Little Rock Lake and Creek Watershed Protection and Improvement Plan
(TMDL Implementation Plan)

303d Impairments:

- Little Rock Lake:
  - Nutrients (Phosphorus)
- Little Rock Creek:
  - Dissolved Oxygen
  - Nitrate
  - Temperature
  - Fish Bioassessment

Prepared for: Minnesota Pollution Control Agency

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ac	acre
AU	Animal Unit
AUID	assessment unit identification number
BH	Bunker Hill
BEHI	Bank Erosion Hazard Index
BMP(s)	best management practice(s)
BWSR	Board of Water and Soil Resources
°C	degrees Celsius
CAFO(s)	Concentrated Animal Feeding Operation(s)
CBOD	carbon biological oxygen demand
cfs	cubic feet per second
Chl-a	Chlorophyll-a
CRP	Conservation Reserve Program
DM	Daily Maximum
DO	dissolved oxygen
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
°F	degrees Fahrenheit
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GJ	gigajoules
IBI	Index of Biotic Integrity
in	inches
kg	kilograms
km	kilometers
LA	load allocation
LRC	Little Rock Creek
LRL	Little Rock Lake
m	meter
mi	mile
mg/L	milligrams per liter
µg/L	micrograms per liter
MDA	Minnesota Department of Agriculture

MDH	Minnesota Department of Health
MGS	Minnesota Geologic Survey
MN DNR	Minnesota Department of Natural Resources
MOS	margin of safety
MPCA	Minnesota Pollution Control Agency
MS4	Municipal Separate Storm Sewer Systems
MWAT	Maximum Weekly Average Temperature
NBOD	nitrogenous biological oxygen demand
NBS	near-bank stress
NCHF	North Central Hardwood Forest
NRCS	Natural Resources Conservation Service
NO_3	nitrate
NPDES/SDS	National Pollutant Discharge Elimination System/State Disposal System
Obwell(s)	observation well(s)
POM	particulate organic matter
ppb	parts per billion
ppm	parts per million
RC	Reserve Capacity
s	seconds
SCSU	Saint Cloud State University
SSTS	Subsurface Sewage Treatment System
SWCD	Soil and Water Conservation District
SWUDS	State Water Use Data System
SOD	sediment oxygen demand
TAC	Technical Advisory Committee
TALU	tiered-aquatic life use
TMDL	total maximum daily load
TP	total phosphorus
VRI	variable rate irrigation
WLA	wasteload allocation
WMA	Wildlife Management Area
WRAC	Water Resource Advisory Committee
YOY	Young of Year
yr	year

Introduction

Minnesota Rules, Chapter 7050, Standards for Protection of Water of the State, outlines the water quality standards developed by the Minnesota Pollution Control Agency (MPCA). When water bodies fail to meet the standards established by the MPCA they become listed on the 303(d) Impaired Waters List, requiring the completion of a Total Maximum Daily Load (TMDL) study that establishes the pollutant reduction goal needed to restore the waters to meet necessary water quality standards. In addition to the TMDL report, an implementation plan is required, setting forth the activities and projects that will be implemented to achieve the required reduction in the pollutant loads as described in order to meet water quality standards.

This implementation plan is to address wasteload and load allocations defined in the Little Rock Lake Nutrient TMDL Report and Little Rock Creek Watershed TMDL Report for the Dissolved Oxygen, Nitrate, Temperature and Fish Bioassessment Impairments. A brief overview of both TMDL report's findings, description of the relationship of Little Rock Lake and Little Rock Creek impairments, the implementation approach, identification of partners, implementation activities, funding sources, and monitoring needs are all included in this implementation plan. If further review of the Little Rock Lake TMDL, Little Rock Creek TMDL or the Little Rock Creek Stressor Identification Report is desired the following are the links to the documents.

Little Rock Lake TMDL:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl/project-little-rock-lake-nutrients.html

Little Rock Creek TMDL and Stressor Identification Report:
http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/upper-mississippi-river-basin-tmdl/project-little-rock-creek-biota.html

The focus of the implementation plan is broad; load reductions will be required from agricultural and lakeshore uses as well as reductions in groundwater use and internal nutrient loading for Little Rock Lake along with possible changes to the management or structure of the Sartell Wildlife Management Area (WMA).

The Little Rock Creek and Little Rock Lake watersheds overlap, allowing the opportunity to address all impairments in one implementation plan. Little Rock Creek flows south through Little Rock Lake and ultimately discharges to the Mississippi River via the Harris Channel. The Mississippi River is a source of drinking water for communities downstream.

Little Rock Lake

303(d) Listing

Table 1 Little Rock Lake 303(d) Listing

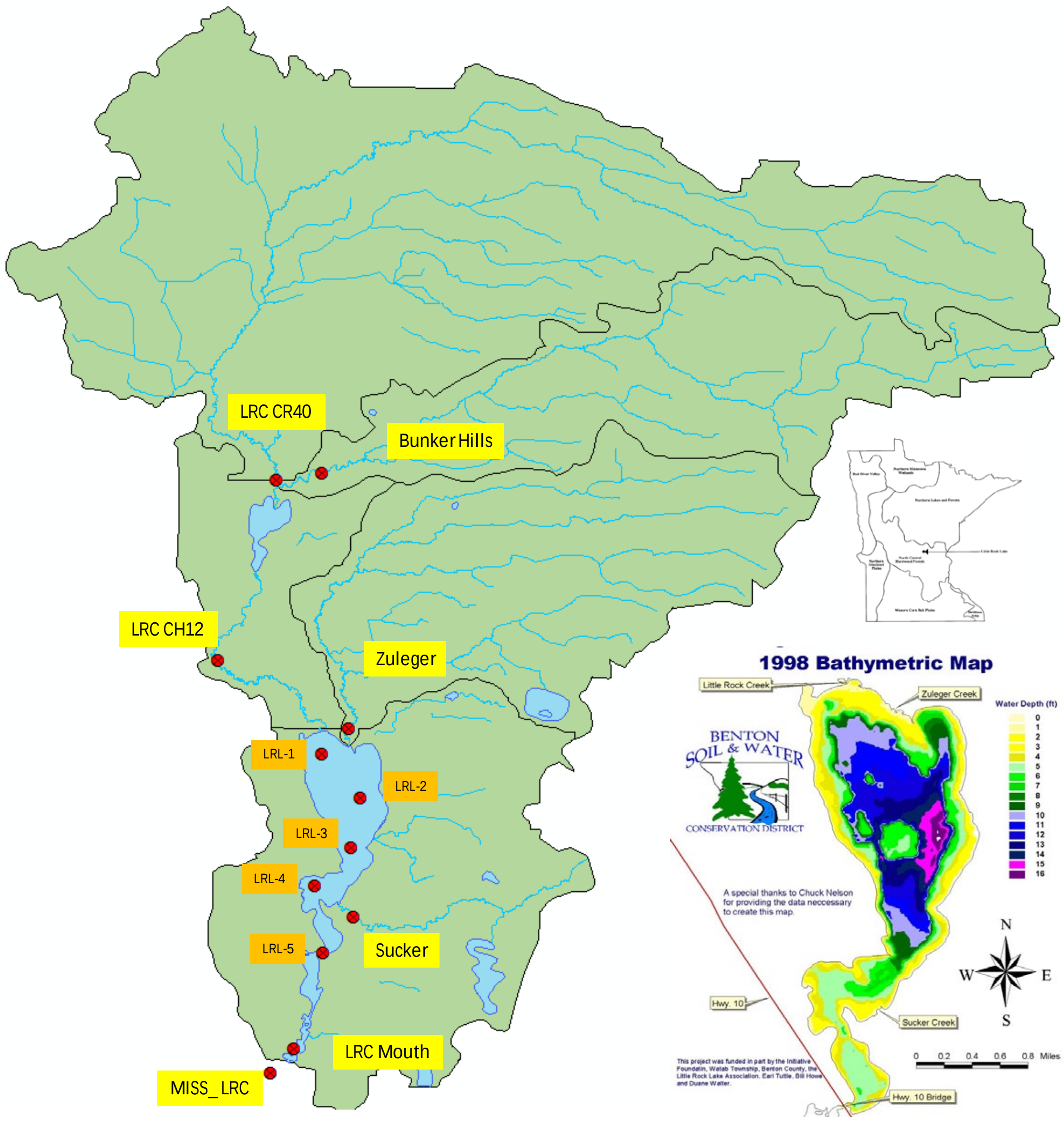
Lake Identification #	Affected Use	Pollutant or Stressor	Status
05-0013-00	Aquatic Recreation	Excess Nutrients: Phosphorus	TMDL is Final

Lake and Watershed Description

Little Rock Lake is located in western Benton County (Figure 1). The Minnesota Department of Natural Resources (MN DNR) lake identification number for Little Rock Lake is 05-0013-00. The watershed lies within the North Central Hardwood Forest (NCHF) Ecoregion. This ecoregion is an area of transition between the forested areas to the north and east and the agricultural areas to the south and west. The terrain varies from rolling hills to smaller plains. Upland areas are forested by hardwoods and conifers. Plains include livestock pastures, hay fields and row crops such as potatoes, beans, peas and corn.

Figure 1 Little Rock Lake Watershed Location

Figure 2 Little Rock Lake Watershed with Monitoring Stations



Originally a wetland, the lake basin was formed in 1911 when a dam was constructed on the Mississippi River downstream of the Little Rock Creek outlet. Water levels were further raised in 1934 and Little Rock Lake evolved from a vegetated marsh to turbid impoundment. The lake freely exchanges water with the Mississippi River through what is called the 'Little Rock Channel,' 'No Name Lake,' or 'Harris Channel.' The water level in Little Rock Lake was raised approximately seven feet by the installation of the dam (Benton Soil and Water Conservation District, 2012).

All waters of Minnesota are assigned classes based on their suitability for the following beneficial uses:

1. Domestic consumption
2. Aquatic life and recreation
3. Industrial consumption
4. Agriculture and wildlife
5. Aesthetic enjoyment and navigation
6. Other uses
7. Limited resource value

Little Rock Lake is listed in the Minnesota Rules Chapter 7050.0470 classification as a 2B water body, aquatic life and recreation.

Little Rock Lake has an approximate surface area of 1,270 acres and is in the upper 25 percent of the lakes in the state, in terms of surface area (Figure 2). It is a very shallow lake, with a mean depth of approximately 8 feet and a maximum depth of 17 feet. The littoral zone (less than 15 feet in depth) covers approximately 1,219 acres or 96% of the surface area. The total length of the shoreline around the lake is 15.7 miles. The 67,650 acre watershed (Figure 2) is almost evenly split between Benton (36,030 acres) and Morrison (31,620 acres) counties. The resulting watershed to lake surface area is relatively large at 53:1. The fetch is approximately two miles long. The estimated water residence time is 0.3 to 0.5 years (Benton Soil and Water Conservation District, 2012).

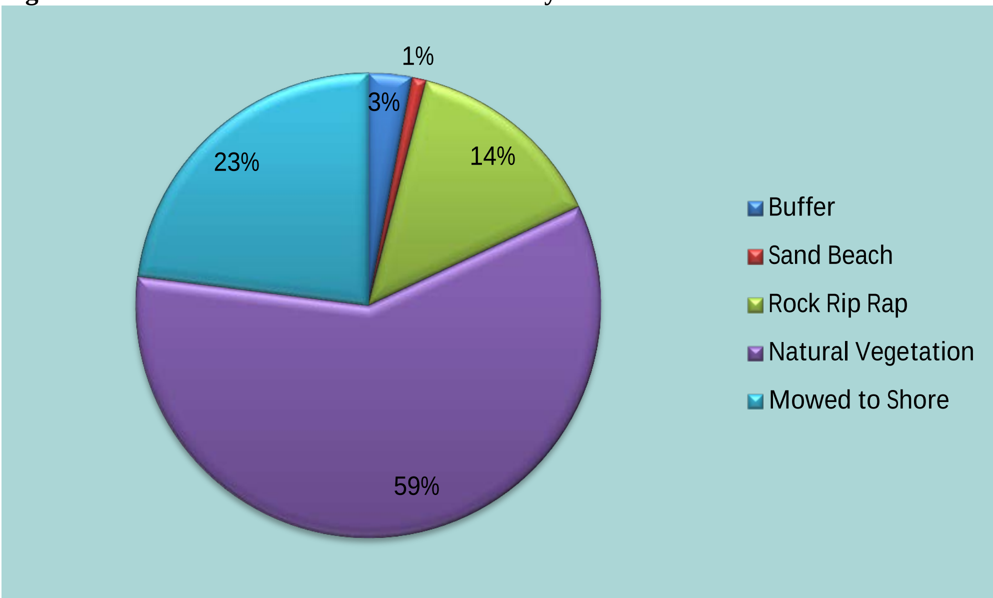
Most of the watershed is in the Agram Sand Plain and the Pierz Drumlin Plain. Due to the predominance of sandy soils in the watershed, many cropland acres are irrigated (Benton Soil and Water Conservation District, 2009). The watershed contains 106 feedlots and 25 to 37 thousand Animal Units (1 AU = 1000 lbs live animal weight, ~ 1 dairy cow) consisting of 26% dairy cattle, 12% beef cattle, 11% swine, and 51% poultry.

In October 2010, Benton SWCD partnered with Little Rock Lake Association to conduct a survey of Little Rock Lake's shoreline. Using GPS Trimble technology, Little Rock Lake's shoreline was classified into five categories. The categories were based on the following criteria:

Buffer: Vegetation extended approximately 15 feet from the shoreline.
Sand Beach: Sand to the shoreline.
Rock Rip Rap: Rock along the shoreline, majority of time rock rip rap was accompanied with groomed lawn to shoreline.
Natural Vegetation: Mix of plants, grasses, wildflowers, shrubs and trees. Width of the vegetation was not feasible to determine.
Mowed to Shore: Manicured lawn directly to shoreline or less than 15 feet of natural vegetation.

Figure 3 shows the results of the 2010 shoreline survey. The survey identified that a large portion of Little Rock Lake's shoreline is natural vegetation; however, it must be noted that the width of that natural vegetation was not determined, so further investigation may be warranted in determining if sufficient 'buffer' is present and also if species present are most beneficial to filter nutrients.

Figure 3 2010 Little Rock Lake Shoreline Survey Results



Little Rock Lake is one of only two recreational lakes in Benton County. As a result, it has a high value both as recreational water and for shoreline development. Many of the "summer cabins" around the lake have been or are being replaced by year-round residences. Table 2 lists parcel numbers provided by Benton County Assessor, Department of Development and GIS departments using 2013 data.

Table 2 2013 Little Rock Lake Lakeshore Parcels

Parcel Type	Number of Parcels
Agricultural	1
Miscellaneous	11
Residential 1-3 units	8
Rural Vacant Land	18
Residential	247
Seasonal Residential	125
TOTAL	**410**

Accomplishments

Benton and Morrison Soil and Water Conservation Districts (SWCDs) have a history of successfully installing Best Management Practices (BMPs) in the Little Rock watersheds. Both districts have taken a leadership role in the coordination and implementation of BMPs and water quality and quantity projects and programs. The following are a few highlights and accomplishments made by Benton and Morrison SWCD's and partners. Each District and partners have different focuses and install different practices; Tables 3, 4, and 5 illustrate a variety of practices installed by Benton and Morrison SWCD or Natural Resource Conservation Service (NRCS) from 2008 through 2012.

Table 3 District Practices Installed from 2008 to Present in the Little Rock Lake Watershed

Practice Installed	Benton SWCD	Morrison SWCD
Feedlot Improvement Projects	5 feedlots	6 feedlots
Filter strips	NA	7 units
Grassed Waterways	NA	1 unit
Irrigation Water Management	557.2 acres	958.2 acres
Irrigation Uniformity Tests	5 pivots	1 pivots
Manure Spreader Calibration	16 calibrations	NA
Native Shoreland Buffers	12 buffers (20, 947 square feet)	NA
Nutrient Management Test Plots	39 test plots (470 acres)	NA
Riparian Buffer Plantings	NA	3 buffers (5,237 square feet)
Shelterbelt/Windbreaks	NA	9 plantings (2,700 feet)
Terraces/Diversions	NA	4 units
Water and Sediment Control Basins	NA	3 units
Well Closures	NA	2 wells

Table 4 EQIP Practices Installed from 2008 to Present in Benton County's Portion of the Little Rock Lake Watershed

Environmental Quality Incentive Program Practice (EQIP) Installed	Benton NRCS
Compost Facilities	1 unit
Conservation Tillage	1605 acres
Cover Crops	40 acres
Feedlot Evaluations	1 feedlot
Fence	8589 feet
Grassed Waterways	1 acre
Headland Planting/Exclusion(Field Border)	1.6 acres
Irrigation Conversion	6415 feet
Irrigation Water Management	557 acres
Manure Pit Storage	1 unit
Nutrient Management	2991 acres
Pasture Seeding	32.5 acres
Pesticide Management	2243 acres
Pipeline	1817 feet
Pit Closures	1 unit
Rain Gutters	546 feet
Shelterbelt	375 feet
Terraces/Diversions	2 units
Tree/Shrub Planting	3 acres
Water and Sediment Basins	2 units
Water Facilities	2 units

Table 5 CRP Practices Installed from 2008 to Present in Morrison County's Portion of the Little Rock Lake Watershed

Conservation Reserve Program (CRP)	Morrison County
CRP Plantings - Total	132.8 acres
Wildlife Habitat	56.1 acres
Riparian Buffer	14.9 acres
Wildlife Food Plot	1.0 acres
Tree Planting Softwoods/Hardwoods	10.2 acres
Native Grasses	42.6 acres
Restore/ Declining Habitat Red/White Pine	6.0 acres
Field Windbreak	2.0 acres

Annual Meetings, Clinics, and Workshops

Benton SWCD attends the Little Rock Lake Association's (LRLA) annual picnic meeting, providing updates on projects and programs. Benton SWCD also facilitates an annual meeting, providing updates to the public on the Little Rock watersheds including monitoring results, practices implemented, and programs offered.

Agricultural Best Management Practice Loan Program

Both Benton and Morrison SWCD's, in cooperation with the Minnesota Department of Agriculture (MDA), offer the Agricultural Best Management Practice Loan Program, also known as the AgBMP Loan Program. The AgBMP Loan Program provides low interest financing to farmers, rural landowners, and agriculture supply businesses to implement practices that prevent or reduce water pollution. This program provides loans for projects that reduce existing water quality problems caused by agricultural activities or failing septic systems. The program provides loans up to $100,000 with a maximum interest rate of 3% interest plus usual and customary fees charged by lenders. Qualified projects are approved by the District Board of Supervisors and/or appropriate staff.

Feedlot Delegation

Benton and Morrison Counties differ in the fact that Morrison County is a feedlot delegated county. This means that the compliance review and enforcement falls upon the responsibility of Morrison County. Benton County is not a feedlot delegated county, so those responsibilities lie in the hands of the MPCA.

Morrison County has 49 feedlots that are required to be registered (either over 50 AU or over 10 AU in shoreland) in the Little Rock Lake watershed. Of the registered feedlots, eight are beef, 16 are dairy, 20 are poultry, and 5 are swine. Since 2008 there has been 7 required completed feedlot fixes, 5 newly registered feedlots, and 2 feedlots closed due to retiring. Benton County numbers were not obtainable at the time of constructing this implementation plan.

Little Rock Lake Association's (LRLA) Long Term Monitoring Program:

In July 2012, Benton SWCD worked with the LRLA to kickoff a long term lake monitoring program. Twice a month, LRLA volunteers collect water samples at sites LRL-1, LRL-2 and LRL-5 (See Figure 2) and then send the samples to a Minnesota Department of Health (MDH) certified lab for analysis of total phosphorus (TP) and Chlorophyll-a. The volunteers also take a secchi disk reading, determining the transparency of the water, and record user perception data at each monitoring site. This program is developed to be a long term monitoring program and is currently funded by LRLA.

Native Buffer Program:
Through a cooperative effort, the Benton SWCD and the LRLA offer a Native Buffer Program. The Native Buffer Program is a voluntary program for people who want to improve water quality by establishing native grasses, flowers, and/or shrubs along their lakeshore. The program provides both technical assistance and cost share to help establish a native buffer. The purpose of the native buffer is to remove nutrients from runoff before it reaches the water's edge.

