



AGENDA

Monday, February 25, 2021

5:30 PM

Parkview Room, Prior Lake City Hall
4646 Dakota St SE, Prior Lake, MN

SPECIAL BOARD MEETING

BOARD OF MANAGERS:

Mike Myser, President; Curt Hennes, Vice President; Bruce Loney, Treasurer

Steve Pany, Secretary and Frank Boyles, Manager

Note: Individuals with items on the agenda or who wish to speak to the Board are encouraged to be in attendance when the meeting is called to order.

5:30 – 5:35 PM **BOARD MEETING CALL TO ORDER & PLEDGE OF ALLEGIANCE**

5:35 – 5:40 PM **PUBLIC COMMENT**

If anyone wishes to address the Board of Managers on an item not on the agenda or on the consent agenda please come forward at this time. Stand up and state your name and address. (The Chair may limit your time for commenting.)

5:40 – 5:45 PM **APPROVAL OF AGENDA** (Additions/Corrections/Deletions)

5:45 – 7:00 PM **NEW BUSINESS**

Draft Upper Watershed Blueprint Report (Brian Kallio, Wenck) *(Discussion Only)*

Upper Watershed Blueprint



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Executive Summary

The Prior Lake-Spring Lake Watershed District (PLSLWD) took action to develop this Upper Watershed Blueprint comprehensively approach stormwater management in the Upper Watershed. This analysis will be used as a prioritized implementation roadmap for the PLSLWD and local partners to improve water quality conditions and reduce flooding in the watershed. This Upper Watershed Blueprint is intended to:

- 1) Recommend and prioritize programs, projects and policy to reduce phosphorus and runoff volume;
- 2) Identify partners and potential funding sources; and
- 3) Detail a 10-year schedule for prioritized program and project implementation including short-and long-term maintenance considerations.

Goals

Phosphorus Reduction Goals

The TMDL requires an annual TP reduction of about 2,959 pounds coming in from the surrounding Spring Lake watershed, out of a total load of 3,595 pounds. This is about 82% of the TP load from the watersheds that are tributary to Spring Lake. The goal of the Upper Watershed Blueprint is to significantly improve the water quality in runoff that originates in the Upper Watershed and move Spring Lake in positive direction towards meeting the overall TMDL goals.

Flood Reduction Goals

The flood reduction goal is to reduce the impacts of regional flooding on Spring Lake and Upper and Lower Prior Lake, as well as in the upper watershed where crops and residences are affected. Values that drive numerical objectives in the flood reduction-based goals are:

- Reduce the 30-day, 25-year return rainfall event high water level for Upper and Lower Prior Lake to 905.5, which protects infrastructure from being inundated and thus limiting emergency vehicle access.
- Limit the number of days that the lake is above the elevation where wake restrictions are applied. That trigger water elevation on Upper and Lower Prior Lakes is 904.0.
- Reduce the impact to structures on the lakes from significant rainfall and flooding events.
- Reduce the impact on upper watershed areas that are actively used for farming or rural residential homes.

Combining Goals

One of the original ambitions for the Upper Watershed Blueprint was to identify and evaluate projects that may provide both a water quality and a flood mitigation benefit. However, it was discovered during the process that the projects that were most beneficial for water quality provide little or no flood mitigation, and projects that are the most efficient for flood reduction offer little in terms of water quality benefit.

This separation is largely due to the nature of flooding in the district. The most beneficial water quality projects will function continuously throughout the year while the most efficient flood storage solutions will only function during significant flood events and would only provide treatment for a fraction of the total annual runoff from the Upper Watershed. As such, the potential projects have been sorted into two categories, water quality projects and flood reduction projects, so that the District may score and select projects by comparable cost-benefit ratios.

Potential Water Quality Projects

Spring Lake and Upper Prior Lake have been identified as impaired waters by the Minnesota Pollution Control Agency for excess nutrients. The high nutrient loading results in undesirable algae blooms and recreational use restrictions. The Total Maximum Daily Load (TMDL) study completed for the lakes requires an 82 percent reduction in total phosphorus (TP) from the watershed load to achieve the state water quality standard, which is about 2,959 pounds annually.

While small projects can provide incremental improvements to water quality and quantity concerns, this report is focused on larger projects that will have a more significant benefit. The 17 projects identified and evaluated in this report have the potential to reduce the annual phosphorous loads to Spring Lake significantly. The four projects with the highest phosphorous reduction potential identified in the study and their estimated load reductions are:

- County Ditch 13 Chemical Treatment System – 1,062 pounds per year.
- Ferric Chloride System Improvements Alternative 2 which includes upgrades to the system, assuming that the entire system can be optimized to remove 70% of the total phosphorous from half of the total flow – 911 pounds per year.
- Sutton Lake Iron Enhanced Sand Filter (IESF) - 735 pounds per year.
- Buck Lake Chemical Treatment System – 793 pounds per year.

These four projects combine to reduce the total phosphorous loads from the Upper Watershed by an estimated 3,501 pounds annually which exceeds the TMDL goal for watershed load reduction. These projects have various funding mechanisms that are available to assist from feasibility study through construction and long-term maintenance.

In addition, the District has received a grant to perform a feasibility study for the project identified as the Buck Lake East Wetland enhancement. This project scored 3rd highest in the project scoring matrix results and will provide an estimated reduction in annual in total phosphorous load of 100 pounds. This project, combined with the four projects identified above, brings the total reduction to about 3,601 pounds per year.

Potential Flood Reduction Projects

Resolving flooding issues on the Spring, Upper Prior and Lower Prior Lake is the second issue evaluated in the study. Periods of extreme flooding cause shoreline erosion and extended periods of no wake zones on the lake, and limit access for emergency vehicles due to road closures. Various models and scenarios indicate that the flooding is driven by discharge volumes to and from the lakes. Based on modeling conducted during this study, and on the 2016 Flood Study report, addressing these flooding concerns in the Upper

Watershed will require upstream storage on a very large scale to provide a measurable benefit for both the magnitude and duration of flooding. Two alternatives that can make a positive impact on the flooding are:

- Prior Lake Outlet Channel Modifications:

Modify the culvert and discharge allowance for the Prior Lake outlet channel to permit a higher discharge rate during period when the capacity is available in downstream channels and basins. Work with the DNR and other partners to allow discharge through the outlet channel at a lower water level in advance of forecasted significant precipitation events to proactively provide storage to contain those events. This water level manipulation combined with a higher discharge rate have the potential to reduce the 25-year high water level on Prior Lake by 0.5 feet.

- Upper Watershed Lakes Controlled Outlet Storage:

Install outlet controls on lakes in the Upper Watershed to limit discharge when targeted water levels are reached on Upper and Lower Prior Lakes. For this report, the targeted condition is to restrict flow from Swamp, Sutton, Fish and Buck Lakes when Upper and Lower Prior Lakes reach the no wake elevation of 904.0.

While not included in this report, the 2016 Flood Study also identified several opportunities with varying levels of impact on the flood elevations.

Policy Options

The report also considered potential regulatory modifications as non-structural options to reduce pollutant loading and limit changes in the rate and volume of runoff as development occurs in the Upper Watershed. Conversion of crop land to developed land by itself can significantly reduce nutrient and sediment loads. However, runoff from new impervious surface could exacerbate flood conditions in downstream lakes. New regulatory controls could potentially prevent increases in downstream flood elevations and have a modest (0.1 foot) reduction in the 25-year high water level on Prior Lake. These reductions are long-term as development and redevelopment occur over the coming decades.

Summary

The nature of the watershed and the causes of flooding present challenges identifying individual projects that address both water quality and flooding. The projects identified in this report were assessed and ranked based on phosphorous reduction potential, flood reduction potential, project cost, and overall feasibility. These scoring matrix rankings can be used to determine a priority list and schedule to implement future projects in the watershed. The District should evaluate any future land use changes or development in the Upper Watershed for potential water quality and flood reduction benefits that those changes may present.

Table ES.1 shows the 17 potential projects identified in the Upper Watershed Blueprint, and their associated pollutant load reduction and flood reduction impacts. To account for ongoing operations and maintenance costs where applicable, the overall cost is presented as a lifecycle cost over 15 years.

Table ES.0.1. Summary of results.

Project	Phosphorous Reduction (lbs/yr)	Flood Reduction (feet)	Phosphorous Reduction (\$/lb)	Lifecycle Cost	Scoring Matrix Rank
WATER QUALITY PROJECTS					
1) Sutton Lake Iron-Enhanced Sand Filter	735	0.0	\$166	\$1,836,000	2
2) Swamp Lake Diversion to Geis Lake	161	0.0	\$204	\$492,000	11
3) Swamp Lake Iron-Enhanced Sand Filter	223	0.0	\$159	\$530,000	7
4) Buck Lake South Wetland Storage	95	0.1	\$459	\$652,000	10
5) Buck Lake East Wetland Enhancement	100	0.1	\$119	\$180,000	5
6) Buck Lake East Stream Restoration	10	0.0	\$637	\$96,000	9
7) County Ditch 13 Improvements	202	0.0	\$389	\$1,177,000	13
8) County Ditch 13 Repairs	50	0.0	\$830	\$623,000	12
9) County Ditch 13 Diversion	90	0.0	\$924	\$1,253,000	14
10) Ferric Chloride System Improvements Alternative 1	250	0.0	\$107	\$400,000	6
11) Ferric Chloride System Improvements Alternative 2	911	0.0	\$151	\$2,069,000	4
12) Spring West Iron-Enhanced Sand Filter	249	0.0	\$112	\$419,000	1
13) Buck Lake Chemical Treatment System	793	0.0	\$204	\$2,431,000	8
14) County Ditch 13 Chemical Treatment System	1,062	0.0	\$157	\$2,500,000	5
FLOOD REDUCTION PROJECTS					
15) Prior Lake Outlet Channel Modifications	0	0.5	\$-	\$2,385,000	2
16) County Ditch 13 Storage	0	0.0	\$-	\$978,000	3
17) Upper Watershed Lakes Controlled Outlet Storage	0	0.5	\$-	\$1,403,000	1

1.0 Introduction

1.1 PROJECT PURPOSE

Wenck has prepared this Upper Watershed Blueprint (UWB) report on behalf of the Prior Lake-Spring Lake Watershed District (PLSLWD). The report presents current conditions and alternatives for stormwater treatment for the Upper Watershed as well as solutions to work towards mitigating flood conditions on Spring, Upper Prior and Lower Prior Lakes.

1.2 BACKGROUND

The Upper Watershed is a 12,760-acre area tributary to Spring Lake, located completely in Scott County, Minnesota. The Upper Watershed represents about 2/3 of the total tributary area to Spring Lake and Upper and Lower Prior Lakes. The Upper Watershed boundaries are shown in Figure 1.1.

The primary land use in the Upper Watershed is agricultural, with some rural residential. The current Scott County zoning map is for rural residential, transition reserve, agricultural preservation, and urban expansion reserve. There are about 2,700 acres of National Wetland Inventory (NWI) Type 3, 4, and 5 wetlands in the Upper Watershed. Cities and townships in the Upper Watershed include a small portion of Sand Creek Township, Spring Lake Township and the City of Prior Lake.

The Upper Watershed is drained primarily through two channel systems. The eastern channel is identified as the Buck Lake system. The Buck Lake system starts at Fish Lake and then flows through a series of streams and wetlands into Buck Lake, and from Buck Lake through a large wetland complex before entering Spring Lake. The land use in the Buck Lake system is a mix of agricultural, wetlands, and residential.

The western half of the Upper Watershed flows through Scott County Ditch 13, a largely man-made ditch that begins at Sutton Lake in the southwest area of the watershed. From Sutton Lake, the excavated channel flows to the north, through several agricultural fields and eventually to Spring Lake. There are two tributaries to County Ditch 13. One rises from Swamp Lake in the western portion of the watershed and flows through to the east and south before its confluence with the main branch of Ditch 13. The second rises at the southern extent of the Upper Watershed and flows north to meet with the main branch of Ditch 13 just west of Highway 13.

After the three ditches converge, the ditch crosses Highway 13 and Highway 282 before flowing into Spring Lake. Parts of the Ditch 13 flows pass through a Ferric Chloride treatment system before entering Spring Lake.

1.3 UPPER WATERSHED PROBLEMS

There are two primary problems for Spring Lake and Upper and Lower Prior Lakes, and the Upper Watershed is a significant contributor to both. First, phosphorus and sediment loading in runoff from the drainage area are the main sources of phosphorous in Spring Lake and Upper and Lower Prior Lakes. Spring Lake and Upper Prior Lake have been designated as Impaired Waters by the Minnesota Pollution Control Agency for excess nutrients, specifically

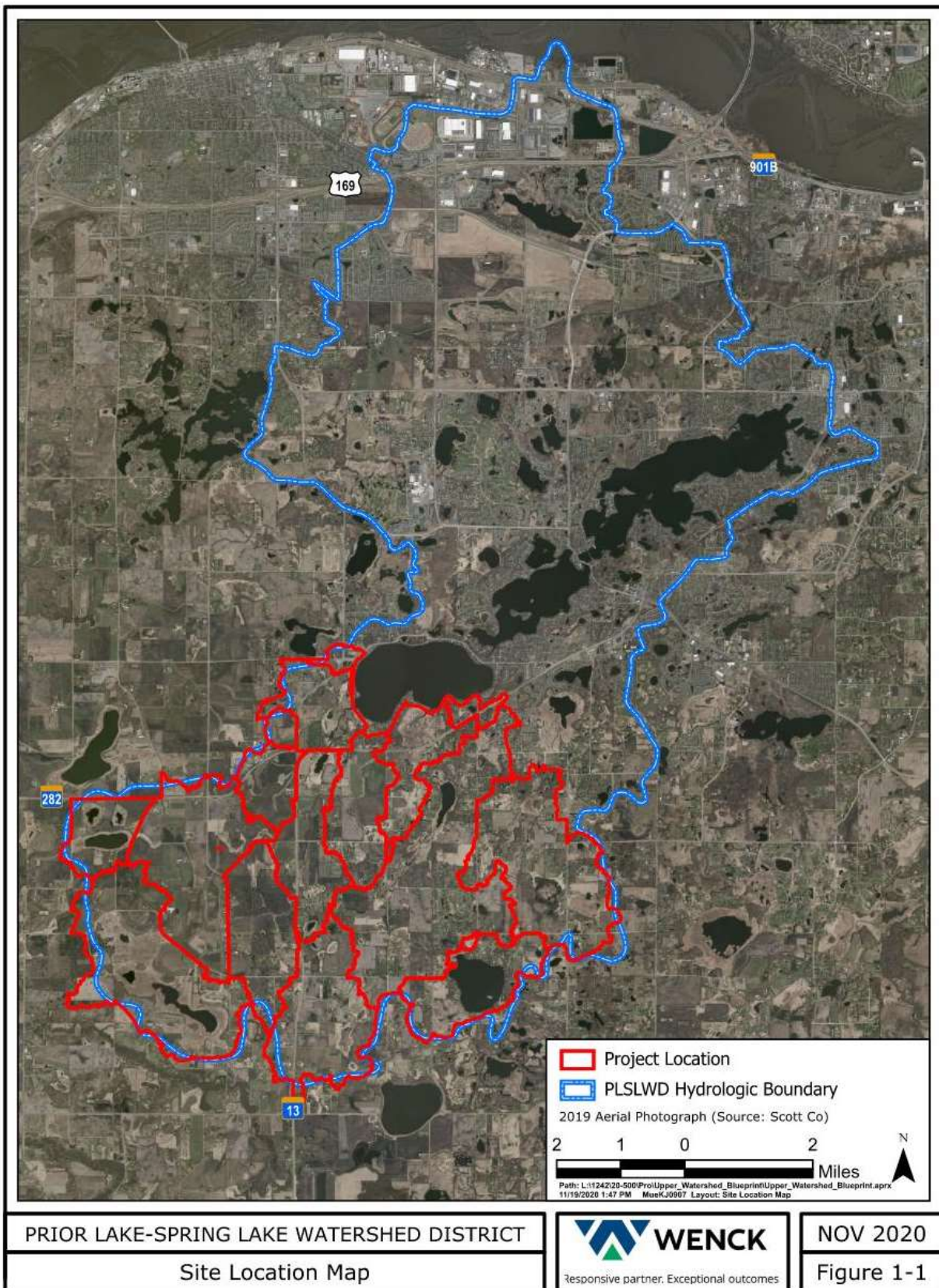


Figure 1.1. Site location map.

total phosphorus (TP). This results in undesirable algae blooms and restrictions on recreational use. Total Maximum Daily Load (TMDL) studies have been completed for each lake. Spring Lake requires an 83 percent overall reduction in TP to achieve the state water quality standard. Spring Lake discharges into Upper Prior Lake, and accounts for about 42 percent of that lake's nutrient load. Improvements to Spring Lake should result in improvements to Upper Prior Lake water quality.

The second problem is associated with the volume of stormwater runoff draining downstream during periods of high rainfall. The runoff volume contributed from the Upper Watershed has a substantial impact on flooding on Spring Lake, Upper Prior Lake, and Lower Prior Lake. Flood elevations and extended periods of high water on the lakes result in safety issues related to emergency vehicle access on flooded roads, shoreline erosion, impact to older homes on the lake, and boating restrictions such as no wake requirements.

In addition, there are many flooding concerns in the Upper Watershed itself. Farmers lose crops due to flooding, rural residential homes become inaccessible, and there can be damage to secondary structures during flood events.

