Prepared by: EOR

For the Comfort Lake Forest Lake Watershed District

Bone Lake Northeast Wetland Restoration Feasibility Report

May 18, 2021

Cover Image

2019 EOR Bone Lake Northeast Wetland Sediment Boring

1. BACKGROUND

Through conversations with a landowner in 2019, District staff learned that there were formerly livestock on a farm adjacent to a wetland located along the northeast shore of Bone Lake. Historic aerial imagery confirmed that a dairy farm was present at that location in 1964 (Figure 2), but not present in 1938 (Figure 3) or currently (Figure 1). Recall that the eastern portion of wetland northwest of Moody Lake, was historically used as a water source for cattle. Over time, a nutrient rich layer of sediment accumulated within the eastern portion of this wetland. This history of direct livestock access to the wetlands allowed nutrient rich runoff to flow directly into the wetlands and downstream to Moody Lake. As such, EOR and District staff conducted a small field investigation of the wetland (Figure 1) in October of 2019 to determine if there were also legacy phosphorus loads present in the wetland soils northeast of Bone Lake resulting from historical manure runoff.

Wetland soil samples collected from the Bone Lake Northeast wetland confirmed an area of phosphorus rich, accumulated sediment located near the historic farm. Surface water quality monitoring in 2020 of the two inlets and outlet of the wetland complex further confirmed an increase in phosphorus load through the wetland, indicating that a wetland rehabilitation project with excavation of the accumulated sediment containing the historic livestock phosphorus legacy loads would permanently remove this phosphorus source and make progress towards achieving the remaining 50 lb/yr reductions needed for Bone Lake to meets its long-term water quality goals.

This report summarizes the results of a feasibility study conducted by the District and EOR in 2020 and 2021 that indicate implementation of the Bone Lake NE Wetland Restoration Project is feasible and cost-effective:

- Permitting Needs
  - Permitting needs assessment
  - Wetland delineation
- Field Data Collection
  - Surface water quality monitoring
  - Existing conditions base CADD drawings
  - Soil coring results
- Design Recommendations
  - Wetland restoration preliminary design
  - Concept CADD drawings
  - Preliminary cost estimates
  - Operation and maintenance considerations

Figure 1. Proposed wetland location for legacy load field investigation on the northeast shore of Bone Lake

Figure 2. 1964 aerial image showing presence of the historic feedlot

Figure 3. 1938 aerial image showing absence of the historic feedlot

2. DATA COLLECTION

The objective of the soil borings collected in 2019 and stream load monitoring conducted in 2020 was to determine if a legacy load is present in the wetland, and if so, the general extent of the accumulated, nutrient rich sediment in the wetland.

2.1. Surface Water Monitoring

A preliminary grab sample was collected and analyzed for total and ortho-phosphorus from the wetland discharge following a rain event on July 15, 2019. Total phosphorus concentration in the water quality sample was 0.58 mg/L, of which 0.55 mg/L was ortho-phosphorus. Based on this result, load monitoring stations were established at the wetland outlet (WETO in Figure 4), and the two major overland runoff inputs (238th E and MELT in Figure 4) as part of the 2020 diagnostic monitoring effort in the Bone Lake Management District.

In 2020, the NE Wetland Outlet had the highest phosphorus concentration of the five tributaries (452 µg/L) and contributed a disproportionate share of the total monitored load to Bone Lake (6% of the total load compared to 3% of the total flow; Table 1). Phosphorus concentrations were higher at the outlet of the NE Wetland compared to the major inlet at 238th E which suggests that the NE Wetland may be acting as a phosphorus source to Bone Lake. In addition, the total watershed TP load to the Bone Lake northeast wetland was 45.7 lb/yr and the total TP load discharged from the wetland was 37.8 lb/yr for a total TP reduction through the wetland of 7.9 lb/yr. A normally functioning wetland would be expected to remove at least 50% of the watershed phosphorus loads (or 22.8 lb/yr), indicating that the existing legacy TP load from this wetland is at least 15 lb/yr.

Table 1. 2020 Bone Lake Diagnostic and Effectiveness Monitoring Summary

Italicized rows indicate monitoring site(s) upstream of the non-italicized site listed below them.

Monitoring Site	Discharges to:	TP Conc. (ug/L)	Flow (ac-ft)	Flow (% total)	TP Load (lb/yr)	TP Load (% of total)
BLNI	Bone Lake	209	265	24%	150.7	25%
238th E	*NE Wetland Outlet*	*221*	*76*		*43.5*	
Melanie Tr	*NE Wetland Outlet*	*462*	*1.7*		*2.2*	
NE Wetland Outlet	Bone Lake	452	31	3%	37.8	6%
Farm Site	*Meadowbrook*	*408*	*53*		*58.8*	
Meadowbrook	Bone Lake	282	284	25%	217.5	36%
228th E	Bone Lake	250	38	3%	26.0	4%
228th W	Bone Lake	127	497	45%	171.0	28%
Total			**1,115**		**603.0**	

