APPENDIX A

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	**Interceptor & Intake Sewers (Contract 3)**	Provides connection points for wastewater collection permitting development of commercial and industrial lands.
2	**750 mm Feeder Main, Silver to Offtake Structure 3 (Contract 4A)**	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	**Force Main (Contract 2A)**	Installation of a single force main to support initial development. Future force main to be designed and constructed when wastewater generation warrants it.
4	**By-Pass Lift Station (Contract 1A)**	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 2024. 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
Groundwater Elevation Monitoring Data						
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).

3.0 SCOPE OF 2023/2024 INVESTIGATION PROGRAM

3.1 General

This section provides a summary of the 2023/2024 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 2023/2024 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.

A test pit excavation and sampling program was completed by KGS Group from February 21 to 22, 2024. A total of two (2) test pits were advanced to refusal on the bedrock surface. The test pits were completed to confirm the depth to bedrock and evaluate the composition of the glacial till on either side of the proposed trenchless crossing of Saskatchewan Avenue and the Canadian Pacific Kansas City Railway (CPKC) right-of-way. Excavation services were provided by J Con Civil Ltd. of Winnipeg, Manitoba using a rubber-tire excavator. Soil samples were collected at changes in soil strata and were visually classified according to the

USCS. Upon completion of excavation, the test pit was examined for indicates of sloughing and seepage and then backfilled.

TABLE 3-1: SUMMARY OF 2023 BOREHOLE AND 2024 TEST PIT LOCATIONS

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
TP24-01	5529179	623763	239.97	5.3	234.87
TP24-02	5529137	623772	240.64	4.6	236.04
PW23-01	5530157	623136	238.91	22.30	
PW23-02	5530127	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	

Borehole ID	Northing (m)	Easting (m)	Approx. Ground Surface Elevation (m)	Approx. Borehole Depth (m)	Approx. Bedrock Contact Elevation (m)
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 for boreholes were established from City of Winnipeg LiDAR data. Ground surface elevations for test pits were established using survey grade GPS.
2) Top of bedrock elevation is reported where bedrock was confirmed during drilling/test pitting.

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.

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.

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 and test pit logs from the 2023/2024 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^3 (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 2023/2024 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-2.

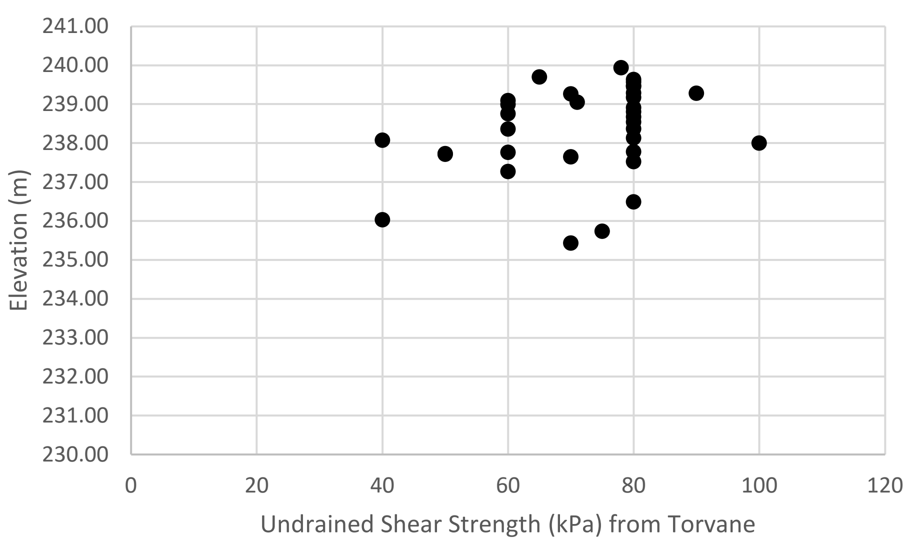
TABLE 4-2: SUMMARY OF LABORATORY AND FIELD TEST RESULTS FOR CLAY FILL

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 (Su) 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 $\phi' = 20.5^{o}$ and $c' = 29.8$ kPa and $\phi' = 15.8^{o}$, respectively. While the effective large strain shear strength parameter for the brown and grey clay were c' = 14.5 kPa and ϕ' = 13.3° and c' = 7.7 kPa and ϕ' = 15.7°, 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 ϕ' = 14° 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 clinochlore 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 smecite 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 2023/2024 geotechnical investigations 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

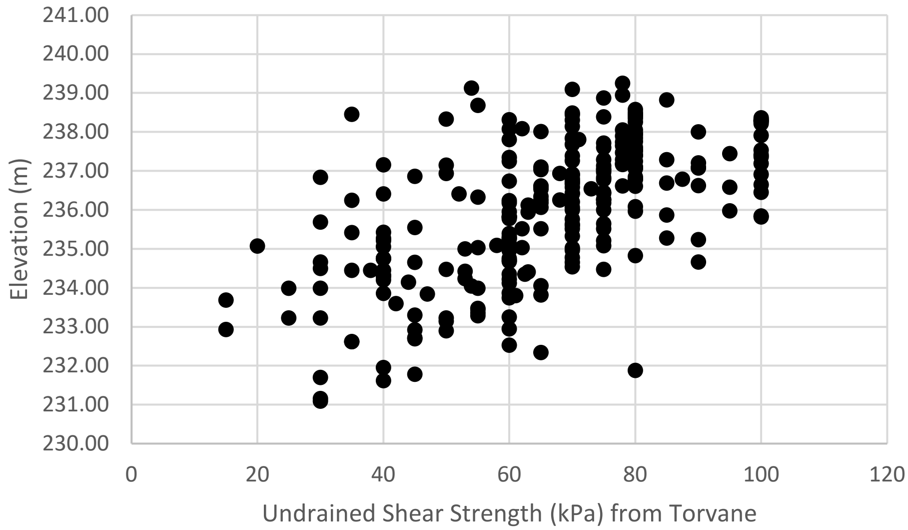
A summary of the laboratory material testing results on the glaciolacustrine clay from the KGS Group 2023 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-4.

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 (Su) 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



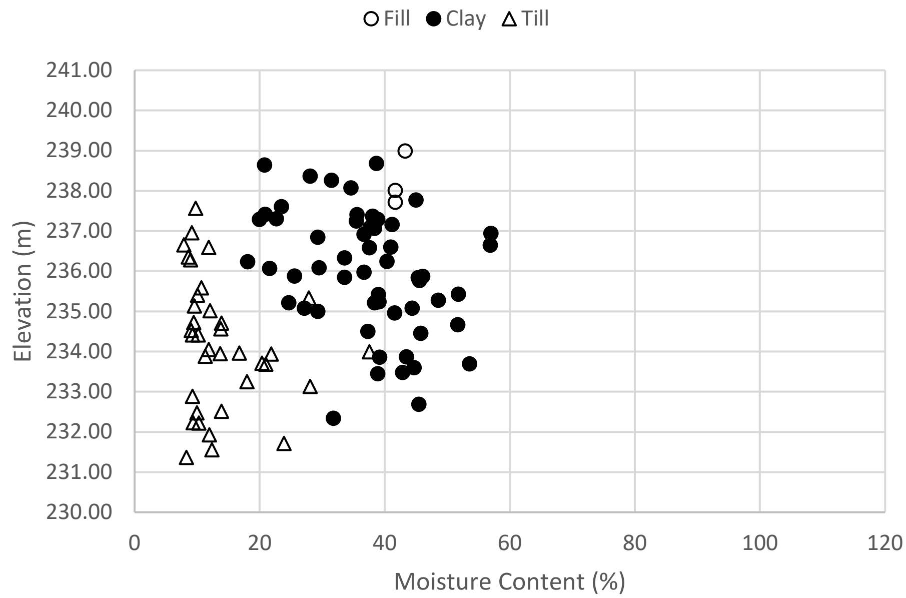
4.1.2.1 Swelling Potential of Clay Deposit

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, 5th 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 % 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

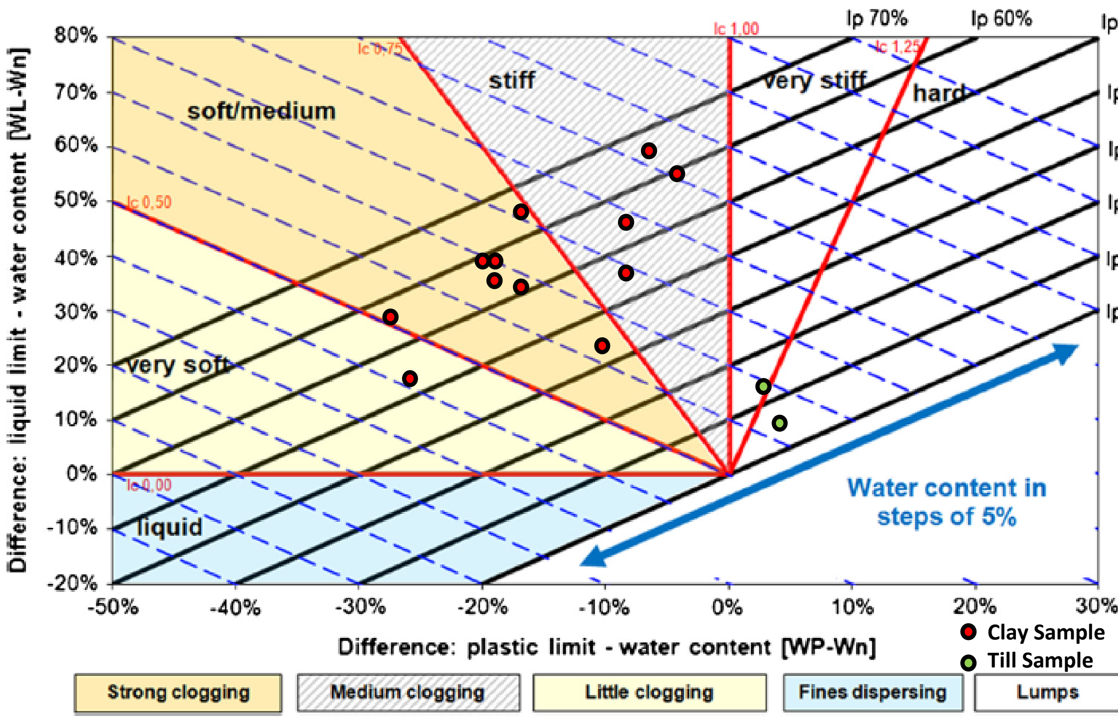


4.1.2.2 Stickiness Potential and Clogging Risks

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 and test pits, 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 contain. Unconfined compressive strengths ranging from 3.4 - 3.6 MPa have been reported for very dense tills with a moisture content of about 5% (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 boulders will contain granite with diameters up to 600 mm based on previous experience in Winnipeg. The percent volume of boulders per total volume of glacial till excavated is estimated to be up to 6%. The boulder frequency observed during the 2024 test pitting investigation was approximately 2 to 4 boulders (greater than 300 mm diameter) per cubic meter of glacial till excavated. These zones can cause difficulties during construction and should be anticipated within the deposits in the project area. Photos of boulders encountered during the test pitting investigation are provided in Appendix C.

The extent of the glacial till deposit identified in KGS Group's 2023/2024 geotechnical investigations 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.

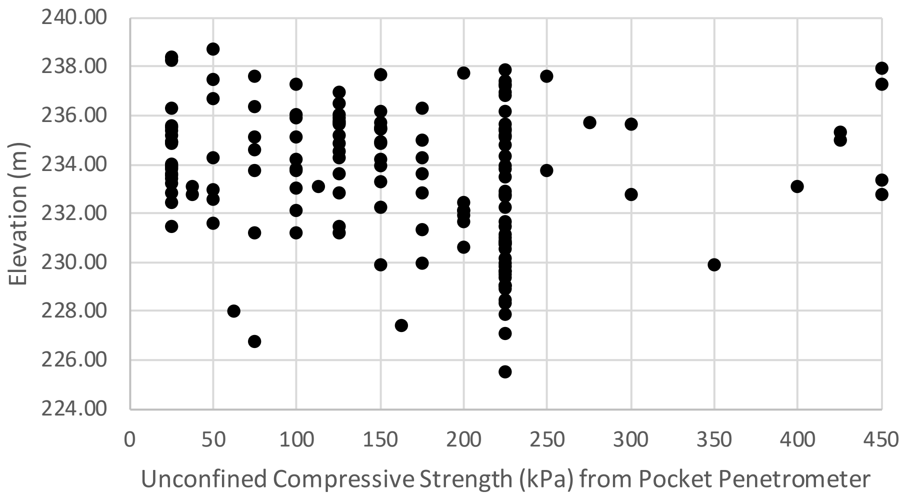
A summary of the laboratory material testing results on the glacial till deposits from the KGS Group 2023 geotechnical investigations and the background geotechnical investigations are summarized in Table 4-6.

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

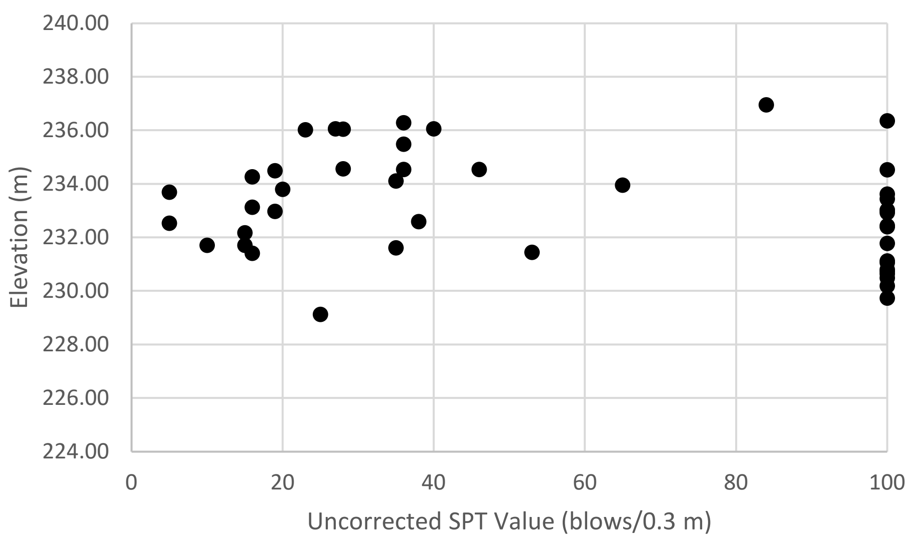
Values of unconfined compressive strength (Cu) with elevation for the glacial till deposit as estimated from a pocket penetrometer during the KGS Group 2023 investigation and background geotechnical investigations throughout the project site are summarized in Figure 4-5.

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 and test pitting, 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 ranged 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/test pits TH23-08, TH23-09, TH23-26, TP24-01, and TP24-02. 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

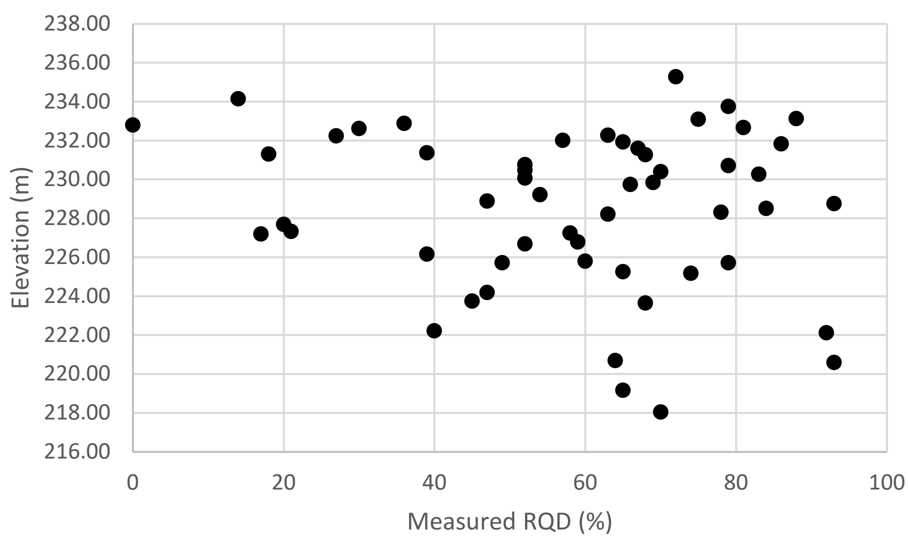
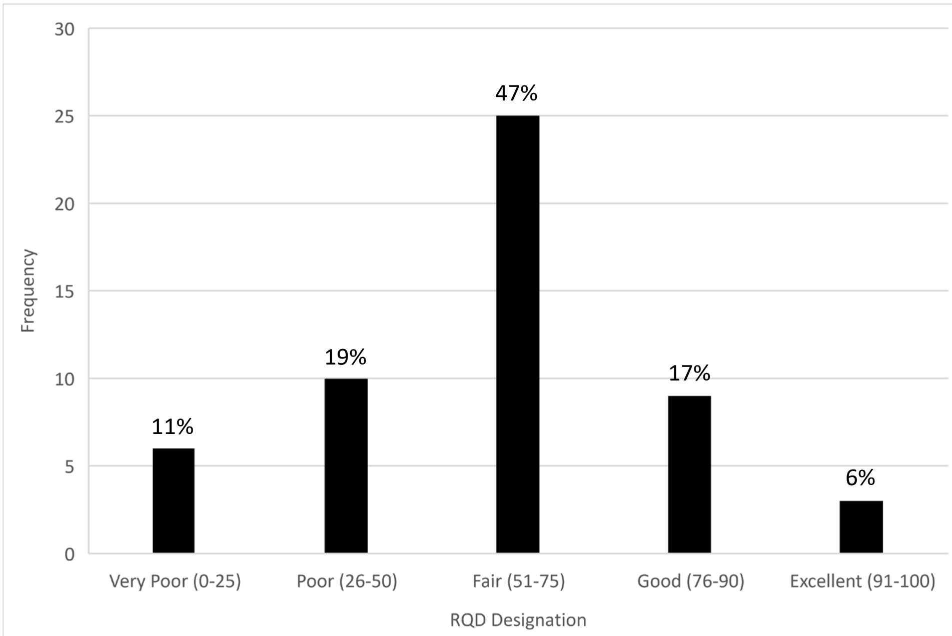
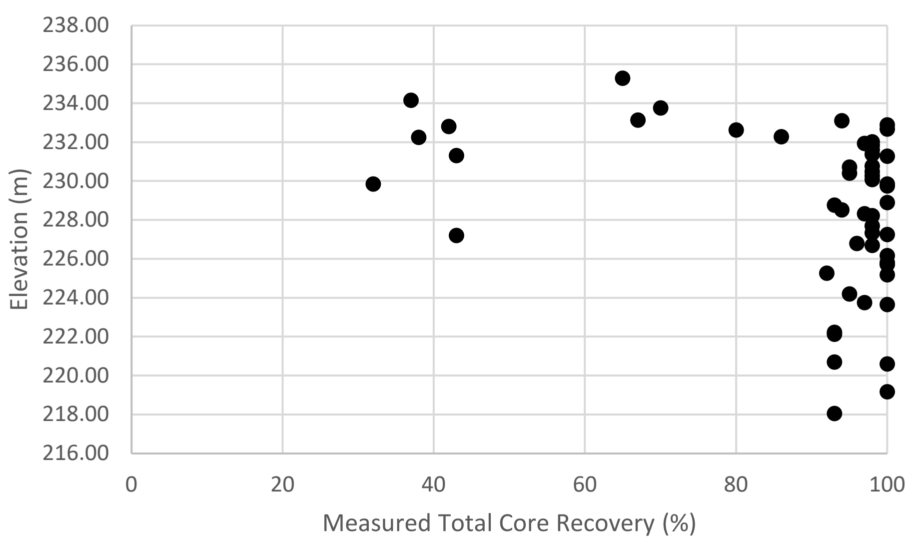


FIGURE 4-8: HISTOGRAM OF DISTRIBUTION OF RQD WITHIN BOREHOLES



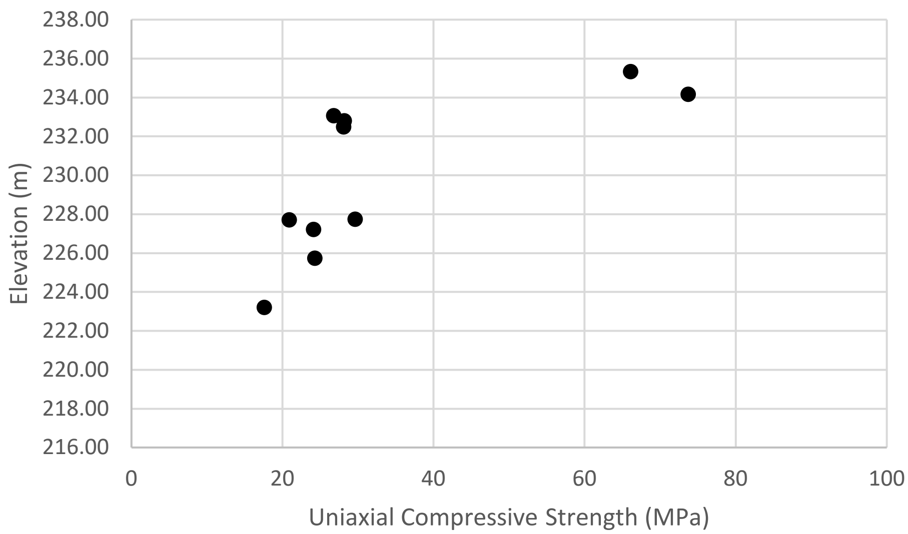
Total Core Recovery (TCR) is the total length of the bedrock core recovered and is expressed as the percentage of actual length of the core run (typically 1.5 m). A summary of the TCR values is provided in Figure 4-9.

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 temporary shaft locations and open-cut trenching. 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 CentrePort project area varied from 260 to 6500, 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^2/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
Average Transmissivity (m^2/day)			2.18	

In general, the aquifer was inferred to have an approximate transmissivity of 2.18 m^2/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 are included in Appendix G

4.3 Groundwater

Groundwater level 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

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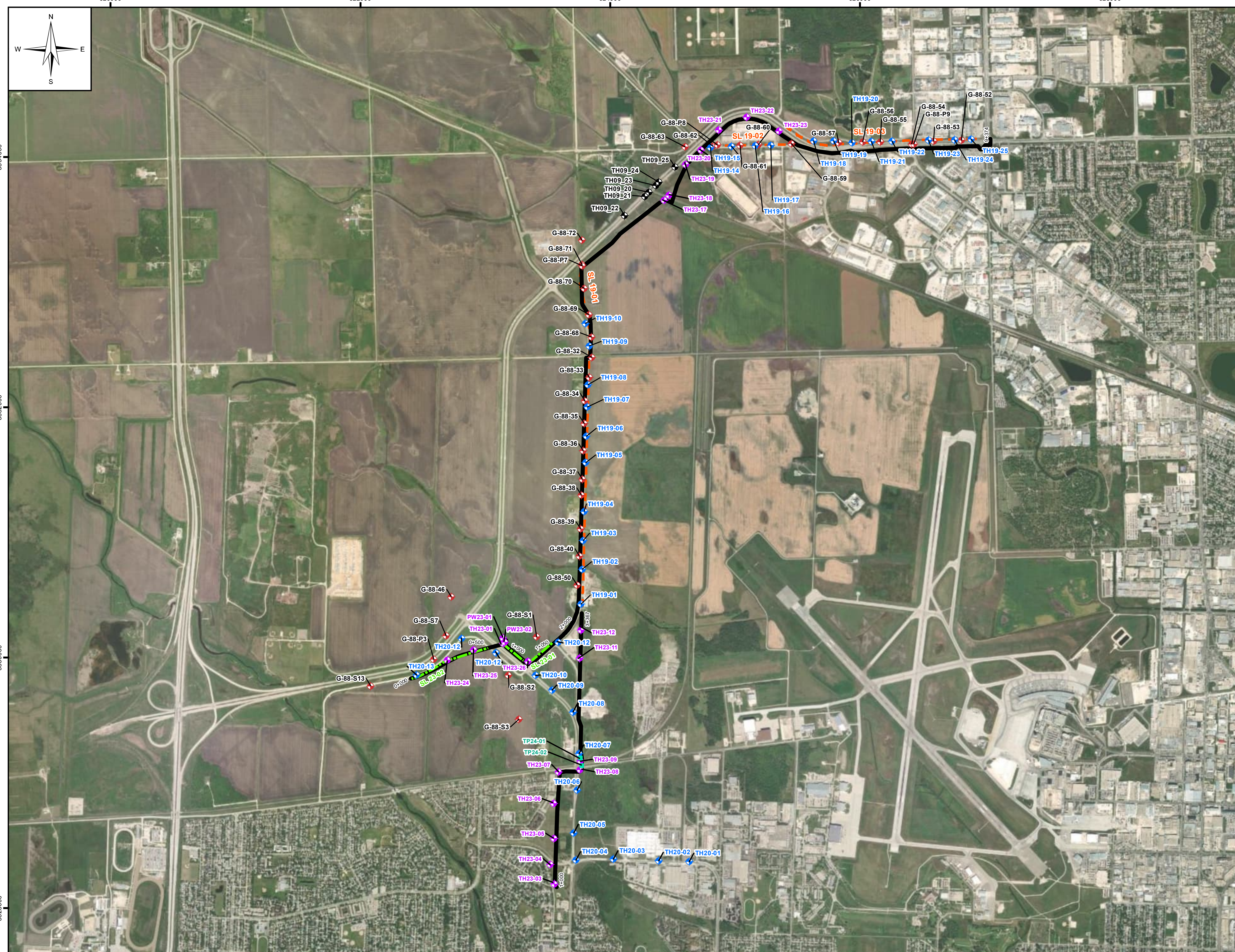
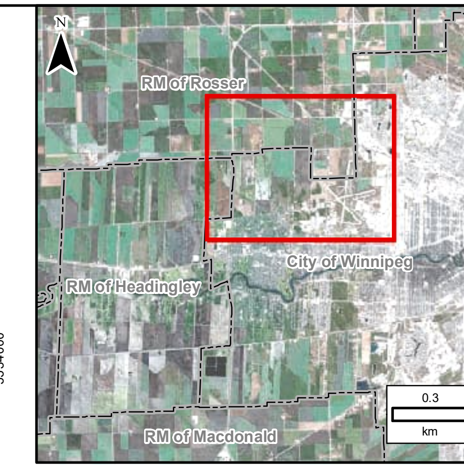
7. KGS Group, Acres Engineering, UMA Engineering (2004). Appendix B, Floodway Channel Pre-Design, Floodway Expansion Project, Project Definition and Environmental Assessment, Preliminary Engineering Report.

FIGURES





LEGEND:

- KGS Group Test Hole (2023)
- KGS Group Test Hole (2019/2020)
- KGS Group Test Hole (2009)
- UMA Test Hole (1988)
- KGS Group Test Pit (2024)
- 2019 Seismic Lines (approximate)
- 2023 Seismic Lines
- Proposed Pipeline Infrastructure Alignment

NOTES:
1. Image Source: ESRI/MAXAR dated as 2023.
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).

0.2 0 0.2 0.4 0.6 0.8 1

Kilometres

SCALE: 1:30,000 METRIC 11"x17"

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KGS GROUP

Winnipeg

CENTREPORT SOUTH REGIONAL WATER & WASTEWATER SERVICES

GEOTECHNICAL DATA REPORT

MARCH 2024 | FIGURE 01 | REV: 0

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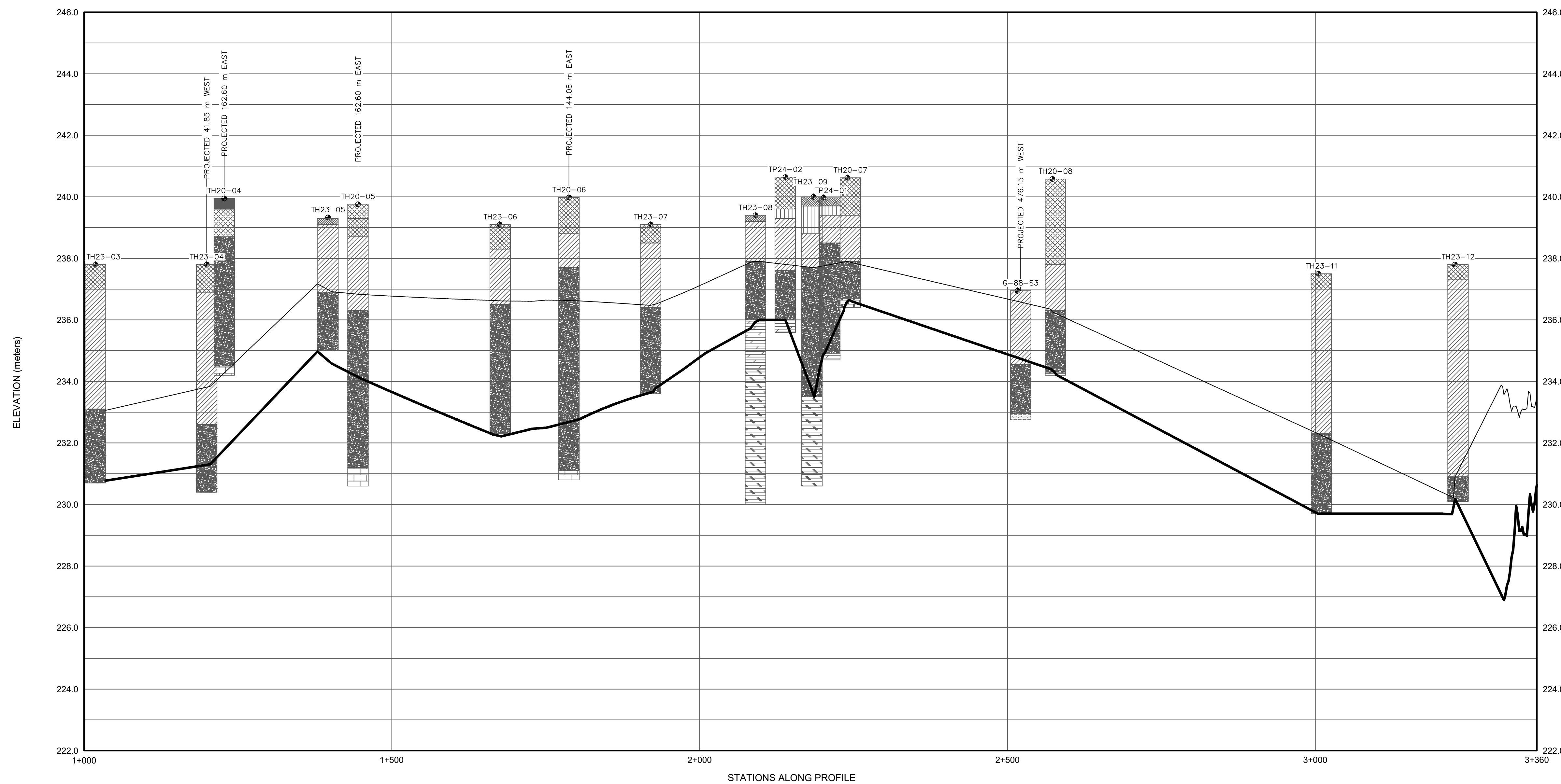

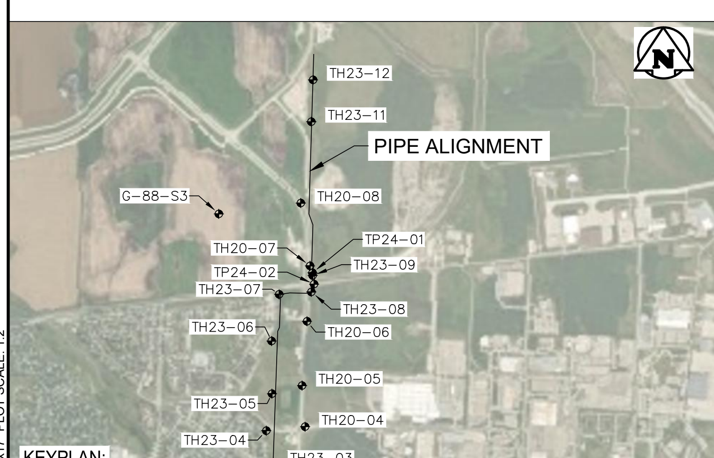

Scale

0 120 240 Meters

Horizontal Scale

Vertical Scale: 50x

Lithology Graphics

Topsoil	Clay Fill	Clay/Silty Clay	Silt Till	Granular Fill	Organic Soil		
Unknown/Poor-Recovery	Jurassic/Argillaceous Limestone	Dolomite	Argillaceous Dolomite	Sand and Gravel	Organic Clay		
Shale with Dolomite Beds	Asphalt	Silt	Limestone	Till Surface (See Note 2)	Bedrock Surface (See Note 2)		

Disclaimer:

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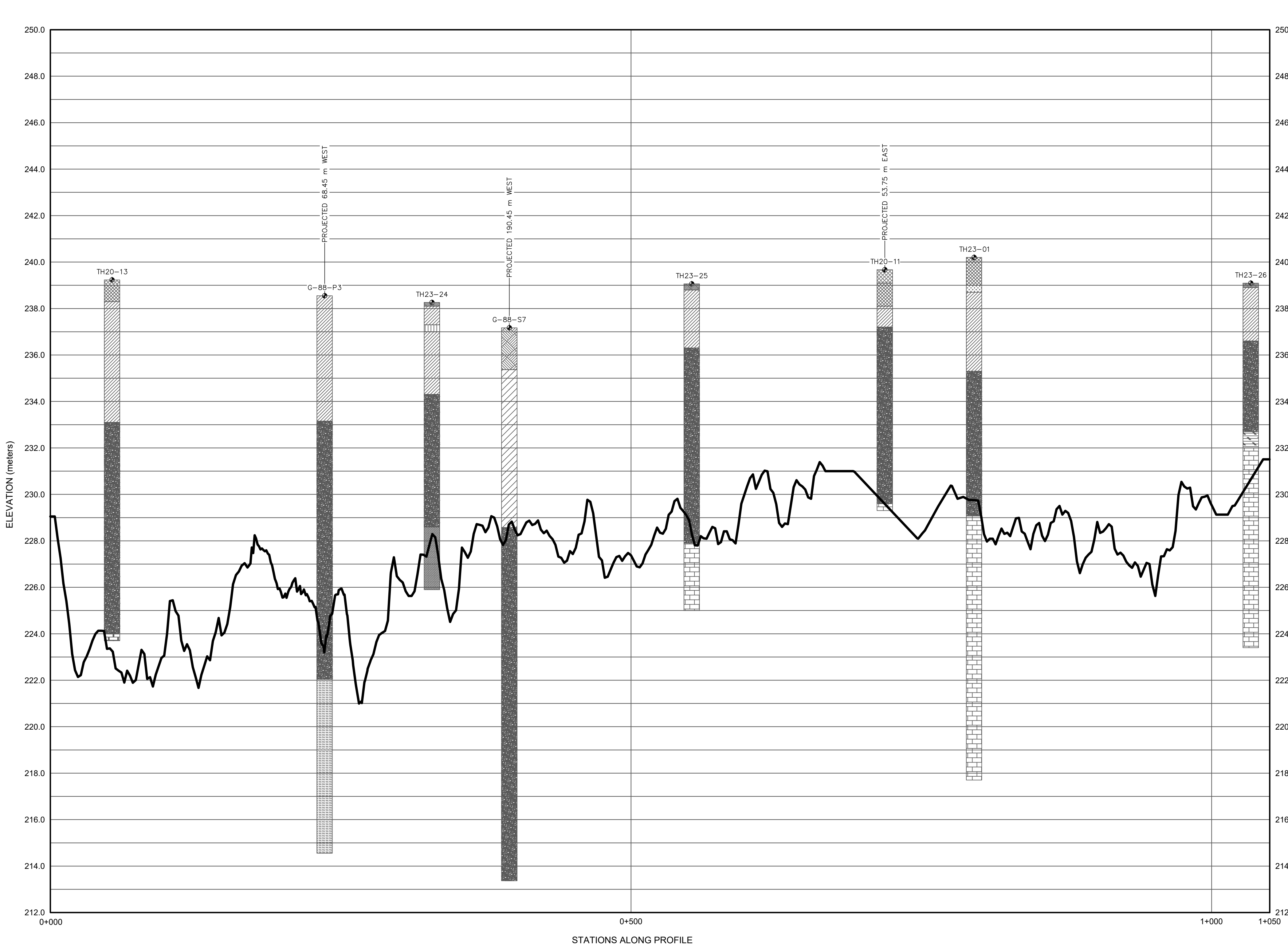
CENTREPORT SOUTH
REGIONAL WATER &
WASTEWATER SERVICING

GEOTECHNICAL DATA REPORT
FEEDER MAIN ALIGNMENT

MARCH 2024 | FIGURE 2 | REV: B

11x17



Scale

0 60 120 Meters

Horizontal Scale

Vertical Scale: 20x

Lithology Graphics

Topsoil
Clay Fill
Clay/Silty Clay
Silt Till
Granular Fill
Organic Soil
Unknown/Poor-Recovery
Jurassic/Argillaceous Limestone
Dolomite
Argillaceous Dolomite
Sand and Gravel
Organic Clay
Shale with Dolomite Beds
Asphalt
Silt
Limestone
Till Surface (See Note 2)
Bedrock Surface (See Note 2)

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CENTREPORT SOUTH
REGIONAL WATER &
WASTEWATER SERVICING

GEOTECHNICAL DATA REPORT
INTERCEPTOR ALIGNMENT

MARCH 2024 | FIGURE 3 | REV: B

FileName: U:\FMS\23-0107-009\Updated Fenline Drawings.dwg - Tab: Interceptor Plotted By: GHeinrichs 24/03/01 [Fri 8:10am]
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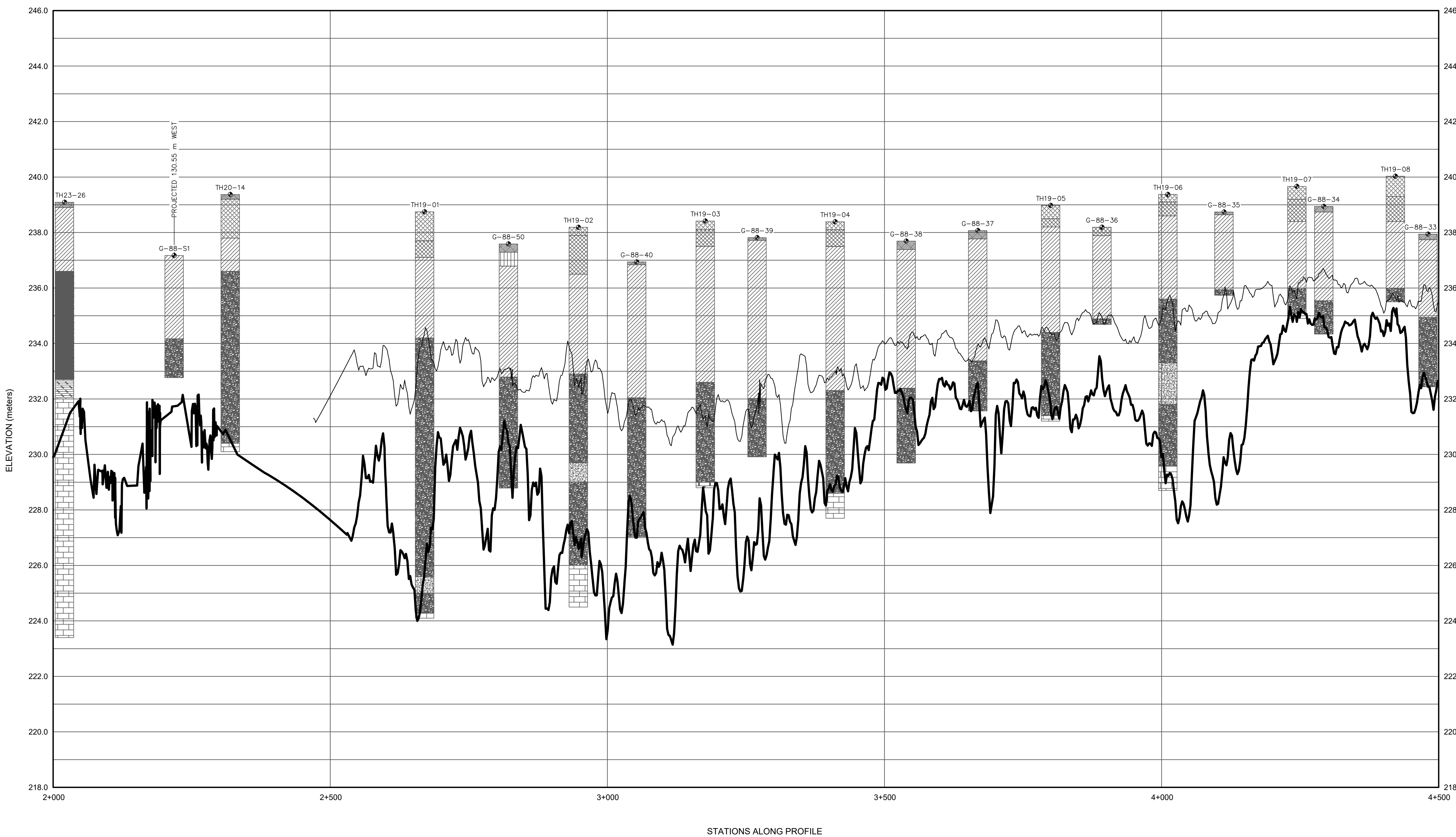
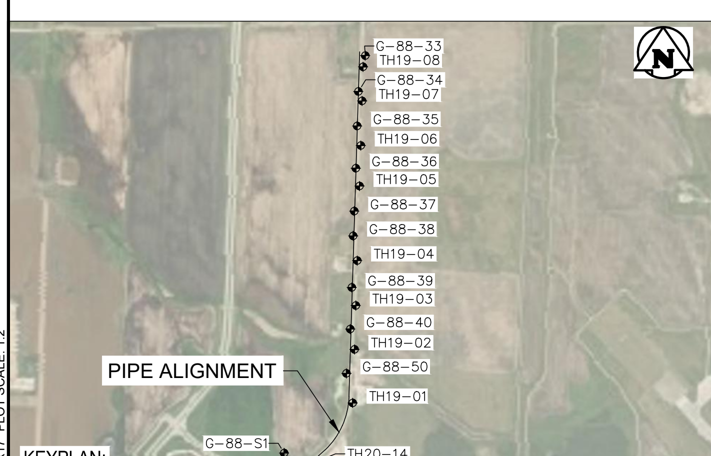
11x17





Scale

0 120 240 Meters

Horizontal Scale

Vertical Scale: 50x

Lithology Graphics

Topsoil
Clay Fill
Clay/Silty Clay
Silt Till
Granular Fill
Organic Soil
Unknown/Poor-Recovery
Jurassic/Argillaceous Limestone
Dolomite
Argillaceous Dolomite
Sand and Gravel
Organic Clay
Shale with Dolomite Beds
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Till Surface (See Note 2)
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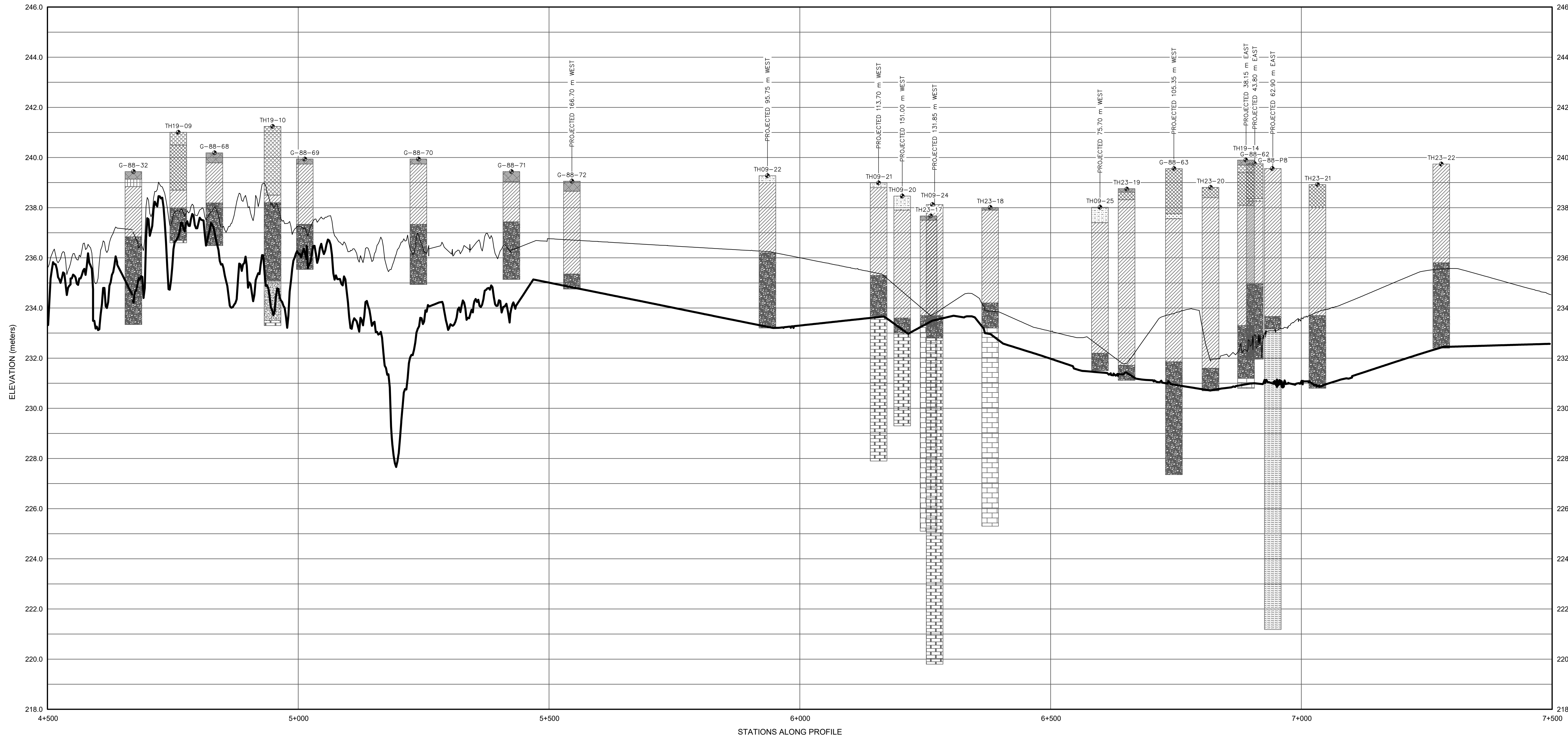
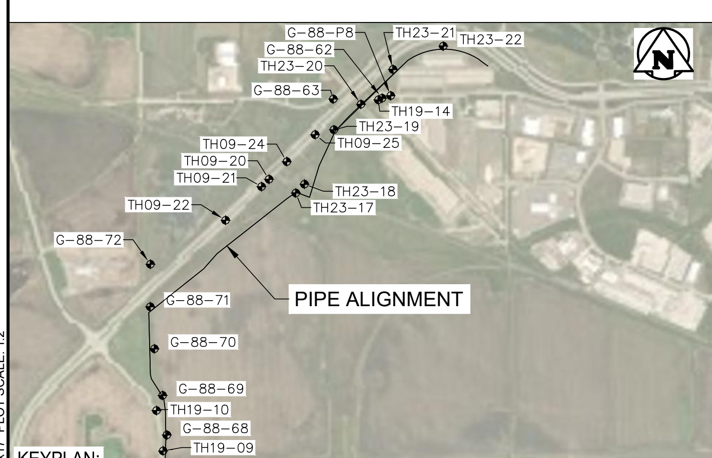
GEOTECHNICAL DATA REPORT
FORCE MAIN ALIGNMENT 01

MARCH 2024 | FIGURE 4 | REV. B





Scale

0 120 240 Meters

Horizontal Scale

Vertical Scale: 50x

Lithology Graphics

- Topsoil
- Clay Fill
- Clay/Silty Clay
- Silt Till
- Granular Fill
- Organic Soil
- Unknown/Poor-Recovery
- Jurassic/Argillaceous Limestone
- Dolomite
- Argillaceous Dolomite
- Sand and Gravel
- Organic Clay
- Shale with Dolomite Beds
- Asphalt
- Silt
- Limestone
- Till Surface (See Note 2)
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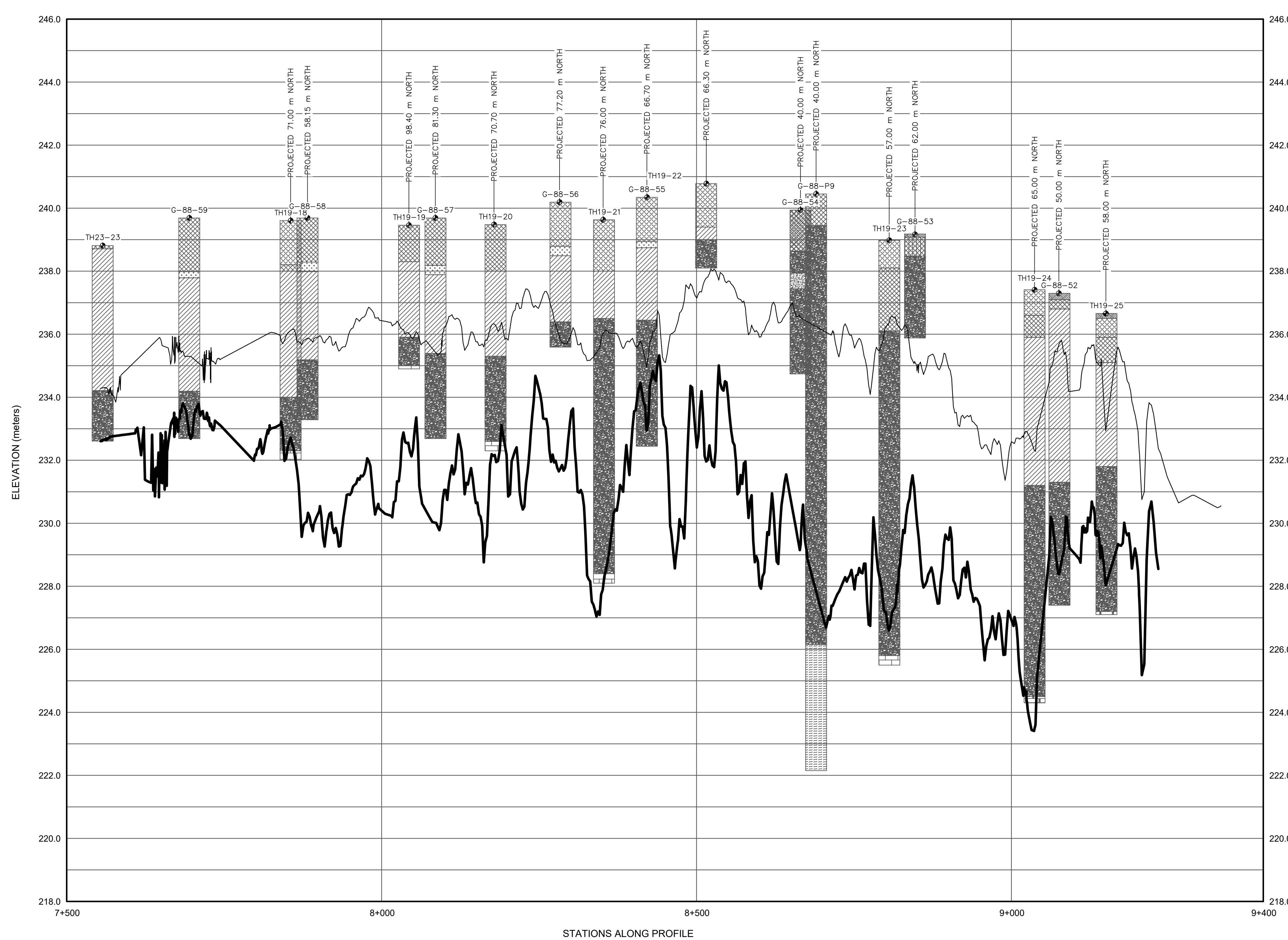
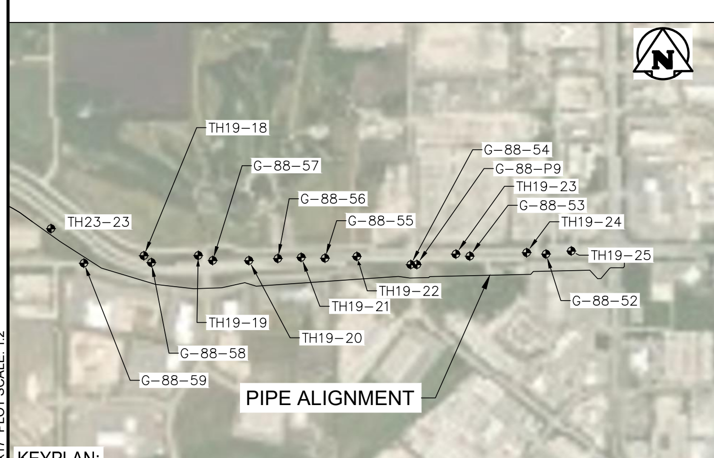
GEOTECHNICAL DATA REPORT
FORCE MAIN ALIGNMENT 02

MARCH 2024 | FIGURE 5 | REV: B





KEYPLAN:

Scale

0 120 240 Meters

Horizontal Scale

Vertical Scale: 50x

Lithology Graphics

Topsoil	Clay Fill	Clay/Silty Clay	Silt Till	Granular Fill	Organic Soil
Unknown/Poor-Recovery	Jurassic/Argillaceous Limestone	Dolomite	Argillaceous Dolomite	Sand and Gravel	Organic Clay
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REGIONAL WATER &
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GEOTECHNICAL DATA REPORT
FORCE MAIN ALIGNMENT 03

MARCH 2024 | FIGURE 6 | REV: B

APPENDIX A

2019/2020 KGS Group Preliminary Geotechnical Investigation Report

KGS GROUP

CITY OF WINNIPEG

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

Final:

Version 02

City of Winnipeg RFP No.:

289-2019

KGS Group Project:

19-0107-009

Date:

March 27, 2020

Prepared by:

____

Jacqueline MacLennan, P.Eng.
Geotechnical Engineer

Approved by:

____

Dami Adedapo, Ph.D., P.Eng.
Geotechnical Department Head/Associate Principal

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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 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, 20202. 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 developed 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 descried 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
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 Centerport 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.

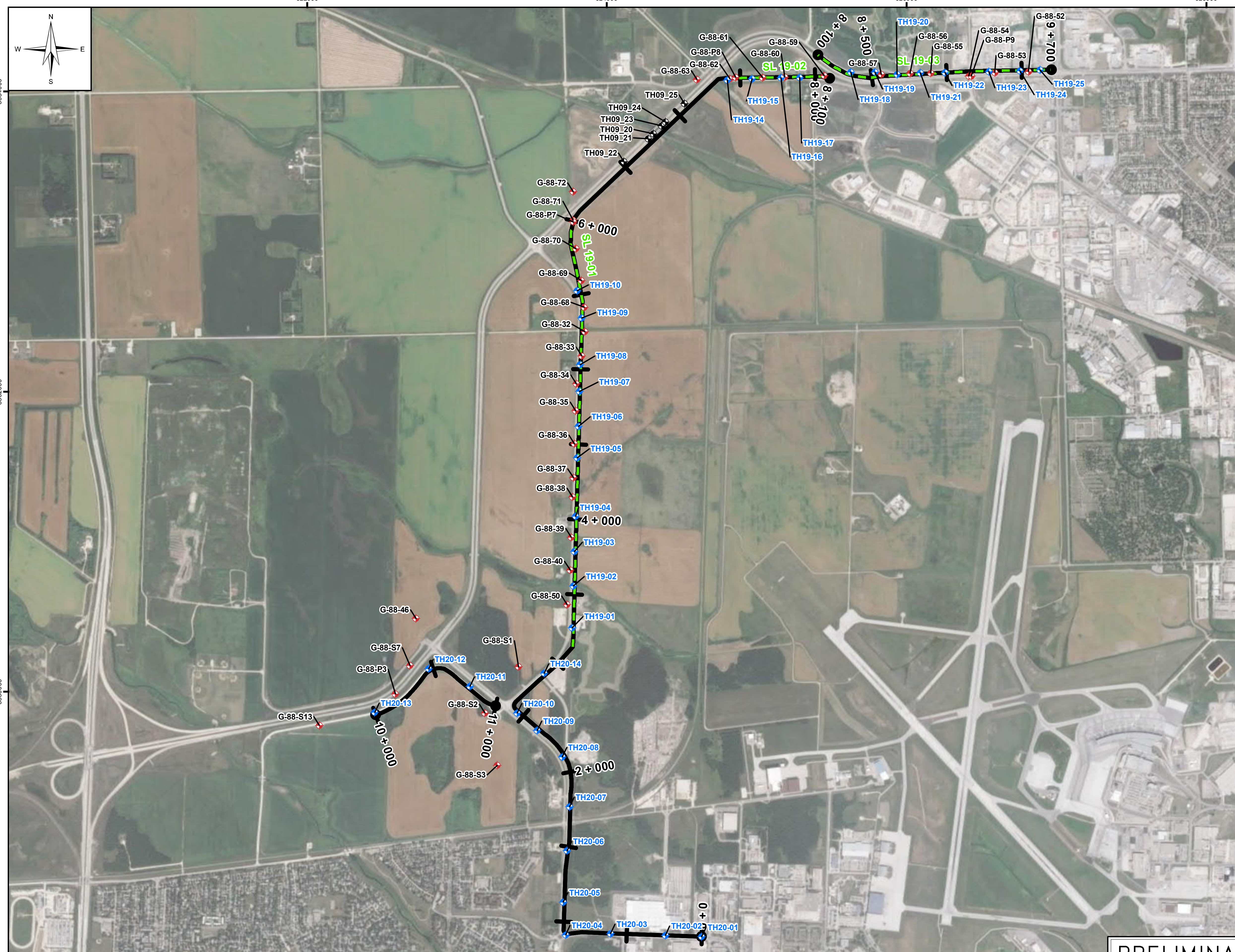
8.0 RECOMMENDATIONS

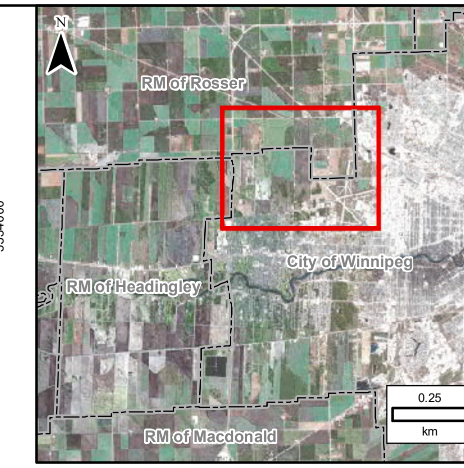
The preliminary geotechnical investigation completed for this project consisted of advancing 36 test holes using sonic drilling methods and seismic refraction along the majority of the proposed alignment. Geotechnical investigations were not completed along the portion of the alignment on CentrePort 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).

