Winnipeg

Embrace the Spirit

Cockburn and Calrossie Combined Sewer Relief Works C5 –Taylor Ave Trunk Sewer Geotechnical Data Report

Final

KGS Group 11-0107-18
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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 along Taylor Ave. from Wentworth to Nathaniel Street. 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 the LDS trunk sewer will consist of 1800, 2100 and 2400 mm pipe from Wentworth Street to Nathaniel Street. The LDS sewer will drain to the 2700 mm LDS sewer installed along Wilton Street. It is further understood that open-face rotary wheel Tunnel Boring Machine (TBM) tunnelling 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 on Taylor Ave. from Wentworth St. to Nathaniel St. 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 encountered subsurface conditions along the alignment.

1.3 REPORT LIMITATIONS

This report has been prepared for the exclusive use of the City of Winnipeg for the specific application to the proposed Contract 5 of the Cockburn/Calrossie Combined Sewer Relief Works project. 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 2016 and 2017. 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 investigation for Contract 4 along the Wilton St. alignment from Taylor Ave to the proposed Parker Storm Retention Basin (SBR). The 2016 investigation consisted of drilling nine (9) test holes to investigate the subsurface stratigraphic conditions. Ten (10) pneumatic piezometers were installed in the clay, silt till and bedrock to monitor the groundwater levels.

The stratigraphy observed during the 2016 site investigation generally consisted of a layer of fill over an extensive layer of high plasticity clay and silt till. Silt layers were encountered within the upper Complex Zone. The top of the silt till was encountered at elevations ranging from 219 to 220.8 m±. The borehole logs from the 2016 geotechnical investigation have been included in Appendix A.

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 2017 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 fill and silt were observed in the test holes within the upper complex zone.

Upper Complex Zone

The Complex Zone consists of stratified 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 clay deposit. In decreasing occurrence, typically 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 1985). The clay deposits changes from brown to grey (sometimes referred to as blue clay) at depths of approximately 4.6 to 7.6 m. 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 the oxidation of the brown clay (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 80%. Liquid Limits in the grey clay typically range from 65 to 95% and the Plastic Index ranges from 40 to 65%. Unconfined compressive strengths usually range from 70 to 100 kPa within the brown clay. Measured values within the upper brown clay are variable due to fissures. Typically 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 70 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 $\phi' = 20.5^o$ and c' = 29.8 kPa and $\phi' = 15.8^o$, respectively. While the effective large strain shear strength parameter for the brown and grey clay were c' = 14.5 kPa and $\phi' = 13.3^o$ and c' = 7.7 kPa and $\phi' = 15.7^o$, 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 $\phi' = 14^o$ for both clays.

The laboratory test results from the 2017 geotechnical investigation typically fall within these bounds.

Till Deposits

The glaciolacustrine clays are underlain by silty tills. The till is typically 0.6 to 2.6 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

Bedrock was cored in five (5) test holes at the site, the bedrock was encountered at elevations ranging from 216.6 to 219 m. The majority of the bedrock observed at the site was dolomite. The upper portion of the bedrock within some test holes was damaged by the drill action when coring. The dolomite was tan to light brown in colour, fine grained, poor quality with increased Rock Quality Designation (RQD) with depth. Interbedded shale and dolomite was encountered in test hole TH17-06 at an elevation of 216.5 m and a thin shale layer was encountered in test hole TH17-15 at elevation 215.5 m. Limestone and dolomitic limestone was encountered in test holes TH17-01 and TH17-06 respectively overlaying the dolomite. The limestone was light brown to yellow in color, poor quality, fractured, and with vugs.

3.0 SCOPE OF THE 2017 INVESTIGATION PROGRAM

3.1 GENERAL

This section provides a summary of the 2017 field investigation program, and laboratory test results; as well as the subsurface conditions encountered at the project site.

The 2017 geotechnical investigation was completed to determine the subsurface conditions at the proposed trunk sewer alignment. The results of the investigation program are presented in this Geotechnical Data Report.

3.2 TEST HOLE DRILLING AND SOIL SAMPLING

The test hole drilling and sampling programs were completed by KGS Group from April 24 to May 4, 2017 and October 5, 2017. Test holes TH17-01 to TH17-15 and TH17-17 were drilled on the west bound curb lane. Test hole TH17-16 was drilled in the park space northwest of the Taylor Ave. and Nathaniel St. intersection. The 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 seventeen (17) 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 and Paddock Drilling, of Brandon, Manitoba provided the drilling services using track and truck mounted drill rigs equipped with 125 mm solid stem augers, casing advancer and NQ coring. The drilling was completed under the 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. 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, and photographs from the drilling are included in Appendix C.

3.3 GROUNDWATER MONITORING

A total of six (6) vibrating wire piezometers, and nine (9) standpipe piezometers were installed in 2017 and two (2) pneumatic piezometers were installed in 2016 along the Contract 5 alignment, test hole TH16-09. Six (6) vibrating wire piezometers and one (1) pneumatic piezometer were installed in the clay, five (5) standpipe piezometers were installed in the silt till and four (4) standpipe piezometers and one (1) pneumatic piezometer were installed in the bedrock. Table 2 summarizes the installation details and the piezometeric monitoring completed to data for the 2016 and 2017 piezometers. The installation details of the piezometers are shown on the borehole log records provided in Appendix A and B.

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, unconfined compressive strength testing and XRD analysis. 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 2017 field program are summarized on Table 3. The laboratory testing for the 2016 and 2017 investigations are included in Appendix D.

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 1
SUMMARY OF TESTHOLE LOCATIONS

Test hole ID	Location	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)
TH16-09	Taylor Ave. Boulevard East of Wilton	5,524,243	632,294	232.73	15.04
TH17-01	Approximately 320 m west of Wilton St.	5,524,081	631,992	232.19	16.46
TH17-02	Approximately 265 m west of Wilton St.	5,524,110	632,046	232.13	12.80
TH17-03	Approximately 140 m west of Wilton St.	5,524,167	632,150	232.32	12.80
TH17-04	Approxiamtely 90 m west of Wilton St.	5,524,195	632,200	232.58	13.72
TH17-05	Approxiamtely 80 m west of Guelph St.	5,524,282	632,359	232.36	12.65
TH17-06	West of Guelph St.	5,524,316	632,420	232.14	16.76
TH17-07	East of Guelph St.	5,524,328	632,442	232.18	13.11
TH17-08	Approximately 70 m east of Guelph St.	5,524,354	632,491	231.86	13.11
TH17-09	West of Harrow St.	5,524,380	632,538	232.12	13.87
TH17-10	East of Harrow St.	5,524,422	632,614	231.76	18.14
TH17-11	Approximately 80 m east of Harrow St.	5,524,441	632,650	231.84	14.02
TH17-12	West of Stafford St.	5,524,462	632,688	231.98	15.70
TH17-13	East of Stafford St.	5,524,501	632,754	232.10	15.32
TH17-14	Approximately 85 m east of Stafford St.	5,524,528	632,806	232.09	14.94
TH17-15	Wentworth St.	5,524,580	632,875	231.79	17.98
TH17-16	Approximately 40 m west of Nathaniel St.	5,523,977	631,776	232.14	15.86
TH17-17	Approximately 90 m East of Nathaniel St.	5,524,030	631,900	232.27	13.73

TABLE 2
GROUNDWATER MEASUREMENTS

Test Hole:	**TH16-09**		**TH17-01**		**TH17-06**		**TH17-07**	**TH17-10**			**TH17-12**		**TH17-13**	**TH17-15**		**TH16-16**	
Ground Elevation (m):	**232.73**		**232.19**	**232.19**	**232.14**	**232.14**	**232.18**	**231.76**	**231.76**	**231.76**	**231.98**	**231.98**	**232.10**	**231.79**	**231.79**	**232.14**	**232.14**
Piezometer No.:	**36897**	**36889**	**VW 1700051**	**Standpipe**	**VW 1700053**	**Standpipe**	**Standpipe**	**VW 1700050**	**Standpipe**	**Standpipe**	**VW 1700049**	**Standpipe**	**Standpipe**	**VW 1700048**	**Standpipe**	**VW 1702738**	**Standpipe**
Tip Elevation (m):	**224.2**	**218.1**	**225.48**	**219.39**	**226.04**	**215.38**	**219.07**	**224.14**	**218.50**	**213.62**	**226.49**	**216.28**	**217.47**	**224.17**	**213.81**	**223.90**	**216.98**
Monitoring Zone:	**Clay**	**Bedrock**	**Clay**	**Silt Till**	**Clay**	**Bedrock**	**Silt Till**	**Clay**	**Silt Till**	**Bedrock**	**Clay**	**Bedrock**	**Silt Till**	**Clay**	**Bedrock**	**Clay**	**Silt Till**
Date	**Piezometric Elevation (m)**																
25-May-16	226.42	225.72															
17-Jun-16	226.42	225.65															
26-Aug-16	224.32	224.86															
6-Oct-16	225.62	225.36															
9-May-17	227.42	227.22	230.92	228.06	230.27	226.66	226.64	230.31	225.19	226.57	228.78	226.43	226.48	231.37	228.12		
14-Jun-2017	227.42	225.79	230.81	225.99	229.98	225.52	225.56	229.99	225.66	225.46	228.65	225.21	225.87	230.92	225.67		
25-Sep-2017	227.40	225.29	230.85	225.38	229.98	224.64	224.63	229.73	225.14	224.65	228.96	224.52	227.75	230.86	225.21		
16-Oct-2017																226.79	225.22

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

FIGURES

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND:

⊕	Test Hole (KGS Group, 2016)
⊕	Test Hole (KGS Group, 2017)

NOTES:
1. Test holes completed by KGS Group in 2016 and 2017.
2. Imagery: ESRI Base, 2016.

25 0 25 50 75 100
Meters

SCALE: 1:4,000 METRIC 11"x17"

All units are metric and in metres unless otherwise specified.
Transverse Mercator Projection, NAD 1983, Zone 14
Elevations are in metres above sea level (MSL)

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	17/11/01	ISSUED WITH FINAL REPORT	JRM	BAT

REVISIONS / ISSUE

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C5 – COCKBURN AND CALROSSIE
SEWER RELIEF WORKS

GEOTECHNICAL DRILLING LOCATIONS

NOVEMBER 2017 FIGURE 01 REV: 0

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

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11"x17" PLOT SCALE 1:1

APPENDIX A

2016 TEST HOLE LOGS

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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

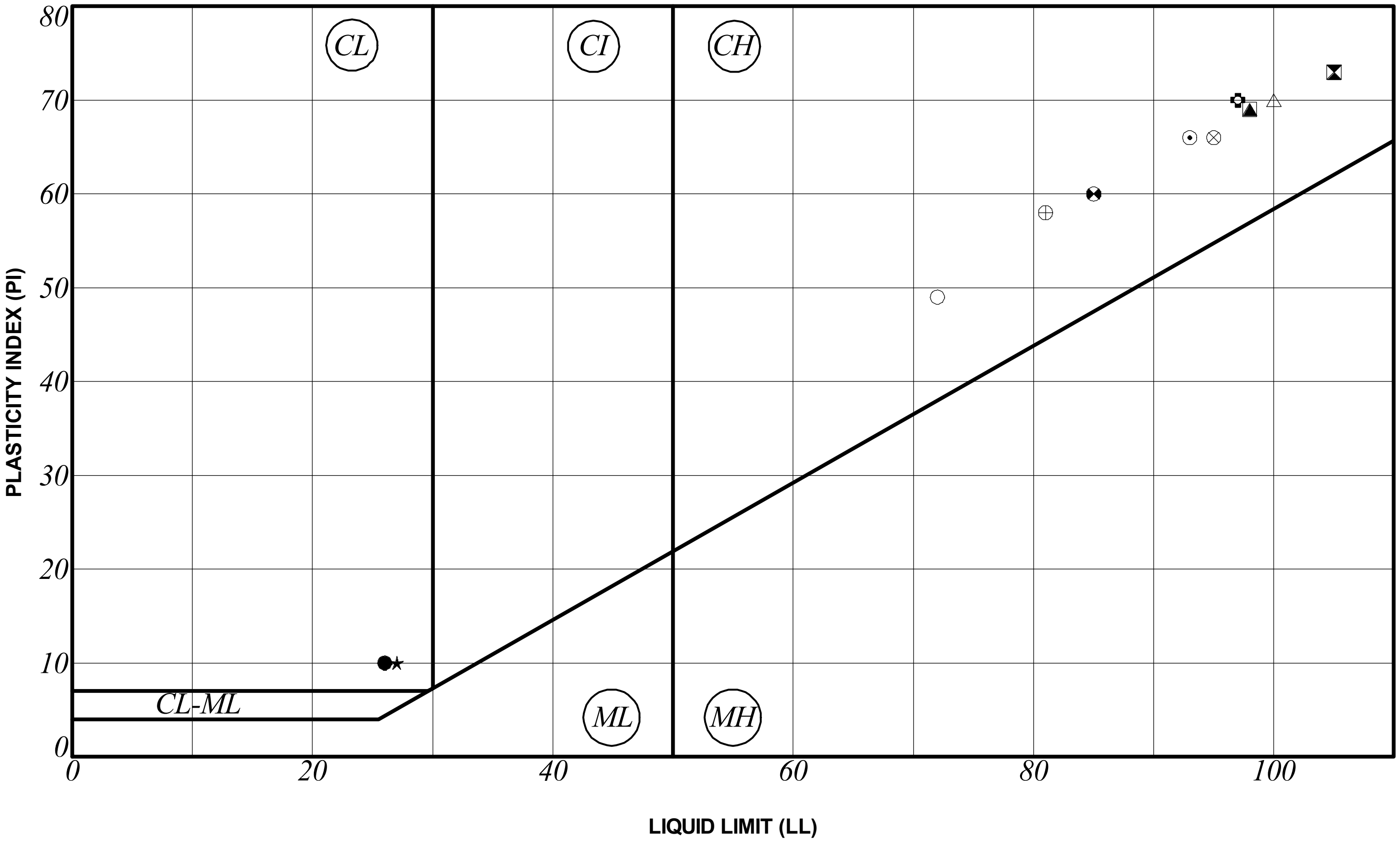
Boulders	>200 mm ø
Cobbles	75 – 200 mm ø
Coarse Grained Gravel	19 – 75 mm ø
Fine Grained Gravel	4.75 – 19 mm ø
Coarse Grained Sand	2 – 4.75 mm ø
Medium Grained Sand	0.425 – 2 mm ø
Fine Grained Sand	0.075 – 0.425 mm ø

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



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

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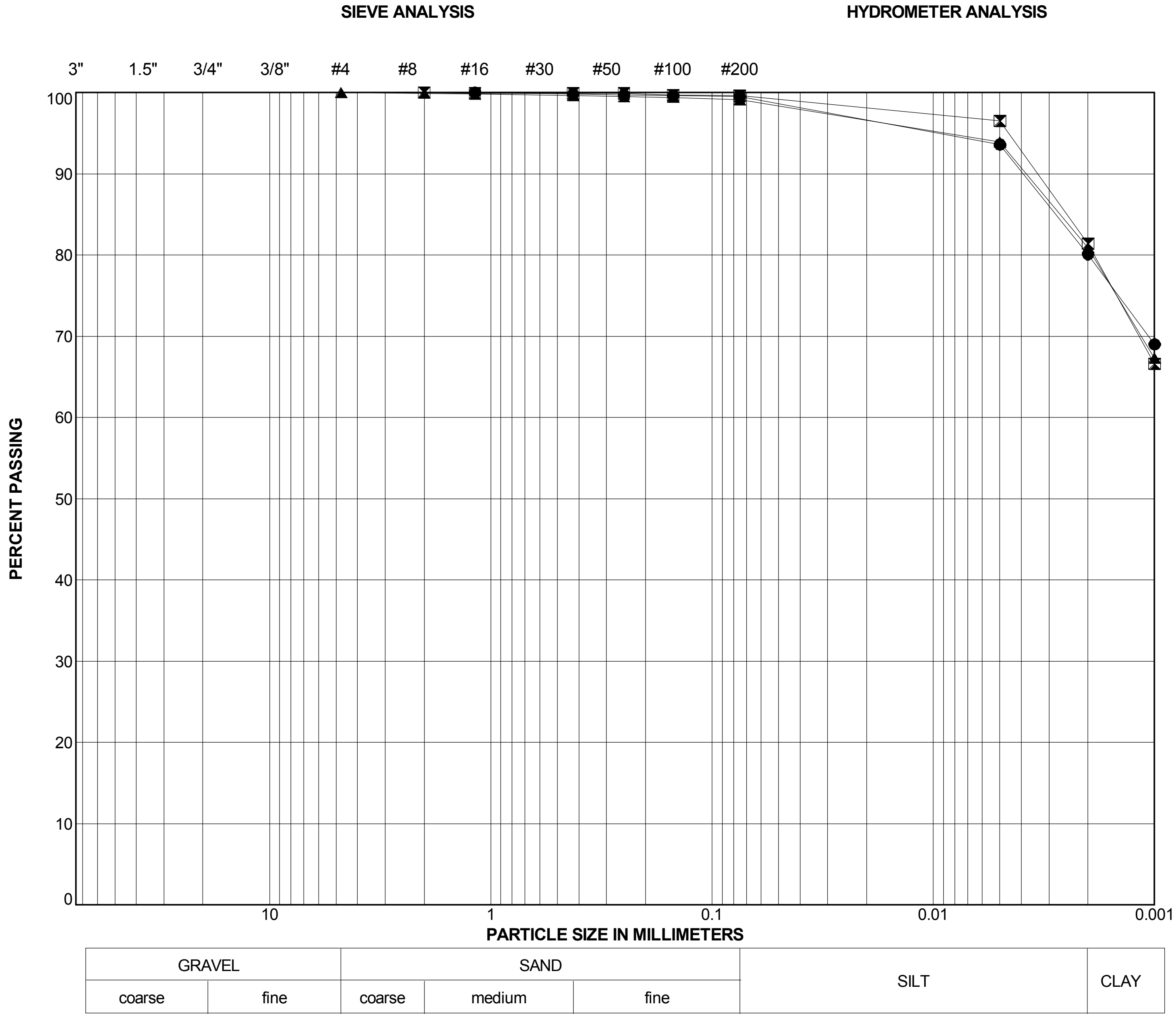
CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Cockburn and Calrossie Combined Sewer Relief

A-LINE PLOT

July 2017	**Figure A1**	**Page 1 of 1**



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*

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CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Cockburn and Calrossie Combined Sewer Relief

GRAIN SIZE ANALYSES

July 2017	**Figure A2**	**Page 1 of 1**

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SUMMARY LOG

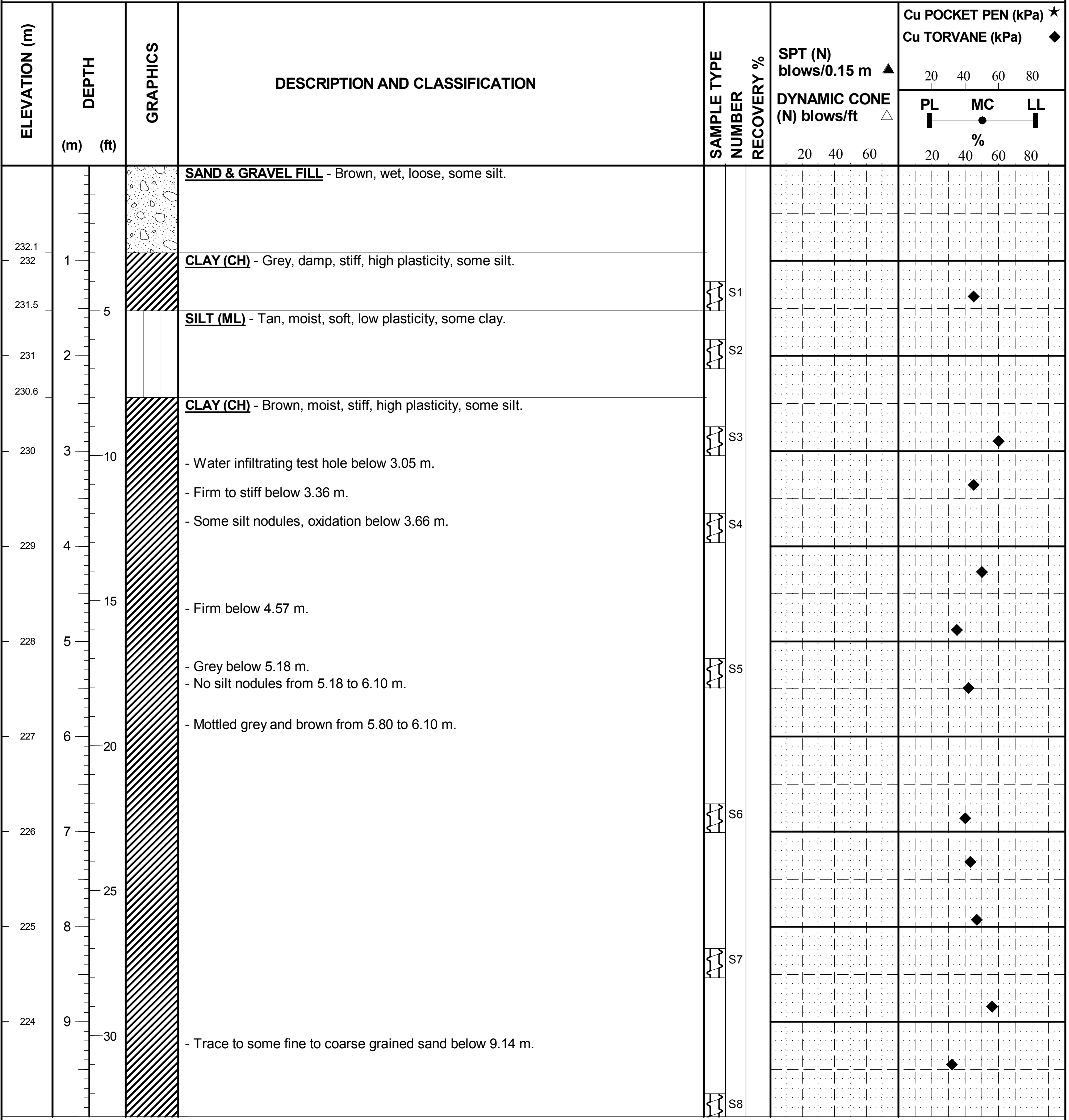
REFERENCE NO.

HOLE NO. **TH16-01 (I1)**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
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



SAND & GRAVEL FILL - Brown, wet, loose, some silt.

CLAY (CH) - Grey, damp, stiff, high plasticity, some silt.

SILT (ML) - Tan, moist, soft, low plasticity, some clay.

CLAY (CH) - Brown, moist, stiff, high plasticity, some silt.

- Water infiltrating test hole below 3.05 m.
- Firm to stiff below 3.36 m.
- Some silt nodules, oxidation below 3.66 m.
- Firm below 4.57 m.
- Grey below 5.18 m.
- No silt nodules from 5.18 to 6.10 m.
- Mottled grey and brown from 5.80 to 6.10 m.
- Trace to some fine to coarse grained sand below 9.14 m.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

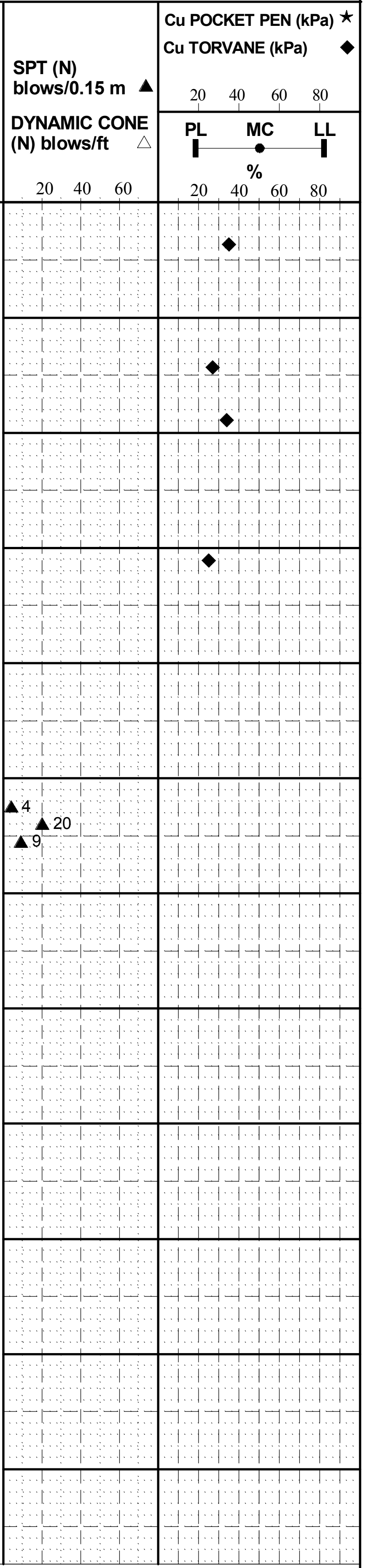
HOLE NO. **TH16-01 (I1)**

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
		35		- Increased fine to coarse grained sand content below 10.67 m.			
222	11						
					Auger Grab	S9	
221	12	40					
					Auger Grab	S10	
220	13			- Soft to firm below 13.12 m.			
		45					
219.0 219	14			**SILT TILL (ML)** - Tan, moist, loose, low plasticity, some fine to coarse grained sand, trace fine grained gravel.			
					Auger Grab	S11	
				- Increased density, with fine to coarse grained sand content below 14.6 m.			
218	15			- Non-plastic from 14.95 to 15.56 m.			
		50		- Damp, compact below 15.20 m.	Split Spoon	S12	56
					Auger Grab	S13	
217	16						
216.7				**AUGER REFUSAL AT 16.31 m.**			
		55					
216	17						
215	18						
		60					
214	19						
		65					
213	20						
212	21						
		70					

Notes:

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.



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR Maple Leaf Enterprises

INSPECTOR J. MACLENNAN

APPROVED DAA

DATE 7/14/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

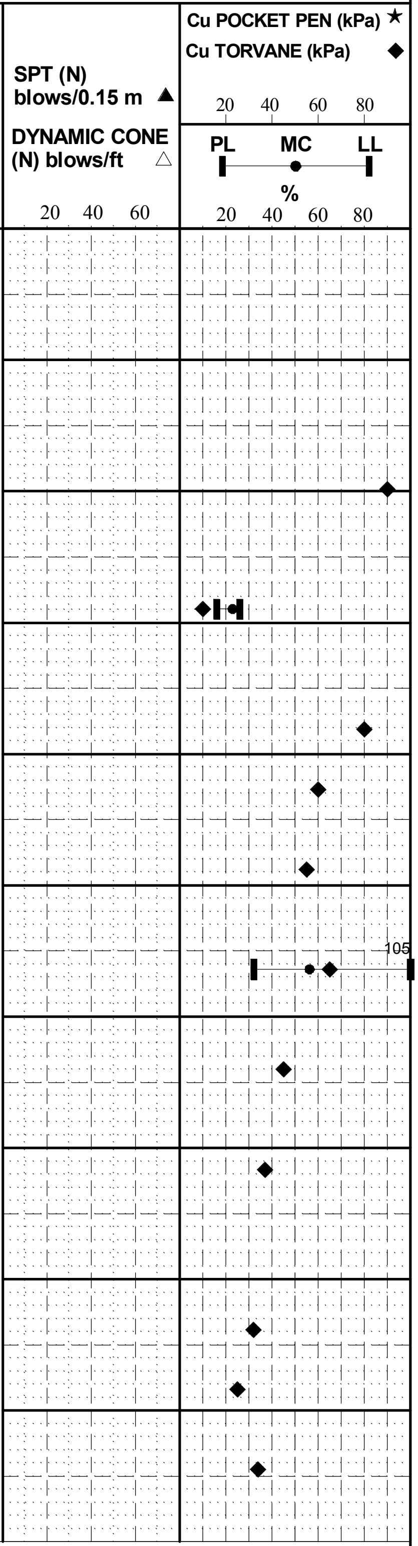
HOLE NO. **TH16-02 (I4/5)**

SHEET 1 of 2

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



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
7/14/17

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
			Auger Grab	S8	
			Auger Grab	S9	
		- Soft below 11.59 m.			
			Auger Grab	S10	
		- Some fine to coarse grained sand, trace fine grained angular gravel below 14.02 m.			
219.3		**SILT TILL (ML)** - Tan, moist, loose, low plasticity, some fine to coarse grained sand, trace fine grained gravel.			
			Auger Grab	S11	
		- Compact, trace to some fine to coarse grained gravel below 15.24 m.	Split Spoon	S12	89
		- Spoon contained angular rock pieces (~30 mm diameter) below 15.25 m.			
			Auger Grab	S13	
218.1		**AUGER REFUSAL AT 15.85 m.**			

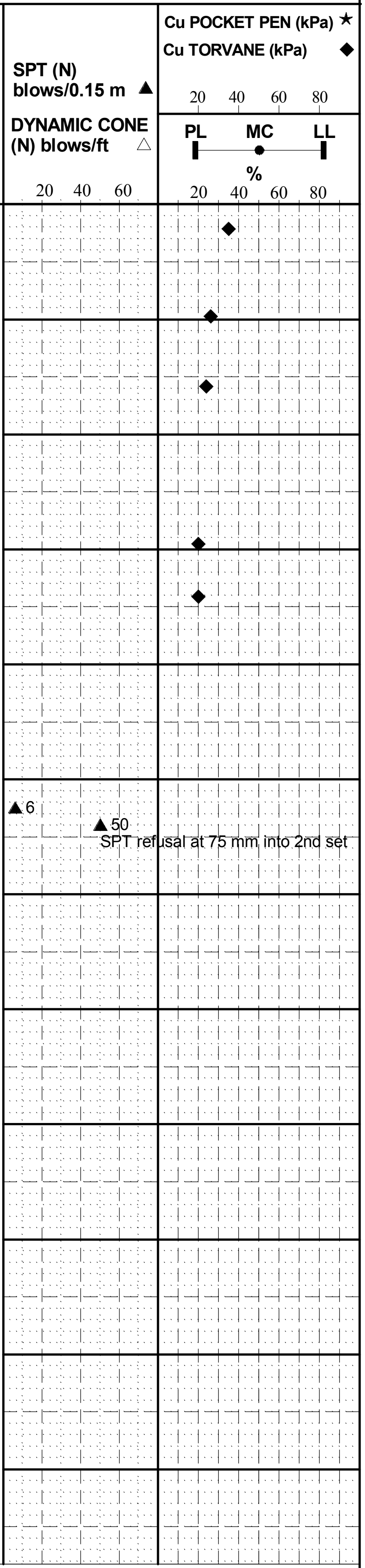
Notes:

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.

ELEVATION (m): 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213

DEPTH (m): 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

DEPTH (ft): 35, 40, 45, 50, 55, 60, 65, 70



SAMPLE TYPE: Auger Grab, Split Spoon

CONTRACTOR: Maple Leaf Enterprises

INSPECTOR: J. MACLENNAN

APPROVED: DAA

DATE: 7/14/17

KGS GROUP

SUMMARY LOG

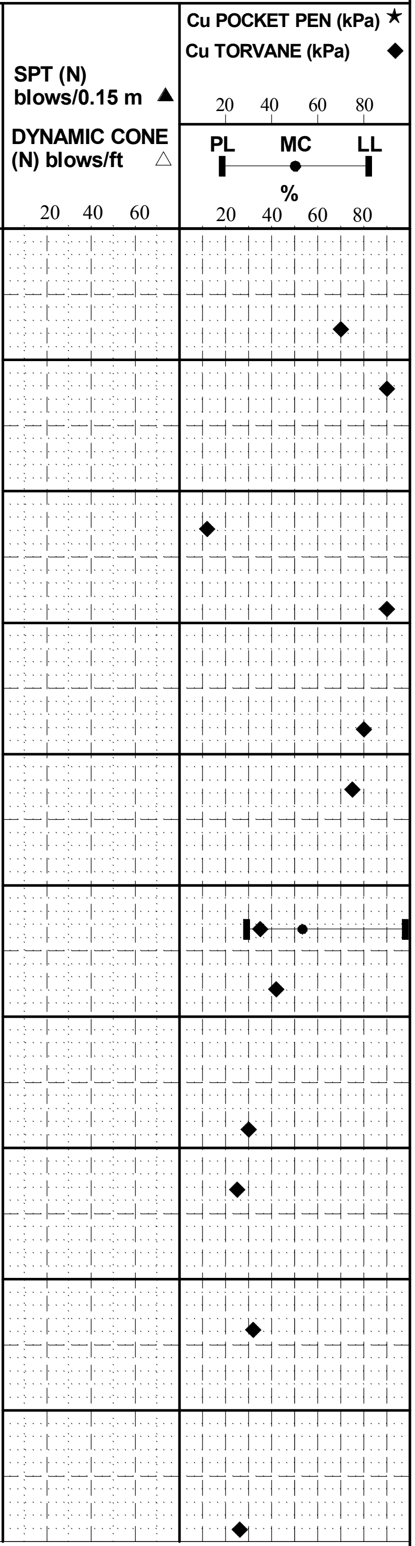
REFERENCE NO.

HOLE NO.
TH16-03 (I7)

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Cockburn and Calrossie Combined Sewer Relief	GROUND ELEV.	233.39
		TOP OF PVC ELEV.	
SITE	Wilton St from Taylor Ave to CN Tracks	WATER ELEV.	
LOCATION	Approx. 65 m Northwest of Shaft B - East of Wilton	DATE DRILLED	4/19/2016
		UTM (m)	N 5,524,081 E 632,378
DRILLING METHOD	100 mm ø Solid Stem Auger, B37X Mobile Drill		

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
	0	**CLAY FILL (CI)** - Black, damp, stiff, intermediate plasticity, some organics, some fine to coarse grained sand, some fine to coarse grained gravel.	S1
231.3		**SILT (ML)** - Brown, moist, soft, low plasticity, some clay.	S2
230.8		**CLAY (CH)** - Brown, moist, stiff, high plasticity, some silt.	S3
		- Trace silt pockets below 3.35 m.	S4
		- Mottled grey and brown below 4.12 m.	
		- Firm below 5.18 m.	S5
			S6
		- Grey, increased silt pockets below 8.23 m.	S7
		- Trace fine to coarse grained sand below 8.54 m.	
			S8



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\TRENCHLESS\LDS_LOGS.GPJ

KGS GROUP

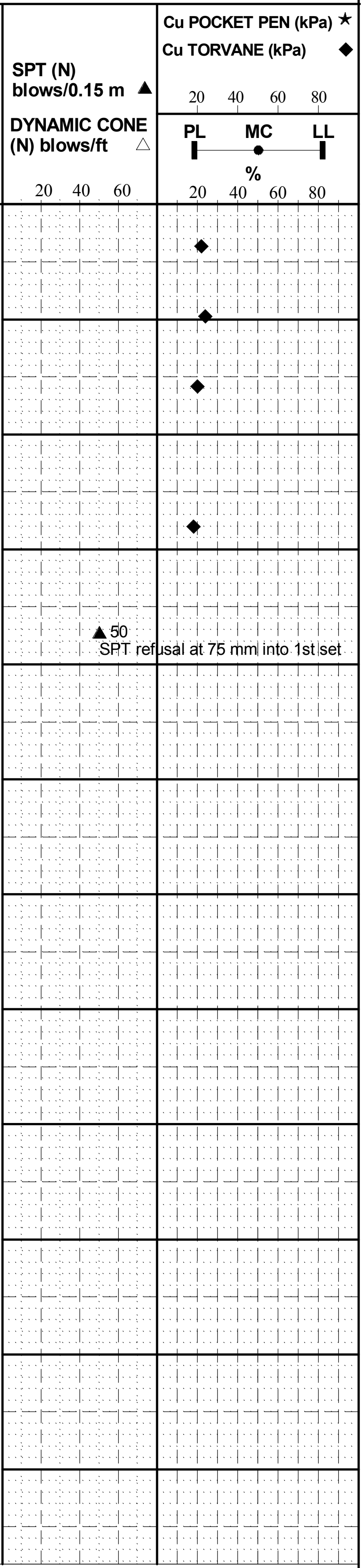
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-03 (I7)

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %
223		35	- Soft below 10.37 m.		
222	11			S9	
221	12	40			
220.4	13		**SILT TILL (ML)** - Tan, moist, firm, low plasticity, some fine to coarse grained sand, trace fine grained gravel.	S10	
220		45		S11	100
219.4	14			S12	
			AUGER REFUSAL AT 15.85 m. 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.		
219					
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: Maple Leaf Enterprises

INSPECTOR: J. MACLENNAN

APPROVED: DAA

DATE: 7/14/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\TRENCHLESS\DS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

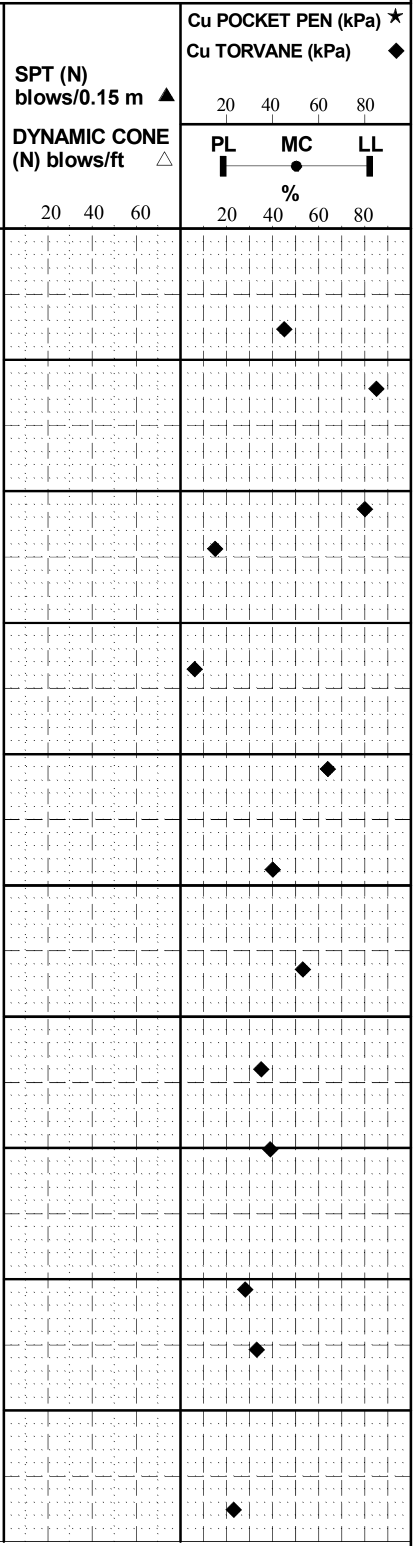
HOLE NO. **TH16-04 (I11)**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
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)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
			CLAY FILL (CI) - Black, moist, firm, intermediate plasticity, some organics, trace fine grained gravel, trace fine to coarse grained sand.	Auger Grab	S1	
232.1						
232	1		**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace fine to coarse grained sand.			
		5		Auger Grab	S2	
231	2					
230.7			**SILT (ML)** - Brown, moist, soft, low plasticity, some clay.	Auger Grab	S3	
230.4			**CLAY (CH)** - Brown, damp, stiff, high plasticity, some silt, trace fine to coarse grained sand.			
230.0 230	3	10	**SILT (ML)** - Brown, moist, soft, low plasticity, some clay.			
229.2			**CLAY (CH)** - Brown, moist, stiff, high plasticity, some silt, trace silt pockets.			
229	4			Auger Grab	S4	
		15	- Firm from 4.57 to 5.19 m.			
228	5			Auger Grab	S5	
			- Grey below 5.79 m.			
227	6	20	- Firm below 6.10 m. - Mottled brown and grey from 6.10 to 6.86 m.			
				Auger Grab	S6	
226	7					
		25				
225	8			Auger Grab	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	7/14/17

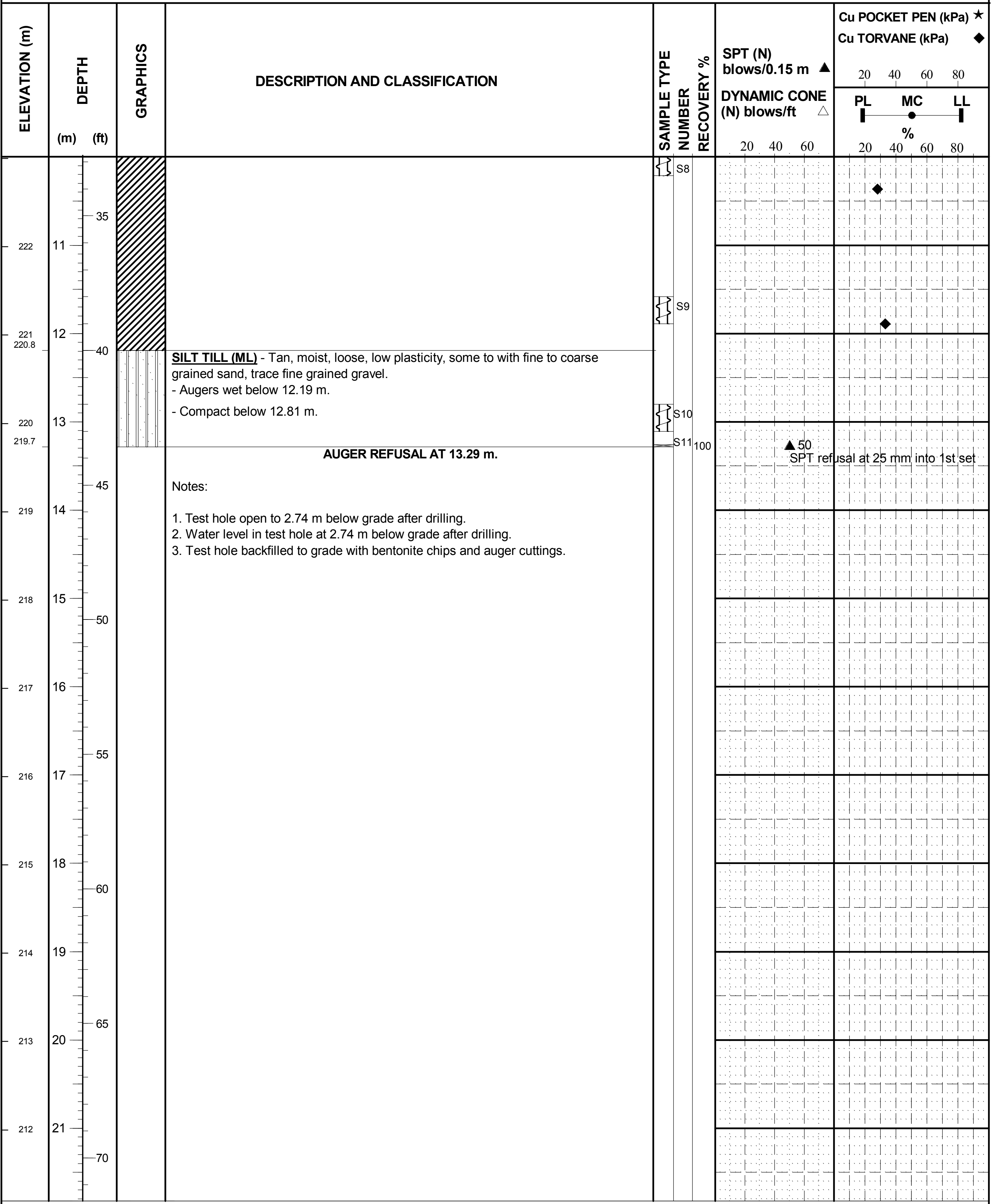
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-04 (I11)

SHEET 2 of 2



SILT TILL (ML) - Tan, moist, loose, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel.
- Augers wet below 12.19 m.
- Compact below 12.81 m.

SPT refusal at 25 mm into 1st set

AUGER REFUSAL AT 13.29 m.

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.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

KGS GROUP

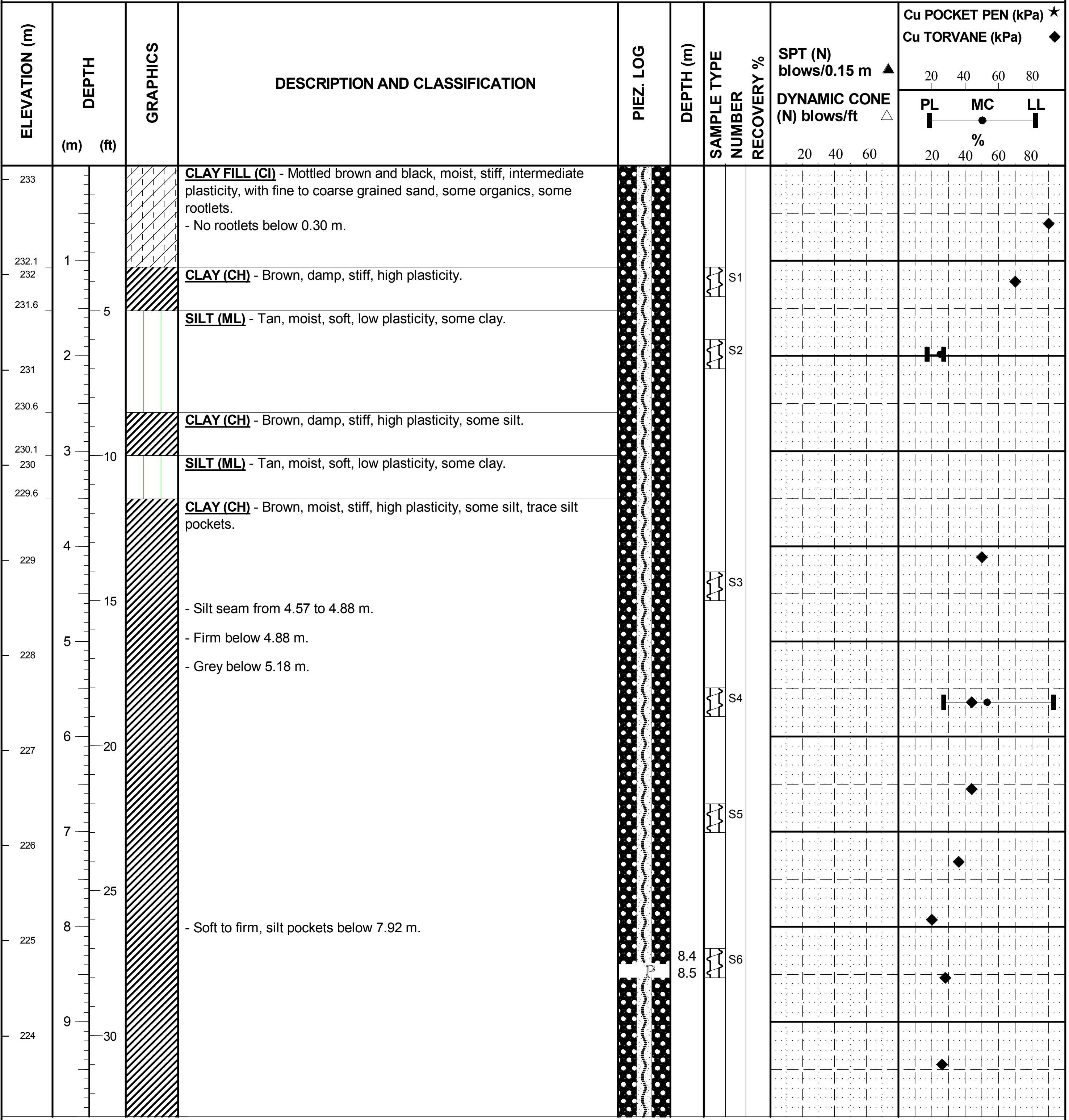
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-05 (I9)

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Cockburn and Calrossie Combined Sewer Relief	GROUND ELEV.	233.15
		TOP OF PVC ELEV.	
SITE	Wilton St from Taylor Ave to CN Tracks	WATER ELEV.	
LOCATION	Approx. 100 m Southeast of Shaft C - East of Wilton	DATE DRILLED	4/19/2016
DRILLING METHOD	100 mm ø Solid Stem Auger, B37X Mobile Drill	UTM (m)	N 5,524,144 E 632,333



Elevation (m)	Description and Classification
233.15	**CLAY FILL (CI)** - Mottled brown and black, moist, stiff, intermediate plasticity, with fine to coarse grained sand, some organics, some rootlets. - No rootlets below 0.30 m.
232.1	**CLAY (CH)** - Brown, damp, stiff, high plasticity.
231.6	**SILT (ML)** - Tan, moist, soft, low plasticity, some clay.
230.6	**CLAY (CH)** - Brown, damp, stiff, high plasticity, some silt.
230.1	**SILT (ML)** - Tan, moist, soft, low plasticity, some clay.
229.6	**CLAY (CH)** - Brown, moist, stiff, high plasticity, some silt, trace silt pockets. - Silt seam from 4.57 to 4.88 m. - Firm below 4.88 m. - Grey below 5.18 m. - Soft to firm, silt pockets below 7.92 m.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\TRENCHLESS\LDS_LOGS.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

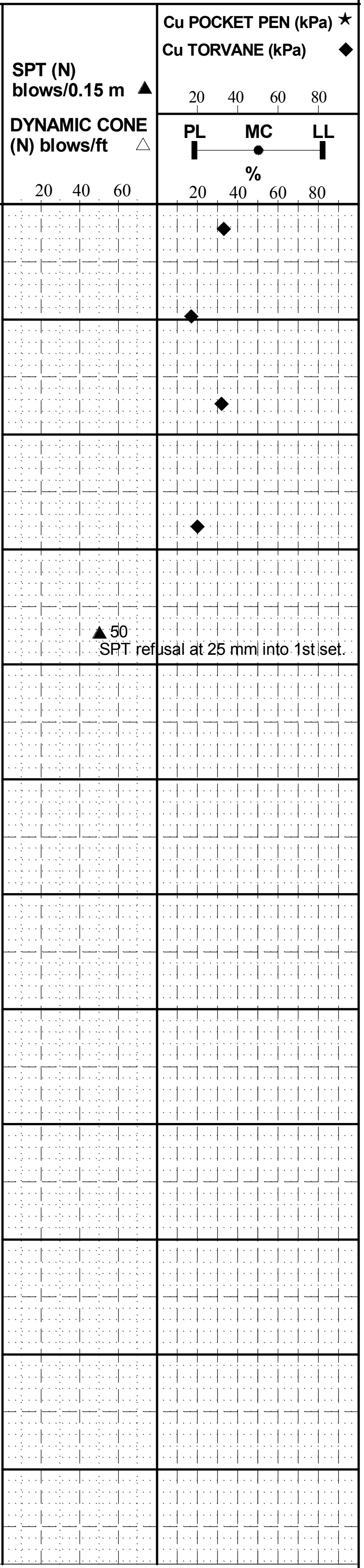
HOLE NO.
TH16-05 (I9)

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %
				S7	
				S8	
		- Auger flights coming up wet below 12.19 m.			
220.0		**SILT TILL (ML)** - Grey, damp, loose to compact, low plasticity, some fine to coarse grained snad, trace to some fine to coarse grained gravel. - Auger refusal, switch to coring at 13.11 m.		S9	
219.4		**LIMESTONE BEDROCK** - Light beige, lightly fractured, strong, RQD = 49%. - Decreased fractures below 14.42 m.	14.5 14.6 14.9	S10 R1	 81
218.2		**END TEST HOLE AT 14.93 m.**			

Notes:

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.
3. Minor sloughing in test hole from 12.80 m to 13.72 m.



SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon ▮ Core Barrel

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
7/14/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

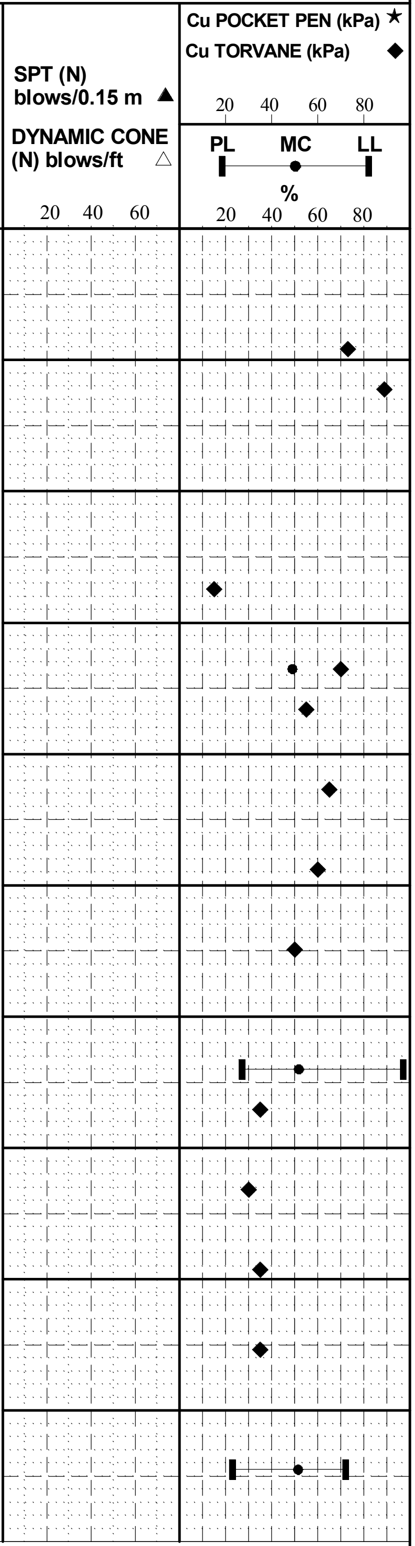
HOLE NO.
TH16-06 (Shaft A)

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
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)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %
233.27	0	**CLAY FILL (CH)** - 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.		S1	
232.2	1.07	**CLAY (CH)** - Black, damp, stiff, high plasticity, some organics, trace fine to coarse grained sand.		S2	
231.3	2.0	**SILT (ML)** - Tan, moist, soft, low plasticity, trace clay. - Increased clay content below 2.29 m. - Auger flights coming up wet below 3.05 m.		S3	
230.1	3.2	**CLAY (CH)** - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets. - 12 mm diameter silt inclusion at 4.11 m.		S4 S5 S6	100
		- Firm below 6.10 m. - Test hole sloughing at 6.10 m. - Unconfined Compressive Strength measured to be 45 kPa at 6.10 m. - Grain Size Distribution: Gravel (0.0%), Sand (0.5%), Silt (19.4%) and Clay (80.1%) at 6.10 m.	7.2 7.3	S7 S8	100
		- Grey below 8.53 m.		S9	
		- Soft below 9.14 m. - Unconfined conmpressive strength was measured to be 53 kPa at 9.14 m. - No recovery from 9.14 to 9.75 m.		S10 S11	100



SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

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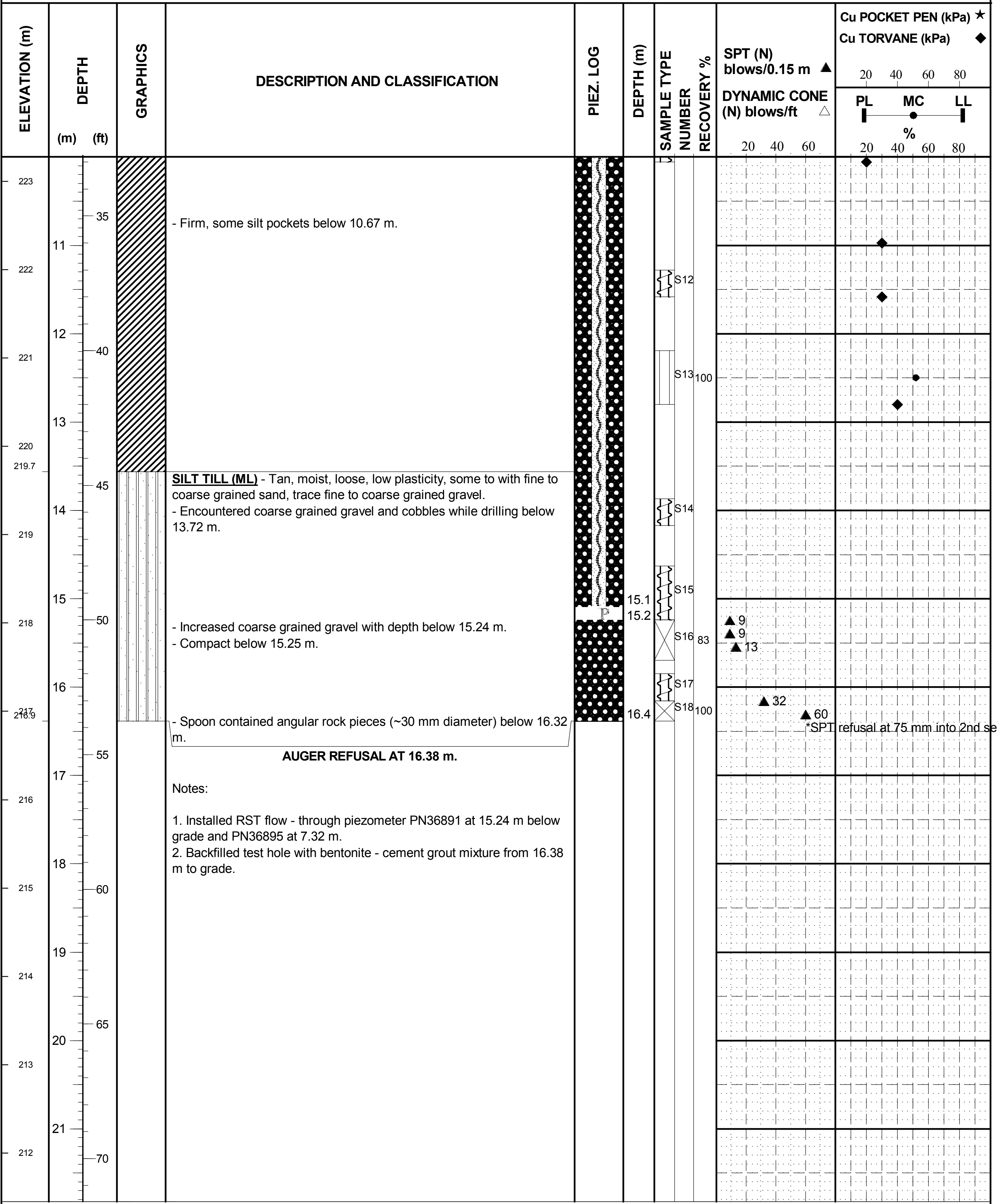
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-06 (Shaft A)

SHEET 2 of 2



- Firm, some silt pockets below 10.67 m.

SILT TILL (ML) - Tan, moist, loose, low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel.
- Encountered coarse grained gravel and cobbles while drilling below 13.72 m.

- Increased coarse grained gravel with depth below 15.24 m.
- Compact below 15.25 m.

- Spoon contained angular rock pieces (~30 mm diameter) below 16.32 m.

AUGER REFUSAL AT 16.38 m.

Notes:

1. Installed RST flow - through piezometer PN36891 at 15.24 m below grade and PN36895 at 7.32 m.
2. Backfilled test hole with bentonite - cement grout mixture from 16.38 m to grade.

SAMPLE TYPE ⌇ Auger Grab ▥ Shelby Tube ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

KGS GROUP

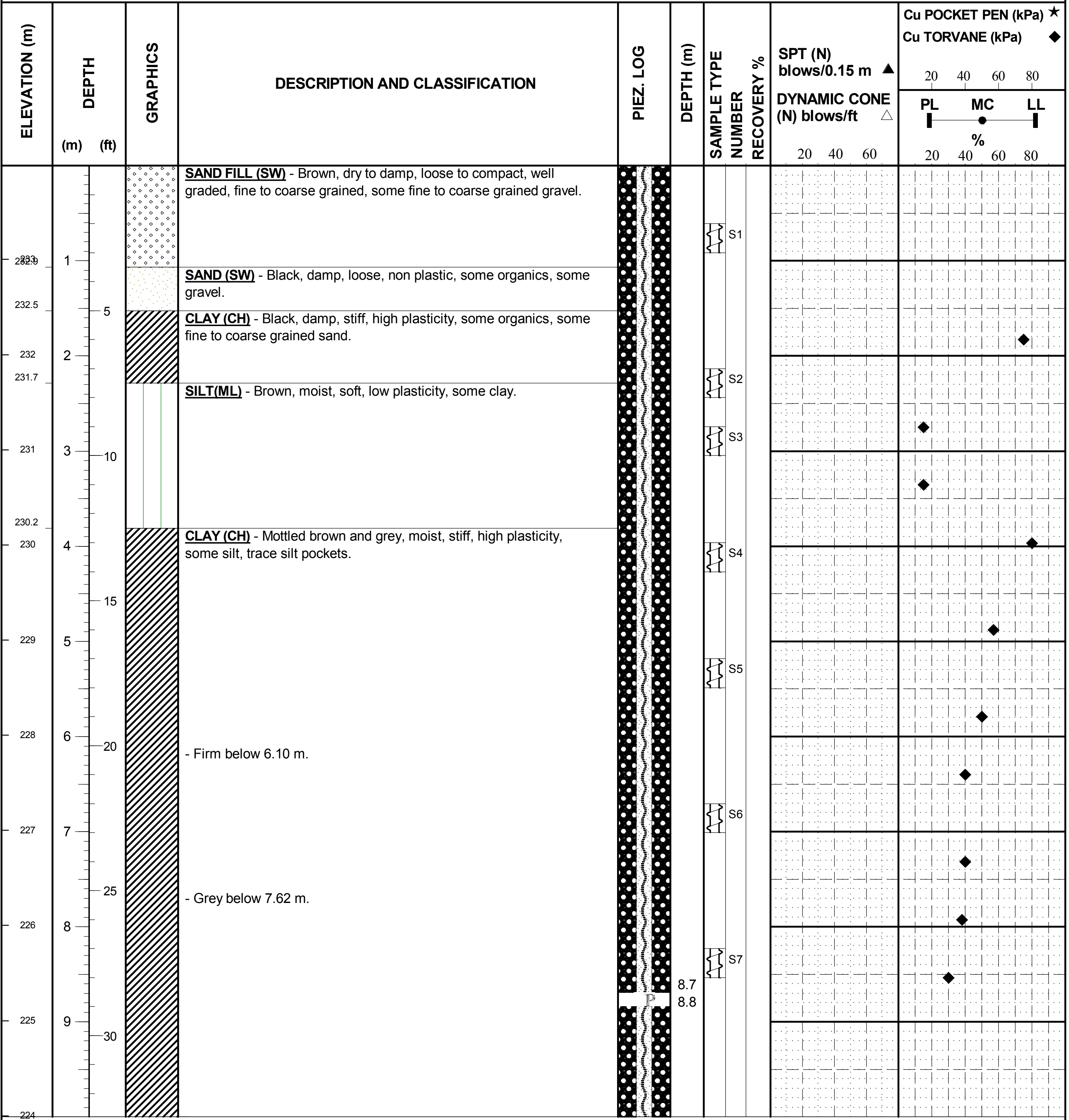
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-07 (I3)

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Cockburn and Calrossie Combined Sewer Relief	GROUND ELEV.	233.99
SITE	Wilton St from Taylor Ave to CN Tracks	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	Approx. 45 m Northwest of Shaft A - East of Wilton	DATE DRILLED	4/20/2016
DRILLING METHOD	100 mm ø Solid Stem Auger, B37X Mobile Drill	UTM (m)	N 5,523,934 E 632,451



SAND FILL (SW) - Brown, dry to damp, loose to compact, well graded, fine to coarse grained, some fine to coarse grained gravel.

SAND (SW) - Black, damp, loose, non plastic, some organics, some gravel.

CLAY (CH) - Black, damp, stiff, high plasticity, some organics, some fine to coarse grained sand.

SILT(ML) - Brown, moist, soft, low plasticity, some clay.

CLAY (CH) - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets.

- Firm below 6.10 m.

- Grey below 7.62 m.

SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

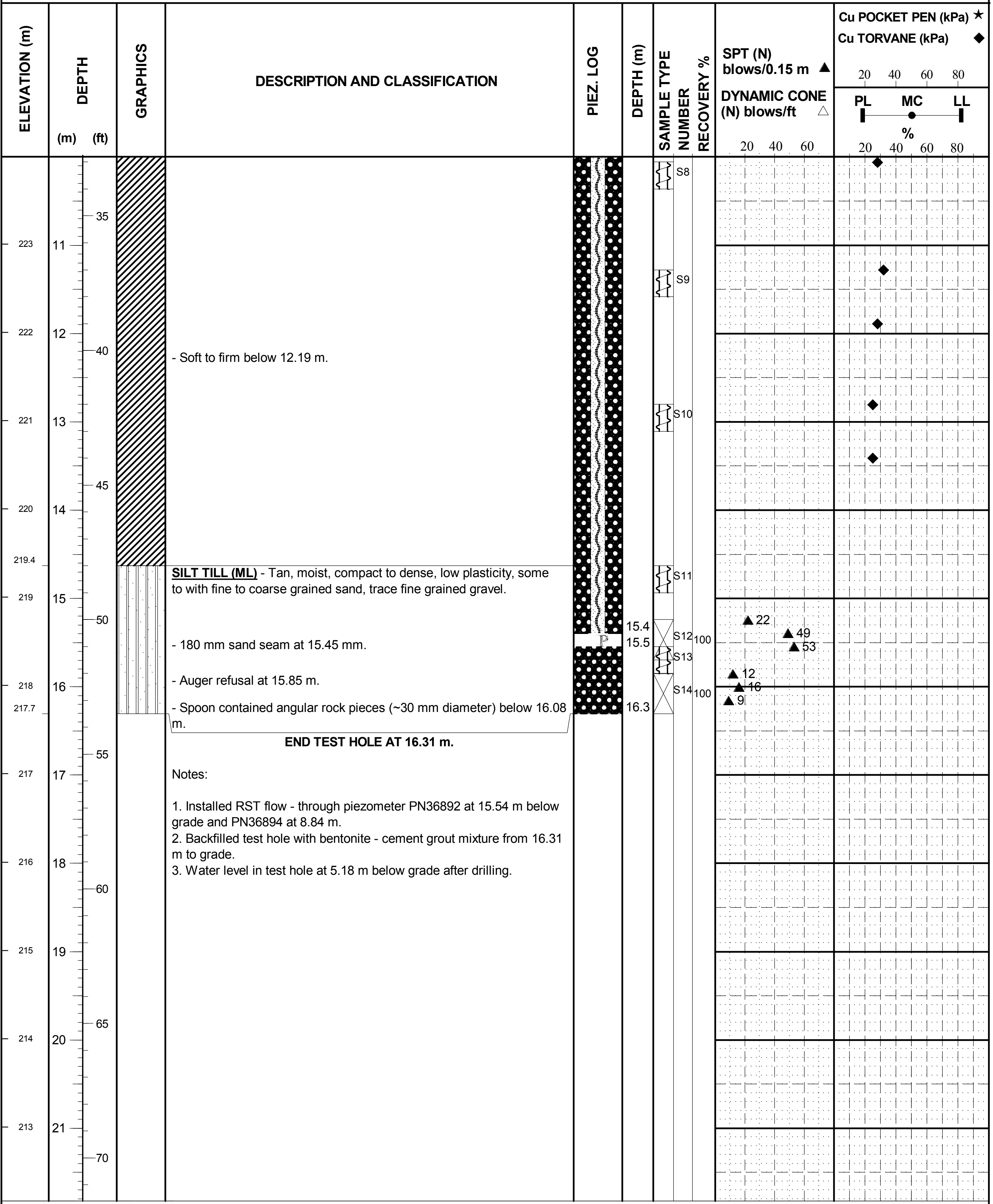
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-07 (I3)

SHEET 2 of 2



- Soft to firm below 12.19 m.

SILT TILL (ML) - Tan, moist, compact to dense, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel.

- 180 mm sand seam at 15.45 mm.

- Auger refusal at 15.85 m.

- Spoon contained angular rock pieces (~30 mm diameter) below 16.08 m.

END TEST HOLE AT 16.31 m.

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.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

KGS GROUP

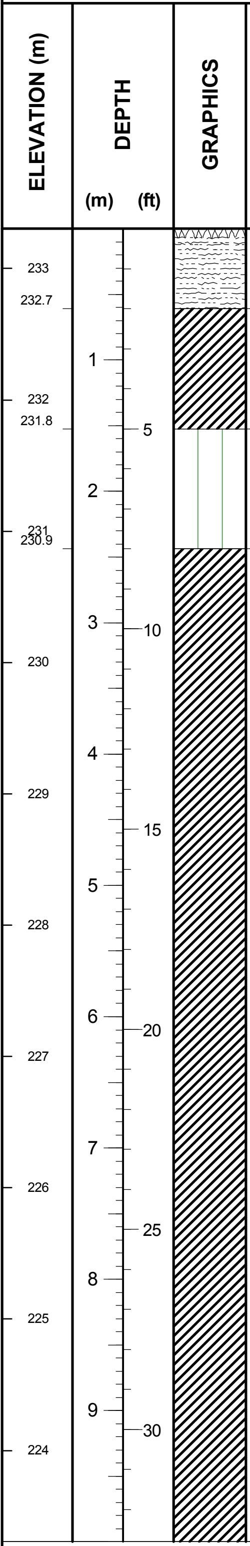
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-08 (Shaft B)

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Cockburn and Calrossie Combined Sewer Relief	GROUND ELEV.	233.30
		TOP OF PVC ELEV.	
SITE	Wilton St from Taylor Ave to CN Tracks	WATER ELEV.	
LOCATION	Approx. Shaft B	DATE DRILLED	4/21/2016
DRILLING METHOD	100 mm ø Solid Stem Auger and NQ coring , B37X Mobile Drill	UTM (m)	N 5,524,036 E 632,399



DESCRIPTION AND CLASSIFICATION

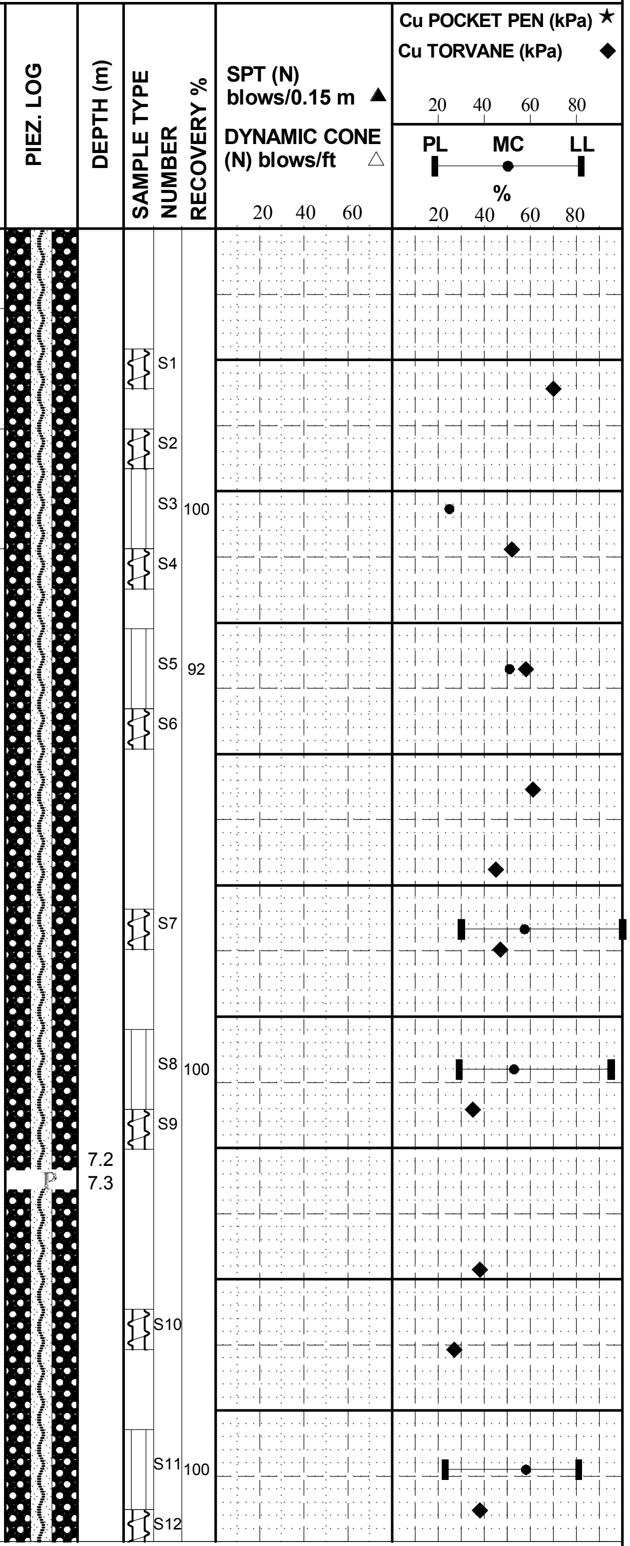
TOPSOIL - Black, damp, firm, non plastic, some fine to coarse grained sand, some rootlets.
- No rootlets below 0.30 m.

CLAY (CH) - Black, damp, stiff, high plasticity, some organics, trace oxidation, trace fine grained sand.

SILT (ML) - Tan, moist, soft, low plasticity, some clay.
- Augers wet below 1.52 m.

CLAY (CH) - Mottled brown and grey, moist, stiff, high plasticity, some silt, trace silt pockets.

- Decreased silt pockets below 4.57 m.
- Firm below 4.88 m.
- Unconfined compressive strength was measured to be 45 kPa at 6.10 m.
- Grain Size Distribution: Gravel (0.0%), Sand (0.4%), Silt (18.2%) and Clay (81.4%) at 6.10 m.
- Trace to some silt pockets below 7.62 m.
- Grey below 8.23 m.
- Unconfined compressive strength was measured to be 79 kPa at 9.14 m.



SAMPLE TYPE Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\TRENCHLESS\LDS_LOGS.GPJ

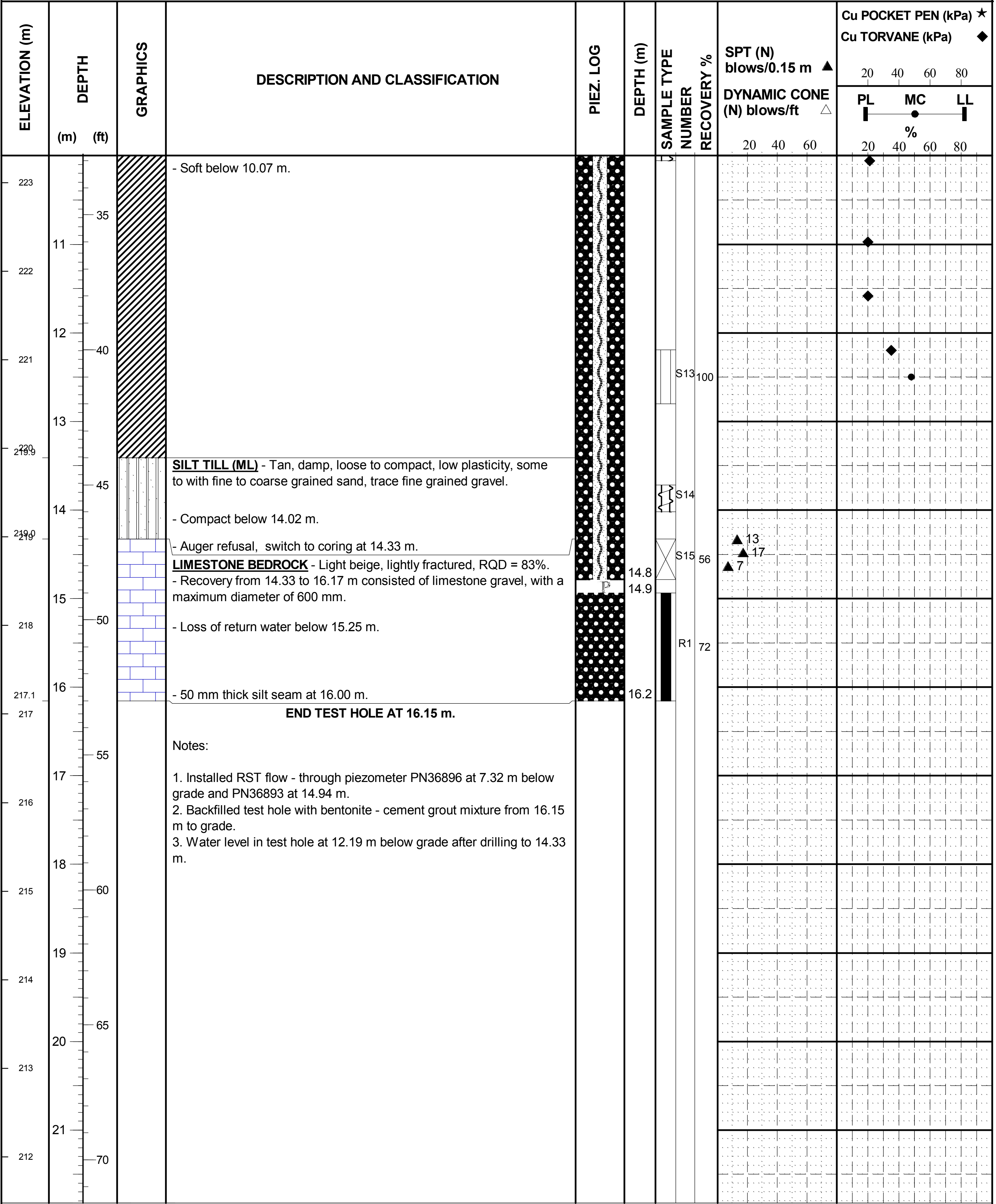
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-08 (Shaft B)

SHEET 2 of 2



- Soft below 10.07 m.

