

Geotechnical Exploration Report

Roseau Lake Rehabilitation
Roseau County, Minnesota

October 4, 2017

Terracon Project No. M5175049

Prepared for:

Roseau River Watershed District
Roseau, Minnesota

Prepared by:

Terracon Consultants, Inc.
Grand Forks, North Dakota

terracon.com

Terracon

Environmental



Facilities



Geotechnical



Materials

October 4, 2017

Roseau River Watershed District
108 3rd Ave SW
Roseau, MN 56751

Attn: Ms. Tracy Halstensgard
P: [218] 242 1737
E: rrw@mnrcable.net

Re: Geotechnical Exploration Report
Roseau Lake Rehabilitation
Roseau County, Minnesota
Terracon Project No. M5175049

Dear Ms. Halstensgard:

Terracon Consultants, Inc. has completed the geotechnical exploration services for the above referenced project. This study was performed as directed by HDR in general accordance with our proposal number PM5175049 dated May 23, 2017. This report presents the findings of the subsurface exploration.

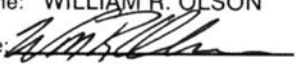
We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.



Jonathan J. Malaterre, EI
Staff Engineer

Enclosures
cc: 1 – HDR

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.	
Print Name: WILLIAM R. OLSON	
Signature: 	
Date: 10/4/17	License # 46391

William R. Olson, PE
Geotechnical Department Manager

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**GEOTECHNICAL EXPLORATION REPORT
ROSEAU LAKE REHABILITATION
ROSEAU COUNTY, MINNESOTA**

Terracon Project No. M5175049

October 4, 2017

INTRODUCTION

services were completed for Roseau Lake in Roseau County, Minnesota.) soils borings were proposed, however, due to site access, only sixteen (16) soil advanced to depths ranging from 20 to 60 feet below existing grade. Logs of the with a Site Location Map, and an Exploration Plan are included in Appendix A of

1.0 INTRODUCTION

PROJECT INFORMATION

2.1 Project Description

The project included advancing soil borings and performing laboratory testing as directed by HDR, Inc.

2.2 Site Location and Description

Item	Description
Location	The project was located at several different locations at the existing Roseau Lake 5 ½ miles northwest of Roseau, Minnesota. See Appendix A, Exhibit A-1: Site Location Map and Exhibit A-2: Exploration Plan.
Existing improvements	None
Existing topography	Agricultural fields/wetlands
Current ground cover	Trees/agricultural fields/grass

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency
1	1 ½ to 6	Topsoil/existing fill	N/A
2	4 ½ to 9 ½	Lean clay/silt with various amounts of sand	Ranges from soft to medium stiff
3	36 ½	Dark gray fat clay	Ranges from very soft to soft
4	Undetermined	Sandy lean clay	Ranges from soft to hard

Conditions at each boring location are indicated on the attached individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report. A discussion of the field sampling is included in Appendix A.

3.2 Groundwater

The boreholes were observed while drilling for the presence and level of groundwater. The groundwater levels measured in the boreholes can be found on the boring logs and are summarized below.

Boring number	Depth of groundwater while drilling, ft.
B-8	31
B-12	12
B-16	7 ½

Groundwater was not observed in the remaining borings while drilling or for the short duration they were allowed to remain open. However, this does not necessarily mean these borings terminated above groundwater or that the measurements above are static groundwater levels. Due to the low permeability of the soils encountered in the borings, a relatively long period of time may be necessary for a groundwater level to develop and stabilize in a borehole in these materials. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

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Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the building may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 GENERAL COMMENTS


The information presented in this exploration summary report is based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This exploration summary report does not reflect variations that may occur between borings or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that the need for further exploration and testing can be evaluated. Any interpretation or design performed by others based on this data is done at their risk.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This exploration summary report has been prepared for the exclusive use of our client and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Analysis, design, and associated recommendations as well as site safety, excavation support, dewatering requirements are the responsibility of others.

APPENDIX A
FIELD EXPLORATION





 AERIAL PHOTOGRAPHY PROVIDED BY
 MICROSOFT BING MAPS

DIAGRAM IS FOR GENERAL LOCATION
 ONLY, AND IS NOT INTENDED FOR
 CONSTRUCTION PURPOSES

Project Manager: JMM
 Drawn by: JLM
 Checked by: WRO
 Approved by: WRO

Project No. M5175049
 Scale 1"=2,000'
 File Name:
 Date: 10/2/2017



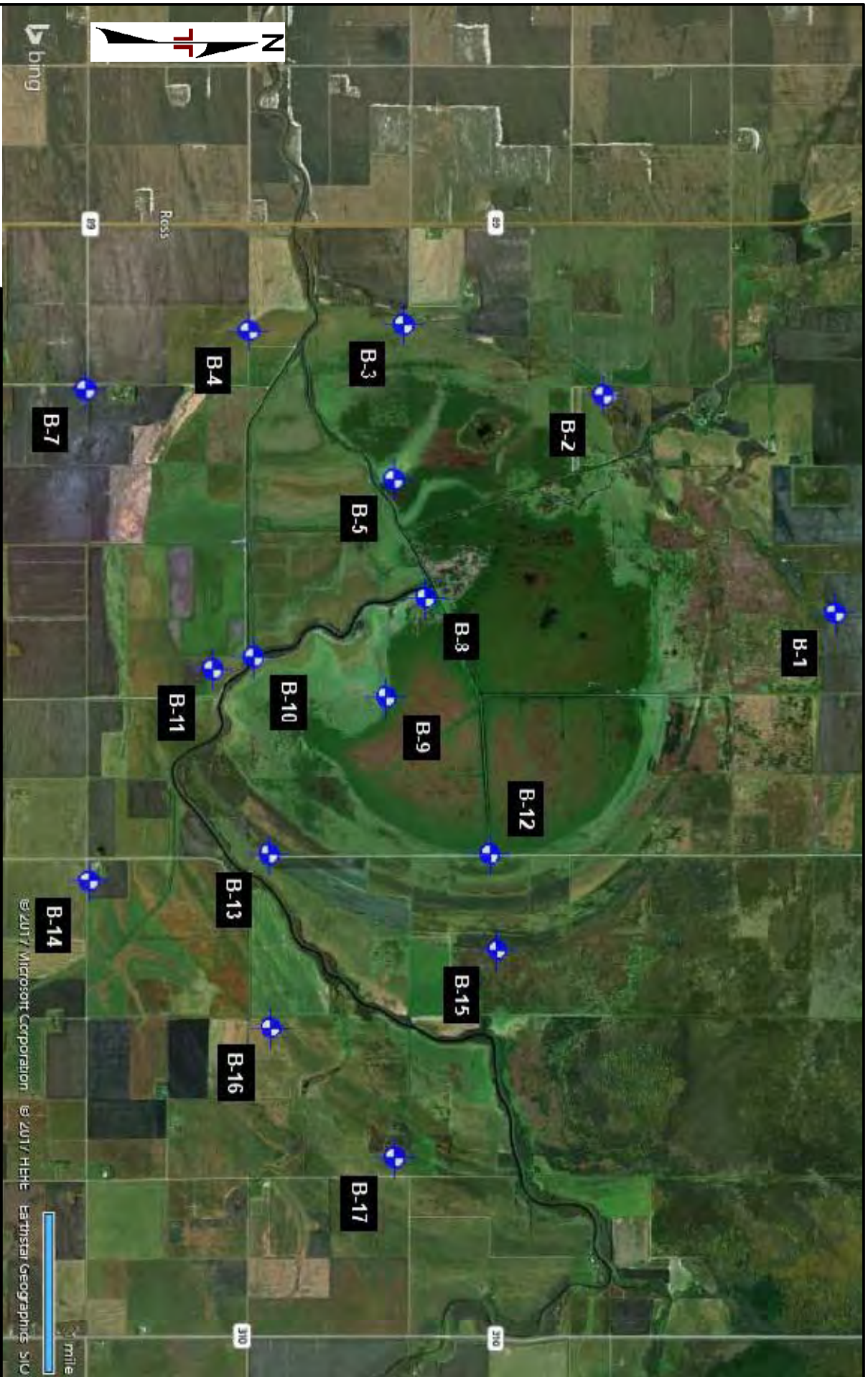
 1555 N 42nd St, Unit B
 Grand Forks, ND 58203-0809

SITE LOCATION

Roseau Lake Rehabilitation
 Roseau County
 Roseau, Minnesota

Exhibit
 A-1

© 2017 Microsoft Corporation © 2017 HERE Earthstar Geographics SIO



AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

Project Manager: JMM
 Drawn by: JMM
 Checked by: WRO
 Approved by: WRO

Project No: M5175049
 Scale: AS SHOWN
 File Name:
 Date: 10/2/2017

Terracon
 1555 N 42nd St, Unit B
 Grand Forks, ND 58203-0809

EXPLORATION PLAN
 Roseau Lake Rehabilitation
 Roseau County
 Roseau, Minnesota

Exhibit
A-2

Geotechnical Exploration Report

Roseau Lake Rehabilitation ■ Roseau County, Minnesota

October 3, 2017 ■ Terracon Project No. M5175049



Field Exploration Description

Sixteen (16) soil test borings were completed from August 9 – 16. The borings were advanced at the approximate locations selected by HDR, Inc. as indicated on Exhibit A-2. The coordinates indicated on the boring logs were obtained using a hand-held GPS unit. The locations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a track-mounted rotary drill rig using 3 ¼ hollow stem augers to advance the boreholes. Soil samples were obtained using split-barrel and Shelby tube sampling procedures. In the split-barrel sampling procedure the number of blows required to advance a standard 2-inch O.D., 1-3/8-inch I.D split-barrel sampler from 6 to 18 inches of penetration by means of a 140-pound hammer with a free fall of 30 inches is used to obtain the Standard Penetration Test (SPT) or N-value. The SPT is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils. In the Shelby tube sampling procedure, a thin wall seamless steel tube with a sharp cutting edge is pushed into the soil by hydraulic pressure to obtain a relatively undisturbed sample of cohesive soil.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed at this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions.

Upon completion, our borings were sealed from the bottom up to the ground surface with high solids bentonite grout in accordance with state regulations. Copies of the sealing records are attached.

A field log of each boring was prepared by the drill crew. These logs included visual classifications of the materials encountered during drilling as well as the driller's interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.95859° Longitude: -95.86783°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
		6.0		X	0.5	5-2-3 N=5						
		6.0		X	0.7	2-2-3 N=5						
		6.0		X	0.9	2-2-3 N=5						
		10.0			2.2			30	54-17-37			
		10.0		X	1.5	2-1-3 N=4						
		14.5		X	1	1-1-2 N=3						
		14.5		X	1.5	0-1-1 N=2						
21.0		X	1.5	0-0-1 N=1								
Boring Terminated at 21 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

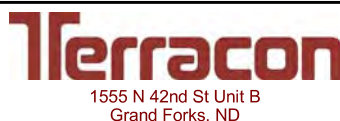
See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343623

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-14-2017

Boring Completed: 08-14-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.93775° Longitude: -95.89762°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	TOPSOIL - ORGANIC CLAY (OH) , black		X		0.7	3-3-3 N=6					
6.0	LEAN CLAY WITH SAND (CL) , gray, soft, silt lenses		X		0.7	2-2-2 N=4					77
6.0	SILT WITH SAND (ML) , gray, stiff		X		1.3	1-1-1 N=2					
10.0	FAT CLAY (CH) , dark gray, soft, silt lenses		X		1	3-5-7 N=12		14		NP	81
10.0	FAT CLAY (CH) , dark gray, soft, silt lenses		X		1.3	3-2-2 N=4					
15.0			X		1.5	2-1-2 N=3					
15.0			X		1.5	1-1-0 N=1					
21.0			X		1.1	0-1-1 N=2					
Boring Terminated at 21 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

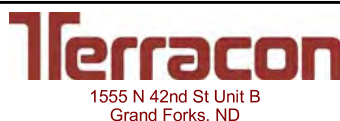
Advancement Method:
3 ¼ inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343624

WATER LEVEL OBSERVATIONS
No free water observed



Boring Started: 08-14-2017

Boring Completed: 08-14-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-5




BORING LOG NO. B-3

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB. RECOVERED.GPJ TERRACON.DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.91982° Longitude: -95.90733°	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
											LL-PL-PI		
	TOPSOIL - ORGANIC CLAY (OH) , black	1.5				0.1	2-1-2 N=3						
	SANDY LEAN CLAY (CL) , trace gravel, olive brown and yellow, medium stiff to stiff to medium stiff		5			1	2-3-2 N=5						
			5			1.1	3-4-6 N=10						
			10			1.1	3-5-7 N=12						
			10			1.5	4-4-4 N=8						
	SANDY FAT CLAY (CH) , trace gravel, dark gray, stiff	12.0				2.3			12		59-15-44		
			15			1.5	3-4-5 N=9						
			20			1.5	4-4-5 N=9						
	Boring Terminated at 21 Feet	21.0											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

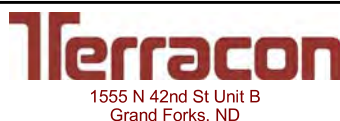
See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343625

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-16-2017

Boring Completed: 08-16-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-6








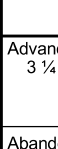
BORING LOG NO. B-4

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90591° Longitude: -95.90643°	DEPTH	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
	TOPSOIL - ORGANIC CLAY (OH) , black	1.5		X	1	2-4-4 N=8		30				
	FAT CLAY (CH) , dark gray, medium stiff, silt lenses	4.5		X	1.1	2-2-2 N=4		28				
	SANDY LEAN CLAY (CL) , trace gravel, olive brown, medium stiff	9.5		X	1	2-2-3 N=5						
	SANDY LEAN CLAY (CL) , trace gravel, gray, medium stiff	21.0		X	1.5	2-3-3 N=6		14		20-11-9		
	SANDY LEAN CLAY (CL) , trace gravel, gray, medium stiff			X	1.3	2-3-3 N=6						
				X	1.5	2-4-4 N=8						
				X	1.3	2-3-4 N=7						
				X	1.3	2-4-5 N=9						
Boring Terminated at 21 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

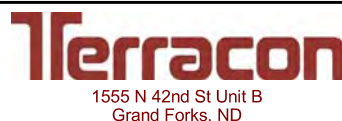
Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343627

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-16-2017

Boring Completed: 08-16-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-7

BORING LOG NO. B-5

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.91898° Longitude: -95.88615°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	1.5	TOPSOIL - ORGANIC CLAY (OH) , black		X	0.3	2-2-3 N=5					
		LEAN CLAY (CL) , dark gray, soft, silt lenses, iron concretions	5		X	1	1-2-1 N=3				
					X	1.3	2-1-2 N=3				
					X	1.1	2-1-2 N=3				
	8.5	FAT CLAY (CH) , dark gray, very soft to soft, silt lenses	10		X	1.5	0-0-1 N=1				
					X	1.5	0-1-1 N=2				
		15		X	1.5	0-1-1 N=2					
		20		X	1.1	1-1-1 N=2					
	Boring Terminated at 21 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

