PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

January 13, 2013

Jennifer Satnik
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194

Re: MN0067377 Prior Lake-Spring Lake Ferric Chloride Inflow Treatment System: 2012 Discharge Monitoring Reports, Residual Solids Management Report and Annual Progress Report

Dear Jennifer Satnik:

Enclosed is an Annual Progress Report for the Prior Lake-Spring Lake Ferric Chloride Treatment System, including a Residual Solids Management Report, as required by the permit.

The Discharge Monitoring Reports for the National Pollutant Discharge Elimination System permit referenced above for the operating year 2012 have been submitted electronically. There are no Customized Supplemental Report Forms because the system was not operated in 2012.

If you have any questions about the enclosed materials or the operation of the Prior Lake-Spring Lake Ferric Chloride Inflow Treatment System in 2012, please contact me at (952) 447-4166 or mkinney@plslwd.org.

Sincerely,

Michael J. Kinney
District Administrator

14070 Commerce Ave NE, Suite 300, Prior Lake, MN 55372 • (952) 447-4166 (phone) • (952) 447-4167 (fax)
www.plslwd.org • info@plslwd.org

2012 Annual Progress and Residual Solids Management Report

Ferric Chloride Inflow Treatment System NPDES Permit MN0067377

Mailed to:
Discharge Monitoring Reports
Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, MN 55155

PRIOR LAKE - SPRING LAKE
WATERSHED DISTRICT

January 13, 2013

Introduction

Spring Lake is a recreational lake located in central Scott County, Minnesota. The lake is listed on the State Impaired Waters List as impaired for aquatic recreation due to excess nutrients. Monitoring completed by the Prior Lake-Spring Lake Watershed District (PLSLWD) in the 1990's identified phosphorus as the nutrient most contributing to water quality impairment and algae blooms. That study also noted that a significant portion of the phosphorus entering Spring Lake was in the form of dissolved phosphorus thus making it readily available for algal uptake. Spring Lake flows directly into Upper Prior Lake, which is also listed as impaired due to excess nutrients.

In 1998, the PLSLWD constructed a ferric chloride ($FeCl_3$) treatment system to precipitate dissolved phosphorus out of stormwater from County Ditch 13, the main inflow to Spring Lake. Appendix 1 shows the location of the system relative to Spring Lake. The system was constructed as part of a Minnesota Pollution Control Agency (MPCA) Clean Water Partnership Implementation Project. The treatment system began operating under a permit from the Department of Natural Resources. In 2004, the treatment system permit was renewed as a National Pollutant Discharge Elimination System permit administered by the MPCA. The District applied to the MPCA for a renewed permit in 2009. While no new permit has been issued, the District had been granted approval to operate the system under the terms of the expired permit, and was again approved for 2012.

The treatment system involves the injection of 32.5% liquid $FeCl_3$ solution into water just downstream of Scott County Ditch 13, immediately upstream of State Trunk Highway 13 and a short distance upstream of Spring Lake. The iron within the $FeCl_3$ binds with the dissolved phosphorus in the water and creates colloidal particles (floc). The treated water flows downstream into a constructed desiltation basin that is located northeast of the $FeCl_3$ injection point and immediately upstream of Spring Lake. The resulting iron-phosphorus floc particles are captured in this basin as the water flows to Spring Lake.

Summary of 2012 Treatment System and Monitoring Operations

The District did not operate the $FeCl_3$ system in 2012. The desiltation pond was dredged in January 2012, coupled with almost no snow cover and spring runoff; the opportunity arose to test the effectiveness of dissolved phosphorus removal in the desiltation basin alone, with no $FeCl_3$ dosing. Having been recently dredged, the pond should have been in its peak performance. In addition, the supply of $FeCl_3$ was depleted in 2011 and the District had contracted to have the tank and facility cleaned since the District was anticipating the replacement of the system in 2012. As such, it seemed impractical to purchase material that might have to be disposed of later in the year during construction if the system was not to be operated. However, May and June saw particularly heavy rain events and then July and August experience above average temperatures which lead to significant algae blooms.

Samples were taken upstream and downstream of the dosing station on 21 days during 2012, approximately 3 times per month. Duplicates were taken on 10 percent of the samples to test for quality control and quality assurance. An ultrasonic distance sensor recorded stage at the weir upstream of the injection site on a 15-minute interval, which was also used to calculate flow by using a stage:discharge relationship (rating curve). Three flow measurements were taken at various stages in 2012 to verify that the current rating curve was accurate. Rainfall was also recorded in 15-minute intervals by a tipping bucket located at the station. Appendix 1 shows the location of the sampling sites and the specific site information. Table 3 presents the results of the sampling in 2012.

Table 1 summarizes the operation of the system during 2012 and Table 2 summarizes the $FeCl_3$ application and flows during each month of operation.

Table 1: 2012 Summary $FeCl_3$ Monthly Operations

Month	Operating Status/Notes
January	Primarily frozen conditions along County Ditch 13 (CD-13). Treatment system was shut down; no dosing occurred.
February	Primarily frozen conditions along CD-13. Treatment system was shut down; no dosing occurred. One monitoring sample collected.
March	Treatment system was shut down; no dosing occurred. Three monitoring samples collected.
April	Treatment system was shut down; no dosing occurred. Three monitoring samples collected, plus one duplicate.
May	Treatment system was shut down; no dosing occurred. Three monitoring samples collected, plus one duplicate.
June	Treatment system was shut down; no dosing occurred. Three monitoring samples collected, plus one duplicate.
July	Treatment system was shut down; no dosing occurred. Three monitoring samples collected, plus one duplicate.
August	Treatment system was shut down; no dosing occurred. Three monitoring samples collected, plus one duplicate.
September	Treatment system was shut down; no dosing occurred. Two monitoring samples collected, plus one duplicate.
October	Treatment system was shut down; no dosing occurred.
November	Treatment system was shut down; no dosing occurred.
December	Treatment system was shut down; no dosing occurred.

Table 2: 2012 Summary of $FeCl_3$ Monthly Dosing

Month	$FeCl_3$ Solution Dosed (gal)	Fe Dosed (kg)	Cl Dosed (kg)	Water Flow (million gallons)	Days Dosed
January	0.00	0.00	0.00	--	0.00
February	0.00	0.00	0.00	--	0.00
March	0.00	0.00	0.00	--	0.00
April	0.00	0.00	0.00	--	0.00
May	0.00	0.00	0.00	--	0.00
June	0.00	0.00	0.00	--	0.00
July	0.00	0.00	0.00	--	0.00
August	0.00	0.00	0.00	--	0.00
September	0.00	0.00	0.00	--	0.00
October	0.00	0.00	0.00	--	0.00
November	0.00	0.00	0.00	--	0.00
December	0.00	0.00	0.00	--	0.00
2012 Total	0.00	0.00	0.00	--	0.00

All numbers in Table 3 under Soluble Reactive Phosphorus were analyzed after being filtered in the lab. Therefore the numbers do not reflect Total Orthophosphate as has been recorded in years previous to 2011, but rather filtered Dissolved Orthophosphate, also known as Soluble Reactive Phosphorus (SRP). These data provide an accurate assessment of the treatment system’s efficiency in reducing SRP which was not obtainable with the previous monitoring parameters.

Table 3: 2012 $FeCl_3$ System Monitoring Results

Date	Total Phosphorus (mg/L)			Soluble Reactive Phosphorus (mg/L)**			Total Iron as Fe (mg/L)	
	Upstream	Downstream	% Decrease Upstream to Downstream	Upstream	Downstream	% Decrease Upstream to Downstream	Upstream	Downstream*
2/29/12	1.000	0.630	37.0%	0.810	0.380	53.1%	0.600	0.560
3/7/12	0.620	0.910	-46.8%	0.360	0.610	-69.4%	0.940	0.670
3/12/12	0.400	0.510	-27.5%	0.072	0.320	-344.4%	1.400	0.540
3/21/12	0.320	0.270	15.6%	0.011	0.010	9.1%	0.760	0.670
4/2/12	0.150	0.130	13.3%	0.014	0.008	42.9%	0.520	0.320
4/9/12	0.130	0.140	-7.7%	0.006	0.006	0.0%	0.031	0.030
4/16/12	0.150	0.150	0.0%	0.031	0.022	29.0%	0.300	0.270
5/2/12	0.150	0.150	0.0%	0.013	0.012	7.7%	0.370	0.390
5/7/12	0.430	0.430	0.0%	0.270	0.270	0.0%	4.000	4.500
5/14/12	0.110	0.120	-9.1%	0.062	0.068	-9.7%	0.500	0.490
6/4/12	0.093	0.095	-2.2%	0.047	0.051	-8.5%	0.410	0.400
6/11/12	0.170	0.100	41.2%	0.066	0.011	83.3%	0.630	0.370
6/19/12	0.370	0.360	2.7%	0.230	0.230	0.0%	3.000	2.800
7/2/12	0.220	0.150	31.8%	0.120	0.006	95.0%	0.630	0.130
7/16/12	0.530	0.370	30.2%	0.320	0.250	21.9%	0.710	0.270
7/24/12	0.390	0.410	-5.1%	0.160	0.290	-81.3%	1.100	0.370
8/6/12	0.450	0.320	28.9%	0.150	0.220	-46.7%	0.840	0.270
8/20/12	0.320	0.310	3.1%	0.060	0.210	-250.0%	1.400	0.260
8/27/12	0.290	0.260	10.3%	0.100	0.130	-30.0%	1.200	0.480
9/4/12 ***	0.360	0.390	-8.3%	0.110	0.190	-72.7%	0.870	0.840
9/10/12 ***	0.290	0.300	-3.4%	0.042	0.170	-595.2%	1.300	0.740
Average	0.386	0.338	12.4%	0.198	0.184	7.1%	1.024	0.732

* Site where permit limit applies (Limit 1.245 mg/L Fe)
** Soluble Reactive Phosphorus, as filtered dissolved Orthophosphate. Lab filtered.

Treatment System Effectiveness

Several studies have been completed through the years on the effectiveness of the $FeCl_3$ system, with the most recent being completed in 2010 (Appendix 2). This analysis was a comprehensive assessment of both the raw monitoring data and the conclusions of the previous studies. It was concluded that for the years the system was in operation and monitoring data are available (1999-2001 and 2006-2008) the system removed 35% of Total Phosphorus (TP). Due to the limitations of the parameters that have been monitored through the years, TP and Total Ortho Phosphorus (TOP), an accurate distinction of the $FeCl_3$'s effect on SRP removal could not be made apart from the potential physical settling occurring within the desiltation basin. This is a departure from the effectiveness conclusions stated in previous studies where reductions in TOP were inaccurately presented as a reduction in Dissolved Phosphorus. In response to this finding, the District began monitoring SRP in 2011. SRP is the most representative parameter of Dissolved Phosphorus, which is the nutrient most available for algae.

Due to a variety of reasons previously mentioned, only 4 of the 30 samples collected since 2011 were collected during a $FeCl_3$ dosing. However, from the small data set collected, the SRP reduction during $FeCl_3$ dosing appears great. When the system is not being dosed with $FeCl_3$, reductions are much less. In 2011, the average SRP reduction collected during dosing was 53.7%. The average SRP reduction of the samples when the system was not dosing was 5.4%. In 2012, with no dosing during the entire year, only an average SRP decrease of 7.1% occurred. See table 4 for summary of these results.

Table 4: Sample Results Summary

	2011 While Dosing	2011 No Dosing	2012 While Dosing	2012 No Dosing
% TP reduction	14.2%	0.88%	N/A	12.4%
% SRP reduction	53.7%	5.4%	N/A	7.1%
# samples collected	4	5	0	21

The results from samples collecting with no dosing are assumed to represent the removal efficiencies of the desiltation basin alone. From this limited dataset, the statistics show that the effectiveness of SRP removal in the desiltation basin alone is very low. The dosing of $FeCl_3$ in 2011 increased the effectiveness 10 times. Many more samples will need to be taken to complete a more accurate analysis of the system. Once the system redesign is complete in early 2013, the system is expected to be running and dosing again, and the District anticipates collecting samples on a regular basis.

In addition, the 2010 analysis identified several factors that lead to reduced effectiveness stemming from the current system design. The first being that when incoming TP concentrations are below the threshold of 0.075 mg/L the operation of the $FeCl_3$ system provides little benefit as indicated by the monitoring data. The data also show that early year runoff events typically have better water quality while in wetter years, where runoff is sustained through the summer months, incoming TP typically increases in concentration. Secondly, it has been shown that for the limited data set of flows greater than 70cfs there is an export of phosphorus from the system. This is likely caused by flushing of the desiltation basin. Thirdly, reductions in effectiveness are likely caused by the presence of rough fish in the desiltation basin which cause resuspension of both the floc material and sediment.

This information regarding causes of reduced efficiency of the system has be taken into consideration when determining the timing of system dosing, selecting monitoring parameters, as well as system design modifications that will help prevent reductions in efficiency and provide a greater accuracy in estimating both total and dissolved phosphorus removal rates. Specifically, this information was essential in changing the monitoring parameters in 2011 to reflect Dissolved Phosphorus efficiencies by beginning to monitor SRP. Additionally, during 2011 several possible $FeCl_3$ system redesign options were drafted, in conjunction with NPDES permit renewal, and recommended changes to increase operational efficiency of the desiltation basin were incorporated. One of the redesign options were chosen in 2012, and will be constructed in 2013; the selected design option includes a high-flow bypass of the desiltation basin, which should dramatically reduce the problem of scouring and resuspension under high flow conditions; see Appendix 3.

Residual Solids Management Report

Investigations of the available volume in the downstream desiltation basin have occurred in 2005, 2006 and 2010. According to the 2010 assessment, the pond bottom elevation was approximately 906.5 ft and an approximate 12,000 cubic yards of accumulated sediment and floc material needed to be removed from the basin in order to return it to the designed depth of 902.5 ft. Given the observed sedimentation rates and the known decrease in removal efficiency as storage volume is reduced, during 2011 the District undertook steps to obtain necessary permits and develop plans for desiltation basin maintenance and excavation. The project was completed during frozen conditions in early 2012. Residual solids removal and disposal occurred in accordance with Chapter 4 requirements of the 2004 NPDES permit.

Anticipated 2013 Operations

The original NPDES permit for the $FeCl_3$ system, MN0067377, expired in August 2009. A permit renewal application was submitted to the MPCA on January 15, 2009. The District received permission from the MPCA to temporarily operate the facility from 2010 - 2012 under the conditions of the expired permit. The MPCA did not approve another extension to the permit in 2013.

MPCA staff notified the District in 2011 that the current design of the $FeCl_3$ system does not meet the requirements of the MPCA's policies and guidance. A design was approved in 2012 that would appeal to the MPCA by avoiding discharge of the FeCl solution into the stream, which is a class 2 water. Instead, the new design will include a pipe bored horizontally to the desiltation pond located downstream of the $FeCl_3$ facility. Since the desiltation pond is considered a stormwater pond and not a natural waterbody, the $FeCl_3$ solution may be discharged into the pond for treatment. This design is anticipated to be completed in Spring of 2013. Normal operations should proceed following completion of design.

Appendix 1: $FeCl_3$ System and Sampling Site Location

Figure 1: $FeCl_3$ System Location within PLSLWD

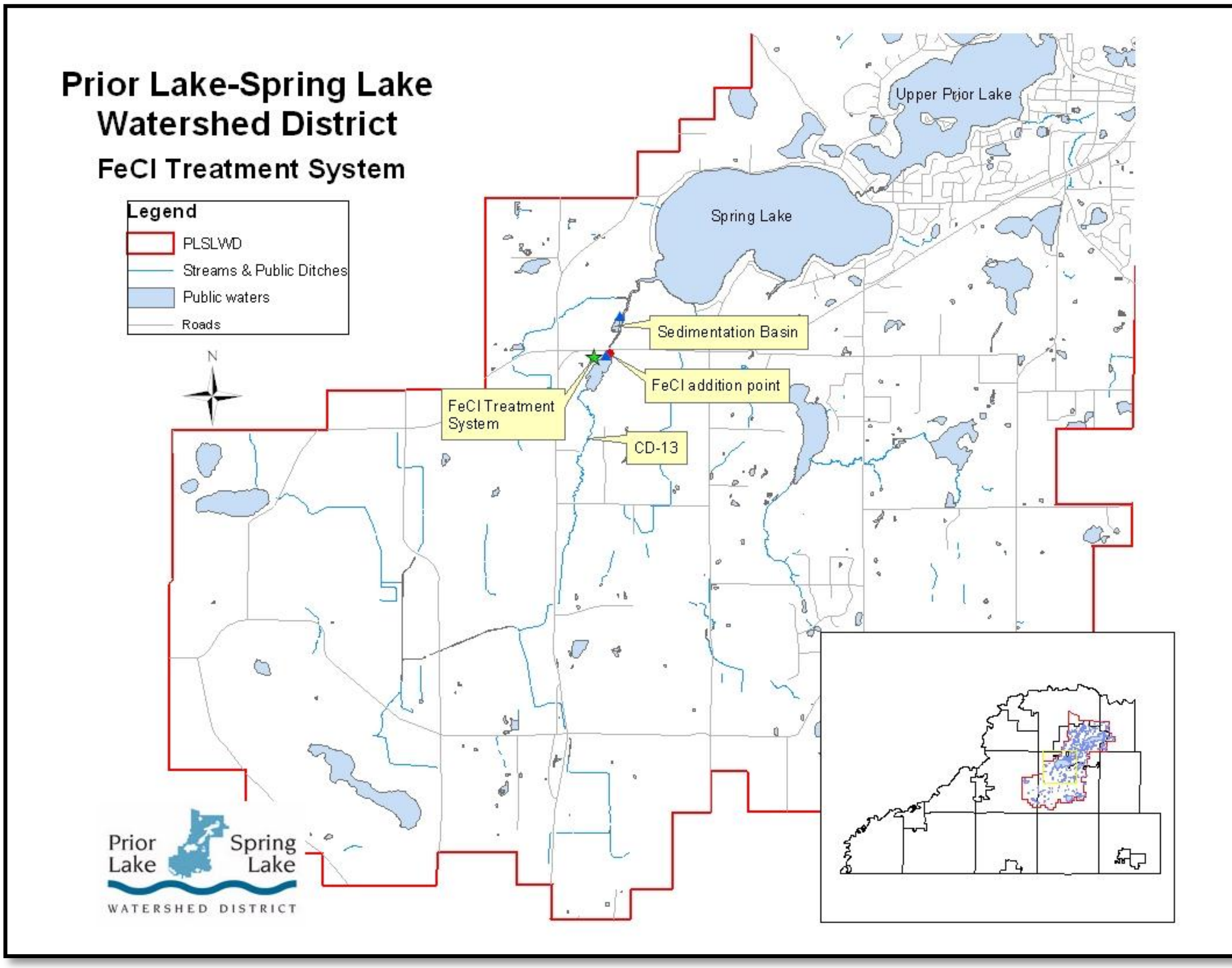

Figure 2: $FeCl_3$ Sampling Site Locations

PLSLWD Site Name	Permit Site Name	STORET ID	Location Information
CD-1		S003-268	CD-13 at CSAH 13, 0.8mi North of Lydia, MN
CD-2 or Upstream	SW001	S003-269	CD-13 at CSAH 13, outlet TMT WL 2.5 mi North of Lydia, MN
	SD001		Flow monitoring immediately downstream of SW001
CD-2a		S004-549	CD-13 to Spring Lake, 100ft North of site S003-269
CD-3 or Downstream	SW002	S002-896	Unnamed stream in Sec 8, SE of Spring Lake

Appendix 2: October 7, 2010 $FeCl_3$ System Evaluation

Prepared by:
Emmons & Olivier Resources, Inc.
for the Prior Lake-Spring Lake Watershed District

Ferric Chloride Treatment System Evaluation

October 7, 2010

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References

Clark, J.W., W. Viessman, Jr., and M.J. Hammer. 1971. Water Supply and Pollution Control. International Textbook Company.

