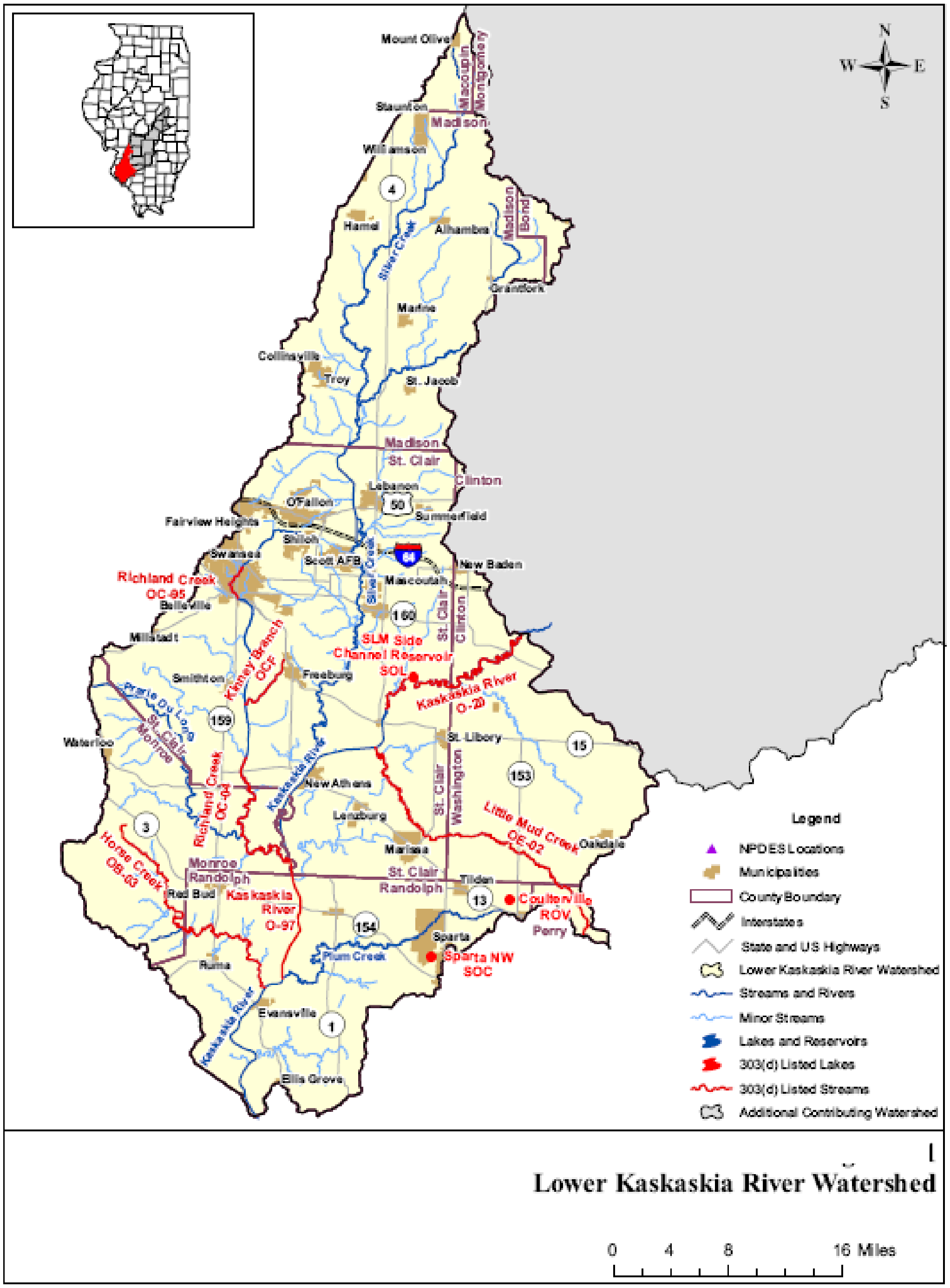
Lower Kaskaskia River Watershed TMDL Report

IEPA/BOW/12-001

February 2012



Illinois Environmental Protection Agency

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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REPLY TO THE ATTENTION OF:
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BUREAU OF WATER
BUREAU CHIEF'S OFF

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

Dear Ms. Willhite:

The U.S. Environmental Protection Agency has conducted a complete review of the final Total Maximum Daily Loads (TMDLs) for the Lower Kaskaskia River Watershed, including supporting documentation and follow up information. The Lower Kaskaskia River Watershed is located in the southern portion of Illinois in Madison, St. Clair, Randolph, and Washington Counties. The fecal coliform, atrazine, manganese, and phosphorus TMDLs submitted by the Illinois Environmental Protection Agency address the impaired designated Public and Food Processing Water Supplies and General Use.

These TMDLs meet the requirements of Section 303(d) of the Clean Water Act and EPA's implementing regulations at 40 C.F.R. Part 130. Therefore, EPA hereby approves Illinois' fourteen TMDLs for fecal coliform, atrazine, manganese, and phosphorus in the Lower Kaskaskia River Watershed. The statutory and regulatory requirements, and EPA's review of Illinois' compliance with each requirement, are described in the enclosed decision document.

We wish to acknowledge Illinois' effort in submitting these TMDLs and look forward to future TMDL submissions by the State of Illinois. If you have any questions, please contact Mr. Peter Swenson, Chief of the Watersheds and Wetlands Branch, at 312-886-0236.

Sincerely,

Tinka G. Hyde
Director, Water Division

Enclosure

cc: Amy Walkenbach, IEPA
Jennifer Clarke, IEPA

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Acronyms

°F	degrees Fahrenheit
μg/L	micrograms per liter
BMP	best management practice
BOD	biochemical oxygen demand
CAFOs	concentrated animal feeding operations
cfs	cubic feet per second
cfu	colony forming units
CRP	Conservation Reserve Program
CSO	combined sewer overflow
CWA	Clean Water Act
CWS	community water supply
DMR	Discharge Monitoring Reports
DO	dissolved oxygen
FRSS	Facility Related Stream Survey
GIS	geographic information system
IDA	Illinois Department of Agriculture
IDNR	Illinois Department of Natural Resources
IL-GAP	Illinois Gap Analysis Project
ILLCP	Illinois Interagency Landscape Classification Project
Illinois EPA	Illinois Environmental Protection Agency
INHS	Illinois Natural History Survey
IPCB	Illinois Pollution Control Board
ISWS	Illinois State Water Survey
LA	load allocation
LC	loading capacity
MCL	maximum contaminant level
mg/L	milligrams per liter
mgd	million gallons per day
MOS	margin of safety
MS4s	municipal separate storm sewer systems
NASS	National Agricultural Statistics Service
NCDC	National Climatic Data Center
NED	National Elevation Dataset

NRCS	National Resource Conservation Service
SOD	sediment oxygen demand
SSURGO	Soil Survey Geographic Database
STORET	Storage and Retrieval
STP	Sewage Treatment Plant
SWAP	Source Water Assessment Program
SWCD	Soil and Water Conservation District
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TOC	total organic carbon
TP	total phosphorus
TSS	total suspended solids
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WLA	waste load allocation

Section 1

Goals and Objectives for the Lower Kaskaskia River Watershed

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 develops a list known as the "303(d) list" of water bodies not meeting water quality standards every two years, and it is included in the Integrated Water Quality Report. Water bodies on the 303(d) list are then targeted for TMDL development. The Illinois EPA's most recent draft Integrated Water Quality Report was issued in March 2008 and is currently awaiting approval by USEPA. In accordance with USEPA's guidance, the report assigns all waters of the state to one of five categories. 303(d) listed water bodies make up category five in the integrated report (Appendix A of the draft 2008 Integrated Report).

In general, a TMDL is a quantitative assessment of water quality impairments, contributing sources, and pollutant reductions needed to attain water quality standards. The TMDL specifies the amount of pollutant or other stressor that needs to be reduced to meet water quality standards, allocates pollutant 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 primary contact (swimming), protection of aquatic life, and public and food processing water supply. 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 the Lower Kaskaskia River 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 (Sections 1-6) and Stage 3 (Sections 7-9) TMDL development for the Lower Kaskaskia River watershed. Stage 2 involves optional data collection and was performed, to a limited extent, by Illinois EPA in 2008. Additional data collected during Stage 2 is incorporated in the Stage 3 portion of this report (Sections 7-9).

Following this process, the TMDL goals and objectives for the Lower Kaskaskia River 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 Lower Kaskaskia River watershed:

- Kaskaskia River (O03)
- Kaskaskia River (O20)
- Kaskaskia River (O30)
- Kaskaskia River (O97)
- Salem Side Channel Reservoir (SOL)
- Horse Creek (OB03)
- Richland Creek- South (OC04)
- Richland Creek- South (OC95)
- Kinney Branch (OCF)
- Sparta NW Reservoir (SOC)
- Mud Creek (OE02)
- Coulterville Reservoir (ROV)

These impaired water body segments are shown on Figure 1-1. There are 12 impaired water body segments within the Lower Kaskaskia River watershed. Table 1-1 lists the water body segment, water body size, and potential causes and sources of impairment for the water body.

Table 1-1 Impaired Water Bodies in Lower Kaskaskia River Watershed

Water Body Segment ID	**Water Body Name**	**Size**	**Impaired Use**	**Cause of Impairment***	**Potential Sources**
O03	Kaskaskia River	15.25 miles	Aquatic Life	*Impairment Unknown*	Unknown
			Public Water Supply	**Atrazine**	Unknown, Crop Production
				Manganese	Unknown
O20	Kaskaskia River	22.3 miles	Primary Contact Recreation	**Fecal Coliform**	Unknown
			Public Water Supplies	**Manganese**	Unknown
O97	Kaskaskia River	8.89 miles	Aquatic Life	*Impairment Unknown*	Unknown
			Public Water Supplies	**Manganese**	Unknown
SOL	SLM Side Channel Reservoir	7 acres	Public Water Supplies	**Atrazine**	Unknown, Crop Production
				Manganese	Unknown
OE02	Mud Creek	34.29 miles	Aquatic Life	**Manganese**	Unknown
				Dissolved Oxygen**	Unknown
				Phosphorus (Total)	Animal Feeding Operations
				Sedimentation/Siltation	Animal Feeding Operations, Crop Production
ROV	Coulterville Reservoir	23.6 acres	Aesthetic Quality	**Phosphorus (Total)**	Crop Production
			Public Water Supplies	**Atrazine**	Crop Production
				Manganese**	Unknown
OB03	Horse Creek	28.09 miles	Aquatic Life	**Dissolved Oxygen****	Animal Feeding Operations
				Sedimentation/Siltation	Crop Production
OC04	Richland Creek- South	17.51 miles	Aquatic Life	*Nitrogen (Total)*	Municipal Point Source Discharges, Crop Production, Combined Sewer Overflows, Urban Runoff/Storm Sewers
				Dissolved Oxygen**	Municipal Point Source Discharges, Urban Runoff/Storm Sewers, Combined Sewer Overflows
				Phosphorus (Total)	Crop Production, Urban Runoff/Storm Sewers, Combined Sewer Overflows, Municipal Point Source Discharges
				Sedimentation/Siltation	Crop Production, Surface Mining, Urban Runoff/Storm Sewers
				Total Suspended Solids	Urban Runoff/Storm Sewers, Surface Mining, Crop Production

Table 1-1 Impaired Water Bodies in Lower Kaskaskia River Watershed (cont.)

Water Body Segment ID	Water Body Name	Size	Impaired Use	Cause of Impairment*	Potential Sources
OCF	Kinney Branch	4.98 miles	Aquatic Life	**Manganese**	Urban Runoff/Storm Sewers
				Nitrogen (Total)	Municipal Point Source Discharges, Crop Production, Urban Runoff/Storm Sewers
				Dissolved Oxygen**	Urban Runoff/Storm Sewers, Municipal Point Source Discharges
				Phosphorus (Total)	Urban Runoff/Storm Sewers, Crop Production, Municipal Point Source Discharges
OC95	Richland Creek- South	2.9 miles	Aquatic Life	*Nitrogen (Total)*	Urban Runoff/Storm Sewers, Municipal Point Source Discharges
				Dissolved Oxygen**	Municipal Point Source Discharges, Urban Runoff/Storm Sewers
				Phosphorus (Total)	Municipal Point Source Discharges, Urban Runoff/Storm Sewers
SOC	Sparta NW Reservoir	33 acres	Aesthetic Quality	**Phosphorus (Total)**	Crop Production
			Public Water Supplies	**Atrazine**	Unknown, Crop Production
				Manganese**	Unknown
O30	Kaskaskia River	13.32 miles	Aquatic Life	**Dissolved Oxygen****	Unknown
				pH**	Unknown
				Phosphorus (Total)	Crop Production
				Sedimentation/Siltation	Crop Production
				Total Suspended Solids	Crop Production
			Primary Contact Recreation	**Fecal Coliform**	Unknown
			Public Water Supply	**Atrazine**	Unknown, Crop Production
				Manganese	Unknown

* **Bold Causes of Impairment have numeric water quality standards.** *Italicized Causes of Impairment do not have numeric water quality standard.*

***TMDLs were not developed for stream pH and dissolved oxygen impairments, or reservoir manganese impairments in Coulterville and Sparta NW reservoirs.*

Illinois EPA is currently only developing TMDLs for parameters that have numeric water quality standards, and therefore the remaining sections of this report will discuss the analysis performed for pH, dissolved oxygen, total fecal coliform, manganese, atrazine, and total phosphorus (numeric standard) impairments in the Lower Kaskaskia River watershed. Ultimately, TMDLs were not developed for dissolved oxygen in streams. Further discussion on dissolved oxygen analysis is provided in Sections 7 and 8. Additionally, no TMDLs for manganese in Coulterville or Sparta NW Reservoirs were developed. The TMDLs developed to address total phosphorus levels in these waterbodies will likely remedy the elevated levels of manganese. Again, further discussion of this analysis is provided in Sections 7 and 8. For potential causes that do not have numeric water quality standards as noted in Table 1-1, TMDLs were not developed at this time. However, in the implementation plans completed during Stage 3 of the TMDL, some of these potential causes are addressed by implementation of controls for the pollutants with water quality standards (see Section 9).

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 Lower Kaskaskia River 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 a timeframe for completion of implementation activities.

1.3 Report Overview

The remaining sections of this report contain:

- **Section 2 Lower Kaskaskia River 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 will occur throughout TMDL development.
- **Section 4 Lower Kaskaskia River Water Quality Standards** defines the water quality standards for the impaired water bodies.

- **Section 5 Lower Kaskaskia River Characterization** presents the available water quality data needed to develop TMDLs, discusses the characteristics of the impaired reservoirs in the watershed, and also describes the point and non-point sources with potential to contribute to the watershed load.

- **Section 6 Approach to Developing TMDL and Identification of Data Needs** makes recommendations for the models and analysis that will be needed for TMDL development and also suggests segments for Stage 2 data collection.

- **Section 7 Methodology Development for the Lower Kaskaskia River Watershed** details the development of the TMDLs for each impaired stream segment and reservoir.

- **Section 8 Total Maximum Daily Load for the Lower Kaskaskia River Watershed** provides the results of the TMDL analysis for each impaired stream segment and reservoir.

- **Section 9 Implementation Plan for the Lower Kaskaskia River Watershed** makes recommendations for implementation actions, point source controls, management measures, and BMPs that can be used to address water quality issues in the watershed.

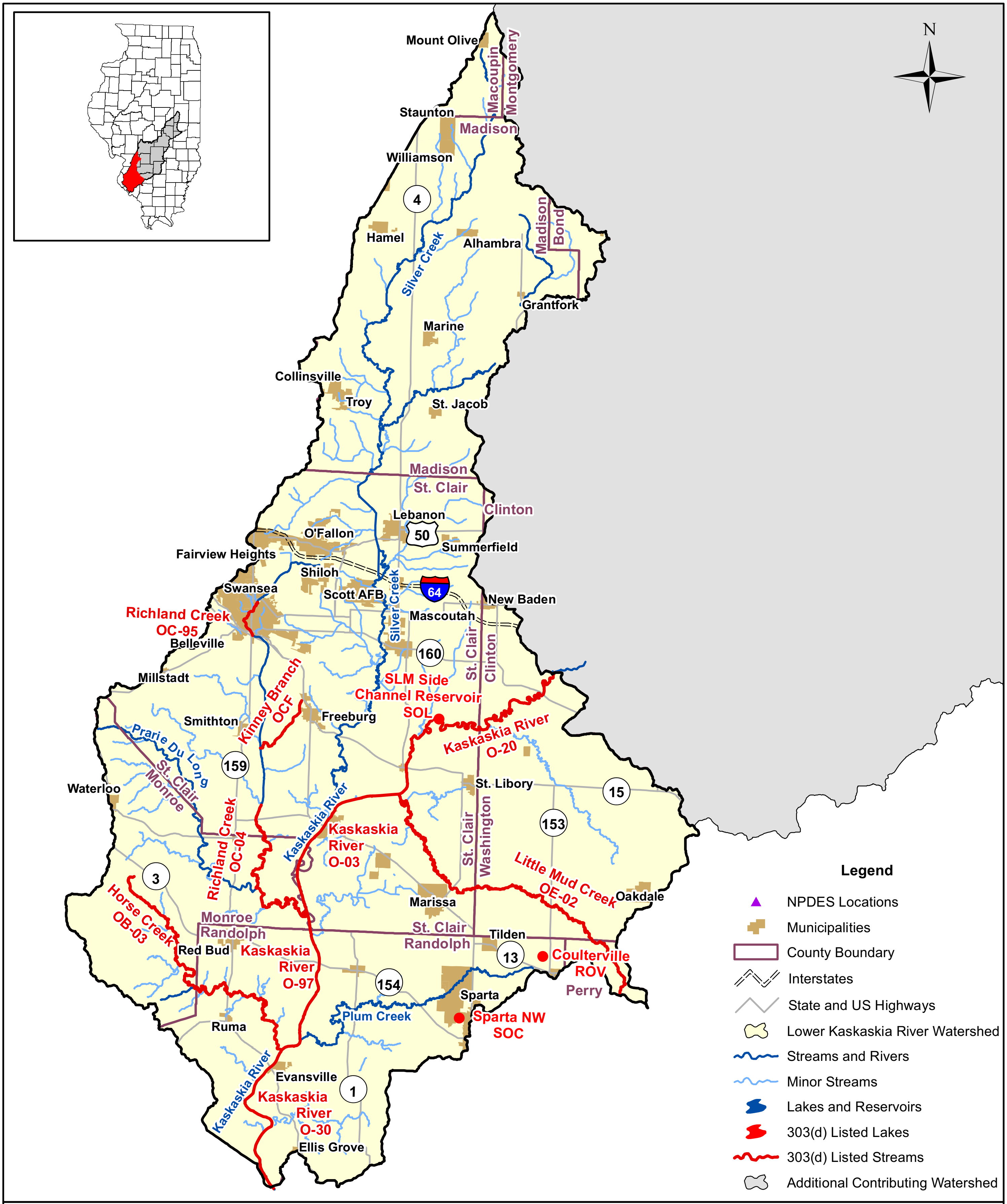

Figure 1-1
Lower Kaskaskia River Watershed

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Section 2
Lower Kaskaskia River Watershed Description

2.1 Lower Kaskaskia River Watershed Location

The Kaskaskia River watershed (Figure 1-1) is located in southern and central Illinois, flows in a southerly direction, and drains over 3.7 million acres. The watershed covers over 10 percent of the total land area in the State of Illinois, and includes some portion of 22 separate counties. To facilitate TMDL development for such a large watershed, Illinois EPA has separated the watershed into several sub-watersheds. Several of the sub-watersheds upstream of the Lower Kaskaskia River watershed have completed, or are in the process of completing TMDL development (i.e., Shoal Creek, Crooked Creek, etc.). Information on upstream sub-watershed impairments and TMDL development are available from the Illinois EPA's TMDL information website: http://www.epa.state.il.us/water/tmdl/. All of the impaired segments discussed in this report are located in the Lower Kaskaskia River watershed, as delineated by Illinois EPA, but the mainstem Kaskaskia River segments receive flow from additional upstream watersheds. Watershed descriptions provided in this section of the report focus primarily on the Lower Kaskaskia River watershed.

Approximately 330,000 acres (36 percent of the total Lower Kaskaskia River watershed) lie in St. Clair County, 170,000 acres (19 percent of the total watershed) lie in Madison County, 167,000 acres (18 percent of the total watershed) lie in Randolph County, 111,000 acres (12 percent of the total watershed) lie in Washington County, and 97,000 acres (11 percent of the total watershed) lie in Monroe County. Small portions of the Lower Kaskaskia River watershed, less than 5 percent of the total watershed area, are within Clinton, Macoupin, Bond, Perry, and Montgomery Counties.

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 Lower Kaskaskia River watershed were obtained by overlaying the NED grid onto the GIS-delineated watershed. Figure 2-1 shows the elevations found within the watershed.

Elevation in the Lower Kaskaskia River watershed ranges from 751 feet above sea level at the northern tip of the watershed near Mount Olive and in the southwest portion of the watershed near Waterloo to 338 feet at its most downstream point along the Kaskaskia River in the southern end of the watershed.

2.3 Land Use

Land use data for the Lower Kaskaskia River 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 (USDA) National Agricultural Statistics Service (NASS), the Illinois Department of Agriculture (IDA), and the Illinois Department of Natural Resources (IDNR). The land cover data was generated using 30-meter grid resolution satellite imagery taken during 1999 and 2000. The IL-GAP Land Cover data layer contains 23 land cover categories, including detailed classification in the vegetated areas of Illinois. Appendix A contains a complete listing of land cover categories. (Source: IDNR, INHS, IDA, USDA NASS's 1:100,000 Scale Land Cover of Illinois 1999-2000, Raster Digital Data, Version 2.0, September 2003.)

The land use of the Lower Kaskaskia River 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 Lower Kaskaskia River watershed, based on the IL-GAP land cover categories and also includes the area of each land cover category and percentage of the watershed area. Figure 2-2 illustrates the land uses of the watershed.

Table 2-1 Land Cover and Land Use in Lower Kaskaskia River Watershed

Land Cover Category	Area (Acres)	Percentage
Soybeans	247,410	27.0
Corn	216,196	23.6
Winter Wheat/Soybeans	91,343	10.0
Rural Grassland	87,709	9.6
Upland Forest	74,166	8.1
Floodplain Forest	55,566	6.1
Winter Wheat	32,784	3.6
Low/Medium Density	24,061	2.6
Partial Canopy/Savannah Upland	13,864	1.5
Surface Water	13,382	1.5
High Density	13,253	1.4
Urban Open Space	12,999	1.4
Other Small Grains & Hay	11,772	1.3
Seasonally/Temporarily Flooded	5,430	0.6
Deep Marsh	4,676	0.5
Other Agriculture	4,354	0.5
Shallow Marsh/Wet Meadow	2,955	0.3
Shallow Water	1,840	0.2
Barren & Exposed Land	952	0.1
Coniferous	530	0.1
Swamp	247	<0.1
Total	**915,493**	**100.0**

The land cover data reveal that approximately 691,570 acres, representing over 76 percent of the total watershed area, are devoted to agricultural activities. Corn and soybean farming account for 24 and 27 percent of the watershed area, respectively, and winter wheat/soybean farming and rural grassland each account for 10 percent of the watershed. Upland forest and floodplain forest account for 8 and 6 percent of the total area, respectively. Other land cover types each represent less than 5 percent of the watershed area.

Land use throughout the entire Kaskaskia River watershed is also dominated by agricultural uses. Approximately 78 percent of the overall watershed is devoted to agricultural uses. A total of 15 percent of the overall watershed is forested and approximately 3.5 percent of the overall watershed is urbanized. Table 2-2 provides information on land use and land cover for the full extent of the Kaskaskia River watershed.

Table 2-2 Complete Land Cover and Land Use for entire Kaskaskia River Watershed

Land Cover Category	Area (Acres)	Percentage
Soybeans	1,150,863	30.9
Corn	1,074,048	28.9
Upland	360,653	9.7
Rural Grassland	282,152	7.6
Winter Wheat/Soybeans	218,718	5.9
Floodplain Forest	166,050	4.5
Winter Wheat	101,575	2.7
Surface Water	59,204	1.6
Low/Medium Density	59,061	1.6
Other Small Grains & Hay	45,918	1.2
Partial Canopy/Savannah Upland	43,566	1.2
High Density	41,559	1.1
Urban Open Space	26,533	0.7
Other Agriculture	26,178	0.7
Shallow Marsh/Wet Meadow	19,495	0.5
Seasonally/Temporarily Flooded	18,282	0.5
Deep Marsh	13,146	0.4
Shallow Water	10,273	0.3
Barren & Exposed Land	2,751	0.1
Coniferous	535	0.0
Swamp	247	0.0
Total	**3,720,808**	**100.0**

2.4 Soils

Soils data are available through the Soil Survey Geographic (SSURGO) database. 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.

Attributes of the spatial coverage can be linked to the 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 Lower Kaskaskia River watershed.

2.4.1 Lower Kaskaskia River Watershed Soil Characteristics

Appendix B contains a table of the SSURGO soil series for the Lower Kaskaskia River watershed. Various soil types exist in the watershed, but no single type covers more than 1 percent of the watershed. 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.

Figure 2-3 shows the hydrologic soils groups found within the Lower Kaskaskia River watershed. 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 A, B, C, D, B/D, and C/D are found within the Lower Kaskaskia River watershed. Groups B, C, and D cover about 42, 34, and 16 percent of the watershed, respectively, and the other groups cover only trivial percent of the watershed. Group B soils are defined as having "moderately low runoff potential when thoroughly wet." These soils have a moderate rate of water transmission. Group C soils are defined as having "moderately high runoff potential when thoroughly wet." These soils have a low rate of water transmission. Group D soils are defined as having "high runoff potential when thoroughly wet." These soils have a very low or non-existent rate of water transmission (NRCS 2007).

In addition, NRCS soil surveys of the Lower Kaskaskia River watershed counties were also reviewed for information regarding the presence of manganese in area soils. Many of the soil series present in the area are described as having “masses of iron and manganese accumulation throughout”.

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 Lower Kaskaskia River watershed range from 0.15 to 0.49.

2.5 Population

The Census 2000 TIGER/Line data from the U.S. Census Bureau were retrieved. Geographic shapefiles of census blocks were downloaded for the following counties within the Lower Kaskaskia River Watershed: Washington, St. Clair, Randolph, Perry, Montgomery, Monroe, Madison, Clinton, and Bond Counties. The census block shapefiles were clipped to each watershed so that only block populations directly associated with the watershed would be counted. City populations were taken from the U.S. Census Bureau. For municipalities located along a watershed boarder, population was estimated based on the percentage of the municipalities' area within the watershed boundary. Approximately 321,200 people reside in the Lower Kaskaskia River watershed. The major municipalities in the watershed are shown in Figure 1-1. The city of Belleville, which has a total population of 41,400 lies in the watershed and is the largest population center in the watershed.

2.6 Climate, Pan Evaporation, and Streamflow

2.6.1 Climate

Southwest Illinois has a temperate climate with hot summers and cold, snowy winters. Monthly precipitation data from Sparta, Illinois (station id. 8147) in Randolph County were extracted from the NCDC database for the years of 1901 through 2006. The data station in Sparta, Illinois was chosen to be representative of precipitation throughout the Lower Kaskaskia River watershed.

Table 2-3 contains the average monthly precipitation along with average high and low temperatures for the period of record. The average annual precipitation is approximately 38.3 inches.

Table 2-3 Average Monthly Climate Data in Sparta, Illinois (1901-2006)

Month	Total Precipitation (inches)	Maximum Temperature (degrees F)	Minimum Temperature (degrees F)
January	2.7	41	23
February	1.4	45	26
March	2.6	56	35
April	4.2	68	45
May	4.8	76	53
June	4.0	84	62
July	4.2	90	66
August	4.2	88	65
September	2.8	82	57
October	3.0	71	46
November	2.6	57	36
December	1.8	44	27
Total	38.3	67	45

2.6.2 Pan Evaporation

Through the ISWS website, pan evaporation data are available from nine locations across Illinois (ISWS 2007). The Belleville station was chosen to be representative of pan evaporation conditions for Sparta NW, SLM Side Channel, and Coulterville Reservoirs. The Belleville station is located approximately 11.3 miles west of SLM

Side Channel Reservoir, approximately 36.4 miles northwest of Sparta NW Reservoir, and approximately 35.9 miles northwest of Coulterville Reservoir. The station was chosen for its proximity to the 303(d)-listed water bodies in south central Illinois and the completeness of the dataset. The average monthly pan evaporation at the Belleville station for the years 1986 to 2006 yields an average annual pan evaporation of 40.6 inches. Actual evaporation is typically less than pan evaporation, so the average annual pan evaporation was multiplied by 0.75 to calculate an average annual evaporation of 30.5 inches (ISWS 2007).

2.6.3 Streamflow

Analysis of the Lower Kaskaskia River watershed requires an understanding of flow throughout the drainage area. Four USGS gages within the watershed have available and recent data (Figure 2-4). Table 2-4 summarizes the stations along with their respective information.

Table 2-4 Streamflow Gages in the Lower Kaskaskia River Watershed

Gage Number	Name	POR
05594450	Silver Creek near Troy, Illinois	1966-2008
05594100	Kaskaskia River near Venedy Station, Illinois	1969-2008
05594800	Silver Creek near Freeburg, Illinois	1970-2008
05595200	Richland Creek near Hecker, Illinois	1969-2008

USGS gage 05594100 (Kaskaskia River near Venedy Station, Illinois) and gage 05595200 (Richland Creek near Hecker, Illinois) were chosen as the appropriate gages from which to estimate flows for the impaired water bodies within the Lower Kaskaskia River watershed. USGS gage 05594100 is located on the Kaskaskia River approximately 10.5 miles southeast of the city of Mascoutah, Illinois and will be used to analyze flow data along the Kaskaskia River. The drainage area to the gage is approximately 4,393 square miles. USGS gage 05595200 is located on Richland Creek and is approximately 13 miles south of the city of Belleville, Illinois and will be used to analyze flow along the smaller impaired creeks within the Lower Kaskaskia River watershed. The drainage area to the gage is approximately 129 square miles.

Data were downloaded through the USGS for the Kaskaskia River and Richland Creek gages for the available period of records, which were both 1969-2008. As previously mentioned, the Kaskaskia River at gage 055994100 has a drainage area of 4,393 square miles, which has over 150 point sources within the drainage area. The streamflow data includes waters received from point sources. This influence was further quantified during the Stage 3 TMDL development. Average daily discharges into the Kaskaskia River watershed upstream of gage 055994100 total approximately 445 million gallons per day (mgd).

There are eight permitted facilities upstream of the USGS gage on Richland Creek. Table 2-5 shows the permitted facilities upstream of the USGS gages on Richland Creek. Richland Creek receives a cumulative discharge of 12.3mgd before gage 05595200.

The average monthly flows in the Kaskaskia River range from 934 cubic feet per second (cfs) to 6511 cfs with a mean flow of 3,622 cfs (see Figure 2-5). For Richland Creek, the before-mentioned cumulative discharge flows from the permitted facilities were subtracted from the USGS gage flows to account for flows associated with precipitation and overland runoff only. The average monthly naturally occurring flows in Richland Creek range from 22 cfs to 164 cfs with a mean flow of 93 cfs (see Figure 2-5). Quantification of watershed contributions and flows for each impaired water body were performed as during model development conducted as part of the Stage 3 TMDL development and are discussed further in Sections 7 and 8 of this report.

Table 2-5 Permitted Facilities that Discharge into Richland Creek Above Gage 05595200

NPDES Permit Number	Facility Name	Permitted Discharge (mgd)
ILG580026	Smithton STP	0.240
IL0020753	Freeburg East STP	0.310
IL0021181	Swansea STP	2.700
IL0021873	Belleville STP #1	8.000
IL0032310	Freeburg West STP	0.400
IL0032514	Millstadt STP	0.500
ILG580250	Smithton-Wildwood	0.154
IL0075442	Home Oil Company-Belleville	0.010
Total	**8**	**12.314**

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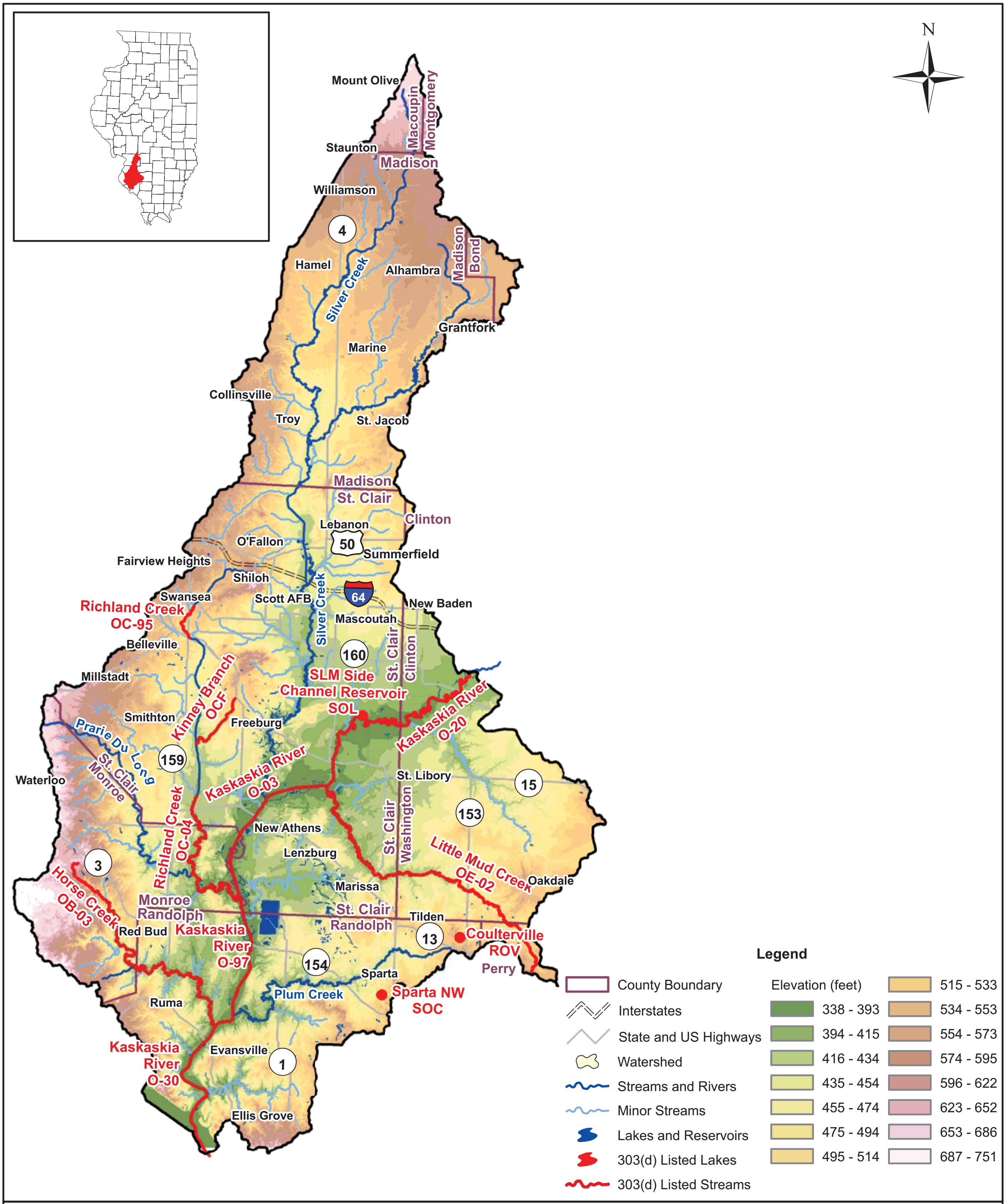

Figure 2-1
Lower Kaskaskia River Watershed Elevation

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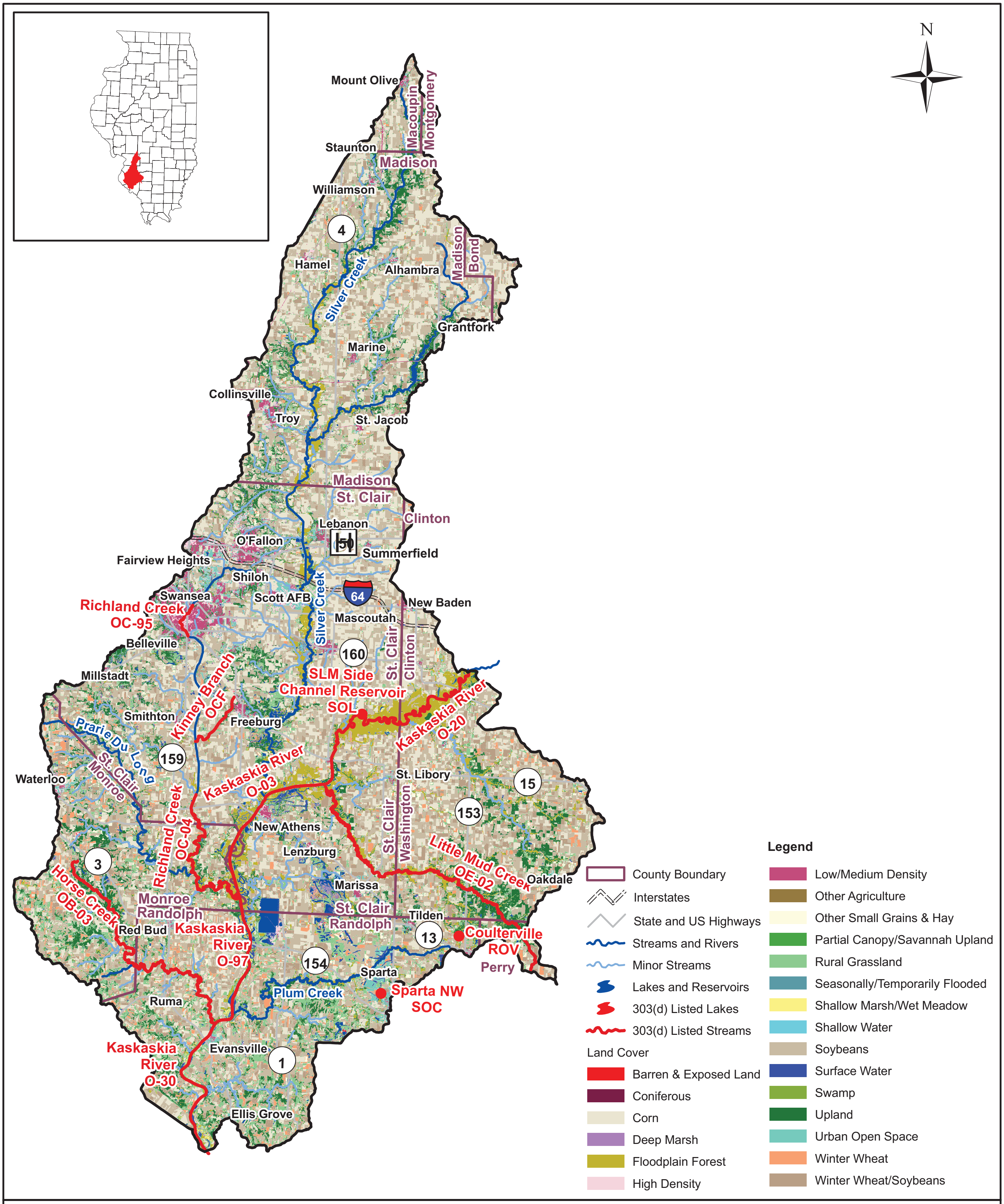

Figure 2-2
Lower Kaskaskia River Watershed
Land Use

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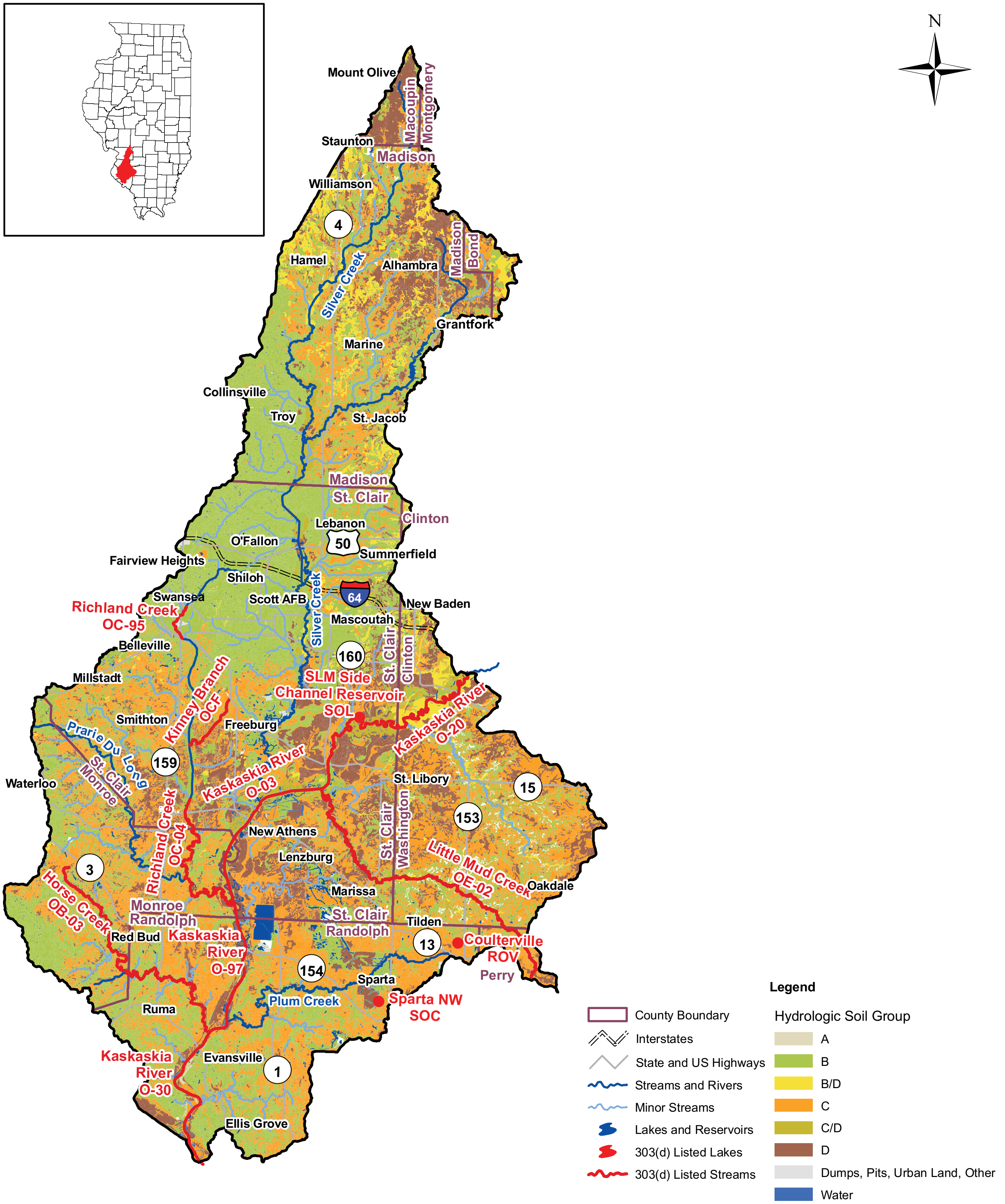

Figure 2-3
Lower Kaskaskia River Watershed Soils

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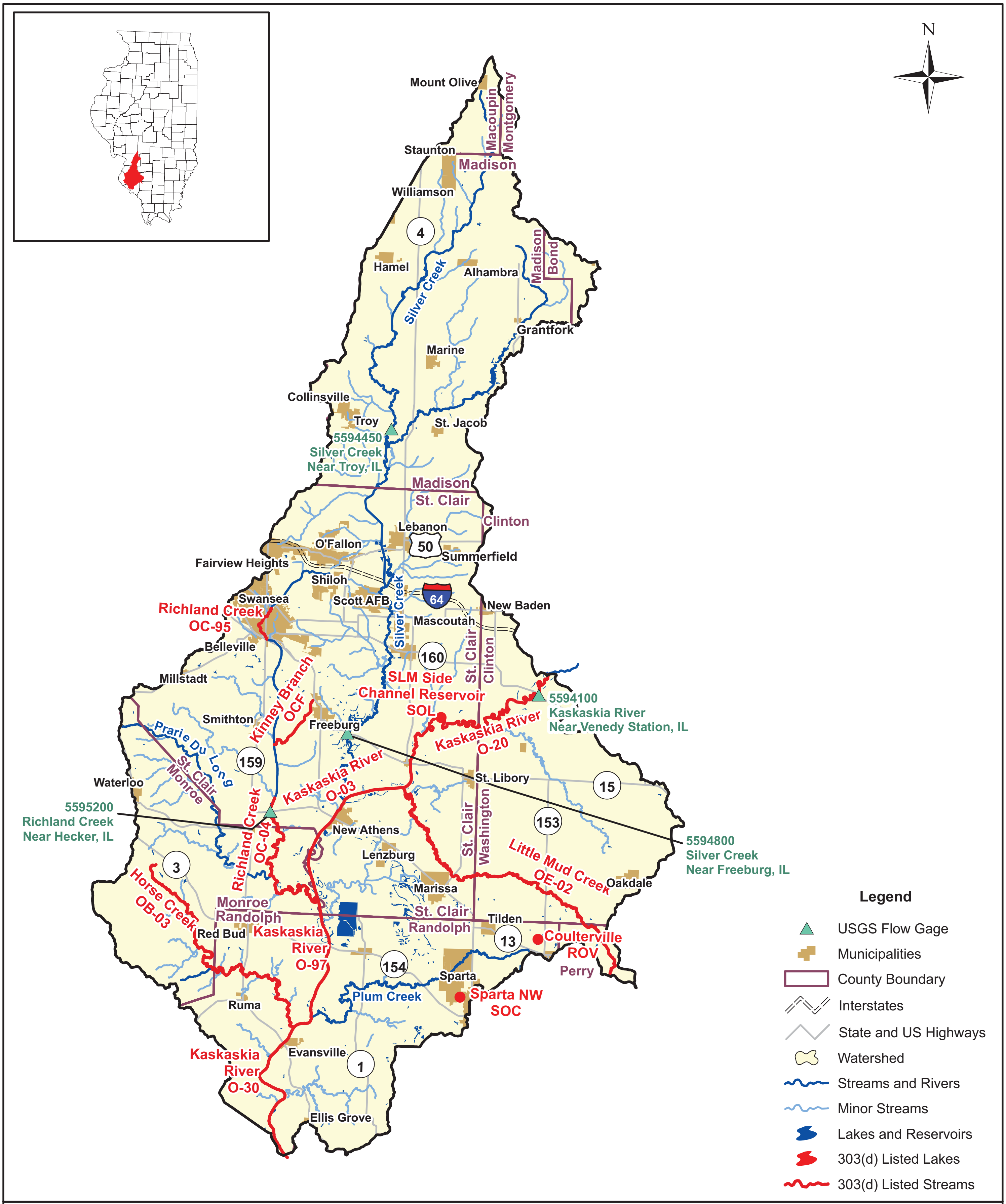

Figure 2-4
Lower Kaskaskia River Watershed
USGS Gages

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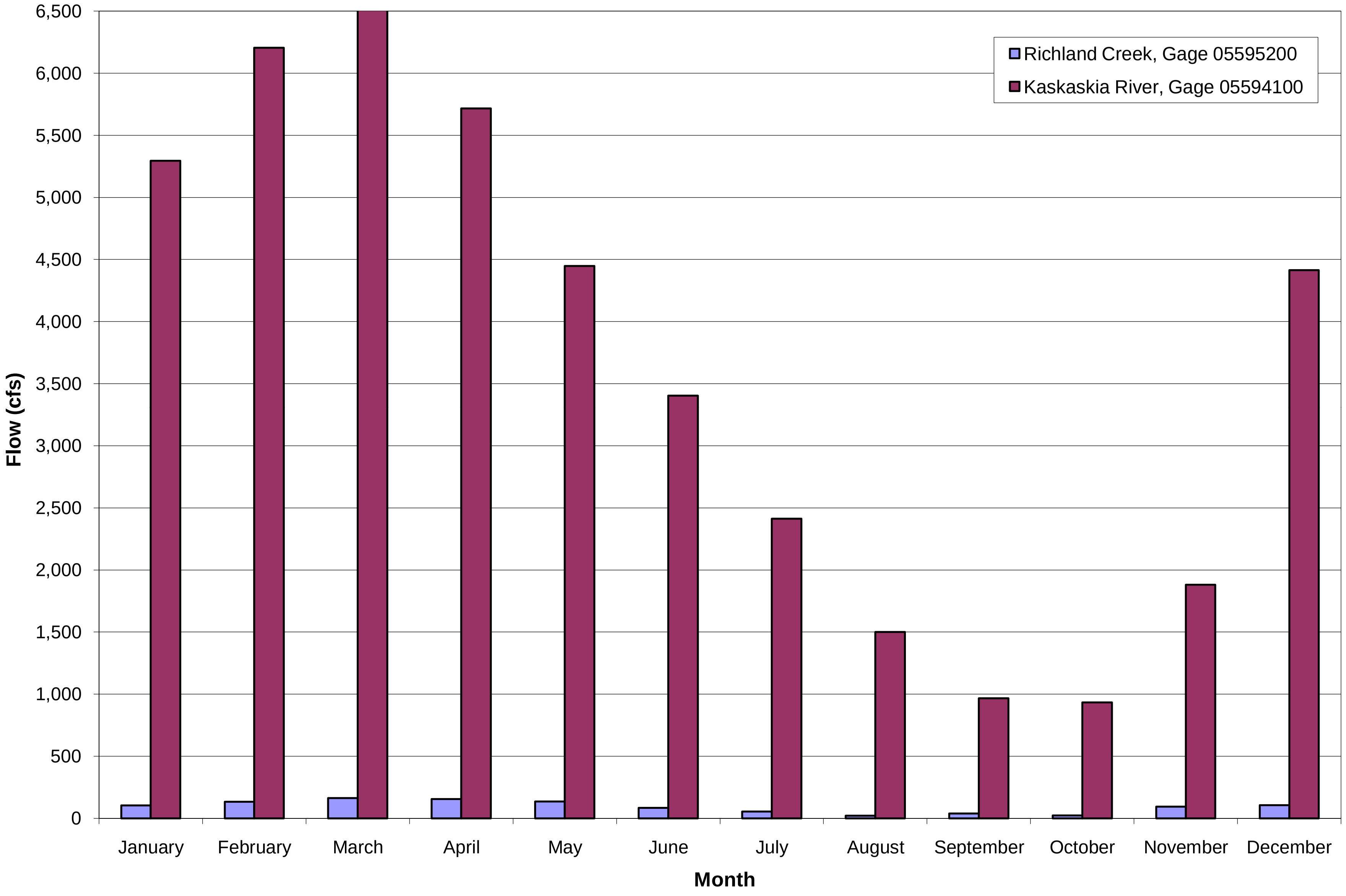

CDM

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Figure 2-5:
Total Monthly Streamflow
in Richland Creek and Kaskaskia River

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Section 3
Public Participation and Involvement

3.1 Lower Kaskaskia River 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, has held one public meeting and will hold one more public meeting within the watershed throughout the course of the TMDL development. Following the completion of Stage 1 of the TMDL process, a public meeting was held in Highland, Illinois on May 13, 2009. No public response comments were submitted to Illinois EPA as a result of this meeting. A similar meeting was held in Highland, IL on July 21, 2010 to present Stage 3 of the TMDL process along with the implementation plan contained in Section 9. No public comments were received after this meeting.

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Section 4
Lower Kaskaskia River Watershed Water Quality Standards

4.1 Illinois Water Quality Standards

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

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

4.2 Designated Uses

The waters of Illinois are classified by designated uses, which include: General Use, Public and Food Processing Water Supplies, Lake Michigan, and Secondary Contact and Indigenous Aquatic Life Use (Illinois EPA 2008). The designated uses applicable to the Lower Kaskaskia River 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 impairment to aquatic life exists, a comparison of available water quality data with water quality standards will then occur. For public and food processing water supply waters, Illinois EPA compares available data with water quality standards to make impairment determinations. Tables 4-1 and 4-2 present the numeric water quality standards of the potential causes of impairment for both lakes and streams in the Lower Kaskaskia River watershed. Only constituents with numeric water quality standards will have TMDLs developed at this time.

Table 4-1 Summary of Numeric Water Quality Standards for Potential Causes of Lake Impairments in Lower Kaskaskia River Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference	Public and Food Processing Water Supplies	Regulatory Reference
Manganese (total)	μg/L	1000	302.208(g)	150	302.304
Total Phosphorus	mg/L	0.05(1)	302.205	No numeric standard	NA
Atrazine	μg/L	Acute standard(2) = 82 Chronic standard(3) = 9	NA(4)	3(5)	611.310(c)

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

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

(2) Not to be exceeded except as provided in 35 Ill. Adm. Code 302.208(d).

(3) Not to be exceeded by the average of at least three samples collected over peak atrazine application periods (Spring, Summer, and Fall).

(4) Aquatic life standard for atrazine found in the Illinois Derived Standards.

(5) The treated water MCL for atrazine is 3 μg/L. For untreated water samples, during the most recent three sampling years i.) any observation is not to exceed four times the treated water MCL (12 μg/L); or ii.) any quarterly average concentration is not to exceed the treated water MCL (3 μg/L); or iii.) any running annual average is not to exceed the treated water MCL (3 μg/L).

Table 4-2 Summary of Numeric Water Quality Standards for Potential Causes of Stream Impairments in Lower Kaskaskia River Watershed

Parameter	Units	General Use Water Quality Standard	Regulatory Reference	Public and Food Processing Water Supplies	Regulatory Reference
Atrazine	µg/L	Acute standard(3) = 82 Chronic standard(4) = 9	NA(5)	3(6)	611.310(c)
Manganese (total)	µg/L	1000	302.208(g)	150	302.304
Dissolved Oxygen	mg/L	*March through July* ≥5.0 minimum & ≥6.0 7-day daily mean averaged over 7 days; *August through February* ≥3.5 minimum, ≥4.0 7-day minimum averaged over 7 days & ≥5.5 30-day daily mean	302.206(b)	No numeric standard	NA
Total Fecal Coliform	Count/ 100 mL	*May through October* 200(1), 400(2)	302.209	2000(1)	302.306
pH	s.u.	6-9	302.204	No numeric standard	NA

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

(1) Geometric mean based on a minimum of five samples taken over not more than a 30-day period.

(2) Standard shall not be exceeded by more than 10 percent of the samples collected during any 30-day period.

(3) Not to be exceeded except as provided in 35 Ill. Adm. Code 302.208(d).

(4) Not to be exceeded by the average of at least three samples collected over peak atrazine application periods (Spring, Summer, and Fall).

(5) Aquatic life standard for atrazine found in the Illinois Derived Standards.

(6) The treated water MCL for atrazine is 3 µg/L. For untreated water samples, during the most recent three sampling years i.) any observation is not to exceed four times the treated water MCL (12 µg/L); or ii.) any quarterly average concentration is not to exceed the treated water MCL (3 µg/L); or iii.) any running annual average is not to exceed the treated water MCL (3 µg/L).

4.4 Potential Pollutant Sources

In order to properly address the conditions within the Lower Kaskaskia River watershed, potential pollutant 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 potential causes for the 303(d) listed segments in this watershed.

Table 4-3 Summary of Potential Pollutant Sources in the Lower Kaskaskia River Watershed

Segment ID	Segment Name	Potential Causes of Impairment	Potential Sources (as identified by the 2008 303(d) list)
O-03	Kaskaskia River	Impairment Unknown, **Atrazine**, **Manganese**	Unknown
O-20	Kaskaskia River	**Fecal Coliform**, **Manganese**	Unknown
O-97	Kaskaskia River	Impairment Unknown, **Manganese**	Unknown
O-30	Kaskaskia River	**Dissolved Oxygen**, **pH**, Phosphorus (Total), Sedimentation/Siltation, Total Suspended Solids, **Fecal Coliform**, **Atrazine**, **Manganese**	Unknown, Crop Production
SOL	Salem Side Channel Reservoir	**Atrazine**, **Manganese**	Unknown, Crop Production
OE-02	Mud Creek	**Manganese**, **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Siltation	Unknown, Animal Feeding Operations, Crop Production
ROV	Coulterville Reservoir	**Phosphorus (Total)**, **Atrazine**, **Manganese**	Crop Production, Unknown
OB-03	Horse Creek	**Dissolved Oxygen**, Sedimentation/Siltation	Animal Feeding Operations, Crop Production
OCF	Kinney Branch	**Manganese**, Nitrogen (Total), **Dissolved Oxygen**, Phosphorus (Total)	Municipal Point Source Discharges, Crop Production, Urban Runoff/Storm Sewers
OC-95	Richland Creek-South	Nitrogen (Total), **Dissolved Oxygen,** Phosphorus (Total)	Municipal Point Source Discharges, Urban Runoff/Storm Sewers
SOC	Sparta NW Reservoir	**Phosphorus (Total)**, **Atrazine**, **Manganese**	Unknown, Crop Production
OC-04	Richland Creek-South	Nitrogen (Total), **Dissolved Oxygen**, Phosphorus (Total), Sedimentation/Silitation, Total Dissolved Solids	Municipal Point Source Discharges, Crop Production, Combined Sewer Overflows, Urban Runoff/Storm Sewers, Surface Mining

***Bold Potential Causes of Impairment have numeric water quality standard and TMDLs will be developed.**

Section 5
Lower Kaskaskia River Watershed Characterization

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

5.1 Water Quality Data

There are 23 historic water quality stations within the Lower Kaskaskia River 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 Lower Kaskaskia River watershed were presented in Section 1. Refer to Table 1-1 for impairment information specific to each segment. The following sections address both stream and lake impairments. Data are summarized by impairment and discussed in relation to the relevant Illinois numeric water quality standard. Data analysis is focused on all available data collected since 1990. The information presented in this section is a combination of USEPA Storage and Retrieval (STORET) database and Illinois EPA database data. STORET data are available for stations sampled prior to January 1, 1999 while Illinois EPA data (electronic and hard copy) are available for stations sampled after that date. Additional data collected by Illinois EPA in 2007 and 2008 from segments OC-95, OC-04, and OCF has been included in this Stage 3 report. The following sections will first discuss Lower Kaskaskia River watershed stream data followed by Lower Kaskaskia River watershed lake data.

5.1.1 Stream Water Quality Data

The Lower Kaskaskia River watershed has nine impaired stream segments within its drainage area that are addressed in this report. There is one active water quality station on each of the impaired segments and four monitoring stations associated with Facility Related Stream Surveys on the impaired Richland Creek and Kinney Branch segments (see Figure 5-1). The data summarized in this section include water quality data for constituents causing impairment as well as parameters that could be useful in future modeling and analysis efforts. All historic water quality data are available in Appendix C.

5.1.1.1 Fecal Coliform

Kaskaskia River segments O-20 and O-30 are listed as impaired by total fecal coliform. Table 5-1 summarizes available historic fecal coliform data on those segments. The general use water quality standard for fecal coliform states that the standard of 200 colony forming units (cfu) 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 cfu 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 O-20 and O-30.

