PRELIMINARY ENGINEERING REPORT
LAKE SHAMINEAU HIGH WATER PROJECT

Prepared for the
Lake Shamineau Lake Improvement District

June 3, 2019

Prepared by:
Widseth Smith Nolting & Associates
Consulting Engineers, Alexandria and Baxter, Minnesota
WSN #260B1434.001

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.

Timothy E. Bayerl, PE Lic. No. 17651

CONTENTS

I. INTRODUCTION
    A. Background
    B. Project Description
    C. Hydrologic and Hydraulic Data

II. PROJECT SIZING ANALYSIS

III. PROJECT ECONOMIC ANALYSIS

IV. FEASIBILITY

V. NEXT STEPS

FIGURES:
    A. Site Location Map
    B. Potential Outlet Route

OPINION OF PROBABLE COST:
    A. Construction Cost
    B. Total Project Cost

APPENDIX:
    A. DNR Recorded Water Levels
    B. North-Northeast Outlet Corridors, Memo dated May 24, 2019

I. INTRODUCTION

A. Background

The water level of Lake Shamineau has been rising in recent years causing problems for riparian landowners. In addition, high water causes shoreline erosion, destruction of wildlife habitat, loss of trees and native vegetation, as well as potential reduction of water quality, and additional boat wake damage. The lake does not have a natural surface water outlet.

A review of four alternatives was conducted and is presented in the Engineer's Feasibility Report dated January 23, 2018, by Houston Engineering, Inc. The four alternatives considered were:

1. Do Nothing
2. Northeast Bound Outlet
3. Southwest Bound Outlet
4. Property Buyout

This report considers another alternative; withdrawing water from the Northeast area of the lake via a pump station and discharging it to an infiltration basin that provides groundwater flow away from Lake Shamineau.

This alternative is described as pumped infiltration in this report. This report is to identify an outlet for the high water on Lake Shamineau to meet Minnesota Department of Natural Resources (MNDNR) funding and permitting requirements.

B. Project Description

A water intake screen would be installed in the lake in water deep enough to remain submerged even at lower lake levels. The screen proposed is a cylindrical shape installed horizontally. The screen will be sized so that the intake flow velocity is low enough so that swimmers, fish, or objects do not get pulled into it. There will also be a barrier to keep people and boats away.

The intake pipe will extend to a pump station on land near the lake shore. The pump station will contain one or two vertical turbine pumps. Two pumps provide more flexibility of operation and are proposed at this time. The pump structure will be underground except for the pump motors which will be located above the concrete structure slab. The water will be pumped through a buried pipeline to the infiltration basins (see Figure 2). The pipeline would likely be 18inch diameter for the proposed pumping rate. The velocity would be about 5.6 feet per second. The proposed infiltration basin will be divided into two cells and flow can be equally split between them or can be directed to either cell. Detailed design might dictate use of more smaller cells to fit site topography.

C. Hydrologic and Hydraulic Data

The Lake Shamineau water surface area is 1,434 acres according to the MNDNR. To lower the lake level one foot would require removal of 1,434 acre-feet of water. This does not include water that is present in the wetlands and sediments around the lake that will drain to the lake as the lake level is lowered.

WSN completed dual-ring infiltrometer and percolation testing at the proposed infiltration site. The site is a gravel pit located to the northeast of Lake Shamineau as shown on Figure 1. Testing indicates that the site is suitable for infiltration and can be loaded with at least 3.63 feet of water per day. More information related to infiltration rates and analysis is available in WSN's Memo titled "North-Northeast Outlet Corridors" dated May 24, 2019 (attached as Appendix B), and the Hydrogeologic Investigation Report dated May 28, 2019. This technical information has been shared with MNDNR staff.

II. PROJECT SIZING ANALYSIS

Infiltration of water can only take place when soil is not frozen. Generally, the season for operation will be mid-May through about the end of October, or approximately 150 to 180 days.

Recent DNR records of lake water level records for Lake Shamineau show the lake rising as much as 1.7 feet in a year (2014). MNDNR recorded water levels for the past ten years is attached as Appendix A. The volume of water for 1.7 feet is 2,438 acre-feet. The lake ordinary high water level (OHW) is 1275.1 feet elevation, and the current water (May 2019) level is 1276.84 or approximately 1.7 feet above the OHW.

