.00     0.17    77.00     7.00
6.00     0.00     0.00     0.00
         ENDATA11       0.                       0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 11A (POINT SOURCE CHARACTERISTICS - CHLOROPHYLL A,
NITROGEN, PHOSPHORUS,
                             COLIFORMS AND SELECTED NON-CONSERVATIVE
CONSTITUENT) $$$

                       POINT
         CARD TYPE      LOAD     ANC     COLI    CHL-A    ORG-N    NH3-N    NO2-
N    N03-N    ORG-P    DIS-P
                       ORDER
         POINTLD-2       1.     0.00 0.00E+00    64.00     0.00     0.60
0.00     0.00     2.17     2.10
         POINTLD-2       2.     0.00 0.00E+00     0.00     0.25     0.25
0.00     0.00     0.00     0.00
         ENDATA11A       0.     0.00 0.00E+00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 12 (DAM CHARACTERISTICS) $$$

                               DAM   RCH   ELE    ADAM    BDAM    FDAM    HDAM

         ENDATA12                 0.    0.    0.    0.00    0.00    0.00    0.00

          $$$ DATA TYPE 13 (DOWNSTREAM BOUNDARY CONDITIONS-1) $$$

              CARD TYPE                TEMP       D.O.      BOD       CM-1
CM-2      CM-3       ANC      COLI

         ENDATA13                      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE
UNCONSTRAINED

          $$$ DATA TYPE 13A (DOWNSTREAM BOUNDARY CONDITIONS-2) $$$
```

```
              CARD TYPE                 CHL-A     ORG-N     NH3-N     NO2-N
NH3-N     ORG-P     DIS-P

         ENDATA13A                      DOWNSTREAM BOUNDARY CONCENTRATIONS ARE
UNCONSTRAINED
```

```
 STEADY STATE ALGAE/NUTRIENT/DISSOLVED OXYGEN SIMULATION; CONVERGENCE SUMMARY:
 -----------------------------------------------------------------------------

                                                   NUMBER OF
            VARIABLE              ITERATION      NONCONVERGENT
                                                   ELEMENTS

  ALGAE GROWTH RATE                 1               64
  ALGAE GROWTH RATE                 2               64
  ALGAE GROWTH RATE                 3               64
  ALGAE GROWTH RATE                 4               64
  ALGAE GROWTH RATE                 5               55
  ALGAE GROWTH RATE                 6               28
  ALGAE GROWTH RATE                 7                0
    NITRIFICATION INHIBITION           1                 0
  ALGAE GROWTH RATE                 8                0
    NITRIFICATION INHIBITION           2                 0


 SUMMARY OF CONDITIONS FOR ALGAL GROWTH RATE SIMULATION:
 -------------------------------------------------------

       1. LIGHT AVERAGING OPTION.   LAVOPT= 2

           METHOD: MEAN SOLAR RADIATION DURING DAYLIGHT HOURS

           SOURCE OF SOLAR VALUES:   DATA TYPE 1A
               DAILY NET SOLAR RADIATION:  1500.000 BTU/FT-2 (  407.056
LANGLEYS)
               NUMBER OF DAYLIGHT HOURS:  0.0
               PHOTOSYNTHETIC ACTIVE FRACTION OF SOLAR RADIATION (TFACT): N/A
               MEAN SOLAR RADIATION ADJUSTMENT FACTOR (AFACT): 0.900


       2. LIGHT FUNCTION OPTION:   LFNOPT= 2

           SMITH FUNCTION, WITH 71% IMAX =  0.179 LANGLEYS/MIN


       3. GROWTH ATTENUATION OPTION FOR NUTRIENTS.   LGROPT= 2

           MINIMUM OF NITROGEN, PHOSPHORUS:   FL*MIN(FN,FP)
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     1
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                      ** HYDRAULICS SUMMARY **

ELE RCH ELE   BEGIN      END           POINT    INCR           TRVL
BOTTOM      X-SECT   DSPRSN
ORD NUM NUM     LOC      LOC    FLOW    SRCE    FLOW     VEL    TIME    DEPTH
WIDTH      VOLUME        AREA        AREA     COEF
               MILE    MILE     CFS     CFS     CFS     FPS     DAY       FT
FT      K-FT-3      K-FT-2        FT-2   FT-2/S

  1   1   1    6.36    6.26    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  2   1   2    6.26    6.16    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  3   1   3    6.16    6.06    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  4   1   4    6.06    5.96    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  5   1   5    5.96    5.86    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  6   1   6    5.86    5.76    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  7   1   7    5.76    5.66    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  8   1   8    5.66    5.56    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  9   1   9    5.56    5.46    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 10   1  10    5.46    5.36    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 11   1  11    5.36    5.26    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 12   1  12    5.26    5.16    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 13   1  13    5.16    5.06    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 14   1  14    5.06    4.96    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 15   1  15    4.96    4.86    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 16   1  16    4.86    4.76    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 17   1  17    4.76    4.66    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 18   1  18    4.66    4.56    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 19   1  19    4.56    4.46    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 20   1  20    4.46    4.36    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
```

```
 21   2   1    4.36    4.26    0.15    0.00    0.01   0.031   0.194    0.482
10.101        2.57        5.84        4.87     0.13
 22   2   2    4.26    4.16    0.16    0.00    0.01   0.033   0.186    0.482
10.101        2.57        5.84        4.87     0.14
 23   2   3    4.16    4.06    0.17    0.00    0.01   0.034   0.178    0.482
10.101        2.57        5.84        4.87     0.14
 24   2   4    4.06    3.96    0.17    0.00    0.01   0.036   0.171    0.482
10.101        2.57        5.84        4.87     0.15
 25   2   5    3.96    3.86    0.18    0.00    0.01   0.037   0.164    0.482
10.101        2.57        5.84        4.87     0.16
 26   2   6    3.86    3.76    0.19    0.00    0.01   0.039   0.158    0.482
10.101        2.57        5.84        4.87     0.16
 27   2   7    3.76    3.66    0.20    0.00    0.01   0.040   0.152    0.482
10.101        2.57        5.84        4.87     0.17
 28   2   8    3.66    3.56    0.20    0.00    0.01   0.042   0.147    0.482
10.101        2.57        5.84        4.87     0.17
 29   2   9    3.56    3.46    0.21    0.00    0.01   0.043   0.142    0.482
10.101        2.57        5.84        4.87     0.18
 30   2  10    3.46    3.36    0.22    0.00    0.01   0.045   0.137    0.482
10.101        2.57        5.84        4.87     0.19
 31   2  11    3.36    3.26    0.22    0.00    0.01   0.046   0.133    0.482
10.101        2.57        5.84        4.87     0.19
 32   2  12    3.26    3.16    0.23    0.00    0.01   0.048   0.129    0.482
10.101        2.57        5.84        4.87     0.20
 33   2  13    3.16    3.06    0.24    0.00    0.01   0.049   0.125    0.482
10.101        2.57        5.84        4.87     0.20
 34   2  14    3.06    2.96    0.25    0.00    0.01   0.050   0.121    0.482
10.101        2.57        5.84        4.87     0.21
 35   2  15    2.96    2.86    0.25    0.00    0.01   0.052   0.118    0.482
10.101        2.57        5.84        4.87     0.22
 36   2  16    2.86    2.76    0.26    0.00    0.01   0.053   0.115    0.482
10.101        2.57        5.84        4.87     0.22
 37   2  17    2.76    2.66    0.27    0.00    0.01   0.055   0.112    0.482
10.101        2.57        5.84        4.87     0.23
 38   2  18    2.66    2.56    0.27    0.00    0.01   0.056   0.109    0.482
10.101        2.57        5.84        4.87     0.23
 39   2  19    2.56    2.46    0.28    0.00    0.01   0.058   0.106    0.482
10.101        2.57        5.84        4.87     0.24


 40   3   1    2.50    2.40    0.27    0.00   -0.01   0.047   0.129    0.508
11.153        2.99        6.43        5.67     0.21
 41   3   2    2.40    2.30    0.26    0.00   -0.01   0.045   0.135    0.508
11.153        2.99        6.43        5.67     0.20
 42   3   3    2.30    2.20    0.24    0.00   -0.01   0.043   0.143    0.508
11.153        2.99        6.43        5.67     0.19
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     2
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                      ** HYDRAULICS SUMMARY **

ELE RCH ELE   BEGIN     END          POINT    INCR            TRVL
BOTTOM      X-SECT   DSPRSN
ORD NUM NUM     LOC     LOC    FLOW    SRCE    FLOW     VEL    TIME    DEPTH
WIDTH      VOLUME       AREA        AREA     COEF
               MILE    MILE     CFS     CFS     CFS     FPS     DAY       FT
FT      K-FT-3      K-FT-2        FT-2   FT-2/S

 43   3   4    2.20    2.10    0.23    0.00   -0.01   0.041   0.150    0.508
11.153        2.99        6.43        5.67     0.18
 44   3   5    2.10    2.00    0.22    0.00   -0.01   0.038   0.159    0.508
11.153        2.99        6.43        5.67     0.17
 45   3   6    2.00    1.90    0.20    0.00   -0.01   0.036   0.169    0.508
11.153        2.99        6.43        5.67     0.16
 46   3   7    1.90    1.80    0.19    0.00   -0.01   0.034   0.180    0.508
11.153        2.99        6.43        5.67     0.15
 47   3   8    1.80    1.70    0.18    0.00   -0.01   0.032   0.193    0.508
11.153        2.99        6.43        5.67     0.14
 48   3   9    1.70    1.60    0.17    0.00   -0.01   0.029   0.208    0.508
11.153        2.99        6.43        5.67     0.13
 49   3  10    1.60    1.50    0.15    0.00   -0.01   0.027   0.225    0.508
11.153        2.99        6.43        5.67     0.12
 50   3  11    1.50    1.40    0.14    0.00   -0.01   0.025   0.245    0.508
11.153        2.99        6.43        5.67     0.11
 51   3  12    1.40    1.30    0.13    0.00   -0.01   0.023   0.269    0.508
11.153        2.99        6.43        5.67     0.10
 52   3  13    1.30    1.20    0.12    0.00   -0.01   0.020   0.299    0.508
11.153        2.99        6.43        5.67     0.09
 53   3  14    1.20    1.10    0.10    0.00   -0.01   0.018   0.336    0.508
11.153        2.99        6.43        5.67     0.08
 54   3  15    1.10    1.00    0.09    0.00   -0.01   0.016   0.383    0.508
11.153        2.99        6.43        5.67     0.07
 55   3  16    1.00    0.90    0.08    0.00   -0.01   0.014   0.446    0.508
11.153        2.99        6.43        5.67     0.06
 56   3  17    0.90    0.80    0.06    0.00   -0.01   0.011   0.533    0.508
11.153        2.99        6.43        5.67     0.05


 57   4   1    0.75    0.65    0.15    0.09    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 58   4   2    0.65    0.55    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 59   4   3    0.55    0.45    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 60   4   4    0.45    0.35    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 61   4   5    0.35    0.25    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
```

```
 62   4   6    0.25    0.15    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13


 63   5   1    0.20    0.10    0.32    0.17    0.00   0.136   0.045    0.280
8.399        1.24        4.73        2.35     0.36
 64   5   2    0.10    0.00    0.32    0.00    0.00   0.136   0.045    0.280
8.399        1.24        4.73        2.35     0.36
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     3
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                 ** REACTION COEFFICIENT SUMMARY
**

RCH ELE     DO  K2  OXYGN    BOD    BOD    SOD   ORGN   ORGN    NH3    NH3
NO2   ORGP   ORGP   DISP   COLI    ANC    ANC    ANC
NUM NUM    SAT OPT  REAIR  DECAY   SETT   RATE  DECAY   SETT  DECAY   SRCE
DECAY  DECAY   SETT   SRCE  DECAY  DECAY   SETT   SRCE
          MG/L      1/DAY  1/DAY  1/DAY  G/F2D  1/DAY  1/DAY  1/DAY MG/F2D
1/DAY  1/DAY  1/DAY MG/F2D  1/DAY  1/DAY  1/DAY MG/F2D

  1   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.14   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  18   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  19   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
  1  20   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  2   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  18   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  19   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  3   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     4
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                               ***** STEADY STATE SIMULATION
*****

                                               ** REACTION COEFFICIENT SUMMARY
**

RCH ELE     DO  K2  OXYGN    BOD    BOD    SOD   ORGN   ORGN    NH3    NH3
NO2   ORGP   ORGP   DISP   COLI    ANC    ANC    ANC
NUM NUM    SAT OPT  REAIR  DECAY   SETT   RATE  DECAY   SETT  DECAY   SRCE
DECAY  DECAY   SETT   SRCE  DECAY  DECAY   SETT   SRCE
         MG/L      1/DAY  1/DAY  1/DAY  G/F2D  1/DAY  1/DAY  1/DAY MG/F2D
1/DAY  1/DAY  1/DAY MG/F2D  1/DAY  1/DAY  1/DAY MG/F2D

  3   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  4   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.10   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.10   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
  4   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  5   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  5   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     5
QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                    ** WATER QUALITY VARIABLES
**

RCH ELE              CM-1   CM-2   CM-3
ANC
NUM NUM       TEMP                          DO    BOD   ORGN   NH3N   NO2N
NO3N  SUM-N   ORGP  DIS-P  SUM-P   COLI          CHLA
             DEG-F                        MG/L   MG/L   MG/L   MG/L   MG/L
MG/L   MG/L   MG/L   MG/L   MG/L #/100ML         UG/L

  1   1      70.00   0.00   0.00   0.00   8.27   5.97   0.25   0.23   0.02
0.01   0.50   0.11   0.11   0.22.00E+00   0.00   9.26
  1   2      70.00   0.00   0.00   0.00   8.06   5.94   0.24   0.21   0.02
0.02   0.49   0.11   0.11   0.22.00E+00   0.00   9.51
  1   3      70.00   0.00   0.00   0.00   7.89   5.91   0.24   0.19   0.03
0.04   0.49   0.10   0.12   0.22.00E+00   0.00   9.78
  1   4      70.00   0.00   0.00   0.00   7.75   5.88   0.23   0.18   0.03
0.05   0.49   0.10   0.12   0.22.00E+00   0.00  10.05
  1   5      70.00   0.00   0.00   0.00   7.64   5.85   0.23   0.16   0.03
0.07   0.49   0.10   0.12   0.22.00E+00   0.00  10.32
  1   6      70.00   0.00   0.00   0.00   7.54   5.83   0.22   0.15   0.03
0.08   0.48   0.10   0.12   0.22.00E+00   0.00  10.61
  1   7      70.00   0.00   0.00   0.00   7.47   5.80   0.22   0.14   0.03
0.10   0.48   0.10   0.12   0.22.00E+00   0.00  10.91
  1   8      70.00   0.00   0.00   0.00   7.41   5.77   0.21   0.13   0.02
0.11   0.48   0.09   0.12   0.22.00E+00   0.00  11.22
  1   9      70.00   0.00   0.00   0.00   7.37   5.74   0.21   0.12   0.02
0.12   0.47   0.09   0.12   0.22.00E+00   0.00  11.54
  1  10      70.00   0.00   0.00   0.00   7.34   5.71   0.21   0.11   0.02
0.13   0.47   0.09   0.13   0.22.00E+00   0.00  11.87
  1  11      70.00   0.00   0.00   0.00   7.31   5.68   0.20   0.10   0.02
0.14   0.46   0.09   0.13   0.21.00E+00   0.00  12.22
  1  12      70.00   0.00   0.00   0.00   7.30   5.66   0.20   0.10   0.02
0.15   0.46   0.09   0.13   0.21.00E+00   0.00  12.57
  1  13      70.00   0.00   0.00   0.00   7.30   5.63   0.19   0.09   0.02
0.15   0.46   0.08   0.13   0.21.00E+00   0.00  12.94
  1  14      70.00   0.00   0.00   0.00   7.30   5.60   0.19   0.09   0.02
0.16   0.45   0.08   0.13   0.21.00E+00   0.00  13.31
  1  15      70.00   0.00   0.00   0.00   7.30   5.57   0.19   0.08   0.02
0.17   0.45   0.08   0.13   0.21.00E+00   0.00  13.70
  1  16      70.00   0.00   0.00   0.00   7.32   5.55   0.18   0.08   0.01
0.17   0.44   0.08   0.13   0.21.00E+00   0.00  14.10
  1  17      70.00   0.00   0.00   0.00   7.33   5.52   0.18   0.07   0.01
0.17   0.44   0.08   0.13   0.21.00E+00   0.00  14.51
  1  18      70.00   0.00   0.00   0.00   7.35   5.49   0.18   0.07   0.01
0.18   0.44   0.08   0.13   0.21.00E+00   0.00  14.94
  1  19      70.00   0.00   0.00   0.00   7.37   5.46   0.17   0.06   0.01
0.18   0.43   0.07   0.13   0.21.00E+00   0.00  15.37
```