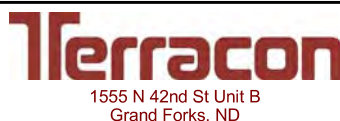
See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343626

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-16-2017

Boring Completed: 08-16-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-8

BORING LOG NO. B-7

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.89126° Longitude: -95.8984°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	TOPSOIL - ORGANIC CLAY (OH) , black		X		1	4-4-5 N=9					
6.0	SILT WITH SAND (ML) , gray, medium stiff		X		1.1	2-3-2 N=5					
9.5	SANDY LEAN CLAY (CL) , trace gravel, dark gray, soft		X		1.3	3-3-3 N=6					
14.5	LEAN CLAY (CL) , trace organics, dark gray and black, soft		X		1.3	1-1-1 N=2					
21.0	FAT CLAY (CH) , dark gray, soft, silt lenses		X		1	0-1-1 N=2					
21.0	Boring Terminated at 21 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

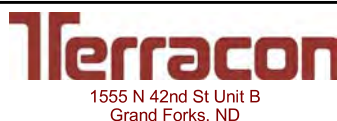
Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343629

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-16-2017

Boring Completed: 08-16-2017

Drill Rig: D-90

Driller: CAS

Project No.: M5175049

Exhibit: A-9

BORING LOG NO. B-8

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.92181° Longitude: -95.86994°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
	DEPTH 1.5 4.5	TOPSOIL - ORGANIC CLAY (OH), black and dark gray LEAN CLAY (CL), brown, soft, silt lenses FAT CLAY (CH), dark gray, soft, silt lenses	0.5 1.1 1.5 1 0.8 1.3 2.1 1.5 1.5 1.5	X X X X X X X X	0.5 1.1 1.5 1 0.8 1.3 2.1 1.5 1.5 1.5	1-2-2 N=4 1-1-2 N=3 1-1-2 N=3 1-1-1 N=2 1-1-1 N=2 1-1-1 N=2 0-1-1 N=2 1-1-1 N=2 1-1-1 N=2	30 28 33 49 45 26 42 62 97 99	84-28-56 62-22-40	99	99	99	99

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343637

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

While drilling



Boring Started: 08-09-2017

Boring Completed: 08-09-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-10

BORING LOG NO. B-8

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.92181° Longitude: -95.86994°	DEPTH	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
	FAT CLAY (CH) , dark gray, soft, silt lenses <i>(continued)</i>											
		35			2			86				
		36.5										
	SANDY LEAN CLAY (CL) , trace gravel, dark gray, soft to very stiff to hard, occasional cobbles and boulders											
		40		X	1.5	2-1-1 N=2		17				
		45		X	1.5	1-1-1 N=2		15				
		50		X	0.5	3-6-14 N=20		15				
		55		X	1	14-22-31 N=53		14				
		60		X	1	30-45-60 N=105		13				
	Boring Terminated at 61 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

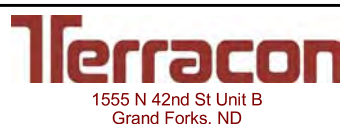
See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343637

WATER LEVEL OBSERVATIONS

While drilling



Boring Started: 08-09-2017

Boring Completed: 08-09-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-10

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

BORING LOG NO. B-9

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.91827° Longitude: -95.85629°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
	1.5				1	1-1-2 N=3		56				
					1.5	2-2-2 N=4		28		58-19-39		
			5			1.3	2-2-2 N=4		54			
						1.3	1-1-1 N=2		60			
			10			1	1-1-1 N=2		54			
						1.5	0-1-1 N=2		50			
			15			1.5	0-1-1 N=2		47			
			20			2			44		80-25-55	
Boring Terminated at 21.5 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 ¼ inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

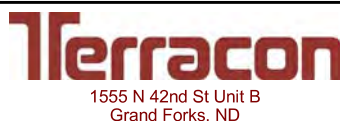
Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343633

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-09-2017

Boring Completed: 08-09-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

BORING LOG NO. B-10

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90633° Longitude: -95.86177°	DEPTH	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
	<p>TOPSOIL - ORGANIC CLAY (OH), black</p> <p>1.5</p> <p>LEAN CLAY (CL), gray, medium stiff, silt lenses</p> <p>9.0</p> <p>FAT CLAY (CH), dark gray, soft, silt lenses, trace wood & organics at 12'</p>			X	0.3	4-5-4 N=9		18				
			5		X	0.7	3-3-3 N=6		22		39-18-21	
					X	1.1	2-2-2 N=4		23			
						1.8			28		35-18-17	
			10		X	1.1	2-1-2 N=3		29			
						2			42		73-25-48	
			15		X	0.5	1-1-1 N=2		41			
						2.3			46		61-19-42	
			25		X	1.1	1-1-1 N=2		61			
			30		X	1.3	0-1-1 N=2		83			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343634

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-14-2017

Boring Completed: 08-14-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-12

BORING LOG NO. B-10

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90633° Longitude: -95.86177°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
DEPTH											
	FAT CLAY (CH) , dark gray, soft, silt lenses, trace wood & organics at 12' <i>(continued)</i>	35		X	1.5	0-1-1 N=2		81			
	FAT CLAY WITH SAND (CH) , dark gray, soft, silt lenses	40		X	1.5	0-1-1 N=2		18			
		45		X	1.5	0-1-1 N=2		29			
	SILT (ML) , gray, stiff to very stiff to hard	50		X	1.5	5-6-5 N=11		19			
		55		X	1.1	7-9-11 N=20		14			
		60		X	0.7	5-13-18 N=31		15			
	Boring Terminated at 61 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

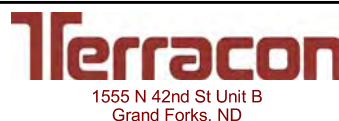
See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343634

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-14-2017

Boring Completed: 08-14-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-12

BORING LOG NO. B-11

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB. RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90264° Longitude: -95.86015°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	1.5	0.3	X		2-2-2 N=4						
	1.5	1.1	X		2-1-1 N=2						
	5	1.3	X		2-2-2 N=4						
	5	0.5	X		1-1-1 N=2						
	10	1.5	X		1-0-1 N=1						
	15	1.5	X		0-1-1 N=2						
	15	1.5	X		0-1-1 N=2						
20	1.5	X		0-1-0 N=1							
<p>Boring Terminated at 21 Feet</p>											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 ¼ inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343630

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-15-2017

Boring Completed: 08-15-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-13

BORING LOG NO. B-12

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.9276° Longitude: -95.83484°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
										LL-PL-PI		
1.5	TOPSOIL - ORGANIC CLAY , black			X	0.8	4-3-3 N=6		25				
4.5	LEAN CLAY (CL) , soft, brown, silt lenses			X	1.1	2-1-2 N=3		38				
7.0	FAT CLAY (CH) , dark gray, medium stiff to soft, silt lenses, iron concretions	5		X	1.1	2-2-3 N=5		32				
	FAT CLAY (CH) , dark gray, soft to very soft to soft, silt lenses			X	1	1-2-1 N=3		51				
		10		X	1.1	1-1-1 N=2		51				
			▽		2.1			52		75-21-54		
		15		X	1.5	0-1-1 N=2		61				
		20		X	1.5	0-1-1 N=2		66				
		25		X	1.5	0-1-1 N=2		27				
		30		X	1.5	0-0-1 N=1		98				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343631

WATER LEVEL OBSERVATIONS

▽ While drilling



Boring Started: 08-10-2017

Boring Completed: 08-10-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-14

BORING LOG NO. B-12

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.9276° Longitude: -95.83484°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
DEPTH											
	FAT CLAY (CH) , dark gray, soft to very soft to soft, silt lenses <i>(continued)</i>										
		35		X	1.5	1-1-1 N=2		95			
		40			2.3			37		51-17-34	
		45		X	1.5	1-1-1 N=2		30			
		50			2.3			34		53-16-37	
		54.5									
	SANDY LEAN CLAY (CL) , trace gravel, gray, stiff, occasional cobbles and boulders	55		X	1.5	12-14-17 N=31		9			
		60		X	1.1	16-22-23 N=45		8			
	Boring Terminated at 61 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 ¼ inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343631

WATER LEVEL OBSERVATIONS

While drilling



Boring Started: 08-10-2017

Boring Completed: 08-10-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-14

BORING LOG NO. B-13

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB. RECOVERED.GPJ TERRACON DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90774° Longitude: -95.83481°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
DEPTH											
0	FILL - POORLY GRADED SAND WITH GRAVEL , brown			X	1	7-5-4 N=9					
1.5	SILTY SAND (SM) , fine grained, brown, loose			X	1.1	5-3-3 N=6				NP	27
5				X	0.8	4-4-3 N=7					
7.0	FAT CLAY (CH) , dark gray, soft				2.3						
10				X	1.3	2-1-2 N=3					
12.0	SILT (ML) , brown, very stiff to stiff, silt lenses			X	1.1	5-8-11 N=19					
15				X	1	6-5-7 N=12					
19.5	FAT CLAY (CH) , dark gray, soft, silt lenses			X	0.7	2-1-2 N=3					
21.0	Boring Terminated at 21 Feet										

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343636

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-09-2017

Boring Completed: 08-09-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-15

BORING LOG NO. B-14

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL_M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.89156° Longitude: -95.83117°	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	TOPSOIL - ORGANIC CLAY (OH) , black		X		0.7	4-3-2 N=5					
7.0	LEAN CLAY (CL) , olive yellow, medium stiff, silt lenses, iron concretions	5	X		1	2-3-2 N=5					
8.5	FAT CLAY (CH) , dark gray, soft, silt lenses	5	X		1.1	2-3-3 N=6					
8.5	SILT (ML) , dark gray, very stiff to stiff to very stiff to medium stiff, silt lenses	10	X		0.8	2-1-2 N=3					
21.0	SILT (ML) , dark gray, very stiff to stiff to very stiff to medium stiff, silt lenses	10	X		1.1	6-8-11 N=19					
21.0	SILT (ML) , dark gray, very stiff to stiff to very stiff to medium stiff, silt lenses	15	X		1	3-4-5 N=9					
21.0	SILT (ML) , dark gray, very stiff to stiff to very stiff to medium stiff, silt lenses	15	X		1.1	3-5-9 N=14					
21.0	SILT (ML) , dark gray, very stiff to stiff to very stiff to medium stiff, silt lenses	20	X		1.1	5-3-4 N=7					
Boring Terminated at 21 Feet											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343638

WATER LEVEL OBSERVATIONS
No free water observed



Boring Started: 08-10-2017

Boring Completed: 08-10-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049




Exhibit: A-16

BORING LOG NO. B-15

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.92823° Longitude: -95.82172°	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
											LL-PL-PI		
	TOPSOIL - ORGANIC CLAY (OH) , black	1.5	1.5		X	0.5	1-0-0 N=0						
	LEAN CLAY (CL) , dark gray, soft to medium stiff, silt lenses, iron concretions	6.0	5		X	0.5	1-1-1 N=2						
	FAT CLAY (CH) , dark gray, medium stiff to soft, silt lenses	21.0	10		X	1.2	3-3-4 N=7						
			15		X	1.1	2-2-2 N=4						
			20		X	1	2-2-3 N=5						
			15		■	2.1	0-1-1 N=2		70		67-23-44		
			20		X	1.5	1-1-1 N=2						
	Boring Terminated at 21 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 1/4 inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

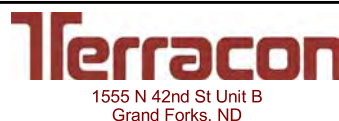
Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343639

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

No free water observed



Boring Started: 08-10-2017

Boring Completed: 08-10-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-17

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

BORING LOG NO. B-16

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90792° Longitude: -95.81105°	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
											LL-PL-PI		
1.5	TOPSOIL - ORGANIC CLAY (OH) , black				X	0.1	2-1-2 N=3						
4.5	LEAN CLAY (CL) , gray, soft, silt lenses, iron concretions				X	1.1	2-2-2 N=4						
7.0	FAT CLAY (CH) , dark gray, medium stiff, silt lenses		5		X	1.3	2-2-3 N=5						
14.5	SILT (ML) , dark gray, medium stiff		10	▽	X	1	5-6-6 N=12						
21.0	FAT CLAY (CH) , dark gray, soft, silt lenses		15		X	1	2-1-2 N=3						
	Boring Terminated at 21 Feet		20		X	1.5	1-1-1 N=2						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
3 ¼ inch Hollow Stem Auger

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).

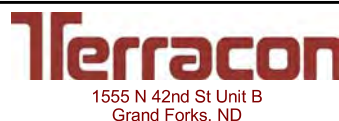
Notes:

Abandonment Method:
Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343635

See Appendix C for explanation of symbols and abbreviations.

WATER LEVEL OBSERVATIONS

▽ While drilling



Boring Started: 08-10-2017

Boring Completed: 08-10-2017

Drill Rig: D-90

Driller: MAR

Project No.: M5175049

Exhibit: A-18

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL. M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

BORING LOG NO. B-17

PROJECT: Roseau Lake Rehabilitation

CLIENT: Roseau River Watershed District
Roseau, Minnesota

SITE: Roseau County
Roseau, Minnesota

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17

GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.91903° Longitude: -95.79326°	DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS		PERCENT FINES
											LL-PL-PI		
	TOPSOIL - ORGANIC CLAY (OH) , black	1.5	5		X	0.5	2-3-2 N=5						
	LEAN CLAY (CL) , brownish gray, soft, silt lenses, iron concretions	6.0	5		X	1	2-2-2 N=4						
	FAT CLAY (CH) , dark gray, soft, silt lenses	21.0	5		X	1.1	2-1-2 N=3						
			10		X	1.3	2-1-3 N=4						
			15		X	1.5	1-2-1 N=3						
			15		X	0.5	1-1-1 N=2						
			20		X	1	1-1-1 N=2						
			20		X	1.5	0-1-1 N=2						
	Boring Terminated at 21 Feet												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

<p>Advancement Method: 3 ¼ inch Hollow Stem Auger</p>	<p>See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.</p>	<p>Notes:</p>						
<p>Abandonment Method: Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343632</p>								
<p>WATER LEVEL OBSERVATIONS</p> <p><i>No free water observed</i></p>	<p>1555 N 42nd St Unit B Grand Forks, ND</p>	<table style="width: 100%; border: none;"> <tr> <td style="border: none;">Boring Started: 08-14-2017</td> <td style="border: none;">Boring Completed: 08-14-2017</td> </tr> <tr> <td style="border: none;">Drill Rig: D-90</td> <td style="border: none;">Driller: CAS</td> </tr> <tr> <td style="border: none;">Project No.: M5175049</td> <td style="border: none;">Exhibit: A-19</td> </tr> </table>	Boring Started: 08-14-2017	Boring Completed: 08-14-2017	Drill Rig: D-90	Driller: CAS	Project No.: M5175049	Exhibit: A-19
Boring Started: 08-14-2017	Boring Completed: 08-14-2017							
Drill Rig: D-90	Driller: CAS							
Project No.: M5175049	Exhibit: A-19							

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
 Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
 Minnesota Unique Well No. or W-series No.
 (Leave blank if not known)

H **343623**

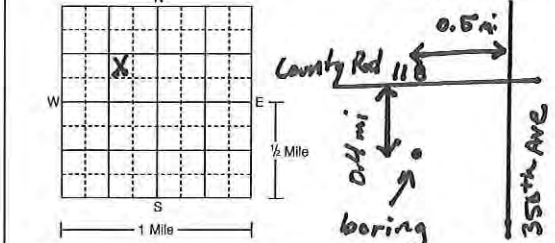
WELL OR BORING LOCATION
 County Name
Roseau

Township Name **Jadis** Township No. **163N** Range No. **40W** Section No. **7** Fraction (sm. → lg.) **NW¹/₄SW¹/₄NW¹/₄** Date Sealed **8/14/17** Date Well or Boring Constructed **8/14/17**

GPS LOCATION – decimal degrees (to four decimal places)
 Latitude **48.95859** Longitude **-95.86783**
 Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
1/2 mi N of 350th Ave, 1/2 mile S. Roseau
 AQUIFER(S) Single Aquifer Multiaquifer
 WELL/BORING Water-Supply Well Monit. Well Measured Estimated Date Measured _____
 Env. Bore Hole Other **25** ft. below above land surface

Show exact location of well or boring in section grid with "X." Sketch map of well or boring location, showing property lines, roads, and buildings.