Removal of 2,438 acre-feet in 150 days requires a continuous pump rate of 8.2 cubic feet per second (cfs), or 3,680 gallons per minute (gpm). Some down time for maintenance at the pump station and infiltration site should be allowed. Assuming the system will have some down time for maintenance, we increased the pumping rate to account for this time (pump rate times 1.2); this requires about 10 cfs rate or 4,500 gpm. The proposed pump station would have two pumps with a maximum capacity of 4,500 gpm with both pumps running full speed.

III. PROJECT ECONOMIC ANALYSIS

A preliminary opinion of construction and total project costs have been developed. The estimated construction amount is approximately $1,500,000 and the total project cost is nearly $1,900,000. Detailed estimated cost breakdowns are attached. The costs do not take into account likely possible MNDNR Flood Hazard Mitigation Grant assistance.

IV. FEASIBILITY

The project is feasible and can be constructed by normal construction methods. The project is necessary to control lake levels and reduce property losses, shoreline erosion, destruction of wildlife habitat, loss of trees and native vegetation. The project is cost effective when compared to other alternatives.

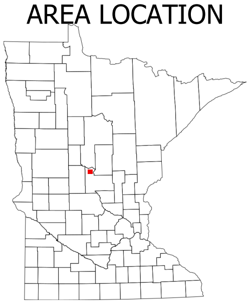
This project, as proposed, is feasible, necessary, and cost effective.

V. NEXT STEPS

The next step in the project, surveying and detailed design, will include the development of operations and maintenance plans, preliminary engineering plan sets, an updated implementation schedule and more detailed cost estimate for construction and plan implementation. After the detailed design is completed, permit applications will be applied for. Once the permits are in place, final design plans and specifications will be completed and the project bid out. Based on bids and qualifications, the contractor will be selected and construction can commence.

IMAGE: UNITED STATES DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY

AREA LOCATION



NORTH

0 0.25 0.5 0.75 1 mi

(IN FEET)