```
  1  20      70.00   0.00   0.00   0.00   7.39   5.44   0.17   0.06   0.01
0.18   0.43   0.07   0.14   0.21.00E+00   0.00  15.81


  2   1      70.00   0.00   0.00   0.00   7.39   5.44   0.17   0.07   0.01
0.18   0.43   0.07   0.13   0.20.00E+00   0.00  15.49
  2   2      70.00   0.00   0.00   0.00   7.39   5.44   0.17   0.07   0.01
0.17   0.42   0.06   0.12   0.19.00E+00   0.00  15.19
  2   3      70.00   0.00   0.00   0.00   7.38   5.44   0.17   0.07   0.01
0.16   0.42   0.06   0.12   0.18.00E+00   0.00  14.90
  2   4      70.00   0.00   0.00   0.00   7.38   5.44   0.17   0.08   0.01
0.16   0.42   0.06   0.12   0.17.00E+00   0.00  14.63
  2   5      70.00   0.00   0.00   0.00   7.37   5.44   0.17   0.08   0.01
0.16   0.42   0.05   0.11   0.16.00E+00   0.00  14.38
  2   6      70.00   0.00   0.00   0.00   7.36   5.44   0.17   0.08   0.01
0.15   0.42   0.05   0.11   0.16.00E+00   0.00  14.14
  2   7      70.00   0.00   0.00   0.00   7.35   5.44   0.18   0.08   0.01
0.15   0.42   0.05   0.10   0.15.00E+00   0.00  13.91
  2   8      70.00   0.00   0.00   0.00   7.35   5.44   0.18   0.09   0.01
0.15   0.42   0.05   0.10   0.15.00E+00   0.00  13.69
  2   9      70.00   0.00   0.00   0.00   7.34   5.44   0.18   0.09   0.01
0.15   0.42   0.04   0.10   0.14.00E+00   0.00  13.48
  2  10      70.00   0.00   0.00   0.00   7.33   5.44   0.18   0.09   0.01
0.14   0.42   0.04   0.09   0.14.00E+00   0.00  13.28
  2  11      70.00   0.00   0.00   0.00   7.32   5.44   0.18   0.09   0.01
0.14   0.42   0.04   0.09   0.13.00E+00   0.00  13.09
  2  12      70.00   0.00   0.00   0.00   7.31   5.44   0.18   0.09   0.01
0.14   0.42   0.04   0.09   0.13.00E+00   0.00  12.91
  2  13      70.00   0.00   0.00   0.00   7.31   5.44   0.18   0.09   0.01
0.14   0.42   0.04   0.09   0.12.00E+00   0.00  12.74
  2  14      70.00   0.00   0.00   0.00   7.30   5.44   0.18   0.09   0.01
0.14   0.42   0.04   0.08   0.12.00E+00   0.00  12.57
  2  15      70.00   0.00   0.00   0.00   7.29   5.44   0.18   0.09   0.01
0.14   0.42   0.03   0.08   0.11.00E+00   0.00  12.41
  2  16      70.00   0.00   0.00   0.00   7.28   5.44   0.18   0.09   0.01
0.14   0.42   0.03   0.08   0.11.00E+00   0.00  12.26
  2  17      70.00   0.00   0.00   0.00   7.28   5.44   0.18   0.09   0.01
0.14   0.42   0.03   0.08   0.11.00E+00   0.00  12.11
  2  18      70.00   0.00   0.00   0.00   7.27   5.44   0.18   0.09   0.01
0.14   0.42   0.03   0.07   0.11.00E+00   0.00  11.97
  2  19      70.00   0.00   0.00   0.00   7.27   5.44   0.18   0.09   0.01
0.14   0.42   0.03   0.07   0.10.00E+00   0.00  11.83


  3   1      70.00   0.00   0.00   0.00   7.27   5.43   0.18   0.09   0.02
0.14   0.42   0.03   0.07   0.10.00E+00   0.00  11.73
  3   2      70.00   0.00   0.00   0.00   7.27   5.41   0.17   0.09   0.02
0.14   0.42   0.03   0.07   0.10.00E+00   0.00  11.62
  3   3      70.00   0.00   0.00   0.00   7.27   5.39   0.17   0.08   0.01
0.15   0.42   0.03   0.07   0.10.00E+00   0.00  11.50
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     6
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                    ** WATER QUALITY VARIABLES
**

RCH ELE              CM-1   CM-2   CM-3
ANC
NUM NUM       TEMP                               DO    BOD   ORGN   NH3N   NO2N
NO3N  SUM-N   ORGP  DIS-P  SUM-P   COLI                CHLA
             DEG-F                              MG/L   MG/L   MG/L   MG/L   MG/L
MG/L   MG/L   MG/L   MG/L   MG/L #/100ML               UG/L

  3   4      70.00   0.00   0.00   0.00   7.28   5.37   0.17   0.08   0.01
0.15   0.41   0.03   0.07   0.10.00E+00   0.00  11.38
  3   5      70.00   0.00   0.00   0.00   7.28   5.36   0.17   0.08   0.01
0.15   0.41   0.03   0.07   0.10.00E+00   0.00  11.25
  3   6      70.00   0.00   0.00   0.00   7.29   5.33   0.16   0.07   0.01
0.16   0.41   0.03   0.07   0.10.00E+00   0.00  11.12
  3   7      70.00   0.00   0.00   0.00   7.30   5.31   0.16   0.07   0.01
0.16   0.41   0.03   0.07   0.10.00E+00   0.00  10.98
  3   8      70.00   0.00   0.00   0.00   7.31   5.29   0.16   0.06   0.01
0.17   0.40   0.03   0.07   0.10.00E+00   0.00  10.83
  3   9      70.00   0.00   0.00   0.00   7.32   5.27   0.16   0.06   0.01
0.17   0.40   0.03   0.07   0.10.00E+00   0.00  10.68
  3  10      70.00   0.00   0.00   0.00   7.33   5.24   0.15   0.06   0.01
0.17   0.40   0.03   0.07   0.10.00E+00   0.00  10.52
  3  11      70.00   0.00   0.00   0.00   7.34   5.21   0.15   0.06   0.01
0.18   0.39   0.02   0.07   0.10.00E+00   0.00  10.34
  3  12      70.00   0.00   0.00   0.00   7.35   5.18   0.15   0.05   0.01
0.18   0.39   0.02   0.07   0.10.00E+00   0.00  10.16
  3  13      70.00   0.00   0.00   0.00   7.37   5.15   0.14   0.05   0.01
0.18   0.39   0.02   0.07   0.10.00E+00   0.00   9.96
  3  14      70.00   0.00   0.00   0.00   7.38   5.11   0.14   0.05   0.01
0.19   0.38   0.02   0.07   0.10.00E+00   0.00   9.75
  3  15      70.00   0.00   0.00   0.00   7.40   5.07   0.14   0.04   0.01
0.19   0.38   0.02   0.07   0.10.00E+00   0.00   9.51
  3  16      70.00   0.00   0.00   0.00   7.42   5.02   0.13   0.04   0.01
0.19   0.37   0.02   0.07   0.09.00E+00   0.00   9.25
  3  17      70.00   0.00   0.00   0.00   7.43   5.00   0.13   0.04   0.01
0.20   0.37   0.03   0.08   0.11.00E+00   0.00   9.20


  4   1      70.00   0.00   0.00   0.00   6.70   9.26   0.05   0.32   0.03
0.09   0.48   1.23   1.27   2.50.00E+00   0.00  44.62
  4   2      70.00   0.00   0.00   0.00   6.77   9.21   0.06   0.28   0.04
0.10   0.46   1.20   1.30   2.50.00E+00   0.00  49.05
  4   3      70.00   0.00   0.00   0.00   6.87   9.15   0.06   0.24   0.04
0.11   0.44   1.17   1.33   2.50.00E+00   0.00  53.83
  4   4      70.00   0.00   0.00   0.00   7.00   9.09   0.06   0.21   0.04
0.12   0.42   1.14   1.36   2.49.00E+00   0.00  58.98
```

```
  4   5      70.00   0.00   0.00   0.00   7.16   9.04   0.06   0.18   0.03
0.12   0.40   1.11   1.38   2.49.00E+00   0.00  64.48
  4   6      70.00   0.00   0.00   0.00   7.34   8.97   0.06   0.16   0.03
0.12   0.37   1.07   1.40   2.47.00E+00   0.00  69.86


  5   1      70.00   0.00   0.00   0.00   7.17   7.41   0.16   0.20   0.02
0.06   0.43   0.51   0.68   1.19.00E+00   0.00  32.68
  5   2      70.00   0.00   0.00   0.00   7.17   7.40   0.16   0.19   0.02
0.06   0.43   0.51   0.68   1.19.00E+00   0.00  32.18
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     7
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                          ** ALGAE DATA **


NH3-N            ALGAE GROWTH RATE ATTEN FACTORS
ELE RCH ELE               ALGY    ALGY    ALGY   A P/R     NET         NH3
FRACT   LIGHT
ORD NUM NUM       CHLA   GRWTH    RESP    SETT   RATIO     P-R        PREF  N-
UPTKE  EXTCO        LIGHT   NITRGN   PHSPRS
                  UG/L   1/DAY   1/DAY   FT/DA      *   MG/L-D          *
*     1/FT           *        *        *

  1   1   1       9.26    0.93    0.11    0.33    7.95    0.27        0.10
0.74    0.13        0.50     0.89     0.96
  2   1   2       9.51    0.92    0.11    0.33    7.93    0.28        0.10
0.51    0.13        0.50     0.88     0.96
  3   1   3       9.78    0.92    0.11    0.33    7.92    0.28        0.10
0.36    0.13        0.50     0.88     0.96
  4   1   4      10.05    0.92    0.11    0.33    7.92    0.29        0.10
0.27    0.13        0.50     0.88     0.96
  5   1   5      10.32    0.92    0.11    0.33    7.93    0.30        0.10
0.21    0.13        0.50     0.88     0.96
  6   1   6      10.61    0.93    0.11    0.33    7.94    0.31        0.10
0.17    0.13        0.50     0.89     0.96
  7   1   7      10.91    0.93    0.11    0.33    7.95    0.32        0.10
0.14    0.13        0.50     0.89     0.96
  8   1   8      11.22    0.93    0.11    0.33    7.95    0.33        0.10
0.12    0.13        0.50     0.89     0.96
  9   1   9      11.54    0.93    0.11    0.33    7.96    0.34        0.10
0.10    0.13        0.50     0.89     0.96
 10   1  10      11.87    0.93    0.11    0.33    7.97    0.35        0.10
0.09    0.14        0.50     0.89     0.96
 11   1  11      12.22    0.93    0.11    0.33    7.97    0.36        0.10
0.08    0.14        0.50     0.89     0.96
 12   1  12      12.57    0.93    0.11    0.33    7.98    0.37        0.10
0.07    0.14        0.50     0.89     0.96
 13   1  13      12.94    0.93    0.11    0.33    7.98    0.38        0.10
0.06    0.14        0.50     0.89     0.96
 14   1  14      13.31    0.93    0.11    0.33    7.98    0.39        0.10
0.06    0.14        0.50     0.89     0.96
 15   1  15      13.70    0.93    0.11    0.33    7.98    0.40        0.10
0.05    0.14        0.50     0.89     0.96
 16   1  16      14.10    0.93    0.11    0.33    7.98    0.41        0.10
0.05    0.14        0.50     0.89     0.96
 17   1  17      14.51    0.93    0.11    0.33    7.98    0.43        0.10
0.04    0.14        0.50     0.89     0.96
 18   1  18      14.94    0.93    0.11    0.33    7.98    0.44        0.10
0.04    0.14        0.50     0.89     0.96
 19   1  19      15.37    0.93    0.11    0.33    7.98    0.45        0.10
0.04    0.15        0.50     0.89     0.96
```

```
 20   1  20      15.81    0.93    0.11    0.33    7.97    0.46        0.10
0.04    0.15         0.50     0.89     0.96


 21   2   1      15.49    0.93    0.11    0.33    7.97    0.45        0.10
0.04    0.15         0.50     0.89     0.96
 22   2   2      15.19    0.93    0.11    0.33    7.96    0.44        0.10
0.04    0.15         0.50     0.89     0.96
 23   2   3      14.90    0.93    0.11    0.33    7.96    0.44        0.10
0.05    0.14         0.50     0.89     0.96
 24   2   4      14.63    0.93    0.11    0.33    7.95    0.43        0.10
0.05    0.14         0.50     0.89     0.96
 25   2   5      14.38    0.93    0.11    0.33    7.95    0.42        0.10
0.05    0.14         0.50     0.89     0.96
 26   2   6      14.14    0.93    0.11    0.33    7.94    0.41        0.10
0.06    0.14         0.50     0.89     0.96
 27   2   7      13.91    0.93    0.11    0.33    7.94    0.41        0.10
0.06    0.14         0.50     0.89     0.95
 28   2   8      13.69    0.93    0.11    0.33    7.94    0.40        0.10
0.06    0.14         0.50     0.89     0.95
 29   2   9      13.48    0.93    0.11    0.33    7.94    0.39        0.10
0.06    0.14         0.50     0.89     0.95
 30   2  10      13.28    0.93    0.11    0.33    7.93    0.39        0.10
0.06    0.14         0.50     0.89     0.95
 31   2  11      13.09    0.93    0.11    0.33    7.93    0.38        0.10
0.06    0.14         0.50     0.89     0.95
 32   2  12      12.91    0.92    0.11    0.33    7.93    0.38        0.10
0.07    0.14         0.50     0.89     0.95
 33   2  13      12.74    0.92    0.11    0.33    7.93    0.37        0.10
0.07    0.14         0.50     0.88     0.94
 34   2  14      12.57    0.92    0.11    0.33    7.93    0.37        0.10
0.07    0.14         0.50     0.88     0.94
 35   2  15      12.41    0.92    0.11    0.33    7.93    0.36        0.10
0.07    0.14         0.50     0.88     0.94
 36   2  16      12.26    0.92    0.11    0.33    7.93    0.36        0.10
0.07    0.14         0.50     0.88     0.94
 37   2  17      12.11    0.92    0.11    0.33    7.93    0.35        0.10
0.07    0.14         0.50     0.88     0.94
 38   2  18      11.97    0.92    0.11    0.33    7.93    0.35        0.10
0.07    0.14         0.50     0.88     0.94
 39   2  19      11.83    0.92    0.11    0.33    7.93    0.34        0.10
0.07    0.14         0.50     0.88     0.94


 40   3   1      11.73    0.92    0.11    0.45    7.92    0.34        0.10
0.07    0.14         0.50     0.88     0.94
 41   3   2      11.62    0.92    0.11    0.45    7.92    0.34        0.10
0.06    0.13         0.50     0.88     0.94
 42   3   3      11.50    0.92    0.11    0.45    7.92    0.33        0.10
0.06    0.13         0.50     0.88     0.94
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     8
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                          ** ALGAE DATA **


NH3-N            ALGAE GROWTH RATE ATTEN FACTORS
ELE RCH ELE               ALGY    ALGY    ALGY   A P/R     NET         NH3
FRACT   LIGHT
ORD NUM NUM       CHLA   GRWTH    RESP    SETT   RATIO     P-R         PREF  N-
UPTKE  EXTCO        LIGHT   NITRGN   PHSPRS
                  UG/L   1/DAY   1/DAY   FT/DA      *   MG/L-D          *
*     1/FT           *        *        *