PROPERTY OWNER'S NAME/COMPANY NAME
STATE LAND - DNR BUREAU
 CASING(S) **N/A**
 Diameter **N/A** Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

Property owner's mailing address if different than well location address indicated above
**500 Lafayette Road
 St. Paul, MN 55155-4030**
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
 SCREEN/OPEN HOLE
 Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

Well owner's mailing address if different than property owner's address indicated above
 OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
 Type of Obstructions (Describe) _____
 Obstructions removed? Yes No Describe _____

GEOLOGICAL MATERIAL COLOR HARDNESS OR FORMATION FROM TO
 If not known, indicate estimated formation log from nearby well or boring.

Fat clay w/sand	dk gray or brown	N/A	0	6
Fat clay	dk gray	soft	6	21

PUMP
 Type _____
 Removed Not Present Other _____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
 _____ in. from _____ to _____ ft. Perforated Removed
 _____ in. from _____ to _____ ft. Perforated Removed
 Type of Perforator _____

VARIANCE
 Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
 Grouting Material **high solids bentonite** from **0** to **21** ft. _____ yards **1** bags
 _____ from _____ to _____ ft. _____ yards _____ bags
 _____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**
 Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # MS175049
 Boring B-1**
 LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
 This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc **M1665**
 Licensee Business Name License or Registration No.
3621 **9/22/2017**
 Certified Representative Signature Certified Rep. No. Date

Christopher Schill
 Name of Person Sealing Well or Boring

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
 Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
 Minnesota Unique Well No. or W-series No.
 (Leave blank if not known)

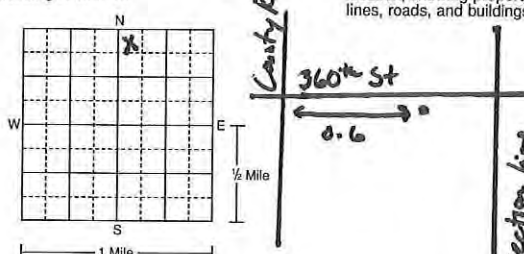
H **343625**

WELL OR BORING LOCATION
 County Name **Roseau**

Township Name **Dieter** Township No. **163N** Range No. **41W** Section No. **26** Fraction (sm. → lg.) **RW¹/₄ NN¹/₄ NE¹/₄** Date Sealed **8/16/17** Date Well or Boring Constructed **8/16/17**

GPS LOCATION – decimal degrees (to four decimal places)
 Latitude **48.91982** Longitude **-95.90733**
 Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
360th Street
 AQUIFER(S) Single Aquifer Multi-aquifer
 WELL/BORING Water-Supply Well Monit. Well Measured Estimated Date Measured _____
 Env. Bore Hole Other _____ **25** ft. below above land surface

Show exact location of well or boring in section grid with "X."
 Sketch map of well or boring location, showing property lines, roads, and buildings.


CASING TYPE(S) **N/A**
 Steel Plastic Tile Other _____

WELLHEAD COMPLETION **N/A**
 Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other _____
 Inside: Basement Offset Well Pit Buried Other _____

PROPERTY OWNER'S NAME/COMPANY NAME
Ar dell Magnusson
 CASING(S) **N/A**
 Diameter _____ Depth _____ Set in oversized hole? Yes No Annular space initially grouted? Yes No Unknown

Property owner's mailing address if different than well location address indicated above
32105 St HWY 310
Roseau, MN 56751
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
 SCREEN/OPEN HOLE
 Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

Well owner's mailing address if different than property owner's address indicated above
 OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
 Type of Obstructions (Describe) _____

Obstructions removed? Yes No Describe _____

PUMP
 Type _____
 Removed Not Present Other _____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
 _____ in. from _____ to _____ ft. Perforated Removed
 _____ in. from _____ to _____ ft. Perforated Removed
 Type of Perforator _____

VARIANCE
 Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
 Grouting Material **high solids bentonite** from **0** to **21** ft. _____ yards **1** bags
 _____ from _____ to _____ ft. _____ yards _____ bags
 _____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**
 Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project # M5175049
Boring B-3
 LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
 This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name **M1665** License or Registration No.
 Certified Representative Signature **3621** Certified Rep. No. **9/22/2017** Date

MINN. DEPT OF HEALTH COPY H **343625**
Christopher Schill
 Name of Person Sealing Well or Boring

WELL OR BORING LOCATION

County Name
Roseau

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

H 343627

Township Name **Dieter** Township No. **163N** Range No. **41W** Section No. **35** Fraction (sm. → lg.) **SE 1/4 NW 1/4** Date Sealed **8/16/17** Date Well or Boring Constructed **8/16/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.90591** Longitude **-95.90643**
Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
County Rd 10
AQUIFER(S)
 Single Aquifer Multiaquifer

Show exact location of well or boring in section grid with "X."
Sketch map of well or boring location, showing property lines, roads, and buildings.

WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other
STATIC WATER LEVEL
 Measured Estimated Date Measured
25 ft. below above land surface

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other
Inside: Basement Offset Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
Roberta A Johnson
CASING(S) **N/A**
Diameter _____ in. from _____ to _____ ft. Depth _____ ft. Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

Property owner's mailing address if different than well location address indicated above
**35219 County Road 115
Badger, MN 56714**

WELL OWNER'S NAME/COMPANY NAME
NO WELL
SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

Well owner's mailing address if different than property owner's address indicated above
OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction

Type of Obstructions (Describe)
Obstructions removed? Yes No Describe _____

GEOLOGICAL MATERIAL COLOR HARDNESS OR FORMATION FROM TO
If not known, indicate estimated formation log from nearby well or boring.

Topsoil black N/A 0 1 1/2
Fast clay dk gray medstiff 1 1/2 5
Sandy lean clay brown medstiff 5 21

PUMP
Type
 Removed Not Present Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal

____ in. from _____ to _____ ft. Perforated Removed
____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **high solids bentonite** from **0** to **21** ft. _____ yards **1** bags

____ from _____ to _____ ft. _____ yards _____ bags
____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project # MS175049
Boring B-4
Other unsealed and unused well or boring on property? Yes No How many?

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc **M1665**
Licensee Business Name License or Registration No.

3621 **9/22/2017**
Certified Representative Signature Certified Rep. No. Date

Christopher Schill
Name of Person Sealing Well or Boring

MINN. DEPT OF HEALTH COPY **H 343627**

WELL OR BORING LOCATION
County Name
Roseau

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

H **343626**

Township Name **Dieter** Township No. **163N** Range No. **41W** Section No. **25** Fraction (sm. → lg.) **SE 1/4 NW 1/4** Date Sealed **8/16/17** Date Well or Boring Constructed **8/16/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.91898** Longitude **-95.88615**
Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
360th Street
AQUIFER(S) Single Aquifer Multiaquifer
WELL/BORING Water-Supply Well Monit. Well Env. Bore Hole Other
STATIC WATER LEVEL Measured Estimated Date Measured
25 ft. below above land surface

Show exact location of well or boring in section grid with "X." Sketch map of well or boring location, showing property lines, roads, and buildings.

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other
WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other
Inside: Basement Offset Well Pit Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
STATE OF MINN DNR
Property owner's mailing address if different than well location address indicated above
**500 Lafayette Dr
St. Paul, MN 55155-4030**
CASING(S) **N/A**
Diameter **N/A** Depth _____ ft. Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
Well owner's mailing address if different than property owner's address indicated above
SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe)
Obstructions removed? Yes No Describe _____

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
Topsoil	black	N/A	0	1 1/2
Lean clay	dk gray	soft	1 1/2	8 1/2
Fat clay	dk gray	soft	8 1/2	21

PUMP
Type _____
 Removed Not Present Other _____
METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **high solids bentonite** from **0** to **21** ft. _____ yards **1** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # M5175049
Boring B-5**
LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
[Signature] Certified Representative Signature
3621 Certified Rep. No. **9/22/17** Date

MINN. DEPT. OF HEALTH COPY H **343626**
Christopher Schill Name of Person Sealing Well or Boring

WELL OR BORING LOCATION
County Name
Roseau

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
Minnesota Statutes, Chapter 103I

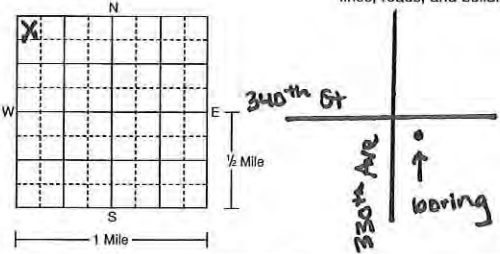
Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

H **343629**

Township Name **Ross** Township No. **162N** Range No. **41W** Section No. **1** Fraction (sm. → lg.) **NW/NE/NE/NE** Date Sealed **8/16/17** Date Well or Boring Constructed **8/16/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.89126** Longitude **-95.8984**
Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
330th Ave
AQUIFER(S)
 Single Aquifer Multiaquifer

Show exact location of well or boring in section grid with "X."
Sketch map of well or boring location, showing property lines, roads, and buildings.

WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

STATIC WATER LEVEL
 Measured Estimated Date Measured _____
25 ft. below above land surface

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pileless Adapter/Unit Well Pit Other _____
Inside: Basement Offset Well Pit Buried Other _____

PROPERTY OWNER'S NAME/COMPANY NAME
John Magnusson
CASING(S)
Diameter **N/A** Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

Property owner's mailing address if different than well location address indicated above
**31645 County Road 123
Roseau, MN 56751**
_____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

Well owner's mailing address if different than property owner's address indicated above
OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction

Type of Obstructions (Describe) _____
Obstructions removed? Yes No Describe _____

GEOLOGICAL MATERIAL COLOR HARDNESS OR FORMATION FROM TO
If not known, indicate estimated formation log from nearby well or boring.

Topsoil	black	N/A	0	1 1/2
Silt w/sand	brown	loose	1 1/2	6
Sandy lean clay	dk gray	soft	6	10
Lean clay	slk gray	soft	10	15
Fat clay	dk gray	soft	15	21

PUMP
Type _____
 Removed Not Present Other _____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed

Type of Perforator _____
VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **high solids bentonite** from **0** to **21** ft. _____ yards **1** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # M5175049
Boring B-7**
LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
 Certified Representative Signature
3621 Certified Rep. No. **9/22/2017** Date

MINN. DEPT. OF HEALTH COPY H **343629**
Christopher Schill
Name of Person Sealing Well or Boring

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No. _____
Minnesota Unique Well No. or W-series No. _____
(Leave blank if not known)

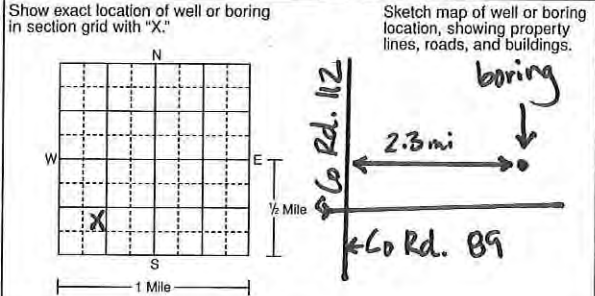
H 343637

WELL OR BORING LOCATION
County Name
Roseau

Township Name Dieter	Township No. 163N	Range No. 40W	Section No. 19	Fraction (sm. → lg.) NE 1/4 SW 1/4	Date Sealed 8/9/17	Date Well or Boring Constructed 8/9/17
--------------------------------	-----------------------------	-------------------------	--------------------------	--	------------------------------	--

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.92181** Longitude **-95.86994**

Numerical Street Address or Fire Number and City of Well or Boring Location
2.3mi E of Co Rd 89 + Co. Rd 112



Depth Before Sealing **61** ft. Original Depth **61** ft.

AQUIFER(S)
 Single Aquifer Multiaquifer
WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

STATIC WATER LEVEL
 Measured Estimated Date Measured **8/9/17**
31 ft. below above land surface

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other
Inside: Basement Offset Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
State of Minn DNR

Property owner's mailing address if different than well location address indicated above
**500 Lafayette Dr
St. Paul, MN 55155-4030**

CASING(S)
Diameter **N/A** Depth _____ ft. Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL

Well owner's mailing address if different than property owner's address indicated above

SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **61** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe)

Obstructions removed? Yes No Describe

PUMP
Type _____
 Removed Not Present Other

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
Topsoil	black	N/A	0	1 1/2
lean clay	brown	soft	1 1/2	6 1/2
Fat clay	dk gray	soft	6 1/2	36 1/2
Sandy lean clay	dk gray	hard	36 1/2	61

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **61** ft. _____ yards **3** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING

**Terracon Project # M5175049
Boring B-0**

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. **M1665**
Licensee Business Name License or Registration No.

[Signature] **3621** **9/22/2017**
Certified Representative Signature Certified Rep. No. Date

MINN. DEPT OF HEALTH COPY **H 343637**

Michael Roberts
Name of Person Sealing Well or Boring

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 1031

Minnesota Well and Boring Sealing No. _____
Minnesota Unique Well No. or W-series No. (Leave blank if not known)

H 343633

WELL OR BORING LOCATION
County Name **Roseau**

Township Name **Dieter** Township No. **163N** Range No. **40W** Section No. **30** Fraction (sm. → lg.) **SE 1/4 NE 1/4**

Date Sealed **8/9/17**

Date Well or Boring Constructed **8/9/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.91827** Longitude **-95.85629**

Depth Before Sealing **21 1/2** ft.

