

**LAKE SARAH EXCESS NUTRIENT TMDL PROJECT
WORK PLAN
DECEMBER 2007**

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Project Information:

Project Title: Lake Sarah Excess Nutrients TMDL Project
Lake Assessment Unit ID
(Reach Name): 27-0191-01 (Lake Sarah-West Bay) and 27-0191-02 (Lake Sarah-East Bay)
Pollutant: Phosphorus
Impaired Uses: Aquatic Recreation due to excess nutrients
303(d) List Schedule: 2007//2012
Project Dates: February 8, 2008 to May 31, 2009

Project Summary:

In 2004, Lake Sarah was placed on the Minnesota Pollution Control Agency's (MPCA) 303(d) list of impaired waters because of excess nutrients (phosphorus). Inclusion on the 303(d) list requires completion of a Total Maximum Daily Load study to determine the magnitude of the impairment, identify pollutant sources and allocate pollutant loading among the permitted (i.e. MS4, construction stormwater, and ISTS) and non-permitted sources in the lake drainage basin.

Data collected by Three Rivers Park District (TRPD) in cooperation with the Pioneer-Sarah Creek Watershed Management Commission (PSCWMC) determined that Lake Sarah had a mean growing season phosphorus concentration in excess of the MPCA State water quality standard of 40 ug/L. As a result of the high in-lake phosphorus concentration, the chlorophyll *a* concentration and the water clarity, as measured by a Secchi disk, Lake Sarah did not meet the recreational use criteria.

This project includes collection of additional data to determine the major phosphorus sources in the watershed and determine the magnitude of the impairment. The data will be used to develop appropriate models to estimate the phosphorus load reductions necessary to meet water quality standards, evaluate watershed and in-lake management practices for phosphorus load reduction potential, and determine the phosphorus allocation from permitted and non-permitted sources in the watershed. Phosphorus load and wasteload allocations will be completed in cooperation with a stakeholder committee established by the Pioneer-Sarah Creek Watershed Commission.

Background Information:

Lake Sarah (MNDNR Lake ID# 27-0191-01 and 27-0191-02) is a 552-acre lake located approximately 18 miles west of Minneapolis in west central Hennepin County. The lake has a maximum depth of 60 feet and a mean depth of 18.2 feet. The lake is used extensively for fishing, boating and aesthetic viewing by local and regional Twin City Metropolitan Area (TCMA) residents. The majority of the west end of the lake is within Lake Sarah Regional Park, operated by Three Rivers Park District.

The lake receives runoff from a 4,608-acre predominantly agricultural watershed which contains portions of five municipalities -- Greenfield, Independence, Corcoran, Loretto, and Medina (Figure 1). Portions of the watershed are undergoing rapid urbanization, although the majority of the new residential lots are large, between 2.5 and 5 acres in size.



Figure 1. Lake Sarah Watershed Land Use.

Three Rivers Park District, in cooperation with the Pioneer-Sarah Creek Watershed Management Commission, collected data on the lake quality approximately bi-annually from 1990 to 2006. In 1992, the Hennepin Conservation District completed a detailed diagnostic/feasibility study through the Clean Water Partnership Program. Data from these programs confirm that the lake is experiencing serious water quality degradation problems.

Problem Statement:

In 2004, Lake Sarah was placed on the Minnesota Pollution Control Agency's (MPCA) 303(d) list of impaired waters because of excess nutrients (phosphorus). As Table 1 shows, the Lake Sarah mean summer phosphorus concentration exceeded the 40 ug/L MPCA water quality standard in 9 years of monitoring from 1996 to 2004. Bi-weekly data indicate that the phosphorus concentration exceeds the 40 ug/L standard throughout the open water season. The data also showed that the chlorophyll *a* and Secchi disk depth exceeded water quality standards for body contact recreation lakes.

YEAR	TP (µg/L)	CHLa (µg/m3)	SECCHI (m)
1996	100.1	28.3	0.96
1997	91.6	39.9	1.42
1998	79.1	45.7	1.39
2000	73.9	24.1	1.57
2002	134.76	40.7	1.33
2004	138.6	62.3	1.53
2005	94.9	56.3	1.83
2006	90.8	48.6	1.30
2007	92.1	54.6	1.13

Table 1. Lake Sarah mean summer phosphorus and chlorophyll *a* concentrations and Secchi disk depth.

Lake Sarah receives excess nutrient loading from the 4,608-acre contributing watershed and from internal recycling mechanisms. The internal loading factor is especially critical in Lake Sarah because an abundant curly-leaf pondweed population provides a phosphorus pulse to the lake when it undergoes senescence in late June each year. As a result of the excessive phosphorus loading, the lake experiences nuisance algae blooms throughout much of the growing season. Recreational use of the lake is severely restricted during these bloom episodes. In addition, the high phosphorus levels and consequent high turbidity levels are affecting the lake fish population, which is beginning to become dominated by rough fish.

