## **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



Environmental Facilities Geotechnical Materials



October 4, 2017

Roseau River Watershed District 108 3<sup>rd</sup> Ave SW Roseau, MN 56751

Attn: Ms. Tracy Halstensgard

P: [218] 242 1737 E: rrwd@mncable.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, El

Staff Engineer

William R. Olson, PE

Signature:

Geotechnical Department Manager

License #46391

I hereby certify that this plan, specification, or report was prepared by me or under my

Licensed Professional Engineer under the

direct supervision and that I am a duly

laws of the State of Minnesota.

Print Name: WILLIAM R. QLSON

10/4/17

Enclosures cc: 1 – HDR

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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 idvanced 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



### 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

Roseau Lake Rehabilitation Roseau County, Minnesota October 4, 2017 Terracon Project No. M5175049



#### SUBSURFACE CONDITIONS 3.0

#### 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.

#### **Geotechnical Exploration Report**

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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.

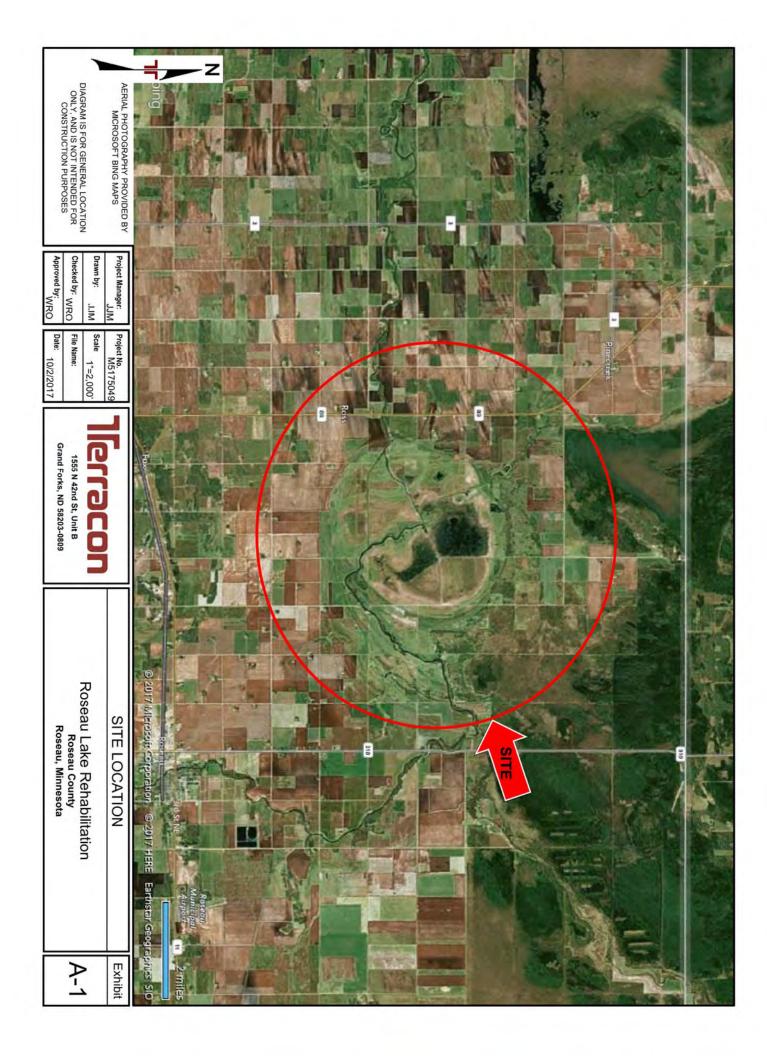
#### 4.0 GENERAL COMMENTS

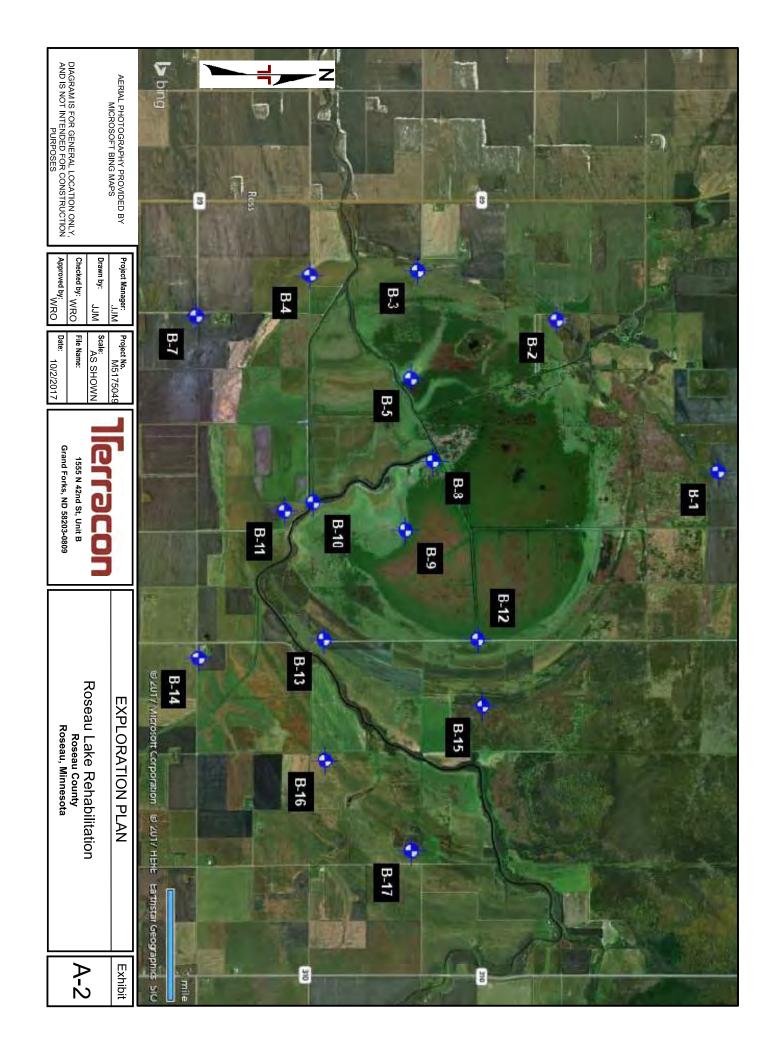
The information presented in this exploration summary report is based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This exploration summary report does not reflect variations that may occur between borings or due to 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





#### **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 L	OG I	NO.	В	-1				F	Page 1 of 1	1
PR	OJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota									
SIT	TE: Roseau County Roseau, Minnesota						.,					
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 LL-PL-PI	PERCENT FINES
	DEPTH FILL - FAT CLAY WITH SAND, trace grave brown	l, dark gray and		> 0	8	0.5	5-2-3	S.O.				
	biowii		-	- ,	X	0.7	N=5 2-2-3 N=5					
	6.0 <b>FAT CLAY (CH)</b> , dark gray, soft, silt lenses,	iron concretions	5-		X	0.9	2-2-3 N=5					
	FAT CLAY (CH), dank gray, soit, silt lenses, iron concretions					2.2			30		54-17-37	
	14.5		10-	-	X	1.5	2-1-3 N=4					
					X	1	1-1-2 N=3					
	FAT CLAY (CH), dark gray, soft to very soft	, silt lenses	15- -		X	1.5	0-1-1 N=2					
			-	-			0.04					
	21.0  Boring Terminated at 21 Feet		20-		X	1.5	0-0-1 N=1					
	Stratification lines are approximate. In-situ, the transition r	may be gradual.					Hammer Type: Auto	omatic				
3 1/4 Abanc	ncement Method: inch Hollow Stem Auger  donment Method: ing backfilled with grout from bottom up after npletion. Well and Boring Sealing Record No. H343623	See Exhibit A-3 for designocedures. See Appendix B for designocedures and addition See Appendix C for expabbreviations.	scription of nal data (if	laborat any).			Notes:					
	WATER LEVEL OBSERVATIONS  No free water observed					В	oring Started: 08-14-2	2017	Borir	ng Com	pleted: 08-14-2	2017
	No tree water observed  1555 N Gran			B		` ⊢	rill Rig: D-90	<u> </u>	Drille Evhi	er: CAS	Δ_4	

		<b>BORING L</b>	OG I	NO	<u>.</u> B	<b>3-2</b>				F	Page 1 of	1	
PR	OJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota										
SI	ΓΕ: Roseau County Roseau, Minnesota						,						
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	
	TOPSOIL - ORGANIC CLAY (OH), black				X	0.7	3-3-3 N=6	0,					
	LEAN CLAY WITH SAND (CL), gray, soft, si	ilt lenses	- - -	- - -		0.7	2-2-2 N=4	,				77	
	6.0 SILT WITH SAND (ML), gray, stiff		5 -		X	1.3	1-1-1 N=2						
	<u>SILT WITH SAND (ML),</u> gray, Sun		-	- - -	X	1	3-5-7 N=12		14		NP	81	
	10.0  FAT CLAY (CH), dark gray, soft, silt lenses		10-		X	1.3	3-2-2 N=4						
			-		X	1.5	2-1-2 N=3						
			15-		X	1.5	1-1-0 N=1						
			-										
	21.0  Boring Terminated at 21 Feet		20-		X	1.1	0-1-1 N=2						
Advar	Bonnig reminated at 211 eet												
	Stratification lines are approximate. In-situ, the transition n	may be gradual.		1	- 1		Hammer Type: Auto	omatic	1	1	1		
Aband Boi	ncement Method: inch Hollow Stem Auger  donment Method: ing backfilled with grout from bottom up after inpletion. Well and Boring Sealing Record No. H343624	See Exhibit A-3 for desiprocedures. See Appendix B for desiprocedures and addition See Appendix C for expabbreviations.	scription of nal data (it	f labora f any).			Notes:						
	WATER LEVEL OBSERVATIONS  No free water observed	Terr	2			В	oring Started: 08-14-2	2017	Borir	Boring Completed: 08-14-2017			
		1555 N 42	nd St Unit			` ⊢	orill Rig: D-90	<u> </u>		er: CAS			
: [		Grand F	orks, ND	1555 N 42nd St Unit B Grand Forks, ND Project No.: M5175049 Exhibit:									

	<b>BORING L</b>	OG I	NO.	. В	3-3				F	Page 1 of	1
PROJECT: Roseau Lake Rehabilitation	1	CLIENT: Roseau River Watershed District Roseau, Minnesota									
SITE: Roseau County Roseau, Minnesota						,					
UCATION 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 LL-PL-PI	PERCENT FINES
TOPSOIL - ORGANIC CLAY (OH), black  SANDY LEAN CLAY (CL), trace gravel, o		_		X	0.1	2-1-2 N=3					
SANDY LEAN CLAY (CL), trace gravel, o yellow, medium stiff to stiff to medium stif	live brown and f	_ _ _	-	X	1	2-3-2 N=5					
		5 -	_	X	1.1	3-4-6 N=10					
		_	-	X	1.1	3-5-7 N=12					
yellow, medium stiff to stiff to medium stif		10-	_	X	1.5	4-4-4 N=8					
SANDY FAT CLAY (CH), trace gravel, dat	k gray, stiff	- - -			2.3			12		59-15-44	
		15-	_	X	1.5	3-4-5 N=9					
		-	-								
21.0  Boring Terminated at 21 Feet		20-		X	1.5	4-4-5 N=9					
Stratification lines are approximate. In-situ, the transitio											
Stratification lines are approximate. In-situ, the transition	n may be gradual.					Hammer Type: Auto	omatic				
Advancement Method: 3 ¼ inch Hollow Stem Auger  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	See Exhibit A-3 for des procedures. See Appendix B for des procedures and additio See Appendix C for expabbreviations.	scription of nal data (if	labora any).			Notes:					
WATER LEVEL OBSERVATIONS	75				B	oring Started: 08-16-	2017	Borii	ng Com	pleted: 08-16-	2017
No free water observed	- lierr	90	0	П	ì H	rill Rig: D-90		-	er: CAS	•	
		nd St Unit Forks, ND	В		F	roject No.: M517504	<del></del>	Exhi	bit:	A-6	

	<b>BORING L</b>	OG 1	VO.	. B	-4				F	Page 1 of	1	
PROJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota										
SITE: Roseau County Roseau, Minnesota												
UCATION See Exhibit A-2			SNS	PE	Ft.)	<b>⊢</b> .	VE psf)	(%	. 8	ATTERBERG LIMITS	ES	
Latitude: 48.90591° Longitude: -95.90643°  Latitude: 48.90591° Longitude: -95.90643°  DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	LL-PL-PI	PERCENT FINES	
TOPSOIL - ORGANIC CLAY (OH), black		_		X	1	2-4-4 N=8		30				
FAT CLAY (CH), dark gray, medium stiff, si	It lenses	-		X	1.1	2-2-2 N=4		28				
SANDY LEAN CLAY (CL), trace gravel, olive stiff	re brown, medium	5 -	-	X	1	2-2-3 N=5						
		-		X	1.5	2-3-3 N=6		14		20-11-9		
9.5  SANDY LEAN CLAY (CL), trace gravel, gra	y, medium stiff	10-	-	X	1.3	2-3-3 N=6						
		-		X	1.5	2-4-4 N=8						
		15-		X	1.3	2-3-4 N=7						
9.5  SANDY LEAN CLAY (CL), trace gravel, olive stiff  SANDY LEAN CLAY (CL), trace gravel, grav		-										
21.0  Boring Terminated at 21 Feet		20-		X	1.3	2-4-5 N=9						
Stratification lines are approximate. In-situ, the transition												
Stratification lines are approximate. In-situ, the transition	may be gradual.					Hammer Type: Auto	omatic					
	See Exhibit A-3 for des	scription of	field		T 1	Notes:						
Advancement Method: 3 ¼ inch Hollow Stem Auger  Abandonment Method: Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343627  WATER LEVEL OBSERVATIONS  No free water observed	see Exhibit A-3 for des procedures. See Appendix B for des procedures and additio See Appendix C for exp abbreviations.	scription of nal data (if	labora any)									
WATER LEVEL OBSERVATIONS	75				Во	oring Started: 08-16-	2017	Borii	ng Com	ompleted: 08-16-2017		
No free water observed		90			Di	rill Rig: D-90		Driller: CAS				
		2nd St Unit Forks, ND	В		Pr	Project No.: M5175049 Exhi				chibit: A-7		

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		<b>BORING L</b>	OG I	ON	. B	<b>3-5</b>				ı	Page 1 of 1	1
PR	OJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota									
SIT	TE: Roseau County Roseau, Minnesota						•					
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	PERCENT FINES
<u> </u>	TOPSOIL - ORGANIC CLAY (OH), black		_		X	0.3	2-2-3 N=5					
(/////	LEAN CLAY (CL), dark gray, soft, silt lenses	s, iron concretions	- -	-	X	1	1-2-1 N=3					
			5 -	_	X	1.3	2-1-2 N=3					
	8.5				X	1.1	2-1-2 N=3					
	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-				1-1-1					
	21.0  Boring Terminated at 21 Feet				X	1.1	N=2					
Advan												
	Stratification lines are approximate. In-situ, the transition m	nay be gradual.					Hammer Type: Auto	omatic				
3 1/4	icement Method: inch Hollow Stem Auger  Ionment Method: ing backfilled with grout from bottom up after	See Exhibit A-3 for design procedures. See Appendix B for design procedures and addition See Appendix C for expabbreviations.	scription of nal data (if	labora any)			Notes:					
com	npletion. Well and Boring Sealing Record No. H343626  WATER LEVEL OBSERVATIONS	-					oring Started: 08-16-	2017	Bori	na Com	unleted: 08_16	2017
	No free water observed	llerr	20	0	n		rill Rig: D-90	_011		Boring Completed: 08-16-2017  Driller: CAS		
		1555 N 42 Grand F	nd St Unit orks, ND	В		P				xhibit: A-8		

		<b>BORING L</b>	OG I	NO	. В	<b>3-7</b>				F	Page 1 of <sup>2</sup>	<u>1_</u>
PR	OJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota									
SI	TE: Roseau County Roseau, Minnesota						•					
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
	TOPSOIL - ORGANIC CLAY (OH), black				X	1	4-4-5 N=9	- 0,				
	SILT WITH SAND (ML), gray, medium stiff		- -		X	1.1	2-3-2 N=5					
	6.0 SANDY LEAN CLAY (CL), trace gravel, dark	gray, soft	5 -		X	1.3	3-3-3 N=6					
	9.5		-		X	1.3	1-1-1 N=2					
	LEAN CLAY (CL), trace organics, dark gray	and black, soft	10-		X	1.3	1-1-1 N=2					
	14.5		-		X	1	0-1-1 N=2					
	FAT CLAY (CH), dark gray, soft, silt lenses		15- - -		X	1.5	0-1-1 N=2					
	21.0  Boring Terminated at 21 Feet		20-		X	1.5	0-1-1 N=2					
Advar	Bornig reminated at 21 reet											
	Stratification lines are approximate. In-situ, the transition m	ay be gradual.		1	I	<u> </u>	I Hammer Type: Auto	omatic	<u> </u>	<u></u>		
Abanc Bor	ncement Method: 4 inch Hollow Stem Auger donment Method: ring backfilled with grout from bottom up after npletion. Well and Boring Sealing Record No. H343629	See Exhibit A-3 for des procedures. See Appendix B for de- procedures and additio See Appendix C for ex- abbreviations.	scription of nal data (it	f labora f any).			Notes:					
	WATER LEVEL OBSERVATIONS  No free water observed					В	oring Started: 08-16-	2017	Borii	Boring Completed: 08-16-2017		
		11 <b>err</b>				` ⊢	rill Rig: D-90			er: CAS		
:				42nd St Unit B d Forks, ND Project No.: M5175049 Exhibit: A-9								