Nutrient Management Test Plots
Nutrient management test plots are used to evaluate management strategies. A small strip of cropland in a field is used to evaluate the University of Minnesota's nutrient recommendation for a chosen crop. The strip receives manure and fertilizer according to the University of Minnesota's guidelines. The farmer then decides how much manure and fertilizer to apply on the adjacent land (plot). The farmer can apply at higher or lower rates. Yields are checked in the fall to determine which plot resulted in better yields. Although not required, the district encourages the farmer to keep track of any increases or decreases in expenses within either plot so that a cost/benefit analysis can be completed. Dependent upon what crop is chosen for the test plot mid-season leaf samples are collected and analyzed for nutrient content. This information, when combined with yield results, will help determine the effectiveness of the test plots. Soil tests are also performed prior to the plot being planted and include tests for P, K, pH and organic matter; a second "high phosphorus" test may be completed for phosphorus tests which exceed 100 parts per million (ppm). Manure spreader calibrations are also a component to test plots where manure is applied instead of commercial fertilizer.

Additional accomplishments can be located following the watershed description of Little Rock Creek.

Little Rock Creek

303(d) Listing

Table 6 Little Rock Creek 303(d) Listing

Water Body (Reach)	Description	Assessment Unit ID	Affected Use	Pollutant or Stressor	Status
Little Rock Creek	T39 R30W S27, south line to T38 R31W S28, east line (trout stream)	07010201-548	Aquatic Life	Lack of coldwater assemblage	Draft TMDL Anticipated Approval Spring 2013
Little Rock Creek	T39 R30W S22, south line to T38 R31W S28, east line	07010201-548	Drinking Water	Nitrates	
Little Rock Creek	T39 R30W S22, south line to T38 R31W S28, east line	07010201-548	Aquatic Life	Dissolved Oxygen	
Bunker Hill Creek	T38 R30W S6, north line to Little Rock Creek	07010201-511	Drinking Water	Nitrates	

Watershed Description

Little Rock Creek (Hydrologic Unit Code 07010201-548) is located within the NCHF Ecoregion. As defined in the Little Rock Lake watershed description, this is a transition zone between the forested areas to the north and east and the agricultural areas to the south and west.

The Little Rock Creek Watershed is 44,229 acres and is divided between Benton (12,590 acres) and Morrison (31,639 acres) counties (Figure 4). The watershed boundary defines the basin where surface water drains whereas the groundwater boundary delineates where groundwater discharges. The groundwater model domain used for the Little Rock Creek Watershed TMDL study was 215,701 acres (337 square miles) (Figure 5) (Barr Engineering, 2012).

As described in the previous section, all waters of Minnesota are assigned classes based on their suitability and beneficial uses. Little Rock Creek is listed in the Minn. Rules Ch. 7050.0470 classification as a 1B, 2A, 3B water body. Water quality standards are associated with each of the three classifications, with a 2A classification being the most restrictive. Class 2A waters are defined as:

> **Class 2A waters:** The quality of Class 2A surface waters shall be such as to permit the propagation and maintenance of a healthy community of cold water sport or commercial fish and associated aquatic life, and their habitats. These waters shall be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. This class of surface waters is also protected as a source of drinking water (Class 1B).

Figure 4 Little Rock Creek Watershed Impaired Reaches and Monitoring Stations

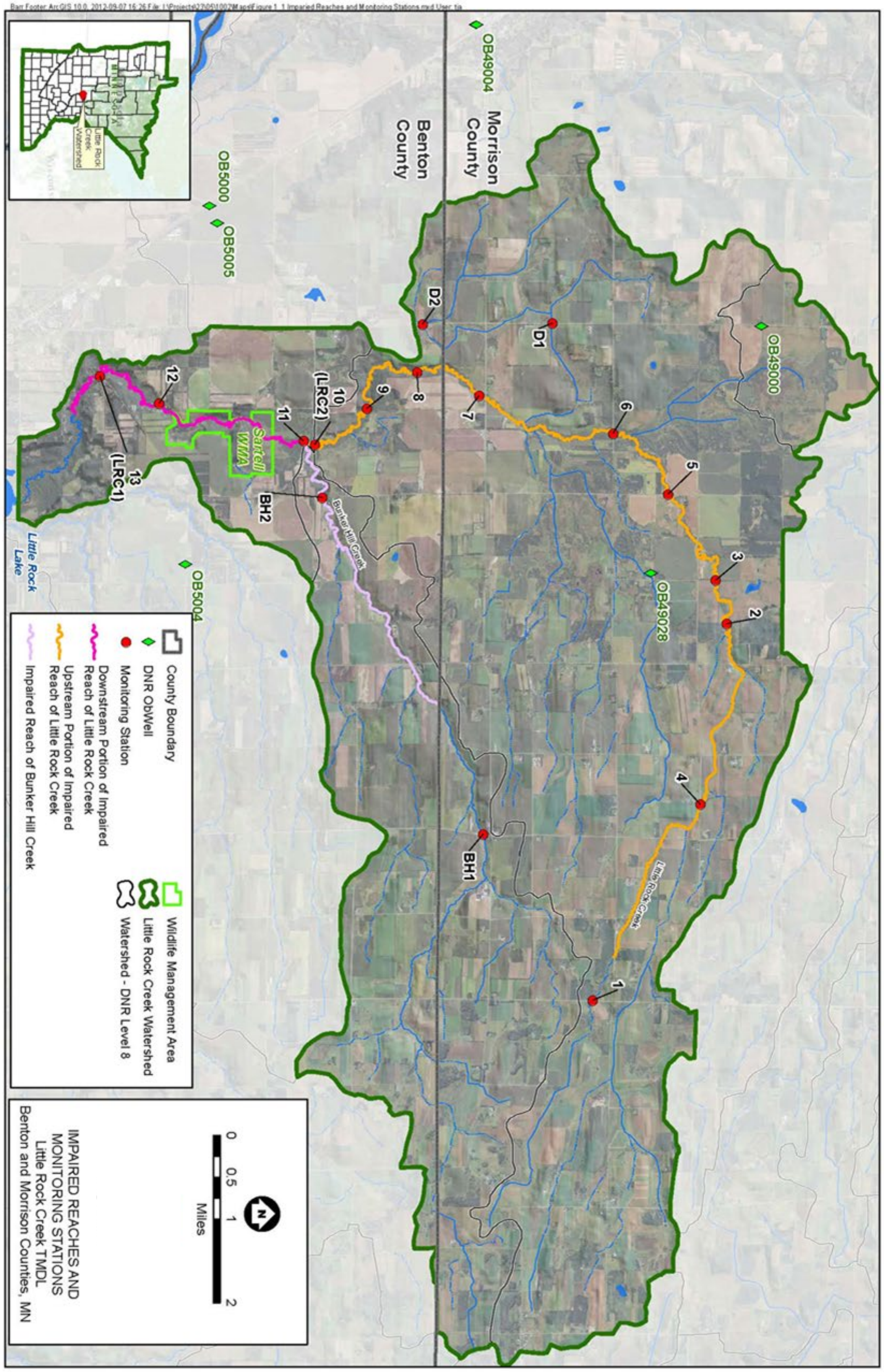
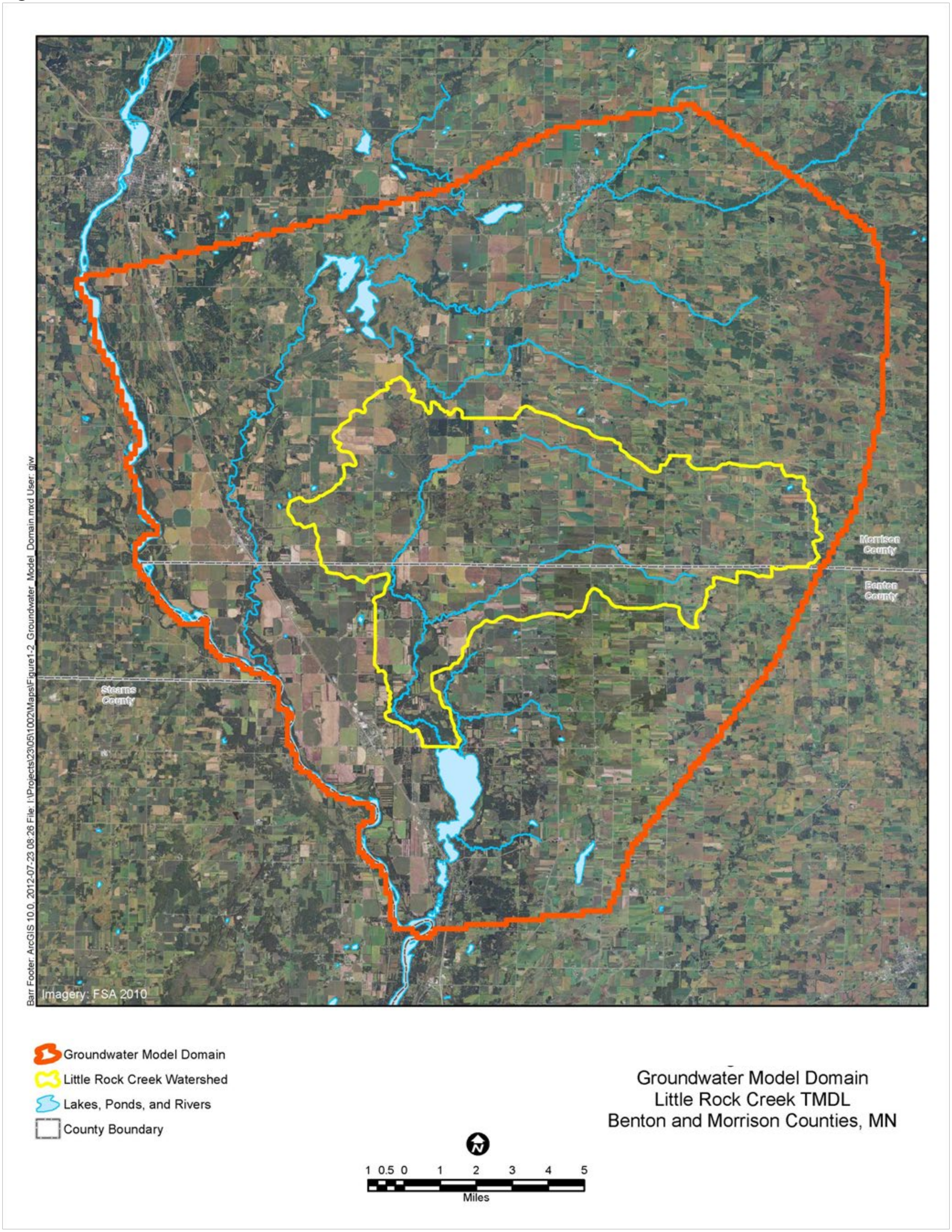


Figure 5 Little Rock Creek Groundwater Model Domain



The main stream segment of Little Rock Creek is perennial, flowing year round. Most tributaries are intermittent or have been converted to drainage ditches; they only flow at different times of the year, or seasonally when there is enough water from rainfall, springs, or other surface sources such as melting snow. Little Rock Creek flows south through Little Rock Lake and ultimately discharges to the Mississippi River via the Harris Channel. The elevation ranges from 1,296 feet in the northeast portion of the watershed to 1,017 feet at the outlet of Little Rock Lake into the Mississippi River.

According to the National Agricultural Statistical Service, in 2009 the land use in the watershed consisted of 50% crops, 14% woodland, 22% grass/pasture, 13% water/wetlands and less than 1% residential development (Benton Soil and Water Conservation District, 2009).

The watershed has alluvial soils made up predominantly of fine sands. The topography is flat to gently rolling. Most of the watershed is in the Agram Sand Plain and the Pierz Drumlin Plain. Due to the predominance of sandy soils in the watershed, many cropland acres are irrigated (Benton Soil and Water Conservation District, 2009

Stream habitat in Little Rock Creek changes throughout its course. The upstream portion (from the headwaters to Station 5) is slow, marshy and warmer than downstream sections. From Station 5 (Figure 4) in Morrison County and downstream, the creek picks up groundwater from springs and the temperature drops. The MN DNR trout stream designation begins at Station 1 and extends downstream to Station 13 (Figure 4). Substrates in the trout stream section change from sand and silt in the vicinity of Station 5 to boulder, rock, gravel and sand near Station 7. Coarse substrates persist from Station 7 downstream approximately 1.5 river miles to where the stream slows and becomes more meandering. Sand and silt substrates dominate throughout the remainder of the stream. Riffle, pool and undercut bank type habitat components do not appear to be limiting factors on brown trout abundance (Little Falls DNR Fisheries Stream Population Assessments).

Accomplishments

Benton County Geologic and Hydrogeologic Atlas:
Recently, the MN DNR Division of Ecological and Water Resources released the Geologic Atlas of Benton County Part B report. County Geologic Atlases are created as part of a joint program between the MN DNR Waters and Minnesota Geologic Survey (MGS). The County Geologic Atlas is a systematic, two-part study of geologic (e.g., rock, sands, and tills) and hydrogeologic (i.e., relating to water and water flow) resources. Together, the two reports provide comprehensive data that tells the story of Benton County's history, formations, groundwater flow systems, aquifer capacity, groundwater chemistry, and sensitivity to pollution. Morrison County is currently undergoing monitoring and data collection for the creation of the Geologic and Hydrogeologic Atlases, expected publication date of June 2013.

Trout Assessment:
DNR records show that Little Rock Creek has supported a low density wild brown trout population since they were introduced into Little Rock Lake in 1908 (Benton Soil and Water Conservation District, 2009). Brown trout were occasionally present in routine stream assessments through the late 1980's. The population assessment done in 1992, however, failed to document the presence of brown trout, suggesting that the population may have become critically low during the drought years of the late 1980's and early 1990's. In an effort to reestablish a self-sustaining brown trout population in Little Rock Creek, wild brown trout were collected from southeast Minnesota streams and stocked in 1995, 1996, 1997 and 1998. Little or

no natural reproduction was documented in DNR assessments following these stockings. A four year gap in brown trout stocking from 1999 through 2003 coincided with a large drop in brown trout abundance in the stream. A stream population assessment completed in the fall of 2003 captured a total of six Young of Year (YOY) brown trout, indicating that only a remnant brown trout population existed that was capable of limited natural reproduction.

Different trout management strategies have been used since 2002 on Little Rock Creek. A wild Minnesota strain of brook trout was stocked in 2002, 2003, 2004, 2006 and 2008. These stockings responded similarly to prior brown trout stockings where good initial survival of stocked fish was documented, but little or no reproduction occurred from established populations. Brood stock quickly declined after cessation of stocking with few fish surviving past age three. No brook trout were sampled in the 2011 assessment while 33 natural brook trout were captured in the 2012 assessment, including several adults.

Annual adult or yearling brown trout stocking commenced in 2004 and continued through 2009. In addition, 10,000 brown trout fingerlings (YOY) were stocked each year in 2010 and 2011. This strategy had been successful in establishing natural populations in other central Minnesota streams. A trout assessment conducted in 2011 sampled the highest trout densities ever recorded on Little Rock Creek. Brown trout densities ranged from 118/mile to 1,185/mile at 5 sampling stations upstream of the Sartell WMA. No stocking occurred in 2012 so that natural reproduction from these stockings could be evaluated. In the 2012 trout assessment, no natural reproduction of brown trout was observed despite the presence of a large adult population. Natural reproduction of brook trout was observed.

Under present and recent conditions, good brown and/or brook trout populations can exist in Little Rock Creek through frequent stocking. In addition to trout, the stream contains a diverse fish community with 28 species sampled in a prior assessment (1992). White sucker, blacknose dace, Johnny darter and creek chub were the most common species sampled.

Irrigation Scheduling Program and Uniformity Testing:

With the support of Morrison SWCD, the Benton SWCD, in interest of sound irrigation management and water management offers the “Irrigation Scheduler Program,” a computer assisted management aid. The program is offered in both Benton and Morrison Counties. The program is designed to provide a second opinion on in-field soil moisture status that can assist the irrigator in determining when to irrigate. The purpose of the program is to prevent crop loss due to insufficient moisture, prevent groundwater contamination due to over application of water and leaching of nutrients and prevent over or inadequate irrigation water application.

Benton SWCD also offers irrigation uniformity testing (catch can tests) to be conducted on center pivots or lateral units to measure the uniformity and efficiency of the water application of the unit.

Irrigation Clinics

In 2012, Benton SWCD put on an irrigation clinic, providing updates on irrigation technology, irrigation water management strategies, and programs available. Benton SWCD will also be offering an irrigation clinic in 2013.

Trout Unlimited Projects

It is Trout Unlimited’s mission to conserve, protect and restore North America’s coldwater fisheries and their watersheds. Since 2007, the St. Cloud Trout Unlimited Chapter has installed 3 projects focusing on streambank erosion, narrowing of channel and trout habitat improvements.

In 2010 a cooperative effort between St. Cloud Trout Unlimited, DNR Fisheries - Little Falls, US Fish and Wildlife Service, and several private land owners led to a brush layering project being installed in the section of Little Rock Creek between the minimum maintenance bridge and approximately ½ mile downstream. Areas of the stream that were widened due to alder growth were narrowed using cedar harvested from local land owner properties. The process was effective at narrowing the channel and built banks while improving actual sediment composition within the streambed.

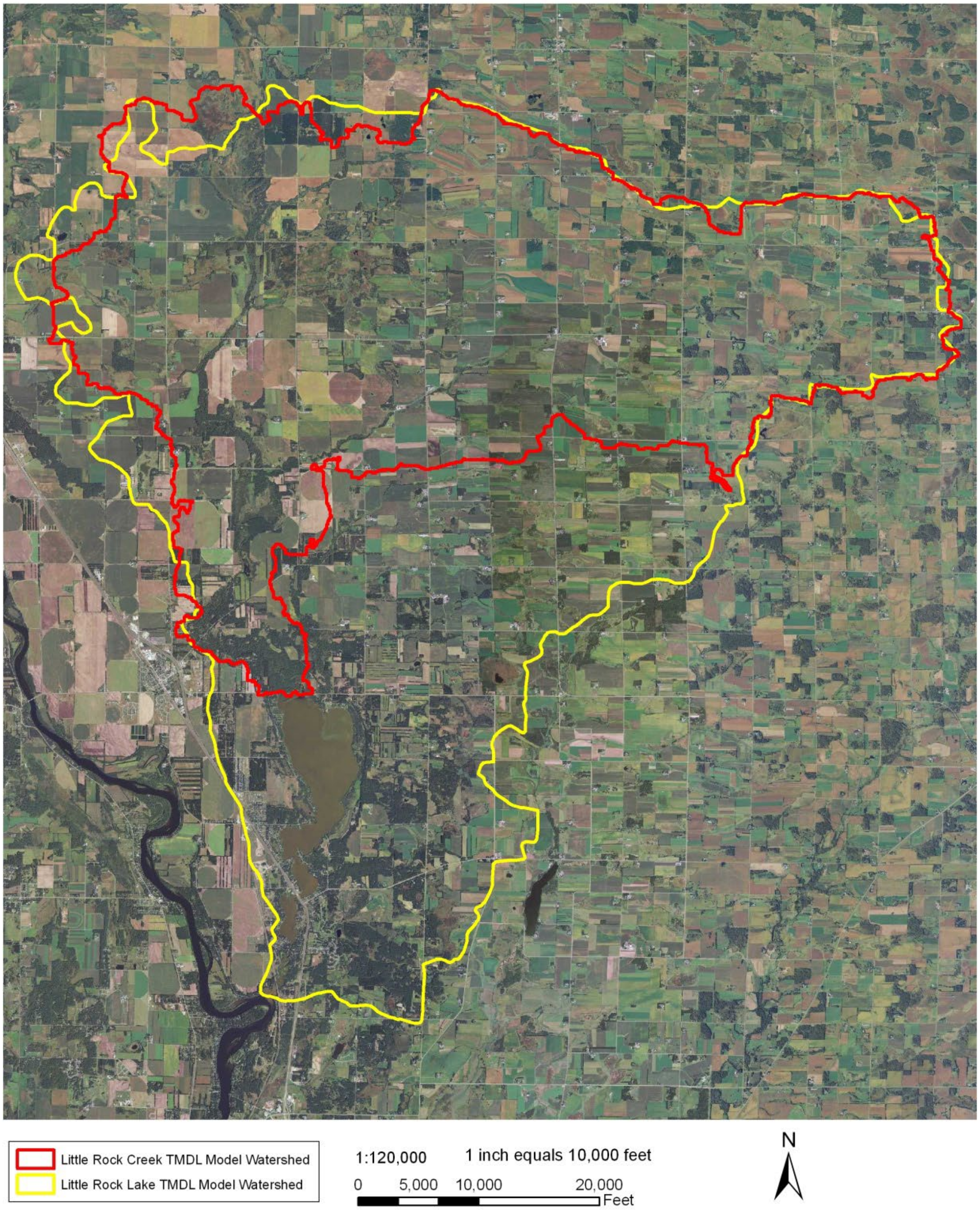
Additional accomplishments can be located following the watershed description of Little Rock Lake.

