Winnipeg

Embrace the Spirit

Cockburn and Calrossie Combined Sewer Relief Works C4 – 2700 Trunk Sewer Geotechnical Data Report

FINAL

KGS Group 11-0107-18
October 2016

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Winnipeg, Manitoba

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1.0 INTRODUCTION

1.1 GENERAL

KGS Group was retained by the City of Winnipeg Water and Waste Department to perform geotechnical investigations to facilitate the design and construction of the proposed Land Drainage System (LDS) trunk sewer pipe from Parker Pond to Taylor Ave. The proposed LDS pipe project is part of the Cockburn/Calrossie Combined Sewer Relief Works currently being undertaken by the City of Winnipeg.

It is our understanding that the proposed LDS pipe will be 2700 mm in diameter, approximately 620 m in length and will convey water from Taylor Ave.to Parker Pond. It is further understood that trenchless construction methods will be employed for the installation of the proposed pipe.

The purpose of our investigation was to identify the subsurface soil and groundwater conditions along the route of the proposed works. This factual report contains a description of the geotechnical investigations program performed by KGS Group and our findings.

1.2 PURPOSE OF REPORT

This report summarizes the geotechnical conditions observed along the alignment from the proposed Parker Pond to Taylor Ave. and provides geotechnical considerations that would form part of the basis of the design for the Work. This report includes geotechnical data collected at the project site and summary of anticipated subsurface conditions along the alignment.

1.3 REPORT LIMITATIONS

This report has been prepared for the exclusive use of the City of Winnipeg for specific application to the proposed Cockburn/Calrossie Combined Sewer Relief Works project (from the proposed Parker Pond to Taylor Ave.). It has been prepared in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made.

The geotechnical data presented in this report are based on the observations and test results obtained from field investigation programs completed between 2015 and 2016. The information provided indicate soil conditions and water levels only at specific locations and times, and only to the depths penetrated. Subsurface conditions and water levels at other locations may differ from conditions occurring at these explored locations. Also, the passage of time may result in a change in conditions at these locations. KGS Group is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or for reuse of subsurface data, without KGS Group's express written authorization.

2.0 BACKGROUND INFORMATION

2.1 OTHER GEOTECHNICAL INVESTIGATIONS NEAR THE SITE

KGS Group completed a geotechnical and environmental investigation south of the proposed trunk sewer in 2015. The 2015 investigation consisted of drilling five (5) test holes to investigate the subsurface stratigraphic conditions. Two (2) pneumatic piezometers were installed in the clay and one (1) standpipe piezometer was installed in the silt till to monitor the groundwater levels at the site.

The stratigraphy observed during the 2015 site investigation generally consisted of a layer of fill over an extensive layer of high plasticity silty clay and silt till. The top of the glacial silt till deposit at the proposed Parker Pond was approximately between elevations El. 218.4 m± and 218.9 m±. The borehole logs from the 2015 geotechnical investigation have been included in Appendix A and the groundwater data within the alignment of the proposed trunk sewer are included in Table 2.

2.2 REGIONAL GEOLOGIC SETTING

Winnipeg geology consisted of carbonate sedimentary bedrock overlaying Precambrian era granite and gneiss. The sedimentary rock consists of limestone, dolomite and shale to a lesser extent. Local geological maps indicate karst topography caused from dissolution of the soluble rock, and a heavily fractured upper bedrock layer. The karst topography is typically infilled with mixtures of silt, sand and gravel till material.

During the last glacial advance and retreat, Winnipeg's glacial till was laid down by ice masses. Glaciolacustrine deposits suspended in glacial lakes confined by ice masses settled to overlie the tills. Additional information on the regional geology can be found in Geological Engineering Report for Urban Development of Winnipeg, University of Manitoba (Reference 1).

2.3 LOCAL GEOLOGY

Summary of the geology across the site as determined from the field investigation program completed in 2016 are provided herein, while the detailed stratigraphic sequence of subsurface material encountered at the site and key engineering considerations are presented in Section 3 of this report.

2.3.1 Overburden

The overburden deposits encountered at the project site generally consist of extensive deposit of high plastic clay overlying silt till deposit. Variable layers of organic clay, fill and silt were observed in the test holes within the upper complex zone.

Upper Complex Zone

The Complex Zone consists of stratified silty clays, and silts with variable amounts of organics, granular and fill material. This zone has high soil variability. The base of the Complex Zone is typically defined by the base of the silt layer. The silt interlayers in the Complex Zones can vary from 100 mm to up to 3 m in thickness and are typically approximately 1 m. Typically the silt is tan in colour, soft in consistency, of no to low plasticity and may have a perched groundwater table. The moisture content of the silt ranges from 20 to 35% and the unit weight is within the range of 18.8 to 20.4 kN/m^3 (Ref 1).

Glaciolacustrine Clay

Underlying the upper Complex Zone is typically 9 to 12 m of glaciolacustrine silty clay deposit. In decreasing occurrence, the predominant mineral composition of the lacustrine clay generally consists of montmorillonite (a member of the smectite family), illite, kaolinite and some mica (Graham and Shields 1984). The clay deposits changes from brown to grey (sometimes referred to as blue clay) at depths of approximately 4 to 6 metres. Within this depth range, the brown and grey clays often appear mottled, making it sometimes difficult to observe a discrete contact between the two colours. It is believed the colour change is due to oxidation (the brown clay

being oxidized) as there is no obvious change in mineralogy, clay content or plasticity (Graham and Shields 1985).

The brown clay is typically stiff in consistency and of a high plasticity. The brown clay is highly fissured with the frequency of fissures decreasing with depth. White gypsum pockets and veins are typically observed within the brown clay, often filling in the fissures. The lower grey clay is firm to stiff in consistency and of intermediate to high plasticity. Fine to coarse grained gravel and boulders are found occasionally in the grey clay, near the till interface.

Typical moisture content in the clay ranges from 40 to 60%. Atterberg Limit tests within the brown and grey clay has shown the brown clay is typically more plastic than the underlying grey clay. Liquid Limits in the brown clay typically range from 80 to 110% and the Plastic Index from 60 to 70%. Liquid Limits in the grey clay range from 65 to 90% and the Plastic Index ranges from 40 to 65%. Unconfined compressive strengths usually range from 71 to 100 kPa. Measured values within the upper brown clay are variable due to fissures. The unconfined compressive strengths generally yield a lower bound to undrained shear strengths (Ref 1).

Undrained shear strengths measured from unconfined compression tests are generally higher within the upper clay zone (~ top 2 to 3 m), typically in the order of 75 to 100 kPa. Below a depth of about 4 to 5 metres, strengths typically decrease approximately uniformly with increasing depth. As the underlying till layer is approached, strengths are typically in the order of 40 kPa but may be as low as 25 kPa. The higher undrained shear strengths with the upper brown clay and lower shear strengths at depth near the till is caused by weathering near the ground surface and decreasing over consolidation ratios to approximately normally consolidated conditions near the bottom of the deposit. They may also reflect artesian ground water conditions (and therefore low vertical effective stresses).

Effective shear strength parameters of the brown and grey clay obtained from consolidated undrained compression triaxial strength testing of a large number of relatively undisturbed samples yielded intact peak strength of c' = 19.6 kPa and ϕ' = 20.5^o and c' = 29.8 kPa and ϕ' = 15.8^o, respectively. While the effective large strain shear strength parameter for the brown and grey clay were c' = 14.5 kPa and ϕ' = 13.3^o and c' = 7.7 kPa and ϕ' = 15.7^o, respectively (Ref 2).

The effective shear strength parameters typically used by local geotechnical engineers in Winnipeg for slope stability analysis are c' = 5 kPa and ϕ' = 14^o for both clays.

The laboratory test results from the 2016 geotechnical investigation typically fall within these bounds.

Till Deposits

The glaciolacustrine clays are underlain by silty tills. The till is typically 3 to 6 m thick around the project site and may include a transition zone of till lenses in clay and clay inclusions in the till. The composition of the till is variable. The till is of varying consistency with the dense to very dense portions of the deposits being a basal till (hardpan). The upper horizon of the till deposit may be frequently loose and considerably softer, and water bearing likely an ablation till (putty till). The upper ablation till typically may have water contents ranging from 10 - 15% while the denser basal till will typically have water contents in the range of 7 - 10%. The upper tills contain more clay, and have a slightly higher plasticity than the lower tills with high silt contain. Unconfined compressive strengths ranging from 3.4 - 3.6 MPa have been reported for very dense tills with a moisture content of about 5% (Ref 1). Young's moduli typically range from 170 to 240 MPa (Ref 1). The tills are highly variable in terms of thickness, density and boulder content. Pockets of non-combustible gas, often under pressure are occasionally encountered in the till layer (Ref 1).

2.3.2 Bedrock

Limestone bedrock was encountered at the site at depths ranging from 13.7 to 14.3 m below existing ground surface. The limestone was light beige in colour, lightly fractured and had Rock Quality Designations (RQD) ranging from 49% to 83%.

3.0 SCOPE OF THE 2016 INVESTIGATION PROGRAM

3.1 GENERAL

This section provides a summary of the 2016 field investigation program, and laboratory test results; as well as the subsurface conditions encountered at the project site.

The 2016 geotechnical investigation was completed to determine the subsurface conditions at the proposed trunk sewer site. The results of the 2016 field investigation were presented in a separate Geotechnical Investigations Report (KGS Group 11-0107-18 dated July 2016). The results of this investigation program are presented in this Geotechnical Data Report.

3.2 TEST HOLE DRILLING AND SOIL SAMPLING

The test hole drilling and sampling program was completed by KGS Group from April 18 to 22, 2016. The approximate locations of the test holes are shown in Figure 1 and a summary of the locations is presented in Table 1.

The program consisted of drilling nine (9) deep test holes to investigate the subsurface stratigraphic conditions. The information obtained from the site investigations will be used to facilitate the design and construction of the various components of the storm sewer line project including the excavation of the launch and reception shafts.

Maple Leaf Drilling Enterprises of Winnipeg, Manitoba provided the drilling services using a track mounted drill rig equipped with 125 mm solid stem augers and NQ coring. The drilling was completed under the continuous supervision and direction of KGS Group personnel. Soil samples were collected directly off the auger flights typically at 1.5 m (5 ft.) intervals or at changes in soil strata encountered during drilling. The soil samples were visually inspected for material type and classified according to the Modified Unified Soil Classification System (USCS).

Standard Penetration Tests were completed in the glacial till material to evaluate the in-situ density. Clay samples were tested with a field Torvane to evaluate consistency and estimate undrained shear strengths. Upon completion of drilling, the test holes were examined for indications of sloughing and seepage, and then backfilled. Squeezing was observed in the silt and clay layers and minor sloughing was observed in the silt till. The squeezing observed in the silt and clay occurred at depths ranging from approximately 2.7 to 12.8 m. Detailed test hole log records incorporating all field observations, field test results, and laboratory test results are provided in the test hole log records in Appendix B.

3.3 GROUNDWATER MONITORING

A total of ten (10) pneumatic piezometers were installed in 2016 and one (1) standpipe was installed in 2015. Five (5) pneumatic piezometers were installed within the clay, two (2) pneumatics piezometers were installed within the till and three (3) were installed within the bedrock. Table 2 summarizes the installation details and the monitoring to date. The installation details of the piezometers are shown on the borehole log records provided in Appendix A and B. A summary of the piezometric monitoring completed to date is included on Table 2.

FIGURE 1
TEST HOLE LOCATIONS

TABLE 1
SUMMARY OF TESTHOLE LOCATIONS

Test hole ID	Location	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)
TH15-05	Approx. Parker Pond inlet	5,523,764	632,435	232.46	14.19
TH16-01	18 m north of CN tracks	5,523,861	632,463	233.00	16.31
TH16-02	Approx. 45 m Southeast of Shaft B - East of Wilton	5,523,978	632,433	233.92	15.85
TH16-03	Approx. 65 m Northwest of Shaft B - East of Wilton	5,524,081	532,378	233.39	15.85
TH16-04	Approx. 50 m Southeast of Shaft C - East of Wilton	5,524,189	632,313	233.02	13.29
TH16-05	Approx. 100 m Southeast of Shaft C - East of Wilton	5,524,144	632,333	233.15	14.93
TH16-06	Approx. Shaft A	5,523,883	632,477	233.27	16.38
TH16-07	Approx. 45 m Northwest of Shaft A - East of Wilton	5,523,934	632,451	233.99	16.31
TH16-08	Approx. Shaft B	5,524,036	632,399	233.3	16.15
TH16-09	Approx. Shaft C - Taylor Ave. Boulevard East of Wilton	5,524,243	632,294	232.73	15.04

TABLE 2
GROUNDWATER MEASUREMENTS

Test Hole:	TH15-05	TH16-05 (I9)		TH16-06 (SHAFT A)		TH16-07 (I3)		TH16-08 (SHAFT B)		TH16-09 (SHAFT C)	
Ground Elevation (m):	**232.80**	**233.15**	**233.15**	**233.27**	**233.27**	**233.99**	**233.99**	**233.30**	**233.30**	**232.73**	**232.73**
Piezometer No.:	**SP**	**36898**	**36890**	**36895**	**36891**	**36894**	**36892**	**36896**	**36893**	**36897**	**36889**
Tip Elevation (m):	**218.58**	**224.62**	**218.52**	**225.95**	**218.03**	**225.15**	**218.45**	**225.98**	**218.36**	**224.2**	**218.1**
Monitoring Zone:	**Silt till**	**Clay**	**Bedrock**	**Clay**	**Silt Till**	**Clay**	**Silt Till**	**Clay**	**Bedrock**	**Clay**	**Bedrock**
Date		**Piezometric Elevation (m)**									
7-Jul-15	225.08		-	-	-	-	-	-	-	-	-
14-Oct-15	225.25		-	-	-	-	-	-	-	-	-
25-May-16		230.03	226.36	227.47	226.30	229.97	(Note 1)	230.57	225.22	226.42	225.72
17-Jun-16	225.60	229.60	226.40	227.47	226.68	230.05	(Note 1)	230.50	224.86	226.42	225.65
26-Aug-16	225.17	229.52	227.10	227.47	227.39	229.90	(Note 1)	230.57	224.65	224.32	224.86
6-Oct-16	-	229.60	227.10	227.90	227.39	229.60	(Note 1)	230.36	224.07	225.62	225.36

Note 1: Erroneous reading

It should be noted that groundwater levels will fluctuate seasonally and following precipitation events.

4.0 LABORATORY TESTING

A diagnostic laboratory testing program was performed on representative soil samples to determine the relevant engineering properties of the subsurface soils relative to the trenchless construction method. Diagnostic testing completed included moisture content analyses, Atterberg Limit tests, grain size analysis and unconfined compressive strength testing for the cohesive soils. All laboratory testing was completed at a local laboratory accredited by Standards Council of Canada and testing was performed in accordance with ASTM standards.

Laboratory test results from the 2016 field program are summarized on Table 3. The laboratory testing for the 2015 and 2016 investigations are included in Appendix C.

5.0 REFERENCES

1. Department of Geological Engineering, the University of Manitoba, (1983). Geological Engineering Report for Urban Development of Winnipeg.

2. KGS Group, Acres Engineering, UMA Engineering (2004). Appendix B, Floodway Channel Pre-Design, Floodway Expansion Project, Project Definition and Environmental Assessment, Preliminary Engineering Report.

6.0 STATEMENT OF LIMITATIONS

6.1 THIRD PARTY USE OF REPORT

This report has been prepared for the City of Winnipeg and designers and bidders for the Cockburn and Calrossie Combined Sewer Relief Works project to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

6.2 GEOTECHNICAL INVESTIGATION STATEMENT OF LIMITATION

The geotechnical investigation findings and recommendations of this report were prepared in accordance with generally accepted professional engineering principles and practice. The findings and recommendations are based on the results of field and laboratory investigations, combined with an interpolation of soil and groundwater conditions found at and within the depth of the test holes drilled by KGS Group at this site. If conditions encountered during construction appear to be different from those shown by the test holes drilled by KGS Group or if the assumptions stated herein are not in keeping with the design, this office should be notified in order that the recommendations can be reviewed and modified if necessary.

TABLES

TABLE 3
SUMMARY OF LABORATORY TESTING

Testhole ID	Sample	Sample Depth (m)	Description	Moisture content (%)	Unconfined Compressive Strength (kPa)	Grain Size Analyses						Atterberg Limit		
						Gravel (> 4.75 mm)	Coarse Sand (2-4.75 mm)	Medium Sand (0.425-2 mm)	Fine Sand (0.075-0.425 mm)	Silt (0.002-0.075 mm)	Clay (<0.002 mm)	Liquid Limit (%)	Plastic Limit (%)	Plastic Index
TH16-02	S3	2.9	Silt	22.9								26	16	10
	S5	5.6	Clay	56.3								105	32	73
TH16-03	S5	5.3	Clay	53.4								98	29	69
TH16-05	S2	2.0	Silt	25								27	17	10
	S4	5.6	Clay	53.1								93	27	66
TH16-06	S4	3.1	Clay	49										
	S7	6.1	Clay	51.8	45	0	0	0.2	0.3	19.4	80.1	97	27	70
	S10	9.1	Clay	51.5	53							72	23	49
	S13	12.2	Clay	51.9										
TH16-08	S3	2.0	Silt	24.8										
	S5	3.1	Clay	51										
	S7	5.3	Clay	57.5								100	30	70
	S8	6.1	Clay	52.9	45	0	0	0.1	0.3	18.2	81.4	95	29	66
	S11	9.1	Clay	58.1	79							81	23	58
	S13	12.2	Clay	47.9										
TH16-09	S3	3.7	Clay	52.2										
	S6	6.1	Clay	57.4	117	0	0.1	0.3	0.5	18.2	80.9	98	29	69
	S9	9.1	Clay	46.5	43							85	25	60
	S12	12.2	Silt Till	54.1										

APPENDIX A

2015 TEST HOLE LOGS

KGS GROUP

SOIL DESCRIPTION CRITERIA

PRINCIPAL AND MINOR SOIL COMPONENTS

And	35 – 50%
With	20 – 35%
Some	10 – 20%
Trace	0 – 10%
Occasional	Trace of very local concentration

FIELD MOISTURE CONTENT

Dry	No moisture visible or to touch when fresh exposure is examined
Damp	Slightly wet to touch
Moist	Fresh exposure wet to touch
Wet	A film of water is readily visible around particles of granular soils, cohesive soils can readily be smeared or remolded; water can be squeezed out
Saturated	Water can easily be squeezed out
Free Water	Water completely separated from the soil particles

DEPOSITIONAL STRUCTURE

Massive	Structureless soil
Stratified (Layered)	Different soils or visible variations in soil constituents arranged in layers, generally but not necessarily parallel to one another, and not necessarily in horizontal position, at least 6 mm thick
Varved	Glaciolacustrine deposits with annual pairs of fine and coarser laminae (thin laminae of alternately deposited inorganic silt and clay)
Laminated	Closely spaced, regularly alternating layers of differing soils and/or colours, or shades of similar gradation, relatively consistent in thickness and consisting of sand, silt, or clay
Lens	Inclusions of a different soil within surrounding soils, which thins out horizontally and may not be continuous over any significant distance
Pocket	A different soil type of very limited thickness or lateral extent (a small lens)
Inclusions	Small pockets
Nuggety	A different soil type in the form of small lumps
Parting	Paper thin separation of one type by another

POST DEPOSITIONAL STRUCTURE

Fissured	A soil breaks along definite, pre-existing planes or fracture with little resistance to fracturing
Slickensided	Polished or glossy, sometimes striated surfaces resulting from movement of a material block relative to the adjacent blocks
Blocky/Friable/Platy	Cohesive soil that can be broken down into angular larger fragments (blocky), small fragments (friable), or thin plate-like fragments (platy) which resist further breakdown
Cemented	Soil particles or fragments held together by cemented materials, often chemical precipitants, or deposits within overall soil mass

GRAIN SIZE DISTRIBUTION IN COARSE GRAINED SOIL

Boulders	>200 mm ø
Cobbles	75 – 200 mm ø
Coarse Grained Gravel	19 – 75 mm ø
Fine Grained Gravel	4.75 – 19 mm ø
Coarse Grained Sand	2 – 4.75 mm ø
Medium Grained Sand	0.425 – 2 mm ø
Fine Grained Sand	0.075 – 0.425 mm ø

DENSITY OF GRANULAR SOIL

Description	Standard Penetration Test	Relative Density
Very Loose	0 – 4 Blows Per 0.3 m	<15%
Loose	4 – 10 Blows Per 0.3 m	15 – 35%
Compact	10 - 30 Blows Per 0.3 m	35 – 65%
Dense	30 - 50 Blows Per 0.3 m	65 – 85%
Very Dense	>50 Blows Per 0.3 m	>85%

CONSISITENCY OF COHESIVE SOILS

Description	Torvane	Standard Penetration Test
Very Soft	<12 kPa	<2
Soft	12 – 25 kPa	2 – 4
Firm	25 – 50 kPa	4 – 8
Stiff	50 – 100 kPa	8 – 15
Very Stiff	100 – 200 kPa	15 – 30
Hard	>200 kPa	>30

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH15-01**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Parker Pond Retention Basin Investigation
SITE Parker Pond
LOCATION Northeast corner
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.80
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/11/2015
UTM (m) N 5,523,789
E 632,421

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
232	1	5		**COAL DUST** - Black, wet, loose, with fine to coarse grained sand.	S1			
231.6				**SILTY CLAY (CH)** - Brown, moist, stiff, high plasticity, trace organics.				
231	2	10		- No organics below 1.53 m. - Infiltration of water into the hole from the coal dust layer. - Trace silt pockets below 2.14 m.	S2			
230	3			- Trace oxidation below 3.05 m.				
229	4	15			S3			
228	5			- Firm below 4.88 m. - Grey below 5.19 m.	S4			
227	6	20		- Trace fine grained sand below 6.10 m.				
226	7				S5			
225	8	25			S6			
224								
223.7	9	30		**END OF HOLE AT 9.15 m**				
223	10			Notes: 1. Test hole open to 9.15 m upon completion of drilling. 2. Water level in test hole 0.92 m below grade immediately after drilling due to surface water infiltration. 3. Backfilled test hole with cuttings and bentonite.				
222	11	35						
221	12	40						
220								

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH15-02**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Parker Pond Retention Basin Investigation
SITE Parker Pond
LOCATION Centre north
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.70
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/11/2015
UTM (m) N 5,523,757
E 632,240

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
232.5				**TOPSOIL** - Black, moist, soft, trace rootlets.			
232.1				**COAL DUST** - Black, wet, loose, with fine to coarse grained sand.			
232				**SILTY CLAY (CH)** - Brown, moist, stiff, high plasticity, trace fine grained sand.			
	1	5				S1	
231				- Trace oxidation below 1.53 m.			
	2					S2	
230				- 50 mm thick silt seam at 2.44 m.			
	3	10		- Water infiltration into the test hole from the coal dust.			
				- Firm below 3.36 m.			
229						S3	
	4						
		15					
228				- Silt pockets below 4.58 m.			
	5						
				- Grey below 5.19 m.		S4	
227							
226.6	6	20		**END OF HOLE AT 6.10 m**			
226				Notes: 1. Test hole open to 6.10 m upon completion of drilling. 2. Water level in test hole 6.10 m below grade immediately after drilling. 3. Backfilled test hole with cuttings and bentonite.			
	7	25					
225							
	8						
224		30					
	9						
223							
	10	35					
222							
	11						
221							
	12	40					
220							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR Maple Leaf Enterprises
INSPECTOR J. MACLENNAN
APPROVED AMH
DATE 12/21/15

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH15-03**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Parker Pond Retention Basin Investigation
SITE Parker Pond
LOCATION Northwest corner
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.30
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/11/2015
UTM (m) N 5,523,679
E 631,939

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
232				**SILTY CLAY Fill** - Brown, moist, firm, high plasticity, some fine to coarse grained sand, trace fine grained gravel.			
231.4							
	1			**CLAYEY SILT** - Brown, moist, firm, intermediate plasticity.		S1	
231							
230.8		5		**SILTY CLAY (CH)** - Brown, damp, firm, high plasticity, trace fine grained sand, trace silt pockets, trace oxidation.			
	2					S2	
230							
	3	10					
229							
	4					S3	
				- Firm below 3.97 m.			
228		15					
				- Grey below 4.56 m.			
	5						
227						S4	
				- Grain Size Distribution: Gravel (0%), Sand (0.6%), Silt (23.2%), and Clay (76.2%) at 5.3 m.			
226.2	6	20		**END OF HOLE AT 6.10 m**			
226							
				Notes: 1. Test hole open to 5.80 m upon completion drilling. 2. Trace water in the bottom of the test hole. 3. Backfilled test hole with cuttings and bentonite.			
	7						
225		25					
	8						
224							
	9	30					
223							
	10						
222		35					
	11						
221							
	12	40					
220							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH15-04**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Parker Pond Retention Basin Investigation
SITE Parker Pond
LOCATION Centre south
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.00
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/11/2015
UTM (m) N 5,523,687
E 632,144

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
231.1				**SILTY CLAY** - Brown, damp, stiff, high plasticity.							
231	1			**CLAYEY SILT** - Brown, wet, firm, intermediate plasticity, trace fine grained sand.							
230.5		5		**SILTY CLAY (CH)** - Brown, moist, firm, high plasticity, trace fine to coarse grained sand, trace oxidation.							
230	2							S1			
								S2			
229	3	10									
				- Stiff between 3.66 and 4.58 m.				S3			
228	4										
		15		- Grey, trace fine grained gravel, silt pockets below 4.58 m.							
227	5							S4			
226	6	20									
225	7							S5			
		25		- Trace fine grained sand below 7.63 m.		7.6					
224	8			- Soft between 8.24 and 10.98 m. - Grain Size Distribution: Gravel (1.5%), Sand (7.2%), Silt (27.1%), and Clay (64.2%) at 8.4 m.				S6			
223	9	30		- Increased silt pockets between 9.15 and 10.07 m.							
222	10							S7			
		35									
221	11			- Soft below 11.29 m.				S8			
220	12	40				12.2					

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH15-04

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
218.9				**SILT TILL** - Brown, moist, compact, low plasticity, some fine to coarse grained sand, some fine to coarse grained gravel.				S9			
		45								▲8	
218	14			- Split spoon dropped last 300 mm of SPT. Suspected gravel seam from 13.88 to 14.18 m.				S10	61		
217	15										
216.8		50				15.2		S11	2		
				END OF HOLE AT 15.27 m							
216	16			Notes: 1. Test hole open to 1.22 m upon completion of drilling. 2. Installed pneumatic piezometer #036650 at 7.63 m and pneumatic piezometer #036654 at 12.20 below grade. 3. Backfilled test hole with grout.							
		55									
215	17										
214	18	60									
213	19										
		65									
212	20										
211	21	70									
210	22										
209	23	75									
208	24										
		80									
207	25										
206	26	85									
205	27										
		90									
204	28										

SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH15-05**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Parker Pond Retention Basin Investigation
SITE Parker Pond
LOCATION Southeast corner
DRILLING METHOD 125 mm ø Solid Stem Auger, ACKER MP5 Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.46
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 6/11/2015
UTM (m) N 5,523,764
E 632,435

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
232										20 40 60	20 40 60 80
231.9				**COAL DUST** - Black, wet, soft, with fine to coarse grained sand.							
	1	5		**SILTY CLAY (CH)** Brown, moist, stiff, high plasticity, trace fine grained sand.				S1			
231								S2			
	2										
230								S3			
	3	10		- 50 mm thick silt seam at 2.90 m. - Silt pockets, trace oxidation below 3.05 m. - Firm between 3.05 and 4.58 m.							
229								S4			
	4										
228		15									
	5			- Firm below 5.49 m.				S5			
227											
	6	20									
226								S6			
	7			- Grey below 7.32 m.							
225		25									
	8							S7			
224											
	9	30									
223								S8			
	10										
222		35		- Increased silt pockets below 10.68 m.							
	11							S9			
221											
	12	40		- Trace fine to coarse grained sand below 12.20 m.							
220								S10			

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

KGS GROUP

SUMMARY LOG

REFERENCE NO.