0.2 0 0.2 0.4 0.6 0.8 1
Kilometres

SCALE: 1:25,000 METRIC 11"x17"

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

KGS GROUP CONSULTING ENGINEERS

Winnipeg Embrace the spirit • Vivez l'esprit

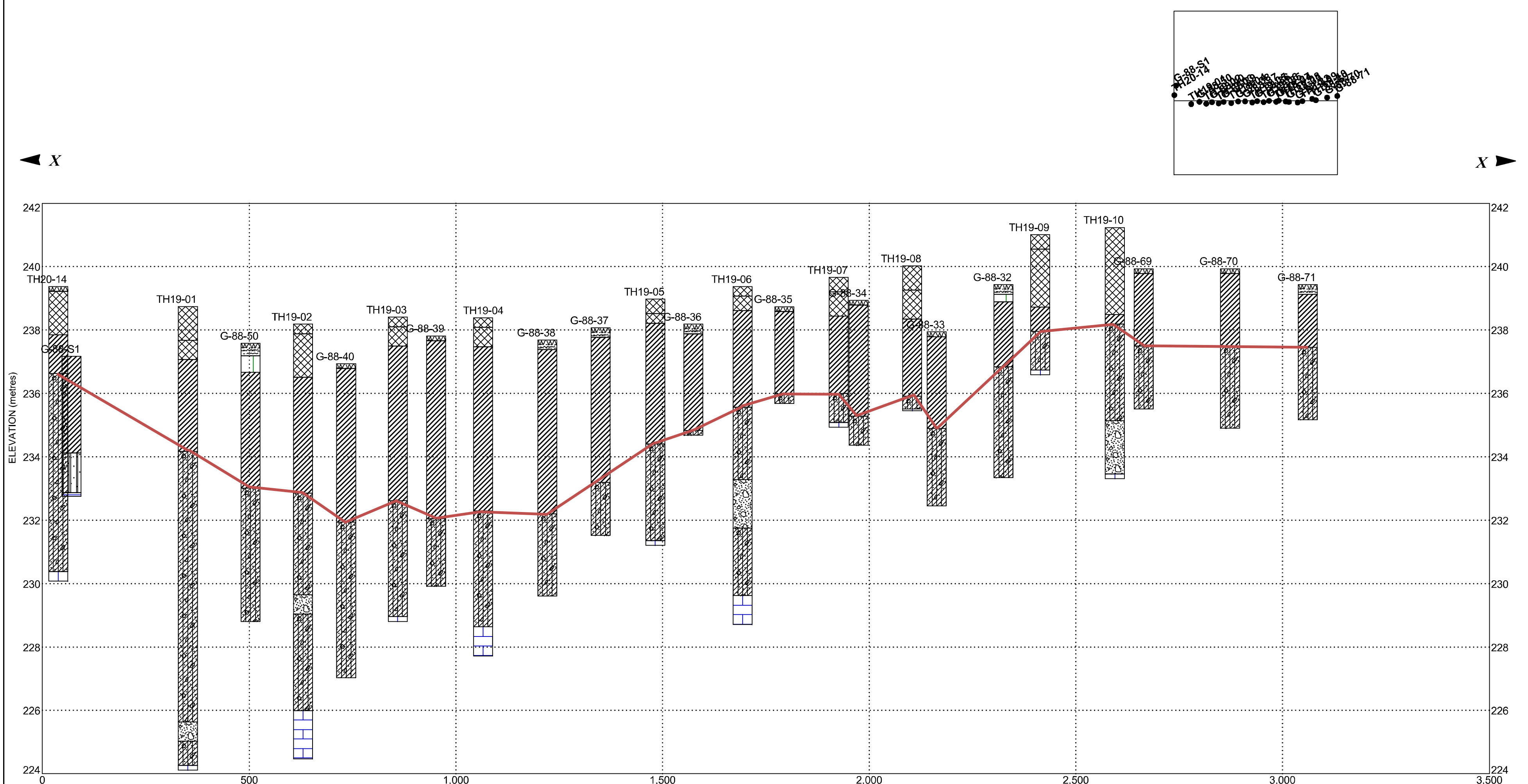
AIRPORT AREA WEST
REGIONAL WATER AND WASTEWATER
SERVICING PRELIM ENGINEERING

2019–2020 PRELIMINARY
GEOTECHNICAL INVESTIGATION REPORT

MARCH 2020 FIGURE 01 REV: 2

PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

FileName: P:\Projects\2019\19-0107-009\Dwg\GIS\MXD\Geotech\Report19-0107-009_Fig01.mxd
11"x17" PLOT SCALE 1:1



DISTANCE ALONG PROFILE (metres)

0 184
Horizontal Scale (meters)
Vertical Exaggeration: 77x

Lithology Graphics

- Topsoil
- Silt Till
- Limestone
- Inorganic silts and sandy silts of slight plasticity, rock flour
- Shale
- Inorganic clays of high plasticity, fat clays
- Fill (made ground)
- Till - mix of gravel, sand, clay and silt
- Sand and Gravel

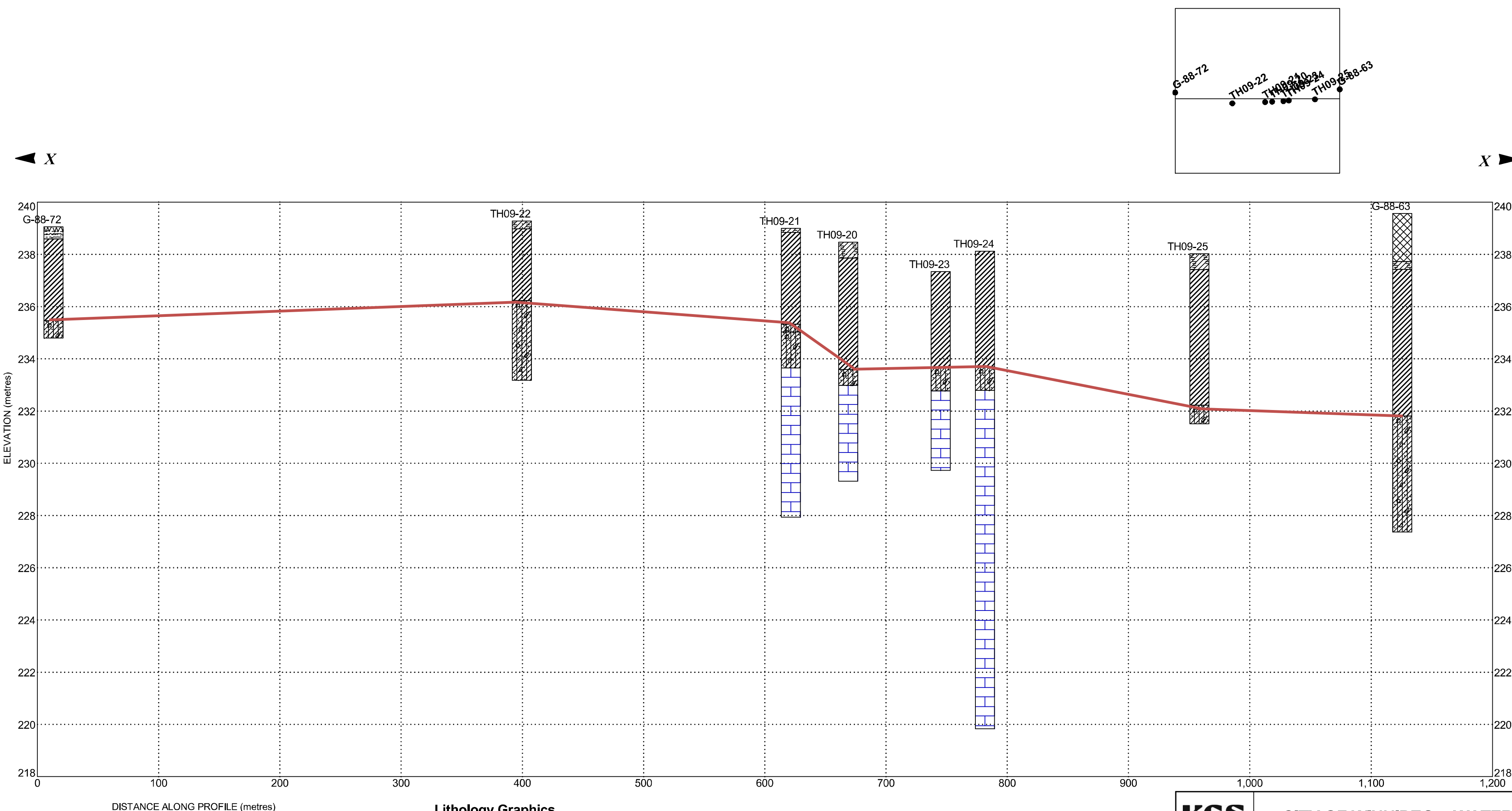
Borehole till surface, consult seismic refraction survey for data in between boreholes

Explanation

G-88-32 Borehole Number
Borehole Lithology
Water Level Reading

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

FENCE W/O WELL INSTALLATION U:\FMS\19-0107-009\19-0107-009.GPJ



0 63
Horizontal Scale (meters)
Vertical Exaggeration: 21.5x

Lithology Graphics

- Fill (made ground)
- Topsoil
- Organic clay of high plasticity
- Limestone
- Inorganic clays of high plasticity, fat clays
- Till - mix of gravel, sand, clay and silt

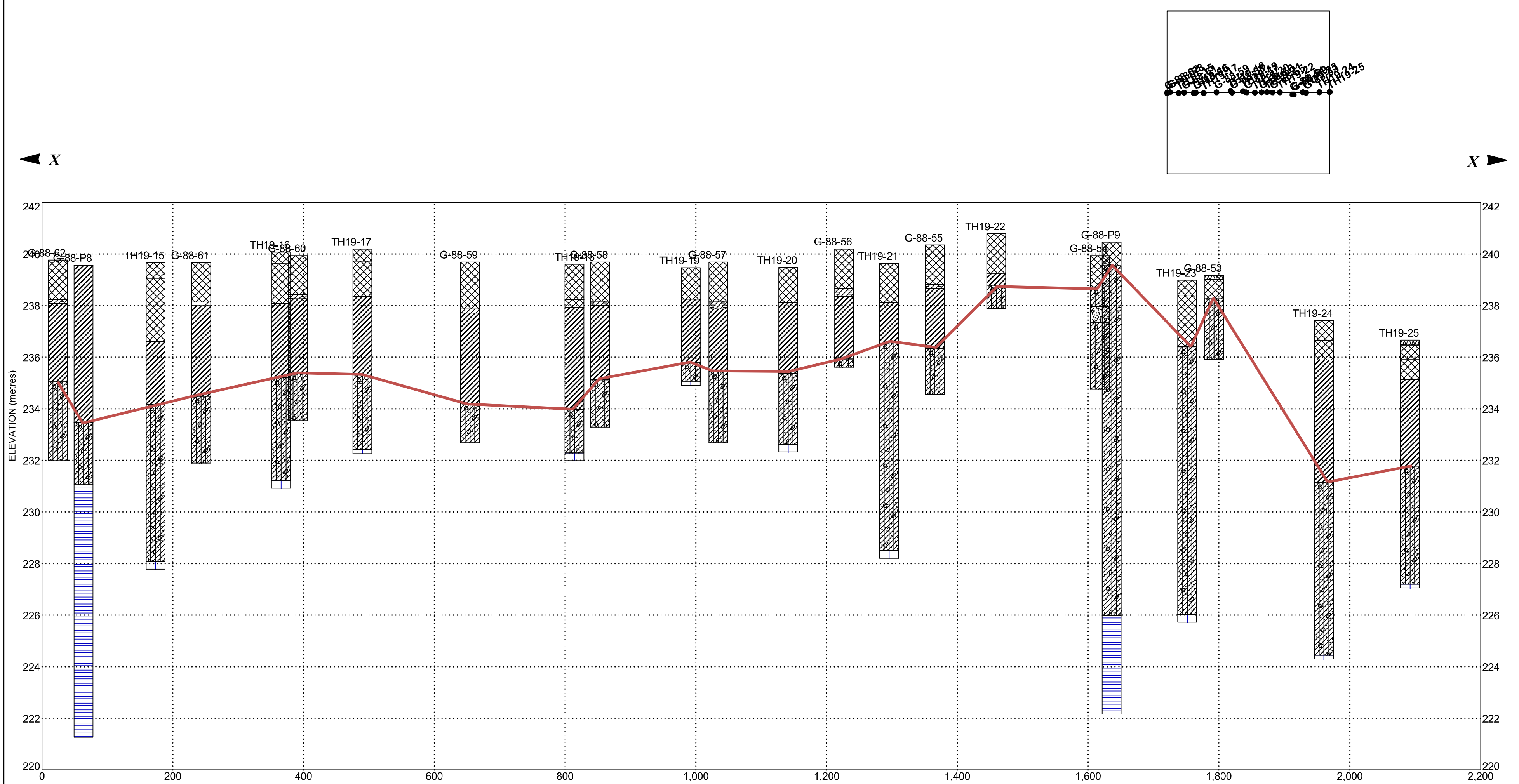
Borehole till surface, consult seismic refraction survey for data in between boreholes

Explanation

G-88-63 Borehole Number
Borehole Lithology
Water Level Reading

KGS GROUP	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering
	Figure 3: Centreport

Mar 2020	**SW to NE**	**Rev 00**



Lithology Graphics

- Topsoil
- Fill (made ground)
- Till - mix of gravel, sand, clay and silt
- Sand and Gravel
- Organic clay of high plasticity
- Inorganic clays of high plasticity, fat clays
- Organic low plasticity silty clay
- Shale
- Limestone

Borehole till surface, consult seismic refraction survey for data in between borehole

Explanation

G-88-53 Borehole Number

Borehole Lithology

Water Level Reading

KGS GROUP

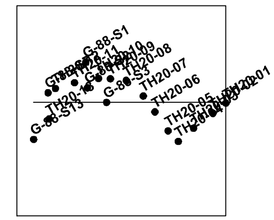
CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

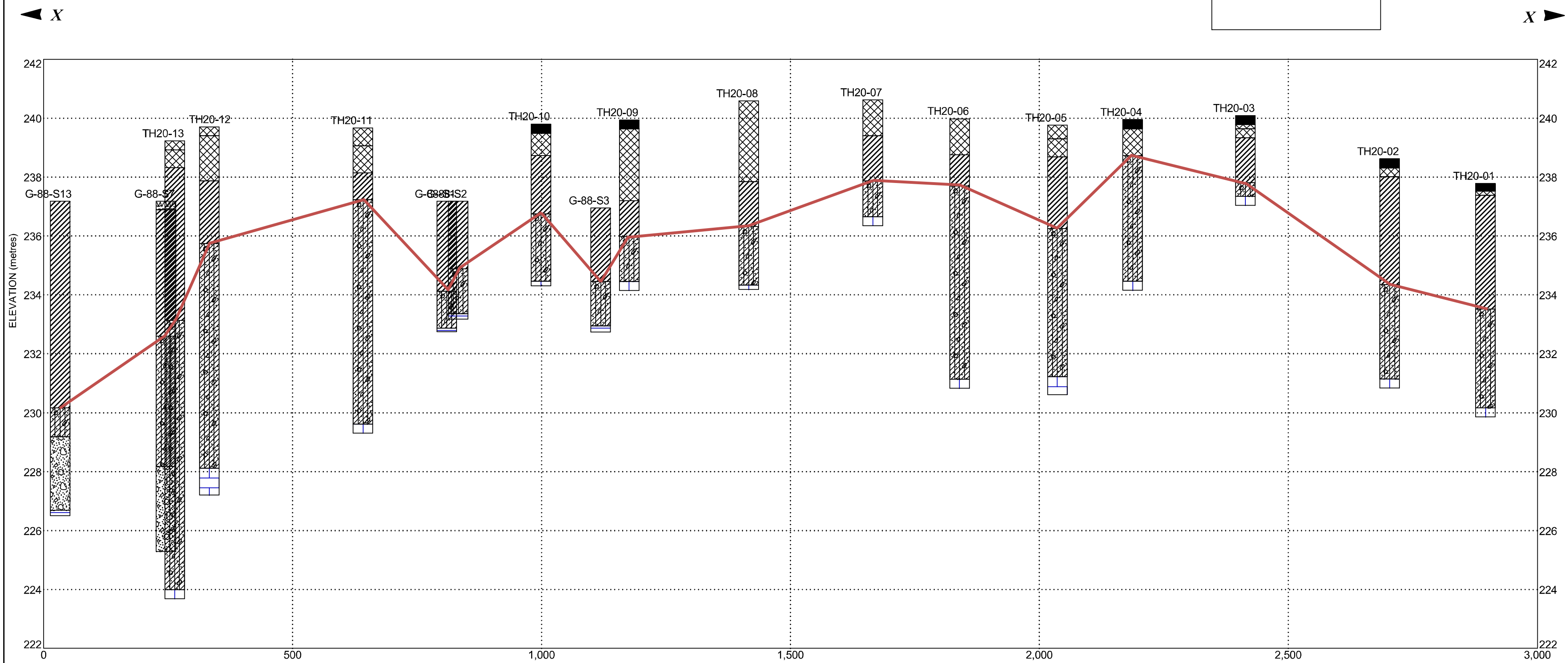
Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering

Figure 4: Inkster

Mar 2020	W to E	Rev 00

FENCE W/O WELL INSTALLATION U:\FMS\19-0107-009\19-0107-009.GPJ





DISTANCE ALONG PROFILE (metres)

0 158

Horizontal Scale (meters)

Vertical Exaggeration: 59x

Lithology Graphics

- Inorganic clays of high plasticity, fat clays
- Till - mix of gravel, sand, clay and silt
- Shale
- Sand and Gravel
- Topsoil
- Asphalt
- Fill (made ground)
- Limestone

Borehole till surface, consult seismic refraction survey for data in between boreholes

Explanation

G-88-S1 — Borehole Number

Borehole Lithology

Water Level Reading

KGS GROUP

CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering

Figure 5: South Sturgeon Road

Mar 2020	**NW to SE**	**Rev 00**

FENCE W/O WELL INSTALLATION U:\FMS\19-0107-009\19-0107-009.GPJ

APPENDIX A

1988 Test Hole Logs

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-32
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0698-266-01
PROJECT ENGINEER: TW		ELEVATION 239.940 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			SILT-DRY, TAN				
1.0			CLAY-SOME SILT -SOME TILL INCLUSIONS -BROWN -FIRM				
2.0							5.0
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			-WATER SEEPAGE				
			AUGER REFUSAL @ 6.09 NOTE: APPROX.1.6 OF WATER IN THE HOLE IN 5 MIN. NO SLOUGHING				20.0
7.0							
8.0							25.0
9.0							
10.0							30.0
11.0							35.0
12.0							
13.0							40.0
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO.

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-33
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0698-266-01
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/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY–SOME SILT –SOME TILL INCLUSIONS (MORE WITH DEPTH) –BROWN TO DARK BROWN –STIFF				
1.0							
2.0							5.0
3.0							10.0
			TILL–WITH SILT –SOME GRANULAR (SAND TO BOULDERS) –GREY –RED BROWN LIMESTONE (WATER BEARING) (SAME RED BROWN LIMESTONE TO REFUSAL)				
4.0							
5.0							15.0
			AUGER REFUSAL @ 5.54 NOTE: WATER ROSE APPROX. 2.1 IN 5 MIN NO SLOUGHING				
6.0							20.0
7.0							
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE
	LOGGED BY TH	DWG NO.	Page 1 of 1

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-SOME SILT -BROWN -FIRM				
2.0			-BROWN TO GRAY -SOME TILL INCLUSIONS -LITTLE SILT				5.0
3.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -SOME CLAY -TAN				10.0
5.0			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				15.0

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO. / Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-35
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0699-266-01
PROJECT ENGINEER: TW		ELEVATION 236.690 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-SOME SILT -SOME TILL INCLUSIONS -BROWN -FIRM TO STIFF				
3.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -SOME CLAY -TAN				10.0
			AUGER REFUSAL @ 3.05 ON ROCK NOTE: NO SLOUGHING NO WATER				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO. — Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-38
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0895-268-01
PROJECT ENGINEER: TW		ELEVATION 236.170 (m)

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

DEPTH (m) | ▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 | ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 | PLASTIC M.C LIQUID 40 80 120 160 | USC | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | Other comments | DEPTH (ft)

Depth (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

TOPSOIL

CLAY–SOME SILT
–LITTLE TILL INCLUSIONS
(MORE WITH DEPTH)
–BROWN
–STIFF

TILL–SILT WITH GRANULAR (SAND TO BOULDERS)
–GREY

AUGER REFUSAL @ 3.51
NOTE: NO WATER
NO SLOUGHING

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE
	LOGGED BY TH	DWG NO.	Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-37
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 237.950 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY–SOME SILT –LITTLE TILL INCLUSIONS –BROWN –STIFF				
5.0			TILL–SILT WITH GRANULAR (SAND TO BOULDERS) –LITTLE CLAY –TAN/GREY –WATER SEEPAGE				
			AUGER REFUSAL @ 6.55 NOTE: WATER APPROX. 1 M IN HOLE IN APPROX. 5 MIN. NO SLOUGHING				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE	
	LOGGED BY TH	DWG NO.		Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-38
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0899-266-01
PROJECT ENGINEER: TW		ELEVATION 237.830 (m)

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

Column headings: DEPTH (m) | ▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 40 80 120 160 | USC | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | Other comments | DEPTH (ft)

Depth (m)	SOIL DESCRIPTION
0.0	TOPSOIL
	CLAY–SOME SILT –BROWN –STIFF
	–TRANSITION TO GREY CLAY
	TILL–SILT WITH GRANULAR (SAND TO BOULDERS) –WET TO PAT TEST –TR CLAY –SMALL WATER BEARING LAYER @ 5.50
	–WATER SEEPAGE (FROM 7.6 TO 7.9) –WATER BEARING LAYER (7.62 TO 7.93)
	AUGER REFUSAL @ 8.08 NOTE: WATER ROSE APPROX.1.0 IN HOLE 5 MIN. NO SLOUGHING

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO.
		Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-98-39
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-266-01
PROJECT ENGINEER: TW		ELEVATION 237.740 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
0.0–5.7			CLAY-SOME CLAY -BROWN -SOME TILL INCLUSIONS -STIFF				
5.7–7.9			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -DAMP -TAN/GREY -WATER SEEPAGE				
7.93			AUGER REFUSAL @ 7.93 NOTE: TRACE OF WATER IN HOLE NO SLOUGHING				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
	LOGGED BY TH	DWG NO.	Page 1 of 1

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-40
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0898-266-01
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/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY—SOME SILT —BROWN —TR TILL INCLUSIONS (MORE WITH DEPTH) —STIFF				
1.0							
2.0							5.0
3.0			—TRANSITION TO GREY CLAY				10.0
4.0							
5.0			TILL—SILT WITH GRANULAR (SAND TO BOULDERS) —TR CLAY —WET TO PAT TEST —TAN —DENSE				15.0
6.0							20.0
7.0							
8.0							25.0
9.0							30.0
10.0			—WATER SEEPAGE AUGER REFUSAL @ 9.91 NOTE: TR WATER IN HOLE NO SLOUGHING				
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO.

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-46
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0895-288-01
PROJECT ENGINEER: TW		ELEVATION 236.150 (m)

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

DEPTH (m)	▲ BULK DENSITY (L/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY–SOME SILT –TILL INCLUSIONS –BROWN –STIFF				
			TILL–SILT WITH GRANULAR (SAND TO BOULDERS) –TAN\GREY –DAMP –LAYER OF BOULDERS 5.49 TO 6.71 –TILL BECOMING MORE SANDY AND DRIER –DENSE				
			AUGER REFUSAL @ 8.23 NOTE: WATER SEEPAGE FROM UPPER PART OF TILL LAYER SOME SLOUGHING FROM 5.5 TO 7.3				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-50
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0626-266-01
PROJECT ENGINEER. TW		ELEVATION 237.770 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			SILT-LITTLE CLAY -DRY -TAN				
1.0			CLAY-SOME SILT -BROWN -STIFF				5.0
2.0 – 4.0							10.0
5.0			TILL-SILT WITH SAND AND GRAVEL -SOME COBBLES AND BOULDERS -SOME WATER SEEPAGE -TR CLAY -GREY -SANDY LAYER (DRIER THAN ABOVE)				15.0 / 20.0
7.0			-BECOMING MORE DENSE				25.0
9.0			AUGER REFUSAL @ 8.64 NOTE: SOME SLOUGHING IN UPPER PART OF TILL LAYER SOME WATER SEEPAGE IN UPPER PART OF TILL LAYER				30.0
10.0 – 14.0							35.0 / 40.0 / 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO.

NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-52
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-286-01
PROJECT ENGINEER. TW		ELEVATION 237.170 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			FILL-CLAY -SILT -SOME FI GRAVEL -BROWN				
			CLAY-ORGANIC (ROOTS) -BLACK				5.0
			CLAY-SOME SILT -BROWN -STIFF -TILL INCLUSIONS -SOME COBBLES				
			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -LITTLE CLAY -DAMP -TAN				
10.0			AUGER REFUSAL @ 9.91 NOTE: NO SLOUGHING NO WATER SEEPAGE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0
Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-53
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 239.010 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			FILL-MIXTURE OF CLAY AND SILT -CONCRETE AND ASPHALT				
1.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -DAMP -TAN				5.0
2.0							
3.0							10.0
			AUGER REFUSAL @ 3.28 NOTE: NO SLOUGHING NO SEEPAGE				
4.0							15.0
5.0							
6.0							20.0
7.0							25.0
8.0							
9.0							30.0
10.0							35.0
11.0							
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-54
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0639-268-01
PROJECT ENGINEER: TW		ELEVATION 240.700 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
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			AUGER REFUSAL @ 5.18 NOTE: NO SLOUGHING NO SEEPAGE				
6.0							20.0
7.0							25.0
8.0							
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd.	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-55
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0899-286-01
PROJECT ENGINEER: TW		ELEVATION 240.660 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0–1.4		FILL–CLAY WITH GRANULAR –LITTLE ASPHALT AND CONC –TR ORGANICS –DK BROWN				0.0
1.4–1.6		LAYER OF BLACK ORGANICS				5.0
1.6–4.0		CLAY–WITH SILT –BROWN –STIFF –WITH TILL INCLUSIONS (MORE WITH DEPTH)				10.0
4.0–7.93		TILL–SILT WITH GRANULAR –WATER SEEPAGE –TAN –SOME COBBLES AND BOULDERS –REDDISH LIMESTONE –WATER SEEPAGE –BECOMING MORE DENSE				15.0 20.0 25.0
7.93		AUGER REFUSAL @ 7.93 NOTE: NO SLOUGHING SOME WATER SEEPAGE @ 5.79				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0
Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-56
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0688-266-01
PROJECT ENGINEER: TW		ELEVATION 240.100 (m)

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

DEPTH (m) | ▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 | ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 | PLASTIC M.C. LIQUID 40 80 120 160 | USC | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | Other comments | DEPTH (ft)

FILL–GRANULAR WITH CLAY AND SILT
–TR ASPHALT
–TR BOARDS/CONST MATERIALS

LAYER BLACK OGANICS MIXED WITH CLAY

CLAY–WITH SILT
–BROWN
–STIFF
–TILL INCLUSIONS
(MORE WITH DEPTH)

TILL–SILT WITH GRANULAR
–WATER SEEPAGE
–GREY
–REDDISH LIMESTONE
–DENSE

AUGER REFUSAL @ 4.57
NOTE: NO SLOUGHING
SOME WATER SEEPAGE

Depth (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd.
Winnipeg, Manitoba

COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-57
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 239.720 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			FILL–CLAY –SOME GRANULAR AND SILT –BROWN				0.0
1.5			LAYER BLACK ORGANIC CLAY				5.0
1.9			CLAY–WITH SILT –BROWN –STIFF –TILL INCLUSIONS (MORE WITH DEPTH)				10.0
4.3			TILL–SILT WITH GRANULAR (SAND TO BOULDERS) –GREY –TR WATER SEEPAGE –TILL BECOMING MORE DENSE –DRIER –REDDISH LIMESTONE				15.0 / 20.0
7.0			AUGER REFUSAL @ 7.01 NOTE: NO SLOUGHING TR WATER SEEPAGE				25.0

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0
Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd.	COMPLETION DEPTH *.* m		COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-58
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 239.780 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 1.5			FILL–CLAY AND SILT –SOME GRANULAR –TR ASPHALT AND CONC –BROWN				0.0
1.5			LAYER OF BLACK ORGANIC CLAY				5.0
1.8 – 4.6			CLAY–WITH SILT –BROWN –STIFF –TILL INCLUSIONS (MORE WITH DEPTH)				10.0
4.6 – 6.4			TILL–SILT WITH GRANULAR –GREY –TR CLAY –WATER SEEPAGE –BECOMING DRIER AND MORE DENSE				15.0 / 20.0
6.4			AUGER REFUSAL @ 6.40 NOTE: NO SLOUGHING SOME WATER SEEPAGE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

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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 239.750 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TILL-CLAY WITH GRANULAR -SOME SILT -TR ASPHALT AND CONC -BROWN				0.0
1.0							5.0
2.0			LAYER BLACK ORGANIC CLAY				
			CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)				
3.0							10.0
4.0							
5.0							15.0
6.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -TR CLAY -TR WATER SEEPAGE -GREY -WATER SEEPAGE				20.0
7.0			AUGER REFUSAL @ 7.01 NOTE: NO SLOUGHING WATER SEEPAGE FROM LAYER @ 6.09				
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-60
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 240.000 (m)

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

DEPTH (m)	BULK DENSITY (t/m3) 1.4 1.8 2.2 2.6 / SHEAR STRENGTH (kPa) 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			FILL-CLAY -SOME GRANULAR -BROWN				0.0
1.0							5.0
2.0			LAYER BLACK CLAY MIXED WITH ORGANICS CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS (MORE WITH DEPTH)				
3.0							10.0
4.0							
5.0			TILL-SANDY -SOME SILT -TR WATER SEEPAGE -LAYERED (SAND AND SILT) -TR CLAY -SOME GRANULAR AND COBBLES -DENSER THAN ABOVE -WATER SEEPAGE				15.0
6.0							20.0
7.0			AUGER REFUSAL @ 6.40 NOTE: NO SLOUGHING SOME WATER SEEPAGE				
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-98-61
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0699-266-01
PROJECT ENGINEER: TW		ELEVATION 239.700 (m)

SAMPLE TYPE: GRAB SAMPLE | SHELBY TUBE | DISTURBED | NO RECOVERY | CORE BARREL | PIPELINE-TYPE

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			FILL-CLAY AND SILT -SOME GRANULAR -BROWN				0.0
1.0							
			LAYER BLACK CLAY AND ORGANICS				5.0
2.0			CLAY-WITH SILT -BROWN -STIFF				
3.0							10.0
4.0			-TRANSITION TO GREY CLAY -TILL INCLUSIONS (MORE WITH DEPTH)				15.0
5.0			TILL-SANDY SILT -SOME GRANULAR -TR CLAY -WATER SEEPAGE				
6.0							20.0
7.0			-COBBLES AND BOULDERS				25.0
8.0			AUGER REFUSAL @ 7.77 NOTE: HOLE STARTING TO SLOUGH WATER IN HOLE				
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-62
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 239.390 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 1.4			FILL—CLAY AND SILT —SOME GRANULAR —BROWN				0.0
1.4 – 4.8			LAYER BLACK CLAY WITH ORGANICS CLAY—SOME SILT —BROWN —STIFF —TILL INCLUSIONS (MORE WITH DEPTH) —TILL POCKETS TO .3 DIA				5.0, 10.0, 15.0
4.8 – 7.77			TILL—SANDY SILT —SOME GRANULAR —WATER SEEPAGE IN THE SANDY TILL —MORE WATER SEEPAGE WITH DEPTH				20.0, 25.0
7.77			AUGER REFUSAL @ 7.77 NOTE: WATER IN HOLE NO SLOUGHING				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0
Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE	
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-63
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0898-286-01
PROJECT ENGINEER: TW		ELEVATION 239.620 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 1.8		FILL–CLAY AND SILT –SOME GRANULAR –BROWN				0.0
1.8 – 2.4		LAYER OF BLACK ORGANIC MATERIAL –ROOTS				5.0
2.4 – 7.8		CLAY–SOME SILT –BROWN –STIFF –TILL INCLUSIONS –TRANSITION TO GRAY CLAY –TILL INCLUSIONS –FIRM –BECOMING SOFTER WITH DEPTH				10.0, 15.0, 20.0, 25.0
7.8 – 12.2		TILL–SILT WITH CLAY –SOME GRANULAR –TR COBBLES –GREY –TAN/YELLOW LIMESTONE –GRANULAR GREENISH COLOR				30.0, 35.0, 40.0
12.2		END OF HOLE @ 12.20 IN GREY TILL NOTE: NO SLOUGHING TR WATER SEEPAGE				45.0

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 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-88-68
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0898-266-01
PROJECT ENGINEER: TW		ELEVATION 240.240 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C. LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-SOME SILT -BROWN -STIFF -SMALL TILL INCLUSIONS				
			TILL-SILT WITH GRANULAR -SOME CLAY -SOME COBBLES AND BOULDERS -WET TO PAT TEST -TAN				
			AUGER REFUSAL @ 3.65 NOTE: NO SLOUGHING NO WATER SEEPAGE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-69
GENSTAR DEVELOPMENTS LTD.		Project No: 08 -0898-288-01
PROJECT ENGINEER: TW		ELEVATION 240.050 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-AND SILT -SOME GRANULAR -TILL INCLUSIONS -DRY -BROWN				5.0
			TILL-SILT WITH GRANULAR -SOME COBBLES -DENSE -TAN -LIMESTONE BECOMING YELLOW				10.0
			AUGER REFUSAL @ 4.42 NOTE: NO SLOUGHING TR WATER ON AUGER TIP				15.0
1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0							20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-70
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER: TW		ELEVATION 240.000 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (KPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-AND SILT -MIX WITH TILL -DRY -LT BROWN				
1.0							
			CLAY-SOME SILT -BROWN -STIFF -TILL INCLUSIONS				5.0
2.0							
3.0			TILL-SILT WITH GRANULAR -SOME CLAY -SOME COBBLES AND BOULDERS -DAMP				10.0
4.0							
5.0			-SAND LAYER				15.0
			AUGER REFUSAL @ 5.03 NOTE: COBBLES AND BOULDERS SLOUGHED MAKING AUGER WITHDRAWAL DIFF TR WATER ON TIP OF AUGER				
6.0							20.0
7.0							
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-71
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-268-01
PROJECT ENGINEER: TW		ELEVATION 239.530 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY–SOME SILT –BROWN –STIFF –TILL INCLUSIONS				
			TILL–SILT WITH CLAY –SOME GRANULAR –TAN –DAMP TO WET (BECOMING WETTER WITH DEPTH) –BECOMING SOFTER (PUTTY LIKE)				
			AUGER REFUSAL @ 4.27 NOTE: NO SLOUGHING TR WATER ON AUGER TIP				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	SUBTERRANEAN LTD.	BOREHOLE No. G-88-72
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-266-01
PROJECT ENGINEER: TW		ELEVATION 239.120 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			TOPSOIL				0.0
			CLAY-WITH SILT -BROWN -STIFF -TILL INCLUSIONS				
			TILL-SILT WITH GRANULAR -SOME CLAY -SOFTER (PUTTY LIKE)				
			AUGER REFUSAL @ 4.27 NOTE: NO SLOUGHING NO WATER SEEPAGE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-68-S1
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0698-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-BROWN				0.0
3.0			TILL-SILT WITH GRANULAR				10.0
			SHALE-DOLOMITE,RED-PURPLE, HARD, BUFF				15.0
			END OF HOLE @ 4.42 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S2
GENSTAR DEVELOPMENTS LTD.		Project No: 06-0899-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C. LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		CLAY-WITH PEBBLES AND STONES				0.0
2.3		TILL-SILT				
3.9		SHALE-DOLOMITE END OF HOLE @ 3.99 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-68-S3
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER. TW		ELEVATION 236.950 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-WITH TILL INCLUSIONS				0.0
2.4			TILL-SILT WITH GRANULAR				
4.0			SHALE-DOLOMITE				
			END OF HOLE @ 4.20 IN SHALE				

Depth (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S7
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6

■ SHEAR STRENGTH (kPa) ■ 100 200 300 400

PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		TOPSOIL				0.0
1.0		CLAY-WITH TILL POCKETS -SOME GRANULAR				
2.0						5.0
3.0						10.0
4.0		TILL-SILT WITH GRANULAR				
5.0						15.0
6.0						20.0
7.0						
8.0						25.0
9.0		GRAVEL-LITTLE WATER				30.0
10.0						
11.0						35.0
12.0		END OF HOLE @ 11.89 IN GRAVEL				40.0
13.0						
14.0						45.0
15.0						50.0
16.0						
17.0						55.0
18.0						60.0
19.0						
20.0						65.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S13
GENSTAR DEVELOPMENTS LTD.		Project No: 06-0696-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		CLAY-BROWN				0.0
7.2		TILL-SILT				
8.1		GRAVEL				
10.5		SHALE-DOLOMITE				
		END OF HOLE @ 10.67 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0
Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-P3
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-386-01
PROJECT ENGINEER: TW		ELEVATION 236.550 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-BROWN			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0							
2.0							5.0
3.0							10.0
4.0							
5.0			-TILL POCKETS				15.0
6.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS) -GRAVEL (6.21 - 9.15) LOST DRILL WATER INTO GRAVEL (NO RETURN)			▼ W/L 232.435 IN TILL PIEZOMETER -232.00 PIEZOMETER TIP ▼ W/L 231.315 IN BEDROCK WELL	20.0
7.0							
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0
15.0						NOTE: WATER LEVELS AS OF NOV 30 \ 88	50.0
16.0							
17.0			SHALE-WITH THIN DOLOMITE BEDS -PURPLE -SOFT -SANDY				55.0
18.0						-220.56 BOT WELL CASING	
19.0							60.0
20.0							65.0
21.0							
22.0							70.0
23.0							75.0
24.0							
25.0							80.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-P8
GENSTAR DEVELOPMENTS LTD.		Project No: 08-0898-266-01
PROJECT ENGINEER: TW		ELEVATION 240.470 (m)

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

DEPTH (m) | BULK DENSITY (t/m3) 1.4 1.8 2.2 2.6 | SHEAR STRENGTH (kPa) 100 200 300 400 | PLASTIC M.C LIQUID 40 80 120 160 | USC | SOIL DESCRIPTION | SAMPLE TYPE | SAMPLE NO | Other comments | DEPTH (ft)

Depth (m)	Soil Description	Other comments
0.0	CLAY-BROWN	PIEZOMETER AND BEDROCK WELL DETAILS
5.0		W\L 235.68 IN BEDROCK WELL
6.0	TILL-SILT WITH GRANULAR (SAND TO BOULDERS)	W\L 234.06 IN TILL PIEZOMETER
		-232.85 PIEZOMETER TIP
		-232.09 BOT WELL CASING
8.6	SHALE-RED BROWN -DOLOMITE LAYERS -SOFT	
		NOTE: WATER LEVELS AS OF NOV 30\88
18.29	END OF HOLE @ 18.29 IN SHALE	

Depth scale (m): 0.0 – 25.0; Depth scale (ft): 0.0 – 80.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-P9
GENSTAR DEVELOPMENTS LTD.		Project No: 0e -0899-286-01
PROJECT ENGINEER: TW		ELEVATION 239.540 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-FILL			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
1.0			TILL-SILT WITH GRANULAR (SAND TO BOULDERS)				
2.0							5.0
3.0							10.0
4.0							
5.0							15.0
6.0							
7.0						▼ W/L 233.195 IN TILL PIEZOMETER	20.0
8.0							25.0
9.0			-DENSE FINE TILL TO 9.76				
10.0						-229.75 PIEZOMETER TIP	30.0
11.0							35.0
12.0			-GRANITIC COBBLES			▼ W/L 227.832 IN BEDROCK WELL	
13.0							40.0
14.0						-225.22 BOT WELL CASING	45.0
15.0			SHALE-DOLOMITE LAYERS -SOFT			NOTE: WATER LEVELS AS OF NOV. 30\88	
16.0							50.0
17.0							55.0
18.0							
18.0			END OF HOLE @ 18.29 IN SHALE				60.0
20.0							65.0
21.0							
22.0							70.0
23.0							75.0
24.0							
25.0							80.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-68-S1
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0609-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0		CLAY-BROWN				0.0
3.0		TILL-SILT WITH GRANULAR				10.0
4.0		SHALE-DOLOMITE, RED-PURPLE, HARD, BUFF				15.0
		END OF HOLE @ 4.42 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S2
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-266-01
PROJECT ENGINEER. TW		ELEVATION 237.170 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-WITH PEBBLES AND STONES				0.0
2.3			TILL-SILT				
4.0			SHALE-DOLOMITE				
			END OF HOLE @ 3.99 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-68-S3
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0696-266-01
PROJECT ENGINEER. TW		ELEVATION 236.950 (m)

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

DEPTH (m)	▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6 / ■ SHEAR STRENGTH (kPa) ■ 100 200 300 400 / PLASTIC M.C LIQUID 40 80 120 160	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0			CLAY-WITH TILL INCLUSIONS				0.0
1.0							
2.0							5.0
3.0			TILL-SILT WITH GRANULAR				10.0
4.0			SHALE-DOLOMITE END OF HOLE @ 4.20 IN SHALE				
5.0							15.0
6.0							20.0
7.0							
8.0							25.0
9.0							30.0
10.0							
11.0							35.0
12.0							40.0
13.0							
14.0							45.0
15.0							50.0
16.0							
17.0							55.0
18.0							60.0
19.0							
20.0							65.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m		COMPLETE
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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S7
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 0.9		TOPSOIL				
0.9 – 4.3		CLAY-WITH TILL POCKETS -SOME GRANULAR				
4.3 – 9.2		TILL-SILT WITH GRANULAR				
9.2 – 11.89		GRAVEL-LITTLE WATER				
11.89		END OF HOLE @ 11.89 IN GRAVEL				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

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NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-S13
GENSTAR DEVELOPMENTS LTD.		Project No: 06-0696-266-01
PROJECT ENGINEER: TW		ELEVATION 237.170 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C. LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 7.3		CLAY-BROWN				
7.3 – 8.2		TILL-SILT				
8.2 – 10.5		GRAVEL				
10.5 – 10.67		SHALE-DOLOMITE				
10.67		END OF HOLE @ 10.67 IN SHALE				

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE	
	LOGGED BY TH	DWG NO.	Page 1 of 1

NORTH OF SASKATCHEWAN	FRIESEN DRILLERS LTD.	BOREHOLE No. G-88-P3
GENSTAR DEVELOPMENTS LTD.		Project No: 06 -0899-386-01
PROJECT ENGINEER: TW		ELEVATION 236.550 (m)

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

▲ BULK DENSITY (t/m3) ▲ 1.4 1.8 2.2 2.6
■ SHEAR STRENGTH (kPa) ■ 100 200 300 400
PLASTIC M.C LIQUID 40 80 120 160

DEPTH (m)	USC	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	Other comments	DEPTH (ft)
0.0 – 5.5		CLAY—BROWN —TILL POCKETS			PIEZOMETER AND BEDROCK WELL DETAILS	0.0
5.5 – 16.6		TILL—SILT WITH GRANULAR (SAND TO BOULDERS) —GRAVEL (6.21 – 9.15) LOST DRILL WATER INTO GRAVEL (NO RETURN)			▼ W/L 232.435 IN TILL PIEZOMETER —232.00 PIEZOMETER TIP ▼ W/L 231.315 IN BEDROCK WELL NOTE: WATER LEVELS AS OF NOV 30 \ 88	
16.6 – 24.0		SHALE—WITH THIN DOLOMITE BEDS —PURPLE —SOFT —SANDY			—220.56 BOT WELL CASING	

Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0

Depth scale (ft): 0.0, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, 65.0, 70.0, 75.0, 80.0

UMA Engineering Ltd. Winnipeg, Manitoba	COMPLETION DEPTH *.* m	COMPLETE
	LOGGED BY TH	DWG NO.

APPENDIX B

2009 Test Hole Logs

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-20**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	238.46 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	239.63 m
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T	DATE DRILLED	5/6/2009
		UTM (m)	N 5,533,717 E 624,309

Column headings: 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 △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Description and Classification
238.46 – 237.9	**ORGANIC CLAY (CI-CH)** - Black, damp, firm, intermediate to high plasticity, trace rootlets, trace silt, trace fine to medium grained sand.
237.9 – 233.6	**SILTY CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt seams (1 to 2 m thick), trace silt pockets (1 to 8 mm diameter), trace fine to medium grained sand. - Mottled brown/grey, damp to moist, firm below 3.05 m.
233.6 – 233.0	**SILT TILL** - Reddish tan, wet, soft to firm, mixture of clay, silt, sands and gravel.
233.0 – 229.3	**LIMESTONE** - Limestone to argillaceous limestone, brown, heavily fossilized, nodular to very poorly laminated, moderately fractured, moderately indurated, some fractures have rust coloured clay fill up to 1.5 cm thick. Occasional thin layer (1 - 2 cm) of grey, unfossilized limestone rip up clasts, core has a red to purplish-brown hue. Many fractures are ground due to drilling action. - 3 reddish clay filled fractures between 6.68 m and 7.39 m. - Friable, soft at 7.29 and 7.37 m. - Hole terminated in a clay filled fracture with a small stone in the clay at 9.14 m.

END OF HOLE ON LIMESTONE AT 9.14 m.

Sample Number	Sample Type	Recovery %
S1	Auger Grab	
S2	Shelby Tube	50
S3	Auger Grab	
S4	Auger Grab	
S5	Shelby Tube	75
S6	Auger Grab	
S7	Auger Grab	
S8	Shelby Tube	100
S9	Auger Grab	
R1	Core Barrel	100
R2	Core Barrel	98
R3	Core Barrel	98

Piezometer depths (m): 8.2, 8.5, 8.8, 9.1

SAMPLE TYPE: Auger Grab | Shelby Tube | Core Barrel

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	B. P. ARPIN	MRJ	12/16/19

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
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.							
	11										
227											
	12	40									
226											
	13										
225		45									
	14										
224											
	15	50									
223											
	16										
222		55									
	17										
221											
	18	60									
220											
	19										
219		65									
	20										
218											
	21	70									
217											

SAMPLE TYPE: Auger Grab, Shelby Tube, Core Barrel

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-21**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	238.99 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
		DATE DRILLED	5/6/2009
DRILLING METHOD	125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T	UTM (m)	N 5,533,684 E 624,275

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △
238.8		**ORGANIC CLAY (CI-CH)** - Black, damp, firm, intermediate to high plasticity, trace rootlets, trace silt inclusions, trace fine to medium grained sand.	S1		
		SILTY CLAY (CH) - Brownish grey, damp, stiff, high plasticity, trace rootlets, trace fine to medium grained sand, trace silt, trace organic seams, trace fine grained gravel.	S2, S3, S4		
		- Brown, trace silt pockets (2 to 10 mm diameter), trace silt lenses, trace silt seams (1 to 3 mm thick), trace medium to coarse grained sand below 1.83 m.	S5, S6, S7		
235.3		**SILTY CLAY TILL** - Brown, damp, firm, mixture of clay, silt, sand and gravel.	S8		
235.0		**SILT TILL** - Tan, dry to damp, compact to dense, mixture of silt, sand and gravel.	S9		
		- Moist to wet below 4.57 m.	S10		6, 6, 10
		- Reddish tan, dry below 5.03 m.	S11		
233.7		**LIMESTONE** - Limestone to argillaceous limestone, grey to redish brown in color, heavily fossilized, heavily fractured limestone, nodular to very poorly laminated, moderately indurated, very few vugs. Several fractures have rust coloured clay fill on them. Core breaks easily in several places into discs between 0.5 to 1 cm thick pieces. Bedrock contact is a 100 mm clay contact zone, red in colour. - 7 cm thick clay seam at 5.72 m. - Friable at 5.72 m. - 5 cm thick clay seam at 6.48 m. - Friable at 6.48 m.	R1	100	
			R2	98	
		- 3 cm thick clay seam at 9.53 m - Friable, soft at 9.53 m.	R3	100	
229					

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

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	B. P. ARPIN	MRJ	12/16/19

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-21**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
		35		- 1.5 cm thick clay seam at 9.88 m. - Friable, soft at 9.88 m.	Core Barrel	R4	94
228	11			-Hole terminates in clay seam at least 7.5 cm thick at 11.0 m. - Friable, soft at 10.97 m.			
				END OF HOLE ON BEDROCK AT 11.05 m.			
				Notes: 1. Switched to HQ core barrel at 5.30 m. 2. Backfilled test hole with cement grout to 5.30 m depth, remainder filled with bentonite.			
227	12	40					
226	13						
		45					
225	14						
224	15	50					
223	16						
		55					
222	17						
221	18	60					
220	19						
		65					
219	20						
218	21	70					

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

Cu POCKET PEN (kPa) ★ — Cu TORVANE (kPa) ◆ — 20 40 60 80

PL — MC — LL, % — 20 40 60 80

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	B. P. ARPIN	MRJ	12/16/19

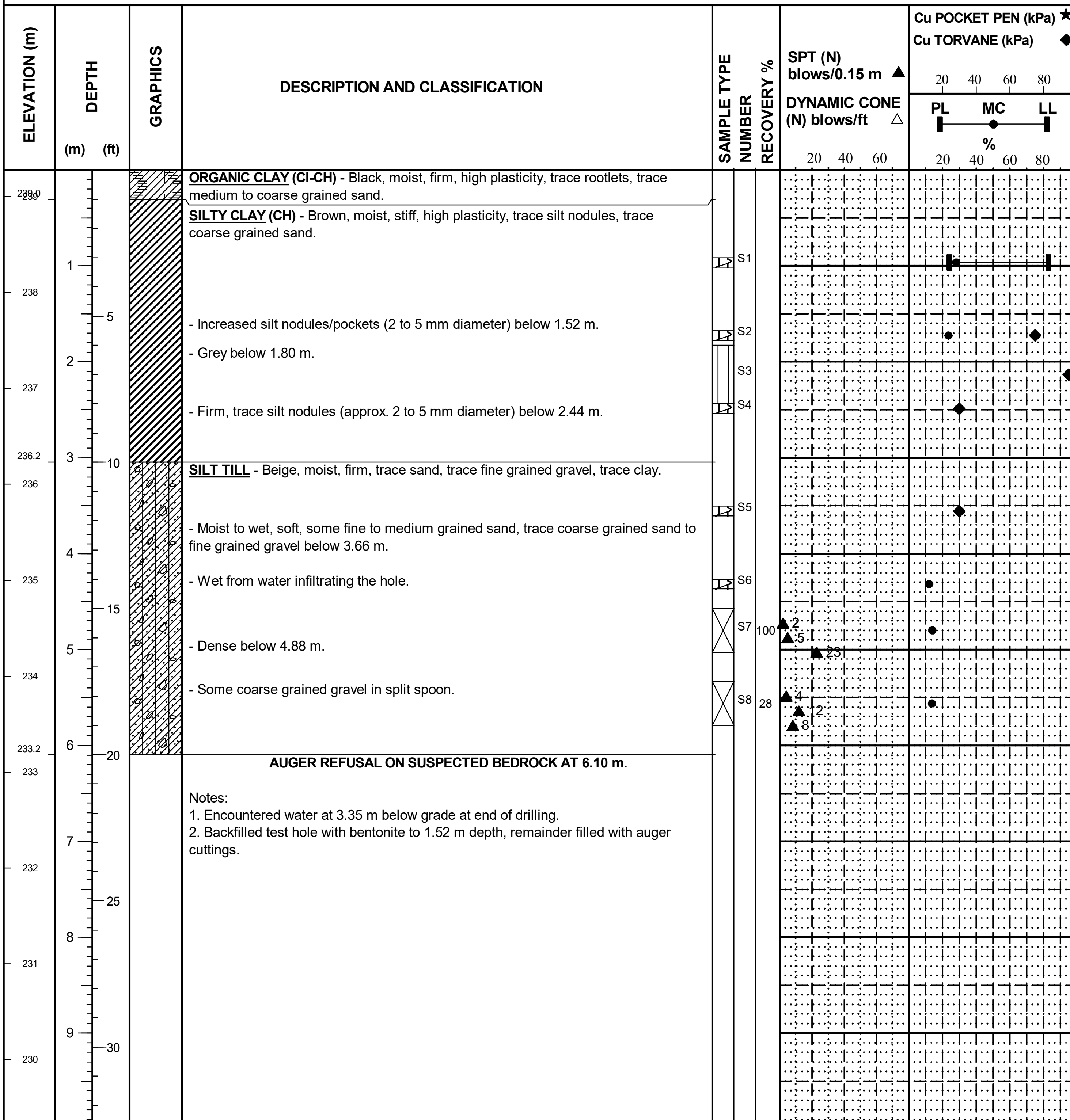
KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-22**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	239.28 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger, Acker MP5-T	DATE DRILLED	5/7/2009
		UTM (m)	N 5,533,532 E 624,113



Elevation (m)	Depth (m)	Description and Classification
239.0	0	**ORGANIC CLAY** (CI-CH) - Black, moist, firm, high plasticity, trace rootlets, trace medium to coarse grained sand.
		SILTY CLAY (CH) - Brown, moist, stiff, high plasticity, trace silt nodules, trace coarse grained sand.
		- Increased silt nodules/pockets (2 to 5 mm diameter) below 1.52 m.
		- Grey below 1.80 m.
		- Firm, trace silt nodules (approx. 2 to 5 mm diameter) below 2.44 m.
236.2	3	**SILT TILL** - Beige, moist, firm, trace sand, trace fine grained gravel, trace clay.
		- Moist to wet, soft, some fine to medium grained sand, trace coarse grained sand to fine grained gravel below 3.66 m.
		- Wet from water infiltrating the hole.
		- Dense below 4.88 m.
		- Some coarse grained gravel in split spoon.
233.2	6	**AUGER REFUSAL ON SUSPECTED BEDROCK AT 6.10 m.**

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

SAMPLE TYPE: Auger Grab, Shelby Tube, Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. FRIESEN	MRJ	12/16/19

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-23**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	237.34 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	238.38 m
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger and HQ Core Barrel, Acker MP5-T	DATE DRILLED	5/7/2009
		UTM (m)	N 5,533,770 E 624,364

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE / NUMBER	RECOVERY %	SPT (N) blows/0.15 m
237.34	0.0	**SILTY CLAY** (CH) - Black, moist, stiff, high plasticity, some organics, trace rootlets, trace medium grained sand.		S1		
		- Brown, trace silt nodules (approx. 1 to 2 mm diameter) below 1.07 m.		S2, S3		
		- Grey, firm, trace silt nodules/pockets (approx. 5 to 25 mm diameter), trace coarse grained sand to fine grained gravel below 2.13 m.		S4, S5, S6		
233.7		**SILT TILL** - Beige, moist, soft, trace medium to coarse grained sand, trace fine grained gravel, trace clay.		S7, S8	0	6 (Note 2)
232.8		**LIMESTONE** - 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.		R1	98	
		- 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.	7.0 7.3 7.6	R2	98	
229.7	7.62	**END OF HOLE AT 7.62 m..**				

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.

Chart columns: Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); DYNAMIC CONE (N) blows/ft △; PL — MC — LL % (20 40 60 80).

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. FRIESEN	MRJ	12/16/19

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH09-24**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	238.12 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger, HQ Core Barrel	DATE DRILLED	5/7/2009
		UTM (m)	N 5,533,797 E 624,389

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE NUMBER	RECOVERY %
238.12	0.00	**SILTY CLAY (CH)** - Brown, moist, stiff, high plasticity, trace rootlets, trace sand, trace fine grained gravel, trace organics upper 0.30 m.	S1, S2	
		- Trace oxidation, trace silt nodules (approx. 1 to 3 mm diameter) below 1.52 m.	S3, S4, S5	
		- Grey, moist, firm, trace silt nodules (approx. 3 to 10 mm diameter), trace silt till, trace coarse grained gravel below 3.05 m.	S6, S7	
233.7		**SILT TILL** - Beige, moist, firm, trace to some clay. - Moist to wet, soft, some sand, trace fine grained gravel below 4.57 m.	S8	
232.8		**LIMESTONE** - Limestone to argillaceous limestone, grey/green to brown and rust red, fossiliferous, oxidized, moderately indurated, mottled to nodular structure, moderately fractured, heavily fossilized, sloughed till material at top 0.19 m.	S9	39
			R1	80
		- Red-brown clay seam (< 50 mm thick), soft, friable, oxidized at 5.87 m.		
		- Trace reddish clay lenses (approx. 25 mm thick), high plasticity.	R2	100
		- Red-brown clay seam (~ 75 mm thick), soft, friable, oxidation at 8.03 m. - Friable, soft, oxidation between 8.03 and 8.10 m.	R3	100
			R4	98

SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ — S9: 17, Note 2

Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; PL — MC — LL %

S1 torvane: >10

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

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. FRIESEN	MRJ	12/16/19

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %
228		35	- Limestone becomes grey-brown to purple-brown, moderately fractured, minor fossils, several clay/shale seams throughout, mottled to nodular structure.	Core Barrel		
227	11		- 1 cm thick clay/shale seams at 10.39 m, 10.67 m, 10.72 m, 11.48 m, 12.07 m, 12.14 m, 12.17 m, 12.98 m, 13.18 m, 13.79 m, 13.92 m, 13.97 m, 14.0 m, 14.02 m, 14.33 m. - 5 cm thick clay/shale seam, soft, friable, oxidation at 11.23 m. - 3.5 cm thick clay/shale seam, soft, friable, oxidation at 11.73 m.	Core Barrel	R5	98
226	12	40				
225	13			Core Barrel	R6	100
224	14	45	- Friable, soft, oxidation between 13.79 and 13.90 m.			
				Core Barrel	R7	100
223	15	50	- Limestone becomes grey to redish brown/dark brown, nodular to poorly laminated, weak to moderate fracturing with occasional clay and shale seams, fossil content is similar to upper portion of hole, several clay and shale seams. - 1 cm thick clay/shale seams at 15.90 m, 16.03 m, 16.56 m, 18.14 m. Soft, friable. - 5 cm thick clay/shale seam at 17.83 m. Soft, friable.			
222	16			Core Barrel	R8	93
221	17	55		Core Barrel	R9	100
220	18		- Friable, soft, oxidation between 17.83 and 17.89 m.			
219.8		60	**END OF HOLE AT 18.29 m.**			
219	19					
218	20	65				
217	21	70				

Notes:
1. Lost circulation between 5.51 and 6.40 m. Possibly in clay layer or fracture in bedrock.
2. Bouncing on suspected bedrock into second set of SPT for S9.
3. Switched to HQ core barrel at 5.30 m.
4. Backfilled test hole with concrete grout to 5.30 m depth, remainder filled with bentonite.
5. Testhole log is a combination of two testholes drilled 2 m apart. First testhole was drilled to 8.56 m and the second testhole was drilled to 18.29 m.

SPT (N) blows/0.15 m ▲ — DYNAMIC CONE (N) blows/ft △ — 20 40 60
Cu POCKET PEN (kPa) ★ — Cu TORVANE (kPa) ◆ — 20 40 60 80
PL MC LL — % — 20 40 60 80

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

CONTRACTOR: Paddock Drilling Ltd. | INSPECTOR: C. FRIESEN | APPROVED: MRJ | DATE: 12/16/19

KGS GROUP

SUMMARY LOG

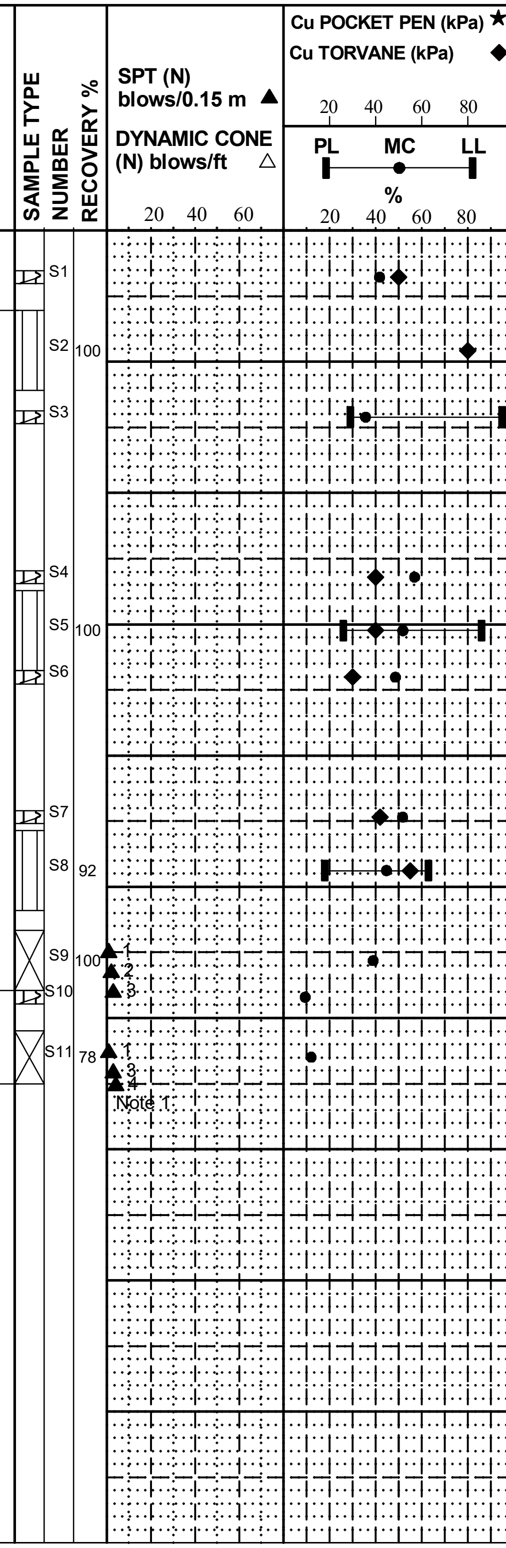
REFERENCE NO.

HOLE NO. **TH09-25**

CLIENT	WSP CANADA GROUP LIMITED	JOB NO.	09-183-01
PROJECT	CENTRE PORT CANADA WAY PROJECT	GROUND ELEV.	238.02 m
SITE	Proposed Interchange at Sturgeon Rd. and Inkster Blvd.	TOP OF PVC ELEV.	
LOCATION	Sturgeon Rd. and Inkster Blvd.	WATER ELEV.	
DRILLING METHOD	125 mm ø Solid Stem Auger, Acker MP5-T	DATE DRILLED	5/8/2009
		UTM (m)	N 5,533,919 E 624,517

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER	RECOVERY %
238.02	0.00	**ORGANIC CLAY (CH)** - Black, moist, stiff, high plasticity, trace medium to coarse grained sand, trace rootlets.	S1	
237.4	0.6	**SILTY CLAY (CH)** - Brown, moist, stiff, high plasticity, trace rootlets, trace sand, trace fine grained gravel, trace organics.	S2	100
		- Brown, moist, stiff, high plasticity, trace silt nodules (approx. 1 mm diameter) below 1.22 m. - Trace silt nodules (approx. 2 to 5 mm diameter) below 1.52 m.	S3	
		- Firm below 2.44 m. - Grey below 2.59 m.	S4	
			S5	100
		- Silt pocket (approx. 25 mm diameter) at 3.99 m.	S6	
		- Medium grained sand pockets (approx. 25 to 30 mm diameter) at 4.42 m.	S7	
			S8	92
		- Trace silt till below 5.18 m. - Trace silt nodules (approx. 1 to 3 mm diameter) below 5.38 m.	S9	100
232.2	5.8	**SILT TILL** - Beige, moist, loose, medium grained to coarse grained sand, trace fine grained gravel, trace to some clay.	S10	
			S11	78
231.5	6.5	**AUGER REFUSAL ON SUSPECTED BEDROCK AT 6.50 m.**		

Notes:
1. SPT bounced on suspected bedrock for S11.
2. Backfilled test hole with bentonite to 1.52 m depth, remainder filled with auger cuttings to grade.



SAMPLE TYPE: Auger Grab, Shelby Tube, Split Spoon

CONTRACTOR	INSPECTOR	APPROVED	DATE
Paddock Drilling Ltd.	C. FRIESEN	MRJ	12/16/19

APPENDIX C

2019/2020 Test Hole and Photograph Logs

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-01**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering
SITE	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 (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER
			GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1
238			- Damp below 0.6 m.	S2
237.7	1		**CLAY FILL** - Black, damp, low plasticity, stiff, some organics.	S3
237.1 / 237		5	**CLAY (CH)** - Mottled brown to grey, moist, stiff, high plasticity.	
	2		- Trace silt nodules below 2.3 m.	S4
236	3	10	- Firm below 3.2 m.	
235	4		- Trace fine to coarse grained gravel below 3.9 m.	S5
234.2 / 234		15	**SILT TILL (ML)** - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	
233	5			S6
	6	20	- Cobbles encountered at 5.9 m. - Moist to wet, loose, some to with fine to coarse grained gravel below 6.0 m.	
232	7			S7
231	8	25		S8
230	9	30	- Damp, dense below 9.0 m.	
229	10			S9
228	11	35		S10
227			- Trace limestone fragments below 11.2 m. - 150 mm sand seam observed at 11.4 m.	
226	12	40	- Cobbles encountered below 12.0 m. - Pink to red, moist below 12.2 m.	S11

Column headings: SAMPLE TYPE; RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m / DYNAMIC CONE (N) blows/ft	Cu POCKET PEN (kPa) / Cu TORVANE (kPa) / PL MC LL %
225.6			**SAND AND GRAVEL** - Brown, moist, dense, some silt, some cobbles.					
225.0		45	**SILT TILL (ML)** - Red, moist, dense, some fine to coarse grained sand, some fine to coarse grained gravel.	Sonic Barrel	S12			
224.3			**JURASSIC LIMESTONE** - Pink to grey, weak.	Sonic Barrel	S13			
224.1			**END OF TEST HOLE AT 14.4 m**					

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.

SAMPLE TYPE: Sonic Barrel

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

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	238.19
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	2570 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/23/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,530,706 E 623,776

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
238 237.9			**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained sand.	
			CLAY FILL - Grey, damp, firm, intermediate plasticity, trace fine to coarse grained gravel.	S1
237	1		- Black, low plasticity, some organics, trace silt nodules below 0.7 m.	S2
236.5	2	5	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S3
236 235	3	10	- Trace fine grained gravel below 3.0 m.	
234	4	15	- Cobbles encountered below 4.2 m.	
233 232.9	5		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel.	S4
232	6	20	- 150 mm sand seam observed at 6.2 m.	
231	7		- Damp to moist below 6.7 m .	S5
230	8	25	- 300 mm sand seam observed at 7.6 m. - With fine to coarse grained gravel below 7.9 m.	S6
229.7			**GRAVEL** - Brown, moist, compact, some fine to coarse grained sand, some silt.	S7
229.0 229	9	30	**SILT TILL (ML)** - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel.	S8
228	10	35	- Damp, dense below 10.3 m. - Very dense below 10.6 m.	S9
227	11			S10
226.0 226	12	40	**JURRASIC LIMESTONE** - Pink to grey, weak.	