SILT TILL (ML) - Tan, damp, loose to compact, low plasticity, some to with fine to coarse grained sand, trace fine grained gravel.

- Compact below 14.02 m.

- Auger refusal, switch to coring at 14.33 m.

LIMESTONE BEDROCK - Light beige, lightly fractured, RQD = 83%.
- Recovery from 14.33 to 16.17 m consisted of limestone gravel, with a maximum diameter of 600 mm.

- Loss of return water below 15.25 m.

- 50 mm thick silt seam at 16.00 m.

END TEST HOLE AT 16.15 m.

Notes:

1. Installed RST flow - through piezometer PN36896 at 7.32 m below grade and PN36893 at 14.94 m.
2. Backfilled test hole with bentonite - cement grout mixture from 16.15 m to grade.
3. Water level in test hole at 12.19 m below grade after drilling to 14.33 m.

SAMPLE TYPE ⌇ Auger Grab ▥ Shelby Tube ☒ Split Spoon ■ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\TRENCHLESSLDS_LOGS.GPJ

KGS GROUP

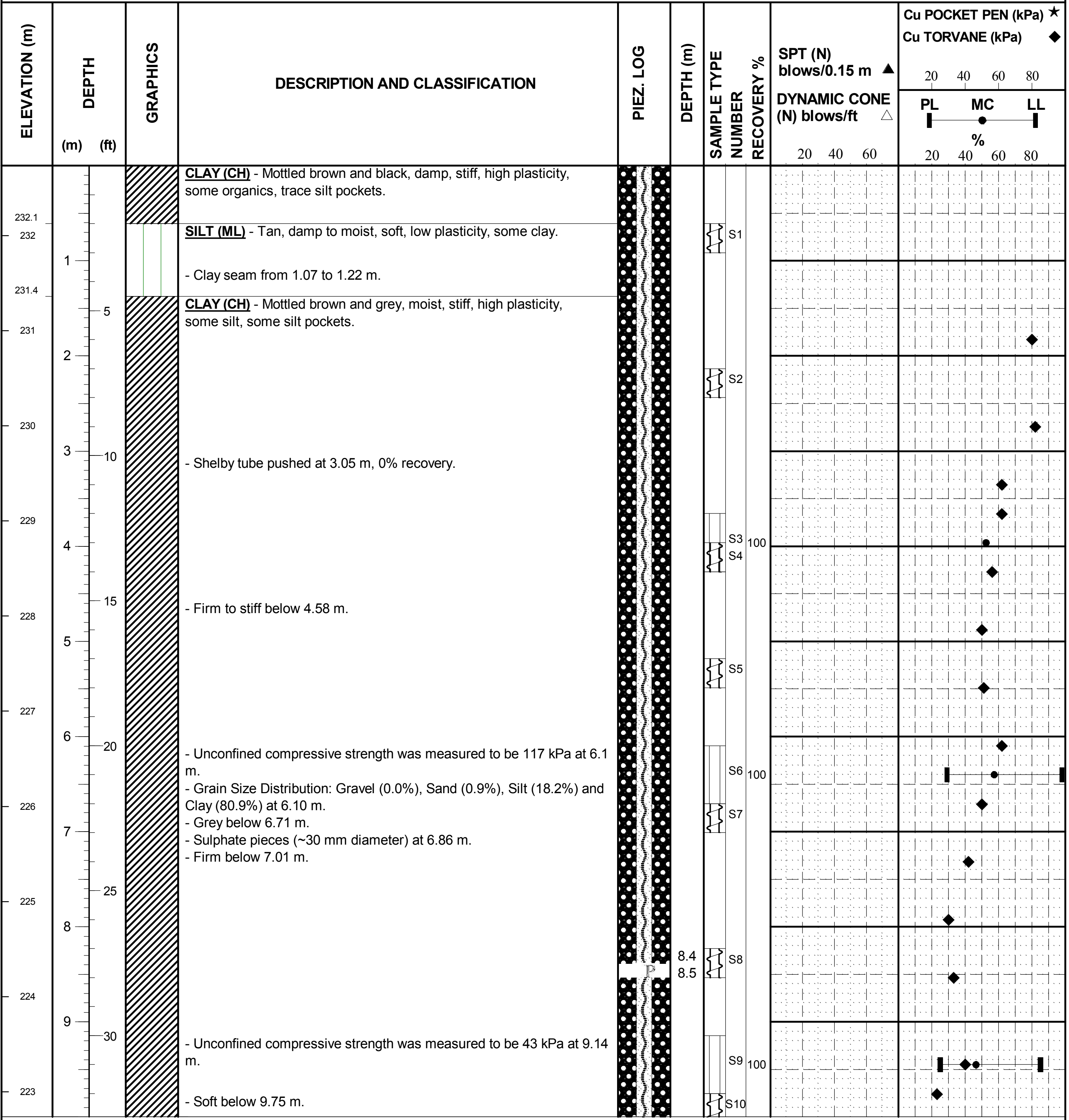
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-09 (Shaft C)

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Cockburn and Calrossie Combined Sewer Relief	GROUND ELEV.	232.73
		TOP OF PVC ELEV.	
SITE	Wilton St from Taylor Ave to CN Tracks	WATER ELEV.	
LOCATION	Approx. Shaft C - Taylor Ave. Boulevard East of Wilton	DATE DRILLED	4/22/2016
		UTM (m)	N 5,524,243
DRILLING METHOD	100 mm ø Solid Stem Auger and NQ coring , B37X Mobile Drill		E 632,294



CLAY (CH) - Mottled brown and black, damp, stiff, high plasticity, some organics, trace silt pockets.

SILT (ML) - Tan, damp to moist, soft, low plasticity, some clay.

- Clay seam from 1.07 to 1.22 m.

CLAY (CH) - Mottled brown and grey, moist, stiff, high plasticity, some silt, some silt pockets.

- Shelby tube pushed at 3.05 m, 0% recovery.

- Firm to stiff below 4.58 m.

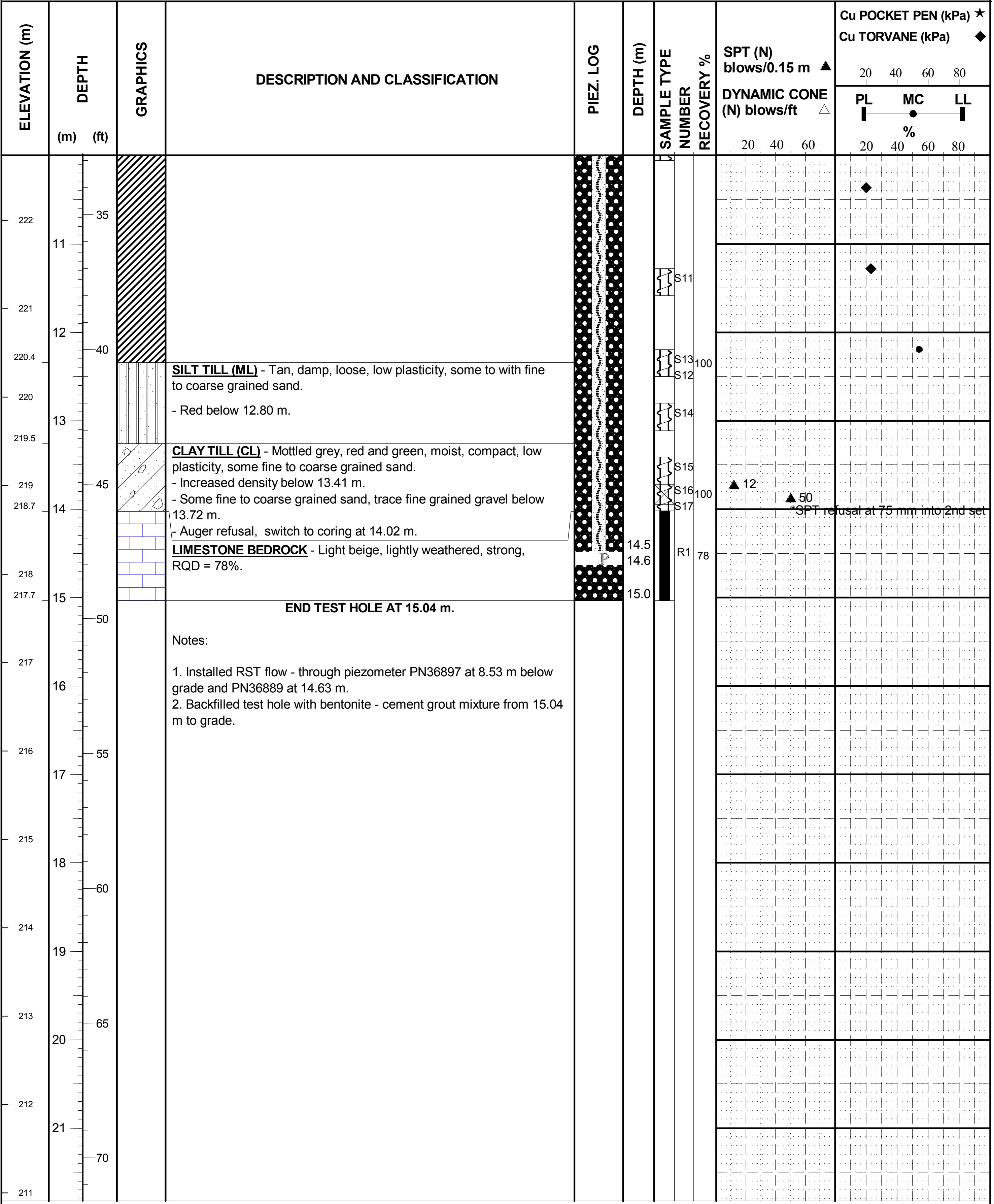
- Unconfined compressive strength was measured to be 117 kPa at 6.1 m.
- Grain Size Distribution: Gravel (0.0%), Sand (0.9%), Silt (18.2%) and Clay (80.9%) at 6.10 m.
- Grey below 6.71 m.
- Sulphate pieces (~30 mm diameter) at 6.86 m.
- Firm below 7.01 m.

- Unconfined compressive strength was measured to be 43 kPa at 9.14 m.

- Soft below 9.75 m.

SAMPLE TYPE ⧉ Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17



SILT TILL (ML) - Tan, damp, loose, low plasticity, some to with fine to coarse grained sand.

- Red below 12.80 m.

CLAY TILL (CL) - Mottled grey, red and green, moist, compact, low plasticity, some fine to coarse grained sand.
- Increased density below 13.41 m.
- Some fine to coarse grained sand, trace fine grained gravel below 13.72 m.
- Auger refusal, switch to coring at 14.02 m.

LIMESTONE BEDROCK - Light beige, lightly weathered, strong, RQD = 78%.

END TEST HOLE AT 15.04 m.

Notes:

1. Installed RST flow - through piezometer PN36897 at 8.53 m below grade and PN36889 at 14.63 m.
2. Backfilled test hole with bentonite - cement grout mixture from 15.04 m to grade.

SAMPLE TYPE Auger Grab Shelby Tube ☒ Split Spoon ■ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	7/14/17

APPENDIX B

2017 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

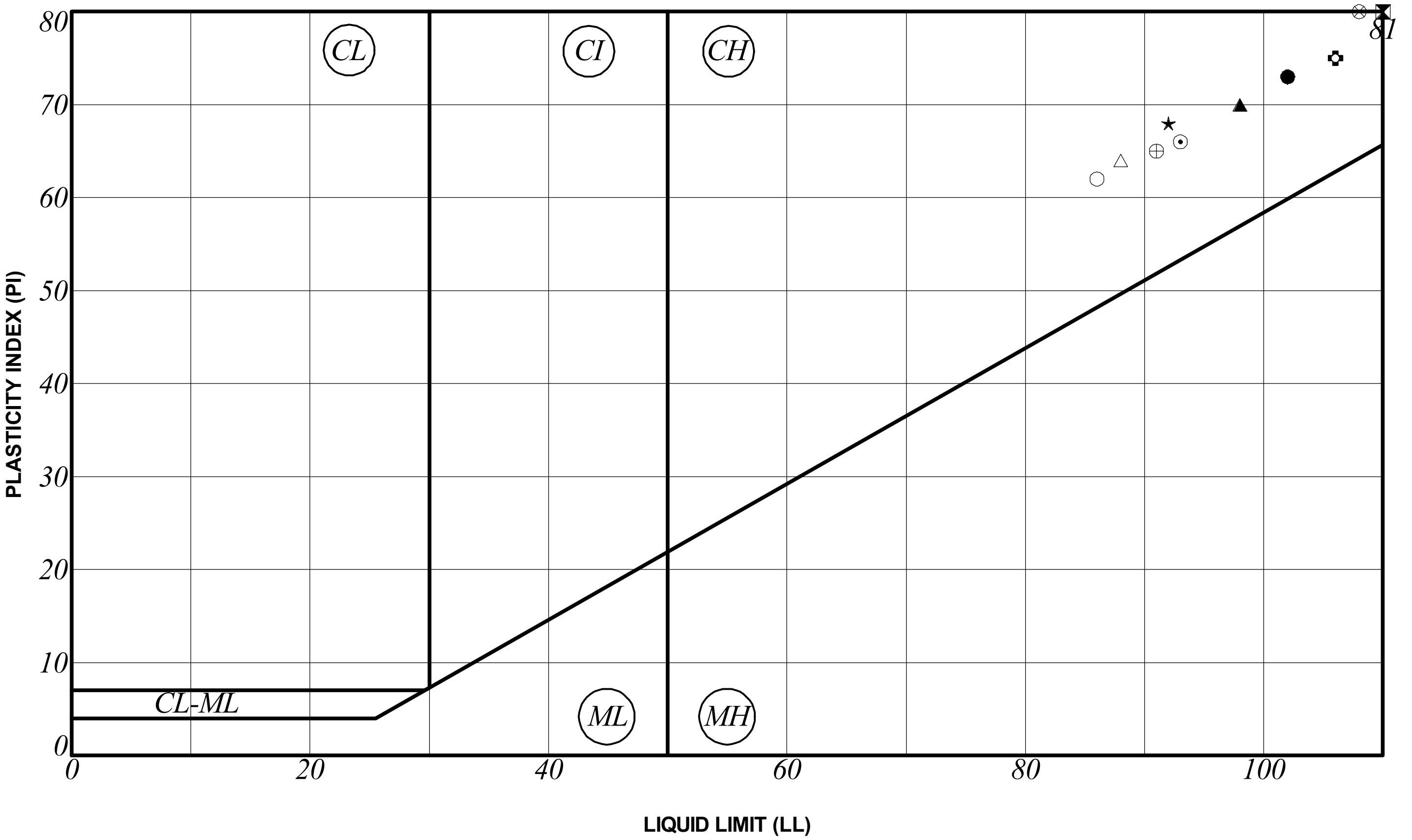
Boulders	>200 mm ø
Cobbles	75 – 200 mm ø
Coarse Grained Gravel	19 – 75 mm ø
Fine Grained Gravel	4.75 – 19 mm ø
Coarse Grained Sand	2 – 4.75 mm ø
Medium Grained Sand	0.425 – 2 mm ø
Fine Grained Sand	0.075 – 0.425 mm ø

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



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	% SAND	% SILT	% CLAY	% MC	CLASSIFICATION
●	TH17-01	3.8	S3	102	29	73				53.1	CH
⧗	TH17-01	4.9	S4	110	29	81				55.4	CH
▲	TH17-06	3.8	S3	98	28	70				48.7	CH
★	TH17-06	6.4	S6	92	24	68				50.0	CH
⊙	TH17-06	9.0	S9	93	27	66				48.4	CH
✤	TH17-10	3.8	S2	106	31	75				54.2	CH
○	TH17-10	6.4	S6	86	24	62				47.8	CH
△	TH17-10	11.4	S11	88	24	64				48.5	CH
⊗	TH17-15	4.9	S4	108	28	80				51.8	CH
⊕	TH17-15	6.4	S6	91	26	65				50.4	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

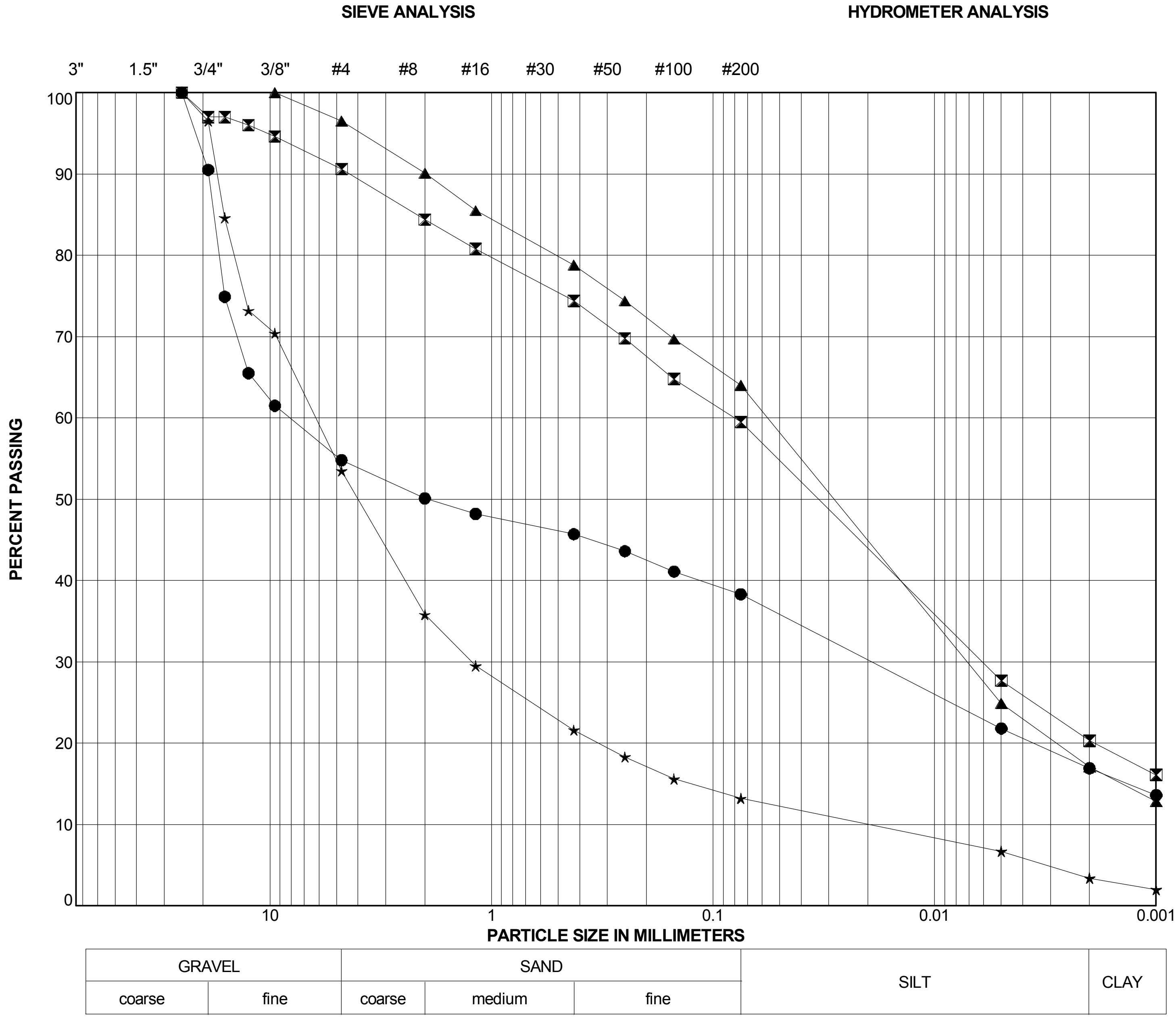
CITY OF WINNIPEG -
WATER AND WASTE
DEPARTMENT

Contract 5 - Cockburn and Calrossie Sewer Relief

A-LINE PLOT

October 2017	**Figure B01**	**Page 1 of 1**

A-LINE PLOT P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ



SYMBOL	HOLE	DEPTH (m)	SAMPLE #	% GRAVEL	% SAND	% SILT	% CLAY	% SILT & CLAY	Cu	Cc	CLASSIFICATION
●	*TH17-06*	*13.0*	*S13*	*45.2*	*16.5*	*21.4*	*16.9*	*38.3*			
⧗	*TH17-09*	*13.6*	*S11*	*9.4*	*31.1*	*39.2*	*20.3*	*59.5*			
▲	*TH17-10*	*13.3*	*S12*	*3.5*	*32.5*	*46.9*	*17.1*	*64.0*			
★	*TH17-13*	*14.5*	*S11*	*46.5*	*40.3*	*9.8*	*3.4*	*13.2*	*313.6*	*12.3*	

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Contract 5 - Cockburn and Calrossie Sewer Relief

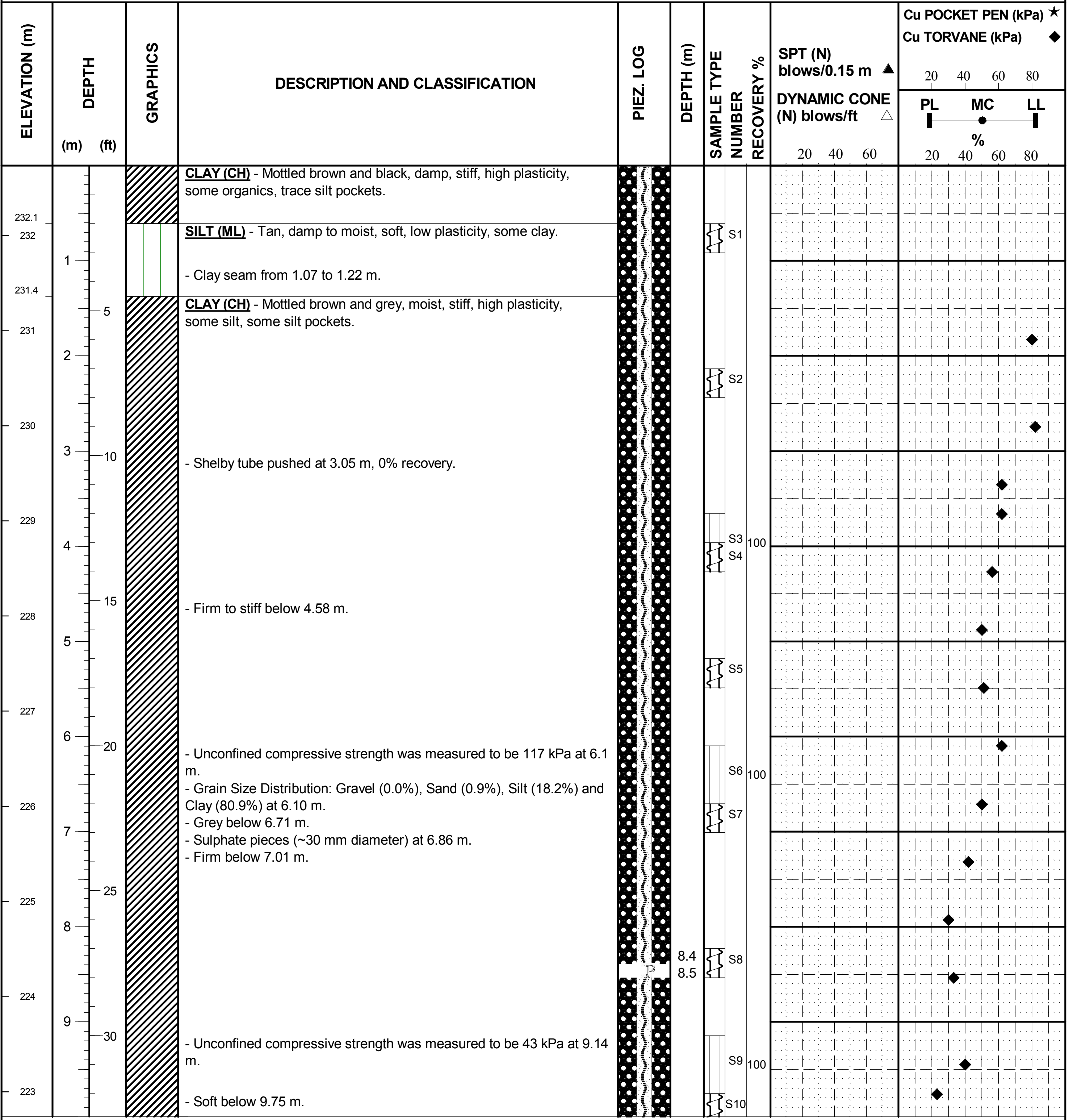
GRAIN SIZE ANALYSES

October 2017	**Figure B2**	**Page 1 of 1**

SIEVE ANALYSIS P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP **SUMMARY LOG** REFERENCE NO. HOLE NO. **TH16-09 (Shaft C)** SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.73
		TOP OF PVC ELEV.	
SITE	Wilton St from Taylor Ave to CN Tracks	WATER ELEV.	
LOCATION	Taylor Ave. Boulevard East of Wilton	DATE DRILLED	4/22/2016
DRILLING METHOD	100 mm ø Solid Stem Auger and NQ coring , B37X Mobile Drill	UTM (m)	N 5,524,243 E 632,294



CLAY (CH) - Mottled brown and black, damp, stiff, high plasticity, some organics, trace silt pockets.

SILT (ML) - Tan, damp to moist, soft, low plasticity, some clay.

- Clay seam from 1.07 to 1.22 m.

CLAY (CH) - Mottled brown and grey, moist, stiff, high plasticity, some silt, some silt pockets.

- Shelby tube pushed at 3.05 m, 0% recovery.

- Firm to stiff below 4.58 m.

- Unconfined compressive strength was measured to be 117 kPa at 6.1 m.
- Grain Size Distribution: Gravel (0.0%), Sand (0.9%), Silt (18.2%) and Clay (80.9%) at 6.10 m.
- Grey below 6.71 m.
- Sulphate pieces (~30 mm diameter) at 6.86 m.
- Firm below 7.01 m.

- Unconfined compressive strength was measured to be 43 kPa at 9.14 m.

- Soft below 9.75 m.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

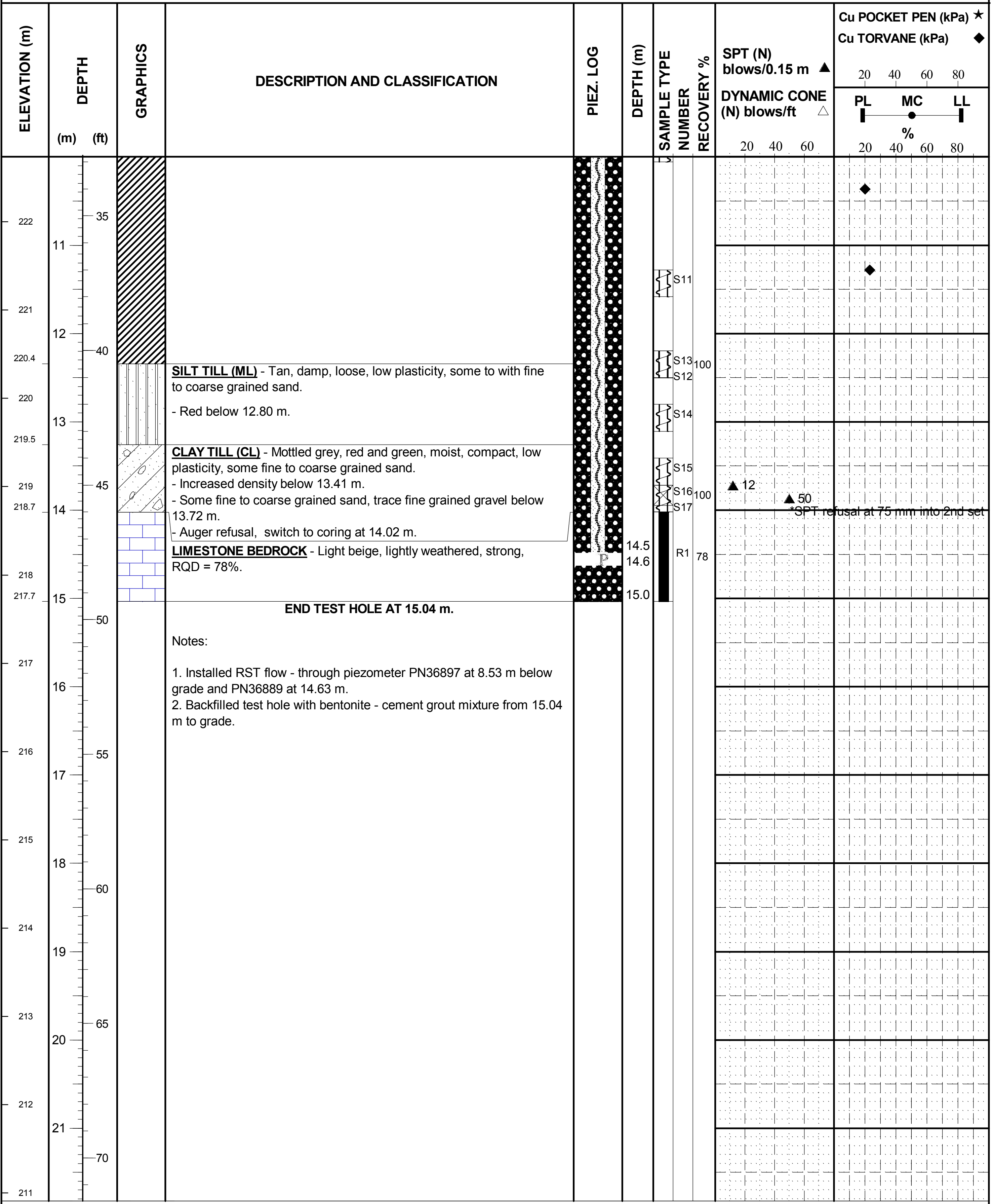
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH16-09 (Shaft C)

SHEET 2 of 2



SILT TILL (ML) - Tan, damp, loose, low plasticity, some to with fine to coarse grained sand.

- Red below 12.80 m.

CLAY TILL (CL) - Mottled grey, red and green, moist, compact, low plasticity, some fine to coarse grained sand.
- Increased density below 13.41 m.
- Some fine to coarse grained sand, trace fine grained gravel below 13.72 m.
- Auger refusal, switch to coring at 14.02 m.

LIMESTONE BEDROCK - Light beige, lightly weathered, strong, RQD = 78%.

END TEST HOLE AT 15.04 m.

Notes:

1. Installed RST flow - through piezometer PN36897 at 8.53 m below grade and PN36889 at 14.63 m.
2. Backfilled test hole with bentonite - cement grout mixture from 15.04 m to grade.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

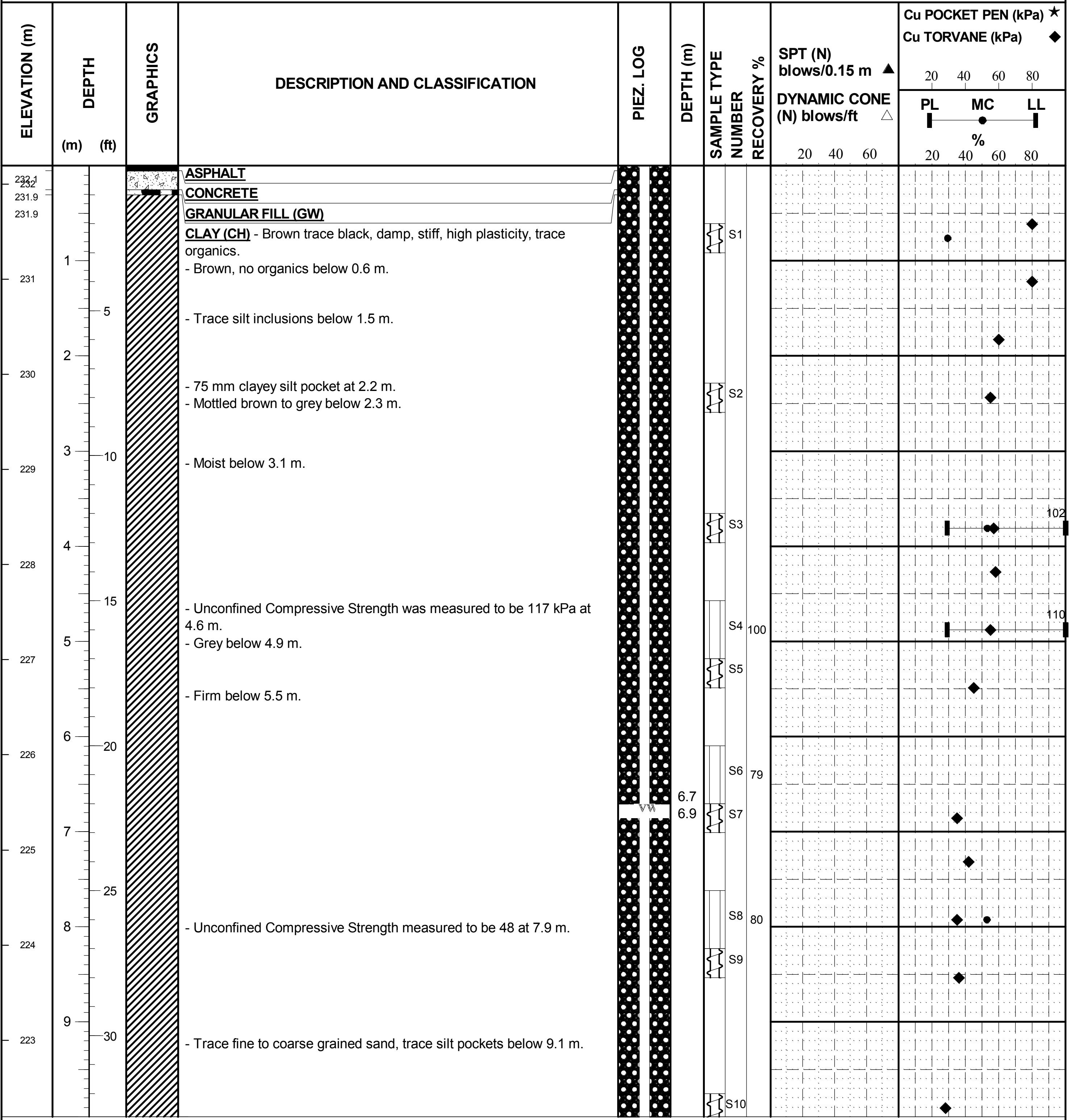
REFERENCE NO.

HOLE NO.
TH17-01

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Approximately 320 m West of Wilton St.
DRILLING METHOD 125 mm ø Solid Stem Auger, and NQ coring, B54X Truck Mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.19
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 5/3/2017
UTM (m) N 5,524,081
E 631,992



ASPHALT

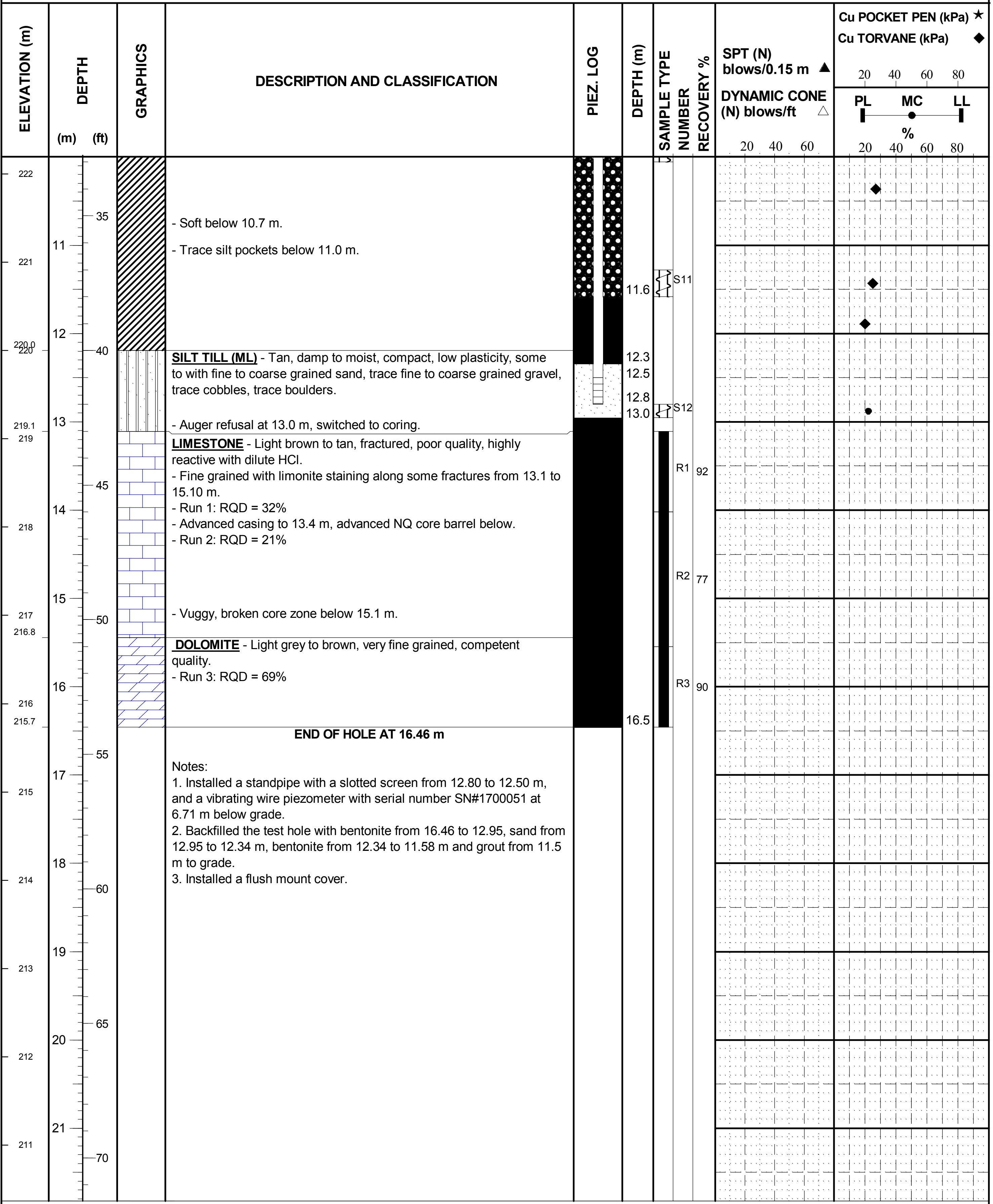
CONCRETE

GRANULAR FILL (GW)

CLAY (CH) - Brown trace black, damp, stiff, high plasticity, trace organics.
- Brown, no organics below 0.6 m.
- Trace silt inclusions below 1.5 m.
- 75 mm clayey silt pocket at 2.2 m.
- Mottled brown to grey below 2.3 m.
- Moist below 3.1 m.
- Unconfined Compressive Strength was measured to be 117 kPa at 4.6 m.
- Grey below 4.9 m.
- Firm below 5.5 m.
- Unconfined Compressive Strength measured to be 48 at 7.9 m.
- Trace fine to coarse grained sand, trace silt pockets below 9.1 m.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17



- Soft below 10.7 m.

- Trace silt pockets below 11.0 m.

SILT TILL (ML) - Tan, damp to moist, compact, low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Auger refusal at 13.0 m, switched to coring.

LIMESTONE - Light brown to tan, fractured, poor quality, highly reactive with dilute HCl.
- Fine grained with limonite staining along some fractures from 13.1 to 15.10 m.
- Run 1: RQD = 32%
- Advanced casing to 13.4 m, advanced NQ core barrel below.
- Run 2: RQD = 21%

- Vuggy, broken core zone below 15.1 m.

DOLOMITE - Light grey to brown, very fine grained, competent quality.
- Run 3: RQD = 69%

END OF HOLE AT 16.46 m

Notes:
1. Installed a standpipe with a slotted screen from 12.80 to 12.50 m, and a vibrating wire piezometer with serial number SN#1700051 at 6.71 m below grade.
2. Backfilled the test hole with bentonite from 16.46 to 12.95, sand from 12.95 to 12.34 m, bentonite from 12.34 to 11.58 m and grout from 11.5 m to grade.
3. Installed a flush mount cover.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

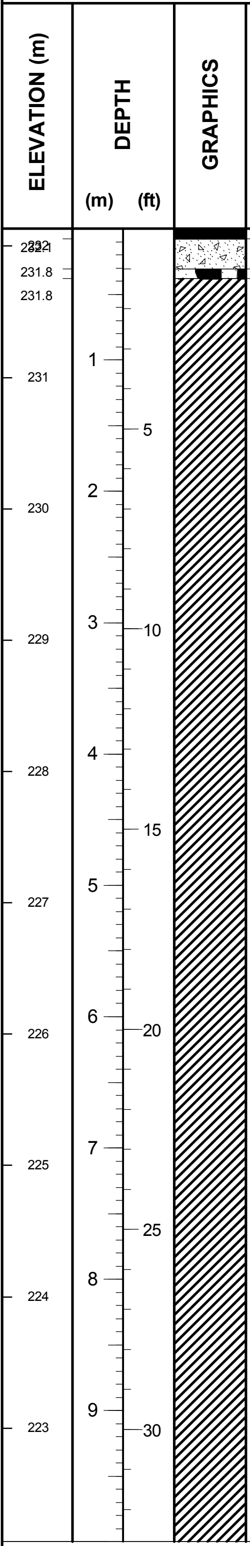
SUMMARY LOG

REFERENCE NO.

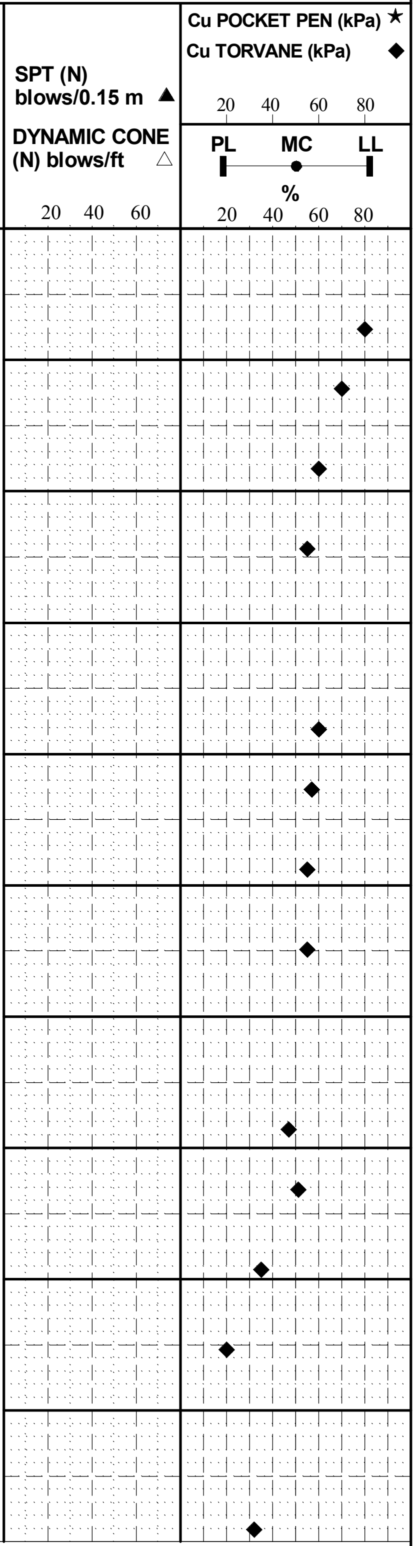
HOLE NO.
TH17-02

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.13
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	Approximately 265 m West of Wilton St.	DATE DRILLED	5/3/2017
		UTM (m)	N 5,524,110
DRILLING METHOD	125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig		E 632,046



DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
ASPHALT			
CONCRETE			
GRANULAR BASE (GW)			
CLAY (CH) Black, stiff, moist, high plasticity, trace to some organics. - Brown, no organics below 0.6 m.	Auger Grab	S1	
- Mottled brown to grey, trace silt inclusions below 1.5 m.			
	Auger Grab	S2	
	Auger Grab	S3	
- Moist below 4.6 m.			
	Auger Grab	S4	
- Firm to stiff below 6.7 m.	Auger Grab	S5	
- Grey, firm below 7.6 m.			
	Auger Grab	S6	
- Soft at 8.5 m.			
- Trace fine to coarse grained sand below 9.1 m.			
	Auger Grab	S7	

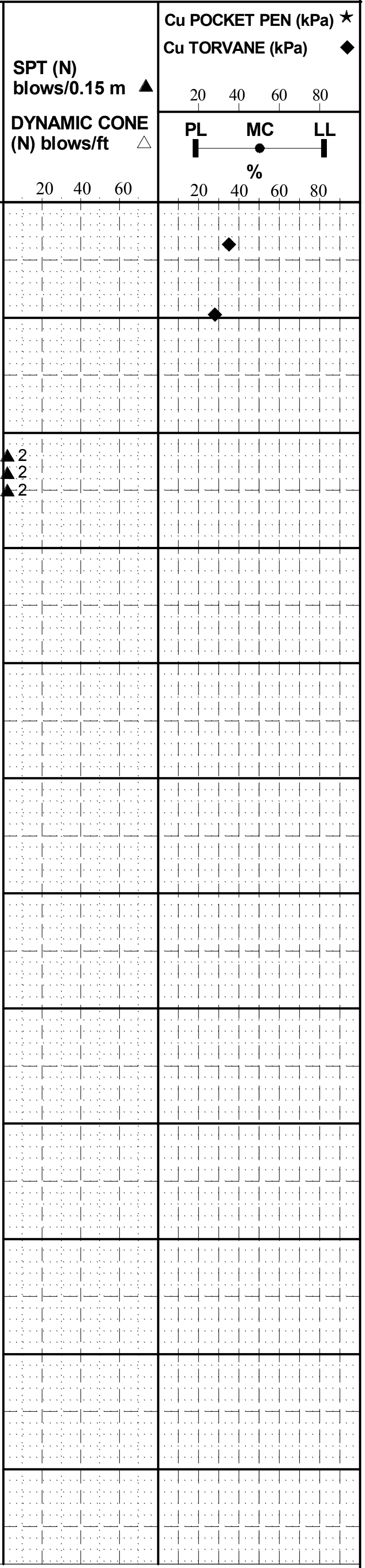


SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲
222							
		35	- Trace silt till pockets below 10.7 m.				
221	11						
220.4			**SILT TILL (ML)** - Tan, moist, loose, low plasticity, some fine to coarse grained sand, some clay, trace fine to coarse grained gravel, trace cobbles, trace boulders.	Auger Grab	S8		
220	12	40		Split Spoon	S9	100	2 2 2
			- Increased water content below 12.5 m.	Auger Grab	S10		
219.3			**AUGER REFUSAL AT 12.80 m**				
219	13						
		45					
218	14						
217	15	50					
216	16						
		55					
215	17						
214	18	60					
213	19						
		65					
212	20						
211	21	70					

Notes:
1. Test hole open to 12.80 m after the completion of drilling.
2. Water level 12.80 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

KGS GROUP

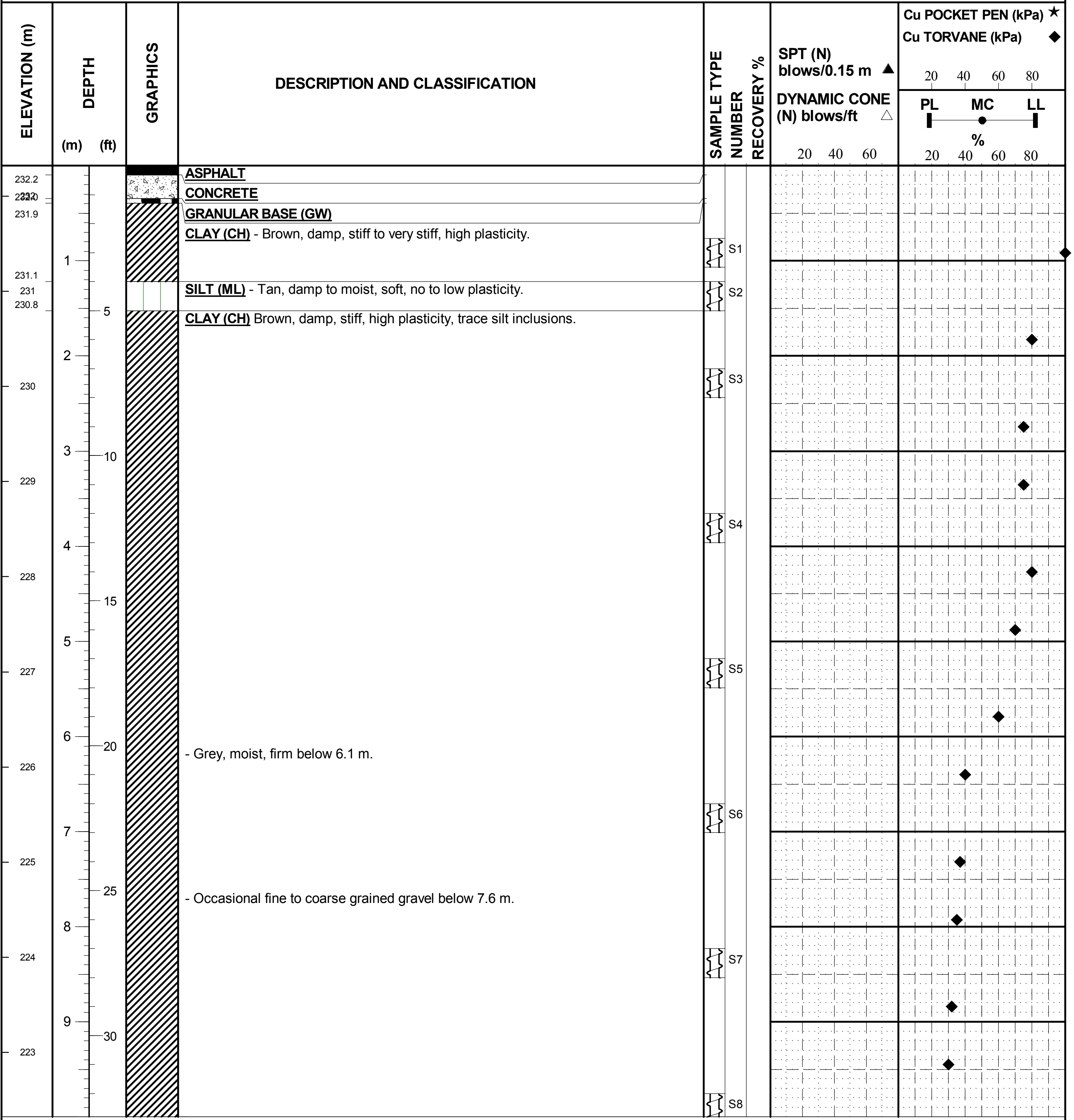
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-03

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.32
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	Approximately 140 m West of Wilton St.	DATE DRILLED	5/4/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig	UTM (m)	N 5,524,167 E 632,150



ASPHALT

CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Brown, damp, stiff to very stiff, high plasticity.

SILT (ML) - Tan, damp to moist, soft, no to low plasticity.

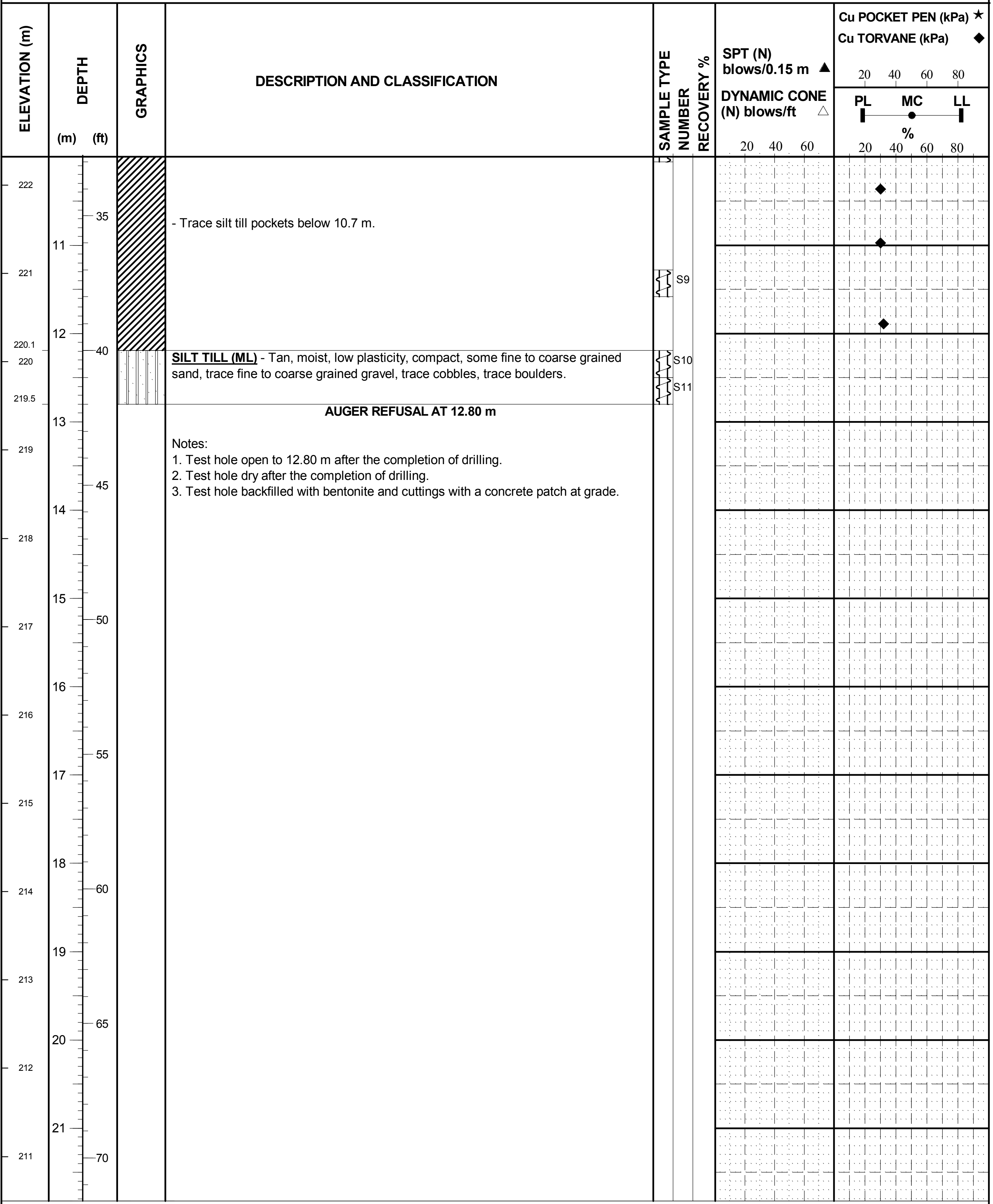
CLAY (CH) Brown, damp, stiff, high plasticity, trace silt inclusions.

- Grey, moist, firm below 6.1 m.

- Occasional fine to coarse grained gravel below 7.6 m.

SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. HAMILTON	DAA	10/20/17



- Trace silt till pockets below 10.7 m.

SILT TILL (ML) - Tan, moist, low plasticity, compact, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

AUGER REFUSAL AT 12.80 m

Notes:
1. Test hole open to 12.80 m after the completion of drilling.
2. Test hole dry after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.

SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	K. HAMILTON	DAA	10/20/17

KGS GROUP SUMMARY LOG

REFERENCE NO.

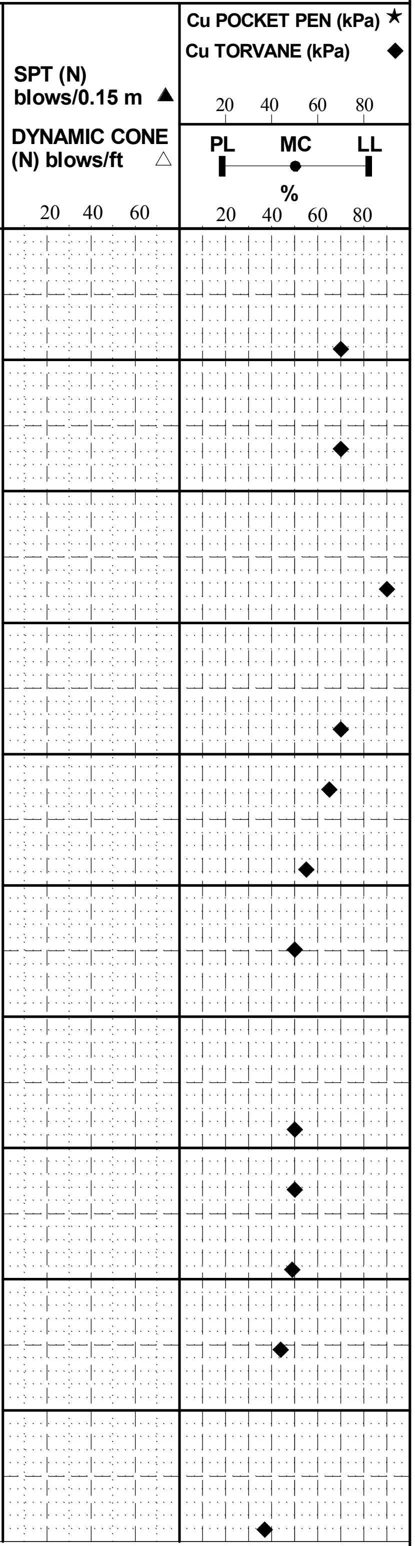
HOLE NO. **TH17-04**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Approximately 90 m West of Wilton St.
DRILLING METHOD 125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.58
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 5/1/2017
UTM (m) N 5,524,195
E 632,200

ELEVATION (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
232.5	ASPHALT	
232.3	CONCRETE	
232.2	GRANULAR BASE (GW)	
232	CLAY (CH) - Black, damp, stiff, high plasticity, trace to some organics. - Brown, no organics below 0.6 m.	
231.4	SILT (ML) - Tan, moist, soft, low plasticity.	S1
231.1	CLAY (CH) - Brown, damp, stiff, high plasticity.	
230.7	SILT (ML) - Tan, moist, soft, low plasticity.	S2
230.1	CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.	S3
	- Grey, moist below 5.2 m.	S4
	- Firm to stiff below 5.5 m.	S5
	- Trace fine grained sand below 7.6 m.	
	- Firm, trace fine to coarse grained sand below 8.2 m.	S6
		S7



SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR Maple Leaf Enterprises
INSPECTOR J. MACLENNAN
APPROVED DAA
DATE 10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

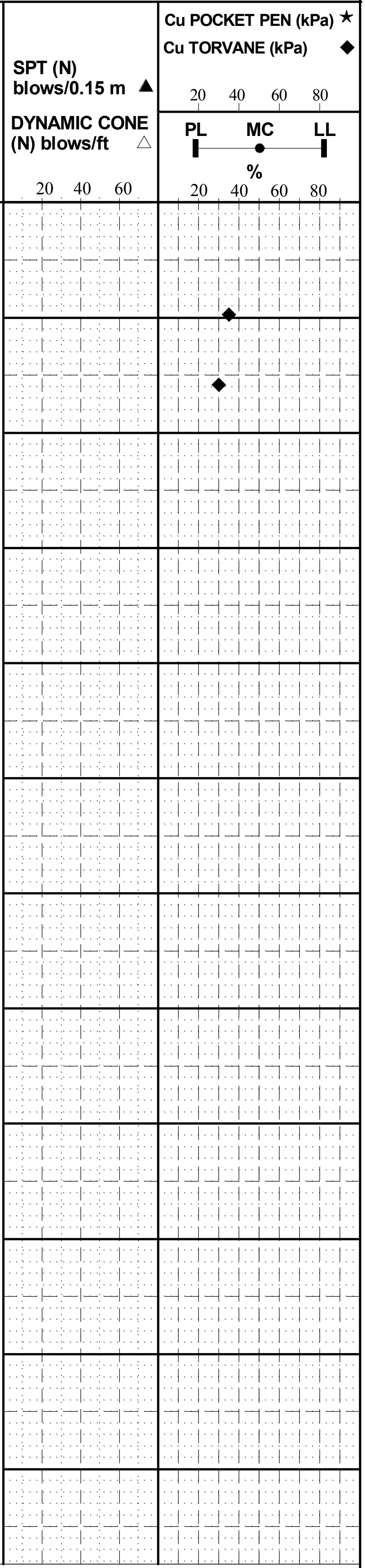
REFERENCE NO.

HOLE NO.
TH17-04

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
222		35		- Trace silt till pockets below 10.7 m.			
	11						
221					Auger Grab	S8	
	12						
220.4		40		**SILT TILL (ML)** - Tan, moist, compact, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.			
220							
	13				Auger Grab	S9	
219				- Moist to wet, no plasticity, some to with fine to coarse grained sand, trace to some fine to coarse grained gravel below 13.4 m.	Auger Grab	S10	
218.9		45		**AUGER REFUSAL AT 13.72 m**		S11	
	14						
218							
	15	50					
217							
	16						
216		55					
	17						
215							
	18	60					
214							
	19						
213		65					
	20						
212							
	21						
211		70					

Notes:
1. Test hole open to 13.56 m after the completion of drilling.
2. Water level 6.10 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

KGS GROUP

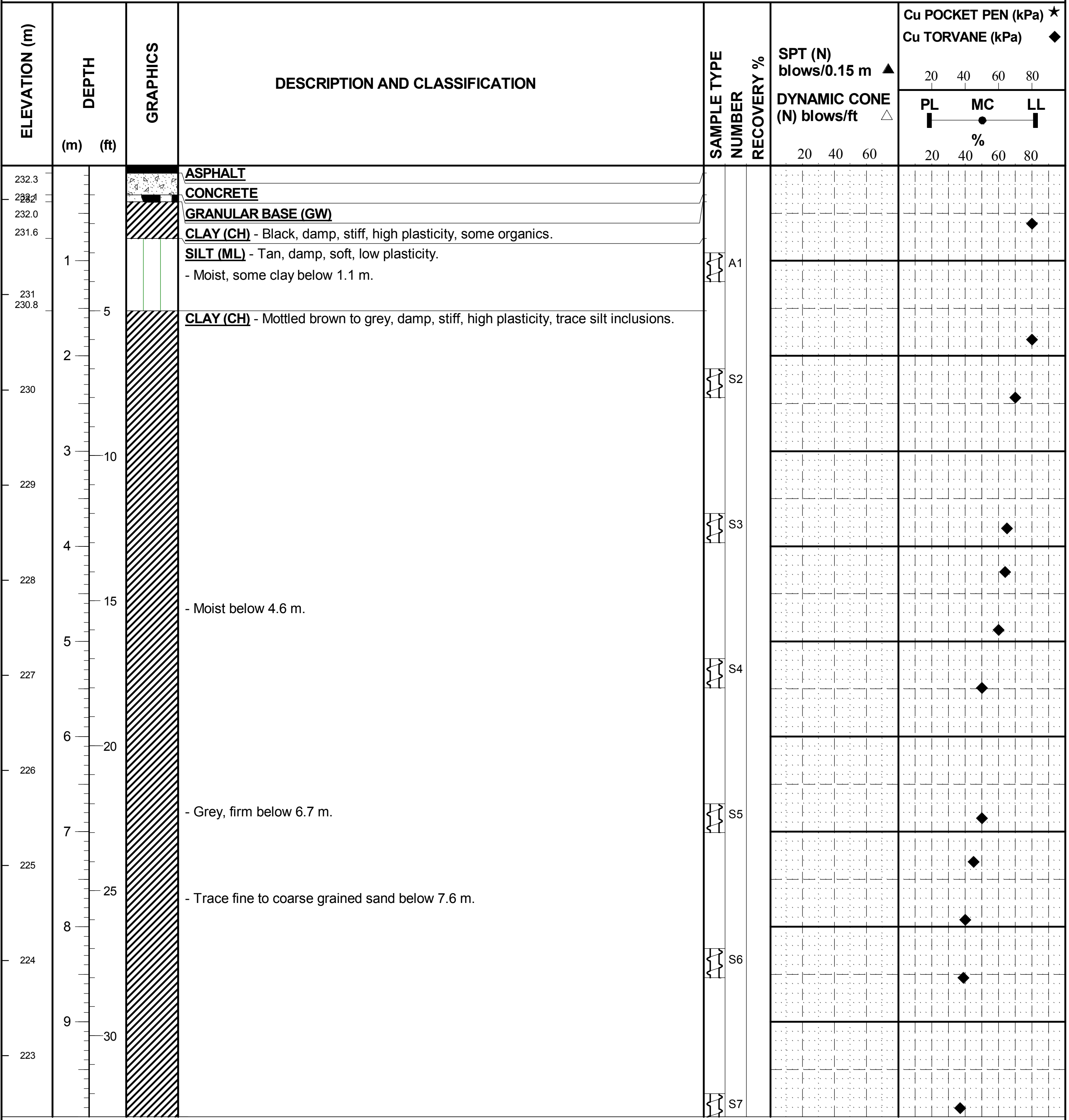
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-05

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.36
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	Approximately 80m West of Guelph St.	DATE DRILLED	5/1/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig	UTM (m)	N 5,524,282 E 632,359



ASPHALT

CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Black, damp, stiff, high plasticity, some organics.

SILT (ML) - Tan, damp, soft, low plasticity.
- Moist, some clay below 1.1 m.

CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.
- Moist below 4.6 m.
- Grey, firm below 6.7 m.
- Trace fine to coarse grained sand below 7.6 m.

SAMPLE TYPE ⸾ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

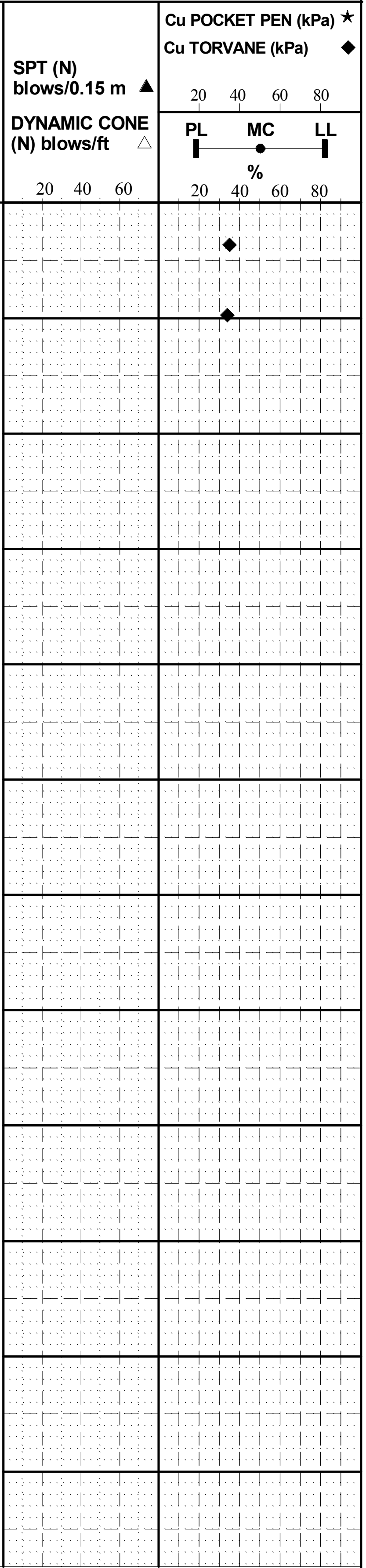
REFERENCE NO.

HOLE NO.
TH17-05

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
222		35				
221	11			Auger Grab	S8	
220.3	12		**SILT TILL (ML)** - Tan, moist, compact, some fine to coarse grained sand, trace fine to coarse grained gravel.	Split Spoon	S9	0
220		40		Auger Grab	S10	
219.7			**AUGER REFUSAL AT 12.65 m**			
219	13					
218	14	45				
217	15	50				
216	16					
215	17	55				
214	18	60				
213	19					
212	20	65				
211	21	70				

Notes:
1. Test hole open to 12.65 m after the completion of drilling.
2. Water level 12.65 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

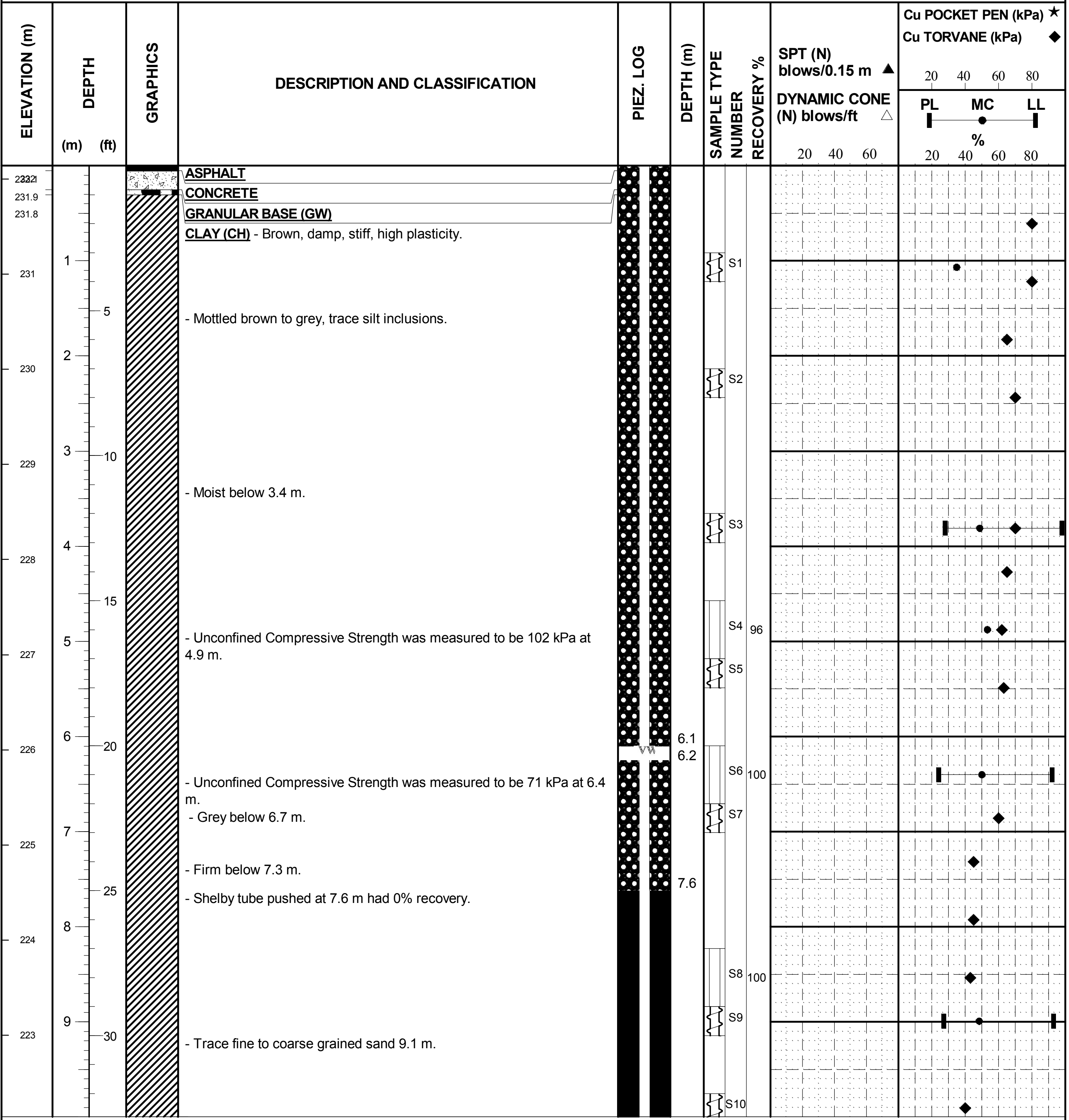
REFERENCE NO.

HOLE NO.
TH17-06

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION West of Guelph St.
DRILLING METHOD 125 mm ø Solid Stem Auger, and NQ coring, B54X Truck Mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.14
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 5/2/2017
UTM (m) N 5,524,316
E 632,420



ASPHALT

CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Brown, damp, stiff, high plasticity.

- Mottled brown to grey, trace silt inclusions.

- Moist below 3.4 m.

- Unconfined Compressive Strength was measured to be 102 kPa at 4.9 m.

- Unconfined Compressive Strength was measured to be 71 kPa at 6.4 m.

- Grey below 6.7 m.

- Firm below 7.3 m.

- Shelby tube pushed at 7.6 m had 0% recovery.

- Trace fine to coarse grained sand 9.1 m.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

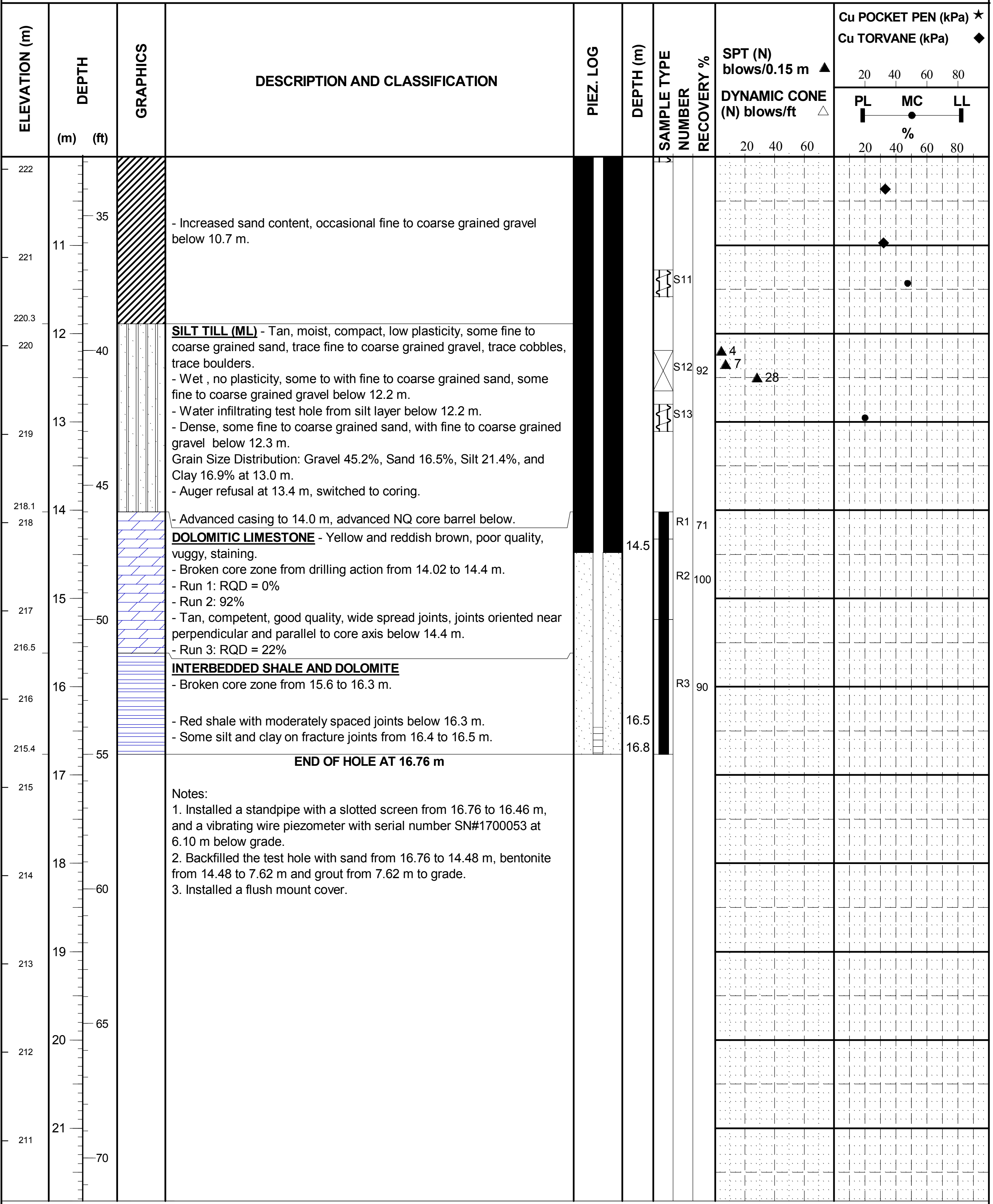
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-06

SHEET 2 of 2



- Increased sand content, occasional fine to coarse grained gravel below 10.7 m.