1.4 PROJECT PARTNERS

Identifying and working with project partners is a critical component of implementing watershed solutions towards effective water quality treatment and quantity mitigation. Scott County, Sand Creek Township, Spring Lake Township, City of Prior Lake, and MnDOT were all consulted during this project. These partners will be crucial to successful implementation of water quality and quantity projects. Working with these project partners when they implement any capital improvements with potential for a water resources benefit and coordination of projects present opportunities for improving water quality in the watershed.

1.5 FUNDING PROJECT PARTNERS

Lack of adequate project funding can be a roadblock to successful implementation. Leveraging resources from various stakeholders and funding agencies will likely be necessary to meet the goals of this project. The following agencies and stakeholders are potential sources of funding for projects:

- Board of Water and Soil Resources (BWSR)
- Minnesota Pollution Control Agency (MPCA)
- Minnesota Department of Natural Resources (DNR)
- United States Army Corps of Engineers (USACE)
- Legislative-Citizen Commission on Minnesota Resources (LCCMR)
- Lessard-Sams Outdoor Heritage Council Funding (LSOHC)
- Minnesota Department of Transportation (MnDOT)
- Legislative appropriation
- Ducks Unlimited
- Pheasants Forever

1.6 PROJECT GOALS

The overall project goal is a framework for a prioritized 10-year capital improvement plan targeted towards: 1) making measurable improvements in water quality, and 2) reducing the magnitude and frequency of flooding on Spring Lake and Upper and Lower Prior Lake.

This report presents, evaluates, and prioritizes projects that can be implemented toward meeting those objectives.

Pollutant-Based Goals

The TMDL requires an annual TP reduction of about 2,959 pounds coming in from the surrounding Spring Lake watershed, out of a total load of 3,595 pounds. This is about 82% of the TP load from the watersheds that are tributary to Spring Lake. The goal of the Upper Watershed Blueprint is to significantly improve the water quality in runoff that originates in the Upper Watershed and move Spring Lake in positive direction towards meeting the overall TMDL goals.

Flood Reduction-Based Goals

The flood reduction goal is to reduce the impacts of regional flooding on Spring Lake and Upper and Lower Prior Lake, as well as in the upper watershed where crops and residences are affected. Impacts include shoreline erosion, infrastructure flooding that limits access for emergency vehicles, and homes built on the lake that are impacted by high waters. Some values that drive numerical objectives in the flood reduction-based goals are:

- Reduce the 30-day, 25-year return rainfall event high water level for Upper and Lower Prior Lake to 905.5, which protects infrastructure from being inundated and thus limiting emergency vehicle access.
- Limit the number of days that the lake is above the elevation where wake restrictions are applied. That trigger water elevation on Upper and Lower Prior Lakes is 904.0.
- Reduce the impact to structures on the lakes from significant rainfall and flooding events.
 - The current 100-year high water level based on the 1997 Flood Insurance Rate Map is 909.0, and the recorded high water level resulting from the 2014 flood was 908.9. Currently, there are about 165 primary structures that are at or below 909.0 based on LIDAR data and information received from the District.
 - The current 30 day, 25-year high water level for Upper and Lower Prior Lakes is 905.1. There are approximately 16 primary structures that are at or below 905.0.
 - The existing 30 day, 10-year, 30-day high water level is 904.3 and there are 6 primary structures that are at or below 904.5.
- Reduce the impact on upper watershed areas that are actively used for farming or rural residential homes.

1.7 REPORT ORGANIZATION

This report is separated into the following sections with data and information towards meeting those goals:

- Section 2.0 – Data Summary
- Section 3.0 – Project Targeting
- Section 4.0 – Funding Sources
- Section 5.0 – Project Conceptual Plans and Evaluation
- Section 6.0 – Project Prioritization
- Section 7.0 – Summary

2.0 Data Summary

2.1 INTRODUCTION

Wenck reviewed historical flow and water quality data for the Upper Watershed to map the TP loads and runoff volumes that are attributable to each of the subcatchments in the tributary area. Wenck also reviewed relevant previous reports.

2.1 HYDROLOGY DATA SUMMARY

Wenck used the District's PC-SWMM model to simulate the last ten years of precipitation (January 1, 2010- January 1, 2020) to estimate the volumes discharged from the Upper Watershed and each of the subwatersheds. Wenck created a precipitation file using 15-minute increment rainfall measurements at Flying Cloud Airport in Eden Prairie, about ten miles north of the watershed, the nearest with data available. Precipitation data discretized into longer durations (e.g. hourly and daily) was too coarse to capture the hydrologic response of the soils (i.e. peak rainfall intensities, which generate large runoff rates, were averaged out by the longer discretization period).

The District routinely monitors flow and water level at various locations throughout the Upper Watershed. The PCSWMM model was previously calibrated to the Spring 2014 flood on Prior Lake using post-ice out water surface elevations as initial conditions and by calculating the snow water equivalent for the 2014 event. To simulate the last 10 years, Wenck added the following information to the model:

- Daily temperature data also obtained from the Flying Cloud airport (used for calculating evaporation and precipitation type).
- Typical monthly wind rates from Technical Bulletin 1955 (used for calculating evaporation).
- Typical initial soil freeze and spring thaw dates from MIDS (December 6 and April 7, respectively). These dates are used to tell the model to not allow infiltration during frozen ground conditions.
- Snow-water equivalent, snowmelt, snow management (i.e. plowable fraction), and snowpack formation parameters based on typical values published by Computational Hydraulics, Inc., like the soil freeze dates, these values are unable to be changed year over year or within a season.

With the additional information added to the model, it far over-predicted the amount of runoff for the Prior Lake watershed and the peak water surface elevation on Spring and Prior Lakes for the spring 2014 event. Wenck then recalibrated the model based on flow and stream level data provided by the District at eleven locations throughout the Upper Watershed. A perfect calibration across the entire 10-year calibration window is not possible due to the limitations of the model associated with:

- Year over year and seasonal differences of snow water equivalents, dates of initial soil freeze and thaw, and dates of lake ice-in and ice-out.
- Land use changes associated with a rapidly developing watershed (i.e. impervious, infiltration, and plowable fraction of snow).

Using the built-in PCSWMM Sensitivity-based Radio Tuning Calibration (SRTC), Wenck ran a Monte Carlo analysis for the 2010-2020 period by adjusting the subwatershed hydrologic inputs based on published ranges of uncertainty associated with each parameter. The uncertainty associated with each hydrologic input shown in Table 2.1 below. PCSWMM then automatically completed a series of runs by manipulating the hydrologic input to the upper bound of its uncertainty range, the lower bound of its uncertainty range, and the median value of its uncertainty range while holding other parameters constant. For uncertainty ranges exceeding 100%, additional runs are completed at half the upper and lower uncertainty bounds. Forty model runs were completed varying the hydrologic parameters. Based on the goodness-of-fit, reducing the watershed width by half best matched the measured data at the eleven measured locations for the 2010-2020 period.

Table 2.1. Uncertainty associated with hydrologic inputs.

Hydrologic Input	Uncertainty (%)
Width	200
Percent Slope	25
Percent Imperviousness	20
Impervious Roughness	10
Pervious Roughness	50
Impervious Depression Storage	20
Pervious Depression Storage	50
Suction Head	50
Hydraulic Conductivity	50
Initial Deficit	25

Wenck evaluated the flood mitigation benefits, in both peak water surface elevation and duration of time above the no wake water surface elevation, to Prior Lake for each of the proposed projects for the 10-year, 30-day and the 2014 water year. These were selected because the 10-year, 30-day is a significant stormwater event and the 2014 water year is the flood of record after the current Prior Lake outlet structure was installed. In general, the post ice-out water surface elevations on Prior Lake are within 0.6 feet of the observed values for the 2010-2020. However, due to the model limitations above changes to the magnitude and duration of flooding on Prior Lake are reported as change from the baseline model (existing conditions). The focus should be on the relative benefit of each project.

The flow output summary from the PC-SWMM model is summarized in Figure 2.1, in terms of average annual volume of flow from each subwatershed area based on the 10-year model simulation. As showing in the figure, the Upper Watershed contributes about 10,000 acre-feet annually through County Ditch 13 and the Buck Lake system. Approximately 7,500 acre-feet of that runoff is contributed through the County Ditch 13 tributary area. The largest single subwatershed contributor to the total flow is the Sutton Lake subwatershed at just under 2,000 acre-feet annually.

Figure 2.1 shows the total annual volume of stormwater contributed by each of the subwatersheds, in acre-feet. Figure 2.2 presents the cumulative volume at each of the stream locations. The volumes are based on the district models using the previous 10 years of climate data. As presented in the map, the largest annual volume of runoff in the Upper Watershed originates in the County Ditch 13 system, including the discharges from Sutton Lake and the agricultural fields surrounding County Ditch 13.

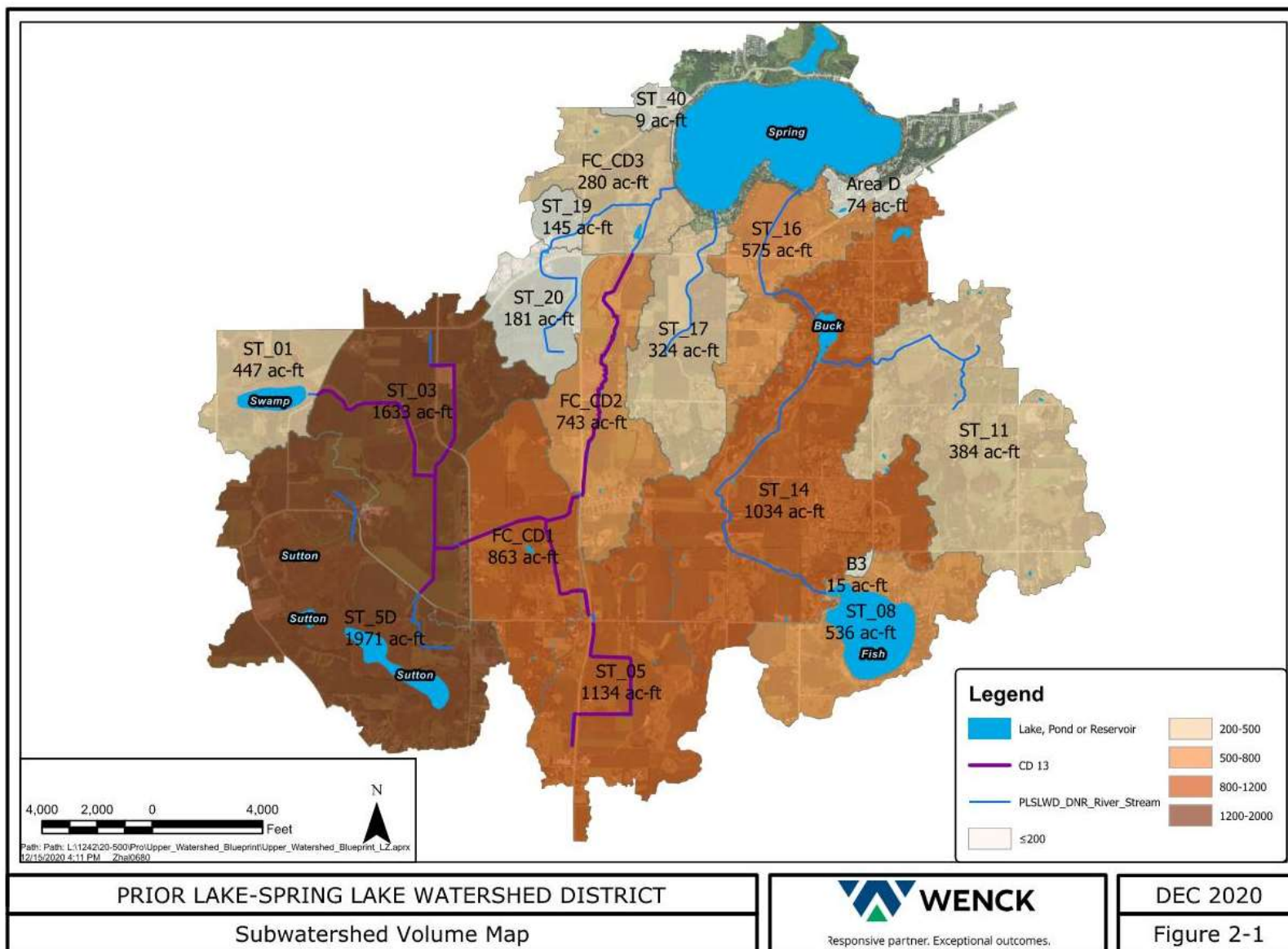


Figure 2.1. Subwatershed volume map.

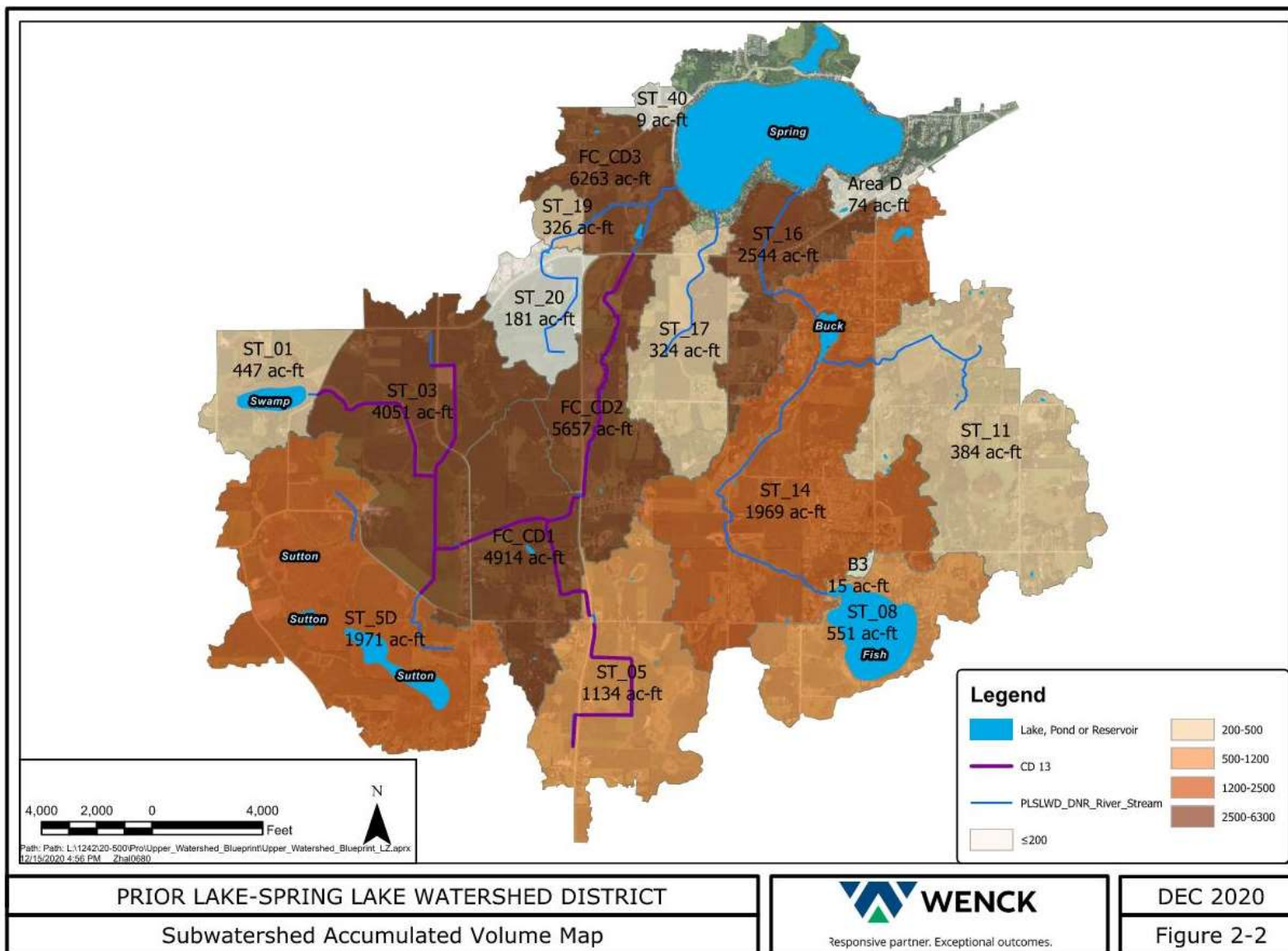


Figure 2.2. Accumulated volume map.

2.2 CHEMICAL DATA SUMMARY

Wenck used the chemistry data and flow volumes to estimate the total pounds of phosphorous originating in each of the subwatersheds, on an average annual basis. Total phosphorous is the driving factor in meeting the water quality goals for Spring Lake and Upper and Lower Prior Lakes.

Nine years (2011-2019) of stream and lake sampling data at 22 monitoring points were analyzed, including the parameters:

- Chloride
- Conductivity
- Total Iron
- Nitrate/Nitrite
- Ortho Phosphorous
- Soluble Reactive Phosphorous
- Temperature
- Total Phosphorous
- Total Suspended Solids
- Dissolved Oxygen
- E-Coli
- Dissolved Iron
- Nitrate + Nitrite
- pH
- Total Dissolved Phosphorous
- Total Kjeldahl Nitrogen
- Turbidity
- Volatile Suspended Solids

The total annual phosphorus loads contributed from each of the subwatersheds in the Upper Watershed are shown graphically in Figure 2.3. Figure 2.4 presents the cumulative load at each point in the watershed. The phosphorus loads shown in the figures are based on stream samples collected by the PLSLWD.

The total calculated phosphorous load from the upper watershed is about 6,380 pounds annually. Of that, the County Ditch 13 system contributes about 4,832 pounds and the Buck Lake channel contributes about 1,244 pounds, representing 75% and 19% of the total load respectively.