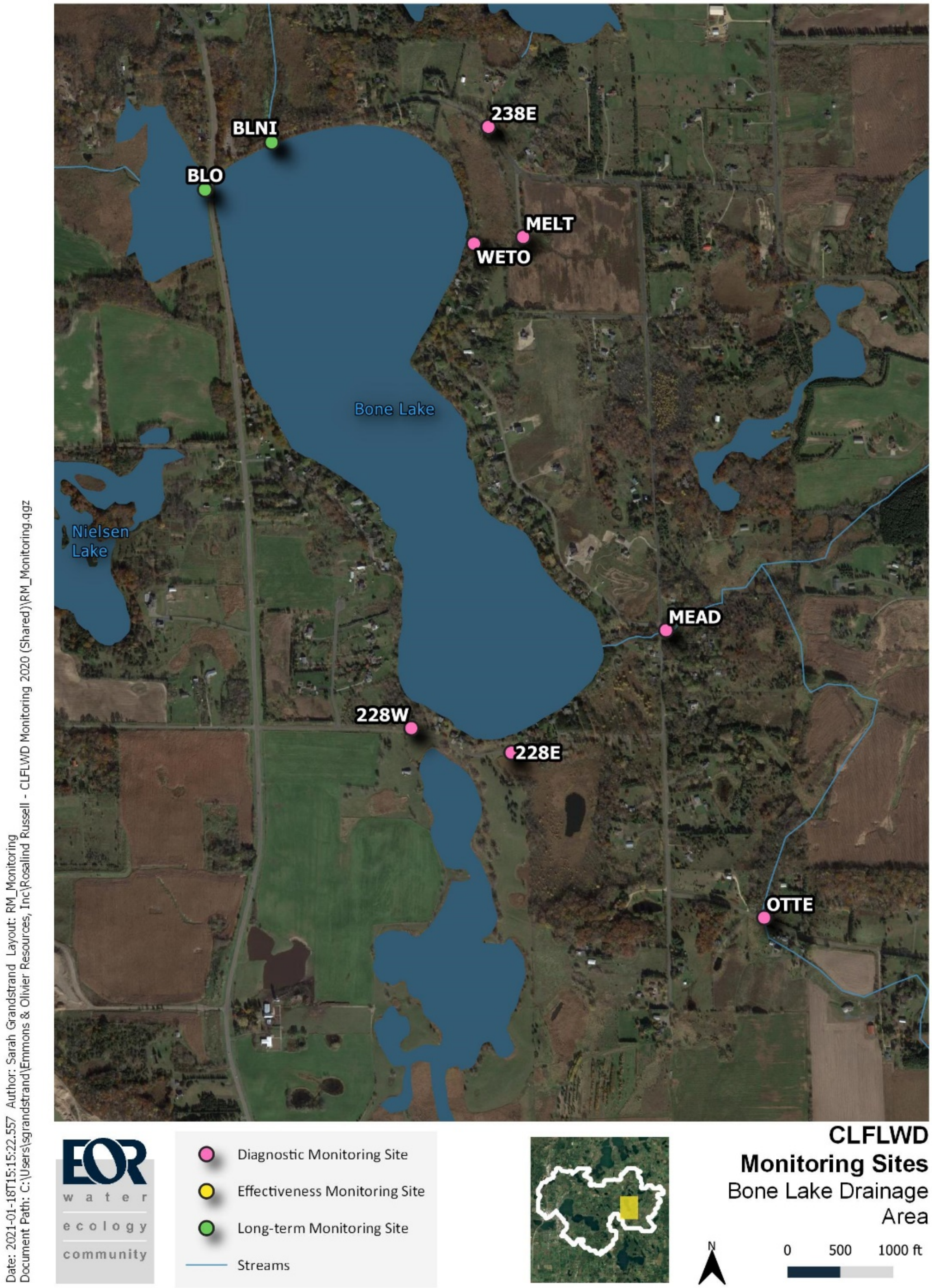


Figure 4. 2020 diagnostic and effectiveness monitoring sites in the Bone Lake Drainage Area of the Bone Lake Management District

2.2. Wetland Soil Borings

A total of 23 soil borings were collected over two sample dates (October 18, 2019 and July 20, 2020) along transects (see Figure 7 in Appendix A) through the wetland to determine the areal extent and depth of accumulated, phosphorus-rich sediment. These cores were assessed for the presence and depth of accumulated sediment based on visual changes in soil horizons. Soil samples were collected at several representative depths from each soil boring and analyzed for total phosphorus, percent organic matter, and dry density. Soil data are summarized by core transect in Appendix A. TP concentrations reported for undisturbed wetland soils range from 250-550 mg TP/kg of dry sediment (Mukherjee *et. al.*, 2009).

Cores collected from the northern portion of the wetland were consistently greater than the undisturbed wetland soils (range of 250-550 mg TP/kg), often exceeding 1,000 mg TP/kg. Cores with high phosphorus concentrations and evidence of accumulated sediment types (muck, inorganics) would indicate impact from historic manure runoff. Nearly all of the cores north of wetland transect D-D' had high phosphorus concentrations and presence of accumulated sediment types to a depth of 2-4 feet. These data were used to inform the preliminary design described in Section 3.4.