 43   3   4      11.38    0.92    0.11    0.45    7.92    0.33        0.10
0.06    0.13        0.50     0.88     0.94
 44   3   5      11.25    0.92    0.11    0.45    7.93    0.33        0.10
0.05    0.13        0.50     0.88     0.94
 45   3   6      11.12    0.92    0.11    0.45    7.93    0.32        0.10
0.05    0.13        0.50     0.88     0.94
 46   3   7      10.98    0.92    0.11    0.45    7.93    0.32        0.10
0.04    0.13        0.50     0.88     0.94
 47   3   8      10.83    0.92    0.11    0.45    7.93    0.32        0.10
0.04    0.13        0.50     0.89     0.94
 48   3   9      10.68    0.93    0.11    0.45    7.93    0.31        0.10
0.04    0.13        0.50     0.89     0.94
 49   3  10      10.52    0.93    0.11    0.45    7.93    0.31        0.10
0.04    0.13        0.50     0.89     0.94
 50   3  11      10.34    0.93    0.11    0.45    7.93    0.30        0.10
0.03    0.13        0.50     0.89     0.94
 51   3  12      10.16    0.93    0.11    0.45    7.94    0.30        0.10
0.03    0.13        0.50     0.89     0.94
 52   3  13       9.96    0.93    0.11    0.45    7.94    0.29        0.10
0.03    0.13        0.50     0.89     0.94
 53   3  14       9.75    0.93    0.11    0.45    7.94    0.28        0.10
0.03    0.13        0.50     0.89     0.94
 54   3  15       9.51    0.93    0.11    0.45    7.94    0.28        0.10
0.02    0.13        0.50     0.89     0.94
 55   3  16       9.25    0.93    0.11    0.45    7.94    0.27        0.10
0.02    0.13        0.50     0.89     0.94
 56   3  17       9.20    0.93    0.11    0.45    7.94    0.27        0.10
0.02    0.13        0.50     0.89     0.94


 57   4   1      44.62    0.97    0.11    0.33    8.29    1.37        0.10
0.28    0.23        0.49     0.93     1.00
 58   4   2      49.05    0.96    0.11    0.33    8.24    1.49        0.10
0.23    0.25        0.49     0.93     1.00
 59   4   3      53.83    0.96    0.11    0.33    8.19    1.63        0.10
0.19    0.26        0.49     0.92     1.00
 60   4   4      58.98    0.95    0.11    0.33    8.14    1.77        0.10
0.16    0.28        0.49     0.92     1.00
```

```
 61   4   5      64.48    0.94    0.11    0.33    8.08    1.92        0.10
0.14    0.29         0.49     0.91     1.00
 62   4   6      69.86    0.93    0.11    0.33    8.00    2.05        0.10
0.13    0.31         0.49     0.90     1.00


 63   5   1      32.68    0.94    0.11    0.33    8.03    0.96        0.10
0.27    0.20         0.50     0.90     0.99
 64   5   2      32.18    0.93    0.11    0.33    8.01    0.95        0.10
0.26    0.20         0.50     0.89     0.99
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     9
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                     ** DISSOLVED OXYGEN DATA **

                                                                  COMPONENTS OF
DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)
ELE RCH ELE              DO              DO     DAM     NIT
ORD NUM NUM    TEMP     SAT       DO     DEF   INPUT   INHIB       F-FNCTN   OXYGN
NET
              DEG-F    MG/L    MG/L    MG/L    MG/L    FACT          INPUT   REAIR
C-BOD     SOD     P-R   NH3-N   NO2-N

  1   1   1   70.00    8.80    8.27    0.54    0.00    0.99        41.71    0.39
-0.14    0.00    0.27   -0.42   -0.05
  2   1   2   70.00    8.80    8.06    0.74    0.00    0.99         0.00    0.53
-0.14    0.00    0.28   -0.39   -0.08
  3   1   3   70.00    8.80    7.89    0.91    0.00    0.99         0.00    0.65
-0.14    0.00    0.28   -0.35   -0.10
  4   1   4   70.00    8.80    7.75    1.05    0.00    0.99         0.00    0.75
-0.14    0.00    0.29   -0.33   -0.10
  5   1   5   70.00    8.80    7.64    1.16    0.00    0.99         0.00    0.84
-0.14    0.00    0.30   -0.30   -0.10
  6   1   6   70.00    8.80    7.54    1.26    0.00    0.99         0.00    0.90
-0.14    0.00    0.31   -0.28   -0.10
  7   1   7   70.00    8.80    7.47    1.33    0.00    0.99         0.00    0.96
-0.14    0.00    0.32   -0.26   -0.09
  8   1   8   70.00    8.80    7.41    1.39    0.00    0.99         0.00    1.00
-0.14    0.00    0.33   -0.24   -0.09
  9   1   9   70.00    8.80    7.37    1.43    0.00    0.99         0.00    1.03
-0.14    0.00    0.34   -0.22   -0.08
 10   1  10   70.00    8.80    7.34    1.46    0.00    0.99         0.00    1.05
-0.14    0.00    0.35   -0.21   -0.08
 11   1  11   70.00    8.80    7.31    1.49    0.00    0.99         0.00    1.07
-0.14    0.00    0.36   -0.19   -0.07
 12   1  12   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.14    0.00    0.37   -0.18   -0.07
 13   1  13   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.14    0.00    0.38   -0.17   -0.06
 14   1  14   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.14    0.00    0.39   -0.16   -0.06
 15   1  15   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.13    0.00    0.40   -0.15   -0.06
 16   1  16   70.00    8.80    7.32    1.49    0.00    0.99         0.00    1.07
-0.13    0.00    0.41   -0.14   -0.05
 17   1  17   70.00    8.80    7.33    1.47    0.00    0.99         0.00    1.06
-0.13    0.00    0.43   -0.13   -0.05
 18   1  18   70.00    8.80    7.35    1.45    0.00    0.99         0.00    1.04
-0.13    0.00    0.44   -0.13   -0.05
 19   1  19   70.00    8.80    7.37    1.43    0.00    0.99         0.00    1.03
-0.13    0.00    0.45   -0.12   -0.04
```

```
 20   1  20  70.00    8.80    7.39    1.41    0.00    0.99         0.00    1.01
-0.13    0.00    0.46   -0.11   -0.04


 21   2   1  70.00    8.80    7.39    1.41    0.00    0.99         1.67    1.01
-0.13    0.00    0.45   -0.12   -0.04
 22   2   2  70.00    8.80    7.39    1.41    0.00    0.99         1.67    1.02
-0.13    0.00    0.44   -0.13   -0.04
 23   2   3  70.00    8.80    7.38    1.42    0.00    0.99         1.67    1.02
-0.13    0.00    0.44   -0.14   -0.04
 24   2   4  70.00    8.80    7.38    1.42    0.00    0.99         1.67    1.02
-0.13    0.00    0.43   -0.14   -0.04
 25   2   5  70.00    8.80    7.37    1.43    0.00    0.99         1.67    1.03
-0.13    0.00    0.42   -0.15   -0.04
 26   2   6  70.00    8.80    7.36    1.44    0.00    0.99         1.67    1.03
-0.13    0.00    0.41   -0.15   -0.04
 27   2   7  70.00    8.80    7.35    1.45    0.00    0.99         1.67    1.04
-0.13    0.00    0.41   -0.15   -0.05
 28   2   8  70.00    8.80    7.35    1.46    0.00    0.99         1.67    1.05
-0.13    0.00    0.40   -0.16   -0.05
 29   2   9  70.00    8.80    7.34    1.46    0.00    0.99         1.67    1.05
-0.13    0.00    0.39   -0.16   -0.05
 30   2  10  70.00    8.80    7.33    1.47    0.00    0.99         1.67    1.06
-0.13    0.00    0.39   -0.16   -0.05
 31   2  11  70.00    8.80    7.32    1.48    0.00    0.99         1.67    1.06
-0.13    0.00    0.38   -0.16   -0.05
 32   2  12  70.00    8.80    7.31    1.49    0.00    0.99         1.67    1.07
-0.13    0.00    0.38   -0.17   -0.05
 33   2  13  70.00    8.80    7.31    1.50    0.00    0.99         1.67    1.07
-0.13    0.00    0.37   -0.17   -0.05
 34   2  14  70.00    8.80    7.30    1.50    0.00    0.99         1.67    1.08
-0.13    0.00    0.37   -0.17   -0.05
 35   2  15  70.00    8.80    7.29    1.51    0.00    0.99         1.67    1.08
-0.13    0.00    0.36   -0.17   -0.05
 36   2  16  70.00    8.80    7.28    1.52    0.00    0.99         1.67    1.09
-0.13    0.00    0.36   -0.17   -0.05
 37   2  17  70.00    8.80    7.28    1.52    0.00    0.99         1.67    1.09
-0.13    0.00    0.35   -0.17   -0.05
 38   2  18  70.00    8.80    7.27    1.53    0.00    0.99         1.67    1.10
-0.13    0.00    0.35   -0.17   -0.05
 39   2  19  70.00    8.80    7.27    1.54    0.00    0.99         1.67    1.10
-0.13    0.00    0.34   -0.17   -0.05


 40   3   1  70.00    8.80    7.27    1.53    0.00    0.99        -2.67    1.10
-0.13    0.00    0.34   -0.17   -0.05
 41   3   2  70.00    8.80    7.27    1.53    0.00    0.99        -2.67    1.10
-0.13    0.00    0.34   -0.16   -0.05
 42   3   3  70.00    8.80    7.27    1.53    0.00    0.99        -2.67    1.10
-0.13    0.00    0.33   -0.15   -0.05
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER    10
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                     ** DISSOLVED OXYGEN DATA **

                                                                  COMPONENTS OF
DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)
ELE RCH ELE              DO              DO     DAM     NIT
ORD NUM NUM    TEMP     SAT      DO     DEF   INPUT   INHIB      F-FNCTN   OXYGN
NET
              DEG-F    MG/L    MG/L    MG/L    MG/L    FACT        INPUT   REAIR
C-BOD     SOD     P-R    NH3-N   NO2-N

 43   3   4  70.00    8.80    7.28    1.52    0.00    0.99         -2.67    1.09
-0.13    0.00    0.33   -0.15   -0.05
 44   3   5  70.00    8.80    7.28    1.52    0.00    0.99         -2.67    1.09
-0.13    0.00    0.33   -0.14   -0.05
 45   3   6  70.00    8.80    7.29    1.51    0.00    0.99         -2.67    1.09
-0.13    0.00    0.32   -0.13   -0.05
 46   3   7  70.00    8.80    7.30    1.50    0.00    0.99         -2.68    1.08
-0.13    0.00    0.32   -0.13   -0.05
 47   3   8  70.00    8.80    7.31    1.50    0.00    0.99         -2.68    1.07
-0.13    0.00    0.32   -0.12   -0.04
 48   3   9  70.00    8.80    7.32    1.49    0.00    0.99         -2.68    1.07
-0.13    0.00    0.31   -0.11   -0.04
 49   3  10  70.00    8.80    7.33    1.48    0.00    0.99         -2.69    1.06
-0.13    0.00    0.31   -0.11   -0.04
 50   3  11  70.00    8.80    7.34    1.46    0.00    0.99         -2.69    1.05
-0.13    0.00    0.30   -0.10   -0.04
 51   3  12  70.00    8.80    7.35    1.45    0.00    0.99         -2.70    1.04
-0.13    0.00    0.30   -0.10   -0.03
 52   3  13  70.00    8.80    7.37    1.44    0.00    0.99         -2.70    1.03
-0.12    0.00    0.29   -0.09   -0.03
 53   3  14  70.00    8.80    7.38    1.42    0.00    0.99         -2.71    1.02
-0.12    0.00    0.28   -0.08   -0.03
 54   3  15  70.00    8.80    7.40    1.40    0.00    0.99         -2.71    1.01
-0.12    0.00    0.28   -0.08   -0.03
 55   3  16  70.00    8.80    7.42    1.39    0.00    0.99         -2.72    1.00
-0.12    0.00    0.27   -0.07   -0.03
 56   3  17  70.00    8.80    7.43    1.37    0.00    0.99         -2.73    0.99
-0.12    0.00    0.27   -0.07   -0.02


 57   4   1  70.00    8.80    6.70    2.10    0.00    0.98         13.75    1.51
-0.22    0.00    1.37   -0.58   -0.09
 58   4   2  70.00    8.80    6.77    2.03    0.00    0.98          0.00    1.46
-0.22    0.00    1.49   -0.51   -0.12
 59   4   3  70.00    8.80    6.87    1.93    0.00    0.98          0.00    1.39
-0.22    0.00    1.63   -0.44   -0.13
 60   4   4  70.00    8.80    7.00    1.80    0.00    0.99          0.00    1.29
-0.22    0.00    1.77   -0.38   -0.13
```

```
 61   4   5   70.00    8.80    7.16    1.64    0.00    0.99         0.00    1.18
-0.22    0.00    1.92   -0.33   -0.12
 62   4   6   70.00    8.80    7.34    1.46    0.00    0.99         0.00    1.05
-0.22    0.00    2.05   -0.29   -0.11


 63   5   1   70.00    8.80    7.17    1.63    0.00    0.99        81.34    1.17
-0.18    0.00    0.96   -0.36   -0.07
 64   5   2   70.00    8.80    7.17    1.63    0.00    0.99         0.00    1.17
-0.18    0.00    0.95   -0.36   -0.07
```

```
TITLE01              Owl Creek TMDL
TITLE02              Loading Capacity -- 6/21/07
TITLE03   NO         CONSERVATIVE MINERAL   I
TITLE04   NO         CONSERVATIVE MINERAL  II
TITLE05   NO         CONSERVATIVE MINERAL III
TITLE06   NO         TEMPERATURE
TITLE07  YES         5-DAY BIOCHEMICAL OXYGEN DEMAND
TITLE08  YES         ALGAE AS CHL-A IN UG/L
TITLE09  YES         PHOSPHORUS CYCLE AS P IN MG/L
TITLE10                (ORGANIC-P; DISSOLVED-P)
TITLE11  YES         NITROGEN CYCLE AS N IN MG/L
TITLE12                (ORGANIC-N; AMMONIA-N; NITRITE-N;' NITRATE-N)
TITLE13  YES         DISSOLVED OXYGEN IN MG/L
TITLE14   NO         FECAL COLIFORM IN NO./100 ML
TITLE15   NO         ARBITRARY NON-CONSERVATIVE
ENDTITLE
LIST DATA INPUT
NOWRITE OPTIONAL SUMMARY
NO FLOW AUGMENTATION
STEADY STATE
NO TRAPEZOIDAL CHANNELS
NO PRINT LCD/SOLAR DATA
NO PLOT DO AND BOD
FIXED DNSTM CONC (YES=1)=        0.          5D-ULT BOD CONV K COEF  =     0.023
INPUT METRIC            =        0.          OUTPUT METRIC           =        0.
NUMBER OF REACHES       =        5.          NUMBER OF JUNCTIONS     =        0.
NUM OF HEADWATERS       =        1.          NUMBER OF POINT LOADS   =        2.
TIME STEP (HOURS)       =        1.          LNTH. COMP. ELEMENT (MI)=      0.10
MAXIMUM ROUTE TIME (HRS)=       60.          TIME INC. FOR RPT2 (HRS)=       1.0
LATITUDE OF BASIN (DEG) =   40.3254          LONGITUDE OF BASIN (DEG)=   88.3531
STANDARD MERIDIAN (DEG) =        0.          DAY OF YEAR START TIME  =      241.
EVAP. COEF.,(AE)        =   0.00068          EVAP. COEF.,(BE)        =   0.00027
ELEV. OF BASIN (ELEV)   =     683.2          DUST ATTENUATION COEF.  =      0.06
ENDATA1
O UPTAKE BY NH3 OXID(MG O/MG N)=  3.43   O UPTAKE BY NO2 OXID(MG O/MG N)=   1.14
O PROD  BY ALGAE (MG O/MG A)   =   1.8   O UPTAKE BY ALGAE (MG O/MG A)  =   1.90
N CONTENT OF ALGAE (MG N/MG A) =   0.09  P CONTENT OF ALGAE (MG P/MG A) =  0.014
ALG MAX SPEC GROWTH RATE(1/DAY)=   2.0   ALGAE RESPIRATION RATE (1/DAY) =  0.105
N HALF SATURATION CONST (MG/L) =   0.03  P HALF SATURATION CONST  (MG/L)=  0.005
LIN ALG SHADE CO (1/H-UGCHA/L) =  0.003  NLIN SHADE (1/H-(UGCHA/L)**2/3)=  0.000
LIGHT FUNCTION OPTION (LFNOPT) =    2.0  LIGHT SATURATION COEF (INT/MIN)=   0.66
DAILY AVERAGING OPTION (LAVOPT)=    2.0  LIGHT AVERAGING FACTOR  (INT)  =    0.9
NUMBER OF DAYLIGHT HOURS (DLH) =   14.2  TOTAL DAILY SOLAR RADTN (INT)  =  1500.
ALGY GROWTH CALC OPTION(LGROPT)=    2.0  ALGAL PREF FOR NH3-N (PREFN)   =    0.1
ALG/TEMP SOLR RAD FACTOR(TFACT)=   0.45  NITRIFICATION INHIBITION COEF  =    0.6
ENDATA1A
THETA    SOD RATE  1.060
ENDATA1B
STREAM REACH     1. RCH= Upstream 1        FROM         6.36    TO          4.36
STREAM REACH     2. RCH= Upstream 2        FROM         4.36    TO          2.50
STREAM REACH     3. RCH= 01 to Fisher      FROM         2.50    TO          0.75
STREAM REACH     4. RCH= Fisher to trib    FROM         0.75    TO          0.20
STREAM REACH     5. RCH= trib to conflu    FROM         0.20    TO          0.00
ENDATA2
ENDATA3
FLAG FIELD RCH=  1.        20.          1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
FLAG FIELD RCH=  2.        19.          2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
```

