Geotechnical Engineering Report

Proposed Bridge Replacement
Newburg, North Dakota
September 4, 2013
MTL/Terracon Project No. M6135004

Prepared for:
Wold Engineering
Bismarck, North Dakota

Prepared by:
Midwest Testing Laboratory
Grand Forks, North Dakota

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

September 4, 2013

Wold Engineering
316 Eastdale Drive
Bismarck, ND 58502

Attn: Mr. Michael Rivinius
E: Michael@woldengr.com

Re: Geotechnical Engineering Report
Proposed Bridge Replacement
Newburg, North Dakota
MTL/Terracon Project Number: M6135004

Dear Mr. Rivinius:

Midwest Testing Laboratory (A Terracon Company) has completed the geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number PM6130044 dated July 24, 2013. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of the proposed bridge foundations.

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,
Midwest Testing Laboratory, A Terracon Company

William R. Olson, PE
Geotechnical Engineer

Loel M. Fetting, PE
Senior Associate

Enclosures
cc: 2 – Client
1 – File

REGISTERED PROFESSIONAL ENGINEER
WILLIAM R. OLSON
PE-5549
DATE 9/4/2013
NORTH DAKOTA

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EXECUTIVE SUMMARY

Geotechnical engineering services have been completed for the proposed bridge replacement near Newburg, North Dakota. Two soil test borings were drilled to a depth of approximately 100 feet below existing grade.

Based on the information obtained from our subsurface exploration, the site can be developed for the proposed project. The following geotechnical considerations were identified:

- Relatively weak clays were encountered in the upper portion of our borings. These weak clays are subject to slope instability. The potential for slope instability will be a concern for the proposed bridge replacement.

- In our opinion, supporting the proposed bridge on a foundation system consisting of driven steel pile is feasible. The pile can obtain capacity in the hard till soils encountered below a depth of 70 to 75 feet.

- Close monitoring of the construction operations discussed herein will be critical in achieving the design subgrade support. We therefore recommend that MTL/Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

GEOTECHNICAL ENGINEERING REPORT
PROPOSED BRIDGE REPLACEMENT
NEWBURG, NORTH DAKOTA

MTL/Terracon Project No. M6135004
September 4, 2013

1.0 INTRODUCTION

Geotechnical engineering services have been completed for the proposed bridge replacement near Newburg, North Dakota. Two soil test borings were drilled to a depth of approximately 100 feet below existing grade. Logs of the borings along with a site location map, and boring location plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- subsurface soil conditions
- groundwater conditions
- pile foundation design and construction
- slope stability

2.0 PROJECT INFORMATION

2.1 Project Description

Item	Description
Site layout	See Appendix A, Exhibit A-2: Boring Location Plan
Structures	The new bridge will be constructed along the same alignment and will have three spans with an overall length of 185 feet. We understand that 2:1 (H:V) slopes are proposed below the bridge abutments.
Bridge construction	Precast concrete
Proposed deck elevation	1426
Maximum loads	We assume maximum factored pile loads will be on the order of 130 to 180 tons per pile.
Grading	We estimate grade changes on the order of two feet adjacent to the bridge.

2.2 Site Location and Description

Item	Description
Location	See Appendix A, Exhibit A-1: Site Location Map

Item	Description
Existing improvements	Existing bridge
Current ground cover	Aggregate surfaced roadway
Existing topography	Relatively level

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	1	Existing fill consisting mainly of sandy lean clay and clayey sand	N/A
2	14	Fat clay of a dark grayish brown and dark olive brown coloration, containing some shell fragments (may be fill)	Soft to medium stiff
3	19 - 24	Lean clay – dark grayish brown	Medium stiff
4	24 – 29	Fat clay – dark grayish brown	Medium stiff
5	49 - 64	Sand – olive brown and dark grayish brown containing varying amounts of silt and gravel	Loose
6	54 – 64	Fat clay – dark brown	Stiff
7	70 – 79	Sand and gravel	Medium dense
8	Undetermined[3]	Till soils consisting of sandy lean clay and sandy fat clay containing variable amounts of gravel and occasional cobbles/boulders	Hard

1. Borings were terminated in this stratum at a depth of 100 feet.

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 and after completion for the presence and level of groundwater. Groundwater was not observed in the borings while drilling. The borings were then sealed with bentonite grout upon completion. We would expect the groundwater level to be located at or somewhat above the water level in the channel at the time of our field activities.

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 structure 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 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of the subsurface exploration, supporting the proposed bridge on a deep foundation system consisting of driven steel piling is feasible at this site. The pile should obtain capacity in the hard soils first encountered below a depth of 70 to 75 feet.

The relatively weak clays encountered in the upper portion of the borings are subject to slope instability. The potential for slope instability will be a concern for the project and is discussed in Section 4.3 of this report.

4.2 Pile Foundations

In our opinion, the proposed bridge can be supported by a deep foundation system consisting of driven piling obtaining bearing in the hard till soils encountered below a depth of 70 to 75 feet. We estimate pile will obtain capacity upon driving to depths of approximately 90 to 95 feet. This corresponds to tip elevations ranging from 1329 to 1334.

Two pile sections were analyzed (HP 12 X 53 and HP 14x73). A bearing capacity graph was developed for each pile section. The graphs have been included in Appendix C of this report. The capacities presented on the graph are ultimate capacities and should be reduced by a factor, Φ. A Φ value of 0.4 should be used for pile evaluated using a conservative energy formula. For piles driven into a dense soil stratum, such as found at this site, the nominal pile resistance should be limited to the structural capacity of the pile section selected.

If the pile does not obtain the desired final driving resistance by 95 feet, we recommend restriking the pile after 24 hours. It is likely that soil setup will occur and the capacity will be obtained.

The pile capacities presented on the attached graphs are estimates based on the standard penetration resistance values and laboratory test results. We would expect the pile to obtain capacity above the depths indicated on the attached graphs. Actual pile lengths should be based upon the final driving resistance. We recommend using a conservative energy formula to determine when each pile has obtained the desired working load. We recommend full time monitoring of the pile driving operation to determine that each pile was driven to the desired working capacity. Another option would be to use a Pile Driving Analyzer to obtain information on estimated pile capacity and hammer performance.

Since the soils encountered at the site would be expected to contain cobbles and boulders, we recommend H pile be equipped with a rock tip.

4.3 Slope Stability

To evaluate the slope stability of the proposed channel slopes below the bridge, SLIDE 6.0 software developed by Rocscience was used. The analysis was conducted to provide limiting equilibrium solutions for a factor of safety completed by the GLE Morganstern-Price method. In this analysis method, a factor of safety is computed by comparing available shear strength along a prospective failure surface to the strength required to maintain stability. When the two strengths are equal, failure impends, and the factor of safety (FS) approaches a value of 1.0. Generally, a factor of safety on the order of 1 ¼ to 1 ½ is recommended for slopes beneath a bridge.

Soil parameters used in our analysis were based upon our laboratory testing program, past experience with similar soils and published data. The slope stability analysis was run using fully softened soil strength parameters. Our analysis was based on a bottom of channel elevation of 1408, a deck elevation of 1426 and abutment height of approximately 6 feet.

Our analysis indicates a factor of safety of approximately 1.0 at the west abutment and 0.8 at the east abutment for the proposed 2:1 (H:V) slopes, indicating a failure would likely occur. To increase the factor of safety to 1 ¼, our analysis indicates a 4:1 slope would be needed at the west abutment and a 5:1 slope would be needed at the east abutment. The results of our analysis are included in Appendix C of this report. If an increased factor of safety is desired, the slopes could be flattened.

5.0 GENERAL COMMENTS

MTL/Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. MTL/Terracon also should be retained to

provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, 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 further evaluation and supplemental recommendations can be provided.

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 report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless MTL/Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

Project Manager: wro	Project No. M6135004	Midwest Testing LABORATORY, INC. A Terracon COMPANY	SITE LOCATION MAP
Drawn by: RAB	Scale: NTS	1555 N 42nd Street- Unit B, Grand Forks, North Dakota 58201	PROPOSED BRIDGE REPLACEMENT NEWBURG, NORTH DAKOTA
Checked by: wro	File Name:	PH. (701)772 2832 FAX. (701) 772 2633	Exhibit A-1
Approved by: wro	Date: 8/29/2013		

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

Project Manager: wro	Project No. M6135004	Midwest Testing LABORATORY, INC. A Terracon COMPANY	BORING LOCATION PLAN
Drawn by: rab	Scale: 1" = 40'	1555 N 42nd Street- Unit B, Grand Forks, North Dakota 58201	PROPOSED BRIDGE REPLACEMENT NEWBURG, NORTH DAKOTA
Checked by: wro	File Name:	PH. (701)772 2832 FAX. (701) 772 2633	Exhibit A-2
Approved by:	Date: 8/29/2013		

Field Exploration Description

Two soil test borings were completed on August 8 and 9, 2013. The borings were advanced at the approximate locations indicated on Exhibit A-2. The boring locations were laid out in the field by a MTL/Terracon representative using hand held GPS equipment. The elevations are referenced to the deck of the existing bridge as indicated on Exhibit A-2, and are rounded to the nearest ½ foot. We understand the approximate existing bridge deck elevation is 1424. The locations and elevation 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 4 ¼ hollow stem augers and mud rotary techniques to advance the boreholes. Samples of the soil encountered in the borings were obtained using split barrel sampling procedures. In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

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.

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

BORING LOG NO. B-1

PROJECT: Proposed Bridge Replacement

CLIENT: Wold Engineering
Bismarck, North Dakota

SITE: Newburg, North Dakota

LOCATION See Exhibit A-2

Approximate Surface Elev: 1424 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
2.0	1422+/-	**FILL - SANDY LEAN CLAY WITH GRAVEL**, olive brown			0.3	5-4-3 N=7						
4.0	1420+/-	**FILL - SANDY LEAN CLAY**, dark olive brown			0.5	1-2-3 N=5			15			
		FAT CLAY (CH), dark grayish brown, medium stiff to stiff, with some shell fragments (may be fill)	5		1	1-2-3 N=5	2000 (HP)		44			
					1.2	2-2-4 N=6	2500 (HP)		43	73	65-31-34	
			10		1.2	2-4-6 N=10			37			
14.0	1410+/-				1.2	2-3-3 N=6	2000 (HP)		34			
		LEAN CLAY WITH SAND (CL), dark grayish brown, medium stiff to stiff	15		1.3	2-2-3 N=5		1380	28	93	45-17-28	83
24.0	1400+/-		20		1.3	3-4-5 N=9	2000 (HP)		28			
		FAT CLAY (CH), dark grayish brown, stiff	25		1.3	3-2-6 N=8			47			
29.0	1395+/-											
		SANDY SILT (ML), grayish brown, medium dense	30		1.3	5-8-14 N=22			29			
34.0	1390+/-											
		POORLY GRADED SAND (SP), dark gray, loose, fine grained	35		1.3	5-3-6 N=9						
			40		1.2	3-3-5 N=8						5
44.0	1380+/-											
		SANDY SILT (ML), dark grayish brown, loose	45		1.3	5-4-4 N=8			32			
49.0	1375+/-											
		LEAN CLAY (CL), grayish brown, medium stiff	50		1.2	2-2-4 N=6			33	87	49-20-29	

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

Hammer Type: Automatic

Advancement Method:
4 ¼" Hollow Stem Auger to 14.5', Mud Rotary to 99.5'

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

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

Notes:

WATER LEVEL OBSERVATIONS

Influenced by drilling fluids

Midwest Testing LABORATORY, INC.
A Terracon COMPANY
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 8/8/2013 | Boring Completed: 8/8/2013
Drill Rig: Diedrich D90 | Driller: DAR
Project No.: M6135004 | Exhibit: A-4

BORING LOG NO. B-1

PROJECT: Proposed Bridge Replacement

CLIENT: Wold Engineering
Bismarck, North Dakota

SITE: Newburg, North Dakota

LOCATION See Exhibit A-2

Approximate Surface Elev: 1424 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
54.0	1370+/-								
LEAN CLAY (CL), grayish brown, medium stiff *(continued)*									
		55	X	1.2	2-4-4 N=8	37			
FAT CLAY (CH), grayish brown, stiff									
		60	X	1.5	3-5-5 N=10	36			
64.0	1360+/-								
POORLY GRADED GRAVEL WITH SAND (GP), grayish brown, medium dense		65	X	0.8	3-5-11 N=16				
69.0	1355+/-								
70.0	1354+/-	70	X	1.2	5-6-11 N=17				
POORLY GRADED SAND (SP), brown, medium grained									
SANDY LEAN CLAY (CL), olive brown, very stiff to hard		75	X	1.2	11-24-34 N=58	17	117		
						10720			
79.0	1345+/-								
SANDY FAT CLAY (CH), dark grayish brown, hard		80	X	1.3	16-22-28 N=50				
		85	X	1.5	19-21-27 N=48	25	102	87-21-66	
						12730			
		90	X	1.5	11-22-28 N=50				
		95	X	1.5	16-27-45 N=72	24	99		
						5040			
101.0	1323+/-	100	X	1.5	11-24-29 N=53				
Boring Terminated at 101 Feet									

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

Hammer Type: Automatic

Advancement Method:
4 ¼" Hollow Stem Auger to 14.5', Mud Rotary to 99.5'