USGS QUADRANGLE MAPS:
MOTLEY SE, CUSHING

PUBLISHED: 1963, 1981
PHOTOREVISED: NA, NA

WIDSETH SMITH NOLTING

LAKE SHAMINEAU HIGH WATER PROJECT - STEP 1
LAKE SHAMINEAU LAKE IMPROVEMENT DISTRICT
MOTLEY, MN

Date: MAY 2019

JOB No. 0260B1434.001

FIGURE 1

SITE LOCATION MAP

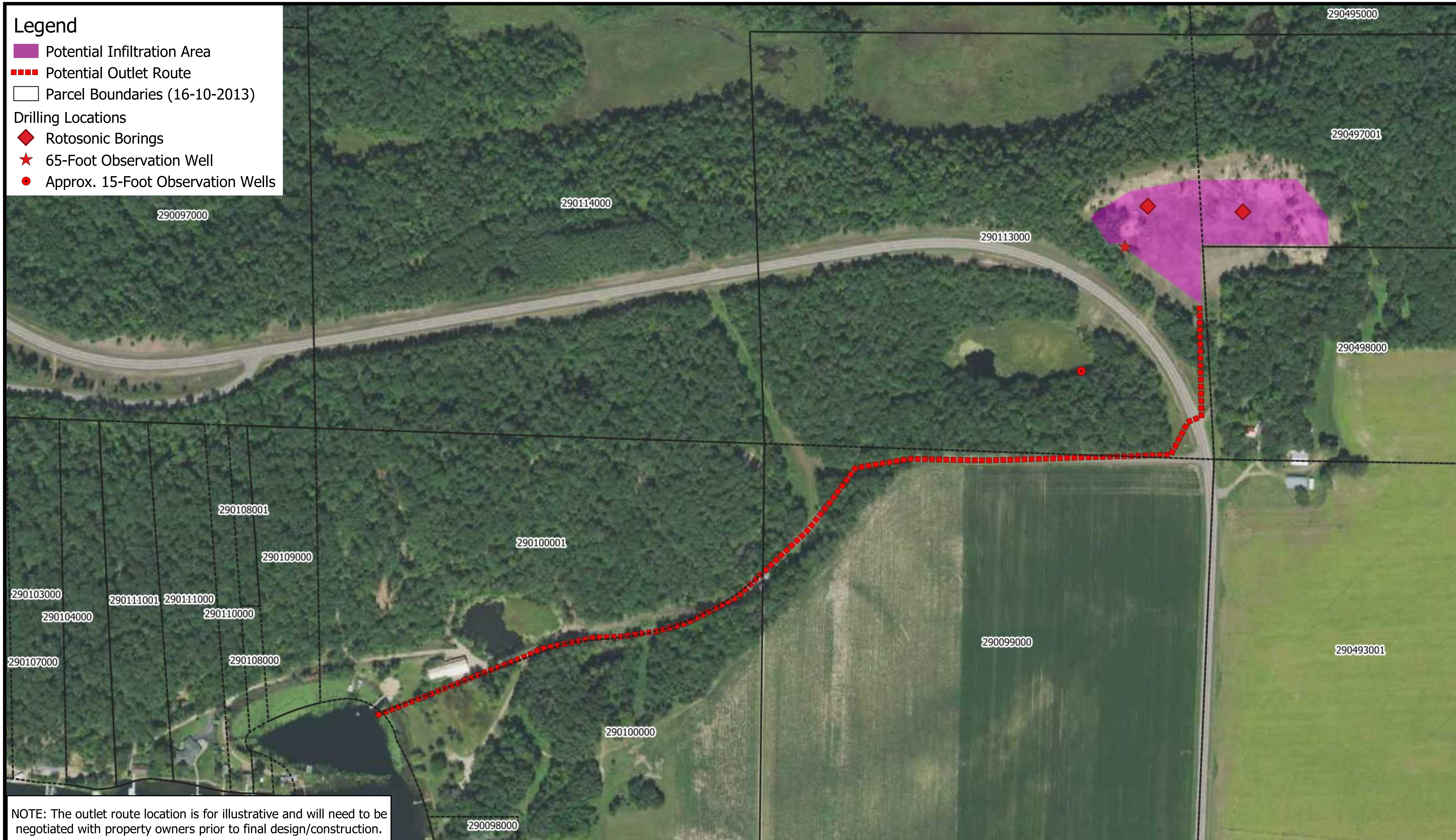


Image: FSA AERIAL (2017)

J:\0260B-Brainerd Environmental\0260B1434-Lake Shamineau High Water Proj. Step 1\0260B1434.001-Lake Shamineau High Water Proj. Step\GIS\Models\W-TP-0250B1434.000.qgz

WIDSETH SMITH NOLTING

NORTH

0 200 400 (IN FEET)

LAKE SHAMINEAU HIGH WATER PROJECT - STEP 1
LAKE SHAMINEAU LAKE IMPROVEMENT DISTRICT
MOTLEY, MN

POTENTIAL OUTLET ROUTE MAP

Date:	
MAY 2019	
JOB No.	FIGURE
0260B1434.000	2

HIGH WATER PROJECT
LAKE SHAMINEAU LAKE IMPROVEMENT DISTRICT

Preliminary Opinion of Probable Construction Cost

June 3, 2019

Item Number	**Item Description**	**Quantity**	**Unit**	**Unit Cost**	**Extended Cost**
1	MOBILIZATION	1	LS	$ 70,000.00	$ 70,000.00
2	CLEAR & GRUB - FM ALIGNMENT	1	AC	$ 5,000.00	$ 5,000.00
3	DEWATERING - PUMP STA. SITE	1	LS	$ 100,000.00	$ 100,000.00
4	COMMON EXCAVATION - INF BASINS	32,000	CY	$ 8.50	$ 272,000.00
5	FILL AT PUMP STATION SITE	200	CY	$ 25.00	$ 5,000.00
6	PUMP STATION	1	LS	$ 300,000.00	$ 300,000.00
7	INTAKE SCREEN & PIPING	1	LS	$ 50,000.00	$ 50,000.00
8	PORTABLE AIR BACKWASH SYS.	1	EA	$ 30,000.00	$ 30,000.00
9	AIR RELEASE VALVE MANHOLE	1	EA	$ 15,000.00	$ 15,000.00
10	18" PVC FORCEMAIN C905	3,500	LF	$ 100.00	$ 350,000.00
11	18" DUCTILE IRON PIPE	290	LF	$ 100.00	$ 29,000.00
12	18" PLUG VALVE	2	EA	$ 10,000.00	$ 20,000.00
13	DIP FITTINGS	2,000	LBS	$ 6.00	$ 12,000.00
14	CONTROL STRUCTURE	1	EA	$ 30,000.00	$ 30,000.00
15	DISCHARGE PAD	2	EA	$ 5,000.00	$ 10,000.00
16	CLASS V AGGREGATE	360	CY	$ 25.00	$ 9,000.00
17	RANDOM RIPRAP CL 3	50	CY	$ 80.00	$ 4,000.00
18	GEOTEXTILE FILTER TYPE III	100	SY	$ 2.00	$ 200.00
19	MACHINE SPLICED SILT FENCE	2,000	LF	$ 4.00	$ 8,000.00
20	FLOATING SILT CURTAIN	450	LF	$ 20.00	$ 9,000.00
21	EROSION CONTROL BIOROLL	250	LF	$ 10.00	$ 2,500.00
22	SCARIFY BASIN BOTTOM	5	AC	$ 500.00	$ 2,500.00
23	SEEDING - LAWN OR ROADWAY MIX	2	AC	$ 2,000.00	$ 4,000.00
24	SEEDING - NATIVE MIX	10	AC	$ 4,000.00	$ 40,000.00
25	MULCH & DISK ANCHOR	6	TON	$ 500.00	$ 2,900.00
26	EROSION CONTROL BLANKET	15,000	SY	$ 2.00	$ 30,000.00
27	WIRE FENCE	200	LF	$ 15.00	$ 3,000.00
28	VEHICLE GATE	1	EA	$ 2,000.00	$ 2,000.00
29	MISCELLANOUS ITEMS	1	LS	$ 20,000.00	$ 20,000.00