Table 5-1 Existing Fecal Coliform Data for Lower Kaskaskia River 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)
Kaskaskia River Segment O-20; Sample Location O-20						
Total Fecal Coliform (cfu/100 mL)	1990-2005; 60	218.46	20,000	10	27	18
Kaskaskia River Segment O-30; Sample Location O-30						
Total Fecal Coliform (cfu/100 mL)	1990-2005; 60	29.75	4,600	ND	6	4

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

5.1.1.2 Dissolved Oxygen

Kaskaskia River segments O-30, Horse Creek segment OB-03, Richland Creek segments OC-04 and OC-95, Kinney Branch segment OCF, and Mud Creek segment OE-02 are impaired by low dissolved oxygen (DO). Data from a 1996 Facility Related Stream Survey (FRSS) for Freeburg, Illinois were the only data available for segment OCF until additional sampling was conducted by Illinois EPA in 2007 and 2008. Likewise, data from the 1996 FRSS for Swansea and Belleville, Illinois are the only data available for segment OC-95 prior to 2007-2008. The 2007-2008 data includes continuous DO monitoring events of approximately 1-week in duration from segments OCF and OC-95. These data were not available prior to completion of the Stage 1 report in 2009, but are now included in the tables below. All available dissolved oxygen data for the impaired segments are summarized in Table 5-2. A sample was considered a violation if it was below 5.0 mg/L between March and July or below 3.5 mg/L between August and February.

Table 5-2 Existing Dissolved Oxygen Data for the Lower Kaskaskia River Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (µg/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Kaskaskia River Segment O-30; Sample Location O-30						
Dissolved Oxygen	5.0(1), 3.5(2)	1990-2005; 143	8.11	17.3	1.1	16
Horse Creek Segment OB-03; Sample Location OB-03						
Dissolved Oxygen	5.0(1), 3.5(2)	1996-2002; 5	5.68	9.3	3.8	2
Richland Creek Segment OC-04; Sample Location OC-04						
Dissolved Oxygen	5.0(1), 3.5(2)	1990-2008; 159	8.46	17	2.3	3
Richland Creek Segment OC-95; Sample Locations OC-SW-A1, OC-SW-C1, OC-SW-C2, OC-SW-C3A, OC-SW-C5, OC-BV-A2						
Dissolved Oxygen	5.0(1), 3.5(2)	1996, 2008; 681	5.17	7.83	0.2	313
Kinney Branch Segment OCF; Sample Locations OCF-FB-A1, OCF-FB-C1, OCF-FB-C2, OCF-FB-C3						
Dissolved Oxygen	5.0(1), 3.5(2)	1996, 2008; 679	5.48	9.08	0.04	166
Mud Creek Segment OE-02; Sample Locations OE-04, OE-05						
Dissolved Oxygen	5.0(1), 3.5(2)	1996; 2	3.80	5.7	1.9	1

(1) Instantaneous Minimum *March-July*
(2) Instantaneous Minimum *August-February*

Figure 5-3 shows the instantaneous DO values for segments O-30, OB-03, OC-04, and OE-05 over time. Figure 5-4 shows the instantaneous DO values for each station on segments OC-95 and OCF as collected during the respective Facility Related Stream Surveys. Figure 5-5 and Figure 5-6 provide plots of the continuous DO monitoring data collected in 2008 from stations OCF and OC-95, respectively.

Table 5-3 contains information on data availability for other parameters that may be useful in data needs analysis and modeling efforts for dissolved oxygen. Where available, all nutrient, biological oxygen demand, and total organic carbon data has been collected for possible use in future analysis.

Table 5-3 Data Availability for DO Data Needs Analysis and Future Modeling Efforts

Sample Location and Parameter	Available Period of Record	Number of Samples
Kaskaskia River Segment O-30; Sample Location O-30		
Dissolved Phosphorus	1990-2005	125
Temperature, Water	1990-2002	116
Total Phosphorus	1990-2005	125
Total Phosphorus in bottom deposits	2002-2002	1
Ammonia, Total	1990-2002	114
Ammonia, unionized	1990-1998	162
Carbon, Total Organic (TOC)	1990-1998	80
COD	1990-1993	35
Nitrogen, Nitrate + Nitrite	1990-2005	129
Nitrogen, Total Kjeldahl (TKN)	1990-2005	114
Horse Creek Segment OB-03; Sample Location OB-03		
Dissolved Phosphorus	1996-2002	5
Temperature, Water	1996-2002	4
Total Phosphorus	1996-2002	5
Total Phosphorus in bottom deposits	2002-2002	1
Ammonia, Total	1996-2002	5
Ammonia, unionized	1996-1996	4
Carbon, Total Organic (TOC)	1996-1996	2
Nitrogen, Nitrate + Nitrite	1996-2002	5
Nitrogen, Total Kjeldahl (TKN)	1996-1996	2

Table 5-3 Data Availability for DO Data Needs Analysis and Future Modeling Efforts (cont.)

Sample Location and Parameter	Available Period of Record	Number of Samples
Richland Creek Segment OC-04; Sample Location OC-04		
Dissolved Phosphorus	1990-2005	120
Temperature, Water	1990-2008	143
Total Phosphorus	1990-2008	127
Total Phosphorus in bottom deposits	2002-2002	1
Ammonia, Total	1990-2008	113
Ammonia, unionized	1990-1998	158
Carbon, Total Organic (TOC)	1996-2008	3
COD	1990-1993	34
Nitrogen, Nitrate + Nitrite	1990-2008	131
Nitrogen, Total Kjeldahl (TKN)	1996-2008	11
Richland Creek Segment OC-95; Sample Locations OC-SW-A1, OC-SW-C1, OC-SW-C2, OC-SW-C3A, OC-SW-C5, OC-BV-A2		
BOD Total	2008-2008	4
Temperature, Water	1996-1996	6
Total Phosphorus	1996-2008	10
Ammonia, Total	1996-2008	10
Ammonia, unionized	1996-1996	6
BOD Carbonaceous	2008-2008	4
Carbon, Total Organic (TOC)	1996-1996	6
Nitrogen, Nitrate + Nitrite	1996-2008	10
Nitrogen, Total Kjeldahl (TKN)	2008-2008	4
Kinney Branch Segment OCF; Sample Locations OCF-FB-A1, OCF-FB-C1, OCF-FB-C2, OCF-FB-C3		
BOD Total	1996-2008	8
Temperature, Water	1996-1996	4
Total Phosphorus	1996-2008	8
Ammonia, Total	1996-2008	8
Ammonia, unionized	1996-1996	4
BOD Carbonaceous	1996-2008	8
Carbon, Total Organic (TOC)	1996-1996	4
Nitrogen, Nitrate + Nitrite	1996-2008	8
Nitrogen, Total Kjeldahl (TKN)	2008-2008	4
Mud Creek Segment OE-02; Sample Locations OE-04, OE-05		
Dissolved Phosphorus	1996-1996	2
Temperature, Water	1996-1996	2
Total Phosphorus	1996-1996	2
Ammonia, Total	1996-1996	2
Ammonia, unionized	1996-1996	4
Carbon, Total Organic (TOC)	1996-1996	2
Nitrogen, Nitrate + Nitrite	1996-1996	2
Nitrogen, Total Kjeldahl (TKN)	1996-1996	2

5.1.1.3 pH

Kaskaskia River segment O-30 is listed for impairment caused by pH. A sample is considered a violation if it falls below 6.5 or above 9.0 standard units at any time. A total of 141 samples have been collected since 1990 from the impaired segment. As shown in Table 5-4, three of the samples collected at O-30 during this time period were in violation of the standard. Figure 5-7 shows the pH samples collected over time at segment O-30.

Table 5-4 Existing pH Data for Lower Kaskaskia River watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Kaskaskia River Segment O-30; Sample Location O-30						
pH	6.5-9.0	1990-2005;141	7.48	8.6	6.1	3

5.1.1.4 Manganese

Kaskaskia River segments O-03, O-20, O-30, O-97, Kinney Branch segment OCF, and Mud Creek segment OE-02 are impaired by manganese. The applicable water quality standard is a maximum total manganese concentration of 1000 µg/L for general use and indigenous aquatic life and 150 µg/L for public water supply. All segments except OCF are sources of public water and are subject to the more stringent 150 µg/L limit. Table 5-5 summarizes the available historic manganese data since 1990 for the impaired stream segments. This includes dissolved manganese samples where available. The table also shows the number of violations for each segment. The first number in the column represents violations of the general use standard while the second number represents violations of the public water supply standard. Total manganese samples collected over time for the impaired segments O-03, O-97, O-20, and O-30 are shown in Figure 5-8. Total Manganese samples collected over time on the remaining stream segments OCF and OE-02 are shown in Figure 5-9.

Table 5-5 Existing Manganese Data for the Lower Kaskaskia River Watershed Impaired Stream Segments

Sample Location and Parameter	Illinois WQ Standard (ug/L)	Period of Record and Number of Data Points	Mean	Maximum	Minimum	Number of Violations
Kaskaskia River Segment O-O3; Sample Location O-03						
Total Manganese	Public Water Supply: 150	2002; 3	220	230	210	3
Dissolved Manganese	NA	2002; 3	22.7	28	20	NA
Kaskaskia River Segment O-20; Sample Location O-20						
Total Manganese	Public Water Supply: 150	1990-2005; 144	278.2	1200	28	110
Dissolved Manganese	NA	1990-2005; 142	100.1	720	3.3	NA
Kaskaskia River Segment O-30; Sample Location O-30						
Total Manganese	Public Water Supply: 150	1990-2005; 143	219.9	890	68	90
Dissolved Manganese	NA	1990-2005; 142	88.4	550	3.2	NA
Kaskaskia River Segment O-97; Sample Location O-04						
Total Manganese	Public Water Supply: 150	2002; 3	200	210	190	3
Dissolved Manganese	NA	2002; 3	22	36	15	NA
Kinney Branch Segment OCF; Sample Locations OCF-FB-A1, OCF-FB-C1, OCF-FB-C2, OCF-FB-C3						
Total Manganese	General Use: 1000	1996-2008; 8	240.1	1100	46	1
Mud Creek Segment OE-02; Sample Locations OE-04, OE-05						
Total Manganese	General Use: 1000	1996-2002; 6	1670	3600	480	3
Dissolved Manganese	NA	1996-2002; 5	1822	3600	420	NA

5.1.1.5 Atrazine

Kaskaskia River segments O-03 and O-30 are listed for impairment caused by atrazine. There is one active station on each impaired stream segment. A raw water intake is located on the Kaskaskia River segment O-03 and is used by the Kaskaskia Water District at New Athens. The town of Evansville has a raw water intake on Kaskaskia River Segment O-30. Data from these two raw water intakes and the associated finished water was used for this report and an inventory of available data is presented in Table 5-6.

Atrazine is an herbicide applied to food crops to control broadleaf and grassy weeds. It is widely used throughout the United States. When properly applied it breaks down into the soil, but it has been found in groundwater wells and surface water near areas of excessive application. Extensive water supply monitoring and studies on the human health effects of atrazine in drinking water have been performed, and efforts are on-going. Atrazine has been suspected to be carcinogenic to humans and a potential endocrine disruptor. USEPA has determined that atrazine is not likely to cause cancer in humans and that it does not adversely affect amphibian gonadal development as suspected. However, the Agency will reconsider whether to reverse its determination on cancer after several epidemiological cancer studies for atrazine are received and reviewed (USEPA, 2008).

Table 5-6 summarizes recent atrazine data in treated and untreated water from each of the impaired stream segments in the Lower Kaskaskia River watershed. The water quality standard to protect public water supply use states that the maximum contaminant level (MCL) for each parameter in treated water must not be exceeded in any samples taken during the most recent three sampling years. The treated water MCL for atrazine is 3 µg/L. Furthermore, for untreated water samples collected during the three most recent sampling years i) any observation is not to exceed four times the treated water MCL (12 µg/L); or ii) any quarterly average concentration is not to exceed the treated water MCL (3 µg/L); or iii) any running annual average is not to exceed the treated water MCL (3 µg/L).

Table 5-6 Recent Atrazine Data from Impaired Kaskaskia River Segment O-03 and O-30

Stream Segment and Sample Type	Period of Record/ Number of Data Points	Average	Maximum	Minimum	Number of samples > 3 µg/L	Number of samples >12 µg/L (4x MCL)
Kaskaskia River Segment O-03						
Raw Water Intake	2003-2005; 95	2.90	57.98	0.05	15	6
Treated Water	2003-2005; 95	1.01	14.73	0.05	5	NA
Kaskaskia River Segment O-30						
Raw Water Intake	2004-2005; 68	2.93	31.25	0.05	12	5
Treated Water	2004-2005; 68	3.10	39.69	0.05	12	NA

As shown in Table 5-6, 5 of the 95 (5 percent) treated water samples in Kaskaskia River Segment O-03 exceeded the MCL of 3 µg/L, and 6 of the 95 raw water samples exceeded 12 µg/L. In Kaskaskia River Segment O-30, 12 of 68 (18 percent) of the treated water samples exceeded the MCL of 3 µg/L and 5 of the raw water samples exceeded 12 µg/L. Table 5-7 shows that 2005 was the only year where the rolling annual average atrazine concentrations in the stream segment O-03 exceeded 3 µg/L. The quarterly average exceeded 3 µg/L in the second quarter of 2003, 2004, and 2005. Similarly, Table 5-8 shows that 2005 was the only year where the rolling annual average atrazine concentrations in the stream segment O-30 exceeded 3 µg/L. The quarterly average exceeded 3 µg/L in the second quarter of 2004 and 2005. Atrazine concentrations in raw and treated water for segments O-03 and O-30 are shown in Figures 5-10 and 5-11, respectively.

Table 5-7 Annual and Quarterly Average Atrazine Concentrations in Kaskaskia River Segments O-03, Untreated Water

Year/QTR	Quarterly Average	Average >3 µg/L	Rolling Annual Average	Average >3 µg/L
2003				
1	NA	NA	NA	NA
2	3.32	Yes	NA	NA
3	1.91	No	NA	NA
4	1.03	No	NA	NA
2004				
1	0.51	No	2.05	No
2	4.65	Yes	2.57	No
3	0.88	No	2.32	No
4	0.54	No	2.24	No
2005				
1	0.28	No	2.14	No
2	9.68	Yes	4.06	Yes
3	1.01	No	4.00	Yes
4	0.11	No	3.93	Yes

Table 5-8 Annual and Quarterly Average Atrazine Concentrations in Kaskaskia River Segments O-30, Untreated Water

Year/QTR	Quarterly Average	Average >3 µg/L	Rolling Annual Average	Average >3 µg/L
2004				
1	0.42	No	NA	NA
2	6.03	Yes	NA	NA
3	1.36	No	NA	NA
4	0.58	No	2.89	No
2005				
1	0.27	No	2.78	No
2	6.86	Yes	3.10	Yes
3	1.36	No	3.05	Yes
4	0.07	No	2.96	No

5.1.2 Lake Water Quality Data

The Lower Kaskaskia River watershed has three impaired reservoirs within its drainage area that are 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 are available in Appendix C.

5.1.2.1 Coulterville Reservoir

Coulterville Reservoir is listed as impaired for total phosphorous, manganese, and atrazine. There are three active stations in Coulterville Reservoir (see Figure 5-12). An inventory of all available data associated with impairments at all depths is presented in Table 5-9.

Table 5-9 Coulterville Reservoir Data Inventory for Impairments

Coulterville Reservoir Segment ROV; Sample Locations ROV-1, ROV-2, and ROV-3		
ROV-1	**Period of Record**	**Number of Samples**
Atrazine	1999-1999	6
Dissolved Phosphorus	1992-2004	23
Manganese in Bottom Deposits	1992-1999	2
Manganese, Total	1999-1999	4
Total Phosphorus	1990-2004	35
ROV-2		
Dissolved Phosphorus	1999-2004	70
Total Phosphorus	1999-2004	9
ROV-3		
Atrazine	1999-1999	1
Dissolved Phosphorus	1999-2004	9
Manganese in Bottom Deposits	1999-1999	1
Total Phosphorus	1990-2004	18
Raw Water Intake		
Atrazine	2003-2005	103
Finished Water from PWS		
Atrazine	2003-2005	98

Table 5-10 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 5-10 represents data collected at varying depths.

Table 5-10 Coulterville Reservoir Data Availability for Data Needs Analysis and Future Modeling Efforts

Coulterville Reservoir Segment ROV; Sample Locations ROV-1, ROV-2, and ROV-3		
ROV-1	**Period of Record**	**Number of Samples**
Chlorophyll a, corrected	2004-2004	2
Chlorophyll a, uncorrected	1992-2004	13
Depth, bottom	1990-2004	60
Dissolved Oxygen	1992-1999	71
Temperature, Water	1992-1999	71
ROV-2		
Chlorophyll a, corrected	2004-2004	2
Chlorophyll a, uncorrected	1999-2004	12
Depth, bottom	1990-2004	34
Dissolved Oxygen	1999-1999	34
Chlorophyll a, corrected	2004-2004	2
ROV-3		
Chlorophyll a, corrected	2004-2004	2
Chlorophyll a, uncorrected	1999-2004	11
Depth, bottom	1990-2004	34
Dissolved Oxygen	1999-1999	13
Temperature, Water	1999-1999	13

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 Coulterville Reservoir are presented in Table 5-11.

Table 5-11 Average Total Phosphorus Concentrations (mg/L) in Coulterville Reservoir at One-Foot depth

	ROV-1		**ROV-2**		**ROV-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	0.235	0; 0	NA	6; 6	0.753	12; 11	0.494
1992	2; 2	0.182	0; 0	NA	1; 1	0.312	3; 3	0.225
1993	2; 2	0.169	0; 0	NA	2; 2	0.194	4; 4	0.182
1999	5; 4	0.172	5; 5	0.178	5; 4	0.181	15; 13	0.177
2004	4; 4	0.175	4; 4	0.173	4; 4	0.180	12; 12	0.176

As shown in the table, the majority of samples from 1990-2004 exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-13 shows the average annual total phosphorous concentrations in Coulterville Reservoir.

5.1.2.1.2 Manganese

Coulterville Reservoir is a public drinking water supply and is listed as impaired for impaired for manganese. The applicable water quality is a maximum total manganese concentration of 150 µg/L. All samples were collected in 1999 and each of them are in violation of the public water supply standard. Table 5-12 contains the available historic manganese data since 1990 for Coulterville Reservoir.

Table 5-12 Historical Total Manganese Concentrations (µg/L) in Coulterville Reservoir

Date	Concentration (µg/L)
4/30/1999	400
6/8/1999	630
8/23/1999	510
10/13/1999	470
Annual Mean Concentration	503

5.1.2.1.3 Atrazine

Coulterville Reservoir is also 303(d) listed for impairment caused by atrazine. A raw water intake is located on the reservoir and is used by the town of Coulterville for public water supply. Data from this raw water intake and the associated finished water was used for this report and an inventory of available data is presented in Table 5-13.

As shown in Table 5-13, 9 of the 98 (5 percent) treated water samples from Coulterville Reservoir exceeded the MCL of 3 µg/L, and 6 of the 103 raw water samples exceeded 12 µg/L. Additionally, 2 of 7 surface water samples collected at Stations ROV-1 and ROV-3 in 1999 exceeded 12 µg/L. Table 5-14 shows that the rolling annual average atrazine concentrations collected at the raw water intake in Coulterville Reservoir exceeded 3 µg/L in late 2003 and early 2004. The quarterly average exceeded 3 µg/L in the second and third quarters of 2003. The 1999 surface water sampling results for atrazine in Coulterville Reservoir are shown in Figure 5-14. Atrazine concentrations in raw and treated water collected from Coulterville Reservoir in 2003-2005 are shown in Figure 5-15.

Table 5-13 Atrazine Concentrations in Raw and Treated Water from Coulterville Reservoir

Stream Segment and Sample Type	Period of Record/ Number of Data Points	Average	Maximum	Minimum	Number of samples >3 µg/L	Number of samples >12 µg/L (4x MCL)
Coulterville Reservoir						
Surface Water*	1999; 7	14.88	50	0.3	2	2
Raw Water Intake	2003-2005; 103	2.07	19.39	0.05	9	6
Treated Water	2003-2005; 98	1.08	7.72	0.05	9	0

*Additional surface water data collected at stations ROV-1 and ROV-3

Table 5-14 Annual and Quarterly Average Atrazine Concentrations in Coulterville Reservoir, Untreated Water Collected at the Raw Water Intake

Year/QTR	Quarterly Average	Average >3 µg/L	Rolling Annual Average	Average >3 µg/L
2003				
1	0.18	NA	NA	NA
2	4.17	Yes	NA	NA
3	10.67	Yes	NA	NA
4	0.85	No	4.84	Yes
2004				
1	0.56	No	4.48	Yes
2	1.65	No	3.39	Yes
3	1.94	No	1.42	No
4	1.28	No	1.49	No
2005				
1	0.40	No	1.43	No
2	0.43	No	0.99	No
3	0.30	No	0.55	No
4	0.05	No	0.32	No

5.1.2.2 Sparta NW Reservoir

Sparta NW Reservoir is listed as impaired for total phosphorous, manganese, and atrazine. There are three active stations in Sparta NW Reservoir (see Figure 5-16). An inventory of all available data associated with impairments at all depths is presented in Table 5-15.

Table 5-15 Sparta NW Reservoir Data Inventory for Impairments

Sparta NW Reservoir Segment SOC; Sample Locations SOC-1, SOC-2, and SOC-3		
SOC-1	**Period of Record**	**Number of Samples**
Dissolved Phosphorus	2003	7
Manganese in Bottom Deposits	2003	1
Total Phosphorus	2003	10
SOC-2		
Atrazine	2003	10
Dissolved Phosphorus	2003	6
Manganese, Total	2003	5
Total Phosphorus	2003	7
SOC-3		
Dissolved Phosphorus	2003	2
Manganese in Bottom Deposits	2003	1
Total Phosphorus	2003	5

Table 5-16 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 5-16 represents data collected at varying depths.

Table 5-16 Sparta NW Reservoir Data Availability for Data Needs Analysis and Future Modeling Efforts

Sparta NW Reservoir Segment SOC; Sample Locations SOC-1, SOC-2, and SOC-3		
SOC-1	**Period of Record**	**Number of Samples**
Chlorophyll a, corrected	2003	5
Chlorophyll a, uncorrected	2003	5
Depth, bottom	2003	11
SOC-2		
Chlorophyll a, corrected	2003	5
Chlorophyll a, uncorrected	2003	5
Depth, bottom	2003	19
Hardness, Total	2003	5
SOC-3		
Chlorophyll a, corrected	2003	5
Chlorophyll a, uncorrected	2003	5
Depth, bottom	2003	5

5.1.2.2.1 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 the single year of available data at each monitoring site in Sparta NW Reservoir are presented in Table 5-17.

Table 5-17 Average Total Phosphorus Concentrations (mg/L) in Sparta NW Reservoir at one-foot depth

	SOC-1		**SOC-2**		**SOC-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**
2003	6; 4	0.501	6; 4	0.068	3; 1	0.054	15; 9	0.207

As shown in the table, the majority of samples from 2003 exceeded the total phosphorous water quality standard of 0.05 mg/L. Figure 5-17 shows the total phosphorous concentrations in Sparta NW Reservoir.

5.1.2.2.2 Manganese

Sparta NW Reservoir is a public drinking water supply and is listed as impaired by manganese. The applicable water quality standard is a maximum total manganese concentration of 150 µg/L. All samples were collected in 2003 and 3 of the five samples are in violation of the public water supply standard. Table 5-18 contains the available historic manganese data for Sparta NW Reservoir.

Table 5-18 Historical Total Manganese Concentrations (µg/L) in Sparta NW Reservoir

Date	**Concentration (µg/L)**
5/6/2003	110
6/30/2003	48
7/22/2003	**290**
8/21/2003	**400**
10/16/2003	**210**
Annual Mean Concentration	**212**

5.1.2.2.3 Atrazine

Sparta NW Reservoir is listed for impairment caused by atrazine. Several surface water samples were collected from station SOC-2 during 2003 and analyzed for atrazine concentration. There is currently no available data from raw water intakes or finished water from Sparta NW Reservoir for analysis. As shown in Table 5-19, no surface water samples exceeded the instantaneous limit of four times the finished water MCL (12 µg/L). However, the quarterly and annual average atrazine concentrations for all samples collected at Sparta NW Reservoir in 2003 were in violation of the 3 µg/L standard. The total atrazine concentrations for samples collected at Sparta NW Reservoir are shown in Figure 5-18.

Table 5-19 Available Atrazine Data in Sparta NW Reservoir

Date	Concentration (µg/L)	Average Greater than 3 µg/L	Sample >12 µg/L (4x MCL)
6/30/2003	6.80	-	No
6/30/2003	6.80	-	No
6/30/2003	7.00	-	No
6/30/2003	7.00	-	No
2nd Quarter Average	**6.90**	**Yes**	**-**
7/22/2003	5.70	-	No
7/22/2003	6.80	-	No
8/21/2003	0.68	-	No
8/21/2003	5.00	-	No
3rd Quarter Average	**4.55**	**Yes**	**-**
10/16/2003	3.40	-	No
10/16/2003	3.60	-	No
4th Quarter Average	**3.50**	**Yes**	**-**
Annual Average	**5.28**	**Yes**	**-**

5.1.2.3 SLM Side Channel Reservoir

SLM Side Channel Reservoir is listed as impaired by manganese and atrazine. There is one active station in SLM Side Channel Reservoir (see Figure 5-19). An inventory of all available data associated with impairments at all depths is presented in Table 5-20.

Table 5-20 SLM Side Channel Reservoir Data Inventory for Impairments

SLM Side Channel Reservoir Segment SOL; Sample Location SOL-1		
SOL-1	**Period of Record**	**Number of Samples**
Atrazine	2003-2006	21
Manganese in Bottom Deposits	2003-2006	2
Total Manganese	2003-2006	10

5.1.2.3.1 Manganese

SLM Side Channel Reservoir is a public drinking water supply and is listed as impaired by manganese. The applicable water quality standard is a maximum total manganese concentration of 150 µg/L. Five samples were collected in 2003 and three of the five samples are in violation of the public water supply standard. An additional five samples were collected in 2006, all of which exceeded the 150 µg/L standard. Table 5-21 summarizes the available historic manganese data for SLM Side Channel Reservoir.

Table 5-21 Historical Total Manganese Concentrations (µg/L) in SLM Side Channel Reservoir

Date	Concentration (µg/L)
5/12/2003	**240**
6/17/2003	94
7/21/2003	120
8/19/2003	**320**
10/15/2003	**150**
4/24/2006	**150**
6/28/2006	**200**
7/12/2006	**240**
8/31/2006	**320**
10/26/2006	**260**
Annual Mean Concentration	**209**

5.1.2.3.2 Atrazine

SLM Side Channel Reservoir is listed for impairment caused by atrazine. Several surface water samples were collected from station SOL-1 and analyzed for atrazine concentration during 2003 and again in 2006. There is currently no available data from raw water intakes or finished water from SLM Side Channel Reservoir for analysis. As shown in Table 5-22, two of the surface water samples collected in 2003 exceeded the instantaneous limit of four times the fished water MCL (12 µg/L). In addition, the 2nd quarter and annual average atrazine concentrations for samples collected at SLM Side Channel Reservoir in 2003 were in violation of the 3 µg/L standard, although with a limited number of samples. There were no violations in the 2006 surface water samples. The total atrazine concentrations for all samples collected at SLM Side Channel Reservoir are shown in Figure 5-20.

Table 5-22 Available Atrazine Data in SLM Side Channel Reservoir

Date	Concentration (µg/L)	Average Greater than 3 µg/L	Sample >12 µg/L (4x MCL)
5/12/2003	4.30	-	No
5/12/2003	4.00	-	No
6/17/2003	14.00	-	Yes
6/17/2003	14.00	-	Yes
2nd Quarter 2003 Average	**9.08**	**Yes**	**-**
7/21/2003	1.90	-	No
7/21/2003	1.80	-	No
8/19/2003	0.75	-	No
8/19/2003	0.73	-	No
3rd Quarter 2003 Average	**1.30**	**No**	**-**
10/15/2003	0.56	-	No
10/15/2003	0.56	-	No
4th Quarter 2003 Average	**0.56**	**No**	**-**

Table 5-22 Available Atrazine Data in SLM Side Channel Reservoir (cont.)

Date	Concentration (µg/L)	Average Greater than 3 µg/L	Sample >12 µg/L (4x MCL)
2003 Annual Average	**4.26**	**Yes**	**-**
4/24/2006	0.31	-	No
4/24/2006	0.00	-	No
6/28/2006	1.30	-	No
6/28/2006	1.00	-	No
2nd Quarter 2006 Average	**0.65**	**No**	**-**
7/12/2006	0.62	-	No
7/12/2006	0.79	-	No
8/31/2006	0.60	-	No
8/31/2006	0.59	-	No
3rd Quarter 2006 Average	**0.65**	**No**	**-**
10/26/2006	0.18	-	No
10/26/2006	0.31	-	No
4th Quarter 2006 Average	**0.25**	**No**	**-**
2006 Annual Average	**0.57**	**No**	**-**

5.2 Reservoir Characteristics

There are three impaired reservoirs in the Lower Kaskaskia River 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 SLM Side Channel, Sparta NW, and Coulterville Reservoirs.

5.2.1 SLM Reservoir

The SLM Side Channel Reservoir is a small side-channel reservoir located adjacent to the SLM Water Commission Water Treatment Plant. The Reservoir was constructed in 1972, and has a surface area of approximately 7 acres. Depths at sampling location SOL-1 have consistently been 6 feet.

According to the Illinois EPA Source Water Assessment Program (SWAP), drinking water for several Illinois communities including Summerfield, Lebanon, and Mascoutah is supplied by the SLM Water Commission (Facility No. 1635090). The Kaskaskia River and the SLM Reservoir serve as the source of this drinking water. Water is obtained from one surface water intake in the river (Illinois EPA #60023) and one intake in the Reservoir (Illinois EPA # 60024). Average pumpage is 2.1 million gallons per day to approximately 133 service connections and an estimated population of 300 people. Facilities that purchase water from SLM Water Commission include; Trenton (0270500), New Baden (0274700), New Memphis PWD (0275350), Tritownship Water District (1190080), Lebanon (1630650), Mascoutah (1630800), Summerfield (1631350) and FSH Water Commission (1635300). In addition, facilities that receive water indirectly from SLM through on the connected supplies listed above include; Albers (0270050), Damiansville (0275200), Hecker (1330150), Freeburg (1630600) and Smithton (1631300).

5.2.2 Sparta NW Reservoir

The SWAP Fact Sheet for Sparta states that drinking water for the City of Sparta, Illinois (Facility No. 1570600) is supplied by the Sparta community water supply (CWS). Three reservoirs; Sparta Old, Sparta North, and Sparta NW, and the Kaskaskia River serve as the source of this drinking water. Water is obtained from one surface water intake in each lake (Illinois EPA #60181, #60182 and #00702) and an intake on the River (Illinois EPA #60183). Average pumpage is 640,000 gallons per day to approximately 2,686 service connections and an estimated population of 6,455 people. Facilities that purchase water from Sparta include Eden PWD (1575600), the Village of Baldwin (1570050), and Egyptian Water Co (1570010).

The Old Sparta Reservoir was created in 1915 by damming a tributary to Mary's River, and the North Reservoir in 1954 by damming a tributary to Maxwell Creek. The newest reservoir is the Sparta NW Reservoir, formed in a former Peabody Coal Co. strip mine. Sparta NW has a surface are of 33 acres. The reservoir is deep with average bottoms depths in 2003 of 48 feet at SOC-1, 23 feet at SOC-2, and 16 feet at SOC-3.

5.2.3 Coulterville Reservoir

The Coulterville Reservoir is located in Randolph County and has a surface area of 27 acres. The lake was created in 1942 by damming and subsequently flooding portions of a tributary to the South Fork Mud Creek. Table 5-23 contains depth information from each sampling location on the reservoir.

Table 5-23 Average Maximum Depths (ft) for Coulterville Reservoir (Illinois EPA 2002 and USEPA 2002a)

Year	ROV-1	ROV-2	ROV-3
1990	17	13.4	10.7
1992	19.1	13.5	10.4
1993	19.8	13.8	9.4
Average	**18.6**	**13.6**	**10.2**

The Coulterville SWAP Fact Sheet states that drinking water for the Village of Coulterville, Illinois (Facility No. 1570150) is supplied by the Coulterville community water supply (CWS). Coulterville Reservoir acts as the source of this drinking water. Coulterville operates a surface water intake (Illinois EPA #60056) in the lake drawing an average of 179,100 gallons per day. This intake has one port at a fixed depth in the lake. Coulterville provides water to approximately 515 service connections and an estimated population of 1,100 people in Randolph County.

5.3 Point Sources

There are 71 active NPDES permitted point sources located within the Lower Kaskaskia River watershed. Table 5-24 contains permit information for these point sources while Figure 5-21 shows the location of each facility. Permit limits and discharge monitoring reports were analyzed during model development and are discussed further in Sections 7 and 8 of this report. Domestic wastewater facilities can contribute nutrients and bacteria to receiving waters. A number of these facilities have disinfection exemptions. These exemptions are further discussed in Section 9 and additional information is available in Appendix F. Industrial facilities and mining operations can contribute sediment, metals, and other pollutants that affect pH levels, among other things.

Municipal separate storm sewer systems (MS4s) permits exist for the cities of Troy, O'Fallon and Collinsville along the Kaskaskia River segment O-97. Segment O-97 is listed as impaired for Manganese, which is not likely to be significantly impacted by urban stormwater runoff. Additional MS4 permits exist for the cities of Fairview Heights and Swansea along Richland Creek segment OC-95 which is impaired for Dissolved Oxygen. Dissolved oxygen impairment and TMDLs in the Lower Kaskaskia River watershed are discussed in section 8.3.4 of this document.

Table 5-24 NPDES Permitted Facilities Discharging in the Lower Kaskaskia River Watershed

Facility ID	Facility Name	Facility ID	Facility Name
IL0000043	DYNEGY MIDWEST GENERATION-BALD	IL0062111	VALLEY VIEW MOBILE HOME PARK
IL0000582	PEABODY COAL COMPANY-RIVER KNG	IL0062740	PEABODY COAL COMPANY
IL0001112	HIGHLAND WTP	IL0063282	RUMA STP
IL0001236	SUMMERFIELD LEBANON MASCOUTAH	IL0064220	SUMMERFIELD STP
IL0020753	FREEBURG EAST STP	IL0066133	SPARTA STP
IL0020893	FAYETTEVILLE STP	IL0066788	TRISIMO MOTEL DEVELOPMENT
IL0021083	CASEYVILLE TOWNSHIP EAST STP	IL0067695	MISSISSIPPI RIVER TRANSMISSION
IL0021181	SWANSEA STP	IL0068314	IL DOT-I64 ST CLAIR COUNTY
IL0021440	EVANSVILLE STP	IL0068861	MUNIE TRUCKING CO.-HIGHLAND
IL0021636	O'FALLON STP	IL0070734	WATERLOO EAST STP
IL0021725	NEW ATHENS WWTP	IL0071579	MAPLE LEAF ESTATES WATER CORP.
IL0021873	BELLEVILLE STP #1	IL0074993	MANORS AT KENSINGTON PARQUE
IL0024601	NEW ATHENS MOBIL HOME PARK	IL0075094	METRO-EAST AIRPARK STP
IL0024813	MARISSA STP	IL0075434	MIDAMERICA AIRPORT
IL0025291	MASCOUTAH STP	IL0075442	HOME OIL COMPANY-BELLEVILLE
IL0025348	RED BUD STP	ILG551025	TRIAD COMMUNITY UNIT DIST #2
IL0026859	SCOTT AIR FORCE BASE	ILG551050	TIMBER LAKE HOMEOWNERS ASSOC
IL0026948	ADORERS OF THE BLOOD OF CHRIST	ILG580004	ALHAMBRA STP
IL0027219	BALDWIN STP	ILG580011	HAMEL STP
IL0029483	LEBANON STP	ILG580013	LENZBURG STP
IL0031488	TROY STP	ILG580014	SAINT LIBORY WWTP
IL0032310	FREEBURG WEST STP	ILG580026	SMITHTON STP
IL0032514	MILLSTADT STP	ILG580107	TILDEN STP
IL0046019	COUNTRYVIEW COURT-SPARTA	ILG580115	LIVINGSTON STP
IL0046493	PEABODY COAL CO BALDWIN #1 MIN	ILG580145	ELLIS GROVE STP
IL0046663	DUTCH HOLLOW VILLAGE, INC.	ILG580212	SAINT JACOB STP
IL0046884	JOHANNISBURG GRADE SCHOOL	ILG580217	HOPKINS PARK STP
IL0048232	ST. CLAIR TWP	ILG580228	MARINE STP
IL0049611	MARINE WTP	ILG580235	HECKER STP
IL0052001	ACKERMAN'S RESTAURANT	ILG640029	ALHAMBRA WTP

Table 5-24 NPDES Permitted Facilities Discharging in the Lower Kaskaskia River Watershed (cont.)

Facility ID	Facility Name	Facility ID	Facility Name
IL0052256	CLANAHAN TRAILER PARK	ILG640056	COULTERVILLE WTP
IL0052558	PEABODY COAL CO-BALDWIN 3 UNDE	ILG640162	ST. LIBORY WTP
IL0052566	PEABODY COAL-MARISSA MINE	ILG640190	BALDWIN WTP
IL0052884	KASKASKIA WATER DIST PWS	ILG840004	COLUMBIA QUARRY-WATERLOO PIT 7
IL0060062	TROY WTP	ILG840054	COLUMBIA QUARRY-HECKER STOCKPLILE
IL0061131	SMITHTON-WILDWOOD STP		

5.4 Nonpoint Sources

There are a number of potential nonpoint sources of pollutant loading to the impaired segments in the Lower Kaskaskia River watershed. This section will discuss cropping practices, animal operations, and area septic systems. General information was collected from the Illinois Department of Agriculture and the national Agricultural Statistics Survey, while site specific data were 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 Lower Kaskaskia River watershed is devoted to crops. Corn and soybean farming account for approximately 27 percent and 24 percent of the watershed respectively. The amount of cropland within the watershed is relevant because it can be a source of bacteria, atrazine, oxygen demanding materials, and manganese to area waterways. This type of landuse can contribute these constituents through general runoff caused by precipitation but can also increase loading by practices in place by the landowners. For instance, manure fertilizers can add significant loads of bacteria and nutrients to receiving waters if not applied correctly. Atrazine can be easily transmitted from herbicide applications on agricultural fields to waterbodies because it is persistent in the environment and weakly adsorbs to soils which can be carried into waterbodies through runoff from precipitation events. Tillage practices can affect runoff; for instance, conservation tillage can significant reduce the amount of water and sediment that enters streams. Tile drains are also a practice employed on farmland in southern Illinois. Tile drains allow faster transmission of pollutant-laden runoff and may even encourage bacteria growth within the drains.

Tillage practices can be categorized as conventional till, reduced till, mulch-till, and no-till. The percentage of each tillage practice for corn, soybeans, and small grains by county are generated by the Illinois Department of Agriculture from County Transect Surveys. The most recent survey was conducted in 2006. Data specific to the Lower Kaskaskia River watershed were not available; however, the Clinton, Monroe, Perry, Randolph, St Clair, and Washington County practices were available and are shown in the following tables.

Table 5-25 Tillage Practices in Clinton County

Tillage System	Corn	Soybean	Small Grain
Conventional	67%	29%	15%
Reduced - Till	5%	5%	0%
Mulch - Till	20%	26%	62%
No - Till	8%	40%	23%

Table 5-26 Tillage Practices in Monroe County

Tillage System	Corn	Soybean	Small Grain
Conventional	68%	20%	2%
Reduced - Till	24%	36%	25%
Mulch - Till	5%	22%	31%
No - Till	3%	22%	42%

Table 5-27 Tillage Practices in Perry County

Tillage System	Corn	Soybean	Small Grain
Conventional	15%	6%	1%
Reduced - Till	32%	23%	6%
Mulch - Till	17%	6%	7%
No - Till	36%	65%	86%

Table 5-28 Tillage Practices in Randolph County

Tillage System	Corn	Soybean	Small Grain
Conventional	81%	21%	17%
Reduced - Till	11%	15%	7%
Mulch - Till	7%	9%	56%
No - Till	1%	55%	20%

Table 5-29 Tillage Practices in St Clair County

Tillage System	Corn	Soybean	Small Grain
Conventional	97%	29%	89%
Reduced - Till	1%	23%	7%
Mulch - Till	1%	7%	2%
No - Till	1%	41%	2%

Table 5-30 Tillage Practices in Washington County

Tillage System	Corn	Soybean	Small Grain
Conventional	49%	12%	10%
Reduced - Till	23%	15%	72%
Mulch - Till	3%	21%	11%
No - Till	25%	52%	7%

Estimates on tile drainage within the Lower Kaskaskia River watershed were provided by the Madison, Monroe, Randolph, St Clair, and Washington County NRCS offices. Following is a summary of each county's estimates:

Madison County: tile drains are used within the TMDL watershed portion of the county, however, the amount of tile used on each field is minimal and less than 50 percent of the fields are extensively tiled

Monroe County: field tiling within this portion of the watershed is minimal, as the majority of fields are drained by surface ditches

Randolph County: field tiles are used on the majority of fields within the Randolph County portion of the watershed; however, no estimate was available as to the percentage of fields. Randolph County NRCS officials acknowledged that the City of Coulterville has been actively working to remedy the atrazine levels in Coulterville Reservoir and that they believe the most likely source of the chemical is a large area of cropland located upstream.

St Clair County: field tiles are minimally used within the county. St Clair County NCRS officials are currently encouraging the use of field tiles within the county, however, the majority of fields were tiled prior to 1900, and as a result no estimate on the percentage of fields tiled was available

Washington County: field tiles are not used in this portion of the watershed. NCRS states that the soils in this portion of the state are too tight to allow adequate drainage of fields via field tiles.

Information on tile drainage was not available for the remaining counties, which cover a very small portion of the watershed. Should more detailed site-specific data become available, it will be incorporated during the remaining stages of TMDL development. If more precise local information is necessary for modeling, soils data may be reviewed for information on hydrologic soil group in order to provide a basis for tile drain estimates.

5.4.2 Animal Operations

Animal populations are available from the National Agricultural Statistics Service. Data specific to the Lower Kaskaskia River watershed were not available; however, the Clinton, Monroe, Perry, Randolph, St. Clair, and Washington County animal populations were reviewed and are presented in the following tables (5-31 through 5-36). Data on animal operations within the watershed is relevant as these operations are a potential source of pollutants to area waterbodies. Livestock are a source of bacteria and nutrients while their grazing can increase erosion introducing sediments (that may contain manganese) to area streams and increasing sediment oxygen demand (SOD) within the segments which can deplete dissolved oxygen.

Table 5-31 Clinton County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	37,735	36,849	-2%
Beef	5,095	2,242	-56%
Dairy	14,830	15,080	2%
Hogs and Pigs	93,190	177,880	91%
Poultry	552,992	514,945	-7%
Sheep and Lambs	473	430	-9%
Horses and Ponies	NA	402	NA

Table 5-32 Monroe County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	10,200	9,846	-3%
Beef	3,525	3,451	-2%
Dairy	950	1,351	42%
Hogs and Pigs	52,235	42,551	-19%
Poultry	444	560	26%
Sheep and Lambs	973	667	-31%
Horses and Ponies	NA	446	NA

Table 5-33 Perry County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	11,968	12,384	3%
Beef	4,601	5,360	16%
Dairy	479	717	50%
Hogs and Pigs	10,253	4,909	-52%
Poultry	488	309	-37%
Sheep and Lambs	231	126	-45%
Horses and Ponies	NA	232	NA

Table 5-34 Randolph County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	21,920	17,967	-18%
Beef	8,246	6,540	-21%
Dairy	2,050	2,039	-1%
Hogs and Pigs	27,140	10,034	-63%
Poultry	1,299	182	-86%
Sheep and Lambs	866	660	-24%
Horses and Ponies	NA	708	NA

Table 5-35 St Clair County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	8,362	6,985	-16%
Beef	1,888	1,656	-12%
Dairy	1,096	1,039	-5%
Hogs and Pigs	39,433	30,188	-23%
Poultry	1,426	790	-45%
Sheep and Lambs	449	374	-17%
Horses and Ponies	NA	879	NA

Table 5-36 Washington County Animal Population (2002 Census of Agriculture)

	1997	2002	Percent Change
Cattle and Calves	25,960	26,581	2%
Beef	4,333	4,482	3%
Dairy	7,854	7,834	0%
Hogs and Pigs	47,626	62,113	30%
Poultry	NA	396	NA
Sheep and Lambs	1,043	359	-66%
Horses and Ponies	NA	101	NA

Further information regarding animal operations was collected through communications with local NRCS officials. Madison County NRCS officials provided that there has been major urbanization within the county during the past ten years. As a result, the majority of concentrated animal feeding operations (CAFOs) have been removed. The remaining CAFOs are closely monitored via their nutrient management plans and NRCS officials do not believe that they are a significant source of water body use impairment. Specific information from the Monroe County NRCS office was not available; however, NRCS officials did state that there are several livestock operations within the watershed in Monroe County. Randolph County NRCS officials indicated that within the watershed area there are only a few small animal operations. St Clair County officials stated that CAFOs within the county are very limited due to urban development. They believe that less than 10 CAFOs exist within this portion of the TMDL watershed. Officials state that due to development, the number of CAFOs is continually decreasing, but the animal units per CAFO are increasing. Washington County NRCS officials indicated that there are approximately 12 dairies within their portion of the watershed, and a few of these operations are located within one mile of each of the impaired segments. It is also estimated that five hog operations exist in this area, but none are located close to impaired segments.

Information on animal operations was not available for the remaining counties, which cover a very small portion of the Lower Kaskaskia River watershed. Additional data from contributing sub-watersheds upstream of the Lower Kaskaskia River watershed are available in TMDL reports for additional watersheds.

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.

Across the U.S., septic systems have been found to be a potential and sometimes significant source of phosphorus and fecal coliform pollution. Septic systems that are not functioning properly or that are failing do not adequately treat sewage which can then seep into area waterways. Information on septic systems within the Lower Kaskaskia River watershed was obtained, specifically for the areas surrounding Kaskaskia River segment O-20 and O-30 (primary contact recreation uses impaired by fecal coliform), and the Coulterville and Sparta NW Reservoirs (aesthetic quality use impaired by total phosphorus). Information on sewered and septic municipalities was obtained from county health departments. Additional information on household estimates was obtained from county tax assessors when necessary.

Clinton County and Washington County health departments were contacted to obtain information regarding the area surrounding Kaskaskia River segment O-20. According to Clinton County Health Department officials, the towns in this area of the county are Wertenberg and New Memphis. The homes within these towns as well as the homes in nearby outlying areas are served by private septic systems. Clinton County health officials provided that they have not received complaints regarding failing septic systems in this area; however, they were unable to estimate the number of homes in this area. Information regarding the number of homes in Clinton County surrounding Kaskaskia River segment O-20 was obtained from the Clinton County Tax Assessor. According to the office of the assessor, there are approximately 150 homes in this section of Clinton County. Washington County health officials provided that there is only one small town called Venedy in the area surrounding segment O-20 within Washington County. The health official stated that this town, as well as the surrounding unincorporated area, is served by private septic systems. Furthermore, they estimate that the population of Venedy is approximately 130 people, residing in about 40 to 50 homes served by private septic systems. Washington County health officials also estimated that there are an additional 50 homes in the unincorporated area surrounding Kaskaskia River segment O-20. The Washington County health department has not received any complaints regarding failing septic systems operating in this area.

With combined information from Clinton and Washington County health departments, and the Clinton County assessor's office, it is estimated that there are 250 homes in the area surrounding Kaskaskia River segment O-20. All of these homes are served by private septic systems. Although the condition of these septic systems is unknown, there have not been any recent complaints reported to the area health departments concerning malfunctions.

The Monroe-Randolph Bi-County Health Department was contacted regarding the areas surrounding Kaskaskia River segment O-30, Sparta NW Reservoir and Coulterville Reservoir. The town of Evansville is located along segment O-30 of the Kaskaskia River and is served by municipal sewers that are treated by lagoons south of the Route 3 overpass. Rural homes in the area are served by private septic systems. The health department was unable to estimate the number of rural residences in this area but has not received any complaints regarding private systems.

Health department officials provided that Sparta NW Reservoir lies along the outskirts of the town of Sparta. While Sparta is served by city sewer within the city limits, health officials estimated that there are approximately 30 to 40 homes served by private septic systems located near the reservoir beyond the city limits. They also estimated that there are a few residences in the area surrounding Coulterville that would be on private septic systems. There have been no complaints received by the health department related to these septic systems.

5.5 Watershed Studies and Other Watershed Information

The extent of previous planning efforts within the Lower Kaskaskia River 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 in the final draft of this document.

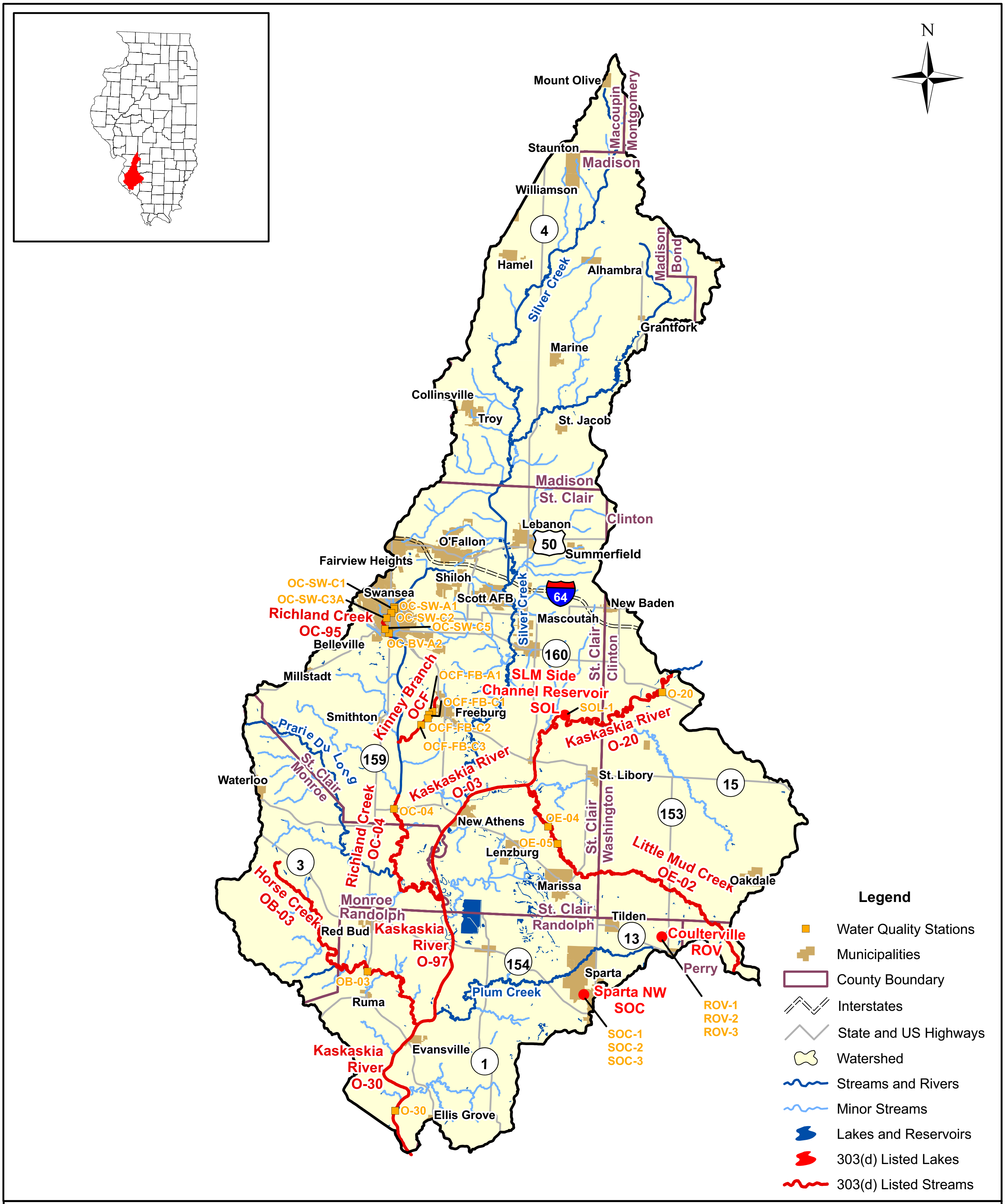

Figure 5-1
Lower Kaskaskia River Watershed
Water Quality Stations

0 5 10 20 Miles

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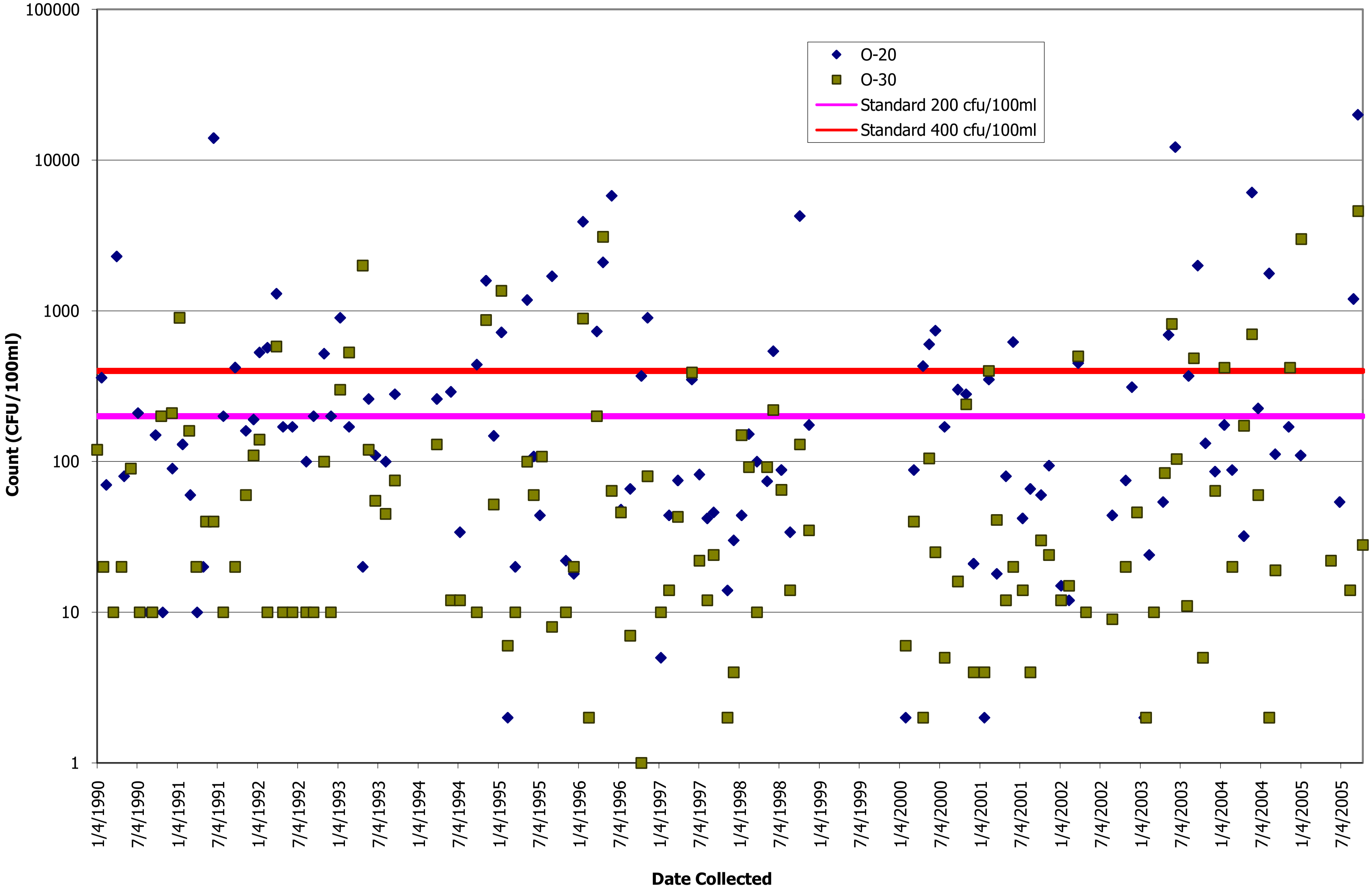

Figure 5-2:
Fecal Coliform Counts
Lower Kaskaskia River

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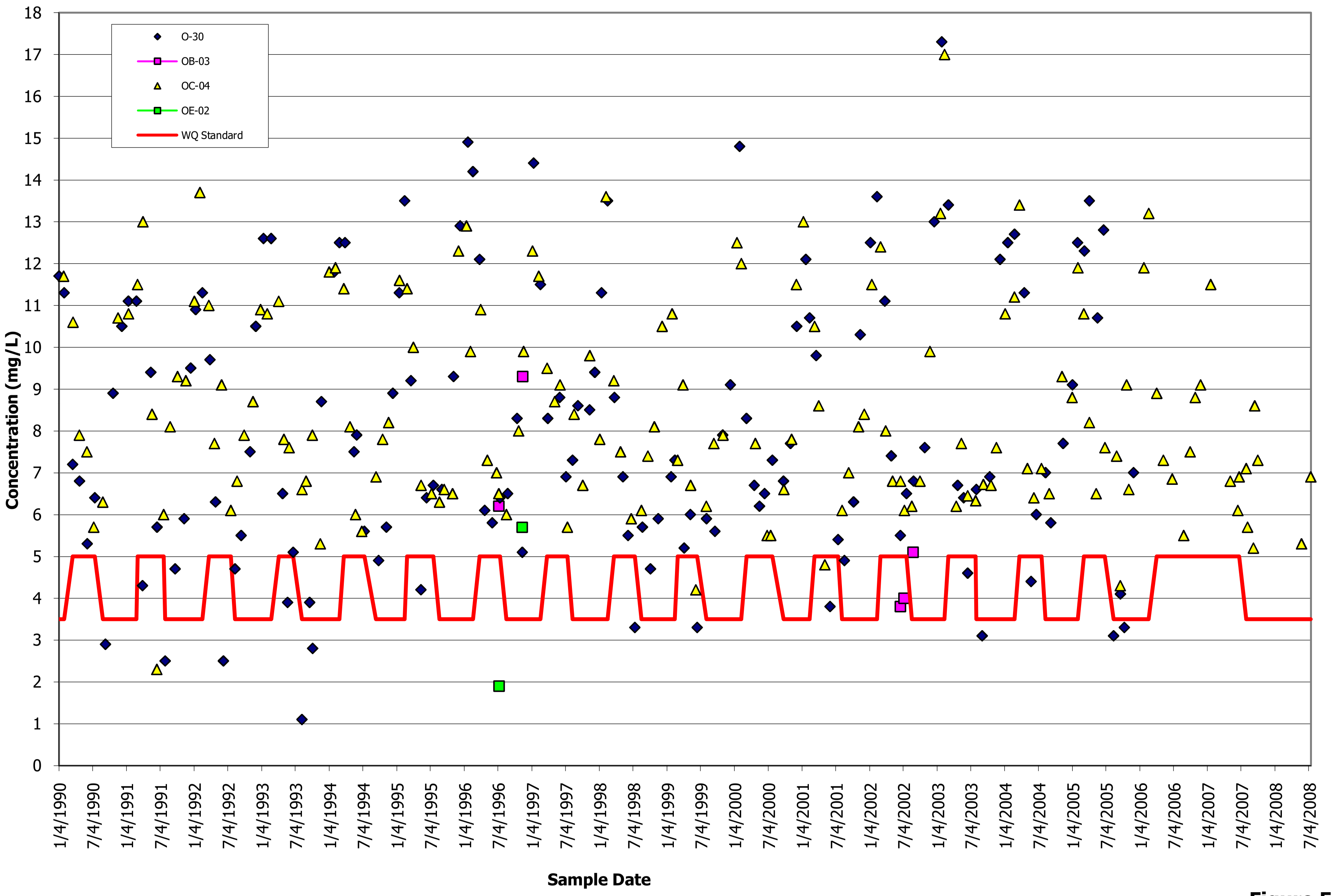