		BORING L	OG I	NO.	В-	8				F	Page 1 of 2	2
PR	OJECT: Roseau Lake Rehabilitation		CLIENT: Roseau River Watershed District Roseau, Minnesota									
SIT	E: Roseau County Roseau, Minnesota											
90	LOCATION See Exhibit A-2		£ [	/EL	/PE	(Ft.)	L	ED silvE (psf)	—— (%)	_ (cf)	ATTERBERG LIMITS	NES
GRAPHIC LOG	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)	LL-PL-PI	PERCENT FINES
<u>, 11, 11, 11, 11, 11, 11, 11, 11, 11, 1</u>	TOPSOIL - ORGANIC CLAY (OH), black and	dark gray	_		X	0.5	1-2-2 N=4		30			_
	LEAN CLAY (CL), brown, soft, silt lenses		-				1-1-2					
			_		<u> </u>	1.1	N=3		28			
	FAT CLAY (CH), dark gray, soft, silt lenses		5-	-		1.5			33		84-28-56	
			_		X	1	1-1-2 N=3		49			
			10-		X	8.0	1-1-1 N=2		45			
			_									
			-	-	X.	1.3	1-1-1 N=2		26			
			15-									
			-		2	2.1			42		62-22-40	
			-									
			-	-								
			20-	]		1.5	0-1-1 N=2		62			
			_	-								
			-									
			25-	-	\ \ \ \ .	1.5	1-1-1 N=2		97			
			_									
			-									
			30-			1 5	1-1-1		00			
			_	$\Box$	$\triangle$	1.5	N=2		99			
Advan	Stratification lines are approximate. In-situ, the transition management	ay be gradual.				ŀ	Hammer Type: Auto	matic				
3 1/4	cement Method: inch Hollow Stem Auger onment Method:	See Exhibit A-3 for design procedures. See Appendix B for design procedures and addition See Appendix C for exp	scription of nal data (if	labora any).			lotes:					
Bor	ng backfilled with grout from bottom up after pletion. Well and Boring Sealing Record No. H343637	abbreviations.		•								
$\overline{\nabla}$	WATER LEVEL OBSERVATIONS While drilling	There	ac			$\vdash$	ring Started: 08-09-2	2017	+		pleted: 08-09-2	2017
		1555 N 42	nd St Unit			$\vdash$	ill Rig: D-90		+	er: MAR		
1		Grand F	orks, ND			1Pro	oject No.: M5175049		Exhil	oit: A	<b>4-10</b>	

		<b>BORING L</b>	OG I	NO.	. B	-8				F	Page 2 of 2	2
Г	PROJECT: Roseau Lake Rehabilitation		CLIE				u River Waters u, Minnesota	shed D	Distri	ct		
-	SITE: Roseau County Roseau, Minnesota						.,					
0	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 LL-PL-PI	PERCENT FINES
ATE.GD1 10/2/17	FAT CLAY (CH), dark gray, soft, silt lenses	(continued)	- -	-								
DAIAIEINIFL	36.5  SANDY LEAN CLAY (CL), trace gravel, dark stiff to hard, occasional cobbles and boulde	gray, soft to very	35	- - -		2			86			
KED.GFJ IERRACCI			40-	- - - -	X	1.5	2-1-1 N=2		17			
AKE KEHAB_KECOVE			45-	- - - -	X	1.5	1-1-1 N=2		15			
IST 3049 ROSEAU EV			50-	- - - -		0.5	3-6-14		15			
AI LOG-NO WELL IN			- - -	-		<b>0.</b> 3	N=20		13			
PORT: GEO SIMARI LOG			55-	- - -	X	1	14-22-31 N=53		14			
M ONIGINAL REP	61.0 Paring Tamping at 64 Fact		60-	-	X	1	30-45-60 N=105		13			
	Boring Terminated at 61 Feet  Stratification lines are approximate. In-situ, the transition n	nay be gradual.					Hammer Type: Auto	matic				
Ab Ab	ivancement Method: 3 1/4 inch Hollow Stem Auger  pandonment Method: Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343637	See Exhibit A-3 for desprocedures. See Appendix B for desprocedures and addition See Appendix C for expabbreviations.	scription of nal data (if	laborat any).			Notes:					
7 C	WATER LEVEL OBSERVATIONS					  E	Boring Started: 08-09-2	.017	Borir	ng Com	pleted: 08-09-	2017
	∠ While drilling		ac nd St Unit				Orill Rig: D-90		Drille	er: MAR		
ź 🗀		nd St Unit	D		-	Project No · M5175049		Eyhi	hit: 4	Δ-10		

			BORING L	OG I	NO.	В	-9				F	Page 1 of 1	1
	PR	OJECT: Roseau Lake Rehabilitation		CLIE	NT: I	Ros Ros	eau eau	น River Waters น, Minnesota	shed D	Distri	ct		
	SIT	E: Roseau County Roseau, Minnesota						,					
	GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.91827° Longitude: -95.85629° 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 LL-PL-PI	PERCENT FINES
/1./7/	1/ · 7/ · 7/	TOPSOIL - ORGANIC CLAY, dark gray, woo	od debris	_		X	1	1-1-2 N=3		56			
LAIE.GDI 10		FAT CLAY (CH), dark gray, soft, silt lenses		- - -	-	X	1.5	2-2-2 N=4		28		58-19-39	
N DAIAIEM				5 -	-	X	1.3	2-2-2 N=4		54			
C LERRACO				-	- - -	X	1.3	1-1-1 N=2		60			
COVERED.G				10-		X	1	1-1-1 N=2		54			
HAB KE				_		X	1.5	0-1-1 N=2		50			
AU LANE RE				15-		X	1.5	0-1-1 N=2		47			
M51/5049 ROSE/				-	-								
		21.5		20-			2			44		80-25-55	
SEPARALED FROM ORIGINAL REPORT. GEO SMART LOG-N		Boring Terminated at 21.5 Feet  Stratification lines are approximate. In-situ, the transition recement Method:		orinting of	fold			Hammer Type: Auto	matic				
ANOLVALID IF 8	3 1/4 Aband Bori	inch Hollow Stem Auger  onment Method: ng backfilled with grout from bottom up after	See Exhibit A-3 for design procedures. See Appendix B for design procedures and addition See Appendix C for expabbreviations.	scription of nal data (if	laborat any).			Notes:					
3 LOG	com	pletion. Well and Boring Sealing Record No. H343633  WATER LEVEL OBSERVATIONS	75				- R	oring Started: 08-09-2	2017	Borin	па Сот	pleted: 08-09-2	2017
2222		No free water observed	llerr	20		M	⊢	rill Rig: D-90		+	er: MAF	•	
10 10 10 10 10 10 10 10 10 10 10 10 10 1			1555 N 42				⊢	roject No : M5175049	1		hit:		

L		BORING LO	DG N	10.	B-	10	<u> </u>			F	Page 1 of 2	2_
PR	OJECT: Roseau Lake Rehabilitation		CLIE				River Waters , Minnesota	shed [	Distri	ct		
SIT	TE: Roseau County Roseau, Minnesota						,					
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
17.21,	TOPSOIL - ORGANIC CLAY (OH), black 1.5		_		$\downarrow$	0.3	4-5-4 N=9		18			
1/////	LEAN CLAY (CL), gray, medium stiff, silt ler	nses	-	- - -		0.7	3-3-3 N=6		22		39-18-21	
			5 -		X	1.1	2-2-2 N=4		23			
	9.0	trans word 9	- - -			1.8			28		35-18-17	
	FAT CLAY (CH), dark gray, soft, silt lenses, organics at 12'	trace wood &	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			
			20-									
			-			2.3			46		61-19-42	
			25-			1,1	1-1-1		61			
			-	_			N=2					
			30-		X	1.3	0-1-1 N=2		83			
Advan	Stratification lines are approximate. In-situ, the transition n	nay be gradual.		1			Hammer Type: Auto	I omatic	<u> </u>	<u> </u>		
Abanc Bor	lonment Method: Inch Hollow Stem Auger  Ionment Method: Ing backfilled with grout from bottom up after	See Exhibit A-3 for des procedures. See Appendix B for des procedures and additio See Appendix C for expabbreviations.	scription of nal data (if	f labora f any).			Notes:					
con	npletion. Well and Boring Sealing Record No. H343634  WATER LEVEL OBSERVATIONS					Br	oring Started: 08-14-2	2017	Boris	na Com	pleted: 08-14-2	.2017
	No free water observed	llerr	20	0		$\vdash$	ill Rig: D-90	_011	-	er: MAF	-	
		1555 N 42 Grand F	nd St Unit Forks, ND	В		$\vdash$	oject No.: M5175049	)	Exhi		A-12	

		<b>BORING LO</b>	DG N	10.	B-1	10				Page 2	of 2
Р	ROJECT: Roseau Lake Rehabilitation		CLIE	NT: F	Rose	au River	· Watersh	ed Dis	trict		
s	SITE: Roseau County Roseau, Minnesota		-	•	1000	aa, miii	loota				
GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.90633° Longitude: -95.86177°  DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	KECOVERY (Ft.)	RESULTS UNCONFINED	COMPRESSIVE STRENGTH (psf) WATER	CONTENT (%) DRY UNIT	MEIGHT (pct)  LL-PL-	N FIN
1020	FAT CLAY (CH), dark gray, soft, silt lenses, organics at 12' (continued)	, trace wood &	-								
A EWILLA	36.0 <u>FAT CLAY WITH SAND (CH)</u> , dark gray, so	ft. silt lenses	35-		1	.5 0·	-1-1 N=2	8	1		
	, can go,, co		-								
OVENED OF THE PARTY OF THE PART			40-		1		-1-1 N=2	1	8		
SE REHADE REC			45-		1		-1-1 V=2	2	9		
48 KOSEAO EAK			-								
WELL WOLLD	49.5  SILT (ML), gray, stiff to very stiff to hard		50-		1		-6-5 =11	1	9		
SWAN LOGINO			55-			4 7 <del>-</del>	9-11				
			-	_		.1 ,- N	=20	1	4		
	61.0		60-		0		13-18 =31	1	5		
AL LED TA	Boring Terminated at 61 Feet  Stratification lines are approximate. In-situ, the transition in	may be gradual.				Hammer	Type: Automa	tic			
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	rancement Method:	lo =:::::	. ,.	<u> </u>		Notos					
Aba	ancement Method: 1/4 inch Hollow Stem Auger  undonment Method: foring backfilled with grout from bottom up after ompletion. Well and Boring Sealing Record No. H343634	See Exhibit A-3 for desprocedures. See Appendix B for desprocedures and addition See Appendix C for expabbreviations.	scription of nal data (if	laborat any).		Notes:					
	WATER LEVEL OBSERVATIONS	75				Boring Star	ted: 08-14-201	7 E	Boring Co	ompleted: 08	3-14-2017
	No free water observed	- lieff	20			Drill Rig: D	-90		Driller: M	IAR	
<u> </u>		1555 N 42	nd St Unit	В	-	Project No.	· M5175049		-yhihit	Δ-12	

	1	BORING LO	DG N	10.	B-	11				F	Page 1 of	1
PR	OJECT: Roseau Lake Rehabilitation		CLIE	NT:	Ros Ros	eau eau	River Waters , Minnesota	shed C	Distri	ct		
SIT	TE: Roseau County Roseau, Minnesota		_				,					
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
	TOPSOIL - ORGANIC CLAY (OH), black 1.5		_		X	0.3	2-2-2 N=4					
<i>- 1/////</i>	LEAN CLAY (CL), gray and dark gray, soft, s concretions	silt lenses, iron	- - -	-		1.1	2-1-1 N=2					
			5 -	_	X	1.3	2-2-2 N=4					
			-		X	0.5	1-1-1 N=2					
	9.5 FAT CLAY (CH), dark gray, very soft, silt len	ses	10-	_	X	1.5	1-0-1 N=1					
			-	-	X	1.5	0-1-1 N=2					
			15-	-	X	1.5	0-1-1 N=2					
			-	-								
	21.0  Boring Terminated at 21 Feet		20-		X	1.5	0-1-0 N=1					
Advand 3 1/4												
	Stratification lines are approximate. In-situ, the transition m	ay be gradual.					Hammer Type: Auto	omatic				
Advanda 3 1/4  Abanda Bori com	cement Method: inch Hollow Stem Auger  Ionment Method: ing backfilled with grout from bottom up after upletion. Well and Boring Sealing Record No. H343630	See Exhibit A-3 for desi procedures. See Appendix B for des procedures and addition See Appendix C for exp abbreviations.	scription of nal data (if	labora any).			lotes:					
	WATER LEVEL OBSERVATIONS  No free water observed	75000				Во	oring Started: 08-15-	2017	Borir	ng Com	pleted: 08-15-	-2017
		1555 N 42	ac nd St Unit			Dri	ill Rig: D-90		Drille	er: MAF	}	
			orks, ND	5		Pro	oject No.: M517504	Э	Exhi	.bit: /	A-13	

	E	BORING LO	OG N	10.	B-	12	2			F	Page 1 of 2	2_
PR	OJECT: Roseau Lake Rehabilitation		CLIE				ı River Waters ı, Minnesota	shed E	Distri	ct	_	
SIT						Jour	., m					
	Roseau, Minnesota			T				_	1		ATTERBERG	
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
17. S. 12.	DEPTH TOPSOIL - ORGANIC CLAY, black			> ö	S	0.8	4-3-3	708	25			<u> </u>
1, 1,					$\triangle$	0.0	N=6		25			
	LEAN CLAY (CL), soft, brown, silt lenses		-	_	X	1.1	2-1-2 N=3		38			
	FAT CLAY (CH), dark gray, medium stiff to se iron concretions	oft, silt lenses,	5 -		X	1.1	2-2-3 N=5		32			
	7.0  FAT CLAY (CH), dark gray, soft to very soft to	o soft, silt lenses	_	_	X	1	1-2-1 N=3		51			
			10-		X	1.1	1-1-1 N=2		51			
			-	$\overline{\nabla}$		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			
Advan	Stratification lines are approximate. In-situ, the transition ma	ay be gradual.		1	<u>ı                                      </u>		l Hammer Type: Auto	I matic	I			
3 1/4 Abano	cement Method: inch Hollow Stem Auger  lonment Method: ing backfilled with grout from bottom up after	See Exhibit A-3 for des procedures. See Appendix B for des procedures and additio See Appendix C for exp abbreviations.	scription of nal data (if	labora any).			Notes:					
con	pletion. Well and Boring Sealing Record No. H343631					$\perp$						
	WATER LEVEL OBSERVATIONS  While drilling	75000				В	oring Started: 08-10-2	2017	Borir	ng Com	pleted: 08-10-2	2017
	TTT GITTING	llerr				D	rill Rig: D-90		Drille	er: MAF	₹	
		1555 N 42 Grand F	nd St Unit Forks, ND	В		Pi	roject No.: M5175049	)	Exhi	bit:	A-14	

		BORING L	OG N	10.	B-	12	2			F	Page 2 of 2	2
PF	ROJECT: Roseau Lake Rehabilitation		CLIE	NT: I	Ros	eal	ı River Waters ı, Minnesota	shed D	Distri	ct		
Sľ	TE: Roseau County Roseau, Minnesota			•	100	out	, mmooda					
GRAPHIC LOG	LOCATION See Exhibit A-2 Latitude: 48.9276° Longitude: -95.83484°  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 LL-PL-PI	PERCENT FINES
	FAT CLAY (CH), dark gray, soft to very soft (continued)	t to soft, silt lenses	-	-								
			35-	- - -	X	1.5	1-1-1 N=2		95			
			40-	-		2.3			37		51-17-34	
			45 <del>-</del>	-	X	1.5	1-1-1 N=2		30			
			50-	-		2.3			34		53-16-37	
	54.5  SANDY LEAN CLAY (CL), trace gravel, gra cobbles and boulders	y, stiff, occasional	- - - 55-	_		1.5	12-14-17		9			
	cobbles and boulders		- - -	- - -		1.5	N=31					
	61.0  Boring Terminated at 61 Feet		60-		X	1.1	16-22-23 N=45		8			
	Stratification lines are approximate. In-situ, the transition	may be gradual.					Hammer Type: Auto	matic	<u> </u>	I		
Aban	donment Method:  donment Method: ring backfilled with grout from bottom up after mpletion. Well and Boring Sealing Record No. H343631	See Exhibit A-3 for desprocedures. See Appendix B for de procedures and additionable See Appendix C for exabbreviations.	escription of onal data (if	laborat any).			Notes:					
	WATER LEVEL OBSERVATIONS	75				В	oring Started: 08-10-2	2017	Borir	ng Com	pleted: 08-10-2	2017
	While drilling	1555 N 42	ac 2nd St Unit			⊢	rill Rig: D-90			er: MAR		
: 1			Forke ND			ΙÞ	roject No · M5175049		Eyhi	hit: 4	Δ_14	