TOTAL **$ 1,435,100.00**

Item 3 Note: Includes dewatering groundwater around pump station.
Item 4 Note: Includes earth moving in the gravel pit to built the infiltration basins.
Item 6 Note: Includes the costs of pumps, electrical controls, and wet well.
Item 10 Note: Includes the excavation, boring, and laying of the pipe from the lake to the infiltration basins.

OPINION OF PROBABLE TOTAL PROJECT COST
LAKE SHAMINEAU LAKE IMPROVEMENT DISTRICT
HIGH WATER PROJECT
MORRISON COUNTY, MN

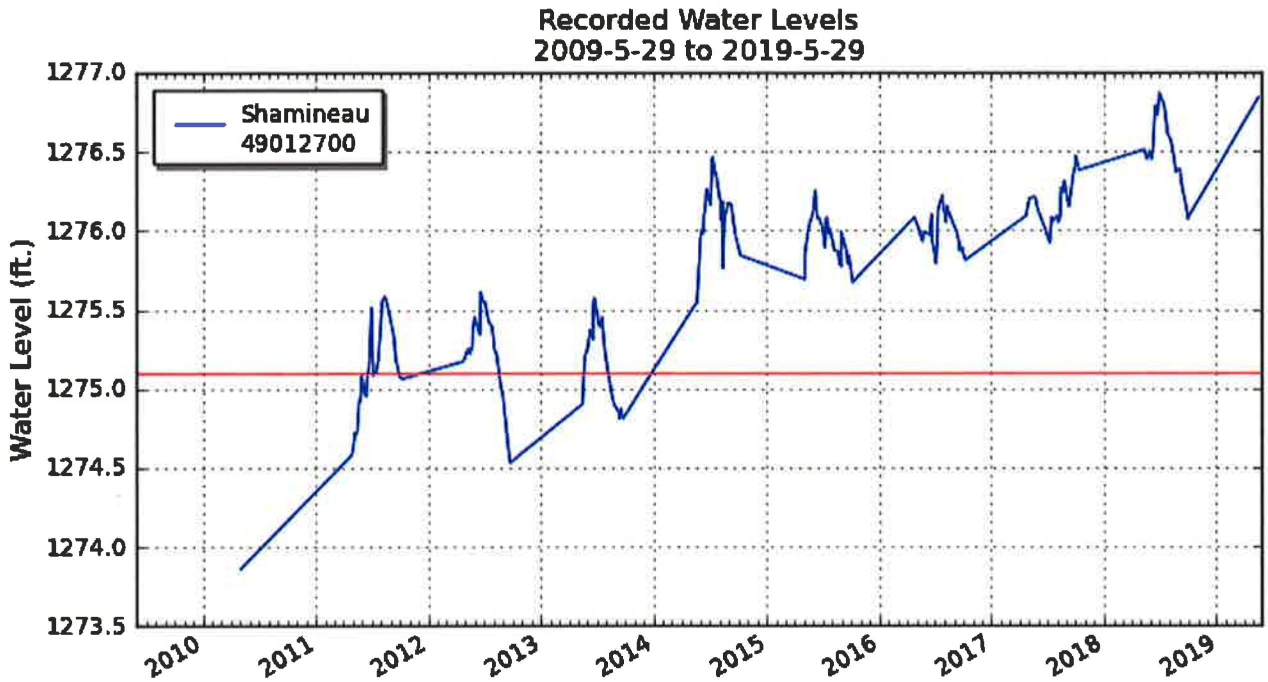
WSN #260B1434.001
June 3, 2019

CONSTRUCTION	$1,435,100	
CONTINGENCY (10%)	$143,510	
Subtotal		**$1,578,610**
ENGINEERING		
Survey and Detailed Design	$130,000 *	
Final Design Estimate	$32,000	
Construction Administration Estimate	$74,000	
Subtotal		**$236,000**
LEGAL, FISCAL, & ADMINISTRATIVE (2%)		$31,572
LAND		$50,000
TOTAL ESTIMATED PROJECT COST		**$1,896,182**