Figure 5-3:
Dissolved Oxygen Concentrations on
Kaskaskia River Segment O-30, Horse Creek Segment OB-03,
Richland Creek South Segment OC-04 and Mud Creek Segment OE-02

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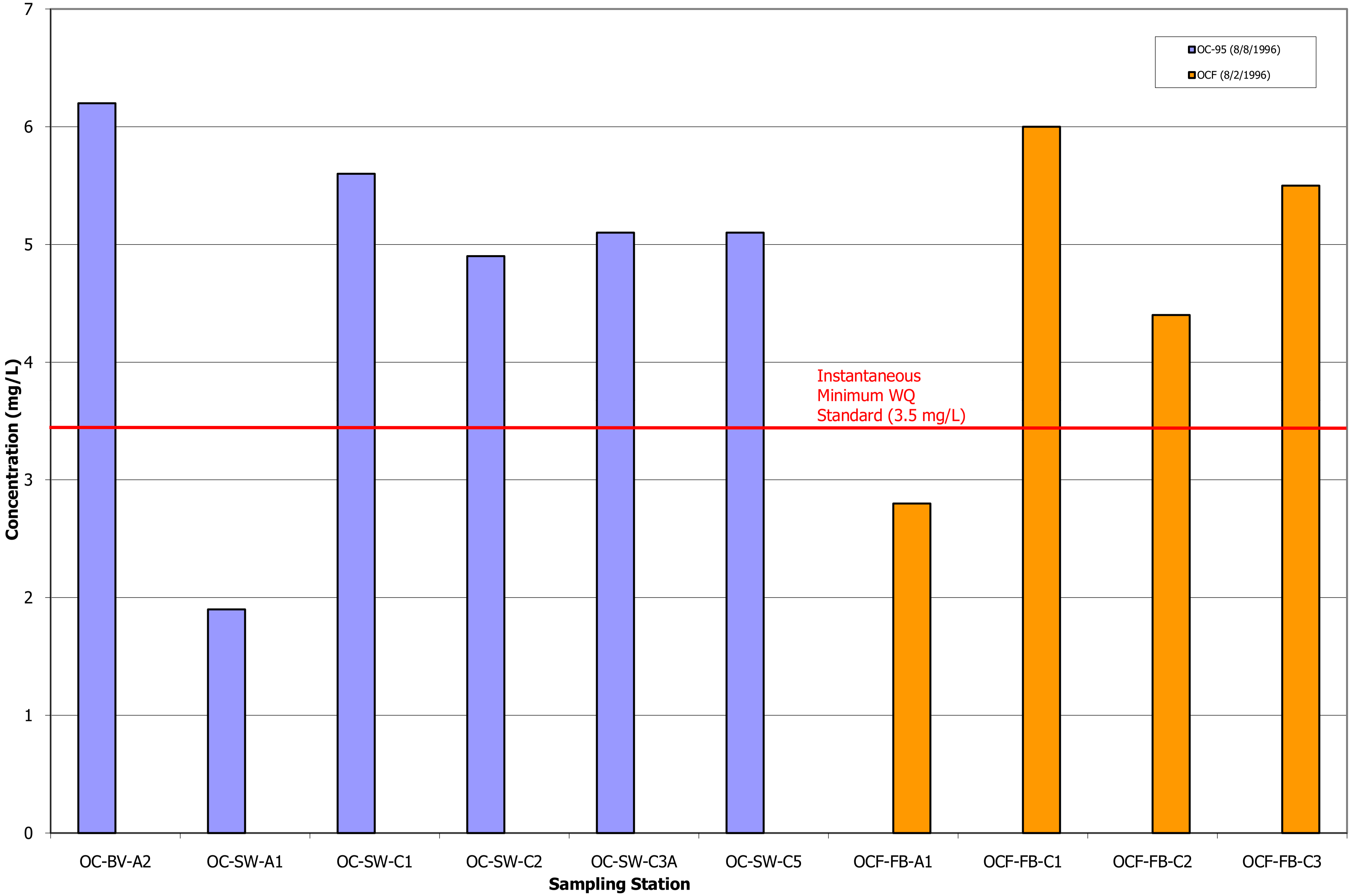

Figure 5-4:
Dissolved Oxygen Concentrations
Facility Related Stream Surveys
Richland Creek South Segment OC-95 and Kinney Branch Segment OCF

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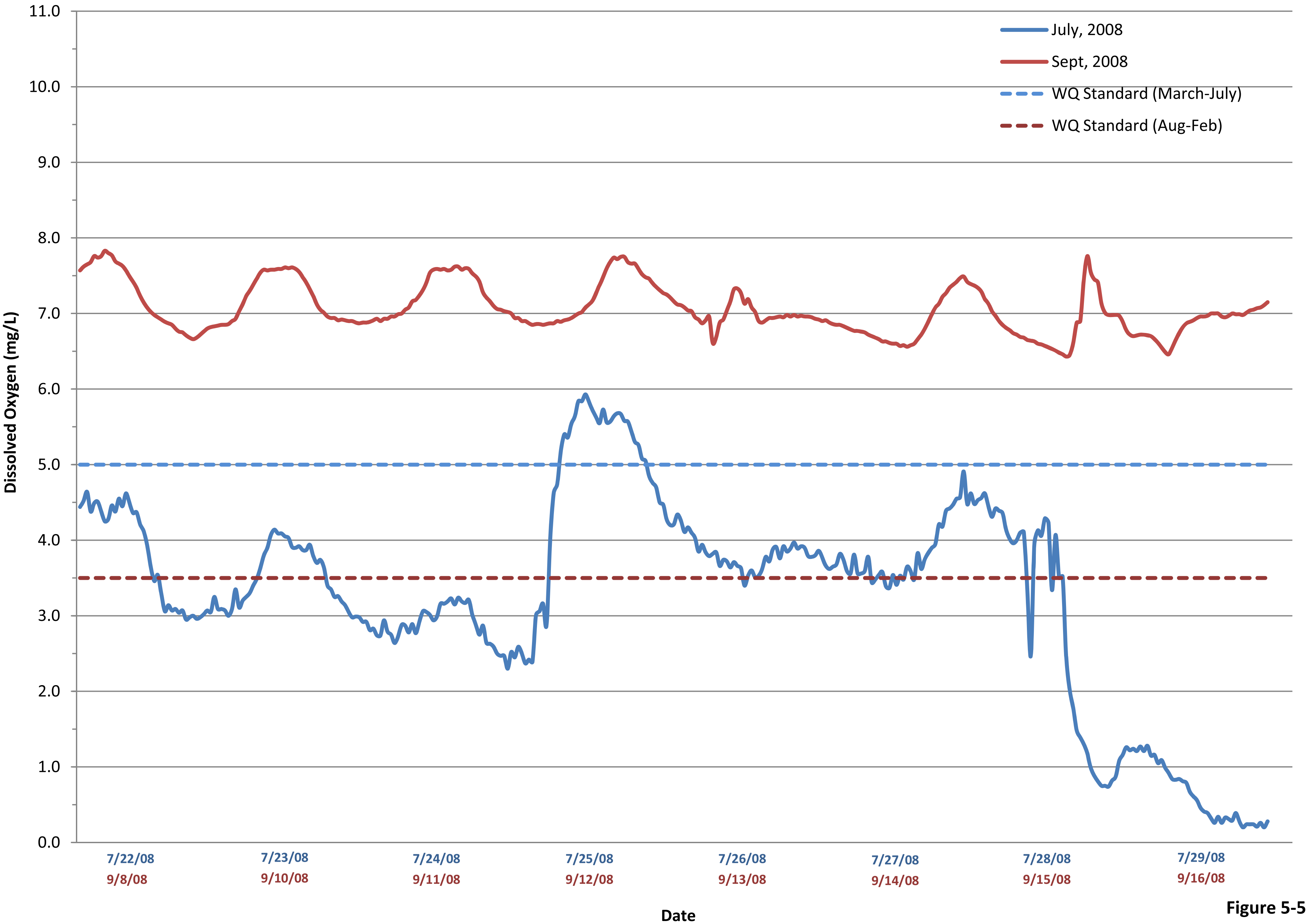

Figure 5-5
Continuous Dissolved Oxygen Data
Richland Creek Segment OC-95

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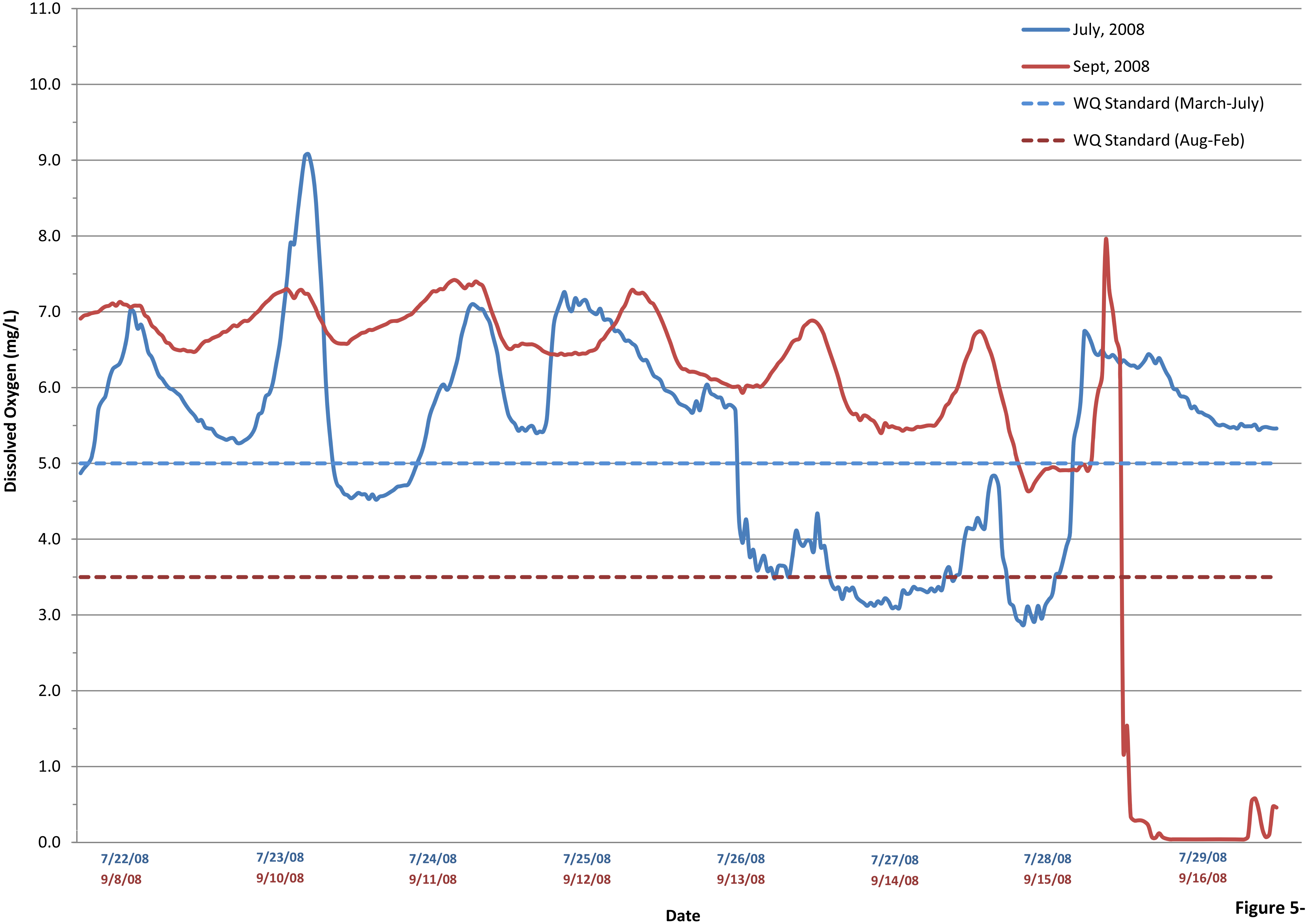

Figure 5-6
Continuous Dissolved Oxygen Data
Kinney Branch Segment OCF

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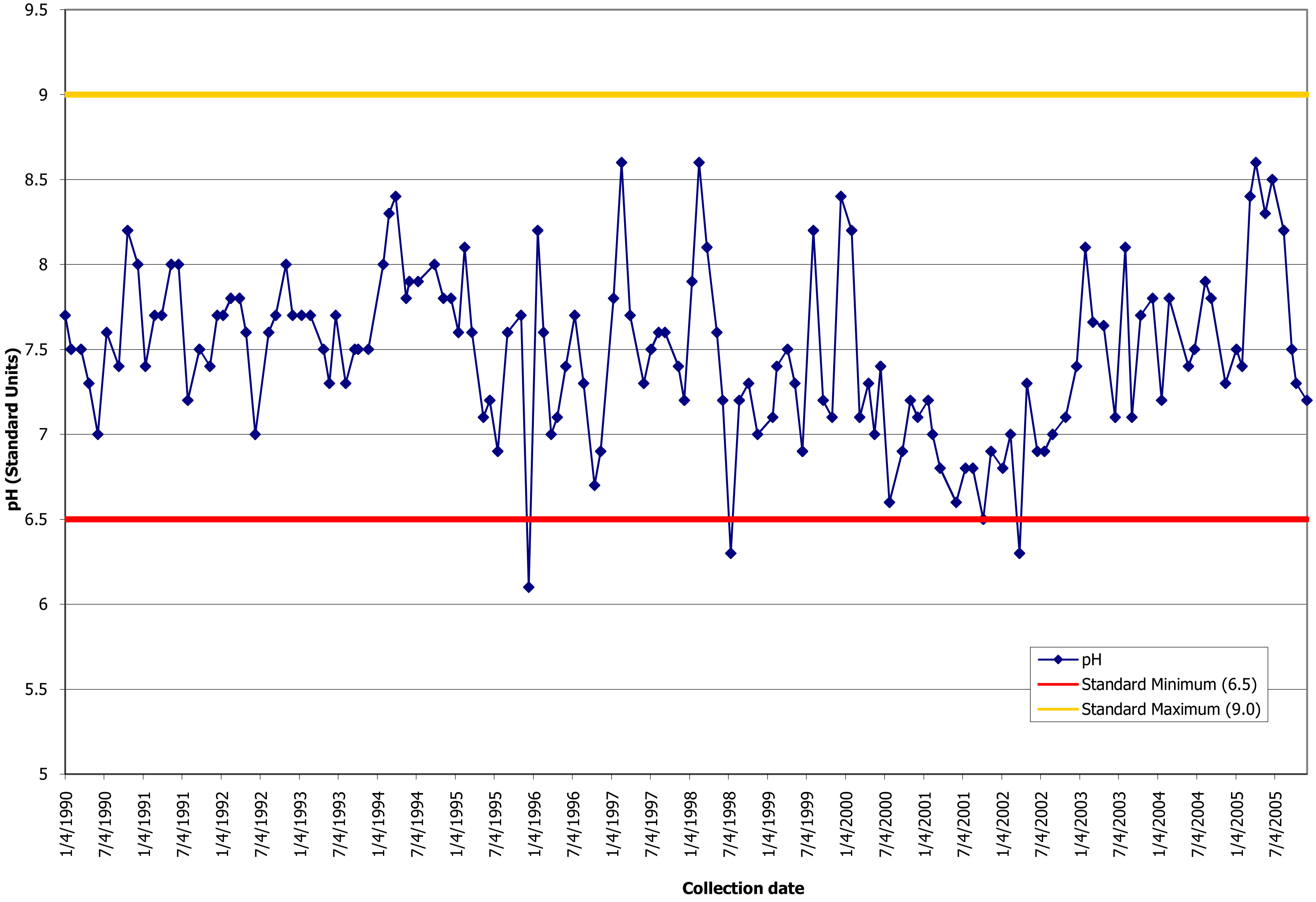

Figure 5-7:
pH Values
Kaskaskia River Segment O-30

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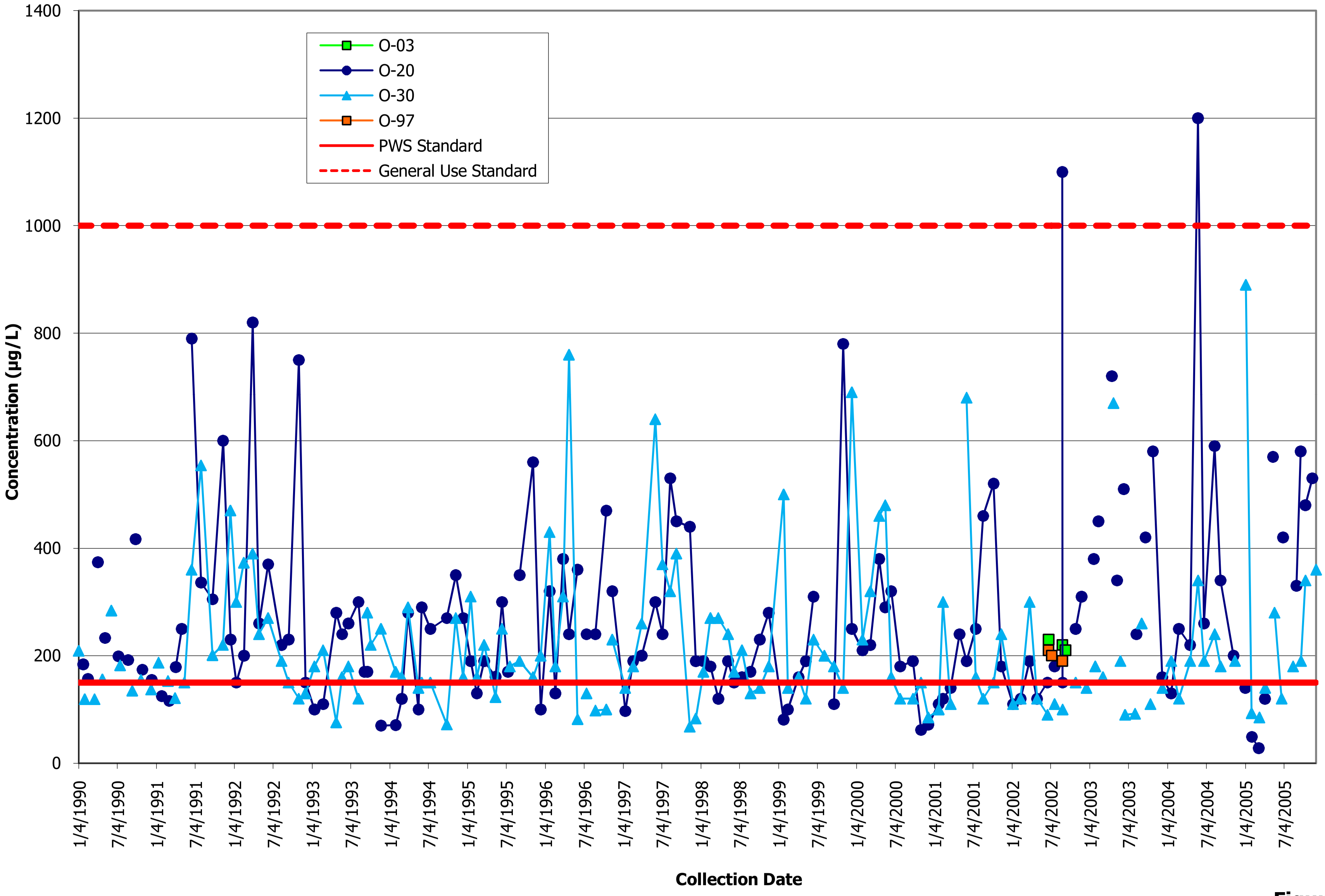

Figure 5-8:
Manganese Concentrations
Public Water Supply Streams
Lower Kaskaski River Watershed

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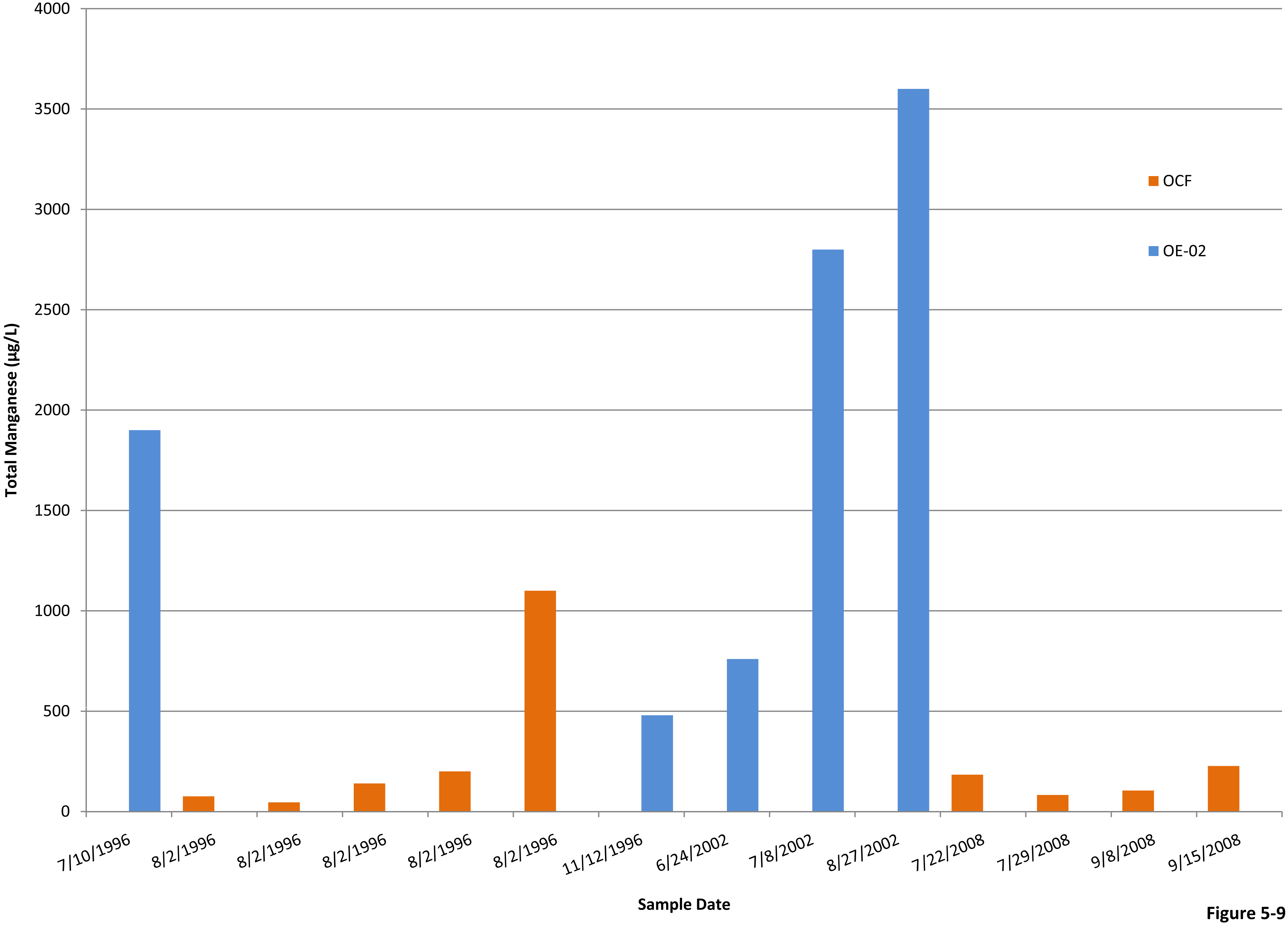

Figure 5-9
Total Manganese Data
Kinney Branch and Mud Creek

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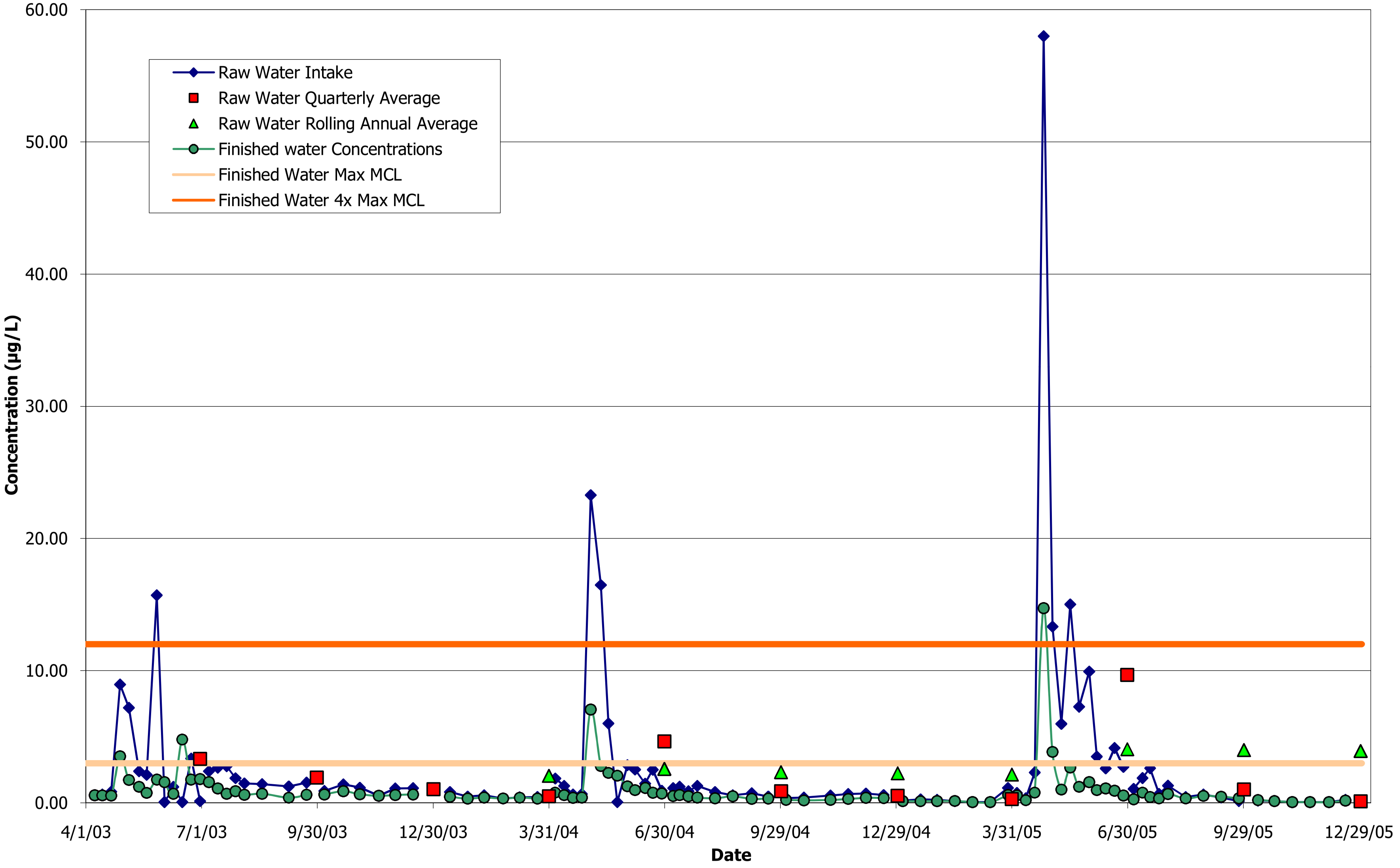

Figure 5-10:
Atrazine Concentrations
Kaskaskia River Segment O-03

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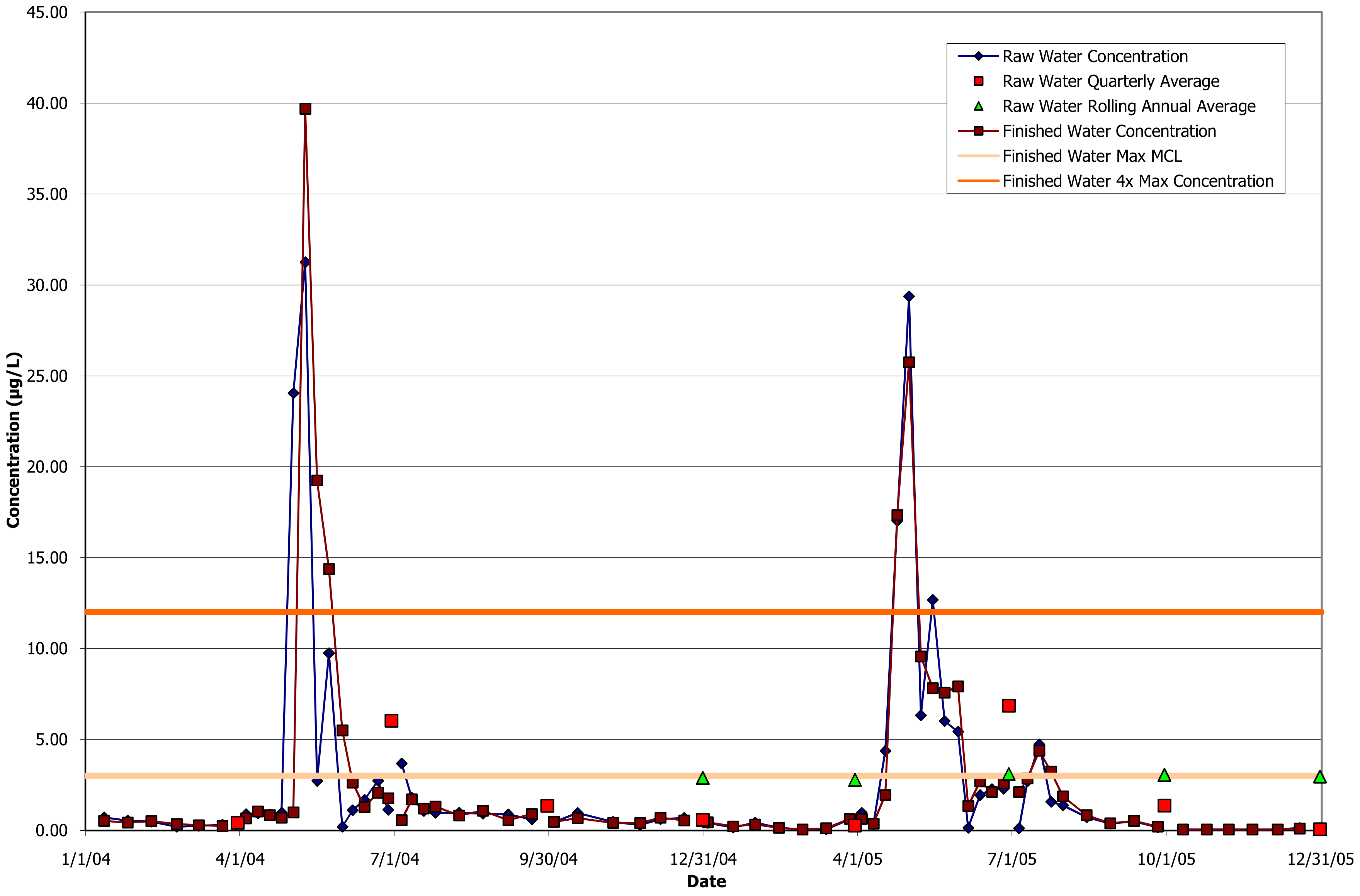

Figure 5-11:
Atrazine Concentrations
Kaskaskia River segment O-30

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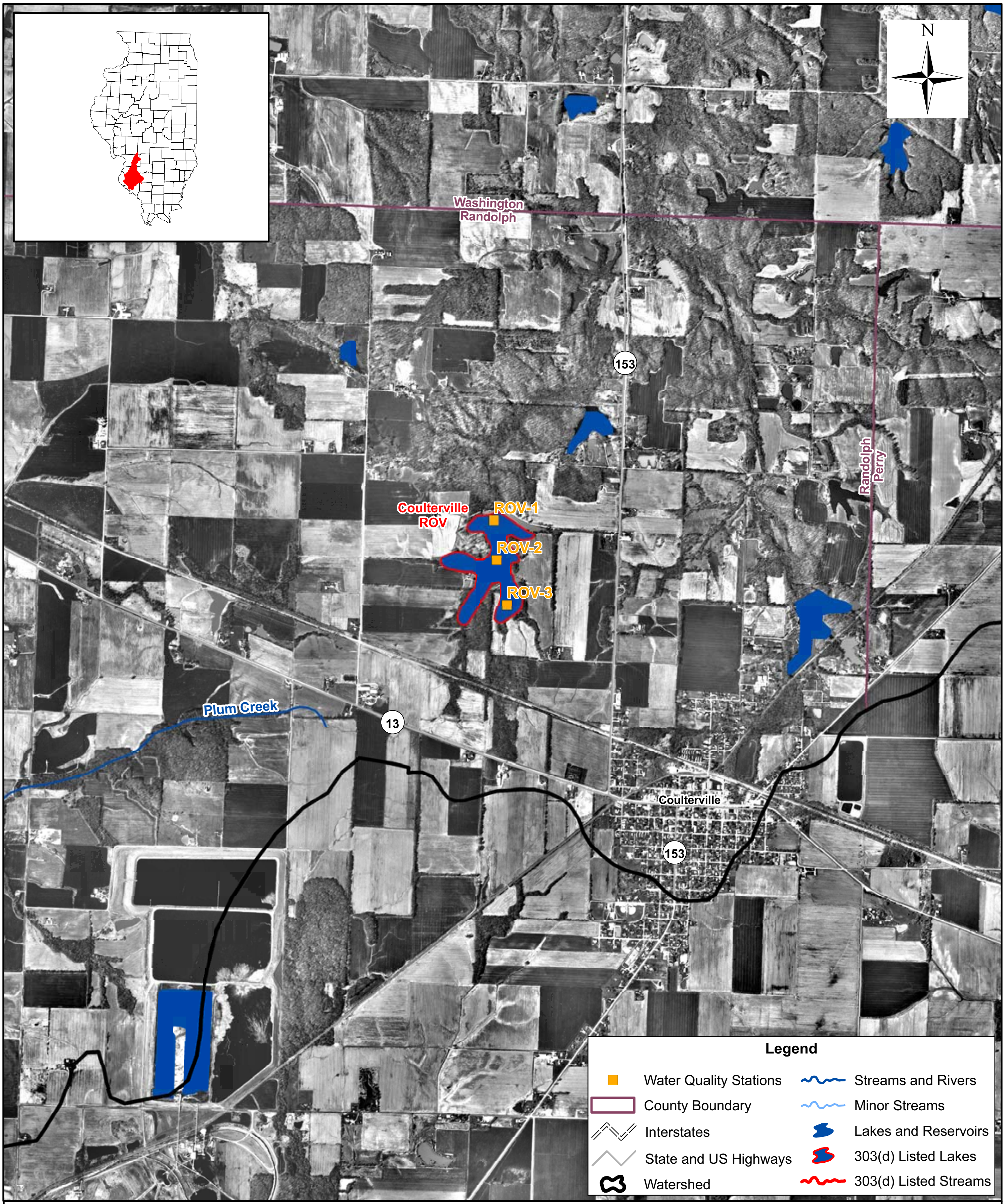

Figure 5-12
Coulterville Reservoir
Lower Kaskaskia River Watershed
Water Quality Sampling Locations

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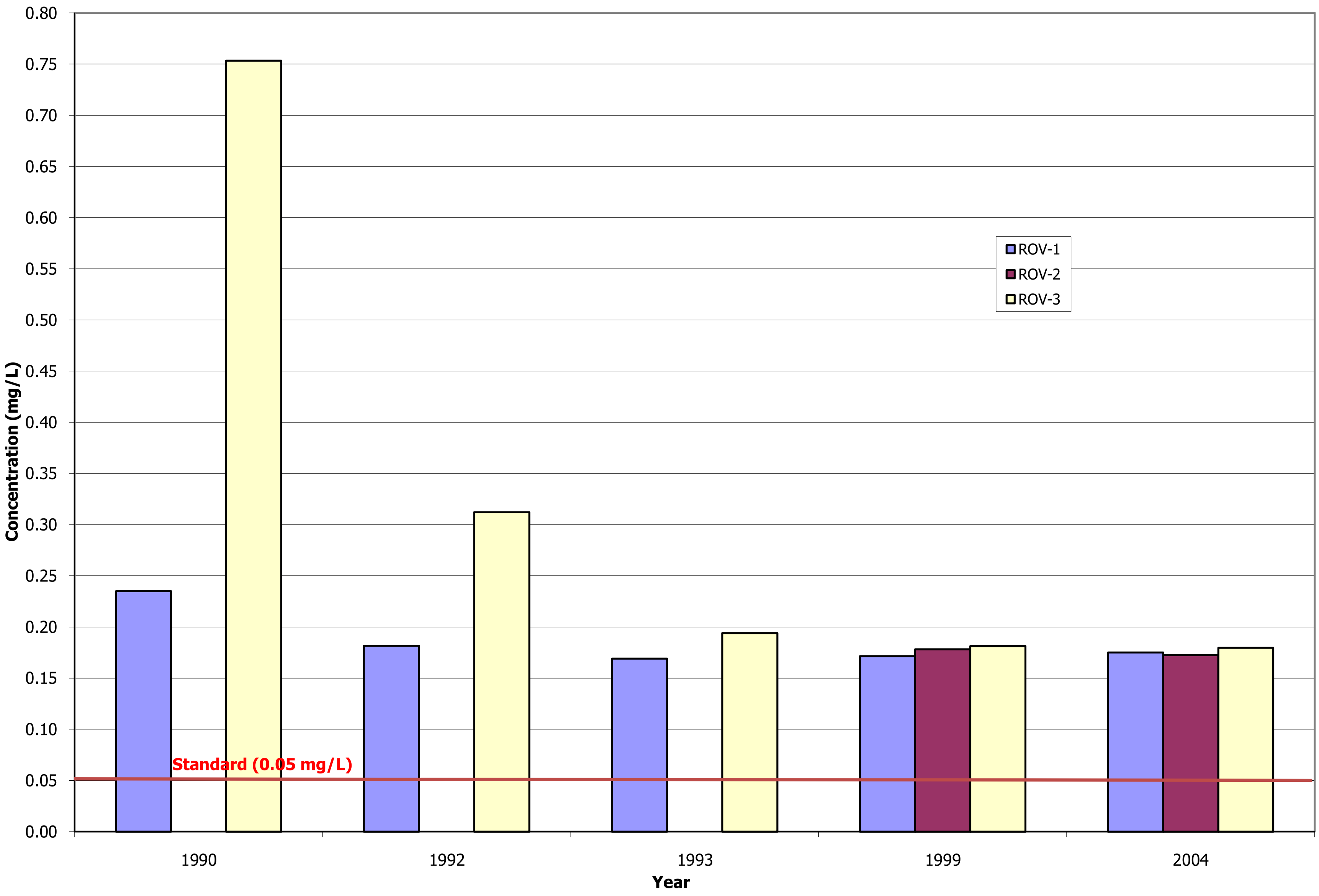

Figure 5-13:
Annual Average Phosphorus Concentrations
Coulterville Reservoir

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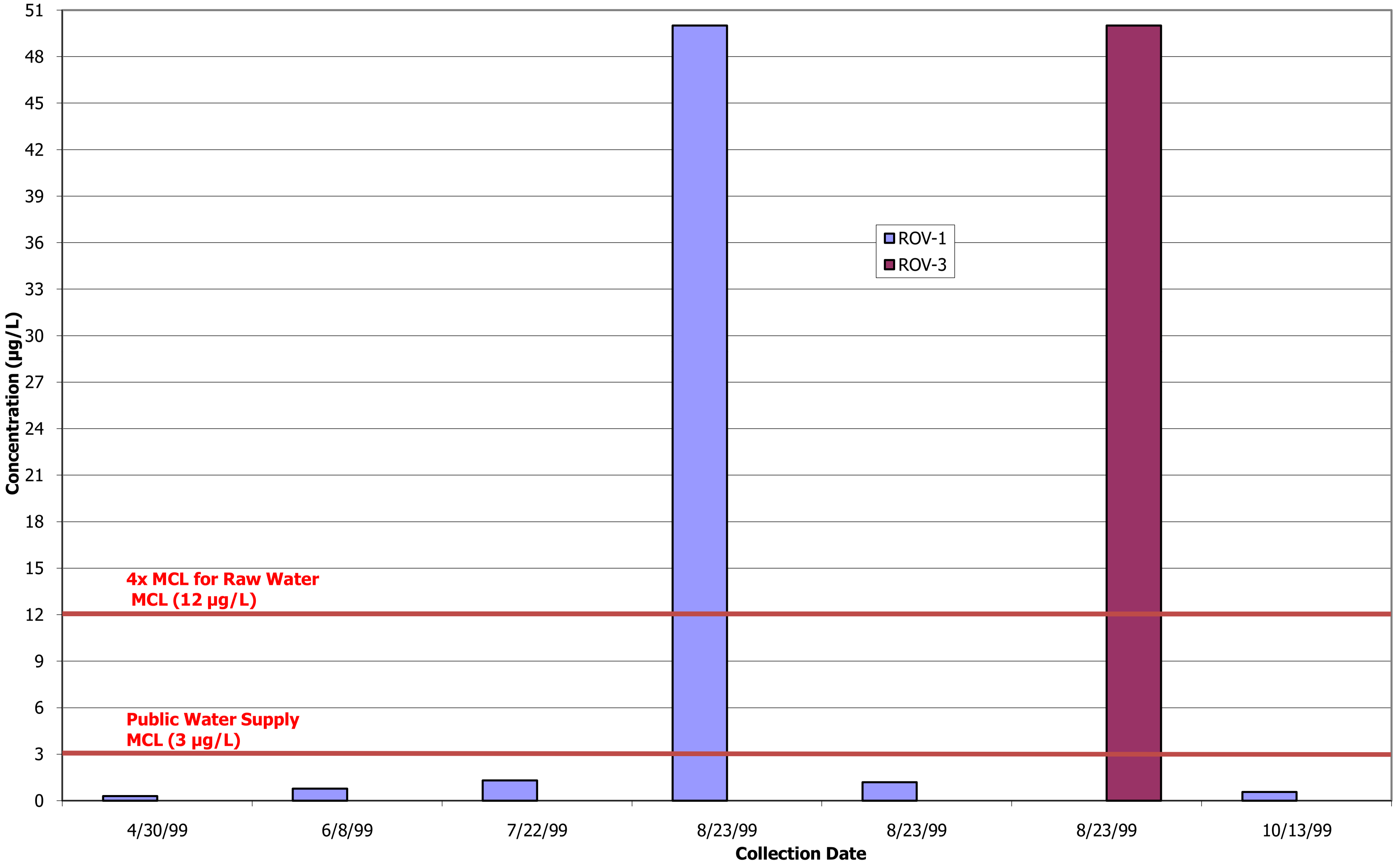

Figure 5-14:
Atrazine Concentrations in Surface Water
Coulterville Reservoir

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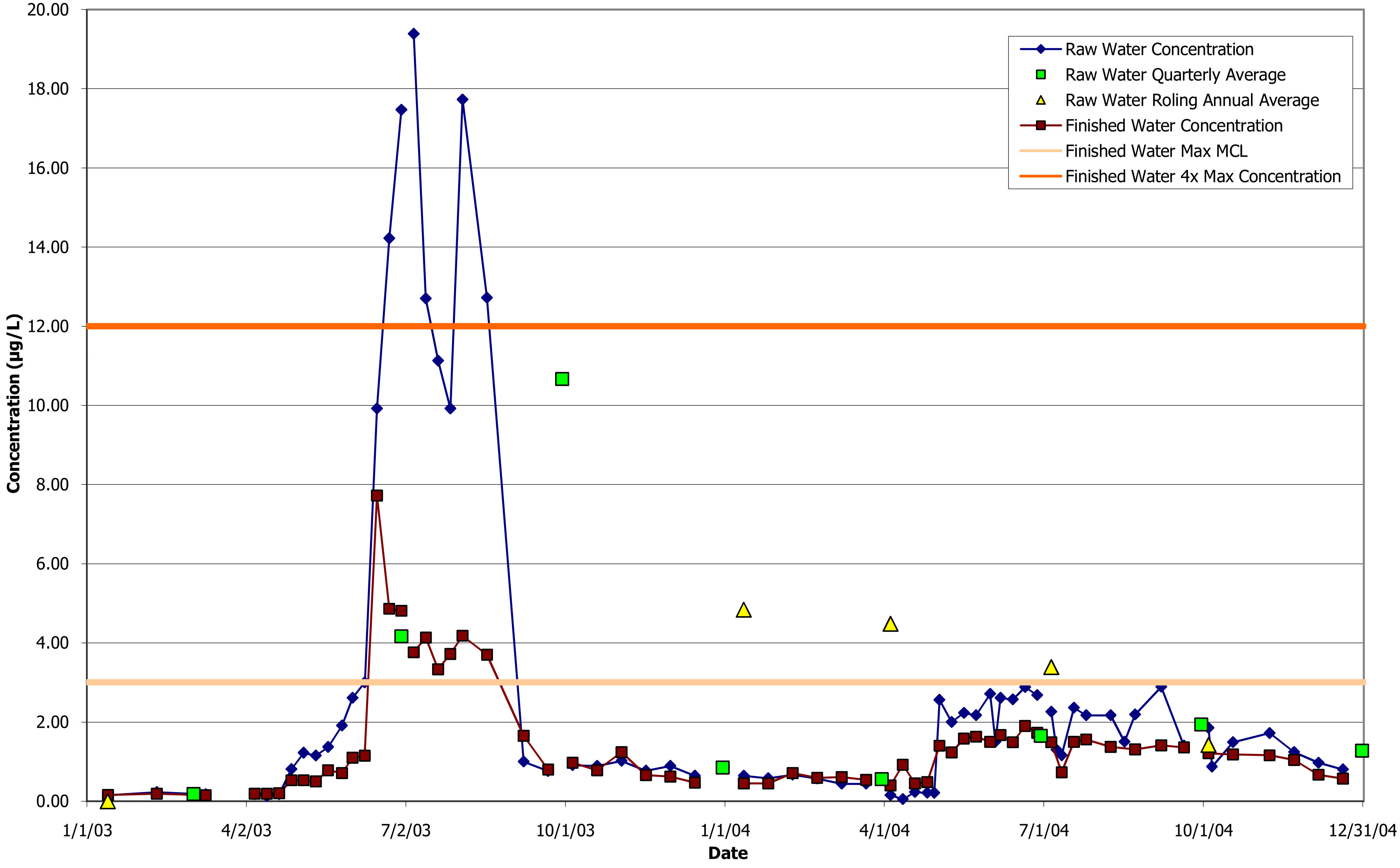

Figure 5-15:
Atrazine Concentrations in Raw and Treated Water
Coulterville Reservoir

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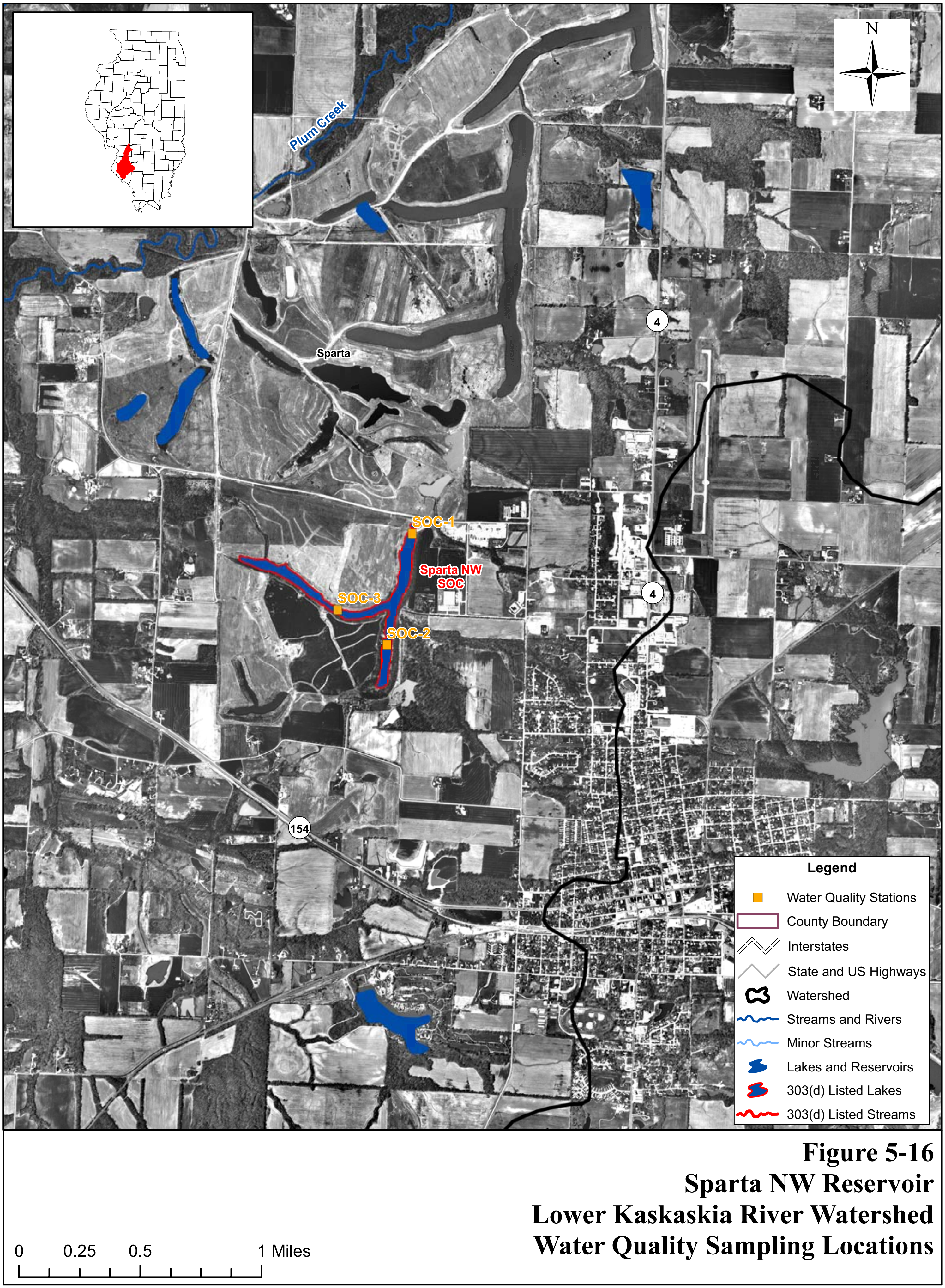

Figure 5-16
Sparta NW Reservoir
Lower Kaskaskia River Watershed
Water Quality Sampling Locations

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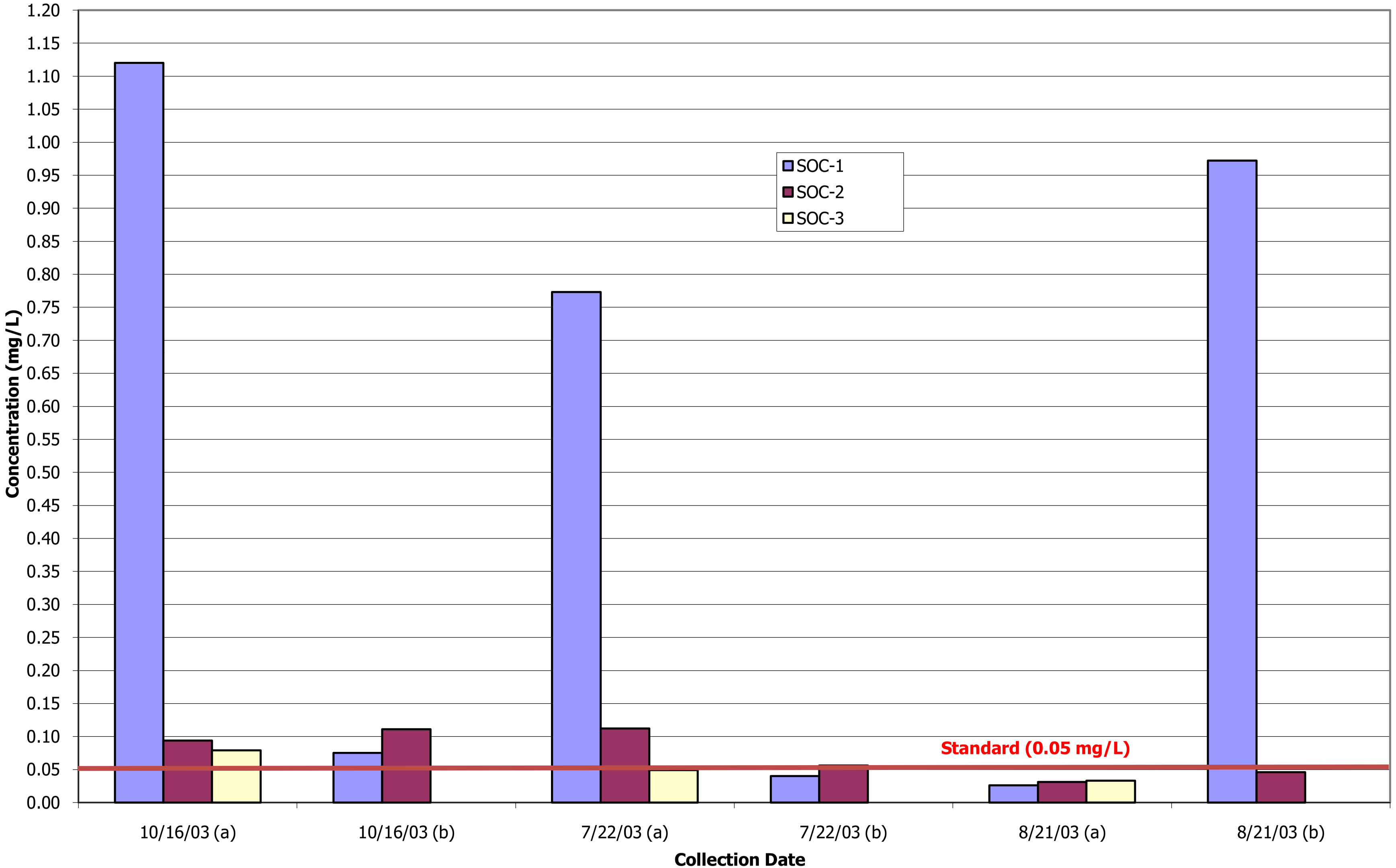

Figure 5-17:
Total Phosphorus Concentrations
at One-Foot Depth
Sparta NW Reservoir

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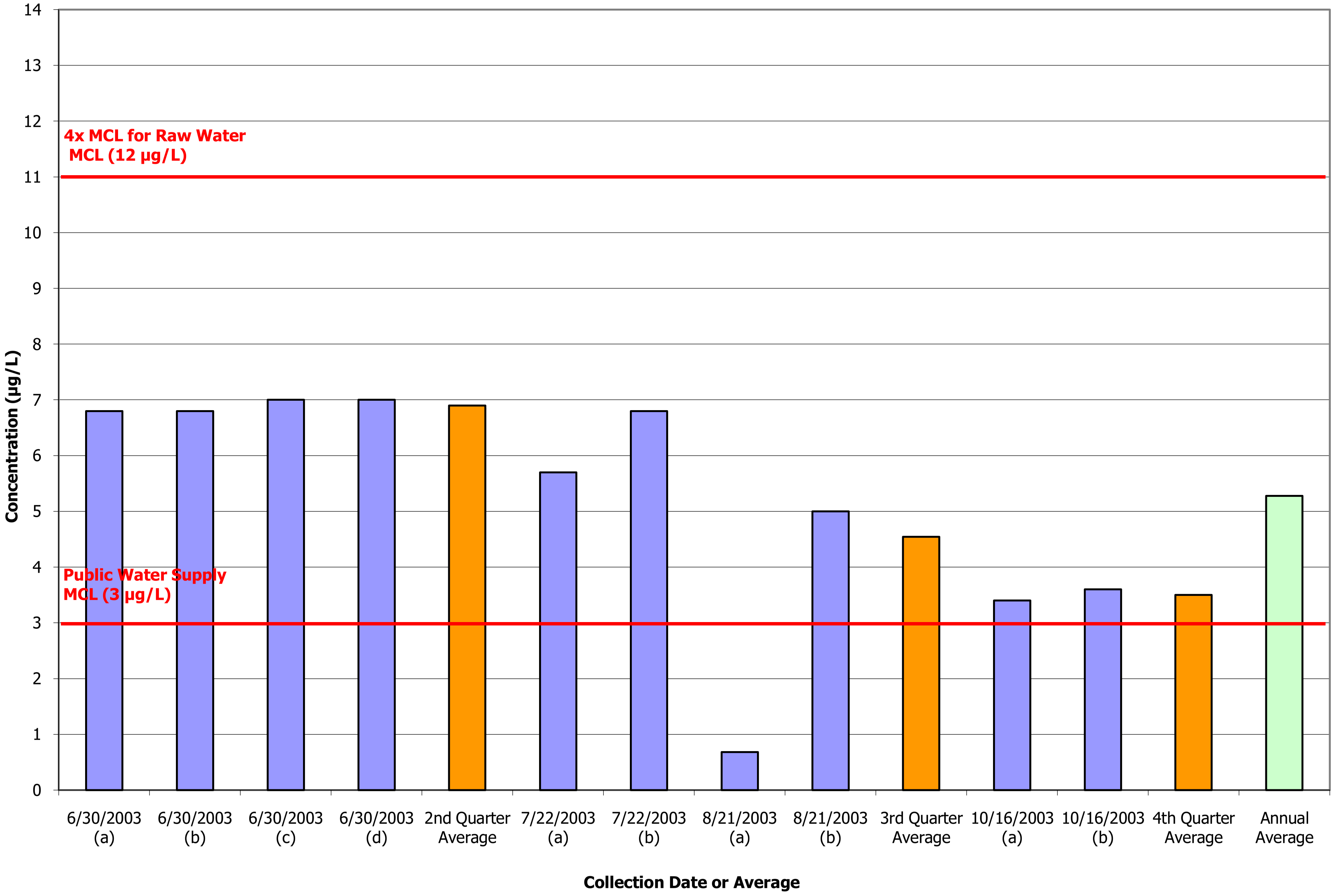