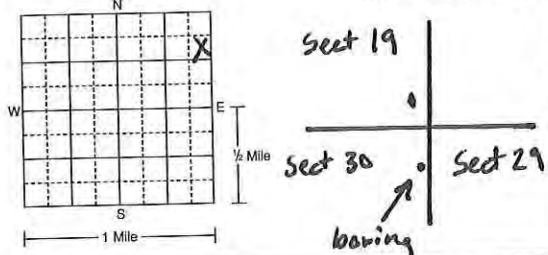
Original Depth **21 1/2** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
3 mi E of Co. Rd. 89

AQUIFER(S)
 Single Aquifer Multiaquifer
WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

STATIC WATER LEVEL
 Measured Estimated Date Measured _____
25 ft. below above land surface

Show exact location of well or boring in section grid with "X". Sketch map of well or boring location, showing property lines, roads, and buildings.



PROPERTY OWNER'S NAME/COMPANY NAME
Terry + Carol Kveen

CASING(S)
Diameter **N/A** Depth _____ ft. Set in oversized hole? Yes No Annular space initially grouted? Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown

Property owner's mailing address if different than well location address indicated above
**N69 W24073 Orchard Ct
Menomonee Falls, WI 53051**

WELL OWNER'S NAME/COMPANY NAME
NO WELL

SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21 1/2** ft.

Well owner's mailing address if different than property owner's address indicated above

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe) _____
Obstructions removed? Yes No Describe _____

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
Topsoil	black	N/A	0	1 1/2
Fast clay	dk gray	soft	1 1/2	21 1/2

PUMP **N**
Type _____
 Removed Not Present Other _____

If not known, indicate estimated formation log from nearby well or boring.

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **21 1/2** ft. _____ yards **2** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

**Terracon Project # M5175049
Boring B-9**

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
[Signature] Certified Representative Signature
3621 Certified Rep. No. **9/22/2017** Date

MINN. DEPT OF HEALTH COPY **H 343633**

Michael Roberts
Name of Person Sealing Well or Boring

WELL OR BORING LOCATION
County Name
Roseau

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

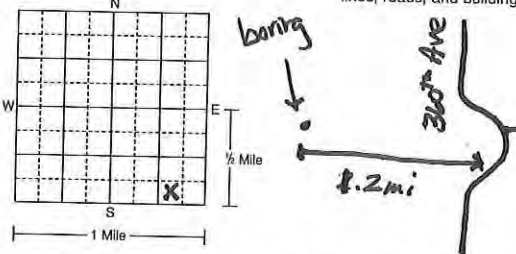
H 343634

Township Name **Dieter** Township No. **163N** Range No. **40W** Section No. **30** Fraction (sm. → lg.) **SW 1/4 SE 1/4 NE 1/4** Date Sealed **8/14/17** Date Well or Boring Constructed **8/14/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.90633** Longitude **-95.86177** Depth Before Sealing **61** ft. Original Depth **61** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
1.2 mi W of 300th Avenue

Show exact location of well or boring in section grid with "X."
Sketch map of well or boring location, showing property lines, roads, and buildings.



AQUIFER(S)
 Single Aquifer Multi-aquifer
WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other
Inside: Basement Offset Well Pit Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
Terry + Carol Kveen

Property owner's mailing address if different than well location address indicated above
**N69 W24073 Orchard Ct
Menomonie Falls, WI 53051**

CASING(S)
Diameter **N/A** Depth _____ ft. Set in oversized hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL

Well owner's mailing address if different than property owner's address indicated above

SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **61** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe)

Obstructions removed? Yes No Describe

PUMP
Type _____
 Removed Not Present Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
Topsoil	black	N/A	0	1 1/2
Lean clay	gray	N/A soft	1 1/2	9
Fat clay	dk gray	N/A soft	9	49 1/2
Silt	gray	med stiff	49 1/2	61

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **61** ft. _____ yards **3** bags

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # M5175049
Boring B-10**

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many?

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
[Signature] Certified Representative Signature **3621** Certified Rep. No. **9/22/2017** Date

Michael Roberts Name of Person Sealing Well or Boring

MINN. DEPT OF HEALTH COPY **H 343634**

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 1031

Minnesota Well and Boring Sealing No. _____
Minnesota Unique Well No. or W-series No. _____
(Leave blank if not known)

H 343630

WELL OR BORING LOCATION
County Name
Roseau

Township Name **Jadis** Township No. **31** Range No. **163N** Section No. **40W** Fraction (sm. → lg.) **SW 1/4 NE 1/4** Date Sealed **8/15/17** Date Well or Boring Constructed **8/15/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.9026** Longitude **-95.8601** Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
350th Avenue AQUIFER(S) Single Aquifer Multiaquifer
WELL/BORING Water-Supply Well Monit. Well Env. Bore Hole Other

Static Water Level
 Measured Estimated Date Measured _____
25 ft. below above land surface

CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

WELLHEAD COMPLETION
Outside: Well House At Grade Pileless Adapter/Unit Well Pit Other
Inside: Basement Offset Well Pit Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
Kreen Joint Revocable Trust
Property owner's mailing address if different than well location address indicated above
**4760 N 186th St
Brookfield, WI 53045**

CASING(S) **N/A**
Diameter _____ in. from _____ to _____ ft. Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
Well owner's mailing address if different than property owner's address indicated above

SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe) _____

Obstructions removed? Yes No Describe _____

PUMP
Type _____
 Removed Not Present Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **21** ft. _____ yards **1** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # M5175049
Boring B-11**

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.
Terracon Consultants, Inc. Licensee Business Name **M1665** License or Registration No.
[Signature] Certified Representative Signature **3621** Certified Rep. No. **9/22/17** Date

MINN. DEPT. OF HEALTH COPY **H 343630**
Michael Roberts Name of Person Sealing Well or Boring

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No. _____
Minnesota Unique Well No. or W-series No. _____
(Leave blank if not known)

H 343631

WELL OR BORING LOCATION

County Name
Roseau

Township Name
N. Roseau UT

Township No. **163N** Range No. **40W** Section No. **21** Fraction (sm. → lg.) **SW¹/₄SW¹/₄NW¹/₄**

Date Sealed
8/10/17

Date Well or Boring Constructed
8/10/17

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.9276** Longitude **-95.8348**

Depth Before Sealing **61** ft. Original Depth **61** ft.

STATIC WATER LEVEL
 Measured Estimated Date Measured **8/10/17**

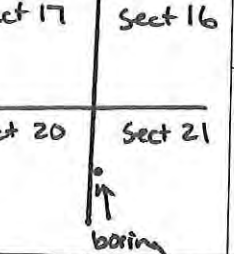
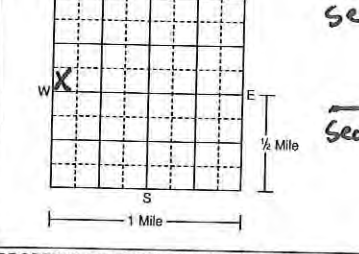
Numerical Street Address or Fire Number and City of Well or Boring Location
360th Avenue

AQUIFER(S)
 Single Aquifer Multiaquifer

WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

Show exact location of well or boring in section grid with "X."

Sketch map of well or boring location, showing property lines, roads, and buildings.



CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

12 ft. below above land surface

PROPERTY OWNER'S NAME/COMPANY NAME
State of Minn Dr

CASING(S) **N/A**

Property owner's mailing address if different than well location address indicated above
**500 LaFayette Dr.
St. Paul, MN 55155**

Diameter _____ Depth _____ Set in oversized hole? Yes No Annular space initially grouted? Yes No Unknown

_____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL

SCREEN/OPEN HOLE

Well owner's mailing address if different than property owner's address indicated above

Screen from _____ to _____ ft. Open Hole from **0** to **61** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction

Obstructions removed? Yes No Describe _____

Type of Obstructions (Describe)

PUMP
Type _____
 Removed Not Present Other

GEOLOGICAL MATERIAL **COLOR** **HARDNESS OR FORMATION** **FROM** **TO**

Obstructions removed? Yes No Describe _____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal

If not known, indicate estimated formation log from nearby well or boring.

Topsoil	black	N/A	0	1 1/2
Lean clay	brown	soft	1 1/2	7 1/2
Fat clay	dk gray	med stiff	7 1/2	5 1/2
Sandy lean clay	gray	stiff	5 1/2	61

_____ in. from _____ to _____ ft. Perforated Removed

_____ in. from _____ to _____ ft. Perforated Removed

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **61** ft. _____ yards **3** bags

_____ from _____ to _____ ft. _____ yards _____ bags

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project # M5175049
Boring B-12**

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

MINN. DEPT OF HEALTH COPY **H 343631**

Terracon Consultants, Inc.
Licensee Business Name

M1665
License or Registration No.

Michael Roberts
Name of Person Sealing Well or Boring

3621
Certified Representative Signature

9/22/2017
Certified Rep. No. Date

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 1031

Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

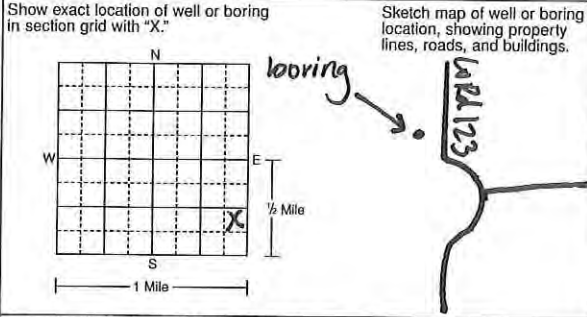
H 343636

WELL OR BORING LOCATION
County Name
Roseau

Township Name **N. Roseau UT** Township No. **163N** Range No. **40W** Section No. **29** Fraction (sm. → lg.) **NE 1/4 SE 1/4 SE 1/4** Date Sealed **8/9/17** Date Well or Boring Constructed **8/9/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.9077** Longitude **-95.8348** Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
Co. Rd 123 **AQUIFER(S)**
 Single Aquifer Multiaquifer **WELL/BORING**
 Water-Supply Well Monit. Well **STATIC WATER LEVEL**
 Measured Estimated Date Measured _____
25 ft. below above land surface



PROPERTY OWNER'S NAME/COMPANY NAME
State of Minn DNR **CASING(S)**
Property owner's mailing address if different than well location address indicated above
500 Lafayette Dr. **Diameter N/A** Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown
St. Paul, MN 55155 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown
_____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL **SCREEN/OPEN HOLE**
Well owner's mailing address if different than property owner's address indicated above
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe) _____

GEOLOGICAL MATERIAL **COLOR** **HARDNESS OR FORMATION** **FROM** **TO** Obstructions removed? Yes No Describe _____

If not known, indicate estimated formation log from nearby well or boring. **PUMP**
Type _____
 Removed Not Present Other _____

Poorly graded sand	brown	N/A	0	2
Silty sand	brown	loose	2	7
Fat clay	dk gray	soft	7	12
Silt	brown	med.stiff	12	19 1/2
Fat clay	dk gray	soft	19 1/2	21

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **21** ft. _____ yards **1** bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project #M5175049
Boring B-13 **LICENSED OR REGISTERED CONTRACTOR CERTIFICATION**
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc **M1665**
Licensee Business Name License or Registration No.
 3621 **9/22/17**
Certified Representative Signature Certified Rep. No. Date

MINN. DEPT OF HEALTH COPY **H 343636** **Michael Roberts**
Name of Person Sealing Well or Boring

**MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD**
Minnesota Statutes, Chapter 1031

Minnesota Well and Boring Sealing No. _____
Minnesota Unique Well No. or W-series No. _____
(Leave blank if not known)

H 343638

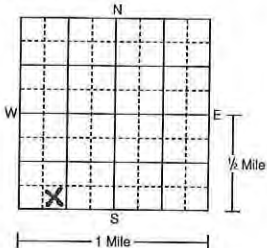
WELL OR BORING LOCATION
County Name Roseau

Township Name Jadis Township No. 163N Range No. 40W Section No. 33 Fraction (sm. → lg.) SE 1/4 SW 1/4 SW 1/4 Date Sealed 8/10/17 Date Well or Boring Constructed 8/10/17

GPS LOCATION – decimal degrees (to four decimal places)
Latitude 48.8915 Longitude -95.8311
Depth Before Sealing 21 ft. Original Depth 21 ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
Co. Rd. 28
AQUIFER(S) Single Aquifer Multiaquifer
WELL/BORING Water-Supply Well Monit. Well
 Env. Bore Hole Other _____

Show exact location of well or boring in section grid with "X."
Sketch map of well or boring location, showing property lines, roads, and buildings.
360th Ave
farm
boring
Co. Rd. 28
STATIC WATER LEVEL
 Measured Estimated Date Measured _____
25 ft. below above land surface



CASING TYPE(S) N/A
 Steel Plastic Tile Other _____

WELLHEAD COMPLETION N/A
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other _____
Inside: Basement Offset Well Pit Buried Other _____

PROPERTY OWNER'S NAME/COMPANY NAME
Terry + Carol Kveen
Property owner's mailing address if different than well location address indicated above
N69 W24073 Orchard Ct
Menomonee Falls, MN 53051
CASING(S) N/A
Diameter _____ Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
Well owner's mailing address if different than property owner's address indicated above
SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from 0 to 21 ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe) _____

Obstructions removed? Yes No Describe _____

PUMP
Type _____
 Removed Not Present Other _____

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____

VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material bentonite from 0 to 21 ft. _____ yards 1 bags
_____ from _____ to _____ ft. _____ yards _____ bags
_____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS UNKNOWN
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project #M5175049
Boring B-14
LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
[Signature] Certified Representative Signature 3621 Certified Rep. No. 9/22/17 Date

MINN. DEPT OF HEALTH COPY **H 343638**
Michael Roberts Name of Person Sealing Well or Boring

WELL OR BORING LOCATION
County Name
Roseau

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
Minnesota Statutes, Chapter 103I

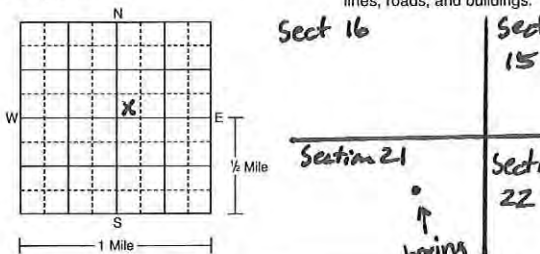
Minnesota Well and Boring Sealing No.
Minnesota Unique Well No. or W-series No.
(Leave blank if not known)

H 343639

Township Name **N. Roseau VT** Township No. **163N** Range No. **45W** Section No. **21** Fraction (sm. → lg.) **SW¹/₄SW¹/₄NE¹/₄** Date Sealed **8/10/17** Date Well or Boring Constructed **8/10/17**

GPS LOCATION – decimal degrees (to four decimal places)
Latitude **48.9282** Longitude **-95.8217**
Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
360th Avenue
AQUIFER(S) Single Aquifer Multi-aquifer
WELL/BORING Water-Supply Well Monit. Well
 Env. Bore Hole Other

Show exact location of well or boring in section grid with "X."
Sketch map of well or boring location, showing property lines, roads, and buildings.


CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

STATIC WATER LEVEL
 Measured Estimated Date Measured
25 ft. below above land surface

WELLHEAD COMPLETION **N/A**
Outside: Well House At Grade Pitless Adapter/Unit Well Pit Other
Inside: Basement Offset Well Pit Buried Other

PROPERTY OWNER'S NAME/COMPANY NAME
State of Minn DNR
Property owner's mailing address if different than well location address indicated above
**500 Lafayette Dr.
St. Paul, MN 55155**

CASING(S)
Diameter **N/A** Depth _____ ft. Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL
Well owner's mailing address if different than property owner's address indicated above

SCREEN/OPEN HOLE
Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
Type of Obstructions (Describe)

OBSTRUCTIONS removed? Yes No Describe

PUMP
Type _____
 Removed Not Present Other

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal

_____ in. from _____ to _____ ft. Perforated Removed
_____ in. from _____ to _____ ft. Perforated Removed
Type of Perforator _____


VARIANCE
Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
Grouting Material **bentonite** from **0** to **21** ft. _____ yards **1** bags

OTHER WELLS AND BORINGS **UNKNOWN**
Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project # M5175049
Boring B-15

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name **M1665** License or Registration No.
 **3621** Certified Representative Signature **9/22/17** Certified Rep. No. Date

Michael Roberts Name of Person Sealing Well or Boring

MINN. DEPT OF HEALTH COPY **H 343639**

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
 Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
 Minnesota Unique Well No. or W-series No.
 (Leave blank if not known)

H 343635

WELL OR BORING LOCATION
 County Name
Roseau

Township Name **Jadis** Township No. **163N** Range No. **40W** Section No. **27** Fraction (sm. → lg.) **SW¹/₄ SW¹/₄ SW¹/₄**

Date Sealed **8/10/17** Date Well or Boring Constructed **8/10/17**

GPS LOCATION – decimal degrees (to four decimal places)
 Latitude **48.9079** Longitude **-95.8110**

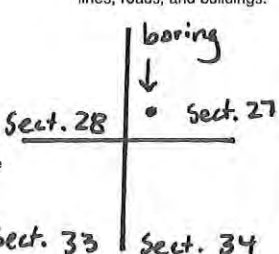
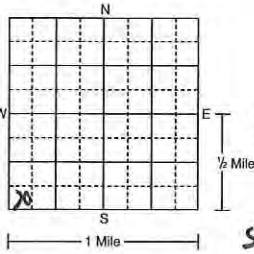
Depth Before Sealing **21** ft. Original Depth **21** ft.

Numerical Street Address or Fire Number and City of Well or Boring Location
N/A

AQUIFER(S)
 Single Aquifer Multiaquifer
 WELL/BORING
 Water-Supply Well Monit. Well
 Env. Bore Hole Other

Show exact location of well or boring in section grid with "X."
 Sketch map of well or boring location, showing property lines, roads, and buildings.

STATIC WATER LEVEL
 Measured Estimated Date Measured **8/10/17**
7 1/2 ft. below above land surface



CASING TYPE(S) **N/A**
 Steel Plastic Tile Other

PROPERTY OWNER'S NAME/COMPANY NAME
Nahlberg Trust

WELLHEAD COMPLETION
 Outside: Well House At Grade Pileless Adapter/Unit Well Pit Other
 Inside: Basement Offset Well Pit Buried Other

Property owner's mailing address if different than well location address indicated above
**309 7th Ave SE
 Roseau, MN 56751**

CASING(S)
 Diameter **N/A** Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME
NO WELL

SCREEN/OPEN HOLE
 Screen from _____ to _____ ft. Open Hole from **0** to **21** ft.

Well owner's mailing address if different than property owner's address indicated above

OBSTRUCTIONS
 Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
 Type of Obstructions (Describe)

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
---------------------	-------	-----------------------	------	----

Obstructions removed? Yes No Describe

If not known, indicate estimated formation log from nearby well or boring.

PUMP
 Type _____
 Removed Not Present Other

GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	TO
Topsoil	black	N/A	0	1 1/2
Lean clay	gray	soft	1 1/2	4 1/2
Fat clay	dk gray	med stiff	4 1/2	7
Silt	dk gray	med stiff	7	14 1/2
Fat clay	dk gray	soft	14 1/2	21

METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
 _____ in. from _____ to _____ ft. Perforated Removed
 _____ in. from _____ to _____ ft. Perforated Removed
 Type of Perforator _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
**Terracon Project #M5175049
 Boring B-16**

VARIANCE
 Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
 Grouting Material **bentonite** from **0** to **21** ft. _____ yards **1** bags
 _____ from _____ to _____ ft. _____ yards _____ bags
 _____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS
 Other unsealed and unused well or boring on property? Yes No How many? _____

LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
 This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name
M1665 License or Registration No.
 Certified Representative Signature
3621 Certified Rep. No.
9/22/17 Date

MINN. DEPT OF HEALTH COPY **H 343635**

Michael Roberts
 Name of Person Sealing Well or Boring

MINNESOTA DEPARTMENT OF HEALTH
WELL AND BORING SEALING RECORD
 Minnesota Statutes, Chapter 103I

Minnesota Well and Boring Sealing No.
 Minnesota Unique Well No. or W-series No.
 (Leave blank if not known)

H 343632

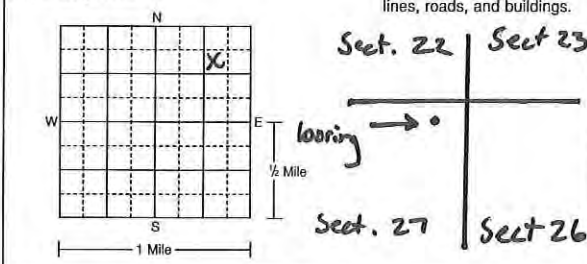
WELL OR BORING LOCATION
 County Name Roseau

Township Name Jadis Township No. 163N Range No. 40W Section No. 27 Fraction (sm. → lg.) SW 1/4 NE 1/4 NE 1/4 Date Sealed 8/14/17 Date Well or Boring Constructed 8/14/17

GPS LOCATION – decimal degrees (to four decimal places)
 Latitude 48.9190 Longitude -95.7932 Depth Before Sealing 21 ft. Original Depth 21 ft.

Numerical Street Address or Fire Number and City of Well or Boring Location N/A
 AQUIFER(S) Single Aquifer Multiaquifer
 WELL/BORING Water-Supply Well Monit. Well Measured Estimated Date Measured _____

Show exact location of well or boring in section grid with "X." Sketch map of well or boring location, showing property lines, roads, and buildings.
 Env. Bore Hole Other 25 ft. below above land surface



CASING TYPE(S) N/A
 Steel Plastic Tile Other _____

WELLHEAD COMPLETION N/A
 Outside: Well House At Grade Pitless Adapter/Unit Buried Well Pit Other _____
 Inside: Basement Offset Well Pit Buried Other _____

PROPERTY OWNER'S NAME/COMPANY NAME Carol Pederson
 CASING(S) Diameter N/A Depth _____ Set in oversize hole? Yes No Annular space initially grouted? Yes No Unknown

Property owner's mailing address if different than well location address indicated above
717 8th Ave SW
Roseau, MN 56755
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown
 _____ in. from _____ to _____ ft. Yes No Yes No Unknown

WELL OWNER'S NAME/COMPANY NAME NO WELL
 SCREEN/OPEN HOLE Screen from _____ to _____ ft. Open Hole from 0 to 21 ft.

Well owner's mailing address if different than property owner's address indicated above
 OBSTRUCTIONS Rods/Drop Pipe Check Valve(s) Debris Fill No Obstruction
 Type of Obstructions (Describe) _____

Obstructions removed? Yes No Describe _____

Table with 5 columns: GEOLOGICAL MATERIAL, COLOR, HARDNESS OR FORMATION, FROM, TO. Row 1: Topsoil, black, N/A, 0, 1/2. Row 2: Lean clay, brown, soft, 1/2, 6. Row 3: Fat clay, dk gray, soft, 6, 21.

PUMP Type _____ Removed Not Present Other _____
 METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
 No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
 _____ in. from _____ to _____ ft. Perforated Removed
 _____ in. from _____ to _____ ft. Perforated Removed
 Type of Perforator _____

VARIANCE Was a variance granted from the MDH for this well? Yes No TN# _____

GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
 Grouting Material bentonite from 0 to 21 ft. _____ yards 1 bags
 _____ from _____ to _____ ft. _____ yards _____ bags
 _____ from _____ to _____ ft. _____ yards _____ bags

OTHER WELLS AND BORINGS UNKNOWN
 Other unsealed and unused well or boring on property? Yes No How many? _____

REMARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING
Terracon Project # M5775049
Boring B-17
 LICENSED OR REGISTERED CONTRACTOR CERTIFICATION
 This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report is true to the best of my knowledge.

Terracon Consultants, Inc. Licensee Business Name M1665 License or Registration No.
[Signature] Certified Representative Signature 3621 Certified Rep. No. 9/22/17 Date

MINN. DEPT. OF HEALTH COPY **H 343632**
Christopher Schill Name of Person Sealing Well or Boring

APPENDIX B
SUPPORTING INFORMATION

Geotechnical Exploration Report

Roseau Lake Rehabilitation ■ Roseau County, Minnesota

October 3, 2017 ■ Terracon Project No. M5175049



Laboratory Testing

Representative samples were selected for laboratory analysis. As directed by HDR, soil samples were tested for the following engineering properties:

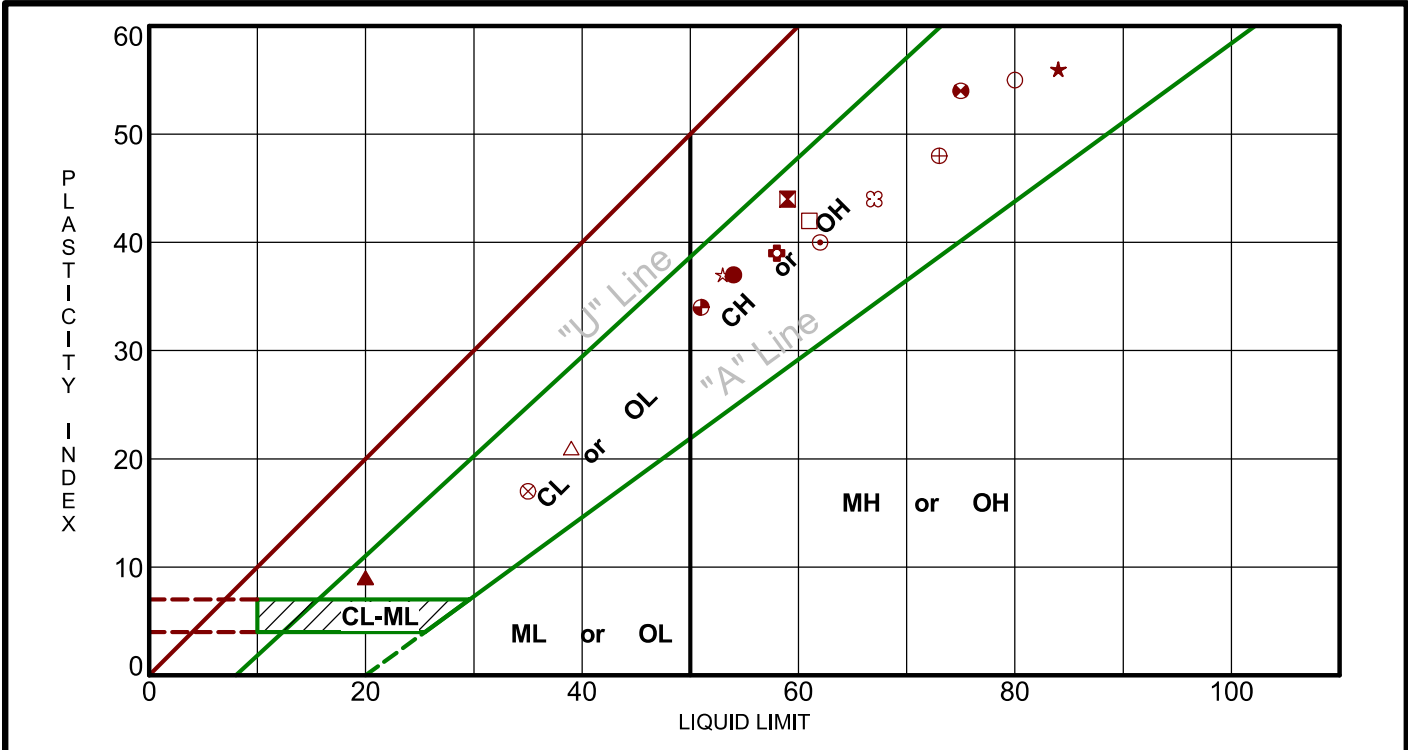
- Water content (ASTM D2216)
- Dry density (ASTM D7263-09 Method B)
- Atterberg limits (ASTM D4318)
- Grain size distribution (ASTM D422)
- Hydraulic conductivity (ASTM D5084)
- One-dimensional consolidation properties (ASTM D2435)
- UU Triaxial (ASTM D2850)
- Hydraulic Conductivity (ASTM D5084)

The laboratory test results are found on the boring logs opposite the samples they represent. Unconfined compressive strength test results are provided on the following pages.

Procedural standards noted above are for reference to methodology in general. In some cases variations to methods are applied as a result of local practice or professional judgment.