The Spring Lake Desiltation Pond (Desilt Pond) was originally constructed in 1978 and dredged in the fall of 1999. The Ferric Chloride Injection System ($FeCl_3$ System) was constructed in 1998 at the outlet of the Highway 13 Wetland Treatment system located upstream of the Desilt Pond. The $FeCl_3$ System in conjunction with the Desilt Pond are designed to reduce the phosphorus loading to Spring Lake.

The Minnesota Pollution Control Agency (MPCA) has indicated that they may not reissue the permit for the $FeCl_3$ System based on concerns regarding removal effectiveness and Desilt Pond design. MPCA's concerns include:

1. Removal efficiencies are uncertain, considering that use of $FeCl_3$ for stormwater treatment is uncommon and that in usual wastewater circumstances many facilities they have seen do not achieve outflow concentrations below 0.1 mg/L total phosphorus (TP) due to the chemistry and physical processes involved. MPCA observed that the inflow concentration is often lower than 0.1 mg/L TP; therefore using $FeCl_3$ alone at those low concentrations could be ineffective.
2. The Desilt Pond does not have a high flow bypass.
3. The Desilt Pond is a Class 2 Water and its use as an effluent treatment system does not fit with state rules.

In light of the MPCA concerns and overall cost-benefit questions raised by the District, the Board ordered this study to assess the water quality benefit and cost-effectiveness of the system based on past monitoring data and the current state of the system.

Can the system efficiently remove phosphorus from the County Ditch 13 drainage system?

For the years when the system was in operation and being monitored (1999-2001 and 2006-2008) the system removed an estimated 1,462 kg (3223 lbs) of phosphorus or 35% of TP from the County Ditch 13 system. Dissolved phosphorus was not monitored; therefore a clear distinction between the Desilt Pond settling removal vs. $FeCl_3$ injection floc removal of dissolved phosphorus can not be made. Based on the monitoring data it does appear that the treatment system as a whole has the potential to remove significant amounts of phosphorus from the County Ditch 13 drainage system; however the system does have a few limitations that limit the overall effectiveness.

Monitoring data does confirm MPCA's statement that when incoming phosphorus concentrations are below a certain threshold (0.075 mg/L TP) the injection of $FeCl_3$ provides little to no benefit. However, the conclusion that water quality is typically below this threshold is not supported by the data. In the recent years where the sampling showed minimal or negative removals the data only included a few data points from early year runoff events that typically have better water quality; there was no flow in the system in the remainder of these years. In wetter years, the incoming phosphorus concentration typically increases to over 0.350 mg/L, a concentration at which the system provides significant phosphorus removal.

While the data set is limited, the monitoring data for rainfall events resulting in flows greater than 70 cfs show an export of phosphorus from the system. This observation supports the MPCA's recommendation to incorporate a high flow bypass to prevent flushing of sediment and floc from the Desilt Pond.

Another limitation to consider is the likelihood of rough fish migration from Spring Lake to the Desilt Pond resulting in resuspension of floc and reduced effectiveness of the system.

Given the current state of the system what is the associated cost to maintain and continue operating the system?

The Desilt Pond has collected sediment and floc over the years and is in need of cleanout. A detailed survey was conducted and approximately 12,000 CY of material needs to be removed to return the basin to its designed depth. Design enhancements are recommended if continued operation of the $FeCl_3$ System is planned. These include a high-flow bypass and potentially a fish barrier to prevent migration of rough fish from Spring Lake to the Desilt Pond.

Potential capital improvement construction costs are estimated at $109,000 for Desilt Pond cleanout and $35,000 for incorporation of the high flow bypass. Ongoing annual maintenance costs are estimated at $8,000 per year. Total costs for construction, engineering, maintenance, and operations for a 20-year period are estimated to be approximately $475,000. The estimated cost per pound of phosphorus removed is estimated to be $44±/lb P removed.

INTRODUCTION

This report is divided into two main sections: 1) Water Quality Evaluation of the Ferric Chloride Injection System (FeCl3 System) and the Spring Lake Desiltation Pond (Desilt Pond) collectively referred to as the Treatment System, and 2) Desilt Pond Maintenance and Design Improvements. The focus of the Water Quality Evaluation section is to assess all of the available monitoring data in an attempt to quantify the phosphorus removal efficiency of the Treatment System. The focus of the Maintenance and Design Improvements sections is to look at potential future modifications and maintenance costs of the Desilt Pond and to ultimately evaluate the cost/benefit of the System.

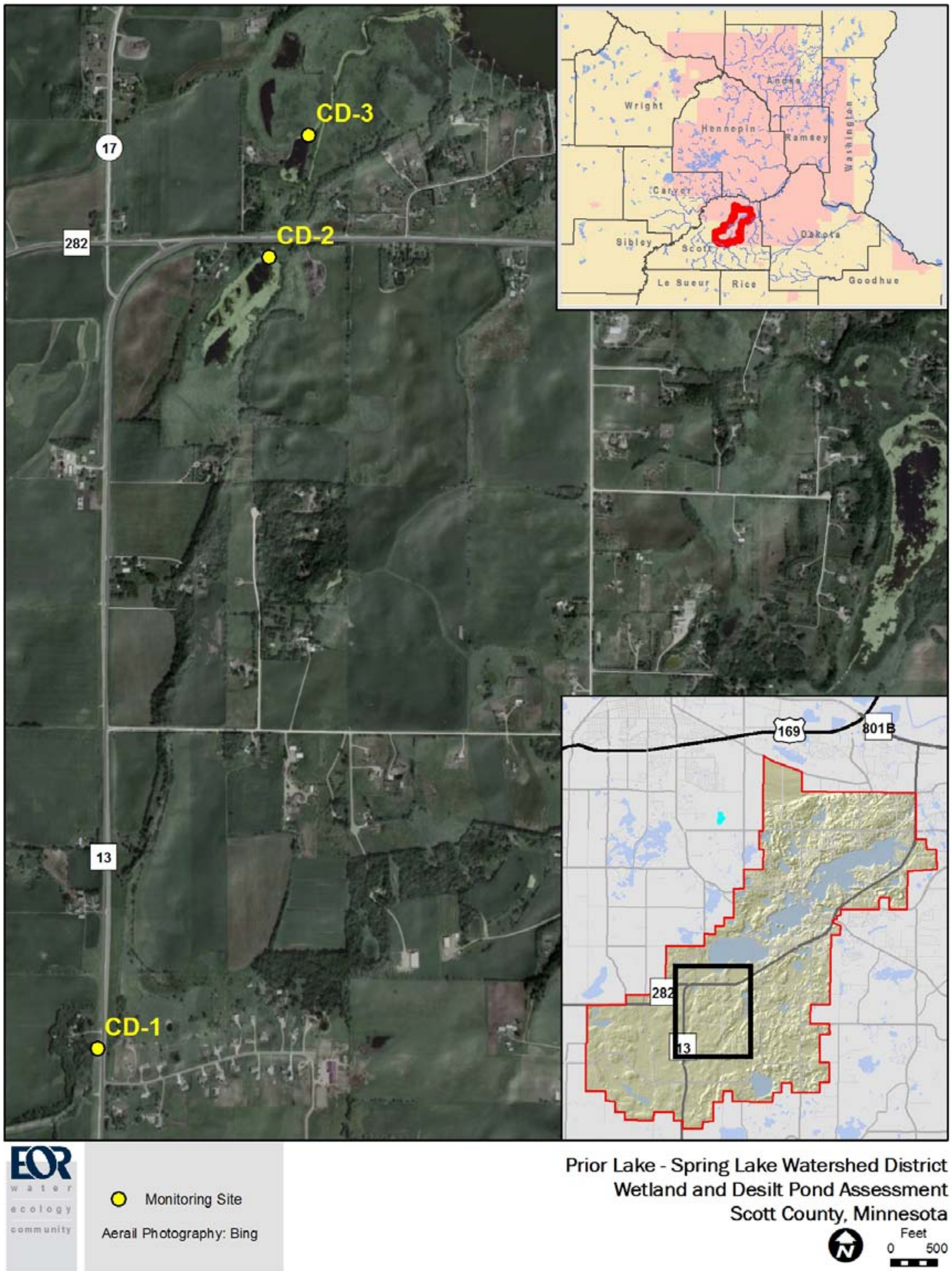
The overall purpose of this report is to give the District a comprehensive understanding of the Treatment System such that the District can make informed decisions as to the continued operations, expenditures, and benefits of the System.

The $FeCl_3$ System and the Desilt Pond (Treatment System) were evaluated to address MPCA's concern about its effectiveness. In their review of the request to reissue the permit, MPCA commented that they were unsure of the removal efficiencies considering that use of $FeCl_3$ for stormwater treatment is uncommon, and that in usual wastewater circumstances, many facilities they have seen do not achieve outflow concentrations below 0.1 mg/L TP due to the chemistry and physical processes involved. MPCA observed that the inflow concentration is often lower than 0.1 mg/L TP; therefore using $FeCl_3$ alone at those low concentrations could be ineffective. The MPCA also commented that because there was no high flow bypass the Desilt Pond effectiveness is also limited. Monitoring data were evaluated to investigate these two MPCA concerns and at the same time assess the overall effectiveness of the Treatment System.

The last maintenance on the Desilt Pond occurred in 1999, when the basin was excavated to a bottom elevation of 902.5 feet. The Highway 13 Wetland is located upstream of the $FeCl_3$ System. While the wetland is not the focus of this analysis, its treatment efficiency is referenced in past studies and is included in this discussion.

Monitoring data were collected upstream of the wetland at site CD-1, which is along County Ditch-13 at CSAH 13; at site CD-2 upstream of the weir and upstream of the ferric chloride injection point; and at site CD-3, at the outlet of the Desilt Pond (Figure 1). There were times when the injection system was not functioning; these dates were noted and the monitoring data were analyzed separately. Two fractions of phosphorus were measured: 1) total phosphorus (TP), which contains all of the phosphorus in the sample (inorganic and organic, particulate and dissolved), and 2) total ortho-phosphate (T-ortho-P), which contains inorganic phosphorus in both the dissolved and particulate form (inorganic phosphorus can be sorbed to particulate matter). Dissolved phosphorus was not measured. Data were collected from 1999 through 2009, with the exception of 2003.

Figure 1. Monitoring site locations



Conclusions from previous studies of treatment system performance

Previous studies have evaluated the performance of the treatment system. The following is a summary of phosphorus removal efficiencies reported in past memoranda and reports.

Watershed Restoration Action Strategy for the Second Implementation Phase of the Prior Lake Spring Lake Improvement Project, 2000 monitoring results

- The entire treatment system (including the wetland, the ferric chloride system, and the Desilt Pond) provided 40% reductions in dissolved phosphorus* and 47% reductions in TP during snowmelt monitoring.
- During the rest of the year, the system provided 40% reductions in dissolved phosphorus* and 11% reductions in total phosphorus. Most of the pollutant reductions occurred between the wetland outlet and the Desilt Pond outlet.

Memorandum dated December 6, 2001 from Paul Nelson to the Board of Managers, regarding County Ditch 13 Treatment Performance

- 34% reduction in ortho-phosphate, 5% reduction of TP during 1999 in the ferric chloride and Desilt Pond; based on estimated loads
- 32% reduction in ortho-phosphate, 25% reduction of TP during 2000 in the ferric chloride and Desilt Pond; based on estimated flow weighted average concentration, not including snow melt data
- 18% reduction in ortho-phosphate, 9% *increase* in TP during 2001 in the ferric chloride and Desilt Pond; based on estimated flow-weighted average concentration, not including snow melt data
- High flows led to resuspension of sediment and particulate phosphorus in the system.

Memorandum dated March 18, 2003 from Greg Wilson to Paul Nelson, regarding Final Technical Memorandum #1--County Ditch 13 Wetland and Ferric Chloride System Sediment and Phosphorus Removal Performance Assessment (attached to this memo)

- FLUX model used to estimate the flow-weighted mean concentrations and loadings at each sampling site for total phosphorus and dissolved phosphorus, 1999-2002 data.
- 31% reduction in dissolved phosphorus*, 18% reduction in TP in 1999-2002 in the ferric chloride and Desilt Pond; based on estimated loads
- The percentage of the phosphorus that is in the dissolved fraction decreases from CD-1 (70% dissolved*) to CD-2 (65% dissolved*) to CD-1 (55% dissolved*).

Database

Data were downloaded from the MPCA's Environmental Data Access (EDA) website and checked against data sent to EOR by Watershed District staff. Data that were not in EDA but were provided by the Watershed District were added to the database.

* Reported "dissolved" phosphorus is actually total ortho-phosphate, which includes both dissolved and particulate inorganic phosphorus.

Performance of ferric chloride treatment system and settling pond at varying incoming phosphorus concentrations

The monitoring data were grouped according to the incoming phosphorus concentration (at site CD-2), and the removal efficiencies were examined in these groups. Data taken when the $FeCl_3$ System was not functioning were removed for this analysis. Records of when the system was functioning are available for monitoring years 2005 through 2010; therefore this analysis only includes data from those years. The two groups were compared using paired (dependent samples) T-tests; samples were paired based on sampling date. Means are considered to be significantly different from one another when the *p*-value is less than 0.05. When the means are different from one another, and when the CD-3 mean is lower than the CD-2 mean, it suggests that the treatment system is working in that the phosphorus concentration coming out of the system is less than the phosphorus concentration that enters the system.

The following are conclusions from this analysis:

- The Treatment System ($FeCl_3$ System plus Desilt Pond) is effective at removing TP at incoming TP concentrations down to 0.075 mg/L; the mean percent removal of these events ranged from 32 to 53% (Table 1).
- The Treatment System ($FeCl_3$ System plus Desilt Pond) is effective at removing total ortho-phosphorus (T-ortho-P) at incoming concentrations down to approximately 0.050 mg/L; the mean percent removal of these events ranged from 57 to 81% (Table 2).

Table 1. Comparisons of mean total phosphorus concentrations at CD-2 and CD-3, 2005-2009

Incoming (CD-2) TP Concentration	CD-2 TP		CD-3 TP		N	*p*-value	Percent Reduction	
	Mean	Std Dev	Mean	Std Dev			Mean	Median
> 0.200 mg/L	0.413	0.105	0.202	0.137	7	< 0.05	53%	65%
0.100 - 0.200 mg/L	0.131	0.020	0.089	0.038	9	< 0.05	32%	33%
0.075 - 0.100 mg/L	0.085	0.010	0.056	0.015	6	< 0.05	34%	39%
0.050 - 0.075 mg/L	0.059	0.011	0.064	0.013	3	0.27	NA	NA

Table 2. Comparisons of mean total ortho-phosphorus concentrations at CD-2 and CD-3, 2005-2009

Incoming (CD-2) Total Ortho-P Concentration	CD-2 Total Ortho-P		CD-3 Total Ortho-P		N	*p*-value	Percent Reduction	
	Mean	Std Dev	Mean	Std Dev			Mean	Median
> 0.200 mg/L	0.336	0.054	0.063	0.010	5	< 0.05	81%	82%
0.100 - 0.200 mg/L	0.120	0.000	0.092	0.040	2	0.50	NA	NA
0.050 - 0.100 mg/L	0.066	0.015	0.026	0.016	7	< 0.05	57%	64%
< 0.050 mg/L	0.017	0.012	0.011	0.009	9	0.19	NA	NA

Removal efficiency of Desilt Pond

Removal efficiencies were examined during times when the $FeCl_3$ System was not functioning; these data represent the removal efficiencies of just the Desilt Pond.

- The Desilt Pond was effective at removing TP at incoming TP concentrations over 0.5 mg/L; the mean percent removal of the events was 74%. Below 0.5 mg/L TP, the sample size was small and the difference in means was not significant.
- The Desilt Pond was effective at removing T-ortho-P at incoming concentrations over 0.2 mg/L; the mean percent removal of the events was 79%. Below 0.2 mg/L T-ortho-P, the sample size was small and the difference in means was not significant.

The percent reductions in phosphorus at times when the $FeCl_3$ System was dosing versus when it was not dosing are very similar to one another. It is unclear via what means the phosphorus is being removed when the $FeCl_3$ System is not in operation, but it is highly unlikely that that this could be attributed to settling alone. The Desilt Pond is at least an order of magnitude undersized when compared to NURP sizing requirements, and TP removal from NURP ponds (if properly designed and maintained) is on the order of 50-60% TP removal. Excess floc is formed during typical operations using ferric chloride; therefore, one potential hypothesis is that potential bonding locations associated with this excess floc remains available in the Desilt Pond for phosphorus to attach even if ferric chloride dosing was not occurring for short periods of time.