Notes:
Construction cost estimate based on preliminary design
Contingency is 10% of Construction Costs
Engineering is shown per Agreement and future estimate
Legal, Fiscal, & Administrative estimated as 2% of Const.+ Contingency
Land cost based on an estimate of purchase and/or easements
* This amount is included in current agreement with WSN

APPENDIX A

DNR RECORDED WATER LEVELS



Recorded Water Levels
2009-5-29 to 2019-5-29
Shamineau
49012700
Water Level (ft.)
1277.0
1276.5
1276.0
1275.5
1275.0
1274.5
1274.0
1273.5
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019

APPENDIX B

NORTH-NORTHEAST OUTLET CORRIDORS

WIDSETH SMITH NOLTING
Brainerd/Baxter
7804 Industrial Park Road
PO Box 2720
Baxter, MN 56425-2720
218.829.5117
218.829.2517
Brainerd@wsn.us.com
WidsethSmithNolting.com

MEMO

Date: May 24, 2019
To: **Lake Shamineau Lake Improvement District Board**
From: Brian Ross (WSN)
Cc: Tim Bayerl (WSN), Paul Strong (WSN)
Project Name: Lake Shamienau High Water Project - Step 1
Project No.: 0260B1434.001
Subject: **North-Northeast Outlet Corridors**

This memo summarizes the assessment of potential outlet corridors to the north-northeast of Lake Shamineau. The first step in determining a north-northeast outlet was to assess if infiltration of high-water from Lake Shamineau would be a viable option.

A gravel pit, owned by the Dick brothers, located to the northeast of Lake Shamineau was investigated by WSN as a potential outlet location for water pumped from Lake Shamineau to infiltrate into the groundwater. The Dick brothers had expressed interest in cooperating with the Lake Improvement District to find an outlet. WSN completed geologic borings, infiltration testing, grain size analysis, installed one observation well, and installed three shallow piezometers. The locations of the geologic borings, piezometers, and infiltration test points are included in a hydrogeologic investigation report. The data gathered is summarized here.

Geologic Borings

Between May 7 and May 9, 2019, a total of three borings to a depth of 65 to 80 feet were completed using rotosonic drilling techniques. WSN staff were on site with North Star Drilling to sample the soils and log the borings. Sediment identified on the site was typified by Coarse Alluvium (mainly coarse to medium-grained sand) from the surface to a depth of at least 80 feet. A one to two-foot thick layer of Loess (silt) was identified in two of the borings at a depth of around 42 feet below the surface in the observation well boring and 55 feet in Boring B2. Additionally, a 6-inch to 12-inch layer of silty sand was identified in two of the borings at approximately 25 feet below the surface. Samples were taken from the loess and silty sand layers for a grain size analysis with a hydrometer. Additional samples throughout the three cores were collected and are stored at WSN's Baxter office for future reference. Several of these samples were classified using grain size analysis. Groundwater was encountered at approximately 60 feet below the surface in each of the borings, with the observation well on site being set at 65 feet below the surface for long term water level measurements.

Infiltration Rate Testing

Dual-ring infiltrometer and percolation testing was completed on site on between May 17 and May 21, 2019 to measure the infiltration rate of soils near the surface. Three tests were completed across the gravel pit area, two at approximately 1-foot below the surface and one at the surface. Infiltration rates for the three sites were;

Test #	Location	Measured Infiltration Rate (in/hr)	Measured Infiltration Rate (ft/day)
1	Middle of gravel pit at the surface.	2.81	5.625
2	Near Boring 2 approximately 1-foot below the surface.	97.83	195.65
3	Near Boring 1 approximately 1-foot below the surface.	98.75	197.50

Test 1 was completed near the surface and had significant organic material (i.e., decomposed vegetation and grass roots) near the surface, which tends to slow the flow of water into the soil. Tests 2 and 3 were completed in clean, coarse sand below the root zone. The infiltrometer and percolation testing showed the soils are very conducive to infiltration.