RECOVERY %

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

Cu POCKET PEN (kPa) ★ — Cu TORVANE (kPa) ◆ — 20 40 60 80

PL MC LL % — 20 40 60 80

SAMPLE TYPE ▮ Sonic Barrel

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

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-02**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
225									
224.5		45		**END OF TEST HOLE AT 13.7 m**					
224	14			Notes: 1. Water observed at 6.4 m below grade after the completion of drilling. 2. TH19-02 open to 6.9 m below grade after the completion of drilling. 3. Backfilled with bentonite chips and auger cuttings.					
223	15	50							
222	16								
221	17	55							
220	18	60							
219	19								
218	20	65							
217	21	70							
216	22								
215	23	75							
214	24	80							
213	25								
212	26	85							
211	27	90							
210	28								

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-03**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

PROJECT Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering

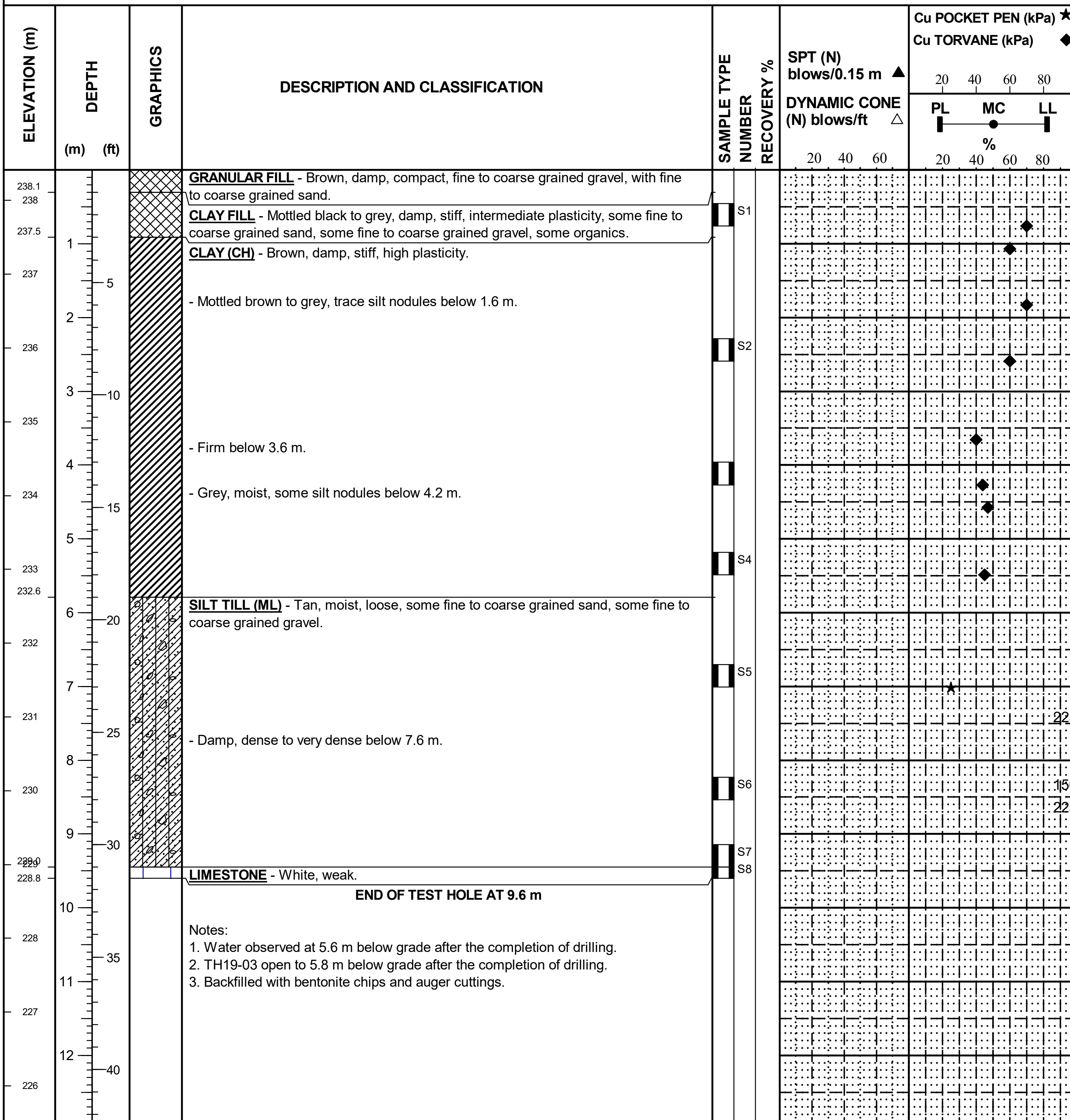
SITE Sturgeon Road

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER
238.1		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	
237.5		**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, some fine to coarse grained sand, some fine to coarse grained gravel, some organics.	S1
		CLAY (CH) - Brown, damp, stiff, high plasticity.	
		- Mottled brown to grey, trace silt nodules below 1.6 m.	S2
		- Firm below 3.6 m.	
		- Grey, moist, some silt nodules below 4.2 m.	S4
232.6		**SILT TILL (ML)** - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel.	S5
		- Damp, dense to very dense below 7.6 m.	S6
229.0		**LIMESTONE** - White, weak.	S7
228.8		END OF TEST HOLE AT 9.6 m	S8



END OF TEST HOLE AT 9.6 m

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-04**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	238.39
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	2100 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/24/2019
		UTM (m)	N 5,531,169 / E 623,790
DRILLING METHOD	Sonic SDC 450, Track Drill Rig		

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE NUMBER
238.1		**GRANULAR FILL** - Brown, damp, loose, fine to coarse grained gravel, with fine to coarse grained sand.		
237.5		**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, trace coarse grained gravel, some organics.		S1
		CLAY (CH) - Brown, damp, stiff, high plasticity.		
		- Mottled brown to grey below 1.5 m.		
		- Trace silt nodules below 1.6 m.		S2
		- 50 mm silt seam observed at 3.6 m.		S3
		- 25 mm silt seam observed at 4.2 m.		
		- Grey, moist below 5.2 m.		S4
			5.9	
232.3		**SILT TILL (ML)** - Tan, moist to wet, loose, some fine to coarse grained sand, trace fine to coarse grained gravel.	6.7	S5
		- 100 mm sand seam observed at 7.0 m.	7.0	S6
		- Damp to moist, compact, trace cobbles below 7.0 m.	7.4	
		- Dense below 7.6 m.	7.7	
		- Red, damp, some fine to coarse grained gravel, trace fine to coarse grained sand below 8.5 m.		S7
			9.4	S8
228.6		**JURRASIC LIMESTONE** - Red to brown, weak, broken (RQD = 0.0).	10.1	S9
			10.1	
			10.5	S10
227.7		**END OF TEST HOLE AT 10.6 m**	10.7	

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.

Column headings: 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 △ (20 40 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-05**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	238.97
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1700 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/24/2019
		UTM (m)	N 5,531,558 E 623,802
DRILLING METHOD	Sonic SDC 450, Track Drill Rig		

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
238.97	0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	
238.5		**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, some organics.	
238.2		**CLAY (CH)** - Brown, damp, stiff, high plasticity.	S1
		- Mottled brown to grey, damp to moist, trace silt nodules below 1.2 m.	S2
		- Grey, trace fine grained gravel below 3.0 m.	S3
234.4		**SILT TILL (ML)** - Tan, damp, loose to compact, some fine to coarse grained gravel, some fine to coarse grained sand.	S4, S5
231.4		**JURASSIC LIMESTONE** - Red, weak.	S6
231.2	7.7	**END OF TEST HOLE AT 7.7 m**	

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; SAMPLE TYPE; NUMBER; RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

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.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-06**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.37
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1480 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/24/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,531,769 E 623,809

Column headings: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Description and Classification	Sample
239.1	**GRANULAR FILL** - Grey, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	
239	**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, some organics.	S1
238.6	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity.	S2
	- Trace silt nodules, trace fine grained gravel below 1.5 m.	S3
	- Moist below 3.0 m.	
235.6	**SILT TILL (ML)** - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	S4
233.3	**SAND AND GRAVEL** - No recovery in sonic barrel from 6.1 m to 7.6 m.	S5
231.8	**SILT TILL (ML)** - Tan, moist to wet, loose to compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	
	- Yellow, moist, dense below 8.5 m.	S6
	- With fine to coarse grained gravel below 9.1 m.	S7
229.6	**JURASSIC LIMESTONE** - Red to purple, broken.	S8
	- 300 mm clay seam observed at 10.3 m.	
228.7	**END OF TEST HOLE AT 10.6 m**	

Elevation scale: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; (ft): 5, 10, 15, 20, 25, 30, 35, 40

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-07**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.66
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1250 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/24/2019
		UTM (m)	N 5,532,002 E 623,816
DRILLING METHOD	Sonic SDC 450, Track Drill Rig		

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
239.66	0.0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - 30 mm organic clay observed at 0.3 m.	
		CLAY FILL - Mottled black to grey, damp, stiff, high plasticity, some organics.	S1
238.4		**CLAY (CH)** - Brown, damp, stiff, high plasticity. - Mottled brown to grey, damp to moist, trace silt nodules below 1.5 m. - Grey, moist, trace fine to coarse grained gravel below 3.0 m.	S2, S3
236.0		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel, some cobbles.	S4
235.1		**LIMESTONE** - White, weathered, soft.	S5
234.9		**END OF TEST HOLE AT 4.7 m**	

Column headings: SPT (N) blows/0.15 m ▲ (20, 40, 60); DYNAMIC CONE (N) blows/ft △; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80); RECOVERY %

Elevation scale: 239.2, 239, 238.4, 238, 237, 236.0, 236, 235.1, 235, 234.9, 234, 233, 232, 231, 230, 229, 228, 227

Depth scale (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12; (ft): 5, 10, 15, 20, 25, 30, 35, 40

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.

SAMPLE TYPE ▮ Sonic Barrel

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

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-08**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.03
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1070 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/25/2019
		UTM (m)	N 5,532,179 E 623,821
DRILLING METHOD	Sonic SDC 450, Track Drill Rig		

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	Cu TORVANE (kPa)
240.03–239.3	0–0.7	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.			
239.3–238.4	0.7–1.6	**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, some organics. - Trace coarse grained gravel below 0.9 m.	Sonic Barrel	S1	◆
238.4–236	1.6–4.0	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	Sonic Barrel	S2	◆
236–235.5	4.0–4.5	**SILT TILL (ML)** - Tan, moist, dense.	Sonic Barrel	S3	
235.5	4.5	**JURASSIC LIMESTONE** - Red, weak.			

END OF TEST HOLE AT 4.5 m

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.

Column headings: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; PL MC LL %; RECOVERY %

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-09**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
241.01–240.5	0.0–0.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1
240.5–238.7	0.5–2.3	**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, trace coarse grained gravel. - 150 mm silt seam observed at 2.1 m.	S2
238.7–238.0	2.3–3.0	**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt nodules.	S3
238.0–236.7	3.0–4.3	**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained sand, some fine to coarse grained gravel. - Some cobbles below 3.3 m. - Moist below 3.9 m.	S4, S5
236.7–236.6	4.3–4.4	**LIMESTONE** - Orange to white.	S6

END OF TEST HOLE AT 4.4 m

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.

Chart columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80)

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-10**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	241.24
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	570 m South of CentrePort Canada Way, East Shoulder of Sturgeon Road	DATE DRILLED	9/25/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,532,672 E 623,801

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
241.24	0.0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - Cobbles encountered at 0.7 m.	S1
238.5	2.7	**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt nodules.	S2
238.2	3.0	**SILT TILL (ML)** - Tan, damp, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles. - Yellow to brown, moist, some cobbles below 4.5 m.	S3, S4, S5
235.1	6.1	**SAND AND GRAVEL** - Brown, damp, compact, fine to coarse grained gravel, some silt, some fine to coarse grained sand.	S6
233.5	7.7	**LIMESTONE** - White to yellow, weak.	S7
233.3	7.9	**END OF TEST HOLE AT 7.9 m**	

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.

Plot columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-14**

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

Column headings: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Description and Classification	Sample
239.7	**TOP SOIL** - Black, damp, stiff, low plasticity, with organics, trace rootlets.	S1
239.4	**GRANULAR FILL** -Brown, damp, compact, fine to coarse grained gravel, trace fine to coarse grained sand.	S2
	CLAY FILL - 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	**CLAY (CH)** - Mottled brown to grey, damp to moist, stiff, high plasticity, trace silt nodules, trace rootlets. - Brown, no rootlets below 3.0 m. - Trace coarse grained gravel below 4.5 m. - 150 mm silt seam observed at 5.8 m. - 300 mm silt seam observed at 6.0 m.	S4, S5
233.3	**SILT TILL (ML)** - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles. - Broken fragments of Jurassic bedrock below 8.2 m.	S6
231.2	**JURASSIC LIMESTONE** - Red, weak.	S7
230.8	**END OF TEST HOLE AT 9.1 m**	

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-15**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.66
SITE	Red Fife Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1470 m West of Oak Point Hwy, North shoulder of Red Fife Road	DATE DRILLED	9/26/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,085 E 624,969

Column headings: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Depth (m)	Description and Classification	Sample
239.66	0.0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	
239.0	0.6	**CLAY FILL** -Black, damp, stiff, low plasticity, some organics, trace coarse grained gravel, trace rootlets, trace cobbles.	S1
		- Mottled black to grey, intermediate plasticity, no rootlets below 1.5 m.	S2
236.6	3.0	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	S3
		- Firm to stiff below 5.1 m.	
234.2	5.4	**SILT TILL (ML)** - Tan, moist, loose, trace fine grained sand.	S4
		- Some fine to coarse grained sand, some fine to coarse grained gravel below 6.0 m.	S5
		- Cobbles encountered below 7.1 m.	S6
		- Damp, compact below 8.0 m.	
		- Dense below 9.1 m.	S9
		- Brown below 9.4 m.	
		- Grey to red below 10.0 m.	S10
228.1	11.5	**JURASSIC LIMESTONE** - Red, weak.	S11
227.8	11.8	**END OF TEST HOLE AT 11.8 m**	

Pocket pen values plotted off scale: 125, 175, 225, 175, 225, 225

Notes:
1. Water observed at 5.5 m below grade after the completion of drilling.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-15**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
				2. Test hole sloughing condition could not be measured due to the drillers broken rod which fell in the test hole after the completion of drilling.					
				3. Backfilled with bentonite chips and auger cuttings.					
226	14	45							
225	15	50							
224	16								
223	17	55							
222	18	60							
221	19								
220	20	65							
219	21	70							
218	22								
217	23	75							
216	24	80							
215	25								
214	26	85							
213	27	90							
212	28								

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-16**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.07
SITE	Red Fife Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1278 m West of Oak Point Hwy, North shoulder of Red Fife Road	DATE DRILLED	9/26/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,090 E 625,160

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	Cu TORVANE (kPa) ◆ / Cu POCKET PEN (kPa) ★
240.07–239.6	0–0.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.		
239.6–238.1	0.5–2.0	**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, trace coarse grained gravel, trace rootlets.	S1	◆ ~80 (0.6 m); ◆ ~80 (1.5 m)
238.1–235.2	2.0–4.9	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel. - Firm below 3.2 m.	S2, S3	◆ ~45; ◆ ~40
235.2–231.2	4.9–8.9	**SILT TILL (ML)** - Tan, moist, loose, trace fine grained sand, trace fine grained gravel. - Trace cobbles below 6.0 m. - Moist to wet below 7.6 m. - Pink below 8.2 m.	S3, S4	★ ~25; ★ ~25; ★ ~38
231.2–230.9	8.9–9.1	**JURASSIC LIMESTONE** - Red, weak.	S5	

END OF TEST HOLE AT 9.1 m

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

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-17**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.18
SITE	Red Fife Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	1155 m West of Oak Point Hwy, North shoulder of Red Fife Road	DATE DRILLED	9/26/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,093 E 625,285

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
240.18 – 239.7	0 – 0.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	
239.7 – 238.4	0.5 – 1.8	**CLAY FILL** - Mottled black to grey, damp, stiff, intermediate plasticity, some organics, some fine grained gravel, trace silt nodules, trace rootlets.	S1, S2
238.4 – 235.3	1.8 – 4.9	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules. - Damp to moist below 3.3 m. - 30 mm silt seam observed at 3.8 m. - 30 mm silt seam observed at 4.1 m. - 40 mm silt seam observed at 4.5 m.	S3, S4
235.3 – 232.4	4.9 – 7.8	**SILT TILL (ML)** - Tan, moist, compact, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles. - 50 mm sand seam observed at 5.8 m. - With fine to coarse grained sand, with fine to coarse grained gravel below 6.4 m. - Cobbles encountered below 7.0 m.	S5, S6
232.4 – 232.3	7.8 – 7.9	**JURASSIC LIMESTONE** - Red, weak.	

END OF TEST HOLE AT 7.9 m

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.

Chart columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL – MC – LL % (20, 40, 60, 80)

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-18**

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 (m)	DESCRIPTION AND CLASSIFICATION	DEPTH (m)	SAMPLE TYPE / NUMBER
239.60	0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.		S1
238.2		**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, some organics.		
237.9		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.		S2
234.0		**SILT TILL (ML)** - Tan, damp, loose, some fine to coarse grained sand, some fine to coarse grained gravel. - Trace cobbles below 6.4 m.	5.5 6.2 6.6 7.0 7.3	S3
232.3		**JURASSIC LIMESTONE** - Red, weak.		S4
232.0		**END OF TEST HOLE AT 7.6 m**		

Column headings: PIEZ. LOG; RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-19**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
239.46 – 238.2	0 – 1.2	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.		
238.2 – 235.8	1.2 – 3.6	**CLAY (CH)** - Mottled brown to grey, moist, stiff, high plasticity.	Sonic Barrel	S1
235.8 – 235.0	3.6 – 4.4	**SILT TILL (ML)** - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel.	Sonic Barrel	S2
235.0 – 234.9	4.4 – 4.5	**LIMESTONE** - White to yellow.		

END OF TEST HOLE AT 4.5 m

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.

Plot columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80); RECOVERY %

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-20**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.42
SITE	Park Royale Way	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	500 m West of Roy Roche Dr, South Shoulder of Park Royale Way	DATE DRILLED	9/27/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,114 E 625,936

ELEVATION (m)	DEPTH (m)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
239.42	0.0		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand. - Trace cobbles below 0.7 m.		
238.0	1.4		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	Sonic Barrel	S1
235.3	4.1		**SILT TILL (ML)** - Tan, moist, loose, some fine to coarse grained sand, some fine to coarse grained gravel. - Compact below 5.3 m. - Trace cobbles below 5.5 m. - With fine to coarse grained gravel below 6.0 m.	Sonic Barrel	S2, S3
232.6	6.8		**JURASSIC LIMESTONE** - Red, weak.	Sonic Barrel	S4
232.3	7.1		**END OF TEST HOLE AT 7.1 m**		

Chart columns: RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80)

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-21**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
239.57–238.0	0–1.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	
238.0–236.5	1.5–3.0	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	S1
236.5–228.4	3.0–11.1	**SILT TILL (ML)** - 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, S3, S4, S5, S6, S7, S8, S9
228.4–228.1	11.1–11.4	**JURASSIC LIMESTONE** - Red.	S10
		END OF TEST HOLE AT 11.4 m	

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.

Legend: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; PL — MC — LL (%). Plotted values: 150, 225, 225.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-22**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.96
SITE	Park Royale Way	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	180 m West of Roy Roche Dr	DATE DRILLED	9/27/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,126 E 626,254

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE
240.96	0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	
239.4		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace coarse grained gravel.	Sonic Barrel
239.0		**SILT TILL (ML)** - Tan, damp, loose, some fine to coarse grained sand, some fine to coarse grained gravel, trace cobbles.	Sonic Barrel
238.1		**END OF TEST HOLE AT 2.9 m**	Sonic Barrel

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.

Chart columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80)

SAMPLE TYPE ▯ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-23**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	238.73
SITE	Inkster Boulevard	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	105 m East of Roy Roche Dr, South Shoulder of Park Royale Way	DATE DRILLED	9/27/2019
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,534,133 E 626,546

Column headings: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Description and Classification	Samples
238.73–238.1	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	
238.1–236.1	**CLAY FILL** - Mottled black to grey, damp, firm, intermediate plasticity, some organics, some fine to coarse grained sand, some fine to coarse grained gravel. - Moist below 2.1 m.	S1
236.1–225.8	**SILT TILL (ML)** - Tan, damp, compact, some fine to coarse grained sand, some fine to coarse grained gravel. - 100 mm sand seam observed at 4.7 m. - Dense below 5.2 m. - Very dense below 8.5 m.	S2, S3, S4, S5, S6

Cu values printed at chart edge: 175 (S2), 225 (below 5 m), 225 (approx. 6 m), 225 (S5).

SAMPLE TYPE ▮ Sonic Barrel

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

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-23**

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
225.5			**LIMESTONE** - White, weak.	Sonic Barrel	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.					

Elevation scale (m): 225, 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213, 212, 211

Depth scale (m): 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28

Depth scale (ft): 45, 50, 55, 60, 65, 70, 75, 80, 85, 90

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-24**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER
237.41 – 236.6	0 – 0.8	**GRANULAR FILL** -Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	
236.6 – 235.9	0.8 – 1.5	**CLAY FILL** -Grey, moist, stiff, high plasticity, trace rootlets.	S1, S2
235.9 – 231.2	1.5 – 6.2	**CLAY (CH)** - Mottled brown to grey, moist, stiff, high plasticity, trace silt nodules, trace coarse grained sand, trace fine grained gravel. - Trace silt nodules below 3.0 m. - Cobbles encountered at 4.2 m. - Firm below 5.8 m. - Cobbles encountered at 6.0 m.	S3, S4, S5, S6
231.2 – 224.5	6.2 –	**SILT TILL (ML)** - 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. - Moist to wet below 9.1 m. - Cobbles encountered at 9.7 m. - 600 mm layer of sand till at 9.7 m. - Red to brown below 10.3 m.	S7, S8, S9, S10, S11, S12, S13, S14, S15

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

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

Pocket pen values plotted off scale: 225 (S7), 225 (S8), 162.5 (S10/S11)

SAMPLE TYPE: Sonic Barrel

CONTRACTOR Paddock Drilling Ltd. | INSPECTOR M. Alfaro | APPROVED JRM | DATE 12/16/19

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
224.3				**LIMESTONE** Red, weak.					
224				END OF TEST HOLE AT 13.2 m					
		45							
	14								
223									
	15								
		50							
222									
	16								
221									
		55							
	17								
220									
	18								
		60							
219									
	19								
218									
		65							
	20								
217									
	21								
		70							
216									
	22								
215									
		75							
	23								
214									
	24								
		80							
213									
	25								
212									
		85							
	26								
211									
	27								
210									
		90							
	28								

Notes:
1. TH19-24 open to 10.9 m below grade after the completion of drilling.
2. Water observed at 8.2 m below grade after the completion of drilling.
3. Backfilled with bentonite chips and auger cuttings.

SAMPLE TYPE ▐ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH19-25**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER	Cu TORVANE / POCKET PEN (kPa)
236.5		**TOP SOIL** - Black, damp, compact.		
236.0		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1	
	1	**CLAY FILL** -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.	S2, S3	◆
235.1		**CLAY (CH)** - Mottled brown to grey, moist, stiff, high plasticity, some to with silt nodules, trace oxidation, trace coarse grained sand, trace fine grained gravel.	S4	◆
	3	- Firm below 3.3 m.	S5	◆
231.8		**SILT TILL (ML)** - Tan, moist, compact, trace fine grained gravel, trace coarse grained sand, trace to some fine grained sand.	S6	◆ ★
	6	- Trace cobbles below 6.0 m.	S7	◆
		- Trace to some fine grained gravel, no cobbles below 7.3 m.		225 ★, 225 ★
	8	- Damp to dry, very dense below 8.0 m.	S8	225 ★
	9	- Cobbles encountered at 9.1 m.	S9	225 ★
227.2		**LIMESTONE** White, weak.	S10	
227.1		**END OF TEST HOLE AT 9.6 m**		

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

SAMPLE TYPE ▐▌ Sonic Barrel

CONTRACTOR Paddock Drilling Ltd. | INSPECTOR M. Alfaro | APPROVED JRM | DATE 12/16/19

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-01**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
237.5		**ASPHALT**	
237.4		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, with fine to coarse grained sand.	S1
		CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity.	S2
		- Trace silt nodules below 1.5 m.	S3
		- Trace coarse grained gravel, some silt pockets below 3.0 m.	
		- 200 mm silt seam observed at 3.3 m.	S4
233.5		**SILT TILL (ML)** - Tan, damp, compact, trace fine to coarse grained gravel, trace coarse grained sand.	S5
		- Trace cobbles below 4.5 m.	
		- With coarse grained gravel below 6.0 m.	S6
230.2		**JURASSIC LIMESTONE** - Red, weak.	S7
229.9	7.9	**END OF TEST HOLE AT 7.9 m**	

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.

Cu POCKET PEN (kPa) ★ — 112.5 (at approx. 4.7 m)
Cu TORVANE (kPa) ◆

SPT (N) blows/0.15 m ▲
DYNAMIC CONE (N) blows/ft △
PL MC LL %

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-02**

SHEET 1 of 1

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER
238.3		**ASPHALT**		
238.0		**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, trace fine to coarse grained gravel, some organics.		
		CLAY (CH) - Mottled brown to grey, damp, stiff, high plasticity.		
		- Trace coarse grained gravel below 0.7 m.	Sonic Barrel	S1
		- Trace silt nodules below 1.5 m.		
		- Some silt nodules below 2.1 m.	Sonic Barrel	S2
			Sonic Barrel	S3
234.4		**SILT TILL (ML)** - Tan, damp, dense, trace fine to coarse grained sand, with fine to coarse grained gravel.	Sonic Barrel	S4
		- Very dense below 6.4 m.	Sonic Barrel	S5
231.2		**JURASSIC LIMESTONE** - Red, weak.	Sonic Barrel	S6
230.8		**END OF TEST HOLE AT 7.7 m**		

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.

Chart headings: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; PL MC LL %. Plotted values: 125, 225, 225.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-03**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.09 m
SITE	Murray Park Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	320 m East of Sturgeon Road, North Shoulder of Murray Park Road	DATE DRILLED	2/3/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,528,390 E 624,024

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	Cu TORVANE (kPa)	Cu POCKET PEN (kPa)
240.0–239.8		**ASPHALT**			
239.8–239.3		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1, S2		
239.3–238.8		**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, with organics, trace rootlets.	S3		
238.8–237.8		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.			
237.8–237.3		**SILT TILL (ML)** - Tan, damp, dense, trace fine to coarse grained sand, with fine to coarse grained gravel, trace cobbles.	S4		150
237.3–237.0	3.0	**LIMESTONE** - White, weak.	S5		

END OF TEST HOLE AT 3.0 m

Notes:
1. TH20-03 open and dry after the completion of drilling.
2. Backfilled with bentonite chips and auger cuttings.

Column headings: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80); RECOVERY %.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-04**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.95 m
SITE	Murray Park Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	40 m East of Sturgeon Road, North Shoulder of Murray Park Road	DATE DRILLED	2/3/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,528,382 E 623,724

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	Cu POCKET PEN (kPa)
239.6		**ASPHALT**			
		GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	Sonic Barrel	S1	
238.7		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel.			
		- Boulder encountered at 1.5 m.	Sonic Barrel	S2	
			Sonic Barrel	S3	225
		- Very dense below 2.4 m.	Sonic Barrel	S4	225
		- Boulder was observed at 3.2 m. - Trace cobbles below 3.2 m.			
			Sonic Barrel	S5	225
		- Some cobbles below 4.1 m.			
			Sonic Barrel	S6	225
234.5		**JURASSIC LIMESTONE** - Red, weak.	Sonic Barrel	S7	
234.2	5.8	**END OF TEST HOLE AT 5.8 m**			

Column headings also shown: RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL, MC, LL % (20, 40, 60, 80); GRAPHICS; DEPTH (m) (ft).

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.

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-05**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.76 m
		TOP OF PVC ELEV.	
SITE	Sturgeon Road	WATER ELEV.	
LOCATION	220 m North of Murray Park Road, East Shoulder of Sturgeon Road	DATE DRILLED	2/4/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,528,600 E 623,708

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER
239.76–239.3	0.0–0.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1
239.3–238.7	0.5–1.1	**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, trace fine to coarse grained gravel, with organics.	
238.7–236.3	1.1–3.5	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity. - Trace silt nodules below 1.5 m. - Some silt nodules below 3.0 m.	S2, S3
236.3–231.2	3.5–8.5	**SILT TILL (ML)** - 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. - Red below 7.3 m.	S4, S5, S6, S7
231.2–230.6	8.5–9.1	**JURASSIC LIMESTONE** - Red, weak.	S8

Chart columns: SAMPLE TYPE; RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL, MC, LL % (20, 40, 60, 80). Pocket pen values plotted off scale: 150, 225, 225, 225.

END OF TEST HOLE AT 9.1 m

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.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-06**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.98 m
		TOP OF PVC ELEV.	
SITE	Sturgeon Road	WATER ELEV.	
LOCATION	170 m South of Saskatchewan Avenue Avenue, East Shoulder of Sturgeon Road	DATE DRILLED	2/4/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,528,941 E 623,734

Column headings: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20 40 60 80); PL MC LL % (20 40 60 80)

Elevation (m)	Description and Classification
239.98	**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, trace coarse grained gravel, some organics, trace rootlets.
238.8	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules, trace fine grained gravel.
237.7	**SILT TILL (ML)** - Tan, damp, compact to dense, some fine to coarse grained gravel. - Some cobbles below 3.0 m. - Dense below 4.0 m. - Red below 7.3 m. - Very dense below 7.6 m.
231.1	**LIMESTONE** - White, weak.
230.8	**END OF TEST HOLE AT 9.1 m**

Samples (Sonic Barrel): S1, S2, S3, S4, S5, S6

Cu pocket pen values plotted off-scale: 125, 125, 150, 225, 225

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.

SAMPLE TYPE ▮ Sonic Barrel

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

SUMMARY LOG

KGS GROUP

REFERENCE NO.

HOLE NO. **TH20-07**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	240.62 m
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	100 m North of Saskatchewan Avenue Avenue, East Shoulder of Sturgeon Road	DATE DRILLED	2/4/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,529,234 E 623,750

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	Cu TORVANE (kPa) ◆ / Cu POCKET PEN (kPa) ★
240.62	0.0	**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, some organics, trace rootlets.			◆
239.4	1.2	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	Sonic Barrel	S1	◆
		- Trace coarse grained gravel below 2.1 m.	Sonic Barrel	S2	◆
237.9	2.7	**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles.	Sonic Barrel	S3	★ 200
			Sonic Barrel	S4	
			Sonic Barrel	S5	★ 225
236.7	3.9	**LIMESTONE** - White, weak.			
236.4	4.2	**END OF TEST HOLE AT 4.2 m**			

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

SPT (N) blows/0.15 m ▲ — DYNAMIC CONE (N) blows/ft △ — PL MC LL %

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-08**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	Cu
240.58	0	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1	
237.8	2.8	**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt nodules. - Some silt nodules below 3.0 m.	S2	
236.3	4.3	**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles. - Boulder encountered at 4.8 m.	S3, S4, S5	125
234.3	6.3	**LIMESTONE** - White, weak.	S5	
234.2	6.4	**END OF TEST HOLE AT 6.4 m**		

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; SAMPLE TYPE; NUMBER; RECOVERY %; SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △; 20 40 60; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; 20 40 60 80; PL MC LL; %; 20 40 60 80

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.

SAMPLE TYPE ▐▌ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-09**

SHEET 1 of 1

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.94 m
SITE	Sturgeon Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	240 m Southeast of Summit Road, East Shoulder of Sturgeon Road	DATE DRILLED	2/5/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,529,743 E 623,535

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ / PL MC LL %
239.6		**ASPHALT**					
		GRANULAR FILL - Brown, damp, compact, fine to coarse grained gravel, with crushed limestone.	Sonic Barrel	S1			
			Sonic Barrel	S2			
237.2		**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt nodules.	Sonic Barrel	S3			◆ ◆
236.0		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles.	Sonic Barrel	S4			125 ★, 225 ★
234.5		**LIMESTONE** - White, weak.	Sonic Barrel	S5			
234.1	5.8	**END OF TEST HOLE AT 5.8 m**					

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.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-10**

CLIENT CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT

PROJECT Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering

SITE 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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	Cu TORVANE (kPa) / Cu POCKET PEN (kPa)
239.5		**ASPHALT**			
238.7		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	Sonic Barrel	S1	
236.8		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	Sonic Barrel	S2	Torvane ~80, ~80, ~80
234.5	3.0	**SILT TILL (ML)** - Tan, damp, dense, with fine to coarse grained gravel, trace fine to coarse grained sand, trace cobbles.	Sonic Barrel	S3, S4	Pocket pen 125, 125, 150, 175
234.3		**LIMESTONE** - White, weak.			

END OF TEST HOLE AT 5.4 m

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.

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-11**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.67 m
SITE	Summit Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	350 m Southeast of Centreport Canada Way, East Shoulder of Summit Road	DATE DRILLED	2/5/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,530,038 E 623,085

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆
239.67 – 239.1	0 – 0.6	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.		
239.1 – 238.1	0.6 – 1.6	**CLAY FILL** - Mottled black to grey, damp, stiff, low plasticity, trace rootlets, some organics.		◆
238.1 – 237.2	1.6 – 2.5	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity.	S1	◆ ◆
237.2 – 229.6	2.5 – 10.0	**SILT TILL (ML)** - Tan, damp, dense, with fine to coarse grained gravel, trace fine to coarse grained sand.	S2, S3, S4, S5, S6, S7	125; 125; 150; 150; 150; 200; 200; 225
		- Trace cobbles below 6.0 m.		
		- Boulder encountered at 6.7 m.		
229.6 – 229.3	10.0 – 10.3	**JURASSIC LIMESTONE** - Red, weak.	S8	

END OF TEST HOLE AT 10.3 m

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.

SPT (N) blows/0.15 m ▲ — DYNAMIC CONE (N) blows/ft △ — PL MC LL % — RECOVERY %

SAMPLE TYPE: Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-12**

CLIENT	CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT	JOB NO.	19-0107-009
PROJECT	Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering	GROUND ELEV.	239.70 m
SITE	Summit Road	TOP OF PVC ELEV.	
		WATER ELEV.	
LOCATION	50 m Southeast of Cebtreport Canada Way, North Shoulder of Summit Road	DATE DRILLED	2/6/2020
DRILLING METHOD	Sonic SDC 450, Track Drill Rig	UTM (m)	N 5,530,153 E 622,811

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	PIEZ. DEPTH (m)	SAMPLE NUMBER	Cu POCKET PEN (kPa)
239.4		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, trace fine to coarse grained sand.			
		CLAY FILL - Mottled black to brown, damp, stiff, low plasticity, trace fine grained gravel, some organics.		S1	
237.9		**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, some silt nodules.	3.5	S2	
235.7		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel, trace cobbles, trace fine to coarse grained sand.	4.0, 4.1, 4.3, 4.6	S3	125
					150
				S4	125
					175
				S5	200
		- 500 mm moist sand seam observed at 7.6 m.		S6	125
					200
		- Very dense below 9.7 m.			225
				S7	225
			11.1	S8	225
228.1		**JURASSIC LIMESTONE** - Red, weak.	11.7, 11.9, 12.3		
227.2		**END OF TEST HOLE AT 12.5 m**	12.5	S9	

Column headings: 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 △; 20 40 60; Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆; 20 40 60 80; PL MC LL; %; 20 40 60 80

SAMPLE TYPE Sonic Barrel

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

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	PIEZ. LOG	DEPTH (m)	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20, 40, 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20, 40, 60, 80) / PL, MC, LL % (20, 40, 60, 80)
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										
223	17	55									
222	18	60									
221	19										
220	20	65									
219	21	70									
218	22										
217	23	75									
216	24	80									
215	25										
214	26	85									
213	27	90									
212	28										

SAMPLE TYPE ▮ Sonic Barrel

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

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-13**

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

Columns: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | SAMPLE TYPE | NUMBER | RECOVERY % | SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60) | Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)

Elevation (m)	Depth (m)	Description and Classification	Samples
238.9		**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1
		CLAY FILL - Mottled black to brown, damp, stiff, low plasticity, some organics.	
238.3		**CLAY (CH)** - Brown, damp, stiff, high plasticity, trace silt nodules.	S2
		- Some silt nodules below 3.0 m.	S3
		- 300 mm silt seam at 5.2 m.	S4
233.1		**SILT TILL (ML)** - Tan, damp, dense, some fine to coarse grained gravel, trace fine to coarse grained sand, trace cobbles.	S5, S6
		- Very dense below 8.2 m.	S7, S8, S9

Pocket penetrometer values plotted (kPa): 175, 200, 225, 225, 225, 225, 225

Elevation scale: 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

Depth scale (m): 1–12; (ft): 5, 10, 15, 20, 25, 30, 35, 40

SAMPLE TYPE ▮ Sonic Barrel

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR M. SAALY

APPROVED JRM

DATE 3/9/20

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO.
TH20-13

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER	RECOVERY %	SPT (N) blows/0.15 m ▲ / DYNAMIC CONE (N) blows/ft △ (20 40 60)	Cu POCKET PEN (kPa) ★ / Cu TORVANE (kPa) ◆ (20 40 60 80) / PL MC LL % (20 40 60 80)
226		45			▮	S10			225 ★
225	14								
224.0	15	50		**LIMESTONE** - White, weak.	▮	S11			
223.7				**END OF TEST HOLE AT 15.5 m**					

Notes:
1. TH20-13 open to 14.6 m below grade after the completion of drilling.
2. Water observed at 11.8 m below grade after the completion of drilling.
3. Backfilled with bentonite chips and auger cuttings.

Elevation scale: 226, 225, 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213, 212, 211
Depth (m): 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28
Depth (ft): 45, 50, 55, 60, 65, 70, 75, 80, 85, 90

SAMPLE TYPE ▮ Sonic Barrel

CONTRACTOR Paddock Drilling Ltd.

INSPECTOR M. SAALY

APPROVED JRM

DATE 3/9/20

KGS GROUP

SUMMARY LOG

REFERENCE NO.

HOLE NO. **TH20-14**

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 (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE / NUMBER
239.2		**TOPSOIL**	
237.8	0.2–1.5	**GRANULAR FILL** - Brown, damp, compact, fine to coarse grained gravel, some fine to coarse grained sand.	S1
236.6	1.5–2.7	**CLAY (CH)** - Mottled brown to grey, damp, stiff, high plasticity, trace silt nodules.	S2
230.4	2.7–9.0	**SILT TILL (ML)** - Tan, damp, dense, trace fine to coarse grained gravel, trace fine to coarse grained sand. - Trace cobbles below 3.3 m.	S3, S4, S5, S6
230.1	9.0–9.3	**JURRASIC LIMESTONE** - Red, weak.	S7

END OF TEST HOLE AT 9.3 m

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.

Chart columns: SPT (N) blows/0.15 m ▲; DYNAMIC CONE (N) blows/ft △ (20, 40, 60); Cu POCKET PEN (kPa) ★; Cu TORVANE (kPa) ◆ (20, 40, 60, 80); PL — MC — LL % (20, 40, 60, 80). Annotation: 125

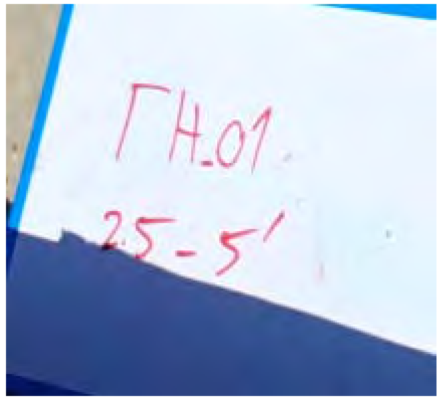
SAMPLE TYPE: Sonic Barrel

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

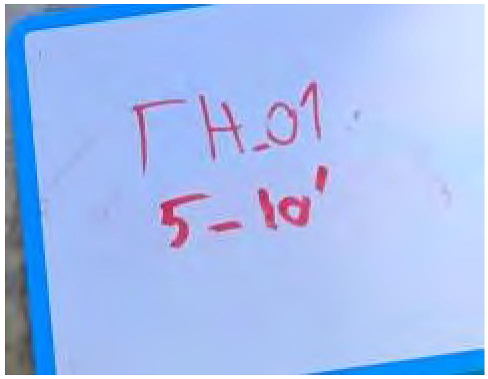
TH19-01


TH-01
0-2.5'


TH-01
0-2.5'
23/09/2019


TH-01
25 - 5'

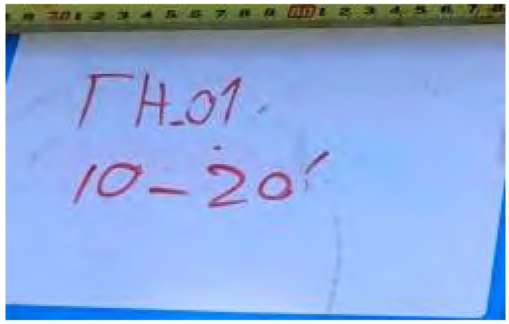

23/09/2019


TH-01
5-10'


23/09/2019

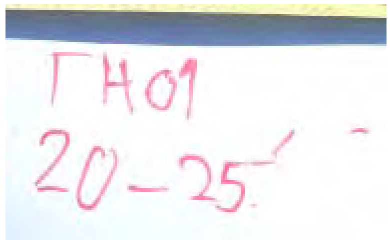

5-10'
23/09/2019


5-10'
23/09/2019


ГН-01
10-20'


ГН-01
10-20'
23/09/2019

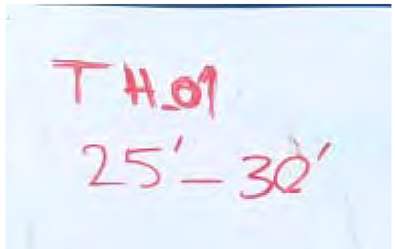

23/09/2019


TH01
20-25


23/09/2019


TH01
20-25'
23/09/2019


TH01
20-25'
23/09/2019


TH 09
25'-30'


23/09/2019

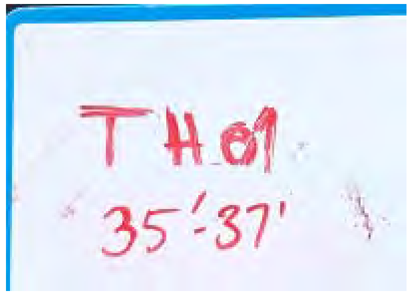

TH.01
25'–30'
23/09/2019


TH01
30'-35'


TH01
30'-35'
23/09/2019

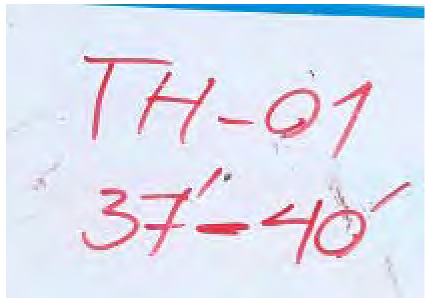

TH.01
30'-35'
23/09/2019


TH.01
30'-35'
23/09/2019

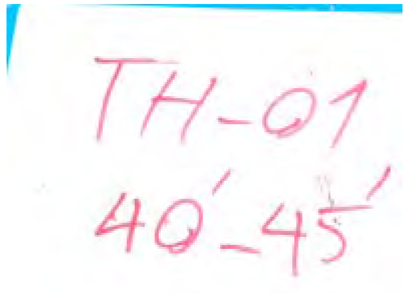

TH 01
35'-37'


TH 01
35'-37'
23/09/2019

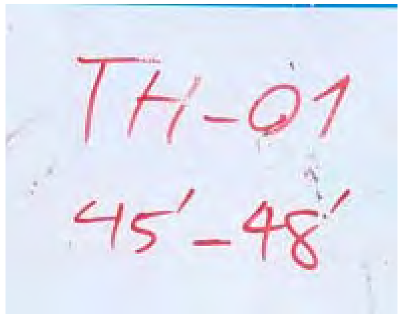

TH 01
35'-37'
HUSKY
23/09/2019


TH-01
37'-40'

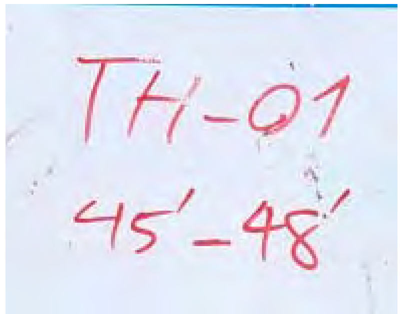

TH-01
37'-40'
23/09/2019


TH-01
40'-45'


TH-01
40'-45'
23/09/2019


TH-01
45'-48'

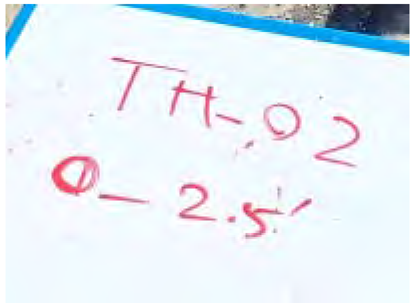

TH-01
45'-48'
23/09/2019


TH-01
45'-48'

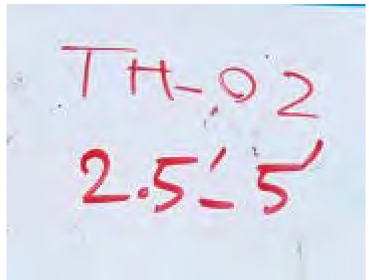

TH-01
45'-48'
23/09/2019


TH-01
45'-48'
23/09/2019

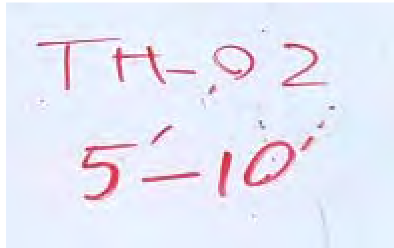
TH19-02


TH-02
0-2.5'

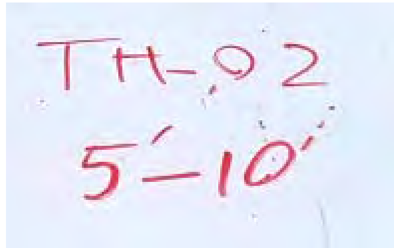

TH-02
0-2.5'
23/09/2019


TH-02
2.5'-5'


TH-02
2.5'-5'
23/09/2019

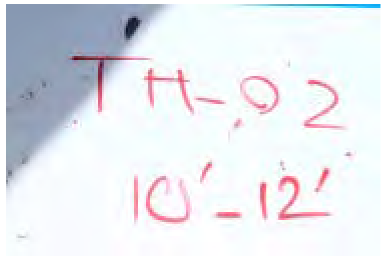

TH-02
5'-10'


TH-02
5'-10'
23/09/2019

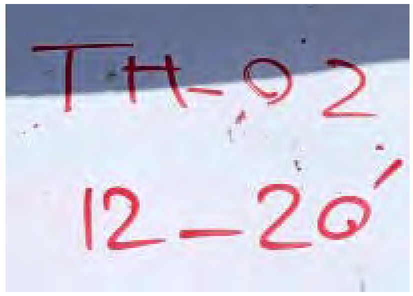

TH-02
5'-10'


TH-02
5'-10'
23/09/2019


TH-02
5'-10'
23/09/2019

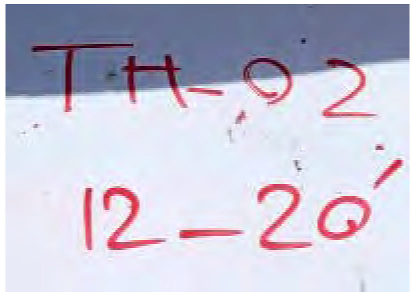

TH-02
10'-12'


TH-02
10'-12'
23/09/2019

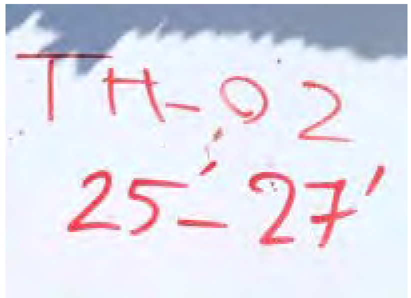

TH-02
12-20'


TH-02
12-20'
23/09/2019


TH-02
12-20'
23/09/2019

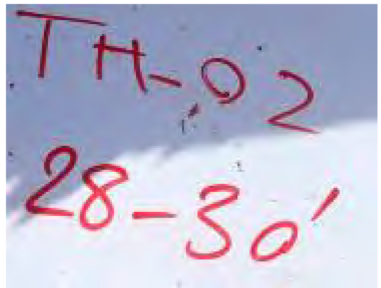

TH-02
12-20'


TH-02
12-20'
23/09/2019

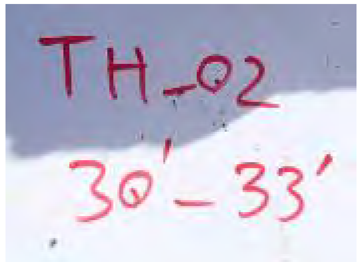

TH-02
25'-27'


TH-02
25'-27'
23/09/2019

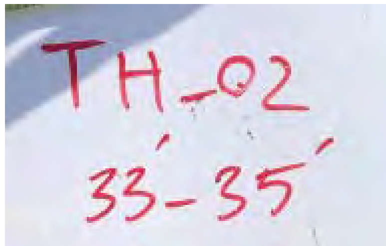

TH-02
25'-27'
23/09/2019


TH-02
28-30'

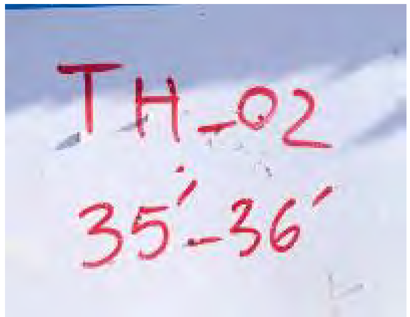

TH-02
28-30'
23/09/2019


TH-02
30'-33'

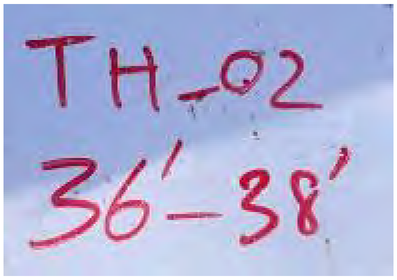

TH-02
30'-33'
23/09/2019


TH-02
33'-35'

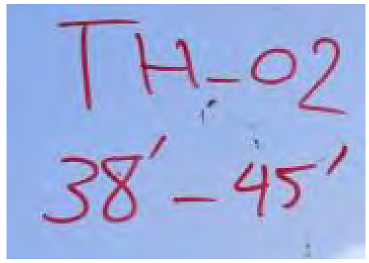

TH-02
33'-35'
23/09/2019


TH-02
35'-36'

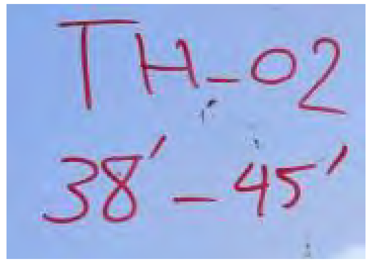

TH-02
35'-36'
23/09/2019


TH-02
36'-38'


TH-02
36'-38'
23/09/2019


TH-02
38'-45'

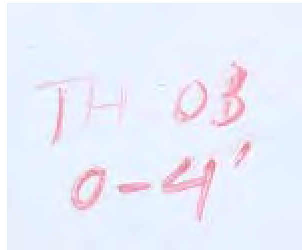

TH-02
38'-45'
23/09/2019


TH-02
38'-45'

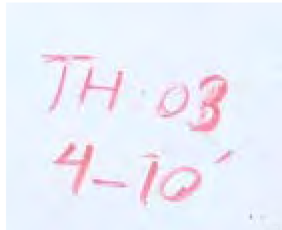

TH-02
38'-45'
23/09/2019


TH-02
38'-45'

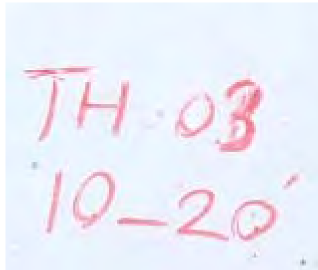
TH19-03


TH 03
0-4'

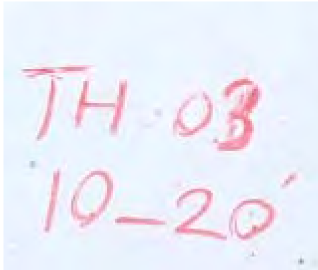

TH 03
0-4'
24/09/2019


TH 03
4-10'

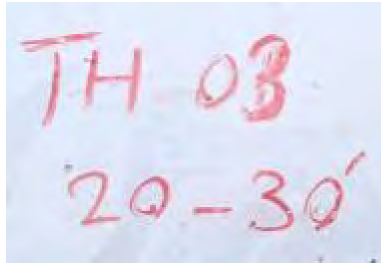

TH 03
4-10'
24/09/2019


TH 03
10–20'

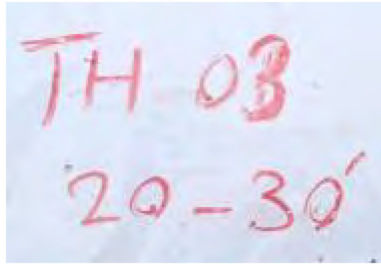

24/09/2019
TH 03
10–20


TH 03
10–20'


TH 03
10–20'
24/09/2019


TH 03
20 - 30'


TH 03
20-30'
24/09/2019

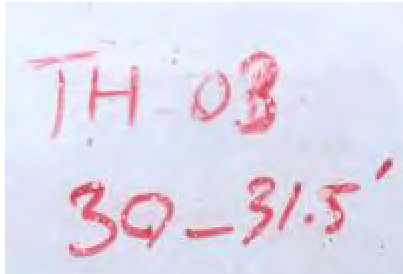

TH 03
20-30'


TH 03
20-30'
24/09/2019


TH 03
24/09/2019


TH 03
20-30'
24/09/2019

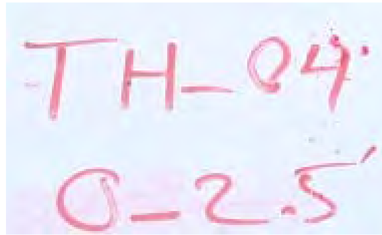

TH 03
20-30'
24/09/2019


TH 08
30_31.5'

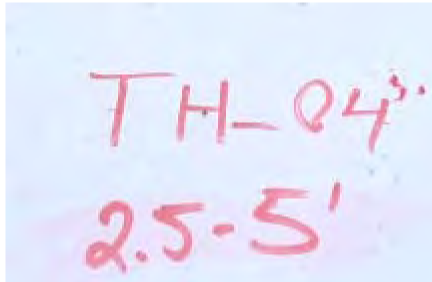

TH 08
30_31.5'
24/09/2019


TH 08
30_31.5'
24/09/2019

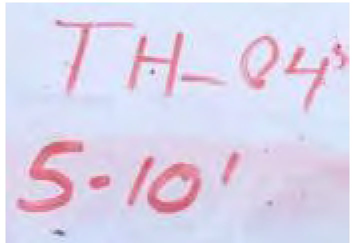
TH19-04


TH-04
0-2.5'

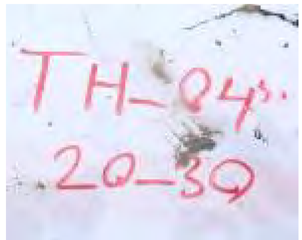

TH-04
0-2.5
24/09/2019


TH-04
2.5-5'

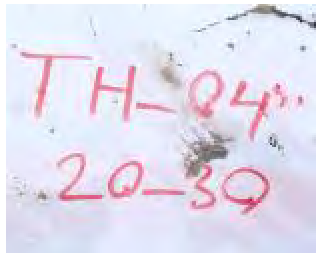

TH-04
2.5-5'
24/09/2019

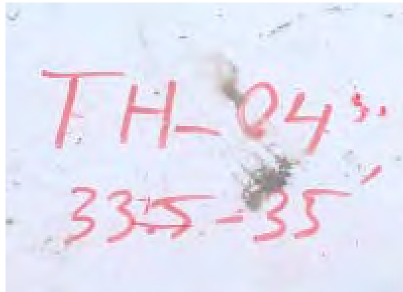

TH-04s
5-10'


24/09/2019

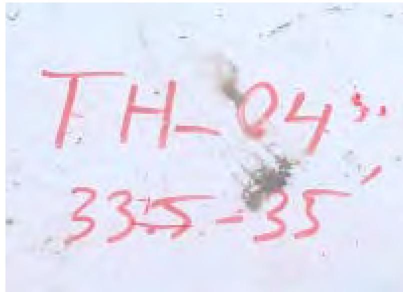

TH-04.
20-30


TH-04
20-30
24/09/2019

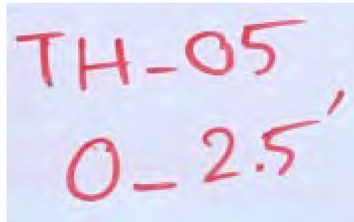

TH-04
20-30


TH-04
33.5-35'

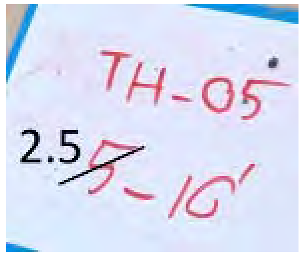

24/09/2019


TH-04
33.5-35'

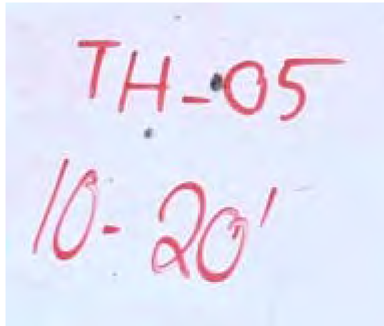
TH19-05


TH-05
0_2.5'


TH-05
0_2.5'
24/09/2019

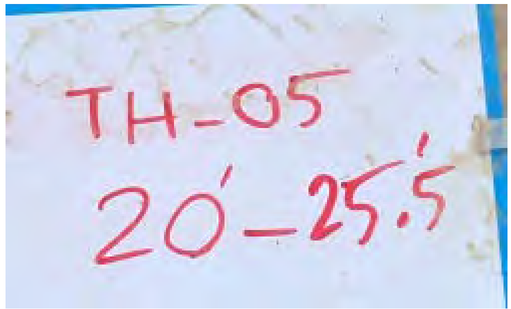

TH-05
2.5 ~~5~~-16'


TH-05
5-16'
24/09/2019


TH-05
10-20'

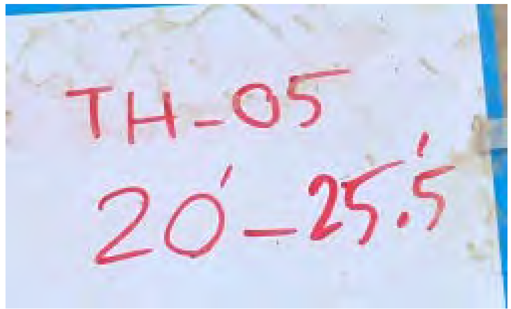

TH-05
10-20'
24/09/2019


TH-05


TH-05
20'-25.5'

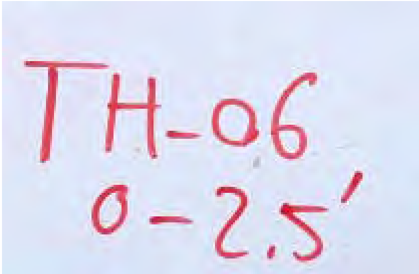

TH-05
20'-25.5'
24/09/2019


24/09/2019

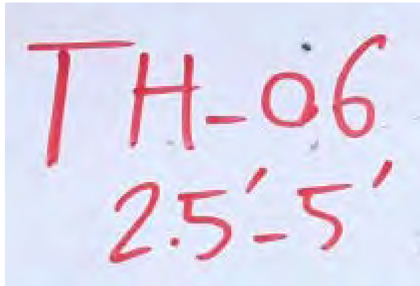

TH-05
20'-25.5'


24/09/2019

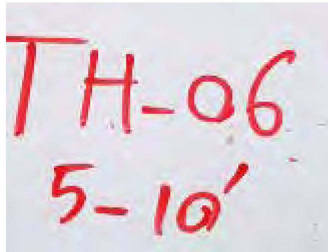
TH19-06


TH-06
0-2.5'

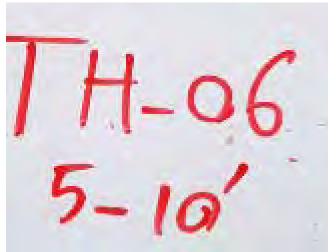

TH-06
0-2.5'
24/09/2019

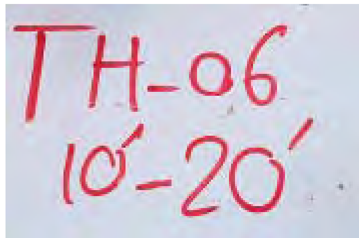

TH-06
2.5'-5'


TH-06
2.5'-5'
24/09/2019

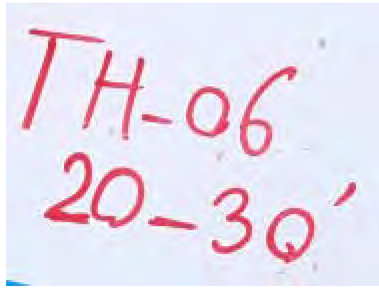

TH-06
5-10'

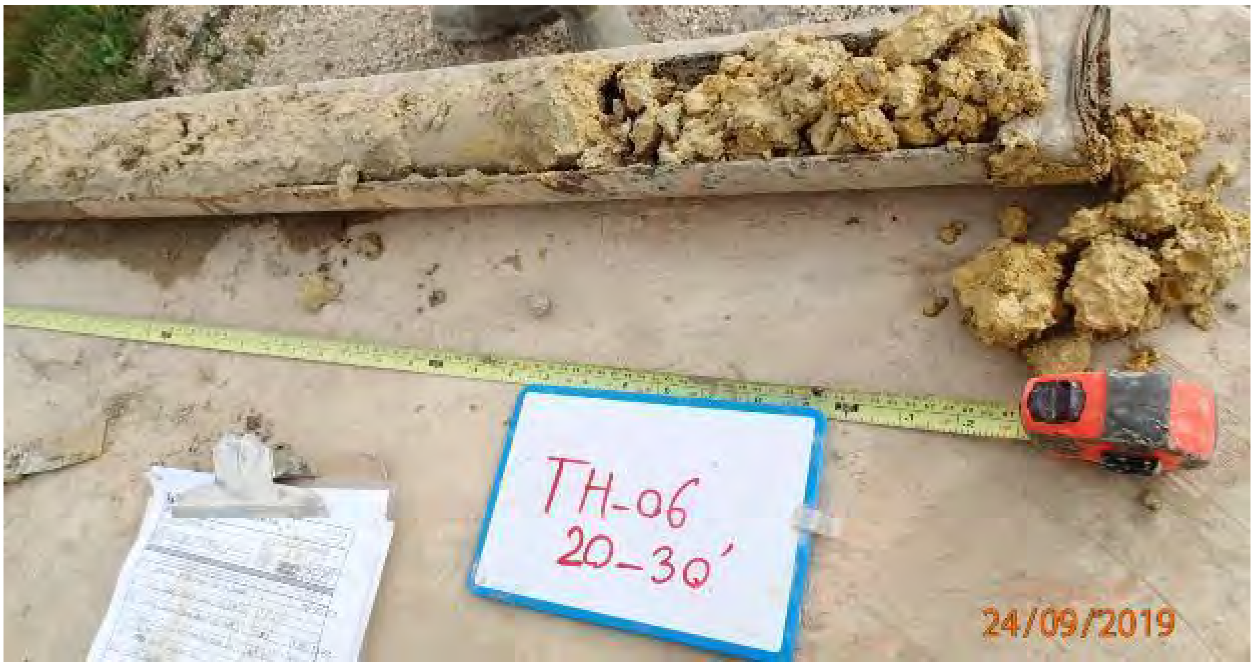

TH-06
5-10'


TH-06
5-10'


TH-06
10'-20'

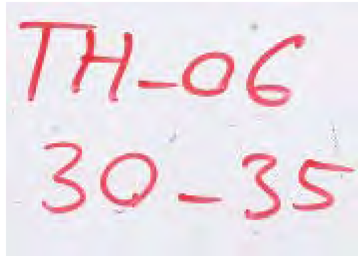

TH-06
10'-20'


TH-06
20-30'


TH-06
20-30'
24/09/2019

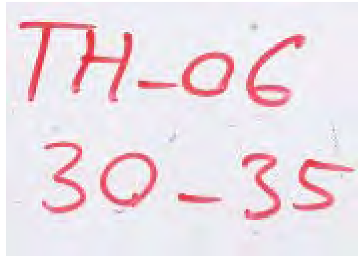

TH-06
20-30'
24/09/2019


TH-06

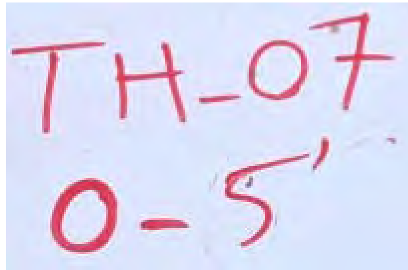

TH-06
30-35


TH-06
30-35

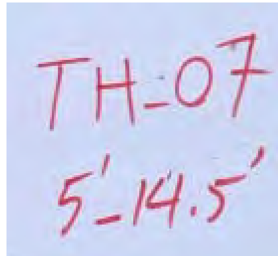

TH-06
30-35
24/09/2019


TH-06
30-35

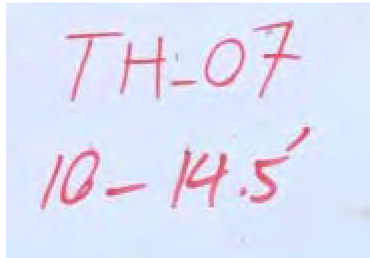
TH19-07


TH_07
0-5'


TH_07
0-5'
24/09/2019

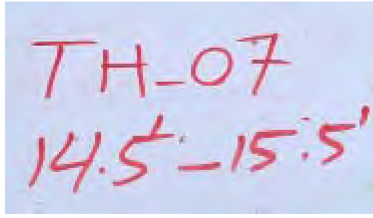

TH-07
5'-14.5'


24/09/2019
TH-07
5'-14.5'


TH-07
10 - 14.5'

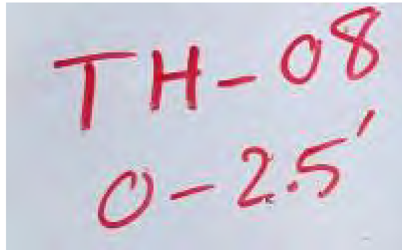

TH-07
10 - 14.5'
24/09/2019


TH_07
10 – 14.5'
24/09/2019

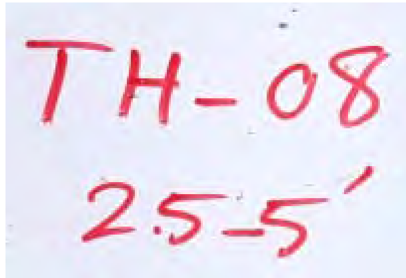

TH_07
14.5'_15.5'