		B	ORING LO	OG N	10.	B	-13	<u> </u>			F	Page 1 of 1	1
Ī	PR	OJECT: Roseau Lake Rehabilitation		CLIE				ı River Waters ı, Minnesota	shed [	Distri	ct		
ŀ	SIT					I	cat	i, iviii ii lesota					
ŀ		Roseau, Minnesota						ī			l	ATTERBERG	
	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)	LL-PL-PI	PERCENT FINES
17.17		DEPTH FILL - POORLY GRADED SAND WITH GRAV  1.5	EL_, brown	_		X	1	7-5-4 N=9					
LAIE.GDI 10		SILTY SAND (SM), fine grained, brown, loose		- -	-	X	1.1	5-3-3 N=6				NP	27
DAIAIEMP				5-	-	X	0.8	4-4-3 N=7					
EKKACON		7.0  FAT CLAY (CH), dark gray, soft		-	-		2.3						
/ERED.GPJ				10-	-	X	1.3	2-1-2 N=3					
HAB RECO		12.0 SILT (ML), brown, very stiff to stiff, silt lenses		-	-	X	1.1	5-8-11 N=19					
-AU LAKE KE				15-	-	X	1	6-5-7 N=12					
15175049 KUSE		19.5		-   -	- - -								
) WELL N		FAT CLAY (CH), dark gray, soft, silt lenses		20-		X	0.7	2-1-2 N=3					
-507 -100-NC		Boring Terminated at 21 Feet											
GEO SMART LO													
M OKIGINAL KEPOKI.													
AKAIEU FRU		Stratification lines are approximate. In-situ, the transition may	y be gradual.					Hammer Type: Auto	omatic				
G IS NOT VALID IF SEP.	3 ¼  Aband  Bori	onment Method:	See Exhibit A-3 for desc procedures. See Appendix B for des procedures and addition See Appendix C for exp abbreviations.	cription of nal data (if	labora any).			Notes:					
		WATER LEVEL OBSERVATIONS					В	oring Started: 08-09-2	2017	Borin	ng Com	pleted: 08-09-2	2017
SCR.		No free water observed	lierr	70		П		rill Rig: D-90		-	er: MAR	-	
2			1555 N 42r Grand F	nd St Unit orks, ND	В		P	roject No.: M5175049	)	Exhil	bit: A	<b>4-</b> 15	

	BORING LO	OG N	10.	B-	-14	,			F	Page 1 of 1	1
PROJECT: Roseau Lake Rehabilitation	n	CLIE				ı River Water ı, Minnesota	shed [	Distri			
SITE: Roseau County Roseau, Minnesota						•					
UCATION See Exhibit A-2 의 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	PERCENT FINES
TOPSOIL - ORGANIC CLAY (OH), black		-		X	0.7	4-3-2 N=5					
r///// LEAN CLAT (CL). Olive vellow. Illedium s	stiff, silt lenses, iron	- - -		X	1	2-3-2 N=5					
concretions		5 -		X	1.1	2-3-3 N=6					
FAT CLAY (CH), dark gray, soft, silt lense				X	0.8	2-1-2 N=3					
SILT (ML), dark gray, very stiff to stiff to stiff, silt lenses	very stiff to medium	10-	-	X	1,1	6-8-11 N=19					
Kithasi Keto		-	-	X	1	3-4-5 N=9					
NEEAU LANE A		15-		X	1.1	3-5-9 N=14					
NO LOGAR		-									
21.0		20-		X	1.1	5-3-4 N=7					
Stratification lines are approximate. In-situ, the transition of the state of the s	on may be gradual.					Hammer Type: Aut	omatic				
Advancement Method:	See Exhibit A-3 for desc	cription of	field		<u> </u>	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	procedures.  See Appendix B for des procedures and addition  See Appendix C for expabbreviations.	cription of nal data (if	labora any).		nd						
WATER LEVEL OBSERVATIONS  No free water observed	7500				В	oring Started: 08-10-	2017	Borii	ng Com	pleted: 08-10-2	2017
200000000000000000000000000000000000000	1555 N 42	ac nd St Unit				rill Rig: D-90		Drill	er: MAF	₹	
<u></u>		orks, ND	U		Pi	roject No.: M517504	9	Exhi	bit:	A-16	

	BORING LO	OG N	10.	B-	15				F	Page 1 of 1	1
PROJECT: Roseau Lake Rehabilitation	n	CLIE				River Water , Minnesota	shed [	Distri	ct		
SITE: Roseau County Roseau, Minnesota		-				.,					
UCATION See Exhibit A-2 Latitude: 48.92823° Longitude: -95.82172° Latitude: 48.92823° Longitude: -95.82172°		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
TOPSOIL - ORGANIC CLAY (OH), black		-		X	0.5	1-0-0 N=0					_
LEAN CLAY (CL), dark gray, soft to med iron concretions	ium stiff, silt lenses,	- -			0.5	1-1-1 N=2					
6.0 FAT CLAY (CH), dark gray, medium stiff	to soft, silt lenses	5 -		X	1.2	3-3-4 N=7					
		-   -		X	1.1	2-2-2 N=4					
		10-		X	1	2-2-3 N=5					
		_		X	1	0-1-1 N=2					
		15-			2.1			70		67-23-44	
NOT THE PROPERTY OF THE PROPER		_									
21.0  Boring Terminated at 21 Feet		20-		X	1.5	1-1-1 N=2					
Stratification lines are approximate. In-situ, the transition development Method:											
Stratification lines are approximate. In-situ, the transition	on may be gradual.					Hammer Type: Auto	omatic				
Advancement Method: 3 ¼ inch Hollow Stem Auger  Abandonment Method: Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H343639  WATER LEVEL OBSERVATIONS  No free water observed	See Exhibit A-3 for descriptocedures. See Appendix B for descriptocedures and addition See Appendix C for expabbreviations.	cription of nal data (if	labora any)			Notes:					
WATER LEVEL OBSERVATIONS  No free water observed	75000				В	oring Started: 08-10-	2017	Borir	ng Com	pleted: 08-10-2	2017
2	1555 N 42				' H	rill Rig: D-90	_	+	er: MAR		
<b>[</b>		orks, ND			P	oject No.: M5175049	9	Exhi	bit: /	A-17	

		BORING LO	DG N	10.	В	-16	<u> </u>			F	Page 1 of <sup>2</sup>	<u>1_</u>
PR	OJECT: Roseau Lake Rehabilitation		CLIE				u River Waters u, Minnesota	shed D	Distri	ct		
SI	ΓΕ: Roseau County Roseau, Minnesota						.,					
90	LOCATION See Exhibit A-2		£	/EL	/PE	(Ft.)	L (0	ED silve (psf)	(%)		ATTERBERG LIMITS	NES
GRAPHIC LOG	Latitude: 48.90792° Longitude: -95.81105°		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	LL-PL-PI	PERCENT FINES
\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	TOPSOIL - ORGANIC CLAY (OH), black		_		X	0.1	2-1-2 N=3					
	LEAN CLAY (CL), gray, soft, silt lenses, iron	concretions	-		X	1.1	2-2-2 N=4					
	4.5  FAT CLAY (CH), dark gray, medium stiff, silt	: lenses	5 -		X	1.3	2-2-3 N=5					
	SILT (ML), dark gray, medium stiff		- - -		X	1	5-6-6 N=12					
			10-		X	1.1	6-6-9 N=15					
	14.5		-		X	1.3	6-5-4 N=9					
	FAT CLAY (CH), dark gray, soft, silt lenses		15-	- - -	$\times$	1	2-1-2 N=3					
	21.0		20-		X	1.5	1-1-1 N=2					
Advar	Stratification lines are approximate. In-situ, the transition m	nav he gradual					Hammer Type: Auto	matic				
A cl		· ·						mullo				
Abanc Bor	ncement Method: 4 inch Hollow Stem Auger  donment Method: ring backfilled with grout from bottom up after pletion. Well and Boring Sealing Record No. H343635	See Exhibit A-3 for design procedures. See Appendix B for design procedures and addition See Appendix C for expabbreviations.	scription of nal data (it	f labora f any).			Notes:					
$\nabla$	WATER LEVEL OBSERVATIONS While drilling	Terr				В	Soring Started: 08-10-	2017	Borir	ng Com	pleted: 08-10-2	2017
	•	1555 N 42	nd St Unit			` ├	Orill Rig: D-90			er: MAR		
1		Grand F	orks, ND			<b> </b> P	Project No.: M5175049	9	Exhi	bit: /	A-18	

	BORING LO	OG N	10.	B	-17	7			F	Page 1 of <sup>2</sup>	1
PROJECT: Roseau Lake Rehabilitati	on	CLIE				ı River Waters ı, Minnesota	shed C	Distri	ct		
SITE: Roseau County Roseau, Minnesota						.,					
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 LL-PL-PI	PERCENT FINES
TOPSOIL - ORGANIC CLAY (OH), black	ck	_		X	0.5	2-3-2 N=5					
LEAN CLAY (CL), brownish gray, soft, concretions	silt lenses, iron	- - -		X	1	2-2-2 N=4					
6.0		5 -		X	1.1	2-1-2 N=3					
FAT CLAY (CH), dark gray, soft, silt le	nses	-		X	1.3	2-1-3 N=4					
		10-	-	X	1.5	1-2-1 N=3					
		-		X	0.5	1-1-1 N=2					
		15-		X	1	1-1-1 N=2					
		-   -									
21.0		20-		X	1.5	0-1-1 N=2					
Stratification lines are approximate. In-situ, the trans											
Stratification lines are approximate. In-situ, the trans	sition may be gradual.					Hammer Type: Auto	omatic	<u> </u>	<u> </u>		
Advancement Method: 3 1/4 inch Hollow Stem Auger  Abandonment Method: Boring backfilled with grout from bottom up after completion. Well and Boring Sealing Record No. H34363:  WATER LEVEL OBSERVATIONS  No free water observed	See Exhibit A-3 for des procedures. See Appendix B for des procedures and addition See Appendix C for expabbreviations.	scription of nal data (if	labora any)			Notes:					
WATER LEVEL OBSERVATIONS  No free water observed	75				В	oring Started: 08-14-	2017	Borir	ng Com	pleted: 08-14-2	2017
2000	1555 N 42	ac nd St Unit				rill Rig: D-90		Drille	er: CAS	;	
<u></u>		Forks, ND	J		F	roject No.: M5175049	9	Exhi	bit:	A-19	

County Name  Roseau	CATION	WELL	AND	BOR	ING SEALING RECORD S	Sealing No. Minnesota Unio or W-series No Leave blank if not known	que Well No.	н 34:	3623
Madis 16	thip No. Range N 3N 40V	17	Fraction (sm		B/IH/17	A CONTRACTOR OF THE PROPERTY O	Boring Constructe 8/14/17	d	
GPS LOCATION – decimal Latitude 48. 958		ecimal places) itude <b>95.</b> (	367B	3	Depth Before Sealing 21	ft. Original Dep	oth 21	ft.	
Numerical Street Address or 7/2 Line W of 350 Show exact location of well in section grid with "X."	Fire Number and C	ity of Well or Bori	ing Location	borina	AQUIFER(S) Single Aquifer  Multiaquifer WELL/BORING Water-Supply Well  Monit. Well Serv. Bore Hole Other		TER LEVEL  ad X Estimated  ft. X below		rface
W S	Count L		355 the Rus	,	CASING TYPE(S)  Steel   Plastic   Tile   Other  WELLHEAD COMPLETION     A  Outside:   Well House   At G    Pitless Adapter/Unit   Buri		Inside: Bas	ed	
PROPERTY OWNER'S NAM STATE LAND - 1 Properly owner's mailing address SOO Lafaye St. Paul, 1	DVR BUR s if different than we	EAU I location address i		ve	CASING(S) Diameter  in. from to to	_ft. 🗆	iet in oversize hole Yes	? Annular space ☐ Yes ☐ [	
31. 10001, )	MM 221	33 700			in. from to	_ft. 🗆	Yes 🗌 No	Yes I	No Unknown
Vell owner's mailing address if o				ve	Screen fromto	ft. Open Hole		to Z I	ال.
GEOLOGICAL MATERIA	1000	FORMATION	PHOM	то	Obstructions removed? Yes No De	escribe			
If not known, indicate estima Fat clay w/san	1 dk gray		or boring.	6	Type ☐ Removed <b>X</b> Not Present	Other	-		
Fat clay	dkgray	soft	6	21	METHOD USED TO SEAL ANNULAR SPACE E  No Annular Space Exists  Annular Space		SINGS, OR CASIN	Casing Per	foration/Removal
					in. from	lo	ft.	Perforated	Removed
					in, from  Type of Perforator  VARIANCE	to	п.	Perforated	Removed
					Was a variance granted from the MDH for this GROUTING MATERIAL(S) (One bag	g of cement = 9		bentonite = 50 lbs.)	
					Grouting Material <b>high solids be</b>		to 21	ft yard	
<del></del>					-	from	to	ft yard	
					OTHER WELLS AND BORINGS UNKN	from_	to	ft yard	ds bags
emarks, source of D. Terracon Pr Boring 3-	ata, difficultie	S IN SEALING	049		Other unsealed and unused well or boring on policies.  LICENSED OR REGISTERED CONTRACTOR of This well or boring was sealed in accordance with the structure of the best of my knowledge.  Terracon Consultations Name  Licensee Business Name  Certified Representative Signature	oroperty?   CERTIFICATION with Minnesota I	Rules, Chapter 472	25. The information of MIG License of 2	
MINN. DEPT OF HEAL		343	623		Christopher Schill Name of Person Sealing Well or Boring				5/1