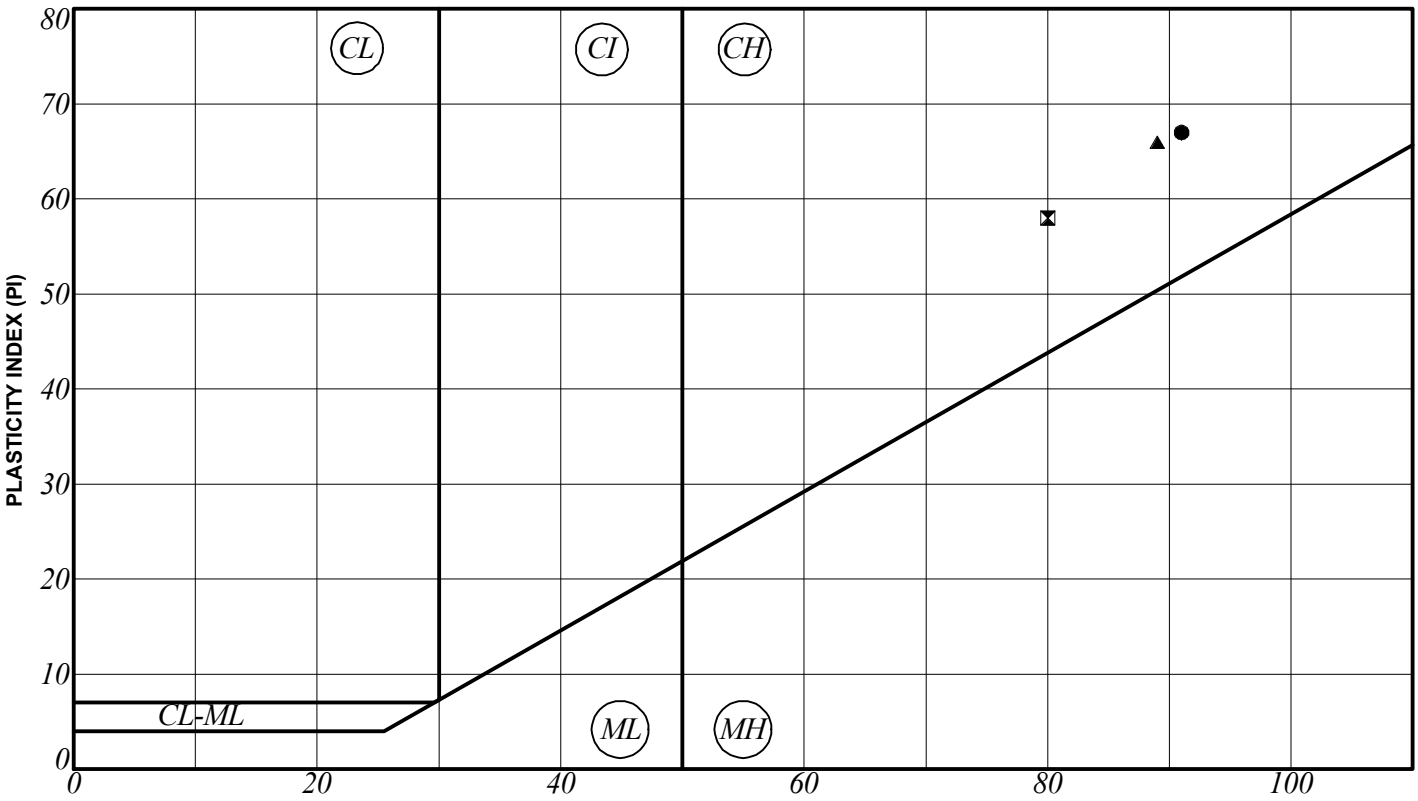
HOLE NO.
TH15-05

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
				- Grain Size Distribution: Gravel (0.1%), Sand (4.2%), Silt (24%), and Clay (71.7%) at 13.0 m		13.7					
218.4	14	45		**SILT TILL** - Brown, damp, dense, low plasticity, some fine to coarse grained sand, some fine to coarse grained gravel.		13.9				▲50 50 blows for 12 mm	
218.3						14.2		S11 S12	3		
218				**END OF HOLE AT 14.19 m**							
	15	50		Notes: 1. Test hole open to 14.19 m upon completion of drilling. 2. Water level in test hole 2.44 m below grade immediately after drilling. 3. Installed a standpipe piezometer within the silt till. 2. Backfilled test hole with sand from 13.73 to 14.19 m, and bentonite from 13.73 m to ground surface.							
217											
	16										
216		55									
	17										
215											
	18	60									
214											
	19										
213											
	20	65									
212											
	21										
211		70									
	22										
210											
	23	75									
209											
	24										
208		80									
	25										
207											
	26	85									
206											
	27										
205		90									
	28										

SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	AMH	12/21/15

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH15-03	5.3	S4	91	24	67	0.6	23.2	76.2	51.6	CH
⊠	TH15-04	8.4	S6	80	22	58	7.2	27.1	64.2	46.3	CH
▲	TH15-05	13.0	S10	89	23	66	4.2	24.0	71.7	49.8	CH

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Parker Pond Retention Basin Investigation

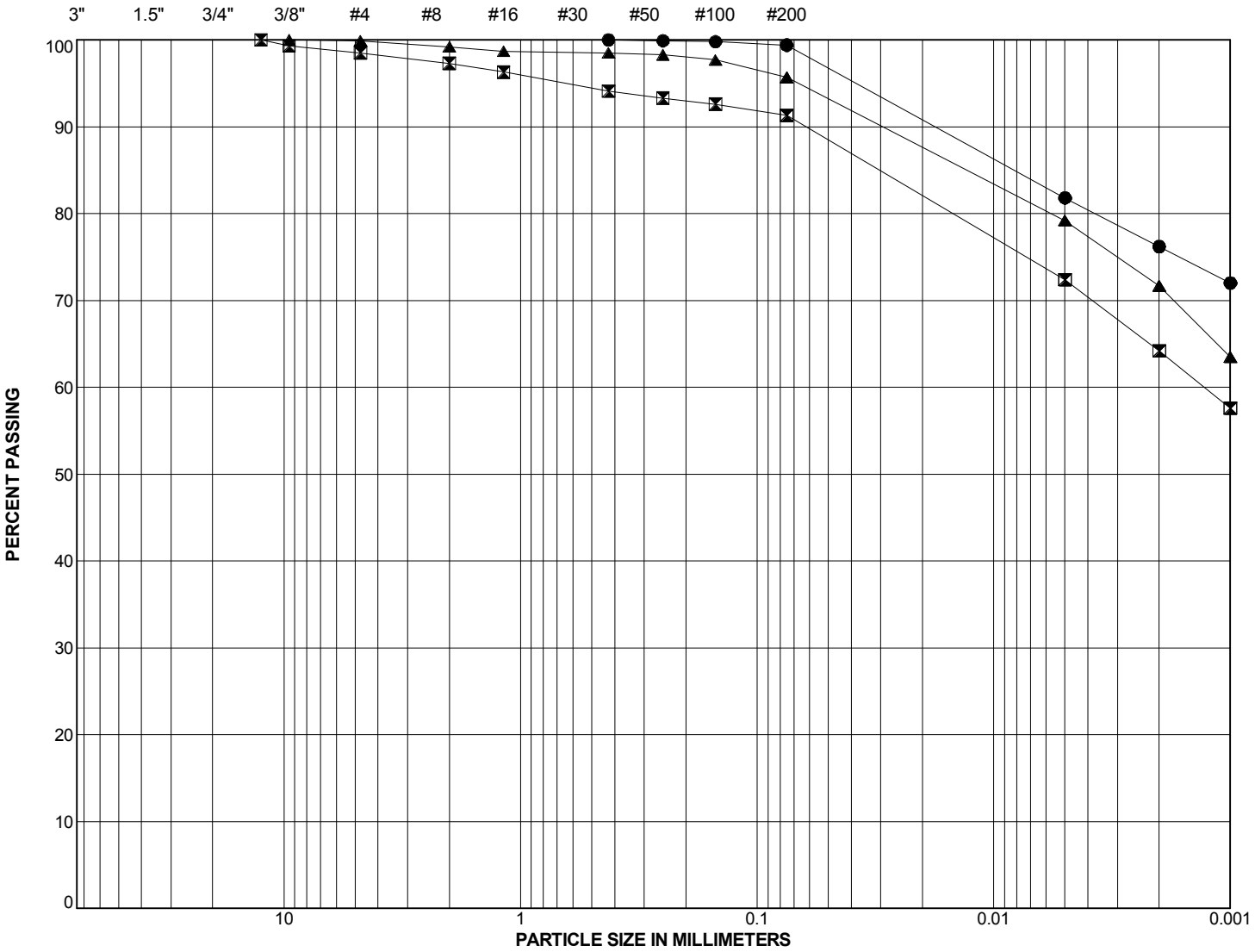
A-LINE PLOT

December 2015	Figure A1	Page 1 of 1

A-LINE PLOT P:\PROJECTS\2011\11-0107-18\DESIGN\GEOLOGS\PARKER POND\PARKERPOND_LOGS.GPJ

SIEVE ANALYSIS

HYDROMETER ANALYSIS



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*TH15-03*	*5.3*	*S4*	*0.0*	*0.6*	*23.2*	*76.2*	*99.4*			*CH*
⧓	*TH15-04*	*8.4*	*S6*	*1.5*	*7.2*	*27.1*	*64.2*	*91.3*			*CH*
▲	*TH15-05*	*13.0*	*S10*	*0.1*	*4.2*	*24.0*	*71.7*	*95.7*			*CH*

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Parker Pond Retention Basin Investigation

GRAIN SIZE ANALYSES

December 2015	Figure A2	Page 1 of 1

SIEVE ANALYSIS P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\LOGS\PARKER POND\PARKERPOND_LOGS.GPJ

APPENDIX B

2016 TEST HOLE LOGS

KGS GROUP

SOIL DESCRIPTION CRITERIA

PRINCIPAL AND MINOR SOIL COMPONENTS

And	35 – 50%
With	20 – 35%
Some	10 – 20%
Trace	0 – 10%
Occasional	Trace of very local concentration

FIELD MOISTURE CONTENT

Dry	No moisture visible or to touch when fresh exposure is examined
Damp	Slightly wet to touch
Moist	Fresh exposure wet to touch
Wet	A film of water is readily visible around particles of granular soils, cohesive soils can readily be smeared or remolded; water can be squeezed out
Saturated	Water can easily be squeezed out
Free Water	Water completely separated from the soil particles

DEPOSITIONAL STRUCTURE

Massive	Structureless soil
Stratified (Layered)	Different soils or visible variations in soil constituents arranged in layers, generally but not necessarily parallel to one another, and not necessarily in horizontal position, at least 6 mm thick
Varved	Glaciolacustrine deposits with annual pairs of fine and coarser laminae (thin laminae of alternately deposited inorganic silt and clay)
Laminated	Closely spaced, regularly alternating layers of differing soils and/or colours, or shades of similar gradation, relatively consistent in thickness and consisting of sand, silt, or clay
Lens	Inclusions of a different soil within surrounding soils, which thins out horizontally and may not be continuous over any significant distance
Pocket	A different soil type of very limited thickness or lateral extent (a small lens)
Inclusions	Small pockets
Nuggety	A different soil type in the form of small lumps
Parting	Paper thin separation of one type by another

POST DEPOSITIONAL STRUCTURE

Fissured	A soil breaks along definite, pre-existing planes or fracture with little resistance to fracturing
Slickensided	Polished or glossy, sometimes striated surfaces resulting from movement of a material block relative to the adjacent blocks
Blocky/Friable/Platy	Cohesive soil that can be broken down into angular larger fragments (blocky), small fragments (friable), or thin plate-like fragments (platy) which resist further breakdown
Cemented	Soil particles or fragments held together by cemented materials, often chemical precipitants, or deposits within overall soil mass

GRAIN SIZE DISTRIBUTION IN COARSE GRAINED SOIL

Boulders	>200 mm ø
Cobbles	75 – 200 mm ø
Coarse Grained Gravel	19 – 75 mm ø
Fine Grained Gravel	4.75 – 19 mm ø
Coarse Grained Sand	2 – 4.75 mm ø
Medium Grained Sand	0.425 – 2 mm ø
Fine Grained Sand	0.075 – 0.425 mm ø

DENSITY OF GRANULAR SOIL

Description	Standard Penetration Test	Relative Density
Very Loose	0 – 4 Blows Per 0.3 m	<15%
Loose	4 – 10 Blows Per 0.3 m	15 – 35%
Compact	10 - 30 Blows Per 0.3 m	35 – 65%
Dense	30 - 50 Blows Per 0.3 m	65 – 85%
Very Dense	>50 Blows Per 0.3 m	>85%

CONSISITENCY OF COHESIVE SOILS

Description	Torvane	Standard Penetration Test
Very Soft	<12 kPa	<2
Soft	12 – 25 kPa	2 – 4
Firm	25 – 50 kPa	4 – 8
Stiff	50 – 100 kPa	8 – 15
Very Stiff	100 – 200 kPa	15 – 30
Hard	>200 kPa	>30

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-01 (I1)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION 18 m North of CN Tracks
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.00
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/18/2016
UTM (m) N 5,523,861
E 632,463

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
232.1				**SAND & GRAVEL FILL** - Brown, wet, loose, some silt.	
232	1			**CLAY** - Grey, damp, stiff, high plasticity, some silt.	
					S1
231.5		5		**SILT** - Tan, moist, soft, low plasticity, some clay.	
					S2
231	2				
230.6				**CLAY** - Brown, moist, stiff, high plasticity, some silt.	
					S3
230	3	10		- Water infiltrating test hole below 3.05 m.	
				- Firm to stiff below 3.36 m.	
				- Some silt nodules, oxidation below 3.66 m.	S4
229	4				
		15		- Firm below 4.57 m.	
228	5				
				- Grey below 5.18 m.	S5
				- No silt nodules from 5.18 to 6.10 m.	
				- Mottled grey and brown from 5.80 to 6.10 m.	
227	6	20			
					S6
226	7				
		25			
225	8				
					S7
224	9	30		- Trace to some fine to coarse grained sand below 9.14 m.	
					S8

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C4 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\TRENCHLESSLDS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-01 (I1)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
		35		- Increased fine to coarse grained sand content below 10.67 m.					
222	11								
						S9			
221	12	40							
						S10			
220	13			- Soft to firm below 13.12 m.					
		45							
219.0	14			**SILT TILL** - Tan, moist, loose, low plasticity, some fine to coarse grained sand, trace fine grained gravel.					
						S11			
218	15			- Increased density, with fine to coarse grained sand content below 14.6 m.					
		50		- Non-plastic from 14.95 to 15.56 m.					
				- Damp, compact below 15.20 m.		S12	56	▲4 ▲20 ▲9	
217	16					S13			
216.7				**AUGER REFUSAL AT 16.31 m.**					
		55		Notes:					
216	17			1. Test hole open to 3.05 m below grade after drilling. 2. Water level in test hole at 0.91 m below grade after drilling. 3. Test hole backfilled to grade with bentonite chips and auger cuttings.					
215	18	60							
214	19								
		65							
213	20								
212	21	70							

SAMPLE TYPE ⊡ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C4 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\TRENCHLESS\LDS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-02 (I4/5)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. 45 m Southeast of Shaft B - East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.92
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/18/2016
UTM (m) N 5,523,978
E 632,433

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
233	0			**SANDY SILT** - Mottled black and brown, damp, loose to compact, non-plastic, with fine to coarse grained sand, trace fine to coarse grained gravel.		S1	
	1			- Low plasticity, some clay below 1.07 m.			
232.4		5		**CLAY** - Mottled grey and black, damp, stiff, high plasticity, some fine to coarse grained sand.		S2	
232	2						
231.8				**SILT** - Tan, damp to moist, low plasticity, soft, some clay, trace coarse grained sand.		S3	
231	3	10					
230.4				**CLAY** - Brown, moist, stiff, high plasticity, some silt, trace silt nodules.		S4	
230	4						
		15		- Mottled grey and brown, trace oxidation below 4.57 m.			
229	5					S5	
228	6	20		- Firm below 6.10 m.			
227	7					S6	
		25		- Grey, trace coarse grained sand below 7.62 m.			
226	8					S7	
				- Soft to firm below 8.54 m.			
225	9	30					
224							

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

105

SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C4 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\TRENCHLESS\LDS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-02 (I4/5)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
								20 40 60	20 40 60 80
223	11	35				S8			◆
									◆
				- Soft below 11.59 m.		S9			
222	12	40							
221	13					S10			◆
		45							◆
220	14			- Some fine to coarse grained sand, trace fine grained angular gravel below 14.02 m.					
219.3				**SILT TILL** - Tan, moist, loose, low plasticity, some fine to coarse grained sand, trace fine grained gravel.					
219	15	50		- Compact, trace to some fine to coarse grained gravel below 15.24 m.		S11			
				- Spoon contained angular rock pieces (~30 mm diameter) below 15.25 m.		S12	89	▲6 ▲50 SPT refusal at 75 mm into 2nd set	
218.1						S13			
218	16			**AUGER REFUSAL AT 15.85 m.**					
		55		Notes: 1. Test hole open to 14.94 m below grade after drilling. 2. Water level in test hole at 9.45 m below grade after drilling. 3. Test hole backfilled to grade with bentonite chips and auger cuttings.					
217	17								
216	18	60							
215	19								
		65							
214	20								
213	21	70							

SAMPLE TYPE ▯ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C4 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\TRENCHLESS\LDS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-03 (I7)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. 65 m Northwest of Shaft B - East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.39
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/19/2016
UTM (m) N 5,524,081
E 632,378

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
233	0	0		**ORGANIC CLAY FILL** - Black, damp, stiff, intermediate plasticity, some fine to coarse grained sand, some fine to coarse grained gravel.	S1			
232	1	5						
231.3	2			**SILT** - Brown, moist, soft, low plasticity, some clay.	S2			
231								
230.8				**CLAY** - Brown, moist, stiff, high plasticity, some silt.	S3			
230	3	10		- Trace silt pockets below 3.35 m.	S4			
229	4	15		- Mottled grey and brown below 4.12 m.				
228	5			- Firm below 5.18 m.	S5			
227	6	20			S6			
226	7	25						
225	8			- Grey, increased silt pockets below 8.23 m. - Trace fine to coarse grained sand below 8.54 m.	S7			
224	9	30			S8			

SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-03 (I7)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
223	11	35		- Soft below 10.37 m.					
222	12	40			S	S9			
221									
220.4	13			**SILT TILL** - Tan, moist, firm, low plasticity, some fine to coarse grained sand, trace fine grained gravel.	S	S10			
220		45			S	S11	100	▲50 SPT refusal at 75 mm into 1st set	
219.4	14				S	S12			
219				**AUGER REFUSAL AT 15.85 m.**					
	15	50		Notes: 1. Test hole open to 9.45 m below grade after drilling. 2. Water level in test hole at 8.53 m below grade after drilling. 3. Test hole backfilled to grade with bentonite chips and auger cuttings.					
218									
217	16								
		55							
216	17								
215	18	60							
214	19								
		65							
213	20								
212	21	70							

SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-04 (I11)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. 50 m Southeast of Shaft C - East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.02
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/19/2016
UTM (m) N 5,524,189
E 632,313

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
232.1				**ORGANIC CLAY FILL** - Black, moist, firm, intermediate plasticity, trace fine grained gravel, trace fine to coarse grained sand.		S1			
232	1			**CLAY** - Brown, damp, stiff, high plasticity, trace fine to coarse grained sand.					
		5				S2			
231	2								
230.7				**SILT** - Brown, moist, soft, low plasticity, some clay.		S3			
230.4				**CLAY** - Brown, damp, stiff, high plasticity, some silt, trace fine to coarse grained sand.					
230.0	3	10		**SILT** - Brown, moist, soft, low plasticity, some clay.					
229.2				**CLAY** - Brown, moist, stiff, high plasticity, some silt, trace silt pockets.					
229	4					S4			
		15							
228	5					S5			
227	6	20		- Grey below 5.79 m. - Firm below 6.10 m. - Mottled brown and grey from 6.10 to 6.86 m.					
						S6			
226	7								
		25							
225	8					S7			
				- Increased silt pockets from 8.54 m to 9.14 m.					
224	9	30		- Soft from 9.15 to 10.07 m.					

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-04 (I11)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
222	11	35				S8			
221	12	40				S9			
220.8				**SILT TILL** - Tan, moist, loose, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel. - Augers wet below 12.19 m.					
220	13			- Compact below 12.81 m.		S10			
219.7						S11	100	▲50 SPT refusal at 25 mm into 1st set	
				AUGER REFUSAL AT 13.29 m.					
219	14	45		Notes: 1. Test hole open to 2.74 m below grade after drilling. 2. Water level in test hole at 2.74 m below grade after drilling. 3. Test hole backfilled to grade with bentonite chips and auger cuttings.					
218	15	50							
217	16								
216	17	55							
215	18	60							
214	19								
213	20	65							
212	21	70							

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH16-05 (I9)**

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. 100 m Southeast of Shaft C - East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.15
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/19/2016
UTM (m) N 5,524,144
E 632,333

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION
233			**ORGANIC CLAY** - Mottled brown and black, moist, stiff, low plasticity, with fine to coarse grained sand, some rootlets.
			- No rootlets below 0.30 m.
232.1	1		
232			**CLAY** - Brown, damp, stiff, high plasticity.
231.6		5	**SILT** - Tan, moist, soft, low plasticity, some clay.
	2		
231			
230.6			**CLAY** - Brown, damp, stiff, high plasticity, some silt.
230.1	3	10	
230			**SILT** - Tan, moist, soft, low plasticity, some clay.
229.6			**CLAY** - Brown, moist, stiff, high plasticity, some silt, trace silt pockets.
229	4		
		15	- Silt seam from 4.57 to 4.88 m.
	5		- Firm below 4.88 m.
228			- Grey below 5.18 m.
	6	20	
227			
	7		
226		25	
	8		- Soft to firm, silt pockets below 7.92 m.
225			
	9	30	
224			

PIEZ. LOG: P at 8.4 m

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %
	S1		
	S2		
	S3		
	S4		
	S5		
8.4	S6		
8.5			

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE: Auger Grab | Split Spoon | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-05 (I9)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
223	11	35					S7			20 40 60	20 40 60 80
222											
221	12	40		- Auger flights coming up wet below 12.19 m.			S8				
220.0	13										
220				**SILT TILL** - Grey, damp, loose to compact, low plasticity, some fine to coarse grained snad, trace to some fine to coarse grained gravel.			S9				
219.4		45		- Auger refusal, switch to coring at 13.11 m.			S10			▲50 SPT refusal at 25 mm into 1st set.	
219	14			**LIMESTONE BEDROCK** - Light beige, lightly fractured, strong, RQD = 49%.							
				- Decreased fractures below 14.42 m.		14.5	R1		81		
218.2	15					14.6					
218		50		**END TEST HOLE AT 14.93 m.**		14.9					
				Notes:							
217	16			1. Installed RST flow - through piezometer PN36898 at 8.53 m below grade and PN36890 at 14.63 m.							
				2. Backfilled test hole with bentonite - cement grout mixture from 14.93 m to grade.							
		55		3. Minor sloughing in test hole from 12.80 m to 13.72 m.							
216	17										
215	18	60									
214	19										
213	20	65									
212	21	70									

SAMPLE TYPE ▨ Auger Grab ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-06 (Shaft A)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. Shaft A
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.27
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/20/2016
UTM (m) N 5,523,883
E 632,477

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %
233			**SILTY CLAY FILL** - Mottled brown and black, damp, stiff, high plasticity, some fine to coarse grained sand, trace organics.					
			- Increased sand content between 0.61 and 0.91 m.					
			- Trace silt lenses below 0.76 m.					
232.2	1		**ORGANIC CLAY** - Black, damp, stiff, high plasticity, trace fine to coarse grained sand.				S1	
232		5					S2	
231.3	2		**SILT** - Tan, moist, soft, low plasticity, trace clay.				S3	
231			- Increased clay content below 2.29 m.					
	3	10	- Auger flights coming up wet below 3.05 m.					
230.1			**CLAY** - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets.				S4	100
230							S5	
	4		- 12 mm diameter silt inclusion at 4.11 m.					
229		15						
	5						S6	
228								
	6	20	- Firm below 6.10 m.				S7	100
227			- Test hole sloughing at 6.10 m.				S8	
			- Unconfined Compressive Strength measured to be 45 kPa at 6.10 m.		7.2			
	7				7.3			
226		25						
	8							
225							S9	
			- Grey below 8.53 m.					
	9	30						
224			- Soft below 9.14 m.				S10	100
			- Unconfined conmpressive strength was measured to be 53 kPa at 9.14 m.					
			- No recovery from 9.14 to 9.75 m.				S11	

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE ▨ Auger Grab ▯ Shelby Tube ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-06 (Shaft A)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
223	11	35		- Firm, some silt pockets below 10.67 m.							
222	12	40					S	12			
221	13						S	13	100		
220											
219.7		45		**SILT TILL** - Tan, moist, loose, low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel.							
219	14			- Encountered coarse grained gravel and cobbles while drilling below 13.72 m.			S	14			
218	15	50		- Increased coarse grained gravel with depth below 15.24 m.		15.1	S	15			
				- Compact below 15.25 m.		15.2	S	16	83	▲9 ▲9 ▲13	
217	16						S	17			
216.9		55		- Spoon contained angular rock pieces (~30 mm diameter) below 16.32 m.		16.4	S	18	100	▲32 ▲60 *SPT refusal at 75 mm into 2nd se	
216	17			**AUGER REFUSAL AT 16.38 m.**							
215	18	60		Notes:							
214	19			1. Installed RST flow - through piezometer PN36891 at 15.24 m below grade and PN36895 at 7.32 m.							
213	20	65		2. Backfilled test hole with bentonite - cement grout mixture from 16.38 m to grade.							
212	21	70									

SAMPLE TYPE: Auger Grab | Shelby Tube | Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-07 (I3)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. 45 m Northwest of Shaft A - East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger, B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.99
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/20/2016
UTM (m) N 5,523,934
E 632,451

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL / %
233										20 40 60	20 40 60 80
232.9	1			**SAND FILL** - Brown, dry to damp, loose to compact, well graded, fine to coarse grained, some fine to coarse grained gravel.				S1			
232.5		5		**ORGANIC SAND** - Black, damp, loose, non plastic, some gravel.							
232	2			**ORGANIC CLAY** - Black, damp, stiff, high plasticity, some fine to coarse grained sand.							
231.7				**SILT** - Brown, moist, soft, low plasticity, some clay.				S2			
231	3	10						S3			
230.2				**CLAY** - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets.							
230	4							S4			
229	5	15									
228	6	20		- Firm below 6.10 m.				S5			
227	7							S6			
226	8	25		- Grey below 7.62 m.							
225	9	30				8.7		S7			
224						8.8					

SAMPLE TYPE ⊠ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-07 (I3)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
223	11	35					S	S8			
222	12	40		- Soft to firm below 12.19 m.			S	S9			
221	13	45					S	S10			
220	14										
219.4				**SILT TILL** - Tan, moist, compact to dense, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel.			S	S11			
219	15	50				15.4	S	S12	100	▲22 ▲49 ▲53	
				- 180 mm sand seam at 15.45 mm.		15.5	S	S13			
218	16			- Auger refusal at 15.85 m.			S	S14	100	▲12 ▲16 ▲9	
217.7				- Spoon contained angular rock pieces (~30 mm diameter) below 16.08 m.		16.3					
217	17	55		**END TEST HOLE AT 16.31 m.**							
216	18	60		Notes: 1. Installed RST flow - through piezometer PN36892 at 15.54 m below grade and PN36894 at 8.84 m. 2. Backfilled test hole with bentonite - cement grout mixture from 16.31 m to grade. 3. Water level in test hole at 5.18 m below grade after drilling.							
215	19	65									
214	20										
213	21	70									

SAMPLE TYPE ⊡ Auger Grab ⊠ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-08 (Shaft B)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. Shaft B
DRILLING METHOD 100 mm ø Solid Stem Auger and NQ coring , B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 233.30
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/21/2016
UTM (m) N 5,524,036
E 632,399

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %
233				**TOPSOIL** - Black, damp, firm, non plastic, some fine to coarse grained sand, some rootlets.					
232.7				- No rootlets below 0.30 m.					
	1			**ORGANIC CLAY** - Black, damp, stiff, high plasticity, trace oxidation, trace fine grained sand.				S1	
232									
231.8		5		**SILT** - Tan, moist, soft, low plasticity, some clay.				S2	
	2			- Augers wet below 1.52 m.				S3	100
231									
230.9				**CLAY** - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets.				S4	
	3	10						S5	92
230									
	4							S6	
229		15		- Decreased silt pockets below 4.57 m.					
	5			- Firm below 4.88 m.				S7	
228									
	6	20		- Unconfined compressive strength was measured to be 45 kPa at 6.10 m.				S8	100
227									
	7					7.2		S9	
226						7.3			
	8	25		- Trace to some silt pockets below 7.62 m.					
225				- Grey below 8.23 m.				S10	
	9	30							
224				- Unconfined compressive strength was measured to be 79 kPa at 9.14 m.				S11	100
								S12	

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE: Auger Grab | Shelby Tube | Split Spoon | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-08 (Shaft B)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
223	11	35		- Soft below 10.07 m.							
222	12	40									
221	13							S13	100		
220				**SILT TILL** - Tan, damp, loose to compact, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel.							
219.9	14	45		- Compact below 14.02 m.				S14			
219.0				- Auger refusal, switch to coring at 14.33 m.							
219				**LIMESTONE BEDROCK** - Light beige, lightly fractured, RQD = 83%.				S15	56	▲ 13, 17, 7	
	15	50		- Recovery from 14.33 to 16.17 m consisted of limestone gravel, with a maximum diameter of 600 mm.	P	14.8					
218				- Loss of return water below 15.25 m.		14.9		R1	72		
217.1	16			- 50 mm thick silt seam at 16.00 m.		16.2					
217				**END TEST HOLE AT 16.15 m.**							
	17	55		Notes:							
216				1. Installed RST flow - through piezometer PN36896 at 7.32 m below grade and PN36893 at 14.94 m.							
	18	60		2. Backfilled test hole with bentonite - cement grout mixture from 16.15 m to grade.							
215				3. Water level in test hole at 12.19 m below grade after drilling to 14.33 m.							
214	19	65									
213	20										
	21	70									
212											

SAMPLE TYPE: Auger Grab | Shelby Tube | Split Spoon | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

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KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-09 (Shaft C)

CLIENT CITY OF WINNIPEG
PROJECT Cockburn and Calrossie Combined Sewer Relief
SITE Wilton St from Taylor Ave to CN Tracks
LOCATION Approx. Shaft C - Taylor Ave. Boulevard East of Wilton
DRILLING METHOD 100 mm ø Solid Stem Auger and NQ coring , B37X Mobile Drill

JOB NO. 11-0107-18
GROUND ELEV. 232.73
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/22/2016
UTM (m) N 5,524,243
E 632,294

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION
232.1	0	0	**SILTY CLAY** - Mottled brown and black, damp, stiff, high plasticity, some organics, trace silt pockets.
232	1		**SILT** - Tan, damp to moist, soft, low plasticity, some clay.
			- Clay seam from 1.07 to 1.22 m.
231.4		5	**CLAY** - Mottled brown and grey, moist, stiff, high plasticity, some silt, some silt pockets.
231	2		
230	3	10	- Shelby tube pushed at 3.05 m, 0% recovery.
229	4		
228		15	- Firm to stiff below 4.58 m.
	5		
227		20	
	6		- Unconfined compressive strength was measured to be 117 kPa at 6.1 m.
226			- Grey below 6.71 m.
	7		- Sulphate pieces (~30 mm diameter) at 6.86 m. - Firm below 7.01 m.
225		25	
	8		
224			
	9	30	- Unconfined compressive strength was measured to be 43 kPa at 9.14 m.
223			- Soft below 9.75 m.

