

**APPENDIX B**  
**GEOTECHNICAL DATA REPORT**

CITY OF WINNIPEG

# CentrePort South Regional Water & Wastewater Servicing Geotechnical Data Report

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# STATEMENT OF LIMITATIONS AND CONDITIONS

## Limitations

This report has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the “Agreement”). This report represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole, and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group’s work.

## Third Party Use of Report

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.

## Geotechnical Investigation Statement of Limitations

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 the site at the time of drilling. 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, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

## 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 detailed design and construction of regional water and wastewater infrastructure to support future industrial and residential developments within CentrePort South.

CentrePort Canada is North America's largest tri-modal port shared between the City of Winnipeg and the RM of Rosser. The goal of this project is to bring regional water and wastewater infrastructure to the southern portions of Centreport Canada (CentrePort South) located within the City of Winnipeg. These lands will ultimately result in an additional 1,457 hectares of serviced lands planned for commercial and residential development. The Phase 1A plan addresses the limited water demand and wastewater generation during years 1 to 5. Phase 1A involves four separate contracts described in Table 1-1 in order of priority.

**TABLE 1-1: PHASE 1A CONTRACTS**

Priority	Phase 1A Contracts	Rationale
1	<b>Interceptor &amp; Intake Sewers (Contract 3)</b>	Provides connection points for wastewater collection permitting development of commercial and industrial lands.
2	<b>750 mm Feeder Main, Silver to Offtake Structure 3 (Contract 4A)</b>	Provides central location to permit initial development of both residential and commercial lands. Feeder Main to be extended further north in future once development warrants it.
3	<b>Force Main (Contract 2A)</b>	Installation of a single force main to support initial development. Future force main to be designed and constructed when wastewater generation warrants it.
4	<b>By-Pass Lift Station (Contract 1A)</b>	Small station to support initial development until wastewater levels are actually generated. Infrastructure to be repurposed as part of future full build-out station.

The purpose of our investigation was to identify the subsurface soil, bedrock, and groundwater conditions along the alignments of the proposed works. This factual report contains a description of the geotechnical investigations program performed by KGS Group and our findings. This GDR should be read in conjunction with the Geotechnical Baseline Report(s) (GBR) prepared by KGS Group for the Project.

## 1.2 Purpose of Report

This report summarizes the geotechnical conditions observed along the alignments of the proposed pipeline infrastructure within the entire project area and provides geotechnical considerations that would form part of the basis of design for the Work. This report includes geotechnical data collected at the project site and summary of encountered subsurface conditions along the alignments.

## 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 CentrePort South Regional Water and Wastewater Servicing 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 1988 and 2023. The information provided in this report and the contract documents indicate soil and bedrock 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 Previous Geotechnical Investigations

A review of available geotechnical information pertinent to the project was conducted and presented in this report, including the 1998 UMA Engineering Ltd. investigations, and investigation programs completed by KGS Group in 2009 and 2019. The boreholes from the previous investigations were considered and incorporated in the development of the site stratigraphy and the associated figures. The results of these geotechnical investigations are summarized below.

#### 2.1.1 1988 GEOTECHNICAL INVESTIGATION

In 1988, UMA Engineering Ltd. completed a geotechnical investigation for Genstar Development Co. in the CentrePort South region. The geotechnical investigation was completed along two (2) proposed sewer alignments leading to and within the land parcel proposed for development. The investigation consisted of geotechnical drilling, piezometer installation, and single channel hammer seismic survey. A total of 74 boreholes were advanced to auger refusal along the proposed sewer alignments at approximately 200 m spacing. Additionally, approximately 200 hammer seismic spreads were laid out on a 200 m grid to estimate the depth to till and bedrock on the western portion of the site.

The boreholes in Table 2-1 were drilled along the proposed pipe alignments for the Centreport South project and were used to develop the soil profiles.

**TABLE 2-1: SELECT 1988 BOREHOLES IN PROJECT AREA**

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
G-88-32	5532399	623852	239.44	6.10	--
G-88-40	5530812	623754	236.94	9.91	--
G-88-46			238.15	8.23	--
G-88-50	5530581	623734	237.59	8.64	--
G-88-62	5534084	624819	239.76	6.40	--
G-88-68	5532561	623848	240.19	3.65	--
G-88-71	5533141	623773	239.44	4.27	--
G-88-P3	5529985	622588	238.55	23.77	222.09
G-88-P8	5534095	624858	239.56	18.29	231.06
G-88-P9	5534102	626431	240.45	18.29	225.97



Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
G-88-S1	5530166	623409	237.17	4.42	232.87
G-88-S3	5529509	623268	236.95	4.21	232.96
G-88-S7	5530174	622685	237.17	11.89	228.18
G-88-S13	5529776	622081	237.17	10.67	226.68

The 1988 borehole logs are included in the 2019 KGS Group Geotechnical Report in Appendix A. The location of the boreholes within the vicinity of the site are shown on Figure 1. Details of the geotechnical investigation are outlined in the report titled “Sewer Alignment Investigation and Property Investigation Lands North of Saskatchewan Ave”, dated December 1988.

### 2.1.2 2009 GEOTECHNICAL INVESTIGATION

In 2009, KGS Group completed a geotechnical investigation for MMM Group Ltd. for the construction of CentrePort Canada Way (CCW). Boreholes were drilled at the CCW and Provincial Trunk Highway (PTH) 101 interchange and at the CCW crossing over the Canadian Pacific Kansas City (CPKC) mainline near Inkster Boulevard. The boreholes in

Table 2-2 were drilled along the proposed pipe alignments for the CentrePort South project and were used to develop the soil profiles.

**TABLE 2-2: SELECT 2009 BOREHOLES IN PROJECT AREA**

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
TH09-20	5533717	624309	238.46	9.14	232.98
TH09-21	5533684	624275	238.99	11.05	233.65
TH09-22	5533532	624113	239.28	6.55	--
TH09-23	5533770	624364	237.34	7.62	232.77
TH09-24	5533797	624389	238.12	18.23	232.79
TH09-25	5533919	624517	238.02	6.55	--

The 2009 borehole logs are included in the 2019 KGS Group Geotechnical Report in Appendix A and the locations are shown on Figure 1. Details of the geotechnical investigation are outlined in the report titled “CentrePort Canada Way Geotechnical Investigation Phase 1 Report”, dated July 2009.

A total of two (2) pneumatic and four (4) standpipes were installed in the clay, till, and bedrock units during the 2009 investigations for the boreholes located within the CentrePort South project area. Two pneumatic piezometers were installed in the clay, two standpipes installed in the till, and two standpipes installed in the bedrock. The installation details of the piezometers are shown on the borehole logs in Appendix A. Groundwater monitoring data for the 2009 instrumentation is summarized in Table 2-3.

**TABLE 2-3: 2009 GROUNDWATER MONITORING DATA**

Borehole ID	TH09-20	TH09-20(2)	TH09-20(2)	TH09-23	TH09-23(2)	TH09-23(2)
Ground Elevation (m)	238.46	238.44	238.44	237.34	237.39	237.39
Piezometer No.	Standpipe 1	Standpipe 2	32314	Standpipe 1	Standpipe 2	32315
Tip Elevation (m)	229.36	233.44	234.44	229.74	232.79	234.39
Monitoring Zone	Bedrock	Till	Clay	Bedrock	Till	Clay
<b>Groundwater Elevation Monitoring Data</b>						
Date						
2009-05-08	236.67	237.18	235.71	--	--	--
2009-05-25	236.65	237.60	239.22	236.77	237.77	235.51
2009-05-29	236.64	237.68	--	236.75	237.81	--
2009-06-09	236.58	237.77	239.29	236.77	237.89	237.90

As part of the laboratory testing program for this project, a total of six (6) one-dimensional consolidation (oedometer) tests were performed on select samples of the clay overburden to determine representative deformation properties of the material for use in estimating the anticipated settlements under embankment loads. Testing results from the relevant boreholes within the CentrePort South project area are included in Appendix E.

### 2.1.3 2019 GEOTECHNICAL INVESTIGATION

In 2019, KGS Group completed a geotechnical investigation for the City of Winnipeg as part of the preliminary design phase for the CentrePort South region. Due to the variable soil conditions with till and bedrock observed outcrop at the surface in some locations, seismic refraction surveys were completed in addition to conventional borehole drilling. A total of 36 boreholes were advanced to bedrock between September 2019 and February 2020 to investigate the subsurface stratigraphic conditions. The drilling was completed using a track-mounted sonic drill rig to provide full drilling recovery of the clay and till. The locations of the boreholes are shown on Figure 1.

Clay samples were tested with a field Torvane to evaluate consistency and estimate the undrained shear strength of cohesive soils. Pocket penetrometers were used to evaluate the consistency of the till. A diagnostic laboratory program was not performed as part of this project.

The boreholes in Table 2-4 were drilled along the proposed pipe alignments for the Centreport South project and were used to develop the soil profiles.

**TABLE 2-4: 2019 BOREHOLES IN PROJECT AREA**

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
TH19-01	5530427.04	623766.69	238.75	14.63	224.27
TH19-02	5530706.00	623776.19	238.19	13.72	226.00
TH19-03	5530934.92	623782.92	238.41	9.60	228.96
TH19-04	5531169.14	623790.12	238.39	10.67	228.63
TH19-05	5531557.79	623802.42	238.97	7.77	231.35
TH19-06	5531769.09	623809.13	239.37	10.67	229.62
TH19-07	5532001.74	623815.91	239.66	4.72	235.09
TH19-08	5532179.49	623820.81	240.03	4.57	235.52
TH19-09	5532489.28	623831.30	241.01	4.42	236.74
TH19-10	5532671.52	623801.35	241.24	7.92	233.47
TH19-14	5534076.22	624802.28	239.90	9.14	231.21
TH19-15	5534084.99	624968.52	239.66	11.89	228.08
TH19-16	5534089.93	625160.45	240.07	9.14	231.23
TH19-17	5534092.93	625284.88	240.18	7.92	232.41
TH19-18	5534128.16	625626.02	239.60	7.62	232.29
TH19-19	5534129.01	625786.32	239.46	4.57	235.04
TH19-20	5534113.91	625935.76	239.48	7.16	232.62
TH19-21	5534123.38	626090.00	239.63	11.43	228.51
TH19-22	5534126	626254	240.78	2.90	--
TH19-23	5534133	626546	238.98	13.26	226.03

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
TH19-24	5534137.26	626754.97	237.41	13.11	224.45
TH19-25	5534142.21	626886.53	236.66	9.60	227.21
TH20-01	5528369	624632	237.78	7.92	230.16
TH20-02	5528377	624389	238.62	7.77	231.15
TH20-03	5528389.90	624024.30	240.09	3.05	237.35
TH20-04	5528382.07	623724.35	239.95	5.79	234.46
TH20-05	5528600	623708	239.76	9.14	231.23
TH20-06	5528940.52	623733.94	239.98	9.14	231.14
TH20-07	5529234	623750	240.62	4.27	236.66
TH20-08	5529566.66	623701.15	240.58	6.40	234.33
TH20-09	5529742.84	623534.88	239.94	5.79	234.45
TH20-10	5529859.34	623401.36	239.80	5.49	234.47
TH20-11	5530037.66	623085.45	239.67	10.36	229.61
TH20-12	5530152.99	622811.01	239.70	12.50	228.12
TH20-13	5529862.39	622450.60	239.23	15.54	223.99
TH20-14	5530123.73	623582.28	239.37	9.30	230.38

The 2019 borehole logs are included in Appendix A. The location of the boreholes within the vicinity of the site are shown on Figure 1. Details of the geotechnical investigation are outlined in the KGS Group report titled “Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering, 2019/2020 Preliminary Geotechnical Investigation Report”, dated March 2020, included as Appendix A.

A total of five standpipes were installed along the proposed alignment during the 2019/2020 geotechnical investigation. Two standpipes were installed in the bedrock and three standpipes were installed in the till. The installation details of the piezometers are shown on the borehole logs in Appendix A. Groundwater monitoring data for the 2019/2020 instrumentation is summarized in Table 2-5.

TABLE 2-5: 2019/2020 GROUNDWATER MONITORING DATA

Borehole ID	TH19-04		TH19-18	TH20-12	
Approx. Station (m)	0+850		5+250	10+500	
Ground Elevation (m)	238.39		239.60	239.7	
Piezometer No.	Standpipe 1	Standpipe 2	Standpipe 1	Standpipe 1	Standpipe 2
Tip Elevation (m)	230.34	228.14	233.08	235.82	228.01
Monitoring Zone	Till	Bedrock	Till	Till	Bedrock
Groundwater Elevation Monitoring Data					
Date					
2019-10-28	236.44	236.33	238.42	--	--
2020-02-28	236.41	236.11	237.01	Dry	233.41

Notes:

- 1) Stationing based on figures contained in the 2019 KGS Group Geotechnical Report (Appendix A)
- 2) The 2019/2020 instrumentation were unable to be located in 2023/2024 to obtain recent readings.

KGS Group retained the services of Frontier Geoscience Inc. to perform seismic refraction surveys along the proposed pipeline alignments. The primary objective of the geophysical survey was to obtain estimates of the depths to till and bedrock along the proposed alignment of the pipelines. The location of the seismic lines is shown on Figure 1. The results of the seismic refraction survey are included in the 2019 KGS Group Geotechnical Report in Appendix A.

### Cobbles and Boulders

As part of the 2019/2020 drilling investigation, cobbles were encountered in the clay deposit near the till interface in some boreholes. Cobbles were observed within the silt till in a majority of the boreholes as indicated on the borehole logs. Based on previous works completed by the City of Winnipeg in the vicinity of this project, it is understood that installation of the new pipelines near the clay/till interface and within the till may encounter substantial quantities of cobbles and boulders. Zones with increased cobbles and boulders were identified as part of the geophysical investigation and were observed at Stations 3+140 to 3+250, 8+820 to 8+950, 9+000 to 9+030, 9+270 to 9+320, and 9+500 to 9+540 (refer to station ranges in Appendix A).

## 2.2 Regional Geologic Setting

The geology in Winnipeg generally consists of carbonate sedimentary bedrock overlaying Precambrian era granite and gneiss. The sedimentary rock consists of alternating layers of limestone, and dolomite and to a lesser extent shale. The proposed pipelines will encounter the Stony Mountain Formation. In the Stony Mountain Formation, the basal Gunn member consists of greyish-red to purplish- and reddish-grey, fossiliferous, calcareous shale with interbeds of relatively clean, fossiliferous limestone. It is overlain by yellowish- to reddish-grey fossiliferous, argillaceous dolomite of the Penitentiary member. These two units together compose the lower Stony Mountain Formation.

The surface of the bedrock is usually highly fractured and disturbed, often mixed with gravels and sands. Geological maps for Winnipeg 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 soils.

During the last glacial advance and retreat, Winnipeg's glacial till was deposited 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 the Geological Engineering Report for Urban Development of Winnipeg, University of Manitoba (Reference 4).

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## 3.0 SCOPE OF 2023 INVESTIGATION PROGRAM

### 3.1 General

This section provides a summary of the 2023 field investigation program, instrumentation installation and monitoring, and laboratory test results; as well as a description of the subsurface conditions encountered at the project site.

The 2023 geotechnical and geophysical investigations were completed to determine the subsurface conditions along the proposed water and wastewater pipeline alignments, and within the footprint of the proposed lift station. The results of the investigation program are presented in this Geotechnical Data Report.

### 3.2 Borehole Drilling and Soil Sampling

The borehole drilling and sampling program was completed by KGS Group from September 25 to November 22, 2023 over multiple field work mobilizations. A total of twenty (20) boreholes were advanced to at least power auger refusal, with seven (7) of the boreholes being advanced into bedrock. The boreholes were completed to investigate the subsurface stratigraphic conditions within the project area and evaluate the suitability of the till and bedrock for trenchless construction methodologies that are anticipated to be utilized for the various construction contracts and at specific road/railway crossing locations. Two pumping wells, PW23-01 and PW23-02, were advanced in the footprint of the future lift station. The locations of the 2023 boreholes are shown in plan on Figure 1 and a summary of the locations is presented in Table 3-1.

Maple Leaf Drilling of Winnipeg, Manitoba provided the drilling services using a track-mounted drill rig equipped with 125 mm solid stem augers, casing advancer, and HQ coring. The drilling was completed under the supervision and direction of KGS Group personnel. Soil samples were collected at intervals of 1.5 m (5 ft.) or at any 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 (SPTs) were completed in the glacial till to evaluate the in-situ density. Clay samples were tested with a field Torvane to evaluate the consistency and estimate the undrained shear strengths of cohesive soils. Glacial till samples were tested with a Pocket Penetrometer to estimate the unconfined compressive strength of non-cohesive soils. Upon completion of drilling, the boreholes were examined for indications of sloughing and seepage and then backfilled. Borehole log records incorporating field observations, and field test results are provided in Appendix B. Photographs of the soil and bedrock samples are included in Appendix C.

TABLE 3-1: SUMMARY OF 2023 BOREHOLE LOCATIONS

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
PW23-01	5530157	623136	238.91	22.30	
PW23-02	5530127x	623154	238.77	22.30	
TH23-01	5530113	623145	240.20	22.50	229.08
TH23-03	5528181	623558	237.80	7.07	
TH23-04	5528361	623519	237.80	7.39	
TH23-05	5528557	623549	239.33	4.27	
TH23-06	5528836	623547	239.10	6.78	
TH23-07	5529083	623587	239.10	5.49	
TH23-08	5529096	623757	239.40	9.45	234.37
TH23-09	5529183	623764	240.00	9.75	233.52
TH23-11	5529997	623757	237.50	7.85	
TH23-12	5530219	623766	237.80	7.62	
TH23-17	5533655	624430	237.67	12.60	233.28
TH23-18	5533695	624469	238.01	12.62	233.16
TH23-19	5533941	624602	238.74	7.32	
TH23-20	5534056	624724	238.81	8.11	
TH23-21	5534214	624686	238.92	8.08	
TH23-22	5534319	625352	239.74	7.32	
TH23-23	5534208	625352	238.81	6.25	
TH23-24	5529982	622695	238.26	12.37	
TH23-25	5530062	622907	239.06	14.07	227.94
TH23-26	5529971	623340	239.09	15.62	232.69

## Notes:

- 1) Ground surface elevations were established from City of Winnipeg LiDAR data.
- 2) Top of bedrock elevation is reported where bedrock was confirmed during drilling.



### 3.3 Groundwater Monitoring

A total of three (3) vibrating wire piezometers and five (5) standpipes piezometers were installed at the project site. The standpipes were installed within the bedrock and the vibrating wire piezometers were installed in the overlying glacial till. Based on the results of the drilling, the standpipe in TH23-24 is likely installed within a zone of cobbles/boulders or highly weathered bedrock. Table 3-2 summarizes the installation details and the piezometer monitoring completed to date. The installation details of the piezometers are shown on the 2023 borehole log records provided in Appendix B.

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**TABLE 3-2: GROUNDWATER MONITORING DATA**

Borehole ID	TH19-04		TH19-18	TH20-12		PW23-01	PW23-02	TH23-01		TH23-09	TH23-18	TH23-24		TH23-25	
Ground Elevation (m)	238.39		239.60	239.70		238.77	238.91	240.20		240.00	238.01	238.26		239.06	
Piezometer No.	Standpipe 1	Standpipe 2	Standpipe 1	Standpipe 1	Standpipe 2	Pump Well	Pump Well	VW171370	Standpipe 1	Standpipe 1	Standpipe 1	VW164950	Standpipe 1	VW163297	Standpipe 1
Tip Elevation (m)	230.34	228.14	233.08	235.82	228.01	216.52	216.66	231.67	218.76	230.86	225.82	228.81	226.07	229.00	225.50
Monitoring Zone	Till	Bedrock	Till	Till	Bedrock	Bedrock	Bedrock	Till	Bedrock	Bedrock	Bedrock	Till	Cobbles/Boulders	Till	Bedrock

**Groundwater Elevation Monitoring Data**

Date															
2019-10-28	236.44	235.33	238.42	--	--										
2020-02-28	236.41	236.11	237.01	Dry	233.41										
2023-11-14								233.21	233.21	232.60					
2023-11-20						230.28	233.42	--	233.18	232.60	237.06	--	236.33	--	233.63
2023-12-01								233.31	233.01	--	236.99	233.63	235.93	233.64	233.61
2023-12-13								233.32	233.09	232.60	237.16	233.63	235.71	233.64	233.51
2024-01-17								233.21	233.08	232.57	237.41	233.47	235.11	233.62	233.52

Notes:

- 1) Instrumentation casings for the 2019/2020 instrumentation were unable to be located during instrumentation readings in 2023/2024.
- 2) Additional instrumentation readings are recommended to be collected during spring and summer conditions to determine seasonal fluctuations of groundwater.

### 3.4 Geophysical Seismic Refraction Survey

KGS Group retained the services of Frontier Geoscience Inc. to complete seismic refraction surveys along a portion of the preferred force main alignments for the interceptor sewer and feeder main contracts. The seismic refraction surveys were completed from October 31 to November 3, 2023. The objective of the geophysical survey was to obtain estimates of the depth to glacial till and bedrock along the preferred alignments as noted. The locations of the 2023 seismic lines are shown on Figure 1 and the results of the seismic refraction survey are included in the Seismic Refraction Survey Report included in Appendix F. The interpreted profiles of the glacial till and bedrock surfaces are also included on the respective Contract Drawings.

### 3.5 Laboratory Testing

Laboratory testing was performed on select soil and bedrock samples for use in the characterization of the subsurface.

Laboratory testing was completed on representative soil samples including:

- Moisture content;
- Particle size distribution; and
- Atterberg Limit

Laboratory testing on the bedrock samples was completed to determine the following mechanical properties:

- Uniaxial Compressive Strength
- CERCHAR Testing (rock abrasivity)

All laboratory testing was performed at a Canadian Council of Independent Laboratories (CCIL) certified laboratory in general accordance with ASTM International standards.

The 2023 laboratory test results are summarized in Section 4.0 and included in Appendix D.

### 3.6 Well Pump Testing

KGS Group completed drilling a 125 mm diameter PVC test well (PW23-02) on November 14, 2023. Drilling services were provided by licensed water well driller Maple Leaf Drilling Ltd., under KGS Group supervision. The borehole was completed using a Canterra CT 250 truck-mounted rig using mud rotary drilling techniques in the overburden and to set the PVC casing into the bedrock. Open hole rotary drilling was used to bore an open hole into the bedrock beneath the casing. The casing was grouted in place, as per the Provincial water well installation guidelines. The location of PW23-02 is shown on Figure 1 and a summary log is included in Appendix B. Pump test well PW23-01 was initially installed at the site, but due to low preliminary yield (<1 USgpm), a second pump test well (PW23-02) was installed to facilitate the pump test.

A pumping test of PW23-02 was conducted on November 20, 2023, to quantify the hydraulic characteristics of the carbonate bedrock aquifer at the test well site, and to monitor the aquifer response to pumping in the piezometers installed in borehole TH23-01 and in PW23-01. A 2-hour pumping test was conducted on PW23-

02 on November 20, 2023, starting a 15:00 and ending at 17:00. Recovery, following the cessation of pumping, was measured for an additional half hour, until 17:30.

The pump test memorandum is included as Appendix G.

DRAFT

## 4.0 SUBSURFACE CONDITIONS

The stratigraphy at the site is described in this section and is based on the exploratory boreholes, seismic refraction surveys, and our understanding of the site geology. Borehole logs from the 1988, 2009, and 2019/2020 geotechnical investigations along the proposed project alignments are provided in the 2019 KGS Group Geotechnical Report in Appendix A. The borehole logs from the 2023 geotechnical investigations are provided in Appendix B.

In general, the stratigraphy consists of fill overlying clay, silt till, and bedrock. The following sections describe the soil and the bedrock encountered during the geotechnical drilling investigation. Fencelines showing soil profiles along the proposed alignment are shown on Figures 2 to 6. The approximate till surface is shown on the fenceline and is generally interpolated between boreholes. The seismic refraction survey results are overlain on the fencelines where survey data exists. The seismic refraction data indicates that there is variability in the till and bedrock elevations between the boreholes.

### 4.1 Overburden

The overburden deposits encountered at the project site generally consist of fill over glaciolacustrine clay, glacial silt till deposit, and underlain by the carbonate bedrock. Variable layers of fill and occasional silt were observed in the boreholes within the Upper Complex Zone.

The Upper Complex Zone in Winnipeg generally 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<sup>3</sup> (Reference 4).

#### 4.1.1 FILL

In the project area, topsoil or fill was generally encountered above the glaciolacustrine clay deposit. For boreholes drilled on or adjacent to roadways, a layer of granular fill was observed.

The granular fill was fine to coarse grained gravel and was described as brown in colour, damp, loose to compact in density, contained some fine to coarse grained sand, and trace silt, and trace clay.

The clay fill was mottled brown to grey, damp, firm to stiff, low to high plasticity, contained trace to some fine to coarse grained gravel, trace to some fine to coarse grained sand, some organics, and trace rootlets.

The extent of the clay fill identified in the project area is outlined in Table 4-1 below.

**TABLE 4-1: CLAY FILL – PROJECT AREA**

Location	Profile	Clay Fill
Project Area	Elevation at Top (m)	235.89 to 241.24
	Thickness (m)	0.15 m to 2.44 m

A summary of the laboratory material testing results on the clay fill from the KGS Group 2023 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-2.

**TABLE 4-2: SUMMARY OF LABORATORY AND FIELD TEST RESULTS FOR CLAY FILL**

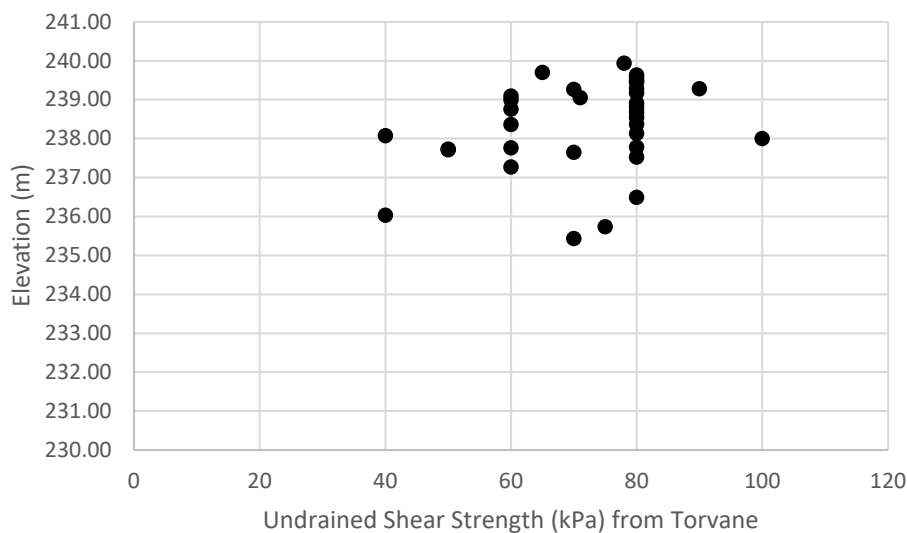
Laboratory Test	Clay Fill
Moisture Content (%)	42 to 43
Undrained Shear Strength (kPa) – Torvane	40 to 100
Unconfined Compressive Strength (kPa) – Pocket Penetrometer	350

Notes:

- 1) Unconfined Compressive Strength is based on one pocket penetrometer test.

Values of undrained shear strength ( $S_u$ ) with elevation for the clay fill as estimated from a field Torvane during the KGS Group 2023 investigation and background geotechnical investigations throughout the project site are summarized in Figure 4-1.

**FIGURE 4-1: UNDRAINED SHEAR STRENGTH WITH ELEVATION FOR CLAY FILL**



#### 4.1.2 GLACIOLACUSTRINE CLAY

The glaciolacustrine clay deposit in the Winnipeg region is typically 9 to 12 m thick. 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 deposit 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.

The glaciolacustrine clay typically contains trace to some silt nodules. These non-plastic, non-clay materials generally occur throughout the clay deposit as varves, veins, seams, inclusions or pockets that are typically less than a centimeter in diameter. The tendency for horizontal orientation of the varves, veins, and seams introduces a visible macrostructure to the clay and are a contributing cause for the observed anisotropy in horizontal permeability and strength of the deposit. Quigley (1968) offers the explanation that frozen silt lumps were rafted into glacial Lake Agassiz by icebergs and dropped into the clays as frozen lumps. Baracos (1977) provided a more likely explanation, considering the sharply defined boundaries of the inclusions, that they were deposited not frozen but as cemented or lithified material which subsequently disintegrated into silt.

Typical moisture content in the glaciolacustrine 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 (Reference 4).

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  $\phi' = 20.5^\circ$  and  $c' = 29.8$  kPa and  $\phi' = 15.8^\circ$ , respectively. While the effective large

strain shear strength parameter for the brown and grey clay were  $c' = 14.5$  kPa and  $\phi' = 13.3^\circ$  and  $c' = 7.7$  kPa and  $\phi' = 15.7^\circ$ , respectively (Reference 4). The effective shear strength parameters typically used by local geotechnical engineers in Winnipeg for slope stability analysis are  $c' = 5$  kPa and  $\phi' = 14^\circ$  for both clays.

XRD analysis was not completed on the clay deposit as part of the 2023 geotechnical investigations. Testing results from another tunnelling site in Winnipeg indicated that the quartz content of the clay samples ranged from 16.1 to 20.2%, the clinocllore content ranged from 13.3 to 17.0%, the muscovite content ranged from 15.4 to 29.3%, the calcite content ranged from 0.6 to 4.5%, the dolomite content ranged from 4.2 to 9.7%, and the smectite content ranged from 28.6 to 37.1%.

In the project area, the thickness of the glaciolacustrine clay deposit is generally less than the majority of the Winnipeg region, with glacial till and bedrock outcrop observed at surface in some areas. The extent of the glaciolacustrine deposits identified in KGS Group's 2023 geotechnical investigation and the background geotechnical investigations is outlined in Table 4-3 below.

**TABLE 4-3: GLACIOLACUSTRINE DEPOSITS – PROJECT AREA**

Location	Profile	Glaciolacustrine Clay
Project Area	Elevation at Top (m)	235.13 to 240.45
	Thickness (m)	0.30 to 7.01

A summary of the laboratory material testing results on the glaciolacustrine clay from the KGS Group 2023 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-4.

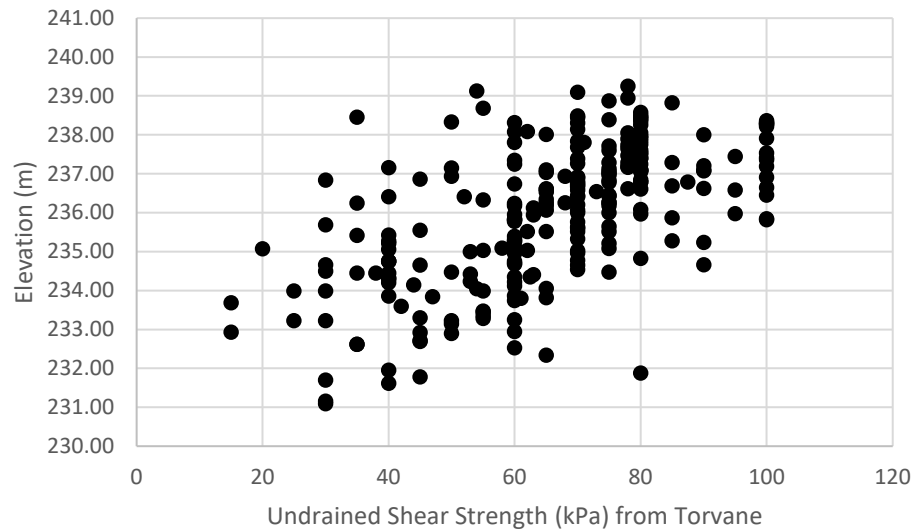
**TABLE 4-4: SUMMARY OF LABORATORY AND FIELD TEST RESULTS FOR GLACIOLACUSTRINE CLAY**

Laboratory Test	Glaciolacustrine Clay
Moisture Content (%)	18 to 57
Atterberg – Plastic Limit (%)	16 to 29
Atterberg – Liquid Limit (%)	49 to 95
Plasticity Index	27 to 66
Grain Size – Gravel (%)	0
Grain Size – Sand (%)	1 to 13
Grain Size – Silt (%)	3 to 32
Grain Size - Clay (%)	53 to 97
Undrained Shear Strength (kPa) – Torvane	15 to 100
Unconfined Compressive Strength (kPa) – Pocket Penetrometer	75 to 450



Values of undrained shear strength ( $S_u$ ) with elevation for the glaciolacustrine clay as estimated from a field Torvane during the KGS Group 2023 investigation and background geotechnical investigations throughout the project site are summarized in Figure 4-2.

**FIGURE 4-2: UNDRAINED SHEAR STRENGTH WITH ELEVATION FOR GLACIOLACUSTRINE CLAY**



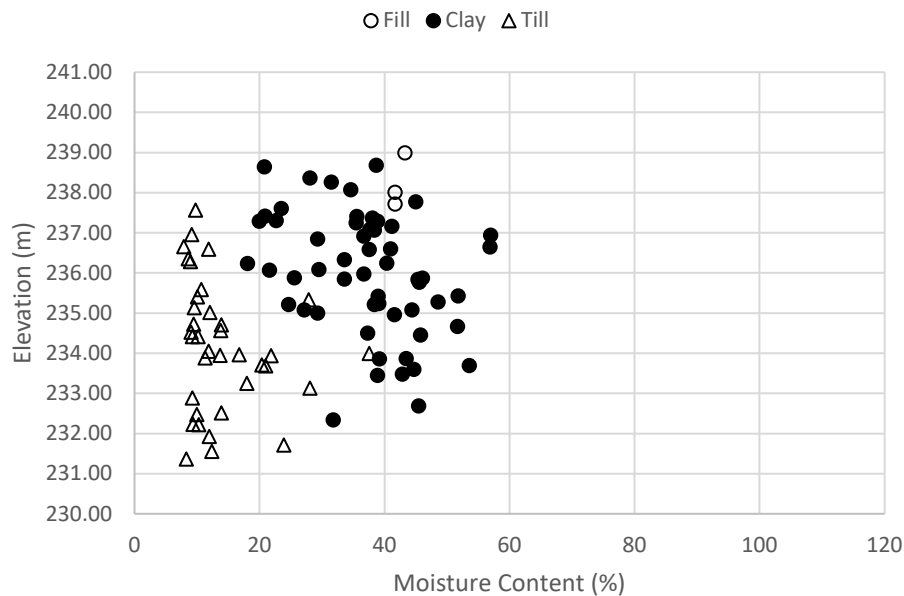
#### 4.1.2.1 Swelling Potential of Clay Deposit

The swelling potential of a clay soil can be categorized based on the plasticity and percentage of clay sized particles (Figure 12.8, Canadian Foundation Engineering Manual, 5<sup>th</sup> Edition). The swelling potential of clay is highest when a sample has a high percentage of clay size particles and high plasticity index. Clay minerals accounts for between 67 and 81 % of the total composition of the Lake Agassiz clay in Winnipeg. The clays' size fractions typically consist of up to 75 % montmorillonite, 10 % illite, and 10 percent kaolinite and approximately 5% quartz mineral. Over-consolidation ratio of the clay is generally less than 2.

The clay in the project area is classified to have a very high potential severity of an expansive soil based on the laboratory testing completed and is subject to considerable volume change with change in moisture content. Volumetric increases are usually in the 2% range with swelling pressure generally less than 75 kPa.

The variability of moisture content in the overburden with elevation in the project area is shown in Figure 4-3.

FIGURE 4-3: MOISTURE CONTENT OF OVERBURDEN WITH ELEVATION

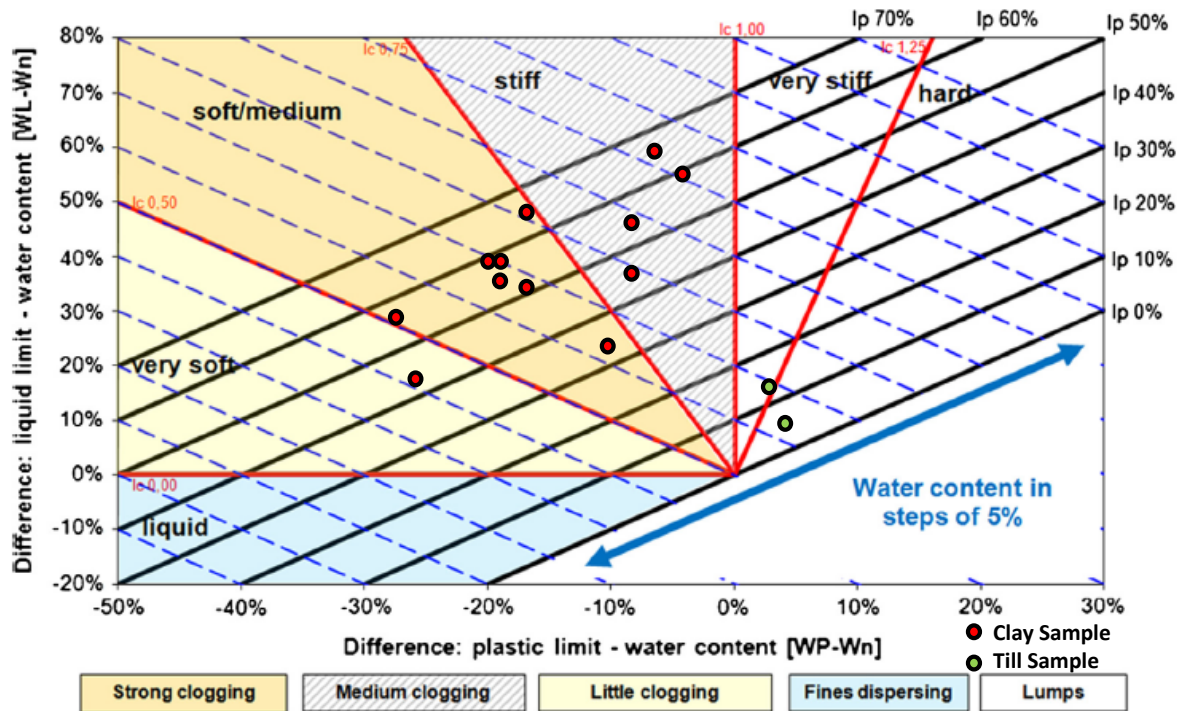


#### 4.1.2.2 Stickiness Potential and Clogging Risks

The clay and silt till deposit present at the site has a tendency to develop sticky behaviour (adhesion of cohesive material to each other or to a metal surface). This stickiness may result in the clogging and blockage of trenchless construction equipment including cutterhead, tooling, work chamber, screw conveyors, muck carts, conveyors, slurry lines, or prevent the shield advancement due to excessive friction.

The potential for clogging while tunnelling through the clay and glacial till formations was evaluated using the chart suggested by Hollmann and Thewes (2013). Atterberg Limits (Liquid limit, Plastic limit, and natural moisture content) of cohesive samples tested in the Laboratory and their Plasticity Indices were plotted on Figure 4-4 to determine the corresponding clogging potential of the clay and glacial till. It should be noted that the Hollman and Thewes chart was developed from data collected from fluid supported trenchless shield drives, but are assumed to be applicable to other tunnelling methods.

FIGURE 4-4: STICKINESS POTENTIAL OF COHESIVE SOIL



#### 4.1.3 GLACIAL TILL DEPOSIT

The glaciolacustrine clays are underlain by glacial silty tills. Based on the borehole drilling, glacial silt till was encountered at elevations ranging from 230.7 to 239.5 m within the project area. The glacial till ranged in thickness from 0.4 to 13.6 m. The glacial till 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 like 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 content. Unconfined compressive strengths ranging from 3.4 - 3.6 MPa have been reported for very dense tills with a moisture content of about 5% (Reference 4). Young's moduli typically range from 170 to 240 MPa (Reference 4). The tills are highly variable in terms of thickness, density and cobble/boulder content. Pockets of non-combustible gas, often under pressure are occasionally encountered in the till layer (Reference 3).

The uncorrected Standard Penetration Test blow counts ranged from 5 to greater than 50 blows/0.3 m, classifying the material as loose to very dense throughout the project area.

In KGS Group's experience and as observed during this program, zones of cobbles and/or boulders have been encountered within the till deposits such as those at this site. The composition of the cobble/boulders will contain granite with diameters ranging from 150 mm to 600 mm based on previous experience in Winnipeg. The percent volume of cobbles/boulders from the 2019/2020 sonic drilling records is estimated to be up to

5%. These zones can cause difficulties during construction and should be anticipated within the deposits in the project area.

The extent of the glacial till deposit identified in KGS Group's 2023 geotechnical investigation and the background geotechnical investigation is outlined in Table 4-5 below.

**TABLE 4-5: GLACIAL TILL – PROJECT AREA**

Location	Profile	Glacial Till
Project Area	Elevation at Top (m)	230.16 to 239.54
	Thickness (m)	0.40 to 13.56

Notes:

- 1) Thickness is based only on boreholes where the bedrock elevation was confirmed.

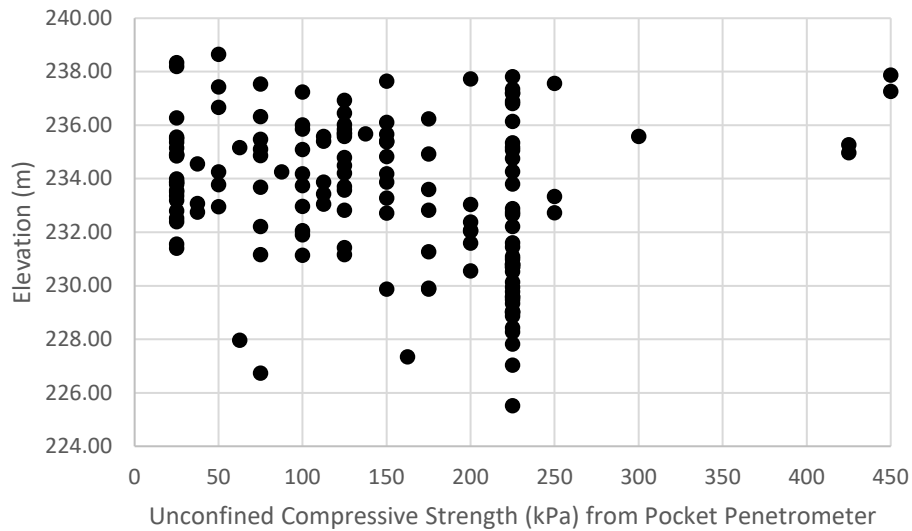
A summary of the laboratory material testing results on the glacial till deposits from the KGS Group 2023 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-6.

**TABLE 4-6: SUMMARY OF LABORATORY TEST RESULTS FOR GLACIAL TILL**

Laboratory Test	Glacial Till
Moisture Content (%)	8 to 28
Atterberg – Plastic Limit (%)	14 to 16
Atterberg – Liquid Limit (%)	21 to 27
Plasticity Index (%)	5 to 13
Grain Size – Gravel (%)	0 to 25
Grain Size – Sand (%)	1 to 37
Grain Size – Silt (%)	15 to 81
Grain Size - Clay (%)	10 to 84
Uncorrected Standard Penetration Test – Blow Count	5 to >100
Unconfined Compressive Strength (kPa) – Pocket Penetrometer	25 to 450

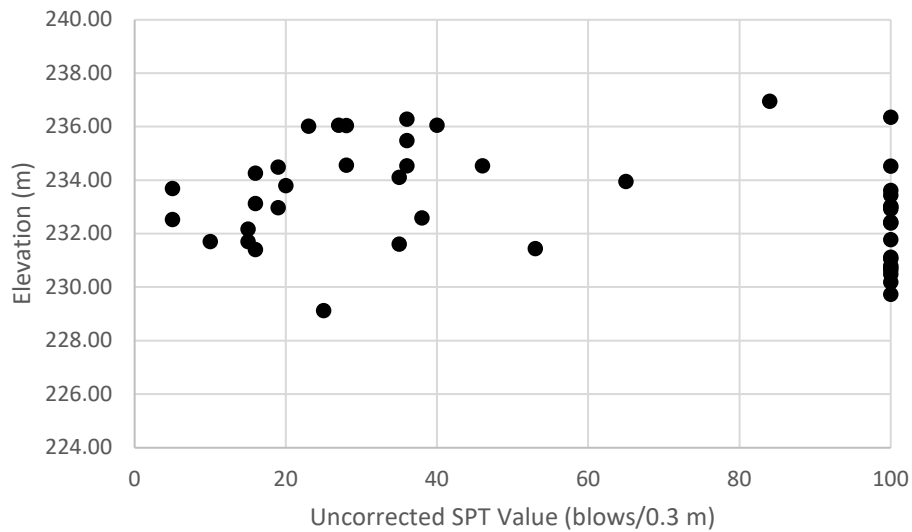
Values of unconfined compressive strength ( $C_u$ ) with elevation for the glacial till deposit as estimated from a pocket penetrometer during the KGS Group 2023 investigation and background geotechnical investigations throughout the project site are summarized in Figure 4-5.

**FIGURE 4-5: UNCONFINED COMPRESSIVE STRENGTH WITH ELEVATION FOR GLACIAL TILL**



Uncorrected Standard Penetration Test (SPT) blow count values (blows/0.3 m) with elevation for the glacial till encountered during the KGS Group 2023 investigation and background geotechnical investigations throughout the project site are summarized in Figure 4-6.

**FIGURE 4-6: UNCORRECTED SPT VALUES WITH ELEVATION FOR GLACIAL TILL**



Notes:

- 1) Values of 100 indicate early refusal of the split spoon during SPT.

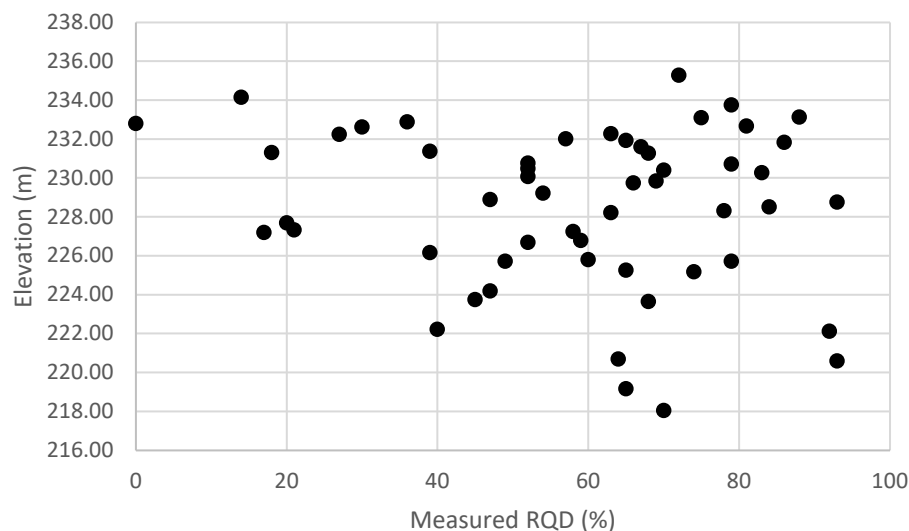
#### 4.1.4 BEDROCK

The carbonate bedrock within the project area belongs to the Gunn and Penitentiary members of the Stony Mountain Formation. The Gunn and Penitentiary members typically include the lowest strength rock in the Winnipeg region with compressive strengths in the order of 25 to 30 MPa. The Young's modulus (E) generally ranges from 15 to 25 GPa for the stronger rocks in the Winnipeg area, and as low as 4 GPa for the weaker rocks (Reference 4).

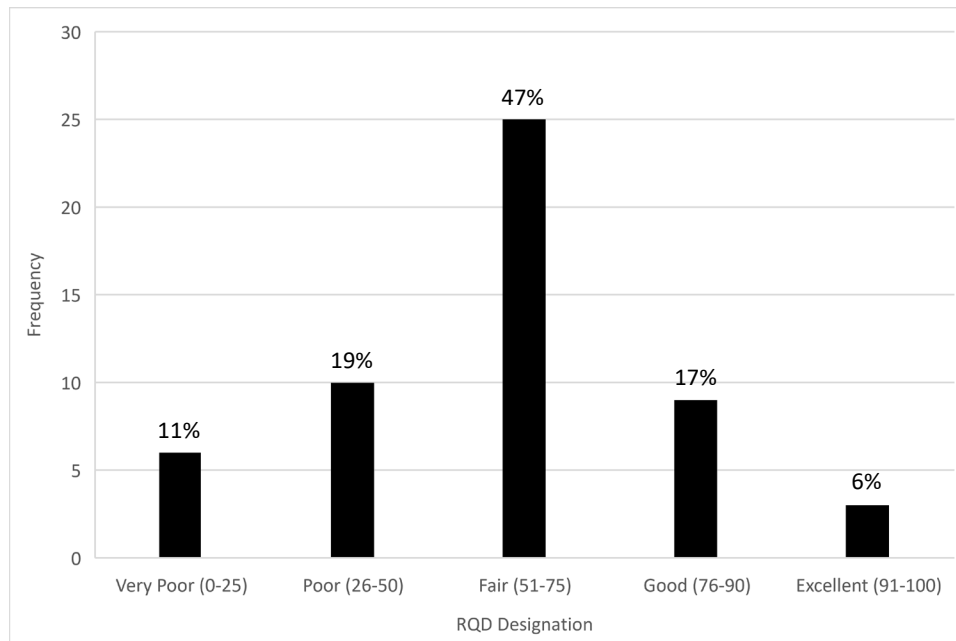
Bedrock was cored in seven (7) boreholes during the 2023 KGS Group investigation and within forty-seven (47) boreholes during previous geotechnical investigations. Based on the borehole drilling, bedrock was encountered below the silt till at elevations ranging from 222.1 to 237.4 m. The estimated bedrock elevation from the 2019 seismic refraction survey ranged from approximate El. 223 m to 238.5 m along Sturgeon Road and range from approximate El. 225 m to 235 m along the northern portion of CentrePort Canada Way (CCW). The estimated bedrock elevation from the 2023 seismic refraction survey ranged from approximate El. 221 m to 231 m on the south side of Sturgeon Access and ranged from approximate El. 225.5 m to 232 m on the north side of Sturgeon Access. The seismic refraction survey results are generally consistent with observations from the drilling. The seismic refraction lines from the 2019 and 2023 surveys are shown on Figure 1.

The bedrock consists of argillaceous limestone to calcareous shale and occasionally overlain by argillaceous dolomite. The dolomite was observed in boreholes TH23-08, TH23-09, and TH23-26. The measured RQD of the bedrock with elevation is shown in Figure 4-7 below, and a histogram with the RQD distribution is shown on Figure 4-8.

**FIGURE 4-7: BEDROCK RQD WITH ELEVATION**

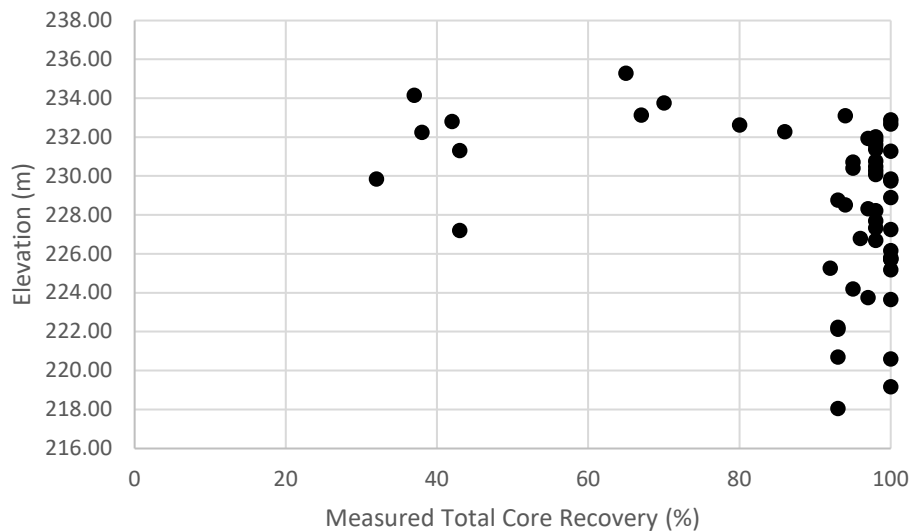


**FIGURE 4-8: HISTOGRAM OF DISTRIBUTION OF RQD WITHIN BOREHOLES**

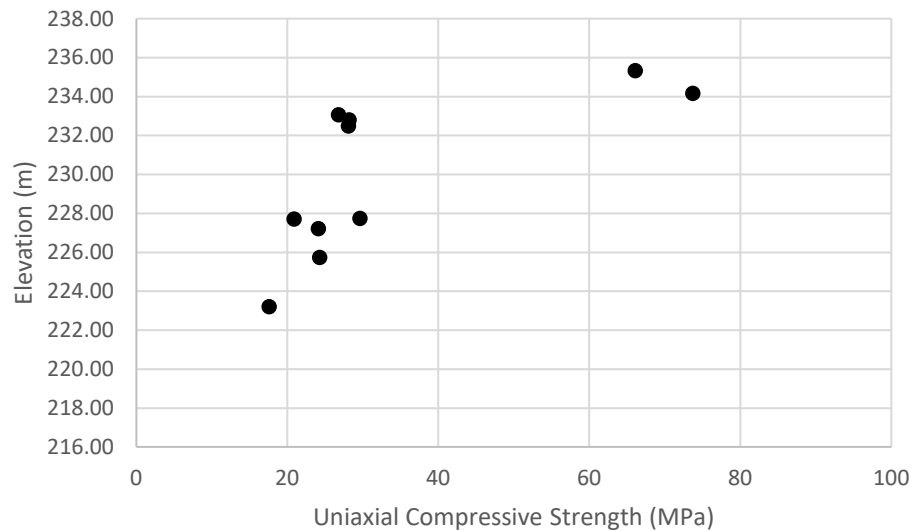


Total Core Recovery (TCR) is the total length of the bedrock core recovered and is expressed as the percentage of actual length of the core run (typically 1.5 m). A summary of the TCR values is provided in Figure 4-9.

**FIGURE 4-9: BEDROCK TOTAL CORE RECOVERY WITH ELEVATION**



Uniaxial compressive strength testing was completed on bedrock samples from boreholes TH23-01, TH23-08, TH23-17, TH23-18, TH23-25, and TH23-26. The results for compressive strength testing are summarized in Figure 4-10.

**FIGURE 4-10: UCS OF BEDROCK WITH ELEVATION**

CERCHAR laboratory testing was completed in accordance with ASTM D7625-22 to determine the CERCHAR Abrasiveness Index (CAI) of the bedrock in order to evaluate the wear on cutting tool components for common trenchless construction techniques (e.g. tunnel boring machine). The results of the CERCHAR testing are summarized in Table 4-7 and a detailed report is provided in Appendix D.

**TABLE 4-7: CERCHAR ABRASIVENESS INDEX RESULTS**

Borehole ID	Sample Depth (m)	Sample Elevation (m)	Description	CAI	ASTM Classification
TH23-17	5.18	232.49	Argillaceous Limestone / Calcareous Shale	0.301	< Very Low Abrasiveness
TH23-18	5.49	232.52		0.445	Very Low Abrasiveness
TH23-25	11.58	227.48		0.525	Very Low Abrasiveness
TH23-26	10.97	228.12		0.278	< Very Low Abrasiveness

#### 4.1.4.1 Excavatability/Rippability of Bedrock

Excavation of bedrock will be required at the tunnel shaft locations and the deep large-diameter shaft for in the vicinity of the future lift station as shown on the Contract Drawings. Rippability of bedrock was assessed using the Kirsten method (Kirsten 1988; ASTM STP 984). Rippability indices for bedrock were estimated using the factors provided in Kirsten (1988) at the elevations where UCS data was collected for the bedrock. The Rippability index for bedrock within the interceptor sewer project area varied from 260 to 2500, indicating a hard to extremely hard ripping classification.



## 4.2 Well Pump Test Results

A summary of measured response to pumping during the 2-hour pumping test are shown in Table 4-8. The pumping test data was analyzed using the Cooper Jacob (1946) method (both time and distance drawdown) method and the hydraulic parameters inferred from the data are shown in Table 4-9.

**TABLE 4-8: PUMPING TEST DRAWDOWN RESULTS**

Test Hole	Instrument Type	Tip Depth (m bgs)	Monitored Zone	Distance from Pumping Well (m)	Static Water Level (m below TOC)	GW Elevation (masl)	End of Test Drawdown (m)
PW23-02	Standpipe	11.73	Bedrock	-	6.096	233.424	5.57
TH23-01	Standpipe	21.4	Bedrock	~ 13	7.930	233.147	0.077
TH23-01	Vibrating wire	9.1	Silt Till	~ 13	7.840	233.28	None
PW23-01	Standpipe	12.95	Bedrock	~ 35	9.069	230.281	None

**TABLE 4-9: TRANSMISSIVITY AND STORATIVITY CALCULATIONS FROM PUMPING TEST**

Data from the Well	Data Type	Method	Transmissivity (m <sup>2</sup> /day)	Storativity
PW23-02	Residual Drawdown vs Elapsed Time	Cooper-Jacob (1946)	1.47	-
PW23-02 and TH23-01	Distance-Drawdown	Cooper-Jacob (1946)	2.9	0.0032
<b>Average Transmissivity (m<sup>2</sup>/day)</b>			2.18	

In general, the aquifer was inferred to have an approximate transmissivity of 2.18 m<sup>2</sup>/day (<500 USgpd/ft), based on the results of the 2-hour, single pumping well test, and the data from the responding observation wells. The drawdown observations from the bedrock monitoring wells (TH23-01, PW23-01) did not show appreciable fracture connectivity to the pumping well. Drawdowns in the limestone aquifer were small but detectable in pumping well PW23-02 and in observation well TH23-01; however, no drawdown was observed in PW23-01. The storativity was inferred to be at 0.0032. It was observed that PW23-02 recovered back to the static groundwater level within the first 10 minutes of the recovery period following pump shutoff.

Radius of influence calculations were not performed; however, it was noted from the drawdown versus time data for TH23-01 that the maximum drawdown at this well location was 0.077 m. It is estimated that assumed that the radius of influence of pumping at 8 USgpm was approximately 13 m.

Details of the pump test assessment is included in Appendix G

### 4.3 Groundwater

Groundwater monitoring data is presented in Table 3-2.

Potentially difficult groundwater inflows were noted in several boreholes from the 2023 geotechnical investigation and background geotechnical investigations. End of drilling observations are included on the borehole logs in Appendix A and B. After completion of drilling, at least 1.0 m of water was observed in the following boreholes within five minutes:

- G-88-32, G-88-33, G-88-34, G-88-37, G-88-38, TH23-01, TH23-21, TH23-22, TH23-23, TH23-24, TH23-25

Water seepage was observed in eleven additional boreholes:

- G-88-40, G-88-50, G-88-55 to G-88-60, G-88-63, TH09-20, and TH09-22, TH23-20

Groundwater levels observed in the 2019/2020 borehole immediately upon the completion of drilling included on the borehole logs may not be representative, as water was used during the sonic drilling program.

In KGS Group's experience, zones of cobbles, boulders, and/or granular layers are known to exist within till deposits. These zones should be expected to be water bearing.

## 5.0 REFERENCES

1. KGS Group (2020). Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering, 2019/2020 Preliminary Geotechnical Investigation Report, Final Version 02. March 2020.
2. UMA Engineering Ltd. (1988). Sewer Alignment Investigation and Property Investigation, Lands North of Saskatchewan Ave. December 1988.
3. KGS Group (2009). Centre Port Canada Way Geotechnical Investigation, Phase 1 Report, Final. July 2009.
4. Department of Geological Engineering, the University of Manitoba, (1983). Geological Engineering Report for Urban Development of Winnipeg.
5. Frontier Geoscience Inc. (2020). Seismic Refraction Survey Report, Winnipeg Richardson International Airport, Winnipeg, MB, Final. February 2020.
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7. KGS Group, Acres Engineering, UMA Engineering (2004). Appendix B, Floodway Channel Pre-Design, Floodway Expansion Project, Project Definition and Environmental Assessment, Preliminary Engineering Report.

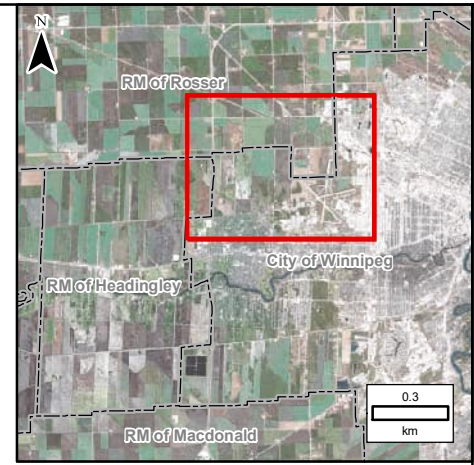
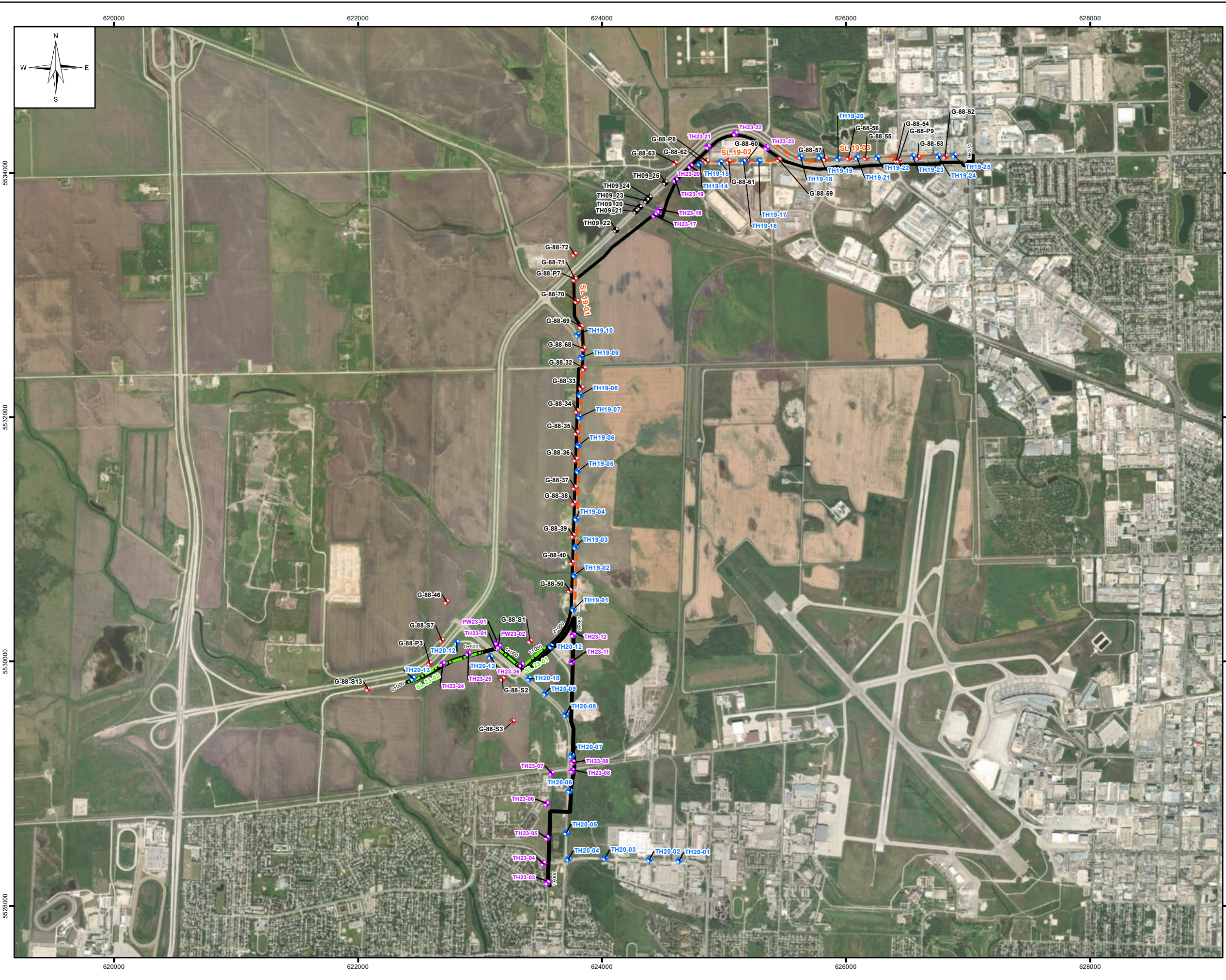
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# FIGURES



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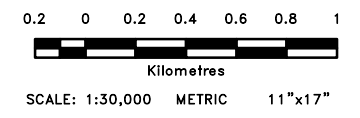


- LEGEND:**
- ◆ KGS Group Test Hole (2023)
  - ◆ KGS Group Test Hole (2019/2020)
  - ◆ KGS Group Test Hole (2009)
  - ◆ UMA Test Hole (1988)
  - 2019 Seismic Lines (approximate)
  - 2023 Seismic Lines
  - Proposed Pipeline Infrastructure Alignment

**NOTES:**

1. Image Source: ESRI/MAXAR dated as 2022.
2. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983 CSRS, Zone 14. Elevations are in metres referencing vertical datum (CGVD28).

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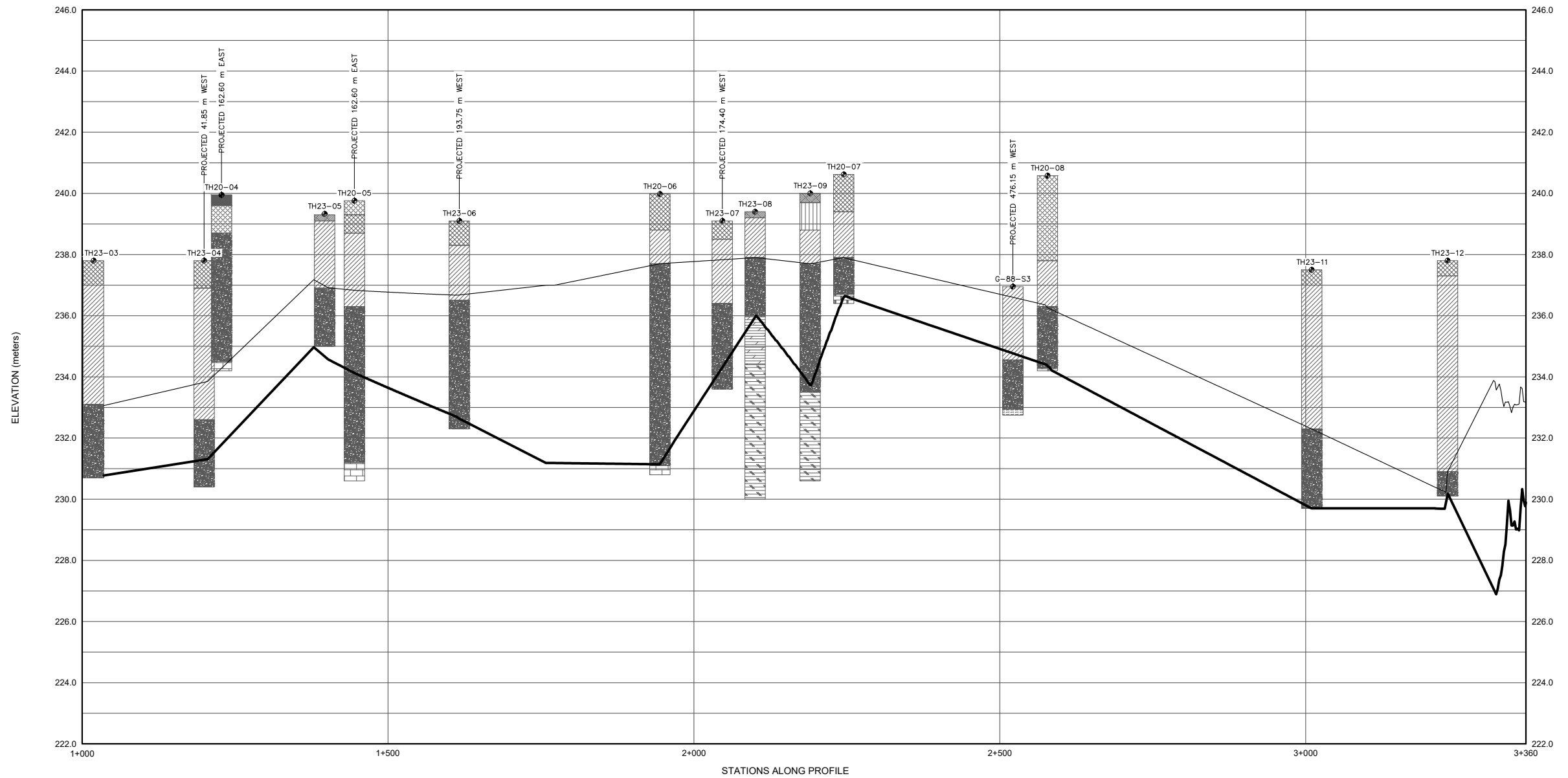
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**CENTREPORT SOUTH REGIONAL  
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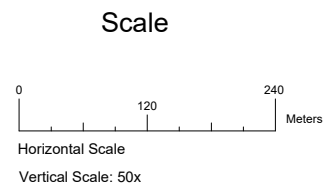
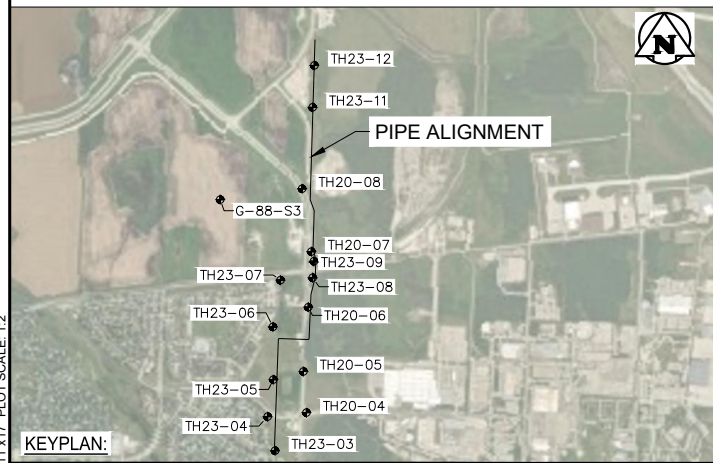
**GEOTECHNICAL DATA REPORT**

FEBRUARY 2024	FIGURE 01	REV: B
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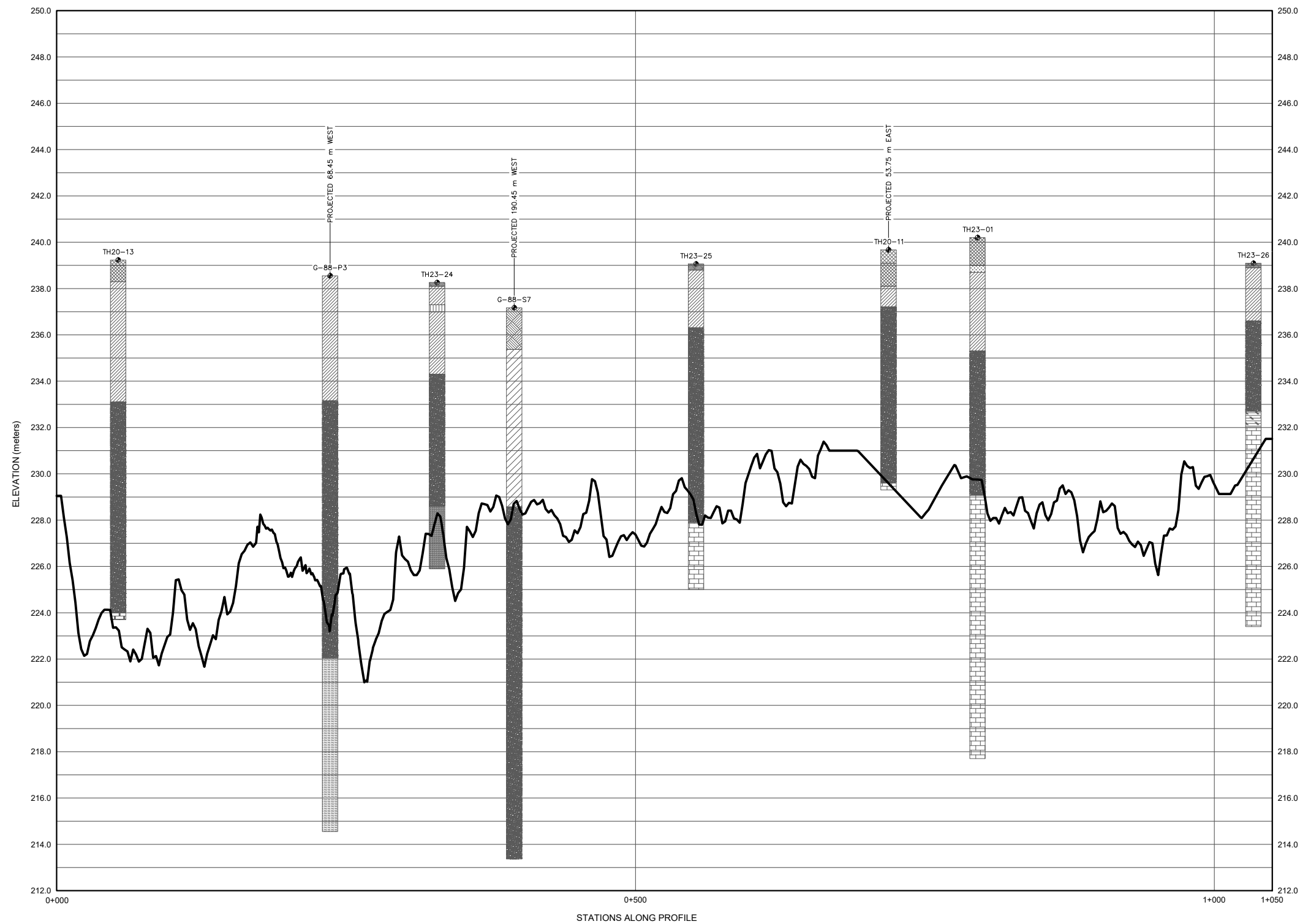
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	Shale with Dolomite Beds		Asphalt
	Clay/Silty Clay		Silt Till
	Dolomite		Argillaceous Dolomite
	Silt		Limestone
	Granular Fill		Sand and Gravel
	Organic Soil		Till Surface (See Note 2)
	Organic Clay		Bedrock Surface (See Note 2)

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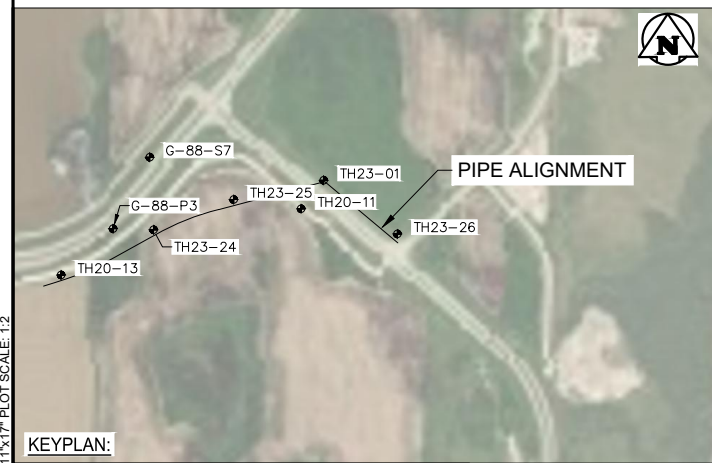
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1. Frontier Geoscience Inc. (2024). Seismic Refraction Survey Report, CentrePort Regional S&W Servicing Project, Winnipeg, MB, Final. January 2024.  
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4. The information provided indicate soil and bedrock conditions only at specific locations and only to the depths penetrated. Subsurface conditions at other locations may differ from conditions occurring at the explored locations. Interpolation between the drilling locations has been supplemented with seismic refraction survey data.

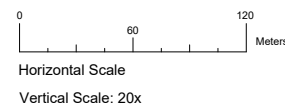
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FEBRUARY 2024		FIGURE 2	REV B



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Scale



Lithology Graphics



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References:

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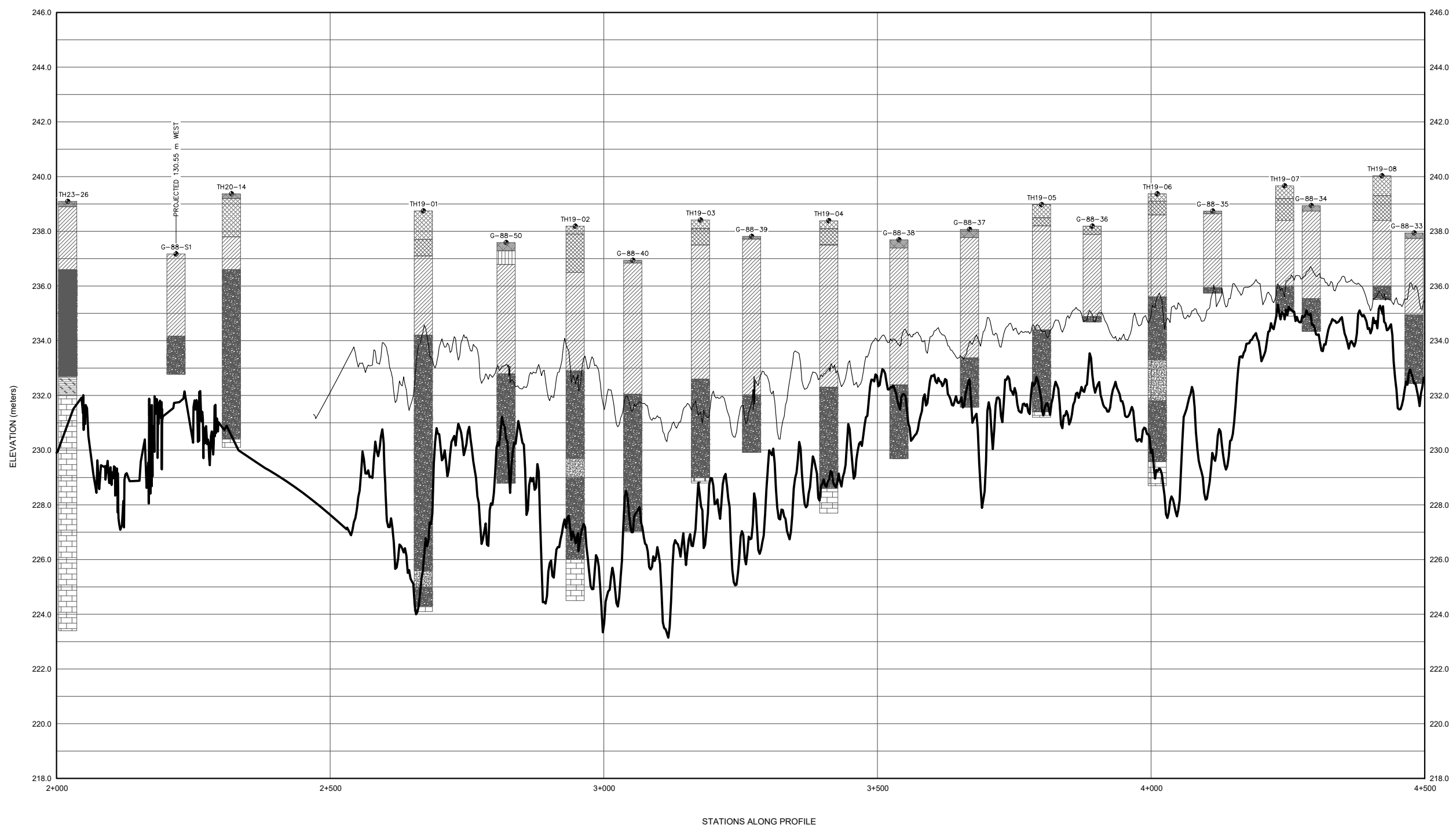
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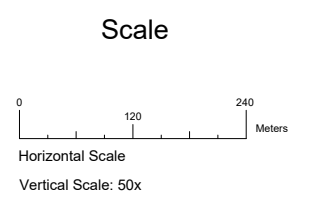
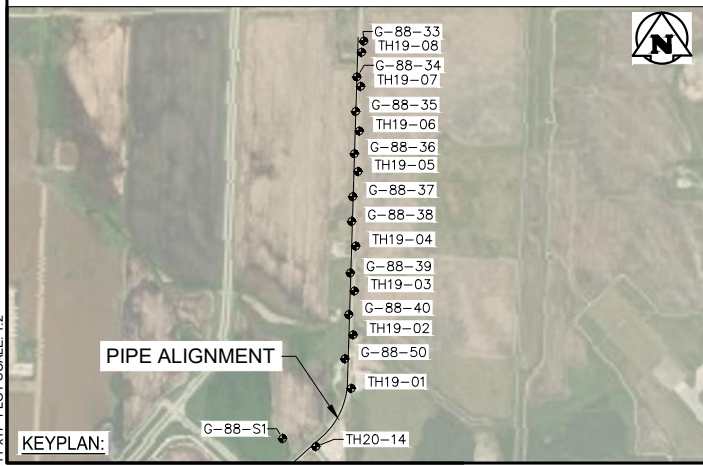


CENTREPORT SOUTH  
REGIONAL WATER &  
WASTEWATER SERVICING  
GEOTECHNICAL DATA REPORT  
INTERCEPTOR ALIGNMENT

FEBRUARY 2024      FIGURE 3      REV. B



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Lithology Graphics			
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	Shale with Dolomite Beds		Asphalt
	Clay/Silty Clay		Dolomite
	Silt Till		Argillaceous Dolomite
	Granular Fill		Sand and Gravel
	Organic Soil		Limestone
	Organic Clay		Till Surface (See Note 2)
	Silt		Bedrock Surface (See Note 2)

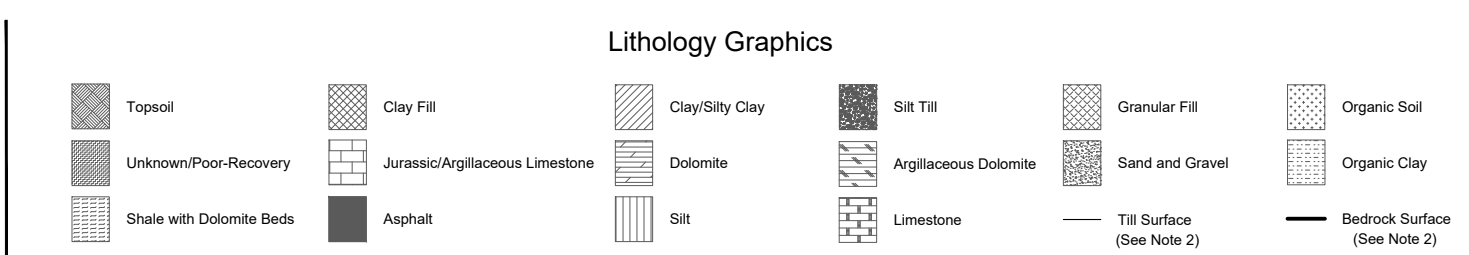
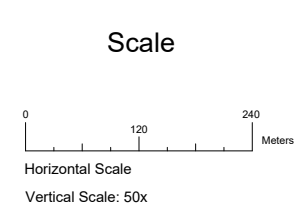
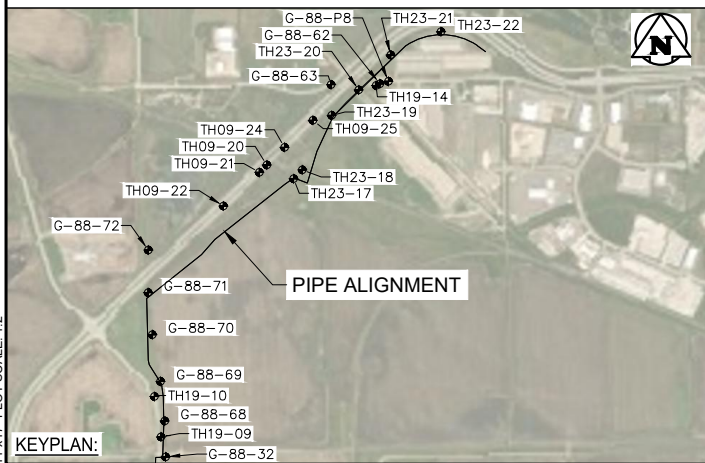
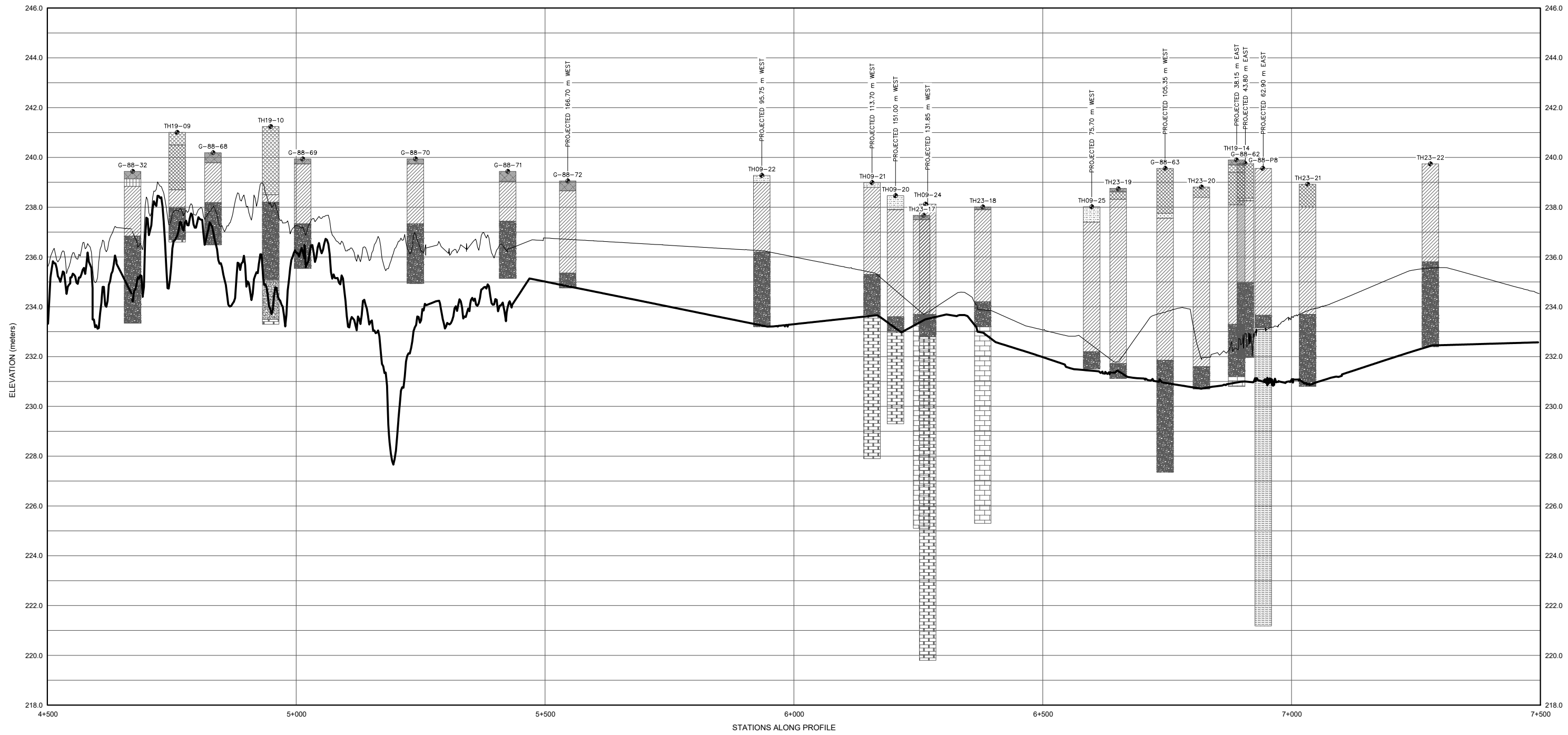
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- References:**
- Frontier Geoscience Inc. (2024). Seismic Refraction Survey Report, CentrePort Regional S&W Servicing Project, Winnipeg, MB, Final. January 2024.
  - Frontier Geoscience Inc. (2020). Seismic Refraction Survey Report, Winnipeg Richardson International Airport, Winnipeg, MB, Final. February 2020.

- Notes:**
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  - The geotechnical data presented on this drawing is based on the observations and results obtained from field investigation programs completed between 1988 and 2023.
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FEBRUARY 2024		FIGURE 4	REV B





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**References:**  
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2. Frontier Geoscience Inc. (2020). Seismic Refraction Survey Report, Winnipeg Richardson International Airport, Winnipeg, MB, Final. February 2020.

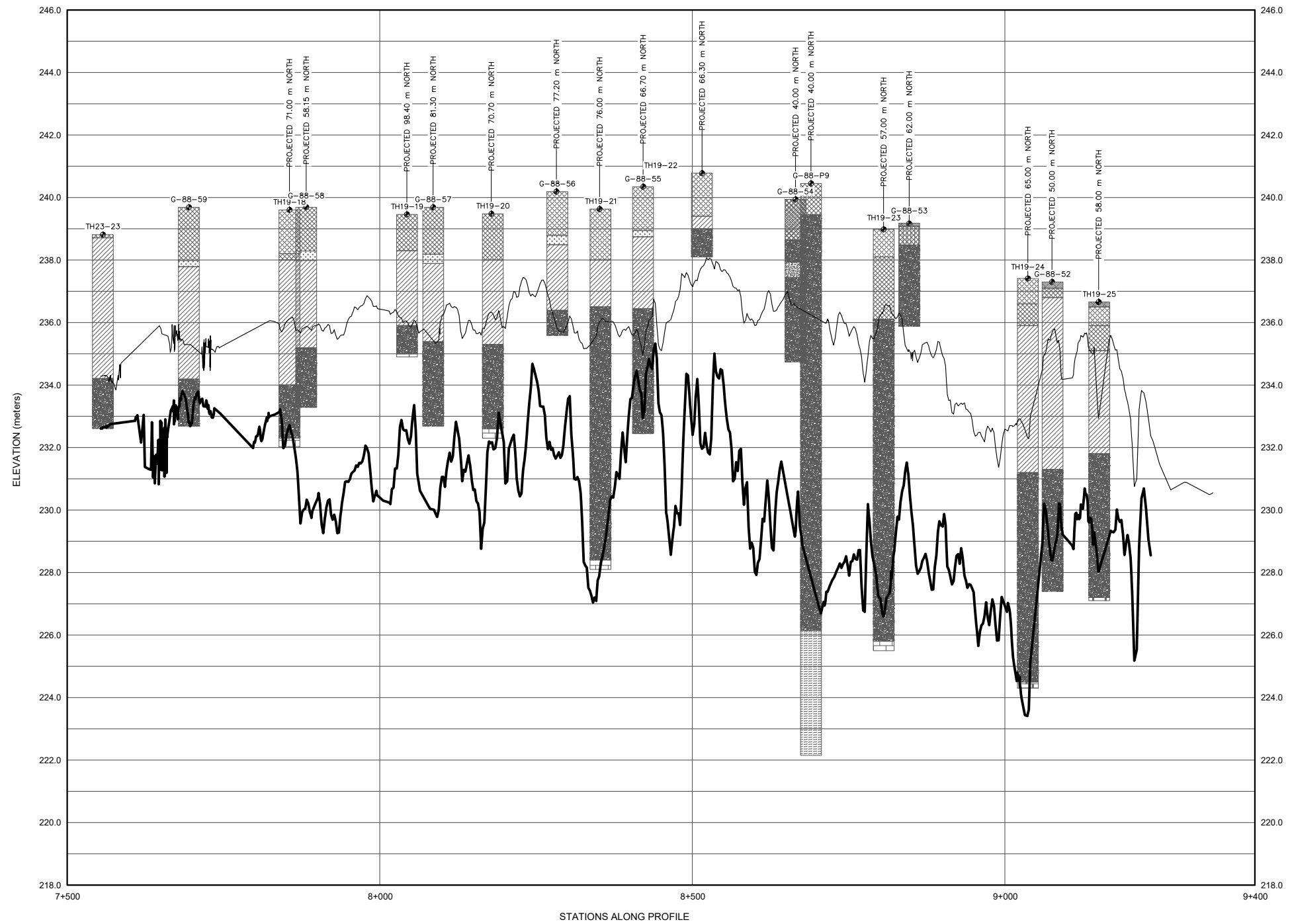
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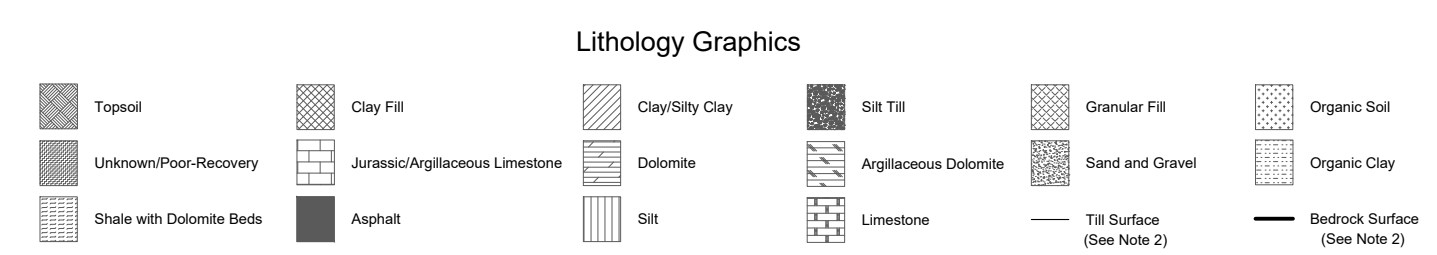
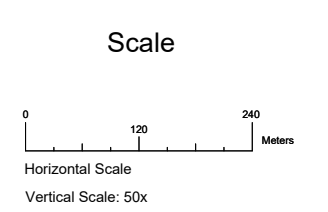
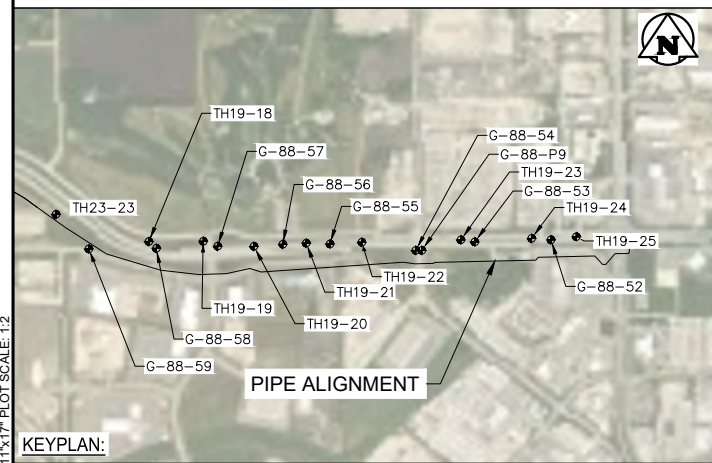
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CENTREPORT SOUTH  
REGIONAL WATER &  
WASTEWATER SERVICING  
GEOTECHNICAL DATA REPORT  
FORCE MAIN ALIGNMENT 02

FEBRUARY 2024	FIGURE 5	REV. B
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**REGIONAL WATER & WASTEWATER SERVICING**  
**GEOTECHNICAL DATA REPORT**  
**FORCE MAIN ALIGNMENT 03**

FEBRUARY 2024	FIGURE 6	REV. B
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# **APPENDIX A**

2019/2020 KGS Group Preliminary Geotechnical  
Investigation Report

CITY OF WINNIPEG

Airport Area West Regional Water and  
Wastewater Servicing Preliminary Engineering  
2019/2020 Preliminary  
Geotechnical Investigation Report

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Final:

Version 02

City of Winnipeg RFP No.:

289-2019

KGS Group Project:

19-0107-009

Date:

March 27, 2020

Prepared by:



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**Jacqueline MacLennan**, P.Eng.

Geotechnical Engineer

Approved by:



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**Dami Adedapo**, Ph.D., P.Eng.

Geotechnical Department Head/Associate Principal

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Appendix C: 2019/2020 Test Hole and Photograph Logs

Appendix D: Seismic Refraction Survey Report

# STATEMENT OF LIMITATIONS AND CONDITIONS

## Limitations

This report has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the “Agreement”). This report represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar reports. The information, data, recommendations and conclusions in this report are subject to the constraints and limitations in the Agreement and the qualifications in this report. This report must be read as a whole and sections or parts should not be read out of context.

This report is based on information made available to KGS Group by City of Winnipeg and unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this report apply only as they existed at the time of KGS Group’s work.

## Third Party Use of Report

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.

## Geotechnical Investigation Statement of Limitations

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 the site at the time of drilling. 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, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.



## 1.0 INTRODUCTION

KGS Group was retained by the City of Winnipeg Water and Waste Department to complete a preliminary engineering assessment for the Airport Area West Regional Water and Wastewater Servicing. The overall goal of the project is to develop a Class 3 cost estimate to determine the extent of the regional infrastructure required to support the proposed industrial and residential developments within the approximately 1,460 Ha of unserviced City lands (located within the AAW site). As part of our scope of services, KGS Group completed geotechnical investigations to facilitate the preliminary design of the water and wastewater systems.

### 1.1 Investigation Objectives

The objectives of the investigations were to review and collect available geotechnical information for the site, and complete additional investigations to gain a better understanding of the soil along the proposed infrastructure route for the purpose of cost estimates, risk assessment and general groundwater conditions along the planned regional routes at a preliminary level.

## 2.0 PREVIOUS GEOTECHNICAL INVESTIGATIONS

A number of geotechnical investigations have been completed in the area, which include a geotechnical drilling and seismic survey investigation for Genstar Developments in 1988 and a geotechnical investigation completed by KGS Group in 2009 for the CentrePort Canada Way development. The test holes from the previous geotechnical investigations were considered and incorporated in the development of the site stratigraphy and the associated figures. The results of these geotechnical investigations are summarized below.

### 2.1 1988 Geotechnical Investigation

In 1988 UMA Engineering Ltd. completed a geotechnical investigation for Genstar Development Co. in the Airport Area West region. The geotechnical investigation was completed along two (2) proposed sewer alignments leading to and within the land parcel proposed for development. The investigation consisted of geotechnical drilling, piezometer installation and single channel hammer seismic survey. A total of 74 test holes were advanced to auger refusal along the proposed sewer alignments at approximately 200 m spacing. Additionally, approximately 200 hammer seismic spreads were laid out on a 200 m grid to estimate the depth to till and bedrock on the western portion of the site.

The following test holes were drilled along the proposed pipe alignment and were used to develop of the soil profiles: G-88-32 to G-88-40, G-88-46G-88-50, G-88-52 to G-88-62, G-88-68 to G-88-71, G-88-P3, G-88-P8, G-88-P9, G-88-S1 to G-88-S3, G-88-S7 and G-88-S13. These 1988 test hole logs are included in Appendix A. The location of the test holes within the vicinity of the site are shown on Figure 1. Details of the geotechnical investigations are outlined in the report titled “Sewer Alignment Investigation and Property Investigation Lands North of Saskatchewan Ave”, dated December 1988.

### 2.2 2009 Geotechnical Investigation

In 2009 KGS Group completed a geotechnical investigation for MMM Group Ltd. for the construction of CentrePort Canada Way (CCW). Test holes were drilled at the CCW and PTH 101 interchange and at the CCW crossing over the CP mainline near Inkster Boulevard. The following test holes were drilled along the proposed pipe alignment and were used in the development of the soil profiles: TH09-20 to TH09-25. These test hole logs are included in Appendix B and the locations are shown on Figure 1. Details of the geotechnical investigation are outlined in the report titled “CentrePort Canada Way Geotechnical Investigation Phase 1 Report”, dated July 2009.

### 3.0 REGIONAL GEOLOGICAL SETTING

Winnipeg geology consisted of carbonate sedimentary bedrock overlaying Precambrian era granite and gneiss. The sedimentary rock consists of limestone, dolomite and to a lesser extent shale. 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 soils.

During the last glacial advance and retreat, Winnipeg's glacial till was deposited 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 the Geological Engineering Report for Urban Development of Winnipeg, University of Manitoba.

## 4.0 2019/2020 FIELD INVESTIGATION PROGRAM

The geotechnical field investigation program was developed to meet the objectives stated in Section 1.1 of this report. Based on projects previously completed in the region, variable soil conditions have been identified. Bedrock, till, sand, clay and silt are known to exist at differing elevations, with till and bedrock observed outcrop at the surface in some locations. Seismic refraction was selected in addition to conventional test hole drilling to provide a continuous profile and assist with identifying obstacles and anomalies along the proposed pipe alignment.

### 4.1 Test Hole Drilling and Soil Sampling

The test hole drilling and sampling programs were completed by KGS Group from September 23 to 28, 2019, and February 3 to 6, 2020. A total of 36 test holes were advanced to bedrock to investigate the subsurface stratigraphic conditions. The information obtained from the site investigations in conjunction with the previous completed investigations was used to develop profiles to facilitate the preliminary design of the water and wastewater lines for the Airport Area West region.

Paddock Drilling of Brandon, Manitoba provided the drilling services using a track mounted sonic drill rig. The sonic drilling approach allowed for full recovery of the clay and till, even through difficult drilling conditions. Soil samples were collected at intervals of 1.5 m (5 ft.) 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).

Test holes TH19-01 to TH19-10 were drilled on the east shoulder of Sturgeon Road. Test holes TH19-14 to TH19-17 were drilled on the north shoulder of the service road south of Inkster Boulevard (Red Fife Road). Test holes TH19-18 to TH19-22 were drilled on the south shoulder of the service road north of Inkster Boulevard (Park Royale Way) and test holes TH19-23 to TH19-25 were drilled on the north shoulder of Inkster Boulevard between Oak Point highway and Brookside Boulevard. Test holes TH20-01 to TH20-04 were drilled on Murray Park Road and test holes TH20-05 to TH20-10 and TH20-14 were drilled on the east shoulder of Sturgeon Road. Test holes TH20-11 to TH20-13 were drilled on the shoulder of Summit Road, the access road south of CentrePort Canada Way. Test holes were not drilled along the portion of the alignment on the previous Sturgeon Road alignment and along CentrePort Canada Way. Test holes were not drilled along the old Sturgeon Road due to wet ground conditions. The locations of the test holes are shown on Figure 1.

Clay samples were tested with a field Torvane to evaluate consistency and estimate undrained shear strengths of cohesive soils. Pocket penetrometers were used to evaluate the consistency of the till. Upon completion of drilling, the test holes were examined for indications of sloughing and seepage, and then backfilled. Detailed test hole log summary reports incorporating field observations, and field test results are provided in Appendix C. Photographs of the soil samples are included in Appendix C.

## 4.2 Groundwater Monitoring

A total of five standpipes were installed along the proposed alignment during the 2019/2020 geotechnical investigation. Two standpipes were installed in the bedrock and three standpipes were installed in the till. The installation details of the piezometers are shown on the test hole logs in Appendix C.

## 4.3 Geophysical Investigation

KGS Group retained the services of Frontier Geoscience Inc to perform seismic refraction surveys along the proposed pipeline alignment from October 1 to 10, 2019. The primary objective of the geophysical survey was to obtain estimates of the depths to till and bedrock along the proposed alignment of the water and wastewater pipelines. The locations of the seismic lines are shown on Figure 1. The results of the seismic refraction survey are included in the Survey Report included in Appendix D.

## 5.0 FIELD INVESTIGATION RESULTS

### 5.1 Subsurface Characterization

The stratigraphy at the site is described in this section is based on the exploratory test holes, seismic refraction survey and our understanding of the site geology. Test hole logs from the 1988, 2009, and 2019/2020 geotechnical investigations along the proposed alignment are provided in Appendices A, B and C, respectively.

The approximate stratigraphic boundaries shown on the test hole logs were inferred from soil sampled during the drilling. The engineering characteristics of the subsurface materials are described in the following sub-sections. The soil classification is based on visual examination.

In general, the stratigraphy consists of granular fill overlying clay, silt till and bedrock. The following sections describe the soil and the bedrock encountered during the geotechnical drilling investigation. Fencelines showing soil profiles along the proposed alignment are shown on Figures 2 to 5. The approximate till surface is shown on the fenceline, interpolation between boreholes, however the seismic refraction survey results, included in Appendix D should be consulted for the till and bedrock surface in between boreholes. The seismic refraction survey shows there is variability in the till and bedrock elevations between the boreholes.

#### 5.1.1 TOPSOIL

Topsoil was encountered from existing ground surface to depths of 0.1 to 0.2 m in test holes TH19-14, TH19-25 and TH20-14. The topsoil was black in colour and damp at the time of drilling.

#### 5.1.2 PAVEMENT STRUCTURE

Test holes TH20-01 to TH20-04, TH20-09 and TH20-10 were drilled on the edge of the road surface, through the pavement structure. The asphalt was less than 0.3 m thick and was founded on granular base material.

#### 5.1.3 FILL

A layer of granular fill was encountered in all of the 2019 and 2020 test holes with the exception of TH20-06 and TH20-07. The granular fill varies in thickness from 0.2 to 2.7 m. The granular fill was fine to coarse grained gravel and was described as brown in colour, damp, loose to compact in density, contained some fine to coarse grained sand, and trace silt and trace clay.

Clay fill was encountered below the granular fill in all 2019 and 2020 test holes with the exception of TH19-10, TH19-19, TH19-20, TH19-21, TH19-22, TH20-01, TH20-04, TH20-08, TH20-09, TH20-10, and TH20-14. The clay fill varied in thickness from 0.3 to 2.4 m. The clay fill was mottled brown to grey, damp, firm to stiff, low to high plasticity, contained trace to some fine to coarse grained gravel, trace to some fine to coarse grained sand, some organics and trace rootlets.

#### 5.1.4 CLAY(CH)

High plasticity clay was encountered in all test holes with exception of TH19-23 at various depths ranging from 0.9 to 3 m below grade. The clay was typically mottled brown to grey in colour, damp to moist, stiff to

firm in consistency and of high plasticity. In general, the consistency of the clay decreased with depth. The material contained trace to some silt nodules. The thickness of the clay deposit ranged from XX to YY m. Fine to coarse grained gravel and boulders were encountered in the grey clay near the till interface. The undrained shear strength of the clay deposit, as determined using a field Torvane on disturbed samples, ranged from 30 to 80 kPa, generally decreasing with depth.