The contract of the property of the contract	WELL OR BORING LO	CATION	WEL	L AN	D BO	PEPARTMENT OF HEALTH RING SEALING RECORD  Minnesota Well and Boring Sealing No. Minnesota Unique Well No.
September   10-3	Roseau					(Leave blank if not known)
September   10-3	Township Name Town					
Lichine 4 10: 93.115 D. (orgline: 95: 97.16.20  Name of the state of t	/ 16 10			SW4S	w/SN	
## Annual and blooks of the Name and City of Well or Browd Location    24	Latitude 48. 937	750 Lor	decimal places) ngitude <b>95.</b> 1	8976	020	TI.
Company Name   Comp	Numerical Street Address or	Fire Number and	City of Well or Bor	ing Loca	ilion	
School production of out of bottom  School production of the color of	295th Ave.	Rosean				WELL/BORING Measured Date Measured
Season Price   Season   Seas	I Show exact location of well a	or boring	Sketch ma	p of we	ll or boring	Water-Supply Well Monit. Well
Steet   Pfeids   The   Other	N		lines, road	ls, and b	uildings.	DAGING STREET
Outlines   Val Finds   Basement Ottset   Basem		+	A 100	leine	)	.76
Property content marrial gooders (Pittered than well occasion achdesis indicated above   12240 238** St. N		E J Mile	13	0.2 p	÷.	Outside:  Well House  At Grade  Inside:  Basement Offset  Pitless Adapter/Unit  Buried  Well Pit  Well Pit
Set In overrise block? Annular space binding product?	Fria Da	sala e				Diameter N/A
SCANDIA, MN 55073    In. from   Io   It.   Yes   No   Wes   No   Unknown	Property owner's mailing address	if different than we		dicated a	bove	Set in oversize hole? Annular space initially grouted?
SCREENOPEN HOLE  SCROENOR  In Open Hole from O to 21 In  OBSTRUCTIONS  GEOLOGICAL MATERIAL  COLOR   MARCHESS OR   FROM   TO   TO   FROM   TO   FROM   TO   TO   TO   TO   TO   TO   TO	12240 238	st. N				tes   No   Yes   No   Unknown
SCREALOPEN HOLE  Not oversity mailing address if different than property connects address indicated above to the connects mailing address if different than property connects address indicated above to the connects mailing address if different than property connects address indicated above to the connects mailing address if different than property connects address indicated above to the connects mailing address if different than property connects address indicated above to the connects mailing address indi	Scandia, M	N 550	73			in from to the Diversity of the Samuel Samue
NO WELL  Screen from 10  ft. Open Hole from 0 to 21 ft.  OBSTRUCTIONS    RodsCripp Pipe   Check Valve(a)   Debris   Fill X No Obstruction   Nype of Obstructions (Describu)   Pump   Obstruction (Describu)   Obstruction (Describu)   Pump   Obstruction (Describu)   Obstruction (Obstruction (Describu)   Obstruction (Obstruction (Describu)   Obstruction (Obstruction (Describu)   Obstruction (Obstruction (Obstruct	WELL OWNER'S NAME/COMP	PANY NAME		-	-	Tes No Yes No Unknown
GEOLOGICAL MATERIAL  COLOR  HARDMESS OR FORMATION Type of Obstructions (Describe)  PUMP  PUMP  PUMP  PUMP  POSOI!  Locar Clary  Growy  SOFT  I Comment of the Wish of the Word	Vell owner's mailing address if dif	NO WE	la la	W 600 W 1		0
METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:    No Annular Space Exists	f not known, indicate estimate	d formation log fr	rom nearby well or	boring.	то	Obstructions removed?
SAND   SAND   STATE ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:	Lean clay	gray	soft	1	6	
The control of the		0		1	10	TWO NO ADDURAT Space Exists     Appuller Co
in. from to ft. Perforated Removed  Type of Perforator  VARIANCE Was a variance granted from the MDH for this well? Yes No TNH  GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)  Grouting Material hist solids beaton to Z1 ft. yards bags  from to Z1 ft. yards bags  OTHER WELLS AND BORINGS VNKNOWN  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.  Terrace Consultants, Inc.  MINOSTRUCTURES IN SEALING  Certified Representative Signature  Certified Rep. No.  Date  Christopher Schill  Christopher Schill		100		100	5.0	in, from
VARIANCE Was a variance granted from the MDH for this well?   Yes   No   TN#    GROUTING MATERIAL(S)	rat day	de gray	50-1+	10	21	in from
Was a variance granted from the MDH for this well?  \[ \text{ Yes } \subseteq \text{ No } \text{ TN#} \]  GROUTING MATERIAL(S)  (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)  Grouting Material high solids beat or it  \[ \text{ Yards } \] bags  from to tl.  \[ \text{ Yards } \] bags  MARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING  OTHER WELLS AND BORINGS \( \text{ VN KNOW N} \)  Other unsealed and unused well or boring on property?  \[ \text{ Yes } \] No How many?  License or Registration contained in this report is true to the best of my knowledge.  Terracon Consultants, Inc.  \[ \text{ MIGC 5} \]  License or Registration No.  Certified Representative Signature  \[ \text{ Certified Rep. No. } \]  Christopher Sulid						Type of Perforator
GROUTING MATERIAL(S)  Grouting Material high solids button to to Z1 it. yards bags  from to ft. yards bags  OTHER WELLS AND BORINGS VNKNOWN  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.  MILLOSS  Certified Representative Signature  Certified Rep. No. Date  Christopher Subtil						
Grouting Material high solids beaton to 21 ft. yards bags    from to ft. yards bags						
Consider the Copy   H 3/1362/1   Consider the Copy						
Consider the Copy   H 3/1362/1   Consider the Copy					C	arouting Material high solids bearing from 0 to 21 ft. yards bags
MARKS, SOURCE OF DATA, DIFFICULTIES IN SEALING  OTHER WELLS AND BORINGS VNKNOWN  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.  MICC5  License or Registration No.  Certified Representative Signature  Certified Rep. No. Date  Christopher Schill  Christopher Schill				- 7		from to a
OTHER WELLS AND BORINGS VNKNOWN  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.  License or Registration No.  License or Registration No.  OTHER WELLS AND BORINGS VNKNOWN  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.  License or Registration No.  Date  Christopher Sulil						bags
Consultants, Source of Data, DIFFICULTIES IN SEALING  Consultants, Source of Data, DIFFICULTIES IN SEALING  Consultants, Difficulties in Sealing  Consultants  Consultants, Difficulties in Sealing  Consultants  Consultan					-	
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.  MIG65  License or Registration No.  Certified Representative Signature  Christopher Suhill  Christopher Suhill  Christopher Suhill	MARKS, SOURCE OF DATA	DIFFICULTIES	IN SEALING			1-10/10/10
Ilcensee Bysiness Name  Licensee or Registration No.  Certified Representative Signature  Christopher Schill  Christopher Schill				3	C	Ither unsealed and unused well or boring on property?
Ilcensee Bysiness Name  License or Registration No.  Certified Representative Signature  Christopher Schill  Christopher Schill	Barina B-2	er as Mi	71 130 47		1.1	riis well of boring was sealed in accordance with Minneseta Dulas Obs. 1 1775
INN. DEPT OF HEALTH COPY H 3/1362/1 Christopher Schill	5				1	Terracon Consultants, Inc. MIGG5  Licensee Bysiness Name  License or Registration No.
INN. DEPT OF HEALTH COPY H 3/362/ Christopher Schill					1	Certified Representative Signature 3621 9/22/201
INN. DEPT OF HEALTH COPY 1 343624 Christopher July		111	2000	0 "	-	Continued riep. Not.
	INN. DEPT OF HEALTH C	OPY	3436	24	-   -	Christopher Schill Name of Person Sealing Well or Boring

WELL OR BORIN County Name			WELL	AND	BOR esota	PEPARTMENT OF HEALTH RING SEALING RECORD  In Statutes, Chapter 1031  Minnesota Well and Boring Sealing No. Minnesota Unique Well No. or W-Series No. (Leave blank if not known)  Minnesota Well and Boring Sealing No. Minnesota Unique Well No. or W-Series No. (Leave blank if not known)
Township Name	Township I	2 22 2 2	o. Section No. Fr			
GPS LOCATION - C	lecimal degr	90	6-65	M,NM,	'NE"	8/16/17 8/16/17
Latitude 48.0			tude - 95. 90	2733		Depth Before Sealing 21 ft. Original Depth 21 ft.
Numerical Street Add	Iress or Fire	Number and Ci	ty of Well or Borin	o Location	1	AQUIFER(S)  STATIC WATER LEVEL  SIngle Aquifer Multiaquifer
360th			y or rion or built	g Location		WELL/BORING Measured Stimated Date Measured
Show exact location in section grid with ">	of well or bo	ring d	Sketch map	of well or	boring	□ Water-Supply Well □ Monit. Well  S X Env. Bore Hole □ Other 25  ft. X below □ above land surface
, , , , , ,	" V	K.	location, she lines, roads,	, and build	lings.	CASING TYPE(S) NIA
<u> </u>	Ж	1	160° St			Steel Plastic Tile Other
		703	30			WELLHEAD COMPLETION
W		ET I	0.6		hing.	Outside: Well House At Grade Inside: Basement Offset
	+ +	½ Mile				☐ Pitless Adapter/Unit ☐ Buried ☐ Well Pit
		111		1	Kethar	☐ Well Pit
1 M		+ 1			3	Other
PROPERTY OWNER						CASING(S)
Property owner's mailing	g address if di	lagnos:	location address inc	dicated abo	ve	Diameter
32105	st hu	OIS YV				in, fromtoft.
Rosean	IAM	51.75	ı			in. fromtoft.
p-o gcoos	1 1000	3613				in. from toft,
WELL OWNER'S NAM		IO WEL				SCREEN/OPEN HOLE
Well owner's mailing add		A COUNTY		dicated abo	ve	Screen from to ft. Open Hole from 0 to 21 ft.
GEOLOGICAL MAT	estimated for	black	NA	0	то 11/2	Type of Obstructions (Describe)  Obstructions removed?
Sandy lean a	day	yellow	medstiff	11/2	12	METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Sundy lean	day i	dkaray	medstit	12	21	No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
	- 1	1. 1				in. from to ft. Perforated Removed
						in. fromtoft.
_						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.)
						high solids bestonite a
						Grouting Material 49 SVII/US from 0 to 21 ft. yards 1 bags
				10		from to ft, bags
						from to ft bags
				( -		OTHER WELLS AND BORINGS UNKNOWN
REMARKS, SOURCE						Other unsealed and unused well or boring on property?
lerracon	Proje	ect #	M51750	49		LICENSED OR REGISTERED CONTRACTOR CERTIFICATION This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report
Terracon Boring t	3-2					is true to the best of my knowledge.
borney c						Jerracon Consultants, Inc. M1665
						Licensee Business Name  License or Registration No.
					-	3621 9/22/2017
					4	Certified Representative Signature Certified Rep. No. Bate
Mikiki person a	next to the	Н	3436	305		Christopher Schill
MINN, DEPT OF	HEALTH C	DPY 1	0400	LU		Name of Person Sealing Well or Boring

WELL OR BORIN County Name Roseau		AND	BOR	ING SEALING RECORD Se	ealing No. innesota Unique W W-series No. ave blank il not known)		н 3	43t	120		
Township Name	Township		Section No. F	raction (se		Date Sealed <b>8/16 / 17</b>	Date Well or Boring		71		
GPS LOCATION - d			cimal places)	0643	3	Depth Before Sealing 21 ft.	. Original Depth	21	n.		
Numerical Street Add	Rd K	Number and Cit		o of well o	n or boring	AQUIFER(S)  Single Aquifer  Multiaquifer  WELL/BORING Water-Supply Well  Monit. Well CASING TYPE(S)	STATIC WATER L.  ☐ Measured		Date Measure		3
W		E T Y Mile	Cty 6	<b>&gt;∘</b>	eriro	CASING TYPE(S)  Steel		e: Basei Well I Burie	Pit d		
PROPERTY OWNER Roberta Property owner's mailing 35214	g address if o	ohnson	location address in	dicated ab	eove	CASING(S) NIA Depth in. from to f	Set in o t. ☐ Yes	versize hole?	Annular s	space initia	ally grouted?
Badger,			1,0			in, from to f	t. 🗌 Yes	☐ No	☐ Yes	□ No	Unknown
WELL OWNER'S NAM						in. fromtof SCREEN/OPEN HOLE	t. Yes	☐ No	Yes	☐ No	Unknown
GEOLOGICAL MA	TERIAL	COLOR	HARDNESS OF FORMATION	FROM	то	OBSTRUCTIONS  Rods/Drop Pipe Check Valve(s)  Type of Obstructions (Describe)  Obstructions removed? Yes No Des		Fill ( <b>X</b> N	o Obstruction		
If not known, indicate	e estimated	formation log fr	om nearby well o	or boring.		PUMP Type					
lopsoil		black	NIA medstif	0 F 11/2	1/2	Removed Not Present  METHOD USED TO SEAL ANNULAR SPACE BI	Other				
Sandy lean	des	brown	medstiff		21		pace Grouted with Tr	A STATE OF THE PARTY OF THE PAR			ion/Removal
June 1	Jung		Indooding.			in. from	to	ft.	Perfora	ted	Removed
						in. from Type of Perforator	_10	ft.	Perforal	ed	Removed
						VARIANCE Was a variance granted from the MDH for this w	unil2 Ves W No	TN#			
	~					A TOTAL CONTRACTOR AND A SECURE OF THE PARTY	of cement = 94 lbs.,		entonite = 50	lbs.) yards_	l bags
							from to	()	ft	yards	bags
							from to	1	ft	yards_	bags
						OTHER WELLS AND BORINGS UN KNOW	NN .				
REMARKS, SOURCE Terracon Boring	Proje B-4	, DIFFICULTIES とけ せん	IN SEALING	<b>†</b> 9		Other unsealed and unused well or boring on prince of the contractor of this well or boring was sealed in accordance with it is true to the best of my knowledge.  Terracon Consultants, Licensee Business Name  Certified Representative Signature	ERTIFICATION th Minnesota Rules,	No How Chapter 4725	5. The informal	MI66	
MINN. DEPT OF	HEALTH	COPY H	343	62	7	Christopher Schill  Name of Person Sealing Well or Boring					
HE-01434-14	ID# 53159	1									5/1

WELL OR BORING LOC County Name			RING SEALING RECORD Sealing No. Minnesota Unique Well No.	
Rosean		1	Minnesota	Statutes, Chapter 1031 Or W-series No.
	hip No. Range No	. Section No. F	raction (sm. → lg.	Date Sealed Date Well or Boring Constructed
Dieter 16:	3N 41W	25 5	e "Nw" ne"	8/16/17 8/16/17
GPS LOCATION - decimal of Latitude 49.918 9		cimal places) ude – 95. E	18615	Depth Before Sealing 21 ft. Original Depth 21 ft.
Numerical Street Address or F	Fire Number and Cit	v of Well or Borin	ng Location	AQUIFER(S)  STATIC WATER LEVEL  STATIC WATER LEVEL
360th Stre		,	g Localion	WELL/BORING
Show exact location of well of in section grid with "X."		Sketch map location, sh	o of well or boring owing property , and buildings.	ti. pt below   above land surface
N ×	Ed 83	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	boring	CASING TYPE(S)
W S 1 Mile	E	368+~ St 1.7 mil	$\rightarrow$ .	WELLHEAD COMPLETION  Outside:  Well House  At Grade  Inside:  Basement Offset  Pitless Adapter/Unit  Buried  Buried  Well Pit  OtherOther
PROPERTY OWNER'S NAME	COMPANY NAME	AID		CASING(S) Diameter  NA  Denth  Sat in oversize hole?  Annular space initially ground?
Property owner's mailing address	if different than well I	ocation address in	dicated above	Diameter Depth Set in oversize hole? Annular space initially grouted? in. from toft.
500 Lafay	ette Dv	•		III. IIVIII IO III. IES IVO IES IVO IUNIOWI
St. Paul, A	NN 551	55-40	30	in. from to ft, Yes No Yes No Unknown
				in. from toft.
WELL OWNER'S NAME/COM	PANY NAME	WELL		SCREEN/OPEN HOLE
Well owner's mailing address if di				Screen from to ft. Open Hole from 0 to 21 ft.
GEOLOGICAL MATERIAL  If not known, indicate estimat		HARDNESS OR FORMATION om nearby well o	PHOM 10	Type of Obstructions (Describe)  Obstructions removed?
Lean day	degray	soft	1/2 8/2	METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Fat clay	de gray	boft	81/2 21	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 bankning to 21 ft. yards bags
				trom to ft, yards bags
				from to ft yards bags
				OTHER WELLS AND BORINGS UN WOUN
REMARKS, SOURCE OF DA	TA, DIFFICULTIES	IN SEALING		Other unsealed and unused well or boring on property?  Yes No How many?
Terracon Pr Boring B-S	roject #	M5175	1049	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.
Boring B-5				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 HEALT	HCOPY H	3430	626	Christopher Schill Name of Person Sealing Well or Boring

County Name  Roseau		AND	BOR	ING SEALING RECORD Statutes, Chapter 1031	Sealing No. Minnesota Uni or W-series No	que Well No.	H 34	3629		
Township Name Town	nship No.	Range No.	Section No. F	raction (s		Date Sealed 8/16 / 17	Date Well o	r Boring Constructed	d	
GPS LOCATION - decima			imal places)	984		Depth Before Sealing 21	_ft. Original De	pth 21	ft.	
Numerical Street Address of	or Fire Nun				n	AQUIFER(S)  Single Aquifer  Multiaquifer  WELL/BORING  Water-Supply Well  Monit. Well		TER LEVEL	Date Measured	
Show exact location of well in section grid with "X."	I or boring		Sketch map location, sh lines, roads	o of well o owing pro and buil	r boring perty dings.	X Env. Bore Hole	25	ft. 🎾 below	above land s	urface
W S S 1 Mile	E	340 <sup>th</sup>	*	poring			At Grade Buried	Inside: Base Well Burie	ed	
Property owner's mailing addre	M ag	n u SS	cation address in	dicated ab	ove	CASING(S) Diameter  in. from to	3 100	Set in oversize hole? Yes \[ \sum No		e initially grouted? No
31645 Cou Roseau, M	AN	Koaa 5675	125			in. from to	ft	Yes No	☐ Yes ☐	No Unknown
WELL OWNER'S NAME/CO			•			in. from to SCREEN/OPEN HOLE	ft	Yes No	☐ Yes ☐	No Unknown
				ı		OBSTRUCTIONS  Rods/Drop Pipe Check Valve(s)  Type of Obstructions (Describe)	☐ Debris	□ Fill 🔼	No Obstruction	
GEOLOGICAL MATERIA		COLOR	HARDNESS OR FORMATION		то	Obstructions removed? Yes No	Describe			
Topsoil		olack	NIA	8	1/2	Type	Other_			
Silt w/sand		Nown	loose	11/2	6	METHOD USED TO SEAL ANNULAR SPACE		ASINGS, OR CASIN	G AND BORE HOL	E:
Swedy leand	Access to the same	Lavay	60ft	6	10	A SECTION AND STREET, SECTION AND ADDRESS.	ar Space Grouted	with Tremie Pipe		rforation/Removal
Lean clay	1	Lgray	soft	10	15	in. from	to	ft.	☐ Perforated	Removed
Fat day		gray	boff	15	21	in, from Type of Perforator	to	ff.	Perforated	Removed
						VARIANCE Was a variance granted from the MDH for the	nis well?  Yes	□ No TN#		
				ļ i			4	4 lbs., one bag of b	pentonite = 50 lbs.)	
						Grouting Material high solids bero	mtgrom 0	to 21	ft yar	rdsbags
							from	to	ft yar	ds bags
							from	to	ft yar	ds bags
Art areas	-3 T			100		OTHER WELLS AND BORINGS		4 7 7		
Terracon Boring B				049		Other unsealed and unused well or boring or LICENSED OR REGISTERED CONTRACTOR This well or boring was sealed in accordance is true to the best of my knowledge.  Terracon Consultar Licensee Business Name  Certified Représentative Signature	R CERTIFICATION e with Minnesota I	N Rules, Chapter 472	5. The information of Miles License	contained in this repo
MINN. DEPT OF HEA	LTH COP	н	343	629	)	Christopher Schill Name of Persoh Sealing Well or Boring				5/1