Table 3. Comparisons of mean total phosphorus concentrations when the ferric chloride system was not dosing

Incoming (CD-2) TP Concentration	CD-2 TP		CD-3 TP		N	*p*-value	% Reduction	
	Mean	Std Dev	Mean	Std Dev			Mean	Median
> 0.500 mg/L	0.978	0.316	0.244	0.111	5	< 0.05	74%	77%
0.100 - 0.500 mg/L	0.347	0.179	0.180	0.069	3	0.21	37%	42%

Table 4. Comparisons of mean total ortho-phosphorus concentrations when the ferric chloride system was not dosing

Incoming (CD-2) Total Ortho-P Concentration	CD-2 Total Ortho-P		CD-3 Total Ortho-P		N	*p*-value	% Reduction	
	Mean	Std Dev	Mean	Std Dev			mean	median
0.200 - 0.500 mg/L	0.396	0.101	0.075	0.029	5	< 0.05	79%	85%
< 0.200 mg/L	0.053	0.067	0.043	0.058	3	0.21	32%	16%

Treatment efficiency relative to flow

Treatment efficiencies are highly variable at low to medium flows and are generally low at high flows (Figure 2). Although there are very few data points (simply due to the infrequency of those events), the data show minimal phosphorus removal for large storm events, and, for the two largest runoff events, there was a net export of phosphorus from the treatment system.

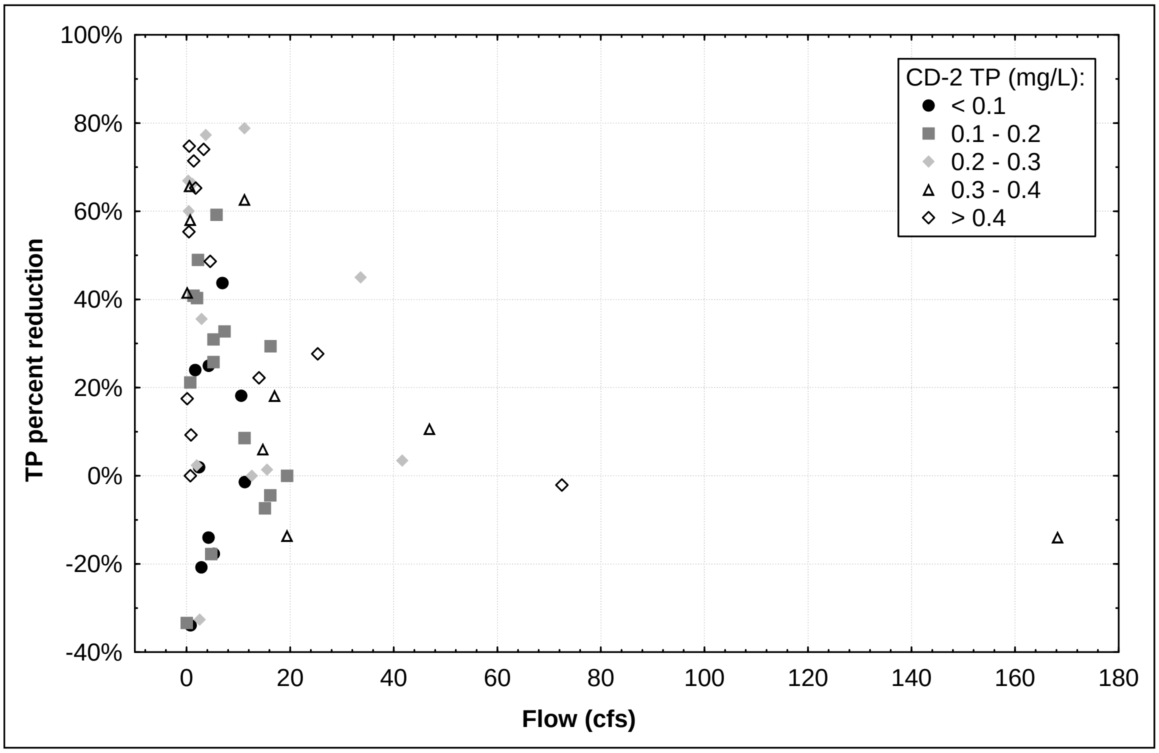


Figure 2. TP treatment efficiency relative to flow and incoming TP concentration

Trends over time

MPCA commented that background conditions in the flow to the treatment system are frequently below 0.1 mg/L TP. This observation was likely based on TP annual means (Figure 3). However, the time of year in which the samples were taken varied from year to year. TP concentrations were generally lower in April and May, increased in June, July, and August, and decreased in September and October (Figure 4). Since there were no samples taken after May in 2008 and 2009, conclusions can not be drawn regarding trends over time if all data are lumped together by year. When data from only April and May are evaluated, there is not a clear decrease in phosphorus concentrations over time (Figure 5). While it appears likely that concentrations in April and May often fall below 0.1 mg/L TP, the concentrations are generally higher throughout the summer.

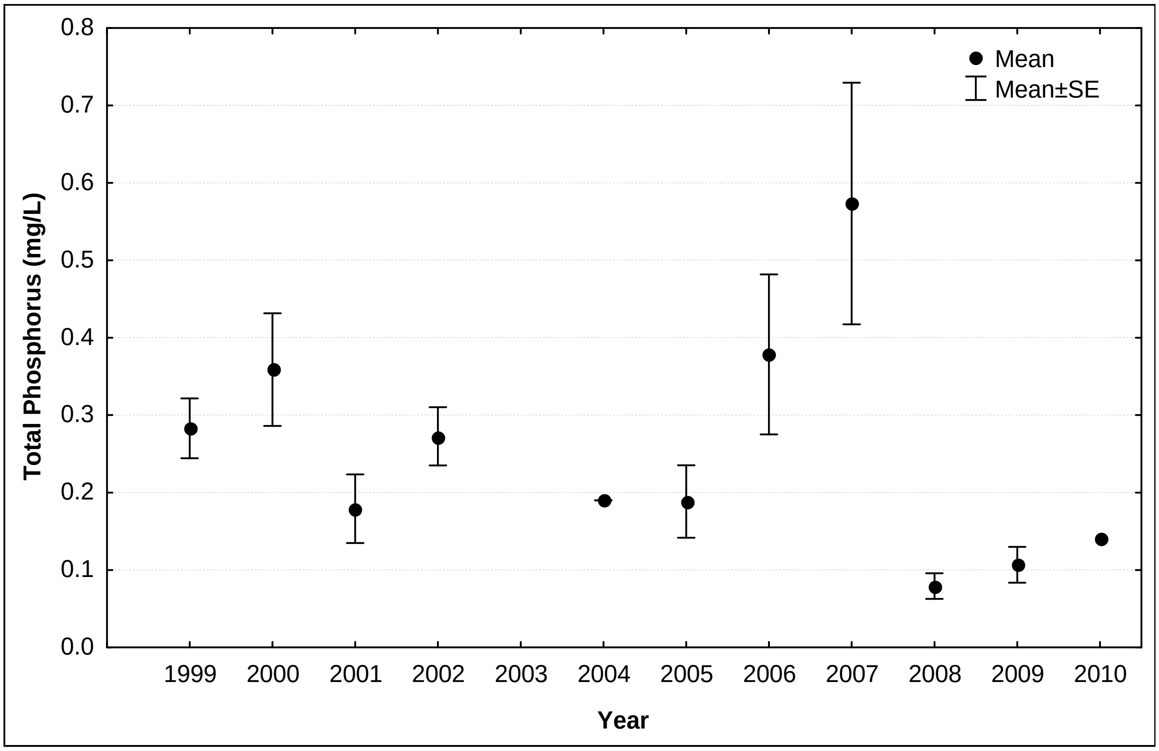


Figure 3. Total phosphorus annual means at CD-2

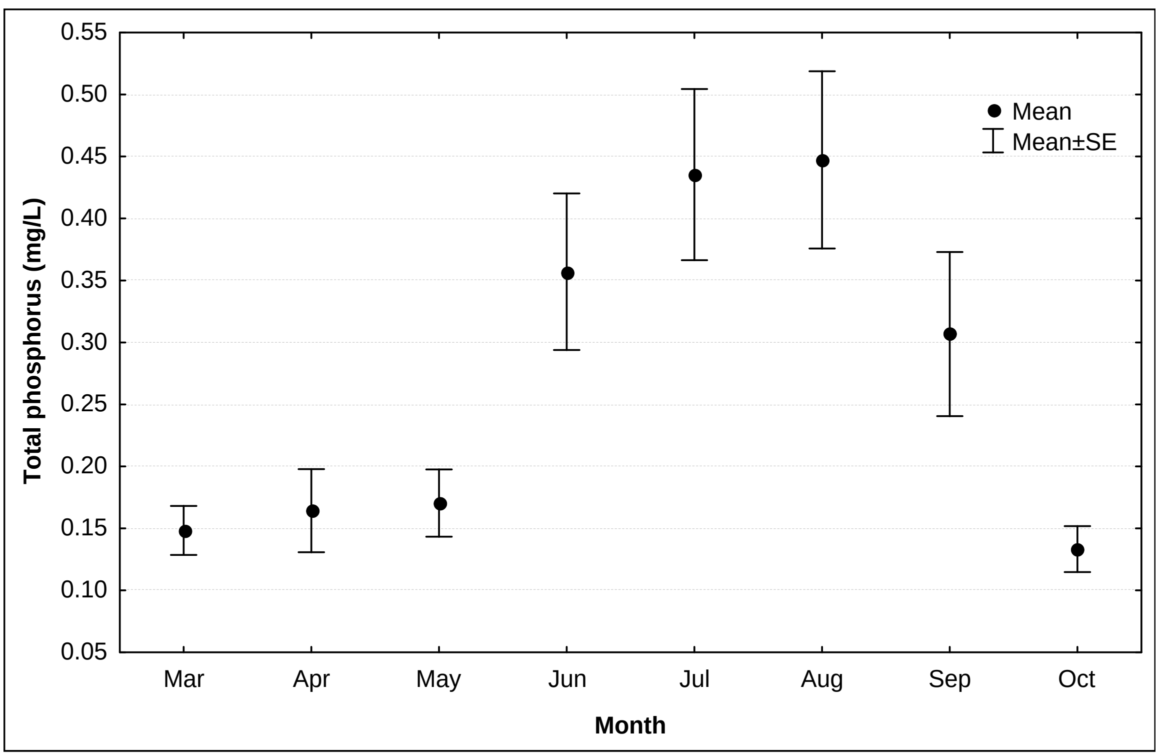


Figure 4. Total phosphorus concentrations at CD-2, averaged by month (all years of data)

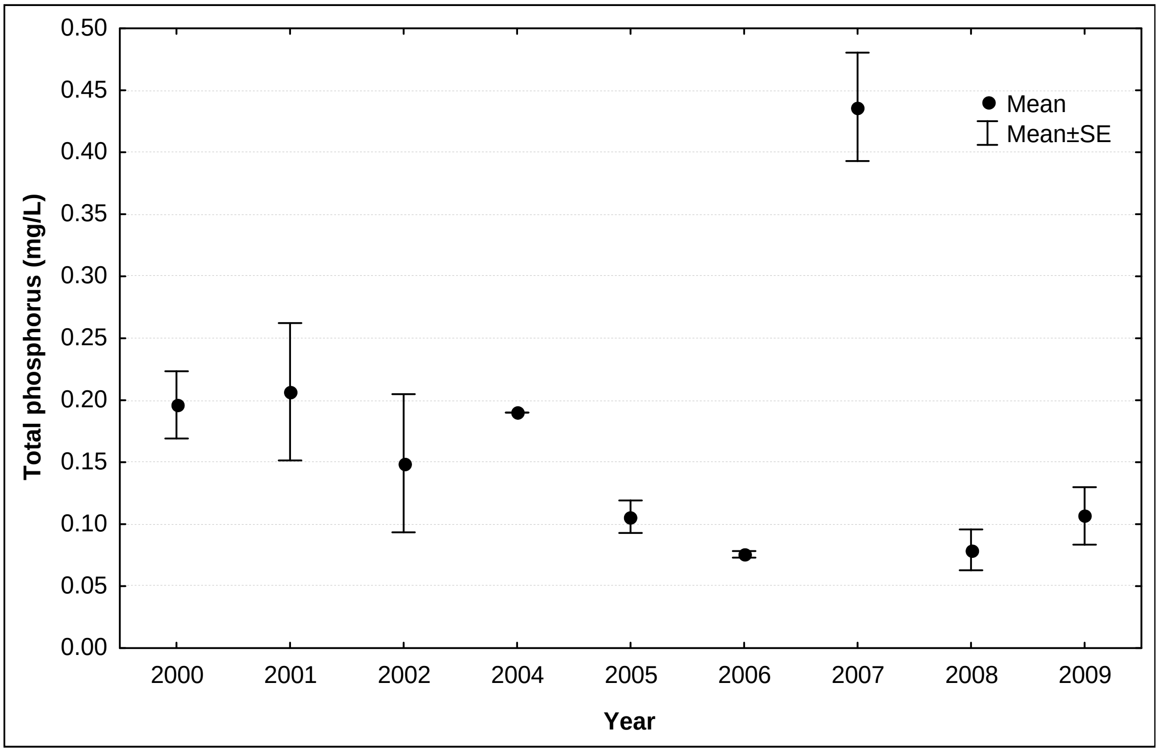


Figure 5. Total phosphorus concentrations at CD-2 during April and May

Removal efficiency of ferric chloride treatment system and Desilt Pond– load analysis

Annual loads are often determined by evaluating the relationship between flow and phosphorus concentrations during monitored events, and then applying this relationship to times when flow was gauged but phosphorus concentrations were not directly measured. In the data set from the Treatment System, there was no predictive relationship between flow and phosphorus concentrations and therefore concentrations during runoff events with no phosphorus data could not be modeled. Instead, the removal efficiency of the Treatment System was estimated using the flow and water quality monitoring data for only the years when the data were available. The annual mean monitored phosphorus concentration at each site was multiplied by the annual volume to arrive at an annual load. While a rough approximation, this is the best approximation of loading given the data set available.

Total phosphorus load reductions between CD-2 and CD-3 varied from a slight increase in phosphorus in 2008 to a 73% removal in 2007 (Table 5). 2008 was unique in that there was little precipitation throughout the summer; the only monitoring data available are from April and May, when incoming phosphorus concentrations are generally low and phosphorus removal is difficult to achieve. Total ortho-phosphorus removal follows a similar pattern (Table 6). There are no clear changes in percent removal over time. However, this is difficult to evaluate considering that the years on record had different runoff patterns and are not fully comparable.

Table 5. Total phosphorus load reductions between monitoring sites

Year	Mean Monitored Concentration (mg/L)			Annual TP Load (kg)			TP Load Reduction Between Stations	
	CD-1	CD-2	CD-3	CD-1	CD-2	CD-3	CD-1 and CD-2	CD-2 and CD-3
1999	0.357	0.283	0.188	1,802	1,690	1,124	6%	33%
2000	0.429	0.399	0.313	360	336	264	7%	22%
2001	0.214	0.179	0.179	746	725	723	3%	0%
2006	0.315	0.378	0.178	318	391	183	-23%	53%
2007	*	0.573	0.155	*	855	231	*	73%
2008	0.081	0.079	0.087	104	105	115	-1%	-10%

*No data.

Table 6. Total ortho-phosphorus load reductions between monitoring sites

Year	Mean Monitored Concentration (mg/L)			Annual Ortho-P Load (kg)			Total ortho-P Load Reduction Between Stations	
	CD-1	CD-2	CD-3	CD-1	CD-2	CD-3	CD-1 and CD-2	CD-2 and CD-3
1999	0.194	0.144	0.064	981	861	383	12%	56%
2000	0.272	0.246	0.134	228	207	113	9%	45%
2001	0.149	0.117	0.087	520	475	351	9%	26%
2006	0.251	0.236	0.050	253	243	52	4%	79%
2007	*	0.326	0.058	*	486	87	*	82%
2008	0.038	0.016	0.019	48	21	25	56%	-17%

*No data.

Conclusions

- The Treatment System ($FeCl_3$ System plus Desilt Pond) is effective at removing TP at incoming TP concentrations down to 0.075 mg/L (Table 1).
- The percent reductions in phosphorus at times when the $FeCl_3$ System was dosing versus when it was not dosing are very similar to one another. It is unclear via what means the phosphorus is being removed when the $FeCl_3$ System is not in operation, but it is highly unlikely that that this could be attributed to settling alone.
- The data do not support a previous observation that the phosphorus concentration entering the treatment system has been declining over time.
- Neither of the phosphorus parameters measured, total phosphorus or total ortho-phosphate, provide an estimate of just dissolved phosphorus. The efficiency of the system to remove dissolved phosphorus can therefore not be evaluated with the existing monitoring data.
- Monitoring during the two largest storm events shows a net export of phosphorus.

Our interpretation of the monitoring data differs from previous interpretations, especially concerning the evaluation of the total ortho-phosphate data. In previous evaluations, the total ortho-phosphate data were used to evaluate the efficiency of the

$FeCl_3$ System in treating dissolved phosphorus. However, since total ortho-phosphate data refers to a whole water sample (not filtered), it represents the dissolved inorganic fraction plus a portion of the inorganic phosphorus in a particulate form (the inorganic phosphorus that is part of the total ortho-phosphate is not well defined; it likely constitutes phosphorus loosely bound to sediment and phosphorus that is bound to iron hydroxides in floc). The Treatment System does however provide significant annual TP removals and it is unlikely that the Desilt Pond alone is capable of removing TP at the levels monitored.

Recommendations

The data do not provide a clear understanding of treatment efficiency of the $FeCl_3$ System alone due to a lack of data on the dissolved fraction of phosphorus and low sample sizes. If operation of the $FeCl_3$ System is to continue, a monitoring program should be developed to determine the effectiveness of the $FeCl_3$ System to remove dissolved phosphorus.