Relationship between Little Rock Lake and Little Rock Creek

Little Rock Creek and Little Rock Lake watersheds overlap, allowing the opportunity to address all impairments in one implementation plan. Little Rock Creek flows south through Little Rock Lake and ultimately discharges into the Mississippi River via the Harris Channel. The 67,650 acre Little Rock Lake watershed encompasses the 44,229 acre Little Rock Creek watershed (Figure 6). Thus, activities of restoration completed in the Little Rock Creek watershed benefit the water quality in the Little Rock Lake watershed.

Since the Little Rock Creek flows through Little Rock Lake and discharges to the Mississippi River, the importance of the Mississippi River must be noted as it is a source of drinking water for the following downstream communities: Cities of St. Cloud, Minneapolis and St. Paul. Thus, the water quality of Little Rock Lake and Little Rock Creek has the potential to have a direct effect upon the water quality of the Mississippi River. The listing of Little Rock Creek and Bunker Hill Creek on the 303 (d) list, for not meeting drinking water standards for nitrates, is of particular concern for the water quality of the Mississippi River.

Figure 6 Little Rock Lake and Little Rock Creek TMDL Model Watersheds



TMDL Modeling and Allocation Summary

A TMDL is a calculation of the maximum amount of pollutant that a waterbody can receive and still meet water quality standards and designated uses. It is the sum of the loads of a single pollutant from all contributing point and nonpoint sources. The goal of a TMDL is to quantify the pollution reduction needed to meet Minnesota's water quality standards in accordance with section 303(d) of the Clean Water Act. Pollution reduction requirements were previously developed and presented in the Little Rock Lake TMDL and Little Rock Creek TMDL Reports.

The TMDL studies were developed according to the following relationship (equation):

LA (s) + WLA (s) + Margin of Safety + Reserve Capacity = Total Maximum Daily Load

Where:
LA= sum of all load allocations; portion of the TMDL allocated to existing or future nonpoint sources of the relevant pollutant. The load allocation may also encompass "natural background" contributions;

WLA= sum of all wasteload allocations; portion of the TMDL allocated to existing or future point sources of the relevant pollutant;

Margin of Safety= an accounting of uncertainty about the relationship between pollutant loads and the quality of the receiving water body;

Reserve Capacity= an allocation set aside for future development;

Pollution reduction strategies were developed and are presented within this implementation plan for both Little Rock Lake and Little Rock Creek impairments. The following two sections summarize the TMDL reports' findings to better understand restoration activities suggested within this plan.

Little Rock Lake TMDL

The Little Rock Lake TMDL provides excess nutrient allocations for Little Rock Lake. It is based on Minnesota's current eutrophication water quality standard for shallow lakes in the NCHF Ecoregion: TP less than or equal to 60 µg/L, chlorophyll-a less than or equal to 20 µg/L, and secchi depth not less than 1.0 m (MN Rules 7050.0222, 2012).

Note that 60 µg/L is the same as 60 ppb and is used interchangeably throughout this document.

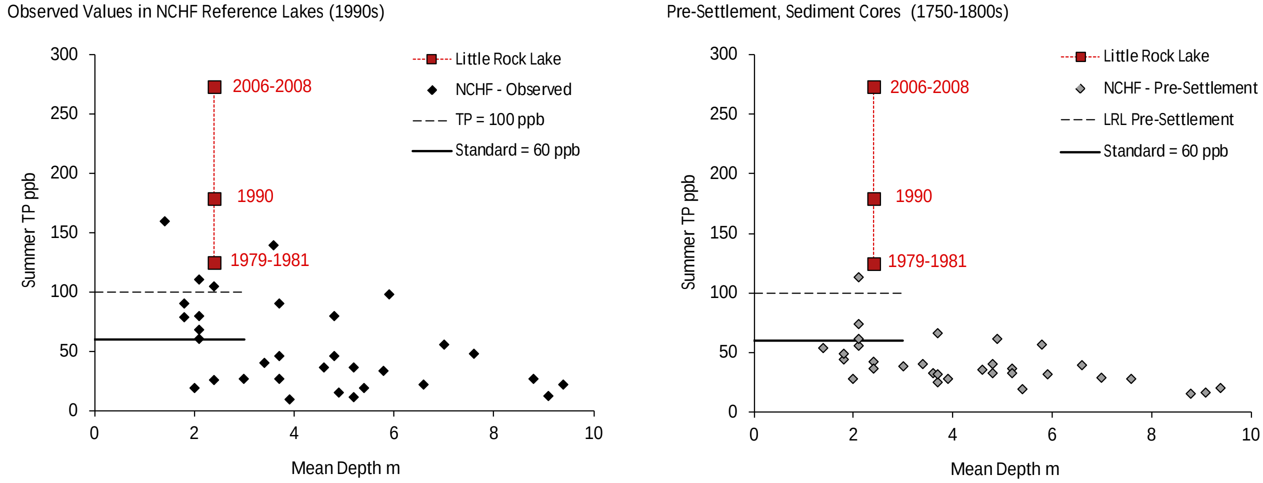
Historical data indicates that Little Rock Lake summer mean TP concentrations increased from ~125 ppb in 1979-1981 to ~270 ppb in 2006-2008, both significantly greater than the 60 ppb water quality standard. Corresponding increases in chlorophyll-a and decreases in transparency were observed.

Lake TP concentrations are highly correlated with chlorophyll-a levels, Secchi depths, and user perceptions of aesthetic qualities and suitability for recreational use. Algal blooms in Little Rock Lake are highly responsive to variations in watershed phosphorus loads, recycling of historical phosphorus loads from bottom sediments, and climate. Toxic bluegreen algal blooms and noxious hydrogen sulfide odors were observed in 2007, when spring runoff contained the highest TP concentrations and loads. High concentrations of other nutrients and fecal coliforms indicate that animal waste was a significant source. The blooms were likely accelerated later in the summer by low inflows and warm temperatures.

Modeling results indicate that achieving the eutrophication water quality standards for TP, Chlorophyll-a (Chl-a), and secchi depth would require reducing the tributary flow-weighted-mean TP concentrations to 83 ppb or less. Reductions in load relative to existing conditions range from 54% to 69% for the individual tributaries, although these estimates could vary considerably because of uncertainty in baseline loads derived from the 2006-2008 data (Table 7).

Figure 7 compares historical summer-mean TP levels with data from other regional lakes classified as "reference" or "minimally-impacted" (Heiskary & Wilson, 2005). The susceptibility of shallow lakes to eutrophication problems is reflected by the negative correlation between TP concentrations and water depth. The left panel shows TP levels measured in the 1990s. The right panel shows estimates for pre-settlement conditions (1750-1900) derived from sediment cores. Total phosphorus concentrations in Little Rock Lake more than doubled over the years to levels that far exceed the standard and values observed in the other shallow lakes. TP concentrations averaged 125 ± 5 ppb in 1979-1981, 179 ± 23 ppb in 1990, and 273 ± 35 ppb in 2006-2008. High values measured in 2006-2008 may be *partially* attributed to extreme climatologic conditions (warm and dry) as opposed to a long-term trend in the lake water quality. The mean value for the reference lakes under pre-settlement conditions (on right) is similar to the 60 ppb phosphorus component of the eutrophication standard.

Figure 7 Little Rock Lake Summer Total Phosphorus Concentrations vs. Data from Other NCHF Lakes



Sediment core studies indicate that Little Rock Lake historical summer-average TP concentrations ranged from 109 ppb in 1911 to 176 ppb in 2008 (Garrison et al, 2009). These estimates were based upon diatom species distribution at sediment depths of 50-52 cm and 0-2 cm, respectively. While the relevance of the 1911 estimate (109 ppb) is questionable because Little Rock Lake was a wetland at that time, it is similar to the 100 ppb TP criterion for extreme bluegreen blooms in turbid lakes (Sas, 1989; MPCA, 1974). While within the range of historical data, the 2008 estimate is relatively uncertain because it required extrapolation of the dating methodology beyond its calibration range. Other sediment profile data, including lower iron-bound P levels in the surface sediments (James, 2008) and increased dominance of microcystis (Garrison et al, 2009), are consistent with increases in nutrient enrichment and transition from a wetland to a turbid hyper-eutrophic lake over the years since Little Rock Lake was formed.

Figure 8 shows seasonal variations in water temperature and trophic state indicators in 1990 and 2006-2008. Lower TP and Chl-a levels observed in 1990 are consistent with lower water and air temperatures in July and August. Relatively high water temperatures, high TP levels, high Chl-a levels, and low Secchi depths were observed in June and July of 2007. Toxic bluegreen algae (Microcystis specie) and atmospheric hydrogen sulfide releases from anoxic bottom sediments were also reported (Lindon et al., 2007). Comparisons with data from other years indicate that severe conditions in 2007 were triggered by high tributary TP loads in March-April (see below) followed by summer low flow and high temperatures.

Figure 8 Seasonal Variations in Little Rock Lake Water Quality During 1990 and 2006-2008

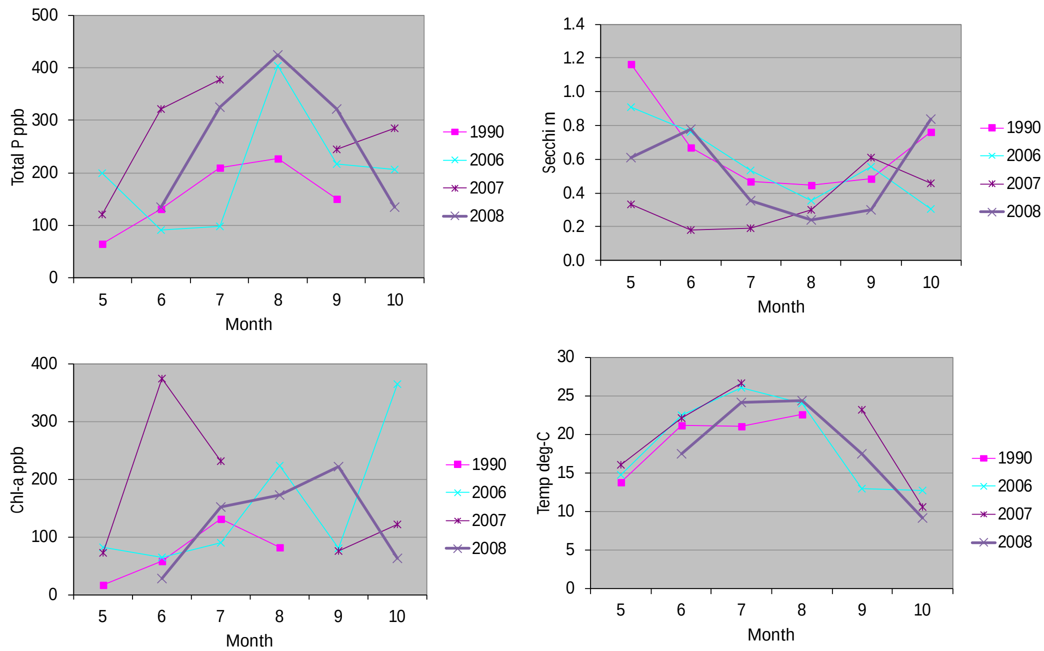
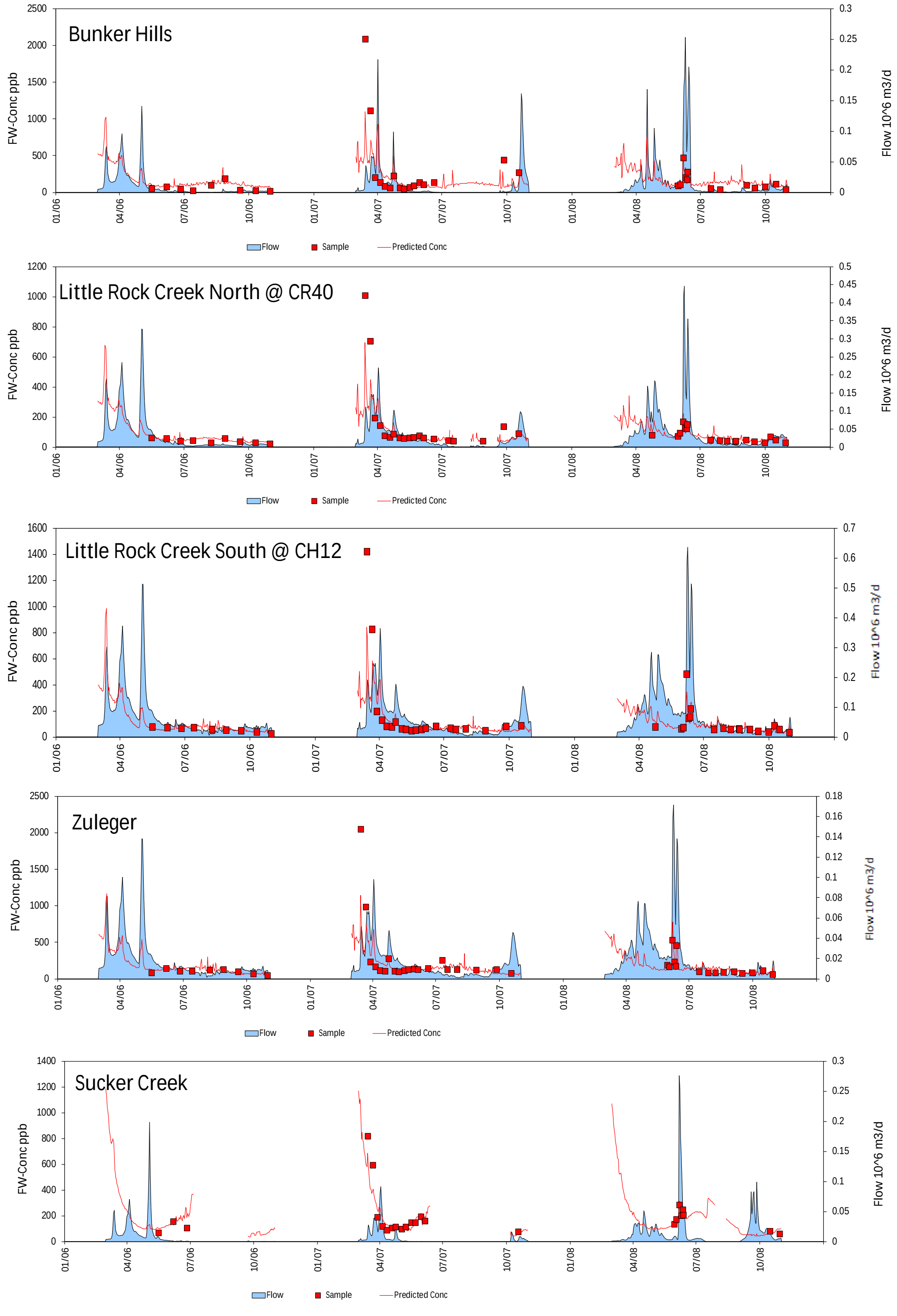


Figure 9 shows daily flows and TP concentrations in the tributaries over the 2006-2009 period. Red lines show daily estimated TP concentrations predicted from regression equations relating sampled values to flow and season (Walker & Havens, 2003). Extremely high TP levels (~500-1000 ppb), as well as high concentrations of fecal coliforms and other nutrients indicative of animal waste, were measured in early spring runoff of 2007 (Benton Soil and Water Conservation District, 2012). Concentration spikes also occurred during the June 2008 runoff event.

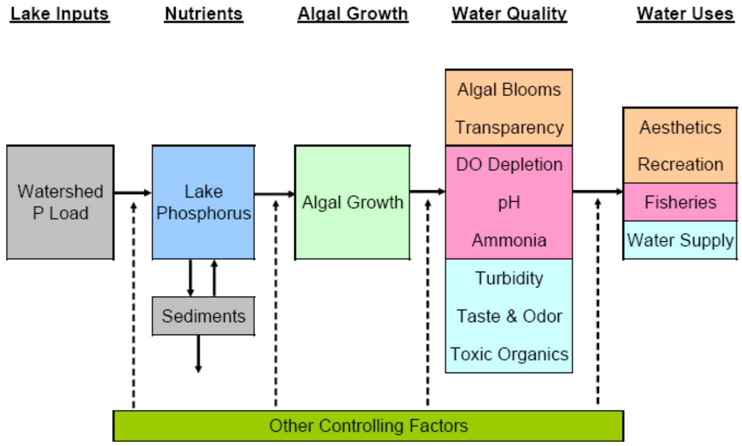
Early spring rains in 2007 would have promoted the transport of nutrients from watershed sources to the lake. Little Rock Creek spring runoff peaked at 148 cfs in 2007 as compared with 583 cfs in 2009, when water quality sampling was not conducted. Lake water levels rose by 0.6 ft in spring of 2007 as compared with 2.5 ft in spring of 2009 (Benton Soil and Water Conservation District, 2012). It is likely that the much larger spring runoff event in 2009 would have contributed substantially more phosphorus to the lake than the spring runoff in 2006-2008.

Figure 9 Daily Flows & Flow-Weighted Mean Phosphorus Concentrations at Tributary Sites



Flow and load allocations across sources for the baseline, interim and TMDL scenarios are listed in Table 7. Load reductions relative to the baseline range from 54 to 69% for the individual tributaries discharging directly into the lake, although these estimates could vary considerably because of uncertainty in baseline loads derived from the 2006-2008 data. It is assumed that the existing high rates of internal phosphorus recycling will decrease as the lake and sediments equilibrate to lower external phosphorus loads (Figure 10).

Figure 10 Casual Pathways Linking Total Phosphorus to Lake Water Quality and Uses



Load Allocation (LA)

The entire watershed load is from nonpoint sources with the exception of a small amount of discharge from regulated Municipal Separate Storm Sewer Systems (MS4s) in the Little Rock Lake subwatershed. Approximately seven percent of the Little Rock Lake subwatershed consists of regulated MS4s. Thus, assuming area proportionality, 7 % of the allocation for the subwatershed was placed into the WLA and the remaining 93% in the LA. Table 7 summarizes allocations for each subwatershed.

Wasteload Allocation (WLA)

As stated previously, seven percent of the load for the Little Rock subwatershed was assigned to municipal stormwater. The WLA is expressed as a categorical allocation because of uncertainty in determining the loads from individual MS4s. The regulated MS4s are covered under the General Permit MNR040000 and include the following:

- Watab Township (ID = MS400161)
- Minnesota Department of Transportation – Outstate (ID = MS400180)
- Benton County (ID = MS400067)

There currently are no regulated industrial stormwater dischargers within the watershed. A WLA of 2 kg/year was assigned to construction activity to account for construction activities regulated under a National Pollutant Discharge Elimination System/State Disposal System (NPDES/SDS) permit. This amounts to 0.0006 % of the total TMDL and is based on historical data on construction activity within the watershed.

In the event that additional stormwater discharges come under permit coverage within the watershed, WLA or LA will be transferred to these new entities based on the process used to set WLA in the TMDL. MS4s will be notified and will have an opportunity to comment on the reallocation.