TH_07
14.5'_15.5'
24/09/2019

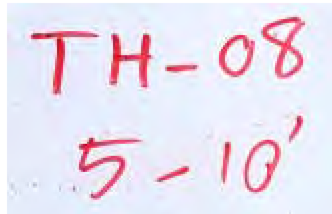
TH19-08


TH-08
0-2.5'

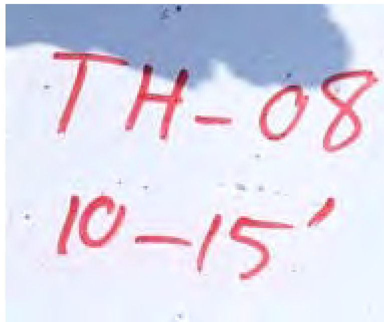

TH-08
0-2.5'
25/09/2019


TH-08
2.5-5'


TH-08
2.5-5'
25/09/2019

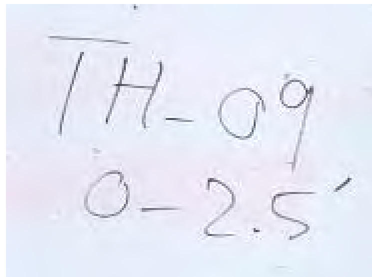

TH-08
5-10'


TH-08
5-10'
25/09/2019

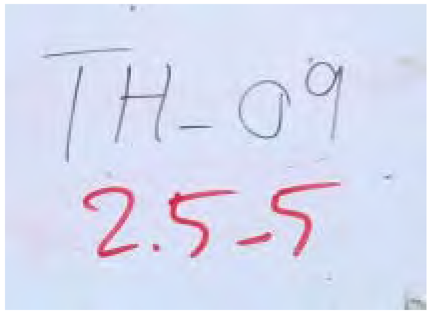

TH-08
10-15'


TH-08
10-15'
25/09/2019

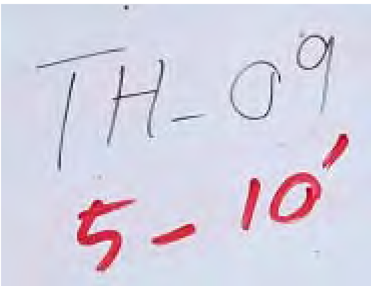
TH19-09


TH-09
0-2.5'


TH-09
0-2.5'
25/09/2019

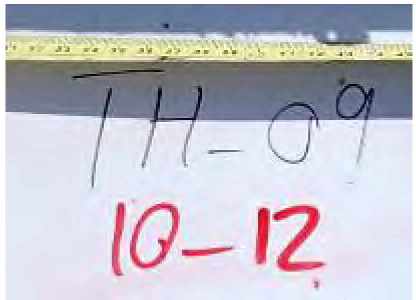

TH_09
2.5-5


TH_09
2.5-5
25/09/2019

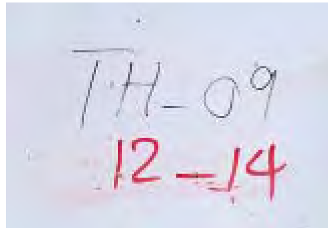

TH-09
5-10'

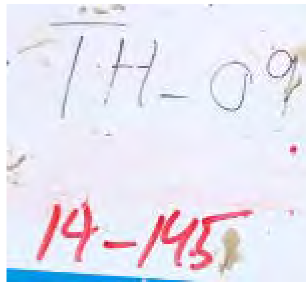

TH-09
5-10'

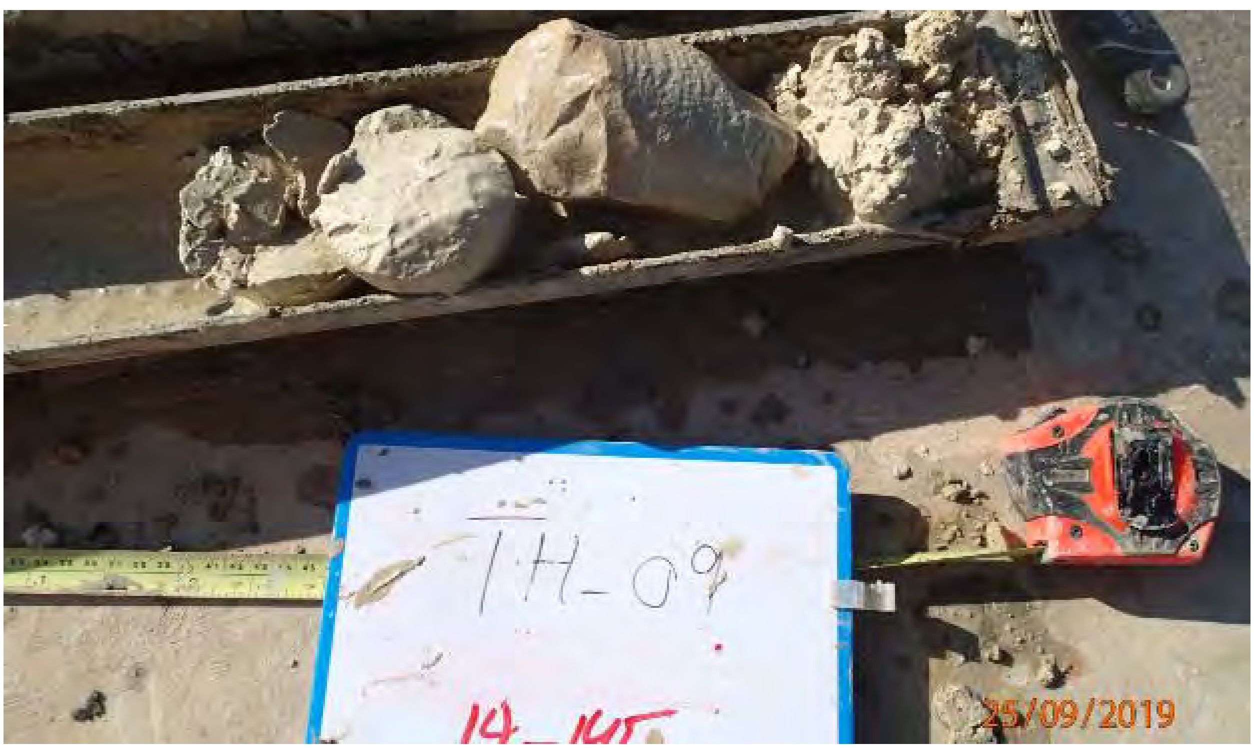

TH-09
5-10'
25/09/2019


TH-09
10-12

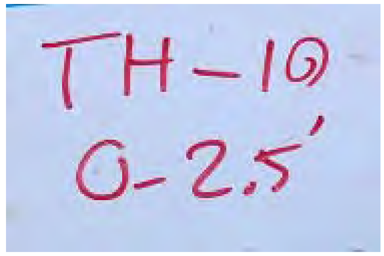

TH-09
10-12
25/09/2019


TH-09
12-14

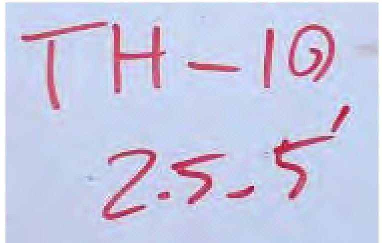

TH-09
14-14.5


TH-09
25/09/2019

TH19-10

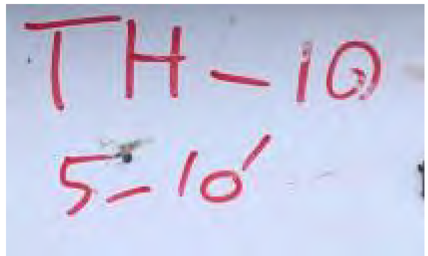

TH-10
0-2.5'


TH-10
0-2.5'
25/09/2019

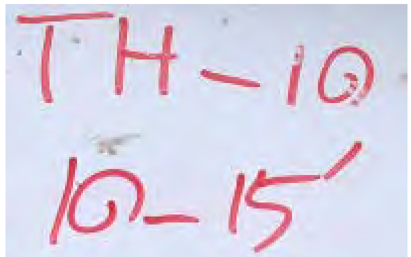

TH-10
2.5-5'


TH-10
2.5-5'
25/09/2019

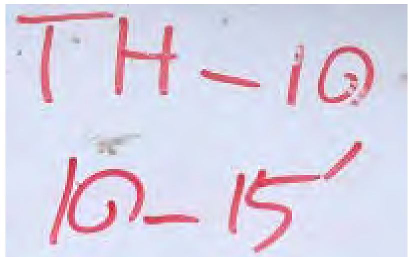

TH-10
2.5-5'


TH-10
5-10'


TH-10
5-10'
25/09/2019

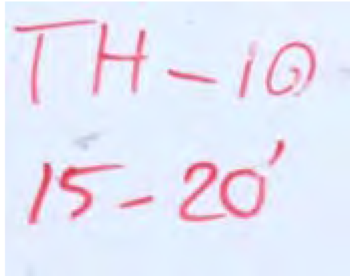

TH-10
10-15'


25/09/2019
TH-10
10-15'


TH-10
10-15'

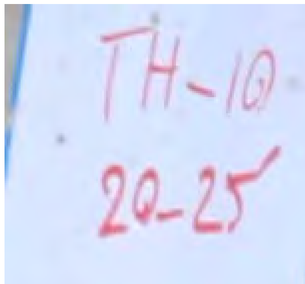

TH-10
10-15'
25/09/2019


TH-10
10-15'
25/09/2019

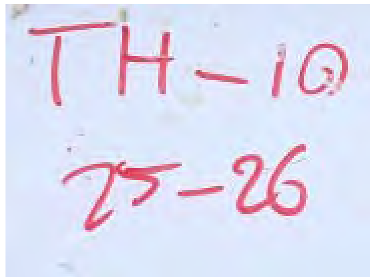

TH-10
15-20'


TH-10
15-20'
25/09/2019


TH-10

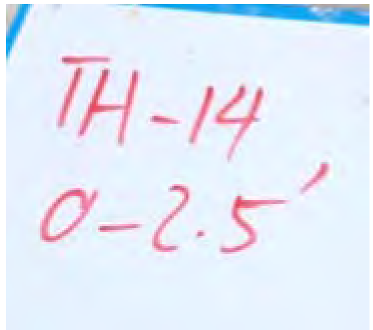

TH-10
20-25'


25/09/2019

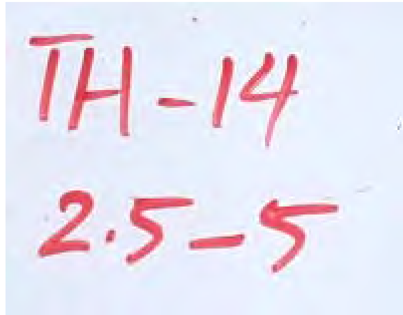

TH-10
25-26


25/09/2019

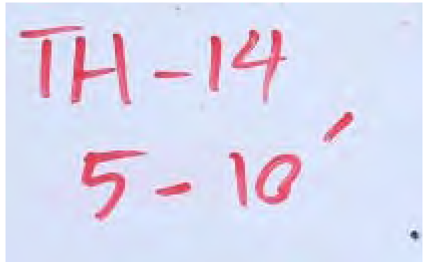
TH19-14


TH-14
0-2.5'

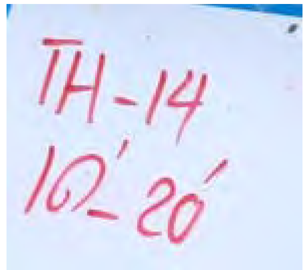

TH-14
0-2.5'
25/09/2019


TH-14
2.5-5


TH-14
2.5-5
25/09/2019

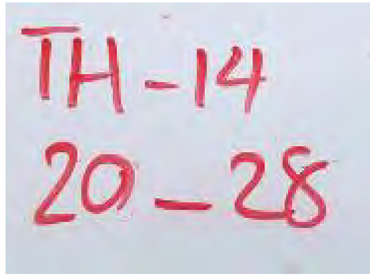

TH-14
5-10´


TH-14
5-10´
25/09/2019

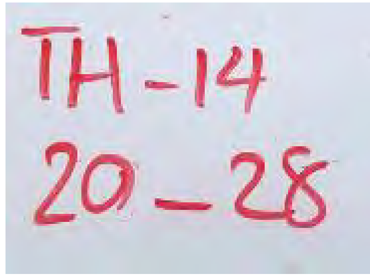

TH-14
10'-20'

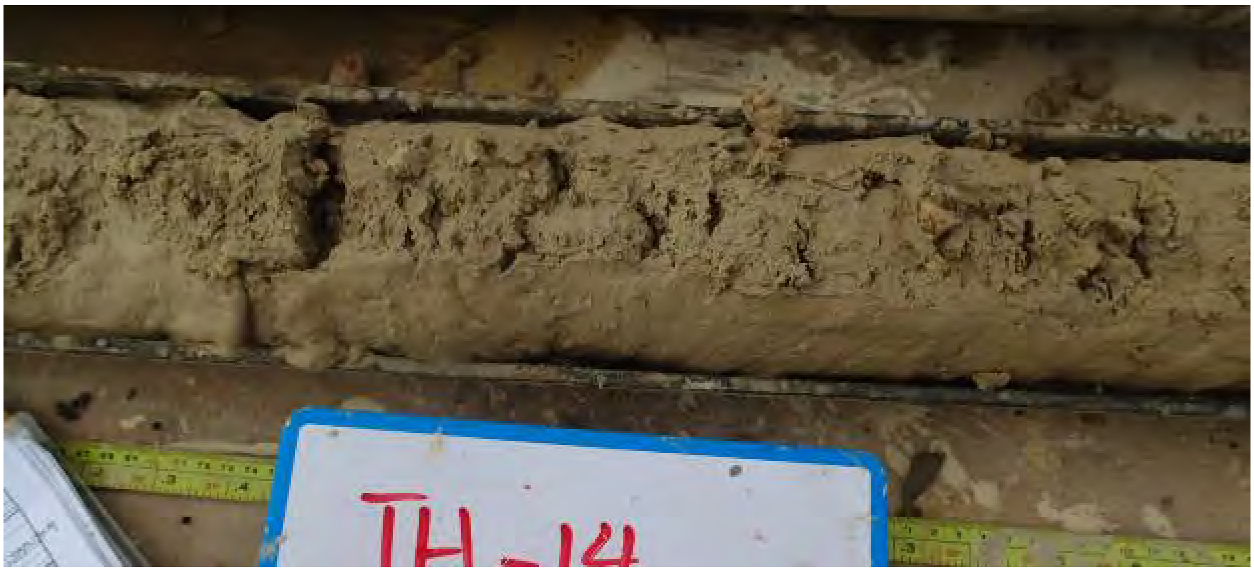

TH-14
10'-20'

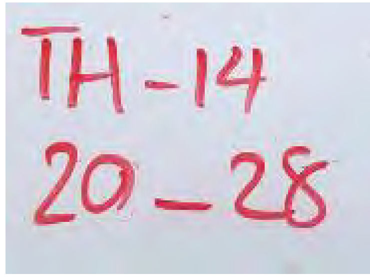

TH-14
10'-20'
25/09/2019

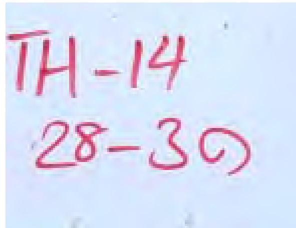

TH-14
20_28


TH-14
20_28


TH-14
20_28


TH-14

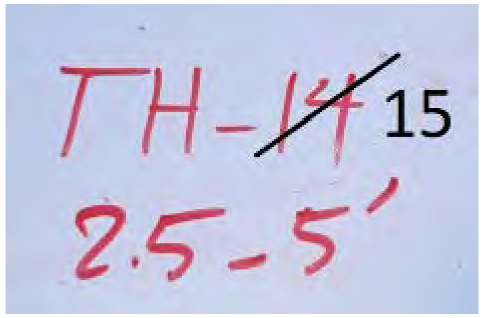

TH-14
20_28


TH-14
28-30


TH-14

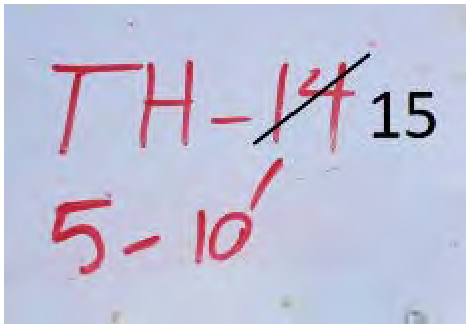

TH-14
28-30

TH19-15

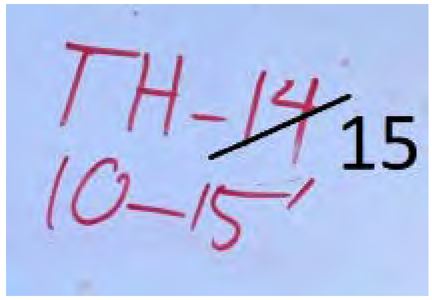

TH-~~14~~ 15
2.5-5'


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

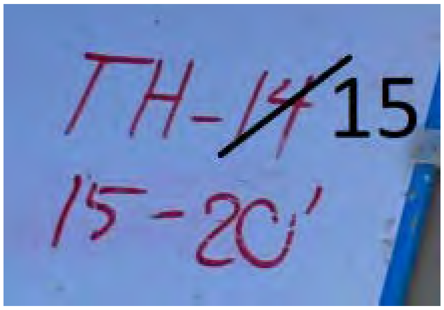

TH-~~14~~ 15
2.5-5'
26/09/2019


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

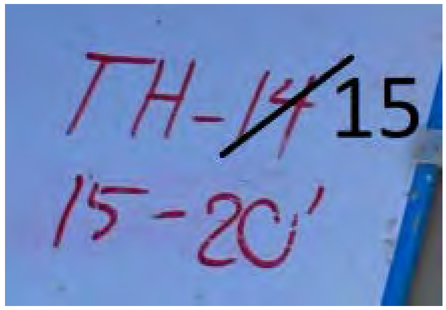

TH-~~14~~ 15
5-10'
26/09/2019

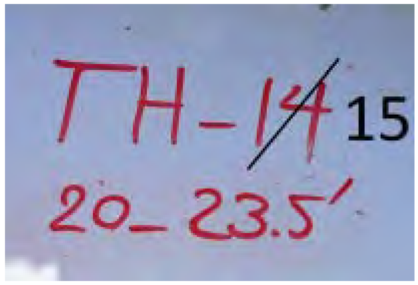

TH-~~14~~ 15
10-15'


TH-~~14~~ 15
10-15'
26/09/2019

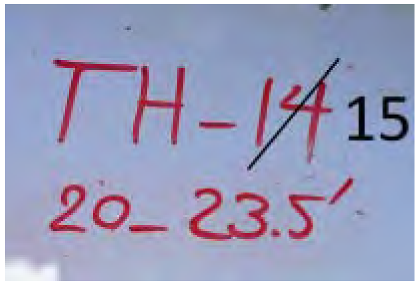

TH-~~14~~15
15-20'


TH-~~14~~15
15-20'
26/09/2019

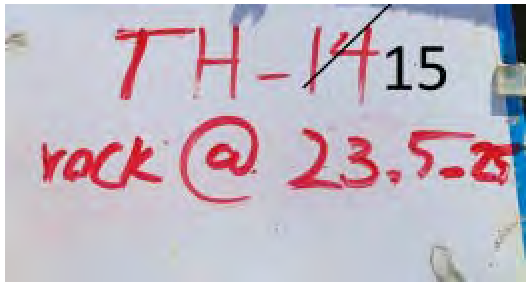

TH-~~14~~15
15-20'


TH-~~14~~ 15
20_23.5'

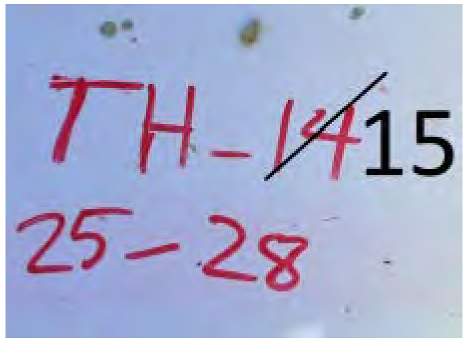

TH-~~14~~ 15
20_23.5'
26/09/2019


TH-~~14~~15
20_23.5'

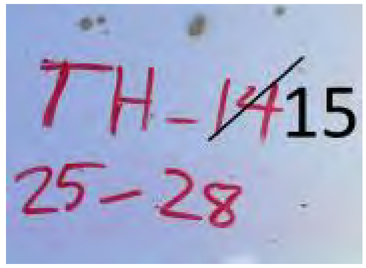

TH-~~14~~15
20_23.5'
26/09/2019

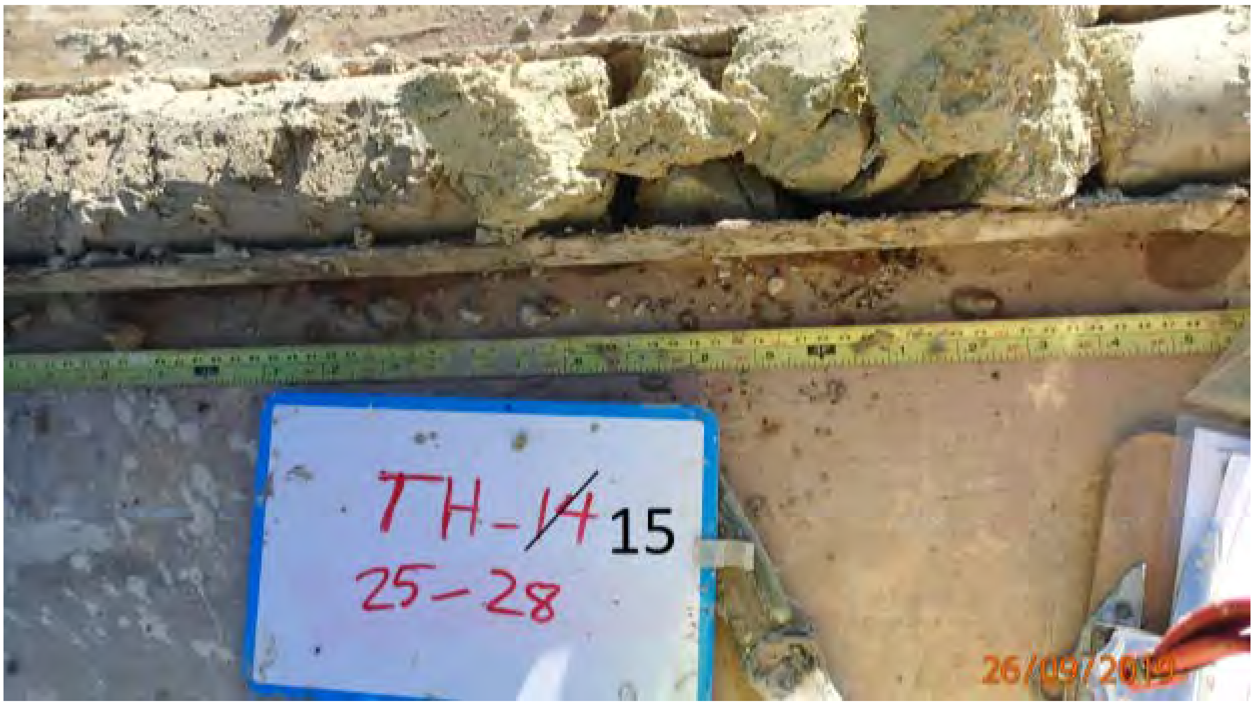

TH-~~14~~15
rock @ 23.5-25


TH-~~14~~15
rock @ 23.5-25
26/09/2019


TH-~~14~~15
25-28


TH-~~14~~15
25-28
26/09/2019


TH-~~14~~15
25-28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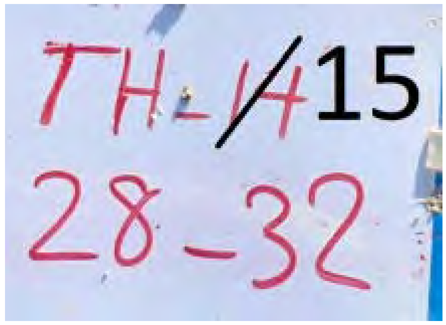
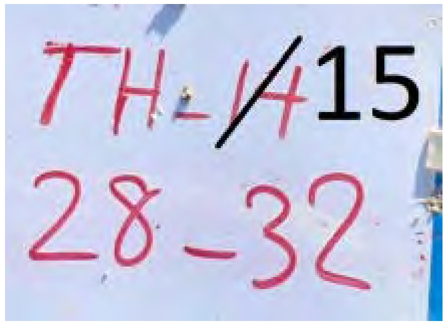
25-28
26/09/2019

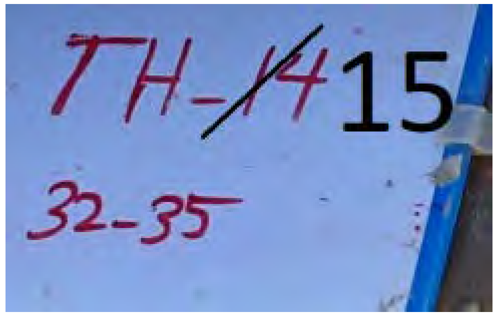

TH-14 15
28-32


TH-14 15
28-32
26/09/2019


TH-14 15
28-32


28-32


28-32
26/09/2019


TH-~~14~~15
32-35


TH-~~14~~15
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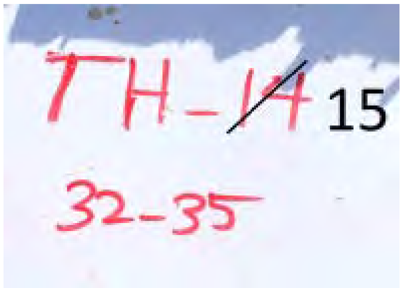
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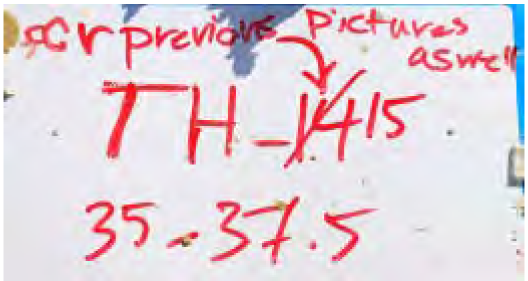
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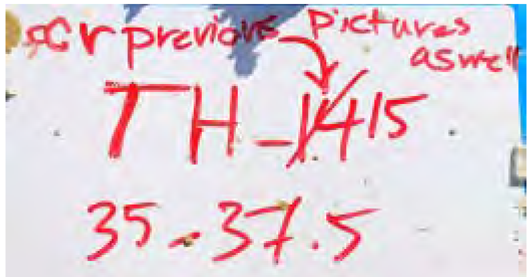
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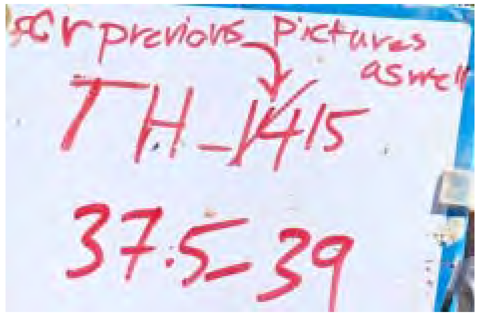
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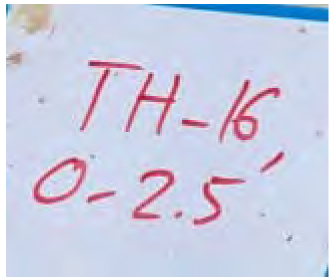
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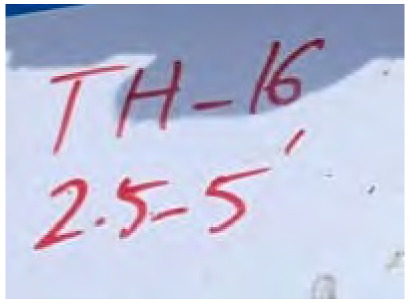
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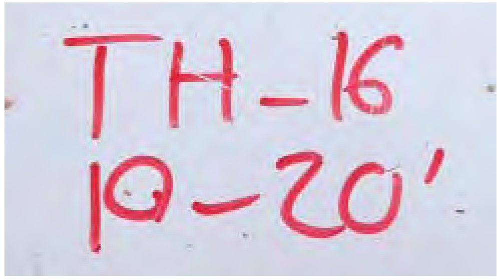
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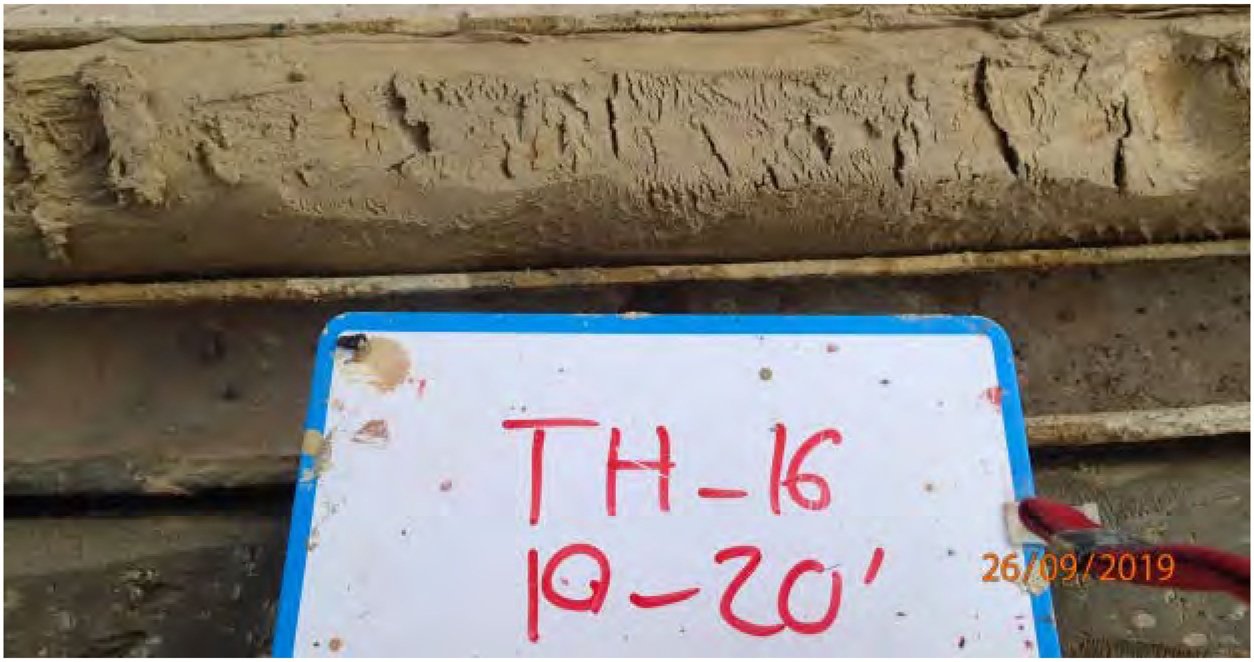
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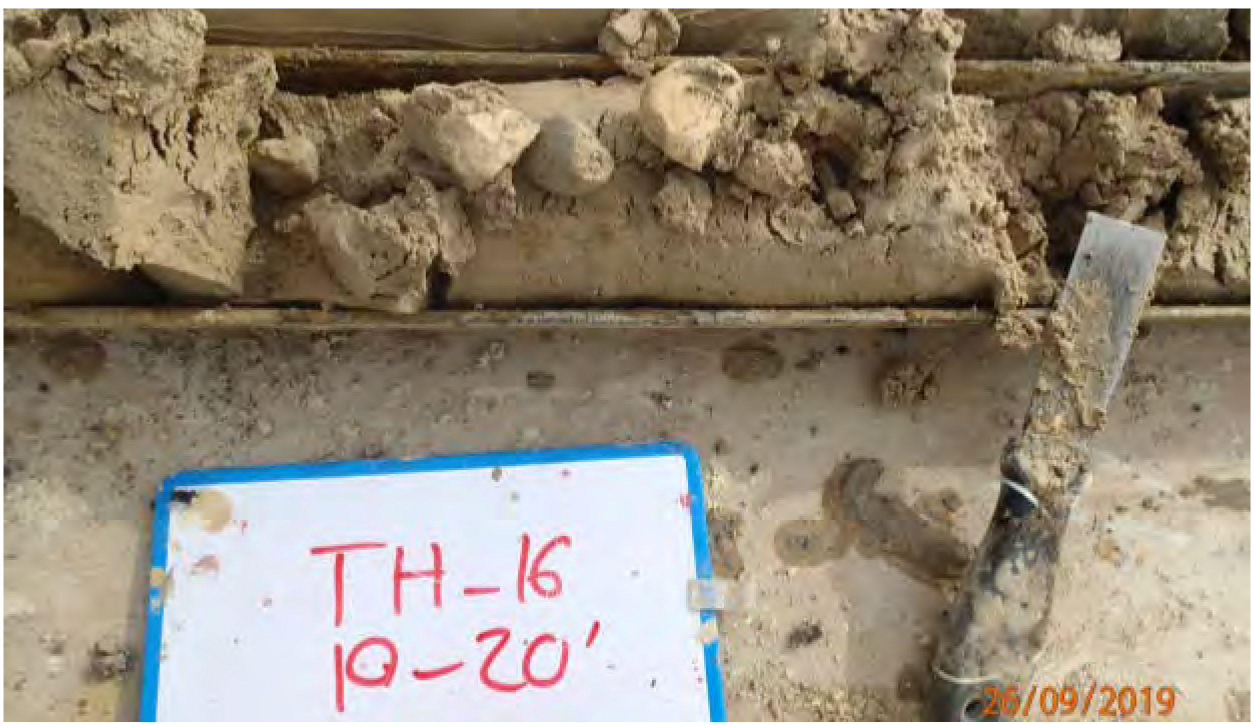
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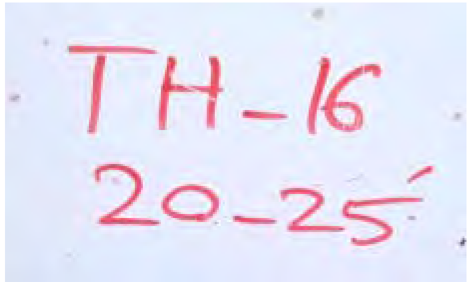
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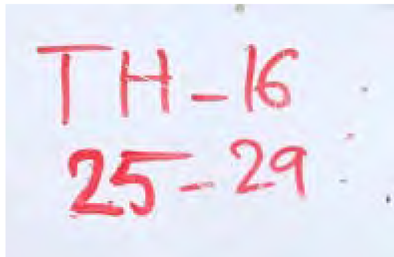
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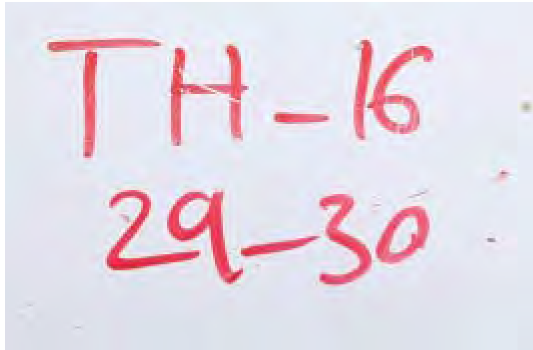
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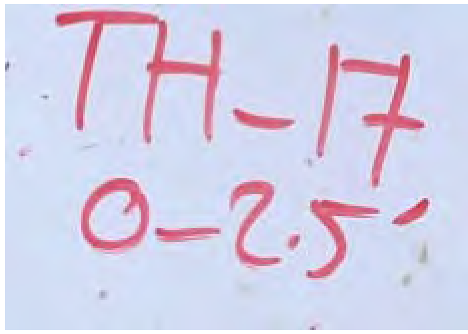
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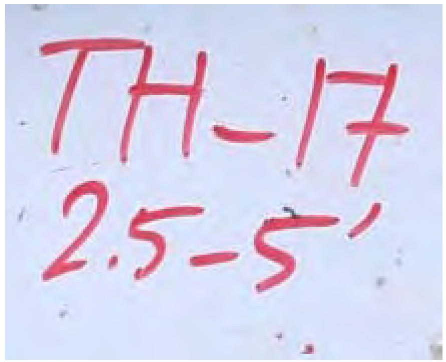
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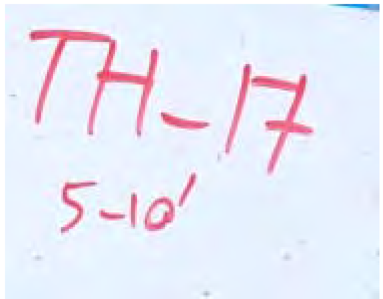
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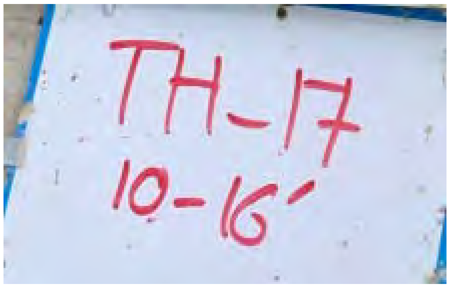
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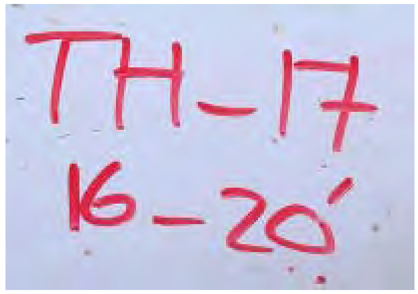
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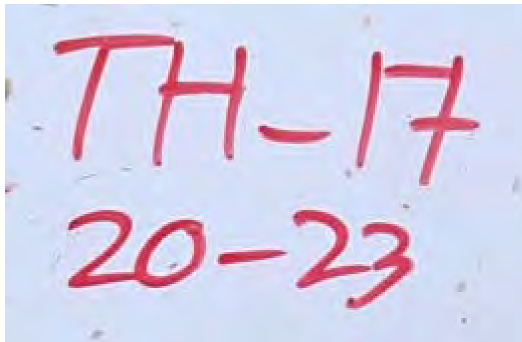
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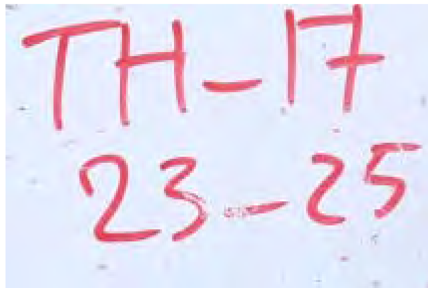
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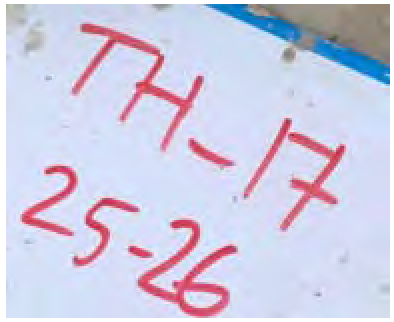
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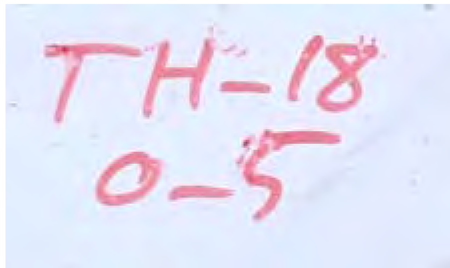
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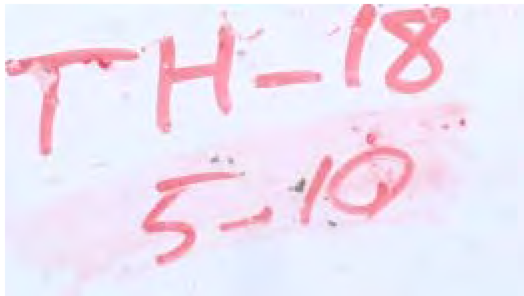
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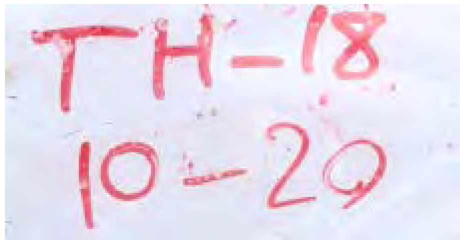
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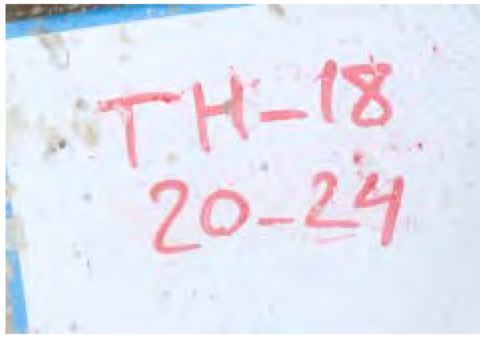
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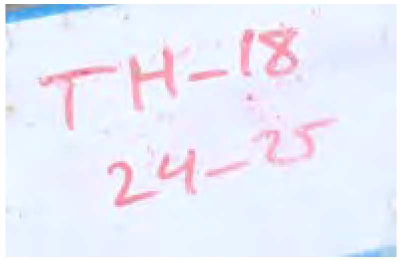
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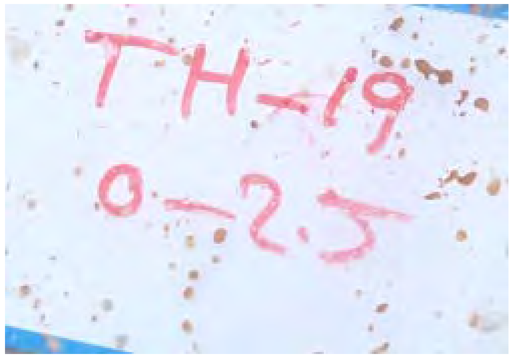
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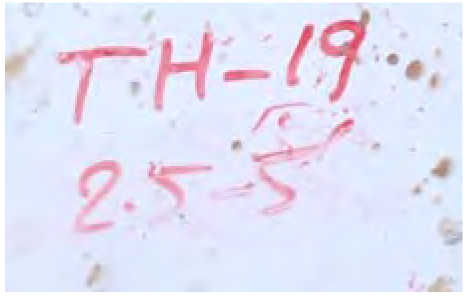
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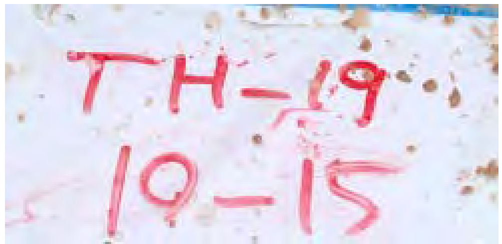
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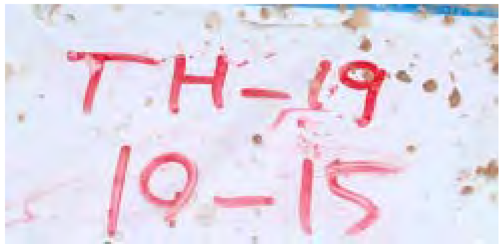
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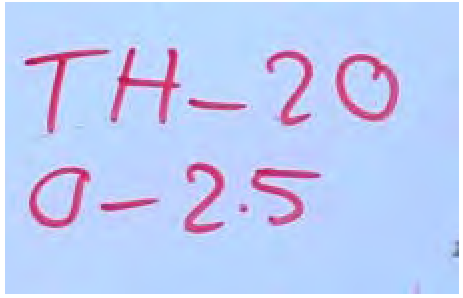
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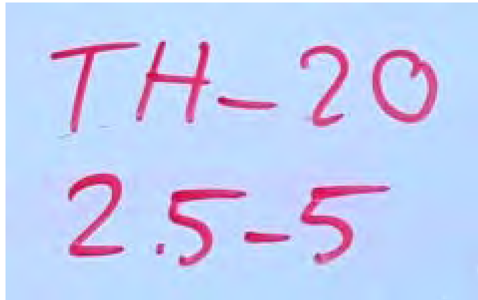
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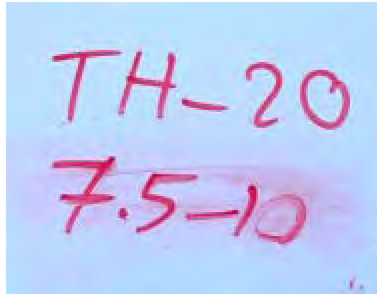
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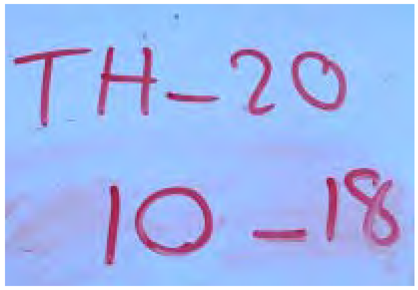
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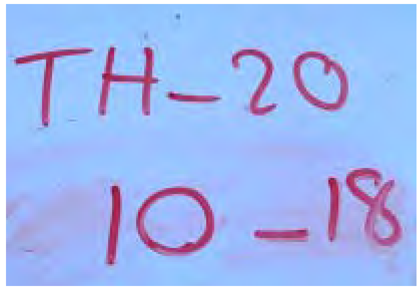
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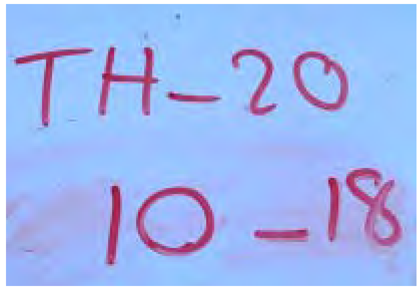
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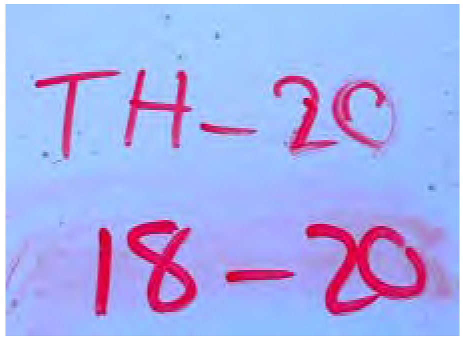
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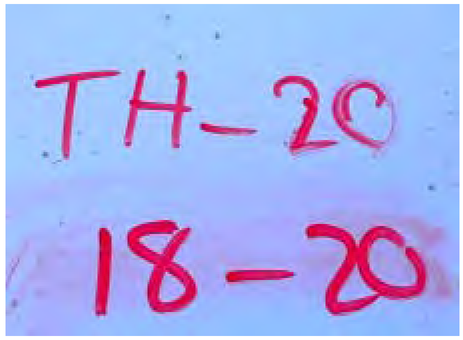
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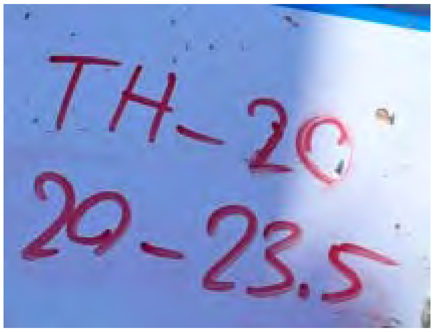
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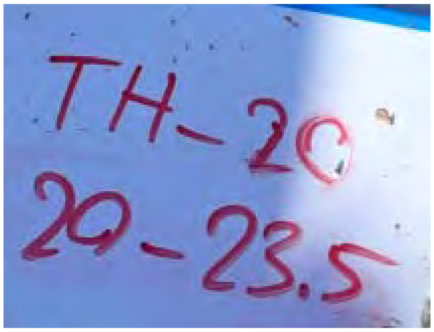
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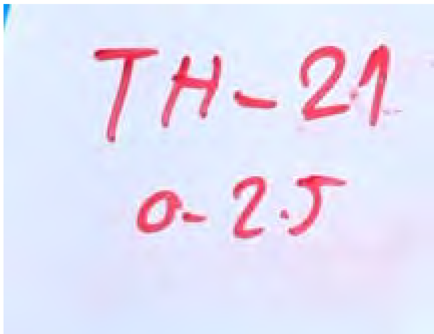
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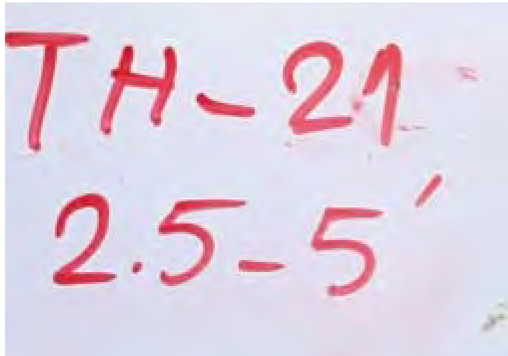
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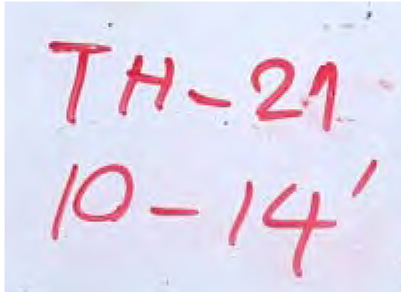
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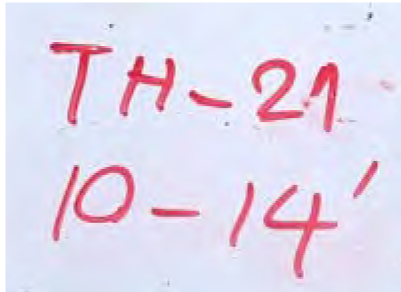
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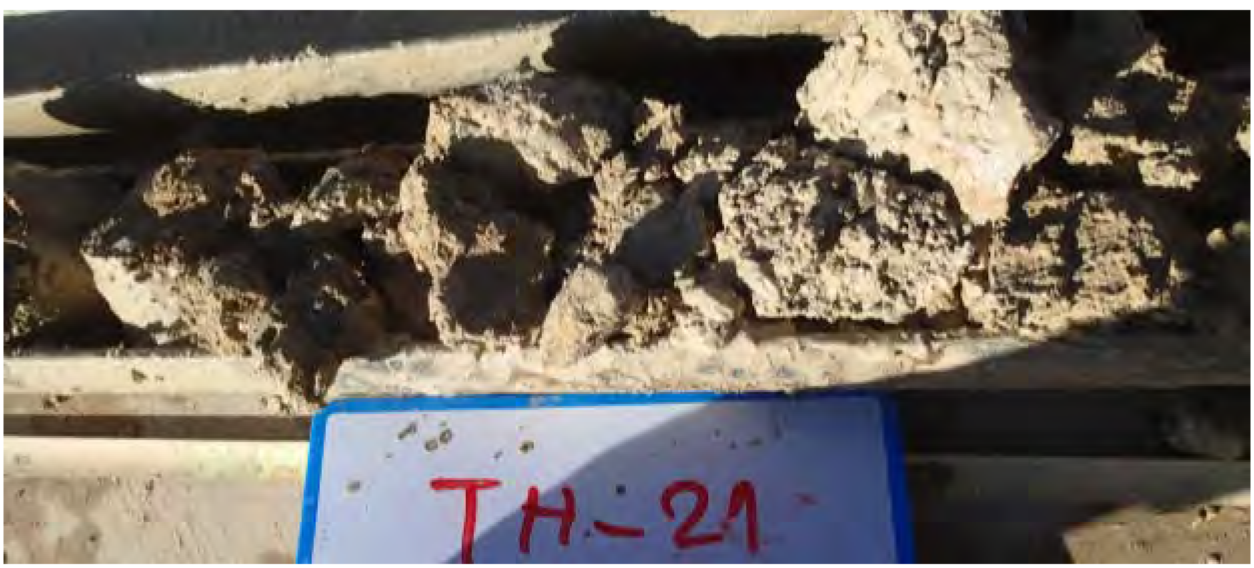
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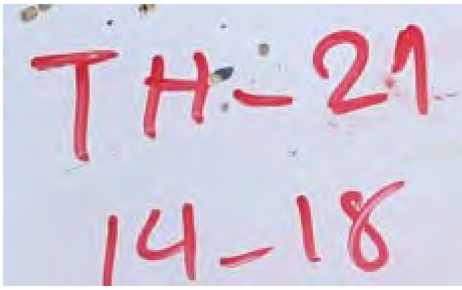
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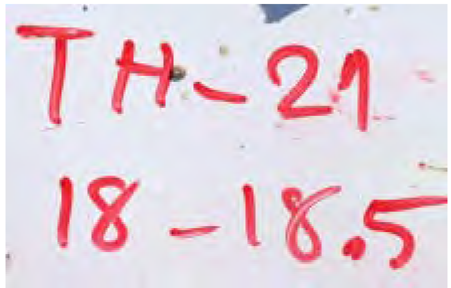
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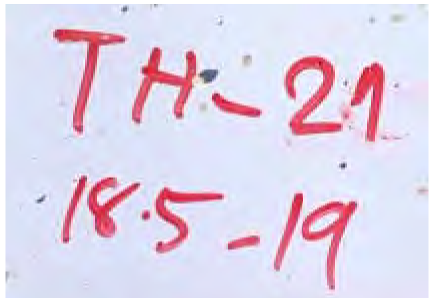
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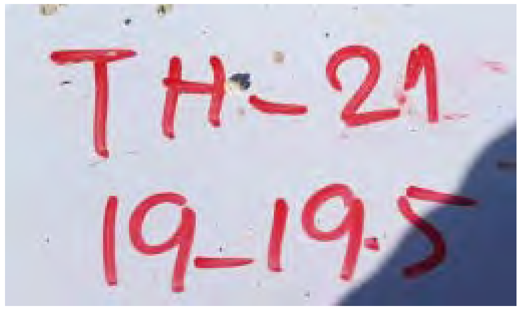
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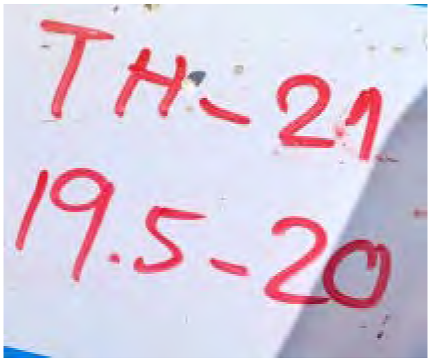
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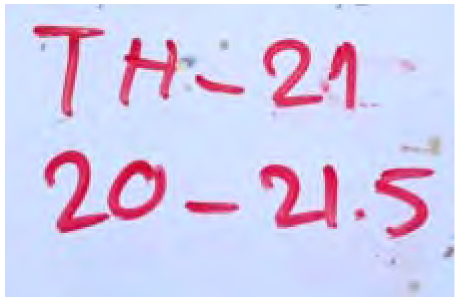
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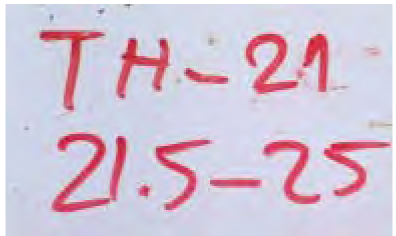
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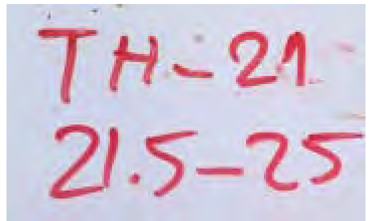
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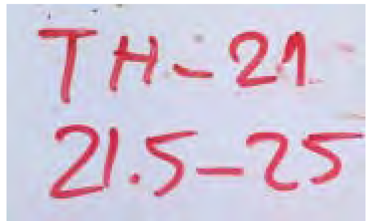
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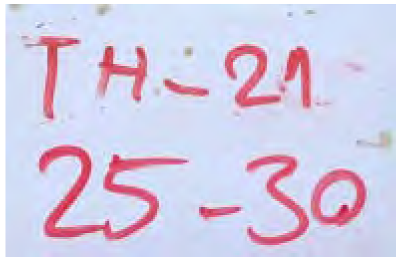
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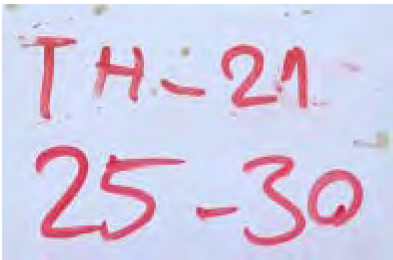
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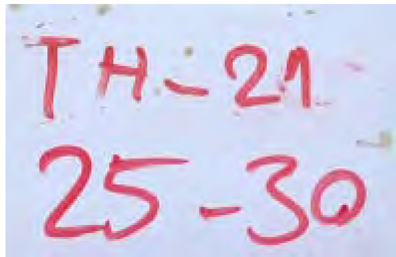
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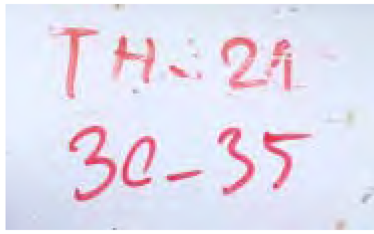
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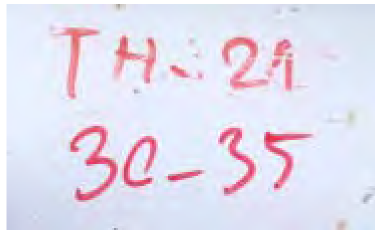
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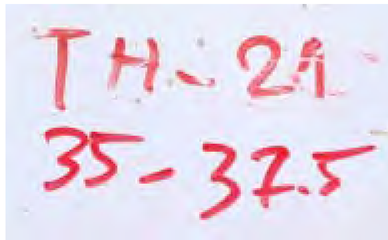
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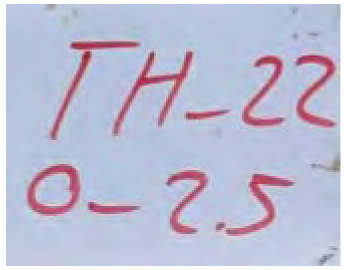
27/09/2019

TH19-22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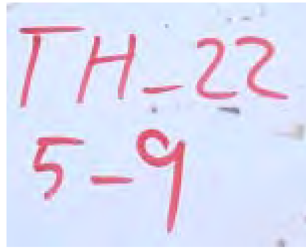
TH_22
0_2.5
27/09/2019


TH_22
2.5_5
27/09/2019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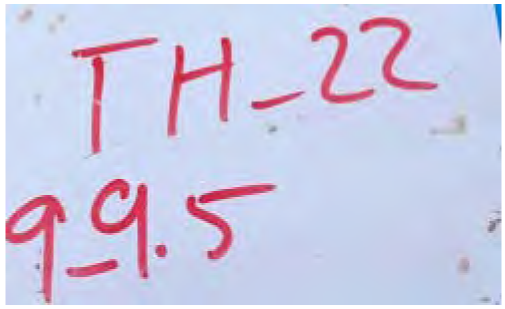
TH_22
27/09/2019


TH_22
5-9
27/09/2019


TH-22
5-9
27/09/2019


27/09/2019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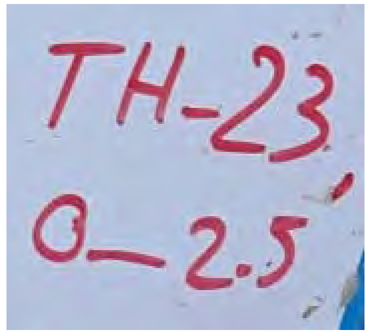
TH_22
9-9.5
27/09/2019

TH19-23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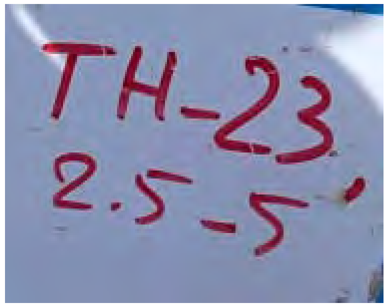
0-2.5'


TH-23,
0-2.5'
27/09/2019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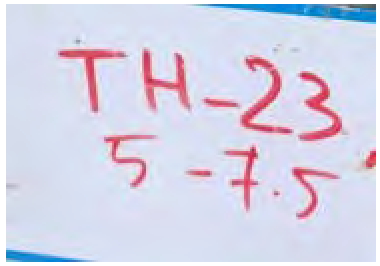
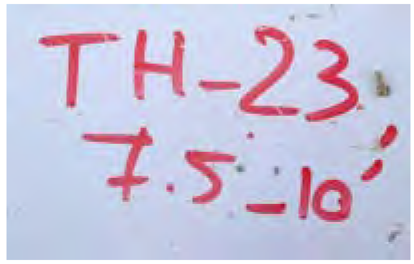
2.5-5'


TH-23
2.5-5'
27/09/2019


TH-23


TH-23
5 -7.5'


27/09/2019
TH-23
5 -7.5'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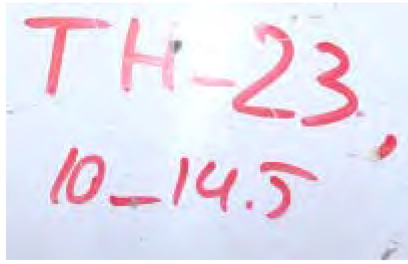
7.5-10'


TH-23
7.5-10'
27/09/2019


TH-23
7.5-10'
27/09/2019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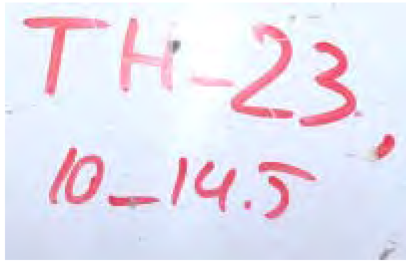
27/09/2019
TH-23
10-14.5'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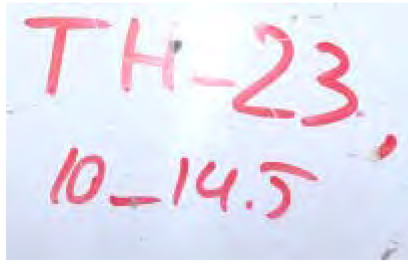
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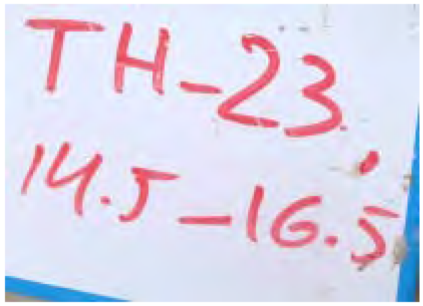
10-14.5'