SILT TILL (ML) - Tan, moist, compact, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.
- Wet , no plasticity, some to with fine to coarse grained sand, some fine to coarse grained gravel below 12.2 m.
- Water infiltrating test hole from silt layer below 12.2 m.
- Dense, some fine to coarse grained sand, with fine to coarse grained gravel below 12.3 m.

Grain Size Distribution: Gravel 45.2%, Sand 16.5%, Silt 21.4%, and Clay 16.9% at 13.0 m.
- Auger refusal at 13.4 m, switched to coring.
- Advanced casing to 14.0 m, advanced NQ core barrel below.

DOLOMITIC LIMESTONE - Yellow and reddish brown, poor quality, vuggy, staining.
- Broken core zone from drilling action from 14.02 to 14.4 m.
- Run 1: RQD = 0%
- Run 2: 92%
- Tan, competent, good quality, wide spread joints, joints oriented near perpendicular and parallel to core axis below 14.4 m.
- Run 3: RQD = 22%

INTERBEDDED SHALE AND DOLOMITE
- Broken core zone from 15.6 to 16.3 m.
- Red shale with moderately spaced joints below 16.3 m.
- Some silt and clay on fracture joints from 16.4 to 16.5 m.

END OF HOLE AT 16.76 m

Notes:
1. Installed a standpipe with a slotted screen from 16.76 to 16.46 m, and a vibrating wire piezometer with serial number SN#1700053 at 6.10 m below grade.
2. Backfilled the test hole with sand from 16.76 to 14.48 m, bentonite from 14.48 to 7.62 m and grout from 7.62 m to grade.
3. Installed a flush mount cover.

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

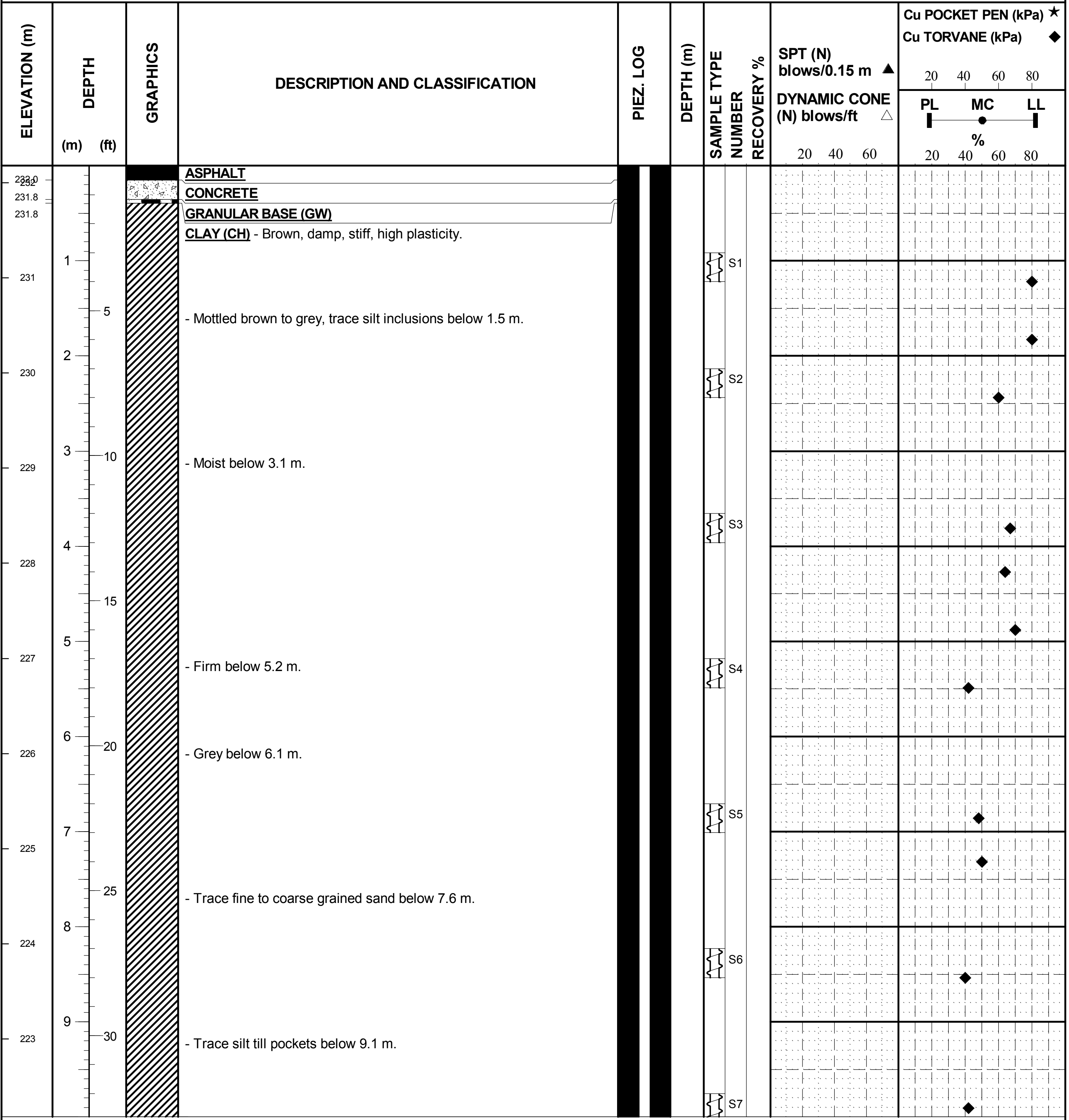
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-07

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.18
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	East of Guelph St.	DATE DRILLED	5/1/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig	UTM (m)	N 5,524,328 E 632,442



ASPHALT

CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Brown, damp, stiff, high plasticity.

- Mottled brown to grey, trace silt inclusions below 1.5 m.

- Moist below 3.1 m.

- Firm below 5.2 m.

- Grey below 6.1 m.

- Trace fine to coarse grained sand below 7.6 m.

- Trace silt till pockets below 9.1 m.

SAMPLE TYPE ⦚ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

SUMMARY LOG

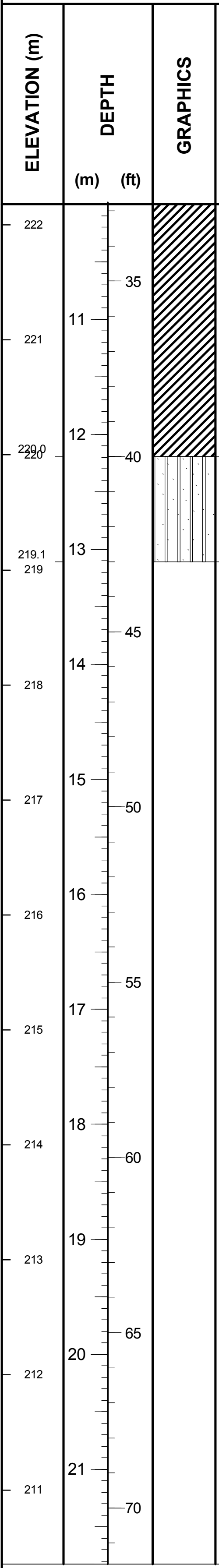
REFERENCE NO.

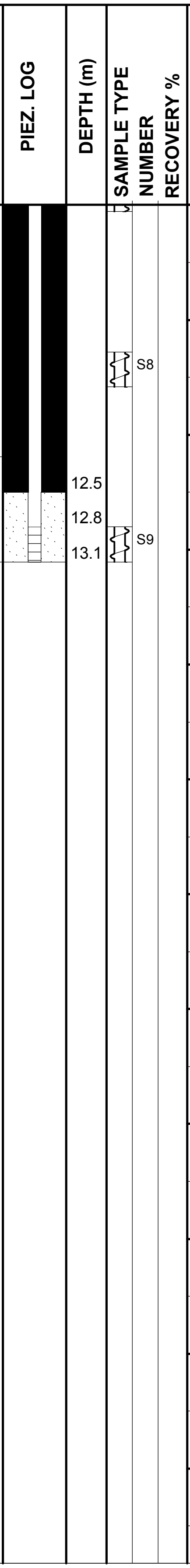
HOLE NO.
TH17-07

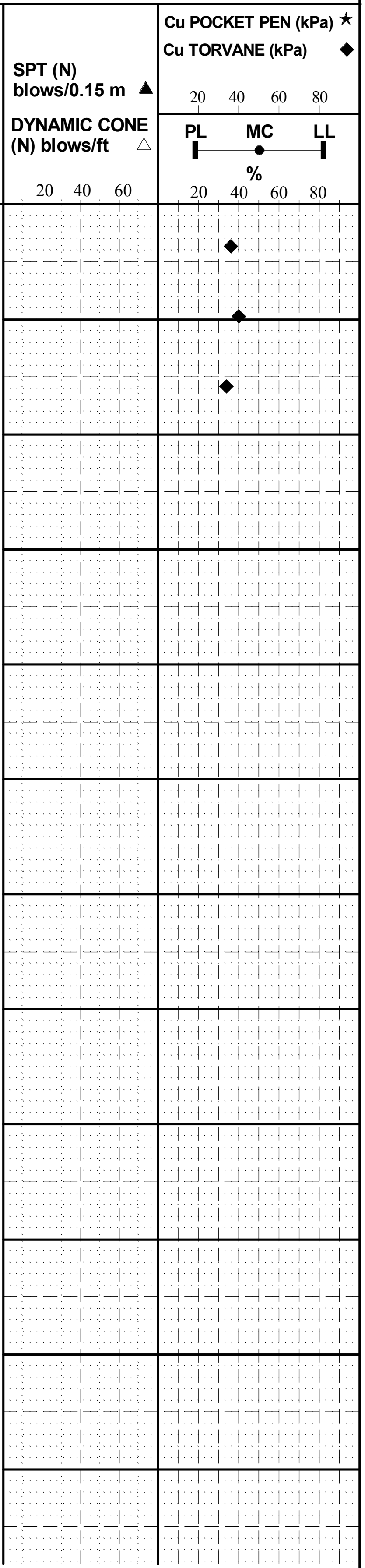
SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE NUMBER
		- Occasional fine to coarse grained gravel below 10.7 m.		
				S8
220.0		**SILT TILL (ML)** - Tan, damp, compact, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.	12.5	
		- Moist to wet below 12.8 m.	12.8	S9
219.1	13.1	**AUGER REFUSAL AT 13.11 m**	13.1	

Notes:
1. Installed a standpipe with a slotted screen from 13.11 to 12.80 m below grade.
2. Backfilled the test hole with sand from 13.11 to 12.50 m, and bentonite from 14.48 to grade.
3. Installed a flush mount cover.







SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

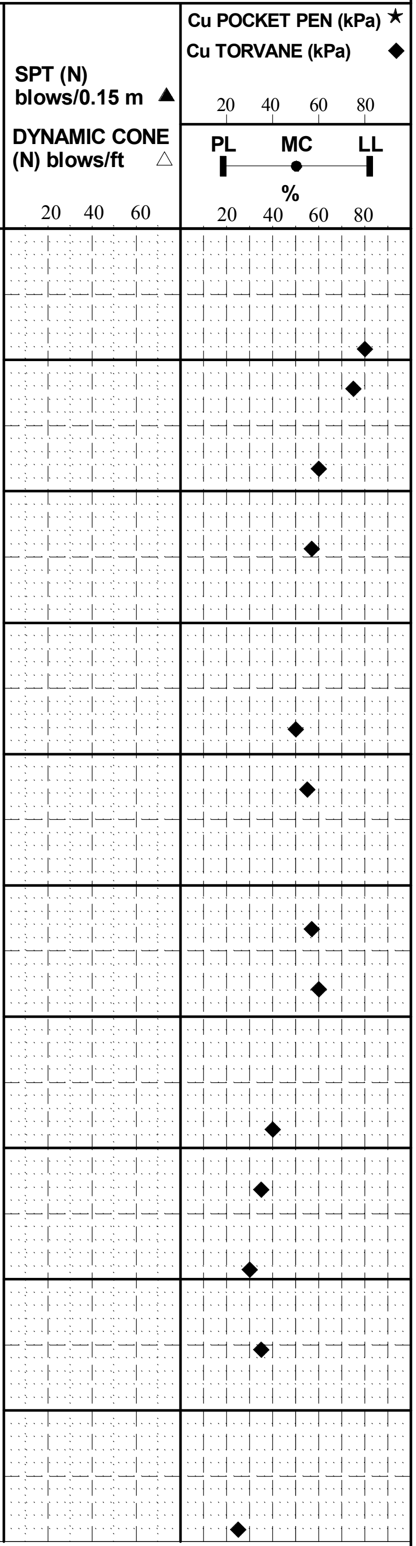
HOLE NO.
TH17-08

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Approximately 70 m East of Guelph St.
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker Renegrade Track Mounted Rig

JOB NO. 11-0107-18
GROUND ELEV. 231.86
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/28/2017
UTM (m) N 5,524,354
E 632,491

ELEVATION (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
231.8	**ASPHALT**		
231.5	**CONCRETE**		
231.5	**GRANULAR BASE (GW)**		
	CLAY (CH) - Brown, damp, stiff, high plasticity.	Auger Grab	S1
	- Mottled brown to grey, trace silt inclusions below 1.2 m.		
	- Occasional fine to coarse grained gravel from 1.5 to 3.1 m.		
		Auger Grab	S2
		Auger Grab	S3
	- Moist below 4.6 m.		
		Auger Grab	S4
	- Grey, firm below 6.1 m.		
		Auger Grab	S5
		Auger Grab	S6
	- Trace fine to coarse grained sand below 9.1 m.		
	- Soft to firm below 9.8 m.	Auger Grab	S7



SAMPLE TYPE Auger Grab

CONTRACTOR Maple Leaf Enterprises
INSPECTOR J. MACLENNAN
APPROVED DAA
DATE 10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

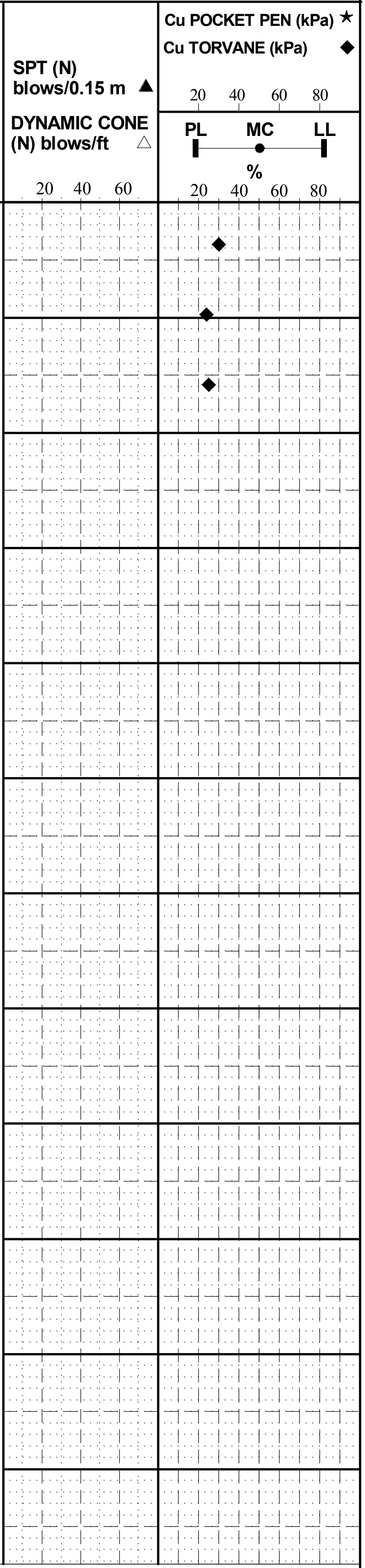
REFERENCE NO.

HOLE NO.
TH17-08

SHEET 2 of 2

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
221	11 / 35		- Trace silt till pockets below 10.7 m.			
				⌇	S8	
220 / 219.7	12 / 40		**SILT TILL (ML)** - Tan, moist, compact, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.			
219 / 218.8	13		- Moist to wet, no plasticity, some to with fine to coarse grained sand, some fine to coarse grained gravel below 12.8 m.	⌇	S9	
			AUGER REFUSAL AT 13.11 m			

Notes:
1. Test hole open to 13.11 m after the completion of drilling.
2. Water level 5.79 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE ⌇ Auger Grab

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

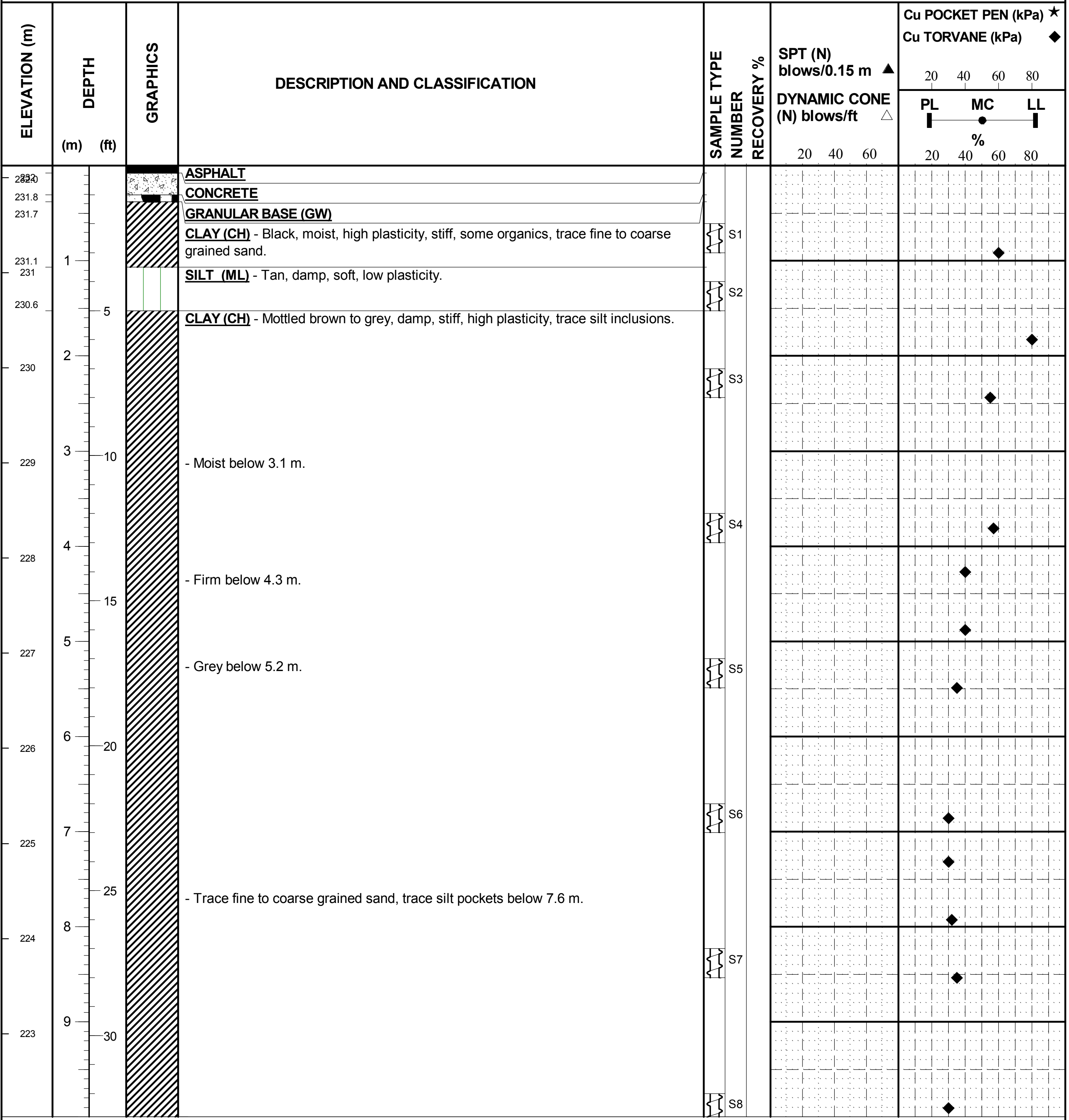
SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-09

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.12
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	West of Harrow St.	DATE DRILLED	5/2/2017
		UTM (m)	N 5,524,380 E 632,538
DRILLING METHOD	125 mm ø Solid Stem Auger, B54X Truck Mounted Drill Rig		



ASPHALT

CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Black, moist, high plasticity, stiff, some organics, trace fine to coarse grained sand.

SILT (ML) - Tan, damp, soft, low plasticity.

CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.

- Moist below 3.1 m.

- Firm below 4.3 m.

- Grey below 5.2 m.

- Trace fine to coarse grained sand, trace silt pockets below 7.6 m.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

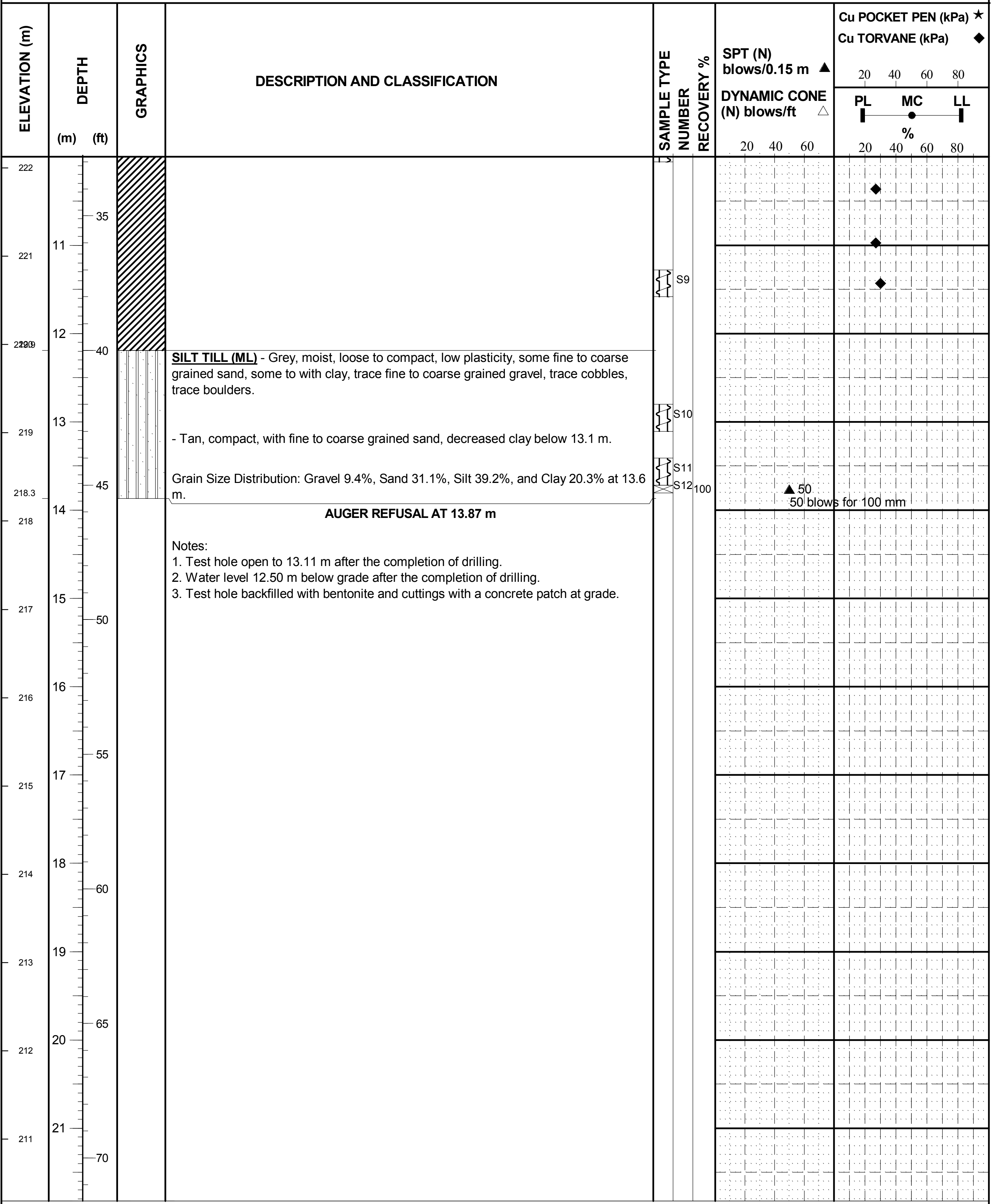
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-09

SHEET 2 of 2



SILT TILL (ML) - Grey, moist, loose to compact, low plasticity, some fine to coarse grained sand, some to with clay, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Tan, compact, with fine to coarse grained sand, decreased clay below 13.1 m.

Grain Size Distribution: Gravel 9.4%, Sand 31.1%, Silt 39.2%, and Clay 20.3% at 13.6 m.

AUGER REFUSAL AT 13.87 m

Notes:
1. Test hole open to 13.11 m after the completion of drilling.
2. Water level 12.50 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH17-10**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

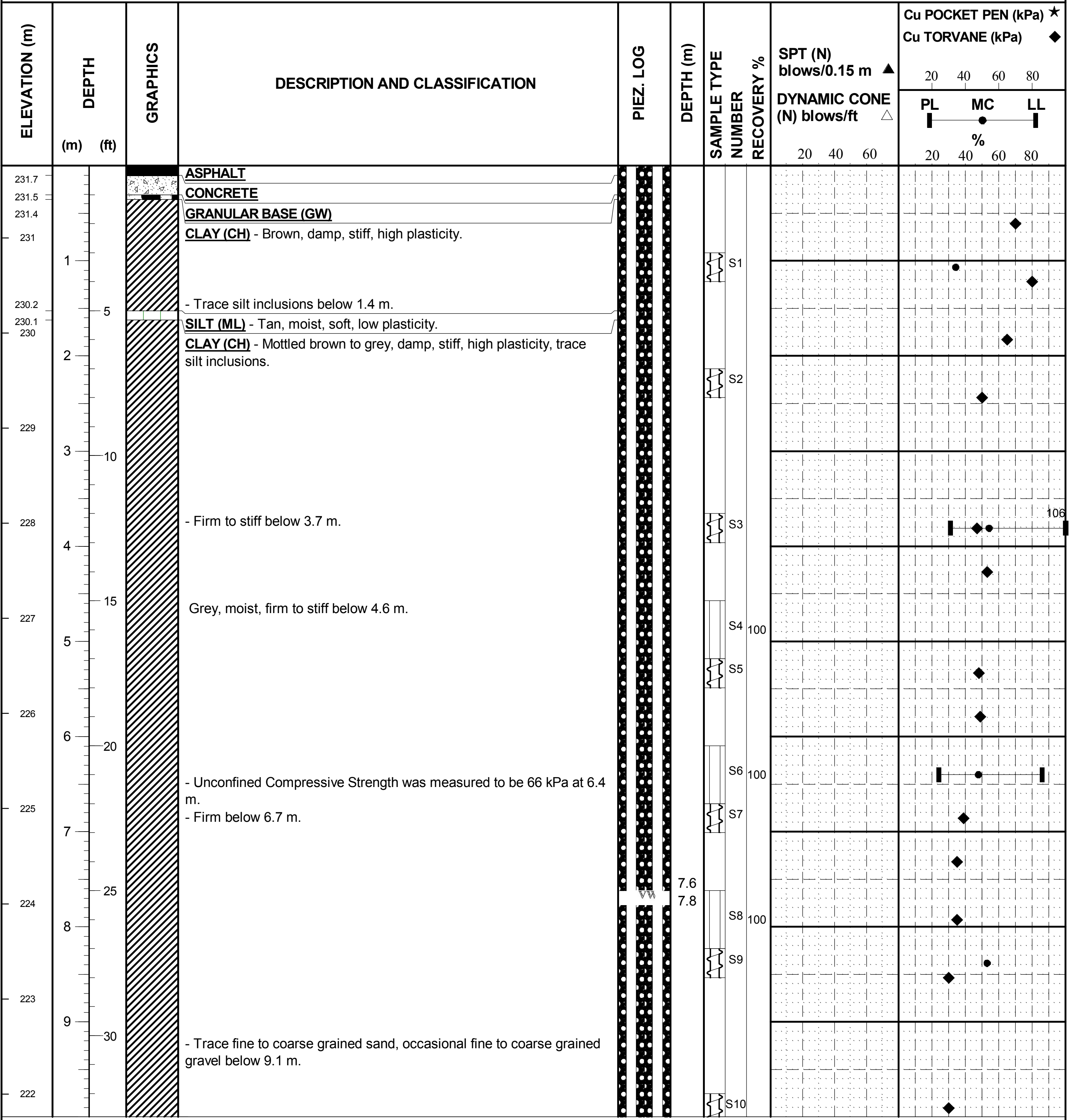
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief

SITE Taylor Ave

LOCATION East of Harrow St.

DRILLING METHOD 125 mm ø Solid Stem Auger, and NQ coring, Acker Renegrade Track Mounted Rig

JOB NO. 11-0107-18
GROUND ELEV. 231.76
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/27/2017
UTM (m) N 5,524,422
E 632,614



ELEVATION (m)	DESCRIPTION AND CLASSIFICATION
231.7	**ASPHALT**
231.5	**CONCRETE**
231.4	**GRANULAR BASE (GW)**
	CLAY (CH) - Brown, damp, stiff, high plasticity.
230.2	- Trace silt inclusions below 1.4 m.
230.1	**SILT (ML)** - Tan, moist, soft, low plasticity.
230	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.
	- Firm to stiff below 3.7 m.
	Grey, moist, firm to stiff below 4.6 m.
	- Unconfined Compressive Strength was measured to be 66 kPa at 6.4 m. - Firm below 6.7 m.
	- Trace fine to coarse grained sand, occasional fine to coarse grained gravel below 9.1 m.

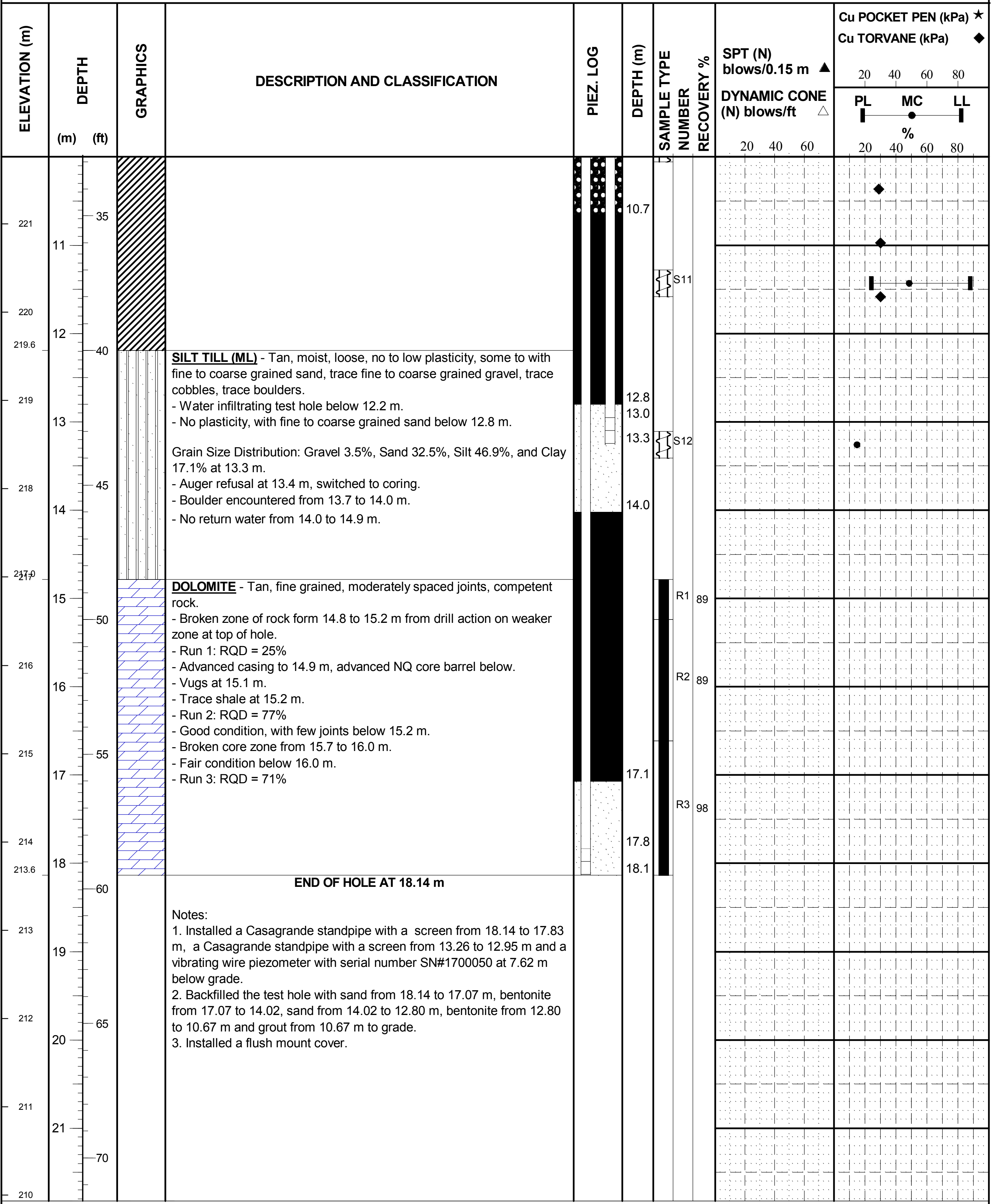
SAMPLE NUMBER	RECOVERY %
S1	
S2	
S3	
S4	100
S5	
S6	100
S7	
S8	100
S9	
S10	

PIEZ. LOG DEPTH (m): 7.6, 7.8

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ



SILT TILL (ML) - Tan, moist, loose, no to low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.
- Water infiltrating test hole below 12.2 m.
- No plasticity, with fine to coarse grained sand below 12.8 m.

Grain Size Distribution: Gravel 3.5%, Sand 32.5%, Silt 46.9%, and Clay 17.1% at 13.3 m.
- Auger refusal at 13.4 m, switched to coring.
- Boulder encountered from 13.7 to 14.0 m.
- No return water from 14.0 to 14.9 m.

DOLOMITE - Tan, fine grained, moderately spaced joints, competent rock.
- Broken zone of rock form 14.8 to 15.2 m from drill action on weaker zone at top of hole.
- Run 1: RQD = 25%
- Advanced casing to 14.9 m, advanced NQ core barrel below.
- Vugs at 15.1 m.
- Trace shale at 15.2 m.
- Run 2: RQD = 77%
- Good condition, with few joints below 15.2 m.
- Broken core zone from 15.7 to 16.0 m.
- Fair condition below 16.0 m.
- Run 3: RQD = 71%

END OF HOLE AT 18.14 m

Notes:
1. Installed a Casagrande standpipe with a screen from 18.14 to 17.83 m, a Casagrande standpipe with a screen from 13.26 to 12.95 m and a vibrating wire piezometer with serial number SN#1700050 at 7.62 m below grade.
2. Backfilled the test hole with sand from 18.14 to 17.07 m, bentonite from 17.07 to 14.02, sand from 14.02 to 12.80 m, bentonite from 12.80 to 10.67 m and grout from 10.67 m to grade.
3. Installed a flush mount cover.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

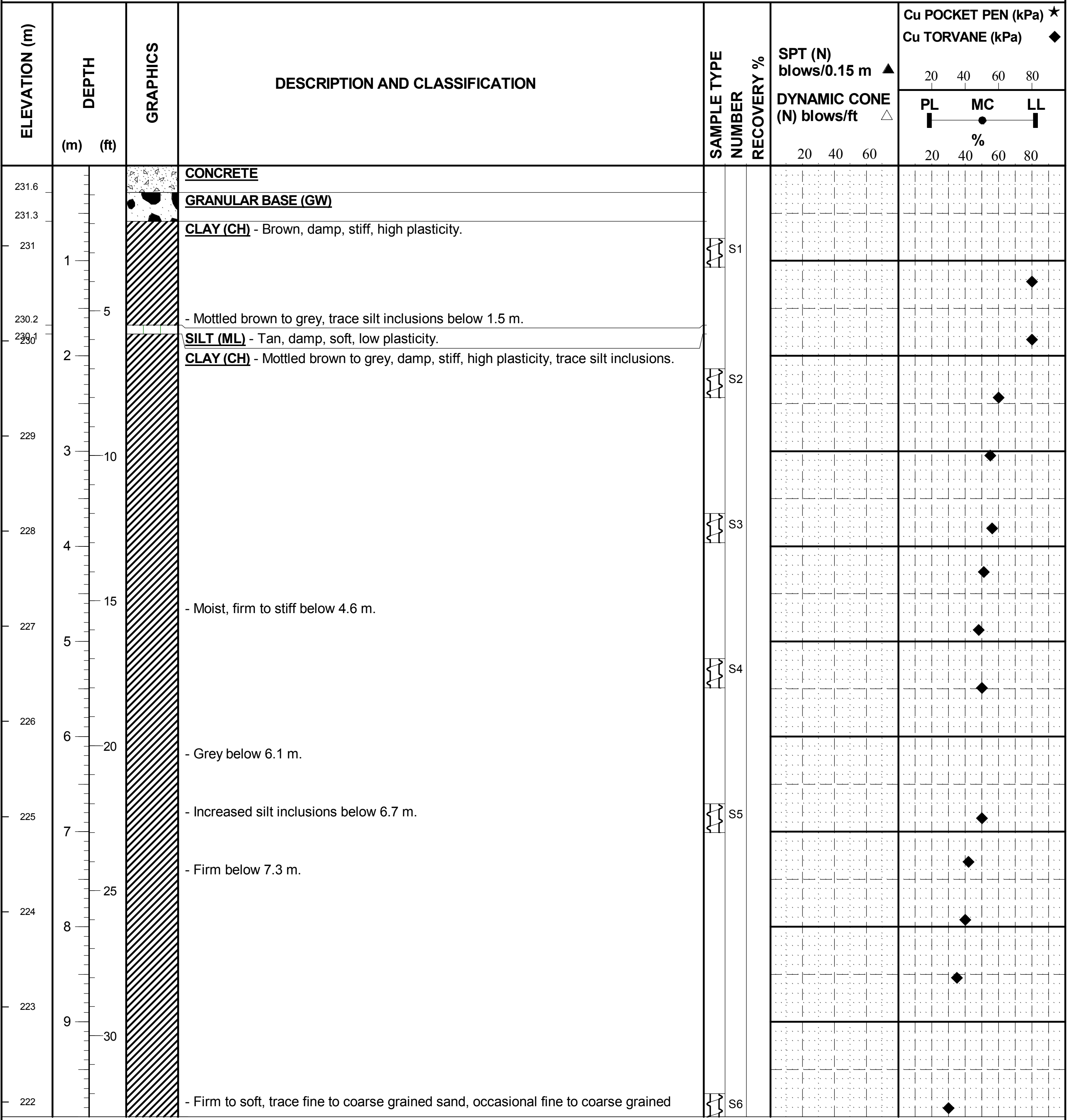
REFERENCE NO.

HOLE NO. **TH17-11**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Approximately 80 m East of Harrow St.
DRILLING METHOD 125 mm ø Solid Stem Auger, Acker Renegrade Track Mounted Rig

JOB NO. 11-0107-18
GROUND ELEV. 231.84
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/28/2017
UTM (m) N 5,524,441
E 632,650



CONCRETE

GRANULAR BASE (GW)

CLAY (CH) - Brown, damp, stiff, high plasticity.

- Mottled brown to grey, trace silt inclusions below 1.5 m.

SILT (ML) - Tan, damp, soft, low plasticity.

CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.

- Moist, firm to stiff below 4.6 m.

- Grey below 6.1 m.

- Increased silt inclusions below 6.7 m.

- Firm below 7.3 m.

- Firm to soft, trace fine to coarse grained sand, occasional fine to coarse grained

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

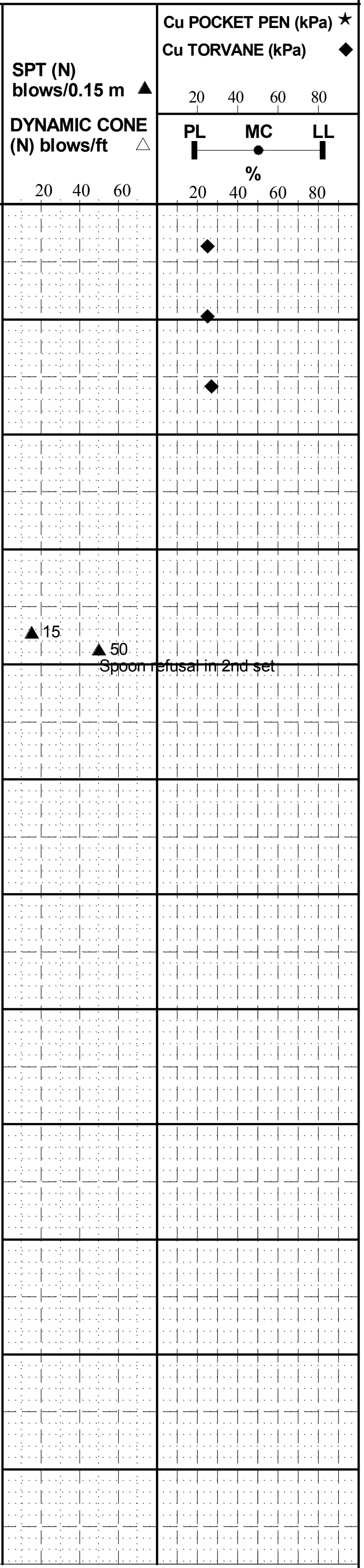
REFERENCE NO.

HOLE NO.
TH17-11

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲
		gravel below 9.7 m.				
		- Trace silt till pockets below 10.7 m.				
			Auger Grab	S7		
219.0		**SILT TILL (ML)** - Grey, moist, loose, low plasticity, some clay, some fine to coarse grained sand, trace fine to coarse grained gravel.				
		- Compact, no to low plasticity, some to with fine to coarse grained sand, trace clay, trace cobbles, trace boulders below 13.4 m.	Auger Grab	S9		
			Split Spoon	S10	25	▲15 ▲50 Spoon refusal in 2nd set
217.8	14.02	**AUGER REFUSAL AT 14.02 m**				

Notes:
1. Test hole open to 14.02 m after the completion of drilling.
2. Water level 13.41 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE: Auger Grab; Split Spoon

CONTRACTOR: Maple Leaf Enterprises

INSPECTOR: J. MACLENNAN

APPROVED: DAA

DATE: 10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP **SUMMARY LOG**

REFERENCE NO.

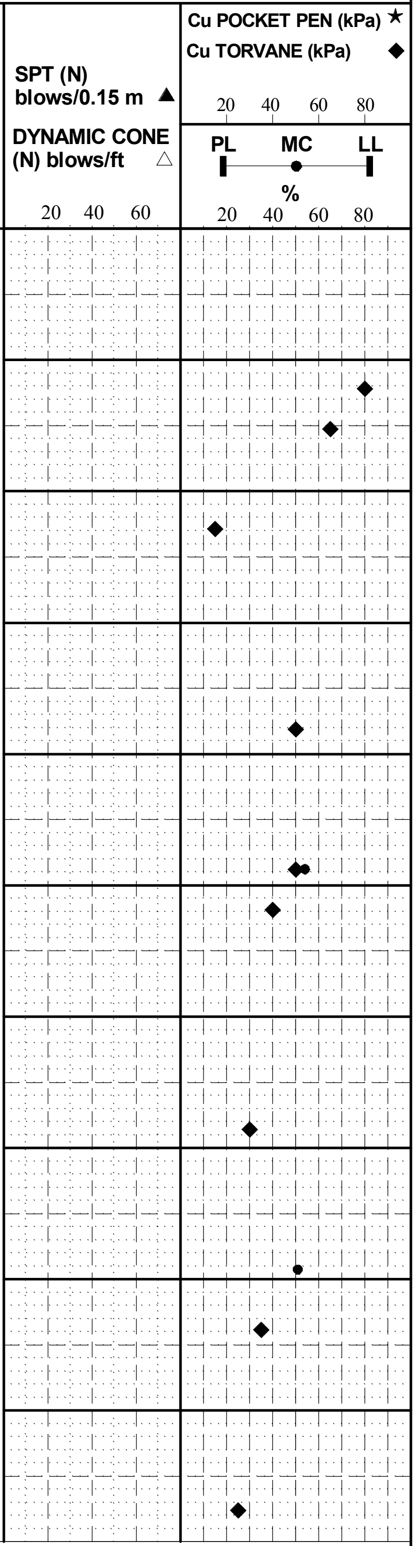
HOLE NO. **TH17-12**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION West of Stafford St.
DRILLING METHOD 125 mm ø Solid Stem Auger, and NQ coring, B40X Truck Mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 231.98
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/26/2017
UTM (m) N 5,524,462
E 632,688

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %
231.9		**ASPHALT**			
231.6		**CONCRETE**			
231.6		**GRANULAR BASE (GW)**			
		CLAY (CH) - Brown, damp, stiff, high plasticity.		S1	
230.2		**SILT (ML)** - Tan, moist, soft.		S2	
229.1		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.		S3	
				S4	100
		- Unconfined Compressive Strength was measured to be 81 kPa at 4.9 m. - Firm below 5.2 m.	5.5 5.6	S5	
		- Grey, moist below 6.1 m. - Water infiltrating test hole below 6.1 m.		S6	100
				S7	
				S8	100
		- Unconfined Compressive Strength was measured to be 84 kPa at 7.9 m.		S9	
		- Soft to firm, trace fine to coarse grained sand below 9.1 m.		S10	



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

CONTRACTOR Maple Leaf Enterprises
INSPECTOR J. MACLENNAN
APPROVED DAA
DATE 10/20/17

KGS GROUP

SUMMARY LOG

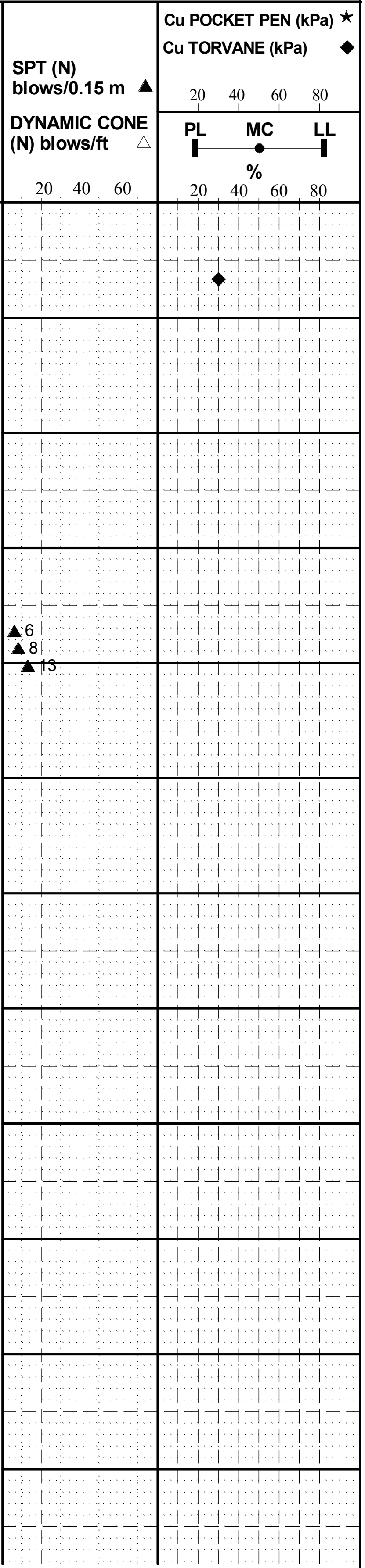
REFERENCE NO.

HOLE NO.
TH17-12

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m
		35		10.7				
221	11				Auger Grab	S11		
220	12	40	- Trace cobbles and boulders below 12.2 m					
219 218.9	13		**SILT TILL (ML)** - Grey, moist, firm, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, some clay, trace cobbles and boulders.		Auger Grab	S12		
		45	- Compact below 13.7 m.		Split Spoon	S13	100	6 8 13
218	14		- Tan, moist, compact to dense, with fine to coarse grained sand, some fine to coarse grained gravel.		Auger Grab	S14		
217.3			- Auger refusal at 14.6 m, switched to coring. - Advanced casing to 14.9 m, advanced NQ core barrel below.	14.6	Core Barrel	R1	25	
217	15	50	**DOLOMITE** - Tan, fine grained, minor limonite staining - Broken zone caused by drill action from 14.6 to 15.4 m,. - Run 1: RQD = 0% - Run 2: RQD = 20%	15.4	Core Barrel	R2	45	
216.3			- Competent, moderately spaced joints.	15.7				
216	16		**END OF HOLE AT 15.70 m**					
215	17	55						
214	18	60						
213	19							
212	20	65						
211	21	70						

Notes:
1. Installed a Casagrande standpipe with a screen from 15.70 to 15.40 m, and a vibrating wire piezometer with serial number SN#1700049 at 5.49 m below grade.
2. Backfilled the test hole with sand from 15.70 to 14.63 m, bentonite from 14.63 to 10.67 m and grout from 10.67 m to grade.
3. Installed a flush mount cover.



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

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

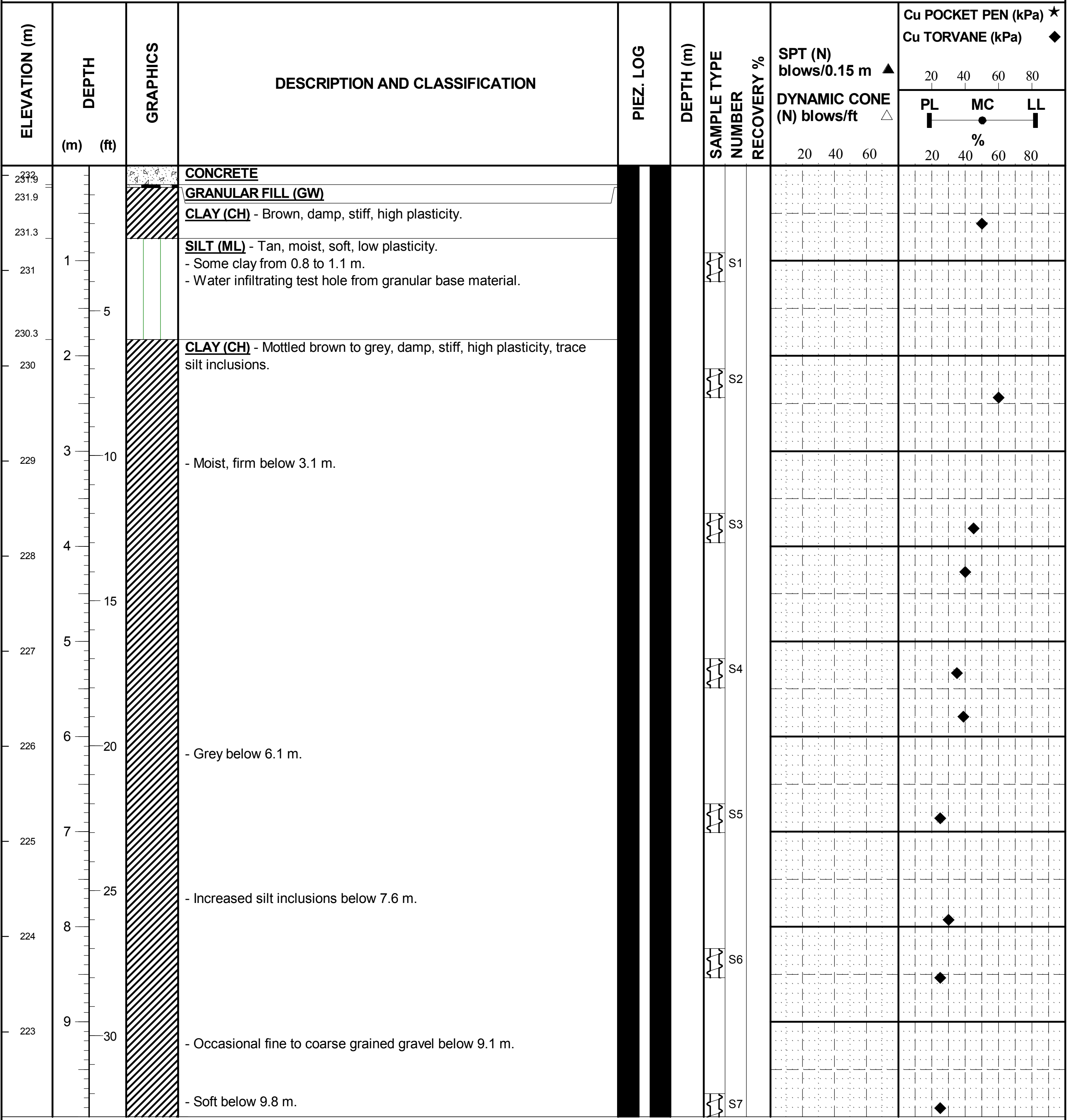
SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH17-13**

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.10
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	East of Stafford St.	DATE DRILLED	4/25/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, B40X Truck Mounted Drill Rig	UTM (m)	N 5,524,501 E 632,754



CONCRETE

GRANULAR FILL (GW)

CLAY (CH) - Brown, damp, stiff, high plasticity.

SILT (ML) - Tan, moist, soft, low plasticity.
- Some clay from 0.8 to 1.1 m.
- Water infiltrating test hole from granular base material.

CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity, trace silt inclusions.

- Moist, firm below 3.1 m.

- Grey below 6.1 m.

- Increased silt inclusions below 7.6 m.

- Occasional fine to coarse grained gravel below 9.1 m.

- Soft below 9.8 m.

SAMPLE TYPE ⦚ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

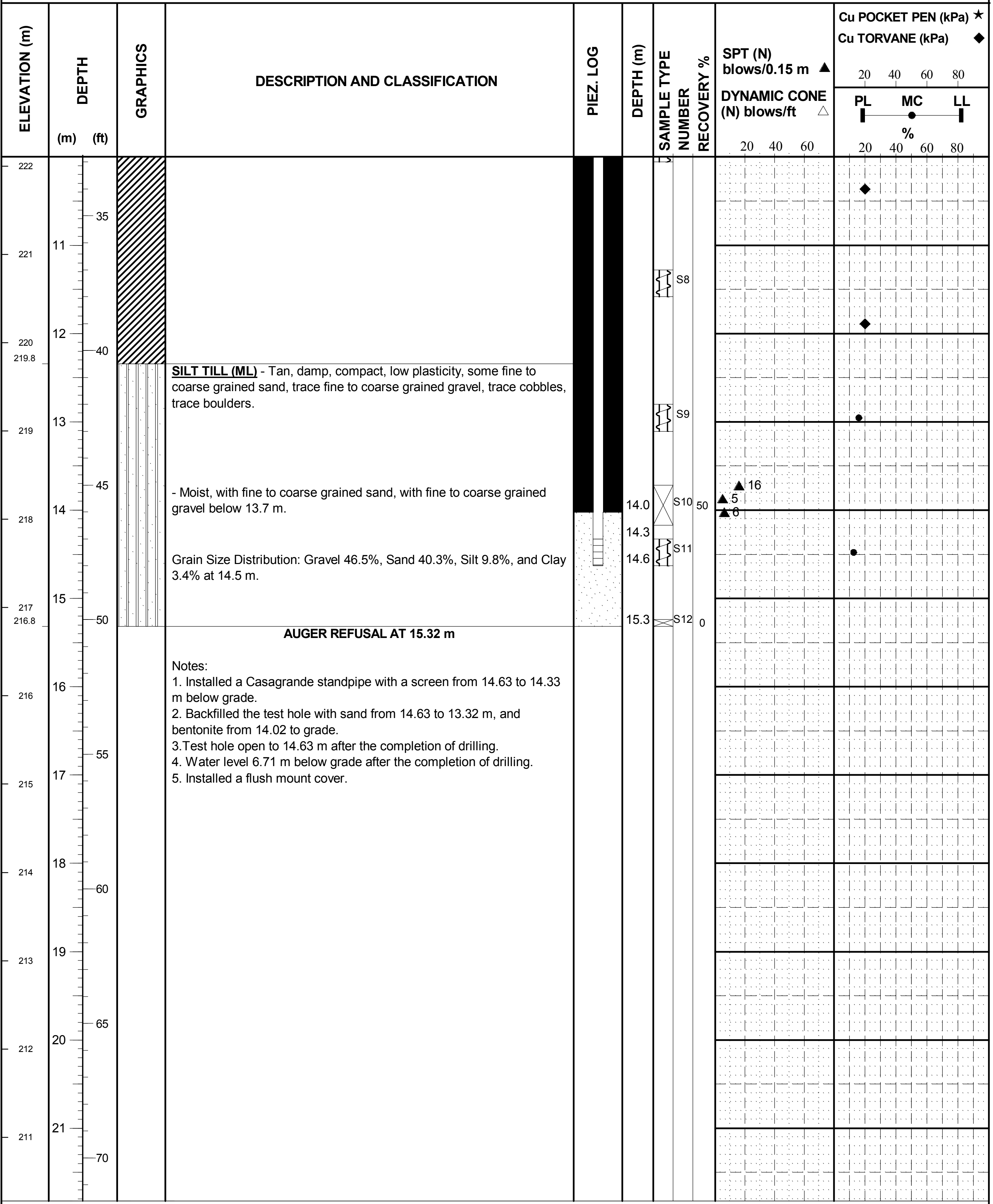
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-13

SHEET 2 of 2



SILT TILL (ML) - Tan, damp, compact, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Moist, with fine to coarse grained sand, with fine to coarse grained gravel below 13.7 m.

Grain Size Distribution: Gravel 46.5%, Sand 40.3%, Silt 9.8%, and Clay 3.4% at 14.5 m.

AUGER REFUSAL AT 15.32 m

Notes:
1. Installed a Casagrande standpipe with a screen from 14.63 to 14.33 m below grade.
2. Backfilled the test hole with sand from 14.63 to 13.32 m, and bentonite from 14.02 to grade.
3.Test hole open to 14.63 m after the completion of drilling.
4. Water level 6.71 m below grade after the completion of drilling.
5. Installed a flush mount cover.

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-14

SHEET 1 of 2

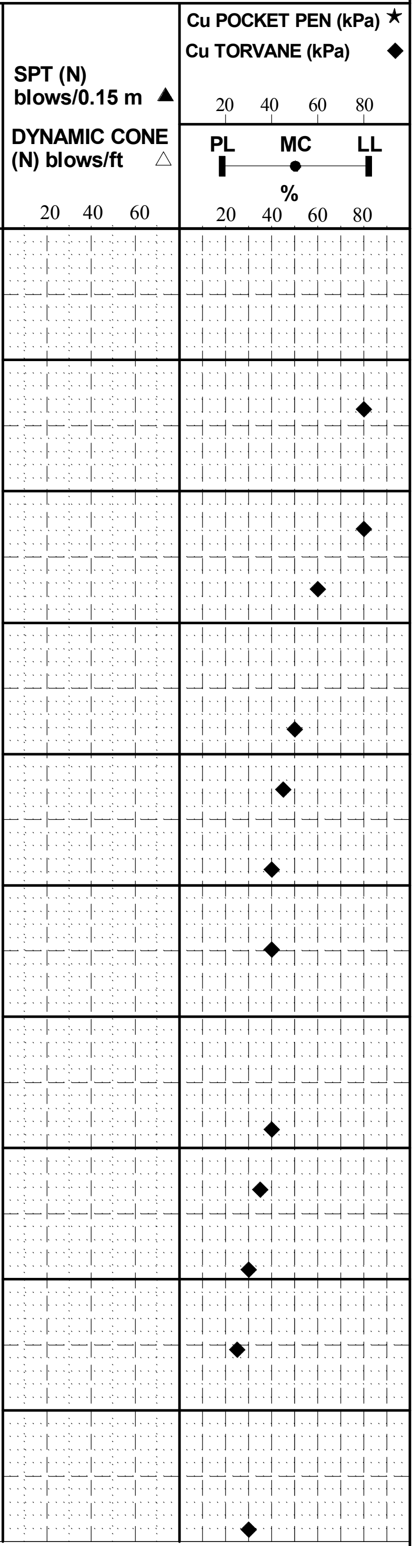
CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.09
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	Approximately 85 m East of Stafford St.	DATE DRILLED	4/25/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, B40X Truck Mounted Drill Rig	UTM (m)	N 5,524,528 E 632,806

ELEVATION (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
232	**CONCRETE**		
231.9	**GRANULAR BASE (GW)**		
231.8	**CLAY (CH)** - Black, damp, stiff, high plasticity, some organics, trace fine to coarse grained sand.		
231.3	**SILT (ML)** - Tan, moist, soft, low plasticity.	Auger Grab	S1
231 230.9	**CLAY (CH)** - Brown. damp, stiff, high plasticity.		
	- Trace silt inclusions below 1.5 m.		
230	- Mottled brown to grey below 2.3 m.	Auger Grab	S2
229			
228	- Firm below 3.7 m.	Auger Grab	S3
227		Auger Grab	S4
226			
225	- Grey, moist below 6.7 m.	Auger Grab	S5
224	- Soft to firm below 7.6 m.		
		Auger Grab	S6
223		Auger Grab	S7

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9 — (ft): 5, 10, 15, 20, 25, 30

GRAPHICS

RECOVERY %



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

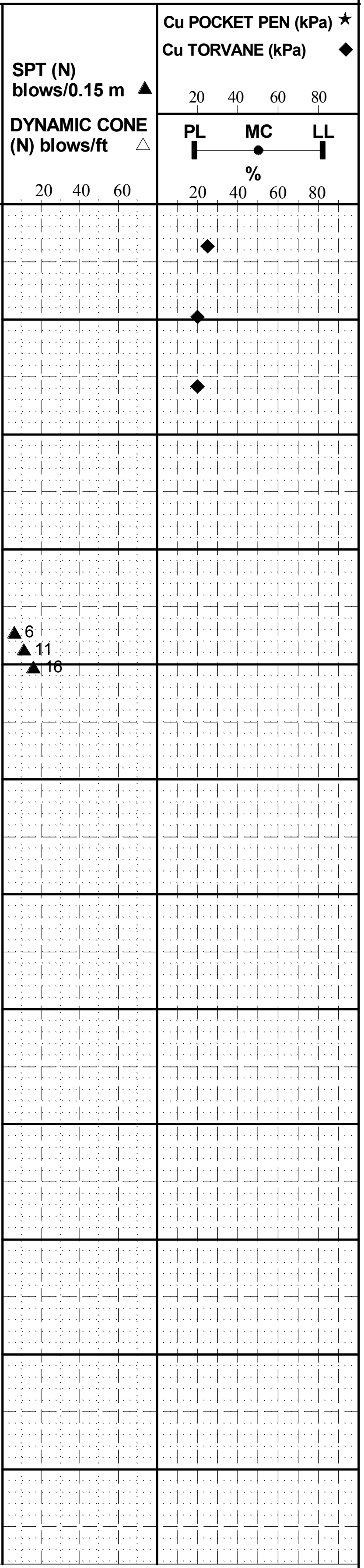
REFERENCE NO.

HOLE NO.
TH17-14

SHEET 2 of 2

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
222		- Soft, trace fine to coarse grained sand below 10.4 m. - Trace silt till inclusions below 10.7 m.			
			Auger Grab	S8	
219.6		**SILT TILL (ML)** - Tan, moist, loose, no to low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders. - Compact below 13.1 m.	Auger Grab	S9	
			Split Spoon	S10	100
			Auger Grab	S11	
		- No plasticity below 14.6 m.	Split Spoon	S12	
217.2		**AUGER REFUSAL AT 14.94 m**			

Notes:
1. Test hole open to 14.33 m after the completion of drilling.
2. Water level 6.10 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.



SAMPLE TYPE Auger Grab Split Spoon

CONTRACTOR
Maple Leaf Enterprises

INSPECTOR
J. MACLENNAN

APPROVED
DAA

DATE
10/20/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

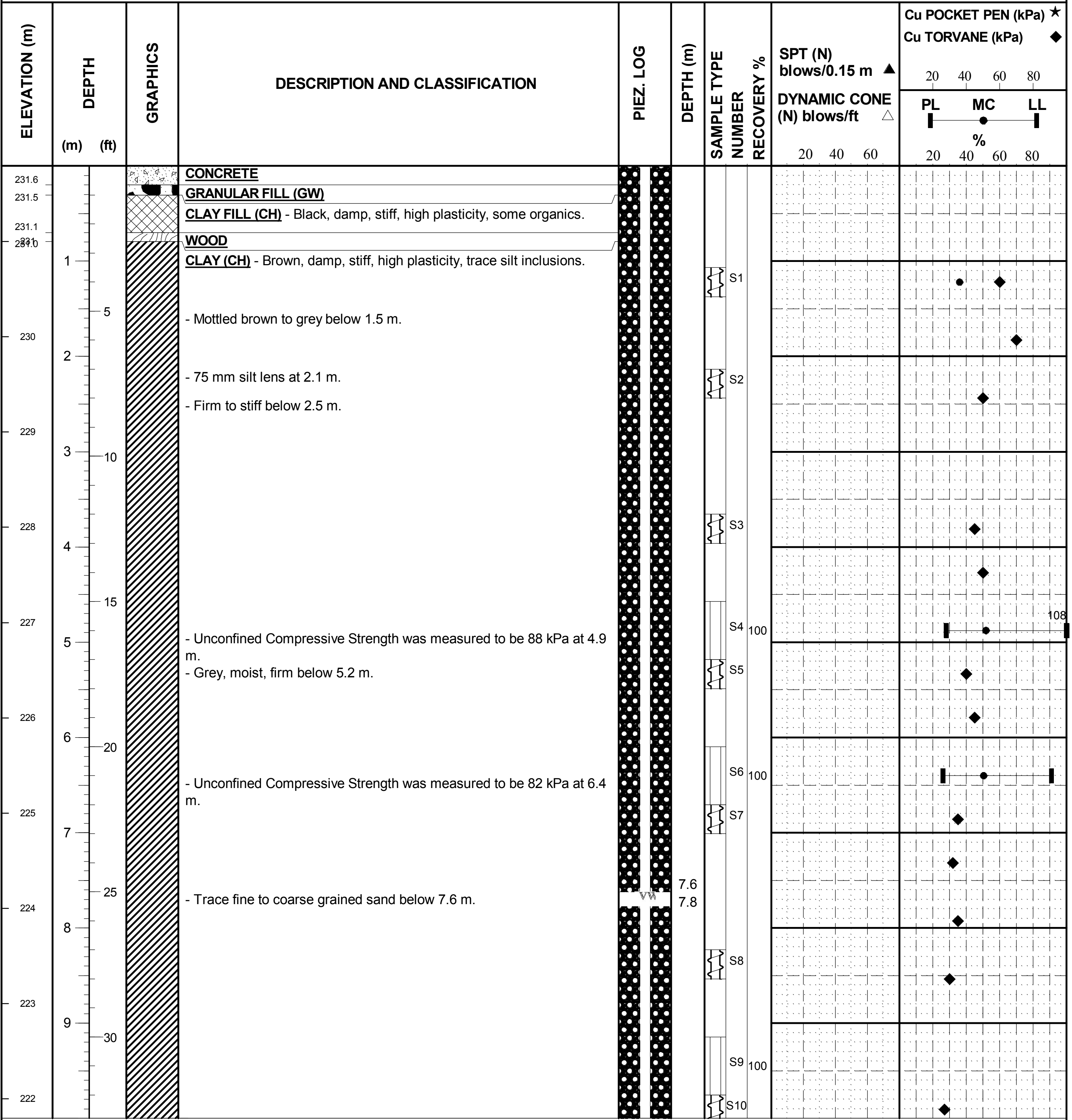
REFERENCE NO.

HOLE NO. **TH17-15**

SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Wentworth St.
DRILLING METHOD 125 mm ø Solid Stem Auger, and NQ coring, B40X Truck Mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 231.79
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 4/24/2017
UTM (m) N 5,524,580
E 632,875



CONCRETE

GRANULAR FILL (GW)

CLAY FILL (CH) - Black, damp, stiff, high plasticity, some organics.

WOOD

CLAY (CH) - Brown, damp, stiff, high plasticity, trace silt inclusions.

- Mottled brown to grey below 1.5 m.

- 75 mm silt lens at 2.1 m.

- Firm to stiff below 2.5 m.

- Unconfined Compressive Strength was measured to be 88 kPa at 4.9 m.
- Grey, moist, firm below 5.2 m.

- Unconfined Compressive Strength was measured to be 82 kPa at 6.4 m.

- Trace fine to coarse grained sand below 7.6 m.

NUMBER	RECOVERY %
S1	
S2	
S3	
S4	100
S5	
S6	100
S7	
S8	
S9	100
S10	

SAMPLE TYPE Auger Grab Shelby Tube Split Spoon Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

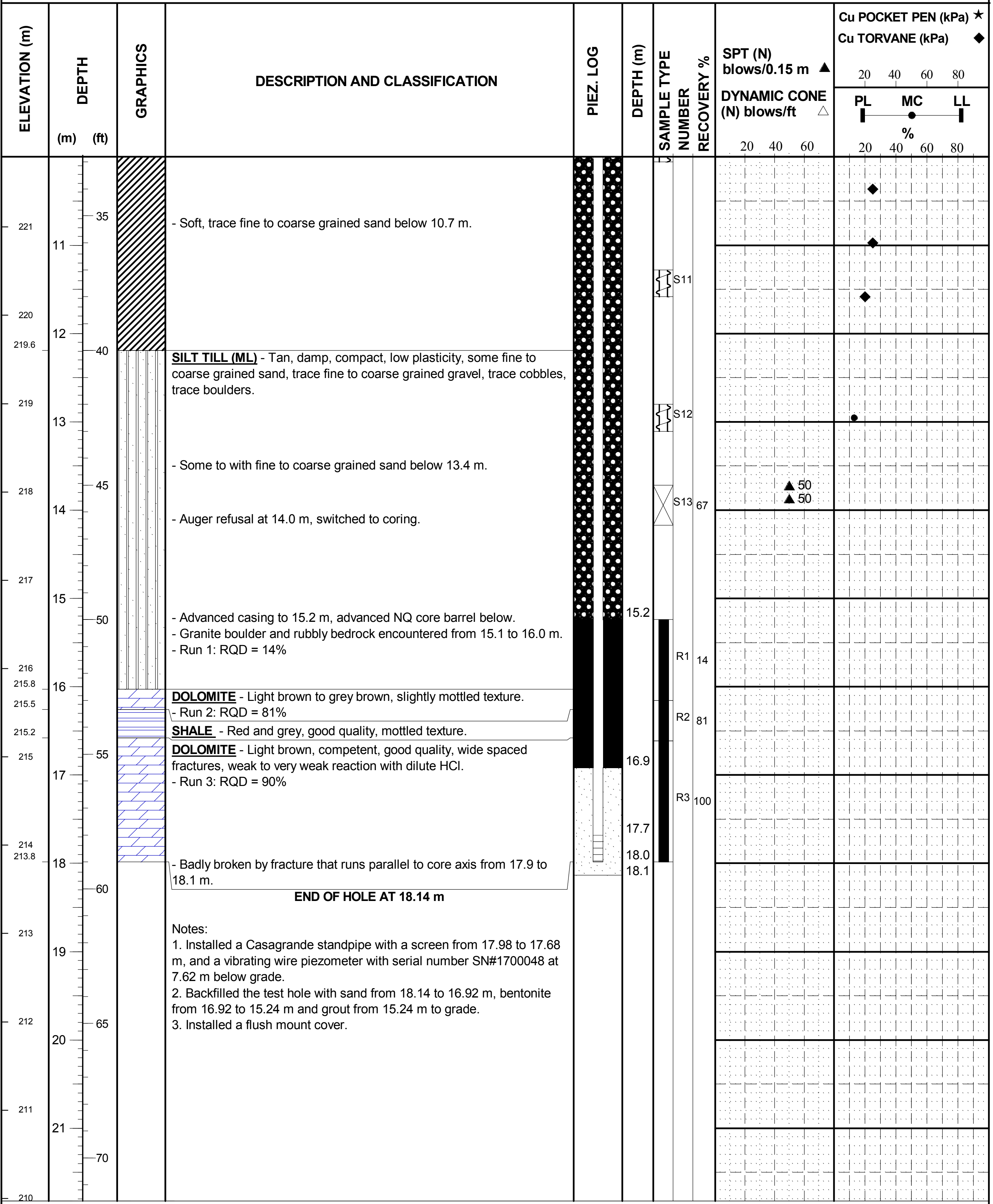
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-15

SHEET 2 of 2



- Soft, trace fine to coarse grained sand below 10.7 m.

SILT TILL (ML) - Tan, damp, compact, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Some to with fine to coarse grained sand below 13.4 m.

- Auger refusal at 14.0 m, switched to coring.

- Advanced casing to 15.2 m, advanced NQ core barrel below.
- Granite boulder and rubbly bedrock encountered from 15.1 to 16.0 m.
- Run 1: RQD = 14%

DOLOMITE - Light brown to grey brown, slightly mottled texture.
- Run 2: RQD = 81%

SHALE - Red and grey, good quality, mottled texture.

DOLOMITE - Light brown, competent, good quality, wide spaced fractures, weak to very weak reaction with dilute HCl.
- Run 3: RQD = 90%

- Badly broken by fracture that runs parallel to core axis from 17.9 to 18.1 m.

END OF HOLE AT 18.14 m

Notes:
1. Installed a Casagrande standpipe with a screen from 17.98 to 17.68 m, and a vibrating wire piezometer with serial number SN#1700048 at 7.62 m below grade.
2. Backfilled the test hole with sand from 18.14 to 16.92 m, bentonite from 16.92 to 15.24 m and grout from 15.24 m to grade.
3. Installed a flush mount cover.

SAMPLE TYPE ⌇ Auger Grab ▯ Shelby Tube ☒ Split Spoon ▮ Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Maple Leaf Enterprises	J. MACLENNAN	DAA	10/20/17

KGS GROUP

SUMMARY LOG

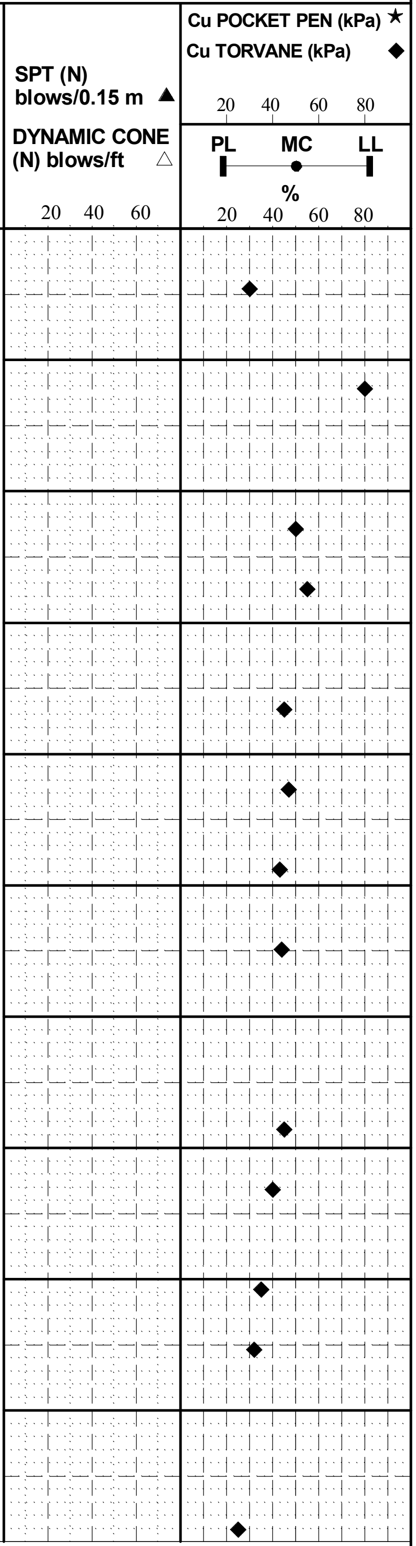
REFERENCE NO.