At a minimum, any future monitoring should include the following:

- Sampling at CD-2 and CD-3 when the $FeCl_3$ System is on and when it is off; these samples should be distributed throughout the entire monitoring season.
- The following fractions of phosphorus should be measured: total phosphorus, total dissolved phosphorus (TDP), and soluble reactive phosphorus (SRP, a measure of dissolved ortho-phosphorus, which is dissolved inorganic phosphorus).

The Desilt Pond provides the settling location for the floc generated upstream at the $FeCl_3$ System. The floc and sediment have filled the Desilt Pond over time and it is in need of clean-out in order to maintain the dead storage and corresponding treatment efficiency of the pond. As discussed in the water quality evaluation, the pond experiences export of phosphorus during high flow events and a high flow bypass is recommended if operation of the $FeCl_3$ System is to continue.

Desilt Pond maintenance

The Desilt Pond was constructed in 1978 with a bottom elevation of 902.5 and an outlet elevation of 910.3. When surveyed in 1998 the bottom was 907.8. Maintenance by the District in 1999 returned the pond back to the original bottom elevation of 902.5. In 2005 the pond bottom elevation was 904.5 and based on the estimated rate of accumulation the pond bottom will reach 908.0± around the year 2012. Sediment and floc have continued to fill the pond and the average bottom elevation near the center of the pond is now approximately 906.5.

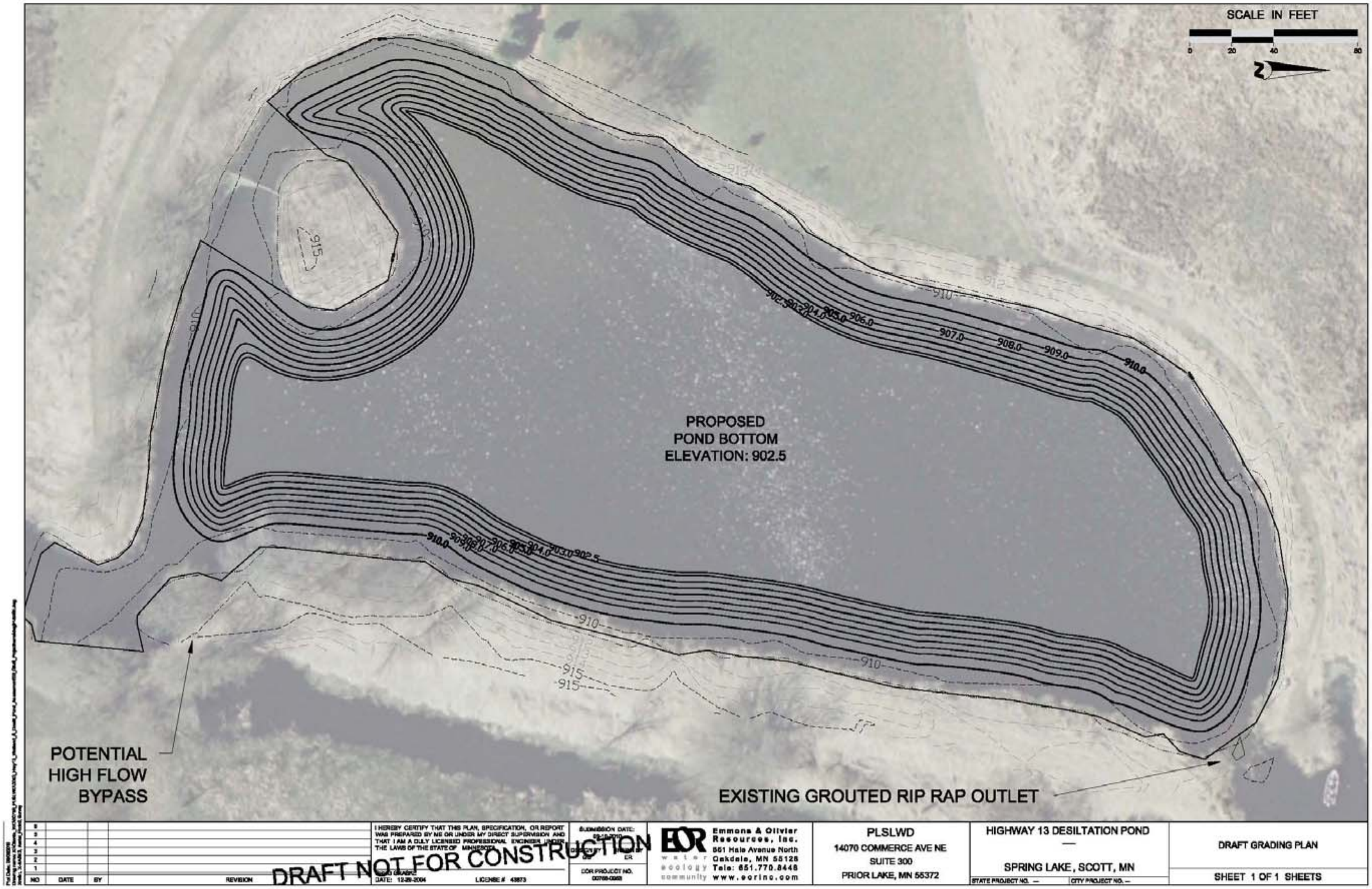
As storage volume is reduced the detention time for settling of floc and sediment is reduced and pollutant removal efficiency of the Desilt Pond decreases. The 2010 survey indicated that the pond has filled an additional 2± feet since the last survey, and maintenance excavation in the fall of 2011 was recommended if the District intends to continue operation of the Treatment System. Approximately 12,000 CY of material needs to be removed from the Desilt Pond to return it to the original bottom elevation of 902.5. A preliminary cost estimate for clean out is included in Table 7 and a draft grading plan is included in Figure 6.

Table 7. Preliminary cost estimate for Desilt Basin clean-out

Line No.	Base Bid Item	Units	Quantity	Unit Cost	Cost
1	Mobilization	Lump	1	5,000	$ 5,000
2	Common Excavation & Disposal*	CY	11,771	8	$ 94,168
3	Construction Fencing	LF	1000	1	$ 1,000
4	Access Restoration	Lump	1	3,000	$ 3,000
5	Rock Construction Entrance	Each	1	2,500	$ 2,500
6	Haul Route Signage and Maintenance	Lump	1	3,000	$ 3,000
	Total				**$108,668**

*Excavation and disposal cost could be highly variable depending on contaminant testing and if there is a local site were the material could be reused.

Figure 6. Draft Desilt Pond Grading Plan



High Flow Bypass

A high flow bypass for the Desilt Pond was recommended by the MPCA to prevent flushing of sediments and nutrients from the Desilt Pond under high flow rates. Based on monitoring and design criteria for flocculation, installation of a high flow bypass would reduce the potential for floc to be transported downstream to Spring Lake. Preliminary design for the bypass takes into account three main factors (discussed in further detail below):

1. Hydrology
2. Settling time (necessary for flocculation of $FeCl_3$)
3. Design hydraulics

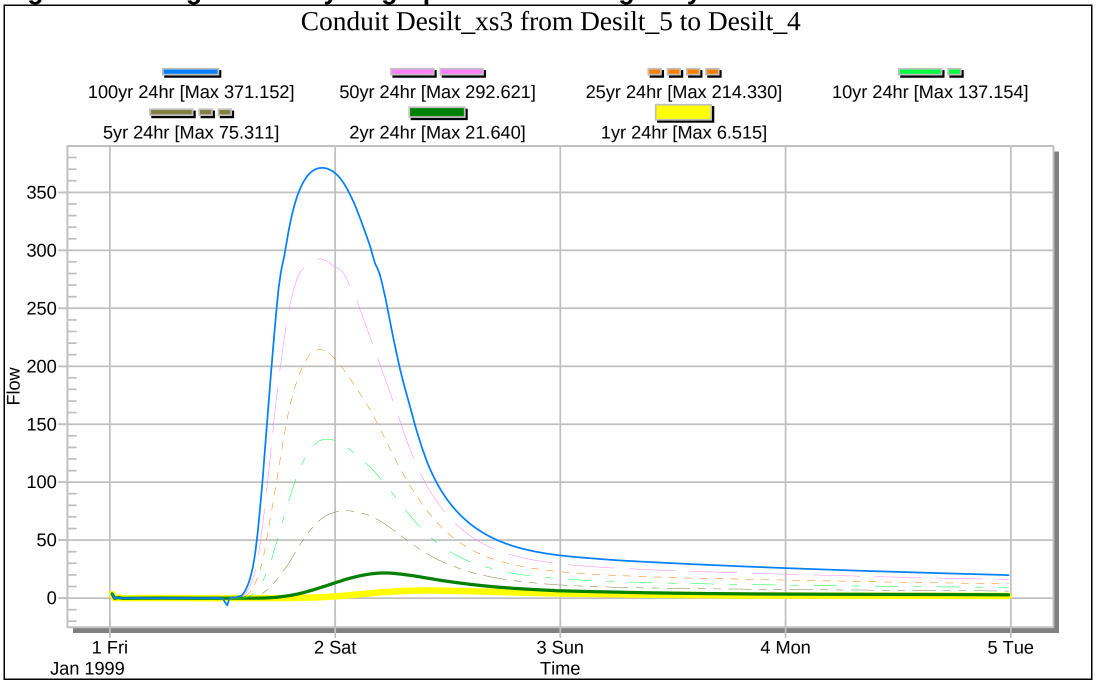
Hydrology

To evaluate different scenarios, the existing district-wide XP-SWMM model was used. This model was updated with survey data collected as part of this project near the $FeCl_3$ treatment system, and model detail was explicitly added to define:

- Storage in the Highway 13 wetland
- Storage in the Desilt Pond
- 4 natural cross sections between the Highway 13 weir and the Desilt Pond
- The Highway 13 culvert
- The Highway 13 wetland weir
- The proposed bypass channel

To verify the model's accuracy, the flow rates from design storms (Figure 7) were compared to large events at Jordan and Shakopee rainfall gauges and monitored flow. This approach was limited by the lack of nearby rainfall data but showed that, for smaller events, the model produces reasonable results. Several storms were run to assess potential flow rates and return frequencies. Figure 7 illustrates the modeled flow rates for the 1, 2, 5, 10, 25, 50 and 100 year storms.

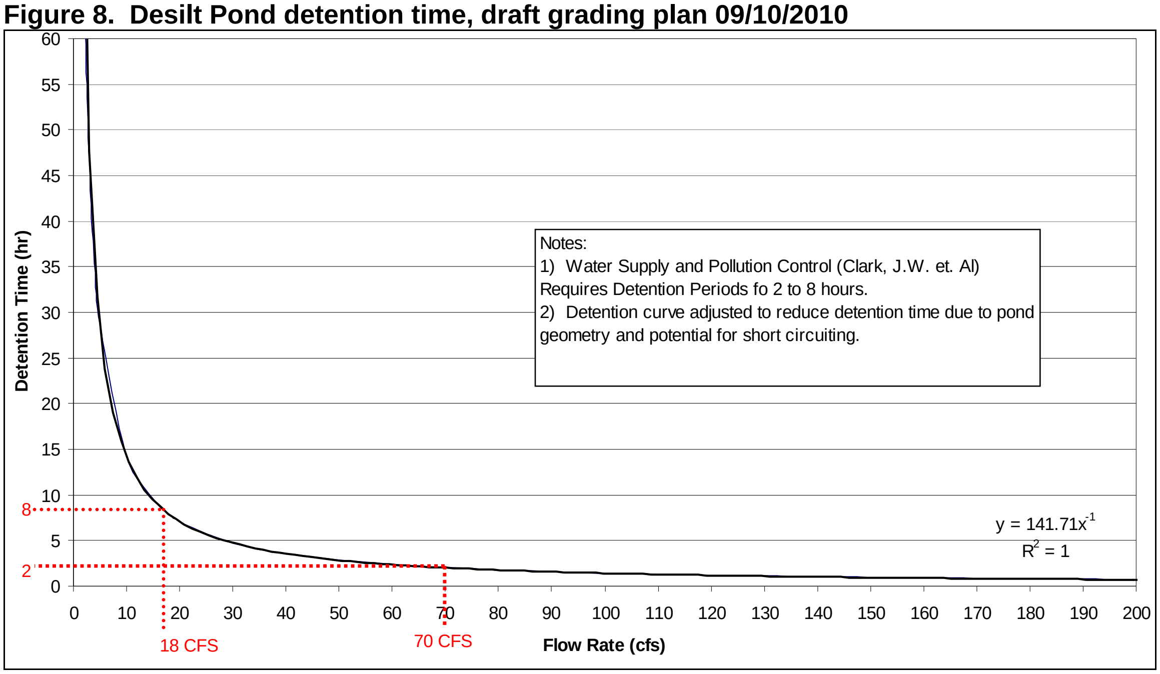
Figure 7. Design storm hydrographs between Highway 13 and the Desilt Pond



<u>Settling time</u>

The settling velocity for floc from chemical coagulation ranges from 2 to 6 ft/hr, and recommended minimum detention periods are generally between 2 and 8 hours (Clark et al. 1971). Figure 8 shows the Desilt Pond detention time versus flow rate based on the draft grading plan volumes and pond geometry. Based on this relationship, the maximum allowable flow rate through the Desilt Pond is 70 cfs to achieve 2 hours of detention time and 18 cfs to achieve 8 hours of detention time.

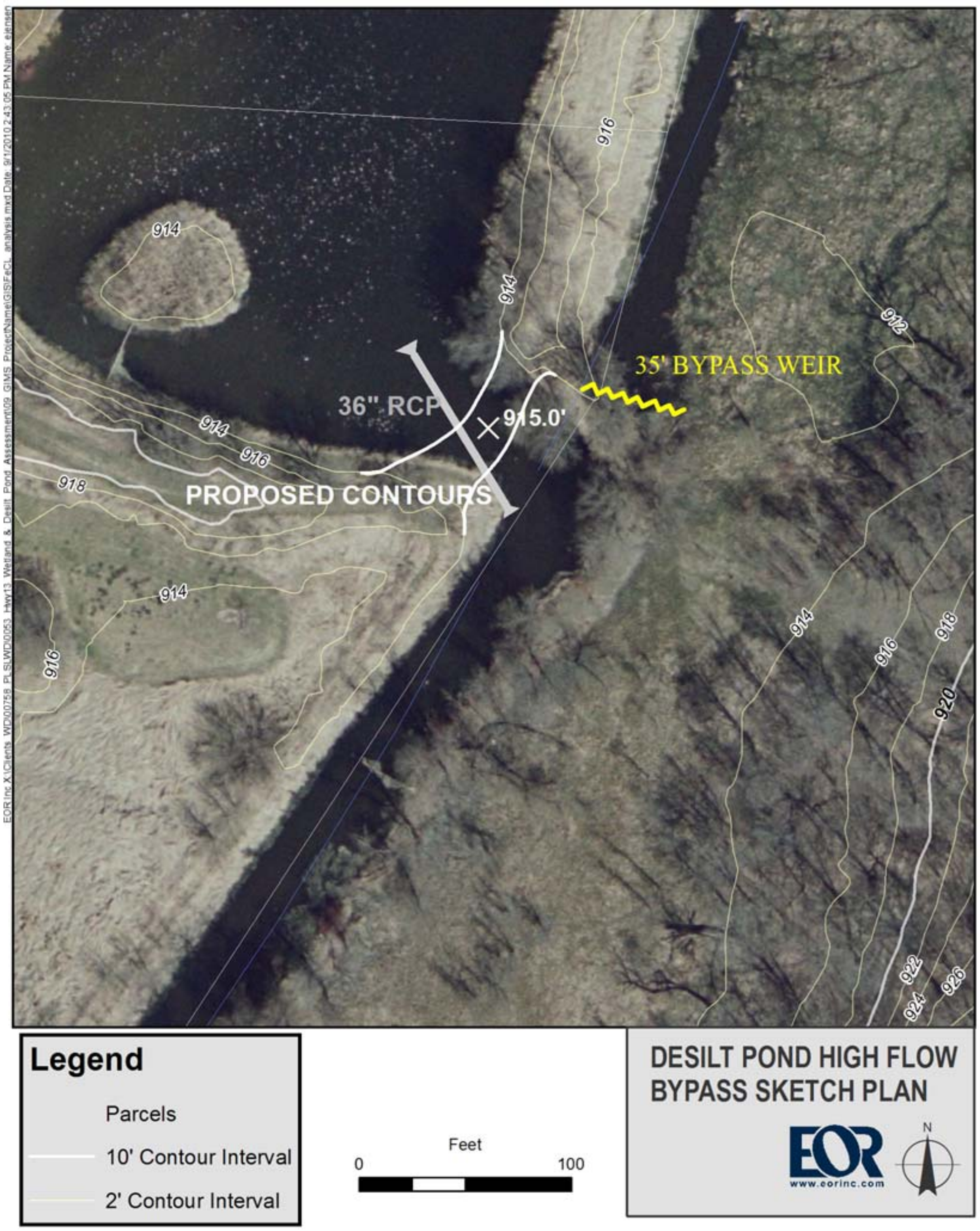
Figure 8. Desilt Pond detention time, draft grading plan 09/10/2010



Design hydraulics

Under the ideal design, a certain amount of flow would be directed to the Desilt Pond, after which any flows greater than the design would be diverted around the pond. Without complex adjustable valves and a very active operation it is not feasible to simply cut flow off at an exact flow rate; however, the design can be optimized to maximize treatment while minimizing resuspension of floc and sediments. Based on numerous modeling runs and testing various configurations a preliminary concept design was reached (Figure 9).

Figure 9. Proposed culvert and high-flow bypass configuration



The preliminary concept design includes:

- An earthen berm would be located at the existing inlet at the southeast corner of the Desilt Pond. An 80-foot long, 36-inch diameter reinforced concrete pipe (RCP) for conveyance of all flows up to approximately 30 cfs to the Desilt Pond. The pipe invert elevation would be set at 909.5± on the upstream side and the pipe slope would be 0.625%.
- A 35-ft wide weir would span the channel that runs east of the Desilt Pond and would serve as the Desilt Pond bypass. This weir would be set at 911.65, the elevation at which the 36-inch RCP passes approximately 30 cfs.