TH-23,
10-14.5
27/09/2019


TH-23
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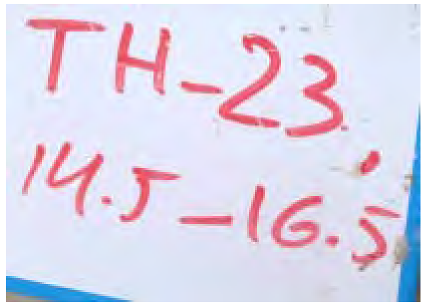
TH-23
14.5-16.5
27/09/2019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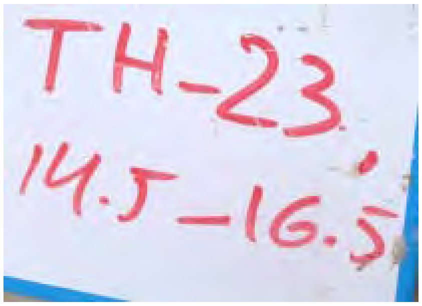
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TH-23
14.5-16.5
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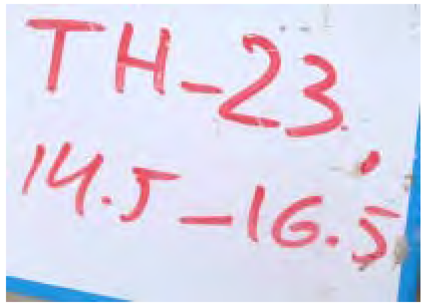
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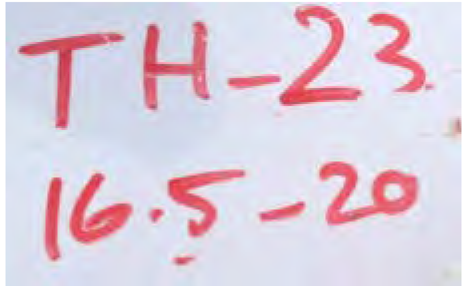
TH-23
14.5-16.5'
27/09/2019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TH-23
16.5-20
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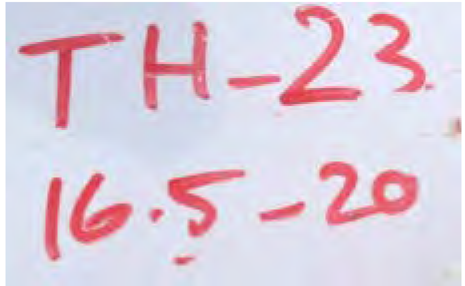
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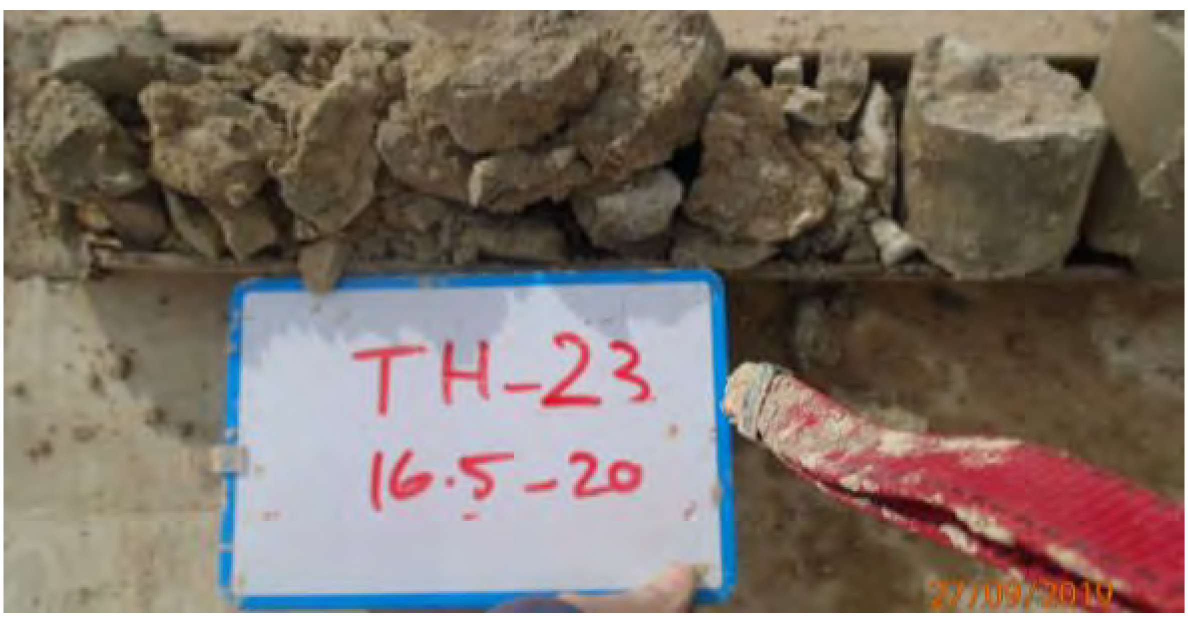
16.5-20


TH-23
16.5-20
27/09/2019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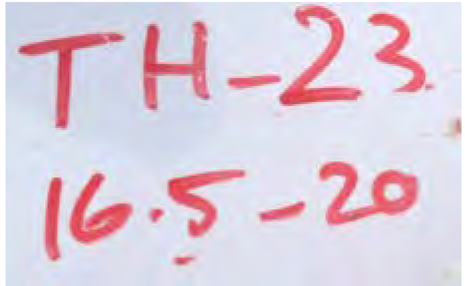
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16.5-20


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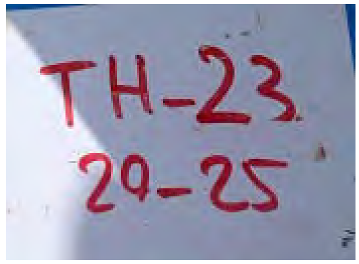
16.5-20
27/09/2019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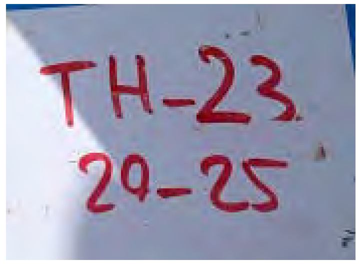
29-25


TH-23
29-25
27/09/2019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TH-23
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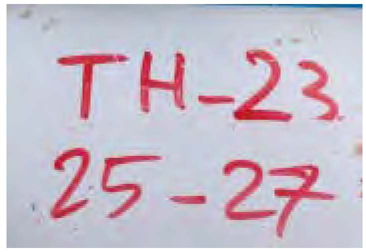
27/09/2019


TH-23
29-25
27/09/2019


TH-23
27/09/2019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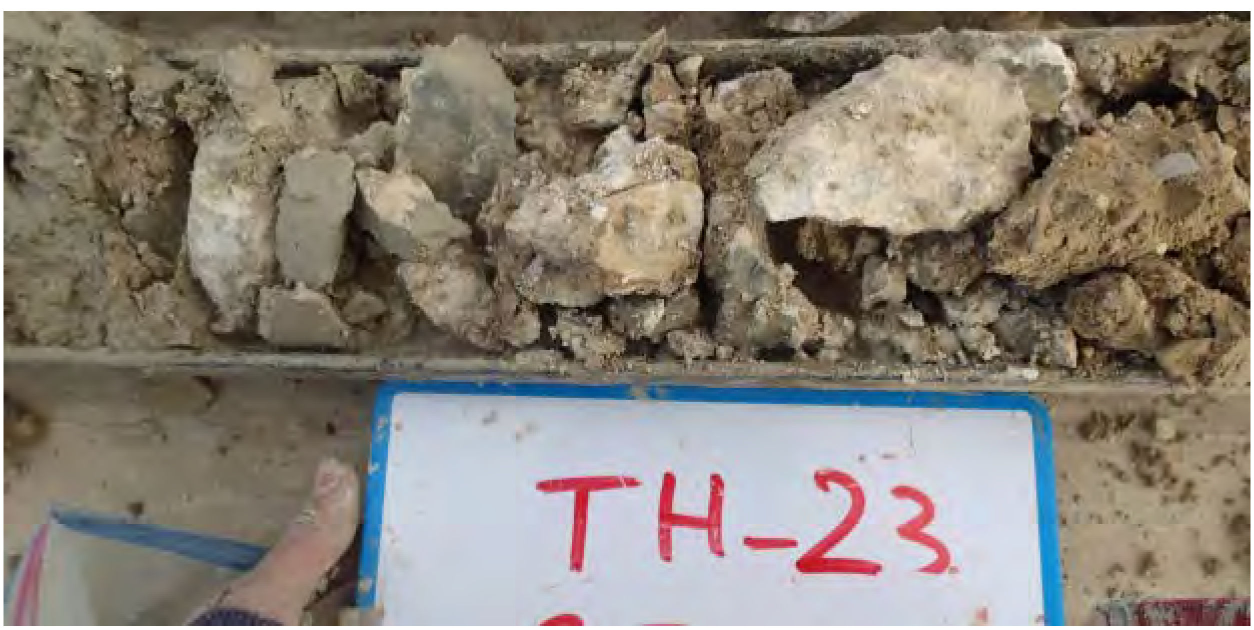
25-27
27/09/2019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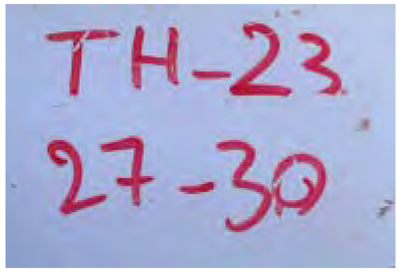
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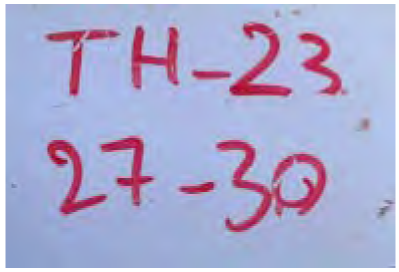
TH-23
27-30
27/09/2019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TH-23
27-30


TH-23
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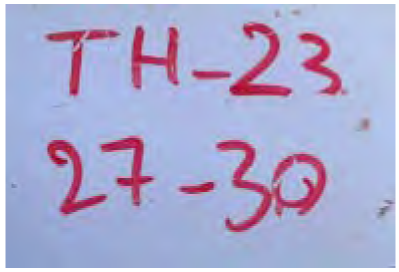
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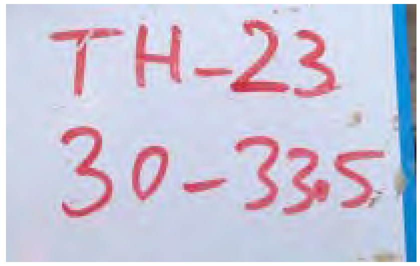
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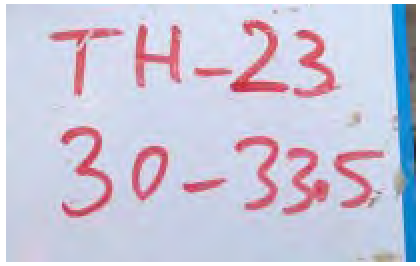
30-33.5


27/09/2019
TH-23
30-33.5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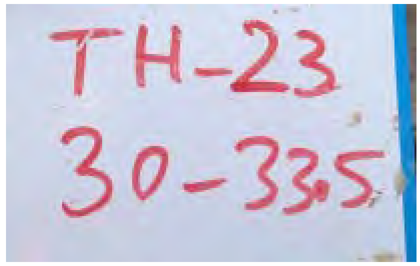
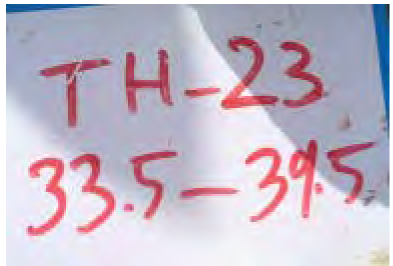
TH-23
30-33.5
27/09/2019

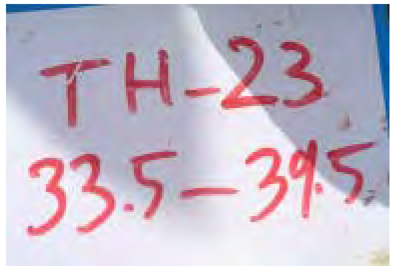

TH-23
30-33.5
27/09/2019


TH-23
30-33.5


TH-23
30-33.5
27/09/2019


TH-23
33.5–39.5


27/09/2019
TH-23
33.5–39.5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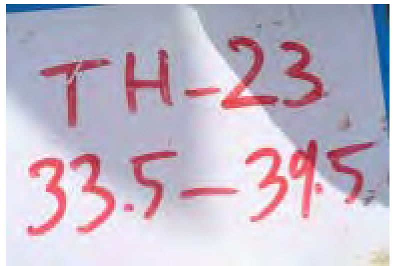
TH-23
27/09/2019


TH-23
33.5–39.5
27/09/2019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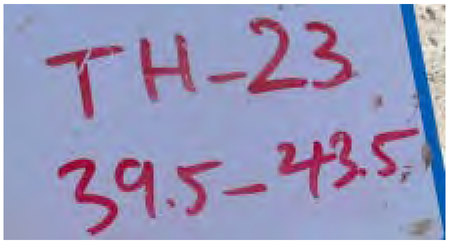
33.5–39.5


TH-23
27/09/2019


TH-23
33.5–39.5
27/09/2019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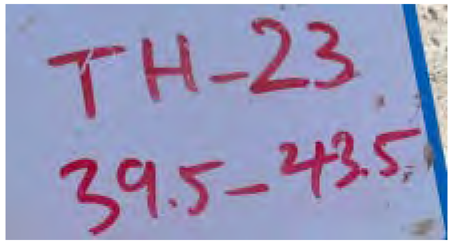
39.5-43.5


27/09/2019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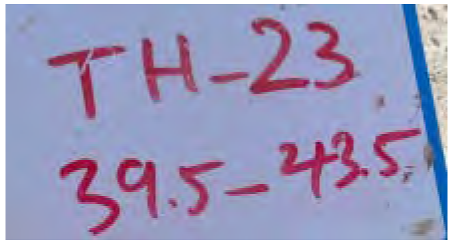
39.5-43.5


TH-23
39.5-43.5
27/09/2019


TH-23
39.5-43.5
27/09/2019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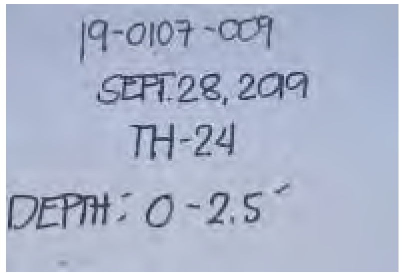
39.5-43.5

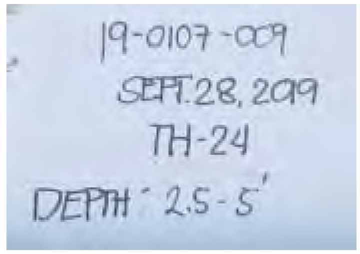

TH-23
39.5-43.5
27/09/2019

TH19-24


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

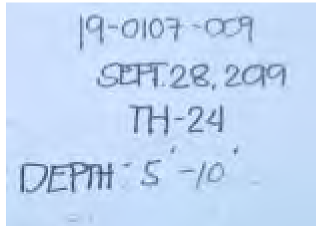

19-0107-009
SEPT.28, 2019
TH-24
DEPTH: 0-2.5´


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: 2.5 - 5'


SEPT.28, 2019
TH-24
2.5 - 5'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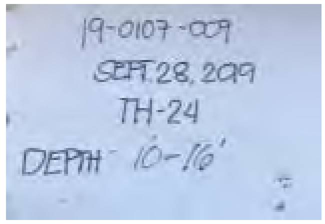
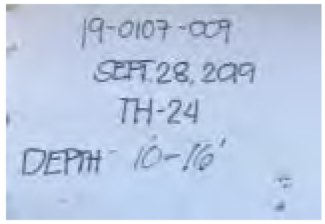
SEPT.28, 2019
TH-24
DEPTH: 5'-10'


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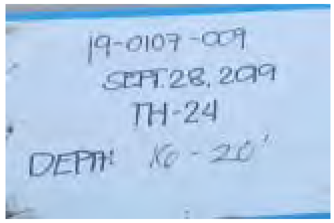
SEPT.28, 2019
TH-24
DEPTH 10-16'


19-0107-009
SEPT.28, 2019
TH-24


19-0107-009
SEPT.28, 2019
TH-24
DEPTH 10-16'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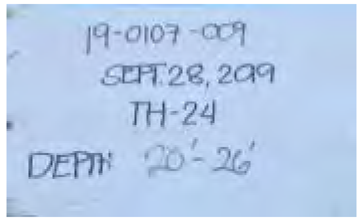
SEPT.28, 2019
TH-24
DEPTH 16 - 20'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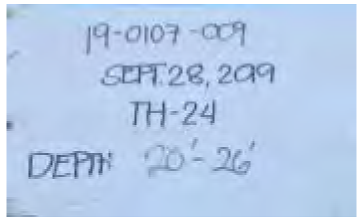
SEPT.28, 2019
TH-24
DEPTH 20'-26'


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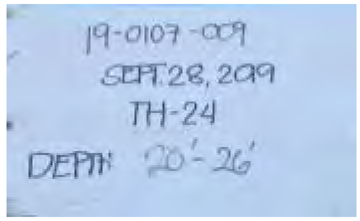
SEPT. 28, 2019
TH-24
DEPTH 20'-26'


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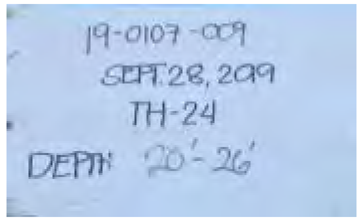
DEPTH 20'-26'


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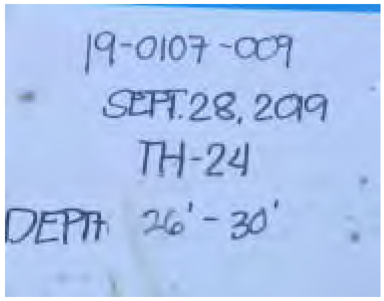
SEPT.28, 2019
TH-24
DEPTH 20'-26'


19-0107-009
SEPT.28, 2019
TH-24
DEPTH 20'-26'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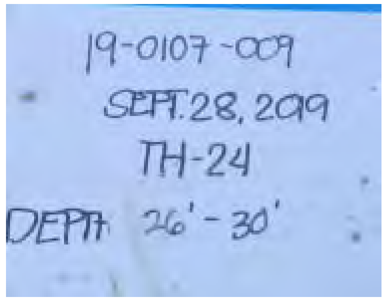
SEPT.28, 2019
TH-24
DEPTH 26'-30'


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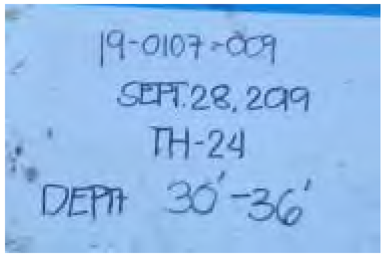
SEPT.28, 2019
TH-24
DEPTH 26' - 30'


19-0107-009
SEPT.28, 2019
TH-24
DEPTH 26' - 30'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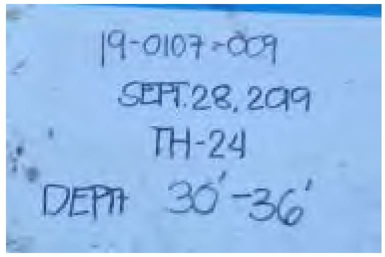
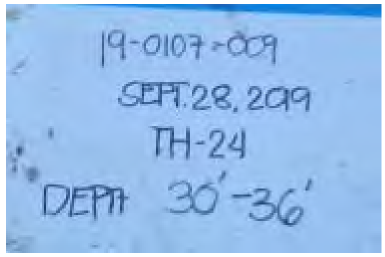
SEPT.28, 2019
TH-24
DEPTH 30'-36'


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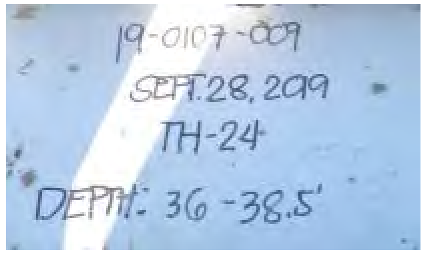
SEPT.28, 2019
TH-24
DEPTH 30'-36'

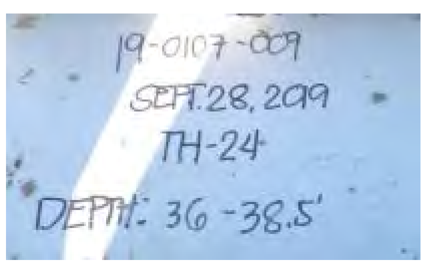

19-0107-009
SEPT.28, 2019
TH-24
DEPTH 30'-36'


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

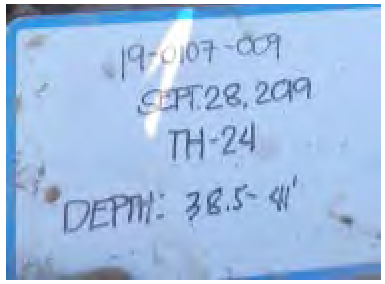

19-0107-009
SEPT. 28, 2019
TH-24
DEPTH: 36 -38.5'


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

i


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


19-0107-009
SEPT. 28, 2019
TH-24
DEPTH: 36 - 38.5'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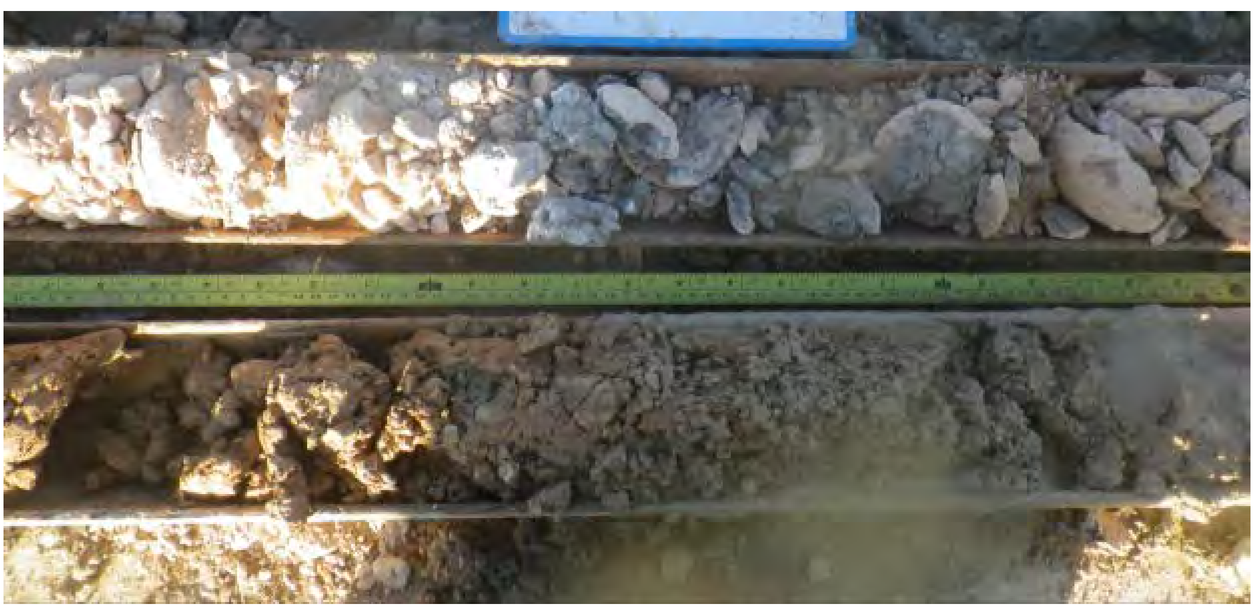
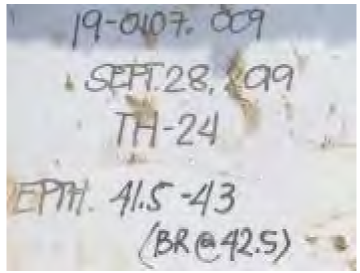
SEPT.28, 2019
TH-24
DEPTH: 38.5-41'



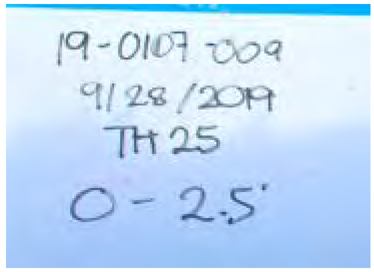

28, 2019
TH-24
38.5-41'


19-0107-009
SEPT. 28, 2019
TH-24
DEPTH: 38.5-41'


19-0107. 009
SEPT. 28, 2019
TH-24
EPTH. 41.5 -43
(BR@42.5)

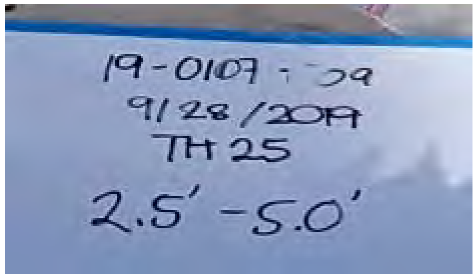

19-0107. 009
SEPT. 28, 2019
TH-24
EPTH. 41.5 -43
(BR@42.5)

TH19-25


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

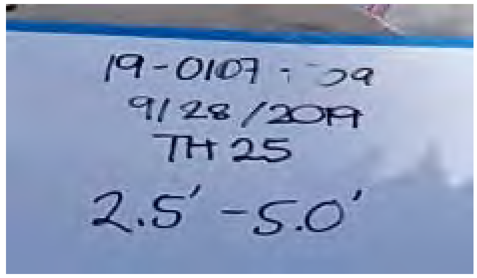

19-0107-009
9/28/2019
TH 25
0 - 2.5'
28/09/2019


19-0107-009
9/28/2019
TH 25
0 - 2.5'
28/09/2019


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

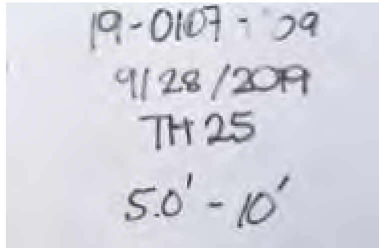

28/09/2019


19-0107-09
9/28/2019
TH 25
2.5'-5.0'
28/09/2019


9/28/2019
TH 25
2.5' - 5.0'


9/28/2019
TH 25
2.5' - 5.0'
28/09/2019


9/28/2019
TH 25
2.5' - 5.0'


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

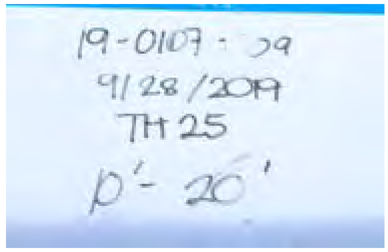

28/09/2019


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


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


28/09/2019


9/28/2019
TH25
5.0' - 10'
28/09/2019


19-0107-09
9/28/2019
TH 25
10'- 20'

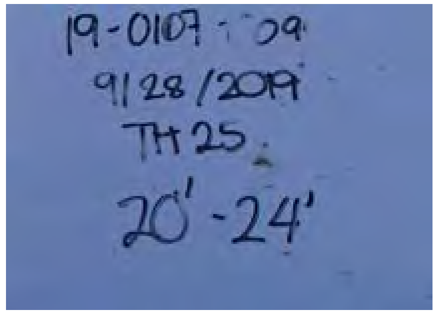

CGJ 262
28/09/2019


28/09/2019


28/09/2019


9/28/2019
TH25
0'- 20'
28/09/2019

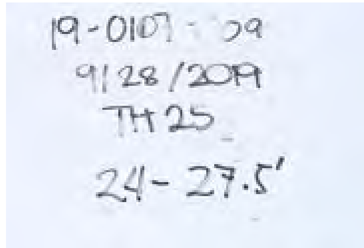

28/09/2019


19-0107-009
9/28/2019
TH25
20'-24'


28/09/2019


19-0107-09
9/28/2019
TH 25
20'-24'
28/09/2019


9/28/2019
TH 25
20'-24'
28/09/2019

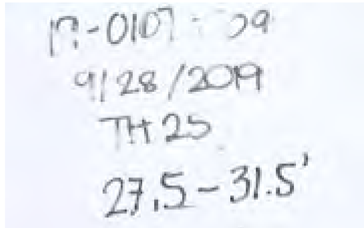

19-0107 09
9/28/2019
TH25
24-27.5'


28/09/2019


19-0107 09
9/28/2019
TH25
24-27.5'
28/09/2019


28/09/2019


19-0107-009
9/28/2019
TH25
24- 27.5'
28/09/2019


19-0107-009
9/28/2019
TH25
27.5-31.5'

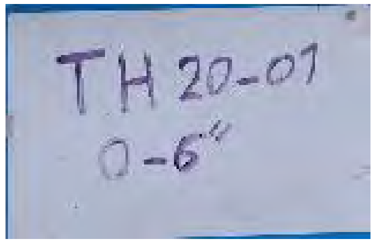

CGJ 262
28/09/2019


19-0107-009
9/28/2019
TH25
27.5-31.5'
28/09/2019

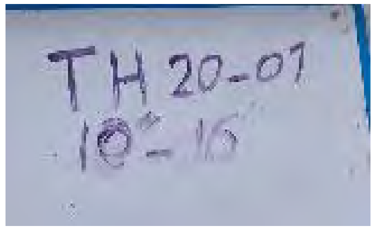

28/09/2019


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

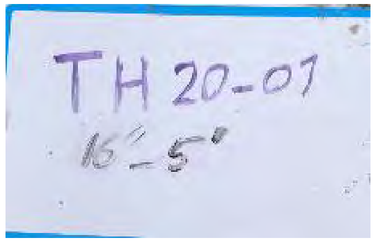
TH20-01


TH 20-01
0-6"


TH 20-01
0-6"

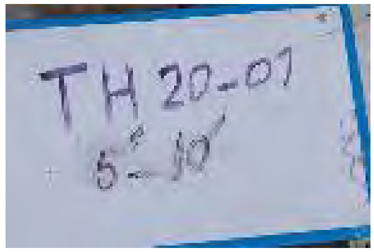

TH 20-01
10'-16'


TH 20-01
10'-16'
03/02/2020

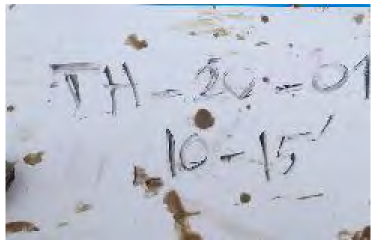

TH 20-07
16'-5'

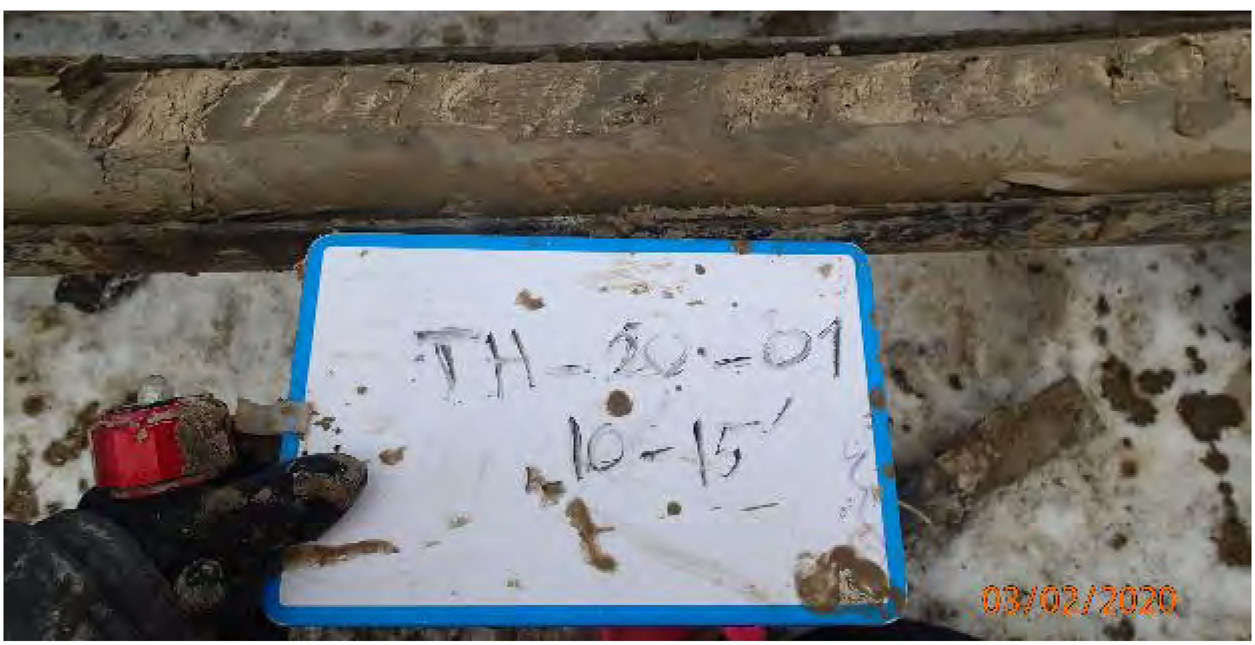

TH 20-07
16'-5'
03/02/2020

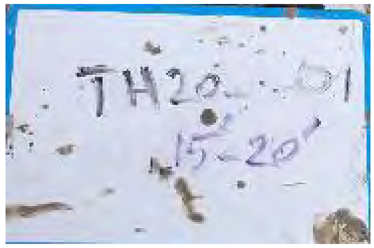

TH 20-07
16'-5'
03/02/2020


TH 20-01
5'-10'

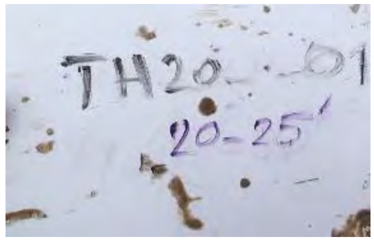

TH 20-01
5'-10'
03/02/2020


TH-20-01
10-15'


TH-20-01
10-15'
03/02/2020

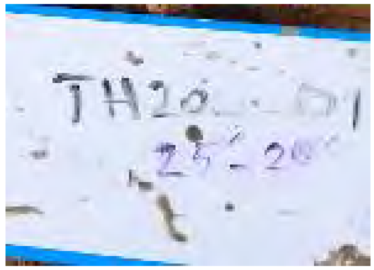

TH20-01
15'-20'


TH20-01
15'-20'
03/02/2020


TH20-01
20-25'

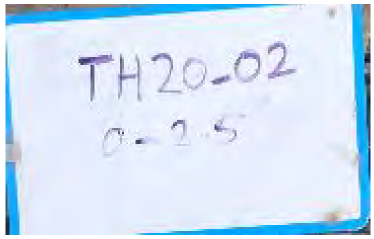

TH20-01
20-25'


TH20-01
20-25'



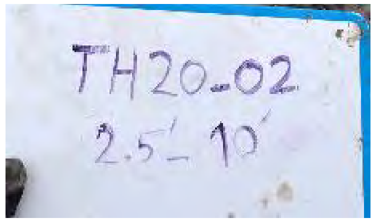

03/02/2020

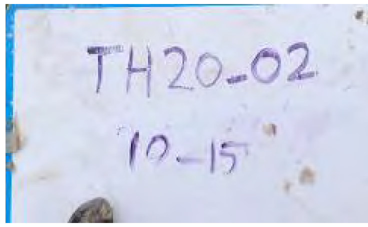
TH20-02


TH20-02
0-2.5'

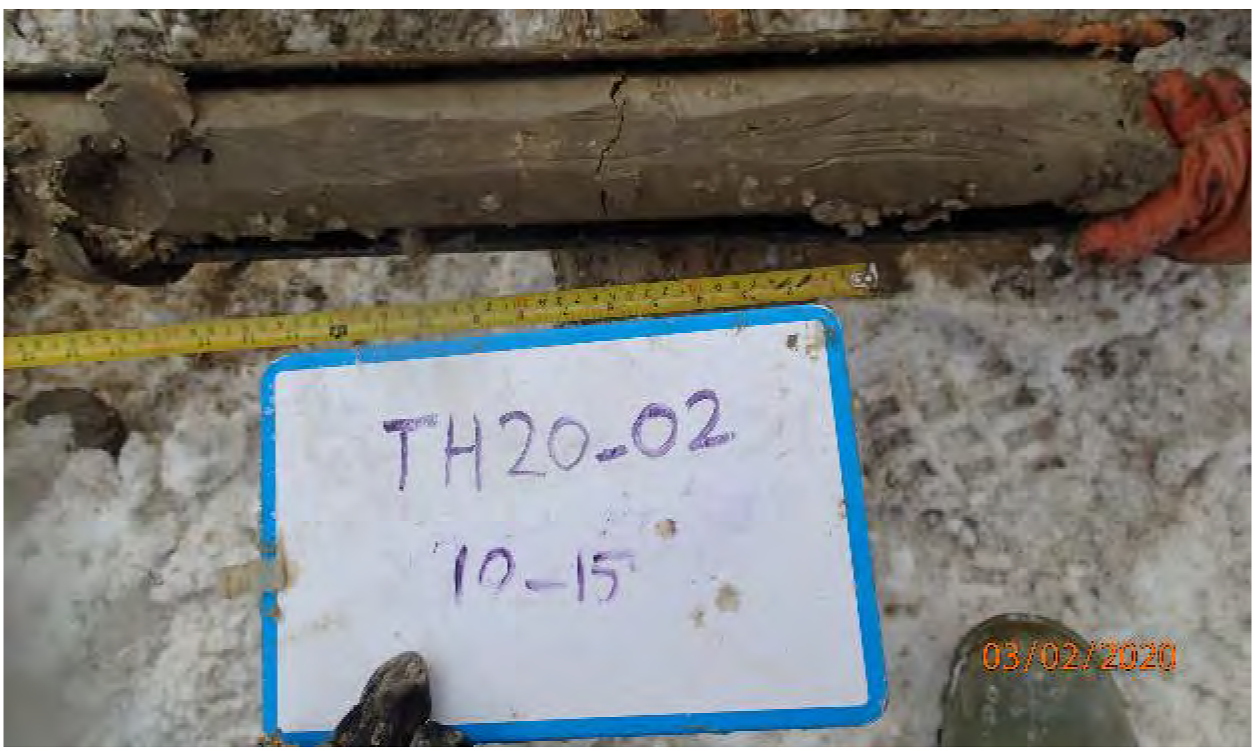

TH20-02
03/02/2020

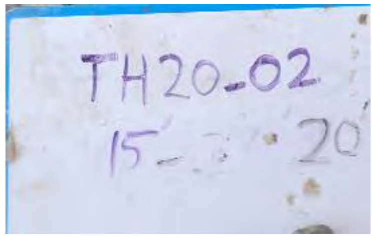

03/02/2020


TH20-02
2.5'-10'

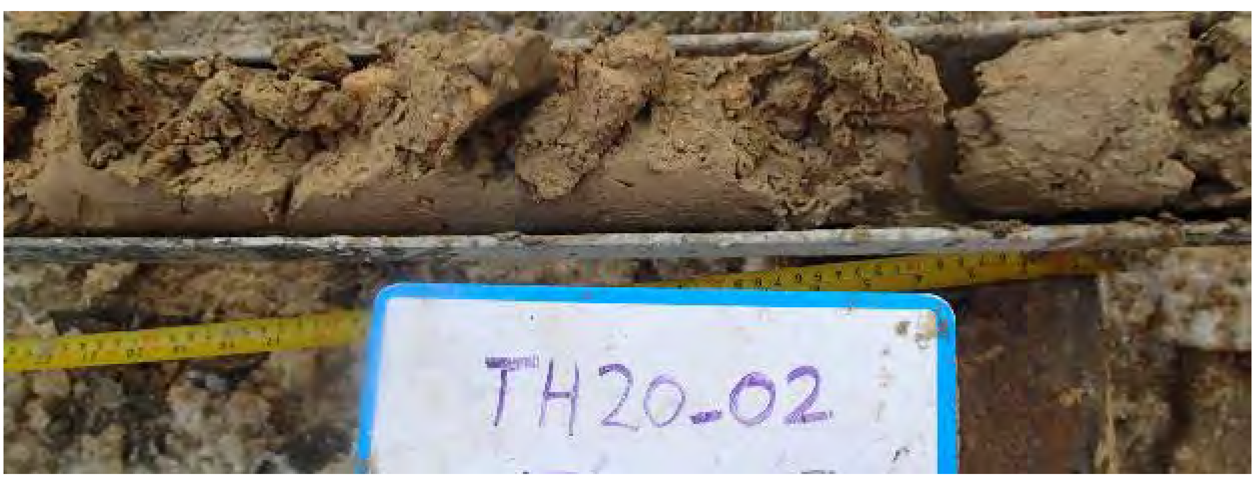

TH20-02
10-15

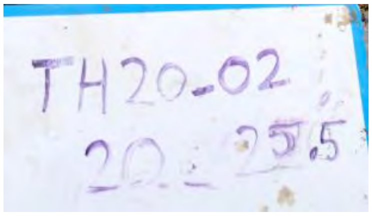

03/02/2020


TH20-02
10-15
03/02/2020


TH20-02

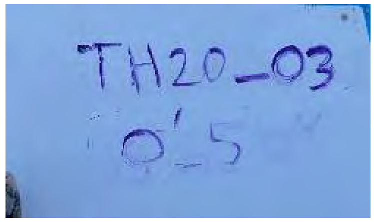

03/02/2020


TH20-02

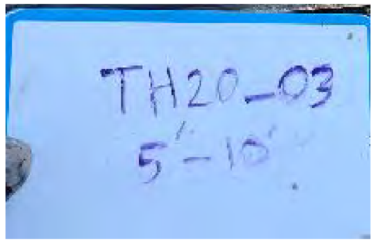

TH20-02
20-25.5


03/02/2020

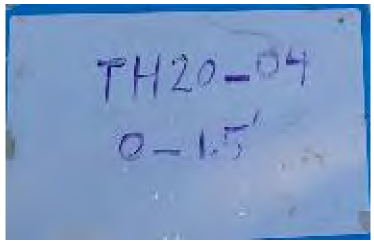
TH20-03


TH20_03
0'_5


TH20_03

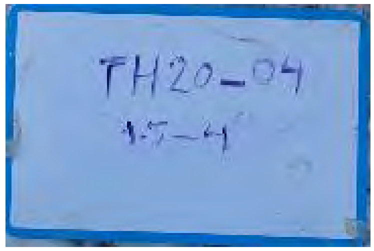

TH20_03
5'-10'

TH20-04

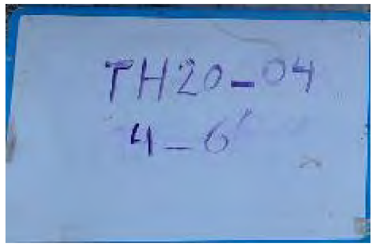

TH20-04
0-1.5'


TH20-04
0-1.5'

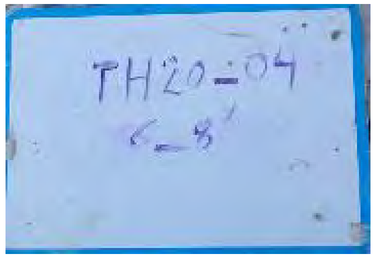

TH20-04
0-1.5'


TH20-04
1.5-4

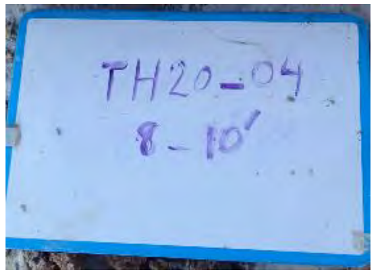

TH20-04
1.5-4


TH20-04
4-6'

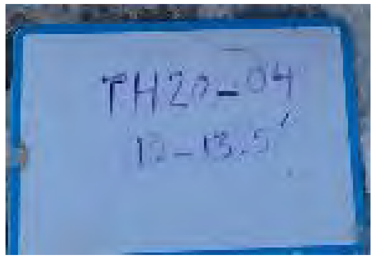

TH20-04
4-6'

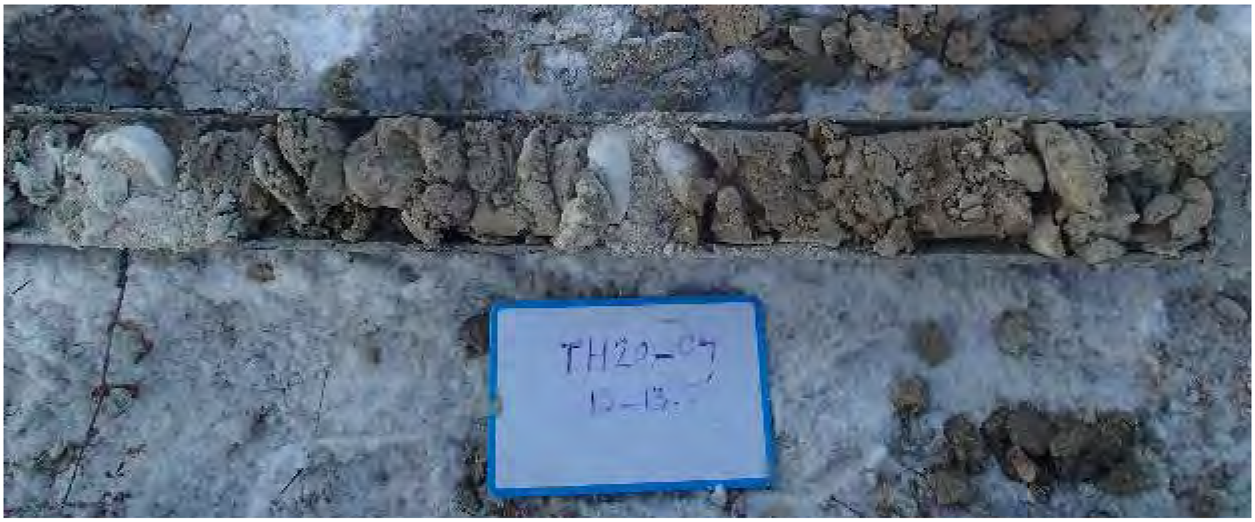

TH20-04
6-8'


TH20-04
6-8'

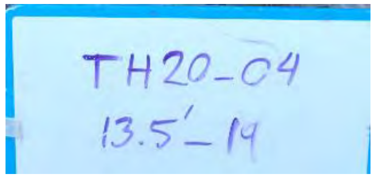

TH20-04
8-10'


TH20-04
8-10'


TH20-04
12-13.5'


TH20-04


TH20-04
12-13.5'


TH20-04
13.5'-14

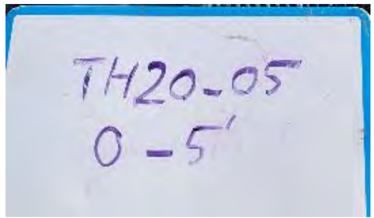

TH20-04
13.5'-14


TH20-04
13.5'-14

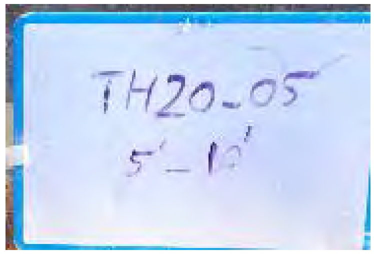

TH20-04
13.5'-14


TH20-04
13.5'-14

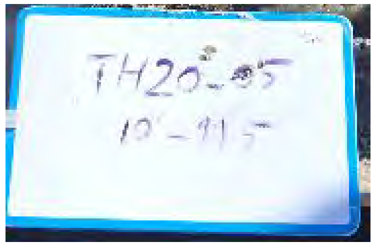
TH20-05


TH20-05
0 - 5'


TH20-05
0 - 5'

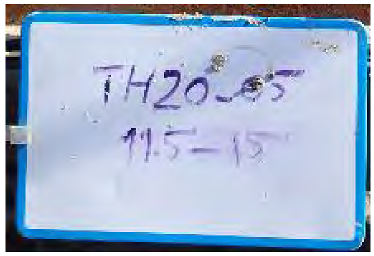

TH20-05
5'-10'

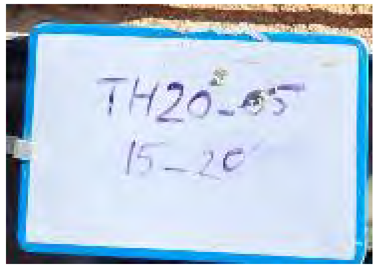

TH20-05
5'-10'


TH20-05
10'-11.5


TH20-05
10'-11.5

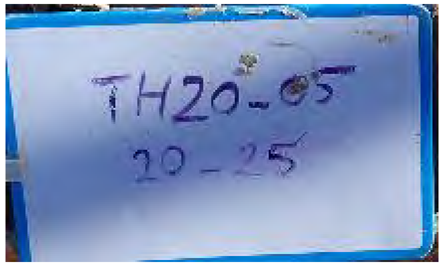

TH20-05
10'-11.5


TH20-05
11.5–15


TH20-05
15-20

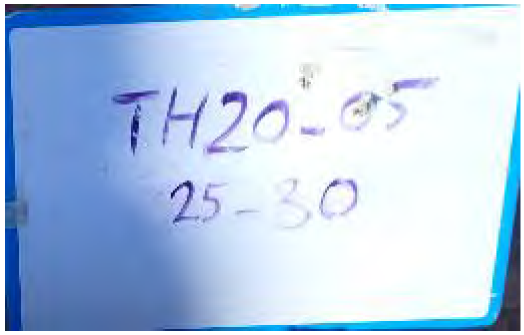

TH20-05
15-20


TH20-05
15-20

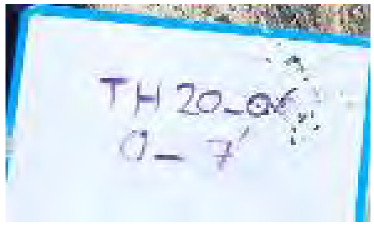

TH20-05
20-25


TH20-05

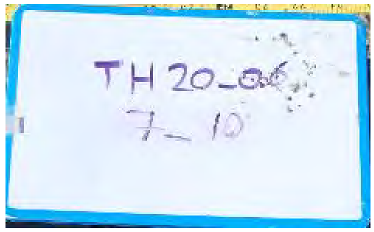

TH20-05
20-25

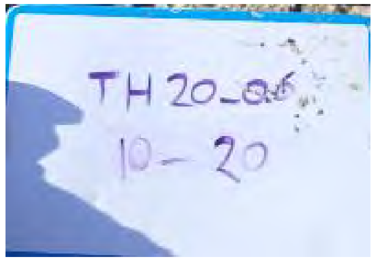

TH20-05
25-30

TH20-06


TH 20-06
0-7'

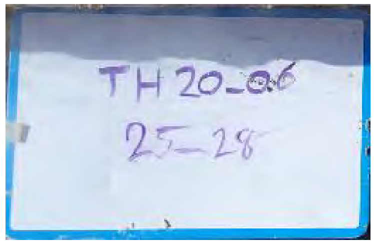

TH 20-06
0-7'


TH 20_06
7_10


TH 20_06
10 – 20

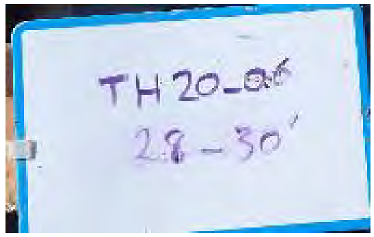

TH 20-06
20 - 25


20 25


TH 20-06
25-28


TH 20-06
25-28

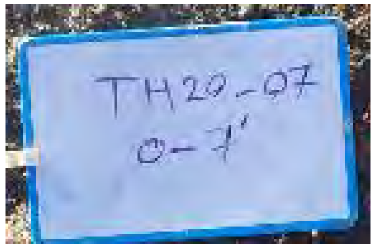

TH 20-06
25-28

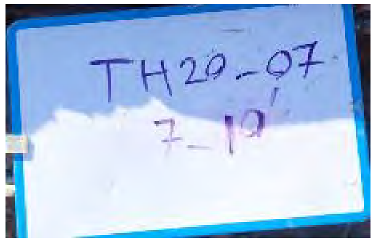

TH 20-06
28-30'


TH 20-06
28-30'


TH 20-06
28-30'

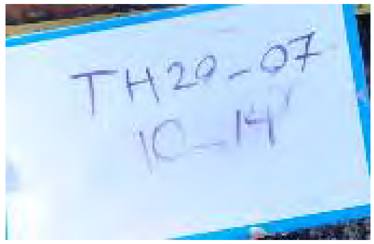
TH20-07


TH20-07
0-7'

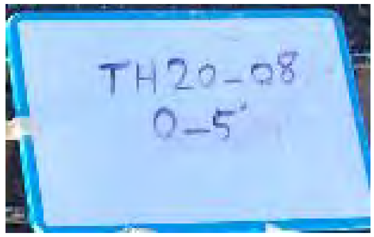

TH20-07
7-10'

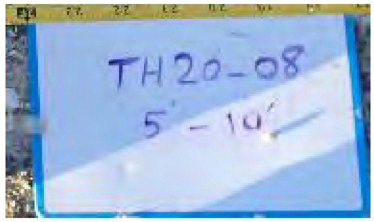

TH20-07
7-10'


TH20-07
7-10'


TH20-07
10-14'

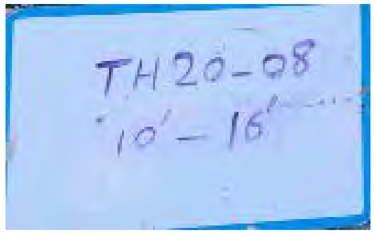
TH20-08


TH20-08
0-5'

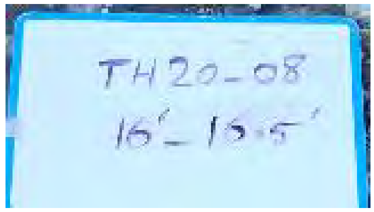

TH20-08
5'-10'


TH20-08
5'-10'

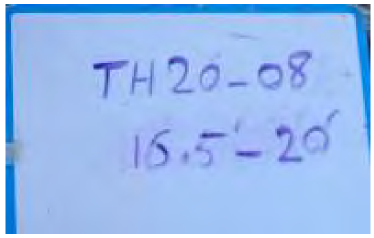

TH20-08
5'-10'


TH20-08
10' – 16'

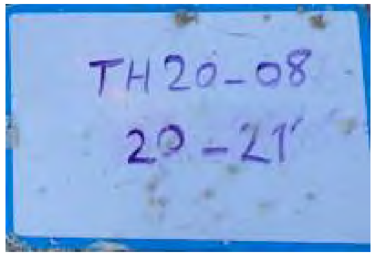

TH20-08
10' – 16'


TH20-08
16'-16.5'


TH20-08
16'-16.5'


TH20-08
16.5'-20'

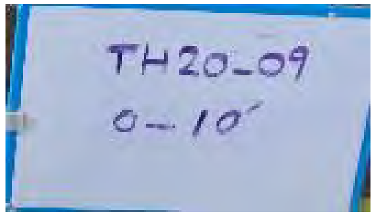

TH20-08
16.5'-20'


TH20-08
20-21'


TH20-08
20-21'

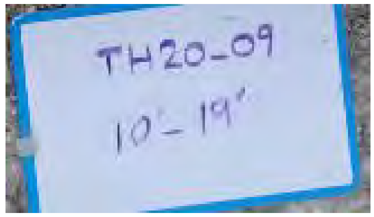

TH20-08
20-21'

TH20-09


TH20-09
0-10'


TH20-09
0-10'

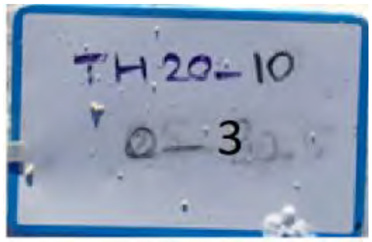

TH20-09
0-10'


TH20-09
10'-19'


TH20-09
10'-19'

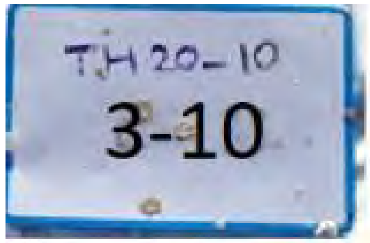

TH20-09
10'-19'

TH20-10

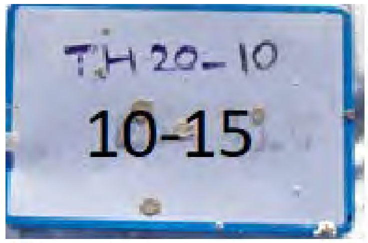

TH 20-10
0 - 3


TH 20-10
06/02/2020


06/02/2020


TH 20-10
3-10


TH 20-10
06/02/2020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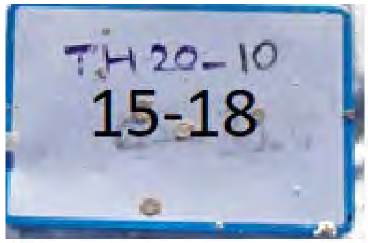
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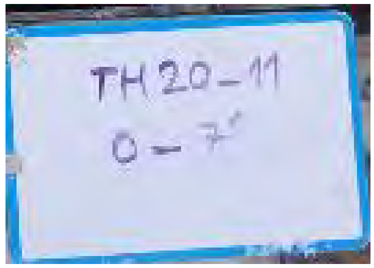
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0 - 7'
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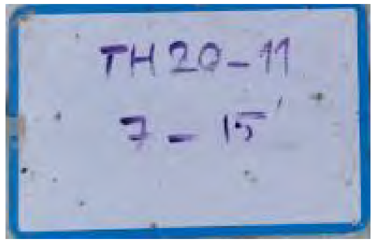
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TH 20-11
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05/02/2020


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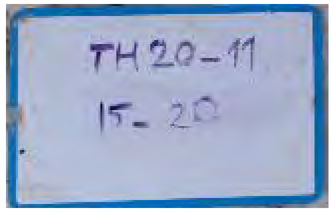
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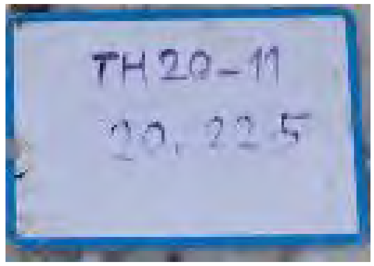
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05/02/2020


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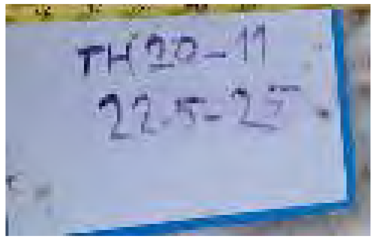
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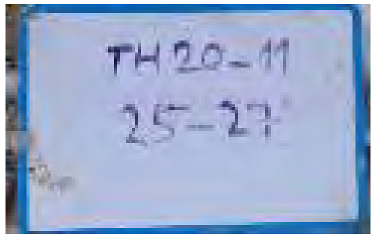
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25-27'


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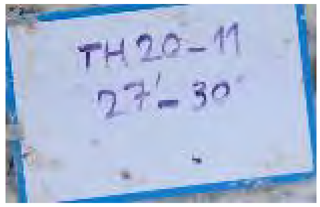
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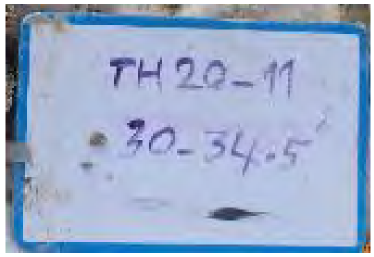
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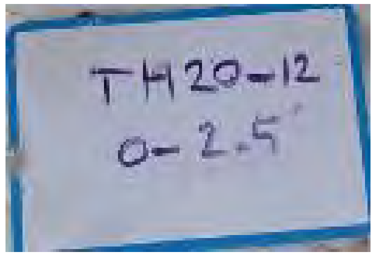
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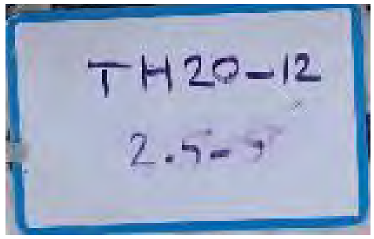
06/02/2020


TH20-12
0-2.5'
06/02/2020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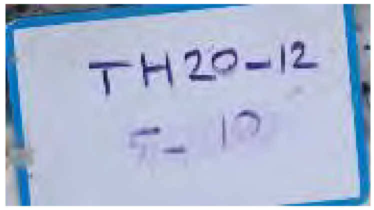
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TH20-12
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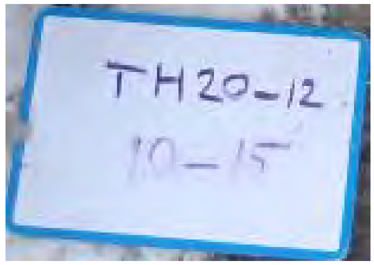
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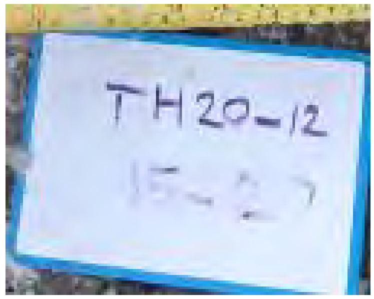
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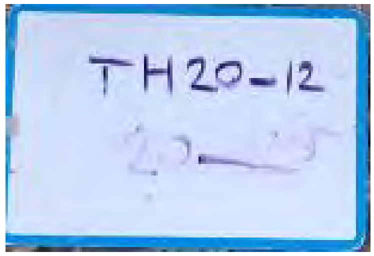
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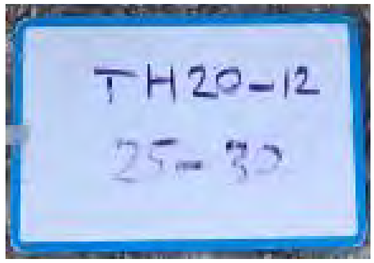
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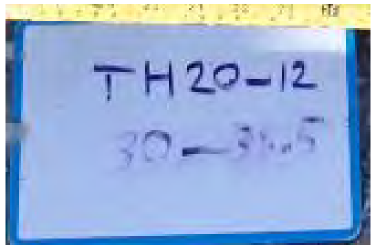
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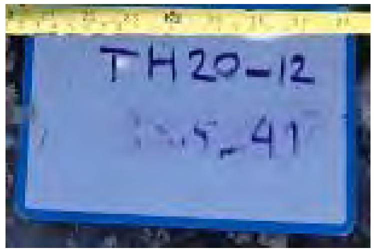
TH20-12
06/02/2020


06/02/2020
TH20-12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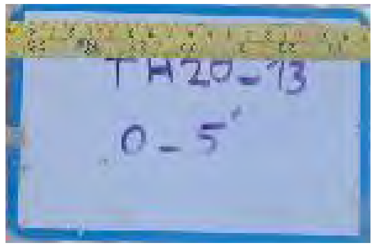
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0-5'


TH20-13
0-5'
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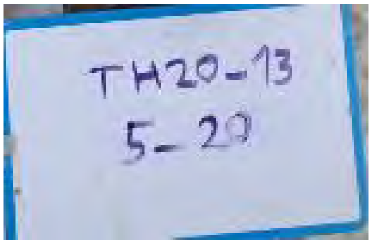
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5-20


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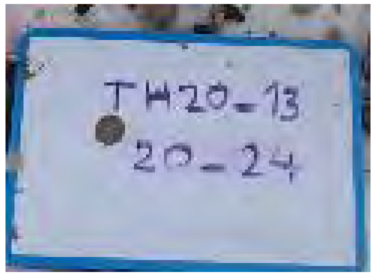
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05/02/2020


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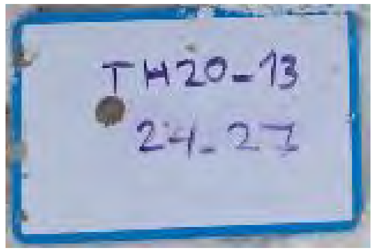
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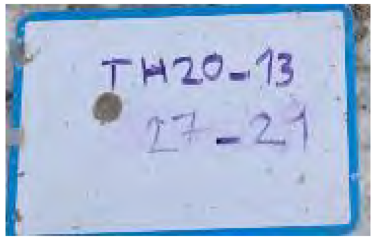
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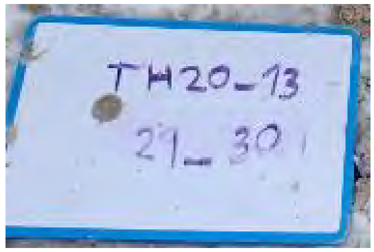
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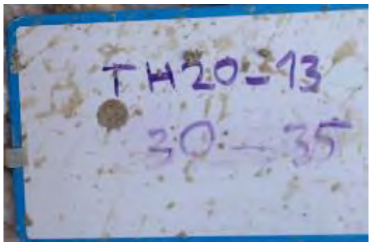
05/02/2020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05/02/2020


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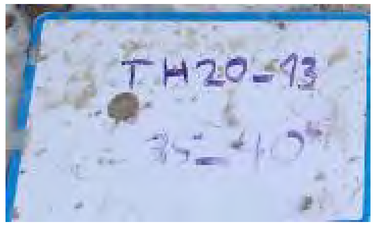
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TH20-13
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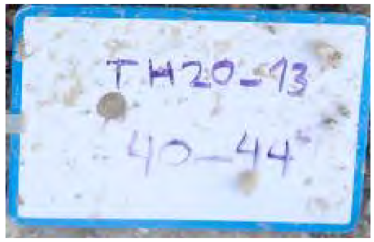
05/02/2020


05/02/2020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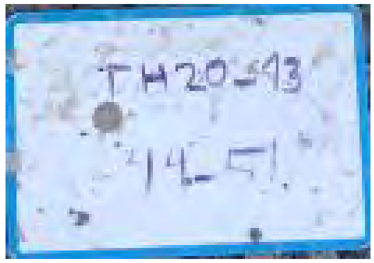
40-44'


TH20-13
40-44'
05/02/2020


05/02/2020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TH20-13
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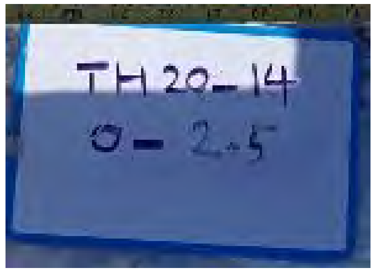
05/02/2020


05/02/2020

TH20-14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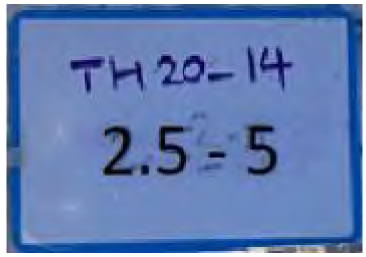
0- 2.5


TH 20-14
0- 2.5
06/02/2020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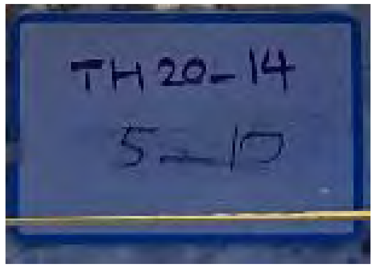
TH 20-14
06/02/2020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TH 20-14
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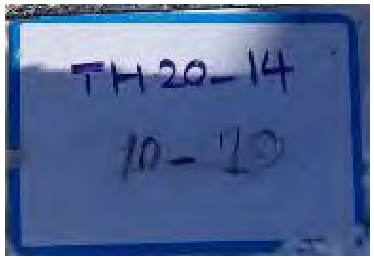
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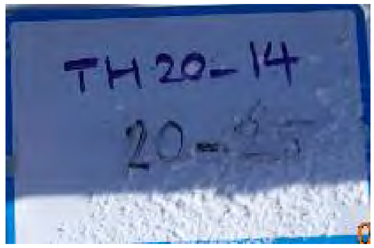
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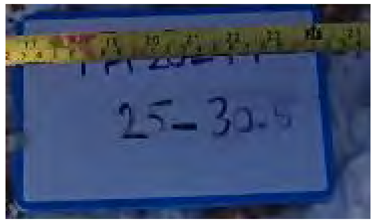
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06/02/2020


TH 20-14
06/02/2020


06/02/2020

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

237 St. Georges Ave.
North Vancouver, B.C.
V7L 4T4

604 987 3037

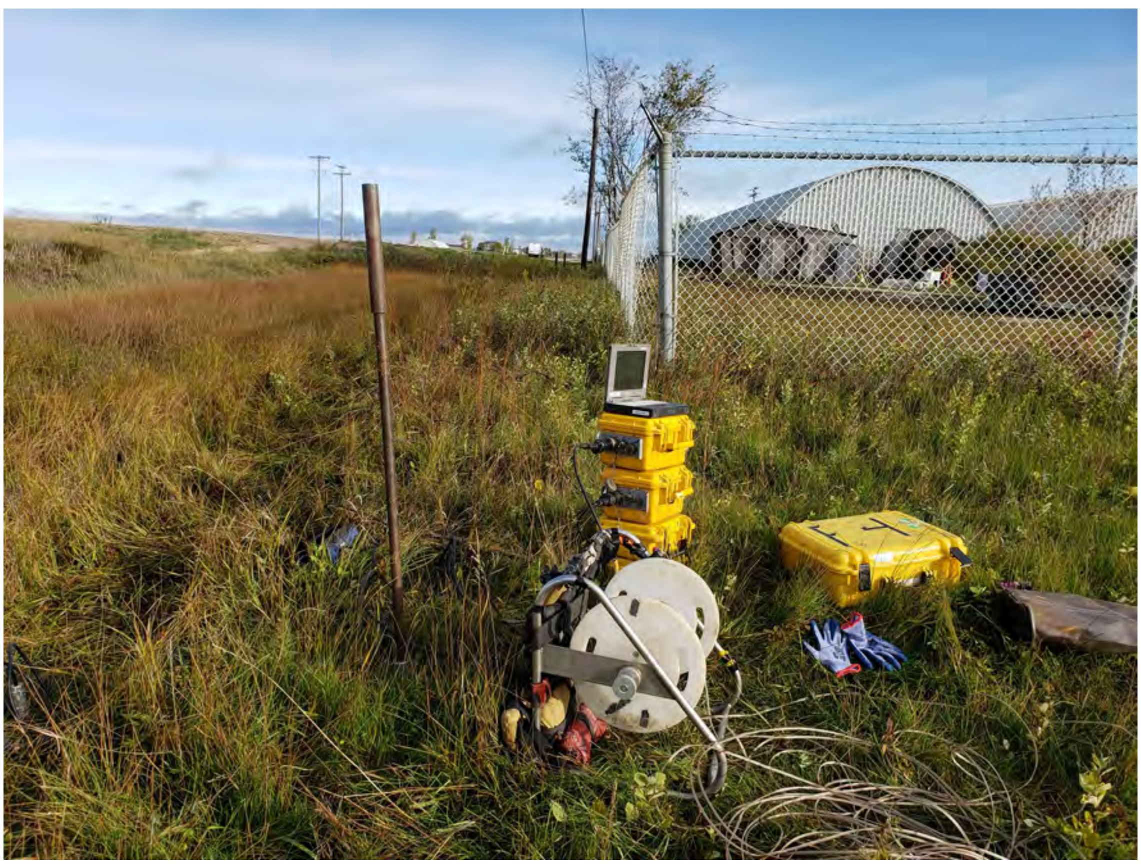
Table of Contents

Illustrations

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 materiel 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 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.