Table 7 Little Rock Lake Load Allocations for Baseline, Interim, & TMDL Scenarios

	Baseline 1991-2009 Hydrology, March-Oct				Interim goal			TMDL Allocation (c)			
Source	Area km2	Flow hm3	Load kg	Conc ppb	Load kg	Conc ppb	Reduc %	Load kg	Load kg/d	Conc ppb	Reduc %
LRC Subwatersheds											
Bunker Hills	50.5	4.4	1267	287	529	120	58%	a			
LRC North	104.5	11.1	1766	160	1328	120	25%	a			
Lake Inflows – Load Allocation											
LR Creek – CH12	165.8	22	3763	184	2456	120	35%	1827	7	83	55%
Zuleger	48	5.9	1570	265	712	120	55%	492	2	83	69%
Sucker	11.2	3	551	182	364	120	34%	252	1	83	54%
Lake Inflows – Wasteload Allocation											
MS4 stormwater	12.5		283					128			
Construction stormwater					185			2	0.5		55%
Total Gauged	237.5	31	6167	199	3717	120	40%	2571	10.5	83	58%
Lakeshed	25.2	3.1	571	184	571	184	0%	571	2.3	184	0%
Total Watershed	262.6	34.1	6739	198	4288	126	36%	3142	12.8	92	53%
Shore. Septic tanks			90		90		0%	b			
Total External	262.6	34.1	6829	200	4379	128	36%	3144	12.8	92	54%
Rainfall	5.1	3.1	94	30	94	30	0%	94	0.4	30	0%
Total Inflow	267.7	37.2	6923	186	4473	120	35%	3238	13.2	87	53%

Predicted Lake	Standard	Mean	10%	90%	Mean	10%	**90%**
Total P ppb	< 60	78	55	111	60	42	**85**
Chlorophyll-a ppb	< 20	24	14	42	18	10	**32**
Secchi m	> 1.0	0.9	0.6	1.2	1.1	0.8	1.5

a TMDL allocations for little Rock Creek Subwatersheds are reflected in the total allocation for LR Creek at CH12
b Direct discharge from septic systems is not permitted under MN state law; therefore the allocation for septic systems is zero.
C The TMDL is the total inflow load (3238 kg)

In summary, the TMDL for Little Rock Lake is 13.2 kg/day, resulting in the need for an overall reduction of 53% of phosphorus. However, due to Little Rock Lake's historical background and the sediment core studies, it is appropriate to set an interim goal of 120 ppb of phosphorus (versus the 60 ppb of phosphorus standard), which would require a 35% overall reduction (Table 7). For more Little Rock Lake TMDL details including modeling approach, water and mass balances, margin of safety and much more, please see the Environmental Protection Agency (EPA) approved Little Rock Lake TMDL located on the MPCA's website, www.pca.state.mn.us.

Little Rock Creek TMDL

The Little Rock Creek TMDL took place in three phases. Phase one activities included gathering and organizing existing data, technical and stakeholder committee meetings to review the existing data collected, initial comparison of available watershed information and landscape activities for possible candidate causes of impairment, and the identified conceptual project structure and additional data needs. Phase two activities included collecting physical, chemical and biological data including flow/stage data, water quality samples, multi-parameter Sonde data, fishery data, habitat analysis data, and invertebrate and habitat data. Information was then compiled from data, along with technical and stakeholder meetings, and a stressor identification report was written. Upon completion of the Little Rock Creek Stressor Identification analysis, it was determined that temperature, bedded sediment, nitrates and dissolved oxygen, all with reference to flow, were sources of impairment. Water quality and groundwater modeling took place in phase three of the Little Rock Creek TMDL, as well as the development of the Little Rock Creek Watershed Total Maximum Daily Load: Dissolved Oxygen, Nitrate, Temperature and Fish Bioassessment Impairments Report.

The Little Rock Creek modeling supported the development of allocation TMDL loads for Little Rock Creek's impairment for lack of coldwater fish assemblage and includes impaired waters listings for dissolved oxygen, temperature and nitrates (including Bunker Hill Creek). Bunker Hill Creek is a tributary to Little Rock Creek and is also impaired for nitrates. The material contained in this section (Little Rock Creek TMDL Summary) is excerpted from the Draft Little Rock Creek Watershed Total Maximum Daily Load Report: Dissolved Oxygen, Nitrate and Fish Bioassessment Impairments prepared for Benton County Soil and Water Conservation District, Minnesota Pollution Control Agency, constructed by Barr Engineering.

Fish Bioassessment

"Lack of Coldwater Assemblage" means that species that favor warmer waters are being found in a stream where we would expect to find species that prefer cold water temperatures, such as in designated trout streams like Little Rock Creek. It could also mean that coldwater species are declining or absent (Brady and Brenneman, 2010). Little Rock Creek was listed on the 2002 303(d) list for impaired waters based on a 1999 in-stream biological assessment for fish; a low fish index of biotic integrity (IBI) was found, based on a warmwater IBI developed for the Upper Mississippi River Basin. The fish community at the location on Little Rock Creek was comprised of highly tolerant warmwater species and absent of species indicative of coldwater habitats. Few trout were captured in the 1999 MPCA fish survey; there was also an absence of Sculpin and Burbot. In 2008, through some revisions to the impaired waters list in previous assessment cycles, Little Rock Creek was listed as impaired for "lack of a coldwater assemblage" rather than the 2002 listing for low fish IBI score.

Dissolved Oxygen

In class 2A streams, the Minnesota standard for dissolved oxygen is 7.0 mg/L as a daily minimum (MPCA, 2012a). It also requires compliance with the standard 50% of the days at which the flow is equal to the 7Q10.

The TMDL for dissolved oxygen has been developed to match the loading capacity for oxygen demanding substances that ensures that the dissolved oxygen daily minimum target of 7 mg/L is met across all reaches for the critical, low flow condition in Little Rock Creek. In a waterbody, dissolved oxygen is consumed both in the water column and through the sediment water interface. Three processes were examined as contributing sources to oxygen depletion in Little Rock Creek: sediment oxygen demand (SOD), nitrogenous biological oxygen demand (NBOD) and carbon biological oxygen demand (CBOD). CBOD represents the amount of oxygen microorganisms require to convert organic carbon to carbon dioxide. It is a representation of the oxygen equivalent of the carbonaceous organic matter in a sample. NBOD represents the oxygen consumption produced through the process of transforming organic nitrogen to ammonia nitrogen and then to nitrate through nitrification. SOD represents the aerobic decay of organic matter in the sediments of a water body. SOD is defined as a rate per unit area of oxygen consumption.

Modeling showed the creek was most sensitive to SOD concentrations. To reach the dissolved oxygen (DO) standard, an 80% reduction in the SOD load was required. The resulting target SOD rate of each reach in the model (g-O2/m2/day) was multiplied by the corresponding wetted area to calculate the SOD TMDL (Table 8).

Load Allocations
The LAs are nonpoint source loads within the stream. For this TMDL, it includes all SOD, CBOD, and NBOD loads.

Waste Load Allocations
There are no wastewater or industrial dischargers in the Little Rock Creek watershed. From the baseflow modeling described in Little Rock Creek TMDL, Appendix A, groundwater flow dominated diffuse water sources during the modeling period. Therefore, all diffuse runoff is received through nonpoint sources and no waste load sources were allocated for this TMDL.

TMDL for Oxygen Demand
The TMDL is the sum of the LAs, the WLAs and the margin of safety. Table 8 illustrates the required loads to meet the TMDL requirements resulting in a minimum DO concentration of 7 mg/L throughout Little Rock Creek. Overall, the total oxygen consumption load needs to be reduced from 327.5 kg/day to 155.9 kg/day under low flow conditions.

Table 8 Loading Capacity and TMDL Allocations for Dissolved Oxygen (AUID: 07010201-548)

	Oxygen Demand (kg/day) from:						*Total Oxygen Demand (kg/day)*	
	CBOD		*NBOD*		*SOD*			
Source	*Current*	*TMDL*	*Current*	*TMDL*	*Current*	*TMDL*	*Current*	*TMDL*
Load: Sediments					227.6	40.4	227.6	40.4
Load: Diffuse Sources	54.4	54.4	45.3	45.3			99.7	99.7
Wasteload: Construction/ Industrial Activities	0.1	0.1	0.1	0.1			0.2	0.2
Margin of Safety						15.6		15.6
Total	54.5	54.5	45.4	45.4	227.6	56.0	327.5	155.9

Overall, a 52% reduction in total oxygen demand is necessary to ensure that the DO standard is met throughout Little Rock Creek under the critical flow conditions.

Nitrates

Little Rock Creek is classified as a 1B stream. This classification designates that treated water will meet both the primary and secondary drinking water standards with approved disinfection. When assessing drinking water-protected surface water Classes 1B and 1C, the 24-hour average nitrate concentrations are compared to the 10 mg/L water quality standard (MPCA, 2012a).

TMDL loading capacities were calculated for two reaches, including all of Little Rock Creek and Bunker Hill Creek, which is a tributary to Little Rock Creek (Figure 4).

Loading Capacity and Nitrate TMDL Allocations for Little Rock Creek
The flow rates were divided into 5 categories: high flows (0-10%), moist conditions (10-40%), mid-range flows (40-60%), dry conditions (60-90%) and low flows (90-100%). The 5 categories were used to calculate the nitrate loading capacities and allocations for Little Rock Creek (Table 9). The total daily loading capacity was calculated using the mid-point flow rates for each of the flow zones and the 10 mg/L nitrate standard concentration. Load Allocations accounted for 89.9% of the capacity being allocated, 0.1% allocated to construction and industrial stormwater, and 10% applied to the margin of safety.

Table 9 Loading Capacity and Nitrate TMDL Allocations for Little Rock Creek (AUID:07010201-548)

	Flow Zone				
	High (95%)	**Moist (75%)**	**Mid (50%)**	**Dry (25%)**	**Low (5%)**
	kg/day				
TOTAL DAILY LOADING CAPACITY	1,740	570	340	230	110
Wasteload Allocation					
Construction/Industrial Stormwater	2	0.6	0.3	0.2	0.1
Load Allocation	1,564	512.4	305.7	206.8	98.9
Margin of Safety	174	57	34	23	11
	Percent of total daily loading capacity				
Wasteload Allocation					
Construction/Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	89.9%	89.9%	89.9%	89.9%	89.9%
Margin of Safety	10%	10%	10%	10%	10%

Loading Capacity and Nitrate TMDL Allocations for Bunker Hill Creek
The total daily loading capacity for Bunker Hill Creek was calculated using the same methods in the Little Rock Creek calculation described in the previous section (Table 10). Load Allocations accounted for 89.9% of the capacity being allocated, 0.1% allocated to construction and industrial stormwater, and 10% applied to the margin of safety.

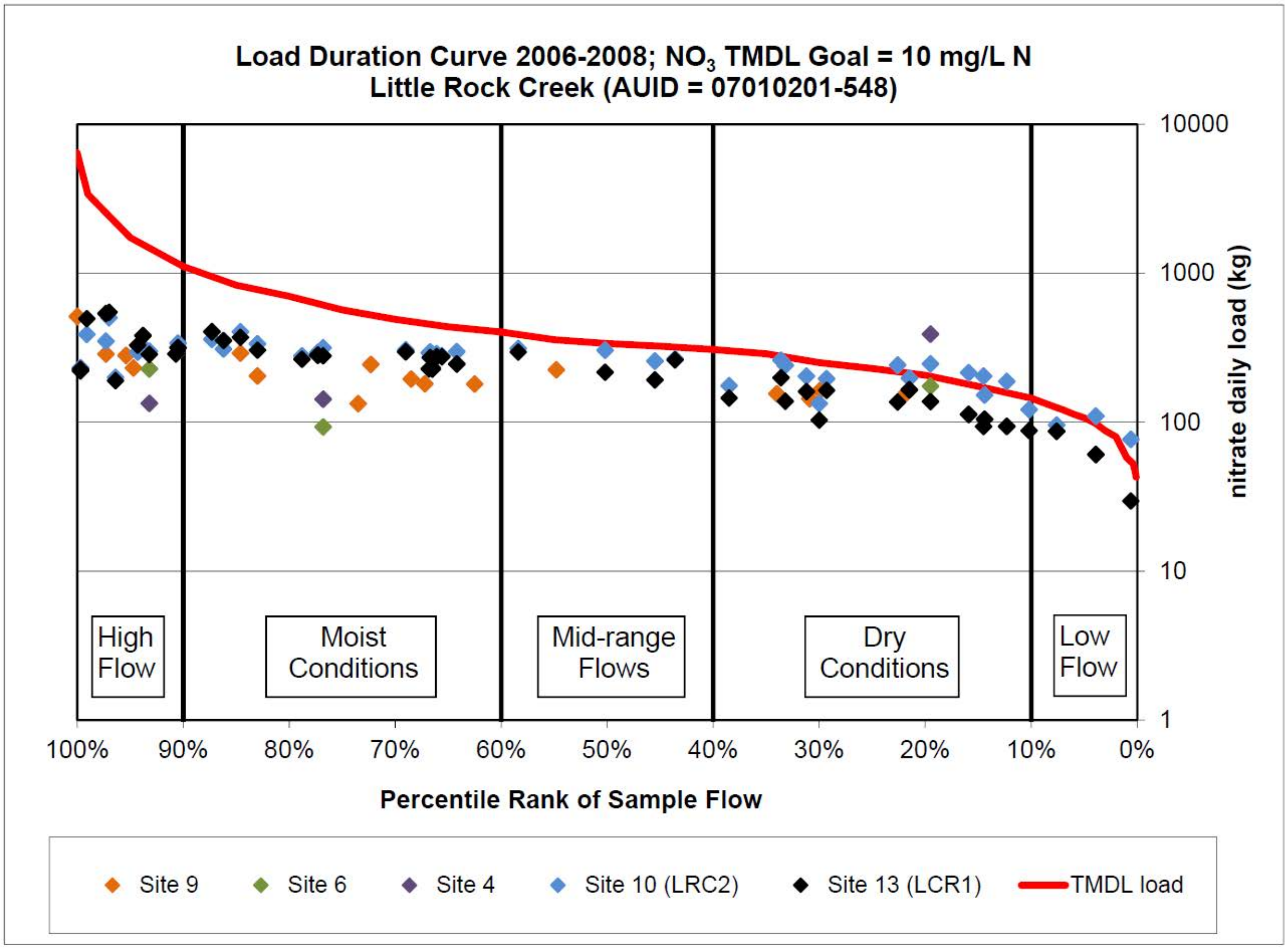
Table 10 Loading Capacity and Nitrate TMDL Allocations for Bunker Hill Creek (AUID: 07010201-511)

	Flow Zone				
	High (95%)	**Moist (75%)**	**Mid (50%)**	**Dry (25%)**	**Low (5%)**
	kg/day				
TOTAL DAILY LOADING CAPACITY	442.5	70.4	20.6	8.4	0.07
Wasteload Allocation					
Construction/Industrial Stormwater	0.4	0.1	<0.1	<0.1	<0.01
Load Allocation	397.8	63.3	18.5	7.6	0.06
Margin of Safety	44.3	7.0	2.1	0.8	0.01
	Percent of total daily loading capacity				
Wasteload Allocation					
Construction/Industrial Stormwater	0.1%	0.1%	0.1%	0.1%	0.1%
Load Allocation	89.9%	89.9%	89.9%	89.9%	89.9%
Margin of Safety	10%	10%	10%	10%	10%

Load Duration Curves

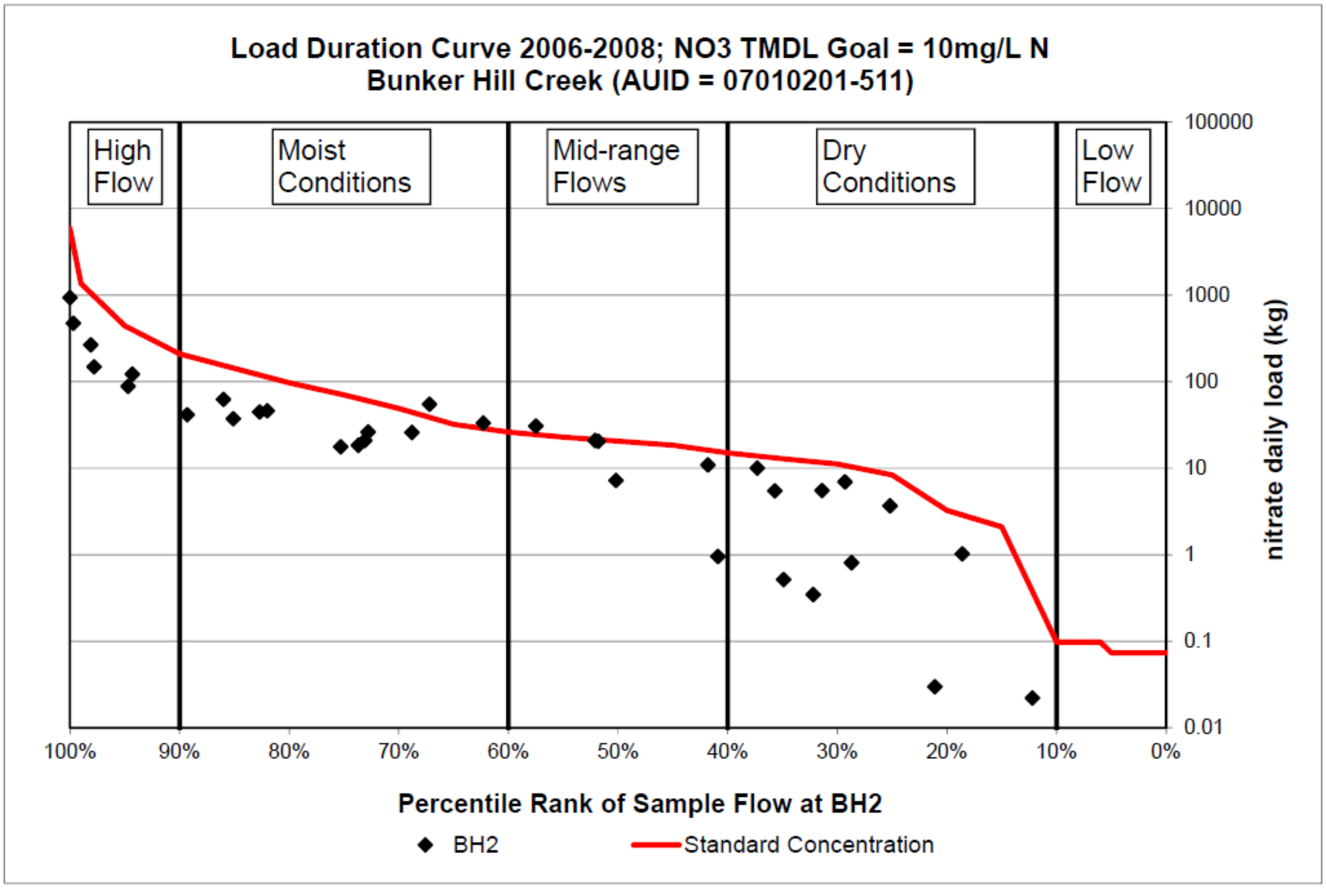
Load duration curves for nitrate in Little Rock Creek and Bunker Hill Creek were developed as shown in Figures 11 and12. Each duration curve includes a line representing the TMDL loading capacity of nitrates for the respective streams and individual sample loads for each flow category. Individual sampling points in the Little Rock Creek duration curve are further sub-divided by the various sampling locations. The loads were calculated using the flow rates at Station 13 and concentrations recorded at various locations throughout the stream. Exceedances of the 10 mg/L standard were observed only under dry or low flow conditions at Stations 4 and 10 (see Figure 4). It is noted that 10 mg/L is a single target concentration and that reducing the highest concentration would be the most effective method for estimating necessary load reductions. The highest percentage load difference above the corresponding TMDL load allocation for each part of the flow regime was used to determine the loading reductions that would be required to ensure that the nitrate loading capacity is always met. Reductions in nitrate load of 47% and 29% are necessary to ensure that the standard is met in Little Rock Creek under the dry and low flow conditions, respectively.

Figure 11 Load Duration Curve Little Rock Creek (AUID: 07010201-548)



In Bunker Hill Creek, based on flow and sampling data from Station BH1, exceedances of the 10 mg/L standard occurred under both moist and mid-range flow conditions (Figure 12). No samples were taken under low flow conditions at this location. Reductions in nitrate load of 33% and 19% are necessary to ensure that the standard is met in Bunker Hill Creek under the moist and mid-range flow conditions, respectively.