Trace to with silt till inclusions were noted in the clay, increasing in frequency with depth in 23 of the 29, 1988 test holes, or approximately 40% of the test holes for that investigation.

### 5.1.5 SILT TILL

Glacial silt till was encountered below the high plasticity clay at depths ranging from 0.9 to 9.1 m below existing ground surface. Shallow till was encountered at a depth of 2.0 m near Station 6+520, and at depths ranging from 0.9 to 2.0 m near Station 0+900 and from Stations 9+120 to 9+420. The silt till was tan in colour, damp to wet, loose to very dense and contained trace to some fine to coarse grained gravel and some fine to coarse grained sand, and trace cobbles. Boulders and cobbles are commonly found within till and should be anticipated within the deposits at the project site.

#### Cobbles and Boulders

As part of the 2019/2020 drilling investigation cobbles were encountered in the clay deposit near the till interface in some test holes. Cobbles were observed within the silt till in majority of the test holes as indicated on the test hole logs. Based on previous works completed by the City of Winnipeg in the vicinity of this project, it is understood that installation of the water and sewer pipes near the clay/till interface and within the till will encounter significant quantities of cobbles and boulders. Zones with increased cobbles and boulders were identified as part of the geophysical investigation and were observed at Stations 3+140 to 3+250, 8+820 to 8+950, 9+000 to 9+030, 9+270 to 9+320, and 9+500 to 9+540.

In KGS Group's experience and as observed during this drilling program, sporadic irregular zones or cobbles and/or boulders have been encountered within the till deposits such as those at this site. These zones can cause difficulties during construction.

### 5.1.6 BEDROCK

Bedrock was encountered below the silt till at depths ranging from 2.7 to 15.3 m below grade. The bedrock consisted of limestone, was pink to red in color in all test holes with exception of test holes TH19-03, TH19-07, TH19-09, TH19-10, TH19-19, TH19-22, TH19-23, TH19-25, TH20-03, TH20-06 to TH20-10 and TH20-13 where it was noted to be white to yellow, weak, and broken.

Shale bedrock was observed in test hole G-88-P8 and G-88-P9 from the 1988 investigation. The shale was observed at depths ranging from 8.5 to 14.5 m and was described as red to brown in colour, soft and contained dolomite layers.

## 5.2 Groundwater Monitoring

Five standpipe piezometers were installed as part of the 2019/2020 geotechnical investigation. The installation details for the standpipes are included on the test hole logs included in Appendix C. Since

installation, groundwater monitoring has been completed twice. Measured groundwater levels are listed below in Table 1.

**TABLE 1: GROUNDWATER MONITORING RESULTS**

Test Hole ID	TH19-04		TH19-18		TH20-12	
Approx. Station (m)	0+850		5+250		10+500	
Ground Elevation (m)	238.39		239.60		239.7	
Piezometer No.	Standpipe 1	Standpipe 2	Standpipe 1	Standpipe 1	Standpipe 2	Standpipe 2
Tip Elevation (m)	230.34	0.00	230.34	235.4	227.0	
Monitoring Zone	Till	Bedrock	Till	Till	Bedrock	
Date						
Oct-28-2019	236.44	236.33	236.44	-	-	
Feb-28-2020	235.25	236.57	237.09	Dry	233.56	



## 6.0 UNDERSTANDING OF THE PROPOSED WORK

The goal of this scope of services is to develop a Class 3 cost estimate to determine the extent of the regional infrastructure required to support the future industrial and residential developments within the approximately 1,460 Ha of unserviced City land. The key components of the regional infrastructure needed to support the future development include a sewage lift station to collect the gravity flows; feeder mains to meet the domestic and fire water demands; and sewage force mains to direct the effluent to the City's Inkster interceptor sewer.

At the time of this report, the proposed location of the lift station is at the intersection of CentrePort Canada Way and the Sturgeon Access road. The pipe sizes had been estimated and minimum grades had been applied to several of the longer branches within the network to determine the overall drop from the most extreme limits of the AAW lands to the proposed lift station location. Using this approach, it was determined that the required invert elevation at the station is approximately 226.50 m, or a depth of approximately 12.0 m below the existing ground surface. The total depth of excavation increases to approximately 15.4 m when considering the required station sump, slab thickness, and mud slab.

Wastewater flows from the AAW lands are to be directed from the wastewater lift station to the 1350mm diameter Inkster Interceptor at Inkster and Brookside Boulevard via force mains. The alignment of the force main extends from the location of the lift station (identified previously) and travels east and north along Sturgeon Road to the north limit of the AAW and City lands. The force main then continues north along the east side of Sturgeon Road within the RM of Rosser to the north terminus of Sturgeon Road at CentrePort Canada Way, where a future interchange is planned to be constructed by the Province of Manitoba. The force main then travels northeast along the south side Centreport Canada Way across both the Canadian Pacific rail line and Canadian National rail lines. Finally, the alignment extends due east through the historic Inkster Boulevard extension (within Rosser) towards CentrePort Canada Way, where it continues along CentrePort Canada Way until it terminates at the Inkster interceptor sewer. The alignment is assumed to be on the east side of the Sturgeon Road and the south side of CentrePort Canada Way to avoid the Cartier Water Supply line located on the west side of Sturgeon Road and north side of CentrePort Canada Way. The current design includes two (2) 500 mm force mains, with a burial depth of approximately 2.5 m. The proposed installation method for the pipes will be likely be open cut with minimal trenchless installation at select locations where open cut is not feasible, e.g. under the Canadian Pacific rail line and Canadian National rail lines.

Feeder mains are required to provide domestic and fire protection flows to the future development within the AAW project site. For the estimate, feeder mains are considered to be water pipes 600 mm in diameter or larger. The feeder mains for this project are located south of the geotechnical investigation and were not considered as part of the scope of this investigation.

## 7.0 CONSTRUCTION CONSIDERATIONS

### 7.1 Presence of Cobbles and Boulders

As discussed in Section 5.2.3 and confirmed through the seismic refraction survey, there are cobbles and boulders within the silt till and in the clay near the silt till interface. The till contains cobbles and boulders and underground utility installations extending to the clay/till interface, or within the till will encounter cobbles and boulders. Zones within the silt till with increased cobbles and boulders were noted in the seismic refraction survey and are marked on the profiles with a dashed purple line. These zones were noted from the seismic survey at approximate at Stations 3+140 to 3+250, 8+820 to 8+950, 9+000 to 9+030, 9+270 to 9+320, and 9+500 to 9+540. Construction methodologies selected for the work should give due consideration to presence of cobbles and boulders.

### 7.2 Groundwater

Potentially difficult groundwater inflows were noted in several of the test holes during drilling. After completion of drilling, 1.0 to 2.1 m of water was observed in the following five test holes within five minutes, G-88-32, G-88-33, G-88-34, G-88-37 and G-88-38, Stations 4+120 to 4+220 and 4+870 to 5+220. Water seepage was observed in eleven additional test holes from Stations 3+370 to 3+620, 6+520 to 7+170, and 7+720 to 7+920. (G-88-40, G-88-50, G-88-55 to G-88-60, G-88-63, TH09-20, and TH09-22).

Groundwater levels observed in the 2019/2020 test hole logs immediately upon the completion of drilling included on the test hole may not be representative, as water was used during the sonic drilling progress. As part of the geotechnical investigation, five standpipes were installed within the silt till and bedrock. The piezometers have been monitored twice since September and the measured groundwater levels are shown on Table 1.

In KGS Group's experience, zones of cobbles, boulders and/or granular layers are known to exist within till deposits. These zones should be expected to be water bearing, which may cause difficulties with open cut or trenchless pipe installation methods.

### 7.3 Potential Soft Ground Conditions

At the time of the geotechnical investigations, soft ground conditions were encountered from Station 5+500 to 6+000, along the old alignment of Sturgeon Road. Due to the soft ground conditions, geotechnical drilling could not be completed. Depending on the alignment of the pipelines, soft ground conditions should be expected during construction. Selected construction methodologies should consider potential soft ground conditions and the required mitigation measures.

### 7.4 Rail Crossing

The current alignment of the force mains crosses the both the Canadian Pacific rail line and Canadian National rail lines. As part of the CentrePort Canada Way development, KGS Group completed a geotechnical

investigation on either side of the rails. Trenchless installation methods will be required for the pipe installations at these crossings. Additional geotechnical investigations may be required by either Canadian Pacific rail line and Canadian National rail lines as part of the utility crossing permit application.

## 7.5 Variable Ground Conditions

Based on the geotechnical drilling investigation and seismic refraction survey, there is variability in the till and bedrock surface along the proposed pipe alignments. The invert of the proposed pipes will likely be designed through multiple soil strata including clay, till with cobbles and boulders and potentially bedrock. If the pipes are installed using trenchless technologies, the equipment will need to be designed to excavate different soil strata.

## 8.0 RECOMMENDATIONS

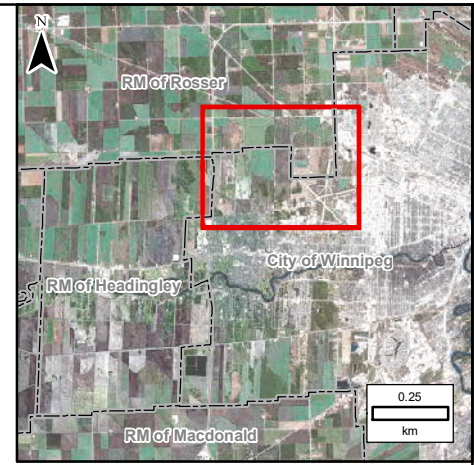
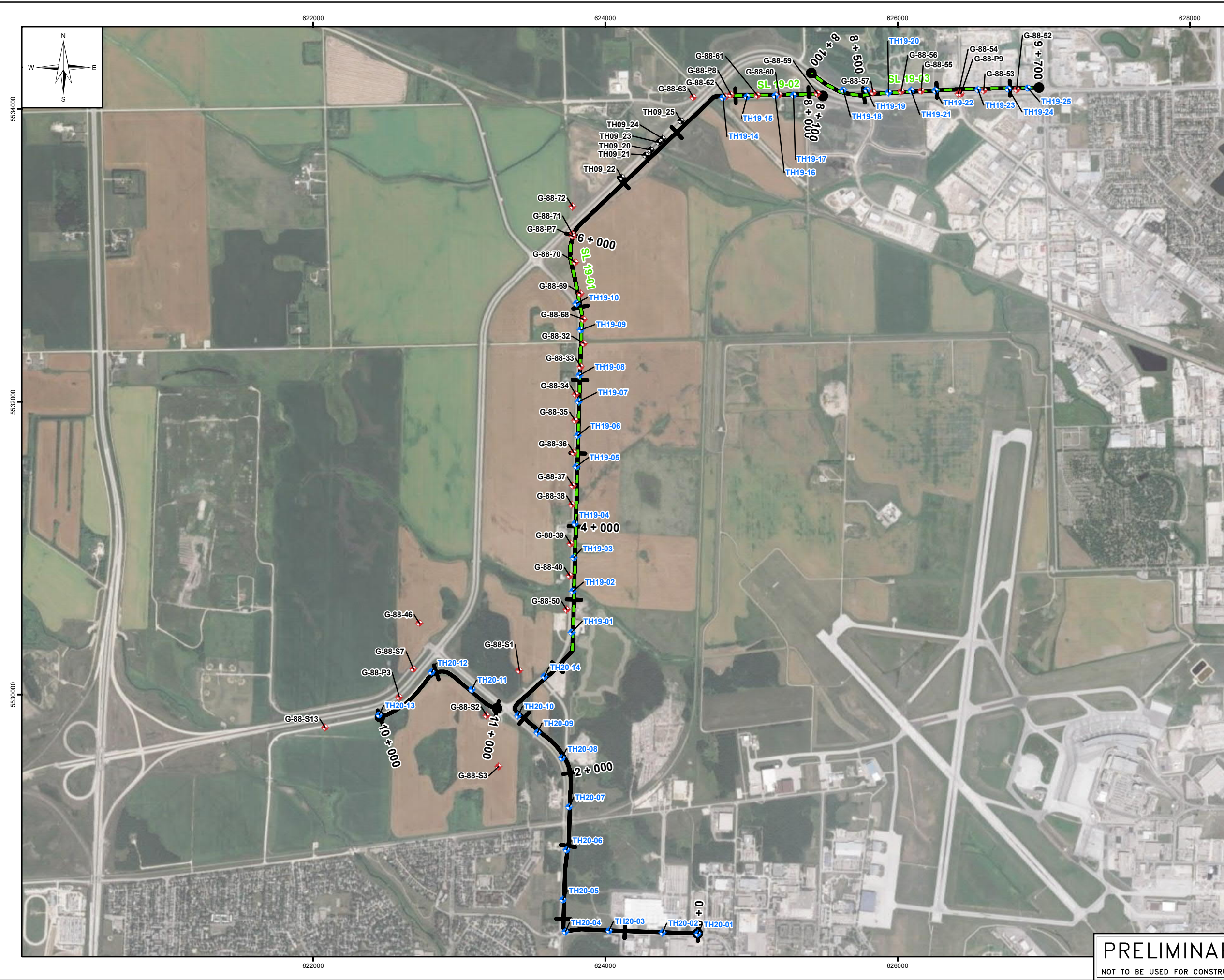
The preliminary geotechnical investigation completed for this project consisted of advancing 36 test holes using sonic drilling methods and seismic refraction along the majority of the proposed alignment. Geotechnical investigations were not completed along the portion of the alignment on CentrePort Canada Way. It is recommended additional geotechnical investigations be completed along this stretch of the route from Station 5+500 to 7+300 in next design phase.

## 9.0 CLOSURE

The geotechnical investigation conducted by KGS Group describes the overburden deposits and bedrock stratigraphy along the proposed alignment based on the information from the 1988, 2009 and 2019/2020 test hole data and seismic refraction survey. This report presented the geotechnical engineer's best judgement of the subsurface and ground conditions anticipated to be encountered across the project site. In order to develop the fencelines, it was necessary to interpolate between test holes. While the actual conditions encountered in the field are expected to be within the range of the conditions discussed in this document, the spatial variability of subsurface conditions that could be encountered may be more complex than the simplified interpretation presented in this report.

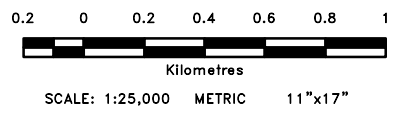
# FIGURES





- LEGEND:**
- ◆ KGS Group Test Hole (2019/2020)
  - ◆ KGS Group Test Hole (2009)
  - ◆ UMA Test Hole (1988)
  - 2019 Seismic Lines (approximate)
  - Alignment

- NOTES:**
1. Image Source: Bing
  2. 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
2	20/03/27	ISSUED WITH FINAL REPORT – REV 2	JRM	MSW
1	20/03/06	ISSUED WITH FINAL REPORT – REV 1	JRM	MSW

REVISIONS / ISSUE

**AIRPORT AREA WEST  
 REGIONAL WATER AND WASTEWATER  
 SERVICING PRELIM ENGINEERING**

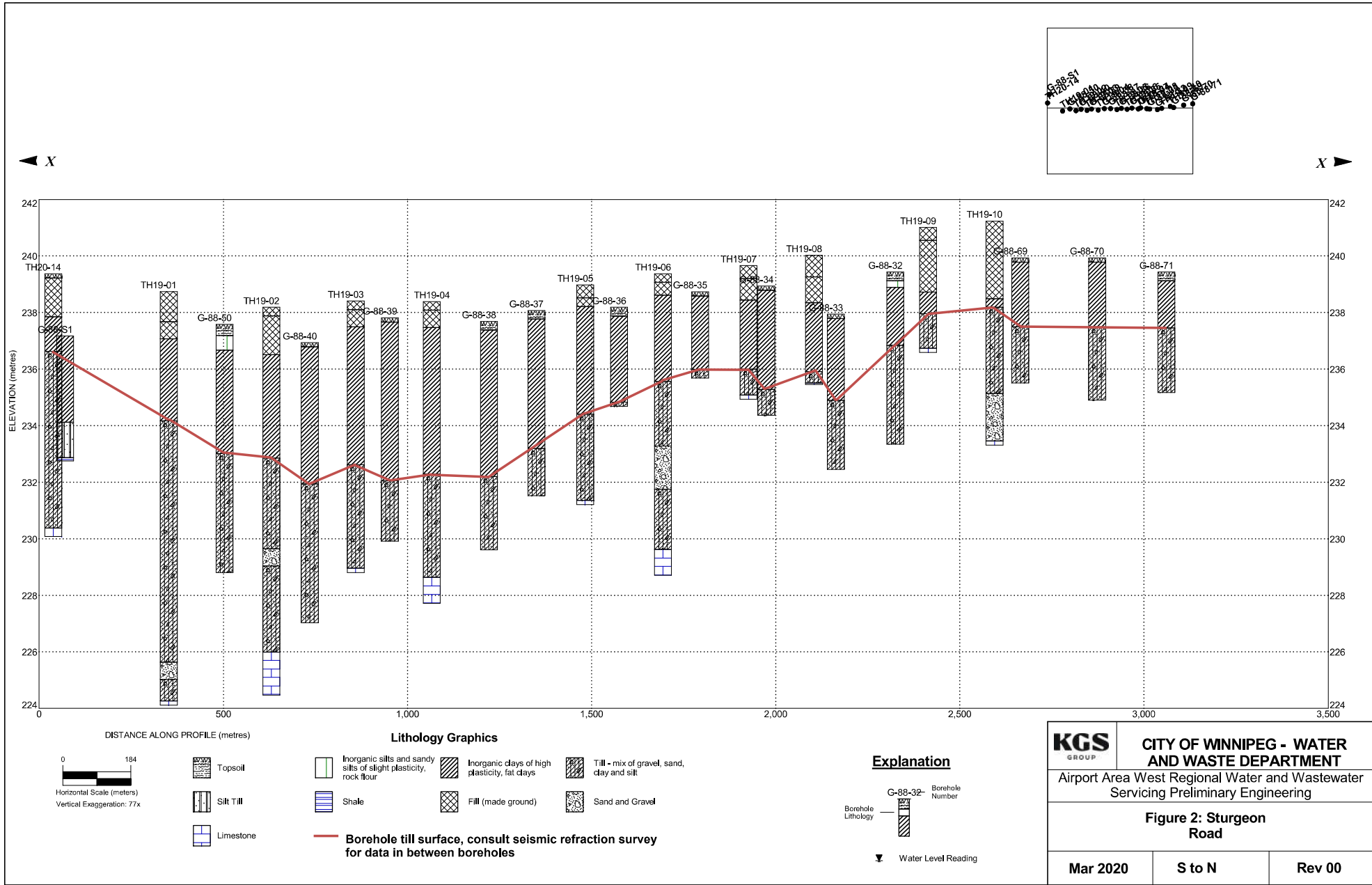
**2019-2020 PRELIMINARY  
 GEOTECHNICAL INVESTIGATION REPORT**

MARCH 2020	FIGURE 01	REV: 2
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**PRELIMINARY**  
 NOT TO BE USED FOR CONSTRUCTION



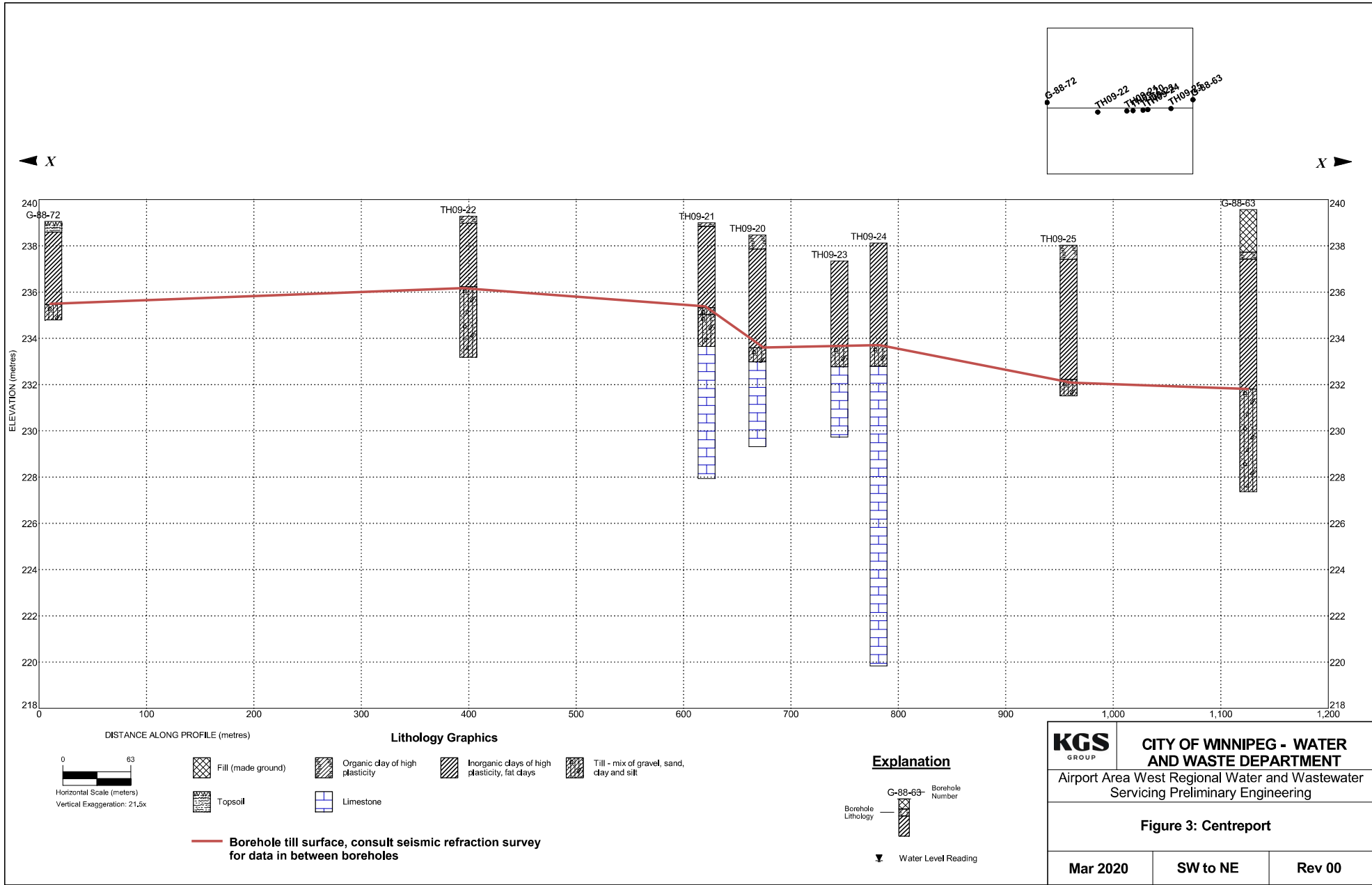
FENCE W/O WELL INSTALLATION U:\FN\8119-07-008\19-0107-009.GPJ



<b>KGS</b> GROUP	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	
	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	
<b>Figure 2: Sturgeon Road</b>		
Mar 2020	S to N	Rev 00

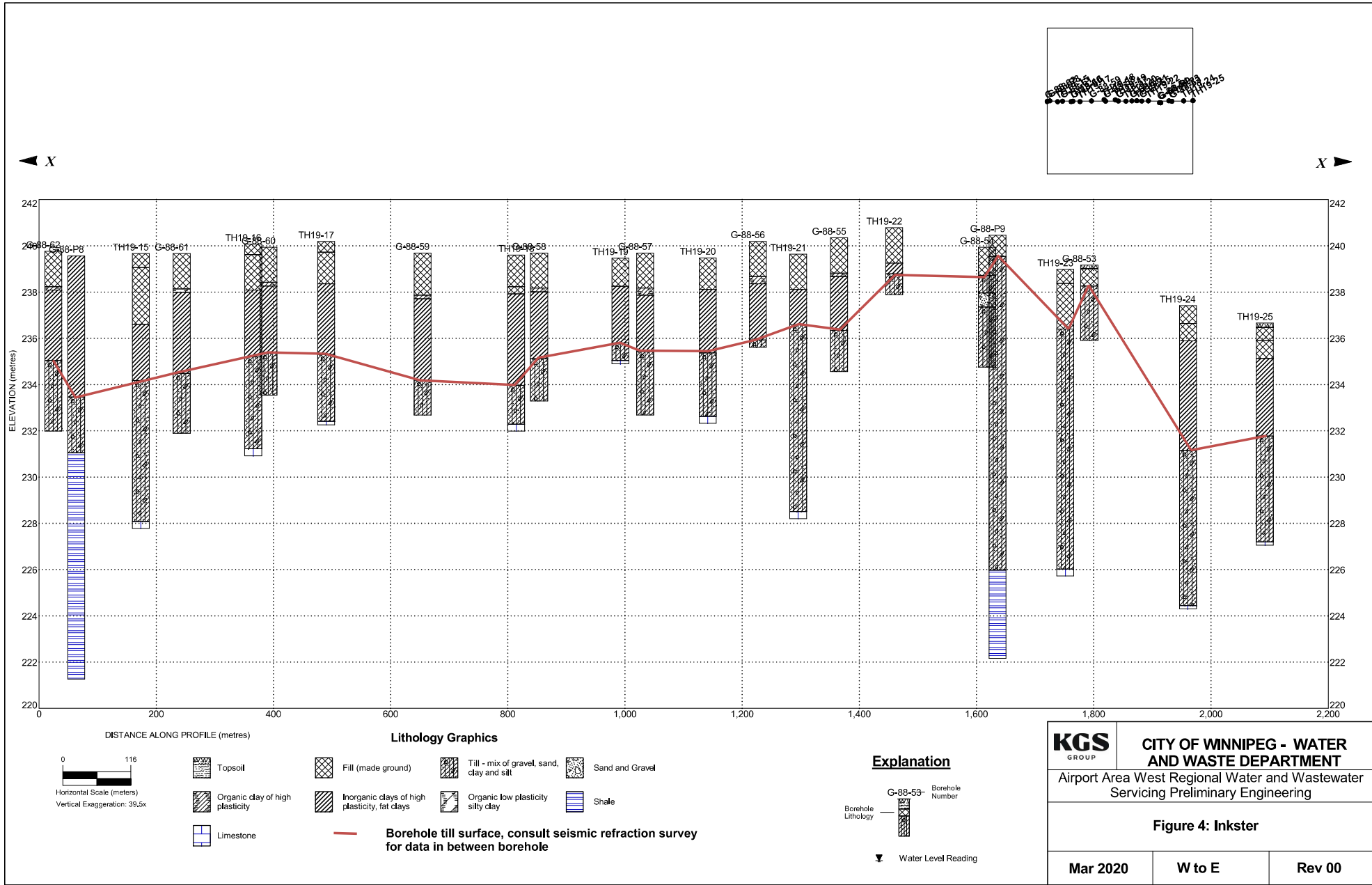


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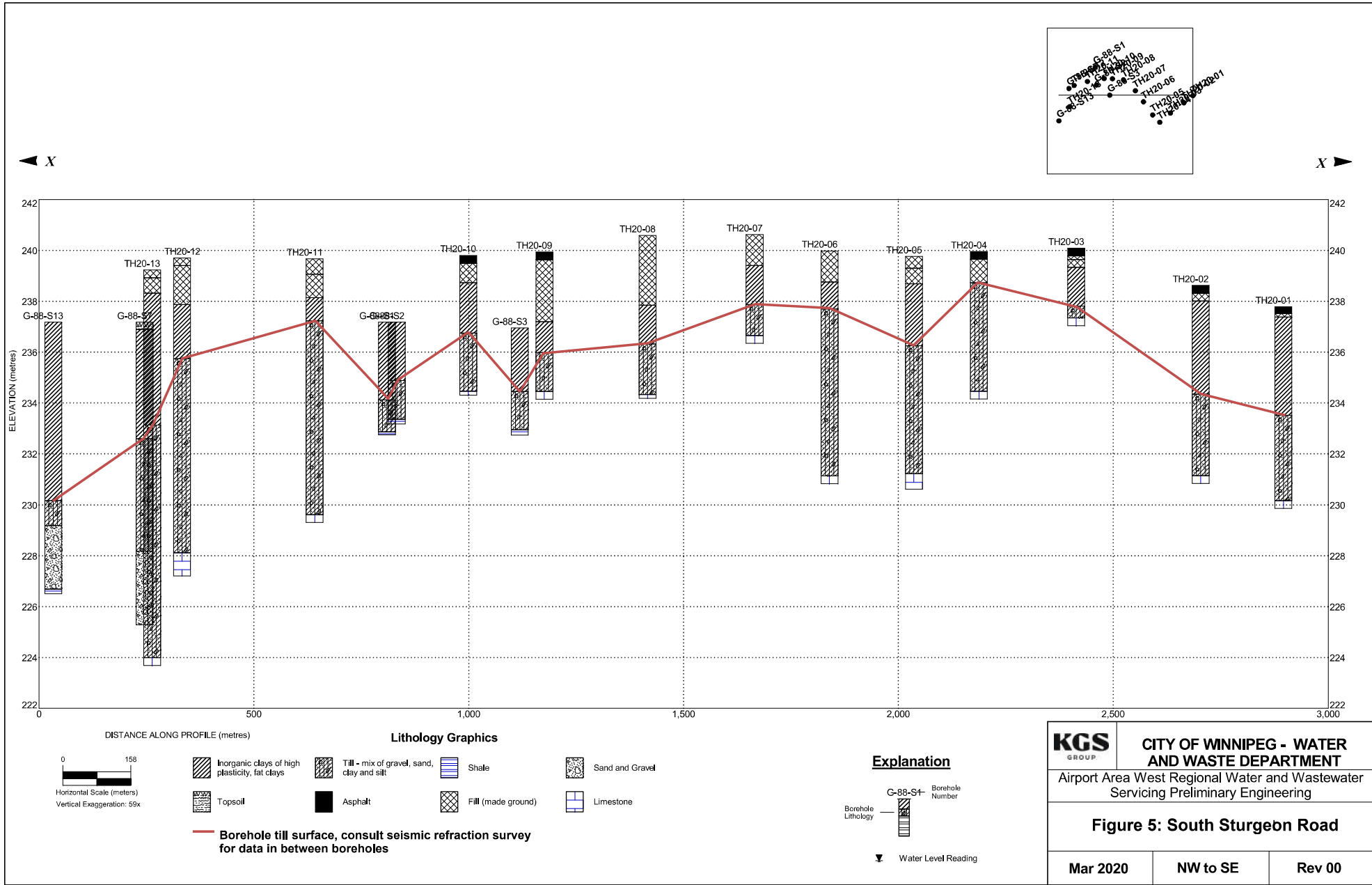
	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	
	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	
<b>Figure 3: Centreport</b>		
<b>Mar 2020</b>	<b>SW to NE</b>	<b>Rev 00</b>

FENCE W/O WELL INSTALLATION U:\FN\819\07-008\19-0107-008.GPJ



<b>KGS</b> GROUP	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	
	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	
<b>Figure 4: Inkster</b>		
Mar 2020	W to E	Rev 00

FENCE W/O WELL INSTALLATION U:\FMS\19-07-008\19-07-008.GPJ



# **APPENDIX A**

1988 Test Hole Logs

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-32
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0898-266-01
PROJECT ENGINEER: TW		ELEVATION 239.840 (m)
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE	<input checked="" type="checkbox"/> SHELLY TUBE	<input checked="" type="checkbox"/> DISTURBED
	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE BARREL
		<input type="checkbox"/> WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa): ■ 100 200 300 400								
	PLASTIC	MLC	LIQUID						
	42	80	120 180						
0.0					TOPSOIL				0.0
-1.0					SILT-DRY, TAN CLAY-SOME SILT -SOME TILL INCLUSIONS -BROWN -FIRM				5.0
-2.0									
-3.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -WET TO PAT TEST -WETTER WITH DEPTH -LITTLE CLAY -TAN				10.0
-4.0									
-5.0									15.0
-6.0									
-7.0									20.0
-8.0									
-9.0									25.0
-10.0									
-11.0									30.0
-12.0									
-13.0									35.0
-14.0									40.0
									45.0
					AUGER REFUSAL @ 6.08 NOTE: APPROX. 1.6 OF WATER IN THE HOLE IN 5 MIN. NO SLOUGHING				

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COMPLETION DEPTH * m	COMPLETE
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	Page 1 of 1

NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-86-33  
 GENSTAR DEVELOPMENTS LTD. Project No: 06 -0896-266-01  
 PROJECT ENGINEER: TW ELEVATION 237.930 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)	
	1.4	1.8	2.2							2.6
	■ SHEAR STRENGTH (kPa) ■									
	100	200	300	400						
	PLASTIC			MC						
	40	80	120	160						
0.0					TOPSOIL				0.0	
					CLAY-SOME SILT					
					-SOME TILL INCLUSIONS					
					(MORE WITH DEPTH)					
					-BROWN TO DARK BROWN					
					-STIFF					
1.0									5.0	
2.0										
3.0										
4.0					TILL-WITH SILT				10.0	
					-SOME GRANULAR (SAND TO BOULDERS)					
					-GREY					
					-RED BROWN LIMESTONE (WATER BEARING)					
					(SAME RED BROWN LIMESTONE TO REFUSAL)					
5.0									15.0	
6.0					AUGER REFUSAL @ 5.54				20.0	
					NOTE: WATER ROSE APPROX. 2.1 IN 5 MIN					
					NO SLOUGHING					
7.0									25.0	
8.0										
9.0										
10.0									30.0	
11.0									35.0	
12.0									40.0	
13.0									45.0	
14.0										

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Winnipeg, Manitoba

COMPLETION DEPTH \*\* m COMPLETE  
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-34
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0896-288-01
PROJECT ENGINEER: TW		ELEVATION 239.090 (m)
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE <input type="checkbox"/> SHIMLEY TUBE <input checked="" type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE BARREL <input type="checkbox"/> WIRELINE-TYPE		

DEPTH (M)	▲ BULK DENSITY (g/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	PLASTIC	MC						
0.0	▲ BULK DENSITY (g/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			TOPSOIL				0.0
1.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400			CLAY-SOME SILT - BROWN - FIRM				5.0
2.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400			- BROWN TO GRAY - SOME TILL INCLUSIONS - LITTLE SILT				10.0
3.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400			TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				15.0
4.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400			- SOME CLAY - TAN				20.0
5.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400			AUGER REFUSAL @ 4.57 NOTE: WATER SEEPAGE FROM 4.26 TO 4.57 1.4 OF WATER IN HOLE IN 4-5 MIN NO SLOUGHING				25.0
6.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							30.0
7.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							35.0
8.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							40.0
9.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							45.0
10.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							50.0
11.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							55.0
12.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							60.0
13.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							65.0
14.0	■ SHEAR STRENGTH (kPa) ■ 100 250 300 400							70.0

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-35

GENSTAR DEVELOPMENTS LTD. Project No: 06-0898-286-01

PROJECT ENGINEER: TW ELEVATION 236.690 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ B.L. DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C.	LIQUID						
	40	80	120	160					
0.0					TOPSOIL				0.0
0.5					CLAY-SOME SILT				1.5
1.0					-SOME TILL INCLUSIONS				3.0
1.5					-BROWN				4.5
2.0					-FIRM TO STIFF				6.0
3.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				10.0
4.0					-SOME CLAY				13.0
5.0					-TAN				16.0
5.0					AUGER REFUSAL @ 3.05 ON ROCK				15.0
5.0					NOTE: NO SLOUGHING				15.0
5.0					NO WATER				15.0
6.0									20.0
7.0									23.0
8.0									26.0
9.0									30.0
10.0									33.0
11.0									36.0
12.0									40.0
13.0									43.0
14.0									45.0

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-38

GENSTAR DEVELOPMENTS LTD. Project No: 08-0895-268-01

PROJECT ENGINEER: JW ELEVATION 236.170 (m)

SAMPLE TYPE  GRAIN SAMPLE  SHELLY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (1/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa): ■ 100 200 300 400							
	PLASTIC M.C. LIQUID 40 80 120 160							
0.0				TOPSOIL				0.0
1.0				CLAY-SOME SILT -LITTLE TILL INCLUSIONS (MORE WITH DEPTH) -BROWN -STIFF				3.0
2.0								6.6
3.0								10.0
4.0				TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -GREY				13.0
5.0				AUGER REFUSAL @ 3.51 NOTE: NO WATER NO SLOUGHING				15.0
6.0								20.0
7.0								25.0
8.0								30.0
9.0								35.0
10.0								40.0
11.0								45.0
12.0								
13.0								
14.0								

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Winnipeg, Manitoba

COMPLETION DEPTH \*\* m COMPLETE  
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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-97

GENSTAR DEVELOPMENTS LTD. Project No: 06-0886-268-01

PROJECT ENGINEER: TW ELEVATION 237.950 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELLY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIZELINE-TYPE

DEPTH (m)	▲ B.L.A. DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.5 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (KPa) ■ 100 200 300 400							
	PLASTIC M.C. LIQUID 40 85 120 180							
0.0				TOPSOIL				0.0
-1.0				CLAY-SOME SILT -LITTLE TILL INCLUSIONS -BROWN -STIFF				5.0
-2.0								10.0
-3.0								15.0
-4.0								20.0
-5.0				TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -LITTLE CLAY -TAN/GREY -WATER SEEPAGE				25.0
-6.0								30.0
-7.0				AUGER REFUSAL @ 6.55 NOTE: WATER APPROX. 1 M IN HOLE IN APPROX. 5 MIN. NO SLOUGHING				35.0
-8.0								40.0
-9.0								45.0
-10.0								50.0
-11.0								55.0
-12.0								60.0
-13.0								65.0
-14.0								70.0

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NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No G-88-38	
GENSTAR DEVELOPMENTS LTD.				Project No: 08-0698-268-01	
PROJECT ENGINEER: TW				ELEVATION 237.830 (m)	
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> SHELBY TUBE		<input checked="" type="checkbox"/> DISTURBED	
		<input type="checkbox"/> NO RECOVERY		<input type="checkbox"/> CORE BARREL	
				<input type="checkbox"/> WIRELINE-TYPE	

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		TOPSOIL				0.0
1.0		CLAY-SOME SILT - BROWN - STIFF				3.0
2.0						6.6
3.0						9.8
4.0		- TRANSITION TO GREY CLAY				13.1
5.0						16.4
6.0		TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				19.7
7.0		- WET TO PAT TEST - TR CLAY - SMALL WATER BEARING LAYER @ 5.50				22.9
8.0		- WATER SEEPAGE (FROM 7.6 TO 7.9) - WATER BEARING LAYER (7.62 TO 7.93)				26.2
9.0		AUGER REFUSAL @ 8.08				29.5
10.0		NOTE: WATER ROSE APPROX. 1.0 IN HOLE 5 MIN. NO SLOUCHING				32.8
11.0						36.1
12.0						39.4
13.0						42.6
14.0						45.9

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-39  
 GENSTAR DEVELOPMENTS LTD. Project No: 08-0899-266-01  
 PROJECT ENGINEER: TW ELEVATION 237.740 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELLEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)	
	1.4	1.5	2.2							2.5
	■ SHEAR STRENGTH (kPa) ■									
	100	200	300	400						
	FLASTIC M.C LIQUID									
	40	80	120	160						
0.0					TOPSOIL				0.0	
1.0					CLAY-SOME CLAY					
					- BROWN					
					- SOME TILL INCLUSIONS					
					- STIFF					
2.0									5.0	
3.0									10.0	
4.0									15.0	
5.0									20.0	
6.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				25.0	
					- DAMP					
					- TAN/GREY					
					- WATER SEEPAGE					
7.0									30.0	
8.0									35.0	
9.0					AUGER REFUSAL @ 7.93				40.0	
					NOTE: TRACE OF WATER IN HOLE					
					NO SLOUGHING					
10.0									45.0	
11.0										
12.0										
13.0										
14.0										

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-40

GENSTAR DEVELOPMENTS LTD. Project No: 08-0888-266-01

PROJECT ENGINEER: TW ELEVATION 237.020 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	MLC	LIQUID						
	40	80	120	160					
0.0					TOPSOIL				0.0
1.0					CLAY-SOME SILT - BROWN - TR TILL INCLUSIONS (MORE WITH DEPTH) - STIFF				5.0
2.0									10.0
3.0					- TRANSITION TO GREY CLAY				15.0
4.0									20.0
5.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				25.0
6.0					- TR CLAY - WET TO PAT TEST - TAN - DENSE				30.0
7.0									35.0
8.0									40.0
9.0									45.0
10.0					- WATER SEEPAGE				
11.0					AUGER REFUSAL @ 9.91 NOTE: TR WATER IN HOLE NO SLOUGHING				
12.0									
13.0									
14.0									

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-46

GENSTAR DEVELOPMENTS LTD. Project No: 08-0886-266-01

PROJECT ENGINEER: TW ELEVATION 236.150 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELLEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400							
	PLASTIC      MC      LIQUID 40      80      120      160							
0.0				TOPSOIL				0.0
1.0				CLAY-SOME SILT -TILL INCLUSIONS -BROWN -STIFF				5.0
2.0								10.0
3.0								15.0
4.0								20.0
5.0								25.0
6.0				TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -TAN/GREY -DAMP -LAYER OF BOULDERS 5.49 TO 6.71				30.0
7.0								35.0
8.0				-TILL BECOMING MORE SANDY AND DRIER -DENSE				40.0
9.0								45.0
10.0				AUGER REFUSAL @ 8.23 NOTE: WATER SEEPAGE FROM UPPER PART OF TILL LAYER SOME SLOUGHING FROM 5.5 TO 7.3				50.0
11.0								55.0
12.0								60.0
13.0								65.0
14.0								70.0

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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-50
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0826-266-01
PROJECT ENGINEER: TW		ELEVATION 237.770 (m)
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE	<input checked="" type="checkbox"/> SEEPY TUBE	<input checked="" type="checkbox"/> DISTURBED
	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE BARREL
		<input type="checkbox"/> PIPELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.5 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	Other comments	DEPTH (ft)
	PLASTIC	MC	LIQUID						
0.0	40 80 120 160				TOPSOIL				0.0
0.5					SILT-LITTLE CLAY - DRY - TAN				1.5
1.0					CLAY-SOME SILT - BROWN - STIFF				3.0
1.5									4.5
2.0									6.0
2.5									7.5
3.0									9.0
3.5									10.5
4.0									12.0
4.5									13.5
5.0									15.0
5.5					TILL-SILT WITH SAND AND GRAVEL - SOME COBBLES AND BOULDERS - SOME WATER SEEPAGE - TR CLAY - GREY - SANDY LAYER (DRIER THAN ABOVE)				16.5
6.0									18.0
6.5									19.5
7.0									21.0
7.5									22.5
8.0									24.0
8.5									25.5
9.0									27.0
9.5									28.5
10.0									30.0
10.5									31.5
11.0									33.0
11.5									34.5
12.0									36.0
12.5									37.5
13.0									39.0
13.5									40.5
14.0									42.0
14.5									43.5
15.0									45.0

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NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No. G-88-52	
GENSTAR DEVELOPMENTS LTD.				Project No: 06 -0892-266-01	
PROJECT ENGINEER: TW				ELEVATION 237.170 (m)	
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> STEELEY TUBE		<input checked="" type="checkbox"/> DISTURBED	
		<input type="checkbox"/> NO RECOVERY		<input type="checkbox"/> CORE BARREL	
				<input type="checkbox"/> WIRELINE-TYPE	

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■								
	PLASTIC	M.C	LIQUID						
	1.4	1.8	2.2						
	100	200	300						
	40	80	120						
0.0					TOPSOIL				0.0
1.0					FILL-CLAY -SILT -SOME FT GRAVEL -BROWN				3.0
2.0					CLAY-ORGANIC (ROOTS) -BLACK				6.5
3.0					CLAY-SOME SILT -BROWN -STIFF -TILL INCLUSIONS				10.0
4.0									13.0
5.0									16.5
6.0									20.0
7.0					-SOME COBBLES TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -LITTLE CLAY -DAMP -TAN				23.0
8.0									26.5
9.0									30.0
10.0									33.5
11.0					AUGER REFUSAL @ 9.91 NOTE: NO SLOUGHING NO WATER SEEPAGE				36.5
12.0									40.0
13.0									43.5
14.0									47.0

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-53  
 GENSTAR DEVELOPMENTS LTD. Project No: 08-0898-268-01  
 PROJECT ENGINEER: TR ELEVATION 239.010 (m)

SAMPLE TYPE  GRAB SAMPLE  SEELEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (M)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
0.0					TOPSOIL				0.0
0.0 - 0.5					FILL - MIXTURE OF CLAY AND SILT - CONCRETE AND ASPHALT				0.0 - 1.5
0.5 - 3.28					TILL - SILT WITH GRANULAR (SAND TO BOULDERS) - DAMP - TAN				1.5 - 10.8
3.28					AUGER REFUSAL @ 3.28 NOTE: NO SLOUGHING NO SEEPAGE				10.8
14.0									45.9

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NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No. G-88-54				
GENSTAR DEVELOPMENTS LTD.				Project No: 08-0898-268-01				
PROJECT ENGINEER: TW				ELEVATION 240.700 (m)				
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> SHELBY TUBE		<input checked="" type="checkbox"/> DISTURBED				
		<input type="checkbox"/> NO RECOVERY		<input type="checkbox"/> CORE BARREL				
				<input type="checkbox"/> WIPELINE-TYPE				
DEPTH (M)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (KPS) ■ 100 200 300 400							
	PLASTIC	LC						
	40 80 120 180							
0.0				FILL-MIXTURE OF SILT AND CLAY -SOME GRANULAR -SOME ASPHALT AND CONC -DRY -BROWN				0.0
1.0				TILL-SILT WITH GRANULAR -SOME CLAY -TAN				5.0
2.0				GRAVEL-CLEAN FINE				
3.0				TILL-GRAVELLY -WITH SILT -WITH COBBLES AND BOULDERS -DAMP -DENSE				10.0
4.0								15.0
5.0								20.0
6.0				AUGER REFUSAL @ 5.18 NOTE: NO SLOUGHING NO SEEPAGE				25.0
7.0								30.0
8.0								35.0
9.0								40.0
10.0								45.0
11.0								
12.0								
13.0								
14.0								
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NORTH OF SASKATCHEWAN	SUTERRANEAN LTD.	BOREHOLE No. G-88-55
GENSTAR DEVELOPMENTS LTD.		Project No: G8-0898-286-01
PROJECT ENGINEER: TW		ELEVATION 240.650 (m)

SAMPLE TYPE  GRAB SAMPLE     SHIELT TUBE     DISTURBED     NO RECOVERY     CORE BARREL     WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4   1.8   2.2   2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100   200   300   400								
	PLASTIC      MC      LIQUID								
	40      60      120      180								
0.0					FILL-CLAY WITH GRANULAR - LITTLE ASPHALT AND CONC - TR ORGANICS - DK BROWN				0.0
1.0									
2.0					LAYER OF BLACK ORGANICS CLAY-WITH SILT - BROWN - STIFF - WITH TILL INCLUSIONS (MORE WITH DEPTH)				5.0
3.0									10.0
4.0									
5.0					TILL-SILT WITH GRANULAR - WATER SEEPAGE - TAN - SOME COBBLES AND BOULDERS - REDDISH LIMESTONE				15.0
6.0					- WATER SEEPAGE				20.0
7.0					- BECOMING MORE DENSE				25.0
8.0									
9.0					AUGER REFUSAL @ 7.93 NOTE: NO SLOUGHING SOME WATER SEEPAGE @ 5.79				30.0
10.0									35.0
11.0									40.0
12.0									45.0
13.0									
14.0									

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NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No. G-88-56	
GENSTAR DEVELOPMENTS LTD.				Project No: 08-0000-268-01	
PROJECT ENGINEER: TW				ELEVATION 240.100 (m)	
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> SHREY TUBE		<input checked="" type="checkbox"/> DISTURBED	
		<input type="checkbox"/> NO RECOVERY		<input type="checkbox"/> CORE BARREL	
				<input type="checkbox"/> WIRELINE-TYPE	

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	1.4	1.6	2.2						
	■ SHEAR STRENGTH (kPa) ■								
	100	200	300	400					
	PLASTIC      MC      LIQUID								
	----- ----- ----- -----								
	40	80	120	160					

0.0		0.0
1.0	FILL-GRANULAR WITH CLAY AND SILT -TR ASPHALT -TR BOARDS/CONST MATERIALS	5.0
2.0	LAYER BLACK ORGANICS MIXED WITH CLAY CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)	10.0
3.0		
4.0	TILL-SILT WITH GRANULAR -WATER SEEPAGE -GREY -REDDISH LIMESTONE -DENSE	15.0
5.0		
6.0	AUGER REFUSAL @ 4.57 NOTE: NO SLOUGHING SOME WATER SEEPAGE	20.0
7.0		
8.0		
9.0		
10.0		
11.0		
12.0		
13.0		
14.0		

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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-57
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0686-266-01
PROJECT ENGINEER: TW		ELEVATION 239.720 (m)
SAMPLE TYPE <input checked="" type="checkbox"/> GRAN SAMPLE	<input checked="" type="checkbox"/> SHELBY TUBE	<input checked="" type="checkbox"/> DISTURBED
	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE BARREL
		<input type="checkbox"/> WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (m)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
0.0	40	80	120	180					0.0
0.0 - 1.0					FILL-CLAY - SOME GRANULAR AND SILT - BROWN				
1.0 - 2.0					LAYER BLACK ORGANIC CLAY CLAY-WITH SILT - BROWN - STIFF - TILL INCLUSIONS (MORE WITH DEPTH)				5.0
2.0 - 3.0									
3.0 - 4.0									
4.0 - 5.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS) - GREY - TR WATER SEEPAGE				15.0
5.0 - 6.0									
6.0 - 7.0					- TILL BECOMING MORE DENSE - DRIER - REDDISH LIMESTONE				20.0
7.0 - 8.0					AUGER REFUSAL @ 7.01 NOTE: NO SLOUGHING TR WATER SEEPAGE				25.0
8.0 - 9.0									
9.0 - 10.0									
10.0 - 11.0									
11.0 - 12.0									
12.0 - 13.0									
13.0 - 14.0									

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NORTH OF BASSETT CREEK      SUBTERRANEAN LTD.      BOREHOLE No. G-88-58  
 GENSTAR DEVELOPMENTS LTD.      Project No. 08-0696-266-01  
 PROJECT ENGINEER: TW      ELEVATION 239.780 (m)

SAMPLE TYPE  GRAB SAMPLE     SHREY TUBE     DISTURBED     NO RECOVERY     CORE BARREL     WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4    1.8    2.2    2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100    200    300    400								
	PLASTIC	M.C	LIQUID						
	-----●-----  40    80    120    160								
0.0					FILL-CLAY AND SILT -SOME GRANULAR -TR ASPHALT AND CONC -BROWN				0.0
-1.0									
-2.0					LAYER OF BLACK ORGANIC CLAY CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)				5.0
-3.0									
-4.0									
-5.0					TILL-SILT WITH GRANULAR -GREY -TR CLAY -WATER SEEPAGE -BECOMING DRIER AND MORE DENSE				15.0
-6.0									20.0
-7.0					AUGER REFUSAL @ 6.40 NOTE: NO SLOUGHING SOME WATER SEEPAGE				25.0
-8.0									
-9.0									
-10.0									
-11.0									
-12.0									
-13.0									
-14.0									

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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No: G-88-59
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0896-266-01
PROJECT ENGINEER: TW		ELEVATION 230.750 (m)

SAMPLE TYPE  GRAB SAMPLE     SPIELEY TUBE     DISTURBED     NO RECOVERY     COPE BARREL     WIRELINE-TYPE

DEPTH (m)	SOIL DESCRIPTION	USC	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0	FILL-CLAY WITH GRANULAR -SOME SILT -TR ASPHALT AND CONC -BROWN					0.0
1.0						3.0
2.0	LAYER BLACK ORGANIC CLAY CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)					6.6
3.0						9.8
4.0						13.1
5.0						16.4
6.0	TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -TR CLAY -TR WATER SEEPAGE -GREY -WATER SEEPAGE					19.7
7.0						22.9
8.0	AUGER REFUSAL @ 7.01 NOTE: NO SLOUCHING WATER SEEPAGE FROM LAYER @ 6.09					26.2
9.0						29.5
10.0						32.8
11.0						36.1
12.0						39.4
13.0						42.6
14.0						45.9

▲ BULK DENSITY (t/m<sup>3</sup>) ▲  
1.4   1.8   2.2   2.6

■ SHEAR STRENGTH (kPa) ■  
100   200   300   400

PLASTIC      M.C      LIQUID

40      80      120      180

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NORTH OF SASKATCHEWAN SUBTERPANEAN LTD. BOREHOLE No. G-88-60

GENSTAR DEVELOPMENTS LTD. Project No: 08-0606-266-01

PROJECT ENGINEER: TW ELEVATION 240.000 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIPELINE-TYPE

DEPTH (m)	▲ BLAH DEPTH (L/M) ▲ 1.4 1.5 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (KPa) ■ 100 200 300 400							
	PLASTIC	M.C						
	42 80 120 160							
0.0				FILL-CLAY -SOME GRANULAR -BROWN				0.0
1.0								1.0
2.0				LAYER BLACK CLAY MIXED WITH ORGANICS CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)				5.0
3.0								10.0
4.0								15.0
5.0				TILL-SANDY -SOME SILT -TR WATER SEEPAGE -LAYERED (SAND AND SILT) -TR CLAY -SOME GRANULAR AND COBBLES -DENSER THAN ABOVE -WATER SEEPAGE				20.0
6.0								25.0
7.0				AUGER REFUSAL @ 6.40 NOTE: NO SLOUGHING SOME WATER SEEPAGE				30.0
8.0								35.0
9.0								40.0
10.0								45.0
11.0								
12.0								
13.0								
14.0								

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NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

SUBTERRANEAN LTD.  
 BOREHOLE No. G-88-61  
 Project No: 06-0698-266-01  
 ELEVATION 239.700 (m)

SAMPLE TYPE  GRAB SAMPLE  SEEBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
	40 80 120 160								
0.0					FILL-CLAY AND SILT -SOME GRANULAR -BROWN				0.0
1.0									
2.0					LAYER BLACK CLAY AND ORGANICS CLAY-WITH SILT -BROWN -STIFF				5.0
3.0									
4.0									
5.0					-TRANSITION TO GREY CLAY -TILL INCLUSIONS (MORE WITH DEPTH)				15.0
6.0					TILL-SANDY SILT -SOME GRANULAR -TR CLAY -WATER SEEPAGE				20.0
7.0									
8.0					-COBBLES AND BOULDERS				25.0
9.0					AUGER REFUSAL @ 7.77 NOTE: HOLE STARTING TO SLOUGH WATER IN HOLE				30.0
10.0									
11.0									35.0
12.0									
13.0									40.0
14.0									
15.0									45.0

NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No. G-88-62	
GENSTAR DEVELOPMENTS LTD.				Project No: G8-0896-266-01	
PROJECT ENGINEER: TW				ELEVATION 230.920 (m)	
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> Shelby Tube		<input type="checkbox"/> NO RECOVERY	
		<input checked="" type="checkbox"/> DISTURBED		<input type="checkbox"/> CORE BARREL	
				<input type="checkbox"/> WIRELINE-TYPE	

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4    1.8    2.2    2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100    200    300    400								
	PLASTIC	M.C	LIQUID						
0.0					FILL - CLAY AND SILT - SOME GRANULAR - BROWN				0.0
1.0									
2.0					LAYER BLACK CLAY WITH ORGANICS CLAY - SOME SILT - BROWN - STIFF - TILL INCLUSIONS (MORE WITH DEPTH)				5.0
3.0									10.0
4.0					- TILL POCKETS TO .3 DIA				15.0
5.0									20.0
6.0					TILL - SANDY SILT - SOME GRANULAR - WATER SEEPAGE IN THE SANDY TILL - MORE WATER SEEPAGE WITH DEPTH				25.0
7.0									30.0
8.0					AUGER REFUSAL @ 7.77 NOTE: WATER IN HOLE NO SLOUGHING				35.0
9.0									40.0
10.0									45.0
11.0									
12.0									
13.0									
14.0									

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-63

GENSTAR DEVELOPMENTS LTD. Project No: 08-0888-286-01

PROJECT ENGINEER: TW ELEVATION 239.820 (m)

SAMPLE TYPE  GEAR SAMPLE  SEELEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIPELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	MC	LIQUID						
	40	80	120	160					
0.0					FILL-CLAY AND SILT -SOME GRANULAR -BROWN				0.0
1.0									3.0
2.0					LAYER OF BLACK ORGANIC MATERIAL -ROOTS				6.6
3.0					CLAY-SOME SILT -BROWN -STIFF				10.0
4.0					-TILL INCLUSIONS				13.0
5.0									16.5
6.0					-TRANSITION TO GRAY CLAY -TILL INCLUSIONS -FIRM				20.0
7.0					-BECOMING SOFTER WITH DEPTH				23.0
8.0									26.0
9.0					TILL-SILT WITH CLAY -SOME GRANULAR -TR COBBLES -GREY				29.5
10.0									33.0
11.0					-TAN/YELLOW LIMESTONE				36.0
12.0					-GRANULAR GREENISH COLOR				39.5
13.0					END OF HOLE @ 12.20 IN GREY TILL NOTE: NO SLOUGHING TR WATER SEEPAGE				43.0
14.0									46.0

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-68

GENSTAR DEVELOPMENTS LTD. Project No: 96-0828-258-01

PROJECT ENGINEER: TH ELEVATION 240.240 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIPELINE-TYPE

DEPTH (F)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (F)	
	1.4	1.8	2.2							2.6
	■ SHEAR STRENGTH (kPa) ■									
	100	200	300	400						
	PLASTIC M.C. LIQUID									
	40	80	120	160						
0.0					TOPSOIL				0.0	
1.0					CLAY-SOME SILT -BROWN -STIFF -SMALL TILL INCLUSIONS				5.0	
2.0					TILL-SILT WITH GRANULAR -SOME CLAY -SOME COBBLES AND BOULDERS -WET TO PAT TEST -TAN				10.0	
3.0										
4.0					AUGER REFUSAL @ 3.65 NOTE: NO SLOUGHING NO WATER SEEPAGE				15.0	
5.0										
6.0									20.0	
7.0										
8.0									25.0	
9.0										
10.0									30.0	
11.0										
12.0									35.0	
13.0										
14.0									40.0	
									45.0	

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NORTH OF SASKATCHEWAN	SUTERRANEAN LTD.	BOREHOLE No. G-88-69
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0696-268-01
PROJECT ENGINEER: TW		ELEVATION 240.050 (m)
SAMPLE TYPE <input checked="" type="checkbox"/> GRAIN SAMPLE <input checked="" type="checkbox"/> SHELBY TUBE <input checked="" type="checkbox"/> DISTURBED <input type="checkbox"/> NO RECOVERY <input type="checkbox"/> CORE BARREL <input type="checkbox"/> WIRELINE-TYPE		

DEPTH (M)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)		
	1.4	1.8							2.2	2.6
	■ SHEAR STRENGTH (kPa) ■									
	100	200	300	400						
	PLASTIC		M.C	LIQUID						
	40	80	120	160						
0.0				TOPSOIL				0.0		
1.0				CLAY-AND SILT - SOME GRANULAR - TILL INCLUSIONS - DRY - BROWN				5.0		
2.0										
3.0				TILL-SILT WITH GRANULAR - SOME COBBLES - DENSE - TAN - LIMESTONE BECOMING YELLOW				10.0		
4.0										
5.0				AUGER REFUSAL @ 4.42 NOTE: NO SLOUGHING TR WATER ON AUGER TIP				15.0		
6.0								20.0		
7.0										
8.0								25.0		
9.0										
10.0								30.0		
11.0										
12.0								35.0		
13.0										
14.0								40.0		
14.6								45.0		

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NORTH OF SASKATCHEWAN SUBTERPANEAN LTD. BOREHOLE No. G-88-70  
 GENSTAR DEVELOPMENTS LTD. Project No: 08-0898-266-01  
 PROJECT ENGINEER: TW ELEVATION 240.000 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELLY TUBE  DISTURBED  NO RECOVERY  COPE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (g/cm <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
	40 80 120 160								
0.0					TOPSOIL				0.0
0.5					CLAY-AND SILT - MIX WITH TILL - DRY - LT BROWN				0.5
1.0					CLAY-SOME SILT - BROWN - STIFF - TILL INCLUSIONS				1.0
2.0									2.0
3.0					TILL-SILT WITH GRANULAR - SOME CLAY - SOME COBBLES AND BOULDERS - DAMP				3.0
4.0									4.0
5.0					- SAND LAYER				5.0
5.03					AUGER REFUSAL @ 5.03 NOTE: COBBLES AND BOULDERS SLOUGHED MAKING AUGER WITHDRAWAL DIFF TR WATER ON TIP OF AUGER				5.03
6.0									6.0
7.0									7.0
8.0									8.0
9.0									9.0
10.0									10.0
11.0									11.0
12.0									12.0
13.0									13.0
14.0									14.0

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NORTH OF SASKATCHEWAN SUBTERRANEAN LTD. BOREHOLE No. G-88-71

GENSTAR DEVELOPMENTS LTD. Project No: 08-0898-268-01

PROJECT ENGINEER: TW ELEVATION 239.530 (m)

SAMPLE TYPE  GRAB SAMPLE  SEEBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (M)	▲ BULK DENSITY (g/cm <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (M)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400							
	PLASTIC	M.C						
	40 80 120 160							
0.0				TOPSOIL				0.0
1.0				CLAY-SOME SILT - BROWN - STIFF - TILL INCLUSIONS				5.0
2.0				TILL-SILT WITH CLAY - SOME GRANULAR - TAN - DAMP TO WET (BECOMING WETTER WITH DEPTH) - BECOMING SOFTER (PUTTY LIKE)				10.0
3.0								15.0
4.0								20.0
5.0				AUGER REFUSAL @ 4.27 NOTE: NO SLOUSHING TR WATER ON AUGER TIP				25.0
6.0								30.0
7.0								35.0
8.0								40.0
9.0								45.0
10.0								
11.0								
12.0								
13.0								
14.0								

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NORTH OF SASKATCHEWAN		SUBTERRANEAN LTD.		BOREHOLE No. G-88-72	
GENSTAR DEVELOPMENTS LTD.				Project No: 08-0890-266-01	
PROJECT ENGINEER: TW				ELEVATION 239.120 (m)	
SAMPLE TYPE <input checked="" type="checkbox"/> GRAB SAMPLE		<input checked="" type="checkbox"/> Shelby Tube		<input checked="" type="checkbox"/> DISTURBED	
		<input type="checkbox"/> NO RECOVERY		<input type="checkbox"/> CORE BARREL	
				<input type="checkbox"/> WIRELINE-TYPE	

DEPTH (m)	▲ BLAK DENSITY (1/m3) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC      MC      LIQUID 40      80      120      160								
0.0					TOPSOIL				0.0
1.0					CLAY-WITH SILT -BROWN -STIFF				5.0
2.0					-TILL INCLUSIONS				10.0
3.0									15.0
4.0					TILL-SILT WITH GRANULAR -SOME CLAY -SOFTER (PUTTY LIKE)				20.0
5.0					AUGER REFUSAL @ 4.27 NOTE: NO SLOUGHING NO WATER SEEPAGE				25.0
6.0									30.0
7.0									35.0
8.0									40.0
9.0									45.0
10.0									
11.0									
12.0									
13.0									
14.0									

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NORTH OF SARATCHEWAN FRIESEN DRILLERS LTD. BOREHOLE No. G-88-S1

GENSTAR DEVELOPMENTS LTD. Project No: 08-0898-286-01

PROJECT ENGINEER: TW ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SILENT TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELOG-TYPE

DEPTH (m)	▲ BULK DENSITY (g/cm <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C.	LIQUID						
0.0	40	80	120	160	CLAY-BROWN				0.0
1.0									3.0
2.0									6.6
3.0									10.0
4.0					TILL-SILT WITH GRANULAR				13.1
5.0					SHALE-DOLOMITE, RED-PURPLE, HARD, BUFF				16.4
6.0					END OF HOLE @ 4.42 IN SHALE				19.7
7.0									23.0
8.0									26.2
9.0									29.5
10.0									32.8
11.0									36.1
12.0									39.4
13.0									42.6
14.0									45.9
15.0									49.2
16.0									52.5
17.0									55.8
18.0									59.1
19.0									62.4
20.0									65.7

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COMPLETION DEPTH \*\* m COMPLETE  
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NORTH OF SASKATCHEWAN      FRIDSEN DRILLERS LTD.      BOREHOLE No. G-88-S2

GENSTAR DEVELOPMENTS LTD.      Project No. 04-0800-200-01

PROJECT ENGINEER. TW      ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE     SEEPY TUBE     DISTURBED     NO RECOVERY     CORE BARREL     PIPELINE-TYPE

DEPTH (m)	▲ B.L. CB STN (l/m <sup>3</sup> ) ▲ 1.4   1.8   2.2   2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 120   230   330   400							
	PLASTIC	M.C						
	-----●-----							
	40	80	120	160				
0.0				CLAY-WITH PEBBLES AND STONES				0.0
1.0								5.0
2.0								10.0
3.0				TILL-SILT				15.0
4.0								20.0
5.0				SHALE-DOLOMITE				25.0
6.0				END OF HOLE @ 3.99 IN SHALE				30.0
7.0								35.0
8.0								40.0
9.0								45.0
10.0								50.0
11.0								55.0
12.0								60.0
13.0								65.0
14.0								70.0
15.0								75.0
16.0								80.0
17.0								85.0
18.0								90.0
19.0								95.0
20.0								100.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S2
GENSTAR DEVELOPMENTS LTD.		Project No: 06-0896-266-01
PROJECT ENGINEER. TW		ELEVATION 236.950 (m)

SAMPLE TYPE	<input checked="" type="checkbox"/> GRAB SAMPLE	<input checked="" type="checkbox"/> SHELLEY TUBE	<input checked="" type="checkbox"/> DISTURBED	<input type="checkbox"/> NO RECOVERY	<input type="checkbox"/> CORE BARREL	<input checked="" type="checkbox"/> WIRELINE-TYPE
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DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		CLAY-WITH TILL INCLUSIONS				0.0
1.0						3.0
2.0						6.6
3.0		TILL-SILT WITH GRANULAR				10.0
4.0						13.1
5.0		SHALE-DOLOMITE				16.4
5.2		END OF HOLE @ 4.20 IN SHALE				17.1
6.0						19.7
7.0						22.8
8.0						26.2
9.0						29.9
10.0						32.8
11.0						35.9
12.0						39.4
13.0						42.6
14.0						45.9
15.0						49.2
16.0						52.5
17.0						55.8
18.0						59.1
19.0						62.3
20.0						65.6

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NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-S7  
 Project No: 06-0896-206-01  
 ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SEELEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIPELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
0.0	40 80 120 160				TOPSOIL				0.0
-1.0					CLAY-WITH TILL POCKETS -SOME GRANULAR				5.0
-2.0									10.0
-3.0					TILL-SILT WITH GRANULAR				15.0
-4.0									20.0
-5.0									25.0
-6.0									30.0
-7.0					GRAVEL-LITTLE WATER				35.0
-8.0									40.0
-9.0					END OF HOLE @ 11.89 IN GRAVEL				45.0
-10.0									50.0
-11.0									55.0
-12.0									60.0
-13.0									65.0
-14.0									70.0
-15.0									75.0
-16.0									80.0
-17.0									85.0
-18.0									90.0
-19.0								95.0	
-20.0								100.0	

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NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-S13  
 Project No: 08-0696-266-01  
 ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SEEBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ B.U. INDEX (1/m) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	MC	LIQUID						
	40	80	120	160					
0.0					CLAY-BROWN				0.0
1.0									5.0
2.0									10.0
3.0									15.0
4.0									20.0
5.0									25.0
6.0									30.0
7.0									35.0
8.0					TILL-SILT				40.0
9.0					GRAVEL				45.0
10.0									50.0
11.0					SHALE-DOLOMITE				55.0
12.0					END OF HOLE @ 10.67 IN SHALE				60.0
13.0									65.0
14.0									70.0
15.0									75.0
16.0									80.0
17.0									85.0
18.0									90.0
19.0									95.0
20.0									100.0

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NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-P3  
 Project No: 08-0898-886-01  
 ELEVATION 236.550 (m)

SAMPLE TYPE  GRAF SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 15.0 20.0 30.0 40.0							
	PLASTIC	M.C						
0.0	40 80 120 160			CLAY-BROWN			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0								5.0
2.0								10.0
3.0								15.0
4.0								20.0
5.0				-TILL POCKETS				25.0
6.0				TILL-SILT WITH GRANULAR (SAND TO BOULDERS)			W/L 232.435 IN TILL PIEZOMETER	20.0
7.0				-GRAVEL (6.21 - 9.15)			-232.00 PIEZOMETER TIP	25.0
8.0				LOST DRILL WATER INTO GRAVEL (NO RETURN)			W/L 231.315 IN BEDROCK WELL	30.0
9.0								35.0
10.0								40.0
11.0								45.0
12.0								50.0
13.0								55.0
14.0								60.0
15.0							NOTE: WATER LEVELS AS OF NOV 30 \88	65.0
16.0								70.0
17.0				SHALE-WITH THIN DOLOMITE BEDS				75.0
18.0				-PURPLE				80.0
19.0				-SOFT				85.0
20.0				-SANDY				90.0
21.0								95.0
22.0								100.0
23.0								105.0
24.0								110.0
25.0								115.0

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NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-P8  
 Project No: 00-0808-266-01  
 ELEVATION 240.470 (m)

SAMPLE TYPE  GRAB SAMPLE  SECRET TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
	40 80 120 160								
0.0					CLAY-BROWN			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0									5.0
2.0									10.0
3.0									15.0
4.0									20.0
5.0								▼ W.L 235.58 IN BEDROCK WELL	25.0
6.0									30.0
7.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS)			▼ W.L 234.06 IN TILL PIEZOMETER	35.0
8.0								-232.85 PIEZOMETER TIP	40.0
9.0								-232.09 BOT WELL CASING	45.0
10.0					SHALE-RED BROWN -DOLOMITE LAYERS -SOFT				50.0
11.0									55.0
12.0									60.0
13.0									65.0
14.0									70.0
15.0								NOTE: WATER LEVELS AS OF NOV 30, 85	75.0
16.0									80.0
17.0									85.0
18.0									90.0
18.0					END OF HOLE @ 18.29 IN SHALE				95.0
20.0									100.0
21.0									105.0
22.0									110.0
23.0									115.0
24.0									120.0
25.0									125.0

UMA Engineering Ltd.  
 Winnipeg, Manitoba

COMPLETION DEPTH \*\* m COMPLETE  
 LOGGED BY TH DWG NO. Page 1 of 1

NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-P9  
 Project No: 08-0888-286-01  
 ELEVATION 239.540 (m)

SAMPLE TYPE  GRAB SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	MC	LIQUID						
	40 80 120 160								
0.0					CLAY-FILL			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0					TILL-SILT WITH GRANULAR (SAND TO BOULDERS)  -DENSE FINE TILL TO 9.76  -GRANITIC COBBLES			W/L 233.195 IN TILL PIEZOMETER	5.0
2.0								-229.75 PIEZOMETER TIP	10.0
3.0									15.0
4.0									20.0
5.0									25.0
6.0									30.0
7.0									35.0
8.0									40.0
9.0									45.0
10.0									50.0
11.0								55.0	
12.0								60.0	
13.0								65.0	
14.0								70.0	
15.0					SHALE-DOLOMITE LAYERS -SOFT			-225.22 BOT WELL CASING	75.0
16.0								NOTE: WATER LEVELS AS OF NOV. 30\88	80.0
17.0									85.0
18.0									90.0
18.0					END OF HOLE @ 18.29 IN SHALE				90.0
19.0									95.0
20.0									100.0
21.0									105.0
22.0									110.0
23.0									115.0
24.0									120.0
25.0									125.0

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COMPLETION DEPTH \*\* m COMPLETE  
 LOGGED BY TH DWG NO. Page 1 of 1



NORTH OF SARATCHEWAN FRIESEN DRILLERS LTD. BOREHOLE No. G-88-S1

GENSTAR DEVELOPMENTS LTD. Project No: 08-0898-246-01

PROJECT ENGINEER: TW ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SILENT TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELOG-TYPE

DEPTH (m)	▲ BULK DENSITY (g/cm <sup>3</sup> ) ▲			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO.	Other comments	DEPTH (ft)
	1.4	1.8	2.2						
	■ SHEAR STRENGTH (kPa) ■								
	100	200	300						
	FLASTIC M.C. LIQUID								
	40 80 120 160								
0.0					CLAY-BROWN				0.0
1.0									3.0
2.0									6.6
3.0									10.0
4.0					TILL-SILT WITH GRANULAR				13.1
5.0					SHALE-DOLOMITE, RED-PURPLE, HARD, BUFF				16.4
6.0					END OF HOLE @ 4.42 IN SHALE				19.7
7.0									22.8
8.0									26.2
9.0									29.5
10.0									32.8
11.0									36.1
12.0									39.4
13.0									42.7
14.0									45.9
15.0									49.2
16.0									52.5
17.0									55.8
18.0									59.1
19.0									62.4
20.0									65.6

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COMPLETION DEPTH \*\* m COMPLETE  
 LOGGED BY TW DWG NO. Page 1 of 1

NORTH OF SASKATCHEWAN      FRIDSEN DRILLERS LTD.      BOREHOLE No. G-88-S2

GENSTAR DEVELOPMENTS LTD.      Project No. 04-0800-200-01

PROJECT ENGINEER: TW      ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE     SEEPY TUBE     DISTURBED     NO RECOVERY     CORE BARREL     PIPELINE-TYPE

DEPTH (m)	▲ B.L. CB STN (l/m <sup>3</sup> ) ▲ 1.4   1.8   2.2   2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 120   230   330   400							
	PLASTIC	M.C						
	-----●-----							
	40	80	120	160				
0.0				CLAY-WITH PEBBLES AND STONES				0.0
1.0								5.0
2.0								10.0
3.0				TILL-SILT				15.0
4.0								20.0
5.0				SHALE-DOLOMITE				25.0
6.0				END OF HOLE @ 3.99 IN SHALE				30.0
7.0								35.0
8.0								40.0
9.0								45.0
10.0								50.0
11.0								55.0
12.0								60.0
13.0								65.0
14.0								70.0
15.0								75.0
16.0								80.0
17.0								85.0
18.0								90.0
19.0								95.0
20.0								100.0

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COMPLETION DEPTH \*\* m      COMPLETE

LOGGED BY TW      DWG NO.      Page 1 of 1

NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S2
GEMSTAR DEVELOPMENTS LTD.		Project No: 06-0896-266-01
PROJECT ENGINEER. TW		ELEVATION 236.950 (m)

SAMPLE TYPE  GRAB SAMPLE     SHELLEY TUBE     DISTURBED     NO RECOVERY     CORE BARREL     WIRELINE-TYPE

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		CLAY-WITH TILL INCLUSIONS				0.0
1.0						3.0
2.0						6.6
3.0		TILL-SILT WITH GRANULAR				10.0
4.0						13.1
5.0		SHALE-DOLOMITE				16.4
6.0		END OF HOLE @ 4.20 IN SHALE				19.7
7.0						22.8
8.0						26.2
9.0						29.5
10.0						32.8
11.0						36.1
12.0						39.4
13.0						42.7
14.0						45.9
15.0						49.2
16.0						52.5
17.0						55.8
18.0						59.1
19.0						62.4
20.0						65.6

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COMPLETION DEPTH ** m	COMPLETE
LOGGED BY TW	DWG NO.
Page 1 of 1	

NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-S7  
 Project No: 06-0896-206-01  
 ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SEELEY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIPELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	M.C	LIQUID						
0.0	40	80	120	180	TOPSOIL				0.0
-1.0					CLAY-WITH TILL POCKETS -SOME GRANULAR				5.0
-2.0									10.0
-3.0					TILL-SILT WITH GRANULAR				15.0
-4.0									20.0
-5.0									25.0
-6.0					GRAVEL-LITTLE WATER				30.0
-7.0									35.0
-8.0					END OF HOLE @ 11.89 IN GRAVEL				40.0
-9.0									45.0
-10.0									50.0
-11.0									55.0
-12.0									60.0
-13.0									65.0
-14.0									70.0
-15.0									75.0
-16.0									80.0
-17.0									85.0
-18.0									90.0
-19.0									95.0
-20.0									100.0

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COMPLETION DEPTH \* \* m COMPLETE  
 LOGGED BY TH DWG NO. Page 1 of 1

NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.

BOREHOLE No. G-88-S13  
 Project No: 08-0696-266-01  
 ELEVATION 237.170 (m)

SAMPLE TYPE  GRAB SAMPLE  SEEBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ B.U. INDEX (1/m) ▲ 1.4 1.8 2.2 2.6			USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 100 200 300 400								
	PLASTIC	MC	LIQUID						
	40 80 120 160								
0.0					CLAY-BROWN				0.0
1.0									5.0
2.0									10.0
3.0									15.0
4.0									20.0
5.0									25.0
6.0									30.0
7.0									35.0
8.0					TILL-SILT				40.0
9.0					GRAVEL				45.0
10.0									50.0
11.0					SHALE-DOLOMITE				55.0
12.0					END OF HOLE @ 10.67 IN SHALE				60.0
13.0									65.0
14.0									70.0
15.0									75.0
16.0									80.0
17.0									85.0
18.0									90.0
19.0									95.0
20.0									100.0

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COMPLETION DEPTH \*\* m COMPLETE  
 LOGGED BY TW DWG NO. Page 1 of 1

NORTH OF SASKATCHEWAN  
 GENSTAR DEVELOPMENTS LTD.  
 PROJECT ENGINEER: TW

FRIESEN DRILLERS LTD.  
 BOREHOLE No. G-88-P3  
 Project No: 08-0898-886-01  
 ELEVATION 236.550 (m)

SAMPLE TYPE  GRAF SAMPLE  SHELBY TUBE  DISTURBED  NO RECOVERY  CORE BARREL  WIRELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m <sup>3</sup> ) ▲ 1.4 1.8 2.2 2.6		USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
	■ SHEAR STRENGTH (kPa) ■ 15.0 200 300 400							
	PLASTIC	M.C						
0.0				CLAY-BROWN			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0								5.0
2.0								10.0
3.0								15.0
4.0				-TILL POCKETS				20.0
5.0								25.0
6.0				TILL-SILT WITH GRANULAR (SAND TO BOULDERS)			F. W/L 232.435 IN TILL PIEZOMETER -232.00 PIEZOMETER TIP V. W/L 231.315 IN BEDROCK WELL	30.0
7.0				-GRAVEL (6.21 - 9.15)				35.0
8.0				LOST DRILL WATER INTO GRAVEL (NO RETURN)				40.0
9.0								45.0
10.0								50.0
11.0								55.0
12.0								60.0
13.0								65.0
14.0								70.0
15.0							NOTE: WATER LEVELS AS OF NOV 30 \88	75.0
16.0								80.0
17.0				SHALE-WITH THIN DOLOMITE BEDS				85.0
18.0				-PURPLE				90.0
19.0				-SOFT				95.0
20.0				-SANDY				100.0
21.0								105.0
22.0								110.0
23.0								115.0
24.0								120.0
25.0								125.0

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 Winnipeg, Manitoba

COMPLETION DEPTH \*\* m

COMPLETE

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DWG NO.

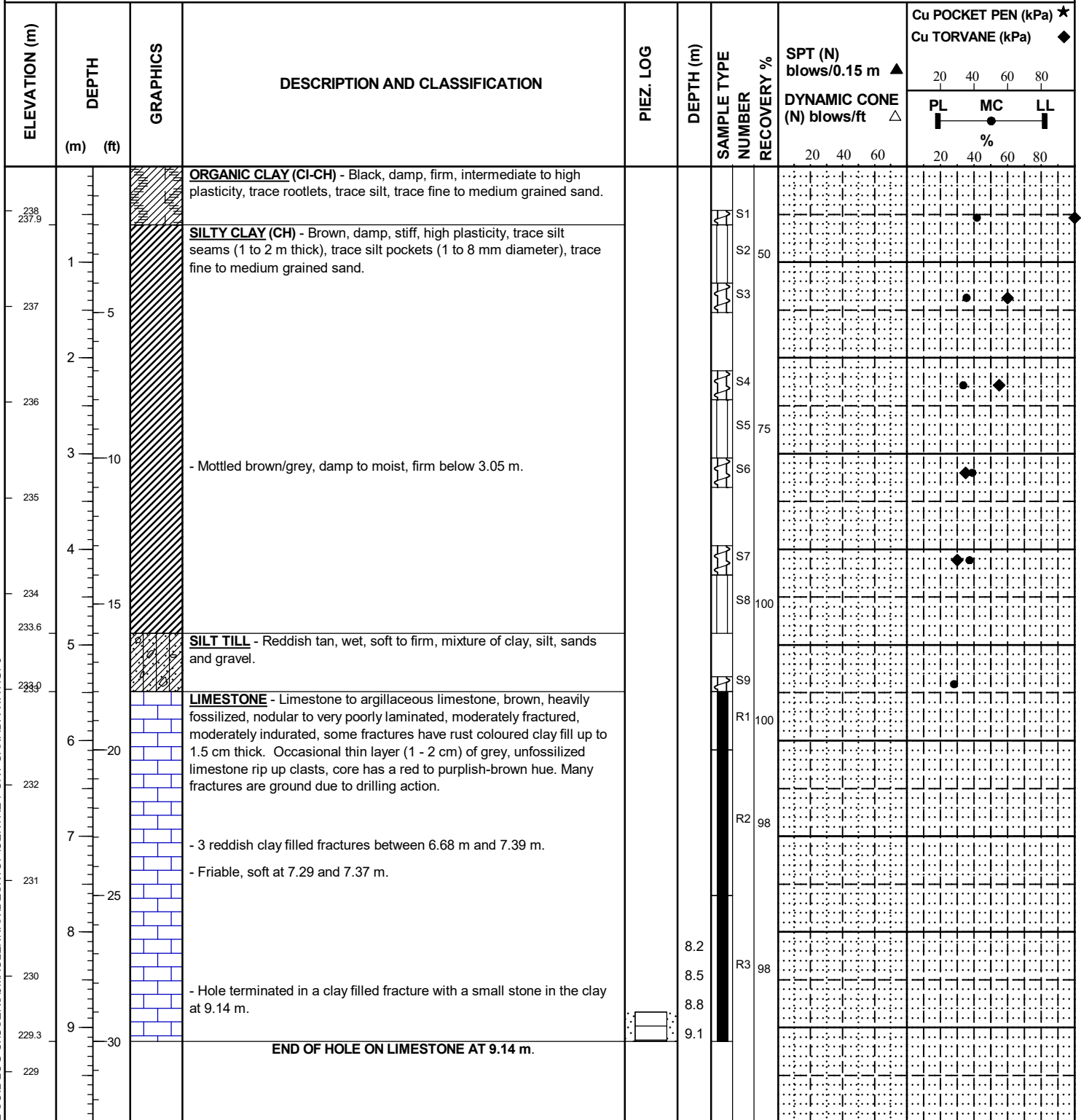
Page 1 of 1

# **APPENDIX B**

2009 Test Hole Logs

**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T

**JOB NO.** 09-183-01  
**GROUND ELEV.** 238.46 m  
**TOP OF PVC ELEV.** 239.63 m  
**WATER ELEV.**  
**DATE DRILLED** 5/6/2009  
**UTM (m)** N 5,533,717  
 E 624,309



SAMPLE TYPE  Auger Grab  Shelby Tube  Core Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 B. P. ARPIN

**APPROVED**  
 MRJ

**DATE**  
 12/16/19



ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆			
									PL	MC	LL	
228	35		Notes: 1. Solid stem auger refusal at 5.49 below grade. 2. Water infiltration between 4.88 and 5.49 m. 3. Switched to HQ core barrel at 5.49 m. 4. Installed a 25 mm diameter standpipe with Casagrande tip to a depth of 9.14 m below grade, stickup = 1.17 m.									
227												
226	40											
225												
224	45											
223												
222	50											
221												
220	55											
219												
218	60											
217												
	65											
	70											

GEOTECHNICAL-SOIL LOG C:\USERS\JMACLENNAN\DESKTOP\CENTRE\_PORT\_CANADA WAY.GPJ

 SAMPLE TYPE  Auger Grab     Shelby Tube     Core Barrel

 CONTRACTOR  
**Paddock Drilling Ltd.**

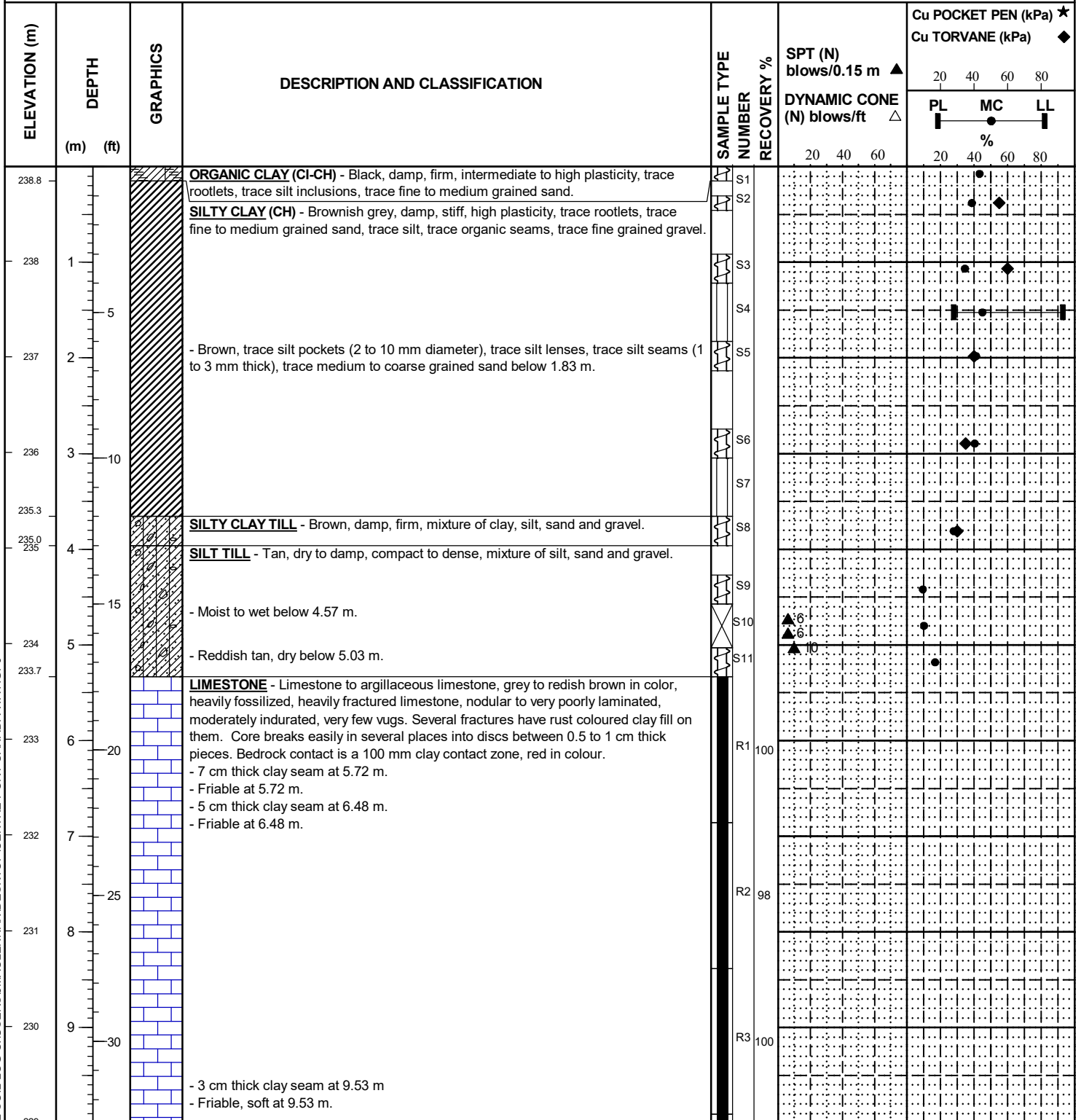
 INSPECTOR  
**B. P. ARPIN**

 APPROVED  
 MRJ

 DATE  
 12/16/19

**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T

**JOB NO.** 09-183-01  
**GROUND ELEV.** 238.99 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 5/6/2009  
**UTM (m)** N 5,533,684  
 E 624,275



GEOTECHNICAL-SOIL LOG C:\USERS\JMACLENNAN\DESKTOP\CENTRE PORT CANADA WAY.GPJ

SAMPLE TYPE Auger Grab Shelby Tube Split Spoon Core Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 B. P. ARPIN

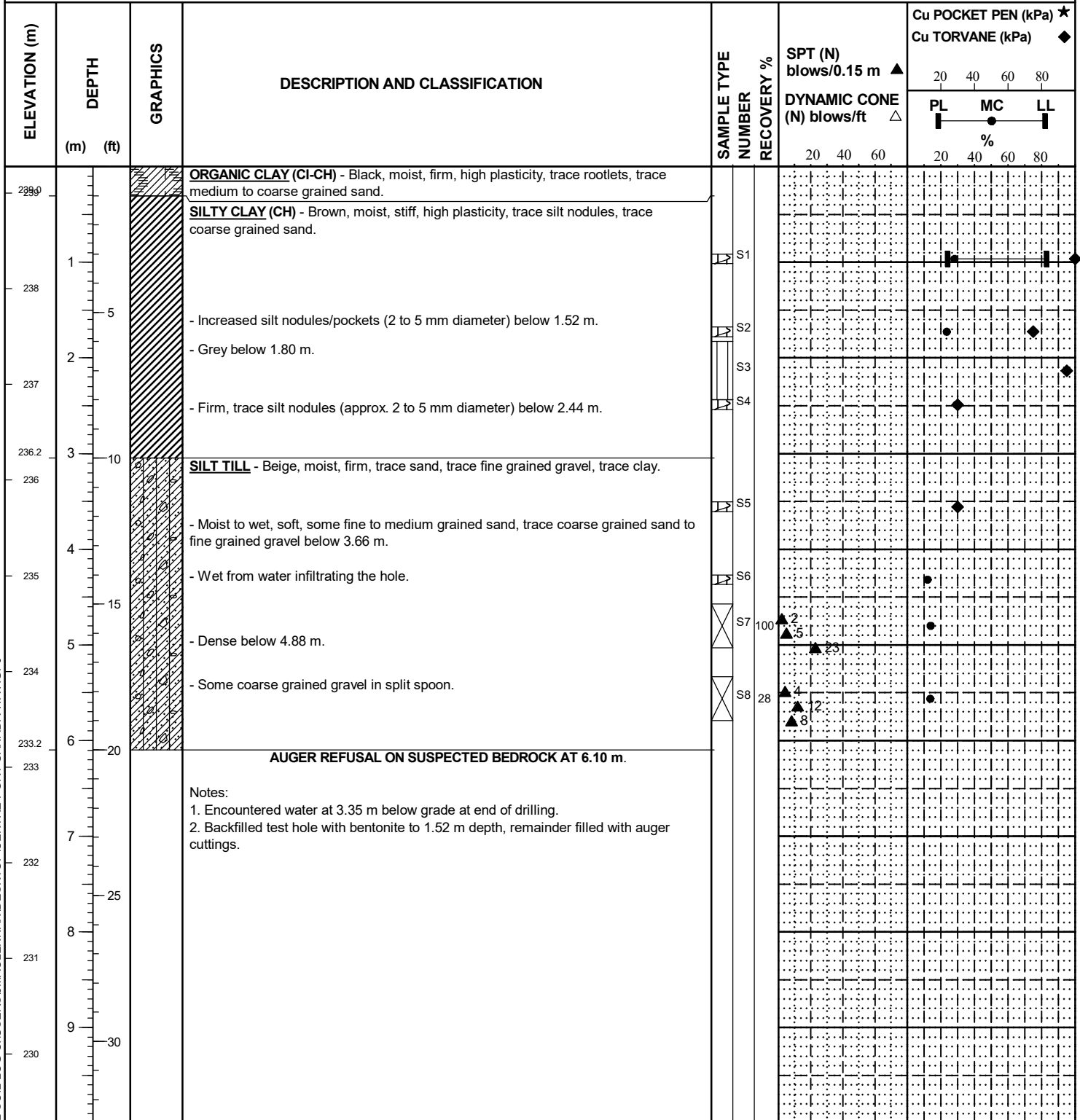
**APPROVED**  
 MRJ

**DATE**  
 12/16/19



**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger, Acker MP5-T

**JOB NO.** 09-183-01  
**GROUND ELEV.** 239.28 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 5/7/2009  
**UTM (m)** N 5,533,532  
 E 624,113



**AUGER REFUSAL ON SUSPECTED BEDROCK AT 6.10 m.**

Notes:

- Encountered water at 3.35 m below grade at end of drilling.
- Backfilled test hole with bentonite to 1.52 m depth, remainder filled with auger cuttings.

SAMPLE TYPE  Auger Grab  Shelby Tube  Split Spoon

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 C. FRIESEN

**APPROVED**  
 MRJ

**DATE**  
 12/16/19

**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T

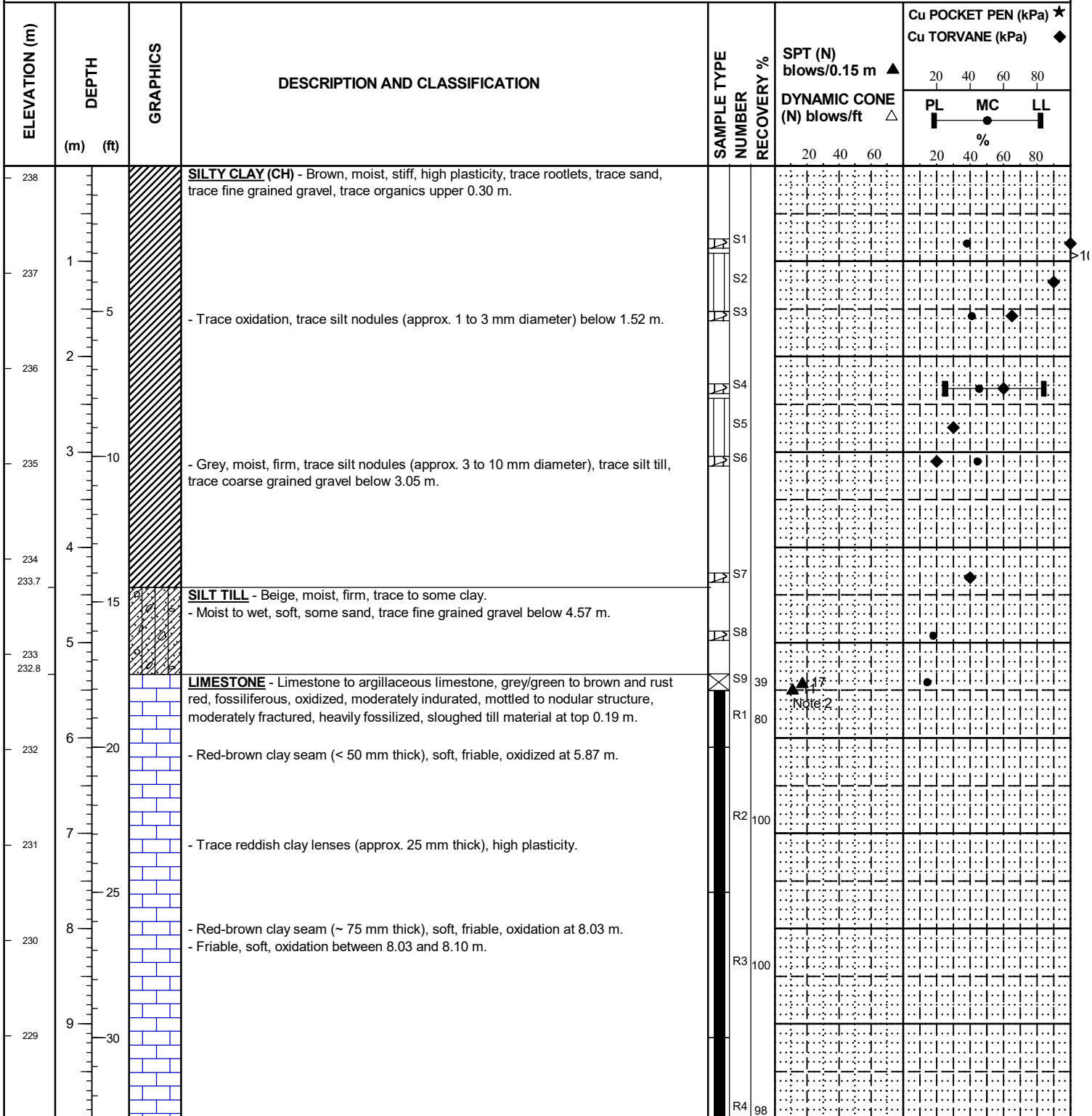
**JOB NO.** 09-183-01  
**GROUND ELEV.** 237.34 m  
**TOP OF PVC ELEV.** 238.38 m  
**WATER ELEV.**  
**DATE DRILLED** 5/7/2009  
**UTM (m)** N 5,533,770  
 E 624,364

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL
237	1		[Diagonal Hatching]	<b>SILTY CLAY (CH)</b> - Black, moist, stiff, high plasticity, some organics, trace rootlets, trace medium grained sand.  - Brown, trace silt nodules (approx. 1 to 2 mm diameter) below 1.07 m.								
236	5		[Diagonal Hatching]									
235	2		[Diagonal Hatching]	- Grey, firm, trace silt nodules/pockets (approx. 5 to 25 mm diameter), trace coarse grained sand to fine grained gravel below 2.13 m.								
234	3	10	[Diagonal Hatching]									
233.7	4		[Cross-hatching]	<b>SILT TILL</b> - Beige, moist, soft, trace medium to coarse grained sand, trace fine grained gravel, trace clay.								
233	15		[Brick Pattern]	<b>LIMESTONE</b> - Limestone to argillaceous limestone, purple-grey, heavily fossilized, mottled tan to redish brown, nodular to very poorly laminated, moderately fractured, a few narrow shale zones. - Friable, rubble core zone between 4.85 and 4.93 m.  - Top 32 cm is heavily fractured.  - Nearly all core fractures are 80° to 90° to core axis.  - Friable at 6.88, 7.14 and 7.16 m. - Becomes grey, moderately fractured, several narrow shale zones (< 1 cm), core tends to break at shale layers.								
232.8	5		[Brick Pattern]									
232	6	20	[Brick Pattern]									
231	7		[Brick Pattern]									
230	7		[Brick Pattern]									
229.7	25		[Brick Pattern]	<b>END OF HOLE AT 7.62 m..</b>								
229	8		[Brick Pattern]	Notes: 1. Installed Casagrande standpipe to a depth of 7.62 m below grade, stickup = 1.04 m. 2. SPT bounced after 6 blows on suspected boulder or bedrock for S8. 3. Switched to HQ core barrel at 4.6 m.								
228	9	30	[Brick Pattern]									

GEOTECHNICAL-SOIL LOG C:\USERS\JMACLENNAN\DESKTOP\CENTRE PORT CANADA WAY.GPJ

**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger, HQ Core Barrel

**JOB NO.** 09-183-01  
**GROUND ELEV.** 238.12 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 5/7/2009  
**UTM (m)** N 5,533,797  
 E 624,389



SAMPLE TYPE Auger Grab Shelby Tube Split Spoon Core Barrel

CONTRACTOR **Paddock Drilling Ltd.**

INSPECTOR **C. FRIESEN**

APPROVED **MRJ**

DATE **12/16/19**

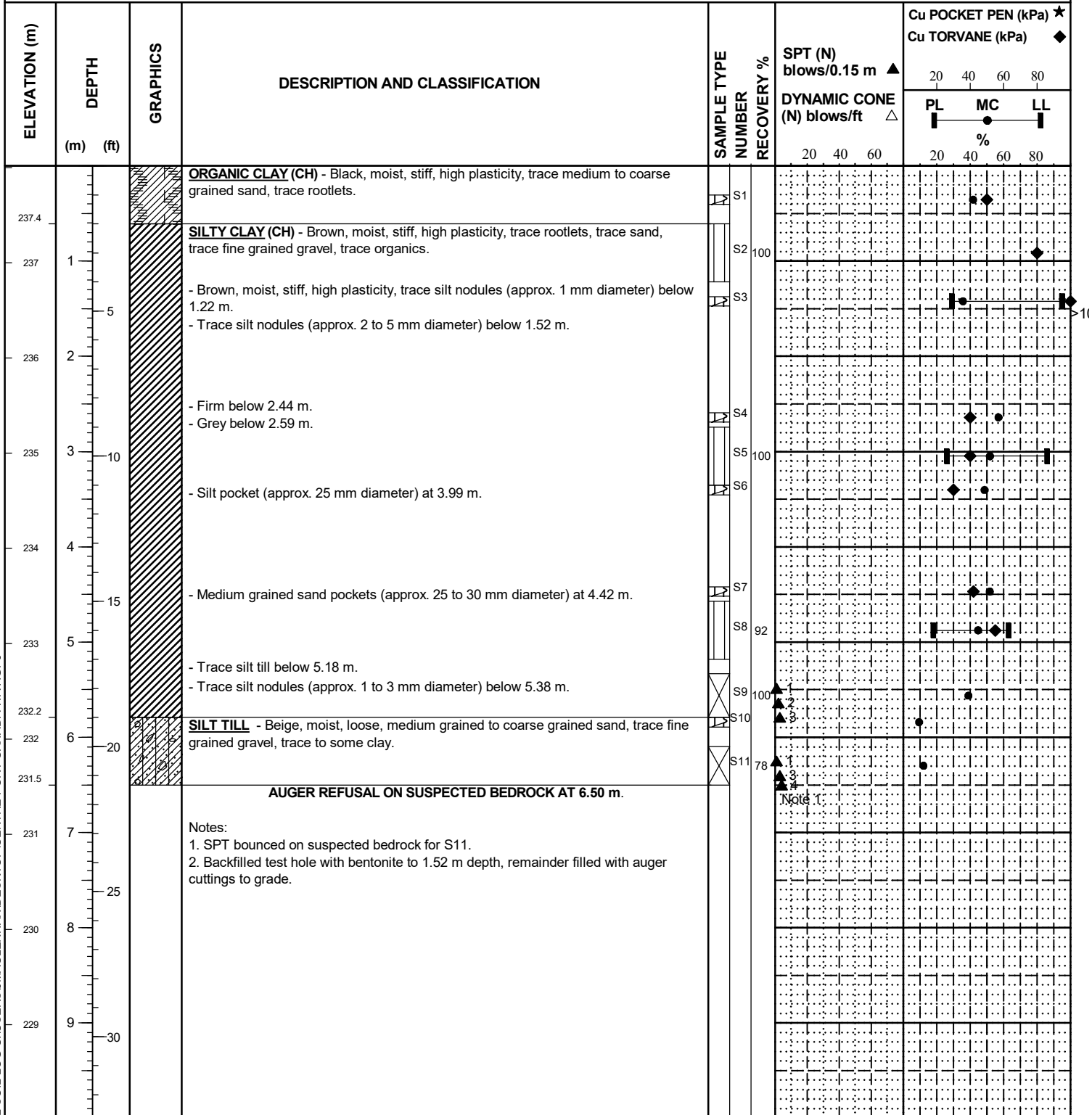
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**CLIENT** WSP CANADA GROUP LIMITED  
**PROJECT** CENTRE PORT CANADA WAY PROJECT  
**SITE** Proposed Interchange at Sturgeon Rd. and Inkster Blvd.  
**LOCATION** Sturgeon Rd. and Inkster Blvd.  
**DRILLING METHOD** 125 mm ø Solid Stem Auger, Acker MP5-T

**JOB NO.** 09-183-01  
**GROUND ELEV.** 238.02 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 5/8/2009  
**UTM (m)** N 5,533,919  
 E 624,517



GEOTECHNICAL-SOIL LOG C:\USERS\JMACLENNAN\DESKTOP\CENTRE PORT CANADA WAY.GPJ

SAMPLE TYPE  Auger Grab  Shelby Tube  Split Spoon

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 C. FRIESEN

**APPROVED**  
 MRJ

**DATE**  
 12/16/19



# **APPENDIX C**

2019/2020 Test Hole and  
Photograph Logs

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 2800 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.75  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/23/2019  
**UTM (m)** N 5,530,427  
 E 623,767

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★		Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC
238				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - Damp below 0.6 m.	S1								
237.7	1			<b>CLAY FILL</b> - Black, damp, low plasticity, stiff, some organics.	S2								
237.1		5		<b>CLAY (CH)</b> - Mottled brown to grey, moist, stiff, high plasticity. - Trace silt nodules below 2.3 m.	S3								
237	2			- Firm below 3.2 m.	S4								
236		10		- Trace fine to coarse grained gravel below 3.9 m.	S5								
235	4			<b>SILT TILL (ML)</b> - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S6								
234.2		15		- Cobbles encountered at 5.9 m. - Moist to wet, loose, some to with fine to coarse grained gravel below 6.0 m.	S7								
234	5				S8								
233		20			S9								
232	7				S10								
231		25			S11								
230	8												
229		30											
228	9												
227		35											
226	10												
		40											

SAMPLE TYPE Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆				
						DYNAMIC CONE (N) blows/ft △	PL	MC	LL	PL	MC	LL		
						20 40 60	20 40 60 80				20 40 60 80			
225.6			<b>SAND AND GRAVEL</b> - Brown, moist, dense, some silt, some cobbles.											
225.0 225	14		<b>SILT TILL (ML)</b> - Red, moist, dense, some fine to coarse grained sand, some fine to coarse grained gravel.	S12										
224.3 224.1 224	15		<b>JURASSIC LIMESTONE</b> - Pink to grey, weak.	S13										
			<b>END OF TEST HOLE AT 14.4 m</b>											
			Notes: 1. Water observed at 6.5 m below grade after the completion of drilling. 2. TH19-01 open to 7.1 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
223	16													
222	17													
221	18													
220	19													
219	20													
218	21													
217	22													
216	23													
215	24													
214	25													
213	26													
212	27													
211	28													

SAMPLE TYPE Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 2570 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.19  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/23/2019  
**UTM (m)** N 5,530,706  
 E 623,776

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★		Cu TORVANE (kPa) ◆	
	(m)	(ft)							PL	MC	LL	PL
238.9				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained sand.								
	1	5		<b>CLAY FILL</b> - Grey, damp, firm, intermediate plasticity, trace fine to coarse grained gravel. - Black, low plasticity, some organics, trace silt nodules below 0.7 m.	S1							
	2	10		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.  - Trace fine grained gravel below 3.0 m.  - Cobbles encountered below 4.2 m.	S2							
	3	15			S3							
	4	20		<b>SILT TILL (ML)</b> - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel.  - 150 mm sand seam observed at 6.2 m. - Damp to moist below 6.7 m.	S4							
	5	25			S5							
	6	30		- 300 mm sand seam observed at 7.6 m. - With fine to coarse grained gravel below 7.9 m.	S6							
	7	35		<b>GRAVEL</b> - Brown, moist, compact, some fine to coarse grained sand, some silt.	S7							
	8	40		<b>SILT TILL (ML)</b> - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel.  - Damp, dense below 10.3 m. - Very dense below 10.6 m.	S8							
	9				S9							
	10				S10							
	11			<b>JURASSIC LIMESTONE</b> - Pink to grey, weak.								