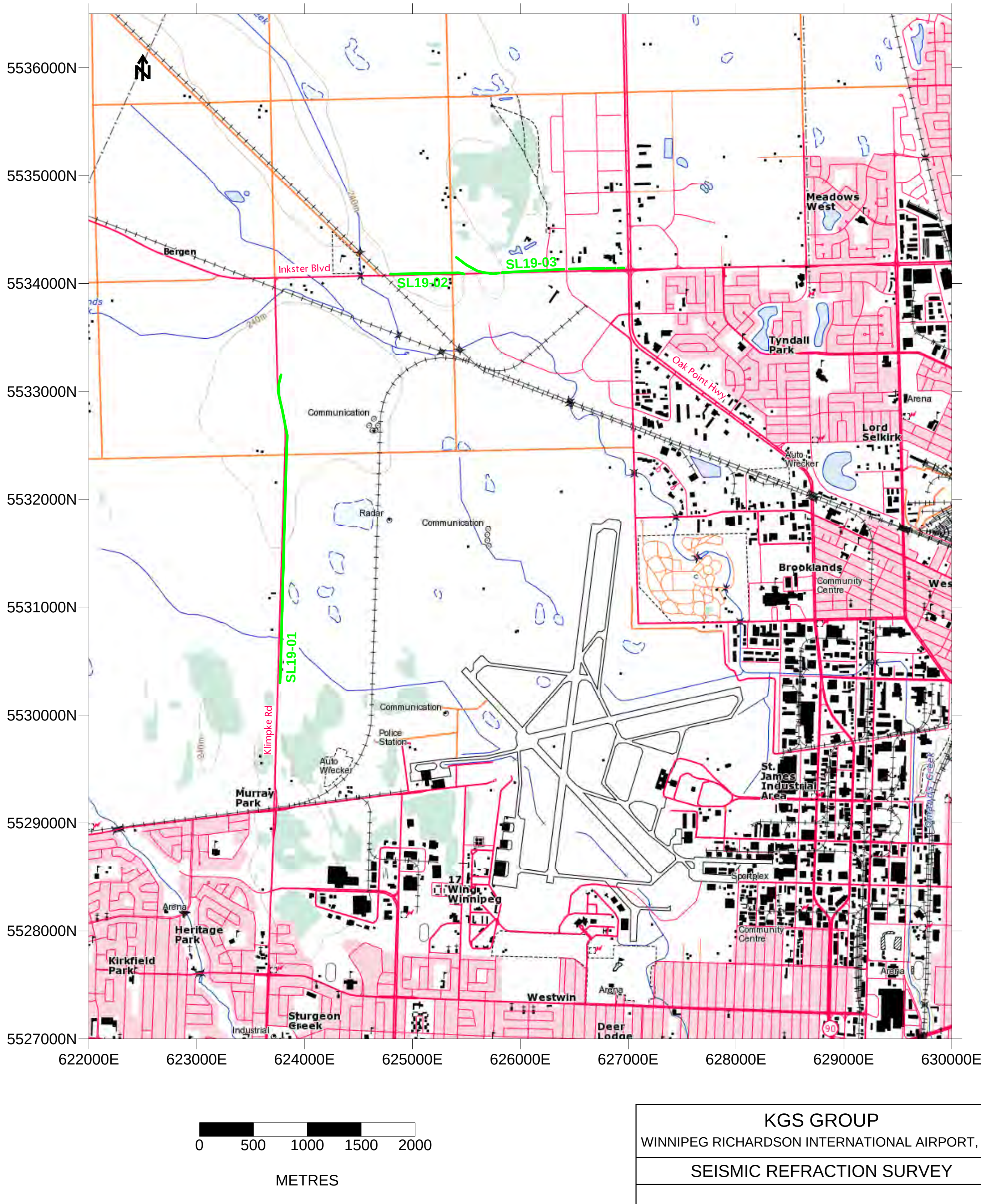
The information in this report is based upon geophysical measurements and field procedures and our interpretation of the data. The results are interpretive in nature and are considered to be a reasonably accurate representation of existing subsurface conditions within the limitations of the seismic refraction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

For: Frontier Geosciences Inc.

PROFESSIONAL PROVINCE OF C. M. GUGINS # 43867 BRITISH COLUMBIA GEOSCIENTIST

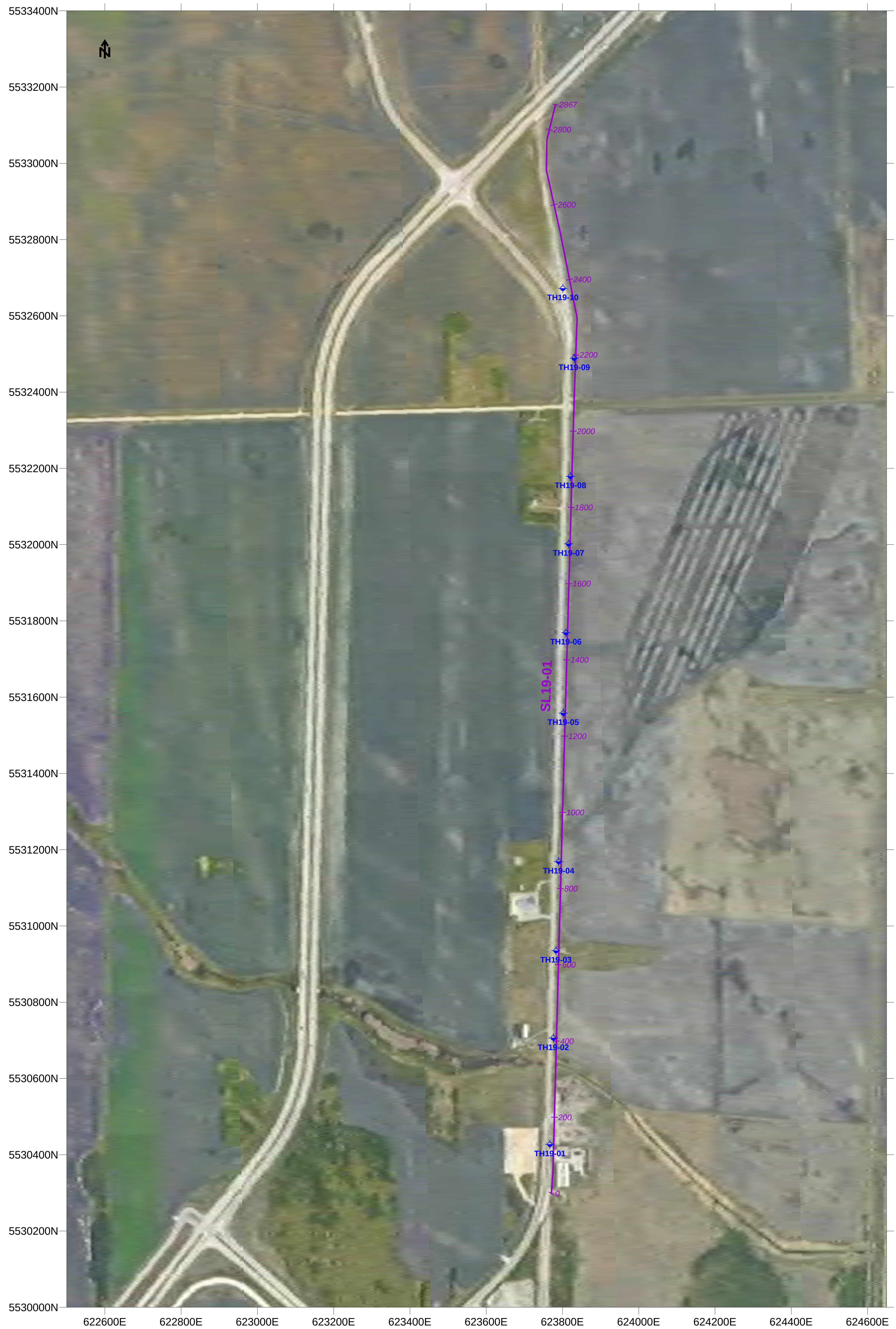
Orgil Bayarsaikhan, B.Sc. Caitlin Gugins, P.Geo. Feb 10, 2020

APPENDIX



NATURAL RESOURCES CANADA
TOPORAMA MAPSHEET 62H14
UTM NAD83 ZONE 14

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



200

SURVEY LINE AND DISTANCE

0 100 200 300 400

METRES

GOOGLE EARTH IMAGERY APPROXIMATE
UTM NAD83 ZONE 14

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

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


SPREAD 3
SPREAD 4
G-88-50
(46.9m W)
TH19-02
(8.3m W)
SILT
CLAY
SILT TILL
FILL
GRAVEL
JURASSIC LIMESTONE
370 m/s
360 m/s
980 m/s
1080 m/s
1800 m/s
1770 m/s
1900 m/s
2050 m/s
3400 m/s
3200 m/s
3900 m/s
2900 m/s
2600 m/s
3800 m/s
ELEVATION (m)
245
240
235
230
225
220
210N 215N 220N 225N 230N 235N 240N 245N 250N 255N 260N 265N 270N 275N 280N 285N 290N 295N 300N 305N 310N 315N 320N 325N 330N 335N 340N 345N 350N 355N 360N 365N 370N 375N 380N 385N 390N 395N 400N 405N 410N 415N 420N 425N
DISTANCE (m)
430 915 1400 1935 2480 3060 3700
COMPRESSIONAL WAVE VELOCITY (m/s)
0 2.5 5 7.5 10
METRES
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

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

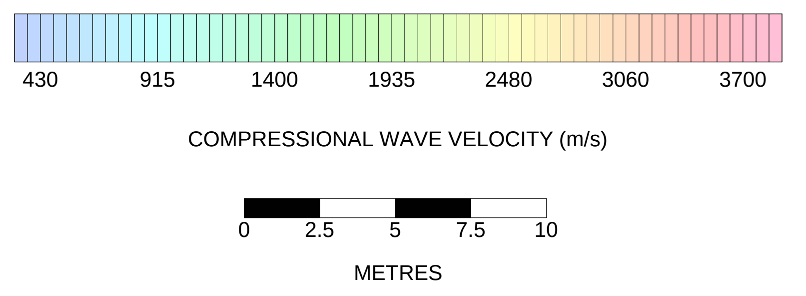
KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01G

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 9



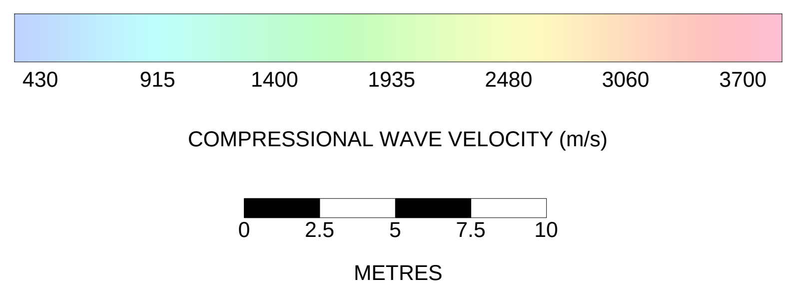
KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01H

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 10



KGS GROUP

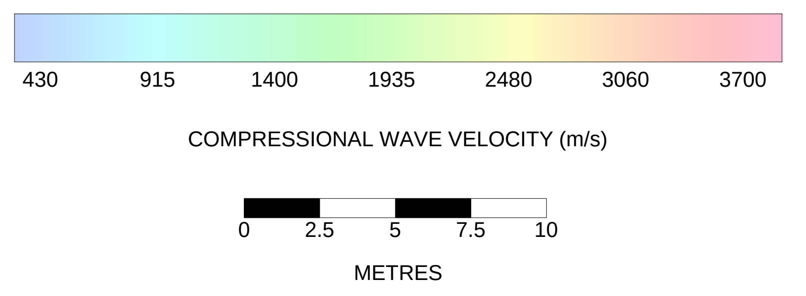
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01I

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 11



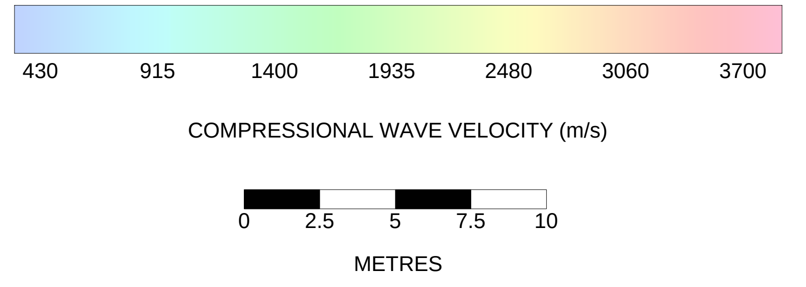
KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01J

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 12



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

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

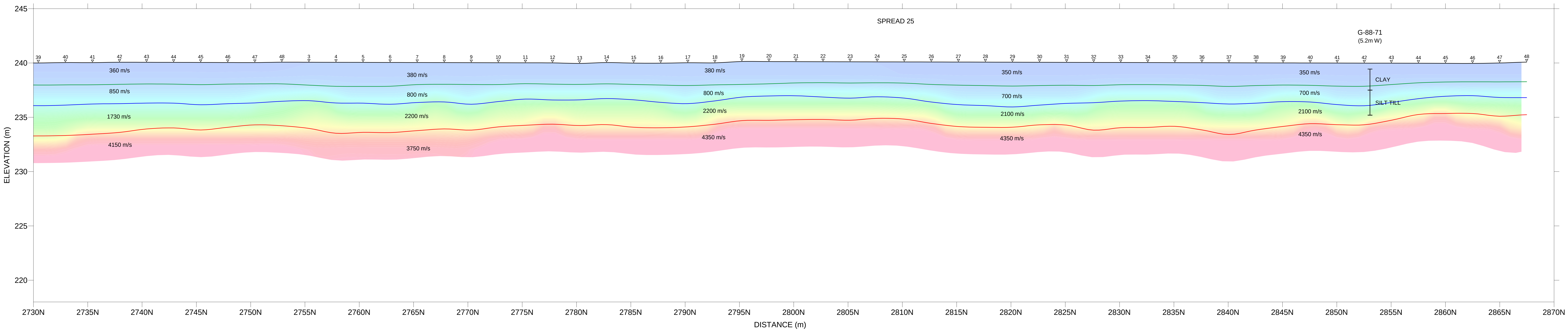
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

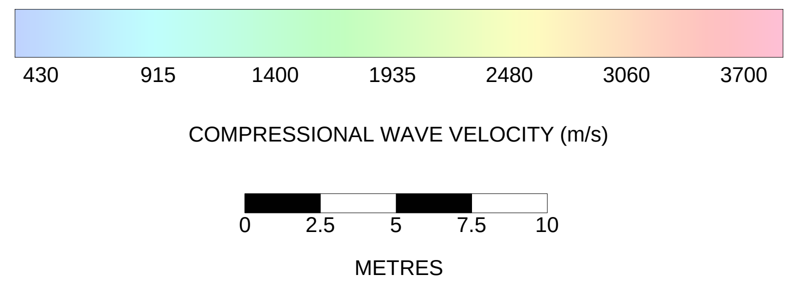
SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01M

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 15





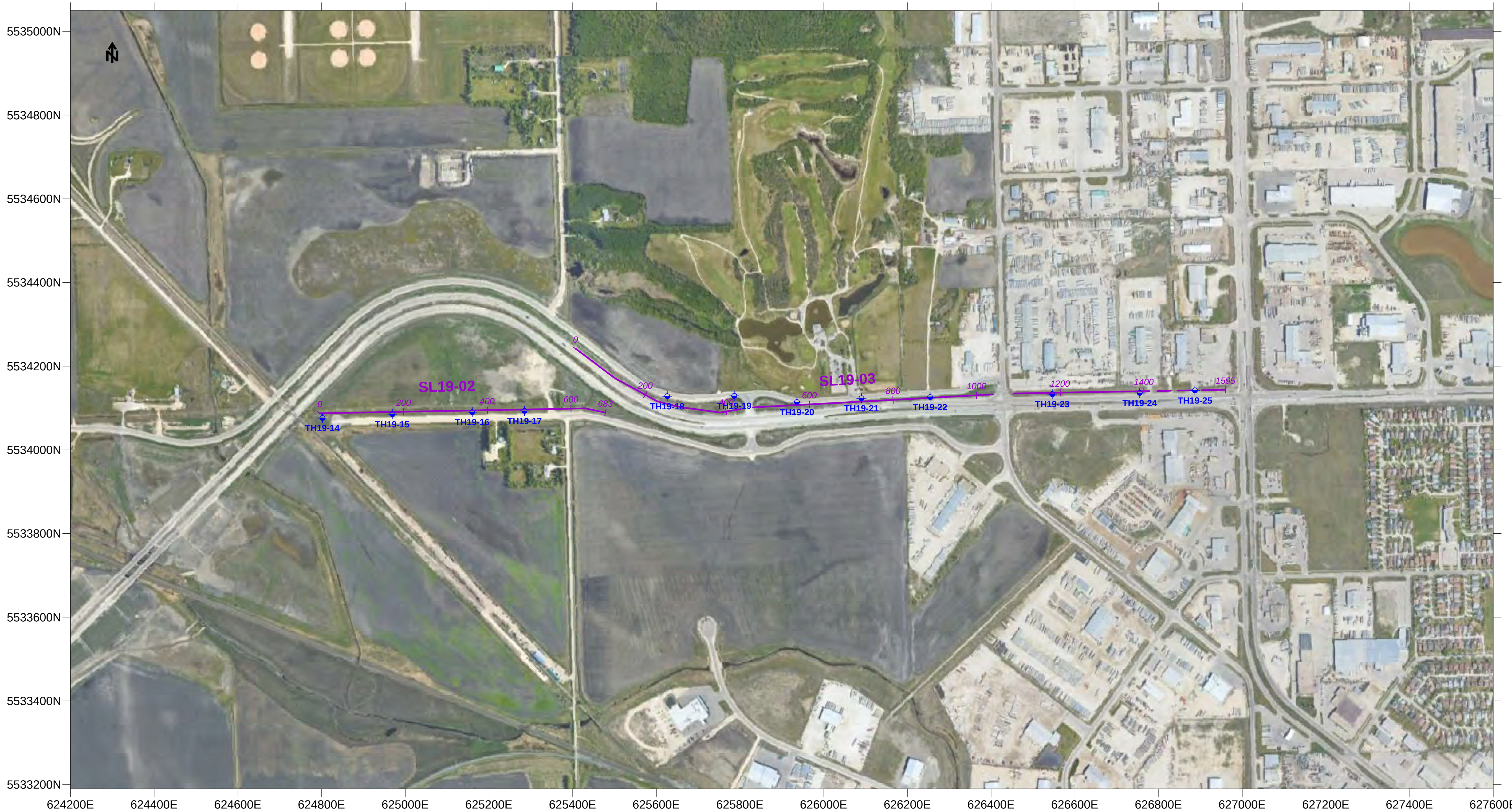
KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-01N

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 16



200

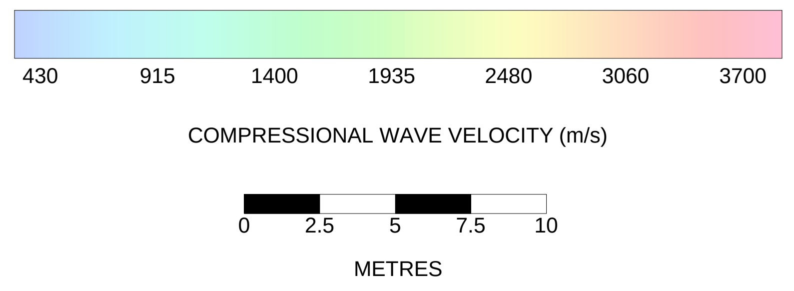
SURVEY LINE AND DISTANCE

0 100 200 300 400

METRES

GOOGLE EARTH IMAGERY APPROXIMATE
UTM NAD83 ZONE 14

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



KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-02A

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 18

KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

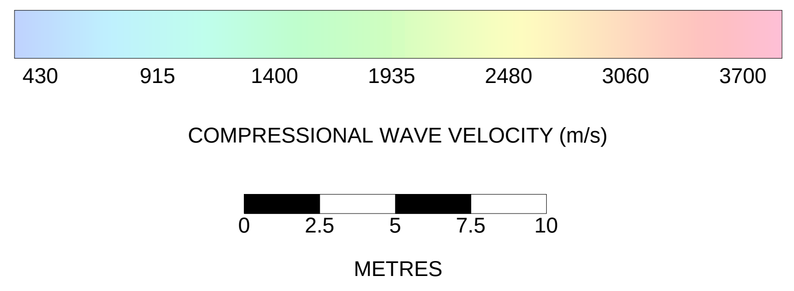
SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-02B

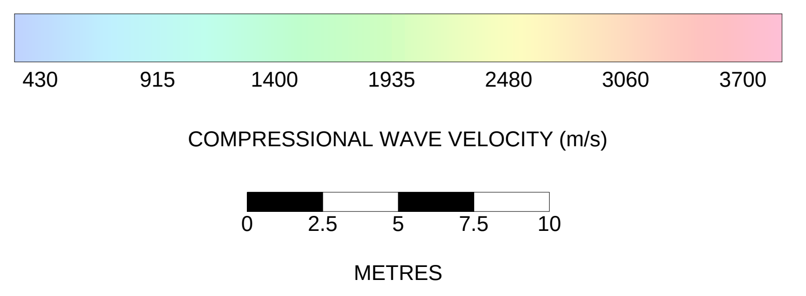
FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 19

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



KGS GROUP WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB		
SEISMIC REFRACTION SURVEY		
INTERPRETED DEPTH SECTION SL19-02D		
FRONTIER GEOSCIENCES INC.		
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

KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-03B

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 23

KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB
SEISMIC REFRACTION SURVEY
INTERPRETED DEPTH SECTION SL19-03C
FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 24

KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-03D

FRONTIER GEOSCIENCES INC.

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

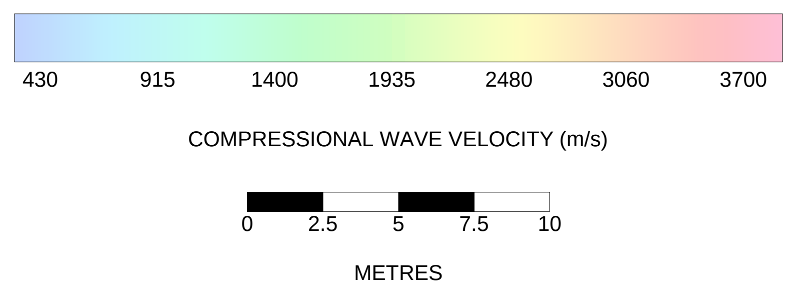
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

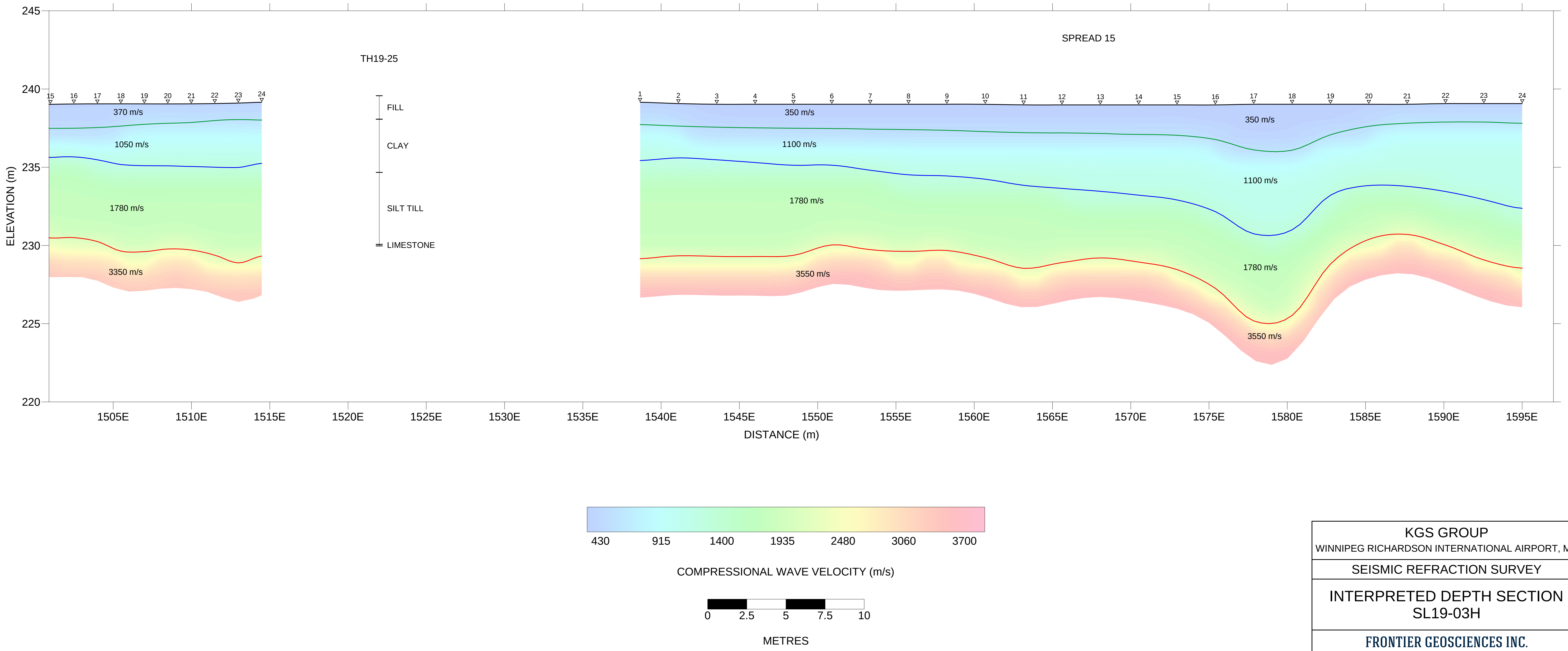
INTERPRETED DEPTH SECTION
SL19-03F

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



KGS GROUP
WINNIPEG RICHARDSON INTERNATIONAL AIRPORT, MB

SEISMIC REFRACTION SURVEY

INTERPRETED DEPTH SECTION
SL19-03H

FRONTIER GEOSCIENCES INC.

DATE: OCT. 2019	SCALE 1:250	FIG. 29

KGS GROUP

Experience in Action

APPENDIX B

2023/2024 KGS Group Borehole/Test Pit Logs

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-01**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.20 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 241.12 m (Standpipe)
DESCRIPTION	Southwest corner of lift station	**START DATE**	9-28-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,530,113
METHOD(S)	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		E 623,145 Zone 14

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	INSTALL DEPTH (m)	SAMPLE NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	qu POCKET PEN (kPa)
0.0	**CLAY FILL** - 1219 mm, Grey and black, dry to damp, very stiff, trace to some organics.			S1					350
1.2	**ORGANIC SOIL** - 305 mm, Black, dry to damp, loose, trace wood, organics.	239.0		S2					
1.5	**CLAY (CH)** - Black, damp to moist, very stiff, high plasticity, trace organics. - Brown to grey, trace to some gypsum and silt pockets below 2.0 m.	238.7		S3					300
									275
				S4					250
									250
	- Stiff below 4.1 m. - LL=66, PL=21, PI=45 at 4.3 m.			S5					
4.9	**SILT TILL (ML)** - Light grey, dry to damp, dense, with coarse grained sand, trace gravel, some clay.	235.3							225
	- PSA: 7% gravel, 34% sand, 45% silt, 14% clay at 5.8 m.			S6					
	- Light brown to grey below 6.1 m.			S7	100		9 14 21	35	
				S8					
				S9	100		14 19 19	38	
	Vibrating Wire VW171370		8.53						
				S10					
	- Very dense below 9.1 m.		9.40	S11	55		49 50/ 100mm	+100	
	- Hard drilling/grinding below 10.0 m. - Grey and black boulders and cobbles, trace to some weathered limestone in sampler from 10.1 m to 11.1 m.		10.46	R1	32				
11.1	**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.	229.1		R2	97	78			

WATER LEVELS ▽ **During Drilling/Digging**	on 9-28-2023 None Encountered	
▼ **Upon Completion**	6.71 m on 9-29-2023	

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE	DATE 1-22-2024

KGS_LOG_ C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009_CENTREPORT_REPORT_SEPT 26 TO 29, 2023.GPJ

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	LOG OF INSTALLS DEPTH (m)	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
228		40	- Good quality from 11.2 m to 12.6 m. - ~30 mm soft shale/clay seam at 12.1 m.					(10)
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	45	- Decreased shale/clay content from 13.1 m to 14.3 m. - Broken/Fractured core zone infilled with soft reddish-purple shale/clay at 13.9 m. - ~125 mm Fractured zone infilled with soft shale/clay, very weak at 14.3 m.					
225	15.0	50	- Moderate strength below 15.2 m.		15.34	R4	92	65 (15)
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	55	- UCS: 17.6 MPa at 16.9 m.					
222	18.0	60				R6	93	40 (18)
221	19.0					R7	93	64 (16)
220	20.0	65	- Fair quality below 20.3 m.					
219	21.0	70	- 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.		21.44	R8	100	65 (14)
218	22.0			217.7	22.50	R9	93	70 (3)
217	23.0	75						
216	24.0	80						
215	25.0							
214	26.0	85						

Other column headings on the sheet: GRAPHICS, WATER LEVEL, DIAGRAM, SAMPLE TYPE, BLOWS/0.15 m, N-VALUE; plot: PL MC LL, Cu TORVANE (kPa) ◆, qu POCKET PEN (kPa) ★, SPT (N) BLOWS/0.30 m ▲ — 20 40 60 80

Notes:
1. End of test hole at 22.5 m.
2. Refusal encountered on suspected boulder at a depth of 9.1 m.
3. Protective well cover installed at surface.
4. 50.8 mm or two (2) inches diameter standpipe installed.
5. Vibrating wire piezometer (VW171370) installed at 8.53 m below grade.

WATER LEVELS ▽ **During Drilling/Digging** on 9-28-2023 None Encountered
▼ **Upon Completion** 6.71 m on 9-29-2023

CONTRACTOR **Maple Leaf Drilling Ltd.**
INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE
DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-03**

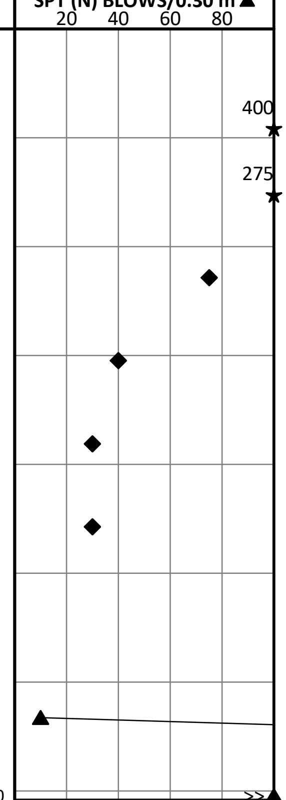
CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.80 m
LOCATION	Winnipeg, Manitoba	**START DATE**	9-27-2023
DESCRIPTION	~180 m south of Silver Ave, ~125 m west of Sturgeon Rd	**UTM (m)**	N 5,528,181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

DESCRIPTION AND CLASSIFICATION	ELEV (m)
CLAY FILL - 762 mm, Grey and black, dry, grass surface.	237.0
CLAY (CH) - Grey, dry to damp, high plasticity, very stiff to hard. - Trace to some silt inclusions below 1.8 m. - Damp to moist, stiff below 2.3 m. - Firm below 3.0 m.	233.1
SILT TILL (ML) - Light grey, moist, compact, some to with fine to coarse grained sand, trace gravel. - With red discoloration/alteration below 5.3 m. - Compact, some limestone fragments in sampler at 6.1 m.	230.7

Notes:
1. End of test hole at 7.1 m.
2. Refusal encountered on suspected bedrock at a depth of 7.0 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6	56	4 5 5	10
S7	17	40/ 60mm	+100

PL MC LL — Cu TORVANE (kPa) ◆ — qu POCKET PEN (kPa) ★ — SPT (N) BLOWS/0.30 m ▲



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

TEST HOLE LOG

KGS GROUP

HOLE NO. **TH23-04**

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

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE	Cu TORVANE (kPa) ◆ / qu POCKET PEN (kPa) ★ / SPT (N) BLOWS/0.30 m ▲
0.0	**CLAY FILL** - 914 mm, Grey and black, dry, grass surface.		S1				
0.9	**CLAY (CH)** - Grey, damp to moist, hard, high plasticity, some silt pockets.	236.9					450 ★
	- Very stiff below 1.5 m.		S2				300 ★
	- Stiff, increasing silt pockets below 2.3 m.						
	- Firm below 3.0 m.		S3				
			S4				
5.2	**SILT TILL (ML)** - Light grey, moist, compact, some to with fine to coarse grained sand, trace fine grained gravel.	232.6	S5				
	- With red discoloration/alteration below 5.6 m.		S6				
	- Compact below 6.1 m.		S7	72	5, 7, 8	15	
7.4		230.4	S8	17	40/ 80mm	+100	>>

Notes:
1. End of test hole at 7.4 m.
2. Refusal encountered on suspected bedrock at a depth of 7.3 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

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

KGS GROUP

TEST HOLE LOG

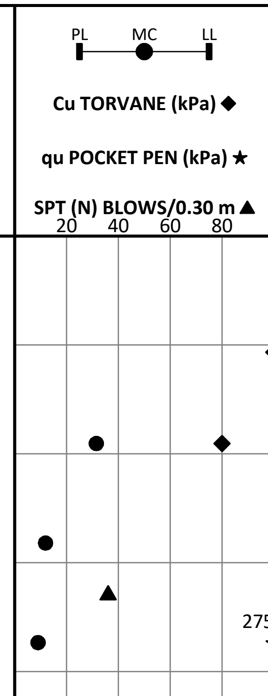
HOLE NO. **TH23-05**

SHEET 1 of 1

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

DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
TOPSOIL - 152 mm, Black, moist, with organics, with rootlets.	239.2					
CLAY (CH) - Brown, moist, very stiff, high plasticity, trace fine to coarse grained sand.						
- Stiff, trace fine grained gravel below 0.8 m.		Grab	S1			
		Grab	S2			
- Mottled brown to grey, trace silt inclusions below 1.5 m.		Grab	S3			
	237.0					
SILT TILL (ML) - Light grey, moist, dense, with fine to coarse grained sand, trace fine to coarse grained gravel, some clay.						
- PSA: 8% gravel, 27% sand, 46% silt, 19% clay at 2.7 m.		Grab	S4			
- No clay below 3.4 m.		SPT	S5	56	9 15 21	36
		Grab	S6			
	235.1					

Notes:
1. End of test hole at 4.3 m.
2. Refusal encountered on suspected bedrock at a depth of 4.3 m.
3. Test hole backfilled with auger cuttings and bentonite chips.



WATER LEVELS	**During Drilling/Digging**	on 11-15-2023 None Encountered
	Upon Completion	on 11-15-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.** INSPECTOR **S. GARG**

APPROVED K. FORDYCE DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-06**

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

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE	Cu TORVANE (kPa) / qu POCKET PEN (kPa)
0.0	**CLAY FILL** - 762 mm, Grey and black, dry, grass surface.		S1				qu 425
0.76	**CLAY (CH)** - Grey, dry to damp, hard, high plasticity.	238.3	S2				qu 450
	- Stiff below 2.1 m.						qu 150
2.6	**SILT TILL (ML)** - Light brown to grey, damp to moist, compact, with fine to coarse grained sand, trace fine grained gravel.	236.5	S3				
	- Compact below 3.0 m.		S4	100	8 11 16	27	
	- Dense, with red discoloration/alteration below 4.6 m.		S5	100	13 24 22	46	
			S6				
	- Very dense below 6.1 m.		S7	100	33 50/ 110mm	+100	
6.8		232.3	S8	17	40/ 80mm	+100	

Notes:
1. End of test hole at 6.8 m.
2. Refusal encountered on suspected bedrock at a depth of 6.7 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

WATER LEVELS
- **During Drilling/Digging** on 9-27-2023 None Encountered
- **Upon Completion** on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE	DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-07**

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

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE	qu POCKET PEN (kPa)
0.0–0.61	**CLAY FILL** - 610 mm, Grey and black, dry, grass surface.	238.5		S1				400
0.61–2.7	**CLAY (CH)** - Grey, damp, hard, high plasticity, some silt pockets.	236.4		S2				350, 400, 400
2.7–5.5	**SILT TILL (ML)** - Light grey, dry to damp, dense, some fine to coarse grained sand, trace fine grained gravel. - Dense below 3.0 m.	233.6		S3				
				S4	56	14 20 20	40	
				S5				
				S6	100	7 7 29	36	
				S7	6	40/ 30mm	+100	

Notes:
1. End of test hole at 5.5 m.
2. Refusal encountered on suspected bedrock at a depth of 5.5 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

WATER LEVELS
- **During Drilling/Digging** on 9-27-2023 None Encountered
- **Upon Completion** on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**
INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE
DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-08**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	239.40 m
LOCATION	Winnipeg, Manitoba	**START DATE**	9-26-2023
DESCRIPTION	South side Saskatchewan Ave Rail Crossing	**UTM (m)**	N 5,529,096
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,757 Zone 14
METHOD(S)	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		

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	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
0.0–0.2	**TOPSOIL/ORGANICS** - 152 mm, Grey and black, dry, trace to some organics.	239.2							
0.2–1.5	**CLAY (CH)** - Grey, dry, hard, high plasticity, trace silt and gypsum pockets, trace fine gravel.	237.9		S1					qu 450; qu 450
1.5–3.4	**SILT TILL (ML)** - Light grey, dry to damp, dense, with fine to coarse grained sand, with fine grained gravel, trace to some clay. - PSA: 25% gravel, 30% sand, 35% silt, 10% clay at 2.7 m. - Very dense below 3.0 m.	236.0		S2 S3	67		8 50/ 80mm	+100	qu 450; SPT >>
3.4–5.0	**DOLOMITE** - Mottled yellow-white, fine grained, massive, trace vugs, very strong. - 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. - 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.	234.4		R1	65	72 (8)			
5.0–9.4	**ARGILLACEOUS DOLOMITE** - Mottled reddish-gray to green, fine grained, fossiliferous, moderately strong. - 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. - 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		R2 R3 R4	70 38 95	79 (2) 27 (3) 79 (12)			

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.

WATER LEVELS
- ▽ **During Drilling/Digging** on 9-27-2023 None Encountered
- ▼ **Upon Completion** on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE	DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-09**

SHEET 1 of 1

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

ELEV (m)	DESCRIPTION AND CLASSIFICATION	INSTALL DEPTH (m)	SAMPLE	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	Lab / Field Tests
239.7	**TOPSOIL/ORGANICS** - 305 mm, Black, damp, with organics and roots.							
238.8	**SILT (ML)** - Light brown, dry to damp, firm, non-plastic, trace sand.		S1					MC
237.7	**CLAY (CH)** - Dark brown, moist, stiff, high plasticity, some silt pockets, trace fine to coarse grained gravel. - Hard drilling below 2.0 m.		S2					Cu Torvane ◆
233.5	**SILT TILL (CL)** - Light brown, moist, dense, low plasticity, with fine to coarse grained sand, some fine grained gravel, some clay. - LL=27, PL=14, PI=13 at 4.4 m. - PSA: 17% gravel, 26% sand, 42% silt, 15% clay at 4.4 m. - Some coarse grained gravel, trace cobbles below 4.9 m. - Loss of return water, 15 cm granite boulder in sampler at 5.3 m.	5.79, 6.10	S3					MC; qu 250
			S4	77		19 34 50/ 130mm	+100	MC; SPT >>
			S5					PL, MC, LL; qu 300, 425
			S6					qu 425
			R1	37	14 (10)			
230.6	**ARGILLACEOUS DOLOMITE** - Mottled green-red, fine grained, fossiliferous, strong. - Very poor quality from 6.5 m to 9.4 m. - Increased shale content on joint faces below 6.5 m. - Highly fractured and broken lost core zones below 6.6 m. - No water return during run at 7.9 m. - Reddish-purple, increased fossils, strong below 9.1 m.	9.14, 9.45	R2	42	0 (10)			
			R3	43	18 (2)			

Notes:
1. End of test hole at 9.8 m.
2. Refusal encountered on boulder or bedrock at a depth of 5.3 m.
3. Protective well cover installed at surface.
4. 25.4 mm or one (1) inch diameter standpipe installed.

WATER LEVELS
- ▽ During Drilling/Digging on 9-27-2023 None Encountered
- ▼ Upon Completion on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **G. GITZEL**
APPROVED K. FORDYCE	DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-11**

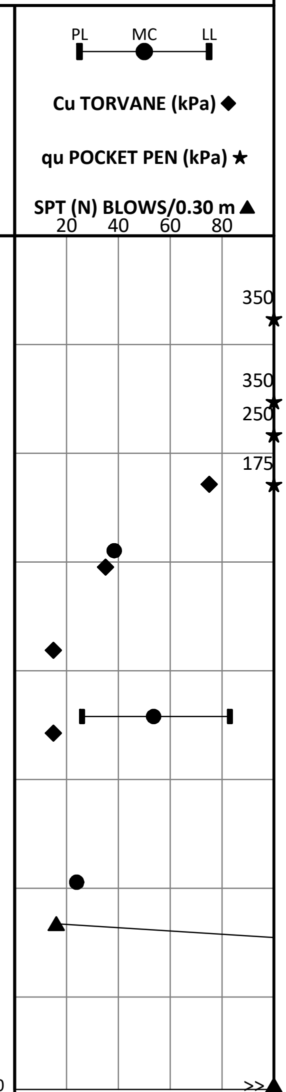
CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.50 m
LOCATION	Winnipeg, Manitoba	**START DATE**	9-26-2023
DESCRIPTION	~60 m northest of Tonka Pt, ~220 m east of Sturgeon Rd	**UTM (m)**	N 5,529,997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

DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
CLAY FILL - 457 mm, Grey and black, dry, some organics, some fine to coarse grained gravel.	237.0	S1			
CLAY (CH) - Light brown to grey, dry to damp, very stiff, high plasticity.		S2			
- Trace to some silt and gypsum pockets below 1.8 m.					
- Damp to moist, stiff below 2.3 m.		S3			
- Firm below 3.0 m.					
- Soft below 3.8 m.					
- LL=83, PL=26, PI=57 at 4.3 m.	232.3	S4			
SILT TILL (ML) - Light brownish grey, moist, compact, low plasticity, with fine to coarse grained sand, trace fine grained gravel, with clay.					
- PSA: 4% gravel, 28% sand, 39% silt, 29% clay at 5.8 m.		S5			
- Compact below 6.1 m.		S6	44	2 4 12	16
	229.7	S7			
		S8	17	50/ 80mm	+100

Notes:
1. End of test hole at 7.8 m.
2. Refusal encountered on suspected bedrock at a depth of 7.8 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Caving encountered at 7.0 m.

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; WATER LEVEL; SAMPLE TYPE; NUMBER; RECOVERY %; BLOWS/0.15 m; N-VALUE

Elevation scale: 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226
Depth scale (m): 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0
Depth scale (ft): 5, 10, 15, 20, 25, 30, 35



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

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-12**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.80 m
LOCATION	Winnipeg, Manitoba	**START DATE**	9-27-2023
DESCRIPTION	~220 m northeast of Tonka Pt, ~75 m east of Sturgeon Road	**UTM (m)**	N 5,530,219
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 623,766 Zone 14
METHOD(S)	0.0 m to 7.6 m: 125 mm ø SSA		

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; ELEV (m); WATER LEVEL; SAMPLE TYPE; NUMBER; 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)

Description and Classification	Elev (m)
<u>CLAY FILL</u> - 457 mm, Grey and black, dry to damp, some organics, some fine to coarse grained gravel.	237.3
<u>CLAY (CH)</u> - Light brown to grey, damp to moist, stiff, high plasticity.	
- Mottled brown/ grey, moist, trace to some gypsum & silt pockets below 2.0 m.	
- Firm below 5.2 m.	
- Increasing silt inclusions below 5.8 m.	230.9
<u>SILT TILL (ML)</u> - Light brownish grey, moist, compact, some to with fine to coarse grained sand, trace to some fine grained gravel.	
- With red discoloration/alteration at 7.6 m.	230.1

Samples: S1, S2, S3, S4, S5, S6, S7

Sample	Recovery %	Blows/0.15 m	N-Value
S7	11	20/ 30mm	+100

Pocket pen values plotted: 150, 150, 150, 125; SPT: >>

Notes:
1. End of test hole at 7.6 m.
2. Refusal encountered on suspected bedrock at a depth of 7.6 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Caving encountered at 6.4 m.

WATER LEVELS
- ▽ **During Drilling/Digging** on 9-27-2023 None Encountered
- ▼ **Upon Completion** on 9-27-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **M. RODRIGUEZ**
APPROVED K. FORDYCE	DATE 1-22-2024

TEST HOLE LOG

KGS GROUP

HOLE NO. **TH23-17**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.67 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-17-2023
DESCRIPTION	~30 m south of CPKC Rail Line, ~125 m east of CCW	**UTM (m)**	N 5,533,655
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer		E 624,430 Zone 14
METHOD(S)	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		

DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE / RUN	RECOVERY %	RQD (JOINTS/RUN)
0.0	**TOPSOIL** - 203 mm, Black, moist, with organics, some rootlets.	237.5			
0.2	**CLAY (CH)** - Dark brown, moist, stiff, high plasticity, trace fine to coarse grained sand, some silt inclusions.		S1		
	- Brown, very stiff, trace fine grained gravel, trace silt inclusions below 1.5 m.				
	- LL=80, PL=25, PI=55 at 2.0 m.		S2		
	- Stiff below 2.4 m.				
	- Brown silt till pocket, moist, compact, some clay, trace fine to coarse grained sand, trace fine grained gravel from 3.0 m to 3.4 m. - Predominantly clay below 3.4 m.		S3		
4.0	**SILT TILL (CL)** - Brown, moist, compact, low plasticity, and clay, some fine to coarse grained sand, trace fine grained gravel. - PSA: 4% gravel, 21% sand, 35% silt, 40% clay at 4.0 m.	233.7	S4		
4.4	**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong. - Strong below at 4.6 m. - 40 mm horizontal joint infilled with shale at 4.7 m. - UCS: 28.2 MPa at 4.9 m. - UCS: 28.1 MPa at 5.2 m.	233.3	R1	94	75 (2)
			R2	97	65 (12)
	- 75 mm horizontal joint infilled with shale at 6.6 m.		R3	95	70 (10)
	- Increased shale content, weak from 8.0 m to 8.1 m. - Three closely spaced joints partially infilled with shale from 8.6 m to 8.8 m.		R4	100	47 (17)
	- Increased shale content / shale interbeds from 9.4 m to 11.6 m. - Very weak with significant shale content from 9.5 m to 10.1 m. - Three 25 - 75 mm shale beds spaced 0.3 to 0.4 m apart from 10.6 m to 11.4 m.		R5	98	21 (23)
			R6	100	60

PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★ (150, 250); SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

WATER LEVELS ▼ **Upon Completion** on 11-17-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **S. GARG**
APPROVED J. MACLENNAN	DATE 1-10-2024

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	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)
		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)	

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.

Elevation scale (m): 225, 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213, 212

Depth scale (m): 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0

Depth scale (ft): 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

WATER LEVELS ▼ **Upon Completion** on 11-17-2023 None Encountered

CONTRACTOR	INSPECTOR
Maple Leaf Drilling Ltd.	**S. GARG**
APPROVED	DATE
J. MACLENNAN	1-10-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-18**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	238.01 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 238.92 m (Standpipe)
DESCRIPTION	~15 m north of CPKC Rail Line, ~125 m east of CCW	**START DATE**	11-16-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,533,695
METHOD(S)	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		E 624,469 Zone 14

DESCRIPTION AND CLASSIFICATION	ELEV (m)	INSTALL DEPTH (m)	SAMPLE NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
TOPSOIL - 152 mm, Black, moist, with organics, with rootlets.	237.9						
CLAY (CH) - Dark brown, moist, stiff, high plasticity, trace fine grained sand. - Brown below 0.5 m. - Light brown, moist, with silt, trace fine to coarse grained sand, trace coarse grained gravel below 2.3 m. - Trace fine grained gravel below 2.4 m. - LL=49, PL=16, PI=33 at 2.4 m. - 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.	234.2		S1, S2, S3, S4				
SILT TILL (CL-ML) - 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.	233.2		S5	100		30/ 100mm	+100
ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE - 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 approximatley 150 mm from 10.1 m to 11.3 m. - Increased shale content, fissile, weak from 11.6 m to 12.0 m.		10.52 11.28	R1 R2 R3 R4 R5 R6	67 86 98 102 98 100	88 63 (7) 52 (15) 54 (15) 20 (25) 39 (14)		

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; WATER LEVEL; LOG OF INSTALLS: DIAGRAM, DEPTH (m); SAMPLE TYPE; PL — MC — LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ (20, 40, 60, 80); >>

Elevation scale: 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227. Depth scale (m): 1.0 – 11.0; (ft): 5 – 35.

WATER LEVELS ▽ **During Drilling/Digging** on 11-16-2023 None on Auger

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **S. GARG**
APPROVED J. MACLENNAN	DATE 1-10-2024

TEST HOLE LOG

HOLE NO. **TH23-18**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	LOG OF INSTALLS DEPTH (m)
		40	- Decreasing shale, moderate strength to the full exploration depth.	225.3	12.19 / 12.62
225	13.0		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.		
		45			
224	14.0				
223	15.0				
		50			
222	16.0				
		55			
221	17.0				
220	18.0				
		60			
219	19.0				
		65			
218	20.0				
217	21.0				
		70			
216	22.0				
		75			
215	23.0				
214	24.0				
		80			
213	25.0				
		85			
212	26.0				

Other column headings: GRAPHICS, WATER LEVEL, DIAGRAM, 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)

WATER LEVELS ∇ **During Drilling/Digging** on 11-16-2023 None on Auger

CONTRACTOR	INSPECTOR
Maple Leaf Drilling Ltd.	**S. GARG**
APPROVED	DATE
J. MACLENNAN	1-10-2024

TEST HOLE LOG

KGS GROUP

HOLE NO. **TH23-19**

SHEET 1 of 1

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

Columns: ELEVATION (m) | DEPTH (m) (ft) | GRAPHICS | DESCRIPTION AND CLASSIFICATION | ELEV (m) | WATER LEVEL | SAMPLE TYPE | NUMBER | 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)

DESCRIPTION AND CLASSIFICATION	ELEV (m)	NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
TOPSOIL - 152 mm, Black, damp, trace organics, trace rootlets.	238.6				
CLAY FILL - 305 mm, Dark greyish brown, moist, very stiff, high plasticity.	238.3	S1			
CLAY (CH) - Mottled grey/brown, moist, very stiff, high plasticity, trace silt inclusions.		S2			
- Stiff below 2.7 m.					
- Trace oxidation staining below 3.0 m.		S3			
- No oxidation staining below 4.6 m.					
- LL=79, PL=24, PI=55 at 5.2 m.		S4			
- Grey, increased silt inclusions below 5.3 m.		S5			
SILT TILL (ML) - Brown, moist, compact, low plasticity, trace coarse grained sand, trace fine grained gravel, trace clay.	231.7	S6			
	231.1	S7	0	50/ 30mm	+100

Notes:
1. End of test hole at 7.6 m.
2. Refusal encountered on suspected bedrock at a depth of 7.6 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

WATER LEVELS ▼ **Upon Completion** on 11-15-2023 None Encountered

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **S. GARG**
APPROVED J. MACLENNAN	DATE 1-10-2024

KGS GROUP

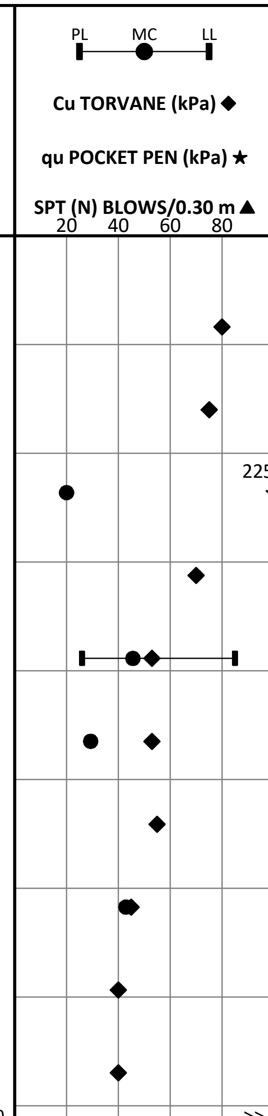
TEST HOLE LOG

HOLE NO. **TH23-20**

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

DESCRIPTION AND CLASSIFICATION	ELEV (m)
CLAY FILL - 457 mm, Black, damp, firm, intermediate plasticity, trace rootlets and grass.	238.4
CLAY (CH) - Light brown to grey, damp, stiff, high plasticity, with silt, trace coarse sand, trace rootlets and organics.	
- No organics below 1.7 m.	
- Decreased silt content below 2.1 m.	
- Light grey, some silt inclusions from 3.0 m to 5.8 m.	
- LL=85, PL=26, PI=59 at 3.8 m.	
- Firm below 6.1 m.	231.6
SILT TILL (ML) - Light brown, damp, loose, non-plastic, some to with fine to coarse sand, trace fine grained gravel.	
- Wet below 7.6 m.	
- Red/Purple limestone fragments in split spoon at 8.1 m.	230.7

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6			
S7			
S8			
S9			
S10			
S11	6	50/ 20mm	+100



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

KGS GROUP

TEST HOLE LOG

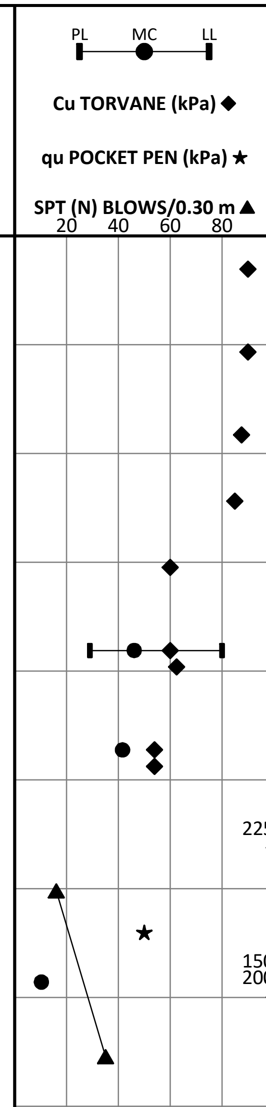
HOLE NO. **TH23-21**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	238.92 m
LOCATION	Winnipeg, Manitoba	**START DATE**	11-22-2023
DESCRIPTION	Ditch, offset ~12 m south of CCW, north Red Fife Rd.	**UTM (m)**	N 5,534,214
DRILL RIG / HAMMER	Mobile B37X Track Mounted Drill Rig with Auto-Hammer		E 624,868 Zone 14
METHOD(S)	0.0 m to 8.1 m: 125 mm ø SSA		

DESCRIPTION AND CLASSIFICATION	ELEV (m)
CLAY FILL - 914 mm, Dark brown, moist, very stiff, high plasticity, trace fine grained gravel, trace organics.	238.0
CLAY (CH) - Brown, moist, stiff, high plasticity, trace coarse grained sand. - Trace silt inclusions below 1.2 m. - Grey below 2.7 m. - LL=80, PL=29, PI=51 at 3.7 m. - Some silt inclusions below 4.0 m. - Silt till pocket at 4.1 m.	233.7
SILT TILL (ML) - Light brown, damp, compact, low plasticity, silt, trace fine grained sand, some clay. - PSA: 0% gravel, 2% sand, 81% silt, 17% clay at 5.5 m. - Free water in split spoon at 5.8 m. - Moist to wet, some fine to coarse sand, trace fine grained gravel below 5.8 m. - Moist, dense, some fine grained gravel below 6.4 m. - Yellow sandy silt till below 7.6 m.	230.8

NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6	89	6 5 11	16
S7			
S8	100	10 13 22	35
S9			



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 6.2 m.

WATER LEVELS ▼ **Upon Completion** 4.27 m on 11-22-2023

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **K. FORDYCE**
APPROVED J. MACLENNAN	DATE 1-10-2024

TEST HOLE LOG

KGS GROUP

HOLE NO. **TH23-22**

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

ELEV (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER	RECOVERY %	BLOWS/0.15 m	N-VALUE
	CLAY (CH) - Greyish brown, moist, very stiff, high plasticity, trace silt inclusions, trace coarse grained sand, trace organics.	S1			
	- Some silt inclusions, trace fine grained gravel below 1.2 m. - Stiff below 1.5 m.	S2			
		S3			
235.8	- Moist to wet below 3.7 m.				
	SILT TILL (ML) - Light brown, damp, dense, non-plastic, silt, trace fine grained sand.	S4			
	- Light grey silt and fine grained sand pocket from 4.3 m to 4.4 m. - Some clay below 4.6 m.	S5	89	11 14 22	36
	- PSA: 0% gravel, 6% sand, 77% silt, 17% clay at 4.7 m.	S6			
	- Moist, trace fine to coarse grained sand, trace fine grained gravel below 5.2 m.	S7			
	- Coarse grained gravel (granite) in tip of split spoon at 5.8 m. - Trace to some sand and gravel below 5.8 m.	S8	67	19 31 34	65
		S9			
232.4		S10	100	50	+100

Pocket pen qu (kPa): 150, 125, 150, 175, 450, 400, 450; SPT: >>

Notes:
1. End of test hole at 7.3 m.
2. Refusal encountered on suspected bedrock at a depth of 7.3 m.
3. Test hole backfilled with auger cuttings and bentonite chips.
4. Caving encountered at 5.8 m.

WATER LEVELS ▼ **Upon Completion** 3.35 m on 11-22-2023

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **K. FORDYCE**
APPROVED J. MACLENNAN	DATE 1-10-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-23**

SHEET 1 of 1

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

Depth (m)	Description and Classification	Elev (m)	Sample Type	Number	Recovery %	Blows/0.15 m	N-Value
0.0	**TOPSOIL** - 152 mm, Black, moist, organic clay.	238.7					
0.15	**CLAY (CH)** - Brown, moist, stiff, high plasticity, trace organics.						
~1.0			Shelby tube	S1			
1.2	- Mottled brown, trace silt inclusions, trace oxide nodules below 1.2 m.						
~2.3			Shelby tube	S2			
2.7	- Trace light brown silt till pockets, no oxide nodules below 2.7 m.		Shelby tube	S3			
3.7	- LL=56, PL=29, PI=27 at 3.7 m.		Shelby tube	S4			
4.0	- Grey below 4.0 m.						
4.6	**SILT TILL (ML)** - Light brown, moist, dense, silt, trace clay.	234.2					
4.9	- Wet, trace fine grained sand below 4.9 m.		Shelby tube	S5			
5.8	- Sloughed material in top 125 mm of split spoon at 5.8 m.		Split spoon	S6	100	14 50	+100
5.9	- Damp to moist, dense, non-plastic, some fine to coarse grained sand, trace fine grained gravel below 5.9 m.	232.6	Shelby tube	S7			

Notes:
1. End of test hole at 6.2 m.
2. Refusal encountered in silt till at a depth of 6.2 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

Legend: PL — MC — LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲; scale 20 40 60 80. SPT value 300.