HOLE NO. **TH17-16**

SHEET 1 of 2

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	11-0107-18
PROJECT	Contract 5 - Cockburn and Calrossie Sewer Relief	GROUND ELEV.	232.14
		TOP OF PVC ELEV.	
SITE	Taylor Ave	WATER ELEV.	
LOCATION	Approximately 40 m West of Nathaniel St.	DATE DRILLED	10/5/2017
DRILLING METHOD	125 mm ø Solid Stem Auger, CT-250 Truck mounted Drill Rig	UTM (m)	N 5,523,977 E 631,776

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE NUMBER
232		**TOPSOIL** - Black, damp, firm, trace roots, trace fine to coarse grained sand.		
231.8		**SILT (ML)** - Tan, moist, soft, low plasticity.		S1
231.4		**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt inclusions.		S2
		- Mottled brown to grey, moist, trace silt inclusions below 1.5 m.		S3
		- Firm below 3.7 m.		S4
		- Grey below 5.2 m.		S5
				S6
		- Silt till pocket, approximately 100 mm thick at 7.6 m.		
		- Trace fine grained gravel below 7.6 m.	8.2 8.4	S7
		- Trace silt till pockets below 9.1 m.		
		- Soft below 9.8 m.		S8



SAMPLE TYPE Auger Grab ☒ Split Spoon

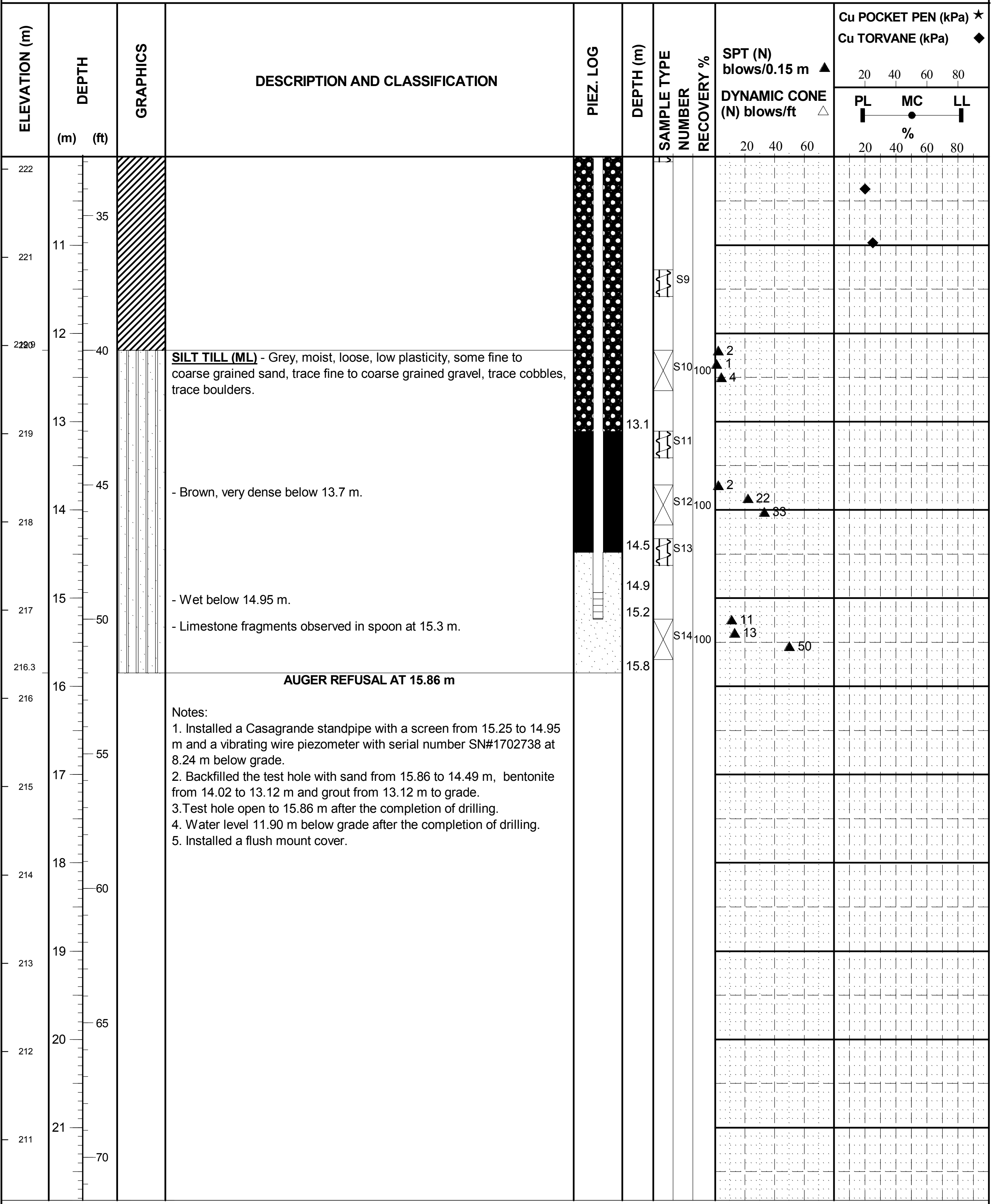
CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. MACLENNAN	DAA	11/1/17

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-16



SILT TILL (ML) - Grey, moist, loose, low plasticity, some fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Brown, very dense below 13.7 m.

- Wet below 14.95 m.

- Limestone fragments observed in spoon at 15.3 m.

AUGER REFUSAL AT 15.86 m

Notes:
1. Installed a Casagrande standpipe with a screen from 15.25 to 14.95 m and a vibrating wire piezometer with serial number SN#1702738 at 8.24 m below grade.
2. Backfilled the test hole with sand from 15.86 to 14.49 m, bentonite from 14.02 to 13.12 m and grout from 13.12 m to grade.
3.Test hole open to 15.86 m after the completion of drilling.
4. Water level 11.90 m below grade after the completion of drilling.
5. Installed a flush mount cover.

SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. MACLENNAN	DAA	11/1/17

GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-17

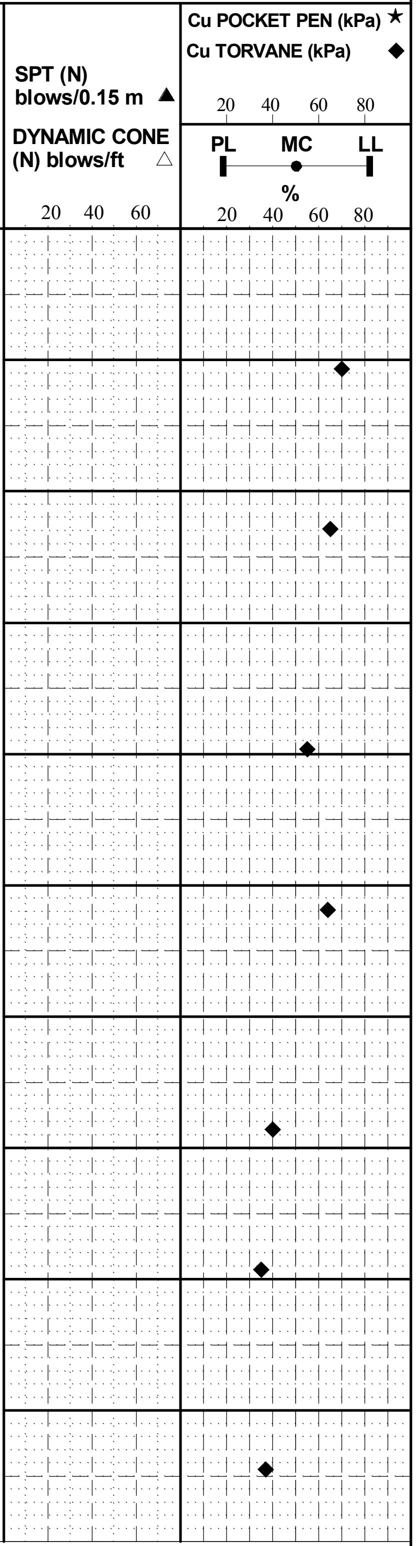
SHEET 1 of 2

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT Contract 5 - Cockburn and Calrossie Sewer Relief
SITE Taylor Ave
LOCATION Approximately 90 m East of Nathaniel St.
DRILLING METHOD 125 mm ø Solid Stem Auger, CT-250 Truck mounted Drill Rig

JOB NO. 11-0107-18
GROUND ELEV. 232.27
TOP OF PVC ELEV.
WATER ELEV.
DATE DRILLED 10/5/2017
UTM (m) N 5,524,030
E 631,900

ELEVATION (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER
232.0 232	**CONCRETE**	
231.9	**GRANULAR BASE (GW)**	
	CLAY (CH) - Brown, damp, stiff, high plasticity.	S1
231.1 231	**SILT (ML)** - Tan, moist, soft, low plasticity.	
230.8	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity. - Trace silt pockets from 1.5 to 3.1 m.	S2
	- Moist below 3.1 m.	S3
		S4
	- Grey, trace silt inclusions below 6.1 m.	
	- Firm below 6.7 m.	S5
	- Trace fine grained gravel below 7.6 m.	S6
		S7

Elevation (m): 230, 229, 228, 227, 226, 225, 224, 223
DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9
DEPTH (ft): 5, 10, 15, 20, 25, 30



SAMPLE TYPE Auger Grab ☒ Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. MACLENNAN	DAA	11/1/17

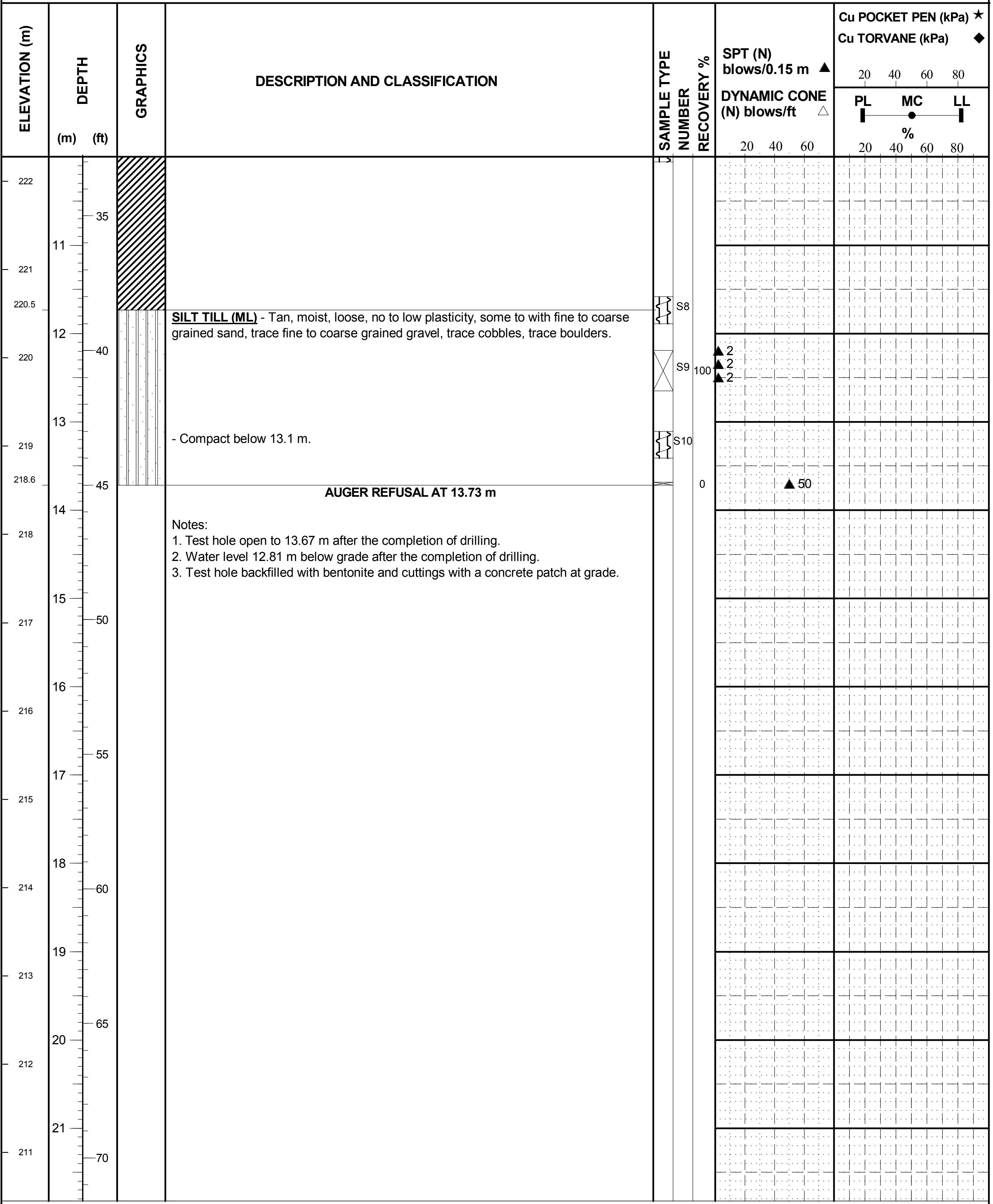
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH17-17

SHEET 2 of 2



SILT TILL (ML) - Tan, moist, loose, no to low plasticity, some to with fine to coarse grained sand, trace fine to coarse grained gravel, trace cobbles, trace boulders.

- Compact below 13.1 m.

AUGER REFUSAL AT 13.73 m

Notes:
1. Test hole open to 13.67 m after the completion of drilling.
2. Water level 12.81 m below grade after the completion of drilling.
3. Test hole backfilled with bentonite and cuttings with a concrete patch at grade.

SAMPLE TYPE ⌇ Auger Grab ☒ Split Spoon

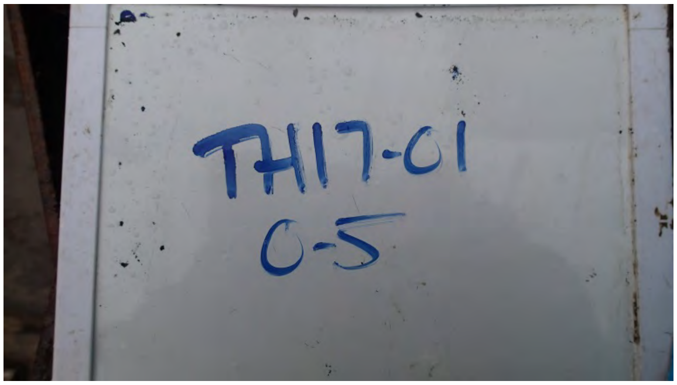
CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	J. MACLENNAN	DAA	11/1/17

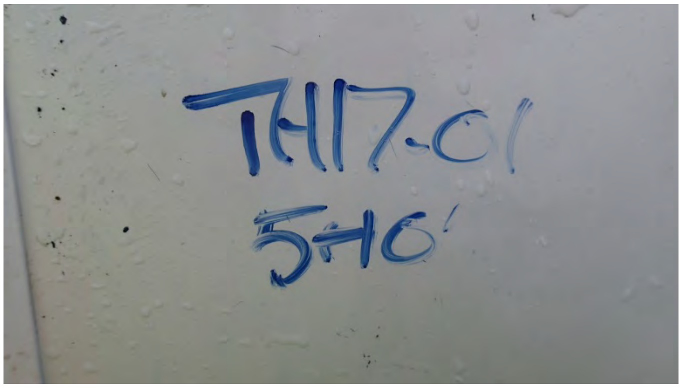
GEOTECHNICAL-SOIL LOG P:\PROJECTS\2011\11-0107-18\DESIGN\GEO\C5 - TAYLOR AVE (PEMBINA TO WEST OF WILTON)\LOGS\C5- COCKBURN.GPJ

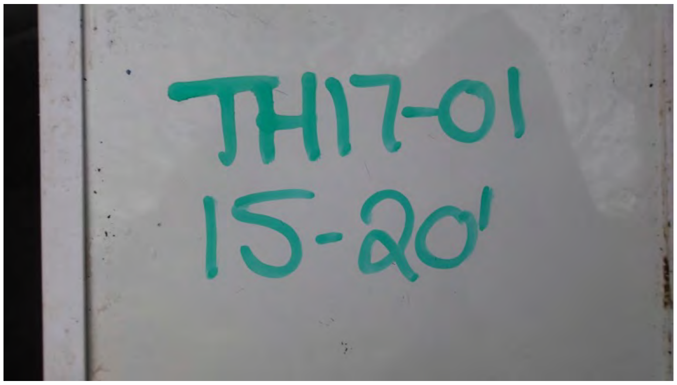
APPENDIX C

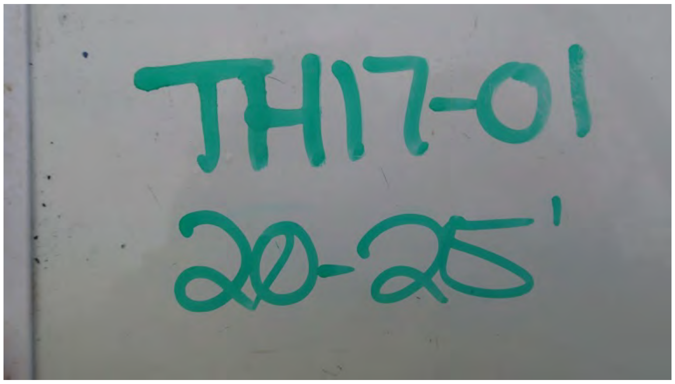
PHOTOS

TH17-01


TH17-01
0-5


TH17-01
5-10'


TH17-01
15-20'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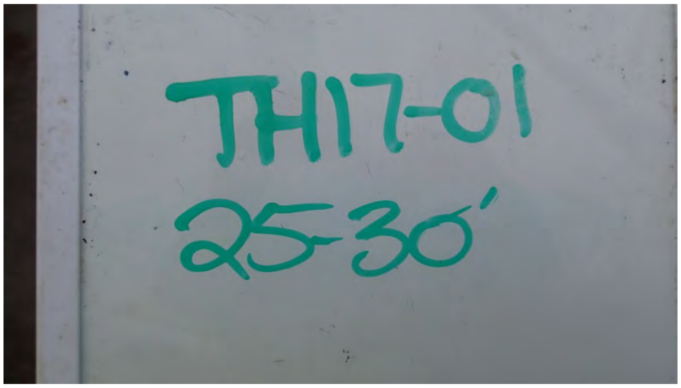
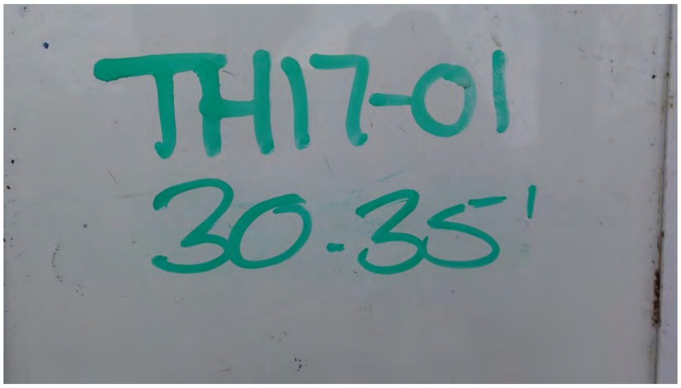
20-25'


TH17-01
25-30'

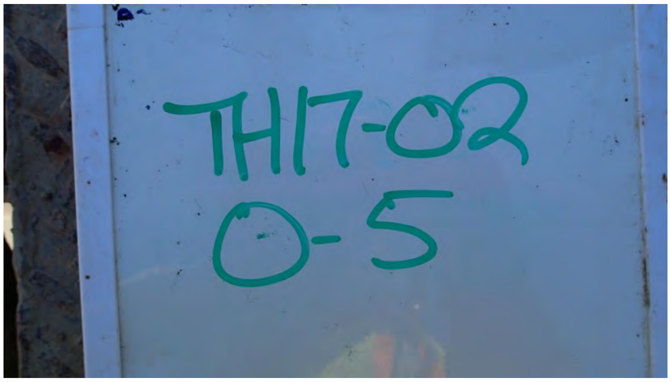

TH17-01
30-35'


TH17-01
R1

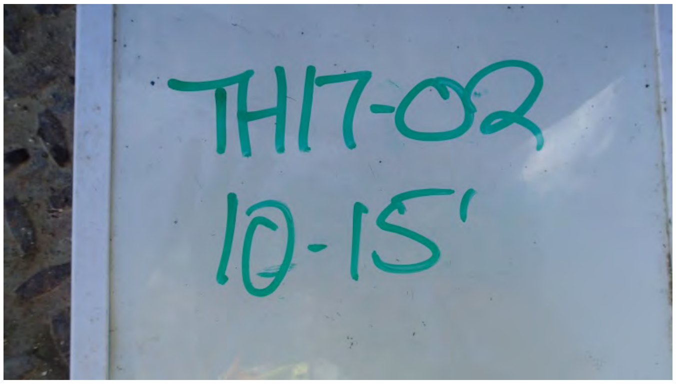

TH17-01
R2


TH17-01
R3

TH17-02


TH17-02
0-5


TH17-02
5-10'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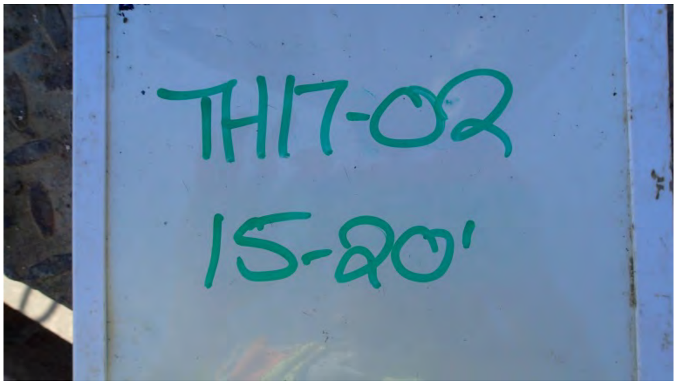
10-15'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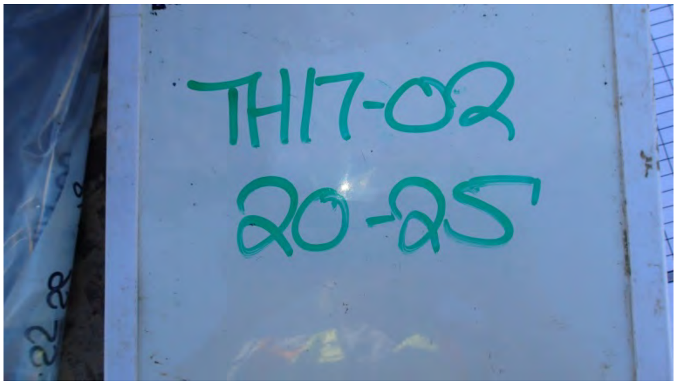
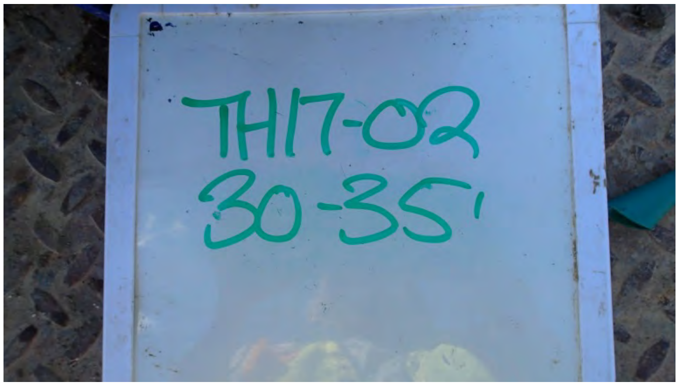
15-20'


TH17-02
20-25'


TH17-02
25-30'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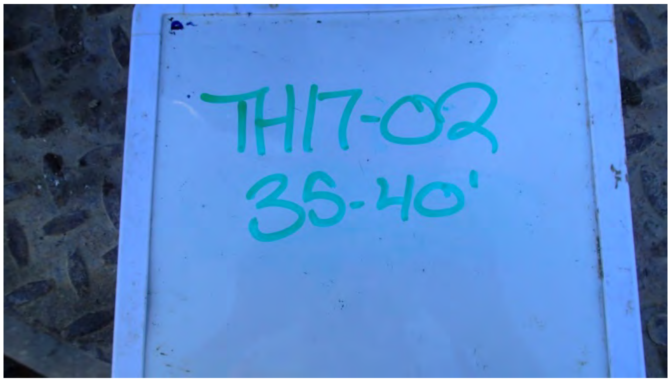
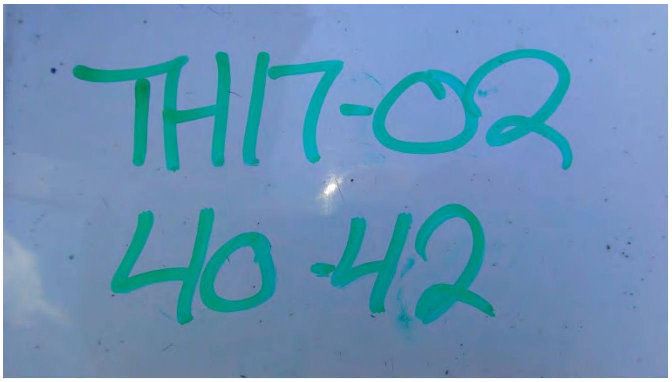
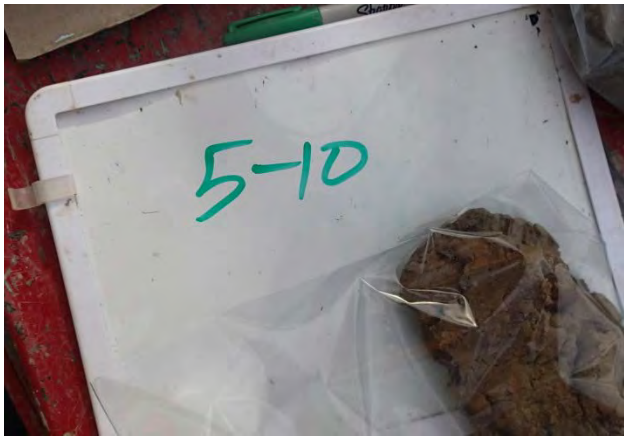

TH17-02
35-40'


TH17-02


TH17-02
40-42

TH17-03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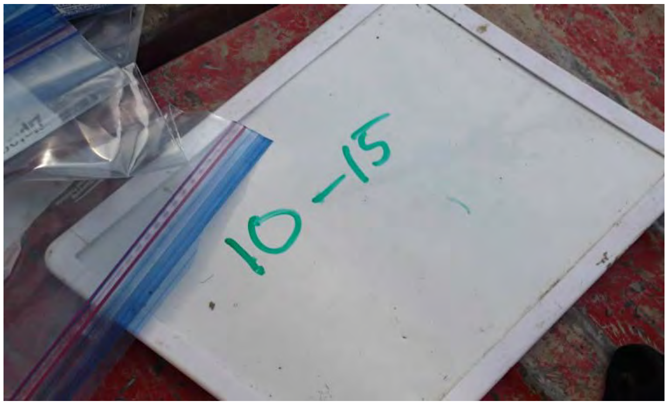
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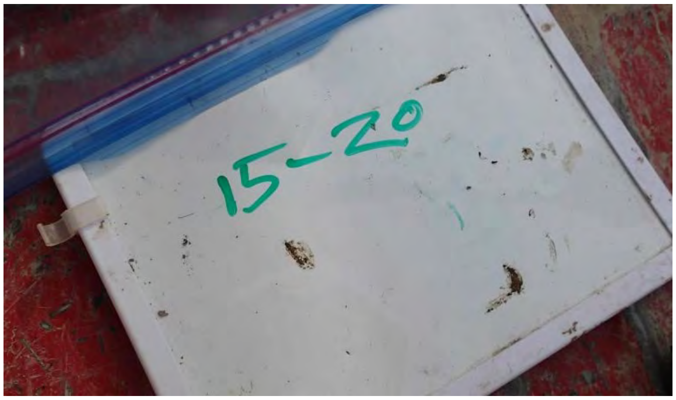
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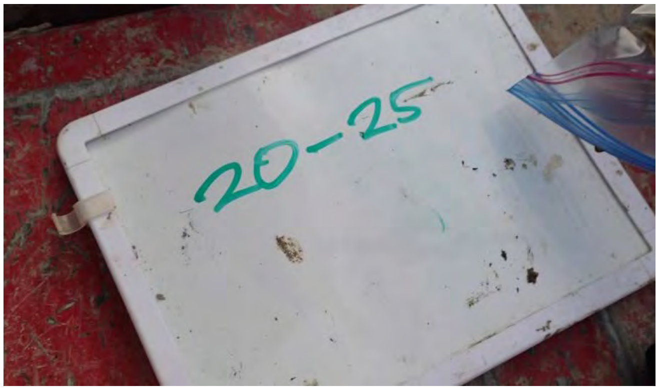
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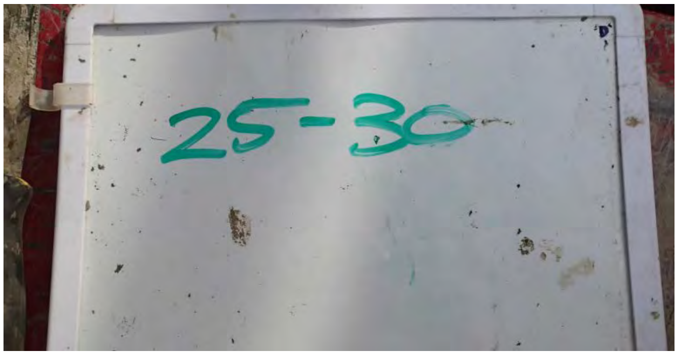
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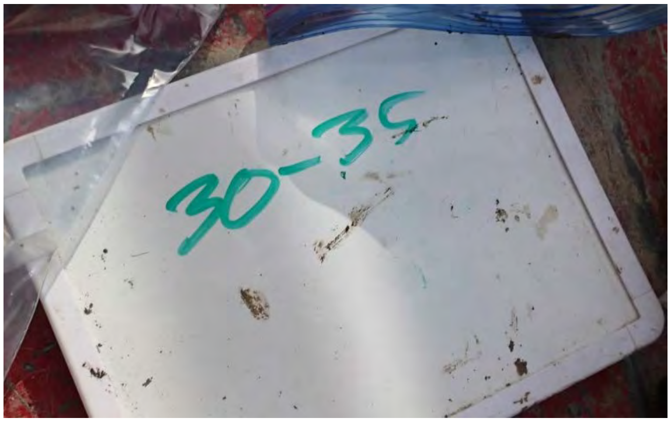
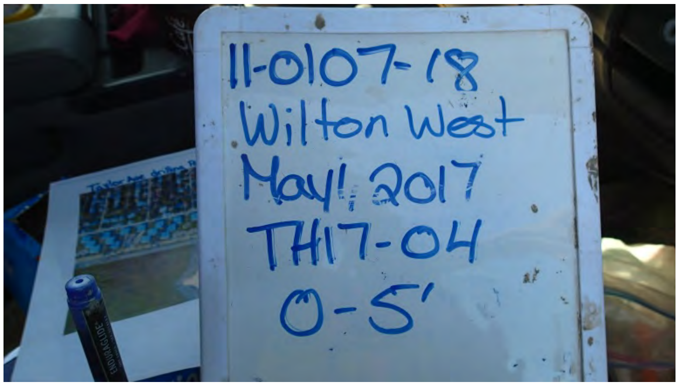

30-35

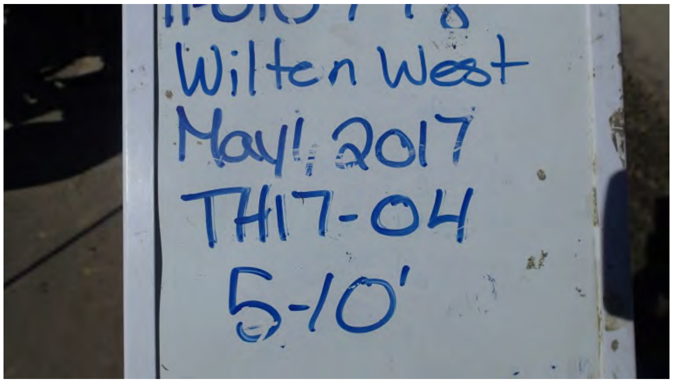
35-40

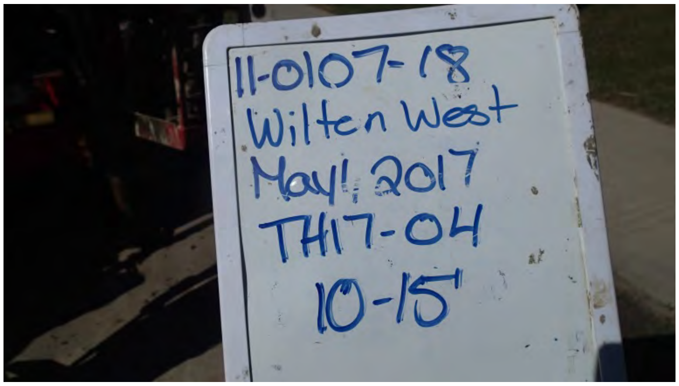

40-42

TH17-04



11-0107-18
Wilton West
May 1, 2017
TH17-04
0-5'


Wilten West
May 1, 2017
TH17-04
5-10'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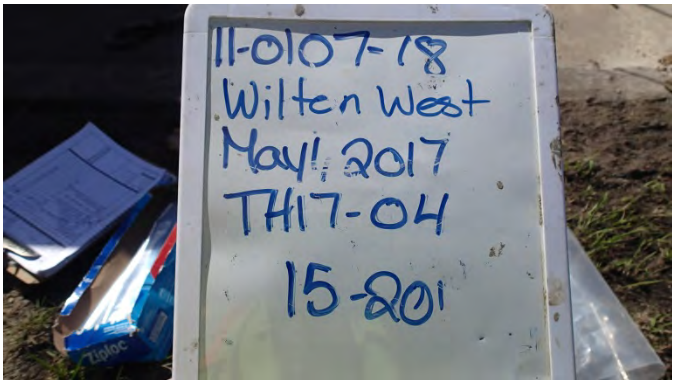
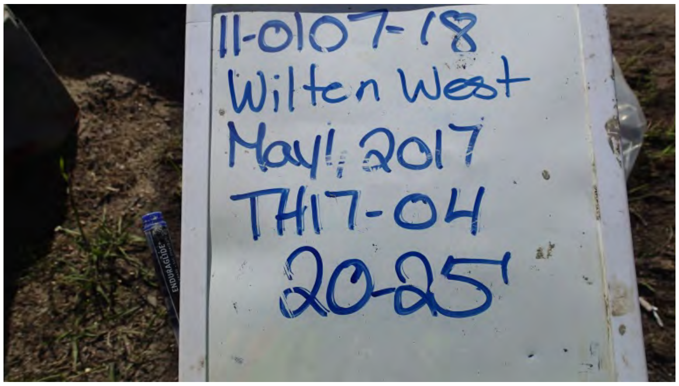
Wilten West
May 1, 2017
TH17-04
10-15'


11-0107-18
Wilten West
May 1, 2017
TH17-04
15-20'
Ziploc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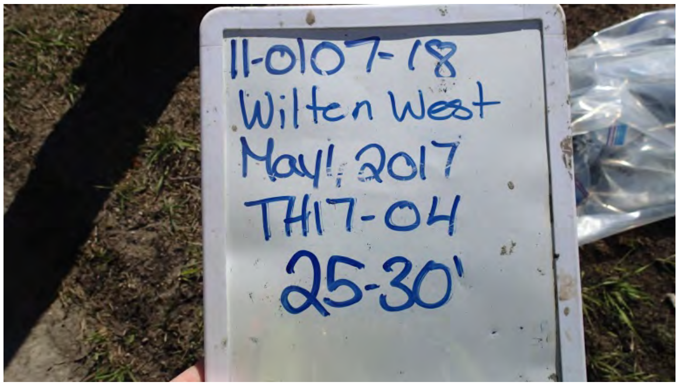
Wilten West
May 1, 2017
TH17-04
20-25'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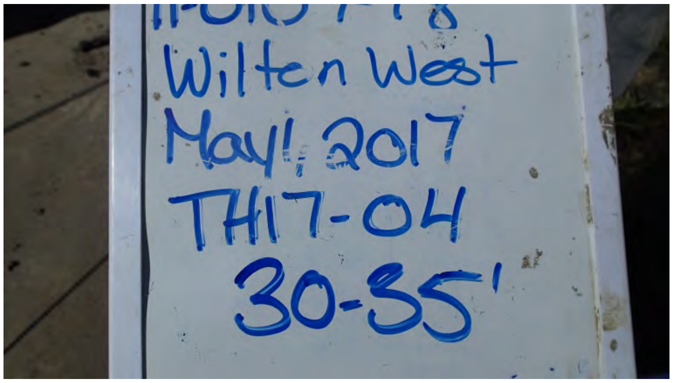
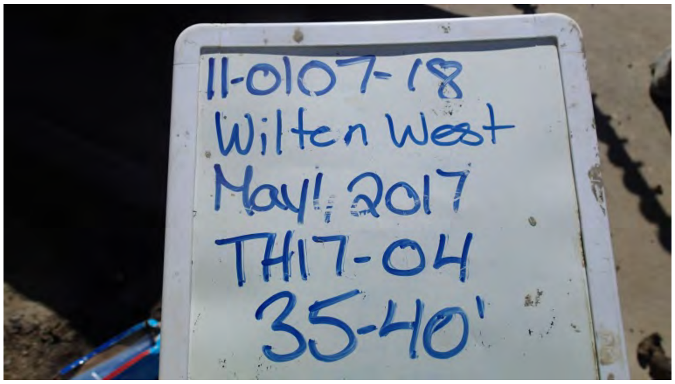
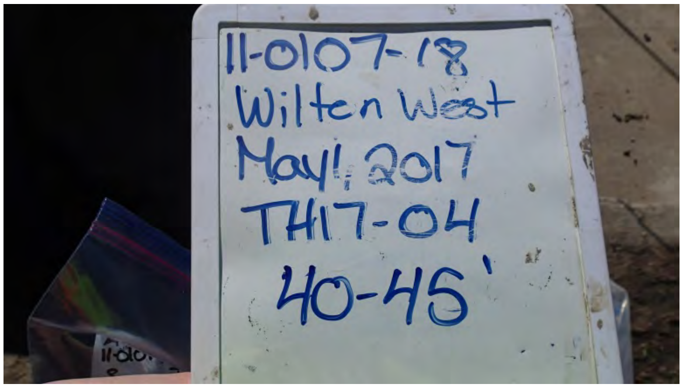
Wilten West
May1, 2017
TH17-04
25-30'

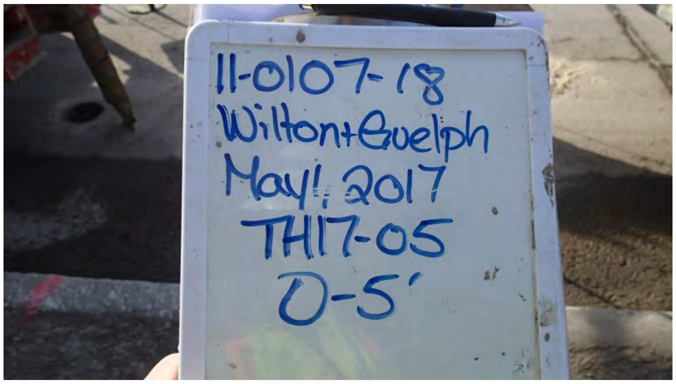

Wilten West
May 1, 2017
TH17-04
30-35'


11-0107-18
Wilten West
May 1, 2017
TH17-04
35-40'


11-0107-18
Wilten West
May 1, 2017
TH17-04
40-45'


11-0107-18
Wilten West
May 1, 2017
TH17-04
45'

TH17-05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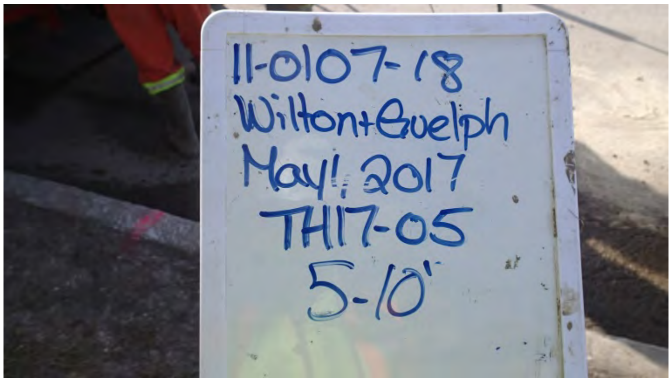
Wilton+Guelph
May 1, 2017
TH17-05
0-5'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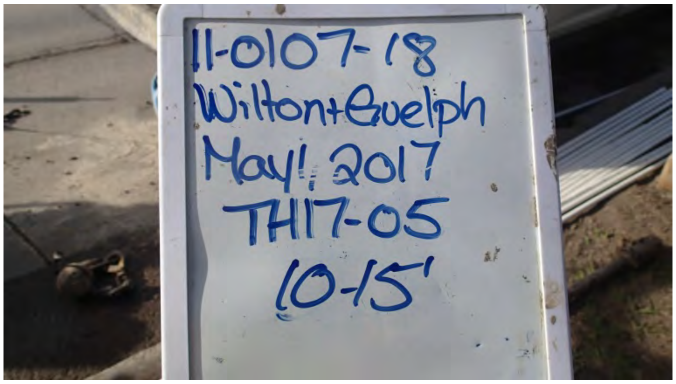
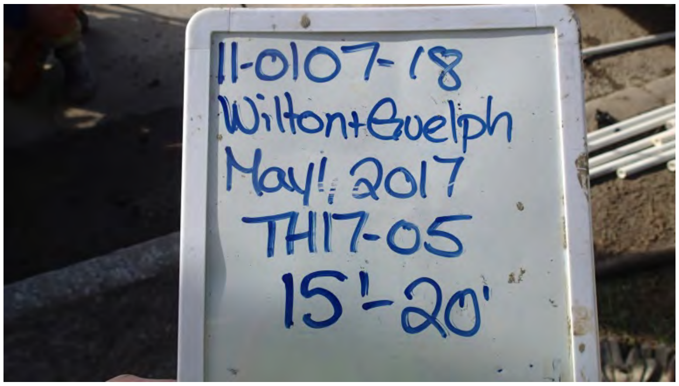
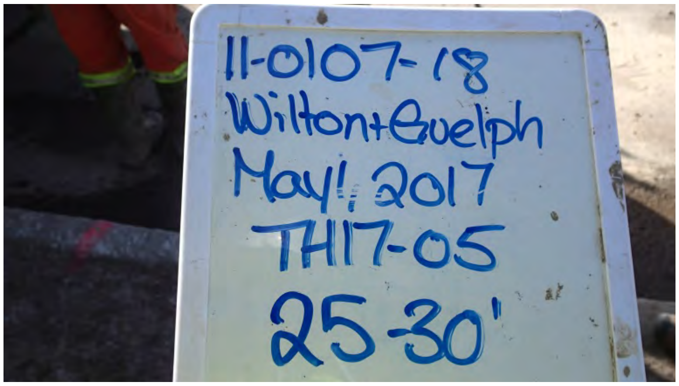
Wilton+Guelph
May 1, 2017
TH17-05
5-10'


11-0107-18
Wilton+Guelph
May 1, 2017
TH17-05
10-15'


11-0107-18
Wilton+Guelph
May 1, 2017
TH17-05
15'-20'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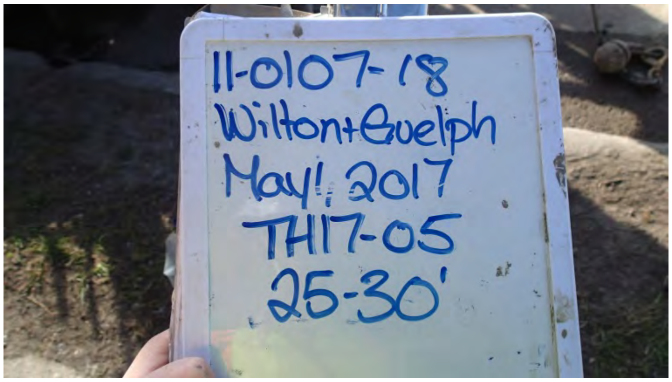
Wilton+Guelph
May 1, 2017
TH17-05
25-30'



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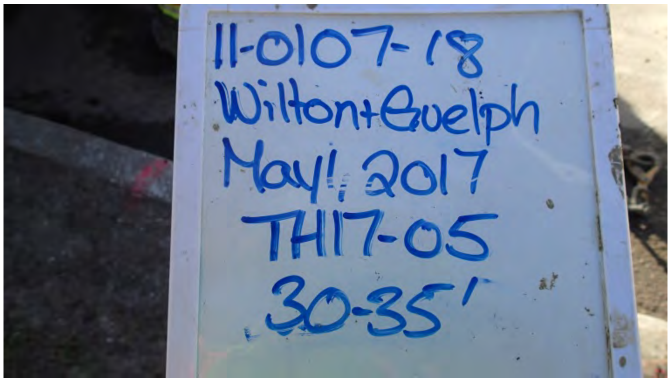
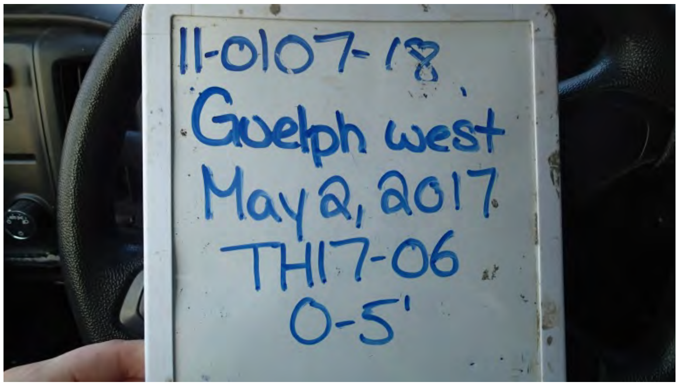
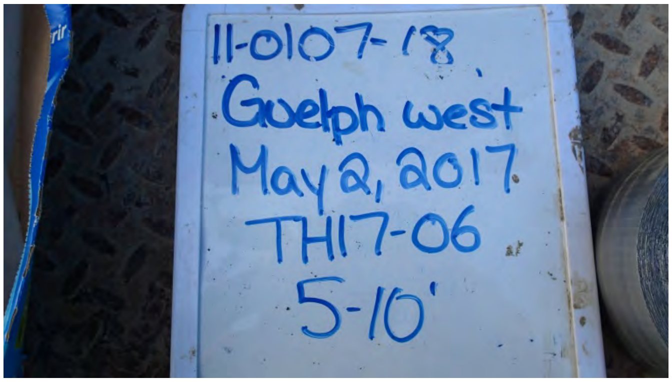
Wilton+Guelph
May 1, 2017
TH17-05
25-30'


11-0107-18
Wilton+Guelph
May 1, 2017
TH17-05
30-35'


11-0107-18
Wilton+Guelph
May 1, 2017
TH17-05
40

TH17-06


11-0107-18
Guelph west
May 2, 2017
TH17-06
0-5'



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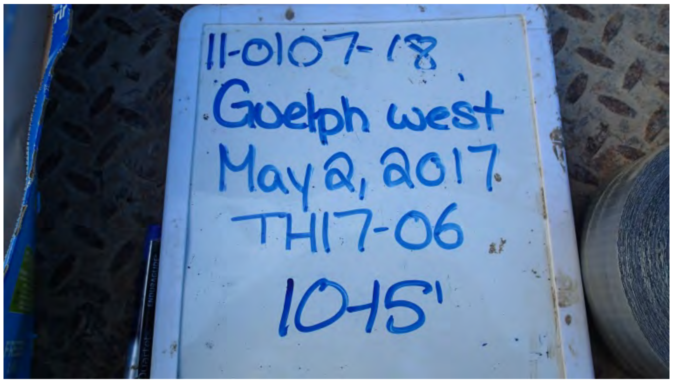
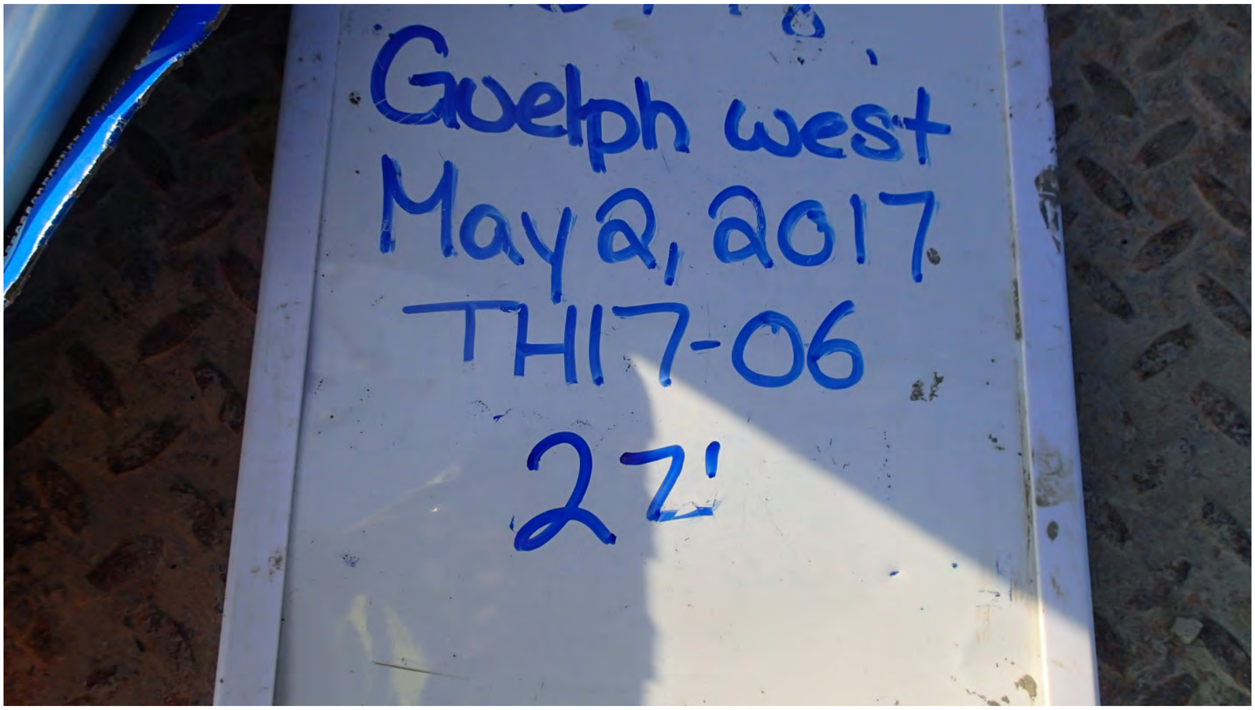
Guelph west
May 2, 2017
TH17-06
5-10'


11-0107-18
Guelph west
May 2, 2017
TH17-06
10-15'


11-0107-18
Guelph west
May 2, 2017
TH17-06
15-20'


11-0107-18
Guelph west
May 2, 2017
TH17-06
20'


11-0107-18
Guelph west
May 2, 2017
TH17-06
20-25'


Guelph west
May 2, 2017
TH17-06
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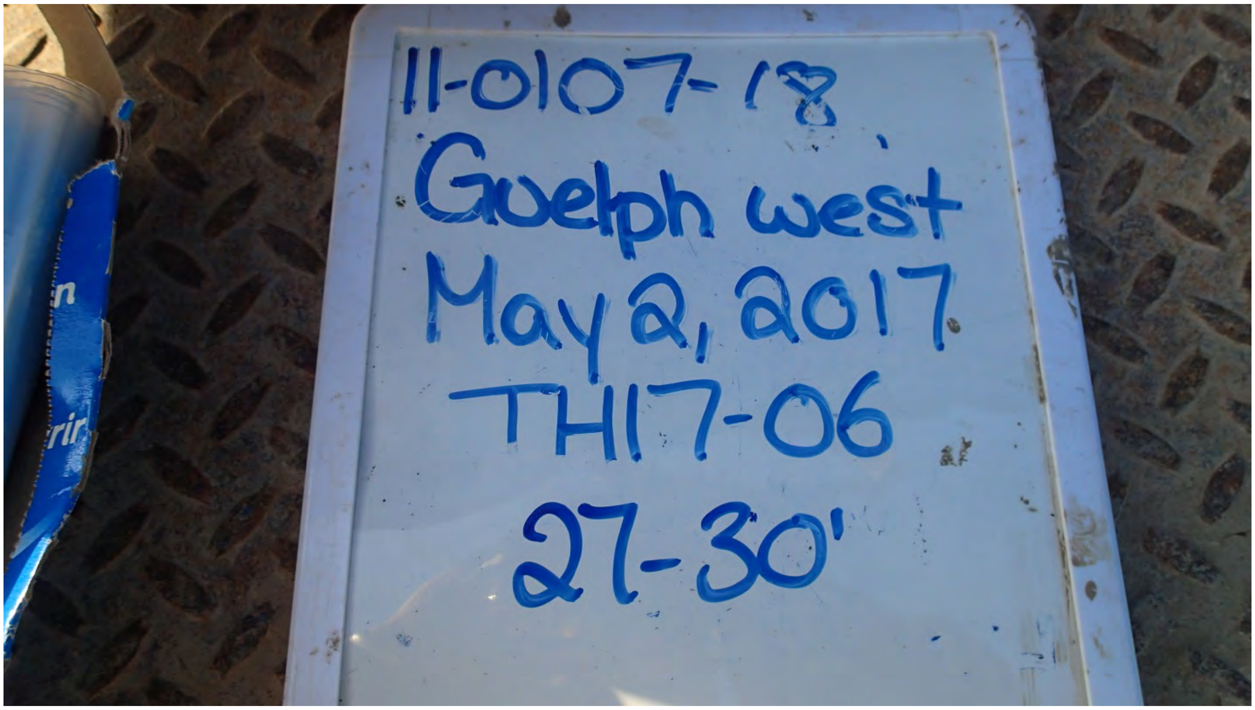
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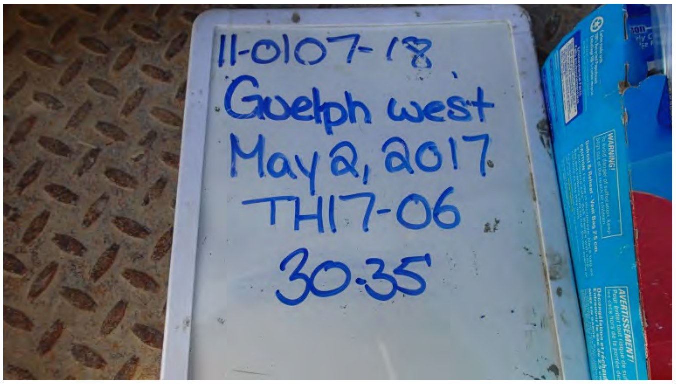
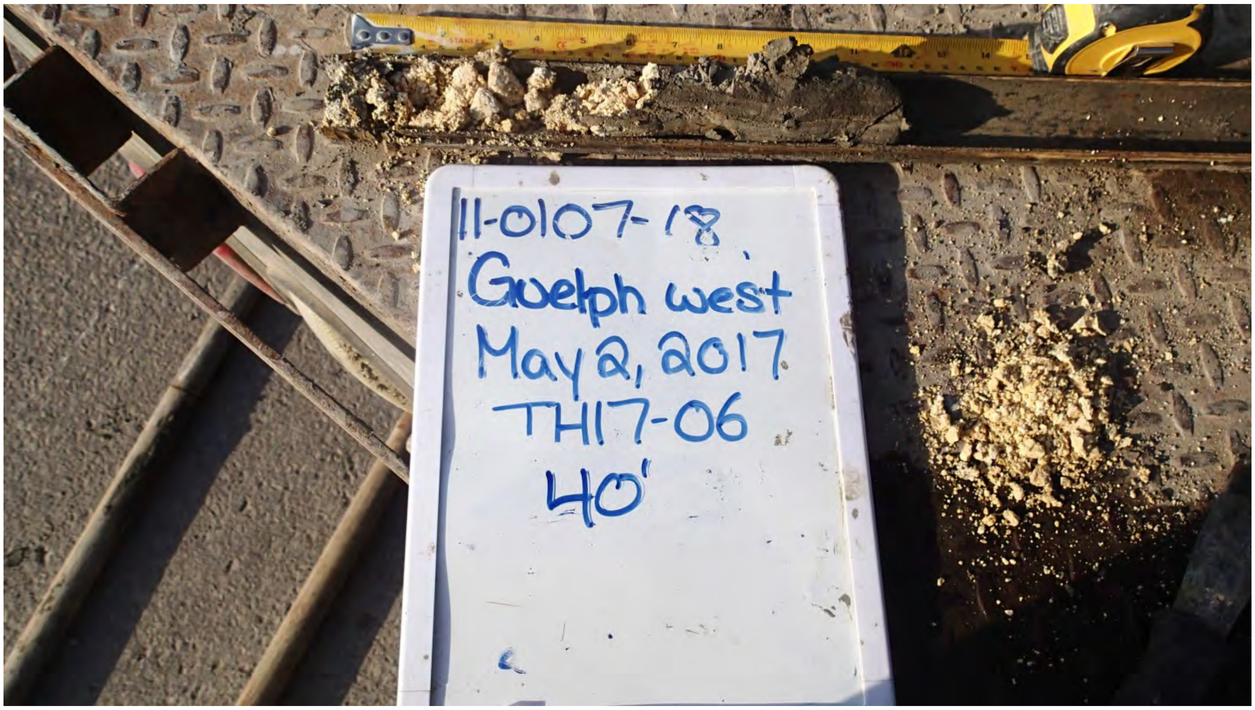
Guelph west
May 2, 2017
TH17-06
27-30'


11-0107-18
Guelph west
May 2, 2017
TH17-06
30-35'

11-0107-18
Guelph west
May 2, 2017
TH17-06
35-40'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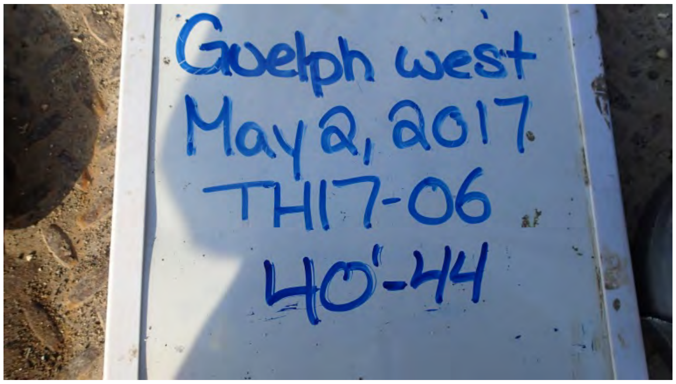
Guelph west
May 2, 2017
TH17-06
40'

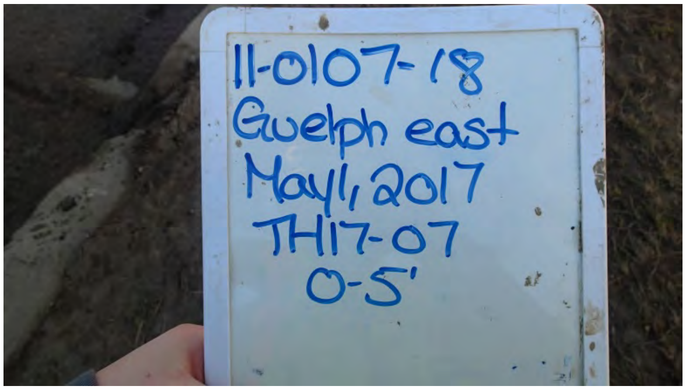

Guelph west
May 2, 2017
TH17-06
40'-44


11-0107-18
Guelph west
May 2, 2017
TH17-06
R1

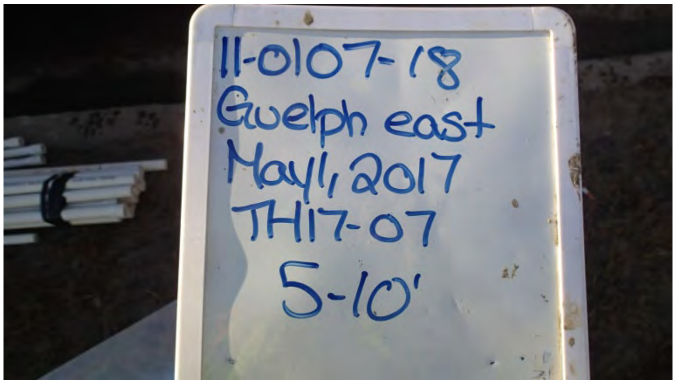

11-0107-18
Guelph west
May 2, 2017
TH17-06
R2


11-0107-18
Guelph west
May 2. 2017
TH17-06
R3

TH17-07



11-0107-18
Guelph east
May1, 2017
TH17-07
0-5'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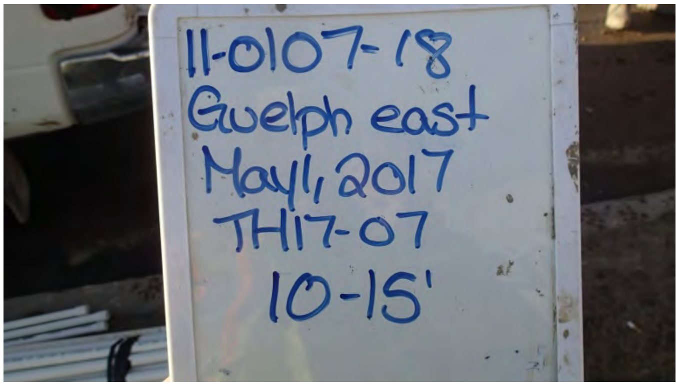
Guelph east
May1, 2017
TH17-07
5-10'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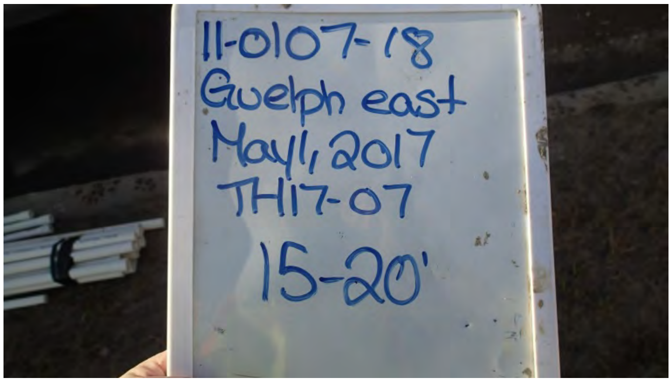
Guelph east
May1, 2017
TH17-07
10-15'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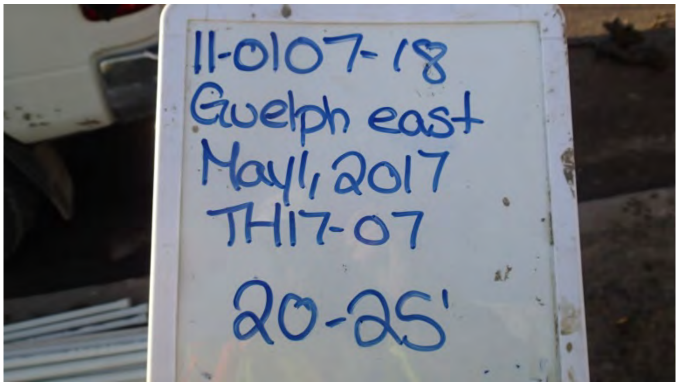
Guelph east
May 1, 2017
TH17-07
15-20'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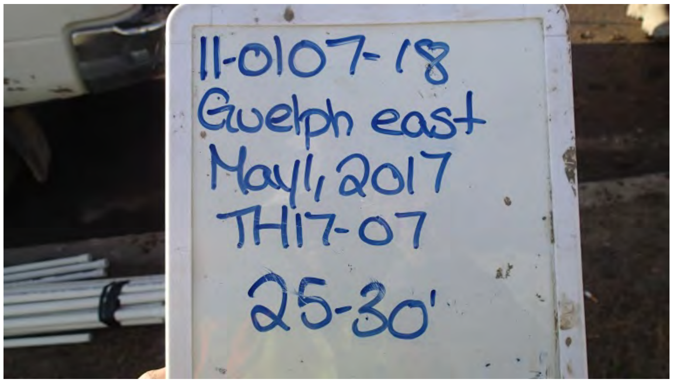
Guelph east
May1, 2017
TH17-07
20-25'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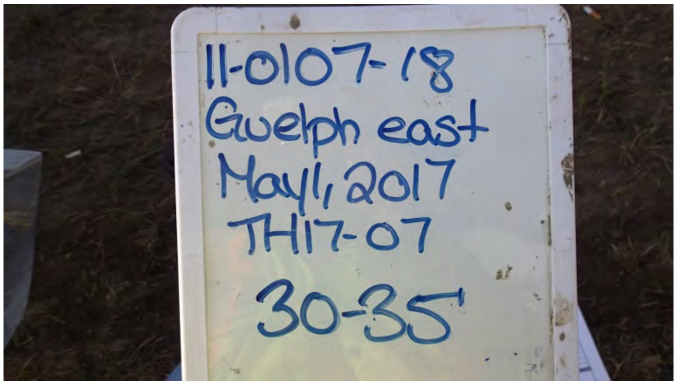
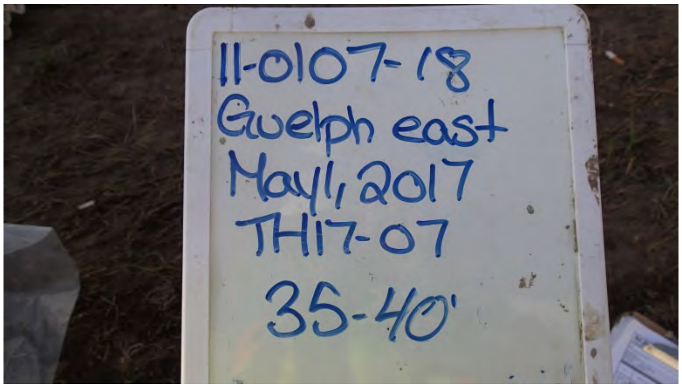
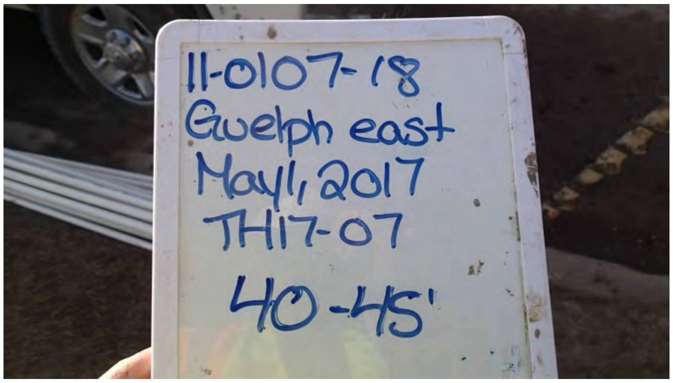
Guelph east
May1, 2017
TH17-07
25-30'

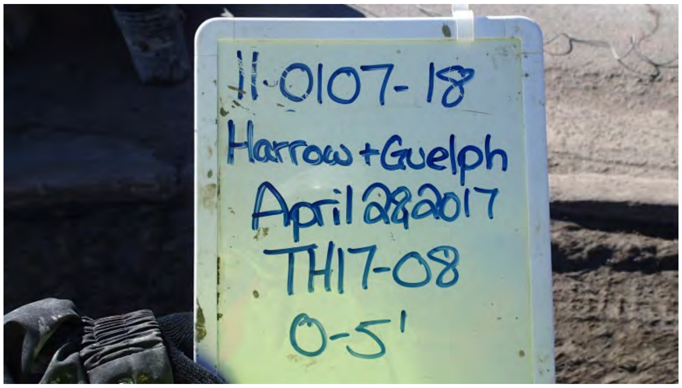

11-0107-18
Guelph east
May1, 2017
TH17-07
30-35'

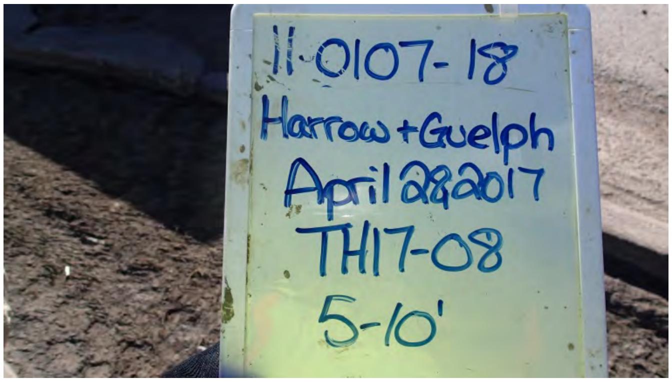

11-0107-18
Guelph east
May1, 2017
TH17-07
35-40'

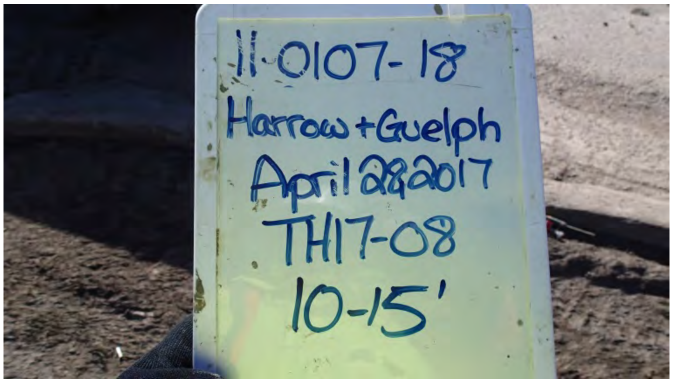


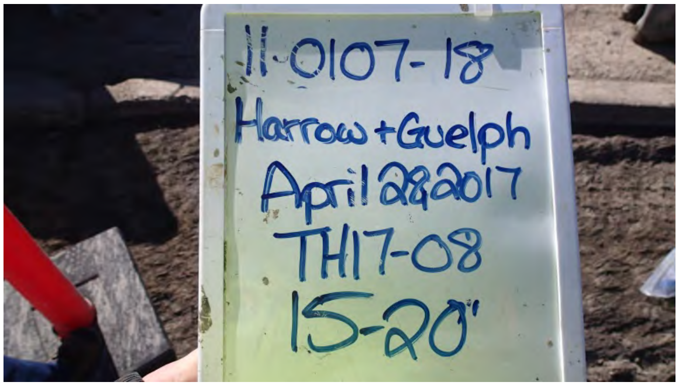
11-0107-18
Guelph east
May 1, 2017
TH17-07
40-45'

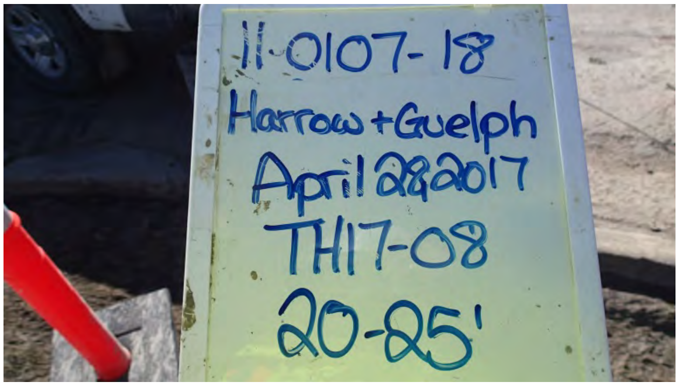
TH17-08


11-0107-18
Harrow+Guelph
April 28 2017
TH17-08
0-5'

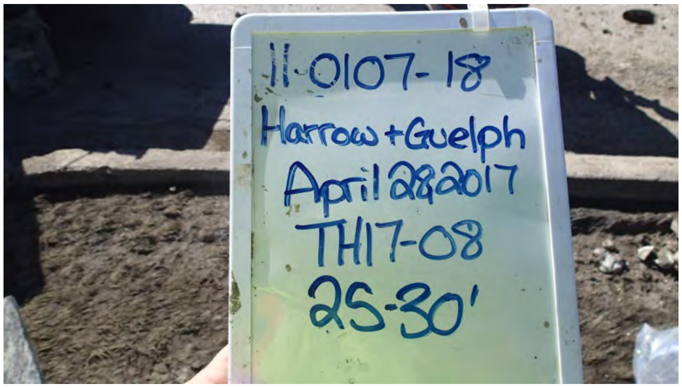

11-0107-18
Harrow+Guelph
April 28 2017
TH17-08
5-10'

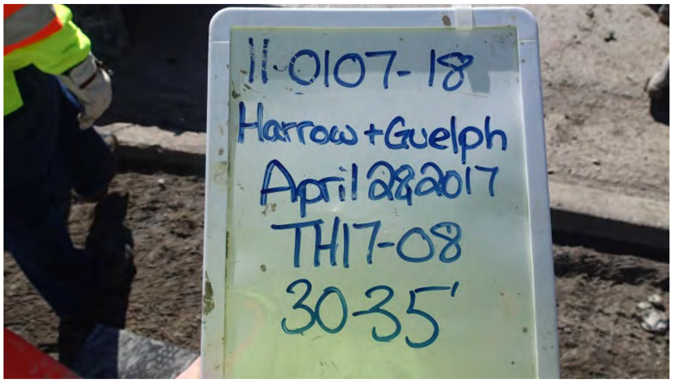

11-0107-18
Harrow + Guelph
April 28 2017
TH17-08
10-15'


11-0107-18
Harrow + Guelph
April 28 2017
TH17-08
15-20'



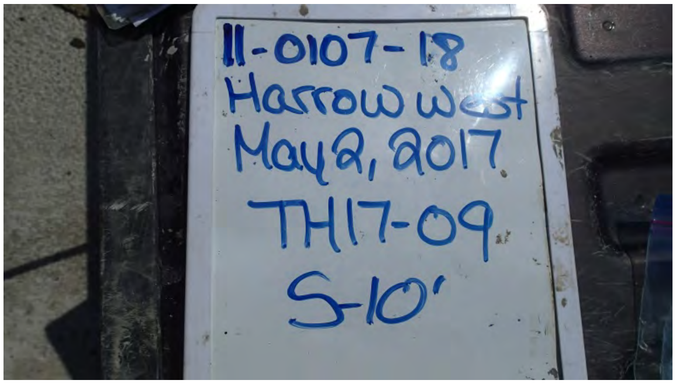
11-0107-18
Harrow + Guelph
April 28 2017
TH17-08
20-25'

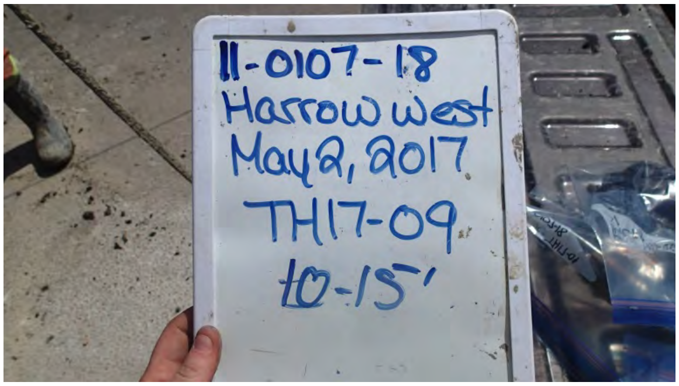

11-0107-18
Harrow + Guelph
April 28 2017
TH17-08
25-30'

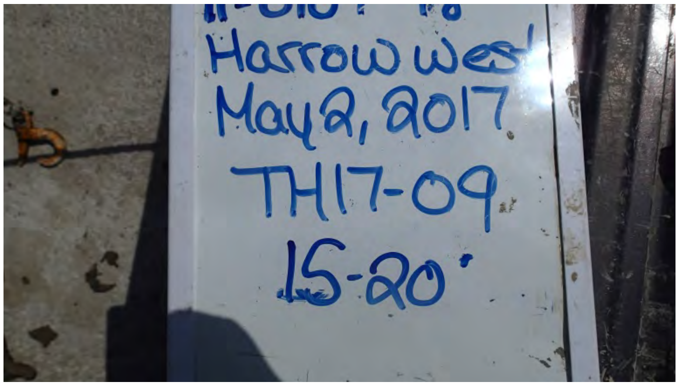

11-0107-18
Harrow+Guelph
April 28 2017
TH17-08
30-35'

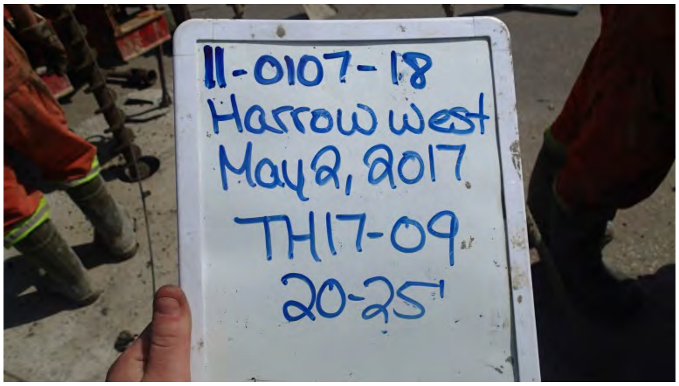

11-0107-18
Harrow + Guelph
April 28 2017
TH17-08
35-40'