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 2330 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.41  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/24/2019  
**UTM (m)** N 5,530,935  
 E 623,783

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
238.1				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.										
238				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some fine to coarse grained sand, some fine to coarse grained gravel, some organics.										
237.5	1			<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity.	S1									
237		5		- Mottled brown to grey, trace silt nodules below 1.6 m.										
236		2			S2									
235		3		- Firm below 3.6 m.										
234		4		- Grey, moist, some silt nodules below 4.2 m.										
233		5			S4									
232.6		6		<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel.										
232		7			S5									
231		8		- Damp, dense to very dense below 7.6 m.										
230		9			S6									
229.0		10		<b>LIMESTONE</b> - White, weak.	S7									
228.8		10		<b>END OF TEST HOLE AT 9.6 m</b>	S8									
228		11		Notes: 1. Water observed at 5.6 m below grade after the completion of drilling. 2. TH19-03 open to 5.8 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
227		12												
226		12												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 2100 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.39  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/24/2019  
**UTM (m)** N 5,531,169  
 E 623,790

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)									PL	MC	LL	PL	MC	LL
238.1				<b>GRANULAR FILL</b> - Brown, damp, loose, fine to coarse grained gravel, with fine to coarse grained sand.												
238				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, trace coarse grained gravel, some organics.												
237.5	1			<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity.												
237		5		- Mottled brown to grey below 1.5 m.												
236		2		- Trace silt nodules below 1.6 m.												
235		10					S2									
234		4		- 50 mm silt seam observed at 3.6 m.												
234		15		- 25 mm silt seam observed at 4.2 m.												
233		5		- Grey, moist below 5.2 m.												
232.3	6						S4									
232		20		<b>SILT TILL (ML)</b> - Tan, moist to wet, loose, some fine to coarse grained sand, trace fine to coarse grained gravel.												
231		7		- 100 mm sand seam observed at 7.0 m.												
231		25		- Damp to moist, compact, trace cobbles below 7.0 m.												
230		8		- Dense below 7.6 m.												
229		9		- Red, damp, some fine to coarse grained gravel, trace fine to coarse grained sand below 8.5 m.												
228.6	10						S7									
228		30		<b>JURASSIC LIMESTONE</b> - Red to brown, weak, broken (RQD = 0.0).												
227.7		35					S8									
227		11														
226		40														
				<b>END OF TEST HOLE AT 10.6 m</b>												
				Notes: 1. TH19-04 open to 10.6 m below grade after the completion of drilling. 2. Installed two 25.4 mm diameter PVC standpipes with 0.3 m casagrande tip to the bedrock- 10.6 m below grade, and to the till- 7.6 m below grade. 3. Backfilled with bentonite chips and auger cuttings.												

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 1700 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.97  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/24/2019  
**UTM (m)** N 5,531,558  
 E 623,802

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
238.5				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.										
238.2				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, some organics.										
238	1			<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity.	S1									
		5		- Mottled brown to grey, damp to moist, trace silt nodules below 1.2 m.										
237	2				S2									
		10		- Grey, trace fine grained gravel below 3.0 m.										
236	3				S3									
235	4													
234.4		15		<b>SILT TILL (ML)</b> - Tan, damp, loose to compact, some fine to coarse grained gravel, some fine to coarse grained sand.	S4									
234	5													
233	6				S5									
232	7													
231.4		25		<b>JURASSIC LIMESTONE</b> - Red, weak.	S6									
231.2				<b>END OF TEST HOLE AT 7.7 m</b>										
231	8			Notes: 1. TH19-05 open to 7.4 m below grade after the completion of drilling. 2. Water encountered at 4.7 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
230	9													
		30												
229	10													
		35												
228	11													
		40												
227	12													
226														

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 1480 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.37  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/24/2019  
**UTM (m)** N 5,531,769  
 E 623,809

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.1				<b>GRANULAR FILL</b> - Grey, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.										
239														
238.6				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, some organics.	S1									
238	1			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity.	S2									
237	2	5		- Trace silt nodules, trace fine grained gravel below 1.5 m.										
236	3	10		- Moist below 3.0 m.	S3									
235.6	4	15		<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.										
235	5	20												
234	6	25		<b>SAND AND GRAVEL</b> - No recovery in sonic barrel from 6.1 m to 7.6 m.	S4									
233.3	7	30												
233	8	35		<b>SILT TILL (ML)</b> - Tan, moist to wet, loose to compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S5									
232	9	40		- Yellow, moist, dense below 8.5 m.	S6									
231.8	10			- With fine to coarse grained gravel below 9.1 m.	S7									
231				<b>JURASSIC LIMESTONE</b> - Red to purple, broken.	S8									
229.6				- 300 mm clay seam observed at 10.3 m.										
229				<b>END OF TEST HOLE AT 10.6 m</b>										
228.7														
228				Notes: 1. TH19-06 open to 8.5 m below grade after the completion of drilling. 2. Water encountered at 5.5 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
227														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 1250 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.66  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/24/2019  
**UTM (m)** N 5,532,002  
 E 623,816

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							20	40	60	80	20	40
239.2				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - 30 mm organic clay observed at 0.3 m.	S1									
239	1	<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, high plasticity, some organics.												
238.4	5	<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity. - Mottled brown to grey, damp to moist, trace silt nodules below 1.5 m.												
238	2	- Grey, moist, trace fine to coarse grained gravel below 3.0 m.												
237	3	- Grey, moist, trace fine to coarse grained gravel below 3.0 m.												
236.0	4			<b>SILT TILL (ML)</b> - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel, some cobbles.	S3									
235.1	4	<b>LIMESTONE</b> - White, weathered, soft.												
234.9	5	<b>END OF TEST HOLE AT 4.7 m</b>												
234	6	Notes: 1. TH19-07 open to 4.5 m below grade after the completion of drilling. 2. Water encountered at 3.8 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.												
233	7													
232	8													
231	9													
230	10													
229	11													
228	12													
227														

SAMPLE TYPE Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 1070 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.03  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/25/2019  
**UTM (m)** N 5,532,179  
 E 623,821

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.3				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.										
239	1			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some organics. - Trace coarse grained gravel below 0.9 m.	S1									
238.4	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.										
238	2				S2									
237	3	10												
236.9	4			<b>SILT TILL (ML)</b> - Tan, moist, dense.	S3									
235.5	15			<b>JURASSIC LIMESTONE</b> - Red, weak.										
235	5			<b>END OF TEST HOLE AT 4.5 m</b>										
				Notes: 1. TH19-08 open to 4.5 m below grade after the completion of drilling. 2. Water observed at 1.8 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
234	6	20												
233	7													
232	8													
231	9	30												
230	10													
229	11	35												
228	12	40												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 M. SAALY

**APPROVED**  
 JRM

**DATE**  
 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Sturgeon Road  
**LOCATION** 760 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 241.01  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/25/2019  
**UTM (m)** N 5,532,489  
 E 623,831

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ Cu TORVANE (kPa) ◆		
	(m)	(ft)						PL	MC	LL
240.5				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1					
240	1			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, trace coarse grained gravel.	S2					
239		5								
238.7	2			- 150 mm silt seam observed at 2.1 m.						
238.4				<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity, trace silt nodules.	S3					
238.4	3			<b>SILT TILL (ML)</b> - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel.	S4					
237		10		- Some cobbles below 3.3 m.						
236.7	4			- Moist below 3.9 m.	S5					
236.6				<b>LIMESTONE</b> - Orange to white.	S6					
236	5			<b>END OF TEST HOLE AT 4.4 m</b>						
236	5			Notes: 1. TH19-09 open to 4.4 m below grade after the completion of drilling. 2. Water observed at 3.6 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.						
235	6									
235	6	20								
234	7									
234	7									
233	8									
233	8									
232	9									
232	9	30								
231	10									
231	10									
230	11									
230	11	35								
229	12									
229	12	40								

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Sturgeon Road  
**LOCATION** 570 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 241.24  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/25/2019  
**UTM (m)** N 5,532,672  
 E 623,801

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL			
241	0	0		<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - Cobbles encountered at 0.7 m.										
238.5	2.5	8.2		<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity, trace silt nodules. <b>SILT TILL (ML)</b> - Tan, damp, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S2									
237	4	13.1		- Yellow to brown, moist, some cobbles below 4.5 m.	S3									
235.1	6	19.7		<b>SAND AND GRAVEL</b> - Brown, damp, compact, fine to coarse grained gravel, some silt, some fine to coarse grained sand.	S4									
233.3	8	26.2		<b>LIMESTONE</b> - White to yellow, weak.	S5									
233	8	26.2		<b>END OF TEST HOLE AT 7.9 m</b>										
232	9	29.5		Notes: 1. TH19-09 open to 4.4 m below grade after the completion of drilling. 2. Water observed at 4.4 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.	S6									
229	12	39.4			S7									

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM

**DATE** 12/16/19



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Red Fife Road  
**LOCATION** 1635 m West of Oak Point Hwy, North shoulder of Red Fife Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.90  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/25/2019  
**UTM (m)** N 5,534,076  
 E 624,802

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.7				<b>TOP SOIL</b> - Black, damp, stiff, low plasticity, with organics, trace rootlets.	S1									
239.4				<b>GRANULAR FILL</b> -Brown, damp, compact, fine to coarse grained gravel, trace fine to coarse grained sand.	S2									
239	1	5		<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, trace silt nodules. - Black, damp to moist, trace rootlets below 0.7 m.	S3									
238.1	2	10		<b>CLAY (CH)</b> - Mottled brown to grey, damp to moist, stiff, high plasticity, trace silt nodules, trace rootlets.	S4									
237	3	15		- Brown, no rootlets below 3.0 m.	S4									
236	4	20		- Trace coarse grained gravel below 4.5 m.	S5									
235	5	25		- 150 mm silt seam observed at 5.8 m. - 300 mm silt seam observed at 6.0 m.	S5									
234	6	30		<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S6									
233.3	7	35		- Broken fragments of Jurassic bedrock below 8.2 m.	S6									
233	8	40		<b>JURASSIC LIMESTONE</b> - Red, weak.	S7									
231.2	9	45		<b>END OF TEST HOLE AT 9.1 m</b>	S7									
231	10	50		Notes: 1. TH19-14 open to 8.8 m below grade after the completion of drilling. 2. Water observed at 3.3 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
230.8	11	55												
230	12	60												
229														
228														
227														

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Red Fife Road  
**LOCATION** 1470 m West of Oak Point Hwy, North shoulder of Red Fife Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.66  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/26/2019  
**UTM (m)** N 5,534,085  
 E 624,969

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL			
239.0				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.											
239	1			<b>CLAY FILL</b> - Black, damp, stiff, low plasticity, some organics, trace coarse grained gravel, trace rootlets, trace cobbles.											
238	5			- Mottled black to grey, intermediate plasticity, no rootlets below 1.5 m.		S1									
237															
236.6	3	10		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.		S2									
236						S3									
235															
234.2	5	15		- Firm to stiff below 5.1 m.											
234				<b>SILT TILL (ML)</b> - Tan, moist, loose, trace fine grained sand.		S4									
233	6	20		- Some fine to coarse grained sand, some fine to coarse grained gravel below 6.0 m.		S5									
232						S6									
231	7	25		- Cobbles encountered below 7.1 m.											
230	8			- Damp, compact below 8.0 m.											
229						S9									
228.1	9	30		- Dense below 9.1 m.											
228				- Brown below 9.4 m.											
227.8	10			- Grey to red below 10.0 m.											
227						S10									
						S11									
	12	40		<b>JURASSIC LIMESTONE</b> - Red, weak.											
				<b>END OF TEST HOLE AT 11.8 m</b>											
				Notes: 1. Water observed at 5.5 m below grade after the completion of drilling.											

SAMPLE TYPE  Sonic Barrel

CONTRACTOR **Paddock Drilling Ltd.**

INSPECTOR **M. SAALY**

APPROVED **JRM**

DATE **12/16/19**

GEO-TECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ





**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Red Fife Road  
**LOCATION** 1278 m West of Oak Point Hwy, North shoulder of Red Fife Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.07  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/26/2019  
**UTM (m)** N 5,534,090  
 E 625,160

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
240				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.										
239.6				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, trace coarse grained gravel, trace rootlets.										
239	1	5			S1									
238.1				<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.										
238	2	15												
237	3	10		- Firm below 3.2 m.	S2									
236	4	15			S3									
235.2				<b>SILT TILL (ML)</b> - Tan, moist, loose, trace fine grained sand, trace fine grained gravel.										
235	5	15			S3									
234	6	20		- Trace cobbles below 6.0 m.										
233	7	25			S4									
232	8	25		- Moist to wet below 7.6 m.										
231.2				- Pink below 8.2 m.										
230.9	9	30		<b>JURASSIC LIMESTONE</b> - Red, weak.	S5									
				<b>END OF TEST HOLE AT 9.1 m</b>										
				Notes: 1. TH19-16 open to 6.4 m below grade after the completion of drilling. 2. Water observed at 3.3 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cutting										
230	10	33												
229	11	35												
228	12	40												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Red Fife Road  
**LOCATION** 1155 m West of Oak Point Hwy, North shoulder of Red Fife Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.18  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/26/2019  
**UTM (m)** N 5,534,093  
 E 625,285

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
240				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.										
239.7				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, some fine grained gravel, trace silt nodules, trace rootlets.	S1									
239	1	5		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S2									
238.4				- Damp to moist below 3.3 m.	S3									
238	2	10		- 30 mm silt seam observed at 3.8 m.	S4									
237				- 30 mm silt seam observed at 4.1 m.										
236				- 40 mm silt seam observed at 4.5 m.										
235.3	5	15		<b>SILT TILL (ML)</b> - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S5									
235				- 50 mm sand seam observed at 5.8 m.										
234	6	20		- With fine to coarse grained sand, with fine to coarse grained gravel below 6.4 m.										
233	7	25		- Cobbles encountered below 7.0 m.	S6									
232.4				<b>JURASSIC LIMESTONE</b> - Red, weak.										
232.3	8	25		<b>END OF TEST HOLE AT 7.9 m</b>										
232				Notes: 1. TH19-17 open to 7.3 m below grade after the completion of drilling. 2. Water observed at 5.2 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
231	9	30												
230	10	35												
229	11	40												
228	12	40												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Park Royale Way  
**LOCATION** 810 m West of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.60  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/26/2019  
**UTM (m)** N 5,534,128  
 E 625,626

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)									PL	MC	LL	PL	MC	LL
239	1		[Cross-hatched pattern]	<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	[Stippled pattern]											
238.2	5			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, some organics.												
237	2		[Diagonal hatched pattern]	<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	[Stippled pattern]											
236	10															
235	4		[Diagonal hatched pattern]		[Stippled pattern]											
234.0	15															
233	6		[Diagonal hatched pattern]	<b>SILT TILL (ML)</b> - Tan, damp, loose, some fine to coarse grained sand, some fine to coarse grained gravel.	[Stippled pattern]											
232.3	20			- Trace cobbles below 6.4 m.												
232.0	25		[Horizontal hatched pattern]	<b>JURASSIC LIMESTONE</b> - Red, weak.	[Stippled pattern]											
231	8			<b>END OF TEST HOLE AT 7.6 m</b>												
230	9			Notes: 1. Installed a 25.4 mm diameter PVC standpipes with 0.3 m casagrande tip to 7.0 m below grade. 2. Test hole sloughing condition and water level could not be measured due to the installation of standpipe. 3. Backfilled with bentonite chips and auger cuttings.												
229	10															
228	11															
227	12															

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM

**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Park Royale Way  
**LOCATION** 650 m West of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.46  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/26/2019  
**UTM (m)** N 5,534,129  
 E 625,786

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆			
	(m)	(ft)							PL	MC	LL				
239				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.											
238.2	1														
238		5		<b>CLAY (CH)</b> - Mottled brown to grey, moist, stiff, high plasticity.											
237	2														
236	3	10													
235.8					S1										
235.0	4			<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel.											
234.9					S2										
234	5	15		<b>LIMESTONE</b> - White to yellow.											
				<b>END OF TEST HOLE AT 4.5 m</b>											
234	6	20		Notes: 1. TH19-19 open to 1.8 m below grade after the completion of drilling. 2. Water suspects to be deeper than 1.8 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
233	7														
232	8	25													
231	9	30													
230	10														
229	11	35													
228	12	40													
227															

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Park Royale Way  
**LOCATION** 500 m West of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.42  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/27/2019  
**UTM (m)** N 5,534,114  
 E 625,936

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL			
239	1	3.3	[Cross-hatched]	<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - Trace cobbles below 0.7 m.										
238.0 238	5	16.4	[Diagonal lines]	<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	S1									
237	10	32.8	[Diagonal lines]											
236	15	49.2	[Diagonal lines]	<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel.										
235.3	5	17.7	[Diagonal lines]		S2									
235	10	35.4	[Diagonal lines]	- Compact below 5.3 m. - Trace cobbles below 5.5 m. - With fine to coarse grained gravel below 6.0 m.										
234	15	52.8	[Diagonal lines]		S3									
233	20	70.2	[Diagonal lines]		S4									
232.6	7	22.9	[Horizontal lines]	<b>JURASSIC LIMESTONE</b> - Red, weak.										
232.3	7	22.9	[Horizontal lines]	<b>END OF TEST HOLE AT 7.1 m</b>										
232	8	26.2	[Horizontal lines]	Notes: 1. TH19-20 open to 3.6 m below grade after the completion of drilling. 2. Water suspects to be deeper than 0.6 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
231	9	29.5	[Horizontal lines]											
230	10	32.8	[Horizontal lines]											
229	11	36.1	[Horizontal lines]											
228	12	39.4	[Horizontal lines]											
227	12	39.4	[Horizontal lines]											

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Park Royale Way  
**LOCATION** 345 m West of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.57  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/27/2019  
**UTM (m)** N 5,534,123  
 E 626,090

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆				
	(m)	(ft)							PL	MC	LL	PL	MC	LL		
239	1		[Cross-hatched pattern]	<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.												
238.0	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	S1											
237	2		[Diagonal hatched pattern]	<b>SILT TILL (ML)</b> - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel. - Moist to wet, trace cobbles below 3.6 m. - Compact at 4.0 m.  - Cobbles observed at 5.9 m. - Damp below 6.2 m.  - Red, dense below 7.0 m.  - Very dense below 7.6 m.	S2											
236.5	3	10			S3											
236	4				S4											
235	5	15			S5											
234	6	20			S6											
233	7				S7											
232	8	25			S8											
231	9	30			S9											
230	10															
229	11	35														
228.4																
228.1				<b>JURASSIC LIMESTONE</b> - Red.	S10											
228				<b>END OF TEST HOLE AT 11.4 m</b>												
227	12	40		Notes: 1. TH19-21 open to 3.3 m below grade after the completion of drilling. 2. Water observed at 0.6 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY  
**APPROVED** JRM  
**DATE** 12/16/19

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Park Royale Way  
**LOCATION** 180 m West of Roy Roche Dr  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.96  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/27/2019  
**UTM (m)** N 5,534,126  
 E 626,254

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL	PL	MC	LL
240	1			<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.											
239.4	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.											
239.0	2			<b>SILT TILL (ML)</b> - Tan, damp, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.											
238.1	3	10		<b>END OF TEST HOLE AT 2.9 m</b>											
238				Notes: 1. TH19-22 open to 2.7 m below grade after the completion of drilling. 2. Water observed at 0.9 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
237	4														
236	5	15													
235	6	20													
234	7														
233	8	25													
232	9	30													
231	10														
230	11	35													
229	12	40													
228															

SAMPLE TYPE Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**APPROVED** JRM  
**DATE** 12/16/19

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Inkster Boulevard  
**LOCATION** 105 m East of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.73  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/27/2019  
**UTM (m)** N 5,534,133  
 E 626,546

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
238.1				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.										
238	1	5		<b>CLAY FILL</b> - Mottled black to grey, damp, firm, intermediate plasticity, some organics, some fine to coarse grained sand, some fine to coarse grained gravel.	S1									
237	2			- Moist below 2.1 m.										
236.1				<b>SILT TILL (ML)</b> - Tan, damp, compact, some fine to coarse grained sand, some fine to coarse grained gravel.	S2									175 ★
236	3	10												
235	4				S3									
234	5	15		- 100 mm sand seam observed at 4.7 m.										225 ★
233	6	20		- Dense below 5.2 m.	S4									225 ★
232	7													
231	8	25												
230	9	30		- Very dense below 8.5 m.	S5									225 ★
229	10				S6									
228	11	35												
227	12	40												
226														
225.8														

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **12/16/19**



ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆				
	(m)	(ft)							PL	MC	LL					
225.5				LIMESTONE - White, weak.		S7										
				END OF TEST HOLE AT 13.2 m												
				Notes: 1. TH19-23 open to 11.2 m below grade after the completion of drilling. 2. Water observed at 6.0 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.												
225		45														
	14															
224																
	15															
		50														
223																
	16															
		55														
222																
	17															
		60														
221																
	18															
		65														
220																
	19															
		70														
219																
	20															
		75														
218																
	21															
		80														
217																
	22															
		85														
216																
	23															
		90														
215																
	24															
		95														
214																
	25															
		100														
213																
	26															
		105														
212																
	27															
		110														
211																
	28															

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR  
**Paddock Drilling Ltd.**

 INSPECTOR  
**M. SAALY**

 APPROVED  
**JRM**

 DATE  
 12/16/19

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Inkster Boulevard  
**LOCATION** 310 m East of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 237.41  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/28/2019  
**UTM (m)** N 5,534,137  
 E 626,755

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL	PL	MC	LL
237				<b>GRANULAR FILL</b> -Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.											
236.6		1		<b>CLAY FILL</b> -Grey, moist, stiff, high plasticity, trace rootlets.		S1									
236.6		5		<b>CLAY (CH)</b> - Mottled brown to grey, moist, stiff, high plasticity, trace silt nodules, trace coarse grained sand, trace fine grained gravel.		S2									
235		2				S3									
235		3				S4									
234		10		- Trace silt nodules below 3.0 m.											
234		4				S5									
233		15		- Cobbles encountered at 4.2 m.											
232		5				S6									
231.2		6		- Firm below 5.8 m. - Cobbles encountered at 6.0 m.		S7									
231		20		<b>SILT TILL (ML)</b> - Tan, moist, dense to very dense, some to with coarse grained gravel, trace to some fine grained gravel, some fine to coarse grained sand, trace clay.		S8									
230		25				S9									
229		9				S10									
228		30		- Moist to wet below 9.1 m.											
228		10		- Cobbles encountered at 9.7 m. - 600 mm layer of sand till at 9.7 m.		S11									
227		35		- Red to brown below 10.3 m.		S12									
226		11				S13									
226		12				S14									
225		40				S15									
224.5															

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. Alfaro**

 APPROVED **JRM**

 DATE **12/16/19**

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Inkster Boulevard  
**LOCATION** 445 m East of Roy Roche Dr, South Shoulder of Park Royale Way  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 236.66  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 9/28/2019  
**UTM (m)** N 5,534,142  
 E 626,887

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL	PL	MC	LL
236.5				<b>TOP SOIL</b> - Black, damp, compact.											
236.0				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.											
235.1	1	3		<b>CLAY FILL</b> - Mottled grey to black, moist, firm to stiff, intermediate plasticity, trace coarse grained gravel, some to with fine to coarse grained gravel. - High plasticity, no gravel below 1.2 m.	S1										
235				<b>CLAY (CH)</b> - Mottled brown to grey, moist, stiff, high plasticity, some to with silt nodules, trace oxidation, trace coarse grained sand, trace fine grained gravel.	S2										
234	2	6			S3										
233				- Firm below 3.3 m.	S4										
232	3	10			S5										
231.8				<b>SILT TILL (ML)</b> - Tan, moist, compact, trace fine grained gravel, trace coarse grained sand, trace to some fine grained sand.	S6										
231	5	15			S7										
230				- Trace cobbles below 6.0 m.	S8										
229	6	20			S9										
228				- Trace to some fine grained gravel, no cobbles below 7.3 m.	S10										
227.2	8	25													
227.1				- Damp to dry, very dense below 8.0 m.											
227	9	30													
227				- Cobbles encountered at 9.1 m.											
227				<b>LIMESTONE</b> White, weak.											
226	10	35		<b>END OF TEST HOLE AT 9.6 m</b>											
225				Notes: 1. TH19-25 open to 8.8 m below grade after the completion of drilling. 2. Water observed at 8.7 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cutting											
224	12	40													

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. Alfaro**

 APPROVED **JRM**

 DATE **12/16/19**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Murray Park Road  
**LOCATION** 235 m West of Moray Street, North Shoulder of Murray Park Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 237.78 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/3/2020  
**UTM (m)** N 5,528,369  
 E 624,632

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)								PL	MC	LL			
237.5				<b>ASPHALT</b>											
237.4				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	S1										
237	1			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity.	S2										
236	5			- Trace silt nodules below 1.5 m.	S3										
235	2														
234	3			- Trace coarse grained gravel, some silt pockets below 3.0 m. - 200 mm silt seam observed at 3.3 m.											
233.5	4				S4										
233	5			<b>SILT TILL (ML)</b> - Tan, damp, compact, trace fine to coarse grained gravel, trace coarse grained sand. - Trace cobbles below 4.5 m.	S5										
232	6			- With coarse grained gravel below 6.0 m.											
231	7				S6										
230.2	8			<b>JURASSIC LIMESTONE</b> - Red, weak.	S7										
229.9	8			<b>END OF TEST HOLE AT 7.9 m</b>											
229	9			Notes: 1. TH20-01 open to 7.1 m below grade after the completion of drilling. 2. Water observed at 4.2 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
228	10														
227	11														
226	12														
225															

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **3/9/20**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Murray Park Road  
**LOCATION** 500 m West of Moray Street, North Shoulder of Murray Park Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 238.62 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/3/2020  
**UTM (m)** N 5,528,377  
 E 624,389

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
238.3				<b>ASPHALT</b>										
238.0				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, trace fine to coarse grained gravel, some organics.										
238	1	3		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity. - Trace coarse grained gravel below 0.7 m.										
237	5	16		- Trace silt nodules below 1.5 m.	S1									
236	2	33		- Some silt nodules below 2.1 m.	S2									
235	3	50			S3									
234.4	4	67			S4									
234	5	84		<b>SILT TILL (ML)</b> - Tan, damp, dense, trace fine to coarse grained sand, with fine to coarse grained gravel.										
233	6	101												
232	7	118		- Very dense below 6.4 m.	S5									
231.2	8	135			S6									
230.8	8	135		<b>JURASSIC LIMESTONE</b> - Red, weak.										
230	9	152		<b>END OF TEST HOLE AT 7.7 m</b>										
229	10	169		Notes: 1. TH20-02 open to 7.7 m below grade after the completion of drilling. 2. Water observed at 6.4 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
228	11	186												
227	12	203												
226														

SAMPLE TYPE  Sonic Barrel

CONTRACTOR **Paddock Drilling Ltd.**

INSPECTOR **M. SAALY**

APPROVED **JRM**

DATE **3/9/20**

GEO-TECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Murray Park Road  
**LOCATION** 320 m East of Sturgeon Road, North Shoulder of Murray Park Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.09 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/3/2020  
**UTM (m)** N 5,528,390  
 E 624,024

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
240				<b>ASPHALT</b>										
239.8				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1									
239.6					S2									
239.3				<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, with organics, trace rootlets.	S3									
239				<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.										
238														
237.8				<b>SILT TILL (ML)</b> - Tan, damp, dense, trace fine to coarse grained sand, with fine to coarse grained gravel, trace cobbles.	S4									150
237.3														
237.0				<b>LIMESTONE</b> - White, weak.	S5									
237				<b>END OF TEST HOLE AT 3.0 m</b>										
				Notes: 1. TH20-03 open and dry after the completion of drilling. 2. Backfilled with bentonite chips and auger cuttings.										
236														
235														
234														
233														
232														
231														
230														
229														
228														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 M. SAALY

**APPROVED**  
 JRM

**DATE**  
 3/9/20

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Murray Park Road  
**LOCATION** 40 m East of Sturgeon Road, North Shoulder of Murray Park Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.95 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/3/2020  
**UTM (m)** N 5,528,382  
 E 623,724

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.6			ASPHALT											
239	1	3.3	GRANULAR FILL	GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1									
238.7			SILT TILL (ML)	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel. - Boulder encountered at 1.5 m.	S2									
238	2	6.6	SILT TILL (ML)	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel. - Very dense below 2.4 m.	S3									225 ★
237	3	9.9	SILT TILL (ML)	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel. - Boulder was observed at 3.2 m. - Trace cobbles below 3.2 m.	S4									225 ★
236	4	13.1	SILT TILL (ML)	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel. - Some cobbles below 4.1 m.	S5									225 ★
235	5	16.4	SILT TILL (ML)	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel. - Some cobbles below 4.1 m.	S6									225 ★
234.5			JURASSIC LIMESTONE	JURASSIC LIMESTONE - Red, weak.	S7									
234	6	19.7		END OF TEST HOLE AT 5.8 m										
233	7	23.0		Notes: 1. TH20-04 open to 5.8 m below grade after the completion of drilling. 2. Water observed at 3.6 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
232	8	26.2												
231	9	29.5												
230	10	32.8												
229	11	36.1												
228	12	39.4												
227														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM

**DATE** 3/9/20



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 220 m North of Murray Park Road, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.76 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/4/2020  
**UTM (m)** N 5,528,600  
 E 623,708

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.3			[Cross-hatched pattern]	<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1									
239	1			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, trace fine to coarse grained gravel, with organics.										
238.7		5	[Diagonal hatched pattern]	<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity. - Trace silt nodules below 1.5 m.	S2									
238	2				S3									
237	3	10			S4									
236.3				<b>SILT TILL (ML)</b> - Tan, damp, dense, with fine to coarse grained gravel, trace cobbles, trace fine to coarse grained sand. - Very dense below 4.4 m. - Pink below 4.5 m.	S5									
236	4	15	[Diagonal hatched pattern]		S6									
235	5				S7									
234	6	20			S8									
233	7	25	[Diagonal hatched pattern]											
232	8													
231.2			[Horizontal hatched pattern]	<b>JURASSIC LIMESTONE</b> - Red, weak.										
231	9	30												
230.6				<b>END OF TEST HOLE AT 9.1 m</b>										
230	10			Notes: 1. TH20-05 open to 8.0 m below grade after the completion of drilling. 2. Water observed at 5.1 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
229	11	35												
228	12	40												
227														

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **3/9/20**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 170 m South of Saskatchewan Avenue Avenue, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.98 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/4/2020  
**UTM (m)** N 5,528,941  
 E 623,734

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239	1		[Cross-hatched pattern]	<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, trace coarse grained gravel, some organics, trace rootlets.										
238.8	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace fine grained gravel.	S1									
238	2		[Diagonal line pattern]	<b>SILT TILL (ML)</b> - Tan, damp, compact to dense, some fine to coarse grained gravel.	S2									
237.7	3	10		- Some cobbles below 3.0 m.	S3									
237	4		[Diagonal line pattern]	- Dense below 4.0 m.	S4									
236	5	15		- Red below 7.3 m.	S5									
235	6	20	[Diagonal line pattern]	- Very dense below 7.6 m.	S6									
234	7	25												
233	8	30	[Horizontal line pattern]	<b>LIMESTONE</b> - White, weak.										
231.1	9		<b>END OF TEST HOLE AT 9.1 m</b>											
230.8	10		Notes: 1. TH20-06 open to 9.1 m below grade after the completion of drilling. 2. Water observed at 7.0 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
230	11	35												
229	12	40												
228														
227														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 M. SAALY

**APPROVED**  
 JRM

**DATE**  
 3/9/20

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 100 m North of Saskatchewan Avenue Avenue, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.62 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/4/2020  
**UTM (m)** N 5,529,234  
 E 623,750

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆			
	(m)	(ft)							PL	MC	LL				
240	1			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, some organics, trace rootlets.											
239.4	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S1										
239	2			- Trace coarse grained gravel below 2.1 m.	S2										
238.9	3			<b>SILT TILL (ML)</b> - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles.	S3										
237	10				S4										
236.7	4			<b>LIMESTONE</b> - White, weak.	S5										
236.4	4			<b>END OF TEST HOLE AT 4.2 m</b>											
236	15														
235	5			Notes: 1. TH20-07 open to 4.2 m below grade after the completion of drilling. 2. Water observed at 2.7 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cutting											
235	6														
234	20														
233	7														
233	25														
232	8														
232	9														
231	30														
230	10														
230	35														
229	11														
228	40														

SAMPLE TYPE Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **3/9/20**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Sturgeon Road  
**LOCATION** 430 m North of Saskatchewan Avenue, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 240.58 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/5/2020  
**UTM (m)** N 5,529,567  
 E 623,701

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆			
	(m)	(ft)							PL	MC	LL	PL	MC	LL	
240	1		[Cross-hatched pattern]	<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1	100	10	10							
239	5														
238	2		[Diagonal hatched pattern]	<b>CLAY (CH)</b> - Brown, damp, stiff, high plasticity, trace silt nodules. - Some silt nodules below 3.0 m.	S2	100	10	10							
237	10														
236.3	4		[Diagonal hatched pattern]	<b>SILT TILL (ML)</b> - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles. - Boulder encountered at 4.8 m.	S3	100	10	10							
236	15														
235	5		[Diagonal hatched pattern]	<b>LIMESTONE</b> - White, weak.	S4	100	10	10							
234.3	20														
234.2	6			<b>END OF TEST HOLE AT 6.4 m</b>	S5	100	10	10							
234	7			Notes: 1. TH20-08 open to 5.8 m below grade after the completion of drilling. 2. Water observed at 3.9 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
233	25														
232	8														
231	9														
230	10														
229	11														
228	12														

SAMPLE TYPE [Symbol] Sonic Barrel

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR M. SAALY

APPROVED JRM

DATE 3/9/20

GEOTECHNICAL-SOIL LOG U:\FMS\19-0107-009\19-0107-009.GPJ

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Sturgeon Road  
**LOCATION** 240 m Southeast of Summit Road, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.94 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/5/2020  
**UTM (m)** N 5,529,743  
 E 623,535

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.6			ASPHALT											
239	1		GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, with crushed limestone.		S1									
238	2		GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, with crushed limestone.		S2									
237.2			GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, with crushed limestone.											
237	3	10	CLAY (CH) - Brown, damp, stiff, high plasticity, trace silt nodules.		S3									
236.0	4	15	SILT TILL (ML) - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles.		S4									
234.5			LIMESTONE - White, weak.		S5									
234	6	20	END OF TEST HOLE AT 5.8 m											
233	7	25	Notes: 1. TH20-09 open to 5.8 m below grade after the completion of drilling. 2. Water observed at 3.9 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.											
232	8	30												
231	9	35												
230	10	40												
229	11													
228	12													
227														

SAMPLE TYPE Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **3/9/20**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing  
**SITE** Preliminary Engineering  
 Sturgeon Road  
**LOCATION** 70 m Southeast of Summit Road, East Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.80 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/6/2020  
**UTM (m)** N 5,529,859  
 E 623,401

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.5				<b>ASPHALT</b>										
239	1	3.3		<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1									
238.7	5	10.0		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S2									
238														
237														
236.8	3	10.0		<b>SILT TILL (ML)</b> - Tan, damp, dense, with fine to coarse grained gravel, trace fine to coarse grained sand, trace cobbles.	S3									
236	4	13.3												
235	5	16.7												
234.5														
234.3				<b>LIMESTONE</b> - White, weak.										
234	6	20.0		<b>END OF TEST HOLE AT 5.4 m</b>										
233	7	23.3		Notes: 1. TH20-10 open to 3.9 m below grade after the completion of drilling. 2. Water observed at 3.3 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
232	8	26.7												
231	9	30.0												
230	10	33.3												
229	11	36.7												
228	12	40.0												
227														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY  
**APPROVED** JRM  
**DATE** 3/9/20



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Summit Road  
**LOCATION** 350 m Southeast of Centreport Canada Way, East Shoulder of Summit Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.67 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/5/2020  
**UTM (m)** N 5,530,038  
 E 623,085

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.1				<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.										
239	1			<b>CLAY FILL</b> - Mottled black to grey, damp, stiff, low plasticity, trace rootlets, some organics.										
238.1	5			<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity.	S1									
238	2													
237.2				<b>SILT TILL (ML)</b> - Tan, damp, dense, with fine to coarse grained gravel, trace fine to coarse grained sand.										
237	3	10			S2									
236	4													
235	5	15			S3									
234	6	20												
233	7			- Trace cobbles below 6.0 m.	S4									
				- Boulder encountered at 6.7 m.	S5									
232	8	25			S6									
231	9	30			S7									
230														
229.6	10			<b>JURASSIC LIMESTONE</b> - Red, weak.	S8									
229.3				<b>END OF TEST HOLE AT 10.3 m</b>										
229	11	35		Notes: 1. TH20-11 open to 10.3 m below grade after the completion of drilling. 2. Water observed at 4.8 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
228	12	40												
227														

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

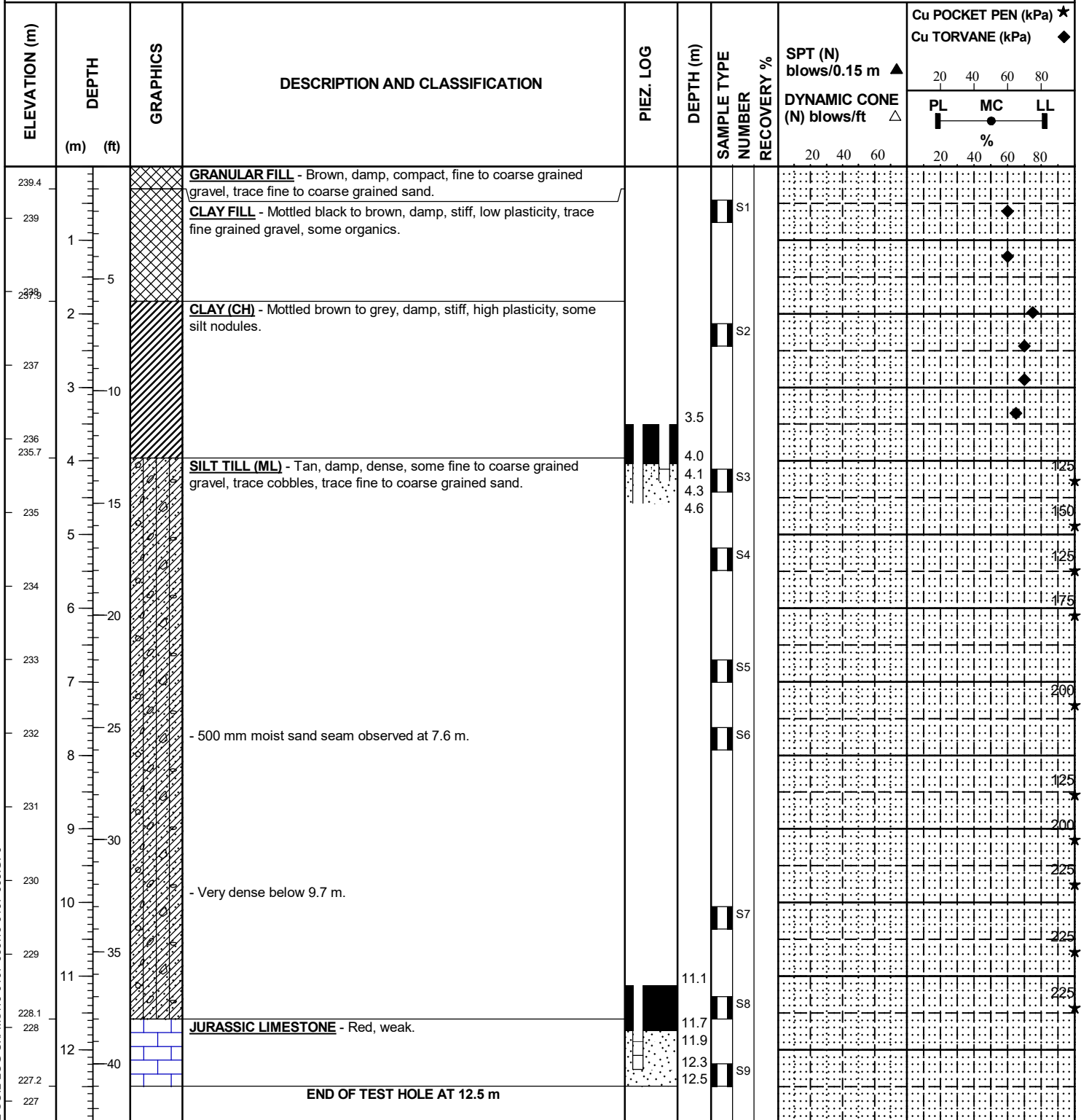
**APPROVED** JRM  
**DATE** 3/9/20

**APPROVED** JRM  
**DATE** 3/9/20

**APPROVED** JRM  
**DATE** 3/9/20

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Summit Road  
**LOCATION** 50 m Southeast of Cebtreport Canada Way, North Shoulder of Summit Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.70 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/6/2020  
**UTM (m)** N 5,530,153  
 E 622,811



SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 3/9/20

**APPROVED** JRM  
**DATE** 3/9/20

**APPROVED** JRM  
**DATE** 3/9/20



ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆			
	(m)	(ft)										20	40	60	80	20	40	60
226	14	45		Notes: 1. TH20-12 open to 12.5 m below grade after the completion of drilling. 2. Water observed at 2.9 m below grade after the completion of drilling. 3. Installed two 25.4 mm diameter PVC standpipes with 0.3 m casagrande tip installed 4.3 m and 11.8 m below grade.														
225	15	50																
224	16	55																
223	17	60																
222	18	65																
221	19	70																
220	20	75																
219	21	80																
218	22	85																
217	23	90																
216	24	95																
215	25	100																
214	26	105																
213	27	110																
212	28	115																

 SAMPLE TYPE  Sonic Barrel

 CONTRACTOR **Paddock Drilling Ltd.**

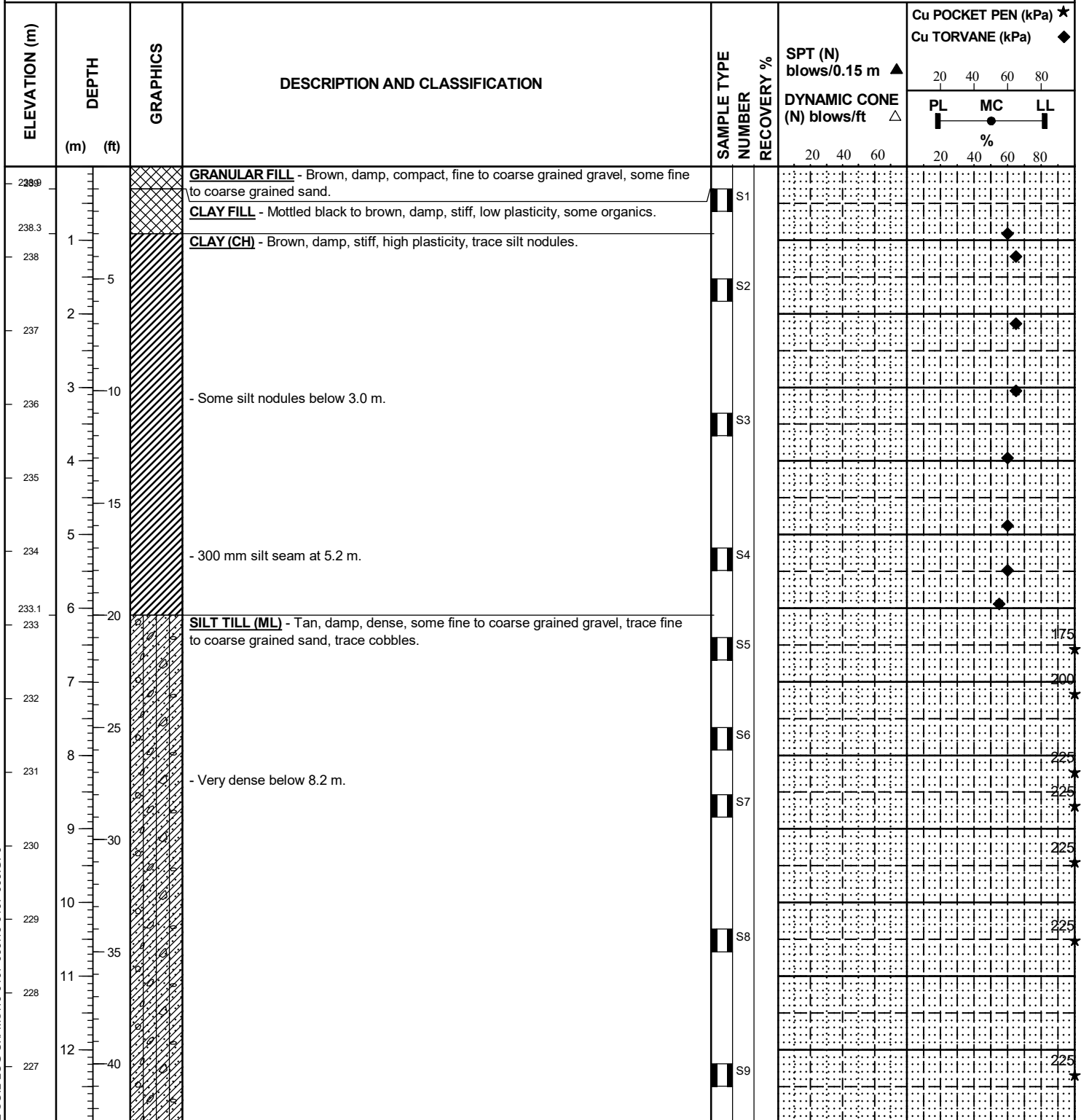
 INSPECTOR **M. SAALY**

 APPROVED **JRM**

 DATE **3/9/20**

**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Summit Road  
**LOCATION** 600 m Southwest of Sturgeon Road, North Shoulder of Summit Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.23 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/5/2020  
**UTM (m)** N 5,529,862  
 E 622,451



SAMPLE TYPE  Sonic Barrel

**CONTRACTOR**  
 Paddock Drilling Ltd.

**INSPECTOR**  
 M. SAALY

**APPROVED**  
 JRM

**DATE**  
 3/9/20



**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT** Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering  
**SITE** Sturgeon Road  
**LOCATION** 250 m Northeast of Sturgeon Access, South Shoulder of Sturgeon Road  
**DRILLING METHOD** Sonic SDC 450, Track Drill Rig

**JOB NO.** 19-0107-009  
**GROUND ELEV.** 239.37 m  
**TOP OF PVC ELEV.**  
**WATER ELEV.**  
**DATE DRILLED** 2/6/2020  
**UTM (m)** N 5,530,124  
 E 623,582

ELEVATION (m)	DEPTH		GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲	DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★			Cu TORVANE (kPa) ◆		
	(m)	(ft)							PL	MC	LL	PL	MC	LL
239.2				<b>TOPSOIL</b>										
239	1	3.3		<b>GRANULAR FILL</b> - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1									
238.8	5	16.7		<b>CLAY (CH)</b> - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S2									
237	2	6.6		<b>SILT TILL (ML)</b> - Tan, damp, dense, trace fine to coarse grained gravel, trace fine to coarse grained sand.										
236.6	3	10.0		- Trace cobbles below 3.3 m.	S3									
236	4	13.3												
235	5	16.7			S4									
234	6	20.0												
233	7	23.3			S5									
232	8	26.7			S6									
231	9	30.0			S7									
230.4				<b>JURRASIC LIMESTONE</b> - Red, weak.										
230.1				<b>END OF TEST HOLE AT 9.3 m</b>										
230				Notes: 1. TH20-14 open to 8.8 m below grade after the completion of drilling. 2. Water observed at 6.0 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.										
229	10	33.0												
228	11	36.3												
227	12	39.6												

SAMPLE TYPE  Sonic Barrel

**CONTRACTOR** Paddock Drilling Ltd.  
**INSPECTOR** M. SAALY

**APPROVED** JRM  
**DATE** 3/9/20

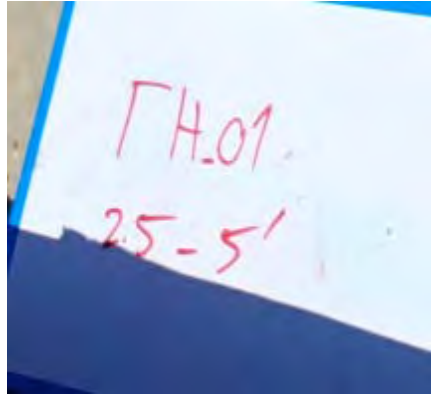
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**DATE** 3/9/20

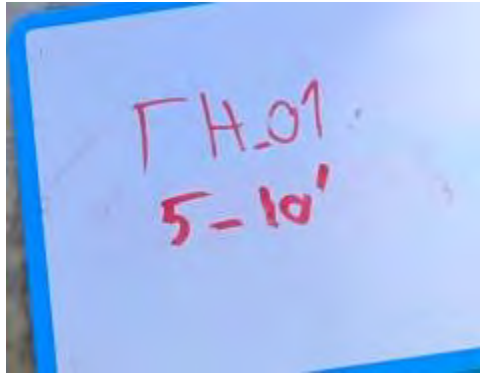
**APPROVED** JRM  
**DATE** 3/9/20

## TH19-01



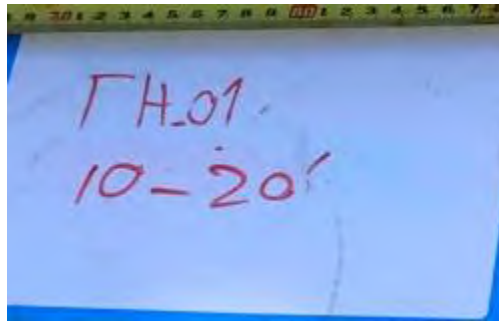
















ГН01  
20-25





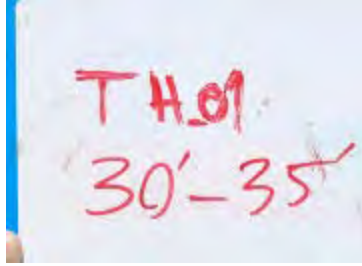


T H.01  
25' - 30'



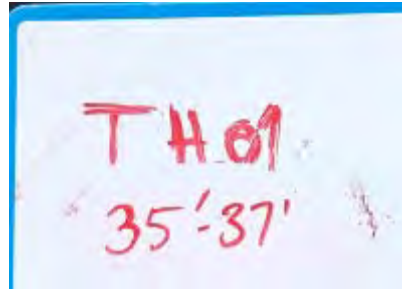














TH-01  
37'-40'



TH-01  
40'-45'



TH-01  
45'-48'



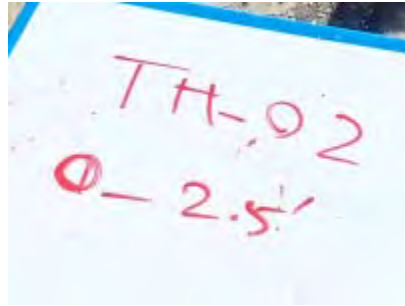


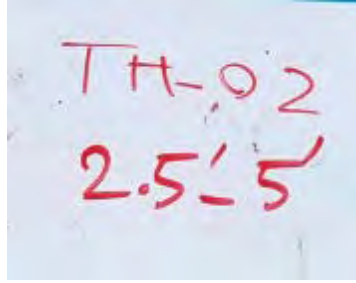
TH-01  
45'-48'



## TH19-02





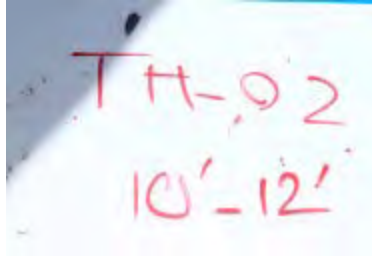


TH-02  
5'-10"











TH-02  
12-20'



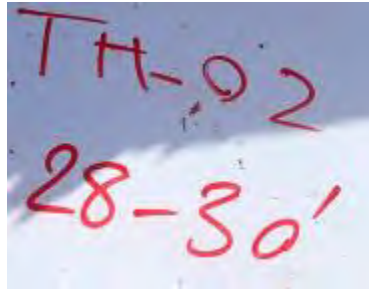
TH-02  
12-20'





TH-02  
25'-27'







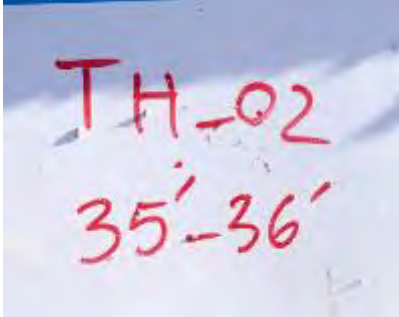
TH-02  
30'-33'



TH-02  
33'-35'







TH-02  
36'-38'





TH-02  
38'-45'



TH-02  
38'-45'



## TH19-03



TH-03  
0-4'



TH 03  
4-10'



TH-03  
10-20'





TH-03  
10-20'

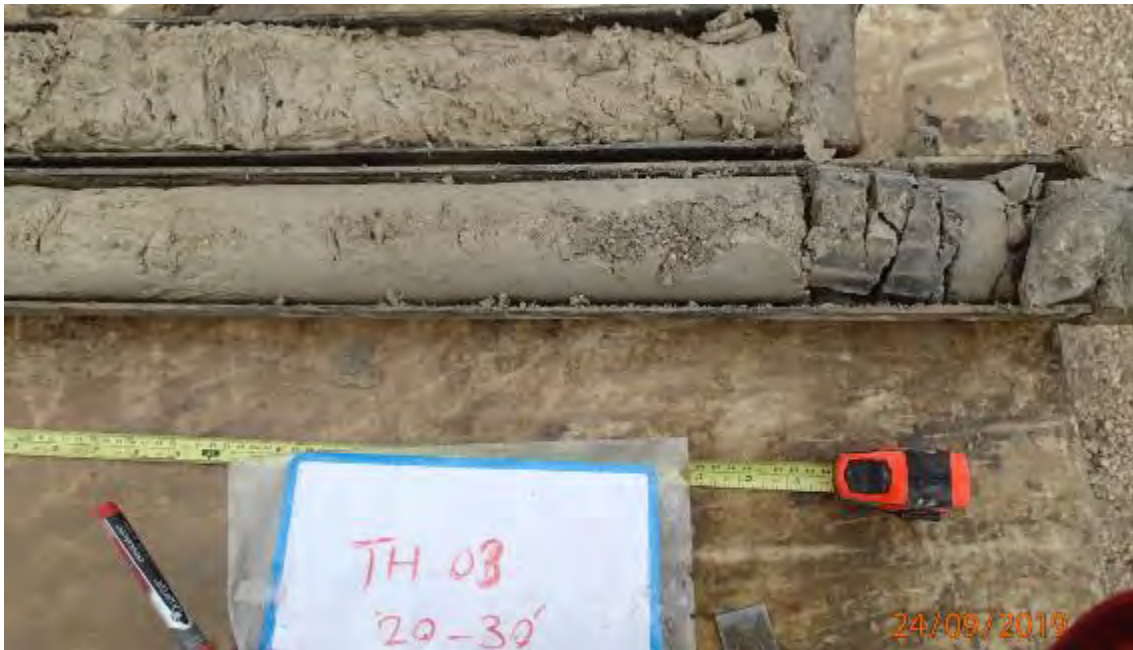


TH-03  
20-30'





TH-03  
20-30'







TH-03  
30-31.5'



**TH19-04**



TH-04  
0-2.5'



TH-04<sup>3</sup>  
2.5-5'



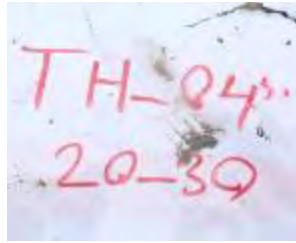




TH-04<sup>s</sup>  
5-10'

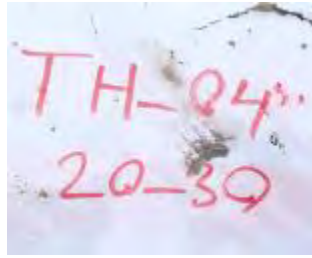














TH-043.  
33.5-35'



TH-043.  
33.5-35'

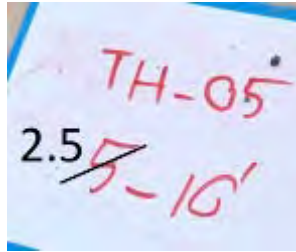


## TH19-05



TH-05  
0-2.5'



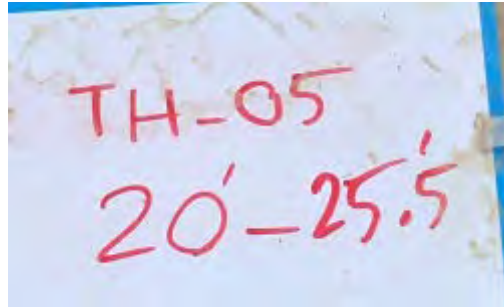


TH-05  
10-20'











TH-05  
20'-25.5'



## TH19-06

TH-06  
0-2.5'





TH-06  
2.5'-5'



TH-06  
5-10'





TH-06  
5-10'



TH-06  
10'-20'







TH-06  
20-30'







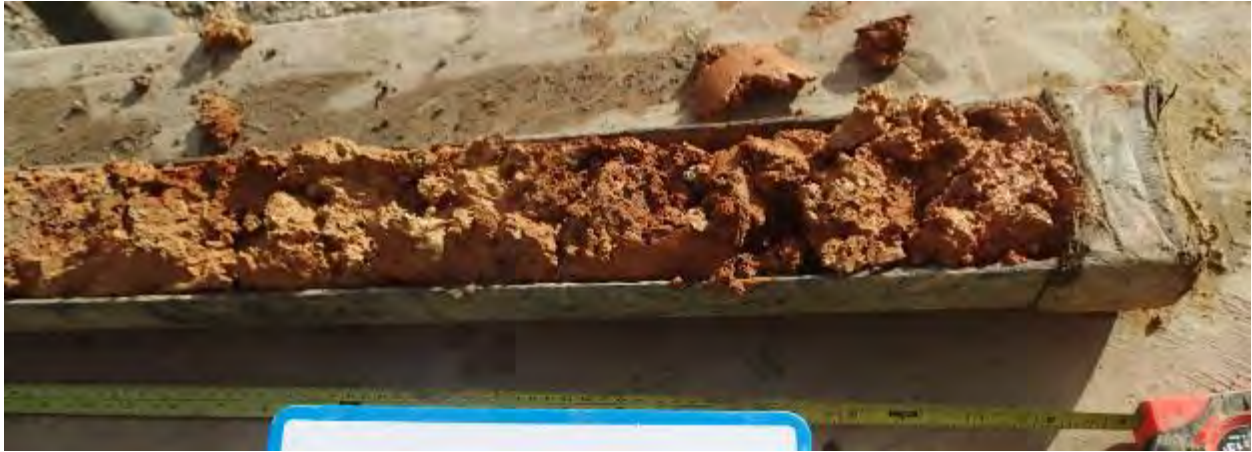


TH-06  
30-35





TH-06  
30-35



## TH19-07



TH-07  
0-5'





TH-07  
5'-14.5'



TH-07  
10-14.5'







TH-07  
14.5'-15.5'



**TH19-08**



TH-08  
0-2.5'



TH-08  
25-5'





TH-08  
5-10'



TH-08  
10-15'



## TH19-09



TH-09  
0-2.5'



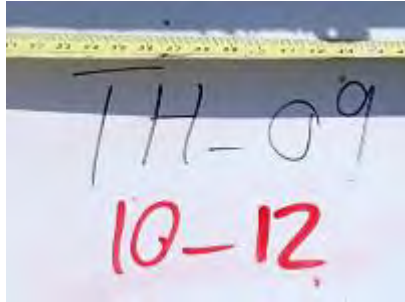
TH-09  
2.5-5



TH-09  
5-10'



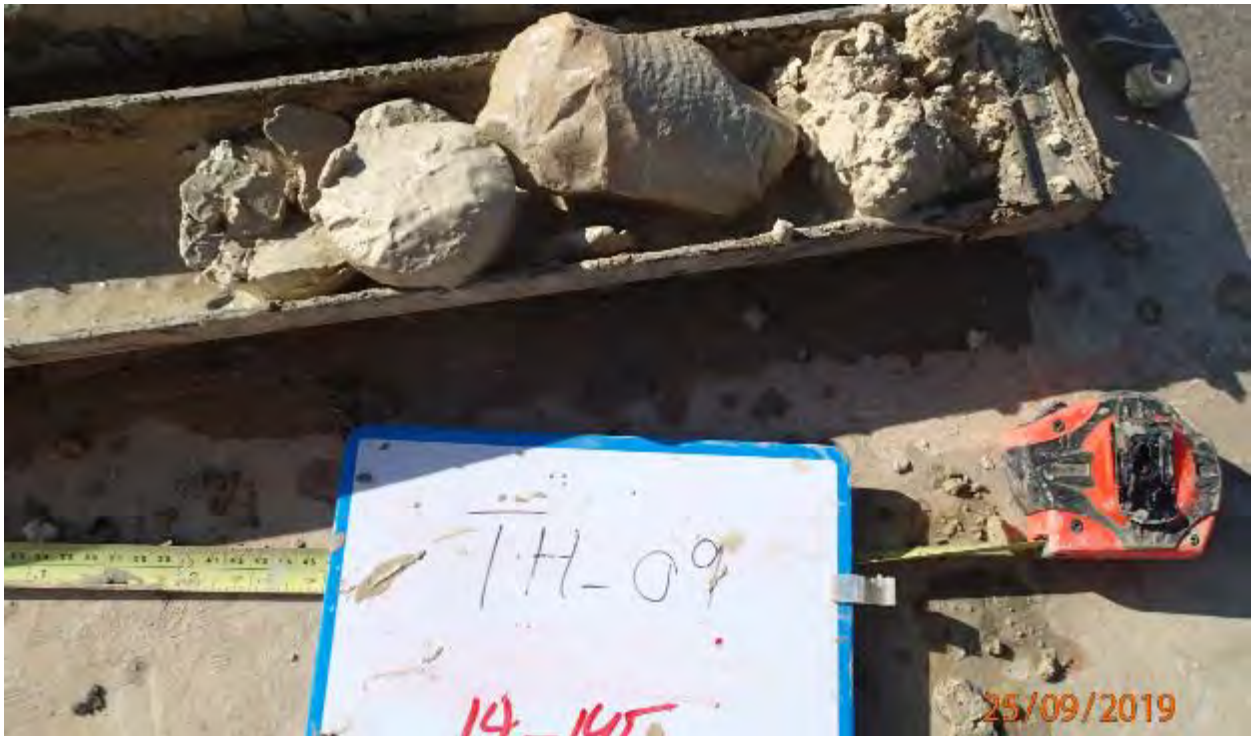
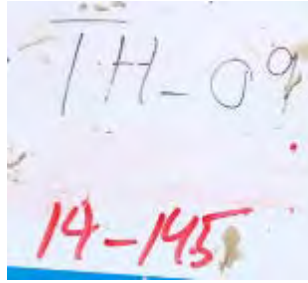




TH-09  
12-14







**TH19-10**

TH-10  
0-2.5'





TH-10  
2.5-5'



TH-10  
5-10'





TH-10  
10-15'



TH-10  
10-15'





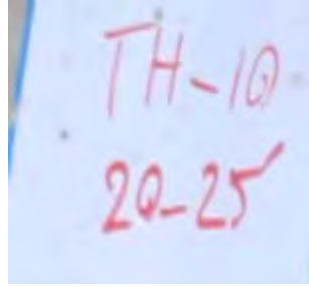


TH-10  
15-20'







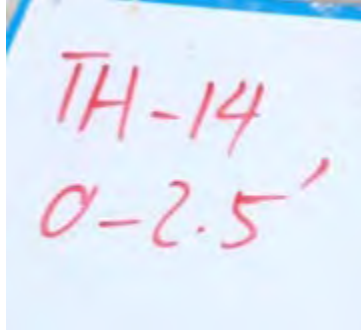


TH-10  
25-26



**TH19-14**





TH-14  
2.5-5





TH-14  
5-10'



TH-14  
10'-20'



TH-14  
20-28





TH-14  
20-28



TH-14  
20-28





TH-14  
28-30





**TH19-15**



TH-14~~15~~  
2.5-5'



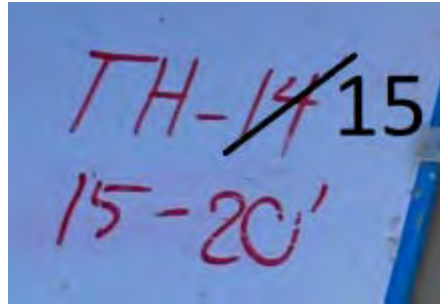


TH-14~~15~~  
5-10'



TH-14  
~~10-15~~ 15







TH-14~~15~~ 15  
15-20'





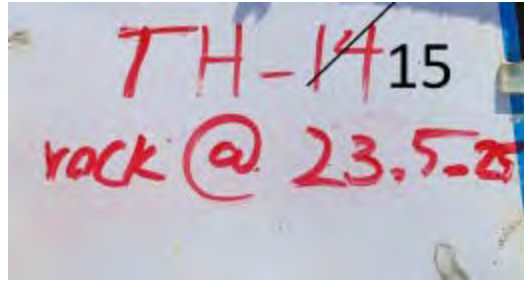
TH-14<sup>15</sup>  
20-23.5'



TH-14~~15~~  
20-23.5'







TH-14~~15~~  
25-28





TH-14~~15~~  
25-28



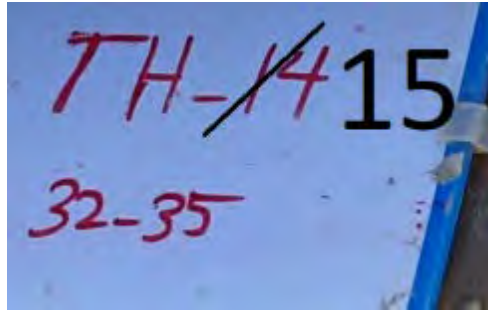
TH-1415  
28-32



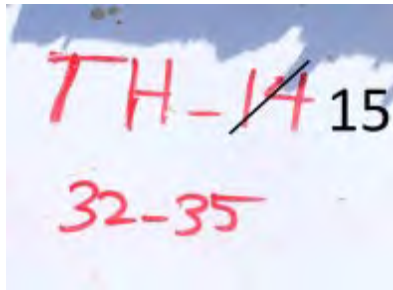


TH-1415  
28-32









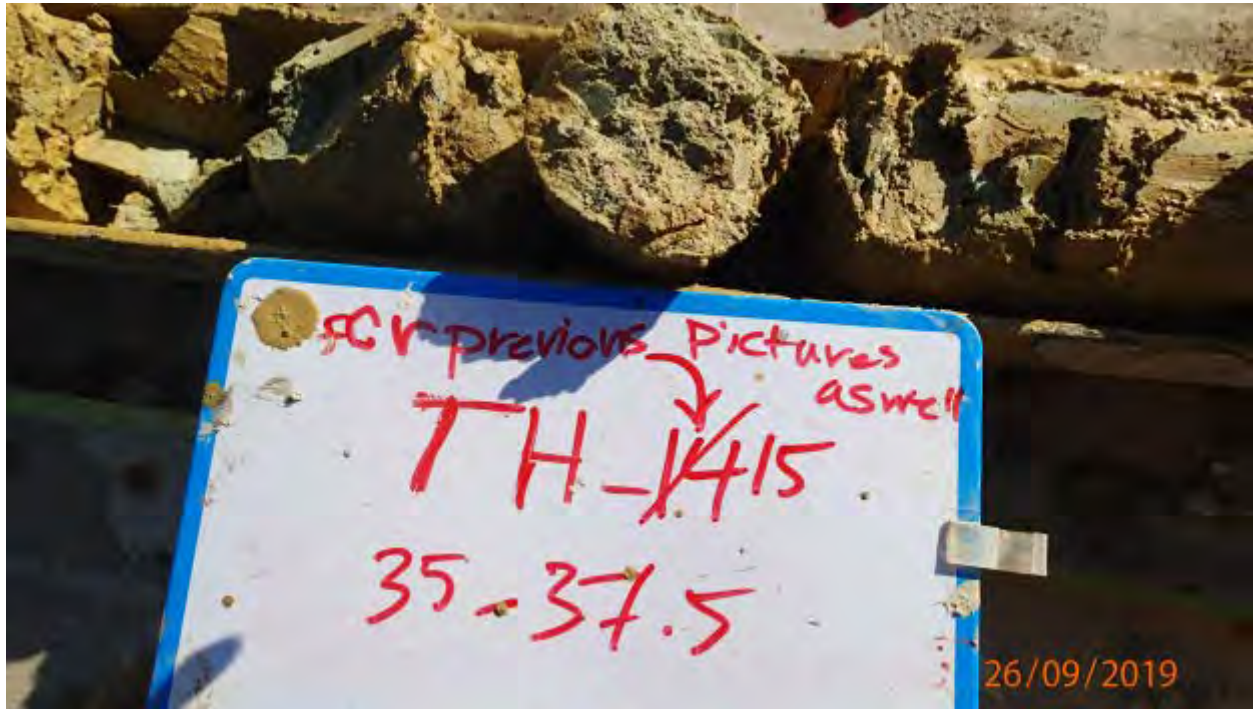




SCR previous Pictures as well  
TH-1415  
35-37.5



SCR previous Pictures as well  
TH-1415  
35-37.5

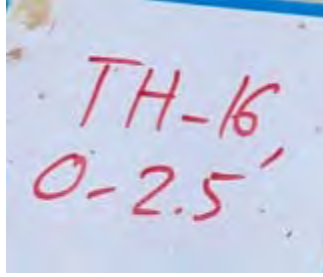


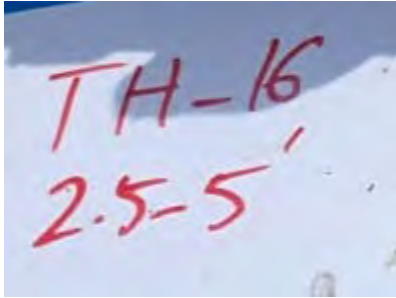


SCR previous pictures  
as well  
T.H.-1415  
37.5-39



**TH19-16**









TH-16  
10-20'







TH-16  
20-25'







TH-16  
25-29











TH-16  
29-30



## TH19-17

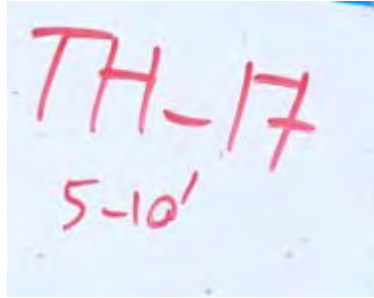
TH-17  
0-2.5'

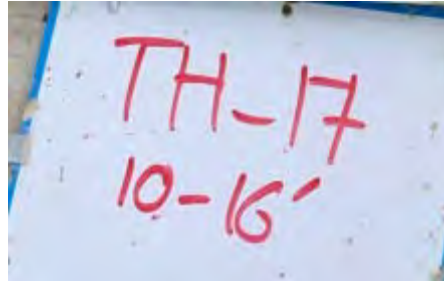


TH-17  
2.5-5'









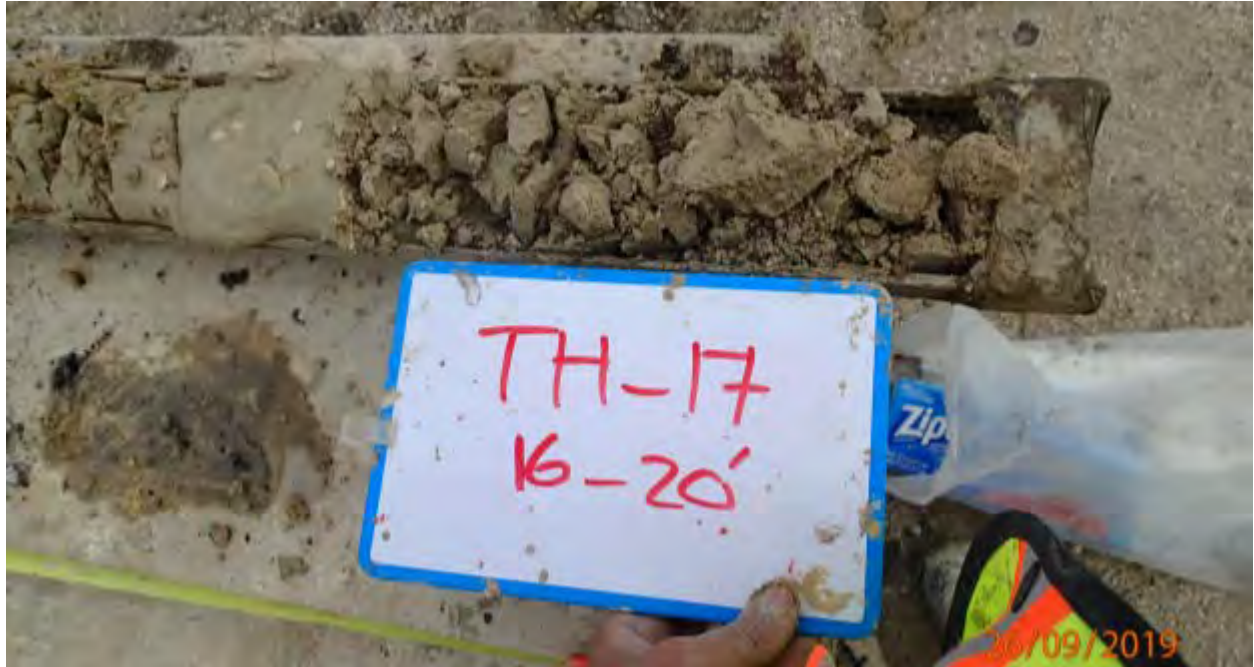
TH-17  
16-20'











TH-17  
20-23



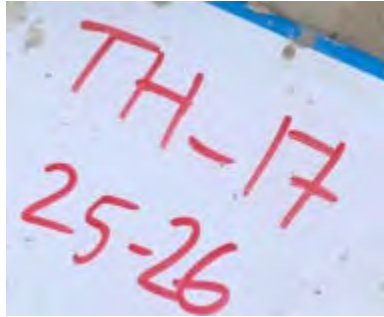




TH-17  
23-25







## TH19-18

TH-18  
0-5



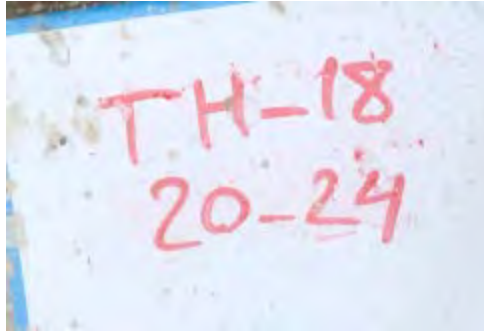
TH-18  
5-10



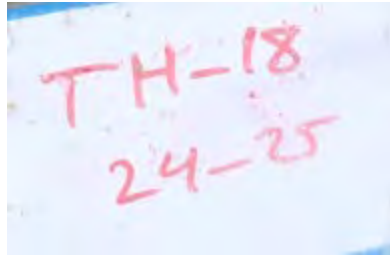


TH-18  
10-29



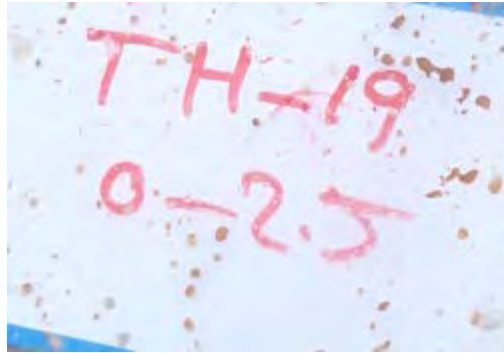


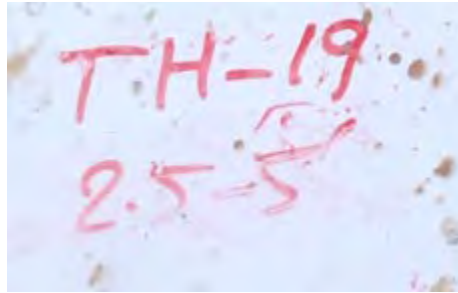


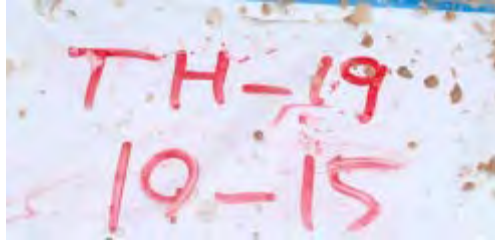


## TH19-19

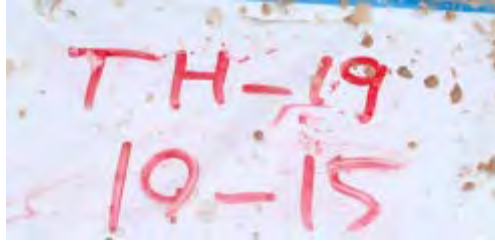














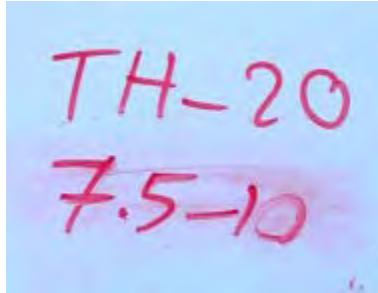
**TH19-20**

TH-20  
0-2.5



TH-20  
2.5-5







TH-20  
10-18



TH-20  
10-18



TH-20  
10-18

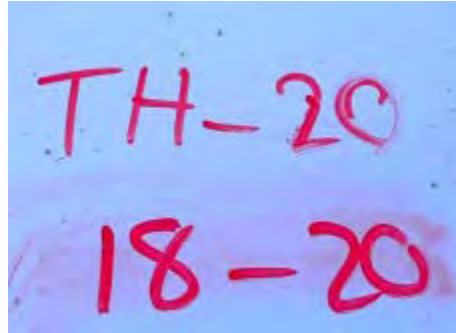




TH-20  
18-20



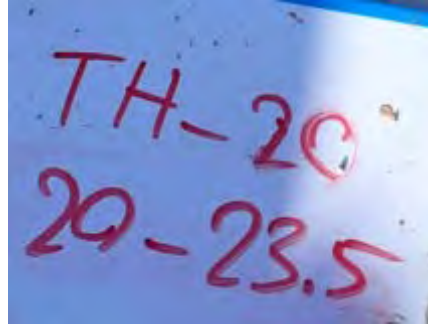




TH-20  
20-23.5



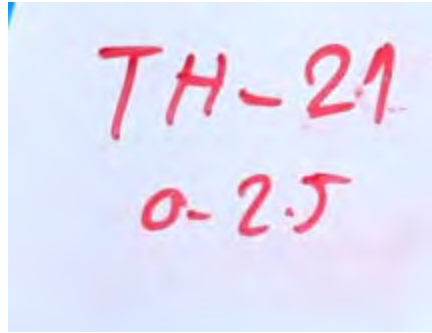








**TH19-21**



TH-21  
2.5-5'



TH-21  
10-14'





TH-21  
10-14'







TH-21  
14-18



TH-21  
18-18.5



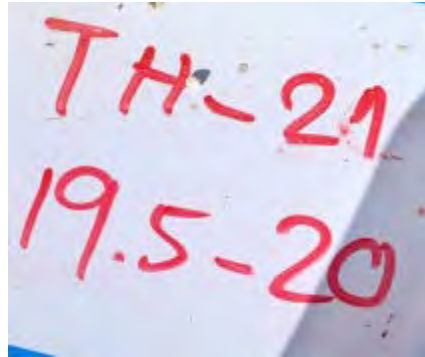


TH-21  
18.5-19



TH-21  
19-19.5







TH-21  
20-21.5







TH-21  
21.5-25





TH-21  
21.5-25



TH-21  
21.5-25







TH-21  
25-30





TH-21  
25-30



TH-21  
25-30





TH-2A  
30-35



TH-2A  
30-35





TH-2A  
35-37.5



**TH19-22**



TH-22  
0-2.5



TH-22  
5-9







TH-22  
9-9.5





**TH19-23**

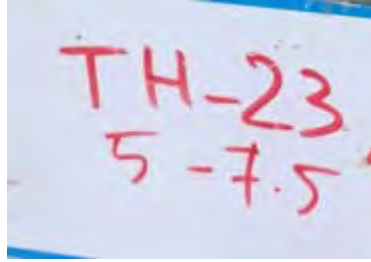
TH-23  
0-2.5'



TH-23  
2.5-5'









TH-23  
7.5-10'



TH-23,  
10-14.5'





TH-23,  
10-14.5'



TH-23,  
10-14.5





TH-23  
14.5-16.5



TH-23  
14.5-16.5'



TH-23,  
14.5-16.5'





TH-23,  
14.5-16.5'

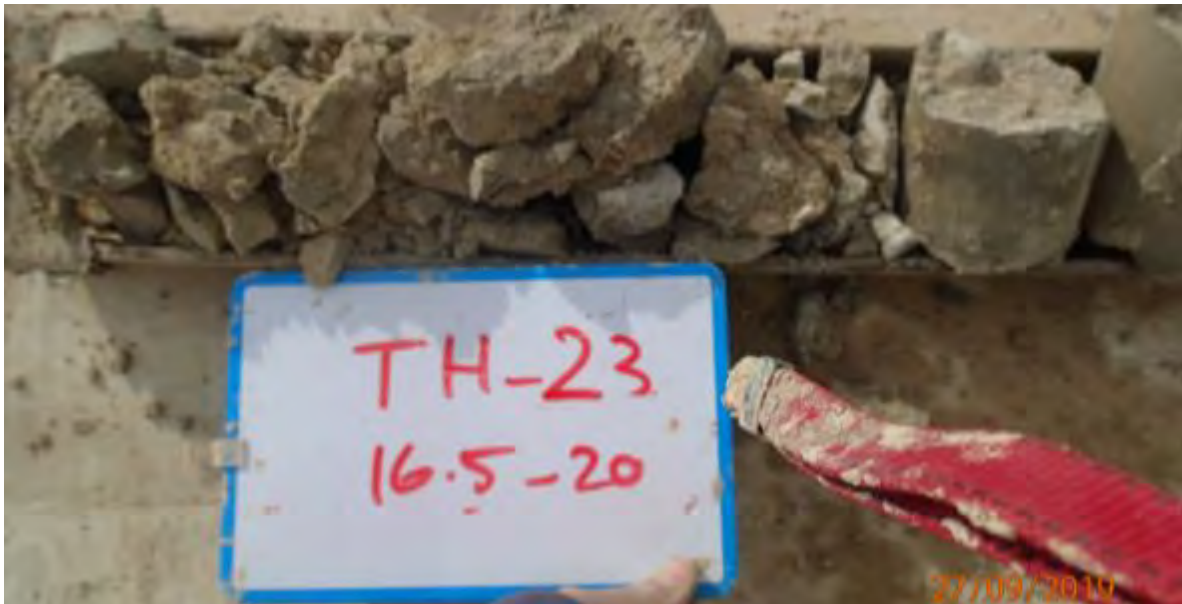




TH-23  
16.5-20



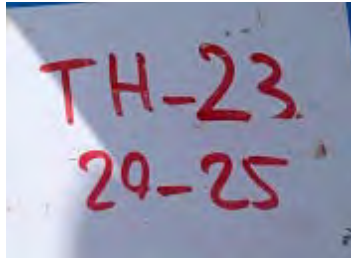
TH-23  
16.5-20



TH-23  
16.5-20









TH-23  
20-25







TH-23  
25-27



TH-23  
27-30





TH-23  
27-30



TH-23  
27-30





TH-23  
30-335



TH-23  
30-335





TH-23  
30-33.5



TH-23  
33.5-39.5





TH-23  
33.5-39.5



TH-23  
33.5-39.5





TH-23  
39.5-43.5



TH-23  
39.5-43.5





TH-23  
39.5-43.5



**TH19-24**



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH: 0-2.5'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH - 2.5 - 5'





19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH: 5'-10"



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 10-16'





19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH - 10-16'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH: K0-20'







19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 20'-26'





19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 20'-26'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 20'-26'





19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH: 20'-26'







19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 26'-30'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 26'-30'





19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 30'-36'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 30'-36'





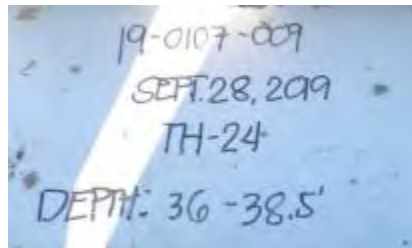
19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH 30'-36'



19-0107-009  
SEPT. 28, 2019  
TH-24  
DEPTH: 36-38.5'



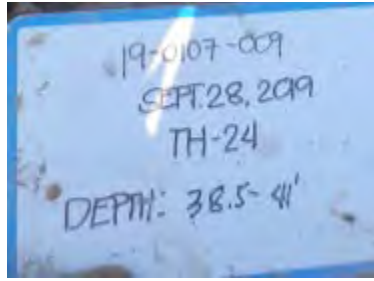




















19-0107.009  
SEPT. 28, 2019  
TH-24  
EPTH. 41.5-43  
(BR @ 42.5)



## TH19-25

19-0107-009  
9/28/2019  
TH 25  
0-2.5'





19-0107-009  
9/28/2019  
TH 25  
2.5'-5.0'





19-0107-009  
9/28/2019  
TH 25  
2.5' - 5.0'



19-0107-09  
9/28/2019  
TH 25  
5.0' - 10'







19-0107-09  
9/28/2019  
TH 25  
D' - 20'







19-0107-009  
9/28/2019  
TH 25  
20'-24'









19-0107-09  
9/28/2019  
TH 25  
24-27.5'







17-0107-09  
9/28/2019  
TH 25  
27.5-31.5'



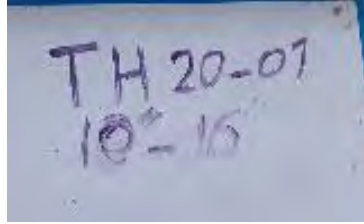


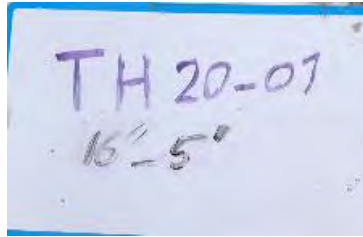


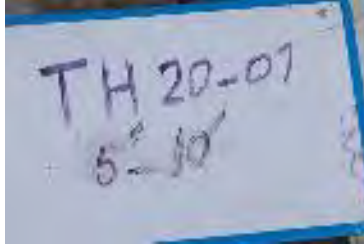
## TH20-01



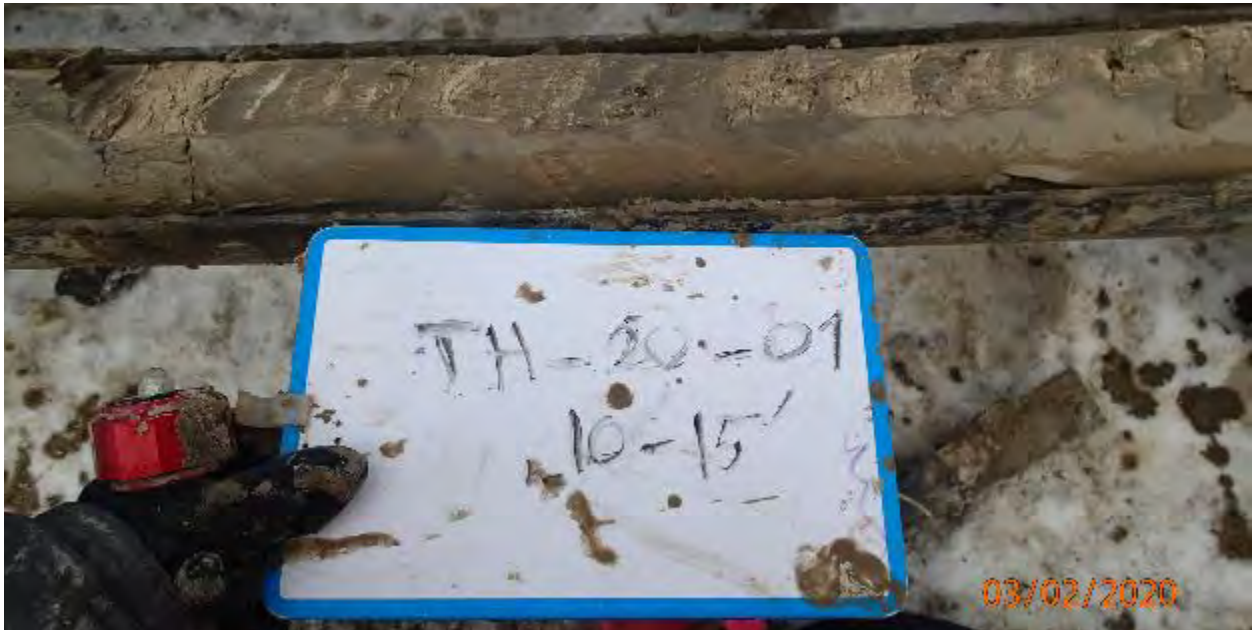
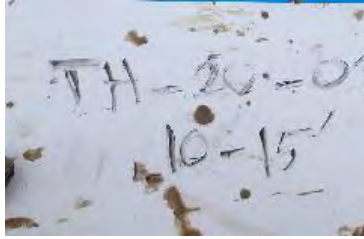


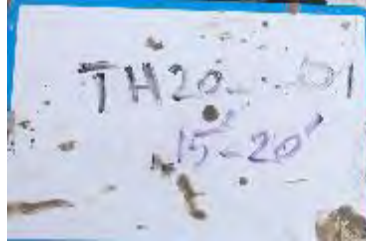




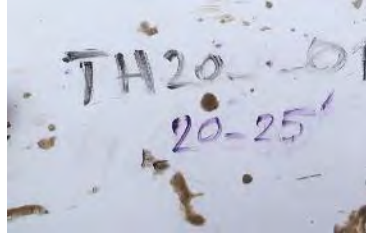




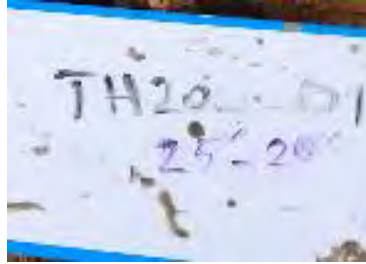




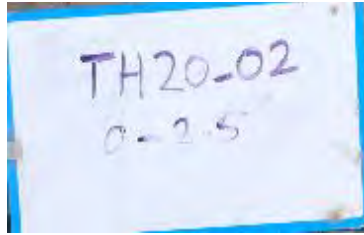




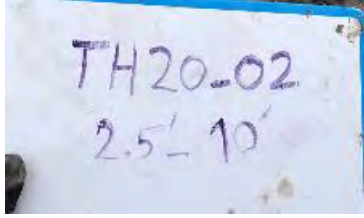


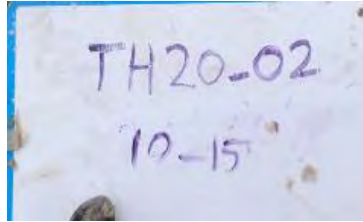


## TH20-02

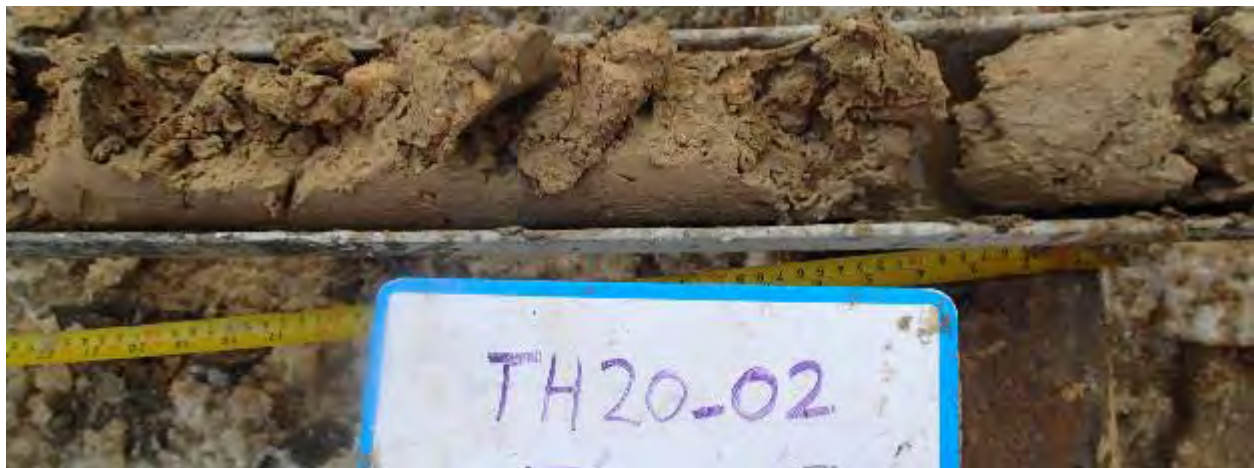
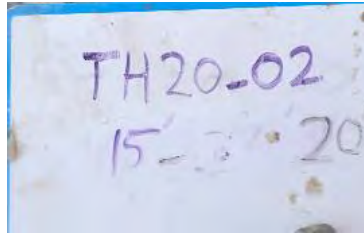






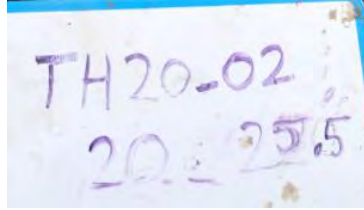






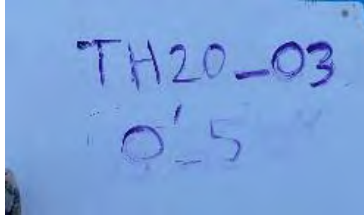


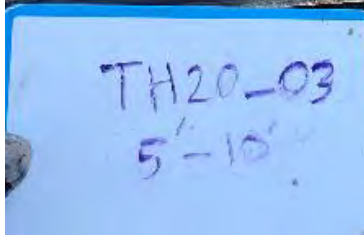




**TH20-03**

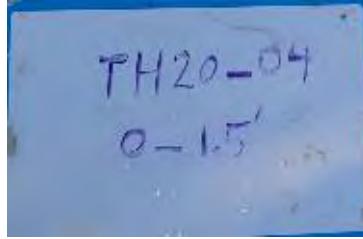


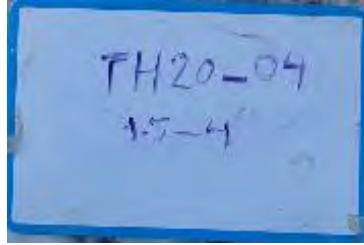


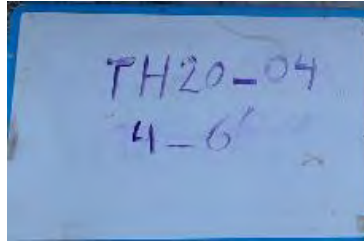


**TH20-04**

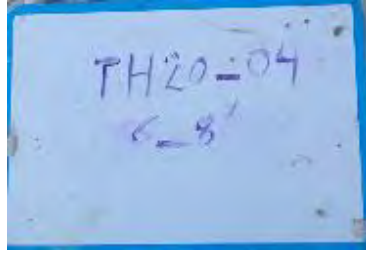


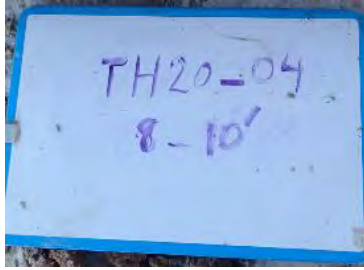


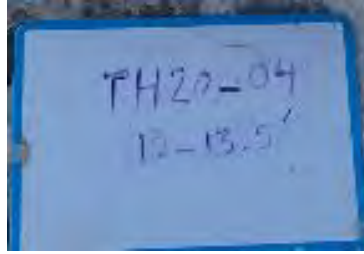




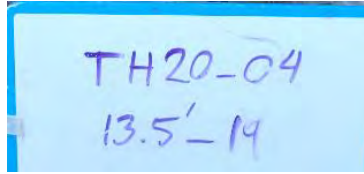










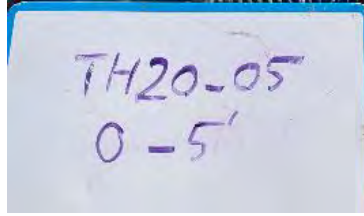


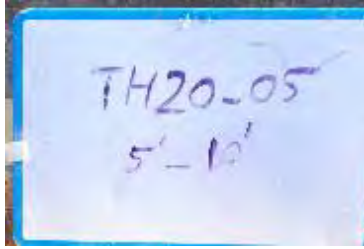




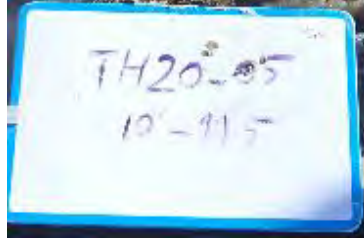
**TH20-05**



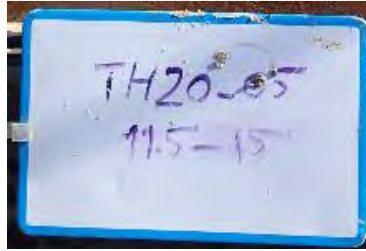


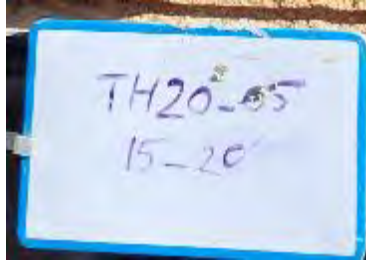




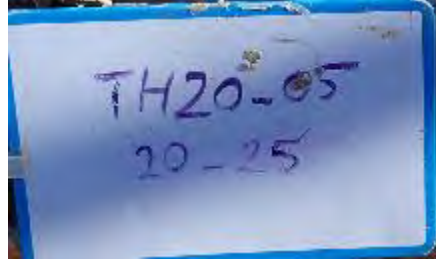




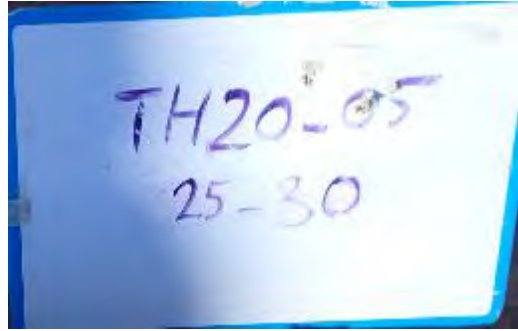




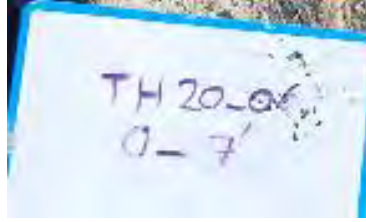




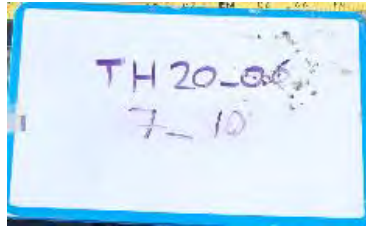


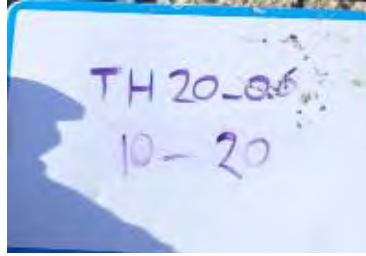


**TH20-06**

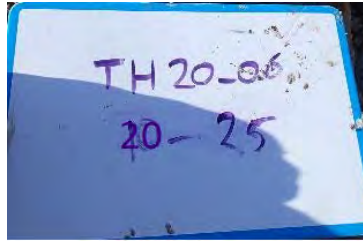




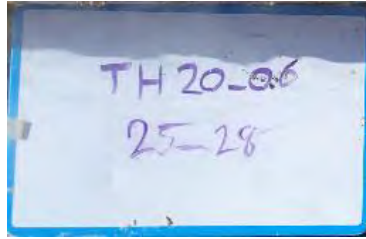




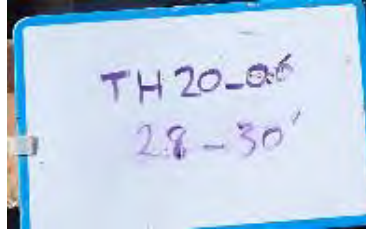






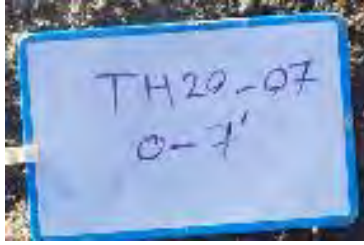


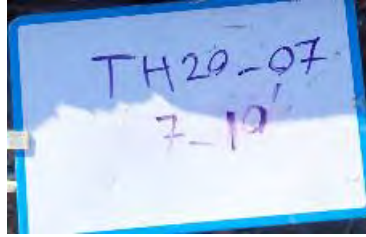




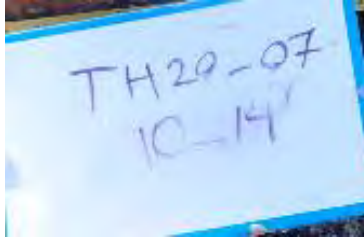
**TH20-07**





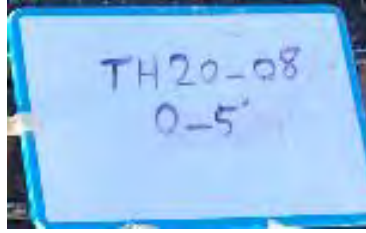


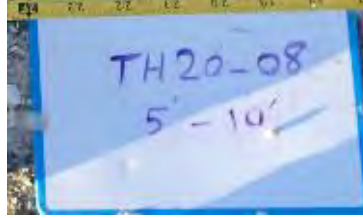




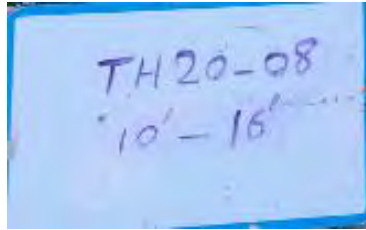


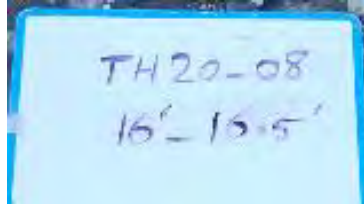
## TH20-08



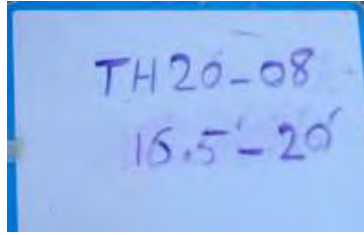




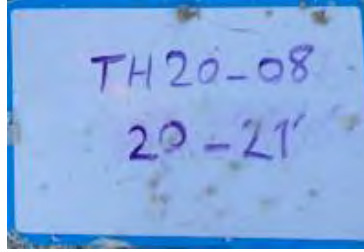






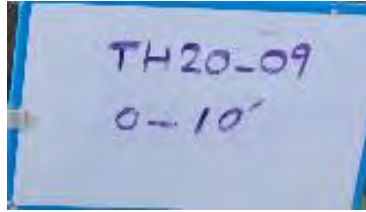




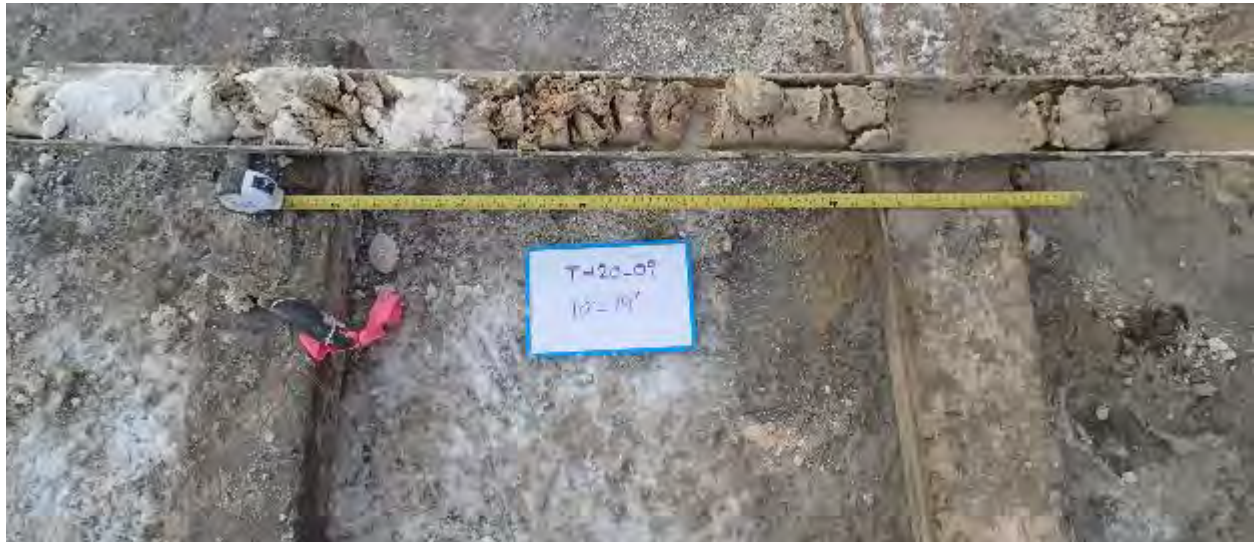
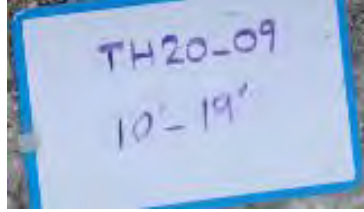


**TH20-09**



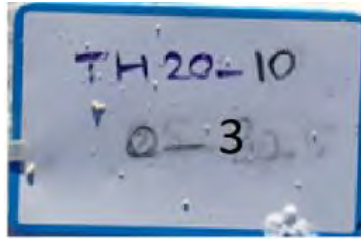




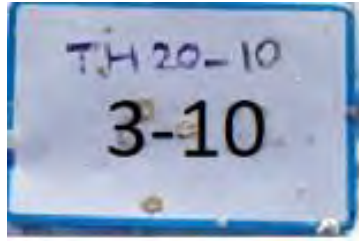


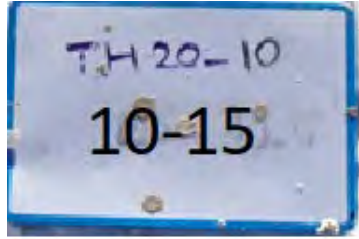
## TH20-10

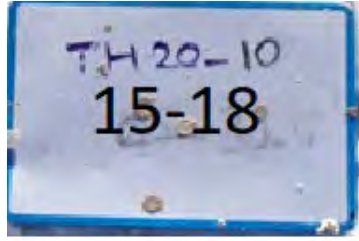






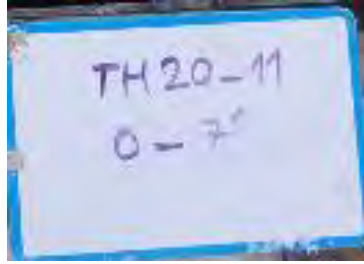


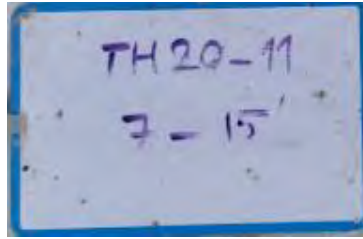






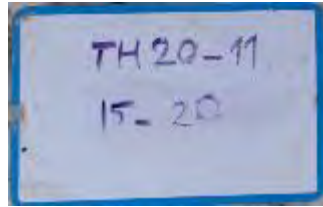
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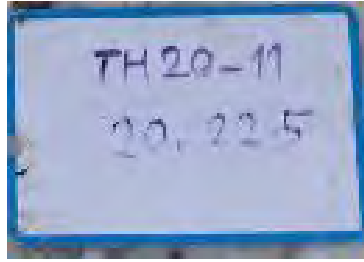






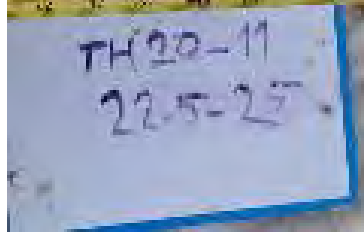




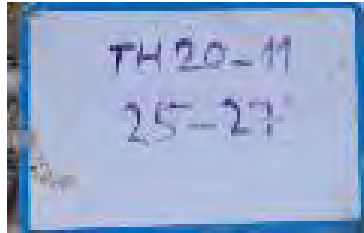




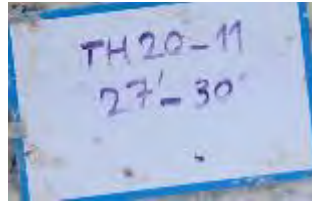






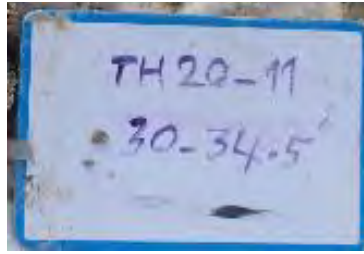






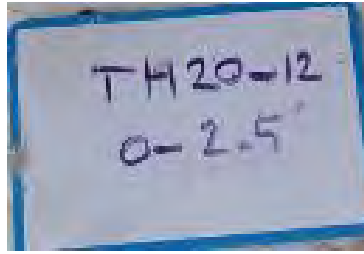


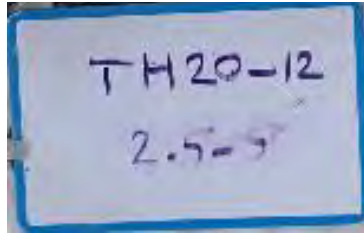




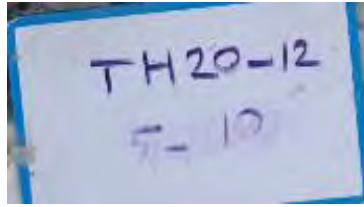


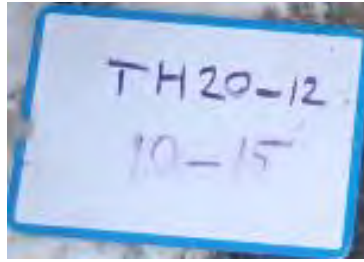
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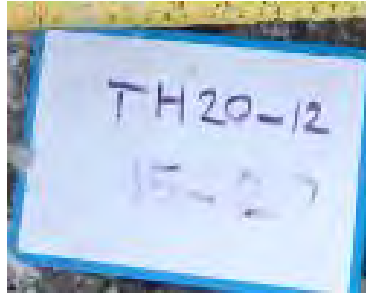




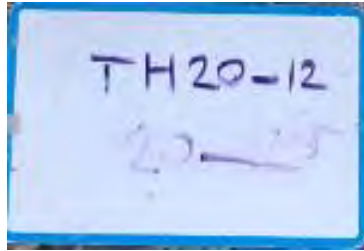




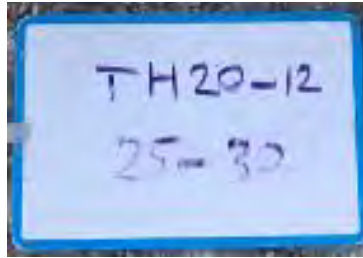




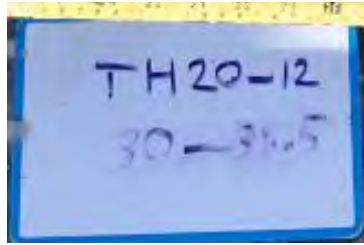




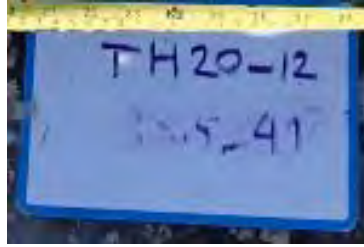




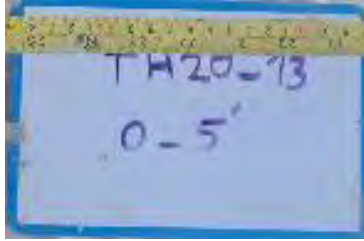




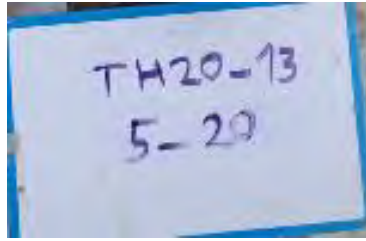


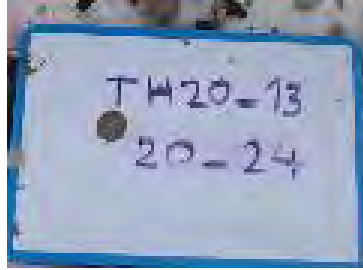


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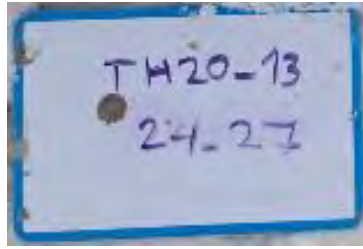


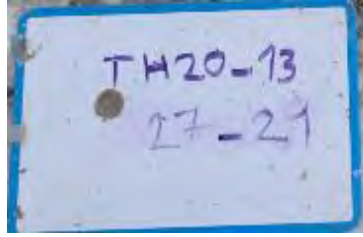




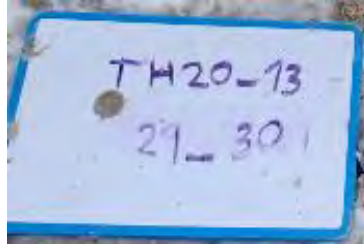




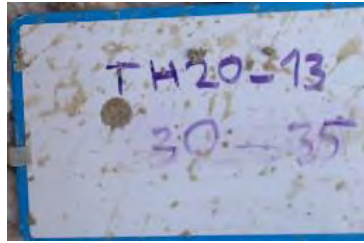






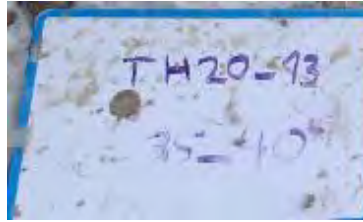






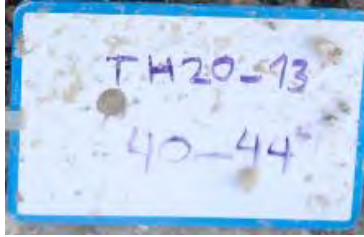




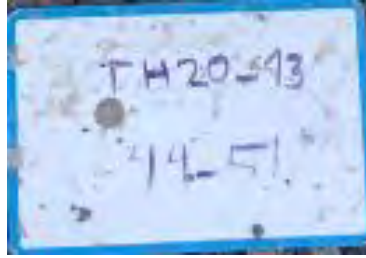






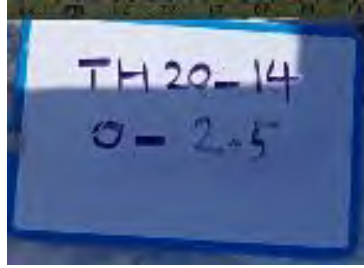


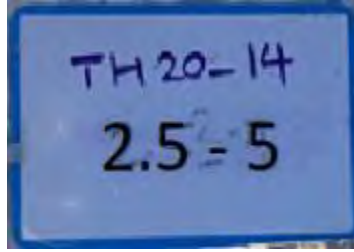




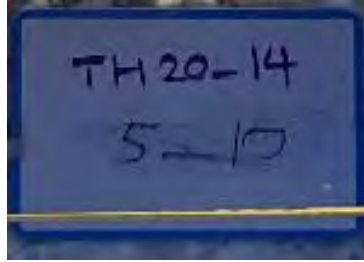


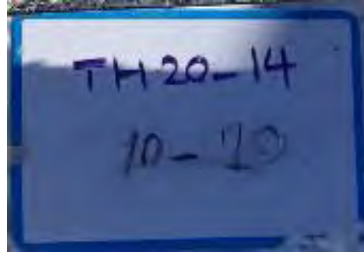
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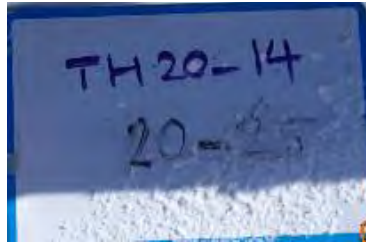




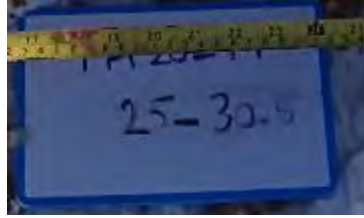














# **APPENDIX D**

Seismic Refraction Survey  
Report



# FRONTIER GEOSCIENCES INC.

SEISMIC REFRACTION SURVEY REPORT  
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT  
WINNIPEG, MB

Submitted to:

**KGS Group**

February 10, 2020

Authors:

Orgil Bayarsaikhan, B.Sc.