PIEZ. LOG: P at 8.4 m and 8.5 m

DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %
	S1		
	S2		
	S3		100
	S4		
	S5		
	S6		
	S7		
8.4	S8		
8.5			
	S9		100
	S10		

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
20 40 60

Cu POCKET PEN (kPa) ★
Cu TORVANE (kPa) ◆
20 40 60 80
PL MC LL
%
20 40 60 80

SAMPLE TYPE: Auger Grab | Shelby Tube | Split Spoon | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16

KGS GROUP

SUMMARY LOG

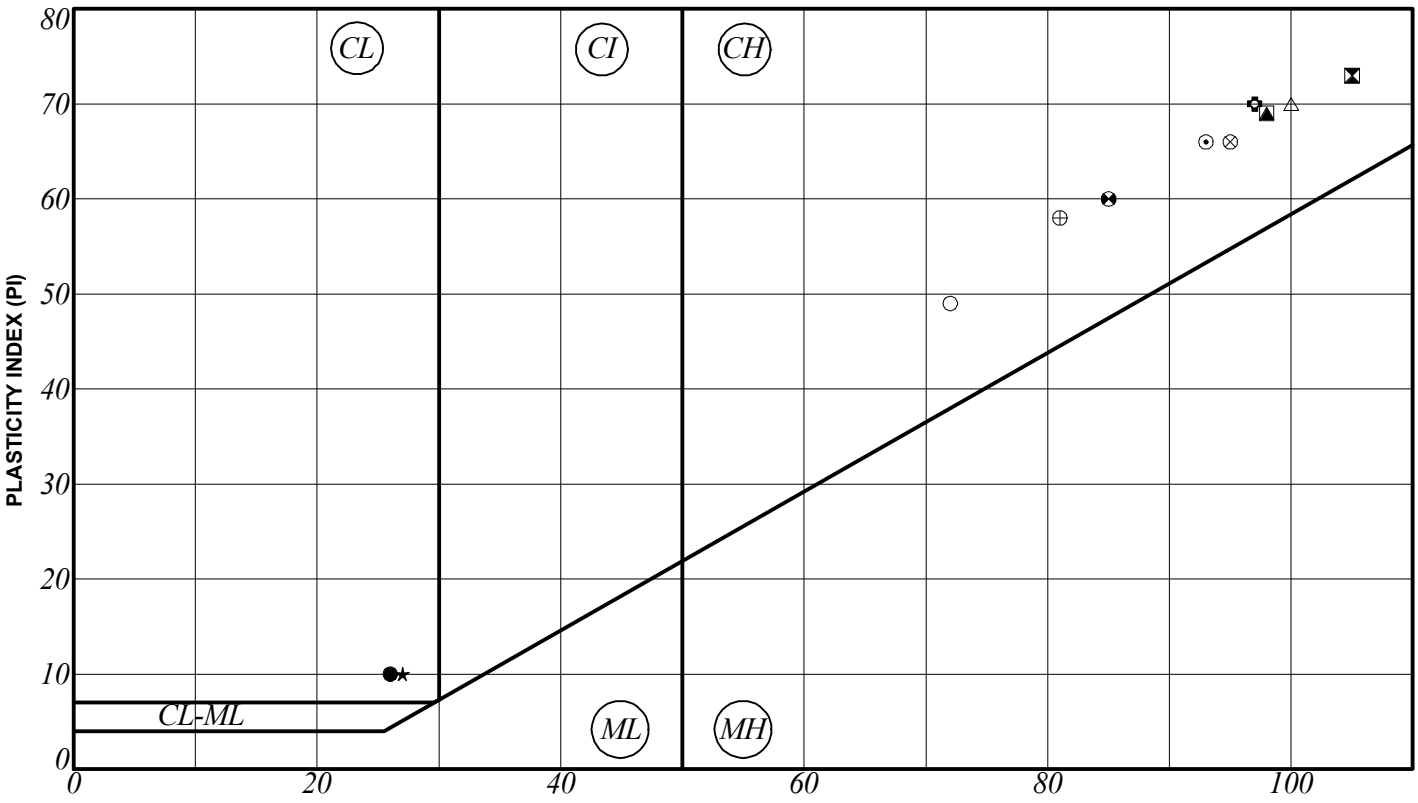
REFERENCE NO.

HOLE NO.
TH16-09 (Shaft C)

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
222	11	35									
221	12	40						S11			
220.4				**SILT TILL** - Tan, damp, loose, low plasticity, some to with fine to coarse grained sand.				S13			
220	13			- Red below 12.80 m.				S12	100		
219.5				**CLAY TILL** - Mottled grey, red and green, moist, compact, low plasticity, some fine to coarse grained sand.				S14			
219		45		- Increased density below 13.41 m.				S15		▲12	
218.7	14			- Some fine to coarse grained sand, trace fine grained gravel below 13.72 m.				S16	100	▲50	
				- Auger refusal, switch to coring at 14.02 m.				S17		*SPT refusal at 75 mm into 2nd set	
218				**LIMESTONE BEDROCK** - Light beige, lightly weathered, strong, RQD = 78%.		14.5 14.6		R1	78		
217.7	15	50		**END TEST HOLE AT 15.04 m.**		15.0					
217	16			Notes:							
216		55		1. Installed RST flow - through piezometer PN36897 at 8.53 m below grade and PN36889 at 14.63 m.							
	17			2. Backfilled test hole with bentonite - cement grout mixture from 15.04 m to grade.							
215											
	18	60									
214											
	19										
213		65									
	20										
212											
	21	70									
211											

SAMPLE TYPE: Auger Grab | Shelby Tube | Split Spoon | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/6/16



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH16-02 (I4/5)	2.9	S3	26	16	10				22.9	CL
⊠	TH16-02 (I4/5)	5.6	S5	105	32	73				56.3	CH
▲	TH16-03 (I7)	5.3	S5	98	29	69				53.4	CH
★	TH16-05 (I9)	2.0	S2	27	17	10				25.0	CL
⊙	TH16-05 (I9)	5.6	S4	93	27	66				53.1	CH
✿	TH16-06 (Shaft A)	6.1	S7	97	27	70	0.5	19.4	80.1	51.8	CH
○	TH16-06 (Shaft A)	9.1	S10	72	23	49				51.5	CH
△	TH16-08 (Shaft B)	5.3	S7	100	30	70				57.5	CH
⊗	TH16-08 (Shaft B)	6.1	S8	95	29	66	0.4	18.2	81.4	52.9	CH
⊕	TH16-08 (Shaft B)	9.1	S11	81	23	58				58.1	CH
□	TH16-09 (Shaft C)	6.1	S6	98	29	69	0.9	18.2	80.9	57.4	CH
⊛	TH16-09 (Shaft C)	9.1	S9	85	25	60				46.5	CH

Notes:
ML - Low Plasticity Silt
MH - High Plasticity Silt
CL-ML - Silty Clay
CL - Low Plasticity Clay
CI - Intermediate Plasticity Clay
CH - High Plasticity Clay
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
MC - Moisture Content
NP - Non-Plastic

KGS GROUP

CITY OF WINNIPEG

Cockburn and Calrossie Combined Sewer Relief

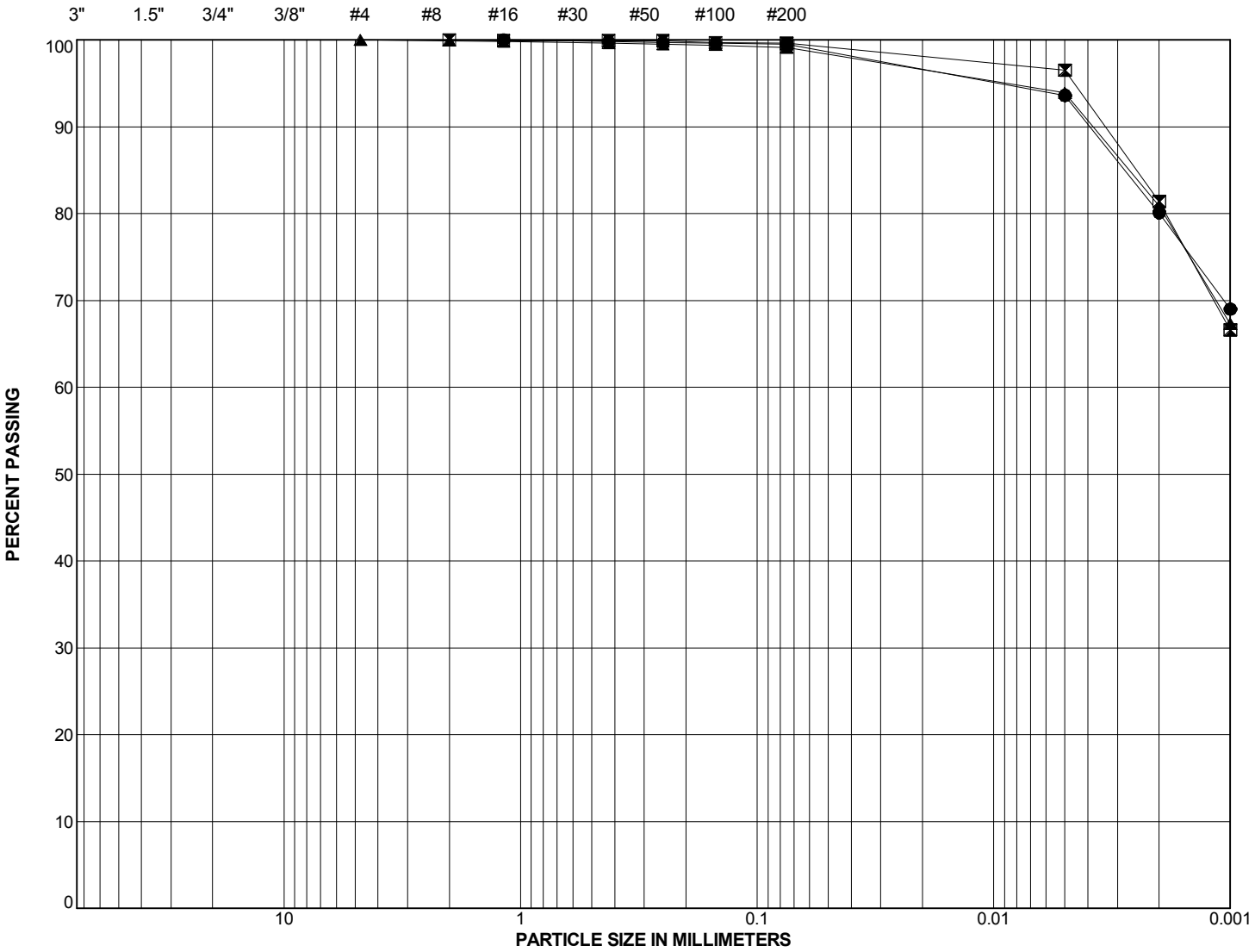
A-LINE PLOT

October 2016	Figure B1	Page 1 of 1

A-LINE PLOT P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\04 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\RENUTILESSLUS_LOGS.GPJ

SIEVE ANALYSIS P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C4 - 2700 TRUNK SEWER - TAYLOR AVE\LOGS\TRENCHLESSLDS_LOGS.GPJ

SIEVE ANALYSIS **HYDROMETER ANALYSIS**



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*TH16-06 (Shaft A)*	*6.1*	*S7*	*0.0*	*0.5*	*19.4*	*80.1*	*99.5*			*CH*
⧓	*TH16-08 (Shaft B)*	*6.1*	*S8*	*0.0*	*0.4*	*18.2*	*81.4*	*99.6*			*CH*
▲	*TH16-09 (Shaft C)*	*6.1*	*S6*	*0.0*	*0.9*	*18.2*	*80.9*	*99.1*			*CH*

KGS GROUP

CITY OF WINNIPEG

Cockburn and Calrossie Combined Sewer Relief

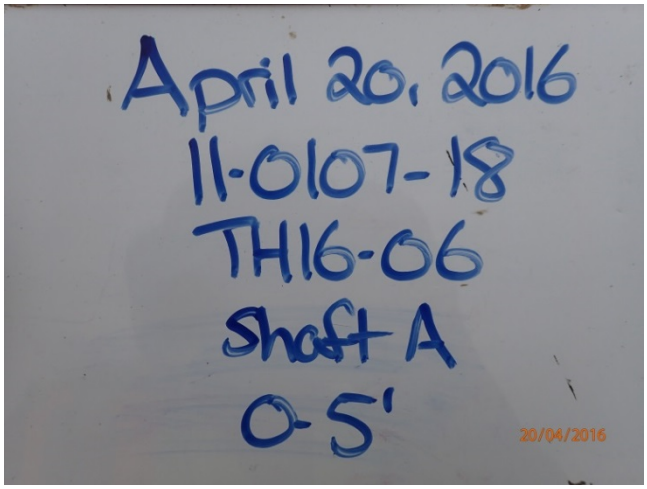
GRAIN SIZE ANALYSES

October 2016	Figure B2	Page 1 of 1

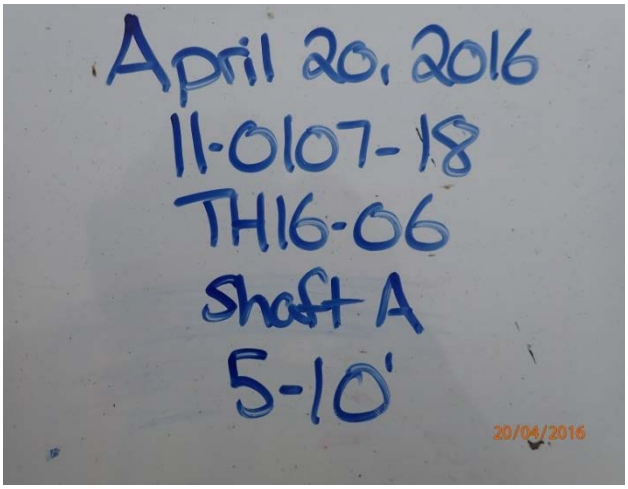
APPENDIX C

PHOTOS

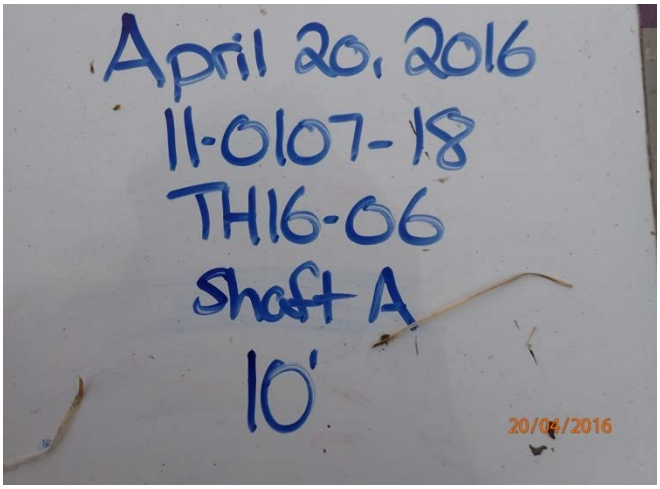
TH16-06 (SHAFT A)


April 20, 2016
11-0107-18
TH16-06
Shaft A
0-5'
20/04/2016


20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
5-10'
20/04/2016

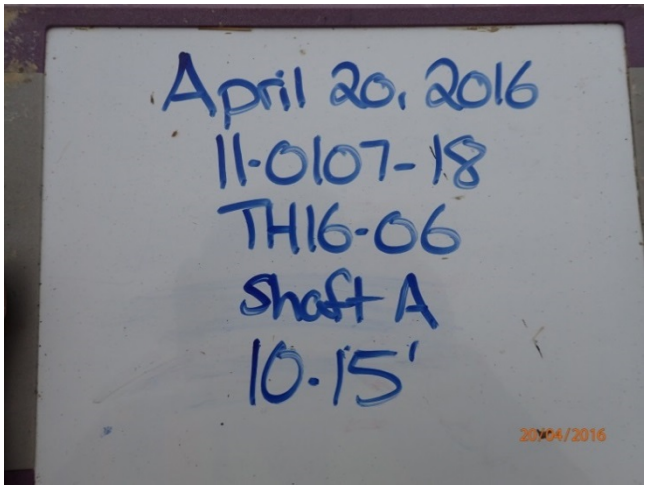

20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
10'
20/04/2016

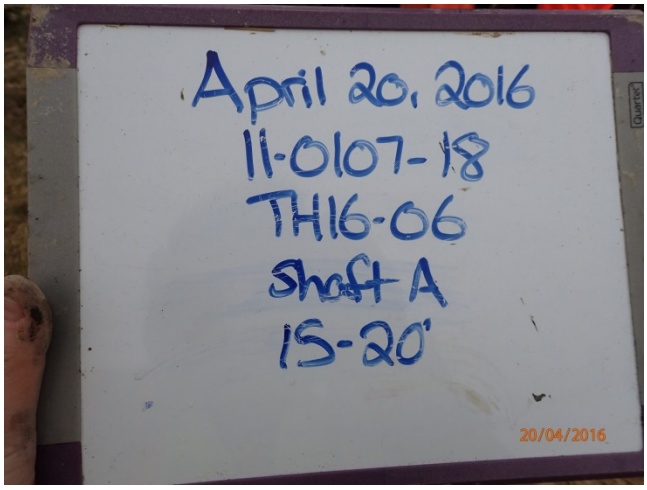

LOAD TRA
232
PROTECTED
1-877-211-8138
20/04/2016


TH16-06
10' 54'
April 20,
2016
27/04/2016

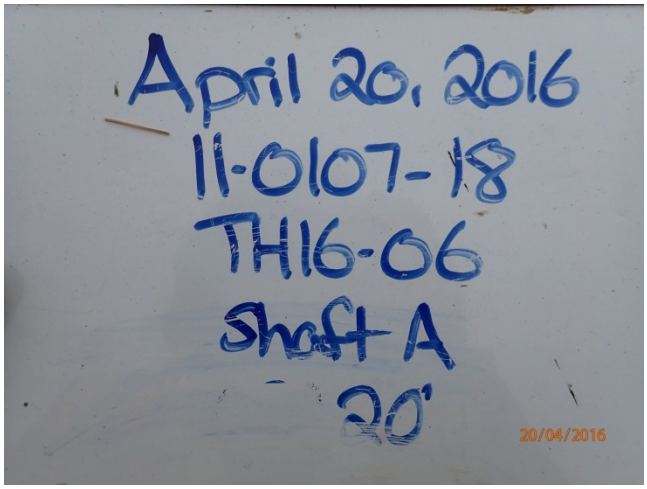

27/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
10.15'


20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
15-20'
20/04/2016

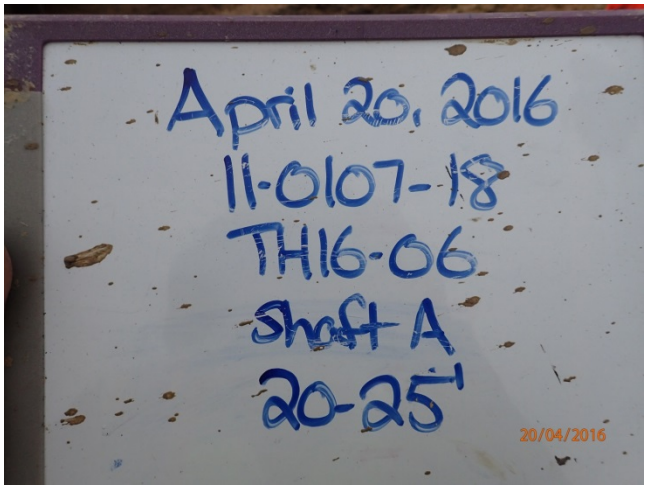

20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
20'
20/04/2016

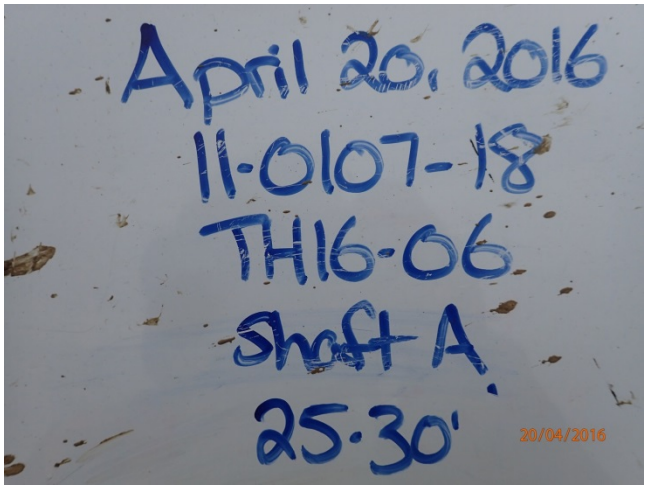

20/04/2016


TH16-06
ST20'
April20,
2016
27/04/2016

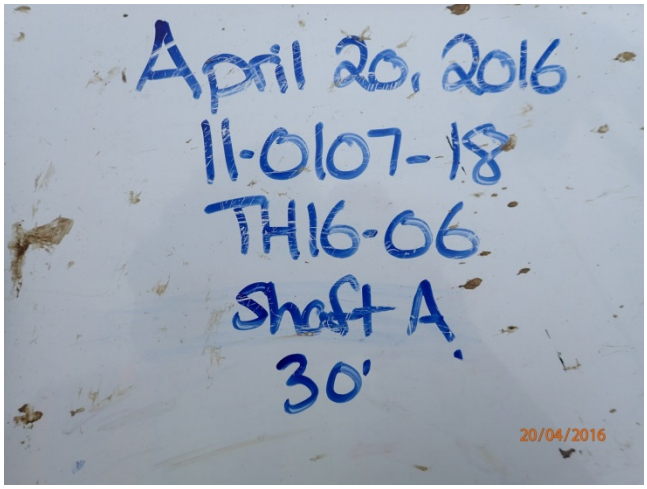

27/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
20-25'
20/04/2016


20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
25-30'
20/04/2016

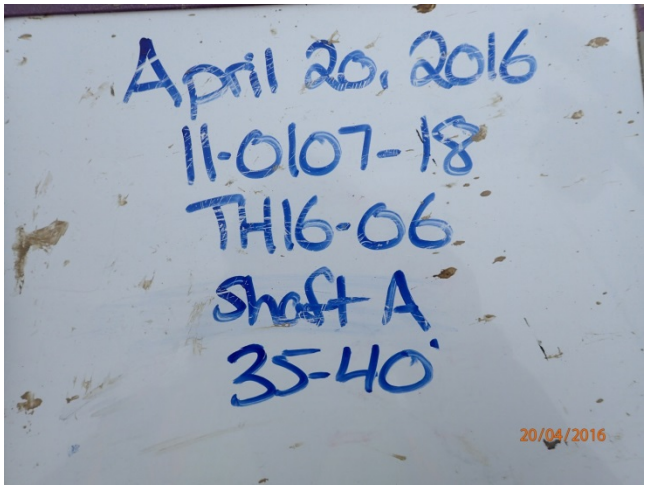

20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
30'
20/04/2016

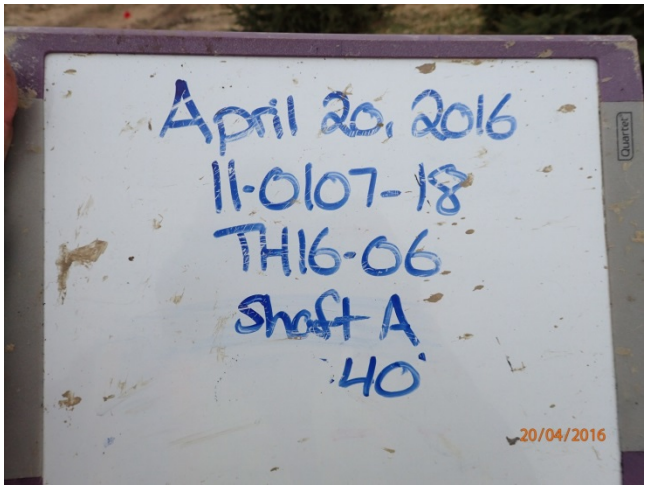

20/04/2016


TH16-06
30.30
April 20.
2016
27/04/2016


27/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
35-40'
20/04/2016

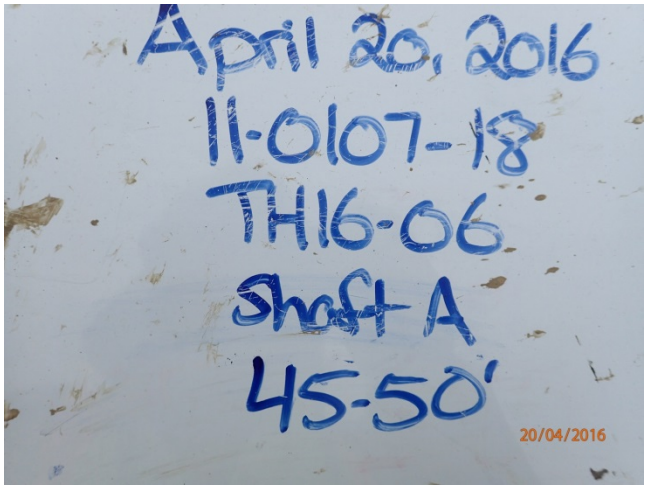

20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
40'
20/04/2016

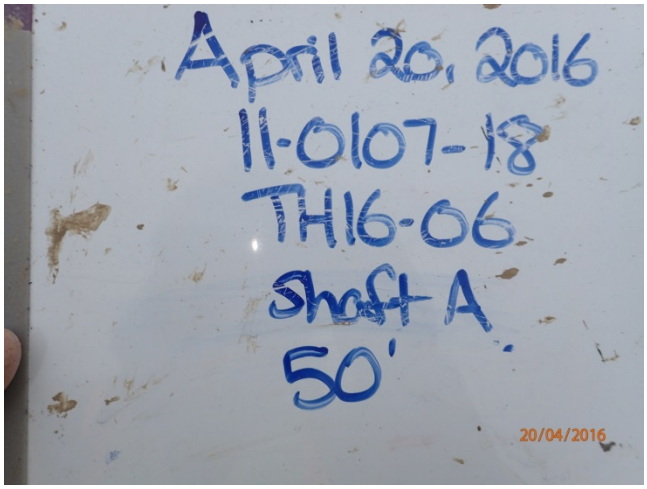

20/04/2016


27/04/2016

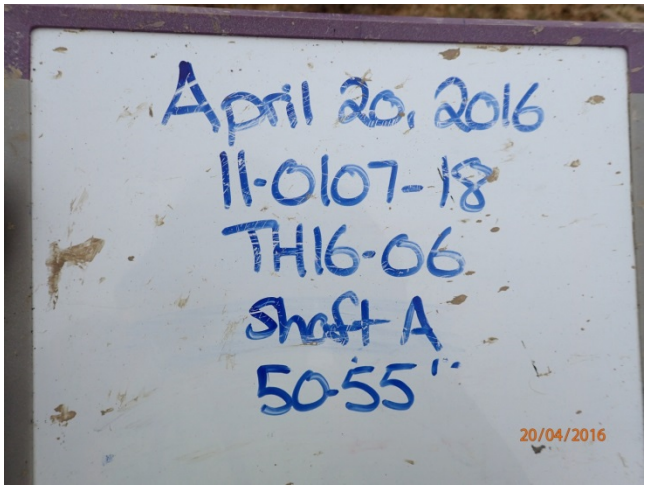

19 20 21 22 23 25 26 27 28 29
47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74
27/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
45-50'
20/04/2016

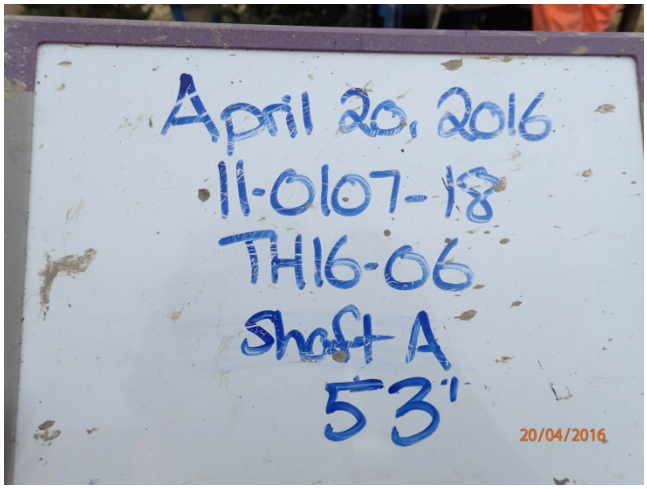

20/04/2016


April 20, 2016
11-0107-18
TH16-06
Shaft A
50'
20/04/2016


20/04/2016

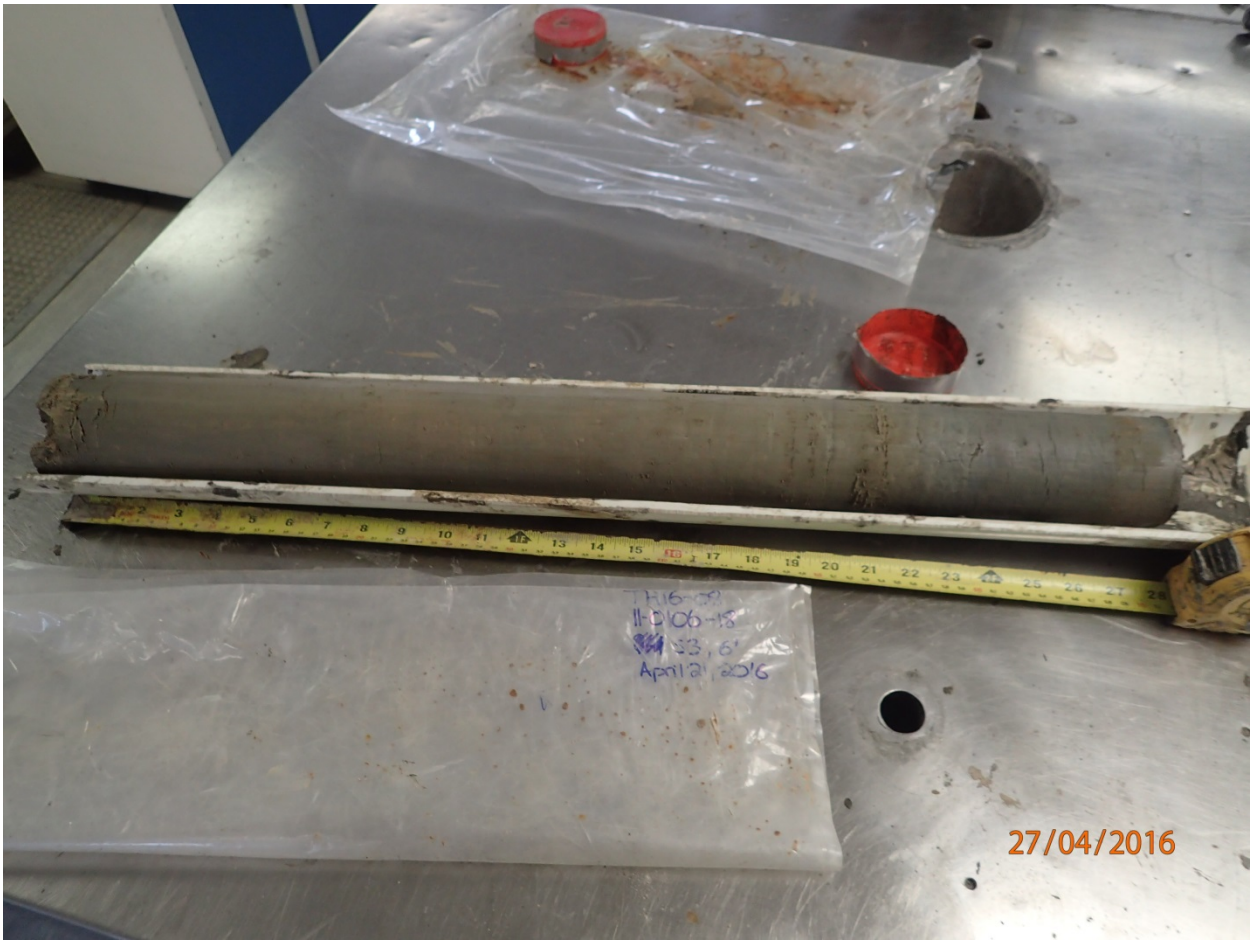

April 20, 2016
11-0107-18
TH16-06
Shaft A
50-55'
20/04/2016


20/04/2016

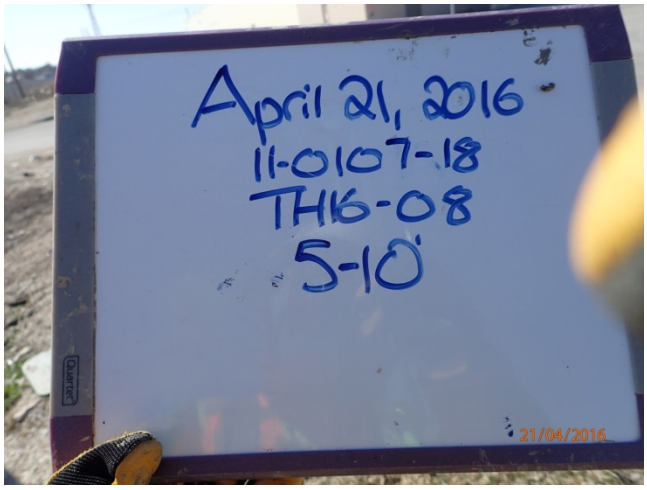

April 20, 2016
11-0107-18
TH16-06
Shaft A
53'
20/04/2016


20/04/2016

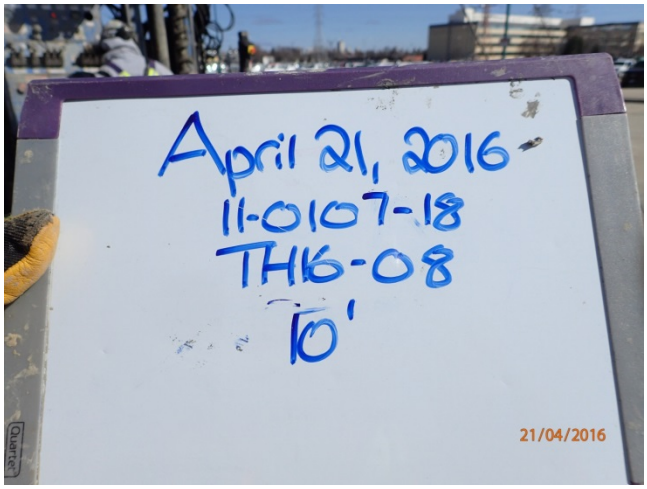
TH16-08 (SHAFT B)