Figure 5-18:
Atrazine Concentrations at SOC-2
Sparta NW Reservoir

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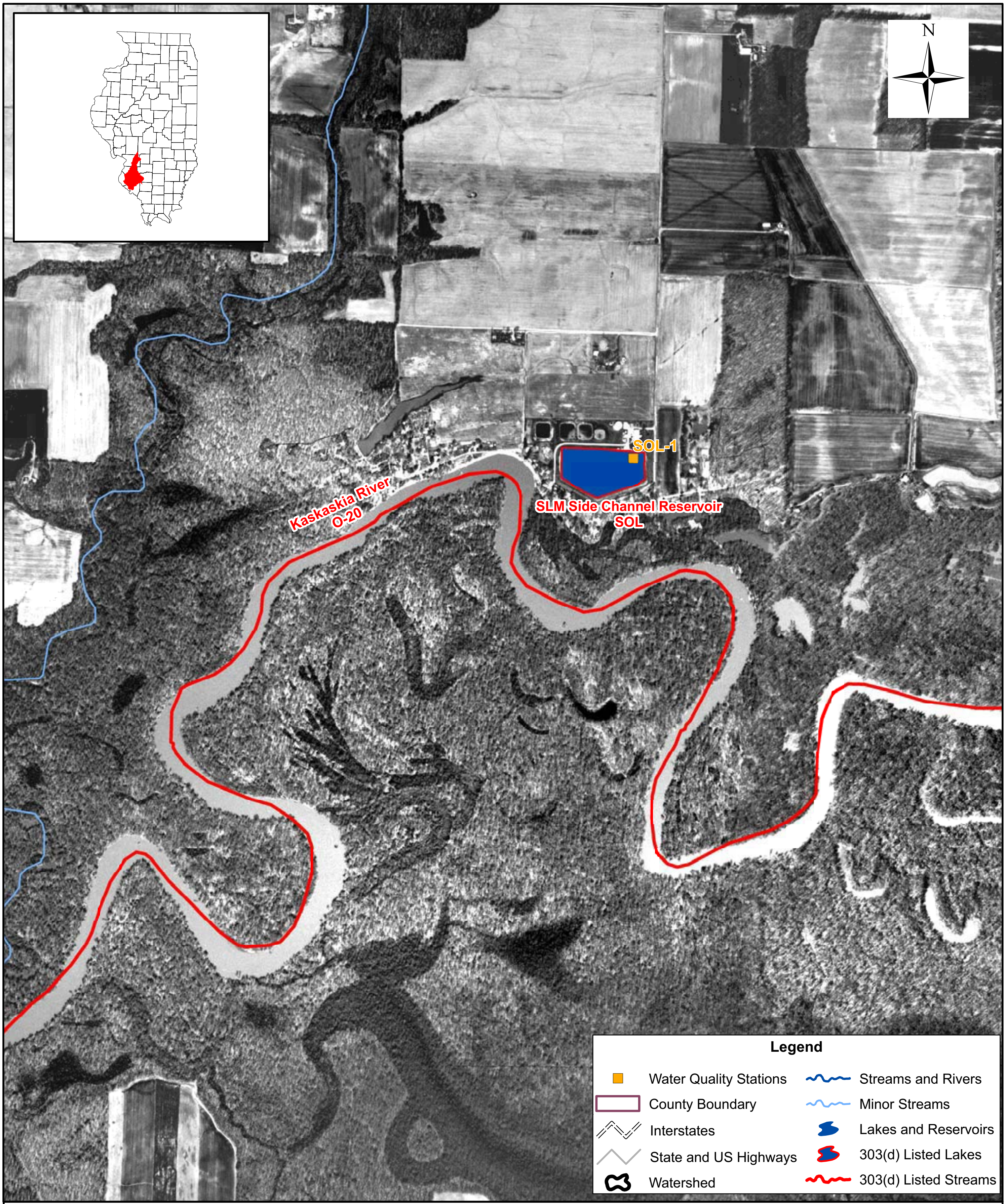

Figure 5-19
SLM Side Channel Reservoir
Lower Kaskaskia River Watershed
Water Quality Sampling Locations

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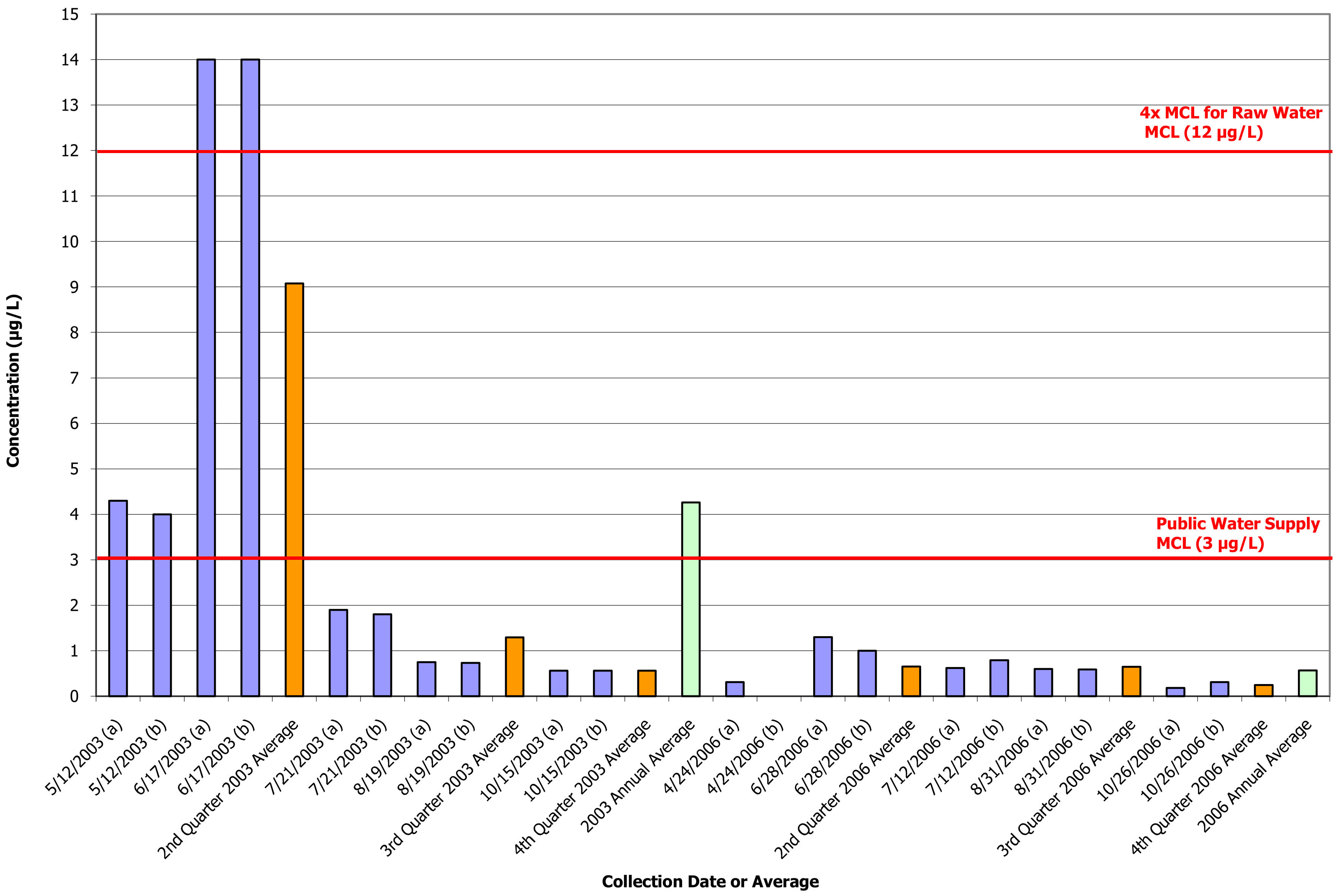

Figure 5-20:
Atrazine Concentrations at SOL-1
SLM Side Channel Reservoir

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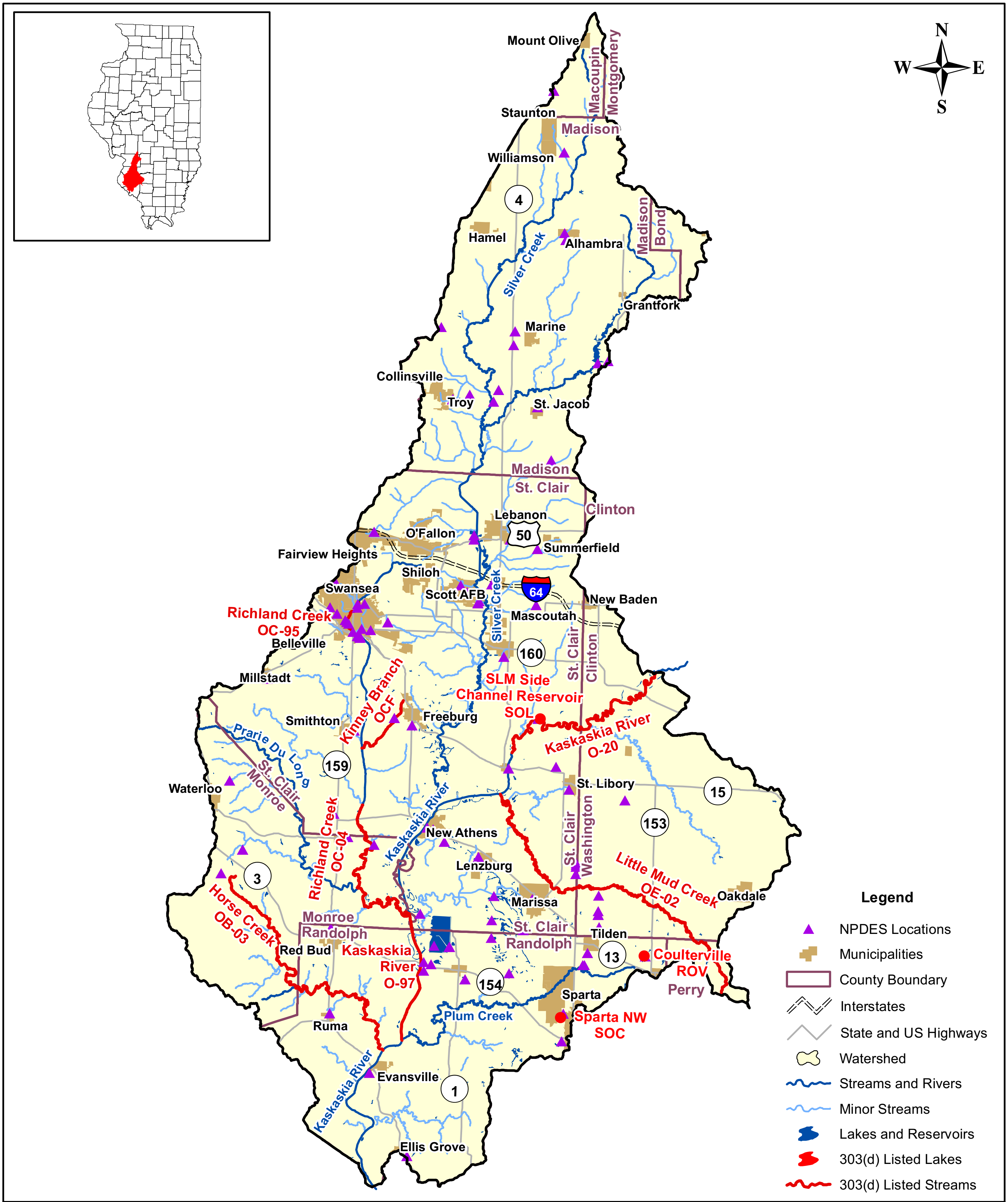

Legend

- ▲ NPDES Locations
- Municipalities
- County Boundary
- Interstates
- State and US Highways
- Watershed
- Streams and Rivers
- Minor Streams
- Lakes and Reservoirs
- 303(d) Listed Lakes
- 303(d) Listed Streams

Figure 5-21
Lower Kaskaskia River Watershed Point Sources

0 4 8 16 Miles

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Section 6
Approach to Developing TMDL and Identification of Data Needs

Illinois EPA is currently developing TMDLs for pollutants that have numeric water quality standards. Of the pollutants causing impairment to stream segments in the Lower Kaskaskia River watershed; manganese, pH, DO, total fecal coliform, and atrazine are all of the parameters with numeric water quality standards. For the reservoirs in the watershed, manganese, atrazine and total phosphorus are the only parameters with numeric water quality standards. Refer to Table 1-1 for a full list of potential causes of impairment. Illinois EPA believes that addressing the parameters with numeric standards 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 Lower Kaskaskia River watershed except for stream segments where there are 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 Lower Kaskaskia River watershed.

6.2 Approaches for Developing TMDLs for Stream Segments in Lower Kaskaskia River Watershed

6.2.1 Recommended Approach for DO TMDLs for Stream Segments

Table 6-1 contains information on the stream segments within the Lower Kaskaskia River watershed that are 303(d) listed for impairment caused by low DO.

Table 6-1 Dissolved Oxygen Data for Impaired Stream Segments

Segment	Data Count	Period Of Record
Kaskaskia River O-30	143	1990-2005
Horse Creek OB-03	5	1996-2002
Richland Creek OC-04	159	1990-2008
Richland Creek OC-95	681	1996-2008
Kinney Branch OCF	679	1996-2008
Mud Creek OE-02	2	1996

The data for these segments do suggest impairment of the DO standard. However, spatial data are limited and therefore, additional data collection is recommended to support model development. Specific data requirements include a synoptic (snapshot in time) water quality survey of each reach with careful attention to the location of the point source dischargers. The surveys 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.

In July and September of 2008, Illinois EPA conducted additional sampling at Richland Creek segment OC-95 and at Kinney Branch segment OCF. The data collection included grab samples for chemical analysis as well as the temporary installation of continuous DO monitors at both locations. The continuous DO monitors were deployed for 7 days in July and 7 days in September at both sites. Water quality measurements were taken at 15 minute intervals during both periods and included DO concentrations and saturation, Temperature, pH, and conductivity measurements. The newly collected data was used to support the development and parameterization of the QUAL2K models. QUAL2K is an updated spreadsheet-based version of the well-known and USEPA-supported QUAL2E model. The model 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 suited to steady-state simulations. It is not anticipated that an additional watershed model will be needed to develop DO TMDLs for these streams

6.2.2 Recommended Approach for pH TMDL in Kaskaskia River Segment O-30

Segment O-30 of the Kaskaskia River is listed for pH impairments. Segment O-30 had only three violations of the pH standard out of 144 samples. All three samples were below the 6.5 minimum value. The lowest value recorded was 6.1. Potential causes of pH issues may be related to abandoned mine drainage and/or acid precipitation, but may also be associated with excess nutrients and organic enrichment of streams. Potential approaches to developing the pH TMDL for this segment include a spreadsheet approach that would take into account natural conditions in the watershed such as soil buffering capacity. A more detailed procedure to develop the pH TMDL would be based on an analytical procedure developed by the Kentucky Department of Environmental Protection (2001). The procedure calculates a maximum allowable hydrogen ion loading in the water column to maintain pH standards. Furthermore, it was anticipated that pH issues would be addressed by implementing load reduction strategies for the TMDL pollutants associated with the segment (in particular nutrient management and reduction of organic materials), as outlined in Section 9 of this document and further data collection was not required.

6.2.3 Recommended Approach for Fecal Coliform, Manganese and Atrazine TMDLs

Segments O-20 and O-30 of the Kaskaskia River are listed as impaired by total fecal coliform. Segments O-03 and O-30 of the Kaskaskia River are listed as impaired by atrazine and segments O-03, O-20, O-97, and O-30 of the Kaskaskia River, OE-02 of Mud Creek, and OCF of Kinney Branch are impaired by manganese. The recommended approach for developing TMDLs for these segments and parameters is 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. Further data collection is not needed. In July and September of 2008, Illinois EPA collected additional samples for manganese at Kinney Branch segment OCF. These data were incorporated into the load duration models for manganese at this segment. No additional fecal coliform or atrazine data were collected by Illinois EPA at segment OCF.

6.3 Approaches for Developing TMDLs for Lake Segments in the Lower Kaskaskia River Watershed

Recommended TMDL approaches for lakes within the Lower Kaskaskia River watershed are discussed below. It is assumed that for the lakes in the watershed, adequate data exist to develop a simple model for use in TMDL development.

6.3.1 Recommended Approach for Total Phosphorus TMDLs

Sparta NW and Coulterville Reservoirs are impaired by total phosphorus. The BATHTUB model is recommended for all lake phosphorus assessments in this watershed. The BATHTUB model performs steady-state water and nutrient balance calculations in a spatially segmented hydraulic network that account 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 were estimated using event mean concentration data, precipitation data and estimated flows within the watershed.

6.3.2 Recommended Approach for Manganese TMDLs

The SLM Side Channel Reservoir, Sparta NW Reservoir and Coulterville Reservoir are sources of public water. Therefore, the applicable water quality standard for manganese in the lakes is 150 µg/L. It is likely that the main source of manganese to the reservoirs is through lake-bottom sediments and watershed erosion. The initial step for TMDL development will be to confirm that background manganese levels are elevated in this area and that no other controllable sources exist. It is possible to complete a TMDL using basic spreadsheet analysis of available empirical data.

It is also possible to investigate nutrient and oxygen levels within the lakes and develop a surrogate TMDL for either parameter based on the interrelated nature of high nutrient levels, low dissolved oxygen concentrations, and the release of manganese from lake sediments during periods when there is no dissolved oxygen in lake-bottom waters. The BATHTUB model was used for Coulterville and Sparta NW Reservoirs which are impaired by both phosphorus and manganese. Due to the limited availability of watershed data, tributary information will be estimated using runoff coefficients for area land uses coupled with event mean concentration data.

The other reservoir is not 303(d) listed for impairments caused by total phosphorus or dissolved oxygen, however, both total phosphorus and dissolved oxygen compliance is assessed at one-foot depth and the total phosphorus standard is not applicable in lakes less than 20 acres in size (the SLM Side Channel Reservoir is only 7 acres). Dissolved oxygen and total phosphorus data throughout the water column were reviewed to determine if concentrations are present above the water quality standards. Sufficient data at SLM Side Channel Reservoir were not available to determine if conditions in the reservoir were favorable for manganese leaching from bottom sediments, leading to the impairment. Therefore, the BATHTUB model was not used to develop a surrogate TMDL for total phosphorus. Further investigation of the reservoir showed that the vast majority of inflow to the reservoir comes from pumping of surface water from Kaskaskia River segment O-20 as part of the water treatment plant operations. Kaskaskia River segment O-20 is also impaired for the public water supply standard for total manganese and therefore implementation measures designed to reduce total manganese concentrations in segment O-20 will lead to compliance with the standard within SLM Side Channel Reservoir. These implementation measures are discussed in Section 9 of this report.

6.3.3 Recommended Approach for Atrazine TMDLs

A simple approach to TMDL development for atrazine is recommended for each of the impaired reservoirs within the Lower Kaskaskia River watershed. This simple approach would estimate the allowable in-lake loads of atrazine by multiplying the lake volumes by the water quality standard. Existing loads would then be calculated based on multiplying the lake volumes by the observed data. Similarly, calculation of existing and allowable loads to the reservoirs based on inflow calculations conducted during BATHTUB modeling can be used to assess the loading of atrazine into the reservoirs from overland runoff within the watershed. The necessary reductions would be the difference between the existing and allowable loads.

Section 7
Methodology Development for the Lower Kaskaskia River Watershed

7.1 Methodology Overview

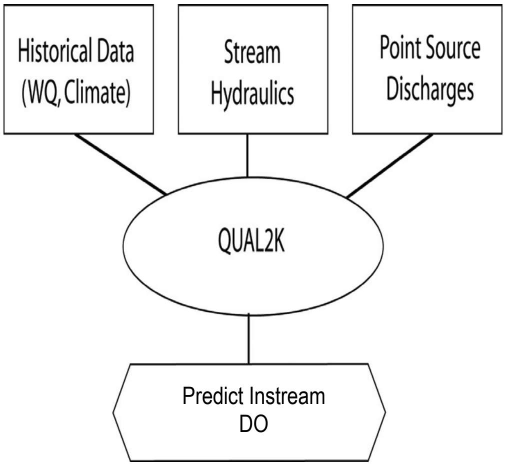
Table 7-1 contains information on the methodologies selected and used to develop TMDLs for impaired segments within the Lower Kaskaskia River watershed.

Table 7-1 Methodologies Used to Develop TMDLs in the Lower Kaskaskia River Watershed

Segment Name/ID	Causes of Impairment	Methodology
Kaskaskia River - O-03	Atrazine, Manganese	Load Duration Curves
Kaskaskia River - O-20	Fecal Coliform, Manganese	Load Duration Curves
Kaskaskia River - O-30	Atrazine, Fecal Coliform, Manganese	Load Duration Curves
	Dissolved Oxygen	QUAL2K
Kaskaskia River - O-97	Manganese	Load Duration Curve
Horse Creek - OB-03	Dissolved Oxygen	QUAL2K
Richland Creek South - OC-04	Dissolved Oxygen	QUAL2K
Richland Creek South - OC-95	Dissolved Oxygen	QUAL2K
Kinney Branch - OCF	Manganese	Load Duration Curve
	Dissolved Oxygen	QUAL2K
Mud Creek - OE-02	Manganese	Load Duration Curve
	Dissolved Oxygen	QUAL2K
SLM Side Channel Reservoir - SOL	Manganese	Load Duration Curve (source waters)
	Atrazine	Load Duration Curve (source waters)
Sparta NW Reservoir - SOC	Total Phosphorus	BATHTUB
	Manganese	Nutrient based - BATHTUB
	Atrazine	Loading Capacity Analysis
Coulterville Reservoir - ROV	Total Phosphorus	BATHTUB
	Manganese	Nutrient based - BATHTUB
	Atrazine	Loading Capacity Analysis

7.1.1 QUAL2K Overview

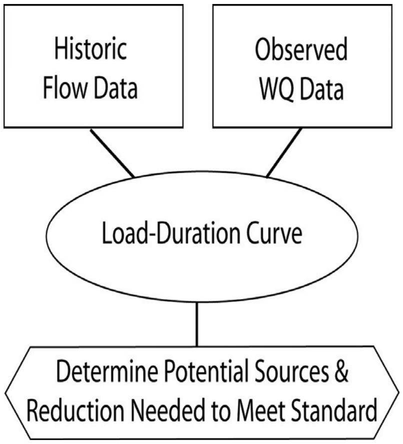
The QUAL2K model was used to develop the dissolved oxygen TMDL for stream segments O-30, OB-03, OC-04, OC-95, OCF, and OE-02 in the Lower Kaskaskia River watershed. QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady state hydraulics and allows for point source inputs, diffuse loading and tributary flows. Historic water quality data, observed hydraulic information, and point source discharge data were coupled with model defaults to predict the resulting instream DO concentrations (see Schematic 1).



Schematic 1

7.1.2 Load-Duration Curve Overview

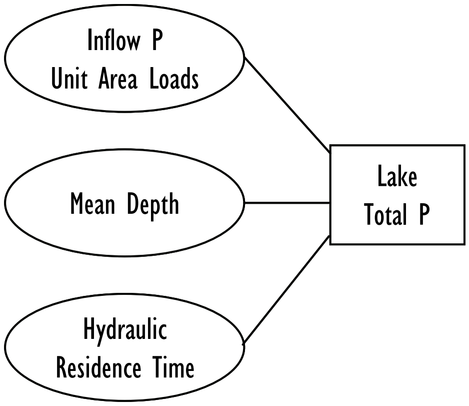
Loading capacity analyses were performed for several of the impaired stream segments in this watershed (O-03, O-20, O-30, O-97, OCF, OE-02). A load-duration curve is a graphical representation of the maximum load of a pollutant that a stream segment can assimilate over a range of flow scenarios while still meeting the instream water quality standard. The load-duration curve approach utilizes historic flow data and observed water quality data to provide useful information regarding the magnitude and frequency of exceedences as well as the flow scenarios when exceedences occur most often (see Schematic 2). In the Lower Kaskaskia River watershed, load duration curves were constructed for atrazine, manganese, and fecal coliform.



Schematic 2

7.1.3 BATHTUB Overview

TMDL analysis for total phosphorus in Sparta NW Reservoir and Coulterville Reservoir involved the use of observed data coupled with the rational method as inputs to the BATHTUB models. This method required inputs from several sources including online databases and GIS-compatible data.



Schematic 3

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

Once the subbasin flows and concentrations were estimated, they were used as input for the BATHTUB models. The BATHTUB model uses empirical relationships between mean reservoir depth, total phosphorus inputted to the reservoir, and the hydraulic residence time to determine in-reservoir concentrations (see Schematic 3).

7.1.4 Loading Capacity Analysis Overview

TMDL analysis for atrazine in Coulterville and Sparta NW Reservoirs was conducted using the loading capacity analysis approach. The loading capacity approach assumes that water quality standards will be attained in each reservoir if the tributary concentrations entering the reservoir remain below the 12µg/L raw water standard. Inflow rates into the reservoirs were extracted from the BATHTUB models previously established to address total phosphorus and total manganese in these waterbodies. Calculations of the maximum allowable load are then achieved by multiplying the average tributary flow into each reservoir by the water quality standard. Although similar to the load duration curve approach, loading capacity analysis was chosen for these reservoirs because available atrazine concentration data are from within the reservoir and not from the tributaries and it is not possible to directly correlate those concentrations with daily flow rates. Loading capacity analysis results in a single estimate of required reductions that applies for all flow conditions into each reservoir.

7.2 Methodology Development

The following sections further discuss and describe the methodologies utilized to examine atrazine, manganese, fecal coliform, dissolved oxygen, and total phosphorus levels in the impaired waterbodies in the Lower Kaskaskia River watershed.

7.2.1 pH

Kaskaskia River segment O-30 is also listed for impairment caused by pH. pH is a measure of acidity and/or alkalinity in the stream and not associated with a pollutant load but rather the amount of H^+ ion in the solution. Changes in pH can impact the concentrations of certain metal ions found in the water by altering the solubility of those metals in water. Acidic waters (pH<7.0) are associated with increased capacity to contain dissolved metals and therefore, pH levels and metal concentrations in waters are often closely interrelated. It is anticipated that pH issues will be addressed by implementing load reduction strategies for the TMDL pollutants associated with the segment, as outlined in Section 9 of this document. In addition, the evidence for impairment by pH at Kaskaskia River segment O-30 is minimal with only 3 violations (pH =6.1, 6.3) reported since 1990. No violations of the pH standard have been reported for this segment since March 27, 2002. Therefore, a specific TMDL calculation for pH on Kaskaskia River segment O-30 was not be developed at this time.

7.2.2 QUAL2K Model Development

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

Several separate Q2K models were developed for the DO impaired segments in the Lower Kaskaskia River watershed. There were no contiguous segments in the Lower Kaskaskia River watershed impaired for DO, therefore, a separate Q2K model was developed for each impaired stream segment. Models were developed for Kaskaskia River segment O-30, Horse Creek segment OB-03, Richland Creek segments OC-04 and OC-95, Kinney Branch segment OCF, and Mud Creek segment OE-02. A total of 6 separate Q2K models were developed for the impaired segments in the Lower Kaskaskia River watershed.

Because Q2K models simulate steady-state diurnal cycles the TMDL endpoints used for TMDL analysis at each segment were the 7-day average daily minimum water quality standards of 6.0 mg/L (March-July) and 4.0 mg/L (August-February). The use of these standards as a TMDL endpoint, as opposed to the 5.0 mg/L (March-July) and 3.5 mg/L (August-February) instantaneous minimum standards also serves as a conservative measure adding to the implicit MOS included in the final TMDL calculations for each impaired segment (see further discussion in Section 8).

7.2.2.1 QUAL2K Inputs

Table 7-2 contains the categories of data required for the Q2K models along with the sources of data used to analyze each of the impaired stream segments in the Lower Kaskaskia River watershed.

Table 7-2 Q2K Data Inputs

Input Category	Data Source
Stream Segmentation	GIS data
Hydraulic characteristics	Aerial photographs; GIS; Illinois EPA field data
Headwater conditions	Historic water quality data collected by Illinois EPA
Meteorologic conditions	National Climatic Data Center
Point Source contributions	Illinois EPA, EPA ICIS

Empirical data amassed during Stage 1 of TMDL development were used to build the Q2K models. In addition to the Stage 1 data, aerial photographs, GIS data and stream cross-section and flow measurements from additional Illinois EPA field data collected in 2008 were used for the Q2K models, where available.

7.2.2.2 Kinney Branch Model

Kinney Branch consists of one stream segment (OCF) and is impaired by low dissolved oxygen concentrations. The stream was sampled by Illinois EPA during a Facility Related Stream Study (FRSS) of the Freeburg West Sewage Treatment Plant (STP) which provided a synoptic dataset of samples collected on the same day from several points along the stream segment. The synoptic FRSS samples were collected on August 2, 1996, a time of year where low flow and low DO conditions are likely to occur and were used to setup and calibrate the Q2K model for Kinney Branch. In 2008, additional water quality samples were collected on the impaired segment and continuous DO monitoring was conducted for 1-week periods in July and September to assess diurnal DO fluctuations.

7.2.2.2.1 Stream Segmentation - Kinney Branch Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. Kinney Branch was divided into six reaches. The Kinney Branch model extends from the upper-most headwaters of Kinney Branch to the confluence of with Richland Creek, a distance of approximately 8 km. Figure 7-1 shows the stream segmentation used for the Kinney Branch Q2K model.

7.2.2.2.2 Hydraulic Characteristics - Kinney Branch Model

The majority of stream hydraulics were specified in the model based on an Illinois EPA field survey conducted in September 2008 under low-flow conditions. One wetted cross-section was surveyed by measuring depths, velocities, and widths at multiple points across a transect. The cross section measurements were taken at Illinois EPA station OCF-96 (Figure 7-1). Appendix G contains the cross section measurement data supplied by Illinois EPA.

7.2.2.2.3 Headwater Conditions Kinney Branch Model

The model was set up with a single headwater at the upper most extent of the impaired segment. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were available for the modeled headwater segment and additional downstream locations from a Facility Related Stream Survey (FRSS) sampling event conducted on 08/02/1996. The FRSS data were used during the calibration phase of model development. Only water quality data collected in the months of July, August, September, and October were used for this model. Due to the relative proximity of the surrogate headwater location, along with the similar land use and flow regime characteristics in both headwaters, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 0.001 cfs. This flow rate is deemed representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

7.2.2.2.4 Diffuse Flow – Kinney Branch Model

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is located approximately 8 km downstream of the confluence of Kinney Branch with Richland

Creek and landuse and land cover characteristics in the gage's entire watershed remain similar to that of the Kinney Branch watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

7.2.2.2.5 Climate - Kinney Branch Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the National Climate Data Center (NCDC). Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.2.6 Point Sources – Kinney Branch Model

Freeburg West STP (permit number IL0032310) is the only NPDES permitted point source discharge within the Kinney Branch watershed. Permit records were reviewed and permitted discharge data were used for model input. The location of the Freeburg West STP facility is shown in Figure 7-1. The facility has a permitted flow of 0.4 mgd, which enters Kinney Branch at reach 3 of the Q2K model. Permit limit concentration data were available only for parameters that are sampled per permit requirements.

7.2.2.2.7 QUAL2K Calibration - Kinney Branch Model

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (August 2, 1996).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within the model-recommended ranges during this process (Appendix G). Due to the minimal amount of representative reach hydraulic (cross-section) data for the sampling period (only 1 cross-section was available from the FRSS report), hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured versus modeled calibration profiles and simulated reaeration rates are provided in Appendix G.

7.2.2.3 Richland Creek South Segment OC-95 Q2K Model

Two stream segments on Richland Creek South are impaired by low dissolved oxygen concentrations. The impaired segments are not contiguous and therefore two separate models were constructed; one for segment OC-95, discussed in this section of the report, and one for segment OC-04 as described in Section 7.2.2.4 of this report. Segment OC-95 of Richland Creek South was sampled by Illinois EPA during a Facility Related Stream Study (FRSS) of the Swansea Sewage Treatment Plant (STP) which provided a synoptic dataset of samples collected on the same day from several points along the stream segment. The synoptic FRSS samples were collected on August 8, 1996, a time of year where low flow and low DO conditions are likely to occur. The FRSS samples were used to setup and calibrate the Q2K model for OC-95. In 2008, additional water quality samples were collected on the impaired segment and continuous DO monitoring was conducted for 1-week periods in July and September to assess diurnal DO fluctuations.

7.2.2.3.1 Stream Segmentation – Richland Creek South Segment OC-95 Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Richland Creek South segment OC-95 was divided into 7 reaches. The modeled OC-95 segment extends from the upper most point in segment OC-95 to the confluence with Vinegar Creek, a total segment length of approximately 4.6 km. Figure 7-2 shows the stream segmentation used for the segment Richland Creek South segment OC-95 Q2K model.

7.2.2.3.2 Hydraulic Characteristics - Richland Creek South Segment OC-95 Model

The majority of stream hydraulics were specified in the model based on an Illinois EPA field survey conducted in September 2008 under relatively low-flow conditions. One wetted cross-section was surveyed by measuring depths, velocities, and widths at multiple points across a transect. The cross section measurements were taken at Illinois EPA station OC-95 (Figure 7-2). Appendix G contains the cross section measurement data supplied by Illinois EPA.

7.2.2.3.3 Diffuse Flow - Richland Creek South Segment OC-95 Model

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is located approximately 22 km downstream of the modeled OC-95 segment and land use and land cover characteristics in the gage's entire watershed remain similar to that of the OC-95 watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

7.2.2.3.4 Headwater Conditions - Richland Creek South Segment OC-95 Model

The model was set up with a single headwater at the upper most extent of the impaired segment OC-95. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were available for the modeled headwater segment from a FRSS sampling event conducted on 08/08/1996 and were used during the calibration phase of model development. Only water quality data collected in the months of July, August, September, and October were used for this model.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 6.36 cfs. This flow rate is representative of the low flow conditions present at the time of synoptic sampling were entered into the Q2K model.

7.2.2.3.5 Climate - Richland Creek South Segment OC-95 Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.3.6 Point Sources - Richland Creek South Segment OC-95 Model

Swansea STP (permit number IL0026701) and Dutch Hollow Village, Inc. STP (permit number IL0046663) are the only NPDES permitted point source discharges within the OC-95 watershed that have measurable average permitted discharges. The average daily discharge for the Swansea STP is 2.7 mgd while the Dutch Hollow Village, Inc. STP has an average daily discharge of 0.08 mgd. In addition, there are 6 combined sewer overflow (CSO) locations permitted under the Belleville STP #1 (permit number IL0021873) located within the OC-95 watershed. CSOs have average daily discharges of 0 mgd based on the NPDES permit. Permit records were reviewed and permitted discharge data were used for model input. The location of the NPDES permitted discharges are shown in Figure 7-2. Permit limit concentration data were available only for parameters that are sampled per permit requirements.

7.2.2.3.7 QUAL2K Calibration - Richland Creek South Segment OC-95 Model

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (August 8, 1996).This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Due to a lack of sufficient representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

7.2.2.4 Richland Creek South Segment OC-04 Q2K Model

In addition to the impaired OC-95 segment of Richland Creek South discussed above, segment OC-04 of Richland Creek South is also impaired for dissolved oxygen. This segment was sampled by Illinois EPA during a Facility Related Stream Study (FRSS) of the Belleville STP and a synoptic dataset consisting of 3 sampling locations on and immediately upstream of the OC-04 segment was available. All 3 stations were sampled on the same day (August 8, 1996) during a time of year where low flow and low DO conditions are likely to occur. This FRSS data was used to setup and calibrate the Q2K model for Richland Creek South segment OC-04.

7.2.2.4.1 Stream Segmentation - Richland Creek South Segment OC-04 Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Richland Creek South was divided into 3 reaches, as shown in Figure 7-3. This modeled portion of Richland

Creek South extends from Illinois EPA sampling location OC-BV-C5 (approximately 4.9 km upstream of the impaired OC-04 segment) to the confluence of Richland Creek South with the Kaskaskia River, a total stream length of approximately 33 km.

7.2.2.4.2 Hydraulic Characteristics - Richland Creek South Segment OC-04 Model

The majority of stream hydraulics are specified in the model based on physical stream characteristic data collected during an additional Illinois EPA field survey conducted in September 2007 under relatively low-flow conditions. One wetted cross-section was surveyed by measuring depths, velocities, and widths at multiple points across a transect. The cross section measurements were taken at Illinois EPA station OC-95 (Figure 7-3). Appendix G contains the cross section measurement data supplied by Illinois EPA. Additional hydraulics data were available from the USGS dataset pertaining to gage 05595200 (Richland Creek near Hecker, Illinois), which is co-located with Illinois EPA sampling station OC-04.

7.2.2.4.3 Headwater Conditions - Richland Creek South Segment OC-04 Model

The model was set up with a single headwater at station OC-BV-05, approximately 4.9km upstream of the impaired segment. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were available from the 1996 FRSS report for the modeled headwater segment and were inputted into the model as a headwater condition during the model calibration.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 12.62 cfs. This flow rate is representative of the low flow conditions present at the time of synoptic sampling.

7.2.2.4.4 Diffuse Flow - Richland Creek South Segment OC-04 Model

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is located near the mid-point of reach 2 in the OC-04 Q2K model. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, at additional locations throughout the system. These flow were included in the model as diffuse inputs to the system.

7.2.2.4.5 Climate- Richland Creek South Segment OC-04 Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.4.6 Point Sources - Richland Creek South Segment OC-04 Model

A total of 15 NPDES permitted point sources discharge within the OC-04 watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-3 contains information for each facility while Figure 7-3 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

Table 7-3 Point Source Discharges within the Richland Creek South Segment OC-04 Watershed

Facility Name	Permit Number	Average Facility Flows	Segment Number
BELLEVILLE STP #1	IL0021873	8.0 mgd	Headwater
COLUMBIA QUARRY-HECKER STOCKPL	ILG840054	No discharge	2
COLUMBIA QUARRY-WATERLOO PIT 7	ILG840004	No discharge	3
DUTCH HOLLOW VILLAGE, INC.	IL0046663	0.08 mgd	Headwater
FREEBURG WEST STP	IL0032310	0.4 mgd	Headwater
HECKER STP	ILG580235	0.08 mgd	2
HOME OIL COMPANY-BELLEVILLE	IL0075442	0.01 mgd	Headwater
MAPLE LEAF ESTATES WATER CORP.	IL0071579	0.0127 mgd	3
MILLSTADT STP	IL0032514	0.5 mgd	Headwater
RED BUD STP	IL0025348	0.6 mgd	3
SMITHTON STP	ILG580026	0.24 mgd	Headwater
SMITHTON-WILDWOOD STP	IL0061131	0.154 mgd	Headwater
SWANSEA STP	IL0021181	2.7 mgd	Headwater
TIMBER LAKE HOMEOWNERS ASSOC	ILG551050	0.0068 mgd	3
WATERLOO EAST STP	IL0070734	0.13 mgd	Headwater

7.2.2.4.7 QUAL2K Calibration - Richland Creek South Segment OC-04 Model

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (August 8, 1996). This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to a lack of adequate reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Finally, diffuse flow input concentrations of nutrients and CBOD, as implied by the synoptic data set, were set as part of the calibration process. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

7.2.2.5 Horse Creek Q2K Model

Horse Creek consists of a single segment (OB-03 that is impaired for dissolved oxygen. Horse Creek discharges to an impaired segment of the Kaskaskia River (O-30) but the two segments do not share a synoptic and therefore, separate Q2K models were developed for each segment. Horse Creek segment OB-03 has a limited data set that consists of data collected at a single sample location (OB-03). The station has been sampled for DO and related parameters only 5 times since 1990. Exceedences of the DO standard were recorded on two occasions in the summer of 2002.

7.2.2.5.1 Stream Segmentation - Horse Creek Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Horse Creek segment OB-03 was divided into 2 reaches. The full extent of Horse Creek was included in the Q2K model, a total reach length of approximately 45.44 km. Figure 7-4 shows the stream segmentation used for the Horse Creek model.

7.2.2.5.2 Hydraulic Characteristics - Horse Creek Model

No hydraulic data were available for Horse Creek. The Manning's Equation was used to drive hydraulics for this segment based on estimated channel width from aerial photographs, channel slope from the National Elevation Dataset, and an estimated Manning's roughness coefficient.

7.2.2.5.3 Headwater Conditions - Horse Creek Model

The model was set up with a single headwater at the upper most extent of the impaired segment OB-03. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary. Measured concentration data were not specifically available for the modeled headwater segment. However, historical water quality data collected at segment OC-95 (the headwaters of Richland Creek, approximately 19 miles away) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model. Due to the relative proximity of the surrogate headwater location, along with the similar land use and flow regime characteristics in both headwaters, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be approximately 0.006 cfs. This flow rate is representative of the low flow conditions present at the time of synoptic sampling.

7.2.2.5.4 Diffuse Flow - Horse Creek Model

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is located approximately 14 km to the northeast of the headwaters of Horse Creek. Land use and land cover characteristics in the gage's entire watershed remain similar to that of the Horse Creek watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

7.2.2.5.5 Climate - Horse Creek Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.5.6 Point Sources - Horse Creek Model

A total of 2 NPDES permitted point sources discharge within the OB-03 watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-4 contains information for each facility while Figure 7-4 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

Table 7-4 Point Source Discharges within the Horse Creek Segment OB-03 Watershed

Facility Name	Permit Number	Average Facility Flows	Segment Number
ADORERS OF THE BLOOD OF CHRIST STP	IL0026948	0.03 mgd	2
RUMA STP	IL0063282	0.02 mgd	2

7.2.2.5.7 QUAL2K Calibration - Horse Creek Model

The limited water quality data available for this segment were sufficient to perform a rudimentary calibration of model kinetic and transport rates. The available data set was collected during a period of low flow on July 7, 2002.This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to the limited representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

7.2.2.6 Mud Creek Q2K Model

Mud Creek consists of a single segment (OE-02) that is impaired for dissolved oxygen. Mud Creek discharges to the Kaskaskia River at segment O-03, which is not impaired for DO. Mud Creek segment OE-02 has a limited data set that consists of data collected at two sample locations (OE-04 and OE-05). The stations have been sampled for DO and related parameters a total of only 5 times since 1990, combined. The stations have never been sampled synoptically. Exceedences of the DO standard were recorded on one date in July 1996 at station OE-04 and on two occasions in July and August of 2002 at station OE-05.

7.2.2.6.1 Stream Segmentation - Mud Creek Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, Mud Creek segment OE-02 was divided into 2 reaches. The full extent of Mud Creek was included in the Q2K model, a total reach length of approximately 55.5 km. Figure 7-5 shows the stream segmentation used for the Mud Creek model.

7.2.2.6.2 Hydraulic Characteristics - Mud Creek Model

No hydraulic data were available for the modeled portion Mud Creek. The Manning's Equation was used to drive hydraulics for this segment based on estimated channel width from aerial photographs, channel slope from the National Elevation Dataset, and an estimated Manning's roughness coefficient.

7.2.2.6.3 Headwater Conditions - Mud Creek Model

The model was set up with a single headwater at the upper most extent of the impaired segment OE-02. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were not specifically available for the modeled headwater segment. However, historical water quality data collected at segment OC-95 (the headwaters of Richland Creek, approximately 25 miles away) were available and were used as a surrogate headwater concentration data set. Only water quality data collected in the months of July, August, September, and October were used for this model. Due to the relative proximity of the surrogate headwater location, along with the similar land use and flow regime characteristics in both headwaters, it was assumed that data collected at the sampling location were representative of conditions at the headwaters.

The stream flow at the headwaters was estimated for the synoptic sampling date using the area ratio method described in Section 2.6 of this report. Headwater stream flow during the synoptic sampling date was estimated to be 0.001 cfs. This flow rate is representative of the zero flow conditions expected to occur at various times of year in the headwater watershed.

7.2.2.6.4 Diffuse Flow - Mud Creek Model

Diffuse flow gains were assumed in the system based on surrogate flow gage calculations. The following USGS flow gage was used for these calculations: USGS 05595200 RICHLAND CREEK NEAR HECKER, IL. This gage is located approximately 15 km to the east of the headwaters of Mud Creek. Land use and land cover characteristics in the gage's entire watershed remain similar to that of the Mud Creek watershed. As with the headwater flow calculations, area-weighting calculations were used to estimate flow gains, exclusive of point sources, through the system. These flows were included in the model as diffuse inputs to the system.

7.2.2.6.5 Climate - Mud Creek Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.6.6 Point Sources- Mud Creek Model

A total of 2 NPDES permitted point sources discharge within the OB-03 watershed. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-5 contains information for each facility while Figure 7-5 shows the locations of each facility. Flow information was available for each discharger; however, permit limit concentration data are available only for parameters that are sampled per permit requirements.

Table 7-5 Point Source Discharges within the Mud Creek Segment OE-03 Watershed

Facility Name	Permit Number	Average Facility Flows	Segment Number
SAINT LIBORY WWTP	ILG580014	0.09 mgd	2
JOHANNISBURG GRADE SCHOOL	IL0046884	0.0018 mgd	2
PEABODY COAL CO-BALDWIN 3 UNDE	IL0052558	N/A	2
PEABODY COAL-MARISSA MINE	IL0052566	N/A	1
COULTERVILLE WTP	ILG640056	0.016 mgd	1
ST. LIBORY WTP	ILG640162	0.05 mgd	2

7.2.2.6.7 QUAL2K Calibration - Mud Creek Model

The limited water quality data available for this segment were sufficient to perform a rudimentary calibration of model kinetic and transport rates. The data set used for model calibration was collected during a period of low flow on 08/08/1996. This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to the limited representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

7.2.2.7 Lower Kaskaskia River Q2K Model

The main stem of the lower Kaskaskia River has one segment impaired for dissolved oxygen (O-30). The Q2K model developed for Kaskaskia River segment (O-30) is discussed in this section of the report. There is a single station within the impaired O-30 segment with dissolved oxygen data. In addition, synoptic data collected on the same date was available for an upstream point (O-20) that served as a headwater condition. The Q2K model was setup and calibrated using data from October 12, 2005. This represents the most recent date in which both stations were sampled at time of year where low flow and low DO conditions are likely to occur.

7.2.2.7.1 Stream Segmentation - Lower Kaskaskia River Model

The Q2K model represents a river as a series of reaches. Each reach shares constant channel geometry and hydraulic characteristics. In this model, the lower Kaskaskia River was divided into 4 reaches. The modeled segments of the lower Kaskaskia River extend from the confluence of the Kaskaskia River with the Mississippi River to the Illinois EPA sampling station O-20, approximately 93 km upstream. Figure 7-6 shows the stream segmentation used for the lower Kaskaskia River Q2K model. Three major tributaries to this reach, Mud Creek, Horse Creek, and Richland Creek South were explicitly modeled in separated Q2K files (described above). Simulated flows and concentrations from the termini of these tributary models were included as steady point sources to the lower Kaskaskia River model.

7.2.2.7.2 Hydraulic Characteristics - Lower Kaskaskia River Model

Limited hydraulic data were available for the modeled portion the lower Kaskaskia River. The headwater station used in the model (O-20) is co-located with the USGS gage 05594100 (Kaskaskia River near Venedy Station, Illinois), for which some channel morphology data was available for input into the model. Appendix G contains the channel morphology data provided by USGS.

7.2.2.7.3 Headwater Conditions - Lower Kaskaskia River Model

The model was set up with one headwater station (O-20) upstream of the impaired O-30 segment of the Kaskaskia River. The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data at station O-20 on October 12, 2005 were used for the modeled headwater segment. These historical water quality data were used because they represent the most recent date where synoptic sampling occurred on the modeled segment of the lower Kaskaskia River.

Stream flow measurements at the headwater station (O-20) were available from the USGS gage co-located with this sampling station (05594100 Kaskaskia River near Venedy Station, Illinois). Stream flows during the synoptic sampling date were measured to be 134 cfs at the headwater O-20. The ISWS-published 7Q10 flow for the Lower Kaskaskia River at the O-20 segment is 74 cfs indicating that the flow rate present at the time of sampling is representative of a low flow condition and were entered into the Q2K model.

7.2.2.7.4 Diffuse Flow - Lower Kaskaskia River Model

Diffuse flow gains were indirectly incorporated into the lower Kaskaskia River model though the inclusion of major tributary inputs to the Kaskaskia River main stem. As described above, these tributaries were modeled separately and included diffusive flow gains calculated using surrogate flow gage data and drainage area ratios.

7.2.2.7.5 Climate - Lower Kaskaskia River Model

Q2K requires inputs for climate. Temperature and wind speed data for the synoptic sampling date were obtained from the NCDC. Data from the nearest available weather station (Scott Air Force Base near Belleville, Illinois) were used for the model.

7.2.2.7.6 Point Sources- Lower Kaskaskia River Model

A total of 71 NPDES permitted point sources discharge within the lower Kaskaskia River watershed downstream of the O-20 headwater station. Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge data were used for model input. Table 7-6 contains information for each facility while Figure 7-6 shows the locations of each facility. Flow information was not available for every discharger and permit limit concentration data are available only for parameters that are sampled per permit requirements.

Additionally, as described above, major tributary inputs, simulated separately, were included as point sources in this model.

Table 7-6 Point Source Discharges within the lower Kaskaskia River Watershed (downstream of O-20)

Facility Name	Permit Number	Average Facility Flows	Segment Number
ACKERMAN'S RESTAURANT	IL0052001	N/A	2
ADORERS OF THE BLOOD OF CHRIST	IL0026948	0.03 mgd	4
ALHAMBRA STP	ILG580004	0.0725 mgd	2
ALHAMBRA WTP	ILG640029	0.006	2
BALDWIN STP	IL0027219	0.051 mgd	3
BALDWIN WTP	ILG640190	N/A	3
BELLEVILLE STP #1	IL0021873	8 mgd	3
CASEYVILLE TOWNSHIP EAST STP	IL0021083	2.2 mgd	2
CLANAHAN TRAILER PARK	IL0052256	0.0042	2
COLUMBIA QUARRY-HECKER STOCKPL	ILG840054	N/A	3
COLUMBIA QUARRY-WATERLOO PIT 7	ILG840004	N/A	3
COULTERVILLE WTP	ILG640056	0.016 mgd	2
COUNTRYVIEW COURT-SPARTA	IL0046019	0.011 mgd	3
DUTCH HOLLOW VILLAGE, INC.	IL0046663	0.08 mgd	3
DYNEGY MIDWEST GENERATION-BALD	IL0000043	23.5 mgd	3
ELLIS GROVE STP	ILG580145	0.0247 mgd	4
EVANSVILLE STP	IL0021440	0.17 mgd	4
FAYETTEVILLE STP	IL0020893	0.04 mgd	1
FREEBURG EAST STP	IL0020753	0.12 mgd	2
FREEBURG WEST STP	IL0032310	0.4 mgd	3
HAMEL STP	ILG580011	0.105 mgd	2
HECKER STP	ILG580235	0.08 mgd	3
HIGHLAND WTP	IL0001112	0.06 mgd	2
HOME OIL COMPANY-BELLEVILLE	IL0075442	0.01 mgd	3
HOPKINS PARK STP	ILG580217	0.25 mgd	2
IL DOT-I64 ST CLAIR COUNTY	IL0068314	N/A	2
JOHANNISBURG GRADE SCHOOL	IL0046884	0.0018 mgd	2
KASKASKIA WATER DIST PWS	IL0052884	0.015 mgd	2
LEBANON STP	IL0029483	0.47 mgd	2
LENZBURG STP	ILG580013	0.0825 mgd	3
LIVINGSTON STP	ILG580115	0.148 mgd	2
MANORS AT KENSINGTON PARQUE	IL0074993	0.0238 mgd	2
MAPLE LEAF ESTATES WATER CORP.	IL0071579	0.0127 mgd	3
MARINE STP	ILG580228	0.24 mgd	2
MARINE WTP	IL0049611	N/A	2
MARISSA STP	IL0024813	0.585 mgd	3
MASCOUTAH STP	IL0025291	0.965 mgd	2
METRO-EAST AIRPARK STP	IL0075094	0.0042 mgd	2
MIDAMERICA AIRPORT	IL0075434	N/A	2
MILLSTADT STP	IL0032514	0.5 mgd	3
MISSISSIPPI RIVER TRANSMISSION	IL0067695	0.0001 mgd	2
MUNIE TRUCKING CO.-HIGHLAND	IL0068861	N/A	2
NEW ATHENS MOBIL HOME PARK	IL0024601	0.0278 mgd	2
NEW ATHENS WWTP	IL0021725	0.12 mgd	2
O'FALLON STP	IL0021636	5.61 mgd	2
PEABODY COAL CO BALDWIN #1 MIN	IL0046493	N/A	3
PEABODY COAL CO-BALDWIN 3 UNDE	IL0052558	N/A	2
PEABODY COAL COMPANY	IL0062740	N/A	3
PEABODY COAL COMPANY-RIVER KNG	IL0000582	N/A	3
PEABODY COAL-MARISSA MINE	IL0052566	N/A	2
RED BUD STP	IL0025348	0.6 mgd	3
RUMA STP	IL0063282	0.02 mgd	4
SAINT JACOB STP	ILG580212	0.14 mgd	2

Table 7-6 Point Source Discharges within the lower Kaskaskia River Watershed (downstream of O-20)

Facility Name	Permit Number	Average Facility Flows	Segment Number
SAINT LIBORY WWTP	ILG580014	0.09 mgd	2
SCOTT AIR FORCE BASE	IL0026859	2 mgd	2
SMITHTON STP	ILG580026	0.24 mgd	3
SMITHTON-WILDWOOD STP	IL0061131	0.154 mgd	3
SPARTA STP	IL0066133	0.25 mgd	3
ST. CLAIR TWP	IL0048232	1.5 mgd	2
ST. LIBORY WTP	ILG640162	N/A	2
SUMMERFIELD LEBANON MASCOUTAH	IL0001236	N/A	1
SUMMERFIELD STP	IL0064220	0.07 mgd	2
SWANSEA STP	IL0021181	2.7 mgd	3
TILDEN STP	ILG580107	0.111 mgd	3
TIMBER LAKE HOMEOWNERS ASSOC	ILG551050	0.0068 mgd	3
TRIAD COMMUNITY UNIT DIST #2	ILG551025	0.0195 mgd	2
TRISIMO MOTEL DEVELOPMENT	IL0066788	0.0092 mgd	2
TROY STP	IL0031488	1.35 mgd	2
TROY WTP	IL0060062	0.1 mgd	2
VALLEY VIEW MOBILE HOME PARK	IL0062111	N/A	3
WATERLOO EAST STP	IL0070734	0.25 mgd	3

7.2.2.7.7 QUAL2K Calibration - Lower Kaskaskia River Model

Sufficient water quality data were available to perform a rudimentary calibration of model kinetic and transport rates. A synoptic data set, spatially distributed data obtained on the same day, were available for a low flow period (October 12, 2005). This data set was used to calibrate key model kinetic parameters and reach hydraulics. All model kinetic parameters were maintained within model recommended ranges during this process (Appendix G). Calibrated kinetic parameters are in close agreement with those calibrated for other reaches in this watershed (described above). Due to the minimal representative reach hydraulic (cross-section) data for the sampling period, hydraulic parameters (mean velocities and depths) were also treated as calibration parameters. These parameters were varied from the initial values described above in order to achieve the reaeration rates implied by the data and ultimately replicate measured dissolved oxygen profiles. Final measured vs. modeled calibration profiles, and simulated reaeration rates, are provided in Appendix G.

7.2.3 Load Duration Curve Development

Load duration curves are used to gain understanding of the range of loads allowable throughout the flow regime of a stream. This approach was used to characterize the current loading of contaminants to impaired segments of the Kaskaskia River (O-03, O-20, O-30 and O-97), Kinney Branch (OCF), and Mud Creek (OE-02).

7.2.3.1 Watershed Delineation and Flow Estimation

Watersheds for the areas contributing directly to the impaired stream segments at the Illinois EPA data collection stations were delineated with GIS analyses through use of the NED as discussed in Section 2.2 of this report. The delineation determined that Kaskaskia River segments O-03, O-20, O-30, and O-97 capture flows from directly contributing watersheds of approximately 5141.2, 4393.0, 5736.4, and 5461.1 square miles, respectively. Kinney Branch segment OCF captures flows from a directly contributing watershed of 4.2 square miles and the watershed for Mud Creek segment OE-02 is 88.2 square miles. Figure 7-7 shows the location of the water quality stations on each segment as well as the boundary of the GIS-delineated watersheds.

In order to create a load duration curve, it is necessary to obtain flow data corresponding to each water quality sample. As discussed in Section 2.6.3 of this report, there are no USGS stream gages within the watersheds that have current, or even recent, streamflow data. Therefore, the drainage area ratio method, represented by the following equation, was used to estimate flows.

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

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

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

USGS gage 05594100 (Kaskaskia River near Venedy Station, Illinois) is located within segment O-03 and therefore serves as an appropriate gage from which to estimate flows for impaired stream segments O-03, O-20, O-30 and O-97 on the Kaskaskia River. The location of the gage on the Kaskaskia River drains a relatively large area of approximately 4,393 square miles, which is within an order of magnitude in size of the watersheds delineated for the impaired segments in the Lower Kaskaskia River watershed and receives comparable precipitation throughout the year. For the smaller watersheds draining to the impaired segments on the Kinney Branch (OCF) and Mud Creek (OE-02), USGS Gage 05595200 (Richland Creek near Hecker, Illinois) was selected as an appropriate surrogate gage. The gage on Richland Creek drains an area of approximately 129.0 square miles. This gage is also located within the Lower Kaskaskia River watershed and is therefore expected to receive comparable precipitation to the impaired segments on Kinney Branch and Mud Creek.

Data were downloaded through the USGS for each gage and multiplied by the area ratio discussed above to estimate flows for the watersheds. A total of 7 NPDES permitted facilities in the Richland Creek watershed have measureable permitted discharge flows. The combined average daily outflow from these facilities is 12 million gallons per day (MGD). These flows were subtracted from the gage to account for point source influence. The impaired segments within the Lower Kaskaskia River watershed receive point source discharges of measurable permitted flow. These flows are added to the estimate flows from surrogate gage calculations for each watershed to account for the influence of NPDES discharge volumes on stream flow in the impaired segments. Spreadsheets used for the area ratio flow calculations are provided in Appendix D.

7.2.3.2 Manganese: Kaskaskia River segments O-03, O-20, O-30, O-97, Kinney Branch segment OCF, and Mud Creek segment OE-02

Flow duration curves for each impaired segment were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard for manganese to generate a load duration curve. The general use water quality standard for manganese is 1.0 mg/L (302.208(g)).