Caitlin Gugins, P.Geo

Project: FGI-1644

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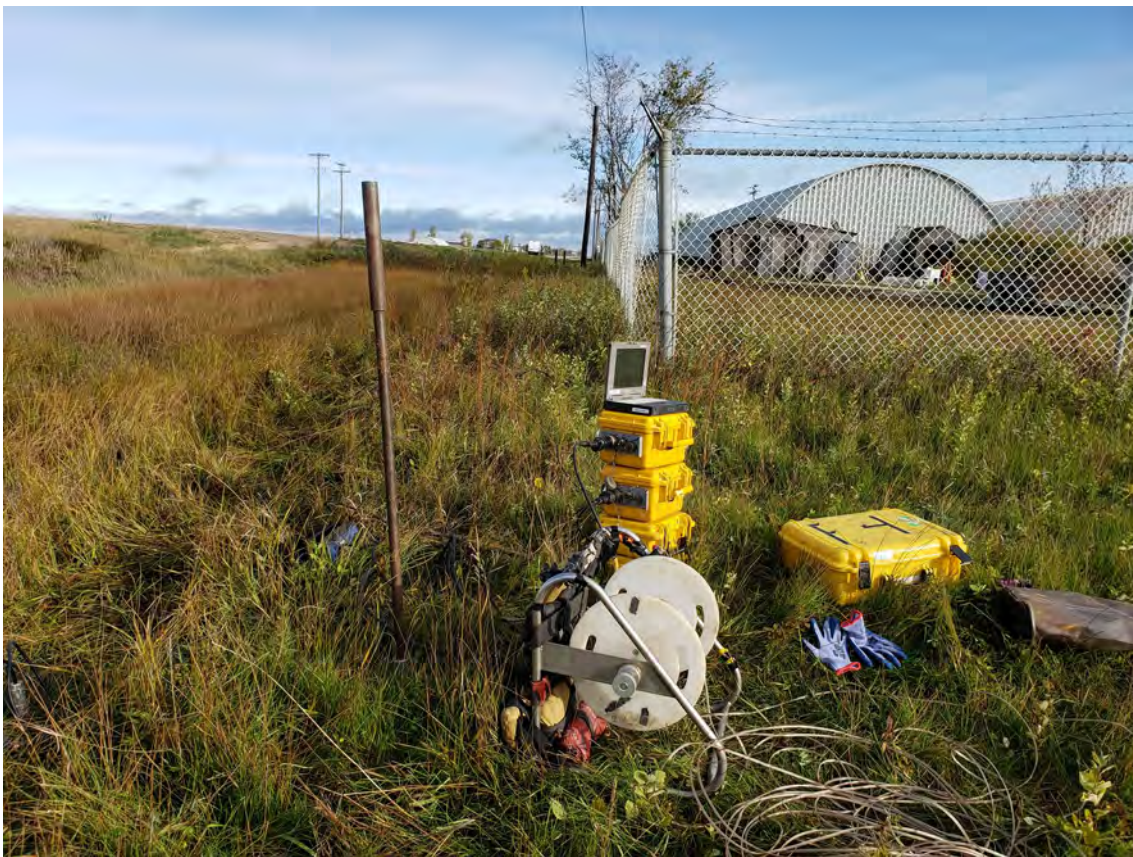
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## 1. Introduction

During the period of October 1 to 10, 2019, Frontier Geosciences Inc. carried out a seismic refraction investigation for KGS Group near the Winnipeg James Armstrong Richardson International Airport, in Winnipeg, Manitoba. The survey area is located to the northwest of the airport, along Klimpke Road and Inkster Boulevard. A Survey Location Plan of the area, is shown at a scale of 1:50,000 in Figure 1.

The purpose of the geophysical survey was to determine depth to bedrock and overburden layering classification to aid in defining depth to a till layer, as well as characterizing material types and densities. In all three separate seismic refraction traverses were surveyed for a total of approximately 5 kilometres of detailed seismic refraction surveying. Two site plans illustrating the locations of the seismic lines are presented at a scale of 1:10,000 in Figures 2 and 17, in the Appendix.



*Instrumentation Setup*

## **2. Seismic Refraction Survey**

### **2.1 Survey Equipment**

The seismic refraction investigation was carried out using two Geometric Geode, 24 channel, signal enhancement seismographs and Oyo Geospace 10 Hz geophones. Geophone intervals along the multicored seismic cable were maintained at 1.5 or 2.5, metres in order to ensure high resolution data on subsurface layering. Seismic energy was provided from a shotgun seismic source firing blank, 8 gauge shotgun shells into hand-excavated shotholes and a sledgehammer striking a steel plate. Shot initiation or zero time was established by metal to metal contact of a striking hammer contacting the firing pin of the shotgun, or the hammer striking the plate.

### **2.2 Survey Procedure**

Field procedure entailed setting out two 24 channel geophone cable in a straight line and implanting the geophones. The spread was traversed with the seismic source, moving progressively down the array of geophones, with up to 9 individual shotpoints on each spread: one at either end of the spread, five at intermediate locations along the seismic cable, and one off each end of the spread to ensure adequate coverage of the basal layer. The shots were triggered individually and arrival times for each geophone were recorded digitally in the seismograph. For quality assurance, field inspection of raw data after each shot was carried out, with additional shots recorded if first arrivals were unclear. Data recorded during field surveying operations was generally of good to excellent quality.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features. Relative elevations along the seismic lines were recorded by chain and inclinometer.

### **2.3 Seismic Refraction Interpretive Method**

The final interpretation of the seismic data was arrived at using the method of differences technique. This method utilizes the time taken to travel to a geophone from shotpoints located to either side of the geophone. Velocities are calculated as the slope of first break pick times and geophone distances. When there is a significant change in slope a new velocity is calculated and assigned to the new layer. Basal velocities are calculated by the arrivals of off-end shots, where picked arrivals are refracted from the basal layer. Each geophone is assigned a velocity and time for each layer. Using the total time, a small vertical time is computed which represents the time taken to travel from the refractor up to the ground surface. This time is then multiplied by the velocity of each overburden layer to obtain the thickness of each layer at that point. The thicknesses are splined along the seismic line to create a continuous boundary between layers.



*Example of Survey Procedure*



### **3. Geophysical Results**

#### **3.1 General**

The seismic refraction survey area is presented in two site areas, with the interpreted results of the seismic refraction data illustrated at a 1:250 scale in each corresponding figure. The Klimpke Road Site Plan, Figure 2, shows line SL-1, with results presented in Figures 3 to 16, in the Appendix. Lines SL-2, and SL-3 are displayed in the Inkster Boulevard Site Plan, Figure 17, with corresponding results presented in Figures 18 to 29. The seismic velocity layer interfaces are marked on the seismic profile in blue, green, purple, and red. The interface line colours are not a specific velocity contour, but rather the interpreted discrete boundary above which velocities are defined within a certain range and below which velocities are within a significantly increased velocity range.

#### **3.2 Discussion**

The results of the seismic refraction survey indicate the area is underlain by up to five distinct velocity layers. The surficial layer, displaying compressional wave velocities varying from 340 m/s to 450 m/s, averages approximately 1.5 metres in thickness, reaching a maximum thickness of 4 metres at station 378E on line SL19-02. This velocity layer corresponds to testhole intersections of granular and clay fill.

Underlying the fill layer is an intermediate velocity layer with an interpreted velocity range of 800 m/s to 1330 m/s. These velocities are consistent with testhole intersections of firm to stiff, clays, with trace sands and gravels. Averaging approximately 3 m in thickness, this layer thins to half a metre around station 2360N on line SL19-01 and near station 900E on line SL19-03 and displays a maximum thickness of 5.5 metres at the end of line SL19-03.

A deeper intermediate layer was identified with compressional wave velocities ranging from 1600 m/s to 2250 m/s. This layer thins to less than 0.5 metre along the end of line SL19-01, while reaching a maximum thickness of almost 10 metres at station 1397E on line SL19-03. This velocity range is consistent with loose to compact silt till, as well as compact sand and gravel encountered in the testholes, indicating this layer correlates with silt till in the area. Faster velocities in this range likely correspond to zones of higher compaction or density.

A third intermediate layer was also identified, with a velocity range from 2500 to 2600 m/s, is interpreted to be a denser zone within the silt till layer with possible increased cobbles and boulders. This layer is illustrated as a dashed purple line in the data, as due to the relatively high velocity and minimal thickness of this layer, it was not accurately resolvable in the data processing, described as a 'hidden' layer. In most areas where this layer is shown, testhole logs indicated presence of this layer, although it may exist in other sections of the survey area.

Underlying the intermediate layers is the interpreted basal layer with compressional wave velocities of 2500 m/s to 4500 m/s. Lower velocities in this range are most likely indicative of weathering and/or fracturing within the bedrock. The lower end of interpreted velocities most likely represents a higher level of fracturing and/or weathered bedrock, while the higher end is indicative of more competent bedrock. The basal layer closely corresponds with limestone bedrock encountered within the testholes in proximity to the seismic lines. This interpreted bedrock surface exhibits an average depth of approximately 8 metres and reaches a maximum depth of almost 16 metres at station 575N along line SL19-01, while rising to a minimum depth of 2.6 metres, at station 2155N on line SL19-01.

In general, seismic refraction results matched well with the nearby provided testholes logs in the area. Additionally, in some areas, updated testholes results may indicate a deeper bedrock layer than illustrated in the profiles, due to the presence of the denser 'hidden' layer described above.

**4. Limitations**

The depths to subsurface boundaries derived from seismic refraction surveys are generally accepted as accurate to within ten percent of the true depths to the boundaries, below 10 metres. Above 10 metres, the accuracy of seismic refraction data is approximately +/- 1.0 metres due mainly to the greater statistical error in determining the upper velocity layers from fewer data points. In some cases, unusual geological conditions may produce false or misleading data points with the result that computed depths to subsurface boundaries may be less accurate. In seismic refraction surveying difficulties with a 'hidden layer' or a velocity inversion may produce erroneous depths. The first condition is caused by the inability to detect the existence of a layer because of insufficient velocity contrasts or layer thicknesses. A velocity inversion exists when an underlying layer has a lower velocity than the layer directly above it. The interpreted depths shown on drawings are to the closest interface location, which may not be vertically below the measurement point if the refractor dip direction departs significantly from the survey line location. Structural discontinuities occurring on a scale less than the geophone spacing or isolated boulders would go undetected in the interpretation of the data. The seismic refraction method may not detect a narrow canyon-like feature incised into bedrock, if the canyon width is narrow relative to the depth of burial of the feature. Contour plan gridded data is only valid directly beneath seismic lines and testholes used in the gridding process, and is interpolated elsewhere. Additionally, small errors may also occur in data gridding.

The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the seismic refraction method.

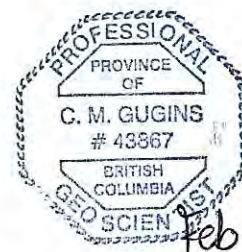
For: Frontier Geosciences Inc.



Orgil Bayarsaikhan, B.Sc.



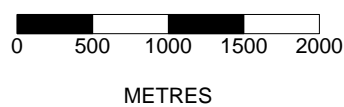
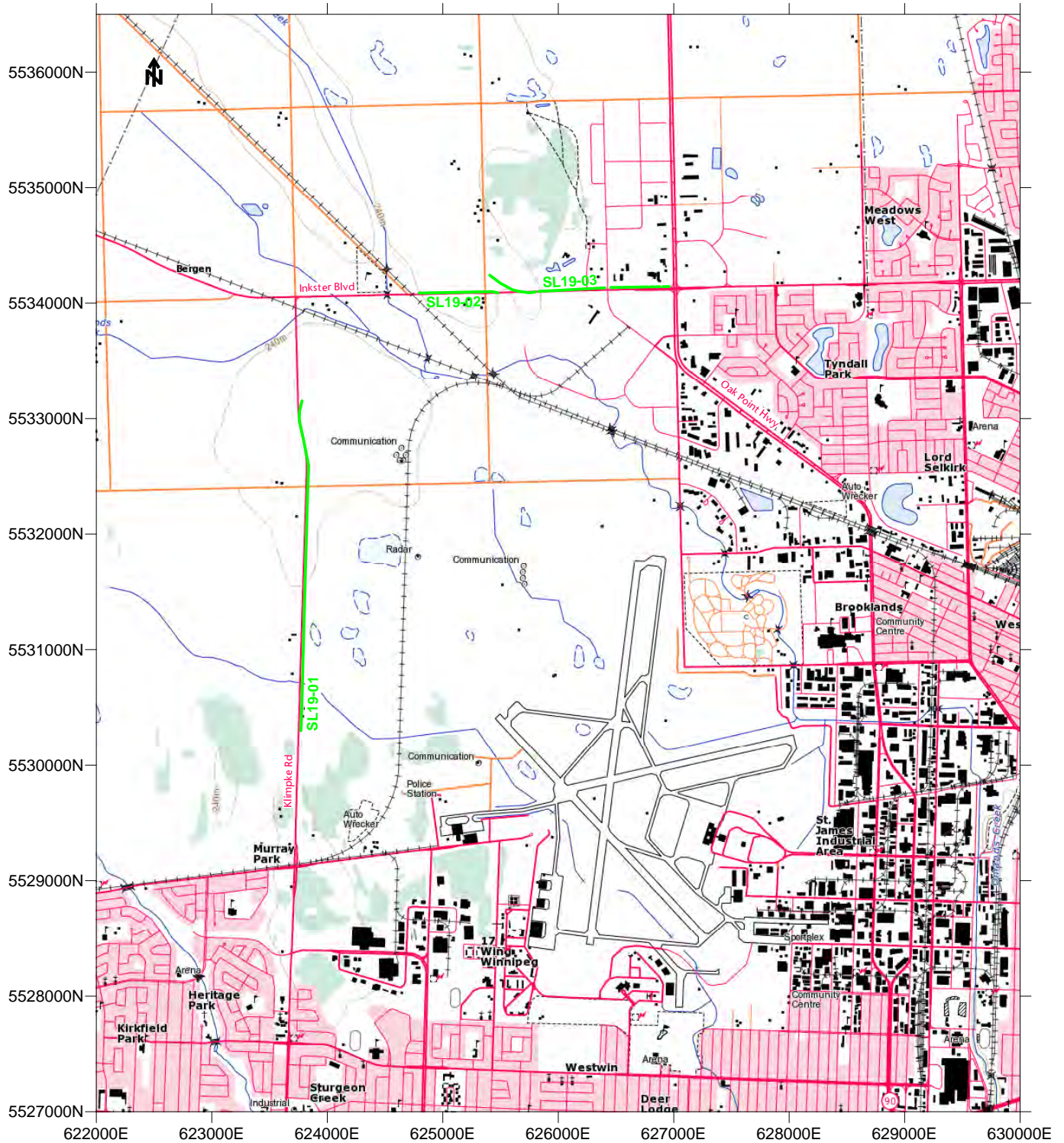
Caitlin Gugins, P.Geol.



Feb 10, 2020



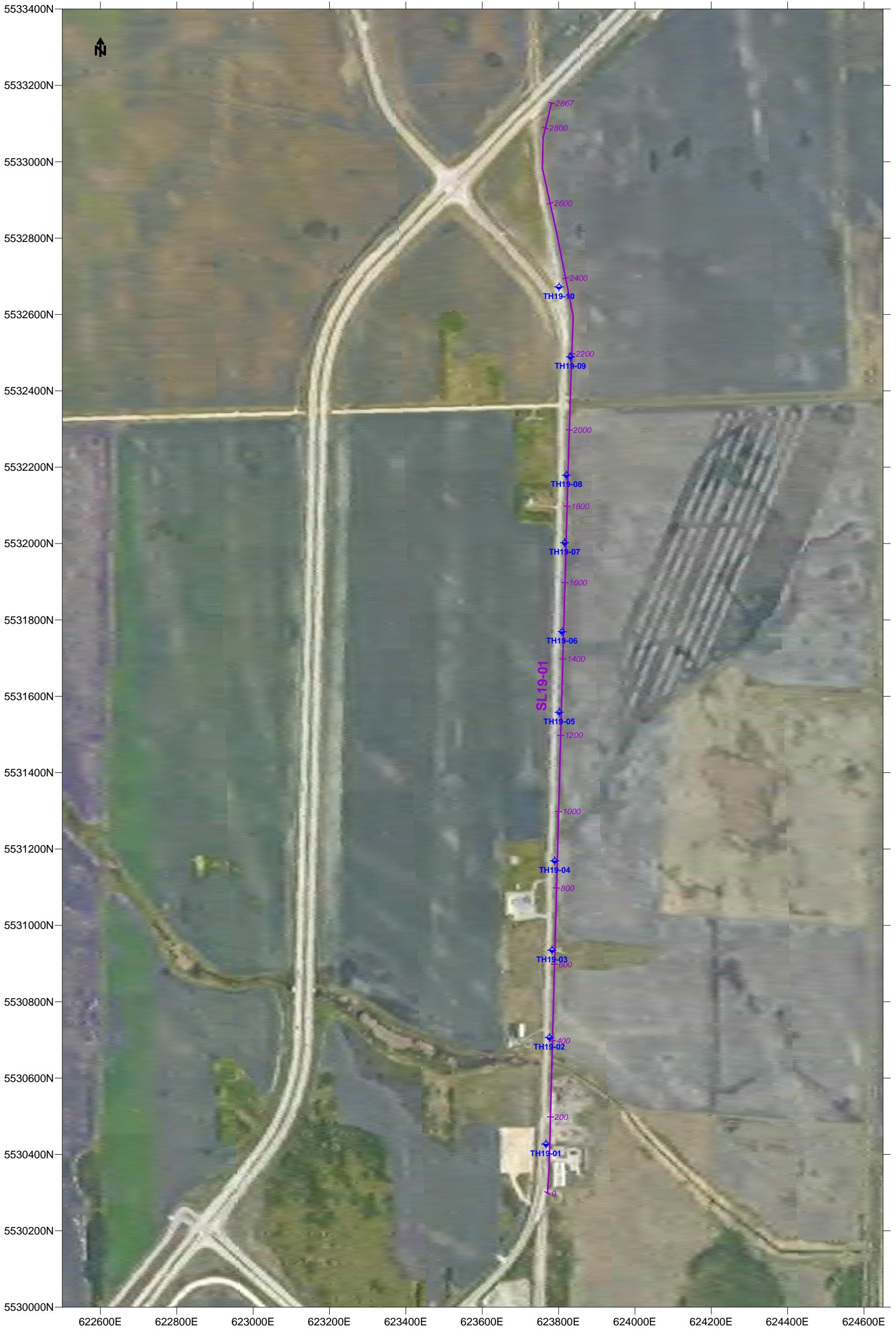
**APPENDIX**



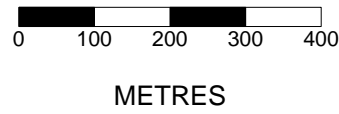
<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
SURVEY LOCATION PLAN		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:50,000	FIG. 1

NATURAL RESOURCES CANADA  
 TOPORAMA MAPSHEET 62H14  
 UTM NAD83 ZONE 14





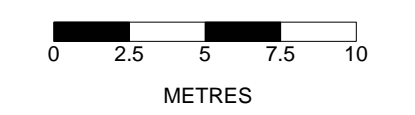
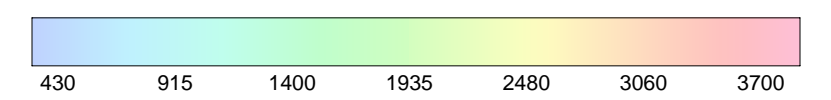
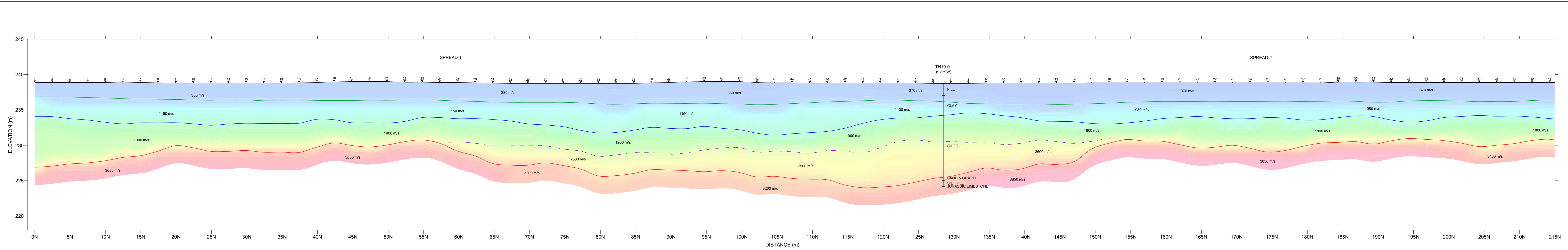
200 SURVEY LINE AND DISTANCE



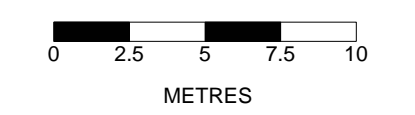
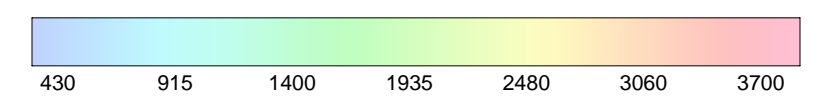
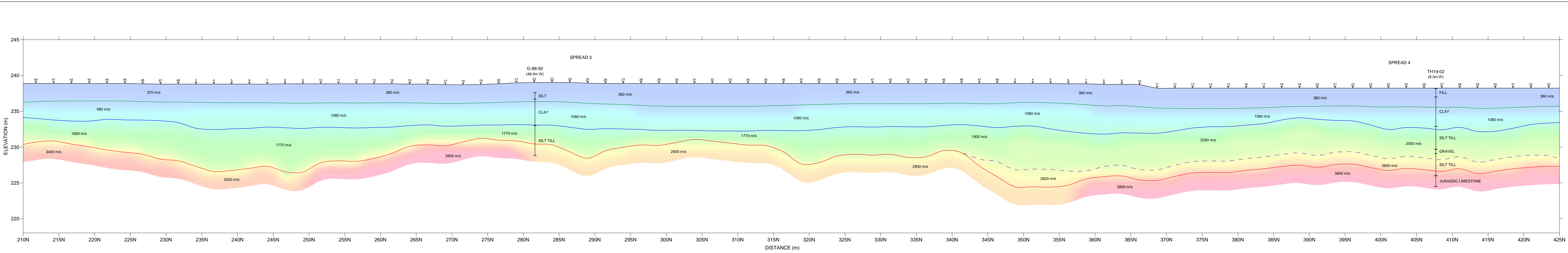
<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
<b>KLIMPKE ROAD SITE PLAN</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:10,000	FIG. 2

GOOGLE EARTH IMAGERY APPROXIMATE  
UTM NAD83 ZONE 14

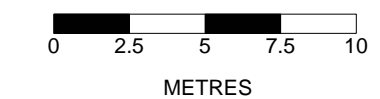
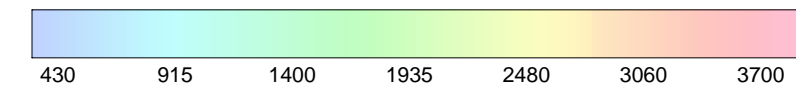
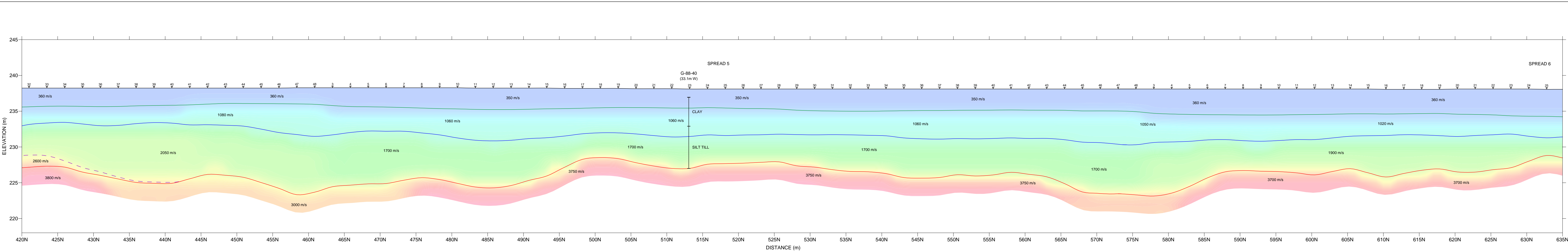




KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01A		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 3

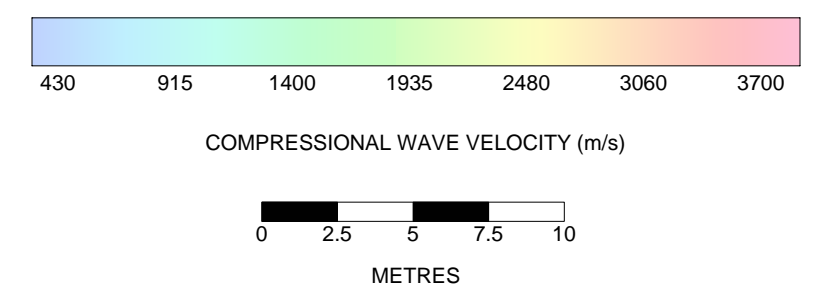
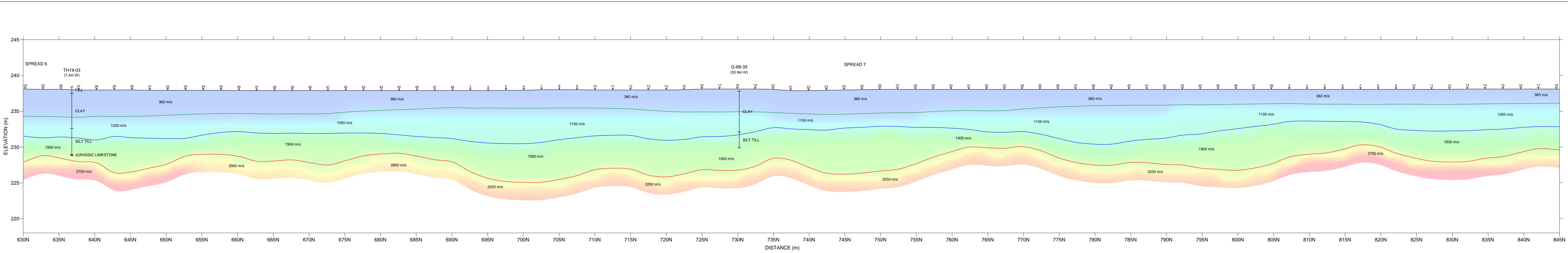


KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-01B		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 4

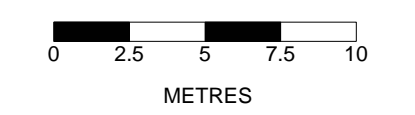
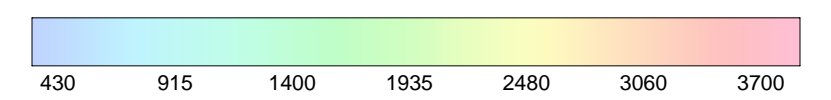
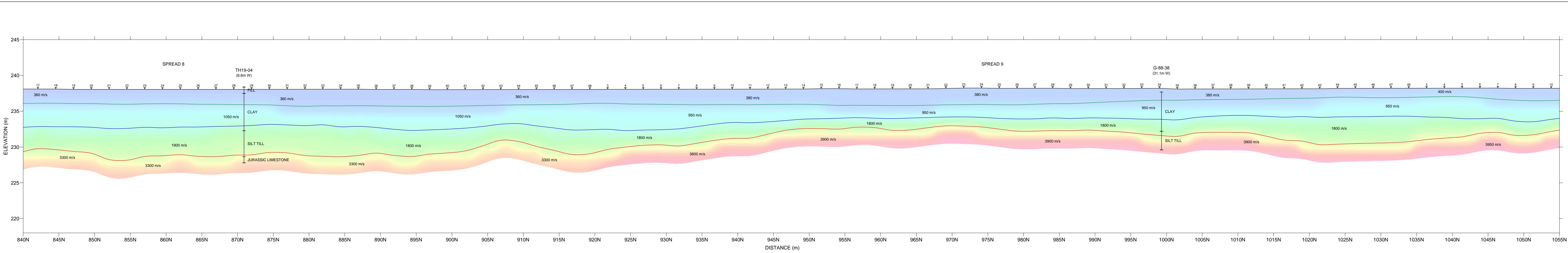


KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-01C		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 5

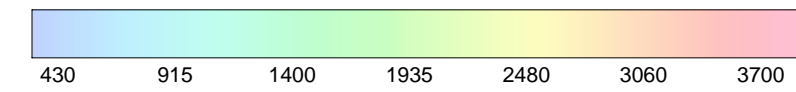
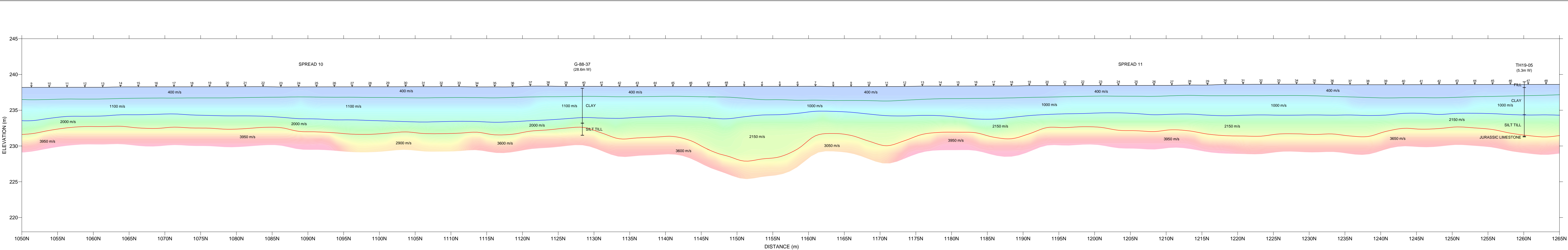




KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01D		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE: 1:250	FIG. 6



KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01E		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 7



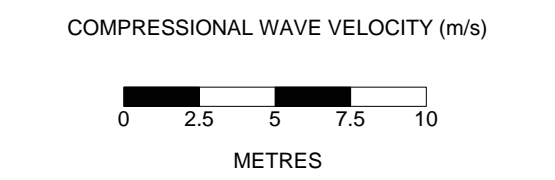
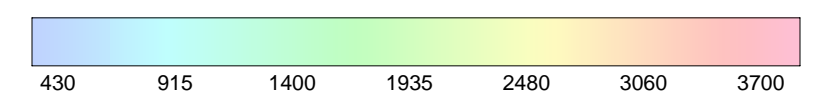
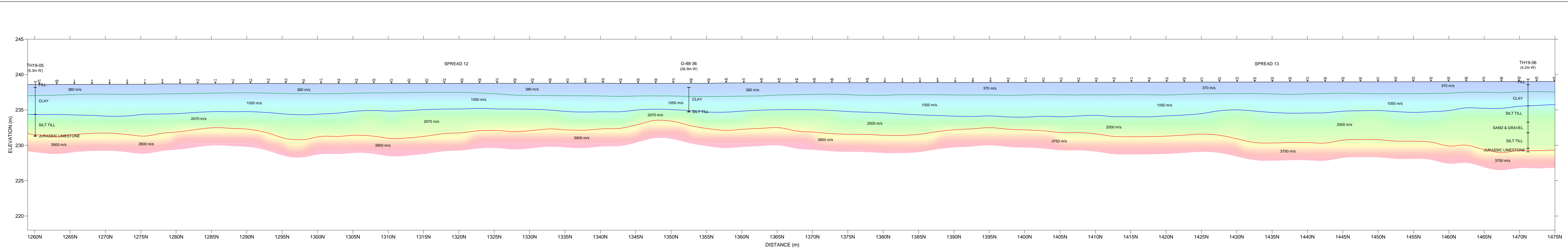
COMPRESSIONAL WAVE VELOCITY (m/s)



METRES

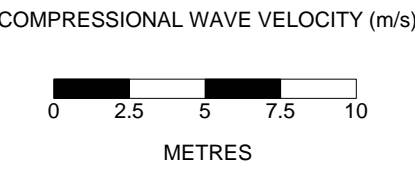
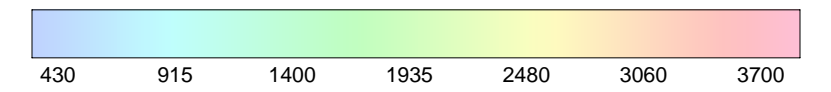
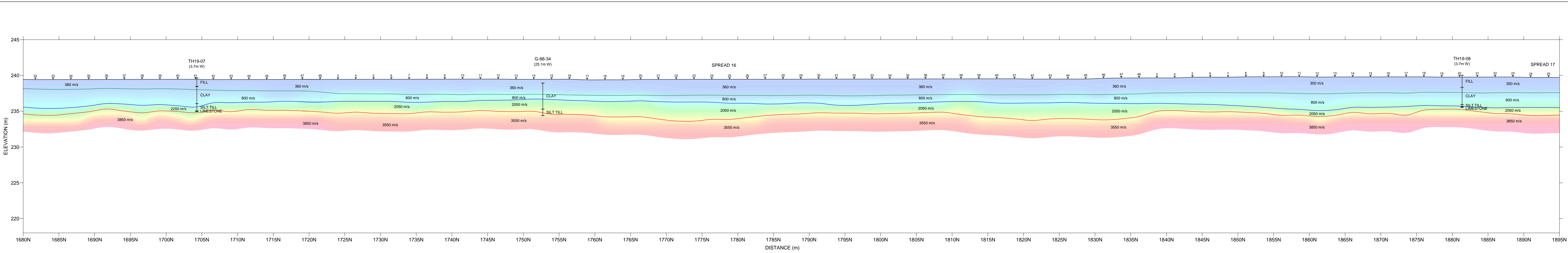
KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01F		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 8





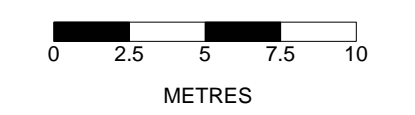
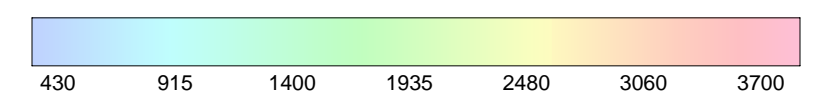
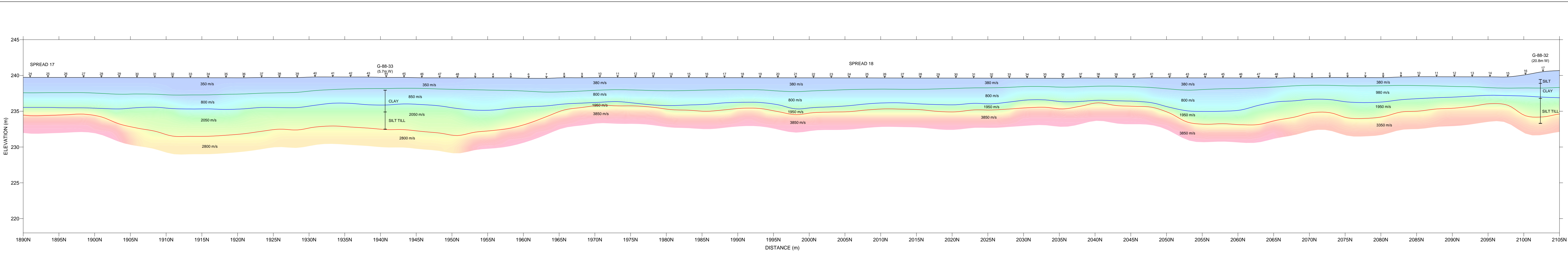
KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01G		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 9



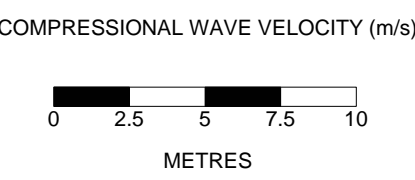
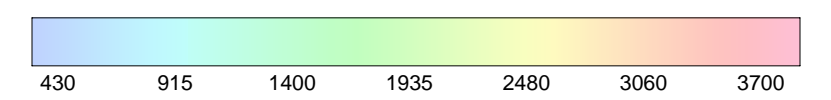
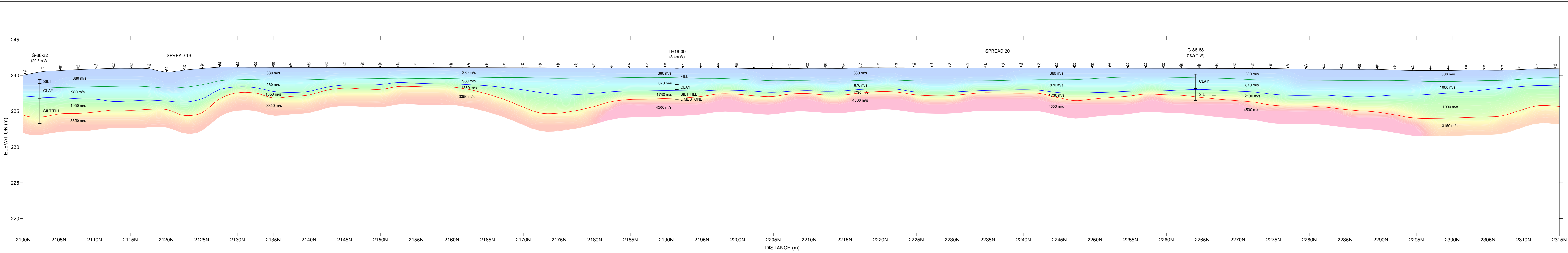


<b>KGS GROUP</b> WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
<b>SEISMIC REFRACTION SURVEY</b>		
<b>INTERPRETED DEPTH SECTION</b> <b>SL19-011</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 11

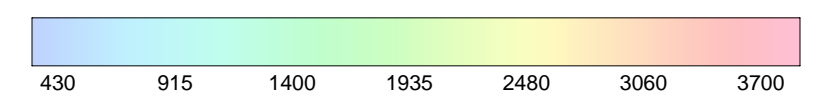
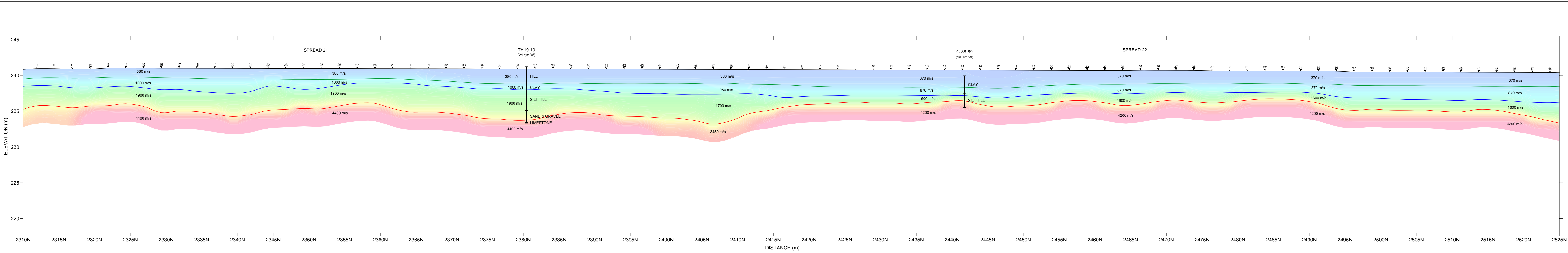




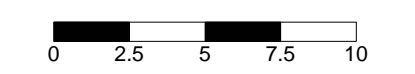
KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01J		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 12



<b>KGS GROUP</b> WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
<b>INTERPRETED DEPTH SECTION</b> SL19-01K		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE: 1:250	FIG. 13



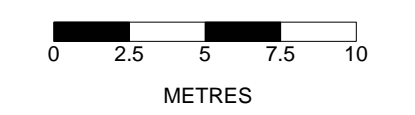
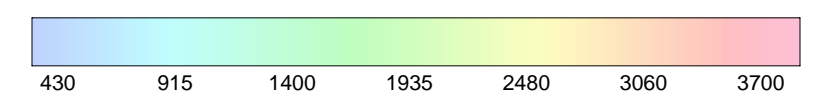
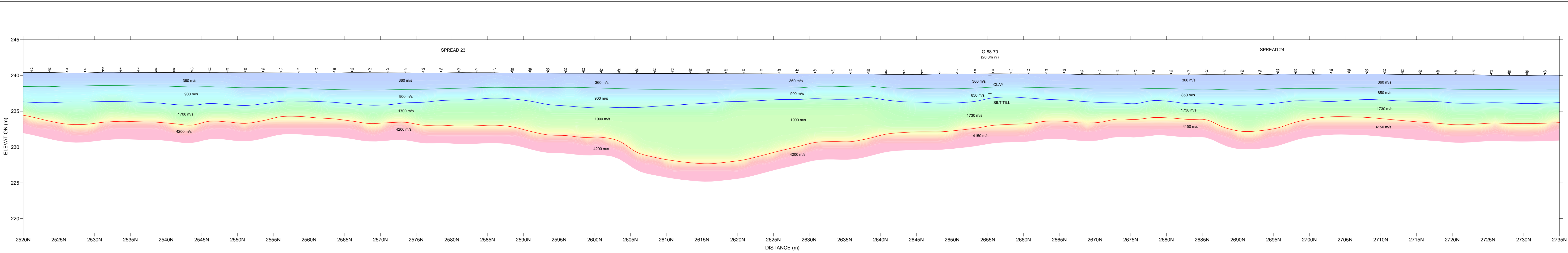
COMPRESSIONAL WAVE VELOCITY (m/s)



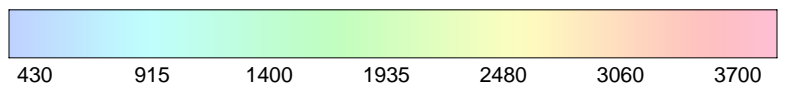
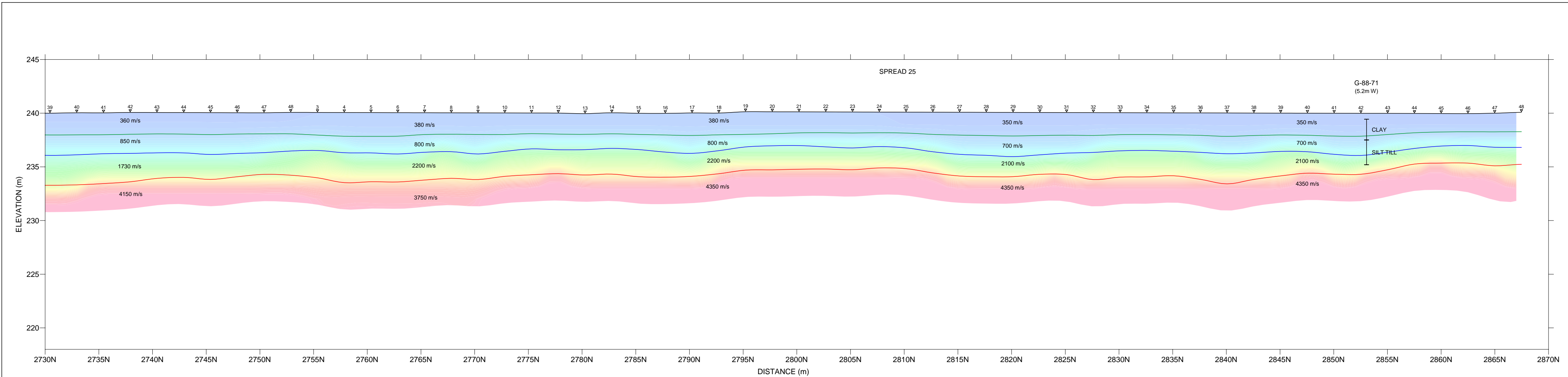
METRES

KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-01L		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 14

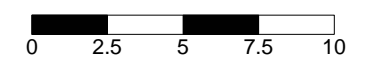




KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-01M		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 15



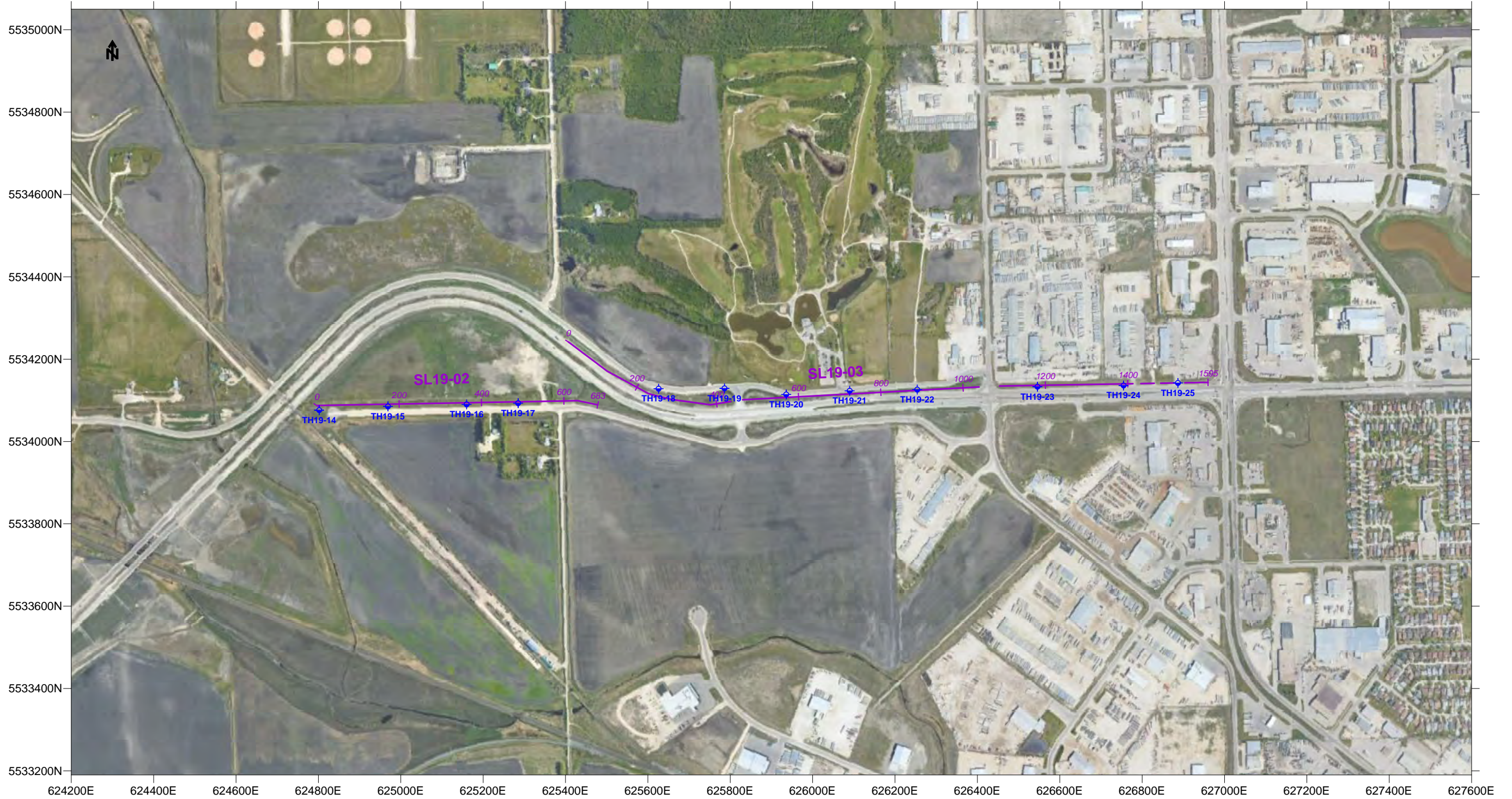
COMPRESSIONAL WAVE VELOCITY (m/s)



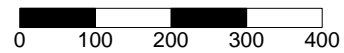
METRES

<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-01N		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 16





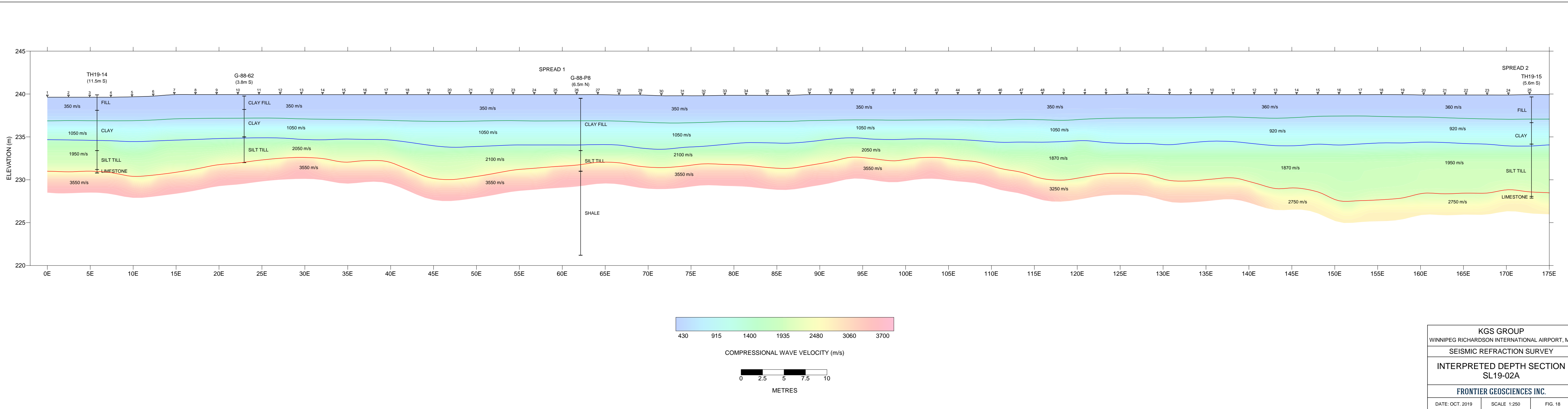
200 SURVEY LINE AND DISTANCE



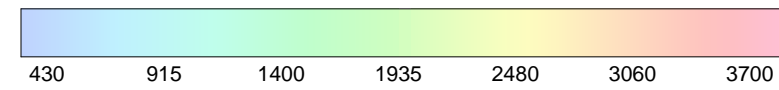
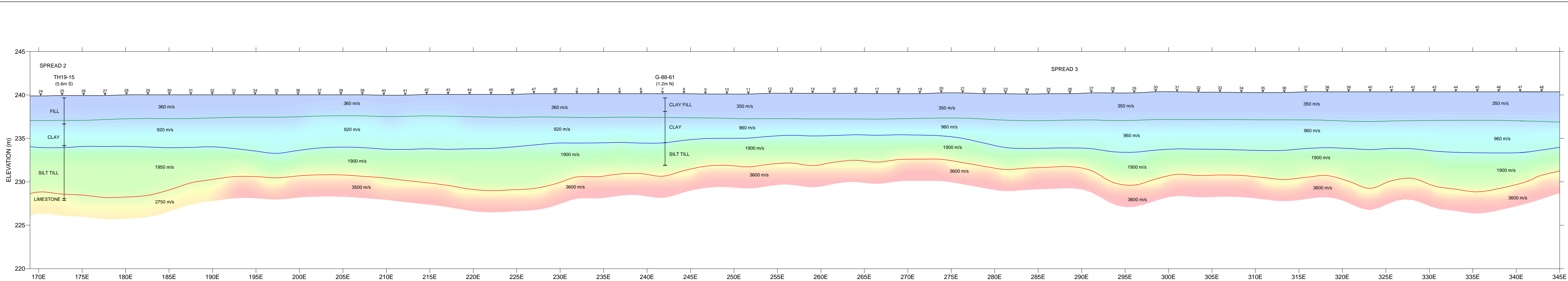
METRES

<b>KGS GROUP</b> WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
<b>SEISMIC REFRACTION SURVEY</b>		
<b>INKSTER ROAD SITE PLAN</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:10,000	FIG. 17





<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-02A		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 18

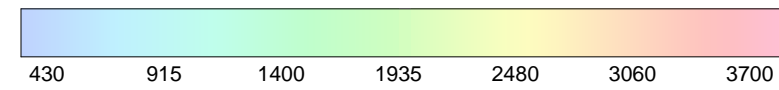
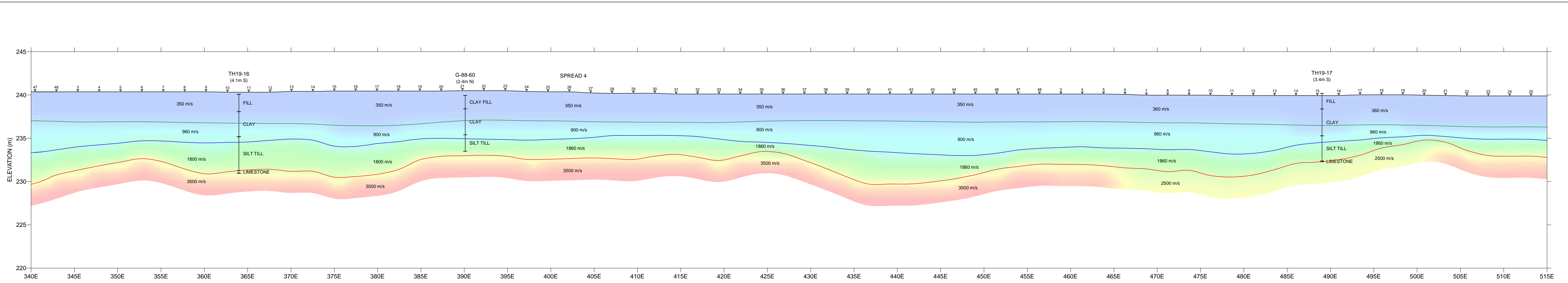


COMPRESSIONAL WAVE VELOCITY (m/s)

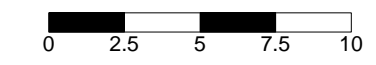


METRES

<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-02B		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 19



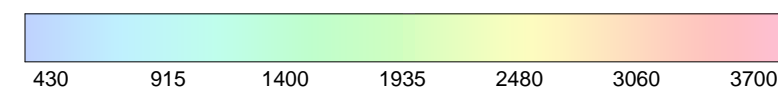
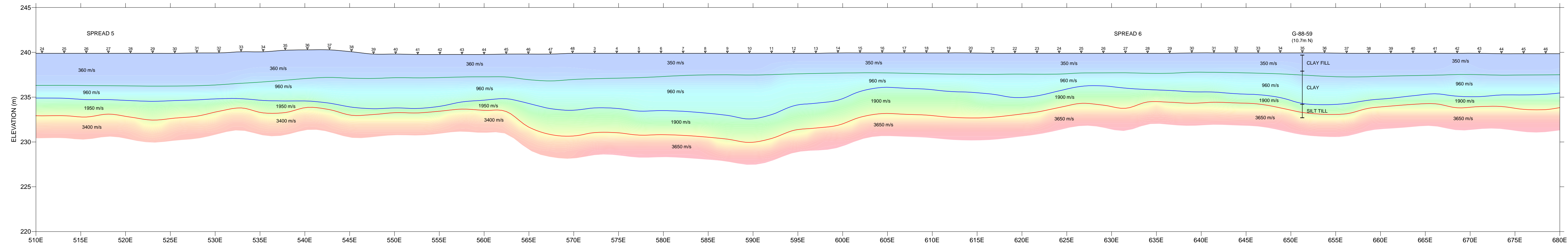
COMPRESSIONAL WAVE VELOCITY (m/s)



METRES

<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-02C		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 20



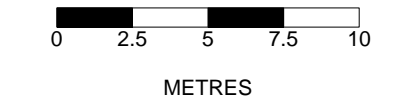
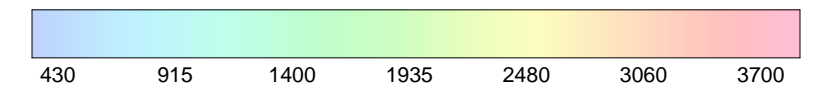
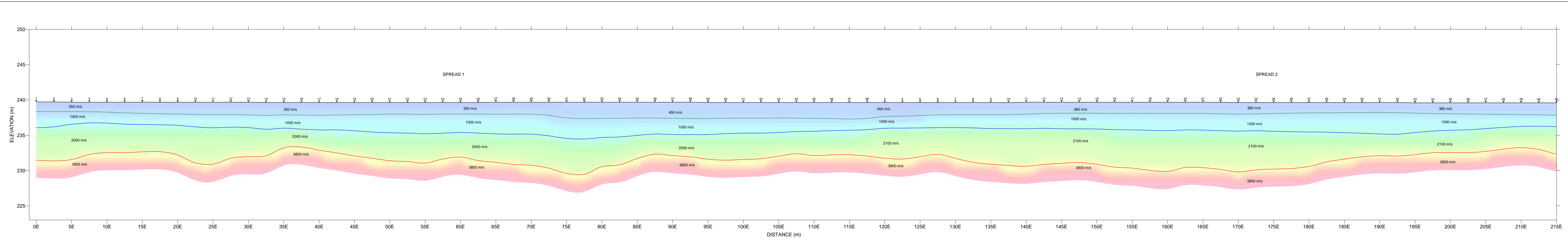


COMPRESSIONAL WAVE VELOCITY (m/s)

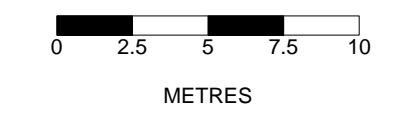
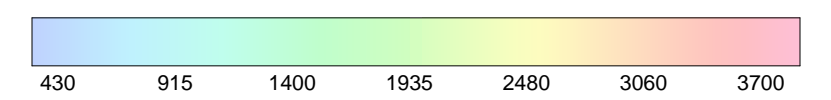
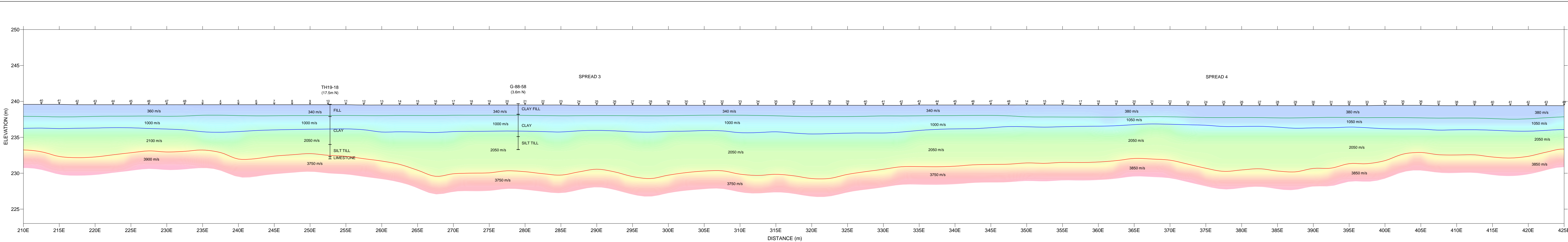


METRES

<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-02D		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 21

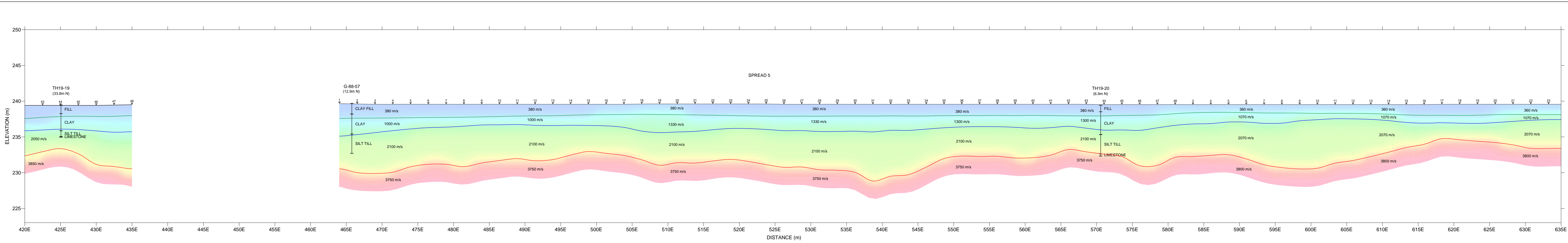


KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-03A		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 22

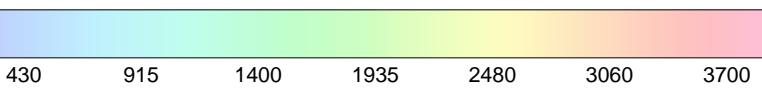
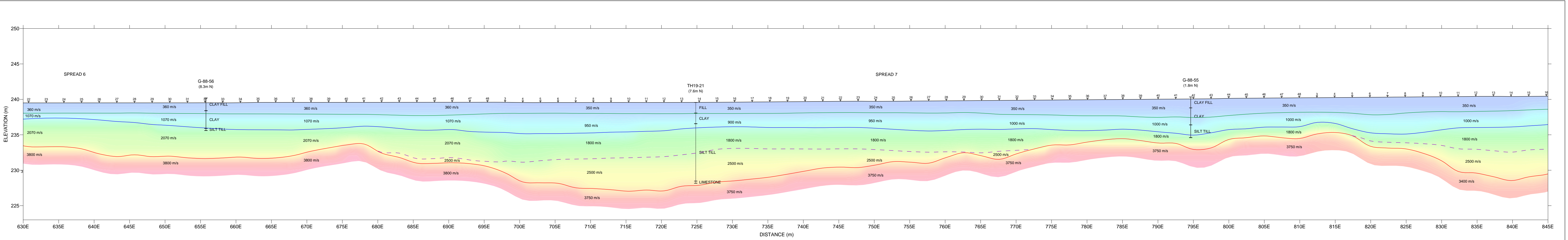


<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
<b>SEISMIC REFRACTION SURVEY</b>		
<b>INTERPRETED DEPTH SECTION</b>		
<b>SL19-03B</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 23





<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
<b>SEISMIC REFRACTION SURVEY</b>		
<b>INTERPRETED DEPTH SECTION</b>		
<b>SL19-03C</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 24

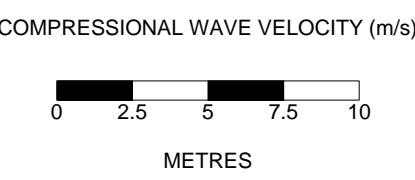
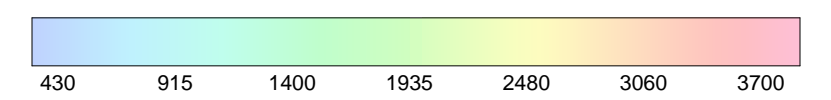
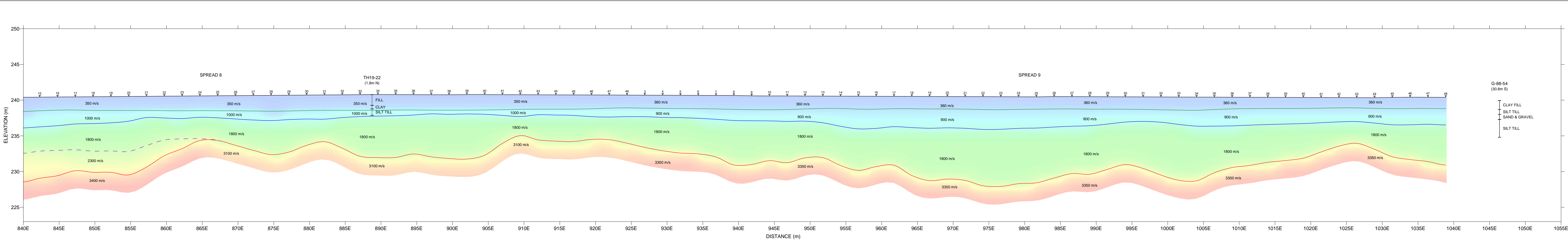


COMPRESSIONAL WAVE VELOCITY (m/s)



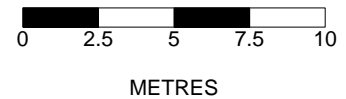
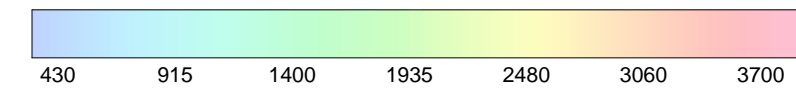
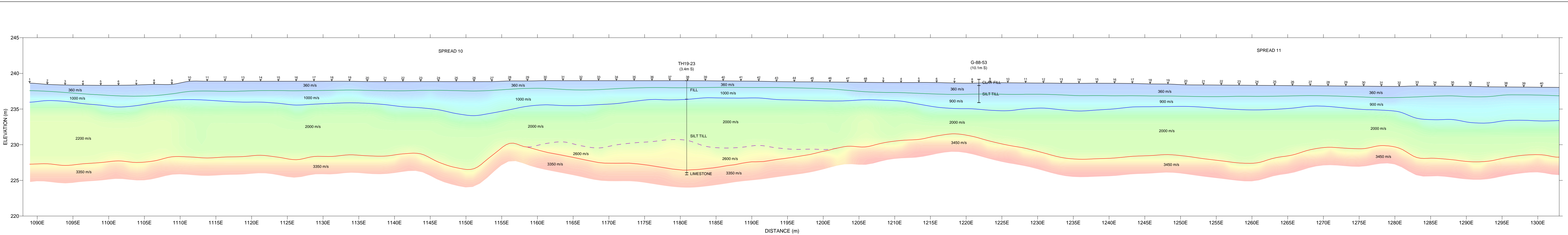
METRES

<b>KGS GROUP</b> WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
<b>SEISMIC REFRACTION SURVEY</b>		
<b>INTERPRETED DEPTH SECTION</b> <b>SL19-03D</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 25

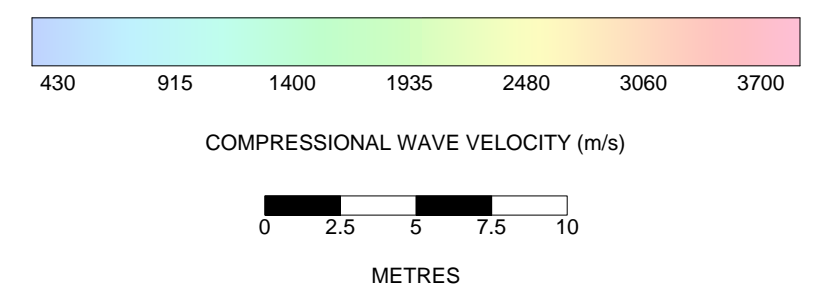
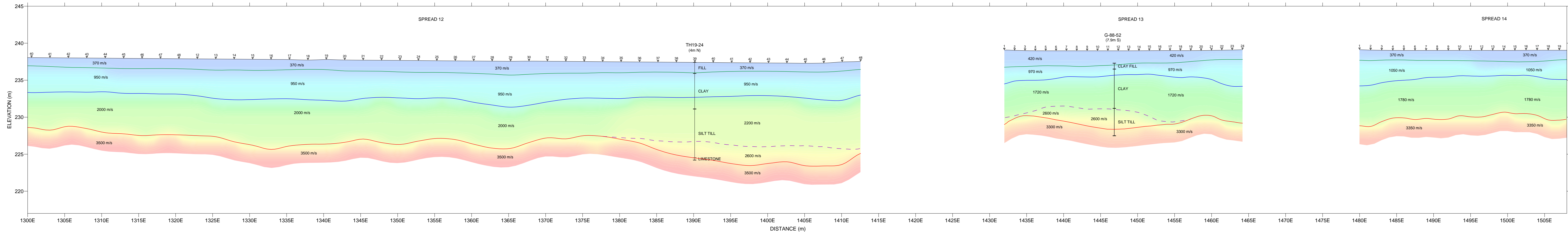


KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-03E		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 26

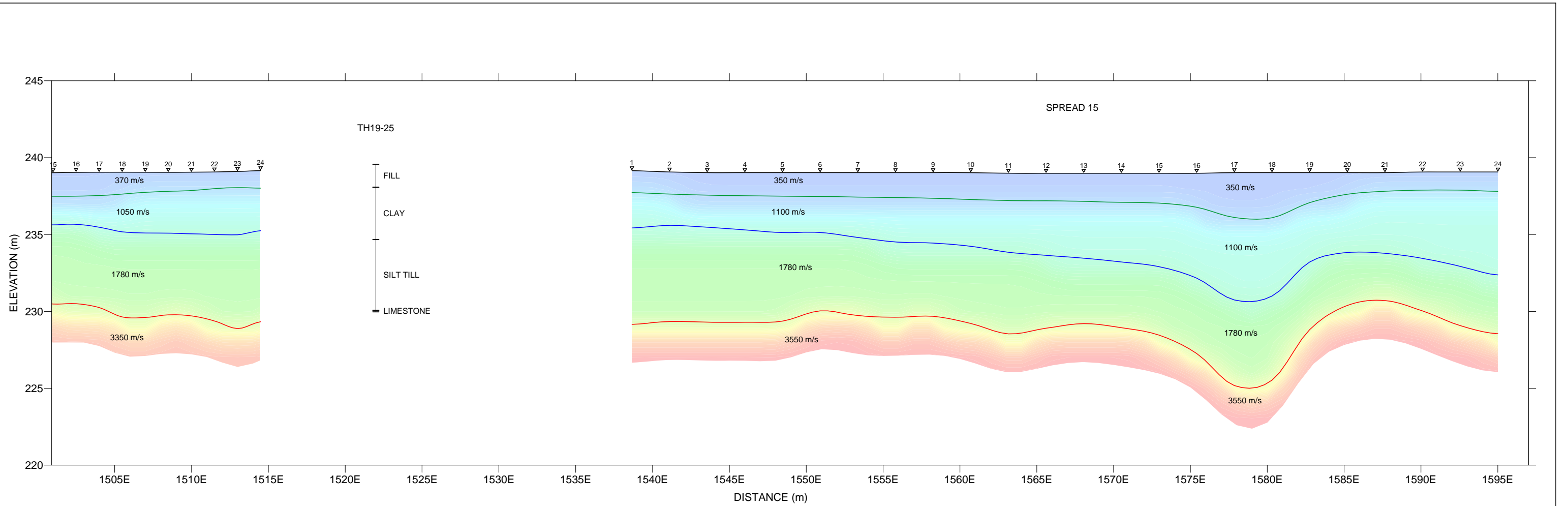




KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-03F		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE: 1:250	FIG. 27



KGS GROUP		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION		
SL19-03G		
FRONTIER GEOSCIENCES INC.		
DATE: OCT. 2019	SCALE 1:250	FIG. 28



<b>KGS GROUP</b>		
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-03H		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: OCT. 2019	SCALE 1:250	FIG. 29



**KGS**  
GROUP

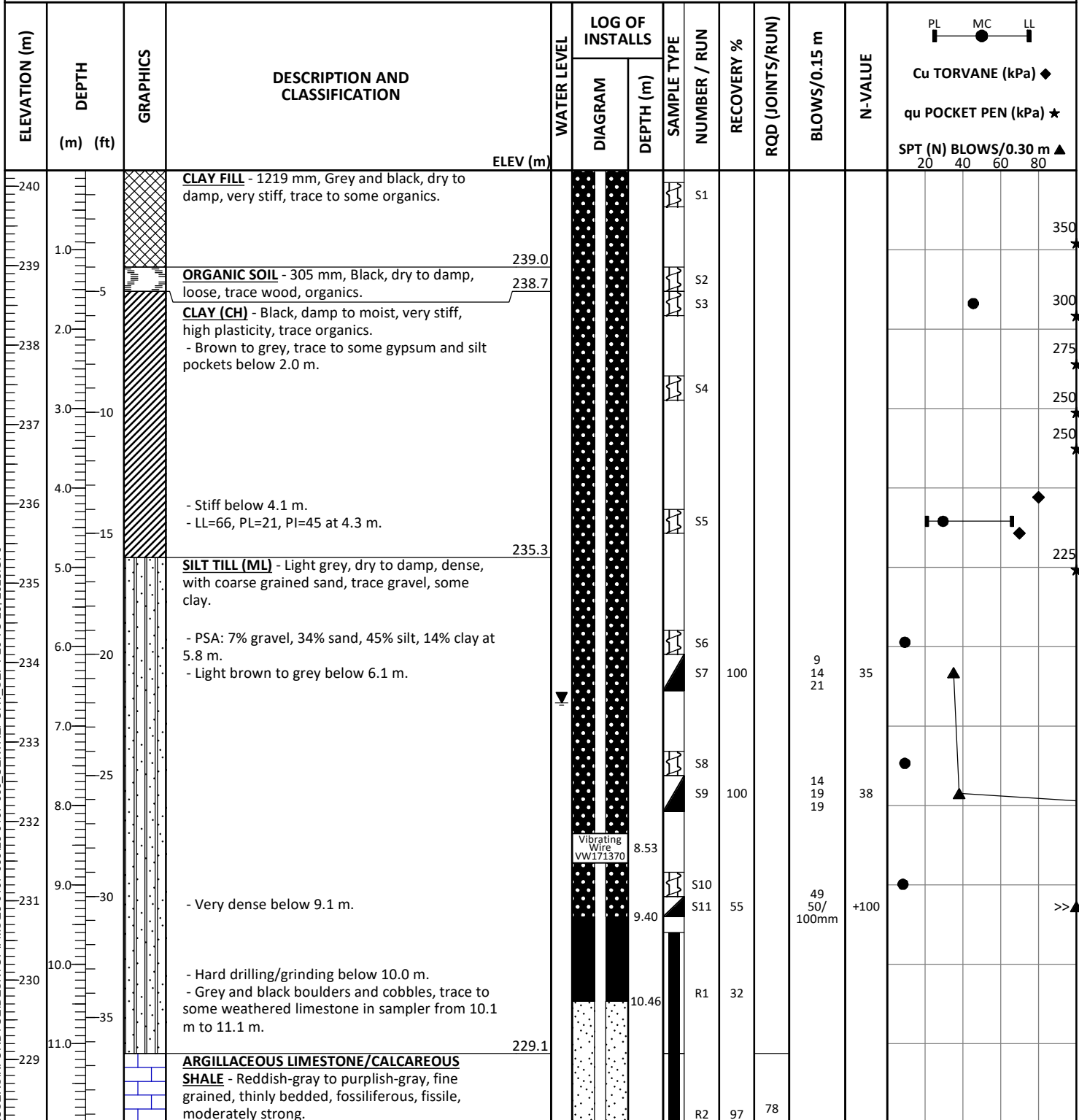
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Experience in Action

# **APPENDIX B**

2023 KGS Group Borehole Logs

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	240.20 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.91 m / 241.12 m (Standpipe)
<b>DESCRIPTION</b>	Southwest corner of lift station	<b>START DATE</b>	9-28-2023
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,530,113 E 623,145 Zone 14
<b>METHOD(S)</b>	0.0 m to 9.1 m: 125 mm ø SSA 9.1 m to 22.5 m: Water Rotary HQ Core - switched due to encountering boulders/ suspected bedrock		



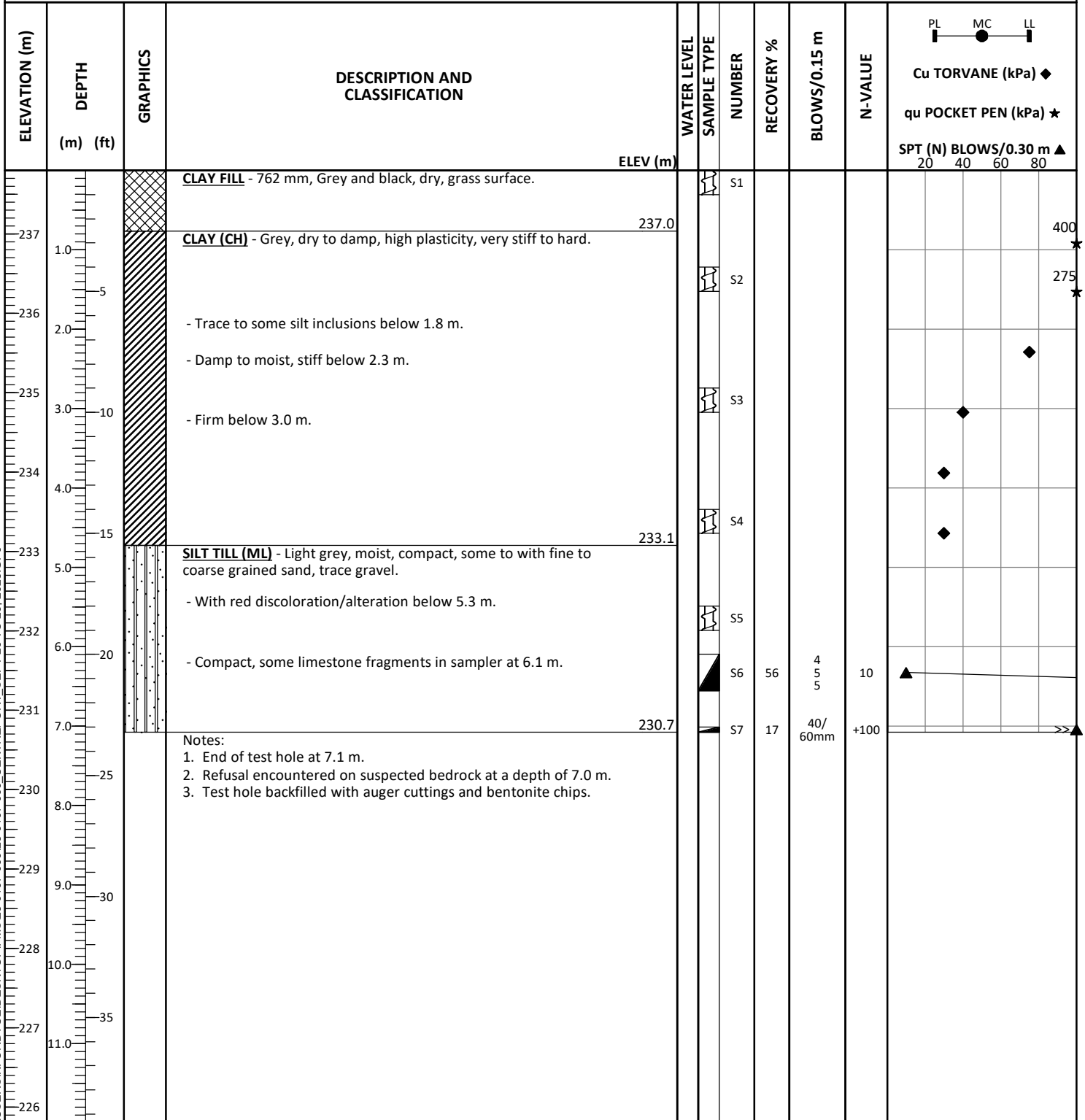
KGS\_LOG\_C:\USERS\KFORDY\DESKTOP\FMS\23-0107-009\23-0107-009\_CENTREPORT\_SEPT 26 TO 29, 2023.GPJ

<b>WATER LEVELS</b>	▽ During Drilling/Digging on 9-28-2023 None Encountered ▼ Upon Completion 6.71 m on 9-29-2023	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> M. RODRIGUEZ
		<b>APPROVED</b> K. FORDYCE	<b>DATE</b> 1-22-2024





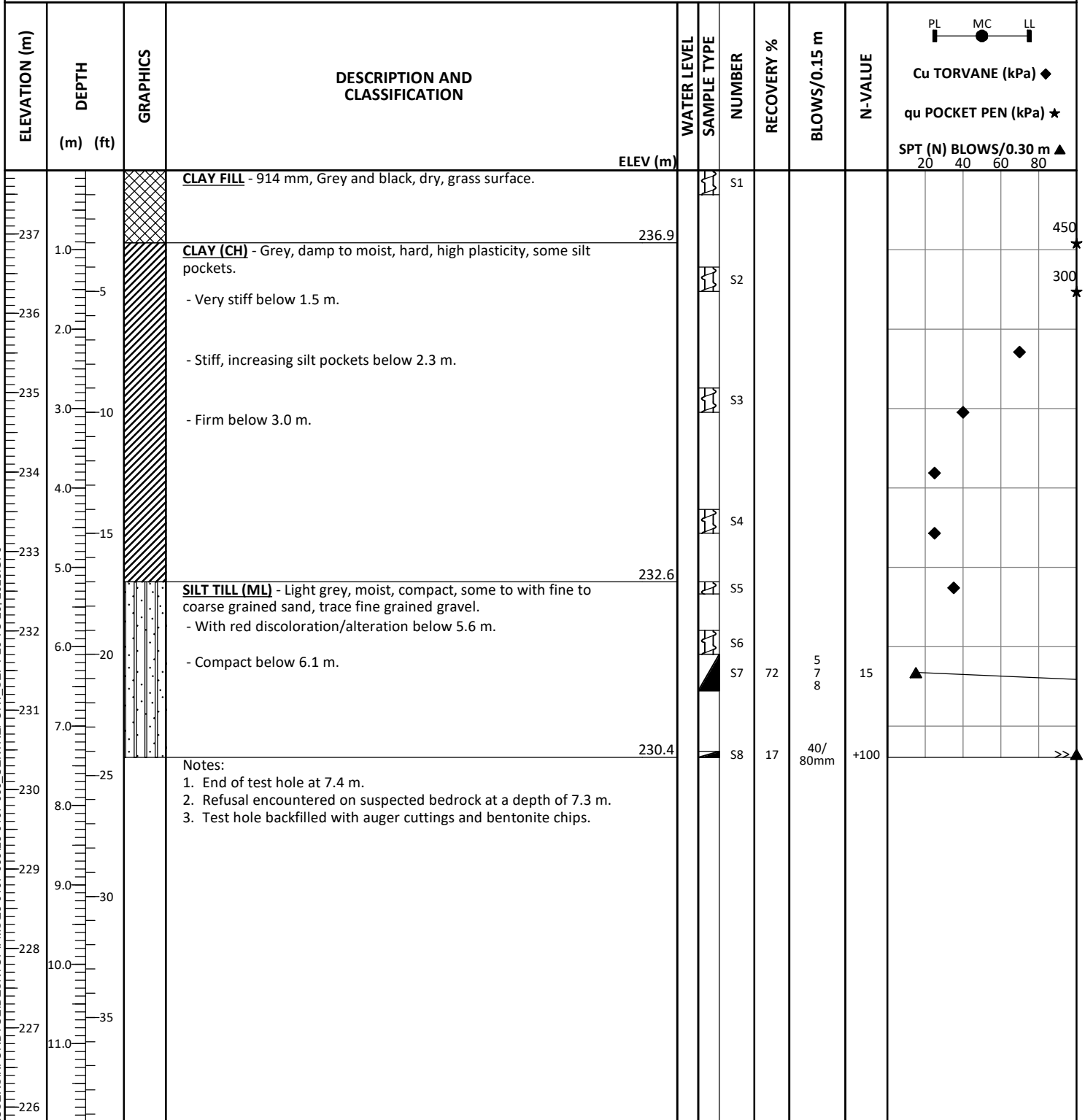
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	237.80 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-27-2023
<b>DESCRIPTION</b>	~180 m south of Silver Ave, ~125 m west of Sturgeon Rd	<b>UTM (m)</b>	N 5,528,181 E 623,558 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer 0.0 m to 7.0 m: 125 mm ø SSA		



KGS\_LOG\_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009 CENTREPORT\_SEPT 26 TO 29, 2023.GPJ

<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	237.80 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-27-2023
<b>DESCRIPTION</b>	~15 m south of Silver Ave, ~175 m west of Sturgeon Rd	<b>UTM (m)</b>	N 5,528,361 E 623,519 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer 0.0 m to 7.3 m: 125 mm ø SSA		

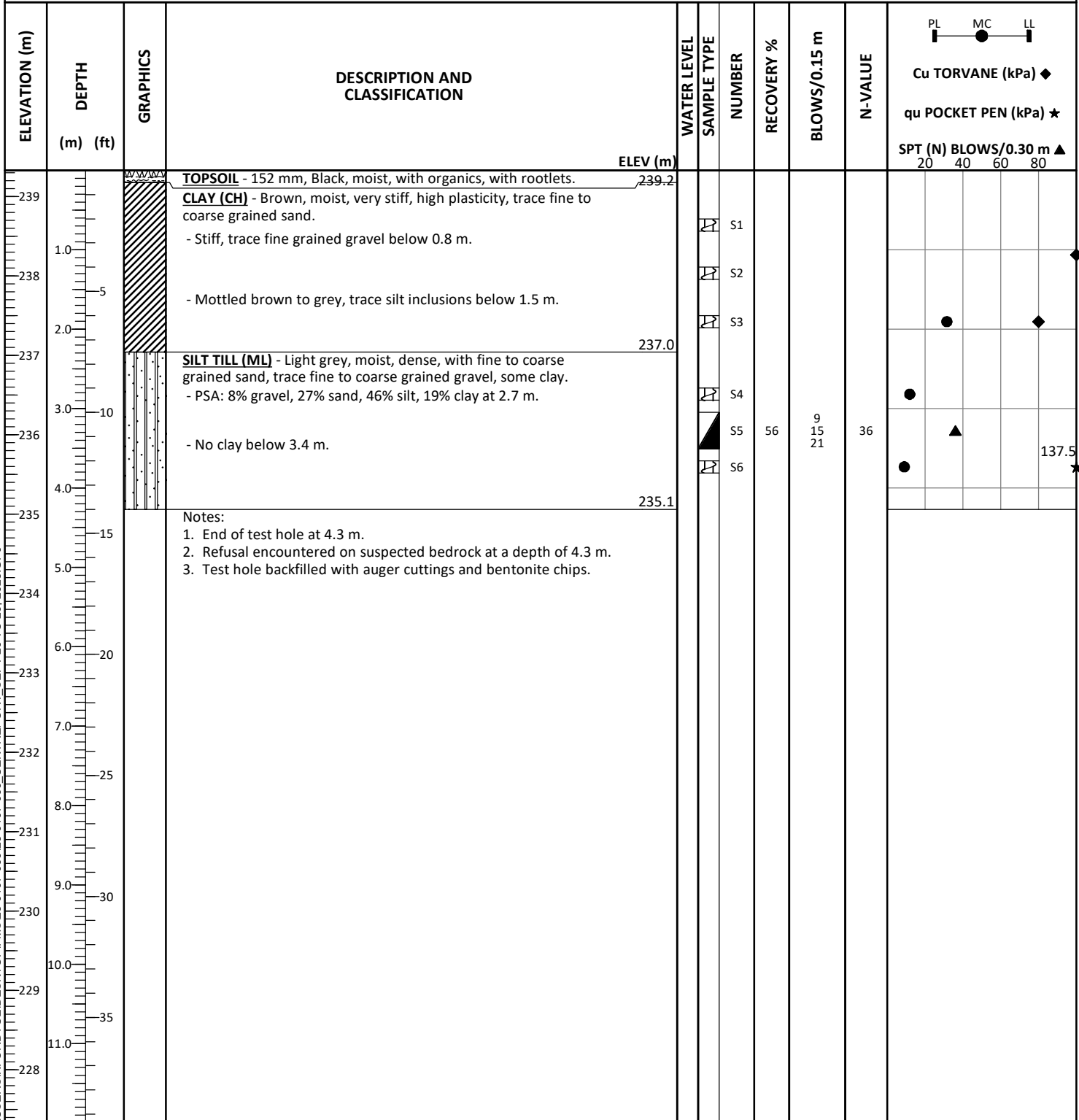


KGS\_LOG\_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\CENTREPORT\_SEPT 26 TO 29, 2023.GPJ

<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>



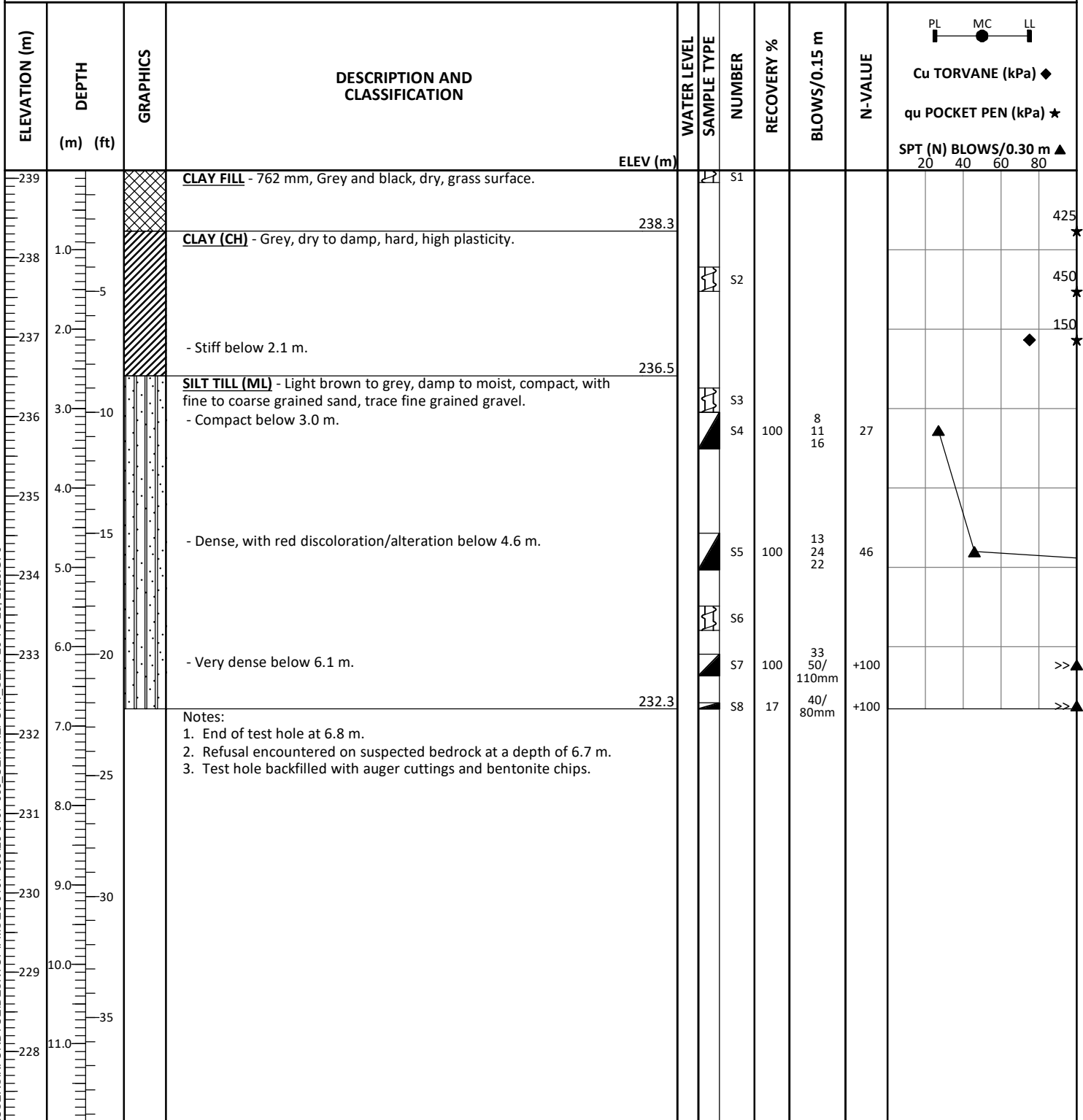
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.33 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-15-2023
<b>DESCRIPTION</b>	~180 m north of Silver Ave, ~150 m west of Sturgeon Rd	<b>UTM (m)</b>	N 5,528,557
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,549 Zone 14
<b>METHOD(S)</b>	0.0 m to 4.3 m: 125 mm ø SSA		



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<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 11-15-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 11-15-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>S. GARG</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>

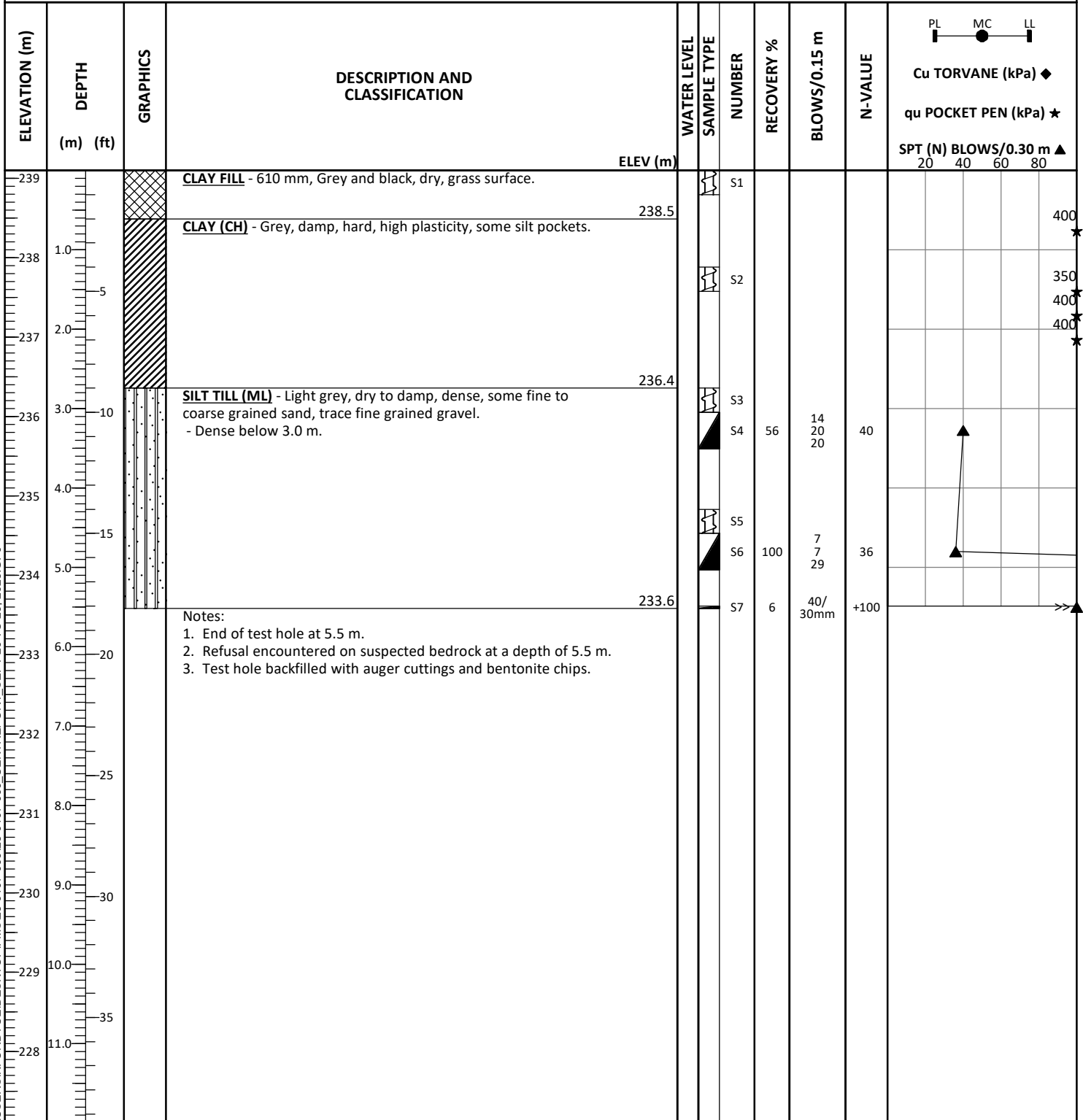
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.10 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-27-2023
<b>DESCRIPTION</b>	~260 m south of Saskatchewan Ave, ~160 m west of Sturgeon Rd	<b>UTM (m)</b>	N 5,528,836
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,547 Zone 14
	0.0 m to 6.7 m: 125 mm ø SSA		



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<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.10 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-27-2023
<b>DESCRIPTION</b>	~15 m south of Saskatchewan Ave, ~130 m west of Sturgeon Rd	<b>UTM (m)</b>	N 5,529,083
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,587 Zone 14
<b>METHOD(S)</b>	0.0 m to 5.5 m: 125 mm ø SSA		



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<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>



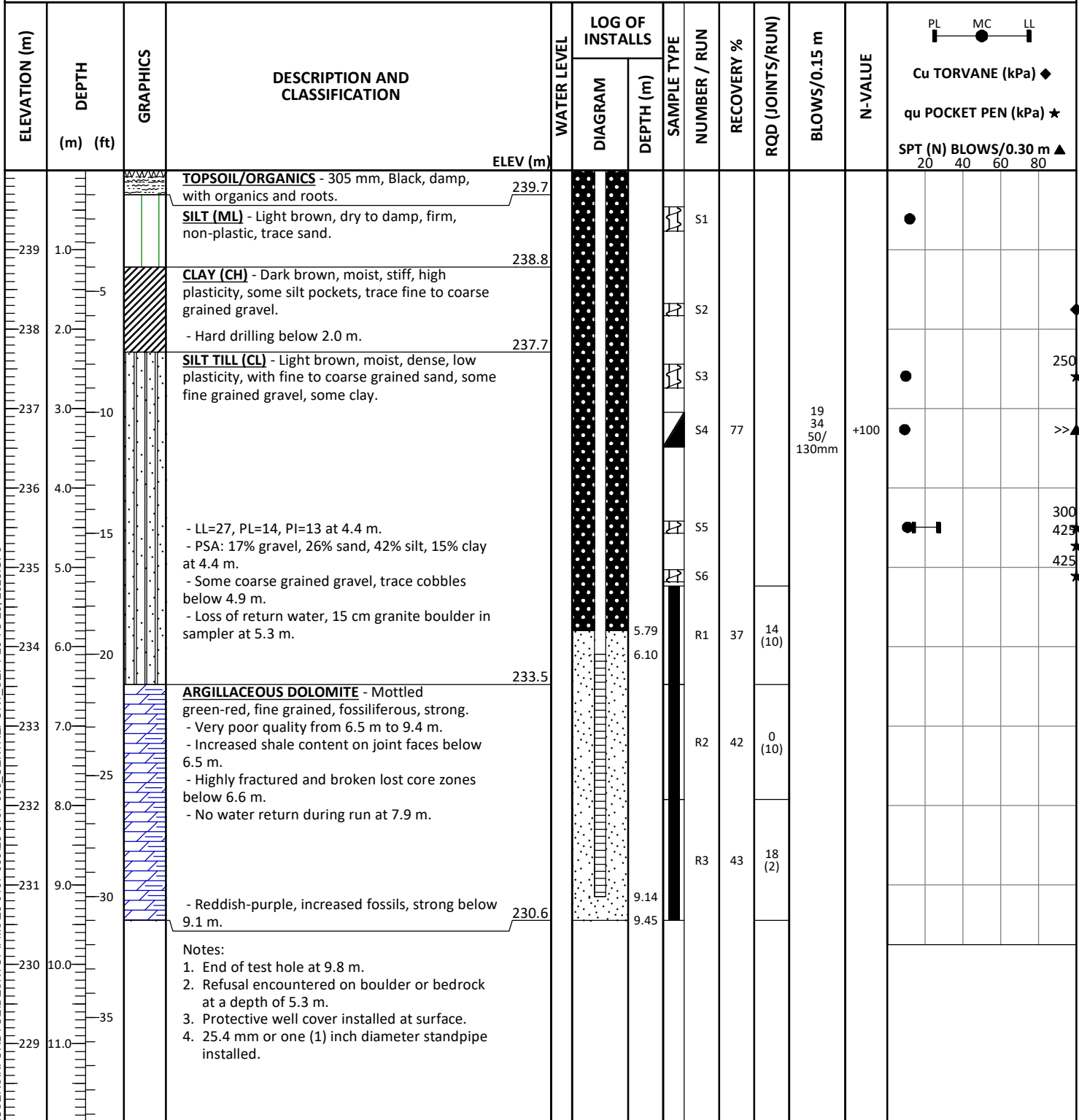
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.40 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-26-2023
<b>DESCRIPTION</b>	South side Saskatchewan Ave Rail Crossing	<b>UTM (m)</b>	N 5,529,096
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,757 Zone 14
<b>METHOD(S)</b>	0.0 m to 3.0 m: 125 mm ø SSA 3.0 m to 9.4 m: Water Rotary HQ Core - switched due to encountering suspected bedrock		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	SAMPLE TYPE NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲
239.2			<b>TOPSOIL/ORGANICS</b> - 152 mm, Grey and black, dry, trace to some organics.							
			<b>CLAY (CH)</b> - Grey, dry, hard, high plasticity, trace silt and gypsum pockets, trace fine gravel.							450
237.9	5		<b>SILT TILL (ML)</b> - Light grey, dry to damp, dense, with fine to coarse grained sand, with fine grained gravel, trace to some clay.		S1					450
			- PSA: 25% gravel, 30% sand, 35% silt, 10% clay at 2.7 m. - Very dense below 3.0 m.							450
236.0	10		<b>DOLOMITE</b> - Mottled yellow-white, fine grained, massive, trace vugs, very strong.		S2 S3	67		8 50/ 80mm	+100	>>▲
			- Fair quality from 3.4 m to 4.9 m. - UCS: 66.1 MPa at 4.0 m. - No water return at 4.3 m.		R1	65	72 (8)			
234.4	15		- Good quality from 4.9 m to 6.4 m. - Highly fractured and broken lost core zone from 4.9 m to 5.0 m.		R2	70	79 (2)			
			<b>ARGILLACEOUS DOLOMITE</b> - Mottled reddish-gray to green, fine grained, fossiliferous, moderately strong.		R3	38	27 (3)			
			- UCS: 73.7 MPa at 5.1 m.							
			- Lost core zone from 6.4 m to 7.5 m. - Poor quality from 6.4 m to 7.9 m.		R4	95	79 (12)			
			- Increased shale content from 7.5 m to 8.5 m.							
			- Good quality below 7.9 m. - ~ 30 mm thick soft shale seam at 8.0 m.							
			- Decreased shale content, increased porosity, very strong below 8.5 m. - Increased joint frequency below 8.5 m.							
230.0	30		Notes: 1. End of test hole at 9.4 m. 2. Refusal encountered on suspected bedrock at a depth of 3.0 m. 3. Test hole backfilled with auger cuttings and bentonite chips.							