There are three primary discharges into Spring Lake from the Upper Watershed: County Ditch 13, the Buck Lake channel, and a smaller watershed between the two channels. These monitoring locations are identified as FC_CD3, ST-16 and ST-17 respectively. The ranges of total phosphorous concentration for the monitoring data for each of the streams are:

- County Ditch 13 ranges from 0.01 to 0.91 mg/L.
- Buck Lake channel ranges from 0.16 to 0.37 mg/L
- The third location at monitoring point ST-17 ranges from 0.046 to 0.867 mg/L.

In addition to the total phosphorous calculations and summation, Wenck calculated the total suspended solids (TSS) loads generated in the Upper Watershed. The average total annual TSS generated in the Upper Watershed is about 150 tons. We calculated the total annual TSS loads in tons per year at the various locations in the watershed using the average sample result and the total annual flow volume at that location. Figure 2-5 shows the total annual TSS loads throughout the watershed.

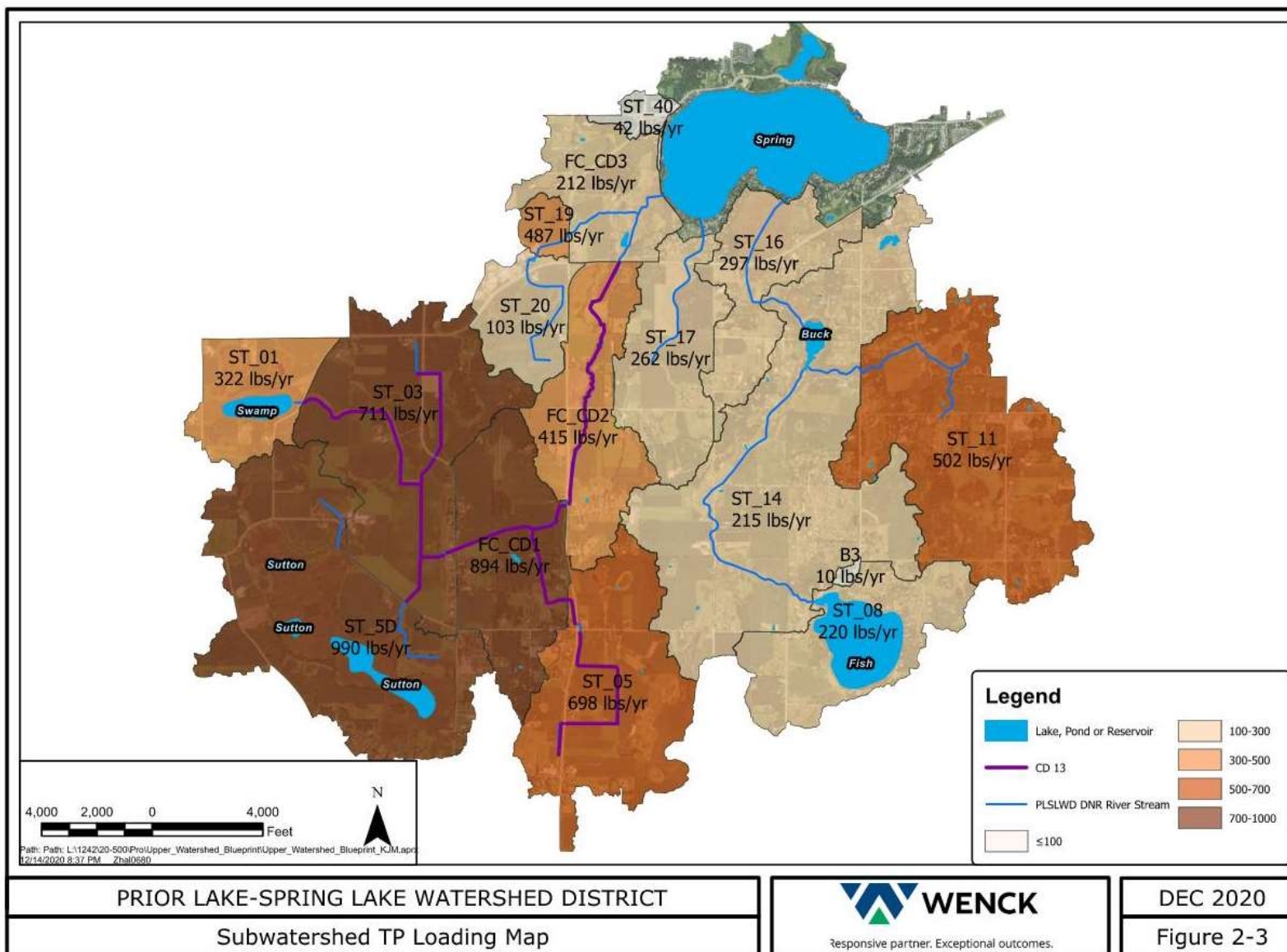


Figure 2.3. Subwatershed TP loading map.

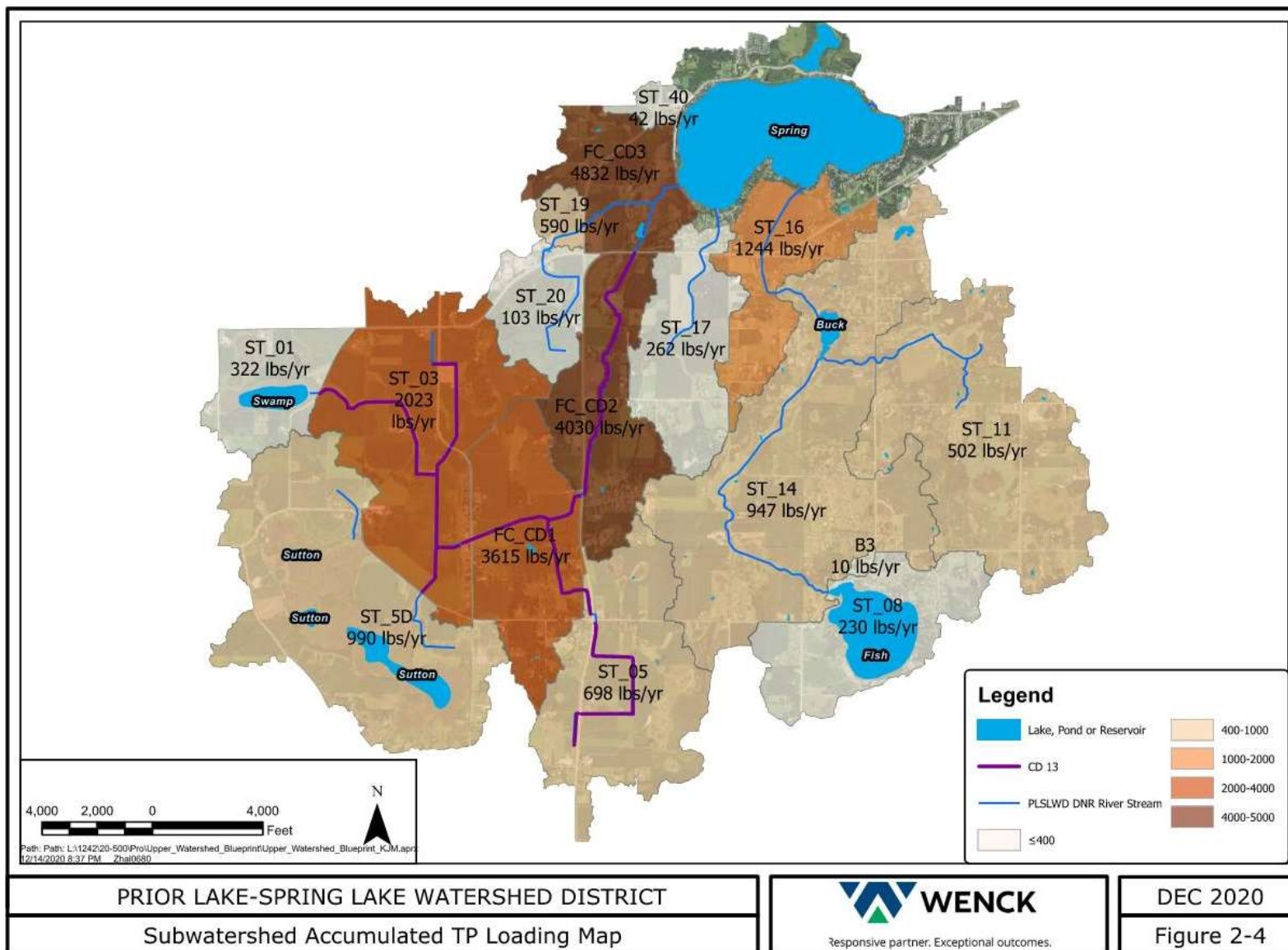


Figure 2.4. Accumulated TP loading map.

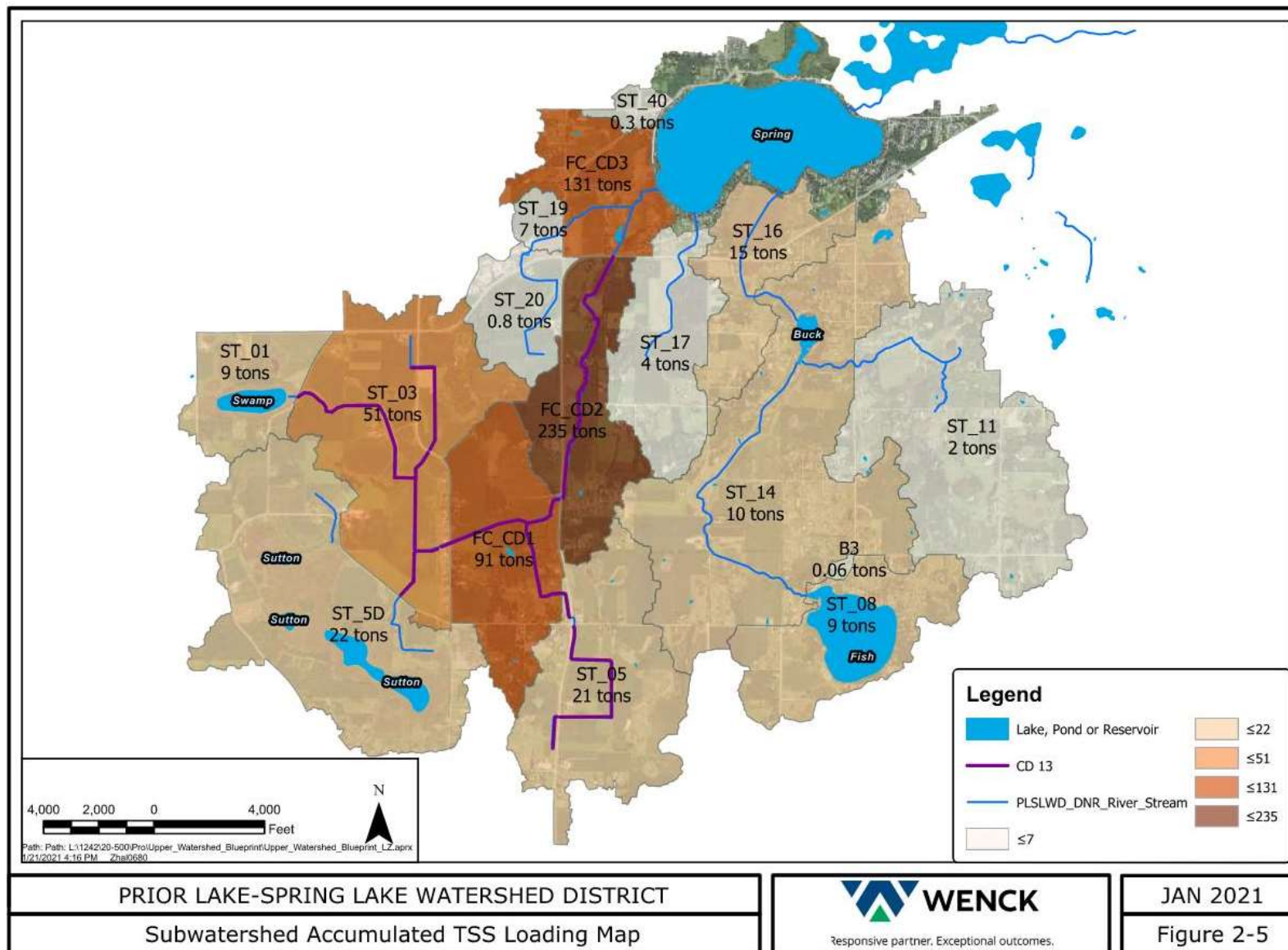


Figure 2.5. Accumulated TSS loading map.

As presented in the map, the Geis wetland appears to be removing a significant amount of the TSS generated in the upper watershed based on the reduction of total TSS load from 235 to 131 tons per year from watershed FC_CD2 to FC_CD3. The Buck Lake Channel system contributes about 15 tons of TSS annually to Spring Lake.

2.3 PRIOR REPORTS

Wenck reviewed information in several prior reports for the Upper Watershed. The reports included the following documents:

- *Spring Lake-Upper Prior Lake Nutrient TMDL* (Wenck Associates, May 2011)
- *Phosphorous release and accumulation in the sediments of Fish and Pike Lake, Scott County, MN* (Herman, Nicholas W, and Hobbs William O., St. Croix Research Station, Undated)
- *County Ditch 13 Plan and Profile* (1968 and 1984)
- *Prior Lake Stormwater Management & Flood Mitigation Study* (Barr Engineering, December 2016)
- *Subwatershed Analysis for West Upper Watershed* (Scott Soil and Water Conservation District, May 2015)
- *Stormwater Retrofit Investigation for the Subwatersheds of Spring Lake* (Scott Soil and Water Conservation District, September 2011)
- *PLSLWD Upper Watershed Review and Assessment Technical Memo* (Emmons and Olivier Resources, April 22, 2010)
- *Hwy 13 Wetland Survey and CD-13 Field Investigation Technical Memo* (Emmons Olivier Resources, August 29, 2017)
- *Feasibility of a Chemical Treatment System Downstream of Buck Lake* (Barr Engineering, October 2014).
- *Tile Drainage Assessment* (Scott Soil and Water Conservation District, September 2017)
- *Feasibility of a Chemical Treatment System Downstream of Buck Lake* (Barr Engineering, October 2014)
- Annual reports for the Ferric Chloride System as available on the PLSLWD website
- Sutton Lake Stormwater Storage Project Information available on the PLSLWD website

2.4 TMDL STUDY SUMMARY

The Total Maximum Daily Load (TMDL) report established goals for nutrient reduction in the Spring Lake and Upper Prior Lake watershed. The TMDL report was prepared in May 2011. The report estimated current nutrient loads for the lakes, waste load allocations and load allocations, and required reductions for the two impaired lakes. Some of the key outputs from the TMDL study are:

- The total internal and external phosphorous load to Spring Lake was 10,464 pounds per year and the total reduction goal was 8,640 pounds per year, or an 83% reduction.

- The external phosphorous load from the Spring Lake Watershed in the TMDL report is 3,595 pounds. This load includes some areas that are tributary to Spring Lake but are not in the upper watershed. The loads from areas that are not in the Upper Watershed are only a very small portion of the total load to Spring Lake.
- The TMDL report presents a target external phosphorous load reduction for the entire Spring Lake watershed of 2,959 pounds annually, which is 82% of the total phosphorous load in the TMDL report.
- 42% of the phosphorous load to Upper Prior Lake is attributed to discharges from Spring Lake, so reducing phosphorous in Spring Lake will have a positive benefit to Upper Prior Lake.
- Phosphorous load reduction from Spring Lake was identified as the key external load reduction target for Upper Prior Lake.

2.5 EXISTING BMPS

Existing BMPs that have been implemented in the Upper Watershed provide a portion of the phosphorous reduction goals. The following existing BMPS are currently in use for Spring Lake and in the Upper Watershed:

- County Ditch 13 ferric chloride treatment system
- Cover crop planting and other lake friendly farming practices
- Spring Lake shoreline & Raymond Park restorations
- Fish Lake shoreline enhancement and prairie restoration
- Carp management on Spring Lake and Upper Prior Lake
- Alum Treatments on Spring Lake and Upper Prior Lake
- Curlyleaf pondweed assessment and management on Tier 1 Lakes
- CR 12/17 wetland restoration
- Tadpole Pond settling basin

3.0 Project Targeting

Wenck used the modeling and current conditions data to identify locations where phosphorous load and volume reduction projects can have the biggest positive impact on Spring Lake. The project targeting process first evaluated the loads and discharges at various locations in the watershed. The following are sites that were identified as high potential sites for positive benefits:

- Locations with high phosphorous loads and concentrations.
- Locations with high flow volume.
- Locations with topography, elevations and current land use that has potential to provide significant benefits with minimal negative impacts.

Wenck focused on large, regional projects that can have a significant impact, rather than on smaller scale opportunities due to the scale of treatment and volume control that will be needed to effectively make a beneficial impact. Smaller projects would be completed opportunistically over a long period of time.

Opportunities to restore connections to existing wetlands were also considered in targeting potential projects. These connections to existing and improved wetlands and natural resource corridors can help to inform and involve the community in water resource improvements projects by creating a beneficial public use of the spaces.

3.1 LAND USE AND SETTING REVIEW

The current land use and setting were analyzed based on topography and surface drainage, land ownership, the presence of productive farm fields, zoning, and existing wetlands. These criteria were evaluated to identify feasible locations that may be implemented as a part of a capital improvement plan.

3.2 NUTRIENT LOADING DATA

Nutrient loading data were also evaluated during the project targeting process. The subwatersheds with higher nutrient loads present the greatest opportunity to reduce nutrient loads from the Upper Watershed. Figure 2.3 presents the total phosphorous loads for individual subwatersheds. Figure 2.4 presents the cumulative phosphorous loads in the streams in the watershed. These values present the framework used to target locations where projects would provide the greatest potential for nutrient reducing benefits.