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

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

Notes:

WATER LEVEL OBSERVATIONS

Influenced by drilling fluids

Midwest Testing LABORATORY, INC.
A Terracon COMPANY
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 8/8/2013 | Boring Completed: 8/8/2013
Drill Rig: Diedrich D90 | Driller: DAR
Project No.: M6135004 | Exhibit: A-4

BORING LOG NO. B-2

PROJECT: Proposed Bridge Replacement

CLIENT: Wold Engineering
Bismarck, North Dakota

SITE: Newburg, North Dakota

LOCATION See Exhibit A-2

Approximate Surface Elev: 1424 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (Ft.)	FIELD TEST RESULTS	LABORATORY TORVANE/HP (psf)	UNCONFINED COMPRESSIVE STRENGTH (psf)	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.0											
	FILL - SANDY LEAN CLAY WITH GRAVEL, brown			0.5	6-5-5 N=10						
2.0	1422+/-										
	FILL - CLAYEY SAND, brown, with a trace of gravel			1.2	1-1-2 N=3			33			
4.0	1420+/-										
	FAT CLAY (CH), dark olive brown, soft to medium stiff, with some shell fragments (may be fill)	5		1.1	1-1-2 N=3			36	81	83-34-49	
				1.3	1-3-3 N=6			40			
		10		1.1	2-2-3 N=5			46			
				1.5	1-2-4 N=6	2000 (HP)		50			
14.0	1410+/-										
	LEAN CLAY (CL), dark grayish brown, medium stiff	15		1.8	1-2-4 N=6		1070	27	95	39-16-23	
19.0	1405+/-										
	FAT CLAY (CH), dark grayish brown, medium stiff	20		1.4	1-2-3 N=5		1820	45	78	101-28-73	99
24.0	1400+/-										
	SILTY SAND (SM), grayish brown, loose, fine grained	25		1.5	3-4-3 N=7			26			
		30		1.3	4-5-4 N=9			31			
		35		1.1	3-4-3 N=7			30		NP	16
		40		1.5	3-3-4 N=7			28			
44.0	1380+/-										
	SANDY SILT (ML), olive brown, medium dense	45		1.6	5-5-5 N=10			25			
49.0	1375+/-										
	FAT CLAY (CH), dark olive brown, medium stiff	50		1.7	3-3-4 N=7		2370	38	84		

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

Hammer Type: Automatic

Advancement Method:
4 ¼" Hollow Stem Auger to 14.5', Mud Rotary to 99.5'

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

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

Notes:

WATER LEVEL OBSERVATIONS

Influenced by drilling fluids

Midwest Testing LABORATORY, INC.
A Terracon COMPANY
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 8/9/2013 | Boring Completed: 8/9/2013
Drill Rig: Diedrich D90 | Driller: DAR
Project No.: M6135004 | Exhibit: A-5

BORING LOG NO. B-2

PROJECT: Proposed Bridge Replacement

CLIENT: Wold Engineering
Bismarck, North Dakota

SITE: Newburg, North Dakota

LOCATION See Exhibit A-2

Approximate Surface Elev: 1424 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	RECOVERY (Ft.)	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
54.0	1370+/-							
FAT CLAY (CH), dark olive brown, medium stiff *(continued)*								
		55	0	2-2-3				
POORLY GRADED GRAVEL WITH CLAY AND SAND (GP-GC), olive brown, loose								
		60	0.3	1-2-3 N=5				
64.0	1360+/-							
POORLY GRADED SAND WITH GRAVEL (SP), brown, loose, medium to coarse grained		65	0.7	7-4-5 N=9				
69.0	1355+/-							
70.0 **POORLY GRADED GRAVEL (GP)**, brown	1354+/-	70	0.7	2-9-29 N=38				
POORLY GRADED SAND WITH CLAY (SP-SC), olive brown, dense								
74.0	1350+/-							
SILTY SAND (SM), dark gray, very dense, fine grained		75	1.2	22-35-30 N=65	16			
79.0	1345+/-							
SANDY LEAN CLAY (CL), very dark grayish brown, hard		80	1.3	12-15-26 N=41	17	117		
		85	1.6	30-82-55 N=137	9			
		90	1.4	38-46-72 N=118	16			
94.0	1330+/-							
SANDY FAT CLAY (CH), dark grayish brown, hard		95	1.5	17-37-42 N=79	21	105	82-18-64	69
		100	2	19-36-55 N=91	22			
101.0	1323+/-							
Boring Terminated at 101 Feet								

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

Hammer Type: Automatic

Advancement Method:
4 ¼" Hollow Stem Auger to 14.5', Mud Rotary to 99.5'

Abandonment Method:
Borings backfilled with cement-bentonite grout upon completion.

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

Notes:

WATER LEVEL OBSERVATIONS

Influenced by drilling fluids

Midwest Testing LABORATORY, INC.
A Terracon COMPANY
1555 N. 42nd St., Unit B
Grand Forks, North Dakota

Boring Started: 8/9/2013 | Boring Completed: 8/9/2013
Drill Rig: Diedrich D90 | Driller: DAR
Project No.: M6135004 | Exhibit: A-5

APPENDIX B
SUPPORTING INFORMATION

Laboratory Testing

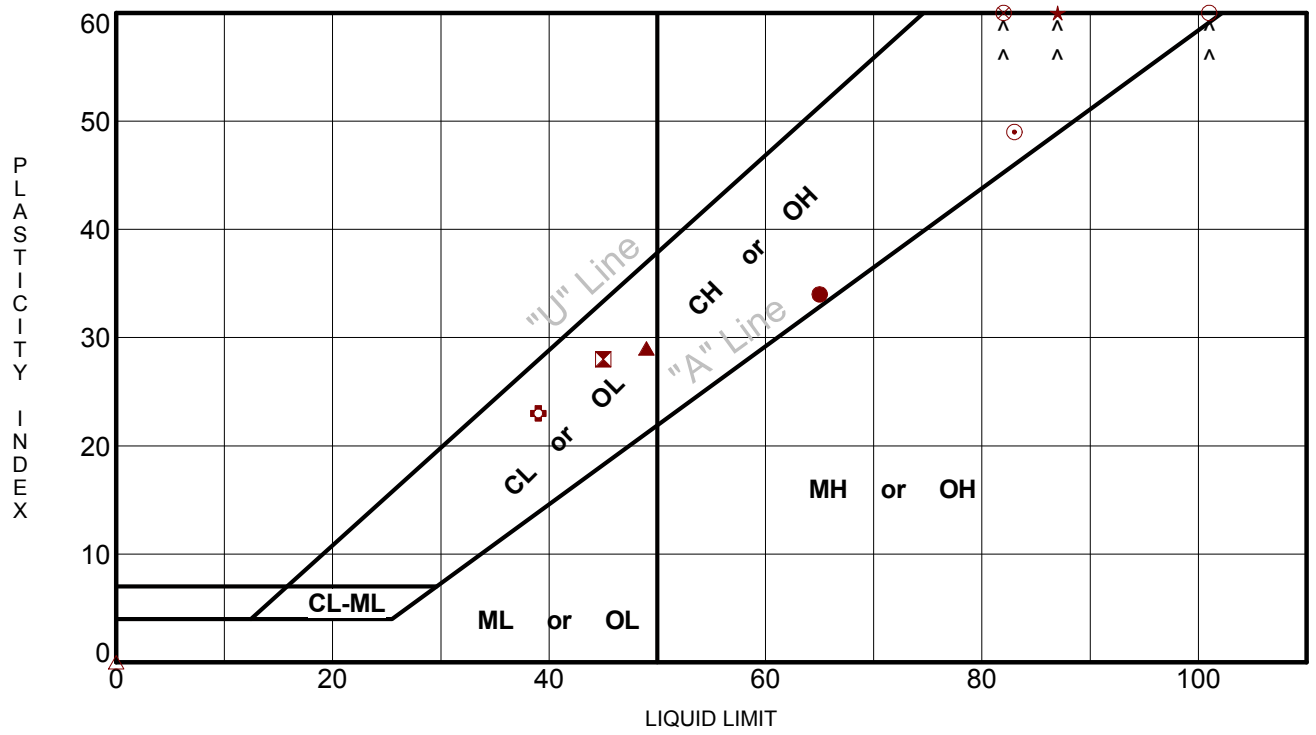
Representative samples were selected for laboratory analysis. The testing program consisted of determining moisture content, dry density, unconfined compressive strength, Atterberg limits, grain size distribution, and percent passing the number 200 sieve. The laboratory test results can be found on the boring logs, opposite the samples they represent or on the following laboratory data sheets.

The unconfined compressive strength tests were performed on split spoon samples. These results should be considered approximate since the samples are disturbed during driving.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the General Notes in Appendix D and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is included in Appendix D of this report. All classification was by visual manual procedures.

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
B-1	7.0	65	31	34		CH	FAT CLAY
B-1	14.5	45	17	28	83	CL	LEAN CLAY with SAND
B-1	49.5	49	20	29		CL	LEAN CLAY
B-1	84.5	87	21	66		CH	SANDY FAT CLAY
B-2	4.5	83	34	49		CH	FAT CLAY
B-2	14.5	39	16	23		CL	LEAN CLAY
B-2	19.5	101	28	73	99	CH	FAT CLAY
B-2	34.5	NP	NP	NP	16	SM	SILTY SAND
B-2	94.5	82	18	64	69	CH	SANDY FAT CLAY

PROJECT: Proposed Bridge Replacement

SITE: Newburg, North Dakota

Midwest Testing LABORATORY, INC. A Terracon COMPANY

1555 N. 42nd St., Unit B
Grand Forks, North Dakota

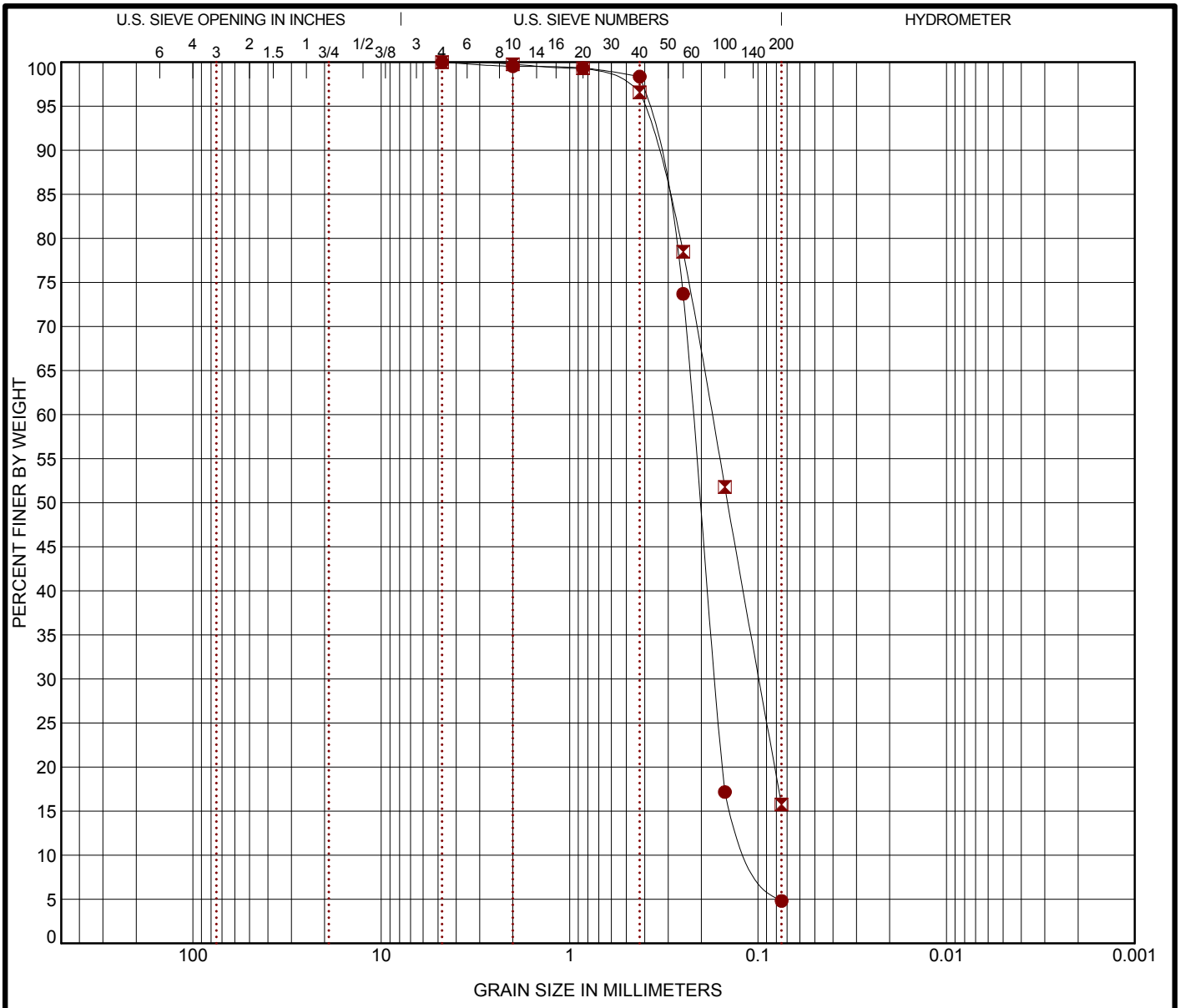
PROJECT NUMBER: M6135004

CLIENT: Wold Engineering
Bismarck, North Dakota

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	LL	PL	PI	Cc	Cu
● B-1	39.5	POORLY GRADED SAND(SP)				1.28	2.20
⊠ B-2	34.5	SILTY SAND(SM)	NP	NP	NP		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
● B-1	39.5	4.75	0.221	0.168	0.1	0.0	95.2	4.8	
⊠ B-2	34.5	4.75	0.176	0.099		0.0	84.2	15.8	