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<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>

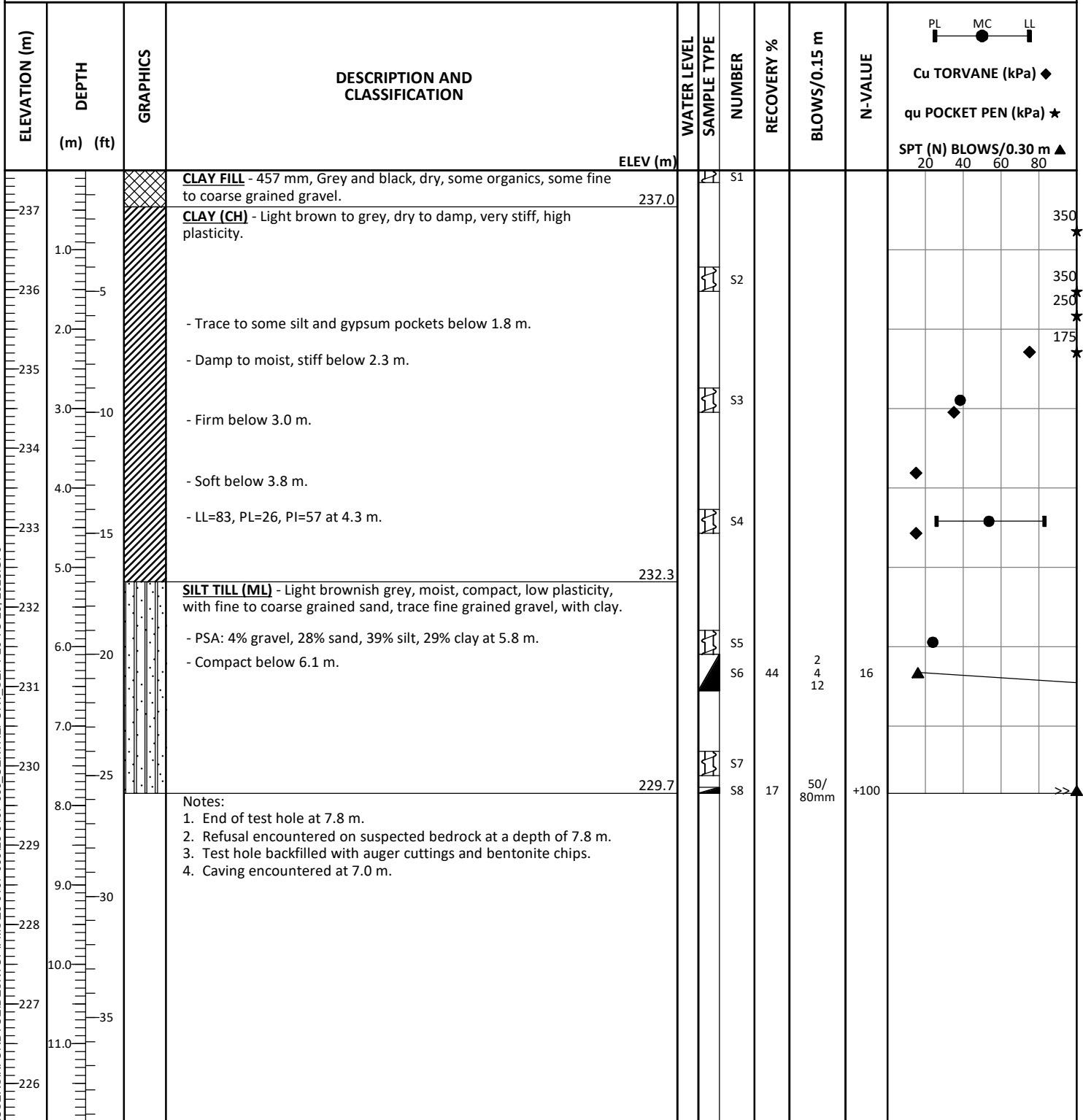
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	240.00 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.91 m / 240.91 m (Standpipe)
<b>DESCRIPTION</b>	North side Saskatchewan Ave Rail Crossing	<b>START DATE</b>	9-25-2023
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,529,183 E 623,764 Zone 14
<b>METHOD(S)</b>	0.0 m to 5.3 m: 125 mm ø SSA 5.3 m to 9.8 m: Water Rotary HQ Core - switched due to encountering suspected bedrock		



<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>G. GITZEL</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>

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<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	237.50 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	9-26-2023
<b>DESCRIPTION</b>	~60 m northwest of Tonka Pt, ~220 m east of Sturgeon Rd	<b>UTM (m)</b>	N 5,529,997 E 623,757 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer 0.0 m to 7.8 m: 125 mm ø SSA		



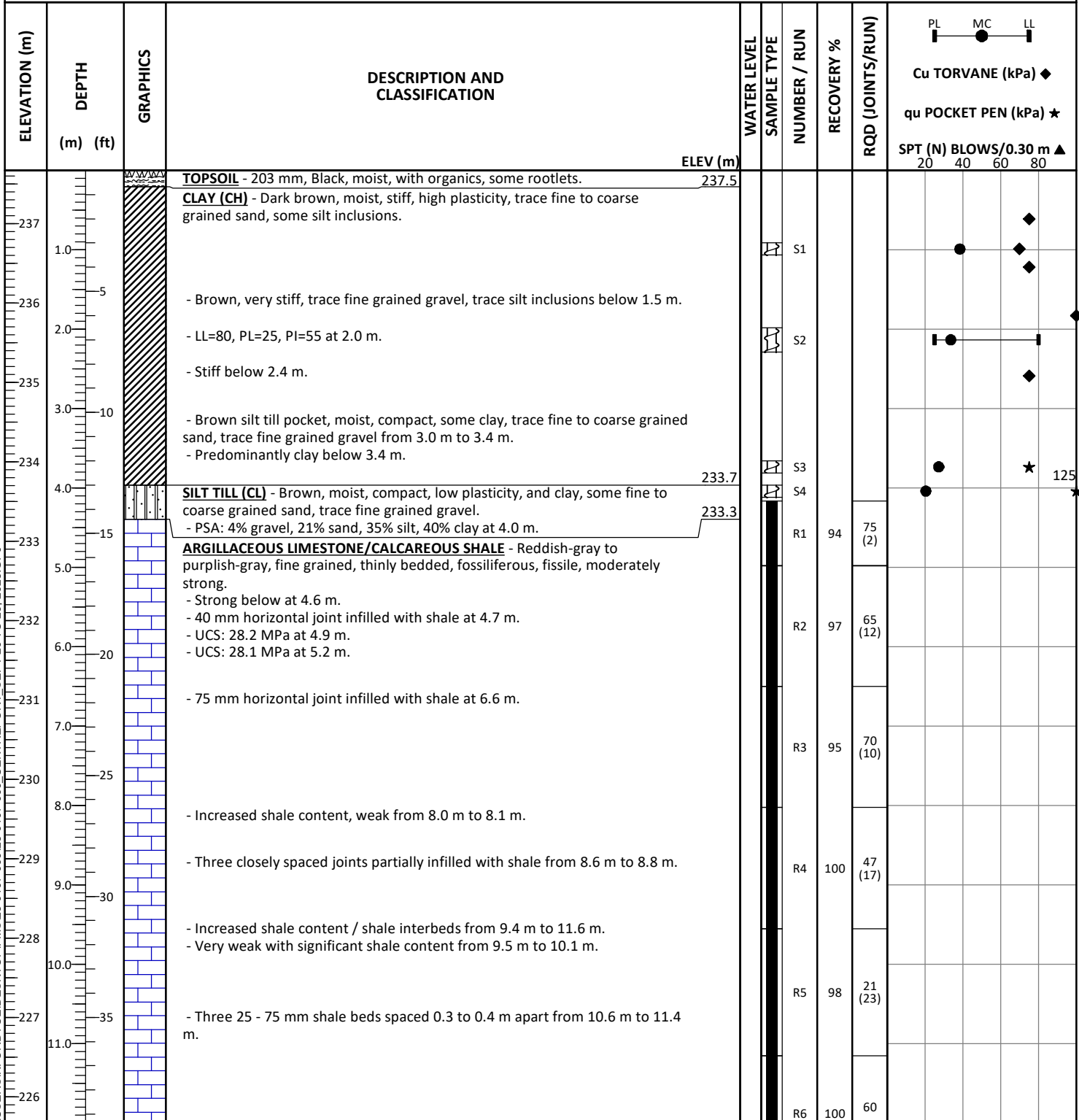
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<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-27-2023 None Encountered	<b>CONTRACTOR</b>	<b>INSPECTOR</b>
	▼ Upon Completion	on 9-27-2023 None Encountered	<b>Maple Leaf Drilling Ltd.</b>	<b>M. RODRIGUEZ</b>
			<b>APPROVED</b>	<b>DATE</b>
			<b>K. FORDYCE</b>	<b>1-22-2024</b>





<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	237.67 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-17-2023
<b>DESCRIPTION</b>	~30 m south of CPKC Rail Line, ~125 m east of CCW	<b>UTM (m)</b>	N 5,533,655 E 624,430 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer 0.0 m to 4.3 m: 125 mm ø SSA 4.3 m to 12.6 m: Water Rotary HQ Core - switched due to encountering dense till		



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<b>WATER LEVELS</b>	▼ Upon Completion	on 11-17-2023 None Encountered	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> S. GARG
			<b>APPROVED</b> J. MACLENNAN	<b>DATE</b> 1-10-2024

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	PL    MC    LL ┌───┴───┐ Cu TORVANE (kPa) ◆  qu POCKET PEN (kPa) ★  SPT (N) BLOWS/0.30 m ▲ 20   40   60   80
				ELEV (m)					
225	40		- Decreasing shale content, increasing limestone from 12.2 m to 12.4 m. - Increasing shale content, fissile from 12.4 m to 12.6 m.	225.1					(15)
224	45		Notes: 1. End of test hole at 12.6 m. 2. Refusal encountered in silt till at a depth of 4.3 m. 3. Test hole backfilled with auger cuttings and bentonite chips.						
223	50								
222	55								
221	60								
220	65								
219	70								
218	75								
217	80								
216	85								

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<b>WATER LEVELS</b> ▼ Upon Completion on 11-17-2023 None Encountered	CONTRACTOR <b>Maple Leaf Drilling Ltd.</b>	INSPECTOR <b>S. GARG</b>
	APPROVED <b>J. MACLENNAN</b>	DATE <b>1-10-2024</b>



<b>CLIENT PROJECT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>LOCATION</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	238.01 m
<b>DESCRIPTION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.91 m / 238.92 m (Standpipe)
<b>DRILL RIG / HAMMER METHOD(S)</b>	~15 m north of CPKC Rail Line, ~125 m east of CCW	<b>START DATE</b>	11-16-2023
	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,533,695 E 624,469 Zone 14
	0.0 m to 4.7 m: 125 mm ø SSA		
	4.7 m to 12.6 m: Water Rotary HQ Core - switched due to encountering boulders/suspected bedrock		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	SPT (N) BLOWS/0.30 m ▲				
					DIAGRAM	DEPTH (m)							PL	MC	LL		
237.9			<b>TOPSOIL</b> - 152 mm, Black, moist, with organics, with rootlets.														
237.0	1.0		<b>CLAY (CH)</b> - Dark brown, moist, stiff, high plasticity, trace fine grained sand. - Brown below 0.5 m.				S1										
236.0	2.0		- Light brown, moist, with silt, trace fine to coarse grained sand, trace coarse grained gravel below 2.3 m.				S2										
235.0	3.0		- Trace fine grained gravel below 2.4 m. - LL=49, PL=16, PI=33 at 2.4 m.				S3										
234.2	4.0		- Grey clay, trace silt below 3.0 m. - Brown to light brown, moist, intermediate plasticity, with silt, trace fine to coarse grained gravel below 3.4 m.				S4										
233.2	5.0		<b>SILT TILL (CL-ML)</b> - Light brown, moist, dense, low plasticity, with fine to coarse grained sand, some clay, trace fine grained gravel. - LL=21, PL=16, PI=5 at 4.0 m. - PSA: 2% gravel, 33% sand, 47% silt, 18% clay at 4.0 m.				S5	100		30/100mm	+100					>>▲	
			<b>ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE</b> - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong. - UCS: 26.8 MPa at 5.0 m. - Highly fractured, broken core zone, two vertical joints from 5.3 m to 5.7 m. - 25 mm shale bed at 5.8 m. - Increased shale content, very weak / fissile from 7.1 m to 7.2 m. - 25 mm shale bed at 7.3 m. - 15 mm shale bed at 7.7 m. - 15 mm shale bed at 7.9 m. - Several shale beds 25 - 50 mm thick, very weak from 8.5 m to 9.0 m.  - Four 12 mm thick shale beds, very weak from 9.5 m to 9.8 m. - Seven 25 - 40 mm thick shale beds spaced approximately 150 mm from 10.1 m to 11.3 m.  - Increased shale content, fissile, weak from 11.6 m to 12.0 m.				R1	67		88							
							R2	86		63 (7)							
							R3	98		52 (15)							
							R4	102		54 (15)							
							R5	98		20 (25)							
							R6	100		39 (14)							

<b>WATER LEVELS</b>	During Drilling/Digging	on 11-16-2023 None Encountered during	<b>OPERATOR</b>	<b>INSPECTOR</b>
			Maple Leaf Drilling Ltd.	S. GARG
			<b>APPROVED</b>	<b>DATE</b>
			J. MACLENNAN	1-10-2024

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ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL    MC    LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲ 20   40   60   80
					DIAGRAM	DEPTH (m)							
			ELEV (m) 225.3			12.19							
			- Decreasing shale, moderate strength to the full exploration depth.  Notes: 1. End of test hole at 12.6 m. 2. Refusal encountered on suspected bedrock at a depth of 4.7 m. 3. Protective well cover installed at surface. 4. 25.4 mm or one (1) inch diameter standpipe installed.			12.62							
225	13.0												
224	14.0												
223	15.0												
222	16.0												
221	17.0												
220	18.0												
219	19.0												
218	20.0												
217	21.0												
216	22.0												
215	23.0												
214	24.0												
213	25.0												
212	26.0												

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**WATER LEVELS** ▽ During Drilling/Digging

on 11-16-2023 None Encountered during Operations

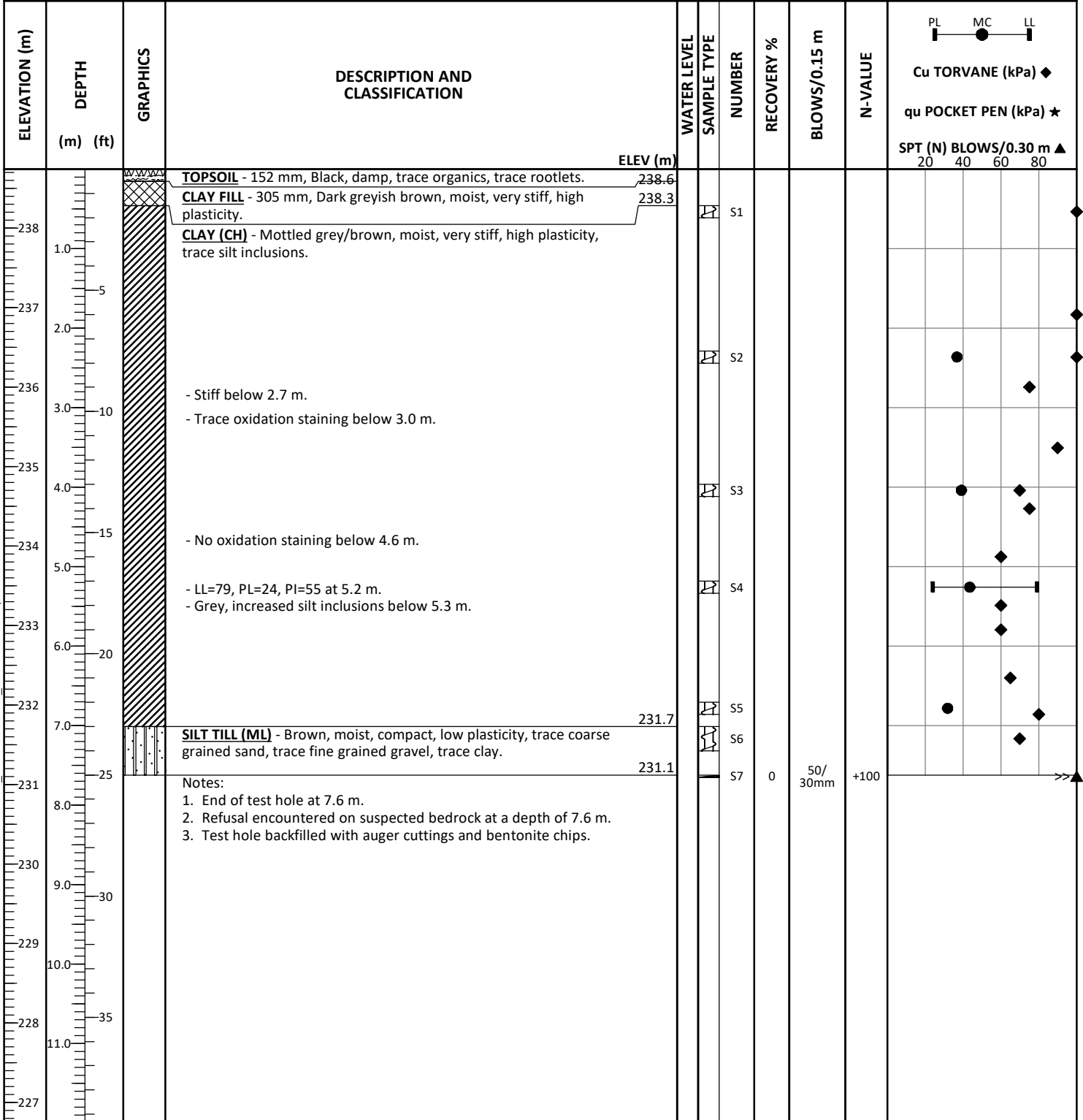
ACCEPTED BY  
**Maple Leaf Drilling Ltd.**

INSPECTOR  
**S. GARG**

APPROVED  
**J. MACLENNAN**

DATE  
**1-10-2024**

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	238.74 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-15-2023
<b>DESCRIPTION</b>	South side of Colony Creek, ~30 m east of CCW	<b>UTM (m)</b>	N 5,533,941 E 624,602 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer 0.0 m to 7.3 m: 125 mm ø SSA		

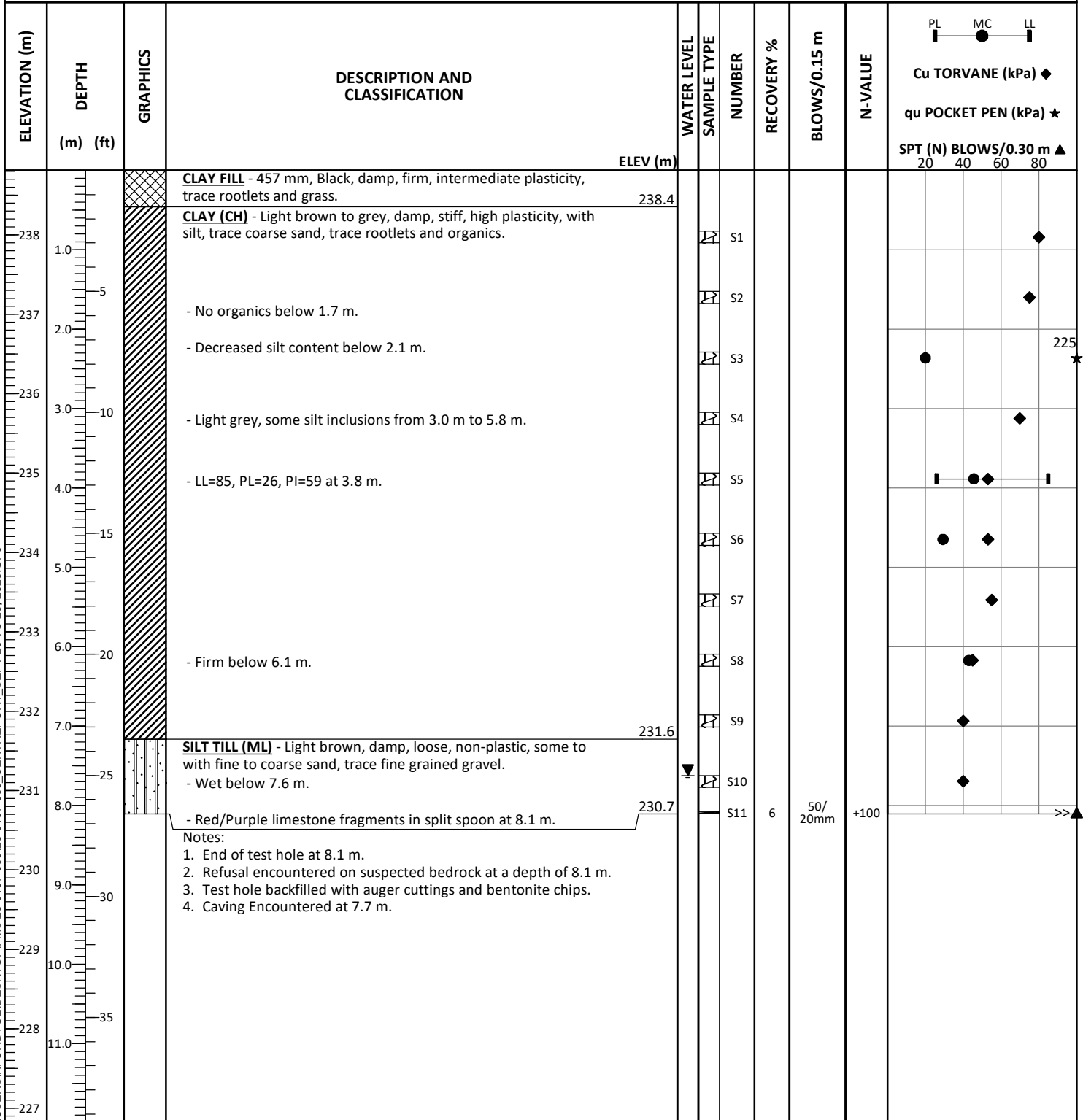


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<b>WATER LEVELS</b>	▼ Upon Completion	on 11-15-2023 None Encountered	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> S. GARG
			<b>APPROVED</b> J. MACLENNAN	<b>DATE</b> 1-10-2024



<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	238.81 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	10-5-2023
<b>DESCRIPTION</b>	15m west of CN Rail Line on Road 64N	<b>UTM (m)</b>	N 5,534,056
<b>DRILL RIG / HAMMER</b>	Mobile B37X Track Mounted Drill Rig with Auto-Hammer		E 624,724 Zone 14
<b>METHOD(S)</b>	0.0 m to 8.1 m: 125 mm ø SSA		



Notes:  
 1. End of test hole at 8.1 m.  
 2. Refusal encountered on suspected bedrock at a depth of 8.1 m.  
 3. Test hole backfilled with auger cuttings and bentonite chips.  
 4. Caving Encountered at 7.7 m.

**WATER LEVELS**  
 ▽ During Drilling/Digging on 10-5-2023 None Encountered  
 ▼ Upon Completion 7.62 m on 10-5-2023

**CONTRACTOR**  
Maple Leaf Drilling Ltd.

**INSPECTOR**  
L. PROVEN

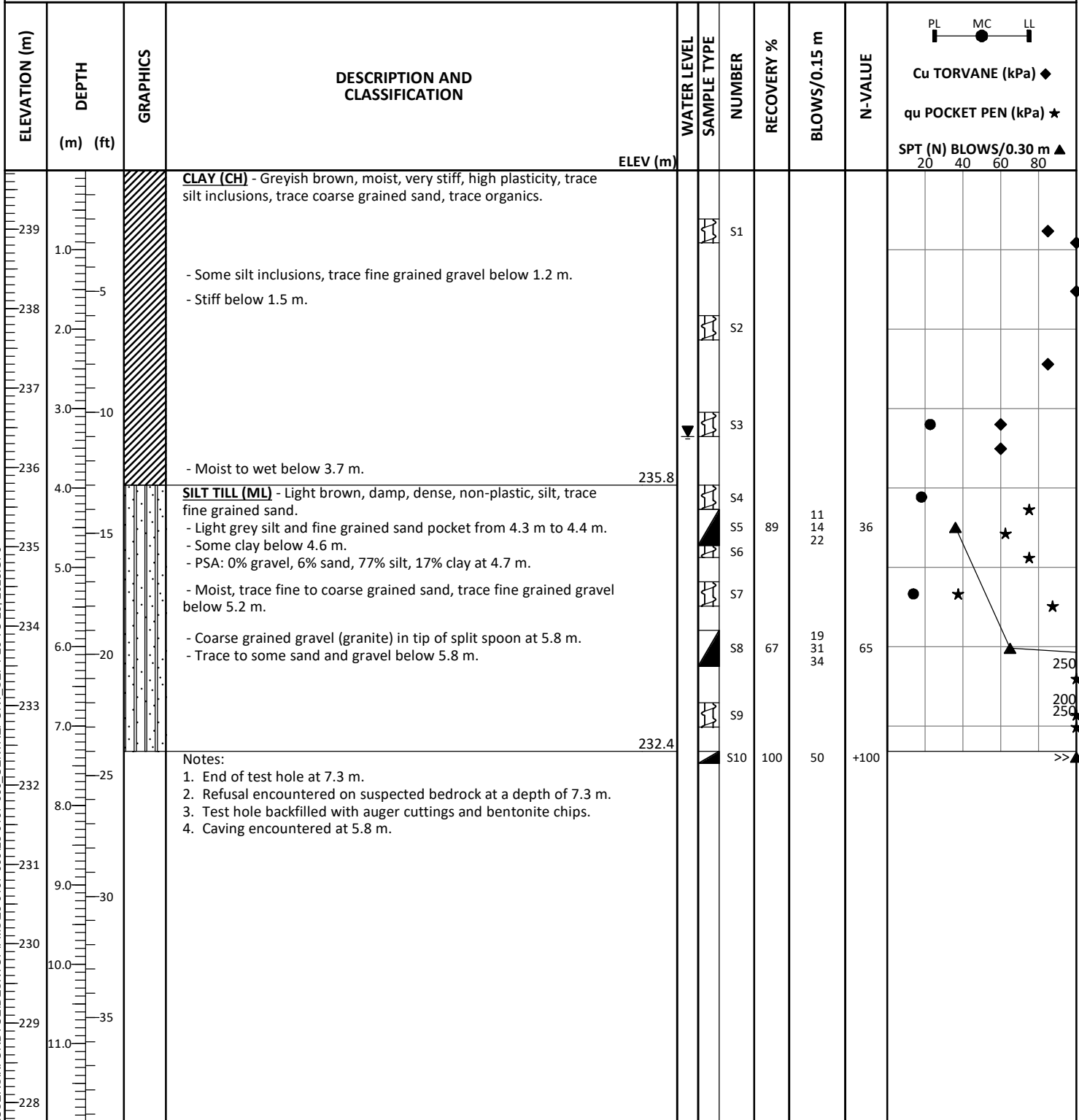
**APPROVED**  
J. MACLENNAN

**DATE**  
1-10-2024

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<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.74 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-22-2023
<b>DESCRIPTION</b>	Ditch, offset ~12 m south of CCW, north Red Fife Rd.	<b>UTM (m)</b>	N 5,534,319 E 625,091 Zone 14
<b>DRILL RIG / HAMMER</b>	Mobile B37X Track Mounted Drill Rig with Auto-Hammer		
<b>METHOD(S)</b>	0.0 m to 7.3 m: 125 mm ø SSA		

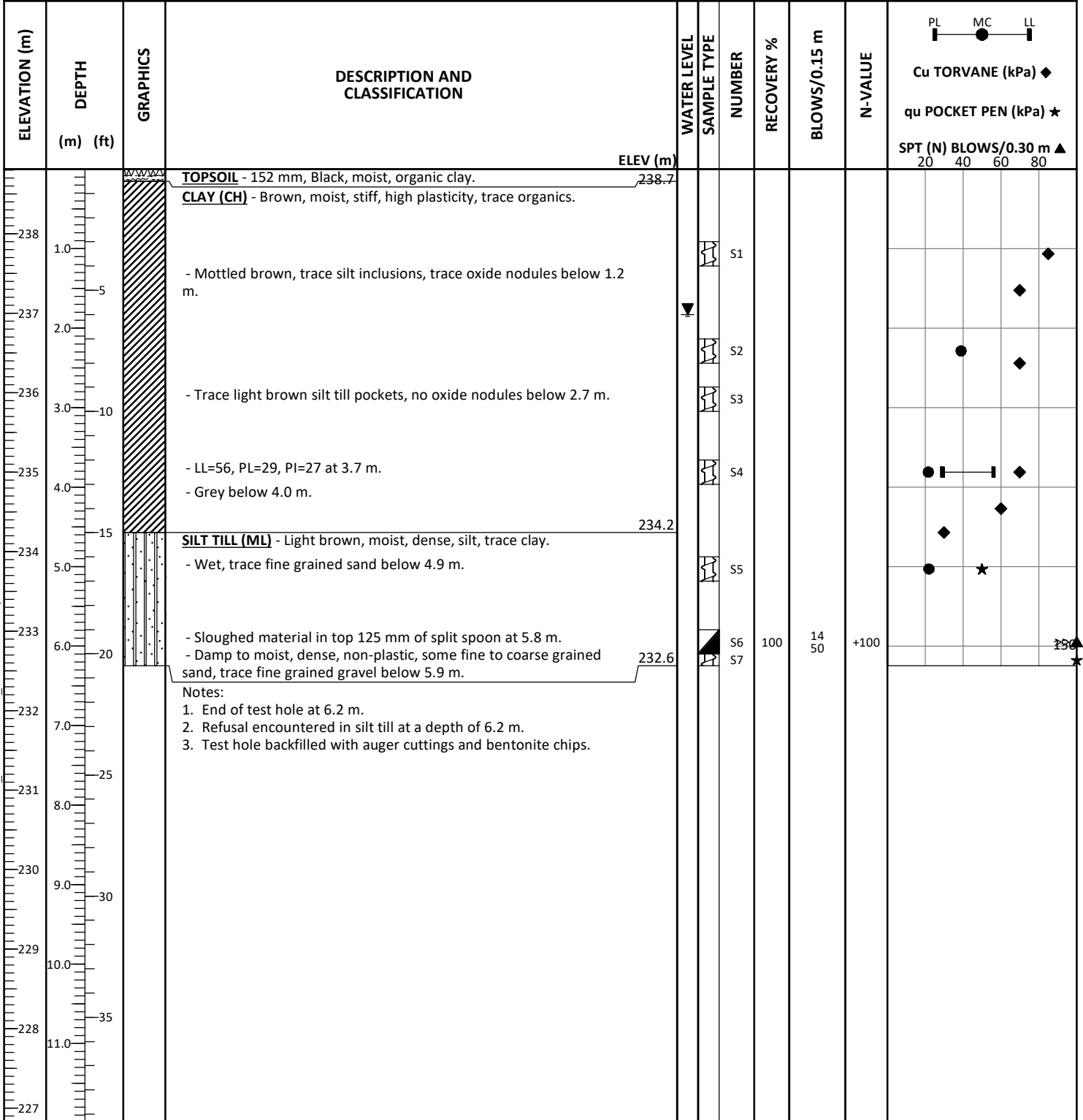


<b>WATER LEVELS</b>	▼ Upon Completion	3.35 m on 11-22-2023	<b>CONTRACTOR</b>	Maple Leaf Drilling Ltd.	<b>INSPECTOR</b>	K. FORDYCE
			<b>APPROVED</b>	J. MACLENNAN	<b>DATE</b>	1-10-2024

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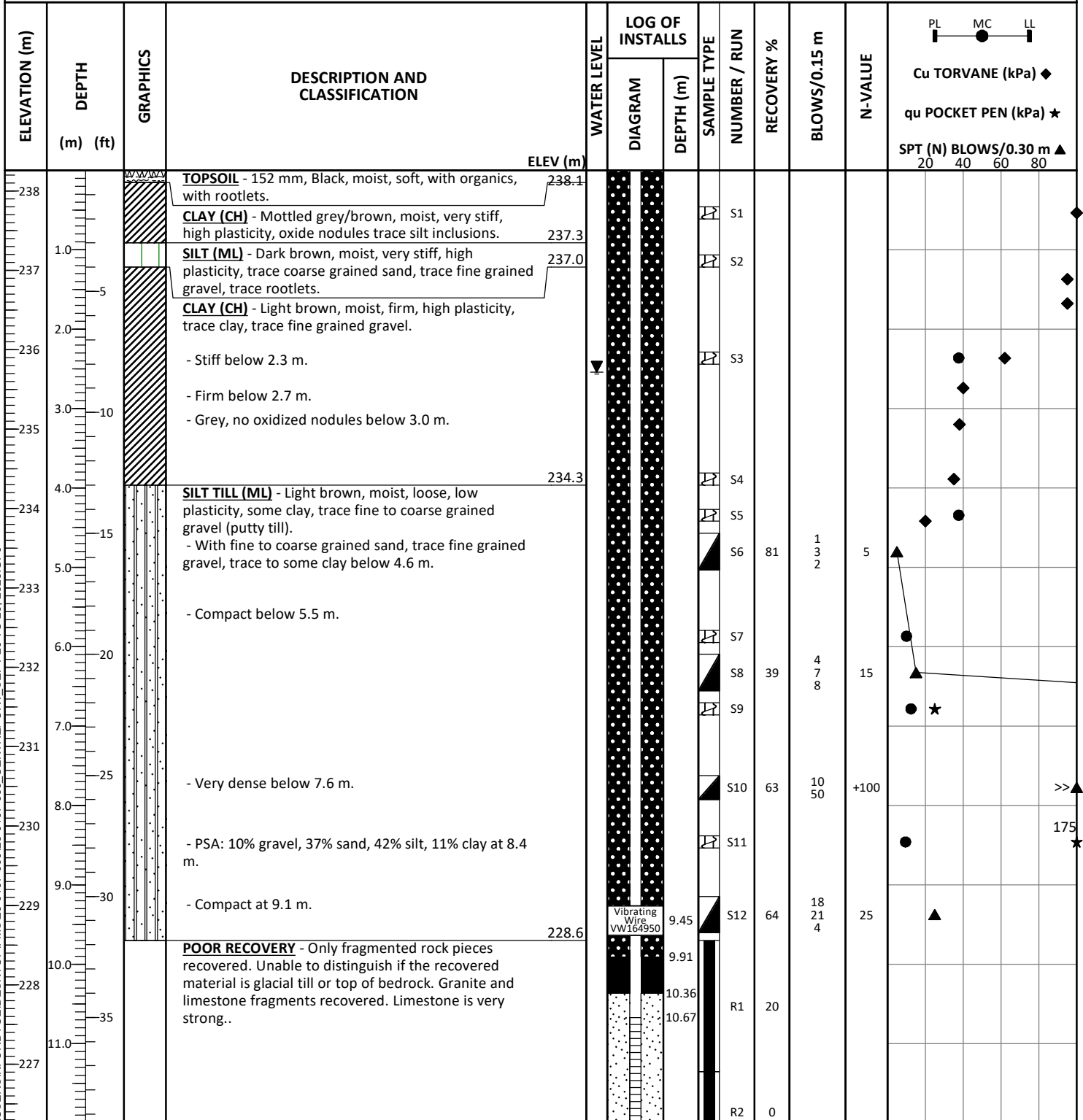
<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	238.81 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-22-2023
<b>DESCRIPTION</b>	Ditch, offset ~12 m south of CCW, north Red Fife Rd.	<b>UTM (m)</b>	N 5,534,208 E 625,352 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	Mobile B37X Track Mounted Drill Rig with Auto-Hammer 0.0 m to 6.2 m: 125 mm ø SSA		



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<b>WATER LEVELS</b>	▼ Upon Completion	1.83 m on 11-22-2023	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> K. FORDYCE
			<b>APPROVED</b> J. MACLENNAN	<b>DATE</b> 1-10-2024

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	238.26 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	1.00 m / 239.26 m (Standpipe)
<b>DESCRIPTION</b>	Farm field, ~75 m east of CCW, ~320 m south of Sturgeon Access	<b>START DATE</b>	11-13-2023
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,529,982 E 622,695 Zone 14
<b>METHOD(S)</b>	0.0 m to 10.1 m: 125 mm ø SSA 10.1 m to 12.4 m: Water Rotary HQ Core - switched due to encountering dense till		



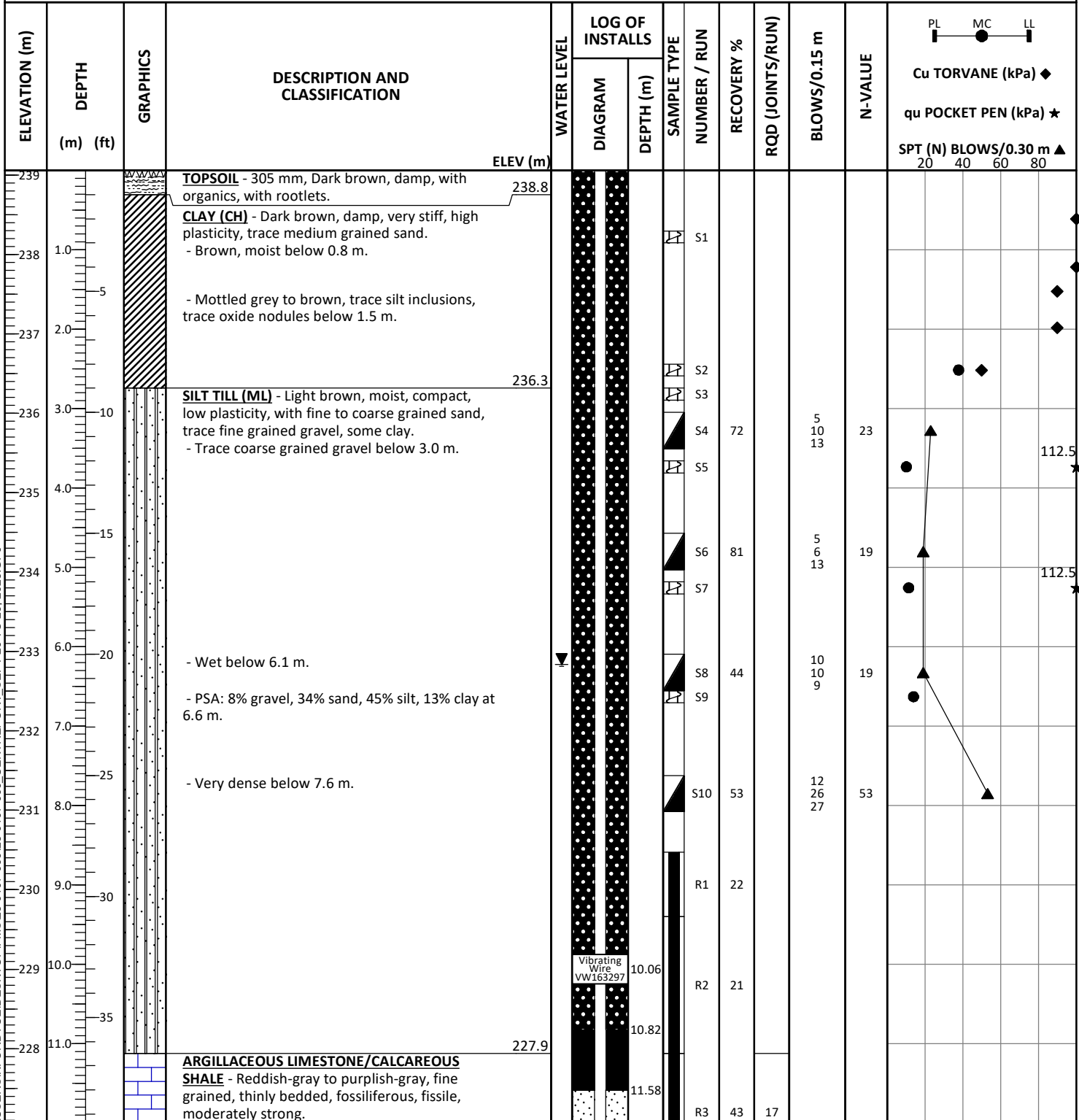
<b>WATER LEVELS</b>	▼ Upon Completion	2.54 m on 11-14-2023	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> G. GITZEL
			<b>APPROVED</b> K. FORDYCE	<b>DATE</b> 1-22-2024

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ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER / RUN	RECOVERY %	BLOWS/0.15 m	N-VALUE	PL      MC      LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲ 20    40    60    80					
					DIAGRAM	DEPTH (m)											
226	40			ELEV (m) 225.9		12.19 12.37											
225	45		Notes: 1. End of test hole at 12.4 m. 2. Refusal encountered on suspected bedrock at a depth of 10.1 m. 3. Test hole backfilled with grout. 4. Protective well cover installed at surface. 5. 25.4 mm or one (1) inches diameter standpipe installed. 6. Vibrating wire piezometer (VW164950) installed at 9.45 m below grade.														
224	50																
223	55																
222	60																
221	65																
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219	75																
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<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.06 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.79 m / 239.85 m (Standpipe)
<b>DESCRIPTION</b>	Farm field, ~180 m east of CCW, ~125 m south of Sturgeon Access	<b>START DATE</b>	11-14-2023
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,530,062 E 622,907 Zone 14
<b>METHOD(S)</b>	0.0 m to 8.2 m: 125 mm $\phi$ SSA 8.2 m to 14.1 m: Water Rotary HQ Core - switched due to encountering dense till		



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<b>WATER LEVELS</b>	▼ Upon Completion	6.22 m on 11-14-2023	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> G. GITZEL
			<b>APPROVED</b> K. FORDYCE	<b>DATE</b> 1-22-2024

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL	MC	LL	
					DIAGRAM	DEPTH (m)							Cu TORVANE (kPa) ◆			qu POCKET PEN (kPa) ★
227	40		<p>ELEV (m) 225.0</p> <p>- Broken core zone, high shale content from 11.1 m to 11.3 m. - UCS: 20.9 MPa at 11.4 m. - Broken lost core zone from 11.7 m to 12.5 m.</p> <p>- UCS: 24.3 MPa at 13.3 m. - 50 mm joint infilled with shale at 13.5 m. - Increased shale content below 13.9 m.</p> <p>Notes: 1. End of test hole at 14.1 m. 2. Refusal encountered on suspected bedrock at a depth of 8.2 m. 3. Test hole backfilled with grout. 4. Protective well cover installed at surface. 5. 25.4 mm or one (1) inches diameter standpipe installed. 6. Vibrating wire piezometer (VW163297) installed at 10.06 m below grade.</p>		12.04		R4	100		79 (8)						
226	13.0				13.56											
225	45				14.07											
224	50															
223	55															
222	60															
221	65															
220	70															
219	75															
218	80															
217	85															
216																
215																
214																
213																

**WATER LEVELS** ▼ Upon Completion 6.22 m on 11-14-2023

CONTRACTOR  
**Maple Leaf Drilling Ltd.**

INSPECTOR  
**G. GITZEL**

APPROVED  
**K. FORDYCE**

DATE  
**1-22-2024**

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	239.09 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>START DATE</b>	11-14-2023
<b>DESCRIPTION</b>	Field, ~35 m west of Sturgeon Rd, ~40 m north of Sturgeon Access	<b>UTM (m)</b>	N 5,529,971 E 623,340 Zone 14
<b>DRILL RIG / HAMMER METHOD(S)</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	SAMPLE TYPE NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL MC LL	Cu TORVANE (kPa) ◆	qu POCKET PEN (kPa) ★	SPT (N) BLOWS/0.30 m ▲
239			<b>TOPSOIL</b> - 152 mm, Black, moist, with organics, with rootlets.										
			<b>CLAY (CH)</b> - Brown, moist, very stiff, high plasticity, trace medium to coarse grained sand, trace rootlets.										
238	1.0		- Grey, trace silt inclusions, trace fine grained gravel, no rootlets below 1.5 m.		S1								
237	2.0				S2								
236	3.0		<b>SILT TILL (ML)</b> - Light brown, damp, compact, low plasticity, trace fine to coarse grained sand, trace fine grained gravel, some clay.		S3								
			- With fine to coarse grained sand below 4.0 m.		S4	78		14 16 12	28			112.5	
235	4.0		- Very dense below 4.6 m.		S5								
			- PSA: 10% gravel, 31% sand, 45% silt, 14% clay at 4.6 m.		S6	96		43 50	+100			>>	
234	5.0												
233	6.0				R1	41							
			<b>ARGILLACEOUS DOLOMITE</b> - Mottled yellow-green, fine grained, fossiliferous, moderately strong, some vugs (6 - 25 mm).										
232	7.0		- Concentrated zone of vugs from 6.4 m to 6.6 m.		R2	98		86 (7)					
			- 50 mm horizontal joint infilled with shale at 6.8 m.										
231	8.0		<b>ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE</b> - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.										
			- 25 mm horizontal joint infilled with red shale at 7.3 m.		R3	98		83					
			- 12 mm horizontal joint infilled with red shale at 7.7 m.										
230	9.0		- Broken core zone with significant shale infill from 8.1 m to 8.3 m.										
			- 75 mm horizontal joint infilled with red shale at 8.5 m.		R4	93		93 (6)					
			- Increasing green shale interbeds; decreased red shale from 8.8 m to 9.8 m.										
229	10.0												
228	11.0		- 7 mm horizontal joint infilled with red shale at 11.0 m.		R5	100		58 (12)					
			- 25 - 65 mm thick shale interbeds spaced at 0.3 - 0.45 m extending to the full exploration depth.										
			- UCS: 29.6 MPa at 11.4 m.										

<b>WATER LEVELS</b>	During Drilling/Digging	on 11-14-2023 None Encountered during	<b>ACCEPTOR</b>	<b>INSPECTOR</b>
			Maple Leaf Drilling Ltd.	G. GITZEL
			<b>APPROVED</b>	<b>DATE</b>
			K. FORDYCE	1-22-2024

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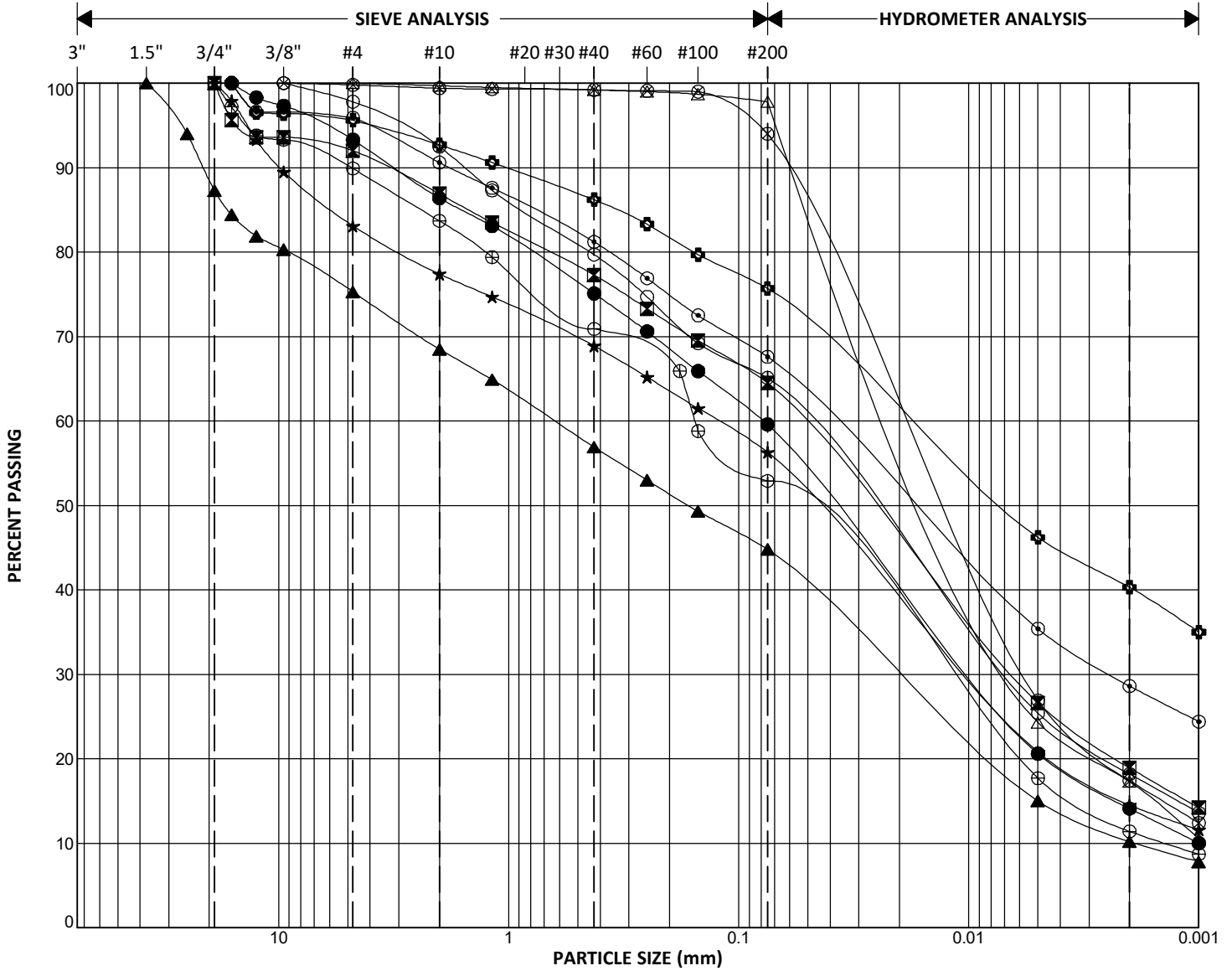


ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	SPT (N) BLOWS/0.30 m ▲				
											20	40	60	80	
227	40		<p>- Three 100 - 125 mm thick limestone interbeds spaced at 0.3 m from 13.5 m to 13.6 m.</p> <p>- Decreasing shale, increasing limestone from 14.9 m to 15.0 m.</p> <p>- Broken core zone, open joint with shale at 15.2 m.</p>	ELEV (m)		R6	100	49 (16)							
226	45					R7	95	47 (12)							
225	50			223.4											
224	55		Notes:												
223	60		<ol style="list-style-type: none"> <li>End of test hole at 15.6 m.</li> <li>Refusal encountered on suspected bedrock at a depth of 5.0 m.</li> <li>Test hole backfilled with auger cuttings and bentonite chips.</li> </ol>												
222	65														
221	70														
220	75														
219	80														
218	85														
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<b>WATER LEVELS</b> <input checked="" type="checkbox"/> During Drilling/Digging on 11-14-2023 None Encountered during	ACCEPTOR <b>Maple Leaf Drilling Ltd.</b>	INSPECTOR <b>G. GITZEL</b>
	APPROVED <b>K. FORDYCE</b>	DATE <b>1-22-2024</b>

# GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-01	5.8	S6	7	33	45	14	60	78.37	1.18	ML
⊠	TH23-05	2.7	S4	8	27	46	19	65			ML
▲	TH23-08	2.7	S2	25	30	35	10	45	334.42	0.32	SM
★	TH23-09	4.4	S5	17	27	42	15	56			CL
⊙	TH23-11	5.8	S5	4	28	39	29	68			ML
⊕	TH23-17	4.0	S4	4	20	35	40	76			CL
○	TH23-18	4.0	S4	2	33	47	18	65			CL-ML
△	TH23-21	5.5	S5	0	2	81	17	98			ML
⊗	TH23-22	4.7	S6	0	6	77	17	94			ML
⊕	TH23-24	8.4	S11	10	37	42	11	53	110.80	0.77	ML

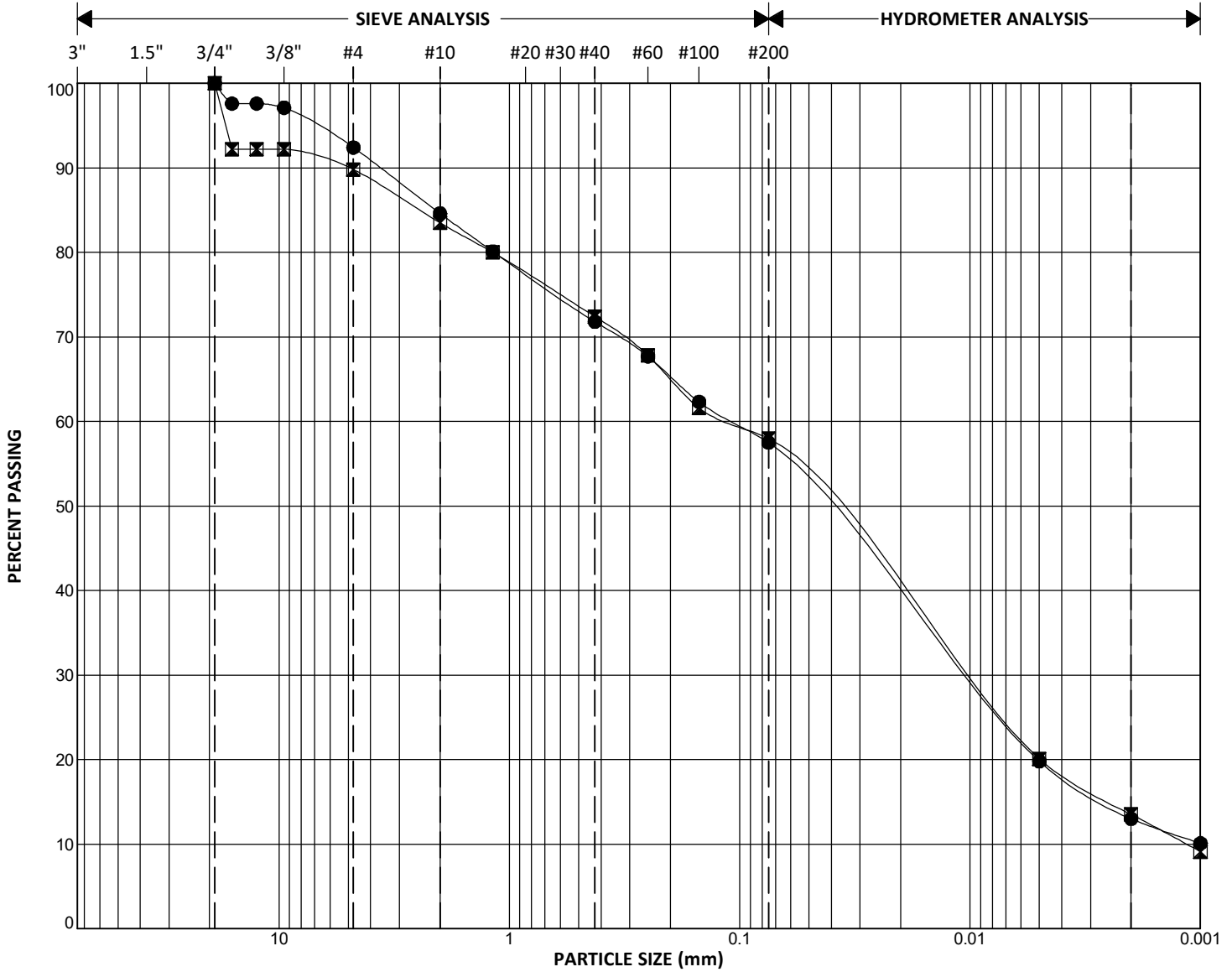
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**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT NAME** CentrePort Regional S&W Servicing  
**TESTED BY** Stantec

**PROJECT NO.** 23-0107-009  
**LOCATION** Winnipeg, Manitoba  
**DATE TESTED** 10/26/2023

# GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-25	6.6	S9	8	34	45	13	58			ML
■	TH23-26	4.6	S6	10	32	45	14	58	95.66	0.81	ML

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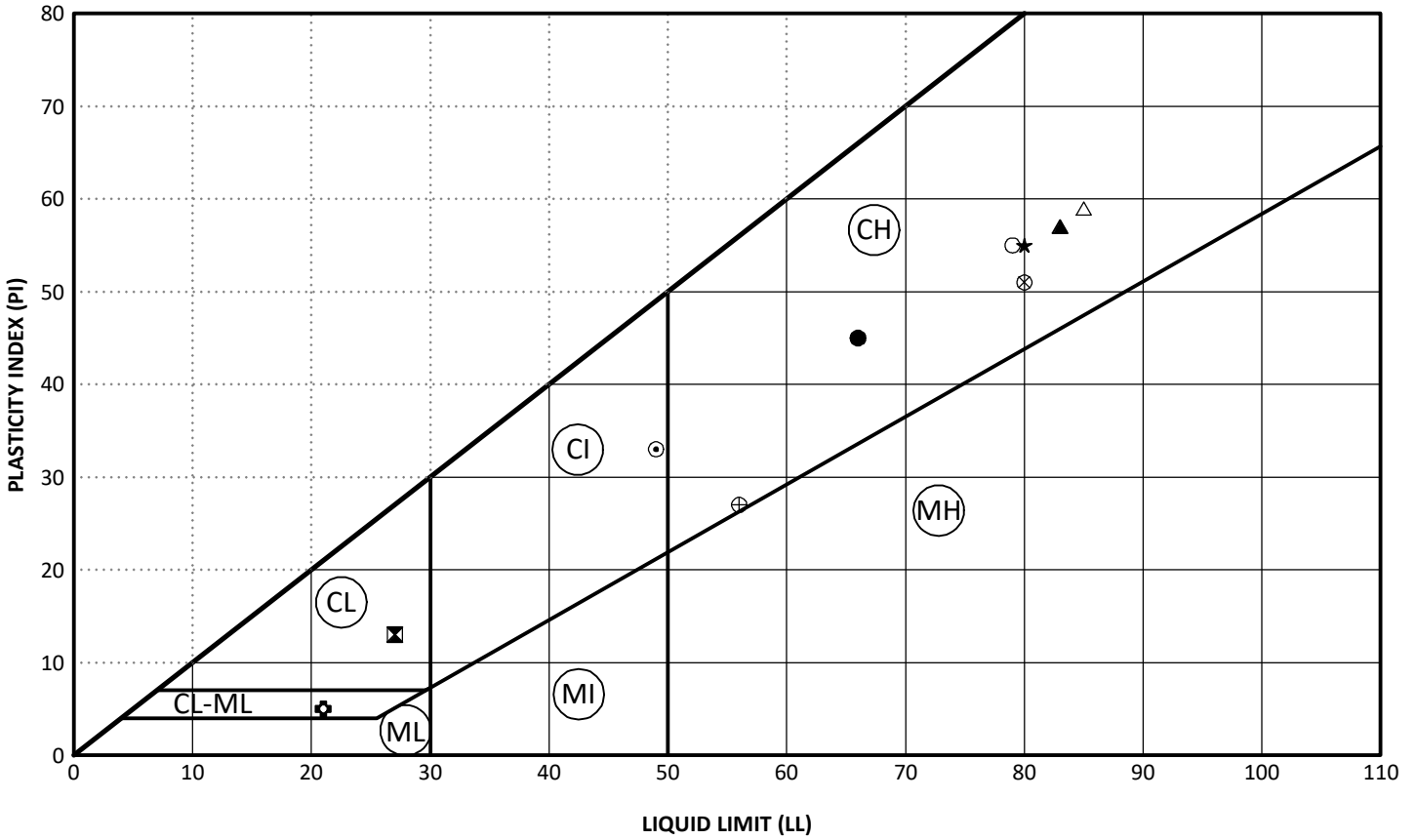


**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT NAME** CentrePort Regional S&W Servicing  
**TESTED BY** Stantec

**PROJECT NO.** 23-0107-009  
**LOCATION** Winnipeg, Manitoba  
**DATE TESTED** 10/26/2023



# ATTERBERG LIMITS



	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH23-01	4.3	S5	66	21	45					30	CH
⊠	TH23-09	4.4	S5	27	14	13	27	42	15	56	11	CL
▲	TH23-11	4.3	S4	83	26	57					54	CH
★	TH23-17	2.0	S2	80	25	55					34	CH
⊙	TH23-18	2.4	S3	49	16	33					26	CI
⊕	TH23-18	4.0	S4	21	16	5	33	47	18	65	12	CL-ML
○	TH23-19	5.2	S4	79	24	55					44	CH
△	TH23-20	3.8	S5	85	26	59					46	CH
⊗	TH23-21	3.7	S3	80	29	51					46	CH
⊕	TH23-23	3.7	S4	56	29	27					22	CH

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







**CLIENT** CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT  
**PROJECT NAME** CentrePort Regional S&W Servicing  
**TESTED BY** Stantec




**PROJECT NO.** 23-0107-009  
**LOCATION** Winnipeg, Manitoba  
**DATE TESTED** 10/24/2023

# KEY TO SYMBOLS






## LITHOLOGIC SYMBOLS

	Clay (CH, high plasticity)
	Dolomite
	Dolomite Shaley
	Fill
	Limestone
	Silt (ML)
	Silt Till
	No Recovery
	Organics
	Topsoil

## SAMPLER SYMBOLS

	Auger Grab
	Core Barrel
	SPT Split Spoon

## WELL CONSTRUCTION SYMBOLS

	Sand Backfill
	Standpipe (bentonite pellets)
	Standpipe (cement/bentonite grout)
	Standpipe (filter sand)
	Screen (filter sand)

## ABBREVIATIONS

LL - Liquid Limit	PN - Pneumatic Piezometer
PL - Plastic Limit	VW - Vibrating Wire Piezometer
PI - Plastic Index	PID - Photoionization Detector
MC - Moisture Content	ppm - Parts Per Million
DD - Dry Density	∇ - Water Level During Drilling
NP - Non-Plastic	▼ - Water Level Upon Completion of Drilling
-200 - Percent Passing No. 200 Sieve	∇ - Water Level Remeasured/Static
TV - Torvane (kPa)	
PP - Pocket Penetrometer (kPa)	
PSA - Particle Size Analysis	
TOC - Top Of Casing	

# **APPENDIX C**

2023 Select Drilling Photos





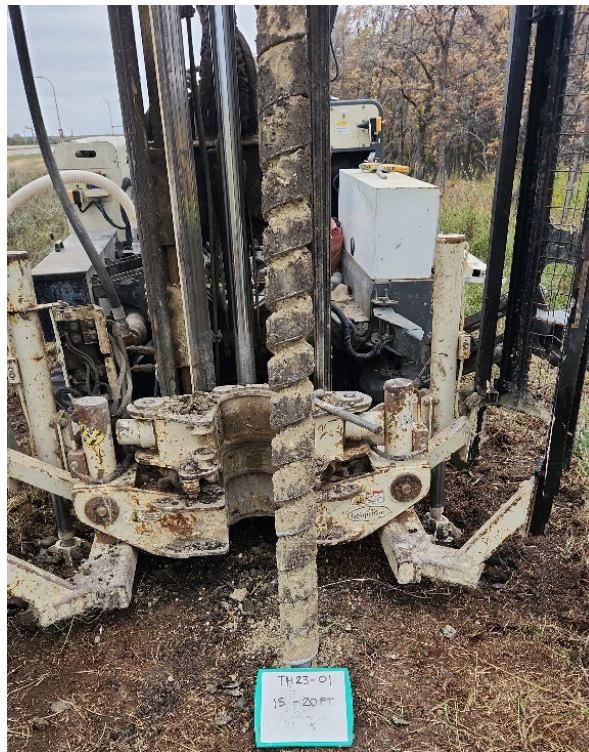
**TH23-01 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-01 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



**TH23-01 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**

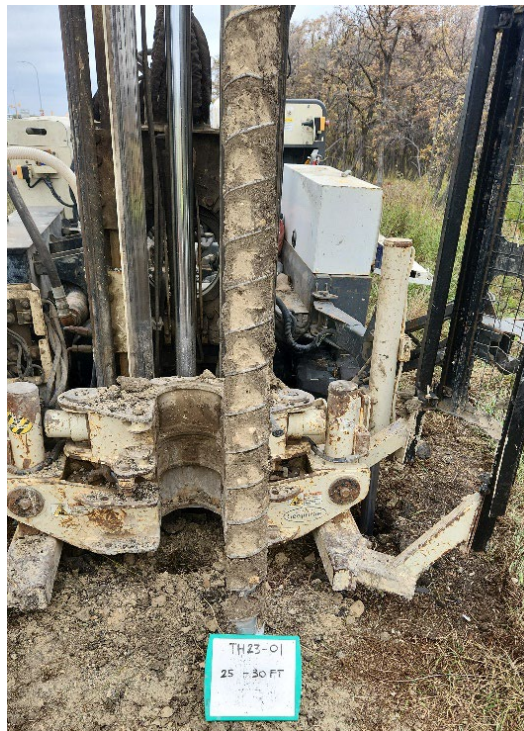


**TH23-01 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)**





**TH23-01 Photo 5: 6.0 m to 7.5 m (20 ft to 25 ft)**



**TH23-01 Photo 6: 7.5 m to 9.0 m (25 ft to 30 ft)**





TH23-01 Photo 7: Bedrock Core, 9.45 m to 22.2 m (31.5 ft to 74 ft)





**TH23-03 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-03 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



TH23-03 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)



TH23-03 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)





**TH23-03 Photo 5: 6.0 m to 7.0 m (20 ft to 23 ft)**



**TH23-04 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-04 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-04 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**



**TH23-04 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)**





**TH23-04 Photo 5: 6.0 m to 7.3 m (20 ft to 24 ft)**



**TH23-05 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-05 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



**TH23-05 Photo 3:** 3.0 m to 4.2 m (10 ft to 14 ft)





TH23-06 Photo 1: 0 to 1.5 m (0 to 5 ft)



TH23-06 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)



**TH23-06 Photo 3: 3.0 m to 4.2 m (10 ft to 14 ft)**



**TH23-06 Photo 4: 3.0 m to 4.5 m (15 ft to 20 ft)**





**TH23-07 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-07 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-07 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**



**TH23-07 Photo 4: 4.5 m to 5.4 m (15 ft to 18 ft)**



TH23-08 Photo 1: Bedrock core, 3.3 m to 9.3 m (11 ft to 31 ft)





**TH23-09 Photo 1: 0.0 m to 1.5 m (0 ft to 5 ft)**



**TH23-09 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





TH23-09 Photo 3: SPT from 3.0 m to 3.3 m (10 ft to 11 ft)



TH23-09 Photo 4: 3.0 m to 4.5 m (10 ft to 15 ft)



TH23-09 Photo 5: 4.5m to 5.2m (15 ft to 17 ft-3 in)





TH23-09 Photo 6: 5.2 m to 9.3m (17 ft-3in to 31ft)





**TH23-11 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-11 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



**TH23-11 Photo 3:** 3.0 m to 4.5 m (10 ft to 15 ft)



**TH23-11 Photo 4:** 4.5 m to 6.0 m (15 ft to 20 ft)





**TH23-12 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-12 Photo 2: 3.0 m to 4.5 m (10 ft to 15 ft)**





**TH23-12 Photo 3: 4.5 m to 6.0 m (15 ft to 20 ft)**



**TH23-12 Photo 4: 6.0 m to 7.5 m (20 ft to 25 ft)**



**TH23-17 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-17 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-17 Photo 3: 3.0 m to 4.2 m (10 ft to 14 ft)**





TH23-17 Photo 4: Bedrock core from 4.2 m to 12.4 m (14 ft to 41 ft – 4in)





**TH23-18 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-18 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



**TH23-18 Photo 3:** 3.0 m to 4.5 m (10 ft to 15 ft)







**TH23-19 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-19 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-19 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**



**TH23-19 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)**





**TH23-19 Photo 5:** 6.0 m to 7.2 m (20 ft to 24 ft)



**TH23-20 Photo 1: 0.0 m to 1.5 m (0 ft to 5 ft)**



**TH23-20 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-20 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**



**TH23-20 Photo 4: 4.5 m to 6.0 m (10 ft to 15 ft)**





**TH23-20 Photo 5:** 6.0 m to 7.5 m (20 ft to 25 ft)



**TH23-20 Photo 6:** 7.5 m to 8.1 m (25 ft to 27ft)



**TH23-20 Photo 7:** Bedrock recovered from SPT at 8.1m (27ft)



**TH23-21 Photo 1: 0 to 1.2 m (0 to 4 ft)**



**TH23-21 Photo 2: 1.2 m to 2.7 m (4 ft to 9 ft)**





**TH23-21 Photo 3: 2.7 m to 4.2 m (9 ft to 14 ft)**



**TH23-21 Photo 4: 4.2 m to 5.7 m (14 ft to 19 ft)**



**TH23-21 Photo 5: SPT at 5.7m (19 ft)**



**TH23-21 Photo 6: 5.7m to 7.2 m (19 ft to 24 ft)**





TH23-21 Photo 7: SPT at 7.2m (24 ft)



TH23-21 Photo 8: 7.2m to 7.8 m (24 ft to 26 ft)





**TH23-22 Photo 1: 0 to 1.2 m (0 to 4 ft)**



**TH23-22 Photo 2: 1.2 m to 2.7 m (4 ft to 9 ft)**



**TH23-22 Photo 3: 2.7 m to 4.2 m (9 ft to 14 ft)**



**TH23-22 Photo 4: SPT at 4.2m (14 ft)**





TH23-22 Photo 5: 4.2 m to 5.7 m (14 ft to 19 ft)



TH23-22 Photo 6: SPT at 5.7m (19 ft)





TH23-22 Photo 7: 5.7 m to 7.2 m (19 ft to 24 ft)



TH23-22 Photo 8: SPT at 7.2m (24 ft)



**TH23-23 Photo 1: 0 to 1.2 m (0 to 4 ft)**



**TH23-23 Photo 2: 1.2 m to 2.7 m (4 ft to 9 ft)**





**TH23-23 Photo 3: 2.7 m to 4.2 m (9 ft to 14 ft)**



**TH23-23 Photo 4: 4.2 m to 5.7 m (14 ft to 19 ft)**





TH23-23 Photo 5: SPT at 5.7m (19 ft)



TH23-23 Photo 6: 5.7 m to 6.2 m (19 ft to 20.5 ft)





**TH23-24 Photo 1: 0 to 1.5 m (0 to 5 ft)**



**TH23-24 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**



**TH23-24 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**



**TH23-24 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)**





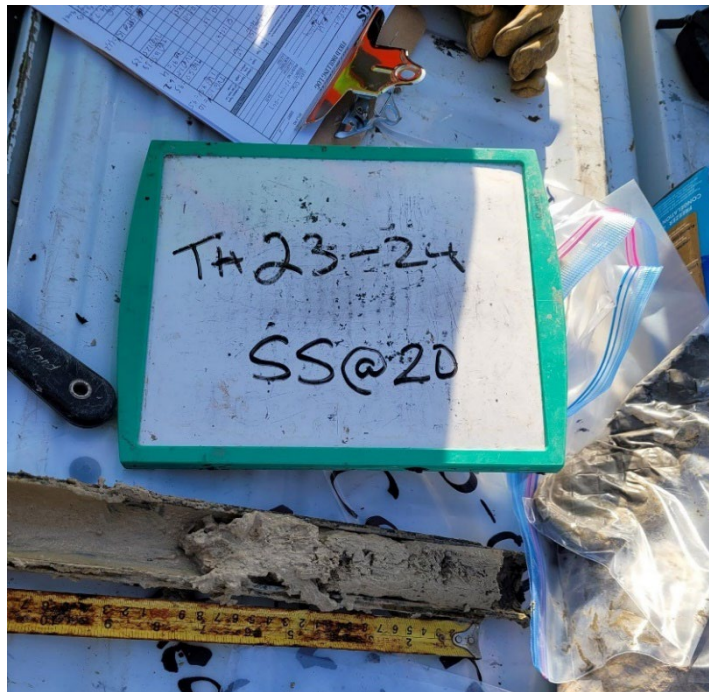
**TH23-24 Photo 5: 7.5 m to 9.0 m (25 ft to 30 ft)**



**TH23-24 Photo 6: 9.0 m to 9.9 m (30 ft to 33 ft)**



TH23-24 Photo 7: SPT at 4.5 m (15ft)

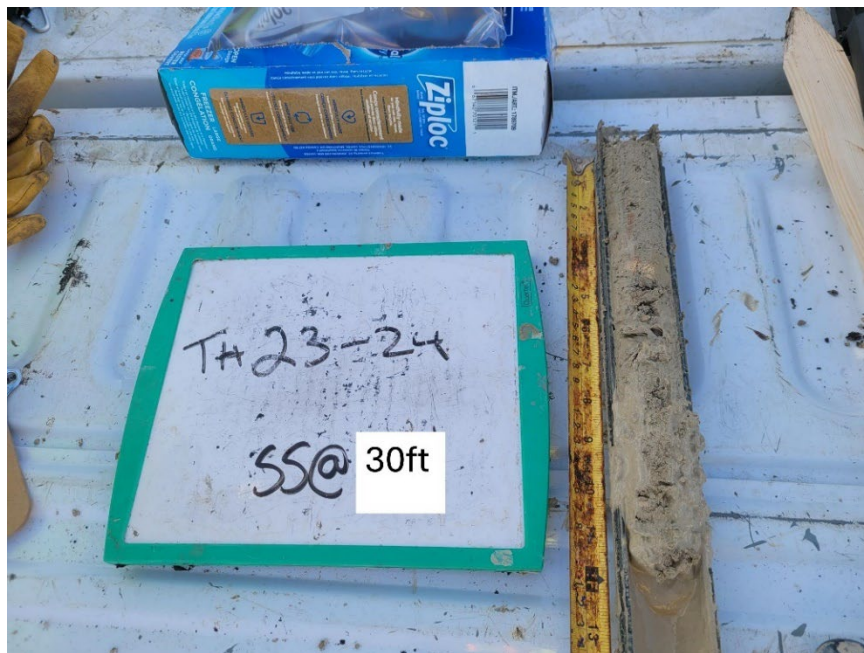


TH23-24 Photo 8: SPT at 6.0 m (20ft)





TH23-24 Photo 9: SPT at 7.5 m (25ft)



TH23-24 Photo 10: SPT at 9.0 m (30ft)





**TH23-24 Photo 11:** Bedrock core from 9.0 m to 11.2 m (30 ft to 37 ft – 3 in)



**TH23-25 Photo 1: 0.0 m to 1.5 m (0 ft to 5 ft)**



**TH23-25 Photo 2: 1.5 m to 3.0 m (5 ft to 10 ft)**





**TH23-25 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)**

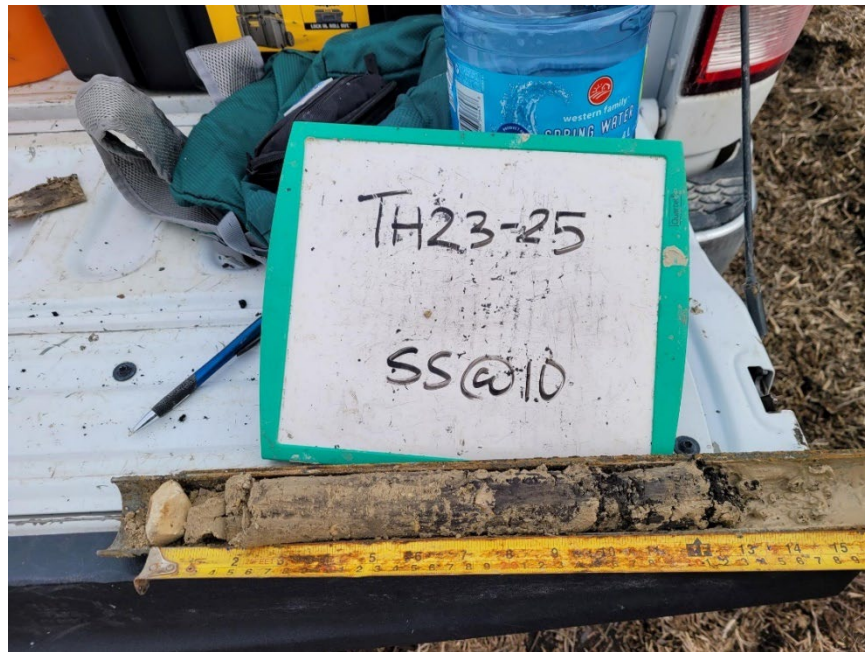


**TH23-25 Photo 4: 4.5 m to 6.0 m (15 ft to 20 ft)**

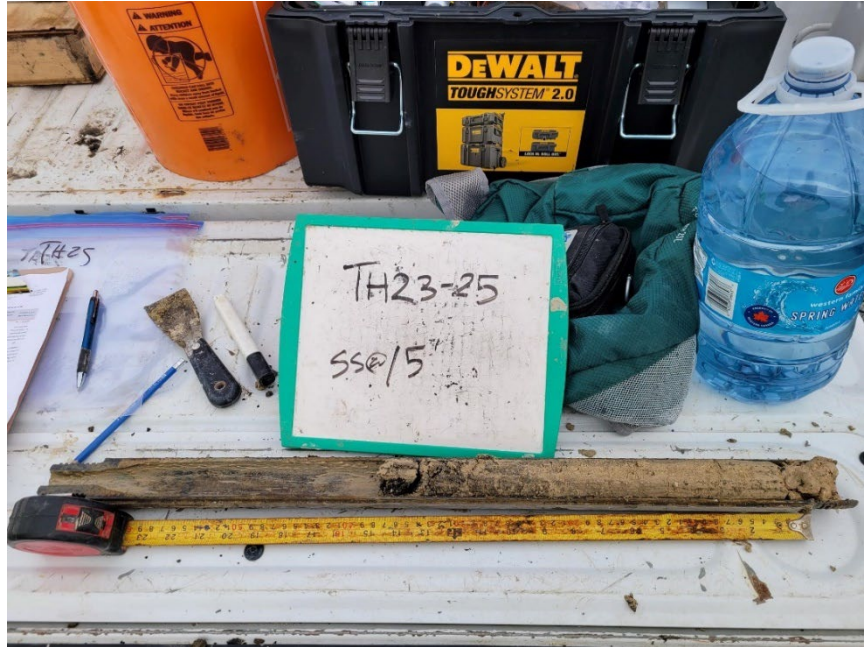




TH23-25 Photo 5: 6.0 m to 7.5 m (20 ft to 25 ft)



TH23-25 Photo 6: SPT at 3.0m (10 ft)



TH23-25 Photo 7: SPT at 4.5m (15 ft)



TH23-25 Photo 8: SPT at 6.0m (20 ft)





TH23-25 Photo 9: SPT at 7.5m (25 ft)





TH23-25 Photo 10: Bedrock core from 8.5 m to 13.9 m (28 ft – 2 in to 46 ft – 2 in)



TH23-26 Photo 1: Bedrock core from 5.5 m to 15.4 m (18 ft – 4 in to 51 ft – 4 in)

# **APPENDIX D**

2023 Laboratory Testing Results





**Stantec Consulting Ltd.**  
 199 Henlow Bay, Winnipeg, MB R3Y 1G4  
 Tel: (204) 488-6999

## ASTM D2216 - LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL AND ROCK BY MASS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 1

DATE SAMPLED: 2023.Sep.25

DATE RECEIVED: 2023.Oct.20

DATE TESTED: 2023.Oct.20


SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Larry Presado

TESTHOLE	SAMPLE	MC %
TH23-01	S3	45.5
	S5	29.5
	S6	9.3
	S8	9.3
	S10	8.3
TH23-08	S1	20.8
	S2	7.9
TH23-09	S1	11.9
	S3	9.8
	S4	9.2
	S5	10.7
TH23-20	S3	20.0
	S5	45.6
	S6	29.3
	S8	42.9

REPORT DATE 2023.Oct.27

REVIEWED BY  Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D2216 - LABORATORY DETERMINATION OF WATER (MOISTURE) CONTENT OF SOIL AND ROCK BY MASS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 2

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Nov.28

SAMPLED BY: KGS Group Inc.


SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

TESTHOLE	SAMPLE	MC %
TH23-05	S3	31.5
	S4	11.9
	S6	9.0
TH23-11	S3	38.4
	S4	53.6
	S5	23.9
TH23-17	S1	38.4
	S2	33.6
	S3	27.2
	S4	20.4
TH23-18	S3	25.6
	S4	11.9
TH23-19	S2	36.7
	S3	39.1
	S4	43.5
	S5	31.8
TH23-21	S3	46.1
	S4	41.6
	S7	10.3
TH23-22	S3	22.7
	S4	18.1
	S7	13.8
TH23-23	S2	38.9
	S4	21.6
	S5	21.9

TESTHOLE	SAMPLE	MC %
TH23-24	S3	37.6
	S5	37.6
	S7	10.0
	S9	12.4
	S11	9.5
TH23-25	S2	37.7
	S5	10.1
	S7	11.3
TH23-26	S9	13.9
	S2	20.9
	S3	8.6
	S5	9.6
	S6	9.1

REPORT DATE 2023.Nov.29

  
 REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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 Tel: (204) 488-6999



## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 1

DATE SAMPLED: 2023.Sep.28

DATE RECEIVED: 2023.Oct.20

DATE TESTED: 2023.Oct.26

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Larry Presado

SAMPLE ID: TH23-01, S5, 14'-15'

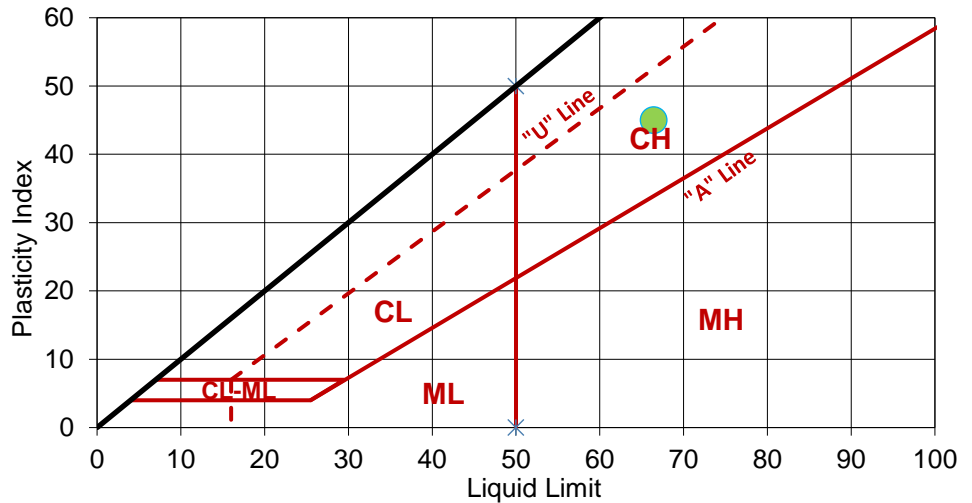
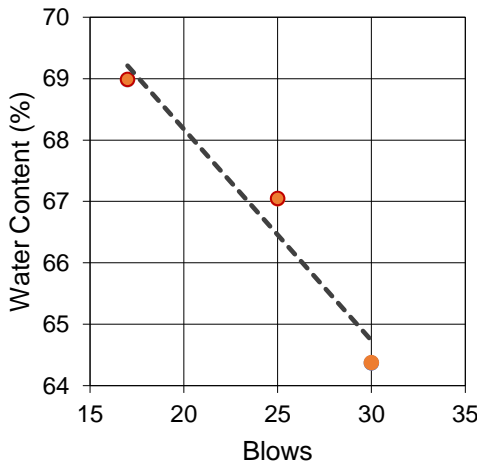
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	30	25	17
MC (%)	64	67	69

### PLASTIC LIMIT


TRIAL	1	2
MC (%)	21	21

LIQUID LIMIT, LL	66
PLASTIC LIMIT, PL	21
PLASTICITY INDEX, PI	45
AS REC'D MC (%)	29.5



COMMENTS:

REPORT DATE 2023.Oct.27

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 2

DATE SAMPLED: 2023.Sep.25

DATE RECEIVED: 2023.Oct.20

DATE TESTED: 2023.Oct.26

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Larry Presado

SAMPLE ID: TH23-09, S5, 14.5'-15'

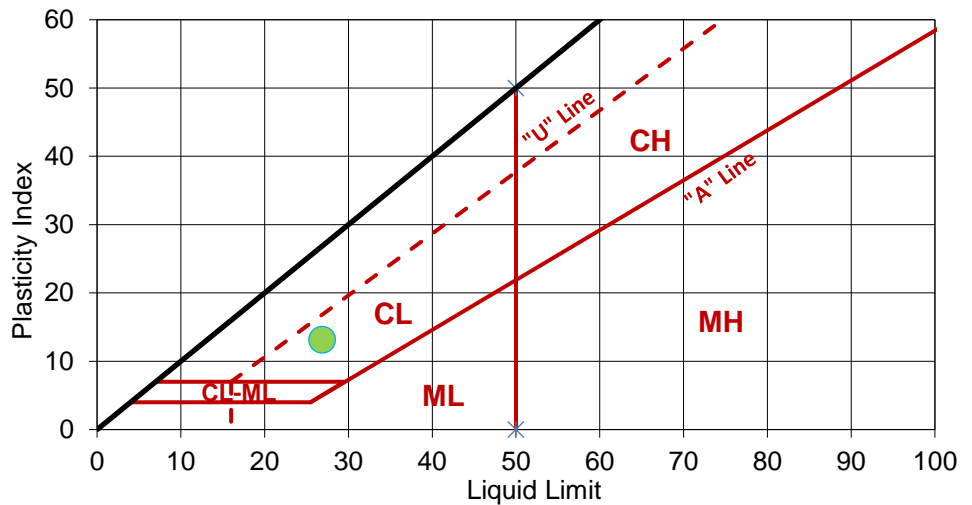
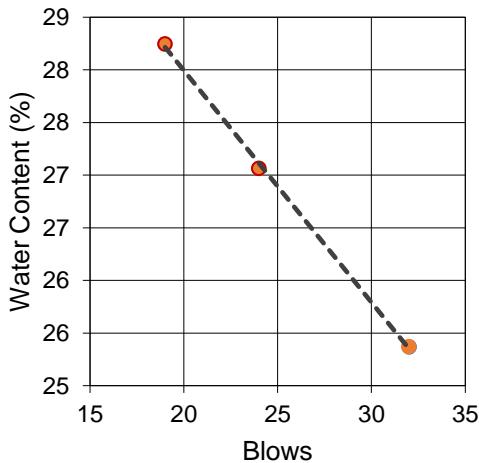
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	32	24	19
MC (%)	25	27	28

### PLASTIC LIMIT


TRIAL	1	2
MC (%)	14	14

LIQUID LIMIT, LL 27  
 PLASTIC LIMIT, PL 14  
 PLASTICITY INDEX, PI 13  
 AS REC'D MC (%) 10.7



COMMENTS:

REPORT DATE 2023.Oct.27

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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 R3T 5P4

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 3

DATE SAMPLED: 2023.Sep.25

DATE RECEIVED: 2023.Oct.20

DATE TESTED: 2023.Oct.26

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Larry Presado

SAMPLE ID: TH23-20, S5, 12.5'-13'

### LIQUID LIMIT

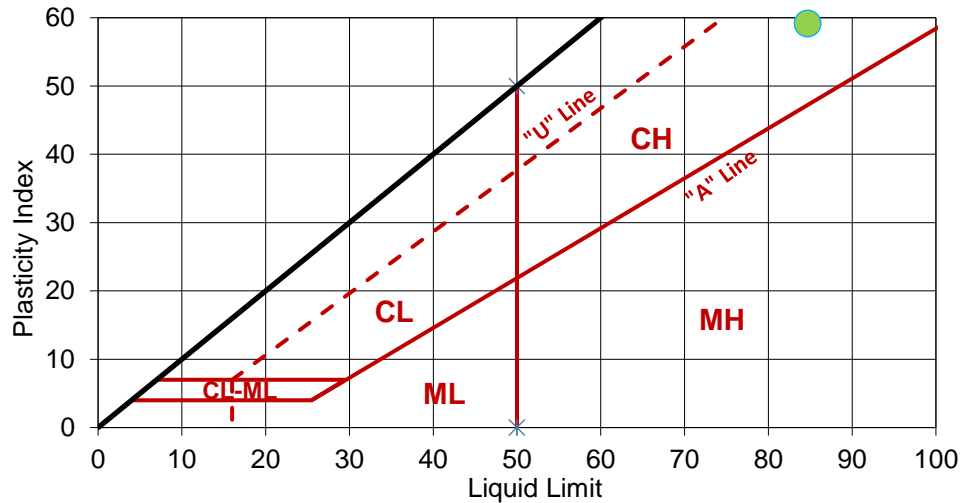
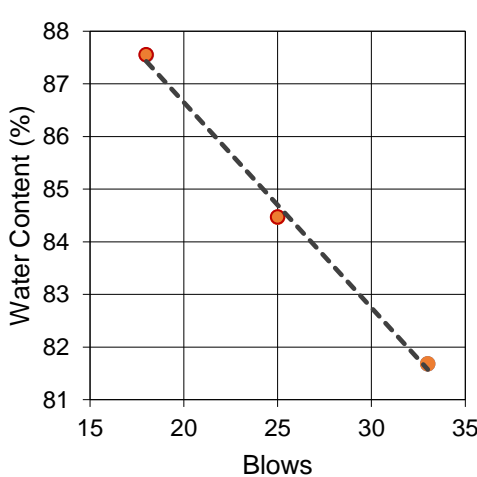
TRIAL	1	2	3
BLOWS	33	25	18
MC (%)	82	84	88

### PLASTIC LIMIT

TRIAL	1	2
MC (%)	26	26

LIQUID LIMIT, LL 85  
 PLASTIC LIMIT, PL 26  
 PLASTICITY INDEX, PI 59  
 AS REC'D MC (%) 45.6

85
26
59
45.6



COMMENTS:

REPORT DATE 2023.Oct.27

REVIEWED BY *Guillaume Beauce*  
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

TO KGS Group Inc.  
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PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 4

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Blair Dawson

SAMPLE ID: TH23-11, S4

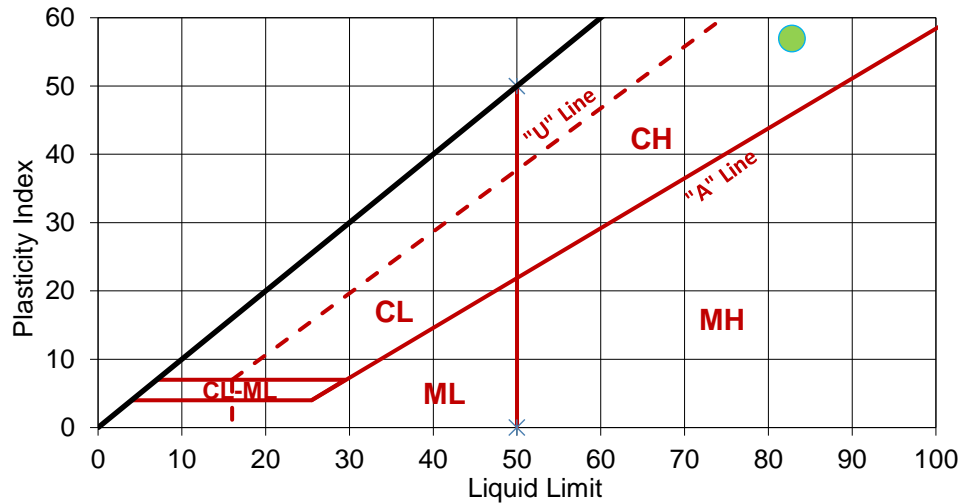
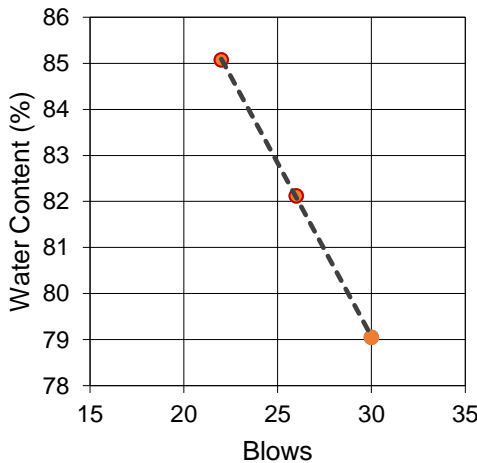
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	30	26	22
MC (%)	79	82	85

### PLASTIC LIMIT


TRIAL	1	2
MC (%)	26	26

LIQUID LIMIT, LL	83
PLASTIC LIMIT, PL	26
PLASTICITY INDEX, PI	57
AS REC'D MC (%)	11.9



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 5

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-17, S2

### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	35	25	19
MC (%)	78	79	80

### PLASTIC LIMIT

TRIAL	1	2
MC (%)	25	25

LIQUID LIMIT, LL

80

PLASTIC LIMIT, PL

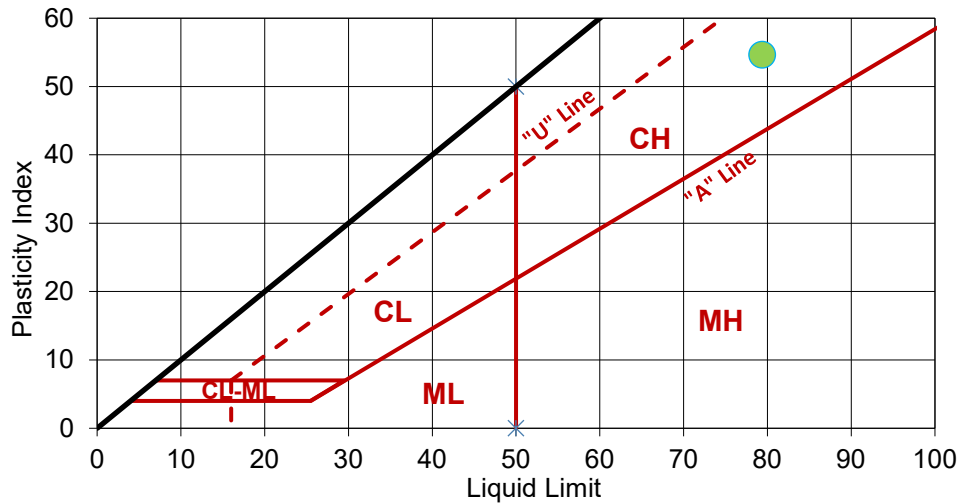
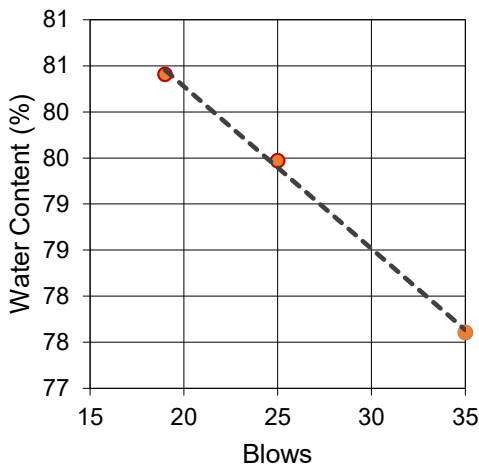
25

PLASTICITY INDEX, PI

55


AS REC'D MC (%)

33.6



COMMENTS:

REPORT DATE 2023.Dec.11

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

TO KGS Group Inc.  
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 Winnipeg, Manitoba  
 R3T 5P4

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 6

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-18, S3

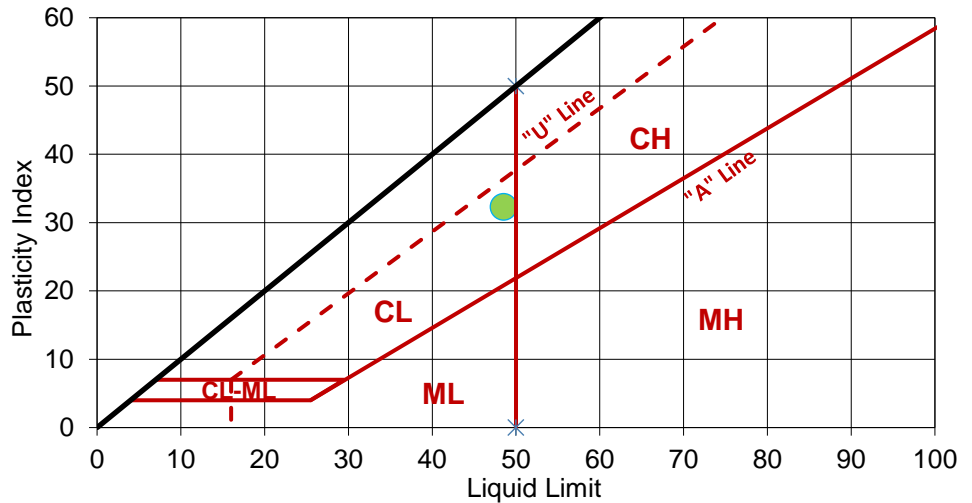
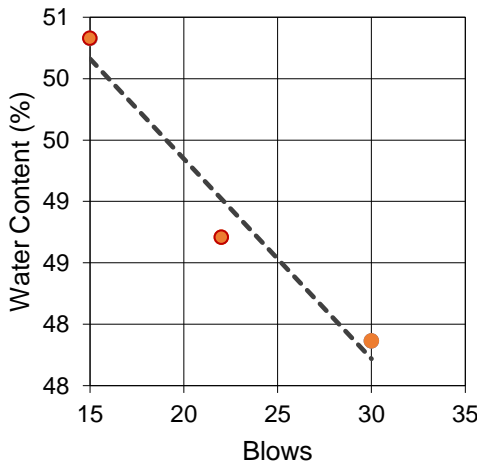
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	30	22	15
MC (%)	48	49	50

### PLASTIC LIMIT


TRIAL	1	2
MC (%)	16	16

LIQUID LIMIT, LL	49
PLASTIC LIMIT, PL	16
PLASTICITY INDEX, PI	33
AS REC'D MC (%)	25.6



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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**Stantec Consulting Ltd.**  
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 Tel: (204) 488-6999



## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 7

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-18, S4

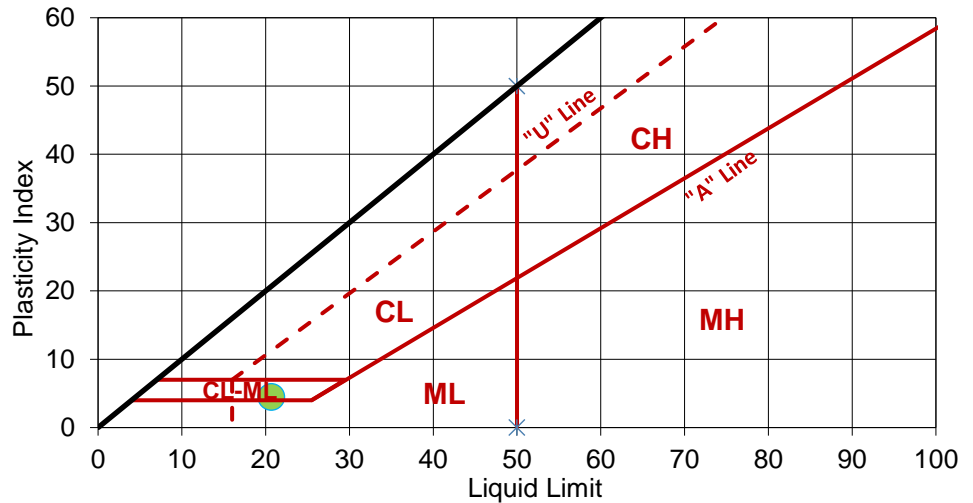
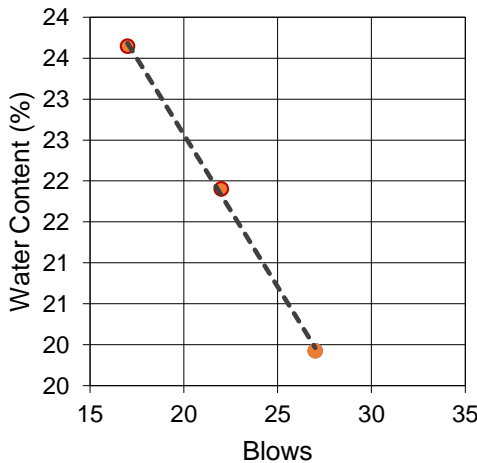
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	27	22	17
MC (%)	20	22	24

### PLASTIC LIMIT

TRIAL	1	2
MC (%)	16	16

LIQUID LIMIT, LL 21  
 PLASTIC LIMIT, PL 16  
 PLASTICITY INDEX, PI 5  
 AS REC'D MC (%) 25.4



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY *Guillaume Beauce*  
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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 Tel: (204) 488-6999



## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 8

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-19, S4

### LIQUID LIMIT

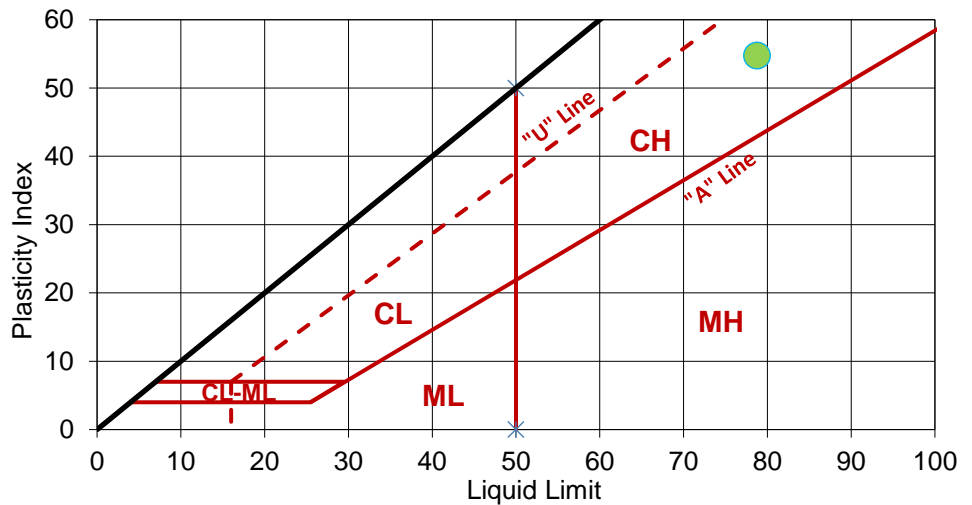
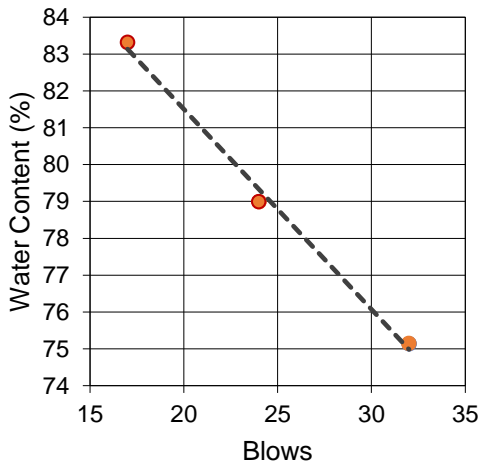
TRIAL	1	2	3
BLOWS	32	24	17
MC (%)	75	79	83

### PLASTIC LIMIT

TRIAL	1	2
MC (%)	24	24

LIQUID LIMIT, LL 79  
 PLASTIC LIMIT, PL 24  
 PLASTICITY INDEX, PI 55  
 AS REC'D MC (%) 43.5

79
24
55
43.5



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY *Guillaume Beauce*  
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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 Tel: (204) 488-6999



## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 9

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-21, S3

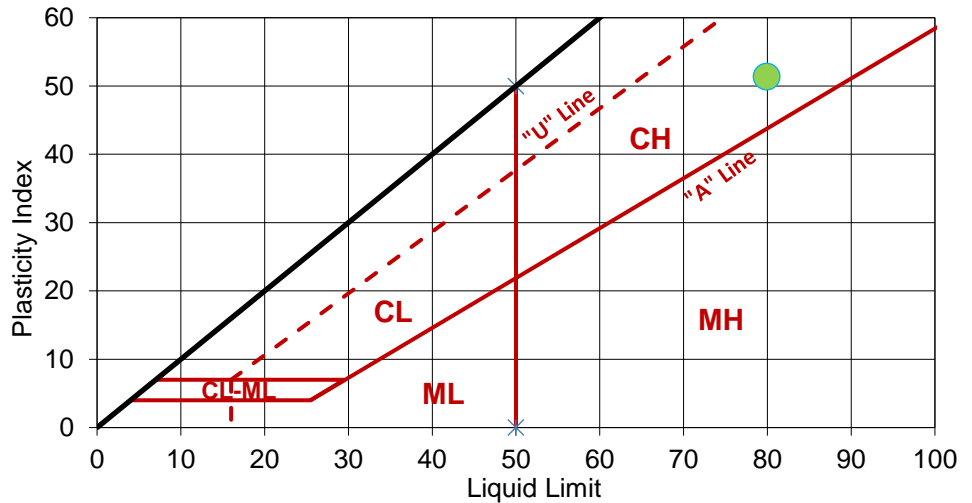
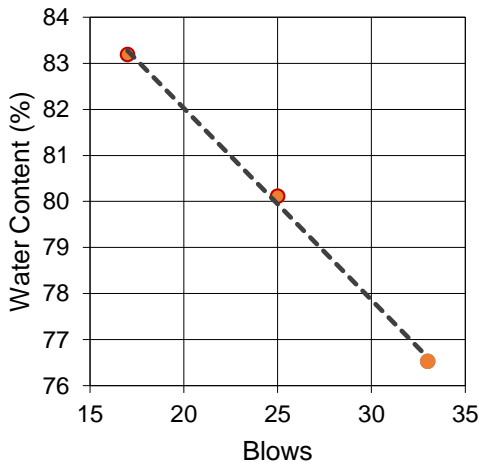
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	33	25	17
MC (%)	77	80	83

### PLASTIC LIMIT


TRIAL	1	2
MC (%)	29	29

LIQUID LIMIT, LL	80
PLASTIC LIMIT, PL	29
PLASTICITY INDEX, PI	51
AS REC'D MC (%)	46.1



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY  Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## ASTM D4318 - LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX OF SOILS (LL METHOD A - MULTIPOINT)

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

PROJECT CentrePort AAW Regional S&W Servicing  
 (23-0107-009)

PROJECT NO. 123316822

ATTN: Grace Gitzel

REPORT NO. 10

DATE SAMPLED: 2023.Nov.15

DATE RECEIVED: 2023.Nov.27

DATE TESTED: 2023.Dec.06

SAMPLED BY: KGS Group Inc.