ATTERBERG LIMITS RESULTS

ASTM D4318



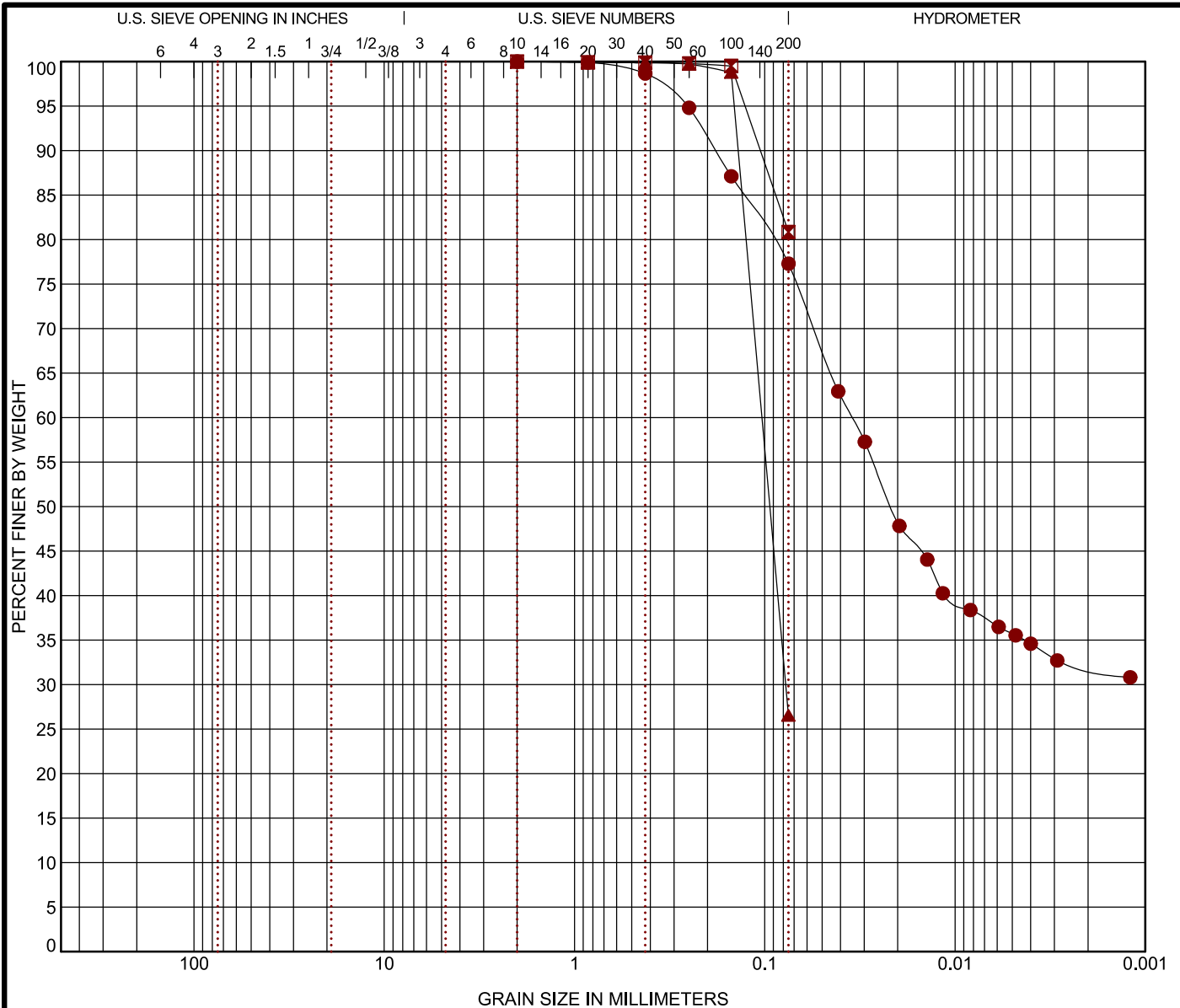
LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS M5175049 ROSEAU LAKE REHAB.GPJ TERRACON_DATATEMPLATE.GDT 9/19/17

Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● B-1	7 - 9	54	17	37		CH	FAT CLAY
⊠ B-3	12 - 14	59	15	44		CH	FAT CLAY
▲ B-4	7 - 8.5	20	11	9		CL	LEAN CLAY
★ B-8	4.5 - 6.5	84	28	56		CH	FAT CLAY
⊕ B-8	14.5 - 16.5	62	22	40		CH	FAT CLAY
⊕ B-9	2 - 3.5	58	19	39		CH	FAT CLAY
○ B-9	19.5 - 21.5	80	25	55		CH	FAT CLAY
△ B-10	2 - 3.5	39	18	21		CL	LEAN CLAY
⊗ B-10	7 - 9	35	18	17		CL	LEAN CLAY
⊕ B-10	12 - 14	73	25	48		CH	FAT CLAY
□ B-10	19.5 - 21.5	61	19	42		CH	FAT CLAY
⊕ B-12	12 - 14	75	21	54		CH	FAT CLAY
⊕ B-12	39.5 - 41.5	51	17	34		CH	FAT CLAY
★ B-12	49.5 - 51.5	53	16	37		CH	FAT CLAY
⊗ B-15	14.5 - 16.5	67	23	44		CH	FAT CLAY

PROJECT: Roseau Lake Rehabilitation	<p>1555 N 42nd St Unit B Grand Forks, ND</p>	PROJECT NUMBER: M5175049
SITE: Roseau County Roseau, Minnesota		CLIENT: Roseau River Watershed District
		EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
● B-2	3 - 5	LEAN CLAY WITH SAND CL						
☒ B-2	7 - 8.5	SILT with SAND (ML)	14	NP	NP	NP		
▲ B-13	2 - 3.5	SILTY SAND (SM)		NP	NP	NP		

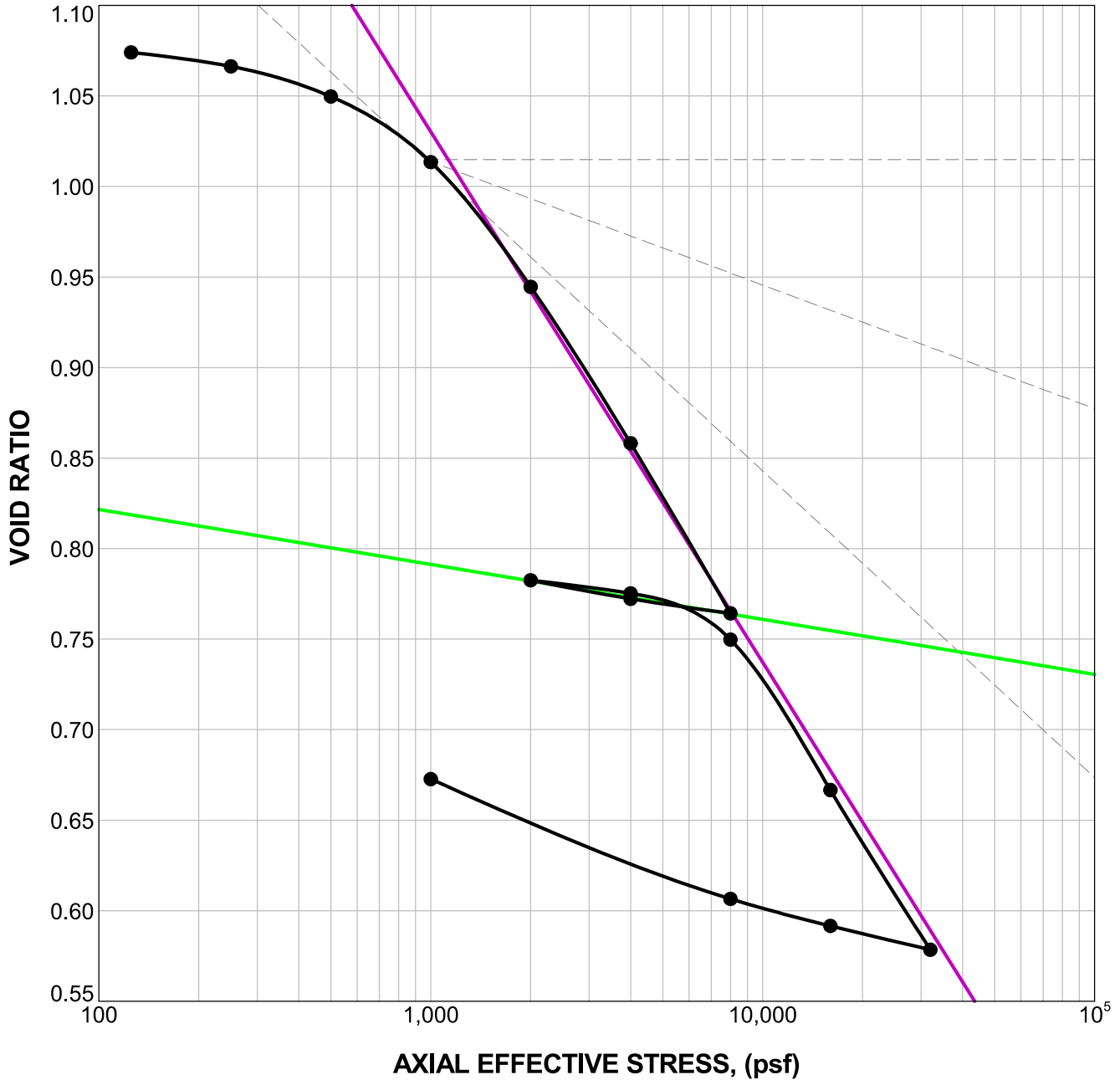
Boring ID	Depth	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Gravel	%Sand	%Silt	%Fines	%Clay
● B-2	3 - 5	2	0.035			0.0	22.7	41.6		35.7
☒ B-2	7 - 8.5	2				0.0	19.1		80.9	
▲ B-13	2 - 3.5	2	0.103	0.078		0.0	73.4		26.6	

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATA_TEMPLATE.GDT 10/2/17

PROJECT: Roseau Lake Rehabilitation	<p>1555 N 42nd St Unit B Grand Forks, ND</p>	PROJECT NUMBER: M5175049
SITE: Roseau County Roseau, Minnesota		CLIENT: Roseau River Watershed District Roseau, Minnesota
		EXHIBIT: B-3

CONSOLIDATION TEST (D2435)

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CONS_LOAD-DEF_PROP_STRESS-VOIDRATIO M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17



Natural		Initial Dry Density (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P _c (psf)	C _i (vr / log stress)	C _v (vr / log stress)	Initial Void Ratio
Saturation	Moisture									
109.9 %	43.9 %	81.1	80	55	2.70		1,184	0.293	0.030	1.078

MATERIAL DESCRIPTION								USCS	AASHTO
FAT CLAY								CH	

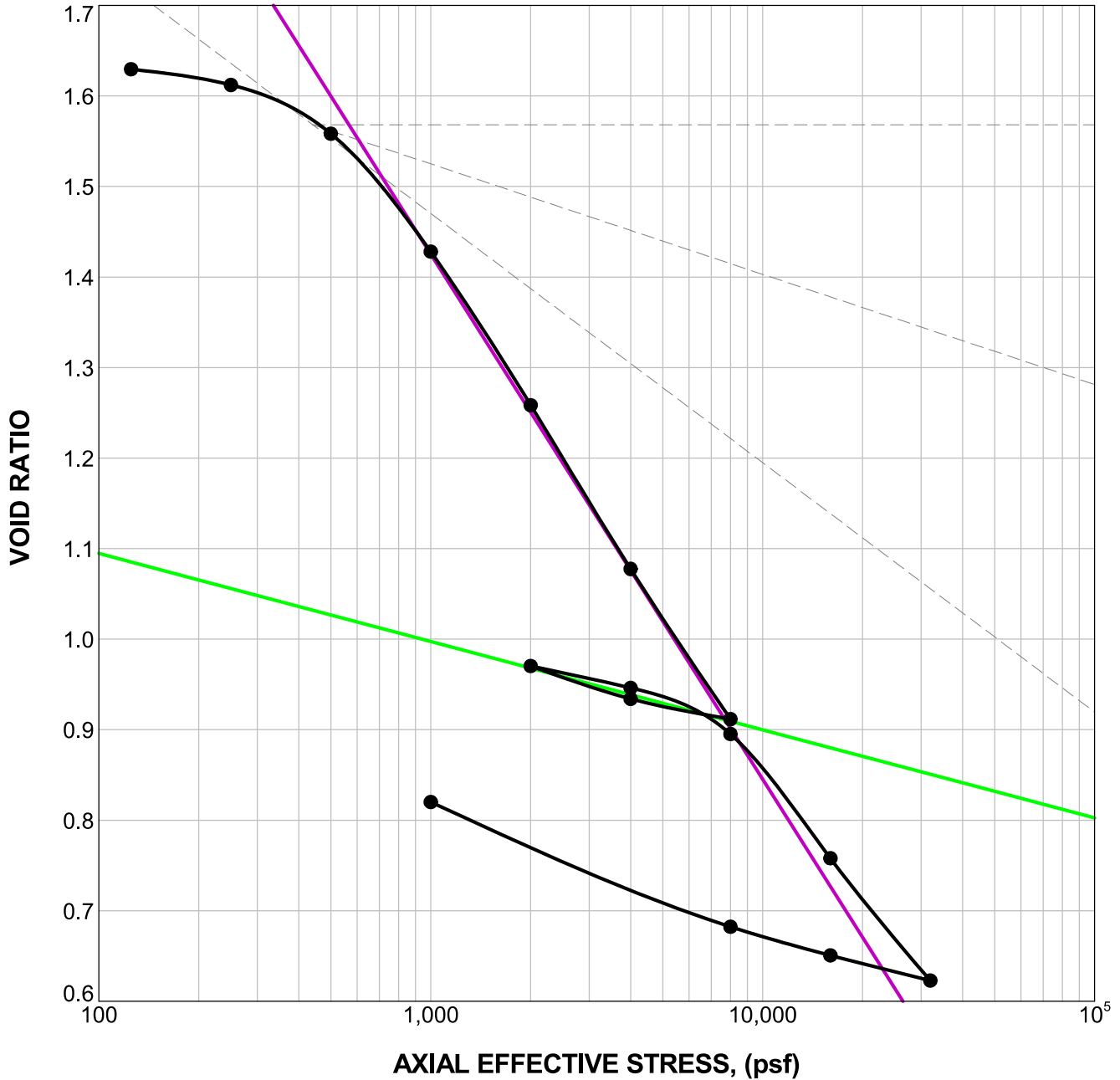
NOTES:

Borehole: B-9 Depth: 19.5 ft Specimen #: 8

PROJECT: Roseau Lake Rehabilitation	<p>1555 N 42nd St Unit B Grand Forks, ND</p>	PROJECT NUMBER: M5175049
SITE: Roseau County Roseau, Minnesota		CLIENT: Roseau River Watershed District Roseau, Minnesota
		EXHIBIT: B-4

CONSOLIDATION TEST (D2435)

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. CONS_LOAD-DEF_PROP_STRESS-VOIDRATIO M5175049 ROSEAU LAKE REHAB_RECOVERED.GPJ TERRACON_DATATEMPLATE.GDT 10/2/17



Natural	Initial Dry Density (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P _c (psf)	C _c (vr / log stress)	C _r (vr / log stress)	Initial Void Ratio
Saturation	Moisture								
98.1 %	59.4 %	63.9	75	54	2.70	606	0.580	0.097	1.636

MATERIAL DESCRIPTION	USCS	AASHTO
FAT CLAY	CH	

NOTES:

Borehole: B-12 Depth: 12 ft Specimen #: 6

PROJECT: Roseau Lake Rehabilitation	1555 N 42nd St Unit B Grand Forks, ND	PROJECT NUMBER: M5175049
SITE: Roseau County Roseau, Minnesota		CLIENT: Roseau River Watershed District Roseau, Minnesota
		EXHIBIT: B-5

HYDRAULIC CONDUCTIVITY REPORT



1555 N. 42nd St., Unit B
Grand Forks, ND 58203
701-772-2832

Client

Roseau River Watershed District

Project

Roseau Lake Rehabilitation

Project Number: M5175049

Test Method:	ASTM D5084 Method C	Sample No.:	Boring B-2 - 3' - 5'
Sample Type:	Remolded	Location :	
Date Sampled :	8/14/2017	Operator :	wro
Soil Type :	LEAN CLAY with SAND (CL) - gray		
Proctor Results :	111.9 pcf	Molded @ :	94.9 % compact
	15.8 %		15.6 % M.C.