Figure 12 Load Duration Curve Bunker Hill Creek (AUID: 07010201-511)



Temperature

The temperature standard for Class 2A waters (aquatic life – cold water fishery) is "no material increase," a narrative standard found in Minnesota Rules, chapter 7050.0222, subpart 2 (MPCA, 2012a). Narrative standards are sometimes called "free forms" because they help keep surface waters free from visible and basic types of water pollution.

In order to quantify and determine a TMDL for Little Rock Creek, a numeric water quality standard had to be selected. This study used the values set forth in the EPA's *Quality Criteria for Water* (1986), also known as the "Gold Book," which provides the following numeric criteria for trout: 19 °C (66 °F) = maximum weekly average temperature (MWAT) for growth (chronic), 24 °C (75 °F) = daily maximum (DM) temperature for survival of short term exposure (acute). The cooler temperature (19 °C) was selected as the standard for two reasons: 1) there were more temperature exceedances to analyze and model at the MWAT instead of the DM, and 2) using an implicit margin of safety (MOS) required the use of the more conservative temperature.

Daily Loading Capacity and Allocations
The MWAT provides chronic temperature criteria for trout growth of 19°C (66°F), while the DM temperature of 24°C (75°F) provides acute criteria for survival of short term exposure. Continuous temperature monitoring was conducted throughout the Little Rock Creek system during the 2008 growing season (June 17-September 23), which included 95 average daily temperature readings that represented a

conservatively warm and dry period for comparison with the temperature criteria. As shown in Table 11, exceedances of the MWAT criteria were more common than exceedances of DM criteria for each of the monitoring stations in the Little Rock Creek system. The DM criteria were exceeded twice at both Stations 11 and 13 (by less than 0.5 °F), while the MWAT criteria were exceeded several times at Stations 5, 7, 8 and 13. As a result, the MWAT criteria have been used to develop the daily loading capacity and heat input allocations.

Table 11 Comparison of Little Rock Creek Temperature Monitoring with Criteria

	Station 5	Station 6	Station 7	Station 8	Station 9	Station 11	Station 13
MWAT	19.1	18.5	19.7	19.5	17.6	17.8	21.6
# Exceedances of 19°C	5	0	9	10	0	0	60
Largest MWAT Exceedance (deg. F) =	0.2	--	1.2	1.0	--	--	4.7
# Exceedances of 24°C	0	0	0	0	0	2	2

This study established a TMDL for temperature in Little Rock Creek that is divided among five portions of the flow regime: high, moist, mid-range, dry and low flow conditions. Heat input exceedances at Little Rock Creek monitoring stations occurred under varying parts of the flow duration range, usually exacerbated in response to runoff events that followed extended dry periods at the monitoring stations upstream of the Sartell Wildlife Management Area (WMA) impoundment. The data clearly indicate that Station 13, which is the only monitoring station downstream of the WMA impoundment, should be the focus of heat loading mitigation activities for achieving the water quality targets of this study. Sixty-three percent of the MWAT readings exceeded the criteria while the exceedance percentages were approximately ten percent or less at the remaining monitoring stations.

Daily Heat Input Allocations

The TMDL loading capacity and allocations were calculated in terms of the gigajoules (GJ) per day of heat that the stream can assimilate and still maintain water temperatures below the 19°C MWAT, the numeric standard used for this TMDL. Because of the complexity associated with presenting allowable “loads” of temperature, this TMDL utilizes the part of EPA’s regulations that allow TMDLs to be expressed “in terms of either mass per time, toxicity, or other appropriate measures” (40 C.F.R. § 130.2(i) of the Clean Water Act [Federal Register, 2002]). In this case, an energy-based allocation (expressed in GJ/day) is used in order to express temperature as a load-based TMDL, based on the flow and temperature monitoring data at Station 13. Gigajoules is a metric term for available energy (1 GJ of electricity will keep a 60-watt bulb lit continuously for 6 months). A portion of the impaired waterway extended beyond Station 13; therefore, the load capacities were adjusted based on the total watershed area compared to the watershed area tributary to Station 13. This addition amounted to a one percent increase in the loading capacity.

The flow rates were divided into 5 categories: high flows (0-10%), moist conditions (10-40%), mid-range flows (40-60%), dry conditions (60-90%) and low flows (90-100%). The 5 categories were used to calculate the total heat input loading capacities and allocations for Little Rock Creek (Table 12). The total daily loading capacity was calculated using the mid-point flow rate for each of the flow zones and the MWAT criteria of 19°C. This loading capacity was then completely allocated to the LA component since there is an implicit MOS and there are no NPDES/SDS permittees subjected to temperature mitigation requirements.

Table 12 Temperature Loading Capacities and Allocations (AUID: 07010201-548)

	Flow Zone				
	High (5%)	**Moist (25%)**	**Mid (50%)**	**Dry (75%)**	**Low (95%)**
	GJ/day				
Total Daily Loading Capacity	73.1	45.8	33.5	22.9	14.8
Load Allocation	73.1	45.8	33.5	22.9	14.8

Overall, a 1% reduction in thermal loading across all thermal sources is needed in the Station 13 section of Little Rock Creek to meet the MWAT criteria.

For more Little Rock Creek Watershed TMDL details including modeling approach, MOS and much more please see the Draft Little Rock Creek TMDL located on the MPCA's website, www.pca.state.mn.us.

Implementation Plan

The following sections outline the implementation strategies developed for Little Rock Lake and Little Rock Creek Watersheds. They describe the approach to the implementation plan, description of the process around the development of the implementation plan, TMDL implementation plan summary for both Little Rock Lake and Little Rock Creek TMDLs, implementation action items that are expected to improve the water quality and biological integrity of the watersheds, as well as the partners that will assist in implementing the identified action items and possible funding opportunities.

Implementation Approach

The activities and BMPs outlined in this implementation plan are the result of five series of meetings led by Benton SWCD. Two of the five were a series of public meetings on the development, process and results of the individual TMDL studies.

Another series of meetings took place with the Little Rock Lake Technical Advisory Committee (TAC). This TAC consisted of interested expert stakeholders that were involved in decisions during the TMDL process. These individuals provided feedback and input into the project from their individual fields of expertise. The committee as a whole had a broad representation, coming with different technical backgrounds. Table 13 is an all inclusive list of the Little Rock Lake TAC members. Technical Advisory Committee meetings were held on June 24, 2008, March 10, 2009, and December 8, 2010.

Table 13 Little Rock Lake TMDL Technical Advisory Committee Members

Attendees	Area of Representation
Adam Birr	Minnesota Department of Agriculture
Bill James	ERDC Eau Galle Aquatic Ecology Laboratory
Bill Walker	Consultant (Modeler)
Bruce Wilson	Minnesota Pollution Control Agency
Chuck Johnson	Minnesota Pollution Control Agency
Dan Lais	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Gerry Maciej	Benton Soil and Water Conservation District
Jeff Hrubes	Board of Water and Soil Resources
Katie Winkelman	Benton Soil and Water Conservation District
Maggie Leach	Minnesota Pollution Control Agency
Mark Evenson	Minnesota Pollution Control Agency
Marshall Deters	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Nick Proulx	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Paul Garrison	Wisconsin Department of Natural Resources
Steve Marod	Minnesota Department of Natural Resources - Fish and Wildlife Division

An additional series of meetings took place with the Little Rock Creek TAC. Similar to the Little Rock Lake TAC, the Little Rock Creek TAC consisted of interested expert stakeholders that were involved in decisions during the TMDL and Implementation Plan process. These individuals provided feedback and input into the project from their individual fields of expertise. The committee as a whole had a broad representation, all coming with different technical backgrounds. Table 14 is a list of Little Rock Creek TAC members. In phase III alone of the Little Rock Creek TMDL, the TAC met three times along with an additional meeting held to coordinate future monitoring.

Table 14 Little Rock Creek TMDL Technical Advisory Committee Members

Attendees	Area of Representation
Adam Birr	Minnesota Department of Agriculture
Nicola Blake-Bradley	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Glen Champion	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Lance Chisholm	Morrison Soil and Water Conservation District
Evan Christianson	Barr Engineering
Evan Drivas	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Mark Evenson	Minnesota Pollution Control Agency
Pat Gehling	Natural Resource Conservation Service (Benton County)
Josh Hanson	Natural Resource Conservation Service (Morrison County)
Jeff Hrubes	Board of Water and Soil Resources
Jeffrey Jasperson	Minnesota Pollution Control Agency
Greg Kruse	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Kimberly Laing	Minnesota Pollution Control Agency
Dan Lais	Minnesota Department of Natural Resources - Ecological and Water Resources Division
Maggie Leach	Minnesota Pollution Control Agency
Beau Liddell	Minnesota Department of Natural Resources – Fish and Wildlife Division
Gerry Maciej	Benton Soil and Water Conservation District
Joe Magner	Minnesota Pollution Control Agency
Steve Marod	Minnesota Department of Natural Resources– Fish and Wildlife Division
Helen McLennan	Morrison Soil and Water Conservation District
Nick Proulx	Minnesota Department of Natural Resources - Ecological and Water Resources Division
John Sandberg	Minnesota Pollution Control Agency
Lori Stevenson	United States Fish and Wildlife Service
Andrew Streitz	Minnesota Pollution Control Agency
Kevin Stroom	Minnesota Pollution Control Agency
Luke Stuewe	Minnesota Department of Agriculture
Stephen Thompson	Minnesota Pollution Control Agency
Greg Wilson	Barr Engineering
Katie Winkelman	Benton Soil and Water Conservation District

The final series of meetings took place with the Little Rock Watershed Stakeholder Committee. This committee was developed to provide input and direction in the construction and management of implementation action items related to both the Little Rock Lake and Little Rock Creek TMDL projects. The Little Rock Watershed Committee consists of 16 members who either live or work in the Little Rock Watershed, including 1 citizen representative from each township within the Little Rock Watershed boundary, a County Commissioner from Benton and Morrison Counties, and a SWCD Supervisor from each county, as well as representatives from the LRLA, Mid-Minnesota Trout Unlimited Association, East Central Irrigation Association, GNP Company (formerly Gold'N Plump) and New Heights Dairy. A complete list of members is illustrated in Table 15. This committee has met a total of 10 times since its establishment in 2010.

Table 15 Little Rock Watershed Stakeholder Committee Members

Attendees	Area of Representation
Joe Wollak	Benton County Commissioner
Don Meyer	Morrison County Commissioner
Bernie Thole	Benton SWCD Supervisor Board Member
Marvin Stangl	Morrison SWCD Supervisor Board Member
Ed Popp	Langola Township – Benton County
Chuck Popp	Graham Township – Benton County
Diane Wojtanowicz	Watab Township – Benton County
Lawrence Thell	Mayhew Lake Township – Benton County
Ray Sieben	Buckman Township – Morrison County
Robert Stuckmayer	Morrill Township – Morrison County
Jeff Tiemann	Bellevue Township – Morrison County
Guy Spence	Little Rock Lake Association
Ken Nodo	Trout Unlimited Association
Rick Schlichting	East Central Irrigation Association
Brent Czech	New Heights Dairy
Wayne Sanders	GNP Company

The implementation plan was distributed to both the Little Rock Lake and Little Rock Creek TACs and the Little Rock Watershed Stakeholder Committee for review.

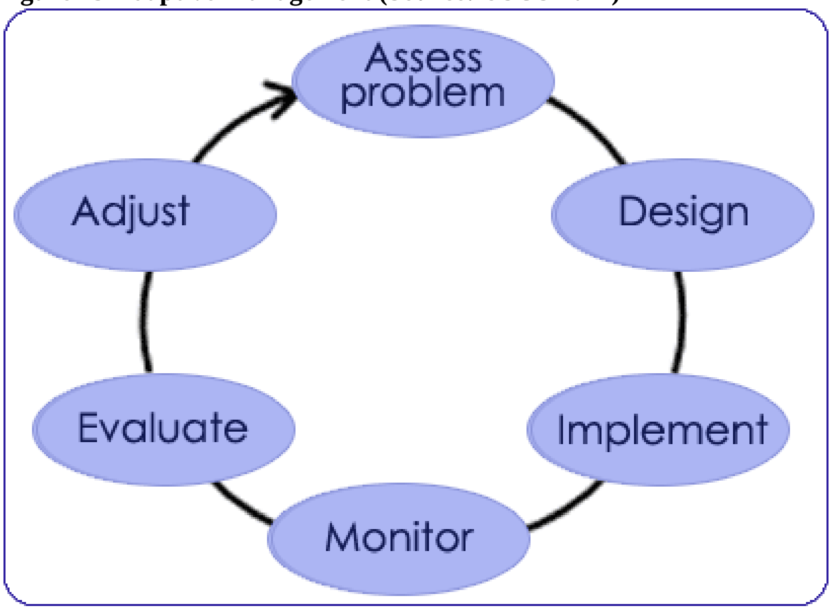
Adaptive Management

Implementation of the Little Rock Lake and the Little Rock Creek TMDLs must commence with reasonable expectations. The impairments are severe. Rehabilitating these watersheds to the goals described previously will be difficult and will take time; making substantial improvements should be a high priority. Reaching water quality standards, especially those for Little Rock Lake, may likely take decades.

This implementation plan follows an adaptive management approach to managing resources in light of uncertainties. Adaptive management is an iterative approach of implementation, evaluation, and course correction, or described by "learning by doing, and adapting based on what's learned" (Figure 13) (USGS, 2012). Adaptive management is necessary given the uncertainties associated with predicting the effectiveness of management measures, as well as the time scales and ultimate response of shallow lakes to load reduction. Implementation activities can occur concurrently or in a structured manner, depending on the availability of funding and willingness of potential participants.

Adaptive management also allows for the incorporation of new technologies. Technology is constantly evolving; agricultural and environmental technologies are no exception to this. As new and improved technologies are developed and put into practice, so does the need to adapt the direction of implementation strategies for the Little Rock Lake and Little Rock Creek.

Figure 13 Adaptive Management (Source: USGS 2012)



Little Rock Lake TMDL Implementation Summary

The Little Rock Lake TMDL report stressed that adaptive implementation of the TMDL is necessary given the uncertainties associated with predicting the effectiveness, as well as time scales and ultimate responses, of shallow lakes to load reductions. Little Rock Lake watershed is home to high AU densities. Based upon watershed AU (1000 lbs live animal weight) and unit waste loading factors ranging from 12 kg P / AU-year for dairy cows to 54 kg P/ AU-year for poultry, the amount of phosphorus in animal waste generated and cycled on the farms is approximately 132-192 times the existing long-term-average P load reaching the lake (6,292 kg/yr, Table 7). Considering that this does not account for fertilizer P, only a small fraction of the P associated with agricultural operations would have to be transported in runoff to the lake in order to account for a significant portion of the total load. A long-term strategy involving farm management to minimize excess phosphorus (fertilizer + animal feed – crop export – animal export), which eventually builds up on the soils or is transported to the lake, is necessary to control the amount of phosphorus reaching Little Rock Lake.

Lower summer inflows resulting from drought and/or groundwater pumping could have adverse impacts on lake water quality through various mechanisms. Lower inflows would provide less dilution for P recycled from the lake bottom sediments and accelerate the buildup of P in the water column and algal blooms, as observed in 2007. Development of stagnant conditions could induce backflow and associated phosphorus loads from the outlet channel in periods when evaporation exceeds the total inflow from the tributaries and rainfall. The predominance of bluegreen algae could be enhanced by decreases in summer nitrate loads; this is potentially significant because of the high nitrate concentrations in summer base flows (NOX-N ~ 5 to 10 ppm). Nitrate loads could have beneficial impacts by oxidizing bottom sediments and decreasing P recycling; thus, supporting BMPs to increase the flow coming into Little Rock Lake and/or decrease the amount of groundwater pumping.

Additional practices identified in the Little Rock Lake TMDL are illustrated in Tables 16 and 17.

Table 16 Little Rock Lake TMDL First Priority Implementation Practices List

Practice	Unit Cost	Units	Note	Qty	Cost
Agricultural BMPs	-	-	-	-	**$2,328,894 to $3,728,894**
Nutrient Management	$14	acre		32,471	$454,594
Cover Crop	$40	acre		4,870	$194,800
Feedlot Projects	$30,000 - $100,000	farm/project	Unit Cost Varies	20	$600,000-$2,000,000
Residue and Tillage Management	$32	acre		10,000	$320,000
Filter Strip	$317	acre		1,000	$317,000
Irrigation Management	$5.80	acre		5,000	$29,000
Stream Crossing	$47	linear feet		500	$16,500
Contour Buffer Strips	$345	acre		1,000	$345,000
Prescribed Grazing	$52	acre		1000	$52,000
Other BMPs	-	-	-	-	**$899,275**
Lakeshore Native Buffers	$1,440	acre		25	$36,000
Rain Gardens	$1,075	garden		25	$26,875
Water and Sediment Control Basin	$13,000	basin		5	$65,000
Wetland Restoration	$7,714	acre		100	$771,400
Miscellaneous	-	-	-	-	**$169,825**
SSTS Inspection Program	$135	septic system		295	$39,825
Education	$6,500	year	-	20	$130,000

*** Unit Cost is a derivative of the NRCS 2011 Minnesota EQIP Conservation Practice Payment) with the exception of Rain Gardens and SSTS Inspection Program.**

Table 17 Little Rock Lake TMDL Second Priority Implementation Practices List

Practice	Unit Cost	Units	Note	Qty	Cost
Miscellaneous	-	-	-	-	**$545,640**
Lakeshore SSTS upgrades	$10,000	each		41	$410,000
Carp control	$25,000	per year	Fish trap	1	$25,000
Aluminum Sulfate Treatment	$800	acre	Recommended applying to zones 15 feet or deeper	50.8	$40,640
Aquatic Plant Management	$70,000	per year	Chemical or Mechanical removal of invasive aquatic plant species replacing with native aquatic plant species	1	$70,000

Little Rock Lake Watershed Source Assessment

The reality is that there are many sources of any single pollutant within a watershed. Little Rock Lake Watershed is no exception to that reality. Sources of phosphorus are spread throughout the watershed. Phosphorus occurs naturally in rocks, soil, animal waste, plant material and even the atmosphere. However, human activity has dramatically increased the amount of phosphorus released into the environment (CCME, 2009). Currently, there is not sufficient data to provide a quantifiable source assessment. However, a source assessment based on general knowledge can be provided as follows. Sources of phosphorus include: internal loading, septic loads, greywater, direct lakeshed runoff, streambank/shoreline erosion, and runoff from the agricultural land uses (livestock, row-crop) as well as practices that might exacerbate pollutant delivery such as row-crop, tiling, winter manure application, and impervious surfaces.

Agricultural land use is dominant in the Little Rock Lake watershed. Animal unit densities are high in proportion to acres giving a high manure production/acre ratio. Spring runoff is a high concern in the Little Rock Lake watershed; high levels of fecal coliforms, BOD, ammonia-N, Kjeldahl-N, TP, and soluble reactive P were present in the results of Little Rock Lake TMDL monitoring.

In the Little Rock Lake lakeshed, agricultural land use is low but the percentage of development is moderate. Urban development sources of concern are greywater, septic system loads, impervious surfaces, and urban runoff. The relative importance of sources depends upon location in the watershed and the source itself. Septic systems, greywater, and impervious surfaces are a larger concern in the lakeshed compared to tributary subwatersheds. Winter manure application, row-crops, and livestock directly on tributaries and waterways are of a higher concern than areas not along a waterway. Understanding this allows for priority areas to be identified for practices. Pasture management practices are a higher priority along streambank and ditches, whereas nutrient management should be applied to all tillable land as well as lawns and gardens. An additional possible source of phosphorus is wildlife animal waste. Like domestic animal waste, this is of more concern in riparian areas, and BMPs suggested in this implementation plan will assist in addressing this source concern.

Little Rock Creek TMDL Implementation Summary

The ideal combination of implementation strategies would combine restoration of groundwater flow, reduction in nutrient and organic contributions to the stream, and a free flowing system at the WMA impoundment to minimize thermal impacts.

Reductions in groundwater use will be necessary to improve conditions in the stream. A variety of potential options to reduce groundwater use should be explored, including: limits on total appropriations, improved irrigation efficiency, scheduling and technologies (precision irrigation, sub irrigation and drip irrigation), identifying alternative sources, timing, proximity to the stream, and other options not yet identified. The largest impacts on groundwater levels and baseflow, and thus the priority focus areas for implementing groundwater flow restoration, primarily exist between Station 7 and the Sartell WMA (Figure 4) especially east of the Little Rock Creek.