SUBMITTED BY: KGS Group Inc.

TESTED BY: Carson Cockwell

SAMPLE ID: TH23-23, S4

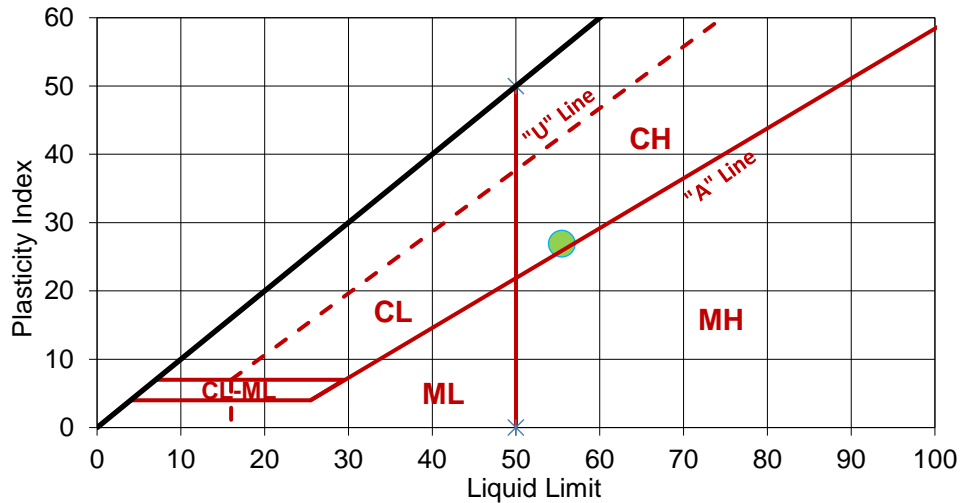
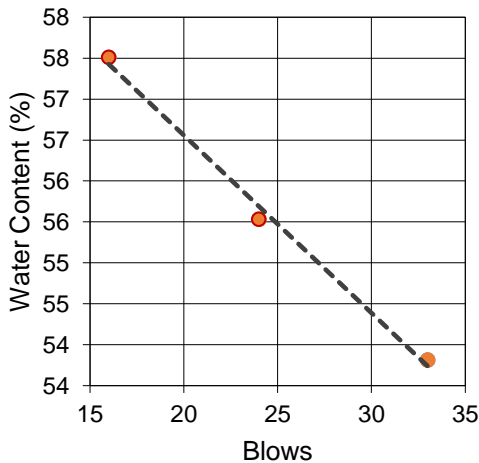
### LIQUID LIMIT

TRIAL	1	2	3
BLOWS	33	24	16
MC (%)	54	56	58

### PLASTIC LIMIT

TRIAL	1	2
MC (%)	29	29

LIQUID LIMIT, LL 56  
 PLASTIC LIMIT, PL 29  
 PLASTICITY INDEX, PI 27  
 AS REC'D MC (%) 21.6



COMMENTS:

REPORT DATE 2023.Dec.08

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

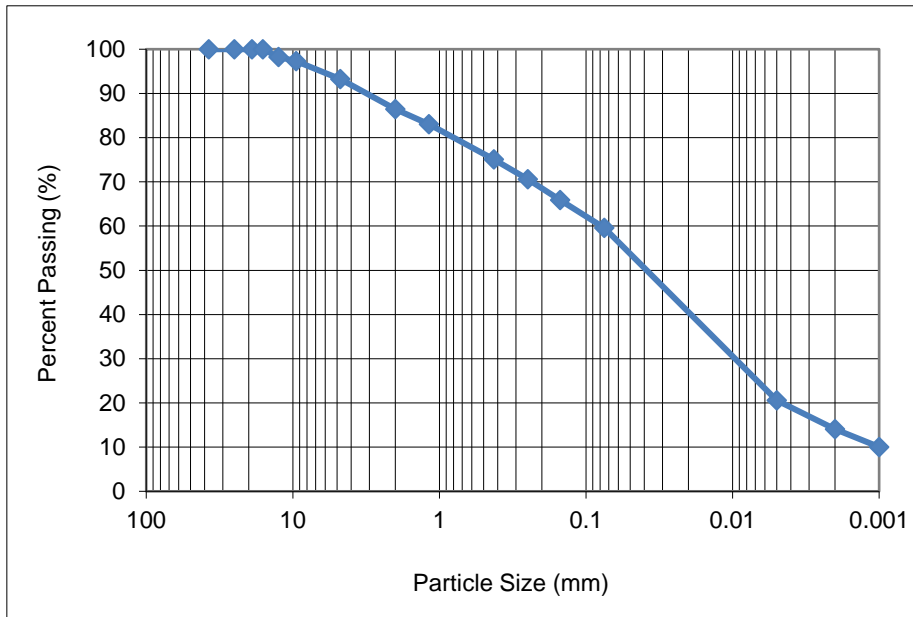
ATTN: Grace Gitzel

REPORT NO. 1

DATE SAMPLED: 2023.Sep.28  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.24  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	98.3
9.5	97.3
4.75	93.3
2.00	86.4
1.18	83.1
0.425	75.1
0.250	70.6
0.150	65.9
0.075	59.6
0.005	20.6
0.002	14.1
0.001	10.0

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
6.7	6.9	11.3	15.5	45.5	14.1	10.0

**COMMENTS:**

Material tested was identified as TH23-01, S6, 19'-20'.

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

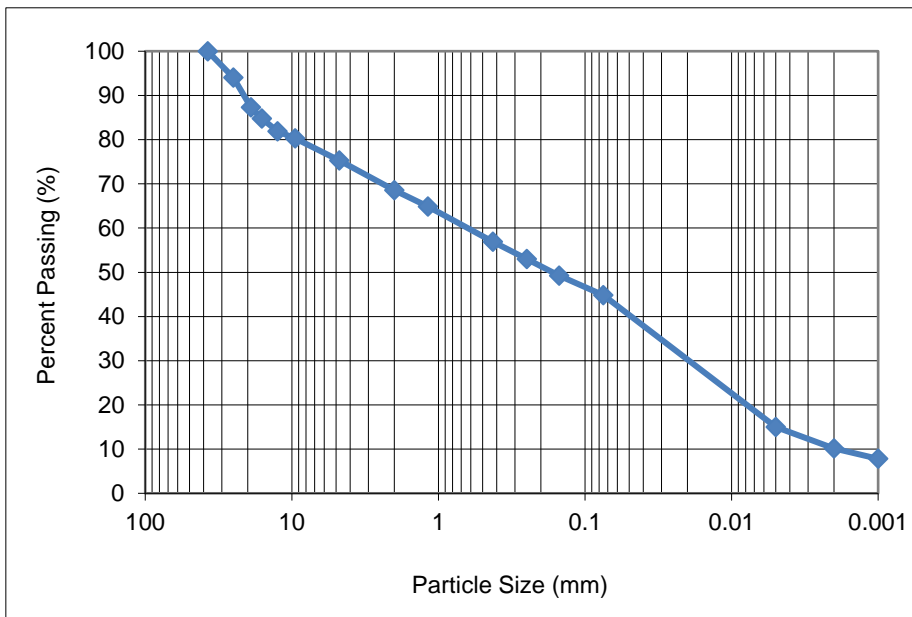
ATTN: Grace Gitzel

REPORT NO. 2

DATE SAMPLED: 2023.Sep.26  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.24  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	94.0
19.0	87.3
16.0	84.8
12.5	81.9
9.5	80.3
4.75	75.3
2.00	68.5
1.18	64.9
0.425	56.9
0.250	53.0
0.150	49.3
0.075	44.8
0.005	15.0
0.002	10.2
0.001	7.8

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
24.7	6.8	11.6	12.1	34.6	10.2	7.8

**COMMENTS:**

Material tested was identified as TH23-08, S2, 10'-11'.

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

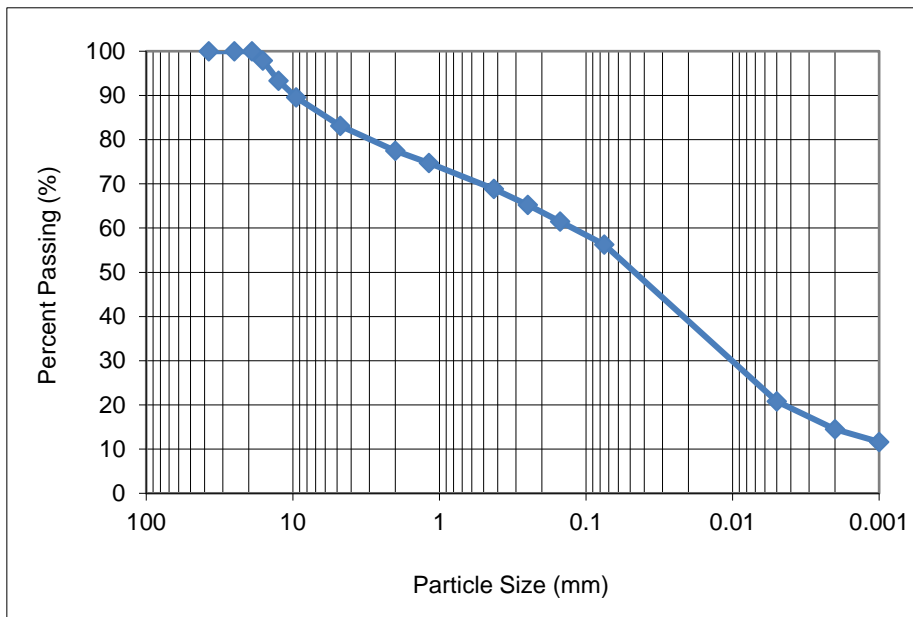
ATTN: Grace Gitzel

REPORT NO. 3

DATE SAMPLED: 2023.Sep.25  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.24  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	97.9
12.5	93.3
9.5	89.5
4.75	83.1
2.00	77.4
1.18	74.7
0.425	68.9
0.250	65.2
0.150	61.5
0.075	56.3
0.005	20.8
0.002	14.5
0.001	11.6

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
16.9	5.7	8.5	12.6	41.8	14.5	11.6

**COMMENTS:**

Material tested was identified as TH23-09, S5, 14.5'-15'.

REPORT DATE 2023.Oct.27

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

TO KGS Group Inc.  
 3rd Floor - 865 Waverley Street  
 Winnipeg, Manitoba  
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PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

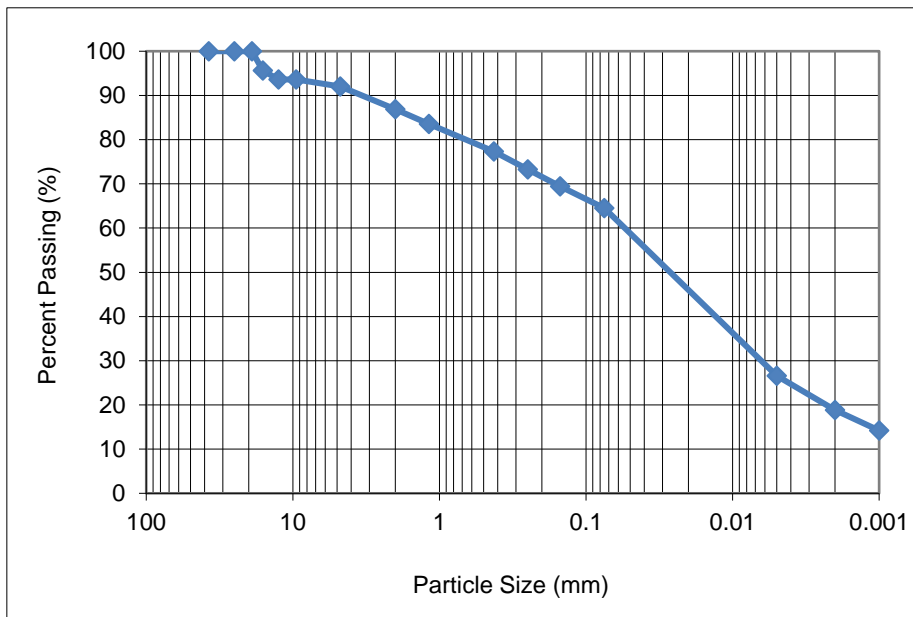
ATTN: Kelly Fordyce

REPORT NO. 4

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado




SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	95.6
12.5	93.6
9.5	93.6
4.75	92.0
2.00	86.9
1.18	83.5
0.425	77.3
0.250	73.3
0.150	69.5
0.075	64.5
0.005	26.6
0.002	18.9
0.001	14.2

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
8.0	5.1	9.6	12.8	45.6	18.9	14.2

**COMMENTS:**

Material tested was identified as TH23-05, S4.

REPORT DATE 2023.Dec.07

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

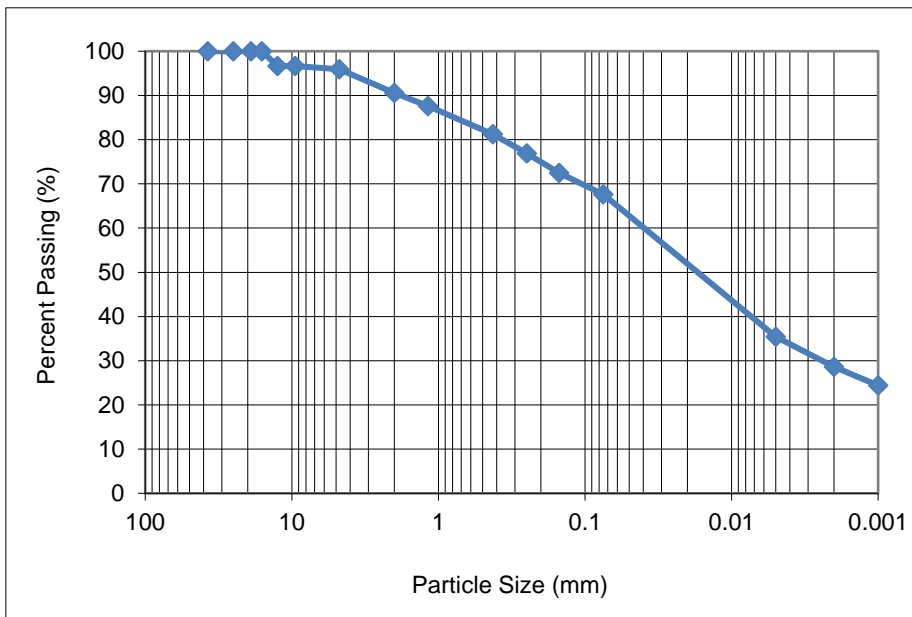
ATTN: Kelly Fordyce

REPORT NO. 5

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	96.6
9.5	96.6
4.75	95.9
2.00	90.6
1.18	87.6
0.425	81.2
0.250	76.9
0.150	72.5
0.075	67.6
0.005	35.4
0.002	28.6
0.001	24.4

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
4.1	5.3	9.4	13.6	39.0	28.6	24.4

**COMMENTS:**

Material tested was identified as TH23-11, S5.

REPORT DATE 2023.Dec.07

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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**Stantec Consulting Ltd.**  
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 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

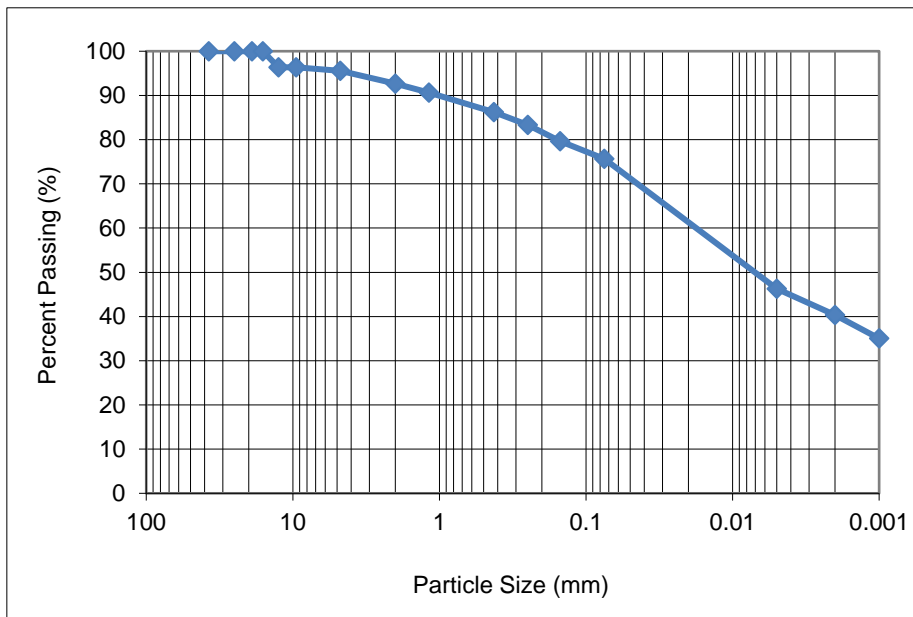
ATTN: Kelly Fordyce

REPORT NO. 6

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	96.4
9.5	96.4
4.75	95.6
2.00	92.7
1.18	90.6
0.425	86.2
0.250	83.3
0.150	79.7
0.075	75.7
0.005	46.2
0.002	40.3
0.001	35.0

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
4.4	2.9	6.5	10.5	35.4	40.3	35.0

**COMMENTS:**

Material tested was identified as TH23-17, S4.

REPORT DATE 2023.Dec.07

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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**Stantec Consulting Ltd.**  
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 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

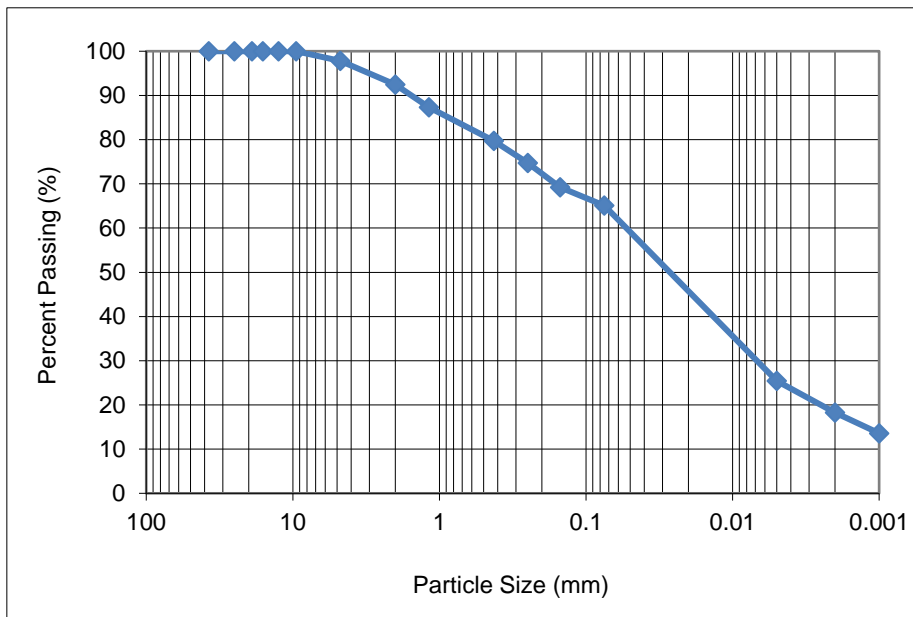
ATTN: Kelly Fordyce

REPORT NO. 7

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	100.0
9.5	100.0
4.75	97.8
2.00	92.5
1.18	87.3
0.425	79.7
0.250	74.7
0.150	69.2
0.075	65.1
0.005	25.4
0.002	18.2
0.001	13.6

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
2.2	5.3	12.8	14.6	46.9	18.2	13.6

**COMMENTS:**

Material tested was identified as TH23-18, S4.

REPORT DATE 2023.Dec.07

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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**Stantec Consulting Ltd.**  
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 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

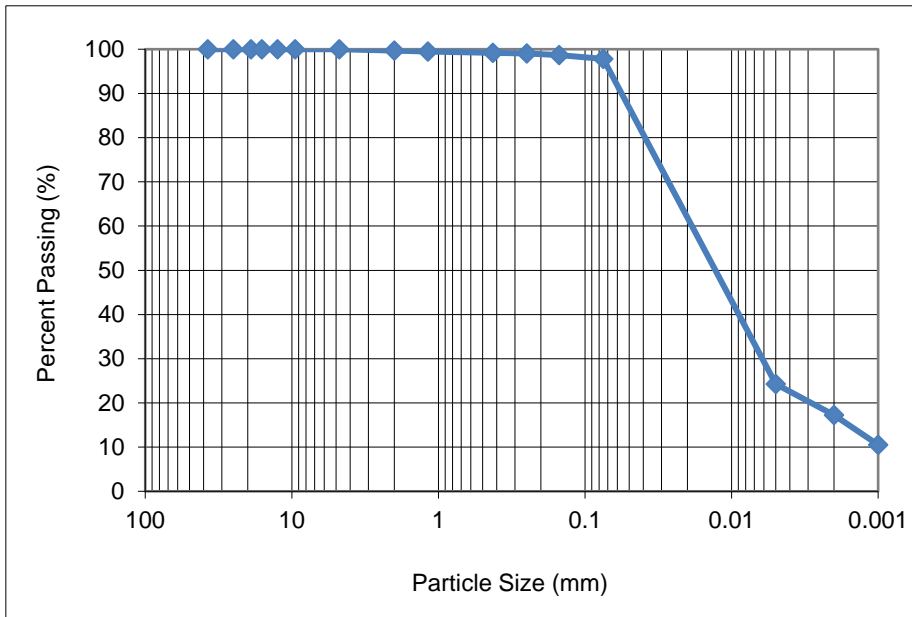
ATTN: Kelly Fordyce

REPORT NO. 8

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	100.0
9.5	100.0
4.75	100.0
2.00	99.7
1.18	99.5
0.425	99.2
0.250	99.0
0.150	98.7
0.075	97.8
0.005	24.3
0.002	17.3
0.001	10.5

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
0.0	0.3	0.5	1.4	80.5	17.3	10.5

**COMMENTS:**

Material tested was identified as TH23-21, S5.

REPORT DATE 2023.Dec.07

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

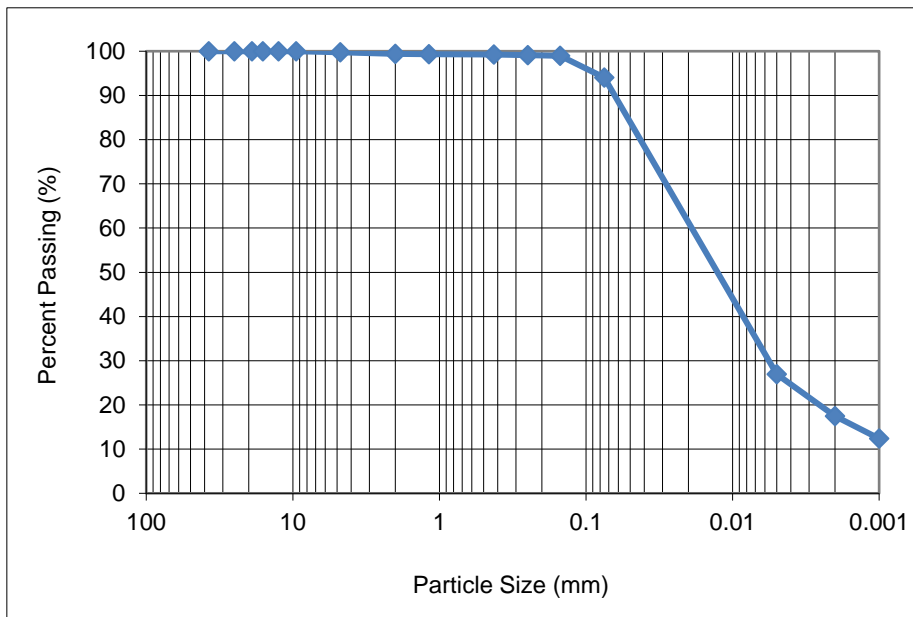
ATTN: Kelly Fordyce

REPORT NO. 9

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado




SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	100.0
9.5	100.0
4.75	99.8
2.00	99.4
1.18	99.3
0.425	99.2
0.250	99.1
0.150	99.0
0.075	94.0
0.005	26.9
0.002	17.4
0.001	12.4

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
0.2	0.4	0.2	5.2	76.6	17.4	12.4

**COMMENTS:**

Material tested was identified as TH23-22, S6.

REPORT DATE 2023.Dec.07

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided on written request. The data presented is for sole use of client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.





**Stantec Consulting Ltd.**  
 199 Henlow Bay, Winnipeg, MB R3Y 1G4  
 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

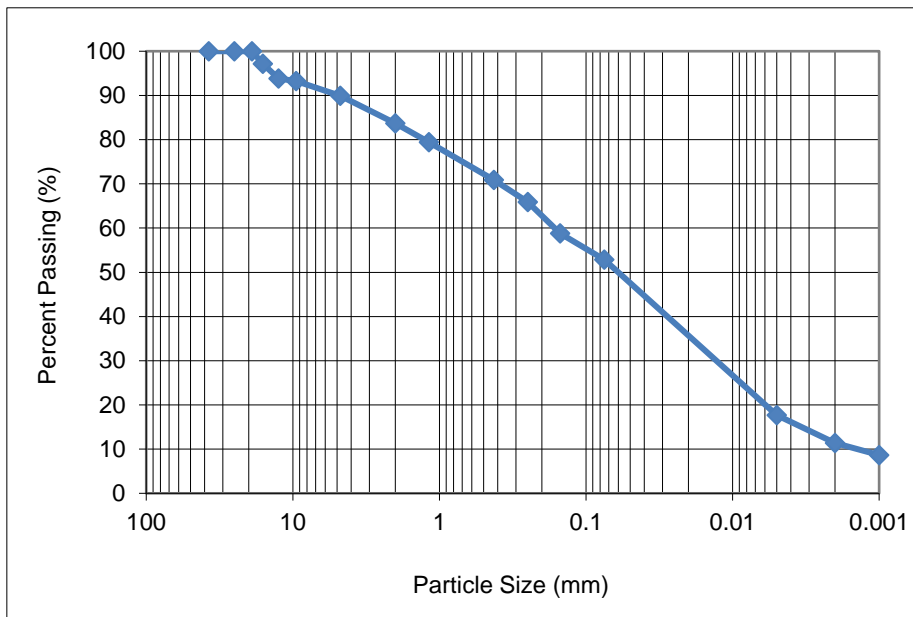
ATTN: Kelly Fordyce

REPORT NO. 10

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	97.2
12.5	93.8
9.5	93.3
4.75	89.9
2.00	83.7
1.18	79.4
0.425	70.9
0.250	65.9
0.150	58.8
0.075	52.9
0.005	17.7
0.002	11.4
0.001	8.7

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
10.1	6.2	12.8	18.0	41.5	11.4	8.7

**COMMENTS:**

Material tested was identified as TH23-24, S11.

REPORT DATE 2023.Dec.11

REVIEWED BY Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

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**Stantec Consulting Ltd.**  
 199 Henlow Bay, Winnipeg, MB R3Y 1G4  
 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

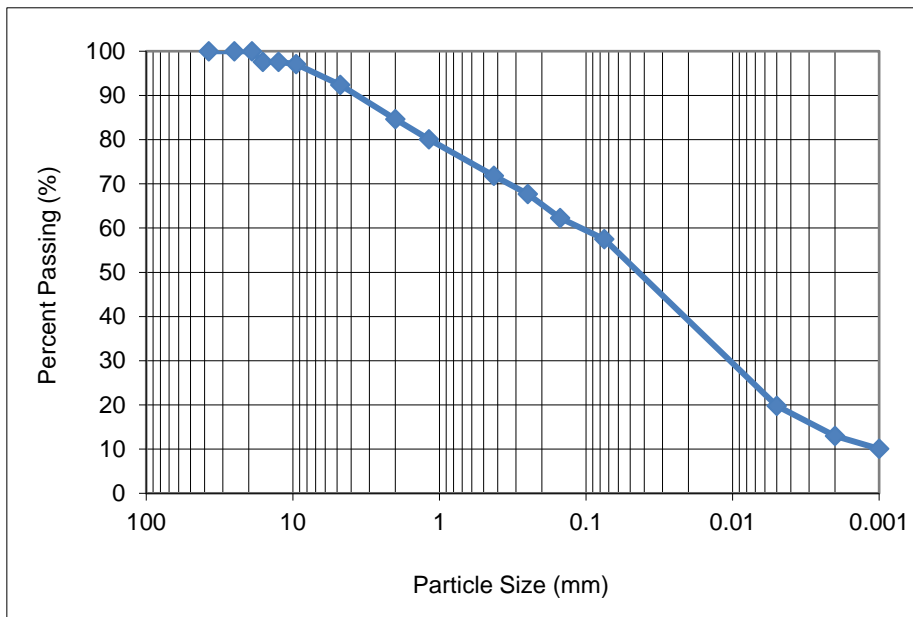
ATTN: Kelly Fordyce

REPORT NO. 11

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado




SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	97.6
12.5	97.6
9.5	97.1
4.75	92.4
2.00	84.6
1.18	80.1
0.425	71.8
0.250	67.7
0.150	62.3
0.075	57.5
0.005	19.8
0.002	13.0
0.001	10.1

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
7.6	7.8	12.8	14.3	44.5	13.0	10.1

**COMMENTS:**

Material tested was identified as TH23-25, S9.

REPORT DATE 2023.Dec.07

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided on written request. The data presented is for sole use of client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.



**Stantec Consulting Ltd.**  
 199 Henlow Bay, Winnipeg, MB R3Y 1G4  
 Tel: (204) 488-6999



## AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

PROJECT CentrePort AAW Regional S&W  
 Servicing (23-0107-009)

PROJECT NO. 123316822

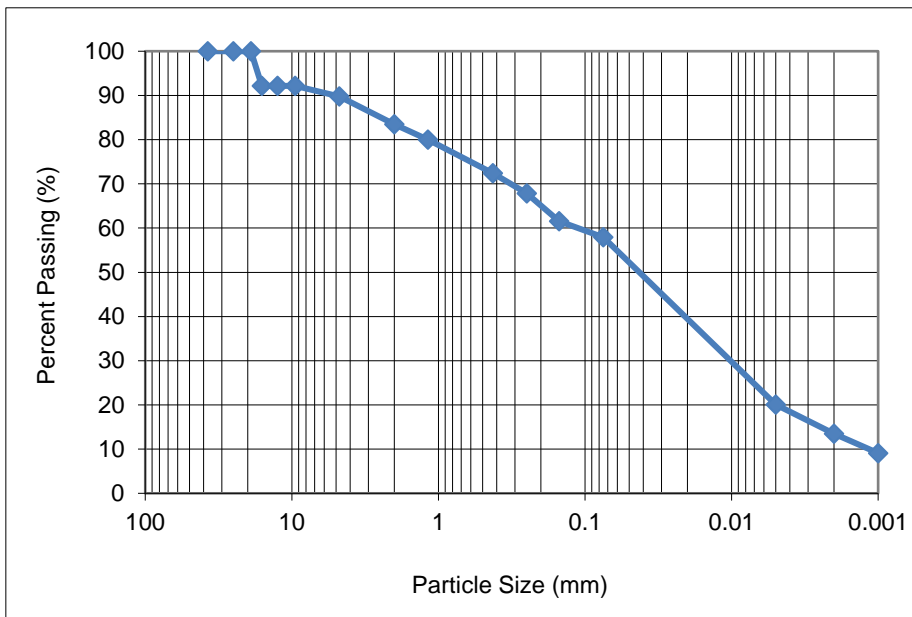
ATTN: Kelly Fordyce

REPORT NO. 12

DATE SAMPLED: 2023.Nov.15  
 SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27  
 SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04  
 TESTED BY: Larry Presado




SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	92.2
12.5	92.2
9.5	92.2
4.75	89.8
2.00	83.5
1.18	80.0
0.425	72.4
0.250	67.8
0.150	61.6
0.075	58.0
0.005	20.1
0.002	13.5
0.001	9.1

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
10.2	6.3	11.1	14.4	44.5	13.5	9.1

**COMMENTS:**

Material tested was identified as TH23-26, S6.

REPORT DATE 2023.Dec.07

REVIEWED BY   
 Guillaume Beauce, P.Eng.  
 Geotechnical Engineer - Materials Testing Services

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of the test results is provided on written request. The data presented is for sole use of client stipulated above. Stantec is not responsible, nor can be held liable, for the use of this report by any other party, with or without the knowledge of Stantec.





**Compressive Strength & Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures**

**Method C  
ASTM D7012 & D4543**

Client:	<u>KGS Group Inc.</u>	Project No.:	<u>123316822</u>
Project:	<u>CentrePort AAW Regional S&amp;W Servicing</u>		
Material Type:	<u>Rock Core</u>	Date Received:	<u>October 26, 2023</u>
Date Sampled:	<u>October 25, 2023</u>	Tested By:	<u>Sagar Khatri</u>
Sampled By:	<u>Stantec</u>	Date Tested:	<u>November 6, 2023</u>

Sample Information				
Borehole Location	TH23-01	TH23-01	TH23-08	TH23-08
Sample Number	2697	2698	2699	2700
Sample Depth	42'4"-42'11"	55'6"-56'0"	13'0"-13'9"	16'8"-17'9"
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Diameter (mm) (≥63.0)	60.63	60.71	60.65	60.63
Average Sample Length (mm)	144.07	127.32	149.05	150.93
Density (kg/m <sup>3</sup> )	2500.81	2428.47	2484.85	2558.87
Unit Weight (kN/m <sup>3</sup> )	24.53	23.82	24.38	25.10
L/D Ratio (2.0-2.5)	2.38	2.10	2.46	2.49
Failure Load (lbs)	15610	11430	42960	47810
Compressive Strength (MPa)	<b>24.1</b>	<b>17.6</b>	<b>66.1</b>	<b>73.7</b>
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	-0.073	0.037	0.011	0.036
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Diagonal cracking from one end.	Diagonal fracture with cracking through ends.	Reasonably well formed cones on both ends.	Reasonably well formed cones on both ends.
Note				

Remarks:

Reviewed by: 

Date: November 7, 2023



**Compressive Strength & Elastic Moduli of Intact Rock Core  
Specimens under Varying States of Stress and Temperatures**

**Method C  
ASTM D7012 & D4543**

Client:	<u>KGS Group Inc.</u>	Project No.:	<u>123316822</u>
Project:	<u>CentrePort AAW Regional S&amp;W Servicing</u>		
Material Type:	<u>Rock Core; Diameter ≥ 63.0 mm</u>	Date Received:	<u>November 30, 2023</u>
Date Sampled:	<u>November 29, 2023</u>	Tested By:	<u>Sagar Kharti</u>
Sampled By:	<u>Stantec</u>	Date Tested:	<u>December 4, 2023</u>

Sample Information				
Borehole Location	TH23-17	TH23-17	TH23-18	TH23-25
Sample Number	2816	2817	2818	2819
Sample Depth	15'6"-16'4"	17'2"-17'11"	15'11"-16'6"	37'0"-37'5"
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report
Average Diameter (mm) (≥63.0)	60.79	61.08	60.73	60.64
Average Sample Length (mm)	145.77	150.82	144.05	122.57
Density (kg/m <sup>3</sup> )	2588.59	2512.24	2588.72	2584.92
Unit Weight (kN/m <sup>3</sup> )	25.39	24.65	25.40	25.36
L/D Ratio (2.0-2.5)	2.40	2.47	2.37	2.02
Failure Load (lbs)	18390	18480	17430	13590
Compressive Strength (MPa)	<b>28.2</b>	<b>28.1</b>	<b>26.8</b>	<b>20.9</b>
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	<0.02
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	<0.001
Parallelism by Procedure FP2 (≤0.25°)	0.025	-0.043	-0.023	-0.060
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	<0.0043
Moisture Condition	As-Received	As-Received	As-Received	As-Received
Description of Break D7012/11.1.13	Reasonably well formed cone on both ends	Reasonably well formed cone on both ends	Reasonably well formed cone on both ends	Reasonably well formed cone on both ends
Note				

Remarks:

Reviewed by: 

Date: December 11, 2023



**Compressive Strength & Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures**

**Method C  
ASTM D7012 & D4543**

Client:	<u>KGS Group Inc.</u>	Project No.:	<u>123316822</u>
Project:	<u>CentrePort AAW Regional S&amp;W Servicing</u>	Date Received:	<u>November 30, 2023</u>
Material Type:	<u>Rock Core; Diameter ≥ 63.0 mm</u>	Tested By:	<u>Sagar Kharti</u>
Date Sampled:	<u>November 29, 2023</u>	Date Tested:	<u>December 4, 2023</u>
Sampled By:	<u>Stantec</u>		

Sample Information				
Borehole Location	TH23-25	TH23-26	TH23-26	
Sample Number	2820	2821	2822	
Sample Depth	43'5"-44'3"	37'0"-37'6"	43'6"-44'0"	
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report	As per Geotechnical Report	
Average Diameter (mm) (≥63.0)	60.72	60.94		
Average Sample Length (mm)	113.62	151.95		
Density (kg/m <sup>3</sup> )	2583.94	2538.38		
Unit Weight (kN/m <sup>3</sup> )	25.35	24.90	#VALUE!	
L/D Ratio (2.0-2.5)	1.87	2.49	#VALUE!	
Failure Load (lbs)	15830	19440	0	
Compressive Strength (MPa)	<b>24.3</b>	<b>29.6</b>	#VALUE!	
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02	<0.02	
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001	<0.001	
Parallelism by Procedure FP2 (≤0.25°)	0.062	-0.078	#N/A	
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043	<0.0043	
Moisture Condition	As-Received	As-Received	As-Received	
Description of Break D7012/11.1.13	Reasonably well formed cone on both ends	Reasonably well formed cone on both ends	0	
Note			Sample broke while preparation	

Remarks:

Reviewed by:

Date: December 11, 2023



December 20, 2023

Jacqueline MacLennan  
KGS Group  
3rd Floor - 865 Waverley St  
Winnipeg, MB  
R3T 5P4

Re: CERCHAR Abrasivity Testing  
(KGS Project No. 23-0107-009)

Dear Jacqueline:

On November 29<sup>th</sup>, 2023, a series of four (4) HQ-sized core samples were received by Geomechanica Inc. via courier service. These samples were identified as being from KGS project 23-0107-009. From these samples, four (4) CERCHAR Abrasivity tests were completed.

Details regarding the steps of specimen preparation and testing along with the test results are presented in the accompanying laboratory report and summary spreadsheet.

Sincerely,



Bryan Tatone Ph.D., P. Eng.

Geomechanica Inc.  
Tel: (647) 478-9767  
Email: [bryan.tatone@geomechanica.com](mailto:bryan.tatone@geomechanica.com)

# Rock Laboratory Testing Results

**A report submitted to:**

Jacqueline MacLennan  
KGS Group  
3rd Floor - 865 Waverley St  
Winnipeg, MB  
Canada, R3T 5P4

**Prepared by:**

Bryan Tatone, PhD, PEng  
Omid Mahabadi, PhD, PEng  
Geomechanica Inc.  
#14-1240 Speers Rd.  
Oakville ON  
L6L 2X4 Canada  
Tel: +1-647-478-9767  
lab@geomechanica.com

**December 20, 2023**

Project number: 23-0107-009

**Abstract**

This document summarizes the results of rock laboratory testing, including 2 CERCHAR Abrasivity tests. The CERCHAR Abrasivity Index (CAI) values are presented herein.

**In this document:**

1	CERCHAR Abrasivity Tests	1
---	--------------------------	---

# 1 CERCHAR Abrasivity Tests

## 1.1 Overview

This section summarizes the results of CERCHAR abrasivity testing. Testing was performed using a Type-2 CERCHAR apparatus as shown in Figure 1a. The tips of the styluses were sharpened to a conical angle of  $90^\circ$  using the setup shown in Figure 1b. The styluses used to perform the tests are shown in Figure 1c-d (Rockwell hardness  $55\pm 1$ ). A static force of 70 N was applied on top of the stylus by using a combination of weights. Details of the testing procedure are as follows:

1. The tips of the five styluses are sharpened using the grinding apparatus (Figure 1b).
2. The styluses are placed under a microscope (60x magnification) and three scaled photos ( $120^\circ$  apart) are captured before the test is conducted to ensure the  $90^\circ$  point has been properly formed.
3. The test specimens are obtained by breaking core samples to expose a fresh fracture surface perpendicular to the core axis.
4. The specimen is secured in the cross-slide vise of the testing apparatus and the stylus is carefully lowered on to the surface of the rock.
5. A scratch measuring 10 mm in length is performed over a duration of 10 seconds. This process is repeated with all five styluses on undisturbed parts of the fracture surface (e.g., Figure 2a).
6. Lastly, the worn tips are re-examined under the microscope. From three scaled photos ( $120^\circ$  apart), the wear flat,  $d$ , is measured (e.g., Figure 2c).

The length or the diameter of the wear flat,  $d$ , was measured from scaled microscope images using the image processing software Fiji (e.g., Figure 2b-c). The mean wear of the tip is calculated by taking the average  $d$  of all tests. The CERCHAR-Abrasivity-Index (CAI) of the sample is subsequently calculated by taking the mean wear and multiplying it by 10. The above testing procedure followed ASTM D7625.

## 1.2 Results

The results of CERCHAR abrasivity testing are provided in Table 1. Please note that additional specimen and testing details are available in the summary spreadsheet that accompanies this report.



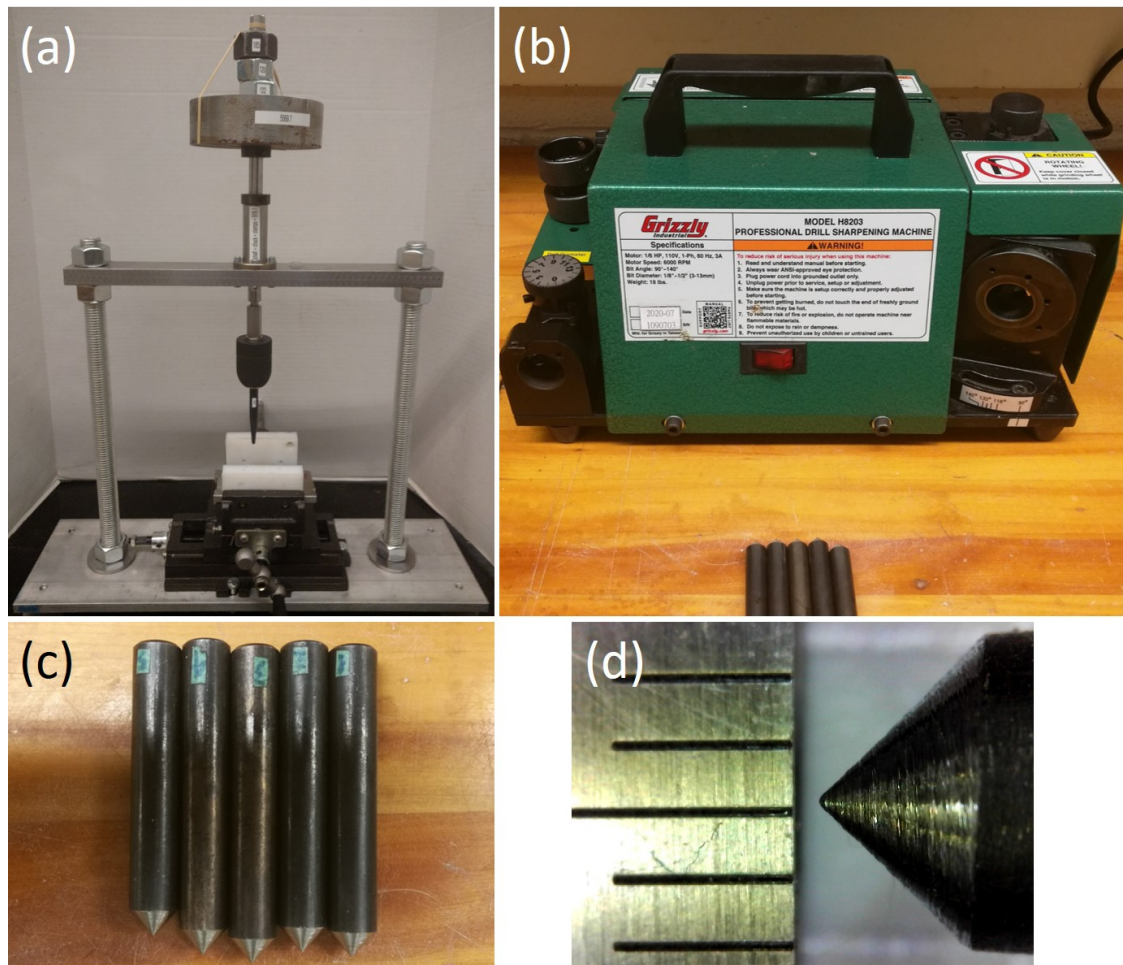


Figure 1: Photos showing (a) the CERCHAR apparatus, (b) tip sharpening setup, (c) the five styluses used to perform the test and (d) a microscope image of one of the stylus tips.

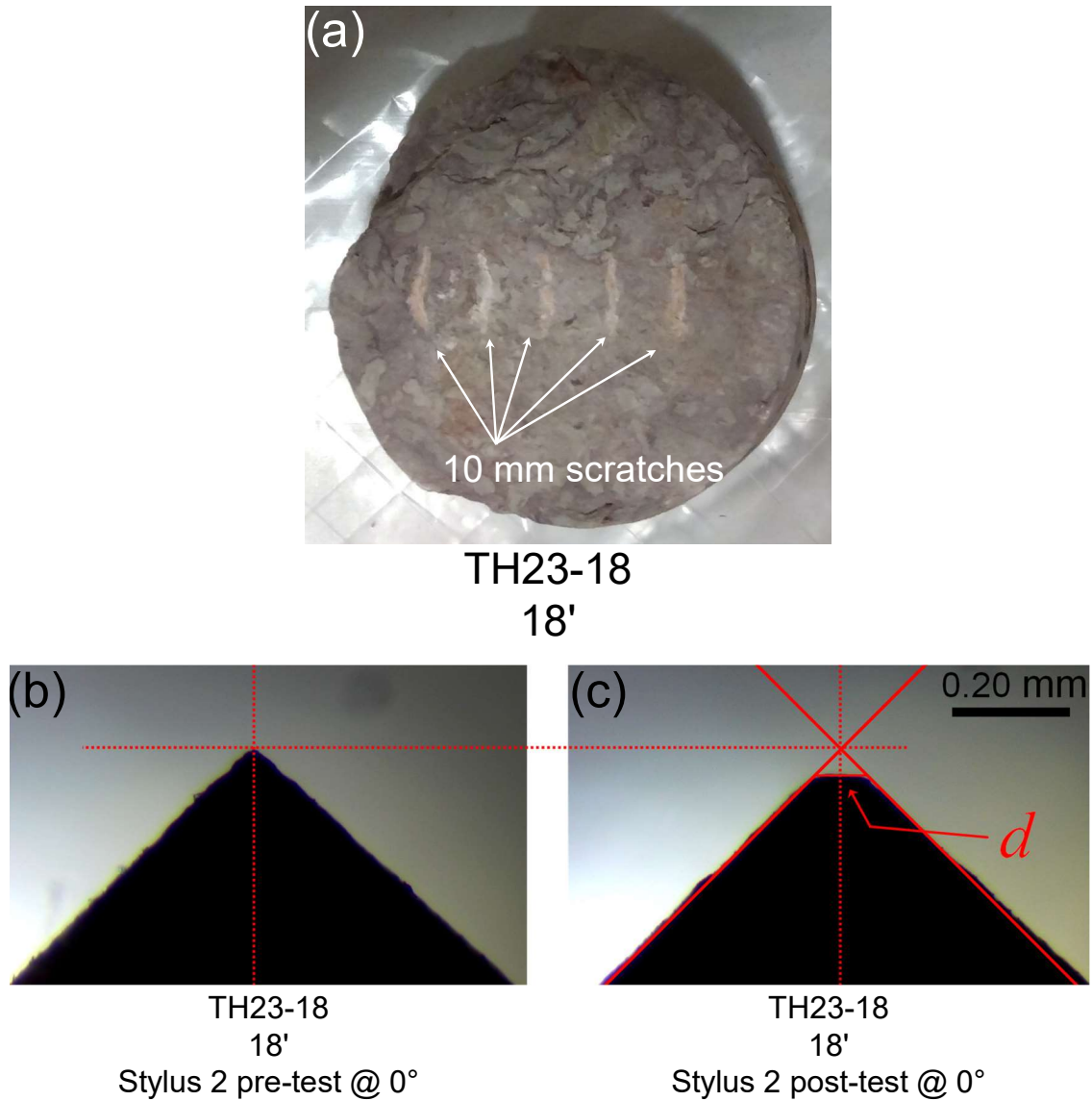


Figure 2: (a) Photograph showing an example of the five 10 mm scratches on a test specimen; (b) microscope image of select stylus prior to testing at the noted position; and (c) microscope image of the same stylus at the same position following testing with the wear flat,  $d$ , denoted.

Table 1: Summary of CERCHAR abrasivity test results.

Sample	Depth (ft)	Test 1	Test 2	Test 3	Test 4	Test 5	Mean	CAI	Description	ASTM
		Mean (mm)	Mean (mm)	Mean (mm)	Mean (mm)	Mean (mm)	Wear (mm)			Classification
TH23-18	18'	0.045	0.094	0.029	0.030	0.025	0.045	0.445	Bedrock	Very Low
TH23-17	17'	0.021	0.022	0.037	0.032	0.038	0.030	0.301	Bedrock	< Very Low
TH23-26	36'	0.030	0.023	0.025	0.025	0.037	0.028	0.278	Bedrock	< Very Low
TH23-25	38'	0.024	0.061	0.060	0.082	0.036	0.053	0.525	Bedrock	Very Low



# **APPENDIX E**

2009 Consolidation Testing Results

KGS Group Inc.  
3<sup>rd</sup> Floor - 865 Waverley St.  
Winnipeg, Manitoba  
R3T 5P4

July 28, 2009

Project: Centre Port

Attention: David Anderson

Soil samples were submitted to our testing laboratory on May 19, 2009. The samples were tested for one-dimensional consolidation properties in accordance with ASTM D2435 (Method A). Additional loadings were applied at the beginning of each test to prevent swelling of the test specimens. The load and unload increments in kPa for the test specimens are summarized in the following table:

TH09-21F S4	TH09-25A S5	TH09-25A S8
23, 36, 41, 46, 51	26, 36	26, 36, 41
	51	51
100	100	100
200	200	200
399	399	399
200	200	200
100	100	100
200	200	200
449	399	399
798	797	798
1196	1195	1196
1594	1594	1595
399	399	399
100	100	100
26	26	26

The test data for the soil samples are summarized in the attached table and graphs.

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



Don Flatt, M.Eng., P.Eng.  
Senior Geotechnical Engineer

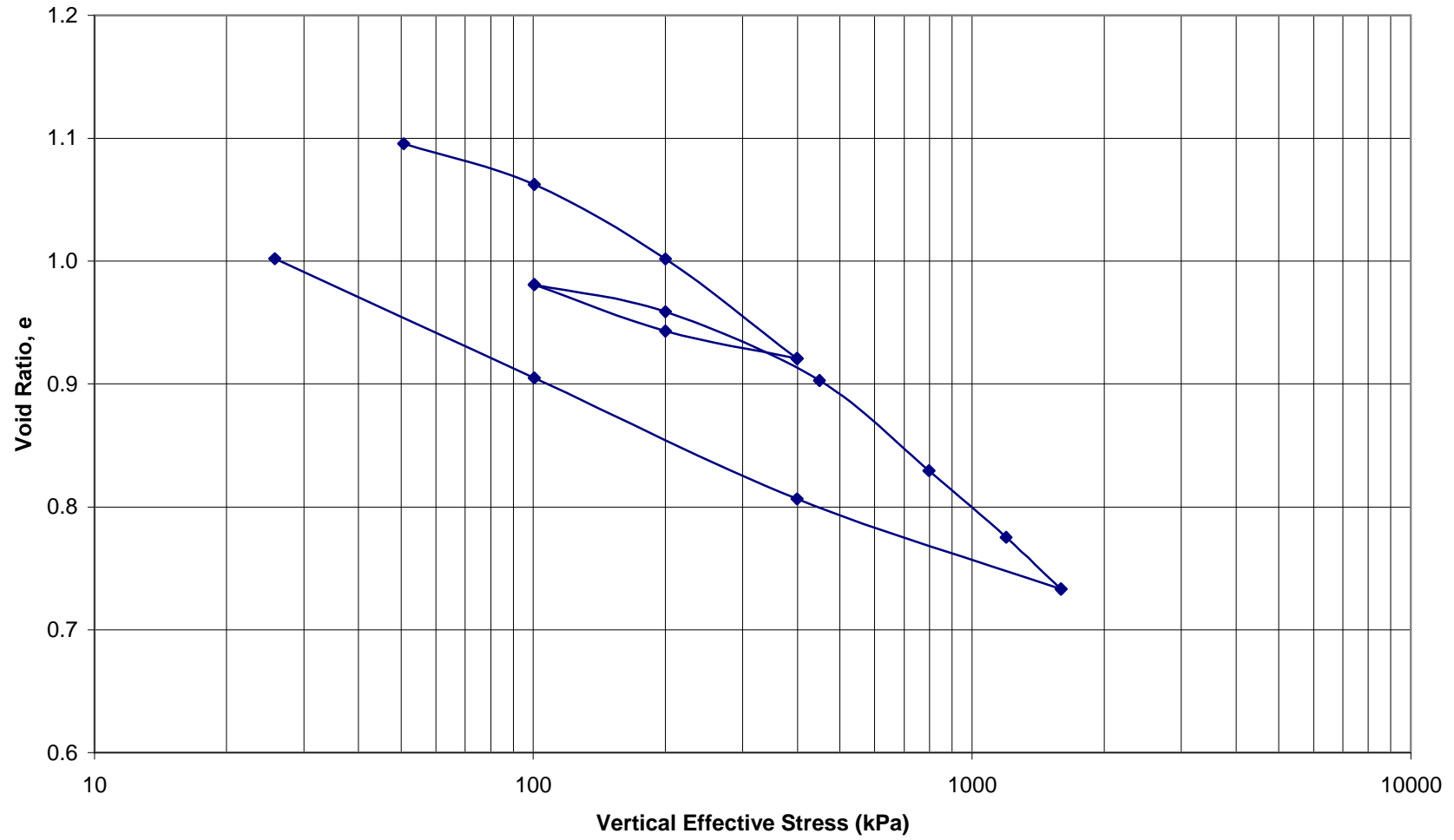


**CONSOLIDATION TEST DATA  
CENTRE PORT**

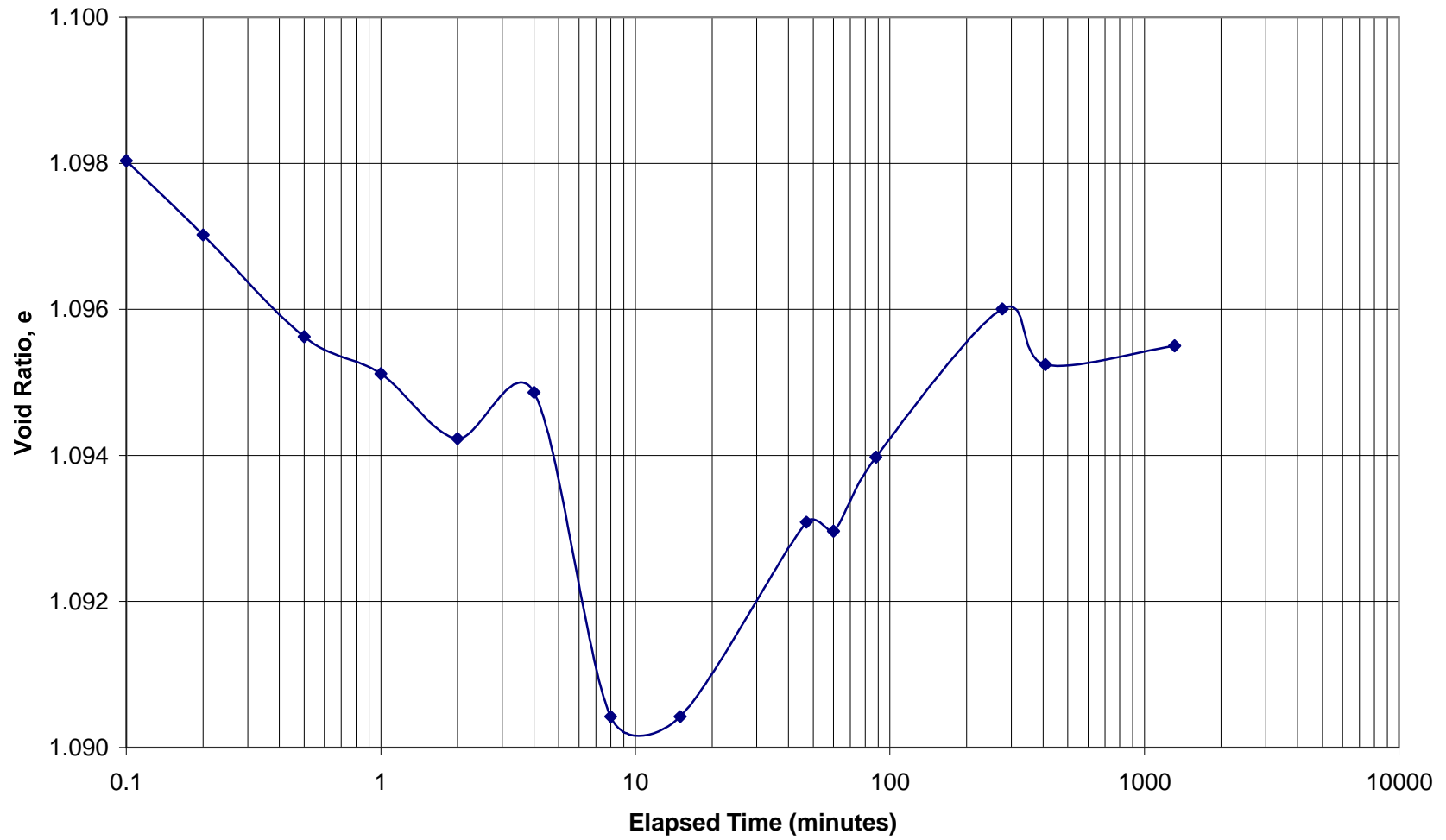
Testhole no.	Sample ID	Cc	Cr	Moisture Content (%)		Saturation (%)		Void Ratio		Wet Density (kg/m <sup>3</sup> )		Dry Density (kg/m <sup>3</sup> )	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
TH09-21F	S4	0.32	0.10	35.3	37.5	84.2	101.0	1.15	1.00	1728	1872	1277	1362
TH09-25A	S5	0.55	0.13	51.3	47.7	83.1	102.1	1.70	1.25	1542	1778	1020	1203
TH09-25A	S8	0.53	0.15	50.1	47.3	94.7	104.2	1.46	1.27	1682	1801	1120	1222



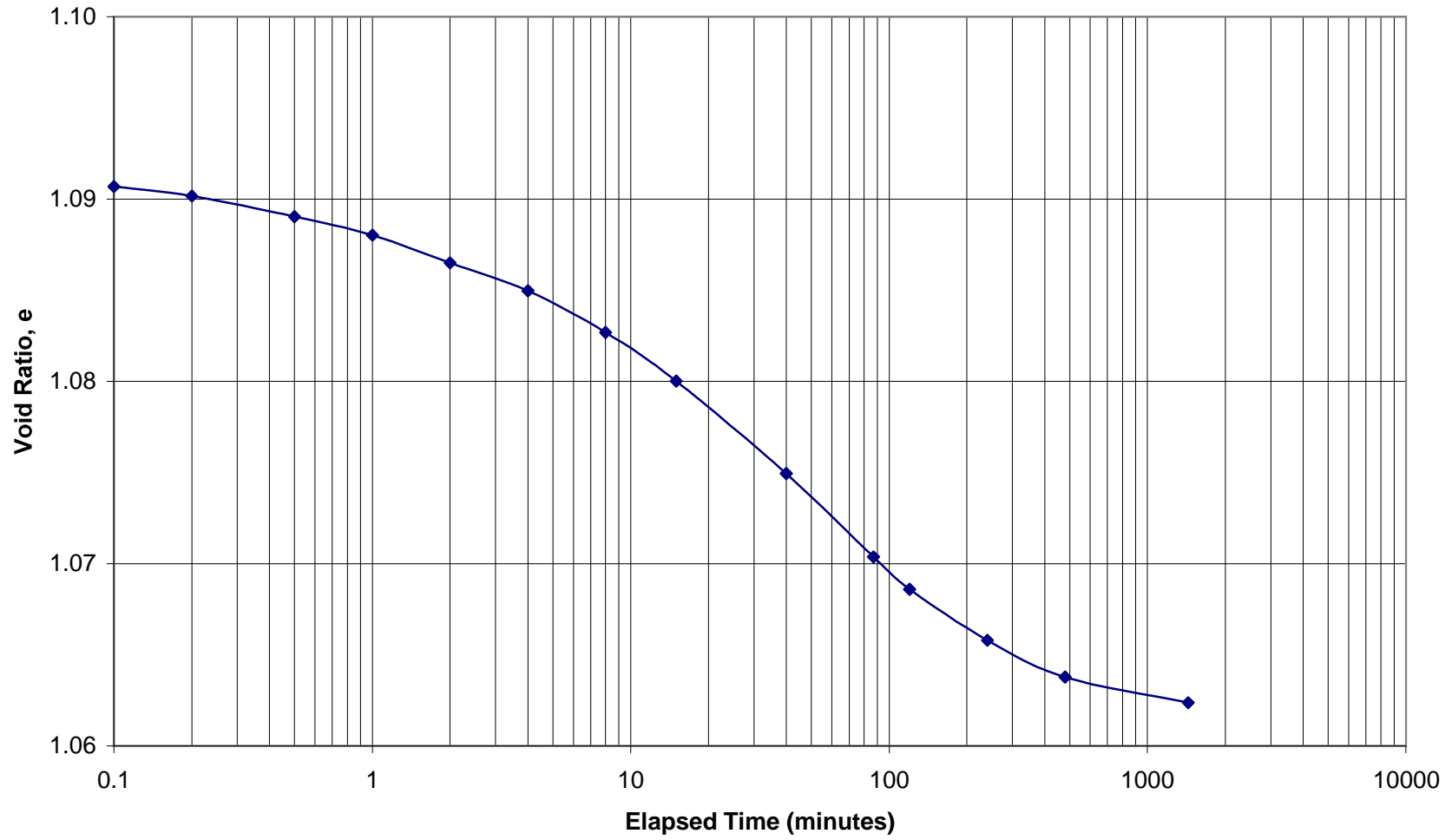
**Void Ratio vs. Vertical Effective Stress**  
**TH09 - 21F S4**



TH09-21F S4  
26, 36, 41, 46, 51 kPa

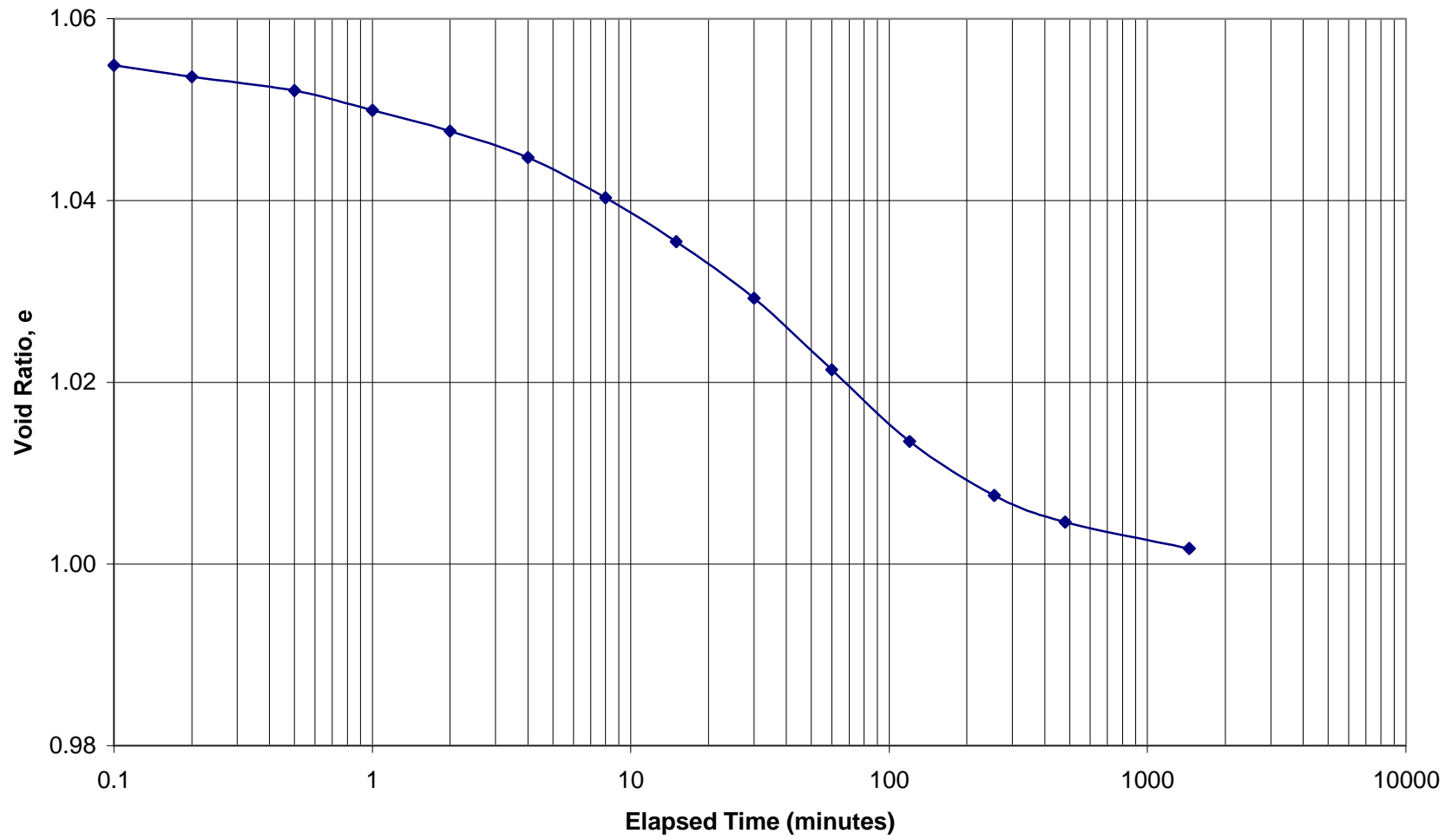


TH09-21F S4  
100 kPa

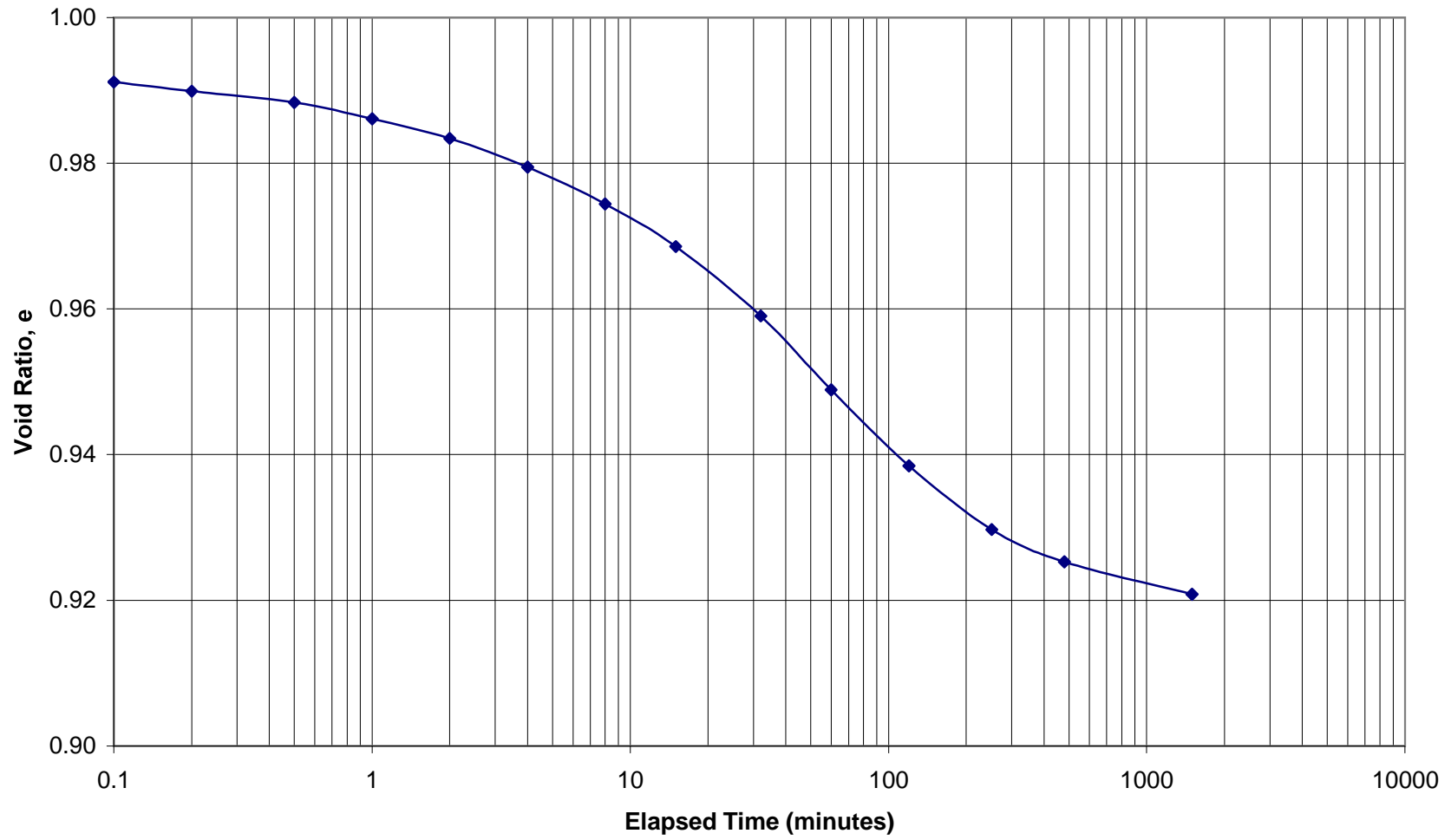




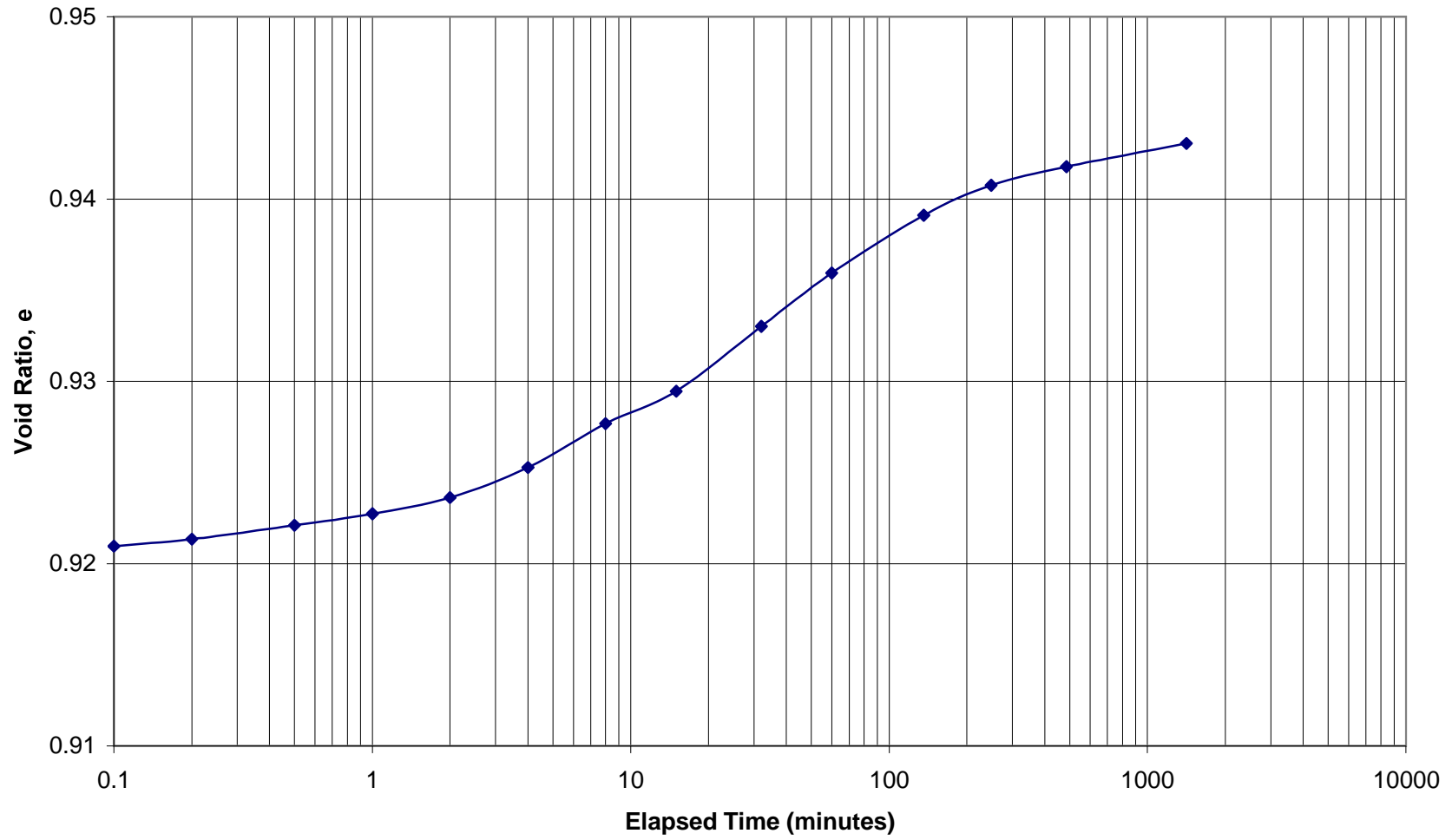
TH09-21F S4  
200 kPa



TH09-21F S4  
399 kPa

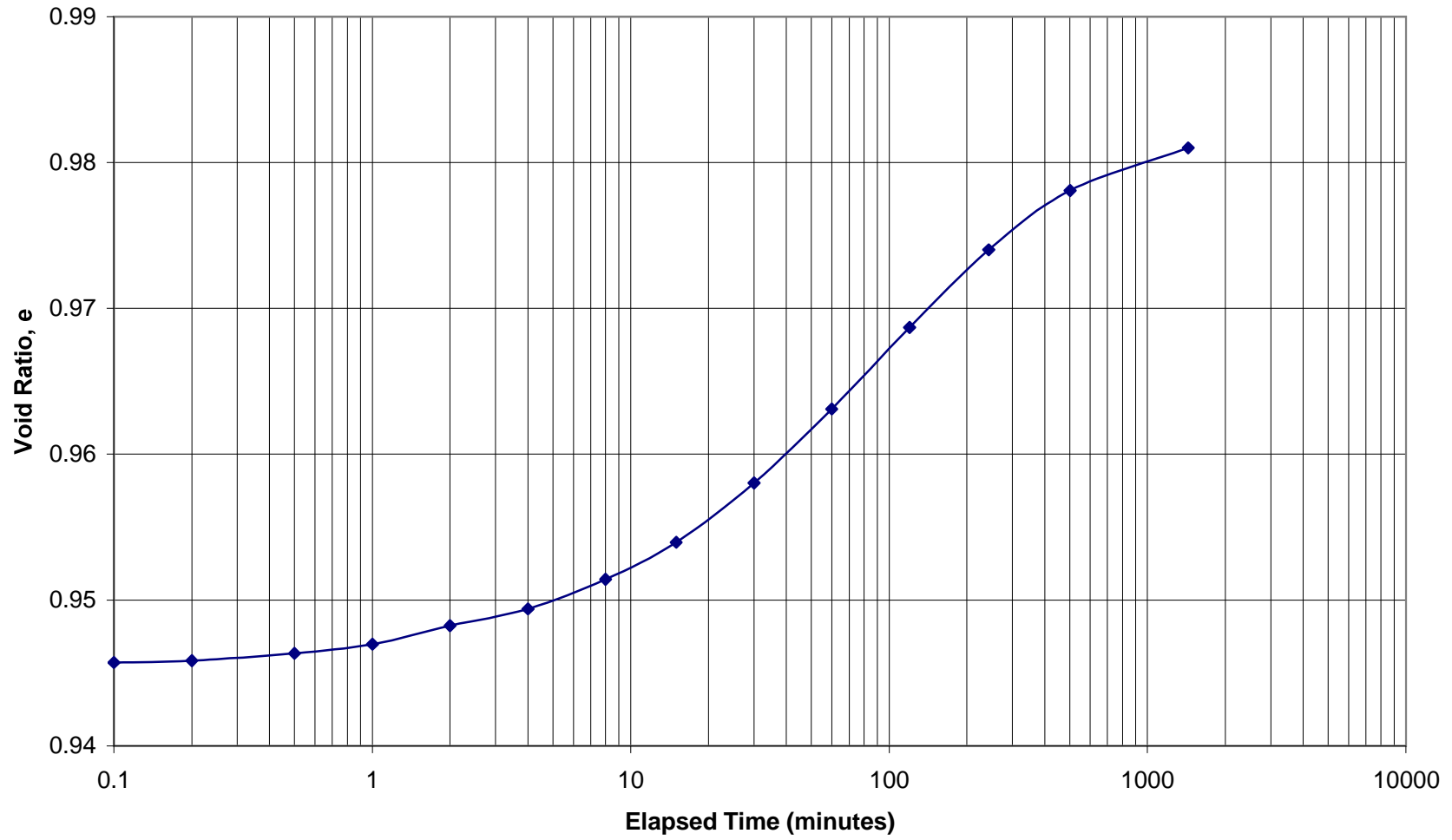


TH09-21F S4  
200 kPa

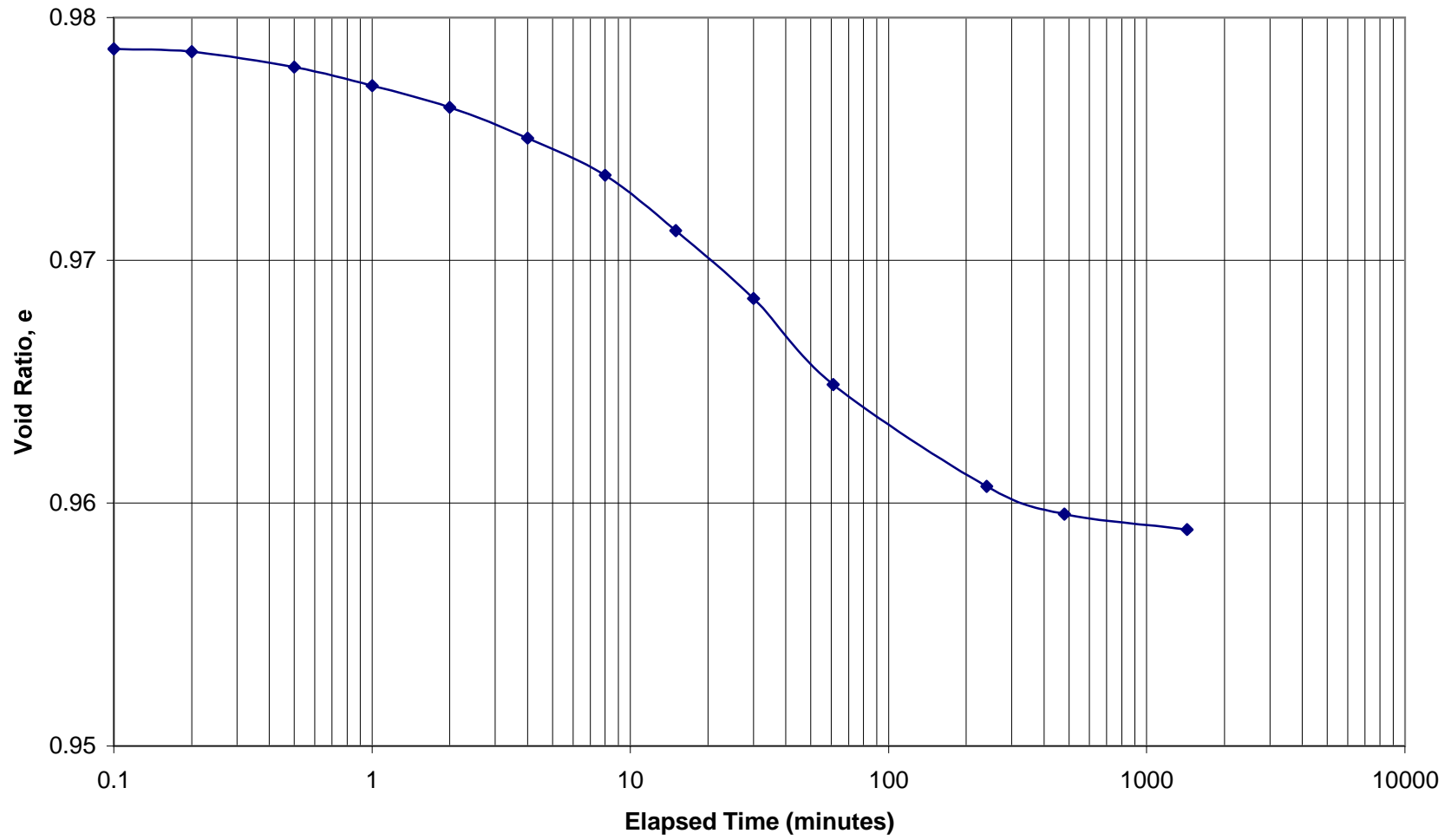




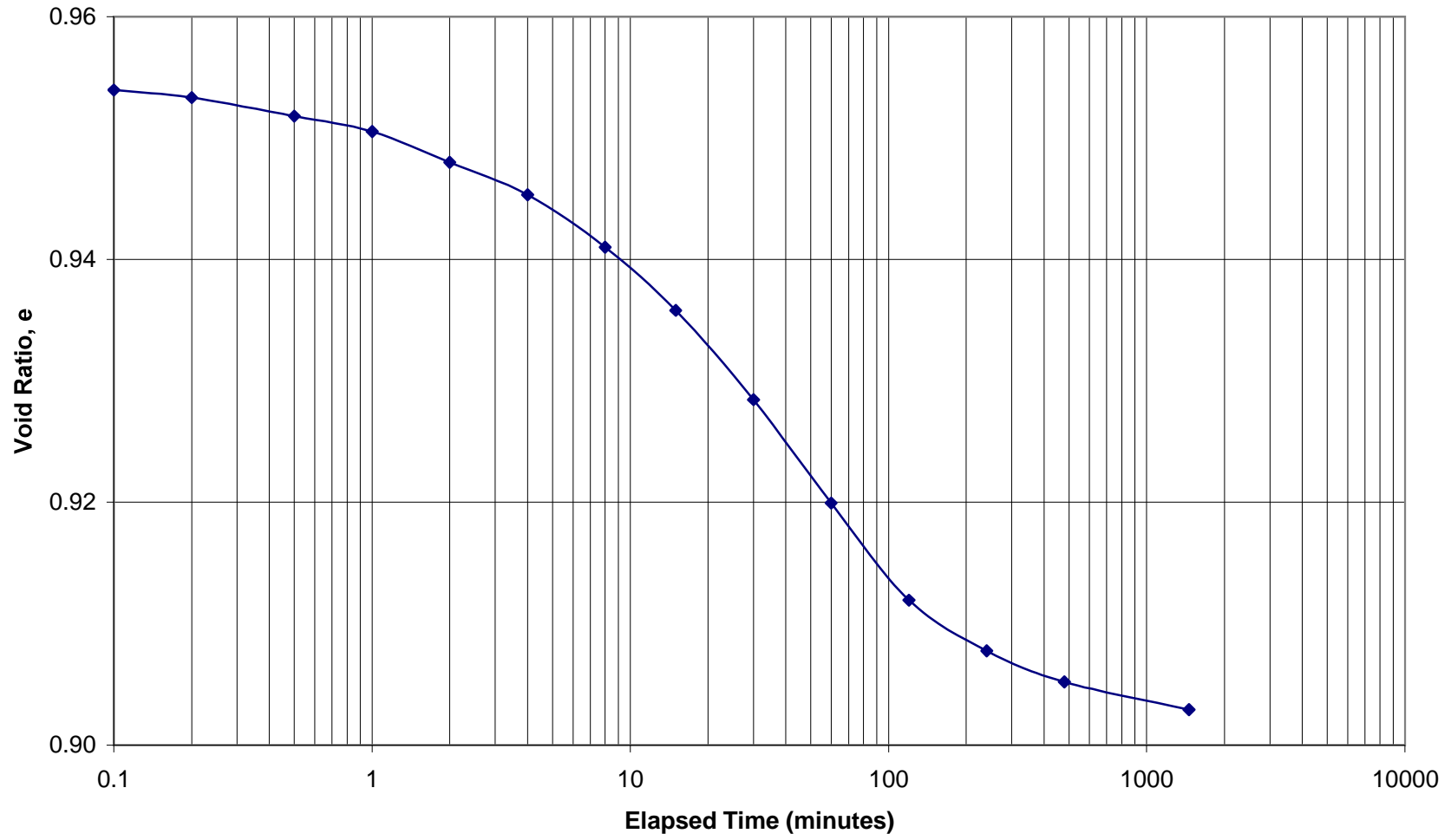
TH09-21F S4  
100 kPa



TH09-21F S4  
200 kPa

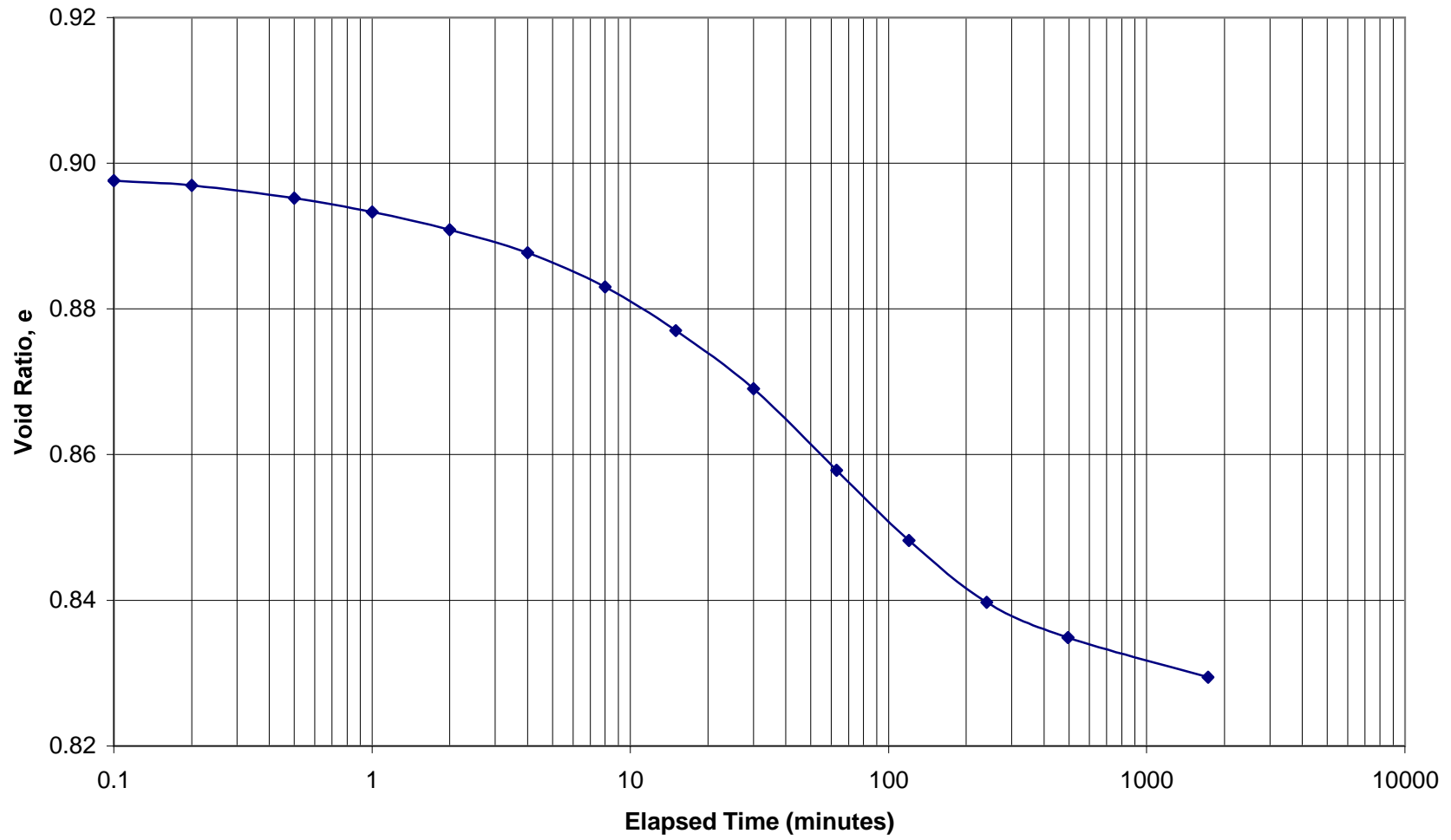


TH09-21F S4  
449 kPa

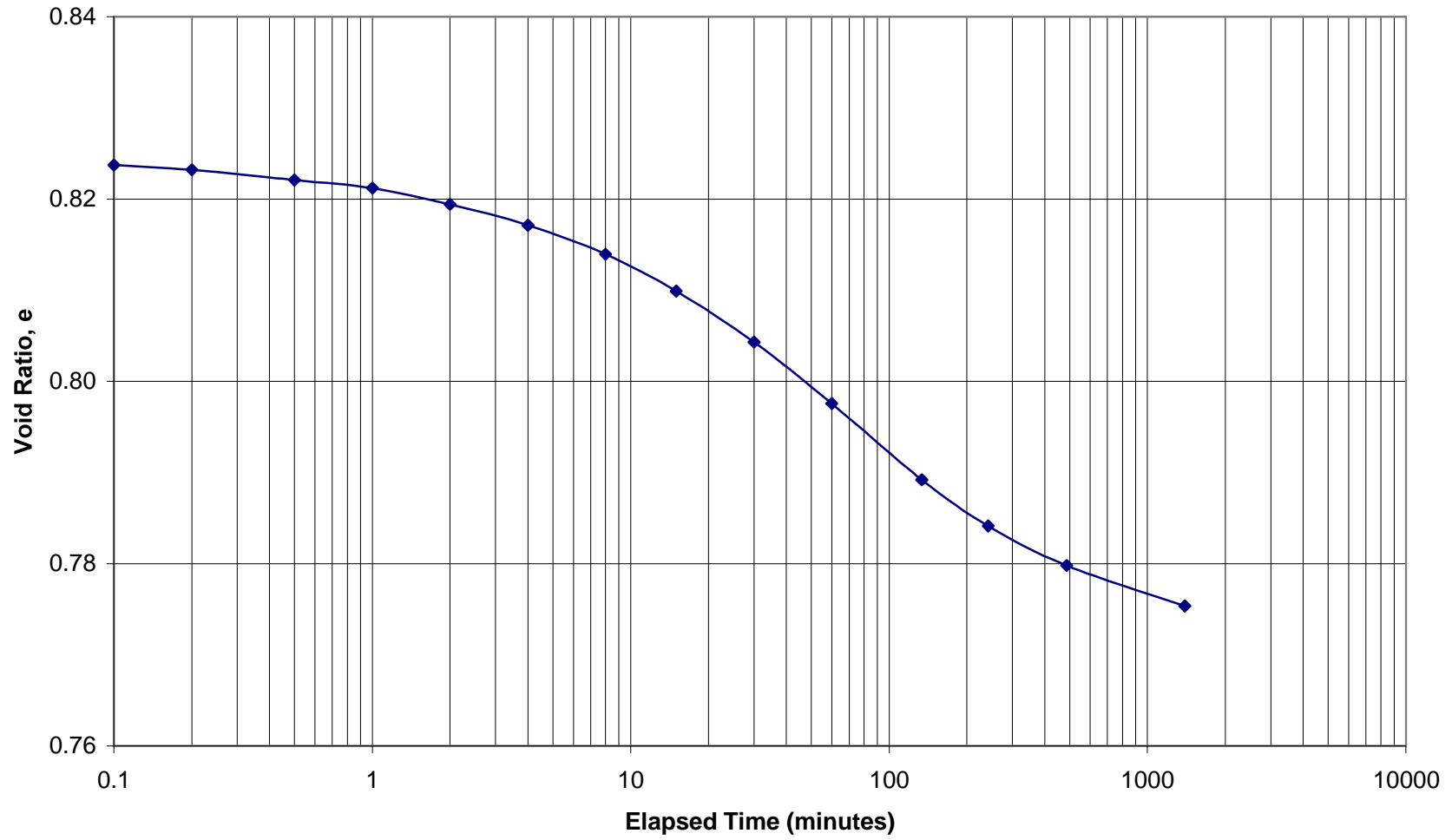




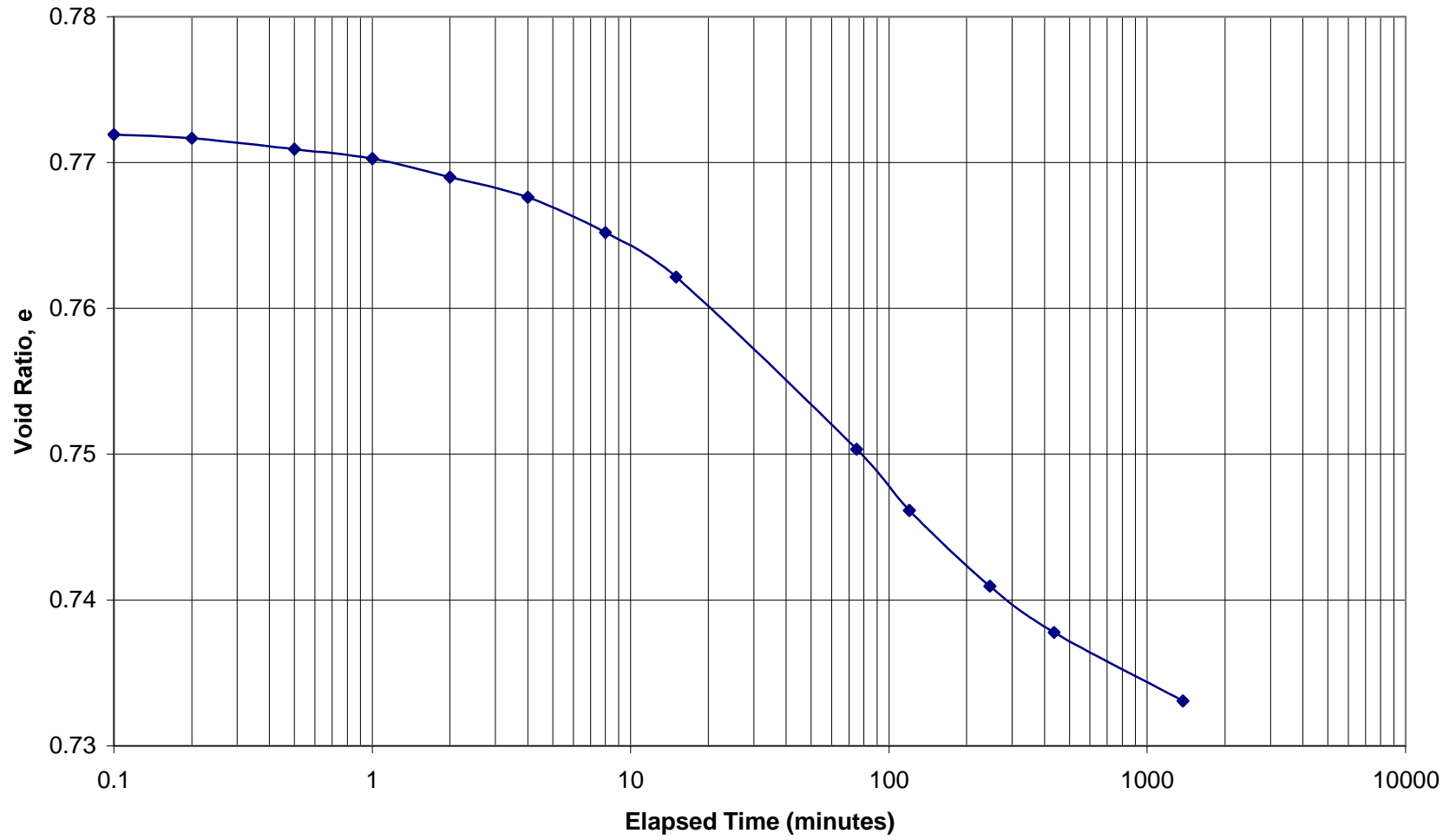
TH09-21F S4  
798 kPa



TH09-21F S4  
1196 kPa

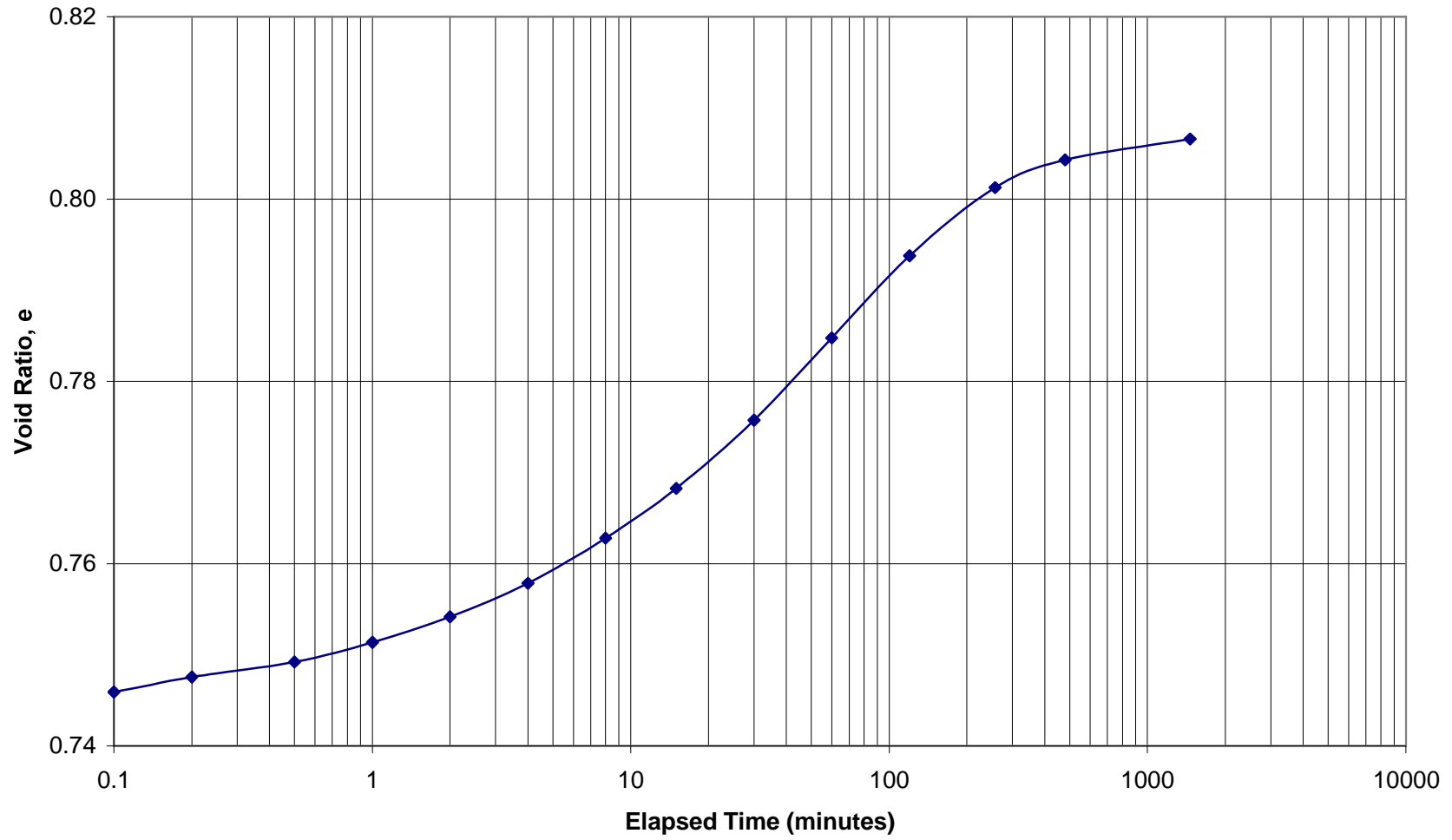


TH09-21F S4  
1594 kPa

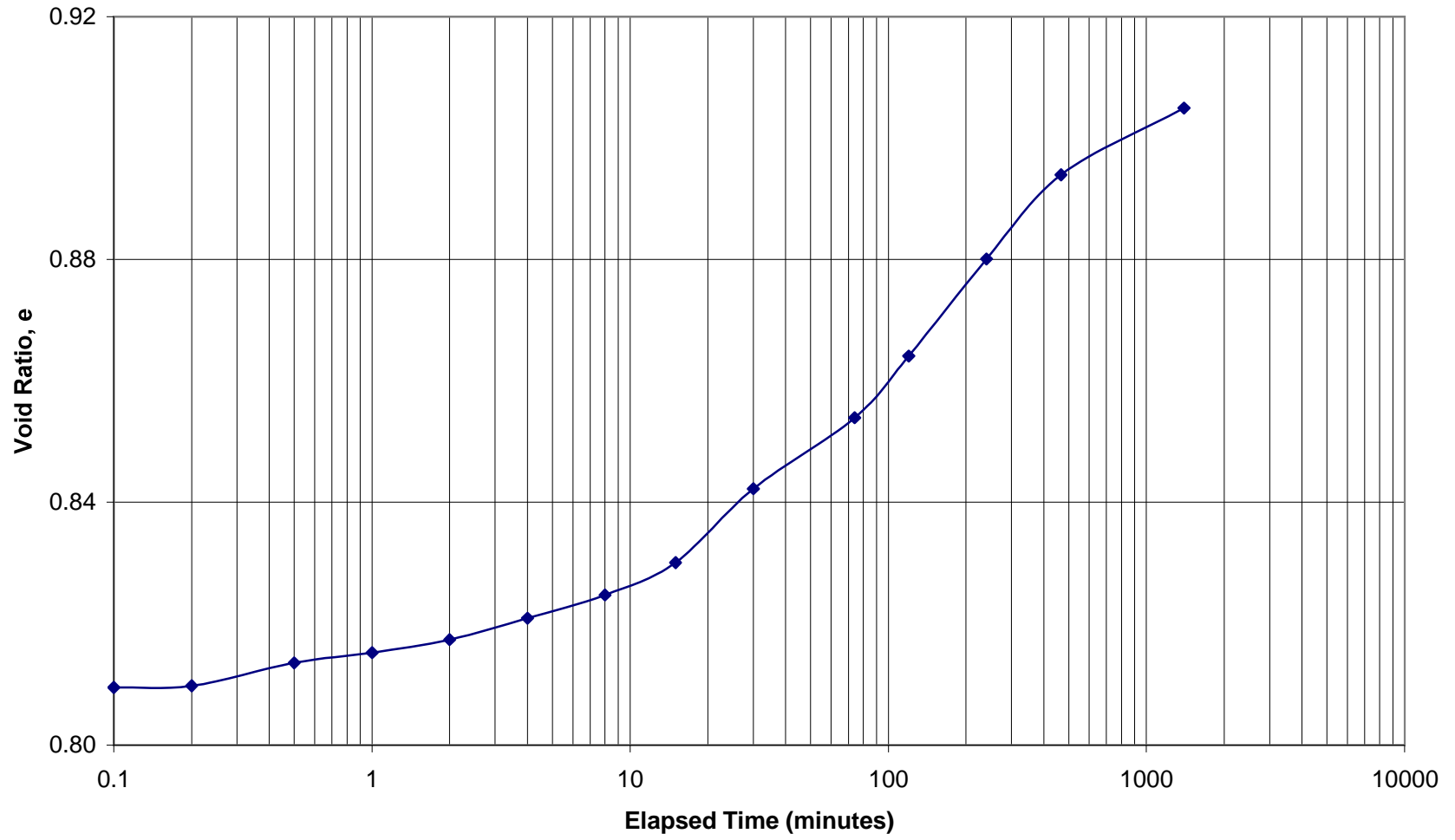




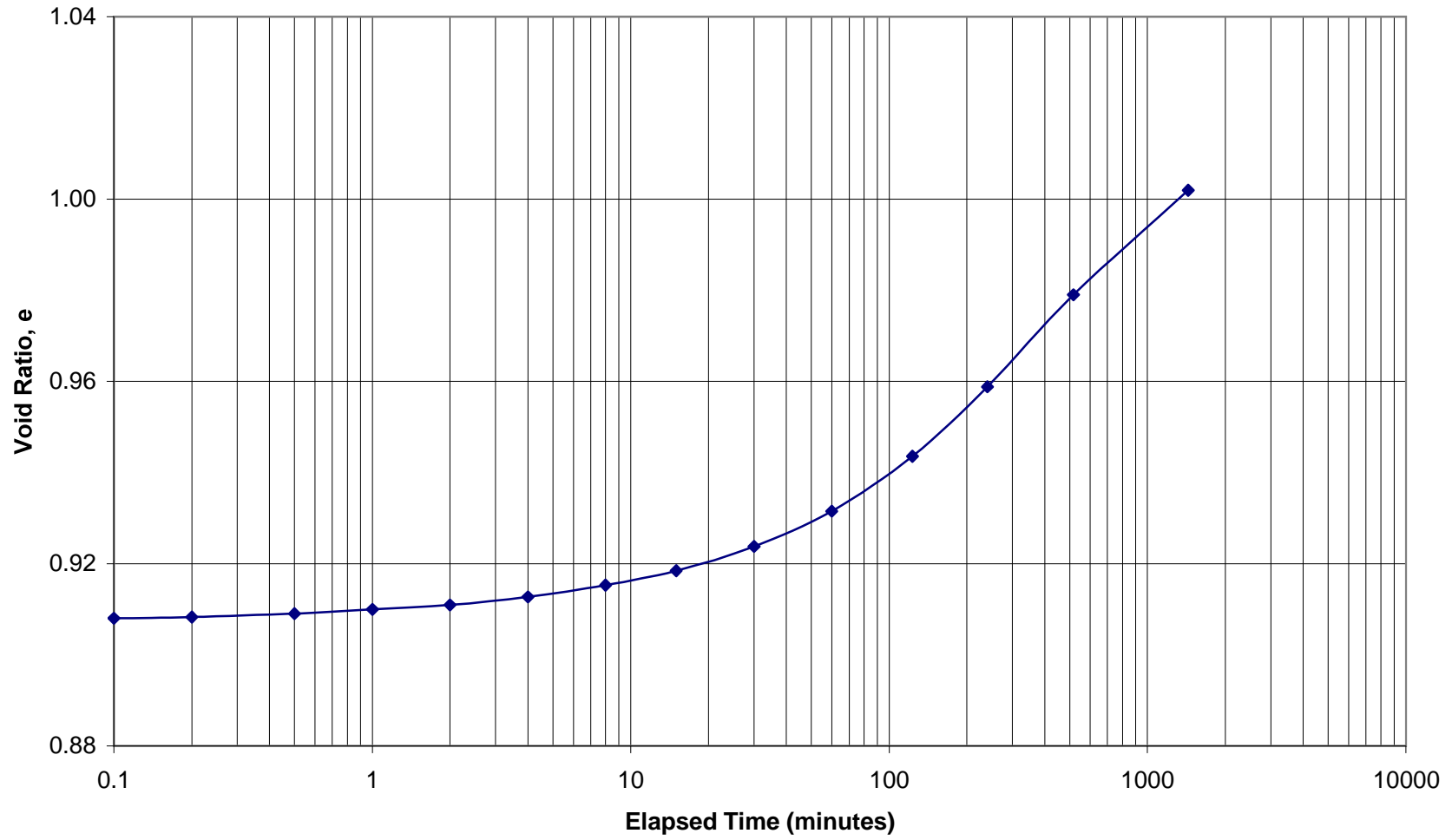
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399 kPa