```
FLAG FIELD RCH=  3.        17.          2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
FLAG FIELD RCH=  4.         6.          6.2.2.2.2.2.
FLAG FIELD RCH=  5.         2.          6.5.
ENDATA4
HYDRAULICS RCH=  1.     100.0     0.2054     1.00      0.482   0.000    0.020
HYDRAULICS RCH=  2.     100.0     0.2054     1.00      0.482   0.000    0.020
HYDRAULICS RCH=  3.     100.0     0.1765     1.00      0.508   0.000    0.020
HYDRAULICS RCH=  4.     100.0     0.1548     1.00      0.659   0.000    0.020
HYDRAULICS RCH=  5.     100.0     0.4252     1.00      0.280   0.000    0.020
ENDATA5
TEMP/LCD          1.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          2.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          3.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          4.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
TEMP/LCD          5.     680.00   0.06   0.10   80.0   60.0  29.59    2.0
ENDATA5A
REACT COEF RCH=   1.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   2.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   3.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   4.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
REACT COEF RCH=   5.   0.023   0.000  0.0000  1.    0.70  0.0000  0.0000
ENDATA6
N AND P COEF   RCH=  1.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  2.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  3.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  4.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
N AND P COEF   RCH=  5.0    0.1    0.0    0.5    0.0    3.0    0.1    0.0    0.0
ENDATA6A
ALG/OTHER COEF RCH=  1.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  2.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  3.0   50.0    .44    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  4.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ALG/OTHER COEF RCH=  5.0   50.0    .32    0.1    0.0    0.0    0.0    0.0
ENDATA6B
INITIAL COND-1 RCH=   1.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   2.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   3.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   4.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
INITIAL COND-1 RCH=   5.  70.00   7.00   5.00   0.00   0.00   0.00  0.000    0.0
ENDATA7
INITIAL COND-2 RCH=   1.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   2.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   3.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   4.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
INITIAL COND-2 RCH=   5.    0.1   0.25   0.25    0.0    0.0    0.0    0.0
ENDATA7A
INCR INFLOW-1  RCH=   1.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   2.  0.135  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   3. -0.216  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   4.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
INCR INFLOW-1  RCH=   5.  0.000  70.00   7.0   6.0   0.0   0.0   0.0   0.0   0.0
ENDATA8
INCR INFLOW-2  RCH=   1.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   2.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   3.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   4.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
INCR INFLOW-2  RCH=   5.   0.00   0.25   0.25   0.00   0.00   0.00   0.00
```

```
ENDATA8A
ENDATA9
HEADWTR-1 HDW=   1. Owl Creek Upstr    0.146 70.00  8.50  6.00  0.0   000    000
ENDATA10
HEADWTR-2 HDW=   1.   0.00   0.0  9.00  0.25  0.25  0.00  0.00  .037  .037
ENDATA10A
POINTLD-1 PTL=   1. Fisher STP  0.00 0.08900  77.0   6.1  12.5   0.0   000   000
POINTLD-1 PTL=   2. unnamed tr  0.00 0.16700  77.0   7.0   6.0   0.0   0.0   0.0
ENDATA11
POINTLD-2 PTL=   1.   0.00   0.0  28.0  0.00  0.60  0.00  0.00  0.95   0.92
POINTLD-2 PTL=   2.   0.00   0.0  0.00  0.25  0.25  0.00  0.00  0.00   0.0
ENDATA11A
ENDATA12
ENDATA13
ENDATA13A
```

```
                                              * * * QUAL-2E  STREAM QUALITY
ROUTING MODEL * * *
                                                           Version 3.22  --  May
1996

          $$$ (PROBLEM TITLES) $$$

         CARD TYPE                              QUAL-2E PROGRAM TITLES
         TITLE01             Owl Creek TMDL
         TITLE02             Loading Capacity -- 6/21/07
         TITLE03   NO        CONSERVATIVE MINERAL   I
         TITLE04   NO        CONSERVATIVE MINERAL  II
         TITLE05   NO        CONSERVATIVE MINERAL III
         TITLE06   NO        TEMPERATURE
         TITLE07  YES        5-DAY BIOCHEMICAL OXYGEN DEMAND
         TITLE08  YES        ALGAE AS CHL-A IN UG/L
         TITLE09  YES        PHOSPHORUS CYCLE AS P IN MG/L
         TITLE10               (ORGANIC-P; DISSOLVED-P)
         TITLE11  YES        NITROGEN CYCLE AS N IN MG/L
         TITLE12               (ORGANIC-N; AMMONIA-N; NITRITE-N;' NITRATE-N)
         TITLE13  YES        DISSOLVED OXYGEN IN MG/L
         TITLE14   NO        FECAL COLIFORM IN NO./100 ML
         TITLE15   NO        ARBITRARY NON-CONSERVATIVE
         ENDTITLE

          $$$ DATA TYPE 1 (CONTROL DATA) $$$

         CARD TYPE                                     CARD TYPE
         LIST DATA INPUT             0.00000
0.00000
         NOWRITE OPTIONAL SUMMARY    0.00000
0.00000
         NO FLOW AUGMENTATION        0.00000
0.00000
         STEADY STATE                0.00000
0.00000
         NO TRAPEZOIDAL CHANNELS     0.00000
0.00000
         NO PRINT LCD/SOLAR DATA     0.00000
0.00000
         NO PLOT DO AND BOD          0.00000
0.00000
         FIXED DNSTM CONC (YES=1)=   0.00000          5D-ULT BOD CONV K COEF  =
0.02300
         INPUT METRIC            =   0.00000          OUTPUT METRIC           =
0.00000
         NUMBER OF REACHES       =   5.00000          NUMBER OF JUNCTIONS     =
0.00000
         NUM OF HEADWATERS       =   1.00000          NUMBER OF POINT LOADS   =
2.00000
         TIME STEP (HOURS)       =   1.00000          LNTH. COMP. ELEMENT (MI)=
0.10000
         MAXIMUM ROUTE TIME (HRS)=  60.00000          TIME INC. FOR RPT2 (HRS)=
1.00000
         LATITUDE OF BASIN (DEG) =  40.32540          LONGITUDE OF BASIN (DEG)=
88.35310
```

```
         STANDARD MERIDIAN (DEG) =   0.00000          DAY OF YEAR START TIME  =
241.00000
         EVAP. COEF.,(AE)        =   0.00068          EVAP. COEF.,(BE)        =
0.00027
         ELEV. OF BASIN (ELEV)   = 683.20001          DUST ATTENUATION COEF.  =
0.06000
         ENDATA1                     0.00000
0.00000

          $$$ DATA TYPE 1A (ALGAE PRODUCTION AND NITROGEN OXIDATION CONSTANTS)
$$$

         CARD TYPE                                              CARD TYPE
         O UPTAKE BY NH3 OXID(MG O/MG N)=    3.4300          O UPTAKE BY NO2
OXID(MG O/MG N)=    1.1400
         O PROD  BY ALGAE (MG O/MG A)   =    1.8000          O UPTAKE BY ALGAE
(MG O/MG A)  =    1.9000
         N CONTENT OF ALGAE (MG N/MG A) =    0.0900          P CONTENT OF ALGAE
(MG P/MG A) =    0.0140
         ALG MAX SPEC GROWTH RATE(1/DAY)=    2.0000          ALGAE RESPIRATION
RATE (1/DAY) =    0.1050
         N HALF SATURATION CONST (MG/L) =    0.0300          P HALF SATURATION
CONST  (MG/L)=    0.0050
         LIN ALG SHADE CO (1/FT-UGCHA/L=)    0.0030          NLIN SHADE(1/FT-
(UGCHA/L)**2/3)=    0.0000
         LIGHT FUNCTION OPTION (LFNOPT) =    2.0000          LIGHT SAT'N COEF
(BTU/FT2-MIN) =    0.6600
         DAILY AVERAGING OPTION (LAVOPT)=    2.0000          LIGHT AVERAGING
FACTOR  (INT)  =    0.9000
         NUMBER OF DAYLIGHT HOURS (DLH) =   14.2000          TOTAL DAILY SOLR
RAD (BTU/FT-2)= 1500.0000
         ALGY GROWTH CALC OPTION(LGROPT)=    2.0000          ALGAL PREF FOR NH3-
N (PREFN)   =    0.1000
         ALG/TEMP SOLR RAD FACTOR(TFACT)=    0.4500          NITRIFICATION
INHIBITION COEF  =    0.6000
         ENDATA1A                            0.0000
0.0000

          $$$ DATA TYPE 1B (TEMPERATURE CORRECTION CONSTANTS FOR RATE
COEFFICIENTS) $$$

         CARD TYPE     RATE CODE     THETA VALUE

         THETA( 1)      BOD DECA        1.047     DFLT
         THETA( 2)      BOD SETT        1.024     DFLT
         THETA( 3)      OXY TRAN        1.024     DFLT
         THETA( 4)      SOD RATE        1.060     USER
         THETA( 5)      ORGN DEC        1.047     DFLT
         THETA( 6)      ORGN SET        1.024     DFLT
         THETA( 7)      NH3 DECA        1.083     DFLT
         THETA( 8)      NH3 SRCE        1.074     DFLT
         THETA( 9)      NO2 DECA        1.047     DFLT
         THETA(10)      PORG DEC        1.047     DFLT
         THETA(11)      PORG SET        1.024     DFLT
         THETA(12)      DISP SRC        1.074     DFLT
         THETA(13)      ALG GROW        1.047     DFLT
         THETA(14)      ALG RESP        1.047     DFLT
```

```
         THETA(15)      ALG SETT        1.024     DFLT
         THETA(16)      COLI DEC        1.047     DFLT
         THETA(17)      ANC DECA        1.000     DFLT
         THETA(18)      ANC SETT        1.024     DFLT
         THETA(19)      ANC SRCE        1.000     DFLT
         ENDATA1B

          $$$ DATA TYPE 2 (REACH IDENTIFICATION) $$$

         CARD TYPE           REACH ORDER AND IDENT               R. MI/KM
R. MI/KM
         STREAM REACH     1.0  RCH= Upstream 1        FROM           6.4    TO
4.4
         STREAM REACH     2.0  RCH= Upstream 2        FROM           4.4    TO
2.5
         STREAM REACH     3.0  RCH= 01 to Fisher      FROM           2.5    TO
0.8
         STREAM REACH     4.0  RCH= Fisher to trib    FROM           0.8    TO
0.2
         STREAM REACH     5.0  RCH= trib to conflu    FROM           0.2    TO
0.0
         ENDATA2          0.0                                        0.0
0.0

          $$$ DATA TYPE 3 (TARGET LEVEL DO AND FLOW AUGMENTATION SOURCES) $$$

         CARD TYPE                 REACH  AVAIL HDWS TARGET     ORDER OF AVAIL
SOURCES
         ENDATA3                    0.        0.       0.0   0.   0.   0.   0.
0.   0.

          $$$ DATA TYPE 4 (COMPUTATIONAL REACH FLAG FIELD) $$$

         CARD TYPE        REACH ELEMENTS/REACH             COMPUTATIONAL FLAGS
         FLAG FIELD        1.       20.
1.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.
         FLAG FIELD        2.       19.
2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.
         FLAG FIELD        3.       17.
2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.2.0.0.0.
         FLAG FIELD        4.        6.
6.2.2.2.2.2.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
         FLAG FIELD        5.        2.
6.5.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.
         ENDATA4          0.        0.
0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.0.

          $$$ DATA TYPE 5 (HYDRAULIC DATA FOR DETERMINING VELOCITY AND DEPTH)
$$$

         CARD TYPE        REACH  COEF-DSPN  COEFQV    EXPOQV    COEFQH   EXPOQH
CMANN
         HYDRAULICS        1.    100.00     0.205     1.000     0.482     0.000
0.020
         HYDRAULICS        2.    100.00     0.205     1.000     0.482     0.000
0.020
```

```
         HYDRAULICS        3.    100.00     0.176     1.000     0.508     0.000
0.020
         HYDRAULICS        4.    100.00     0.155     1.000     0.659     0.000
0.020
         HYDRAULICS        5.    100.00     0.425     1.000     0.280     0.000
0.020
         ENDATA5           0.      0.00     0.000     0.000     0.000     0.000
0.000

          $$$ DATA TYPE 5A (STEADY STATE TEMPERATURE AND CLIMATOLOGY DATA) $$$

         CARD TYPE                     DUST     CLOUD   DRY BULB  WET
BULB     ATM               SOLAR RAD
                         REACH   ELEVATION     COEF     COVER     TEMP      TEMP
PRESSURE     WIND   ATTENUATION
         TEMP/LCD          1.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          2.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          3.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          4.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         TEMP/LCD          5.      680.00      0.06      0.10     80.00
60.00     29.59      2.00      1.00
         ENDATA5A          0.        0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 6 (REACTION COEFFICIENTS FOR DEOXYGENATION AND
REAERATION) $$$

         CARD TYPE        REACH     K1        K3       SOD         K2OPT     K2
COEQK2   OR    EXPQK2
                                                       RATE
TSIV COEF  OR    SLOPE

FOR OPT 8      FOR OPT 8
         REACT COEF        1.      0.02      0.00      0.000        1.      0.70
0.000        0.00000
         REACT COEF        2.      0.02      0.00      0.000        1.      0.70
0.000        0.00000
         REACT COEF        3.      0.02      0.00      0.000        1.      0.70
0.000        0.00000
         REACT COEF        4.      0.02      0.00      0.000        1.      0.70
0.000        0.00000
         REACT COEF        5.      0.02      0.00      0.000        1.      0.70
0.000        0.00000
         ENDATA6           0.      0.00      0.00      0.000        0.      0.00
0.000        0.00000

           $$$ DATA TYPE 6A (NITROGEN AND PHOSPHORUS CONSTANTS) $$$

         CARD TYPE           REACH    CKNH2    SETNH2     CKNH3      SNH3
CKNO2     CKPORG   SETPORG     SPO4
         N AND P COEF          1.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
```

```
         N AND P COEF          2.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          3.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          4.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         N AND P COEF          5.      0.10      0.00      0.50      0.00
3.00      0.10      0.00      0.00
         ENDATA6A              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 6B (ALGAE/OTHER COEFFICIENTS) $$$

         CARD TYPE           REACH    ALPHAO    ALGSET    EXCOEF      CK5
CKANC    SETANC    SRCANC
                                                                    CKCOLI
         ALG/OTHER COEF        1.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        2.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        3.     50.00      0.44      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        4.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ALG/OTHER COEF        5.     50.00      0.32      0.10      0.00
0.00      0.00      0.00
         ENDATA6B              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 7 (INITIAL CONDITIONS) $$$

         CARD TYPE           REACH    TEMP       D.O.      BOD       CM-1
CM-2      CM-3       ANC      COLI
         INITIAL COND-1        1.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        2.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        3.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        4.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         INITIAL COND-1        5.     70.00      7.00      5.00      0.00
0.00      0.00      0.00      0.00
         ENDATA7               0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 7A (INITIAL CONDITIONS FOR CHOROPHYLL A, NITROGEN, AND
PHOSPHORUS) $$$

         CARD TYPE           REACH    CHL-A     ORG-N     NH3-N     NO2-N
NO3-N     ORG-P     DIS-P
         INITIAL COND-2        1.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        2.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        3.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
```

```
         INITIAL COND-2        4.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         INITIAL COND-2        5.      0.10      0.25      0.25      0.00
0.00      0.00      0.00
         ENDATA7A              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 8 (INCREMENTAL INFLOW CONDITIONS) $$$