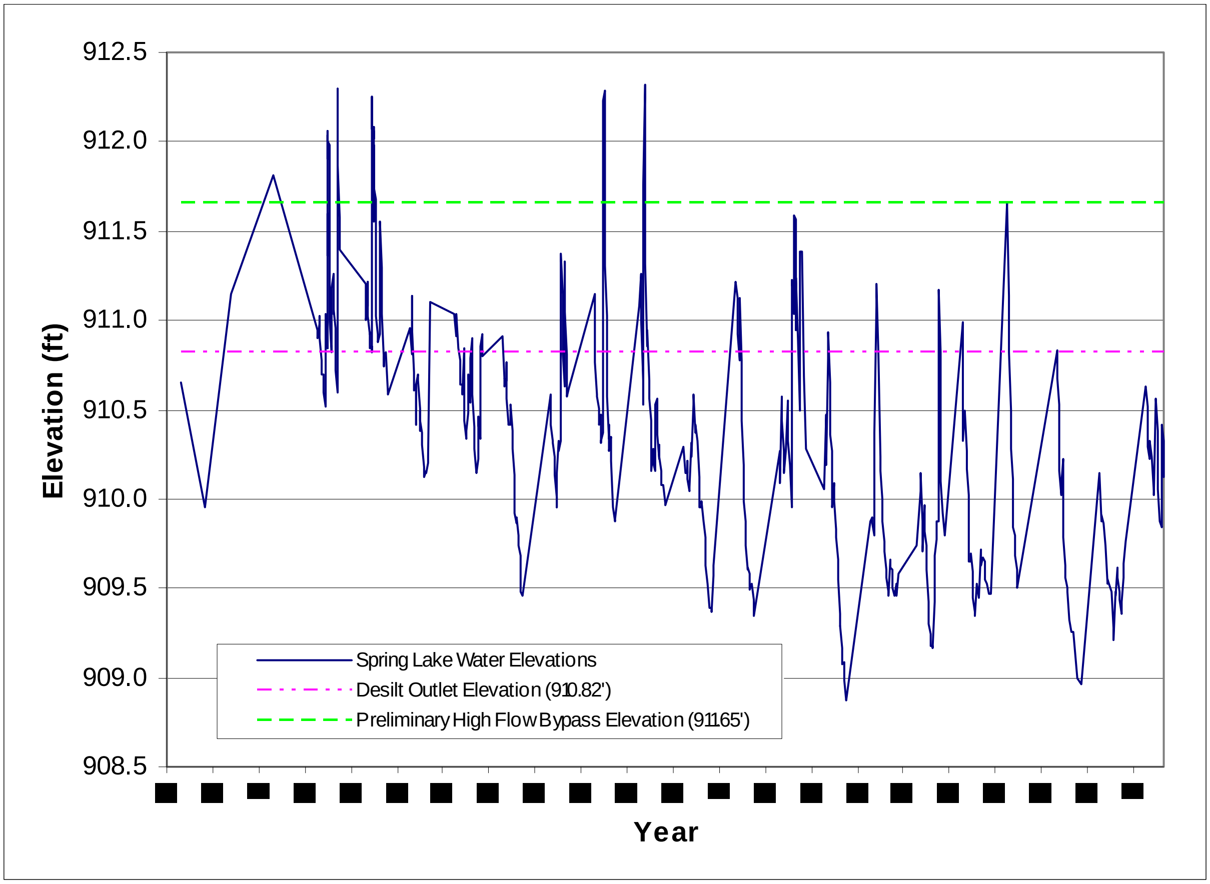
The 36-inch RCP would convey all flows to the Desilt Pondup to approximately 30 cfs, at which point the bypass weir would start to be used. Once the bypass is overtopped the flow would be split and for large storms the majority of additional flows would be diverted around the Desilt Pond via the weir (Table 8). A preliminary estimated cost to construct the high flow bypass system is $35,000.

Table 8. Pipe flow and weir flow corresponding to water elevations just upstream of the Desilt Basin, preliminary design configuration

Elevation (ft)	Pipe Flow (cfs)	Weir Flow (cfs)	Total Flow (cfs)	Notes
910.8	-	-	-	Desilt Pond outlet elevation is 910.82'
910.9	9	-	9	Peak 1-year storm is 7 CFS
911.4	24	-	24	Peak 2-year storm is 22 CFS
911.5	26	-	26	
911.6	31	-	31	
911.7	34	2	36	High-flow bypass weir is set to 911.65'
911.8	37	7	44	
911.9	41	13	54	
912.0	45	24	69	Peak 5-year storm is 75 CFS
912.4	59	75	134	Peak 10-year storm is 137 CFS
912.8	72	142	214	Peak 25-year storm is 214 CFS
913.1	81	200	281	Highway 13 weir elevation at 913.15'
913.2	83	221	304	Peak 50-year storm is 293 CFS
913.5	89	290	380	Peak 100-year storm is 371 CFS.
913.6	91	309	400	

Backwater conditions from Spring Lake occasionally impact the Desilt Pond under existing and proposed conditions (Figure 10). When high tail water conditions exist the high flow bypass may not fully function as intended (i.e. if the elevation of Spring Lake is higher than the bypass weir low flows would likely flow through the channel as opposed to being routed through the Desilt Pond). In cases where flow is using the bypass weir it would be recommended that the $FeCl_3$ System not be operated in order to prevent floc from being discharged downstream into Spring Lake.

Figure 10. Spring Lake historic elevations



Fish Barrier

The Highway 13 Wetland Treatment System has a fish barrier to prevent migration of fish upstream into the wetland; however the Desilt Pond, which is just downstream of the Highway 13 wetland, does not have a fish barrier. It is likely that rough fish migrate from Spring Lake to the Desilt Pond resulting in resuspension of floc and reducing the effectiveness of the system. A fish barrier limiting fish migration into the Desilt Pond could be considered as an additional enhancement.

Cost/Benefit

Continued operation of the $FeCl_3$ System represents a sizable expenditure for the District. In order to look at the cost/benefit of the system a simple assessment of forecasted expenditures over a 20-year period is itemized in Table 9.

Table 9. 20-year forecasted expenditures

Line No.	Description	Cost*	Frequency	20-year Cost*
1	Desilt Pond clean out**	$135,860	every 10± years	$271,720
2	High-flow bypass**	$43,750	1 time installation cost	$43,750
3	MPCA permit fees	$350	annually	$7,000
4	Misc. Repairs	$500	annually	$10,000
5	Monitoring	$3,500	annually	$70,000
6	Ferric chloride	$3,500	annually	$70,000
7	Electricity	$120	annually	$2,400
			Total	**$474,870**

*2010 dollars
**25% has been added to the construction costs to account for engineering design, permitting & construction observation expenses

Over the 6 years analyzed in the water quality assessment section of this report an average of 244 kg (538 lbs) of phosphorus was removed annually. The 20-year cost of $474,870 as summarized above represents an average annual cost of $23,744. Dividing the average annual cost by the average annual pounds of phosphorus removed results in a cost per pound of phosphorus removed of $44±/lb P removed.

It should be noted that this the cost per pound of phosphorus removed calculation assumes that system is in operation every year; however, historically the system has not been in operation every year due to lack of flows through the system during dry years.

Recommendations

If operation of the $FeCl_3$ System is to continue, the following actions are recommended:

- Desilt Pond Maintenance Excavation final design, permitting and construction
- High Flow Bypass final design and construction
- Consideration and assessment of fish barrier options at the outlet of the Desilt Pond

Appendix 3: Ferric Chloride Redesign

WATERSHED DISTRICT
PRIOR LAKE/SPRING LAKE, MINNESOTA

FERRIC CHLORIDE FEED SYSTEM

CONTRACT DRAWINGS
2013

BOLTON & MENK, INC.
CONSULTING ENGINEERS AND SURVEYORS
MANKATO, MINNESOTA

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA

SIGNATURE ______
TYPED OR PRINTED NAME TERESA J. BURGESS
DATE 1/2/2013 REG. NO. 25315

RECORD DRAWING INFORMATION	PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT	SHEET
OBSERVER:	FERRIC CHLORIDE FEED SYSTEM	1.1
CONTRACTOR:	TITLE SHEET	
DATE:		

CONSTRUCTION ACTIVITY NOTES:

EROSION PREVENTION PRACTICES:

Phased construction will be used to extent practical or as indicated in the plans to minimize exposed soils.

Areas not to be disturbed shall be delineated with flags, stakes, signs, silt fence, etc. prior to work beginning. The normal wetted perimeter of all ditches or swales, including storm water management pond slopes, that drain waters from the site must be stabilized within 200' of any property edge or discharge point, including storm sewer inlets, within 24 hours of connection.

Energy dissipation or other outlet treatment must be installed within 24 hours of connection.

All exposed soils must be stabilized as soon as possible but in no case later than 14 days after the construction activity has temporarily or permanently ceased.

Seed and/or sod, fertilizer, and mulch shall be placed as indicated in the plans and project specifications.

Rapid stabilization shall be of type and quantity indicated in the project specifications. Additional rapid stabilization may be necessary to minimize erosion throughout the duration of the project. Type and quantity shall be determined by the engineer or inspector prior to installation. In extreme cases, the contractor shall use any available rapid stabilization to immediately mitigate erosion, then further remedy the situation with approval by owner or engineer.

If the Contractor stockpiles material on site, he shall install the appropriate erosion control devices around the stockpile and perform the best management practices possible to avoid erosion from the stockpile.

Temporary (or permanent) sedimentation ponds are required for areas > 10 acres of disturbed soils draining to one point.

SEDIMENT CONTROL PRACTICES:

Installation of all down gradient sediment protection measures shall be completed prior to commencement of upstream land disturbing activities.

Bioroll shall be installed along constant contours with continuous lengths not to exceed 600 feet. As indicated on plans, silt fence will be periodically broken and hooked upslope in "J-hook" or "smile" patterns to provide ponding and slow runoff.

No unbroken slope lengths greater than 75 feet are permitted when slope is 3:1 or greater. Slope shall be broken with silt fence or biorolls as indicated on plans.

The timing and installation of sediment control practices may be adjusted to accommodate short term activities, but sediment control practices must be installed before the next precipitation event even if the activity is not complete

Install ditch checks (Biorolls) as shown in plan. Ditch checks to be installed after street is removed and left in place until final restoration is established.

Vehicle tracking to be minimized to all practical extents. All eroded material that leaves the construction zone shall be collected by the contractor and returned to the site at the contractor's expense.

All stock piles shall be surrounded by silt fence and seeded with temporary seed and mulch. See erosion and sediment control plans.

Sediment shall be removed from surface waters immediately upon discovery and in no case later than 7 days after discovery.

Sediment shall be removed from surface waters immediately upon discovery and in no case later than 7 days after discovery.

TEMPORARY SEDIMENTATION BASINS & DEWATERING:

Temporary sedimentation basins are required prior to runoff leaving the construction site or entering surface waters when 10 or more acres of disturbed soils drain to a common location. The basin must provide 3,600 cubic feet of storage below the outlet per acre drained. If hydraulic calculations are available, the temporary sedimentation basin must provide a storage volume equivalent to the 2-year, 24-hour storm, but in no case less than 1800 cubic feet per acre drained. The temporary sedimentation basin must be constructed and made operational concurrent with the start of soil distrubance upgradient of the pond. The temporary sedimentation basin shall be designed to prevent short circuiting. The outfall shall be designed to remove floatable debris, allow for complete drawdown of the pond, and have energy disipation. The emergency spillway shall be stabilized.

All dewatering on site during construction must be routed to temporary sedimentation basins.

Temporary sedimentation basins must be drained within 48 hours of any rainfall event. If the rock filtered outlets plug or cause the pond not to drain within 48 hours, ponds are to be drained with pumps. Pump inlets should be protected with a geotextile membrane and rock filter setup as shown in the details, or an approved alternative. Excessive sediment-laden water that is not properly filtered will not be permitted to discharge from site.

Dewatering practices cannot cause downstream nuisance conditions, erosion, or non-permitted wetland inundation.

When sediment level has reached 1/2 the storage volume in the temporary sedimentation basin, the basin shall be drained and sediment removed within 7 days.

POLLUTION PREVENTION:

All solid waste collected from the construction site must be disposed of in accordance with MPCA disposal requirements.

Concrete washout must be contained in device such as provided by Neaton Brothers Concrete Washout LLC, or equivalent unit. Unit must be maintained to manufacturer recommendation.

All hazardous materials (e.g., oil, gasoline, fuel, antifreeze, paint, cleaning solvents, curing compounds, fertilizers, etc.) must be properly stored (including secondary containment when necessary) to prevent spills, hazardous waste must be in compliance with MPCA leaks, or other discharge. Storage and disposal of regulations.

External washing areas must be limited to a defined area of the site. All runoff containing hazardous material must be properly collected and disposed of. Defined area must be contained with heavy- or super-duty silt fence. NO ENGINE DEGREASING ALLOWED ON SITE.

The contractor is responsible for monitoring air pollution and ensuring it does not exceed levels set by local, state, or federal regulations. This includes dust created by work being performed on the site. Air pollution and dust control correction is considered incidental to the unit bid prices for which work is being performed. Additional dust control measures may be required by the Engineer.

INSPECTION & MAINTENANCE:

The permittees must routinely inspect the construction site once every seven (7) days during active construction and within 24 hours of a rainfall event greater than 0.5 inches in a 24 hour period.

All inspections performed during construction must be recorded and records retained on site with the SWPPP in accordance with the storm water permit. Records must include a site map showing areas of land disturbing activities and areas where activities have temporarily or permanently ceased.

Sediment control devices must be maintained when non-functional or when accumulated sediment reaches 1/3 of device height.

Off site vehicle tracking to be removed within 24 hours of occurrence.

All non-functional BMPs must be repaired, replaced, or supplemented with functional BMPs within 24 hours of discovery, or as soon as field conditions allow access.

Maintenance and inspection record forms are located in the project specifications for reference or provided by the site inspector.

FINAL STABILIZATION:

The Contractor must ensure final stabilization of the site. Final stabilization shall include a minimum of 70% vegetation establishment (100% stabilized) on all pervious areas.

All temporary erosion control measures and BMPs must be removed as part of the final site stabilization, unless directed otherwise by owner or engineer.

IMPLEMENTATION SCHEDULE & PHASING:

The Ferric Chloride Feed and Weir/RCP Installation may be staged together or separate at the Contractor's choosing.
Mud Mats or an approved alternate shall be used for site access across areas not within the project disturbance limits.

FERRIC CHLORIDE FEED

1. Contractor shall identify directional drilling pit locations and submit for Engineer's approval.
2. Install bioroll on down grade side of drilling pit.
3. install ferric chloride feed line.

WEIR AND RCP INSTALLATION

4. Install bioroll and silt curtain.
5. install weir and new pond inlet pipe.
6. Add additional temporary BMP's as necessary during construction based on inspection reports.
7. Ensure final stabilization measures are complete.

RECORD RETENTION:

The SWPPP, all changes to it, and inspections and maintenance records must be kept at the site during construction.

PLAN SHEETS:

Sheet numbers Sheets 2.1, 2.2, and 2.3 of this plan set are also considered a part of the SWPPP for this project.

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I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

TERESA J. BURGESS P.E.
LIC. NO. 25315 DATE 1/2/2013

DESIGNED TJB
DRAWN DJB
CHECKED TJB

BOLTON & MENK, INC.
Consulting Engineers & Surveyors
MANKATO, MN FAIRMONT, MN SLEEPY EYE, MN BURNSVILLE, MN
WILLMAR, MN CHASKA, MN RAMSEY, MN MAPLEWOOD, MN
BAXTER, MN ROCHESTER, MN AMES, IA SPENCER, IA

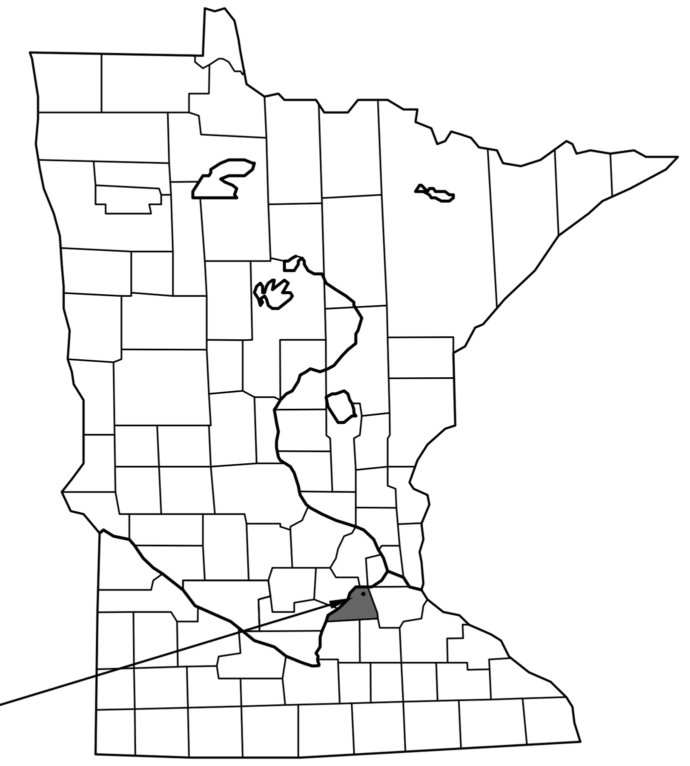
REV.	BY	DATE

PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT
FERRIC CHLORIDE FEED SYSTEM
STORM WATER POLLUTION PREVENTION PLAN
NARRATIVE

SHEET 2.1

STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

PRIOR LAKE/SPRING LAKE DISTRICT
2012
SCOTT COUNTY, MINNESOTA



GENERAL PROJECT INFORMATION:

RESPONSIBLE PARTIES:
The Contractor and Owner must apply for coverage under the MPCA's General Storm Water Permit for Construction Activity as required by the National Pollutant Discharge Elimination System (NPDES) Phase II program. Coverage under the permit will begin automatically 7 calendar days after the postmarked date on the permit application. [Longer time frames apply to sites that: (1) disturb areas greater than 50 acres AND discharge within 1 mile of a Special or Impaired Water; or (2) Use alternative storm water treatment techniques].