TH09-21F S4  
100 kPa

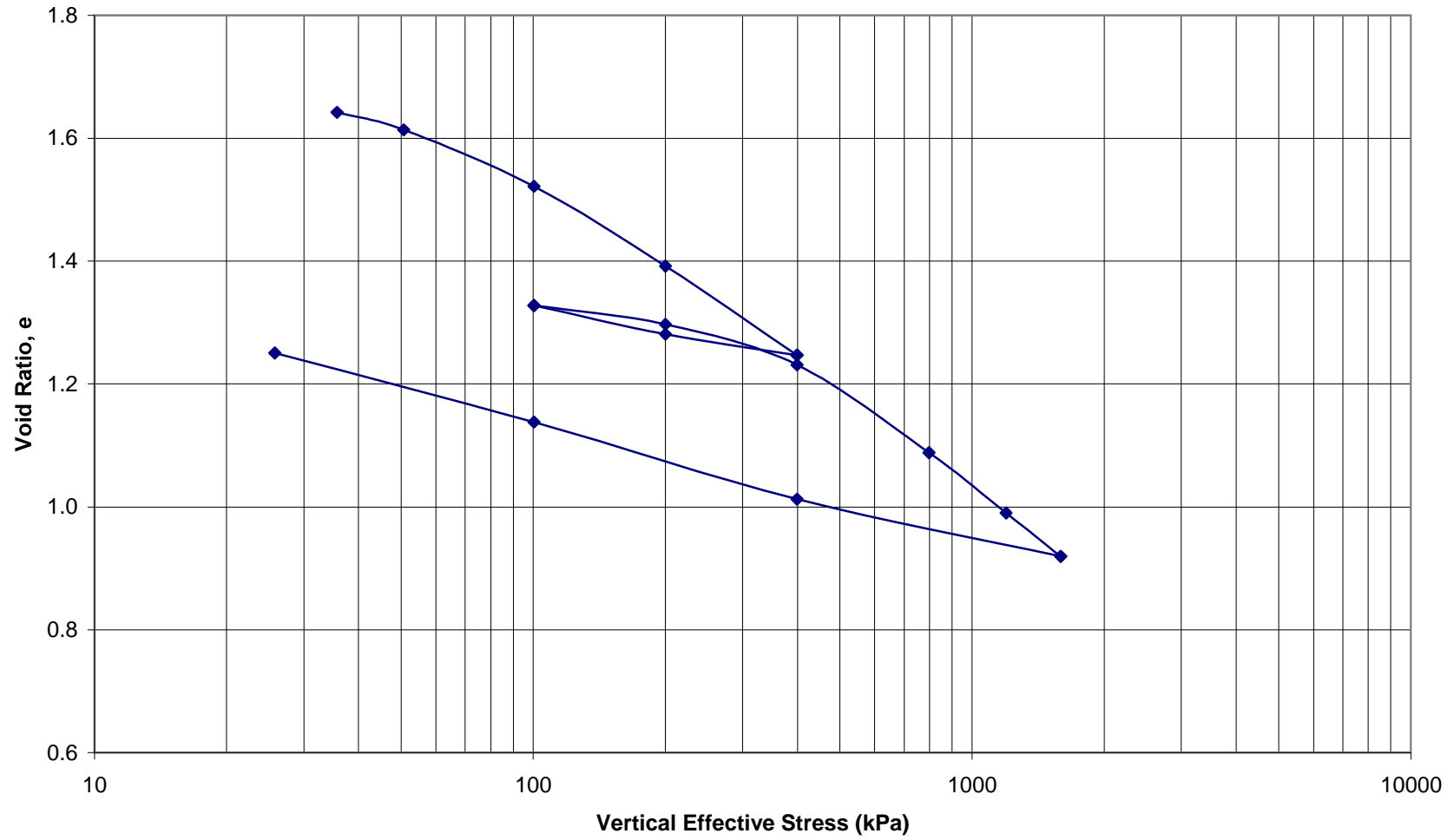


TH09-21F S4  
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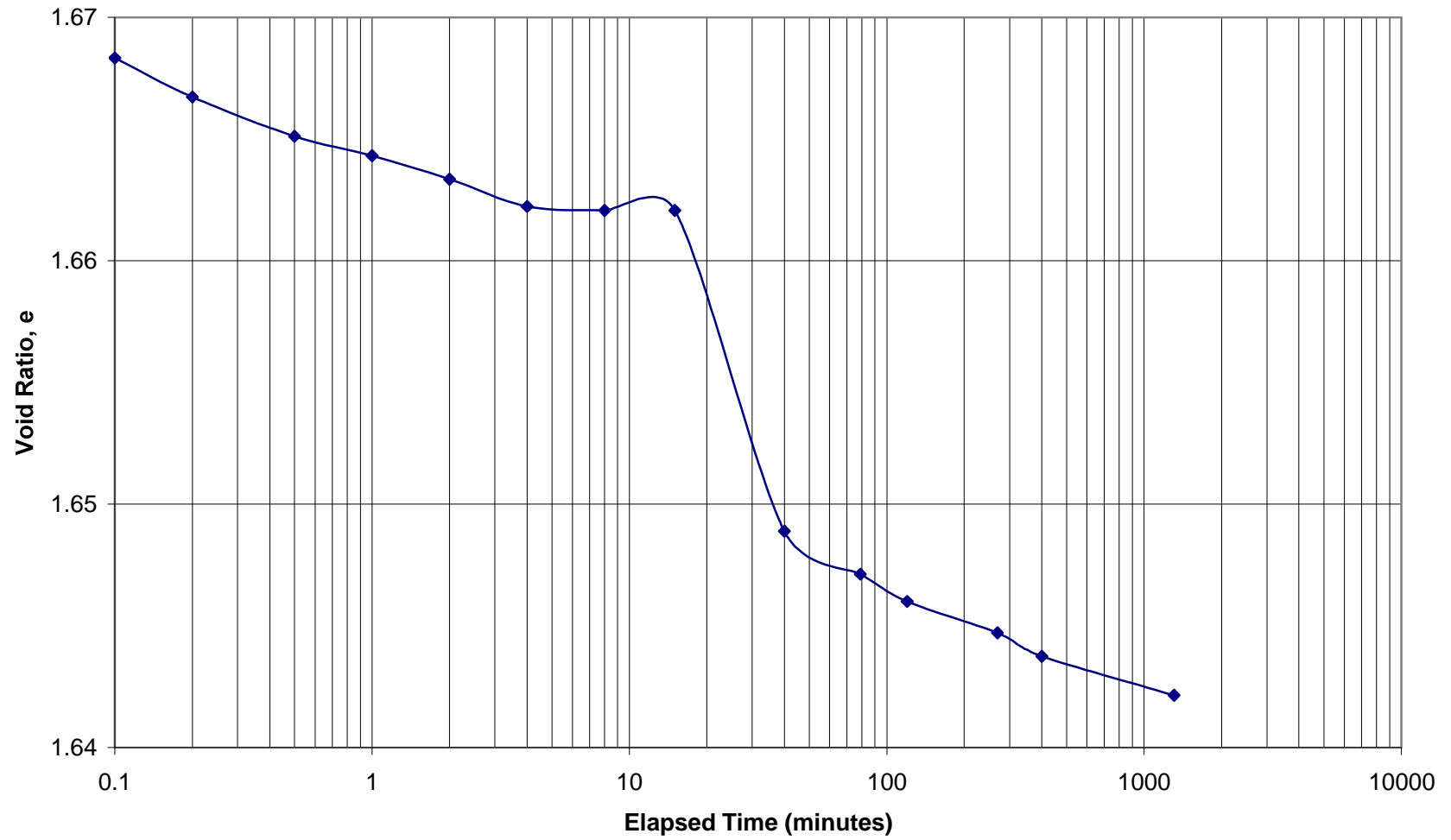




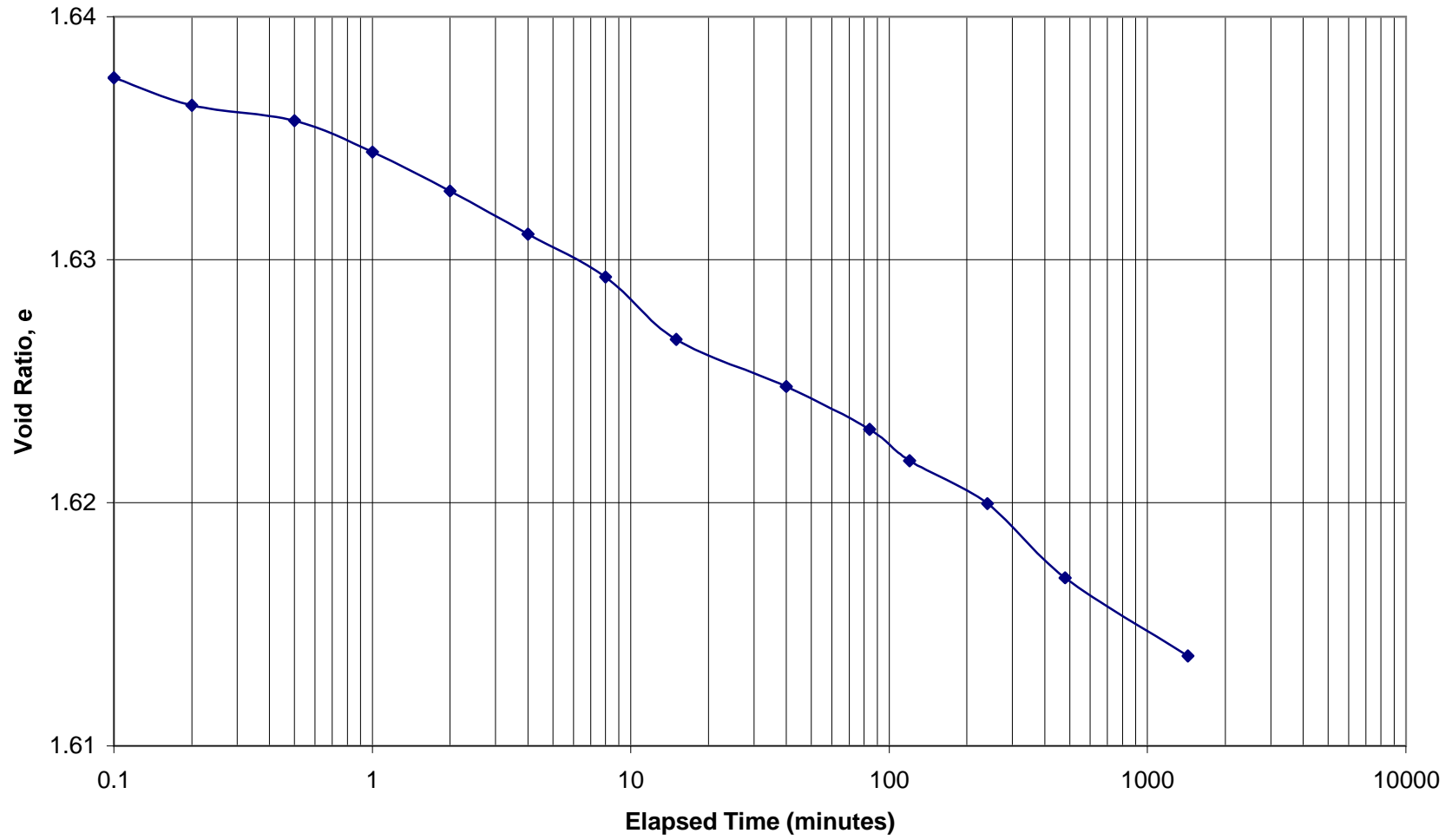
**Void Ratio vs. Vertical Effective Stress**  
**TH09 - 25A S5**



TH09-25A S5  
26, 36 kPa

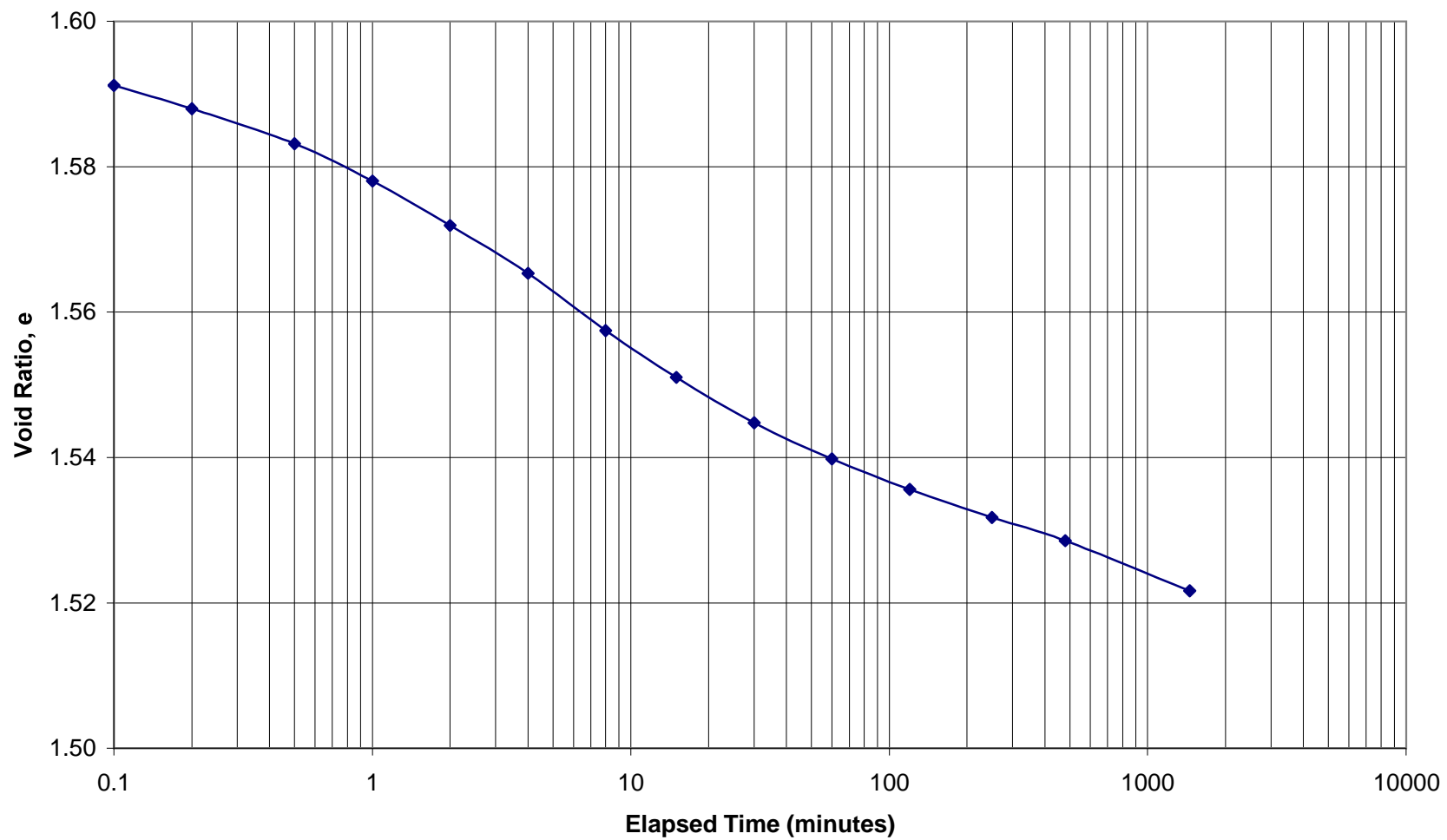


TH09-25A S5  
51 kPa

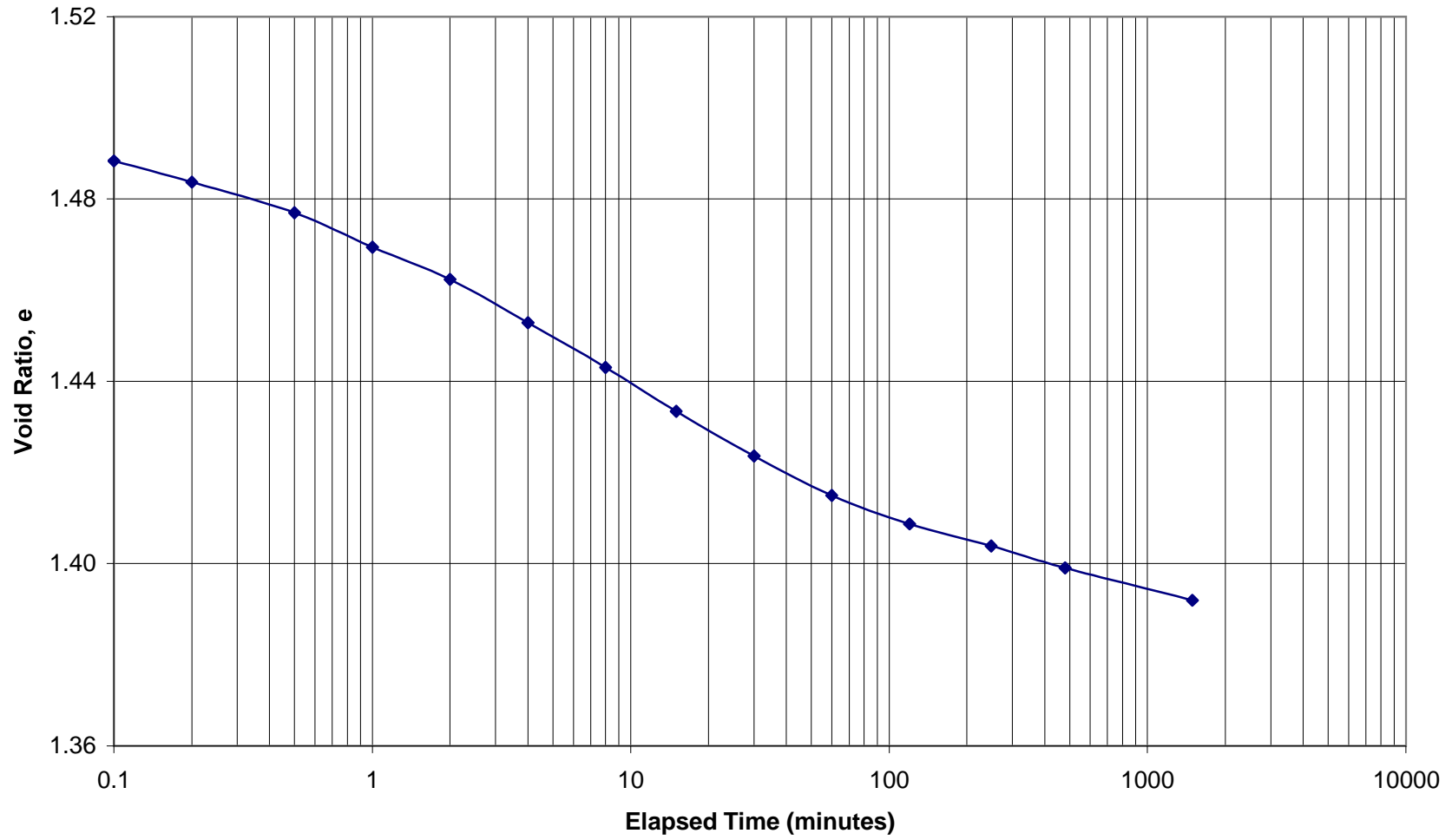




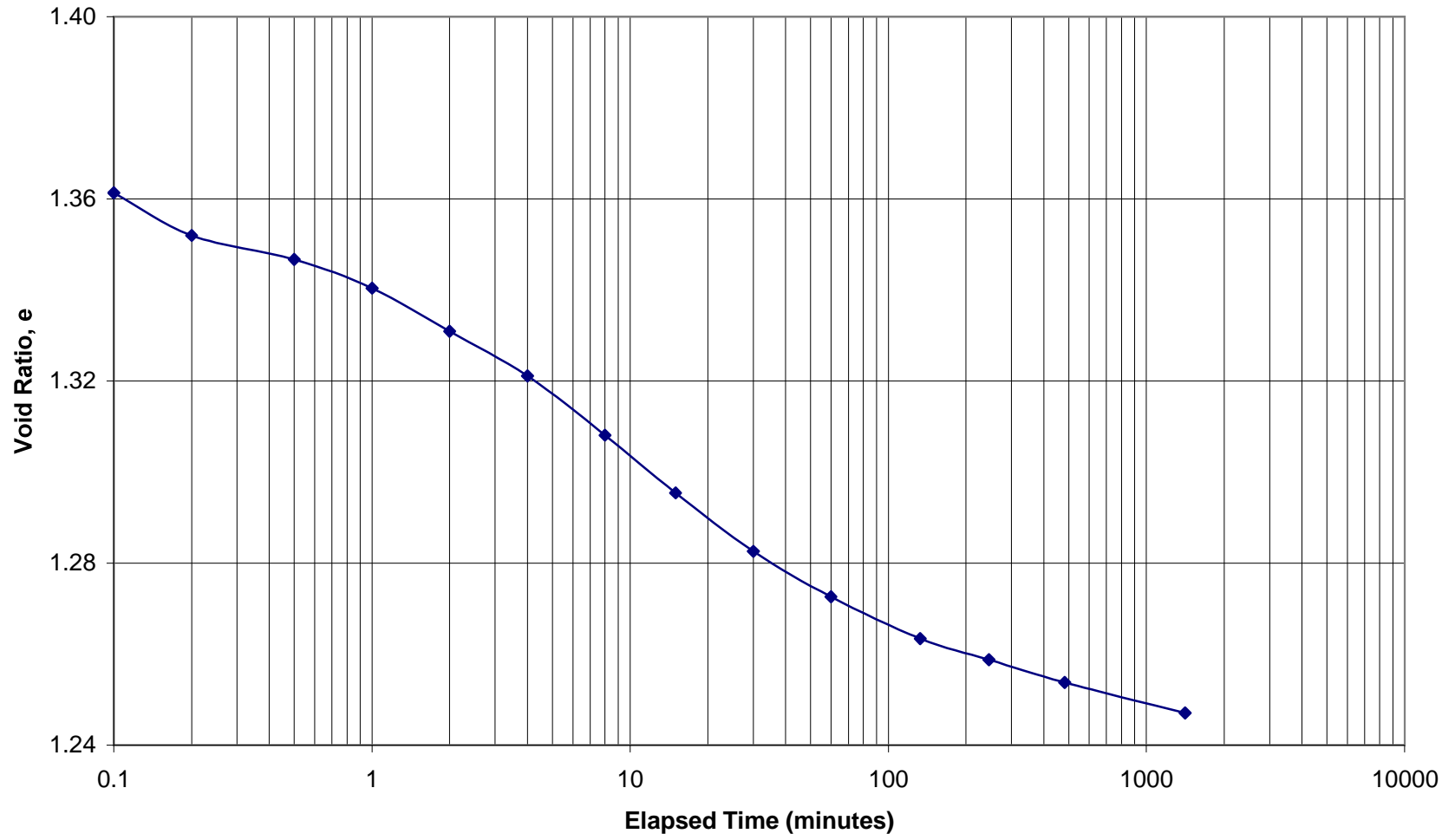
TH09-25A S5  
100 kPa



TH09-25A S5  
200 kPa

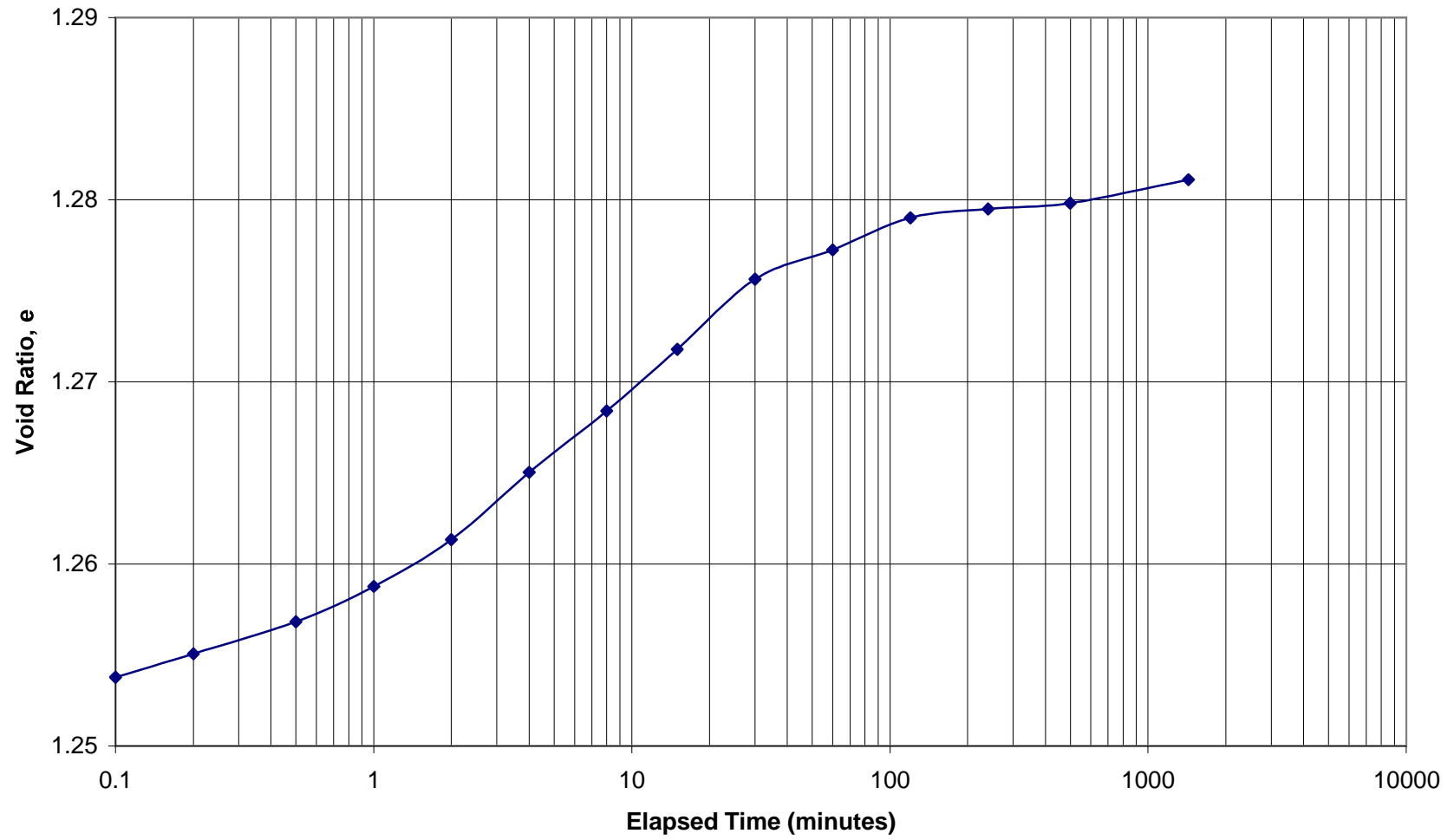


TH09-25A S5  
399 kPa

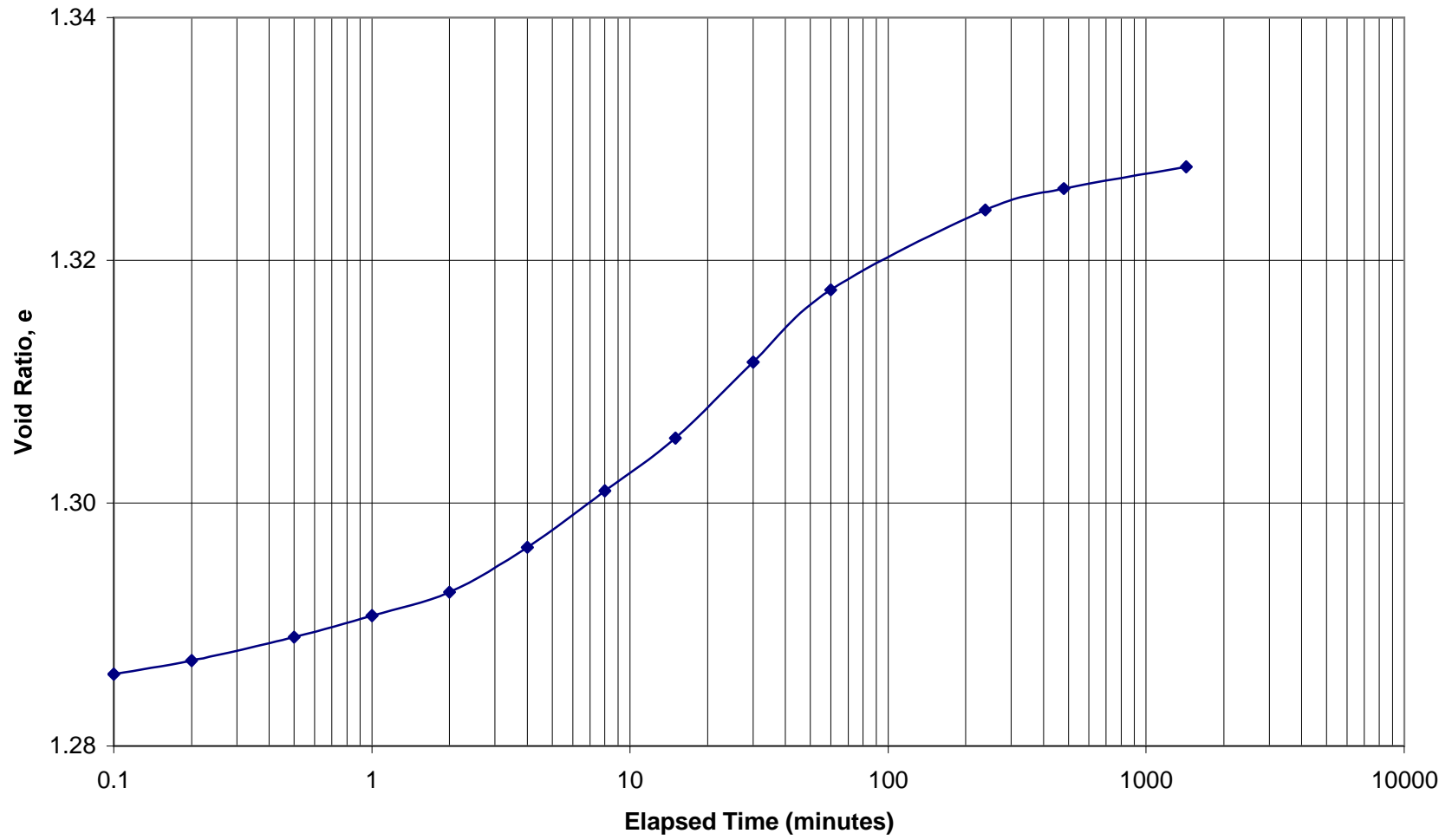




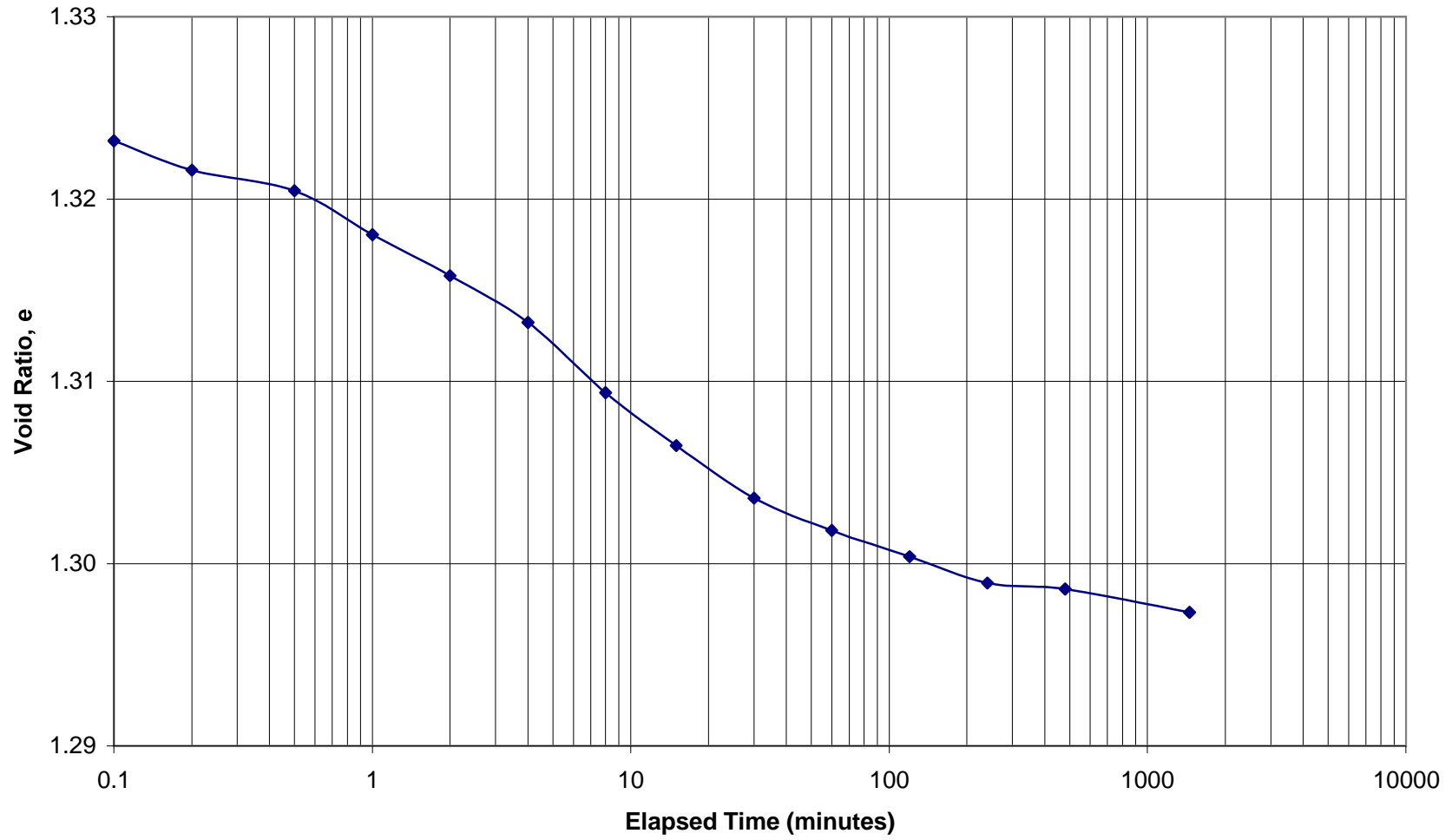
TH09-25A S5  
200 kPa



TH09-25A S5  
100 kPa

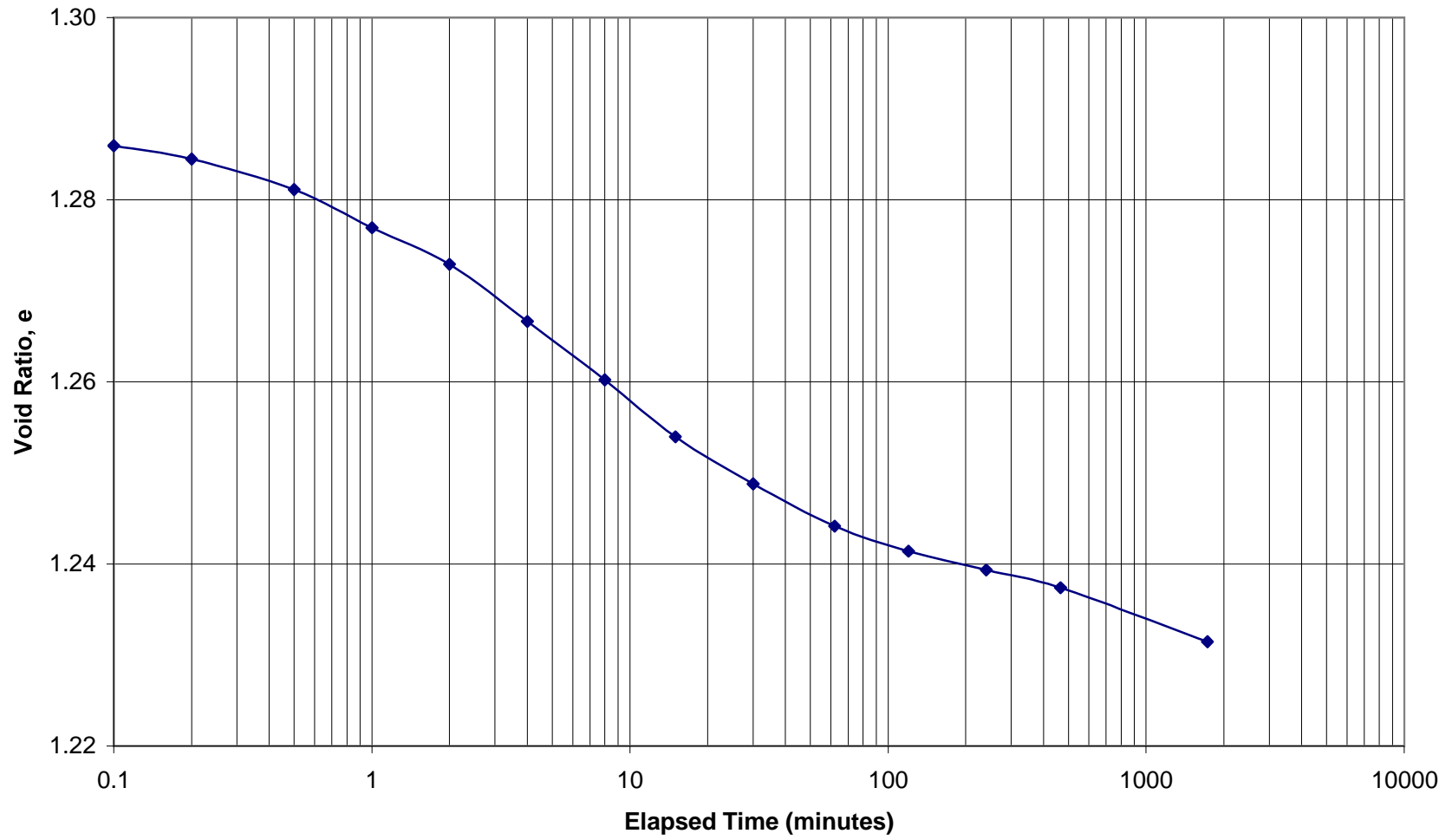


TH09-25A S5  
200 kPa

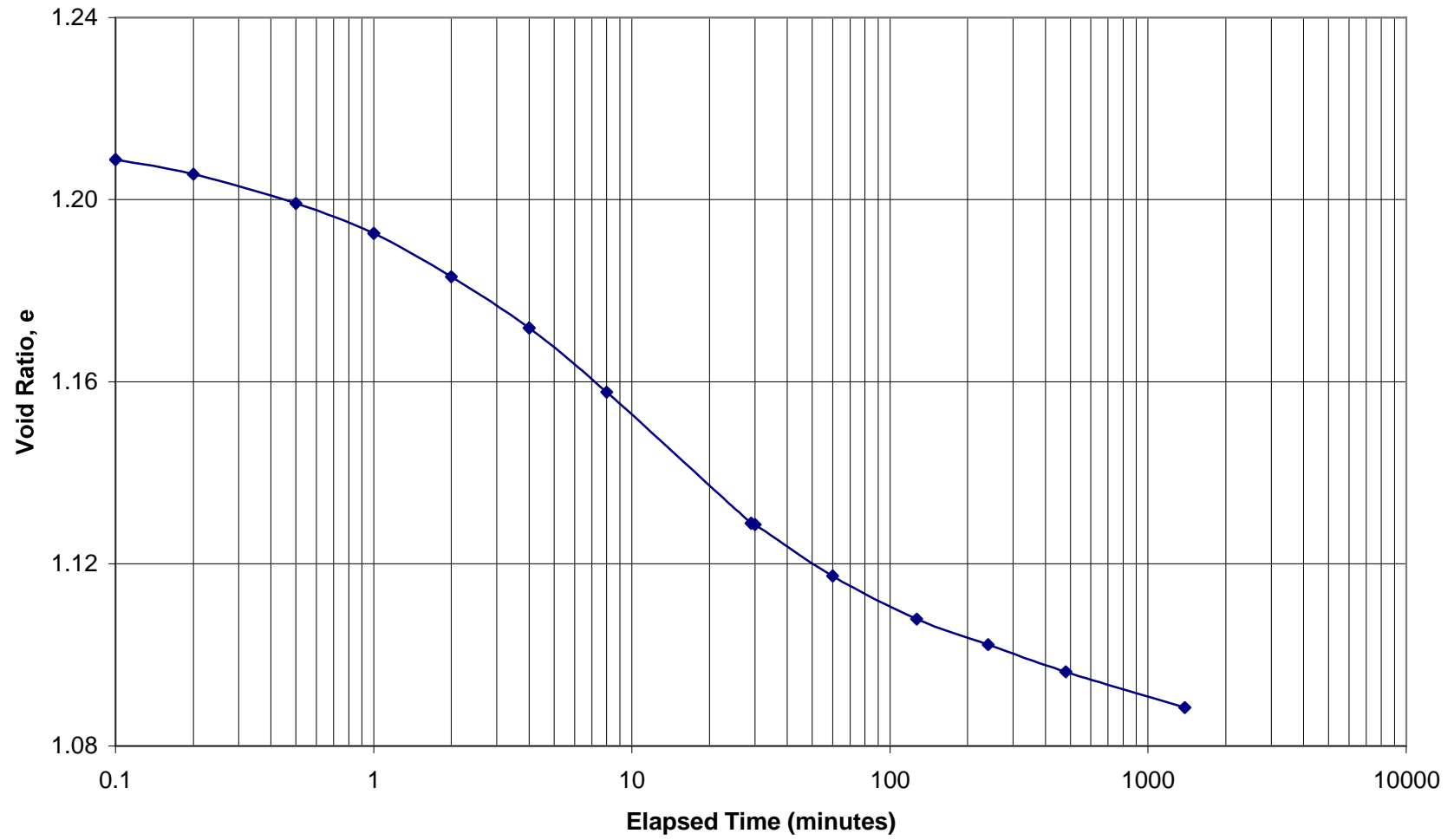




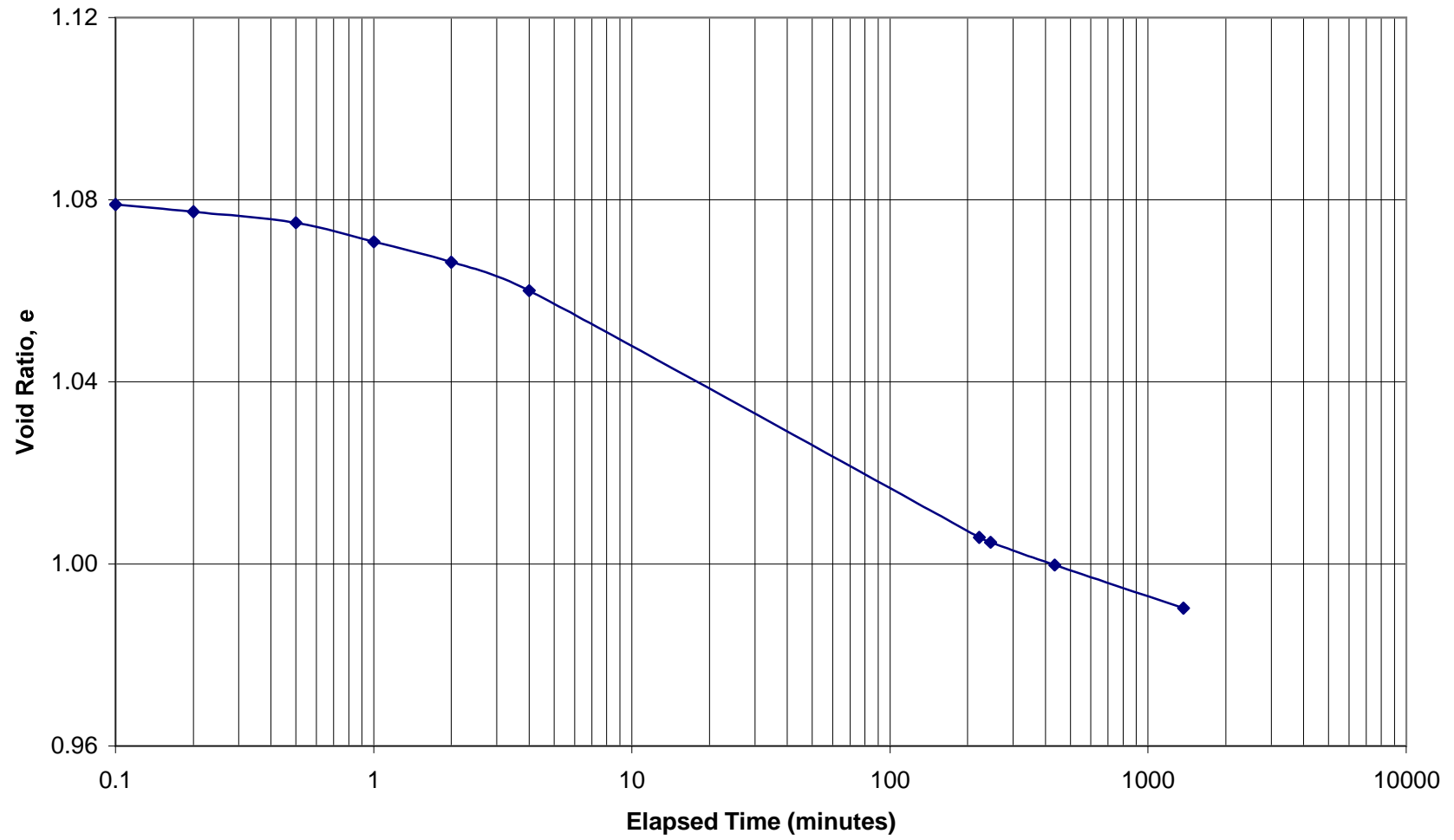
TH09-25A S5  
399 kPa



TH09-25A S5  
797 kPa

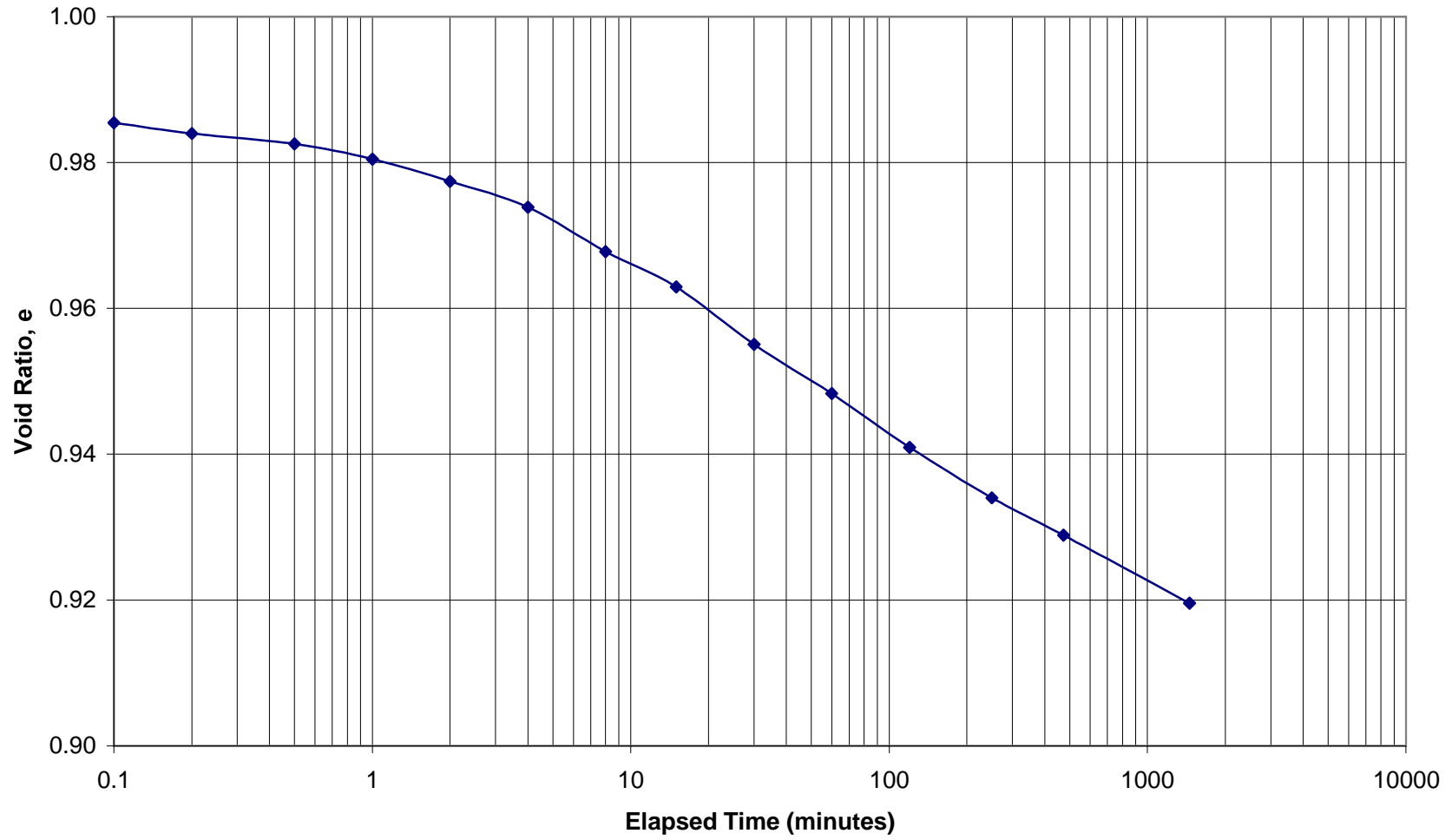


TH09-25A S5  
1195 kPa

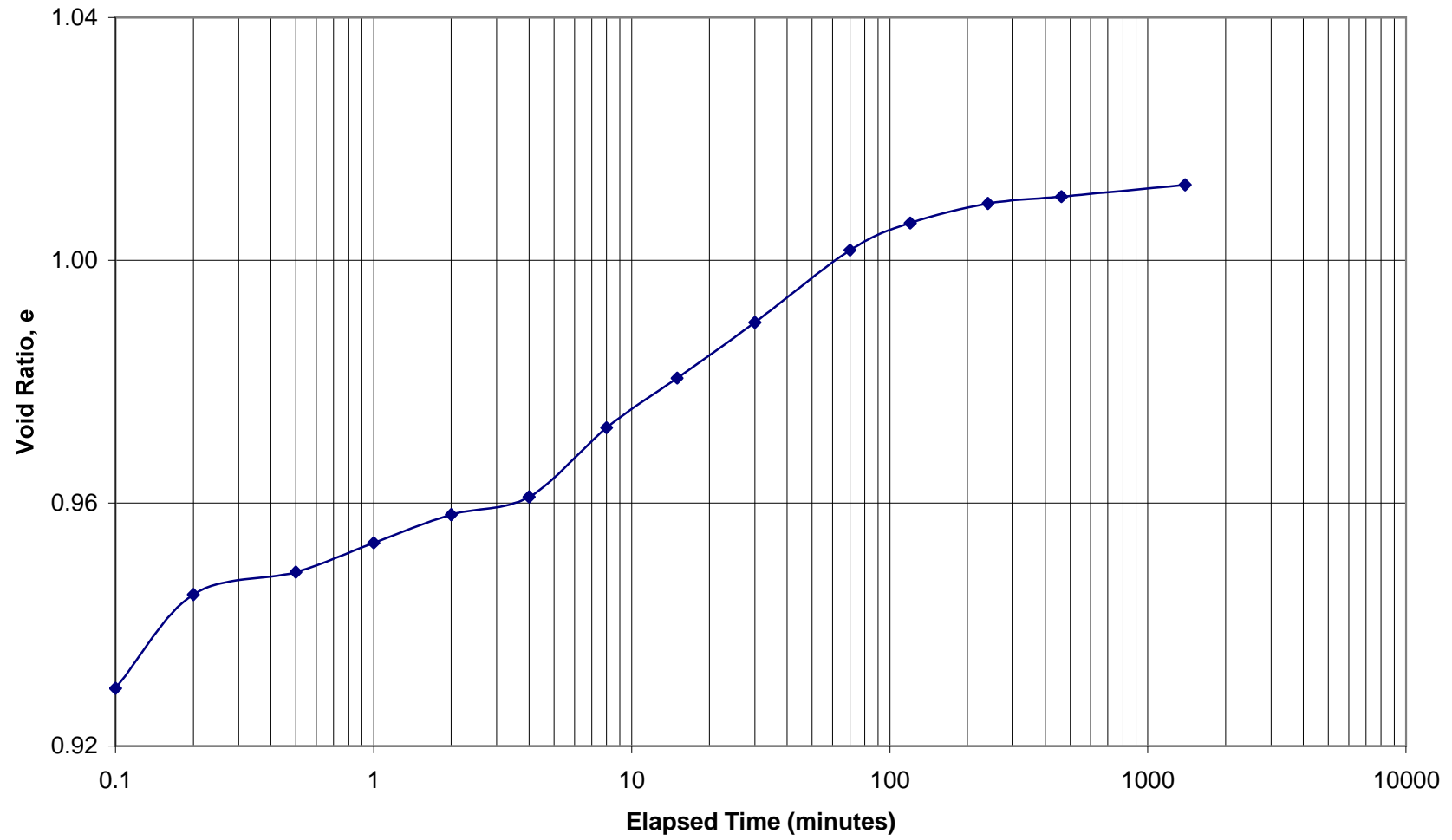




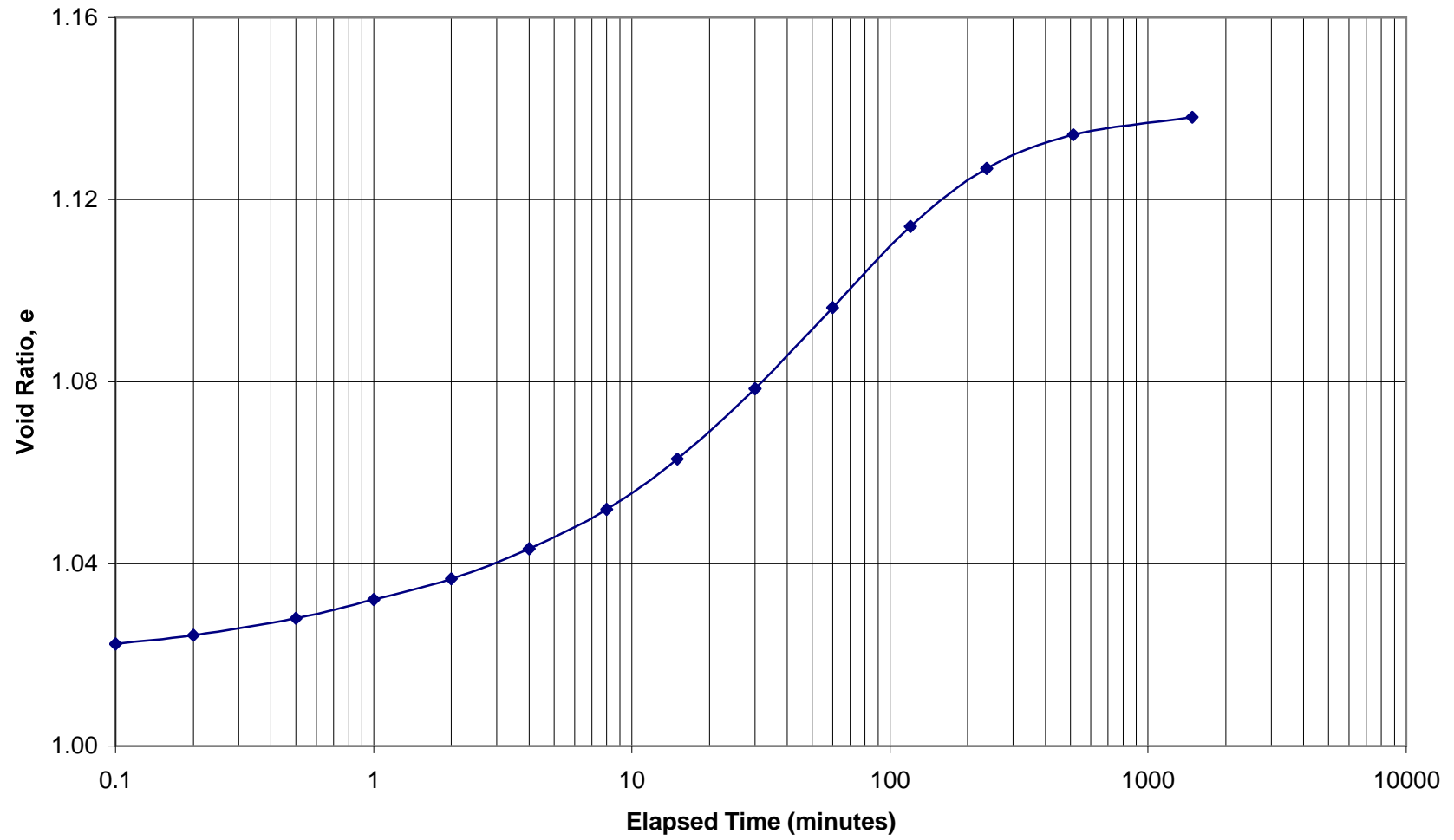
TH09-25A S5  
1594 kPa



TH09-25A S5  
399 kPa

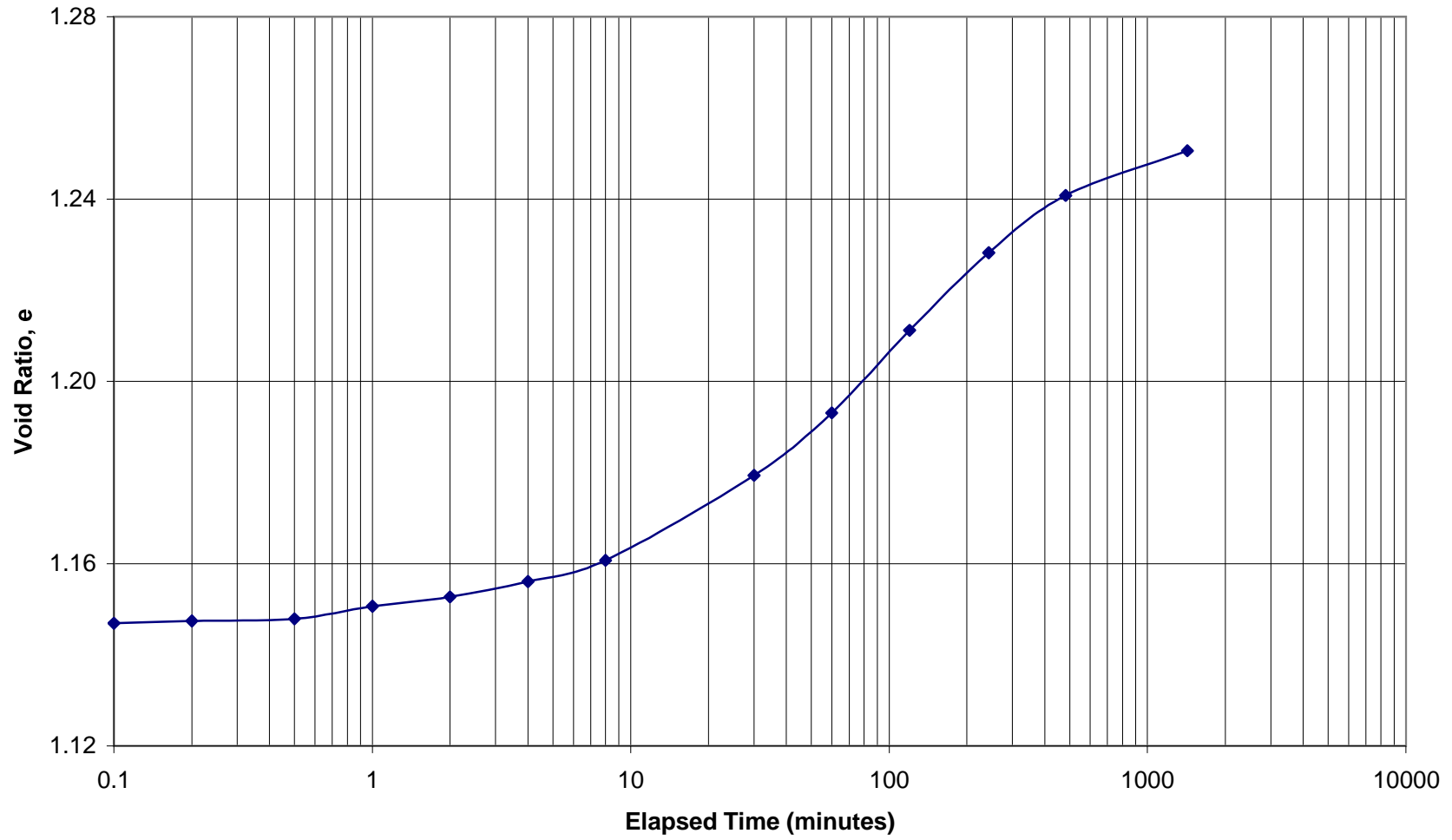


TH09-25A S5  
100 kPa

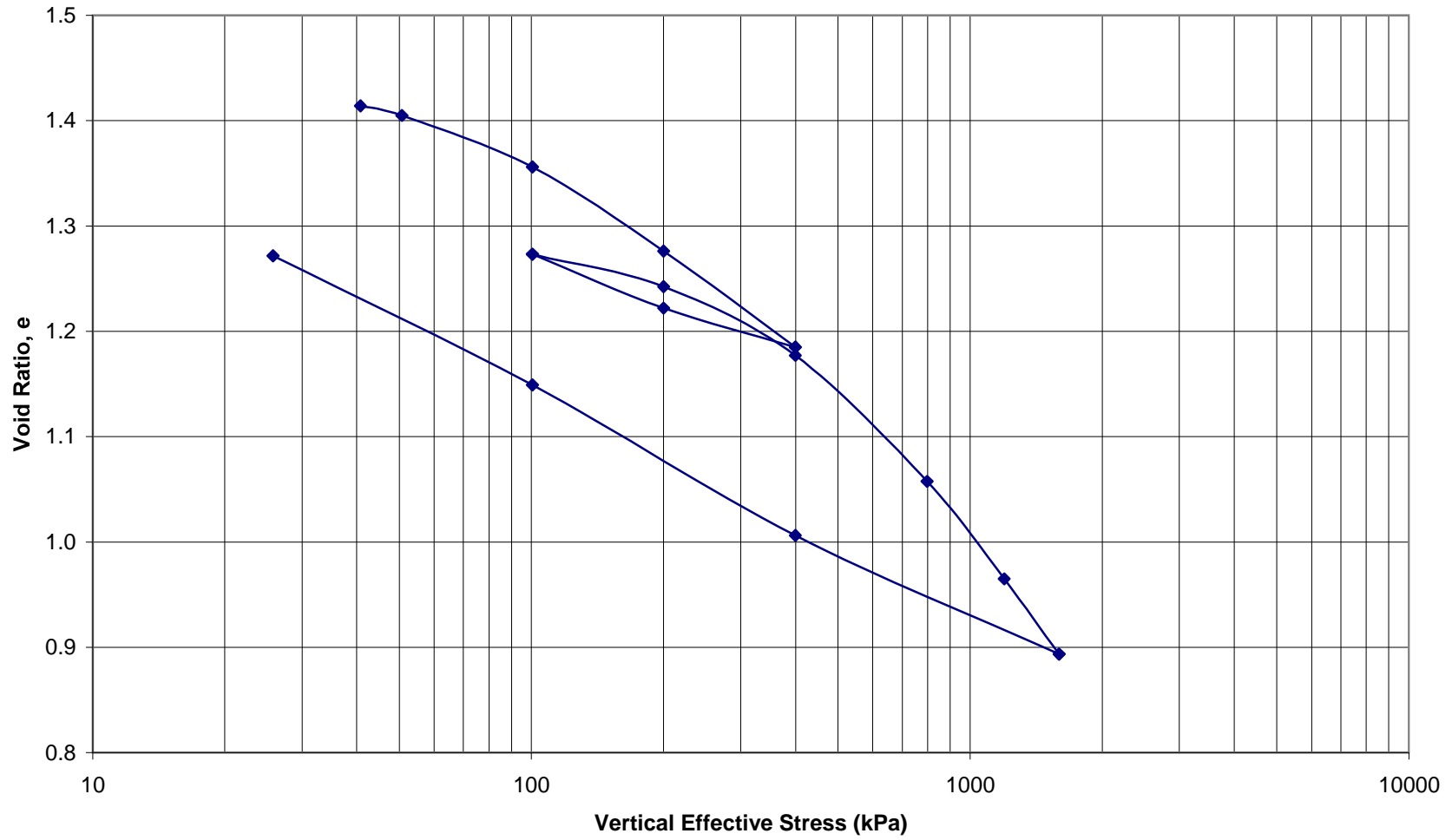




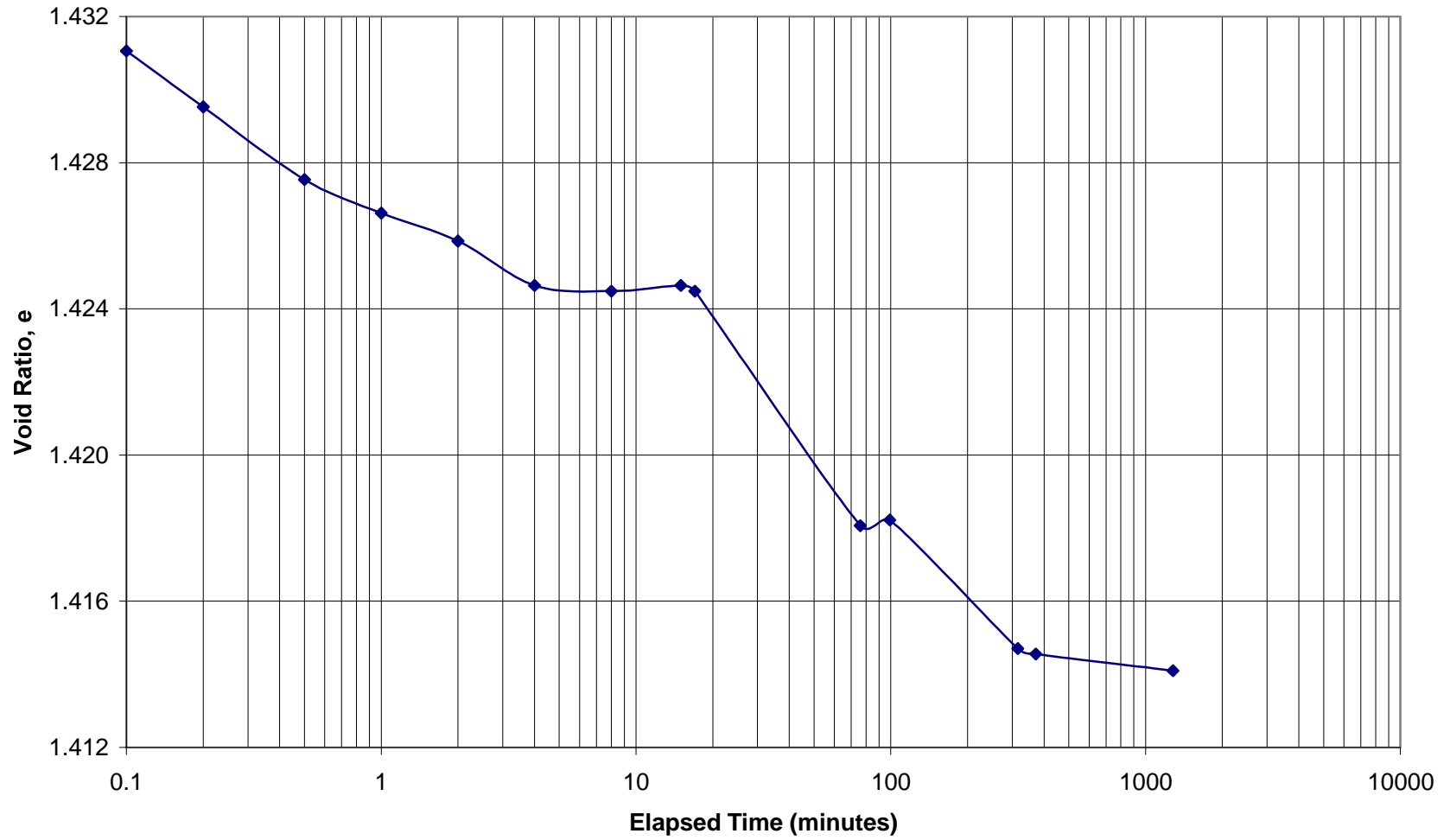
TH09-25A S5  
26 kPa



**Void Ratio vs. Vertical Effective Stress**  
**TH09 - 25A S8**

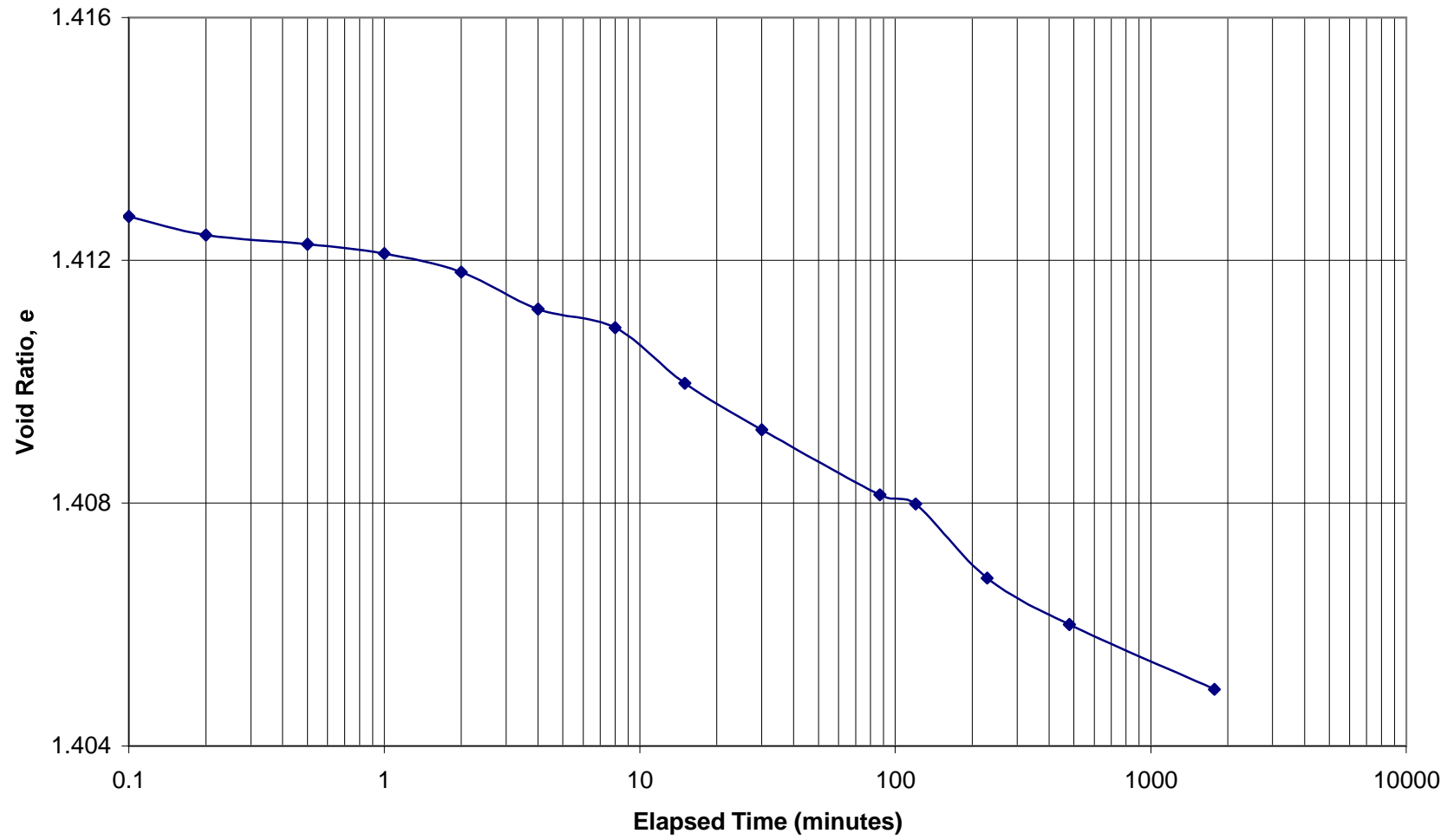


TH09-25A S8  
26, 36, 41 kPa

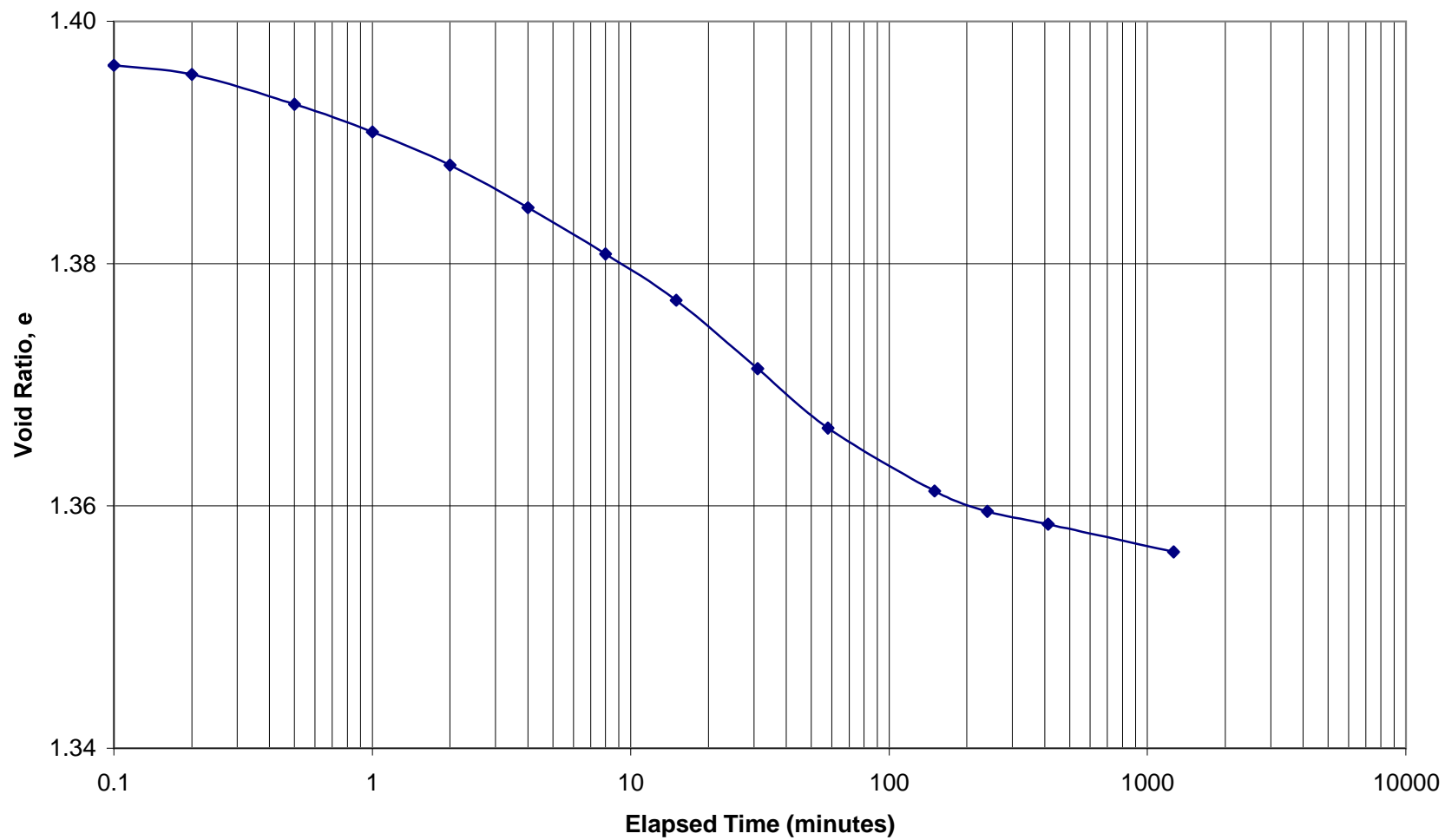




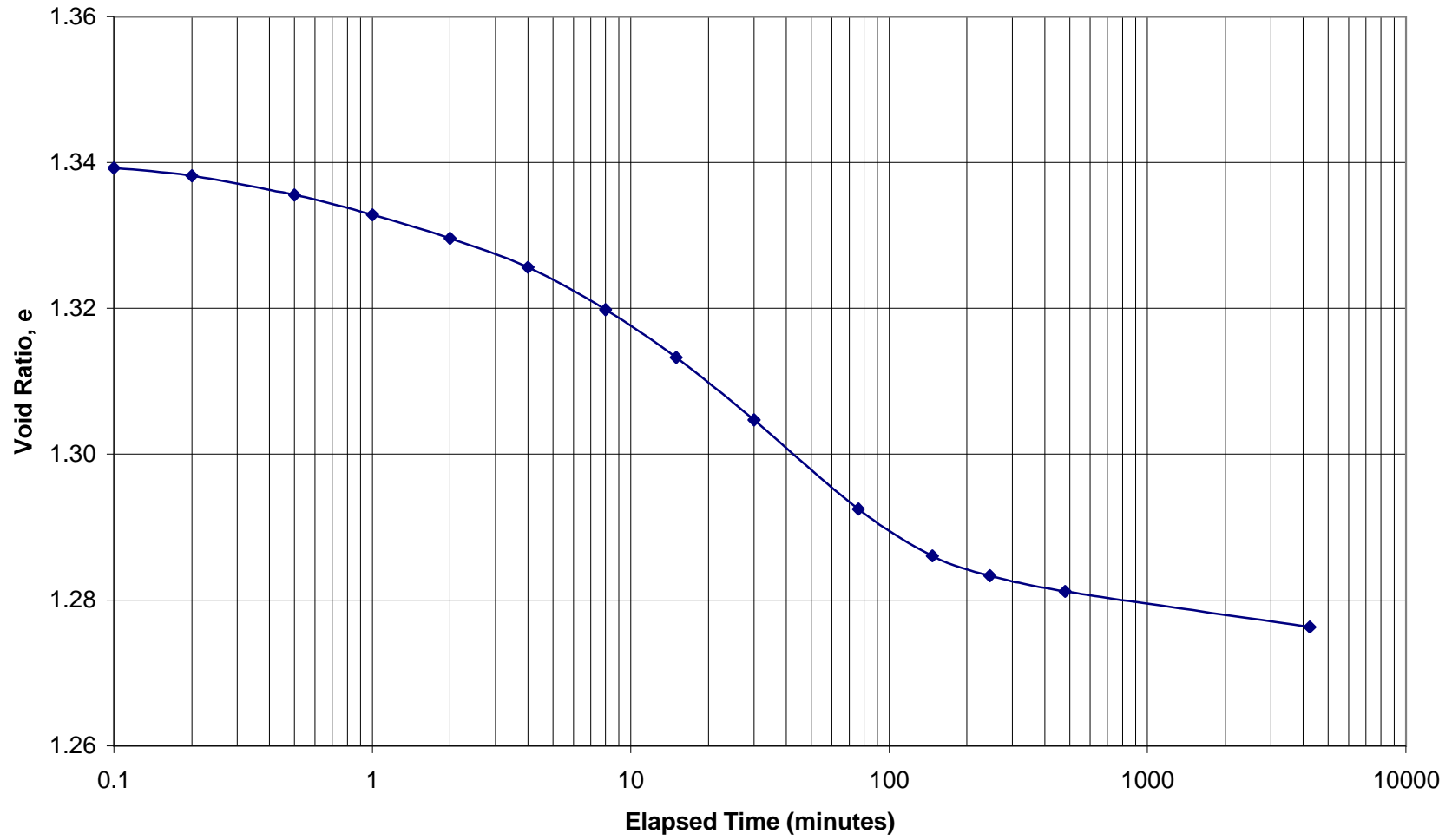
TH09-25A S8  
51 kPa



TH09-25A S8  
100 kPa

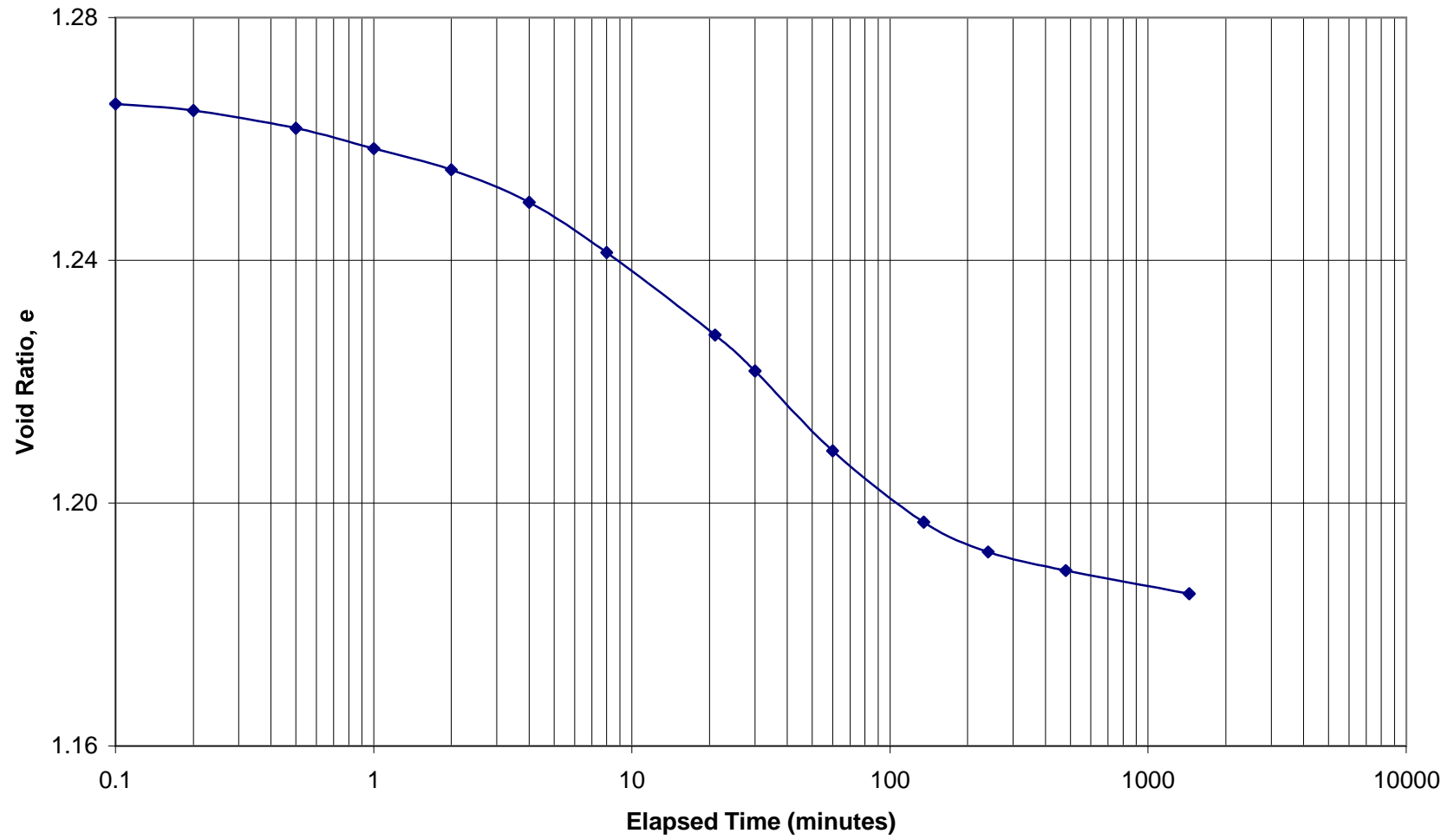


TH09-25A S8  
200 kPa

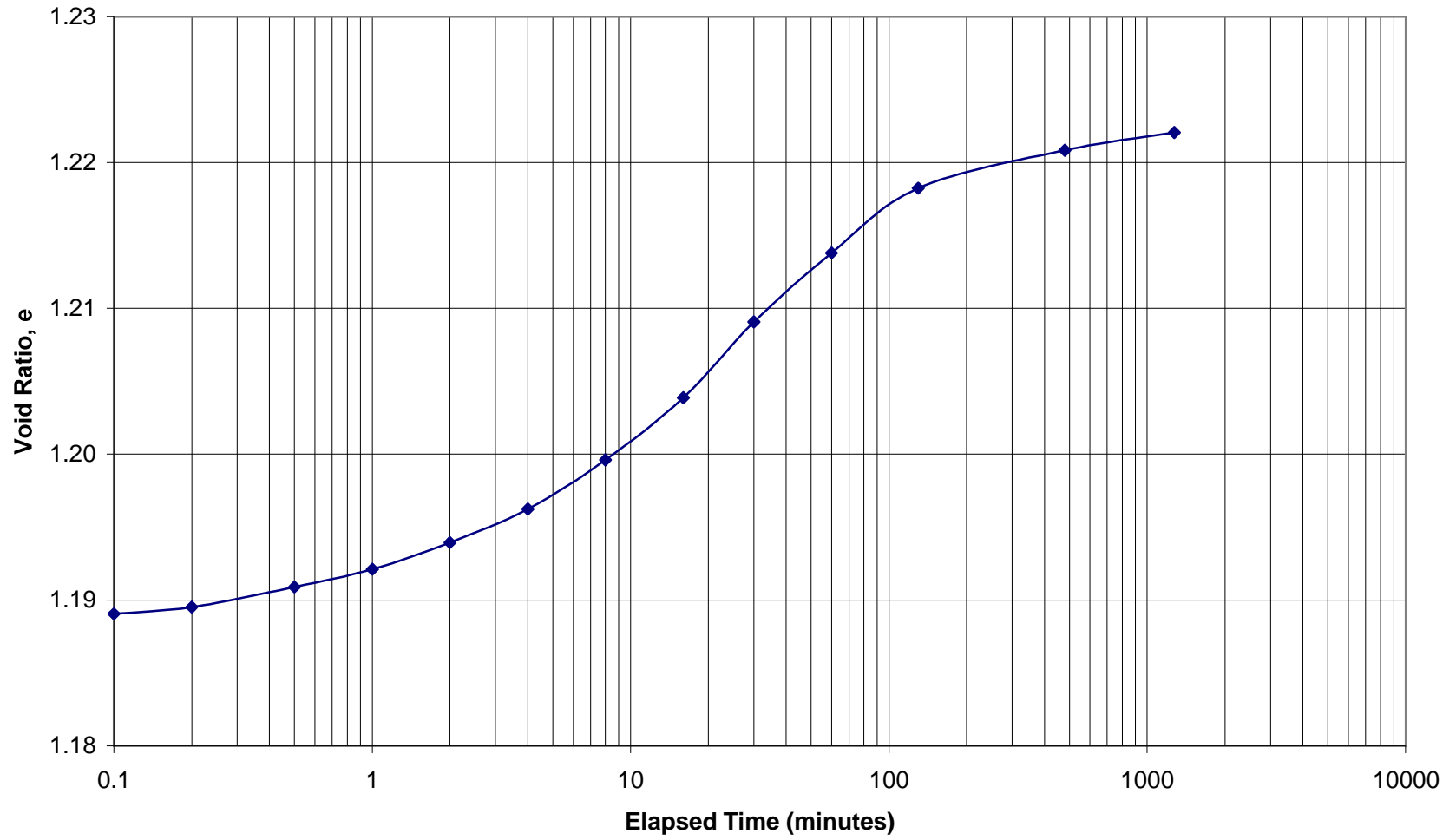




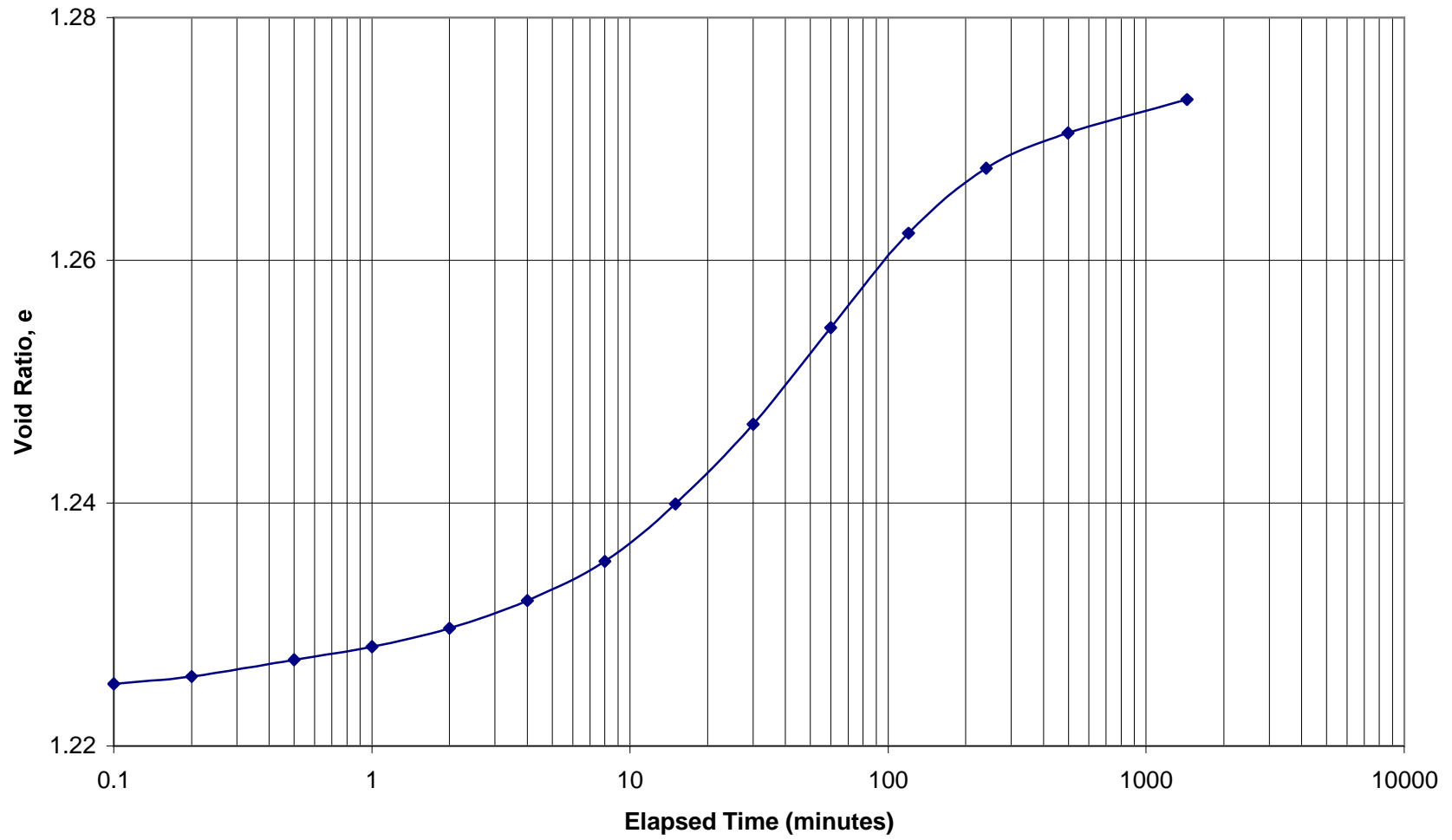
TH09-25A S8  
399 kPa



TH09-25A S8  
200 kPa

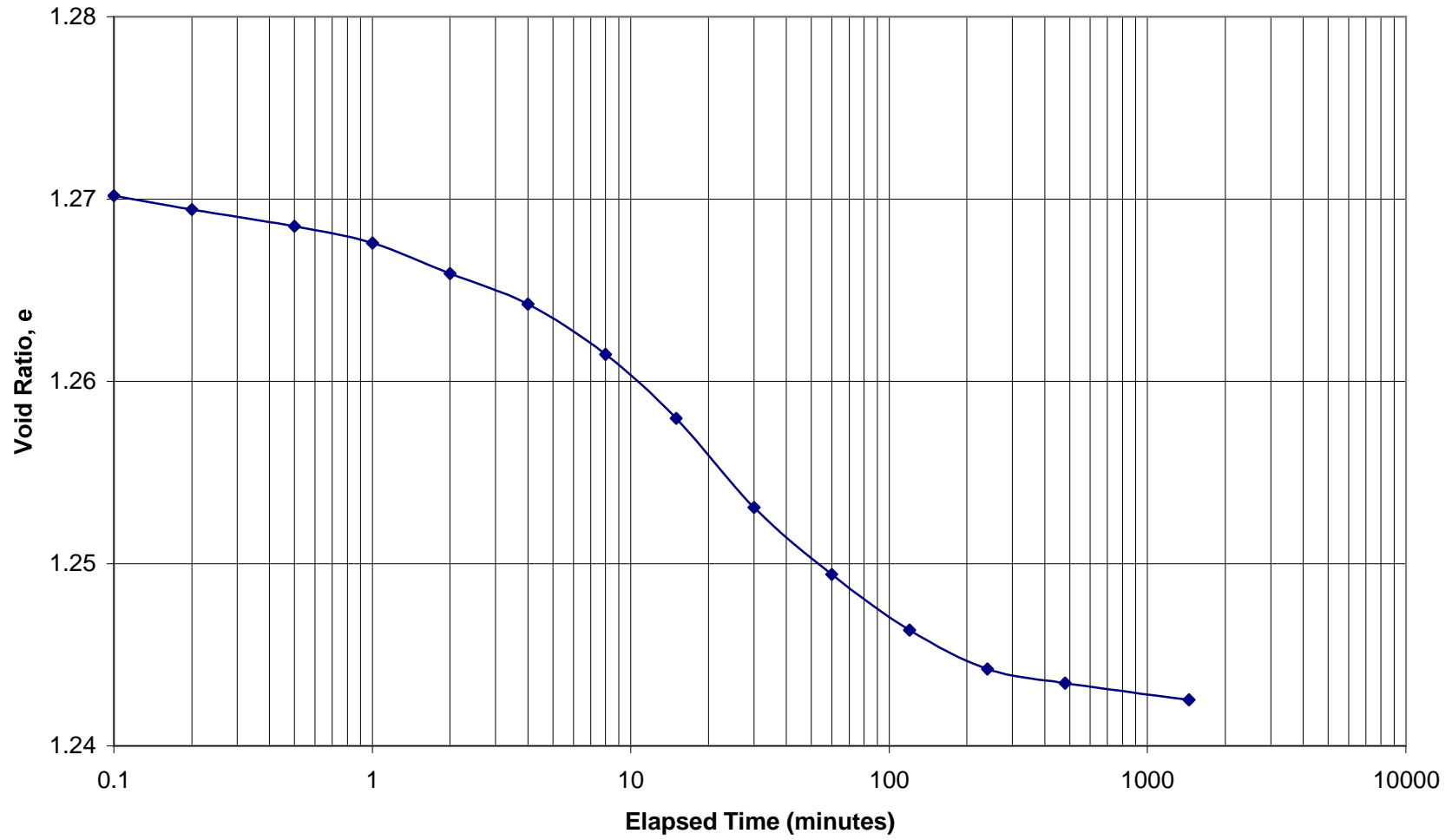


TH09-25A S8  
100 kPa

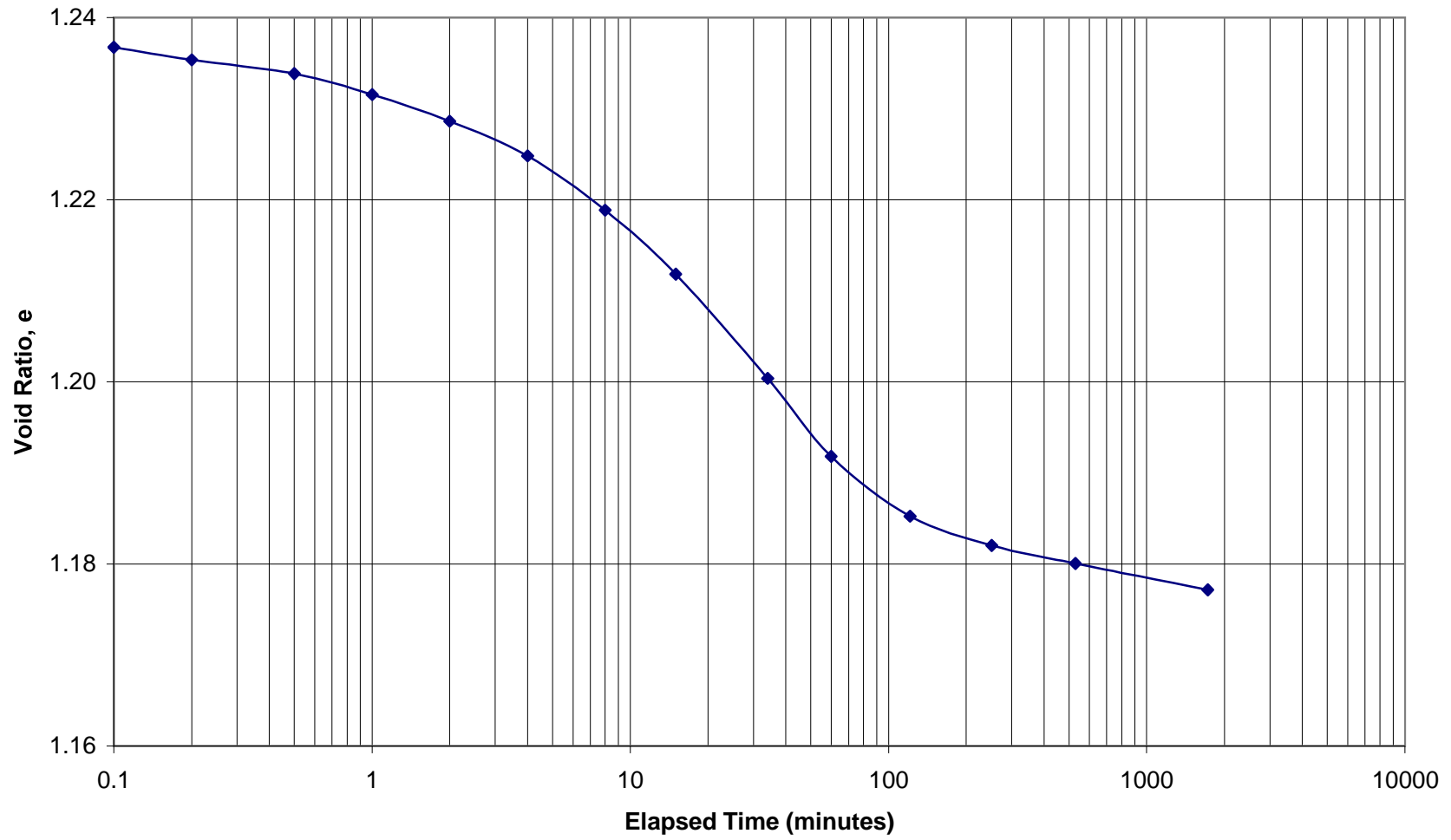




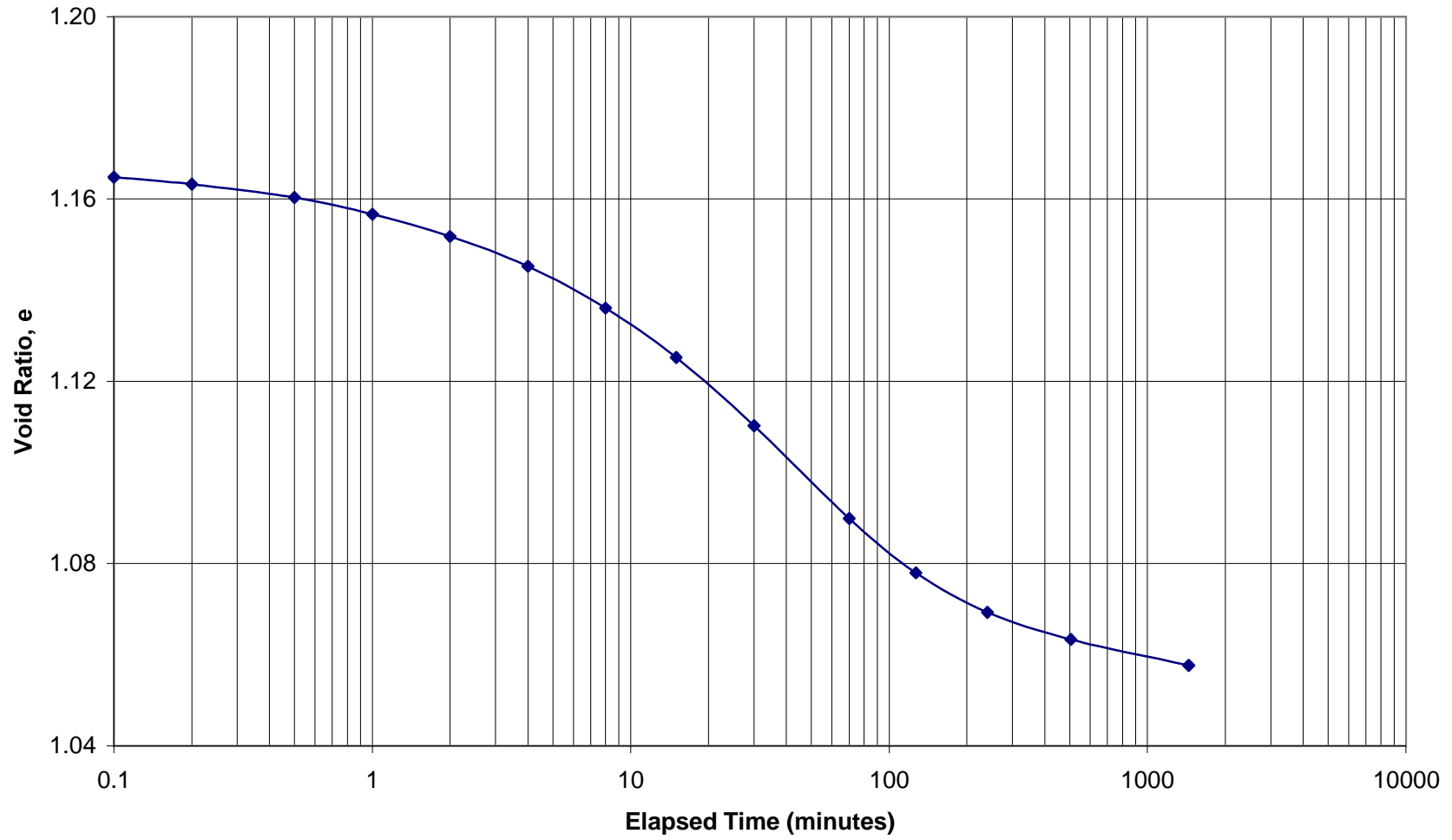
TH09-25A S8  
200 kPa



TH09-25A S8  
399 kPa

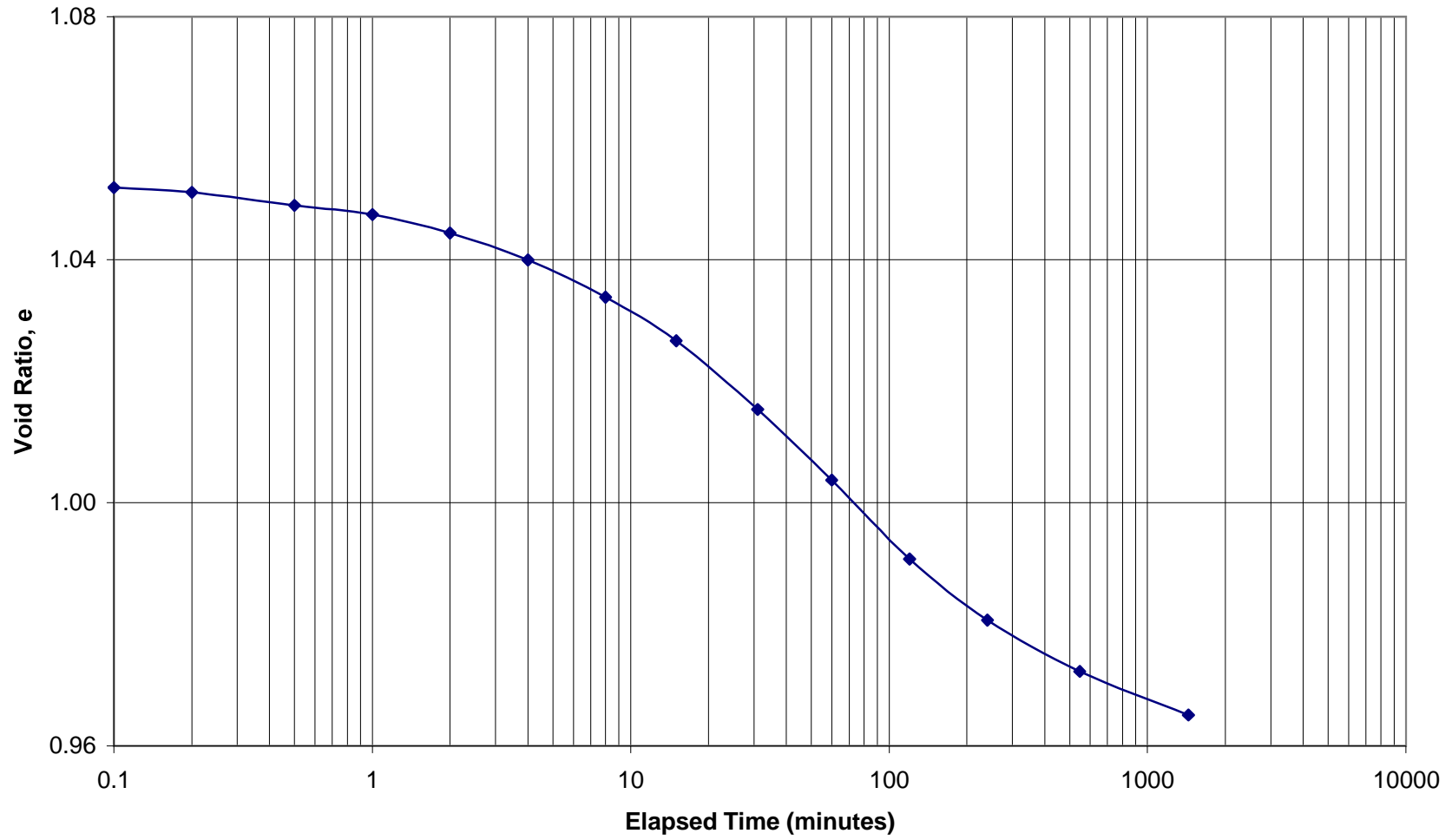


TH09-25A S8  
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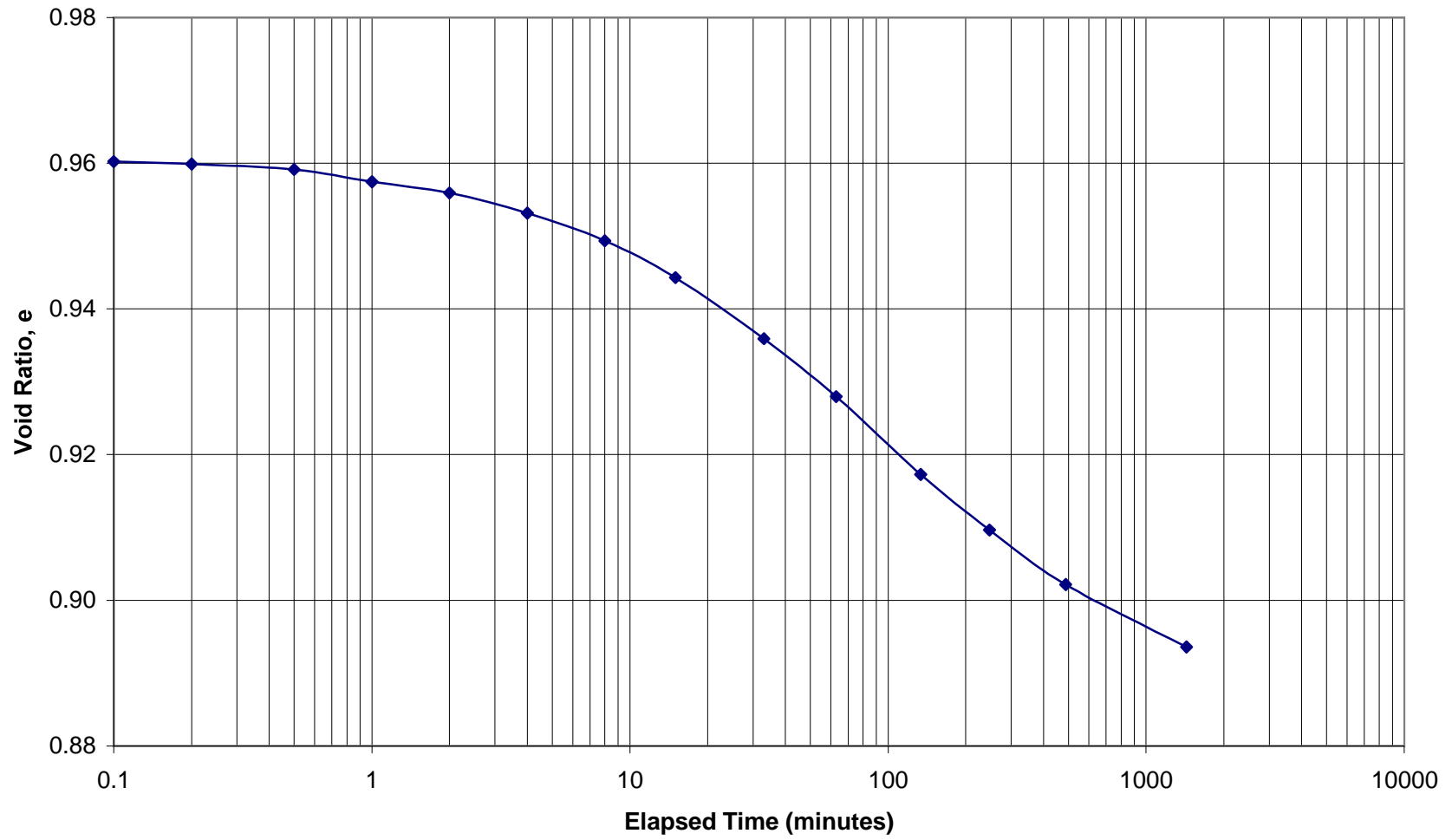