         CARD TYPE           REACH     FLOW      TEMP      D.O.       BOD
CM-1      CM-2      CM-3       ANC      COLI
         INCR INFLOW-1         1.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1         2.     0.135     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1         3.    -0.216     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1         4.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         INCR INFLOW-1         5.     0.000     70.00      7.00      6.00
0.00      0.00      0.00      0.00      0.00
         ENDATA8               0.     0.000      0.00      0.00      0.00
0.00      0.00      0.00      0.00      0.00

          $$$ DATA TYPE 8A (INCREMENTAL INFLOW CONDITIONS FOR CHLOROPHYLL A,
NITROGEN, AND PHOSPHORUS) $$$

         CARD TYPE           REACH    CHL-A     ORG-N     NH3-N     NO2-N
NO3-N     ORG-P     DIS-P
         INCR INFLOW-2         1.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2         2.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2         3.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2         4.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         INCR INFLOW-2         5.      0.00      0.25      0.25      0.00
0.00      0.00      0.00
         ENDATA8A              0.      0.00      0.00      0.00      0.00
0.00      0.00      0.00

          $$$ DATA TYPE 9 (STREAM JUNCTIONS) $$$

         CARD TYPE              JUNCTION ORDER AND IDENT         UPSTRM
JUNCTION    TRIB
         ENDATA9                0.                                 0.        0.
0.

          $$$ DATA TYPE 10 (HEADWATER SOURCES) $$$

         CARD TYPE    HDWTR     NAME              FLOW      TEMP      D.O.
BOD      CM-1      CM-2      CM-3
                      ORDER
         HEADWTR-1      1.   Owl Creek Upstr      0.15     70.00      8.50
6.00      0.00      0.00      0.00
```

```
         ENDATA10       0.                        0.00      0.00      0.00
0.00      0.00      0.00      0.00

          $$$ DATA TYPE 10A (HEADWATER CONDITIONS FOR CHLOROPHYLL, NITROGEN,
PHOSPHORUS,
                             COLIFORM AND SELECTED NON-CONSERVATIVE CONSTITUENT)
$$$

         CARD TYPE     HDWTR     ANC     COLI    CHL-A    ORG-N    NH3-N    NO2-
N    NO3-N    ORG-P    DIS-P
                       ORDER
         HEADWTR-2       1.     0.00 0.00E+00     9.00     0.25     0.25
0.00     0.00     0.04     0.04
         ENDATA10A       0.     0.00 0.00E+00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 11 (POINT SOURCE / POINT SOURCE CHARACTERISTICS) $$$

                       POINT
         CARD TYPE      LOAD    NAME              EFF     FLOW     TEMP     D.O.
BOD     CM-1     CM-2     CM-3
                       ORDER
         POINTLD-1      1.   Fisher STP          0.00     0.09    77.00     6.10
12.50     0.00     0.00     0.00
         POINTLD-1      2.   unnamed tr          0.00     0.17    77.00     7.00
6.00     0.00     0.00     0.00
         ENDATA11       0.                       0.00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 11A (POINT SOURCE CHARACTERISTICS - CHLOROPHYLL A,
NITROGEN, PHOSPHORUS,
                             COLIFORMS AND SELECTED NON-CONSERVATIVE
CONSTITUENT) $$$

                       POINT
         CARD TYPE      LOAD     ANC     COLI    CHL-A    ORG-N    NH3-N    NO2-
N    N03-N    ORG-P    DIS-P
                       ORDER
         POINTLD-2       1.     0.00 0.00E+00    28.00     0.00     0.60
0.00     0.00     0.95     0.90
         POINTLD-2       2.     0.00 0.00E+00     0.00     0.25     0.25
0.00     0.00     0.00     0.00
         ENDATA11A       0.     0.00 0.00E+00     0.00     0.00     0.00
0.00     0.00     0.00     0.00

          $$$ DATA TYPE 12 (DAM CHARACTERISTICS) $$$

                               DAM   RCH   ELE    ADAM    BDAM    FDAM    HDAM

         ENDATA12                 0.    0.    0.    0.00    0.00    0.00    0.00

          $$$ DATA TYPE 13 (DOWNSTREAM BOUNDARY CONDITIONS-1) $$$

              CARD TYPE               TEMP       D.O.      BOD       CM-1
CM-2      CM-3       ANC      COLI
```

```
         ENDATA13                     DOWNSTREAM BOUNDARY CONCENTRATIONS ARE
UNCONSTRAINED

          $$$ DATA TYPE 13A (DOWNSTREAM BOUNDARY CONDITIONS-2) $$$

              CARD TYPE               CHL-A     ORG-N     NH3-N     NO2-N
NH3-N     ORG-P     DIS-P

         ENDATA13A                    DOWNSTREAM BOUNDARY CONCENTRATIONS ARE
UNCONSTRAINED
```

```
 STEADY STATE ALGAE/NUTRIENT/DISSOLVED OXYGEN SIMULATION; CONVERGENCE SUMMARY:
 -----------------------------------------------------------------------------

                                                   NUMBER OF
            VARIABLE              ITERATION      NONCONVERGENT
                                                   ELEMENTS

  ALGAE GROWTH RATE                 1               64
  ALGAE GROWTH RATE                 2               64
  ALGAE GROWTH RATE                 3               64
  ALGAE GROWTH RATE                 4               63
  ALGAE GROWTH RATE                 5               61
  ALGAE GROWTH RATE                 6               55
  ALGAE GROWTH RATE                 7               28
  ALGAE GROWTH RATE                 8                0
    NITRIFICATION INHIBITION           1                 0
  ALGAE GROWTH RATE                 9                0
    NITRIFICATION INHIBITION           2                 0


 SUMMARY OF CONDITIONS FOR ALGAL GROWTH RATE SIMULATION:
 -------------------------------------------------------

       1. LIGHT AVERAGING OPTION.   LAVOPT= 2

           METHOD: MEAN SOLAR RADIATION DURING DAYLIGHT HOURS

           SOURCE OF SOLAR VALUES:   DATA TYPE 1A
               DAILY NET SOLAR RADIATION:  1500.000 BTU/FT-2 (  407.056
LANGLEYS)
               NUMBER OF DAYLIGHT HOURS:  0.0
               PHOTOSYNTHETIC ACTIVE FRACTION OF SOLAR RADIATION (TFACT): N/A
               MEAN SOLAR RADIATION ADJUSTMENT FACTOR (AFACT): 0.900


       2. LIGHT FUNCTION OPTION:   LFNOPT= 2

           SMITH FUNCTION, WITH 71% IMAX =  0.179 LANGLEYS/MIN


       3. GROWTH ATTENUATION OPTION FOR NUTRIENTS.   LGROPT= 2

           MINIMUM OF NITROGEN, PHOSPHORUS:   FL*MIN(FN,FP)
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     1
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                      ** HYDRAULICS SUMMARY **

ELE RCH ELE   BEGIN     END           POINT    INCR            TRVL
BOTTOM      X-SECT   DSPRSN
ORD NUM NUM     LOC     LOC    FLOW    SRCE    FLOW     VEL    TIME    DEPTH
WIDTH      VOLUME        AREA         AREA     COEF
               MILE    MILE     CFS     CFS     CFS     FPS     DAY       FT
FT      K-FT-3      K-FT-2        FT-2   FT-2/S

  1   1   1    6.36    6.26    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  2   1   2    6.26    6.16    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  3   1   3    6.16    6.06    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  4   1   4    6.06    5.96    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  5   1   5    5.96    5.86    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  6   1   6    5.86    5.76    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  7   1   7    5.76    5.66    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  8   1   8    5.66    5.56    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
  9   1   9    5.56    5.46    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 10   1  10    5.46    5.36    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 11   1  11    5.36    5.26    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 12   1  12    5.26    5.16    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 13   1  13    5.16    5.06    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 14   1  14    5.06    4.96    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 15   1  15    4.96    4.86    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 16   1  16    4.86    4.76    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 17   1  17    4.76    4.66    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 18   1  18    4.66    4.56    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 19   1  19    4.56    4.46    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
 20   1  20    4.46    4.36    0.15    0.00    0.00   0.030   0.204    0.482
10.101        2.57        5.84        4.87     0.12
```

```
 21   2   1    4.36    4.26    0.15    0.00    0.01   0.031   0.194    0.482
10.101        2.57        5.84        4.87     0.13
 22   2   2    4.26    4.16    0.16    0.00    0.01   0.033   0.186    0.482
10.101        2.57        5.84        4.87     0.14
 23   2   3    4.16    4.06    0.17    0.00    0.01   0.034   0.178    0.482
10.101        2.57        5.84        4.87     0.14
 24   2   4    4.06    3.96    0.17    0.00    0.01   0.036   0.171    0.482
10.101        2.57        5.84        4.87     0.15
 25   2   5    3.96    3.86    0.18    0.00    0.01   0.037   0.164    0.482
10.101        2.57        5.84        4.87     0.16
 26   2   6    3.86    3.76    0.19    0.00    0.01   0.039   0.158    0.482
10.101        2.57        5.84        4.87     0.16
 27   2   7    3.76    3.66    0.20    0.00    0.01   0.040   0.152    0.482
10.101        2.57        5.84        4.87     0.17
 28   2   8    3.66    3.56    0.20    0.00    0.01   0.042   0.147    0.482
10.101        2.57        5.84        4.87     0.17
 29   2   9    3.56    3.46    0.21    0.00    0.01   0.043   0.142    0.482
10.101        2.57        5.84        4.87     0.18
 30   2  10    3.46    3.36    0.22    0.00    0.01   0.045   0.137    0.482
10.101        2.57        5.84        4.87     0.19
 31   2  11    3.36    3.26    0.22    0.00    0.01   0.046   0.133    0.482
10.101        2.57        5.84        4.87     0.19
 32   2  12    3.26    3.16    0.23    0.00    0.01   0.048   0.129    0.482
10.101        2.57        5.84        4.87     0.20
 33   2  13    3.16    3.06    0.24    0.00    0.01   0.049   0.125    0.482
10.101        2.57        5.84        4.87     0.20
 34   2  14    3.06    2.96    0.25    0.00    0.01   0.050   0.121    0.482
10.101        2.57        5.84        4.87     0.21
 35   2  15    2.96    2.86    0.25    0.00    0.01   0.052   0.118    0.482
10.101        2.57        5.84        4.87     0.22
 36   2  16    2.86    2.76    0.26    0.00    0.01   0.053   0.115    0.482
10.101        2.57        5.84        4.87     0.22
 37   2  17    2.76    2.66    0.27    0.00    0.01   0.055   0.112    0.482
10.101        2.57        5.84        4.87     0.23
 38   2  18    2.66    2.56    0.27    0.00    0.01   0.056   0.109    0.482
10.101        2.57        5.84        4.87     0.23
 39   2  19    2.56    2.46    0.28    0.00    0.01   0.058   0.106    0.482
10.101        2.57        5.84        4.87     0.24


 40   3   1    2.50    2.40    0.27    0.00   -0.01   0.047   0.129    0.508
11.153        2.99        6.43        5.67     0.21
 41   3   2    2.40    2.30    0.26    0.00   -0.01   0.045   0.135    0.508
11.153        2.99        6.43        5.67     0.20
 42   3   3    2.30    2.20    0.24    0.00   -0.01   0.043   0.143    0.508
11.153        2.99        6.43        5.67     0.19
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     2
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                      ** HYDRAULICS SUMMARY **

ELE RCH ELE   BEGIN      END           POINT    INCR           TRVL
BOTTOM      X-SECT   DSPRSN
ORD NUM NUM     LOC     LOC    FLOW    SRCE    FLOW     VEL    TIME    DEPTH
WIDTH      VOLUME       AREA        AREA     COEF
               MILE    MILE     CFS     CFS     CFS     FPS     DAY        FT
FT      K-FT-3      K-FT-2        FT-2   FT-2/S

 43   3   4    2.20    2.10    0.23    0.00   -0.01   0.041   0.150    0.508
11.153        2.99        6.43        5.67     0.18
 44   3   5    2.10    2.00    0.22    0.00   -0.01   0.038   0.159    0.508
11.153        2.99        6.43        5.67     0.17
 45   3   6    2.00    1.90    0.20    0.00   -0.01   0.036   0.169    0.508
11.153        2.99        6.43        5.67     0.16
 46   3   7    1.90    1.80    0.19    0.00   -0.01   0.034   0.180    0.508
11.153        2.99        6.43        5.67     0.15
 47   3   8    1.80    1.70    0.18    0.00   -0.01   0.032   0.193    0.508
11.153        2.99        6.43        5.67     0.14
 48   3   9    1.70    1.60    0.17    0.00   -0.01   0.029   0.208    0.508
11.153        2.99        6.43        5.67     0.13
 49   3  10    1.60    1.50    0.15    0.00   -0.01   0.027   0.225    0.508
11.153        2.99        6.43        5.67     0.12
 50   3  11    1.50    1.40    0.14    0.00   -0.01   0.025   0.245    0.508
11.153        2.99        6.43        5.67     0.11
 51   3  12    1.40    1.30    0.13    0.00   -0.01   0.023   0.269    0.508
11.153        2.99        6.43        5.67     0.10
 52   3  13    1.30    1.20    0.12    0.00   -0.01   0.020   0.299    0.508
11.153        2.99        6.43        5.67     0.09
 53   3  14    1.20    1.10    0.10    0.00   -0.01   0.018   0.336    0.508
11.153        2.99        6.43        5.67     0.08
 54   3  15    1.10    1.00    0.09    0.00   -0.01   0.016   0.383    0.508
11.153        2.99        6.43        5.67     0.07
 55   3  16    1.00    0.90    0.08    0.00   -0.01   0.014   0.446    0.508
11.153        2.99        6.43        5.67     0.06
 56   3  17    0.90    0.80    0.06    0.00   -0.01   0.011   0.533    0.508
11.153        2.99        6.43        5.67     0.05


 57   4   1    0.75    0.65    0.15    0.09    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 58   4   2    0.65    0.55    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 59   4   3    0.55    0.45    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 60   4   4    0.45    0.35    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
 61   4   5    0.35    0.25    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13
```

```
 62   4   6    0.25    0.15    0.15    0.00    0.00   0.024   0.256    0.659
9.803        3.41        5.87        6.46     0.13


 63   5   1    0.20    0.10    0.32    0.17    0.00   0.136   0.045    0.280
8.399        1.24        4.73        2.35     0.36
 64   5   2    0.10    0.00    0.32    0.00    0.00   0.136   0.045    0.280
8.399        1.24        4.73        2.35     0.36
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     3
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                 ** REACTION COEFFICIENT SUMMARY
**

RCH ELE     DO  K2  OXYGN    BOD    BOD    SOD   ORGN   ORGN    NH3    NH3
NO2   ORGP   ORGP   DISP   COLI    ANC    ANC    ANC
NUM NUM    SAT OPT  REAIR  DECAY   SETT   RATE  DECAY   SETT  DECAY   SRCE
DECAY  DECAY   SETT   SRCE  DECAY  DECAY   SETT   SRCE
        MG/L      1/DAY  1/DAY  1/DAY  G/F2D  1/DAY  1/DAY  1/DAY MG/F2D
1/DAY  1/DAY  1/DAY MG/F2D  1/DAY  1/DAY  1/DAY MG/F2D

  1   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.14   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.13   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  18   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  1  19   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
  1  20   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  2   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  18   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  2  19   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  3   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     4
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                 ** REACTION COEFFICIENT SUMMARY
**

RCH ELE     DO  K2  OXYGN    BOD    BOD    SOD   ORGN   ORGN    NH3    NH3
NO2   ORGP   ORGP   DISP   COLI    ANC    ANC    ANC
NUM NUM    SAT OPT  REAIR  DECAY   SETT   RATE  DECAY   SETT  DECAY   SRCE
DECAY  DECAY   SETT   SRCE  DECAY  DECAY   SETT   SRCE
          MG/L      1/DAY  1/DAY  1/DAY  G/F2D  1/DAY  1/DAY  1/DAY MG/F2D
1/DAY  1/DAY  1/DAY MG/F2D  1/DAY  1/DAY  1/DAY MG/F2D

  3   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   7   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   8   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3   9   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  10   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.11   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  11   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  12   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  13   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  14   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  15   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  16   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  3  17   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.12   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  4   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.53   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   3   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.53   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   4   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.53   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
  4   5   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.53   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  4   6   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.09   0.11   0.00   0.00   0.00   0.00   0.00   0.00


  5   1   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.10   0.11   0.00   0.00   0.00   0.00   0.00   0.00
  5   2   8.80   1   0.72   0.02   0.00   0.00   0.11   0.00   0.54   0.00
3.10   0.11   0.00   0.00   0.00   0.00   0.00   0.00
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     5
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                    ** WATER QUALITY VARIABLES
**

RCH ELE              CM-1   CM-2   CM-3
ANC
NUM NUM       TEMP                          DO    BOD   ORGN   NH3N   NO2N
NO3N  SUM-N   ORGP  DIS-P  SUM-P   COLI          CHLA
             DEG-F                        MG/L   MG/L   MG/L   MG/L   MG/L
MG/L   MG/L   MG/L   MG/L   MG/L #/100ML         UG/L

