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Section 1
Methodology Development for the Cahokia Creek/Holiday Shores Lake Watershed

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

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

1.1.1 QUAL2K Overview
The QUAL2K model was used to develop the dissolved oxygen TMDL for segment JQ07 of the Cahokia Diversion Canal. QUAL2K is a stream water quality model that is one-dimensional and applicable to well-mixed streams. The model assumes steady state hydraulics and allows for point source inputs, diffuse loading and tributary flows. Historic water quality data, observed hydraulic information, and point source discharge data were coupled with model defaults to predict the external oxygen-demanding load to the system.

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

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

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

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

1.2 Methodology Development

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

1.2.1 QUAL2K Model

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

### 1.2.1.1 QUAL2K Inputs

Table 1-2 contains the categories of data required for the Q2K model along with the sources of data used to analyze segment JQ07 of the Cahokia Diversion Canal.

<table>
<thead>
<tr>
<th>Input Category</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream Segmentation</td>
<td>GIS data</td>
</tr>
<tr>
<td>Hydraulic characteristics</td>
<td>CDM field survey and GIS analysis</td>
</tr>
<tr>
<td>Headwater conditions</td>
<td>Historic water quality data collected at JQ05</td>
</tr>
<tr>
<td>Meteorologic conditions</td>
<td>National Climatic Data Center</td>
</tr>
<tr>
<td>Point Source contributions</td>
<td>Illinois EPA</td>
</tr>
</tbody>
</table>

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

#### 1.2.1.1.1 Stream Segmentation

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

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

#### 1.2.1.1.2 Hydraulic Characteristics

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

#### 1.2.1.1.3 Headwater Conditions

The headwater flow and concentrations are user-specified in the model and represent the system's upstream boundary condition. Measured concentration data were available from sampling location JQ05 (Cahokia Canal segment JQ05), which is located just upstream of the impaired segment of the Cahokia Diversion Canal. There have been
44 DO samples collected at station JQ05 since 1999. Of the 44 samples collected, seven resulted in DO concentrations less than 5 mg/L. The majority of violating samples were collected between the months of July through October. These months are associated with low flows in the stream. Because of this, only water quality data collected in the months of July, August, September, and October were used for this model.

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

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

1.2.1.5 Point Sources
A number of point sources discharge within the Cahokia Creek/Holiday Shores Lake watershed, however, the majority of the point sources are located significantly upstream of the Cahokia Diversion Canal. Three point sources (the Explorer Pipeline - Wood River, Conoco Inc – Wood River, and the Village of Roxana STP) discharge to the furthest downstream reach of the segment (see Figure 1-1). Q2K allows user input of point source locations, flow and water quality data. Permit records were reviewed and permitted discharge limit data were used for model input. Table 1-3 contains information for each facility. Flow information was available for each discharger; however, effluent concentration data are available only for parameters that are sampled per permit requirements.

Table 1-3 Point Source Discharges within the Cahokia Diversion Canal Watershed

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Permit Number</th>
<th>Segment Number</th>
<th>Permitted Facility Flows (mgd)</th>
<th>Permitted DO (mg/L)</th>
<th>Permitted CBOD (mg/L)</th>
<th>Permitted Ammonia (mg/L)</th>
</tr>
</thead>
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<td>Explorer Pipeline – Wood River</td>
<td>IL0061522</td>
<td>3</td>
<td>0.14</td>
<td>&gt;6</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Conoco Inc – Wood River</td>
<td>IL0071803</td>
<td>3</td>
<td>0.006</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wheel Ranch MHP</td>
<td>IL0044598</td>
<td>3</td>
<td>0.65</td>
<td>&gt;6</td>
<td>10</td>
<td>6.9</td>
</tr>
</tbody>
</table>

1.2.1.2 QUAL2K Calibration
The QUAL2K model for the Cahokia Diversion Canal was set up and run as discussed in the preceding sections. Data collected during Stage 2 at sample locations JQ07 and JQ01 were used for model calibration. Initially, "truth checking" was performed on key model calculated parameters, such as reaeration rates, SOD fluxes, temperature, and phytoplankton concentrations using literature values and best professional judgment. SOD rates and CBOD decay rates were then adjusted until the predicted DO concentrations closely matched the observed data at both sites. Figure 1-2 shows the calibration outcome. Appendix B contains the model input/output worksheets.
1.2.2 Load Duration Curve Development

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

1.2.2.1 Flow Data

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

1.2.2.2 Fecal Coliform Analysis for Cahokia Creek Segment JQ05

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

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

1.2.3 BATHTUB Development for Holiday Shores Lake

Holiday Shores Lake was listed on the 2004 303(d) for impairment caused by total phosphorus and manganese. For this TMDL, manganese will not be analyzed because it is assumed that development of the phosphorus TMDL will control the manganese concentrations. The manganese target is maintenance of hypolimnetic DO concentrations above zero, because the only controllable source of manganese to the lake is the release of manganese from lake sediments during periods when there is no DO in lake bottom waters. The lack of DO in lake bottom waters is presumed to be due to the effects of nutrient enrichment, as there are no significant sources of oxygen demanding materials to the lake. For this reason, attainment of the total phosphorus
standard is expected to result in oxygen concentrations that will reduce sediment manganese flux to natural background levels. The TMDL target for manganese is therefore set as a total phosphorus concentration of 0.05 mg-P/L. The BATHUB model was used to determine the total phosphorus TMDL.

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

1.2.3.1 Global Inputs
Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in the Stage 1 report (Appendix A), the average annual precipitation input to the model was 40.08 inches, and the average annual evaporation input to the model was 35.3 inches. The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km2-yr (USACE 1999b).

1.2.3.2 Reservoir Segment Inputs
Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Holiday Shores Lake is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 1-4. Segmentation was established based on available water quality and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the averaged data from the water quality stations discussed in the Stage 1 report. These data are shown below (Table 1-4) for reference. Segment lengths and surface areas were determined in GIS. A single layer model was utilized for the analyses performed here. The depth to the metalimnion was assumed to be the average depth of the lake.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</table>

1.2.3.3 Tributary Inputs
Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. See
Figure 1-4 for subbasin boundaries. The watershed was broken up into six tributaries for purposes of the model. There are three tributary streams that flow into the Holiday Shores Lake and three areas of direct overland flow (one for each lake segment). Joulters Creek and an unnamed tributary northwest of the lake flow into segment RJN-3, while another unnamed tributary, also to the northwest, flows into segment RJN-2. In addition, the Holiday Shores Sanitary District pumps an average of 188,000 gallons per day from the middle lake segment (Illinois EPA, SWAP Fact Sheet, 2003).

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

\[
Q_{\text{ungaged}} = Q_{\text{gaged}} \left( \frac{\text{Area}_{\text{ungaged}}}{\text{Area}_{\text{gaged}}} \right)
\]

where

- \(Q_{\text{gaged}}\) = Streamflow of the gaged basin
- \(Q_{\text{ungaged}}\) = Streamflow of the ungaged basin
- \(\text{Area}_{\text{gaged}}\) = Area of the gaged basin
- \(\text{Area}_{\text{ungaged}}\) = Area of the ungaged basin

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

USGS gage 05587900 (Cahokia Creek at Edwardsville, Illinois) was chosen as an appropriate gage from which to estimate flows into Holiday Shores Lake. The gage drains an area of 141 square miles. The Holiday Shores Lake watershed encompasses 5 square miles.

The total mean flow into Holiday Shores Lake was determined to be 5.92 cfs. The flow contribution from each tributary was estimated by multiplying the total mean annual inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 1-5.