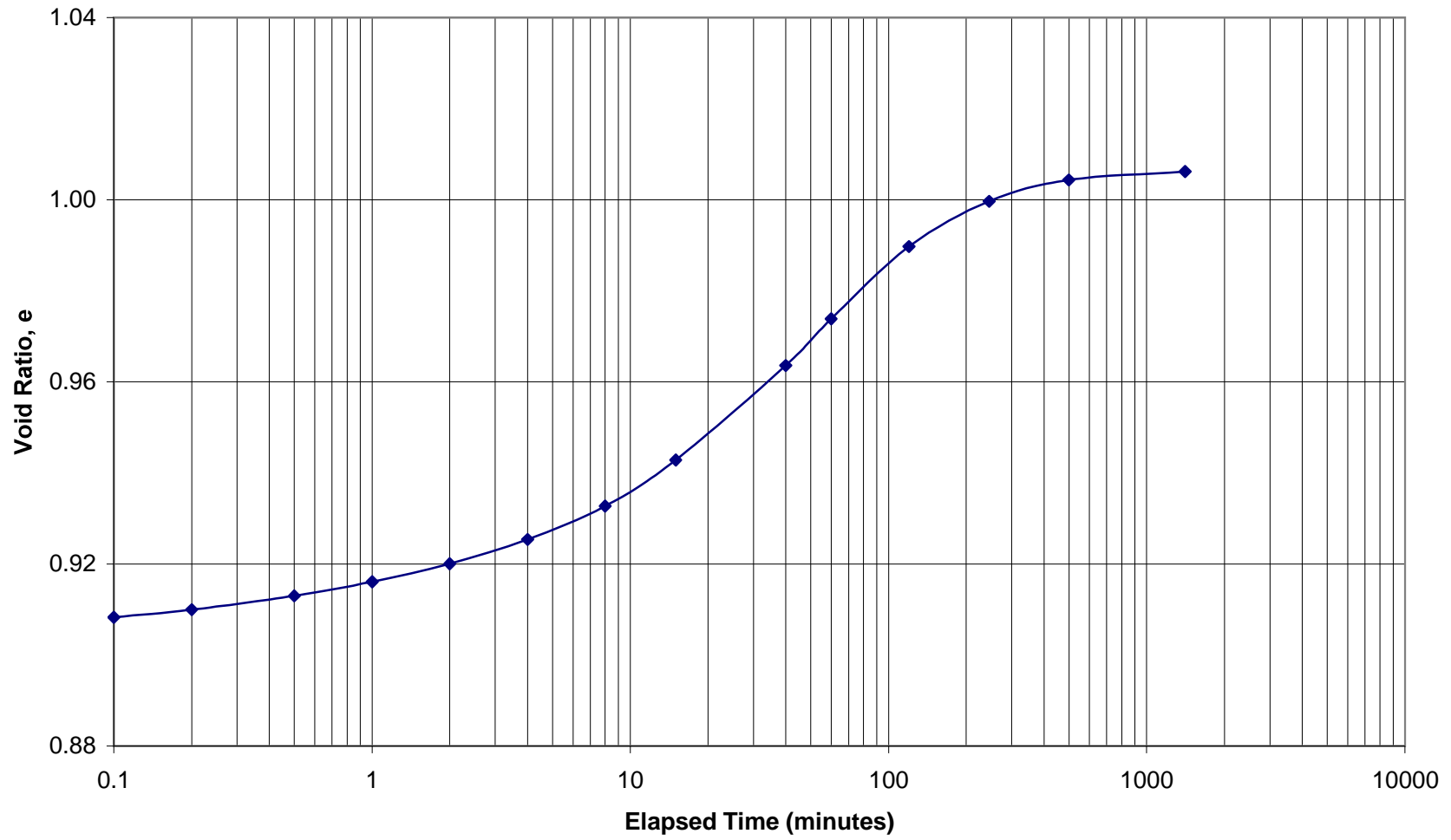
TH09-25A S8  
1196 kPa



TH09-25A S8  
1595 kPa

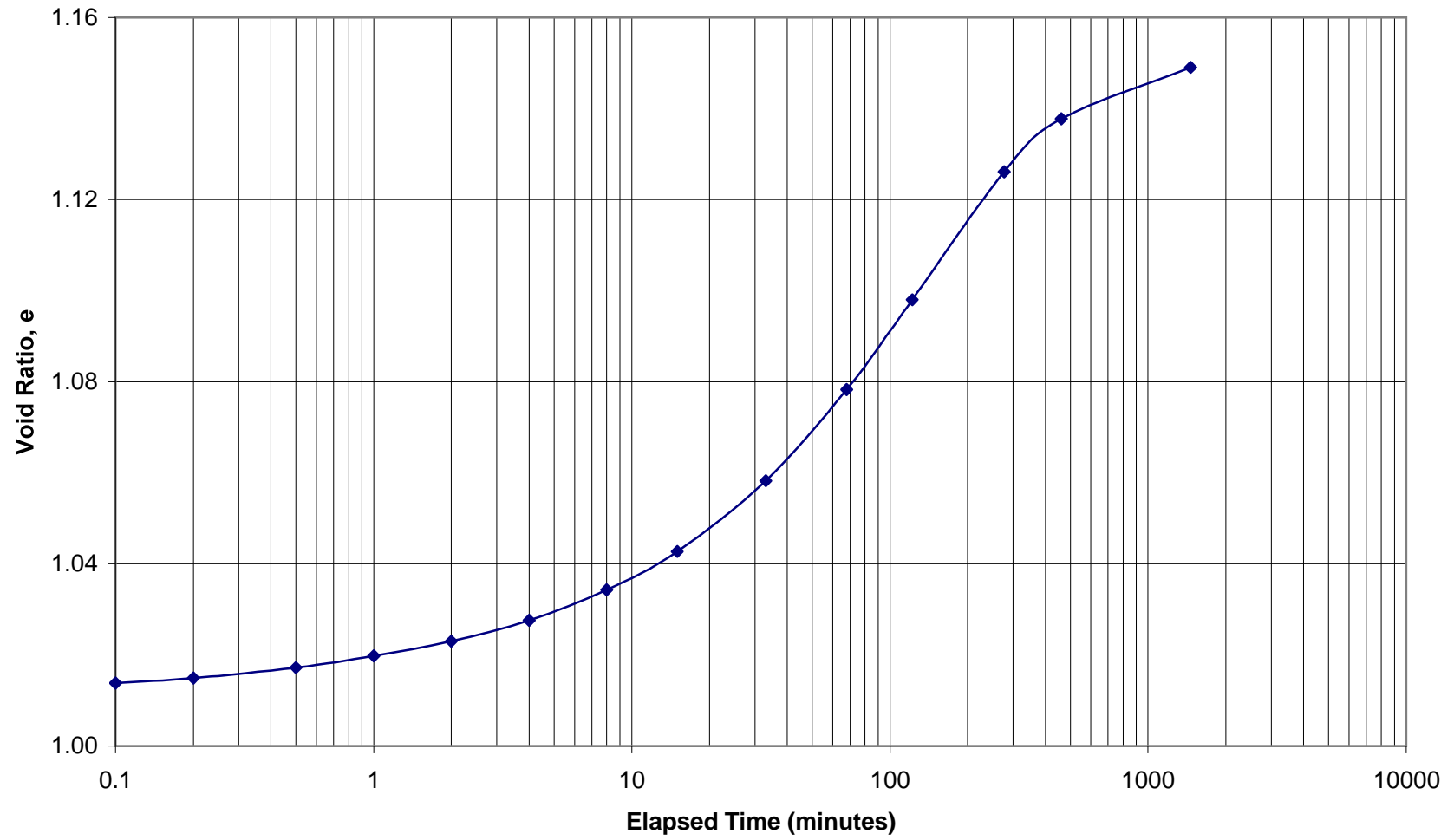


TH09-25A S8  
399 kPa

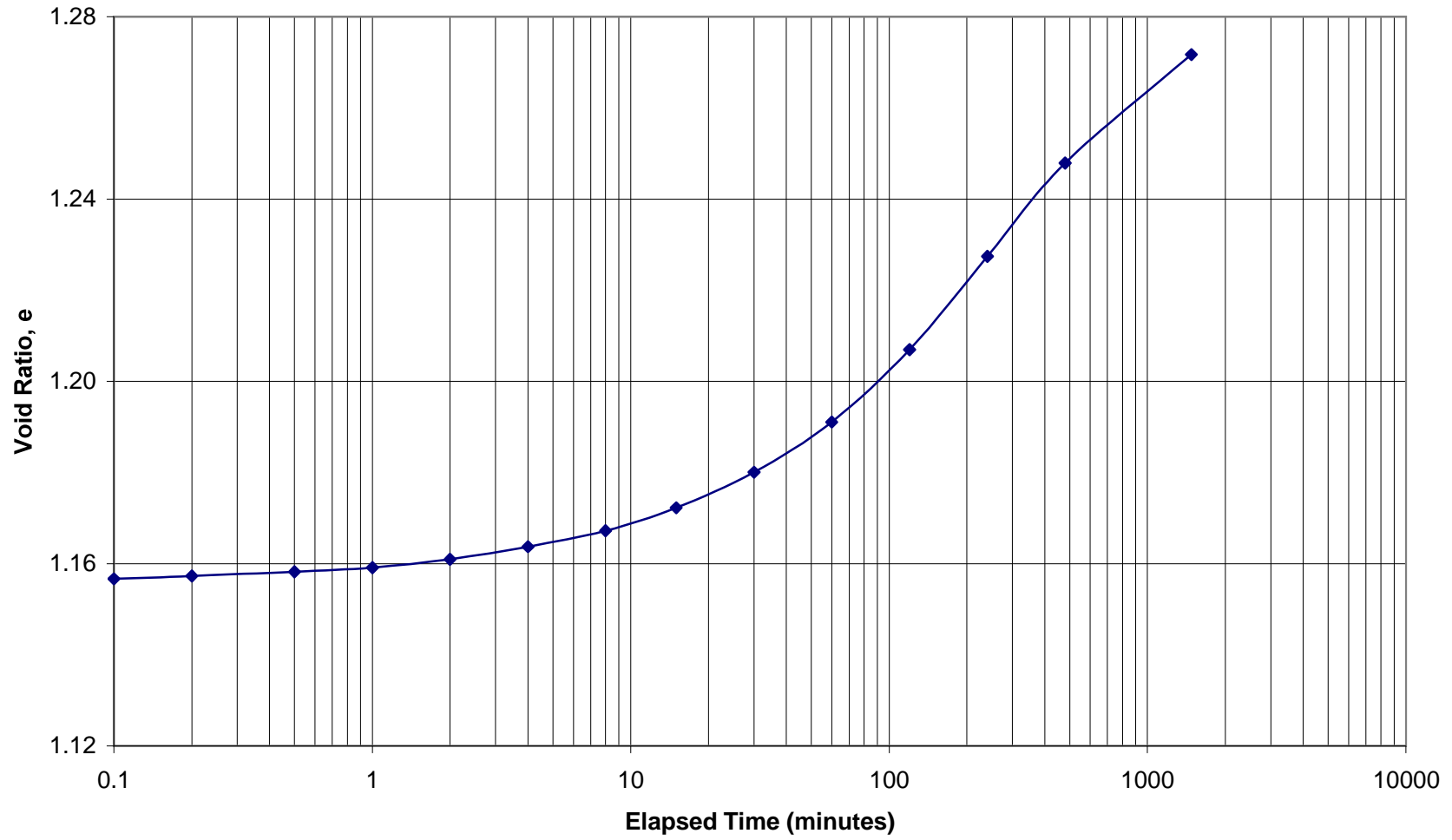




TH09-25A S8  
100 kPa



TH09-25A S8  
26 kPa



# **APPENDIX F**

2023 Frontier Geoscience Seismic Refraction Survey  
Report



# FRONTIER GEOSCIENCES INC.

SEISMIC REFRACTION

SURVEY REPORT

CENTREPORT REGIONAL S&W SERVICING PROJECT

WINNIPEG, MB

Submitted to:

**KGS Group**

January 25, 2024

Authors:

Laysa Vieira, M.Sc.

Caitlin Gugins, P.Geo.

Project: FGI-1852

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2.3 Interpretive Method	3
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4. Limitations	6
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Figure 3 Interpreted Seismic Refraction Depth Section SL23-01A	Appendix
Figure 4 Interpreted Seismic Refraction Depth Section SL23-01B	Appendix
Figure 5 Interpreted Seismic Refraction Depth Section SL23-01C	Appendix
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Figure 7 Interpreted Seismic Refraction Depth Section SL23-02A	Appendix
Figure 8 Interpreted Seismic Refraction Depth Section SL23-02B	Appendix
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Figure 10 Interpreted Seismic Refraction Depth Section SL23-03B	Appendix

**1. Introduction**

During the period October 31 to November 3, 2023, Frontier Geosciences Inc. carried out a seismic refraction investigation for KGS Group in support of the Centreport Regional S&W Servicing Project, in Winnipeg, Manitoba. The survey area is located adjacent to Summit Road and Sturgeon Road, and to the west of the Winnipeg Richardson International Airport. A Survey Location Plan of the area is shown at a scale of 1:50,000 in Figure 1, in the Appendix.

The purpose of the geophysical survey was to determine depth to bedrock and overburden layering classification to aid in defining depth to a till layer, as well as characterizing material types and densities. Approximately 1150 metres of detailed seismic refraction data were collected along three separate seismic traverses. A Site Plan showing the line locations is presented at a scale of 1:5,000 in Figure 2, of the Appendix. This project is an augmentation of a previous geophysical investigation carried out by Frontier Geosciences Inc. in October, 2019.



*Line SL23-03 Looking Northwest*



**2. Seismic Refraction Survey**

**2.1 Survey Equipment**

The seismic refraction investigation was carried out using two Geometric Geode, 24 channel, signal enhancement seismographs and Oyo Geospace 10 Hz geophones. Geophone intervals along the multicored seismic cable were maintained at 2.5 metres in order to ensure high resolution data on subsurface layering. Seismic energy was provided from a percussive firing rod (PFR) discharging 8 gauge, blank, black powder shells into hand-excavated shotholes. Shot initiation or zero time was established by metal to metal contact of a hammer contacting the firing pin.



*Example of Instrumentation Setup*

## **2.2 Survey Procedure**

Field procedure entailed setting out two 24 channel geophone cables in a straight line and implanting the geophones. The spread was traversed with the seismic sources, moving progressively down the array of geophones, with up to 9 individual shotpoints on each spread: one at either end of the spread, up to 5 at intermediate locations along the seismic cable, and one off each end of the spread, where possible, to ensure adequate coverage of the subsurface. The shots were triggered individually and arrival times for each geophone were acquired in the seismographs and recorded in the field laptop. For quality assurance, field inspection of raw data after each shot was carried out, with additional shots recorded if first arrivals were unclear.

Throughout the survey, notes were recorded regarding seismic line positions in relation to topographic and geological features. Relative elevations along the seismic lines were recorded by chain and inclinometer, with absolute elevations taken from the City of Winnipeg 2020 WWD Lidar.

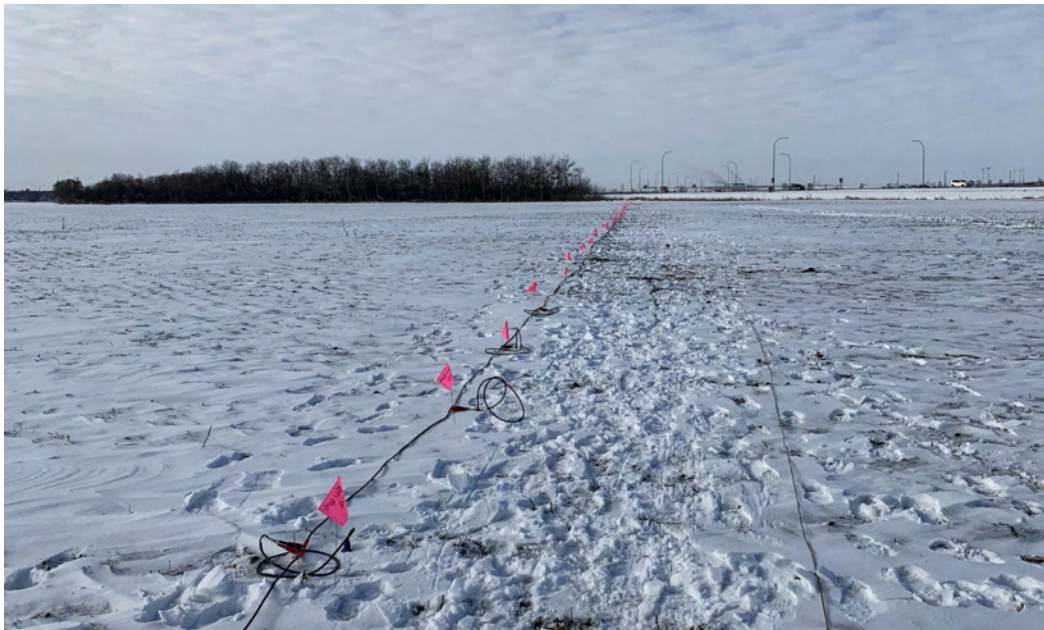
## **2.3 Interpretive Method**

The final interpretation of the seismic data was arrived at using the method of differences technique. This method utilises the time taken to travel to a geophone from shotpoints located to either side of the geophone. Velocities are calculated as the slope of first break pick times and geophone distances. When there is a significant change in slope a new velocity is calculated and assigned to the new layer. Basal velocities are calculated by the arrivals of off-end shots where picked arrivals are refracted from the basal layer. Each geophone is assigned a velocity and time for each layer. Using the total time, a small vertical time is computed which represents the time taken to travel from the refractor up to the ground surface. This time is then multiplied by the velocity of each overburden layer to obtain the thickness of each layer at that point. The thicknesses are splined along the seismic line to create a continuous boundary between layers.

### **3. Geophysical Results**

#### **3.1 General**

The interpreted results of the seismic refraction lines are illustrated at a scale of 1:250, in profile in Figures 3 to 10 in the Appendix. The seismic velocity layer interfaces are marked on the seismic profiles in green, blue and red. The interface line colours are not a specific velocity contour, but rather the interpreted discrete boundary above which velocities are defined within a certain range, and below which velocities are within a significantly increased velocity range.



*Line SL23-01 Looking Northeast*

#### **3.2 Discussion**

The interpreted results of the seismic refraction survey indicate the area is underlain by four distinct velocity layers. The surficial layer with compressional velocities ranging from 360 m/s to 440 m/s, is consistent with a surficial sediment layer, such as clays, silts and fills. This layer averages approximately 2.7 metres in thickness, reaching a maximum thickness of 5.6 metres near station 125SE on line SL23-03 and a minimum of 1.5 metres at station 157NE on line SL23-02.



Below the surficial layer is an upper intermediate layer with an interpreted velocity range of 820 m/s to 1150 m/s. Averaging 3.3 metres, this layer reaches a maximum thickness of 5.3 m at the southeastern end of line SL23-03, while thinning to approximately one metre at station 30SE on SL23-03. These velocities are consistent with testhole intersections of firm to very stiff, clays and silts, or in some locations, a loose to compact, unsaturated silt till material.

The base of this upper intermediate layer is illustrated by a blue line, and in places may represent the transition from unsaturated to saturated in the compact to dense silt till present in the area; however, the thickness of the saturated zone is not large enough to significantly increase the compressional wave velocity to delineate it as a discrete velocity layer.

Bounded on the surface by this blue line, is a deeper intermediate layer, ranging in compressional wave velocity from 1800 m/s to 2250 m/s. This velocity range is consistent with dense to very dense silt till encountered in the testholes, indicating this layer correlates with, likely saturated, silt till in the area. The interpreted thickness of this layer varies significantly, from a minimum thickness of 1.1 metres near the end of line SL23-03, to a maximum of over 11 metres in more than one location along the first half of line SL23-01, with an average thickness of 5.5 metres.

Underlying the intermediate layers is the interpreted basal layer with compressional wave velocities of 3650 m/s to 4050 m/s. These velocities are consistent with testhole intersections of a limestone or shale bedrock, and is the interpreted bedrock surface. Lower velocities in this range most likely represents an increased level of fracturing and/or weathered bedrock, while the higher end is indicative of more competent bedrock. This interpreted bedrock surface exhibits an average depth of approximately 11.5 metres and reaches a maximum depth of almost 18 metres near station 265NE along line SL23-01, while rising to a minimum depth of 6.6 metres, at station 70NE on line SL23-02.

**4. Limitations**

The depths to subsurface boundaries derived from seismic refraction surveys are generally accepted as accurate to within ten percent of the true depths to the boundaries, below 10 metres. Above 10 metres, the accuracy of seismic refraction data is approximately +/- 1.0 metres due mainly to the greater statistical error in determining the upper velocity layers from fewer data points. In some cases, unusual geological conditions may produce false or misleading data points with the result that computed depths to subsurface boundaries may be less accurate. In seismic refraction surveying difficulties with a 'hidden layer' or a velocity inversion may produce erroneous depths. The first condition is caused by the inability to detect the existence of a layer because of insufficient velocity contrasts or layer thicknesses. A velocity inversion exists when an underlying layer has a lower velocity than the layer directly above it. The interpreted depths shown on drawings are to the closest interface location, which may not be vertically below the measurement point if the refractor dip direction departs significantly from the survey line location. Structural discontinuities occurring on a scale less than the geophone spacing or isolated boulders would go undetected in the interpretation of the data. The seismic refraction method may not detect a narrow canyon-like feature incised into bedrock, if the canyon width is narrow relative to the depth of burial of the feature.

The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the methods used.

For: Frontier Geosciences Inc.



Laysa Vieira, M.Sc.

  
Caitlin Gugins, P.Geol.

25, 2024

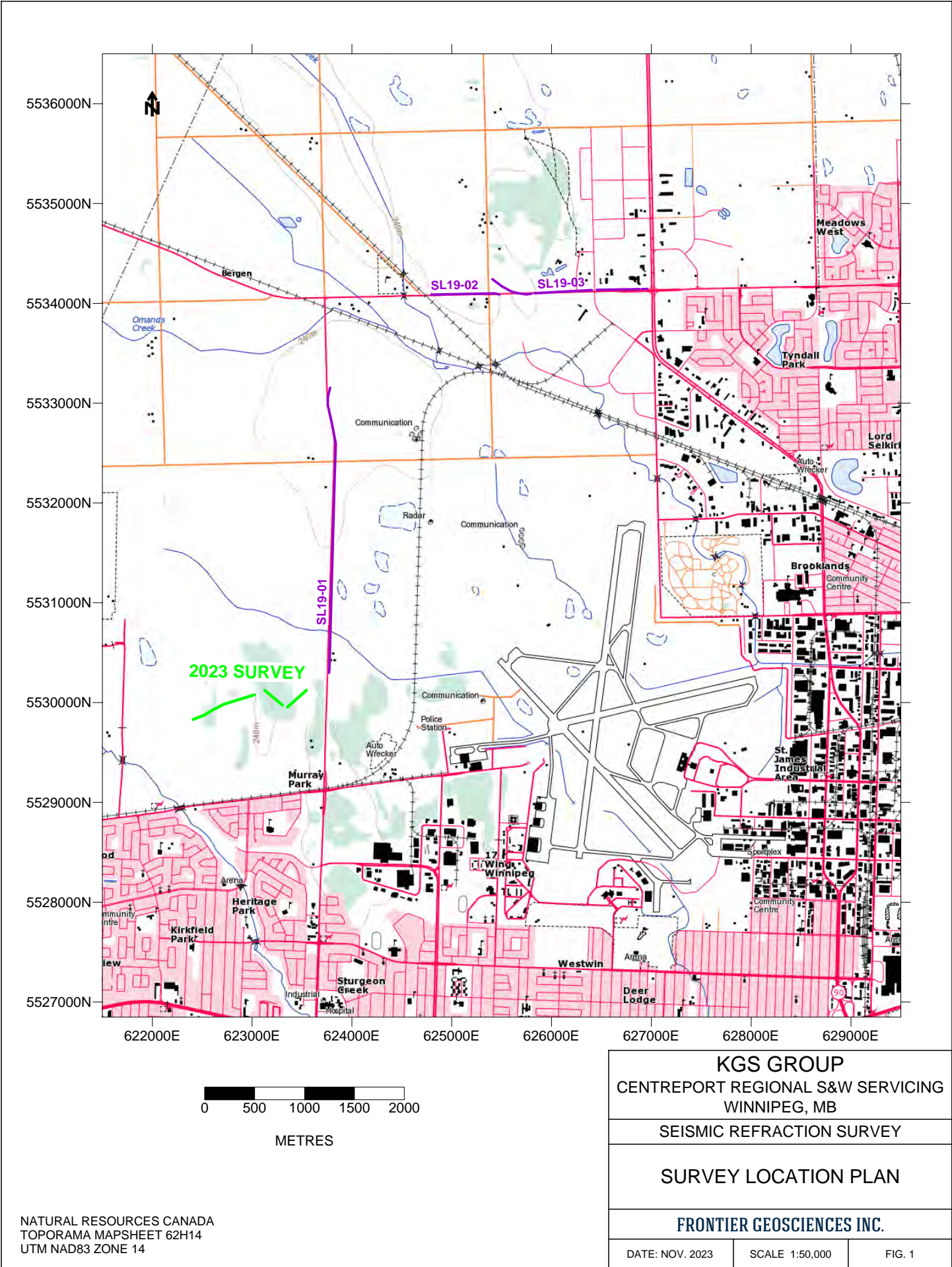
Engineers and Geoscientists of Manitoba Certificate of Authorization #7657

**5. References**

1. *Seismic Refraction Survey Report*, Winnipeg Richardson International Airport, Winnipeg, MB; Submitted to KGS Group; Frontier Geosciences Inc.; Project No. FGI-1644; October, 2019

**APPENDIX**





NATURAL RESOURCES CANADA  
 TOPORAMA MAPSHEET 62H14  
 UTM NAD83 ZONE 14

**KGS GROUP**  
 CENTREPORT REGIONAL S&W SERVICING  
 WINNIPEG, MB

SEISMIC REFRACTION SURVEY

SURVEY LOCATION PLAN

**FRONTIER GEOSCIENCES INC.**

DATE: NOV. 2023

SCALE 1:50,000

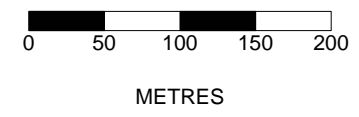
FIG. 1





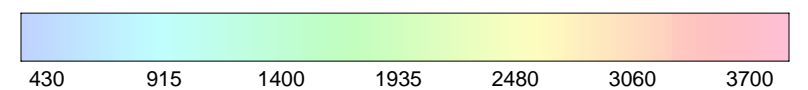
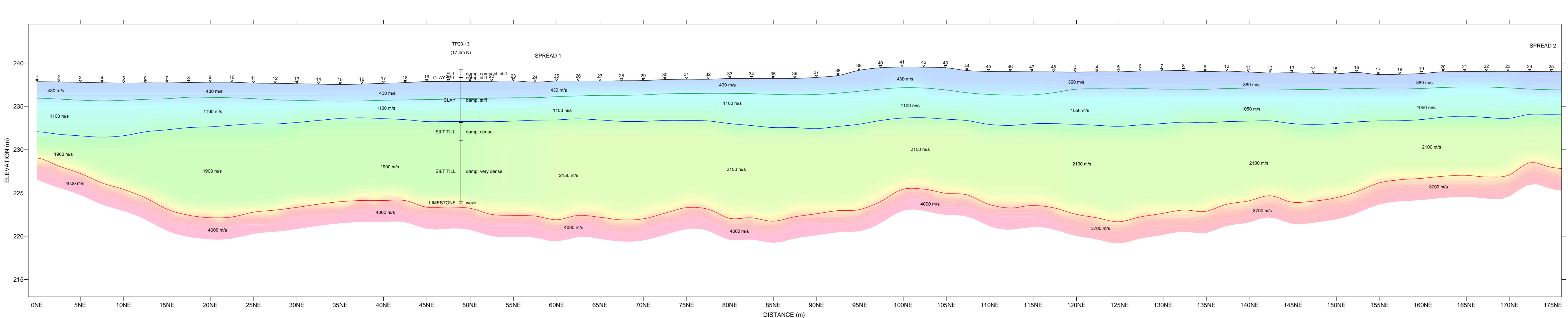
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- 2023 SEISMIC REFRACTION LINE
- 2019 SEISMIC REFRACTION LINE
- + TESTHOLE

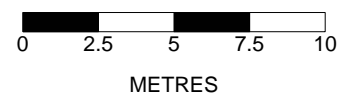


<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
<b>SITE PLAN</b>		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:5,000	FIG. 2

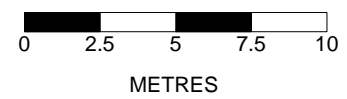
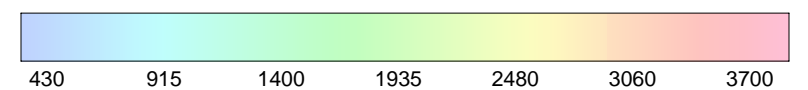
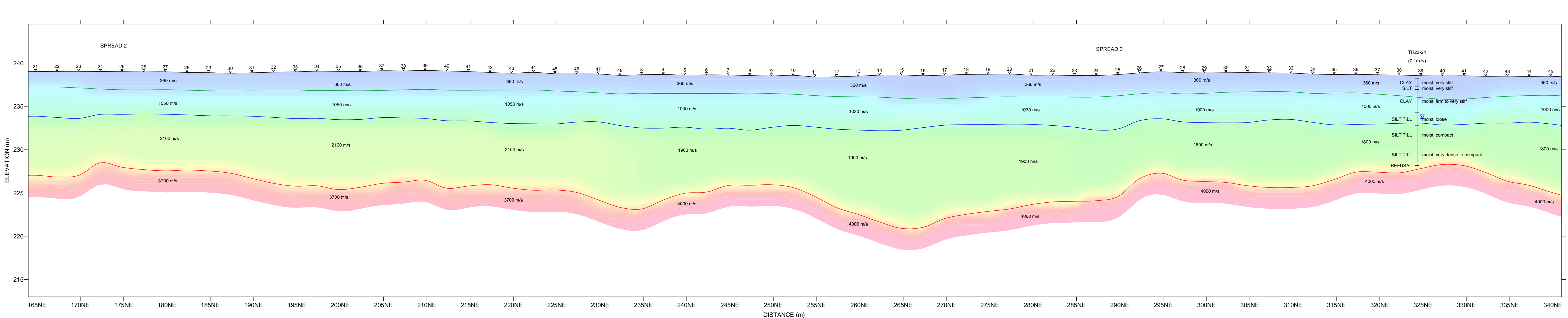




COMPRESSIONAL WAVE VELOCITY (m/s)

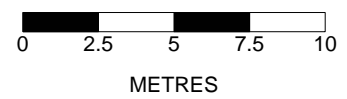
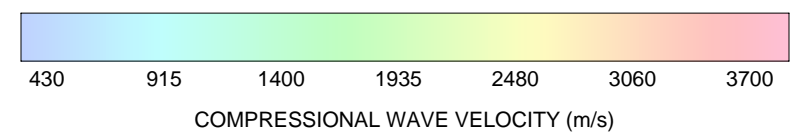
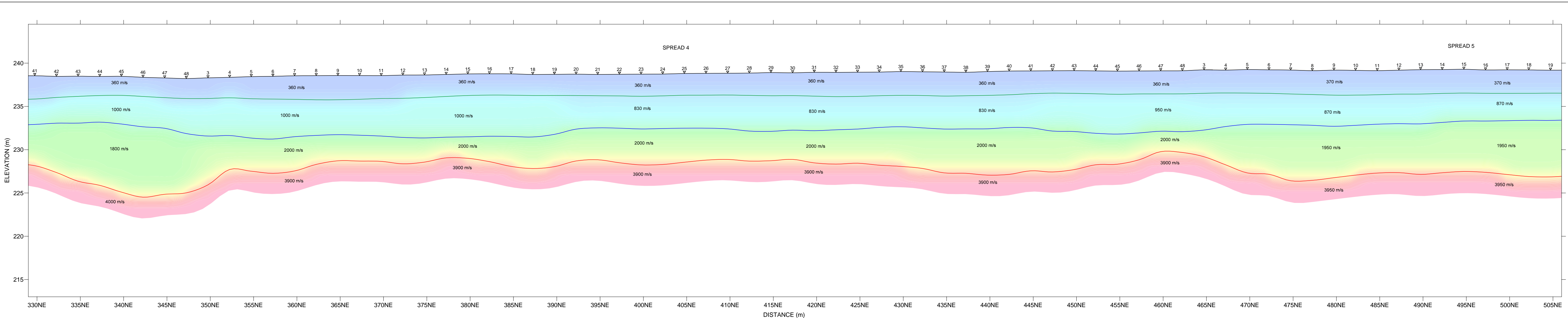


<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-01A		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 3



<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-01B		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 4



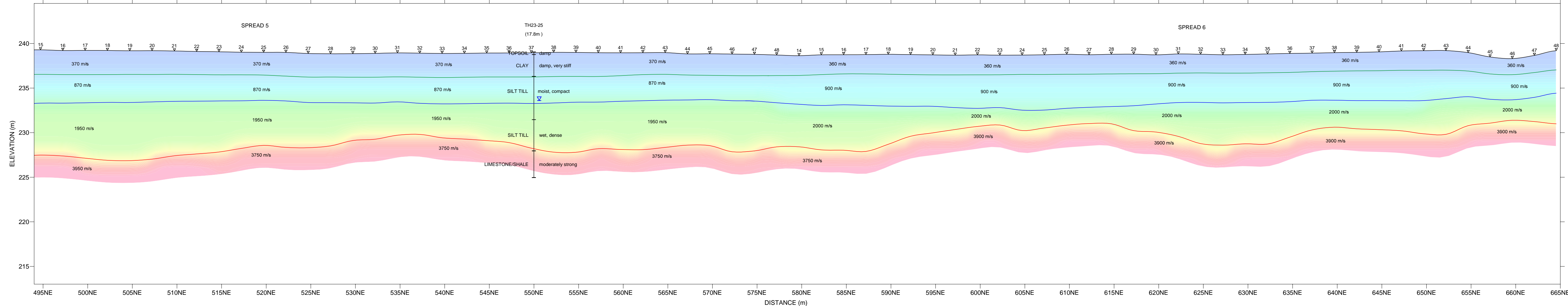


**KGS GROUP**  
CENTREPORT REGIONAL S&W SERVICING  
WINNIPEG, MB

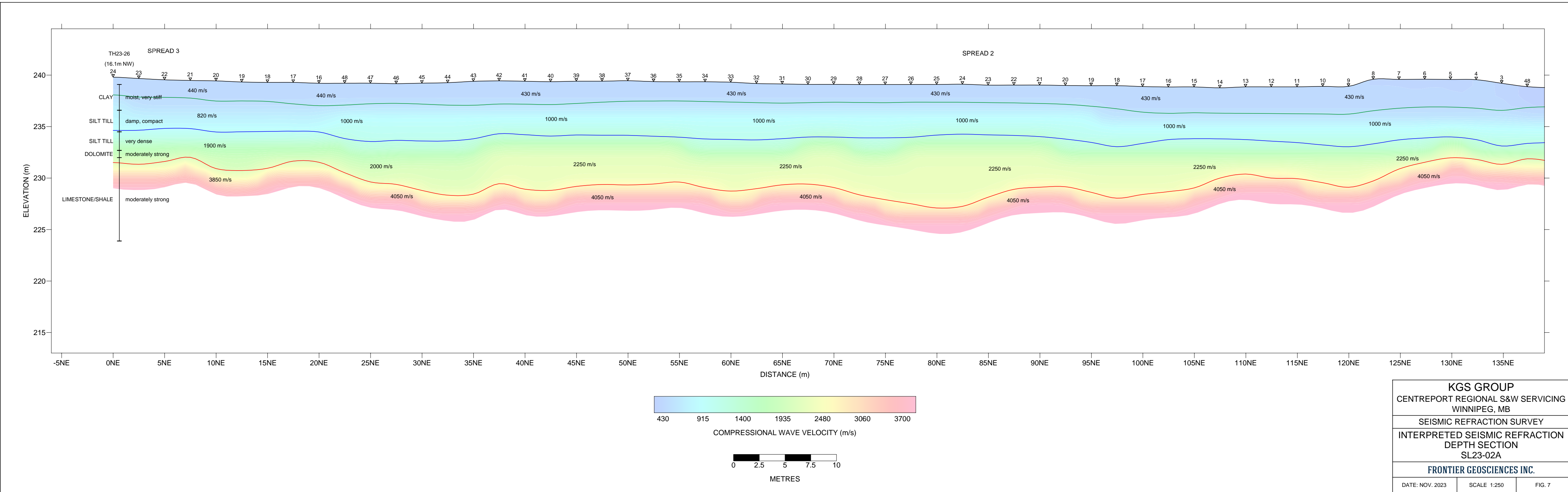
SEISMIC REFRACTION SURVEY  
INTERPRETED SEISMIC REFRACTION  
DEPTH SECTION  
SL23-01C

**FRONTIER GEOSCIENCES INC.**

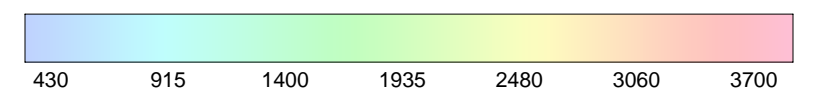
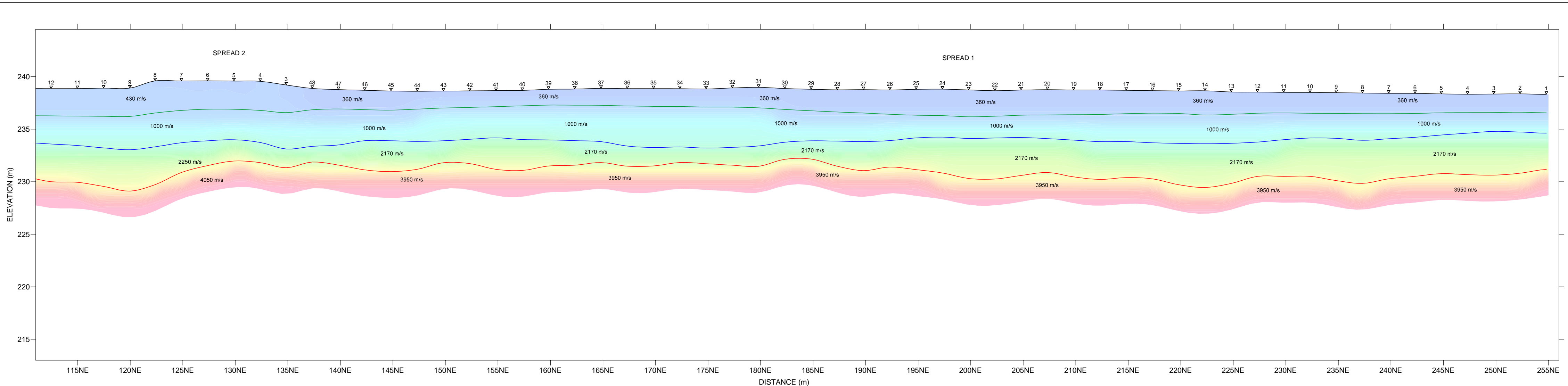
DATE: NOV. 2023    SCALE 1:250    FIG. 5



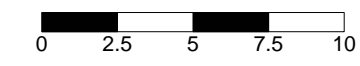
<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-01D		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 6



<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-02A		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 7



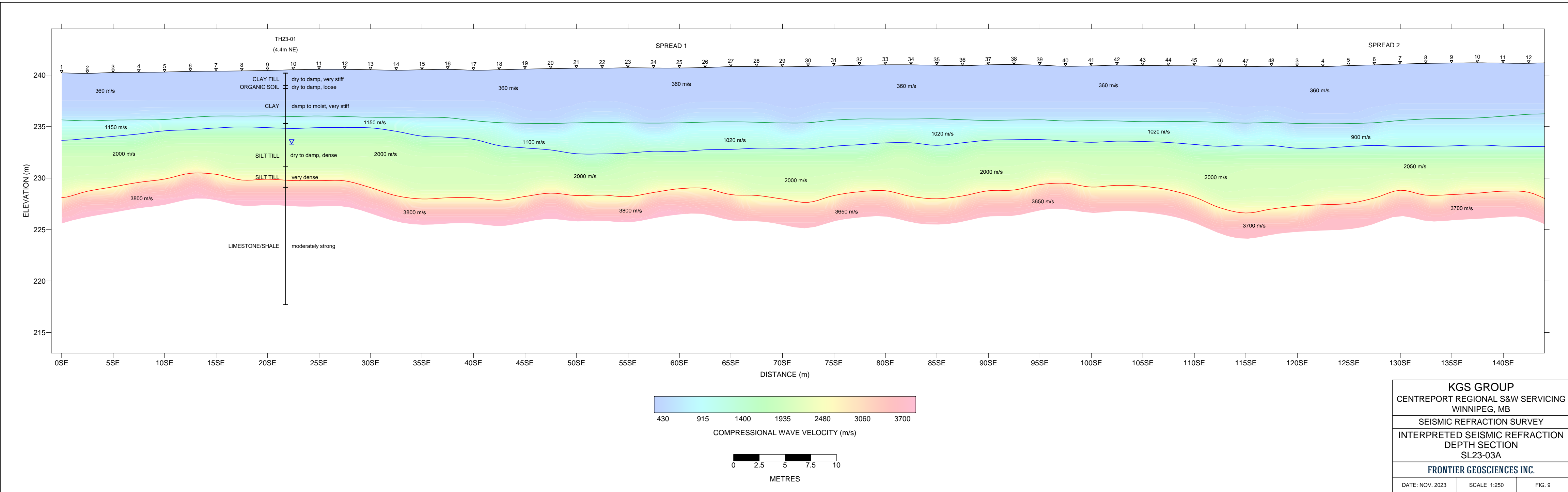
COMPRESSIONAL WAVE VELOCITY (m/s)



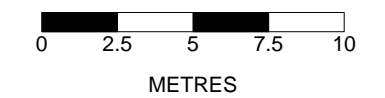
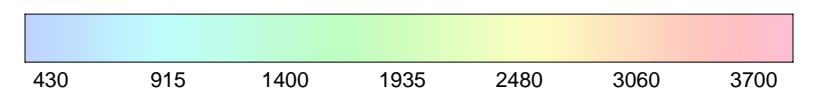
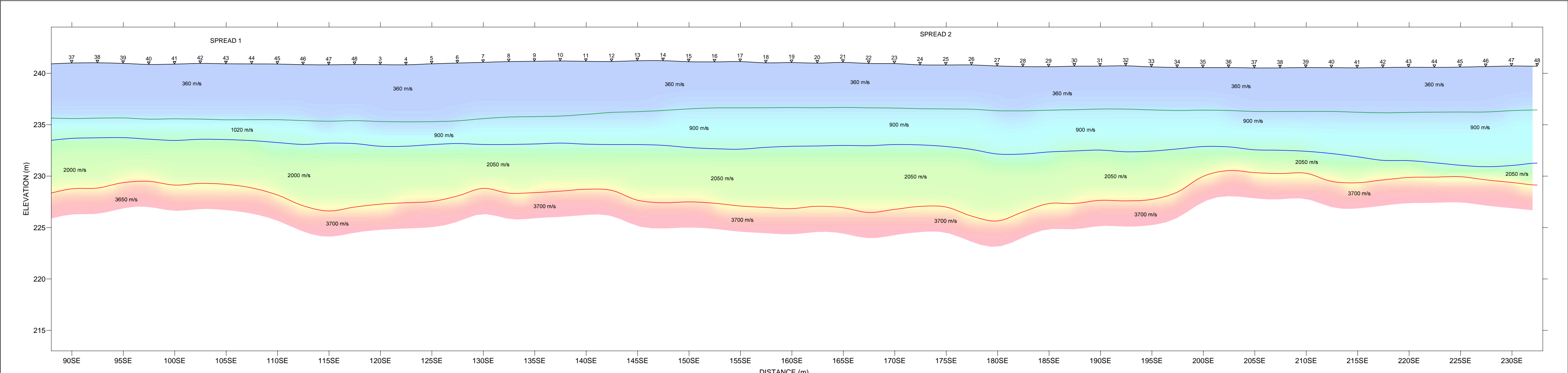
METRES

<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-02B		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 8





<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-03A		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 9



<b>KGS GROUP</b>		
CENTREPORT REGIONAL S&W SERVICING WINNIPEG, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED SEISMIC REFRACTION DEPTH SECTION SL23-03B		
<b>FRONTIER GEOSCIENCES INC.</b>		
DATE: NOV. 2023	SCALE 1:250	FIG. 10

# **APPENDIX G**

2023 KGS Group Hydrogeological Assessment Memo

# Memorandum

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<b>To:</b> <b>Ray Offman</b> Municipal Department Head KGS Group	<b>Date:</b> January 16, 2024
	<b>Project No.:</b> 23-0107-007
<b>From:</b> <b>Paul Lindell, B.Sc., P.Eng.</b> KGS Group <b>Simratpal Singh, M.Sc. EIT</b> KGS Group	<b>Cc:</b> <b>Dami Adedapo, Ph.D., P.Eng.</b> Principal & Geotechnical Department Head <b>Kelly Fordyce, B.Sc., P.Eng.</b> Geotechnical Engineer, KGS Group <b>Jason Mann, M.Sc., P.Geo., FGC</b> Principal, KGS Group
<b>Re:</b> Pumping Test at Centreport	

---

## 4.2. PUMPING TEST DESIGN AND ANALYSIS

### 4.2.1. Pumping Test Design

A pumping test was completed within the footprint of the future CentrePort South lift station site to understand the bedrock aquifer conditions for the deep shaft excavations that will be required for construction.

Observation well TH23-01 was installed on September 28, 2023, to a total depth of 22.5 m below ground elevation. This borehole was drilled using a GeoProbe 3230 track mounted drill rig. At this location, a standpipe piezometer was installed within the bedrock, and a vibrating wire piezometer (SN# VW171370) was installed at an elevation of 231.67 m (asl) within the silt till.

A 127 mm (5-inch) diameter pumping well PW23-01 was installed at the Site on November 14, 2023 using a Canterra CT 250 truck-mounted mud rotary drill rig. PVC well casing was installed through the overburden into the bedrock until competent bedrock was encountered. The bottom of PVC casing was installed at 12.5 m below ground surface with an open hole drilled in the limestone bedrock from 12.5 m to 22.3 m below ground surface. The preliminary yield testing on this well resulted in a calculated specific capacity of <1 USgpm, which was low, and a second pumping well (PW23-02) was installed closer to TH23-01. PW23-01 would be used as an additional observation well during the pump test at PW23-02.



Pumping well PW23-02 was installed approximately 35 m southwest of PW23-01, and with similar depth specifications as PW23-01. The specific capacity of this well was calculated to be 5 USgpm. The geographical location of the wells are shown in Figure 4.2.1. The drilling contractor used for this pumping test was Maple Leaf Drilling Ltd., of Winnipeg, Manitoba.

The UTM coordinates of the wells were collected using a handheld GPS and are accurate to +/- 4m. The borehole drilling and well construction details for the test wells are presented in Table 4.2.1, and the borehole logs are included in Appendix A.

**TABLE 4.2.1: BOREHOLE INSTALLATION DETAILS**

Well Name	Casing Diameter and Type	Depth of Casing (m bgs)	Total Depth (m bgs)	Easting (UTM)	Northing (UTM)
PW23-01	5 inch $\phi$ PVC	12.95	22.3	623136	5530157
PW23-02	5 inch $\phi$ PVC	11.73	22.3	623154	5530127
TH23-01	2 inch $\phi$ PVC	21.4	22.5	623145	5530113

#### 4.2.2. Aquifer Monitoring and Aquifer Testing

A 2-hour pumping test was conducted on PW23-02 on November 20, 2023, starting at 15:00 and ending at 17:00. Initially, an 8-hour pumping test was planned, but was revised to 2-hours to accommodate time to drill the additional pumping well PW23-02. Field observations indicated that 2 hours of pumping could establish the drawdown around the well and allow the drawdown cone to expand from PW23-02 to the observation well TH23-01. Recovery was monitored in the observation wells to at least 90% of the static water level.

A 3-inch diameter submersible pump was installed in PW23-02 at a depth of 10.9 m (36 ft) below grade. Power was supplied by an on-site portable generator. The 2-hour pumping test commenced on November 20, 2023 at 15:00 hrs and was completed at 17:00 hrs. The pumping test was started with a flow rate of 5 USgpm for the first 26 minutes to achieve a stable drawdown in PW23-02. A stable drawdown of 1.73 m (5.67 ft) was achieved within the first 26 minutes of pumping. The pumping rate was then increased to 10 USgpm to test the well response, and it was observed that the groundwater table quickly lowered to the pump elevation within approximately 10 minutes of pumping at 10 USgpm. The pumping rate was then adjusted to 8 USgpm and stabilized at 5.3 m of drawdown for the duration of the pumping test.

Water levels in observation wells TH23-01 and PW23-01 were monitored using Heron DipperLog non-vented M30/F100 and M10/F30 automatic data logging pressure transducers, respectively, to record how the aquifer response to pumping. The water level in PW23-02 was monitored using a manual water level meter. The vibrating wire in the silt layer installed in TH23-01 was monitored manually intermittently throughout the pumping test.

A barometric pressure logger (Heron BarLog) was deployed onsite for use in barometric compensation of non-vented transducers. Both the transducers as well as the barologger were installed in the respective wells at least one hour prior to the start of pumping to collect static water level data. The transducer plots and drawdown measured in each observation well are shown in Figure 4.2.2.

The discharge from the pumping test was piped to a ditch south of the site, and approximately 30 m west of the pumping well. Recirculation was not expected to occur during the 2-hour test.

**FIGURE 4.2.1: MONITORING WELL NETWORK FOR 2-HOUR PUMPING TEST – CENTREPORT REGIONAL S&W SERVICING**



### 4.2.3. Pumping Test Data Analysis

The Cooper-Jacob (1946) method is the most common approach for analyzing the results from aquifer pumping tests in confined aquifers and is a semi-log approximation of Theis (1935) method. Critical assumptions integral to these methods are detailed as follows:

- Darcy’s law is valid
- The pumping well diameter is infinitesimal
- The aquifer is horizontal and has constant thickness
- The wells are fully penetrating the aquifer formation
- The aquifer is infinite in areal extent
- The aquifer is bounded by impermeable strata above and below
- Single pumping well
- Uniform hydraulic conductivity
- The pumping rate is constant
- The aquifer is homogeneous and isotropic
- The aquifer has constant storage properties through time
- Head always remains above the top of the pumped aquifer
- There are no water level changes in the aquifer from any other nearby pumping.
- The head is known everywhere prior to pumping.

Through a review of the assumptions, it can be seen that some of the assumptions for the analysis of the pumping tests conducted at the Centreport well field site are not fully satisfied for the Theis (1935) as well as the Cooper-Jacob (1946) approaches. For example, the limestone aquifer does not appear to have isotropic conditions in the areal extent as the yielding capacity of both the pumping wells (PW23-01 and PW23-02) appears to be distinct since the number of water-producing fractures likely vary at both locations. However, the limestone aquifer does appear to satisfy the confined aquifer conditions as an impermeable layer of clay, silt till and a calcareous shale exists above the limestone. No change in pressure readings were observed from the vibrating wire installed in the silt till zone as pumping was being carried out in the limestone bedrock. This suggests that a hydraulic disconnect exists between the silt till and the deeper bedrock aquifers making limestone bedrock a confined aquifer.

The Cooper-Jacob (1946) approach is highly idealized to the assessment of the aquifer and represents the state of the art for the determination of aquifer parameters. The method has been found to be reasonably workable for aquifer engineering evaluation, all over the world, for more than 80 years. In this case, conditions of the Cooper-Jacob (1946) approach are not being severely violated and the methodology provides for good comparisons to the other regional work conducted in the area.

A summary of measured response to pumping during the 2-hour pumping test are shown in Table 4.2.2. The pumping test data was analyzed using the Cooper-Jacob (1946) (both time and distance drawdown) method and the hydraulic parameters inferred from the data are shown in Table 4.2.3.

**TABLE 4.2.2: PUMPING TEST DRAWDOWN RESULTS**

Test Hole	Instrument Type	Tip Depth (m bgs)	Monitored Zone	Distance from Pumping Well (m)	Static Water Level (m below TOC)	GW Elevation (m asl)	End of Test Drawdown (m)
PW23-02	Standpipe	11.73	Bedrock	-	6.096	233.424	5.57
TH23-01	Standpipe	21.4	Bedrock	~ 13	7.930	233.147	0.077
TH23-01	Vibrating wire	9.1	Silt Till	~ 13	7.840	233.28	None
PW23-01	Standpipe	12.95	Bedrock	~ 35	9.069	230.281	None

Note: The GW Elevations were calculated using the ground elevations from the Lidar elevations data presented in figure 4.2.1.

**TABLE 4.2.3: TRANSMISSIVITY AND STORATIVITY CALCULATIONS FROM PUMPING TEST**

Data from the Well	Data Type	Method	Transmissivity (m <sup>2</sup> /day)	Storativity
PW23-02	Residual Drawdown vs Elapsed Time	Cooper-Jacob (1946)	1.47	-
PW23-02 and TH23-01	Distance-Drawdown	Cooper-Jacob (1946)	2.9	0.0032
<b>Average Transmissivity (m<sup>2</sup>/day)</b>			2.18	

In general, the aquifer was inferred to have an approximate transmissivity of 2.18 m<sup>2</sup>/day (<500 USgpd/ft), based on the results of the 2-hour, single pumping well test, and the data from the responding observation wells. The drawdown observations from the bedrock monitoring wells did not show appreciable fracture connectivity to the pumping well. Drawdown in the limestone aquifer were small but detectable in the pumping well PW23-02 and in observation well TH23-01; however, no drawdown was observed in PW23-01. The storativity was inferred to be at 0.0032.

Drawdown versus time for the pumping well PW23-02 is shown as Figure 4.2.5. This data was not considered in the analysis as the drawdown was stabilized initially at 5 USgpm for the first 26 minutes; however, on increasing the pumping rate to 10 USgpm, the groundwater level rapidly drew down to the elevation where the pump was sitting in the well. The pumping rate was then reduced to 8 USgpm and the water level stabilized at 5.3 m for the duration of the test. The residual drawdown verses time plot for the pumping well is shown in figure 4.2.4. It was observed that PW23-02 recovered back to the static groundwater level within first 10 minutes of recovery period after pump shutoff.

The radius of influence calculation was not performed; however, it can be noted from the drawdown versus time data for TH23-01 (Figure 4.2.3) that the maximum drawdown at this well location was 0.077 m. It can be assumed that the radius of influence of pumping at 8 USgpm was approximately 13 m.



# STATEMENT OF LIMITATIONS AND CONDITIONS

## Limitations

This memorandum has been prepared for City of Winnipeg in accordance with the agreement between KGS Group and City of Winnipeg (the “Agreement”). This memorandum represents KGS Group’s professional judgment and exercising due care consistent with the preparation of similar documents. The information, data, recommendations and conclusions in this memorandum are subject to the constraints and limitations in the Agreement and the qualifications in this memorandum. This memorandum must be read as a whole, and sections or parts should not be read out of context.

This memorandum is based on information made available to KGS Group by City of Winnipeg. Unless stated otherwise, KGS Group has not verified the accuracy, completeness or validity of such information, makes no representation regarding its accuracy and hereby disclaims any liability in connection therewith. KGS Group shall not be responsible for conditions/issues it was not authorized or able to investigate or which were beyond the scope of its work. The information and conclusions provided in this memorandum apply only as they existed at the time of KGS Group’s work.

## Third Party Use of Memorandum

Any use a third party makes of this memorandum 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 memorandum.

## Geo-Environmental Statement of Limitations

KGS Group prepared the geo-environmental conclusions and recommendations for this memorandum in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this memorandum is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of City of Winnipeg. As this memorandum is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

## Geotechnical Investigation Statement of Limitations

The geotechnical investigation findings and recommendations of this memorandum 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 the site at the time of drilling. 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, KGS Group should be notified in order that the recommendations can be reviewed and modified if necessary.

Prepared By:

Simratpal Singh, M.Sc., EIT  
Environmental Hydrogeologist

SPS/jdm  
Attachments

Approved By:

Jason Mann, M.Sc. P.Geo., FGS  
Principal

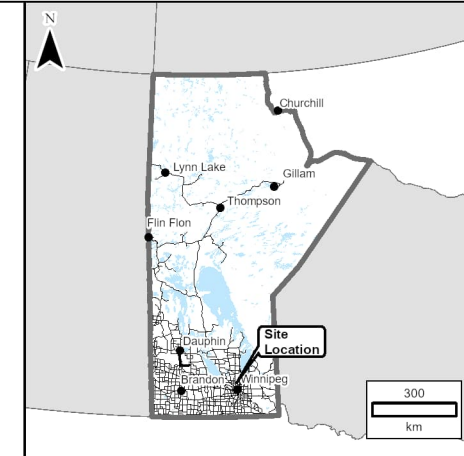
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# FIGURES

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DRAFT





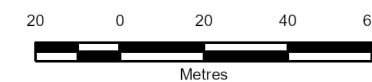
**LEGEND:**

- ◆ Centreport Hole Locations

**NOTES:**

1. All units are metric and in metres unless otherwise specified. Transverse Mercator Projection, NAD 1983 CSRS, Zone 14. Elevations are in metres referencing vertical datum (CGVD28).
2. Imagery Source: ESRI/MAXAR, dated 2022.

DRAFT



SCALE: 1:1,800 METRIC 11"x17"

A	23/12/23	ISSUED WITH DRAFT REPORT	SPS	PLJ
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REVISIONS / ISSUE				

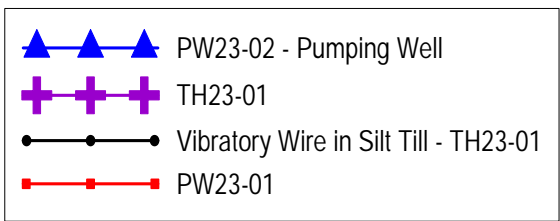
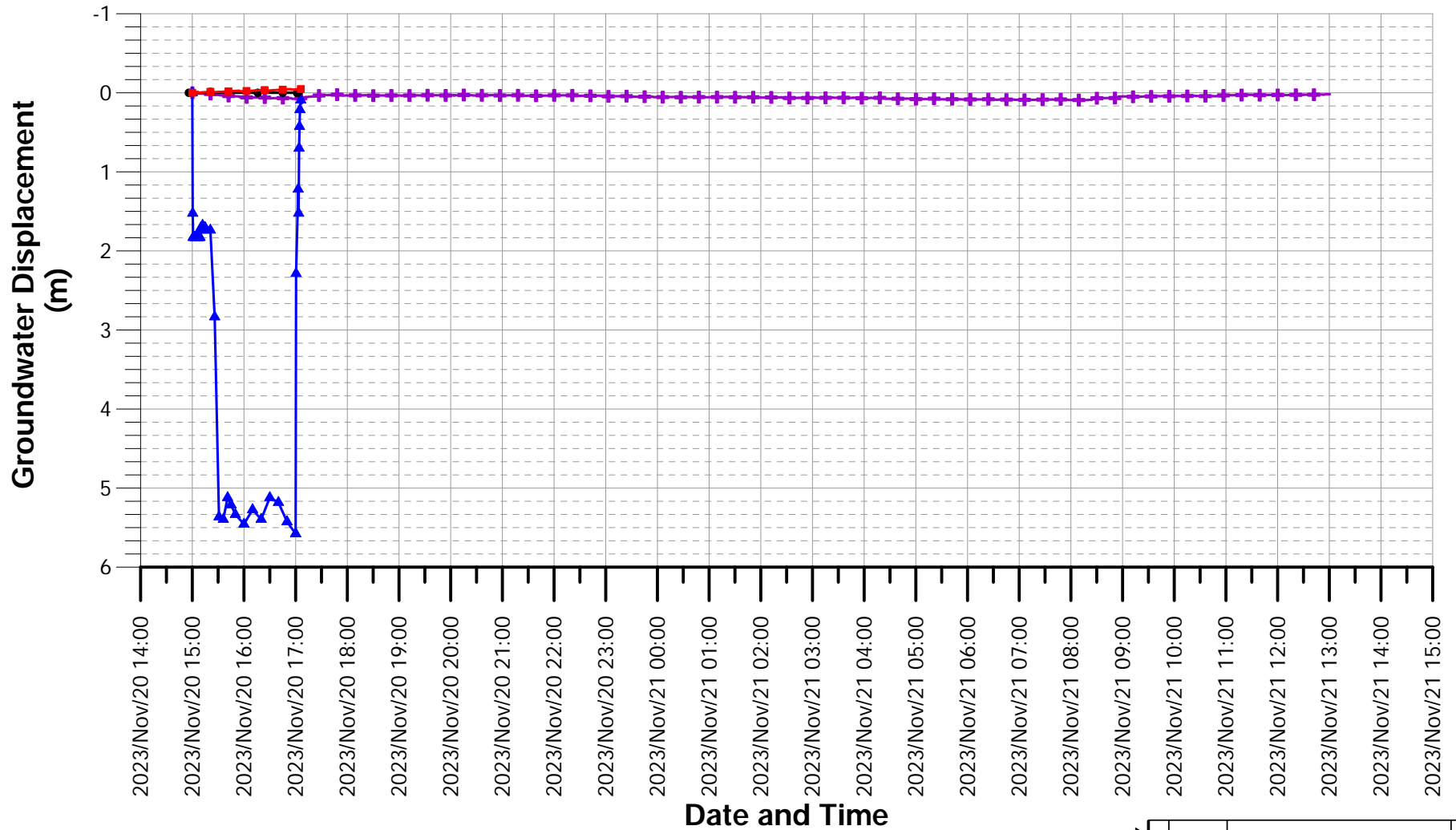


CITY OF WINNIPEG  
CENTREPORT REGIONAL S&W SERVICING

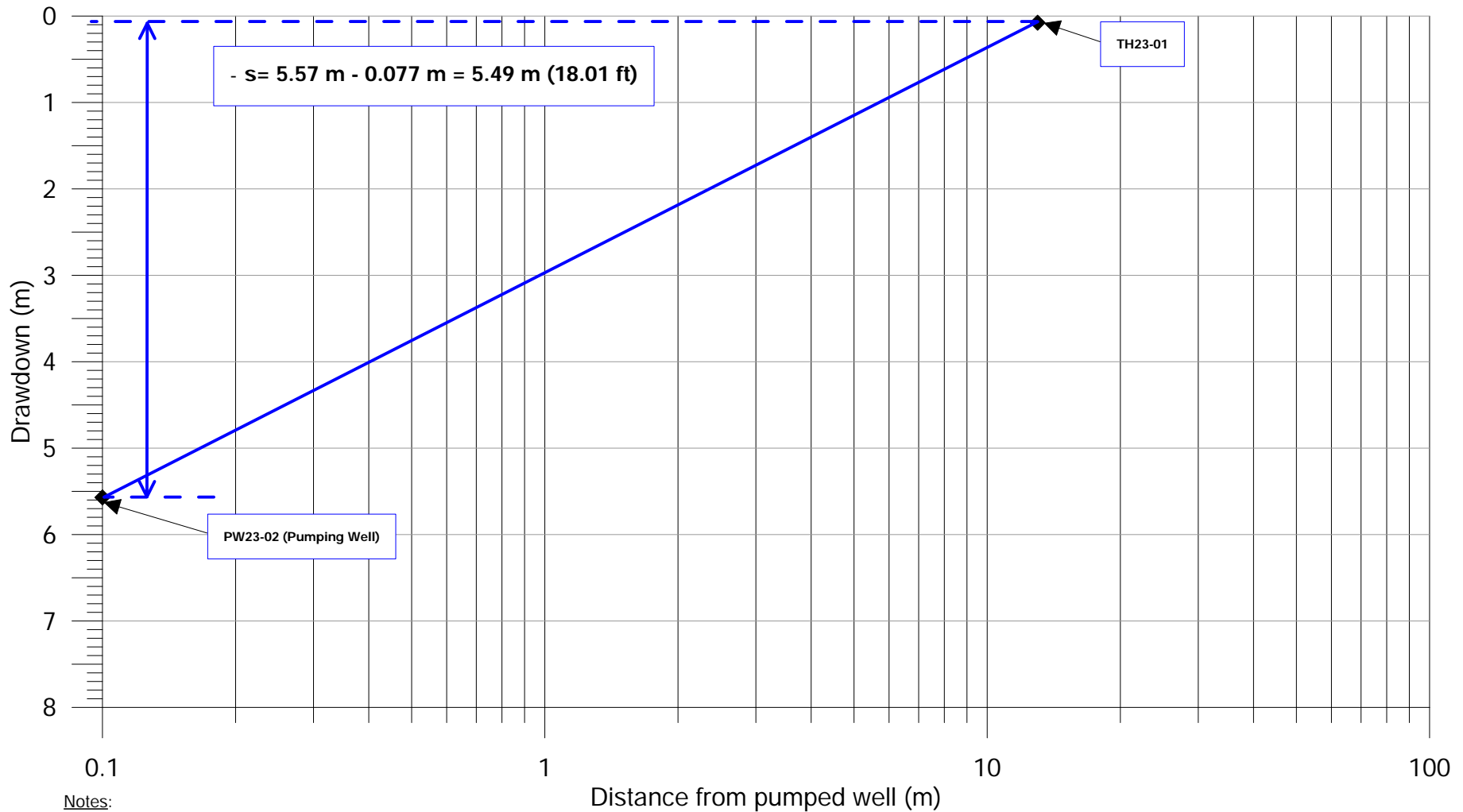
CENTREPORT PUMPING TEST AT PW23-02

DECEMBER 2023	FIGURE 4.2.1	REV: A
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➔	A	23/12/06	ISSUED WITH DRAFT REPORT	SPS	PJL
	NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
REVISIONS / ISSUE					
CITY OF WINNIPEG CENTREPORT REGIONAL S&W SERVICING					
PUMPING TEST AT PW23-02 GROUNDWATER DISPLACEMENT DATA					
DEC 2023			FIGURE 4.2.2		REV: A



**Notes:**

Date: November 20, 2023  
 Pumping Well: PW23-02  
 Observation: TH23-01 and PW23-01  
 Drawdown: 5.57 m at PW23-02  
 0.077 m at TH23-01  
 No drawdown observed at PW23-01  
 Pump Rate (Q): 43.6 m<sup>3</sup>/day (8 USgpm)

**Transmissivity**

$T = (0.366)(Q) / -s$        $Q = 43.6 \text{ m}^3/\text{day} (8 \text{ USgpm})$   
 $-s = 5.49 \text{ m}$        $T = 2.9 \text{ m}^2/\text{day} (241 \text{ gpd/ft})$

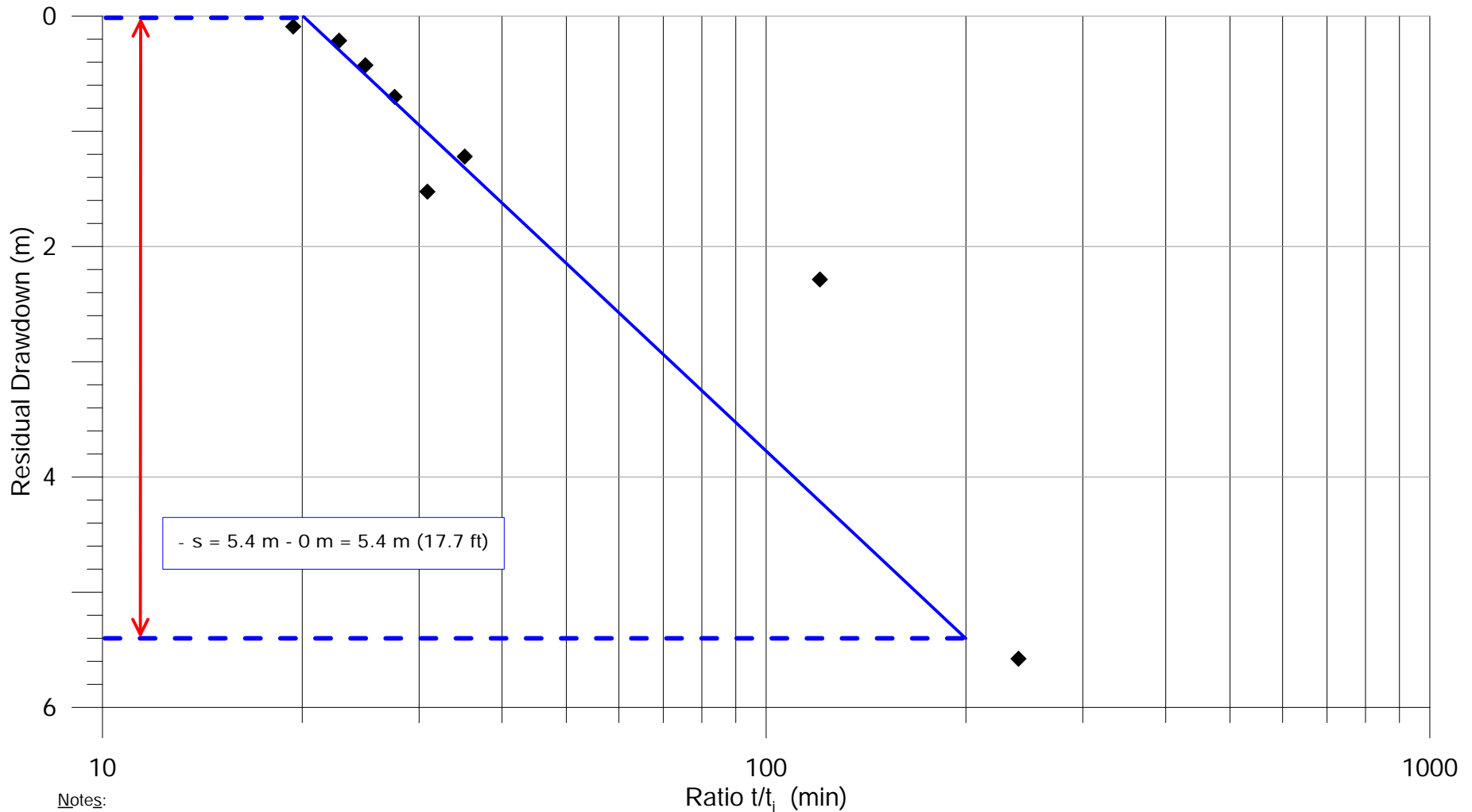
**Storativity**

$S = 2.25Tt / r_o^2$   
 $T = 2.9 \text{ m}^2/\text{day}$   
 $r_o = 13 \text{ m}$   
 $t = 0.083 \text{ days} (120 \text{ min})$   
 $S = 0.0032$

◆ Drawdown

UTM collected with hand-held GPS  
 (horizontal accuracy +/- 4m)

A	23/12/06	ISSUED WITH DRAFT REPORT	SPS	PJL
NO.	YYMMDD	DESCRIPTION	Design By	Design Check
REVISIONS / ISSUE				
<b>KGS GROUP</b>				
CITY OF WINNIPEG CENTREPORT REGIONAL S&W SERVICING				
PUMPING TEST AT PW23-02 DISTANCE DRAWDOWN				
DEC 2023		FIGURE 4.2.3		REV: A



- s = 5.4 m - 0 m = 5.4 m (17.7 ft)

**Notes:**

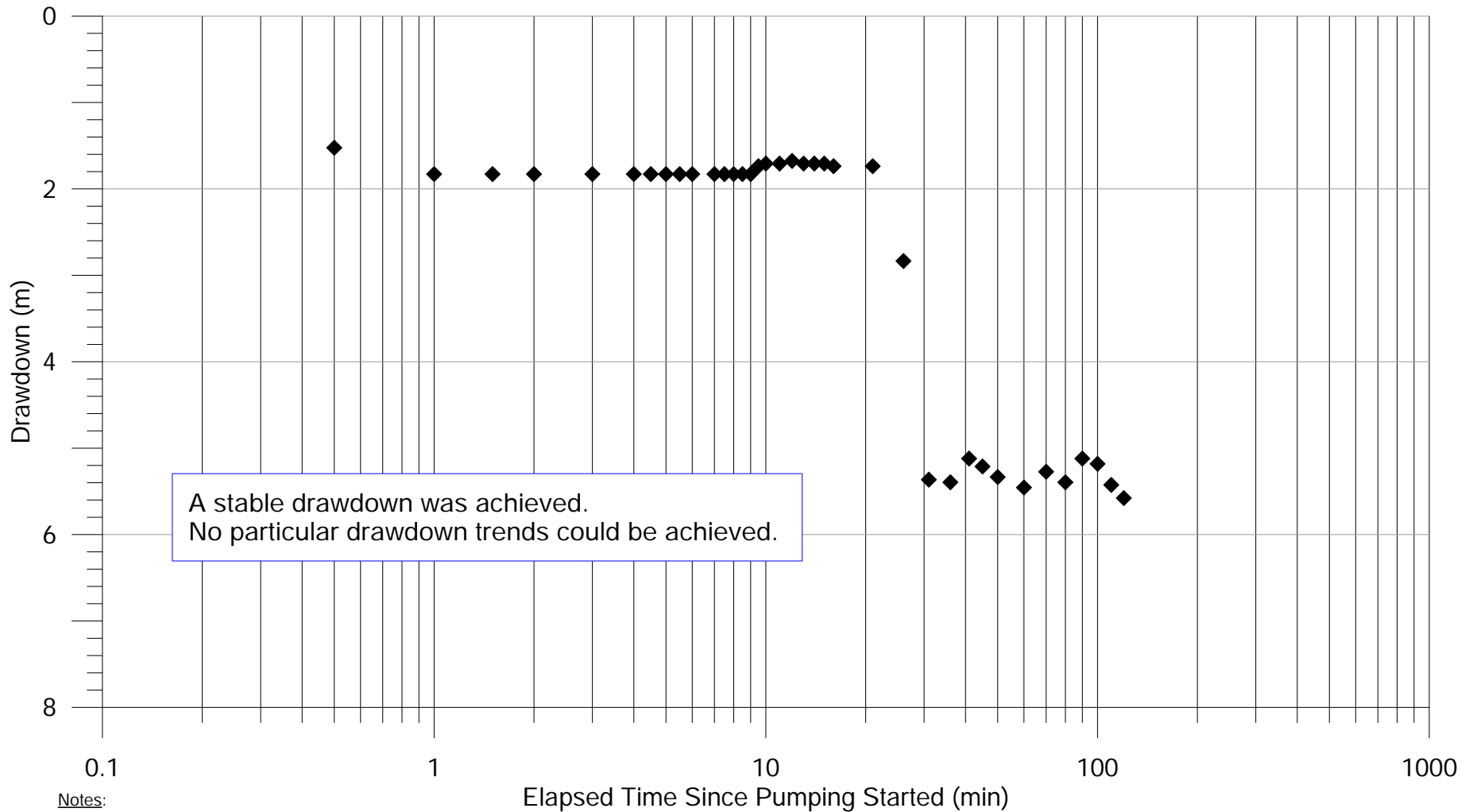
Date: November 20, 2023  
 Pumping Well: PW23-02  
 Observation: PW23-02  
 Drawdown: 5.57 m  
 Pump Rate (Q): 43.6 m<sup>3</sup>/day (8 USgpm)

**Transmissivity**

$T = (0.183)(Q) / -s$        $Q = 43.6 \text{ m}^3/\text{day} (8 \text{ USgpm})$   
 $-s = 5.4 \text{ m} (17.7 \text{ ft})$        $T = 1.47 \text{ m}^2/\text{day} (118.9 \text{ gpd/ft})$

◆ TH21-03-Manual

A	23/12/06	ISSUED WITH DRAFT REPORT	SPS	PJL
NO.	YYMMDD	DESCRIPTION	Design By	Design Check
REVISIONS / ISSUE				
<b>KGS</b> GROUP				
CITY OF WINNIPEG CENTREPORT REGIONAL S&W SERVICING				
PUMPING AT PW23-02 RESIDUAL DRAWDOWN - OBSERVATION AT PW23-02				
DEC 2023	FIGURE 4.2.4	REV:	A	



A stable drawdown was achieved.  
No particular drawdown trends could be achieved.

**Notes:**

Date: November 20, 2023  
 Pumping Well: PW23-02  
 Observation: PW23-02  
 Drawdown: 5.57 m  
 Pump Rate (Q): 27.2 - 43.6 m<sup>3</sup>/day (5 - 8 USgpm)

Transmissivity calculations were not carried using this data.

A	23/12/06	ISSUED WITH DRAFT REPORT	SPS	PJL
NO.	YYMMDD	DESCRIPTION	Design By	Design Check
REVISIONS / ISSUE				
CITY OF WINNIPEG CENTREPORT REGIONAL S&W SERVICING				
PUMPING AT PW23-02 TIME VS DRAWDOWN OBSERVATION AT PW23-02				
DEC 2023		FIGURE 4.2.5		REV: A



# APPENDIX A












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Borehole Logs




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# KEY TO SYMBOLS






## LITHOLOGIC SYMBOLS

	Clay (CH, high plasticity)
	Dolomite
	Dolomite Shaley
	Fill
	Limestone
	Silt (MH)
	Silt (ML)
	Silt Till
	Organics
	Silt Till
	Topsoil

## SAMPLER SYMBOLS

	Auger Grab
	Core Barrel
	SPT Split Spoon

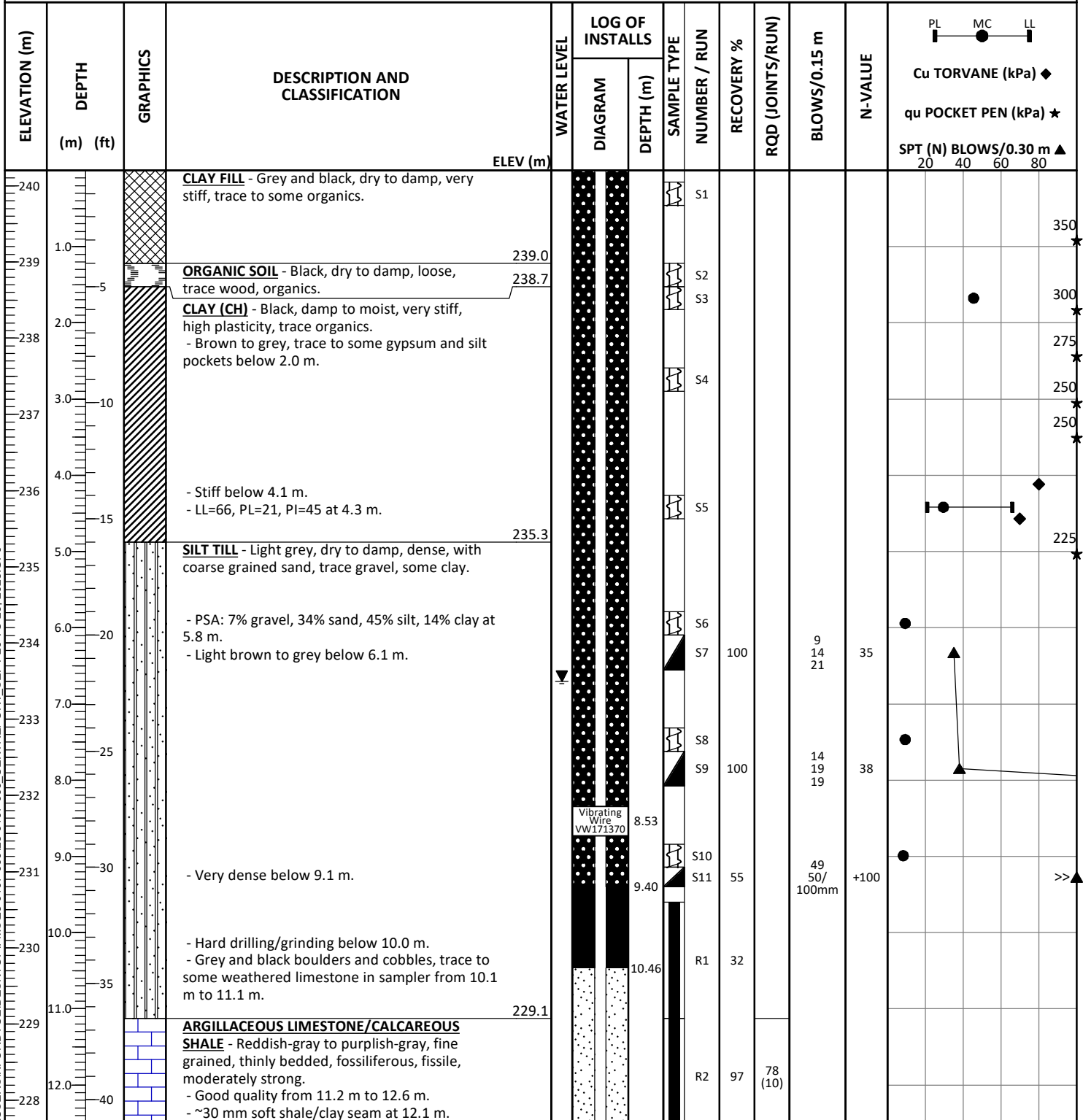
## WELL CONSTRUCTION SYMBOLS

	Sand Backfill
	Standpipe (bentonite pellets)
	Standpipe (cement/bentonite grout)
	Standpipe (filter sand)
	Screen (filter sand)

## ABBREVIATIONS

LL - Liquid Limit	PN - Pneumatic Piezometer
PL - Plastic Limit	VW - Vibrating Wire Piezometer
PI - Plastic Index	PID - Photoionization Detector
MC - Moisture Content	ppm - Parts Per Million
DD - Dry Density	∇ - Water Level During Drilling
NP - Non-Plastic	▼ - Water Level Upon Completion of Drilling
-200 - Percent Passing No. 200 Sieve	∇ - Water Level Remeasured/Static
TV - Torvane (kPa)	
PP - Pocket Penetrometer (kPa)	
PSA - Particle Size Analysis	
TOC - Top Of Casing	

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-0107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	240.20 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.91 m / 241.12 m (Standpipe)
<b>DESCRIPTION</b>	Southwest corner of lift station	<b>START DATE</b>	9-28-2023
<b>DRILL RIG / HAMMER</b>	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	<b>UTM (m)</b>	N 5,530,113 E 623,145 Zone 14
<b>METHOD(S)</b>	0.0 m to 9.1 m: 125 mm ø SSA 9.1 m to 22.5 m: Water Rotary HQ Core - switched due to encountering boulders/ suspected bedrock		



<b>WATER LEVELS</b>	▽ During Drilling/Digging	on 9-28-2023 None Encountered	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> M. RODRIGUEZ
	▼ Upon Completion	6.71 m on 9-29-2023		
			<b>APPROVED</b> DRAFT	<b>DATE</b>

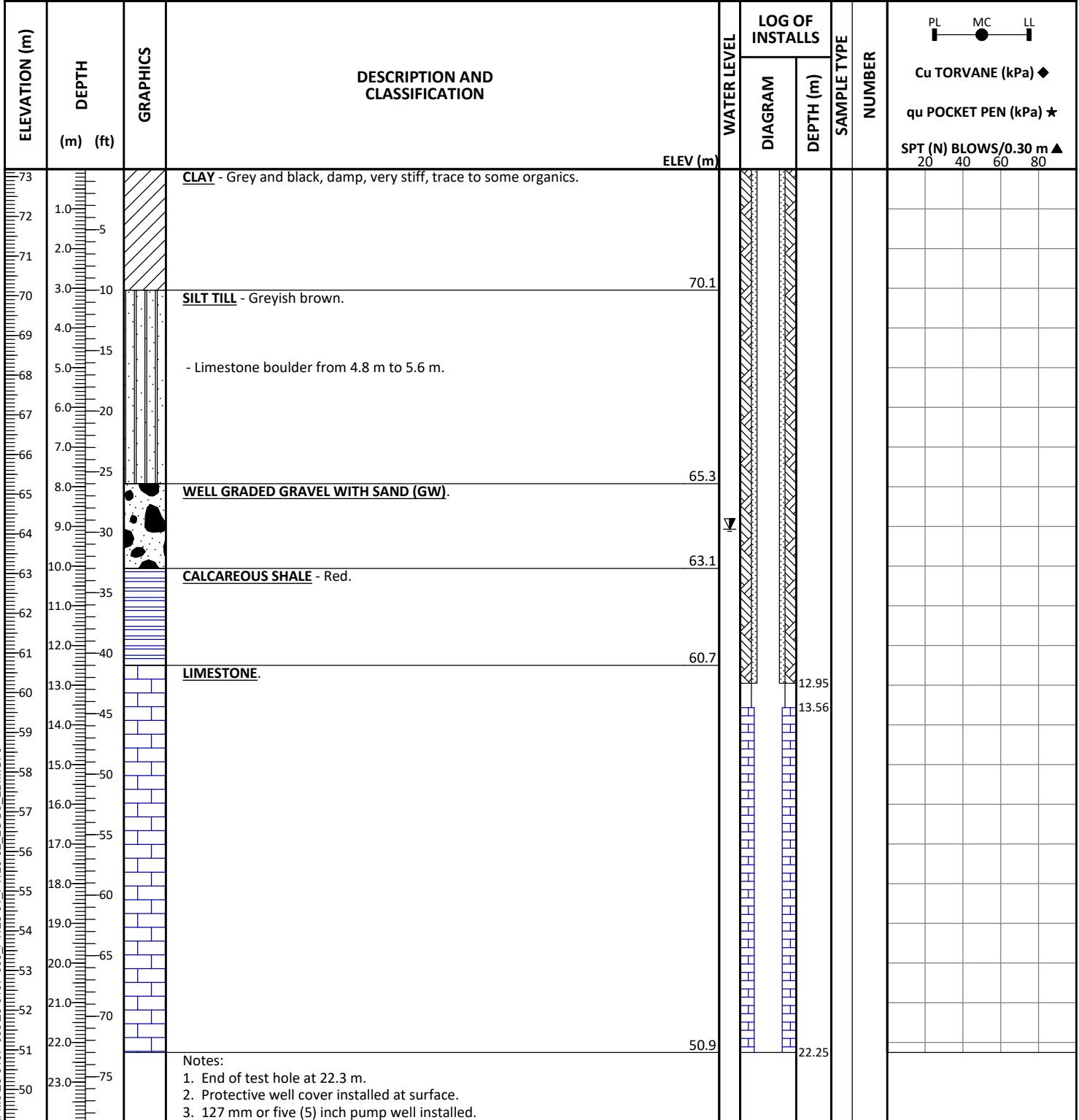
KGS\_LOG\_C:\USERS\KFORDE\DESKTOP\FMS\23-0107-009\23-0107-009\_CENTREPORT\_SEPT 26 TO 29\_2023.GPJ

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	PL    MC    LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲ 20    40    60    80					
					DIAGRAM	DEPTH (m)												
227	13.0		- Fair quality from 12.6 m to 15.7 m. - UCS: 24.1 MPa at 12.9 m. - Increased shale content, weak, several ~20 mm joints with soft shale/clay infill from 13.0 m to 13.1 m.					R3	96	59 (14)								
226	14.0		- Decreased shale/clay content from 13.1 m to 14.3 m. - Broken/Fractured core zone infilled with soft reddish-purple shale/clay. - ~125 mm Fractured zone infilled with soft shale/clay, very weak.					R4	92	65 (15)								
225	15.0		- Moderate strength below 15.2 m.			15.34												
224	16.0		- Poor quality from 15.7 m to 20.3 m. - 50 - 100 mm thick shale interbeds spaced 150 - 300 mm apart from 16.0 m to 18.0 m.					R5	97	45 (23)								
223	17.0		- UCS: 17.6 MPa at 16.9 m.															
222	18.0							R6	93	40 (18)								
221	19.0																	
220	20.0		- Fair quality below 20.3 m.															
219	21.0		- Two ~75 mm thick shale/clay interbeds from 20.9 m to 21.5 m. - Decreasing shale/clay content, increasing strength below 21.2 m.					R8	100	65 (14)								
218	22.0																	
217	23.0					21.44		R7	93	64 (16)								
216	24.0																	
215	25.0							R9	93	70 (3)								
214	26.0																	
213	27.0					22.50												
<b>WATER LEVELS</b> ▽ During Drilling/Digging ▼ Upon Completion			on 9-28-2023 None Encountered 6.71 m on 9-29-2023					<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.			<b>INSPECTOR</b> M. RODRIGUEZ							
								<b>APPROVED</b> DRAFT			<b>DATE</b>							

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<b>CLIENT</b>	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	<b>PROJECT NO.</b>	23-107-009
<b>PROJECT</b>	CentrePort Regional S&W Servicing	<b>SURFACE ELEV.</b>	73.19 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.61 m / 73.80 m (Standpipe)
<b>DESCRIPTION</b>	W side of lift station; 40m NNW of TH23-01	<b>START DATE</b>	11-14-2023
<b>DRILL RIG / HAMMER</b>	Canterra CT 250 Truck Mounted Drill Rig	<b>UTM (m)</b>	N 5,530,157 E 623,136 Zone 14
<b>METHOD(S)</b>	0.0 m to 13.0 m: Mud Rotary/Air Hammer 13.0 m to 13.6 m: Mud Rotary, 150 mm ø Tricone Bit - switched due to encountering bedrock 13.6 m to 22.3 m: Mud Rotary, 125 mm ø Tricone Bit		



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<b>WATER LEVELS</b>	▼ Remeasured/Static	9.07 m on 11-20-2023 Monitoring Well	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> L. MCALLISTER
			<b>APPROVED</b> DRAFT	<b>DATE</b>

<b>CLIENT</b>	<b>CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT</b>	<b>PROJECT NO.</b>	23-107-009
<b>PROJECT</b>	<b>CentrePort Regional S&amp;W Servicing</b>	<b>SURFACE ELEV.</b>	73.19 m
<b>LOCATION</b>	Winnipeg, Manitoba	<b>TOC STICK-UP / ELEV.</b>	0.61 m / 73.80 m (Standpipe)
<b>DESCRIPTION</b>	S side of lift station; 16m NE of TH23-01	<b>START DATE</b>	11-17-2023
<b>DRILL RIG / HAMMER</b>	Canterra CT 250 Truck Mounted Drill Rig	<b>UTM (m)</b>	N 5,530,127
<b>METHOD(S)</b>	0.0 m to 11.7 m: Mud Rotary/Air Hammer		E 623,154 Zone 14
	11.7 m to 12.3 m: Mud Rotary, 150 mm $\phi$ Tricone Bit - switched due to encountering bedrock		
	12.3 m to 22.3 m: Mud Rotary, 125 mm $\phi$ Tricone Bit		

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	WATER LEVEL	LOG OF INSTALLS		SAMPLE TYPE	NUMBER	PL    MC    LL Cu TORVANE (kPa) ◆ qu POCKET PEN (kPa) ★ SPT (N) BLOWS/0.30 m ▲ 20    40    60    80
					DIAGRAM	DEPTH (m)			
73	0		<b>CLAY</b> - Grey and black, damp, stiff.						
71.1	2.0		<b>SILT TILL</b> - Greyish brown, with boulders.  - Limestone and granite boulders from 4.0 m to 4.7 m.						
64.3	9.0		<b>CALCAREOUS SHALE</b> - Red.						
61.6	11.4		- Broken Purple Limestone below 11.4 m.						
50.9	22.3		<b>LIMESTONE</b> .			11.73 12.34			
			Notes: 1. End of test hole at 22.3 m. 2. Protective well cover installed at surface. 3. 127 mm or five (5) inch pump well installed.			22.25			

<b>WATER LEVELS</b>	▼ Remeasured/Static	6.10 m on 11-20-2023 Monitoring Well	<b>CONTRACTOR</b> Maple Leaf Drilling Ltd.	<b>INSPECTOR</b> S. SINGH
			<b>APPROVED</b> DRAFT	<b>DATE</b>

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Experience in Action