PROJECT: Proposed Bridge Replacement

SITE: Newburg, North Dakota

Midwest Testing Laboratory, Inc. A Terracon Company

1555 N. 42nd St., Unit B
Grand Forks, North Dakota

PROJECT NUMBER: M6135004

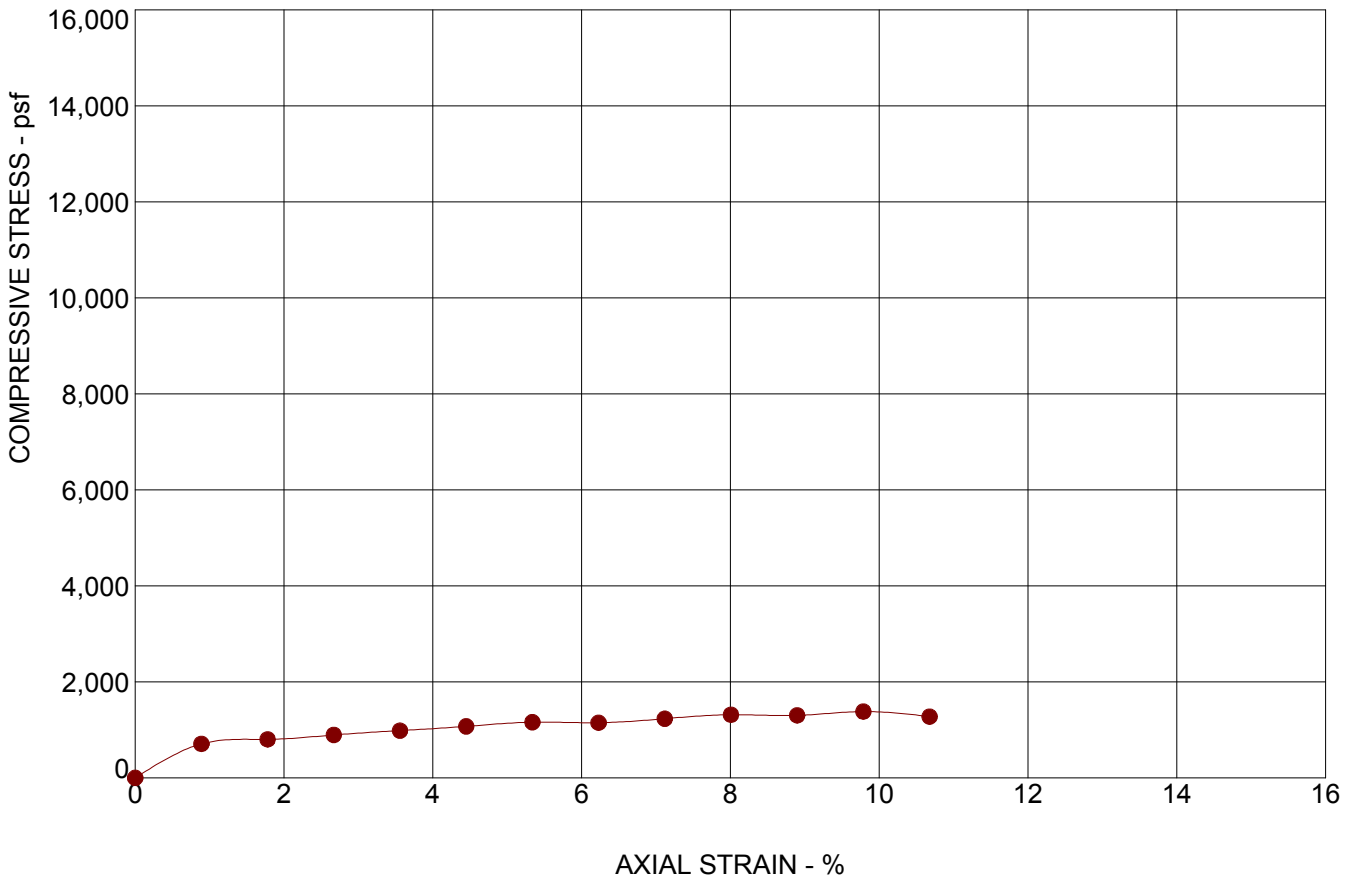
CLIENT: Wold Engineering
Bismarck, North Dakota

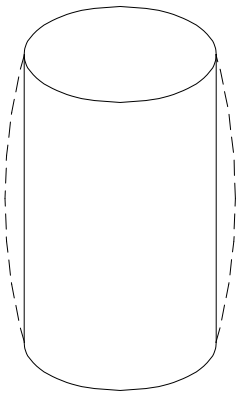
EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 M6135004.GPJ TERRACON2012.GDT 9/3/13

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	28.4
	Dry Density:	pcf	93.2
	Diameter:	in.	1.34
	Height:	in.	2.81
	Height / Diameter Ratio:		2.10
	Calculated Saturation:	%	96.98
	Calculated Void Ratio:		0.78
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	9.79
	Unconfined Compressive Strength	(psf)	1381
	Undrained Shear Strength:	(psf)	691
	Strain Rate:	in/min	0.0600
	Remarks:		

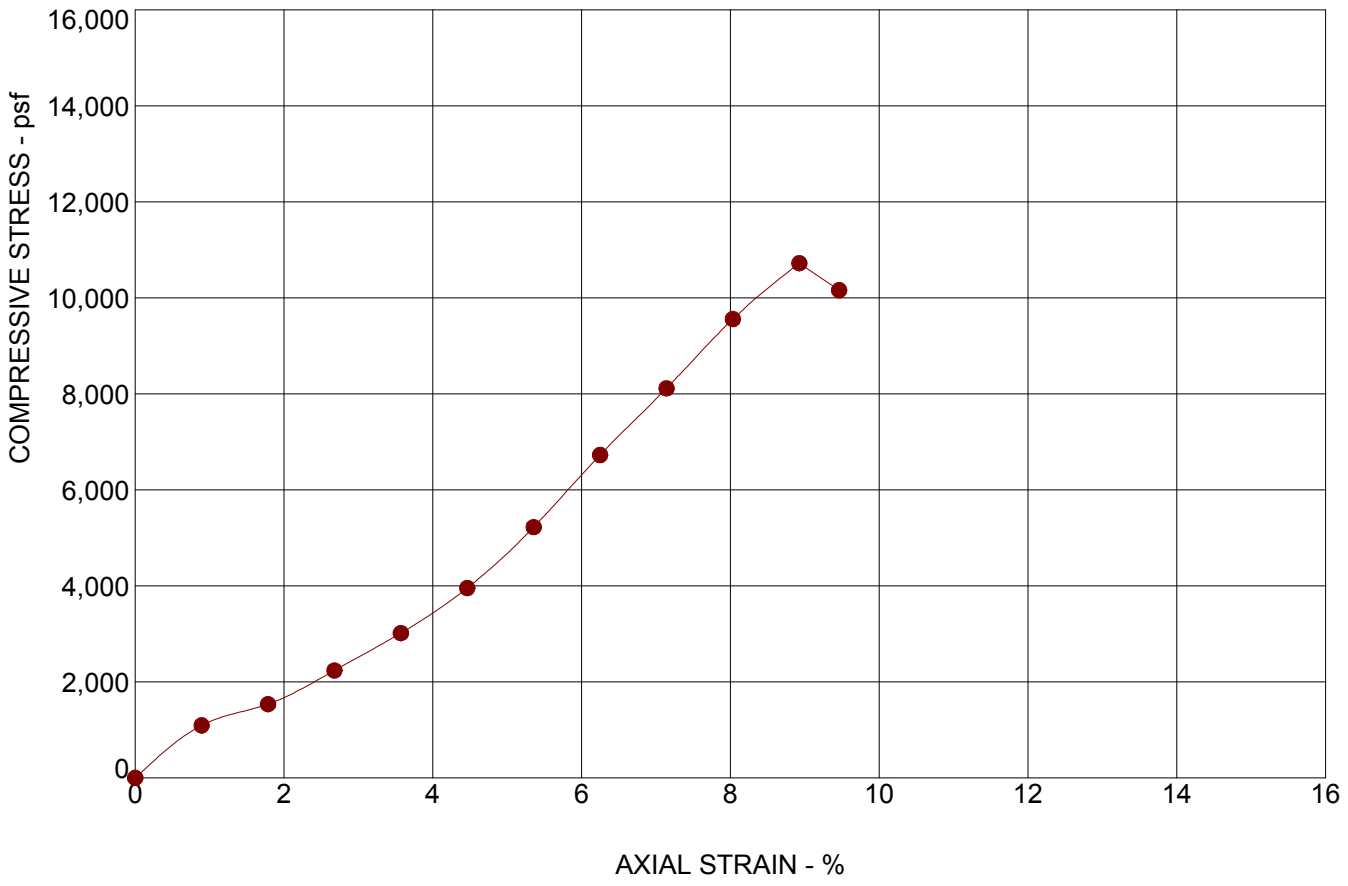
Failure Mode: Bulge (dashed)

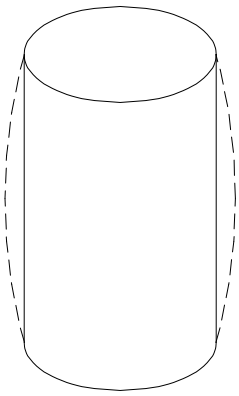
SAMPLE TYPE: SS	SAMPLE LOCATION: B-1 @ 14.5			
DESCRIPTION: LEAN CLAY with SAND(CL)	LL	PL	PI	Percent < #200 Sieve
	45	17	28	83

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-4

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	16.7
	Dry Density:	pcf	117.2
	Diameter:	in.	1.41
	Height:	in.	2.80
	Height / Diameter Ratio:		1.98
	Calculated Saturation:	%	107.53
	Calculated Void Ratio:		0.41
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	8.93
	Unconfined Compressive Strength	(psf)	10723
	Undrained Shear Strength:	(psf)	5362
	Strain Rate:	in/min	0.0600
	Remarks:		

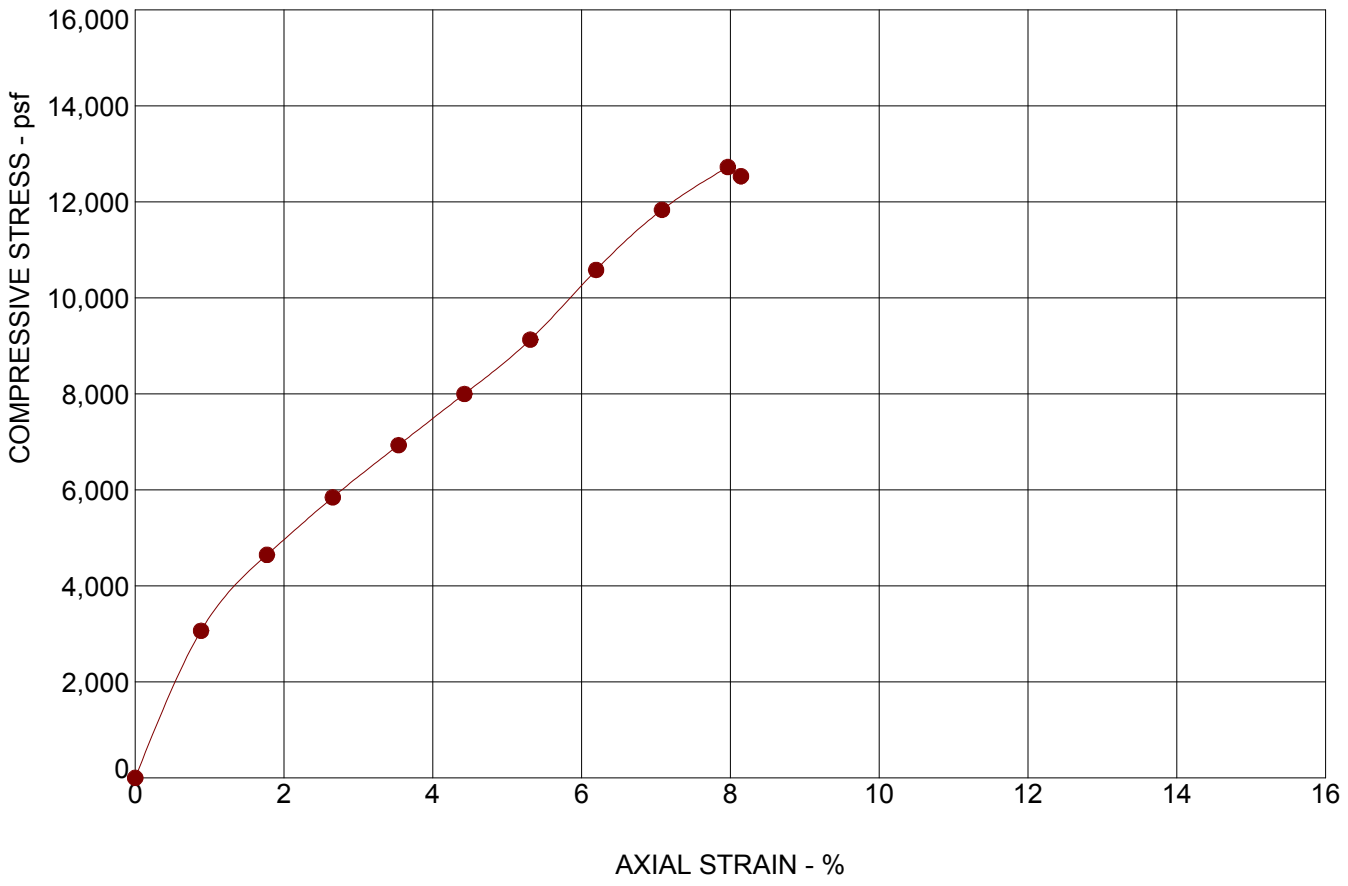
Failure Mode: Bulge (dashed)