Project activities and schedule:

Task 1 – Data collection

Data collection will be performed by Three Rivers Park District in cooperation with Pioneer-Sarah Creek WMC. Data collection for the Lake Sarah TMDL will include bi-weekly lake monitoring from ice-out until freeze-up in 2008. Samples will be analyzed for total and soluble phosphorus, total nitrogen, and chlorophyll *a*. During each site visit dissolved oxygen, conductivity, and pH measurements will be taken at one meter intervals from the surface to the lake bottom. In addition, a vegetation survey will be completed to determine the extent of the nuisance curly-leaf pondweed growth.

Continuous flow data will be collected at the two main inflow streams as well as at the lake outlet. Automatic samplers will be slaved to the flow data loggers and programmed to collect samples during rainfall runoff events. Although inflow monitoring was completed in 2007, there was no inflow during the growing season because of the extensive drought, limiting the value of the data. Inflow and outflow samples will be analyzed for total and soluble phosphorus, total nitrogen, nitrate nitrogen, ammonia and suspended solids.

Samples will be analyzed at the Three Rivers Park District Water Quality Laboratory (MN Department of Health Certification # 027-053-352). The laboratory and field sampling QA/QC plan will be submitted to MPCA prior to initiating the monitoring program. This QA/QC Plan was previously approved by MPCA and EPA staff. Field dataloggers and samplers owned by Three Rivers Park District will be used to complete the monitoring.

A watershed assessment will be completed to determine land use, soils, slopes, cropping practices, feedlot information, land cover, drainage practices, individual sewage treatment system practices, and wetland information. All information will be incorporated into the Park District GIS system for analysis.

Data will be used for model development and verification. Three Rivers Park District will provide the MPCA with their water quality data collection procedures and the MPCA will develop a Quality Assurance Project Plan (QAPP).

Deliverables: Water quality runoff data representative of different annual rainfall conditions for the watershed and lake response to loading rates. All data will be entered into the Three Rivers Park District database and be made available to the MPCA in a format suitable for entry in the STORET database system.

Task 2 – Data analysis and Summary

This task will involve compiling, reviewing and analyzing all existing and newly collected water quality, water quantity and biological data relating to the Lake Sarah watershed including flow, soils, land use, pollutant loading, drainage flow patterns, cropping information and feedlot information. The data will be used to identify critical sources of phosphorus in the watershed, calibrate pollutant loading and lake response models, and determine pollutant loading reductions necessary to meet established water quality goals. Specifically, problem identification and pollutant loading reduction analysis will include the following:

- Evaluating algae bloom frequency and lake user response to conditions.
- Comparing current lake water quality with reference or background conditions estimated by MINLEAP and Vighi and Chiaudani.
- Evaluating in-lake water quality trends and comparing trends with land use changes.
- Determining the critical conditions for compliance with water quality standards.
- Evaluating watershed loading under various rainfall patterns and annual flow conditions.
- Evaluating the magnitude of the curly-leaf pondweed senescence pulse on the annual in-lake phosphorus concentration.

Deliverables: Compilation of Lake Sarah watershed data. Draft report for incorporation into the TMDL Report discussing critical pollutant sources, needed phosphorus reductions to achieve water quality standards, impact of internal loading on in-lake water quality, and annual water quality variability as a function of precipitation patterns.

Task 3 – Watershed and In-Lake Modeling

This task will involve development and calibration of appropriate watershed runoff and lake response models to evaluate the phosphorus load and wasteload allocations necessary to achieve

water quality standards. It is anticipated that the FLUX and BATHTUB Models will be the primary tools used to accomplish this task, although additional models may also be used.

The FLUX Model will be calibrated using the flow and water quality data collected at tributary streams during Task 1 of the workplan. Sufficient model runs will be completed to estimate loading rates for various rainfall patterns to ensure an adequate margin of safety in load and wasteload allocations. The FLUX Model will be used in conjunction with internal phosphorus recycling estimates to determine the relative pollutant load from the curly-leaf pondweed senescence.

The BATHTUB Model will be calibrated to predict measured in-lake phosphorus concentrations for observed precipitation patterns and then used to predict the phosphorus load reductions necessary to achieve water quality standards with an adequate margin of safety. The model will also be used to evaluate in-lake phosphorus concentration changes under different watershed management scenarios and future watershed development.