The traditional perception of wetlands as nutrient sinks has limitations. Excessive nutrient loading in wetlands accelerates primary productivity and increases net accumulation of organic matter and nutrients (phosphorus) especially in the portions of the wetland closest to inflow points. Over time, the accumulation of phosphorus within the wetland sediments can become the main source of phosphorus to the wetland, even in years with low external inputs. Soil phosphorus accumulation as a function of distance to inflow is a well-documented phenomenon (Figure 5; Reddy et al., 1993).

Consistently high phosphorus concentrations observed in the soil cores collected closest to the former feedlot operation, in addition to lower-than-expected TP load reductions through the wetland (see Section 2.1), provide evidence to suggest that this portion of the wetland is likely a source of TP to Bone Lake even though the cattle are no longer present today. Therefore, the data support a targeted excavation of phosphorus-rich, accumulated sediment in the areas of the wetland closest to the former feedlot operation to permanently remove legacy TP loads and improve the water quality of Bone Lake.

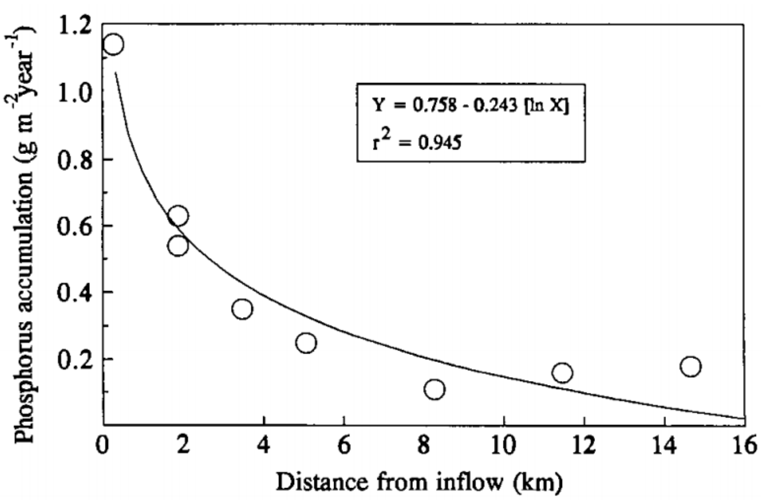


Figure 5. Phosphorus accumulation rates as a function of distance from surface inflows (Reddy et al., 1993).

3. PROJECT FEASIBILITY

3.1. Landowner Agreements

District staff is currently working to finalize and execute the easement for the project. The landowners have committed to project implementation and did submit a letter of support for the project that was used to in the grant application process. An easement has been drafted and approvals from the City of Scandia (utility and drainage easement consent) and from the mortgage company (non-disturbance agreement and project consent) are in progress. The landowners have reviewed the draft easement and are assisting the District in coordinating with the mortgage company.

3.2. Permitting Needs

EOR investigated the need for and requirements of project permits from applicable permitting agencies, including: MPCA (NPDES and SWPPP), City of Scandia, Washington County, BWSR, and USACOE. A summary of the applicable permits and requirements are listed in Table 2. Only a state SDS construction stormwater permit and SWPPP and local and federal Wetland Conservation Act (WCA) permits will be needed for this project.

A construction stormwater permit is standard practice for these projects and will be submitted by the contractor. EOR will develop the construction SWPPP as part of the construction plan sheets.

EOR completed a wetland delineation on 8/13/2020 in accordance with the 1987 Corps of Engineers Wetland Delineation Manual and regional supplements for the Northeast-Northcentral Region. One wetland consisting of Type 3 Shallow Marsh and Type 6 Shrub Swamp was delineated at the project site (Figure 6).

EOR submitted a Boundary and Type Joint Application on 10/12/2020 on behalf of the Comfort Lake Forest Lake Watershed District for the proposed Bone Lake NE Wetland Restoration Project. EOR hosted a Technical Evaluation Panel (TEP) meeting on 10/16/2020 with Jay Riggs (LGU/WCD) and Ben Meyer (WCD). The TEP concurred with EOR's findings and issued a Notice of Decision approving the wetland boundary and types on 11/9/2020.

A second Joint Application will be submitted for review by the LGU after finalization of site construction plans. This application will provide details on the proposed construction plan and will request a no-loss decision under WCA and the Clean Water Act, assuming final project design meets no-loss criteria.

An EAW is currently not expected to be required for this project.

Table 2. Project permitting requirements

Permitting Agency	Permit	Application Requirements	Timeline
MPCA	NPDES/SDS construction stormwater permit for construction activities disturbing one acre or more of soil	SWPPP completed by EOR as part of construction drawings	Permit coverage begins 7 days after contractor completes and submits application electronically through MPCA e-Services

Permitting Agency	Permit	Application Requirements	Timeline
Federal: USACOE St. Paul District **State:** The City of Scandia is the WCA LGU. Washington Conservation District provides wetland regulatory services to the City.	Wetland Permitting: No-loss for excavation of contaminated sediment in a Type 3 wetland.	Joint Application form, wetland delineation, demonstration of contaminated sediment and minimum excavation to achieve desired purpose, final construction plans, and language on how the project meets the no-loss determination.	Joint Application and supporting documentation can be submitted following completion of final site plans. No –loss approval expected within 30- days of submittal. Mitigation permitting, if required, could extend permitting out to 120 days.