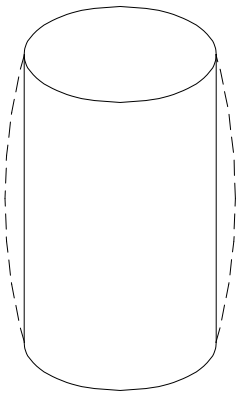
SAMPLE TYPE: SS	SAMPLE LOCATION: B-1 @ 74.5			
DESCRIPTION: SANDY LEAN CLAY	LL	PL	PI	Percent < #200 Sieve

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-5

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	24.8
	Dry Density:	pcf	101.9
	Diameter:	in.	1.42
	Height:	in.	2.82
	Height / Diameter Ratio:		1.99
	Calculated Saturation:	%	105.50
	Calculated Void Ratio:		0.62
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	7.97
	Unconfined Compressive Strength	(psf)	12726
	Undrained Shear Strength:	(psf)	6363
	Strain Rate:	in/min	0.0600
	Remarks:		

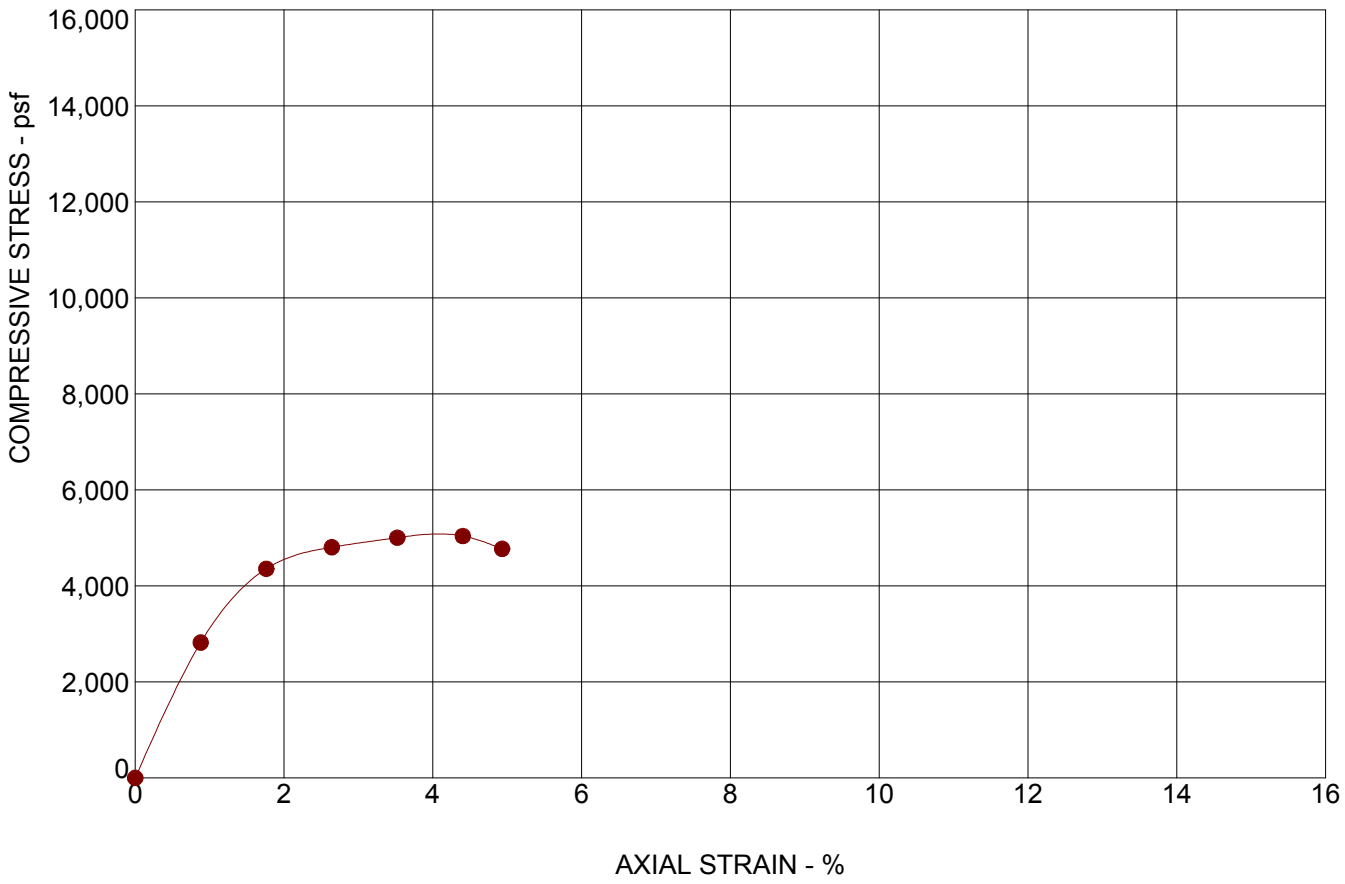
Failure Mode: Bulge (dashed)

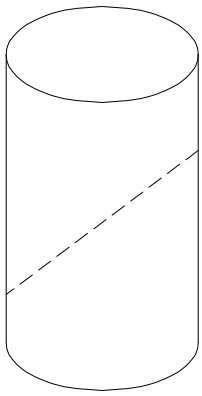
SAMPLE TYPE: SS	SAMPLE LOCATION: B-1 @ 84.5			
DESCRIPTION: SANDY FAT CLAY	LL	PL	PI	Percent < #200 Sieve
	87	21	66	

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-6

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	23.6
	Dry Density:	pcf	99.3
	Diameter:	in.	1.48
	Height:	in.	2.84
	Height / Diameter Ratio:		1.92
	Calculated Saturation:	%	93.92
	Calculated Void Ratio:		0.67
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	4.40
	Unconfined Compressive Strength	(psf)	5039
	Undrained Shear Strength:	(psf)	2520
	Strain Rate:	in/min	0.0600
	Remarks:		

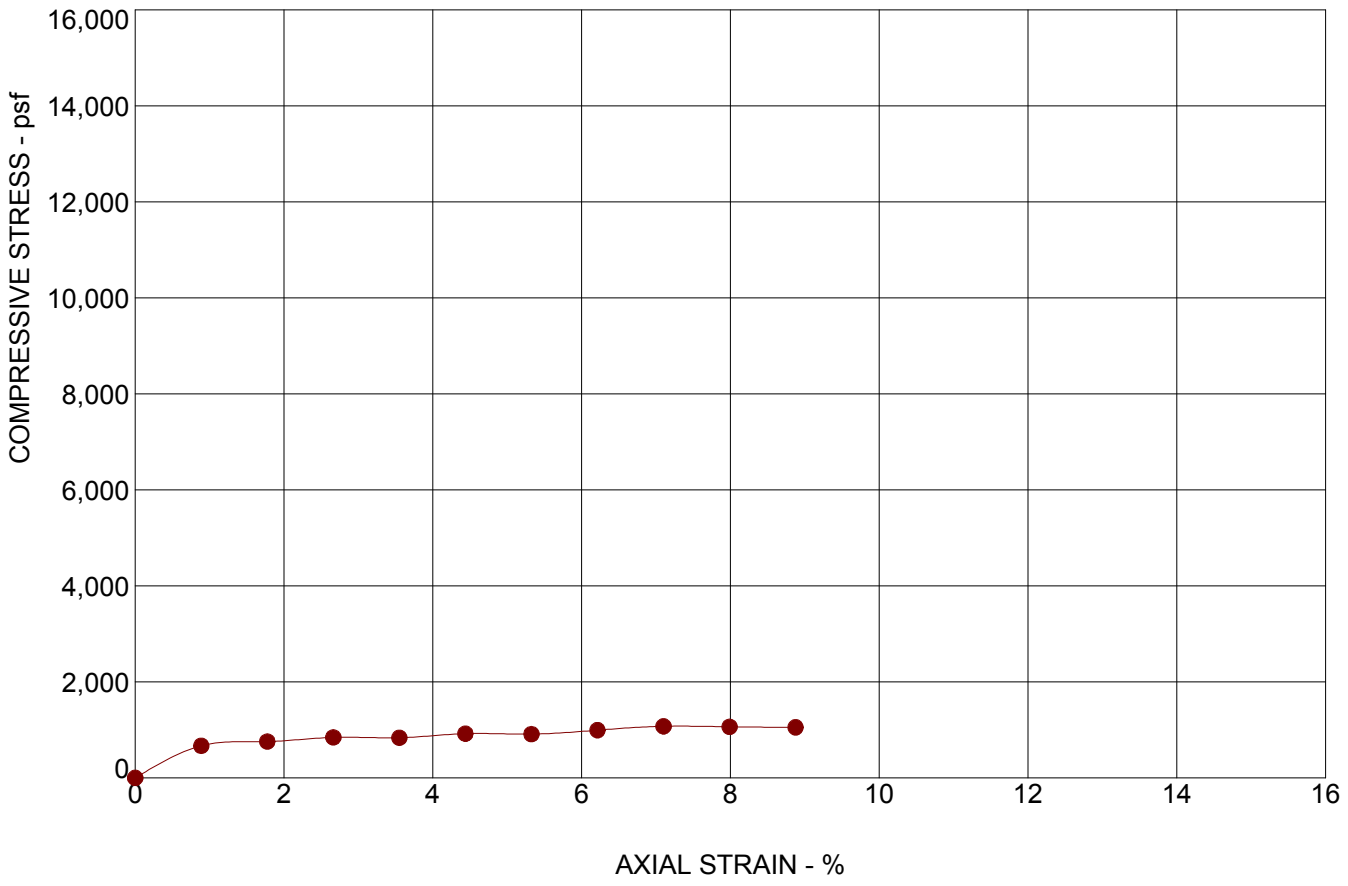
Failure Mode: Shear (dashed)

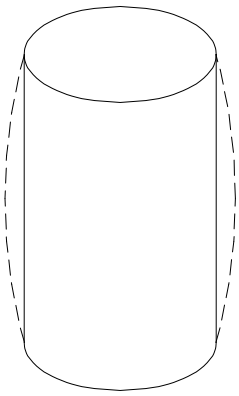
SAMPLE TYPE: SS	SAMPLE LOCATION: B-1 @ 94.5			
DESCRIPTION: SANDY FAT CLAY	LL	PL	PI	Percent < #200 Sieve

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-7

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	28.1
	Dry Density:	pcf	95.5
	Diameter:	in.	1.38
	Height:	in.	2.82
	Height / Diameter Ratio:		2.04
	Calculated Saturation:	%	97.78
	Calculated Void Ratio:		0.73
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	7.10
	Unconfined Compressive Strength	(psf)	1074
	Undrained Shear Strength:	(psf)	537
	Strain Rate:	in/min	0.0600
	Remarks:		