3.3 VOLUME DATA

The volume data was also evaluated to identify locations where projects could be implemented to achieve the greatest flood control benefit for the downstream lakes. The PC-SWMM model and Figures 2.1 and 2.2 were used to determine which areas of the Upper Watershed made the largest volume contributions to the runoff to Spring and Upper and Lower Prior Lakes.

The volume and nutrient loading data reviewed concurrently also provides insight on the more efficient locations in the Upper Watershed to target projects for nutrient reduction.

Subwatersheds with a high phosphorous load relative to a low runoff volume are an opportunity to develop smaller scale projects requiring less infrastructure than projects that may require more up-front costs for similar reductions.

3.4 WATER QUALITY VS. FLOOD MITIGATION

One of the original ambitions for the Upper Watershed Blueprint was to identify and evaluate projects that may provide both a water quality and a flood mitigation benefit. However, it was discovered during the process that the projects that were most beneficial for water quality provide little or no flood mitigation, and projects that are the most efficient for flood reduction offer little in terms of water quality benefit.

This separation is largely due to the nature of flooding in the district. The most beneficial water quality projects will function continuously throughout the year while the most efficient flood storage solutions will only function during significant flood events and would only provide treatment for a fraction of the total annual runoff from the Upper Watershed.

3.5 GIS TOOLS

A GIS-based web mapping application was developed to depict the lower subwatersheds total phosphorus (TP) values as they exist now and how these values will change depending on whether different projects are implemented.

The application shows the existing total phosphorous values and color-coded map with value ranges assigned to each color. A menu on the lower left-hand side of the application, provides the ability to select different projects or combinations of projects. This will change the layer, color, and symbology that is displayed on the map to depict the total phosphorous value range for the selected project. The project name and value range will also be reflected in the 'Proposed total phosphorous values' legend on top of the project selection menu. The application provides users with the ability to identify each subwatershed to view the specific values and other relevant information. Additional tools are provided that allow users to change basemaps, create bar charts to visualize phosphorous value changes by project or groups of projects, print maps and turn different layers on and off.

3.6 OTHER PROJECTS CONSIDERED

Several projects were discussed during the screening process that were not evaluated for various reasons. Those projects that were considered, along with reasons for not carrying them through a full evaluation are presented in Table 3.1.

Table 3.1. Projects considered but not evaluated.

Project	Location	Reason for Not Evaluating
Ducks Unlimited Wetland Improvements	Ducks Unlimited Wetland at the location of the Buck Lake discharge to Spring Lake	Improving the Ducks Unlimited Wetland or converting to different regime (i.e., wild rice) presents an opportunity for an esthetic and natural resource benefit. Improvements would not necessarily offer a significant improvement in water quality, and the location and elevation of the wetland in comparison to Spring Lake does not present opportunities for flood mitigation.
Highway 282/13 Interchange	Intersection of Highway 282 and 13	This may become a viable alternative site for a future improvement when an intersection update is planned. However, without a full understanding of what the improved interchange will be, a specific project cannot be defined for evaluation. Additionally, this is a topographically high point and is not suitable for a significant stormwater treatment project with current grades.
Re-meander and improve County Ditch 13	Various locations along County Ditch 13	Much of the ditch is currently in good condition with well-established banks and buffers and not a significant contributor to the concerns in the Upper Watershed. The reduction in overall erosion and sediment load would be minimal.
Stormwater reuse for irrigation	Various	The farmers in the Upper Watershed typically do not use irrigation systems.
Reintroduce beavers to streams to create natural pools	Buck Lake South Wetland, various stream locations	Projects will require relatively precise elevations and management to prevent unintended impacts. Continually managing nature to maintain the proper levels is not feasible in an urban setting.
Reroute drainage from County Ditch 13 to the central ditch, between the Buck Lake Channel and County Ditch 13	Near 186 th Avenue	Elevations do not allow a connection to the Spring Central Stream.
Wetland restorations on agricultural fields	Various locations	The total benefit from individual fields is limited. This alternative should be offered as a lake friendly farming opportunity.

4.0 Funding Sources

Wenck identified potential funding sources for the projects identified in the project. We discussed the opportunities with the various agencies who have input on public project funding for water resources projects and the types of projects that can be funded under their programs. Several of the agencies participated in a funding partners meeting to further that discussion. Table 4.1 presents a summary of some of those funding sources and the types of projects that may be eligible for funding.

Table 4.1. Potential funding sources.

Source	Funding Mechanism	Project Types
Board of Soil and Water Resources	Clean Water Fund	Surface water and drinking water protection, enhancement, and improvements
		Habitat protection, restoration, and enhancement
		Support parks, trails, and heritage
	Watershed-based Implementation Funding Program	Pursue watershed-based project instead of on a project by project basis
Minnesota DNR	Flood Hazard Mitigation Grant Assistance Program	Flood damage reduction studies
	Conservation Partners Legacy Grants	Conservation projects that restore, enhance, or protect forests, wetlands, prairies, and habitat for fish, game, and wildlife
Minnesota Pollution Control Agency	Clean Water Partnership	Nonpoint pollution projects to improve surface waters
	Section 319 Grants	Surface water quality projects
	Clean Water Revolving Fund	Construction of accepted engineering practices that provide water quality benefits
US Army Corps of Engineers	Continuing Authorities Programs Section 206	Restoration of degrading aquatic ecosystem structure, function and process
Legislative-Citizen Commission on Minnesota Resources	Environment and Natural Resources Trust Fund	Activities that protect, conserve, preserve, and enhance Minnesota's air, water, land, fish, wildlife, and other natural resources
Lessard-Sams Outdoor Heritage Council	Outdoor Heritage Fund	Habitat protection, restoration, and enhancement
Ducks Unlimited	Outdoor Heritage Fund	Waterfowl Habitat Protection, Restoration, and Enhancement
Pheasants Forever	Outdoor Heritage Fund	Habitat Protection, Restoration, and Enhancement

5.0 Project Conceptual Plans and Evaluation

This section presents concept plans for the various alternatives identified in this study. The subsections describe reasoning and analysis used to select the project locations and suggested alternatives for capital improvement projects.

Ideally, projects can be located and implemented to provide benefits in terms of both water quality and in flood mitigation. The nature of the setting, nutrient loads, and flooding in the Upper Watershed does not offer realistic opportunities to achieve both goals.

The most effective phosphorus load reduction projects will operate continuously throughout the rainy season and provide no flood reduction benefits. The most effective and feasible flood mitigation projects in the upper watershed operate on a periodic basis in response to or with predictions of a rainfall or high-water event. Much of the reason for this need to separate the goals is because the flooding in the watershed and for the downstream lakes is driven by the total volume of water and by the limits on the allowed discharge from the overall system. Flood reduction requires a significant storage component and results in increases in flooding in that area of the upper watershed.

A table of the potential benefits, challenges in design, permitting and construction, estimated cost and funding partners is also included in the summaries. Because the projects that provide flood relief and those that address water quality are separate, this section is arranged to include water quality improvement alternatives in sections 5.1 through 5.14 and flood mitigation alternatives in 5.15 through 5.17. Section 5.18 discusses future policy direction as it can impact water quality and flooding.

The projects presented in this section have been evaluated using the GIS tool specific to the Upper Watershed. One of the outputs from that GIS tool is a map book that shows the specific project locations and benefits achieved by each project. The map book is included as Appendix A.

5.1 SUTTON LAKE IRON-ENHANCED SAND FILTER

WATER QUALITY PROJECT

Subwatershed

Sutton Lake is identified as a priority target location first because it has the highest identified phosphorous and volume load in the Upper Watershed and the highest modeled annual discharge volume. The calculated annual runoff volume, phosphorous load, and total suspended solids load from Sutton Lake are:

Total Annual Volume	1971 acre-feet
Total Annual Phosphorous Load	990 pounds
Total Suspended Solids Load	22 tons

In addition to the chemical data and model outputs, the setting at the discharge from Sutton Lake is suitable for an iron enhanced sand filter (IESF). The ditch discharging from Sutton Lake drops approximately nine feet in elevation over less than 1,000 feet to provide topography for a gravity-controlled treatment system. In addition to the favorable topography, the landowner upstream of the road crossing has expressed a willingness to work with the district to construct this type of solution.

Project Concept

Iron- enhanced sand filters (IESF) are a relatively new tool that is used to remove phosphorus from stormwater runoff. IESFs contain iron filings which bind phosphorus and remove it from the stormwater, trapping it in the filter.

The conceptual plan for the Sutton Lake IESF is shown in Figure 5.1. This filter is approximately 2.2 acres in surface area and situated along the ditch from Sutton Lake to Sutton Lake Boulevard. The filter would optimally be constructed in cells to allow ease of maintenance. The overall footprint would be sized to allow the entire Sutton Lake discharge volume to be filtered with an infiltration rate of 5 inches per hour, assuming that the discharge can be controlled to be evenly distributed through the year. The filter would consist of a one-foot layer of iron enhanced sand, overlying a coarse drainage layer with drain tiles to collect the filtered discharge. The drain tile would be discharged to a larger culvert to discharge into County Ditch 13 downstream of Sutton Lake Boulevard.



Figure 5.1. Sutton Lake IESF.

Results Summary

Table 5.1. Sutton Lake IESF Summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	735 pounds/year
Implementation Challenges	1) High Cost/Funding 2) Easements with landowners
Estimated Construction Cost	\$1,760,000
15-year lifecycle cost	\$1,836,000
15-years cost per pound of phosphorous reduction	\$166
Project Partners	1 Affected Landowner Scott County Sand Creek Township
Funding Partners	BWSR MPCA
Implementation Timeframe	2 – 4 years. The project has a willing landowner and it is a type of project that is frequently funded

5.2 SWAMP LAKE DIVERSION TO GEIS LAKE

WATER QUALITY PROJECT

Subwatershed Overview

Swamp Lake is identified as a priority target location because it has potential to provide some improvements in water quality and the setting is favorable to treat the discharges to the County Ditch 13 system. A diversion routing part of the Swamp Lake runoff to Geis Lake was identified as a potential project location because elevations would allow a diversion outlet and an existing 18-inch drain tile formerly connected from the Swamp Lake wetland and discharging to Geis Lake may be able to be used for the diversion. The calculated annual runoff volume, phosphorous load and total suspended solids load from Swamp Lake, assuming that a new diversion would reroute between 25% and 75% of the total Swamp Lake discharge are:

Total Annual Volume	110-330 ac-ft
Total Annual Phosphorous Load	80-240 pounds
Total Suspended Solids Load	2-6 tons

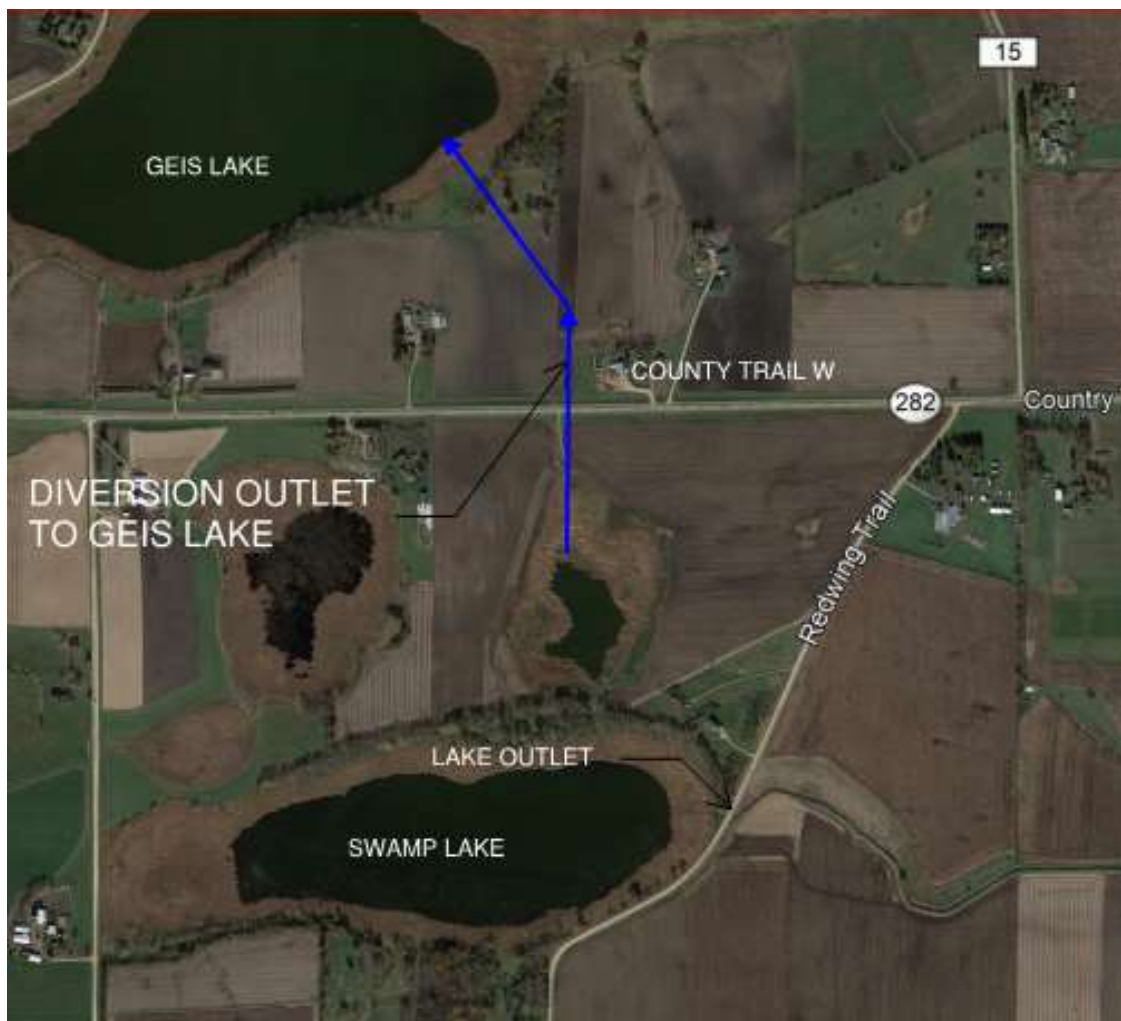


Figure 5.2. Swamp Lake diversion to Geis Lake.

Project Concept

The Swamp Lake diversion would include reconnecting an 18" drain tile from the mitigated wetland north of Swamp Lake. The original drain was routed to Geis Lake and discharged to the Picha Creek watershed basin. The concept would use controls to determine when discharge is routed to Geis Lake and when the discharges are routed to County Ditch 13. The outlet controls could be based on Spring Lake levels, Swamp Lake levels, rainfall forecasts or other criteria that provide the maximum benefit but do not adversely impact the Picha Creek Basin or Geis Lake. Any runoff diverted to Geis Lake would reduce the volume and corresponding phosphorous loads to Spring Lake. Optimization of outlet control triggers will be fleshed out in a feasibility study for the Swamp Lake.

Modeling Results Summary

The recalibrated PCSWMM model was updated to reflect a proposed weir structure to limit normal flows out of the existing outlet and a proposed diversion outlet to Geis Lake. The results of the proposed diversion are shown in Table 5.2 and are not expected to noticeably change the flooding severity on Prior Lake.

Table 5.2. Impacts of Swamp Lake Diversion to flooding severity on Prior Lake.

Flooding Severity	10-year, 30-day Flood¹	25-year, 30-day Flood¹	2014 water Year¹
Change in Peak Water Surface Elevation relative to Existing Conditions (feet)	0.0	0.0	-0.1
Change in Time Above No Wake Water Level on Prior Lake (days)	-1	-1	-3

1 + Increase in peak water surface elevation or number of days above no wake water level on Prior Lake (904.0 ft)
- Decrease in peak water surface elevation or number of days above no wake water level on Prior Lake

Table 5.3. Swamp Lake Diversion to Geis Lake Summary

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	161 pounds (80-240 pounds ¹)
Implementation Challenges	1) Permitting Difficulty 2) Easement Acquisition
Estimated Construction Cost	\$476,000
15-year cost	\$492,000
15-years cost per pound of phosphorous reduction	\$204 (\$139-\$417 ¹)
Project Partners	2-3 Affected Landowners Scott County Sand Creek Township
Funding Partners	Scott County MnDNR – FDR Grant
Implementation Timeframe	4 – 8 years. The project would involve multiple landowners. Diverting water to a different watershed would be challenging. Funding availability is limited.

1- Values are the range of results if 25 to 75% of the discharges are routed to Geis Lake. Final values need to consider the operating range and factors.

5.3 SWAMP LAKE IRON-ENHANCED SAND FILTER

WATER QUALITY PROJECT

Subwatershed Overview

Swamp Lake is identified as a priority target location because it has potential to provide some improvements in water quality and the setting is favorable to treat the discharges to the County Ditch 13 system. The ditch bottom elevation is about 3-4 feet below the Swamp Lake outlet at Redwing Trail, providing a change in elevation that will be amenable to constructing a gravity controlled system, and the construction can be confined to the area within the existing limits of the ditch. Although the volume and phosphorous loads are relatively low for the Swamp Lake discharge relative to other subwatersheds, the physical setting of Swamp Lake is favorable to providing some water quality benefits. The calculated annual runoff volume, phosphorous load, and total suspended solids from Swamp Lake are:

Total Annual Volume	447 acre-feet
Total Annual Phosphorous Load	322 pounds
Total Suspended Solids Load	9 tons

Project Concept

The filter is sized to allow the entire Swamp Lake discharge volume to be filtered with an infiltration rate of 5 inches per hour, assuming that the discharge can be controlled to be evenly distributed through the year through construction of a weir or other structure at the Swamp Lake outlet. As shown in Figure 5.3 the filter would be approximately 0.5 acres in size, placed near the invert elevation of the Redwing Trail culvert crossing from Sutton Lake. The filter would consist of a one-foot layer of iron enhanced sand, overlying a coarse drainage layer with drain tiles to collect the filtered discharge. The drain tile will be collected in a larger culvert to discharge into the ditch at the downstream end of the filter.