Owner: PRIOR LAKE SPRING LAKE WATERSHED DISTRICT
Contact Person — Phone

SWPPP Preparer: BOLTON & MENK, INC. — TERESA BURGESS — 507.625.4171
Contact Person — Phone

Contractor:
Contact Person — Phone

Person Responsible For Inspections:
Contact Person — Phone

Party Responsible for Long Term O&M
Contact Person — Phone

The individuals identified above have been trained in accordance with the Permit's training requirements.

At least one trained individual shall be present on the permitted project site or available to the project site in 72 hours

Documentation of proper training shall be available within 72 hours upon request.

SPECIAL ENVIRONMENTAL CONSIDERATIONS:
An environmental review was not required for this site.

This site does not have the potential to affect threatened or endangered species.

This site does not drain to a Calcareous fen.

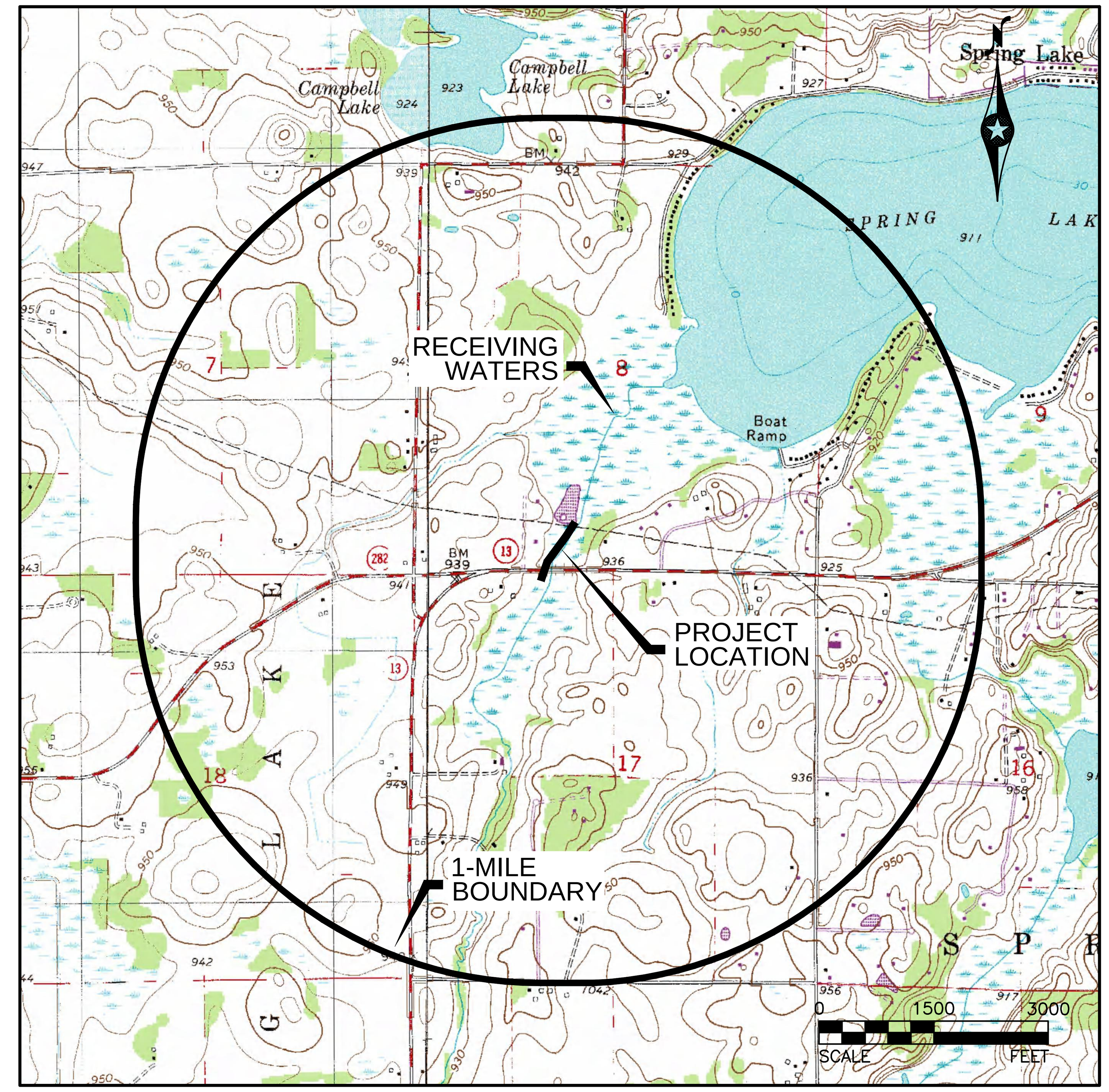
PROJECT DESCRIPTION:
This project includes disturbance of approximately 0.8 acres. Construction activities include Directional drilling of ferric chloride feed line, installation of RCP and flared end sections, install sheet piling bypass weir, install clay core trench.

STORM WATER MANAGEMENT:
Type of storm water management used if more than 1 acre of new impervious surface is created:

Wet sedimentation basin [ ] Infiltration [ ] Filtration [ ] Regional pond [ ] Permanent storm water management not required [X] Alternative methods [ ]

Required Water Quality Volume:	0 AC–FT
Design Water Quality Volume:	0 AC–FT
Elevation of Water Quality Volume Storage:	0 AC–FT
Surface Area at Water Quality Volume Storage:	0 AC
Allowable Discharge of Water Quality Volume:	0 CFS
Designed Discharge for Water Quality Volume:	0 CFS
Required Infiltration Volume:	0 AC–FT
Designed Infiltration Volume:	0 AC–FT

USGS QUAD MAP



USDA SCS SOIL SURVEY MAP

PROJECT LOCATION:

County, State	Township	Range	Section(s)	Latitude	Longitude
Scott, MN	114N	22W	8 and 17	44.690647	93.492747

PROJECT AREAS:

Total Project Size (disturbed area) =	0.75 AC
Existing area of impervious surface =	0 AC
Post construction area of impervious surface =	0 AC
Total new impervious surface area created =	0 AC
Planned Construction Start Date:	TBD
Estimated Construction Completion Date:	TBD

DESCRIPTION OF SITE ACTIVITIES:
The site drains to existing DeSilt Pond operated by Prior Lake Silver Lake Watershed District. The outlets to a ditch which ultimately discharges to Silver Lake. This project will not change the except that in high flow storm events a bypass weir will allow the excess flow to directly discharge to the existing ditch that outlets to Silver Lake bypassing the DeSilt Pond.

All modifications to this SWPPP shall be maintained on site and approved by the engineer.

SOIL TYPE SUMMARY:

Map Unit Symbol	Soil Name	Hyd. Soil Group
BB	Beach materials and muck	A/D
HAC2	Hayden loam, 6 to 12 percent slopes, moderately eroded	B
LCE2	Lester loam, 18 to 25 percent slopes	B
PAA	Palms muck, 0 to 2 percent slopes	B/D
PBA	Houghton muck, 0 to 2 percent slopes	A/D

BMP SUMMARY:

BMP	Quantity	Unit
BIOROLL	500	LF
SEED AND MULCH	0.75	ACRE
MUD MATS	1	LS
SILT CURTAIN	115	LF

RECEIVING WATERS:
Surface waters which will receive storm water from the site within 1 mile of project boundary. Include waters shown on USGS 7.5 minute quad and all waters identified in Appendix A of the permit.

For sites with a discharge point within one mile of, and flows to, an impaired water, additional BMPs have been included in this SWPPP.

For receiving waters with approved TMDLs, all specific implementation activities and BMPs regarding construction activities are included in this SWPPP.

Name of Water Body	Type (ditch, pond, wetland, lake, etc.)	Appendix A Special Water?	Flows to Impaired Water within 1 mile?	USEPA Approved TMDL?
PLSWD DeSilt Pond	Pond	NO	YES	NO
Spring Lake	Lake	YES	YES	YES

Impairment: , Phosphorous (nutrient etrophication biological indicators)

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
TERESA J. BURGESS P.E.
LIC. NO. 25315 DATE 1/2/2013

DESIGNED	DRAWN	CHECKED
TJB	DJB	TJB

BOLTON & MENK, INC.
Consulting Engineers & Surveyors
MANKATO, MN FAIRMONT, MN SLEEPY EYE, MN BURNSVILLE, MN WILLMAR, MN CHASKA, MN RAMSEY, MN MAPLEWOOD, MN BAXTER, MN ROCHESTER, MN AMES, IA SPENCER, IA

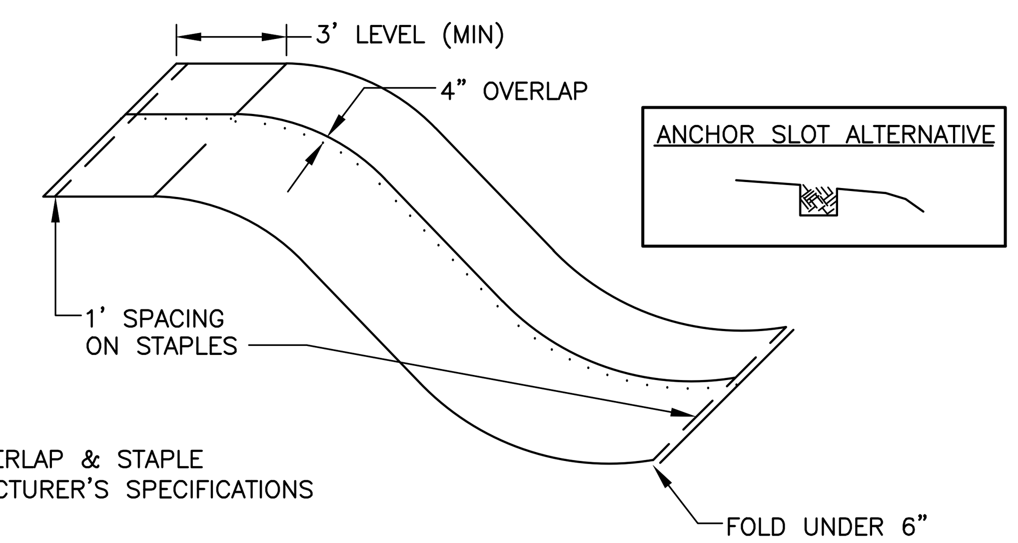
REV.	BY	DATE

PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT
FERRIC CHLORIDE FEED SYSTEM
STORM WATER POLLUTION PREVENTION PLAN
USGS LOCATION MAP & SOILS MAP

SHEET 2.2

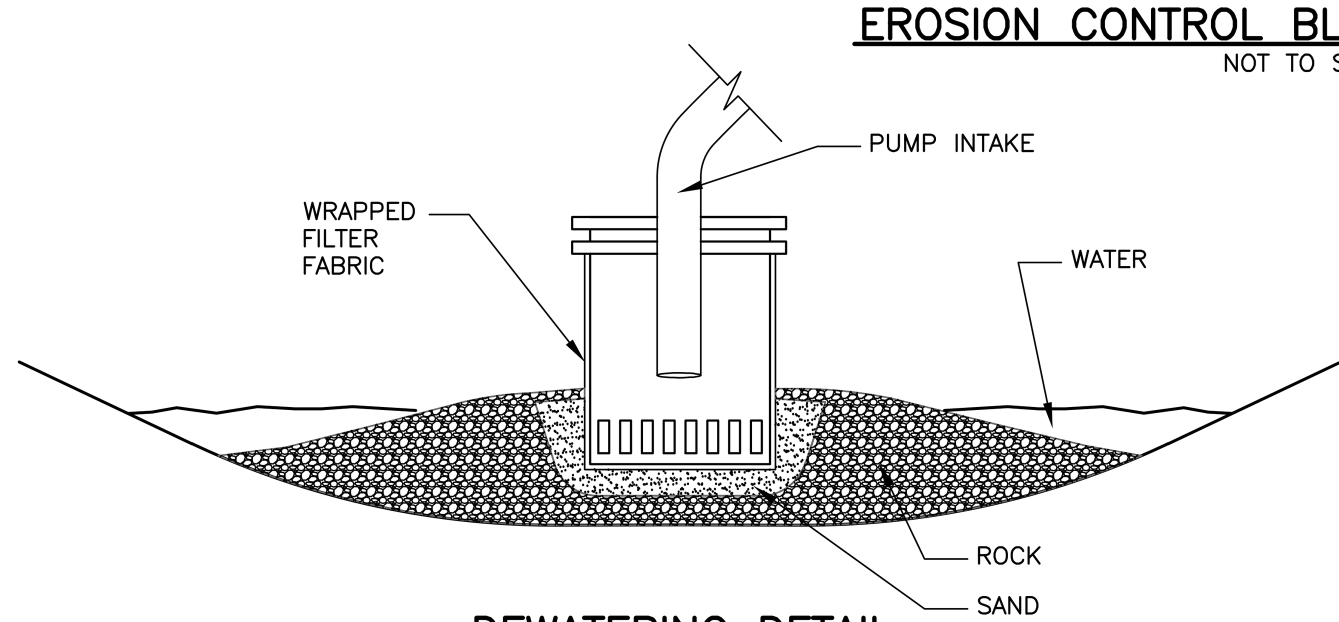
LEGEND

- EXISTING MAIN CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED MAIN CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- PROPOSED RIPRAP
- PROPOSED SHEET PILE WEIR
- PROPOSED INJECTION STRUCTURE
- EXISTING DRAINAGE
- PROPOSED DRAINAGE
- SILT CURTAIN
- BIOROLL