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development and data collected by Illinois EPA in 2008 and 2009 were paired with the corresponding flow for the sampling dates and plotted against the load duration curves. Figures 7-8 through 7-13 show the load duration curves as solid lines and the historically observed pollutant loads for manganese as points on each graph.

Historic manganese data are limited within the watershed with the exceptions of Kaskaskia River segments O-20 and O-30. The load duration curve for manganese on segment O-20 shows that 109 of the 143 total samples collected since 1990 have exceeded the total manganese standard of 1.0 mg/L (or 1,000 µg/L). For segment O-30, manganese load duration analysis shows that 90 of the 143 total samples collected since 1990 have exceeded the total manganese standard. In both cases, exceedences for manganese have occurred with similar frequency across the full range of flow levels.

Segment OCF on the Kinney Branch has 9 historic samples collected since 1990, of which 4 samples were collected by Illinois EPA in 2007 and 2008 and were not included in the original Stage 1 report. The only exceedence reported for this segment occurred under low flow conditions. The remaining segments impaired for manganese (Kaskaskia River O-03 and O-97, and Mud Creek OE-02) each have only three historic samples available for analysis. The load duration curves for manganese on these segments show that exceedences occurred under the full range of flow conditions. Spreadsheets used for the calculation of manganese load duration curves are provided in Appendix E.

7.2.3.3 Atrazine: Kaskaskia River segments O-03 and O-30

Flow duration curves for analysis of atrazine loads to impaired segments were generated by ranking the estimated daily flow data generated through the area ratio method discussed above, determining the percent of days these flows were exceeded, and then graphically plotting the results. The flows in the duration curve were then multiplied by the water quality standard for atrazine to generate a load duration curve. Atrazine is a common herbicide applied to food crops to control broadleaf and grassy weeds. Efforts to characterize the effects of atrazine on human health and the environment are still on-going. The water quality standard to protect public water supply use states that the maximum contaminant level (MCL) for each parameter in treated water must not be exceeded in any samples taken during the most recent three sampling years. The treated water MCL for atrazine is 3 µg/L. Furthermore, for untreated water samples, during the most recent three sampling years i) any observation is not to exceed four times the treated water MCL (12 µg/L); or ii) any quarterly average concentration is not to exceed the treated water MCL (3 µg/L); or iii) any running annual average is not to exceed the treated water MCL (3 µg/L). In order to facilitate load duration curve development, the limit of 12µg/L (3x the drinking water MCL) was used in calculations because of the limited data requirements for assessing this portion of the standard.

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development were paired with the corresponding flow for the sampling dates and plotted against the load duration curves. Figures 7-14 and 7-15 show the load duration curves as solid lines and the historically observed pollutant loads for atrazine as points on each graph.

The load duration curve for atrazine on segment O-03 shows that 6 of the 95 total samples since 1990 exceeded the water quality criteria. Five of the six exceedences at O-03 occurred under dry conditions. The load duration curve developed for atrazine at segment O-30 shows that 5 of the 68 samples collected exceeded the water quality standard. All 5 of the reported exceedences at O-30 occurred under dry conditions. Appendix H contains spreadsheets used for the calculation of the load duration curves for atrazine.

7.2.3.4 Fecal Coliform: Kaskaskia River segments O-20 and O-30

Flow duration curves were developed for Kaskaskia River segments O-20 and O-30 for fecal coliform bacteria by determining the percent of days each estimated flow was exceeded, and then graphically plotting the results. Because the fecal coliform standard is seasonal and is only applicable between the months of May and October, only flows and samples for this time period were used in the analysis. The flows in the duration curves were then multiplied by the water quality standard of 200 cfu/100mL to generate a load duration curve. Fecal coliform data collected between May and October were compiled from data amassed during Stage 1 of TMDL development. These data were then paired with the corresponding flows for the sampling dates and plotted against the load duration curve. Figures 7-16 and 7-17 show the load duration curve for each segment as a solid line and the observed pollutant loads as points on the graphs.

The load duration curve for fecal coliform at segment O-20 indicates, since 1990, 27 of the 60 samples collected between the months of May and October have exceeded the geometric mean standard of 200 cfu/100ml. Exceedences at O-20 occurred across the whole range of flow conditions, however, a somewhat higher proportion of exceedences occurring in the low to mid flow ranges.

The load duration curve for fecal coliform at segment O-30 indicates, since 1990, 6 of the 60 samples collected between the months of May and October have exceeded the geometric mean standard of 200 cfu/100ml. The exceedences at O-30 were concentrated in the mid to somewhat elevated flow ranges. Exceedences during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the re-suspension of fecal material in the stream sediment. Appendix F contains spreadsheets used for the calculation of the load duration curves for fecal coliform at Kaskaskia River segment O-30.

7.2.4 BATHTUB Development for Coulterville Reservoir

Coulterville Reservoir is listed as impaired for total phosphorus, manganese and atrazine. For this TMDL, manganese will not be analyzed because it is assumed that development of the phosphorus TMDL will control the manganese concentrations. The manganese target is maintenance of hypolimnetic DO concentrations above zero, because the major controllable source of manganese to the lake is the release of manganese from lake sediments during periods when there is no DO in lake bottom waters. The lack of DO in lake bottom waters is presumed to be due to the effects of nutrient enrichment, as there are no significant sources of oxygen demanding materials to the lake. For this reason, attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target for manganese is therefore set as a total phosphorus concentration of 0.05 mg-P/L.

The BATHTUB model was used to develop the total phosphorus TMDL for Coulterville Reservoir. BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections along with watershed and operational information for the lake.

The BATHTUB analyses used for development of the phosphorus TMDL is not appropriate for use in development of a TMDL for atrazine, which is not likely to be influenced by nutrient loading and eutrophication. A description of the methodology used to develop the TMDL for atrazine in Coulterville Reservoir is provided in section 7.2.6 of this report.

7.2.4.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed section 2.6 of this report, the average annual precipitation input to the model was 38.3 inches, and the average annual evaporation input to the model was 30.5 inches (ISWS 2008). The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kilograms per square kilometer (kg/km$^{2)}$-year (U.S. Army Corps of Engineers [USACE] 1999). This value is based on a compilation of available historic data and Illinois EPA believes that it is appropriate for use in this watershed where site-specific rates of deposition are not available.

7.2.4.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Coulterville Reservoir is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 7-18. Segmentation was established based on available water quality sampling locations and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the 2002 data from the water quality stations discussed in section 5.1.2. Segment lengths and surface areas were determined in GIS. These data are shown below (Table 7-7) for reference.

Table 7-7 Coulterville Reservoir Segment Data

Segment	Surface Area (km^2)	Segment Length (km)	Average Depth (m)
ROV-1	0.063	0.29	6.6
ROV-2	0.058	0.52	4.1
ROV-3	0.035	0.45	2.7

7.2.4.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. Figure 7-18 also shows the subbasin boundaries. The watershed was broken up into three tributaries for purposes of the model. There are no perennial tributaries that flow into Coulterville Reservoir and no water quality or flow data are available for any of the drainages. Therefore, the three areas contributing loads to each lake segment were used for the BATHTUB tributary inputs.

As discussed in Section 7.2.1, there are no flow gages within the watershed and the drainage area ratio method was used to estimate flows. The total mean flow into Coulterville Reservoir was estimated to be 0.7 cfs. The flow contribution from each tributary was estimated by multiplying the average inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 7-8.

Table 7-8 Coulterville Reservoir Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (acres)	Flow Rate (cfs)
Overland Flow to ROV-3	Segment 1: ROV-3	161	0.23
Overland Flow to ROV-2	Segment 2: ROV-2	271	0.39
Overland Flow to ROV-1	Segment 3: ROV-1	59	0.08
	TOTAL	**491**	**0.71**

No data regarding the normal storage volume of Coulterville Reservoir was available from to the US Army Corps of Engineers' National Dam Inventory. However, based on the output data from the BATHTUB model developed for Coulterville reservoir, the lake residence time is approximately 1.12 years.

Because there are no available historic tributary concentration data, phosphorus loads from the contributing watershed were estimated based on land use data and the median annual export coefficients for each land use. Export coefficients for each land use category found in the Coulterville Reservoir watershed were extracted from the USEPAs PLOAD version 3.0 user's manual. This document provides an extensive list of phosphorus export coefficients for various land uses in several regions of the country compiled from a number of sources in the literature. The export coefficients for each land use are reported in lbs/acre/year which can then be multiplied by the number of acres of each land use in the Coulterville Reservoir watershed to provide a total median phosphorus load into the reservoir. The overall load is then distributed to each tributary area for modeling input based on the proportion of the overall watershed represented by each subbasin.

7.2.4.4 BATHTUB Confirmatory Analysis

Historical water quality data for Coulterville Reservoir are summarized in Section 5.1.2 of this report. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

The Coulterville Reservoir BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. When using these loadings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, the internal loading rates were increased. Internal loading rates reflect nutrient recycling from bottom sediments. Because the lake is relatively deep, a review of historic dissolved oxygen levels recorded at depths near the lake bottom was performed to see if there was a potential for sediment loading of phosphorus. The data show that during summer months, the lake bottom waters regularly have dissolved oxygen levels near zero, especially at site ROV-1 which is located nearest the dam in the deepest lake segment. This lends confidence to the potential for internal loading. As can be seen in Table 7-9, an excellent match was achieved, lending significant support to the predictive ability of this simple model. A printout of the BATHTUB model files is provided in Appendix I of this report.

Table 7-9 Summary of Model Confirmatory Analysis- Coulterville Reservoir Total Phosphorus (mg/L)

Lake Site	Observed	Predicted	Internal Loading Rate (mg/m2-day)
Segment 1 : ROV-3	0.242	0.242	17.85
Segment 2 : ROV-2	0.173	0.172	11.22
Segment 3 : ROV-1	0.216	0.216	36.20
Lake Average	**0.206**	**0.206**	

7.2.5 BATHTUB Development for Sparta NW Reservoir

Sparta NW Reservoir is impaired for total phosphorus, manganese and atrazine. For this TMDL, manganese will not be analyzed because it is assumed that development of the phosphorus TMDL will control the manganese concentrations. The manganese target is maintenance of hypolimnetic DO concentrations above zero, because the only controllable source of manganese to the lake is the release of manganese from lake sediments during periods when there is no DO in lake bottom waters. The lack of DO in lake bottom waters is presumed to be due to the effects of nutrient enrichment, as there are no significant sources of oxygen demanding materials to the lake. For this reason, attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target for manganese is therefore set as a total phosphorus concentration of 0.05 mg-P/L.

The BATHTUB model was used to develop the total phosphorus TMDL for Sparta NW Reservoir. BATHTUB has three primary input interfaces: global, reservoir segment(s), and watershed inputs. The individual inputs for each of these interfaces are described in the following sections along with watershed and operational information for the lake.

The BATHTUB analyses used for development of the phosphorus TMDL is not appropriate for use in development of a TMDL for atrazine, which is not likely to be influenced by nutrient loading and eutrophication. A description of the methodology used to develop the TMDL for atrazine in Sparta NW Reservoir is provided in section 7.2.6 of this report.

7.2.5.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in section 2.6, the average annual precipitation input to the model was 38.3 inches, and the average annual evaporation input to the model was 30.5 inches (ISWS 2008). The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kilograms per square kilometer (kg/km$^{2)}$-year (U.S. Army Corps of Engineers [USACE] 1999). This value is based on a compilation of available historic data and Illinois EPA believes that it is appropriate for use in this watershed where site-specific rates of deposition are not available.

7.2.5.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Sparta NW Reservoir is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 7-19. Segmentation was established based on available water quality sampling locations and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the data from the water quality stations discussed previously in this report. Segment lengths and surface areas were determined in GIS. These data are shown below (Table 7-10) for reference.

Table 7-10 Sparta NW Reservoir Segment Data

Segment	Surface Area (km^2)	Segment Length (km)	Average Depth (ft)
SOC-3	0.059	1.06	15.8
SOC-2	0.033	0.52	23.6
SOC-1	0.048	0.61	46.0

7.2.5.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. Figure 7-19 also shows the subbasin boundaries. The watershed was broken up into three tributaries for purposes of the model. There are no perennial tributary streams that flow into Sparta NW Reservoir. Therefore, the three areas contributing loads to each lake segment were used for the BATHTUB tributary inputs.

As discussed in Section 7.2.1, there are no flow gages within the watershed and the drainage area ratio method was used to estimate flows. The total mean flow into Sparta NW Reservoir was estimated to be 1.32 cfs. The flow contribution from each tributary was estimated by multiplying the average inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 7-11.

Table 7-11 Sparta NW Reservoir Tributary Subbasin Areas and Estimated Flows

Tributary Name	Lake Segment	Area (acres)	Flow Rate (cfs)
Overland Flow to SOC-3	Segment 1: SOC-3	301	0.43
Overland Flow to SOC-2	Segment 2: SOC-2	383	0.55
Overland Flow to SOC-1	Segment 3: SOC-1	234	0.34
	TOTAL	**918**	**1.32**

Because there are no available historic concentration data from tributaries to the reservoir, phosphorus loads from the contributing watershed were estimated based on land use data and the median annual export coefficients for each land use. Export coefficients for each land use category found in the Sparta NW Reservoir watershed were extracted from the USEPAs PLOAD version 3.0 user's manual. This document provides an extensive list of phosphorus export coefficients for various land uses in several regions of the country compiled from a number of sources in the literature. The export coefficients for each land use are reported in lbs/acre/year which can then be multiplied by the number of acres of each land use in the Sparta NW Reservoir watershed to provide a total median phosphorus load into the reservoir. The overall load is then distributed to each tributary area for modeling input based on the proportion of the overall watershed represented by each subbasin.

7.2.5.4 BATHTUB Confirmatory Analysis

Historical water quality data for Sparta NW Reservoir are summarized in Section 5.1.2 of this report. These data were used to help confirm model calculations. Although the analyses presented below do lend confidence to the modeling, they should not be considered a true model "calibration." Additional lake and tributary water quality and flow data are required to fully calibrate the model.

The Sparta NW Reservoir BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. When using these loadings, the BATHTUB model under-predicted the concentrations when compared to actual water quality data. To achieve a better match with actual water quality data, internal loading rates were adjusted. Internal loading rates reflect nutrient recycling from bottom sediments. Based on the confirmatory analysis internal cycling is occurring in both segments SOC-1 and SOC-2 of Sparta NW Reservoir, but at a higher rate at SOC-1.

The model was simulated using the median phosphorus loads calculated with the unit area load method. These initial results showed that the predicted lake concentrations were consistently lower than observed lake concentrations. Therefore, the default phosphorus decay coefficient was lowered to increase predicted total phosphorus concentration. The reduction in phosphorus decay rate brought predicted phosphorus levels in line with the observed concentrations. As seen in Table 7-12, an excellent match was achieved, lending significant support to the predictive ability of this simple model. A printout of the BATHTUB model files is provided in Appendix I of this report.

Table 7-12 Summary of Model Confirmatory Analysis- Sparta NW Reservoir Total Phosphorus (mg/L)

Lake Site	*Observed*	*Predicted*
Segment 1 : SOC-3	0.054	0.059
Segment 2 : SOC-2	0.068	0.065
Segment 3 : SOC-1	0.501	0.500
Lake Average	0.210	0.212

7.2.6 Atrazine TMDL Development for Coulterville and Sparta NW Reservoirs

The primary potential pollutant source for atrazine in Coulterville and Sparta NW Reservoirs is runoff from agricultural lands; therefore, a loading capacity approach was used in atrazine analysis for these reservoirs. Similar to a load duration curve approach, loading capacity analysis defines the maximum amount of pollutant load entering a waterbody that will result in compliance with a water quality standard. The public water supply water quality standard for manganese is 3.0µg/L for treated water and 4 times that concentration (12µg/L) for raw water found in the Coulterville and Sparta NW Reservoirs.

Atrazine is easily transmitted from herbicide applications on agricultural fields to waterbodies because is persistent in the environment and weakly adsorbs to soils which can be carried into waterbodies through runoff from precipitation events. Once in the waterways, atrazine remains dissolved in the surface waters and degrades slowly in lakes and reservoirs. The amount of atrazine entering the reservoir on a given year is dependent on application methods and amounts, rainfall patterns, soil types, and erosion potential in the watershed. The concentration of atrazine in a reservoir along with the length and magnitude of any exceedences of water quality standards depends primarily on the volume and residence time of the reservoir. Residence times in relatively small reservoirs such as Coulterville and Sparta NW vary considerably with precipitation patterns. Addressing the potential for runoff of atrazine in the watershed is necessary for determining means of reducing concentrations of atrazine in Coulterville and Sparta NW Reservoirs in order to meet the applicable water quality standard. This loading capacity approach was selected over the full load-duration curve approach because the available atrazine data were collected from within the reservoirs themselves and do not represent daily loads.

The loading capacity approach assumes that water quality standards will be attained in each reservoir if the tributary concentrations entering the reservoir remain below the 12µg/L raw water standard. Inflow into the reservoir was calculated during development of the BATHTUB models described above using the area ratio method. The maximum allowable load was calculated by multiplying the average tributary flow into each reservoir by the water quality standard. The loading capacity approach is similar to the load duration curve approach. However, because available atrazine concentration data are from within the reservoir and not from the tributaries, it is not possible to directly correlate those concentrations with daily flow rates. Therefore, a single estimate of required reduction that applies for all time periods is calculated in lieu of load reduction estimates for the range of seasonal flow conditions provided by load the duration curve approach.

Data collected from USEPA STORET and Illinois EPA databases during Stage 1 of TMDL development. Historic atrazine data within each reservoir are limited. Analysis of the available atrazine data show that 8 of the 110 samples collected from Coulterville Reservoir and 0 of the 12 raw water samples from Sparta NW Reservoir collected since 1990 exceeded the 12µg/L (3 times the finished water standard) water quality standard for raw water in public drinking water supplies. As discussed in section 5.1.2.2.3 of this report, the available atrazine data for Sparta NW reservoir does not include samples collected at raw water intakes or from treated water. However, 8 of the 12 surface water samples from Sparta NW Reservoir collected since 1990 do exceed the 3µg/L water quality standard for treated drinking water so this standard is used as a conservative method of TMDL analysis in lieu of data on the efficacy of water treatment in reducing atrazine concentrations in finished water from Sparta NW Reservoir. In both reservoirs, exceedences typically occur in the summer or early fall (June - September), presumably as a result of seasonal application to agricultural lands within the watershed. Spreadsheets developed for atrazine loading capacity analyses are provided in Appendix H.

7.2.7 Atrazine and Manganese Model Development for SLM Side Channel Reservoir

SLM Side Channel Reservoir is an approximately 6 acre reservoir located 5 miles southeast of Mascoutah, Illinois. The SLM Reservoir is a small side-channel reservoir constructed in 1972 adjacent to SLM Water Commission water treatment plant. The reservoir is located adjacent to the Kaskaskia River at segment O-20 (Figure 7-20), which serves as the source water for the reservoir. The reservoir is filled by pumping water from the Kaskaskia River. SLM Side Channel Reservoir may receive some portion of its inflow from direct overland runoff from the surrounding area. However, due to the nature of the reservoir design, the localized topography and exact land area contributing overland flow into the reservoir remains uncertain. Detailed topographic surveying of the area would likely be required to establish a more accurate estimate of the watershed area contributing flow to the reservoir. Data for volumes and durations of pumping water into the reservoir is not available; however, a majority of the water entering SLM Side Channel Reservoir is pumped directly from the Kaskaskia River segment O-20 during normal operations at the SLM water treatment plant.

Historic manganese data collected at SLM Side Channel Reservoir show that 8 of 12 samples collected in the reservoir since 1990 exceed the 150µg/L water quality standard for public drinking water supplies. For atrazine, 2 of the 21 samples collected at SLM Side Channel reservoir were in exceedence of the 12µg/L public drinking water supply standard for raw water. Both of the samples that exceeded the atrazine standard were collected on the same date (June 17, 2003). Due to the lack of correlated raw and finished drinking water samples from the reservoir, it is not possible to assess the treatment potential of the treatment facility, so it should be noted that 1 additional sample collected at SLM Side Channel Reservoir exceeded the finished water standard of 3µg/L.

SLM Side Channel Reservoir is primarily filled through pumping of surface water from Kaskaskia River Segment O-20, which is also listed as a public drinking water supply and is impaired for total manganese. Therefore, it is expected that TMDL calculations and implementation plans developed for total manganese impairment at segment O-20 will be applicable to the total manganese impairment reported at SLM Side Channel Reservoir. As discussed in section 7.2.2.2, the load duration curve for manganese on segment O-20 shows that 109 of the 143 total samples collected since 1990 have exceeded the applicable total manganese standard of 150 µg/L. Exceedences for manganese occurred with similar frequency across the full range of flow levels.

Although segment O-20 is not listed as impaired for atrazine, the segment of the Kaskaskia River immediately down gradient of O-20, segment O-03 is listed as impaired for both atrazine and total manganese. This segment is approximately 4.3 miles downstream of the SLM Side Channel water intake. All violations of the atrazine standard reported at SLM Side Channel Reservoir occurred in 2003, a year for which there is no available atrazine data from Kaskaskia River segment O-20. Due to the limited nature of the atrazine data available for segment O-20, a total of 12 samples collected over 3 days in 2002, it is possible that the source of the atrazine at concentrations above the water quality standard is, in fact, the Kaskaskia River at segment O-20.Additional sources of atrazine may include overland runoff from the small watershed directly contributing to SLM Side Channel Reservoir, however, sufficient data is not available to assess this potential and a specific TMDL for atrazine at SLM side Channel Reservoir will not be developed at this time. However, implementation measures discussed in Section 9 of this report for mitigating the impairment of other segments and reservoirs in the watershed (O-03, O-30, Sparta NW Reservoir, and Coulterville Reservoir) are directly applicable to the atrazine impairment at SLM Side Channel Reservoir.

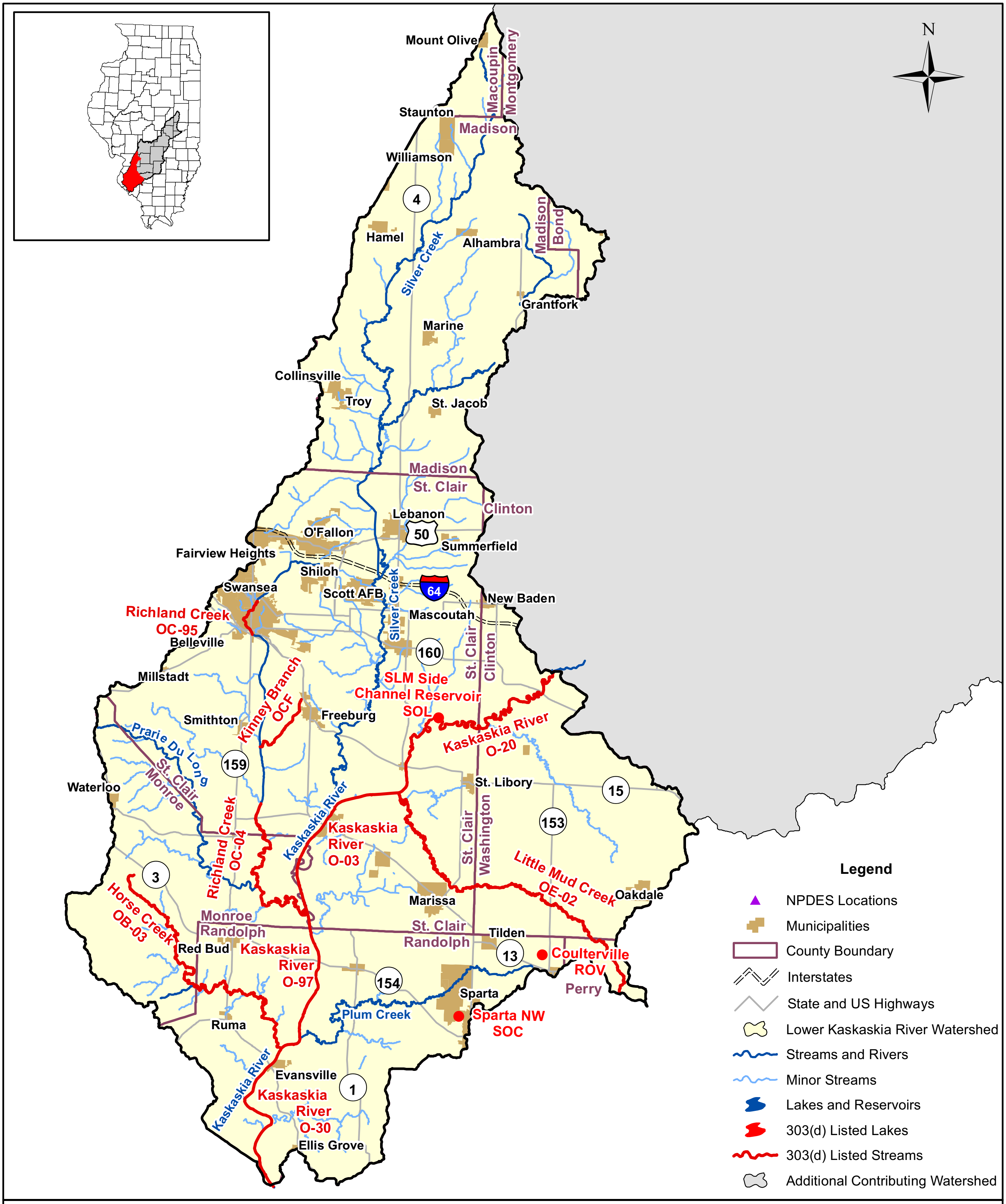


Figure 7-1
Lower Kaskaskia River Watershed

0 4 8 16 Miles

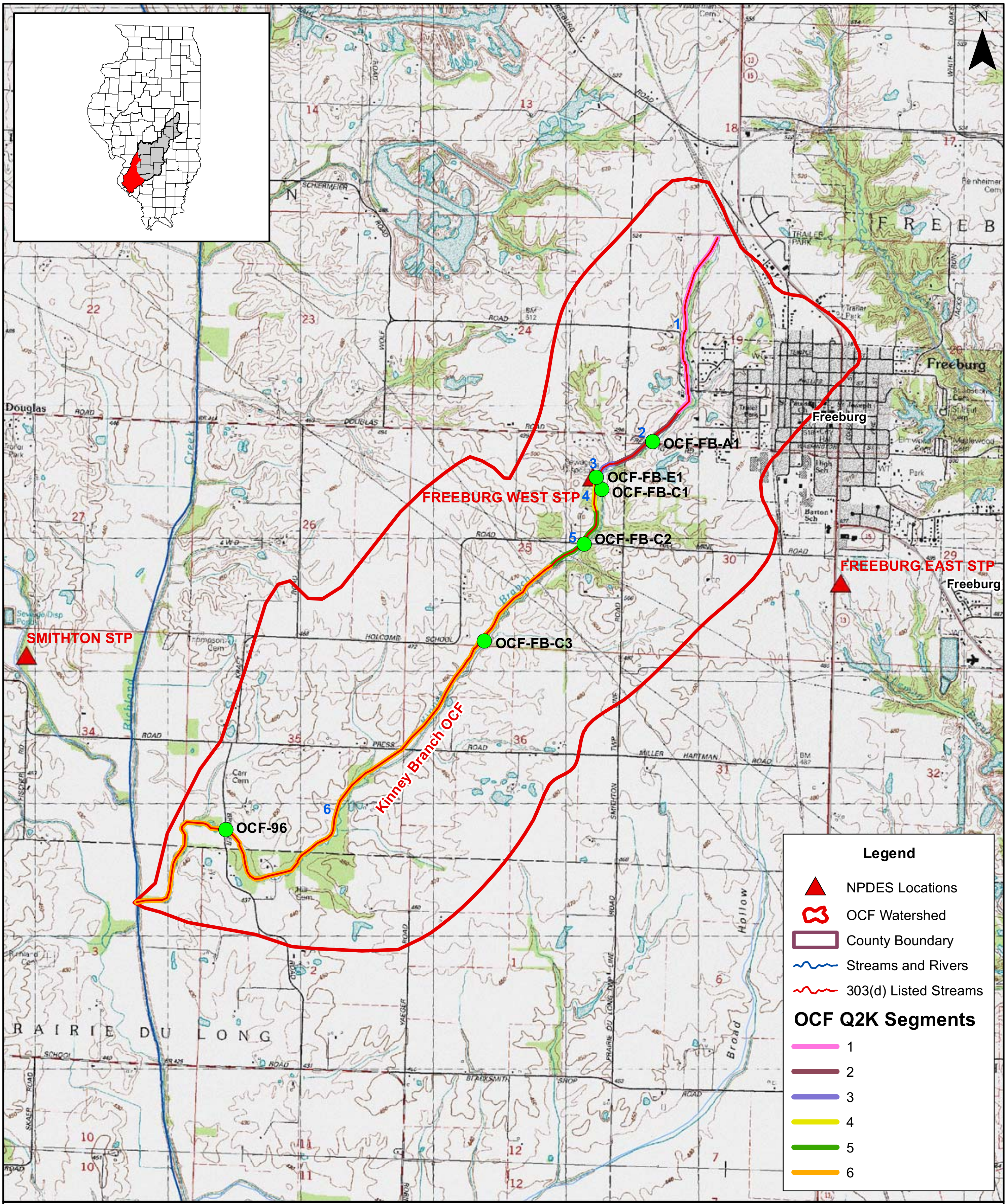


Figure 7-2
Lower Kaskaskia River Watershed
Kinney Branch QUAL2K Segmentation

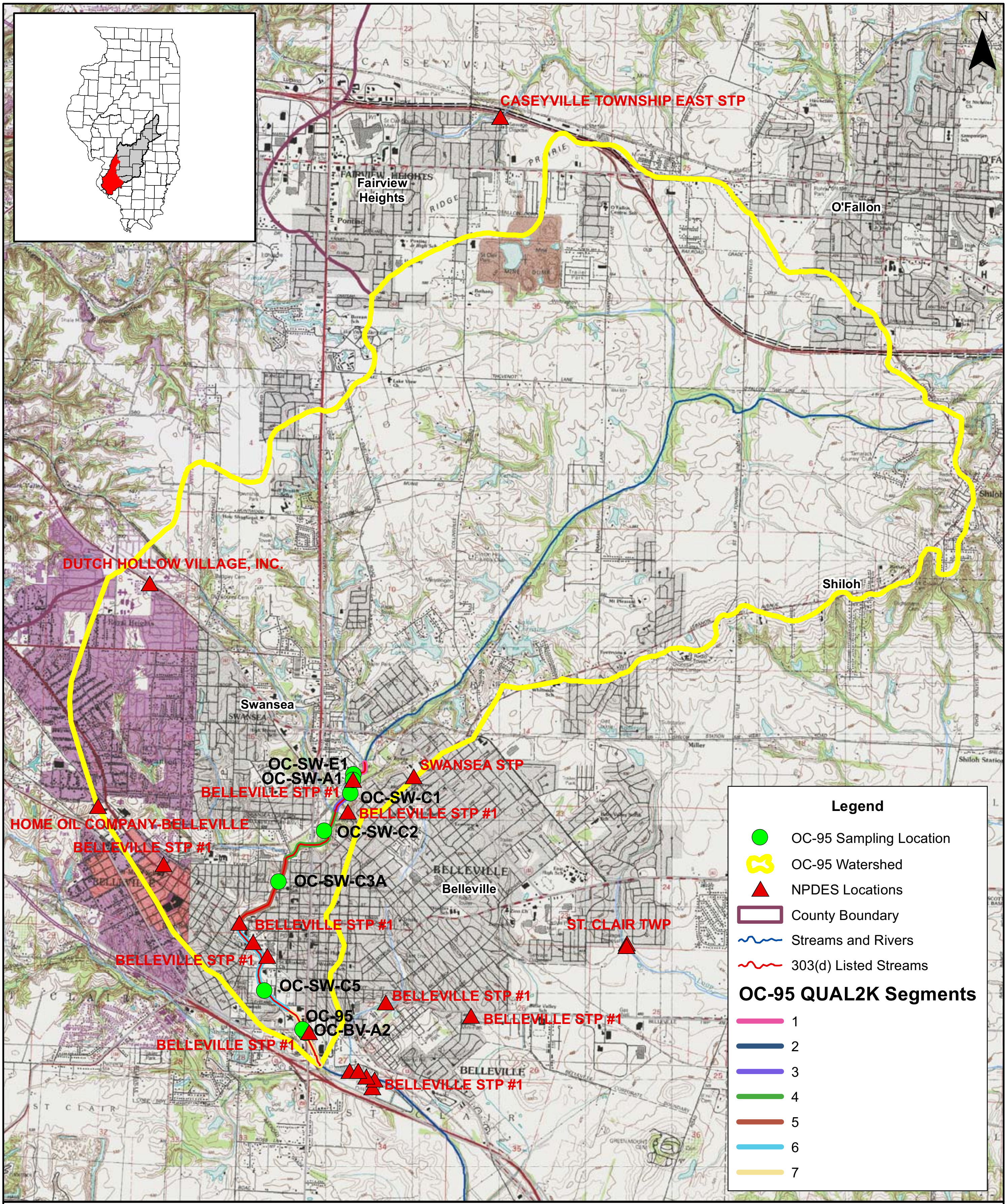


Figure 7-3
Lower Kaskaskia River Watershed
Richland Creek OC-95 QUAL2K Segmentation

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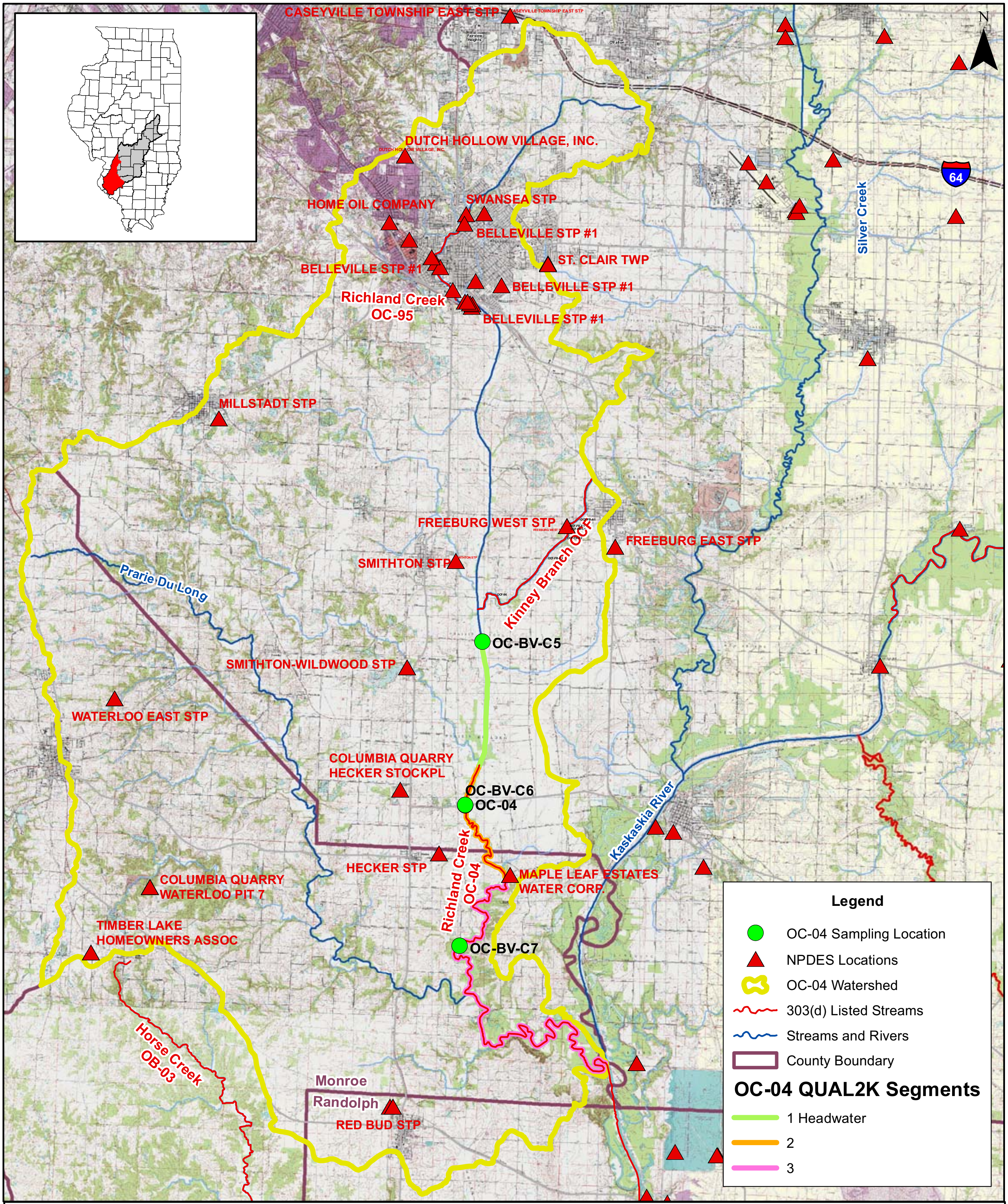

Figure 7-4
Lower Kaskaskia River Watershed
Richland Creek OC-04 QUAL2K Segmentation

0 2 4 Miles

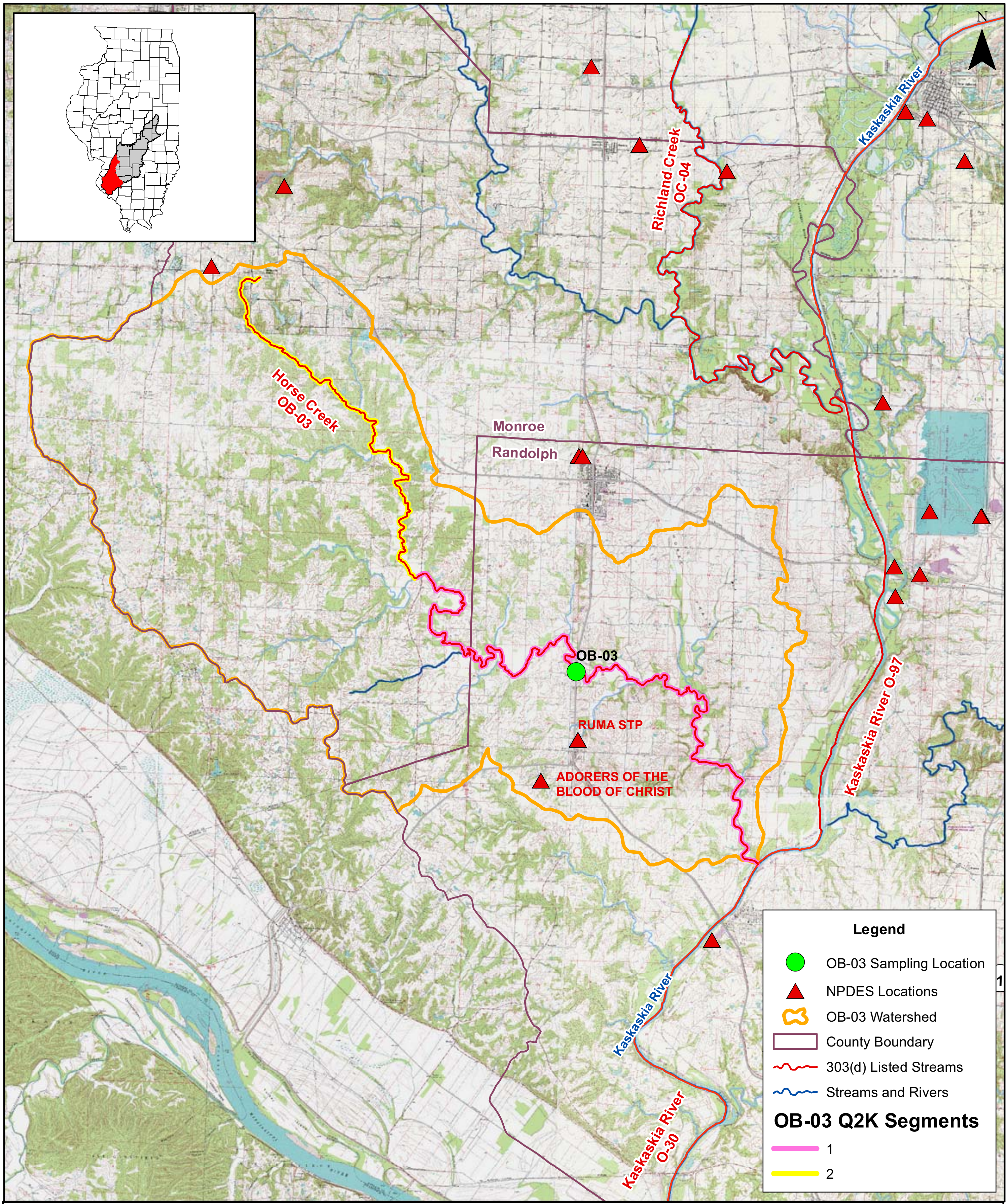

Figure 7-5
Lower Kaskaskia River Watershed
Horse Creek OB-03 QUAL2K Segmentation

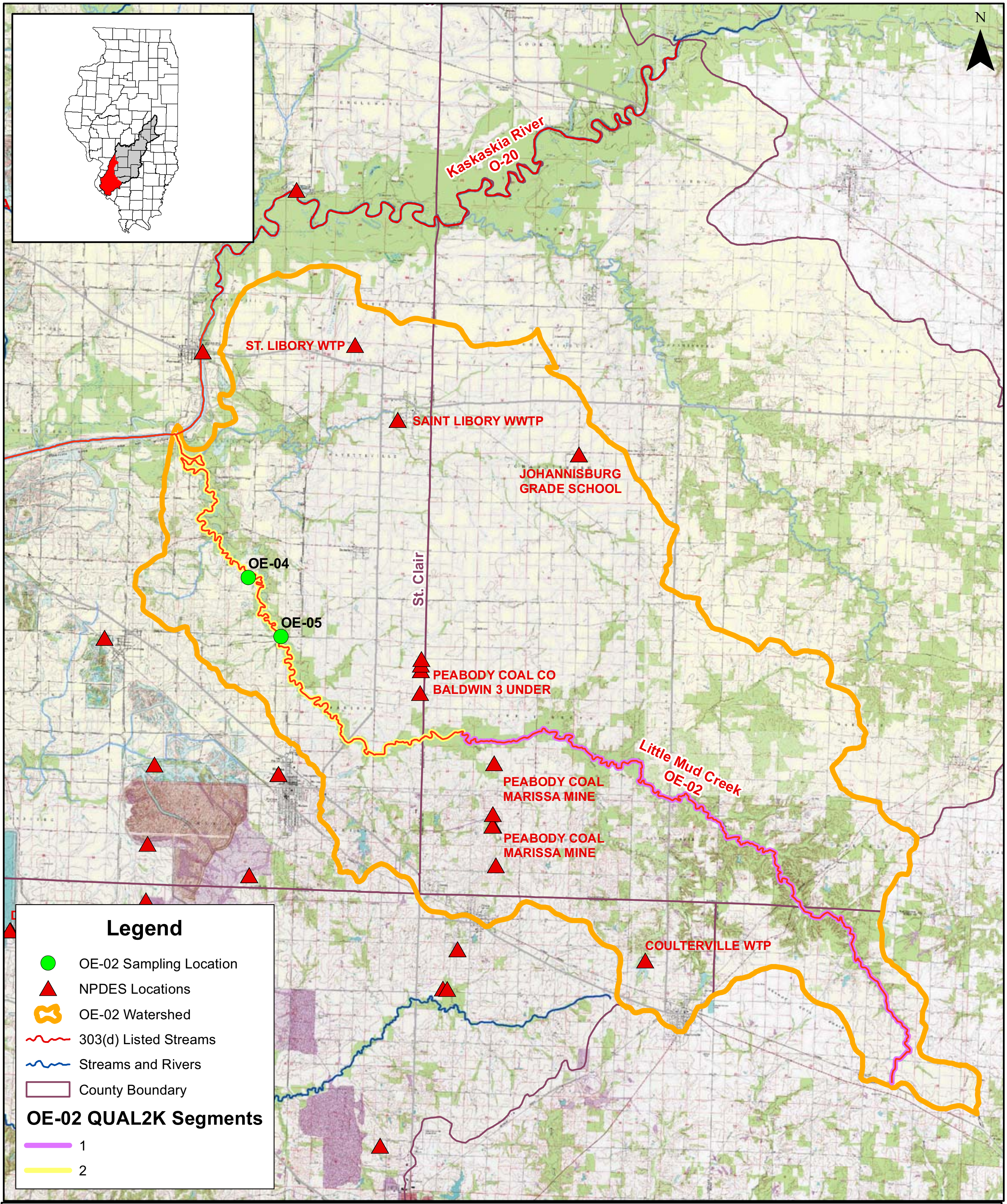

Figure 7-6
Lower Kaskaskia River Watershed
Mud Creek OE-02 QUAL2K Segmentation

0 2 4 Miles

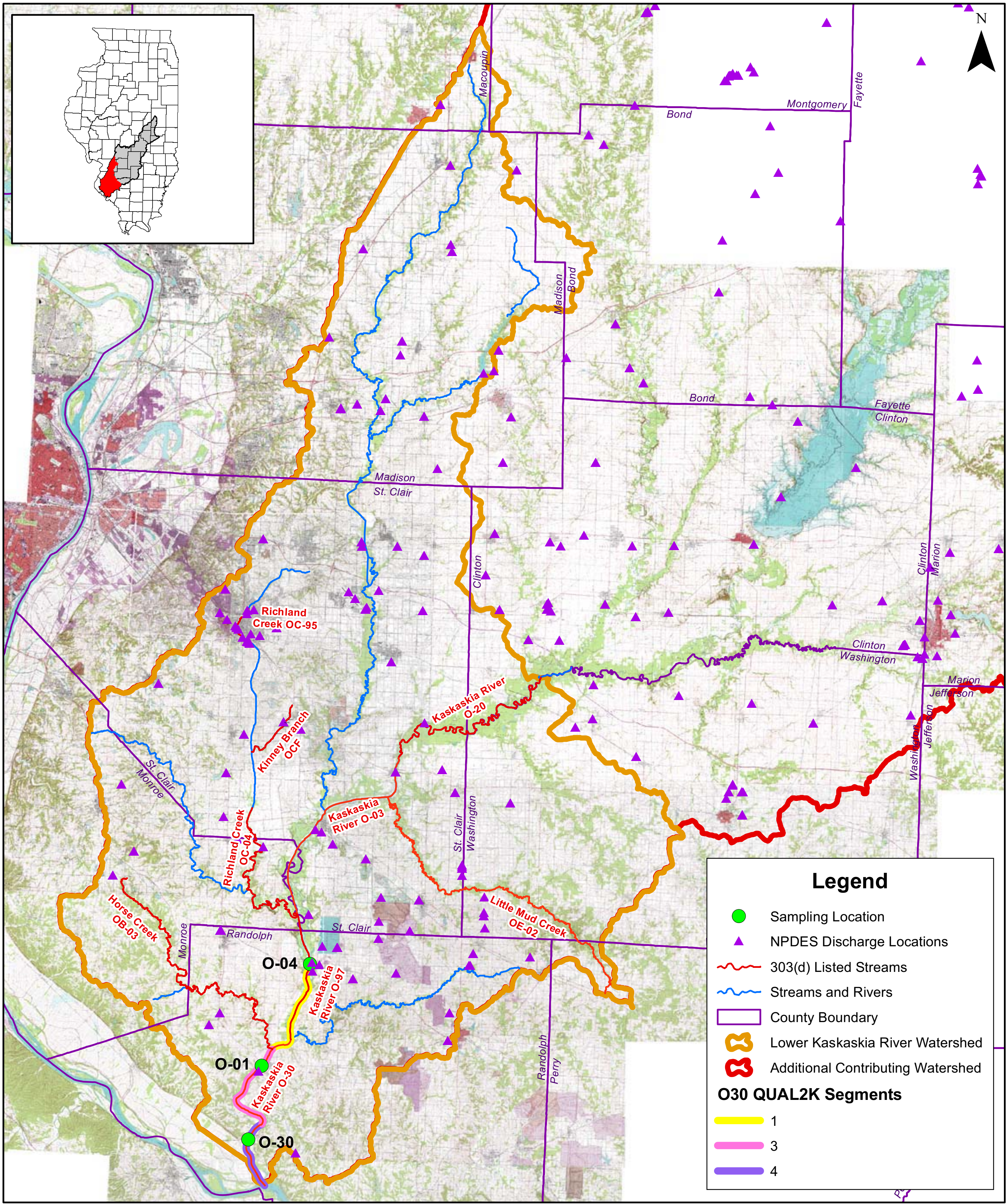

Figure 7-7
Lower Kaskaskia River Watershed
Lower Kaskaskia River QUAL2K Segmentation

0 5 10 Miles

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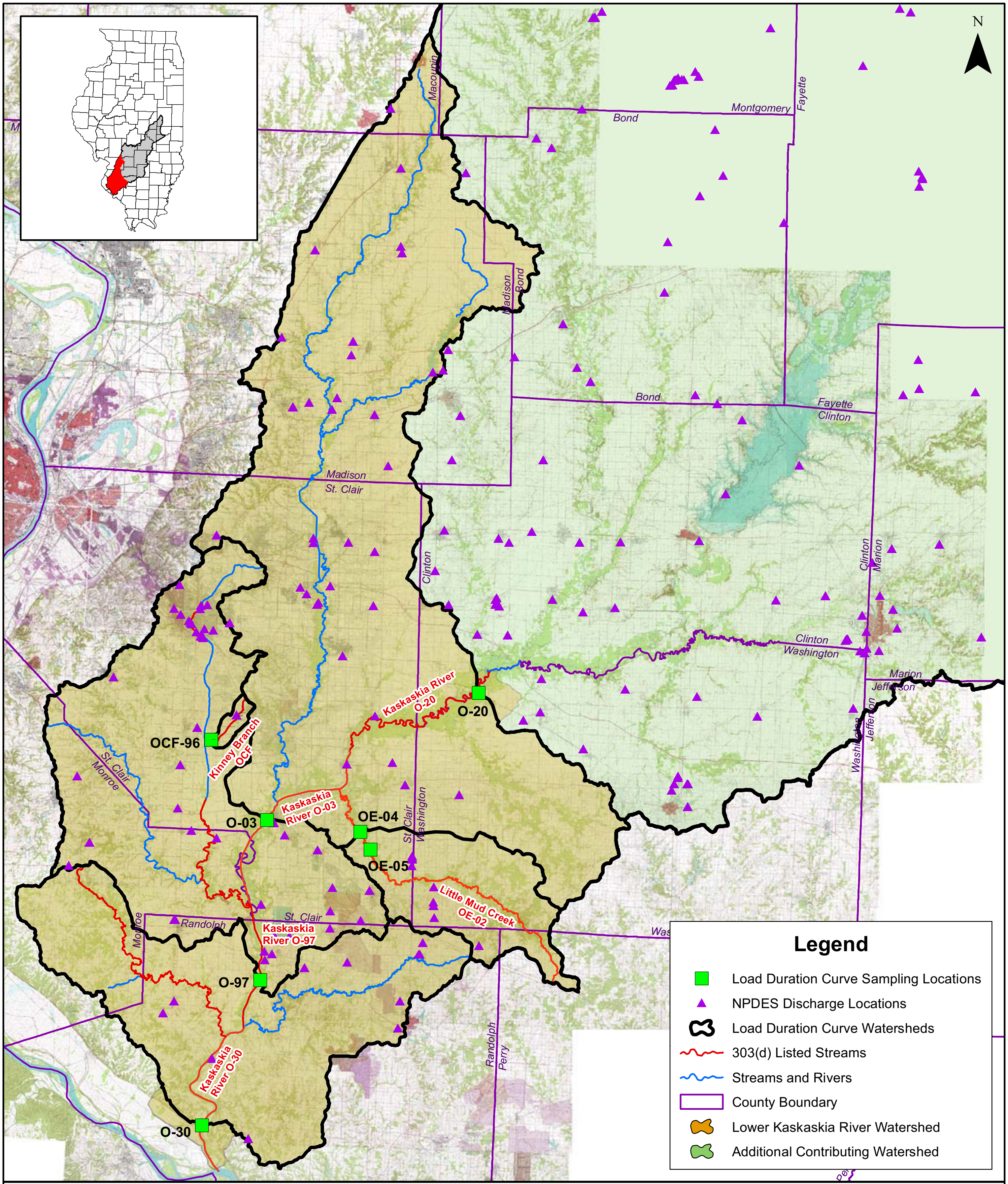

Figure 7-8
Lower Kaskaskia River Watershed
Load Duration Curve Watersheds and Sampling Locations

0 5 10 Miles

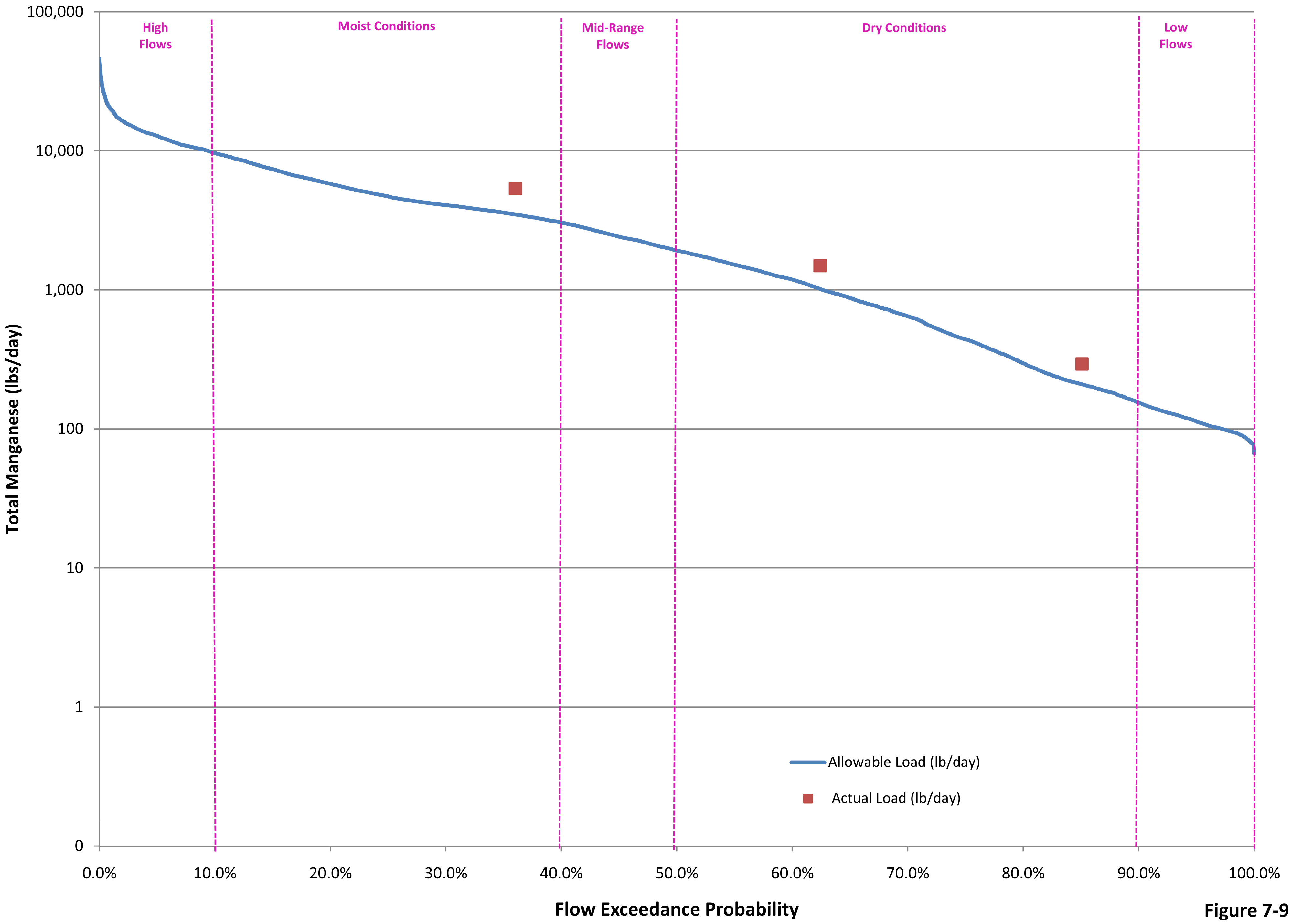

Figure 7-9
Kaskaskia River Segment O-03
Manganese Load Duration Curve

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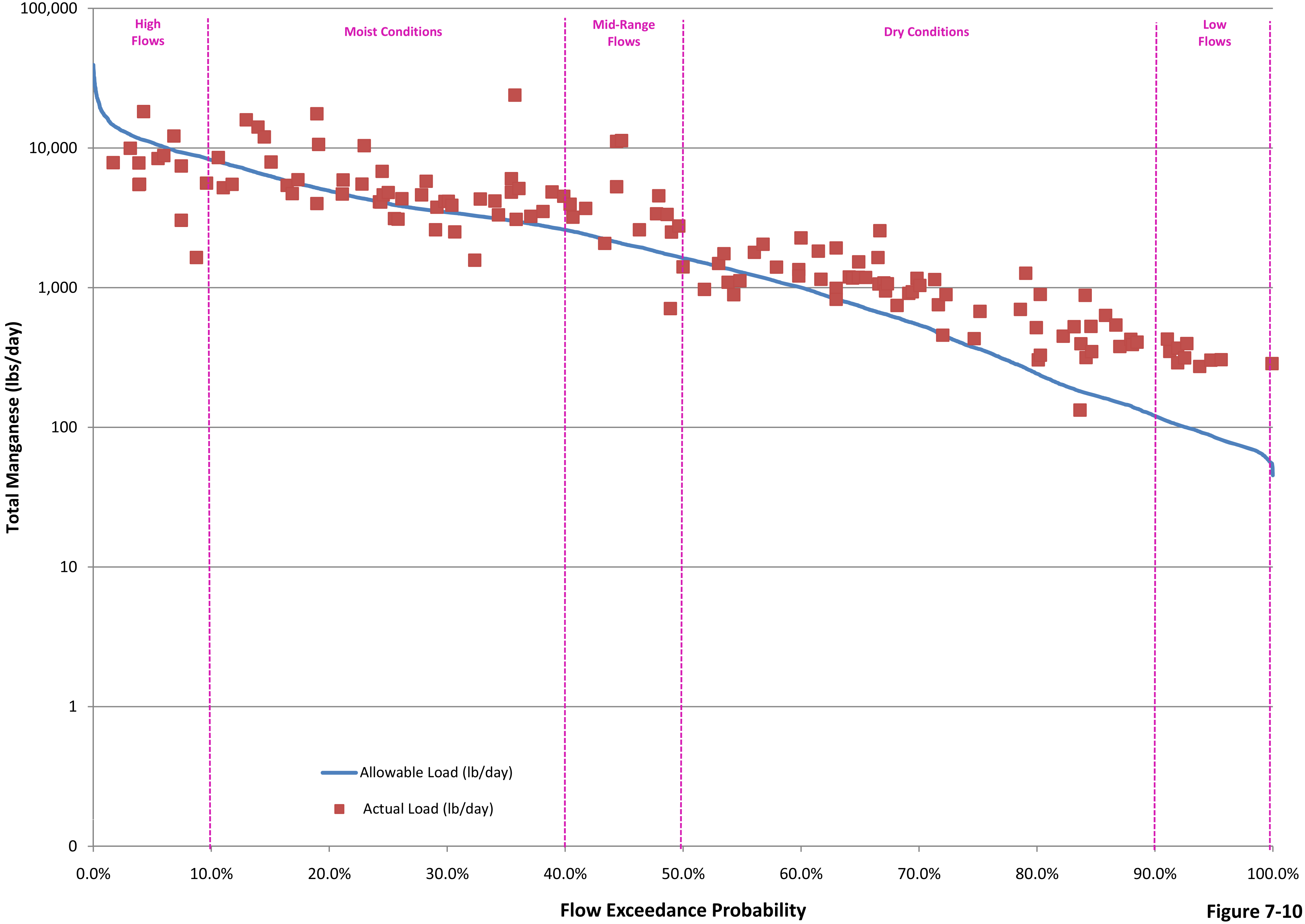