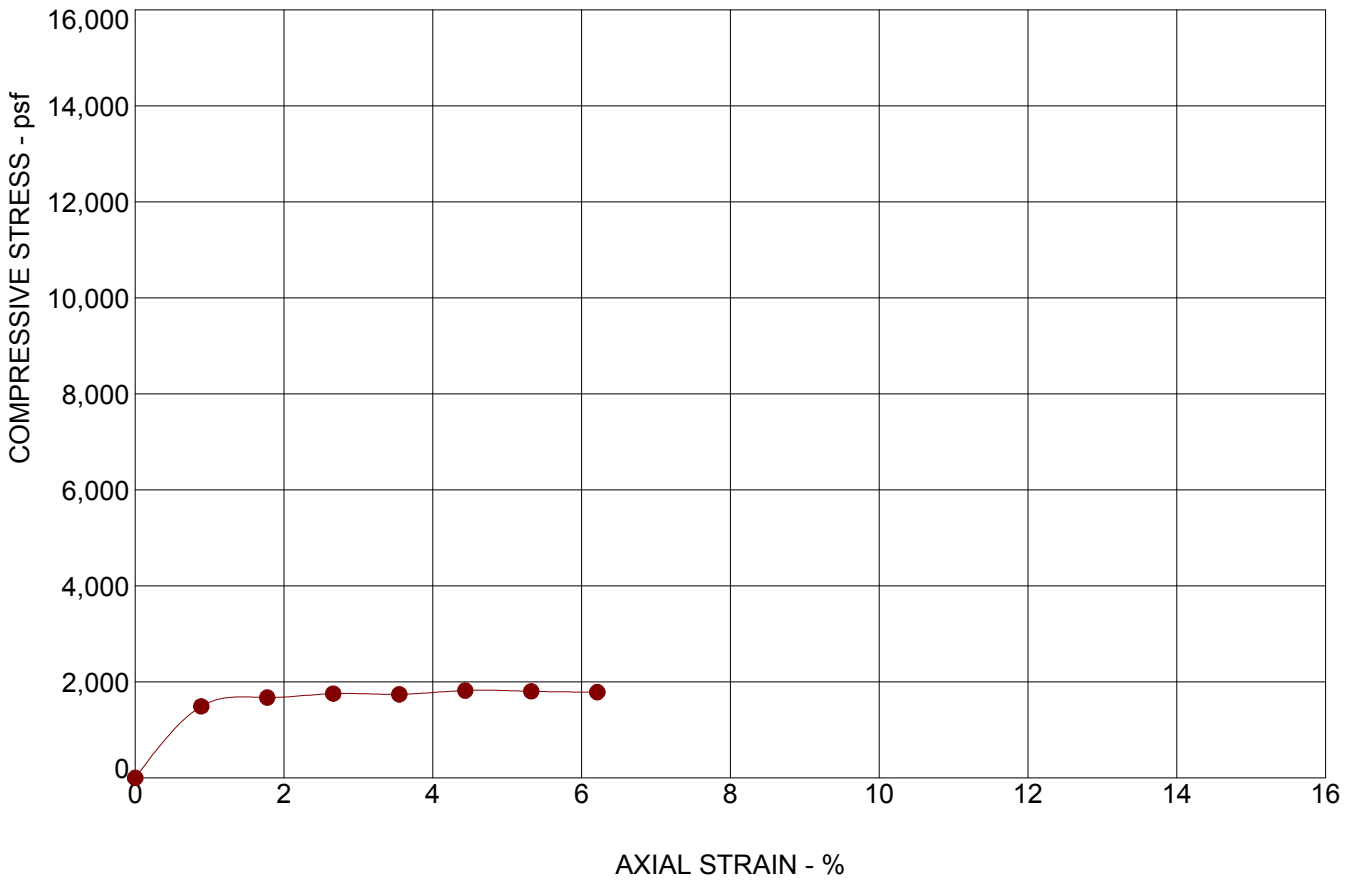
Failure Mode: Bulge (dashed)

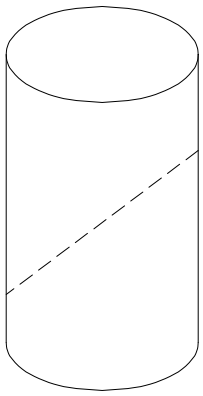
SAMPLE TYPE: SS	SAMPLE LOCATION: B-2 @ 14.5			
DESCRIPTION: LEAN CLAY	LL	PL	PI	Percent < #200 Sieve
	39	16	23	

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-8

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	44.5
	Dry Density:	pcf	77.6
	Diameter:	in.	1.35
	Height:	in.	2.82
	Height / Diameter Ratio:		2.08
	Calculated Saturation:	%	104.36
	Calculated Void Ratio:		1.13
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	4.44
	Unconfined Compressive Strength	(psf)	1820
	Undrained Shear Strength:	(psf)	910
	Strain Rate:	in/min	0.0600
	Remarks:		

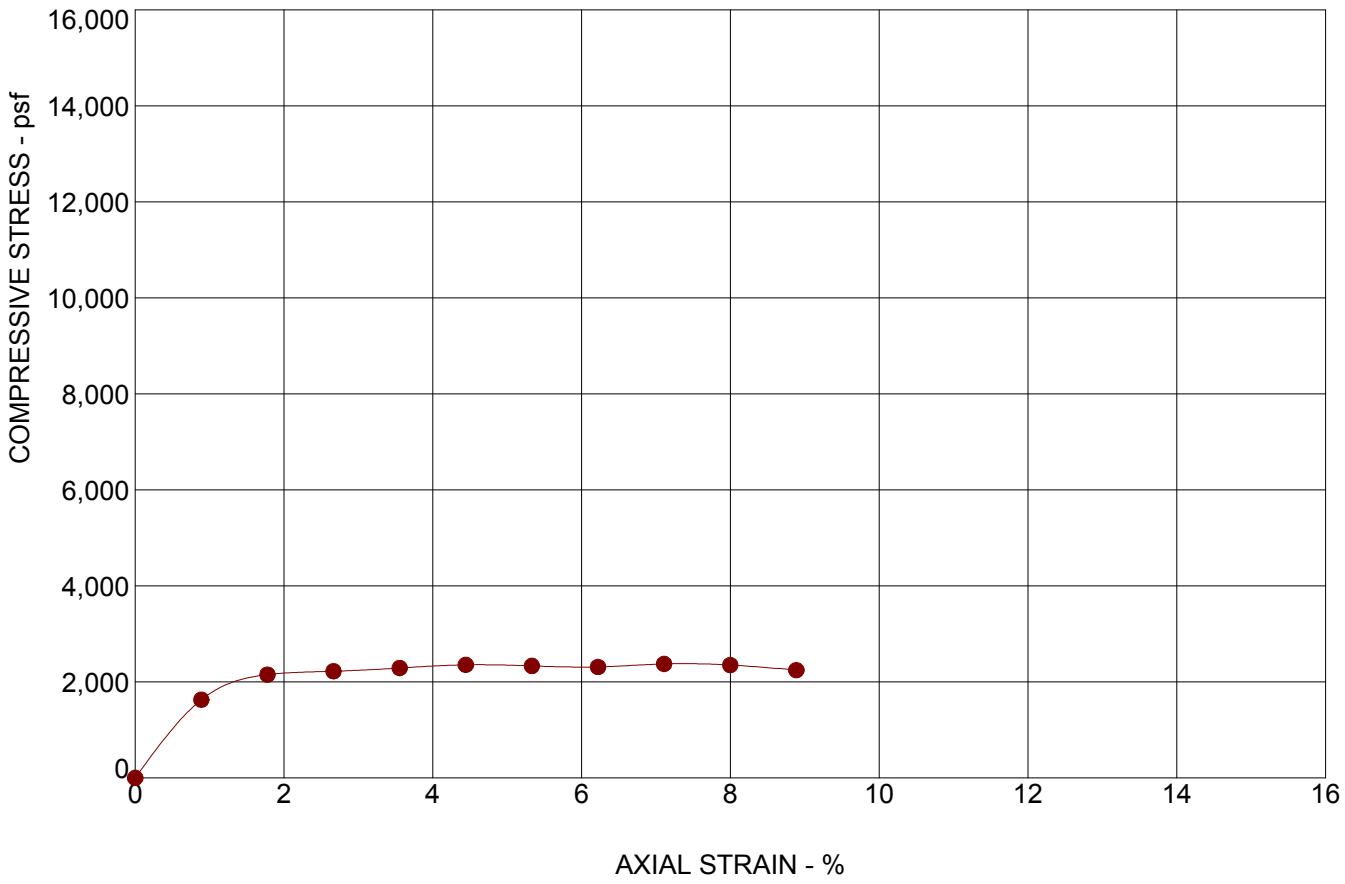
Failure Mode: Shear (dashed)

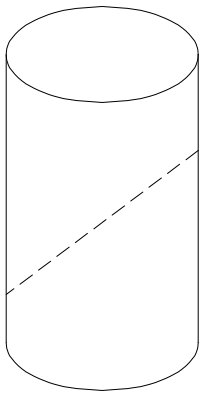
SAMPLE TYPE: SS	SAMPLE LOCATION: B-2 @ 19.5			
DESCRIPTION: FAT CLAY(CH)	LL	PL	PI	Percent < #200 Sieve
	101	28	73	99

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-9

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	35.0
	Dry Density:	pcf	84.2
	Diameter:	in.	1.42
	Height:	in.	2.81
	Height / Diameter Ratio:		1.99
	Calculated Saturation:	%	104.45
	Calculated Void Ratio:		0.97
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	7.11
	Unconfined Compressive Strength	(psf)	2374
	Undrained Shear Strength:	(psf)	1187
	Strain Rate:	in/min	0.0600
	Remarks:		

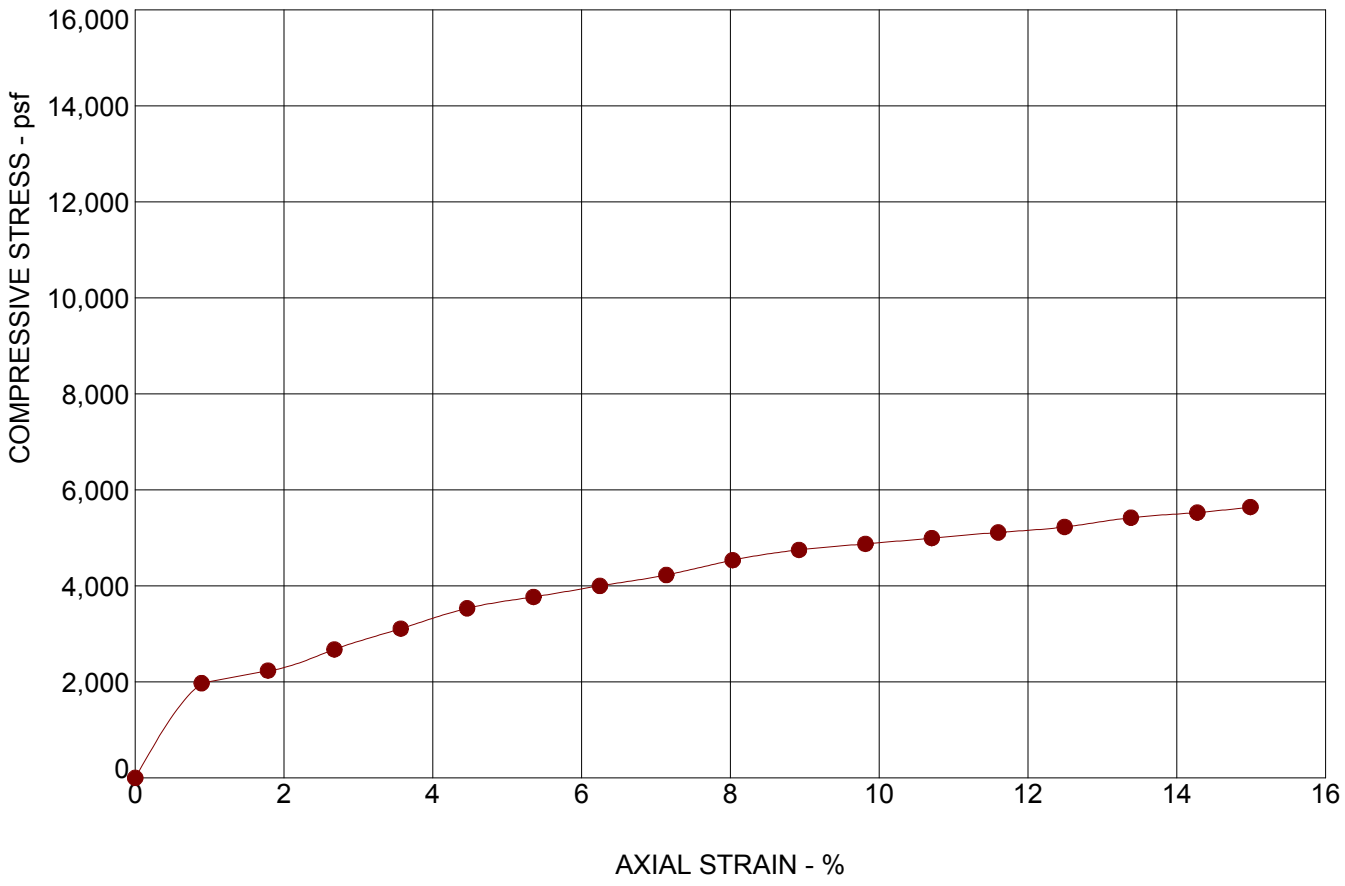
Failure Mode: Shear (dashed)

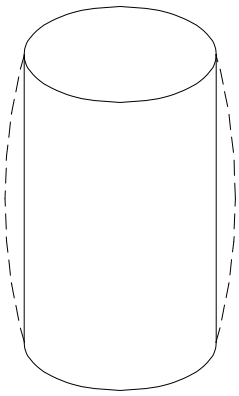
SAMPLE TYPE: SS	SAMPLE LOCATION: B-2 @ 49.5			
DESCRIPTION: FAT CLAY	LL	PL	PI	Percent < #200 Sieve

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-10

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	17.3
	Dry Density:	pcf	116.9
	Diameter:	in.	1.39
	Height:	in.	2.80
	Height / Diameter Ratio:		2.02
	Calculated Saturation:	%	106.41
	Calculated Void Ratio:		0.42
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	14.99
	Unconfined Compressive Strength	(psf)	5642
	Undrained Shear Strength:	(psf)	2821
	Strain Rate:	in/min	0.0600
	Remarks:		