It is especially important to properly manage nitrogen use on the coarse textured soils prevalent in the Little Rock Creek watershed. UMN Extension (2008) provides guidance for fertilizer applications to corn and edible beans for this situation. Irrigation water management under these conditions also require consideration of irrigation scheduling, available water in the root zone, soil water deficit, allowable soil water depletion, irrigation water depth and crop water use (UMN Extension, 2012).

Additional actions to address the nutrient loadings include upgrading of noncompliant septic systems and correction of feedlots with runoff problems.

Creating more of a free flowing system at the Sartell WMA would improve the conditions for connectivity and temperature.

Table 18 provides an excerpt of the UDSA-NRCS Minnesota (2002) matrix that provides guidance on the expected physical effects associated with implementation of a selection of conservation practices that are expected to be pertinent to the Little Rock Creek watershed.

Table 18 NRCS Conservation Practice Physical Effects Matrix

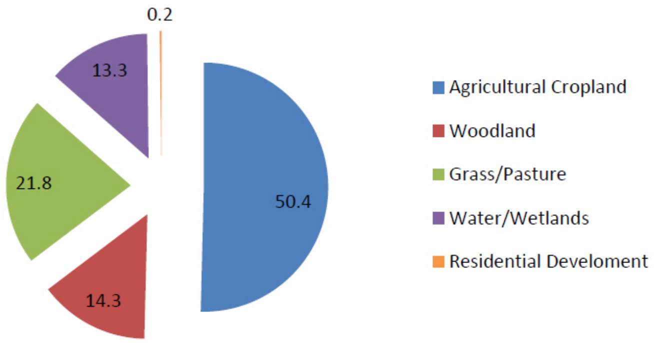
NRCS Standard #	Conservation Practice	Water Quantity—Inefficient Water Use on Irrigated Land	Surface Water Pollution—Nutrients and Organics	Water Quality—Harmful Temperatures in Surface Water	Surface Water Pollution—Low Dissolved Oxygen
327	Conservation Cover	N	SMD	N	SMD
328	Conservation Crop Rotation		SMD		SMD
332	Contour Buffer Strips		SMD		SLD
585	Contour Stripcropping	SMD	SMD	SLD	SMD
393	Filter Strip		SLD	N	SLD
528A	Prescribed Grazing	SLD	SMD	SLD	SMD
449	Irrigation Water Management	SD	SMD	N	SSD
329A	Residue Management	SMI	MD	SLD	SMD
590b	Nutrient Management	N	SD	N	SD

N—Negligible
SD—Significant Decrease
SMD—Slight to Moderate Decrease
SLD—Slight Decrease
SSD—Slight to Significant Decrease
MD—Moderate Decrease
SMI—Slight to Moderate Increase

Little Rock Creek Watershed Source Assessment

Similar to the Little Rock Lake watershed source assessment, there are many individual sources of nitrates, oxygen demanding substances, and thermal inputs spread throughout the Little Rock Creek watershed. Nutrients such as carbon occur naturally in soil, animal waste, plant material and the atmosphere, while thermal loadings are exacerbated by the lack of vegetation or shade. Currently, there is not sufficient data to provide a quantifiable watershed source assessment. However, a source assessment based on general knowledge can be provided as follows. Sources of nutrients and oxygen demanding substances include: septic systems, erosion, groundwater, runoff from the developed and agricultural land uses (livestock feedlots, row-crop), as well as practices that might exacerbate pollutant delivery such as row-crop, tiling, winter manure application, and impervious surfaces. Agricultural land use is dominant in the Little Rock Creek watershed (see Figure 14).

Figure 14 Little Rock Creek Land Use Percentages



Animal unit densities are high based on livestock numbers in proportion to agricultural land area, giving a high rate of manure production per acre. As a result, spring runoff is of more concern in the Little Rock Creek watershed, with higher levels of nutrients and oxygen demanding substances available for runoff to the stream. A portion of this pollutant load would be expected to drop out of suspension as the flow progresses downstream where it could later result in a higher SOD under late-summer, lower flow conditions. It is also expected that another contributor to higher SOD has been the higher loadings and accumulation of nutrients and organics in the stream channel sediment as a result of past land management practices and riparian use in the watershed.

Like the source assessment of Little Rock Lake watershed, the relative importance of pollutant sources in the Little Rock Creek watershed depends upon location in the watershed and the source itself. Winter manure application, row-crops, and livestock directly on tributaries and waterways are of a higher concern than the same sources that are buffered or located in the headwaters of the watershed. Thus, practices such as pasture management would have a higher impact along tributaries and waterways. Nutrient management may have more impact in tributary or waterway courses but should be applied to all tillable land in addition to lawns and gardens. Groundwater withdrawals result in higher pollutant concentrations and pollutant loading capacities in Little Rock Creek, intensifying the DO and temperature stressors for fish. The Little Rock Creek TMDL study indicates that the largest impacts on groundwater levels and baseflow, and thus the priority focus areas for implementing groundwater flow restoration, primarily exist between Station 7 and the Sartell WMA (Figure 4), especially east of the Little Rock Creek. But similar to nutrient management, implementing groundwater flow restoration should still continue throughout the entire recharge area. Another source identified is the Little Rock Creek impoundment at the Sartell WMA which also reduces the pollutant loading capacity of the stream.

Implementation Practices

The following are implementation activities and projects that were identified in the TMDL reports as well as by the TACs and/or Little Rock Watershed Stakeholder Committee members. Table 19 lists first priority practices along with the anticipated impairment impact. Impairment impacts were ranked by the members of both TACs using a “high, medium, low, or negligible” ranking system from the table in the appendix which was simplified to a “yes or no” positive impact ranking system. Table 20 lists second priority practices along with the anticipated impairment impact with the same ranking system.

Table 19 First Priority Practices with Impairment Impact

Practice	Nitrates	Phosphorus	Dissolved Oxygen	Temperature	Fish Bioassessment
Animal Feedlot Improvements	Yes	Yes	Yes	No	No
Conservation Ditch Management	Yes	Yes	Yes	No	Yes
Cover Crop	Yes	Yes	No	No	Yes
Feed Management	Yes	Yes	Yes	No	Yes
Filter Strip	Yes	Yes	Yes	Yes	Yes
Harvestable Filter Strips	Yes	Yes	Yes	Yes	Yes
Irrigation System Conversion	Yes	No	Yes	Yes	Yes
Irrigation System Maintenance	Yes	No	Yes	Yes	Yes
Irrigation System Uniformity Test	Yes	No	Yes	Yes	Yes
Irrigation Water Management	Yes	No	Yes	Yes	Yes
Lakeshore Native Buffers	No	Yes	No	No	No
Nutrient Management	Yes	Yes	Yes	No	Yes
Pasture Management/Prescribed Grazing	Yes	Yes	Yes	Yes	Yes
Residential BMPs	Yes	Yes	Yes	Yes	No
Residue and Tillage Management	Yes	Yes	Yes	Yes	Yes
Riparian Buffer	Yes	Yes	Yes	Yes	Yes
SSTS Upgrades	Yes	Yes	Yes	No	Yes
Stream Habitat Improvement Management	No	No	Yes	Yes	Yes
Wetland Restoration	Yes	Yes	Yes	Yes	Yes

Table 20 Second Priority Practices with Impairment Impact

Practice	**Nitrates**	**Phosphorus**	**Dissolved Oxygen**	**Temperature**	**Fish Bioassessment**
Aluminum Sulfate Treatment	No	Yes	No	No	No
Aquatic Plant Management	No	Yes	No	No	No
Carp control	No	Yes	No	No	No
Channel Bed Stabilization	No	No	No	No	Yes
Conservation Crop Rotation	Yes	Yes	Yes	No	Yes
Conservation Drainage Management	Yes	Yes	Yes	No	Yes
Contour Buffer Strips	Yes	Yes	No	No	No
Field Borders	Yes	Yes	Yes	No	Yes
Grassed Waterways	Yes	Yes	Yes	No	Yes
Irrigation Technology – Variable Rate Irrigation	Yes	No	Yes	Yes	Yes
Manure Spreader Calibration	Yes	Yes	Yes	No	Yes
Pasture Exclusion	Yes	Yes	Yes	Yes	Yes
Stream Crossing	No	Yes	No	No	Yes
Terraces	Yes	Yes	No	No	No
Water and Sediment Control Basins	Yes	Yes	No	No	No

Practice descriptions are also provided as well as corresponding purpose (environmental benefit). Each practice is labeled with the impairment (s) that it is associated with improving. Impairments are color coordinated to help better identify BMPs that will assist in addressing the resource of concern.

Nitrates-Green
Phosphorus - Orange
Dissolved Oxygen -Blue
Temperature - Red
Fish Bioassessment – Brown

Each practice is also labeled with the land use that it pertains to. Land uses are also color coordinated to assist in identifying BMPs that will assist in addressing the resource of concern.

Agricultural – Hunter Green
In-Lake or **In-Stream - Aqua**
Lakeshore –Purple
Residential (urban and/or rural) **– Pink**

First Priority Practices

Animal Feedlot Improvements:
Nitrates, Phosphorus, Dissolved Oxygen
Agricultural
An animal feedlot is a lot or building or combination of lots and buildings intended for the confined feeding, breeding, raising, or holding of animals. It is specifically designed as a confinement area in which manure may accumulate or where the concentration of animals is such that a vegetative cover cannot be maintained within the enclosure. Thus, animal feedlot improvements would be reducing the environmental impact of the feedlot. This can be accomplished by a wide range of BMPs. The following are examples of BMPs that maybe used to assist in the animal feedlot improvement; however, it must be stated that this is in no way an all-inclusive list, just examples to provide an image of possible improvements: waste storage facilities (manure pits), roof runoff structures, vegetative treatment areas.

Conservation Ditch Management
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural, Residential
In regards to this implementation plan, conservation ditch management is the practice of altering or maintaining new or existing ditch systems in an environmentally friendly manner. It is the intention of this implementation plan that if landowners are going to repair or alter new or existing ditches that we promote this to be completed in a conservational manner. A component of this practice could be converting conventional ditching to more sustainable ditching practices such as two-stage ditches or a ditch system that resembles more of a meandering stream versus the straight ditch system.

Cover Crops:
Nitrates, Phosphorus, Fish Bioassessment
Agricultural
A cover crop is grasses, legumes, forbs, or other herbaceous plants that are established for seasonal cover and conservation purposes. This practice may be used to: reduce wind or water erosion by establishing cover after a low residue crop; to take up excess nutrients in the soil profile; to increase carbon sequestration and improve soil structure; to provide nutrients for the next crop and for weed suppression.

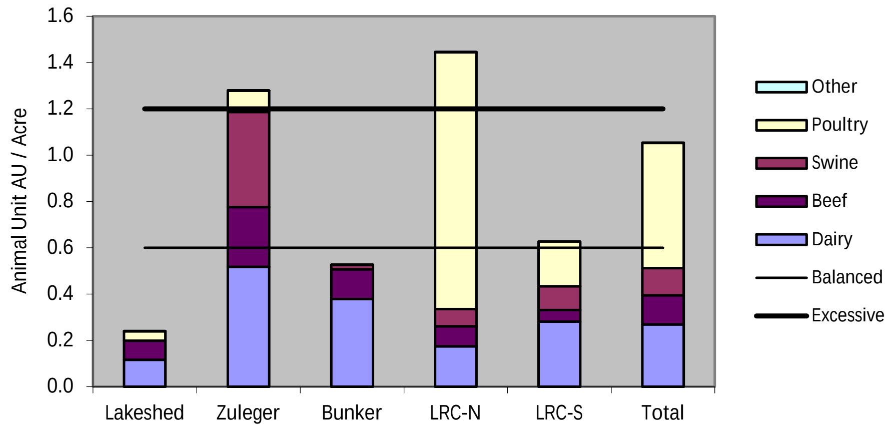
Education/Outreach:
Agricultural, Lakeshore, Residential
Education and outreach is vital to the success of administration of this implementation plan. Education plays a critical role in all practices, projects and programs. More details about education and outreach are explained in the section following Implementation Programs and Projects titled "**Education/Outreach"**.

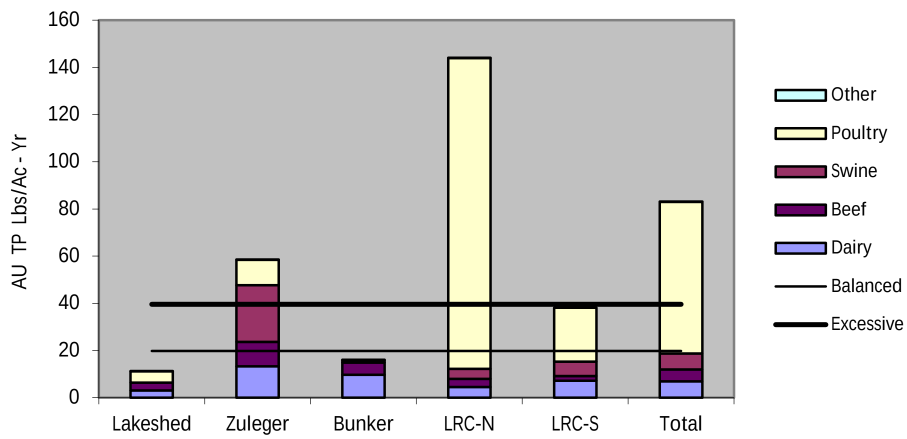
Feed Management:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
As identified in the Little Rock Lake TMDL, the high concentrations, seasonal distribution, and flow-dependence of several water quality constituents in spring runoff (fecal coliforms, BOD, ammonia-N, Kjeldahl-N, TP, and soluble reactive phosphorus, Little Rock Lake TMDL Appendix B) indicate that animal waste is an important component of nutrient loads to Little Rock Lake. Based upon watershed AU (1000 lbs live animal weight) estimates ranging from 25,471 to 37,076 and unit waste loading factors ranging from 12 kg P / AU-year for dairy cows to 54 kg P/ AU-year for poultry (NRCS, 1995), the amount of phosphorus in animal waste generated and cycled on the farms is approximately 132-192 times the existing long-term-average phosphorus load reaching the lake (6,292 kg/yr, Table 7). Considering that this does not account for fertilizer phosphorus, only a small fraction of the phosphorus associated with agricultural operations would have to be transported in runoff to the lake in order to account for a significant portion of the total load. Figure 15 shows AU densities and manure phosphorus production expressed per unit of cropland in each watershed relative to guidance values developed for managing farm phosphorus balances in Vermont. These inventories can be refined with additional site-specific information on AU densities and manure management in each basin.

Long-term strategy involves farm management to minimize excess phosphorus (fertilizer + animal feed – crop export – animal export), which eventually builds up in the soils or is transported to the lake. While transport is considered to occur primarily in surface runoff, sub-surface flows are expected to become increasingly important as soluble phosphorus concentrations build up in soils subject to excess phosphorus applications (Schippers et al., 2006; Sharpley et al, 2003). Farm-scale and watershed-scale phosphorus budgets guided by soil testing can be used as a basis for managing excess phosphorus and buildup of soluble phosphorus in the soils; this type of program could be coupled with traditional BMPs to reduce surface runoff and phosphorus transport from feedlots and cropland.

Feed Management is defined as manipulating and controlling the quantity and quality of available nutrients, feedstuffs, or additives fed to livestock and poultry. This practice may be used to improve feeding efficiency in a manner that facilitates and contributes to the conservation of natural resources, reduces the quantity of nitrogen, phosphorus, sulfur, salts and other nutrients excreted in the manure, reduces the quantity and viability of pathogens in manure, reduces odor, particulate matter, and greenhouse gas (GHG) emissions production from animal feeding operations.

Figure 15 Animal Unit Densities in Little Rock Lake Watershed





Animal Unit data from GIS Layer (bmms_FL-P_mn009)
Animal Unit densities expressed per acre of total cropland.

NRCS (1995)	Dairy	Beef	Swine	Poultry	Other
Lbs - TP / AU - Yr	26	40	58	119	26

Guidance values for AU Densities to Manage Farm P Balance, Vermont
http://www.sera17.ext.vt.edu/Documents/BMP_phosphorus_balance.pdf

Farm Features	Farm Phosphorus Balance		
	Deficit	Balanced	Excess
Animal Density (Animal Units* per acre routinely manured)	Low <0.6	Medium 0.6 to 1.2	High >1.2
% of total feed from off-farm sources	<20	20 to 40	>40

* *1 Animal Unit = 1000 lbs live weight*

Filter Strips:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
A strip or area of herbaceous vegetation that removes contaminants from overland flow. The purpose of this practice is to reduce suspended solids and associated contaminants in runoff and reduce dissolved contaminant loadings in runoff.

Harvestable Filter Strips:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
Harvestable filter strips are currently a practice that is still under development. Benton SWCD's thoughts are to create a practice that is similar to the filter strip practice but allowing the strips to be harvested. There would be limited tillage and manure application on the harvestable filter strip, thus providing more flexibility/profitability to the landowner than the conventional filter strip while still gaining similar water quality benefits.

Irrigation System Conversions:
Nitrates, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
High pressure to low pressure system conversion, traveling gun to low pressure irrigation system, or a combination of such. An irrigation system and all necessary equipment and facilities that are installed for efficiently applying water by means of nozzles operated under pressure. This practice may achieve one or more of the following purposes: efficiently and uniformly apply irrigation water to maintain adequate soil water for the desired level of plant growth and production without excessive water loss, erosion, or water quality impairment; climate control and/or modification; applying chemicals, nutrient, and waste water; and reduce energy use.

Irrigation System Maintenance:
Nitrates, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
Conducting annual/routine maintenance on irrigation unit to aid in more efficiently and uniformly applied irrigation water. This may take action such as replacing broken or worn nozzles or sprinklers, fixing leaks, proper end gun equipment etc.

Irrigation System Uniformity Test:
Nitrates, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
Also known as a Catch Can Test, this is a test procedure that measures the amount of water applied to the soil surface. This can be conducted on center pivots and lateral units. The test can assist in determining if nozzles and sprinklers are operating properly, if they are in the proper order, if the system is receiving adequate pressure, or if the end gun needs adjustments. Possible benefits of the uniformity test are as follows: energy savings, improve the utilization of water, and the possibility of more uniform crop yields.

Figure 16 Uniformity Test

Irrigation Water Management:
Nitrates, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural, Lakeshore, Residential
The process of determining and controlling the volume, frequency and application rate of irrigation water in a planned, efficient manner. This practice may be applied as part of a resource management system to achieve one or more of the following purposes: manage soil moisture to promote desired crop response; optimize use of available water supplies; minimize irrigation induced soil erosion; decrease non-point source pollution of surface and groundwater resources; manage air, soil, or plant micro-climate; proper and safe chemigation or fertigation; and reduce energy use. Irrigation Water Management can be applied to lawns, gardens, and golf courses in addition to agricultural crops.

Lakeshore Native Buffers:
Phosphorus
Lakeshore
A lakeshore native buffer is an un-mowed strip of native vegetation that extends both lakeward and landward from the water's edge. Installing a buffer zone can restore many functions critical to the health of the lake that may have been eliminated previously by sod, impervious structures or mowing. Planting grasses, shrubs and flowering plants that are native to the area will diversify and enhance the shoreline, providing erosion control benefits as well as nutrient absorptions benefits.

Nutrient Management:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural, Lakeshore, Residential
Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments. This practice is applied: to budget, supply, and conserve nutrients for plant production; to minimize agricultural nonpoint source pollution of surface and groundwater resources; to properly utilize manure or organic by-products as a plant nutrient source; to protect air quality by reducing odors, nitrogen emission (ammonia, oxides of nitrogen), and the formation of atmospheric particulates; to maintain or improve the physical, chemical, and biological condition of soil.

The high cost of commercial fertilizers has been an economic driver for the adoption of Nutrient Management practices within the last five to seven years. Nutrient Management can be applied to lawns and gardens in addition to all tillable acres.

