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Hilderman Thomas Frank Cram

Assiniboine Forest Pond Overlook

Prepared for:

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Attn:

Glen Manning

Project Number: 0116 003 00

Date: August 21, 2014

TREK GEOTECHNICAL Quality Engineering | Valued Relationships

August 21, 2014 Our File No. 0116 003 00

Glen Manning, MALA, SALA, CSLA, GRP
Hilderman Thomas Frank Cram
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RE: Geotechnical Investigation for Assiniboine Forest Pond Overlook

TREK Geotechnical Inc. is pleased to submit our Final Report for the geotechnical investigation for the above noted project.

Please contact the undersigned should you have any questions.

Sincerely,

TREK Geotechnical Inc.
Per:

Brent Hay, P.Eng.
Geotechnical Engineer
Tel: 204.975.9433 ext. 105

BH: jh
Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	BH	August 21, 2014	Final Report

Authorization Signatures

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Prepared By:

Brent Hay, P.Eng
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APEGM
Certificate of Authorization
Trek Geotechnical Inc.
No. 4877 Date: Aug 21, 2014

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Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

This report summarizes the results of the geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed outlook structure at Assiniboine forest in Winnipeg, Manitoba. The terms of reference for the investigation are included in our proposal dated June 20, 2014. The scope of work includes a sub-surface investigation, laboratory testing, and the provision of recommendations for the design and construction of suitable foundation systems. Other considerations such as water management, foundation and site drainage, cement specifications, materials testing and inspection requirements will be included.

2.0 Background

The site is located in Assiniboine Forest approximately 750 m down an asphalt pathway from Grant Ave, atop of a small, man-made hill around 4m in height. TREK understands that the hill was constructed approximately 30 years ago. The hill overlooks a pond to the east and is surrounded by forest in other directions. TREK understands that the proposed outlook structure will be constructed on top of the hill and will consist of a small, lightly loaded outlook trellis, constructed out of steel pipe columns, a steel bed and timber trellis joints. An asphalt pathway, approximately 2.4 m wide, is present through the crest of the hill along with timber retaining walls on either side of the pathway that are approximately 0.6 m in height.

3.0 Field Program

3.1 Sub-Surface Investigation

A subsurface investigation was undertaken on July 24th, 2014 under the supervision of TREK personnel. Two test holes (TH14-01 and 02) were drilled to determine the sub-surface conditions present on-site. The test hole were drilled using a Yanmar C25R track-mounted drill rig equipped with 108 mm diameter solid stem augers. Sub-surface soils observed during drilling were visually classified based on the Unified Soil Classification System (USCS). Disturbed (auger cutting) samples and relatively undisturbed (Shelby tube) samples were collected during drilling. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of moisture content determination on all samples. Undrained shear strength testing (pocket penetrometer, torvane and unconfined compression) was performed on select samples. The test holes were backfilled with auger cuttings to the ground surface.

Test hole logs have been prepared and are included in Appendix A. Soil laboratory testing results are included in Appendix B. The test hole logs include a description and elevation of soil units encountered, sample type, sample location, results of field and laboratory testing, and other pertinent information such as sloughing, groundwater seepage, UTM coordinates and relative elevations of test hole locations. The test hole location was recorded using a hand held GPS. The test hole elevation was determined from a rod and level survey based on a relative local benchmark assigned an arbitrary elevation of 100.000 m. The top of a rock containing a commemorative plaque was used as the relative local benchmark. The test hole locations are shown on Figure 01.

3.2 Sub-surface Conditions

3.2.1 Soil Stratigraphy

The subsurface stratigraphy in descending order from ground surface consisted of organic clay (topsoil) overlying clay (fill), silty clay and silt till. A brief description of the soil units encountered at the test hole locations is provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the detailed test hole logs in Appendix A.

Organic Clay

Organic clay (topsoil) was encountered at both test hole locations extending from surface to a depth ranging from 0.1 m (TH14-02) to 1.1 m (TH14-01). The organic clay (topsoil) is silty, contains trace sand and trace roots, is black, moist, firm and of intermediate plasticity. A 0.1 m thick layer of organic clay was also encountered between the clay (fill) and silty clay in each test hole at a depth of about 5m.

Clay (fill)

Clay (fill) was encountered below the organic clay (topsoil) in both test holes and is the material used to construct the hill above the surrounding prairie elevation. The clay (fill) is silty, contains trace sand, trace gravel, is grey, moist, stiff to very stiff and of high plasticity. TREK understands that this hill was constructed approximately 30 years ago; construction records for the original fill placement are not available.

Silty Clay

Silty clay was encountered below the clay fill in both test holes to depths of 11.6 and 10.9 m in TH14-01 and 02, respectively. The silty clay contains trace sand, trace gravel, is grey to brown, moist and of high plasticity. The silty clay has undrained shear strengths (based on unconfined compressive tests) ranging from 73 to 36 kPa with an average of 60 kPa and trends towards decreasing strength with depth. The bulk unit weight of the silty clay ranges from 18.7 to 17.8 kN/m^3 with an average of 18.2 kN/m^3.

Silt (Till)

Silt (till) was encountered below the silty clay and was observed to power auger refusal at depths of 11.9 and 11.7 m in TH14-01 and 02, respectively. The silt (till) contains trace clay, is grey, moist and non-plastic. The moisture content of two samples from the silt (till) are 10 and 17 %.

3.2.2 Seepage and Sloughing

Sloughing was not observed in either test holes. Seepage was observed from the silt (till) in both test holes. The water level was measured at 11.0 and 11.4 m in TH14-01 and 02, respectively, immediately after drilling. These observations are short term and should not be considered reflective of (static) groundwater levels at the site, which would require monitoring over an extended period of time to determine. It is important to recognize that groundwater conditions may change seasonally, annually, or as a result of construction activities.

4.0 Foundation Recommendations

4.1 Limit State Design

Limit state design recommendations according to the National Building Code of Canada (NBCC, 2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on probabilistic reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load. Table 1 summarizes the resistance factors that can be used for the design of foundations as per the NBCC (2010) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities (or unit resistances) are provided that are developed on the basis of limiting settlement to approximately 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS capacity if a more stringent settlement tolerance is required.

Table 1. Ultimate Limit States Resistance Factors for Deep Foundations

Case	Resistance Factor
Deep Foundation with bearing resistance to axial load based on semi-empirical analysis using laboratory and *in-situ* test data.	0.4
Deep Foundation with analysis using dynamic modeling results	0.5
Deep Foundation with analysis using static loading test results	0.6

4.2 Foundation Options

Site conditions and anticipated building loads make this site well suited to cast-in-place concrete friction piles. Foundation systems such as driven end bearing piles (either steel h-piles or precast concrete) bearing on the silt (till) are also a feasible foundation type, however are not likely cost effective. TREK understands that driven steel pipe piles or helical pipe piles are also being considered by Hilderman, Thomas, Frank, Cram and TREK has provided recommendations for this foundation option however TREK cautions that this is likely not the most cost effective foundation alternative.. Recommendations are provided below for cast-in-place concrete friction piles, helical pipe piles and driven steel pipe piles.

Based on the age and measured consistency of the clay fill at this site, TREK is of the opinion that settlement associated with consolidation of the fill soils or underlying silty clay soils has been completed. As such TREK does not consider any additional design considerations to accommodate future settlement associated with original hill construction (such as negative skin friction) warranted for this project.

4.3 Cast-in-Place Concrete Friction Piles

The ultimate limit state (ULS) pile capacity for friction piles in silty clay can be calculated using the factored ULS skin friction and end-bearing resistances provided in Table 2. A resistance factor of 0.4 should be applied unless full scale static pile load testing is performed. For evaluation of the SLS, the pile capacity can be calculated based on the SLS skin friction values provided in Table 2. The pile settlement under applied (unfactored) loads equal to the SLS pile capacity can be expected to be 25 mm or less. If required, a detailed settlement analysis can be provided by TREK once the final pile loads are known.

Table 2. Skin Friction Values for Friction Piles

Soil	Depth (m)		Factored ULS Axial Unit Resistance			SLS Shaft Adhesion Value
			Compression $\phi = 0.4$		Uplift $\phi = 0.3$	
	From	To	Shaft Adhesion	End-Bearing[1]	Shaft Adhesion	
Frost Zone	0.0	2.4	0	0	0	0
Clay (Fill) and Silty Clay	2.4	11.0	17 kPa	90 kPa	13 kPa	14 kPa

Notes: 1-ULS end bearing value assumes a machine cleaned base and pile diameter less than 0.5 m.

Additional design and construction recommendations for cast-in-place concrete piles are provided below:

1. The weight of the embedded portion of the pile may be neglected.
2. Skin friction within the upper 2.4 m of the pile should be ignored to take into consideration potential shrinkage and environmental effects such as frost action over that depth.

3. Piles should not extend beyond 10.5 m depth from existing grade to protect against seepage and sloughing from the silt (till) layer.
4. For piles subjected to freezing conditions, the pile embedment length should be designed to resist ad-freezing and uplift forces related to frost action acting along the vertical faces of the pile and pile cap within the depth of frost penetration (2.4 m below ground surface). In this regard, piles may be subject to an ad-freeze bond stress of 65 kPa within the depth of frost penetration. These forces will be resisted by structural dead loads and uplift resistance provided by the length of the pile below the depth of frost penetration. All piles should be reinforced for their full length. All cast-in-place piles require reinforcement design by a qualified structural engineer for the anticipated axial, lateral and bending loads from the superstructure.
5. Based on observed conditions, sleeving of the pile holes is likely unnecessary. If seepage and sloughing is observed, sleeves should be used.
6. Drilling and concrete placement for the piles should be inspected by geotechnical personnel to verify the soil conditions and proper installation of the piles.
7. Prior to casting the pile, any groundwater within the shaft should be removed or controlled. If water is present, the concrete should be placed using Tremie methods.
8. Concrete should be placed as soon as possible after drilling of the pile shaft.
9. Pile spacing should not be less than 2.5 pile diameters, measured centre to centre. If pile spacing must be closer than 2.5 pile diameters, TREK should be notified so that an evaluation of pile group effects can be performed.
10. Grade beams and pile caps should be constructed with a minimum 150 mm void space between soils and the underside of the concrete to minimize the effects of soil heave due to swelling or frost action.