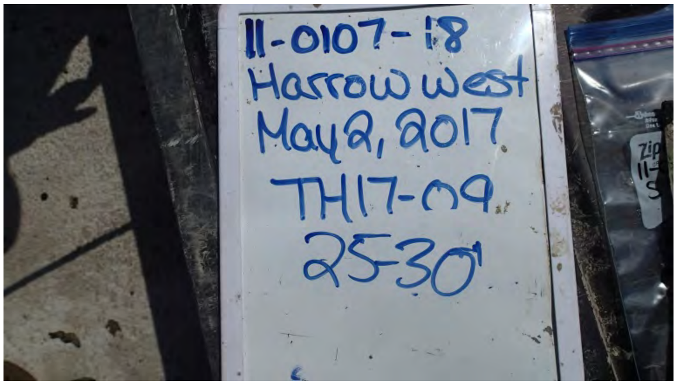
TH17-09

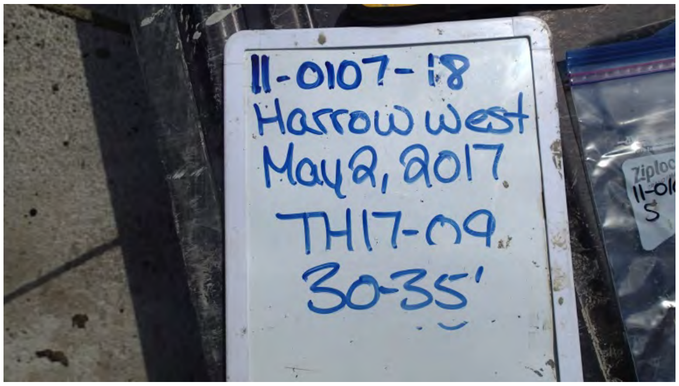

11-0107-18
Harrow West
May 2, 2017
TH17-09
S-10'

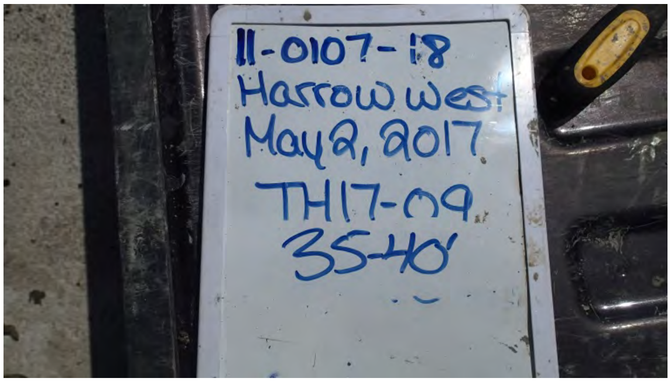

11-0107-18
Harrow West
May 2, 2017
TH17-09
10-15'

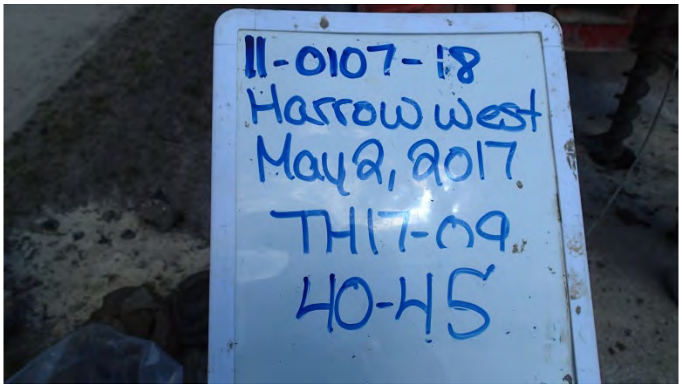

Harrow West
May 2, 2017
TH17-09
15-20'

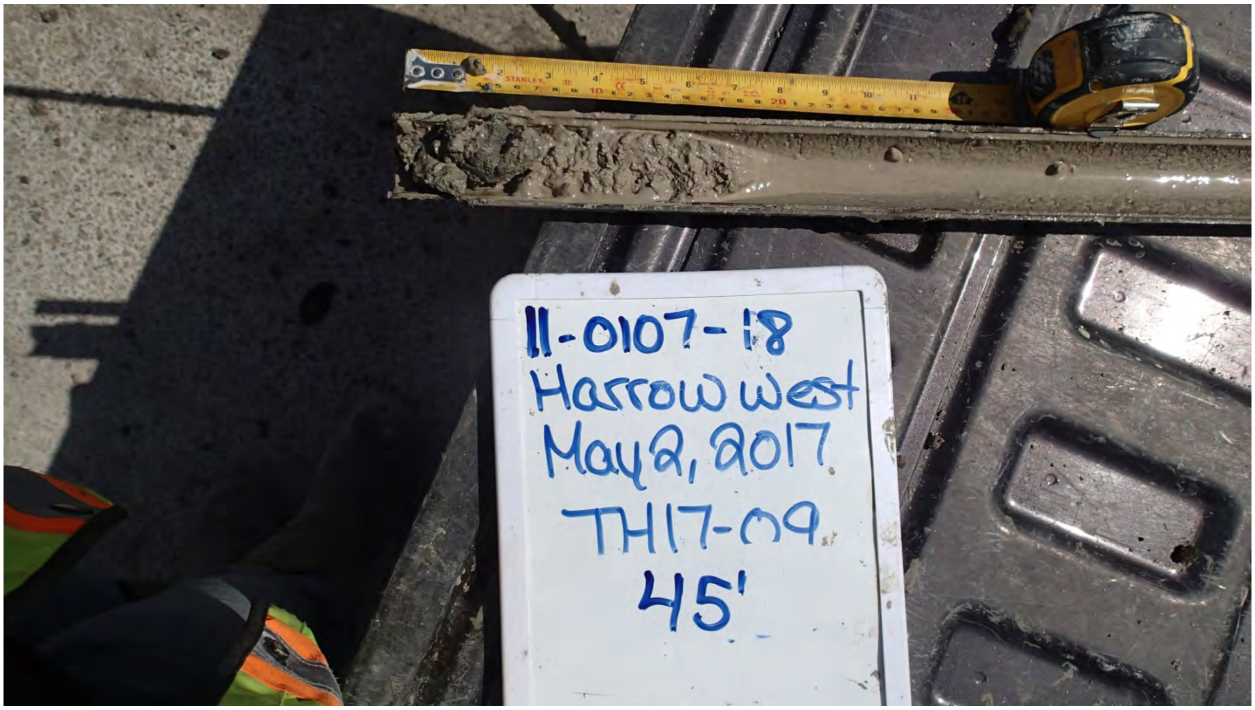

11-0107-18
Harrow west
May 2, 2017
TH17-09
20-25'


11-0107-18
Harrow West
May 2, 2017
TH17-09
25-30'


11-0107-18
Harrow West
May 2, 2017
TH17-09
30-35'
Ziploc
11-01
S

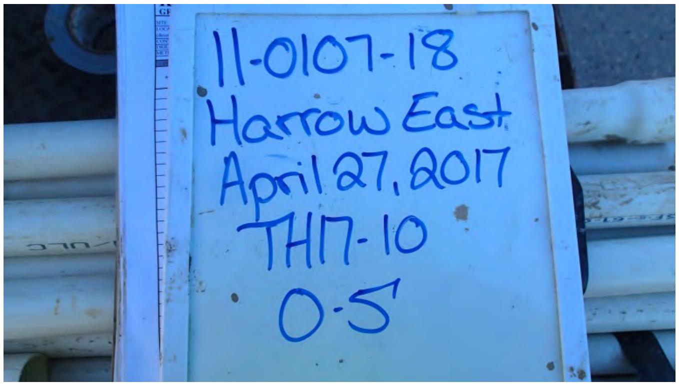

11-0107-18
Harrow West
May 2, 2017
TH17-09
35-40'

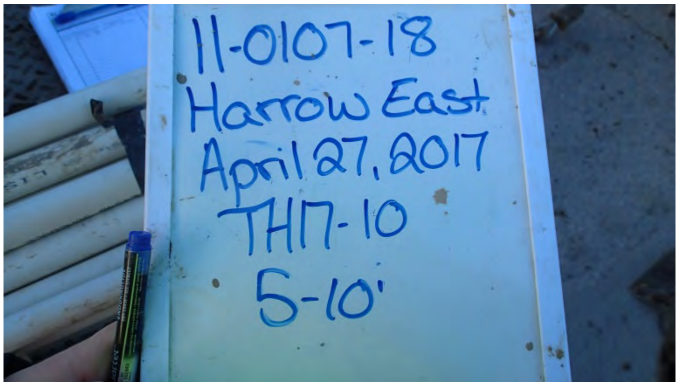

11-0107-18
Harrow West
May 2, 2017
TH17-09
40-45'

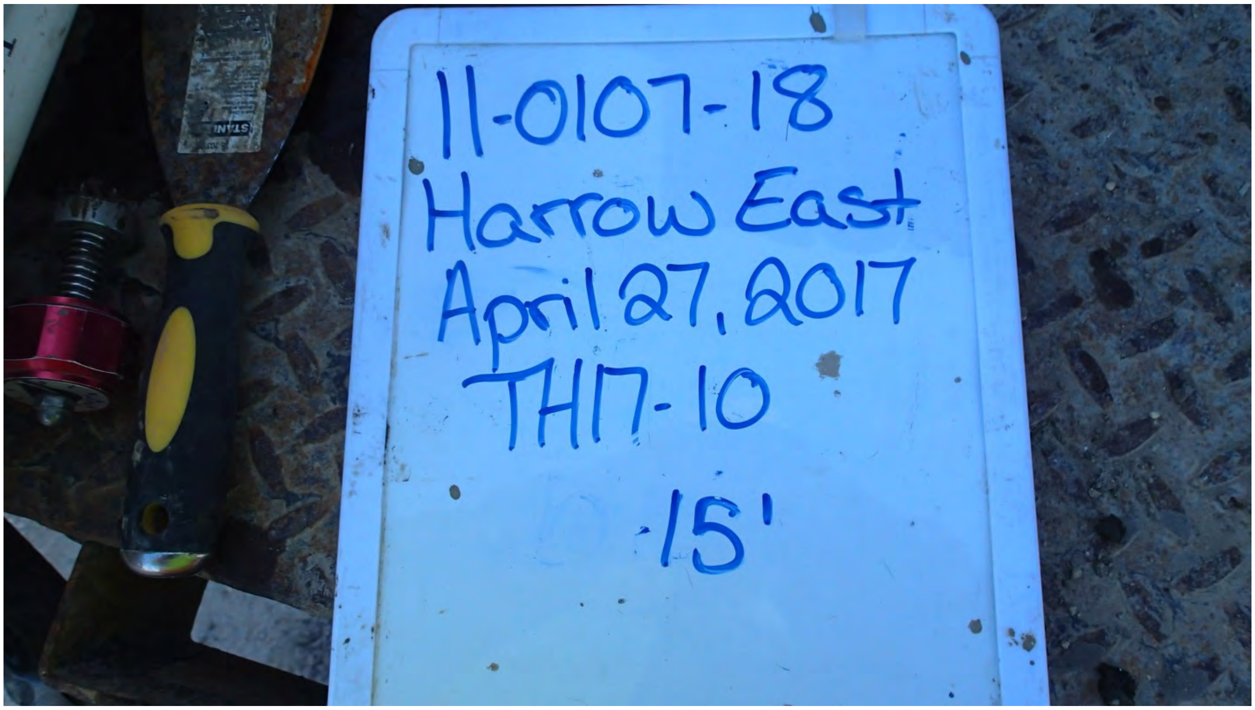

11-0107-18
Harrow west
May 2, 2017
TH17-09
45'

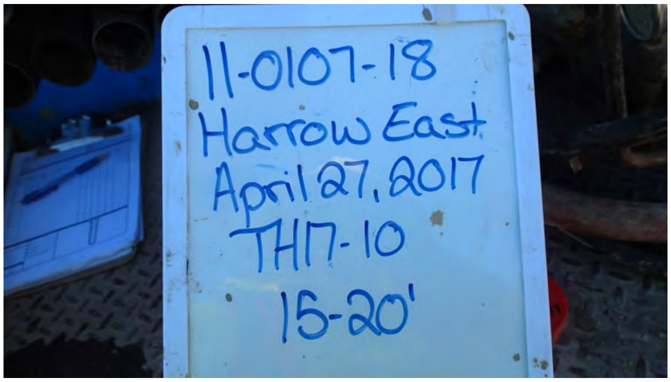

11-0107-18

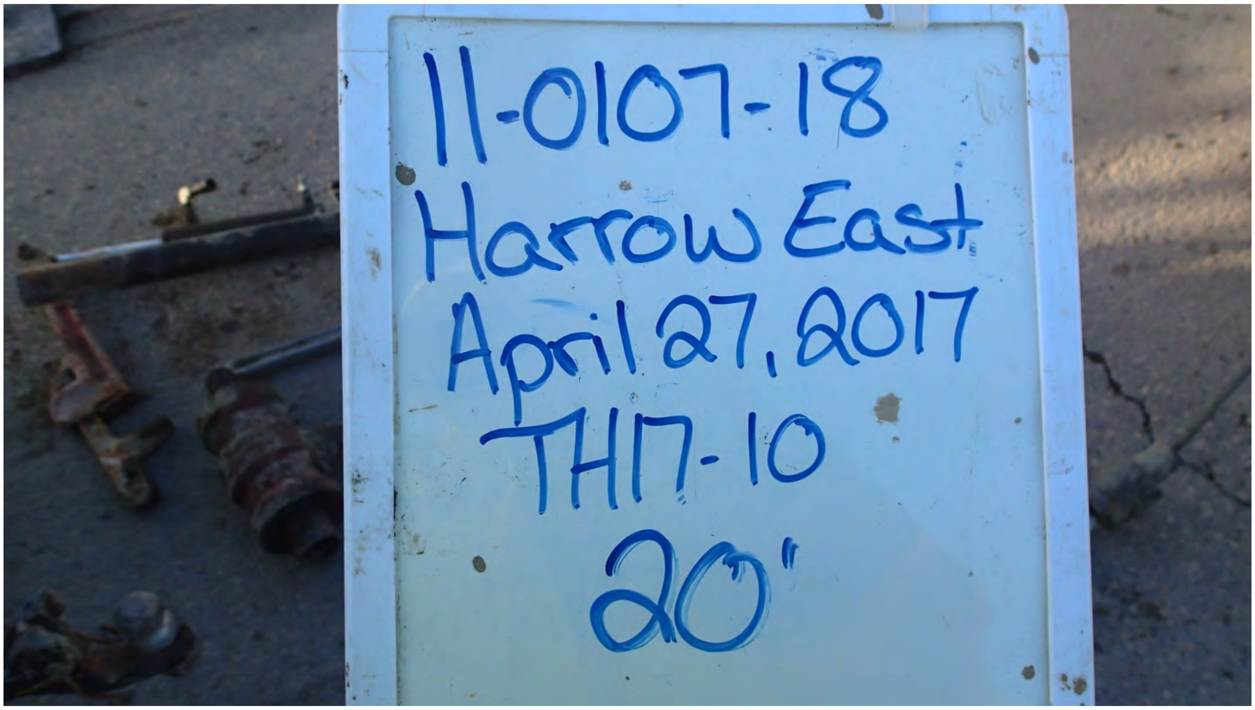
TH17-10

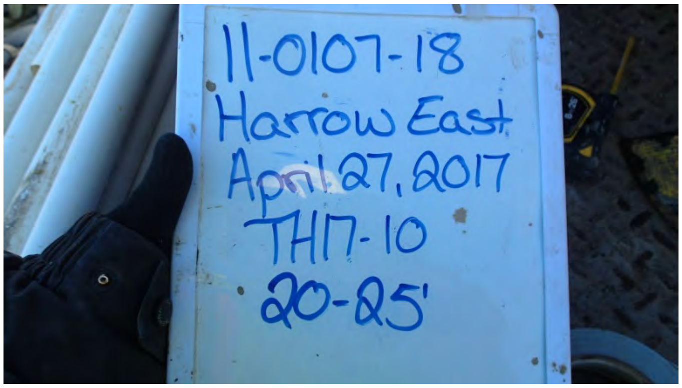

11-0107-18
Harrow East
April 27, 2017
TH17-10
0-5'

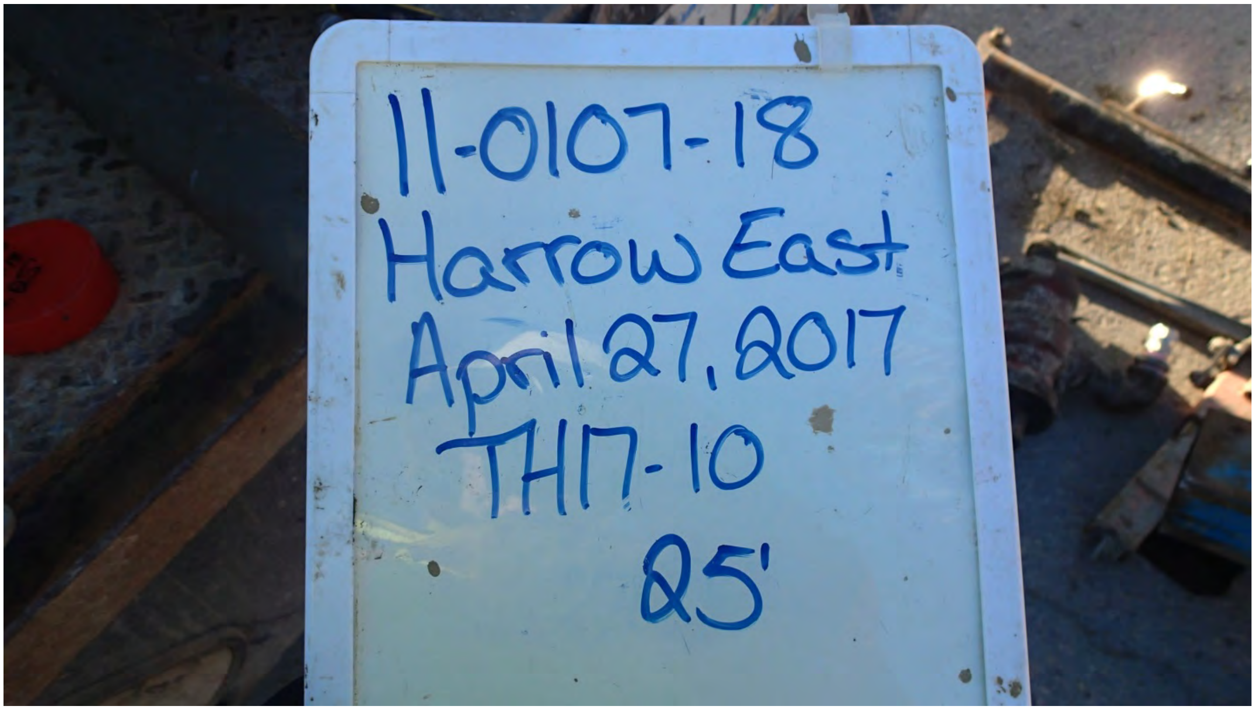

11-0107-18
Harrow East
April 27, 2017
TH17-10
5-10'

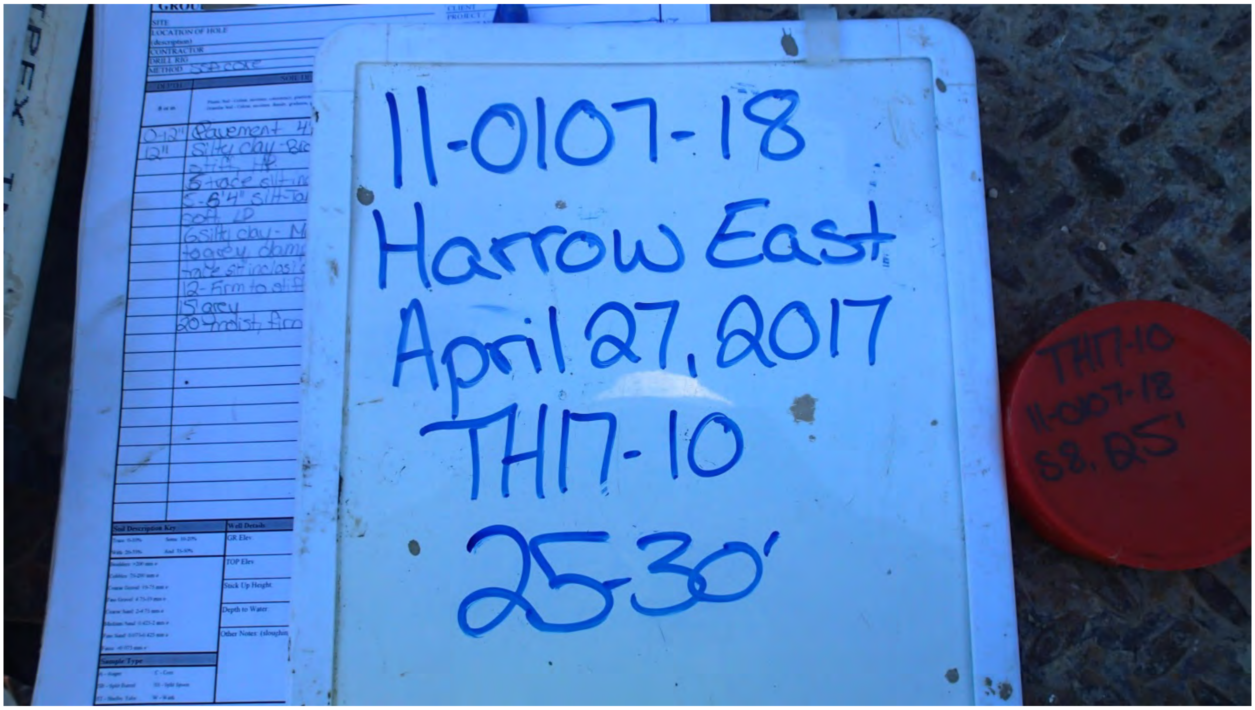

11-0107-18
Harrow East
April 27, 2017
TH17-10
15'

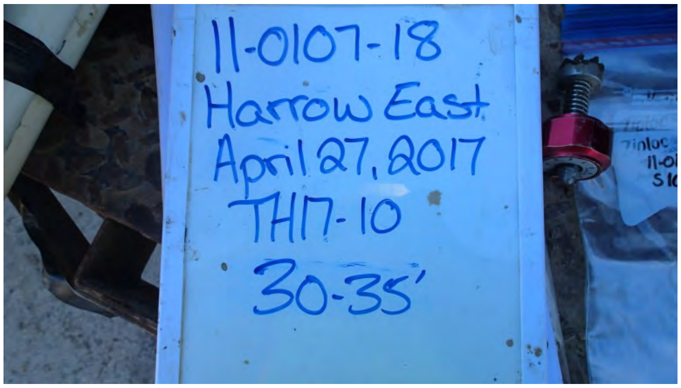

11-0107-18
Harrow East
April 27, 2017
TH17-10
15-20'

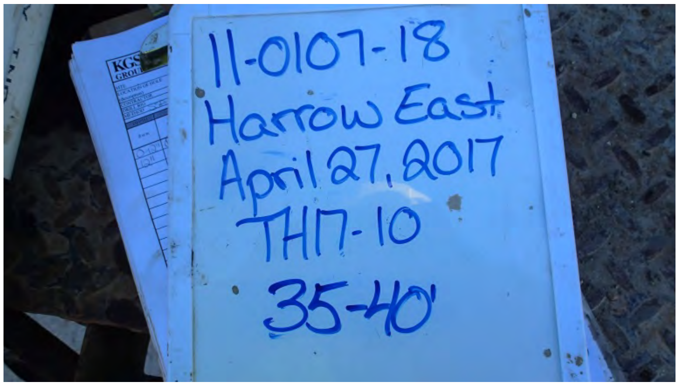

11-0107-18
Harrow East
April 27, 2017
TH17-10
20'

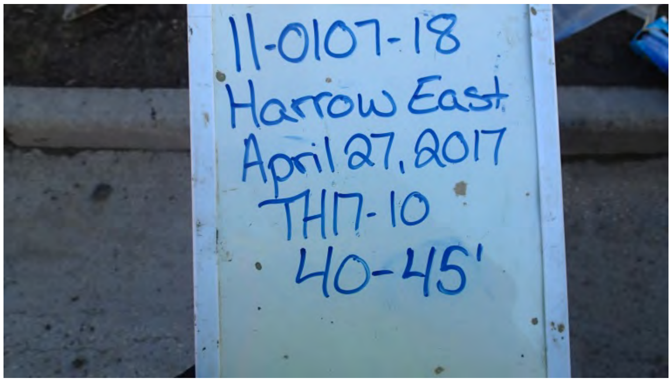

11-0107-18
Harrow East
April 27, 2017
TH17-10
20-25'


11-0107-18
Harrow East
April 27, 2017
TH17-10
25'


11-0107-18
Harrow East
April 27, 2017
TH17-10
25-30'
TH17-10
11-0107-18
S8, 25'


11-0107-18
Harrow East
April 27, 2017
TH17-10
30-35'


11-0107-18
Harrow East
April 27, 2017
TH17-10
35-40'

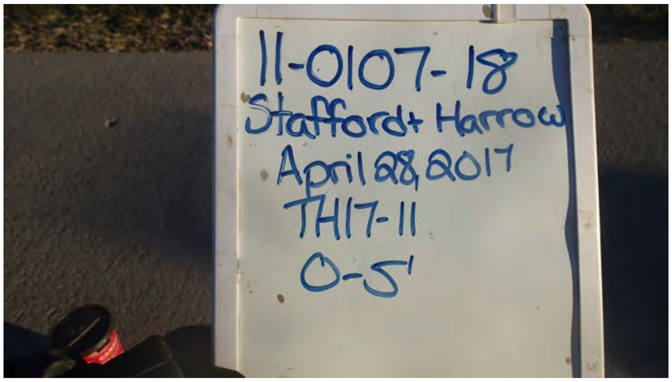

11-0107-18
Harrow East
April 27, 2017
TH17-10
40-45'

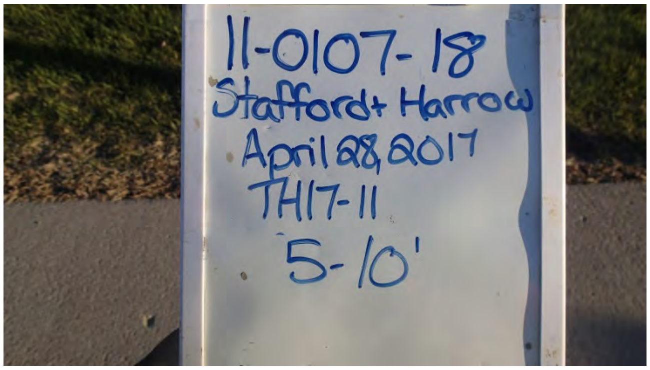

11-0107-18
Harrow East
April 27, 2017
TH17-10
R1


11-0107-18
Harrow East
April 27, 2017
TH17-10
R2
END R1 50

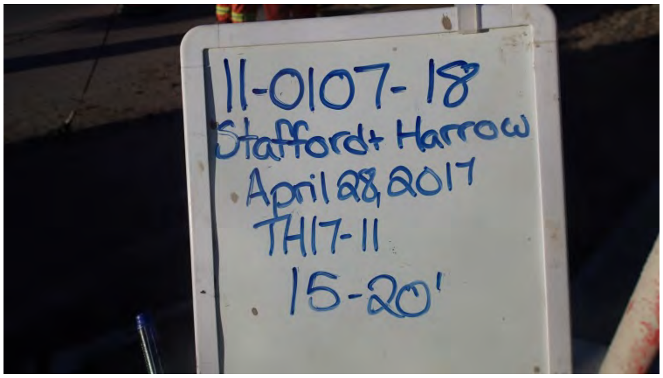

11-0107-18
Harrow East
April 27, 2017
TH17-10
R3

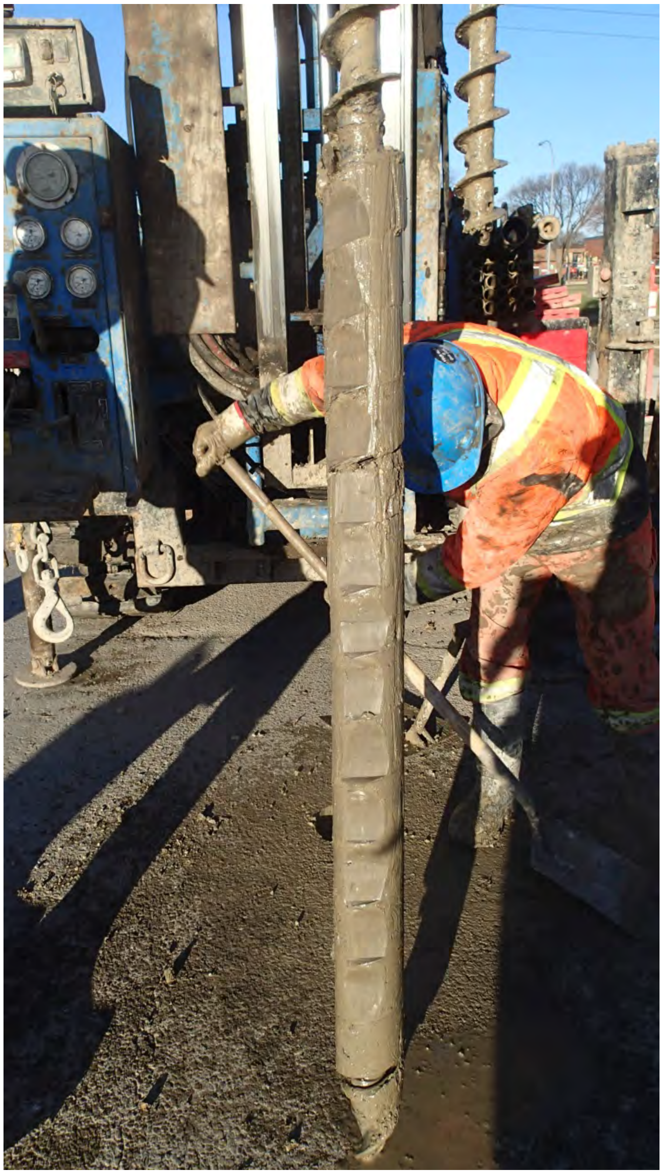
TH17-11

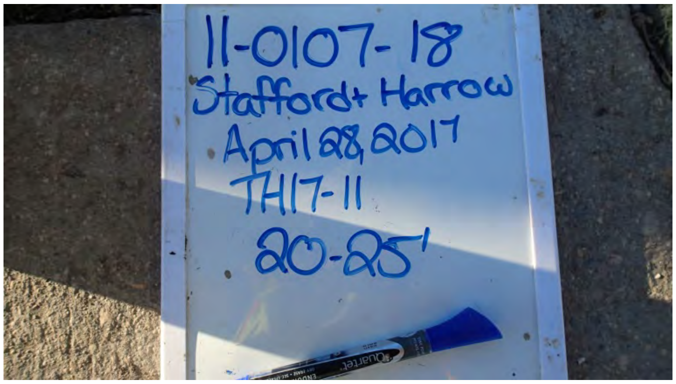

11-0107-18
Stafford + Harrow
April 28, 2017
TH17-11
0-5'

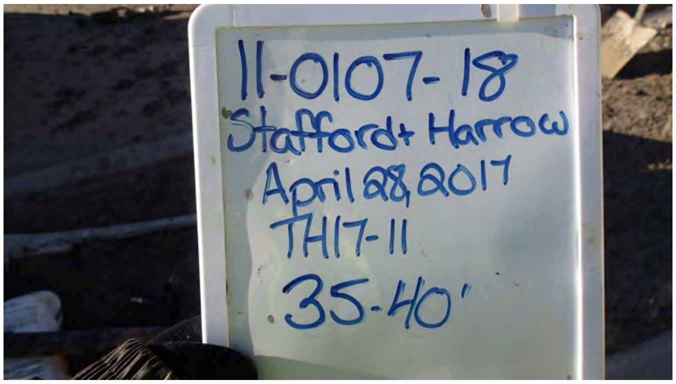

11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
5-10'

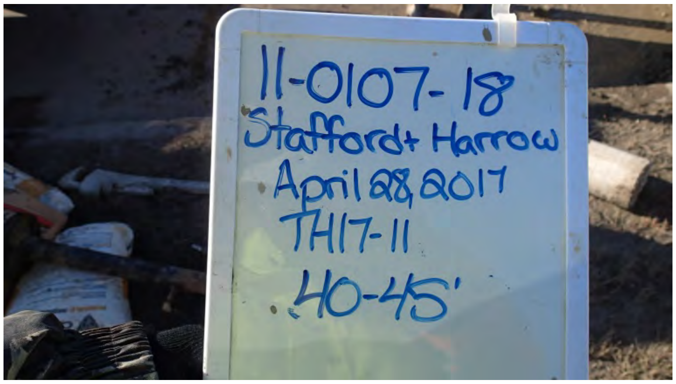

11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
10-15'


11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
15-20'




11-0107-18
Stafford + Harrow
April 28, 2017
TH17-11
20-25'

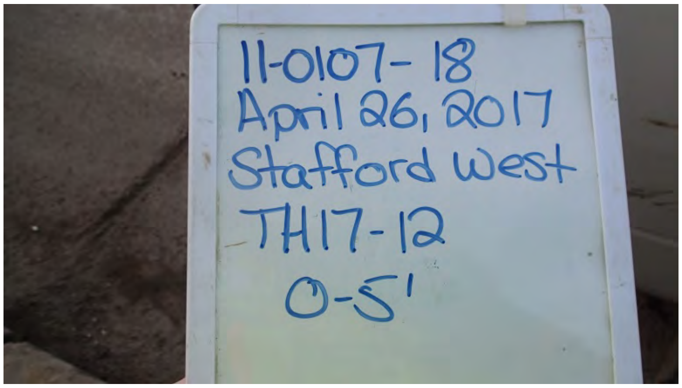

11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
35-40'

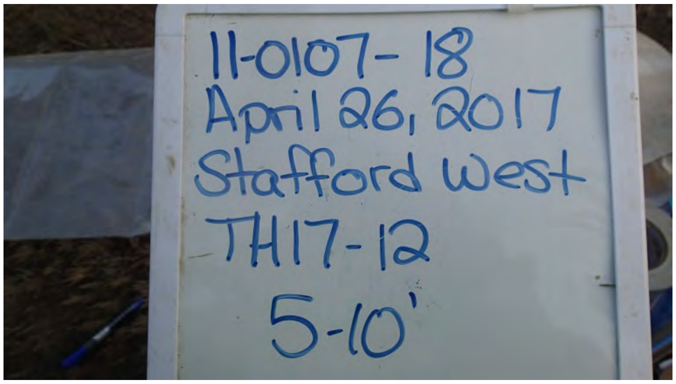

11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
40-45'

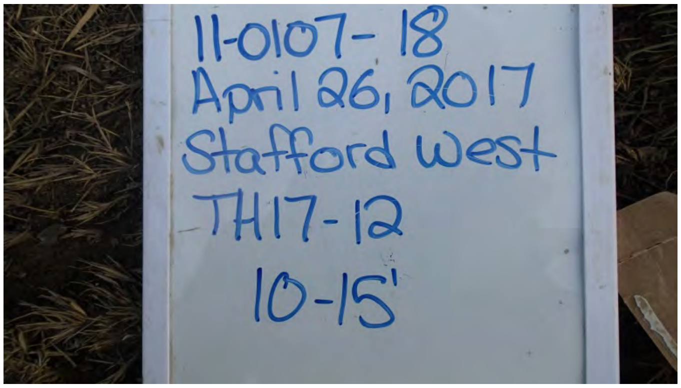

11-0107-18
Stafford+ Harrow
April 28, 2017
TH17-11
45'
STANLEY

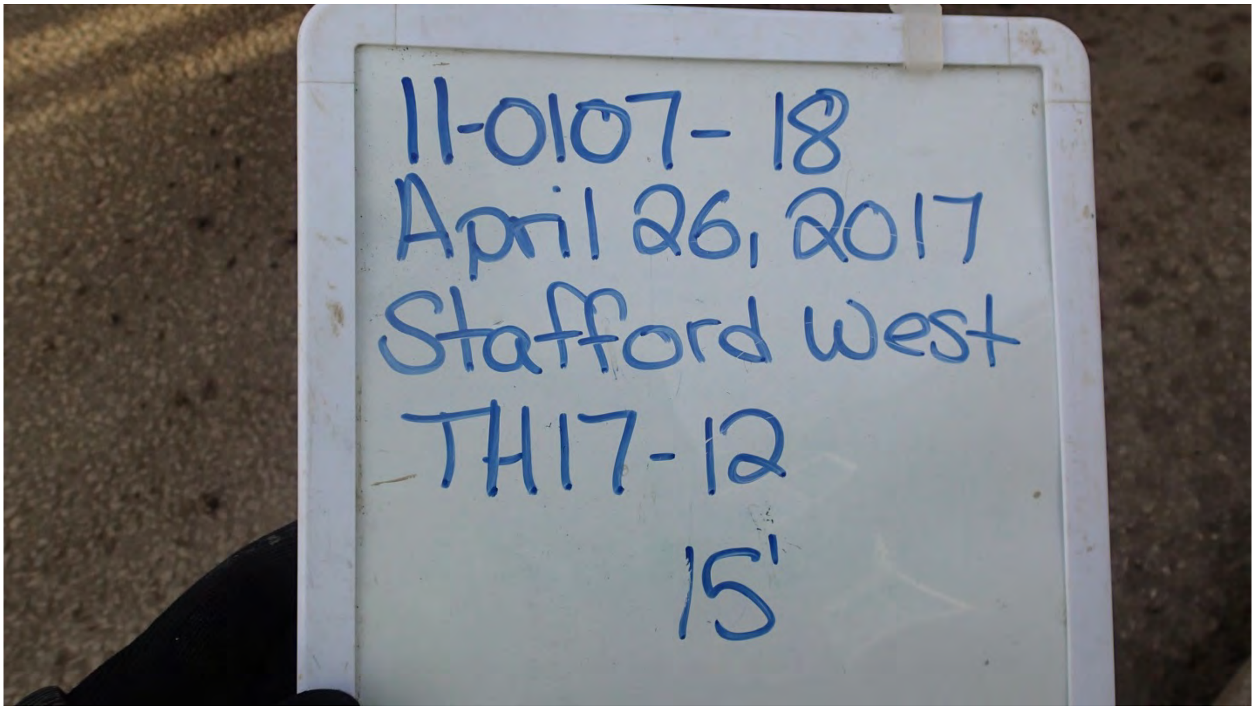

STANLEY

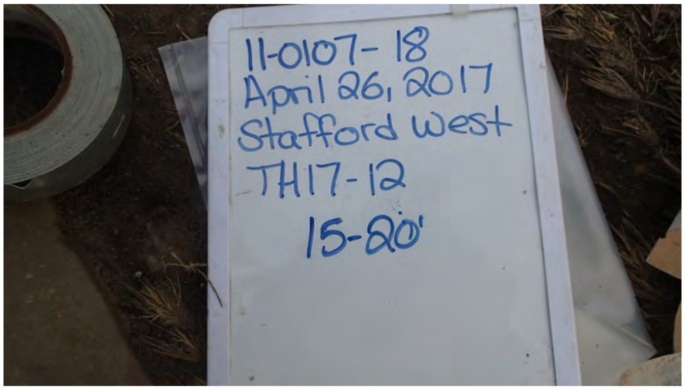
TH17-12

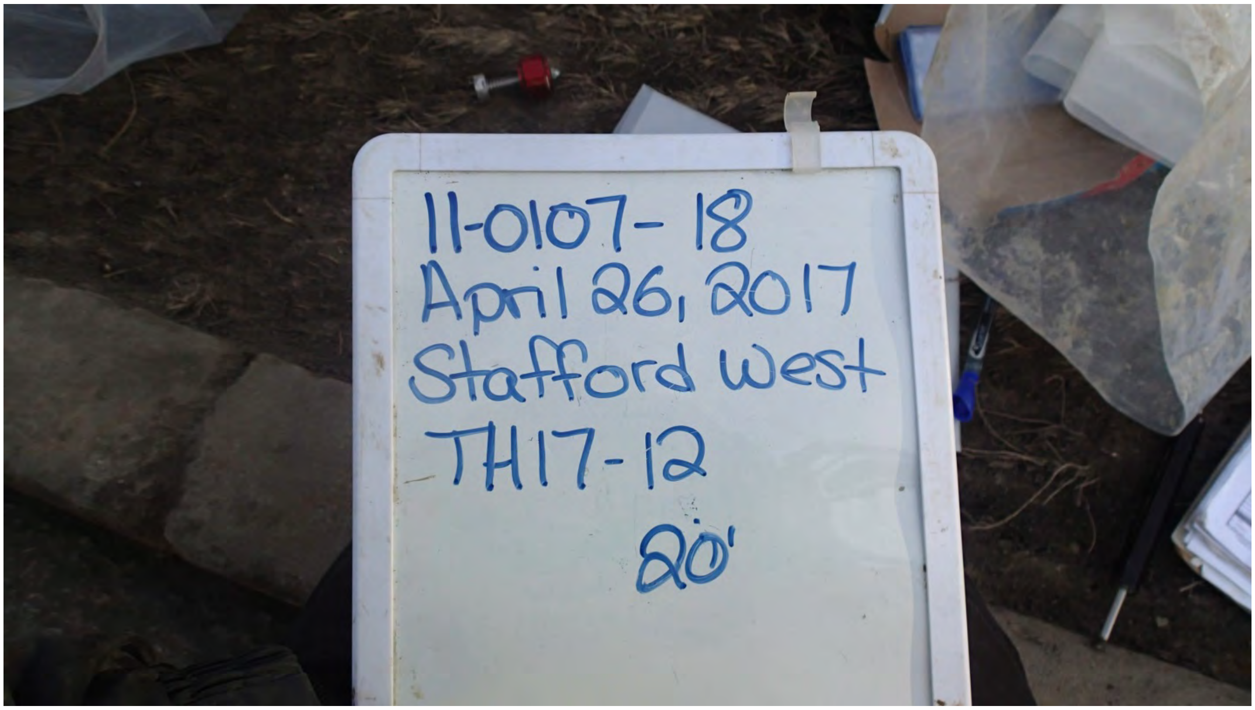

11-0107-18
April 26, 2017
Stafford West
TH17-12
0-5'

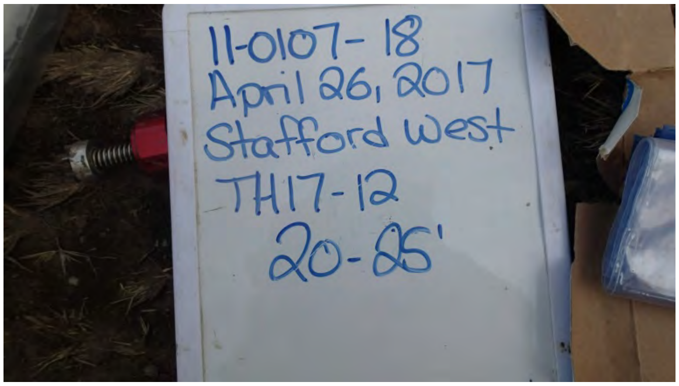

11-0107-18
April 26, 2017
Stafford West
TH17-12
5-10'

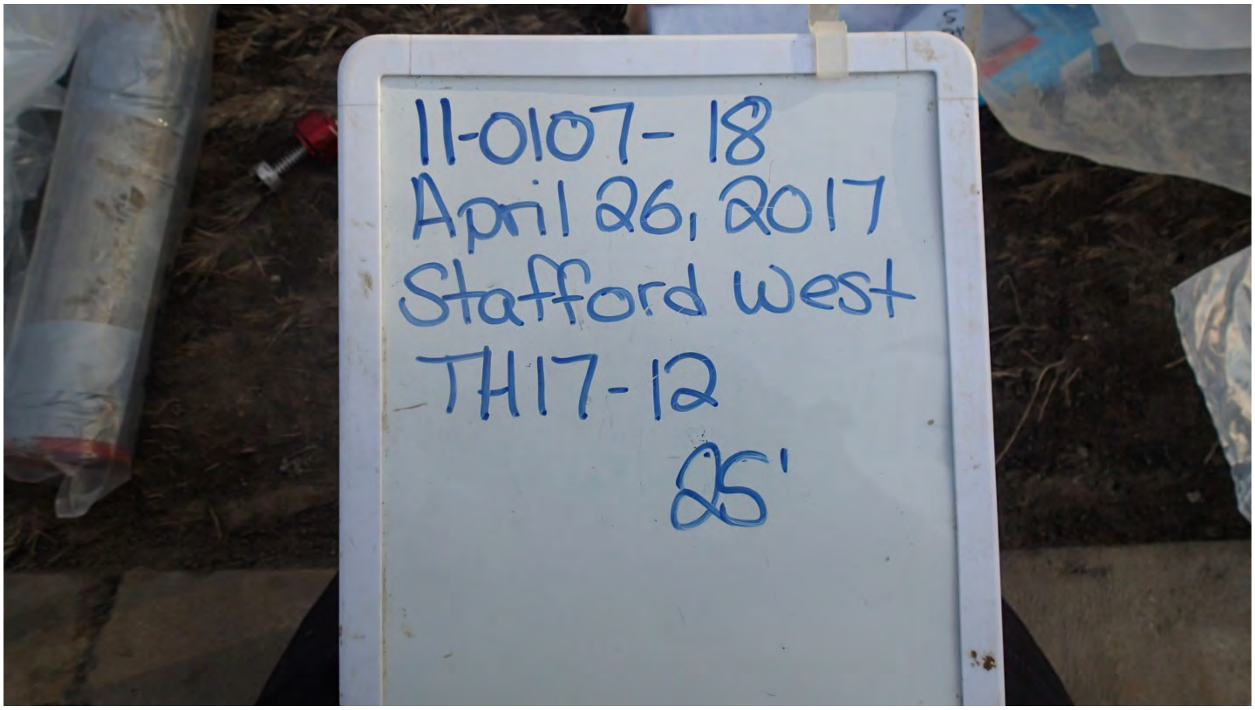

11-0107- 18
April 26, 2017
Stafford West
TH17-12
10-15'

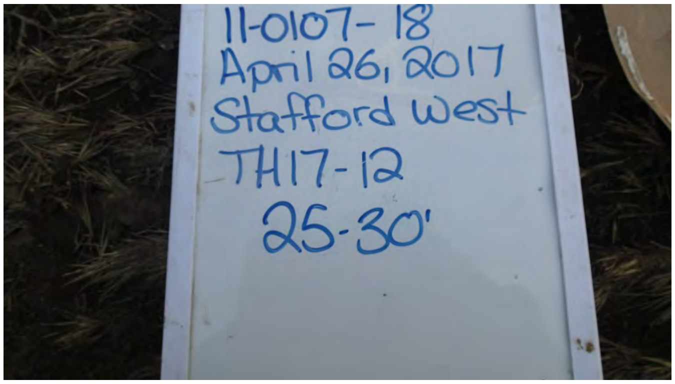

11-0107-18
April 26, 2017
Stafford West
TH17-12
15'

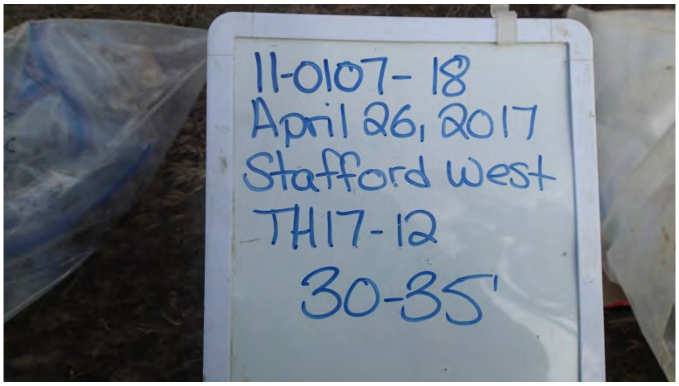

11-0107-18
April 26, 2017
Stafford West
TH17-12
15-20'

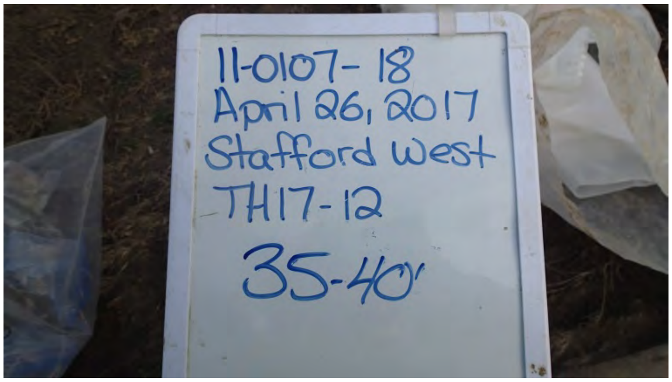

11-0107- 18
April 26, 2017
Stafford West
TH17-12
20'

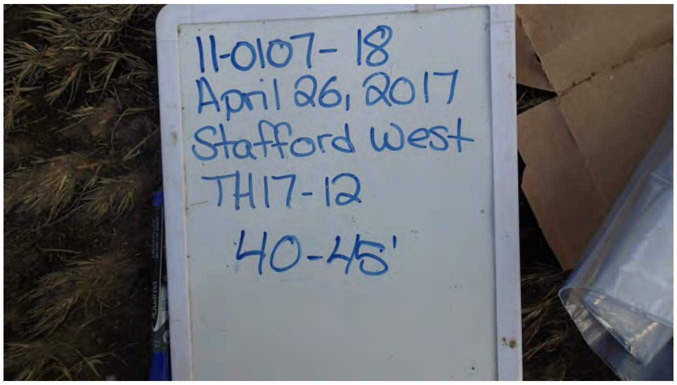

11-0107-18
April 26, 2017
Stafford West
TH17-12
20-25'


11-0107- 18
April 26, 2017
Stafford West
TH17-12
25'


11-0107-18
April 26, 2017
Stafford West
TH17-12
25-30'

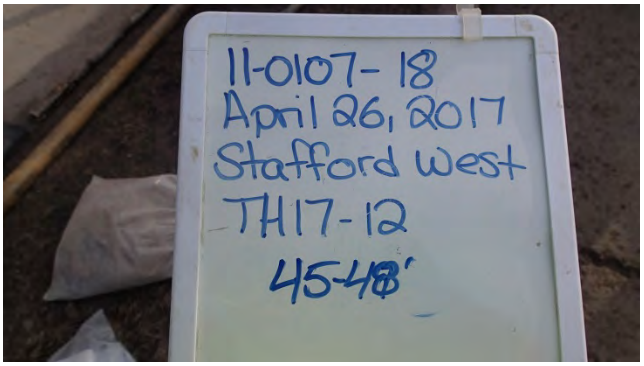

11-0107-18
April 26, 2017
Stafford West
TH17-12
30-35'

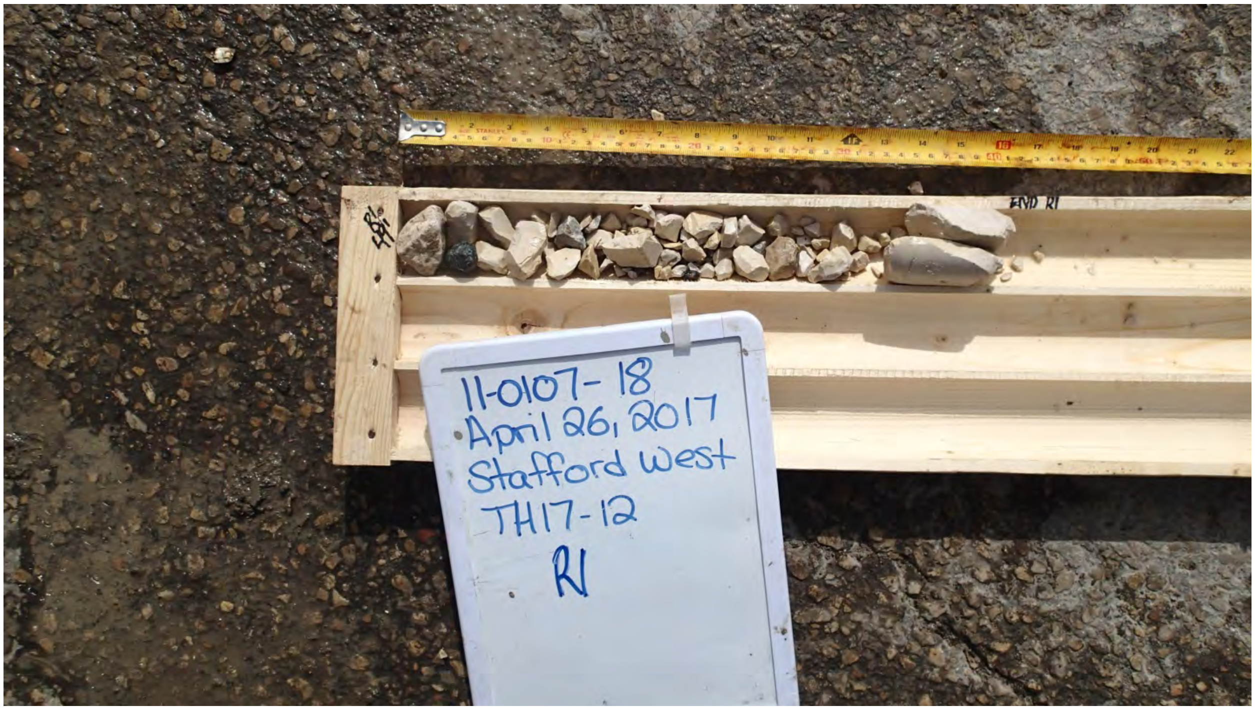

11-0107-18
April 26, 2017
Stafford West
TH17-12
35-40'


11-0107- 18
April 26, 2017
Stafford West
TH17-12
40-45'


11-0107- 18
April 26, 2017
Stafford West
TH17-12
45'
STANLEY

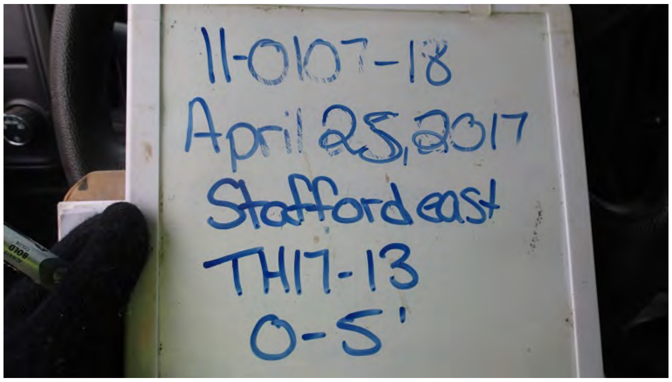

STANLEY

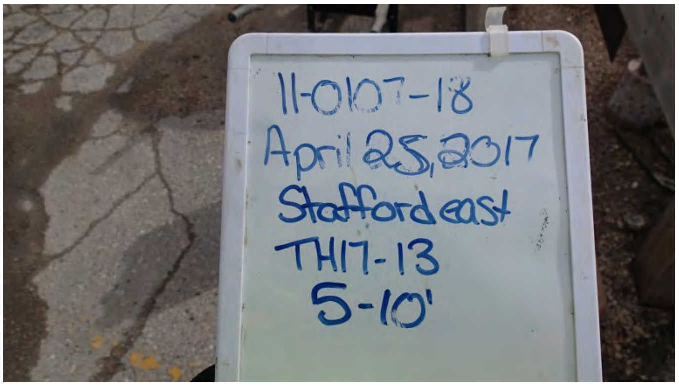

11-0107-18
April 26, 2017
Stafford West
TH17-12
45-48'

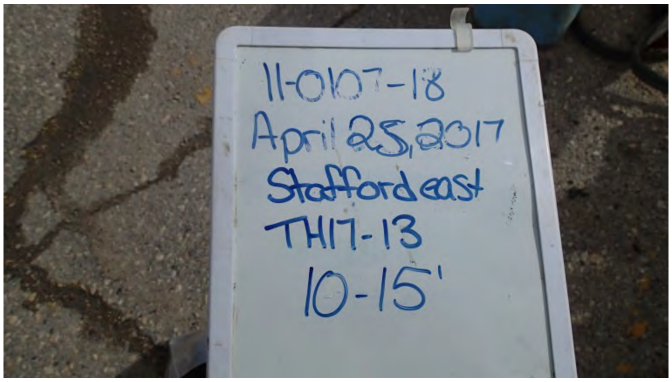

11-0107- 18
April 26, 2017
Stafford West
TH17-12
R1
END R1
48'

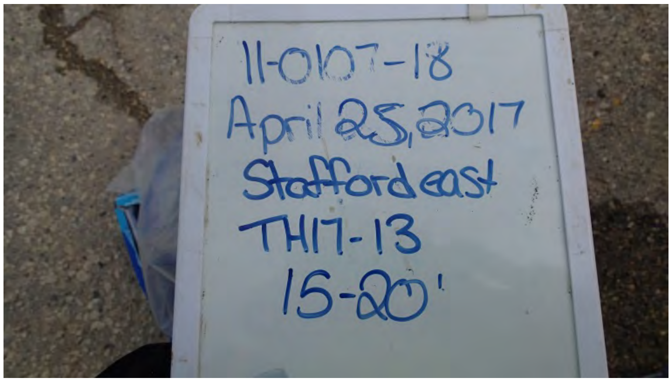

11-0107- 18
April 26, 2017
Stafford West
TH17-12
R2
END R1
END R1 49'

TH17-13

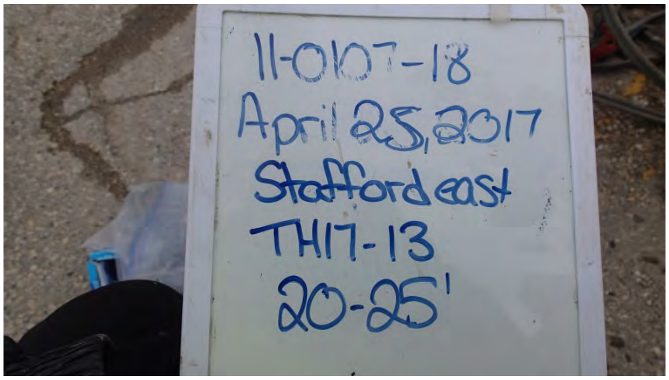

11-0107-18
April 25, 2017
Stafford east
TH17-13
0-5'

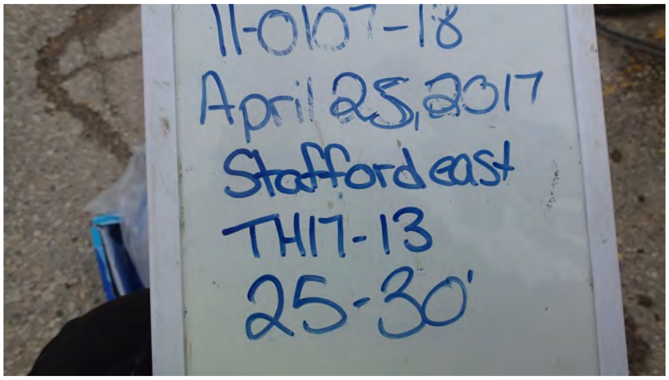

11-0107-18
April 25, 2017
Stafford east
TH17-13
5-10'

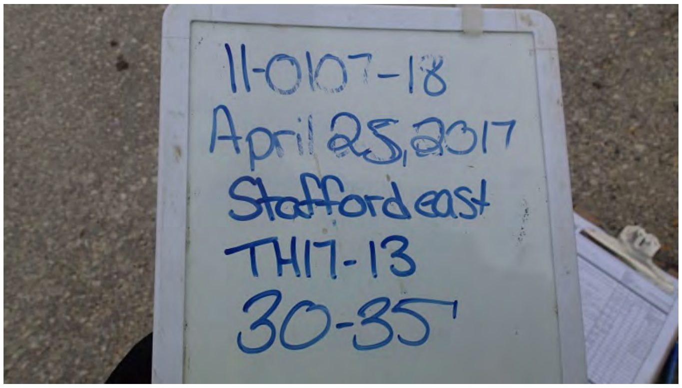

11-0107-18
April 25, 2017
Stafford east
TH17-13
10-15'



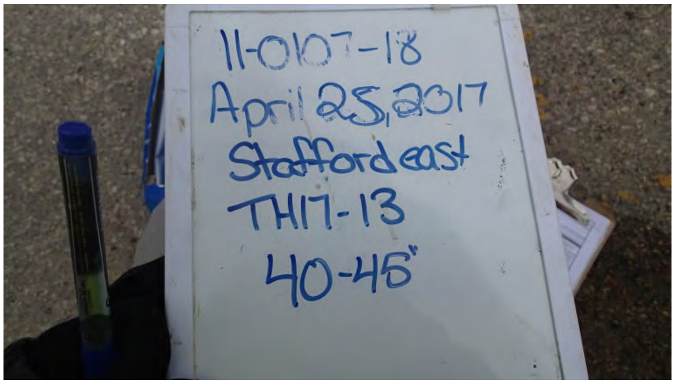
11-0107-18
April 25, 2017
Stafford east
TH17-13
15-20'


11-0107-18
April 25, 2017
Stafford east
TH17-13
20-25'

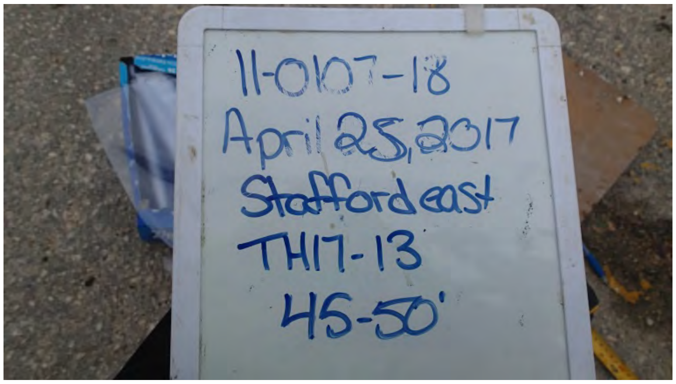

11-0107-18
April 25, 2017
Stafford east
TH17-13
25-30'


11-0107-18
April 25, 2017
Stafford east
TH17-13
30-35'


11-0107-18
April 25, 2017
Stafford east
TH17-13
35-40'

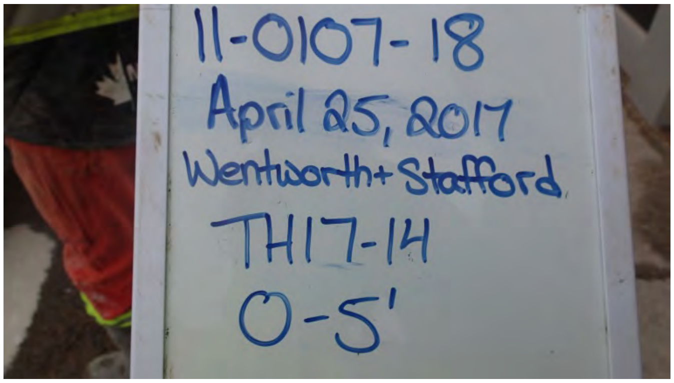

11-0107-18
April 25, 2017
Stafford east
TH17-13
40-45'

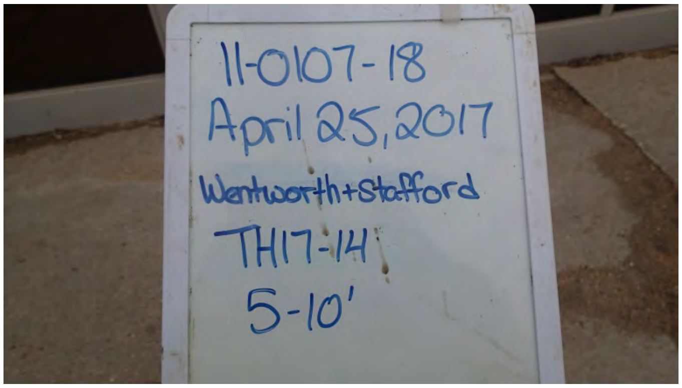

11-0107-18
April 25, 2017
Stafford east
TH17-13
45'


11-0107-18
April 25, 2017
Stafford east
TH17-13
45-50'

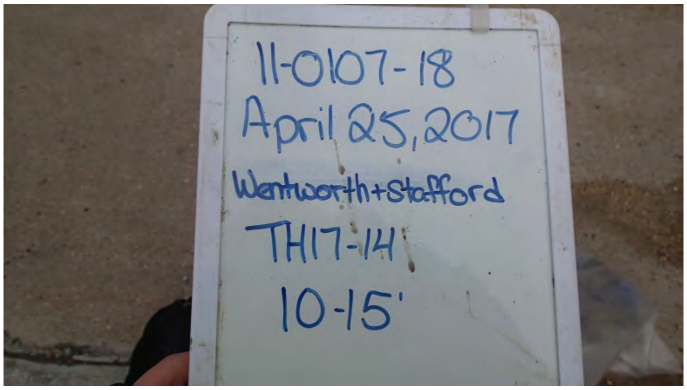
11-0107-18
April 25, 2017
Stafford east
TH17-13
50'
STANLEY

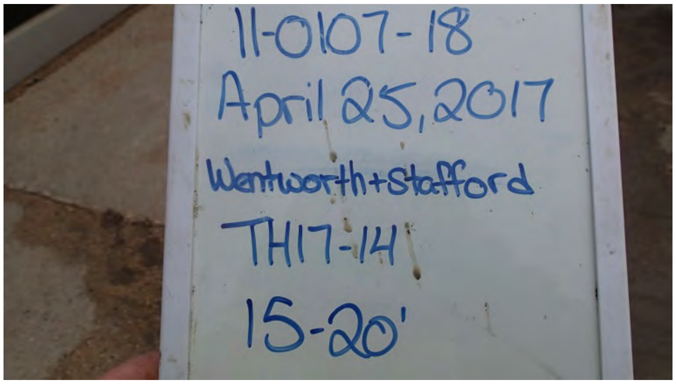
TH17-14


11-0107-18
April 25, 2017
Wentworth+Stafford
TH17-14
0-5'

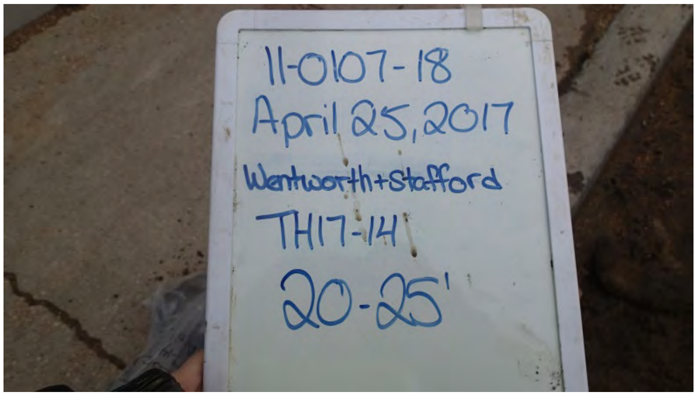


11-0107-18
April 25, 2017
Wentworth + Stafford
TH17-14
5-10'


11-0107-18
April 25, 2017
Wentworth+Stafford
TH17-14
10-15'



11-0107-18
April 25, 2017
Wentworth+Stafford
TH17-14
15-20'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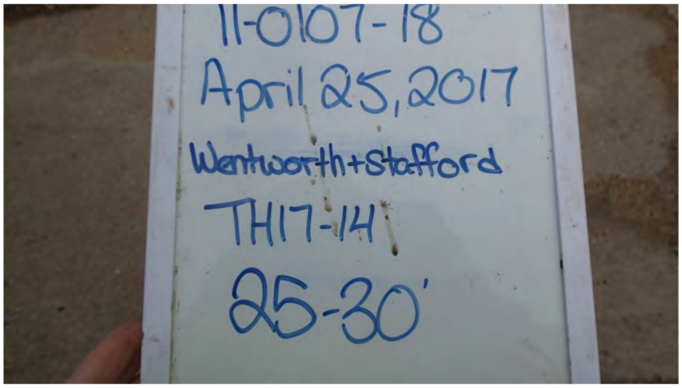
April 25, 2017
Wentworth+Stafford
TH17-14
20-25'



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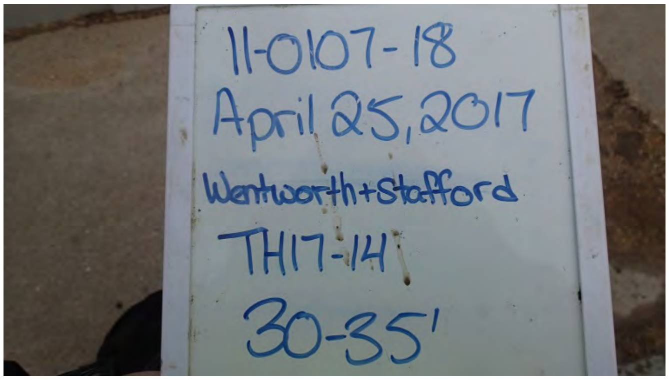
TH17-14
25-30'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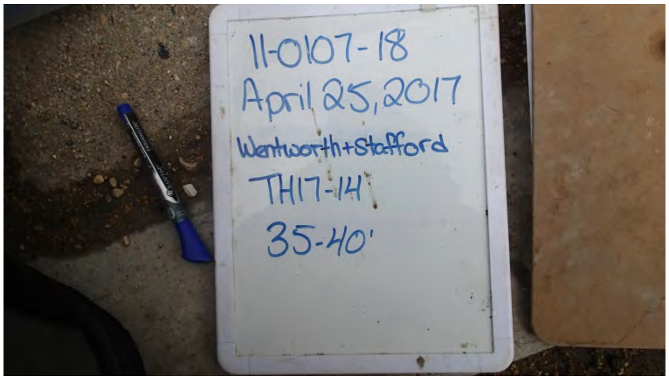
Wentworth + Stafford
TH17-14
30-35'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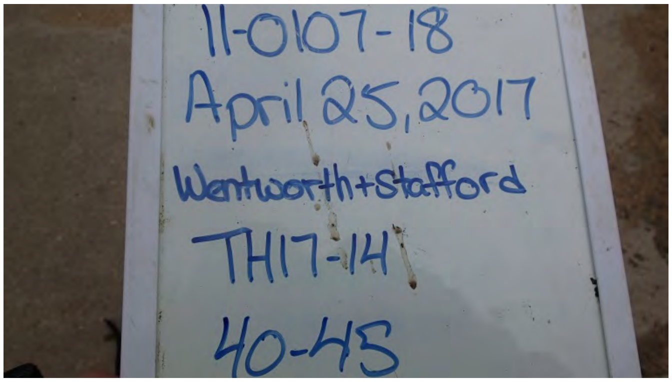
April 25, 2017
Wentworth + Stafford
TH17-14
35-40'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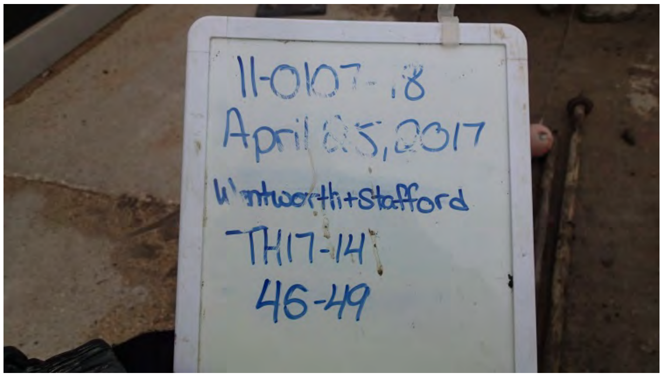
April 25, 2017
Wentworth + Stafford
TH17-14
40-45


11-0107-18
April 25, 2017
Wentworth+Stafford
TH17-14
45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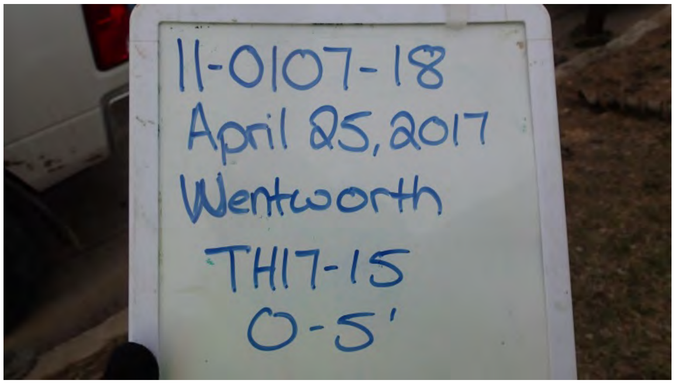
April 25,2017
Wentworth+Stafford
TH17-14
46-49

TH17-15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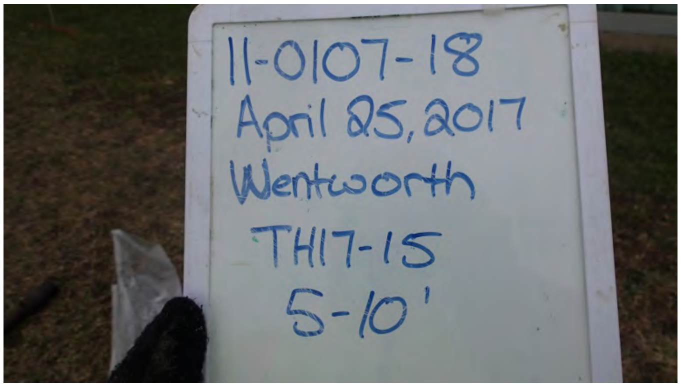
Wentworth
TH17-15
0-5'



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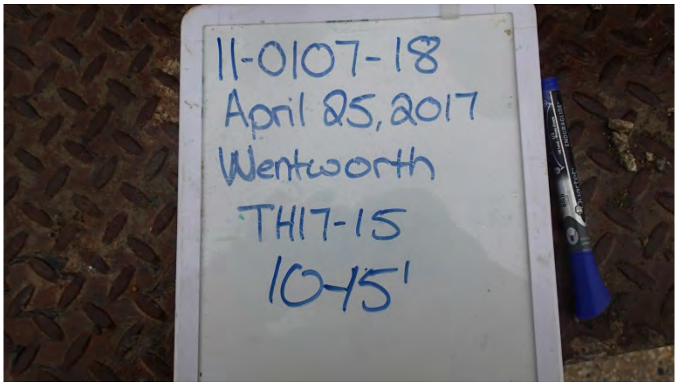
Wentworth
TH17-15
5-10'