  1   1      70.00   0.00   0.00   0.00   8.26   5.97   0.25   0.23   0.02
0.01   0.50   0.04   0.04   0.07.00E+00   0.00   9.24
  1   2      70.00   0.00   0.00   0.00   8.06   5.94   0.24   0.21   0.02
0.02   0.49   0.04   0.04   0.07.00E+00   0.00   9.50
  1   3      70.00   0.00   0.00   0.00   7.89   5.91   0.24   0.19   0.03
0.04   0.49   0.03   0.04   0.07.00E+00   0.00   9.76
  1   4      70.00   0.00   0.00   0.00   7.75   5.88   0.23   0.18   0.03
0.05   0.49   0.03   0.04   0.07.00E+00   0.00  10.03
  1   5      70.00   0.00   0.00   0.00   7.64   5.85   0.23   0.16   0.03
0.07   0.49   0.03   0.04   0.07.00E+00   0.00  10.30
  1   6      70.00   0.00   0.00   0.00   7.54   5.83   0.22   0.15   0.03
0.08   0.48   0.03   0.04   0.07.00E+00   0.00  10.59
  1   7      70.00   0.00   0.00   0.00   7.47   5.80   0.22   0.14   0.03
0.10   0.48   0.03   0.04   0.07.00E+00   0.00  10.88
  1   8      70.00   0.00   0.00   0.00   7.41   5.77   0.21   0.13   0.02
0.11   0.48   0.03   0.04   0.07.00E+00   0.00  11.19
  1   9      70.00   0.00   0.00   0.00   7.37   5.74   0.21   0.12   0.02
0.12   0.47   0.03   0.04   0.07.00E+00   0.00  11.50
  1  10      70.00   0.00   0.00   0.00   7.33   5.71   0.21   0.11   0.02
0.13   0.47   0.03   0.04   0.07.00E+00   0.00  11.82
  1  11      70.00   0.00   0.00   0.00   7.31   5.68   0.20   0.10   0.02
0.14   0.47   0.03   0.04   0.07.00E+00   0.00  12.15
  1  12      70.00   0.00   0.00   0.00   7.30   5.66   0.20   0.10   0.02
0.15   0.46   0.03   0.04   0.07.00E+00   0.00  12.49
  1  13      70.00   0.00   0.00   0.00   7.29   5.63   0.19   0.09   0.02
0.15   0.46   0.03   0.04   0.07.00E+00   0.00  12.83
  1  14      70.00   0.00   0.00   0.00   7.29   5.60   0.19   0.09   0.02
0.16   0.45   0.03   0.04   0.07.00E+00   0.00  13.19
  1  15      70.00   0.00   0.00   0.00   7.30   5.57   0.19   0.08   0.02
0.17   0.45   0.03   0.04   0.07.00E+00   0.00  13.56
  1  16      70.00   0.00   0.00   0.00   7.31   5.55   0.18   0.08   0.01
0.17   0.45   0.03   0.04   0.07.00E+00   0.00  13.93
  1  17      70.00   0.00   0.00   0.00   7.32   5.52   0.18   0.07   0.01
0.17   0.44   0.03   0.04   0.06.00E+00   0.00  14.31
  1  18      70.00   0.00   0.00   0.00   7.34   5.49   0.18   0.07   0.01
0.18   0.44   0.03   0.04   0.06.00E+00   0.00  14.70
  1  19      70.00   0.00   0.00   0.00   7.36   5.46   0.17   0.06   0.01
0.18   0.43   0.03   0.04   0.06.00E+00   0.00  15.10
```

```
  1  20      70.00   0.00   0.00   0.00   7.38   5.44   0.17   0.06   0.01
0.18   0.43   0.03   0.04   0.06.00E+00   0.00  15.51


  2   1      70.00   0.00   0.00   0.00   7.38   5.44   0.17   0.07   0.01
0.18   0.43   0.02   0.04   0.06.00E+00   0.00  15.15
  2   2      70.00   0.00   0.00   0.00   7.37   5.44   0.17   0.07   0.01
0.17   0.43   0.02   0.03   0.06.00E+00   0.00  14.80
  2   3      70.00   0.00   0.00   0.00   7.37   5.44   0.17   0.07   0.01
0.17   0.43   0.02   0.03   0.05.00E+00   0.00  14.45
  2   4      70.00   0.00   0.00   0.00   7.36   5.44   0.17   0.08   0.01
0.16   0.43   0.02   0.03   0.05.00E+00   0.00  14.12
  2   5      70.00   0.00   0.00   0.00   7.35   5.44   0.17   0.08   0.01
0.16   0.42   0.02   0.03   0.05.00E+00   0.00  13.79
  2   6      70.00   0.00   0.00   0.00   7.34   5.44   0.17   0.08   0.01
0.16   0.42   0.02   0.03   0.05.00E+00   0.00  13.46
  2   7      70.00   0.00   0.00   0.00   7.33   5.44   0.18   0.08   0.01
0.15   0.42   0.02   0.03   0.04.00E+00   0.00  13.14
  2   8      70.00   0.00   0.00   0.00   7.31   5.44   0.18   0.09   0.01
0.15   0.42   0.02   0.03   0.04.00E+00   0.00  12.83
  2   9      70.00   0.00   0.00   0.00   7.30   5.44   0.18   0.09   0.01
0.15   0.42   0.02   0.02   0.04.00E+00   0.00  12.53
  2  10      70.00   0.00   0.00   0.00   7.29   5.44   0.18   0.09   0.01
0.15   0.43   0.01   0.02   0.04.00E+00   0.00  12.23
  2  11      70.00   0.00   0.00   0.00   7.28   5.44   0.18   0.09   0.01
0.15   0.43   0.01   0.02   0.04.00E+00   0.00  11.94
  2  12      70.00   0.00   0.00   0.00   7.27   5.44   0.18   0.09   0.01
0.15   0.43   0.01   0.02   0.04.00E+00   0.00  11.66
  2  13      70.00   0.00   0.00   0.00   7.26   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  11.38
  2  14      70.00   0.00   0.00   0.00   7.25   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  11.11
  2  15      70.00   0.00   0.00   0.00   7.24   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  10.84
  2  16      70.00   0.00   0.00   0.00   7.23   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  10.58
  2  17      70.00   0.00   0.00   0.00   7.22   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  10.33
  2  18      70.00   0.00   0.00   0.00   7.21   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00  10.08
  2  19      70.00   0.00   0.00   0.00   7.20   5.44   0.18   0.09   0.01
0.14   0.43   0.01   0.02   0.03.00E+00   0.00   9.84


  3   1      70.00   0.00   0.00   0.00   7.19   5.43   0.18   0.09   0.02
0.15   0.43   0.01   0.02   0.03.00E+00   0.00   9.62
  3   2      70.00   0.00   0.00   0.00   7.19   5.41   0.17   0.09   0.02
0.15   0.43   0.01   0.02   0.03.00E+00   0.00   9.38
  3   3      70.00   0.00   0.00   0.00   7.19   5.39   0.17   0.08   0.01
0.16   0.42   0.01   0.02   0.03.00E+00   0.00   9.14
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     6
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                    ** WATER QUALITY VARIABLES
**

RCH ELE              CM-1   CM-2   CM-3
ANC
NUM NUM       TEMP                          DO    BOD   ORGN   NH3N   NO2N
NO3N  SUM-N   ORGP  DIS-P  SUM-P   COLI          CHLA
             DEG-F                        MG/L   MG/L   MG/L   MG/L   MG/L
MG/L   MG/L   MG/L   MG/L   MG/L #/100ML         UG/L

  3   4      70.00   0.00   0.00   0.00   7.18   5.37   0.17   0.08   0.01
0.16   0.42   0.01   0.02   0.03.00E+00   0.00   8.88
  3   5      70.00   0.00   0.00   0.00   7.18   5.36   0.17   0.08   0.01
0.17   0.42   0.01   0.02   0.03.00E+00   0.00   8.62
  3   6      70.00   0.00   0.00   0.00   7.18   5.33   0.16   0.07   0.01
0.17   0.42   0.01   0.02   0.03.00E+00   0.00   8.35
  3   7      70.00   0.00   0.00   0.00   7.18   5.31   0.16   0.07   0.01
0.17   0.42   0.01   0.02   0.03.00E+00   0.00   8.07
  3   8      70.00   0.00   0.00   0.00   7.18   5.29   0.16   0.07   0.01
0.18   0.42   0.01   0.02   0.03.00E+00   0.00   7.78
  3   9      70.00   0.00   0.00   0.00   7.19   5.27   0.16   0.06   0.01
0.19   0.41   0.01   0.02   0.03.00E+00   0.00   7.48
  3  10      70.00   0.00   0.00   0.00   7.19   5.24   0.15   0.06   0.01
0.19   0.41   0.01   0.02   0.02.00E+00   0.00   7.17
  3  11      70.00   0.00   0.00   0.00   7.19   5.21   0.15   0.06   0.01
0.20   0.41   0.01   0.02   0.02.00E+00   0.00   6.84
  3  12      70.00   0.00   0.00   0.00   7.20   5.18   0.15   0.05   0.01
0.20   0.41   0.01   0.02   0.02.00E+00   0.00   6.50
  3  13      70.00   0.00   0.00   0.00   7.21   5.15   0.14   0.05   0.01
0.21   0.41   0.01   0.02   0.02.00E+00   0.00   6.15
  3  14      70.00   0.00   0.00   0.00   7.21   5.11   0.14   0.05   0.01
0.21   0.40   0.01   0.01   0.02.00E+00   0.00   5.77
  3  15      70.00   0.00   0.00   0.00   7.22   5.07   0.13   0.04   0.01
0.22   0.40   0.01   0.01   0.02.00E+00   0.00   5.38
  3  16      70.00   0.00   0.00   0.00   7.23   5.02   0.13   0.04   0.01
0.22   0.40   0.01   0.01   0.02.00E+00   0.00   4.97
  3  17      70.00   0.00   0.00   0.00   7.24   5.00   0.12   0.04   0.01
0.23   0.40   0.01   0.02   0.03.00E+00   0.00   4.70


  4   1      70.00   0.00   0.00   0.00   6.47   9.26   0.05   0.32   0.03
0.11   0.51   0.54   0.54   1.08.00E+00   0.00  19.88
  4   2      70.00   0.00   0.00   0.00   6.40   9.21   0.05   0.28   0.04
0.13   0.50   0.52   0.55   1.08.00E+00   0.00  21.91
  4   3      70.00   0.00   0.00   0.00   6.37   9.15   0.05   0.25   0.04
0.15   0.49   0.51   0.56   1.07.00E+00   0.00  24.14
  4   4      70.00   0.00   0.00   0.00   6.37   9.09   0.05   0.22   0.04
0.17   0.48   0.50   0.57   1.07.00E+00   0.00  26.58
```

```
  4   5      70.00   0.00   0.00   0.00   6.40   9.04   0.05   0.19   0.04
0.19   0.47   0.48   0.59   1.07.00E+00   0.00  29.24
  4   6      70.00   0.00   0.00   0.00   6.46   8.97   0.05   0.17   0.03
0.20   0.45   0.47   0.59   1.06.00E+00   0.00  31.93


  5   1      70.00   0.00   0.00   0.00   6.73   7.41   0.15   0.20   0.02
0.10   0.48   0.22   0.29   0.51.00E+00   0.00  14.96
  5   2      70.00   0.00   0.00   0.00   6.72   7.40   0.15   0.20   0.02
0.10   0.48   0.22   0.29   0.51.00E+00   0.00  14.74
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     7
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                          ** ALGAE DATA **


NH3-N            ALGAE GROWTH RATE ATTEN FACTORS
ELE RCH ELE               ALGY    ALGY    ALGY   A P/R     NET          NH3
FRACT   LIGHT
ORD NUM NUM       CHLA   GRWTH    RESP    SETT   RATIO     P-R         PREF  N-
UPTKE  EXTCO        LIGHT   NITRGN   PHSPRS
                  UG/L   1/DAY   1/DAY   FT/DA       *   MG/L-D          *
*     1/FT           *        *        *

  1   1   1       9.24    0.92    0.11    0.33    7.90    0.27         0.10
0.74    0.13         0.50     0.89     0.88
  2   1   2       9.50    0.92    0.11    0.33    7.91    0.28         0.10
0.51    0.13         0.50     0.88     0.88
  3   1   3       9.76    0.92    0.11    0.33    7.91    0.28         0.10
0.36    0.13         0.50     0.88     0.88
  4   1   4      10.03    0.92    0.11    0.33    7.92    0.29         0.10
0.27    0.13         0.50     0.88     0.88
  5   1   5      10.30    0.92    0.11    0.33    7.92    0.30         0.10
0.21    0.13         0.50     0.88     0.88
  6   1   6      10.59    0.92    0.11    0.33    7.93    0.31         0.10
0.17    0.13         0.50     0.89     0.88
  7   1   7      10.88    0.92    0.11    0.33    7.93    0.32         0.10
0.14    0.13         0.50     0.89     0.88
  8   1   8      11.19    0.93    0.11    0.33    7.93    0.33         0.10
0.12    0.13         0.50     0.89     0.89
  9   1   9      11.50    0.93    0.11    0.33    7.93    0.33         0.10
0.10    0.13         0.50     0.89     0.89
 10   1  10      11.82    0.93    0.11    0.33    7.93    0.34         0.10
0.09    0.14         0.50     0.89     0.89
 11   1  11      12.15    0.93    0.11    0.33    7.93    0.35         0.10
0.08    0.14         0.50     0.89     0.89
 12   1  12      12.49    0.93    0.11    0.33    7.93    0.36         0.10
0.07    0.14         0.50     0.89     0.89
 13   1  13      12.83    0.92    0.11    0.33    7.93    0.37         0.10
0.06    0.14         0.50     0.89     0.89
 14   1  14      13.19    0.92    0.11    0.33    7.93    0.38         0.10
0.06    0.14         0.50     0.89     0.88
 15   1  15      13.56    0.92    0.11    0.33    7.92    0.39         0.10
0.05    0.14         0.50     0.89     0.88
 16   1  16      13.93    0.92    0.11    0.33    7.92    0.40         0.10
0.05    0.14         0.50     0.89     0.88
 17   1  17      14.31    0.92    0.11    0.33    7.92    0.42         0.10
0.04    0.14         0.50     0.89     0.88
 18   1  18      14.70    0.92    0.11    0.33    7.91    0.43         0.10
0.04    0.14         0.50     0.89     0.88
 19   1  19      15.10    0.92    0.11    0.33    7.90    0.44         0.10
0.04    0.15         0.50     0.89     0.88
```

```
 20   1  20       15.51    0.92    0.11    0.33    7.90    0.45        0.10
0.04    0.15         0.50     0.89     0.88


 21   2   1       15.15    0.92    0.11    0.33    7.85    0.44        0.10
0.04    0.15         0.50     0.89     0.88
 22   2   2       14.80    0.91    0.11    0.33    7.79    0.42        0.10
0.04    0.14         0.50     0.89     0.87
 23   2   3       14.45    0.90    0.11    0.33    7.74    0.41        0.10
0.05    0.14         0.50     0.89     0.86
 24   2   4       14.12    0.90    0.11    0.33    7.69    0.40        0.10
0.05    0.14         0.50     0.89     0.86
 25   2   5       13.79    0.89    0.11    0.33    7.63    0.38        0.10
0.05    0.14         0.50     0.89     0.85
 26   2   6       13.46    0.88    0.11    0.33    7.58    0.37        0.10
0.06    0.14         0.50     0.89     0.85
 27   2   7       13.14    0.88    0.11    0.33    7.53    0.36        0.10
0.06    0.14         0.50     0.89     0.84
 28   2   8       12.83    0.87    0.11    0.33    7.47    0.35        0.10
0.06    0.14         0.50     0.89     0.83
 29   2   9       12.53    0.87    0.11    0.33    7.42    0.34        0.10
0.06    0.14         0.50     0.89     0.83
 30   2  10       12.23    0.86    0.11    0.33    7.37    0.33        0.10
0.06    0.14         0.50     0.89     0.82
 31   2  11       11.94    0.85    0.11    0.33    7.31    0.32        0.10
0.06    0.14         0.50     0.89     0.82
 32   2  12       11.66    0.85    0.11    0.33    7.26    0.31        0.10
0.06    0.13         0.50     0.89     0.81
 33   2  13       11.38    0.84    0.11    0.33    7.21    0.30        0.10
0.07    0.13         0.50     0.89     0.80
 34   2  14       11.11    0.83    0.11    0.33    7.16    0.29        0.10
0.07    0.13         0.50     0.89     0.80
 35   2  15       10.84    0.83    0.11    0.33    7.10    0.28        0.10
0.07    0.13         0.50     0.89     0.79
 36   2  16       10.58    0.82    0.11    0.33    7.05    0.27        0.10
0.07    0.13         0.50     0.89     0.79
 37   2  17       10.33    0.82    0.11    0.33    7.00    0.26        0.10
0.07    0.13         0.50     0.89     0.78
 38   2  18       10.08    0.81    0.11    0.33    6.95    0.25        0.10
0.07    0.13         0.50     0.89     0.78
 39   2  19        9.84    0.80    0.11    0.33    6.90    0.24        0.10
0.07    0.13         0.50     0.89     0.77