11-0107-18
April 21, 2016
27/04/2016


27/04/2016


April 21, 2016
11-0107-18
TH16-08
5-10'
21/04/2016

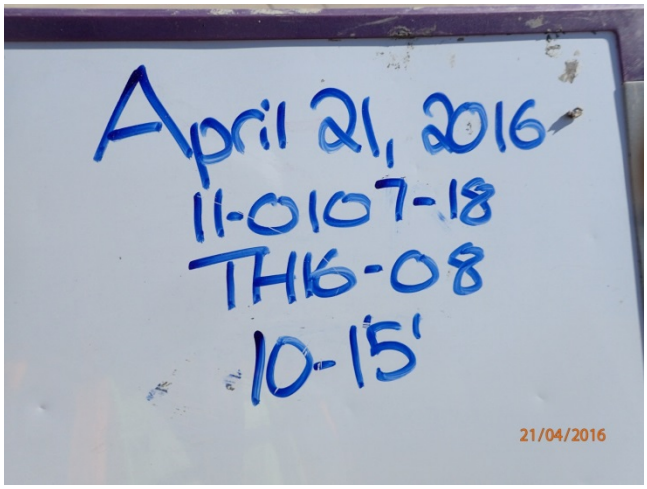

21/04/2016


April 21, 2016
11-0107-18
TH16-08
10'
21/04/2016

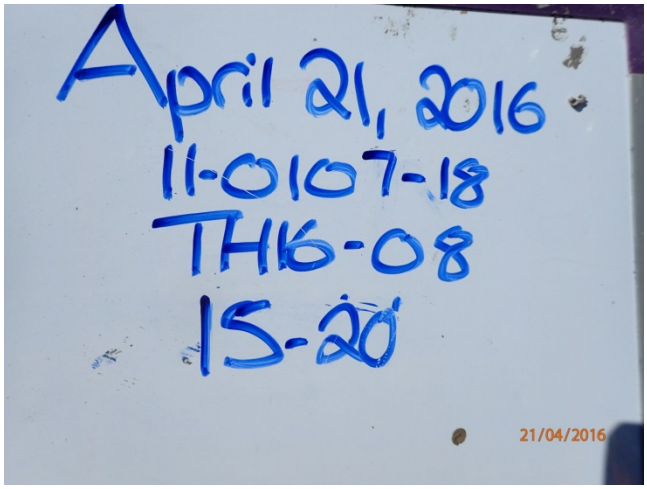

21/04/2016


TH16-08
SS, 10'
11-0107-18
April 26, 2016
27/04/2016

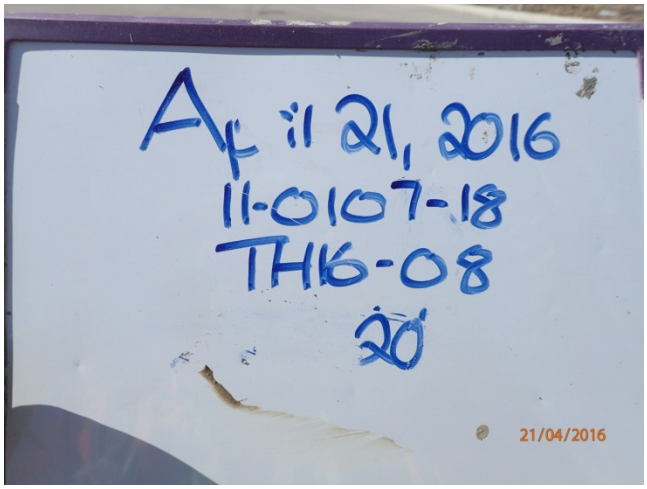

27/04/2016

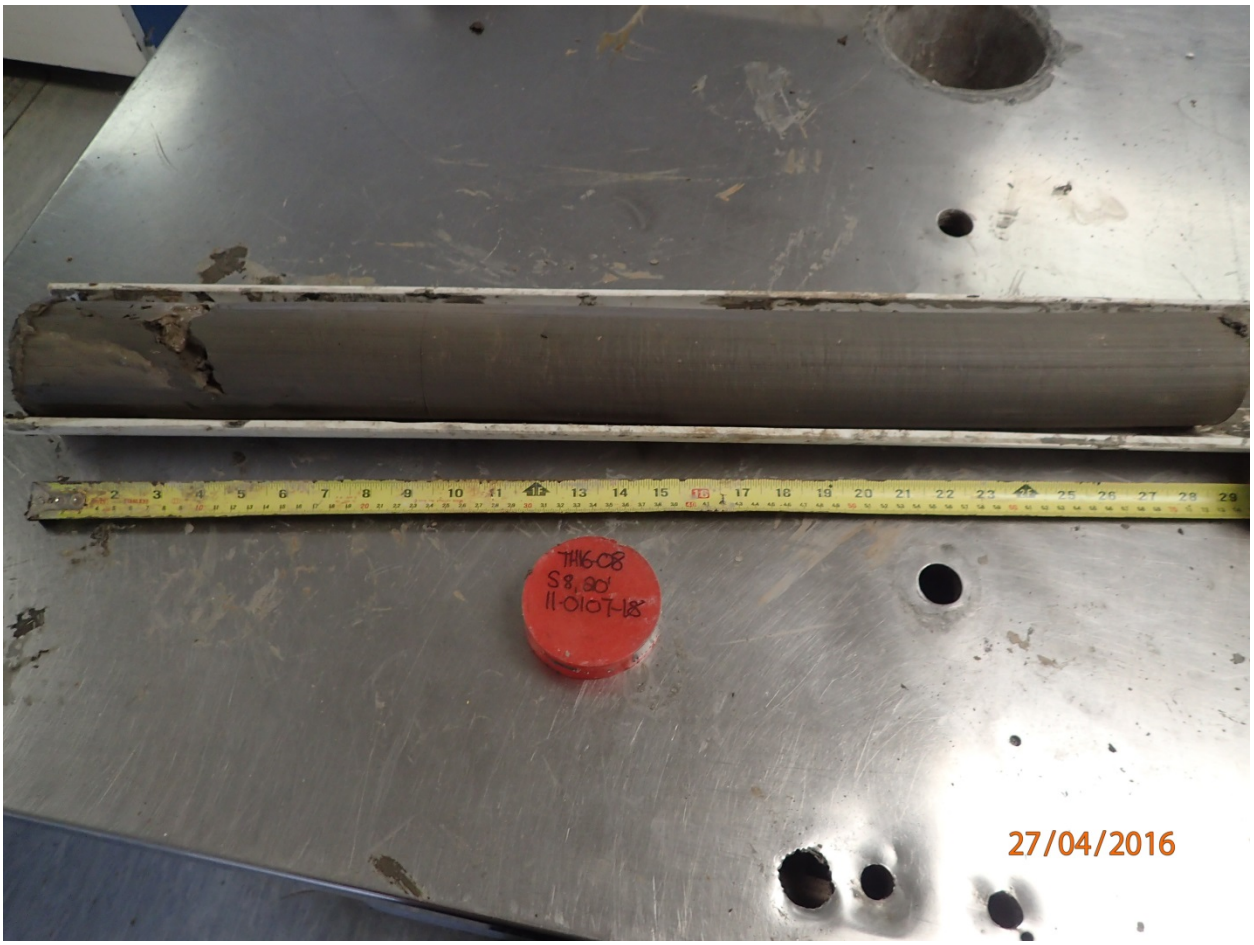

April 21, 2016
11-0107-18
TH16-08
10-15'
21/04/2016

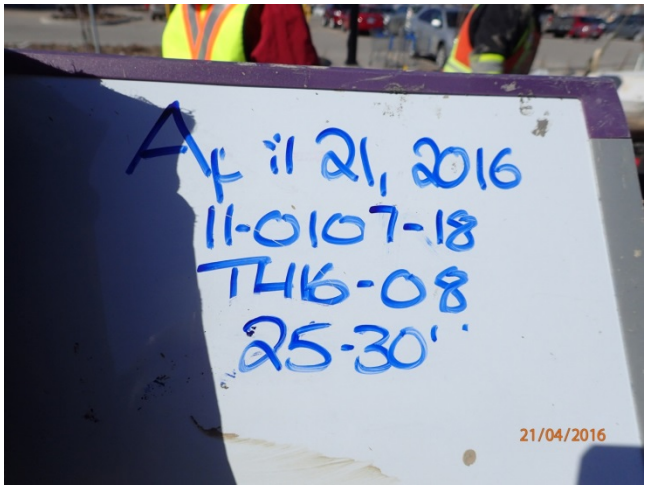

21/04/2016


April 21, 2016
11-0107-18
TH16-08
15-20
21/04/2016


21/04/2016


April 21, 2016
11-0107-18
TH16-08
20'
21/04/2016

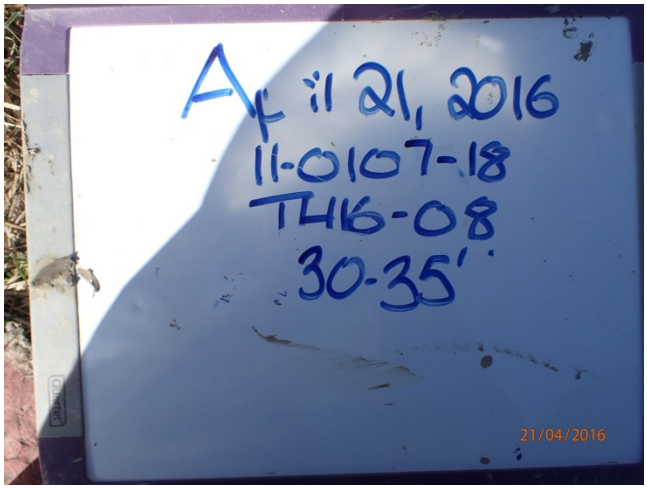

TH16-08
S8, 20'
11-0107-18
27/04/2016


April 21, 2016
11-0107-18
TH16-08
25-30'
21/04/2016

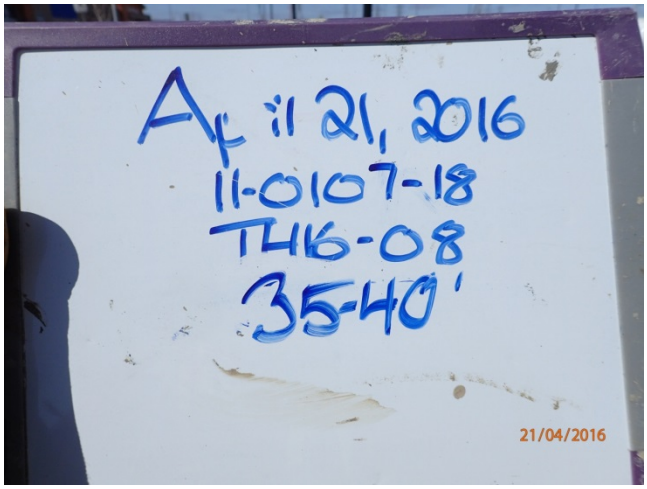

21/04/2016


TH16-08
S11, 30'
April 21, 2016
11-0107-18
27/04/2016

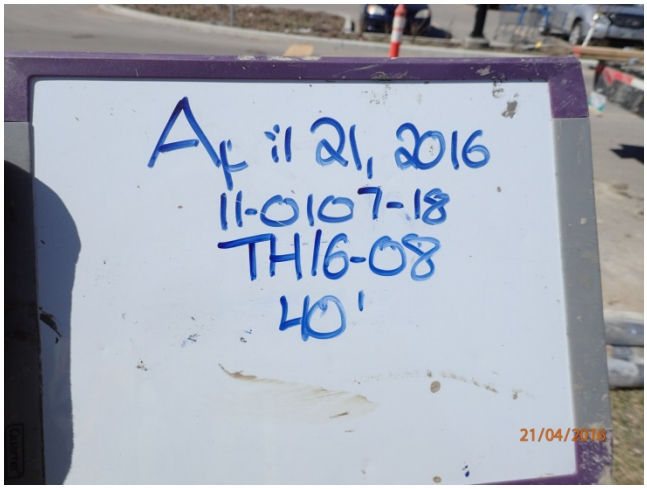

27/04/2016


April 21, 2016
11-0107-18
TH16-08
30-35'
21/04/2016


21/04/2016


April 21, 2016
11-0107-18
TH16-08
35-40'
21/04/2016

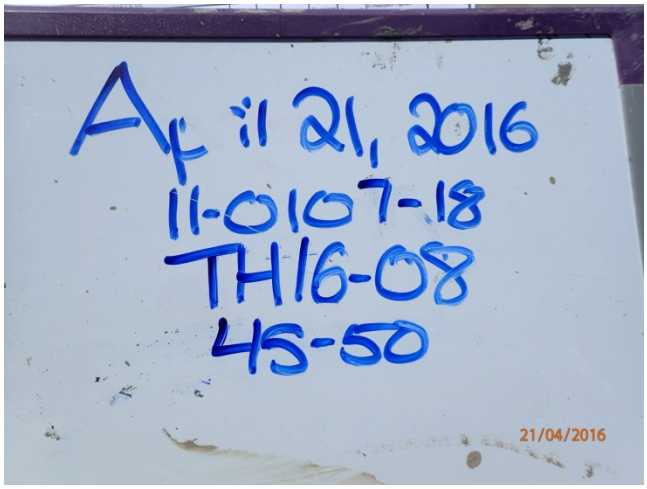

21/04/2016


April 21, 2016
11-0107-18
TH16-08
40'
21/04/2016

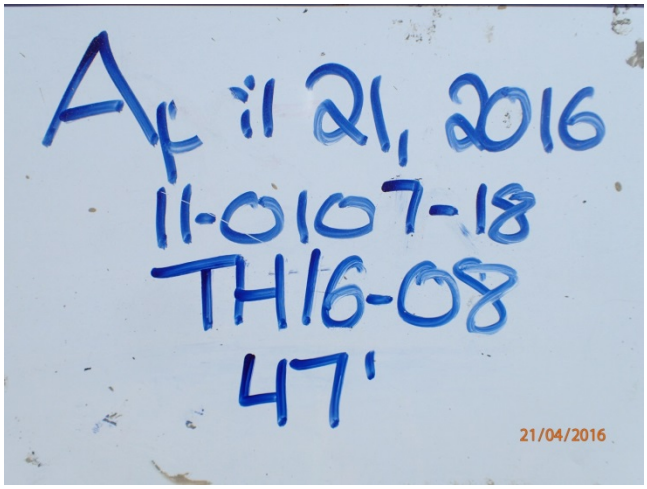

21/04/2016


27/04/2016


27/04/2016


April 21, 2016
11-0107-18
TH16-08
45-50
21/04/2016


21/04/2016

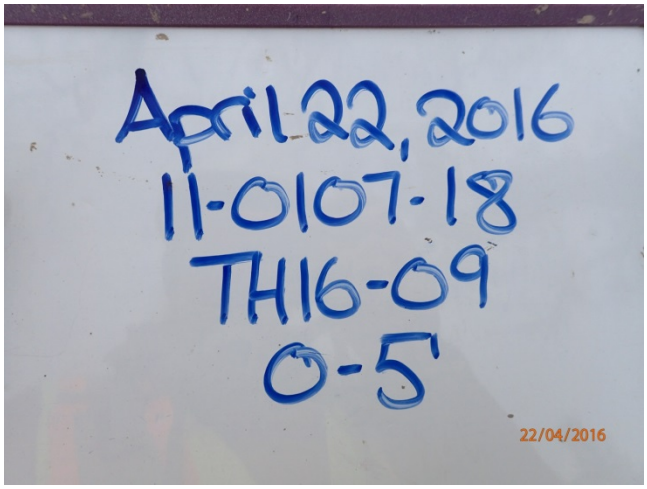

April 21, 2016
11-0107-18
TH16-08
47'
21/04/2016


21/04/2016

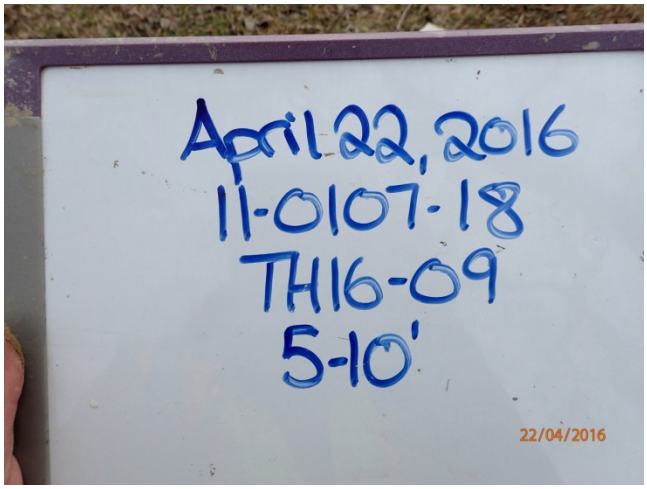

END OF RUN TH16-05
21/04/2016


149'
21/04/2016

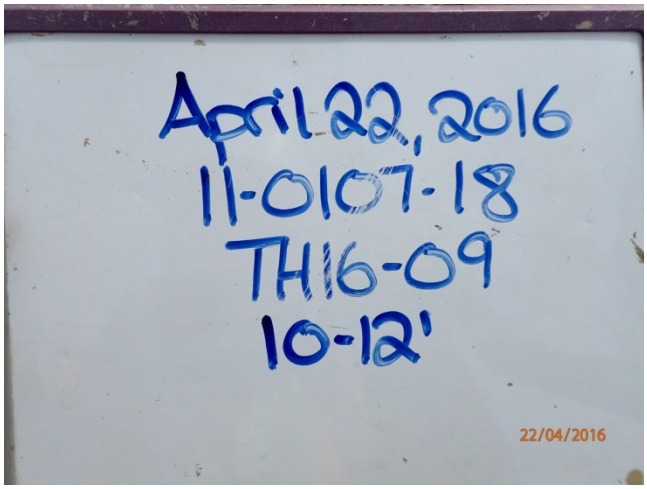
TH16-09 (SHAFT C)


April 22, 2016
11-0107-18
TH16-09
0-5
22/04/2016

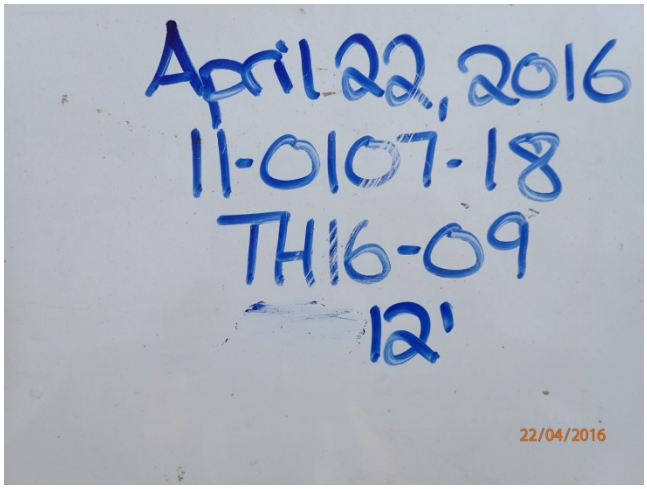

22/04/2016


April 22, 2016
11-0107-18
TH16-09
5-10'
22/04/2016

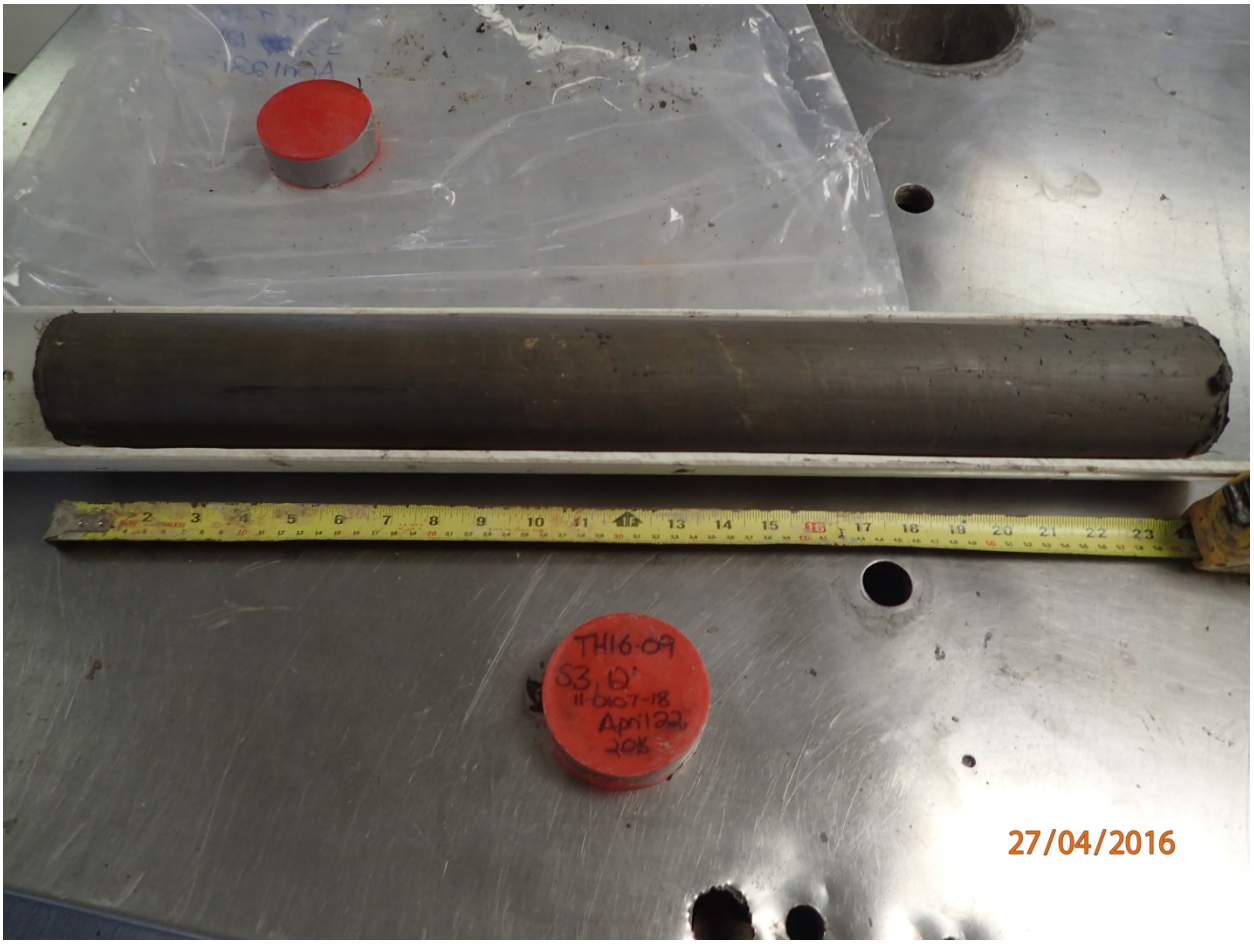

22/04/2016


April 22, 2016
11-0107-18
TH16-09
10-12'
22/04/2016

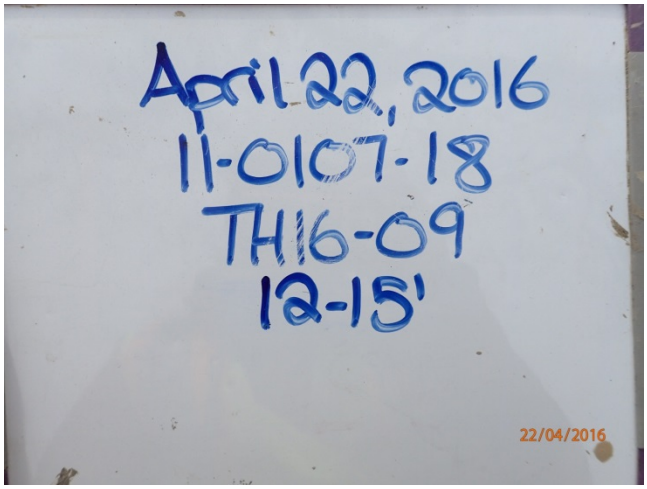

22/04/2016


April 22, 2016
11-0107-18
TH16-09
12'
22/04/2016


22/04/2016


TH16-09
S3, 12'
11-0107-18
April 22,
2016
27/04/2016


27/04/2016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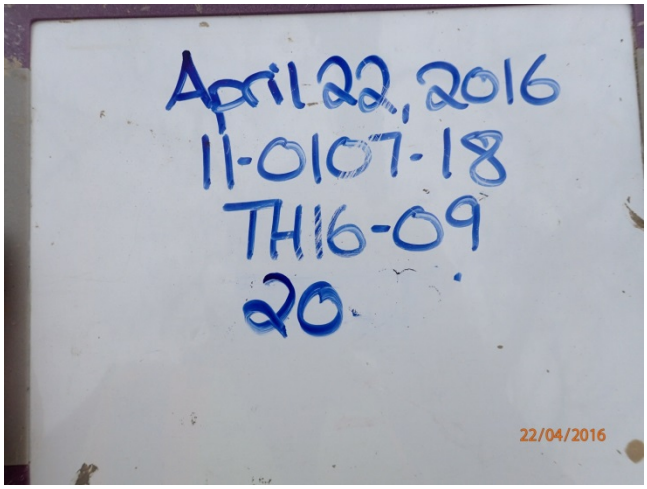
TH16-09
12-15'
22/04/2016