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


### Table 1-5 Holiday Shores Lake Tributary Subbasin Areas and Estimated Flows

<table>
<thead>
<tr>
<th>Tributary Name</th>
<th>Lake Segment</th>
<th>Area (ac)</th>
<th>Flow Rate (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Flow to RJN-1</td>
<td>Segment 1: RJN-3</td>
<td>350.3</td>
<td>0.57</td>
</tr>
<tr>
<td>Direct Flow to RJN-2</td>
<td>Segment 2: RJN-2</td>
<td>652.4</td>
<td>1.07</td>
</tr>
<tr>
<td>Direct Flow to RJN-3</td>
<td>Segment 3: RJN-1</td>
<td>225.0</td>
<td>0.37</td>
</tr>
<tr>
<td>Joulters Creek</td>
<td>Segment 1: RJN-3</td>
<td>1637.2</td>
<td>2.69</td>
</tr>
<tr>
<td>Unnamed Trib - Northwest 1</td>
<td>Segment 3: RJN-1</td>
<td>379.9</td>
<td>0.62</td>
</tr>
<tr>
<td>Unnamed Trib - Northwest 2</td>
<td>Segment 2: RJN-2</td>
<td>362.7</td>
<td>0.59</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>3607.6</strong></td>
<td><strong>5.92</strong></td>
</tr>
</tbody>
</table>

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

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

The phosphorus load from each tributary was determined by multiplying the total phosphorus load by the ratio of the subbasin areas. To obtain phosphorus concentrations for each tributary, the nutrient mass was divided by the volume of flow.

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

### 1.2.3.4 BATHTUB Confirmatory Analysis

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

The Holiday Shores Lake BATHTUB model was initially simulated assuming default phosphorus kinetic parameters (assimilation and decay) and no internal phosphorus loading. The lake concentrations are lower than the incoming tributary concentrations indicating that the lake is a net sink of total phosphorus. Therefore, in order to achieve a calibration, the model "sedimentation" rates (nutrient removal rates) were decreased, rather than adjusting internal loads.
The model was simulated using the median phosphorus loads calculated with the unit area load method. These initial results showed that the predicted lake concentrations were consistently lower than observed lake concentrations. Therefore, the default phosphorus decay coefficient was lowered to increase predicted total phosphorus concentration. The reduction in phosphorus decay rate brought predicted phosphorus levels in line with the observed concentrations. As can be seen, an excellent match was achieved, lending significant support to the predictive ability of this simple model.

### Table 1-6 Summary of Model Confirmatory Analysis- Lake Total Phosphorus (mg/L)

<table>
<thead>
<tr>
<th>Lake Site</th>
<th>Observed</th>
<th>Predicted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment 1: RJN -3</td>
<td>0.193</td>
<td>0.195</td>
</tr>
<tr>
<td>Segment 2: RJN 2</td>
<td>0.155</td>
<td>0.158</td>
</tr>
<tr>
<td>Segment 3: RJN-1</td>
<td>0.149</td>
<td>0.144</td>
</tr>
<tr>
<td>Lake Average</td>
<td>0.159</td>
<td>0.159</td>
</tr>
</tbody>
</table>

#### 1.2.4 BATHTUB Development for Tower Lake

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

##### 1.2.4.1 Global Inputs

Global inputs represent atmospheric contributions of precipitation, evaporation, and atmospheric phosphorus. Based on precipitation and evaporation rates discussed in the Stage 1 report (Appendix A), the average annual precipitation input to the model was 40.08 inches, and the average annual evaporation input to the model was 35.3 inches. The default atmospheric phosphorus deposition rate suggested in the BATHTUB model was used in absence of site-specific data, which is a value of 30 kg/km2-yr (USACE 1999b).

##### 1.2.4.2 Reservoir Segment Inputs

Reservoir segment inputs in BATHTUB are used for physical characterization of the reservoir. Tower Lake is modeled with three segments in BATHTUB. The segment boundaries are shown on Figure 1-5. Segmentation was established based on available water quality and lake morphologic data. Segment inputs to the model include average depth, surface area, segment length, and depth to the metalimnion. The lake depth was represented by the averaged data from the water quality stations discussed in the Stage 1 report. Segment lengths and surface areas were determined in GIS. A single layer model was utilized for the analyses performed here. These data are shown below (Table 1-7) for reference.

### Table 1-7 Tower Lake Segment Data

<table>
<thead>
<tr>
<th>Segment</th>
<th>Surface Area (km²)</th>
<th>Segment Length (m)</th>
<th>Average Depth (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJO-1</td>
<td>0.134</td>
<td>447</td>
<td>36.25</td>
</tr>
<tr>
<td>RJO-2</td>
<td>0.085</td>
<td>720</td>
<td>22.07</td>
</tr>
<tr>
<td>RJO-3</td>
<td>0.072</td>
<td>512</td>
<td>19.62</td>
</tr>
</tbody>
</table>
1.2.4.3 Tributary Inputs

Tributary inputs to BATHTUB include drainage area, flow, and total phosphorus (dissolved and solid-phase) loading. The drainage area of each tributary is equivalent to the basin or subbasin it represents, which was determined with GIS analyses. See Figure 1-5 for subbasin boundaries. The watershed was broken up into 4 tributaries for purposes of the model. In addition to the four tributary areas, there are three point sources that discharge into the Tower Lake. These include Southern Illinois University Edwardsville (SIUE) STP, SIUE cooling water and the SIUE pool.

The area ratio method, as discussed in Section 1.2.3.3, was used to estimate flows in the Tower Lake watershed. The total mean flow into Tower Lake was determined to be 0.83 cfs. The flow contribution from each tributary was estimated by multiplying the total mean annual inflow by the ratio of the subbasin areas. The estimated flow from each tributary is shown in Table 1-8. In addition, permitted discharge rates were used for point source flows.

### Table 1-8 Tower Lake Tributary Sub basin Areas and Estimated Flows

<table>
<thead>
<tr>
<th>Tributary Name</th>
<th>Lake Segment</th>
<th>Area (ac)</th>
<th>Percent of Total</th>
<th>Flow Rate (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Flow 1</td>
<td>RJO-1</td>
<td>143.80</td>
<td>28.5</td>
<td>0.23</td>
</tr>
<tr>
<td>Direct Flow 2</td>
<td>RJO-2</td>
<td>108.28</td>
<td>21.5</td>
<td>0.18</td>
</tr>
<tr>
<td>Direct Flow 3</td>
<td>RJO-3</td>
<td>63.73</td>
<td>12.5</td>
<td>0.10</td>
</tr>
<tr>
<td>Unnamed Creek</td>
<td>RJO-2</td>
<td>188.39</td>
<td>37.5</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>504.2</td>
<td></td>
<td>0.82</td>
</tr>
</tbody>
</table>

#### Point Source Discharges

<table>
<thead>
<tr>
<th>Source</th>
<th>RJO-1</th>
<th>mgd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Illinois Univ – Treatment Plant</td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td>Southern Illinois Univ - Pool</td>
<td>RJO-3</td>
<td>0.045</td>
</tr>
<tr>
<td>Southern Illinois Univ – Cooling Water</td>
<td>RJO-1</td>
<td>8.47</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>9.12</td>
</tr>
</tbody>
</table>

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

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

The phosphorus load from each tributary was determined by multiplying the total phosphorus load by the ratio of the subbasin areas. To obtain phosphorus concentrations for each tributary, the nutrient mass was divided by the volume of flow.

Phosphorus loads from the point sources were determined from a number of sources. The SIUE treatment plant is the only facility required to sample phosphorus per permit requirements. Historic discharge monitoring report data show that the average concentration of total phosphorus from the facility is 0.38mg/L. The facility is
permitted to discharge 1.0mg/L which is significantly higher than the lake standard. The SIUE pool and cooling facility do not have permit limits for total phosphorus. In lieu of data, the pool discharge was modeled with a concentration of 0.05mg/L. The cooling facility uses lake water and redischarges the same water without the addition of nutrients. It should be noted that the cooling water reenters the lake at elevated temperatures which can encourage algal growth which also leads to decreased oxygen levels in the lake. Decreased oxygen levels in the lake promote favorable conditions for internal loading of nutrients from the lake sediments. The cooling water’s concentration for total phosphorus was modeled using the in-lake concentration from sampling location RJO-1.