Figure 5.3. Swamp Lake IESF.

Project Summary

Table 5.4. Swamp Lake IESF summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	223 Pounds
Implementation Challenges	1) Access 2) Easement Acquisition 3) Funding
Estimated Construction Cost	\$480,000
15-year cost	\$530,000
15-years cost per pound of phosphorous reduction	\$159
Project Partners	2 Affected Landowners Scott County Spring Lake Township
Funding Partners	BWSR, DNR, Scott County
Implementation Timeframe	3 – 5 years. Only one landowner would be involved, and impacts can be limited to the existing ditch area. The project is a type of project that is frequently funded

Subwatershed

Although the Buck Lake system contributes smaller loads in terms of both volume and pollutants compared to County Ditch 13, projects in the Buck Lake subwatershed can still provide a benefit. The area between Fish Lake and Buck Lake includes a 100-acre wetland that may be suitable for improvements and enhancements. The improvements can leverage an existing natural area to provide benefits in terms of both water quality and flood controls. The calculated annual runoff volume, phosphorous load, and total suspended solids through this wetland are:

Total Annual Volume	1034 acre-feet
Total Annual Phosphorous Load	947 Pounds
Total Suspended Solids Load	10 tons

The wetland areas upstream of Buck Lake were identified as a potential location for wetland enhancements due to their size and the topography. This is a favorable location for storage and attenuation of suspended solids and phosphorous. A concept sketch of the Buck Lake South Wetland Improvements is shown in Figure 5.4.

Project Concept

The wetlands in the areas upstream of Buck Lake are nearly 100 acres. The conceptual plan for this area is to construct stepped berms with controlled outlets to hold more runoff in the wetlands and allow a larger surface area for storage during smaller rainfall events. At 1-1/2 feet in depth, the wetlands can retain almost 150 acre-feet of stormwater, which represents 15% of the total annual runoff generated from the area upstream of Buck Lake. This increased storage capacity can provide mitigation to flooding in Spring Lake and extended runoff detention as well as retention of suspended solids, phosphorous and nutrients. Outlet automation based on rainfall predictions and water levels on downstream water bodies can be implemented to optimize the system operation.

Results Summary

The Minnesota Stormwater Manual estimates a 40% phosphorous reduction for wetlands. The 40% reduction is used to estimate the potential phosphorous reduction achieved by reconnecting the flood plain wetlands to the ditch as well as for other projects that include improved wetlands. Details are summarized in Table 5.5.



Figure 5.4. Buck Lake South wetland storage.

Table 5.5. Buck Lake South Wetland Storage summary.

Parameter	Results
Flood Reduction Potential	-0.1 feet ¹
Phosphorous Load Reduction	95 Pounds ²
Implementation Challenges	1) High Cost/Funding 2) Easement Acquisition 3) Accessibility
Estimated Construction Cost	\$620,000
15-year cost	\$652,000
15-years cost per pound of phosphorous reduction	\$459
Project Partners	>10 affected Landowners Scott County
Funding Partners	BWSR, Scott County LCCMR, LSOHC, Ducks Unlimited Pheasants Forever
Implementation Timeframe	7 – 10 years. Multiple landowners involved. Ideally for funding through heritage funds, the affected areas would need to be placed in conservation easement.

1- Modeled 25-year, 30-year rainfall event change in high water level on Prior Lake

2- Reduction based on 10% reduction through impoundment and extended detention.

5.5 BUCK LAKE EAST WETLAND ENHANCEMENT

WATER QUALITY PROJECT

Subwatershed

The watershed to the east of Buck Lake, identified as the Buck Lake East subwatershed, is relatively high in phosphorus load in consideration of the annual runoff volume. Most of the watershed flows through a stream and wetlands that run into Buck Lake on the south end of the lake. The calculated annual runoff volume, phosphorous load, and total suspended solids load through the Buck Lake East wetland are:

Total Annual Volume	384 ac-ft
Total Annual Phosphorous Load	502 pounds
Total Suspended Solids Load	2 tons

Project Concept

The channel discharge starts at a 40-acre wetland situated near the center of the subwatershed. The wetland discharges into the beginning of the stream at a private road crossing. This wetland was also identified as a potential location for upper watershed flood storage and modeled in the *Prior Lake Stormwater Management & Flood Mitigation Study* (Barr 2016). Improvement of this wetland would provide phosphorous reduction and some flood attenuation. The restoration can be as simple as constructing a berm with an outlet structure to contain the water at a higher elevation and reduce the discharge rate. The location is shown in Figure 5.5.



Figure 5.5. Buck Lake East wetland enhancement.

Results Summary

Table 5.6. Buck Lake East wetland enhancement summary.

Parameter	Results
Flood Reduction Potential ¹	0.1 feet ¹
Phosphorous Load Reduction	100 pounds ²
Implementation Challenges	1) Easement Acquisition 2) Access 3) High Cost/Funding
Estimated Construction Cost	\$167,000
15-year cost	\$180,000
15-years cost per pound of phosphorous reduction	\$119
Project Partners	3 Affected Landowners Scott County Spring Lake Township
Funding Partners	BWSR, Scott County, LSOHC
Implementation Timeframe	2-4 years. The district has been approved for funding to conduct a feasibility study for this project.

1- Value based on 2016 flood study.

2- Removal based on ½ of the watershed flowing through the wetland and 40% phosphorous reduction.

Subwatershed

The watershed to the east of Buck Lake, identified as the Buck Lake East subwatershed, is relatively high in phosphorus load in consideration of the annual runoff volume. Most of the watershed flows through a stream and wetlands that run into Buck Lake on the south end of the lake. The calculated annual runoff volume, phosphorous load, and total suspended solids load through this reach of stream are:

Total Annual Volume	384 ac-ft
Total Annual Phosphorous Load	502 pounds
Total Suspended Solids Load	2 tons

Project Concept

The stream that flows to Buck Lake from the wetland was identified by PLSLWD as a potential target location for a stream bank restoration. There is a reach of the stream to the west of Fairlawn Avenue that has degraded and has an eroding bank. Restoring this reach of stream will reduce the sediment and phosphorus load to Buck Lake. Using natural vegetation for restoration would also require clearing the tree canopy to allow natural sunlight on the stream, or the banks may be restored with hard armoring such as rip rap or other engineered products. Potential beneficial projects in the Buck Lake East watershed are shown in Figure 5.5. The benefits provided by this project are summarized in Table 5.7.

Results Summary**Table 5.7. Buck Lake East Stream Restoration summary.**

Parameter	Results
Flood Reduction Potential ¹	0.0 feet
Phosphorous Load Reduction	10 Pounds
Implementation Challenges	1) Tree Removal 2) Access 3) Easement Acquisition
Estimated Construction Cost	\$89,000
15-year cost	\$96,000
15-years cost per pound of phosphorous reduction	\$637
Project Partners	4 Affected Landowners Scott County Spring Lake Township
Funding Partners	Scott County, DNR
Implementation Timeframe	2 – 4 years. Lowest cost alternative. Landowners would be only affected during construction and not long-term. Possible delays for objections over tree impacts.

1- Modeled 25-year, 30-year rainfall event change in high water level on Prior Lake

5.7 COUNTY DITCH 13 IMPROVEMENTS

WATER QUALITY PROJECT

Subwatershed

The subwatersheds that flow to and through County Ditch 13 are a significant contributor of phosphorous to Spring Lake. The TP load in County Ditch 13 at the road crossing at Highway 282 is about 4,030 pounds per year based on the stream flow sampling and data. Improvements that capture or mitigate even a fraction of the total flow through this reach of ditch can provide a measurable benefit in pounds of phosphorous reduction annually. The calculated annual runoff volume, phosphorous load, and total suspended solids load through County Ditch 13 at this location are:

Total Annual Volume	5,657 ac-ft
Total Annual Phosphorous Load	4,030 pounds
Total Suspended Solids Load	235 tons

These reaches of County Ditch 13 were included in the evaluation because it is the location with the highest annual phosphorous loads and the greatest potential for load reduction.

Most of the areas along County Ditch 13 are currently productive agricultural land and would not be likely candidates for ditch improvements or restoration. Much of County Ditch 13 has a well-established buffer, which provides sediment and phosphorous reduction from the surface runoff. The ditch appears to be well vegetated and in good condition to minimize bank erosion. This is one of the farm friendly practices in use in the Upper Watershed that effectively reduce the pollutant and sediment loads from those watersheds.

Project Concept

The wetlands on the overbank of County Ditch 13 and north of the single-family homes on Butterfly Lane comprise about 20 acres in total area. Conceptually, the wetland on the east bank of the ditch can be excavated to a bench near the existing normal flow elevation of the ditch, and the larger wetland area can be restored to a more functional condition. This can allow for lower velocity and increased mitigation during low flow conditions. Even though small in area, these improvements can make an incremental improvement in the water quality. Locations and concepts for this improvement are shown in Figure 5.6. A summary of the County Ditch 13 improvements is provided in Table 5.7.



Figure 5.6. County Ditch 13 improvements.

Results Summary

Table 5.8. County Ditch 13 Improvements summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	202 pounds
Implementation Challenges	1) Access 2) Easement Acquisition 3) High cost/Funding
Estimated Construction Cost	\$1,151,000
15-year cost	\$1,177,000
15-years cost per pound of phosphorous reduction	\$389
Project Partners	>10 Affected Landowners Scott County Spring Lake Township Farmer Led Council
Funding Partners	BWSR, Scott County, DNR
Implementation Timeframe	5 – 7 years. Multiple affected landowners. Improvements would result in loss of productive fields.

5.8 COUNTY DITCH 13 REPAIRS

WATER QUALITY PROJECT

Subwatershed

Two locations on County Ditch 13 were identified by the District as needing repair. The reach immediately downstream of the Sutton Lake outlet has been eroded and the reach from 190th Street to Geis Wetland has frequent washouts and bank erosion.

Project Concept

The ditch downstream of Sutton Lake is relatively steep compared to other areas of the County Ditch 13 system. The repairs would include regrading and stabilizing the banks with native vegetation and constructing a series of rip rap check dams to reduce the velocity and the erosion in the ditch. The location for these repairs is shown in Figure 5.7.



Figure 5.7. County Ditch 13 repairs at Sutton Lake.

The stretch of ditch between 190th Street and Geis Wetland will be regraded to repair the undercut sections of ditch. The area is relatively wooded, and selective tree removal to allow a more robust vegetative growth on the bank and significantly improve the stability. Targeted locations in the ditch will be armored with rip rap to protect heavily shaded areas and to direct the flow to reduce the erosive forces. The location for these repairs is shown in Figure 5.8.



Figure 5.8. County Ditch 13 repairs south of Geis Wetland.

Results Summary

The results of these repairs of County Ditch 13 are presented in Table 5.8. These repairs represent a very small incremental improvement in the overall water quality for the system.

Table 5.9. County Ditch 13 Repairs summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	50 pounds
Implementation Challenges	1) Access 2) Easement Acquisition 3) High cost/Funding
Estimated Construction Cost	\$597,000
15-year cost	\$623,000
15-years cost per pound of phosphorous reduction	\$830
Project Partners	Landowners, Scott County Spring Lake Township, Farmer Led Council
Funding Partners	BWSR, Scott County, DNR
Implementation Timeframe	3 – 7 years. The disturbances would be limited to the current ditch area and only during construction.

5.9 COUNTY DITCH 13 DIVERSION

WATER QUALITY PROJECT

Subwatershed

The watersheds upstream of Langford Avenue contribute more than half of the total phosphorous loads from the Upper Watershed. The calculated total annual runoff volume, phosphorous load, and total suspended solids load through County Ditch 13 at Langford Avenue are:

Total Annual Volume	4,914 ac-ft
Total Annual Phosphorous Load	3,615 pounds
Total Suspended Solids Load	91 tons

Project Concept

The existing topography would allow a portion of the flow through County Ditch 13 to be diverted to the Buck Lake system, although it would need to be a piped discharge due to the topography between the two channels. The discharge would flow from County Ditch 13 near the crossing at Langford Avenue to the Buck Lake system near the intersection of Vergus Avenue and 195th Street Northeast. Possible benefits provided by this diversion include:

- Reducing the flow through County Ditch 13 from the diversion to Spring Lake. This would reduce the volume flowing County Ditch 13 and the ferric chloride treatment system and potentially improve the efficiency of that system.
- The corridor created by a discharge would create an opportunity for a trail connection between Langford Avenue and Vergus Avenue.
- The diversion could take advantage of the wetland systems upstream of Buck Lake to provide retention and treatment of the runoff from the County Ditch 13 subwatersheds. This benefit would be further enhanced if the Buck Lake wetland storage alternative were implemented.

Diverting flows from County Ditch 13 to the Buck Lake channel as shown in Figure 5.9 presents both opportunities and challenges. The diversion would decrease flows and loads through the downstream reach of County Ditch 13; however, it would increase the flows and loads to Buck Lake by an equal amount.

The flows allowed through a diversion would need to be balanced to not cause a negative impact on the loads or flood levels on Buck Lake. The diversion would also need to be coupled with some form of treatment, such as the wetland enhancements in section 4.3, an IESF, or a proprietary treatment device to prevent increasing the nutrient loads to Buck Lake. A full feasibility study would need to be completed to confirm the effectiveness and benefit provided by a diversion. The system would also need to consider the existing ferric chloride treatment systems and any impact, positive or negative, on that existing BMP.

The recalibrated PCSWMM model was updated to reflect a proposed 3-foot diameter pipe, approximately 4,000 feet long, to route part of the flood flows to Buck Lake. The modifications do not change the frequency or severity of flooding severity on Prior Lake.



Figure 5.9. County Ditch 13 Diversion.

Results Summary

Table 5.10. County Ditch 13 Diversion summary.

Parameter	Results
Total Annual Volume of Water Diverted	1,228 ac-ft ¹
Total Annual Phosphorous Load of Water Diverted	904 pounds ¹
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	90 pounds ²
Implementation Challenges	1) Access 2) Easement Acquisition 3) High Cost/Funding 4) Permitting 5) Adverse Impacts to Buck Lake
Estimated Construction Cost	\$1,203,000
15-year cost	\$1,253,000
15-years cost per pound of phosphorous reduction	\$924
Project Partners	6+ Landowners Scott County
Funding Partners	
Implementation Timeframe	7 – 10 years. Multiple affected landowners. Significant studies needed to evaluate impacts on Buck Lake system. Funding availability is limited.

1 – Assumes diversion of 25% of the total County Ditch 13 flow and load at this location.

2 – Assumes that the Buck Lake wetland system reduces phosphorous loading by 40% per literature values and 25% of the flow is treated.

Subwatershed Overview

This is a targeted location because it is the final discharge point of the County Ditch 13 system before entering Spring Lake and there is an existing treatment system in place. The calculated total annual runoff volume, phosphorous load, and total suspended solids load at the ferric chloride system are:

Total Annual Volume	5,657 ac-ft
Total Annual Phosphorous Load	4,030 pounds
Total Suspended Solids	235 tons

Project Concept

The existing ferric chloride system removes about 12% of the total phosphorus based on the calculated flow volumes and the phosphorus reduction in the annual operating reports. The system should be capable of removing nearly 70% of the total phosphorous when operating at maximum efficiency. Minor modifications to the system could provide for increased annual phosphorous reduction. Some possible inefficiencies in the current system include:

- The desilt pond is somewhat undersized for the County Ditch 13 flow. The pond surface area is about 2.5 acres. Increasing the pond footprint would increase the residence time and improve the sedimentation capacity of the flocculated particles.
- The injection port is in a short length of culvert and the treatment could benefit from improved mixing between the ferric chloride injection point and the desilt pond.
- The discharge rate from Geis Wetland is not controlled so it is subject to variations in flow rate. Even though the system flow is monitored, and the dosage is calibrated based on flow, it may operate more efficiently with a more constant flow rate.

Currently, discharges through the County Ditch 13 system flow into Geis Wetland located south of Highway 13. Geis Wetland flows over a weir, through the culvert crossing under Highway 13, and to the channel downstream. Most of the discharge at this location is routed through a 24-inch culvert, where it is mixed with ferric chloride, and then into a sedimentation basin identified as the desilt pond. The iron in the ferric chloride binds with the phosphorous in the stormwater and creates particles that settle out in the desilt pond prior to discharge to Spring Lake.

Modifications to the operating parameters or infrastructure associated with the ferric chloride treatment system may provide opportunities to increase the load reduction for County Ditch 13. The existing ferric chloride system removes about 500 pounds of the total phosphorous coming from the County Ditch 13 system annually based on reductions seen from 2013 to 2019. Even minor modifications could have a modest benefit to the phosphorous reduction and water quality for the discharges from County Ditch 13 to Spring Lake.