WELL OR BORING	G LOCAT	LION	The second secon	MINNESOTA DEPARTMENT OF HEALTH  Minnesota Well and Boring  H  3436						637		
				ING SEALING RECORD M	innesota Unique Well No. W-series No.							
Kosean	Lan and the same					(Le	eave blank if not known)					
Township Name	Township		Section No. F	raction (s SW			Date Well or Boring C	constructed				
GPS LOCATION - de	16601			R. JW	"JW"	8/9/17	8/9/17				_	
Latitude 48.92181 Longitude = 95.86994						Depth Before Sealing 6	. Original Depth	61	ft.			
						AQUIFER(S)	STATIC WATER LEV	EL		e de la companya de		
Numerical Street Address					on	X Single Aquifer						
Show exact location o	f well or b				or boring	☐ Water-Supply Well ☐ Monit. Well	31					
in section grid with "X.			Sketch map location, sh lines, roads	owing pro	operty Idings.	Env. Bore Hole Other	3\ _ft.	below [	above land surfa	ace		
		127		bori	C	CASING TYPE(S)						
w		3	2.3 mi	4	1	WELLHEAD COMPLETION MA						
" <del>             </del>		3	-	->0		Outside: Well House At Gr	rade Inside:	☐ Baseme	ent Offset			
X		½ Mile 🦫		20	-	☐ Pitless Adapter/Unit ☐ Burie	d	☐ Well Pit	r			
Lilil s			eCoRd.	89		☐ Well Pit		☐ Buried ☐ Other				
- 1 Mile	le ———	⊣ °				Other		Other				
PROPERTY OWNER'S			NAP			CASING(S) Diameter N/A Depth	E-Maria		Mary Wal		7	
Property owner's mailing	address if		Ocation address in	dicated ab	oove	J. Bopan	Set in over t. Yes		Annular space in		2=-	
500 La	fay.	ette Dr				in. from to f	t tes	No	∐ Yes ☐ No	Unknow	n	
500 Las	1 14	11 551!	55-40	30		in. from to f	t. Yes	☐ No	Yes No	Unknow	'n	
Dr. Palac	1 100	N 33.				in. from to f	t. Yes	☐ No	Yes No	Unknow	'n	
WELL OWNER'S NAME	E/COMPA	NY NAME	WELL			SCREEN/OPEN HOLE		City.			-	
Well owner's mailing addr	ress if differ				ove	Screen from to ft.	Open Hole from	٥	10 61	t.		
						OBSTRUCTIONS  Rods/Drop Pipe Check Valve(s)	☐ Debris ☐ Fi	No o	Obstruction			
						Type of Obstructions (Describe)						
GEOLOGICAL MAT	ERIAL	COLOR	HARDNESS OR FORMATION	FROM	то	Obstructions removed? Yes No Des	scribe					
If not known, indicate	estimated	formation log fro	100000000000000000000000000000000000000	r boring.		PUMP						
Topsoil		black	NIA	0	11/2	Type ☐ Removed						
1-0		brown	Soft	11/2	6/2		Other	ar a complete				
Lean du	7	A COLUMN TO THE	18 7 7 7 7	6/2		METHOD USED TO SEAL ANNULAR SPACE BE  NO Annular Space Exists   Annular Space	cace Grouted with Trem		Casing Perfor	ation/Removal		
Fat clay	,	digray	soft	100000		in, from	lo	ft.	Perforated	Removed		
Suraly lean c	lay	Me going	hand	36/2	61	in. from	to -	fit.	Perforated	Removed		
,	J	, ,					- 10		[_] i cilorated	□ Hemoved		
				1		Type of Perforator						
						Was a variance granted from the MDH for this w	ell? Yes No	TN#				
						GROUTING MATERIAL(S) (One bag of	of cement = 94 lbs., one	bag of bent	tonite = 50 lbs.)		=	
				-		Grouting Material best on te	from O to (	0 1 ft.	yards	3 bags		
							from to	ft	yards_	bags		
							from to	ft	yards_	bags		
						OTHER WELLS AND BORINGS UN KN	NWO					
REMARKS, SOURCE			IN SEALING			Other unsealed and unused well or boring on pro		lo How ma	ny?			
Terracon Boring B	Proj	ect #	M51750	49		LICENSED OR REGISTERED CONTRACTOR CE This well or boring was sealed in accordance with is true to the best of my knowledge.		apter 4725. T	he information cont	tained in this repo	ort	
Boring B	3-0					Terracon Consult	rants, Inc		MIL License or F	65 Registration No.		
						1/1/2/1/1	-		-/	1		
						Certified Representative Signature	36 ce	Z/ rtified Rep. N	No. Date	2/24	7	
MINN. DEPT OF H	EALTH (	сору Н	3436	337	7	Michael Roberts Name of Person Sealing Well or Boring						
	D# 55.55											

VELL OR BORING LOCATIO	ON	WELL A	ND BO	ORII	IG SEALING RECORD Se	Intesofat Weil and Burling Inling No. Intesofa Unique Well No. W-series No. W-series No. W-series No.
Rosean Dwnship Name Township N	o. Range No. S				Date Sealed	Date Well or Boring Constructed
Dieter 163N			NE "N	0.00	8/9/17	8/9/17
APS LOCATION – decimal degree Latitude 48.91827	es (lo four decim	nal places) <sub>e</sub> - 95.	629		Depth Before Sealing 21 1/2	Original Depth 211/2 ft.
lumerical Street Address or Fire I					AQUIFER(S) X Single Aquifer  Multiaquifer	☐ Measured ☑ Estimated Date Measured
3 mi E of Co.					WELL/BORING  Water-Supply Well Monit, Well	
show exact location of well or bo	A Comment	Sketch map of location, show	well or be	oring rty	Env. Bare Hole Other	
n section grid with "X." N	-	lines, roads, a	nd buildin		CASING TYPE(S)	
	5	eet 19			Steel Plastic Tile Other	
					WELLHEAD COMPLETION NA	The second secon
w	ET _	•			Outside: Well House At G	□ Well Bit
	½ Mile Sec	+ 30 .	Sect	29	☐ Pitless Adapter/Unit ☐ Buri	Buried
		1	200		Well Pit	Other
S 1 Mile	-1	boring			Other	
PROPERTY OWNER'S NAME/C	OMPANY NAME				CASING(S)	Set in oversize hole? Annular space initially grouted?
Terry + Cars	KVOON	cation address Indi	cated abov	e	Diameter Depth in. from to	ft. Yes No Yes No Unknown
N69 W24073						ft. Yes No Yes No Unknown
Menomonee			51		in, from to	The Disknown
Menomonee	ranco, vy	L 520.	71		in. from to	ft. Yes No Yes No Unknown
WELL OWNER'S NAME/COMPA	NY NAME	O WELL			SCREEN/OPEN HOLE	# Open Hole from 0 to ZI'/2 ft.
Well owner's mailing address if diffe			icated abov	/e	Screen fromto	ft. Open Hole from 0 to 21/2 it.
GEOLOGICAL MATERIAL  If not known, indicate estimate	COLOR	HARDNESS OR FORMATION	FROM	то	Type of Obstructions (Describe)  Obstructions removed?  Yes No Description	Describe
-	black	NIA	0	11/2	TypeNot Present	Other_
Topacil	24		11/2	711	METHOD LISED TO SEAL ANNULAR SPACE	BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Fast clay	degray	901	1.2	21.1	No Annular Space Exists Annula	Space Grouted with Tremie Pipe
					in, from	toft. Perforated Removed
		-		-	in, from	toft.
					Type of Perforator	
					VARIANCE	THE PARTY THE
			1		Was a variance granted from the MDH for th	ag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
						fromO to2112 ft yards2 bags
					Grouting Material Dentonia	2013
					V	from to ft yards bags
		1				from to ft yards bags
					OTHER WELLS AND BORINGS UN	KNOWN
REMARKS, SOURCE OF DA	TA. DIFFICULTIF	S IN SEALING	1_	1	Other unsealed and unused well or boring of	n property?    Yes    No How many?
Terracon P	roject	立 M517	5049	7	LICENSED OR REGISTERED CONTRACTO	R CERTIFICATION e with Minnesota Rules, Chapter 4725. The information contained in this repo
1	3				is true to the best of my knowledge.	
Boring B-	7				Terracon Consult	ants, Inc. M1665 License or Registration No.
3					Licensee Business Name	LILETIES OF POSISIFILITION
					Mmille	3621 9/22/201 Certified Rep. No. Date
					Certified Representative Signature	
	30			_	Michael Robert	5
MINN DEPT OF HEAL	TH COPY	343	63	3	Name of Person Sealing Well or Boring	

WELL OR BORING LOC County Name	CATION	WELI	L AND BOI	RING SEALING RECORD  Minnesota Unique Well No.  Minnesota Unique Well No.
Rosean				d Statutes, Chapter 1031 Of W-series No.
20.1	and the first of the second of the		Fraction (sm, → Ig	and the state of t
GPS LOCATION – decimal	3N 40W		sw"se" ne"	8/14/17
Latitude 48.90633		gitude = 95.	86177	Depth Before Sealing 6 1. Original Depth 6 1 ft.
Numerical Street Address or I		V		AQUIFER(S) STATIC WATER LEVEL
10 1 1 -		LNJE	ing Location	Mac   Ma
Show exact location of well of	CC HAY	Sketch ma	p of well or boring	U Water-Supply Well ☐ Monit. Well
in section grid with "X."		location, s	howing property s, and buildings.	Myenv. Bore Hole Otherft. below above land surface
		1.Zmi	340th Ave	Steel Plastic Tile Other
S   Mile				
PROPERTY OWNER'S NAME	(COMPANY MAN		1	_ Other
lerry + (au	al Kupp.	^		CASING(S) Diameter Depth Set in oversize hole? Appulor space initially appulor
Property owner's mailing address	if different than well	location address in		Depth Set in oversize hole? Annular space initially grouted? in. fromtoft.
N69 W240				in term
Menomonee I	falls, u	JI 530	51	in, irom toft.
VELL OWNER'S NAME/COMP	DANIV NIALAE			in, from toft.
Vell owner's mailing address if diff	NI	D ME M		SCREEN/OPEN HOLE
		Luppura		OBSTRUCTIONS  ☐ Rods/Drop Pipe ☐ Check Valve(s) ☐ Debris ☐ Fill
GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM TO	Obstructions removed? Yes No Describe
f not known, indicate estimate		12 300		Туре
Topsoil	blade	NIA	0 1/2	☐ Removed ☐ Cother ☐
Lean clay	gray	ATTA Soft	1/2 9	METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Silt	gray	med stift	9 4912	No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal in. from to ft. Perforated Removed
3.71	Jung	Incon State	11201	toft.
				Type of Perforator
				VARIANCE
				Was a variance granted from the MDH for this well? Tyes A No TN#
				GROUTING MATERIAL(S) (One bag of cement = 94 lbs., one bag of bentonite = 50 lbs.)
				Grouting Material bertonite from 0 to 61 ft. yards 3 bags
				from to the
				bags bags
				fromtofitbags
MARKS, SOURCE OF DATA	, DIFFICULTIES I	N SEALING		OTHER WELLS AND BORINGS VIKNOWN
Ferracon Pro Boring B-	ject # 10	¥ M517.	5049 L	Differ unsealed and unused well or boring on property? Yes No How many?  ICENSED OR REGISTERED CONTRACTOR CERTIFICATION This well or boring was sealed in accordance with Minnesota Rules, Chapter 4725. The information contained in this report to the best of my knowledge.  Terrace Canaultants, Inc.  Much S
				Licensee Business Name  License or Registration No.
				Certified Representative Signature  362/ Certified Representative Signature  362/ Certified Rep. No. Date
MINN, DEPT OF HEALTH C	H H	3436	34	Michael Roberts  Name of Person Sealing Well or Boring
D1434-14 ID# E21E0				Tham's of Forson Sealing well of Boring

County Name  Loseur	ATION	WELL			ING SEALING RECORD Se	aling No. nnesota Unique Well No W-series No. ve blank if not known)	n 343030
Township Name Townsh		Section No. F			and the second s	Date Well or Boring Cons	
Jadis 3	46-	The second second	M, NE	NE	B/15/17	8/15/17	
GPS LOCATION - decimal d		cimal places) ude_ <b>-95, B</b>	601		Depth Before Sealing 21 ft.  AQUIFER(S)	Original Depth 2	I ft.
Numerical Street Address or F	ire Number and Cit	y of Well or Bori	ng Location	1	Single Aquifer  Multiaquifer	Measured X Estim	rated Data Manageral
350th Avenue					WELL/BORING  Water-Supply Well Monit. Well	7	ated Date Measureo
Show exact location of well or in section grid with "X."	boring	Sketch ma location, sh lines, roads	p of well or nowing pro	r boring perty	Env. Bore Hole Other	25 ft. (X)	pelow above land surface
N N	n ,	lines, roads	s, and build	oings.	CASING TYPE(S)		
Я	S	et 30	Het	29	Steel Plastic Tile Other		
					WELLHEAD COMPLETION (A)		
W	TT.				Outside: Well House At Gra	W. S. C.	Basement Offset
	Mile Se	2+31	Sect	32	Pitless Adapter/Unit Burier		] Well Pit ] Buried
S		1			☐ Well Pit		Other
1——1 Mile——	<b>⊣</b> 6	aring 1			Other		
PROPERTY OWNER'S NAME.	COMPANY NAME	uble T	in set		CASING(S) N/A Depth	Set in oversize	hole? Annular space initially grouted?
Property owner's mailing address	if different than well i	location address in	ndicated abo	ove	in. from to f	The state of the s	
4760 N 186	th st				in, from to fi	. Yes 🗀 I	No ☐ Yes ☐ No ☐ Unknown
Brookfield,	WI 53	045					
					in. from toft	. Yes 1	No Yes No Unknown
WELL OWNER'S NAME/COME	PANY NAME	WELL			SCREEN/OPEN HOLE	^	71
Well owner's mailing address if dif	ferent than property	owner's address in	ndicated abo	ove	Screen from to ft.  OBSTRUCTIONS	Open Hole fromO	to 21 it.
					☐ Rods/Drop Pipe ☐ Check Valve(s)  Type of Obstructions (Describe)	☐ Debris ☐ Fill	₩ No Obstruction
GEOLOGICAL MATERIAL	COLOR	HARDNESS OF FORMATION	FROM	то	Obstructions removed?  Yes No Des	cribe	
If not known, indicate estimate	d formation log fro	F. LOSS, Justine	or boring.		PUMP		
Topsal	lolack	NIA	0	1/2	TypeRemoved Not Present	Other	
Lean der	gray	soft	11/2	10	METHOD USED TO SEAL ANNULAR SPACE BE	7-0-10-0-	CASING AND BORE HOLE:
Fat day	dh gray	504	10	21		ace Grouted with Tremie F	Pipe Casing Perforation/Removal
10. 00.49	- Groging		-	-	in. from	to	ft. Perforated Removed
			11		in. from	to	ft. Perforated Removed
					Type of Perforator		
					VARIANCE	and a service of the service of	
					Was a variance granted from the MDH for this was GROUTING MATERIAL(S) (One bag of		
						f cement = 94 lbs., one ba	
					Grouting Material benturite	from 0 to Z	ft yards bags
					-	from to	ft yards bags
						fromto	ft yards bags
				-	OTHER WELLS AND BORINGS UNKN	OWN	
REMARKS, SOURCE OF DAT	A, DIFFICULTIES	IN SEALING			Other unsealed and unused well or boring on pro		How many?
Terracon Pr	oject #	M5175	०५९		LICENSED OR REGISTERED CONTRACTOR CE This well or boring was sealed in accordance with is true to the best of my knowledge.		er 4725. The information contained in this report
Terracon Pr Boring B	-11				Terracon Consultano	ts, Inc.	M1665 License or Registration No.
					1/2/201	21	
					Certified Representative Signature	362 Certifi	ed Rep. No. Date
MINN. DEPT OF HEALTH	H COPY	343	630	)	Michael Roberts  Name of Person Sealing Well or Boring		
AD COLORS AND AD WINDOW							