22/04/2016


April 22, 2016
11-0107-18
TH16-09
15-20'
22/04/2016


22/04/2016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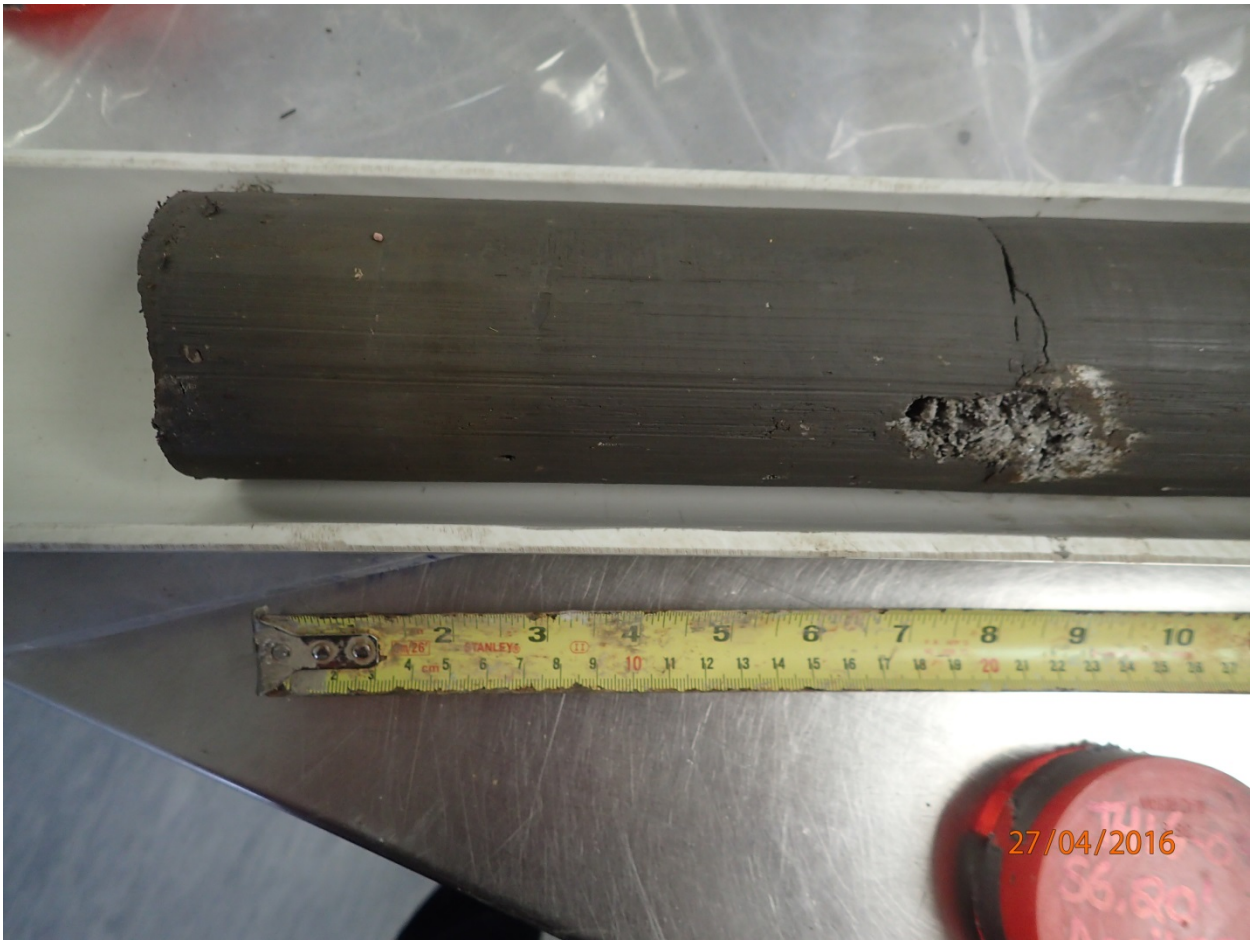
11-0107-18
TH16-09
20
22/04/2016


www.mapleleafdrillin
22/04/2016


TH16-09
S6.80'
April 22, '16
11-0107-18
27/04/2016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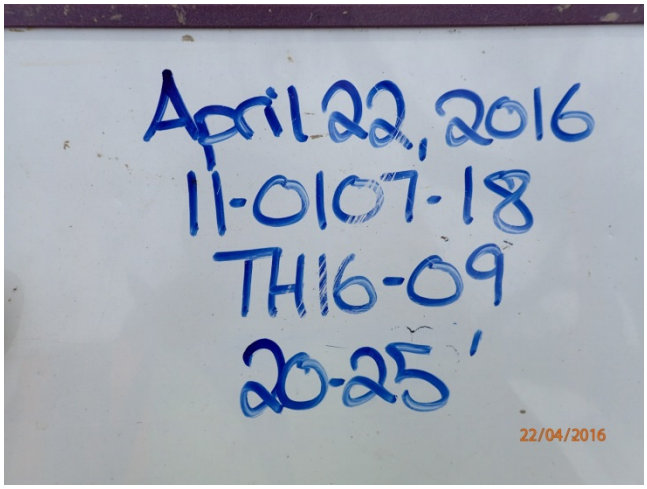
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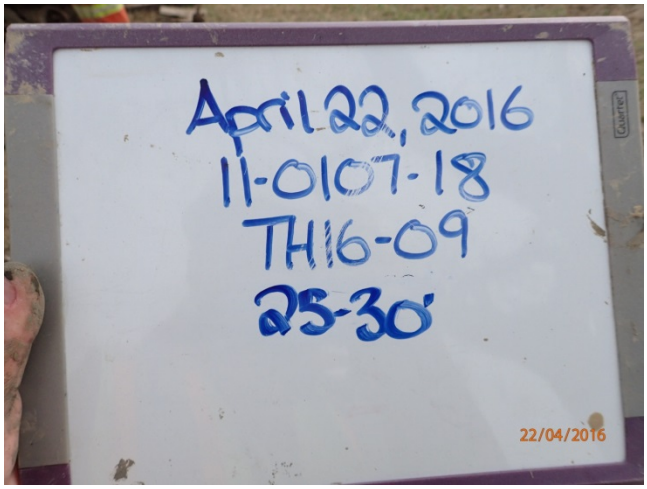
TH16-09
20-25'
22/04/2016


22/04/2016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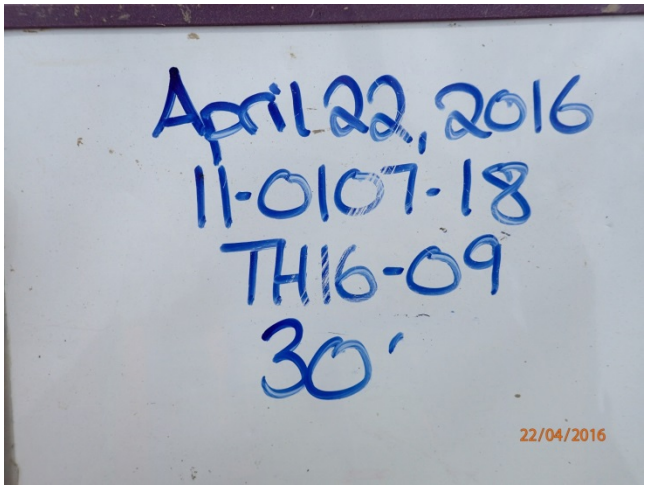
TH16-09
25-30'
22/04/2016


22/04/2016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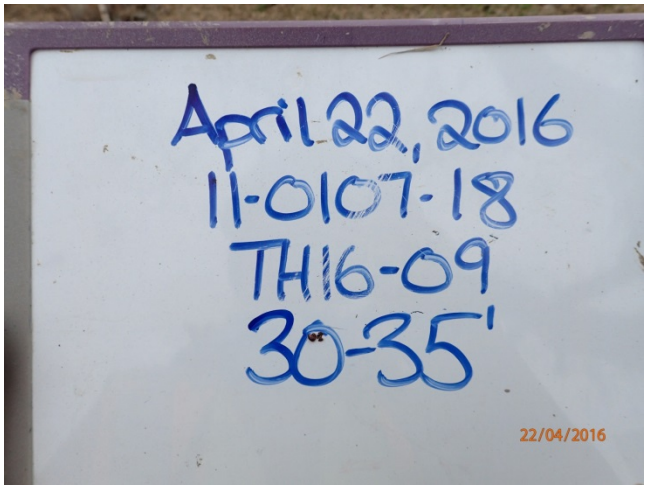
TH16-09
30'
22/04/2016


22/04/2016


THI6-09
11-0107-18
59.30' JRM
April 22, 2016
27/04/2016


TH16-09
11-0107-18
S9, 30' JRM
April 22, 2016
27/04/2016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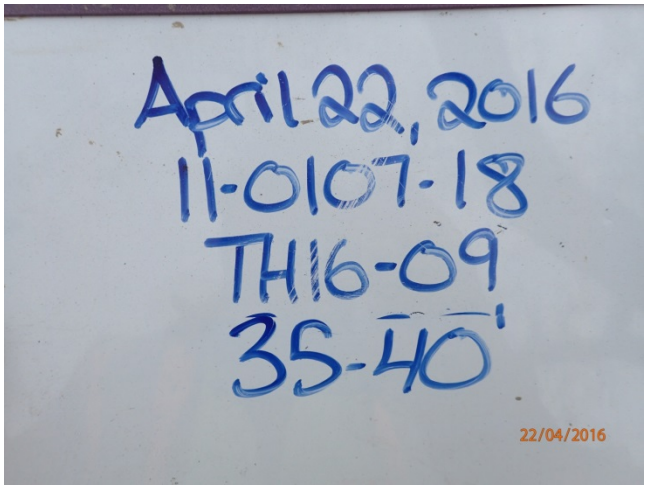
TH16-09
30-35'
22/04/2016


22/04/2016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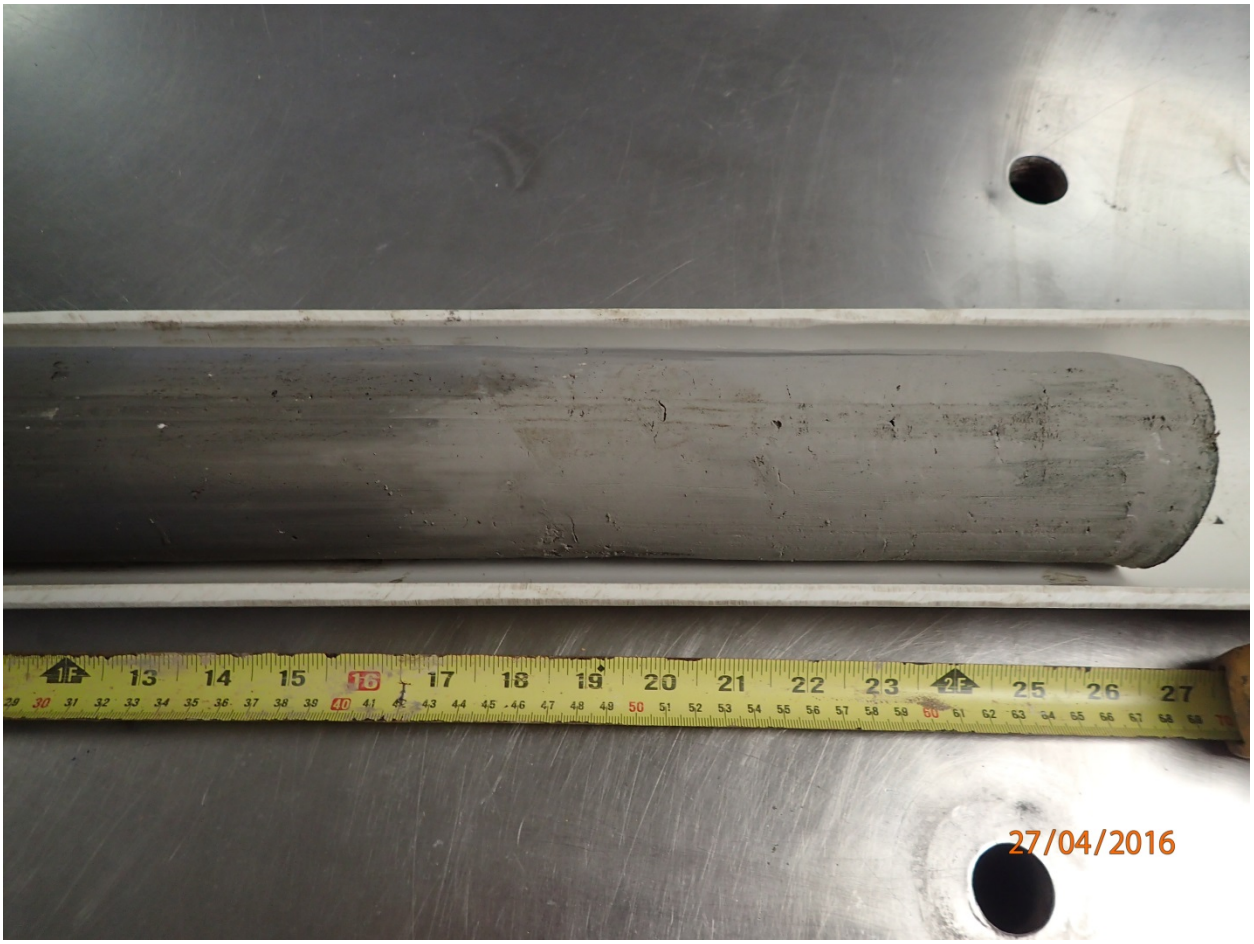
TH16-09
35-40'
22/04/2016


22/04/2016


April 22, 2016
11-0107-18
TH16-09
40
22/04/2016


22/04/2016


27/04/2016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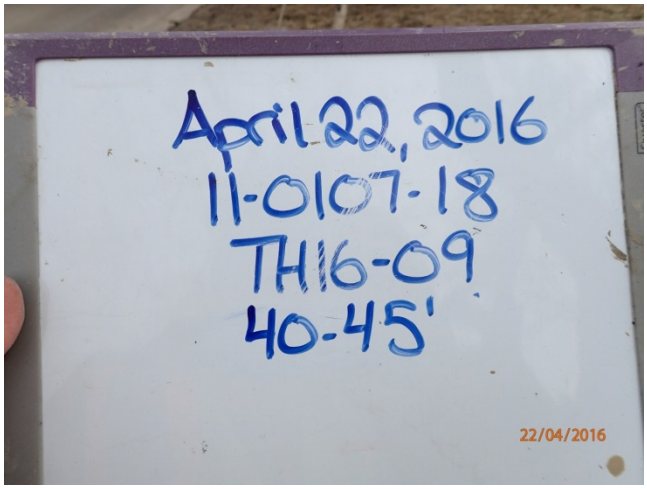
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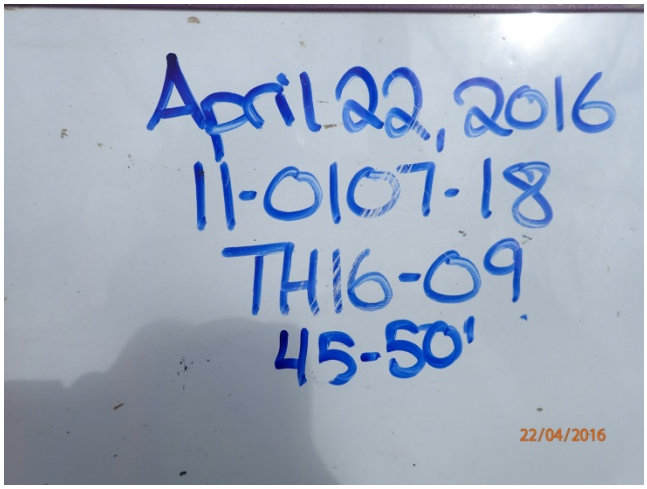
TH16-09
40-45'
22/04/2016


22/04/2016


April 22, 2016
11-0107-18
TH16-09
45-50'
22/04/2016


22/04/2016


TH16-
TCP
Start
46'
22/04/2016


22/04/2016

APPENDIX D

GEOTECHNICAL INVESTIGATIONS

LABORATORY DATA

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg MB R3Y 1G4

June 24, 2015
File: 123311974

Attention: Ms. Jacqueline MacLennan
KGS Group Inc.
3rd Floor – 865 Waverley Street
Winnipeg, MB R3T 5P4

Good day Jacqueline,

Reference: Cockburn & Calrossie Sewer Relief (11-0107-18)

Soil samples were submitted to our laboratory on June 16, 2015. The following tests were conducted on selected soil samples:

- Water content (ASTM D2216)
- Particle-Size Analysis (ASTM D422)
- Liquid Limit (multipoint), plastic limit, and plasticity index (ASTM D4318)

We appreciate the opportunity to assist you in this project. Please call if you have any questions regarding this report.

Regards,

STANTEC CONULTING LTD.

Jason Thompson, C.E.T.
Senior Associate – Team Lead
Manager, Materials Testing Services
Phone: (204) 928-4004
Fax: (204) 488-6947
Jason.Thompson@stantec.com

Attachment: Table 1 - Water Content Test Data
Table 2 – Particle Size Analysis and Atterberg Limits Test Data
3 x Particle Size Analysis Reports
3 x Atterberg Limits Reports

Reference: Cockburn & Calrossie Sewer Relief (11-0107-18)

TABLE 1
WATER CONTENT TEST DATA

Testhole	Sample ID	Sample Depth (ft)	Water Content (%)	Testhole	Sample ID	Sample Depth (ft)	Water Content (%)
TH15-01	S2	7-8	31.7	TH15-04	S5	22-23	49.8
TH15-01	S3	13-14	49.1	TH15-04	S6	27-28	46.3
TH15-01	S4	17-18	58.1	TH15-04	S7	33-34	58.2
TH15-01	S5	22-23	53.0	TH15-04	S8	37-38	50.6
TH15-01	S6	26-27	41.8	TH15-04	S9	43-44	17.9
TH15-02	S1	4-5	27.7	TH15-05	S1	1-2	34.8
TH15-02	S2	7-8	29.6	TH15-05	S3	8-9	39.1
TH15-02	S3	12-13	50.6	TH15-05	S4	12-13	51.1
TH15-02	S4	17-18	48.5	TH15-05	S5	17-18	51.3
TH15-03	S1	3-4	23.1	TH15-05	S6	22-23	51.1
TH15-03	S2	6-7	37.8	TH15-05	S7	27-28	46.9
TH15-03	S3	12-13	52.6	TH15-05	S8	32-33	57.7
TH15-03	S4	17-18	51.6	TH15-05	S9	37-38	59.0
TH15-04	S1	4-5	23.9	TH15-05	S10	42-43	49.8
TH15-04	S3	12-13	51.2	TH15-05	S11	46-46.5	16.4
TH15-04	S4	17-18	46.7				

TABLE 2
PARTICLE SIZE AND ATTERBERG LIMITS TEST DATA

Testhole	Sample ID	Particle Size Analysis							Atterberg Limits		
		Gravel (%) 75 to 4.75 mm	Sand (%)			Silt (%) <0.075 to 0.002 mm	Clay (%) <0.002 mm	Colloids (%) < 0.001 mm	Liquid Limit	Plastic Limit	Plasticity Index
			Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm						
TH15-03	S4 (17'-18')	0.0	0.0	0.0	0.6	23.2	76.2	72.0	91	24	67
TH15-04	S6 (27'-28')	1.5	1.2	3.2	2.8	27.1	64.2	57.6	80	22	58
TH15-05	S10 (42'-43')	0.1	0.7	0.7	2.8	24.0	71.7	63.5	89	23	66

Notes:
1. A high speed stirring device was used for 1 minute to disperse the test sample for particle size analysis.
2. The soil samples were air-dried during sample preparation for Atterberg limits and particle size analysis.

LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

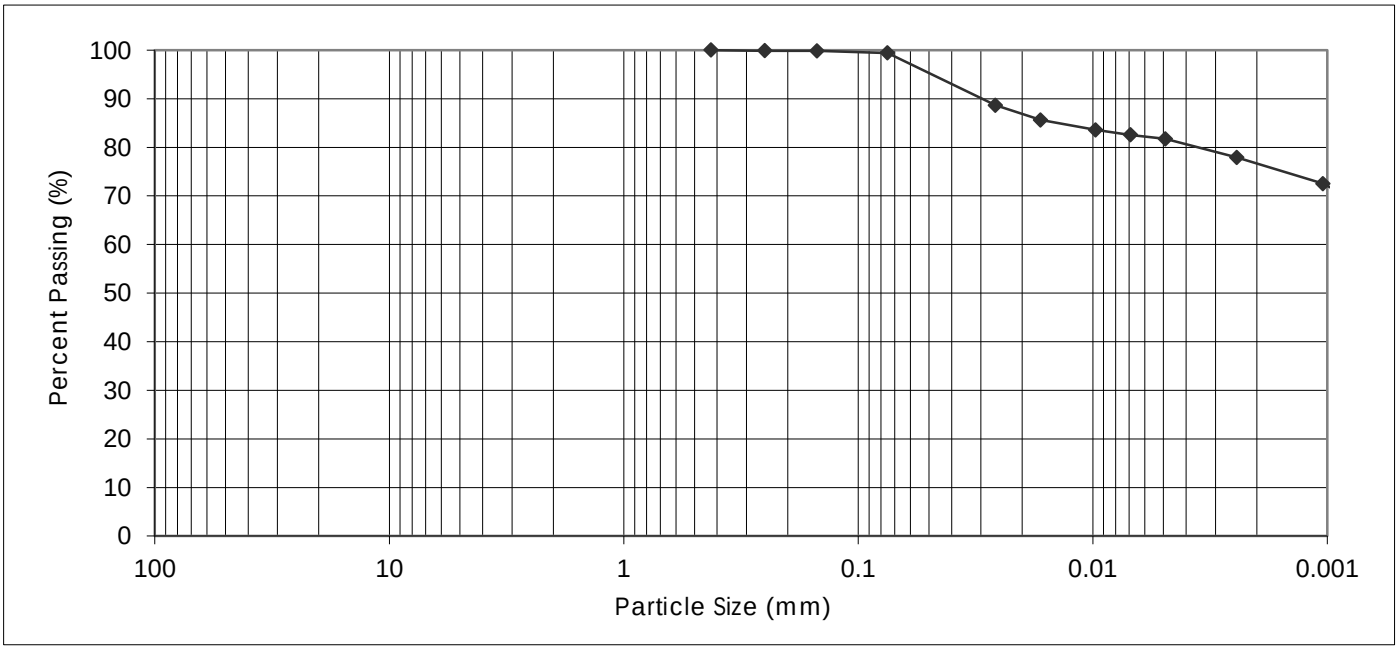
PROJECT: Cockburn & Calrossie Sewer Relief (11-0107-18)

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH15-03, S4 (17'-18')

DATE RECEIVED: June 16, 2015
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	100.0
4.75 mm	100.0
2.00 mm	100.0

PARTICLE SIZE	PERCENT PASSING
1.18 mm	100.0
0.425 mm	100.0
0.250 mm	99.9
0.150 mm	99.8
0.075 mm	99.4
0.005 mm	81.8
0.002 mm	76.2
0.001 mm	72.0

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
0.0	0.0	0.0	0.6	23.2	76.2	72.0

June 24, 2015

REVIEWED BY: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - 865 Waverley Street
Winnipeg, Manitoba
R3T 5P4

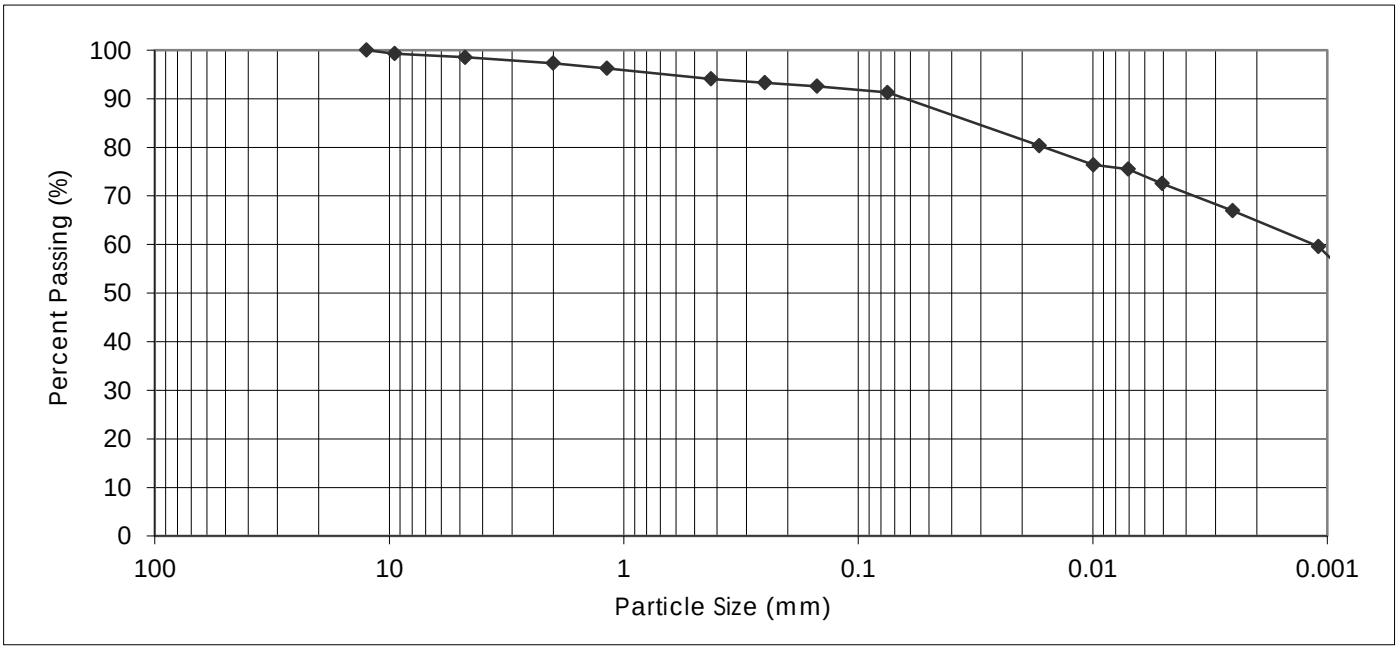
PROJECT: Cockburn & Calrossie Sewer Relief (11-0107-18)

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH15-04, S6 (27'-28')

DATE RECEIVED: June 16, 2015
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	99.3
4.75 mm	98.5
2.00 mm	97.3

PARTICLE SIZE	PERCENT PASSING
1.18 mm	96.3
0.425 mm	94.1
0.250 mm	93.3
0.150 mm	92.6
0.075 mm	91.3
0.005 mm	72.4
0.002 mm	64.2
0.001 mm	57.6

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
1.5	1.2	3.2	2.8	27.1	64.2	57.6

June 24, 2015

REVIEWED BY: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group Inc.
3rd Floor - Waverley Street
Winnipeg, Manitoba
R3T 5P4

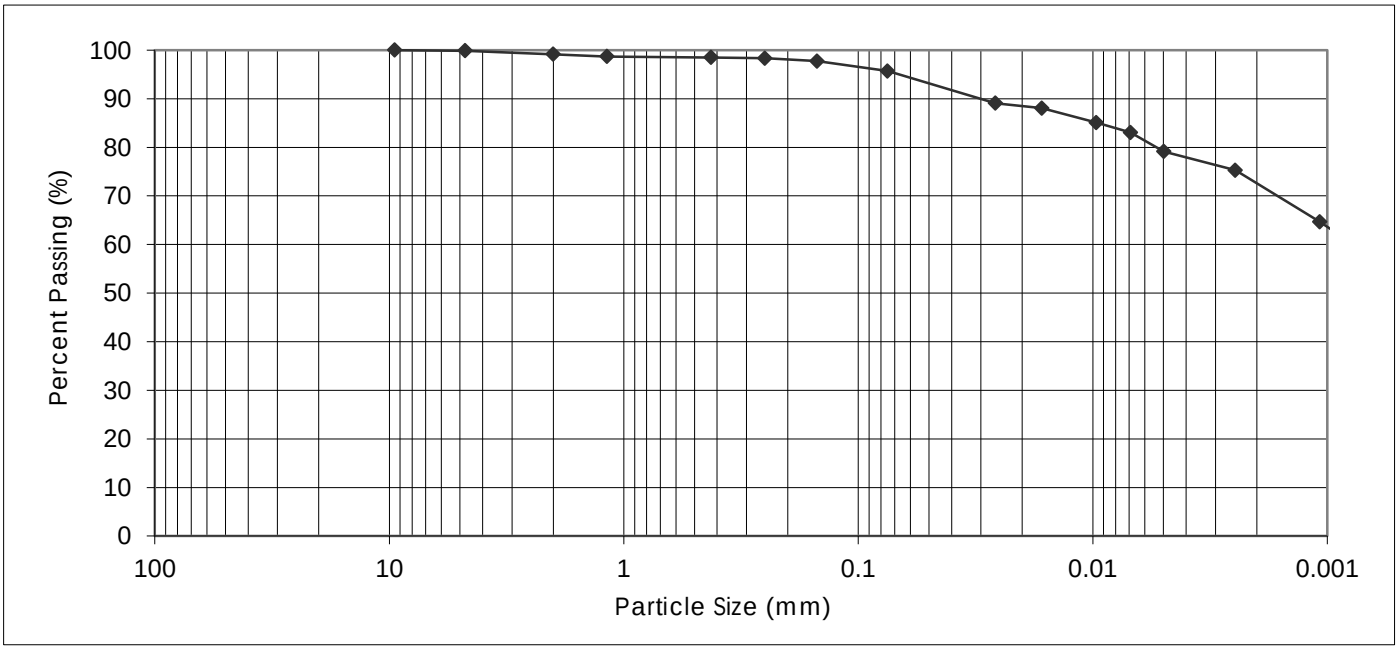
PROJECT: Cockburn & Calrossie Water Relief (11-0107-18)

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH15-05, S10 (42'-43')

DATE RECEIVED: June 16, 2015
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	100.0
4.75 mm	99.9
2.00 mm	99.2

PARTICLE SIZE	PERCENT PASSING
1.18 mm	98.7
0.425 mm	98.5
0.250 mm	98.3
0.150 mm	97.7
0.075 mm	95.7
0.005 mm	79.2
0.002 mm	71.7
0.001 mm	63.5

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
0.1	0.7	0.7	2.8	24.0	71.7	63.5

June 24, 2015

REVIEWED BY: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie Sewer
Project No:	123311974
Date Received:	June 16, 2015
Date Tested:	June 19, 2015
Tested By:	Yan Wang

Sample : TH15-03, S4 (17'-18')

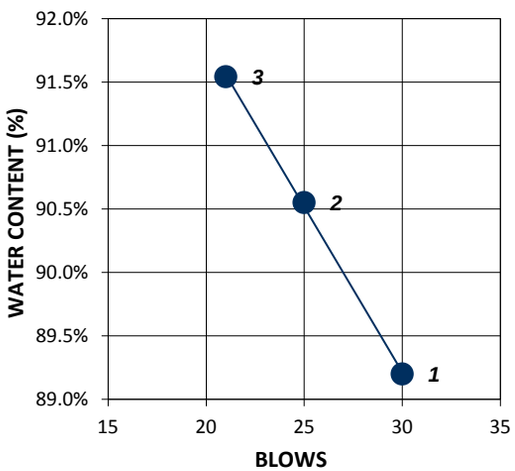
LIQUID LIMIT

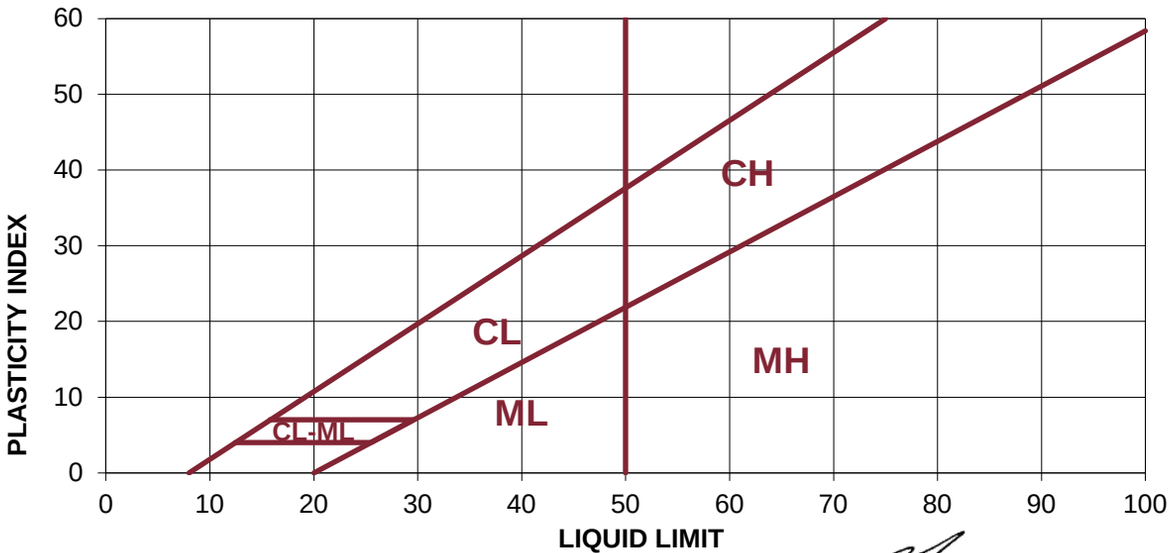
Trial	1	2	3
No. of Blows	30	25	21
Tare No.	162	163	214
Wt. Sa. (wet+tare)(g)	37	40	37
Wt. Sa. (dry+tare)(g)	29	30	29
Wt. Tare (g)	20	20	21
Wt. Dry Soil (g)	8.9	10.4	8.6
Wt. Water (g)	7.9	9.4	7.9
Water Content (%)	89.2%	90.5%	91.5%