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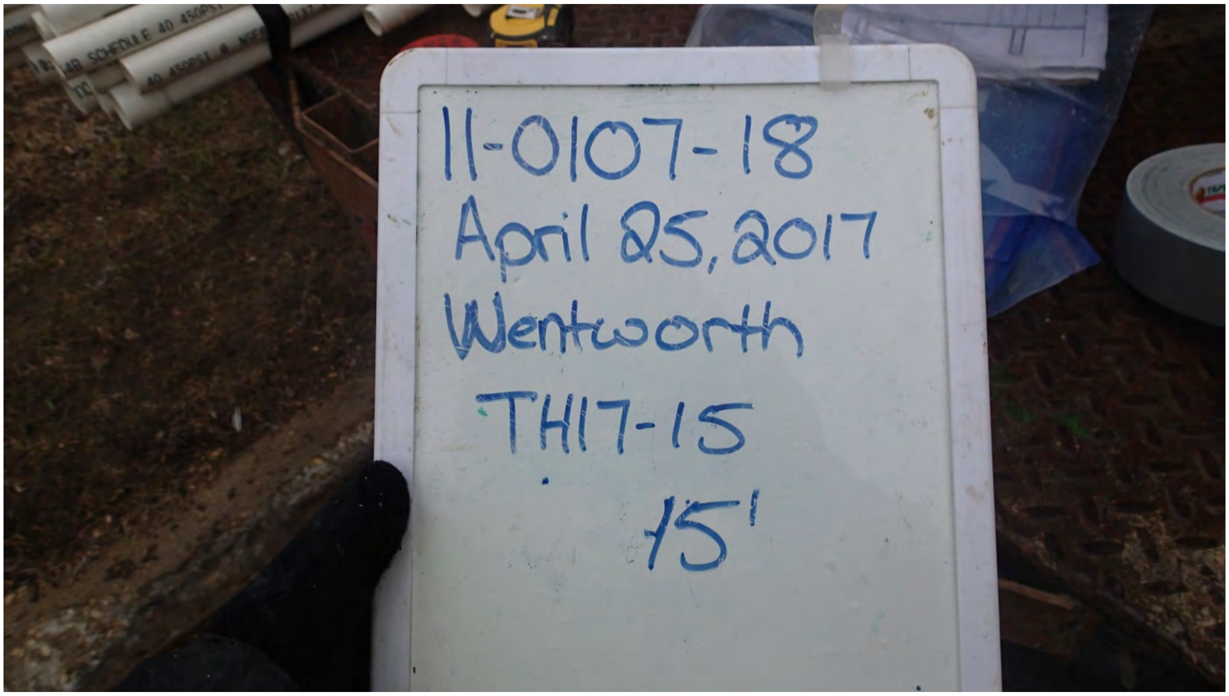
Wentworth
TH17-15
10-15'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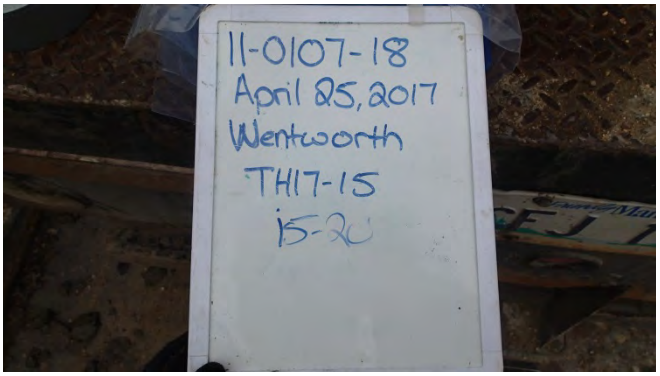
15'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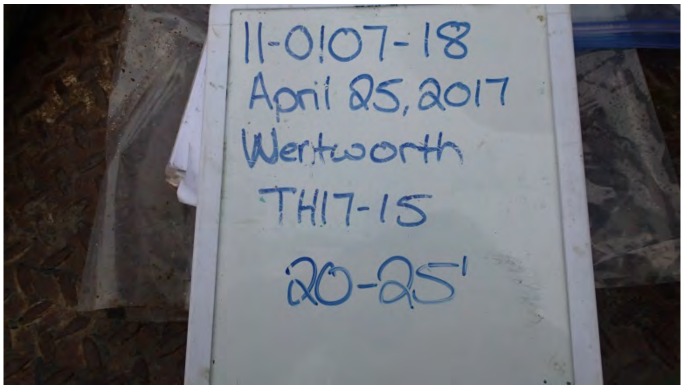
April 25, 2017
Wentworth
TH17-15
15-20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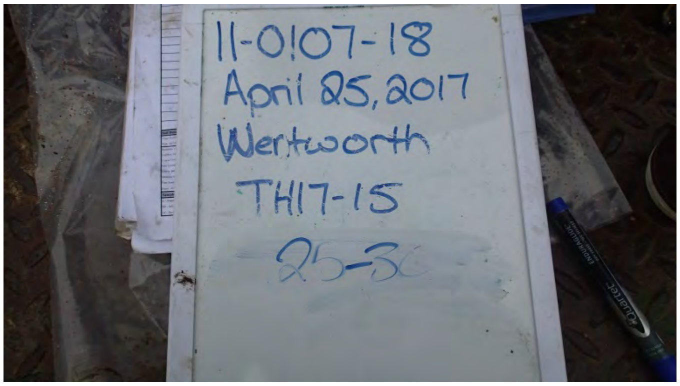
Wentworth
TH17-15
20-25'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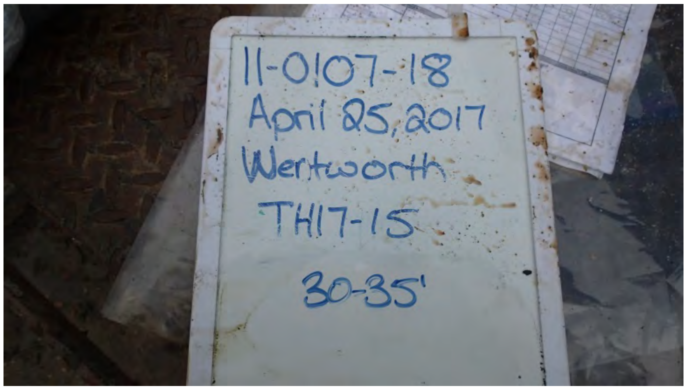
April 25, 2017
Wentworth
TH17-15
25-30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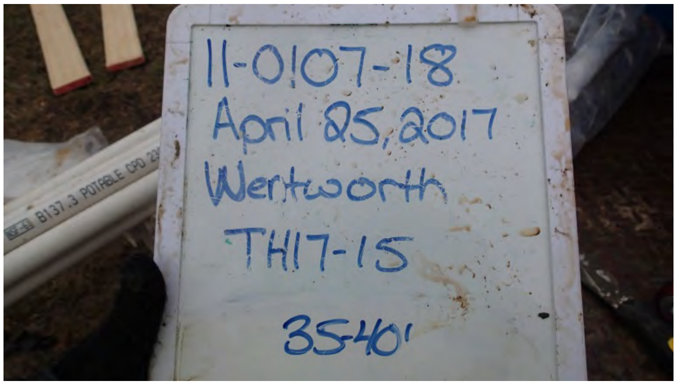
April 25, 2017
Wentworth
TH17-15
30-35'



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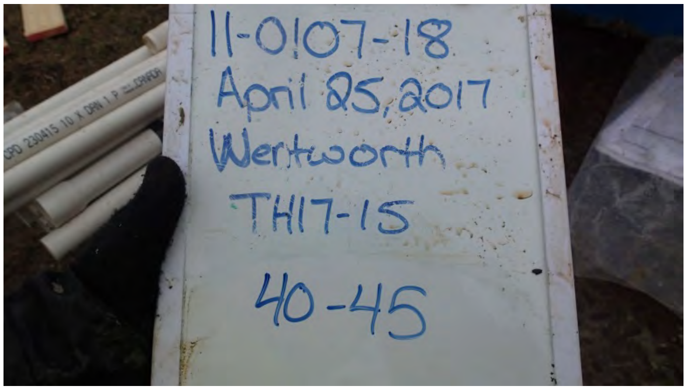
Wentworth
TH17-15
35-40'



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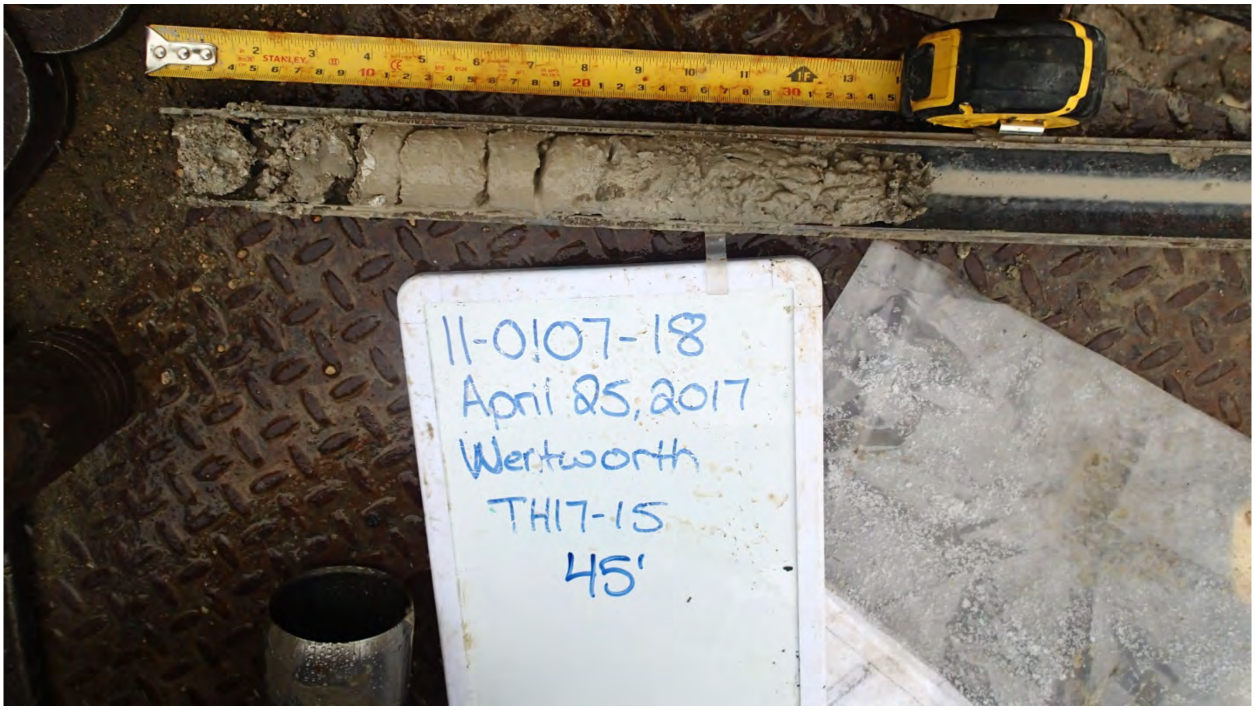
April 25, 2017
Wentworth
TH17-15
40-45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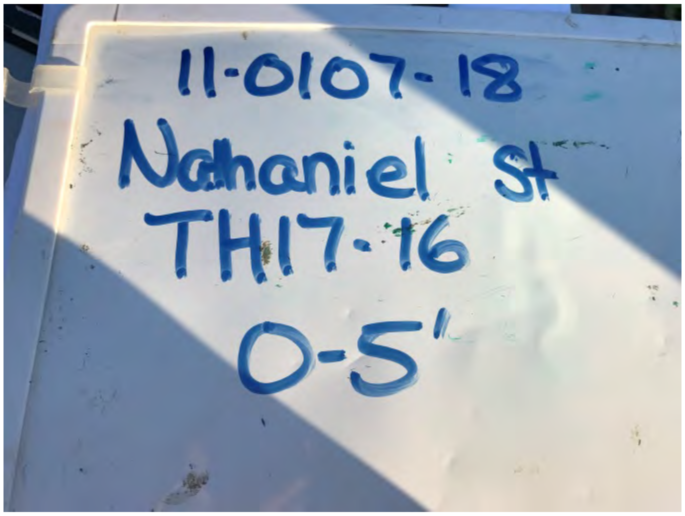
April 25, 2017
Wentworth
TH17-15
45'

TH17-16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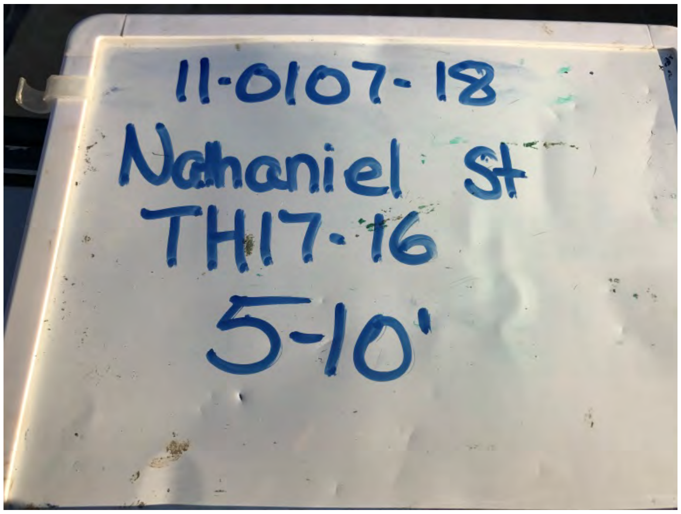
Nathaniel St
TH17-16
0-5'



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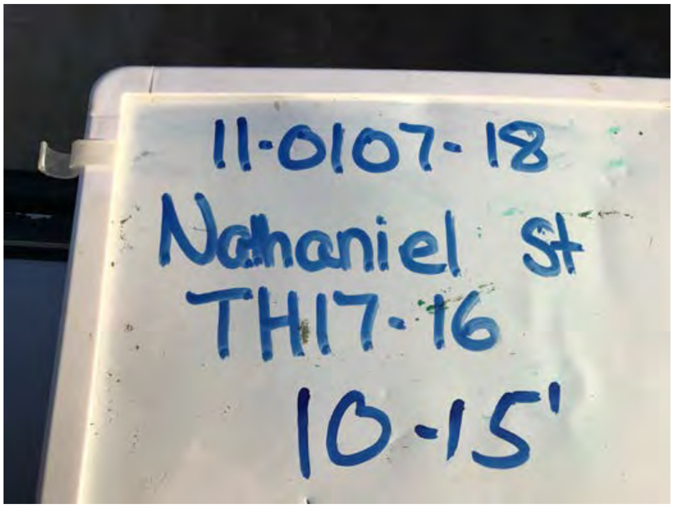
Nathaniel St
TH17-16
5-10'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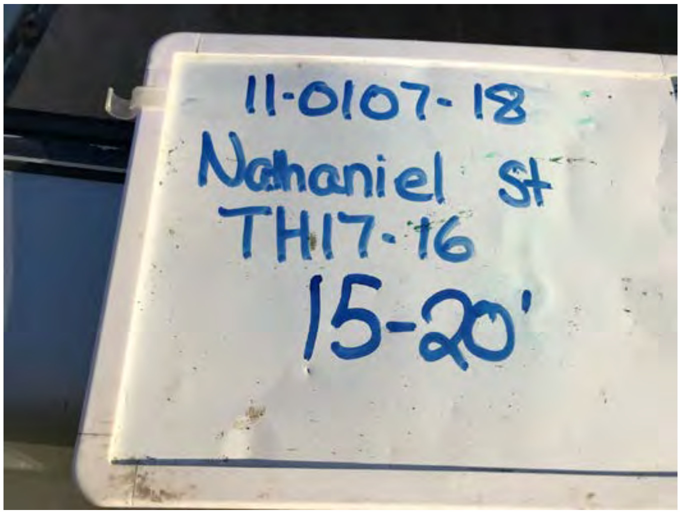
Nathaniel St
TH17-16
10-15'


CGJ 256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Nathaniel St
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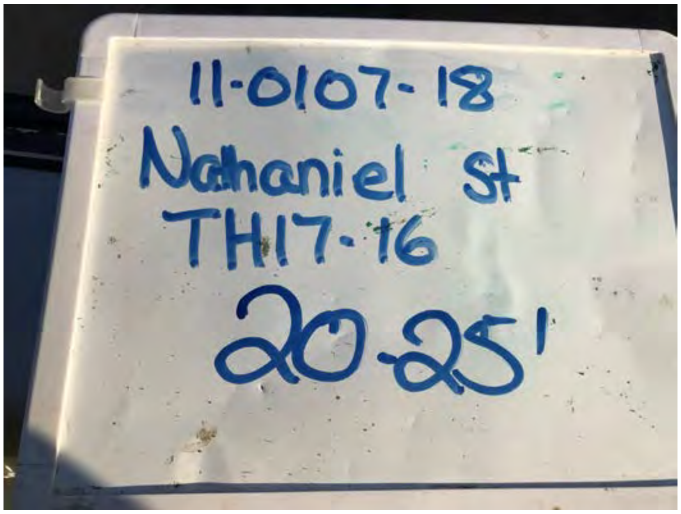
15-20'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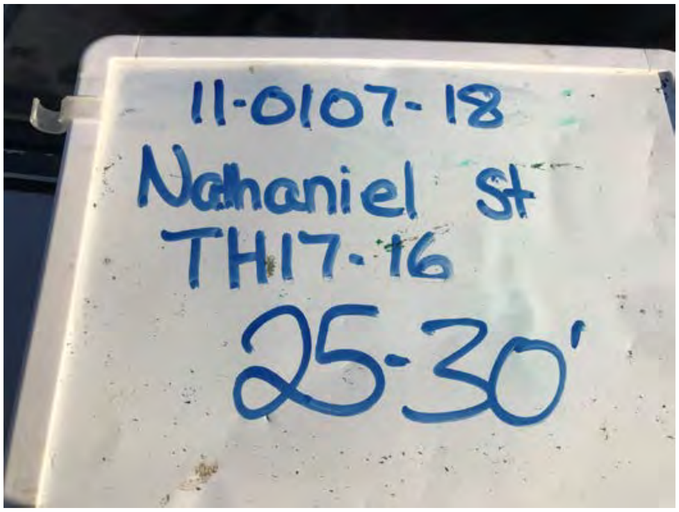
Nathaniel St
TH17-16
20-25'


CGJ 256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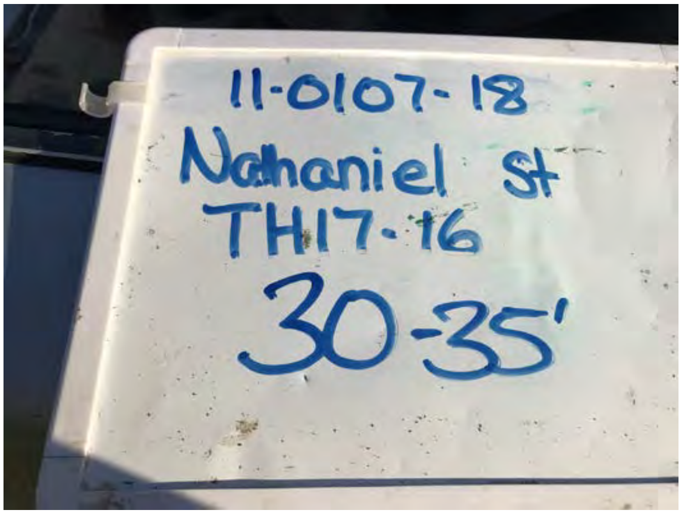
Nathaniel St
TH17-16
25-30'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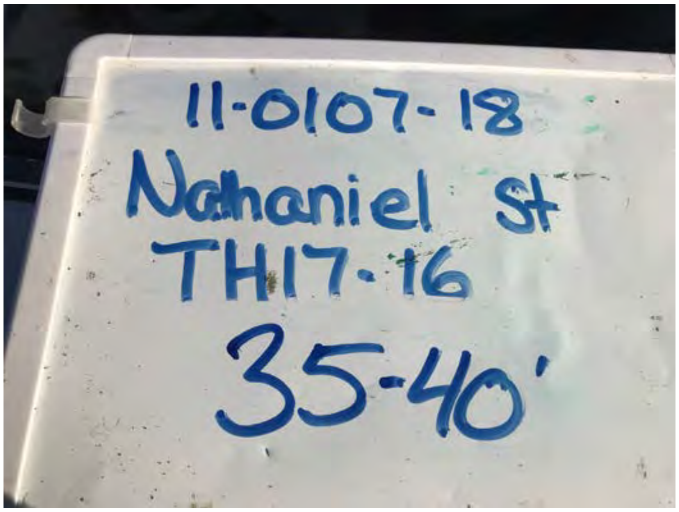
Nathaniel St
TH17-16
30-35'


CGJ 25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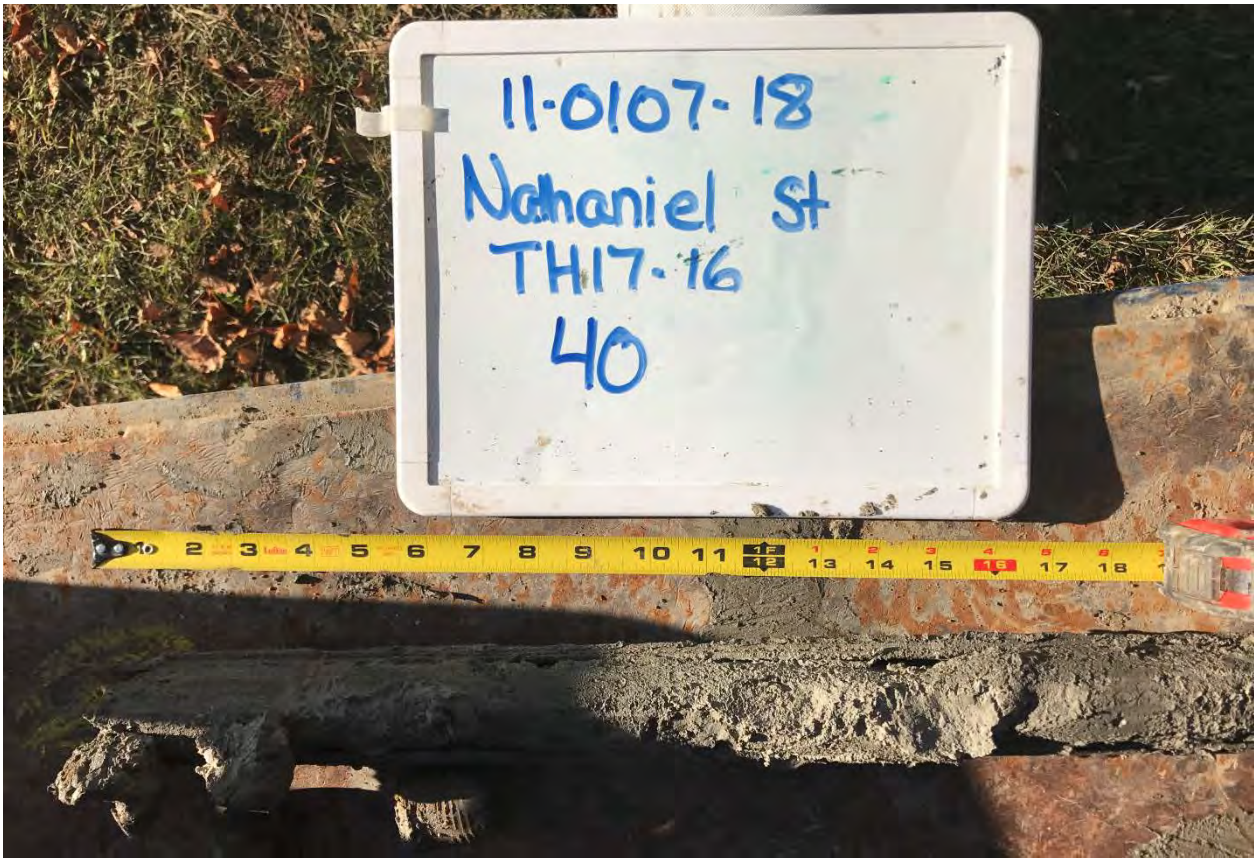
Nathaniel St
TH17-16
35-40'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TH17-16
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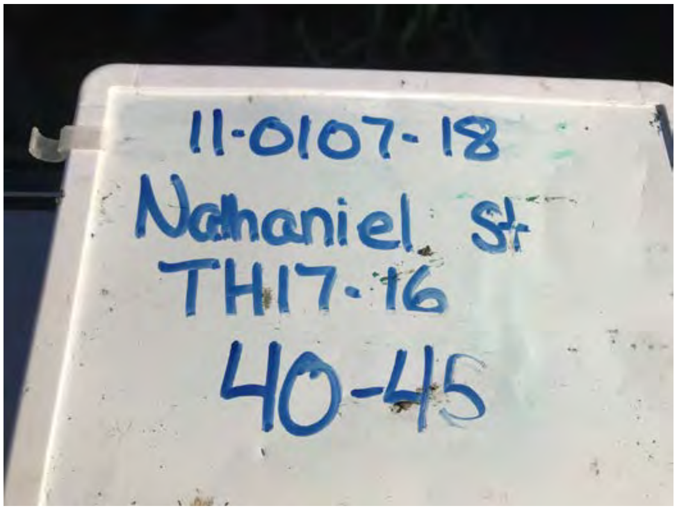
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Nathaniel St
TH17-16
40-45


CGJ 256


11-0107-18
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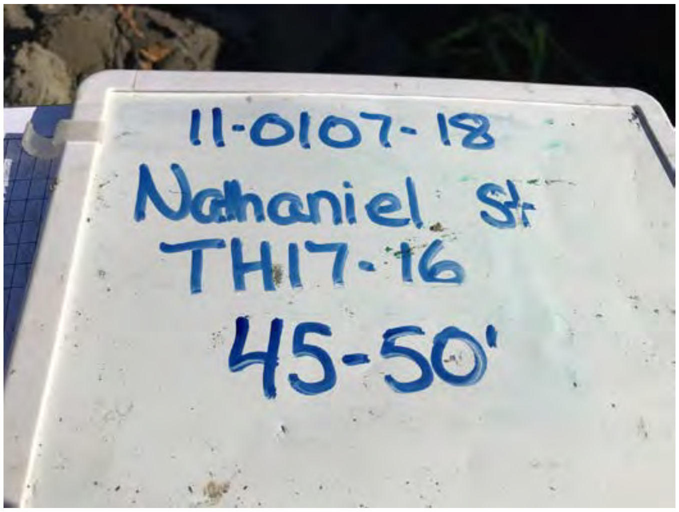
TH17-16
45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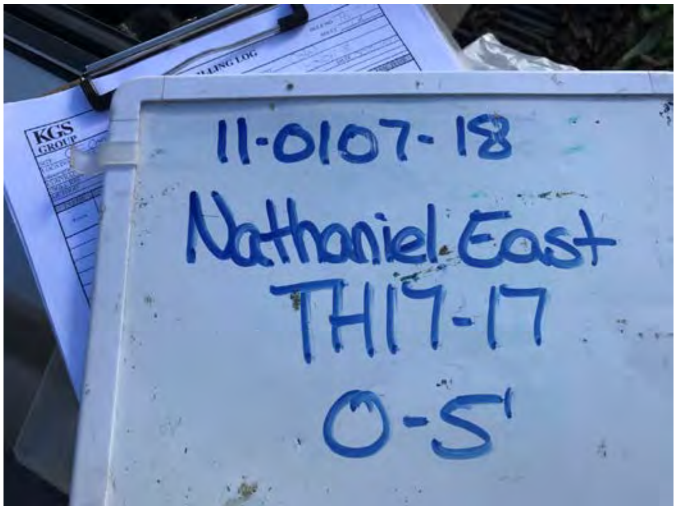
Nathaniel St
TH17-16
45-50'


CGJ 256


11-0107-18
Nathaniel St
TH17-16
50'

TH17-17

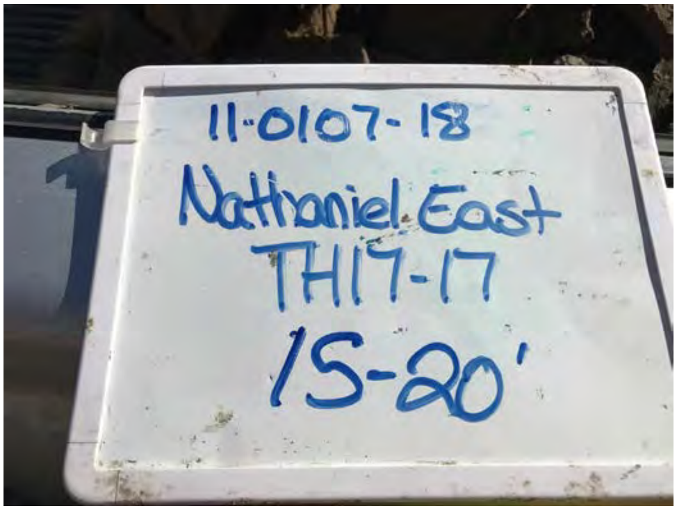

11-0107-18
Nathaniel East
TH17-17
0-5'
KGS GROUP


11-0107-18
Nathaniel East
TH17-17
5-10'


CGJ 256


11-0107-18
Nathaniel East
TH17-17
10-15'


Manitoba
GJ 256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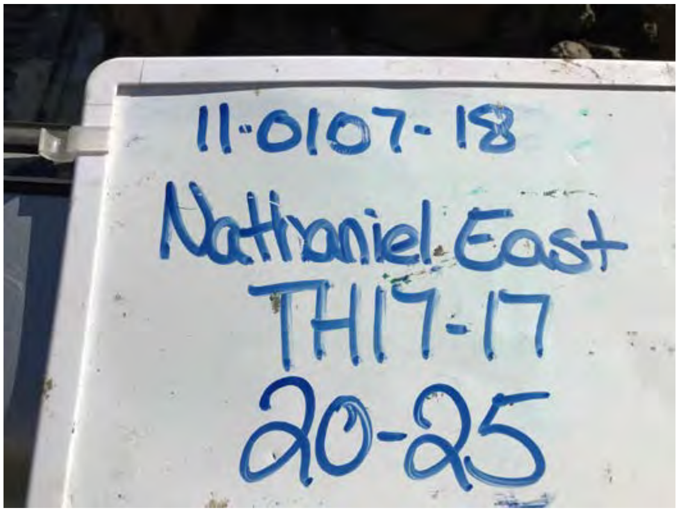
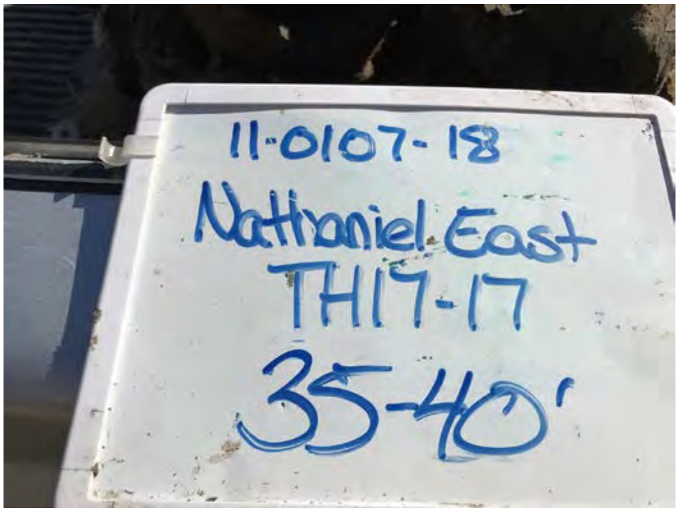
Nathaniel East
TH17-17
15-20'

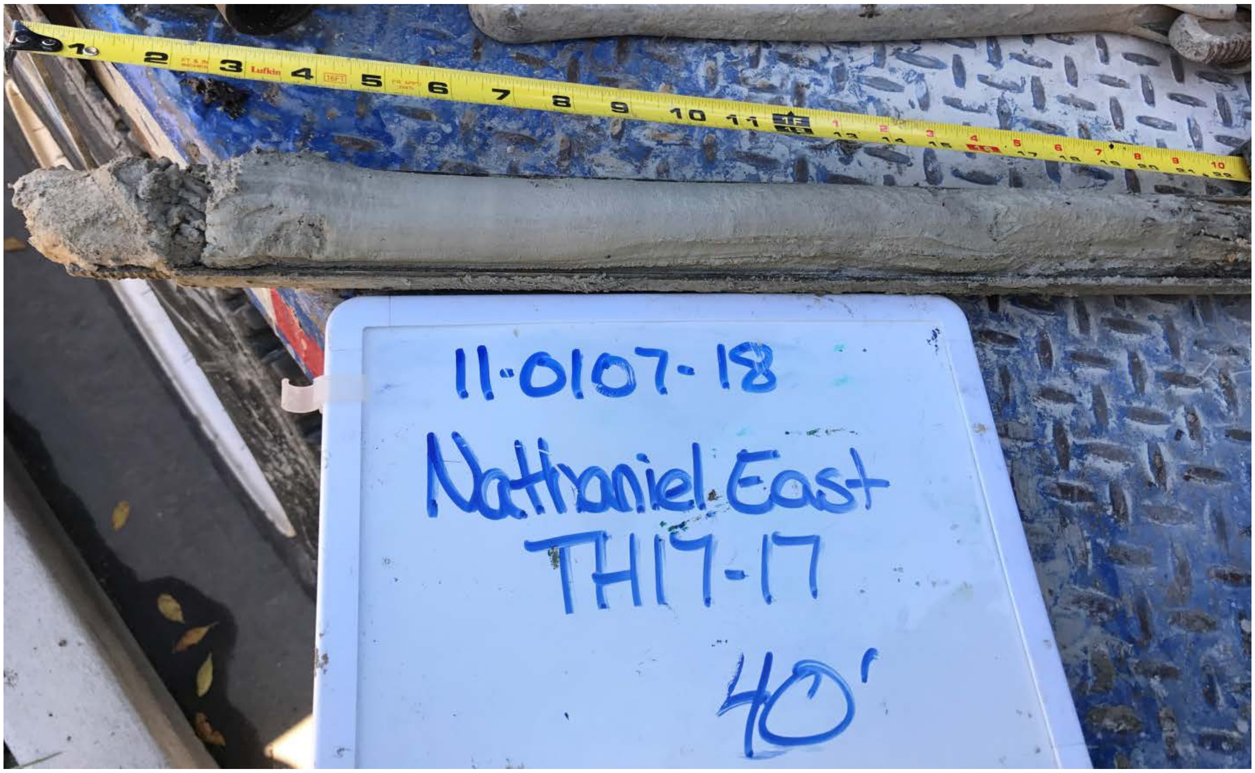

11-0107-18
Nathaniel East
TH17-17
20-25


11-0107-18
Nathaniel East
TH17-17
25-30'


11-0107-18
Nathaniel East
TH17-17
30-35'



11-0107-18
Nathaniel East
TH17-17
35-40'


11-0107-18
Nathaniel East
TH17-17
40'


11-0107-18
Nathaniel East
TH17-17
40-45'

APPENDIX D

GEOTECHNICAL INVESTIGATIONS LABORATORY DATA

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

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

PARTICLE SIZE ANALYSIS
ASTM D422

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

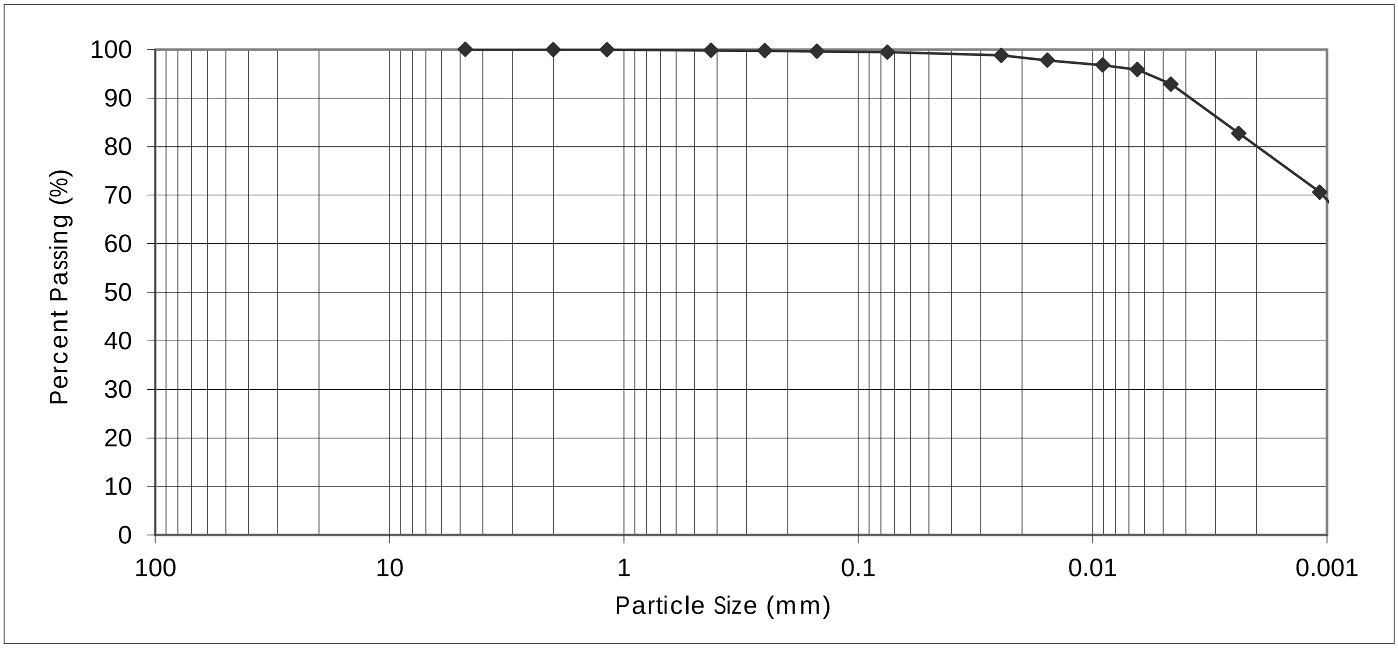
PROJECT: Cockburn & Calrossie

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

CERTIFIED BY CCIL

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

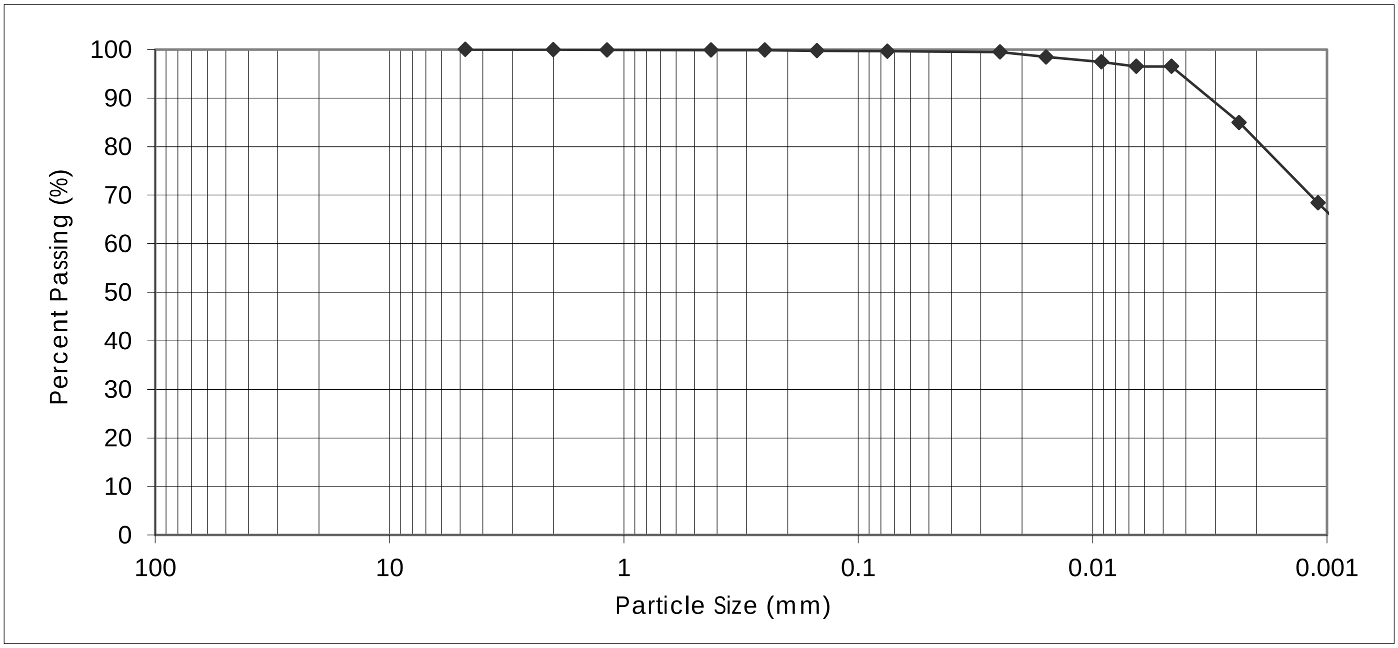
PROJECT: Cockburn & Calrossie

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.

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

PARTICLE SIZE ANALYSIS
ASTM D422

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

PROJECT: Cockburn & Calrossie

Attention: Ms. Jacqueline MacLennan

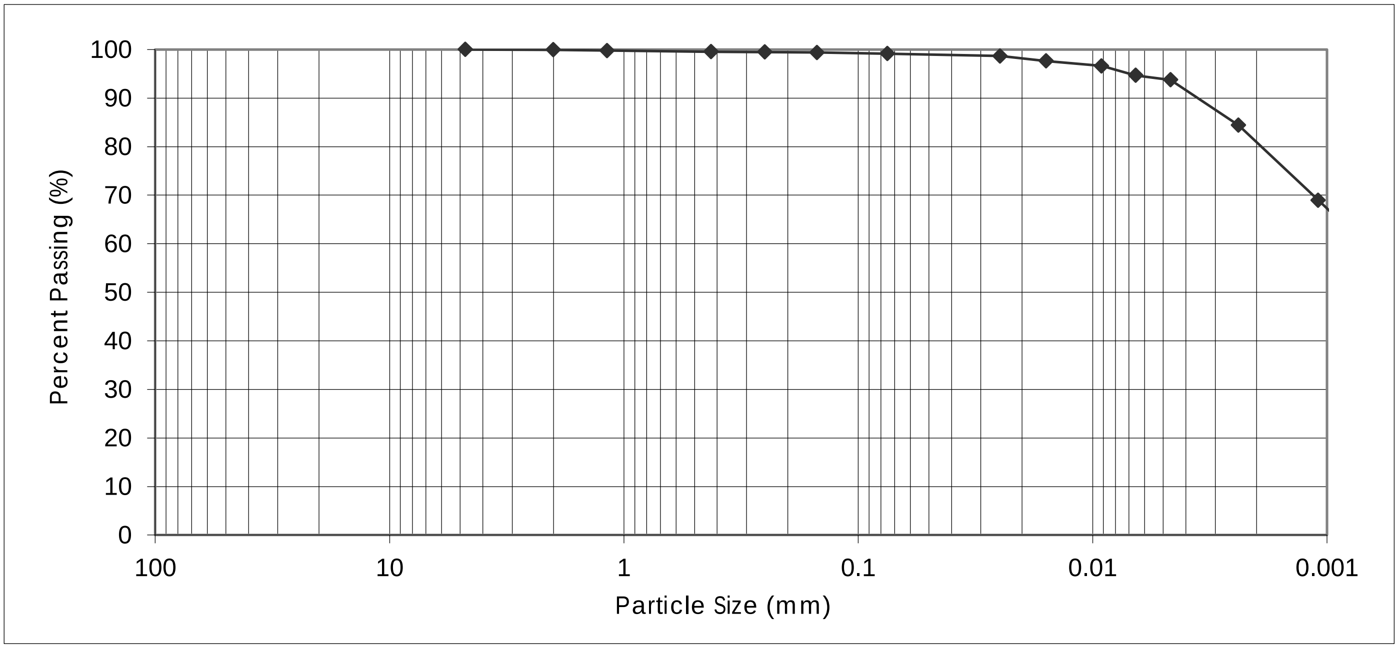
PROJECT NO.: 123311974

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.

Stantec

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

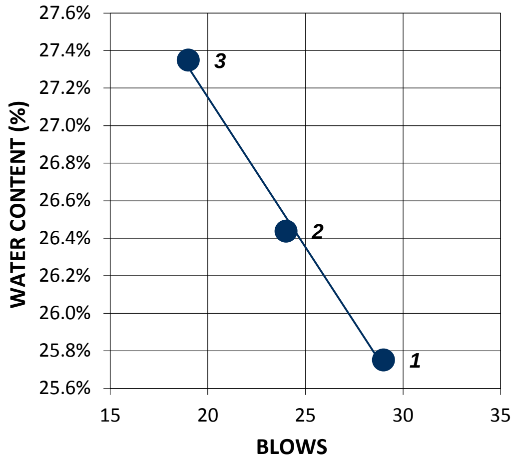
LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

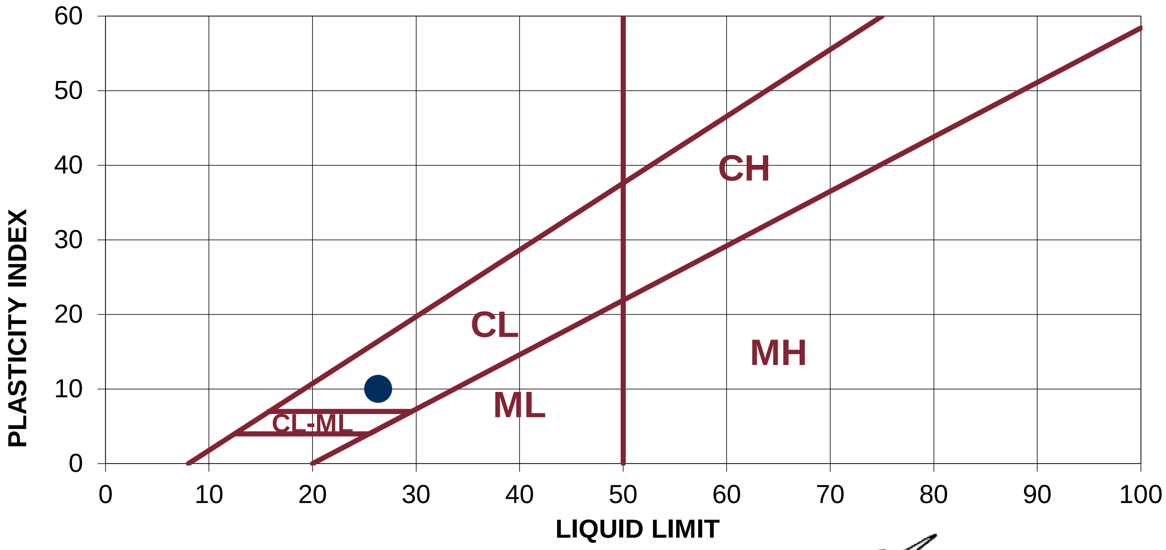
Tel: (204) 488-6999

Sample : TH16-02, S3

	LIQUID LIMIT			PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	29	24	19			
Tare No.	158	181	217	Tare No.	261	280
Wt. Sa. (wet+tare)(g)	48	41	43	Wt. Sa. (wet+tare)(g)	40.82	35.96
Wt. Sa. (dry+tare)(g)	43	37	38	Wt. Sa. (dry+tare)(g)	37.99	33.78
Wt. Tare (g)	20	20	19	Wt. Tare (g)	20.39	20.21
Wt. Dry Soil (g)	22.3	16.3	19.1	Wt. Dry Soil (g)	17.6	13.6
Wt. Water (g)	5.7	4.3	5.2	Wt. Water (g)	2.8	2.2
Water Content (%)	25.8%	26.4%	27.3%	Water Content (%)	16.1%	16.1%

RESULTS	
LL	**26**
PL	**16**
PI	**10**





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 11, 2016
Tested By:	Nestor Abarca

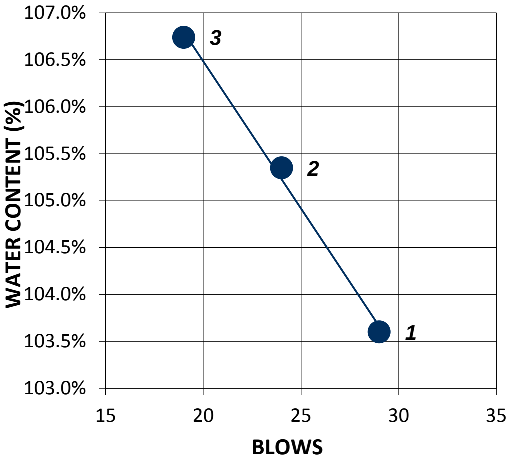
LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

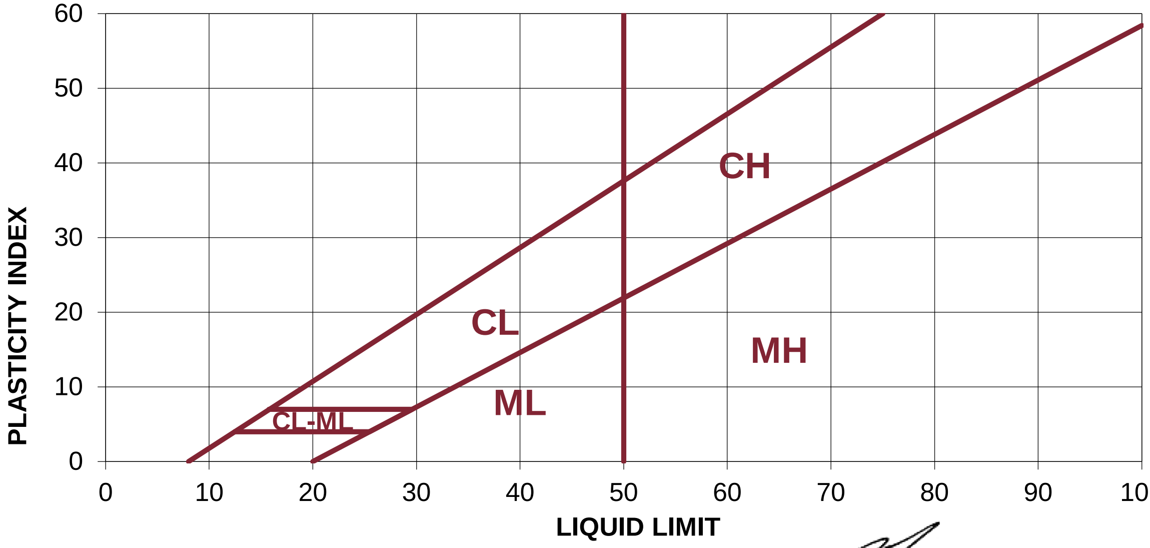
Tel: (204) 488-6999

Sample : TH16-02 , S5

LIQUID LIMIT				PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	29	24	19			
Tare No.	133	140	178	Tare No.	238	310
Wt. Sa. (wet+tare)(g)	38	40	39	Wt. Sa. (wet+tare)(g)	30.54	28.54
Wt. Sa. (dry+tare)(g)	29	30	29	Wt. Sa. (dry+tare)(g)	28.17	26.62
Wt. Tare (g)	20	20	20	Wt. Tare (g)	20.70	20.54
Wt. Dry Soil (g)	9.2	9.9	9.2	Wt. Dry Soil (g)	7.5	6.1
Wt. Water (g)	9.5	10.4	9.8	Wt. Water (g)	2.4	1.9
Water Content (%)	103.6%	105.3%	106.7%	Water Content (%)	31.7%	31.6%

RESULTS	
LL	**105**
PL	**32**
PI	**73**





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CCIL

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

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

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-03, S5

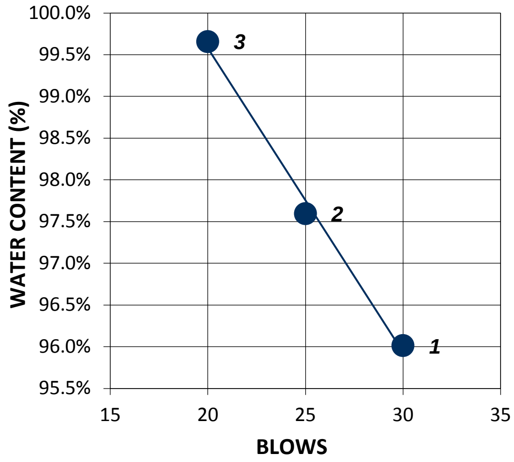
LIQUID LIMIT

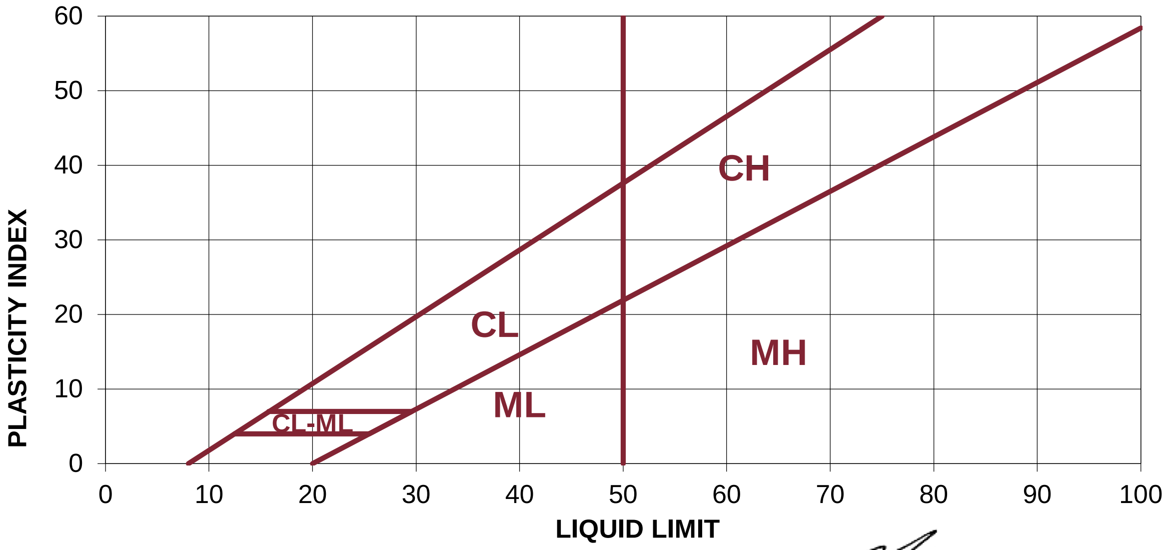
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	133	140	178
Wt. Sa. (wet+tare)(g)	39	40	43
Wt. Sa. (dry+tare)(g)	30	30	31
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	10.0	10.4	11.7
Wt. Water (g)	9.6	10.2	11.7
Water Content (%)	96.0%	97.6%	99.7%

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**





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

LABORATORY
199 Henlow Bay
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Tel: (204) 488-6999

Sample : TH16-05, S2

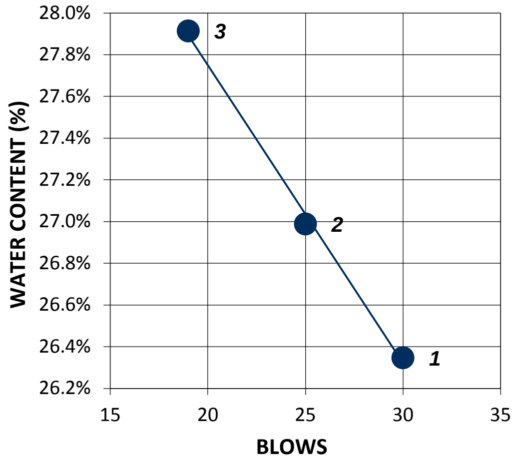
LIQUID LIMIT

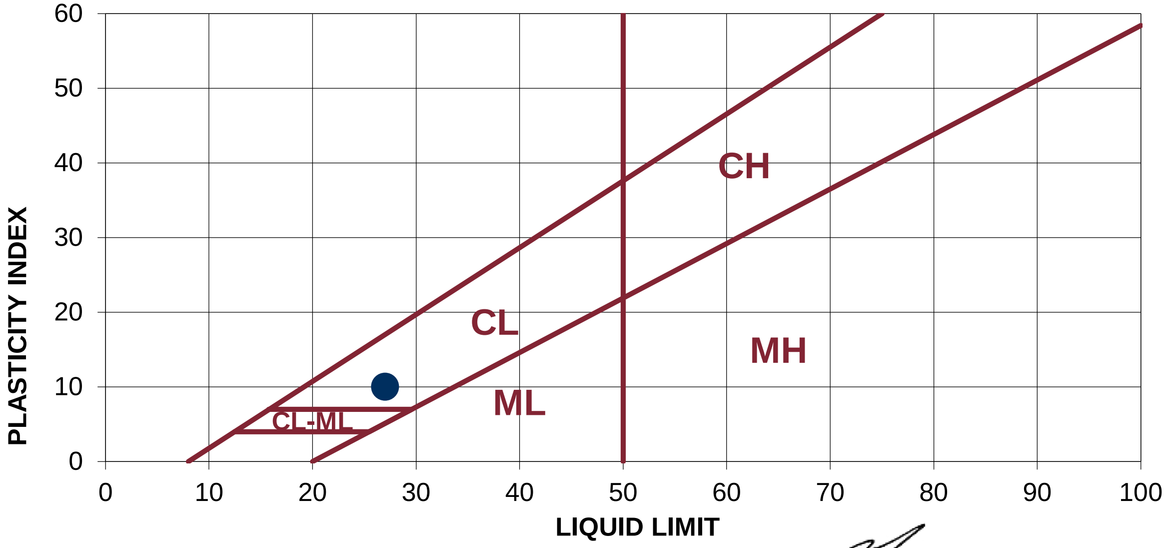
Trial	1	2	3
No. of Blows	30	25	19
Tare No.	189	196	259
Wt. Sa. (wet+tare)(g)	43	41	44
Wt. Sa. (dry+tare)(g)	38	37	39
Wt. Tare (g)	19	20	20
Wt. Dry Soil (g)	18.8	17.0	18.3
Wt. Water (g)	4.9	4.6	5.1
Water Content (%)	26.3%	27.0%	27.9%

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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LABORATORY
199 Henlow Bay
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Tel: (204) 488-6999

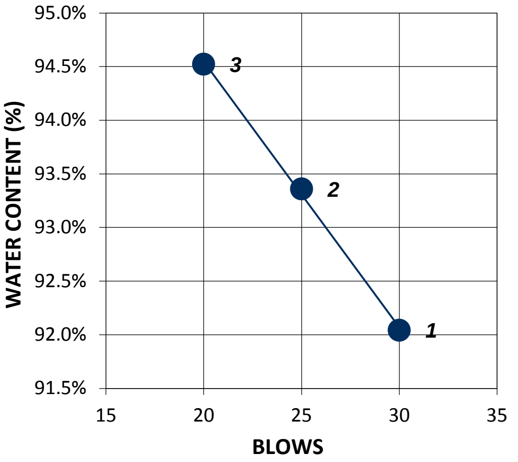
Atterberg Limits
ASTM D4318
Method A- Multi-Point

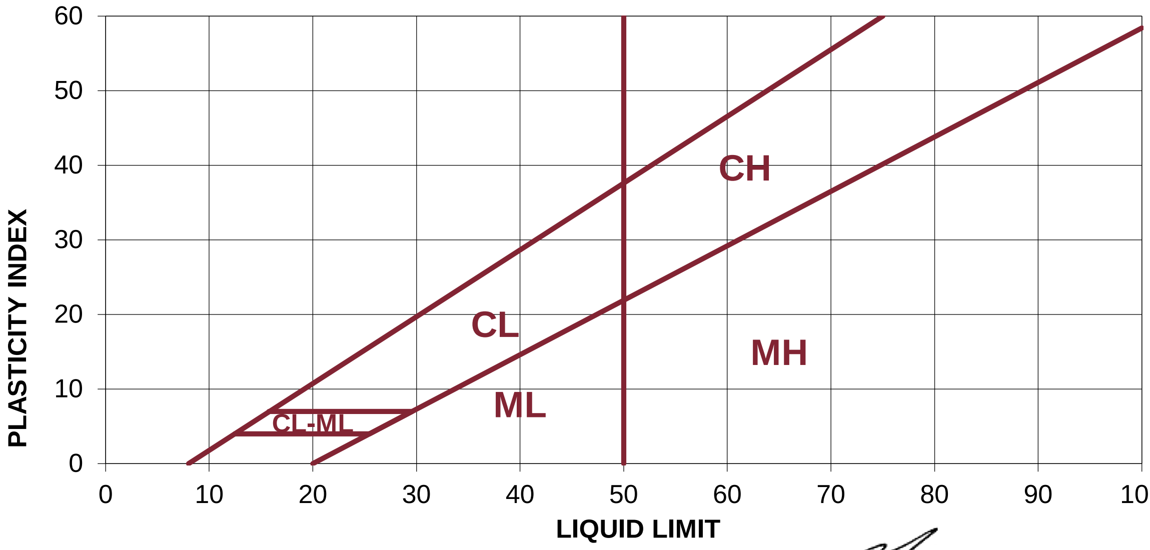
Client: KGS Group
Project Name: Cockburn & Calrossie
Project No: 123311974
Date Received: May 4, 2016
Date Tested: May 11, 2016
Tested By: Nestor Abarca

Sample : TH16-05 , S4

	LIQUID LIMIT			PLASTIC LIMIT		
Trial	1	2	3	Trial	1	2
No. of Blows	30	25	20			
Tare No.	154	235	247	Tare No.	264	293
Wt. Sa. (wet+tare)(g)	38	40	40	Wt. Sa. (wet+tare)(g)	28.83	31.05
Wt. Sa. (dry+tare)(g)	29	31	30	Wt. Sa. (dry+tare)(g)	27.00	28.87
Wt. Tare (g)	20	20	20	Wt. Tare (g)	20.23	20.89
Wt. Dry Soil (g)	9.3	10.1	10.4	Wt. Dry Soil (g)	6.8	8.0
Wt. Water (g)	8.6	9.4	9.8	Wt. Water (g)	1.8	2.2
Water Content (%)	92.0%	93.4%	94.5%	Water Content (%)	27.0%	27.3%

RESULTS	
LL	93
PL	27
PI	66





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 11, 2016
Tested By: Nestor Abarca

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
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Tel: (204) 488-6999

Sample : TH16-06 , S7

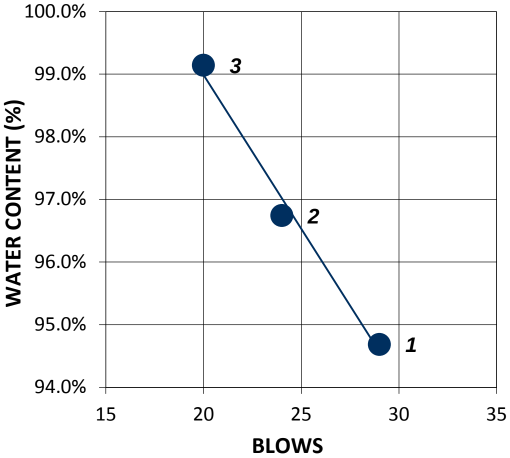
LIQUID LIMIT

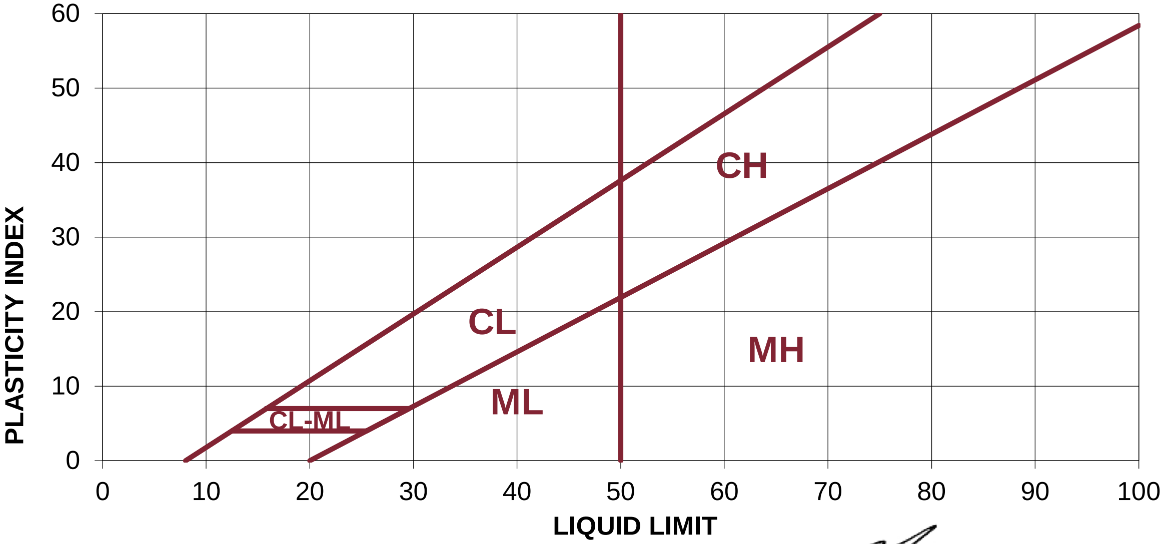
Trial	1	2	3
No. of Blows	29	24	20
Tare No.	152	157	192
Wt. Sa. (wet+tare)(g)	36	38	36
Wt. Sa. (dry+tare)(g)	28	29	28
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	8.5	8.9	8.2
Wt. Water (g)	8.0	8.6	8.1
Water Content (%)	94.7%	96.7%	99.1%

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.

Stantec

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

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-06 , S10

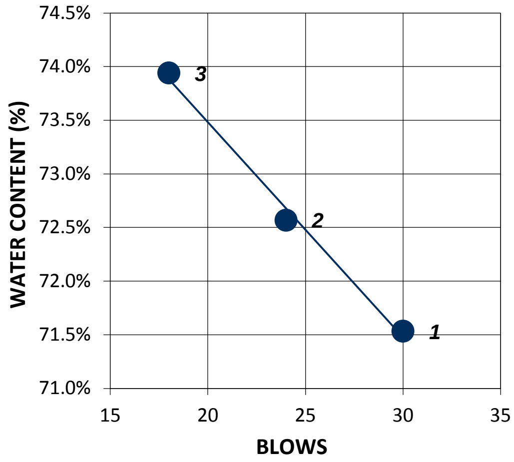
LIQUID LIMIT

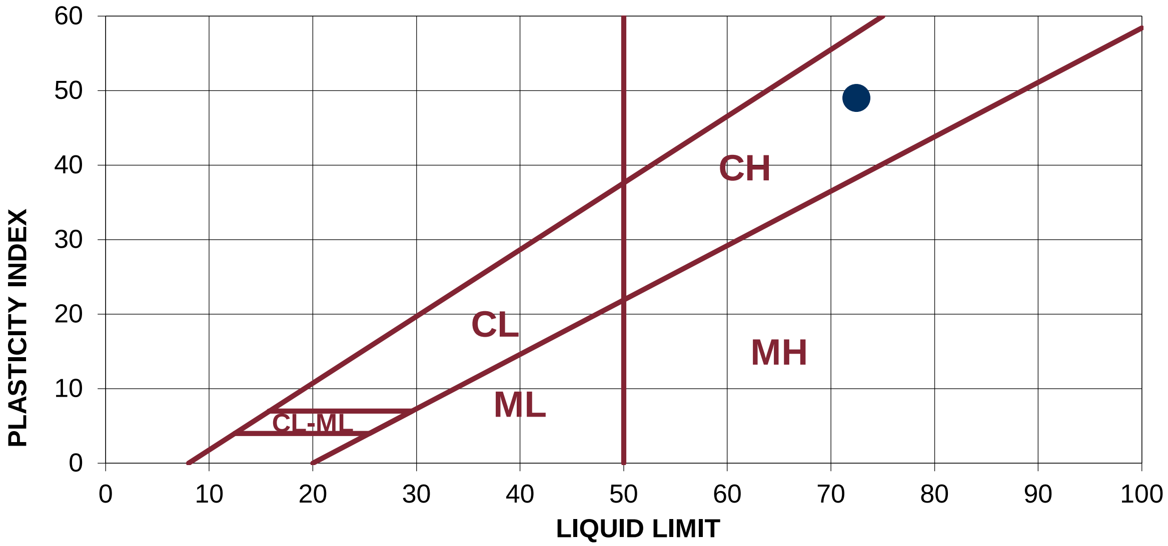
Trial	1	2	3
No. of Blows	30	24	18
Tare No.	158	181	217
Wt. Sa. (wet+tare)(g)	41	44	39
Wt. Sa. (dry+tare)(g)	33	34	30
Wt. Tare (g)	20	20	19
Wt. Dry Soil (g)	12.3	13.8	11.3
Wt. Water (g)	8.8	10.0	8.4
Water Content (%)	71.5%	72.6%	73.9%

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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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 11, 2016
Tested By: Nestor Abarca

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-08 , S7

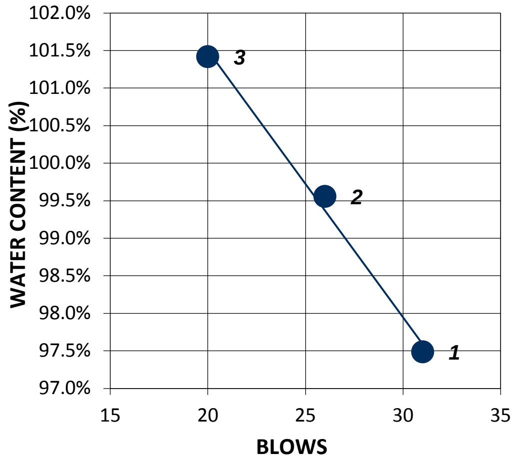
LIQUID LIMIT

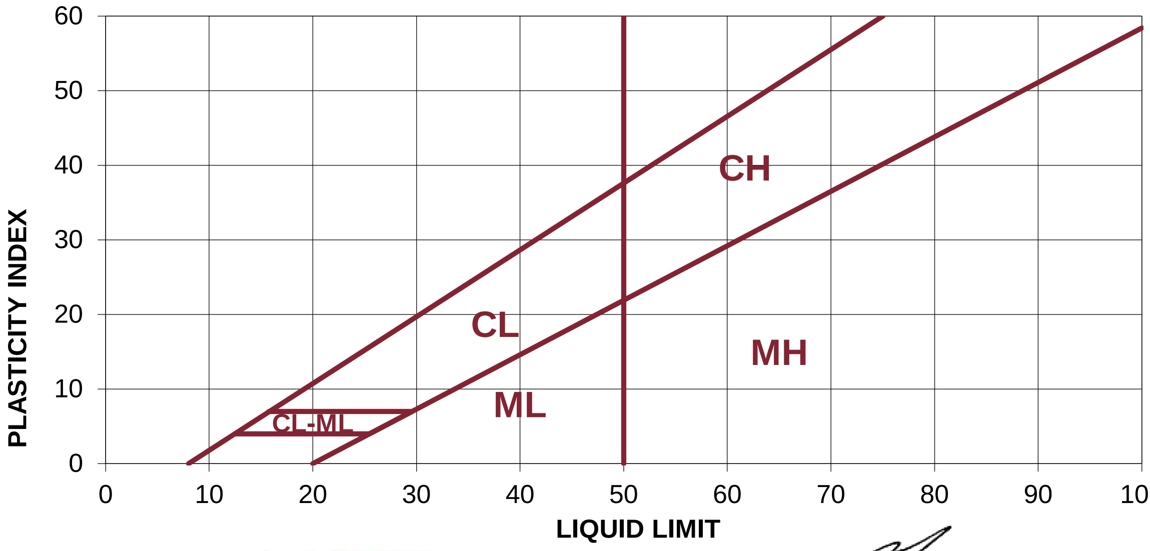
Trial	1	2	3
No. of Blows	31	26	20
Tare No.	234	245	249
Wt. Sa. (wet+tare)(g)	37	38	38
Wt. Sa. (dry+tare)(g)	29	29	29
Wt. Tare (g)	21	20	20
Wt. Dry Soil (g)	8.4	9.0	9.2
Wt. Water (g)	8.2	9.0	9.3
Water Content (%)	97.5%	99.6%	101.4%

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.

Stantec

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

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-08, S8

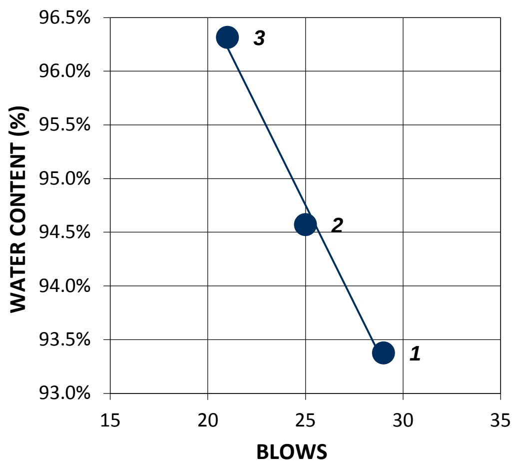
LIQUID LIMIT

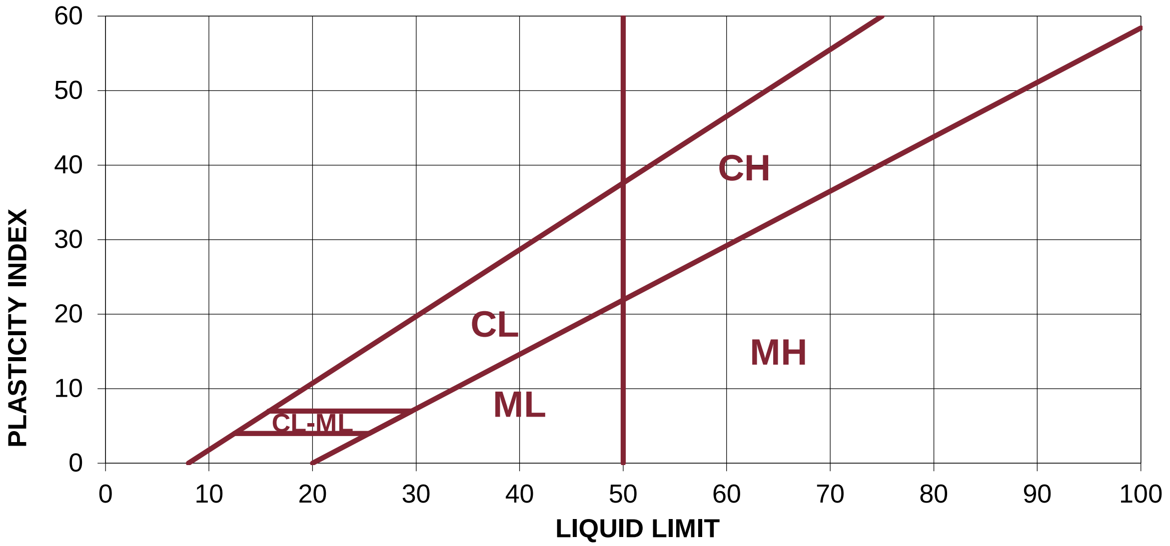
Trial	1	2	3
No. of Blows	29	25	21
Tare No.	152	157	192
Wt. Sa. (wet+tare)(g)	38	38	42
Wt. Sa. (dry+tare)(g)	29	30	31
Wt. Tare (g)	20	20	20
Wt. Dry Soil (g)	9.5	9.2	11.4
Wt. Water (g)	8.9	8.7	11.0
Water Content (%)	93.4%	94.6%	96.3%

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**





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

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

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-08, S11

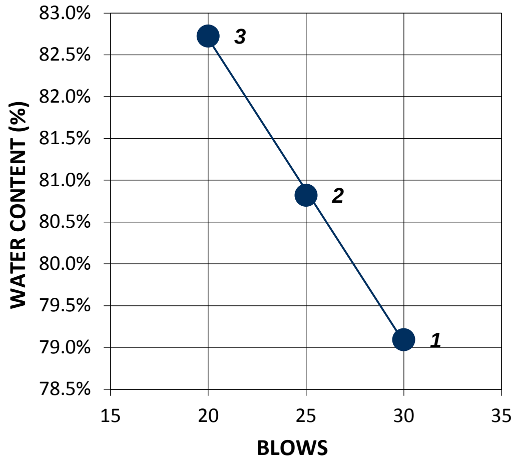
LIQUID LIMIT

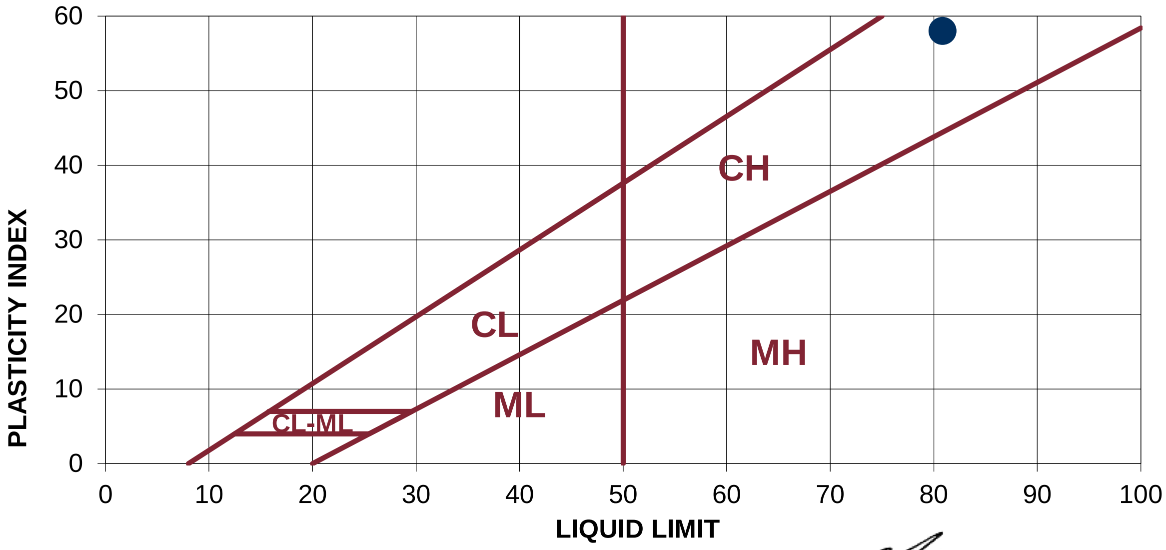
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	234	245	249
Wt. Sa. (wet+tare)(g)	41	41	41
Wt. Sa. (dry+tare)(g)	32	32	32
Wt. Tare (g)	21	20	20
Wt. Dry Soil (g)	11.2	11.7	11.5
Wt. Water (g)	8.9	9.4	9.5
Water Content (%)	79.1%	80.8%	82.7%

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**





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

LABORATORY
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Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-09, S6

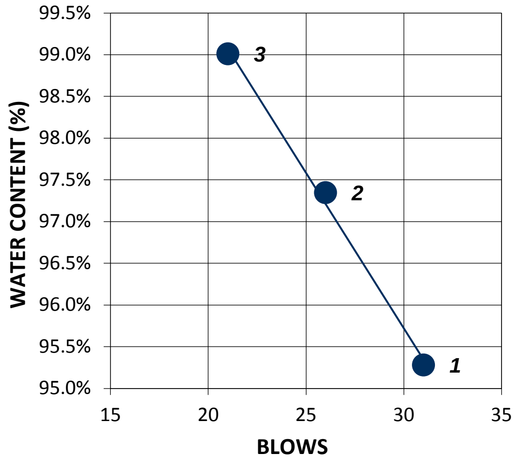
LIQUID LIMIT

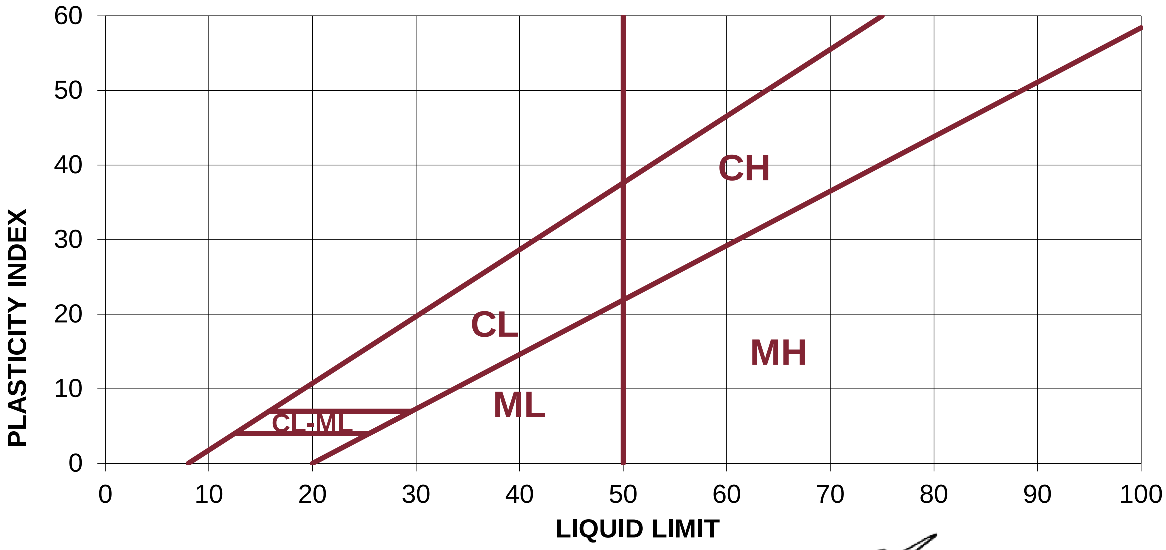
Trial	1	2	3
No. of Blows	31	26	21
Tare No.	189	196	259
Wt. Sa. (wet+tare)(g)	37	40	39
Wt. Sa. (dry+tare)(g)	28	30	30
Wt. Tare (g)	19	20	20
Wt. Dry Soil (g)	9.1	10.6	9.1
Wt. Water (g)	8.7	10.3	9.0
Water Content (%)	95.3%	97.3%	99.0%

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**





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

LABORATORY
199 Henlow Bay
Winnipeg, Manitoba
Canada R3Y 1G4

Tel: (204) 488-6999

Sample : TH16-09, S9

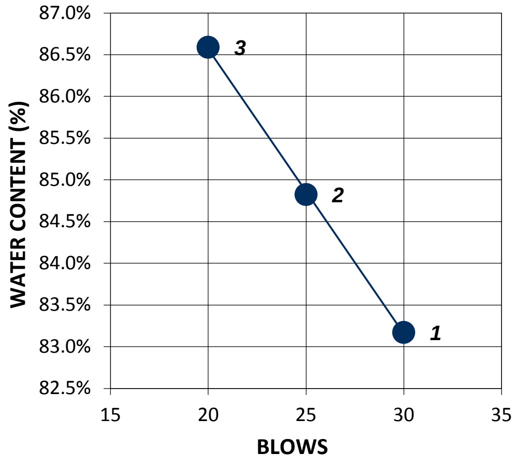
LIQUID LIMIT

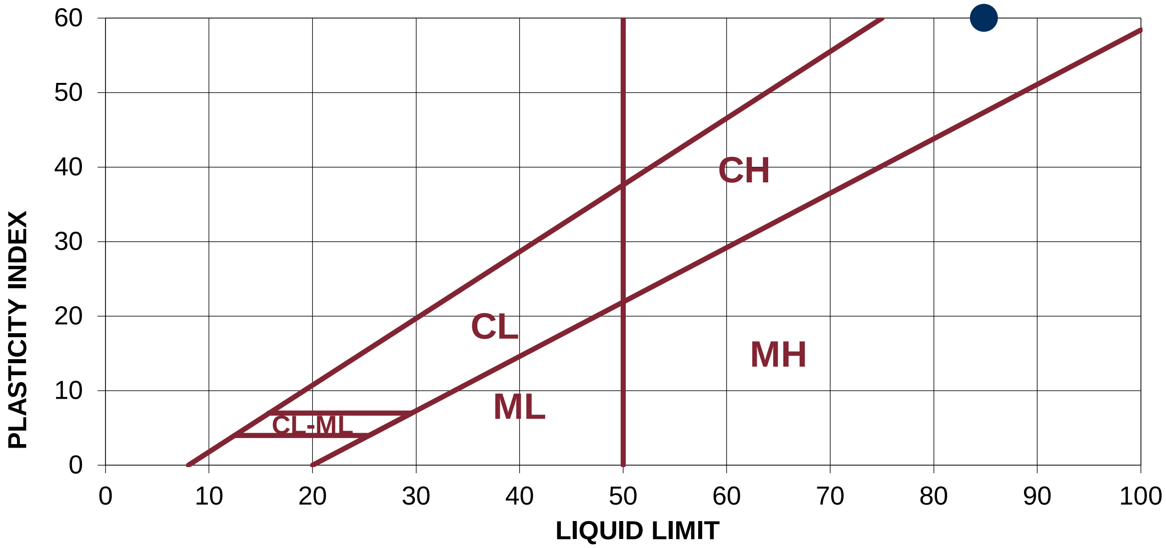
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	154	235	247
Wt. Sa. (wet+tare)(g)	42	40	44
Wt. Sa. (dry+tare)(g)	32	31	33
Wt. Tare (g)	20	21	20
Wt. Dry Soil (g)	12.4	10.4	12.9
Wt. Water (g)	10.3	8.8	11.2
Water Content (%)	83.2%	84.8%	86.6%

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.