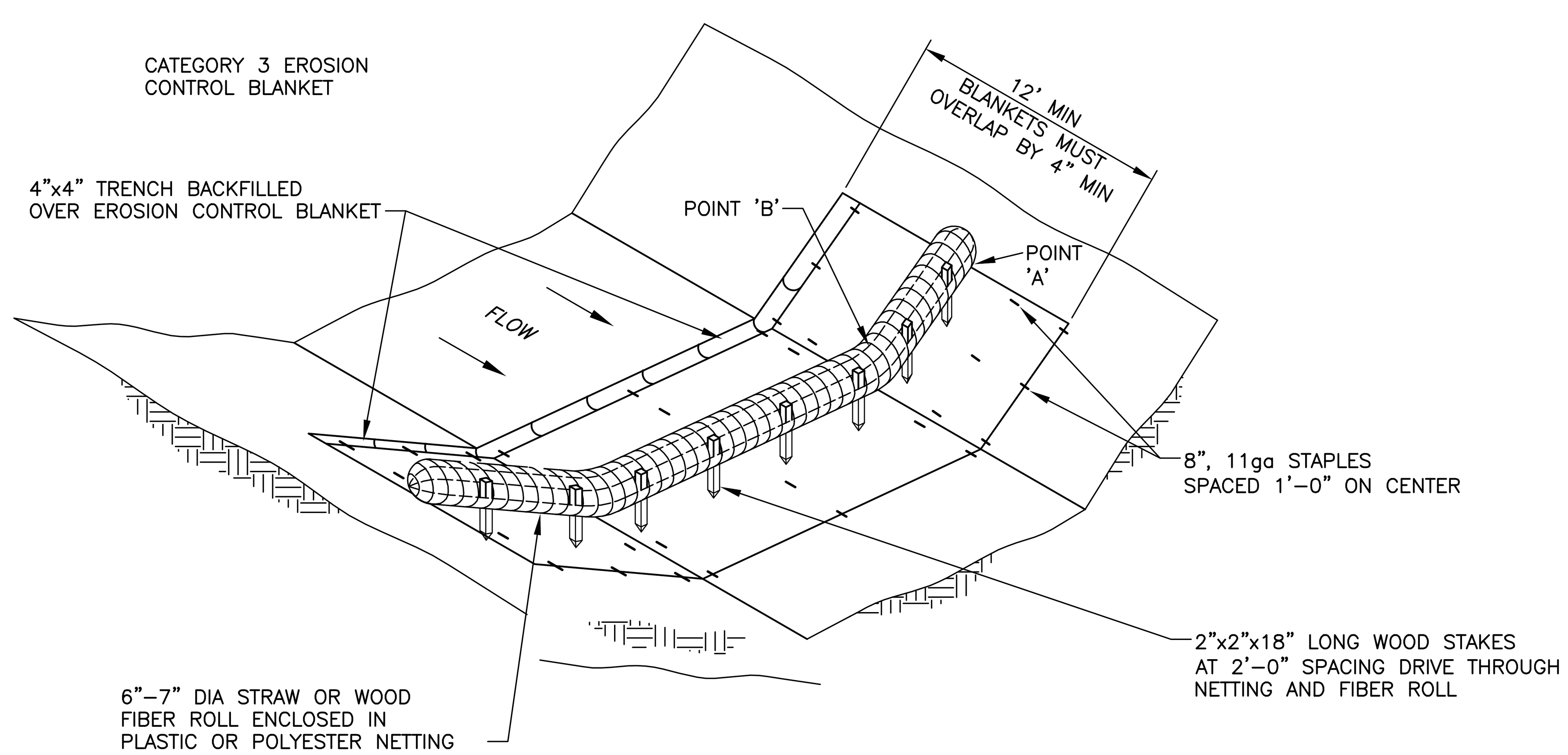
EROSION CONTROL BLANKET INSTALLATION

NOT TO SCALE



DEWATERING DETAIL

NOT TO SCALE



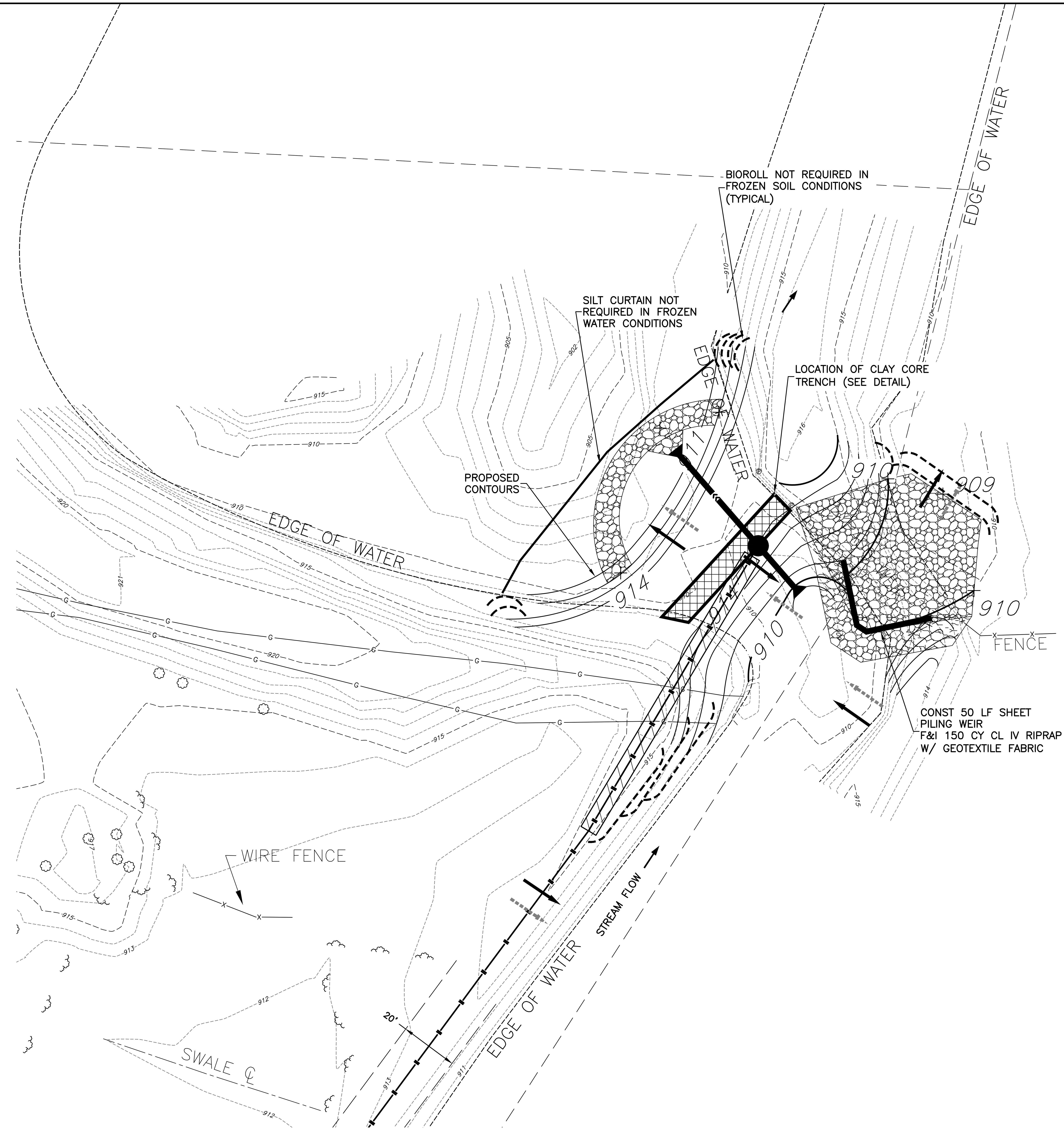
DITCH CHECK – BIOROLL

NOT TO SCALE

NOTE:
POINT 'A' MUST BE 1'-0" MIN HIGHER THAN POINT 'B' TO ENSURE THAT WATER FLOWS OVER THE DITCH CHECK AND NOT AROUND THE ENDS

EROSION CONTROL NOTES:

1. REFER TO SWPPP NARRATIVE AND SPECIFICATIONS FOR ADDITIONAL EROSION AND SEDIMENT CONTROL REQUIREMENTS.
2. THE CONTRACTOR MAY SUBSTITUTE SILT FENCE OR ROCK LOGS FOR BIOROLL.
3. SILT FENCE MAY NOT BE USED IN PLACE OF SILT CURTAIN.
4. ALL DISTURBED VEGETATIVE AREAS SHALL BE SEEDED WITH MNDOT MIX 310 AND TYPE 2 EROSION CONTROL BLANKET INSTALLED PER THE DETAIL UNLESS OTHERWISE APPROVED BY THE ENGINEER. EROSION CONTROL BLANKET SHALL EXTEND A MINIMUM 2-FOOT BELOW THE NORMAL WATER LINE WHERE INSTALLED ABUTTING WATER.
5. A MINIMUM 4-INCHES OF TOPSOIL SHALL BE PLACED ON ALL DISTURBED AREAS PRIOR TO INSTALLATION OF SEED AND EROSION CONTROL BLANKET.



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SCALE FEET

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WILLMAR, MN CHASKA, MN RAMSEY, MN MAPLEWOOD, MN
BAXTER, MN ROCHESTER, MN AMES, IA SPENCER, IA

REV.	BY	DATE

PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT
FERRIC CHLORIDE FEED SYSTEM
EROSION AND SEDIMENT CONTROL PLAN

SHEET 2.3

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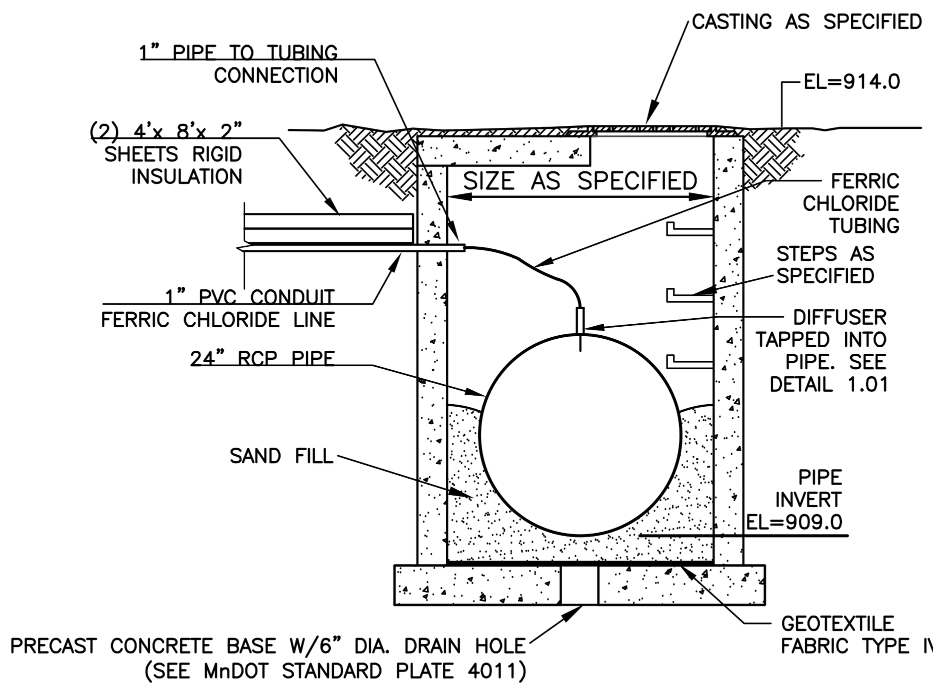
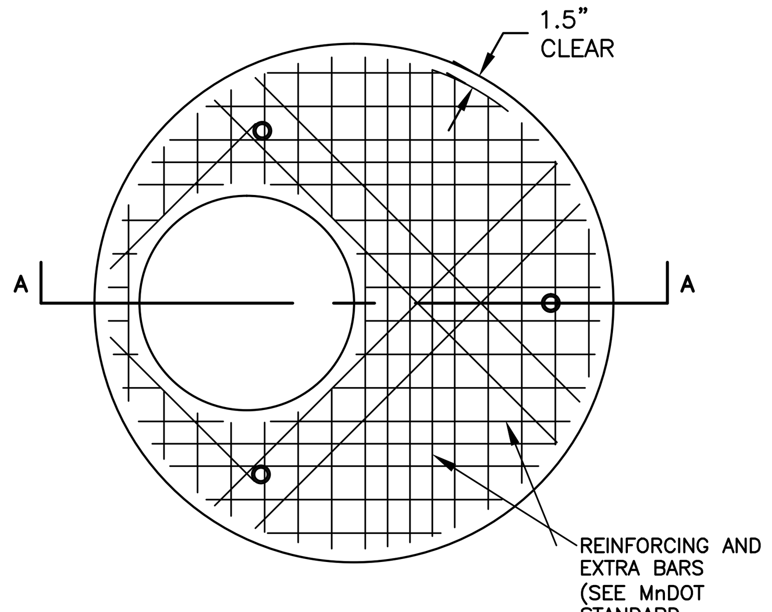


DESIGN 4020 MANHOLE/CATCH BASIN

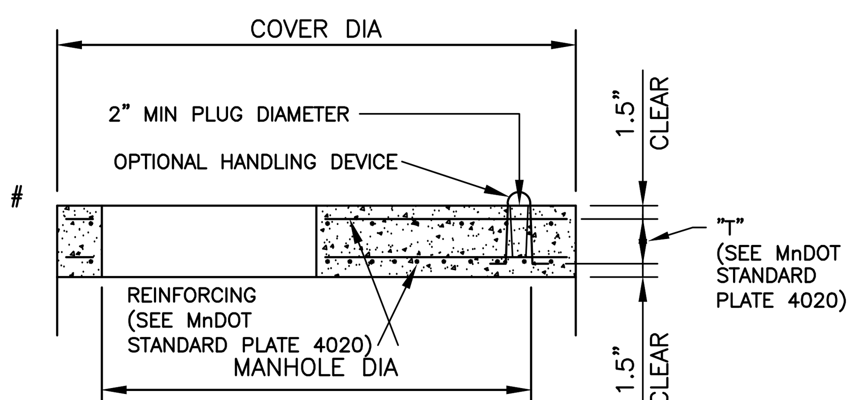


PLAN OF COVER
TOP BARS NOT SHOWN

NOTES:

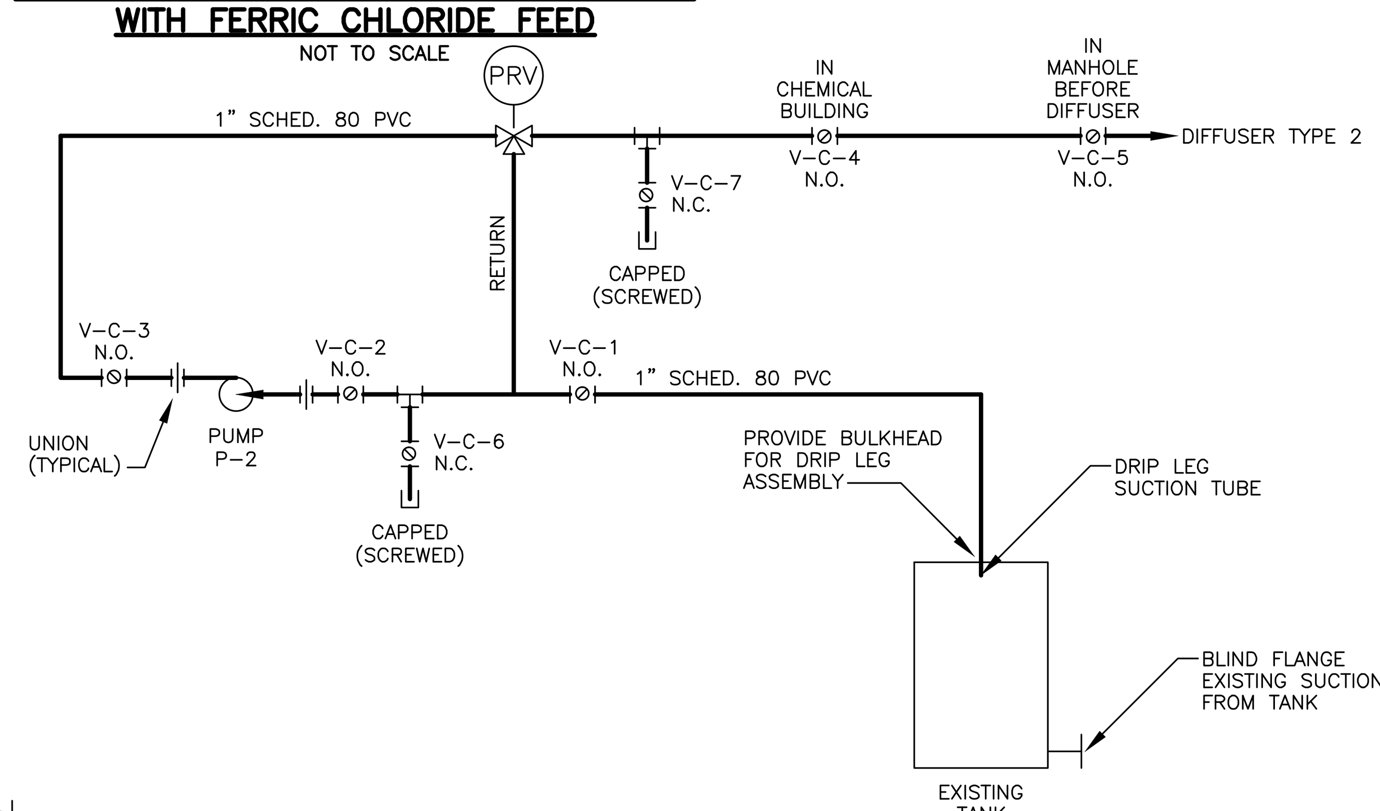
1. AASHTO HS 25 LOADING MAX FILL HEIGHT 15'
2. THE # 4020 SHALL BE PERMANENTLY MARKED ON THE TOP COVER
3. EQUIVALENT STEEL AREAS IN WIRE MESH MAY BE USED
4. REINFORCEMENT PER SPEC 3301, GRADE 60 A SINGLE HOOP OF 8ga STEEL WIRE
5. PIPE LENGTH INCLUDES APRONS (2 EACH)

DESIGNATION:
DESIGN DIAMETER – STANDARD PLATE #
DESIGN 48-4020

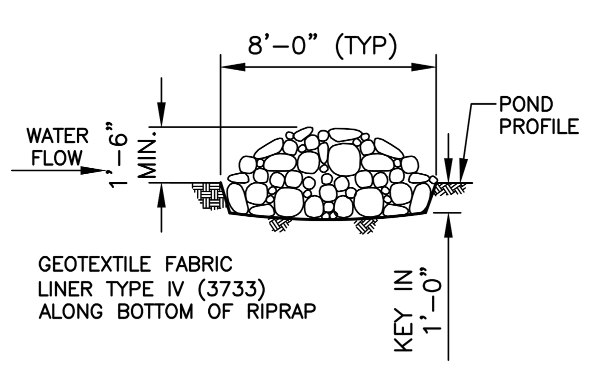


SECTION A-A

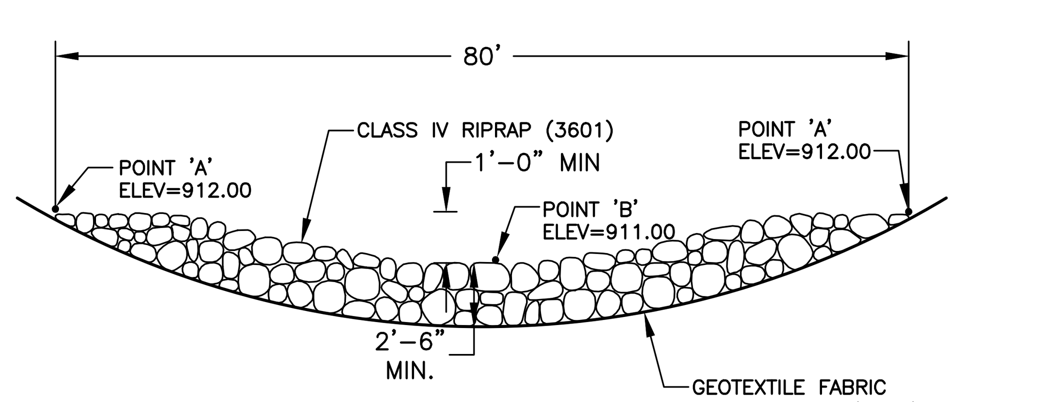
STORM SEWER STRUCTURE–DESIGN 4020 WITH FERRIC CHLORIDE FEED
NOT TO SCALE



DETAIL 1.02: FERRIC CHLORIDE PIPING SCHEMATIC
NO SCALE



PROFILE VIEW



CROSS SECTION

NOTES:

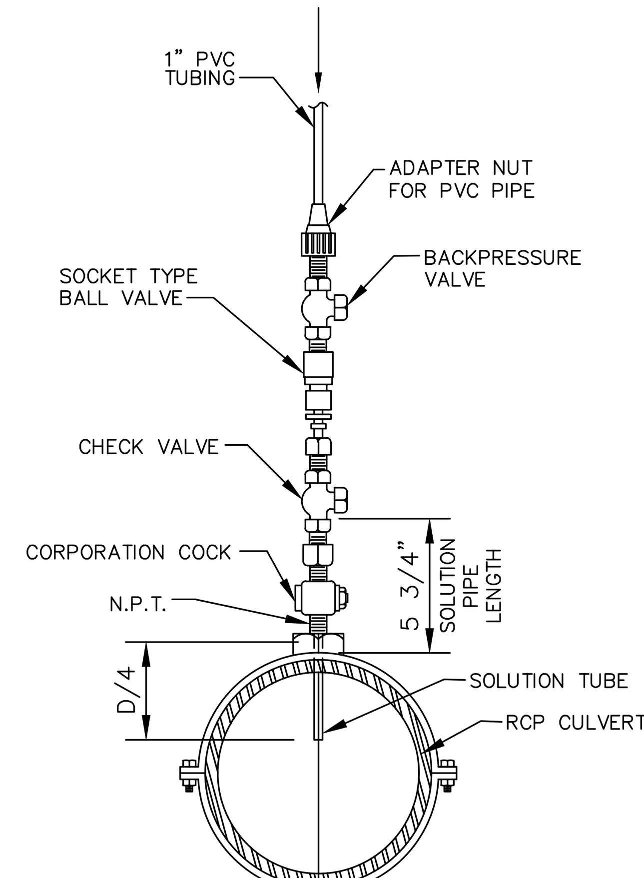
CLASS IV RIPRAP (MN/DOT SPEC 3601) WITH GEOTEXTILE FABRIC LINER, TYPE IV (MN/DOT SPEC 3733).