Initial Sample Parameters				Water Content			
Wet Wt. (g)	664.79	Diameter (in)	2.850	Height (in)	3.228	Pan No.:	136
Dry Wt. (g)	575.32		2.876		3.217	Wet Wt.	70.25
Area (cm ²)	41.350		2.844		3.202	Dry Wt.	62.97
Area (in ²)	6.409	Average (in)	2.857	Average(in)	3.216	Pan Wt.	16.16
Density (pcf)	106.2					W.C. (%)	15.6
Assumed Sp.G.	2.65	Void Ratio:	0.556			% Saturation	74.0
Vol Wet (cc)	337.74	Vol. Solids Vs(cc)	217.10	Porosity n (%)	36		

Final Sample Parameters				Water Content			
Wet Wt. (g)	715.94	Diameter (in)	2.897	Height (in)	3.202	Pan No.:	19
Dry Wt. (g)	593.41		2.859		3.267	Wet Wt.	797.36
Area (cm ²)	42.048		2.886		3.192	Dry Wt.	674.89
Area (in ²)	6.517	Average (in)	2.881	Average(in)	3.220	Pan Wt.	81.79
Density (pcf)	107.6					W.C. (%)	20.6
						% Saturation	101.8

Panel No.: 2 Chamber No.: 3 Hydraulic Gradient: 17.9
 Cell Press.(psi) 58.4 Back Press.(psi) 54.1 Tail Press. (psi) 52.0
 Pipette Burette Pipe Area (cm²) 0.079 Fluid: De-aired tap w water

Date and Time	Temp	Head (h1)	Tail (h2)	Elapsed Time (S)	Total Head	k (cm / s)	k ₂₀ (cm/sec)	dt / dh
9/13/17 7:21	23	26.40	25.00		144.26			
9/13/17 9:15	23	28.00	23.40	6840	140.68	2.87E-08	2.67E-08	1.00
9/13/17 11:26	23	30.00	21.50	7860	136.31	3.13E-08	2.92E-08	0.95
9/13/17 13:29	23	32.00	19.80	7380	132.17	3.26E-08	3.04E-08	0.85
9/13/17 15:37	23	34.00	18.20	7680	128.14	3.15E-08	2.93E-08	0.80

HYDRAULIC CONDUCTIVITY (k₂₀) = **AVERAGE 2.89E-08 cm/sec**

HYDRAULIC CONDUCTIVITY REPORT



1555 N. 42nd St., Unit B
Grand Forks, ND 58203
701-772-2832

Client

Roseau River Watershed District

Project

Roseau Lake Rehabilitation

Project Number: M5175049

Test Method:	ASTM D5084 Method C	Sample No.:	Boring B-10, Sample #4, 7' -9'
Sample Type:	3-inch Shelby tube	Location :	
Date Sampled :	8/14/2017	Operator :	wro
Soil Type :	LEAN CLAY (CL) - gray, silt lenses		
Proctor Results :	pcf	Molded @ :	% compact
	%		% M.C.

Initial Sample Parameters

Wet Wt. (g)	651.57	Diameter (in)	2.808	Height (in)	3.275	Water Content	
Dry Wt. (g)	510.51		2.802		3.279	Pan No.:	170
Area (cm ²)	39.821		2.800		3.262	Wet Wt.	94.00
Area (in ²)	6.172	Average (in)	2.803	Average(in)	3.272	Dry Wt.	77.22
Density (pcf)	96.2					Pan Wt.	16.49
Assumed Sp.G.	2.65	Void Ratio:	0.718			W.C. (%)	27.6
Vol Wet (cc)	330.94	Vol. Solids Vs(cc)	192.65	Porosity n (%)	42	% Saturation	101.8

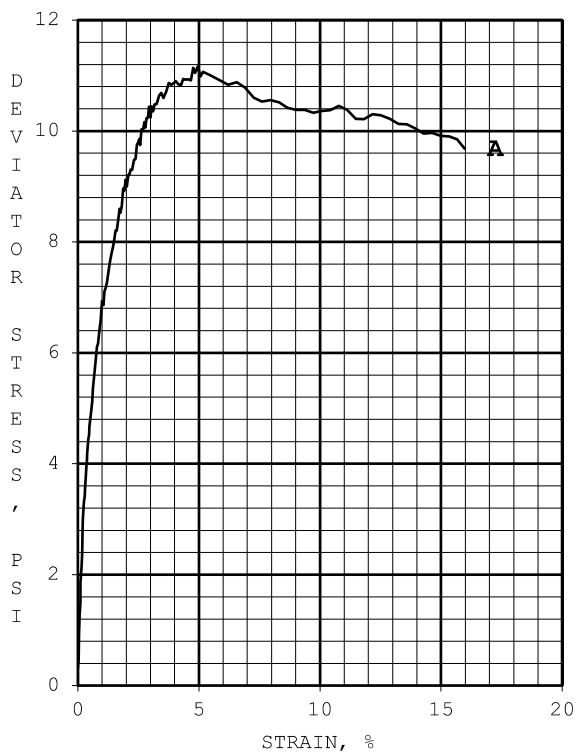
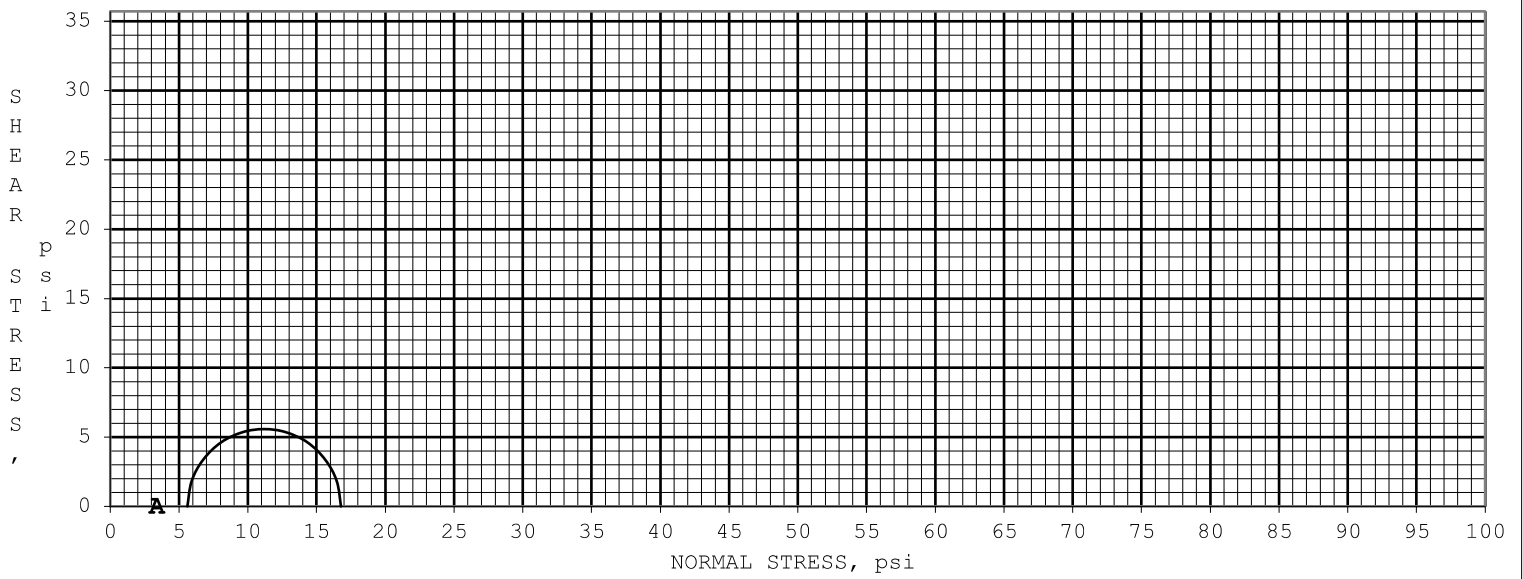
Final Sample Parameters

Wet Wt. (g)	648.83	Diameter (in)	2.802	Height (in)	3.242	Water Content	
Dry Wt. (g)	505.15		2.803		3.237	Pan No.:	45
Area (cm ²)	39.858		2.809		3.230	Wet Wt.	727.37
Area (in ²)	6.178	Average (in)	2.805	Average(in)	3.236	Dry Wt.	583.74
Density (pcf)	96.2					Pan Wt.	78.75
						W.C. (%)	28.4
						% Saturation	104.6

Panel No.: 1 Chamber No.: 1 Hydraulic Gradient: 16.9
 Cell Press.(psi) 59.3 Back Press.(psi) 54.1 Tail Press. (psi) 52.1
 Pipette Burette Pipe Area (cm²) 0.079 Fluid: De-aired tap water

Date and Time	Temp	Head (h1)	Tail (h2)	Elapsed Time (S)	Total Head	k (cm / s)	k ₂₀ (cm/sec)	dt / dh
9/13/17 7:21	23	25.60	25.20		139.75			
9/13/17 9:15	23	26.90	23.80	6840	136.72	2.64E-08	2.46E-08	1.08
9/13/17 11:26	23	28.30	22.50	7860	133.70	2.35E-08	2.18E-08	0.93
9/13/17 13:29	23	29.60	21.30	7380	130.90	2.36E-08	2.20E-08	0.92
9/13/17 15:37	23	31.00	20.00	7680	127.88	2.51E-08	2.34E-08	0.93

HYDRAULIC CONDUCTIVITY (k₂₀) = **AVERAGE 2.29E-08 cm/sec**



SPECIMEN #:		A	
INITIAL	WATER CONTENT, % FROM TRIMMINGS	33.0	
	DRY DENSITY, pcf	87.8	
	SATURATION, %	97	
	VOID RATIO	0.92	
WATER CONTENT, % AFTER SHEAR		33.4	
MINOR PRINCIPAL STRESS, psi		5.6	
MOHR'S CIRCLES DRAWN AT % STRAIN		5.0	
DEVIATOR STRESS AT % STRAIN, psi		11.2	
STRAIN AT PEAK DEVIATOR STRESS, %		5.0	
DEVIATOR STRESS AT 15% STRAIN, psi		9.9	
INITIAL DIAMETER, inch		2.844	
INITIAL HEIGHT, inch		5.620	
STRAIN RATE, %/minute		0.33	

CONTROLLED - STRAIN TEST

DESCRIPTION OF SPECIMENS: LEAN CLAY, VERY DARK GRAYISH BROWN TRACE YELLOWISH BROWN

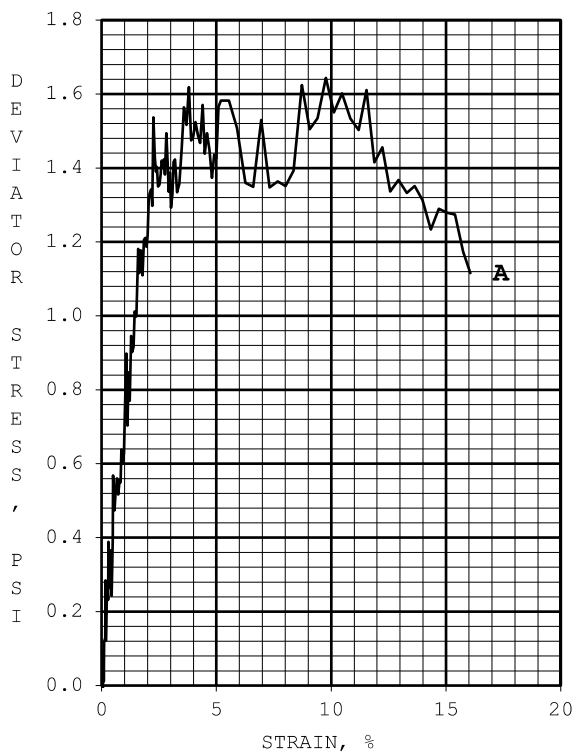
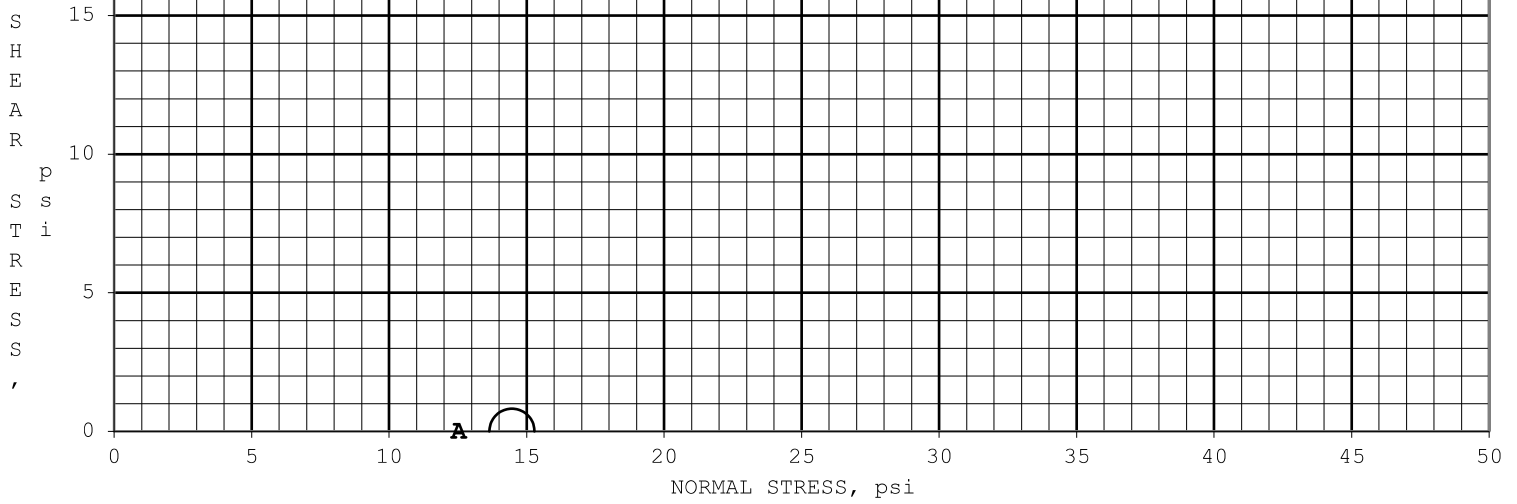
LL	PL	PI	Gs 2.7 EST.	SAMPLE TYPE: 3" SHELBY TUBE	TEST TYPE: UU
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REMARKS:	PROJECT: ROSEAU LAKE REHABILITATION	
	ROSEAU, MINNESOTA	M5175049
	BORING #: B-8	
	SAMPLE #: 3	
	DEPTH, feet: 4.5 - 6.5	
	LABORATORY: TERRACON - LENEXA	DATE: 9/15/2017

TRIAxIAL COMPRESSION TEST REPORT

PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTM'S D2216 AND D4318 IF APPLICABLE.