1.2.4.4 BATHTUB Confirmatory Analysis

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

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

<table>
<thead>
<tr>
<th>Lake Segment</th>
<th>Observed Concentration</th>
<th>Predicted Concentration</th>
<th>Internal Loading Rate (mg/m²-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RJO 1</td>
<td>0.252</td>
<td>0.245</td>
<td>55</td>
</tr>
<tr>
<td>RJO 2</td>
<td>0.109</td>
<td>0.108</td>
<td>6</td>
</tr>
<tr>
<td>RJO 3</td>
<td>0.113</td>
<td>0.117</td>
<td>3.5</td>
</tr>
<tr>
<td>Lake average</td>
<td>0.176</td>
<td>0.173</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1-1:
QUAL2K Segmentation
Cahokia Creek/Chahokia Diversion Channel
Figure 1-2: QUAL2K Calibration

Cahokia Diversion Canal

T:\GIS\Stage3\Cahokia-Holiday\DOfiles\calibration Chart.xls Dissolved Oxygen
Figure 1-3: Fecal Coliform Load Duration Curve
Cahokia Creek Segment JQ05

Flow Exceedance Probability

100,000,000
10,000,000
1,000,000
100,000
10,000
1,000
100
10

Sample Collected at JQ05
Load associated with 200cfu/100mL

million cfu/day
Legend
- Sampling Locations
- Lake Tributaries
- Holiday Shores Lake
- Watershed Area

0 0.25 0.5 1 Miles

Figure 1-4:
BATHTUB Segmentation
Holiday Shores Lake

DRAFT
Figure 1-5:
BATHTUB Segmentation
Tower Lake
Section 2
Total Maximum Daily Loads for the Cahokia Creek/Holiday Shores Lake Watershed

2.1 TMDL Endpoints

The TMDL endpoints for DO, fecal coliform and total phosphorus for the impaired segments in the Cahokia Creek/Holiday Shores Lake watershed are summarized in Table 2-1. All concentrations must be below the TMDL endpoints except for DO concentrations which need to be above 6.0 mg/L during 16 hours of any 24 hour period and must never go below 5.0 mg/L. The endpoints are based on the protection of aquatic life in the Cahokia Diversion Ditch, Holiday Shores Lake and Tower Lake and the protection of the recreational uses of Cahokia Creek. Further monitoring as outlined in the monitoring plan presented in Section 3 of this report, will help further define when impairments are occurring in the watershed and support the TMDL allocations outlined in the remainder of this section.

Table 2-1 TMDL Endpoints and Average Observed Concentrations for Impaired Constituents in the Cahokia Creek/Holiday Shores Lake Watershed

<table>
<thead>
<tr>
<th>Impaired Segment</th>
<th>Constituent</th>
<th>TMDL Endpoint</th>
<th>Average Observed Value on Impaired Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cahokia Creek JQ05</td>
<td>Fecal Coliform</td>
<td>200 cfu/100 mL during October - May</td>
<td>388 cfu/mL (geometric mean)</td>
</tr>
<tr>
<td>Cahokia Diversion Canal JQ07</td>
<td>DO</td>
<td>6.0 mg/L (16 hours of any 24-hour period), 5.0 mg/L instantaneous minimum</td>
<td>3.09 mg/L</td>
</tr>
<tr>
<td>Holiday Shores Lake RJN</td>
<td>Total Phosphorus</td>
<td>0.05 mg/L</td>
<td>0.18 mg/L</td>
</tr>
<tr>
<td>Tower Lake RJO</td>
<td>Total Phosphorus</td>
<td>0.05 mg/L</td>
<td>0.11 mg/L</td>
</tr>
</tbody>
</table>

2.2 Pollutant Source and Linkage

Potential pollutant sources for the impaired waterbodies in the Cahokia Creek/Holiday Shores Lake watershed were identified through the existing data review described in Sections 1 through 5 and the TMDL methodologies discussed and presented in Sections 6 and 7 of the Stage One report. The likely source of oxygen depletion in the Cahokia Diversion Canal is low flows. Problems are caused by slow-moving waters and increased water temperatures that promote algal growth. Sources of fecal coliform to Cahokia Creek during high flows are likely attributable to the fecal matter introduced to the stream via overland runoff and the resuspension of fecal material in the ditch sediment. Dry weather sources of fecal coliform likely include point sources, failing septic systems in the watershed and livestock with direct access to the ditch or its tributaries. Nutrient sources to Holiday Shores Lake are dominated by nonpoint sources while nutrient sources to Tower Lake are likely associated with Southern Illinois University point sources and internal loading.
2.3 Allocation

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

\[ \text{TMDL} = \text{LC} = \sum \text{WLA} + \sum \text{LA} + \text{MOS} \]

where:
- \( \text{LC} \) = Maximum amount of pollutant loading a water body can receive without violating water quality standards
- \( \text{WLA} \) = The portion of the TMDL allocated to existing or future point sources
- \( \text{LA} \) = Portion of the TMDL allocated to existing or future nonpoint sources and natural background
- \( \text{MOS} \) = 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.

2.3.1 Cahokia Diversion Canal DO TMDL

2.3.1.1 Loading Capacity

The LC is the maximum amount of oxygen-demanding material that the Cahokia Diversion Canal can receive and still maintain compliance with the water quality standards. The allowable loads of oxygen-demanding material that can be generated in the watershed and still maintain water quality standards were determined with the methodology discussed in Section 1.2.1.

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

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

Further monitoring and implementation measures to increase aeration in the system are discussed in Section 3.
2.3.2 Cahokia Creek Fecal Coliform TMDL

2.3.2.1 Loading Capacity

The LC is the maximum amount of fecal coliform that Cahokia Creek can receive and still maintain compliance with the water quality standards. The allowable fecal coliform loads that can be generated in the watershed and still maintain the water quality standard of 200 cfu/100mL were determined with the methodology discussed in Section 1.2.2. The fecal coliform loading capacity according to flow is presented in Table 2-2.

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

2.3.2.2 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. Similarly, critical conditions have been addressed by considering all flow scenarios.

2.3.2.3 Margin of Safety

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

2.3.2.4 Waste Load Allocation

There are four point sources with the potential to contribute discharge within the Cahokia Creek segment JQ 05. The average daily flows from these permitted facilities are listed in Table 2-3. The majority of these discharges are a considerable distance upstream of the impaired segment.

<table>
<thead>
<tr>
<th>Mean Daily Flow (cfs)</th>
<th>Load Capacity (mil col/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>24,468</td>
</tr>
<tr>
<td>10</td>
<td>48,937</td>
</tr>
<tr>
<td>20</td>
<td>97,874</td>
</tr>
<tr>
<td>50</td>
<td>244,685</td>
</tr>
<tr>
<td>100</td>
<td>489,370</td>
</tr>
<tr>
<td>200</td>
<td>978,739</td>
</tr>
<tr>
<td>500</td>
<td>2,446,848</td>
</tr>
<tr>
<td>1000</td>
<td>4,893,696</td>
</tr>
</tbody>
</table>
Table 2-3 WLA for Point Sources Discharging Upstream of Cahokia Creek Segment JQ 05 (Illinois EPA 2005)

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Period of Record Permit Number</th>
<th>Receiving Water/Downstream Impaired Waterbody</th>
<th>Constituent</th>
<th>Average Value</th>
<th>Average Loading (lb/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holiday Shores SD STP 1998-2005 ILG580193</td>
<td>Cahokia Creek/Cahokia Creek Segment JQ 05</td>
<td>Average Daily Flow</td>
<td>0.25 mgd</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Staunton WWTP 1992-2005 IL0031232</td>
<td>Ginseng Creek/Cahokia Creek Segment JQ 05</td>
<td>Average Daily Flow</td>
<td>0.91 mgd</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Wilsonville STP 1998-2005 ILG580172</td>
<td>Cahokia Creek/Cahokia Creek Segment JQ 05</td>
<td>Average Daily Flow</td>
<td>0.09 mgd</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Worden STP 1994-2005 ILG580015</td>
<td>Cahokia Creek/Cahokia Creek Segment JQ 05</td>
<td>Average Daily Flow</td>
<td>0.125 mgd</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. In Illinois, a number of these treatment plants have applied for and received disinfection exemptions which allow a facility to discharge wastewater water without disinfection. All of the treatment facilities are required to comply with the geometric mean fecal coliform water quality standard of 200 cfu/100mL at the closest point downstream where recreational use occurs in the receiving water or where the water flows into a fecal-impaired segment. Because each of these facilities has a disinfection exemption, the WLA is not applicable at this time. However, facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. Facilities directly discharging into a fecal-impaired segment may have their year-round disinfection exemption revoked through future NPDES permitting actions.