Figure 6. Approved wetland delineation boundary and types.

3.3. Existing Site Conditions

EOR completed a topographic survey of the project area including both upland and wetland bathymetry and requested existing utility information from the City of Scandia and known public utilities. An existing conditions plan with surveyed utilities is included in Appendix B.

3.4. Preliminary Design

Following completion of soil borings within the wetland, the results were investigated to determine locations of phosphorus-laden soil for removal. Soils with high phosphorus concentrations and evidence of accumulated sediment types (muck, inorganics) would indicate impact from historic manure runoff. Nearly all of the sediment cores north of wetland transect D-D' had high phosphorus concentrations and presence of accumulated sediment types to a depth of 2-4 feet (see Appendix A). Based on this analysis, areas within the wetland were targeted for sediment removal of 2.2 feet on average and up to 4 feet in some locations. A feasibility design plan is attached as Appendix C.

This wetland excavation will remove the phosphorus-leaching soils while providing the added benefit of creating deeper pool of open water in the wetland that will increase residence time for future sediment accumulation. Removing the targeted nutrient-rich soils is anticipated to require 5,500 cubic yards of sediment removal over 1.55 acres of the wetland (10.81 acres estimated total footprint). In addition to the wetland sediment excavation, this project will establish a 450-ft long native vegetation buffer around the wetland in the areas that are currently turf grass to provide additional filtering for runoff directly entering the wetland.

3.5. Preliminary Cost Estimate

A preliminary cost estimate was created for the feasibility design detailed above. Unit costs were determined utilizing recent similar construction project bid results both within the District and in the greater Twin Cities metro area. The project has a feasibility construction cost estimate of <u>$200,130.00</u>. This cost is based on preliminary design and has an estimated accuracy range of $185,120.00.25 to $215,139.75 (+/-7.5% per ASTM E 2516-06 level of design.) This cost is based on preliminary design and will vary as design progresses forward.

3.6. Water Quality Benefits

This project is estimated to reduce watershed phosphorus loads to Bone Lake by at least 15 lb/yr (or 33% of the remaining 50 lb/yr reduction needed for Bone Lake to achieve the District long-term goal of 30 µg/L). In 2020, the total watershed TP load to the Bone Lake northeast wetland was 45.7 lb/yr and the total TP load discharged from the wetland was 37.8 lb/yr. A normally functioning wetland would be expected to remove at least 50% of the watershed phosphorus loads, indicating that the existing legacy TP load from this wetland is at least 15 lb/yr. Therefore, removal of the phosphorus-rich wetland soils is expected to result in legacy TP load reductions of up to 15 lb/yr from within the wetland itself. In addition, a PondNET model predicted the wetland enhancement would result in a removal of 11.2 lb TP/yr from watershed runoff inputs due to the increased open water area within the wetland (based on an open water surface area of 1.55 acres, an open water mean depth of 2.2 feet, the 2020 monitored watershed load of 43.5 lb TP/yr and the 2020 monitored watershed runoff volume of 76 ac-ft). The total phosphorus load reduction resulting from the Bone Lake northeast wetland restoration project is expected to range from 15 lb TP/yr (based on the predicted legacy TP load reductions from the 2020 monitoring data) to 26 lb TP/yr (based on legacy and watershed runoff TP load reductions).

3.7. Operation & Maintenance Considerations

Operation and maintenance should be relatively minimal for this project. The selected Contractor awarded the construction contract for this project will be responsible for 3-year extended maintenance and warranty of the native vegetation on the site to ensure a strong vegetative buffer in addition to the standard 1-year project warranty. It is recommended District staff inspect the vegetation establishment regularly and work closely with the Contractor during this warranty period to ensure successful native vegetation. Seasonal inspections (Spring & Fall) are recommended following the conclusion of the Contractor's warranty period.

Annual visual inspections of the wetland by District staff are recommended to identify and monitor any sediment or foreign inputs into the wetland. District staff should also regularly check in with the landowner for any observation and/or concerns regarding project components.

REFERENCES

Mukherjee, A., Nair, V. D., Clark, M. W., and Reddy, K. R. 2009. Development of indices to predict phosphorus release from wetland soils, J. Environ. Qual., 38, 878–886, 2009.

Reddy, K. R., et al. "Long-term nutrient accumulation rates in the Everglades." Soil Science Society of America Journal 57.4 (1993): 1147-1155.