Shallow Piezometer Installation

A total of three, 1-inch piezometers were installed to a depth of six to eight feet below the ground surface to allow for continued groundwater measurements. The three piezometers (PZ-#) were installed on the west side of Bugle Road, north of the gravel pit, and east of the gravel pit in a low area, all on the Dick brother's land. These borings found mainly sand to gravel and encountered ground water between four and eight feet below the surface. They will be used to observe water levels over time as part of the engineering and environmental review process. Boring logs for the three piezometers are included in the hydrogeologic investigation report.

Grain Size Analysis and Hydraulic Conductivity Estimates

Several soil samples from the rotosonic borings and the infiltrometer testing areas were run through sieves for a grain size analysis. The results showed the samples were medium to coarse grained sands with a bit of gravel. The Hazen Approximation technique was used to estimate hydraulic conductivity of the samples. The results indicated hydraulic conductivities of 3.3×10^{-1} to 3.6×10^{-2} cm/sec, which indicate very permeable soils that can be used for infiltration.

Assessment of Infiltration

The conditions observed in the field indicate that infiltration is feasible in the gravel pit area. The slowest infiltration rate measured was approximately 5.5 feet per day. The United States Environmental Protection Agency (EPA) has a process design manual for Land Treatment of Municipal Wastewater – Supplement on Rapid Infiltration and Overland Flow (1981). Wastewater application rates would be lower than the clean water from Lake Shamineau because of the low salt and organic content of the lake water compared to treated wastewater; however, the manual does discuss the infiltration of standing water from a basin with low surface clogging. The EPA design manual indicates that the time to drain a basin of standing water is approximately two thirds of the measured hydraulic conductivity assuming a soil porosity of 40% (sand) and basin flooding depth of one foot. Assuming a hydraulic conductivity of 5.5 feet per day, the loading could be as high as 3.63 feet per day.

At this rate, a 5-acre infiltration area could take approximately 18.15 acre-feet per day, which equates to approximately 4,100 gallons per minute or 9.15 cubic feet per second. The actual flow rate would likely be less than this, as the infiltration basin and pump(s) will need to be taken offline regularly for maintenance; however, alternating between several basins would allow for flow to be maintained with minimal downtime. The gravel pit itself is approximately 4.5 acres. An infiltration area utilizing two, two-acre cells could be constructed within the gravel pit itself; however, the estimated flow rate would be approximately 1,650 gallons per minute. As a greater flow rate is desired to lower the high-water levels on Lake Shamineau, land outside of the gravel pit will be needed for a second and/or third cell to achieve a higher flow rate.

Other Outlet Corridors Assessment

The fact that infiltration is viable for an outlet allows us to compare other outlet corridors for the high-water from Lake Shamineau. The potential for pumping water to Perch Lake (also known as Duck Lake) was assessed and quickly eliminated because topographic and LiDAR data indicated the lake does not have an outlet and pumping water to the lake would likely affect lake shore residents. Another option was to directional bore through the ridge north of Lake Shamineau all the way to the wetland area north of Stanchfield Lake; this would require extensive landowner permission and would exceed the limits of directional boring technology (it would require multiple boring pits in difficult to reach areas), so this option also does not appear feasible. A third option was a direct discharge by pumping from Lake Shamineau over the ridge to the north to a wetland on the Dick Brother's land. WSN staff viewed and assessed this route for discharge and it is a viable option; however, the wetland on the Dick's Brother's land flows east to a Public Water/Wetland. DNR staff would not approve an outlet to the Dick's Brother's wetland without a treatment process for invasive species because Lake Shamineau is infested with Eurasian milfoil. The treatment process to remove invasive species from the water pumped from Lake Shamineau, while possible, would add considerably to the cost for sand filters and possible disinfection. The treatment components would need to be in a building and maintenance requirements would be higher than the infiltration option.

In summary, WSN has determined the gravel pit area has the needed characteristics for high rates of infiltration. The DNR would not require treatment of the water pumped from Lake Shamineau because the infiltrated groundwater would infiltrate through a few hundred feet of sand and gravels, effectively filtering out any invasive species from making there way to wetlands or the Public Water/Wetland. Based on the viability of infiltration, the limited impact to wetlands, and the restriction on direct discharge of water with invasive species, WSN believes the north-northeast outlet corridor should be to infiltration basins at the Dick Brother's gravel pit. This is the outlet option we will pursue with our engineering design and report.