### 2.3.2.5 Load Allocation and TMDL Summary

The load duration analysis described in Section 1.3.2.1 determined that a 96 percent reduction in fecal coliform loading needs to occur in order to meet the TMDL endpoint of and instream concentration of 200 cfu/100mL. The LA was determined by subtracting the explicit MOS from the determined LC. Table 2-4 shows a summary of the TMDL for Cahokia Creek.

Table 2-4 TMDL Summary for Fecal Coliform in Cahokia Creek

<table>
<thead>
<tr>
<th>Estimated Mean Daily Flow (cfs)</th>
<th>LC (mil col/d)</th>
<th>WLA (mil col/d)</th>
<th>LA (mil col/d)</th>
<th>MOS (mil col/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>24,300</td>
<td>NA</td>
<td>21,870</td>
<td>2,430</td>
</tr>
<tr>
<td>10</td>
<td>44,200</td>
<td>NA</td>
<td>39,780</td>
<td>4,420</td>
</tr>
<tr>
<td>20</td>
<td>88,400</td>
<td>NA</td>
<td>79,560</td>
<td>8,840</td>
</tr>
<tr>
<td>50</td>
<td>221,000</td>
<td>NA</td>
<td>198,900</td>
<td>22,100</td>
</tr>
<tr>
<td>100</td>
<td>442,000</td>
<td>NA</td>
<td>397,800</td>
<td>44,200</td>
</tr>
<tr>
<td>200</td>
<td>884,000</td>
<td>NA</td>
<td>795,600</td>
<td>88,400</td>
</tr>
<tr>
<td>500</td>
<td>2,200,000</td>
<td>NA</td>
<td>1,980,000</td>
<td>220,000</td>
</tr>
<tr>
<td>1000</td>
<td>4,420,000</td>
<td>NA</td>
<td>3,978,000</td>
<td>442,000</td>
</tr>
</tbody>
</table>
2.3.4 Holiday Shores Lake Total Phosphorus TMDL

2.3.4.1 Pollutant Sources and Linkages

Pollutant sources and their linkages to Holiday Shores Lake were established through the BATHTUB modeling and unit area load techniques described previously (Section 1). Pollutant sources of phosphorus include nonpoint source runoff from various land use categories. The predicted median phosphorus loads from unit area load calculations, broken down by land use, are presented in Table 2-5. The loads presented in Table 2-5 were calculated from total phosphorus export coefficients taken from the literature, as described earlier in this section. These median loads were then used to generate a median load from the Holiday Shores Lake watershed, which, in turn, were used to confirm the BATHTUB model and support the analyses described below. The majority of the predicted phosphorus load is from agricultural nonpoint sources (corn and soybeans).

<table>
<thead>
<tr>
<th>Land Use Category</th>
<th>Phosphorus Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High lb/yr</td>
</tr>
<tr>
<td>Soybeans</td>
<td>9784</td>
</tr>
<tr>
<td>Corn</td>
<td>9296</td>
</tr>
<tr>
<td>Rural Grassland</td>
<td>1134</td>
</tr>
<tr>
<td>High Density</td>
<td>2284</td>
</tr>
<tr>
<td>Surface Water</td>
<td>124</td>
</tr>
<tr>
<td>Urban Open Space</td>
<td>80</td>
</tr>
<tr>
<td>Floodplain Forest</td>
<td>35</td>
</tr>
<tr>
<td>Upland</td>
<td>35</td>
</tr>
<tr>
<td>Partial Canopy/Savannah Upland</td>
<td>29</td>
</tr>
<tr>
<td>Low/Medium Density</td>
<td>96</td>
</tr>
<tr>
<td>Winter Wheat/Soybeans</td>
<td>38</td>
</tr>
<tr>
<td>Winter Wheat</td>
<td>17</td>
</tr>
<tr>
<td>Seasonally/Temporarily Flooded</td>
<td>3</td>
</tr>
<tr>
<td>Shallow Water</td>
<td>2</td>
</tr>
<tr>
<td>Deep Marsh</td>
<td>0</td>
</tr>
<tr>
<td>Shallow Marsh/Wet Meadow</td>
<td>0</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>22,957</strong></td>
</tr>
</tbody>
</table>

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

2.3.4.2 Loading Capacity

The loading capacity of Holiday Shores Lake is the total mass of phosphorus that can be assimilated by the lake and still meet the water quality standard of 0.05 mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the models that were set up and calibrated as discussed in Section 1.2.3. To accomplish this, modeled phosphorus loads were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Holiday Shores Lake. The allowable phosphorus load was determined to be 1.6 lbs/day. A spreadsheet summary of this analysis is included as Appendix D.
2.3.4.3 Seasonal Variation
A season is represented by changes in weather; for example, a season can be classified as warm or cold as well as wet or dry. Seasonal variation is represented in the Holiday Shores Lake TMDL as conditions were modeled on an annual basis. Modeling on an annual basis takes into account the seasonal effects the lake will undergo during a given year. Since the pollutant source can be expected to contribute loadings in different quantities during different time periods (e.g., various portions of the agricultural season resulting in different runoff characteristics), the loadings for this TMDL will focus on average annual loadings converted to daily loadings rather than specifying different loadings by season. Because an average annual basis was used for TMDL development, it is assumed that the critical condition is accounted for within the analysis.

2.3.4.4 Margin of Safety
The MOS can be implicit (incorporated into the TMDL analysis through conservative assumptions) or explicit (expressed in the TMDL as a portion of the loadings) or a combination of both. The MOS for the Horseshoe Lake TMDL is implicit. The analysis completed for Holiday Shores Lake is conservative because of the following:

- Unit area loads are based on conservative assumptions over a broad geographic area and are not site-specific to the Holiday Shores Lake Watershed
- Unit area loads are likely higher than those predicted using a watershed model
- The unit area loads assumed for the percent reduction analysis are at the high end of the literature reported median loads by landuse
- In the absence of site-specific data, an atmospheric loading rate of 30 kg/km2-yr total phosphorus (USACE 1999b) was assumed in the BATHTUB model

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

2.3.4.6 Load Allocation and TMDL Summary
Table 2-6 shows a summary of the TMDL for Holiday Shores Lake. A 76 percent reduction of total phosphorus loads to the lake would result in compliance with the water quality standard of 0.05 mg/L total phosphorus. Table 2-6 summarizes the TMDL for Holiday Shores Lake.