APPENDIX A. SOIL BORING RESULTS

Transect A-A'

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
11	749	282	1,100	680	870	390		
3	1,050							269

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
11	M-SA	M-SA/SI-M	SI-M/P	P	M-P	M-P/M-C		
3	M	M/M-P	M	M	M	M	C-M	S-M

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
11								
3								

Transect B-B'

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
1	3,100		5,210					802
2	260				678		880	309
12	2,800		910					

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
1	P/M-P	M-P	M	M	M	M	M	M
2	M-S	M	M	M	M	M	M-P	P-M/ P
12	M-P	M-P	M-P/P	P	P	P	P	P

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
1								
2								
12								

Transect C-C’

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
9	**800**		**560**				**250**	
6	**795**			**584**		**509**		
4	**1,000**				**520**			**320**

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
9	SA-P	SI-P-M	C-SI	C-SI	SI-C/SI-SA	SI-SA		
6	M-P	M-P	M-P	M-P	M-P/S-M	P		
4	P-M	P-M	P-M	P-M	S-C	S-C	S-C	S-C

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
9								
6								
4								

Transect D-D’

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
10	**570**	**480**	**450**	**490**				
7	**755**					**625**		
5	**221**					**342**	**183**	

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
10	M	SI/SA-M	SI-C	SI-C	SI-C	C		
7	P-M	P-M	P-M	P-M	M-P	M-P	M-P	M-P
5	M-P	SI-M	SI-M	SI-M	SI-P	SI-P	SI-C	G-SA

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
10								
7								
5								

Transect E-E'

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
15	890		490	490				
14	1,100	1,000	710	710	710			
13	600	680	460	260	260	260	260	260
8	1,200				1,100			

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
15	M-P	P	P	M-P	M-P	M-P		
14	M-P	P	P	P	P			
13	P	M	C-M	C	SA-C	SA-C		
8	M-P	P	P	P	P			

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
15								
14								
13								
8								

Transect F-F’

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
15	890		490	490				
16	590		620	620	410	410		
17	800-820	580		460				

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
15	M-P	P	P	M-P	M-P	M-P		
16	P	P	M-P	M-P	M-P	M-P		
17	P	M-P	P	P	P	P		

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
15								
16								
17								

Transect G-G’

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
19	700-730			630				
18	410		470					
17	800-820	580		460				

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
19	M	P-M	P-M	P-M	P-M	P-M		
18	P	P	P	P	M-P	M-P		
17	P	M-P	P	P	P	P		

Proposed Excavation:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48”
19								
18								
17								

Transect H-H'

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
19	**700-730**			**630**				
20	**640**	**270**		**340**		**1,000**		
21	**490**		**620**			**370**		
22	**730**		**520**		**590**			

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
19	M	P-M	P-M	P-M	P-M	P-M		
20	P	M	P-M	P	M-P	M-P		
21	P	P	P	P	P	P		
22	P	P	P	P	P	P		

Wetland Outlet

TP Concentrations:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
23	**930**				**190**	**260**		

Soil Type:

Soil Boring	1-6"	7-12"	13-18"	19-24"	25-30"	31-36"	37-42"	43-48"
23	P	P	M	SA-M	SA-M	SA-C		