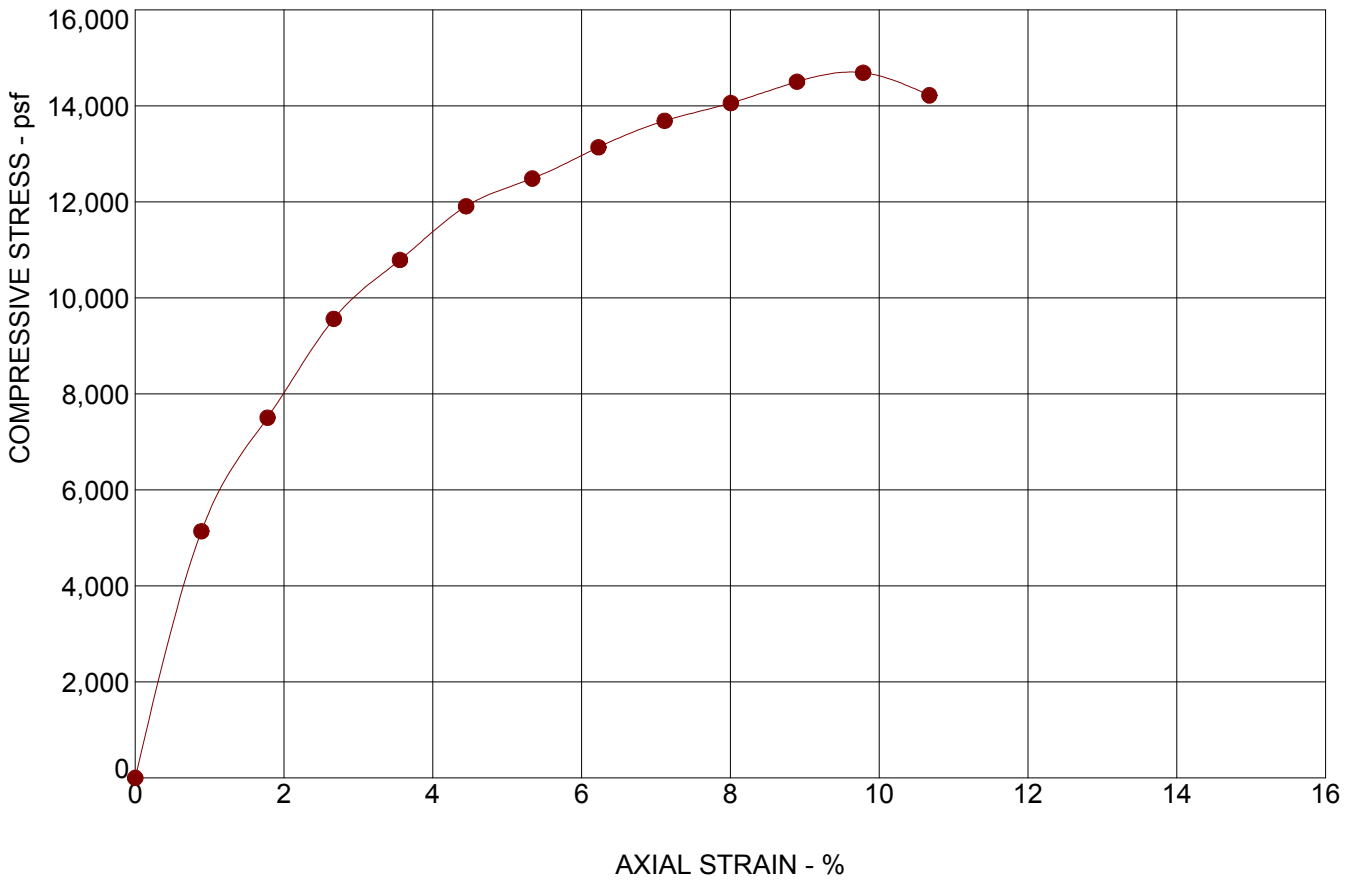
Failure Mode: Bulge (dashed)

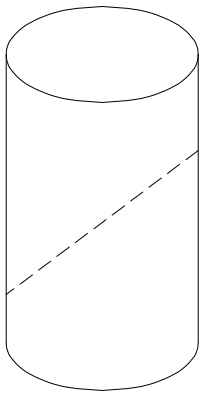
SAMPLE TYPE: SS	SAMPLE LOCATION: B-2 @ 79.5			
DESCRIPTION:	LL	PL	PI	Percent < #200 Sieve

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-11

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	20.8
	Dry Density:	pcf	105.4
	Diameter:	in.	1.42
	Height:	in.	2.81
	Height / Diameter Ratio:		1.98
	Calculated Saturation:	%	96.95
	Calculated Void Ratio:		0.57
	Assumed Specific Gravity:		2.65
	Failure Strain:	%	9.78
	Unconfined Compressive Strength	(psf)	14690
	Undrained Shear Strength:	(psf)	7345
	Strain Rate:	in/min	0.0600
	Remarks:		

Failure Mode: Shear (dashed)

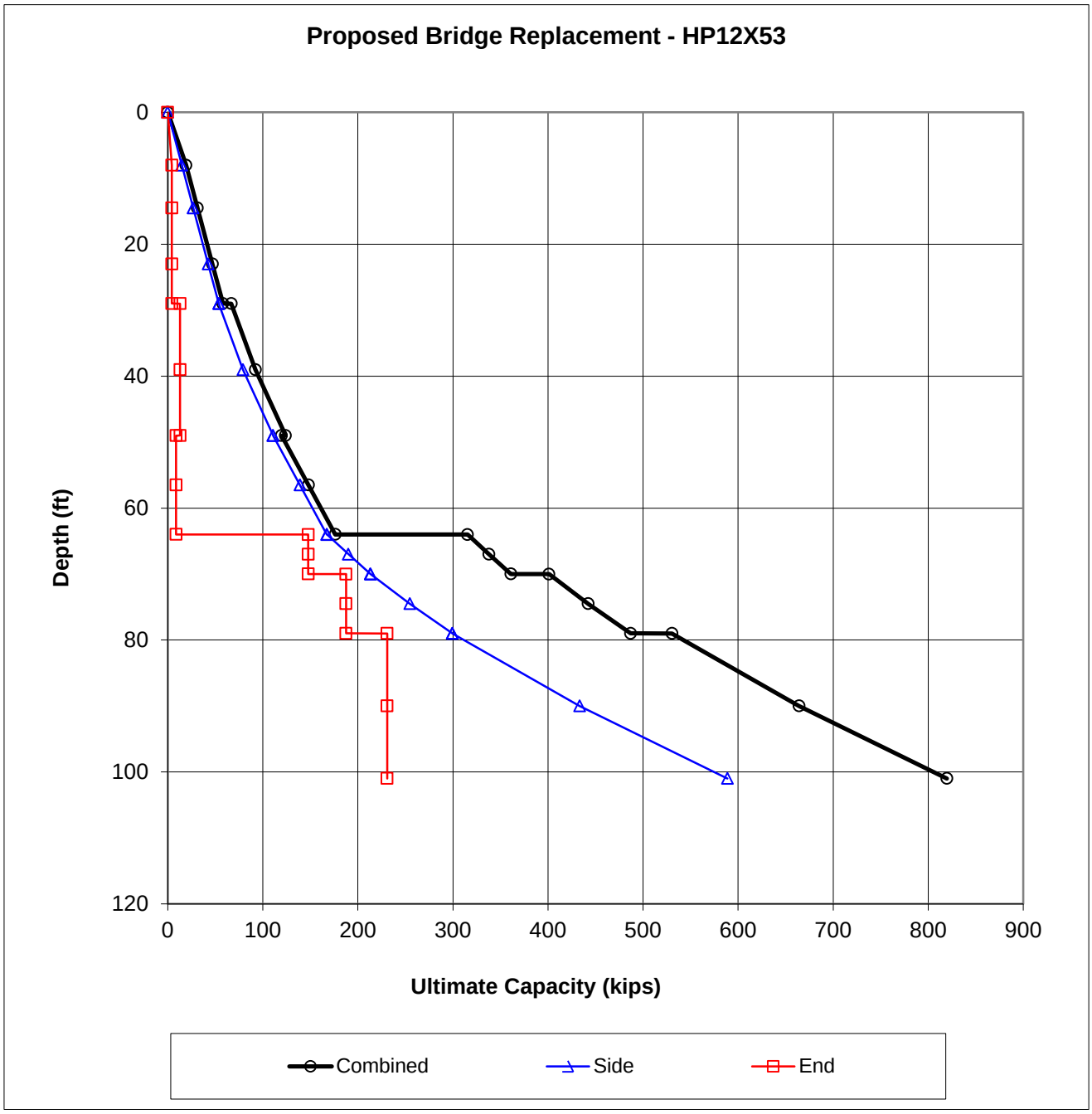
SAMPLE TYPE: SS	SAMPLE LOCATION: B-2 @ 94.5			
DESCRIPTION: SANDY FAT CLAY(CH)	LL	PL	PI	Percent < #200 Sieve
	82	18	64	69

PROJECT: Proposed Bridge Replacement	Midwest Testing LABORATORY, INC. A Terracon COMPANY	PROJECT NUMBER: M6135004
SITE: Newburg, North Dakota	1555 N. 42nd St., Unit B Grand Forks, North Dakota	CLIENT: Wold Engineering Bismarck, North Dakota
		EXHIBIT: B-12

APPENDIX C
PILE CAPACITY GRAPHS
SLOPE STABILITY DIAGRAMS

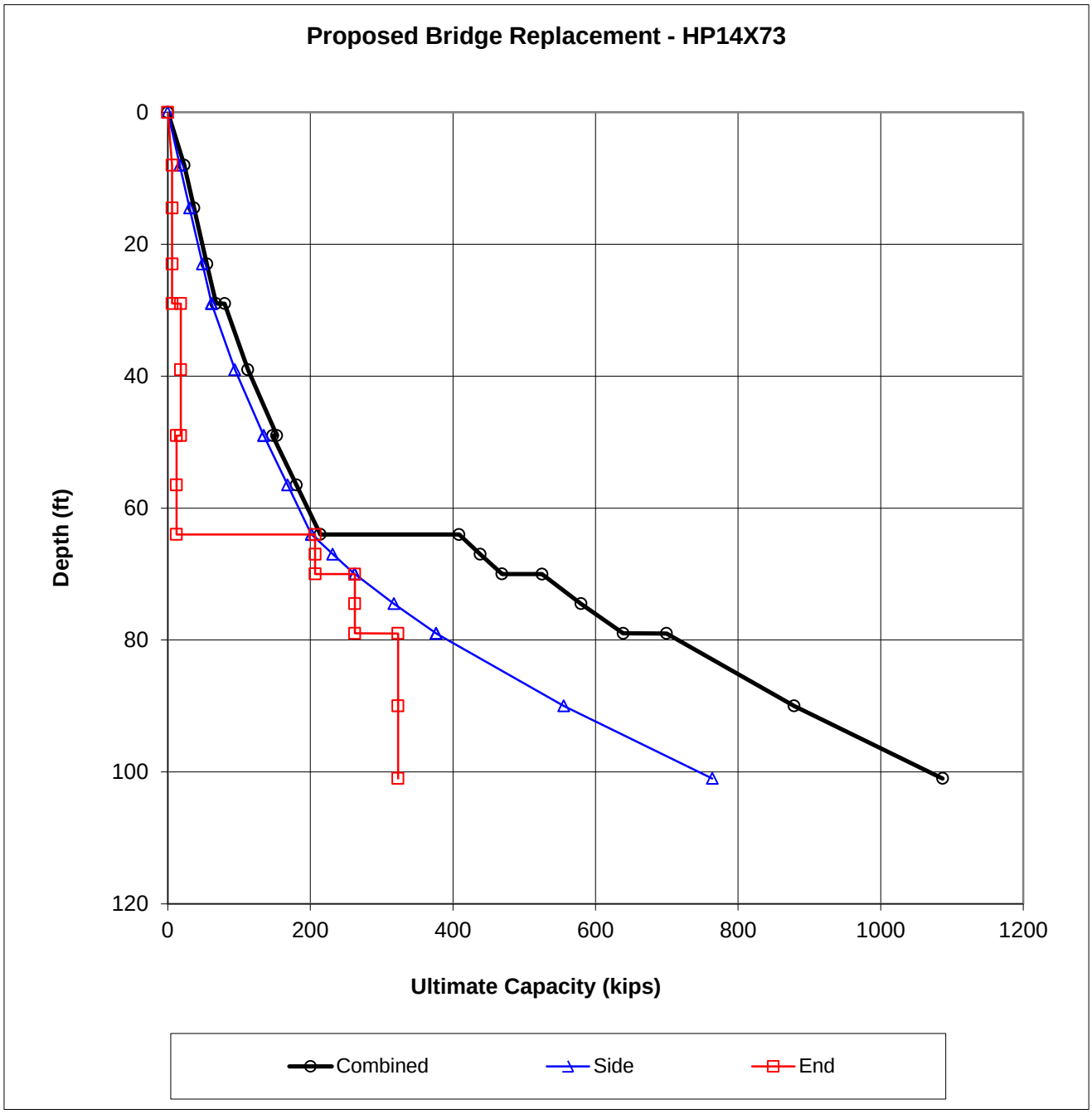
Driven Pile Capacity

Project Name:	Proposed Bridge Replacement
Project Number:	M6135004
Notes:	Soil profile taken from boring B-1
Date:	8/29/2013