<table>
<thead>
<tr>
<th>Load Source</th>
<th>Estimated Current Load (lb/day)</th>
<th>LC (lb/day)</th>
<th>WLA (lb/day)</th>
<th>LA (lb/day)</th>
<th>MOS (lb/day)</th>
<th>Reduction Needed (lb/day)</th>
<th>Reduction Needed (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>External</td>
<td>6.7</td>
<td>1.6</td>
<td>0</td>
<td>1.6</td>
<td>0</td>
<td>5.1</td>
<td>76</td>
</tr>
</tbody>
</table>
2.3.5 Tower Lake Total Phosphorus TMDL

Pollutant sources and their linkages to Tower Lake were established through the BATHTUB modeling and unit area load techniques described previously (Section 1). Pollutant sources of phosphorus include point sources from SIUE, nonpoint sources for the surrounding watershed and internal loading. The predicted median phosphorus loads from unit area load calculations, broken down by land use, are presented in Table 2-7. The loads presented in Table 2-7 were calculated from total phosphorus export coefficients taken from the literature, as described earlier in this section. These median loads were then used to generate a range of potential loads from the Tower Lake watershed, which, in turn, were used to confirm the BATHTUB model and support the analyses described below. The majority of the predicted phosphorus load is from urban land associated with the university and agricultural nonpoint sources.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Percent of Total Area</th>
<th>High lb/yr</th>
<th>Low lb/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep Marsh</td>
<td>0%</td>
<td>0.4</td>
<td>0.1</td>
</tr>
<tr>
<td>Floodplain Forest</td>
<td>13%</td>
<td>8.3</td>
<td>5.1</td>
</tr>
<tr>
<td>High Density</td>
<td>13%</td>
<td>134.5</td>
<td>67.3</td>
</tr>
<tr>
<td>Low/Medium Density</td>
<td>13%</td>
<td>33.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Partial Canopy/Savannah Upland</td>
<td>13%</td>
<td>8.7</td>
<td>5.3</td>
</tr>
<tr>
<td>Rural Grassland</td>
<td>0%</td>
<td>0.8</td>
<td>0.3</td>
</tr>
<tr>
<td>Seasonally/Temporarily Flooded</td>
<td>3%</td>
<td>3.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Shallow Water</td>
<td>0%</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Soybeans</td>
<td>10%</td>
<td>47.2</td>
<td>47.2</td>
</tr>
<tr>
<td>Surface Water</td>
<td>1%</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Upland</td>
<td>13%</td>
<td>8.7</td>
<td>5.4</td>
</tr>
<tr>
<td>Urban Open Space</td>
<td>19%</td>
<td>15.0</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>262</strong></td>
<td><strong>138</strong></td>
</tr>
</tbody>
</table>

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

2.3.5.1 Loading Capacity

The loading capacity of Tower Lake is the total mass of phosphorus that can be assimilated by the lake and still meet the water quality standard of 0.05 mg/L total phosphorus. The allowable phosphorus loads that can be generated in the watershed and still maintain water quality standards were determined with the models that were set up and calibrated as discussed in Section 1.2.4. To accomplish this, modeled phosphorus loads were reduced by a percentage and entered into the BATHTUB model until the water quality standard of 0.05-mg/L total phosphorus was met in Tower Lake. The modeled existing conditions show that the current load to the lake is 38.4 lbs/day. Of the current load to the lake, 47 percent is from internal loading, 2 percent is from tributary contributions and 51 percent is from point sources. The allowable phosphorus load to meet in-lake standards was determined to be
8.28 lbs/day. This requires an overall total phosphorus load reduction of 78 percent. A spreadsheet summary of this analysis is included as Appendix E.

### 2.3.5.2 Seasonal Variation

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

### 2.3.5.3 Margin of Safety

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

- Unit area loads are based on conservative assumptions over a broad geographic area and are not site-specific to the Tower Lake Watershed
- Unit area loads are likely higher than those predicted using a watershed model
- The unit area loads assumed for the percent reduction analysis are at the high end of the literature reported median loads by landuse
- In the absence of site-specific data, an atmospheric loading rate of 30 kg/km²-yr total phosphorus (USACE 1999b) was assumed in the BATHTUB model

### 2.3.5.4 Waste Load Allocation

There are three point sources within the Tower Lake watershed. The WLA for the SIUE treatment plant was calculated based on the existing permit limit of 1.0 mg/L. The WLAs for the remaining dischargers (the pool and the cooling facilities) were determined by multiplying the target total phosphorus concentration of 0.05 mg/L by the permitted flows. It is not recommended that the WLA be used for permitting limits for the SIUE Cooling Water because the facility uses lake water for cooling and then redischarges the same water without the addition of nutrients. Theoretically, the cooling water discharge will improve as the total phosphorus concentrations in the lake improve. Table 2-8 contains the WLA for each facility.
Table 2-8 WLA for Total Phosphorus in Tower Lake

<table>
<thead>
<tr>
<th>Point Source</th>
<th>Permit Number</th>
<th>Permitted Flow (mgd)</th>
<th>TP target (mg/L)</th>
<th>WLA (lb/day)</th>
<th>Current Average Discharge (lbs/day)</th>
<th>Reduction Needed (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SIUE Treatment Plant</td>
<td>IL0046761</td>
<td>0.6</td>
<td>*</td>
<td>5.01</td>
<td>1.9</td>
<td>none</td>
</tr>
<tr>
<td>SIUE Pool</td>
<td>IL0075841</td>
<td>0.045</td>
<td>0.05</td>
<td>0.02</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>SIUE Cooling Water</td>
<td>IL0075311</td>
<td>8.47</td>
<td>0.05</td>
<td>3.53</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>8.56</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Pursuant to Section 304.123, the total phosphorus limit for this facility must remain at 1.0 mg/L total phosphorus

Table 2-8 shows that the WLA exceeds the LC of Tower Lake. Even with a 100% reduction in internal and external nonpoint source loading, the lake will not meet the water quality standard. As noted in the table, Section 304.123 states that the permitted discharge limit of total phosphorus from the treatment plant must remain at 1.0 mg/L. Because this limit is significantly higher than the water quality standard for the lake, and the lake is not large enough to assimilate that level of loading, the results will be exceedences consistently recorded in the lake. More discussion on this issue is provided below in section 2.3.5.5.

2.3.5.5 Load Allocation and TMDL Summary

Table 2-9 shows a summary of the TMDL for Tower Lake with current discharge regulations in place. In addition, Table 2-10 shows various scenarios should Section 304.123 total phosphorus limits change or no longer be applicable in the future. It should be noted that historic discharge records show that the treatment plant is discharging effluent with significantly lower concentrations of total phosphorus than they are permitted to discharge. However, the historic effluent concentrations are still elevated above the in-lake standard. For reference (and shown in Table 2-10), the average historic effluent concentration is 0.38 mg/L. Tables 2-9 summarize the TMDL for Tower Lake.

Table 2-9 TMDL Summary for Total Phosphorus in Tower Lake

<table>
<thead>
<tr>
<th>Estimated Current Load (lb/day)</th>
<th>LC (lb/day)</th>
<th>WLA (lb/day)</th>
<th>LA (lb/day)</th>
<th>MOS (lb/day)</th>
<th>Reduction Needed (lb/day)</th>
<th>Reduction Needed (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>38.4</td>
<td>8.3</td>
<td>8.6</td>
<td>0</td>
<td>0</td>
<td>30.1</td>
<td>78</td>
</tr>
</tbody>
</table>

Table 2-10 TMDL Scenarios for Total Phosphorus in Tower Lake

<table>
<thead>
<tr>
<th>SIUE STP Discharge Concentration (mg/L)</th>
<th>SIUE STP WLA (lbs/day)</th>
<th>Estimated Current Load (lb/day)</th>
<th>LC (lb/day)</th>
<th>WLA (lb/day)</th>
<th>LA (lb/day)</th>
<th>MOS (lb/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>4.51</td>
<td>38.4</td>
<td>8.3</td>
<td>8.06</td>
<td>0.24</td>
<td>0</td>
</tr>
<tr>
<td>0.8</td>
<td>4.01</td>
<td>38.4</td>
<td>8.3</td>
<td>7.56</td>
<td>0.74</td>
<td>0</td>
</tr>
<tr>
<td>0.7</td>
<td>3.50</td>
<td>38.4</td>
<td>8.3</td>
<td>7.05</td>
<td>1.25</td>
<td>0</td>
</tr>
<tr>
<td>0.6</td>
<td>3.00</td>
<td>38.4</td>
<td>8.3</td>
<td>6.55</td>
<td>1.75</td>
<td>0</td>
</tr>
<tr>
<td>0.5</td>
<td>2.50</td>
<td>38.4</td>
<td>8.3</td>
<td>6.05</td>
<td>2.25</td>
<td>0</td>
</tr>
<tr>
<td>0.38*</td>
<td>1.90</td>
<td>38.4</td>
<td>8.3</td>
<td>5.45</td>
<td>2.85</td>
<td>0</td>
</tr>
</tbody>
</table>