Proposed Excavation: None

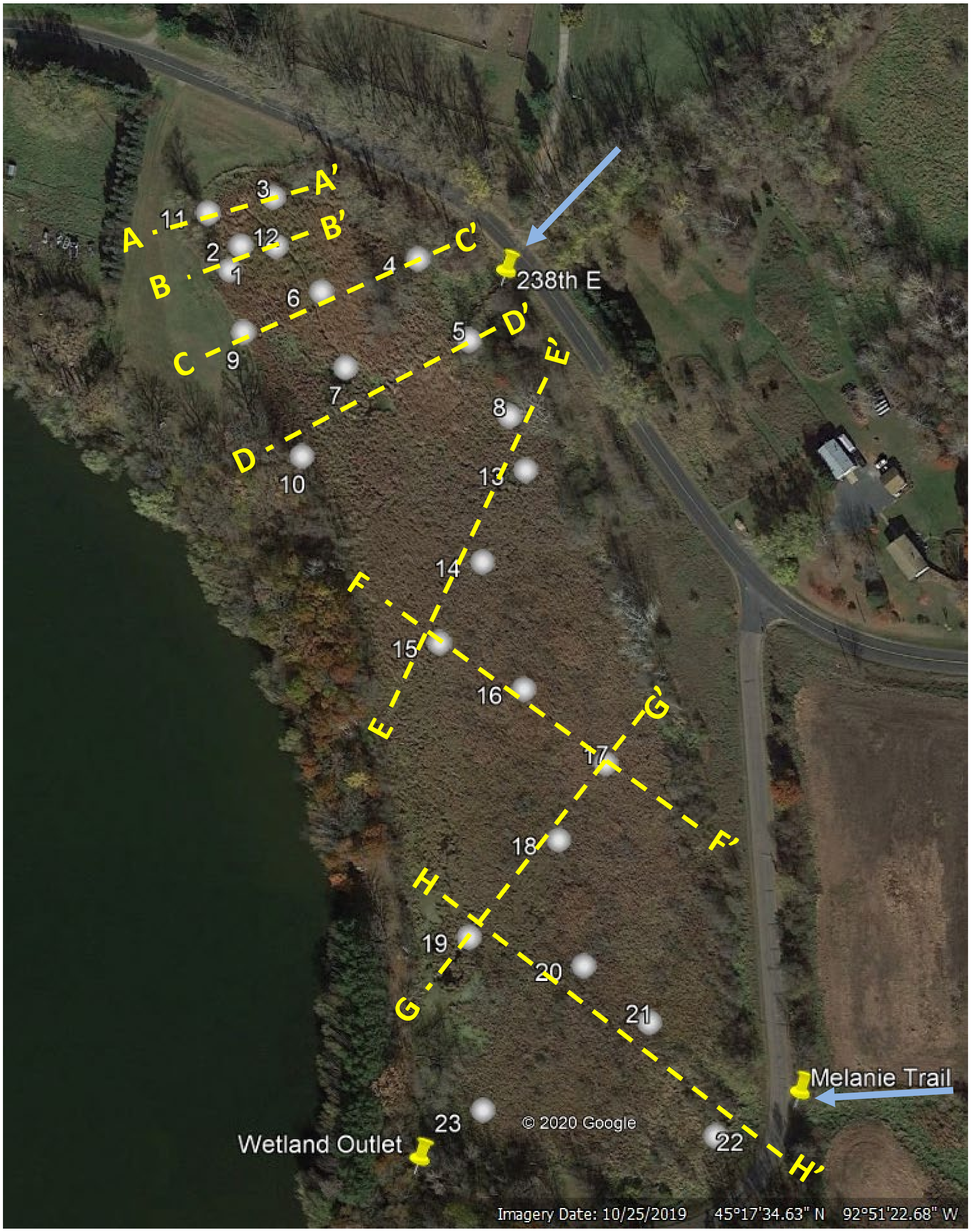


Figure 7. Plan view of Bone Lake Northeast Wetland with soil boring & transect locations and overland flow inlet points.