Deliverables: Report for insertion into the final TMDL Report document that describes the existing loading and lake quality conditions, the estimated assimilative capacity of Lake Sarah (the TMDL), the loading reductions necessary to reach the assimilative capacity, the load and wasteload allocations necessary to achieve the water quality standards, and the necessary margin of safety necessary to account for annual variation in loading and lake response. The report will also discuss phosphorus sources and potential management practices to address excessive loading.

Task 4 – Solution Identification/Pollutant Allocations and Implementation Strategies

The calibrated FLUX model will be used to identify non-point phosphorus source loadings in the watershed, develop load and waste load allocations, identify and evaluate the effectiveness of potential BMP practices to reduce pollutant loads, and determine the margin of safety. The lake response to the expected watershed and in-lake load reductions will be evaluated with the calibrated BATHTUB model. In particular, water quality improvements anticipated from the curly-leaf pondweed control program will be estimated with the calibrated model.

Model results will provide general implementation strategies for inclusion in the TMDL draft report. The model output will be further refined to select specific BMPs to develop a detailed Implementation Plan for Lake Sarah. Model output will be used to provide cost-benefit information on specific BMP selections to the stakeholder committee to ensure understanding of the implications of the TMDL plan.

Deliverables: Report detailing non-point source pollution loadings and in-lake phosphorus recycling estimates, recommended best management practice scenarios for the watershed and in-lake management, and load and wasteload allocations necessary to achieve water quality standards. This report will be incorporated into the draft TMDL document.

Task 5 – Stakeholder participation

Determination of a target goal for Lake Sarah, as well as the wasteload allocations and load allocations will be completed by a large group of stakeholders in the watershed. The following groups are represented on the TMDL stakeholder committee appointed by the Pioneer-Sarah Creek Commission:

- The Lake Sarah Improvement Association
- Pioneer Sarah Creek Watershed Management Commission
- The City of Medina
- The City of Independence
- The City of Greenfield
- The City of Loretto
- The City of Corcoran
- The Independence Horse Owners Association
- The Medina Horse Association
- Hennepin County Department of Environmental Services (HCDES)
- Three Rivers Park District
- At-large citizens
- A representative of the agricultural producers in the watershed
- The Department of Natural Resources
- The Minnesota Pollution Control Agency
- The Board of Soil and Water Resources
- Minnesota Department of Transportation

Committee members will meet bi-monthly for approximately two years. The committee will be chaired by a representative from the Lake Sarah Improvement Association. Initial meetings of the group to establish water quality goals for the lake began in early 2007. Currently the group is focusing on developing a Lake Vegetation Management Plan which includes a five-year curly-leaf pondweed control program scheduled to begin in 2008.

As part of the public participation process, the Pioneer-Sarah Creek WMC will host a minimum of two open houses to present the draft TMDL report and the final results of the TMDL. Citizens attending these meetings will be afforded an opportunity to provide input into the TMDL process. Annually, the Lake Sarah Improvement Association will host a public meeting where additional input to the TMDL will be solicited. The Pioneer-Sarah Creek WMC will also organize multiple meetings with council members from the five municipalities in the watershed to discuss load and wasteload allocations, and implementation strategies.

Deliverables: Consensus from stakeholders regarding the water quality goals for Lake Sarah, Load and Wasteload Allocations, meetings as noted above, and support from project partners and stakeholders on the development of the model and the draft TMDL.

Task 6 – Final TMDL report(s) and Implementation Plan

This task consists of completing draft and final TMDL reports based on EPA guidelines; MPCA, EPA, WMC, and stakeholder reviews and public comments. The draft and final TMDL will

include background information, permitted (wasteload) and non-permitted (load) allocations, margin of safety, critical conditions, reasonable assurance, implementation strategies, data assessments, and a summary of public outreach activities. The TMDL report will be submitted to the MPCA and EPA for their review and comment. The Implementation Plan will also be completed as part of this project scope and reviewed by the WMC, stakeholders, and MPCA.

Two semi-annual progress reports will be prepared each year due **February 1st and August 1st** that will include an update on completed work plan tasks and a budget update.

Deliverables: Draft and final TMDL report in both hard copy and digital format. An Implementation Plan in both hard copy and digital format. Semi-annual reports.

TASK SCHEDULE AND RESPONSIBLE PARTY

TASK	COMPLETION DATE	LEAD
1. Data Collection	November 1, 2008	TRPD/Pioneer-Sarah Creek WMC
2. Data analysis and summary	November 15, 2008	TRPD
3. Watershed and In-Lake Modeling	December 31, 2008	TRPD/HCDDES
4. Solution Identification	November 30, 2008	All project partners
5. Stakeholder participation	December 30, 2008	All project partners
6. Final TMDL Report	May 31, 2009	TRPD