 40   3   1        9.62    0.80    0.11    0.45    6.89    0.24        0.10
0.06    0.13         0.50     0.89     0.77
 41   3   2        9.38    0.80    0.11    0.45    6.87    0.23        0.10
0.06    0.13         0.50     0.89     0.77
 42   3   3        9.14    0.80    0.11    0.45    6.86    0.22        0.10
0.06    0.13         0.50     0.89     0.77
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     8
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                          ** ALGAE DATA **


NH3-N            ALGAE GROWTH RATE ATTEN FACTORS
ELE RCH ELE               ALGY    ALGY    ALGY   A P/R     NET          NH3
FRACT   LIGHT
ORD NUM NUM       CHLA   GRWTH    RESP    SETT   RATIO     P-R         PREF  N-
UPTKE  EXTCO        LIGHT   NITRGN   PHSPRS
                  UG/L   1/DAY   1/DAY   FT/DA      *   MG/L-D          *
*     1/FT            *        *        *

 43   3   4       8.88    0.80    0.11    0.45    6.85    0.22        0.10
0.05    0.13         0.50     0.89     0.76
 44   3   5       8.62    0.80    0.11    0.45    6.84    0.21        0.10
0.05    0.13         0.50     0.89     0.76
 45   3   6       8.35    0.80    0.11    0.45    6.82    0.20        0.10
0.05    0.13         0.50     0.89     0.76
 46   3   7       8.07    0.79    0.11    0.45    6.81    0.20        0.10
0.04    0.12         0.50     0.89     0.76
 47   3   8       7.78    0.79    0.11    0.45    6.80    0.19        0.10
0.04    0.12         0.50     0.89     0.76
 48   3   9       7.48    0.79    0.11    0.45    6.78    0.18        0.10
0.04    0.12         0.50     0.89     0.76
 49   3  10       7.17    0.79    0.11    0.45    6.77    0.17        0.10
0.03    0.12         0.50     0.89     0.76
 50   3  11       6.84    0.79    0.11    0.45    6.76    0.17        0.10
0.03    0.12         0.50     0.89     0.75
 51   3  12       6.50    0.79    0.11    0.45    6.74    0.16        0.10
0.03    0.12         0.50     0.89     0.75
 52   3  13       6.15    0.79    0.11    0.45    6.73    0.15        0.10
0.03    0.12         0.50     0.89     0.75
 53   3  14       5.77    0.78    0.11    0.45    6.72    0.14        0.10
0.02    0.12         0.50     0.90     0.75
 54   3  15       5.38    0.78    0.11    0.45    6.71    0.13        0.10
0.02    0.12         0.50     0.90     0.75
 55   3  16       4.97    0.78    0.11    0.45    6.70    0.12        0.10
0.02    0.11         0.50     0.90     0.75
 56   3  17       4.70    0.82    0.11    0.45    7.05    0.12        0.10
0.02    0.11         0.50     0.90     0.79


 57   4   1      19.88    0.97    0.11    0.33    8.35    0.61        0.10
0.24    0.16         0.50     0.93     0.99
 58   4   2      21.91    0.97    0.11    0.33    8.33    0.67        0.10
0.19    0.17         0.50     0.93     0.99
 59   4   3      24.14    0.97    0.11    0.33    8.31    0.74        0.10
0.15    0.17         0.49     0.93     0.99
 60   4   4      26.58    0.97    0.11    0.33    8.29    0.81        0.10
0.12    0.18         0.49     0.93     0.99
```

```
 61   4   5      29.24    0.96    0.11    0.33    8.27    0.89        0.10
0.10    0.19         0.49     0.93     0.99
 62   4   6      31.93    0.96    0.11    0.33    8.25    0.97        0.10
0.09    0.20         0.49     0.92     0.99


 63   5   1      14.96    0.95    0.11    0.33    8.16    0.45        0.10
0.18    0.14         0.50     0.91     0.98
 64   5   2      14.74    0.95    0.11    0.33    8.16    0.44        0.10
0.18    0.14         0.50     0.91     0.98
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER     9
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                     ** DISSOLVED OXYGEN DATA **

                                                                  COMPONENTS OF
DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)
ELE RCH ELE              DO              DO     DAM     NIT
ORD NUM NUM    TEMP     SAT      DO     DEF   INPUT   INHIB      F-FNCTN   OXYGN
NET
              DEG-F    MG/L    MG/L    MG/L    MG/L    FACT        INPUT   REAIR
C-BOD     SOD     P-R   NH3-N   NO2-N

  1   1   1   70.00    8.80    8.26    0.54    0.00    0.99        41.71    0.39
-0.14    0.00    0.27   -0.42   -0.05
  2   1   2   70.00    8.80    8.06    0.74    0.00    0.99         0.00    0.53
-0.14    0.00    0.28   -0.39   -0.08
  3   1   3   70.00    8.80    7.89    0.91    0.00    0.99         0.00    0.65
-0.14    0.00    0.28   -0.35   -0.10
  4   1   4   70.00    8.80    7.75    1.05    0.00    0.99         0.00    0.75
-0.14    0.00    0.29   -0.33   -0.10
  5   1   5   70.00    8.80    7.64    1.16    0.00    0.99         0.00    0.84
-0.14    0.00    0.30   -0.30   -0.10
  6   1   6   70.00    8.80    7.54    1.26    0.00    0.99         0.00    0.90
-0.14    0.00    0.31   -0.28   -0.10
  7   1   7   70.00    8.80    7.47    1.33    0.00    0.99         0.00    0.96
-0.14    0.00    0.32   -0.26   -0.09
  8   1   8   70.00    8.80    7.41    1.39    0.00    0.99         0.00    1.00
-0.14    0.00    0.33   -0.24   -0.09
  9   1   9   70.00    8.80    7.37    1.43    0.00    0.99         0.00    1.03
-0.14    0.00    0.33   -0.22   -0.08
 10   1  10   70.00    8.80    7.33    1.47    0.00    0.99         0.00    1.05
-0.14    0.00    0.34   -0.21   -0.08
 11   1  11   70.00    8.80    7.31    1.49    0.00    0.99         0.00    1.07
-0.14    0.00    0.35   -0.19   -0.07
 12   1  12   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.14    0.00    0.36   -0.18   -0.07
 13   1  13   70.00    8.80    7.29    1.51    0.00    0.99         0.00    1.08
-0.14    0.00    0.37   -0.17   -0.06
 14   1  14   70.00    8.80    7.29    1.51    0.00    0.99         0.00    1.08
-0.14    0.00    0.38   -0.16   -0.06
 15   1  15   70.00    8.80    7.30    1.50    0.00    0.99         0.00    1.08
-0.13    0.00    0.39   -0.15   -0.06
 16   1  16   70.00    8.80    7.31    1.49    0.00    0.99         0.00    1.07
-0.13    0.00    0.40   -0.14   -0.05
 17   1  17   70.00    8.80    7.32    1.48    0.00    0.99         0.00    1.06
-0.13    0.00    0.42   -0.13   -0.05
 18   1  18   70.00    8.80    7.34    1.46    0.00    0.99         0.00    1.05
-0.13    0.00    0.43   -0.13   -0.05
 19   1  19   70.00    8.80    7.36    1.44    0.00    0.99         0.00    1.04
-0.13    0.00    0.44   -0.12   -0.04
```

```
 20   1  20   70.00    8.80    7.38    1.42    0.00    0.99         0.00    1.02
-0.13    0.00    0.45   -0.11   -0.04


 21   2   1   70.00    8.80    7.38    1.42    0.00    0.99         1.67    1.02
-0.13    0.00    0.44   -0.12   -0.04
 22   2   2   70.00    8.80    7.37    1.43    0.00    0.99         1.67    1.03
-0.13    0.00    0.42   -0.13   -0.04
 23   2   3   70.00    8.80    7.37    1.43    0.00    0.99         1.67    1.03
-0.13    0.00    0.41   -0.14   -0.04
 24   2   4   70.00    8.80    7.36    1.44    0.00    0.99         1.67    1.04
-0.13    0.00    0.40   -0.14   -0.04
 25   2   5   70.00    8.80    7.35    1.45    0.00    0.99         1.67    1.04
-0.13    0.00    0.38   -0.15   -0.04
 26   2   6   70.00    8.80    7.34    1.46    0.00    0.99         1.67    1.05
-0.13    0.00    0.37   -0.15   -0.04
 27   2   7   70.00    8.80    7.33    1.47    0.00    0.99         1.67    1.06
-0.13    0.00    0.36   -0.15   -0.05
 28   2   8   70.00    8.80    7.31    1.49    0.00    0.99         1.67    1.07
-0.13    0.00    0.35   -0.16   -0.05
 29   2   9   70.00    8.80    7.30    1.50    0.00    0.99         1.67    1.08
-0.13    0.00    0.34   -0.16   -0.05
 30   2  10   70.00    8.80    7.29    1.51    0.00    0.99         1.67    1.08
-0.13    0.00    0.33   -0.16   -0.05
 31   2  11   70.00    8.80    7.28    1.52    0.00    0.99         1.67    1.09
-0.13    0.00    0.32   -0.16   -0.05
 32   2  12   70.00    8.80    7.27    1.53    0.00    0.99         1.67    1.10
-0.13    0.00    0.31   -0.17   -0.05
 33   2  13   70.00    8.80    7.26    1.54    0.00    0.99         1.67    1.11
-0.13    0.00    0.30   -0.17   -0.05
 34   2  14   70.00    8.80    7.25    1.55    0.00    0.99         1.67    1.12
-0.13    0.00    0.29   -0.17   -0.05
 35   2  15   70.00    8.80    7.24    1.56    0.00    0.99         1.67    1.12
-0.13    0.00    0.28   -0.17   -0.05
 36   2  16   70.00    8.80    7.23    1.58    0.00    0.99         1.67    1.13
-0.13    0.00    0.27   -0.17   -0.05
 37   2  17   70.00    8.80    7.22    1.59    0.00    0.99         1.67    1.14
-0.13    0.00    0.26   -0.17   -0.05
 38   2  18   70.00    8.80    7.21    1.60    0.00    0.99         1.67    1.15
-0.13    0.00    0.25   -0.17   -0.05
 39   2  19   70.00    8.80    7.20    1.61    0.00    0.99         1.67    1.15
-0.13    0.00    0.24   -0.17   -0.05


 40   3   1   70.00    8.80    7.19    1.61    0.00    0.99        -2.64    1.16
-0.13    0.00    0.24   -0.17   -0.05
 41   3   2   70.00    8.80    7.19    1.61    0.00    0.99        -2.64    1.16
-0.13    0.00    0.23   -0.16   -0.05
 42   3   3   70.00    8.80    7.19    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.22   -0.15   -0.05
```

```
         STREAM QUALITY SIMULATION
OUTPUT PAGE NUMBER    10
         QUAL-2E STREAM QUALITY ROUTING MODEL
Version 3.22  --  May 1996
                                                 ***** STEADY STATE SIMULATION
*****

                                                     ** DISSOLVED OXYGEN DATA **

                                                                  COMPONENTS OF
DISSOLVED OXYGEN MASS BALANCE (MG/L-DAY)
ELE RCH ELE              DO              DO     DAM     NIT
ORD NUM NUM    TEMP     SAT      DO     DEF   INPUT   INHIB      F-FNCTN   OXYGN
NET
              DEG-F    MG/L    MG/L    MG/L    MG/L    FACT        INPUT   REAIR
C-BOD     SOD     P-R   NH3-N   NO2-N

 43   3   4  70.00    8.80    7.18    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.22   -0.15   -0.05
 44   3   5  70.00    8.80    7.18    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.21   -0.14   -0.05
 45   3   6  70.00    8.80    7.18    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.20   -0.13   -0.05
 46   3   7  70.00    8.80    7.18    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.20   -0.13   -0.05
 47   3   8  70.00    8.80    7.18    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.19   -0.12   -0.04
 48   3   9  70.00    8.80    7.19    1.62    0.00    0.99        -2.64    1.16
-0.13    0.00    0.18   -0.11   -0.04
 49   3  10  70.00    8.80    7.19    1.61    0.00    0.99        -2.64    1.16
-0.13    0.00    0.17   -0.11   -0.04
 50   3  11  70.00    8.80    7.19    1.61    0.00    0.99        -2.64    1.16
-0.13    0.00    0.17   -0.10   -0.04
 51   3  12  70.00    8.80    7.20    1.60    0.00    0.99        -2.64    1.15
-0.13    0.00    0.16   -0.10   -0.04
 52   3  13  70.00    8.80    7.21    1.60    0.00    0.99        -2.64    1.15
-0.12    0.00    0.15   -0.09   -0.03
 53   3  14  70.00    8.80    7.21    1.59    0.00    0.99        -2.65    1.14
-0.12    0.00    0.14   -0.09   -0.03
 54   3  15  70.00    8.80    7.22    1.58    0.00    0.99        -2.65    1.13
-0.12    0.00    0.13   -0.08   -0.03
 55   3  16  70.00    8.80    7.23    1.57    0.00    0.99        -2.65    1.13
-0.12    0.00    0.12   -0.07   -0.03
 56   3  17  70.00    8.80    7.24    1.56    0.00    0.99        -2.66    1.12
-0.12    0.00    0.12   -0.07   -0.02


 57   4   1  70.00    8.80    6.47    2.33    0.00    0.98        13.75    1.67
-0.22    0.00    0.61   -0.59   -0.09
 58   4   2  70.00    8.80    6.40    2.40    0.00    0.98         0.00    1.73
-0.22    0.00    0.67   -0.51   -0.13
 59   4   3  70.00    8.80    6.37    2.44    0.00    0.98         0.00    1.75
-0.22    0.00    0.74   -0.45   -0.14
 60   4   4  70.00    8.80    6.37    2.43    0.00    0.98         0.00    1.75
-0.22    0.00    0.81   -0.40   -0.13
```

```
 61   4   5   70.00    8.80    6.40    2.40    0.00    0.98         0.00    1.73
-0.22    0.00    0.89   -0.35   -0.13
 62   4   6   70.00    8.80    6.46    2.34    0.00    0.98         0.00    1.68
-0.22    0.00    0.97   -0.31   -0.12