THE ROCK WEIR SHOULD BE USED AS A PERMANENT DIFFUSION DEVICE.

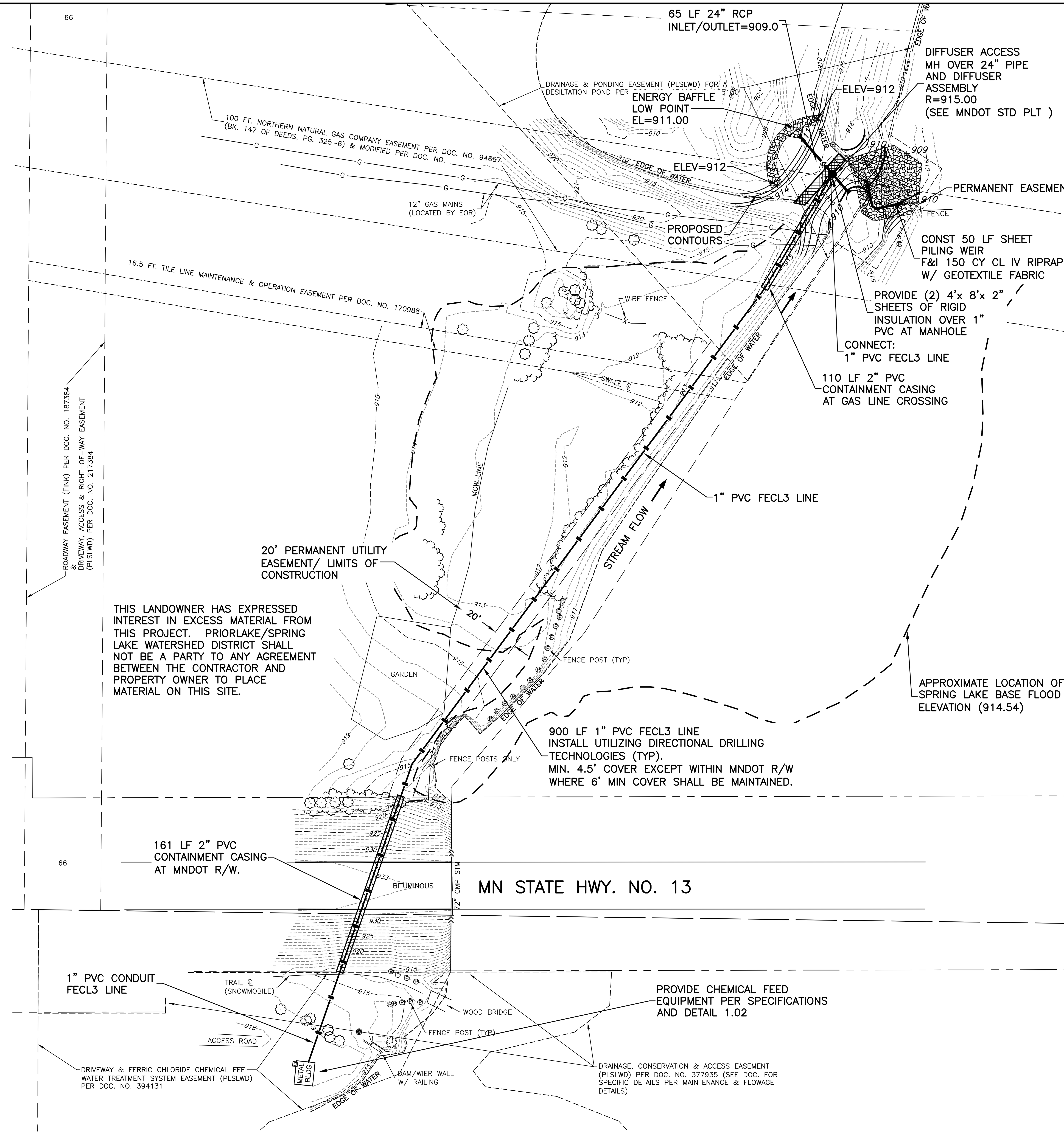
ROCK WEIR SHOULD BE KEYED INTO THE SLOPE 1' TO HOLD ROCK IN PLACE.

POINT "A" MUST BE 1'-0" MINIMUM HIGHER THAN POINT "B" TO ENSURE THAT WATER FLOWS OVER THE DIKE AND NOT AROUND THE ENDS.

ENERGY BAFFLE
NOT TO SCALE



DETAIL 1.01: DIFFUSER TYPE 2
NO SCALE



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SCALE FEET

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LIC. NO. 25315 DATE 1/2/2013

DESIGNED TJB
DRAWN DJB
CHECKED TJB

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WILLMAR, MN CHASKA, MN RAMSEY, MN MAPLEWOOD, MN
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REV. | BY | DATE

PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT
FERRIC CHLORIDE FEED SYSTEM
SITE/GRADING PLAN

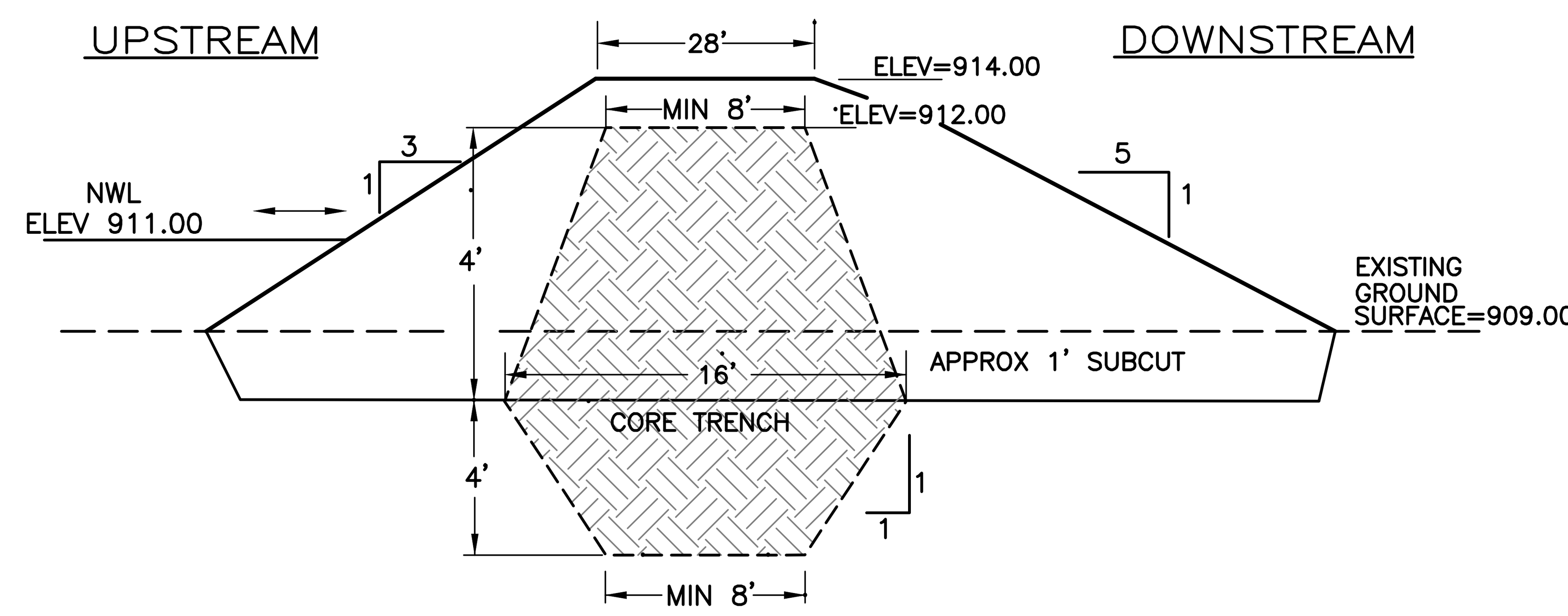
SHEET 3.1

LEGEND

(dashed line)	EXISTING MAIN CONTOUR
(light dashed line)	EXISTING INTERMEDIATE CONTOUR
(solid line)	PROPOSED MAIN CONTOUR
(thin solid line)	PROPOSED INTERMEDIATE CONTOUR
(riprap pattern)	PROPOSED RIPRAP
(heavy line)	PROPOSED SHEET PILE WEIR
(line with dot and arrow)	PROPOSED INJECTION STRUCTURE

CONSTRUCTION NOTES:

1. PLACE NONWOVEN GEOTEXTILE FABRIC UNDER ALL RIPRAP
2. RIPRAP SHALL BE MINIMUM 18" THICK UNLESS OTHERWISE NOTED OR APPROVED BY ENGINEER
3. THE CONTRACTOR SHALL PROVIDE A MINIMUM ALLOWABLE SETTLEMENT OF 5% OF THE TOTAL FILL DEPTH.

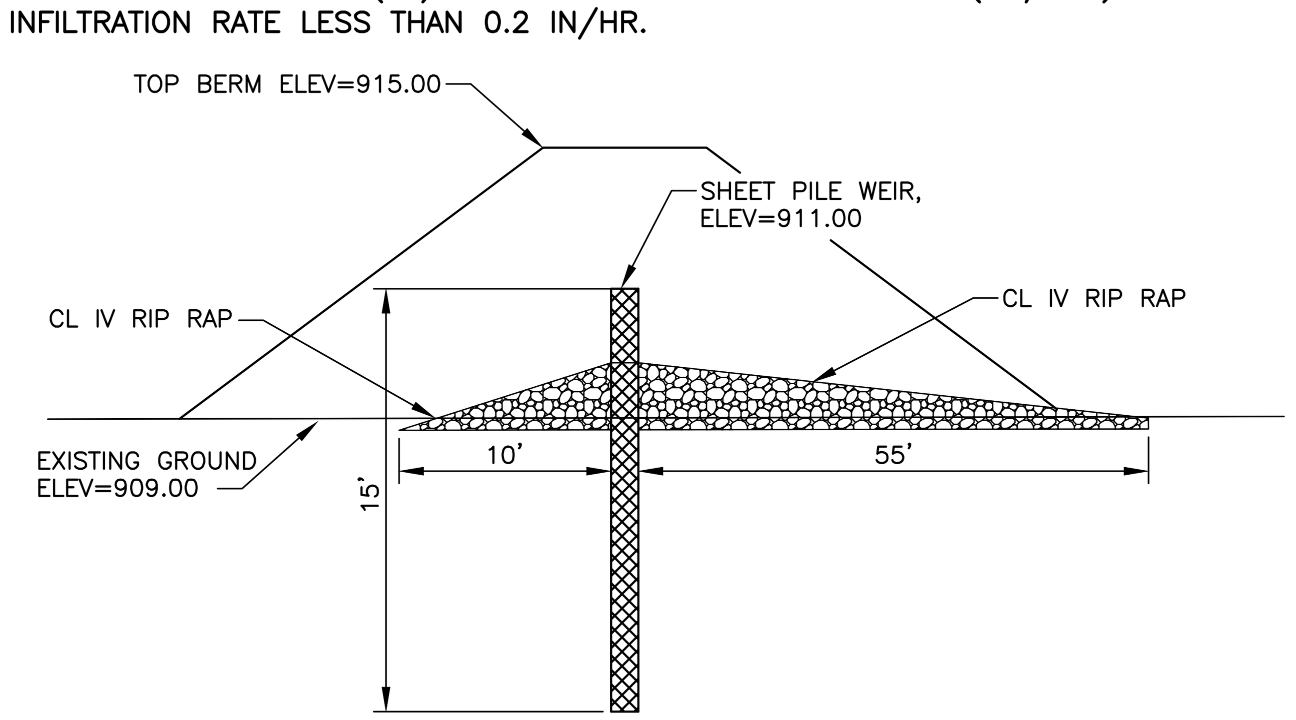


TYPICAL X-SECTION OF EMBANKMENT

NOT TO SCALE

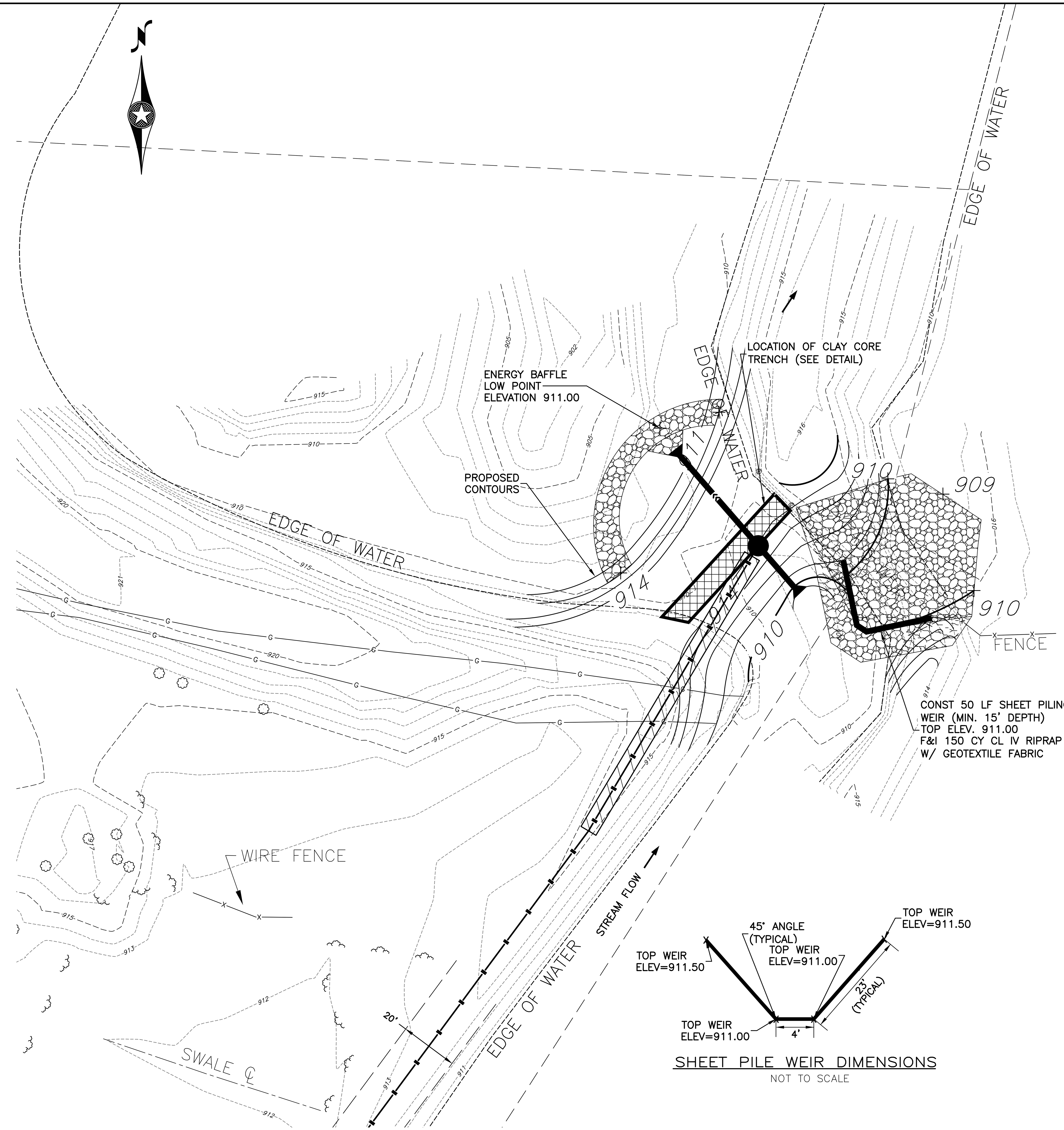
CORE TRENCH NOTES:

1. SUITABLE MATERIAL FOR EMBANKMENT CONSTRUCTION SHALL BE OBTAINED FROM THE SPILLWAY EXCAVATIONS AND DESIGNATED BORROW AREAS.
2. STRIP ALL ORGANICS AND TOPSOIL BENEATH EMBANKMENT
3. EXCAVATE 4 FT CORE TRENCH. CORE TRENCH SHALL BE INSPECTED BY ENGINEER PRIOR TO BACKFILLING.
4. ANY AREAS WITH SUSPECT TILE WILL BE FURTHER EXCAVATED. ANY TILE FOUND SHALL BE REMOVED FROM UNDER THE EMBANKMENT FOR A DISTANCE OF 20 FEET BOTH UPSTREAM AND DOWNSTREAM OF THE EMBANKMENT FOOTPRINT.
5. CONSTRUCT CORE TRENCH ALONG APPROXIMATE CENTERLINE OF FILL
6. EXTEND CORE INTO AND UP SIDES SLOPES TO NORMAL POOL ELEVATION
7. EXCAVATE MINIMUM OF 4' DEPTH, OR UNTIL SUITABLE MATERIAL IS REACHED
8. SIDES SLOPES SHALL NOT BE STEEPER THAN 1:1
9. FILL SHALL BE PLACED IN MINIMUM 9" LIFTS PRIOR TO COMPACTION
10. BACKFILL WITH LOW PERMEABILITY MATERIAL
11. THE MAXIMUM THICKNESS OF EACH LAYER OF FILL BEFORE COMPACTION SHALL BE AS SPECIFIED. THE ENTIRE SURFACE LAYER OF FILL SHALL BE COMPACTED BY AT LEAST 2 PASSES OF THE COMPACTION EQUIPMENT.
12. MATERIAL SHALL BE LEAN CLAY (CL) WITH A HYDRAULIC CONDUCTIVITY (CM/SEC) $1X10_{-7}$ TO $1X10_{-8}$ AND AN INFILTRATION RATE LESS THAN 0.2 IN/HR.



CROSS SECTION AT CENTER OF SHEET PILE WEIR

NOT TO SCALE



SHEET PILE WEIR DIMENSIONS

NOT TO SCALE

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SCALE FEET

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REV. BY DATE

PRIOR LAKE/SPRING LAKE WATERSHED DISTRICT
FERRIC CHLORIDE FEED SYSTEM
SITE/GRADING PLAN & SHEET PILE

SHEET 3.2