PLASTIC LIMIT

Trial	1	2
Tare No.	231	288
Wt. Sa. (wet+tare)(g)	29.11	31.71
Wt. Sa. (dry+tare)(g)	27.51	29.58
Wt. Tare (g)	20.73	20.5
Wt. Dry Soil (g)	6.8	9.1
Wt. Water (g)	1.6	2.1
Water Content (%)	23.6%	23.5%

RESULTS	
LL	91
PL	24
PI	67





Reviewed By: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie Sewer
Project No:	123311974
Date Received:	June 16, 2015
Date Tested:	June 19, 2015
Tested By:	Yan Wang

Sample : TH15-04, S6 (27'-28')

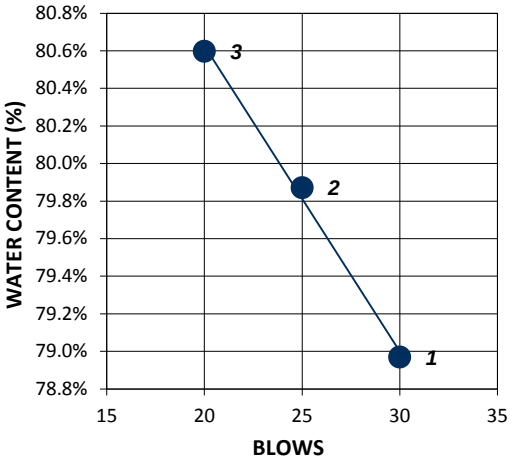
LIQUID LIMIT

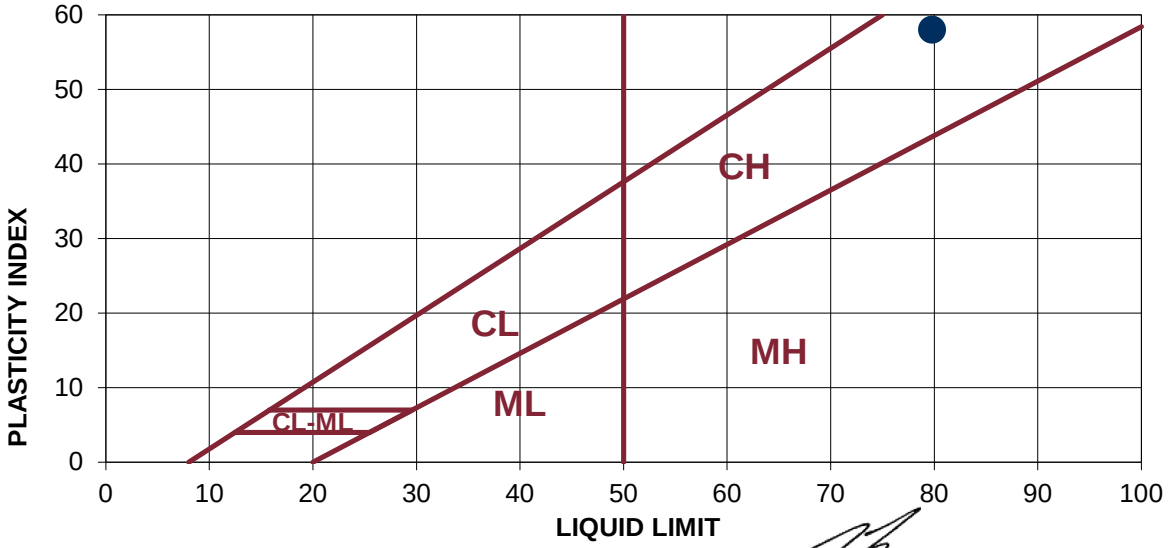
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	135	235	305
Wt. Sa. (wet+tare)(g)	50	54	48
Wt. Sa. (dry+tare)(g)	37	39	36
Wt. Tare (g)	20	21	21
Wt. Dry Soil (g)	16.7	18.6	15.1
Wt. Water (g)	13.2	14.8	12.1
Water Content (%)	79.0%	79.9%	80.6%

PLASTIC LIMIT

Trial	1	2
Tare No.	260	266
Wt. Sa. (wet+tare)(g)	34.06	31.93
Wt. Sa. (dry+tare)(g)	31.61	29.95
Wt. Tare (g)	20.52	20.77
Wt. Dry Soil (g)	11.1	9.2
Wt. Water (g)	2.5	2.0
Water Content (%)	22.1%	21.6%

RESULTS	
LL	80
PL	22
PI	58





Reviewed By: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Stantec

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie Sewer
Project No:	123311974
Date Received:	June 16, 2015
Date Tested:	June 19, 2015
Tested By:	Yan Wang

Sample : TH15-05, S10 (42'-43')

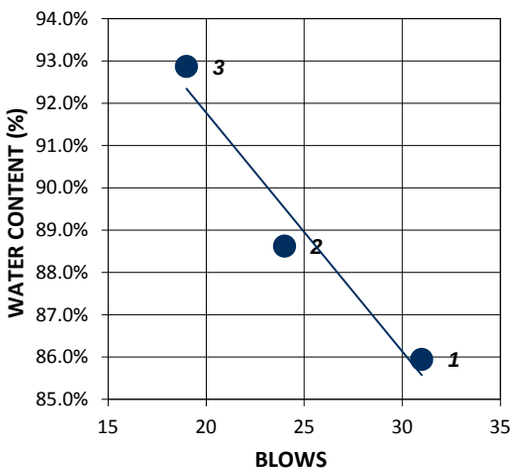
LIQUID LIMIT

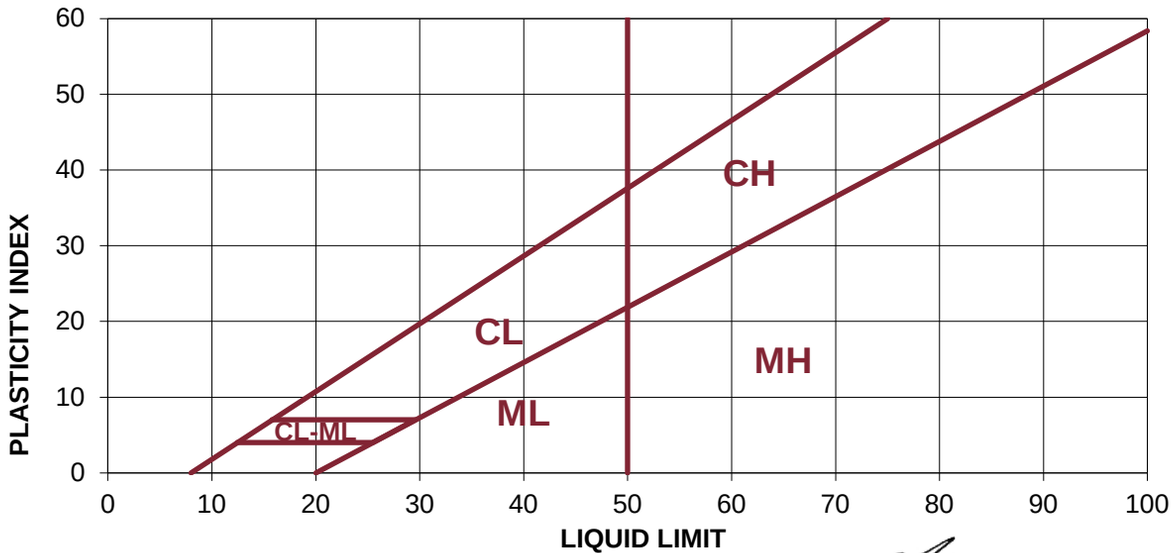
Trial	1	2	3
No. of Blows	31	24	19
Tare No.	318	286	249
Wt. Sa. (wet+tare)(g)	39	46	49
Wt. Sa. (dry+tare)(g)	30	34	35
Wt. Tare (g)	21	21	20
Wt. Dry Soil (g)	9.8	13.0	14.7
Wt. Water (g)	8.4	11.5	13.7
Water Content (%)	85.9%	88.6%	92.9%

PLASTIC LIMIT

Trial	1	2
Tare No.	289	195
Wt. Sa. (wet+tare)(g)	31.38	33.12
Wt. Sa. (dry+tare)(g)	29.22	30.71
Wt. Tare (g)	19.86	20.1
Wt. Dry Soil (g)	9.4	10.6
Wt. Water (g)	2.2	2.4
Water Content (%)	23.1%	22.7%

RESULTS	
LL	89
PL	23
PI	66





CERTIFIED BY CCIL

Reviewed By: Jason Thompson, C.E.T.

Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg MB R3Y 1G4

May 19, 2016
File: 123311974

Attention: Ms. Jacqueline MacLennan
KGS Group Inc.
3rd Floor – 865 Waverley Street
Winnipeg, Manitoba R3T 5P4

Good day Jacqueline,

Reference: Cockburn and Calrossie Sewer Relief (11-0107-18)

Soil samples were submitted to our laboratory on May 4, 2016. The following tests were conducted on selected soil samples:

- Water content (ASTM D2216)
- Particle-Size Analysis (ASTM D422)
- Liquid Limit (multi-point), plastic limit, and plasticity index (ASTM D4318)
- Unconfined Compressive Strength of Cohesive Soil (ASTM D2166)

We appreciate the opportunity to assist you in this project. Please call if you have any questions regarding this report.

Regards,

STANTEC CONSULTING LTD.

Larry Presado, C.Tech.
Geotechnical Technologist
Phone: (204) 488-6999
larry.presado@stantec.com

Jason Thompson, C.E.T.
Senior Associate – Team Lead
Manager, Materials Testing Services
Phone: (204) 928-4004
jason.thompson@stantec.com

Attachment: Table 1 - Water Content Test Data
Table 2 – Particle Size Analysis and Atterberg Limits Test Data
3 x Particle Size Analysis Reports
12 x Atterberg Limits Reports
6 x Unconfined Compressive Strength Reports

Reference: Cockburn and Calrossie Sewer Relief (11-0107-018)

TABLE 1
WATER CONTENT TEST DATA

Testhole	Field Sample No.	Depth (ft.)	Water Content (%)	Testhole	Field Sample No.	Depth (ft.)	Water Content (%)
TH16-02	S3	9-10	22.9	TH16-08	S5	10	51.0
	S5	18-19	56.3		S7	17-18	57.5
TH16-03	S5	17-18	53.4		S8	20	52.9
TH16-05	S2	-	25.0		S11	30	58.1
	S4	18-19	53.1		S13	40	47.9
TH16-06	S4	10	49.0	TH16-09	S3	12	52.2
	S7	20	51.8		S6	20	57.4
	S10	30	51.5		S9	30	46.5
	S13	40	51.9		S12	40	54.1
TH16-08	S3	6	24.8				

Reference: Cockburn and Calrossie Sewer Relief (11-0107-018)

TABLE 2
PARTICLE SIZE AND ATTERBERG LIMITS TEST DATA

Testhole	Field Sample No.	Depth (ft.)	Particle Size Analysis							Atterberg Limits		
			Gravel (%) 75 to 4.75 mm	Sand (%)			Silt (%) <0.075 to 0.002 mm	Clay (%) <0.002 mm	Colloids (%) < 0.001 mm	Liquid Limit	Plastic Limit	Plasticity Index
				Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm						
TH16-02	S3	9-10	NT	NT	NT	NT	NT	NT	NT	26	16	10
TH16-02	S5	18-19	NT	NT	NT	NT	NT	NT	NT	105	32	73
TH16-03	S5	17-18	NT	NT	NT	NT	NT	NT	NT	98	29	69
TH16-05	S2	-	NT	NT	NT	NT	NT	NT	NT	27	17	10
TH16-05	S4	18-19	NT	NT	NT	NT	NT	NT	NT	93	27	66
TH16-06	S7	-	0.0	0.0	0.2	0.3	19.4	80.1	69.0	97	27	70
TH16-06	S10	-	NT	NT	NT	NT	NT	NT	NT	72	23	49
TH16-08	S7	17-18	NT	NT	NT	NT	NT	NT	NT	100	30	70
TH16-08	S8	-	0.0	0.0	0.1	0.3	18.2	81.4	66.6	95	29	66
TH16-08	S11	-	NT	NT	NT	NT	NT	NT	NT	81	23	58
TH16-09	S6	-	0.0	0.1	0.3	0.5	18.2	80.9	67.3	98	29	69
TH16-09	S9	-	NT	NT	NT	NT	NT	NT	NT	85	25	60

Notes:
1. A high speed stirring device was used for 1 minute to disperse the test sample for particle size analysis
2. The soil samples were air-dried during sample preparation for Atterberg limits and particle size analysis
3. NT* sample not tested

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PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

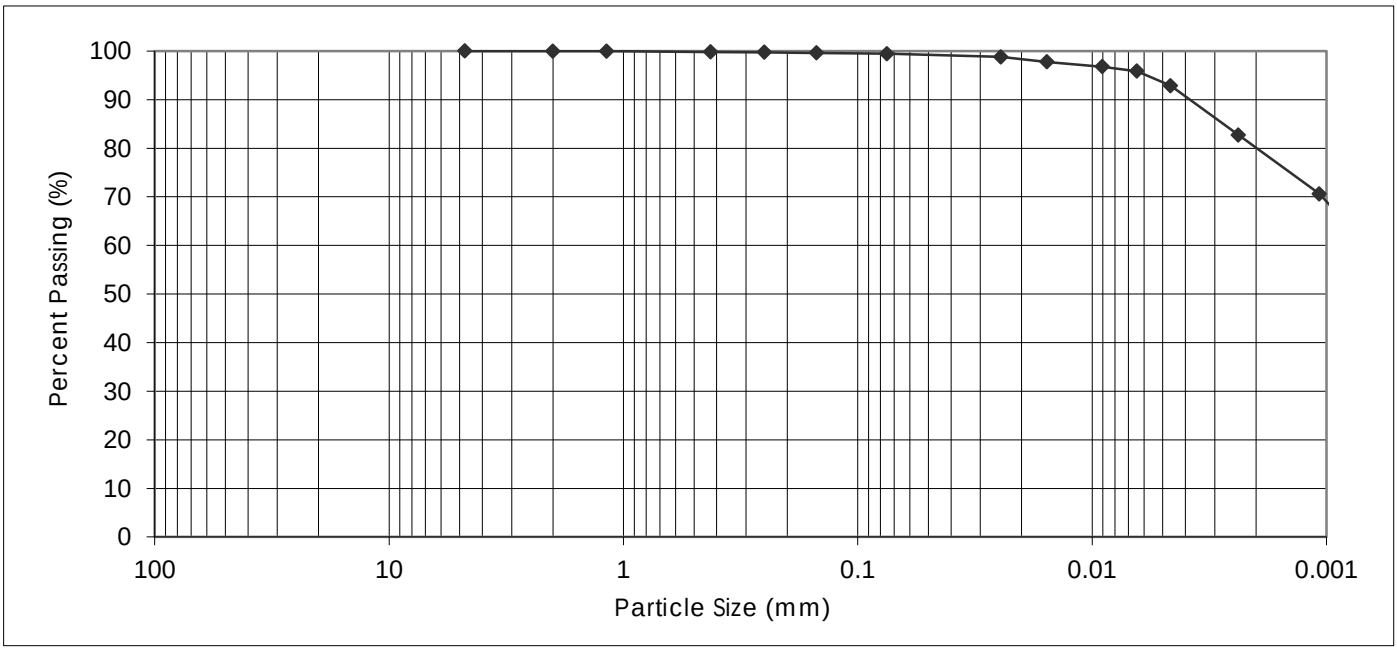
PROJECT: Cockburn & Calrossie

Attention: Ms. Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH16-06, S7

DATE RECEIVED: May 10, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	100.0
4.75 mm	100.0
2.00 mm	100.0

PARTICLE SIZE	PERCENT PASSING
1.18 mm	100.0
0.425 mm	99.8
0.250 mm	99.7
0.150 mm	99.6
0.075 mm	99.5
0.005 mm	93.6
0.002 mm	80.1
0.001 mm	69.0

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
0.0	0.0	0.2	0.3	19.4	80.1	69.0

REPORT DATE: May 14, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

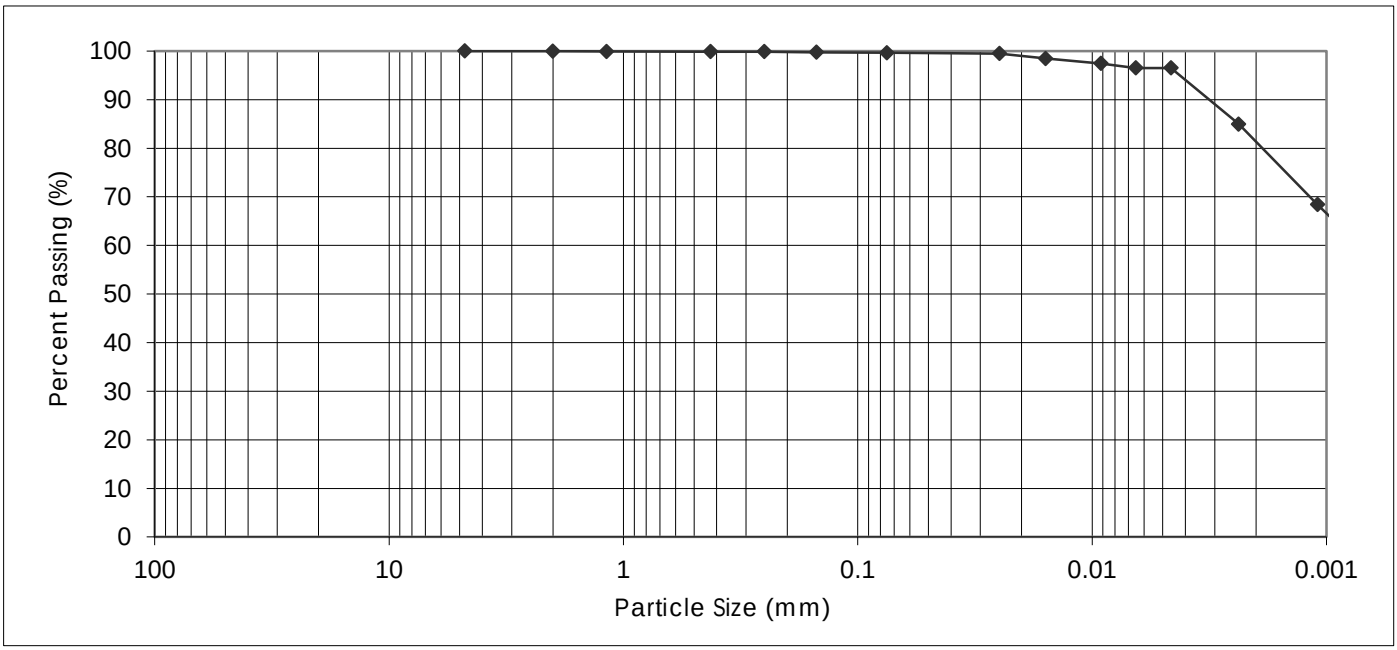
PROJECT: Cockburn & Calrossie

Attention: Ms. Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH16-08, S8

DATE RECEIVED: May 10, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	100.0
4.75 mm	100.0
2.00 mm	100.0

PARTICLE SIZE	PERCENT PASSING
1.18 mm	99.9
0.425 mm	99.9
0.250 mm	99.9
0.150 mm	99.7
0.075 mm	99.6
0.005 mm	96.5
0.002 mm	81.4
0.001 mm	66.6

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
0.0	0.0	0.1	0.3	18.2	81.4	66.6

REPORT DATE: May 14, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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PARTICLE SIZE ANALYSIS
ASTM D422

KGS Group
3rd Floor - 865 Waverley St.
Winnipeg, Manitoba
R3T 5P4

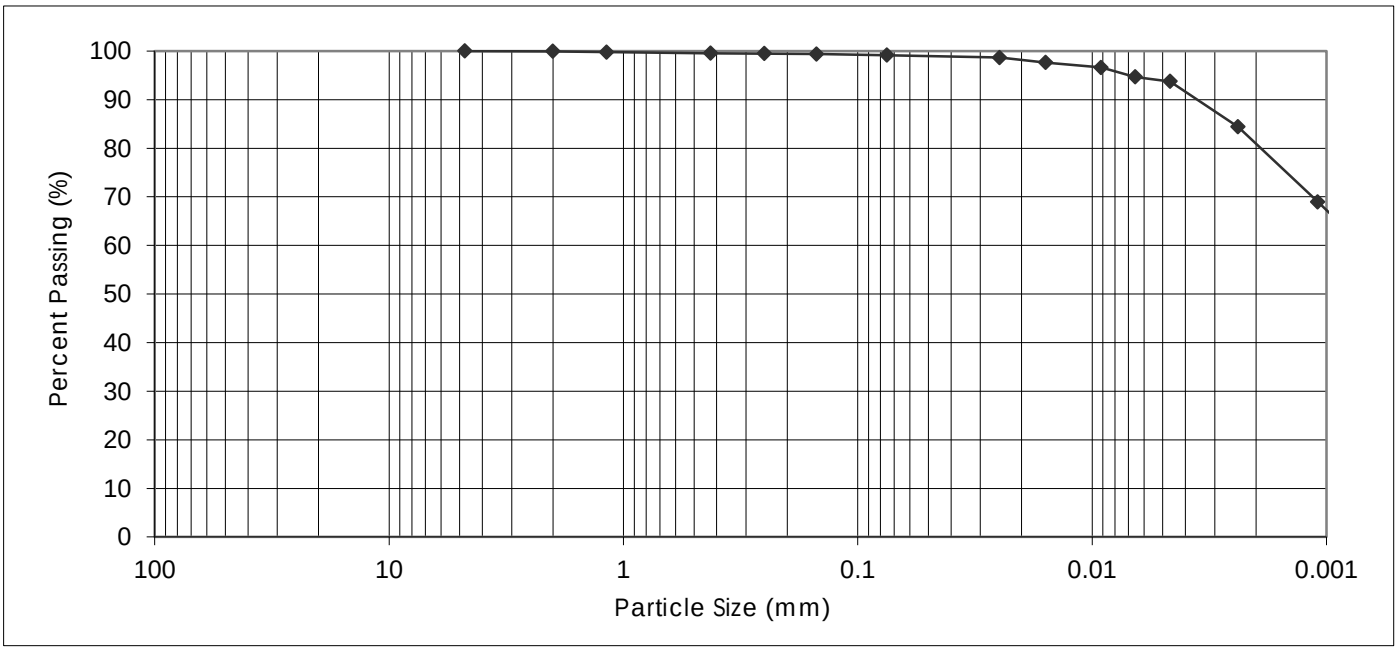
PROJECT: Cockburn & Calrossie

Attention: Ms. Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH16-09, S6

DATE RECEIVED: May 10, 2016
TESTED BY: Nestor Abarca



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	100.0
16.00 mm	100.0
12.50 mm	100.0
9.50 mm	100.0
4.75 mm	100.0
2.00 mm	99.9

PARTICLE SIZE	PERCENT PASSING
1.18 mm	99.8
0.425 mm	99.6
0.250 mm	99.5
0.150 mm	99.4
0.075 mm	99.1
0.005 mm	93.9
0.002 mm	80.9
0.001 mm	67.3

Gravel, % 75 to 4.75 mm	Sand, %			Silt, % <0.075 to 0.002 mm	Clay, % <0.002 mm	Colloids, % < 0.001 mm
	Coarse <4.75 to 2.0 mm	Medium <2.0 to 0.425 mm	Fine <0.425 to 0.075 mm			
0.0	0.1	0.3	0.5	18.2	80.9	67.3

REPORT DATE: May 14, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-02, S3

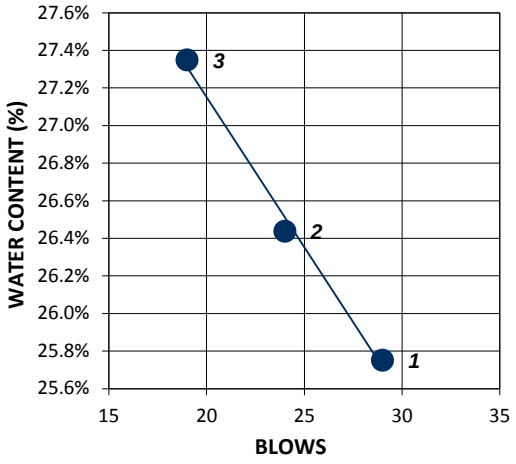
LIQUID LIMIT

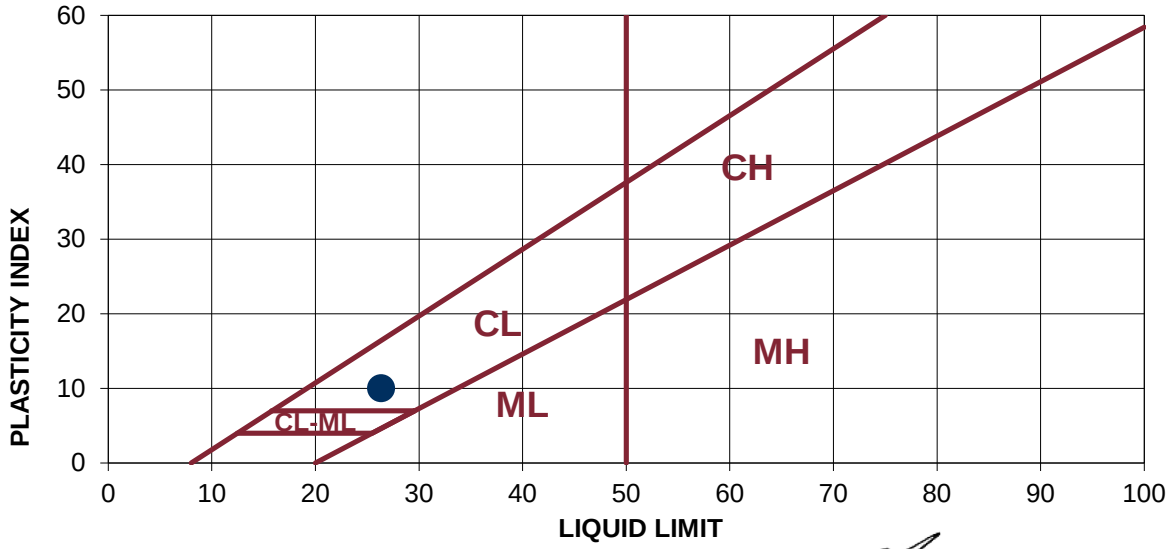
Trial	1	2	3
No. of Blows	29	24	19
Tare No.	158	181	217
Wt. Sa. (wet+tare)(g)	48	41	43
Wt. Sa. (dry+tare)(g)	43	37	38
Wt. Tare (g)	20	20	19
Wt. Dry Soil (g)	22.3	16.3	19.1
Wt. Water (g)	5.7	4.3	5.2
Water Content (%)	25.8%	26.4%	27.3%

PLASTIC LIMIT

Trial	1	2
Tare No.	261	280
Wt. Sa. (wet+tare)(g)	40.82	35.96
Wt. Sa. (dry+tare)(g)	37.99	33.78
Wt. Tare (g)	20.39	20.21
Wt. Dry Soil (g)	17.6	13.6
Wt. Water (g)	2.8	2.2
Water Content (%)	16.1%	16.1%

RESULTS	
LL	26
PL	16
PI	10





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 11, 2016
Tested By:	Nestor Abarca

Sample : TH16-02 , S5

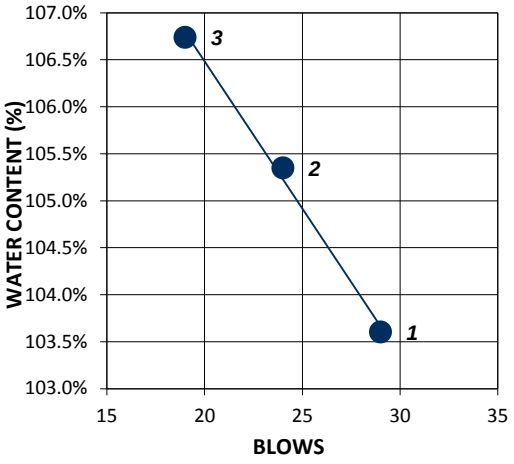
LIQUID LIMIT

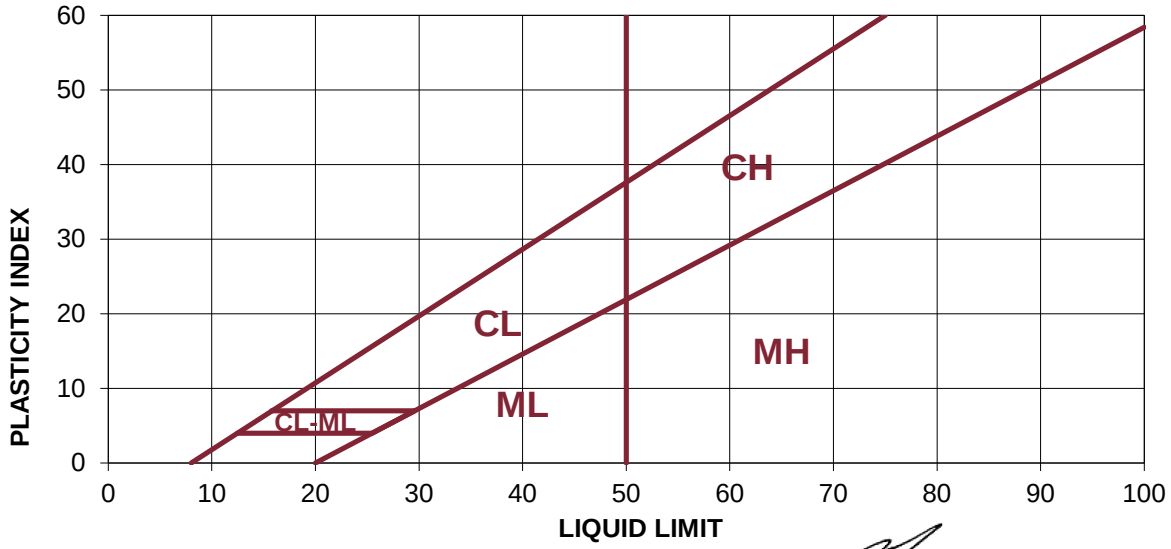
Trial	1	2	3
No. of Blows	29	24	19
Tare No.	133	140	178
Wt. Sa. (wet+tare)(g)	38	40	39
Wt. Sa. (dry+tare)(g)	29	30	29
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	9.2	9.9	9.2
Wt. Water (g)	9.5	10.4	9.8
Water Content (%)	103.6%	105.3%	106.7%