Figure 7-10
Kaskaskia River Segment O-20
Manganese Load Duration Curve

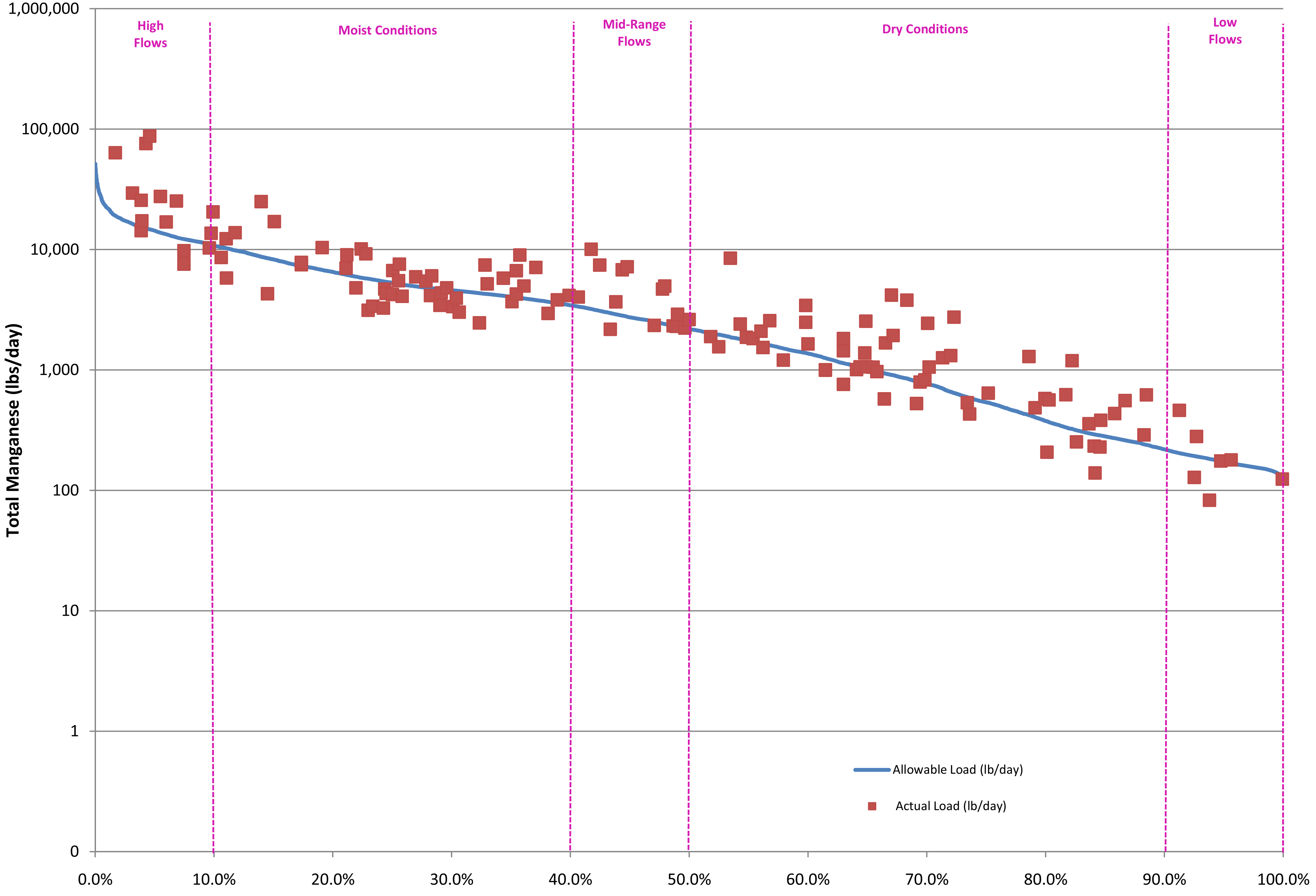


Figure 7-11
Kaskaskia River Segment O-30
Manganese Load Duration Curve

CDM

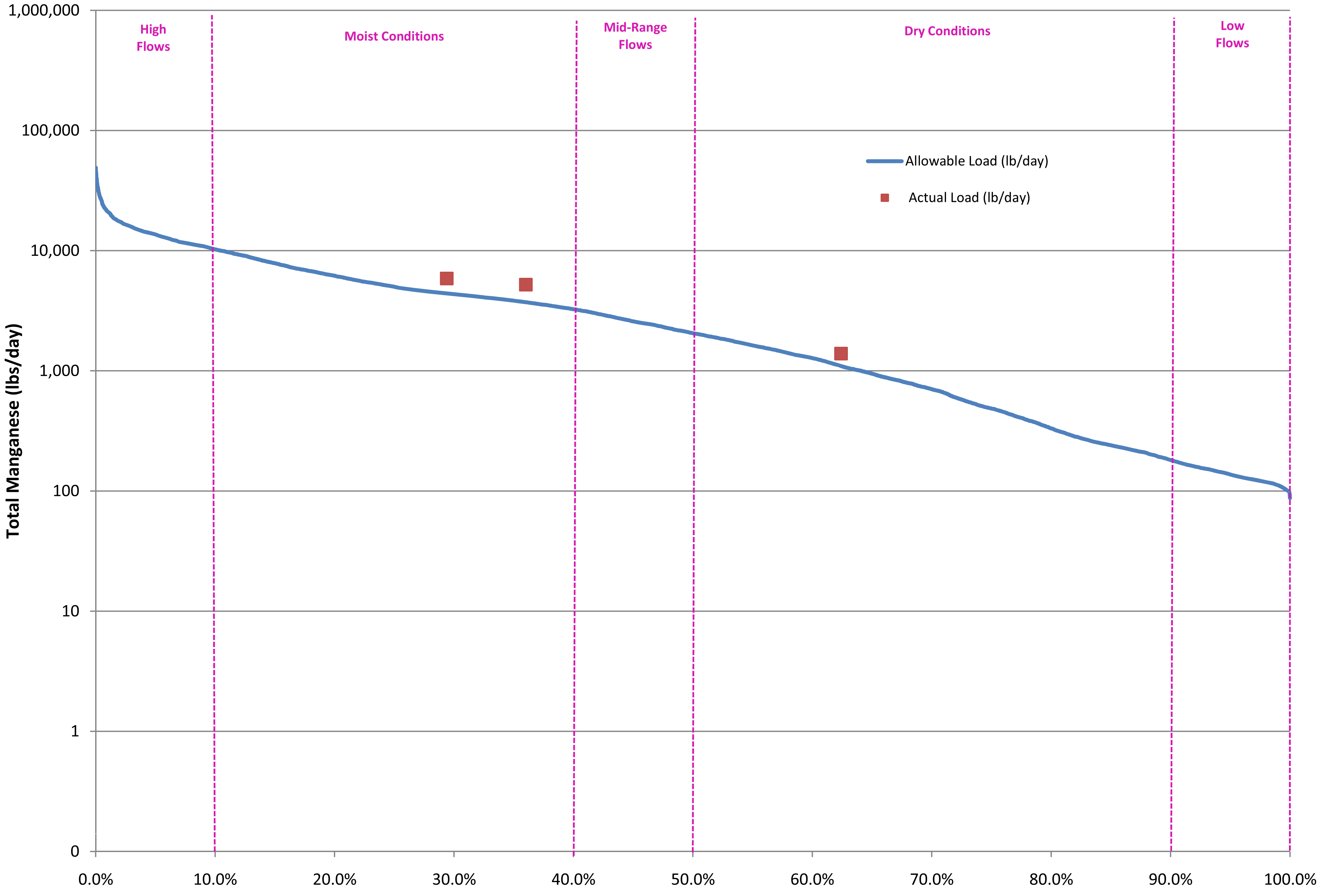


Figure 7-12
Kaskaskia River Segment O-97
Manganese Load Duration Curve

CDM

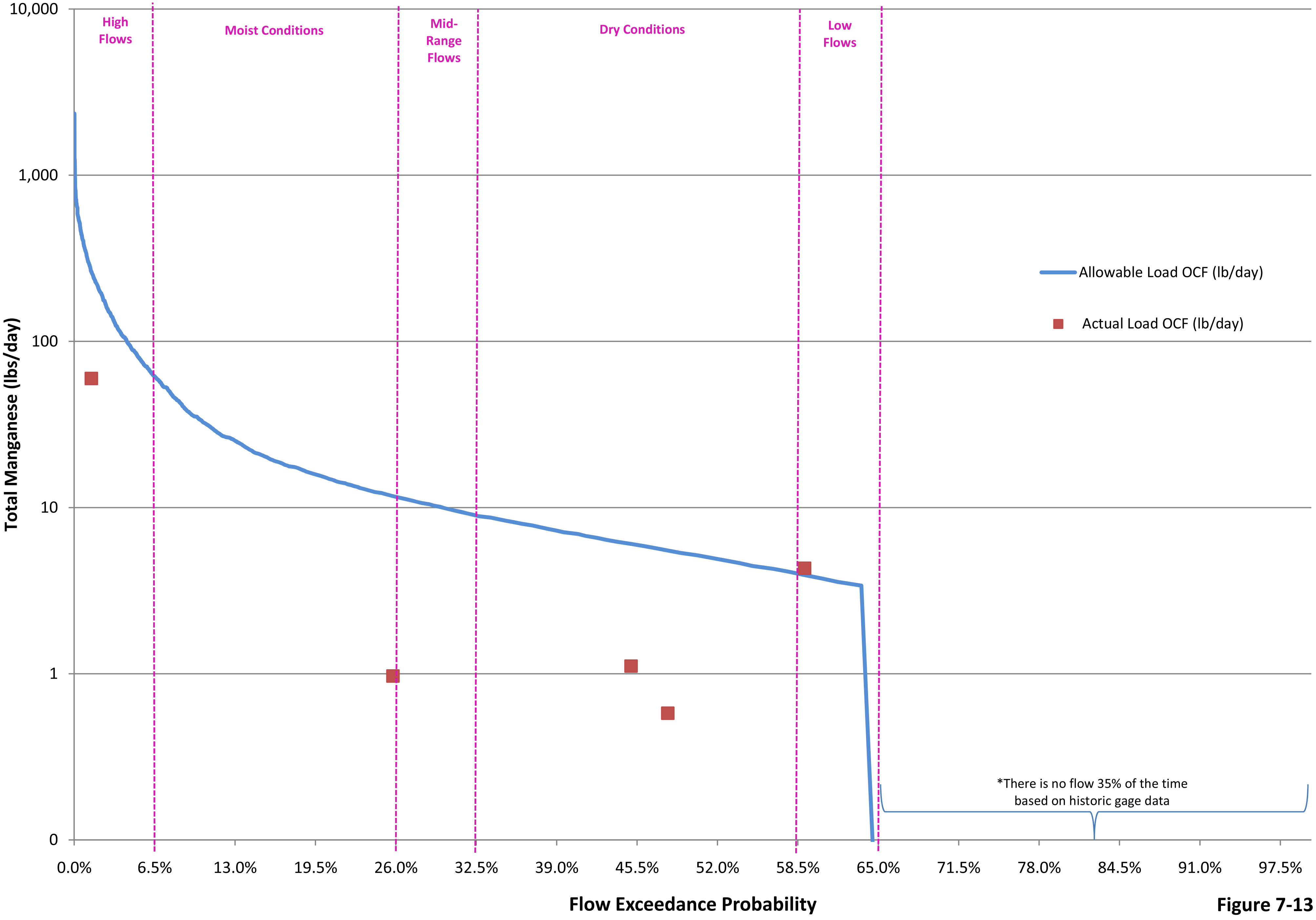


Figure 7-13
Kinney Branch Segment OCF
Manganese Load Duration Curve

CDM

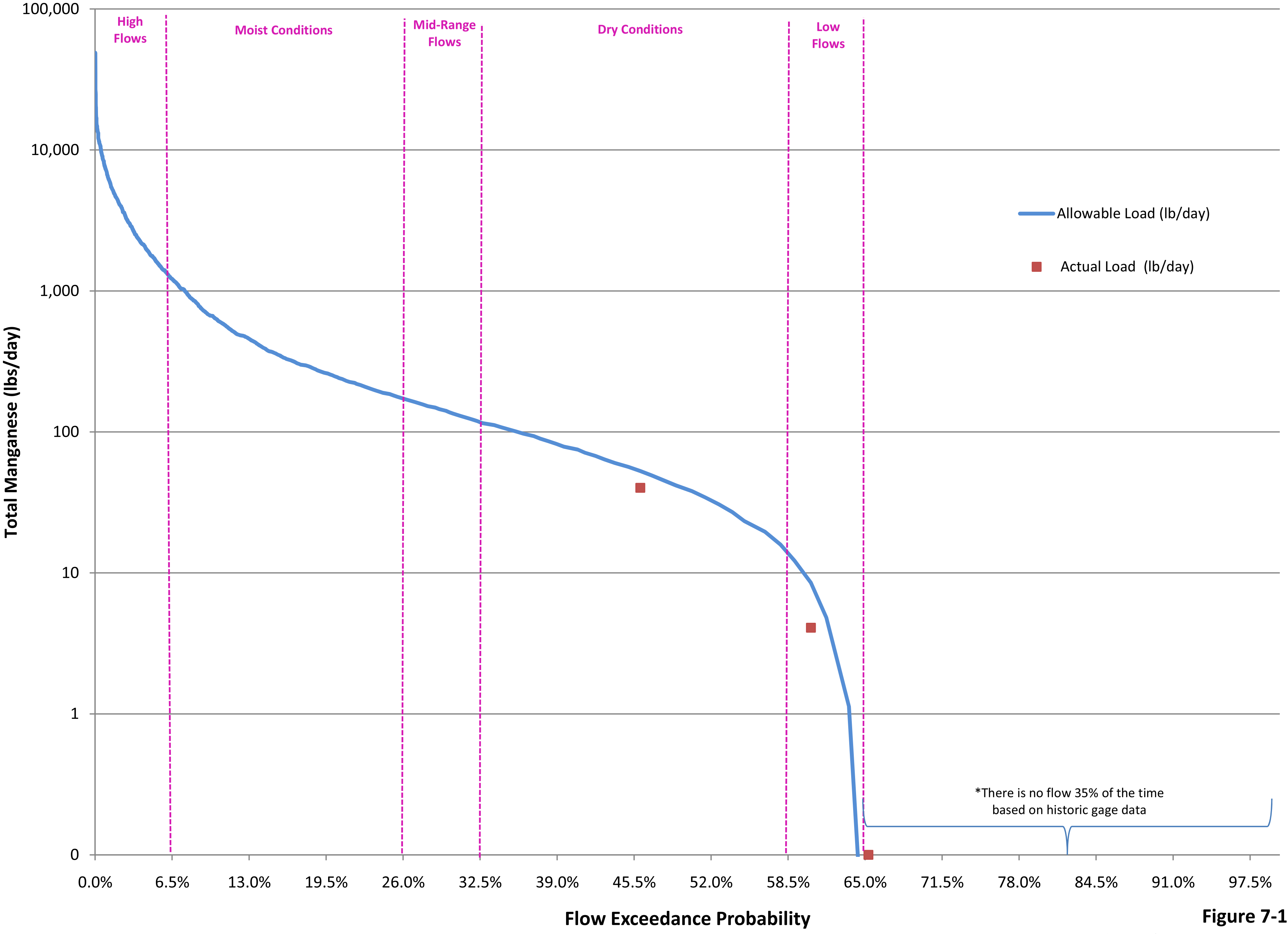


Figure 7-14
Mud Creek Segment OE-02
Manganese Load Duration Curve

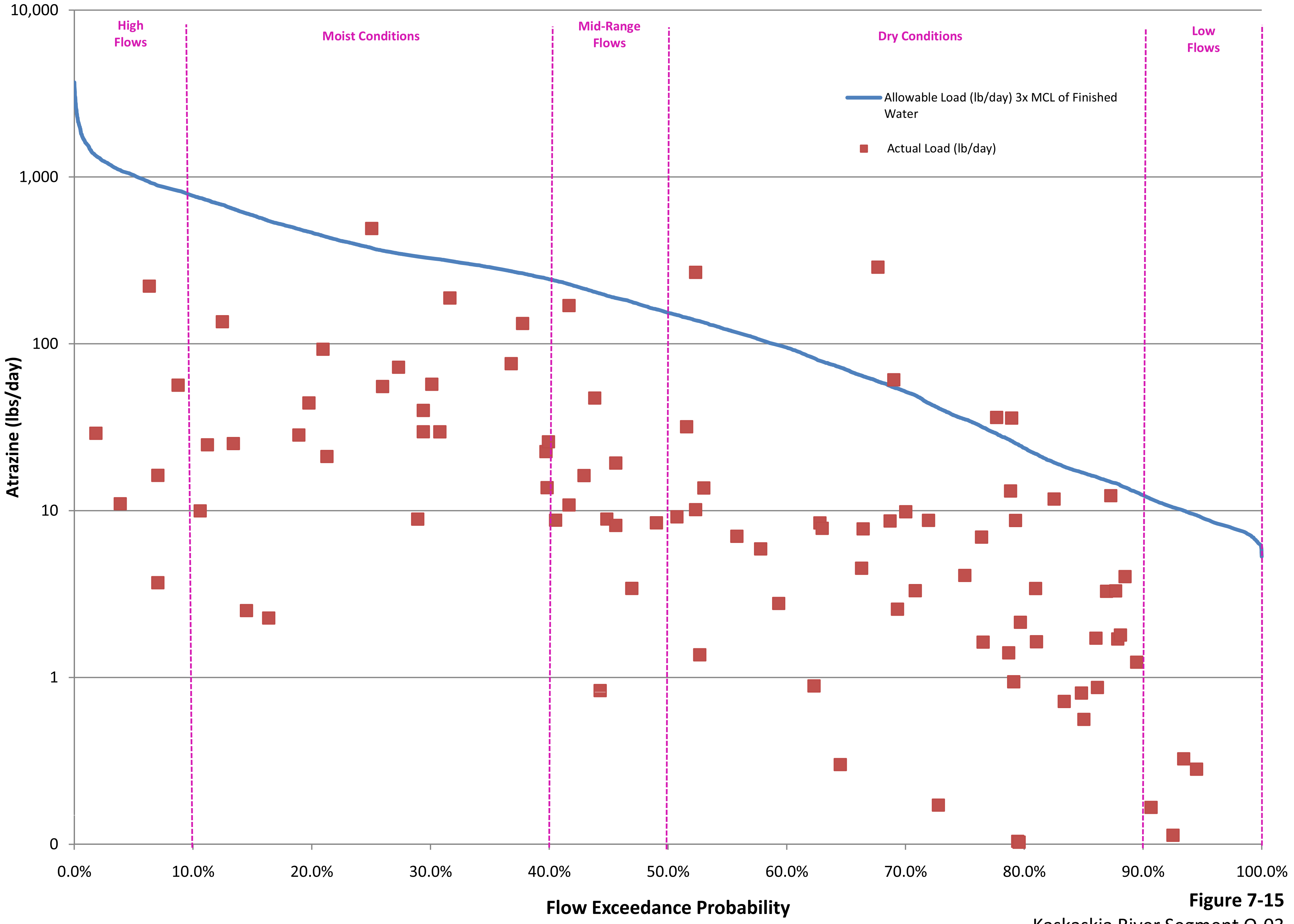


Figure 7-15
Kaskaskia River Segment O-03
Atrazine Load Duration Curve

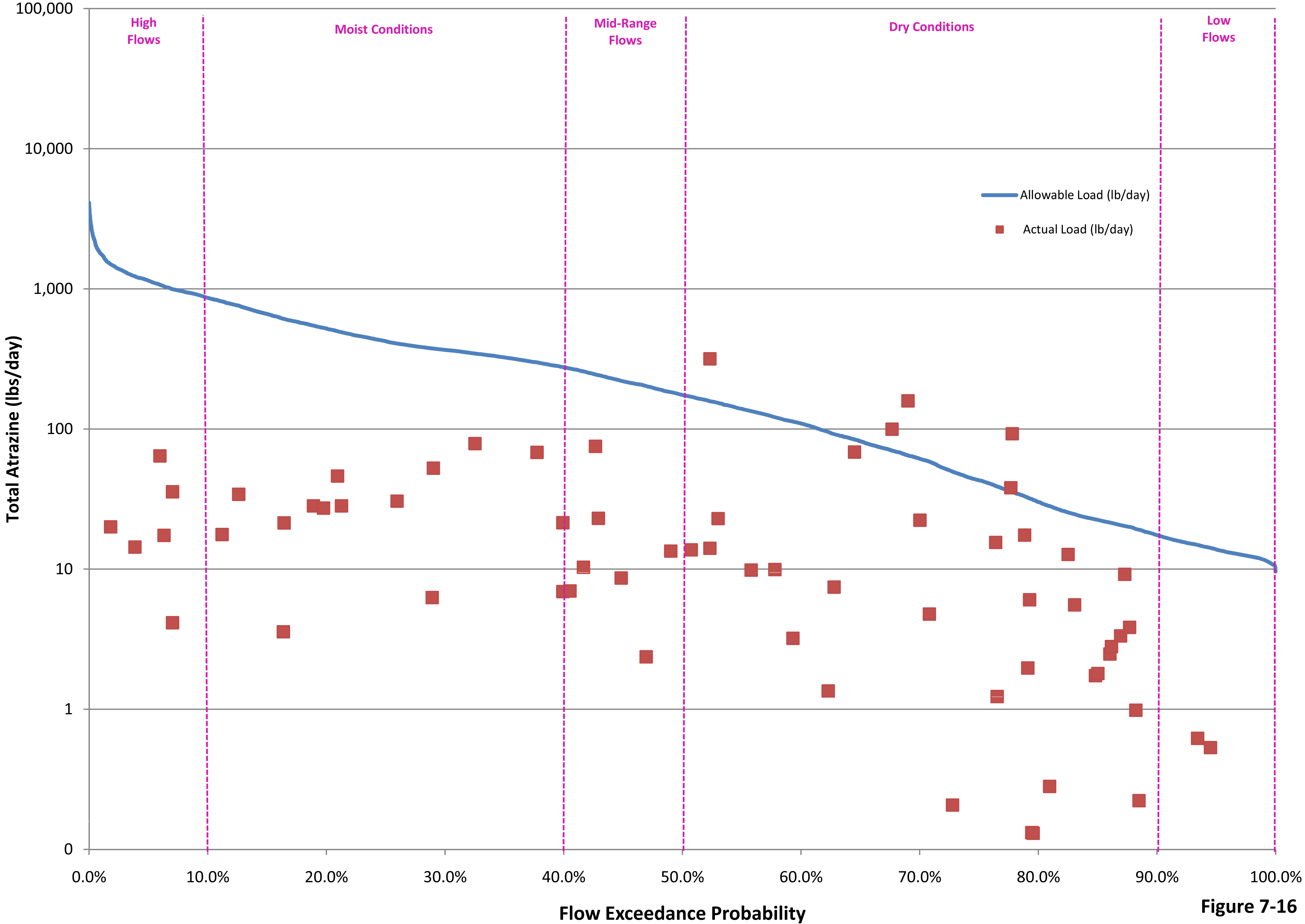
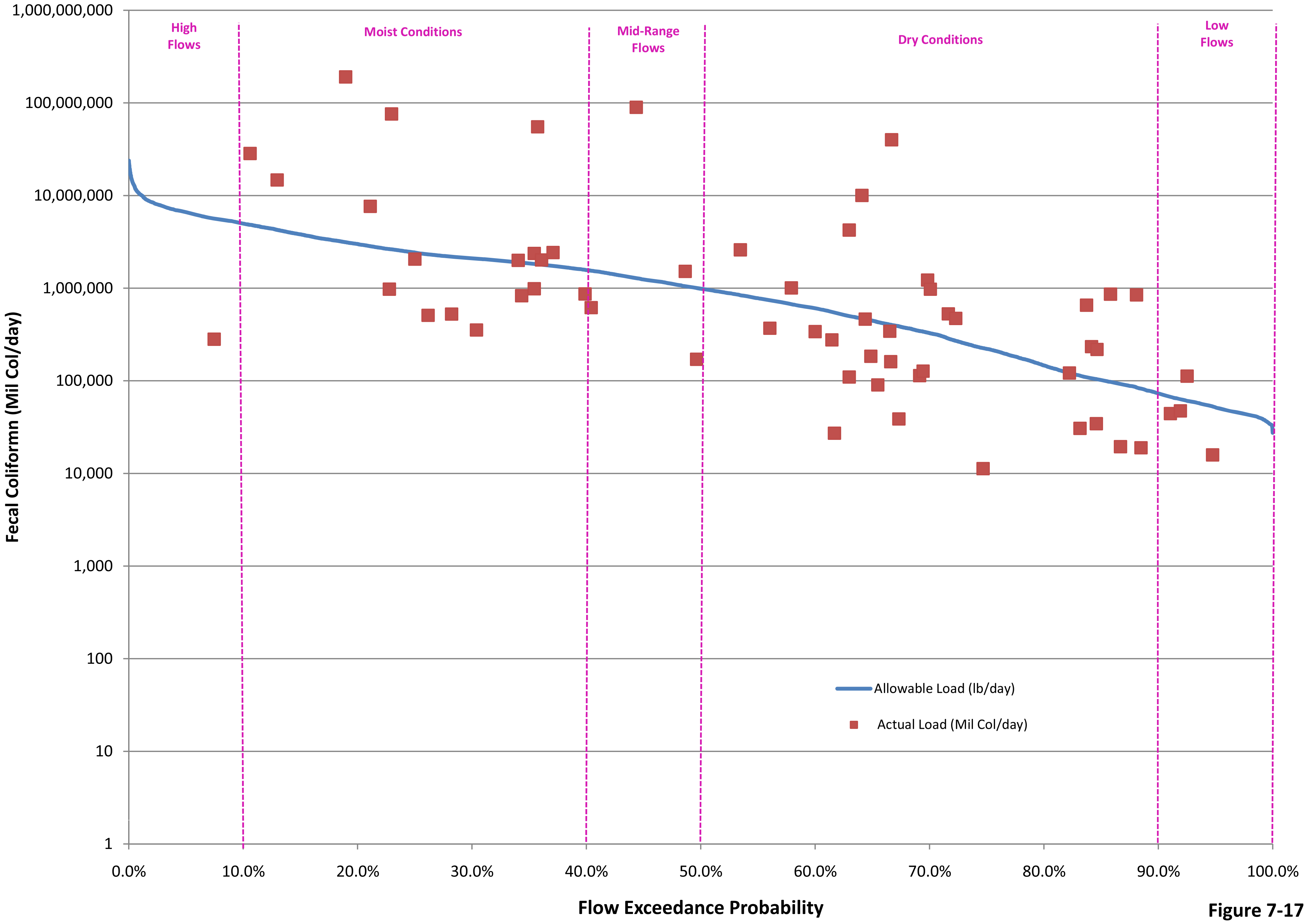


Figure 7-16
Kaskaskia River Segment O-30
Atrazine Load Duration Curve

CDM



CDM

Figure 7-17
Kaskaskia River Segment O-20
Fecal Coliform Load Duration Curve

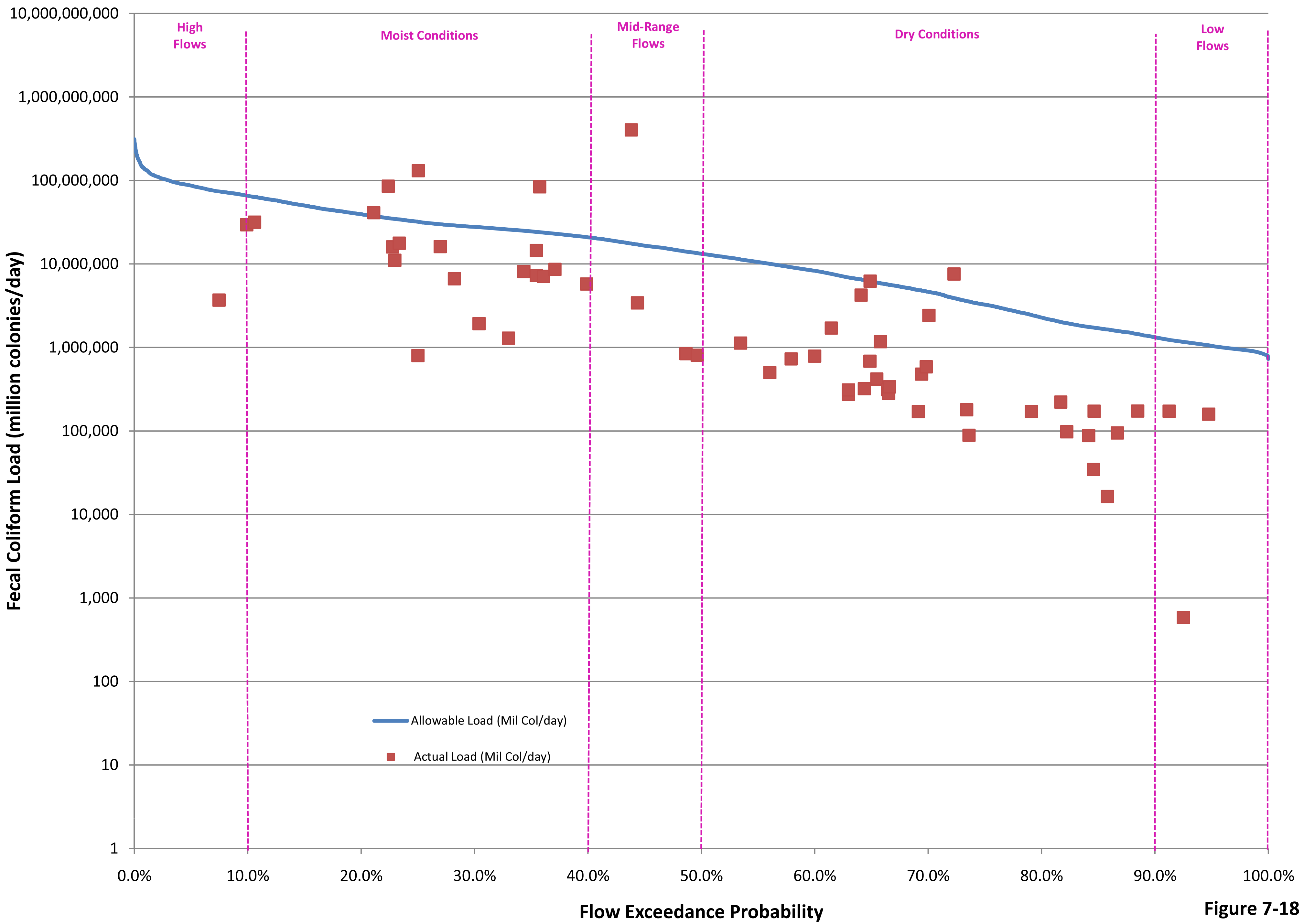


Figure 7-18
Kaskaskia River Segment O-30
Fecal Coliform Load Duration Curve

CDM

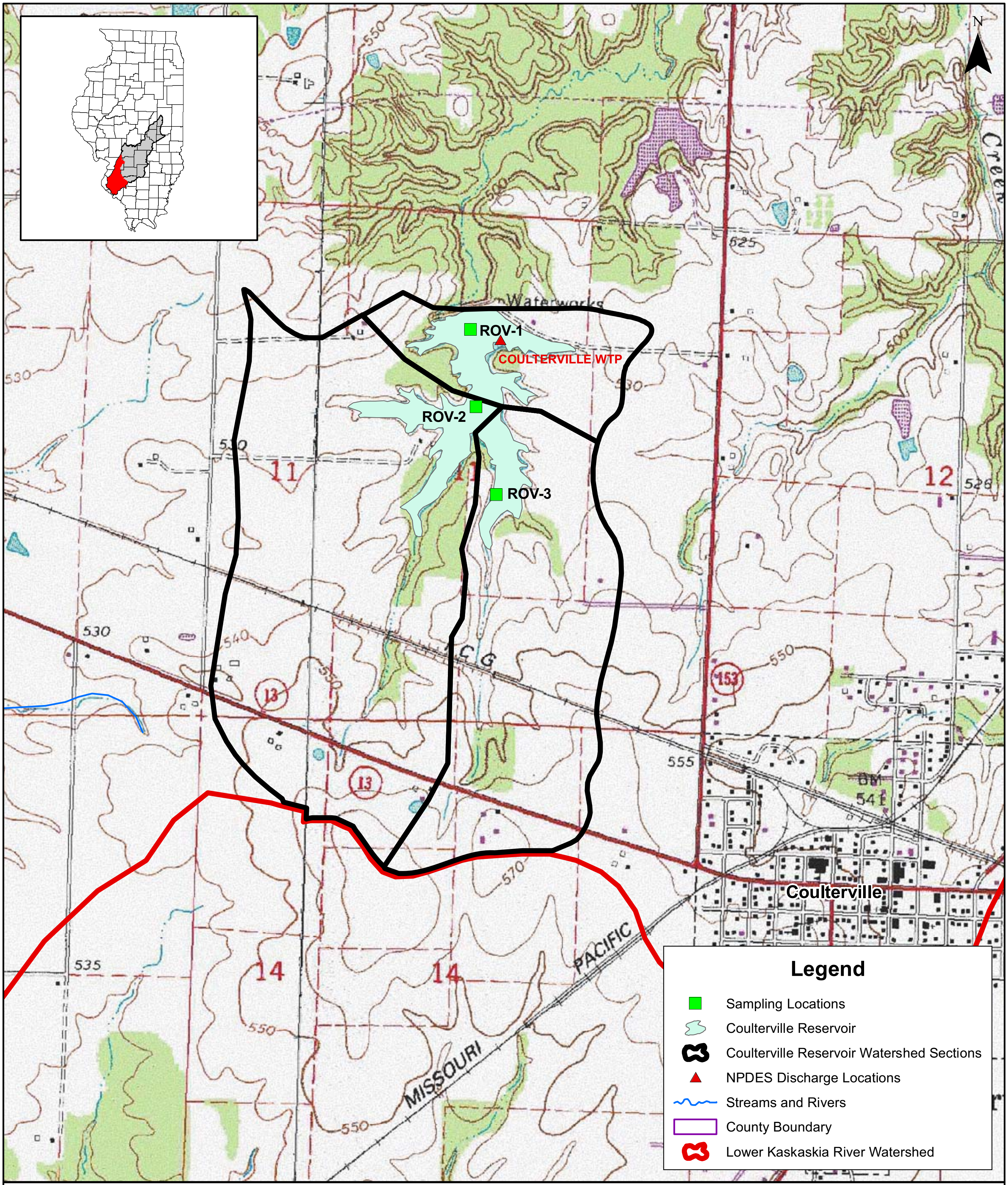


Figure 7-19
Lower Kaskaskia River Watershed
Coulterville Reservoir BATHTUB Segmentation & Watershed Delineation

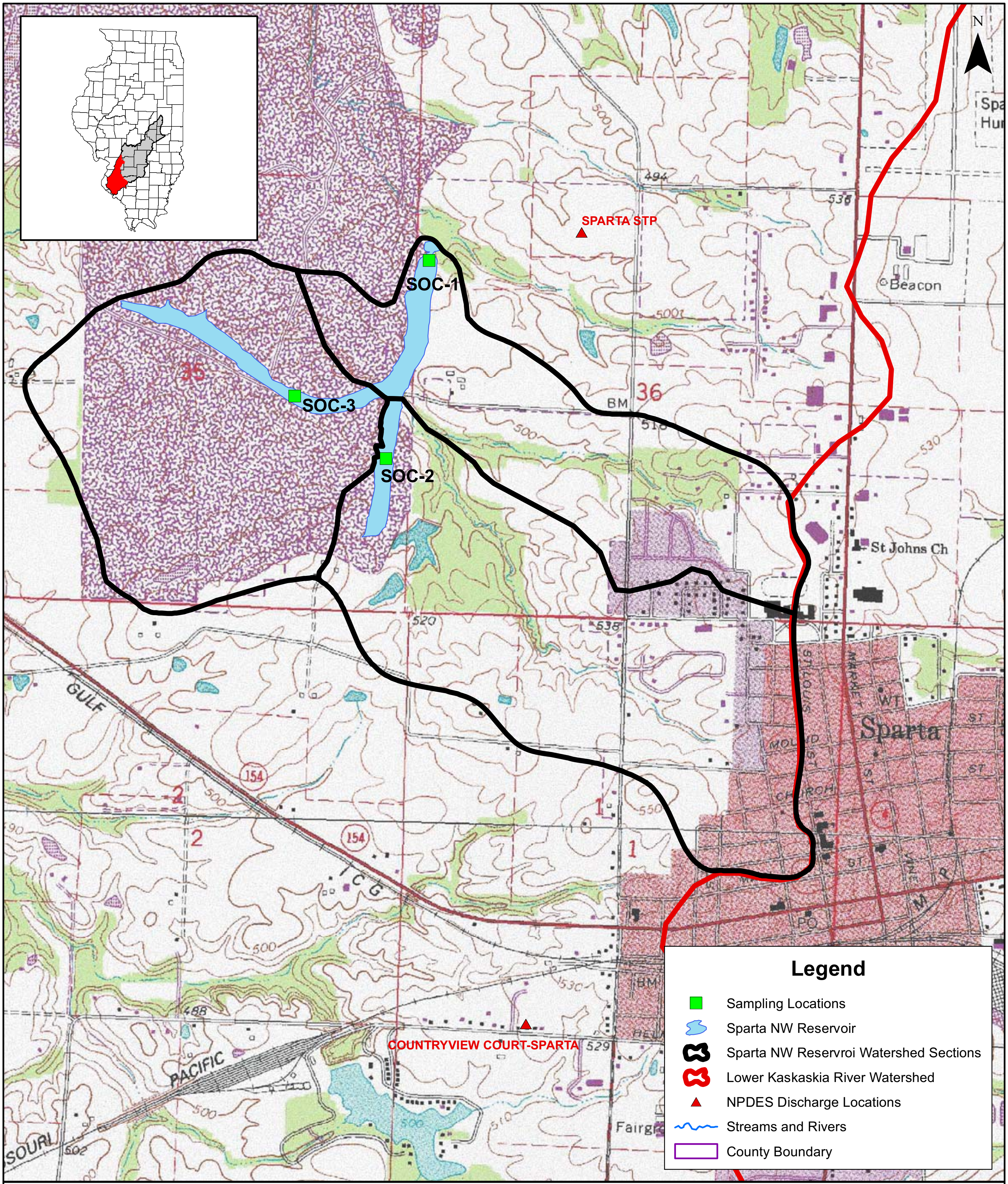


Figure 7-20
Lower Kaskaskia River Watershed
Sparta NW Reservoir BATHTUB Segmentation & Watershed Delineation

0 0.25 0.5 Miles

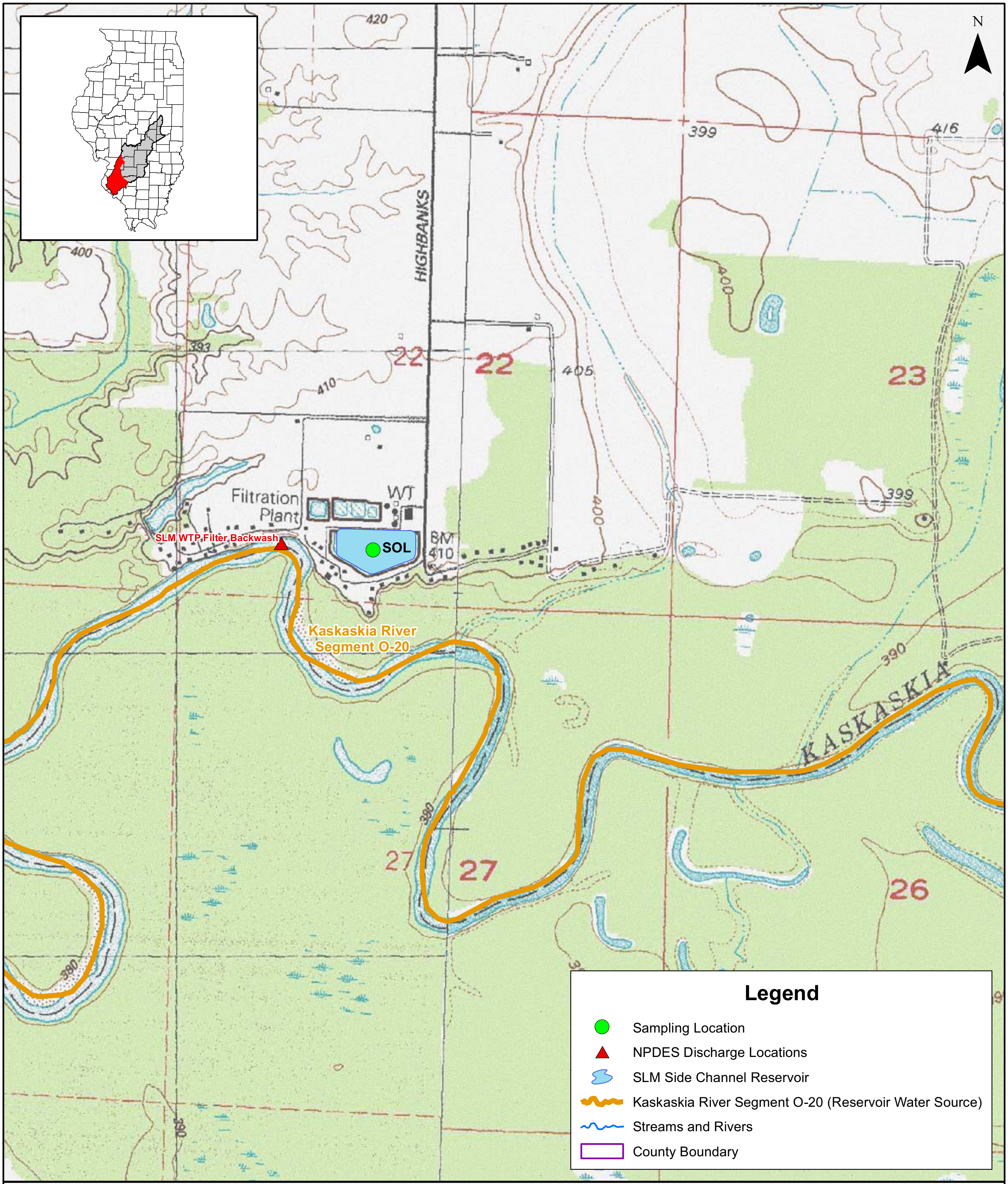


Figure 7-21
Lower Kaskaskia River Watershed
SLM Side Channel Reservoir Location

0 0.25 0.5 Miles

Section 8
Total Maximum Daily Load for the Lower Kaskaskia River Watershed

8.1 TMDL Endpoints for the Lower Kaskaskia River Watershed

The TMDL endpoints for fecal coliform, manganese, atrazine, pH, phosphorus and dissolved oxygen are summarized in Table 8-1. For all parameters except dissolved oxygen, the concentrations must be below the TMDL endpoint. For dissolved oxygen, concentrations must be above the TMDL endpoint. The TMDL endpoints for fecal coliform and dissolved oxygen vary seasonally while the endpoints for pH, atrazine, and manganese are consistent throughout the year. The TMDL endpoints for dissolved oxygen in all stream segments and manganese in segments OCF and OE-02 are based on protection of aquatic life. Endpoints for other segments and reservoirs impaired by manganese, as well as those impaired by atrazine are based on protection of public drinking water supplies. TMDL endpoints for fecal coliform on segments O-20 and O-30 are based on protection of the primary body contact beneficial use while endpoints for phosphorus in Coulterville Reservoir and Sparta NW Reservoir are based on the protection of aesthetic quality.

Some of the average concentrations presented in Table 8-1 meet the desired endpoints. However, the data sets have maximum or minimum values, presented earlier in this report, which do not meet the desired endpoints and this was the basis for TMDL analysis. Further monitoring as outlined in the monitoring plan presented in Section 9, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Lower Kaskaskia River Watershed

Segment Name/ID	Parameter	TMDL Endpoint	Average Observed Value
Kaskaskia River - O-03	Atrazine	12 µg/L	2.90 µg/L
	Manganese	150 µg/L	220 µg/L
Kaskaskia River - O-20	Fecal Coliform	400 cfu/100 mL (May-Oct)	1,326 cfu/100 mL
	Manganese	150 µg/L	272 µg/L
Kaskaskia River - O-30	pH	6.0 - 9.0	7.48
	Atrazine	12 µg/L	2.93 µg/L
	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	8.11 mg/L
	Fecal Coliform	400 cfu/100 mL (May-Oct)	155 cfu/100 mL
	Manganese	150 µg/L	219.9 µg/L
Kaskaskia River - O-97	Manganese	150 µg/L	200 µg/L
SLM Sidechannel Reservoir - SOL	Manganese	150 µg/L	209 µg/L
	Atrazine	12 µg/L	2.3 µg/L

Table 8-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Lower Kaskaskia River Watershed (cont.)

Segment Name/ID	Parameter	TMDL Endpoint	Average Observed Value
Horse Creek - OB-03	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	5.68 mg/L
Richland Creek South - OC-04	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	8.44 mg/L
Richland Creek South - OC-95	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	5.17 mg/L
Kinney Branch - OCF	Manganese	1,000 µg/L	240 µg/L
	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	5.84 mg/L
Sparta NW - SOC	Total Phosphorus	0.05 mg/L	0.24 mg/L
	Manganese	150 µg/L	212 µg/L
	Atrazine	12 µg/L	5.3 µg/L
Mud Creek - OE-02	Manganese	1,000 µg/L	1,908 µg/L
	DO	*7-day average daily minimum:* 6.0 mg/L (*Mar. - Jul.*) 4.0 mg/L (*Aug. - Feb.*)	3.84 mg/L
Coulterville - ROV	Total Phosphorus	0.05 mg/L	0.30 mg/L
	Manganese	150 µg/L	503 µg/L
	Atrazine	12 µg/L	14.9 µg/L

8.2 Pollutant Source and Linkages

Potential pollutant sources for the Lower Kaskaskia River watershed include both point and nonpoint sources as described in Section 5 of this report. Load duration curves were developed for the manganese, atrazine, and fecal coliform in streams TMDLs and are described in this section. Load duration curves are useful in that they provide a link between historic sampling values and hydraulic condition. Table 8-2 shows the example source area/hydrologic condition consideration developed by EPA.

Table 8-2 Example Source Area/Hydrologic Condition Considerations (EPA, 2007)

Contributing Source Area	Duration Curve Zone				
	High Flow	Moist	Mid-Range	Dry	Low Flow
Point Source				M	H
Onsite Wastewater System			H	M	
Riparian Areas		H	H	H	
Stormwater: Impervious Areas		H	H	H	
Combined sewer overflows	H	H	H		
Stormwater: Upland	H	H	M		
Bank Erosion	H	M			

Note: potential relative importance of source area to contribute loads under given hydrologic conditions (H: High; M: Medium)

Pollutant sources and their linkages to Coulterville Reservoir, Sparta NW Reservoir, and SLM Side Channel Reservoir were established through the BATHTUB modeling or through loading calculations discussed in Section 7. Modeling indicated that loads of total phosphorus and manganese may originate from internal and external sources while potential sources of atrazine are primarily external. Potential sources of pollutants in the watersheds include nonpoint sources such as runoff from surrounding grassland, forest and parkland, and internal loading from lake sediments. Contaminants bound in eroded soils and plant materials are introduced to the lakes through precipitation events. Once in the waterbodies, nutrients are introduced to the water column and/or nutrient rich soils and plant materials settle to the bottom perpetuating the internal cycling of nutrients.

Further pollutant source discussion is provided throughout this section and implementation activities to reduce loading from the potential sources are outlined in Section 9.

8.3 Allocation

As explained in Section 1 of the stage 1 report, the TMDL for impaired segments in the Lower Kaskaskia River watershed will address the following equation:

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

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

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

8.3.1 Fecal Coliform TMDL

Lower Kaskaskia River segments O-30 and O-20 are listed for impairment caused by fecal coliform. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standards at varying flow scenarios.

8.3.1.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Lower Kaskaskia River segments O-20 and O-30 can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the geometric mean standard of 200 cfu/100mL were determined with the methodology discussed in Section 7. The fecal coliform loading capacity according to flow is presented in Table 8-3.

8.3.1.2 Seasonal Variation

Consideration of seasonality is inherent in the load duration analysis. Because the load duration analysis represents the range of expected stream flows, the TMDL has been calculated to meet the standard during all flow conditions. In addition, seasonality is addressed because the TMDL has been calculated to address loading only when the seasonal standard is applicable (May through October).

Table 8-3 Fecal Coliform Loading Capacity for Lower Kaskaskia River Segments O-20 and O-30

Estimated Mean Daily Flow (cfs)	Load Capacity (mil col/day)
5	24,466
10	48,932
50	244,663
100	489,332
500	2,446,689
1,000	4,893,434
5,000	24,467,455
10,000	48,935,475
15,000	73,404,063

For the fecal coliform TMDLs, the critical period for fecal coliform is the primary contact recreation season which is May through October each year. There is no one critical condition during the recreation season. The fecal coliform standard must be met under all flow scenarios and standard exceedences have occurred during the majority of flow scenarios. By using the load duration curve method, all of these "critical conditions" are accounted for in the loading allocations.

8.3.1.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the O-20 and O-30 TMDLs are implicit as the analysis compared individual sample results to the 200 cfu/100 ml geometric mean component of the WQS. Illinois EPA considered this conservative as the standard is based upon a geometric mean of 5 samples taken over a 30 day period. This, in effect, increases the reductions needed to meet the standard. Illinois EPA also included additional MOS in the TMDL because no rate of decay was used in calculations or in load duration curves for the fecal coliform. Because bacteria have a limited capability of surviving outside their hosts, a rate of decay would normally be used. Thus, it was determined by Illinois EPA that it is more conservative to use the water quality standard of 200 cfu/100ml fecal coliform, and not to apply a rate of decay which could result in a discharge limit greater than the water quality standard.

8.3.1.4 Waste Load Allocation

There are a total of 51 municipal sewage treatment facilities with NPDES permitted discharges within the Lower Kaskaskia River watershed. Specific fecal coliform data were not available for all of these facilities; therefore the fecal coliform standard (200 cfu/100ml) and each facilities' design average flow (DAF) values were used to set the WLA for low and moderate flow levels. At high flow levels, the facilities' design maximum flows (DMF) were used to calculate the WLA allocations. Using the conservative fecal coliform standard to calculate the WLA for the watershed ensures that point sources will not be contributing to fecal coliform exceedances instream. The WLA for the STPs in the O-20 watershed was determined to be 270,516 million colonies/day using the DAFs and 678,312 million colonies/day when calculated for higher flow levels using the facilities' DMFs. The WLA for the STPs in the O-30 watershed was determined to be 539,406 million colonies/day using the DAFs and 1,308,196 million colonies/day when calculated for higher flow levels using the facilities' DMFs. WLAs for each facility are shown in Tables 8-4 and 8-5.

Table 8-4 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-20 Watershed

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
AMEREN - COFFEEN POWER STATION	IL0000108	0.0085	64	0.03	227
KRAFT FOODS-CHAMPAIGN	IL0004227	0.558	4,225	0.558	4,225
AVISTON STP	IL0020001	0.167	1,264	0.35	2,650
NOKOMIS STP	IL0020206	0.36	2,725	0.9	6,814
LITCHFIELD STP	IL0020621	3.04	23,015	5.835	44,176
BECKEMEYER STP	IL0021270	0.125	946	0.408	3,089
ARTHUR STP	IL0021741	0.5	3,785	1.25	9,464
SULLIVAN STP	IL0021806	0.75	5,678	0.75	5,678
SHELBYVILLE STP	IL0021890	0.73	5,527	2	15,142
PANA STP	IL0022314	1.17	8,858	3.13	23,697
WITT STP	IL0022667	0.115	871	0.29	2,196
BREESE STP	IL0022772	0.629	4,762	1.57	11,886
BETHANY STP	IL0023051	0.2	1,514	0.404	3,059
SALEM STP	IL0023264	1.672	12,658	3.762	28,481
VANDALIA STP	IL0023574	1.3	9,842	8.25	62,459
PATOKA COMMUNITY UNIT SCHOOL	IL0024376	0.006	45	0.008	61
CENTRAL CITY STP	IL0024899	0.304	2,302	1.267	9,592
ATWOOD STP	IL0025097	0.2	1,514	0.5	3,785
RAYMOND STP	IL0025381	0.1	757	0.25	1,893
COE-WILBORN CREEK	IL0025895	0.015	114	0.0375	284
CORPS OF ENGR-CARLYLE BOULDER	IL0025933	0.001	8	0.001	8
GREENVILLE STP	IL0026298	1.57	11,886	3.93	29,753

Table 8-4 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-20 Watershed (cont.)

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
TRENTON STP	IL0026701	0.5	3,785	1.25	9,464
NASHVILLE STP	IL0027081	0.5	3,785	1.7	12,870
CARLYLE STP	IL0027901	1.4	10,599	3.2	24,227
CENTRALIA STP	IL0027979	3.15	23,848	4.5	34,069
COWDEN STP	IL0028231	0.075	568	0.75	5,678
HIGHLAND STP	IL0029173	1.6	12,113	4	30,283
HILLSBORO STP	IL0029203	1.045	7,911	3.067	23,220
CENTRALIA-KASKASKIA COLLEGE	IL0029335	0.125	946	0.312	2,362
ST. ELMO STP	IL0030872	0.343	2,597	1.31	9,918
SANDOVAL STP	IL0030961	0.18	1,363	0.45	3,407
URBANA-CHAMPAIGN SD SW STP	IL0031526	7.98	60,415	17.25	130,596
BEMENT STP	IL0032549	0.176	1,332	0.48	3,634
NEW BADEN STP	IL0032603	0.78	5,905	1.349	10,213
RAMSEY LAKE STATE PARK	IL0037974	0.015	114	0.0375	284
DALTON CITY STP	IL0046281	0.075	568	0.185	1,401
PANAMA STP	IL0048992	0.0525	397	0.131	992
ADDIEVILLE STP	IL0049140	0.033	250	0.083	628
FILLMORE STP	IL0050156	0.049	371	0.195	1,476
RACCOON CONSOLIDATED SCHOOL	IL0052981	0.0125	95	0.031	235
IL DNR-ELDON HAZLETT SP CAMPGR	IL0053996	0.045	341	0.11	833
LITCHFIELD-LAKE YAEGAR REC STP	IL0054976	0.004	30	0.01	76
IL DOC-CENTRALIA CORRECTIONAL	IL0061344	0.234	1,772	0.343	2,597
HICKORY SHORES RESORT	IL0061697	0.01	76	0.02	151
HOLIDAY INN CARLINVILLE	IL0063525	0.026	197	0.033	250
DAMIANSVILLE STP	IL0063762	0.06	454	0.234	1,772
BEECHER CITY STP	IL0063878	0.052	394	0.105	795
OAK TERRACE-BEYERS LAKE	IL0066672	0.09	681	0.36	2,725
GATEWAY RETREAT CENTER	IL0072281	0.016	121	0.068	515
OKAWVILLE STP	IL0074179	0.25	1,893	0.877	6,640
NEW DOUGLAS STP	IL0074292	0.055	416	0.18	1,363
CASTLE RIDGE ESTATES SUBDIVSN	IL0075388	0.0175	132	0.0735	556
WESCLIN HIGH SCHOOL DIST 3	ILG551011	0.02	151	0.05	379
IL DOT-I-70 REST AREA	ILG551027	0.028	212	0.072	545
WESTERN SPRINGS MHP-CENTRALIA	ILG551030	0.0187	142	0.048	363
ROCK SPRINGS LLC	ILG551052	0.04	303	0.1	757
COUNTRY SCHOOL MHP	ILG551055	0.0024	18	0.006	45
WEST SIDE MOBILE HOME PARK	ILG551078	0.02	151	0.05	379
SAINT ROSE SD STP	ILG580002	0.039	295	0.53	4,013
BARTELSO STP	ILG580003	0.0668	506	0.167	1,264
IRVINGTON SD WWTF	ILG580006	0.093	704	0.33	2,498
ST. PETER EAST STP	ILG580007	0.042	318	0.17	1,287
POCAHONTAS STP	ILG580010	0.125	946	0.5	3,785
HOYLETON STP	ILG580016	0.059	447	0.159	1,204
ALBERS STP	ILG580017	0.0907	687	0.227	1,719
PATOKA STP	ILG580022	0.072	545	0.149	1,128
BROWNSTOWN STP	ILG580027	0.1	757	0.327	2,476

Table 8-4 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-20 Watershed (cont.)

