

Lake Sarah TMDL Project

8/1/08 Progress Update

Three Rivers Park District

Task 1 – Data collection

Three Rivers Park District sampled Lake Sarah to assess the current trophic status of the lake. The lake was sampled five times during this reporting period. The in-lake sampling has occurred bi-weekly from April 29 through June 23, 2008. Both the west (MNDNR Lake ID#: 27-0191-01) and east (MNDNR Lake ID#: 27-0191-02) portions of Lake Sarah are currently being monitored for seasonal changes in water quality. At each sample location, a water quality profile was collected at 1-m depth intervals. The water quality parameters collected included temperature, dissolved oxygen, specific conductivity, and pH. Water clarity was also measured at each sampling site with a secchi disk. Water samples were collected for nutrient analysis at the surface, thermocline, and 1-m from the bottom. The in-lake water samples collected at the surface were analyzed for total phosphorus, soluble reactive phosphorus, total nitrogen, and chlorophyll-a. The water samples collected at the thermocline and 1-m from the bottom were analyzed for total phosphorus and total nitrogen. All of the water samples were analyzed by the Three Rivers Park District certified laboratory. Currently, the in-lake monitoring is approximately 42% completed. The in-lake monitoring will continue through September and it is estimated that data will be collected for approximately 7 more times in 2008.

Three Rivers Park District monitored the watershed nutrient loading to Lake Sarah. There were three automated samplers with flow loggers to measure continuous flow measurements and collect water samples during storm events in 2007. The same three monitoring stations were re-installed on April 22, 2008. There were two monitoring stations located at primary inflow sites to Lake Sarah; and one monitoring station located at the primary outlet that flows from Lake Sarah. A total of 15 samples have been collected from the three sampling sites from April 22 through June 31, 2008. There were two more automated sampling stations installed in early June to better understand the dynamics and functionality various wetlands provide within the watershed. These sampling sites were installed June 12 and June 17, 2008. Due to the delayed site installation, there were no samples collected from these sampling sites during this reporting period. Currently, these sampling sites are monitoring continuous flow measurements and collecting samples for the next reporting period. Samples collected at each of these monitoring sites are analyzed for total phosphorus, soluble reactive phosphorus, total nitrogen, and total suspended solids. All of the samples were analyzed by the Three Rivers Park District certified laboratory. The watershed monitoring is approximately 50% completed. The watershed monitoring will continue through October and/or possibly into November.

A point intercept aquatic vegetation survey was also completed to assess the plant community in Lake Sarah. The survey was completed from May 21 through 22 in 2008. The plant community was surveyed for both the west (MNDNR Lake ID#: 27-0191-01) and east (MNDNR Lake ID#: 27-0191-02) portions of Lake Sarah. There was 121 points surveyed for the west portion of Lake Sarah, and there was 76 points surveyed for the east portion of Lake Sarah. Another point intercept survey is scheduled to be completed in August of 2008.

Three Rivers Park District conducted two surveys of the agricultural practices in the Lake Sarah watershed. The first survey was to assess the different crops that were grown within the watershed. The second survey was to assess the quantity and type of livestock present on feedlots in the watershed. These surveys were completed from a vehicle and documented on aerial photography maps of the watershed.

Task 2 – Data analysis and Summary

The in-lake water quality data has been compiled and analyzed from 1996 through 2007. Lake Sarah water quality exceeds the MPCA standard criteria to fully support recreational use. The annual average total phosphorus concentrations ranged from 74 µg/L to 139 µg/L. Due to high concentrations of phosphorus, Lake Sarah had significant algae blooms that reduced water clarity conditions. The annual average chlorophyll-*a* concentration ranged from 29 µg/l to 62 µg/l. The chlorophyll-*a* concentration is typically the highest during the summer when water temperatures are warmer. The secchi depth transparency during the summer is frequently below 1.0 m in depth. These parameters were used to further determine the Trophic Status Index (TSI) for Lake Sarah. The TSI values suggest that Lake Sarah has eutrophic conditions that are above average in comparison to other lakes within the Central Hardwood Forest Ecoregion. The trends in Lake Sarah water quality will be further evaluated with 2008 data collected. The in-lake water quality parameters collected in 2008 is currently considered incomplete and has not been analyzed to incorporate into the existing database.