* Average Historic Effluent Concentration
If this system is modeled using the average historic effluent concentration of 0.38mg/L total phosphorus, the resulting load allocation to nonpoint sources could be achieved through a 60% reduction in direct runoff loading and a 90% reduction in internal loading.
Section 3
Implementation Plan for the Cahokia Creek/Holiday Shores Lake Watershed

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

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

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

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

To assist in adaptive management, implementation actions, management measures, available assistance programs, and recommended continued monitoring are all discussed throughout the remainder of this section.
3.2 Implementation Actions and Management Measures for DO in the Cahokia Diversion Canal

DO impairments are generally addressed by focusing on organic loads that consume oxygen through decomposition and nutrient loads that can cause algal growth, which can also deplete DO. Analysis discussed in Section 2 established a relationship between low flows, oxygen-demanding materials (BOD$_5$, ammonia-nitrogen and organic nitrogen) and DO concentrations in the Cahokia Diversion Canal segment JQ07, so management measures for segment JQ07 will focus on increasing reaeration and decreasing loads of oxygen-demanding materials to increase DO concentrations.

DO impairments in the Cahokia Diversion Canal segment JQ07 are mostly attributed to low flow or stagnant conditions within the canal. Runoff from nonpoint sources may also contribute loading of oxygen-demanding materials in the segment. An additional contributor to low DO is increased water temperatures. Therefore, management measures for the segment JQ07 watershed will focus on reducing nonpoint source loading through sediment and surface runoff controls, reducing stream temperatures, and reducing stagnant conditions through reaeration.

3.2.1 Point Sources of Oxygen-Demanding Materials

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

3.2.1.1 Stormwater Sources

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

- Edwardsville
- Wood River

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

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

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

### 3.2.1.2 Municipal/Industrial Sources

A number of small STPs discharge oxygen-demanding materials within the Cahokia Creek/Holiday Shores watershed. All of these facilities are located a significant distance upstream of the impaired segment on segments that are not listed for DO issues. However, there are three point sources that discharge directly to or to a close tributary of the Cahokia Diversion Canal (see Figure 1-1). Table 3-1 contains permit information on each of these facilities.

**Table 3-1: Point Source Discharges to Cahokia Diversion Canal Segment JQ07**

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

Illinois EPA will evaluate the need for point source controls through the NPDES permitting program as each permit is due for renewal. Each facility is located at the downstream end of the segment and does not contribute significant flow to the system. The facilities are not believed to be a significant source of oxygen-demanding materials to the Cahokia Diversion Canal. Only the Village of Roxanna STP permit has limits for DO, BOD\(_5\) and ammonia-nitrogen. The facility is required to discharge effluent with DO concentrations higher than 6.0 mg/L, ammonia concentrations between 2.1 and 2.8 mg/L (during low flow months), and BOD\(_5\) concentrations of 10 mg/L. These permit limits are thought to be adequately protective of aquatic life uses within the canal. Because the other two discharges are from petroleum related facilities (Conoco and Explorer Pipeline) with relatively low discharge flows, they are not expected to contribute significant oxygen-demanding materials to the canal.

### 3.2.2 Nonpoint Sources of Oxygen-Demanding Materials

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

- Filter strips
- Reaeration/Erosion Control/Streambank Stabilization

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

3.2.2.1 Filter Strips

Filter strips can be used as a control to reduce pollutant loads, including nutrients and sediment, to the Cahokia Diversion Canal. Filter strips implemented along stream segments slow and filter nutrients and sediment out of runoff, help reduce stream water temperatures thereby increasing the water body DO saturation level, and provide bank stabilization decreasing erosion and deposition. The following paragraphs focus on the implementation of filter strips in the Cahokia Creek/Holiday Shores watershed. Finally, design criteria and size selection of filter strips are detailed.

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

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

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

Filter strip widths for the Cahokia Diversion Canal TMDL were estimated based on the land slope. According to the NRCS Planning and Design Manual, the majority of
sediment is removed in the first 25 percent of the width (NRCS 1994). Table 3-2 outlines the guidance for filter strip flow length by slope (NRCS 1999).

<table>
<thead>
<tr>
<th>Percent Slope</th>
<th>0.5%</th>
<th>1.0%</th>
<th>2.0%</th>
<th>3.0%</th>
<th>4.0%</th>
<th>5.0% or greater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>36</td>
<td>54</td>
<td>72</td>
<td>90</td>
<td>108</td>
<td>117</td>
</tr>
<tr>
<td>Maximum</td>
<td>72</td>
<td>108</td>
<td>144</td>
<td>180</td>
<td>216</td>
<td>234</td>
</tr>
</tbody>
</table>

GIS land use data described in Section 5 of the Stage 1 report (Appendix A) were used in conjunction with soil slope data to provide an estimate of acreage where filter strips could be installed. As discussed in Section 2.4.1, the most predominant soil type in the watershed is Hickory Loams ranging from silts to clays on ten to 60 percent slopes. Based on these slope values, filter strip widths of 117 to 234 feet could be incorporated into agricultural lands adjacent to the canal and its tributaries. Mapping software was then used to buffer stream segments to determine the total area found within 234 feet of tributaries in the watershed. There are approximately 12,928 total acres within this buffer distance. The land use data were then clipped to the buffer area to determine the amount of this land that is agricultural. There are an estimated 2,985 acres of agricultural land surrounding tributaries of the Cahokia Diversion Canal where filter strips and riparian buffers could potentially be installed. Landowners should evaluate their land near the Cahokia Diversion Canal and its tributaries and install or extend filter strips according to the NRCS guidance provided in Table 3-2. Programs available to fund the construction of these buffer strips are discussed in Section 3.6.

3.2.2.2 Reaeration/Streambank Stabilization

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

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

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

3.3.1.1 Stormwater Sources

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

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

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

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

3.3.1.2 Municipal Wastewater Sources

There are four municipal treatment plant point sources of fecal coliform to Cahokia Creek. Sewage from treatment plants treating domestic and/or municipal waste contains fecal coliform as it is indigenous to sanitary sewage. As discussed in Section 2.3.2.4, each of these facilities have disinfection exemptions meaning that they do not have to disinfect as long as the instream fecal coliform standard is being met at the downstream end of the disinfection exempt segment. However, facilities with year-round disinfection exemptions may be required to provide the Agency with updated information to demonstrate compliance with these requirements. Because each facility has a disinfection exemption, the actual load of fecal coliform originating at each facility is unknown. None of the facilities are discharging directly to the impaired segment. The Holiday Shores STP is located the closest to the impaired segment of the creek. Table 3-3 contains permit information for each facility.
### Table 3-3 Point Sources Discharging Upstream of Cahokia Creek Segment JQ 05 (Illinois EPA 2005)

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Period of Record</th>
<th>Permit Number</th>
<th>Average Discharge Value</th>
<th>Permit Expiration</th>
<th>Average Loading (lb/d)</th>
</tr>
</thead>
</table>

### 3.3.2 Nonpoint Sources of Fecal Coliform

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

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

Each alternative is discussed briefly in this section.

#### 3.3.2.1 Filter Strips

Filter strips were discussed in Section 3.2.2.1. The same technique for evaluating available land was applied to the Cahokia Creek watershed. There are 8,309 acres of land within 234 feet of Cahokia Creek, of this area, 2,985 acres are categorized as agricultural and could potentially be converted into filter strips.