Pasture Management/Prescribed Grazing:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
Managing the harvest of vegetation with grazing and/or browsing animals. This practice may be applied as a part of conservation management system to achieve one or more of the following: improve or maintain desired species composition and vigor of plant communities; improve or maintain quantity and quality of forage for grazing and browsing animals health and productivity; improve or maintain surface and/or subsurface water quality and quantity; improve or maintain riparian and watershed function; reduce accelerated soil erosion and maintain or improve soil condition.

Residential BMPs:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature
Lakeshore, Residential
Residential BMPs handle water on a residential lot which typically have a large amount of impervious surface. Residential BMPs slow water down so that infiltration may occur, collect water to use at another time, and/or filter water so that nutrients and other components are removed. A few examples of residential BMPs are: rain barrels, rain gardens, rain gutters, green roofs, and permeable pavers. Residential BMPs can be applied to rural or urban residential settings.

Residue/Tillage Management:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
Leaving last year's crop residue on the soil surface by limiting tillage, including no-till, strip-till, mulch-till and ridge-till, to manage the amount, orientation and distribution of crop and other plant residue on the soil surface year round. Also involves limiting soil disturbing activities to only those necessary to place nutrients, condition residue and plant crops. This practice: reduces wind and water soil erosion; improves soil organic matter content; improves water infiltration and reduces evaporation from the soil surface; and reduces soil compaction.

Riparian Buffers:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural, Lakeshore, Residential
An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. The purpose of this practice is to: create shade to lower or maintain water temperatures to improve habitat for aquatic organisms; reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrient and other chemicals in shallow groundwater flow; and reduce erosion and improve stability to stream banks and shorelines.

SSTS Upgrades:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural, Lakeshore, Residential
The purpose of a Subsurface Sewage Treatment System (SSTS), or septic system, is to treat sewage from a household. While residents of towns and cities have their sewage treated at a municipal treatment plant, residents of areas without access to this type of treatment own, operate, and maintain their own "mini-treatment plants," their septic system. Proper treatment of wastewater reduces health risks to humans and animals, and prevents surface and groundwater contamination. A system that fails to treat sewage can allow excess nutrients to reach nearby lakes and streams. SSTS upgrades may take place on an individual basis or, in appropriate situations, a group system (cluster system) may replace multiple septic systems.

The number of failing septic system in the watersheds is currently unknown; further research and inventory, as well as discussion on septic system compliance procedures, is needed. Septic system compliance is important throughout both watersheds; however, having a non-compliant system along the Little Rock Lake or contributing waterways does have a more direct impact on water quality.

Stream Habitat Improvement and Management:
Dissolved Oxygen, Temperature, Fish Bioassessment
In-Stream
Maintain, improve or restore physical, chemical and biological functions of a stream and its associated riparian zone, necessary for meeting the life history requirements of desired aquatic species. This is to provide suitable habitat for desired fish and other aquatic species, and to provide stream channel and associated riparian conditions that maintain stream corridor ecological processes and hydrological connections of diverse stream habitat types important to aquatic species. Stream channel stability should be the goal when attempting to improve habitat. Stability is defined as "the ability of a stream, over time, in the present climate, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern and profile without either aggrading nor degrading" Rosgen (1996). Geomorphic assessments can provide information of current channel condition, likely future issues by characterizing the stream channel evolutionary processes, and potential strategies to restore the segment; there is more discussion to come on geomorphology monitoring needs in section "Monitoring Plan – Geomorphology".

Wetland Restoration:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural, Residential
The return of a wetland and its functions to a close approximation of its original condition as it existed prior to disturbance on a former or degraded wetland site. The purpose of a wetland restoration is to restore wetland function, value, habitat, diversity and capacity to a close approximation of the pre-disturbance condition, resulting in multiple environmental benefits. Environmental benefits may include: improves surface and ground water quality by collecting and filtering sediment, nutrients, pesticides and bacteria in runoff; reduces soil erosion and downstream flooding by slowing overland flow and storing runoff water; wetland plants and ponded conditions utilize trapped nutrients, restore soil organic matter and promote carbon sequestration; provides food, shelter and habitat for many species and enables the recovery of rare or threatened plant communities.

Careful consideration of the location of wetland restoration is needed. For example, having a wetland restoration near a stream may allow water exchange between the wetland and the stream which may have a warming effect upon the stream and, in the case of Little Rock Creek, may add additional stress to the coldwater fish assemblage. However, wetland restoration projects implemented in upland areas may provide positive impacts on nitrates, phosphorus, DO and temperature.

Second Priority Practices

Aluminum Sulfate Treatment:
Phosphorus
In-Lake
Both monitoring and modeling have indicated that phosphorus loading from the lake sediments is a source of phosphorus for Little Rock Lake. The placement of aluminum sulfate (alum) has proven to be effective in controlling phosphorus release from sediment, especially when an adequate dose has been delivered and where watershed sediment and phosphorus have been minimized (Moore and Thorton, 1988). Alum binds with phosphorus and settles to the lake bottom, removing it from the water column and prevents release from the sediments as well. This practice may not be deemed cost efficient until the amount of phosphorus entering the system is reduced. Alum treatments are not intended to be completed on a regular basis.

Aquatic Plant Management:
Phosphorus
In-Lake
Aquatic plants are important to the health of aquatic ecosystems, especially lakes, by providing water quality benefits (nutrient cycling, prevented sediment suspension, etc) and habitat for fish and invertebrates. Any aquatic vegetation management plan needs to balance the benefits of aquatic plants and recreational access. In addition, there remain many unanswered questions around the value of managing aquatic plants such as curly-leaf pondweed for water quality purposes. Clearly, curly-leaf pondweed releases phosphorus as it matures in the summer when conditions are typically favorable for algal growth, which in turn reduces water clarity. More information is needed to determine the amount of progress that can be made when annually managing curly-leaf pondweed at various densities, under different climatic conditions, as well as assessing the existing aquatic macrophyte community and how it might respond to curly-leaf pondweed control. A recent paper on curly-leaf pondweed and water quality trends indicate that shallow lake basins without any native aquatic vegetation see the most pronounced algal blooms post senescence of curly-leaf pondweed (Heiskary & Valley 2012). Little Rock Lake may fall into this category.

An aquatic vegetation management plan should be developed and implemented for Little Rock Lake. Implementation of a plan is an important step in meeting beneficial use goals in Little Rock Lake. The plan may entail a range of aquatic plant control methods of which may be physical, mechanical, chemical, and/or biological. The plan provides a means to make informed decisions for managing aquatic plants that protect human health and the environment, as well as assures that aquatic plant management is consistent with other management plans affecting the water body.

Carp Control:
Phosphorus
In-Lake
Carp and other benthivorous (bottom-feeding) fish can re-suspend phosphorus into the water column and degrade water quality, as well as destroy native aquatic plant communities. They also can impact the long-term effectiveness of an alum treatment of lake bottom sediments. Maintaining a balanced fishery is an important aspect of any lake management plan. To accomplish a balanced fishery in Little Rock Lake, carp and other benthivorous fish control may be necessary. There are many control techniques currently used in the United States, including rotenone, barriers, water drawdown, and trapping, that may be applicable to Little Rock Lake. It is also important to locate carp spawning habitats and keep the adults out of that area to reduce or eliminate recruitment.

Channel Bed Stabilization:
Fish Bioassessment
In-Stream
Measure(s) used to stabilize the bed or bottom of a channel. The purpose of this practice is to maintain or alter channel bed elevation or gradient, modify sediment transport or deposition, and manage surface water and groundwater levels in floodplains, riparian areas, and wetlands.

Conservation Crop Rotation:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
Growing different crops in a recurring sequence on the same piece of land. This may include alternating row crop production from a high residue-producing crop (such as corn harvested for grain) with a low residue-producing crop (like soybeans). It may also involve rotation with a small grain or grass-legume hay crop. This practice is applied as part of a conservation management system. Good rotations can reduce soil erosion by water and/or wind, improve crop yields, increase profit, return more organic matter to the soil to improve or maintain tilth, manage plant pests, and reduce fertilizer needs by managing the balance of plant nutrients.

Conservation Drainage Water Management:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
The process of managing water discharges from surface and/or subsurface agricultural drainage systems. Benefits may include the reduction of nutrients, pathogens, and/or pesticide loading from drainage systems into downstream receiving waters.

Contour Buffer Strips:
Nitrates, Phosphorus
Agricultural
Narrow strips of permanent, herbaceous vegetative cover established around the hill slope with wider cropped strips that are farmed on the contour. This practice is applied to achieve one or more of the following: reduce sheet and rill erosion; reduce transport of sediment and other waterborne containments down slope; and increase water infiltration.

Field Border:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
A strip of permanent vegetation established at the edge or around the perimeter of a field. Vegetation consists of adapted grasses, legumes, and /or shrubs. This practice is applied: to reduce erosion from wind and water; for soil and water quality protection; for the management of harmful insect populations; to provide wildlife food and cover; to increase carbon storage in biomass and soils; and to improve air quality.

Grassed Waterways:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
A shaped or graded channel that is established with suitable vegetation to carry surface water at a non-erosive velocity to a stable outlet. The purpose is to convey runoff from terraces, diversions or other water

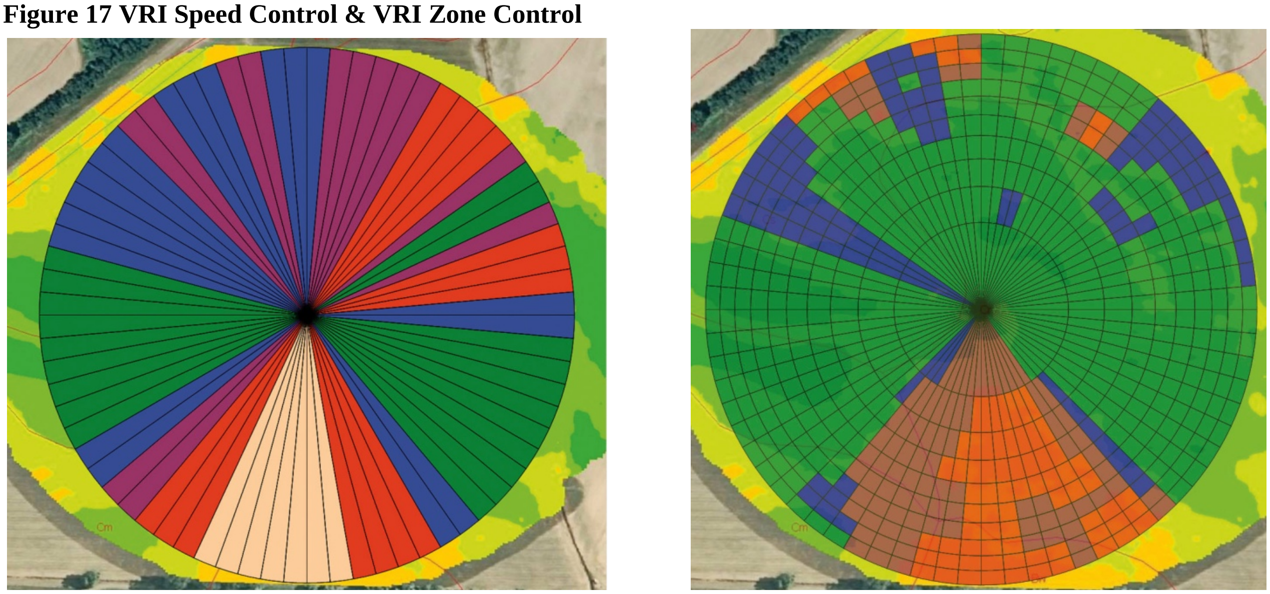
concentrations without causing erosion or flooding, and to reduce gully erosion and protect/improve water quality.

Irrigation Technology: Variable Rate Irrigation (VRI) for site-specific application:
Nitrates, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
An innovative technology that enables a center pivot irrigation system to optimize irrigation application. A majority of fields are not uniform due to natural variations in soil type and topography. VRI technology allows farmers to apply varying rates of irrigation water based on individual management zones within a field. If used properly, the benefits of VRI technology are: improved uniformity, water savings, optimized pumping costs, help to keep water out of non-farmed areas, prevent "double watering" where pivots overlap, improved irrigation management decisions, increase flexibility in fields with multiple crops or planting dates, and improved benefits of other precision agriculture practices.

VRI speed control speeds up/slows down the pivot to achieve the desired application depth along a sector (Figure17 –left image). VRI zone control pulses control valves on/off any pivot zone to achieve the desired application depth with a management zone; this can be used for on/off control for specific areas in a field where you may not want to water, such as ditches, canals, wet areas, or other spots in the field (Figure17 – right image). This technology is fairly new to the industry, but is still forecasted as a valuable tool for irrigation management.

Other new irrigation technology that has yet to be identified should also be considered to help manage the amount of groundwater that is being used/consumed.

Figure 17 VRI Speed Control & VRI Zone Control



Manure Spreader Calibrations:
Nitrates, Phosphorus, Dissolved Oxygen, Fish Bioassessment
Agricultural
A manure spreader calibration is done by weighing the spreader full, then empty, to determine how many tons or gallons, depending on form of manure, it contains. When the manure is hauled to the field, measurements are taken to find the area covered with manure. This information is then used to determine

the actual application rate. A manure spreader calibration is only one component of the first step to knowing the nutrient content and rate of the manure that is being applied to a field, but it is a very valuable component that assists in determining if manure is being applied properly.

Pasture Exclusions:
Nitrates, Phosphorus, Dissolved Oxygen, Temperature, Fish Bioassessment
Agricultural
The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area. For example, excluding animals from a portion of the pasture that has a stream/ditch/water flowing through it.

Stream Crossing:
Phosphorus, Fish Bioassessment
Agricultural, Residential
A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. The placement of a stream crossing is determined by working with the existing channel geomorphology by placing it at stable riffle/glide segments. The purpose is to provide access to another land unit, improve water quality by reducing sediment, nutrient, organic and inorganic loading of the stream, and to reduce streambank and streambed erosion.

Terraces:
Nitrates, Phosphorus
Agricultural
An earth embankment, or a combination ridge and channel, constructed across the field slope. This practice is applied as part of a resource management system for one or more of the following purposes: reduce erosion by reducing slope length and to retain runoff for moisture conservation.

Water and Sediment Control Basins:
Nitrates, Phosphorus
Agricultural
A small earthen ridge and channel or embankment built across (perpendicular to) a small watercourse or area of concentrated flow within a field (or other landscape). The basin temporarily stores runoff water behind the berm, eliminating its erosive capabilities further down slope. The ponded water is slowly released through an inlet riser pipe to an underground tile exiting at an adequate outlet.

Implementation Programs and Projects

Green Roofs, Blue Waters Project:
The Benton County Water Plan calls for the promotion of land and water BMPs in shoreland and riparian areas, such as vegetative buffers, rain gardens, rain barrels, and rain gutters. In 2011, the Benton County Water Resource Advisory Committee (WRAC) identified the following as problems with existing residential developments: infiltration, runoff, and impervious surfaces. The WRAC wanted the Benton SWCD to address these problems along with the aforementioned Water Plan objective from a non-regulatory, incentive and education-based stance.

In 2012, Benton SWCD approached St. Cloud State University (SCSU) to work together on a model which measures the ability of a property to handle a 2-year 24-hour rainfall (~2.65 inches for Benton County). This model will incorporate the following data: soil type, infiltration type, plant cover, impervious surface area, slope, historical precipitation data, and runoff measurements. Benton SWCD is also working with the Benton County Department of Development and the Mississippi River Renaissance on a landowner registry. This registry will be created by door-to-door contact to gauge each landowner's interest in water quality practices. Geographic Information Systems (GIS) will be utilized to estimate values for some of the data used in the SCSU model in an effort to identify high priority properties.

Once the model and registry are completed, the SWCD will be able to offer assessments of properties free of charge. If a property can adequately handle a 2-year 24-hour rainfall, the property and landowner will be acknowledged through a sign, window cling, or certificate. Landowners whose property cannot handle this amount of rainfall will have the opportunity to work with SWCD staff to address these problems through a number of different land and water BMPs.

Groundwater Management Area (DNR):
According to Minnesota Statute 103G.287 Subd. 4 "The commissioner [of DNR] may designate groundwater management areas and limit total annual water appropriations and uses within a designated area to ensure sustainable use of groundwater that protects ecosystems, water quality, and the ability of future generations to meet their own needs. Water appropriations and uses within a designated management area must be consistent with a plan approved by the commissioner that addresses water conservation requirements and water allocation priorities established in section 103G.261."

It has yet to be determined if Little Rock Creek watershed will be designated a Groundwater Management Area, however it could be a possibility in the future.

Groundwater Well Boring Review:
Evaluate whether deeper aquifer sources may be available and the degree of connection between aquifers and the stream. Information sources useful to this evaluation are well boring logs, DNR geophysical surveys, published geological maps and cross sections, future pumping tests, observation-well monitoring, and streamflow monitoring.

Sartell Wildlife Management Area (WMA):
The Sartell WMA is viewed differently by many agencies, special interest groups and stakeholders. The WMA is not managed for coldwater fish assemblage habitat but that of waterfowl habitat. There is a need for further discussion between agencies, within agency's departments, special interest groups and stakeholders to establish common goals and management of the WMA. As it currently stands, three management options exist for the WMA in an effort to address stressors from the WMA and below. They are as follows:

1. Create more of a free flowing system (bypass) to improve connectivity and temperature issues during the critical conditions described in the Little Rock Creek TMDL report.
2. Keep existing WMA but create new management plans and priorities
3. Complete removal of WMA impoundment area.

As discussions take place it is expected that more options to the management and structure of the WMA will surface. Adaptive management will allow for the adoption of the new ideas that are generated from these discussions.

SSTS Inspection Program: Septic systems in the Little Rock Lake watershed have received an abundance of attention historically as a possible source of nutrients to the lake. It is proposed to conduct a SSTS inspection program. This would consist of having a certified septic inspector inspect all systems in the Little Rock Lake watershed or other delineated area within the watershed. Systems deemed noncompliant would be required to upgrade according to set guideline/time frame. It would also be important to offer assistance to those noncompliant, either through the Low Interest Loan program or other form of financial support.

Education/Outreach

Education is key to the success of the restoration of the Little Rock Watersheds. Education plays a critical role in all practices, programs, partnerships, and monitoring described in this implementation plan. Activities described in this implementation plan require one form or another of education. The following are just a few ways to accomplish this.

Public Education and Outreach

As part of the TMDL process, Benton SWCD has been meeting with stakeholders and the public to discuss the TMDLs and water quality improvement within the watersheds. Given the significant load reduction requirements for TMDLs, cooperation and "buy in" is necessary over a long period of time to ensure implementation. Morrison SWCD publishes articles in local newspaper with a circulation of over 30,000. Radio spots are also used to inform citizens of current practices and funding opportunities in addition to current environmental concerns.

Encourage Public Official and Staff Education

There is a need for township, city, county and state officials and staff to understand the TMDL process and the proposed implementation activities so that they can effectively make budget and programming decisions, conduct daily business, and possibly make regulatory changes to support stakeholders in restoration activities.

Presentations at Meetings, Field Days, and Events

Awareness of lake, stream, and watershed management can be raised through periodic presentations at meetings of lake associations, homeownership associations, irrigation associations, trout unlimited, townships and county meetings, as well as other agricultural and non agricultural group meetings. Displays at events such as county fairs, nitrate clinics, field days and other environmental awareness events can also raise public awareness.

Demonstration Projects

Property owners may be reluctant to adopt good lake, stream and watershed management practices without examples they can evaluate and emulate. In accordance with the Benton and Morrison County Water Plans, each District will encourage demonstration projects so property owners can see how a project or practice is implemented and how it looks. Examples might include native plantings, restoring shorelines, low impact development projects, irrigation water management and agricultural BMP installations. Demonstration projects improve the overall understanding and awareness of practices.

Implementation Partners

Little Rock Watersheds are extremely fortunate to have a large network of implementation partners. Implementation Partners are identified based off of their participation in practices and existing programs. As the implementation plan for Little Rock Watershed continues to evolve so will the partners.

Table 21 illustrates primary and secondary respective partners per practice or projects; however, this is not an all inclusive list of partners and responsibilities. As demonstrated in Table 21, there is an immense amount of partnering between agencies, special interest groups, government entities and stakeholders; this leads to an even greater need for communication between all partners. With resources spread thin for all parties, the need for sharing data, research, and project information is critical. It is imperative that all partners communicate with one another and stay connected with stakeholders.