4.4 Helical Pipe Piles

Based on site access and soil conditions present at site helical pipe piles would perform adequately for this structure. The helical pipe piles will likely be installed into the firm clay and could be subject to some vertical movements as a result of moisture content changes in the clay below the pile. Helical pipe piles are not commonly used in Winnipeg and as such, their long term performance has not been determined. The design and associated capacity of helical pipe piles are typically established by the contractor/supplier and verified by the design engineer. For preliminary design purposes, the limit state design capacity of a single helix pile end-bearing in clay 5 m below grade can be approximated by the following equations. The SLS capacity should be expected to limit settlement to less than 25 mm.

<u>Helical Pipe Piles End-Bearing in Cohesive Soils (Clays)</u>

$$\text{SLS Capacity (kN)} = 1/3 \times (9C_u+\gamma'H) \times (\pi(D-d)^2/4)$$

$$\text{ULS Capacity (kN)} = \Phi_r \times (9C_u+\gamma'H) \times (\pi(D-d)^2/4)$$

Where:

N_q = Bearing Capacity Factor (a value of 7 should be used at this site)

γ' =Effective unit weight (a value of 8 should be used at this site)

C_u = the undrained shear strength of the clay (a value of 50 kPa is appropriate for use for the clay at 5 m depth)

H = Helix embedment depth below final grade (m)

D = Helix diameter (m)

d = pipe diameter (m)

Φ_r = ULS resistance factor (a factor of 0.4 should be used unless a static pile load test is completed at the site

The actual selection of pile dimensions and capacity should be performed by the piling contractor/supplier and reviewed by TREK. Pile load tests are commonly performed by helical pipe piles contractors to confirm pile capacity prior to production piling. In addition to this, the following is recommended:

1. The weight of the embedded portion of the pile may be neglected in the design.
2. Skin friction resistance should be neglected in all organic soils, non-clay fill soils or within the upper 2.5 m of the embedded pile, whichever is greater.
3. The pile must be designed to handle design loads and stresses during installation.
4. In unheated areas, the pile should be designed to resist frost jacking forces. In this regard, uplift forces due to ad-freezing in the upper 2.4 m below ground should be based on an uplift adhesion of 100 kPa for steel shaft piles.
5. Helical piles are known to have installation difficulties in frozen ground conditions. Pre-boring of the upper portion of the pile may be required through frozen material.
6. Pile spacing should not be less than 5 times the largest helix diameter, measured center to centre. If pile spacing is closer than this, a reduction to capacity resulting from group effects will need to be evaluated. TREK should be contacted to re-assess capacity the allowable capacity should this condition arise.
7. Piles should be installed under the supervision of qualified geotechnical personnel.
8. Torque should be measured and recorded during installation to verify proper installation.
9. TREK should be notified if the pile installation depth differs from 5 m.

Any piles that are damaged, misaligned an excessive amount, or that do not achieve the target embedment depth may need to be replaced as per recommendations by the structural and geotechnical designers.

4.5 Driven Steel Pipe Piles

TREK understands that driven steel pipe piles are being considered for the outlook structure. It should be recognized that this type of pile performs best when driven to refusal into dense glacial till or bedrock. In this regard, the anticipated length of pile would be in excess of 12 m (40'). The resistance provided by a steel pipe pile not driven to refusal is less than that provided by either a cast in place concrete friction pile or helical pipe pile end bearing in stiff clay. The equipment required to drive steel piles coupled with site access limitations likely makes steel pipe piles a less cost effective option than the other two.

A ULS skin friction value of 14 kPa and SLS skin friction value of 11 kPa can be used for design of driven steel pipe piles that are driven to length (*e.g*. not driven to refusal). If piles are driven to refusal, a preliminary allowable pile capacity of 600 kN is recommended. Once the pile type and driver is determined, this capacity can be confirmed and the set criteria established by our office. We anticipate that a hammer with a minimum energy rating of 32 kJ per blow will be required. Should higher allowable capacities be required, we recommend dynamic testing of piles (PDA) during production. If necessary, TREK can provide further recommendations on PDA testing once a piling plan has been finalized. Since driven end bearing piles will develop the majority of their resistance from tip resistance, there is no need to reduce pile capacity due to group effects.

Additional design and construction recommendations for driven steel piles are provided below:

1. The weight of the embedded portion of the pile may be neglected in the design.
2. The pile must be designed to withstand design loads and to handle stresses and driving forces during installation.
3. End-bearing capacity should be neglected for piles that are not driven to refusal.
4. Pile spacing should not be less than 2.5 pile diameters, measured centre to centre.
5. To aid in pile alignment and reduce pile heave during driving, pre-boring may be undertaken. The pre-bore depth should be minimized to 3 m. The pre-bore diameter should be a maximum of 50 mm larger than the pile diameter. If lateral forces are required in design, the annulus surrounding the pre-bore section of the piles should be filled with lean mix concrete for compliance with the surrounding soil.
6. During the final set, driven piles should be driven continuously once driving is initiated to the required refusal criteria.
7. All driven piles within 5 pile diameters of each other should be monitored for pile heave during installation and neighbouring piles. Driven piles that have heaved should be re-driven to the refusal criteria.
8. Any driven piles that are damaged, misaligned an excessive amount, or that have reached premature refusal may need to be replaced. The structural designer will have to assess non-conforming piles to determine if they are acceptable.
9. A steel follower should not be used for driving of the steel piles.
10. To increase stiffness, the pipe piles could be filled with concrete after driving.

5.0 Foundation Concrete

The degree of exposure for concrete subjected to sulphate attack is classified as severe according to Table 3, CSA A23.1-09 (Concrete Materials and Methods of Concrete Construction). Accordingly, all concrete in contact with the native soil should be made with high sulphate-resistant cement (HS or HSb). Furthermore, the concrete should have a minimum specified 56 day compressive strength of 32 MPa and have a maximum water to cement ratio of 0.45 in accordance with Table 2, CSA A23.1-09 for concrete with severe sulphate exposure (S2). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-09.

6.0 Additional Considerations

Drainage adjacent to the building should promote runoff away from the structure. A minimum slope of 2% should be used for both landscaped and paved areas immediately around the building. All roof leaders should be extended sufficiently away from the building walls.

7.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation, laboratory testing, geometries). Soil conditions are natural deposits that can be highly variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of Hilderman Thomas Frank Cram (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figures

0116 003 00

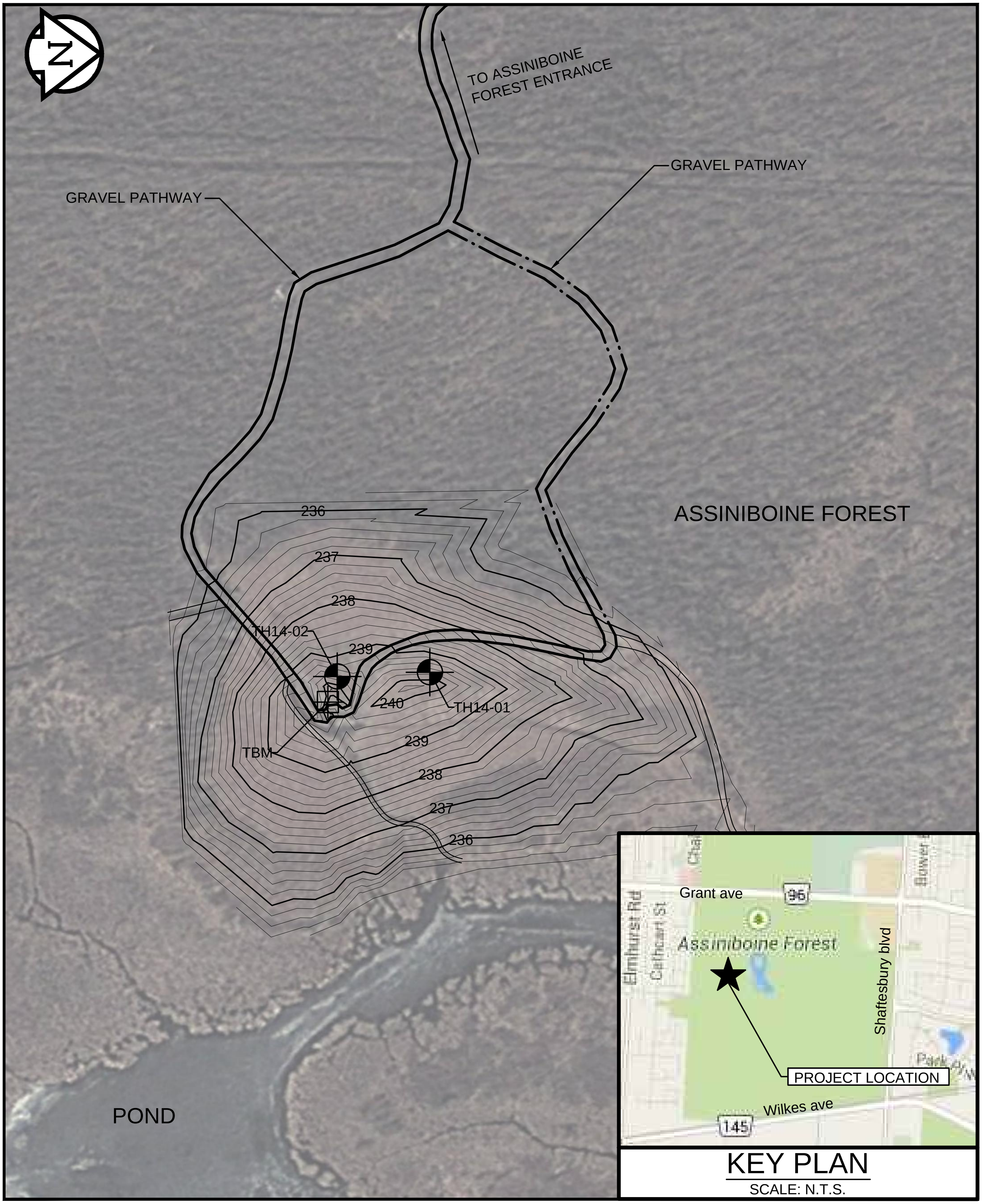
Hilderman Thomas Frank Cram

Assiniboine Forest Pond Overlook

8 1/2" x 11"

PLOT: 21/08/2014 4:08:02 PM

FILE NAME: 0116 003 00_RB.dwg



KEY PLAN

SCALE: N.T.S.