County Name Rose	~			L AN	D BOF Innesota	RING SEALING RECORD Statutes, Chapter 1031	nnesota Well and Boring aling No. nnesota Unique Well No. W-series No. ve blank if not known)	н 343631
N. Roseau UT	Township No.	40W	No. Section No.		(sm. → lg. N %NW%	Date Sealed 8/16/17	Date Well or Boring Construc	sted
GPS LOCATION - de			decimal places)	334	8	Depth Before Sealing 6 ft.	Original Depth 6	ft.
Numerical Street Addre	ess or Fire Nur					AQUIFER(S)  Single Aquifer  Multiaquifer	STATIC WATER LEVEL	
360th A	reme		, , , , , , , , , , , , , , , , , , , ,	ing Eood	illott	WELL/BORING	Measured Estimate	d Date Measured 8/10/17
Show exact location of in section grid with "X."	well or boring	)	Sketch ma location, s lines, road	p of wel howing p	l or boring property	Water-Supply Well	12 ft. X belo	w above land surface
N			lines, road Sect 17	1	uildings. et 16	CASING TYPE(S) N/A  Steel Plastic Tile Other	<b>A</b>	I dove faild surface
WX S	<u> </u>	½ Mile	Sect 20	se m borin	ct 21	WELLHEAD COMPLETION NIA  Outside: Well House		all Pit ried
State o	Minn	Or			,	CASING(S) N/A Diameter Depth	Cot in avarages but	
Froperty owner's mailing a	ddress if differe	e Dr	location address in	idicated a	above	in. from toft.	Set in oversize hold	e? Annular space initially grouted?  Yes No Unknown
St. Paul						in. from to ft.	☐ Yes ☐ No	☐ Yes ☐ No ☐ Unknow
	9					in. fromtoft.	☐ Yes ☐ No	
VELL OWNER'S NAME	COMPANY N		O WELL			SCREEN/OPEN HOLE		☐ Yes ☐ No ☐ Unknow
GEOLOGICAL MATER	timated forma	OLOR ition log fr	HARDNESS OR FORMATION om nearby well o	FHON	то	Type of Obstructions (Describe)  Obstructions removed?  Yes  No Descr	ibe	
Lean clay		own	soft	1/2	-11	the same of the sa	Other	
Fat day	du	gran	dredst.H		1,0	METHOD USED TO SEAL ANNULAR SPACE BETA No Annular Space Exists   Annular Space	VEEN 2 CASINGS, OR CASING Grouted with Tremie Pipe	IG AND BORE HOLE:  Casing Perforation/Removal
Sandy lean cl	75.	1	अस्र	541/2	- 48.00	in. from to	)ft,	Perforated Removed
						Type of Perforator		
						ARIANCE las a variance granted from the MDH for this well?	Vos Ma This	
							ement = 94 lbs., one bag of b	entonite = 50 lbs.)
				1	G	1. A1.	om_ O to_ 61	ftyards3bags
				_ (		fro	omto	ft yards bags
	-1/1					fro	om to	
					0	THER WELLS AND BORINGS UNKNOW	N	n yards bags
MARKS, SOURCE OF					0	her unsealed and unused well or boring on proper	ty? Yes No How	many?
Terraeon P Boring B	roject	# /	M517504	9	1.1	CENSED OR REGISTERED CONTRACTOR CERT is well or boring was sealed in accordance with M true to the best of my knowledge.	FICATION innesota Rules, Chapter 4725	. The information contained in this repor
) "					ī	Terracon Consultants	,Inc.	MIG65 License or Registration No.
					20	ertified Representative Signature	362/ Certified Rep	9/22/2017 . No. Date
INN. DEPT OF HEA	LTH COPY	Н	3436	31	-	Michael Roberts Name of Person Sealing Well or Boring		
11434-14 10# 5	0450					TO PRODUCE TO THE PROPERTY OF		

County Name  Zosean	ATION		AND	BOR	RING SEALING RECORD a Statutes, Chapter 1031  Willingsota Well and Boring Sealing No. Minnesota Unique Well No. or W-series No. (Leave bank if no known)
Township Name Townsh N. Roseau UT 163	nip No. Range No.	29 1		(sm. → lg. · % <b>SE</b> ¼	
GPS LOCATION – decimal d		ecimal places) itude_ <b>-95.</b> 6	3348	3	Depth Before Sealing 21 ft. Original Depth 21 ft.
Numerical Street Address or Fi  (o Rd 12  Show exact location of well or	ire Number and Ci	ity of Well or Borin	ng Location	ion or borina	AQUIFER(S)  STATIC WATER LEVEL  Single Aquifer
in section grid with "X."	looring	lines, roads	owing pr , and bu	roperty ildings.	CASING TYPE(S)  Steel   Plastic   Tile   Other   Other
W S S I Mile	E T // Mile	[5	<u></u>		WELLHEAD COMPLETION Outside: Well House At Grade Inside: Basement Offset Pitless Adapter/Unit Buried Well Pit Well Pit Other
PROPERTY OWNER'S NAME/ State of A Property owner's mailing address i	Minn DN	IB.	dicated al	bove	CASING(S) Diameter  Depth  Depth  Set in oversize hole? Annular space initially grouted?
500 Lataye St. Paul, N	tte Dr.				
31. 4001,10	110 3510				in, fromtoft.
WELL OWNER'S NAME/COMP.	No	well	dicated ab	pove.	SCREEN/OPEN HOLE  Screen from to ft. Open Hole from 0 to 21 ft.  OBSTRUCTIONS  Rods/Drop Pipe Check Valve(s) Debris Fill Na No Obstruction
GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	то то	Type of Obstructions (Describe)  Obstructions removed?  No Describe
If not known, indicate estimate	d formation log fr	The state of the s	r boring.		PUMP
roomly graded soud	bown	NA	Ó	2	Type ☐ Removed
Silty sand	brown	loose	2	7	METHOD USED TO SEAL ANNULAR SPACE BETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Foot clay	dk gray	soft	7	12	M. No Annular Space Exists Annular Space Grouted with Tremie Pipe Casing Perforation/Removal
Silt	proud	med stiff	12	191/2	
Fast clay	de gray	soft	191/2	21	in. fromtoft.
					VARIANCE  Was a variance granted from the MDH for this well? ☐ Yes 🕅 No TN#
			150	-	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
					fromtobags
					from to ft yards bags
EMARKS SOURCE OF DATA	DIEFICILITIES	INCEALING			OTHER WELLS AND BORINGS
Terracon Pro			049		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 Proj Boring B-	13				Terracan Consultants, Inc MIGG5  Licensee Business Name Licensee or Registration No.
					Certified Representative Signature  362/ 9/22/17  Certified Rep. No. Date
MINN. DEPT OF HEALTH	СОРУ	3436	38	5	Michael Roberts Name of Person Sealing Well or Boring

County Name	ın			AND Mir	BOR inesota	ING SEALING RECORD Statutes, Chapter 1031	Minnesota Well and Sealing No. Minnesota Unique W or W-series No. Leave blank if not known)		H	343	638
Township Name	Township N	yow	33	Fraction (		B/Io /IT	Date Well or Boring		d		
GPS LOCATION - d			ecimal places) itude <b>-95.2</b>	311		Depth Before Sealing	ft. Original Depth_	21	ft.		
Numerical Street Add.					on	AQUIFER(S)   X  Single Aquifer	STATIC WATER LI		Date Meas	ured	
Show exact location on section grid with "X	of well or bori	ing	Sketch ma location, s lines, road	p of well on howing pros, and bui	or boring operty Idings.			<b>⋈</b> below	above	land surfa	ce
W S		E T ½ Mile •	We Co. B	1	ring B	Steel Plastic Tile Other  WELLHEAD COMPLETION Outside: Well House Adapter/Unit Burk  Well Pit Other	200	Base Well Burie	ed	· V	
ROPERTY OWNER'S	S NAME/CON	Kvee	in.			CASING(S) N/A Diameter Depth	Set in ov	ersize hole?	2 Annula	r space inil	ially grouted?
roperty owner mailing	073 (	orchan	d ct		ove	in. fromto	ft. Yes	□ No	☐ Yes	□ No	Unknow
Menomor	nee Fa	ills, M	IN 5309	51			ft. Yes	∐ No	☐ Yes	□ No	Unknow
VELL OWNER'S NAM	IE/COMPANY	NAME N	O WELL			SCREEN/OPEN HOLE	ii lies		∐ Yes	□ No	Unknow
GEOLOGICAL MAT	estimated for	COLOR	HARDNESS OF FORMATION	FHOM		Type of Obstructions (Describe)  Obstructions removed?  Yes No Describe  PUMP  Type  Removed Not Present					
Lean clas	, ,	rellow	medshift		/	METHOD USED TO SEAL ANNULAR SPACE BI			G AND BORE	HOLE:	
Fat clay	0	lkgray	soft	7	8 PZ	No Annular Space Exists Annular S in. from	pace Grouted with Tre	mie Pipe ft.	☐ Casi		ion/Removal
Silf /	dl	i gray	medshift	8/2	21	in. from	to	ft.	☐ Perfora	ated	Removed
						Type of Perforator		Section 1			
						Was a variance granted from the MDH for this w GROUTING MATERIAL(S) (One bag of	vell? ☐ Yes ☑ No of cement = 94 lbs., or		entonite = 50	lbs.)	
						Grouting Material bentonite		21	t	_ yards	bags
							to		1,	_ yards	bags
						OTHER WELLS AND DODINGS	from to_		t	_ yards	bags
MARKS, SOURCE OF Terracon Boring				યુગ		OTHER WELLS AND BORINGS UNKNOOD THE UNKNOO	operty? Yes DERTIFICATION Ith Minnesota Rules, Cl		The informa	M166	
MINN. DEPT OF HI 01434-14	EALTH COF	м H	3430	638		Michael Roberts  Name of Person Sealing Well or Boring					5/

WELL OR BORING LOCA County Name	ATION		AND	BOR	ING SEALING RECORD Se	innesota Well and Boring saling No. innesota Unique Well No. W-series No. we blank if not known)
	P No. Range No.	200	action (sr		Date Sealed 8/10/17	Date Well or Boring Constructed 8/10/17
GPS LOCATION - decimal de	egrees (to four dec				Depth Before Sealing 21 it	Colorinal County 21
Latitude_ 48.928 7	Longitu	rde - 95.8	217		Depth Before Sealing It  AQUIFER(S)	Original Depth ft.  STATIC WATER LEVEL
Numerical Street Address or Fi	re Number and City	of Well or Boring	Location	1	Single Aquifer  Multiaquifer	
360th Avec	re				WELL/BORING  Water-Supply Well Monit. Well	Measured Sestimated Date Measured
Show exact location of well or in section grid with "X."	boring	Sketch map location, sho lines, roads,	of well or	boring	KEnv. Bore Hole  Other	25 ft. □ below □ above land surface
N N	Sec	lines, roads,		lings. Sect 15	CASING TYPE(S)  Steel Plastic Tile Other  WELLHEAD COMPLETION	
W	E T % Mile 5	ection 21	ing	Secti 22	Outside:	
PROPERTY OWNER'S NAME/	inn DVR	neation address inc	dicated abo	ove	CASING(S) Diameter  in. from to	Set in oversize hole? Annular space initially grouted?  ft. ☐ Yes ☐ No ☐ Yes ☐ No ☐ Unknown
500 Lataye St. Poul, M.	ette Dr. N 5515	5				ft. Yes No Yes No Unknown
OI. FOL. 1 /00					in. fromto	ft. Yes No Yes No Unknown
WELL OWNER'S NAME/COMP	PANY NAME	WELL			SCREEN/OPEN HOLE	
GEOLOGICAL MATERIAL	COLOR	HARDNESS OR FORMATION	FROM	то	☐ Rods/Drop Pipe  ☐ Check Valve(s)  Type of Obstructions (Describe)  Obstructions removed? ☐ Yes ☐ No De	□ Debris □ Fill ☑ No Obstruction
If not known, indicate estimate	ed formation log fro	m nearby well o	r boring.		РИМР	
Topsoil	black	NIA	0	11/2	Type Not Present	Other
Lean clay	dk gray	soft	11/2	6		ETWEEN 2 CASINGS, OR CASING AND BORE HOLE:
Foot clay	dhown	soft	6	2.1	[[[[[[[]]]]]] [[[[]]] [[]] [[] [[]] [[] [[]] [[] [[]] [[]] [[]] [[] [[]] [[]] [[] [[]] [[] [[]] [[]] [[]] [[] [[]] [[]] [[] [[]] [[]] [[]] [[]] [[]] [[]] [[]] [[] [[]	Space Grouted with Tremie Pipe
Fax cury	ungray	3007		<u> </u>	in. from	toft. Perforated Removed
		-			in. from	toft. Perforated Removed
					Type of Perforator	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\ bags
						from to ft. yards bags
					OTHER WELLS AND TARRES	from to ft. yards bags
BEILLEICA SAUDES	ra pierioi : =:=	IN OF ALTER				ENOW N
Terracon Pri Boring B	eject #	M5/175	049		is true to the best of my knowledge.	SERTIFICATION ith Minnesota Rules, Chapter 4725. The information contained in this report
Boring 13	-15				Terracon Consultari Licensee Business Name Certified Representative Signature	15, Inc. MI665 License or Registration No.  3621  Certified Rep. No.  Date
MINN. DEPT OF HEALT HE-01434-14 ID# 531		343	639	9	Michael Roberts Name of Person Sealing Well or Boring	Cerilled Rep. No. Date

WELL OR BORING LOC	ATION					nnesota Well and Boring aling No.	н 343635
County Name		WELL		75.5	ING SEALING NECOND Mir	nesota Unique Well No.	
Rosean			Mini	nesota	Statutes, Chapter 103I or \(\(\text{(Leave}\)	W-series No. e blank if not known)	L.
Township Name Townsh	ip No. Range No	Section No. Fr			Date Sealed	Date Well or Boring Construc	ted
Jadis 162	IN YOW	27 5	J'A SW	4 SW14	8/10/17	8/10/17	
GPS LOCATION – decimal of Latitude 48.907		cimal places) ude – 95, 8	110		Depth Before Sealing 21 ft.	Original Depth 21	ft.
					AQUIFER(S)	STATIC WATER LEVEL	2.498 WK
Numerical Street Address or F	ire Number and Cit	y of Well or Borin	g Locatio	n	X Single Aquifer Multiaquifer WELL/BORING	Measured Estimate	Date Measured 8/10/17
Show exact location of well or in section grid with "X."	boring	Sketch map	owing pro	perty	_	7 1/2 ft. X belo	w  above land surface
N N	<del></del> .	lines, roads		dings.	CASING TYPE(S) NIA		
		اط	oring		Steel Plastic Tile Other		
W 38 S	½ Mile	.4.28	Sec	ł. 27	WELLHEAD COMPLETION Outside:  Well House		ried
1 Mile	- Sect	33 150	et. i	34	Other		
PROPERTY OWNER'S NAME Wahlberg Property owner's mailing addres	Trust if different than well		dicated ab	ove	CASING(S) Diameter V/A Depth in, from to ff.	Set in oversize ho ☐ Yes ☐ No	ie? Annular space initially grouted?  Yes No Unknown
309 7th A					in. fromtoft.	Yes No	Yes No Unknown
Roseau, A	IN 567	51			in, from to ft.	Yes No	Yes No Unknown
WELL OWNER'S NAME/COM	DALINA NALES				SCREEN/OPEN HOLE		
Well owner's mailing address if di	~	O MET			Screen from to ft.	Open Hole from	to 21 ft
GEOLOGICAL MATERIAL  If not known, indicate estimat	COLOR	HARDNESS OR FORMATION om nearby well o	PHOM	то	Type of Obstructions (Describe)  Obstructions removed?  Yes No Description	oribe	7 1 1 1 1 2 1 1 1 1
Topsoil	black	NA	0	11/2	Type		
		Soft	11/2	41/2	Removed Not Present	Other	
Leun Clay	gray		-		METHOD USED TO SEAL ANNULAR SPACE BE  No Annular Space Exists   Annular Sp	TWEEN 2 CASINGS, OR CAS ace Grouted with Tremie Pipe	
Fat clay	dkgray			7	in, from_	toft.	Perforated Removed
Sitt	alk yray	medstiff	7	14/2			
Fat clay	dkgray	soft	14/2	21	in. from	toft.	Perforated Removed
100 00-1	and and	5061	1.10	601	Type of Perforator		
					VARIANCE		
					Was a variance granted from the MDH for this we		ALCON CONTROL CONTROL
						f cement = 94 lbs., one bag o	r bentonite = 50 lbs.)
			1		Grouting Material bentonite	from 0 to 21	_ ft yards bags
						from to	_ ft yards bags
						from to	ft yards bags
			1		OTHER WELLS AND BORINGS		
REMARKS, SOURCE OF DA	TA, DIFFICULTIES	IN SEALING			Other unsealed and unused well or boring on pro	perty? Yes You Ho	w many?
Terraeon & Boring B-	roject :	HM517	504	9	LICENSED OR REGISTERED CONTRACTOR CE This well or boring was sealed in accordance will is true to the best of my knowledge.	RTIFICATION	
Boring 15-	16				Terracon Consultants	, Inc.	M1665 License or Registration No.
					Certified Representative Signature	362 Certified	
	T						nop. No. Date
MINN, DEPT OF HEALT	н сору	343	635	5	Michael Roberts Name of Person Sealing Well or Boring		