WATER LEVELS ▼ **Upon Completion** 1.83 m on 11-22-2023

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **K. FORDYCE**
APPROVED J. MACLENNAN	DATE 1-10-2024

KGS GROUP

TEST HOLE LOG

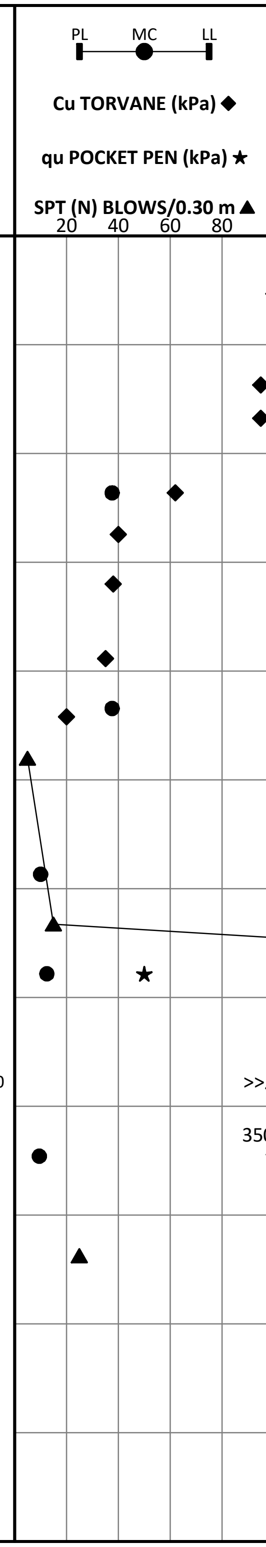
HOLE NO. **TH23-24**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	238.26 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	1.00 m / 239.26 m (Standpipe)
DESCRIPTION	Farm field, ~75 m east of CCW, ~320 m south of Sturgeon Access	**START DATE**	11-13-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,529,982
METHOD(S)	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		E 622,695 Zone 14

ELEV (m)	DESCRIPTION AND CLASSIFICATION
238.1	**TOPSOIL** - 152 mm, Black, moist, soft, with organics, with rootlets.
237.3	**CLAY (CH)** - Mottled grey/brown, moist, very stiff, high plasticity, oxide nodules trace silt inclusions.
237.0	**SILT (ML)** - Dark brown, moist, very stiff, high plasticity, trace coarse grained sand, trace fine grained gravel, trace rootlets.
234.3	**CLAY (CH)** - Light brown, moist, firm, high plasticity, trace clay, trace fine grained gravel. - Stiff below 2.3 m. - Firm below 2.7 m. - Grey, no oxidized nodules below 3.0 m.
228.6	**SILT TILL (ML)** - Light brown, moist, loose, low plasticity, some clay, trace fine to coarse grained gravel (putty till). - With fine to coarse grained sand, trace fine grained gravel, trace to some clay below 4.6 m. - Compact below 5.5 m. - Very dense below 7.6 m. - PSA: 10% gravel, 37% sand, 42% silt, 11% clay at 8.4 m. - Compact at 9.1 m.
	POOR RECOVERY - Only fragmented rock pieces recovered. Unable to distinguish if the recovered material is glacial till or top of bedrock. Granite and limestone fragments recovered. Limestone is very strong..

NUMBER / RUN	RECOVERY %	BLOWS/0.15 m	N-VALUE
S1			
S2			
S3			
S4			
S5			
S6	81	1 3 2	5
S7			
S8	39	4 7 8	15
S9			
S10	63	10 50	+100
S11			
S12	64	18 21 4	25
R1	20		
R2	0		

LOG OF INSTALLS: Vibrating Wire VW164950 — depths 9.45, 9.91, 10.36, 10.67



WATER LEVELS ▼ Upon Completion 2.54 m on 11-14-2023

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **G. GITZEL**
APPROVED K. FORDYCE	DATE 1-22-2024

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS DIAGRAM	LOG OF INSTALLS DEPTH (m)	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
226	40			225.9			12.19 12.37						

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.

Elevation scale (m): 226, 225, 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213

Depth scale (m): 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0

Depth scale (ft): 40, 45, 50, 55, 60, 65, 70, 75, 80, 85

WATER LEVELS ▼ **Upon Completion** 2.54 m on 11-14-2023

CONTRACTOR	INSPECTOR
Maple Leaf Drilling Ltd.	**G. GITZEL**
APPROVED	DATE
K. FORDYCE	1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-25**

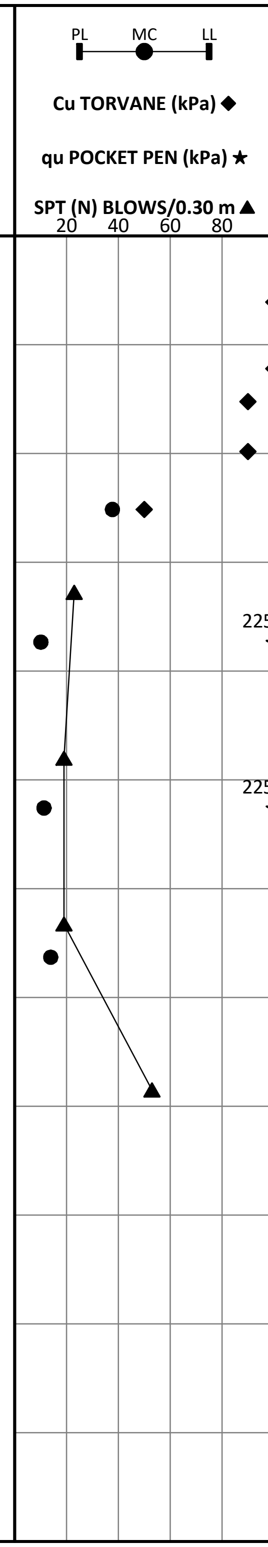
CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	239.06 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.79 m / 239.85 m (Standpipe)
DESCRIPTION	Farm field, ~180 m east of CCW, ~125 m south of Stugeon Access	**START DATE**	11-14-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,530,062
METHOD(S)	0.0 m to 8.2 m: 125 mm ø SSA 8.2 m to 14.1 m: Water Rotary HQ Core - switched due to encountering dense till		E 622,907 Zone 14

DESCRIPTION AND CLASSIFICATION

ELEV (m)	Description
238.8	**TOPSOIL** - 305 mm, Dark brown, damp, with organics, with rootlets.
236.3	**CLAY (CH)** - Dark brown, damp, very stiff, high plasticity, trace medium grained sand. - Brown, moist below 0.8 m. - Mottled grey to brown, trace silt inclusions, trace oxide nodules below 1.5 m.
227.9	**SILT TILL (ML)** - Light brown, moist, compact, low plasticity, with fine to coarse grained sand, trace fine grained gravel, some clay. - Trace coarse grained gravel below 3.0 m. - Wet below 6.1 m. - PSA: 8% gravel, 34% sand, 45% silt, 13% clay at 6.6 m. - Very dense below 7.6 m.
	ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.

LOG OF INSTALLS: Vibrating Wire VW163297 — 10.06; 10.82; 11.58

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
S1				
S2				
S3				
S4	72		5 10 13	23
S5				
S6	81		5 6 13	19
S7				
S8	44		10 10 9	19
S9				
S10	53		12 26 27	53
R1	22			
R2	21			
R3	43	17		



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

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS DEPTH (m)	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)
227		40		- 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.			12.04							
226	13.0			- UCS: 24.3 MPa at 13.3 m. - 50 mm joint infilled with shale at 13.5 m.			13.56		R4	100	79 (8)			
225	14.0	45		- Increased shale content below 13.9 m.	225.0		14.07							

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.

Elevation scale: 224, 223, 222, 221, 220, 219, 218, 217, 216, 215, 214, 213
Depth (m): 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0
Depth (ft): 50, 55, 60, 65, 70, 75, 80, 85

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

CONTRACTOR	INSPECTOR
Maple Leaf Drilling Ltd.	**G. GITZEL**
APPROVED	DATE
K. FORDYCE	1-22-2024

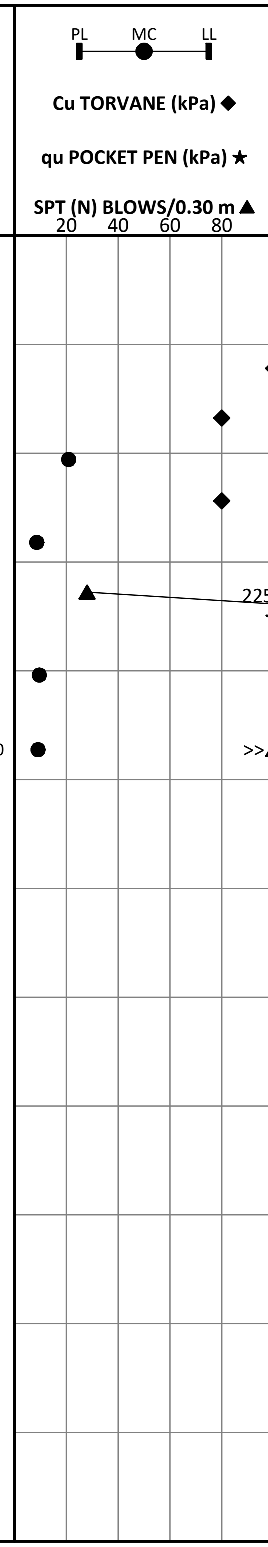
KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-26**

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

DEPTH (m)	ELEV (m)	DESCRIPTION AND CLASSIFICATION	SAMPLE NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
0.0	238.9	**TOPSOIL** - 152 mm, Black, moist, with organics, with rootlets.					
0.15		**CLAY (CH)** - Brown, moist, very stiff, high plasticity, trace medium to coarse grained sand, trace rootlets.	S1				
		- Grey, trace silt inclusions, trace fine grained gravel, no rootlets below 1.5 m.	S2				
2.5	236.6	**SILT TILL (ML)** - Light brown, damp, compact, low plasticity, trace fine to coarse grained sand, trace fine grained gravel, some clay.	S3				
			S4	78		14 16 12	28
		- With fine to coarse grained sand below 4.0 m.	S5				
		- Very dense below 4.6 m. - PSA: 10% gravel, 31% sand, 45% silt, 14% clay at 4.6 m.	S6	96		43 50	+100
			R1	41			
6.4	232.7	**ARGILLACEOUS DOLOMITE** - Mottled yellow-green, fine grained, fossiliferous, moderately strong, some vugs (6 - 25 mm). - Concentrated zone of vugs from 6.4 m to 6.6 m. - 50 mm horizontal joint infilled with shale at 6.8 m.					
7.1	232.0	**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - 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. - 12 mm horizontal joint infilled with red shale at 7.7 m.	R2	98	86 (7)		
		- 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. - Increasing green shale interbeds; decreased red shale from 8.8 m to 9.8 m.	R3	98	83		
			R4	93	93 (6)		
		- 7 mm horizontal joint infilled with red shale at 11.0 m. - 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.	R5	100	58 (12)		



WATER LEVELS ∇ **During Drilling/Digging** on 11-14-2023 None on Auger

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **G. GITZEL**
APPROVED K. FORDYCE	DATE 1-22-2024

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-26**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
227		40					
226	13.0		- Three 100 - 125 mm thick limstone interbeds spaced at 0.3 m from 13.5 m to 13.6 m.		R6	100	49 (16)
225	14.0	45					
224	15.0	50	- Decreasing shale, increasing limestone from 14.9 m to 15.0 m. - Broken core zone, open joint with shale at 15.2 m.	223.4	R7	95	47 (12)

Notes:
1. End of test hole at 15.6 m.
2. Refusal encountered on suspected bedrock at a depth of 5.0 m.
3. Test hole backfilled with auger cuttings and bentonite chips.

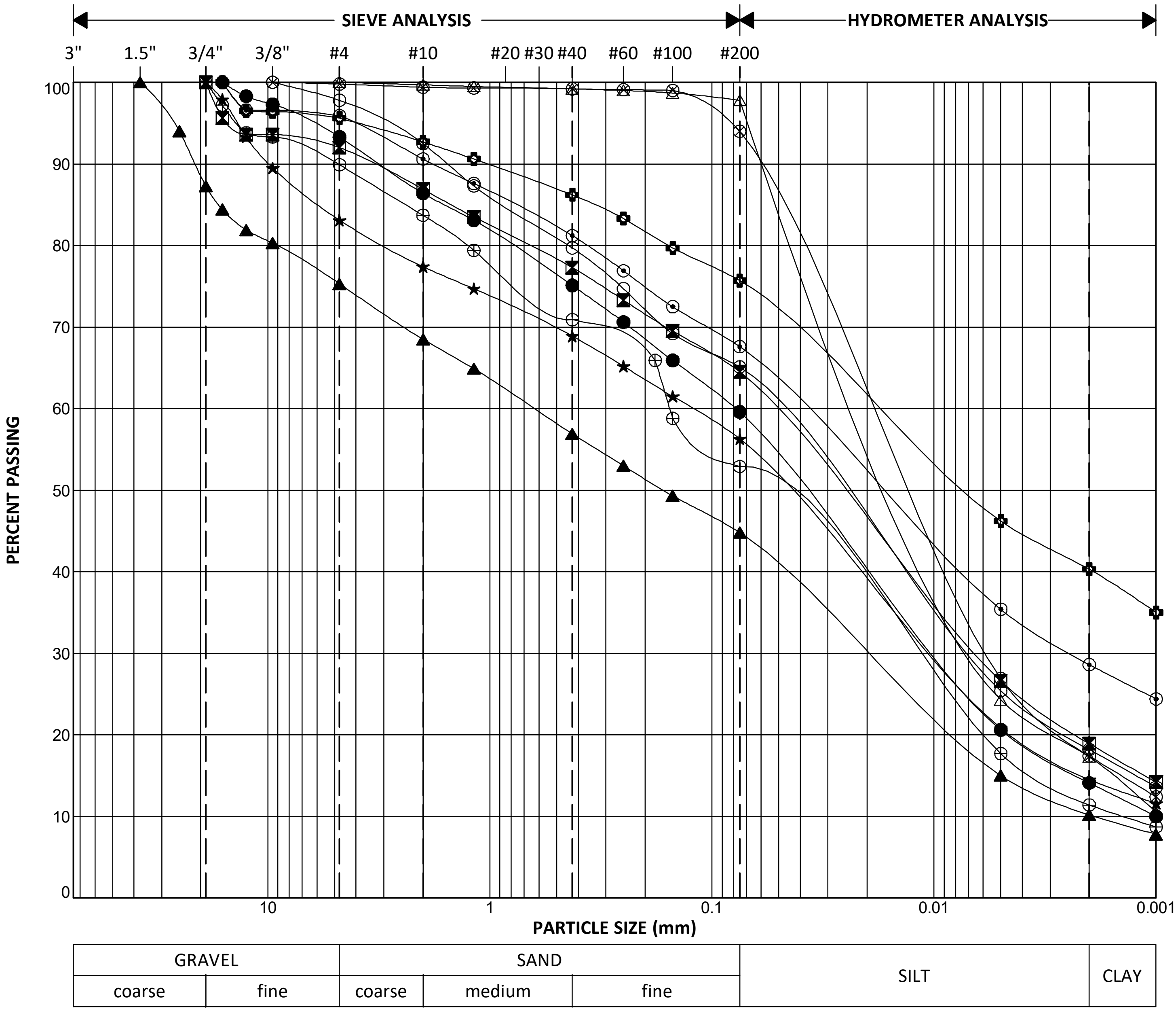
Depth scale: 16.0 to 26.0 m (ft 55 to 85); Elevation scale: 223 to 213 m.

Columns: WATER LEVEL, SAMPLE TYPE, 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

WATER LEVELS ▽ **During Drilling/Digging** on 11-14-2023 None on Auger

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **G. GITZEL**
APPROVED K. FORDYCE	DATE 1-22-2024

GRAIN SIZE DISTRIBUTION

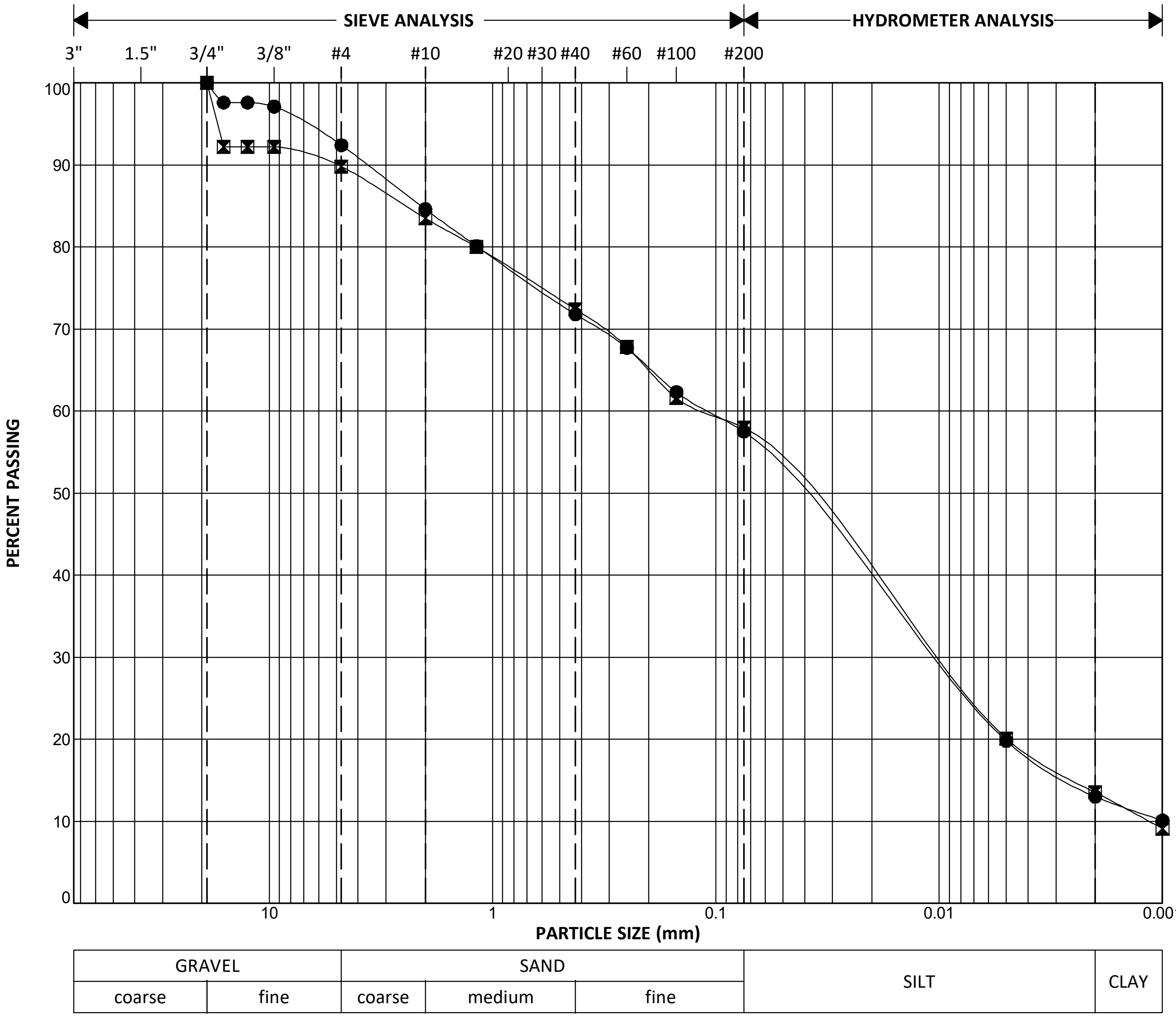


	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-01	5.8	S6	7	33	45	14	60	78.37	1.18	ML
⧗	TH23-05	2.7	S4	8	27	46	19	65			ML
▲	TH23-08	2.7	S2	25	30	35	10	45	334.42	0.32	SM
★	TH23-09	4.4	S5	17	27	42	15	56			CL
⊙	TH23-11	5.8	S5	4	28	39	29	68			ML
✿	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

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**DATE TESTED**	10/26/2023

GRAIN SIZE DISTRIBUTION



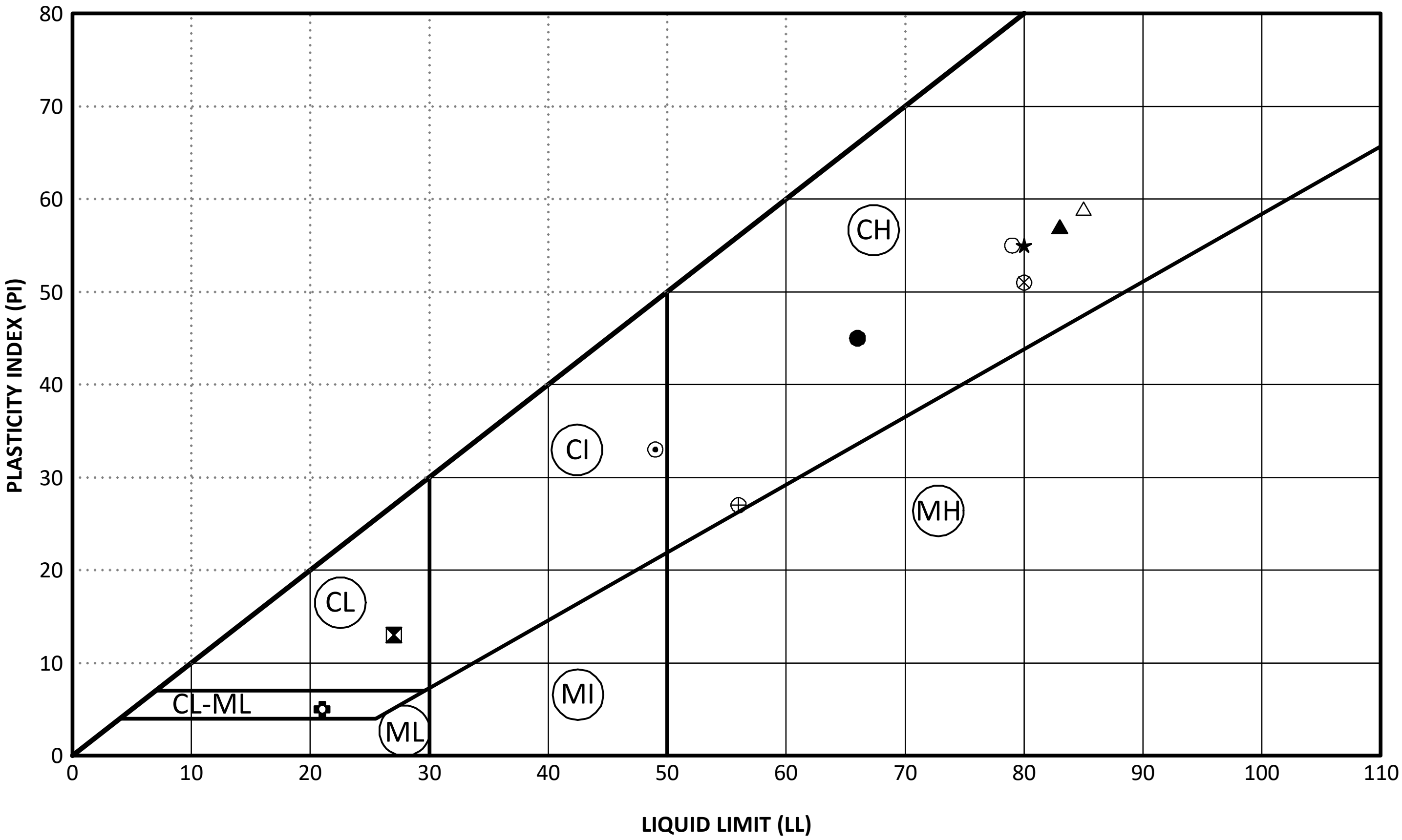
	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-25	6.6	S9	8	34	45	13	58			ML
⧗	TH23-26	4.6	S6	10	32	45	14	58	95.66	0.81	ML

SIEVE ANALYSIS C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\23-0107-009_CENTREPORT_SEPT 26 TO 29, 2023.GPJ

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**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

KGS GROUP

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba
TESTED BY	Stantec	**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
PL - Plastic Limit
PI - Plastic Index
MC - Moisture Content
DD - Dry Density
NP - Non-Plastic
-200 - Percent Passing No. 200 Sieve
TV - Torvane (kPa)
PP - Pocket Penetrometer (kPa)
PSA - Particle Size Analysis
TOC - Top Of Casing

PN - Pneumatic Piezometer
VW - Vibrating Wire Piezometer
PID - Photoionization Detector
ppm - Parts Per Million
∇ Water Level During Drilling
$\blacktriangledown$ Water Level Upon Completion of Drilling
$\blacktriangledown$ Water Level Remeasured/Static

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT NAME	CentrePort Regional S&W Servicing	**LOCATION**	Winnipeg, Manitoba

KGS GROUP

TEST PIT LOG

HOLE NO. **TP24-01**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	239.97 m
LOCATION	Winnipeg, Manitoba	**START DATE**	2-21-2024
DESCRIPTION	Approx 15 m North of TH23-09	**UTM (m)**	N 5,529,197.34
EXCAVATOR	CAT 320 Excavator		E 623,763.07 Zone 14
METHOD(S)			

DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE NUMBER
TOPSOIL - Black, frozen, with grass and rootlets.	239.7	
SILT - Light brown, non-plastic, frozen.	239.4	S1
CLAY - Brown, damp, stiff, low plasticity, some silt.	238.5	S2
SILT TILL - Light brownish grey, dry, dense, low plasticity, some gravel, some sand, some clay, trace cobbles/boulders. - Increased gravel, cobbles/boulders. Average boulder size of 380 mm and maximum size of 560 mm below 2.0 m. - Silt till mixed with weathered bedrock at 4.9 m.	234.9	S3, S4, S5, S6
BEDROCK - Reddish brown, argillaceous, brittle.	234.7	S7

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; WATER LEVEL; SAMPLE TYPE; NUMBER; PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

Notes:
1. End of test pit at 5.3 m.
2. Refusal encountered on boulder or bedrock at a depth of 5.1 m.
3. Test pit backfilled with excavated material.

WATER LEVELS ▼ **Upon Completion** 5.10 m Dry

CONTRACTOR **J CON Civil**	INSPECTOR **L. PROVEN**
APPROVED K. FORDYCE	DATE 2-29-2024

KGS GROUP

TEST PIT LOG

HOLE NO. **TP24-02**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.64 m
LOCATION	Winnipeg, Manitoba	**START DATE**	2-22-2024
DESCRIPTION	North Shoulder of Saskatchewan Ave outside CPKC ROW	**UTM (m)**	N 5,529,137.29
EXCAVATOR	CAT 320 Excavator		E 623,771.87 Zone 14
METHOD(S)			

Depth (m)	Description and Classification	ELEV (m)	Water Level	Sample Type	Number
0.0–1.0	**CLAY FILL** - Black, topsoil at ground surface, frozen, trace rootlets.	239.6			
1.0–1.3	**SILT** - Light brown, dry, low plasticity, some clay.	239.3		Grab	S1
1.3–3.0	**CLAY** - Brown, damp, hard, low plasticity, with silt.	237.6		Grab	S2
3.0–4.6	**SILT TILL** - Light grey, damp, dense, low plasticity, and clay, some gravel, some sand, trace cobbles/boulders. - Trace clay. Sedimentary/Igneous boulders (maximum size of 600 mm) encountered below 3.5 m.	236.0	▼	Grab	S3, S4
4.6–5.0	**BEDROCK** - Mottled yellow grey dolomite, hard, strong.	235.6		Grab	S5

Notes:
1. End of test pit at 5.0 m.
2. Refusal encountered on boulder or bedrock at a depth of 4.6 m.
3. Test pit backfilled with excavated material.

Column headings: ELEVATION (m); DEPTH (m) (ft); GRAPHICS; DESCRIPTION AND CLASSIFICATION; WATER LEVEL; SAMPLE TYPE; NUMBER; PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

WATER LEVELS ▼ **Upon Completion** 4.60 m Dry

CONTRACTOR **J CON Civil**	INSPECTOR **L. PROVEN**
APPROVED K. FORDYCE	DATE 2-29-2024

APPENDIX C

2023/2024 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)

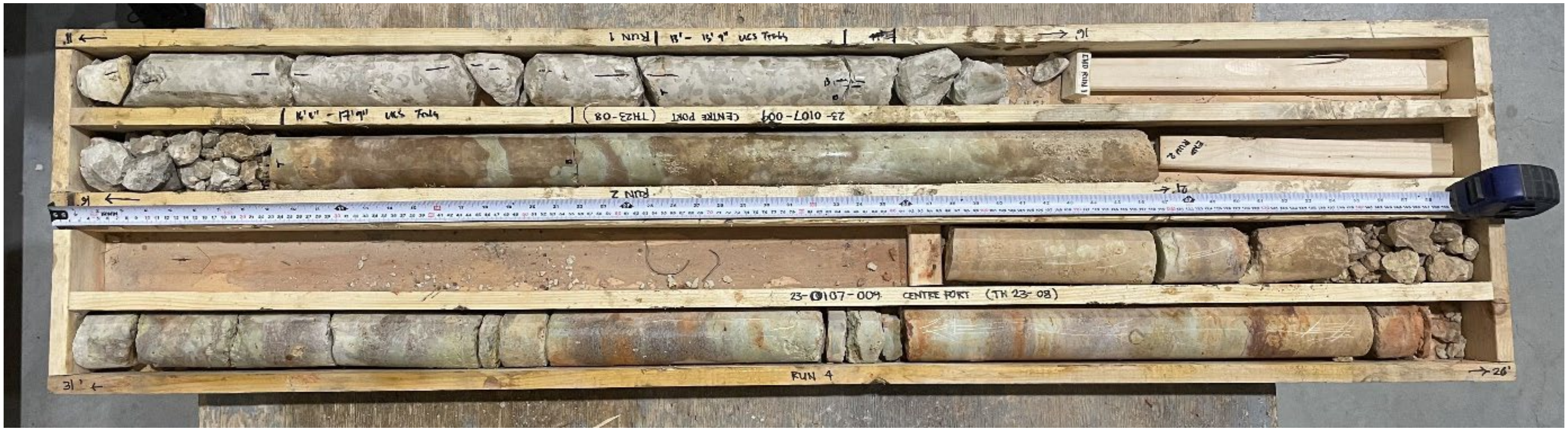
TH23-06 Photo 4: 3.0 m to 4.5 m (15 ft to 20 ft)

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)

TH23-18 Photo 4: Bedrock core from 4.6 m to 12.4 m (15 ft – 5 in to 41 ft – 5 in)

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)

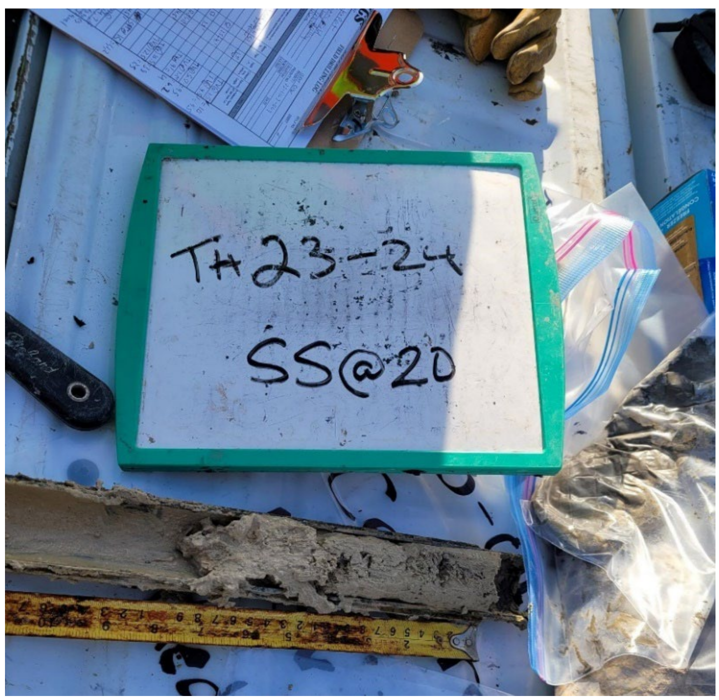
TH23-24 Photo 3: 3.0 m to 4.5 m (10 ft to 15 ft)

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)

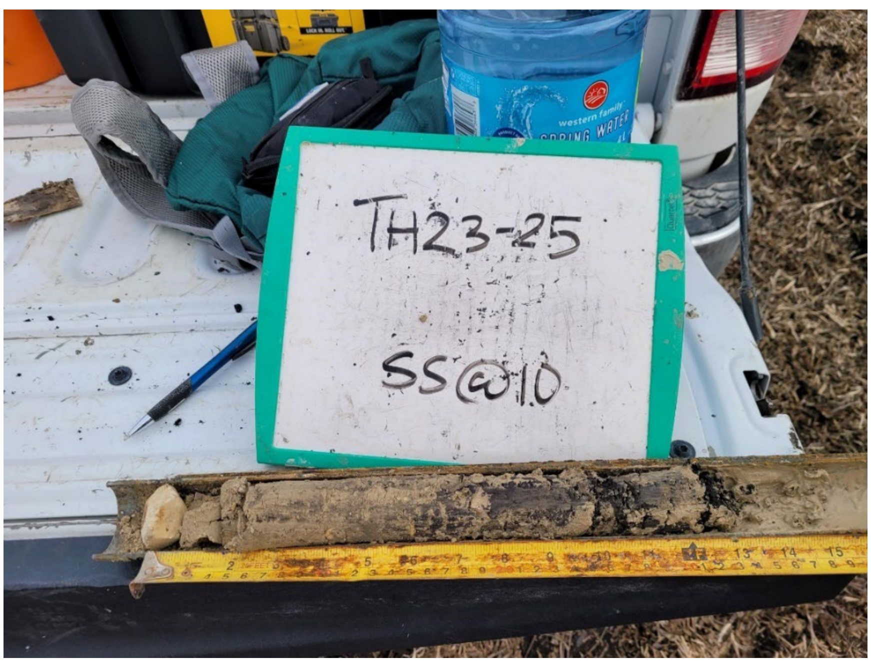
TH23-25 Photo 1: 0.0 m to 1.5 m (0 ft to 5 ft)

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)

TP24-01 Photo 1: Completed test pit to 5.1 m

TP24-01 Photo 2: Clay -rich Silt Till

TP24-01 Photo 3: Silt Till with Higher Gravel Content

TP24-01 Photo 4: Boulders from Silt Till

TP24-01 Photo 5: Sedimentary Boulder (22 inches)

TP24-01 Photo 6: Igneous Boulder (22 inches)

TP24-01 Photo 7: Sedimentary Boulder

TP24-01 Photo 8: Reddish Brown Argillaceous Bedrock at 5.1 m.

TP24-02 Photo 1: Top of bedrock encountered at 4.6 m

TP24-02 Photo 2: Cobbles and Boulders from silt till

TP24-02 Photo 3: Boulder from silt till (22 inches)

TP24-02 Photo 4: Boulders from silt till (16 inches)

TP24-02 Photo 5: Boulder from silt till (24 inches)

TP24-02 Photo 6: Igneous boulder in silt till

APPENDIX D

2023 Laboratory Testing Results

Stantec
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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

REPORT NO. 1

DATE SAMPLED: 2023.Sep.25
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Oct.20
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Oct.20
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

Stantec

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

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
	S9	13.9
TH23-26	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

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

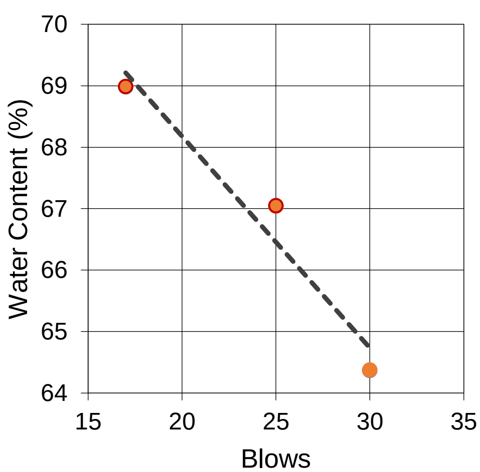
LIQUID LIMIT

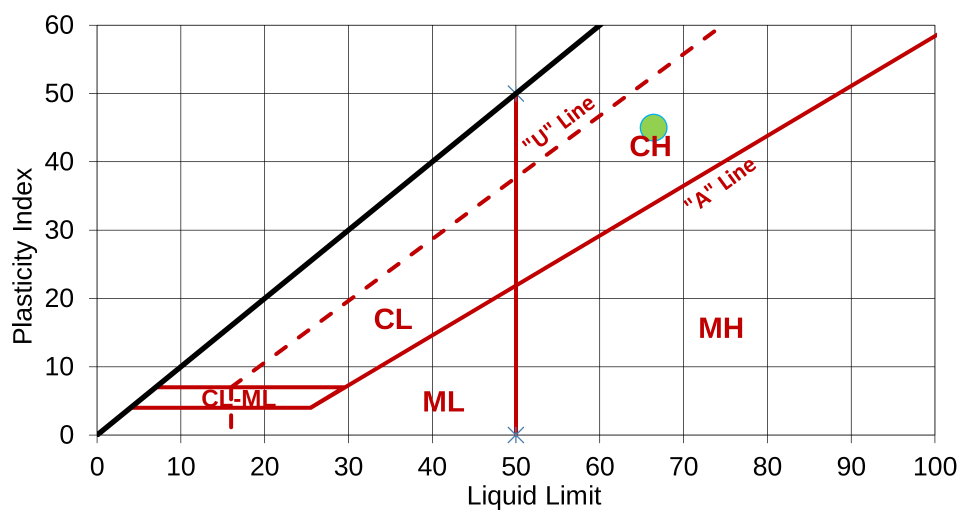
TRIAL	1	2	3
BLOWS	30	25	17
MC (%)	64	67	69

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

Stantec

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

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

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'

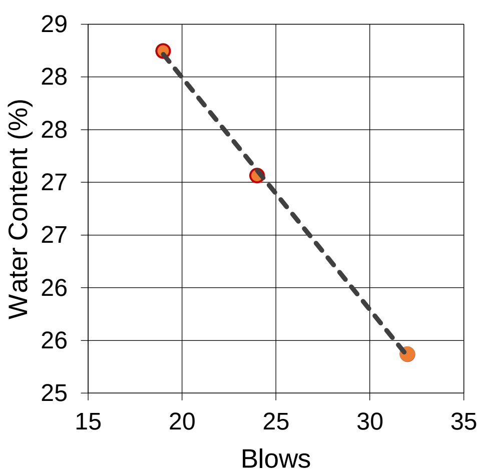
LIQUID LIMIT

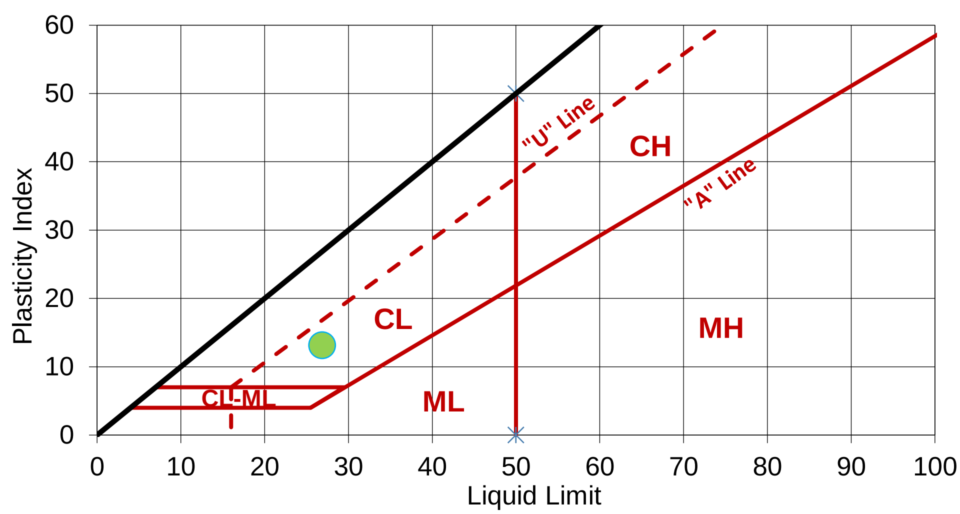
TRIAL	1	2	3
BLOWS	32	24	19
MC (%)	25	27	28

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

Stantec

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

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

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.26
TESTED BY: Larry Presado

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

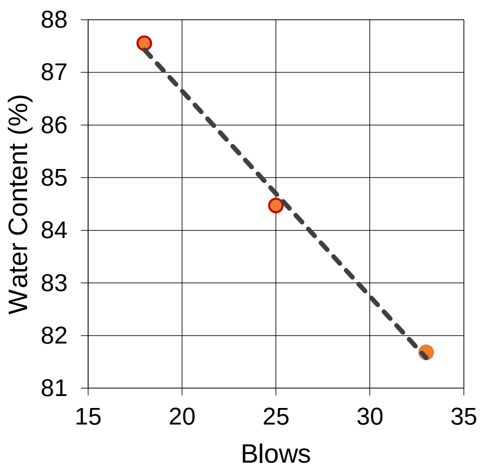
LIQUID LIMIT

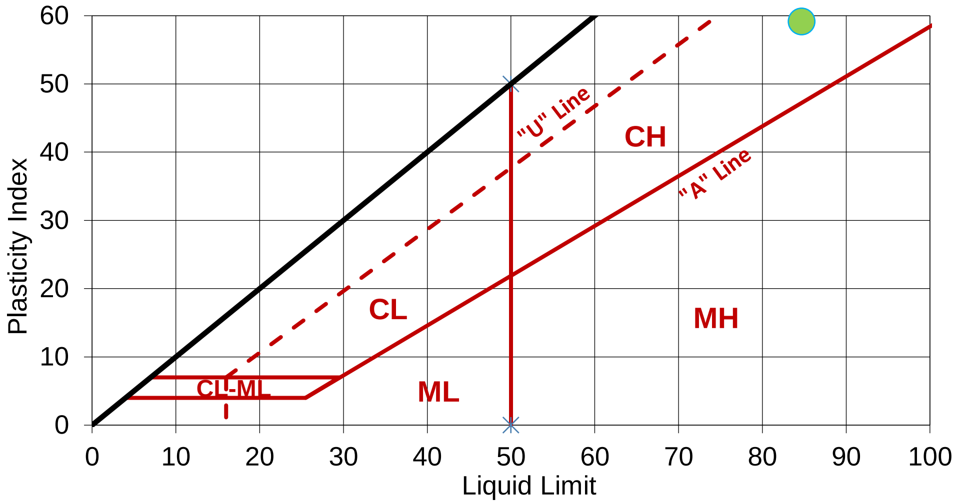
TRIAL	1	2	3
BLOWS	33	25	18
MC (%)	82	84	88

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





COMMENTS:

REPORT DATE 2023.Oct.27

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

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

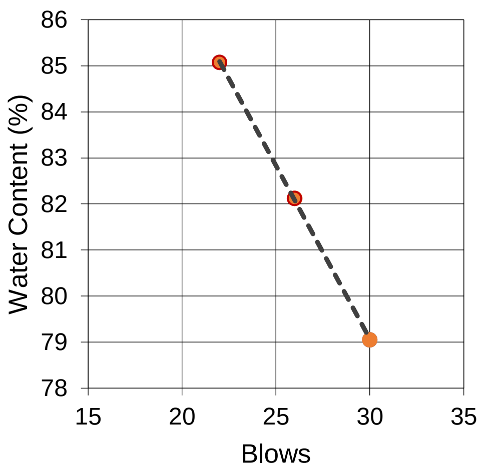
LIQUID LIMIT

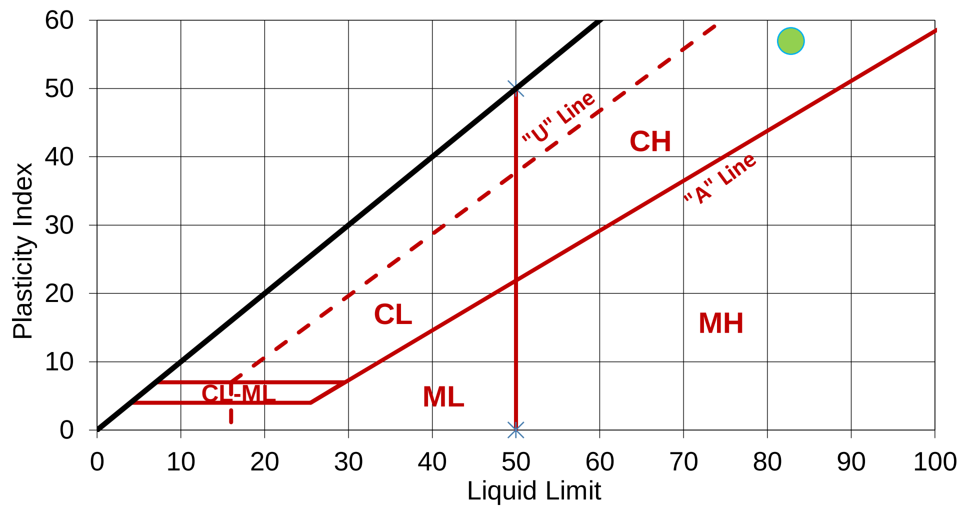
TRIAL	1	2	3
BLOWS	30	26	22
MC (%)	79	82	85

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

Stantec

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

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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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

REPORT NO. 5

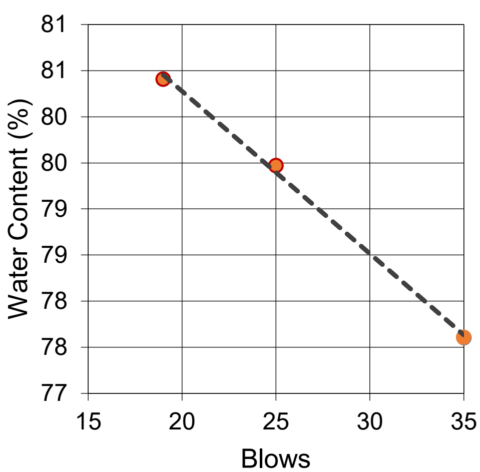
DATE SAMPLED: 2023.Nov.15 DATE RECEIVED: 2023.Nov.27 DATE TESTED: 2023.Dec.06
SAMPLED BY: KGS Group Inc. SUBMITTED BY: KGS Group Inc. TESTED BY: Carson Cockwell

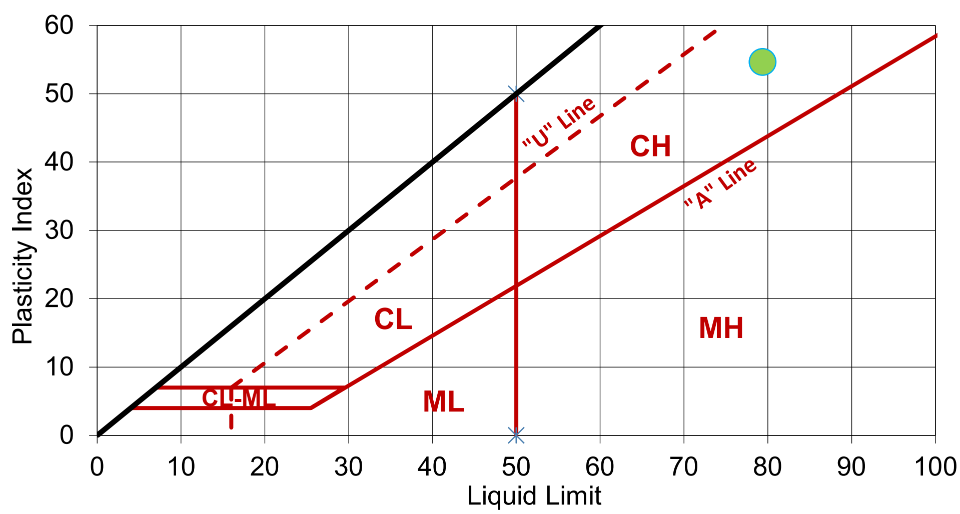
SAMPLE ID: TH23-17, S2

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

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

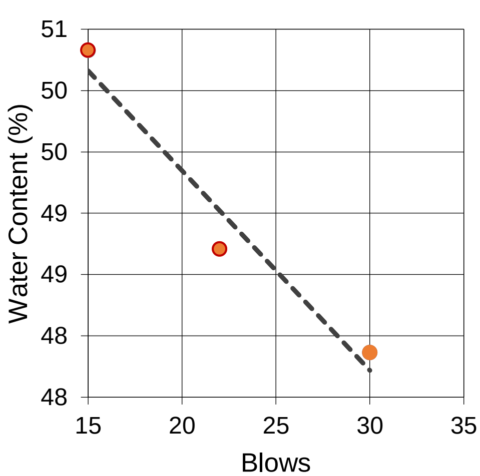
LIQUID LIMIT

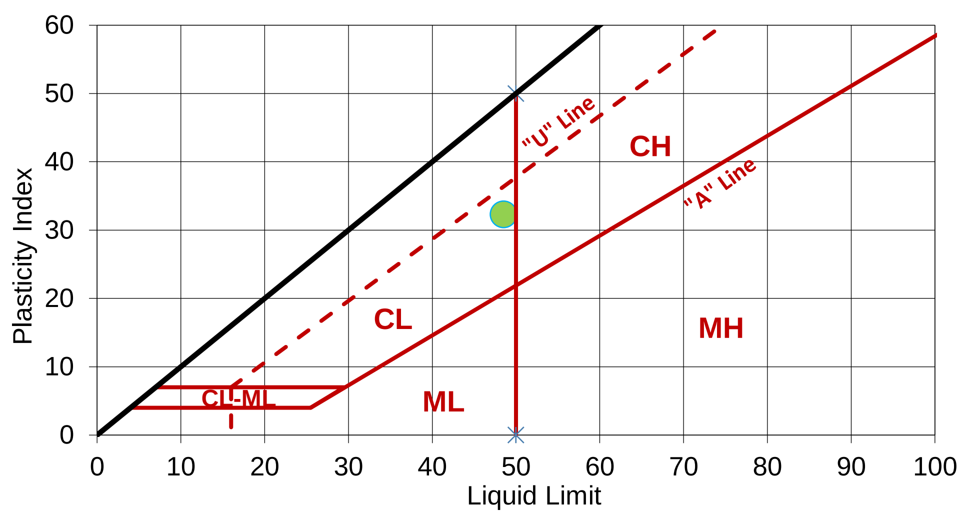
TRIAL	1	2	3
BLOWS	30	22	15
MC (%)	48	49	50

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

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

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.06
TESTED BY: Carson Cockwell

SAMPLE ID: TH23-18, S4

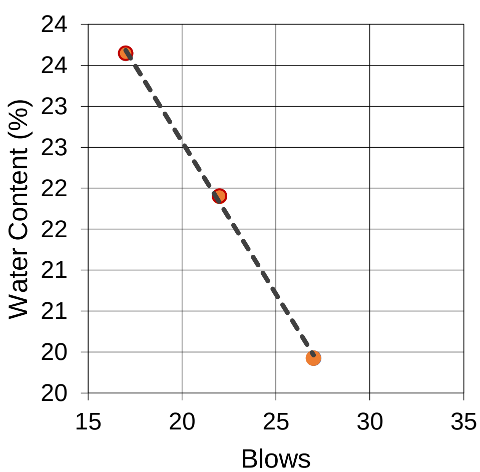
LIQUID LIMIT

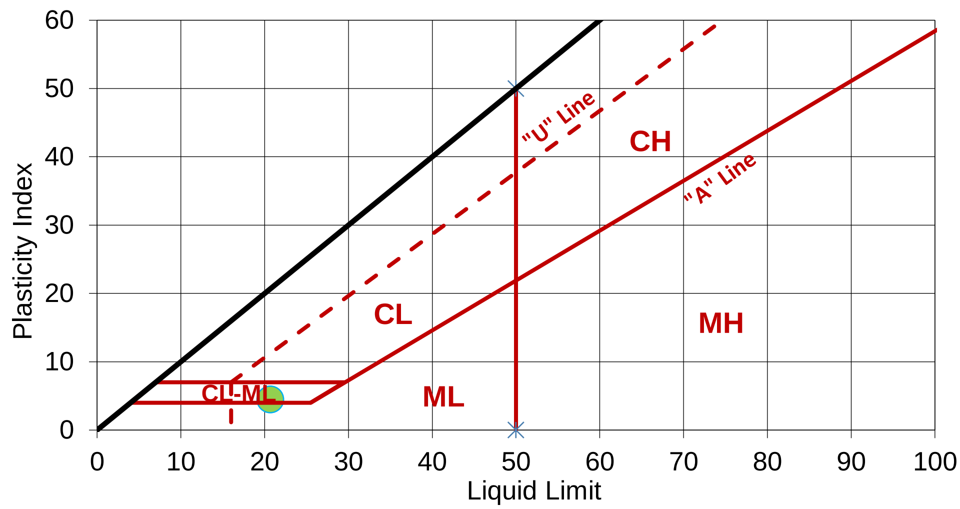
TRIAL	1	2	3
BLOWS	27	22	17
MC (%)	20	22	24

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, 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

Stantec Consulting Ltd.
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Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

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.06
TESTED BY: Carson Cockwell

SAMPLE ID: TH23-19, S4

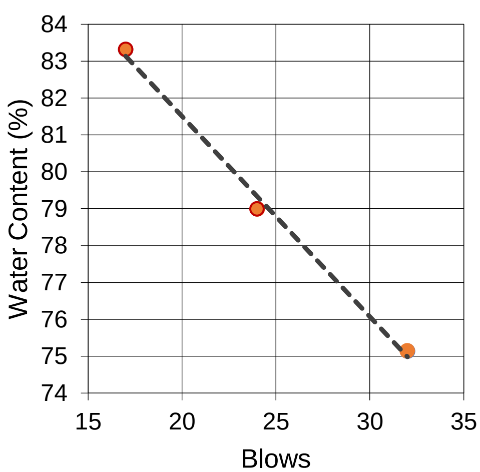
LIQUID LIMIT

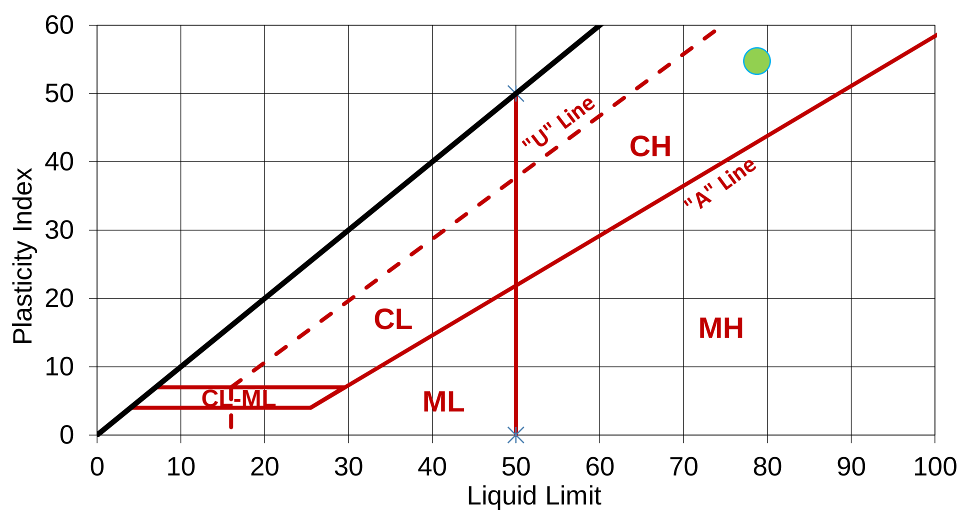
TRIAL	1	2	3
BLOWS	32	24	17
MC (%)	75	79	83

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





COMMENTS:

REPORT DATE 2023.Dec.08

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

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Tel: (204) 488-6999

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

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

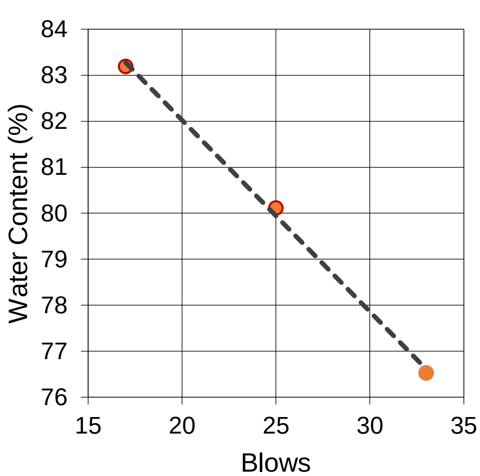
LIQUID LIMIT

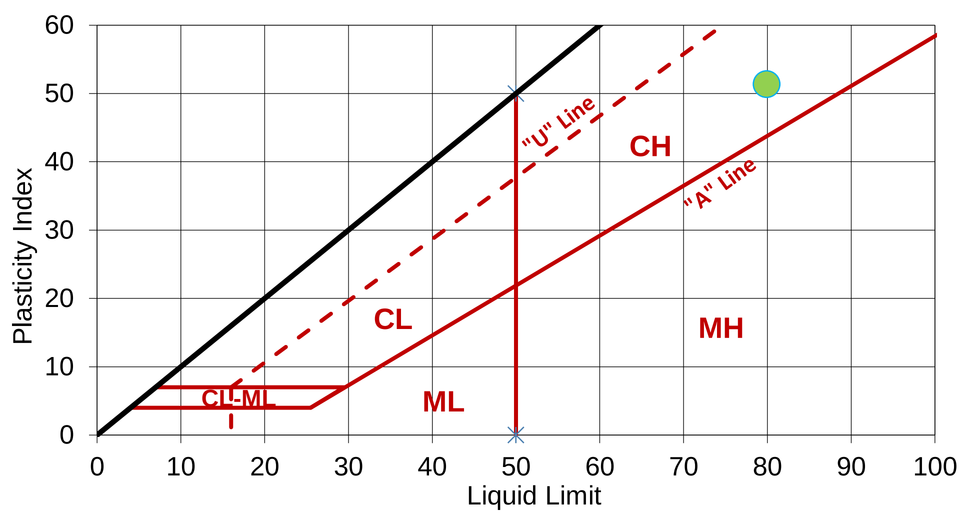
TRIAL	1	2	3
BLOWS	33	25	17
MC (%)	77	80	83

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

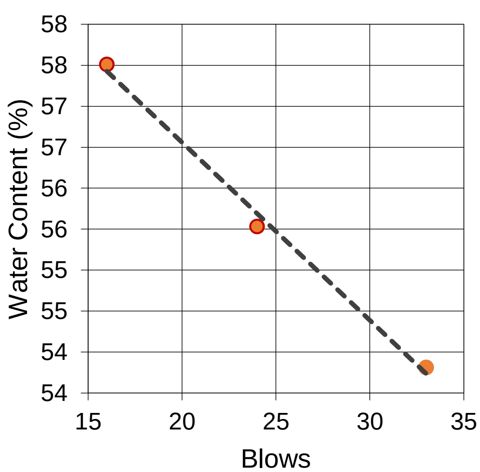
LIQUID LIMIT

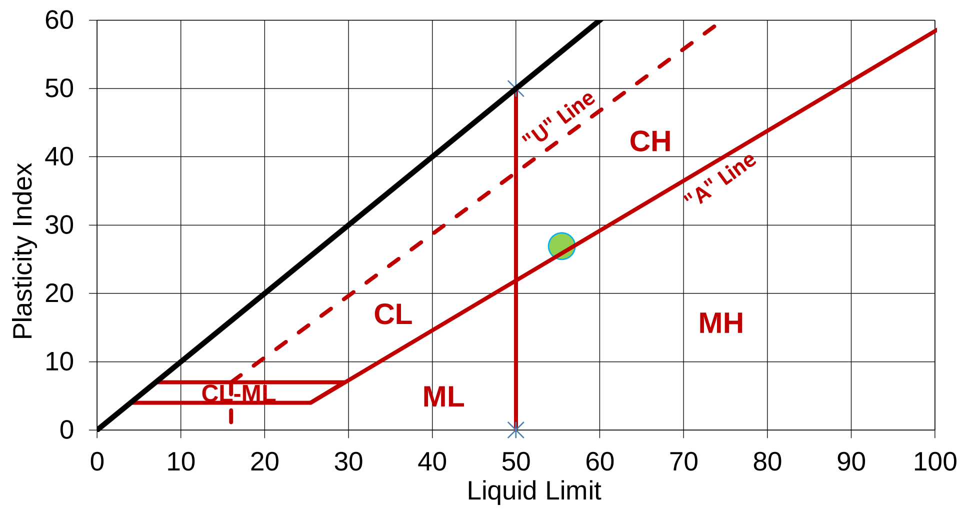
TRIAL	1	2	3
BLOWS	33	24	16
MC (%)	54	56	58

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

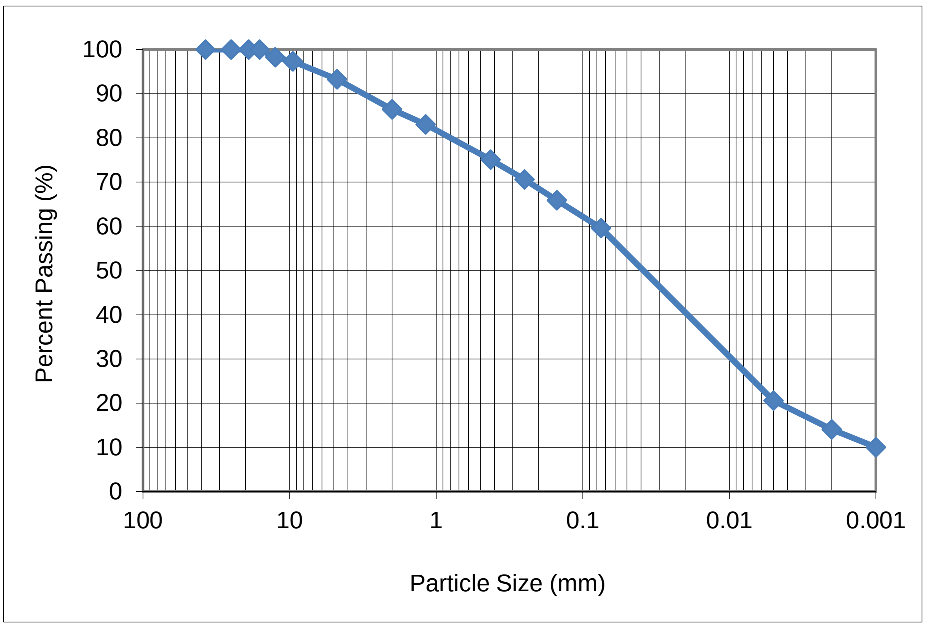
Stantec

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:	Grace Gitzel	REPORT NO.	1

DATE SAMPLED:	2023.Sep.28	DATE RECEIVED:	2023.Oct.20	DATE TESTED:	2023.Oct.24
SAMPLED BY:	KGS Group Inc.	SUBMITTED BY:	KGS Group Inc.	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

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

ATTN: Grace Gitzel

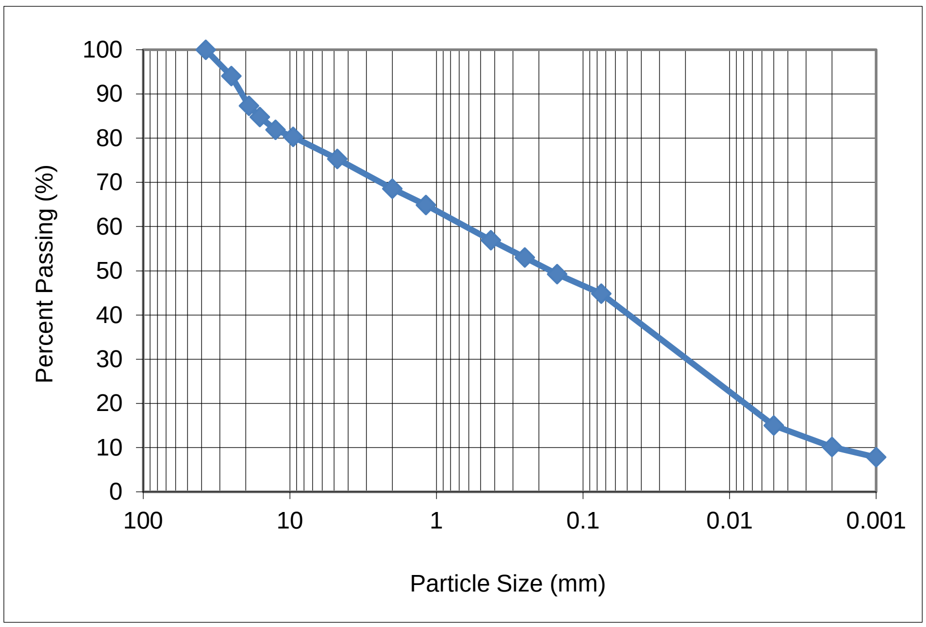
PROJECT: CentrePort AAW Regional S&W Servicing (23-0107-009)