0 | 12.5 | 25 | 37.5 | 50m

SCALE : 1:1250 (279mm x 432mm)

LEGEND :

- TEST HOLE (TREK, AUGUST 13, 2014)
- APPROXIMATE LOCATION OF TEMPORARY BENCHMARK (ASSUMED ELEVATION OF 100.000m)

Figure 01

Site Plan and

Test Hole Layout

Appendix A – Test Hole Logs

Sub-Surface Log

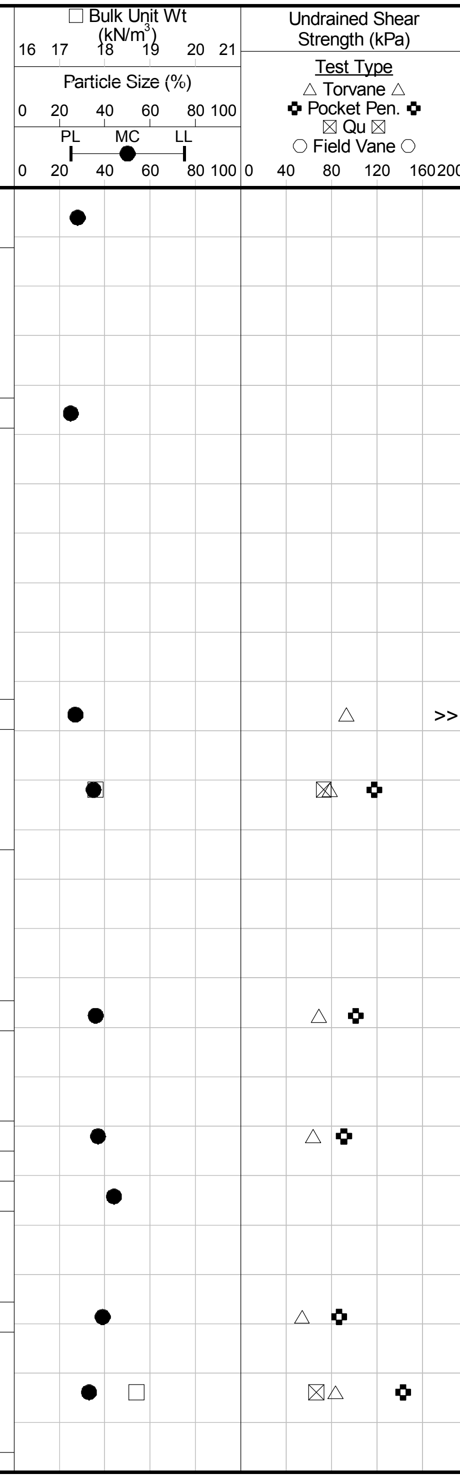
TREK GEOTECHNICAL

Client:	Hilderman Thomas Frank Cram	**Project Number:**	0116 003 00
Project Name:	Assiniboine Forest Lookout	**Location:**	UTM N-5523857, E-626084
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	99.75 m
Method:	108 mm Solid Stem Auger / Yanmar C25R Rubber Track Mount	**Date Drilled:**	July 24, 2014

Sample Type: Grab (G) | Shelby Tube (T) | Split Spoon (SS) | Split Barrel (SB) | Core (C)

Particle Size Legend: Fines | Clay | Silt | Sand | Gravel | Cobbles | Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
	0.0 – 1.05	ORGANIC CLAY - silty, trace sand, trace rootlets - black - moist, firm to stiff - intermediate plasticity	Grab	G1
98.7	1.05 – 5.05	CLAY (FILL) - silty, trace sand, trace gravel, trace silt inclusions (< 20 mm dia.), trace precipitates (< 10 mm dia.), trace organics, trace oxidation - light grey to dark grey - moist, stiff to very stiff - high plasticity, laminated silt and clay (<2mm)	Grab; Grab; Shelby Tube; Grab; Grab	G2, G3, T4, G5, G6
94.7	5.05 – 5.15	ORGANIC CLAY - silty, trace sand, trace rootlets - black, moist, firm to stiff, intermediate plasticity	Grab	G7
94.6	5.15 –	CLAY - silty, trace sand, trace gravel, trace rootlets, trace oxidation - mottled grey and brown - moist, stiff to very stiff - high plasticity, blocky	Grab; Shelby Tube	G8, T9

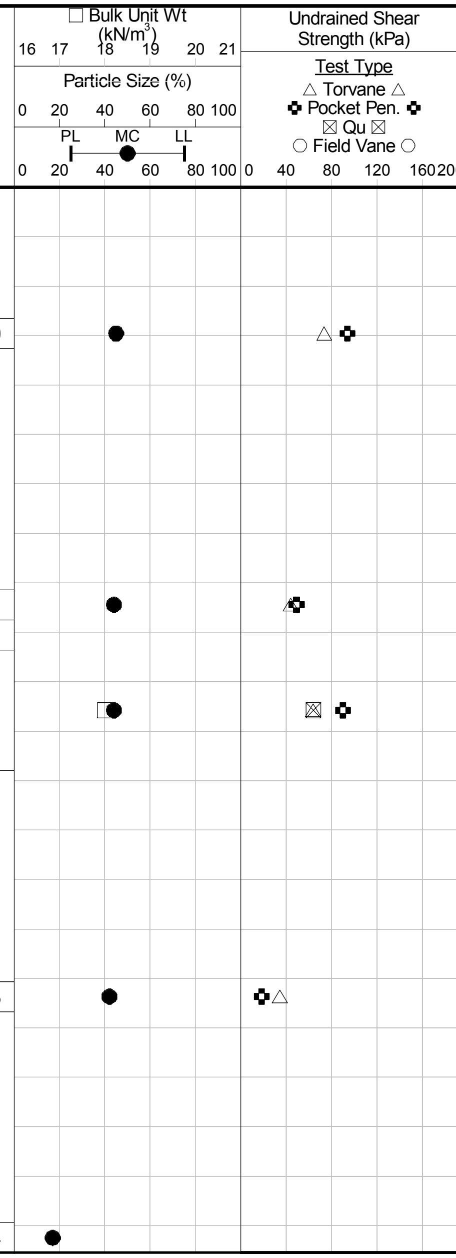


Logged By: Martial Lemoine **Reviewed By:** Brent Hay **Project Engineer:** Brent Hay

TREK GEOTECHNICAL

Sub-Surface Log

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
	7.0				
					G10
	7.5				
	8.0				
	8.5				G11
			- firm to stiff below 8.7 m		
	9.0				T12
	9.5				
	10.0				
			- grey, trace till inclusions (<20 mm dia.) below 10.4 m		
	10.5				G13
	11.0				
88.2	11.5		SILT (TILL) - trace to some clay, trace oxidation - light grey, moist, loose to compact, low to no plasticity		
87.9					G14



END OF TEST HOLE AT 11.9 m IN SILT (TILL)
Notes:
1. Power auger refusal at 11.9 m.
2. No sloughing observed.
3. Seepage observed at 11.6 m in silt (till).
4. Water level was measured to 11.0 m depth.
5. Test hole backfilled with auger cuttings to the ground surface.

Logged By: Martial Lemoine **Reviewed By:** Brent Hay **Project Engineer:** Brent Hay

Sub-Surface Log

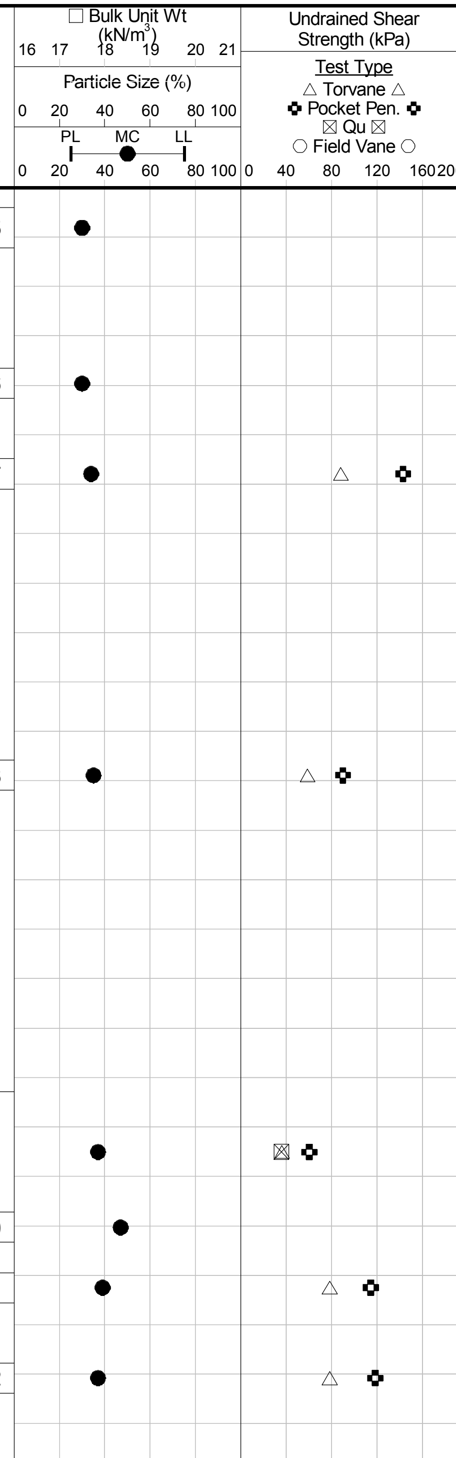
TREK GEOTECHNICAL

Client:	Hilderman Thomas Frank Cram	**Project Number:**	0116 003 00
Project Name:	Assiniboine Forest Lookout	**Location:**	UTM N-5523835, E-626085
Contractor:	Paddock Drilling Ltd.	**Ground Elevation:**	99.38 m
Method:	108 mm Solid Stem Auger / Yanmar C25R Rubber Track Mount	**Date Drilled:**	July 24, 2014

Sample Type: Grab (G), Shelby Tube (T), Split Spoon (SS), Split Barrel (SB), Core (C)

Particle Size Legend: Fines, Clay, Silt, Sand, Gravel, Cobbles, Boulders

Elevation (m)	Depth (m)	MATERIAL DESCRIPTION	Sample Type	Sample Number
99.3		ORGANIC CLAY - silty, trace sand, trace rootlets, black, moist, compact, low plasticity		
		CLAY (FILL) - silty, trace sand, trace gravel, trace silt inclusions (< 20 mm dia.), trace precipitates (< 10 mm dia.), trace organics (woody) - light brown - moist, very stiff to hard - high plasticity	Grab	G15
	1.0		Grab	G16
			Grab	G17
	3.0		Grab	G18
			Shelby Tube	T19
94.3	5.0	ORGANIC CLAY - silty, trace sand - black, moist to wet, very stiff, low to intermediate plasticity		
94.2		CLAY - silty, trace sand, trace gravel, trace silt inclusions (<5 mm), trace precipitates (<5 mm),trace rootlets, trace oxidation - mottled grey and brown - moist, stiff to very stiff - high plasticity, blocky	Grab	G20
			Grab	G21
	6.0		Grab	G22