PLASTIC LIMIT

Trial	1	2
Tare No.	238	310
Wt. Sa. (wet+tare)(g)	30.54	28.54
Wt. Sa. (dry+tare)(g)	28.17	26.62
Wt. Tare (g)	20.70	20.54
Wt. Dry Soil (g)	7.5	6.1
Wt. Water (g)	2.4	1.9
Water Content (%)	31.7%	31.6%

RESULTS	
LL	105
PL	32
PI	73





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-03, S5

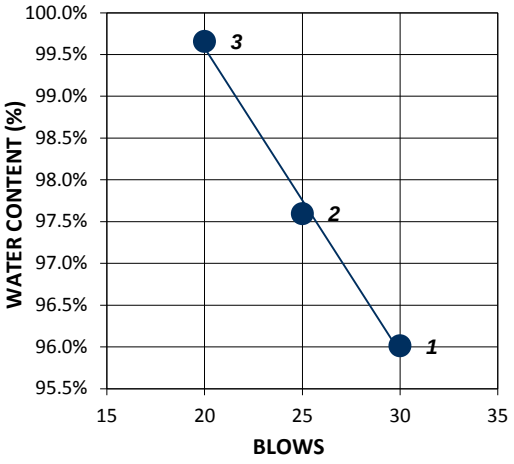
LIQUID LIMIT

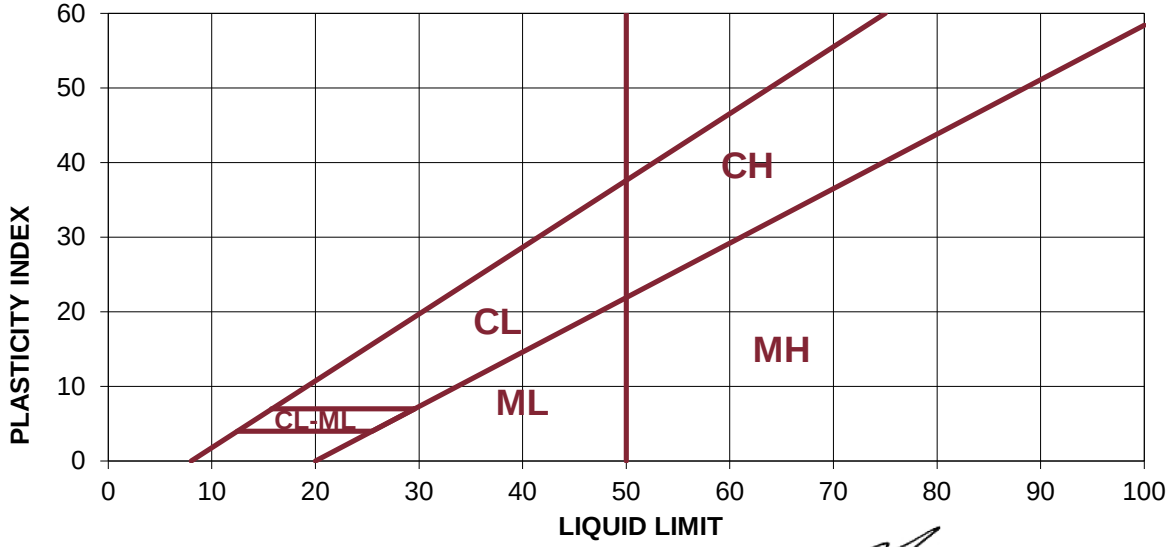
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	133	140	178
Wt. Sa. (wet+tare)(g)	39	40	43
Wt. Sa. (dry+tare)(g)	30	30	31
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	10.0	10.4	11.7
Wt. Water (g)	9.6	10.2	11.7
Water Content (%)	96.0%	97.6%	99.7%

PLASTIC LIMIT

Trial	1	2
Tare No.	238	310
Wt. Sa. (wet+tare)(g)	29.30	31.07
Wt. Sa. (dry+tare)(g)	27.34	28.68
Wt. Tare (g)	20.68	20.54
Wt. Dry Soil (g)	6.7	8.1
Wt. Water (g)	2.0	2.4
Water Content (%)	29.4%	29.4%

RESULTS	
LL	98
PL	29
PI	69





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-05, S2

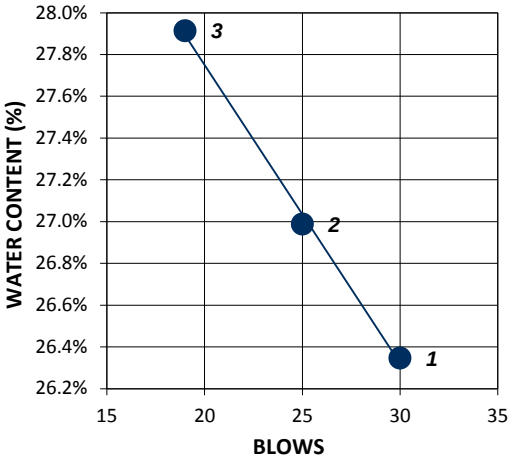
LIQUID LIMIT

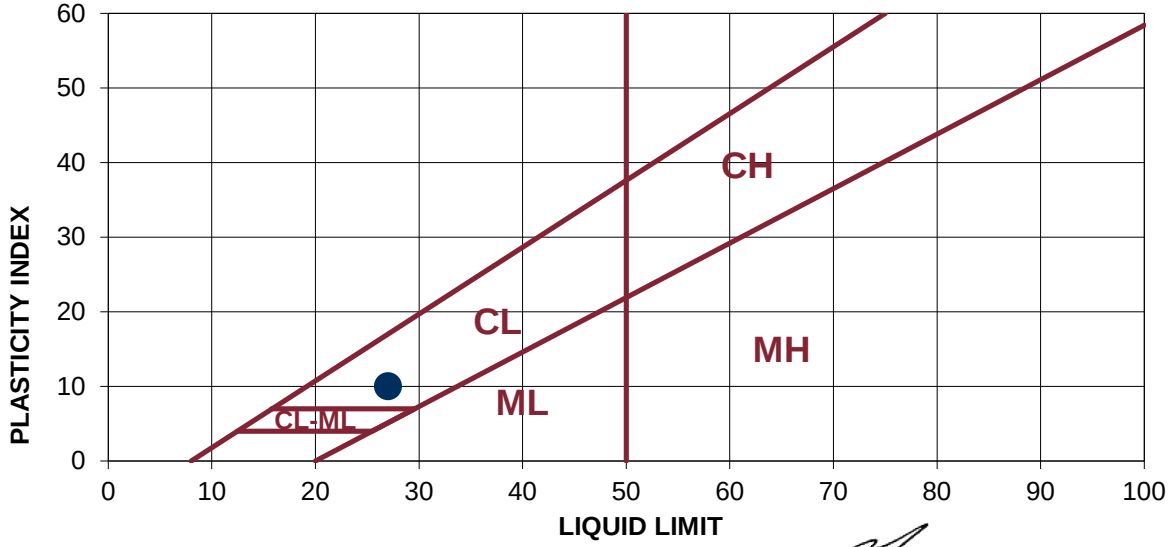
Trial	1	2	3
No. of Blows	30	25	19
Tare No.	189	196	259
Wt. Sa. (wet+tare)(g)	43	41	44
Wt. Sa. (dry+tare)(g)	38	37	39
Wt. Tare (g)	19	20	20
Wt. Dry Soil (g)	18.8	17.0	18.3
Wt. Water (g)	4.9	4.6	5.1
Water Content (%)	26.3%	27.0%	27.9%

PLASTIC LIMIT

Trial	1	2
Tare No.	266	311
Wt. Sa. (wet+tare)(g)	36.69	38.28
Wt. Sa. (dry+tare)(g)	34.33	35.72
Wt. Tare (g)	20.61	20.77
Wt. Dry Soil (g)	13.7	15.0
Wt. Water (g)	2.4	2.6
Water Content (%)	17.2%	17.1%

RESULTS	
LL	27
PL	17
PI	10





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 11, 2016
Tested By:	Nestor Abarca

Sample : TH16-05 , S4

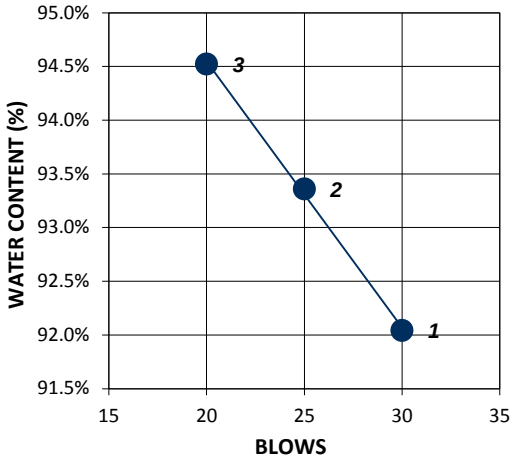
LIQUID LIMIT

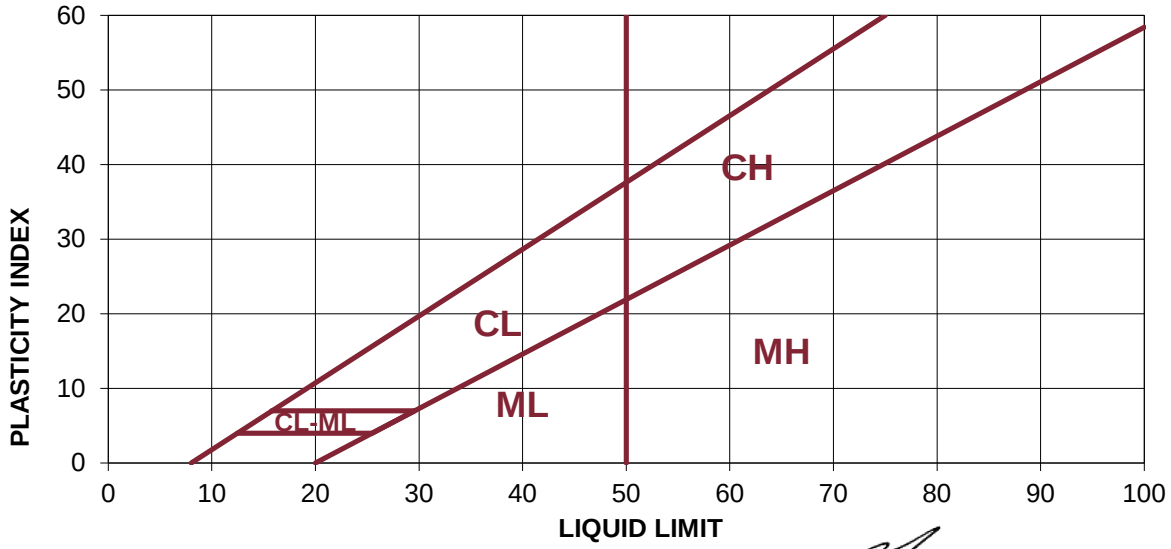
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	154	235	247
Wt. Sa. (wet+tare)(g)	38	40	40
Wt. Sa. (dry+tare)(g)	29	31	30
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	9.3	10.1	10.4
Wt. Water (g)	8.6	9.4	9.8
Water Content (%)	92.0%	93.4%	94.5%

PLASTIC LIMIT

Trial	1	2
Tare No.	264	293
Wt. Sa. (wet+tare)(g)	28.83	31.05
Wt. Sa. (dry+tare)(g)	27.00	28.87
Wt. Tare (g)	20.23	20.89
Wt. Dry Soil (g)	6.8	8.0
Wt. Water (g)	1.8	2.2
Water Content (%)	27.0%	27.3%

RESULTS	
LL	93
PL	27
PI	66





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 11, 2016
Tested By:	Nestor Abarca

Sample : TH16-06 , S7

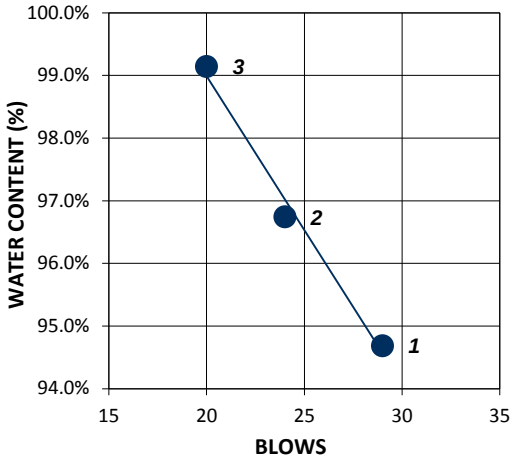
LIQUID LIMIT

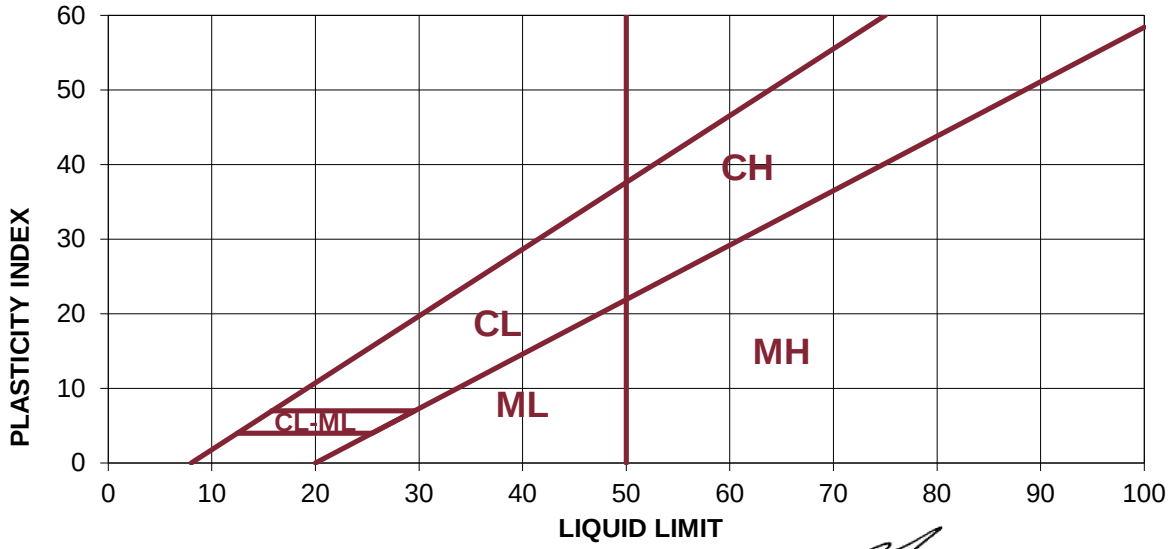
Trial	1	2	3
No. of Blows	29	24	20
Tare No.	152	157	192
Wt. Sa. (wet+tare)(g)	36	38	36
Wt. Sa. (dry+tare)(g)	28	29	28
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	8.5	8.9	8.2
Wt. Water (g)	8.0	8.6	8.1
Water Content (%)	94.7%	96.7%	99.1%

PLASTIC LIMIT

Trial	1	2
Tare No.	243	254
Wt. Sa. (wet+tare)(g)	30.70	32.96
Wt. Sa. (dry+tare)(g)	28.59	30.31
Wt. Tare (g)	20.86	20.65
Wt. Dry Soil (g)	7.7	9.7
Wt. Water (g)	2.1	2.7
Water Content (%)	27.3%	27.4%

RESULTS	
LL	97
PL	27
PI	70





Reviewed By: Jason Thompson, C.E.T.

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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 10, 2016
Tested By:	Nestor Abarca

Sample : TH16-06 , S10

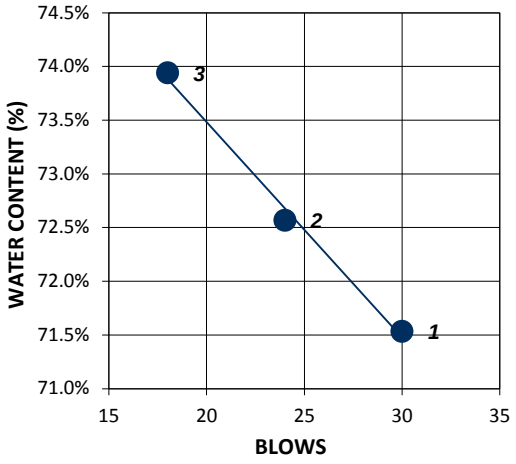
LIQUID LIMIT

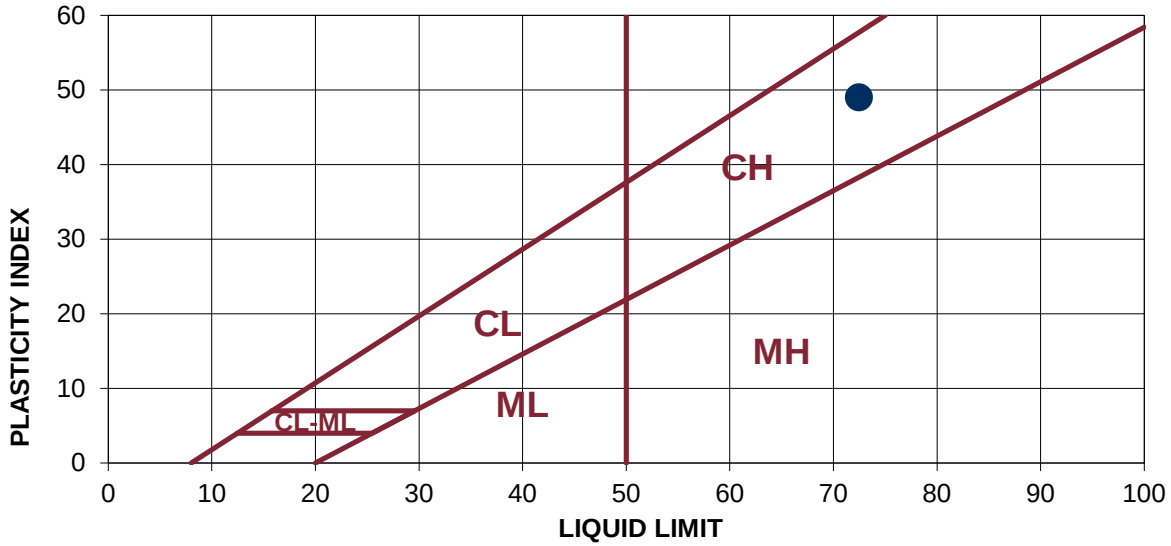
Trial	1	2	3
No. of Blows	30	24	18
Tare No.	158	181	217
Wt. Sa. (wet+tare)(g)	41	44	39
Wt. Sa. (dry+tare)(g)	33	34	30
Wt. Tare (g)	20	20	19
Wt. Dry Soil (g)	12.3	13.8	11.3
Wt. Water (g)	8.8	10.0	8.4
Water Content (%)	71.5%	72.6%	73.9%

PLASTIC LIMIT

Trial	1	2
Tare No.	261	280
Wt. Sa. (wet+tare)(g)	35.13	32.56
Wt. Sa. (dry+tare)(g)	32.40	30.29
Wt. Tare (g)	20.40	20.22
Wt. Dry Soil (g)	12.0	10.1
Wt. Water (g)	2.7	2.3
Water Content (%)	22.8%	22.5%

RESULTS	
LL	72
PL	23
PI	49





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 11, 2016
Tested By:	Nestor Abarca

Sample : TH16-08 , S7

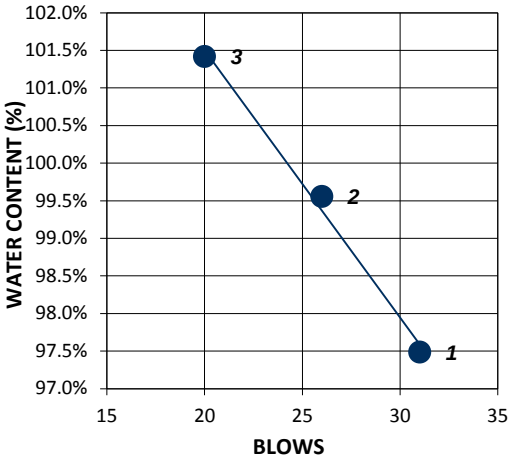
LIQUID LIMIT

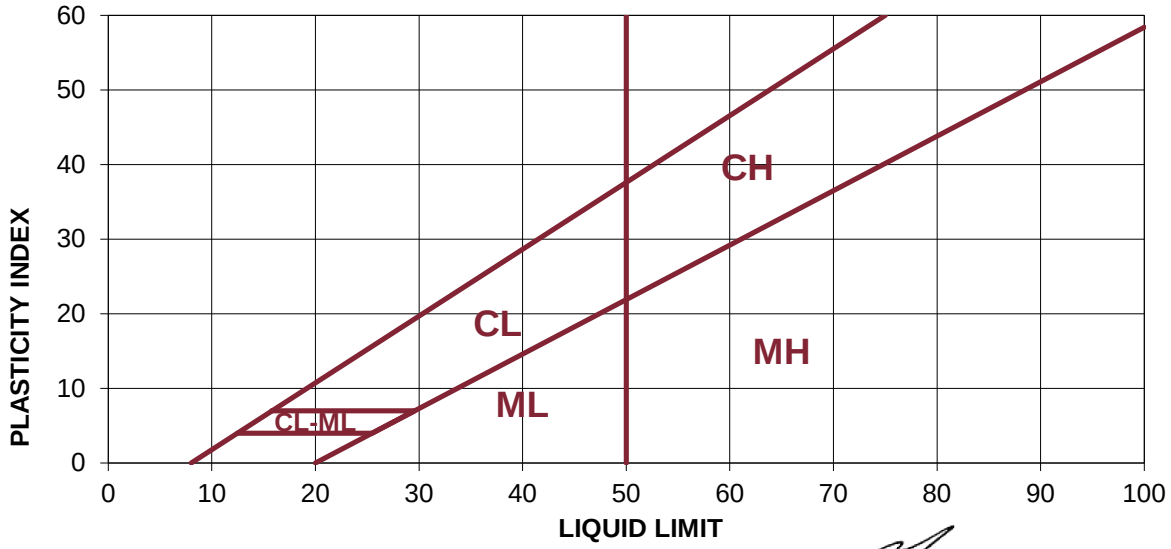
Trial	1	2	3
No. of Blows	31	26	20
Tare No.	234	245	249
Wt. Sa. (wet+tare)(g)	37	38	38
Wt. Sa. (dry+tare)(g)	29	29	29
Wt. Tare (g)	21	20	20
Wt. Dry Soil (g)	8.4	9.0	9.2
Wt. Water (g)	8.2	9.0	9.3
Water Content (%)	97.5%	99.6%	101.4%

PLASTIC LIMIT

Trial	1	2
Tare No.	262	287
Wt. Sa. (wet+tare)(g)	30.28	33.21
Wt. Sa. (dry+tare)(g)	28.10	30.29
Wt. Tare (g)	20.72	20.57
Wt. Dry Soil (g)	7.4	9.7
Wt. Water (g)	2.2	2.9
Water Content (%)	29.5%	30.0%

RESULTS	
LL	100
PL	30
PI	70





Reviewed By: Jason Thompson, C.E.T.

LABORATORY
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Winnipeg, Manitoba
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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-08, S8

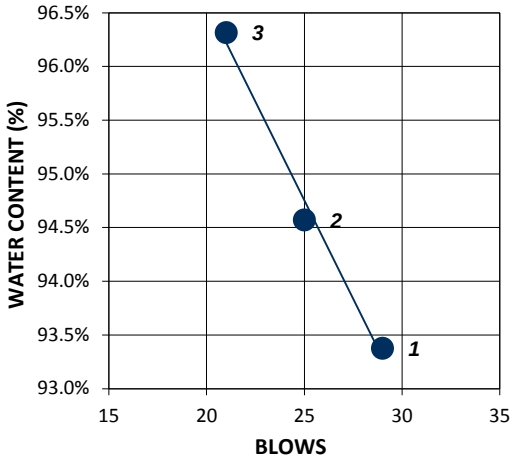
LIQUID LIMIT

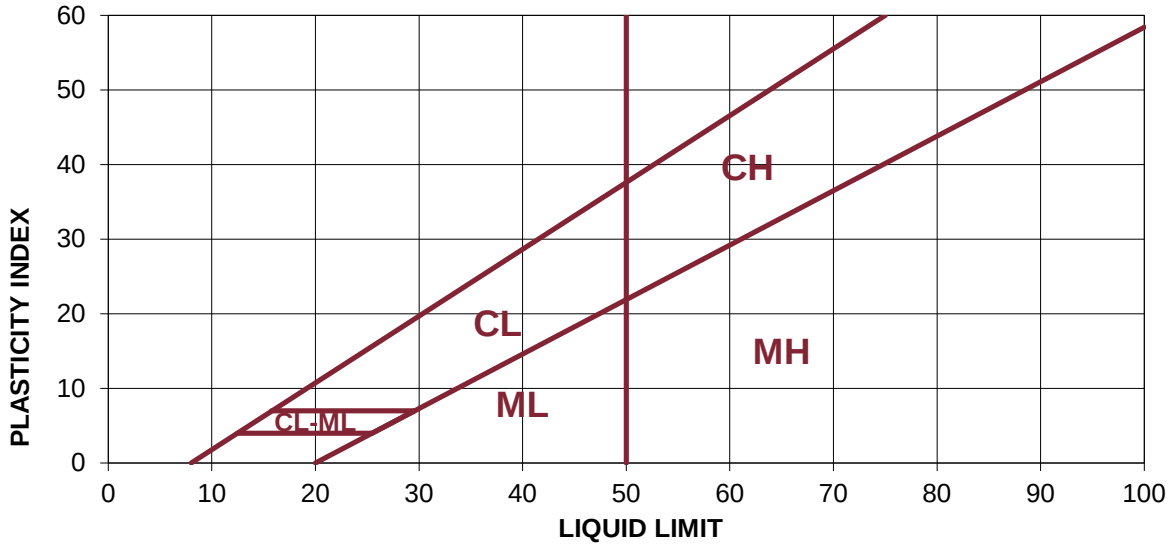
Trial	1	2	3
No. of Blows	29	25	21
Tare No.	152	157	192
Wt. Sa. (wet+tare)(g)	38	38	42
Wt. Sa. (dry+tare)(g)	29	30	31
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	9.5	9.2	11.4
Wt. Water (g)	8.9	8.7	11.0
Water Content (%)	93.4%	94.6%	96.3%

PLASTIC LIMIT

Trial	1	2
Tare No.	243	254
Wt. Sa. (wet+tare)(g)	30.56	30.81
Wt. Sa. (dry+tare)(g)	28.40	28.53
Wt. Tare (g)	20.85	20.64
Wt. Dry Soil (g)	7.6	7.9
Wt. Water (g)	2.2	2.3
Water Content (%)	28.6%	28.9%

RESULTS	
LL	95
PL	29
PI	66





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-08, S11

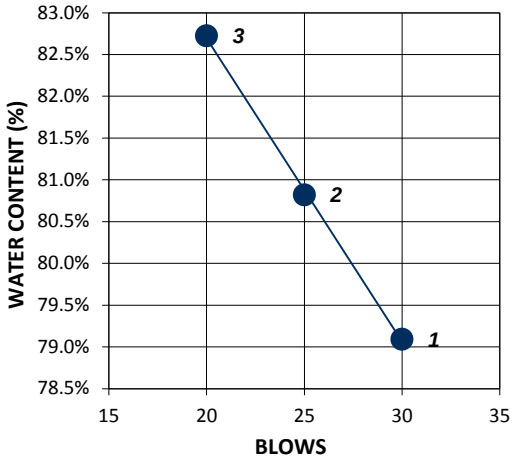
LIQUID LIMIT

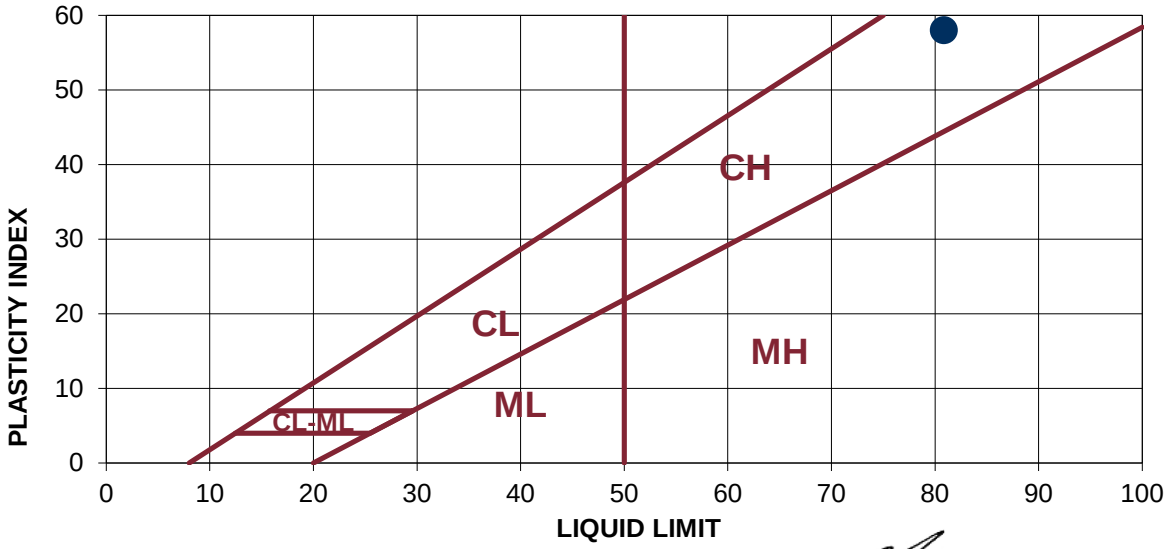
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	234	245	249
Wt. Sa. (wet+tare)(g)	41	41	41
Wt. Sa. (dry+tare)(g)	32	32	32
Wt. Tare (g)	21	20	20
Wt. Dry Soil (g)	11.2	11.7	11.5
Wt. Water (g)	8.9	9.4	9.5
Water Content (%)	79.1%	80.8%	82.7%

PLASTIC LIMIT

Trial	1	2
Tare No.	262	287
Wt. Sa. (wet+tare)(g)	30.65	30.48
Wt. Sa. (dry+tare)(g)	28.76	28.59
Wt. Tare (g)	20.70	20.55
Wt. Dry Soil (g)	8.1	8.0
Wt. Water (g)	1.9	1.9
Water Content (%)	23.4%	23.5%

RESULTS	
LL	81
PL	23
PI	58





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 10, 2016
Tested By:	Nestor Abarca