The building that houses the pumps and tank for ferric chloride is located on the south side of Highway 13. The ferric chloride is pumped from the equipment through a double walled pipe, about 900 feet, and into the 24-inch culvert. Extremely high flows bypass the culvert and flow over a weir and directly to Spring Lake without treatment. Out of about 1,200 measurements at the desilt pond and on Spring Lake from 2014 through 2019, the water

level in the desilt pond was higher than the bypass weir for 97 measurements. The water level in Spring Lake was above the weir for 66 of those measurements. These data show that the upstream discharges from large rainfall events in the County Ditch 13 watershed area only bypassed the desilt pond 31 times out of 1,200 measurements so most of the discharges through County Ditch 13 are treated prior to discharge to Spring Lake.

The ferric chloride system locations are shown in Figure 5.10.



Figure 5.10. Ferric Chloride System improvements alternative 1.

Two possible options were evaluated for improvements to the system to increase the volume that passes through the system, improve mixing efficiency, or improve the settlement of flocculated particles. This project presents the first possible modification to the ferric chloride treatment system as presented in Table 5.9.

Improvement alternative 1: Improved mixing and flow optimization.

- Construct a mixing tank, with a new 700-foot long pipe directly to the desilt pond from Geis Wetland. Construct the outlet to discharge at a rate that optimizes the overall operation of the system. Include real time flow measurement to the discharge from Geis Wetland to the desilt pond to optimize dosing rates.
- Install a treatment device to provide pre-settlement of flocculated particles.

Results Summary

Table 5.11. FeCl System Improvements Alternative 1 summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	250 pounds ¹
Implementation Challenges	1) Permitting 2) Siting new equipment
Estimated Construction Cost	\$275,000
15-year cost	\$400,000
15-years cost per pound of phosphorous reduction	\$107
Project Partners	2 affected Landowners Scott County Spring Lake Township MPCA
Funding Partners	BWSR Scott County MPCA
Implementation Timeframe	2 – 7 years. The project would require a study to confirm the ideal parameters. Need access agreements for modifications.

1 – Assumes a 50% increase in the potential phosphorous reduction. Additional study needs to be completed to determine optimal operating parameters and treatment capacity.

2 – Anticipated that 75% of the discharge will be treated and that the overall system will reduce phosphorous by 70%. Jar tests would be required to determine actual reduction efficiency.

3 – Number of affected landowners would depend on the location where a new basin is sited.

5.11 FECL SYSTEM IMPROVEMENTS ALTERNATIVE 2

WATER QUALITY PROJECT

Subwatershed Overview

This is a targeted location because it is the final discharge point of the County Ditch 13 system before entering Spring Lake and there is an existing treatment system in place. The calculated total annual runoff volume, phosphorous load, and total suspended solids load at the ferric chloride system are:

Total Annual Volume	5,657 ac-ft
Total Annual Phosphorous Load	4,030 pounds
Total Suspended Solids	235 tons

Project Concept

The background to the existing project was further explained in the previous Section 5.10. Based on the summary of the existing FeCl system, two possible options were evaluated for improvements to the system to increase the volume that passes through the system, improve mixing efficiency, or improve the settlement of flocculated particles. This project explores a second possible modifications to the ferric chloride treatment system as presented in Table 5.10.

Improvement alternative 2: Increase settling basin capacity.

- Construct a mixing tank, with a new 700-foot long pipe directly to the desilt pond from Geis Wetland. Construct the outlet to discharge at a rate that optimizes the overall operation of the system. Include real time flow measurement to the discharge from Geis Wetland to the desilt pond to optimize dosing rates.
- Evaluate options to increase the settling capacity of the desilt pond; or
- Construct a flow splitter and site a second basin in the vicinity of the existing Ferric Chloride treatment building and the ditch that is suitable and amenable to increasing the treatment capacity.

Results Summary

Table 5.12. Ferric Chloride System Improvements summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	911 pounds ²
Implementation Challenges	1) Permitting 2) Identifying available land 3) Land acquisition
Estimated Construction Cost	\$1,561,000
15-year cost	\$2,069,000
15-years cost per pound of phosphorous reduction	\$151
Project Partners	Multiple Landowners ³ Scott County Spring Lake Township MPCA
Funding Partners	BWSR, Scott County, MPCA

Implementation Timeframe	5 – 10 years. Need to identify suitable property for expansion. Expanding the existing basin impacts the adjacent wetlands.
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1 – Assumes a 50% increase in the potential phosphorous reduction. Additional study needs to be completed to determine optimal operating parameters and treatment capacity.

2 – Anticipated that 75% of the discharge will be treated and that the overall system will reduce phosphorous by 70%. Jar tests would be required to determine actual reduction efficiency.

3 – Number of affected landowners would depend on the location where a new basin is sited.

5.12 SPRING WEST IRON-ENHANCED SAND FILTER

WATER QUALITY PROJECT

Subwatershed

This area has a small contributing subwatershed with a high relative phosphorous load. A feedlot and associated lagoon are potential sources of some of that phosphorous load. Based on the preliminary design calculations provided by the District, the current preferred concept is for an IESF at this location, which has potential to reduce the particulate phosphorous loading by 168 pounds annually and ortho-phosphorous 81 pounds of ortho-phosphorous. The calculated total annual runoff volume phosphorous load, and total suspended solids load from the upstream subwatersheds are:

Total Annual Volume	326 ac-ft
Total Annual Phosphorous Load	590 pounds
Total Suspended Solids Load	7 tons

Project Concept

The Spring West IESF project is currently in the feasibility study and concept plan stage. The concept will use the existing ditch to construct a filter to remove phosphorous, similar to the IESF suggested for the Sutton Lake and Swamp Lake outlets. The final details on sizing and location are still being considered. The general location of the Spring West IESF is shown in Figure 5.11.



Figure 5.11. Spring West IESF.

Results Summary

The Spring West IESF summary is presented in Table 5.10.

Table 5.13. Spring West IESF filter summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	249 pounds
Implementation Challenges	1) Easement Acquisition
Estimated Construction Cost	\$344,000
15-year cost	\$419,000
15-years cost per pound of phosphorous reduction	\$112
Project Partners	1 Affected Landowner Scott County Spring Lake Township
Funding Partners	BWSR Scott County MPCA
Implementation Timeframe	1 – 3 years. The project is already being planned by the district and it is a type of project that is frequently funded

Subwatershed Overview

This is a targeted location because it is the final discharge point of the Buck Lake system. A chemical treatment system was evaluated in the 2014 report, *Feasibility of a Chemical Treatment System Downstream of Buck Lake*. The calculated total annual runoff volume, phosphorous load, and total suspended solids load at this location are:

Total Annual Volume	1,969 ac-ft
Total Annual Phosphorous Load	1,244 pounds
Total Suspended Solids Load	10 tons

Project Concept

The concept presented as the preferred alternative in the report is a ferric chloride treatment system located upstream of the location where the Buck Lake channel crosses highway 13. The project includes constructing a diversion structure to direct the channel flow to a treatment system and settling pond sited on a portion of the Prior Lake Jehovah's Witness property that is currently unused and is not highly suitable for future use. The layout is shown in Figure 5.12.

Construction for this alternative would include constructing a weir in the channel and a culvert from the channel to the treatment system and settling pond. The treatment would include ferric chloride or alum injection and a mixing tank prior to discharge into the basin. The basin will discharge treated water back into the channel on the downstream side of the diversion weir. Additional studies will be necessary for a chemical treatment system to optimize the various operating parameters.

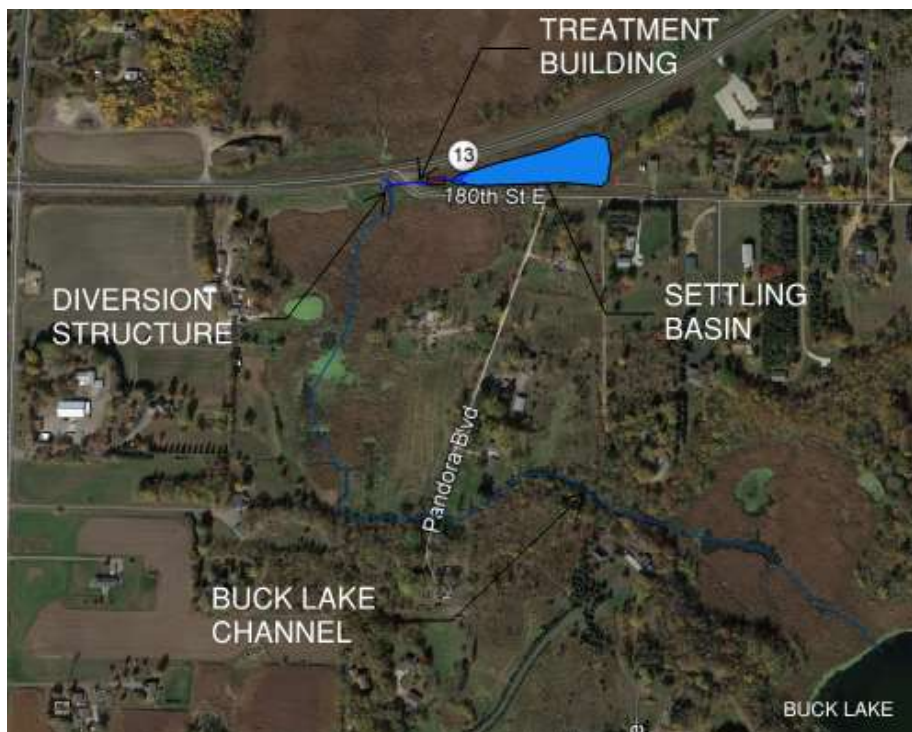


Figure 5.12. Buck Lake chemical treatment system.

Results Summary

Table 5.14. Buck Lake Chemical Treatment System results summary.

Parameter	Results ¹
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	793 pounds
Implementation Challenges	1) Easement Acquisition 2) Land Acquisition 3) Sludge/sediment disposal
Estimated Construction Cost	\$1,539,000
15-year cost	\$2,431,000
15-years cost per pound of phosphorous reduction	\$204
Project Partners	2 Affected Landowners Scott County MNDOT work in the right of way
Funding Partners	BWSR, Scott County, MPCA
Implementation Timeframe	5 – 10 years. Land acquisition or easement for the basin would be required. The project needs significant testing and analysis to confirm parameters

1- Results based on 2014 Report *Feasibility of a Chemical Treatment System Downstream of Buck Lake*

5.14 COUNTY DITCH 13 CHEMICAL TREATMENT SYSTEM WATER QUALITY PROJECT

Subwatershed Overview

This is a targeted location because it is a location with relatively high phosphorous load coming from the Sutton and Swamp Lake watersheds and it is topographically the lowest area between the lakes and Xeon Avenue. The calculated total annual runoff volume, phosphorous load, and total suspended solids load at the ferric chloride system are:

Total Annual Volume	2,023 ac-ft
Total Annual Phosphorous Load	4,051 pounds
Total Suspended Solids Load	91 tons

Project Concept

Construction for this alternative would include constructing a weir in the ditch and a culvert from the ditch to the treatment system and settling pond. The settling pond and treatment system would be constructed on approximately 3-4 acres of the adjacent 16-acre parcel. Spoils generated during construction may be used to raise the elevation of other parts of the property to raise the elevation for protection during high water events on the ditch. The basin will discharge treated water back into the channel on the downstream side of the diversion weir. The treatment would include ferric chloride or alum injection and a mixing tank prior to discharge into the basin. The layout is shown in Figure 5-13.

Additional studies will be necessary for a chemical treatment system to optimize the most efficient chemical and the other operating parameters. For the purposes of this study, it is assumed that 75% of the flow can be treated with 70% phosphorous reduction potential using ferric chloride.



Figure 5.13. County Ditch 13 chemical treatment system.

Results Summary

Table 5.15. County Ditch 13 Chemical Treatment System summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	1,062 pounds
Implementation Challenges	1) Easement Acquisition 2) Land Acquisition 3) Sludge/sediment disposal
Estimated Construction Cost	\$1,739,000
15-year cost	\$2,500,000
15-years cost per pound of phosphorous reduction	\$157
Project Partners	1 Affected Landowner ¹ Scott County
Funding Partners	BWSR, Scott County, MPCA
Implementation Timeframe	5 – 7 years. Land acquisition or easement for the basin would be required, but the project offers opportunity to provide owner with a benefit. The project needs significant testing and analysis to confirm parameters.

1- Affected landowner is based on current concept. There may be more suitable locations affecting different properties.

5.15 PRIOR LAKE OUTLET CHANNEL MODIFICATIONS

FLOOD REDUCTION PROJECT

The Prior Lake outlet channel modifications is a volume and flood based alternative and does not affect the water quality. The goal of this alternative is to actively manage the water level on Upper and Lower Prior Lake in anticipation of a predicted rainfall event and to renegotiate a discharge agreement to allow a higher maximum discharge rate when downstream conditions allow.

Subwatershed Overview

The Prior Lake Outlet Channel (PLOC) is the outlet from Prior Lake to the Minnesota River. Prior to the construction of the outlet channel in 1983, Spring Lake and Prior Lake were landlocked and subject to more frequent flooding and higher water levels. The outlet was constructed through a joint agreement with City of Prior Lake, the City of Shakopee, the Shakopee Mdewakanton Sioux Community, and the Prior Lake-Spring Lake Watershed District.

The operation of the outlet is controlled by the Prior Lake Outlet Control Structure Management Policy and Operating Procedures approved by the Minnesota DNR. The approved operation of the outlet includes:

- The maximum discharge through the outlet channel is 65 cubic feet per second (cfs). The discharge rate is controlled by the peak capacity of the downstream culvert.
- The accordion weir allows discharge when the Lower Prior Lake water level reaches 902.45 feet above MSL.
- The outlet structure includes a low flow gate that can be opened to allow discharge when the Lower Prior Lake Elevation is between 902 and 902.5 as approved by the DNR.

Project Concept

Modifications to the PLOC can have a significant effect on the lake flooding with minimal land disturbance in terms of both grading and expanding existing flood plains. The concepts for modifying the outlet channel include:

- Renegotiate the discharge agreement to allow allowances for an increased discharge rate. The limiting factor for the discharge rate is the downstream 36-inch diameter culvert. Increasing the outlet size to a 54-inch diameter culvert would allow the added capacity.
- Allow discharges to lower water levels when a significant rainfall event is forecast to provide capacity to store the coming runoff and reduce the high-water level of the lakes.

At the allowed discharge rate, the lake water level recedes by only about 0.1 foot per day. Renegotiating the DNR agreement for the PLOC to allow discharges under some circumstances could provide significant relief from the duration and frequency of lake flooding. Feasible modifications may include:

- Allow the district to open the low flow gate when water levels are at or below 902.0 when significant rainfall is expected to provide storage capacity for the incoming event.

- Allow the district to release greater than 65 cfs when the downstream channel flow allows a higher rate of discharge. The channel is large enough to carry a larger flow when areas between Prior Lake and the Minnesota River are not discharging at high rates. The time to reduce the water level in Prior Lake by one foot would be reduced from about 10.5 days to 4.5 days by increasing the peak discharge rate to 150 cfs.

The recalibrated PCSWMM model was updated with two configurations to reflect a proposed Prior Lake outlet structure capable of discharging 150 cfs:

- **Increased Outlet Capacity:** The Prior Lake outlet capacity is increased to 150-cfs, the estimated conveyance capacity of the downstream channel. The rating curve for low and normal discharges remains unchanged. This analysis shows that during the 2014 water year, the peak flood elevation would have been approximately one foot lower and the duration of time above the no wake water level shorter by approximately one month.
- **Increased Outlet Capacity Forecasting + Drawdown:** The Prior Lake outlet capacity is increased to 150-cfs, the estimated conveyance capacity of the downstream channel. When the following conditions were met, a preemptive drawdown at a rate of 85-cfs was added (this rate was assumed that the estimated conveyance capacity of the downstream channel could not exceed 150-cfs). Lake drawdown is conducted when all of the following conditions are met:
 - Rainfall event occurs between May and October
 - Prior Lake level is higher than 901.5 feet
 - More than 1 inch of rain is in the 3-day forecast based on the national weather service
 - Note that a 'perfect' forecast was assumed (i.e. the observed rainfall was assumed to be forecast three days prior to the rainfall occurring)

This scenario establishes the theoretical maximum reduction in flooding severity on Prior Lake. Even during this scenario, water levels on Prior Lake are expected to exceed the no wake elevation by one quarter of a foot and for more than one week.

Results Summary

These two analyses of modifications to Prior Lake have the greatest benefit of all scenarios analyzed, to flooding severity on Prior Lake. The results of these analyses are shown in Table 5.16 and a summary of the results are shown in Table 5.17.

Table 5.16. Impacts of Proposed Outlet Channel Modifications to flooding severity.

Scenario	Flooding Severity	10-year, 30-day Flood ¹	25-year, 30-day Flood ¹	2014 Water Year ¹
Increased Outlet Capacity	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	-0.3	-0.5	-0.9
	Change in Time Above No Wake Water Level on Prior Lake (days)	-14	-17	-29
Increased Outlet Capacity Increased Outlet Capacity with Flood Forecasting + Drawdown	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	N/A ²	N/A ²	-2.6
	Change in Time Above No Wake Water Level on Prior Lake (days)	N/A ²	N/A ²	-53

1 + Increase in peak water surface elevation or number of days above no wake water level on Prior Lake (904.0 ft)

- Decrease in peak water surface elevation or number of days above no wake water level on Prior Lake

2 Not simulated because the predictive modeling does not fit into the rainfall distribution curve for design rainfall events.

Table 5.17. Prior Lake Outlet Channel Modification results summary.