Logged By: Martial Lemoine **Reviewed By:** Brent Hay **Project Engineer:** Brent Hay

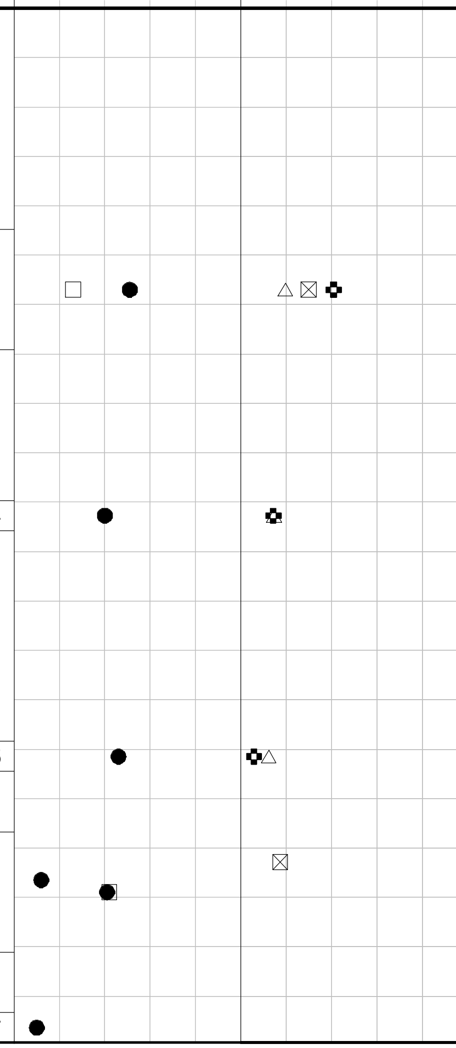
TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH14-02

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number
	7.0 – 8.0				T23
	8.8		- trace till inclusions (<20 mm dia.) below 8.8 m		G24
	10.1		- grey below 10.1 m		G25
88.4	10.9		SILT (TILL) - trace to some clay, trace oxidation - light grey - moist, compact to dense - low plasticity		T26
87.6	11.6		- some sand below 11.6 m		G27

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21
Particle Size (%): 0 20 40 60 80 100
PL MC LL: 0 20 40 60 80 100
Undrained Shear Strength (kPa) — Test Type: △ Torvane △, ✪ Pocket Pen. ✪, ⊠ Qu ⊠, ○ Field Vane ○: 0 40 80 120 160 200



END OF TEST HOLE AT 11.7 m IN SILT (TILL)

Notes:

1. Power auger refusal at 11.7 m.
2. No sloughing observed.
3. Seepage observed at 11.0 m in silt (till).
4. Water level was measured to 11.4 m depth.
5. Test hole backfilled with auger cuttings to the ground surface.

Logged By: Martial Lemoine **Reviewed By:** Brent Hay **Project Engineer:** Brent Hay

Appendix B – Soils Laboratory Testing

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Moisture Content Report
ASTM D2216-98

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Sample Date 24-Jul-14
Test Date 25-Jul-14
Technician Daniel Mroz

Test Pit	TH14-01	TH14-01	TH14-01	TH14-01	TH14-01	TH14-01
Depth (m)	0.0 - 0.3	1.1 - 1.2	2.6 - 2.7	3.1 - 3.2	4.1 - 4.3	4.7 - 4.9
Sample #	G1	G2	G3	T4	G5	G6
Tare ID	F96	W108	Z54	F14	A26	N53
Mass of tare	8.4	8.4	8.3	8.4	8.2	8.4
Mass wet + tare	65.1	166.9	260.0	294.3	320.3	310.4
Mass dry + tare	52.7	135.6	207.0	220.4	237.1	228.9
Mass water	12.4	31.3	53.0	73.9	83.2	81.5
Mass dry soil	44.3	127.2	198.7	212.0	228.9	220.5
Moisture %	28.0%	24.6%	26.7%	34.9%	36.3%	37.0%

Test Pit	TH14-01	TH14-01	TH14-01	TH14-01	TH14-01	TH14-01
Depth (m)	5.0 - 5.2	5.6 - 5.8	5.8 - 5.9	7.2 - 7.3	8.5 - 8.7	8.8 - 8.9
Sample #	G7	G8	T9	G10	G11	T12
Tare ID	Z77	F10	Z75	F95	Z57	F82
Mass of tare	8.3	8.4	8.4	8.3	8.3	8.5
Mass wet + tare	241.5	300.4	262.2	309.8	289.6	377.4
Mass dry + tare	170.0	219.0	199.0	215.8	203.9	264.7
Mass water	71.5	81.4	63.2	94.0	85.7	112.7
Mass dry soil	161.7	210.6	190.6	207.5	195.6	256.2
Moisture %	44.2%	38.7%	33.2%	45.3%	43.8%	44.0%

Test Pit	TH14-01	TH14-01	TH14-02	TH14-02	TH14-02	TH14-02
Depth (m)	10.5 - 10.7	11.7 - 11.9	0.1 - 0.3	0.9 - 1.1	1.4 - 1.5	2.9 - 3.0
Sample #	G13	G14	G15	G16	G17	G18
Tare ID	Z29	Z101	F74	N13	W26	F74
Mass of tare	8.4	8.2	8.5	8.4	8.3	8.2
Mass wet + tare	341.8	312.4	279.4	300.7	255.1	265.9
Mass dry + tare	243.4	269.1	217.0	234.1	191.9	198.4
Mass water	98.4	43.3	62.4	66.6	63.2	67.5
Mass dry soil	235.0	260.9	208.5	225.7	183.6	190.2
Moisture %	41.9%	16.6%	29.9%	29.5%	34.4%	35.5%

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Moisture Content Report
ASTM D2216-98

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Sample Date 24-Jul-14
Test Date 25-Jul-14
Technician Daniel Mroz

Test Pit	TH14-02	TH14-02	TH14-02	TH14-02	TH14-02	TH14-02
Depth (m)	4.6 - 4.7	5.2 - 5.3	5.5 - 5.6	5.9 - 6.1	7.6 - 7.7	9.0 - 9.1
Sample #	T19	G20	G21	G22	T23	G24
Tare ID	F45	H46	Z47	N96	Z59	E112
Mass of tare	8.3	8.4	8.6	8.4	8.4	8.5
Mass wet + tare	227.4	330.2	260.1	276.5	367.5	265.2
Mass dry + tare	168.6	227.1	188.9	203.7	246.6	192.3
Mass water	58.8	103.1	71.2	72.8	120.9	72.9
Mass dry soil	160.3	218.7	180.3	195.3	238.2	183.8
Moisture %	36.7%	47.1%	39.5%	37.3%	50.8%	39.7%

Test Pit	TH14-02	TH14-02	TH14-02	TH14-02		
Depth (m)	10.2 - 10.4	10.7 - 10.8	10.9 - 11.3	11.6 - 11.7		
Sample #	G25	T26 CLAY	T26 SILT (TILL)	G27		
Tare ID	H99	N10	H79	F88		
Mass of tare	8.4	8.5	8.3	8.3		
Mass wet + tare	245.2	428.5	385.8	375.3		
Mass dry + tare	171.0	306.1	345.0	340.5		
Mass water	74.2	122.4	40.8	34.8		
Mass dry soil	162.6	297.6	336.7	332.2		
Moisture %	45.6%	41.1%	12.1%	10.5%		

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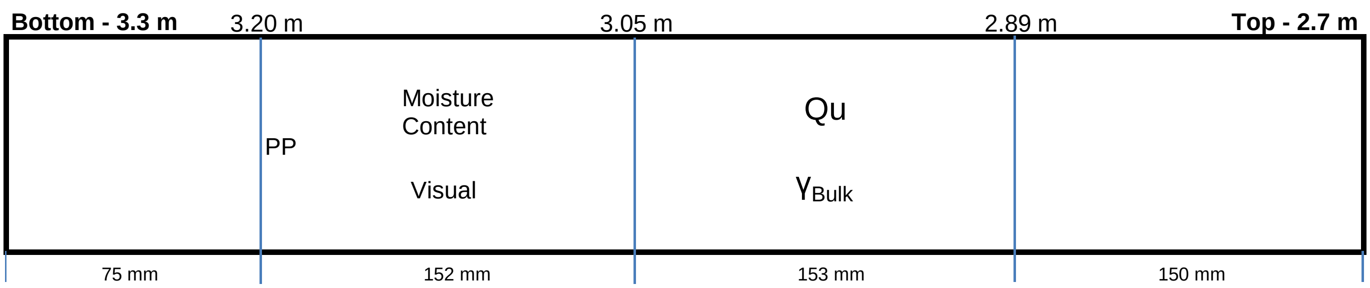
Shelby Tube Visual

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-01
Sample #	T04
Depth (m)	2.7 - 3.3
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Tube Extraction

Recovery (mm) 530



Visual Classification

Material	CLAY (Fill)
Composition	silty
trace gravel	
trace sand	
trace organics (rootlets)	
Color	dark grey
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	-
Vane Size (s,m,l)	-
Undrained Shear Strength (kPa)	-

Pocket Penetrometer

Reading	**1**	1.50
	2	1.30
	3	1.50
	Average	1.43
Undrained Shear Strength (kPa)		70.3

Moisture Content

Tare ID	F14
Mass tare (g)	8.4
Mass wet + tare (g)	294.3
Mass dry + tare (g)	220.4
Moisture %	34.9%

Unit Weight

Bulk Weight (g)		1143.00
Length (mm)	**1**	153.31
	2	153.21
	3	153.11
	4	153.25
Average Length (m)		0.153
Diam. (mm)	**1**	72.36
	2	72.33
	3	72.30
	4	72.22
Average Diameter (m)		0.072
Volume (m^3)		6.29E-04
Bulk Unit Weight (kN/m^3)		17.8
Bulk Unit Weight (pcf)		113.4
Dry Unit Weight (kN/m^3)		13.2
Dry Unit Weight (pcf)		84.1

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Unconfined Compressive Strength
ASTM D2166

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout
Test Hole	TH14-01
Sample #	T04
Depth (m)	2.7 - 3.3
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Unconfined Strength

	kPa	ksf
Max q_u	146.2	3.1
Max S_u	73.1	1.5

Specimen Data

Description CLAY (Fill) - silty, trace gravel, trace sand, trace organics (rootlets), dark grey, moist, stiff, high plasticity, blocky