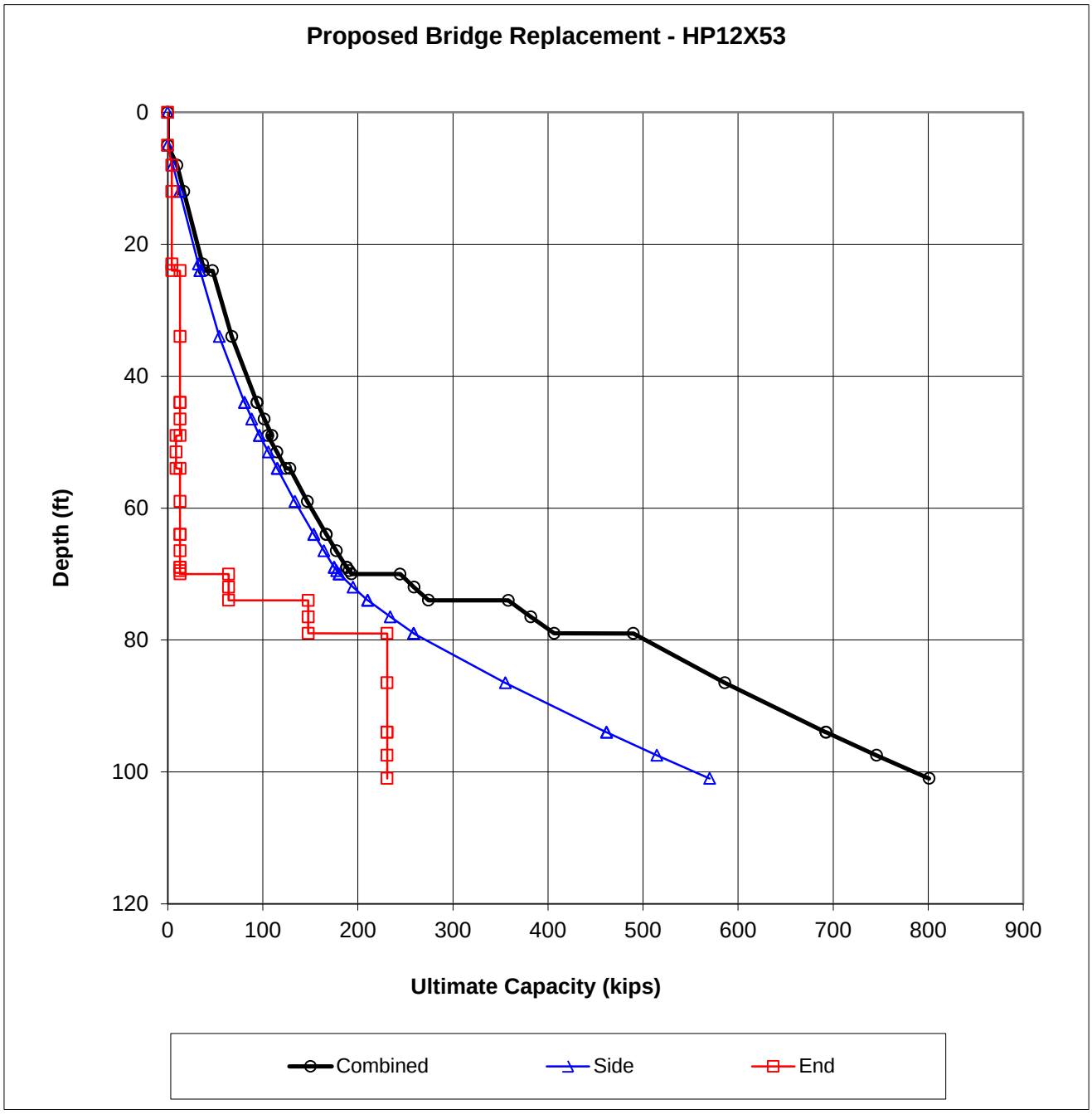
Driven Pile Capacity

Project Name:	Proposed Bridge Replacement
Project Number:	M6135004
Notes:	Soil profile taken from boring B-1
Date:	8/29/2013



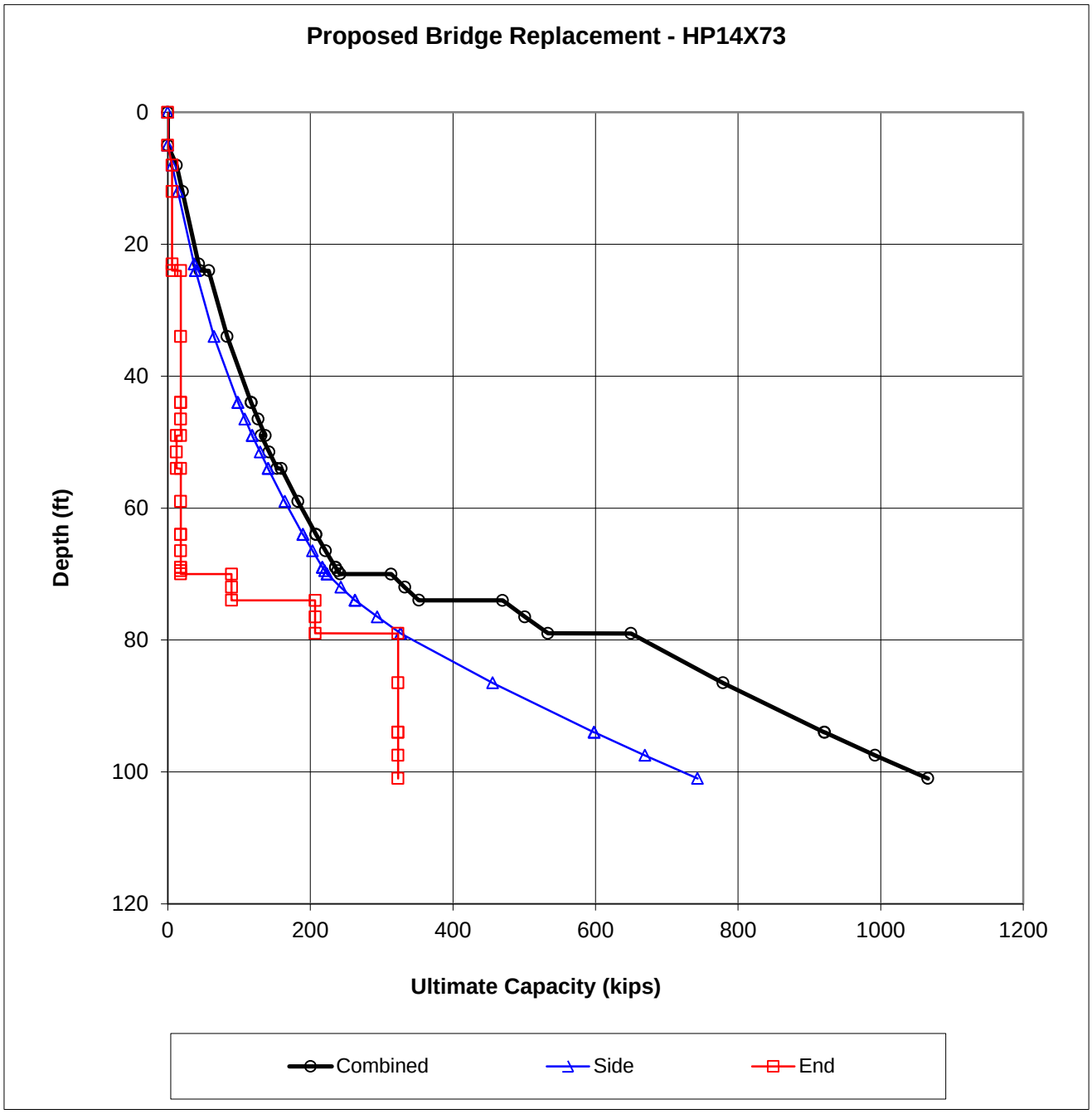
Driven Pile Capacity

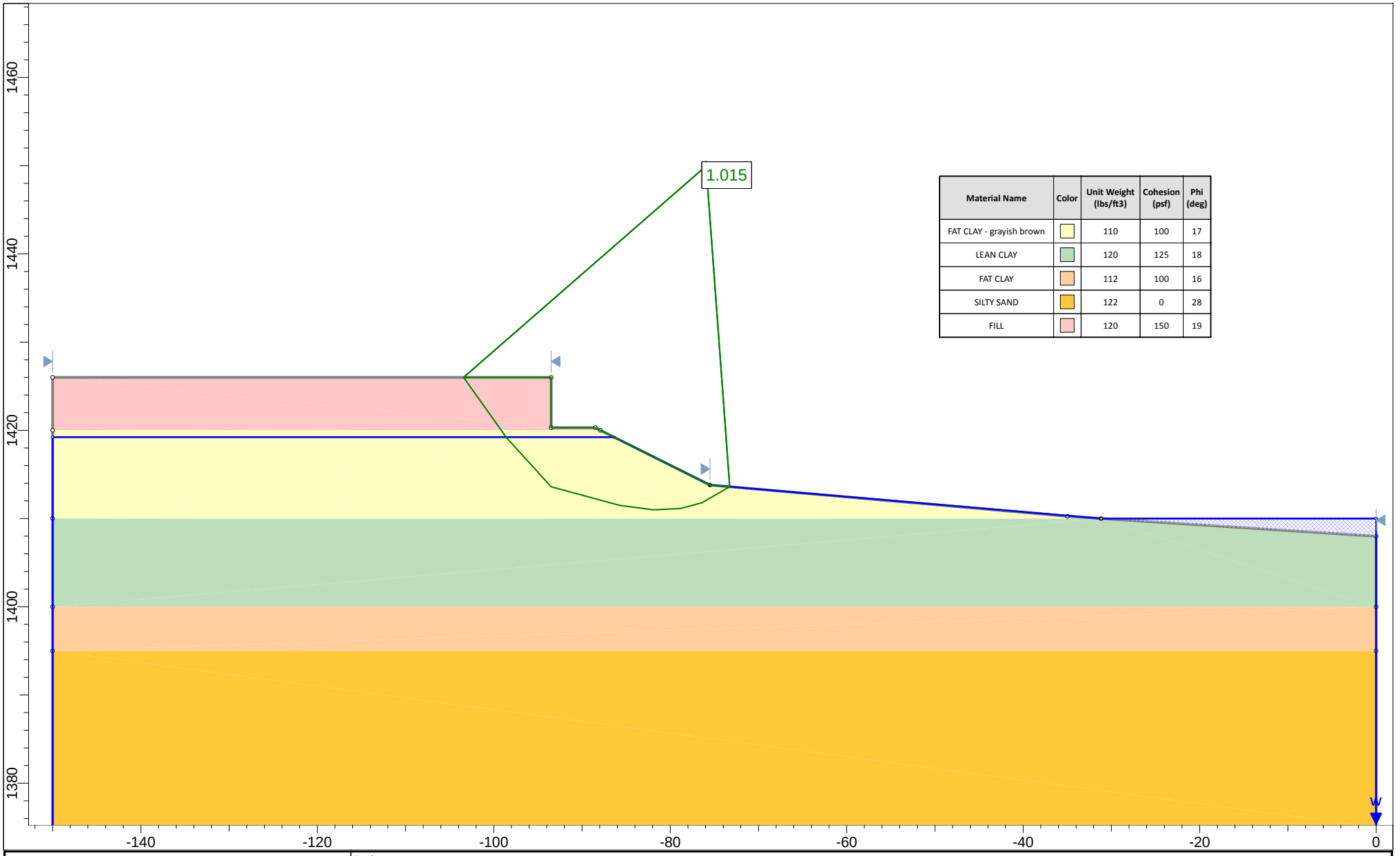
Project Name:	Proposed Bridge Replacement
Project Number:	M6135004
Notes:	Soil profile taken from boring B-2
Date:	8/29/2013



Driven Pile Capacity

Project Name:	Proposed Bridge Replacement
Project Number:	M6135004
Notes:	Soil profile taken from boring B-2
Date:	8/29/2013