Parameter	Results
Flood Reduction Potential	-0.5 feet
Phosphorous Load Reduction	0 pounds
Implementation Challenges	1) Land Use Agreements 2) Access 3) Modification of Discharge Agreement
Estimated Construction Cost	\$2,321,000
15-year cost	\$2,385,000
15-years cost per pound of phosphorous reduction	NA
Project Partners	Multiple affected Landowners City of Prior Lake Scott County SMSC City of Shakopee
Funding Partners	Scott County DNR
Implementation Timeframe	7 – 10 years. The project would require a significant amount of stakeholder interaction to modify the discharge agreement. Several property owners would be impacted.

5.16 COUNTY DITCH 13 STORAGE

FLOOD REDUCTION PROJECT

Subwatershed Overview

This is a targeted location because it is on the Ditch 13 system, which represents a large portion of the total volume and phosphorous generated in the Upper Watershed. The location is at the junction where the branches from Sutton Lake and Swamp Lake meet, just upstream of the airport and Xeon Avenue. The calculated total annual runoff volume, phosphorous load, and total suspended solids load at this location are:

Total Annual Volume	4,051 ac-ft
Total Annual Phosphorous Load	3,615 pounds
Total Suspended Solids Load	51 tons

Project Concept

Many of the fields adjacent to the ditch along this reach are used for hay and frequently flood. The fields range in elevation from about 930 to 934, and the 10-year high water level is about 933.

The concept for this location is to construct a berm along the west bank of the ditch at the 10-year high water level of the ditch, to protect the fields from surface water flooding up to the 10-year rainfall event. The area behind the berm will be excavated to provide 150 acre-feet of storage, which would only be used in the event of a rainfall event large enough to overtop the berm. The concept plan for this consideration also includes a controlled outlet that can be used to drain the stored water after water elevations on Upper and Lower Prior Lake have receded to 904.0 or another protective elevation selected.

Excavated spoil material may be used to construct the berm and to elevate other fields in the area to reduce the probability of flooding. This provides a benefit to the district in providing flood storage for large rainfall events and benefits the landowner because it reduces the frequency of flooding. Figure 5.13 shows the conceptual plan for this alternative.



Figure 5.14. County Ditch 13 Storage.

Results Summary

Table 5.18. County Ditch 13 Storage results summary.

Parameter	Results
Flood Reduction Potential	0.0 feet
Phosphorous Load Reduction	0 pounds ¹
Implementation Challenges	1) Land Use Agreements
Estimated Construction Cost	\$952,000
15-year cost	\$978,000
15-years cost per pound of phosphorous reduction	NA ¹
Project Partners	1 Affected Landowners Scott County Farmer Led Council
Funding Partners	Scott County, DNR
Implementation Timeframe	5 – 10 years. Land acquisition or easement for the basin would be required. The project can provide a landowner benefit.

1- Phosphorous reduction would not happen in a normal precipitation year, small reductions would be seen for events that overtop the berm.

5.17 UPPER WATERSHED LAKES CONTROLLED OUTLET STORAGE FLOOD REDUCTION PROJECT

The Upper Watershed lakes controlled outlet storage concept is only intended for flood reduction and does *not* provide regular nutrient reduction.

Subwatershed Overview

This is a targeted location because Sutton, Swamp, Fish and Buck Lakes are natural, existing basins to hold stormwater in the Upper Watershed and reduce runoff volumes to Spring Lake. The total potential storage in these lakes is greater than 300 acre-feet per foot of depth. The calculated total annual runoff volume, phosphorous load, and total suspended solids load from these locations, as a sum of the loads from the four lakes, are:

Total Annual Volume	4,387 ac-ft
Total Annual Phosphorous Load	2,489 pounds
Total Suspended Solids Load	50 tons

Project Concept

The Upper Watershed storage concept includes constructing controlled outlets on Sutton, Swamp, Fish and Buck Lakes. The outlets remain open under normal conditions and are modeled as closed when the water level on Upper and Lower Prior Lakes reaches the no-wake zone elevation of 904.0. The controlled outlets were modeled to have an overflow weir at the 25-year high water level for those lakes to allow overflow discharges during extremely large rainfall events. Figure 5.14 shows the conceptual plan for this alternative.

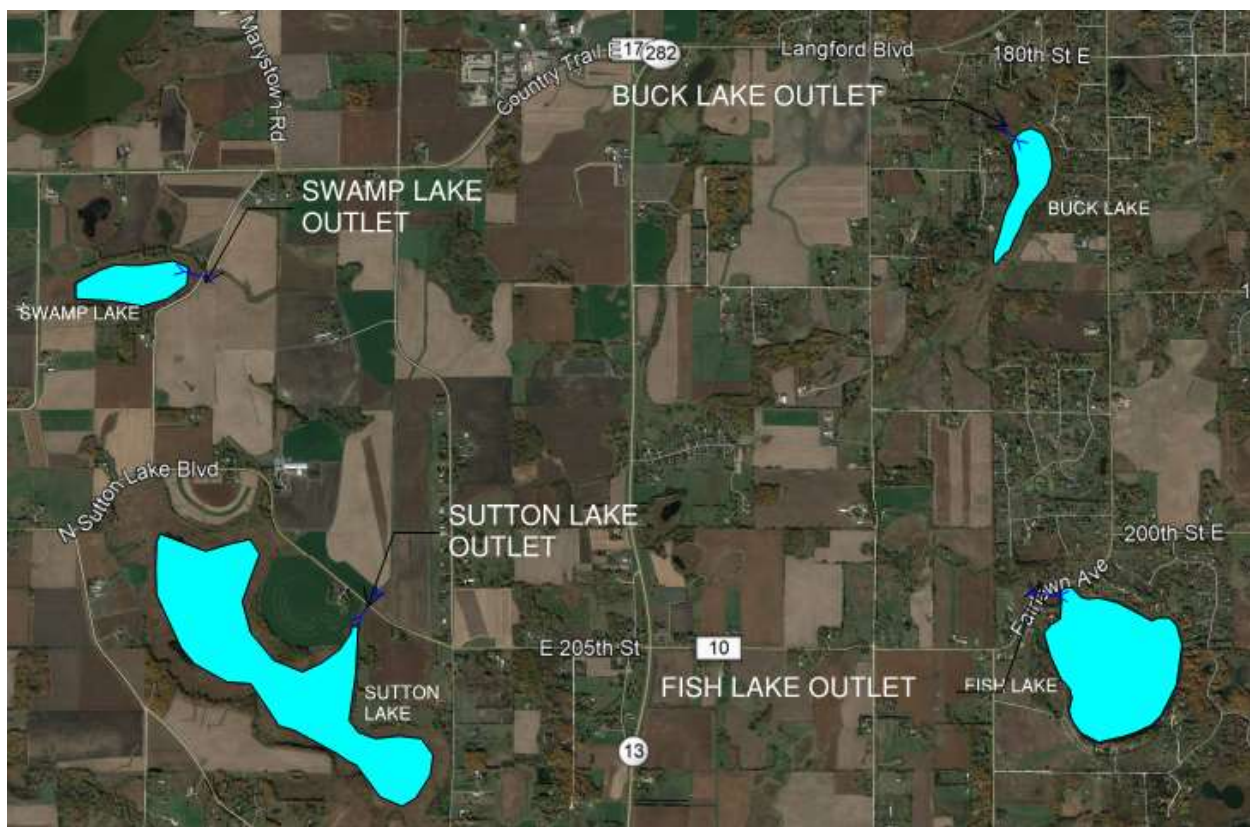


Figure 5.15. Upper Watershed Lakes Controlled Outlet Storage concept.

Results Summary

Table 5.19. Upper Watershed Lakes Controlled Outlet Storage results summary.

Parameter	Results
Flood Reduction Potential	-0.5 feet
Phosphorous Load Reduction	0 pounds
Implementation Challenges	1) Land Use Agreements
Estimated Construction Cost	\$1,206,000
15-year cost	\$1,403,000
15-years cost per pound of phosphorous reduction	NA
Project Partners	Multiple Affected Landowners ¹ Scott County
Funding Partners	Scott County DNR
Implementation Timeframe	5 – 10 years. The project would require buy-ins from several landowners. Multiple phases would extend schedules.

1- This concept would impact all landowners on lakes with controlled outlets with increased durations of inundation during events when the outlets are operated.

5.18 POLICY

Governing policy can also have a significant effect on water quality and quantity, but policy direction takes time and often needs to wait until lands are developed. The current district rules for land disturbing activities are:

- Maintain existing discharge rates for the 2, 10, and 100-year rainfall events.
- Provide for infiltration or other means of retention to retain the equivalent of 1 inch of runoff from all new and reconstructed impervious surfaces on sites with one or more acre of new impervious surfaces. Retain 0.5 inches of runoff from all impervious surfaces for sites with less than one acre of new impervious surfaces.
- In addition to the infiltration requirement, provide additional BMPs or infiltration to retain the runoff from a 2-year rainfall event.

Some watersheds have more strict policies for development either on a district wide basis or in selected high priority areas of the district. These enhanced policies can be implemented to improve the water quality or to address downstream flooding concerns. Some of the enhanced policies that may be considered are:

- Require that new developments meet greater than the typical standards for stormwater retention and treatment.
- Encourage low impact design standards to minimize impervious surfaces in new developments.
- Encourage and support the use of retention and treatment practices other than infiltration, such as manufactured treatment devices and stormwater reuse.
- Provide for easement areas, such as increased easement over ditches and streams, to allow for larger regional storage or treatment systems.
- Provide regional ponds and treatment facilities to centralize the systems and allow opportunities to optimize the use to provide maximum benefits for the watershed.
- Require stormwater management to meet typical district standards on smaller projects and not only larger developments.

Current policies should be reviewed and updated to provide the maximum possible benefit as currently open land is developed in the future. The future policies will need to be balanced with reasonable land use and take any restrictions on the land into consideration, such as high water tables, low permeability soil, environmental concerns and other restrictions as identified in the Minnesota Stormwater Manual.

Future Land Use Impact on Water Quality

Conversion of crop land to developed land by itself will significantly improve the water quality. The Scott County 2040 Land Use maps show much of the farmland along County Ditch 13, upstream of Langford Avenue as a Transition Area. The Transition Area is zoned as 1 unit per 10 acres with clustered developments.

Taking this subwatershed and using the Model My Watershed tool developed by the Stroud Water Research Center, conversion of the estimated 875 acres of cropland upstream of Langford Avenue to 20% low density mixed land use, 20% open space, and the remaining

60% remaining in crops would reduce the phosphorous load from this area of the watershed by about 30%. Converting the entire subwatershed to low density mixed land use would reduce that load by 75%. This is a significant benefit to the water quality for the lakes, but it would happen over many years and will not provide any short-term solutions. Adding additional controls for new developments will increase that load reduction. Policies that will directly improve the water quality include:

- Include requirements to reduce phosphorous in stormwater runoff from new construction and development to a higher standard than the typical MPCA standards.
- Requiring the retention of stormwater through infiltration, rainwater harvesting, or other technologies.
- Allow the use of manufactured treatment devices as treatment alternatives to meet future stormwater treatment goals.
- Evaluate opportunities for larger scale BMP construction as lands develop in the Upper Watershed.

Future Land Use Impact on Lake Flooding

Wenck reviewed several policies and ordinances that could be adopted within the Upper Watershed to better manage flooding on Prior Lake. These policies and ordinances were added to the recalibrated PCSWMM model to determine the effectiveness of each:

- **2040 Land Use- No Onsite Rate Control:** Land use in the Upper Watershed is transitioned from primarily agricultural areas to the land uses changes occur on the attached map. In general, the watershed area west of Highway 13 transitions from agricultural land use to *Urban Transition* land use, which Scott County defines as one structure per 10 acres. The area east of Highway 13 transitions to *Rural or Large-Lot Residential*, which Met Council defines as one residence per 1-2 acres. While unlikely, should these properties be developed individually, they may not trigger stormwater pollution and rate control rules. To understand the worst-case outcome, Wenck assumed this area was developed with no stormwater rate control was required for the area east of Highway 13.

Based on the expected land use changes, the area of west of Highway 13 is expected to have reduced rates and volume of runoff; however, this is more than offset by the increased volume of runoff from the imperviousness from development east of Highway 13 and will result in a slight increase in the flood severity on Prior Lake. While rate control policies and ordinances may help flooding on public and private property and infrastructure adjacent to the development, the increased volume of runoff (not rate control) increases flood severity on Prior Lake.

- **2040 Land Use- Onsite Rate Control for Residential Area (East of Highway 13):** This analysis assumes the land is developed identically to the "2040 Land Use- No Onsite Rate Control"; however, stormwater rate control (but not volume control) features are added along with development. This scenario marginally improves the flooding severity outcomes on Prior Lake over the *No Onsite Rate Control* scenario, but because the volume of runoff from the new development drives flooding severity on Prior Lake, the lake is still expected to have somewhat worsened flooding severity than during current conditions.

- Development East of Highway 13 required to match 100-year Post Development Stormwater Runoff Rates to Pre-Development 50-year Rates:**
 This analysis assumes the land is developed identically to the "2040 Land Use- *No Onsite Rate Control*"; however, stormwater rate control (but not volume control) features are added requiring post-development 100-year peak discharge rates to match pre-project 50-year peak discharge rates. This scenario marginally improves the flooding severity outcomes on Prior Lake over the *No Onsite Rate Control* scenario and does not improve the outcome over typical rate control rules (i.e. proposed peak discharge rates must be less than or match pre-development peak discharge rates), but because the volume of runoff from the new development drives flooding severity on Prior Lake, the lake is still expected to have somewhat worsened flooding severity than during current conditions.
- Development East of Highway 13 required to match 100-year Post Development Stormwater Runoff Rates to Pre-Development 50-year Rates and Abstract the First 1.1-inches of Runoff from New Development:** This analysis assumes the land is developed identically to the "Development East of Highway 13 required to match 100-year Post Development Stormwater Runoff Rates to Pre-Development 50-year Rates"; however, stormwater rate control and volume features are added along with development. Based on the guidance from the Minnesota Pollution Control Agency, the first 1.1-inches of runoff is abstracted for the new development greater than one acre. This scenario is the only scenario to improve flooding severity outcomes on Prior Lake over current conditions and demonstrates the importance of volume control in the Upper Watershed to reducing flooding severity on Prior Lake.

The results of these analyses are shown in Table 5.17.

Table 5.20. Impacts of proposed policy changes to flooding severity on Prior Lake.

Scenario	Flooding Severity	10-year, 30-day Flood ¹	25-year, 30-day Flood ¹	2014 Water Year ¹
2040 Land Use- No Onsite Rate Control	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	0.2	0.2	0.4
	Change in Time Above No Wake Water Level on Prior Lake (days)	4	2	8
2040 Land Use- Onsite Runoff Control for Residential Areas (East of Highway 13)	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	0.1	0.1	0.3
	Change in Time Above No Wake Water Level on Prior Lake (days)	1	1	8
Development East of Highway 13 required to match 100-year Post Development Stormwater Runoff Rates to Pre-Development 50-year Rates	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	0.1	0.1	0.3
	Change in Time Above No Wake Water Level on Prior Lake (days)	1	1	8
Development East of Highway 13 have 100-year Post Project rate match pre-project 50-year rates +1.1" of Abstraction	Change Peak Water Surface Elevation relative to Existing Conditions (feet)	-0.1	-0.1	N/A ²
	Change in Time Above No Wake Water Level on Prior Lake (days)	-2	-1	

1 + Increase in peak water surface elevation or number of days above no wake water level on Prior Lake (904.0 ft)
 - Decrease in peak water surface elevation or number of days above no wake water level on Prior Lake

2 Conditional on BMP media recovery times, therefore not simulated

6.0 Project Screening

The projects described in Section 5 have potential to provide a significant reduction the total phosphorous concentration. Only the modifications to the Prior Lake Outlet structure or implementing much of the Upper Watershed storage solutions identified in the 2016 Flood Study will have a significant benefit for the flooding concerns on Prior Lake. The suggested projects for improved water quality do not provide a significant flood reduction benefit.

This section presents the screening results for the projects discussed in Section 5. The projects are screened based on phosphorous reduction, Upper Prior, and Lower Prior Lake flood reduction potential, construction costs, total lifecycle cost per pound of phosphorous reduction, and on overall feasibility.

The scoring for the alternatives is based on a maximum score of 50 for each category, with the alternative that has the best value for that category being scored 50 and the others receiving a score based on the ratio of that value to the score. For example, the highest score for total pounds of phosphorous reduction is for a chemical treatment system on County Ditch 13, with a reduction of 1,062 pounds of phosphorous annually. The score for total annual phosphorous reduction for each of the other options is calculated by multiplying the value calculated for that alternative by 50 and dividing by 1062. A similar formula is used for each category.

6.1 PROJECT SCORING MATRIX

The scoring for each individual project is provided in table 6.1 through 6.17. A summary of the values used to score the projects is shown in Table 6.18, including the annual phosphorous reduction, flood reduction potential, cost per pound of phosphorous reduction, and the total lifecycle cost for each alternative. Table 6.19 provides the scores for each alternative based on the scoring categories and the scoring method described above. The total score presented in each alternative is the sum of the screening categories and the rank is included, with 1 being the highest scoring project for either nutrient reduction or flood reduction.

Table 6.1. Sutton Lake Iron-Enhanced Sand Filter score.

Category	Description	Score
Total Annual Phosphorous Load Reduction	735 pounds	35
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$166	32
Lifecycle Cost	\$1,836,000	3
Implementation Challenges	High cost. The project may need to be implemented in phases with construction of separate cells to reduce yearly construction costs and increase outside funding ability.	41
Total Score	Rank: 2	111

Table 6.2. Swamp Lake Diversion to Geis Lake.

Category	Description	Score
Total Annual Phosphorous Load Reduction	161 pounds ¹	8
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$204	26
Lifecycle Cost	\$492,000	10
Implementation Challenges	1) Permitting Difficulty 2) Easement acquisition	8
Total Score	Rank: 11	52

1- The phosphorous load reduction potential is estimated with 50% of the total discharge from Swamp Lake diverted to Geis Lake.