Length	153.2	(mm)
Diameter	72.3	(mm)
L/D Ratio	2.1	
Initial Area	0.00411	(m^2)
Load Rate	1.00	(%/min)

Moisture %	35%	
Bulk Unit Wt.	17.8	(kN/m^3)
Dry Unit Wt.	13.2	(kN/m^3)
Liquid Limit	-	
Plastic Limit	-	
Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading tsf	Undrained Shear Strength kPa	ksf
-	-	-

Vane Size

-

Pocket Penetrometer

Reading tsf	Undrained Shear Strength kPa	ksf
1.50	73.6	1.54
1.30	63.8	1.33
1.50	73.6	1.54
1.43	**70.3**	**1.47**

Failure Geometry

Sketch:

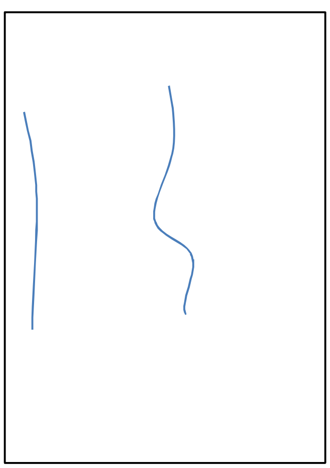

Photo:

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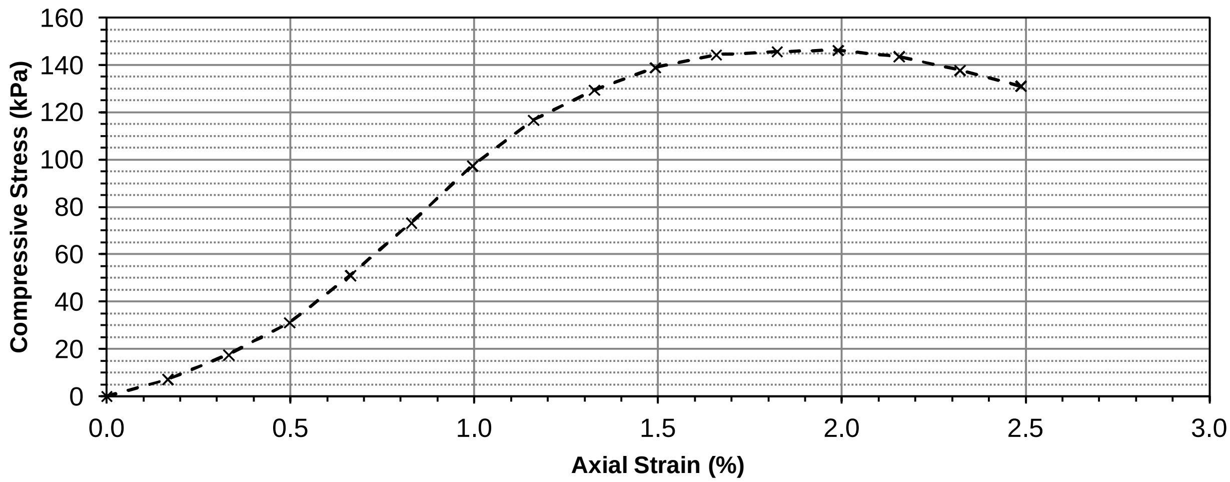
Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004106	0.0	0.00	0.00
10	9	0.2540	0.17	0.004113	29.4	7.16	3.58
20	22	0.5080	0.33	0.004119	72.1	17.49	8.75
30	39	0.7620	0.50	0.004126	128.6	31.17	15.58
40	64	1.0160	0.66	0.004133	211.0	51.06	25.53
50	92	1.2700	0.83	0.004140	303.3	73.26	36.63
60	122	1.5240	0.99	0.004147	403.8	97.37	48.69
70	146	1.7780	1.16	0.004154	484.6	116.67	58.33
80	162	2.0320	1.33	0.004161	538.5	129.42	64.71
90	174	2.2860	1.49	0.004168	578.9	138.90	69.45
100	181	2.5400	1.66	0.004175	602.5	144.31	72.16
110	183	2.7940	1.82	0.004182	609.2	145.68	72.84
120	184	3.0480	1.99	0.004189	612.6	146.24	73.12
130	181	3.3020	2.16	0.004196	602.5	143.58	71.79
140	174	3.5560	2.32	0.004203	578.9	137.73	68.87
150	166	3.8100	2.49	0.004210	552.0	131.10	65.55

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Unconfined Compressive Strength
ASTM D2166

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-01
Sample #	T09
Depth (m)	5.8 - 6.3
Sample Date	24-Jul-14
Test Date	11-Aug-14
Technician	Jodi Neumann

Unconfined Strength

	kPa	ksf
Max q_u	133.2	2.8
Max S_u	66.6	1.4

Specimen Data

Description CLAY - silty, trace rootlets, dark grey, moist, very stiff, high plasticity, blocky

Length	152.6	(mm)	**Moisture %**	33%	
Diameter	72.4	(mm)	**Bulk Unit Wt.**	18.7	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	14.0	(kN/m^3)
Initial Area	0.00411	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading tsf	Undrained Shear Strength kPa	ksf
-	-	-

Vane Size

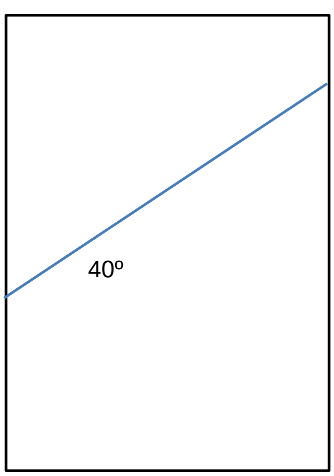
-

Pocket Penetrometer

Reading tsf	Undrained Shear Strength kPa	ksf
2.20	107.9	2.25
2.10	103.0	2.15
1.90	93.2	1.95
2.07	**101.4**	**2.12**

Failure Geometry

Sketch:



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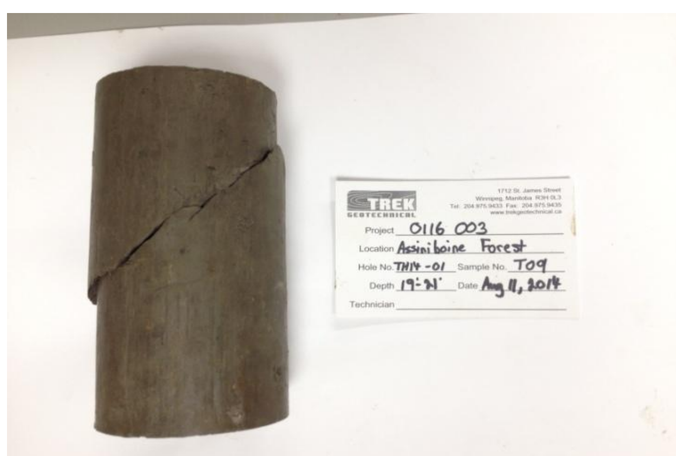

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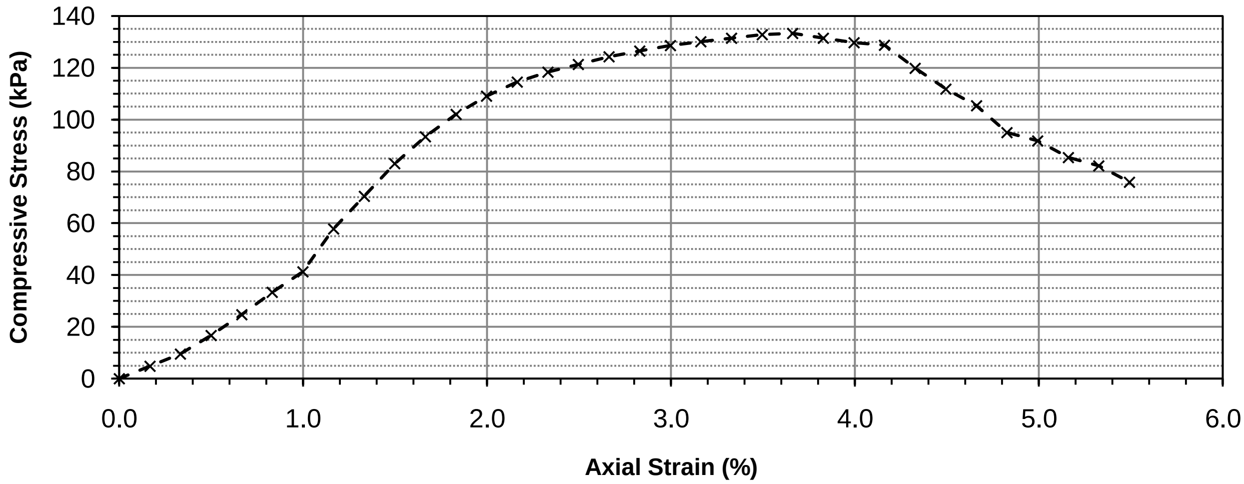
Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004113	0.0	0.00	0.00
10	6	0.2540	0.17	0.004120	19.6	4.76	2.38
20	12	0.5080	0.33	0.004127	39.3	9.51	4.76
30	21	0.7620	0.50	0.004134	68.8	16.64	8.32
40	31	1.0160	0.67	0.004140	102.2	24.69	12.34
50	42	1.2700	0.83	0.004147	138.5	33.39	16.69
60	52	1.5240	1.00	0.004154	171.4	41.27	20.63
70	73	1.7780	1.17	0.004161	240.7	57.84	28.92
80	89	2.0320	1.33	0.004168	293.4	70.40	35.20
90	105	2.2860	1.50	0.004175	346.6	83.00	41.50
100	118	2.5400	1.66	0.004183	390.3	93.32	46.66
110	129	2.7940	1.83	0.004190	427.4	102.01	51.01
120	138	3.0480	2.00	0.004197	457.7	109.06	54.53
130	145	3.3020	2.16	0.004204	481.3	114.48	57.24
140	150	3.5560	2.33	0.004211	498.1	118.28	59.14
150	154	3.8100	2.50	0.004218	511.5	121.27	60.64
160	158	4.0640	2.66	0.004225	525.0	124.25	62.13
170	161	4.3180	2.83	0.004233	535.1	126.43	63.21
180	164	4.5720	3.00	0.004240	545.2	128.59	64.30
190	166	4.8260	3.16	0.004247	552.0	129.96	64.98
200	168	5.0800	3.33	0.004255	558.7	131.32	65.66
210	170	5.3340	3.50	0.004262	565.5	132.68	66.34
220	171	5.5880	3.66	0.004269	568.8	133.23	66.62
230	169	5.8420	3.83	0.004277	562.1	131.43	65.72