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

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client KGS Group Inc.
Address 3rd Floor - 865 Waverley Street
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

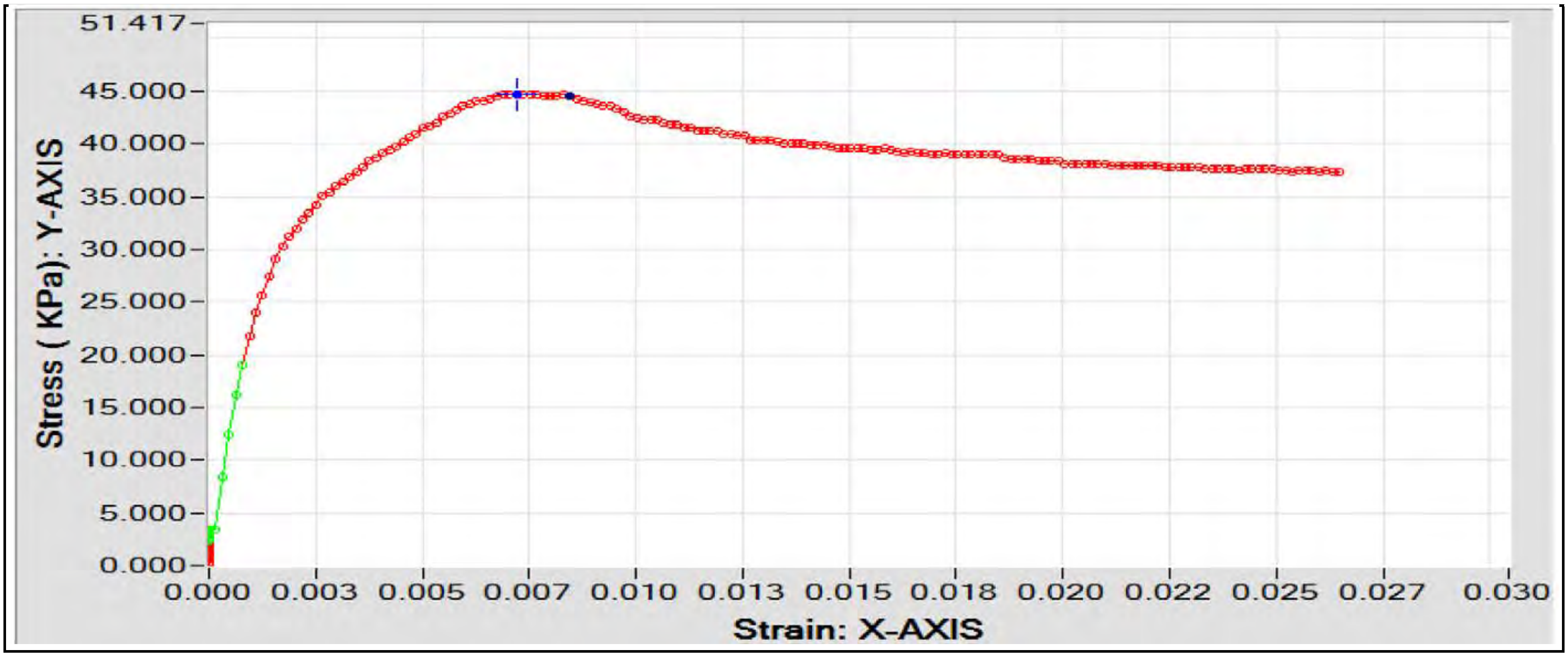
Attention: Ms. Jacqueline MacLennan

PROJECT: Cockburn/Calrossie (11-0107-18)
PROJECT NO.: 123311974
REPORT NO.:

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

DATE RECEIVED: May 4, 2016
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.

Stantec

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

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL
ASTM D2166

Client KGS Group Inc.
Address 3rd Floor - 865 Waverley Street
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

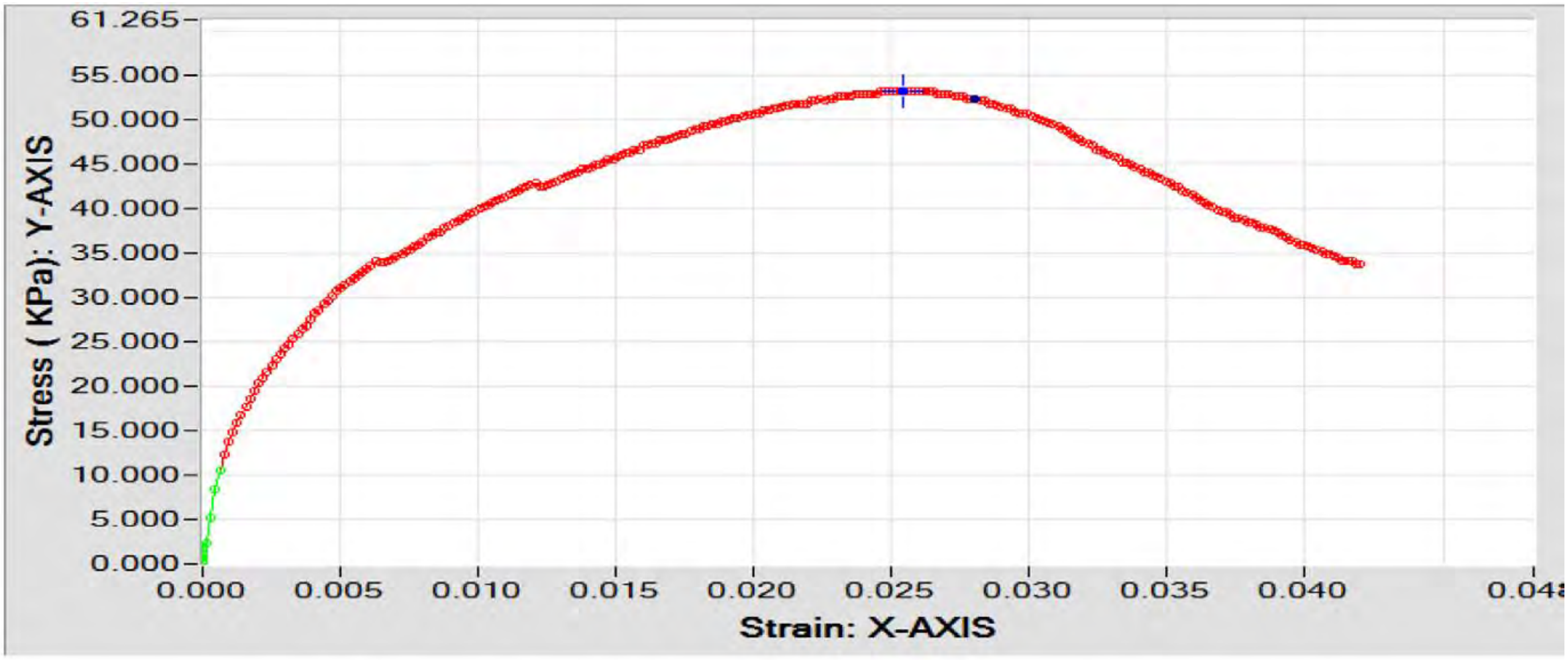
Attention: Ms. Jacqueline MacLennan

PROJECT: Cockburn/Calrossie (11-0107-18)
PROJECT NO.: 123311974
REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH16-06, S10

DATE RECEIVED: May 4, 2016
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

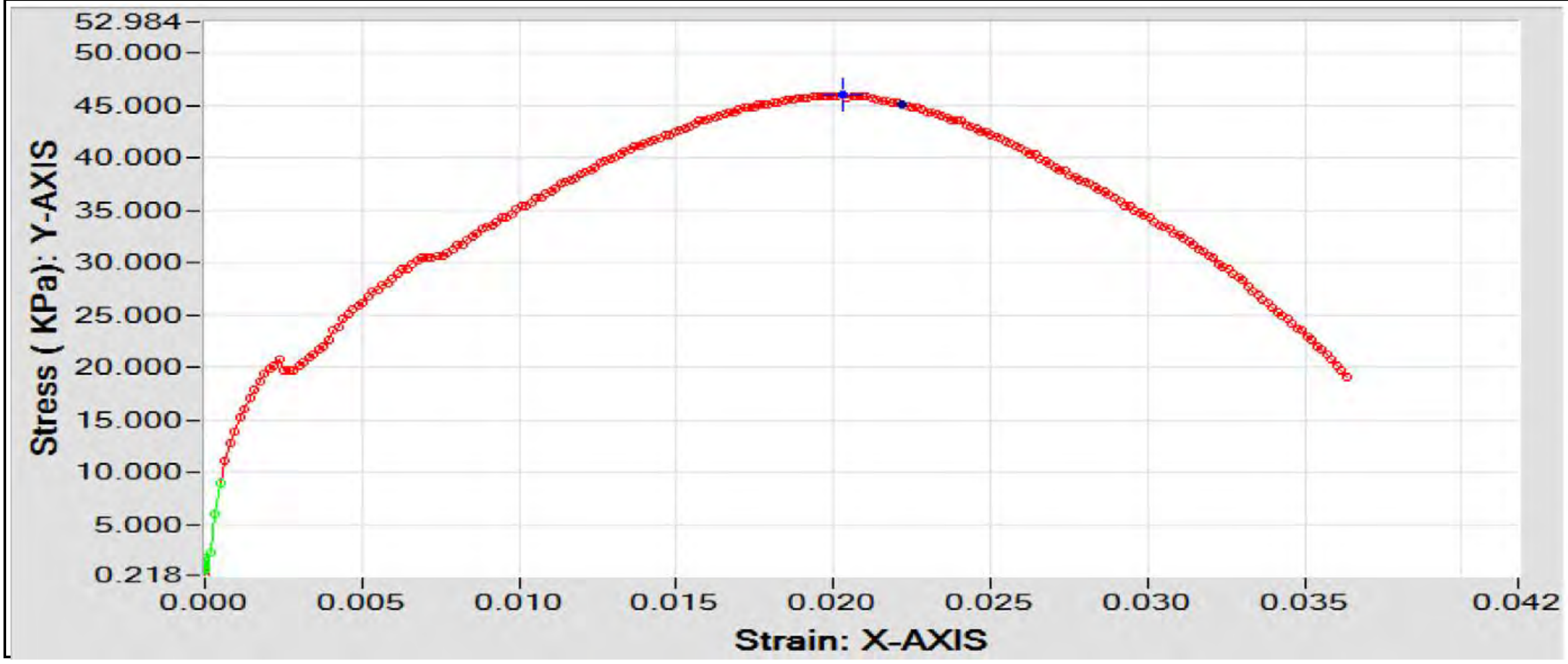
REVIEWED BY: Jason Thompson, C.E.T.

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:	TH16-08, 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

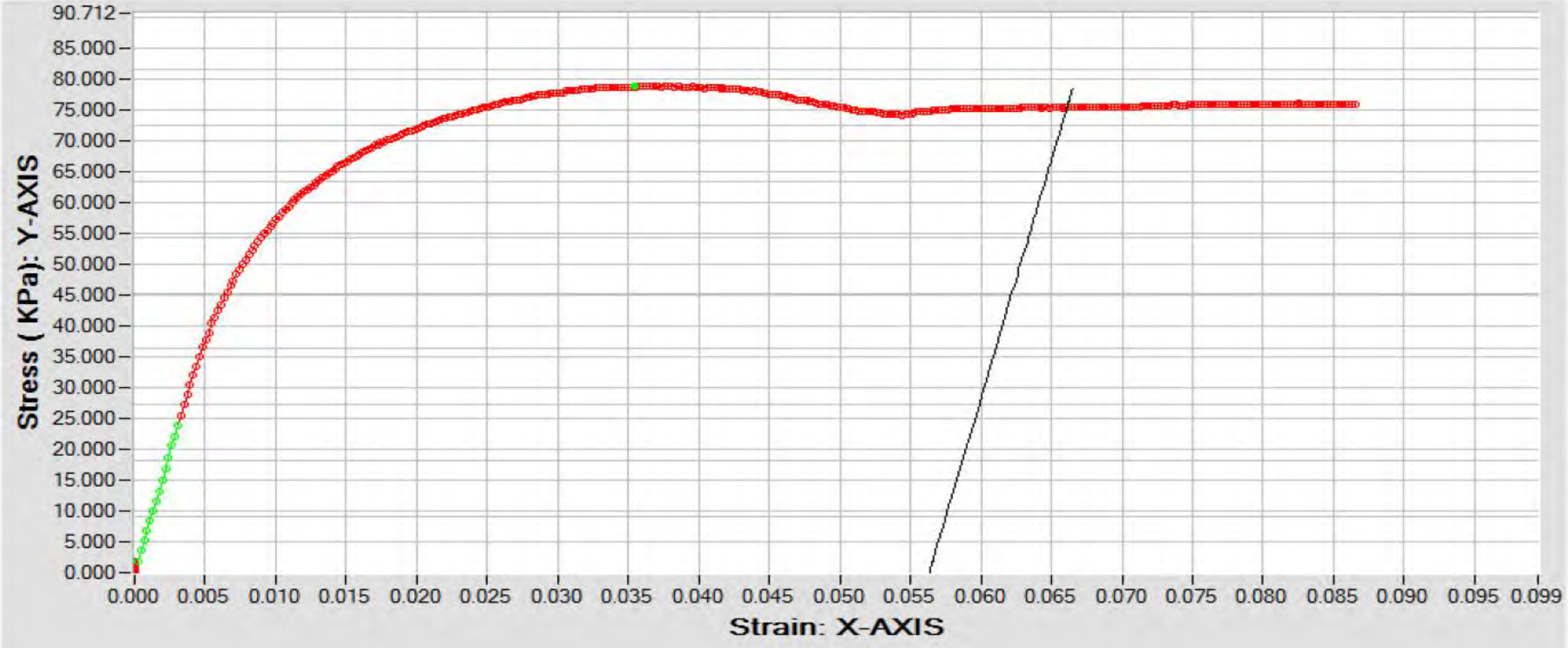
REVIEWED BY: Jason Thompson, C.E.T.

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:	TH16-08, 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.

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

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client KGS Group Inc.
Address 3rd Floor - 865 Waverley Street
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

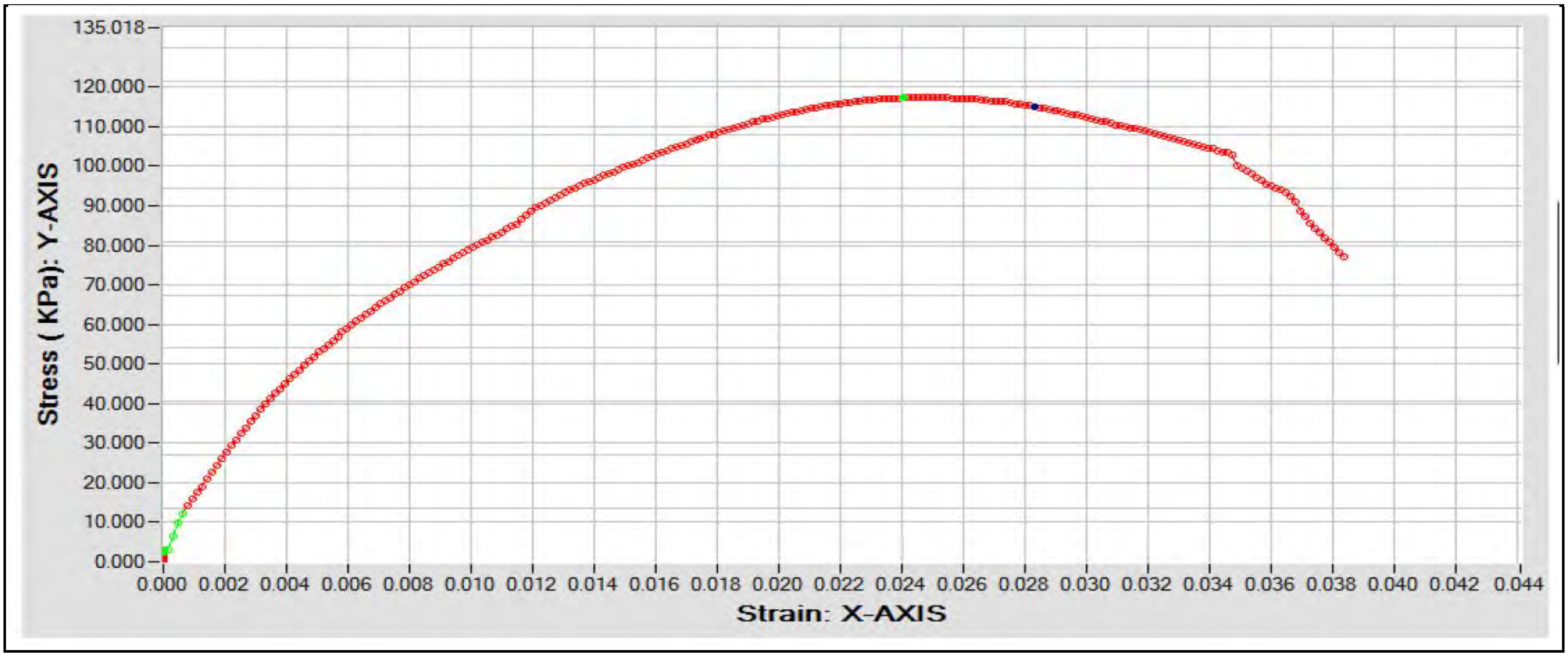
Attention: Ms. Jacqueline MacLennan

PROJECT: Cockburn/Calrossie (11-0107-18)
PROJECT NO.: 123311974
REPORT NO.:

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

DATE RECEIVED: May 4, 2016
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.

Stantec

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

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client KGS Group Inc.
Address 3rd Floor - 865 Waverley Street
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

Attention: Ms. Jacqueline MacLennan

PROJECT: Cockburn/Calrossie (11-0107-18)

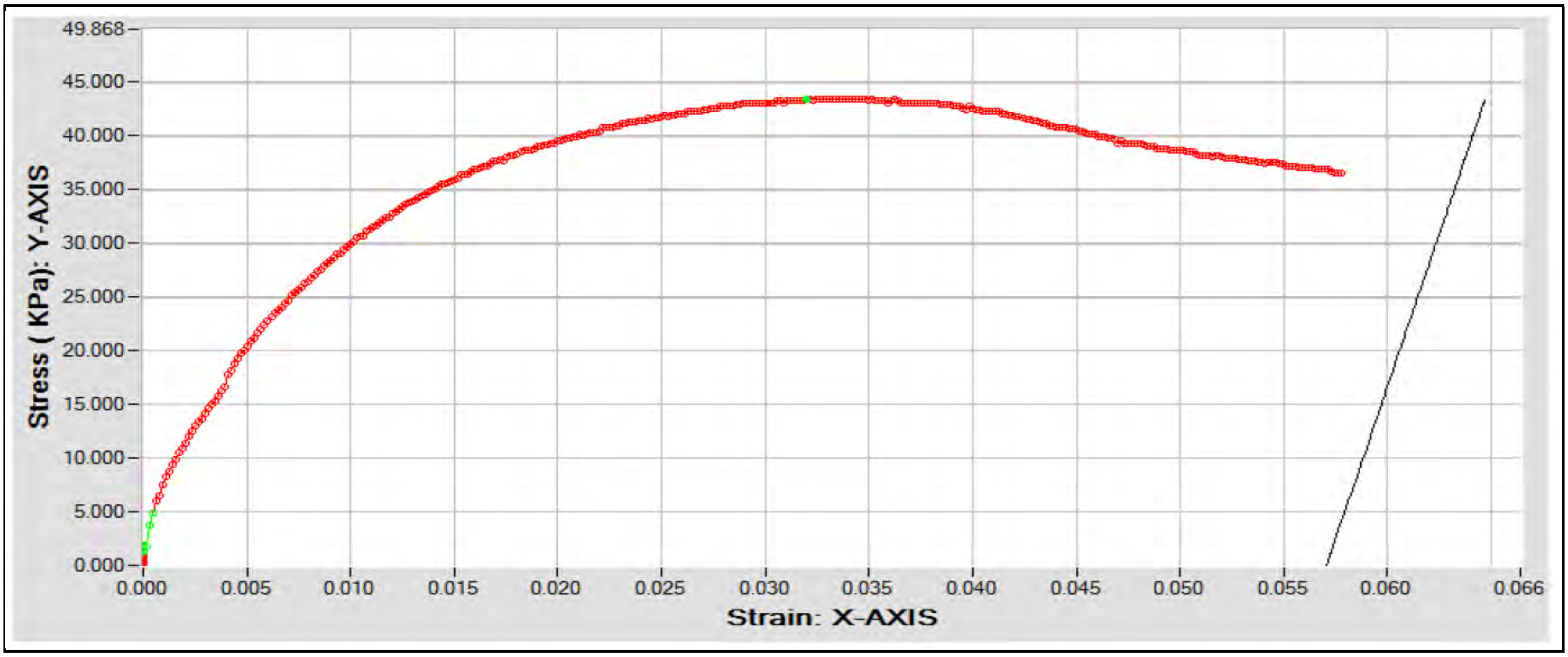
PROJECT NO.: 123311974

REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH16-09, S9

DATE RECEIVED: May 4, 2016
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.

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

May 16, 2017
File: 123311974

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

Dear Jacqueline,

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

On May 9, 2017, a total of thirty-nine (39) soil samples were submitted to our laboratory for analysis. 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,

Nestor Abarca, C. Tech.
Geotechnical Technologist
Phone: (204) 488-6999
nestor.abarca@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 Test Data
Table 3 - Atterberg Limits Test Data
9 x Shelby Tube Photos
4 x Particle Size Analysis Reports
10 x Atterberg Limits Reports
9 x Unconfined Compressive Strength Reports

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

TABLE 1
WATER CONTENT TEST DATA

Testhole	Field Sample No.	Water Content (%)	Testhole	Field Sample No.	Water Content (%)
TH17-01	S1	29.4	TH17-10	S1	34.2
	S3	53.1		S3	54.2
	S12	22.2		S9	53.0
TH17-06	S1	34.9		S11	48.5
	S3	48.7		S12	14.8
	S9	48.4	TH17-13	S9	16.0
	S11	47.5		S11	12.7
	S13	20.0	TH17-15	S1	36.0
TH17-09	S10	22.8		S12	13.0
	S11	16.1			

TABLE 2
PARTICLE SIZE ANALYSIS TEST DATA

Testhole	Field Sample No.	Particle Size Analysis						
		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			
TH17-06	S13	45.2	4.7	4.4	7.4	21.4	16.9	13.6
TH17-09	S11	9.4	6.2	10.0	14.9	39.2	20.3	16.1
TH17-10	S12	3.5	6.4	11.3	14.8	46.9	17.1	12.8
TH17-13	S11	46.5	17.7	14.2	8.4	9.8	3.4	2.0

Notes:

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

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 particle size analysis

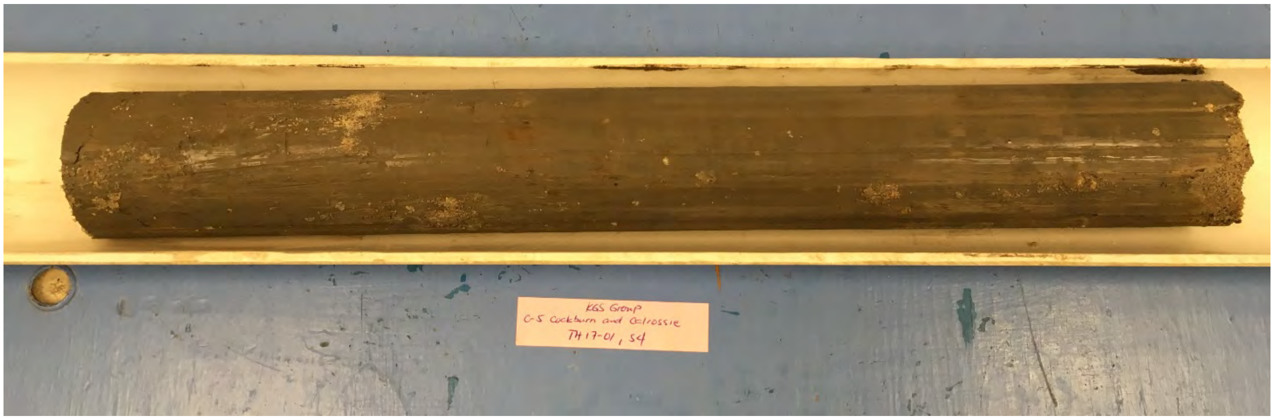
TABLE 3
ATTERBERG LIMITS TEST DATA

Testhole	Field Sample No.	Atterberg Limits		
		Liquid Limit	Plastic Limit	Plasticity Index
TH17-01	S3	102	29	73
TH17-01	S4	110	29	81
TH17-06	S3	98	28	70
TH17-06	S6	92	24	68
TH17-06	S9	93	27	66
TH17-10	S3	106	31	75
TH17-10	S6	86	24	62
TH17-10	S11	88	24	64
TH17-15	S4	108	28	80
TH17-15	S6	91	26	65

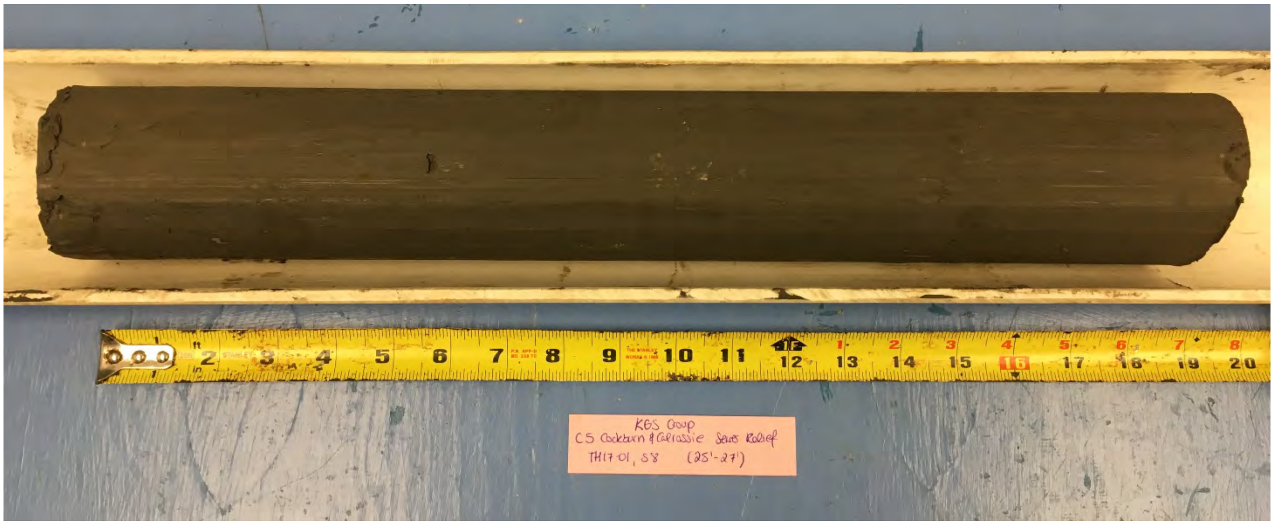
Notes:
1. The soil samples were air-dried during sample preparation for Atterberg limits

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

Shelby Tube Photos

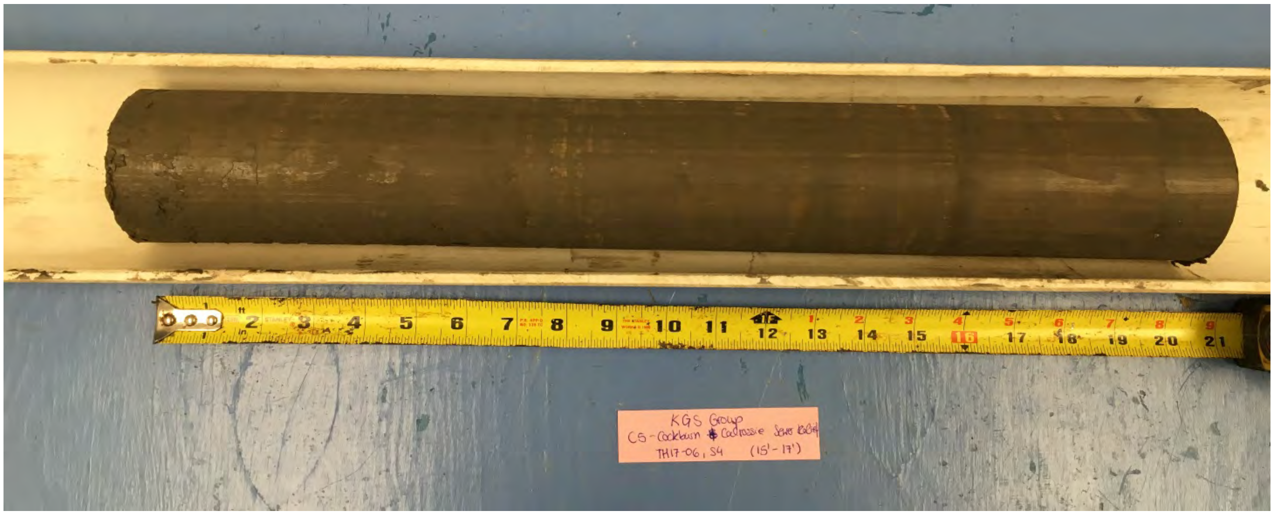


TH17-01, S4



TH17-01, S8

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)



TH17-06, S4

TH17-06, S6

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

TH17-10, S6

TH17-12, S4

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

TH17-12, S8

TH17-15, S4

Reference: C5 – Cockburn & Calrossie Sewer Relief (11-0107-18)

TH17-15, S6

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

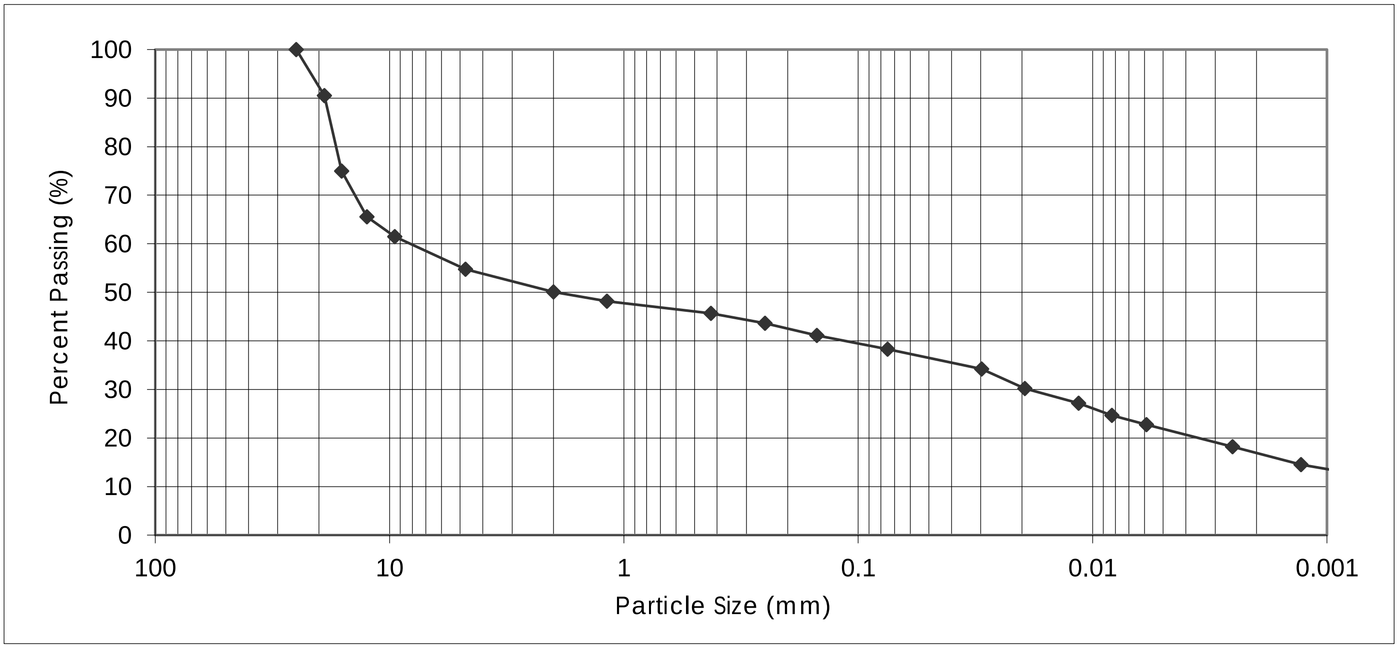
PROJECT: C-5 Cockburn & Calrossie
Sewer Relief

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH17-06, S13

DATE RECEIVED: May 9, 2017
TESTED BY: Nestor Abarca, C.Tech.



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	90.5
16.00 mm	74.9
12.50 mm	65.5
9.50 mm	61.5
4.75 mm	54.8
2.00 mm	50.1

PARTICLE SIZE	PERCENT PASSING
1.18 mm	48.2
0.425 mm	45.7
0.250 mm	43.6
0.150 mm	41.1
0.075 mm	38.3
0.005 mm	21.8
0.002 mm	16.9
0.001 mm	13.6

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			
45.2	4.7	4.4	7.4	21.4	16.9	13.6

REPORT DATE: May 16, 2017

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

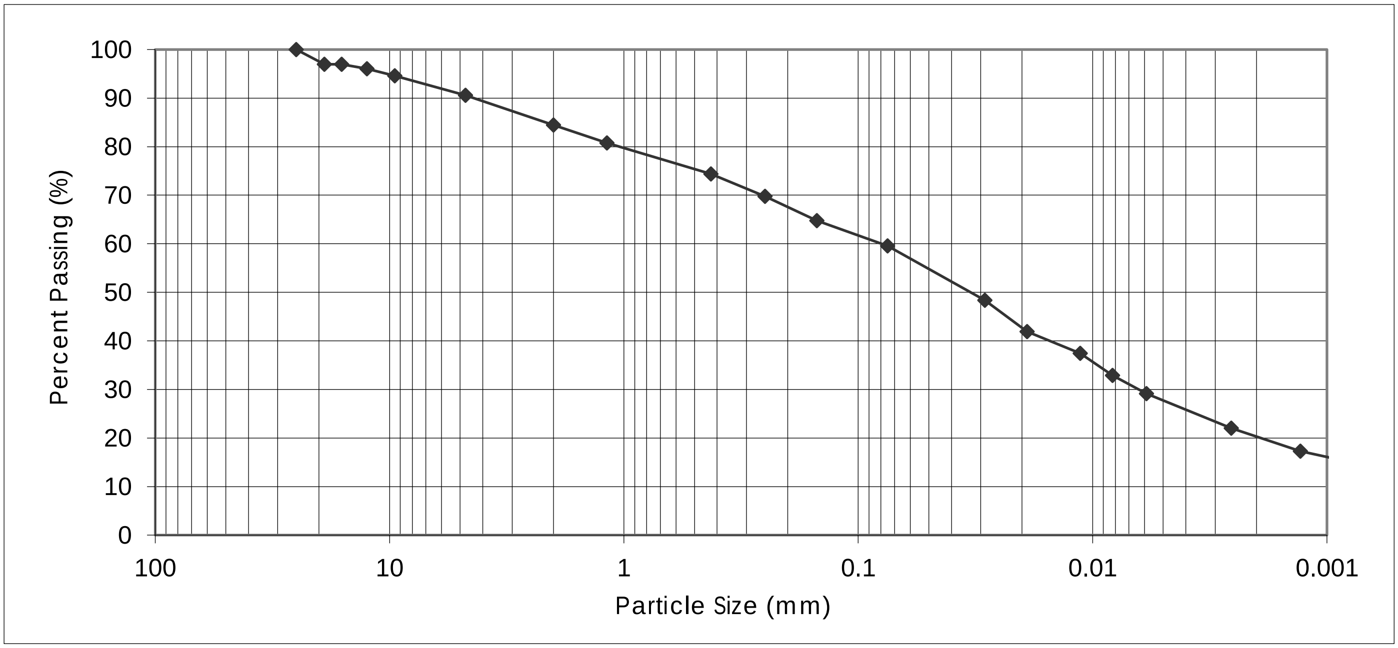
PROJECT: C-5 Cockburn & Calrossie
Sewer Relief

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH17-09, S11

DATE RECEIVED: May 9, 2017
TESTED BY: Nestor Abarca, C.Tech.



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	97.0
16.00 mm	97.0
12.50 mm	96.0
9.50 mm	94.6
4.75 mm	90.6
2.00 mm	84.4

PARTICLE SIZE	PERCENT PASSING
1.18 mm	80.8
0.425 mm	74.4
0.250 mm	69.8
0.150 mm	64.8
0.075 mm	59.5
0.005 mm	27.7
0.002 mm	20.3
0.001 mm	16.1

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			
9.4	6.2	10.0	14.9	39.2	20.3	16.1

REPORT DATE: May 16, 2017

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

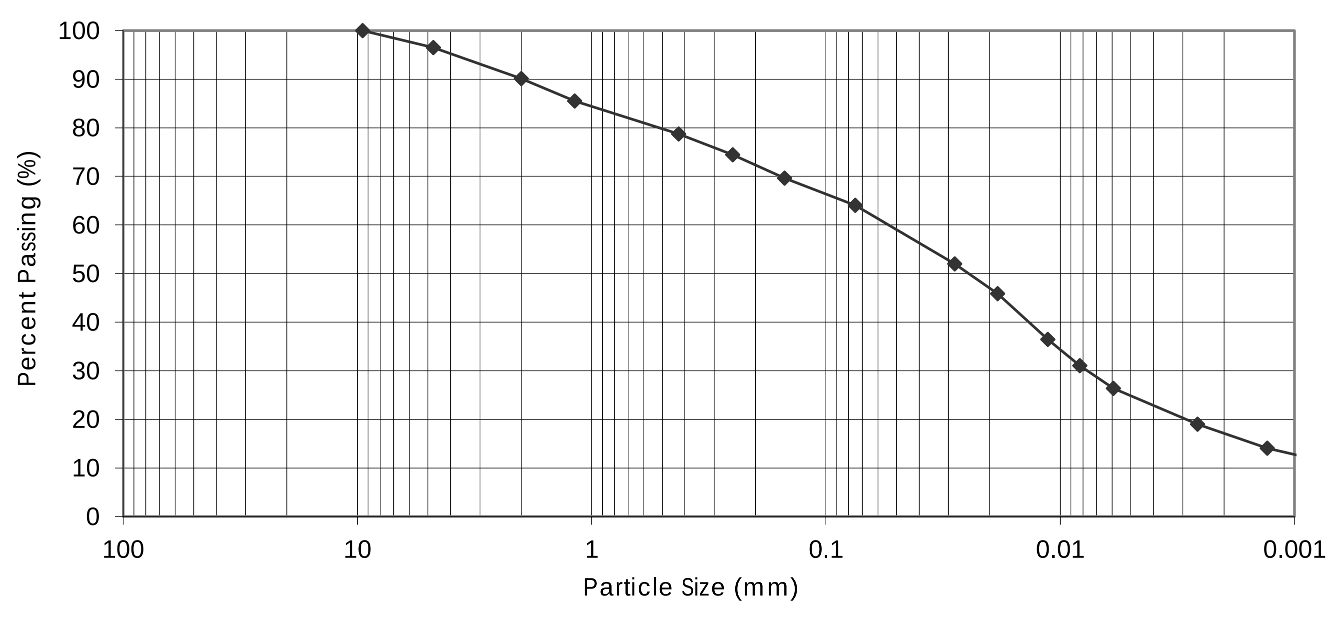
PROJECT: C-5 Cockburn & Calrossie Sewer Relief

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH17-10, S12

DATE RECEIVED: May 9, 2017
TESTED BY: Nestor Abarca, C.Tech.



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	96.5
2.00 mm	90.1

PARTICLE SIZE	PERCENT PASSING
1.18 mm	85.5
0.425 mm	78.8
0.250 mm	74.4
0.150 mm	69.7
0.075 mm	64.0
0.005 mm	24.9
0.002 mm	17.1
0.001 mm	12.8

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			
3.5	6.4	11.3	14.8	46.9	17.1	12.8

CERTIFIED BY CCIL

REPORT DATE: May 16, 2017

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

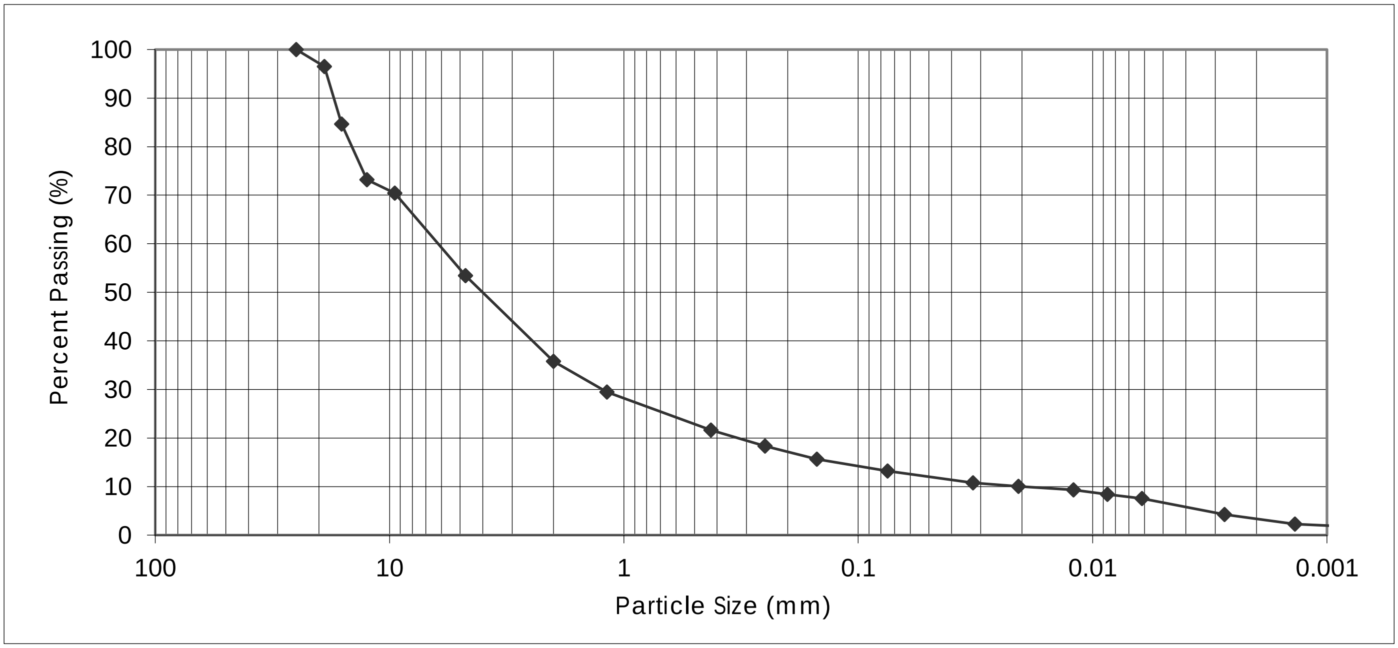
PROJECT: C-5 Cockburn & Calrossie
Sewer Relief

Attention: Jacqueline MacLennan

PROJECT NO.: 123311974

SAMPLED BY: Client
SAMPLE ID: TH17-13, S11

DATE RECEIVED: May 9, 2017
TESTED BY: Nestor Abarca, C.Tech.



PARTICLE SIZE	PERCENT PASSING
37.50 mm	100.0
25.00 mm	100.0
19.00 mm	96.5
16.00 mm	84.6
12.50 mm	73.2
9.50 mm	70.4
4.75 mm	53.5
2.00 mm	35.8

PARTICLE SIZE	PERCENT PASSING
1.18 mm	29.5
0.425 mm	21.6
0.250 mm	18.3
0.150 mm	15.6
0.075 mm	13.2
0.005 mm	6.7
0.002 mm	3.4
0.001 mm	2.0

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			
46.5	17.7	14.2	8.4	9.8	3.4	2.0

REPORT DATE: May 16, 2017

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

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 11, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-01, S3

LIQUID LIMIT

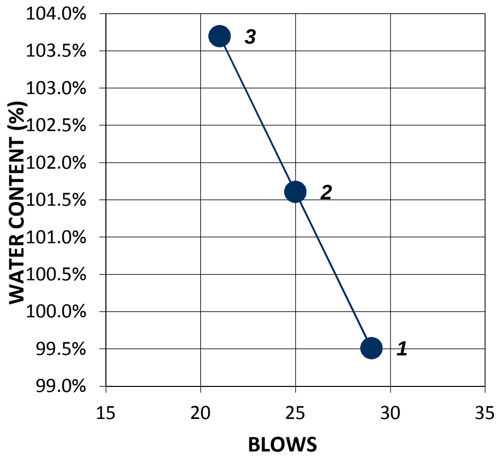
Trial	1	2	3
No. of Blows	29	25	21
Tare No.	149	157	194
Wt. Sa. (wet+tare)(g)	35	37	37
Wt. Sa. (dry+tare)(g)	27	29	28
Wt. Tare (g)	19	20	19
Wt. Dry Soil (g)	8.2	8.1	9.2
Wt. Water (g)	8.1	8.2	9.5
Water Content (%)	99.5%	101.6%	103.7%

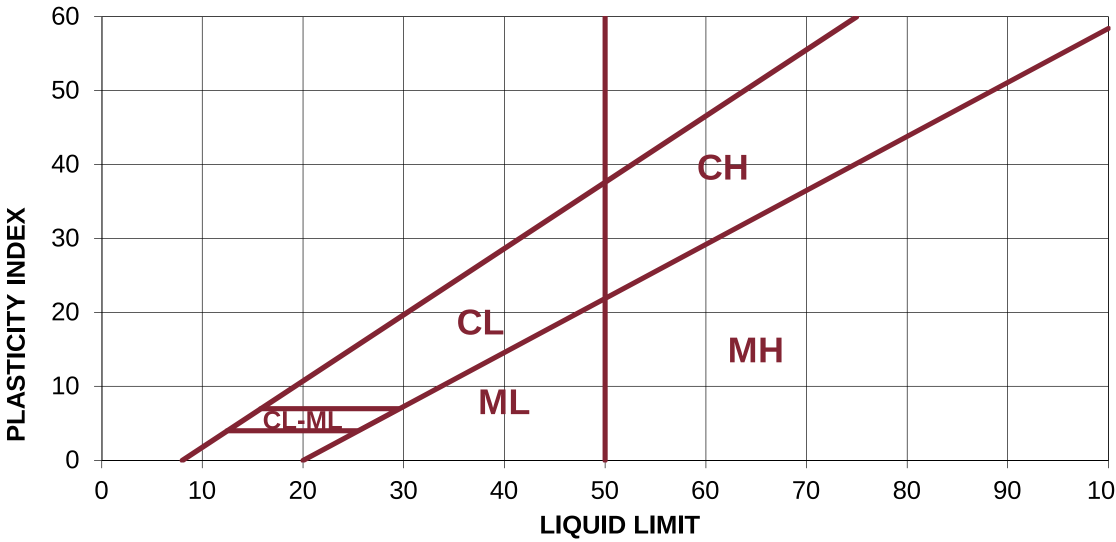
PLASTIC LIMIT

Trial	1	2
Tare No.	304	305
Wt. Sa. (wet+tare)(g)	29.92	29.74
Wt. Sa. (dry+tare)(g)	27.72	27.6
Wt. Tare (g)	20.14	20.38
Wt. Dry Soil (g)	7.6	7.2
Wt. Water (g)	2.2	2.1
Water Content (%)	29.0%	29.6%

RESULTS

LL	102
PL	29
PI	73
Natural MC (%)	
53.1%	





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

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 12, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-01, S4

LIQUID LIMIT

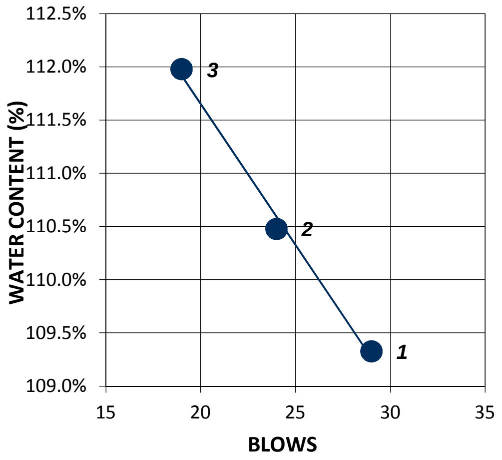
Trial	1	2	3
No. of Blows	29	24	19
Tare No.	147	160	185
Wt. Sa. (wet+tare)(g)	37	37	37
Wt. Sa. (dry+tare)(g)	28	27	27
Wt. Tare (g)	20	19	19
Wt. Dry Soil (g)	8.2	8.4	8.4
Wt. Water (g)	8.9	9.3	9.4
Water Content (%)	109.3%	110.5%	112.0%

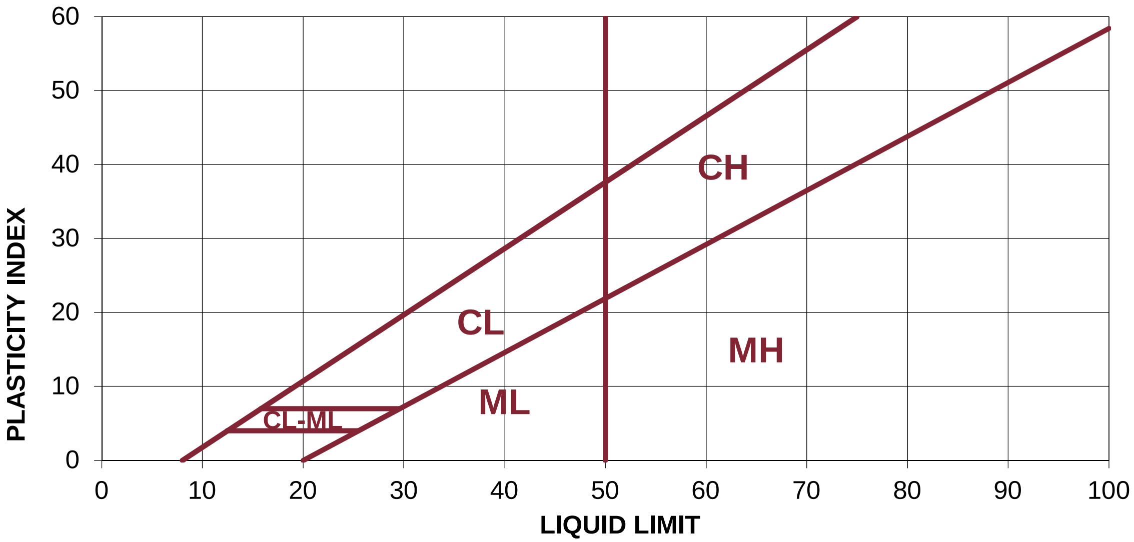
PLASTIC LIMIT

Trial	1	2
Tare No.	187	260
Wt. Sa. (wet+tare)(g)	31.52	33.95
Wt. Sa. (dry+tare)(g)	28.83	30.86
Wt. Tare (g)	19.63	20.3
Wt. Dry Soil (g)	9.2	10.6
Wt. Water (g)	2.7	3.1
Water Content (%)	29.2%	29.3%

RESULTS

LL	**110**
PL	**29**
PI	**81**
Natural MC (%)	
55.7%	





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

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 11, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-06, S3

LIQUID LIMIT

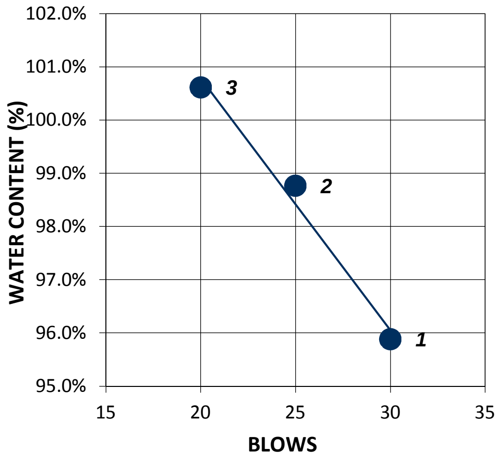
Trial	1	2	3
No. of Blows	30	25	20
Tare No.	159	163	200
Wt. Sa. (wet+tare)(g)	37	39	36
Wt. Sa. (dry+tare)(g)	29	29	28
Wt. Tare (g)	19	19	19
Wt. Dry Soil (g)	9.2	9.7	8.2
Wt. Water (g)	8.9	9.6	8.2
Water Content (%)	95.9%	98.8%	100.6%

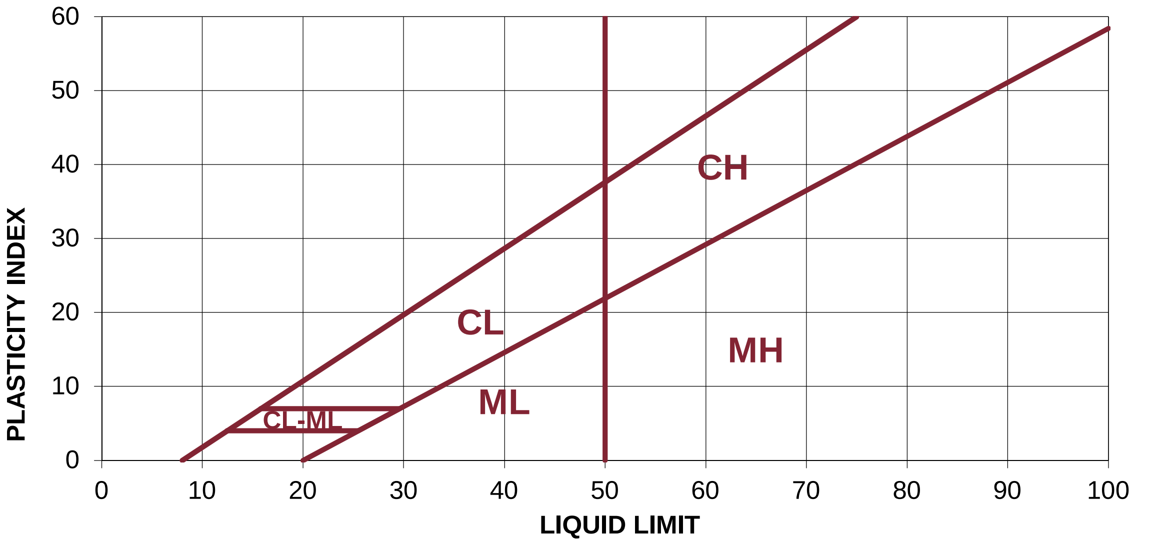
PLASTIC LIMIT

Trial	1	2
Tare No.	238	318
Wt. Sa. (wet+tare)(g)	29.77	30.08
Wt. Sa. (dry+tare)(g)	27.79	27.96
Wt. Tare (g)	20.68	20.44
Wt. Dry Soil (g)	7.1	7.5
Wt. Water (g)	2.0	2.1
Water Content (%)	27.8%	28.2%

RESULTS

LL	**98**
PL	**28**
PI	**70**
Natural MC (%)	
48.7%	





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

Stantec

Atterberg Limits

ASTM D4318

Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 15, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-06, S6

LIQUID LIMIT

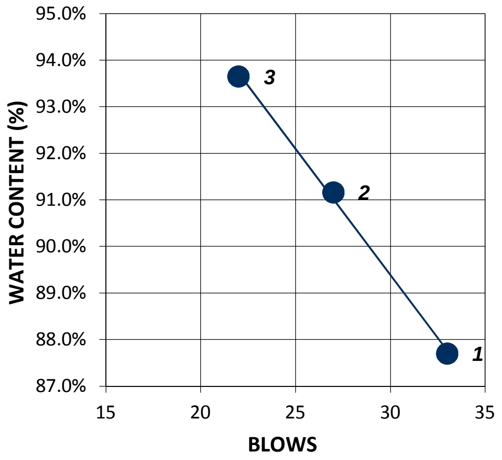
Trial	1	2	3
No. of Blows	33	27	22
Tare No.	173	227	250
Wt. Sa. (wet+tare)(g)	39	39	38
Wt. Sa. (dry+tare)(g)	30	30	30
Wt. Tare (g)	19	20	21
Wt. Dry Soil (g)	10.6	9.8	9.1
Wt. Water (g)	9.3	9.0	8.6
Water Content (%)	87.7%	91.2%	93.6%

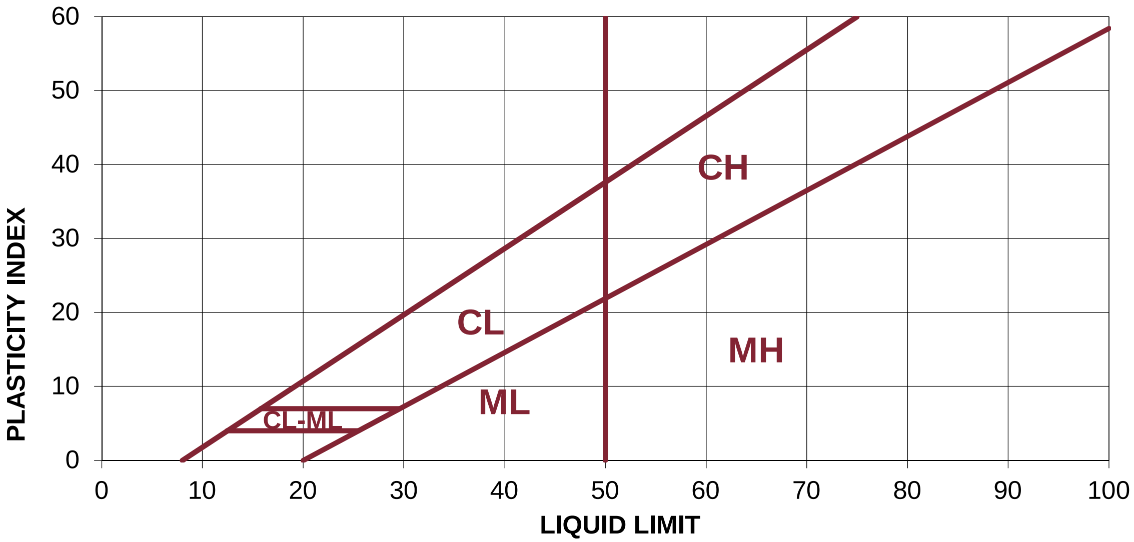
PLASTIC LIMIT

Trial	1	2
Tare No.	261	308
Wt. Sa. (wet+tare)(g)	29.62	30.38
Wt. Sa. (dry+tare)(g)	27.80	28.42
Wt. Tare (g)	20.24	20.35
Wt. Dry Soil (g)	7.6	8.1
Wt. Water (g)	1.8	2.0
Water Content (%)	24.1%	24.3%

RESULTS

LL	**92**
PL	**24**
PI	**68**
Natural MC (%)	
51.0%	





CERTIFIED BY CCIL

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

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client: KGS Group Inc.
Project Name: C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No: 123311974
Date Received: May 9, 2017
Date Tested: May 11, 2017
Tested By: Larry Presado, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-06, S9

LIQUID LIMIT

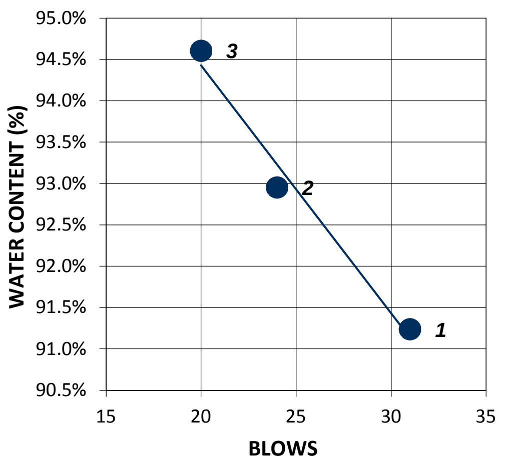
Trial	1	2	3
No. of Blows	31	24	20
Tare No.	320	297	293
Wt. Sa. (wet+tare)(g)	40	44	43
Wt. Sa. (dry+tare)(g)	31	33	32
Wt. Tare (g)	21	21	21
Wt. Dry Soil (g)	10.0	12.2	11.1
Wt. Water (g)	9.2	11.3	10.5
Water Content (%)	91.2%	93.0%	94.6%

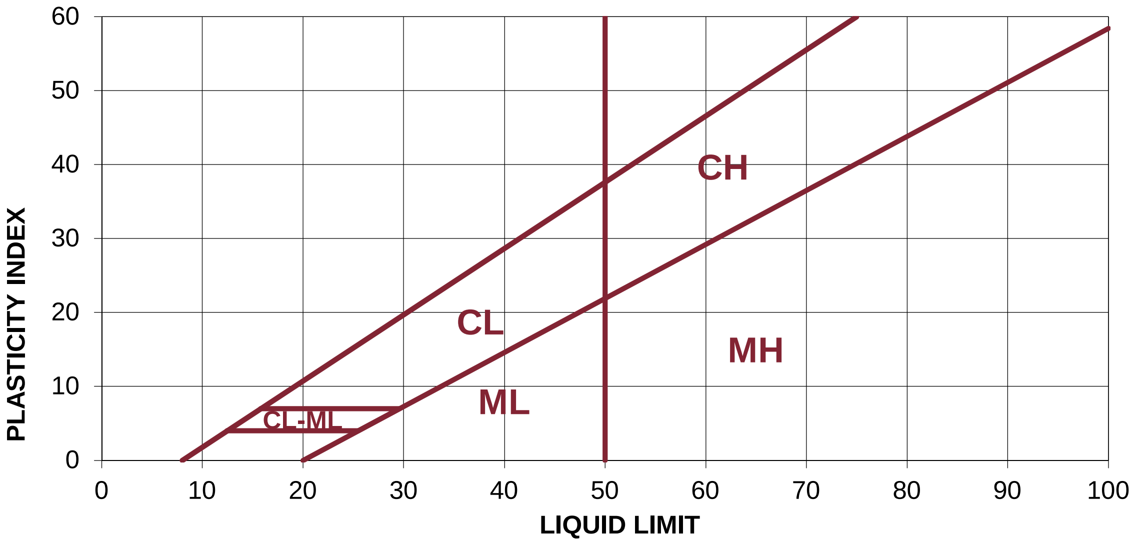
PLASTIC LIMIT

Trial	1	2
Tare No.	228	276
Wt. Sa. (wet+tare)(g)	31.42	30.46
Wt. Sa. (dry+tare)(g)	29.08	28.35
Wt. Tare (g)	20.35	20.49
Wt. Dry Soil (g)	8.7	7.9
Wt. Water (g)	2.3	2.1
Water Content (%)	26.8%	26.8%

RESULTS

LL	**93**
PL	**27**
PI	**66**
Natural MC (%)	
48.4%	





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

Atterberg Limits
ASTM D4318
Method A- Multi-Point

Client: KGS Group Inc.
Project Name: C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No: 123311974
Date Received: May 9, 2017
Date Tested: May 11, 2017
Tested By: Larry Presado, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-10, S3

LIQUID LIMIT

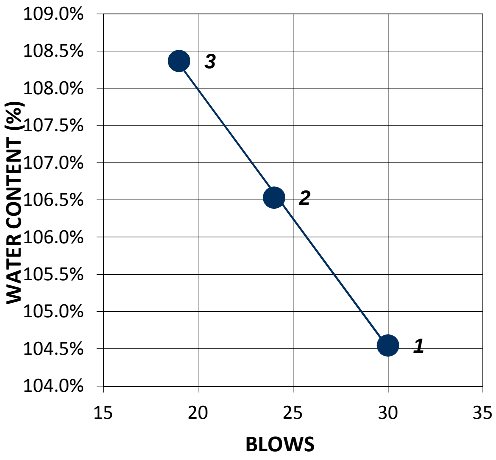
Trial	1	2	3
No. of Blows	30	24	19
Tare No.	286	271	265
Wt. Sa. (wet+tare)(g)	39	40	42
Wt. Sa. (dry+tare)(g)	30	30	31
Wt. Tare (g)	21	21	20
Wt. Dry Soil (g)	9.0	9.3	10.3
Wt. Water (g)	9.4	10.0	11.1
Water Content (%)	104.5%	106.5%	108.4%

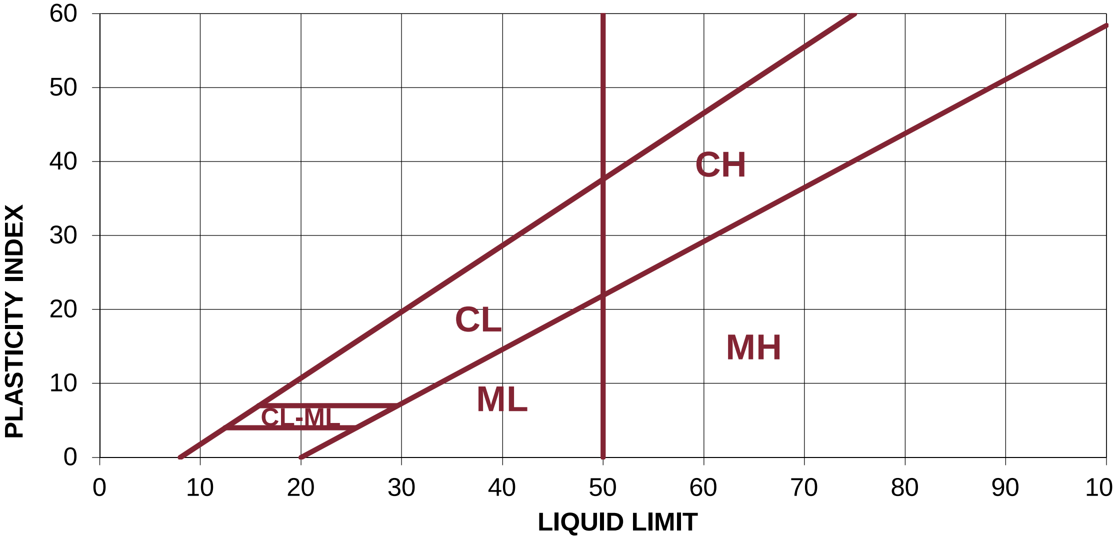
PLASTIC LIMIT

Trial	1	2
Tare No.	180	162
Wt. Sa. (wet+tare)(g)	29.70	30.71
Wt. Sa. (dry+tare)(g)	27.13	28.15
Wt. Tare (g)	18.94	19.98
Wt. Dry Soil (g)	8.2	8.2
Wt. Water (g)	2.6	2.6
Water Content (%)	31.4%	31.3%

RESULTS

LL	**106**
PL	**31**
PI	**75**
Natural MC (%)	
54.2%	





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

Stantec

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 12, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-10, S6

LIQUID LIMIT

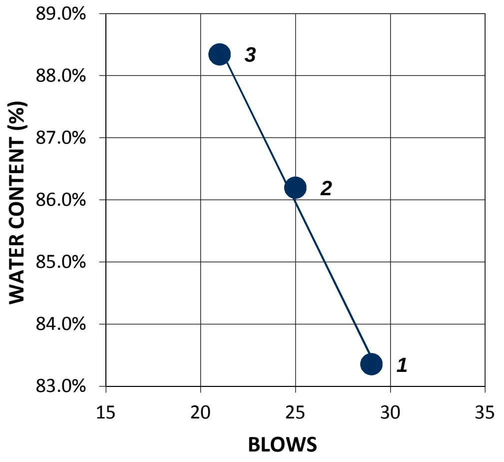
Trial	1	2	3
No. of Blows	29	25	21
Tare No.	145	154	160
Wt. Sa. (wet+tare)(g)	35	38	39
Wt. Sa. (dry+tare)(g)	27	29	30
Wt. Tare (g)	18	19	19
Wt. Dry Soil (g)	9.3	9.9	10.6
Wt. Water (g)	7.7	8.5	9.3
Water Content (%)	83.4%	86.2%	88.3%

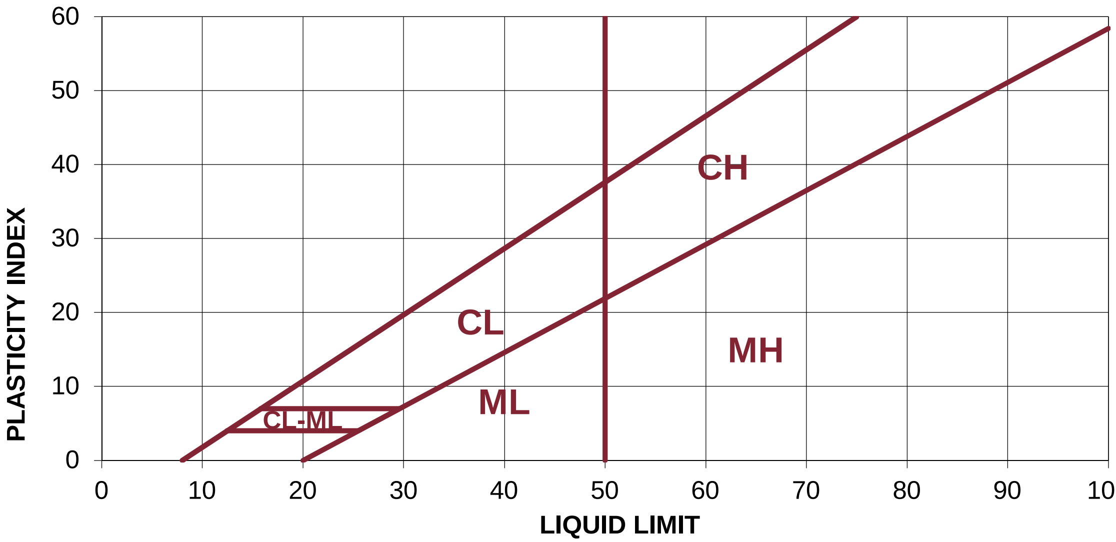
PLASTIC LIMIT

Trial	1	2
Tare No.	178	235
Wt. Sa. (wet+tare)(g)	29.31	31.37
Wt. Sa. (dry+tare)(g)	27.42	29.24
Wt. Tare (g)	19.70	20.55
Wt. Dry Soil (g)	7.7	8.7
Wt. Water (g)	1.9	2.1
Water Content (%)	24.5%	24.5%

RESULTS

LL	**86**
PL	**24**
PI	**62**
Natural MC (%)	
46.3%	





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

Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 12, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-10, S11

LIQUID LIMIT

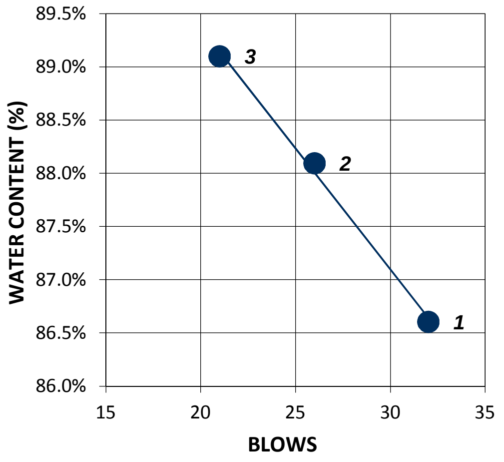
Trial	1	2	3
No. of Blows	32	26	21
Tare No.	170	202	212
Wt. Sa. (wet+tare)(g)	38	36	37
Wt. Sa. (dry+tare)(g)	29	28	29
Wt. Tare (g)	20	19	20
Wt. Dry Soil (g)	9.6	9.1	9.1
Wt. Water (g)	8.3	8.0	8.1
Water Content (%)	86.6%	88.1%	89.1%

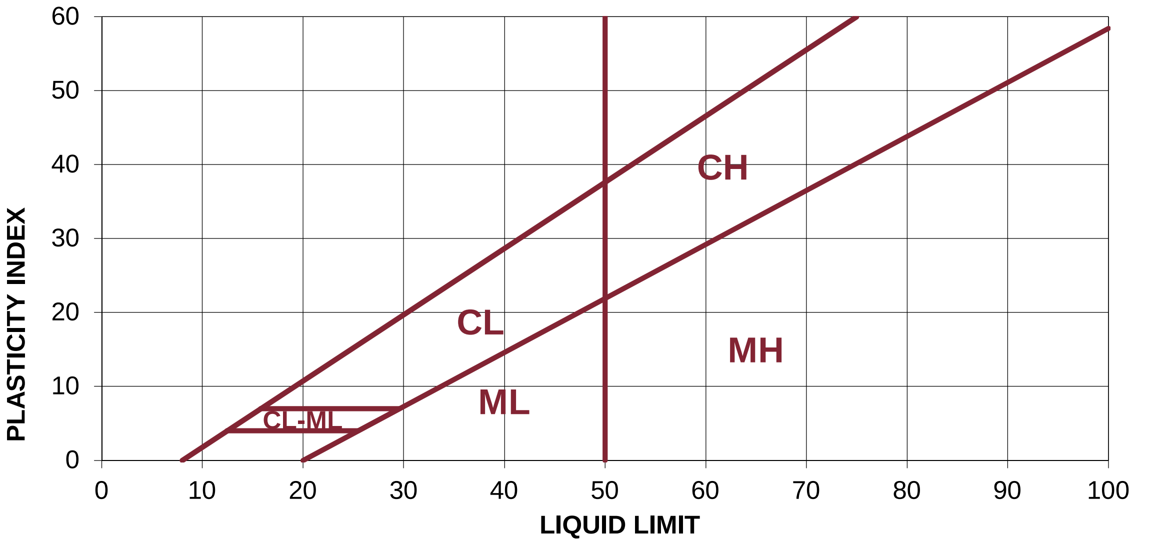
PLASTIC LIMIT

Trial	1	2
Tare No.	217	317
Wt. Sa. (wet+tare)(g)	29.35	30.15
Wt. Sa. (dry+tare)(g)	27.32	28.28
Wt. Tare (g)	18.72	20.45
Wt. Dry Soil (g)	8.6	7.8
Wt. Water (g)	2.0	1.9
Water Content (%)	23.6%	23.9%

RESULTS

LL	**88**
PL	**24**
PI	**64**
Natural MC (%)	
48.5%	





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

Atterberg Limits ASTM D4318 Method A- Multi-Point	

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 12, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-15, S4

LIQUID LIMIT

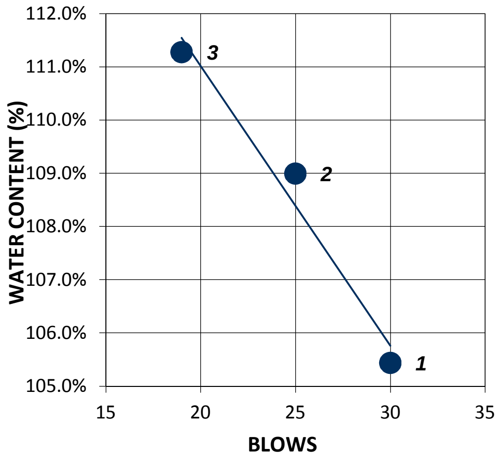
Trial	1	2	3
No. of Blows	30	25	19
Tare No.	151	233	270
Wt. Sa. (wet+tare)(g)	37	37	37
Wt. Sa. (dry+tare)(g)	28	28	28
Wt. Tare (g)	20	20	21
Wt. Dry Soil (g)	8.3	8.1	7.5
Wt. Water (g)	8.7	8.9	8.4
Water Content (%)	105.4%	109.0%	111.3%

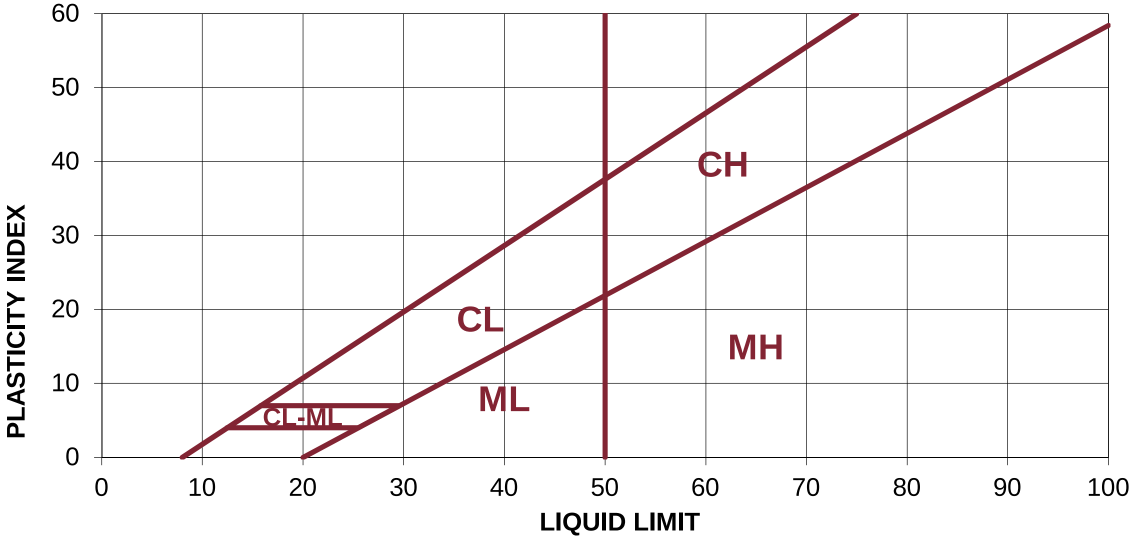
PLASTIC LIMIT

Trial	1	2
Tare No.	285	311
Wt. Sa. (wet+tare)(g)	31.84	28.16
Wt. Sa. (dry+tare)(g)	29.49	26.53
Wt. Tare (g)	21.17	20.82
Wt. Dry Soil (g)	8.3	5.7
Wt. Water (g)	2.4	1.6
Water Content (%)	28.2%	28.5%

RESULTS

LL	**108**
PL	**28**
PI	**80**
Natural MC (%)	
52.2%	





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

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Atterberg Limits

ASTM D4318
Method A- Multi-Point

Client:	KGS Group Inc.
Project Name:	C5 - Cockburn and Calrossie Sewer Relief (11-0107-18)
Project No:	123311974
Date Received:	May 9, 2017
Date Tested:	May 12, 2017
Tested By:	Nestor Abarca, C. Tech.