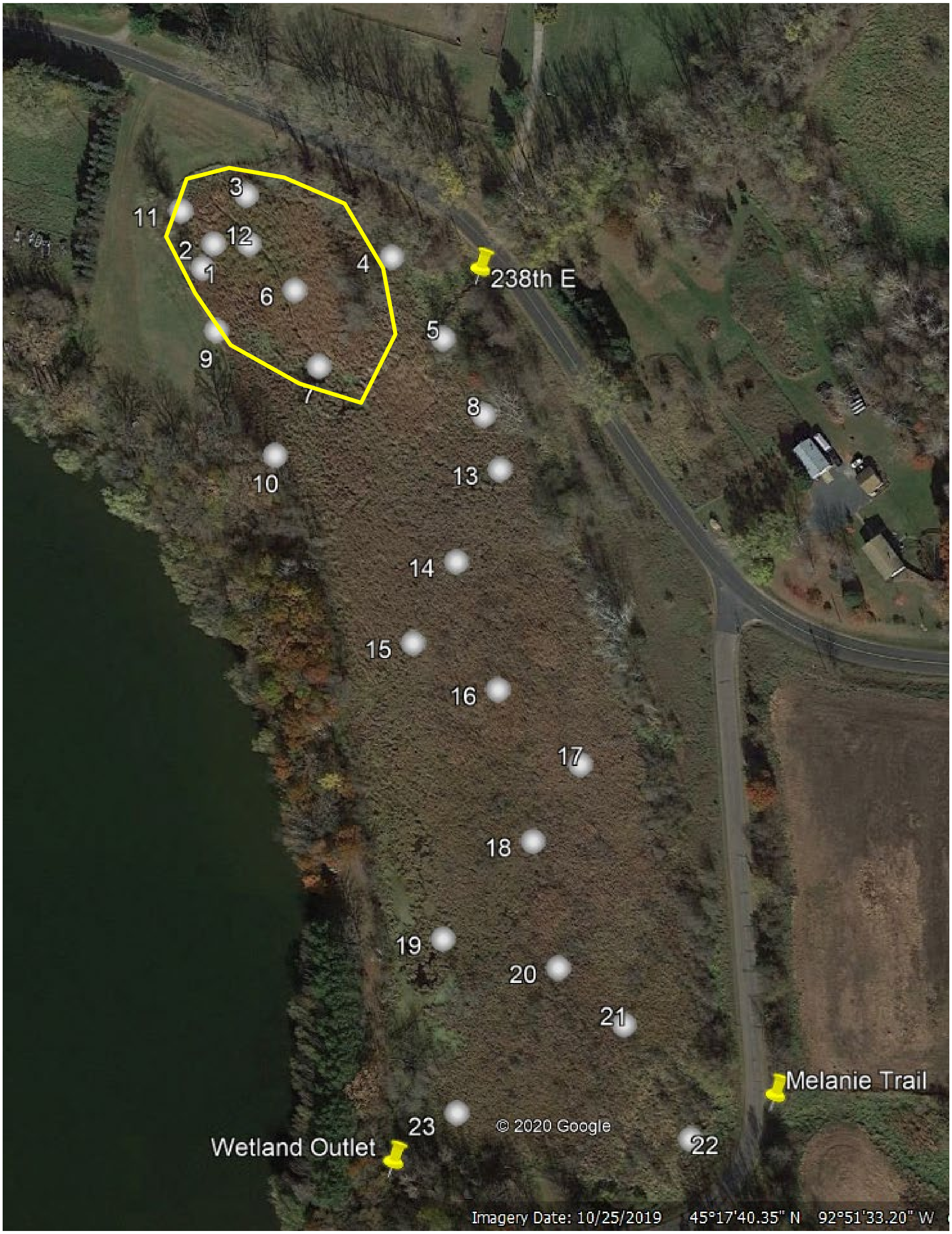
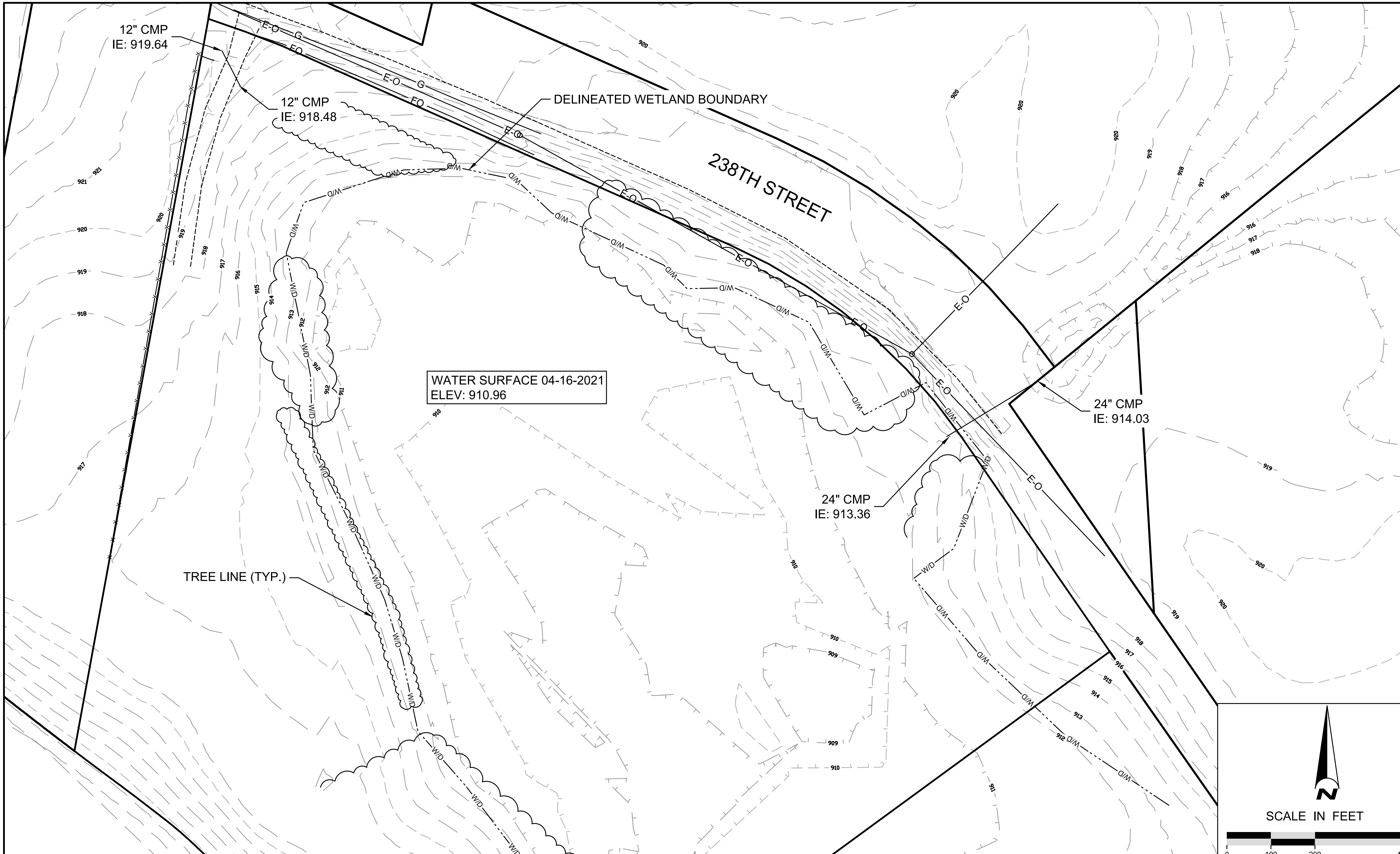


Figure 8. Proposed Excavation area based on soil TP and type data

APPENDIX B. EXISTING SITE CONDITIONS



NO	DATE	BY	REVISION
6			
5			
4			
3			
2			
1			

NOT FOR CONSTRUCTION

SUBMISSION DATE: 05-11-2021
DESIGN BY KDC
DRAWN BY BR
EOR PROJECT NO. 00376-0181

EOR water ecology community
Emmons & Olivier Resources, Inc.
1919 Univ. Ave W #300
St. Paul, MN 55104
Tele: 651.770.8448
www.eorinc.com