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Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	167	6.0960	3.9946	0.004284	555.4	129.64	64.82
250	166	6.3500	4.16	0.004291	552.0	128.62	64.31
260	155	6.6040	4.33	0.004299	514.9	119.78	59.89
270	145	6.8580	4.49	0.004306	481.3	111.75	55.88
280	137	7.1120	4.66	0.004314	454.3	105.31	52.65
290	124	7.3660	4.83	0.004321	410.5	95.00	47.50
300	120	7.6200	4.99	0.004329	397.0	91.72	45.86
310	112	7.8740	5.16	0.004337	370.1	85.35	42.68
320	108	8.1280	5.33	0.004344	356.7	82.10	41.05
330	100	8.3820	5.49	0.004352	329.7	75.76	37.88

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Shelby Tube Visual

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout
Test Hole	TH14-01
Sample #	T12
Depth (m)	8.8 - 9.4
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Tube Extraction

Recovery (mm) 600

Bottom - 9.4 m	9.09 m	8.94 m	**Top - 8.8 m**
Visual	Qu γ_{Bulk}	PP Tv	Moisture Content Visual
349 mm	151 mm	100 mm	

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace precipitates	
Color	mottled grey and brown
Moisture	moist
Consistency	stiff
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.35
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	85.8

Pocket Penetrometer

Reading	**1**	1.70
	2	1.90
	3	1.50
	Average	1.70
Undrained Shear Strength (kPa)		83.4

Moisture Content

Tare ID	F82
Mass tare (g)	8.5
Mass wet + tare (g)	377.4
Mass dry + tare (g)	264.7
Moisture %	44.0%

Unit Weight

Bulk Weight (g)		1149.80
Length (mm)	**1**	150.69
	2	150.59
	3	150.70
	4	150.65
Average Length (m)		0.151
Diam. (mm)	**1**	72.96
	2	72.70
	3	72.70
	4	72.56
Average Diameter (m)		0.073
Volume (m^3)		6.26E-04
Bulk Unit Weight (kN/m^3)		18.0
Bulk Unit Weight (pcf)		114.7
Dry Unit Weight (kN/m^3)		12.5
Dry Unit Weight (pcf)		79.6

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Unconfined Compressive Strength

ASTM D2166

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-01
Sample #	T12
Depth (m)	8.8 - 9.4
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Unconfined Strength

	kPa	ksf
Max q_u	128.0	2.7
Max S_u	64.0	1.3

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace precipitates, mottled grey and brown, moist, stiff, high plasticity, blocky

Length	150.7	(mm)	**Moisture %**	44%	
Diameter	72.7	(mm)	**Bulk Unit Wt.**	18.0	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	12.5	(kN/m^3)
Initial Area	0.00415	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
0.35	85.8	1.79
Vane Size		
s		

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	**kPa**	**ksf**
1.70	83.4	1.74
1.90	93.2	1.95
1.50	73.6	1.54
1.70	**83.4**	**1.74**

Failure Geometry

Sketch:

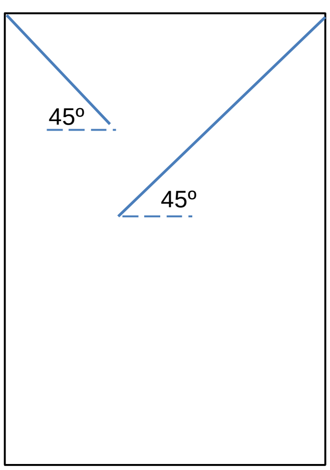

Photo:

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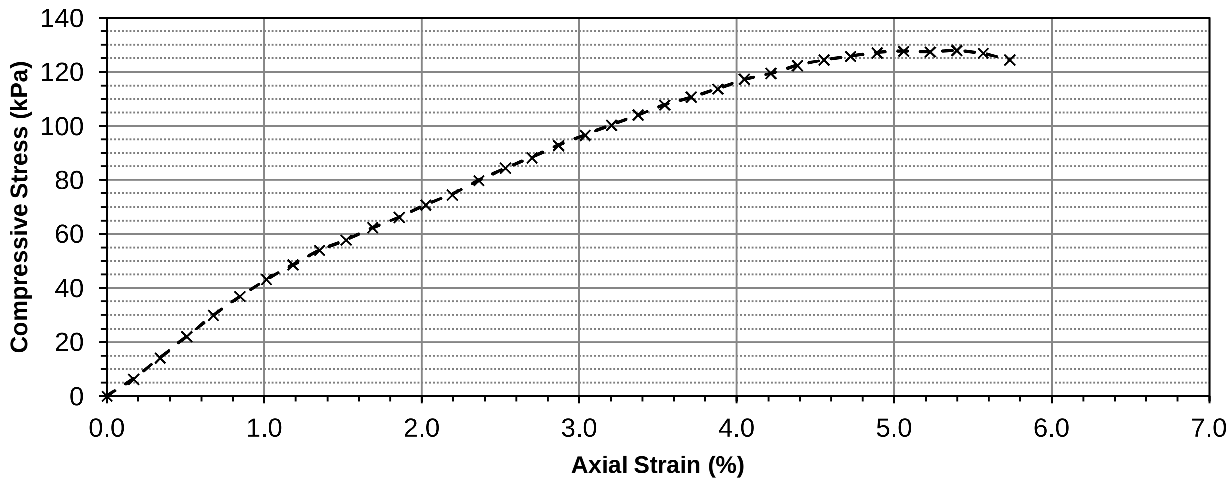
Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004154	0.0	0.00	0.00
10	8	0.2540	0.17	0.004161	26.2	6.29	3.14
20	18	0.5080	0.34	0.004169	58.9	14.14	7.07
30	28	0.7620	0.51	0.004176	92.3	22.10	11.05
40	38	1.0160	0.67	0.004183	125.3	29.96	14.98
50	47	1.2700	0.84	0.004190	155.0	36.99	18.49
60	55	1.5240	1.01	0.004197	181.4	43.21	21.61
70	62	1.7780	1.18	0.004204	204.4	48.62	24.31
80	69	2.0320	1.35	0.004211	227.5	54.02	27.01
90	74	2.2860	1.52	0.004218	244.0	57.84	28.92
100	80	2.5400	1.69	0.004226	263.8	62.42	31.21
110	85	2.7940	1.85	0.004233	280.2	66.20	33.10
120	91	3.0480	2.02	0.004240	300.0	70.76	35.38
130	96	3.3020	2.19	0.004248	316.5	74.52	37.26
140	103	3.5560	2.36	0.004255	339.8	79.86	39.93
150	109	3.8100	2.53	0.004262	360.0	84.46	42.23
160	114	4.0640	2.70	0.004270	376.9	88.26	44.13
170	120	4.3180	2.87	0.004277	397.0	92.83	46.42
180	125	4.5720	3.03	0.004285	413.9	96.61	48.30
190	130	4.8260	3.20	0.004292	430.7	100.36	50.18
200	135	5.0800	3.37	0.004299	447.6	104.10	52.05
210	140	5.3340	3.54	0.004307	464.4	107.82	53.91
220	144	5.5880	3.71	0.004315	477.9	110.76	55.38
230	148	5.8420	3.88	0.004322	491.4	113.68	56.84

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Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	153	6.0960	4.0463	0.004330	508.2	117.38	58.69
250	156	6.3500	4.21	0.004337	518.3	119.50	59.75
260	160	6.6040	4.38	0.004345	531.8	122.39	61.20
270	163	6.8580	4.55	0.004353	541.9	124.50	62.25
280	165	7.1120	4.72	0.004360	548.6	125.82	62.91
290	167	7.3660	4.89	0.004368	555.4	127.14	63.57
300	168	7.6200	5.06	0.004376	558.7	127.68	63.84
310	168	7.8740	5.23	0.004384	558.7	127.45	63.73
320	169	8.1280	5.40	0.004391	562.1	127.99	64.00
330	168	8.3820	5.56	0.004399	558.7	127.00	63.50
340	165	8.6360	5.73	0.004407	548.6	124.48	62.24

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Shelby Tube Visual

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-02
Sample #	T19
Depth (m)	4.6 - 5.0
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Tube Extraction

Recovery (mm) 460

Bottom - 5.0 m	4.83 m	4.72 m	Top - 4.6 m
TOPSOIL - silty, trace organics,	Transitio	Qu γ_{Bulk}	PP Tv Moisture Content Visual
201 mm		114 mm	145 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace sand	
Color	grey
Moisture	moist
Consistency	firm to stiff
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.37
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	36.3

Pocket Penetrometer

Reading	**1**	1.20
	2	1.30
	3	1.20
	Average	1.23
Undrained Shear Strength (kPa)		60.5

Moisture Content

Tare ID	F45
Mass tare (g)	8.3
Mass wet + tare (g)	227.4
Mass dry + tare (g)	168.6
Moisture %	36.7%

Unit Weight

Bulk Weight (g)		866.80
Length (mm)	**1**	113.78
	2	114.28
	3	114.39
	4	114.20
Average Length (m)		0.114
Diam. (mm)	**1**	72.53
	2	72.56
	3	72.52
	4	72.66
Average Diameter (m)		0.073
Volume (m^3)		4.72E-04
Bulk Unit Weight (kN/m^3)		18.0
Bulk Unit Weight (pcf)		114.6
Dry Unit Weight (kN/m^3)		13.2
Dry Unit Weight (pcf)		83.9

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Unconfined Compressive Strength
ASTM D2166

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-02
Sample #	T19
Depth (m)	4.6 - 5.0
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Unconfined Strength

	kPa	ksf
Max q_u	71.9	1.5
Max S_u	35.9	0.8

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace sand, grey, moist, firm to stiff, high plasticity, blocky

Length	114.2	(mm)	**Moisture %**	37%	
Diameter	72.6	(mm)	**Bulk Unit Wt.**	18.0	(kN/m^3)
L/D Ratio	1.6		**Dry Unit Wt.**	13.2	(kN/m^3)
Initial Area	0.00414	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.37	36.3	0.76
Vane Size		
m		

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	kPa	ksf
1.20	58.9	1.23
1.30	63.8	1.33
1.20	58.9	1.23
1.23	**60.5**	**1.26**

Failure Geometry

Sketch:

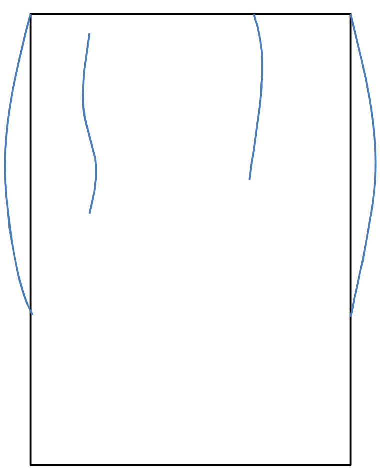

Photo:

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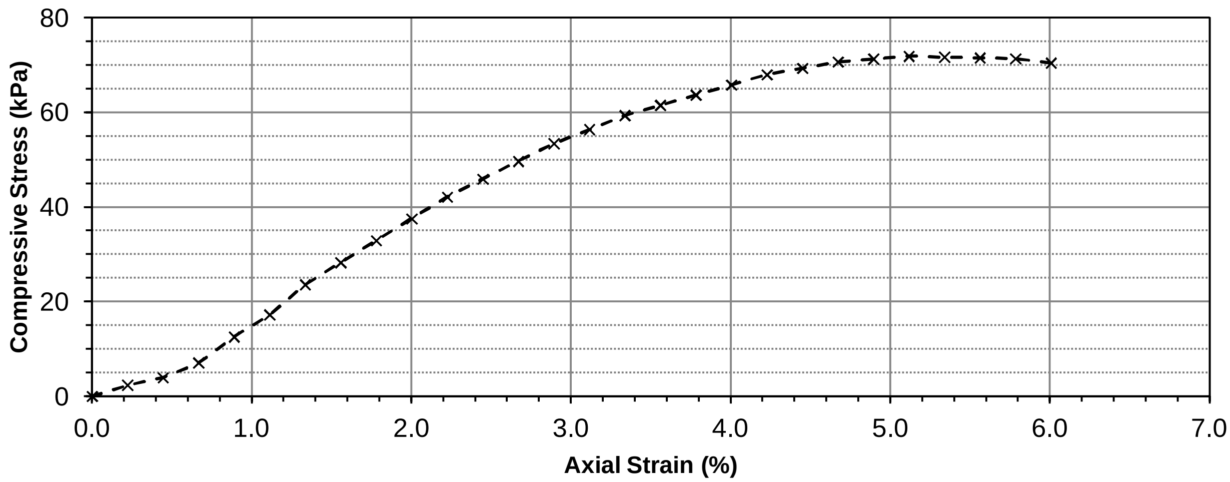
Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004136	0.0	0.00	0.00
10	3	0.2540	0.22	0.004145	9.8	2.37	1.18
20	5	0.5080	0.44	0.004154	16.3	3.93	1.97
30	9	0.7620	0.67	0.004164	29.4	7.07	3.53
40	16	1.0160	0.89	0.004173	52.4	12.55	6.27
50	22	1.2700	1.11	0.004182	72.1	17.23	8.61
60	30	1.5240	1.33	0.004192	98.9	23.60	11.80
70	36	1.7780	1.56	0.004201	118.7	28.25	14.12
80	42	2.0320	1.78	0.004211	138.5	32.88	16.44
90	48	2.2860	2.00	0.004220	158.3	37.50	18.75
100	54	2.5400	2.22	0.004230	178.0	42.08	21.04
110	59	2.7940	2.45	0.004240	194.5	45.88	22.94
120	64	3.0480	2.67	0.004249	211.0	49.66	24.83
130	69	3.3020	2.89	0.004259	227.5	53.41	26.71
140	73	3.5560	3.11	0.004269	240.7	56.38	28.19
150	77	3.8100	3.34	0.004279	253.9	59.33	29.67
160	80	4.0640	3.56	0.004289	263.8	61.51	30.75
170	83	4.3180	3.78	0.004299	273.7	63.66	31.83
180	86	4.5720	4.00	0.004308	283.5	65.81	32.90
190	89	4.8260	4.23	0.004318	293.4	67.95	33.98
200	91	5.0800	4.45	0.004329	300.0	69.31	34.66
210	93	5.3340	4.67	0.004339	306.6	70.67	35.34
220	94	5.5880	4.89	0.004349	309.9	71.26	35.63
230	95	5.8420	5.12	0.004359	313.2	71.85	35.93

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Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	95	6.0960	5.3398	0.004369	313.2	71.68	35.84
250	95	6.3500	5.56	0.004380	313.2	71.51	35.76
260	95	6.6040	5.78	0.004390	313.2	71.35	35.67
270	94	6.8580	6.01	0.004400	309.9	70.43	35.21

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Shelby Tube Visual

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-02
Sample #	T23
Depth (m)	7.6 - 8.2
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Tube Extraction

Recovery (mm) 600

Bottom - 8.2 m	7.87 m	7.72 m	Top - 7.6 m
	Qu γ_{Bulk}	PP Tv	Moisture Content Visual
348 mm	152 mm	100 mm	

Visual Classification

Material	CLAY
Composition	silty
trace silt inclusions (<5 mm diam.)	
trace precipitates	
trace oxidation	
Color	mottled grey and brown
Moisture	moist
Consistency	stiff to very stiff
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.43
Vane Size (s,m,l)	s
Undrained Shear Strength (kPa)	105.4

Pocket Penetrometer

Reading	**1**	1.70
	2	1.30
	3	1.70
	Average	1.57
Undrained Shear Strength (kPa)		76.8

Moisture Content

Tare ID	Z59
Mass tare (g)	8.4
Mass wet + tare (g)	367.5
Mass dry + tare (g)	246.6
Moisture %	50.8%

Unit Weight

Bulk Weight (g)		1123.50
Length (mm)	**1**	151.95
	2	151.75
	3	151.55
	4	151.82
Average Length (m)		0.152
Diam. (mm)	**1**	73.21
	2	73.20
	3	73.21
	4	73.15
Average Diameter (m)		0.073
Volume (m^3)		6.39E-04
Bulk Unit Weight (kN/m^3)		17.3
Bulk Unit Weight (pcf)		109.8
Dry Unit Weight (kN/m^3)		11.4
Dry Unit Weight (pcf)		72.9

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Unconfined Compressive Strength
ASTM D2166

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout

Test Hole	TH14-02
Sample #	T23
Depth (m)	7.6 - 8.2
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Unconfined Strength

	kPa	ksf
Max q_u	119.4	2.5
Max S_u	59.7	1.2

Specimen Data

Description CLAY - silty, trace silt inclusions (<5 mm diam.), trace precipitates, trace oxidation, mottled grey and brown, moist, stiff to very stiff, high plasticity, blocky

Length	151.8	(mm)	**Moisture %**	51%	
Diameter	73.2	(mm)	**Bulk Unit Wt.**	17.3	(kN/m^3)
L/D Ratio	2.1		**Dry Unit Wt.**	11.4	(kN/m^3)
Initial Area	0.00421	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.43	105.4	2.20
Vane Size		
s		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
1.70	83.4	1.74
1.30	63.8	1.33
1.70	83.4	1.74
1.57	**76.8**	**1.60**

Failure Geometry

Sketch:

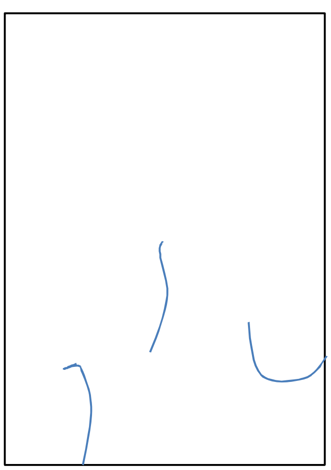

Photo:

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Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
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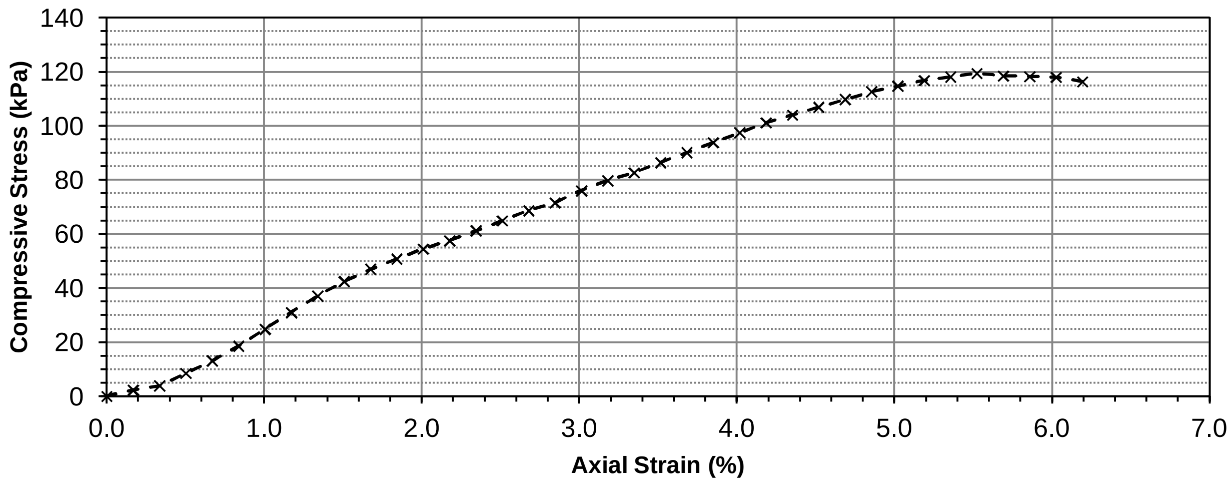
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004207	0.0	0.00	0.00
10	3	0.2540	0.17	0.004215	9.8	2.33	1.16
20	5	0.5080	0.33	0.004222	16.3	3.87	1.94
30	11	0.7620	0.50	0.004229	36.0	8.51	4.25
40	17	1.0160	0.67	0.004236	55.7	13.14	6.57
50	24	1.2700	0.84	0.004243	78.6	18.53	9.27
60	32	1.5240	1.00	0.004250	105.5	24.83	12.41
70	40	1.7780	1.17	0.004257	131.9	30.98	15.49
80	48	2.0320	1.34	0.004265	158.3	37.11	18.56
90	55	2.2860	1.51	0.004272	181.4	42.45	21.23
100	61	2.5400	1.67	0.004279	201.1	47.00	23.50
110	66	2.7940	1.84	0.004286	217.6	50.77	25.38
120	71	3.0480	2.01	0.004294	234.1	54.52	27.26
130	75	3.3020	2.18	0.004301	247.3	57.49	28.75
140	80	3.5560	2.34	0.004308	263.8	61.22	30.61
150	85	3.8100	2.51	0.004316	280.2	64.93	32.47
160	90	4.0640	2.68	0.004323	296.7	68.64	34.32
170	94	4.3180	2.85	0.004331	309.9	71.56	35.78
180	100	4.5720	3.01	0.004338	329.7	76.00	38.00
190	105	4.8260	3.18	0.004346	346.6	79.75	39.87
200	109	5.0800	3.35	0.004353	360.0	82.70	41.35
210	114	5.3340	3.51	0.004361	376.9	86.42	43.21
220	119	5.5880	3.68	0.004368	393.7	90.12	45.06
230	124	5.8420	3.85	0.004376	410.5	93.81	46.91