#### 3.3.2.2 Private Septic System Inspection and Maintenance Program

Investigation into watershed septic systems was performed during Stage 1 of TMDL development. The health departments for Macoupin and Madison County were unable to provide an estimate of septic systems in the area. Because there are a number of sanitary treatment plants in the watershed, it is thought that the number of septic systems in the watershed is limited. However, because the information is unknown, it is recommended that a septic survey be completed in the area to assess the number of systems and their locations. After a survey has determined the extent of septic systems in the watershed, a program that actively manages functioning systems and addresses non-functioning systems could be put in place. The USEPA has developed guidance for managing septic systems, which includes assessing the functionality of systems, public health, and environmental risks (EPA 2005). It also introduces procedures for selecting and implementing a management plan.
To reduce the excessive amounts of contaminants from a faulty septic system, a regular maintenance plan that includes regular pumping and maintenance of the septic system should be followed. The majority of failures originate from excessive suspended solids, nutrients, and BOD loading to the septic system. Reduction of solids to the tank can be achieved via limiting garbage disposals use and water conservation.

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

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

The cost of each management measure is site specific and there is not specific data on septic systems and management practices for the watershed; therefore, costs for these practices were not outlined in Section 3.6.

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

3.3.2.3 Restrict Livestock Access to Cahokia Creek and Tributaries

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

Phosphorus loads in the Holiday Shores Lake and Tower Lake watersheds originate from both external and internal sources. As discussed in previous sections, possible sources of total phosphorus in the Holiday Shores Lake watershed include runoff from urban and agricultural areas while sources of total phosphorus to Tower Lake include point source discharges and internal cycling. To achieve a reduction of total phosphorus for these lakes, management measures must address loading through sediment and surface runoff controls, point source limits and internal nutrient cycling through in-lake management.

3.4.1 Point Sources of Phosphorus

The phosphorus TMDLs for Holiday Shores Lake and Tower Lake describe waste load allocations for point source dischargers in the watershed. Holiday Shores Lake does not have any point source contributions and the associated WLA was therefore set to zero. Three facilities associated with SIUE discharge to Tower Lake. The pool and treatment plant’s WLA were set based on the facilities’ discharge rate and the water quality standard of 0.05mg/L. The cooling facility was not addressed in the WLA because the facility uses lake water for cooling operations and then redischarges the water without the addition of additional nutrients. It is assumed that as the nutrient concentrations in the lake improve, the cooling facility’s effluent will subsequently improve and not cause further impairment.

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

3.4.2 Nonpoint Sources of Phosphorus

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

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

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

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

3.4.2.1 Conservation Tillage Practices
For the Holiday Shores Lake watershed, where a significant portion of the watershed consists of agricultural land uses, conservation tillage practices could help reduce nutrient loads in the lake. The lake potentially receives nonpoint source runoff from row crops and small grain agriculture in the watershed. Total phosphorus loading from cropland is controlled through management BMPs, such as conservation tillage. Conservation tillage maintains at least 30 percent of the soil surface covered by residue after planting. Crop residuals or living vegetation cover on the soil surface protect against soil detachment from water and wind erosion. Conservation tillage practices can remove up to 45 percent of the dissolved and total phosphorus from runoff and approximately 75 percent of the sediment. Additionally, studies have found around 93 percent less erosion occurred from no-till acreage compared to acreage subject to moldboard plowing (USEPA 2003); however, filter strips are less effective at removing dissolved phosphorus only. The 2002 Illinois Department of Agriculture's Soil Transect Survey estimated that conventional till currently accounts for 72 percent of corn, 8 percent of soybean, and 100 percent of small grain tillage practices in Madison County, and these percentages were assumed to apply to the Holiday Shores Lake watershed as well. To achieve TMDL load allocations, tillage practices already in place should be continued, and practices should be assessed and improved upon for all agricultural acres in the Holiday Shores Lake watershed.

3.4.2.2 Filter Strips
Filter strips were discussed in Section 3.2.2.1. The same technique for evaluating available land was applied to the lake watershed. In the Holiday Shores Lake watershed there are 206 acres of land within 234 feet of the lake tributaries; of this area, 105 acres are categorized as agricultural and could potentially be converted into filter strips.

3.4.2.3 Wetlands
The use of wetlands as a structural control is applicable to nutrient reduction from agricultural lands in the Holiday Shores Lake watershed. To treat loads from agricultural runoff, a wetland could be constructed on the upstream end of the reservoir. Wetlands are an effective BMP for sediment and phosphorus control because they:

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

A properly designed and functioning wetland can provide very efficient treatment of pollutants, such as phosphorus. Design of wetland systems is very important and should consider soils in the proposed location, hydraulic retention time, and space requirements. Constructed wetlands, which comprise the second or third stage of nonpoint source treatment, can be effective at improving water quality. Studies have shown that artificial wetlands designed and constructed specifically to remove pollutants from surface water runoff have removal rates for suspended solids of greater than 90 percent, 0 to 90 percent for total phosphorus, 20 to 80 percent of orthophosphate, and 10 to 75 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 3-4 outlines estimated wetland areas for each subbasin in the Holiday Shores Lake watershed based on these recommendations. A wetland system to treat agricultural runoff from the lake subbasins could be approximately 22 acres (Denison and Tilton 1993).

<table>
<thead>
<tr>
<th>Subbasin</th>
<th>Area (acres)</th>
<th>Recommended Wetlands (acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Flow RJN3</td>
<td>350</td>
<td>2.1</td>
</tr>
<tr>
<td>Direct Flow RJN2</td>
<td>652</td>
<td>3.9</td>
</tr>
<tr>
<td>Direct Flow RJN1</td>
<td>225</td>
<td>1.3</td>
</tr>
<tr>
<td>Joulters Creek</td>
<td>1637</td>
<td>9.8</td>
</tr>
<tr>
<td>Unnamed Trib - Northwest 2</td>
<td>363</td>
<td>2.2</td>
</tr>
<tr>
<td>Unnamed Trib - Northwest 1</td>
<td>380</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3608</strong></td>
<td><strong>21.6</strong></td>
</tr>
</tbody>
</table>

### 3.4.2.4 Nutrient Management

Nutrient management could result in reduced nutrient loads to Holiday Shores Lake. A nutrient management plan should address fertilizer application rates, methods, and timing. Initial soil phosphorus concentrations are determined by onsite soil testing, which is available from local vendors. Losses through plant uptake are subtracted, and gains from organic sources such as manure application or industrial/municipal wastewater are added. The resulting phosphorus content is then compared to local guidelines to determine if fertilizer should be added to support crop growth and maintain current phosphorus levels. In some cases, the soil phosphorus content is too high, and no fertilizer should be added until stores are reduced by crop uptake to target levels.
The Illinois Agronomy Handbook (IAH) lists guidelines for fertilizer application rates based on the inherent properties of the soil (typical regional soil phosphorus concentrations, root penetration, pH, etc.), the starting soil test phosphorus concentration for the field, and the crop type and expected yield.

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

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

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

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

The effectiveness of nutrient management plans (application rates, methods, and timing) in reducing phosphorus loading from agricultural land will be site specific.
In Illinois, Nutrient Management Plans have successfully reduced phosphorus application to agricultural lands by 36-lb/acre. National reductions range from 11 to 106-lb/acre, with an average reduction of 35-lb/acre (USEPA 2003).

3.4.2.5 Septic System Maintenance and Sanitary System
The extent of septic systems within the Holiday Shores Lake watershed is not known. Depending on the number of septic systems in the watershed, they could be a potential source of nutrients to the lake. Septic system maintenance was discussed in Section 3.3.1.2.

3.4.3 In-Lake Phosphorus
The Tower Lake phosphorus TMDL determined that approximately 47 percent of the current phosphorus load to Tower Lake comes from internal cycling. Reduction of phosphorus from in-lake cycling through management strategies is necessary for attainment of the TMDL load allocation. Internal phosphorus loading occurs when the water above the sediments become anoxic causing the release of phosphorus from the sediment in a form which is available for plant uptake. The addition of bioavailable phosphorus in the water column stimulates more plant growth and die-off, which perpetuates the anoxic conditions and enhances the subsequent release of phosphorus into the water.