The watershed nutrient loading for the three monitoring sites established in 2007 has been analyzed. There appears to be a considerable amount of nutrient loading from the two primary inflow sampling stations. Unfortunately, there were very few rainfall events in 2007 that produced a significant amount of runoff volume for sample collection. Consequently, there were only 13 samples collected for the two inflow stations, and there were only 6 samples collected for the outflow sampling stations. The majority of the water quality samples represented rainfall events that occurred in the spring and the fall. There were no samples collected throughout the summer, and the lack of samples continued into the early fall due to the extreme drought conditions in 2007. It appears that several rainfall events were necessary to adequately recharge the wetlands within the watershed before any stream flow was produced to provide water quality samples. The watershed monitoring in 2007 was not considered representative of average precipitation conditions. Consequently, monitoring efforts were resumed in 2008 to provide additional nutrient concentration and continuous flow data. There were two more automated sampling stations installed to better understand the dynamics and functionality of the wetlands within the watershed. The watershed monitoring data for 2008 is currently considered incomplete and has not been analyzed. The watershed monitoring data from 2007 and 2008 will be used to calibrate the watershed model.

The point intercept aquatic vegetation survey has been completed for the spring of 2008. The survey data has not been analyzed to provide a detailed assessment of the plant community for Lake Sarah. Typically, Lake Sarah has nuisance growth conditions of curlyleaf pondweed that inhibits recreational use. Preliminary analysis of the data indicates that curlyleaf pondweed appears to be the dominant plant species in the spring survey. The senescence of curlyleaf pondweed at the end of June and beginning of July has been identified as a source of internal nutrient loading that degrades Lake Sarah water quality conditions. The extent that curlyleaf

pondweed influences water quality conditions for Lake Sarah is currently unknown. Another point intercept survey will be completed in August or September of 2008 to further assess the plant community.

Three Rivers Park District conducted two surveys of the agricultural practices in the Lake Sarah watershed, the first to assess the crops grown in the watershed and the second to assess the quantity and type of livestock present on feedlots in the watershed. Park District staff observed 109 horses, 37 beef cattle, 53 dairy cows, 6 goats and 1 donkey on 33 properties in March, 2008. The crop survey found that the dominant crops were corn and soybeans in a corn-soybean rotation. Other minor crops in the watershed were alfalfa, hay, pumpkins and wheat.

Task 3 – Watershed and In-Lake Modeling

The Three Rivers Park District estimated nutrient loading at each of the watershed monitoring stations. The nutrient concentrations and continuous flow measurements collected from the monitoring stations were entered into a FLUX model. The FLUX model was used to estimate the watershed nutrient loading at the two inflow stations and the outflow station in 2007. The FLUX model will also be used to estimate the nutrient loading for the sampling sites that were monitored for 2008. These estimates of nutrient loading at each respective monitoring site will be used to further calibrate a watershed model for Lake Sarah.