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Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	129	6.0960	4.0167	0.004384	427.4	97.50	48.75
250	134	6.3500	4.18	0.004391	444.2	101.16	50.58
260	138	6.6040	4.35	0.004399	457.7	104.04	52.02
270	142	6.8580	4.52	0.004407	471.2	106.92	53.46
280	146	7.1120	4.69	0.004414	484.6	109.79	54.89
290	150	7.3660	4.85	0.004422	498.1	112.63	56.32
300	153	7.6200	5.02	0.004430	508.2	114.72	57.36
310	156	7.8740	5.19	0.004438	518.3	116.80	58.40
320	158	8.1280	5.36	0.004446	525.0	118.10	59.05
330	160	8.3820	5.52	0.004453	531.8	119.41	59.70
340	159	8.6360	5.69	0.004461	528.4	118.44	59.22
350	159	8.8900	5.86	0.004469	528.4	118.23	59.12
360	159	9.1440	6.03	0.004477	528.4	118.02	59.01
370	157	9.3980	6.19	0.004485	521.6	116.30	58.15

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Shelby Tube Visual

Project No.	0116 003 00
Client	Hilderman Thomas Frank Cram
Project	Assiniboine Forest Lookout
Test Hole	TH14-02
Sample #	T26
Depth (m)	10.7 - 11.3
Sample Date	24-Jul-14
Test Date	25-Jul-14
Technician	Lee Boughton

Tube Extraction

Recovery (mm) 600

Bottom - 11.3 m		10.93 m		10.79 m	**Top - 10.7 m**
SILT (Till) - trace clay, trace gravel, trace sand, light grey, moist, soft, low plasticity, homogenous	Kept	Transition	Qu γ_{Bulk}	PP Tv	Moisture Content Visual
340 mm			142 mm		118 mm

Visual Classification

Material	CLAY
Composition	silty
trace silt till inclusions	
Color	dark grey
Moisture	moist
Consistency	firm
Plasticity	high plasticity
Structure	blocky
Gradation	-

Torvane

Reading	0.26
Vane Size (s,m,l)	m
Undrained Shear Strength (kPa)	25.5

Pocket Penetrometer

Reading	**1**	0.60
	2	0.80
	3	0.90
	Average	0.77
Undrained Shear Strength (kPa)		37.6

Moisture Content

	SILT (Till)	**CLAY**
Tare ID	H79	N10
Mass tare (g)	8.3	8.5
Mass wet + tare (g)	385.8	428.5
Mass dry + tare (g)	345.0	306.1
Moisture %	12.1%	41.1%

Unit Weight

Bulk Weight (g)		1079.10
Length (mm)	**1**	141.73
	2	141.80
	3	141.50
	4	141.60
Average Length (m)		0.142
Diam. (mm)	**1**	73.00
	2	72.26
	3	72.20
	4	72.35
Average Diameter (m)		0.072
Volume (m^3)		5.84E-04
Bulk Unit Weight (kN/m^3)		18.1
Bulk Unit Weight (pcf)		115.4
Dry Unit Weight (kN/m^3)		12.8
Dry Unit Weight (pcf)		81.7

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Unconfined Compressive Strength

ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Test Hole TH14-02
Sample # T26
Depth (m) 10.7 - 11.3
Sample Date 24-Jul-14
Test Date 25-Jul-14
Technician Lee Boughton

Unconfined Strength

	kPa	ksf
Max q_u	69.4	1.4
Max S_u	34.7	0.7

Specimen Data

Description CLAY - silty, trace silt till inclusions, dark grey, moist, firm, high plasticity, blocky

Length	141.7	(mm)	**Moisture %**	41%	
Diameter	72.5	(mm)	**Bulk Unit Wt.**	18.1	(kN/m^3)
L/D Ratio	2.0		**Dry Unit Wt.**	12.8	(kN/m^3)
Initial Area	0.00412	(m^2)	**Liquid Limit**	-	
Load Rate	1.00	(%/min)	**Plastic Limit**	-	
			Plasticity Index	-	

Undrained Shear Strength Tests

Torvane

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.26	25.5	0.53
Vane Size		
m		

Pocket Penetrometer

Reading	**Undrained Shear Strength**	
tsf	**kPa**	**ksf**
0.60	29.4	0.61
0.80	39.2	0.82
0.90	44.1	0.92
0.77	**37.6**	**0.79**

Failure Geometry

Sketch:

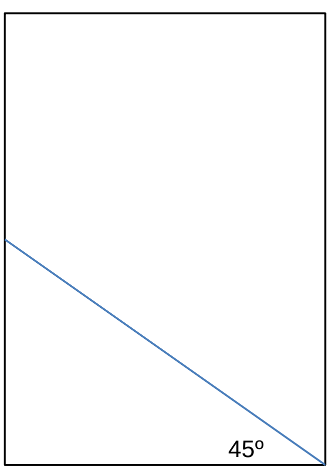

Photo:

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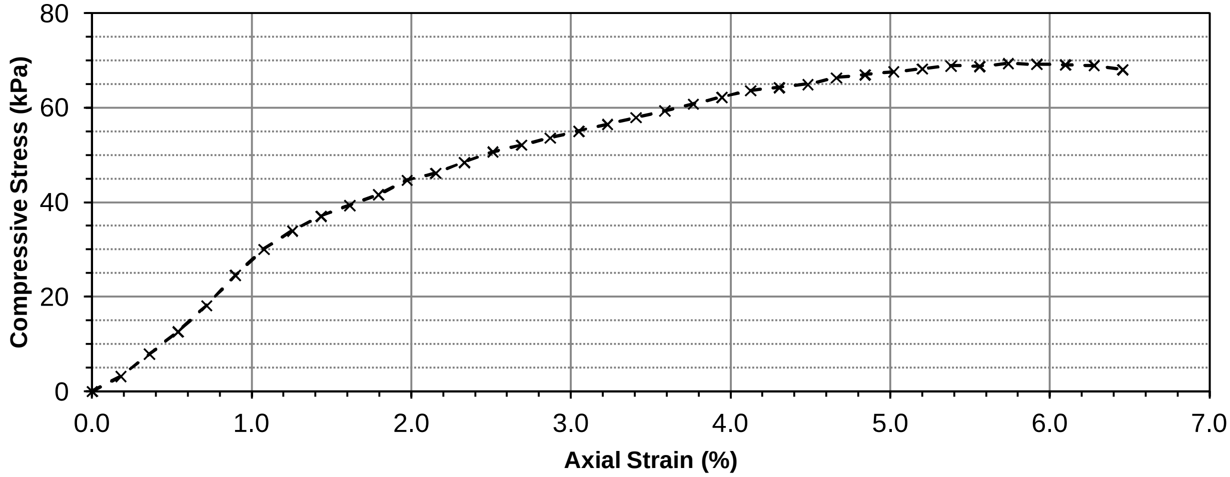
Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004123	0.0	0.00	0.00
10	4	0.2540	0.18	0.004130	13.1	3.17	1.58
20	10	0.5080	0.36	0.004138	32.7	7.90	3.95
30	16	0.7620	0.54	0.004145	52.4	12.63	6.32
40	23	1.0160	0.72	0.004153	75.3	18.14	9.07
50	31	1.2700	0.90	0.004160	102.2	24.57	12.29
60	38	1.5240	1.08	0.004168	125.3	30.07	15.03
70	43	1.7780	1.26	0.004175	141.8	33.95	16.98
80	47	2.0320	1.43	0.004183	155.0	37.05	18.53
90	50	2.2860	1.61	0.004190	164.9	39.34	19.67
100	53	2.5400	1.79	0.004198	174.7	41.62	20.81
110	57	2.7940	1.97	0.004206	187.9	44.69	22.34
120	59	3.0480	2.15	0.004214	194.5	46.17	23.08
130	62	3.3020	2.33	0.004221	204.4	48.42	24.21
140	65	3.5560	2.51	0.004229	214.3	50.68	25.34
150	67	3.8100	2.69	0.004237	220.9	52.14	26.07
160	69	4.0640	2.87	0.004245	227.5	53.59	26.80
170	71	4.3180	3.05	0.004252	234.1	55.05	27.53
180	73	4.5720	3.23	0.004260	240.7	56.50	28.25
190	75	4.8260	3.41	0.004268	247.3	57.93	28.97
200	77	5.0800	3.59	0.004276	253.9	59.37	29.68
210	79	5.3340	3.77	0.004284	260.4	60.79	30.40
220	81	5.5880	3.94	0.004292	267.1	62.22	31.11
230	83	5.8420	4.12	0.004300	273.7	63.64	31.82

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Unconfined Compressive Strength
ASTM D2166

Project No. 0116 003 00
Client Hilderman Thomas Frank Cram
Project Assiniboine Forest Lookout

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m^2)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	84	6.0960	4.3033	0.004308	276.9	64.28	32.14
250	85	6.3500	4.48	0.004316	280.2	64.93	32.46
260	87	6.6040	4.66	0.004324	286.8	66.33	33.16
270	88	6.8580	4.84	0.004333	290.2	66.97	33.49
280	89	7.1120	5.02	0.004341	293.4	67.60	33.80
290	90	7.3660	5.20	0.004349	296.7	68.23	34.12
300	91	7.6200	5.38	0.004357	300.0	68.86	34.43
310	91	7.8740	5.56	0.004365	300.0	68.73	34.36
320	92	8.1280	5.74	0.004374	303.3	69.35	34.68
330	92	8.3820	5.92	0.004382	303.3	69.22	34.61
340	92	8.6360	6.10	0.004391	303.3	69.09	34.54
350	92	8.8900	6.28	0.004399	303.3	68.95	34.48
360	91	9.1440	6.46	0.004407	300.0	68.08	34.04