WELL OR BORI County Name	NG LOCAT	ION	WEL			ING SEALING RECORD	Sealing No. Minnesota Unique \		H 34	30	132
	plan			Mini	nesota	Statutes, Chapter 1031	or W-series No. (Leave blank if not known)		1		
Township Name  Jadis	Township I		1000	Fraction (s		Date Sealed 8/14/17	Date Well or Borin	ng Constructed	f <sub>0</sub>		
GPS LOCATION - Latitude 48	decimal degr . 9190		cimal places) ude <b>-95.</b> 7	1932		Depth Before Sealing 2	_ft. Original Depth_	21	ft.		
Numerical Street Ad	Idress or Fire	Number and Cit	y of Well or Bo	oring Locatio	n	AQUIFER(S)  Single Aquifer  Multiaquifer  WELL/BORING	STATIC WATER		Date Measured		
Show exact location in section grid with		oring	Sketch m location,	nap of well o showing pro ds, and buil	or boring	☐ Water-Supply Well ☐ Monit. Well  ☑ Env. Bore Hole ☐ Other	25 "	. below	above land	surface	0
w	×	S ET lossin	et. 22		et 23	CASING TYPE(S)  Steel Plastic Tile Other  WELLHEAD COMPLETION Outside: Well House	t Grade Insi	de: □ Base	amont Office		
——————————————————————————————————————	S Mile	½ Mile See	) *. 27	Sec	+26	Pitless Adapter/Unit   Bu		Well Burie	Pit d		
PROPERTY OWNE  Carb  Property owner's mail	Ped	erson	ocation address	indicated ab	oove	CASING(S) Diameter  in. from  to	Set in	oversize hole?		ace initial	lly grouted?
717 8tm						in. from to	ftYes	□ No		_ No	Unknown
Kosewi	L, MN	5675				in. from to	ft.	□No	☐ Yes ☐	No	Unknown
Well owner's mailing a	ddress if differe		O WEU		oove	Screen from	_ft. Open Hole from		to 21	ft.	
GEOLOGICAL M	27.21	COLOR	HARDNESS (	N THOM	то	Obstructions removed? Yes No I	Describe				
If not known, indica			100	1.47	11/2	Туре					
lopsoil	- 7	black	NA	1/2		Removed Not Present	Other				
Lean clay		dkyray	Soft Soft	6	21	And the second of the second o	E BETWEEN 2 CASING or Space Grouted with 1	remie Pipe	G AND BORE HO Casing F	Perforatio	
		400				in. from		ft.			Removed
						in, from Type of Perforator	to	ft.	Perforated		Removed
						VARIANCE Was a variance granted from the MDH for this					
							ag of cement = 94 lbs.				
						Grouting Material Dentonite		0 21		ards	bags
						-		0	•	ards	bags
						OTHER WELLS AND BORINGS		01	ft y	ards	bags
Terrace Boring				7504	9	Other unsealed and unused well or boring on LICENSED OR REGISTERED CONTRACTOR This well or boring was sealed in accordance is true to the best of my knowledge.  Tewacan Consultation Licensee Business Name  Certified Representative Signature	property? Yes a CERTIFICATION I with Minnesota Rules,	.,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	5. The information	M16	
MINN DEPT OF	F HEALTH C	OPY H	343	632	2	Christopher Schill Name of Person Sealing Well or Boring					
HE-01434-14	ID# 53159										5/

# 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:

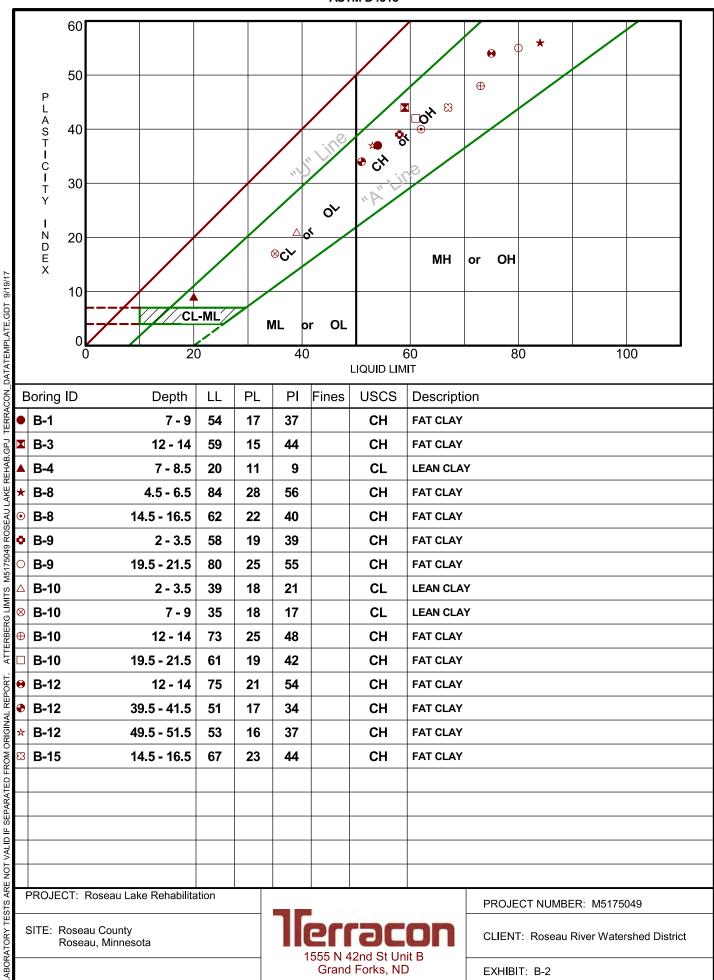
- Water content (ASTM D2216)
- Dry density (ASTM D7263-09 Method B)
- Atterberg limits (ASTM D4318)
- Grain size distribution (ASTM D422)
- Hydraulic conductivity (ASTM D5084)
- One-dimensional consolidation properties (ASTM D2435)
- UU Triaxial (ASTM D2850)
- Hydraulic Conductivity (ASTM D5084)

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.

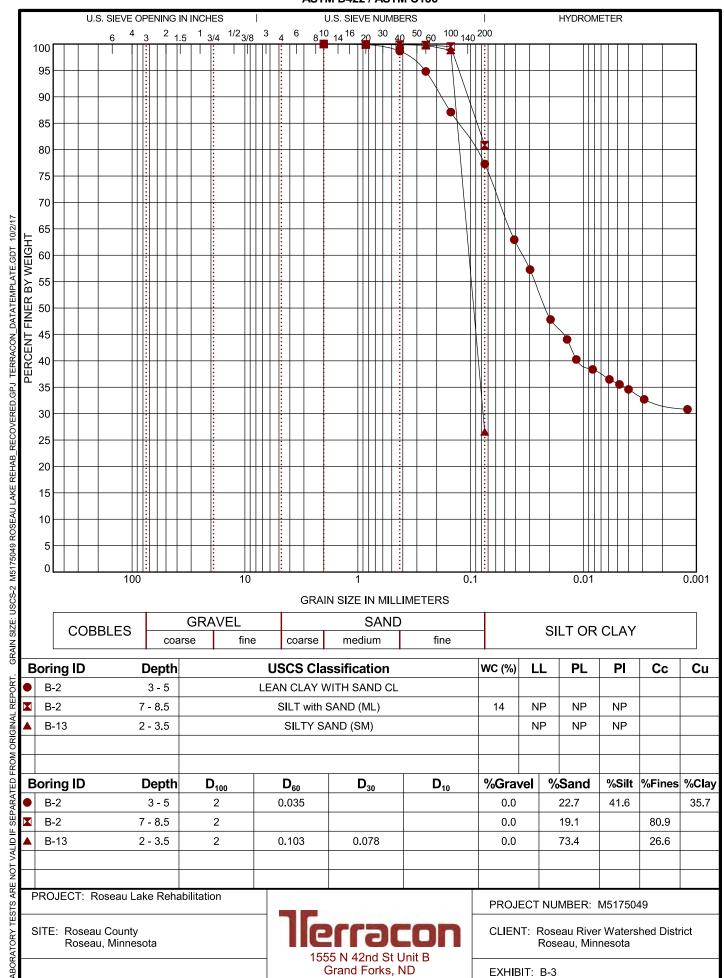
# ATTERBERG LIMITS RESULTS

**ASTM D4318** 

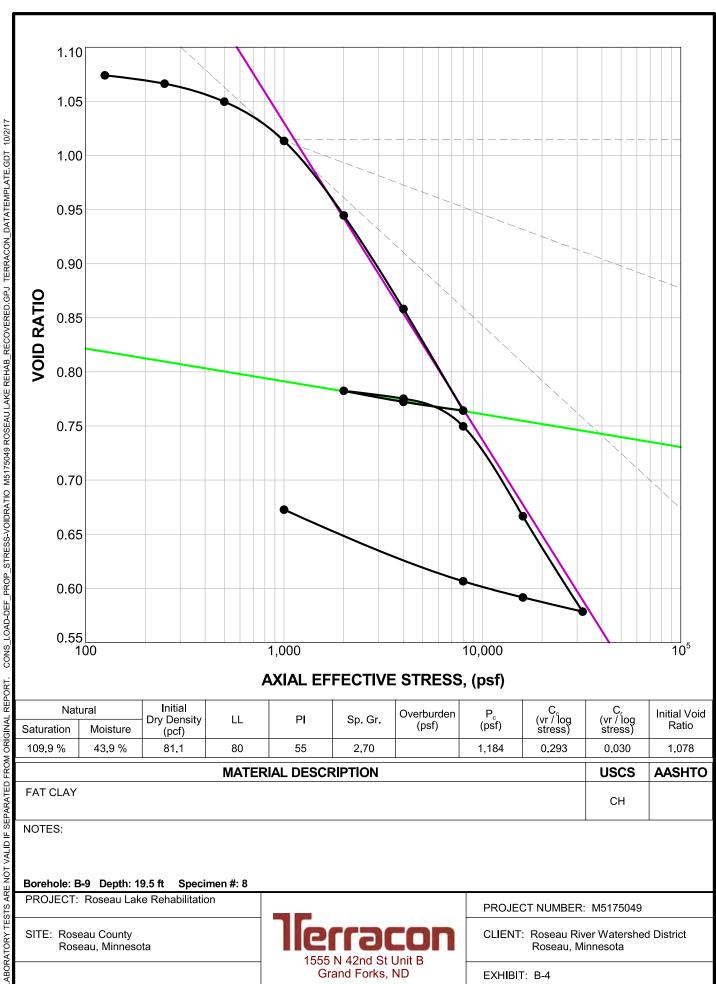


### GRAIN SIZE DISTRIBUTION

**ASTM D422 / ASTM C136** 



# **CONSOLIDATION TEST (D2435)**



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

PROJECT: Roseau Lake Rehabilitation

SITE: Roseau County Roseau, Minnesota

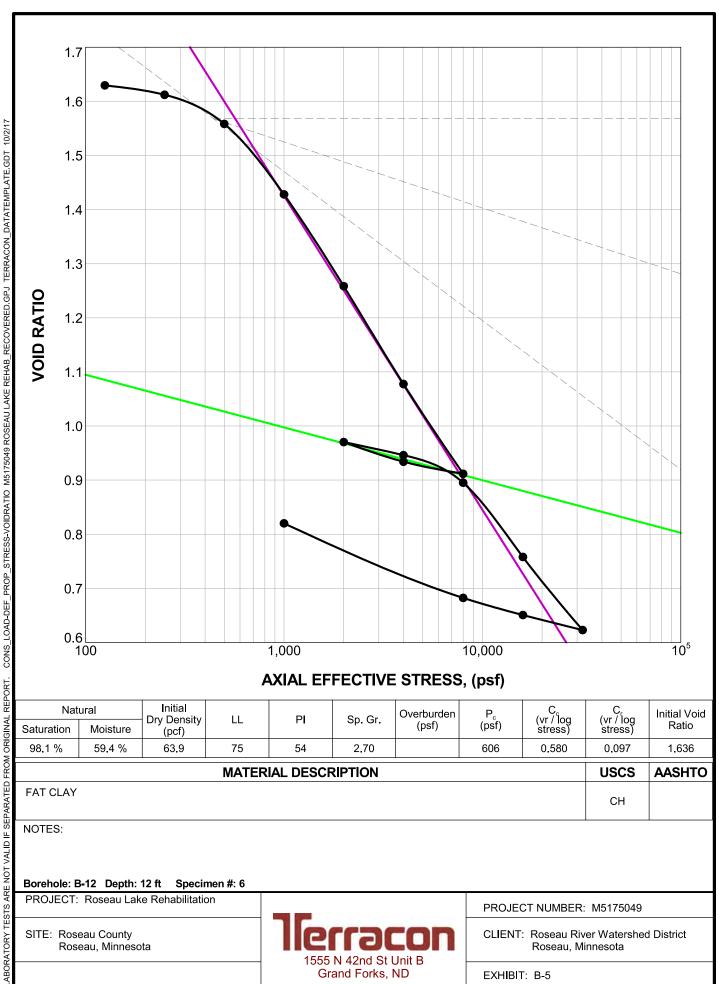


PROJECT NUMBER: M5175049

CLIENT: Roseau River Watershed District Roseau, Minnesota

EXHIBIT: B-4

# **CONSOLIDATION TEST (D2435)**



PROJECT: Roseau Lake Rehabilitation

SITE: Roseau County Roseau, Minnesota



PROJECT NUMBER: M5175049

CLIENT: Roseau River Watershed District Roseau, Minnesota

EXHIBIT: B-5

## **HYDRAULIC CONDUCTIVITY REPORT**



Client Project

Roseau River Watershed District

Roseau Lake Rehabilitation

					P	roject Number:	M 5175049		
Test Method:	ļ	ASTM D5084 Method (		Sample No.:		Boring E	3-2 - 3' - 5'		
Sample Type:		Remolded		Location :					
Date Sampled :		8/14/2017		Operator :		V	v ro		
Soil Type :	LEAN CLAY	with SAND (CL) - gra	у						
Proctor Results:	111.9	pcf	-		Molded @:	94.9	% compact		
	15.8	%				15.6	% M.C.		
Initial Sample Par	ameters						Content		
Wet Wt. (g)	664.79	Diameter (in)	2.850	Height (in)	3.228	-			
Dry Wt. (g)	575.32		2.876		3.217	Wet Wt.	70.25		
Area (cm²)	41.350		2.844	i	3.202	Dry Wt	62.97		
Area (in²)		Average (in)	2.857	Average(in)	3.216	Pan Wt.	16.16		
Density (pcf)						W.C. (%)	15.6		
Assumed Sp.G.			Void Ratio:	0.556	_	% Saturation	74.0		
Vol Wet (cc)	337.74	Vol. Solids Vs(cc)	217.10	Porosity n (%):	36	-			
Final Sample Para	meters					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 (cm²)	42.048		2.886		3.192	Dry Wt.	674.89		
Area (in²)	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.:		Chamber No.:	3	,	u <b>l</b> ic Gradient:		-		
Cell Press (psi)	58.4	Back Press.(psi)		Tail Press. (psi)	52.0	-			
		Pipette • Bu	rette	Pipe Area (cm²)	0.079	Fluid:	De-aired tap w	<i>i</i> ater	
Date and Time	Temp	Head (h1)	Tail (h2)	⊟apsed Time (S)	Total Head	k(cm/s)	k <sub>20</sub> (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 (k<sub>20</sub>) = AVERAGE