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

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

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

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

3.5.1 Available Cost-Share Programs
Approximately 65 percent of the Cahokia Canal/Holiday Shores Lake watershed is classified as agricultural row crop, and small grains land. There are several voluntary conservation programs established through the 2002 U.S. Farm Bill (the 2007 Farm Bill is currently being developed), which encourage landowners to implement resource-conserving practices for water quality and erosion control purposes. These programs would apply to crop fields and rural grasslands that are presently used as pasture land. Each program is discussed separately in the following paragraphs.

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

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

Eligible land must be one of the following:

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

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

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

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

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

3.5.1.3 Clean Water Act Section 319 Grants

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

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

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

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

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

### 3.5.1.4 Wetlands Reserve Program (WRP)

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

Eligible participants must have owned the land for at least 1 year and be able to provide clear title. Restoration agreement participants must show evidence of ownership. Owners may be an individual, partnership, association, corporation, estate, trust, business, or other legal entity; a state (when applicable); a political subdivision of a state; or any agency thereof owning private land. Land eligibility is dependent on length of ownership, whether the site has been degraded as a result of agriculture, and the land's ability to be restored.
The 2002 Farm Bill reauthorized the program through 2007. The reauthorization increased the acreage enrollment cap to 2,275,000 acres with an annual enrollment of 250,000 acres per calendar year. The program is limited by the acreage cap and not by program funding. Since the program began in 1985, the average cost per acre is $1,400 in restorative costs and the average project size is 177 acres. The costs for each enrollment options follow in Table 3-5 (USDA 2006).

### Table 3-5 Costs for Enrollment Options of WRP Program

<table>
<thead>
<tr>
<th>Option</th>
<th>Permanent Easement</th>
<th>30-year Easement</th>
<th>Restoration Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment for Easement</td>
<td>100% Agricultural Value</td>
<td>75% Agricultural Value</td>
<td>NA</td>
</tr>
<tr>
<td>Payment Options</td>
<td>Lump Sum</td>
<td>Lump Sum</td>
<td>NA</td>
</tr>
<tr>
<td>Restoration Payments</td>
<td>100% Restoration Cost</td>
<td>75% Restoration Cost</td>
<td>75% Restoration Cost</td>
</tr>
<tr>
<td></td>
<td>Reimbursements</td>
<td>Reimbursements</td>
<td>Reimbursements</td>
</tr>
</tbody>
</table>

#### 3.5.1.5 Environmental Quality Incentive Program (EQIP)

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

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

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

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

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

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

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

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

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

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

3.5.1.10 Local Program Information

The Farm Service Agency (FSA) administers the CRP. NRCS administers the EQIP, WRP, and WHIP. Local NRCS contact information in Macoupin and Madison Counties are listed in the Table 3-6 below.

<table>
<thead>
<tr>
<th>Contact</th>
<th>Address</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Madison County</td>
<td>7205 Marine Road</td>
<td>618-656-4710</td>
</tr>
<tr>
<td></td>
<td>Edwardsville, IL 62025</td>
<td></td>
</tr>
<tr>
<td>Macoupin County</td>
<td>300 Carlinville Plaza</td>
<td>217-854-4102</td>
</tr>
<tr>
<td></td>
<td>Carlinville, IL 62626</td>
<td></td>
</tr>
</tbody>
</table>

3.5.2 Cost Estimates of BMPs

Cost estimates for different best management practices and individual practice prices such as filter strip installation are detailed in the following sections. Table 3-7 outlines the estimated cost of implementation measures in the Cahokia Canal/Holiday Shores Lake watershed.

3.5.2.1 Wetlands

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

### 3.5.2.2 Filter Strips and Riparian Buffers

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

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

Assuming a buffer width of 90 ft on either side of the stream channel and an adjacent treated width of 300 ft of agricultural land, one acre of buffer will treat approximately 3.3 acres of adjacent agricultural land. The cost per treated area is thus $30/ac to construct and $142.50/ac to maintain over the life of the buffer. Assuming a system life of 30 years results in an annualized cost of $59.25/yr for each acre of agricultural land treated.

### 3.5.2.3 Nutrient Management Plan - NRCS

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

### 3.5.2.4 Nutrient Management Plan - IDA and Illinois EPA

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

### 3.5.2.5 Conservation Tillage

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

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

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

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

3.5.2.6 Septic System Maintenance

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

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

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

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

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

Internal cycling was identified as a source of nutrients to Tower Lake. Controls of internal phosphorus cycling in lakes are costly. The in-lake controls have been converted to year 2004 dollars assuming an average annual inflation rate of 3 percent. The number and size of hypolimnetic aerators used in a waterbody depend on lake morphology, bathymetry, and hypolimnetic oxygen demand. Total cost for successful systems has ranged from $170,000 to $1.7 million (Tetra Tech, 2002). USEPA (1993) reports initial costs ranging from $340,000 to $830,000 plus annual operating costs of $60,000. System life is assumed to be 20 years.

Alum treatments are effective on average for approximately 8 years per application and can reduce internal loading by 80 percent. Treatment cost ranges from $290/ac to $720/ac (WIDNR, 2003). The surface area of Tower Lake is approximately 72 ac, so total application costs for the lake would likely range from $21,000 to $52,000.

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

3.5.2.8 Planning Level Cost Estimates for Implementation Measures

Cost estimates for different implementation measures are presented in Table 3-6. Cost estimates shown in Table 3-6 are the total estimated cost per acre and many costs could be reduced through cost share opportunities discussed in Section 3.5.1. The column labeled Program or Sponsor lists the financial assistance program or sponsor available for various BMPs. The programs and sponsors represented in the table are the Soil Stabilization and Restoration Practice (SSRP), Wetlands Reserve Program (WRP), the Conservation Reserve Program (CRP), National Resource Conservation Service (NRCS), Conservation Cost-Share Program (CPP), Illinois EPA, and Illinois Department of Agriculture (IDA). It should be noted that Illinois EPA 319 Grants are applicable to all of these practices.

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

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.
3.6 Monitoring Plan
The purpose of the monitoring plan for the Cahokia Creek/Holiday Shores Lake watershed is to assess the overall implementation of management actions outlined in this section. This can be accomplished by conducting the following monitoring programs:

- Track implementation of management measures in the watershed
- Estimate effectiveness of management measures
- Further monitoring of point source discharges in the watershed
- Continued ambient monitoring of all TMDL segments
- Investigation of tile line flow and associated water quality from agricultural land
- Further information gathering on area septic systems including locations and failure rates
- Storm-based monitoring of high flow events
- Tributary monitoring
- Storm Sewer surveys to monitor outfall concentration of parameters of concern

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

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

Estimating the effectiveness of the BMPs implemented in the watershed could be completed by monitoring before and after the BMP is incorporated into the watershed. Additional monitoring could be conducted on specific structural systems such as a constructed wetland. Inflow and outflow measurements could be conducted to determine site-specific removal efficiency. If aeration is used to control internal loading, site-specific data could be collected to assess the effectiveness of this management measure. In addition, sampling should be performed before and after management operations employed within both lakes to determine their effects on lake nutrient levels.
IEPA monitors lakes every three years and conducts Intensive Basin Surveys every five years. Additionally, ambient sites are monitored nine times a year. Continuation of this state monitoring program will assess lake and stream water quality as improvements in the watershed are completed. This data will also be used to assess whether water quality standards in the impaired segments are being attained.

Regular and more extensive monitoring of point sources in the watershed would confirm their collective contributions and provide additional information regarding oxygen-demanding materials to the Cahokia Diversion Canal, fecal coliform to Cahokia Creek and total phosphorus to Tower Lake. As permits come up for renewal, Illinois EPA NPDES program should review the permits and decide if further management measures are required.

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

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

3.7 Implementation Time Line

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