Modeling the Lake Sarah watershed was very complex because several different land use types exist in the drainage area. Three Rivers Park District constructed a model using the Soil and Water Assessment Tool (SWAT) to assess nutrient loading in the watershed. The primary land uses in the Lake Sarah watershed are residential and agricultural. The SWAT model was selected because of its strength in modeling agricultural areas. Spatial inputs to the SWAT model were land use from Hennepin County Environmental Services augmented with Park District Staff observations, soils from the Soil Survey Geographic (SSURGO) Database and 10-meter resolution elevation from the National Elevation Dataset. Daily precipitation, maximum and minimum temperatures were input to the model from the Rockford, MN National Weather Service Cooperative Observer station. The model was initially calibrated to simulate the daily stream flow at the two inflow monitoring stations for the period of record in 2007. Preliminary data analysis suggests that stream flow compared favorably with the goodness-of-fit as calculated with the Nash-Sutcliffe Coefficient of Efficiency greater than 0.5 for both sites. The 10-year average corn and soybean yields were calibrated to the National Agricultural Statistics Service (NASS) yearly county-wide crop yields for Hennepin County from 1997 to 2007 to calibrate agricultural removal of phosphorus from the landscape. Additionally, the portions of the watershed that were defined as rural residential or residential were modeled using the SLAMM or P8 model. The impervious and pervious surface drainage area from these urban areas was incorporated into these models to estimate phosphorus loading. These areas were modeled separately to accurately estimate the phosphorus loading attributed to these urban areas. These urban loading estimates were incorporated into the SWAT model. The urban and residential portions of the SWAT model were calibrated to match the phosphorus export from the SLAMM or P8 models on a kg/ha basis over a 15-year period. Modeled stream phosphorus exports at the two sites were compared with the samples taken by Three Rivers Park District staff. The monitored phosphorus values were compared to the modeled phosphorus output visually, but goodness-of-fit was not calculated because of the small number of samples. The

model will be re-calibrated for daily stream flow and nutrient loading at each monitoring station for 2008.

The watershed nutrient loading estimates will be input into an in-lake response model. A BATHTUB model is currently being set up to simulate the in-lake water quality conditions. A preliminary model has been completed using WILMS to determine whether the current nutrient loading estimates accurately estimate the in-lake water quality conditions for Lake Sarah. The WILMS model uses similar algorithms that BATHTUB incorporates to simulate the in-lake response for estimating water quality conditions. The WILMS model appears to accurately predict the existing water quality conditions for Lake Sarah using the current loading estimates derived from the watershed modeling. The BATHTUB model will be completed after the watershed model has been calibrated using the 2007 and 2008 monitoring data.

Task 4 – Solution Identification/Pollutant Allocations and Implementation Plan

The calibrated SWAT model will be used to identify non-point phosphorus source loadings in the watershed as well as developing waste load allocations. The SWAT model has been calibrated to the 2007 monitoring data. Based on preliminary model simulations, potential non-point sources of pollution and waste load allocations have been estimated for each municipality. The watershed nutrient loading has been incorporated into the in-lake response WILMS model. The reduction in pollutant loading necessary to achieve in-lake water quality goals has been estimated using the WILMS model. The SWAT and BATHTUB model will be re-calibrated using the 2007 and 2008 data to better predict non-point sources of pollutant loads and waste load allocations.

The SWAT model will also be used to evaluate the effectiveness of potential BMP practices to reduce pollutant loads. Three River Park District has researched best management practices to determine the potential comparative reductions in pollutant loading. A preliminary cost analysis for implementation of the best management practices has also been completed. A more detailed analysis of best management practices will be completed after final calibration of the SWAT and BATHTUB model. These best management practices will be incorporated into the Implementation Plan for Lake Sarah TMDL.

Task 5 – Stakeholder participation

There have been several stakeholder meetings for the Lake Sarah TMDL during the reporting period from January 1 through June 31, 2008. The objective of each stakeholder meeting for the Lake Sarah TMDL is listed below.

January 15 – The Lake Sarah TMDL stakeholder committee members were educated on the TMDL process. The committee members developed and discussed water quality goals for the lake.

February 25- The stakeholder meeting discussed the impacts curlyleaf pondweed has on Lake Sarah water quality. The committee members were educated about the internal loading attributed to curlyleaf pondweed senescence. Management options to control curlyleaf pondweed were discussed. There were further discussions about developing an aquatic vegetation management plan.

April 7-The stakeholder meeting discussed the preliminary modeling efforts and the pollutant loads attributed to each municipality. There was further discussion about potential waste load allocations for each municipality.

June 16-The stakeholder meeting further discussed waste load allocations for each municipality. There were discussions about best management practices that could be used to reduce nutrient loading.

Task 6 – Final TMDL report(s)

A draft of the Lake Sarah TMDL report will be completed by December 31, 2008.