Sample : TH16-09, S6

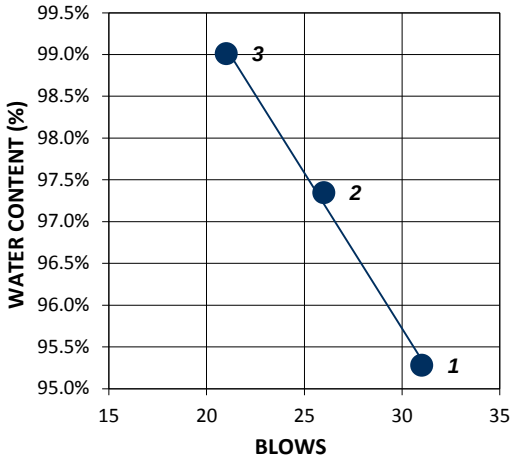
LIQUID LIMIT

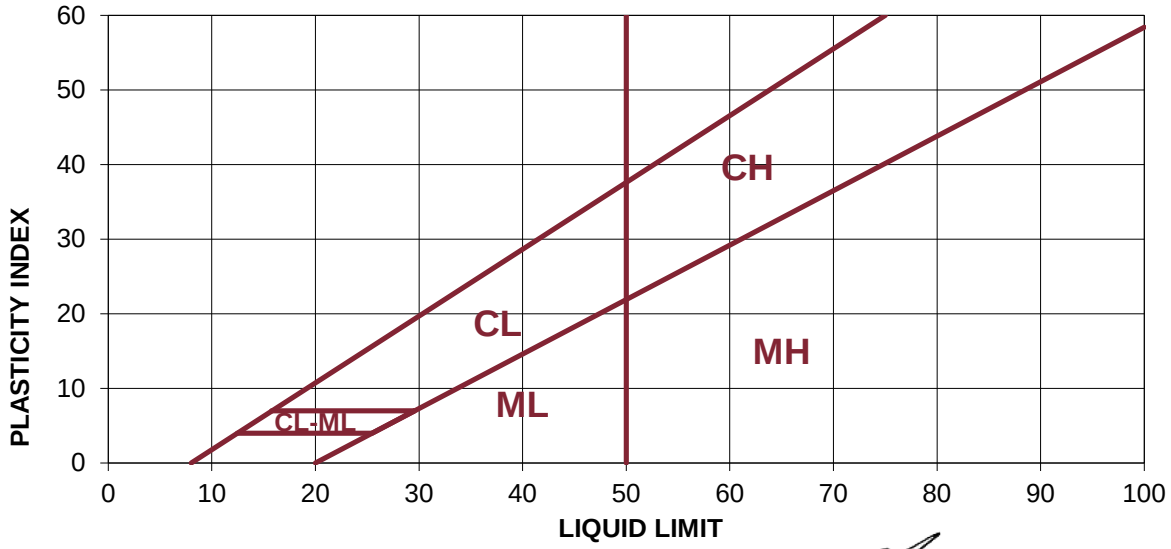
Trial	1	2	3
No. of Blows	31	26	21
Tare No.	189	196	259
Wt. Sa. (wet+tare)(g)	37	40	39
Wt. Sa. (dry+tare)(g)	28	30	30
Wt. Tare (g)	19	20	20
Wt. Dry Soil (g)	9.1	10.6	9.1
Wt. Water (g)	8.7	10.3	9.0
Water Content (%)	95.3%	97.3%	99.0%

PLASTIC LIMIT

Trial	1	2
Tare No.	266	311
Wt. Sa. (wet+tare)(g)	31.55	32.1
Wt. Sa. (dry+tare)(g)	29.11	29.56
Wt. Tare (g)	20.61	20.79
Wt. Dry Soil (g)	8.5	8.8
Wt. Water (g)	2.4	2.5
Water Content (%)	28.7%	29.0%

RESULTS	
LL	98
PL	29
PI	69





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Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group
Project Name:	Cockburn & Calrossie
Project No:	123311974
Date Received:	May 4, 2016
Date Tested:	May 12, 2016
Tested By:	Nestor Abarca

Sample : TH16-09, S9

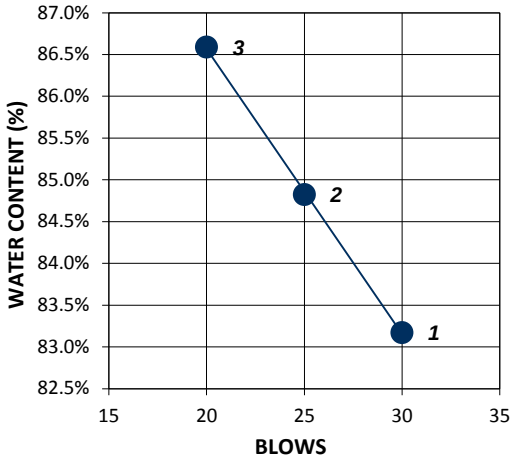
LIQUID LIMIT

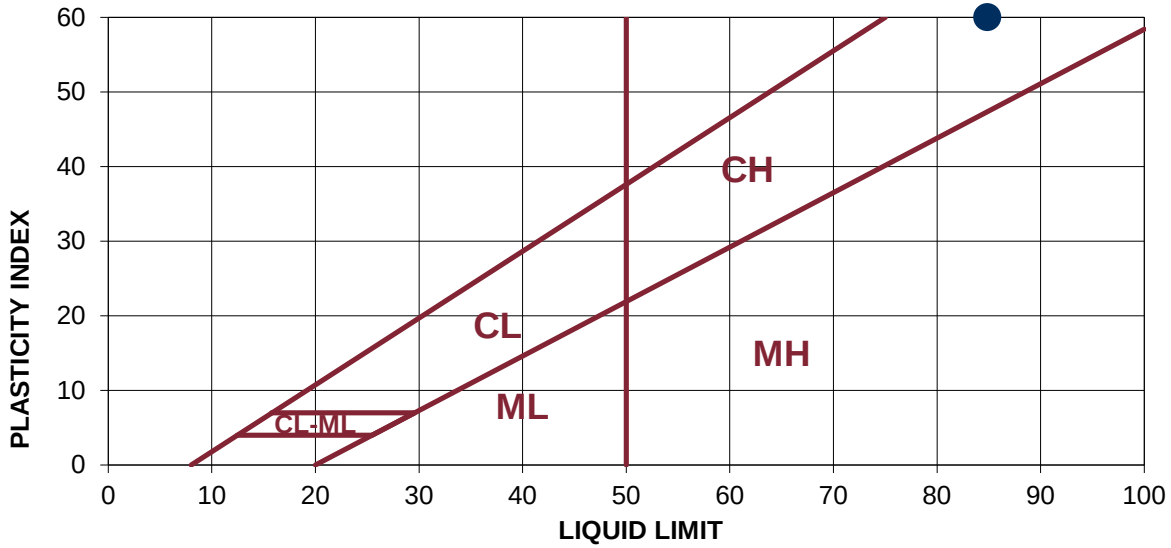
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	154	235	247
Wt. Sa. (wet+tare)(g)	42	40	44
Wt. Sa. (dry+tare)(g)	32	31	33
Wt. Tare (g)	20	21	20
Wt. Dry Soil (g)	12.4	10.4	12.9
Wt. Water (g)	10.3	8.8	11.2
Water Content (%)	83.2%	84.8%	86.6%

PLASTIC LIMIT

Trial	1	2
Tare No.	264	293
Wt. Sa. (wet+tare)(g)	33.52	33.69
Wt. Sa. (dry+tare)(g)	30.88	31.15
Wt. Tare (g)	20.23	20.87
Wt. Dry Soil (g)	10.7	10.3
Wt. Water (g)	2.6	2.5
Water Content (%)	24.8%	24.7%

RESULTS	
LL	85
PL	25
PI	60





Reviewed By: Jason Thompson, C.E.T.

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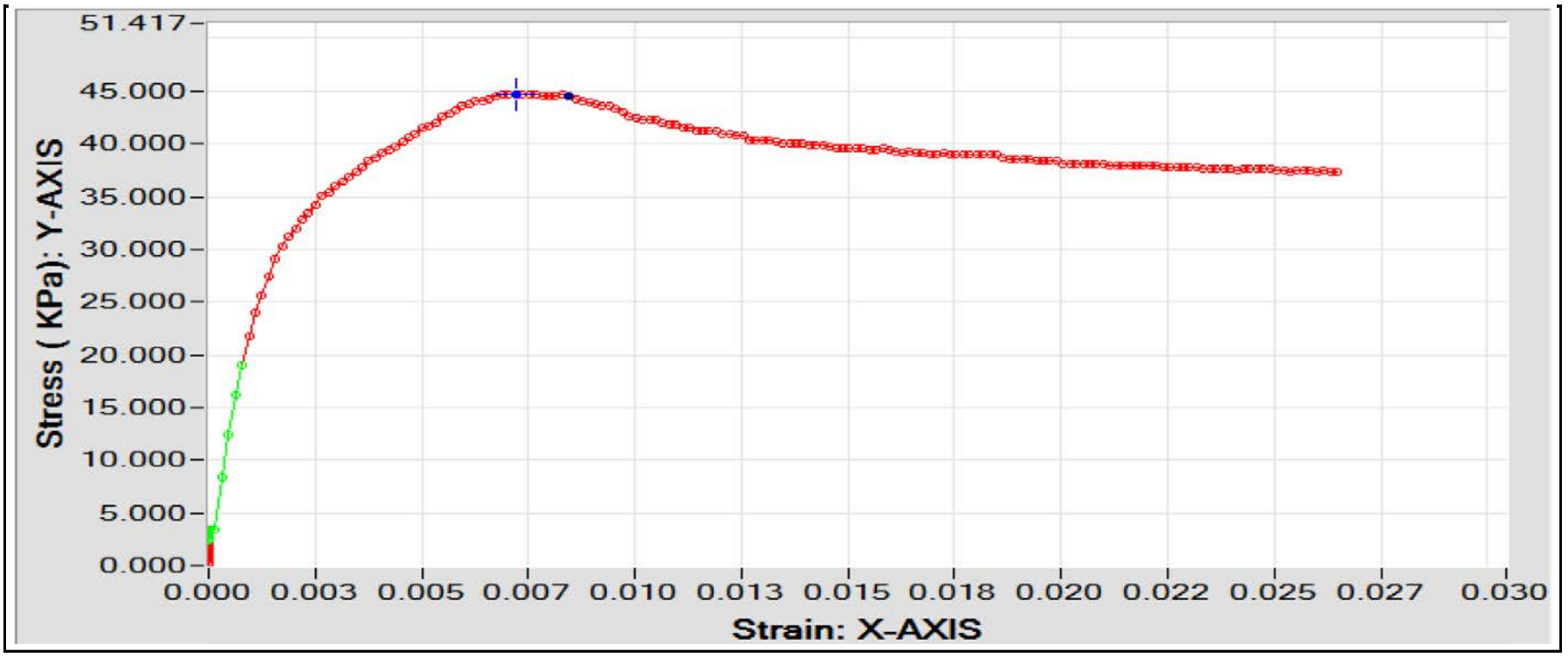
Tel: (204) 488-6999

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-06, S7	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	71.36
Height, mm:	162.17
Height/Diameter Ratio:	2.27 : 1
Sample Weight, g:	1108.87
Moisture Content. %:	53.1
Wet Unit Weight, kN/m³:	16.76
Dry Unit Weight, kN/m³:	10.95
Void ratio:	1.46
Saturation, %:	99.84
Unconfined Compressive Strength, kPa:	45
Strain at Failure, %:	0.72

REPORT DATE: May 18, 2016

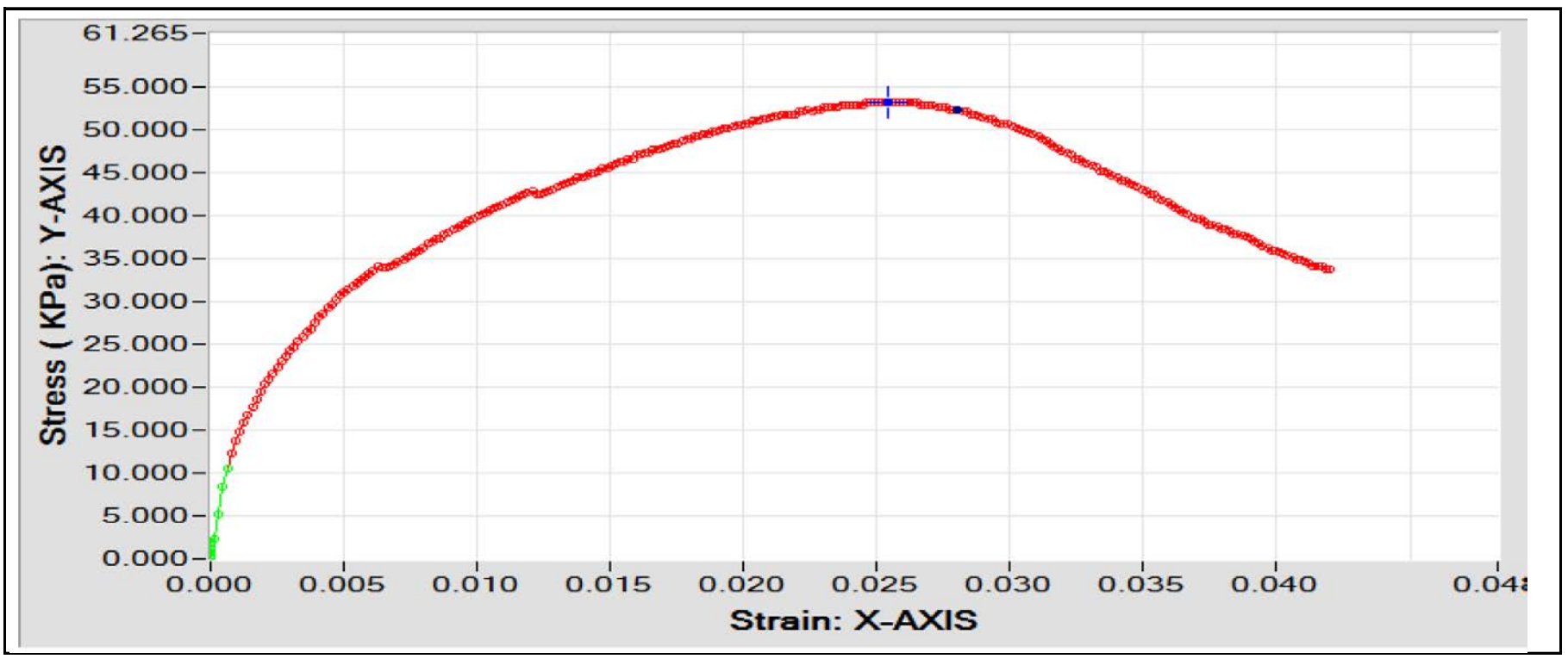
REVIEWED BY: Jason Thompson, C.E.T.

LABORATORY
199 Henlow Bay
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-06, S10	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	71.88
Height, mm:	162.10
Height/Diameter Ratio:	2.26 : 1
Sample Weight, g:	1130.61
Moisture Content. %:	52.4
Wet Unit Weight, kN/m³:	16.84
Dry Unit Weight, kN/m³:	11.05
Void ratio:	1.44
Saturation, %:	100.16
Unconfined Compressive Strength, kPa:	53
Strain at Failure, %:	2.54

REPORT DATE: May 18, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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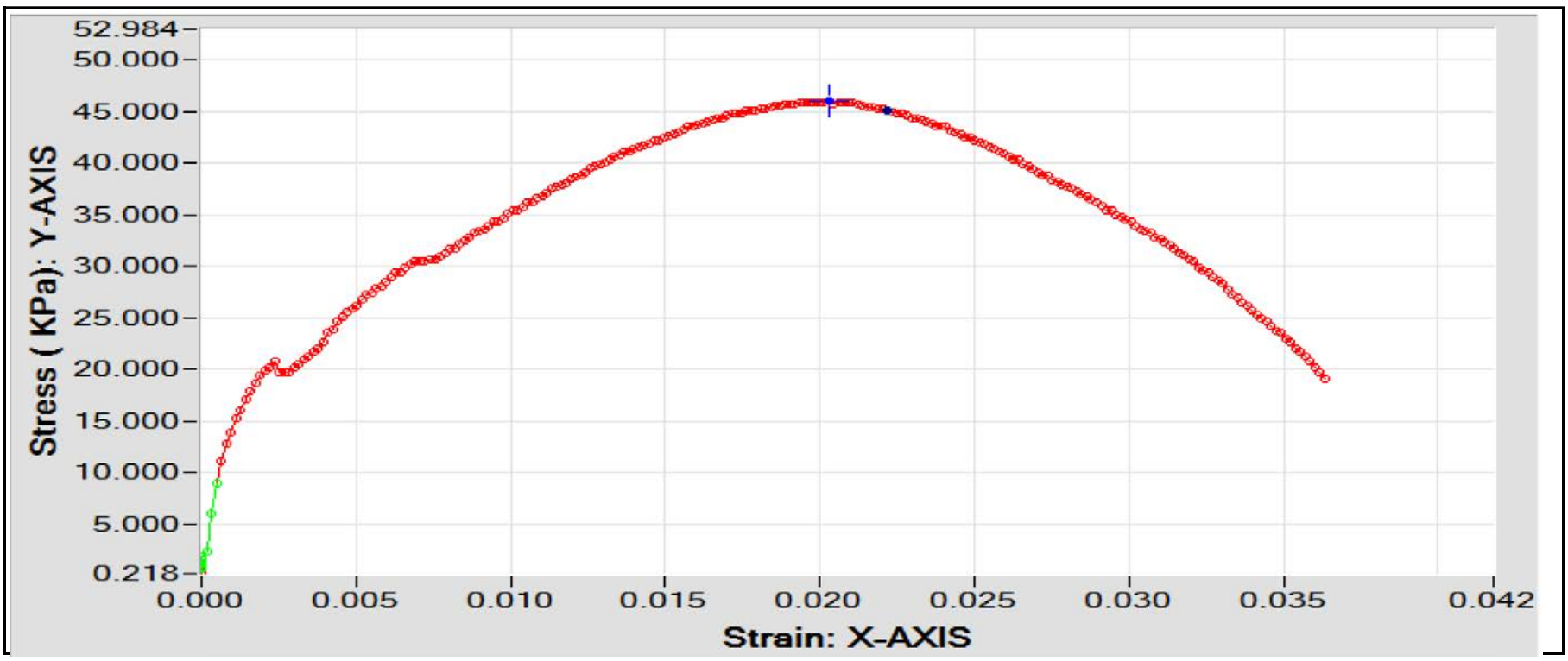
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-08, S8	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	72.11
Height, mm:	161.47
Height/Diameter Ratio:	2.24 : 1
Sample Weight, g:	1099.55
Moisture Content. %:	58.1
Wet Unit Weight, kN/m³:	16.34
Dry Unit Weight, kN/m³:	10.34
Void ratio:	1.61
Saturation, %:	99.39
Unconfined Compressive Strength, kPa:	45
Strain at Failure, %:	2.03

REPORT DATE: May 18, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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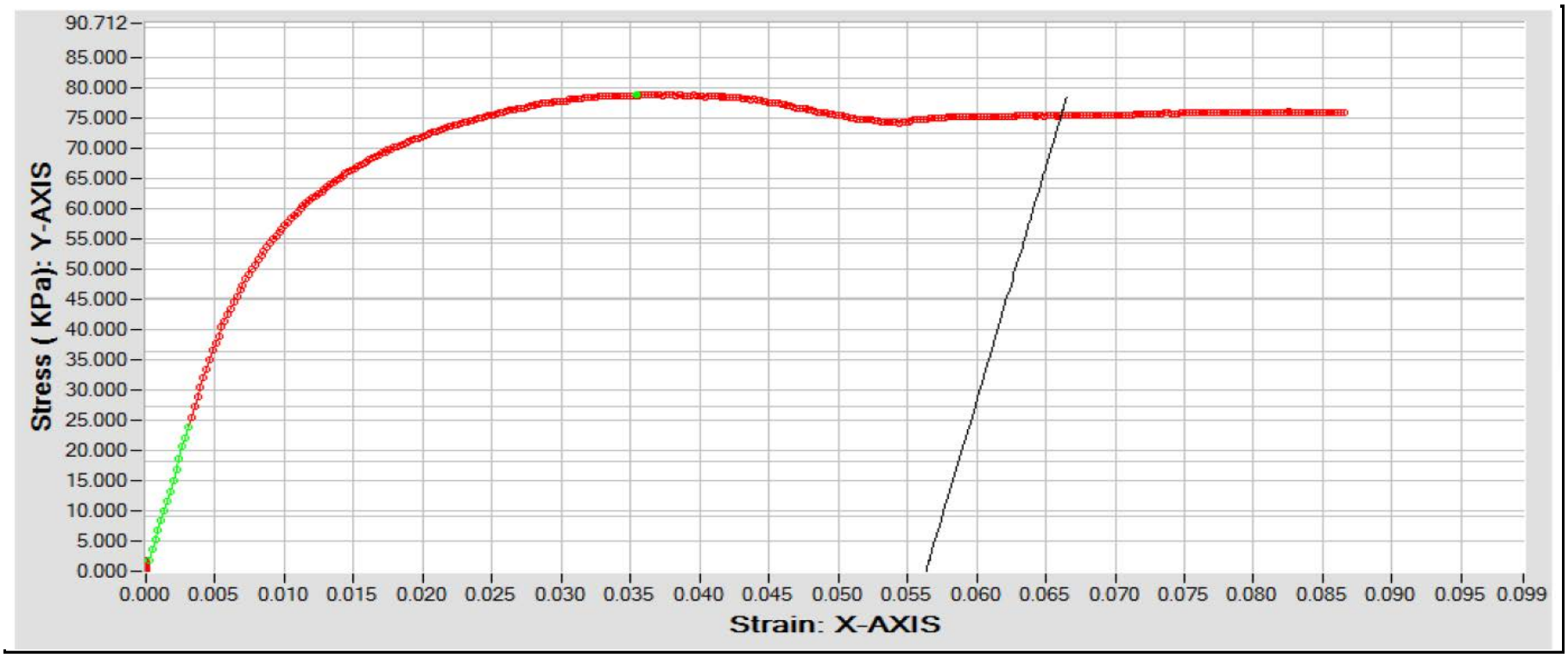
UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-08, S11	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	71.85
Height, mm:	116.27
Height/Diameter Ratio:	1.62 : 1
Sample Weight, g:	818.44
Moisture Content. %:	54.1
Wet Unit Weight, kN/m³:	17.02
Dry Unit Weight, kN/m³:	11.04
Void ratio:	1.44
Saturation, %:	103.28
Unconfined Compressive Strength, kPa:	79
Strain at Failure, %:	3.54

REPORT DATE: May 18, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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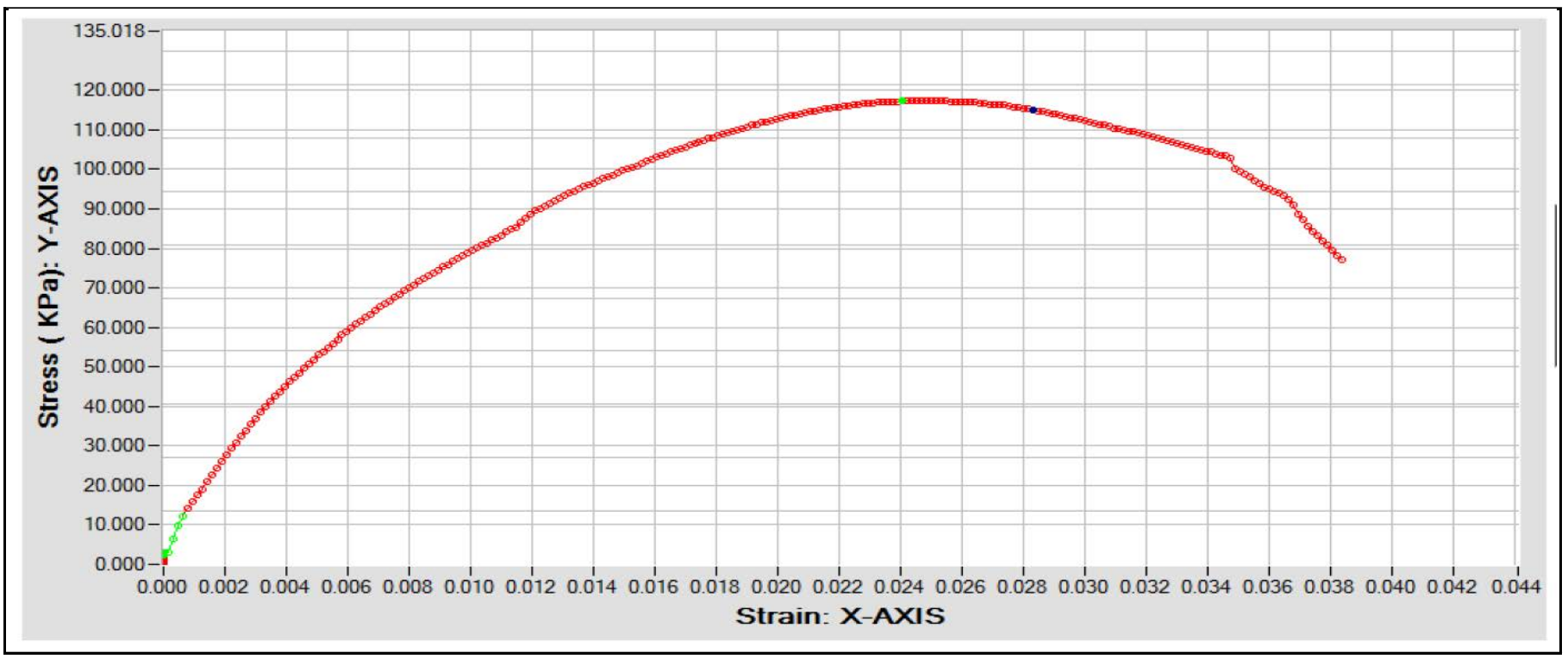
Tel: (204) 488-6999

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-09, S6	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	72.09
Height, mm:	161.26
Height/Diameter Ratio:	2.24 :1
Sample Weight, g:	1105.62
Moisture Content. %:	51.2
Wet Unit Weight, kN/m³:	17.00
Dry Unit Weight, kN/m³:	10.89
Void ratio:	1.47
Saturation, %:	95.40
Unconfined Compressive Strength, kPa:	117
Strain at Failure, %:	2.41

REPORT DATE: May 18, 2016

REVIEWED BY: Jason Thompson, C.E.T.

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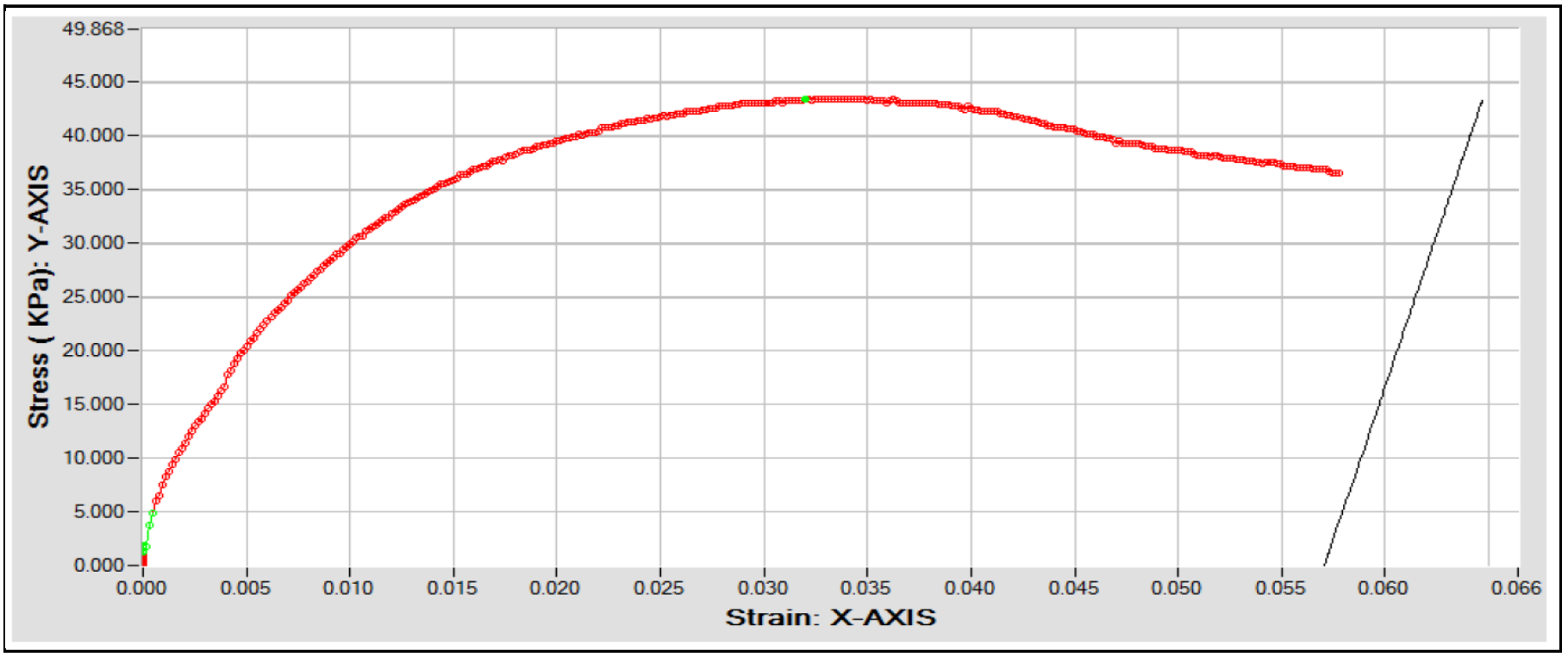
Winnipeg MB R3Y 1G4
Tel: (204) 488-6999

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client	KGS Group Inc.	PROJECT:	Cockburn/Calrossie (11-0107-18)
Address	3rd Floor - 865 Waverley Street		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Ms. Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 4, 2016
SAMPLE ID:	TH16-09, S9	TESTED BY:	Larry Presado

Soil Description: Clay, grey, firm, moist, high plasticity
trace silt till inclusions



Failure Description: Diagonal shear failure

Diameter, mm:	72.82
Height, mm:	160.54
Height/Diameter Ratio:	2.2:1
Sample Weight, g:	1117.87
Moisture Content. %:	52.1
Wet Unit Weight, kN/m³:	16.40
Dry Unit Weight, kN/m³:	10.77
Void ratio:	1.50
Saturation, %:	95.40
Unconfined Compressive Strength, kPa:	43
Strain at Failure, %:	3.20

REPORT DATE: May 18, 2016

REVIEWED BY: Jason Thompson, C.E.T.