Stakeholders can be defined as anyone who lives, works or plays in the Little Rock Lake and Little Rock Creek watersheds. They may or may not come from an environmental background, may or may not own property in the watershed, but it is their actions that affect the water quality and biological integrity of the watersheds. Since the vast majority of the pollutant loads are from nonpoint sources, the majority of implementation activities are going to be on a voluntary basis. This means that support and "buy in" is vital for the success of restoration of these two valuable watersheds.

Table 21 Responsible Partners

Practice	Primary Responsible Partners	Secondary Responsible Partners
Aluminum Sulfate Treatment	LRLA	MN DNR, MPCA, Benton SWCD
Animal Feedlot Improvements	Benton and Morrison SWCD, NRCS, West Central Technical Service, NRCS	BWSR, MDA, MPCA
Aquatic Plant Management	LRLA	MN DNR
Carp control	LRLA	MN DNR
Channel Bed Stabilization	MN DNR, Trout Unlimited	Benton and Morrison SWCD, NRCS BWSR, MPCA,
Conservation Crop Rotation	NRCS, Benton and Morrison SWCD	BWSR, MDA, MPCA
Conservation Drainage Management	Benton and Morrison County, Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Conservation Ditch Management	Benton and Morrison County, Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Contour Buffer Strips	Benton and Morrison County, Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Cover Crop	Benton and Morrison County, Benton and Morrison SWCD, NRCS,	BWSR, MDA, MPCA
Education	Benton and Morrison SWCD, Benton and Morrison Counties, NRCS, MN DNR, LRLA	BWSR, MPCA,

Feed Management	GNP Company, Benton SWCD	West Central Technical Service, NRCS, BWSR
Field Borders	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Filter Strip	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Grassed Waterways	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Harvestable Filter Strips	Benton SWCD	Morrison SWCD, West Central Technical Service, NRCS
Irrigation System Uniformity Test	Benton SWCD, NRCS	BWSR, Morrison SWCD, MDA,
Irrigation System Conversion	NRCS	BWSR, Benton and Morrison SWCD, MDA
Irrigation System Maintenance	Private Irrigation Company	Benton and Morrison SWCD, MDA, NRCS
Irrigation Technology – Variable Rate Irrigation	Private Irrigation Company	BWSR, Benton and Morrison SWCD, MDA, NRCS
Irrigation Water Management	Benton SWCD, NRCS	BWSR, Morrison SWCD, MDA, MN DNR
Lakeshore Native Buffers	Benton SWCD, LRLA	BWSR , Initiative Foundation, MN DNR, MPCA
Manure Spreader Calibration	Benton SWCD, Morrison SWCD, NRCS	BWSR, University of MN Extension
Nutrient Management	Benton and Morrison SWCD, NRCS, Private Crop Consultants	BWSR, GNP Company, MDA, MPCA
Pasture Exclusion	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Pasture Management/Prescribed Grazing	Benton and Morrison SWCD, NRCS	BWSR, MDA, MPCA
Residential BMPs	Benton and Morrison SWCD and Benton and Morrison Counties	BWSR, MPCA
Residue and Tillage Management	Benton and Morrison SWCD, NRCS	BWSR, MDA, MPCA
Riparian Buffer	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
SSTS Upgrades	Benton and Morrison County	MDH, Benton and Morrison SWCD
Stream Crossing	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Stream Habitat Improvement Management	MN DNR, NRCS, Trout Unlimited	BWSR, MDA, MPCA
Terraces	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA

Water and Sediment Control Basins	Benton and Morrison SWCD, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Wetland Restoration	Benton and Morrison SWCD, MN DNR, NRCS, West Central Technical Service	BWSR, MDA, MPCA
Projects	-	-
Green Roofs, Blue Waters Project	Benton SWCD, Benton County, SCSU	BWSR, Mississippi River Renaissance, MPCA
Groundwater Management Area (DNR)	MN DNR	Benton and Morrison SWCD
Groundwater Well Boring Review	MN DNR	
SSTS Inspection Program	Benton and Morrison County, MDH	BWSR
Wildlife Management Area Improvement	MN DNR	Trout Unlimited

Implementation Cost

Based on the implementation activities suggested in this report for both the Little Rock Lake and Little Rock Creek impairments, an overall cost estimate would range from approximately $15,612,160 – $23,204,160. A combination of references and general knowledge based on past projects were utilized to calculate this cost estimate. References included: Conservation Practice Physical Effects - NRCS Economics, NRCS 2013 EQIP Payment Schedule, and the Stearns County SWCD's Agricultural Watershed Restoration Grant Phase 2 for the Hobeken Creek Watershed, Minnesota.

More details on the cost estimate are illustrated in Table 22 and 23, based on first and second priority practices respectively. The chart was constructed based on a 20 year outlook. The costs associated with each practice are estimates only; as technology changes, resource costs fluctuate, and the direction of implementation strategies evolve (adaptive management), so will the cost of implementation.

Table 22 Cost Estimate for First Priority Practices

Practice	Unit Cost	Units	Note	Qty	Cost
	-	-	-	-	**$11,921,160- $19,513,160**
Animal Feedlot Improvements	$30,000 - $200,000	farm/project	Unit Cost Varies	40	$1,200,000 – $8,000,000
Conservation Ditch Management	Variable	-	-	-	-
Cover Crop	$45	acre	-	10,000	$450,000
Education/Outreach	$20,000	year	-	20	$400,000
Feed Management	variable	-	-	-	-
Filter Strip	$98.80	acre	-	500	$49,400
Harvestable Filter Strips	Not Available	acre	-	-	Not Available
Irrigation System Conversion	$5.20	linear ft	-	20,000	$104,000
Irrigation System Maintenance	Variable	Pivot	-	-	Not Available
Irrigation System Uniformity Test	$550.3	pivot	-	200	$110,060
Irrigation Water Management	$40	acre	-	100,000	$4,000,000
Lakeshore Native Buffers	$1,550	acre	-	100	$155,000
Nutrient Management	$20	acre	-	100,000	$2,000,000
Pasture Management/Prescribed Grazing	$54.86	acre	-	1,000	$54,860
Residential BMPs	$100 -$10,000	Variable	-	80	$8,000 - $800,000
Residue and Tillage Management	$20	acre	-	20,000	$400,000
Riparian Buffer	$78.44	acre	-	1,000	$78,440
SSTS Upgrades	$12,000	upgrade	-	160	$1,920,000
Stream Habitat Improvement Management	$11,000	acre	-	20	$220,000
Wetland Restoration	$7,714	acre	-	100	$771,400

Table 23 Cost Estimate for Second Priority Practices

Practice	Unit Cost	Units	Note	Qty	Cost
	-	-	-	-	**$3,691,000**
Aluminum Sulfate Treatment	$2,000	acre	Recommended applying to zones 15 feet or deeper	51	$102,000
Aquatic Plant Management	$70,000	year		5	$350,000
Carp control	$25,000	year	Fish trap	5	$125,000
Channel Bed Stabilization	$30	ft	-	2,000	$60,000
Conservation Crop Rotation	$5	acre	-	10,000	$50,000
Conservation Drainage Management	Variable	-	-	-	-
Contour Buffer Strips	$345	acre	-	1,000	$345,000
Field Borders	$81.60	acre	-	1,000	$816,000
Grassed Waterways	$100	acre	-	1,000	$100,000
Irrigation Technology – Variable Rate Irrigation	Not Available	-	-	-	Not Available
Manure Spreader Calibration	$300	Calibration	-	100	$30,000
Pasture Exclusion	$12,000	per exclusion	-	20	$240,000
Stream Crossing	$47	Linear ft	-	2,000	$940,000
Terraces	$2.73	ft	-	100,000	$273,000
Water and Sediment Control Basins	$13,000	basin	-	20	$260,000

Implementation Funding

A variety of funding sources are considered necessary to fulfill implementation strategies laid out in this implementation plan. Partners described previously will need to contribute to ensure success. One significant funding opportunity is the Clean Water, Land and Legacy funds. On November 4, 2008, Minnesota voters approved the Clean Water, Land and Legacy Amendment. The Amendment increased the general sales and use tax rate by 0.375% starting July 1, 2009 and continuing through 2034. This amendment dedicated the additional proceeds to four categories, including a category to protect, enhance, and restore water quality in lakes, rivers, streams, groundwater, and other drinking water sources (BWSR, 2012). Other potential funding opportunities include but are not limited to: Natural Resource Block Grants and State Cost Share through the Board of Soil and Water Resources (BWSR), 319 Grants through MPCA, grant opportunities provided by the MDA and the MN DNR, as well as funding for individual projects through NRCS's multiple programs.

Though a portion of the cost associated with the installation of practices are covered through grants and programs, the cooperator is also required to contribute to the expenses out of pocket. The cooperators not only incur these expenses but they also may contribute their time and equipment to their project. Grants and programs do not cover maintenance; therefore, all maintenance costs are the responsibility of the cooperator.

Currently, Benton and Morrison SWCDs receive partial funding from their respective county. Benton and Morrison SWCD's are currently utilizing three Clean Water Land and Legacy grants. One grant's focus is on water quantity BMPs (irrigation scheduling and uniformity tests), with that grant's funds expiring at the end of 2013. Another grant focuses on water quality and erosion BMPs, with that grant's funds expiring at the end of 2014. The final grant is to work with producers and industries on feed management and nutrient management BMPs, with that grant's funds also expiring at the end of 2014. Together, a total of $303,260 grant dollars are being implemented within the Little Rock Lake, and Little Rock Creek watershed and recharge areas.

Monitoring Plan

Continued monitoring is essential to improve the baseline and to track responses to implementation activities. Monitoring will aid in determining whether the implementation activities have improved water quality, assist in determining the effectiveness of various BMPs and indicate when adaptive management should be initiated.

Monitoring Needs

Due to limited staff, time and funding, it is not deemed feasible to identify partners for all monitoring components nor is it feasible to complete all suggested monitoring. This is a statewide issue that we recognize needs to be resolved at the state level. The MPCA's "ten year monitoring and assessment" program will partially resolve this problem; however, additional resources need to be identified for special situations such as Little Rock Lake and Little Rock Creek. Responsible partners for monitoring may include, but are not limited to: MPCA, MN DNR (multiple divisions), MDA, SWCDs, volunteer stakeholders and interest groups.

Monitoring needs includes water quality, biological, groundwater and geomorphology monitoring components identified in the Little Rock Lake TMDL and Little Rock Creek Watershed TMDL.

Water Quality and Biological Monitoring

Monitoring the entire spring-summer-fall season in tributaries and the lake is <u>crucial</u>.

- Monitor the entire spring-summer-fall season in tributaries and the lake. While tracking compliance with the lake standards requires June-September sampling, spring and fall data are needed to evaluate responses to watershed phosphorus controls, the lake phosphorus mass balance, and the buildup of phosphorus and blooms over the growing season.

- The number of lake sites can be decreased from five to three: LRL-1, LRL-2 (deepest point) and LRL-5 (representing outflow from the lake). The lake outlet can be sampled during spring runoff if ice cover precludes access to the lake (Figure 2).

- The lake can be sampled monthly and parameters should include at a minimum (every year) TP (surface & bottom at LRL-2), Chl-a, transparency, field profiles, and user perception survey. The remaining parameters specified in the 2008 design can be monitored every third year (LRL-2 only).

- Monitoring of tributary flow and water quality should be performed each year and integrated with the creek TMDL plan. The plan should include sufficient samples to capture the rising and falling limbs of the spring runoff period (at least weekly frequency).

- The downstream sites at the Little Rock Creek basin outlet and Mississippi River can be eliminated. Special sampling is recommended to document lake responses to extreme flooding events on the Mississippi and shoreline flooding.

The results should be compiled and reported yearly to track progress. A comprehensive review of the data, mass balances, and modeling update should be performed after three to five years of continuous monitoring.

At a minimum, water quality monitoring should occur in the Little Rock Creek watershed for assessment/study purposes as a part of the next MPCA monitoring cycle, currently scheduled for 2016. This monitoring should include:

- Continuous monitoring for flow, temperature and routine water quality sampling— key monitoring sites include Stations 6, 9, BH2, 11 and 13 (shown in Figure 4)
- Compliance monitoring:
  - Conduct longitudinal (am/pm) surveys during critical low-flow and a range of higher flow conditions, including measurements of temperature, DO, flow rate, nitrate, ammonia, CBOD, particulate organic matter (POM) and Chl-a. Add continuous DO meters where possible.
  - Chemical composition, DO and temperature measurements from shallow groundwater sources; time of travel survey

Evidence regarding predation on trout by pike and other warmwater piscivores and connectivity was inconclusive due to insufficient evidence, but suggests that each has the potential to contribute to the biological impairment. Further monitoring could shed light on the potential effects of predation and connectivity as stressors to the biological community of Little Rock Creek.

Future data collection/analysis needs include:

- Document any changes in temperature above and below water control structures and culverts
- Determine at what flows, if any, culverts become fish or other biotic community migration barriers and/or sediment barriers
- Determine if the biotic sampling results indicate barrier issues
- Finalize an IBI for cold and cool water fish assemblage, and incorporation of the MN DNR fisheries monitoring into the various components of the IBI; incorporate the future development of a tiered-aquatic life use (TALU) framework to clarify the attainable use for Little Rock Creek
- Overall, determine how mobile the bedload is and where is aggradation/degradation occurring within the watershed, this may be able to be accomplished by strictly looking at historical data but additional data collection maybe necessary.
- Conduct surveys of watershed producers to document crop rotations, tillage, conservation and nutrient management practices

Groundwater Monitoring

Groundwater observation well monitoring and tracking of appropriations should be continued in the Little Rock Creek Groundwater Domain (Figure 5) for assessment/study purposes, as well as a part of the conditions of appropriations permits. This monitoring should include:

- Pumping volume audits to verify the accuracy of the State Water Use Data System (SWUDS) data (MN DNR)
  - Methods used to track pumping volumes range from electric timers on pumps to more accurate in-line flow meters. In many cases, an assumed pumping capacity is used and simply multiplied by how long the pump was on. Specific capacities likely decrease throughout the year and particularly as the well ages; hence, volumes may actually be overestimated. Currently, all data is self-reported and it is unknown how accurate the data is.

    - Pumping volumes are currently reported on a monthly basis and compiled annually by the MN DNR. Compiling pumping volumes more often (e.g., weekly) and publicly sharing this data regularly enables the ability to find areas where increased irrigation efficiency may be achieved
- Pumping tests (ideally involving most sensitive wells) intended to:
    - Identify wells open to water table aquifer and wells open to deeper buried sand and gravel aquifers
    - Monitor both upper and lower aquifer during test to gain better understanding of the connection
- Continued synoptic water level measurements, semiannually in the spring and fall of each year
- Pressure transducers and data loggers in select monitoring wells

Geomorphology

Little Rock Creek contains numerous segments that show evidence of aggradation, mostly of fine sand material. This aggradation of sediments has altered the channel pattern, profile and dimension in many segments. Evidence on a smaller scale can be found at the road crossings where sediment is building up on the upstream side and large scour pools downstream. The riparian corridor is pretty well in tact with perennial vegetation, so it is reasonable to assume that the origin of the sediment was historical and could have been a catastrophic event, such as wildfire, wide scale removal of perennial riparian vegetation, major flooding, or cumulative effects related to land use change.

An analysis of the watershed history is needed to provide context for both the TMDL and Implementation reports. In addition, repeat and additional geomorphic survey; sites should be completed, organized by valley type, stream type and Pfankuch stability rating (good/fair & poor). Each combination of these metrics should have a representative survey completed. The surveys should include a longitudinal profile, cross-sections (riffle, pool, run and glide), pebble counts and streambank erosion estimates (Bank Erosion Hazard Index [BEHI], Near-Bank Stress [NBS]) and validation (bank pins). The potential products and outcomes from these assessments will include an evaluation of stream channel succession, i.e. how close the stream channel is to reaching a stable state, and how the channel is dealing with the legacy sediment, accurate streambank erosion rates and prioritized implementation strategies.

Monitoring of Stations 2, 5, 6, 7, 8, 9, 11, 12 and 13 (see Figure 4), as was done for the Stressor Identification project (Benton Soil and Water Conservation District, 2009) over a period of years, will provide a better picture of whether there are active erosion sites contributing to bedded sediment. A more detailed investigation of local sources of runoff to the stream channels should be performed to determine if upland BMPs can be implemented to reduce the rate and volume of runoff, as well as the likelihood of streambank erosion or increases to the allocated pollutant loadings.

Current Monitoring Activities

As stated previously, due to limited staff, time and funding it is not deemed feasible to complete all suggested monitoring; however, efforts are being made to complete monitoring activities as budgets and staffing allows. The following are either current monitoring activities or planned activities to be implemented in the future.

Little Rock Lake Monitoring

- LRLA is collecting bi-monthly water samples at LRL1, LRL2 and LRL5 monitoring sites. They are sampling for TP, Chl-a, transparency and user perception.
- MPCA Monitoring Cycle (2016)
  - Monitor the entire spring-summer-fall season in tributaries and the lake

Little Rock Creek Monitoring

- MPCA Monitoring Cycle (2016)
  - Conduct longitudinal (am/pm) surveys during critical low-flow and a range of higher flow conditions, including measurements of temperature, DO, flow rate, nitrate, ammonia, CBOD, particulate organic matter (POM) and Chl-a. Add continuous DO meters where possible.
  - Chemical composition, DO and temperature measurements from shallow groundwater sources; time of travel survey

Miscellaneous Monitoring

- Irrigation pumping volumes are currently reported on a monthly basis and compiled annually by the MN DNR.

Clearly there is a gap between suggested monitoring and current monitoring activities. Stakeholders and the community at large are requesting trend analysis data; with the current monitoring activities it is not conceivable to provide trend analysis. These are two statewide issues that we recognize needs to be resolved at the state level. Additional resources must be identified for special situations such as Little Rock Lake and Little Rock Creek. In order to accomplish monitoring needs all partners must work together, combining resources to accommodate for tight budgets and limited staff.

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Appendix

Impairment impacts were ranked by the members of both technical advisory committees using a H-High, M-Medium, L-Low, N-Negligible ranking system

Practice	Nitrates	Phosphorus	Dissolved Oxygen	Temperature	Fish Bioassessment
Animal Feedlot Improvements	H	H	M	N	N
Conservation Ditch Management	M	L	L	N	L
Cover Crop	M	M	N	N	L
Feed Management	H	H	M	N	M
Filter Strip	H	H	L	L	M
Harvestable Filter Strips	H	H	M	L	M
Irrigation System Conversion	M	N	L	L	L
Irrigation System Maintenance	M	N	L	L	L
Irrigation System Uniformity Test	H	N	M	M	M
Irrigation Water Management	M	N	L	L	L
Lakeshore Native Buffers	N	H	N	N	N
Nutrient Management	H	H	M	N	M
Pasture Management/Prescribed Grazing	M	M	L	L	L
Residential BMPs	L	H	L	L	N
Residue and Tillage Management	L	H	L	L	L
Riparian Buffer	H	H	M	M	M
SSTS Upgrades	M	H	L	N	L
Stream Habitat Improvement Management	N	N	M	M	H
Wetland Restoration	L	M	L	L	L

Practice	**Nitrates**	**Phosphorus**	**Dissolved Oxygen**	**Temperature**	**Fish Bioassessment**
Aluminum Sulfate Treatment	N	H	N	N	N
Aquatic Plant Management	N	H	N	N	N
Carp control	N	H	N	N	N
Channel Bed Stabilization	N	N	N	N	M
Conservation Crop Rotation	M	M	L	N	L
Conservation Drainage Management	M	L	L	N	L
Contour Buffer Strips	L	M	N	N	N
Field Borders	L	H	L	N	L
Grassed Waterways	L	H	L	N	L
Groundwater Management Area	N	N	M	M	M
Irrigation Technology – Variable Rate Irrigation	H	N	M	M	M
Manure Spreader Calibration	H	H	L	N	L
Pasture Exclusion	M	M	L	L	L
Stream Crossing	N	L	N	N	M
Terraces	L	M	N	N	N
Water and Sediment Control Basins	L	M	N	N	N
Project					
Sartell Wildlife Management Area (WMA)	N	N	H	H	H