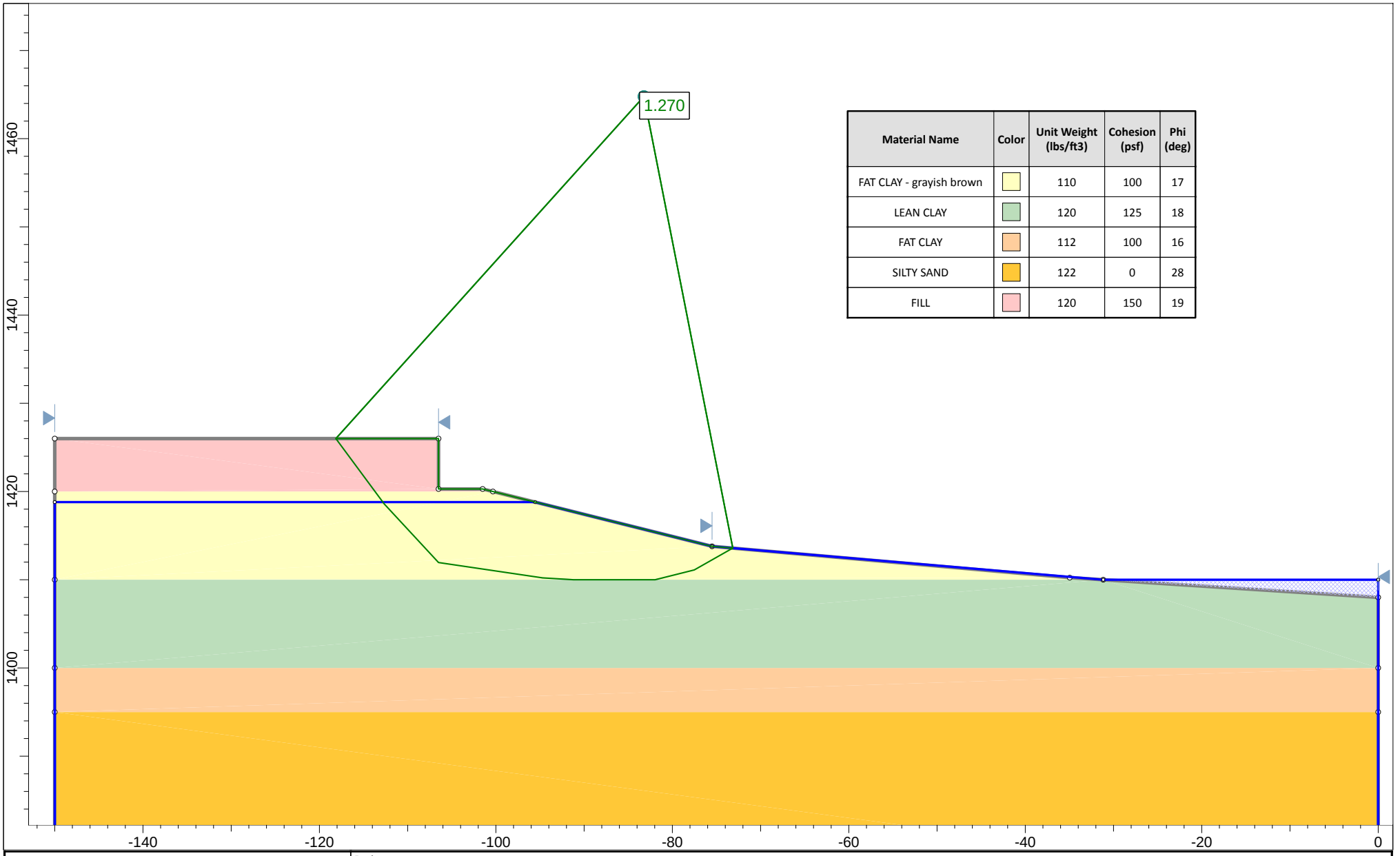


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
FAT CLAY - grayish brown		110	100	17
LEAN CLAY		120	125	18
FAT CLAY		112	100	16
SILTY SAND		122	0	28
FILL		120	150	19

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

SLIDEINTERPRET 6.020

Project	Proposed Bridge Replacement, Newburg, North Dakota		
Analysis Description	West Abutment 2:1 Slope		
Drawn By	wro	*Scale* 1:180	*Company* MTL/Terracon
Date	9/4/2013		*Exhibit* C-5

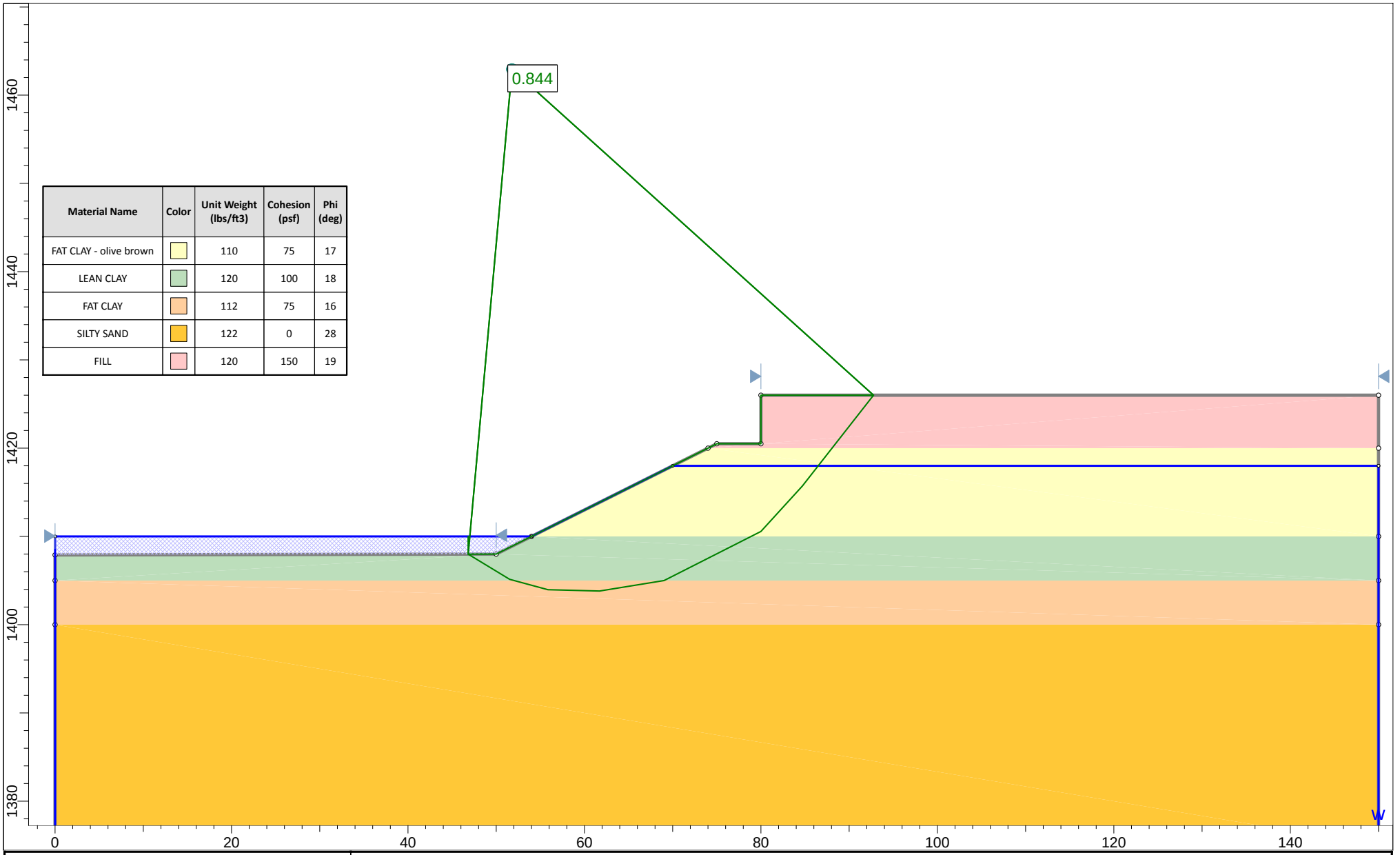


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
FAT CLAY - grayish brown		110	100	17
LEAN CLAY		120	125	18
FAT CLAY		112	100	16
SILTY SAND		122	0	28
FILL		120	150	19

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

SLIDEINTERPRET 6.020

Project	Proposed Bridge Replacement, Newburg, North Dakota		
Analysis Description	West Abutment 4:1 Slope		
Drawn By	wro	Scale 1:180	Company MTL/Terracon
Date	9/4/2013		Exhibit C-6

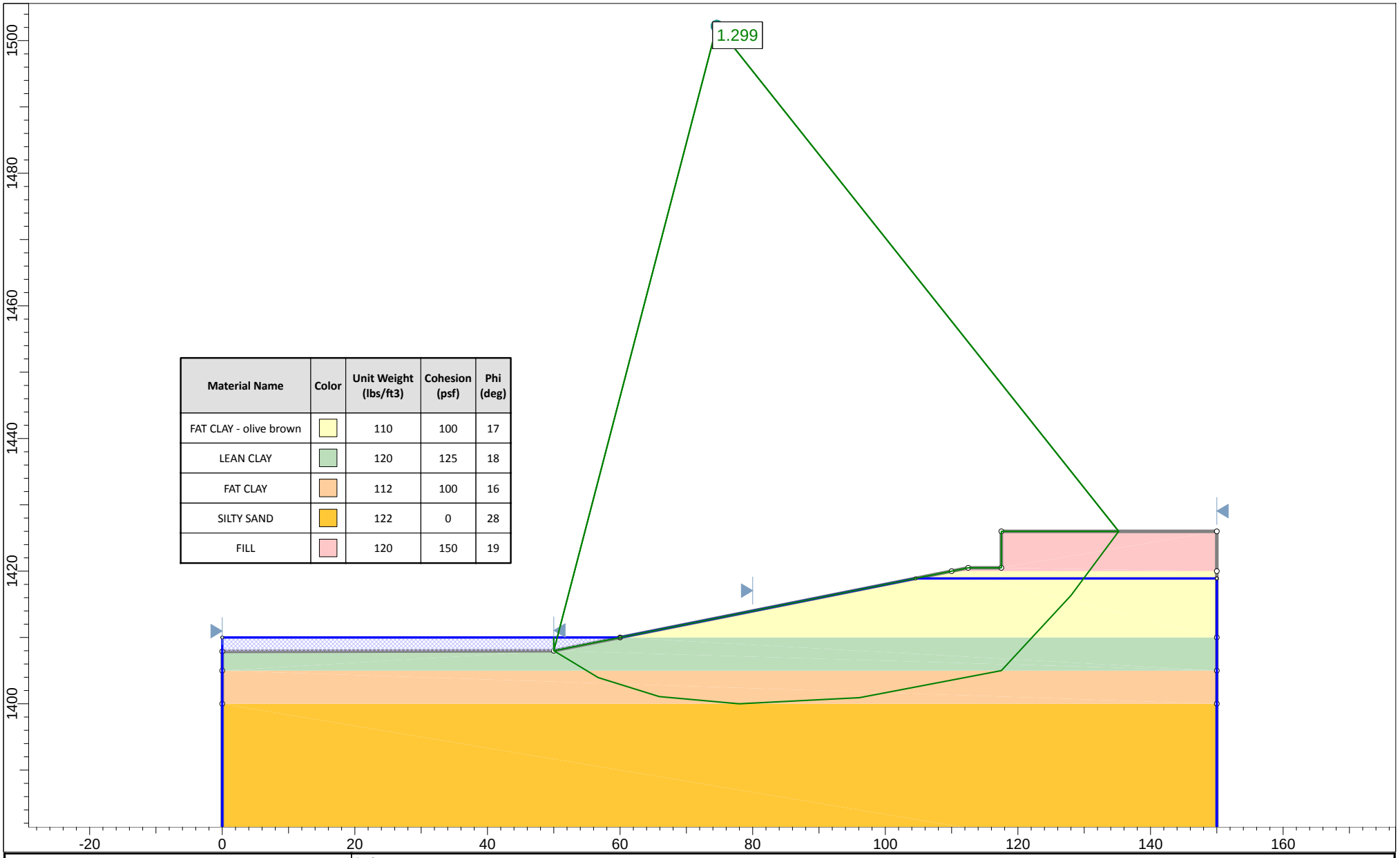


Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
FAT CLAY - olive brown		110	75	17
LEAN CLAY		120	100	18
FAT CLAY		112	75	16
SILTY SAND		122	0	28
FILL		120	150	19

Midwest Testing LABORATORY, INC.
A Terracon COMPANY

SLIDEINTERPRET 6.020

Project	Proposed Bridge Replacement, Newburg, North Dakota		
Analysis Description	East Abutment 2:1 Slope		
Drawn By	wro	*Scale* 1:180	*Company* MTL/Terracon
Date	9/4/2013		*Exhibit* C-7



Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
FAT CLAY - olive brown		110	100	17
LEAN CLAY		120	125	18
FAT CLAY		112	100	16
SILTY SAND		122	0	28
FILL		120	150	19

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A Terracon COMPANY

SLIDEINTERPRET 6.020

Project	Proposed Bridge Replacement, Newburg, North Dakota		
Analysis Description	East Abutment 5:1 Slope		
Drawn By	wro	*Scale* 1:240	*Company* MTL/Terracon
Date	9/4/2013		*Exhibit* C-8

APPENDIX D
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(DCP)	Dynamic Cone Penetrometer
(PID)	Photo-Ionization Detector
(OVA)	Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

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

LOCATION AND ELEVATION NOTES

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

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by 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		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

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

GRAIN SIZE TERMINOLOGY

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

RELATIVE PROPORTIONS OF FINES

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

PLASTICITY DESCRIPTION

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

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Exhibit: D-1

UNIFIED SOIL CLASSIFICATION SYSTEM

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

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

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

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

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

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

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

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

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

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

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

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

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.