 63   5   1   70.00    8.80    6.73    2.07    0.00    0.98        81.34    1.49
-0.18    0.00    0.45   -0.37   -0.07
 64   5   2   70.00    8.80    6.72    2.08    0.00    0.98         0.00    1.49
-0.18    0.00    0.44   -0.37   -0.08
```

Attachment 4

This page is blank to facilitate double sided printing.

Lake Decatur

Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment: 4 Area-Wtd Mean

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	193.6		94.0%	187.8		93.6%
CARLSON TSI-P	80.1		94.0%	79.6		93.6%

Segment: 1 Downstream Near Dam

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	191.6		93.8%	158.7		90.8%
CARLSON TSI-P	79.9		93.8%	77.2		90.8%

Segment: 2 Middle

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	192.7		93.9%	202.2		94.5%
CARLSON TSI-P	80.0		93.9%	80.7		94.5%

Segment: 3 Upstream

	Predicted Values--->			Observed Values--->		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	197.0		94.2%	202.2		94.5%
CARLSON TSI-P	80.3		94.2%	80.7		94.5%

Lake Decatur

Overall Water & Nutrient Balances

Overall Water Balance **Averaging Period = 0.17 years**

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance (hm3/yr)^2	CV -	Runoff m/yr
1	1	1	Trib 1		24.9	0.00E+00	0.00	
2	1	2	Trib 2		2.5	0.00E+00	0.00	
3	1	3	Trib 3		192.8	0.00E+00	0.00	
PRECIPITATION				11.6	12.8	0.00E+00	0.00	1.10
TRIBUTARY INFLOW					220.1	0.00E+00	0.00	
***TOTAL INFLOW				11.6	232.9	0.00E+00	0.00	20.03
ADVECTIVE OUTFLOW				11.6	220.1	0.00E+00	0.00	18.93
***TOTAL OUTFLOW				11.6	220.1	0.00E+00	0.00	18.93
***EVAPORATION					12.8	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	Trib 1	5110.4	11.2%	0.00E+00		0.00	205.5	
2	1	2	Trib 2	509.0	1.1%	0.00E+00		0.00	205.5	
3	1	3	Trib 3	39610.1	86.9%	0.00E+00		0.00	205.5	
PRECIPITATION				348.8	0.8%	0.00E+00		0.00	27.3	30.0
TRIBUTARY INFLOW				45229.5	99.2%	0.00E+00		0.00	205.5	
***TOTAL INFLOW				45578.4	100.0%	0.00E+00		0.00	195.7	3919.7
ADVECTIVE OUTFLOW				42160.9	92.5%	0.00E+00		0.00	191.6	3625.8
***TOTAL OUTFLOW				42160.9	92.5%	0.00E+00		0.00	191.6	3625.8
***RETENTION				3417.5	7.5%	0.00E+00		0.00		

Overflow Rate (m/yr)	18.9	Nutrient Resid. Time (yrs)	0.0752
Hydraulic Resid. Time (yrs)	0.0804	Turnover Ratio	2.2
Reservoir Conc (mg/m3)	194	Retention Coef.	0.075

Lake Decatur

Hydraulic & Dispersion Parameters

Seg	**Name**	**Outflow Seg**	**Net Inflow hm^3/yr**	**Resid Time years**	**Overflow Rate m/yr**	**Velocity km/yr**	**Dispersion--------> Estimated km^2/yr**	**Numeric km^2/yr**	**Exchange hm^3/yr**
1	Downstream Near Dam	0	220.1	0.0423	57.2	73.7	5345.7	114.7	0.0
2	Middle	1	195.2	0.0220	45.9	316.6	11702.7	1103.1	937.9
3	Upstream	2	192.8	0.0212	54.7	414.0	5887.6	1818.9	215.6

Morphometry

Seg	**Name**	**Area km^2**	**Zmean m**	**Zmix m**	**Length km**	**Volume hm^3**	**Width km**	**L/W -**
1	Downstream Near Dam	3.8	2.4	2.4	3.1	9.3	1.2	2.5
2	Middle	4.3	1.0	1.0	7.0	4.3	0.6	11.4
3	Upstream	3.5	1.2	1.2	8.8	4.1	0.4	21.9
Totals		11.6	1.5			17.7		

Lake Decatur

Segment & Tributary Network

--------Segment: 1 Downstream Near Dam
Outflow Segment: 0 Out of Reservoir
Tributary: 1 Trib 1 Type: Monitored Inflow

--------Segment: 2 Middle
Outflow Segment: 1 Downstream Near Dam
Tributary: 2 Trib 2 Type: Monitored Inflow

--------Segment: 3 Upstream
Outflow Segment: 2 Middle
Tributary: 3 Trib 3 Type: Monitored Inflow

Lake Decatur

Description:

Single reservoir (2,873 acres (from GIS))
3 segments

Global Variables	Mean	CV
Averaging Period (yrs)	0.166667	0.0
Precipitation (m)	0.1829	0.0
Evaporation (m)	0.1829	0.0
Storage Increase (m)	0	0.0

Atmos. Loads (kg/km^2-yr)	Mean	CV
Conserv. Substance	0	0.00
Total P	30	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

Model Options	Code	Description
Conservative Substance	0	NOT COMPUTED
Phosphorus Balance	6	FIRST ORDER
Nitrogen Balance	0	NOT COMPUTED
Chlorophyll-a	0	NOT COMPUTED
Secchi Depth	0	NOT COMPUTED
Dispersion	1	FISCHER-NUMERIC
Phosphorus Calibration	2	CONCENTRATIONS
Nitrogen Calibration	0	NONE
Error Analysis	0	NOT COMPUTED
Availability Factors	0	IGNORE
Mass-Balance Tables	1	USE ESTIMATED CONCS
Output Destination	2	EXCEL WORKSHEET

Segment Morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})		Internal Loads (mg/m2-day) Conserv.		Total P		Total N	
Seg	Name	Segment	Group	km^2	m	km	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Downstream Near Dam	0	1	3.846709	2.42	3.115147	2.42	0	0	0	0	0	0	0	0	0	0	0
2	Middle	1	1	4.254451	1.01	6.968581	1.01	0	0	0	0	0	0	0	0	0	0	0
3	Upstream	2	1	3.526886	1.16	8.787018	1.16	0	0	0	0	0	0	0	0	0	0	0

Segment Observed Water Quality

	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seq	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	0	0	158.6667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	202.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	202.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Segment Calibration Factors

	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seq	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Tributary Data

				Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Trib	Trib Name	Segment	Type	km^2	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Trib 1	1	1	0	24.86821	0	0	0	205.5	0	0	0	0	0	0	0
2	Trib 2	2	1	0	2.47679	0	0	0	205.5	0	0	0	0	0	0	0
3	Trib 3	3	1	0	192.7501	0	0	0	205.5	0	0	0	0	0	0	0

Model Coefficients	Mean	CV
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

Lake Decatur

Predicted & Observed Values Ranked Against CE Model Development Dataset

Segment:	**4**	**Area-Wtd Mean**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	50.0		51.9%	187.8		93.6%
CARLSON TSI-P	60.6		51.9%	79.6		93.6%

Segment:	**1**	**Downstream Near Dam**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	49.6		51.5%	158.7		90.8%
CARLSON TSI-P	60.4		51.5%	77.2		90.8%

Segment:	**2**	**Middle**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	49.8		51.7%	202.2		94.5%
CARLSON TSI-P	60.5		51.7%	80.7		94.5%

Segment:	**3**	**Upstream**				
	Predicted Values--->			**Observed Values--->**		
Variable	**Mean**	**CV**	**Rank**	**Mean**	**CV**	**Rank**
TOTAL P MG/M3	50.6		52.4%	202.2		94.5%
CARLSON TSI-P	60.7		52.4%	80.7		94.5%

Lake Decatur

Overall Water & Nutrient Balances

Overall Water Balance

Averaging Period = 0.17 years

Trb	Type	Seg	Name	Area km^2	Flow hm^3/yr	Variance $(hm3/yr)^2$	CV -	Runoff m/yr
1	1	1	Trib 1		24.9	0.00E+00	0.00	
2	1	2	Trib 2		2.5	0.00E+00	0.00	
3	1	3	Trib 3		192.8	0.00E+00	0.00	
PRECIPITATION				11.6	12.8	0.00E+00	0.00	1.10
TRIBUTARY INFLOW					220.1	0.00E+00	0.00	
***TOTAL INFLOW				11.6	232.9	0.00E+00	0.00	20.03
ADVECTIVE OUTFLOW				11.6	220.1	0.00E+00	0.00	18.93
***TOTAL OUTFLOW				11.6	220.1	0.00E+00	0.00	18.93
***EVAPORATION					12.8	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	Trib 1	1293.1	11.0%	0.00E+00		0.00	52.0	
2	1	2	Trib 2	128.8	1.1%	0.00E+00		0.00	52.0	
3	1	3	Trib 3	10023.0	85.0%	0.00E+00		0.00	52.0	
PRECIPITATION				348.8	3.0%	0.00E+00		0.00	27.3	30.0
TRIBUTARY INFLOW				11444.9	97.0%	0.00E+00		0.00	52.0	
***TOTAL INFLOW				11793.8	100.0%	0.00E+00		0.00	50.6	1014.3
ADVECTIVE OUTFLOW				10911.2	92.5%	0.00E+00		0.00	49.6	938.3
***TOTAL OUTFLOW				10911.2	92.5%	0.00E+00		0.00	49.6	938.3
***RETENTION				882.6	7.5%	0.00E+00		0.00		

Overflow Rate (m/yr)	18.9	Nutrient Resid. Time (yrs)	0.0750
Hydraulic Resid. Time (yrs)	0.0804	Turnover Ratio	2.2
Reservoir Conc (mg/m3)	50	Retention Coef.	0.075

Lake Decatur

Hydraulic & Dispersion Parameters

Seg	Name	Outflow Seg	Net Inflow hm³/yr	Resid Time years	Overflow Rate m/yr	Velocity km/yr	Dispersion--------> Estimated km²/yr	Numeric km²/yr	Exchange hm³/yr
1	Downstream Near Dam	0	220.1	0.0423	57.2	73.7	5345.7	114.7	0.0
2	Middle	1	195.2	0.0220	45.9	316.6	11702.7	1103.1	937.9
3	Upstream	2	192.8	0.0212	54.7	414.0	5887.6	1818.9	215.6

Morphometry

Seg	Name	Area km²	Zmean m	Zmix m	Length km	Volume hm³	Width km	L/W -
1	Downstream Near Dam	3.8	2.4	2.4	3.1	9.3	1.2	2.5
2	Middle	4.3	1.0	1.0	7.0	4.3	0.6	11.4
3	Upstream	3.5	1.2	1.2	8.8	4.1	0.4	21.9
Totals		11.6	1.5			17.7		

Lake Decatur

Segment & Tributary Network

--------Segment:	1	Downstream Near Dam		
Outflow Segment:	0	Out of Reservoir		
Tributary:	1	Trib 1	Type:	Monitored Inflow
--------Segment:	2	Middle		
Outflow Segment:	1	Downstream Near Dam		
Tributary:	2	Trib 2	Type:	Monitored Inflow
--------Segment:	3	Upstream		
Outflow Segment:	2	Middle		
Tributary:	3	Trib 3	Type:	Monitored Inflow

Lake Decatur

Description:

Single reservoir (2,873 acres (from GIS))
3 segments

Global Variables	Mean	CV
Averaging Period (yrs)	0.166667	0.0
Precipitation (m)	0.1829	0.0
Evaporation (m)	0.1829	0.0
Storage Increase (m)	0	0.0

Atmos. Loads (kg/km^2-yr)	Mean	CV
Conserv. Substance	0	0.00
Total P	30	0.50
Total N	1000	0.50
Ortho P	15	0.50
Inorganic N	500	0.50

Model Options	Code	Description
Conservative Substance	0	NOT COMPUTED
Phosphorus Balance	6	FIRST ORDER
Nitrogen Balance	0	NOT COMPUTED
Chlorophyll-a	0	NOT COMPUTED
Secchi Depth	0	NOT COMPUTED
Dispersion	1	FISCHER-NUMERIC
Phosphorus Calibration	2	CONCENTRATIONS
Nitrogen Calibration	0	NONE
Error Analysis	0	NOT COMPUTED
Availability Factors	0	IGNORE
Mass-Balance Tables	1	USE ESTIMATED CONCS
Output Destination	2	EXCEL WORKSHEET

Segment Morphometry

		Outflow		Area	Depth	Length	Mixed Depth (m)		Hypol Depth		Non-Algal Turb (m^{-1})		Internal Loads (mg/m2-day) Conserv.		Total P		Total N	
Seg	Name	Segment	Group	km^2	m	km	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Downstream Near Dam	0	1	3.846709	2.42	3.115147	2.42	0	0	0	0	0	0	0	0	0	0	0
2	Middle	1	1	4.254451	1.01	6.968581	1.01	0	0	0	0	0	0	0	0	0	0	0
3	Upstream	2	1	3.526886	1.16	8.787018	1.16	0	0	0	0	0	0	0	0	0	0	0

Segment Observed Water Quality

	Conserv		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	0	0	158.6667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	202.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	202.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Segment Calibration Factors

	Dispersion Rate		Total P (ppb)		Total N (ppb)		Chl-a (ppb)		Secchi (m)		Organic N (ppb)		TP - Ortho P (ppb)		HOD (ppb/day)		MOD (ppb/day)	
Seg	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
2	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0

Tributary Data

				Dr Area	Flow (hm^3/yr)		Conserv.		Total P (ppb)		Total N (ppb)		Ortho P (ppb)		Inorganic N (ppb)	
Trib	Trib Name	Segment	Type	km^2	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	Trib 1	1	1	0	24.86821	0	0	0	52	0	0	0	0	0	0	0
2	Trib 2	2	1	0	2.47679	0	0	0	52	0	0	0	0	0	0	0
3	Trib 3	3	1	0	192.7501	0	0	0	52	0	0	0	0	0	0	0

Model Coefficients	Mean	CV
Dispersion Rate	1.000	0.70
Total Phosphorus	1.000	0.45
Total Nitrogen	1.000	0.55
Chl-a Model	1.000	0.26
Secchi Model	1.000	0.10
Organic N Model	1.000	0.12
TP-OP Model	1.000	0.15
HODv Model	1.000	0.15
MODv Model	1.000	0.22
Secchi/Chla Slope (m^2/mg)	0.025	0.00
Minimum Qs (m/yr)	0.100	0.00
Chl-a Flushing Term	1.000	0.00
Chl-a Temporal CV	0.620	0
Avail. Factor - Total P	0.330	0
Avail. Factor - Ortho P	1.930	0
Avail. Factor - Total N	0.590	0
Avail. Factor - Inorganic N	0.790	0

Attachment 5

This page is blank to facilitate double sided printing.

Attachment 5: Responsiveness Summary

This responsiveness summary responds to substantive questions and comments received during the public comment period from July 9, 2007 through August 14, 2007 postmarked, including those from the July 31, 2007 public meeting discussed below.

What is a TMDL?

A Total Maximum Daily Load (TMDL) is the sum of the allowable amount of a pollutant that a water body can receive from all contributing sources and still meet water quality standards or designated uses. This TMDL is for the Sangamon River/Lake Decatur watershed. This report details the watershed characteristics, impairment, sources, load and wasteload allocations, and reductions for each segment. The Illinois EPA implements the TMDL program in accordance with Section 303(d) of the federal Clean Water Act and regulations there under.

Background

The Sangamon River/ Lake Decatur watershed drains approximately 594,100 acres and lies in Ford, Champaign, McLean, Piatt, Macon, De Witt and Shelby counties. Land use in the watershed is 90 percent agriculture, three percent urban, two percent forest and two percent wetland. Waters impaired in this watershed are Sangamon River, Owl Creek and Lake Decatur. Sangamon River is listed on the Illinois EPA 2006 Section 303(d) List as being impaired for primary contact recreation (swimming) use with the potential cause of fecal coliform. Owl Creek is impaired for aquatic life use with the potential cause of low dissolved oxygen. Lake Decatur is impaired for public water supply use with the potential cause of nitrate. It is also impaired for aquatic life use and aesthetic quality use with the potential causes of total phosphorus, total suspended solids and siltation. The Clean Water Act and USEPA regulations require that states develop TMDLs for waters on the Section 303(d) List.

Public Meetings

Public meetings were held in Decatur on May 31, 2006 and July 31, 2007. The Illinois EPA provided public notices for all meetings by placing display ads in three newspapers in the watershed; the Decatur Herald and Review, Monticello Piatt County Journal Republican and Rantoul Press. These notices gave the date, time, location, and purpose of the meetings. It also provided references to obtain additional information about this specific site, the TMDL Program and other related issues. Individuals and organizations were also sent the public notice by first class mail. The draft TMDL Report was available for review at the Decatur Public Library, the Monticello Public Library and on the Agency's web page at http://www.epa.state.il.us/water/tmdl .

The first public meeting on May 31, 2006 started at 6:00 p.m. and was attended by approximately fifteen people. The second public meeting on July 31, 2007, started at 6:00 p.m. and was attended by ten people. The meeting record remained open until midnight, August 14, 2007.

Questions and Comments

1. Is there a lot of private septic system information?

   Response
   The Illinois Department of Public Health (IDPH) has contracts with county health departments. Most county health departments have information on new system installations and failing septic systems that have been reported but information varies greatly from county to county.

2. How does the TMDL program have any "reasonable assurance" that results will happen?

   Response
   For point sources, Illinois EPA uses the NPDES permit system to regulate discharges. Illinois EPA has no regulatory authority over nonpoint sources. Nonpoint source pollution controls consist of an incentive voluntary basis.

3. How extensive was the data set for nitrate? Did you use the waters treatment plant's data to get the reduction of 13-28 percent?

   Response
   Nitrate data used for the TMDL calculation included data collected by Illinois EPA (2000- 2006), Decatur Water Treatment Plant (2001-2005) and Illinois State Water Survey (2002-2003).

4. ISWS has been monitoring Lake Decatur for years. Why continue monitoring? Isn't it a waste of money?

   Response
   Monitoring will help keep track of any changes in a water body and will be used to measure progress in water restoration.