Table 6.3. Swamp Lake Iron-Enhanced Sand Filter.

Category	Description	Score
Total Annual Phosphorous Load Reduction	223 pounds	10
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$159	34
Lifecycle Cost	\$530,000	9
Implementation Challenges	Land ownership and Easements	41
Total Score	Rank: 7	94

Table 6.4. Buck Lake South Wetland Storage.

Category	Description	Score
Total Annual Phosphorous Load Reduction	95 pounds	4
Flood Reduction Potential	-0.1	10
Cost per Pound of Phosphorous Reduction	\$459	12
Lifecycle Cost	\$652,000	7
Implementation Challenges	Land ownership and Easements Flood plain changes Multiple landowners involved Need for Conservation easements	25
Total Score	Rank: 10	58

Table 6.5. Buck Lake East Wetland Enhancement.

Category	Description	Score
Total Annual Phosphorous Load Reduction	100 pounds	5
Flood Reduction Potential	-0.1 feet	10
Cost per Pound of Phosphorous Reduction	\$119	45
Lifecycle Cost	\$180,000	27
Implementation Challenges	Land ownership and Easements Flood plain changes	24
Total Score	Rank: 3	111

Table 6.6. Buck Lake East Stream Restoration.

Category	Description	Score
Total Annual Phosphorous Load Reduction	10 pounds	0
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$637	8
Lifecycle Cost	\$96,000	50
Implementation Challenges	Land Ownership and Easements Accessibility Tree Removal required	31
Total Score	Rank: 9	89

Table 6.7. County Ditch 13 Improvements.

Category	Description	Score
Total Annual Phosphorous Load Reduction	202 pounds	9
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$389	14
Lifecycle Cost	\$1,177,000	4
Implementation Challenges	Land Ownership and Easements Accessibility Impacts to productive farmland Tree Removal required	12
Total Score	Rank: 13	39

Table 6.8. County Ditch 13 Repairs.

Category	Description	Score
Total Annual Phosphorous Load Reduction	50 pounds	2
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$830	6
Lifecycle Cost	\$623,000	8
Implementation Challenges	Accessibility, funding	28
Total Score	Rank: 12	44

Table 6.9. County Ditch 13 Diversion.

Category	Description	Score
Total Annual Phosphorous Load Reduction	90 pounds ¹	4
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$924	6
Lifecycle Cost	\$1,253,000	4
Implementation Challenges	Land Ownership and Easements Accessibility Impacts to productive farmland Lack of funding resources	9
Total Score	Rank: 14	23

1- The phosphorous load reduction potential is estimated with 25% of the total discharge at County Ditch 13 diverted and treated by the enhanced Buck Lake wetland storage at 10% reduction

Table 6.10. Ferric Chloride System Improvements Alternative 1.

Category	Description	Score
Total Annual Phosphorous Load Reduction	250 pounds ¹	12
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$107	50
Lifecycle Cost	\$400,000	12
Implementation Challenges	Additional data and study needed	28
Total Score	Rank: 6	102

1- The phosphorous load reduction potential assumes a 50% improvement on the existing system.

Table 6.11. Ferric Chloride system Improvements Alternative 2.

Category	Description	Score
Total Annual Phosphorous Load Reduction	911 pounds ¹	43
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$151	48
Lifecycle Cost	\$2,069,000	2
Implementation Challenges	Additional data and study needed Need to acquire land for additional basin capacity	28
Total Score	Rank: 4	108

1- The phosphorous load reduction potential assumes a 70% total reduction for 50% of the flow passing through the system.

Table 6.12. Spring West Iron-Enhanced Sand Filter.

Category	Description ¹	Score
Total Annual Phosphorous Load Reduction	249 pounds	12
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$112	48
Lifecycle Cost	\$419,000	11
Implementation Challenges	Easements needed for construction and maintenance Project is in feasibility study stage	50
Total Score	Rank: 1	121

1- Values and information provided by Emmons Olivier Resources.

Table 6.13. Buck Lake Chemical Treatment System.

Category	Description ¹	Score
Total Annual Phosphorous Load Reduction	793 pounds	37
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$204	26
Lifecycle Cost	\$2,431,000	2
Implementation Challenges	Easements needed for construction and maintenance Additional testing and study are needed	26
Total Score	Rank: 8	91

1- Values and information in 2014 Feasibility Study for a Chemical Treatment System on Buck Lake.

Table 6.14. County Ditch 13 Chemical Treatment System.

Category	Description	Score
Total Annual Phosphorous Load Reduction	1,062 pounds	50
Flood Reduction Potential	No change in Prior Lake High Water Level	0
Cost per Pound of Phosphorous Reduction	\$157	34
Lifecycle Cost	\$2,500,000	2
Implementation Challenges	Land acquisition, significant testing is needed.	28
Total Score	Rank: 5	104

The following three tables present the three options discussed in the report that are targeted at providing flooding relief. The scores are only in consideration of the 3 alternatives listed and the ranks are for those three projects.

Table 6.15. Prior Lake Outlet Channel Modifications.

Category	Description	Score
Total Annual Phosphorous Load Reduction	0 pounds	0
Flood Reduction Potential	0.5 feet	50
Cost per Pound of Phosphorous Reduction	NA	0
Lifecycle Cost	\$2,385,000	21
Implementation Challenges	Easements for construction and maintenance Need to modify discharge agreements with DNR, SMSC, and other entities The project does not provide any water quality benefit	35
Total Score	Rank: 2	106

Table 6.16. County Ditch 13 Storage.

Category	Description	Score
Total Annual Phosphorous Load Reduction	0 pounds	0
Flood Reduction Potential	0 feet	0
Cost per Pound of Phosphorous Reduction	NA	0
Lifecycle Cost	\$978,000	50
Implementation Challenges	Landowner agreements, No improvement in downstream water levels.	32
Total Score	Rank: 3	82

Table 6.17. Upper Watershed Lakes Controlled Outlet Storage.

Category	Description	Score
Total Annual Phosphorous Load Reduction	0 pounds	0
Flood Reduction Potential	0.5 feet	50
Cost per Pound of Phosphorous Reduction	NA	0
Lifecycle Cost	\$1,403,000	35
Implementation Challenges	Easements for construction and maintenance Extended detention time on upstream lakes affecting property owners	50
Total Score	Rank: 1	135

6.2 PROJECT RANKING SUMMARY

Table 6.18 provides a summary of the values used for the rankings of the 14 projects that address phosphorous reduction and Table 6.19 presents values for the three projects that address flooding concerns. The scores and rankings for each of the projects identified are listed in table 6.20 for the phosphorous-reducing projects and in Table 6.21 for the flood mitigation projects. These matrices of values and scoring can be used to prioritize and implement future projects that will move the district towards improved water quality and flood conditions.

Table 6.18. Summary of values for phosphorous reduction projects.

Project	Annual Phosphorous Reduction (pounds)	Flood Reduction Potential (feet)	Cost per Pound of Phosphorous Reduction	Lifecycle Cost
1) Sutton Lake Iron-Enhanced Sand Filter	735	0.0	\$166	\$1,836,000
2) Swamp Lake Diversion to Geis Lake	161	0.0	\$204	\$492,000
3) Swamp Lake Iron-Enhanced Sand Filter	223	0.0	\$159	\$530,000
4) Buck Lake South Wetland Storage	95	0.1	\$459	\$652,000
5) Buck Lake East Wetland Enhancement	100	0.1	\$119	\$180,000
6) Buck Lake East Stream Restoration	10	0.0	\$637	\$96,000
7) County Ditch 13 Improvements	202	0.0	\$389	\$1,177,000
8) County Ditch 13 Repairs	50	0.0	\$830	\$623,000
9) County Ditch 13 Diversion	90	0.0	\$924	\$1,253,000
10) Ferric Chloride System Alternative 1	250	0.0	\$107	\$400,000
11) Ferric Chloride System Alternative 2	911	0.0	\$151	\$2,069,000
12) Spring West Iron-Enhanced Sand Filter	249	0.0	\$112	\$419,000
13) Buck Lake Chemical Treatment System	793	0.0	\$204	\$2,431,000
14) CD 13 Chemical Treatment System	1062	0.0	\$157	\$2,500,000

Table 6.19. Summary of values for flood mitigation projects.

Project	Annual Phosphorous Reduction (pounds)	Flood Reduction Potential (feet)	Cost per Pound of Phosphorous Reduction	Lifecycle Cost
15) Prior Lake Outlet Channel Modifications	0	0.5	\$-	\$2,385,000
16) County Ditch 13 Storage	0	0.0	\$-	\$978,000
17) Upper Watershed Lakes Controlled Outlet Storage	0	0.5	\$-	\$600,000

Table 6.20. Summary of scores for phosphorous reduction projects.

Project	Annual P Reduction	Flood Reduction Potential	Cost per Pound of P Reduction	Lifecycle Cost	Feasibility	Total Score
1) Sutton Lake Iron-Enhanced Sand Filter	35	0	32	3	41	111
2) Swamp Lake Diversion to Geis Lake	8	0	26	10	8	52
3) Swamp Lake Iron-Enhanced Sand Filter	10	0	34	9	41	94
4) Buck Lake South Wetland Storage	4	10	12	7	25	58
5) Buck Lake East Wetland Enhancement	5	10	45	27	24	111
6) Buck Lake East Stream Restoration	0	0	8	50	31	89
7) County Ditch 13 Improvements	9	0	14	4	12	39
8) County Ditch 13 Repairs	2	0	6	8	28	44
9) County Ditch 13 Diversion	4	0	6	4	9	23
10) Ferric Chloride System Improvements Alternative 1	12	0	50	12	28	102
11) Ferric Chloride System Improvements Alternative 2	43	0	35	2	28	108
12) Spring West Iron-Enhanced Sand Filter	12	0	48	11	50	121
13) Buck Lake Chemical Treatment System	37	0	26	2	26	91
14) CD 13 Chemical Treatment System	50	0	34	2	18	104

Table 6.21. Summary of scores for flood mitigation projects.

Project	Annual P Reduction	Flood Reduction Potential	Cost per Pound of P Reduction	Lifecycle Cost	Feasibility	Total Score
15) Prior Lake Outlet Channel Modifications	0	50	0	21	35	106
16) County Ditch 13 Storage	0	0	0	50	32	82
17) Upper Watershed Lakes Controlled Outlet Storage	0	50	0	35	50	135

7.0 Summary

This Upper Watershed Blueprint identified potential projects to address water quality and flood reduction improvements for Spring, Upper Prior and Lower Prior Lakes. Seventeen projects were evaluated in detail and ranked in accordance with their several metrics, including cost effectiveness, and ease of implementation, and potential to help meet water quality and flood reduction goals.

Reducing Phosphorus Loading

The 17 projects identified and evaluated in this report have the potential to reduce the annual phosphorous loads to Spring Lake significantly. The four projects with the highest phosphorous reduction potential identified in the study and their estimated load reductions are:

- County Ditch 13 Chemical Treatment System – 1,062 pounds per year.
- Ferric Chloride System Improvements Alternative 2 which includes upgrades to the system, assuming that the entire system can be optimized to remove 70% of the total phosphorous from half of the total flow – 911 pounds per year.
- Sutton Lake Iron Enhanced Sand Filter (IESF) - 735 pounds per year.
- Buck Lake Chemical Treatment System – 793 pounds per year.

These four projects combine to reduce the total phosphorous loads from the Upper Watershed by about 3,501 pounds annually, or just over half of the watershed load. This exceeds the TMDL goal. These projects have various funding mechanisms that are available to assist from feasibility study through construction and long-term maintenance.

In addition, the District has received a grant to perform a feasibility study for the project identified as the Buck Lake East Wetland enhancement. This project scored 3rd highest in the project scoring matrix results and will provide an estimated reduction in annual in total phosphorous load of 100 pounds. This project, combined with the four projects identified above, brings the total reduction to about 3,601 pounds per year.

Reducing Flooding Impacts

The most cost-effective pollutant load reducing projects would appear to have limited flood control impacts. To address these concerns, the Blueprint includes options to address Upper Watershed flooding as well as high water elevations on the lake system. The most effective structural options are:

- Prior Lake Outlet Channel Modifications:

Install outlet controls on lakes in the Upper Watershed to limit discharge when targeted water levels are reached on Upper and Lower Prior Lakes. For this report, the targeted condition is to restrict flow from Swamp, Sutton, Fish and Buck Lakes when Upper and Lower Prior Lakes reach the no wake elevation of 904.0.

- Upper Watershed Lakes Controlled Outlet Storage:

Modify the culvert and discharge allowance for the Prior Lake outlet channel to permit a higher discharge rate during period when the capacity is available in downstream channels and basins. Work with the DNR and other partners to allow discharge through the Prior Lake outlet channel at a lower water level in advance of forecasted significant precipitation events to provide storage to contain those events. This water level manipulation combined with a higher discharge rate have potential to reduce the 25-year high water level on Prior Lake by 0.5 feet.

The report also considered potential regulatory modifications as a non-structural option to reduce pollutant loading and limit changes in the rate and volume of runoff as development occurs in the Upper Watershed. Conversion of crop land to developed land by itself can significantly reduce nutrient and sediment loads. However, runoff from new impervious surface could exacerbate flood conditions in downstream lakes. New regulatory controls could potentially prevent increases in downstream flood elevations and have a modest (0.1 foot) reduction in the 25-year high water level on Prior Lake. These reductions are long-term as development and redevelopment occur over the coming decades.

- Require development and redevelopment east of Highway 13 to limit 100-year post project runoff rate to the pre-project 50-year rates and require 1.1" of runoff volume abstraction.
- Modeling indicates that volume retention for future development is critical to reducing or maintaining current flood elevations on Upper and Lower Prior Lake. Future policy should provide a framework to encourage alternatives to infiltration for areas where it is not feasible, such as stormwater harvesting, green infrastructure, and other options.

Next Steps

This Upper Watershed Blueprint is a framework to prepare a long term improvements plan to move towards improving water quality and reducing flood impacts in the District. The information can be re-evaluated with any changes in land use and other conditions in the Upper Watershed. Table 8.1 presents a recommended schedule for the consideration of potential improvements. In practice, implementation will be driven by availability of funding and securing necessary permits and stakeholder approvals. The projects included in table 8.1 and reasons why these projects are prioritized, are:

Water Quality Projects:

- **Spring West Iron Enhanced Sand Filter:** This project provides a total annual phosphorous reduction of 249 pounds and is already underway and the most likely to be constructed in the short-term. *Scoring Matrix Rank: 1*
- **Sutton Lake Iron Enhanced Sand Filter:** This project has the second highest phosphorous reduction potential and has a good probability of landowner approval. The IESF provides an estimated 735 pounds of phosphorous reduction annually. *Scoring Matrix Rank: 2*
- **Buck lake East Wetland Enhancement:** The district recently received a grant to perform a feasibility study for this project. This will provide an estimated phosphorous reduction of 100 pounds per year. *Scoring Matrix Rank: 3*

- **Ferric Chloride System Improvements Alternative 2:** This project is second on the list of total phosphorous reduction at up to 911 pounds per year, depending on ability to increase the sedimentation capacity. *Scoring Matrix Rank: 4*
- **County Ditch 13 Chemical Treatment System:** This project has the highest phosphorous reduction potential of the 14 projects identified, at 1,062 pounds per year. *Scoring Matrix Rank: 5*

Flood Reduction Projects:

- **Upper Watershed Lakes Controlled Outlet Storage:** This was the highest scoring flood mitigation alternative in all categories and could reduce the 25-year high water level on Upper and Lower Prior Lake by about 0.5 feet. *Scoring Matrix Rank: 1*
- **Prior Lake Outlet Channel Modifications:** This was the other alternative that can reduce the 25-year high water level on Upper and Lower Prior Lake by 0.5 feet but at a much higher cost and with a much lower feasibility. *Scoring Matrix Rank: 2*

In total, these five pollutant reduction projects could reduce the total phosphorous loads from the Upper Watershed by an estimated 3,057 pounds annually. This exceeds the annual reduction goal in the TMDL report. Either of the flood reduction projects can decrease the flood levels on Upper and Lower Prior Lake by about 0.5 feet.

Table 7.1. Potential implementation schedule for high-priority projects.

Project	Year									
	1	2	3	4	5	6	7	8	9	10
POLLUTANT LOAD REDUCTION PROJECTS										
<i>Buck Lake East Wetland Enhancement</i>										
Feasibility, assemble funding										
Construct										
<i>Spring West Iron Enhanced Sand Filter</i>										
Feasibility, assemble funding										
Construct										
<i>County Ditch 13 Chemical Treatment System</i>										
Feasibility, assemble funding, permitting										
Construct										
<i>Sutton Lake Iron Enhanced Sand Filter</i>										
Feasibility, assemble funding										
Construct										
<i>Ferric Chloride System Improvements Alternative 2</i>										
Feasibility, assemble funding, permitting										
Construct (multiple phases)										
<i>Opportunistic Projects</i>										
As opportunities, funding is available										
FLOOD CONTROL PROJECTS										
<i>Upper Watershed Lakes Controlled Outlet Storage</i>										
Feasibility, assemble funding, permitting, stakeholder work										
Construct (multiple phases)										
<i>Prior Lake Outlet Channel Modifications</i>										
Feasibility, permitting, agency and stakeholder work										
Construct (multiple phases)										
POLICY OPTIONS										
<i>Adopt new development controls</i>										
Stakeholder discussions										
Rule revisions										

Appendix A

The [Map Book](#) is available separately.