COMFORT LAKE - WATERSHED DISTRICT - FOREST LAKE

BONE LAKE NE WETLAND
FOREST LAKE, WASHINGTON COUNTY, MINNESOTA

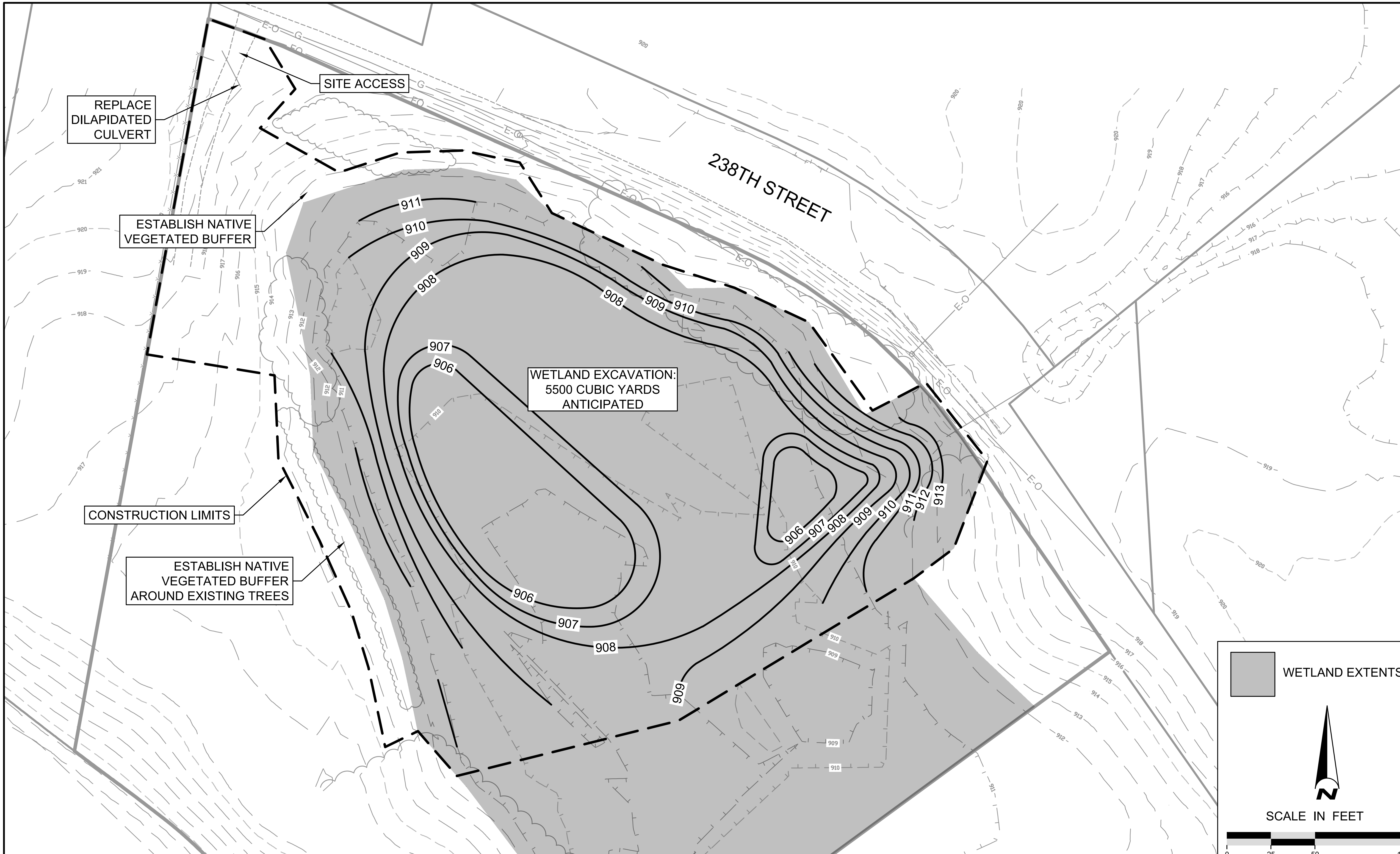
STATE PROJECT NO. ---
CITY PROJECT NO. #

EXISTING CONDITIONS PLAN

SHEET 01 OF 06 SHEETS

Plot Date: 05/11/2021
Drawing name: X:\Clients_WD\00376_CLFLWD\0181_Bone_Lake_Legacy_Load\09_GIMS\dwg\376-0181_CD.dwg
Xrefs: X-Base2, P-Base

APPENDIX C. PRELIMINARY PROJECT DESIGN



NO	DATE	BY	REVISION
6			
5			
4			
3			
2			
1			

NOT FOR CONSTRUCTION

SUBMISSION DATE: 05-11-2021

DESIGN BY KDC | DRAWN BY BR

EOR PROJECT NO. 00376-0181

EOR water ecology community

Emmons & Olivier Resources, Inc.
1919 Univ. Ave W #300
St. Paul, MN 55104
Tele: 651.770.8448
www.eorinc.com

COMFORT LAKE - WATERSHED DISTRICT - FOREST LAKE

BONE LAKE NE WETLAND
FOREST LAKE, WASHINGTON COUNTY, MINNESOTA

STATE PROJECT NO. ---
CITY PROJECT NO. #

FEASIBILITY DESIGN

SHEET 01 OF 01 SHEETS

Plot Date: 05/12/2021
Drawing name: X:\Clients_WD\00376_CLFLWD\0181_Bone_Lake_Legacy_Load\09_GMS\dwg\376-0181_CD.dwg
Xrefs: X-Base2, P-Base