2.89E-08 cm/sec

# **HYDRAULIC CONDUCTIVITY REPORT**



Client Project

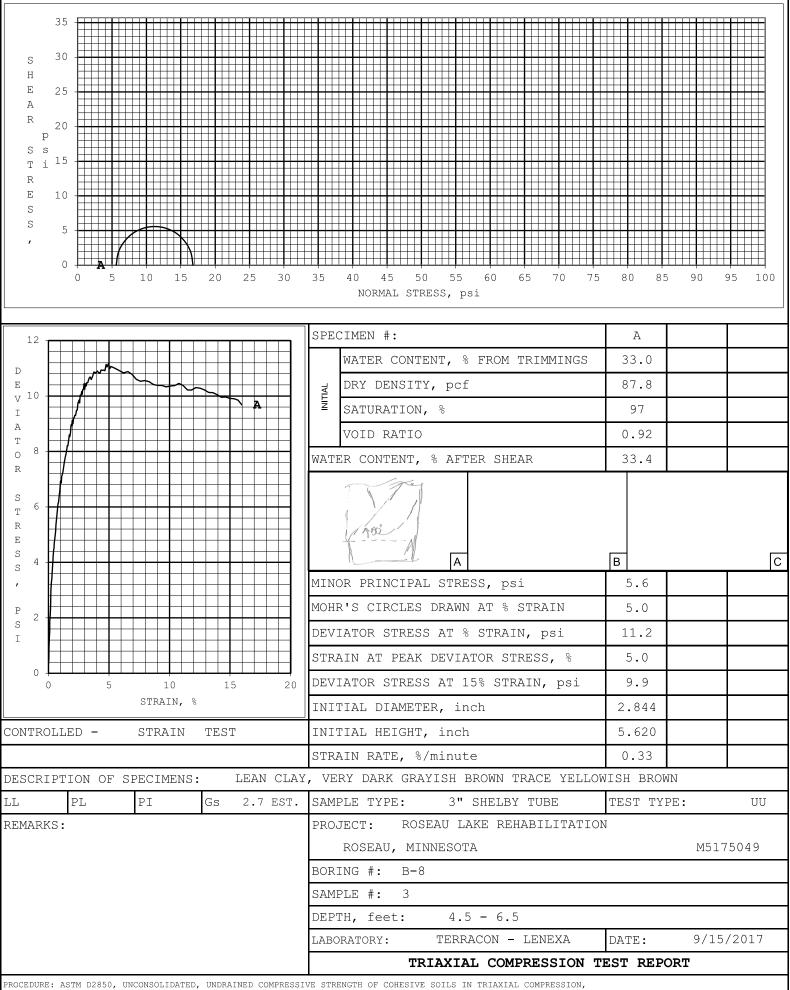
Roseau River Watershed District

Roseau Lake Rehabilitation

					Pı	roject Number:	M 5175049		
Test Method:	,	ASTM D5084 Method (	5	Sample No.:		Boring B-10, S	Sample #4, 7' -9	9'	
Sample Type:		3-inch Shelby tube		Location :					
Date Sampled :		8/14/2017		Operator :		٧	vro		
Soil Type :	LEAN CLAY	(CL) - gray, silt lense	S						
Proctor Results:		pcf			Molded @:		% compact		
		%					% M.C.		
Initial Sample Par	ameters					Water	Content		
Wet Wt. (g)	651.57	Diameter (in)	2.808	Height (in)	3.275	Pan No.:	170		
Dry Wt. (g)	510.51		2.802		3.279	Wet Wt.	94.00		
Area (cm²)	39.821		2.800	_	3.262	Dry Wt.	77.22		
Area (in²)	6.172	Average (in)	2.803	Average(in)	3.272				
Density (pcf)	96.2					W.C. (%)	27.6		
Assumed Sp.G.	2.65		Void Ratio:	0.718	_	% Saturation	101.8		
Vol Wet (cc)	330.94	Vol. Solids Vs(cc)	192.65	Porosity n (%):	42				
Final Sample Para	ameters					Water	Content		
Wet Wt. (g)	648.83	Diameter (in)	2.802	Height (in)	3.242	Pan No.:	45		
Dry Wt. (g)	505.15		2.803		3.237	Wet Wt.	727.37		
Area (cm²)	39.858		2.809		3.230	Dry Wt.	583.74		
Area (in²)	6.178	Average (in)	2.805	Average(in)	3.236	Pan Wt.	78.75		
Density (pcf)	96.2	•		•		W.C. (%)	28.4		
•		•				% Saturation	104.6		
Panel No.:		Chamber No.:	1		ulic Gradient:	16.9	_		
Cell Press (psi)	59.3	Back Press.(psi)	54.1	Tail Press. (psi)	52.1				
		Pipette	rette	Pipe Area (cm²)	0.079	Fluid:	De-aired tap w	/ ater	
Date and Time	Temp	Head (h1)	Tail (h2)	⊟apsed Time (S)	Total Head	k(cm/s)	k <sub>20</sub> (cm/sec)	dt / dh	
9/13/17 7:21	23	, ,	25.20	(-)	139.75	,	20 ( /		
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			133.70	2.35E-08			0.93
9/13/17 13:29	23	29.60	21.30		130.90				0.92
9/13/17 15:37	23	31.00	20.00	7680	127.88	2.51E-08			0.93

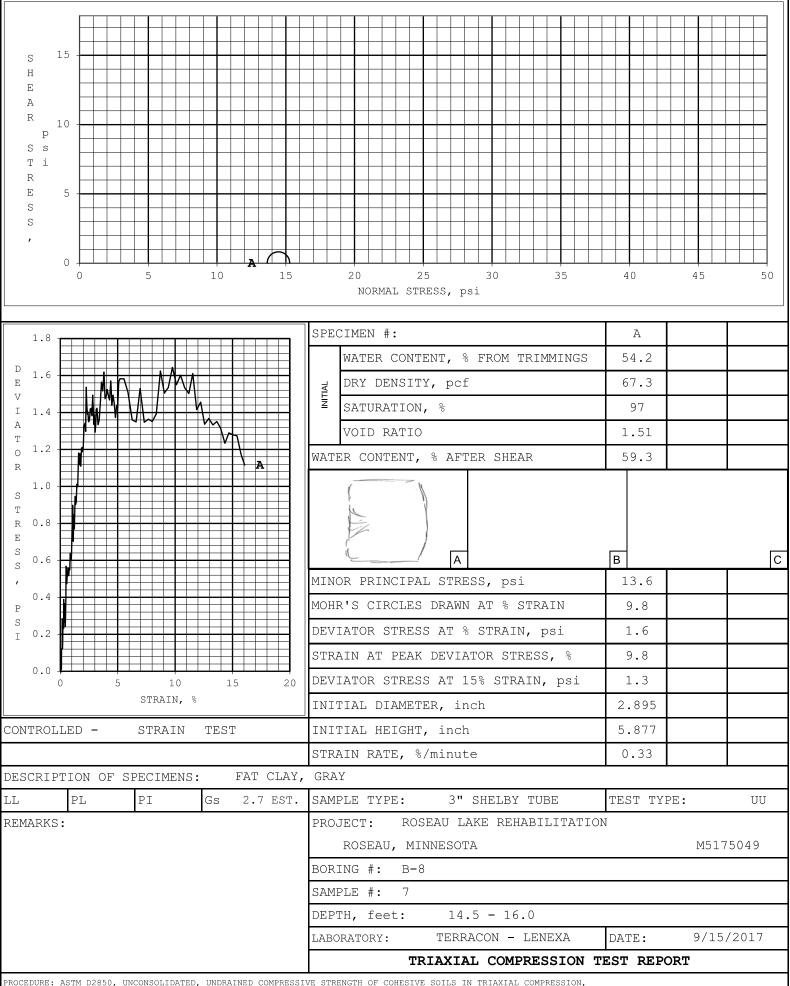
HYDRAULIC CONDUCTIVITY (k<sub>20</sub>) = AVERAGE

2.29E-08 cm/sec



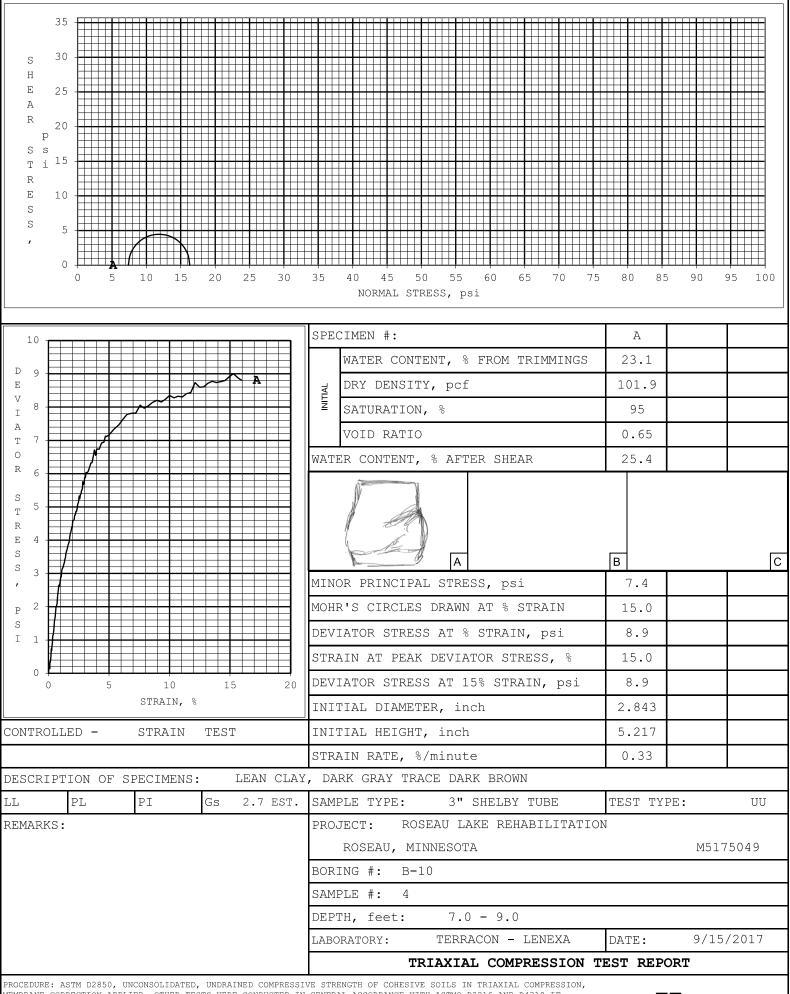
PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION
MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTMS D2216 AND D4318 IF
APPLICABLE.





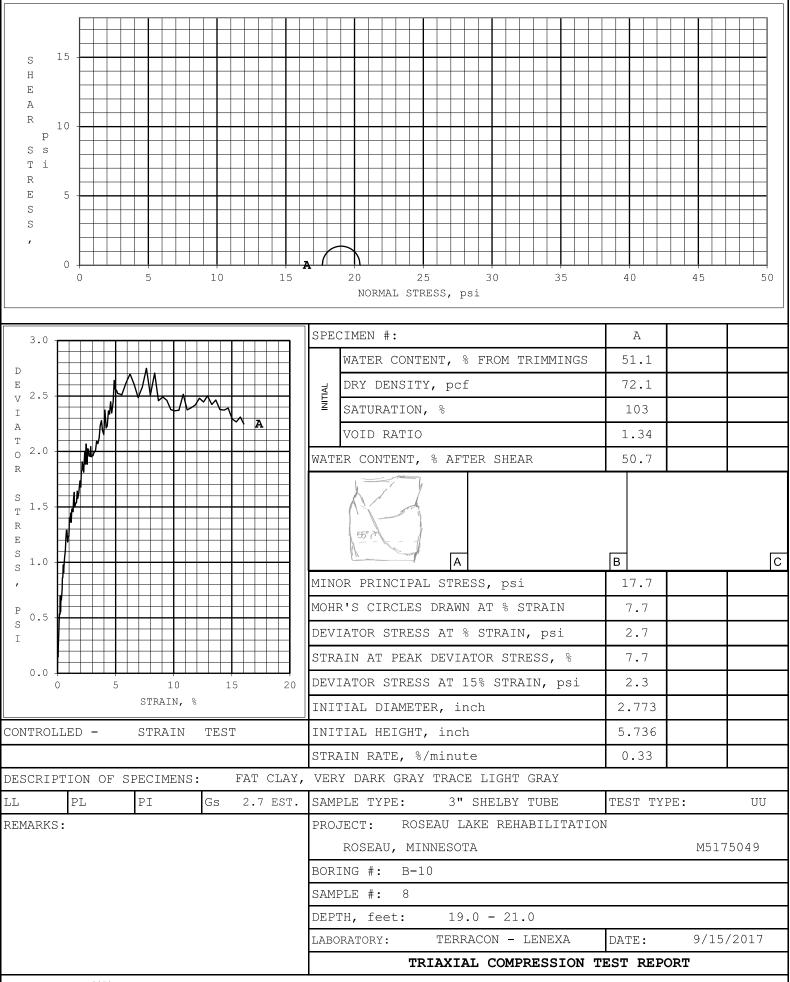
PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTMS D2216 AND D4318 IF





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





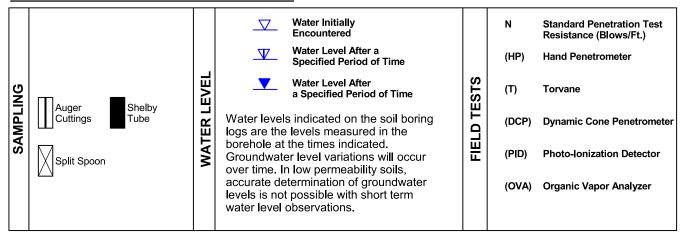
PROCEDURE: ASTM D2850, UNCONSOLIDATED, UNDRAINED COMPRESSIVE STRENGTH OF COHESIVE SOILS IN TRIAXIAL COMPRESSION, MEMBRANE CORRECTION APPLIED. OTHER TESTS WERE CONDUCTED IN GENERAL ACCORDANCE WITH ASTMS D2216 AND D4318 IF



# APPENDIX C SUPPORTING DOCUMENTS

## **GENERAL NOTES**

### **DESCRIPTION OF SYMBOLS AND ABBREVIATIONS**



### **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.

	(More than 50%	retained on No. 200 sieve.) Standard Penetration Resistance	CONSISTENCY OF FINE-GRAINED SOILS  (50% or more passing the No. 200 sieve.)  Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance						
RMS	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.				
뽀	Very Loose	0 - 3	Very Soft	less than 500	0 - 1				
RENGT	Loose	4 - 9	Soft	500 to 1,000	2 - 4				
RE	Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8				
\ <u>\</u>	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

# GRAIN SIZE TERMINOLOGY

PLASTICITY DESCRIPTION

<u>Descriptive Term(s)</u>	Percent of	<u>Major Component</u>	Particle Size
of other constituents	Dry Weight	<u>of Sample</u>	
Trace With Modifier	< 15 15 - 29 > 30	Boulders Cobbles Gravel Sand Silt or Clay	Over 12 in. (300 mm) 12 in. to 3 in. (300mm to 75mm) 3 in. to #4 sieve (75mm to 4.75 mm) #4 to #200 sieve (4.75mm to 0.075mm Passing #200 sieve (0.075mm)

#### **RELATIVE PROPORTIONS OF FINES**

<u>Descriptive Term(s)</u> of other constituents	<u>Percent of</u> Dry Weight	<u>Term</u>	Plasticity Index
of other constituents	<u>Dry weight</u>	Non-plastic	0
Trace	< 5	Low	1 - 10
With	5 - 12	Medium	11 - 30
Modifier	> 12	High	> 30



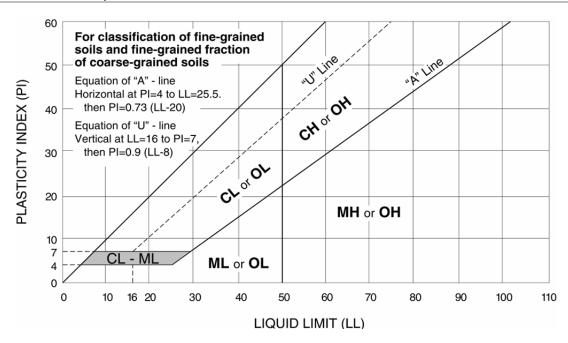
## UNIFIED SOIL CLASSIFICATION SYSTEM

		Soil Classification			
Criteria for Assigr	ning Group Symbols	s and Group Names	s Using Laboratory Tests <sup>A</sup>	Group Symbol	Group Name <sup>B</sup>
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:	Cu ≥ 4 and 1 ≤ Cc ≤ 3 <sup>E</sup>	GW	Well-graded gravel F
		Less than 5% fines <sup>c</sup>	Cu < 4 and/or 1 > Cc > 3 <sup>E</sup>	GP	Poorly graded gravel F
		Gravels with Fines:	Fines classify as ML or MH	GM	Silty gravel F,G,H
		More than 12% fines <sup>c</sup>	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 ≥ 6 and 1 ≤ Cc ≤ 3 <sup>E</sup>	SW	Well-graded sand I
			Cu < 6 and/or 1 > Cc > 3 <sup>E</sup>	SP	Poorly graded sand I
		Sands with Fines: More than 12% fines D	Fines classify as ML or MH	SM	Silty sand <sup>G,H,I</sup>
			Fines classify as CL or CH	sc	Clayey sand <sup>G,H,I</sup>
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 <sup>K,L,M</sup>
			PI < 4 or plots below "A" line J	ML	Silt K,L,M
		Organic:	Liquid limit - oven dried	OL	Organic clay K,L,M,N
			Liquid limit - not dried		Organic silt K,L,M,O
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line	СН	Fat clay <sup>K,L,M</sup>
			PI plots below "A" line	МН	Elastic Silt K,L,M
		Organic:	Liquid limit - oven dried	ОН	Organic clay K,L,M,P
			Liquid limit - not dried < 0.75		Organic silt <sup>K,L,M,Q</sup>
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

<sup>&</sup>lt;sup>A</sup> Based on the material passing the 3-inch (75-mm) sieve

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

<sup>&</sup>lt;sup>Q</sup> PI plots below "A" line.





<sup>&</sup>lt;sup>B</sup> If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

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.
 Sands with 5 to 12% fines require dual symbols: SW-SM well-graded

<sup>&</sup>lt;sup>D</sup> 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

 $<sup>^{\</sup>text{F}}$  If soil contains  $\geq$  15% sand, add "with sand" to group name.

 $<sup>^{\</sup>rm G}$  If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

<sup>&</sup>lt;sup>H</sup> If fines are organic, add "with organic fines" to group name.

<sup>&</sup>lt;sup>1</sup> If soil contains ≥ 15% gravel, add "with gravel" to group name.

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

<sup>&</sup>lt;sup>K</sup> If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

 $<sup>^{\</sup>text{L}}$  If soil contains  $\geq$  30% plus No. 200 predominantly sand, add "sandy" to group name.

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

<sup>&</sup>lt;sup>N</sup> PI ≥ 4 and plots on or above "A" line.

 $<sup>^{\</sup>rm O}$  PI < 4 or plots below "A" line.

P PI plots on or above "A" line.