LABORATORY
199 Henlow Bay

Winnipeg, Manitoba
Canada R3Y 1G4
Tel: (204) 488-6999

Sample : TH17-15, S6

LIQUID LIMIT

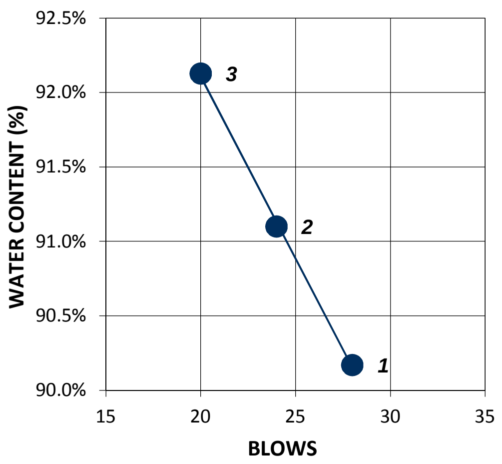
Trial	1	2	3
No. of Blows	28	24	20
Tare No.	173	227	250
Wt. Sa. (wet+tare)(g)	36	38	40
Wt. Sa. (dry+tare)(g)	28	30	31
Wt. Tare (g)	19	20	21
Wt. Dry Soil (g)	8.9	9.1	10.2
Wt. Water (g)	8.0	8.3	9.4
Water Content (%)	90.2%	91.1%	92.1%

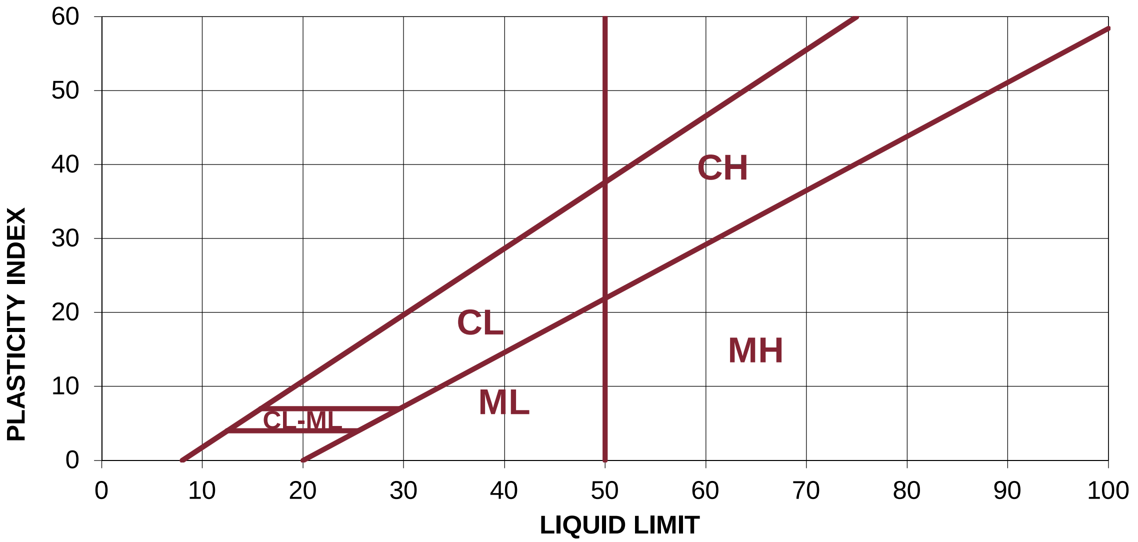
PLASTIC LIMIT

Trial	1	2
Tare No.	261	308
Wt. Sa. (wet+tare)(g)	29.68	31.74
Wt. Sa. (dry+tare)(g)	27.72	29.37
Wt. Tare (g)	20.25	20.36
Wt. Dry Soil (g)	7.5	9.0
Wt. Water (g)	2.0	2.4
Water Content (%)	26.2%	26.3%

RESULTS

LL	**91**
PL	**26**
PI	**65**
Natural MC (%)	
52.6%	





CCIL

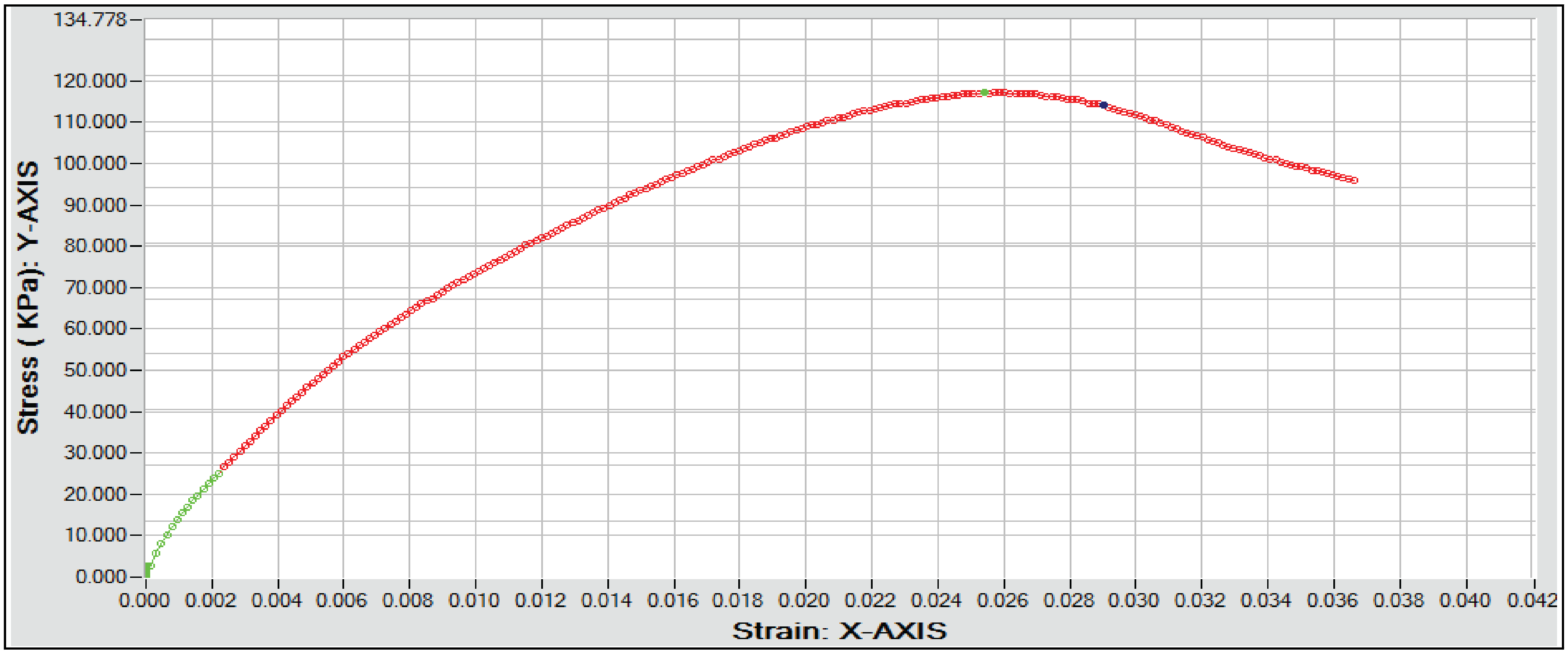
Reviewed By: Jason Thompson, C.E.T.

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:	C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)
Address	3rd Floor - 865 Waverley St.		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 9, 2017
SAMPLE ID:	TH17-01, S4	TESTED BY:	Larry Presado

Soil Description: clay, brown, firm, moist, high plasticity



Failure Description: diagonal shear failure

Diameter, mm:	73.24
Height, mm:	161.06
Height/Diameter Ratio:	2.20
Sample Weight, g:	1137.44
Moisture Content. %:	55.4
Wet Unit Weight, kN/m³:	16.43
Dry Unit Weight, kN/m³:	10.57
Void ratio:	1.55
Saturation, %:	98.36
Unconfined Compressive Strength, kPa:	117
Strain at Failure, %:	2.54

REPORT DATE: May 16, 2017

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.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)

PROJECT NO.: 123311974

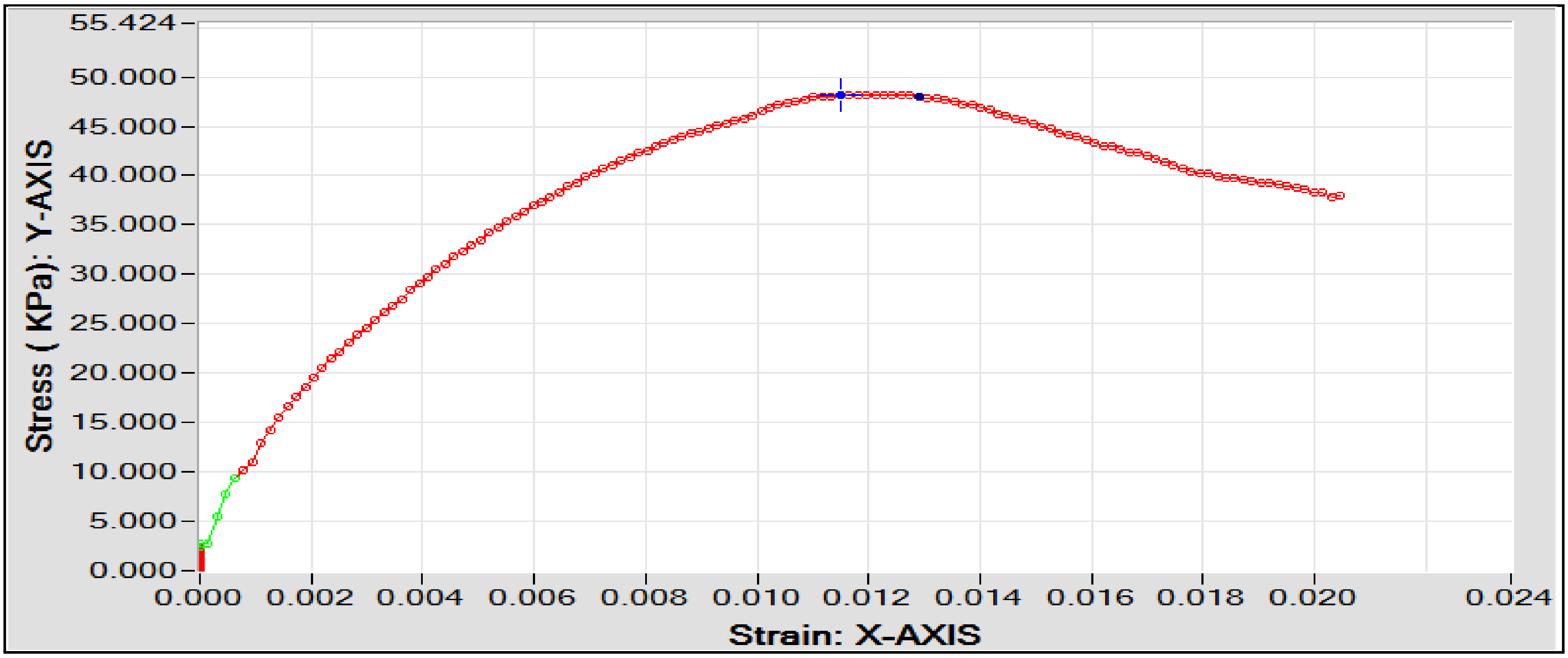
Attention: Jacqueline MacLennan

REPORT NO.:

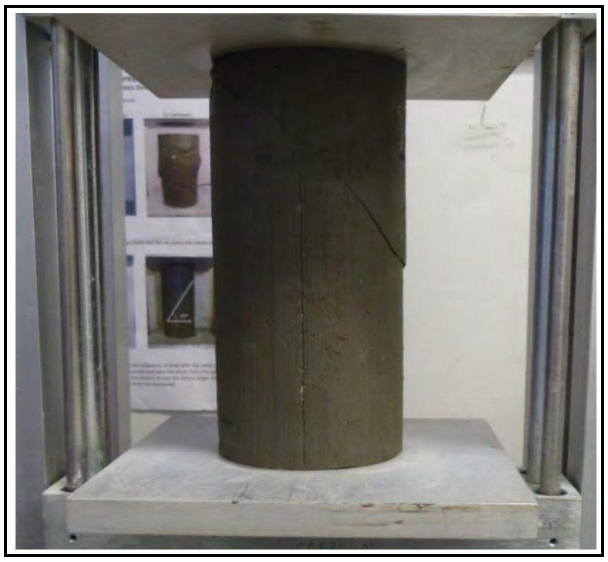
SAMPLED BY: Client
SAMPLE ID: TH17-01, S8

DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, firm, moist, high plasticity, silty



Failure Description: diagonal shear



Diameter, mm:	72.72
Height, mm:	161.42
Height/Diameter Ratio:	2.22
Sample Weight, g:	1139.30
Moisture Content. %:	52.9
Wet Unit Weight, kN/m³:	16.65
Dry Unit Weight, kN/m³:	10.89
Void ratio:	1.47
Saturation, %:	98.70
Unconfined Compressive Strength, kPa:	48
Strain at Failure, %:	1.15

REPORT DATE: May 16, 2017

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

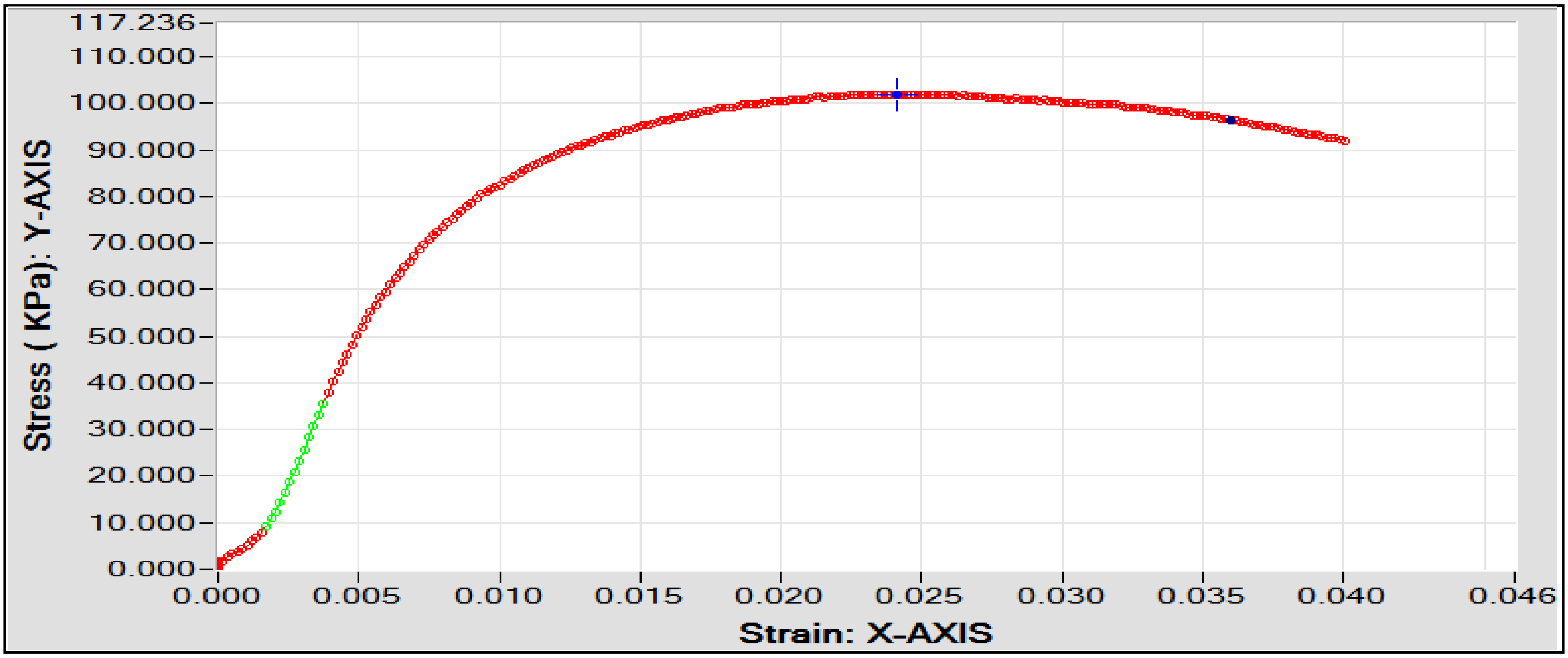
Client KGS Group Inc.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

Attention: Jacqueline MacLennan

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)
PROJECT NO.: 123311974
REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-06, S4
DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, brown, stiff, moist, high plasticity, trace silt



Failure Description: diagonal shear failure & slightly buldge mid-section of sample specimen

Diameter, mm:	72.15
Height, mm:	149.58
Height/Diameter Ratio:	2.07
Sample Weight, g:	1038.31
Moisture Content. %:	53.3
Wet Unit Weight, kN/m³:	16.64
Dry Unit Weight, kN/m³:	10.85
Void ratio:	1.48
Saturation, %:	98.80
Unconfined Compressive Strength, kPa:	102
Strain at Failure, %:	2.41

REPORT DATE: May 16, 2017

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.
Address: 3rd Floor - 865 Waverley St.
City, Prov: Winnipeg, Manitoba
Postal Code: R3T 5P4

Attention: Jacqueline MacLennan

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)

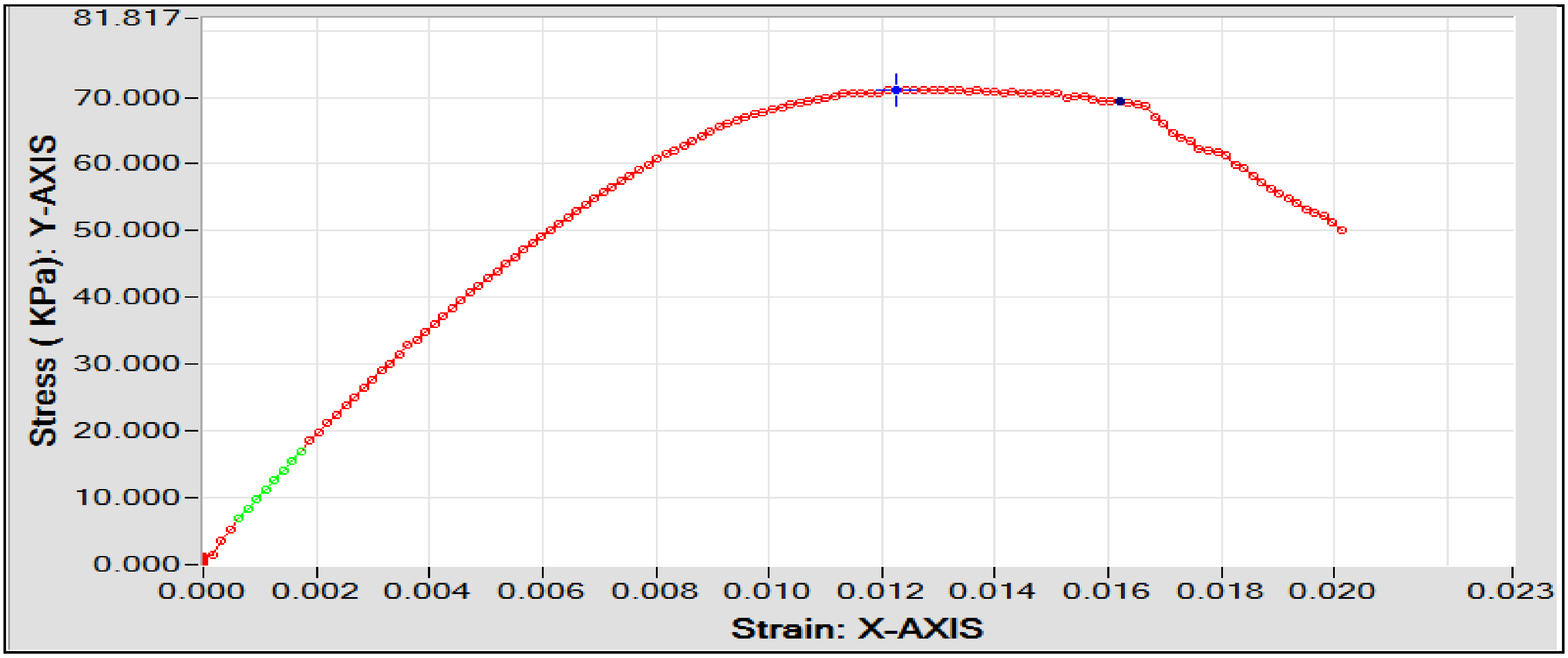
PROJECT NO.: 123311974

REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-06, S6

DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, stiff, moist, high - med. plasticity, trace silt



Failure Description: diagonal shear top of soil specimen "slickensided"

Diameter, mm:	72.32
Height, mm:	161.58
Height/Diameter Ratio:	2.23
Sample Weight, g:	1155.48
Moisture Content. %:	50.0
Wet Unit Weight, kN/m³:	17.06
Dry Unit Weight, kN/m³:	11.37
Void ratio:	1.37
Saturation, %:	100.43
Unconfined Compressive Strength, kPa:	71
Strain at Failure, %:	1.23

REPORT DATE: May 16, 2017

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

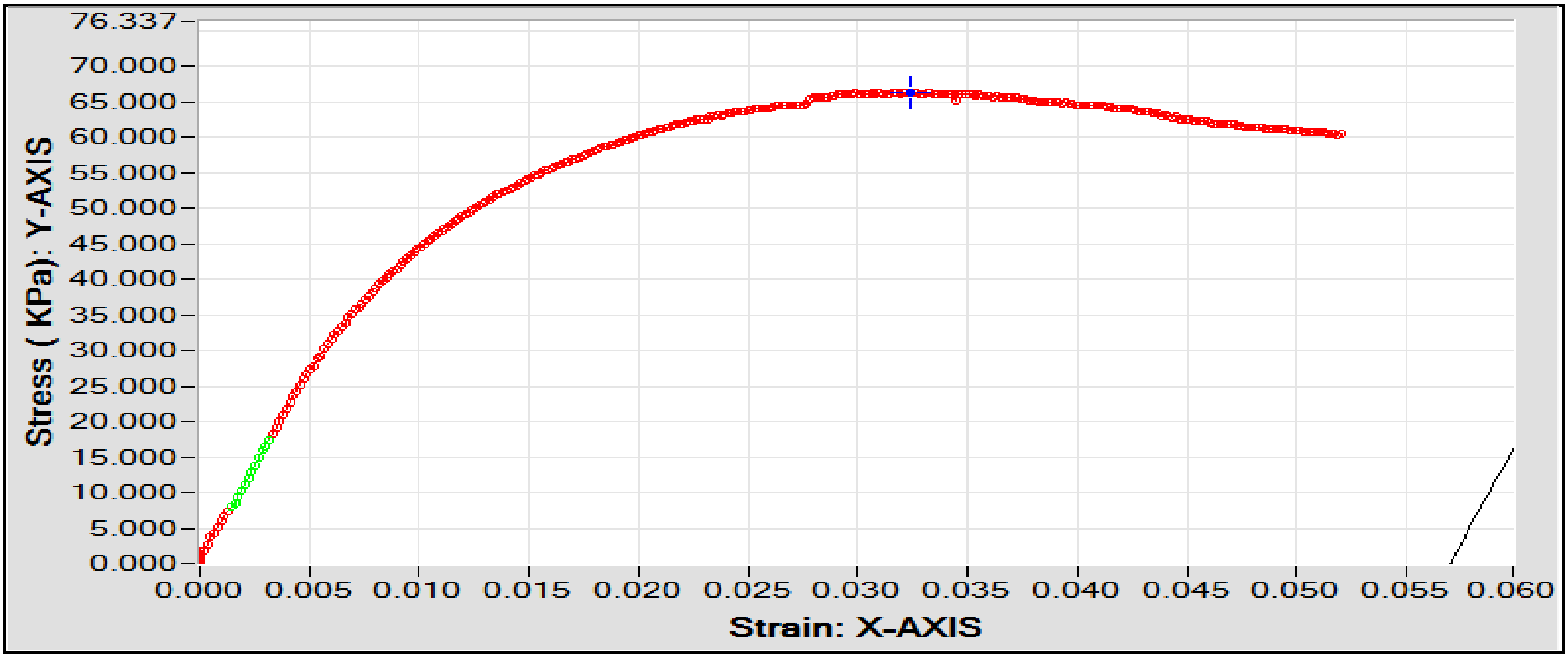
Client KGS Group Inc.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

Attention: Jacqueline MacLennan

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)
PROJECT NO.: 123311974
REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-10, S6
DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, stiff, moist, high plasticity, trace silt



Failure Description: diagonal shear top & bottom of soil specimen

Diameter, mm:	72.32
Height, mm:	161.56
Height/Diameter Ratio:	2.23
Sample Weight, g:	1141.75
Moisture Content. %:	47.8
Wet Unit Weight, kN/m³:	16.86
Dry Unit Weight, kN/m³:	11.41
Void ratio:	1.36
Saturation, %:	96.46
Unconfined Compressive Strength, kPa:	66
Strain at Failure, %:	3.24

REPORT DATE: May 16, 2017

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.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

Attention: Jacqueline MacLennan

PROJECT: C5 - Cockburn & Calrossie
Sewer Relief (11-0107-18)

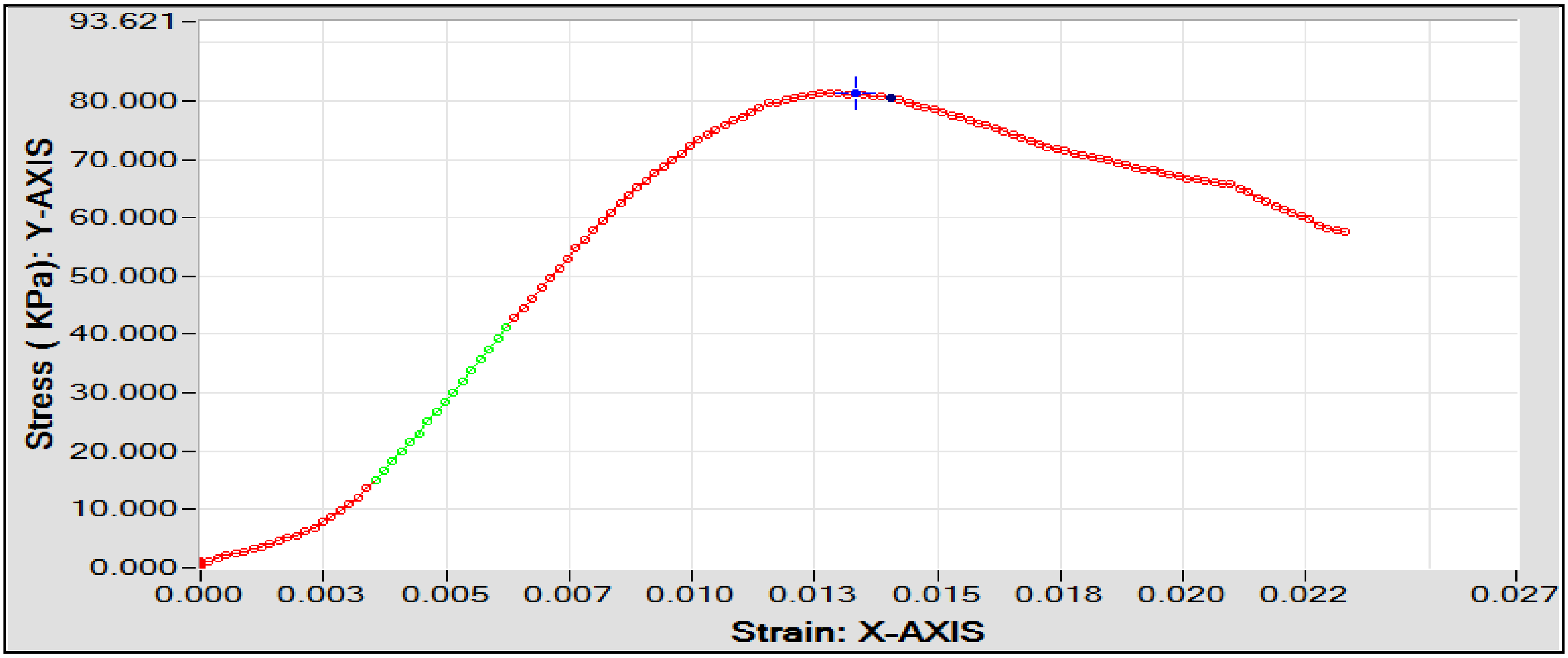
PROJECT NO.: 123311974

REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-12, S4

DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, firm, moist, high plasticity, trace silt



Failure Description: diagonal shear, "slickenslided"

Diameter, mm:	72.77
Height, mm:	142.89
Height/Diameter Ratio:	1.96
Sample Weight, g:	964.30
Moisture Content. %:	54.0
Wet Unit Weight, kN/m³:	15.90
Dry Unit Weight, kN/m³:	10.33
Void ratio:	1.61
Saturation, %:	92.21
Unconfined Compressive Strength, kPa:	81
Strain at Failure, %:	1.33

REPORT DATE: May 16, 2017

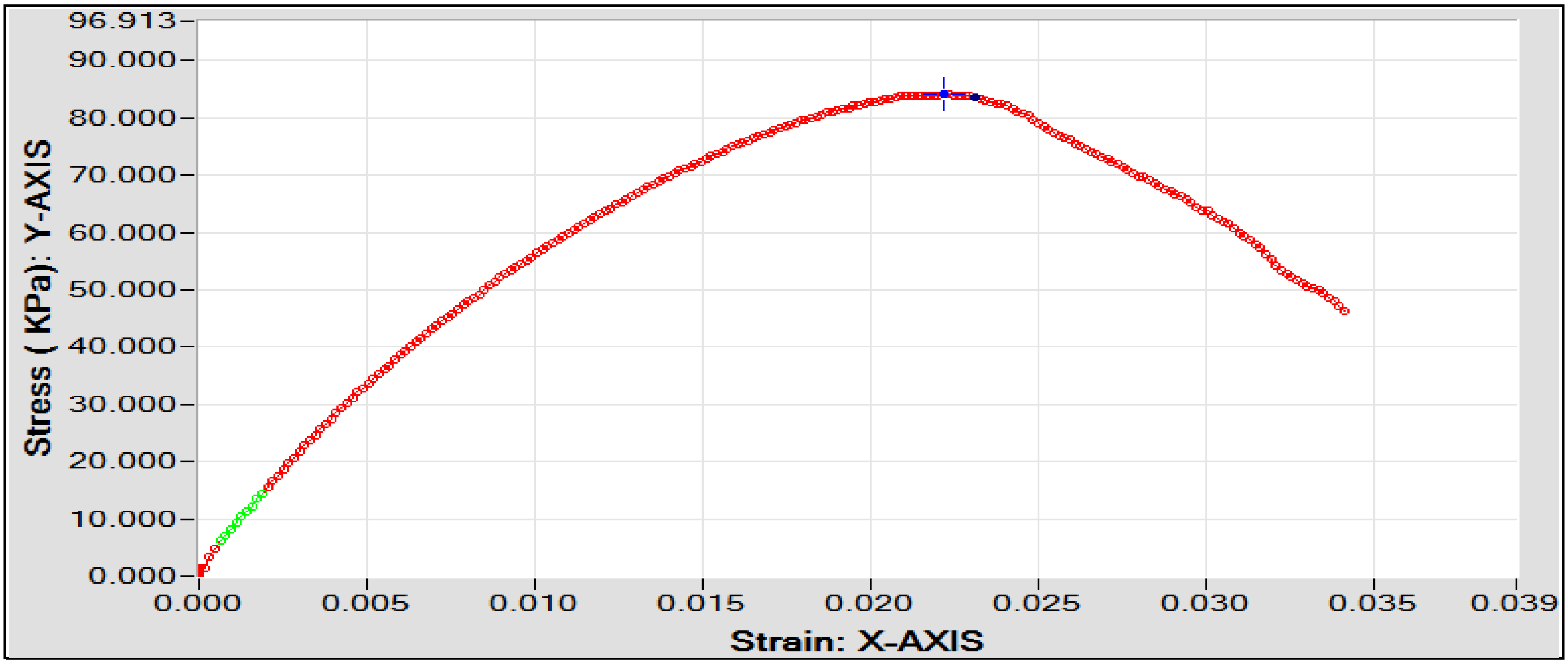
REVIEWED BY: Jason Thompson, C.E.T.

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:	C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)
Address	3rd Floor - 865 Waverley St.		
City, Prov	Winnipeg, Manitoba		
Postal Code	R3T 5P4	PROJECT NO.:	123311974
Attention:	Jacqueline MacLennan	REPORT NO.:	
SAMPLED BY:	Client	DATE RECEIVED:	May 9, 2017
SAMPLE ID:	TH17-12, S8	TESTED BY:	Larry Presado

Soil Description: clay, grey, firm, moist, high plasticity, trace silt



Failure Description: diagonal shear failure on sample specimen, "slicken-slided"

Diameter, mm:	72.17
Height, mm:	161.46
Height/Diameter Ratio:	2.24
Sample Weight, g:	1145.19
Moisture Content. %:	50.9
Wet Unit Weight, kN/m³:	16.99
Dry Unit Weight, kN/m³:	11.26
Void ratio:	1.39
Saturation, %:	100.45
Unconfined Compressive Strength, kPa:	84
Strain at Failure, %:	2.22

REPORT DATE: May 16, 2017

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

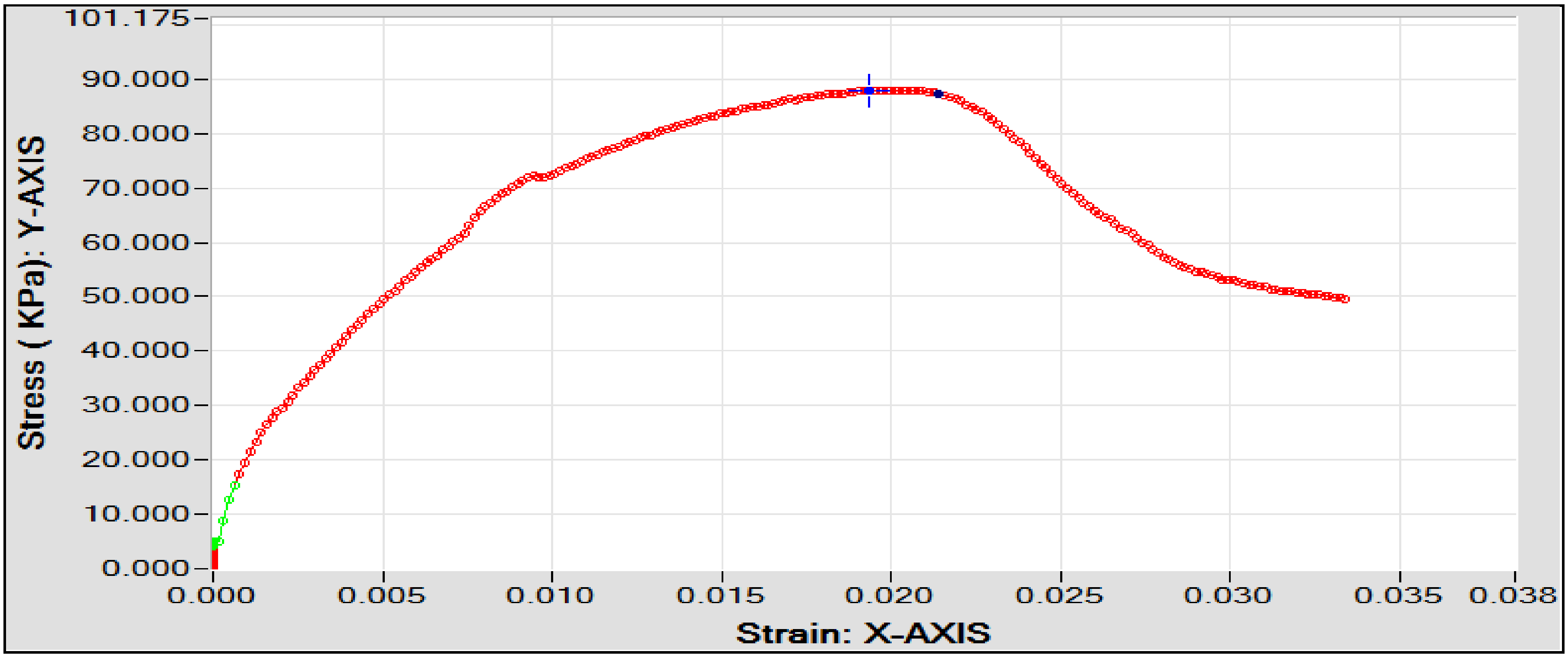
Client KGS Group Inc.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)
PROJECT NO.: 123311974

Attention: Jacqueline MacLennan
REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-15, S4
DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, stiff, moist, high plasticity, trace silt



Failure Description: diagonal shear failure on top of sample specimen

Diameter, mm:	72.30
Height, mm:	161.27
Height/Diameter Ratio:	2.23
Sample Weight, g:	1148.86
Moisture Content. %:	51.8
Wet Unit Weight, kN/m³:	17.00
Dry Unit Weight, kN/m³:	11.20
Void ratio:	1.41
Saturation, %:	101.35
Unconfined Compressive Strength, kPa:	88
Strain at Failure, %:	1.94

REPORT DATE: May 16, 2017
REVIEWED BY: Jason Thompson, C.E.T.

Stantec

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

UNCONFINED COMPRESSIVE STRENGTH OF COHESIVE SOIL ASTM D2166

Client KGS Group Inc.
Address 3rd Floor - 865 Waverley St.
City, Prov Winnipeg, Manitoba
Postal Code R3T 5P4

PROJECT: C5 - Cockburn & Calrossie Sewer Relief (11-0107-18)

PROJECT NO.: 123311974

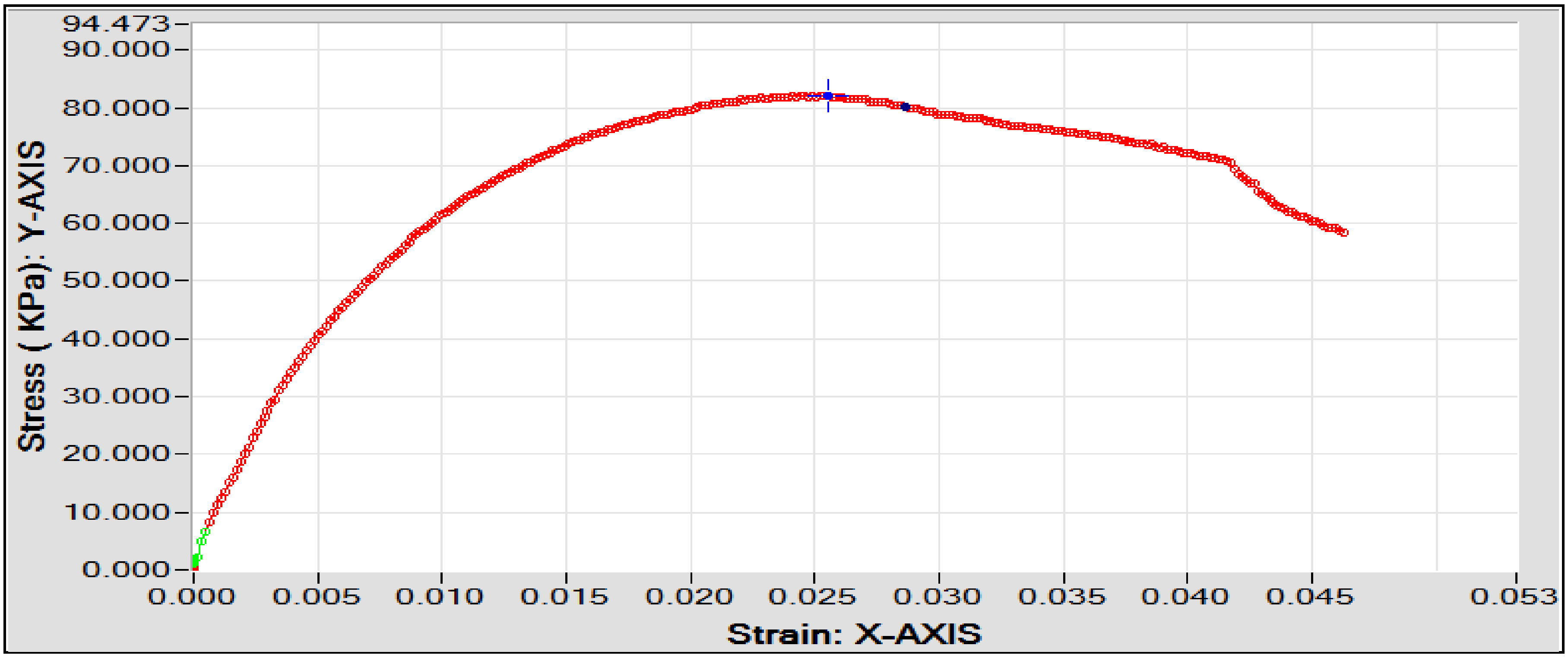
Attention: Jacqueline MacLennan

REPORT NO.:

SAMPLED BY: Client
SAMPLE ID: TH17-15, S6

DATE RECEIVED: May 9, 2017
TESTED BY: Larry Presado

Soil Description: clay, grey, firm, moist, high plasticity, trace silt



Failure Description: diagonal shear top & bottom of soil specimen

Diameter, mm:	72.29
Height, mm:	161.38
Height/Diameter Ratio:	2.23
Sample Weight, g:	1169.72
Moisture Content. %:	50.4
Wet Unit Weight, kN/m³:	17.31
Dry Unit Weight, kN/m³:	11.50
Void ratio:	1.34
Saturation, %:	103.31
Unconfined Compressive Strength, kPa:	82
Strain at Failure, %:	2.55

REPORT DATE: May 16, 2017

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

CONFIDENTIAL REPORT

XRD Analysis

Prepared for KGS Group

By Steven Creighton, PhD and Lucy Hunt, PhD
Saskatchewan Research Council
Mining and Minerals

SRC Publication No. 10400-17C17

June 2017

CONFIDENTIAL REPORT

XRD Analysis

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Saskatchewan Research Council
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SRC Publication No. 10400-17C17

June 2017

Advanced Microanalysis Centre^{TM}
Saskatchewan Research Council
125 – 15 Innovation Blvd.
Saskatoon, SK   S7N 2X8
Tel: 306-385-4066

Sample preparation

A portion of each sample was dried crushed in a manual steel crusher and then ground in an agate ball mill. A random aliquot of 0.5g of sample was loaded into a stainless steel holder and secured in place with a plastic backing. The sample was stored in a sealed ethylene glycol chamber at 50°C overnight. The final sample thickness is 1mm – sufficient to be considered infinitely thick for X-ray diffraction using a Cu source.

XRD Analysis and data processing

Samples were irradiated with Cu Kα radiation (λ=1.54056 Å) in a Bruker D4 Endeavor X-ray diffractometer (XRD) operating at 1.6 kW power (40 kV accelerating potential and 40 mA current). The XRD is outfitted with a high speed LynxEye silicon strip detector with fluorescence background suppression. Samples were measured from 3.5 to 70° 2θ with a 0.02° step size and 0.35 seconds dwell time with a 0.300° divergence slit.

The raw diffraction data was processed using MDI Products Jade software for mineral identification and quantification. Minerals were identified based on the observed interatomic spacing of the crystal lattices present constrained by common mineral associations. All mineral abundances were calculated using whole-pattern fitting algorithms with peak intensities scaled with internally-consistent relative intensity ratios. Non-orientable mineral abundances were quantified using patterns derived from the American Mineralogist Crystal Structure Database (AMCSD). Clay mineral abundances were quantified using reference spectra proprietary to SRC because the preferred orientation and glycol solvation precludes the use of published (e.g. ICDD, AMCSD) mineral reference databases.

Detection and precision limits

The detection limit of XRD analysis is controlled by the abundance and symmetry of all the minerals present in the sample. Low symmetry minerals are harder to detect in the presence of higher symmetry minerals. The estimated detection limit for most minerals is 1-3 wt.%.

Based on repeat analyses of secondary standards, the estimated accuracy of the clay analysis is ± 3 wt.%.

Results

The following pages contain the results of the XRD mineral identification and quantitative mineral abundances. A summary spreadsheet of the mineralogy is also included.

Client: KGS Group

Contact: Jacqueline MacLennan

Samples: 4

SRC Advanced Microanalysis Centre™

125 - 15 Innovation Blvd, Saskatoon, SK, S7N 2X8

Tel: 306.385.4066 Email: microlab@src.sk.ca

Group No.: AMC2017-053

Date of Report: Jun. 15, 2017

XRD Analysis

Semi-oriented EG Treated Mount

Sample	Quartz wt%	Clinochlore wt%	Muscovite wt%	Calcite wt%	Dolomite wt%	Smectite wt%	Total
TH17-09-S4-12'	18.3	15.7	20.3	3.7	6.0	35.9	99.9
TH17-04-S4-17'	16.1	15.0	22.2	4.5	9.7	32.5	100.0
TH17-04-S3-12'	20.2	17.0	29.3	0.6	4.2	28.6	99.9
TH17-09-S5-17'	20.2	13.3	15.4	4.4	9.5	37.1	99.9

Bruker AXS D4 Endeavor, Cu Kα radiation; 40 kV, 40 mA; 5-70° 2θ; rotated

-TH17-04-S3-12'

FILE: [TH17-09-S3-12'.raw] TH17-09-S3-12'
SCAN: 4.0/69.9946/0.01997/49.7(sec), Cu(40kV,40mA), I(p)=17555, 06/09/17 08:27a
PROC: [WPF Control File]

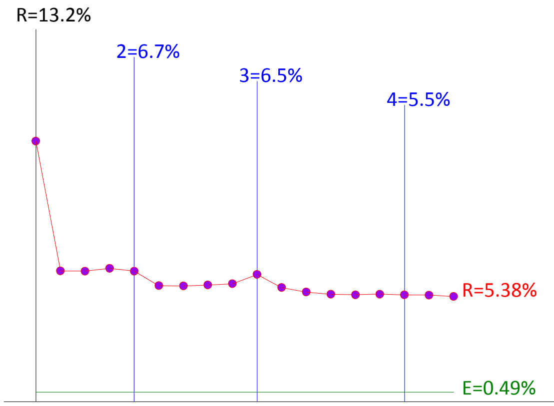
☑ K-alpha2 Peak Present
☑ LS Weighting in 1 / Sqr(I)
☑ LS Weighting in Sin(Theta)
☑ Apply Anomalous Scattering

[Diffractometer LP] Two-Theta Range of Fit = 4.0 - 70.0(deg)
☑ Specimen Displacement - Cos(Theta) = 0.027144(0.001919)
☐ Monochromator Correction for LP Factor = 1.0
☐ K-alpha2/K-alpha1 Intensity Ratio = 0.5

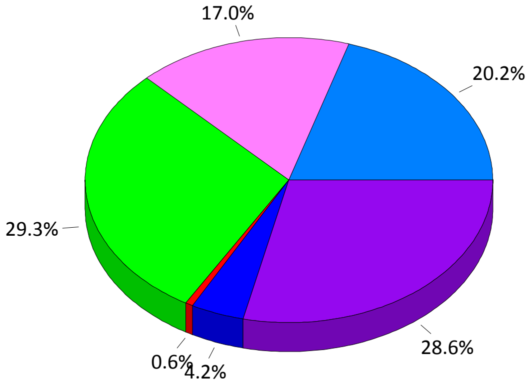
Profile Shape Function (PSF) for All Phases: Pearson-VII, Fixed-BG, Lambda=1.54059Å (Cu/K-alpha1)

	Phase ID (6)	Source	I/Ic	Wt%	#L
■	Quartz - SiO_2	PDF#98-091-4776	4.52(5%)	20.2 (1.2)	18
■	Clinochlore - $Mg_{4.95}Al_{1.7}Fe_{.33}Si_{3.02}O_{18}H_8$	PDF#98-090-4182	0.63(5%)	17.0 (1.5)	267
■	Muscovite - $(K_{.92}Na_{.08})Si_{3.16}Al_{2.68}Ti_{.04}Fe_{.12}Mg_{.14}H_{.26}O_{11.96}F_{.04}$	PDF#98-091-2033	1.50(5%)	29.3 (1.8)	200
■	Calcite - $CaCO_3$	PDF#98-090-3365	3.28(5%)	0.6 (0.1)	19
■	Dolomite - $CaMgC_2O_6$	PDF#98-090-5855	2.70(5%)	4.2 (0.4)	26
■	Smectite - $(Na_{0.2}Ca_{0.1})(Al_{1.3}Mg_{0.2}Fe_{0.3})Si_4O_{10}(OH)$	PDF#99-003-0009	3.60(5%)	28.6 (2.0)	24

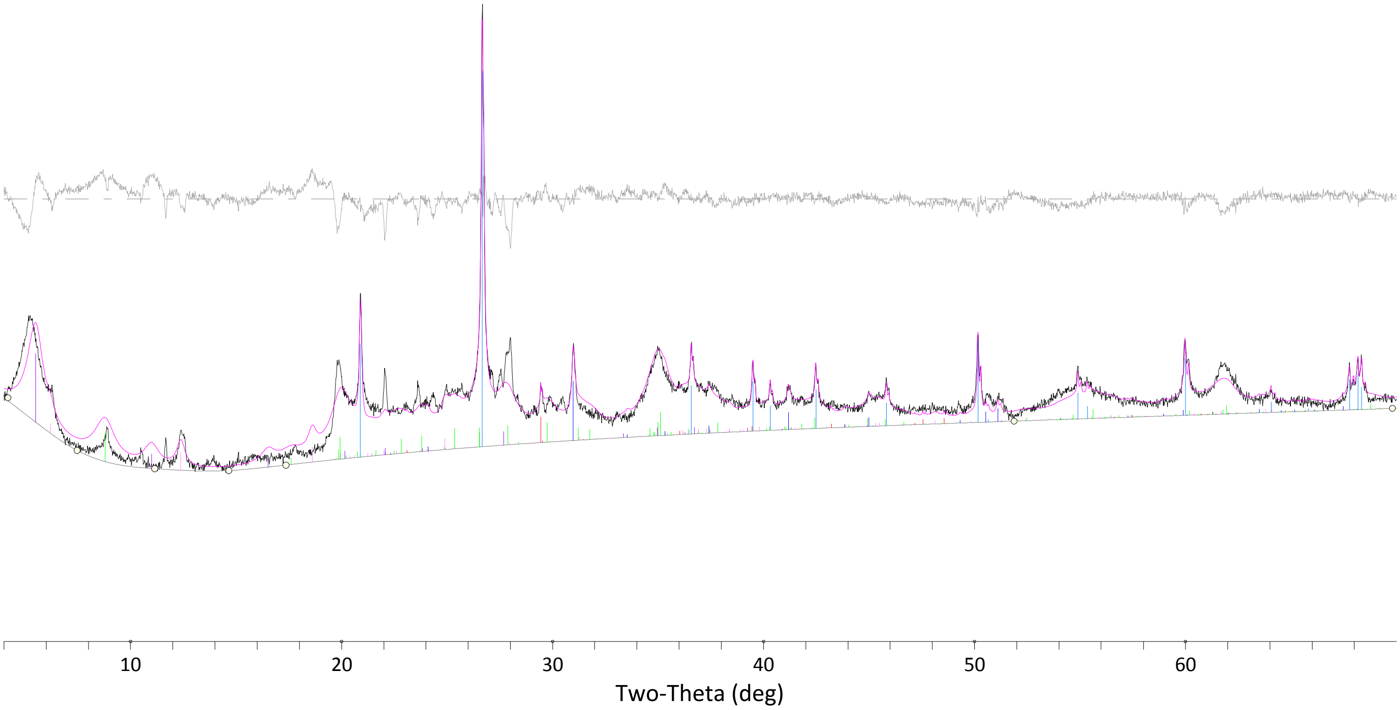
NOTE: Fitting Halted at Iteration 18(4): R=5.38% (E=0.49%, R/E=10.95, P=40, EPS=0.5)



Refinement Iterations



Wt%



-TH17-04-S4-17'

FILE: [TH17-04-S4-17'.raw] TH17-04-S4-17'
SCAN: 4.0/69.9946/0.01997/49.7(sec), Cu(40kV,40mA), I(p)=19203, 06/09/17 09:09a
PROC: [WPF Control File]

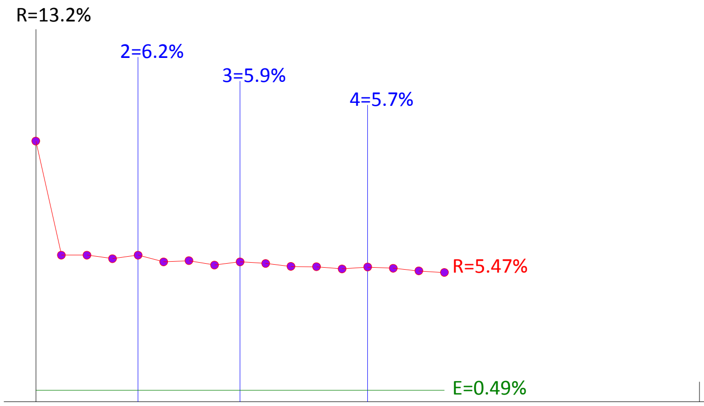
☑ K-alpha2 Peak Present
☑ LS Weighting in 1 / Sqr(I)
☑ LS Weighting in Sin(Theta)
☑ Apply Anomalous Scattering

[Diffractometer LP] Two-Theta Range of Fit = 4.0 - 70.0(deg)
☑ Specimen Displacement - Cos(Theta) = 0.019731(0.002044)
☐ Monochromator Correction for LP Factor = 1.0
☐ K-alpha2/K-alpha1 Intensity Ratio = 0.5

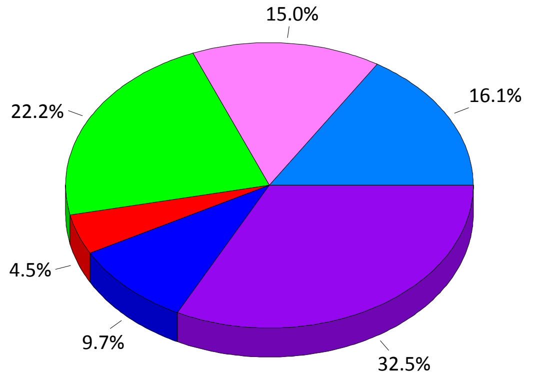
Profile Shape Function (PSF) for All Phases: Pearson-VII, Fixed-BG, Lambda=1.54059Å (Cu/K-alpha1)

	Phase ID (6)	Source	I/Ic	Wt%	#L
🟦	Quartz - SiO_2	PDF#98-091-4776	4.52(5%)	16.1 (0.9)	18
🟪	Clinochlore - $Mg_{4.95}Al_{1.7}Fe_{.33}Si_{3.02}O_{18}H_8$	PDF#98-090-4182	0.63(5%)	15.0 (1.2)	258
🟩	Muscovite - $(K_{.92}Na_{.08})Si_{3.16}Al_{2.68}Ti_{.04}Fe_{.12}Mg_{.14}H_{.26}O_{11.96}F_{.04}$	PDF#98-091-2033	1.50(5%)	22.2 (1.3)	199
🟥	Calcite - $CaCO_3$	PDF#98-090-3365	3.28(5%)	4.5 (0.3)	19
🟦	Dolomite - $CaMgC_2O_6$	PDF#98-090-5855	2.70(5%)	9.7 (0.6)	26
🟪	Smectite - $(Na_{0.2}Ca_{0.1})(Al_{1.3}Mg_{0.2}Fe_{0.3})Si_4O_{10}(OH)$	PDF#99-003-0009	3.60(5%)	32.5 (2.1)	25

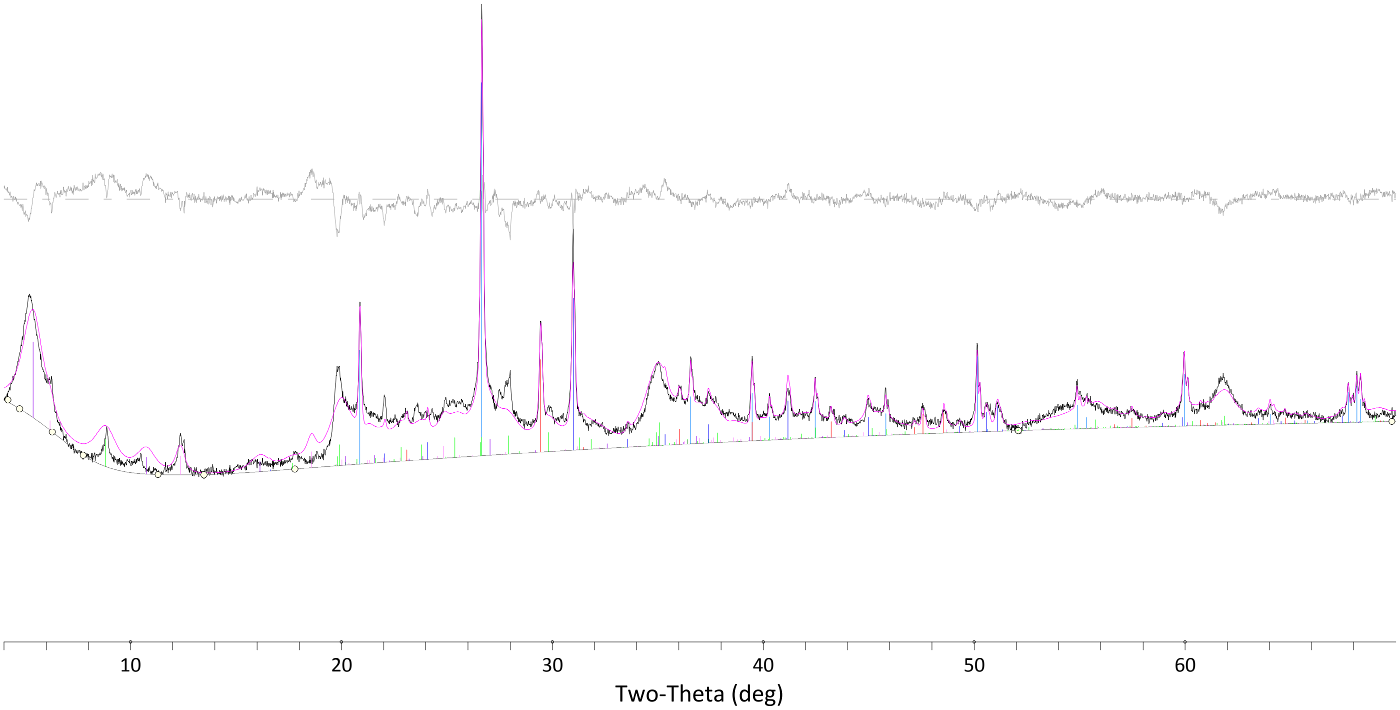
NOTE: Fitting Halted at Iteration 17(4): R=5.47% (E=0.49%, R/E=11.06, P=41, EPS=0.5)



Refinement Iterations



Wt%



-TH17-09-S4-12'

FILE: [TH17-09-S4-12'.raw] TH17-09-S4-12'
SCAN: 4.0/69.9946/0.01997/49.7(sec), Cu(40kV,40mA), I(p)=18446, 06/09/17 08:48a
PROC: [WPF Control File]

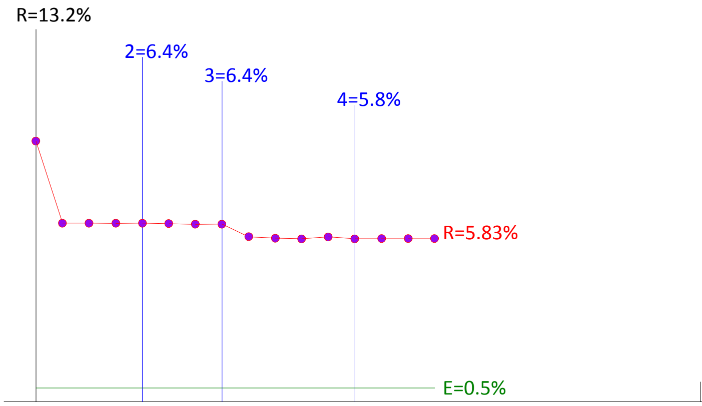
☑ K-alpha2 Peak Present
☑ LS Weighting in 1 / Sqr(I)
☑ LS Weighting in Sin(Theta)
☑ Apply Anomalous Scattering

[Diffractometer LP] Two-Theta Range of Fit = 4.0 - 70.0(deg)
☑ Specimen Displacement - Cos(Theta) = 0.023215(0.001997)
☐ Monochromator Correction for LP Factor = 1.0
☐ K-alpha2/K-alpha1 Intensity Ratio = 0.5

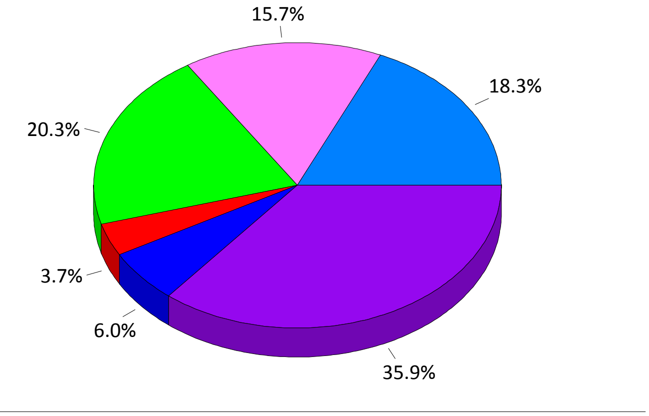
Profile Shape Function (PSF) for All Phases: Pearson-VII, Fixed-BG, Lambda=1.54059Å (Cu/K-alpha1)

	Phase ID (6)	Source	I/Ic	Wt%	#L
🟦	Quartz - SiO_2	PDF#98-091-4776	4.52(5%)	18.3 (1.1)	18
🟪	Clinochlore - $Mg_{4.95}Al_{1.7}Fe_{.33}Si_{3.02}O_{18}H_8$	PDF#98-090-4182	0.63(5%)	15.7 (1.3)	267
🟩	Muscovite - $(K_{.92}Na_{.08})Si_{3.16}Al_{2.68}Ti_{.04}Fe_{.12}Mg_{.14}H_{.26}O_{11.96}F_{.04}$	PDF#98-091-2033	1.50(5%)	20.3 (1.3)	201
🟥	Calcite - $CaCO_3$	PDF#98-090-3365	3.28(5%)	3.7 (0.3)	19
🟦	Dolomite - $CaMgC_2O_6$	PDF#98-090-5855	2.70(5%)	6.0 (0.4)	26
🟪	Smectite - $(Na_{0.2}Ca_{0.1})(Al_{1.3}Mg_{0.2}Fe_{0.3})Si_4O_{10}(OH)$	PDF#99-003-0009	3.60(5%)	35.9 (2.4)	25

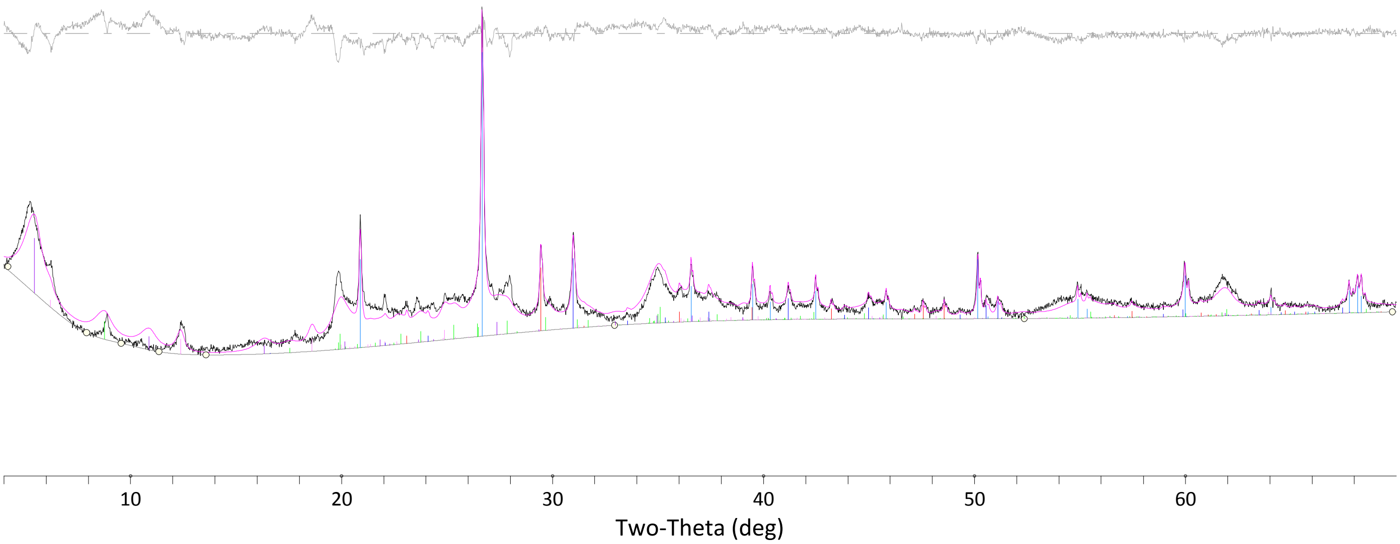
NOTE: Fitting Halted at Iteration 16(4): R=5.83% (E=0.5%, R/E=11.76, P=40, EPS=0.5)



Refinement Iterations



Wt%



-TH17-09-S5-17'

FILE: [TH17-09-S5-17'.raw] TH17-09-S5-17'
SCAN: 4.0/69.9946/0.01997/49.7(sec), Cu(40kV,40mA), I(p)=24844, 06/13/17 10:55a
PROC: [WPF Control File]

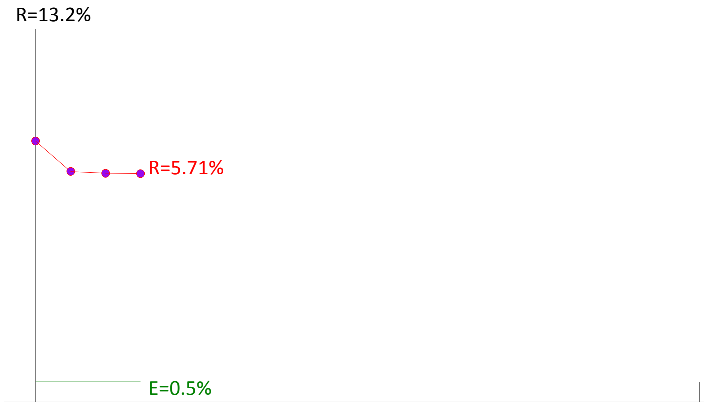
☑ K-alpha2 Peak Present
☑ LS Weighting in 1 / Sqr(I)
☑ LS Weighting in Sin(Theta)
☑ Apply Anomalous Scattering

[Diffractometer LP] Two-Theta Range of Fit = 4.0 - 70.0(deg)
☑ Specimen Displacement - Cos(Theta) = 0.027564(0.001607)
☐ Monochromator Correction for LP Factor = 1.0
☐ K-alpha2/K-alpha1 Intensity Ratio = 0.5

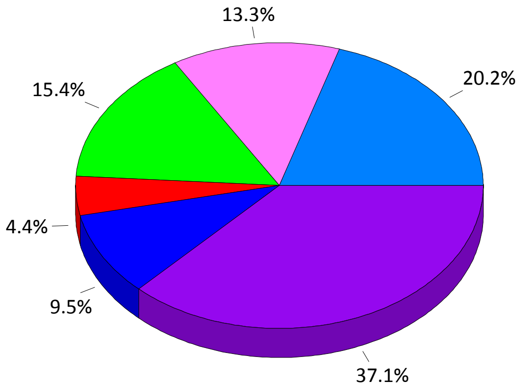
Profile Shape Function (PSF) for All Phases: Pearson-VII, Fixed-BG, Lambda=1.54059Å (Cu/K-alpha1)

Phase ID (6)	Source	I/Ic	Wt%	#L
🟦 Quartz - SiO_2	PDF#98-091-4776	4.52(5%)	20.2 (1.2)	18
🟪 Clinochlore - $Mg_{4.95}Al_{1.7}Fe_{.33}Si_{3.02}O_{18}H_8$	PDF#98-090-4182	0.63(5%)	13.3 (1.1)	258
🟩 Muscovite - $(K_{.92}Na_{.08})Si_{3.16}Al_{2.68}Ti_{.04}Fe_{.12}Mg_{.14}H_{.26}O_{11.96}F_{.04}$	PDF#98-091-2033	1.50(5%)	15.4 (0.9)	198
🟥 Calcite - $CaCO_3$	PDF#98-090-3365	3.28(5%)	4.4 (0.3)	19
🟦 Dolomite - $CaMgC_2O_6$	PDF#98-090-5855	2.70(5%)	9.5 (0.6)	27
🟪 Smectite - $(Na_{0.2}Ca_{0.1})(Al_{1.3}Mg_{0.2}Fe_{0.3})Si_4O_{10}(OH)$	PDF#99-003-0009	3.60(5%)	37.1 (2.3)	25

NOTE: Fitting Halted at Iteration 4(4): R=5.71% (E=0.5%, R/E=11.34, P=41, EPS=0.5)



Refinement Iterations



Wt%