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
FARINA STP	ILG580047	0.105	795	0.062	469
SORENTO STP	ILG580049	0.07	530	0.175	1,325
HUMBOLT STP	ILG580051	0.07	530	0.175	1,325
CERRO GORDO STP	ILG580066	0.2	1,514	0.5	3,785
LOUISVILLE STP	ILG580081	0.15	1,136	0.375	2,839
HAMMOND STP	ILG580095	0.07	530	0.175	1,325
KINMUNDY STP	ILG580123	0.146	1,105	0.442	3,346
WINDSOR STP	ILG580131	0.149	1,128	0.5	3,785
PIERRON WEST STP	ILG580137	0.0429	325	0.172	1,302
TAYLOR SPRINGS STP	ILG580140	0.088	666	0.1344	1,018
WAMAC STP	ILG580144	0.15	1,136	0.6	4,542
STEWARDSON STP	ILG580163	0.11	833	0.275	2,082
GERMANTOWN STP	ILG580186	0.135	1,022	0.33	2,498
ODIN STP	ILG580187	0.195	1,476	1.8	13,627
MULBERRY GROVE SD STP	ILG580191	0.0864	654	0.237	1,794
IRVING STP	ILG580198	0.075	568	0.1875	1,420
KEYESPORT STP	ILG580204	0.09	681	0.135	1,022
HOFFMAN STP	ILG580205	0.06	454	0.15	1,136
RAMSEY STP	ILG580222	0.171	1,295	0.632	4,785
PIERRON EAST STP	ILG580237	0.0206	156	0.0854	647
STRASBURG STP	ILG580240	0.06	454	0.15	1,136
COFFEEN STP	ILG580243	0.1	757	0.864	6,541
TOWER HILL STP	ILG580244	0.1	757	0.38	2,877
		Total	270,516		678,312

Table 8-5 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-30 Watershed

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
ADDIEVILLE STP	IL0049140	0.033	250	0.083	628
ADORERS OF THE BLOOD OF CHRIST	IL0026948	0.03	227	0.114	863
ALBERS STP	ILG580017	0.0907	687	0.227	1,719
ALHAMBRA STP	ILG580004	0.0725	549	0.288	2,180
AMEREN - COFFEEN POWER STATION	IL0000108	0.0085	64	0.03	227
ARTHUR STP	IL0021741	0.5	3,785	1.25	9,464
ATWOOD STP	IL0025097	0.2	1,514	0.5	3,785
AVISTON STP	IL0020001	0.167	1,264	0.35	2,650
BALDWIN STP	IL0027219	0.051	386	0.128	969
BARTELSO STP	ILG580003	0.0668	506	0.167	1,264
BECKEMEYER STP	IL0021270	0.125	946	0.408	3,089
BEECHER CITY STP	IL0063878	0.052	394	0.105	795
BELLEVILLE STP #1	IL0021873	8	60,566	16	121,133
BEMENT STP	IL0032549	0.176	1,332	0.48	3,634
BETHANY STP	IL0023051	0.2	1,514	0.404	3,059
BREESE STP	IL0022772	0.629	4,762	1.57	11,886
BROWNSTOWN STP	ILG580027	0.1	757	0.327	2,476
CARLYLE STP	IL0027901	1.4	10,599	3.2	24,227

Table 8-5 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-30 Watershed (cont.)

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
CASEYVILLE TOWNSHIP EAST STP	IL0021083	4.4	33,312	11.39	86,231
CASTLE RIDGE ESTATES SUBDIVSN	IL0075388	0.0175	132	0.0735	556
CENTRAL CITY STP	IL0024899	0.304	2,302	1.267	9,592
CENTRALIA STP	IL0027979	3.15	23,848	4.5	34,069
CENTRALIA-KASKASKIA COLLEGE	IL0029335	0.125	946	0.312	2,362
CERRO GORDO STP	ILG580066	0.2	1,514	0.5	3,785
CLANAHAN TRAILER PARK	IL0052256	0.0042	32	0.01	76
COE-WILBORN CREEK	IL0025895	0.015	114	0.0375	284
COFFEEN STP	ILG580243	0.1	757	0.864	6,541
COLWELL SYSTEMS INC.	IL0067202	0.008	61	0.008	61
CORPS OF ENGR-CARLYLE BOULDER	IL0025933	0.001	8	0.001	8
COUNTRY SCHOOL MHP	ILG551055	0.0024	18	0.006	45
COUNTRYVIEW COURT-SPARTA	IL0046019	0.011	83	0.028	212
COWDEN STP	IL0028231	0.075	568	0.75	5,678
DALTON CITY STP	IL0046281	0.075	568	0.185	1,401
DAMIANSVILLE STP	IL0063762	0.06	454	0.234	1,772
DUTCH HOLLOW VILLAGE, INC.	IL0046663	0.08	606	0.2	1,514
DYNEGY MIDWEST GENERATION-BALD	IL0000043	0.01375	104	0.04	303
ELLIS GROVE STP	ILG580145	0.0247	187	0.041	310
EVANSVILLE STP	IL0021440	0.17	1,287	0.425	3,218
FARINA STP	ILG580047	0.105	795	0.062	469
FAYETTEVILLE STP	IL0020893	0.05	379	0.199	1,507
FILLMORE STP	IL0050156	0.049	371	0.195	1,476
FREEBURG EAST STP	IL0020753	0.31	2,347	0.775	5,867
FREEBURG WEST STP	IL0032310	0.4	3,028	1	7,571
GATEWAY RETREAT CENTER	IL0072281	0.016	121	0.068	515
GERMANTOWN STP	ILG580186	0.135	1,022	0.33	2,498
GREENVILLE STP	IL0026298	1.57	11,886	3.93	29,753
HAMEL STP	ILG580011	0.105	795	0.263	1,991
HAMMOND STP	ILG580095	0.07	530	0.175	1,325
HECKER STP	ILG580235	0.08	606	0.12	908
HICKORY SHORES RESORT	IL0061697	0.01	76	0.02	151
HIGHLAND STP	IL0029173	1.6	12,113	4	30,283
HILLSBORO STP	IL0029203	1.045	7,911	3.067	23,220
HOFFMAN STP	ILG580205	0.06	454	0.15	1,136
HOLIDAY INN CARLINVILLE	IL0063525	0.026	197	0.033	250
HOPKINS PARK STP	ILG580217	0.25	1,893	0.88	6,662
HOYLETON STP	ILG580016	0.059	447	0.159	1,204
HUMBOLT STP	ILG580051	0.07	530	0.175	1,325
IL DNR-ELDON HAZLETT SP CAMPGR	IL0053996	0.045	341	0.11	833
IL DOC-CENTRALIA CORRECTIONAL	IL0061344	0.234	1,772	0.343	2,597
IL DOT-I64 ST CLAIR COUNTY	IL0068314	0.03	227	0.18	1,363
IL DOT-I-70 REST AREA	ILG551027	0.028	212	0.072	545
IRVING STP	ILG580198	0.075	568	0.1875	1,420
IRVINGTON SD WWTF	ILG580006	0.093	704	0.33	2,498

Table 8-5 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-30 Watershed (cont.)

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
JOHANNISBURG GRADE SCHOOL	IL0046884	0.0018	14	0.0045	34
KEYESPORT STP	ILG580204	0.09	681	0.135	1,022
KINMUNDY STP	ILG580123	0.146	1,105	0.442	3,346
KRAFT FOODS-CHAMPAIGN	IL0004227	0.558	4,225	0.558	4,225
LEBANON STP	IL0029483	0.878	6,647	1.3	9,842
LENZBURG STP	ILG580013	0.0825	625	0.165	1,249
LITCHFIELD STP	IL0020621	3.04	23,015	5.835	44,176
LITCHFIELD-LAKE YAEGAR REC STP	IL0054976	0.004	30	0.01	76
LIVINGSTON STP	ILG580115	0.148	1,120	0.6678	5,056
LOUISVILLE STP	ILG580081	0.15	1,136	0.375	2,839
MANORS AT KENSINGTON PARQUE	IL0074993	0.0238	180	0.0595	450
MARINE STP	ILG580228	0.24	1,817	0.66	4,997
MARISSA STP	IL0024813	0.585	4,429	2.54	19,230
MASCOUTAH STP	IL0025291	0.965	7,306	2.972	22,500
METRO-EAST AIRPARK STP	IL0075094	0.0042	32	0.015	114
MILLSTADT STP	IL0032514	0.965	7,306	1.838	13,915
MULBERRY GROVE SD STP	ILG580191	0.0864	654	0.237	1,794
NASHVILLE STP	IL0027081	0.5	3,785	1.7	12,870
NEW ATHENS MOBIL HOME PARK	IL0024601	0.0278	210	0.0645	488
NEW ATHENS WWTP	IL0021725	0.3	2,271	0.75	5,678
NEW BADEN STP	IL0032603	0.78	5,905	1.349	10,213
NEW DOUGLAS STP	IL0074292	0.055	416	0.18	1,363
NOKOMIS STP	IL0020206	0.36	2,725	0.9	6,814
OAK TERRACE-BEYERS LAKE	IL0066672	0.09	681	0.36	2,725
ODIN STP	ILG580187	0.195	1,476	1.8	13,627
O'FALLON STP	IL0021636	5.61	42,472	13.14	99,480
OKAWVILLE STP	IL0074179	0.25	1,893	0.877	6,640
PANA STP	IL0022314	1.17	8,858	3.13	23,697
PANAMA STP	IL0048992	0.0525	397	0.131	992
PATOKA COMMUNITY UNIT SCHOOL	IL0024376	0.006	45	0.008	61
PATOKA STP	ILG580022	0.072	545	0.149	1,128
PIERRON EAST STP	ILG580237	0.0206	156	0.0854	647
PIERRON WEST STP	ILG580137	0.0429	325	0.172	1,302
POCAHONTAS STP	ILG580010	0.125	946	0.5	3,785
RACCOON CONSOLIDATED SCHOOL	IL0052981	0.0125	95	0.031	235
RAMSEY LAKE STATE PARK	IL0037974	0.015	114	0.0375	284
RAMSEY STP	ILG580222	0.171	1,295	0.632	4,785
RAYMOND STP	IL0025381	0.1	757	0.25	1,893
RED BUD STP	IL0025348	0.6	4,542	1.2	9,085
ROCK SPRINGS LLC	ILG551052	0.04	303	0.1	757
RUMA STP	IL0063282	0.04	303	0.16	1,211
SAINT JACOB STP	ILG580212	0.14	1,060	0.35	2,650
SAINT LIBORY WWTP	ILG580014	0.09	681	0.225	1,703
SAINT ROSE SD STP	ILG580002	0.039	295	0.53	4,013
SALEM STP	IL0023264	1.672	12,658	3.762	28,481
SANDOVAL STP	IL0030961	0.18	1,363	0.45	3,407
SCOTT AIR FORCE BASE	IL0026859	2	15,142	3	22,712
SHELBYVILLE STP	IL0021890	0.73	5,527	2	15,142
SMITHTON STP	ILG580026	0.24	1,817	0.6	4,542
SMITHTON-WILDWOOD STP	IL0061131	0.154	1,166	0.614	4,648

Table 8-5 Fecal Coliform WLAs for Permitted Discharges in the Kaskaskia River O-30 Watershed (cont.)

Facility	NPDES Permit Number	Design Average Flow (MGD)	WLA-DAF (mil. Col/Day)	Design Maximum Flow (MGD)	WLA-DMF (mil. Col/Day)
SORENTO STP	ILG580049	0.07	530	0.175	1,325
SPARTA STP	IL0066133	0.25	1,893	0.62	4,694
ST. CLAIR TWP	IL0048232	1.5	11,356	3.75	28,391
ST. ELMO STP	IL0030872	0.343	2,597	1.31	9,918
ST. PETER EAST STP	ILG580007	0.042	318	0.17	1,287
STEWARDSON STP	ILG580163	0.11	833	0.275	2,082
STRASBURG STP	ILG580240	0.06	454	0.15	1,136
SULLIVAN STP	IL0021806	0.75	5,678	0.75	5,678
SUMMERFIELD STP	IL0064220	0.07	530	0.245	1,855
SWANSEA STP	IL0021181	5.015	37,968	11.89	90,017
TAYLOR SPRINGS STP	ILG580140	0.088	666	0.1344	1,018
TILDEN STP	ILG580107	0.111	840	0.275	2,082
TIMBER LAKE HOMEOWNERS ASSOC	ILG551050	0.0068	51	0.017	129
TOWER HILL STP	ILG580244	0.1	757	0.38	2,877
TRENTON STP	IL0026701	0.5	3,785	1.25	9,464
TRIAD COMMUNITY UNIT DIST #2	ILG551025	0.0195	148	0.0488	369
TRISIMO MOTEL DEVELOPMENT	IL0066788	0.0092	70	0.037	280
TROY STP	IL0031488	1.35	10,221	3.902	29,541
URBANA-CHAMPAIGN SD SW STP	IL0031526	7.98	60,415	17.25	130,596
VALLEY VIEW MOBILE HOME PARK	IL0062111	0	-	0	-
VANDALIA STP	IL0023574	1.3	9,842	8.25	62,459
WAMAC STP	ILG580144	0.15	1,136	0.6	4,542
WATERLOO EAST STP	IL0070734	0	-	0	-
WESCLIN HIGH SCHOOL DIST 3	ILG551011	0.02	151	0.05	379
WEST SIDE MOBILE HOME PARK	ILG551078	0.02	151	0.05	379
WESTERN SPRINGS MHP-CENTRALIA	ILG551030	0.0187	142	0.048	363
WINDSOR STP	ILG580131	0.149	1,128	0.5	3,785
WITT STP	IL0022667	0.115	871	0.29	2,196

Under certain low stream flow conditions, the effluent discharge from the treatment facilities may represent the only source of flow in the receiving stream. Under these low flow conditions, large proportions of the discharge will be lost to evaporation and infiltration into the stream bed, limiting the potential for conveyance of discharged materials into downstream reaches. Because WLA calculations are based on the DAFs for each facility, at low flow conditions the WLA can be overestimated and the resulting calculations will show WLA exceeding the LC for the receiving stream. In the case of O-20, the WLA at the dry and low flow levels was set equal to the calculated loading capacities at each flow level and the resulting non-point source load percent reduction needed is calculated at 100%. The WLA is a combination of facility flows and the water quality standard. The TMDL does not suggest limiting effluent concentrations below the water quality standard. Further discussion of all the point sources within this watershed is provided in Section 9.

8.3.1.5 Load Allocation and TMDL Summary

Table 8-6 shows a summary of the TMDL for Lower Kaskaskia River segment O-20. A summary of the TMDL for segment O-30 is provided in Table 8-7.

Table 8-6 Fecal Coliform TMDL for Kaskaskia River at O-20

Zone	Flow Exceedence Range (%)	LC (mil col/day)	LA (mil col/day)	WLA (mil col/day)	MOS	Actual Load[1] (mil col/day)	Percent Reduction Needed (%)
High	0-10	6,601,824	5,923,512	678,312	implicit	281,356	0%
Moist	10-20	3,794,826	3,116,514	678,312	implicit	158,510,205	98%
	20-30	2,413,333	1,735,022	678,312	implicit	41,854,302	96%
	30-40	1,848,511	1,170,199	678,312	implicit	12,983,879	91%
Mid-Range	40-50	1,237,231	966,715	270,516	implicit	63,273,777	98%
Dry	50-60	772,658	502,142	270,516	implicit	2,117,364	76%
	60-70	444,034	173,518	270,516	implicit	7,719,014	98%
	70-80	221,039	0	221,039	implicit	840,626	100%
	80-90	102,206	0	102,206	implicit	848,039	100%
Low Flow	90-100	51,837	0	51,837	implicit	92,777	100%

[1] Actual Load was calculated using the 90th percentile of observed fecal coliform concentrations in a given flow range (EPA 2007)

Table 8-7 Fecal Coliform TMDL for Kaskaskia River at O-30

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	86,577,245	85,269,050	1,308,196	implicit	2,691,434	0%
Moist	10-20	49,923,316	48,615,121	1,308,196	implicit	9,912,866	0%
	20-30	31,883,709	30,575,513	1,308,196	implicit	9,458,533	0%
	30-40	24,508,223	23,200,027	1,308,196	implicit	2,842,576	0%
Mid-Range	40-50	16,526,096	15,986,689	539,406	implicit	28,371,455	44%
Dry	50-60	10,459,679	9,920,272	539,406	implicit	102,712	0%
	60-70	6,168,487	5,629,081	539,406	implicit	322,735	0%
	70-80	3,256,607	2,717,201	539,406	implicit	552,135	0%
	80-90	1,704,881	1,165,475	539,406	implicit	18,792	0%
Low Flow	90-100	1,047,154	507,748	539,406	implicit	16,992	0%

[1] Actual Load was calculated using the 90th percentile of observed fecal coliform concentrations in a given flow range (EPA 2007)

8.3.2 Manganese TMDLs

Six stream segments within the Lower Kaskaskia River watershed are listed for impairment caused by manganese: Kaskaskia River segments O-03, O-20, O-30, O-97; Kinney Branch segment OCF; and Mud Creek segment OE-02. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the applicable instream water quality standard at varying flow levels. All four segments of the Lower Kaskaskia River (O-03, O-20, O-30, and O-97) have public drinking water supply designated uses with a corresponding water quality standard of 150µg/L for manganese. The other segments impaired for manganese in the Lower Kaskaskia River watershed are not listed as public drinking water supplies, and therefore the 1,000µg/L general use water quality standard for manganese.

8.3.2.1 Loading Capacities

The LC is the maximum amount of manganese that the impaired segments can receive and still maintain compliance with the water quality standard. In order to determine the loading capacity at various flow conditions, a range of flows were multiplied by the applicable water quality standard for each segment. Table 8-8 contains the loading capacities for manganese based on the 150µg/L public water supply standard and Table 8-9 contains the loading capacities for manganese based on the 1,000µg/L general use water quality standard.

Table 8-8 Manganese Loading Capacity for Impaired Segments O-03, O-20, O-30, and O-97 in the Lower Kaskaskia River Watershed based on the Public Water Supply standard of 150µg/L

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	4.0
10	8.1
50	40
100	81
500	405
1,000	809
5,000	4,046
10,000	8,091
15,000	12,137

8.3.2.2 Seasonal Variations

Consideration to seasonality is inherent in the load duration analysis described above. The standards for manganese are not seasonal and the full range of expected flows is represented in the loading capacity tables (Table 8-8 and 8-9). Therefore, the loading capacity represents conditions throughout the year. Load duration curve development and analysis (Section 7) showed that manganese violations in the impaired segments are most likely to occur under mid-range to moist conditions. By considering and addressing all flow scenarios, these critical conditions when the stream segments are most vulnerable to water quality exceedences were addressed.

Table 8-9 Manganese Loading Capacity for Impaired Segments OCF and OE-02 in the Lower Kaskaskia River Watershed based on the General Use standard of 1,000µg/L

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	27
10	54
50	270
100	539
500	2,697
1,000	5,394
5,000	26,969
10,000	53,938
15,000	80,907

8.3.2.3 Margins of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The manganese TMDLs developed for the impaired segments within the Lower Kaskaskia River watershed contain an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the manganese TMDLs developed for these watersheds because the use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the downstream USGS gage. The methodology employed in estimating watershed flows is discussed in Section 7.4 of this document.

8.3.2.4 Waste Load Allocations

There are large numbers of permitted facilities in the Kaskaskia River segments O-03, O-20, O-30, and O-97 watersheds, one permitted facility in the Kinney Branch (OCF) watershed, and 6 permitted discharges in the Mud Creek (OE-02) watershed. The single NPDES permitted facility in the Kinney Branch (OCF) watershed is a small municipal wastewater treatment plant (Freeburg West STP – permit # IL0032310). The other impaired watersheds have a mixture of municipal treatment plant discharges, industrial discharges, and permitted discharges related to runoff from mining operations. None of the municipal treatment facilities are required to monitor for manganese and therefore DMR data does not include concentrations of manganese. Due to the nature of municipal treatment facilities' operations, manganese loading from these discharges is not expected to be an issue.

There are 5 current and historic permitted NPDES mining operations in the Lower Kaskaskia River watershed. Mining discharges are typically required to meet the applicable water quality standard for manganese for the receiving water. The only active permitted mining operation in the Lower Kaskaskia River watershed, Peabody Coal Company/Hillside Recreational Lands, L.L.C- Randolph Prep (NPDES Permit No IL0062740) is not required to monitor for manganese, so no total manganese concentration data are available. The lack of available daily flow rates and total manganese concentration data from the current and inactive mining operations' outfalls does not allow for calculation of WLAs and the WLA for segments was set to zero for all manganese TMDL calculations. Point source discharges from mining operations in the overall contributing watersheds are believed to represent low relative proportions of overall stream flow for the mainstem Kaskaskia River segments impaired by manganese (O-03, O-20, O-30, and O-97). Possible contributions of total manganese to these impaired segments are accounted for in the applied Margin of Safety (MOS) for each TMDL. Should Illinois EPA determine that a facility requires manganese limits in the future, limits should be based on the water quality standard and the facility's flow.

8.3.2.5 Load Allocations and TMDL Summaries

The manganese loads have been allocated between the LAs (nonpoint sources) and the MOSs. Table 8-10 shows the summary of the manganese TMDLs for the impaired segments along with the percent reductions required at various flow levels. Stream segments on the Kinney Branch (OCF) and Mud Creek (OE-02) both have annual periods of zero-flow, so the flow regime zones were shifted from the typical 25th, 50th, and 75th percentile brackets to represent only periods of the year with measurable flow. The typical percentile brackets were used for the Kaskaskia River segments because zero-flow conditions do not occur on these segments. Stream segment OE-02 on Mud Creek had samples collected under zero flow conditions, which mathematically cannot be assigned a load allocation or a current load. The samples collected under zero-flow conditions are omitted from Table 8-10.

Violations of the public drinking water supply manganese standard (150µg/L) on the Kaskaskia River segments (O-03, O-20, O-30, O-97) occurred across a broad range of flow conditions. Violations for the general use manganese standard of 1,000µg/L on Mud Creek (OE-02) and Kinney Branch (OCF) occurred under dry or low flow conditions. However, in the case of Mud Creek (OE-02), all sample data available was collected under dry or low flow conditions, so the potential for exceedences at higher flows has not been assessed. Recommendations for reducing in-stream manganese concentrations on these segments are discussed in Section 9 of this report.

Table 8-10 Total Manganese TMDLs for the Lower Kaskaskia River Watershed

Kaskaskia River Segment O-03							
Zone	**Flow Exceedence Range (%)**	**LC (lbs/day)**	**LA (lbs/day)**	**WLA (lbs/day)**	**MOS (10% of LC)**	**Actual Load[1] (lbs/day)**	**Percent Reduction Needed (%)**
High	0-10	12,788	11,510	n/a	1278.8	-	-
Moist	10-20	7,357	6,621	n/a	735.7	-	-
	20-30	4,683	4,215	n/a	468.3	-	-
	30-40	3,590	3,231	n/a	359.0	5,349	40%
Mid-Range	40-50	2,407	2,167	n/a	240.7	-	-
Dry	50-60	1,508	1,358	n/a	150.8	-	-
	60-70	873	785	n/a	87.3	1,492	47%
	70-80	441	397	n/a	44.1	-	-
	80-90	211	190	n/a	21.1	293	35%
Low Flow	90-100	114	102	n/a	11.4	-	-

Table 8-10 Total Manganese TMDLs for the Lower Kaskaskia River Watershed (cont.)

Kaskaskia River Segment O-20

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	10,916	9,824	n/a	1091.6	11,750	16%
Moist	10-20	6,275	5,647	n/a	627.5	15,576	64%
	20-30	3,990	3,591	n/a	399.0	6,272	43%
	30-40	3,056	2,751	n/a	305.6	5,584	51%
Mid-Range	40-50	2,046	1,841	n/a	204.6	8,813	79%
Dry	50-60	1,278	1,150	n/a	127.8	2,022	43%
	60-70	734	661	n/a	73.4	1,838	64%
	70-80	365	329	n/a	36.5	1,157	72%
	80-90	169	152	n/a	16.9	733	79%
Low Flow	90-100	86	77	n/a	8.6	401	81%

Kaskaskia River Segment O-30

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	14,315	12,884	n/a	1431.5	70,909	82%
Moist	10-20	8,255	7,429	n/a	825.5	17,841	58%
	20-30	5,272	4,745	n/a	527.2	8,883	47%
	30-40	4,052	3,647	n/a	405.2	7,263	50%
Mid-Range	40-50	2,733	2,459	n/a	273.3	7,331	66%
Dry	50-60	1,729	1,557	n/a	172.9	3,262	52%
	60-70	1,020	918	n/a	102.0	2,667	66%
	70-80	538	485	n/a	53.8	2,441	80%
	80-90	282	254	n/a	28.2	622	59%
Low Flow	90-100	173	156	n/a	17.3	353	56%

Kaskaskia River Segment O-97

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	n/a	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	13,601	12,241	n/a	1360.1	-	-
Moist	10-20	7,831	7,048	n/a	783.1	-	-
	20-30	4,992	4,492	n/a	499.2	5,681	21%
	30-40	3,831	3,448	n/a	383.1	5,021	31%
Mid-Range	40-50	2,574	2,317	n/a	257.4	-	-
Dry	50-60	1,619	1,457	n/a	161.9	-	-
	60-70	944	849	n/a	94.4	1,218	30%
	70-80	485	437	n/a	48.5	-	-
	80-90	241	217	n/a	24.1	-	-
Low Flow	90-100	138	123.8	n/a	13.8	-	-

Table 8-10 Total Manganese TMDLs for the Lower Kaskaskia River Watershed (cont.)

Kinney Branch Segment OCF

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0 - 6.5	129.6	116.7	n/a	12.96	59.80	0%
Moist	6.5 - 13	35.4	31.8	n/a	3.54	-	-
	13 - 19.5	18.9	17.0	n/a	1.89	-	-
	19.5 - 26	13.5	12.1	n/a	1.35	0.97	0%
Mid-Range	26 - 32.5	10.3	9.3	n/a	1.03	-	-
Dry	32.5 - 39	8.2	7.3	n/a	0.82	-	-
	39 - 45.5	6.6	5.9	n/a	0.66	1.11	0%
	45.5 - 52	5.3	4.8	n/a	0.53	0.58	0%
	52 - 58.5	4.4	4.0	n/a	0.44	-	-
Low Flow	58.5 - 65	3.6	3.2	n/a	0.36	4.31	26%

Mud Creek Segment OE-02*

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0 - 6.5	2,450.1	2,205.1	n/a	245.0	-	-
Moist	6.5 - 13	621.4	559.3	n/a	62.1	-	-
	13 - 19.5	302.7	272.4	n/a	30.3	-	-
	19.5 - 26	196.4	176.8	n/a	19.6	-	-
Mid-Range	26 - 32.5	134.7	121.3	n/a	13.5	-	-
Dry	32.5 - 39	93.6	84.2	n/a	9.4	-	-
	39 - 45.5	62.7	56.5	n/a	6.3	-	-
	45.5 - 52	38.8	34.9	n/a	3.9	37.3	6%
	52 - 58.5	21.6	19.5	n/a	2.2	-	-
Low Flow	58.5 - 65	4.5	4.0	n/a	0.4	12	65%

[1] *Actual Load was calculated using the 90th percentile of observed Total Manganese concentrations in a given flow range (EPA 2007)*

**Two samples for Total Manganese at segment OE-02 correspond to zero discharge based on historical gage. Both samples concentrations exceeded the 1000ug/L standard, but could not be included in the TMDL calculations.*

8.3.3 Atrazine TMDLs for Kaskaskia River Segments O-03 and O-30

Lower Kaskaskia River segments O-30 and O-30 are listed for impairment caused by atrazine. Load duration curves were developed (see Section 7) to determine load reductions needed to meet the instream water quality standards at varying flow scenarios.

8.3.3.1 Loading Capacity

The LC is the maximum amount of atrazine that Lower Kaskaskia River segments O-03 and O-30 can receive and still maintain compliance with the water quality standards. The allowable atrazine loads that can be generated in the watershed and still maintain the standard of 12μg/L for raw (untreated) water were determined with the methodology discussed in Section 7. The atrazine loading capacity according to flow is presented in Table 8-11.

8.3.3.2 Seasonal Variation

Consideration of seasonality is inherent in the load duration analysis. Because the load duration analysis represents the range of expected stream flows, the TMDL has been calculated to meet the standard during all flow conditions. The standards for atrazine are not seasonal and the full range of expected flows is represented in the loading capacity table (Table 8-11). Therefore, the loading capacity represents conditions throughout the year. Load duration curve development and analysis (Section 7) showed that atrazine violations in the impaired segments are most likely to occur under low flow conditions. By considering and addressing all flow scenarios, these critical conditions when the stream segments are most vulnerable to water quality exceedences were addressed.

Table 8-11 Atrazine Loading Capacity for Lower Kaskaskia River Segments O-03 and O-30

Estimated Mean Daily Flow (cfs)	Load Capacity (lbs/day)
5	0.3
10	0.6
50	3.2
100	6.5
500	32.4
1,000	64.7
5,000	323.6
10,000	647.3
15,000	971.0

8.3.3.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The atrazine TMDLs developed for the impaired segments within the Lower Kaskaskia River watershed contain an explicit MOS of 10 percent. Ten percent is considered adequate to compensate for any uncertainty in the atrazine TMDLs developed for these watersheds due to the fact that the load duration curve approach minimizes a great deal of the uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the downstream USGS gage. The methodology employed in estimating watershed flows is discussed in Section 7.4 of this document.

8.3.3.4 Waste Load Allocation

There are a large number of NPDES permitted discharges within the Lower Kaskaskia River segment O-20 watersheds. However, none of these facilities are required to monitor for atrazine and therefore DMR data does not include concentrations of atrazine. Due to the nature of these facilities' operations, atrazine loading from these discharges is not expected to be an issue. Therefore, the WLA for segments was set to zero for all atrazine TMDL calculations.

8.3.3.5 Load Allocation and TMDL Summary

Table 8-12 shows a summary of the TMDL for Lower Kaskaskia River segment O-03. A summary of the TMDL for segment O-30 is provided in Table 8-13.

Table 8-12 Atrazine TMDL for Kaskaskia River at O-03

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	1,023.1	920.8	0	102.3	139.0	0%
Moist	10-20	588.5	529.7	0	58.9	71.6	0%
	20-30	374.7	337.2	0	37.5	212.2	0%
	30-40	287.2	258.5	0	28.7	149.1	0%
Mid-Range	40-50	192.6	173.3	0	19.3	47.3	0%
Dry	50-60	120.7	108.6	0	12.1	79.0	0%
	60-70	69.8	62.8	0	7.0	83.5	25%
	70-80	35.3	31.8	0	3.5	24.5	0%
	80-90	16.9	15.2	0	1.7	8.6	0%
Low Flow	90-100	9.1	8.2	0	0.9	0.3	0%

[1] Actual Load was calculated using the 90th percentile of observed Fecal coliform concentrations in a given flow range (EPA 2007)

Table 8-13 Atrazine TMDL for Kaskaskia River at O-30

Zone	Flow Exceedence Range (%)	LC (lbs/day)	LA (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	Actual Load[1] (lbs/day)	Percent Reduction Needed (%)
High	0-10	1,189.8	1,070.8	0	118.98	52.0	0%
Moist	10-20	705.0	634.5	0	70.50	33.4	0%
	20-30	466.3	419.7	0	46.63	55.4	0%
	30-40	368.8	331.9	0	36.88	85.6	0%
Mid-Range	40-50	263.2	236.9	0	26.32	51.9	0%
Dry	50-60	183.0	164.7	0	18.30	180.1	9%
	60-70	126.2	113.6	0	12.62	225.9	50%
	70-80	87.7	78.9	0	8.77	80.8	0%
	80-90	67.1	60.4	0	6.71	26.6	0%
Low Flow	90-100	58.4	52.6	0	5.84	2.4	0%

[1] Actual Load was calculated using the 90th percentile of observed Fecal coliform concentrations in a given flow range (EPA 2007)

8.3.4 Dissolved Oxygen TMDLs

A total of 6 impaired stream segments within the Lower Kaskaskia River watershed are listed for impairment caused by low dissolved oxygen (Lower Kaskaskia River segment O-30, Horse Creek segment OB-03, Richland Creek South segments OC-04 and OC-95, Kinney Branch segment OCF, and Mud Creek segment OE-02). As discussed in Section 7 of this report, individual QUAL2K water quality models were developed for each impaired segment. The QUAL2K model developed for the impaired segment of Lower Kaskaskia River (O-30) included the modeled outputs from the Mud Creek (OE-02), Richland Creek South segment OC-04, and Horse Creek (OB-03) models as point sources along the modeled segment.

All QUAL2K models were developed (see Section 7) to determine load reductions of oxygen demanding materials needed to meet the instream water quality standard of 6.0mg/L during the months of March - July and 4.0mg/L for the months of August -

February at varying flow levels. These seasonal minimum DO standards are based on a 7-day daily mean averaged over 7 days and were the used as endpoints for the QUAL2K models in order to provide a conservative endpoint that will provide some implicit margin of safety for TMDL calculations derived from the model outputs.

8.3.4.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that a given water body can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the Lower Kaskaskia River watershed and still maintain water quality standards were analyzed using the calibrated models described in Section 7. Modeling analysis revealed that, for each of the modeled reaches in the watershed, the dissolved oxygen standards could not be met with reductions in oxygen-demanding material loads alone. This analysis indicates that, given the best available data and constructed model, low dissolved oxygen levels in this watershed are driven primarily by a combination of low reaeration and high sediment oxygen demand (SOD). SOD is the sum of all chemical and biological processes in the sediment that take up oxygen. SOD generally consists of a combination of biological respiration from benthic organisms and the biochemical decay processes in the top layer of deposited sediments, together with the release of oxygen-demanding (reduced) anaerobic chemicals such as iron, manganese, sulfide, and ammonia.

Because low DO levels in this watershed are driven primarily by a combination of low reaeration and high SOD, loading capacities were not explicitly calculated for any of the study reaches. Rather, the constructed models were used to estimate levels of stream channel hydraulic alteration and/or SOD reduction needed to achieve DO targets. Model internal rates were maintained at calibrated values for this exercise. Results are summarized in Table 8-14. These results are intended to provide guidance for future implementation projects.

Because a TMDL cannot be developed for reaeration or SOD, no TMDL allocations were developed at this time. Potential further monitoring and implementation measures to increase aeration or reduce SOD in the system are discussed in Section 9. Further monitoring is also recommended to confirm the preliminary conclusions outlined above.

Table 8-14 Summary of Dissolved Oxygen TMDL Modeling[1]

	DO Standard (mg/L)[2]	Current Critical Period DO (mg/L)	Required % Reduction in SOD	Required Factor Increase in Reaeration
Kinney Branch Segment OCF				
March - July	6	2.52	100%	1.6
August - February	4	2.52	35%	0
Richland Creek South Segment OC-95				
March - July	6	1.86	100%	66.9
August - February	4	1.86	100%	11.1
Richland Creek South Segment OC-04				
March - July	6	5.38	45%	0
August - February	4	5.38*	0%	0
Horse Creek Segment OB-03				
March - July	6	3.71	85%	0
August - February	4	3.71	11%	0
Mud Creek Segment OE-02				
March - July	6	0.36	100%	10.9
August - February	4	0.36	100%	2.6
Lower Kaskaskia River Segment O-30				
March - July	6	3.28	64%	0
August - February	4	3.28	16%	0

[1] Assuming design average flow (DAF) for all point sources
[2] Based on 7-day daily mean averaged over 7 days

8.3.5 Total Phosphorus TMDLs for Coulterville Reservoir and Sparta NW Reservoir

8.3.5.1 Loading Capacity

The LCs of Coulterville and Sparta NW Reservoirs are the pounds of total phosphorus that can be allowed as input to each lake per day and still meet the applicable water quality standard. The water quality standard for total phosphorus is 0.05mg/L. The allowable load of total phosphorus that can be generated in the watershed and still maintain water quality standards were determined with the BATHTUB models that were set up and confirmed as discussed in Section 7. To accomplish this, the loads calculated using average values from the historic data were reduced by a percentage and entered into the BATHTUB models until the water quality standards were met. The allowable loads for total phosphorus as determined by reducing modeled inputs to Coulterville and Sparta NW Reservoirs through BATHTUB are shown in Tables 8-15 and 8-16, respectively.

Table 8-15 TMDL Summary for Coulterville Reservoir

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
External	0.39	0	0.35	0.039	7.85	7.49	95%
Internal	0.20	0	0.18	0.020	0.91	0.73	80%
Total	0.60	0	0.54	0.060	8.75	8.22	94%

Table 8-16 TMDL Summary for Sparta NW Reservoir

Load Source	LC (lb/day)	WLA (lb/day)	LA (lb/day)	MOS (lb/day)	Current Load (lb/day)	Reduction Needed (lb/day)	Reduction Needed (percent)
External	0.36	0	0.32	0.036	1.11	0.79	71%
Internal	0.61	0	0.54	0.061	37.21	36.66	99%
Total	0.96	0	0.86	0.096	38.32	37.46	98%

8.3.5.2 Seasonal Variation

A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Coulterville and Sparta NW Reservoir TMDLs as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted to daily loads rather than specifying different loadings by season. Coulterville Reservoir and Sparta NW Reservoir watersheds would most likely experience critical conditions annually based on the growing season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

8.3.5.3 Margin of Safety

The margin of safety (MOS) can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Coulterville Reservoir and Sparta NW Reservoir TMDLs are both implicit and explicit. An explicit MOS of 10% was included to account for the lack of site-specific data available within these watersheds.

Additionally, the analyses completed for these waterbodies were conservative because default values were used in the BATHTUB model, which in absence of site-specific information are conservative. Default model values, such as the phosphorus assimilation rate, are based on scientific data accumulated from a large survey of lakes. Because no site-specific data are available, default model rates are used which are based on error analysis calculations. The model used for this analysis uses estimates of second-order sedimentation coefficients which are generally accurate to within a factor of 2 for phosphorus and a factor of 3 for nitrogen. This provides a conservation range of where the predictions could fall and provides confidence in the predicted values.

8.3.5.4 Waste Load Allocation

There are no point sources within the Coulterville or Sparta NW Reservoir watersheds. Therefore, the WLA is set to zero for this TMDL.

8.3.5.5 Load Allocation and TMDL Summary

Table 8-15 shows a summary of the TMDLs for Coulterville Reservoir. A total reduction of 94 percent of total phosphorus loads Coulterville Reservoir would result in compliance with the applicable water quality standards.

Similarly, Table 8-16 shows a summary of the TMDLs for Sparta NW Reservoir. A total reduction of 98 percent of total phosphorus loads Sparta NW Reservoir would result in compliance with the applicable water quality standards.

8.3.6 Manganese TMDLs for Coulterville Reservoir and Sparta NW Reservoir

As discussed in section 7, the likely cause of manganese concentrations in excess of the public drink water supply standard of 150µg/L as seen in Coulterville and Sparta NW Reservoirs is related to high concentrations of total phosphorus in the reservoirs. Elevated total phosphorus concentrations promote excessive algal growth and, in turn, low hypolimnetic dissolved oxygen and internal loading of manganese from the sediments. This inherent relationship between the high total phosphorus and high manganese concentrations allow for the manganese impairment to be assessed primarily through assessment of total phosphorus concentrations. It is expected that steps taken to reduce total phosphorus concentrations within the reservoirs would also lead to reductions in the concentrations of manganese within the lakes levels below the water quality standard. Therefore, attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target for manganese is therefore set as a total phosphorus concentration of 0.05 mg-P/L. The TMDLs for total phosphorus in Coulterville and Sparta NW Reservoirs are discussed in section 8.3.4 of this report.

8.3.7 Atrazine TMDLs for Coulterville Reservoir and Sparta NW Reservoir

Coulterville and Sparta NW Reservoirs are both listed as public water supplies and the applicable water quality standard for atrazine is 12µg/L in raw water, or 4 times the standard for finished drinking water (3µg/L). A loading capacity approach was used to determine the maximum load of atrazine that can enter the reservoir and still allow the reservoir to meet the applicable water quality standard.

8.3.7.1 Loading Capacity

The LC of Coulterville and Sparta NW Reservoirs are the pounds of atrazine that can be allowed as input to the lake per day and still maintain compliance with the applicable water quality standards. The loading capacity approach assumes that water quality standards will be attained in each reservoir if the watershed runoff concentrations entering the reservoir remain below the water quality standard. The allowable atrazine loads that can be generated in the watershed and still maintain the raw water standard of 12µg/L were determined with the methodology discussed in Section 7. Due to the lack of correlated atrazine concentration data for raw and finished water from each reservoir, a more conservative loading capacity analysis was also conducted using the 3µg/L finished water standard. The atrazine loading capacity according to flow is presented in Table 8-17 for both reservoirs and water quality standards. Based on the drainage area ratio method calculated during development of BATHTUB models for each reservoir and described in section 7 of the report; the average daily flow into Coulterville Reservoir is estimated to be 0.706cfs while the average daily flow into Sparta NW Reservoir is estimated to be 1.319cfs.

8.3.7.2 Seasonal Variation

Consideration of seasonality is inherent in the load capacity analysis because the analysis represents the range of expected stream flows. The TMDL has been calculated to meet the standard during all flow conditions.

The pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics). Coulterville Reservoir and Sparta NW Reservoir watersheds would most likely experience critical conditions annually based on the growing season. By using the loading capacity method over a full range of flow conditions, all of these "critical conditions" are accounted for in the loading allocations.

Table 8-17 Atrazine loading capacity for Coulterville and Sparta NW Reservoirs based on the finished water (3µg/L) and the raw water standards (12µg/L).

Input Flow (cfs)	Allowable Load for Finished Water (lbs/day)	Allowable Load for Raw Water (lbs/day)
0.01	0.0002	0.0006
0.10	0.0016	0.0065
0.50	0.0081	0.0324
1.00	0.0162	0.0647
5.00	0.0809	0.3236
10.00	0.1618	0.6473
50.00	0.8091	3.2363
100.00	1.6181	6.4725
200.00	3.2363	12.9451

8.3.7.3 Margin of Safety

The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The atrazine TMDLs developed for Coulterville and Sparta NW Reservoirs contain both implicit and explicit margins of safety. An implicit Margin of Safety is inherent to the assessment due to the use of a conservative model to define load capacity. The model assumes no loss of atrazine that enters the lake, and therefore represents an upper bound of expected concentrations for a given pollutant load. In addition, an explicit MOS of 10 percent has been included in the TMDL calculations. Ten percent is considered adequate to compensate for any uncertainty in the atrazine TMDLs developed for the reservoirs due to the fact that the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the downstream USGS gage. The methodology employed in estimating watershed flows is discussed in Section 7.4 of this document.

8.3.7.4 Waste Load Allocation

There are a no NPDES permitted discharges within the Coulterville or Sparta NW Reservoir watersheds. Therefore, WLAs were not calculated and were set to zero.

8.3.7.5 Load Allocation and TMDL Summary

Table 8-18 shows a summary of the atrazine TMDLs for Coulterville and Sparta NW Reservoirs. The atrazine loads have been allocated between the LAs (nonpoint sources) and the MOSs. The loading capacity model differs from the load duration model in that available atrazine data collected in each reservoir cannot be directly correlated with tributary and watershed inflow. Therefore, percent reductions for each flow regime zones cannot be calculated. The maximum percent reduction in atrazine concentration necessary to meet both the raw and finished drinking water standards at each reservoir were calculated based on maximum reported atrazine concentrations and are shown in Table 8-19. Recommendations for reducing watershed loading of atrazine into Coulterville and Sparta NW reservoirs are discussed in Section 9 of this report.

Table 8-18 TMDL summary by inflow rate for Coulterville and Sparta NW Reservoirs based on the raw water and finished water standards

	3 µg/L Finished Water Standard				12 µg/L Raw Water Standard			
Inflow (cfs)	LC (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	LA (lbs/day)	LC (lbs/day)	WLA (lbs/day)	MOS (10% of LC)	LA (lbs/day)
0.01	0.0002	0	0.00002	0.0001	0.0006	0	0.00006	0.0006
0.10	0.0016	0	0.00016	0.0015	0.0065	0	0.00065	0.0058
0.50	0.0081	0	0.00081	0.0073	0.0324	0	0.00324	0.0291
1.00	0.0162	0	0.00162	0.0146	0.0647	0	0.00647	0.0583
5.00	0.0809	0	0.00809	0.0728	0.3236	0	0.03236	0.2913
10.00	0.1618	0	0.01618	0.1456	0.6473	0	0.06473	0.5825
50.00	0.8091	0	0.08091	0.7282	3.2363	0	0.32363	2.9126
100.00	1.6181	0	0.16181	1.4563	6.4725	0	0.64725	5.8253
200.00	3.2363	0	0.32363	2.9126	12.9451	0	1.29451	11.6506

Table 8-19 Percent reductions of in-lake atrazine concentrations required to meet the public water supply water quality standards, based on maximum reported concentrations.

Reservoir	Maximum reported Atrazine Concentration (µg/L)	Percent Reduction Required (3 µg/L Standard)	Percent Reduction Required (12 µg/L Standard)
Coulterville Reservoir	50.0	94.0%	76.0%
Sparta NW Reservoir	7.0	57.1%	0.0%

8.3.8 Manganese and Atrazine TMDLs for SLM Side Channel Reservoir

8.3.8.1 Loading Capacity

The LC is the maximum amount of contaminant that the SLM Side Channel Reservoir can receive and still maintain compliance with the applicable water quality standards. SLM Side Channel Reservoir is listed as a public water supply with applicable water quality standards of 150µg/L for manganese and 12µg/L for atrazine in untreated (raw) water. Atrazine concentrations in treated (finished) water must remain below 3µg/L in order to meet the public water supply standard. The percent reduction required to meet the applicable standard for each contaminant based on the maximum exceedence values for manganese and atrazine measured in the reservoir and are shown in Table 8-20. As a conservative measure and due to the lack of correlated raw and finished water samples from SLM Side Channel Reservoir, both the 12µg/L and the 3µg/L standards have been included in Table 8-20.

As discussed in section 7 of this report, SLM Side Channel Reservoir receives the majority of its inflow through pumping of water from Kaskaskia River segment O-20 as part of the SLM water treatment plant operations. Water quality samples at the reservoir have been collected in-lake and data for inflow water is not available. Therefore, direct calculations of the loading capacities for manganese and atrazine in SLM Side Channel Reservoir are not possible. As discussed in Section 7, any actions taken to reduce loading of manganese to Kaskaskia River segment O-20 and atrazine and manganese to Kaskaskia River segment O-03 will result in reductions to the loading in SLM Side Channel Reservoir. Recommendations for reducing watershed loading atrazine and manganese are discussed in Section 9 of this report.

Table 8-20 Percent reductions of in-lake manganese and atrazine concentrations required to meet the public water supply water quality standards, based on maximum reported concentrations.

Parameter	Maximum reported Concentration (µg/L)	Water Quality Standard (µg/L)	Percent Reduction Required (%)
Total Manganese	320	150	53%
Atrazine	14	3(1)	79%
		12(2)	14%

[1] Based on the finished water public water supply standard
[2] Based on the raw water public water supply standard (4 times the finished water standard)

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Section 9
Implementation Plan for the Lower Kaskaskia River Watershed

9.1 Adaptive Management

An adaptive management or phased approach is recommended for the TMDLs developed for the Lower Kaskaskia River watershed due to the limited amount of data available for the TMDL analysis. Adaptive management is a systematic process for continually improving management policies and practices through learning from the outcomes of operational programs. Some of the differentiating characteristics of adaptive management are:

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

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

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

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

9.2 Implementation Actions and Management Measures for Manganese and pH in streams of the Lower Kaskaskia River Watershed

Violations of the applicable manganese standard have been reported on Kaskaskia River segments O-03, O-20, O-30 and O-97 and on Kinney Branch (OCF) and Mud Creek (OE-02). The impaired segments of the Kaskaskia River are all designated as public water supplies and are subject to the 150µg/L manganese standard. Kinney Branch (OCF) and Mud Creek (OE-02) are not designated as public water supplies and, therefore, the 1,000µg/L general use water quality standard for manganese applies. The most likely sources of these contaminants include runoff from historic mining operations in the watershed as well as natural sources including overland runoff, soil erosion, and groundwater.

There are a number of active and historic mining operations in the Kaskaskia River watershed that may contribute to the loads of these contaminants to the impaired stream segments. Although not specifically listed as a potential source of impairments from manganese and pH in the Lower Kaskaskia River watershed, impacts from abandoned mine lands, acid mine drainages, surface mining, and mine tailings have all been identified in the 303(d) list as potential sources of metals and pH violations in the other watersheds throughout southern Illinois. Implementation actions and management measures available to address the water quality issues associated with these sources of contaminants in the impaired stream segments in the Lower Kaskaskia River watershed are discussed below.

9.2.1 Point Sources of Manganese and pH

9.2.1.1 Permitted Mining Outfalls

There are a total of 5 active and historic permitted NPDES mining operations in the Lower Kaskaskia River watershed. There is one active permitted facility within the watershed, Peabody Coal Company/Hillside Recreational Lands, L.L.C- Randolph Prep (NPDES Permit No. IL0062740). This facility is a reclaimed surface coal mine with permit requirements to monitor for iron, suspended solids, and settleable solids and has no average daily flow information. The additional mining operations within the Lower Kaskaskia River Watershed no longer maintain active permits (NPDES Permits IL0046493, IL0052558, IL0000582, IL0052566) and flow and manganese concentration data we not available for these discharges. Mining operations within the Lower Kaskaskia River watershed do not have explicitly stated permit NPDES permits without explicitly listed discharge limitations are typically required to comply with the applicable water quality standards of the receiving stream.

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as the permits are due for renewal. Mine effluent limitations are provided in Part 406 of the Illinois Administrative Code Section 406.202 states:

> *In addition to the other requirements of this Part, no mine discharge or non-point source mine discharge shall, alone or in combination with other sources, cause a violation of any water quality standards of 35 Ill. Adm. Code 302 or 303. When the Agency finds that a discharge which would comply with effluent standards contained in this Part would cause or is causing a violation of water quality standards, the Agency shall take appropriate action under Section 31 or 39 of the Environmental Protection Act to require the discharge to meet whatever effluent limits are necessary to ensure compliance with the water quality standards. When such a violation is caused by the cumulative effect of more than one source, several sources may be joined in an enforcement or variance proceeding and measures for necessary effluent reductions will be determined on the basis of technical feasibility, economic reasonableness and fairness to all discharges (IPCB 1999b).*

These permits and their associated limits are thought to be adequately protective of aquatic life uses within the receiving waters.

9.2.2 Nonpoint Sources of Manganese

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

Following are examples of potentially applicable erosion control measures:

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

The remainder of this section discusses these management options.

9.2.2.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads from runoff and sedimentation to impaired stream segments in the Lower Kaskaskia River watershed. Filter strips implemented along stream segments slow and filter runoff and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips in the watershed.

Filter strips may help control contaminant levels by removing loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips have been shown to remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of other contaminants such as metals from runoff may fall within this range (NCSU 2000). Riparian vegetation also provides bank stability that further reduces sediment loading to the stream and therefore reduces the loading of manganese found in soils.

Filter strip widths for the impaired stream segments TMDLs were estimated based on the land slope. According to the NRCS Planning and Design Manual, the majority of sediment is removed in the first 25 percent of the width (NRCS 1994). Table 9-1 outlines the guidance for filter strip flow length by slope (NRCS 1999).

Table 9-1 Filter Strip Flow Lengths Based on Land Slope

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

GIS land use data described in Section 2 of the Stage 1 report were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1 this report, there is a wide diversity of soil types in the watershed with no single soil type accounting for more than 1 percent of the watershed. Because soil type and corresponding slope values vary so widely across the watershed, maximum values associated with 5 percent or greater slopes were used for this analysis. Based on this slope value, filter strip widths of 234 feet could be incorporated into agricultural lands adjacent to the ditch and its tributaries.

Mapping software was then used to buffer impaired stream segments and their major tributaries to determine the total area found within 234 feet of the stream channels. There are approximately 574,145 total acres within this buffer distance throughout the watershed. The land use data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are an estimated 241,600 acres of agricultural land surrounding tributaries of the Lower Kaskaskia River watershed where filter strips and riparian buffers could potentially be installed. The relative areas within the buffer distance for each impaired stream segment and its tributaries are provided in Table 9-2. Landowners should evaluate their land near the stream and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 9-1. Programs available to fund the construction of these buffer strips are discussed in Section 9.5.

Table 9-2 Total Area and Area of Agricultural Land Within 234-feet Buffer by Segment

Stream Name	Segment ID	Area in 234 ft Buffer (Acres)	Agricultural Land In 234 ft Buffer (Acres)
Kaskaskia River	O-03	133,661	55,889
	O-20	112,164	47,830
	O-30	170,909	71,278
	O-97	142,939	60,194
Horse Creek	OB-03	2,629	1,564
Richland Creek South	OC-04	7,873	3,891
	OC-95	460	66
Kinney Branch	OCF	254	137
Mud Creek	OE-02	3,254	755

9.2.2.2 Sediment Control Basins

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

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

9.2.2.3 Streambank Stabilization/Erosion Control

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

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

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

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

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

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

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

9.3 Implementation Actions and Management Measures for Fecal Coliform in the Lower Kaskaskia River Watershed

The TMDL analysis performed for fecal coliform bacteria in O-20 and O-30 showed that although exceedences were reported over the full range of flow conditions. Exceedences of the standard collected during higher flow conditions are likely a result of stormwater runoff and re-suspension of instream fecal material. Exceedences of the fecal coliform standard that occur under low flow conditions are likely a result of point source contributions, failed septic systems, livestock, and/or groundwater inputs.

9.3.1 Point Sources of Fecal Coliform

9.3.1.1 NPDES Permitted Municipal Point Sources

There are 51 NPDES permitted municipal wastewater treatment facilities with point sources discharges in the Lower Kaskaskia River watershed. The facilities are located both on tributaries of the impaired segments and, in some cases, directly discharge effluent to impaired stream segments.

Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. In Illinois, a number of these treatment plants have applied for and received a disinfection exemption, which allows a facility to discharge waste water without disinfection. All of these treatment facilities are required to comply with the geometric mean fecal coliform water quality standard of 200 cfu/100 mL at the closest point downstream where recreational use could occur in the receiving water or where the water flows into a fecal-impaired segment.

Facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. In addition, facilities directly discharging into a segment whose recreational use is impaired by fecal coliform may have their year-round disinfection exemption revoked through future National Pollutant Discharge Elimination System (NPDES) permitting actions. Descriptions of each discharge's disinfection exemption status and the resulting exempted stream reaches are provided in Appendix F.

Average daily discharge rates for permitted municipal treatment plants occurring within the Lower Kaskaskia River watershed are shown in Table 9-3. Waste load allocations (WLA) for fecal coliform calculated for each facility (based on the 200 cfu/100ml water quality standard) are shown in Table 9-3 along with impaired segments downstream of each municipal STP.

Table 9-3 Point source discharges and fecal coliform WLA in the Lower Kaskaskia River Watershed

NPDES Permitted STP	NPDES Permit Number	Receiving Water	303d Listed Segment ID	Average Daily Flow (MGD)	WLA-Fecal Coliform (mil. Col./Day)
ACKERMAN'S RESTAURANT	IL0052001	Wendell Branch	O-03, O-97, O-30	n/a	-
ADORERS OF THE BLOOD OF CHRIST	IL0026948	Unnamed Tributary to Horse Creek	O-30	0.03	227
ALHAMBRA STP	ILG580004	Silver Creek	O-03, O-97, O-30	0.0725	549
BALDWIN STP	IL0027219	Unnamed Tributary to Plum Creek	O-30	0.051	386
BELLEVILLE STP #1	IL0021873	Richland Creek - Kaskaskia River	O-97, O-30	8	60,566
CASEYVILLE TOWNSHIP EAST STP	IL0021083	Intermittent Tributary to Ogles Creek	O-03, O-97, O-30	4.4	33,312
CLANAHAN TRAILER PARK	IL0052256	Unnamed Tributary to Silver Creek	O-03, O-97, O-30	0.0042	32
COUNTRYVIEW COURT-SPARTA	IL0046019	Little Plum Creek	O-30	0.011	83
DUTCH HOLLOW VILLAGE, INC.	IL0046663	Unnamed Tributary to Schoenburger Creek	O-97, O-30	0.08	606
ELLIS GROVE STP	ILG580145	Little Nine Mile Creek	O-30	0.0247	187
EVANSVILLE STP	IL0021440	Kaskaskia River	O-30	0.17	1,287
FAYETTEVILLE STP	IL0020893	Kaskaskia River	O-20, O-03, O-97, O-30	0.05	379
FREEBURG EAST STP	IL0020753	Lemon Creek to Silver Creek	O-03, O-97, O-30	0.31	2,347
FREEBURG WEST STP	IL0032310	Kinney Branch - Richland Creek	O-97, O-30	0.4	3,028
HAMEL STP	ILG580011	Silver Creek	O-03, O-97, O-30	0.105	795
HECKER STP	ILG580235	Richland Creek	O-97, O-30	0.08	606
HIGHLAND STP	IL0029173	Lindenthal Creek	O-03, O-97, O-30	1.6	12,113
HOPKINS PARK STP	ILG580217	Unnamed Tributary to Little Beaver Creek	O-03, O-97, O-30	0.25	1,893
IL DOT-I64 ST CLAIR COUNTY	IL0068314	Reinhardt Slough	O-03, O-97, O-30	0.03	227
JOHANNISBURG GRADE SCHOOL	IL0046884	Unnamed Tributary to Little Muddy Creek	O-03, O-97, O-30	0.0018	20
LEBANON STP	IL0029483	Little Silver Creek	O-03, O-97, O-30	0.878	6,647
LENZBURG STP	ILG580013	Doza Creek	O-97, O-30	0.0825	625
LIVINGSTON STP	ILG580115	Silver Creek	O-03, O-97, O-30	0.148	1,120
MANORS AT KENSINGTON PARQUE	IL0074993	Unnamed Tributary to Wendell Branch	O-03, O-97, O-30	0.0238	180
MAPLE LEAF ESTATES WATER CORP.	IL0071579	Unnamed Tributary to Richland Creek	O-97, O-30	0.0127	96

Table 9-3 Point source discharges and fecal coliform WLA in the Lower Kaskaskia River Watershed (cont.)

NPDES Permitted STP	NPDES Permit Number	Receiving Water	303d Listed Segment ID	Average Daily Flow (MGD)	WLA-Fecal Coliform (mil. Col./Day)
MARINE STP	ILG580228	Unnamed Tributary to Silver Creek	O-03, O-97, O-30	0.24	1,817
MARISSA STP	IL0024813	Doza Creek to Kaskaskia River	O-97, O-30	0.585	4,429
MASCOUTAH STP	IL0025291	Silver Creek	O-03, O-97, O-30	0.965	7,306
METRO-EAST AIRPARK STP	IL0075094	Unnamed Tributary to Silver Creek	O-03, O-97, O-30	0.0042	32
MILLSTADT STP	IL0032514	South Branch Douglas Creek	O-97, O-30	0.965	7,306
NEW ATHENS MOBIL HOME PARK	IL0024601	Unnamed Tributary to Lively Branch Creek	O-03, O-97, O-30	0.0278	210
NEW ATHENS WWTP	IL0021725	Kaskaskia River	O-03, O-97, O-30	0.3	2,271
O'FALLON STP	IL0021636	Silver Creek	O-03, O-97, O-30	5.61	42,472
RED BUD STP	IL0025348	Black Creek	O-97, O-30	0.6	4,542
RUMA STP	IL0063282	Ruma Creek	O-30	0.04	303
SAINT JACOB STP	ILG580212	Silver Creek - Kaskaskia River	O-03, O-97, O-30	0.14	1,060
SAINT LIBORY WWTP	ILG580014	Little Mud Creek	O-03, O-97, O-30	0.09	681
SCOTT AIR FORCE BASE	IL0026859	Unnamed Tributary to Silver Creek	O-03, O-97, O-30	2	15,142
SMITHTON STP	ILG580026	Douglas Creek	O-97, O-30	0.24	1,817
SMITHTON-WILDWOOD STP	IL0061131	West Fork Richland Creek	O-97, O-30	0.154	1,166
SPARTA STP	IL0066133	Unnamed Tributary to Plum Creek	O-30	0.25	1,893
SUMMERFIELD STP	IL0064220	Unnamed Tributary to Little Silver Creek	O-03, O-97, O-30	0.07	530
SWANSEA STP	IL0021181	Richland Creek	O-97, O-30	5.015	37,968
TILDEN STP	ILG580107	Plum Creek	O-30	0.111	840
TIMBER LAKE HOMEOWNERS ASSOC	ILG551050	Unnamed Tributary to Rockhouse Creek	O-97, O-30	0.0068	51
TRIAD COMMUNITY UNIT DIST #2	ILG551025	Silver Creek	O-03, O-97, O-30	0.0195	148
TRISIMO MOTEL DEVELOPMENT	IL0066788	Unnamed Tributary to Silver Creek	O-03, O-97, O-30	0.0092	70
TROY STP	IL0031488	Troy Creek - Wendell Branch - Silver Creek	O-03, O-97, O-30	1.35	10,221
VALLEY VIEW MOBILE HOME PARK	IL0062111	Doza Creek	O-97, O-30	n/a	-
WATERLOO EAST STP	IL0070734	Unnamed Tributary to Gerhardt Creek	O-97, O-30	0.25	1,893

9.3.1.2 Stormwater Sources

A portion of the watershed is urban in nature (approximately 2.2 percent of the Lower Kaskaskia River watershed area) and several of the municipalities within the watershed are required to have stormwater permits. However, little information is available regarding stormwater runoff in the watershed. It is recommended that a storm sewer survey be performed to determine the amount of fecal coliform that may be contributed to the stream via urban stormwater sources.