SPECIMEN #:		A	
INITIAL	WATER CONTENT, % FROM TRIMMINGS	54.2	
	DRY DENSITY, pcf	67.3	
	SATURATION, %	97	
	VOID RATIO	1.51	
WATER CONTENT, % AFTER SHEAR		59.3	
MINOR PRINCIPAL STRESS, psi		13.6	
MOHR'S CIRCLES DRAWN AT % STRAIN		9.8	
DEVIATOR STRESS AT % STRAIN, psi		1.6	
STRAIN AT PEAK DEVIATOR STRESS, %		9.8	
DEVIATOR STRESS AT 15% STRAIN, psi		1.3	
INITIAL DIAMETER, inch		2.895	
INITIAL HEIGHT, inch		5.877	
STRAIN RATE, %/minute		0.33	

CONTROLLED - STRAIN TEST

DESCRIPTION OF SPECIMENS: FAT CLAY, GRAY

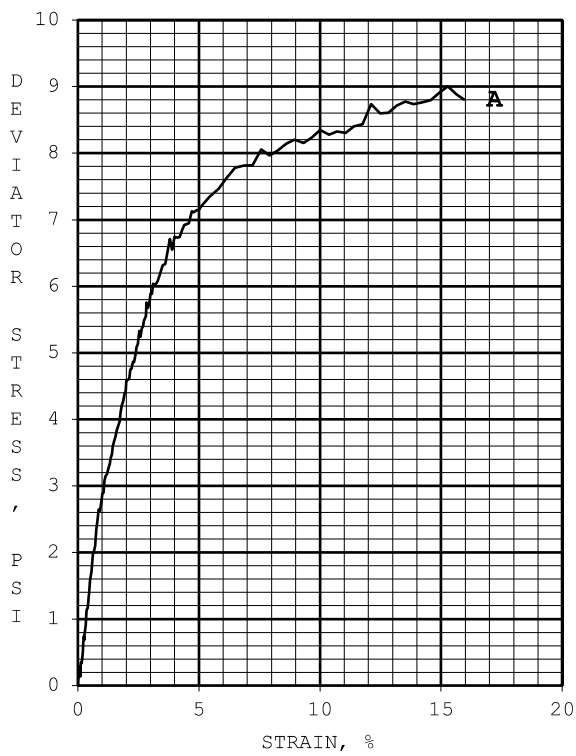
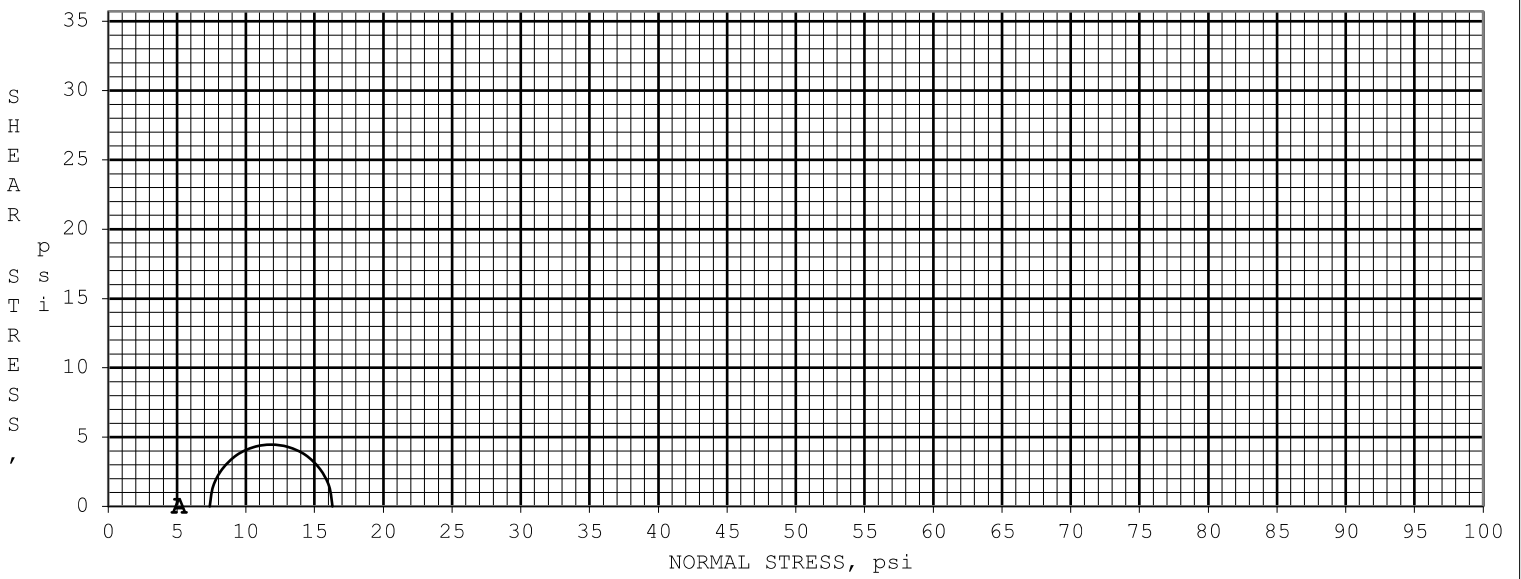
LL	PL	PI	Gs 2.7 EST.	SAMPLE TYPE: 3" SHELBY TUBE	TEST TYPE: UU
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REMARKS:	PROJECT: ROSEAU LAKE REHABILITATION	
	ROSEAU, MINNESOTA	M5175049
	BORING #: B-8	
	SAMPLE #: 7	
	DEPTH, feet: 14.5 - 16.0	
	LABORATORY: TERRACON - LENEXA	DATE: 9/15/2017

TRIAxIAL COMPRESSION TEST REPORT

PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTM D2216 AND D4318 IF APPLICABLE.





SPECIMEN #:		A	
INITIAL	WATER CONTENT, % FROM TRIMMINGS	23.1	
	DRY DENSITY, pcf	101.9	
	SATURATION, %	95	
	VOID RATIO	0.65	
WATER CONTENT, % AFTER SHEAR		25.4	
MINOR PRINCIPAL STRESS, psi		7.4	
MOHR'S CIRCLES DRAWN AT % STRAIN		15.0	
DEVIATOR STRESS AT % STRAIN, psi		8.9	
STRAIN AT PEAK DEVIATOR STRESS, %		15.0	
DEVIATOR STRESS AT 15% STRAIN, psi		8.9	
INITIAL DIAMETER, inch		2.843	
INITIAL HEIGHT, inch		5.217	
STRAIN RATE, %/minute		0.33	

CONTROLLED - STRAIN TEST

DESCRIPTION OF SPECIMENS: LEAN CLAY, DARK GRAY TRACE DARK BROWN

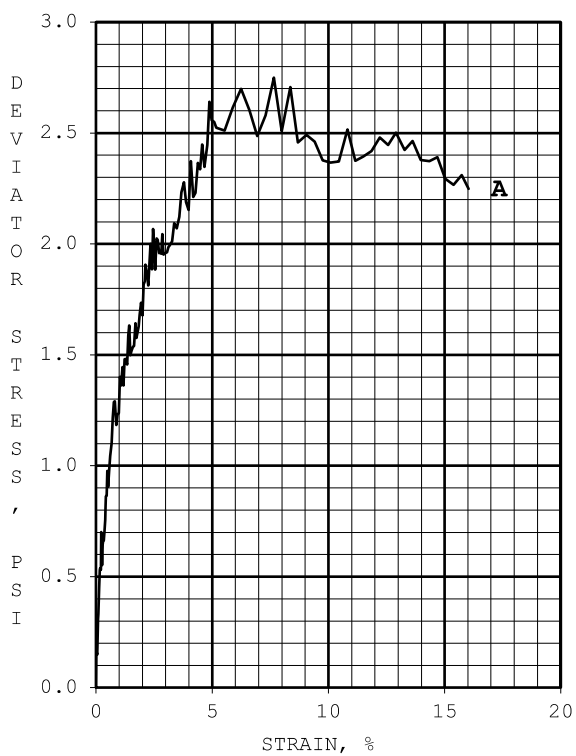
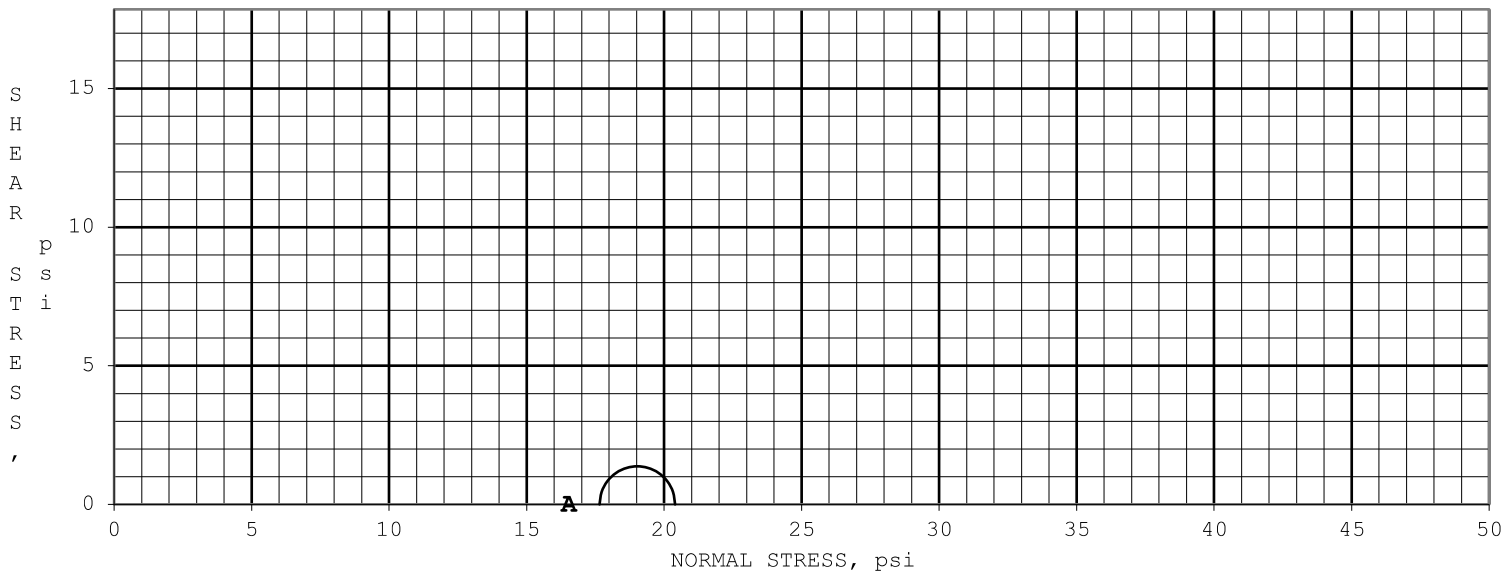
LL	PL	PI	Gs 2.7 EST.	SAMPLE TYPE: 3" SHELBY TUBE	TEST TYPE: UU
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REMARKS:	PROJECT: ROSEAU LAKE REHABILITATION	
	ROSEAU, MINNESOTA	M5175049
	BORING #: B-10	
	SAMPLE #: 4	
	DEPTH, feet: 7.0 - 9.0	
	LABORATORY: TERRACON - LENEXA	DATE: 9/15/2017

TRIAxIAL COMPRESSION TEST REPORT

PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTM'S D2216 AND D4318 IF APPLICABLE.





SPECIMEN #:		A	
INITIAL	WATER CONTENT, % FROM TRIMMINGS	51.1	
	DRY DENSITY, pcf	72.1	
	SATURATION, %	103	
	VOID RATIO	1.34	
WATER CONTENT, % AFTER SHEAR		50.7	
MINOR PRINCIPAL STRESS, psi		17.7	
MOHR'S CIRCLES DRAWN AT % STRAIN		7.7	
DEVIATOR STRESS AT % STRAIN, psi		2.7	
STRAIN AT PEAK DEVIATOR STRESS, %		7.7	
DEVIATOR STRESS AT 15% STRAIN, psi		2.3	
INITIAL DIAMETER, inch		2.773	
INITIAL HEIGHT, inch		5.736	
STRAIN RATE, %/minute		0.33	

CONTROLLED - STRAIN TEST

DESCRIPTION OF SPECIMENS: FAT CLAY, VERY DARK GRAY TRACE LIGHT GRAY

LL	PL	PI	Gs 2.7 EST.	SAMPLE TYPE: 3" SHELBY TUBE	TEST TYPE: UU
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REMARKS:	PROJECT: ROSEAU LAKE REHABILITATION	
	ROSEAU, MINNESOTA	M5175049
	BORING #: B-10	
	SAMPLE #: 8	
	DEPTH, feet: 19.0 - 21.0	
	LABORATORY: TERRACON - LENEXA	DATE: 9/15/2017

TRIAxIAL COMPRESSION TEST REPORT







PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTM'S D2216 AND D4318 IF APPLICABLE.



APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING	WATER LEVEL	 Auger Cuttings  Shelby Tube  Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time	FIELD TESTS	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer
		Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.			

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS <small>(More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance</small>		CONSISTENCY OF FINE-GRAINED SOILS <small>(50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance</small>		
	Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength Qu, (psf)	Standard Penetration or N-Value Blows/Ft.
	Very Loose	0 - 3	Very Soft	less than 500	0 - 1
	Loose	4 - 9	Soft	500 to 1,000	2 - 4
	Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
	Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
	Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
			Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification		
				Group Symbol	Group Name ^B	
Coarse Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F	
			$Cu < 4$ and/or $1 > Cc > 3$ ^E	GP	Poorly graded gravel ^F	
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}	
			Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}	
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E	SW	Well-graded sand ^I	
			$Cu < 6$ and/or $1 > Cc > 3$ ^E	SP	Poorly graded sand ^I	
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G,H,I}	
			Fines classify as CL or CH	SC	Clayey sand ^{G,H,I}	
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	$PI > 7$ and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}	
			$PI < 4$ or plots below "A" line ^J	ML	Silt ^{K,L,M}	
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried		OH	Organic silt ^{K,L,M,O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}	
			PI plots below "A" line	MH	Elastic Silt ^{K,L,M}	
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried		OH	Organic silt ^{K,L,M,Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat	

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

^D Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.