9.3.2 Nonpoint Sources of Fecal Coliform

Several management options have been identified to help reduce fecal coliform counts in the impaired segments of the Lower Kaskaskia River (O-20 and O-30). These management options focus on the most likely sources of fecal coliform within the basin, such as agricultural runoff, septic systems, and livestock. The alternatives that were identified are:

- Filter Strips
- Private Septic System Inspection and Maintenance Program
- Restrict Livestock Access to Harding Ditch and Tributaries

Each alternative is discussed briefly in this section.

9.3.2.1 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of manganese loadings into impaired waterbodies. Filter strips will have a similar impact in reducing loads of fecal coliform from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to fecal coliform controls. As described in Section 9.2.2.8, there are approximately 170,909 acres of land within 234 feet of O-30 and its major tributaries. Nearly 42 percent of this area, approximately 71,278 acres, are categorized as agricultural and could potentially be converted into filter strips. Similarly, there are approximately 112,164 acres of land within 234 feet of O-20 and its major tributaries, of which, approximately 47,830 acres or 43 percent is agricultural and could potentially be converted into filter strips.

9.3.2.2 Private Septic System Inspection and Maintenance Program

Given the large size and mostly rural nature of the Lower Kaskaskia River watershed, a large number of septic systems exist in the watershed associated with the rural residences in the area. Failing or leaking septic systems can be a significant source of fecal coliform pollution. A program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.

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

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

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

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

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

9.3.2.3 Restrict Livestock Access to Lower Kaskaskia River and Tributaries

As discussed previously in this report, livestock are present in the Lower Kaskaskia River watershed. NRCS reports cattle operations and CAFOs exist within the watershed. Due to the large extent of the watershed, specific numbers of livestock occurring within the Kaskaskia River watershed are not available. It is unknown to what extent these animals have access to the Lower Kaskaskia River or its tributaries. Reduction of livestock access to streams, however, is recommended to reduce bacteria loads. The USEPA found that livestock exclusion from waterways and other grazing management measures were successful in reducing fecal coliform counts by 29 to 46 percent (2003). Fencing and alternate watering systems are effective ways to restrict livestock from streams.

9.4 Implementation Actions and Management Measures for DO in the Lower Kaskaskia River Watershed

DO impairments are generally addressed by focusing on organic loads that consume oxygen through decomposition and nutrient loads that can cause algal growth, which can also deplete DO. Analysis discussed in Section 8 established a relationship between low flows, sediment oxygen demand (SOD), oxygen-demanding materials (BOD_5, ammonia-nitrogen and organic nitrogen), and DO concentrations in the impaired segments; therefore, management measures for these segments will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

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

9.4.1 Point Sources of Oxygen-Demanding Materials

Point sources within the Lower Kaskaskia River watershed include municipal sources. This section discusses the sources and their potential to contribute oxygen-demanding materials.

9.4.1.1 Municipal/Industrial Sources

A number of STPs discharge oxygen-demanding materials within the watersheds of each impaired segment. The facilities are located both on tributaries of the impaired segments and, in some cases, directly discharge effluent to the impaired stream segments. In total, over 50 municipal STPs exist within the Lower Kaskaskia River watershed. Table 9-4 contains permit information on each of these facilities as well as model input parameters for available parameters used in the QUAL2K modeling discussed in Section 8 of this report.

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. Violations of discharge limits for some QUAL2K model input parameters such as DO, BOD, TSS, and ammonia have been reported from several of the municipal discharges at various intervals in the past decade. However, reported violations have not been ongoing and the facilities are not believed to be a significant source of oxygen-demanding materials to the impaired segments. The existing permit limits are thought to be adequately protective of aquatic life uses within the impaired segments. The NPDES permitted facilities discharge monitoring reports (DMRs) continue to be monitored and ongoing violations of the effluent limits at any of the permitted facilities may prompt further regulatory action.

Table 9-4 Point Source Discharges and DO and Oxygen-Demanding Material Model inputs in the Lower Kaskaskia River Watershed

NPDES Permitted STP	NPDES Permit Number	Receiving Water	303d Listed Seg ID	Avg. Daily Flow (MGD)	*DO (lbs/day)*	*Fast CBOD (lbs/day)*	*Ammonia N (lbs/day)*	*Nitrate + NItrite (lbs/day)*	*Organic P (lbs/day)*	*Inorganic P (lbs/day)*
ACKERMAN'S RESTAURANT	IL0052001	Wendell Branch	O-30	n/a	-	-	-	-	-	-
ADORERS OF THE BLOOD OF CHRIST	IL0026948	Unnamed Tributary to Horse Creek	O-30, OB-03	0.03	1.67	0.91	-	-	-	-
ALHAMBRA STP	ILG580004	Silver Creek	O-30	0.0725	-	-	-	-	-	-
BALDWIN STP	IL0027219	Unnamed Tributary to Plum Creek	O-30	0.051	-	9.26	-	-	-	-
BELLEVILLE STP #1	IL0021873	Richland Creek - Kaskaskia River	O-30	8	545.10	96.74	20.68	-	-	-
CASEYVILLE TOWNSHIP EAST STP	IL0021083	Intermittent Tributary to Ogles Creek	O-30	2.2	151.37	90.09	5.69	-	-	-
CLANAHAN TRAILER PARK	IL0052256	Unnamed Tributary to Silver Creek	O-30	0.0042	-	-	-	-	-	-
COUNTRYVIEW COURT-SPARTA	IL0046019	Little Plum Creek	O-30	0.011	-	-	-	-	-	-
DUTCH HOLLOW VILLAGE STP	IL0046663	Unnamed Tributary to Schoenburger Creek	O-30, OC-95	0.2	-	-	0.08	-	-	-
ELLIS GROVE STP	ILG580145	Little Nine Mile Creek	O-30	0.0247	-	3.52	-	-	-	-
EVANSVILLE STP	IL0021440	Kaskaskia River	O-30	0.17	-	4.25	-	-	-	-
FAYETTEVILLE STP	IL0020893	Kaskaskia River	O-30	0.05	-	8.84	-	-	-	-
FREEBURG EAST STP	IL0020753	Lemon Creek to Silver Creek	O-30	0.31	-	29.86	-	-	-	-
Freeburg West STP	IL0032310	Kinney Branch - Richland Creek	O-30, OCF	0.4	23.35	3.34	2.77	48.04	9.34	24.02
HAMEL STP	ILG580011	Silver Creek	O-30	0.105	-	-	-	-	-	-

Table 9-4 Point Source Discharges and DO and Oxygen-Demanding Material Model inputs in the Lower Kaskaskia River Watershed (cont.)

NPDES Permitted STP	NPDES Permit Number	Receiving Water	303d Listed Seg ID	Avg. Daily Flow (MGD)	*DO (lbs/day)*	*Fast CBOD (lbs/day)*	*Ammonia N (lbs/day)*	*Nitrate + NItrite (lbs/day)*	*Organic P (lbs/day)*	*Inorganic P (lbs/day)*
HECKER STP	ILG580235	Richland Creek	O-30, OC-04	0.08	-	5.27	-	-	-	-
HIGHLAND STP	IL0029173	Lindenthal Creek	O-30	1.6	-	-	-	-	-	-
HOPKINS PARK STP	ILG580217	Unnamed Tributary to Little Beaver Creek	O-30	0.25	-	31.48	-	-	-	-
IL DOT-I64 ST CLAIR COUNTY	IL0068314	Reinhardt Slough	O-30	n/a	-	-	-	-	-	-
JOHANNISBURG GRADE SCHOOL	IL0046884	Unnamed Tributary to Little Muddy Creek	O-30, OE-02	0.0018	0.09	0.03	0.01	-	-	-
LEBANON STP	IL0029483	Little Silver Creek	O-30	0.878	-	-	-	-	-	-
LENZBURG STP	ILG580013	Doza Creek	O-30	0.0825	-	-	-	-	-	-
LIVINGSTON STP	ILG580115	Silver Creek	O-30	0.148	-	-	-	-	-	-
MANORS AT KENSINGTON PARQUE	IL0074993	Unnamed Tributary to Wendell Branch	O-30	0.0238	-	-	-	-	-	-
MAPLE LEAF ESTATES WATER CORP.	IL0071579	Unnamed Tributary to Richland Creek	O-30, OC-04	0.0127	-	-	-	-	-	-
MARINE STP	ILG580228	Unnamed Tributary to Silver Creek	O-30	0.24	-	10.35	-	-	-	-
MARISSA STP	IL0024813	Doza Creek to Kaskaskia River	O-30	0.585	-	-	-	-	-	-
MASCOUTAH STP	IL0025291	Silver Creek	O-30	0.965	-	-	0.23	-	-	-
METRO-EAST AIRPARK STP	IL0075094	Unnamed Tributary to Silver Creek	O-30	0.0042	-	-	-	-	-	-
MILLSTADT STP	IL0032514	South Branch Douglas Creek	O-30	0.5	29.52	-	0.63	-	-	-

Table 9-4 Point Source Discharges and DO and Oxygen-Demanding Material Model inputs in the Lower Kaskaskia River Watershed (cont.)

NPDES Permitted STP	**NPDES Permit Number**	**Receiving Water**	**303d Listed Seg ID**	**Avg. Daily Flow (MGD)**	***DO (lbs/day)***	***Fast CBOD (lbs/day)***	***Ammonia N (lbs/day)***	***Nitrate + NItrite (lbs/day)***	***Organic P (lbs/day)***	***Inorganic P (lbs/day)***
NEW ATHENS MOBIL HOME PARK	IL0024601	Unnamed Tributary to Lively Branch Creek	O-30	0.0278	-	-	-	-	-	-
NEW ATHENS WWTP	IL0021725	Kaskaskia River	O-30	0.3	-	10.78	-	-	-	-
O'FALLON STP	IL0021636	Silver Creek	O-30	5.61	362.27	93.57	7.63	-	-	-
RED BUD STP	IL0025348	Black Creek	O-30, OC-04	0.6	30.42	8.96	0.80	-	-	-
RUMA STP	IL0063282	Ruma Creek	O-30, OB-03	0.04	2.53	0.80	0.21	-	-	-
SAINT JACOB STP	ILG580212	Silver Creek - Kaskaskia River	O-30	0.14	-	2.94	-	-	-	-
SAINT LIBORY WWTP	ILG580014	Little Mud Creek	O-30, OE-02	0.09	-	-	-	-	-	-
SCOTT AIR FORCE BASE	IL0026859	Unnamed Tributary to Silver Creek	O-30	2	124.77	55.21	2.84	-	-	-
SMITHTON STP	ILG580026	Douglas Creek	O-30	0.24	-	-	-	-	-	-
SMITHTON-WILDWOOD STP	IL0061131	West Fork Richland Creek	O-30, OC-04	0.154	-	11.10	-	-	-	-
SPARTA STP	IL0066133	Unnamed Tributary to Plum Creek	O-30	0.25	13.95	6.34	4.48	-	-	-
ST. CLAIR TWP	IL0048232	Loop Creek - Silver Creek	O-30	1.5	93.32	25.02	5.25	-	-	-
SUMMERFIELD STP	IL0064220	Unnamed Tributary to Little Silver Creek	O-30	0.07	-	4.28	7.53	-	-	-
SWANSEA STP	IL0021181	Richland Creek	O-30, OC-095	2.7	181.04	34.68	21.39	-	-	-
TILDEN STP	ILG580107	Plum Creek	O-30	0.111	-	14.13	-	-	-	-
TIMBER LAKE HOMEOWNERS ASSOC	ILG551050	Unnamed Tributary to Rockhouse Creek	O-30, OC-04	0.0068	-	0.93	-	-	-	-

Table 9-4 Point Source Discharges and DO and Oxygen-Demanding Material Model inputs in the Lower Kaskaskia River Watershed (cont.)

NPDES Permitted STP	**NPDES Permit Number**	**Receiving Water**	**303d Listed Seg ID**	**Avg. Daily Flow (MGD)**	***DO (lbs/day)***	***Fast CBOD (lbs/day)***	***Ammonia N (lbs/day)***	***Nitrate + NItrite (lbs/day)***	***Organic P (lbs/day)***	***Inorganic P (lbs/day)***
TRIAD COMMUNITY UNIT DIST #2	ILG551025	Silver Creek	O-30	0.0195	-	-	-	-	-	-
TRISIMO MOTEL DEVELOPMENT	IL0066788	Unnamed Tributary to Silver Creek	O-30	0.0092	0.56	0.89	-	-	-	-
TROY STP	IL0031488	Troy Creek - Wendell Branch - Silver Creek	O-30	1.35	119.57	10.58	1.35	-	-	-
VALLEY VIEW MOBILE HOME PARK	IL0062111	Doza Creek	O-30	n/a	-	-	-	-	-	-
WATERLOO EAST STP	IL0070734	Unnamed Tributary to Gerhardt Creek	O-30, OC-04	0.25	17.76	30.00	-	-	-	-

9.4.2 Nonpoint Sources of Oxygen-Demanding Materials

In addition to point sources of oxygen-demanding materials within the watershed, there are a number or potential nonpoint sources. The potential sources of nonpoint pollution to the impaired segments of the Lower Kaskaskia River watershed include over-fertilization (associated with both agricultural and urban land uses), streambank erosion, low flows, and high temperatures. BMPs evaluated for treatment of these nonpoint sources are:

- Conservation tillage practices
- Filter strips
- Riparian Buffers
- Nutrient management
- Reaeration/Streambank Stabilization

Organic and nutrient loads originating from cropland can be treated with a combination of riparian buffer or grass filter strips. Streambank stabilization and erosion control can limit the oxygen-demanding material entering the stream. A reduction in nutrient loads will decrease the biological productivity and, along with the decreased inputs of oxygen-demanding materials, will lead to a reduction in the levels of sediment oxygen demand (SOD) present in the stream. Instream management measures for DO focus on reaeration techniques. The Q2K models used to develop the TMDLs utilize reaeration coefficients. Increasing the reaeration coefficient by physical means will increase DO in the impaired segments.

9.4.2.1 Conservation Tillage Practices

For the Lower Kaskaskia River watershed, conservation tillage practices could help reduce nutrient and sediment loads into the stream segments. Approximately 2.9 million acres in the Lower Kaskaskia River watershed are under cultivation, which accounts for 78 percent of the total watershed area. Nutrient and sediment loading from cropland can be controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2006 Illinois Department of Agriculture's Soil Transect Survey estimates indicate that conventional till currently accounts for the vast majority of tillage practices in the 21 counties containing some portion of the Kaskaskia River watershed. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural areas in the Lower Kaskaskia River watershed.

9.4.2.2 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of manganese loadings and in Section 9.3.2.1 for control of fecal coliform loadings into impaired waterbodies. Filter strips will have a similar impact in reducing loads of nutrients and sediments from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to controls designed to reduce oxygen-demanding materials. Filter strips implemented along stream segments slow and filter nutrients and sediment out of runoff, help reduce stream water temperatures thereby increasing the water body DO saturation level, and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips to control oxygen demanding materials entering waterbodies in the Lower Kaskaskia River watershed.

Organic debris in topsoil contributes to the BOD_5 load to water bodies (USEPA 1997). Increasing the length of stream bordered by grass and riparian buffer strips will decrease the amount of BOD_5 and nutrient load associated with sediment loads to the impaired segments of the Lower Kaskaskia River watershed. Nutrient criteria for streams are currently being developed and expected to be adopted in the near future by the Illinois EPA and will assess the instream nutrient concentrations required for the watershed. Excess nutrients in streams can cause excessive algal growth, which can deplete DO in streams. Adoption of nutrient criteria will potentially affect this DO TMDL and help control exceedences of DO water quality criteria in the Lower Kaskaskia River watershed.

Filter strips will help control BOD_5 levels by removing organic loads associated with sediment from runoff; however, no studies were identified as providing an estimate of removal efficiency. Grass filter strips can remove as much as 75 percent of sediment and 45 percent of total phosphorus from runoff, so it is assumed that the removal of BOD_5 falls within this range (NCSU 2000). Riparian buffer strips also help reduce water temperatures which can in turn increase the water body DO saturation level.

Riparian vegetation, specifically shade, plays a significant role in controlling stream temperature change. The shade provided will reduce solar radiation loading to the stream. Furthermore, riparian vegetation provides bank stability that reduces sediment loading to the stream and the stream width-to-depth ratio. Research in California (Ledwith 1996), Washington (Dong et al. 1998), and Maine (Hagan and Whitman 2000) has shown that riparian buffers effect microclimate factors such as air temperature and relative humidity proximal to the stream. Ledwith (1996) found that a 500-foot buffer had an air temperature decrease of 12°F at the stream over a zero-foot buffer. The greatest change occurred in the first 100 feet of the 500-foot buffer where the temperature decreased 2°F per 30 feet from the stream bank. A decrease in the air temperature proximal to the stream would result in a smaller convective flux to the stream during the day.

The relative areas within the buffer distance for each impaired stream segment and its tributaries are provided in Table 9-2.

9.4.2.3 Riparian Buffers

Riparian corridors, including both the stream channel and adjacent land areas, are important components of watershed ecology. Tree canopies of riparian forests cool the water in streams which can affect the composition of the fish species in the stream, as well as the rate of biological reactions. Channelization or widening of streams moves the canopy farther apart, decreasing the amount of shaded water surface and increasing water temperature which can increase DO problems.

Preserving natural vegetation along stream corridors can effectively reduce water quality degradation associated with development. The root structure of the vegetation in a buffer enhances infiltration of runoff and subsequent trapping of nonpoint source pollutants. However, the buffers are only effective in this manner when the runoff enters the buffer as a slow moving, shallow "sheet"; concentrated flow in a ditch or gully will quickly pass through the buffer offering minimal opportunity for retention and uptake of pollutants.

Even more important than the filtering capacity of the buffers is the protection they provide to streambanks. The rooting systems of the vegetation serve as reinforcements in streambank soils, which help to hold streambank material in place and minimize erosion. Due to the increase in stormwater runoff volume and peak rates of runoff associated with agriculture and development, stream channels are subject to greater erosional forces during stormflow events. Thus, preserving natural vegetation along stream channels minimizes the potential for water quality and habitat degradation due to streambank erosion and enhances the pollutant removal of sheet flow runoff from developed areas that passes through the buffer.

Converting land adjacent to streams for the creation of riparian buffers will provide stream bank stabilization, stream shading, and nutrient uptake and trapping from adjacent areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. NCSU (2002) reports phosphorus removal rates of approximately 25 to 30 percent for 30 foot wide buffers and 70 to 80 percent for 60- to 90-foot wide buffers. Land use data were clipped to 25 feet buffer zones created around the impaired segments in the Lower Kaskaskia River watershed. There are 18,452 acres within 25 feet of the impaired segments. Approximately 8,164 of these acres are existing grassland or forest while 5,815 acres are currently classified as agricultural. Landowners should assess parcels adjacent to the stream channel and maintain or improve existing riparian areas or potentially convert cultivated lands.

Riparian corridors typically treat a maximum of 300 feet of adjacent land before runoff forms small channels that short circuit treatment. In addition to the treated area, the land converted from agricultural land to buffer will generate 90 percent less nutrients based on data presented in Haith et al. (1992).

9.4.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to the DO impaired stream segments in the Lower Kaskaskia River watershed. Crop management of nitrogen and phosphorus originating in the agricultural portions of the watershed can be accomplished through Nutrient Management Plans, which focus on increasing the efficiency with which applied nutrients are used by crops, thereby reducing the amount available to be transported to both surface and groundwater. In the past, nutrient management focused on application rates designed to meet crop nitrogen requirements but avoid groundwater quality problems created by excess nitrogen leaching. This results in buildup of soil phosphorus above amounts sufficient for optimal crop yields. Illinois, along with most Midwestern states, demonstrates high soil test phosphorus in greater than 50 percent of soil samples analyzed (Sharpley et al. 1999).

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

- Review of aerial photography and soil maps
- Regular soil testing
- Review of current and/or planned crop rotation practices
- Yield goals and associated nutrient application rates
- Nutrient budgets with planned rates, methods, timing and form of application
- Identification of sensitive areas and restrictions on application when land is snow covered, frozen or saturated

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

9.4.2.5 Reaeration

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

9.4.2.6 Streambank Stabilization

Soil erosion is the process of moving soil particles or sediment by flowing water or wind. Eroding soil transports pollutants, such as oxygen-demanding materials, that can potentially degrade water quality. Following are two available approaches to stabilizing eroding banks that could, in turn, decrease nonpoint source oxygen demanding loads which can increase sediment oxygen demand in the stream:

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

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

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

9.5 Implementation Actions and Management Measures for Atrazine in the Lower Kaskaskia River Watershed

Two stream segments on the Kaskaskia River (O-03 and O-30) and 3 reservoirs in the Lower Kaskaskia River watershed (Coulterville, Sparta NW, and SLM Side Channel Reservoirs) have shown violations of the public water supply standard for atrazine. Atrazine is a common herbicide used on agricultural lands and the main potential sources of atrazine in waterway is from runoff from agricultural land following application, runoff of atrazine-containing soils, and potentially from direct deposition of the herbicide in streams during the application process (overspraying).

The TMDL analysis performed for atrazine in Kaskaskia River segments O-03 and O-30 showed that exceedences were more likely to occur at dry flow conditions (50-90 percent flow exceedence range). SLM Side Channel Reservoir is a small water supply reservoir located immediately adjacent to segment O-20 of the Kaskaskia River which is filled by pumping water directly from the Kaskaskia River. Since the majority of SLM Side Channel Reservoir's water is pulled directly from the Kaskaskia River, implementation actions designed to address impairments for atrazine on the Kaskaskia River will serve to reduce atrazine loadings into this reservoir as well. Implementation actions to reduce atrazine loads to Coulterville and Sparta NW Reservoirs address the same potential sources of atrazine (runoff from agricultural lands and direct deposition during the application process), and are also discussed in the following sections.

9.5.1 Point Sources of Atrazine

9.5.1.1 NPDES Permitted Municipal Point Sources

Although there are a large number of active point sources located within the Lower Kaskaskia River watershed, none of the point sources are reported to discharge atrazine to area streams and are not expected to be a contributing factor to stream impairments due to atrazine. No point source discharges are located in the Coulterville or Sparta NW Reservoirs.

9.5.2 Nonpoint Sources of Atrazine

Several management options have been identified to help reduce atrazine concentrations in the impaired waterways in Illinois including segments of the Lower Kaskaskia River (O-03 and O-30) as well as Coulterville, Sparta NW and SLM Side Channel Reservoirs. These management options focus on the most likely sources of atrazine within the basin: agricultural runoff and erosion of atrazine-containing soils. The alternatives identified include:

- Conservation tillage
- Filter strips
- Improved application practices (BMPs)

Each alternative is discussed briefly in this section.

9.5.2.1 Conservation Tillage

As discussed in Section 9.4.2, pollutant loading from cropland can be controlled through management BMPs, such as conservation tillage. Kaskaskia River segments O-03 and O-30 receive nonpoint source runoff from the approximately 2.6 million acres and 2.9 million acres in each watershed which is under cultivation, respectively. The agricultural lands account for 78 percent of the total watershed area for each segment. Approximately 356 acres (72 percent) of the Coulterville Reservoir is under cultivation and the Sparta NW Reservoir watershed consists of approximately 328 acres of agricultural land, a total of 36 percent of the watershed area. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 67-90 percent of the pesticides from runoff (USEPA 2003). Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2006 Illinois Department of Agriculture's Soil Transect Survey estimates indicate that conventional till currently accounts for the vast majority of tillage practices in the 21 counties containing some portion of the Kaskaskia River watershed. To achieve TMDL load allocations, conservation tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural areas in the reservoirs' watersheds.

9.5.2.2 Filter Strips

Filter strips were discussed in Section 9.2.2.8 for control of manganese loadings and in Section 9.3.2.1 for control of fecal coliform loading in area waterways. Filter strips will have a similar impact in reducing loads of atrazine from overland runoff in the watershed. Therefore the same technique for evaluating available land can be applied to atrazine controls. As described in Section 9.2.2.8, there are approximately 170,909 acres of land within 234 feet of O-30 and its major tributaries. Nearly 42 percent of this area, approximately 71,278 acres, are categorized as agricultural and could potentially be converted into filter strips. Similarly, there are approximately 133,660 acres of land within 234 feet of O-03 and its major tributaries, of which, approximately 55,890 acres or 42 percent is agricultural and could potentially be converted into filter strips with potential to reduce loadings of pollutants such as atrazine from the waterways. There are 72.7 acres of land within 234 feet of Coulterville Reservoir, of which, 38.8 acres are categorized as agricultural. In the Sparta NW Reservoir watershed there are 136.5 acres of land within 234 feet of the lake and its tributaries of which 38.4 acres are categorized as agricultural and could potentially be converted into filter strips.

9.5.2.3 Improved Atrazine use/application practices (BMPs)

In addition to the implementation measures for atrazine control discussed above, measures taken to improve the use and application of atrazine and other pesticides can play a major role in reducing the runoff of these contaminants into area waterways. In a publication titled "*Managing to Minimize Atrazine Runoff*" the Kansas State University Agricultural Experiment Station and Cooperative Extension Service (KSU) provides a list of best management practices (BMPs) that are effective at reducing the amount of atrazine that runs off of agricultural lands and enters waterways (Devlin et. al. 2000). The measures described in this publication include recommendations to:

- Use alternative herbicides, several non-atrazine options are available.
- Incorporate atrazine into the top 2 inches of soil. This will improve weed control and can reduce runoff by 60 to 75 percent compared to surface application.
- Use fall or early spring applications. Runoff can be reduced by 50 percent if atrazine is applied during lower rain periods that occur in the fall and early spring.
- Use post-emergence atrazine premix products. These mixtures contain less atrazine, but may be more expensive to apply.
- Reduce soil-applied atrazine application rates by following the recommended application rate and use alternatives to atrazine when available.
- Apply atrazine in split applications several weeks apart. This can reduce atrazine runoff by up to 25 percent.

- Use integrated pest management strategies. By properly managing a field, weed infestation levels can be managed with non-herbicide alternatives.

- Only apply atrazine in the areas where needed (directly over the row). This can reduce atrazine application rates by 50 to 67 percent compared to a broadcast surface application.

- Follow proper atrazine application rates, mixing, loading, and disposal practices.

9.6 Implementation Actions and Management Measures for Total Phosphorus and Manganese in Coulterville and Sparta NW Reservoirs

As discussed in sections 7 and 8 of this report, a primary cause of manganese exceedences seen in Coulterville and Sparta NW Reservoirs is likely internal loading related to the high concentrations of total phosphorus in the reservoirs. Attainment of the total phosphorus standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. Additional potential sources of manganese in the reservoirs are similar to phosphorus and include overland runoff and sedimentation. The implementation actions discussed in this section focus primarily on reducing phosphorus loads in the reservoirs which will in turn lead to reductions in manganese concentrations in each reservoir.

Phosphorus loads in the Coulterville Reservoir and Sparta NW Reservoir watersheds originate from both external and internal sources. As identified by the 2008 303(d) list, possible sources of total phosphorus in the Coulterville Reservoir and Sparta NW Reservoir watersheds include runoff from surrounding agricultural lands. Internal loading from lake sediments has also been identified as a significant source of phosphorus in Coulterville Reservoir. The phosphorus TMDLs determined that the total allowable load to Coulterville Reservoir is 0.60 lbs/day and the total allowable load to Sparta NW Reservoir is 0.64 lbs/day. For Coulterville Reservoir, approximately 67 percent of the total allowable load was allocated to external sources while the other 33 percent of the allowable load was allocated to internal sources. A total reduction of 94 percent of total phosphorus loads will need to be achieved for Coulterville Reservoir to be in compliance with the water quality standard of 0.05 mg/L. Estimated inflow concentrations of phosphorus exceeded in-lake concentrations at Sparta NW Reservoir, so 100 percent of the total allowable load of phosphorus allocated to external sources for this reservoir. A reduction of 48 percent of total phosphorus loads will need to be achieved for Sparta NW Reservoir to be in compliance with the 0.05 mg/L water quality standard. To achieve a reduction of total phosphorus for Coulterville Reservoir and Sparta NW Reservoir, management measures must address loading through sediment and surface runoff controls. Internal nutrient cycling must also be addressed at Coulterville Reservoir through in-lake management.

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

It is generally more effective to install a combination of BMPs or a BMP system. A BMP system is a combination of two or more individual BMPs that are used to control a pollutant from the same critical source. In other words, if the watershed has more than one identified pollutant, but the transport mechanism is the same, then a BMP system that establishes controls for the transport mechanism can be employed. (Osmond et al.1995). The remainder of this section will discuss implementation actions and management measures for phosphorus sources in the watershed.

9.6.1 Municipal/Industrial Point Sources of Phosphorus

There are no municipal or industrial point sources permitted to discharge within the Coulterville Reservoir or Sparta NW Reservoir watersheds.

9.6.2 Stormwater Sources of Phosphorus

No municipal stormwater permits list waters within the Coulterville Reservoir or Sparta NW Reservoir watersheds as receiving waters. Approximately 9 acres (2 percent) of the land within the Coulterville Reservoir watershed are urbanized and consist of low, medium, and high density residential land uses which may contribute to stormwater runoff entering the lake. The Sparta NW Reservoir watershed is considerably more developed than Coulterville reservoir's watershed with approximately 87 acres of land in the watershed consists of low and medium density residential land use. An additional 14.4 acres of high density land use and 330.9 acres of urban open space are also found within the Sparta NW Reservoir watershed. Runoff from the residential developments within this watershed likely contributes to stormwater loading. Section 9.6.3 discusses management measures that can be implemented within the watersheds for treating phosphorus in overland runoff.

9.6.3 Nonpoint Sources of Phosphorus

In addition to urban stormwater, runoff from agricultural land is a potential nonpoint source of phosphorus pollution in the Coulterville and Sparta NW watersheds and was identified as such in the 2008 Integrated Report. BMPs evaluated that could be utilized to treat these nonpoint sources are:

- Conservative tillage
- Filter strips
- Riparian Buffers
- Wetlands
- Nutrient management
- In-lake management measures

9.6.3.1 Conservation Tillage Practices

As discussed in section 9.4.2, total phosphorus loading from cropland can be controlled through management BMPs, such as conservation tillage. Coulterville Reservoir potentially receives nonpoint source runoff from the approximately 356 acres in the watershed which is under cultivation, which accounts for 72 percent of the total watershed area. Sparta NW Reservoir watershed consists of approximately 328 acres of agricultural land, a total of 36 percent of the watershed area. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003). The 2006 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 81 percent of corn, 21 percent of soybean, and 17 percent of small grain tillage practices in Randolph County, where both Coulterville and Sparta NW Reservoirs are located. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural areas in the reservoirs' watersheds.

9.6.3.2 Filter Strips

Filter strips were discussed in Section 9.2.2.8. The same technique for evaluating available land was applied to the Coulterville and Sparta NW Reservoir watersheds. In the Coulterville Reservoir watershed there are 72.7 acres of land within 234 feet of the lake. Of this area, 38.8 acres are categorized as agricultural and could potentially be converted into filter strips. In the Sparta NW Reservoir watershed there are 136.5 acres of land within 234 feet of the lake and its tributaries of which 38.4 acres are categorized as agricultural and could potentially be converted into filter strips.

9.6.3.3 Riparian Buffers

Riparian corridors were discussed in Section 9.5.2.3 as an implementation action for mitigating DO issues in streams in the Lower Kaskaskia River watershed. For many of the same reasons discussed in Section 9.5.2.3, riparian buffers could also be beneficial in reducing total phosphorus loads to Coulterville and Sparta NW Reservoirs. Converting land adjacent to the reservoirs and their tributaries for the creation of riparian buffers will provide stream bank stabilization and nutrient uptake and trapping from adjacent areas. Minimum buffer widths of 25 feet are required for water quality benefits. Higher removal rates are provided with greater buffer widths. NCSU (2002) reports phosphorus removal rates of approximately 25 to 30 percent for 30 ft wide buffers and 70 to 80 percent for 60 to 90 ft wide buffers. Using GIS, land use data were clipped to 25 feet buffer zones created around the reservoirs and their major tributaries. There are approximately 9.8 acres within 25 feet of the Coulterville Reservoir and 15.5 acres within 25 feet of Sparta NW Reservoir and its tributaries. Approximately 1.7 of these acres in the Coulterville Reservoir watershed and 4.5 acres in the Sparta NW Reservoir watershed are existing grassland or forest while 1.6 and

1.0 acres, respectively, are currently classified as agricultural. Riparian corridors typically treat a maximum of 300 ft of adjacent land before runoff forms small channels that short circuit treatment. In addition to the treated area, any land converted from agricultural land to buffer will generate 90 percent less nutrients based on data presented in Haith et al. (1992).

9.6.3.4 Wetlands

The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Coulterville and Sparta NW Reservoirs watersheds. To treat loads from agricultural runoff, a wetland could potentially be constructed on the upstream ends of each reservoir. Wetlands are an effective BMP for phosphorus control because they:

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

A properly designed and functioning wetland can provide very efficient treatment of pollutants such as phosphorus. Design of wetland systems is very important and should consider soils in the proposed location, hydraulic retention time, and space requirements. Constructed wetlands, which comprise the second or third stage of nonpoint source treatment, can be effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates for suspended solids of greater than 90 percent, 0 to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to75 percent for nitrogen species (Johnson, Evans, and Bass 1996; Moore 1993; USEPA 1993; Kovosic et al. 2000). Although the removal rate for phosphorus is low in long-term studies, the rate can be improved if sheet flow is maintained to the wetland and vegetation and substrate are monitored to ensure the wetland is operation optimally. Sediment or vegetation removal may be necessary if the wetland removal efficiency is lessened over time (USEPA 1993; NCSU 2000). Guidelines for wetland design suggest a wetland to watershed ratio of 0.6 percent for nutrient and sediment removal from agricultural runoff. Table 9-5 outlines estimated wetland areas for each agricultural subbasin in Coulterville and Sparta NW Reservoirs watersheds based on these recommendations. The full wetland system to treat agricultural runoff from the subbasins would be relatively small at approximately

Table 9-5 Acres of wetland for the Coulterville and Sparta NW Reservoirs watersheds

Reservoir	Subbasin	Watershed Area (acres)	Recommended Wetlands (acres)
Coulterville Reservoir	ROV-1	59	0.4
	ROV-2	271	1.6
	ROV-3	161	1.0
	Total	**491**	**2.9**
Sparta NW Reservoir	SOC-1	234	1.4
	SOC-2	383	2.3
	SOC-3	301	1.8
	Total	**918**	**5.5**

2.9 acres for Coulterville Reservoir and 5.5 acres for Sparta NW Reservoir (Denison and Tilton 1993).

9.6.3.5 Nutrient Management

As discussed in Section 9.5.2.4, nutrient management can result in reduced nutrient loads to waterbodies, including Coulterville and Sparta NW Reservoirs. Reducing phosphorus loss in agricultural runoff may be brought about by source and transport control measures, such as filter strips or grassed waterways. Implementing Nutrient Management Plans for the Coulterville and Sparta NW Reservoirs watersheds could help to reduce phosphorus loads to the reservoirs. In Illinois, Nutrient Management Plans have successfully reduced phosphorus application to agricultural lands by up to 36-lb/acre. National reductions range from 11 to 106-lb/acre, with an average reduction of 35-lb/acre (USEPA 2003).

9.6.4 In-Lake Phosphorus

The Coulterville Reservoir phosphorus TMDL allocated approximately 66 percent of the total allowable phosphorus load to internal cycling. Reduction of phosphorus from in-lake cycling through management strategies is necessary for attainment of the TMDL load allocation. Internal phosphorus loading can occur when the water above the sediments become anoxic causing the release of phosphorus from the sediment in a form which is available for plant uptake. The addition of bioavailable phosphorus in the water column stimulates more plant growth and die-off, which may perpetuate or create anoxic conditions and enhance the subsequent release of phosphorus into the water. Internal phosphorus loading can also occur in shallow lakes through release from sediments by the physical mixing and reintroduction of sediments into the water column as a result of wave action, winds, boating activity, and other means. Internal cycling was not determined by BATHTUB modeling to be a significant source of phosphorus in Sparta NW Reservoir.

For lakes experiencing high rates of phosphorus inputs from bottom sediments, several management measures are available to control internal loading. Three BMP options for the control of internal loading include the installation of an aerator, the addition of aluminum, and dredging. Hypolimnetic (bottom water) aeration involves an aerator air-release that can be positioned at a selected depth or at multiple depths to increase oxygen transfer efficiencies in the water column and reduce internal loading by establishing aerobic conditions at the sediment-water interface. This option may be viable for parts of Coulterville Reservoir if it is determined that fully anoxic conditions do occur periodically in the hypolimnion.

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

Phosphorus release from the sediment is greatest from recently deposited layers. Dredging about one meter of recently deposited phosphorus–rich sediment can remove approximately 80 to 90 percent of the internally loaded phosphorus without the addition of potentially toxic compounds to the reservoir. Dredging may also contribute to reductions in internal phosphorus loading by increasing the depth of large portions of the waterbody, reducing the degree of reintroduction of sediments into the water column through physical mixing. However, dredging is more costly than other management options (NRCS 1992).

9.7 Implementation Actions and Management Measures for Manganese in SLM Side Channel Reservoir

As previously discussed, SLM Side Channel Reservoir is a small (7 acre) reservoir constructed for use by the SLM Water Treatment facility. The reservoir has little natural drainage area and receives a vast majority of its volume through pumping of water directly from Kaskaskia River segment O-20. Kaskaskia River segment O-20 is also listed as a public drinking water supply which is impaired for manganese. Implementation actions designed to reduce loadings of manganese to segment O-20 are discussed in Section 9.2 of this report and include point source controls, filters strips, sediment control basins, and streambank stabilization/erosion control. Due to the strong interconnectivity of SLM Side Channel Reservoir and Kaskaskia River segment O-20, it is expected that the implementation actions discussed in Section 9.2 would be fully applicable to SLM Side Channel Reservoir and the implementation actions discussed would lead to a reduction in manganese loading to the reservoir.

9.8 Reasonable Assurance

Reasonable assurance means that a demonstration is given that nonpoint source reductions in this watershed will be implemented. It should be noted that all programs discussed in this section are voluntary and some may currently be in practice in the watershed. The discussion in Sections 9.2 through 9.8 provided information on available BMPs for reducing pollutant loads from point and nonpoint sources. The remainder of this section discusses an estimate of costs to the watershed for implementing nonpoint source management practices and programs available to assist with funding.

9.8.1 Available Programs for Nonpoint Source Management

There are several voluntary conservation programs established through the 2008 U.S. Farm Bill, which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

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

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

9.8.1.2 Conservation Reserve Program

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

Eligible land must be one of the following:

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

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

In addition to the eligible land requirements, cropland must meet one of the following criteria:

- Have a weighted average erosion index of 8 or higher;
- Be expiring CRP acreage; or
- Be located in a national or state CRP conservation priority area.

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

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

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

The current extent of land enrolled in CRP within the Lower Kaskaskia River watershed is unknown.

9.8.1.3 Clean Water Act Section 319 Grants

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

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

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

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

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

9.8.1.4 Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to restore, enhance, and protect wetlands. The goal of WRP is to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program. This program offers landowners an opportunity to establish long-term conservation and wildlife practices and protection.

The program offers three enrollment options:

1. *Permanent Easement* is a conservation easement in perpetuity. USDA pays 100 percent of the easement value and up to 100 percent of the restoration costs.

2. *30-Year Easement* is an easement that expires after 30 years. USDA pays up to 75 percent of the easement value and up to 75 percent of the restoration costs. For both permanent and 30-year easements, USDA pays all costs associated with recording the easement in the local land records office, including recording fees, charges for abstracts, survey and appraisal fees, and title insurance.

3. *Restoration Cost-Share Agreement* is an agreement to restore or enhance the wetland functions and values without placing an easement on the enrolled acres. USDA pays up to 75 percent of the restoration costs.

The total number of acres that can be enrolled in the program is 3,041,200 – an increase of 766,200 additional acres over the previous Farm Bill.

- Payments for easements valued at $500,000 or more will be made in at least five annual payments.

- For restoration cost-share agreements, annual payments may not exceed $50,000 per year.

- No easement shall be created on land that has changed ownership during the preceding 7 years.

- Eligible acres are limited to private and Tribal lands.

9.8.1.5 Environmental Quality Incentive Program

The Environmental Quality Incentive Program (EQIP) is a voluntary USDA conservation program for farmers and private landowners engaged in livestock or agricultural production who are faced with serious threats to soil, water, and related natural resources. Through EQIP, the NRCS develops contracts with agricultural producers to implement conservation practices to address environmental natural resource problems. Payments are made to producers once conservation practices are completed according to NRCS requirements.

Persons engaged in livestock or agricultural production and owners of non-industrial private forestland are eligible for the program. Eligible land includes cropland, rangeland, pastureland, private non-industrial forestland, and other farm or ranch lands. Persons interested in entering into a cost-share agreement with the USDA for EQIP assistance may file an application at any time.

NRCS works with the participant to develop the EQIP plan of operations. This plan becomes the basis of the EQIP contract between NRCS and the participant. NRCS provides conservation practice payments to landowners under these contracts that can be up to 10 years in duration.

The EQIP objective to optimize environmental benefits is achieved through a process that begins with National priorities that address: impaired water quality, conservation of ground and surface water resources improvement of air quality reduction of soil erosion and sedimentation, and improvement or creation of wildlife habitat for at-risk species. National priorities include: reductions of nonpoint source pollution, such as nutrients, sediment, pesticides, or excess salinity in impaired watersheds consistent with TMDLs where available as well as the reduction of groundwater contamination and reduction of point sources such as contamination from confined animal feeding operations; conservation of ground and surface water resources; reduction of emissions, such as particulate matter, nitrogen oxides (NOx), volatile organic compounds, and ozone precursors and depleters that contribute to air quality impairment violations of National Ambient Air Quality Standards reduction in soil erosion and sedimentation from unacceptable levels on agricultural land; and promotion of at-risk species habitat conservation.

EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. The overall payment limitation is $300,000 per person or legal entity over a 6-year period. The Secretary of Agriculture may raise the limitation to $450,000 for projects of special environmental significance. Payment limitations for organic production may not exceed an aggregate $20,000 per year or $80,000 during any 6-year period for installing conservation practices.

Conservation practices eligible for EQIP funding which are recommended BMPs for this watershed TMDL include field borders, filter strips, cover crops, grade stabilization structures, grass waterways, riparian buffers, streambank shoreline protection, terraces, and wetland restoration.

The selection of eligible conservation practices and the development of a ranking process to evaluate applications are the final steps in the optimization process. Applications will be ranked based on a number of factors, including the environmental benefits and cost effectiveness of the proposal. More information regarding State and local EQIP implementation can be found at www.nrcs.usda.gov/programs/eqip.

9.8.1.6 Wildlife Habitat Incentives Program

The Wildlife Habitat Incentive Plan (WHIP) is a voluntary program administered by NRCS which is designed to assist those who want to develop and improve wildlife habitat primarily on private lands and nonindustrial private forest land. It provides both technical assistance and cost share payments to help:

- Promote the restoration of declining or important native fish and wildlife species.
- Protect, restore, develop, or enhance fish and wildlife habitat to benefit at-risk species.
- Reduce the impacts of invasive species in fish and wildlife habitat.
- Protect, restore, develop, or enhance declining or impaired aquatic wildlife species habitat.

Participants who own or control land agree to prepare and implement a wildlife habitat development plan. The NRCS provides technical and financial assistance for the establishment of wildlife habitat development practices. In addition, if the landowner agrees, cooperating State wildlife agencies and nonprofit or private organizations may provide expertise or additional funding to help complete a project.

Participants work with the NRCS to prepare a wildlife habitat development plan in consultation with the local conservation district. The plan describes the participant's goals for improving wildlife habitat, includes a list of practices and a schedule for installing them, and details the steps necessary to maintain the habitat for the life of the agreement. This plan may or may not be part of a larger conservation plan that addresses other resource needs such as water quality and soil erosion.

The NRCS and the participant enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts from 5 to 10 years from the date the agreement is signed for general applications and up to 15 years for essential habitat applications. Cost-share payments may be used to establish new practices or replace practices that fail for reasons beyond the participant's control.

WHIP has a continuous sign-up process. Applicants can sign up anytime of the year at their local NRCS field office. Conservation practices eligible for WHIP funding which are recommended BMPs for this watershed TMDL include but are not limited to filter strips, field borders, riparian buffers, streambank and shoreline protection, and wetland restoration.

9.8.1.7 Illinois Conservation and Climate Initiative

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

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

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

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

9.8.1.8 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information for counties containing some portion of the Kaskaskia River Watershed are listed in the Table 9-6 below.

Table 9-6 Local NRCS and FSA Contact Information

County	Contact	Address	Phone
Local SWCD Office			
Bond County	Emily Hartmann	111 East Harris Avenue Greenville, IL 62246	(618) 664-0555 ext. 3
Champaign County	Renee Weitekamp	2110 W. Park Ct., Suite C Champaign, IL 61821	(217) 352-3536 ext. 3
Christian County	Sue M. Davis	951-2 West Spresser Street Taylorville, IL 62568	(217) 287-1315 ext. 3
Clinton County	Jill Brammeier	1780 North 4th Street Breese, IL 62230	(618) 526-7919 ext. 3
Coles County	Andrew Cerve	6021 Development Dr., Ste 2 Charleston, IL 61920	(217) 345-3901 ext. 3
Douglas County	Cynthia Stevens	900 S. Washington, Box 2D Tuscola, IL 61953	(217) 253-2022 ext. 3
Effingham County	Denise Willenbor	2701 S. Banker, Ste. 101A Effingham, IL 62401	(217) 347-7107 ext. 3

Table 9-6 Local NRCS and FSA Contact Information (cont.)

County	Contact	Address	Phone
Fayette County	Karen Sander	301 South Third Street Vandalia, IL 62471	(618) 283-1095 ext. 3
Jefferson County	Robert Hood	221 Withers Drive Mt. Vernon, IL 62864	(618) 244-0773 ext. 3
Macon County	Linda Good	4004 College Park Rd. Decatur, IL 62521	(217) 877-5670 ext. 3
Macoupin County	Rhonda Koehne	300 Carlinville Plaza Carlinville, IL 62626	(217) 854-2628 ext. 3
Madison County	Norma Kuethe	7205 Marine Road Edwardsville, IL 62025	(618) 656-7300
Marion County	Debbie Holsappl	1150 East Main Salem, IL 62881	(618) 548-2230 ext. 3
Monroe County	Cindy Zipfel	140 Williamsburg Lane Waterloo, IL 62298	(618) 939-6181 ext. 3
Montgomery County	Melissa Cauble	1621 Vandalia Rd., Ste. D Hillsboro, IL 62049	(217) 532-3610 ext. 3
Moultrie County	Tammy Clayton	1412 South Hamilton Sullivan, IL 61951	(217) 728-7921 ext. 3
Perry County	Jeannie Millikin	617 N. Main Street Pinckneyville, IL 62274	(618) 357-6016 ext. 3
Piatt County	Phyllis A. Muse	1201A Bear Kane Monticello, IL 61856	(217) 762-2146 ext. 3
Randolph County	Cheryl Houghlan	313 W. Belmont Street Sparta, IL 62286	(618) 443-4381 ext. 3
Shelby County	Vicky Wagner	111 N. Cedar, Suite 3 Shelbyville, IL 62565	(217) 774-5564 ext. 3
St. Clair County	Bonita Rubach	2031 Mascoutah Avenue Belleville, IL 62220	(618) 233-5383
Washington County	Shelly Harre	424 East Holzhauer Drive Nashville, IL 62263	(618) 327-3078 ext. 101
Local FSA Office			
Bond County	Amanda Grundy	111 East Harris Avenue Greenville, IL 62246	(618) 664-3590 ext. 2
Champaign County	Yvonne Odom	2110 W. Park Ct., Suite C Champaign, IL 61821	(217) 352-3536 ext. 2
Christian County	Dustin Cruit	951-2 West Spresser Street Taylorville, IL 62568	(217) 824-2123 ext. 2
Clinton County	Mike Eggerman	1780 North 4th Street Breese, IL 62230	(618) 526-7919 ext. 2
Coles County	Bret Bierman	6021 Development Dr., Ste 2 Charleston, IL 61920	(217) 345-3901 ext. 2
Douglas County	Steve Niemann	900 S. Washington, Box 2D Tuscola, IL 61953	(217) 253-3340 ext. 2
Effingham County	Randy Tillman	2701 S. Banker, Ste. 101A Effingham, IL 62401	(217) 347-7107 ext. 2
Fayette County	Caryl Hickerson	301 South Third Street Vandalia, IL 62471	(618) 283-2311 ext. 2
Jefferson County	Sandy Frick	221 Withers Drive Mt. Vernon, IL 62864	(618) 244-0773 ext. 2
Macon County	Larry DeSutter	4004 College Park Rd. Decatur, IL 62521	(217) 877-5670 ext. 2
Macoupin County	John Nolan	300 Carlinville Plaza Carlinville, IL 62626	(217) 854-2626 ext. 2
Madison County	Brad Grotefendt	7205 Marine Road Edwardsville, IL 62025	(618) 656-4710 ext. 2
Marion County	Daryl Hargrave	1150 East Main Salem, IL 62881	(618) 548-2230 ext. 2
Monroe County	Linda Mathew	140 Williamsburg Lane Waterloo, IL 62298	(618) 939-6181 ext. 2

Table 9-6 Local NRCS and FSA Contact Information (cont.)

County	Contact	Address	Phone
Montgomery County	Dan Puccetti	1621 Vandalia Rd., Ste. D Hillsboro, IL 62049	(217) 532-3361 ext. 2
Moultrie County	Phil Short	1412 South Hamilton Sullivan, IL 61951	(217) 728-8813 ext. 2
Perry County	Jess Cushman	617 N. Main Street Pinckneyville, IL 62274	(618) 357-6016 ext. 2
Piatt County	Tim M. Berry	1201A Bear Kane Monticello, IL 61856	(217) 762-2571 ext. 2
Randolph County	Jess Cushman	313 W. Belmont Street Sparta, IL 62286	(618) 443-4381 ext. 2
Shelby County	Roger West	111 N. Cedar, Suite 3 Shelbyville, IL 62565	(217) 774-5561 ext. 2
St. Clair County	Barb Burns	2031 Mascoutah Avenue Belleville, IL 62220	(618) 235-2500 ext. 2
Washington County	Kim Taylor	424 East Holzhauer Drive Nashville, IL 62263	(618) 327-8862 ext. 2
Local NRCS Office			
Bond County	Justin E. King	111 East Harris Avenue Greenville, IL 62246	(618) 664-0555 ext. 3
Champaign County	Kevin W. Donoho	2110 W. Park Ct., Suite C Champaign, IL 61821	(217) 352-3536 ext. 3
Christian County	Anthony Hammond	951-2 West Spresser Street Taylorville, IL 62568	(217) 824-2123 ext. 3
Clinton County	Howard E. Zenner	1780 North 4th Street Breese, IL 62230	(618) 526-7919 ext. 3
Coles County	Laura Smithenry	6021 Development Dr., Ste 2 Charleston, IL 61920	(217) 345-3901 ext. 3
Douglas County	Ben Mingo	900 S. Washington, Box 2D Tuscola, IL 61953	(217) 253-2022 ext. 3
Effingham County	Bart Pals	2701 S. Banker, Ste. 101A Effingham, IL 62401	(217) 347-7107 ext. 3
Fayette County	MaryAnn Hoeffliger	301 South Third Street Vandalia, IL 62471	(618) 224-0773 ext. 3
Jefferson County	Art J. Friederich	221 Withers Drive Mt. Vernon, IL 62864	(618) 283-1095 ext. 3
Macon County	Annette Holmes	4004 College Park Rd. Decatur, IL 62521	(217) 877-5670 ext. 3
Macoupin County	Jeremy Jackman	300 Carlinville Plaza Carlinville, IL 62626	(217) 854-2626 ext. 3
Madison County	Denny Steinmann	7205 Marine Road Edwardsville, IL 62025	(618) 656-4710 ext. 3
Marion County	D. Anthony Antonacci	1150 East Main Salem, IL 62881	(618) 548-2230 ext. 3
Monroe County	Wayne W. Johanning	140 Williamsburg Lane Waterloo, IL 62298	(618) 939-6181 ext. 3
Montgomery County	C.J. Liddell	1621 Vandalia Rd., Ste. D Hillsboro, IL 62049	(217) 532-3610 ext. 3
Moultrie County	Annette Holmes	1412 South Hamilton Sullivan, IL 61951	(217) 728-8813 ext. 3
Perry County	Robert L. Spencer	617 N. Main Street Pinckneyville, IL 62274	(618) 357-6016 ext. 3
Piatt County	Michelle Lewis	1201A Bear Kane Monticello, IL 61856	(217) 762-2571 ext. 3
Randolph County	Andrew W. Schlichting	313 W. Belmont Street Sparta, IL 62286	(618) 443-4382 ext. 3
Shelby County	*To Be Filled*	111 N. Cedar, Suite 3 Shelbyville, IL 62565	(217) 774-5564 ext. 3

Table 9-6 Local NRCS and FSA Contact Information (cont.)

County	Contact	Address	Phone
St. Clair County	John F. Harryman	2031 Mascoutah Avenue Belleville, IL 62220	(618) 235-2500 ext. 3
Washington County	Gary Gaubatz	424 East Holzhauer Drive Nashville, IL 62263	(618) 327-8862 ext. 3

9.8.2 Cost Estimates of BMPs

Cost estimates for different BMPs and individual practice prices such as filter strip installation are detailed in the following sections. Finally, an estimate of the total order of magnitude costs for implementation measures in the Lower Kaskaskia River watershed are presented in Section 9.9.2.6 and Table 9-7.

9.8.2.1 Filter Strips and Riparian Buffers

The Illinois EQIP document used for wetland pricing also provides filter strip and riparian buffer cost estimates. Filter strip implementation that includes seedbed preparation and native seed was estimated at $88/acre while riparian buffers ranged from $130/acre for herbaceous cover up to $800/acre for forested buffers

9.8.2.2 Nutrient Management Plan – NRCS

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

9.8.2.3 Nutrient Management Plan – IDA and Illinois EPA

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

9.8.2.4 Conservation Tillage

Conservation tillage is assumed to include tillage practices that preserve at least 30 percent residue cover of the soil after crops are planted. Costs associated with converting to conservation tillage will depend on the degree of conservation tillage practices implemented. The University of Iowa has estimated a cost for conversion to no-till practices. The study acknowledged that some equipment conversion is needed, but converting to no-till only means (for most producers) the addition of heavier down-pressure springs, row cleaners, and possibly a coulter on each planter row unit. The cost of converting existing equipment ranges between $300 and $400 per planter row, which for many producers, amounts to a nominal additional production cost of approximately $1 or $2 per acre per year (Al-Kaisi 2002).

9.8.2.5 Wetlands

The price to establish a wetland is very site specific. There are many different costs that could be incurred depending on wetland construction. Examples of costs associated with constructed wetlands include excavation costs. EQIP program cost documentation for Illinois published in 2009 estimates $1,700/acre for wetland excavation, earthwork, and native seeding. More information can be found at: ftp://ftp-fc.sc.egov.usda.gov/IL/farmbill/EQIPpaymnt_schdl_Tradtnl_0509.pdf

9.8.2.6 Septic System Maintenance

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

The cost to pump a septic tank ranges from $250 to $350 depending on how many gallons are pumped out and the disposal fee for the area. If a system is pumped once every three to five years, this expense averages out to less than $100 per year.

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

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

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

9.8.2.7 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 9-7. The column labeled "Program" or "Sponsor" lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the Wetlands Reserve Program (WRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), Conservation Cost-Share Program (CPP), Illinois EPA, and Illinois Department of Agriculture (IDA). It should be noted that IEPA 319 Grants are applicable to all of these practices.

Table 9-7 Cost Estimate of Various BMP Measures

Source	Program	Sponsor	BMP	Installation Mean $
Nonpoint	CRP	NRCS and IDA	Filter strip (seeded)	$88/acre
	CRP	NRCS and IDA	Riparian Buffer	$130-$800/acre
	EQIP	NRCS	Livestock Fencing – Woven Wire	$1.55/ft
			Livestock Fencing – Barbed Wire	$1.22/ft
	WRP	NRCS	Wetland	$1,700/acre
		NRCS	Nutrient Management Plan	$6-18/acre
		IDA and Illinois EPA	Nutrient Management Plan	$13/acre
	SSRP	IDA	Bank Stabilization	$25/ft
			Rock Riffle Grade Control	$7,500/riffle
	CRP	NRCS and IDA	Conservation Tillage	varies

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

9.9 Monitoring Plan

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

- Track implementation of management measures in the watershed
- Estimate effectiveness of management measures
- Further monitoring of point source discharges in the watershed
- Continued monitoring of impaired stream segments
- Storm-based monitoring of high flow events
- Low flow monitoring of dissolved oxygen in impaired streams
- Livestock survey within watershed to assess livestock access to stream channels
- Tributary monitoring

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

- Determine the extent to which management measures and practices have been implemented compared to action needed to meet TMDL endpoints

- Establish a baseline from which decisions can be made regarding the need for additional incentives for implementation efforts

- Measure the extent of voluntary implementation efforts

- Support work-load and costing analysis for assistance or regulatory programs

- Determine the extent to which management measures are properly maintained and operated

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed. Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency.

IEPA conducts Intensive Basin Surveys every 5 years. Additionally, ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

9.10 Implementation Time Line

Implementing the actions outlined in this section for the Lower Kaskaskia River watershed should occur in phases and assess effectiveness of the management actions as improvements are made. It is assumed that it may take up to 5 years to secure funding for actions needed in the watershed and five to seven years after funding to implement the measures. Once improvements are implemented, it may take 10 years or more for impaired waters to reach water quality standard targets. In summary, it may take up to 20 years for the impaired waterbodies to meet the applicable water quality standards.

Section 10
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