PROJECT NO. 123316822

REPORT NO. 2

DATE SAMPLED: 2023.Sep.26 | DATE RECEIVED: 2023.Oct.20 | DATE TESTED: 2023.Oct.24

SAMPLED BY: KGS Group Inc. | SUBMITTED BY: KGS Group Inc. | 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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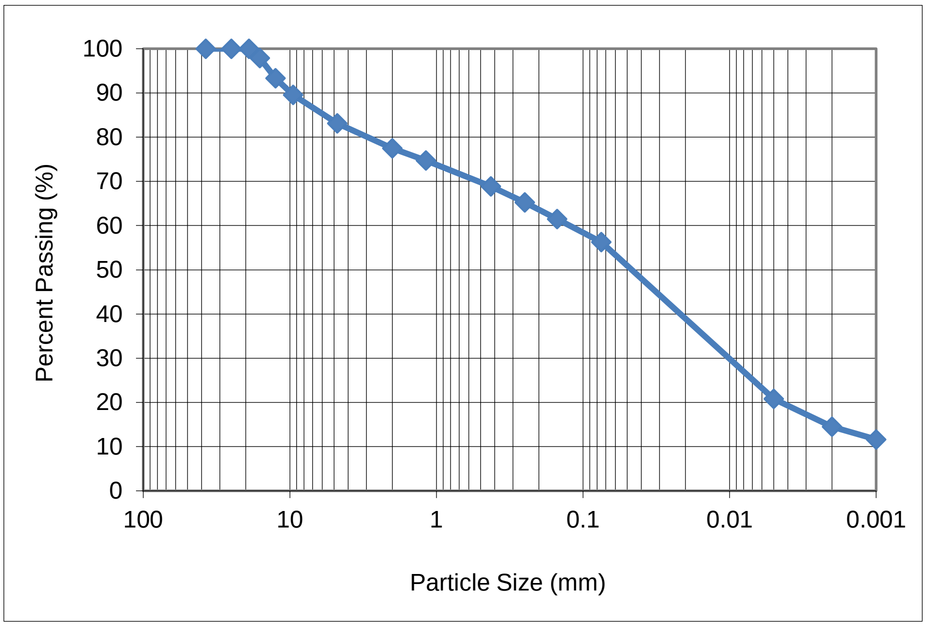
Stantec Consulting Ltd.
199 Henlow Bay, Winnipeg, MB R3Y 1G4
Tel: (204) 488-6999

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:	Grace Gitzel	REPORT NO.	3

DATE SAMPLED:	2023.Sep.25	DATE RECEIVED:	2023.Oct.20	DATE TESTED:	2023.Oct.24
SAMPLED BY:	KGS Group Inc.	SUBMITTED BY:	KGS Group Inc.	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

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

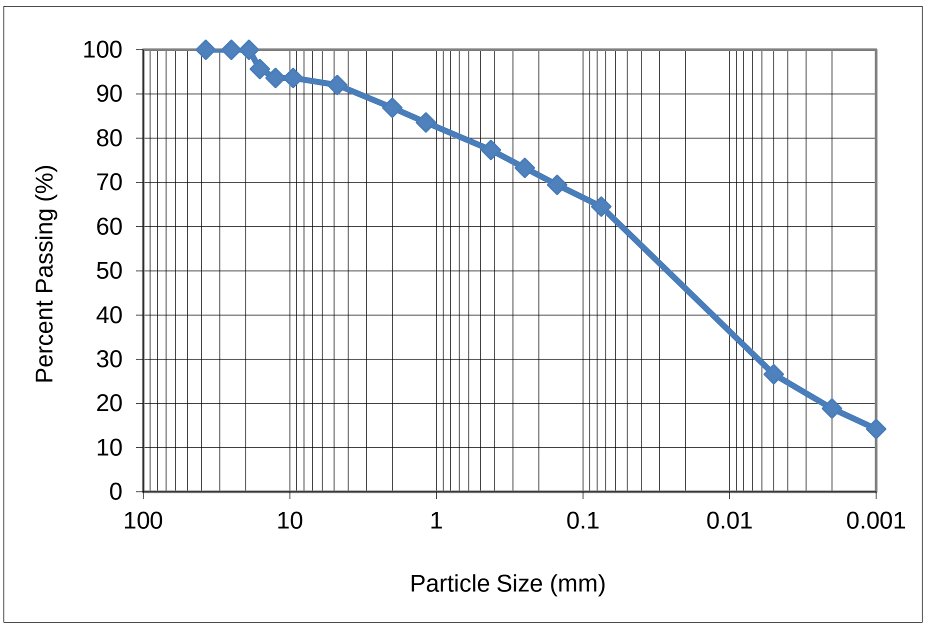
ATTN: Kelly Fordyce

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

PROJECT NO. 123316822

REPORT NO. 4

DATE SAMPLED: 2023.Nov.15 DATE RECEIVED: 2023.Nov.27 DATE TESTED: 2023.Dec.04
SAMPLED BY: KGS Group Inc. SUBMITTED BY: KGS Group Inc. 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

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

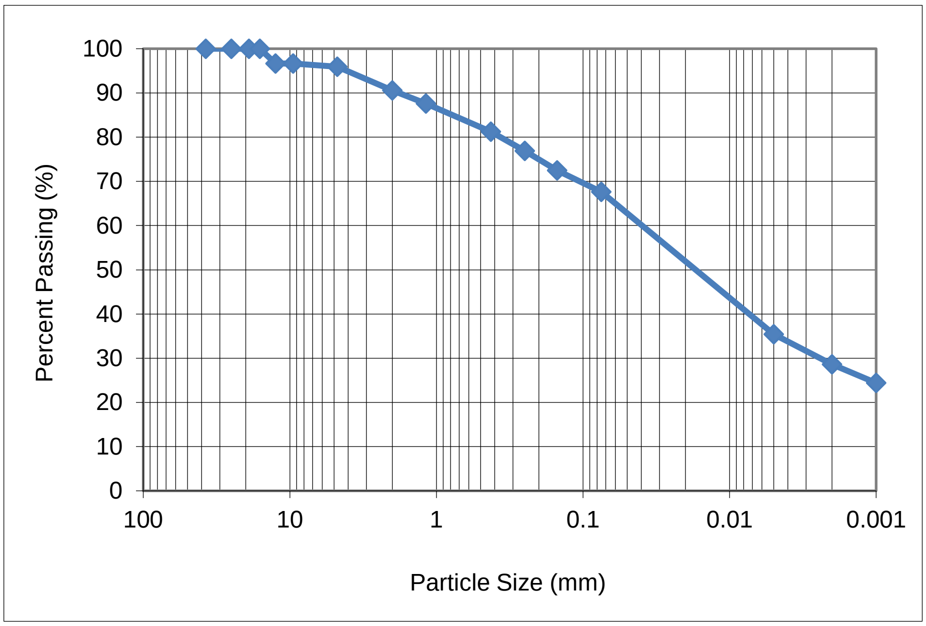
ATTN: Kelly Fordyce

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

PROJECT NO. 123316822

REPORT NO. 5

DATE SAMPLED: 2023.Nov.15 DATE RECEIVED: 2023.Nov.27 DATE TESTED: 2023.Dec.04
SAMPLED BY: KGS Group Inc. SUBMITTED BY: KGS Group Inc. 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

Stantec

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

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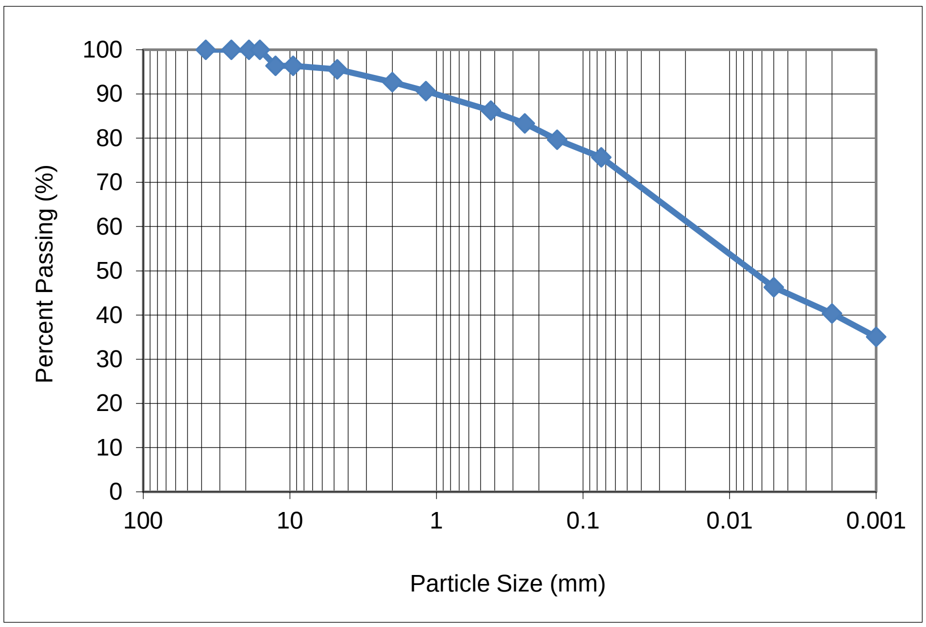
For specific tests as listed on www.ccil.com

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

TO	KGS Group Inc. 3rd Floor - 865 Waverley Street Winnipeg, Manitoba R3T 5P4
ATTN:	Kelly Fordyce
PROJECT	CentrePort AAW Regional S&W Servicing (23-0107-009)
PROJECT NO.	123316822
REPORT NO.	6

DATE SAMPLED:	2023.Nov.15	DATE RECEIVED:	2023.Nov.27	DATE TESTED:	2023.Dec.04
SAMPLED BY:	KGS Group Inc.	SUBMITTED BY:	KGS Group Inc.	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

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

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

ATTN: Kelly Fordyce

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

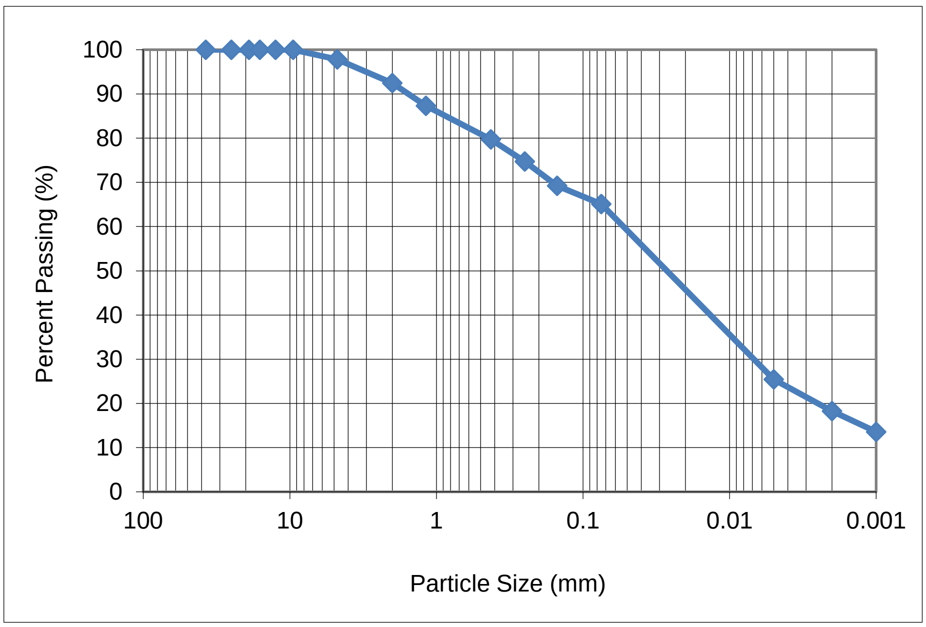
PROJECT NO. 123316822

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

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

ATTN: Kelly Fordyce

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

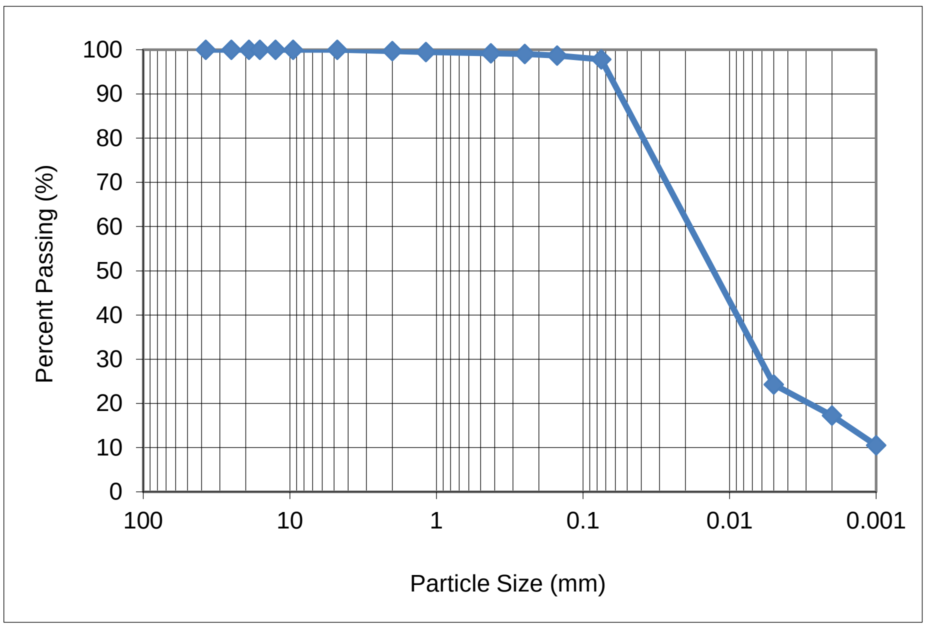
PROJECT NO. 123316822

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

Stantec

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

CERTIFIED BY CCIL Canadian Council of Independent Laboratories For specific tests as listed on www.ccil.com

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

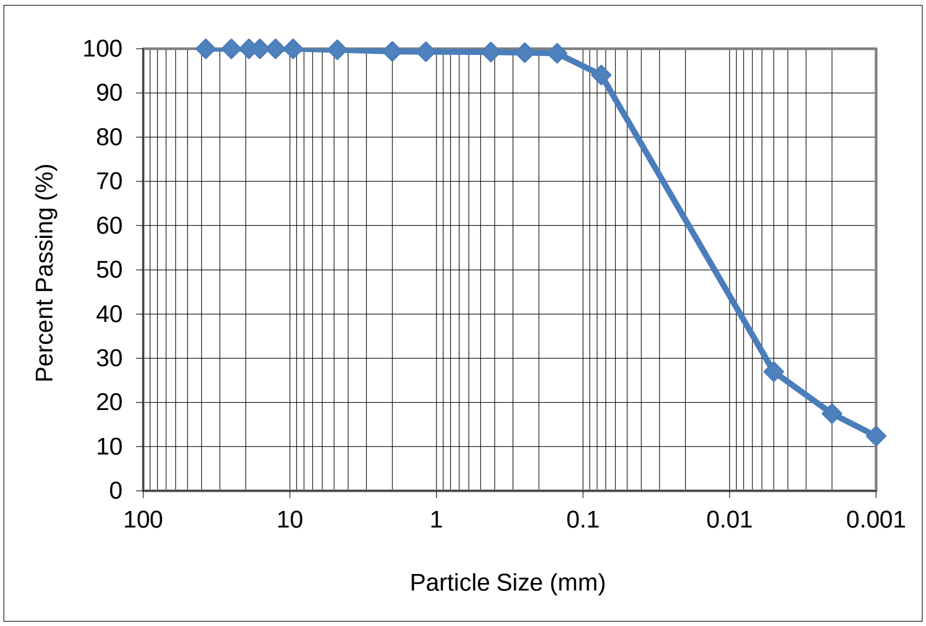
ATTN: Kelly Fordyce

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

PROJECT NO. 123316822

REPORT NO. 9

DATE SAMPLED: 2023.Nov.15 DATE RECEIVED: 2023.Nov.27 DATE TESTED: 2023.Dec.04
SAMPLED BY: KGS Group Inc. SUBMITTED BY: KGS Group Inc. 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

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

ATTN: Kelly Fordyce

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

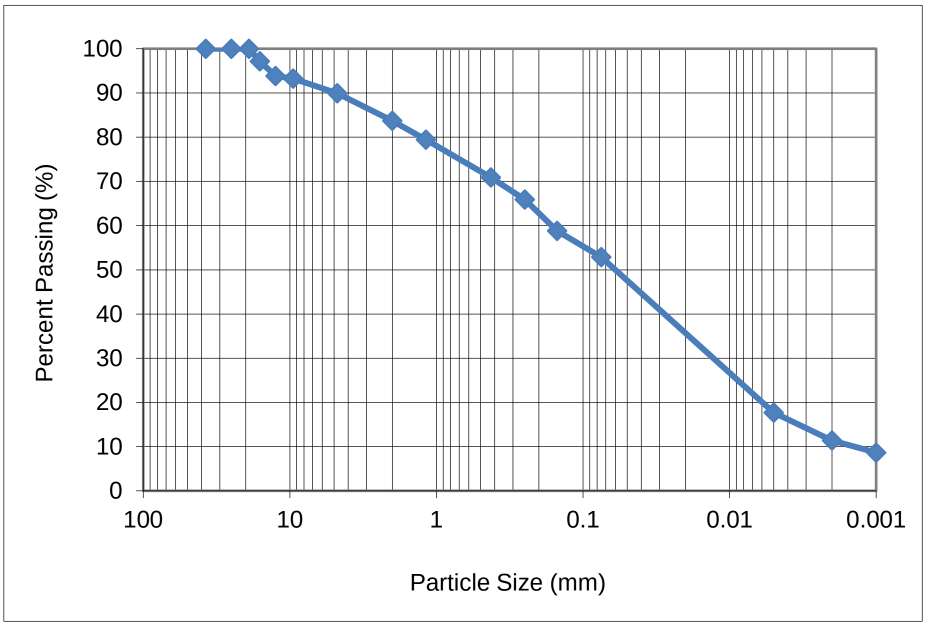
PROJECT NO. 123316822

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

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

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For specific tests as listed on www.ccil.com

AASHTO T88 (ASTM D422) - PARTICLE-SIZE ANALYSIS OF SOILS

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

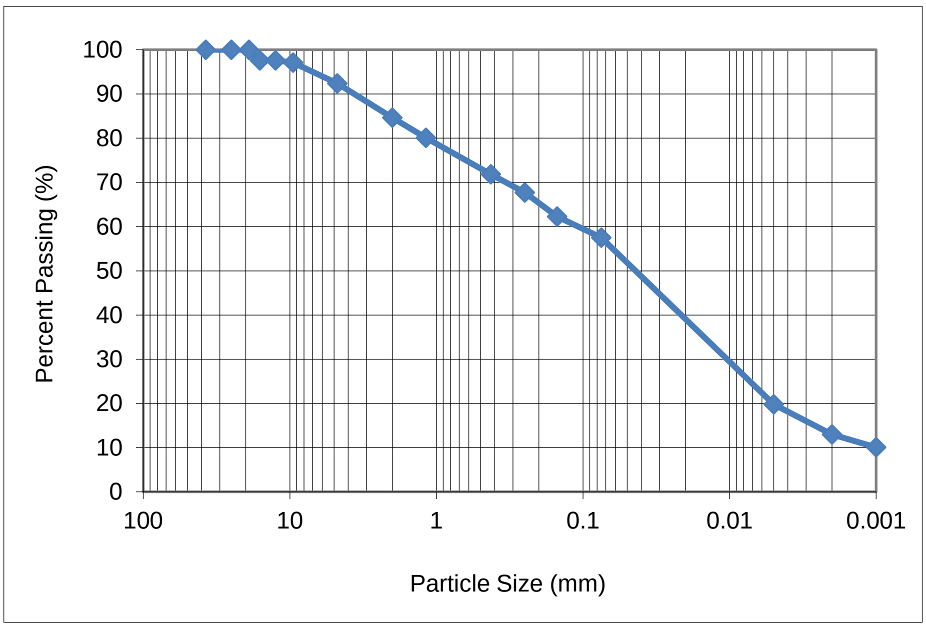
ATTN: Kelly Fordyce

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

PROJECT NO. 123316822

REPORT NO. 11

DATE SAMPLED: 2023.Nov.15 DATE RECEIVED: 2023.Nov.27 DATE TESTED: 2023.Dec.04
SAMPLED BY: KGS Group Inc. SUBMITTED BY: KGS Group Inc. 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

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

ATTN: Kelly Fordyce

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

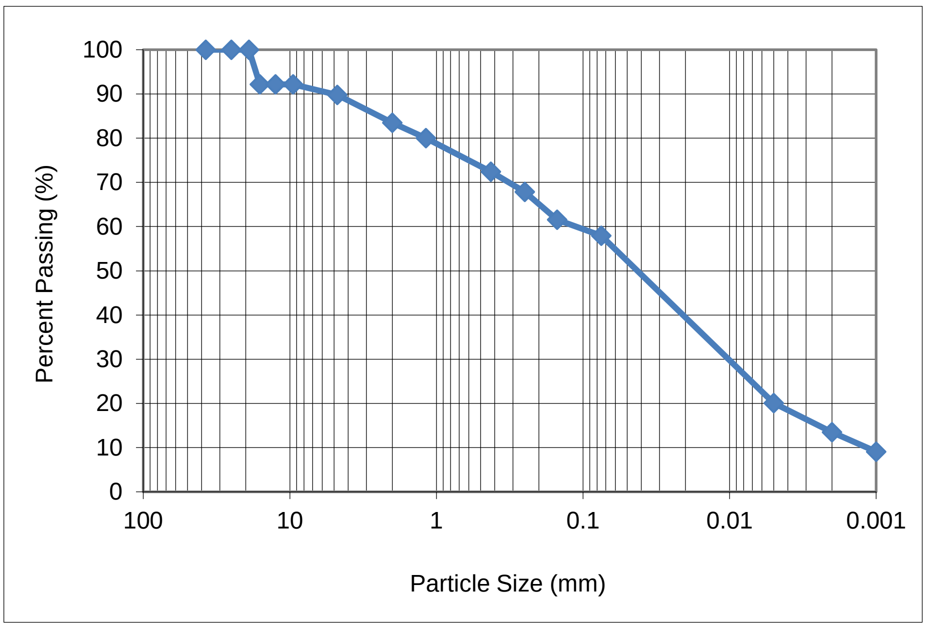
PROJECT NO. 123316822

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

Stantec

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures
Method C
ASTM D7012 & D4543

Client:	KGS Group Inc.	Project No.:	123316822
Project:	CentrePort AAW Regional S&W Servicing		
Material Type:	Rock Core	Date Received:	October 26, 2023
Date Sampled:	October 25, 2023	Tested By:	Sagar Khatri
Sampled By:	Stantec	Date Tested:	November 6, 2023

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^3)	2500.81	2428.47	2484.85	2558.87
Unit Weight (kN/m^3)	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)	**24.1**	**17.6**	**66.1**	**73.7**
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.	Reasonbly well formed cones on both ends.	Reasonbly well formed cones on both ends.
Note				

Remarks:

Reviewed by: Brian Prevost

Date: November 7, 2023

Stantec

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures
Method C
ASTM D7012 & D4543

Client:	KGS Group Inc.	Project No.:	123316822
Project:	CentrePort AAW Regional S&W Servicing		
Material Type:	Rock Core; Diameter ≥ 63.0 mm	Date Received:	November 30, 2023
Date Sampled:	November 29, 2023	Tested By:	Sagar Kharti
Sampled By:	Stantec	Date Tested:	December 4, 2023

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^3)	2588.59	2512.24	2588.72	2584.92
Unit Weight (kN/m^3)	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)	**28.2**	**28.1**	**26.8**	**20.9**
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: Brian Prevost

Date: December 11, 2023

Compressive Strength & Elastic Moduli of Intact Rock Core Speciments under Varying States of Stress and Temperatures
Method C
ASTM D7012 & D4543

Stantec

Client:	KGS Group Inc.	Project No.:	123316822
Project:	CentrePort AAW Regional S&W Servicing		
Material Type:	Rock Core; Diameter ≥ 63.0 mm	Date Received:	November 30, 2023
Date Sampled:	November 29, 2023	Tested By:	Sagar Kharti
Sampled By:	Stantec	Date Tested:	December 4, 2023

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^3)	2583.94	2538.38		
Unit Weight (kN/m^3)	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)	**24.3**	**29.6**	**#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: Brian Prevost

Date: December 11, 2023

Geomechanica Inc.
Unit 14 – 1240 Speers Rd.
Oakville Ontario
Canada L6L 2X4

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 29th, 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

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 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° using the setup shown in Figure 1b. The styluses used to perform the tests are shown in Figure 1c-d (Rockwell hardness 55±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° apart) are captured before the test is conducted to ensure the 90° 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° 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.

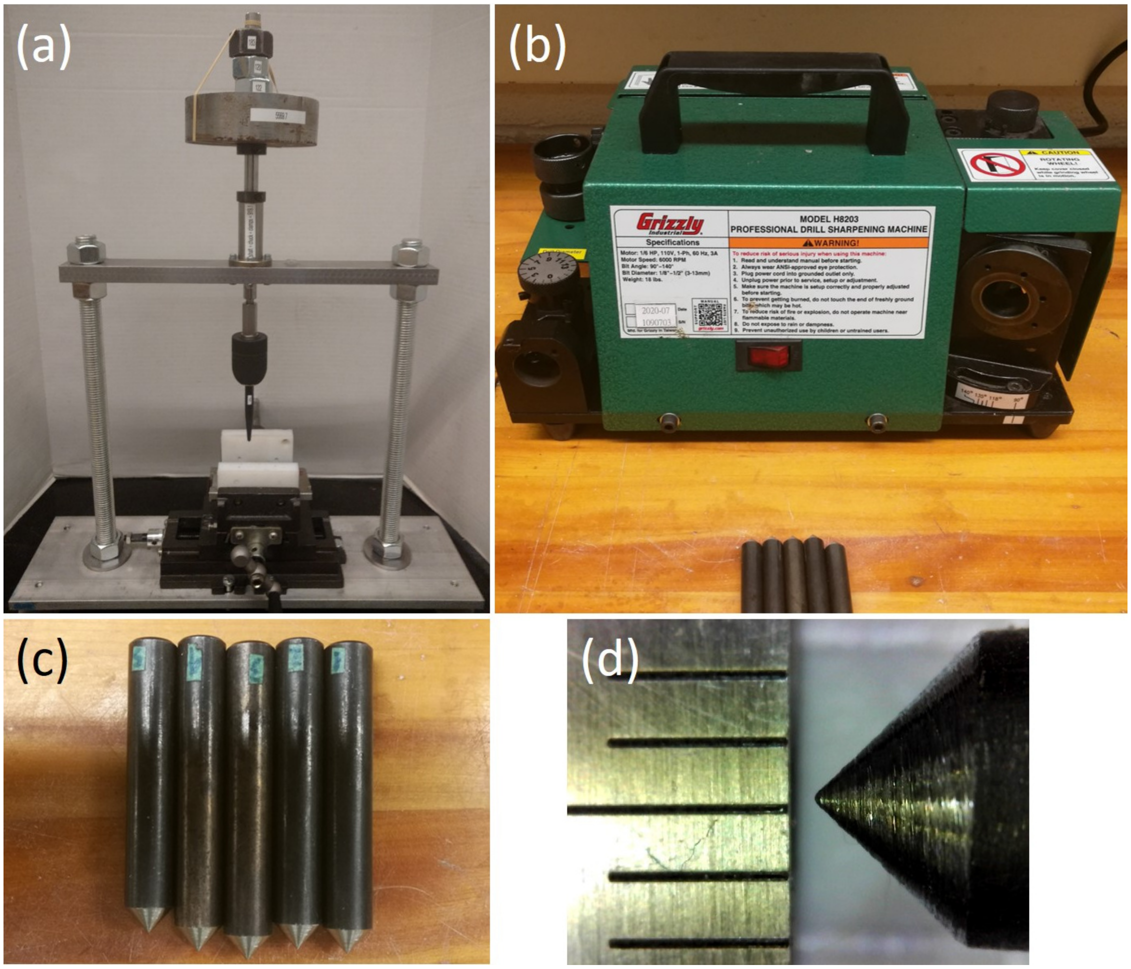


Figure 1: Photos showing (a) the CERCHAR apparatus, (b) tip sharpening setup, (c) the five styluses used to perform the test and (d) a microscope image of one of the stylus tips.

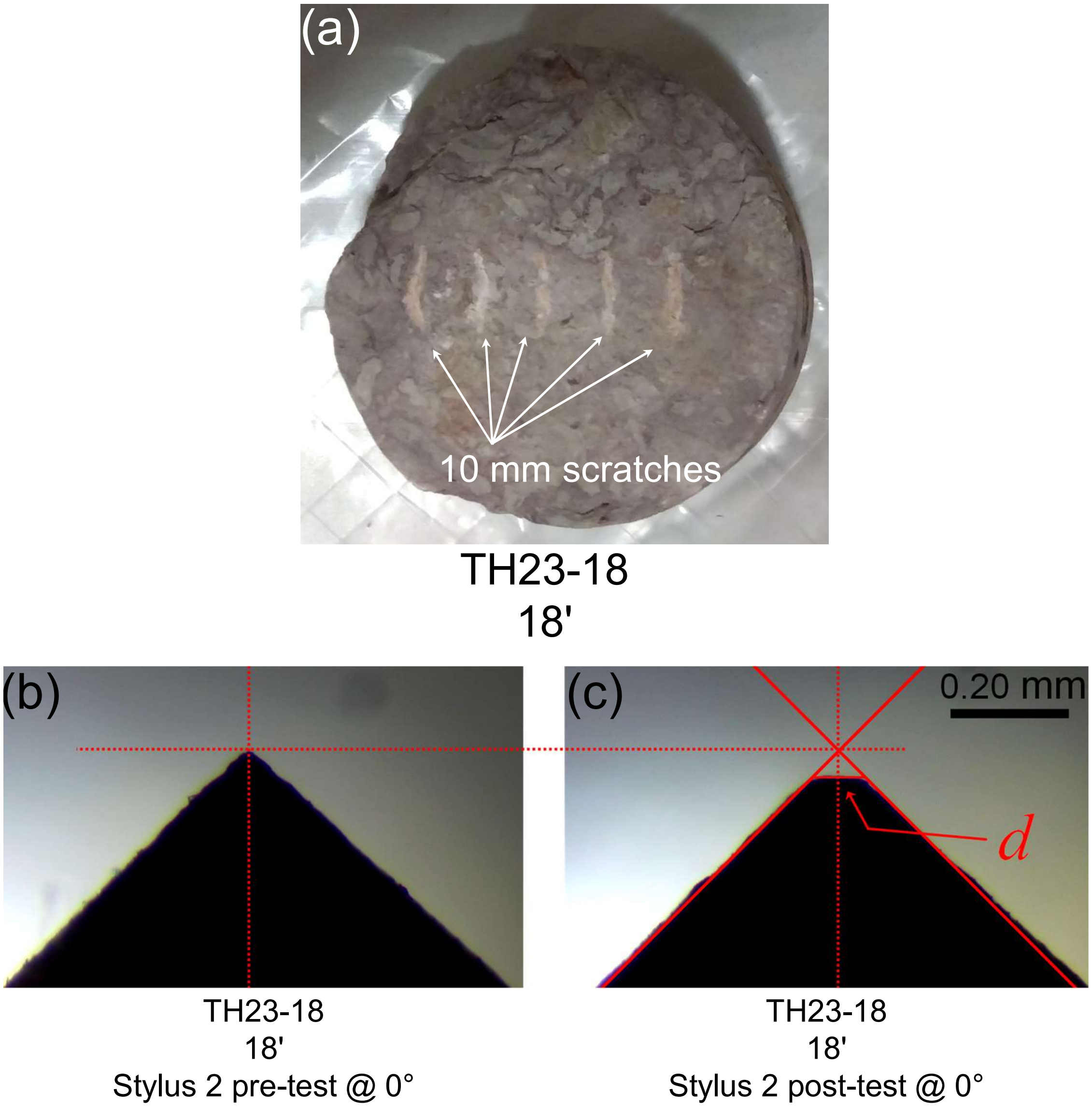


Figure 2: (a) Photograph showing an example of the five 10 mm scratches on a test specimen; (b) microscope image of select stylus prior to testing at the noted position; and (c) microscope image of the same stylus at the same position following testing with the wear flat, d, denoted.

Table 1: Summary of CERCHAR abrasivity test results.

Sample	Depth (ft)	Test 1 Mean (mm)	Test 2 Mean (mm)	Test 3 Mean (mm)	Test 4 Mean (mm)	Test 5 Mean (mm)	Mean Wear (mm)	CAI	Description	ASTM 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

THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

199 Henlow Bay
Winnipeg, MB R3Y 1G4
Phone (204) 488-6999
Fax (204) 488-6947
Email info@nationaltestlabs.com
www.nationaltestlabs.com

KGS Group Inc.
3rd 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.

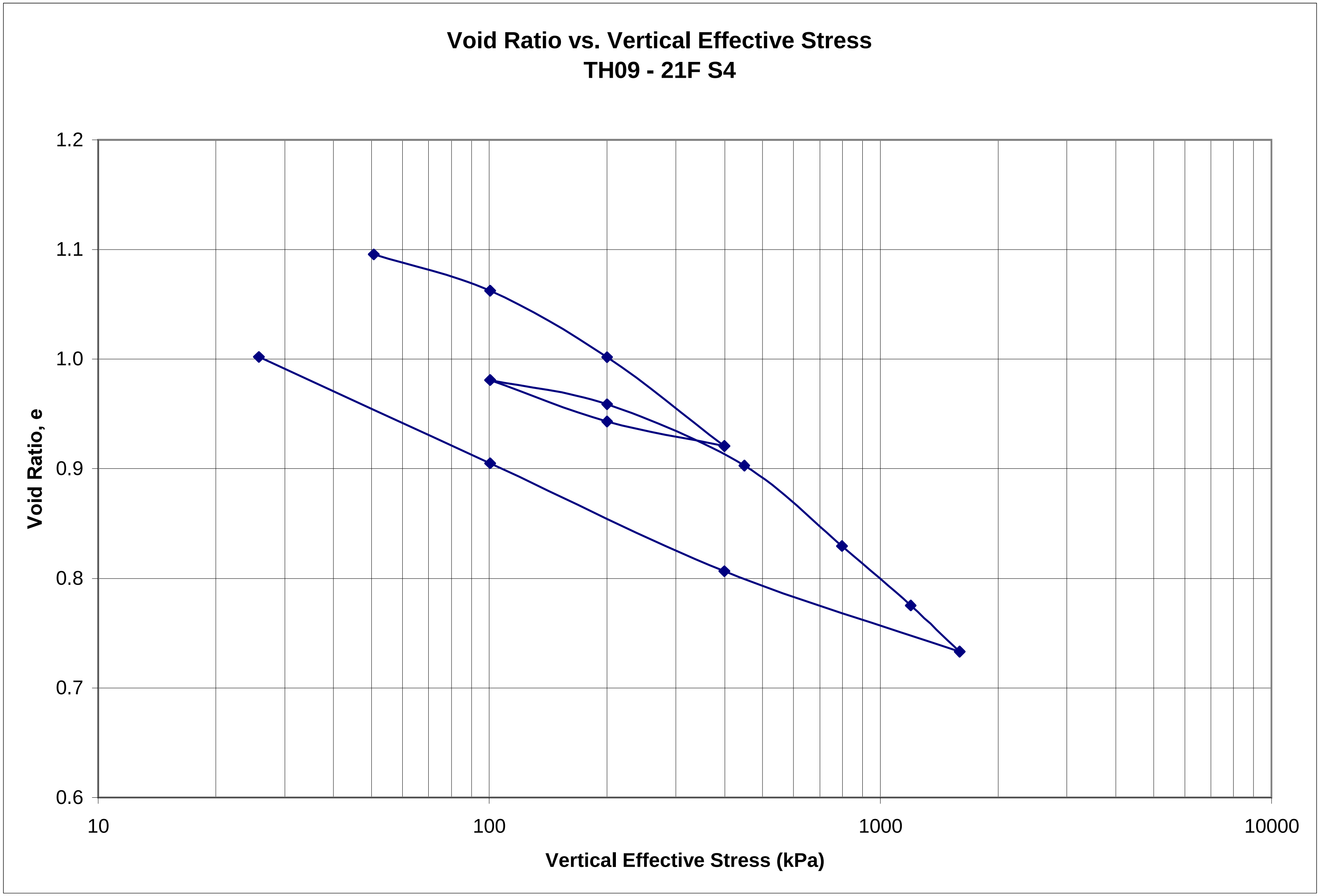
Don Flatt

Don Flatt, M.Eng., P.Eng.
Senior Geotechnical Engineer

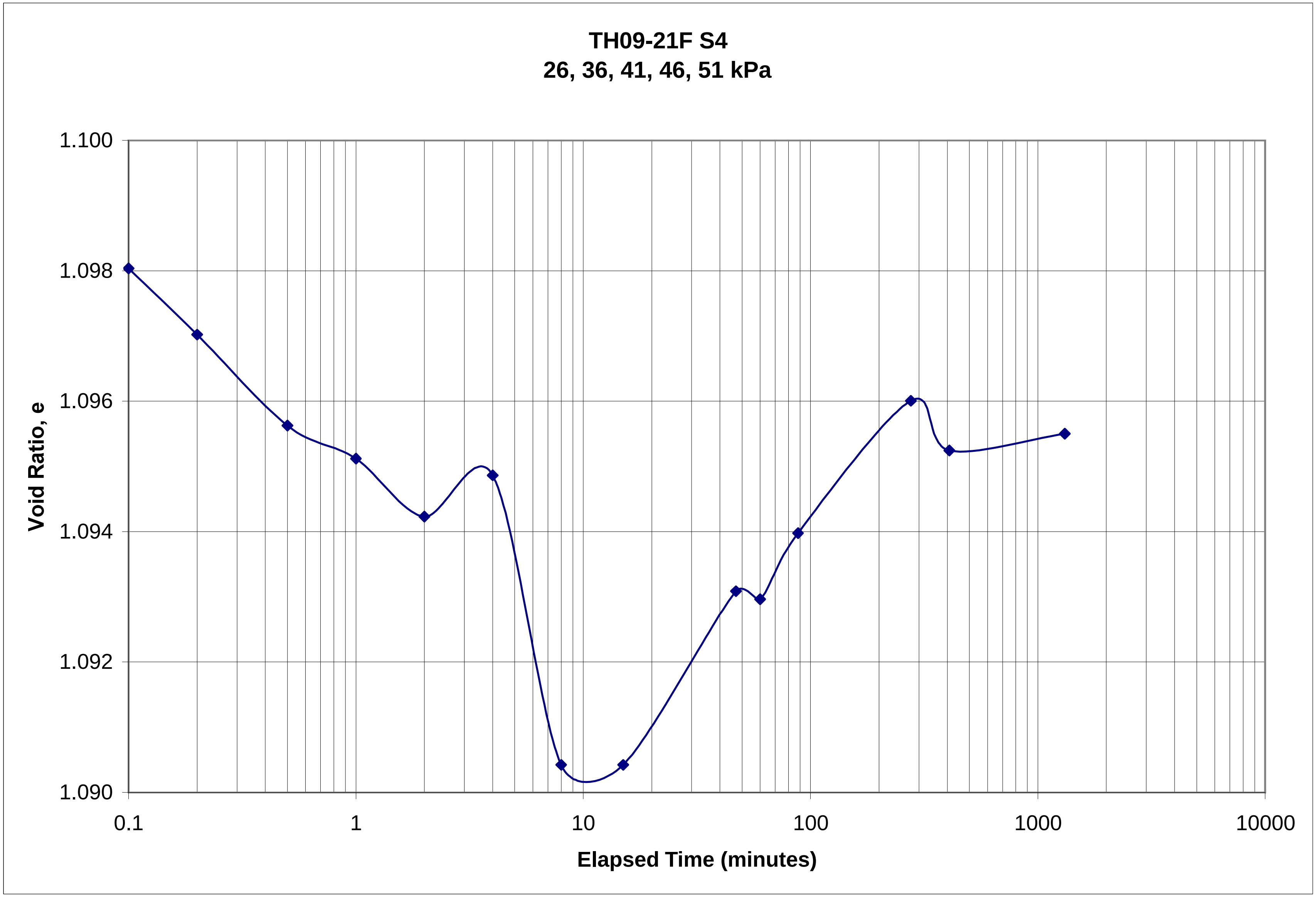
THE NATIONAL TESTING LABORATORIES LIMITED
Established in 1923

CONSOLIDATION TEST DATA
CENTRE PORT

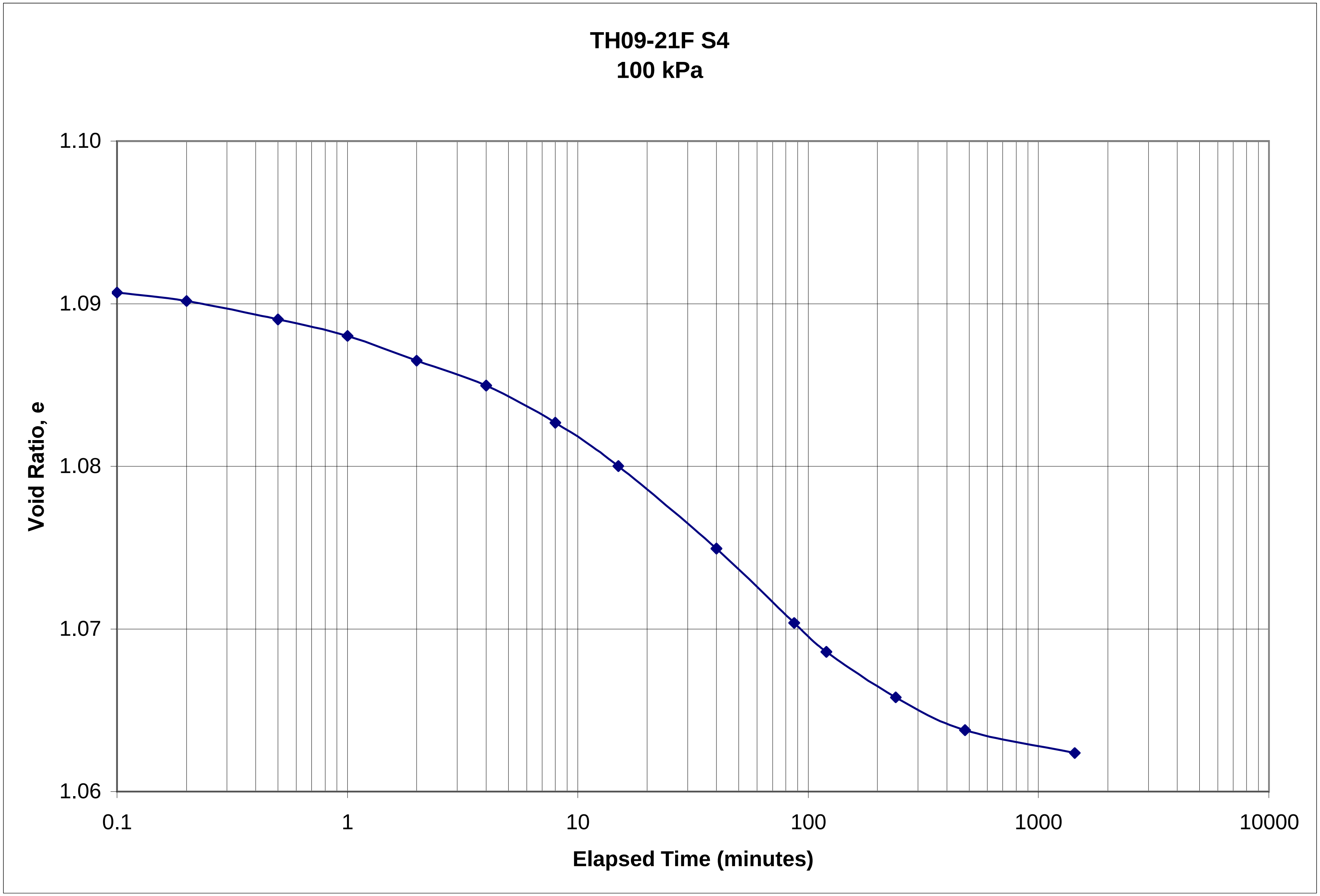
Testhole no.	Sample ID	Cc	Cr	Moisture Content (%)		Saturation (%)		Void Ratio		Wet Density (kg/m³)		Dry Density (kg/m³)	
				Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
TH09-21F	S4	0.32	0.10	35.3	37.5	84.2	101.0	1.15	1.00	1728	1872	1277	1362
TH09-25A	S5	0.55	0.13	51.3	47.7	83.1	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

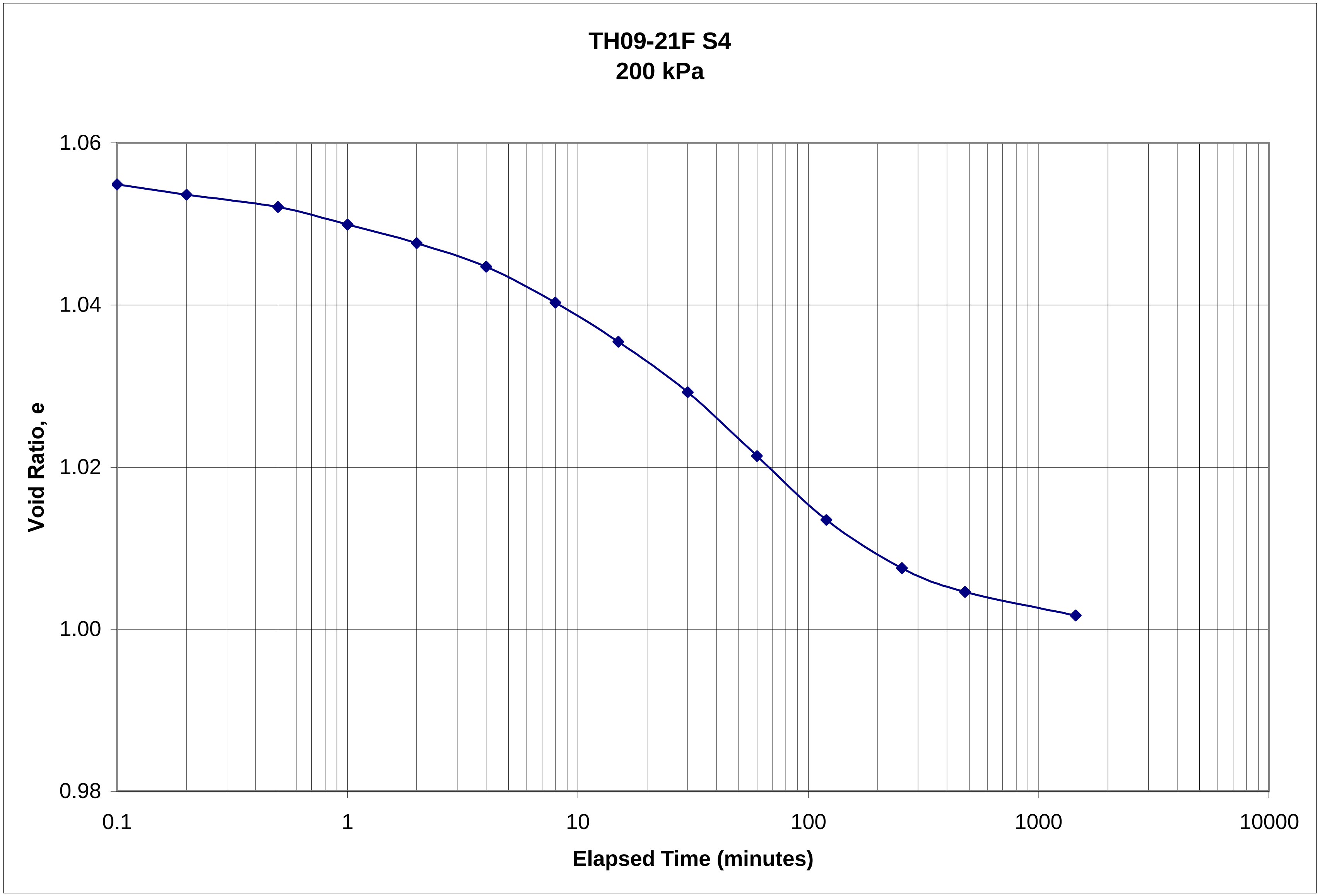


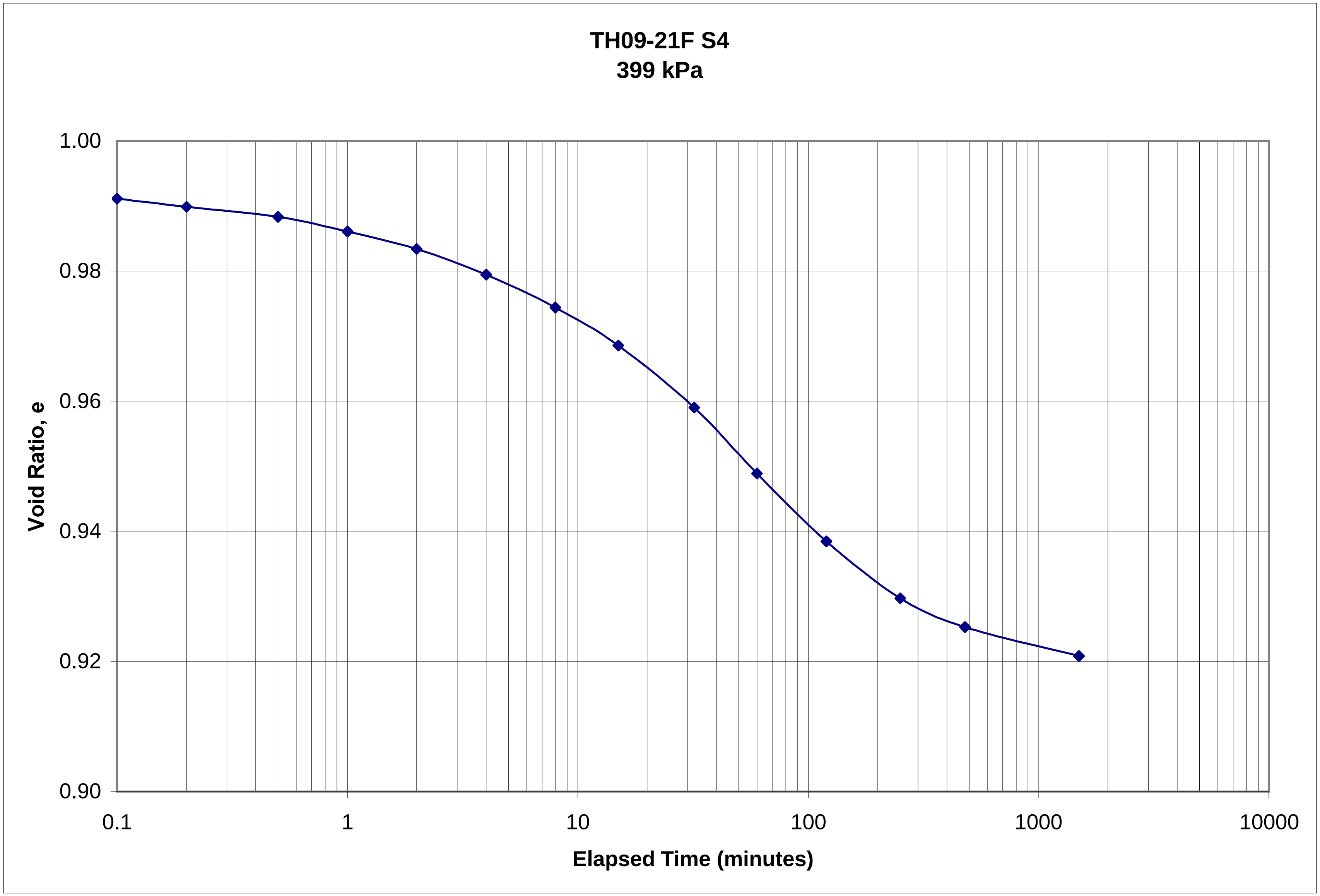
Void Ratio vs. Vertical Effective Stress
TH09 - 21F S4
Void Ratio, e
1.2
1.1
1.0
0.9
0.8
0.7
0.6
10
100
1000
10000
Vertical Effective Stress (kPa)

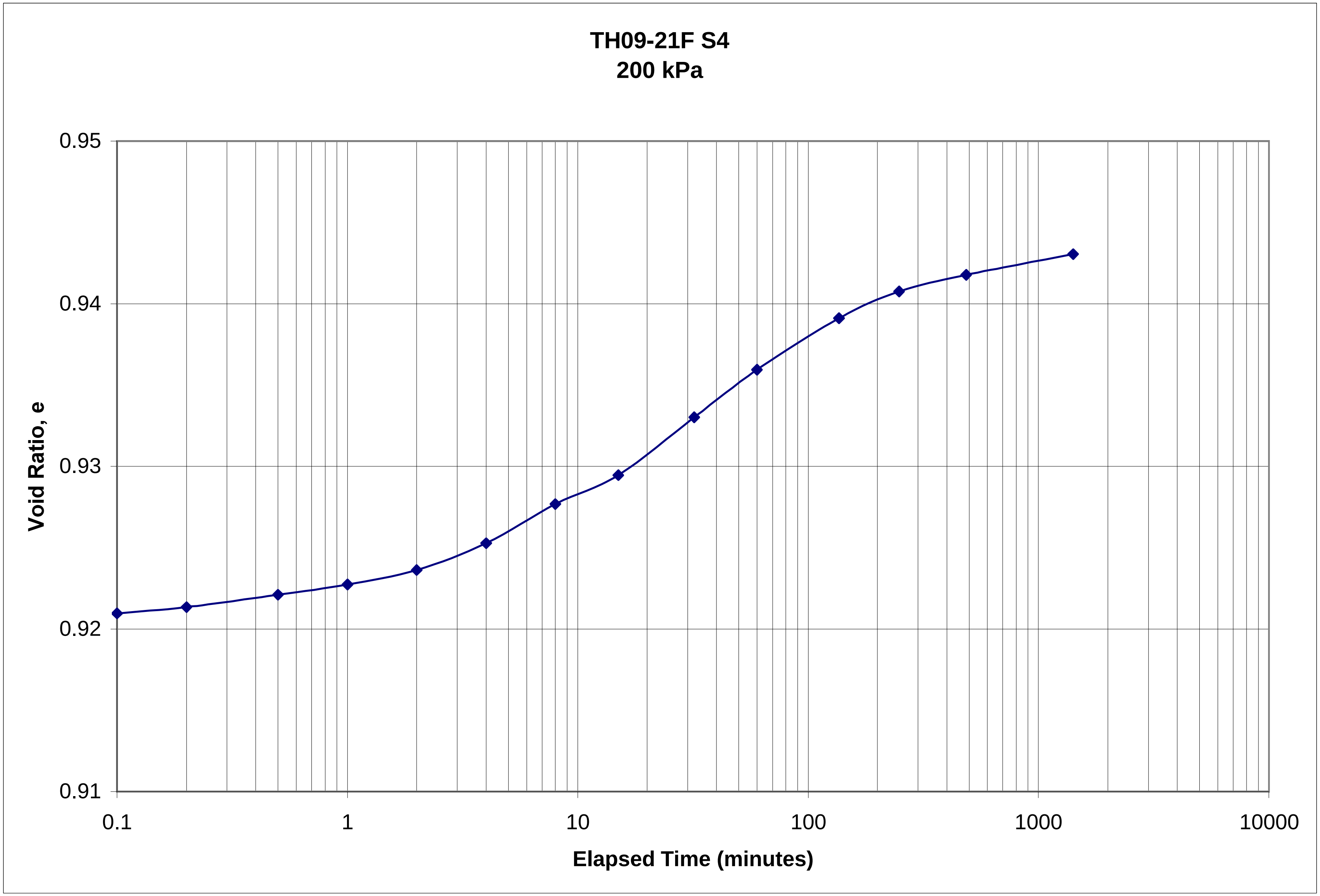


TH09-21F S4
26, 36, 41, 46, 51 kPa
Void Ratio, e
1.100
1.098
1.096
1.094
1.092
1.090
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

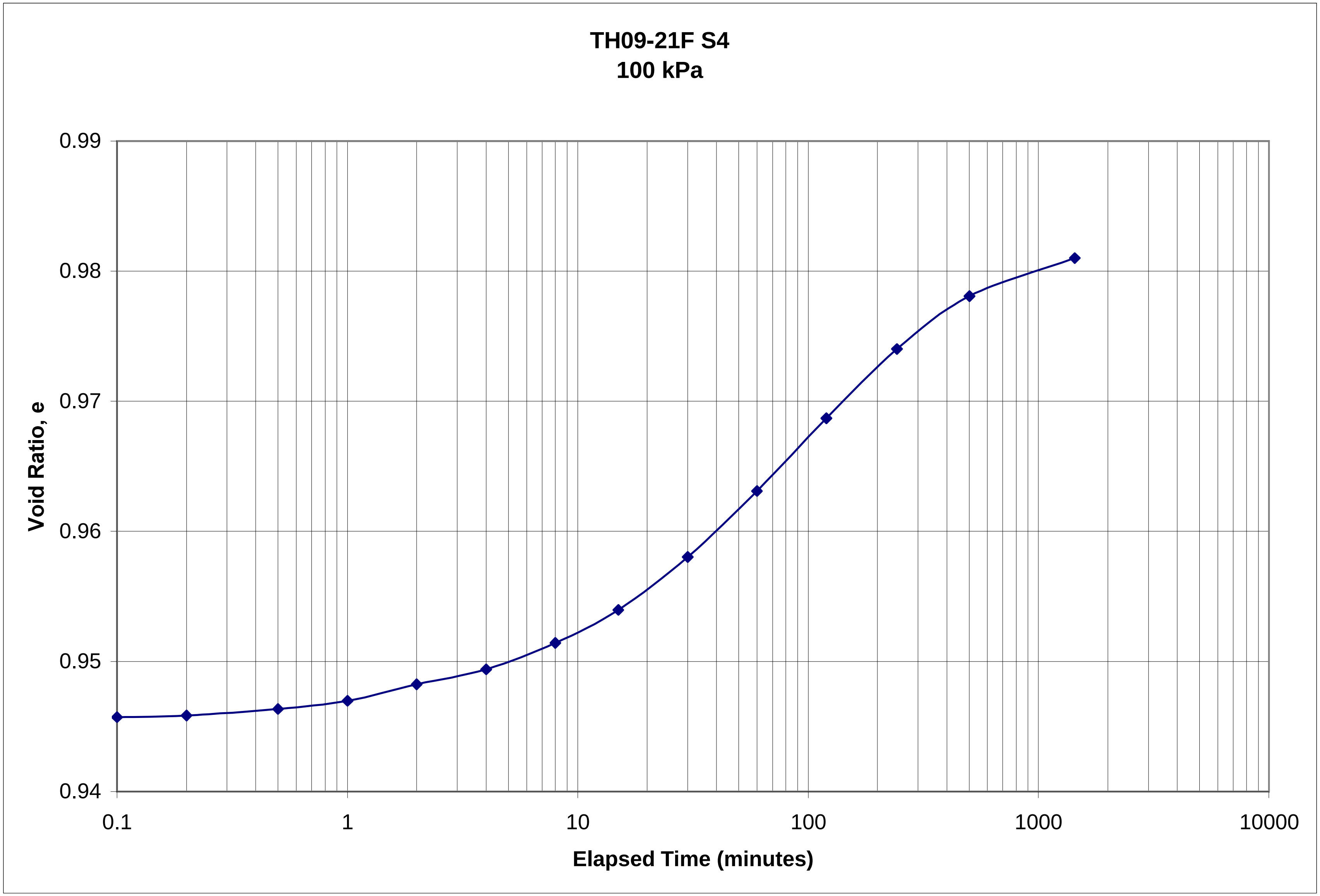

TH09-21F S4
100 kPa
Void Ratio, e
1.10
1.09
1.08
1.07
1.06
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-21F S4
200 kPa
Void Ratio, e
1.06
1.04
1.02
1.00
0.98
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

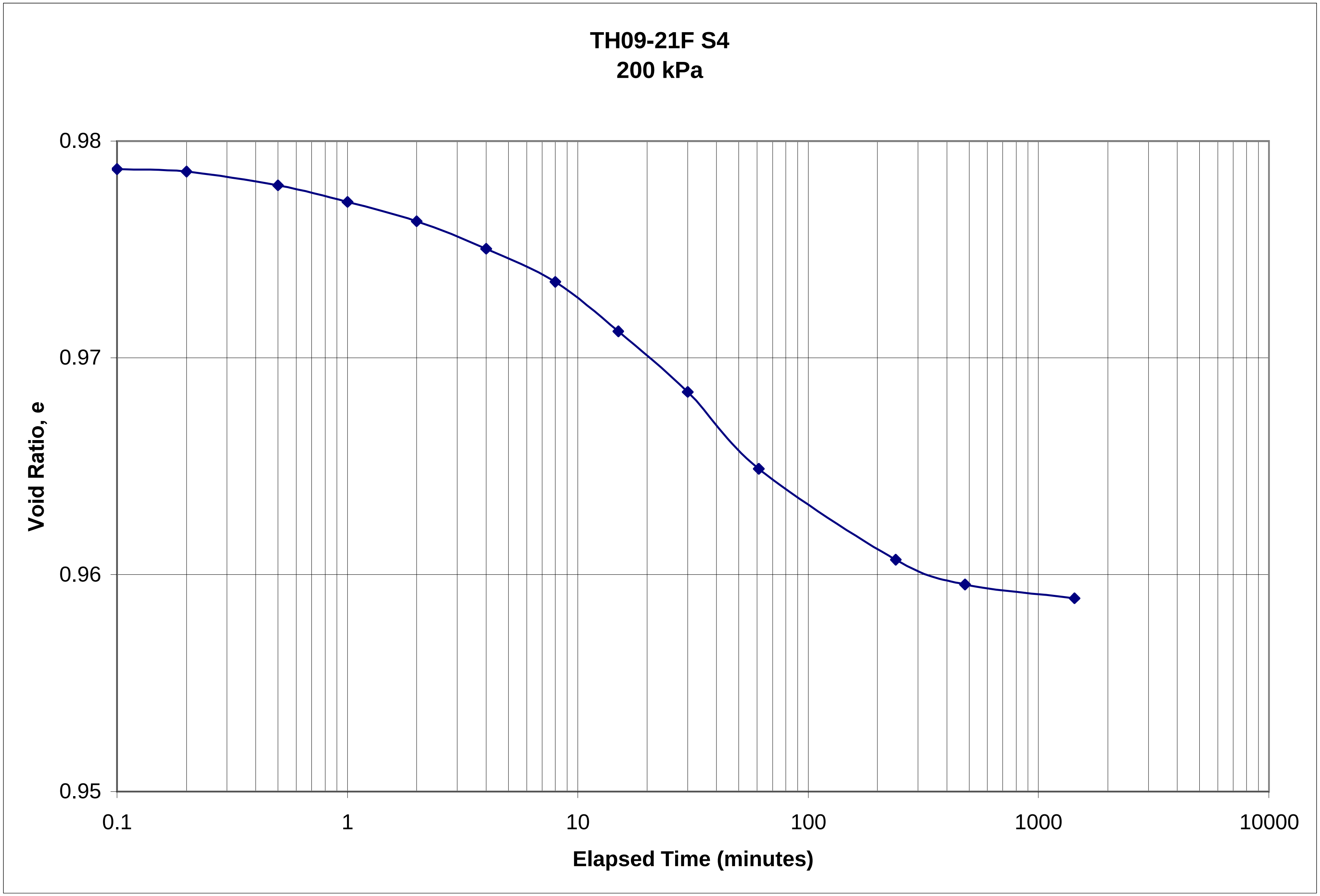

TH09-21F S4
399 kPa
Void Ratio, e
1.00
0.98
0.96
0.94
0.92
0.90
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



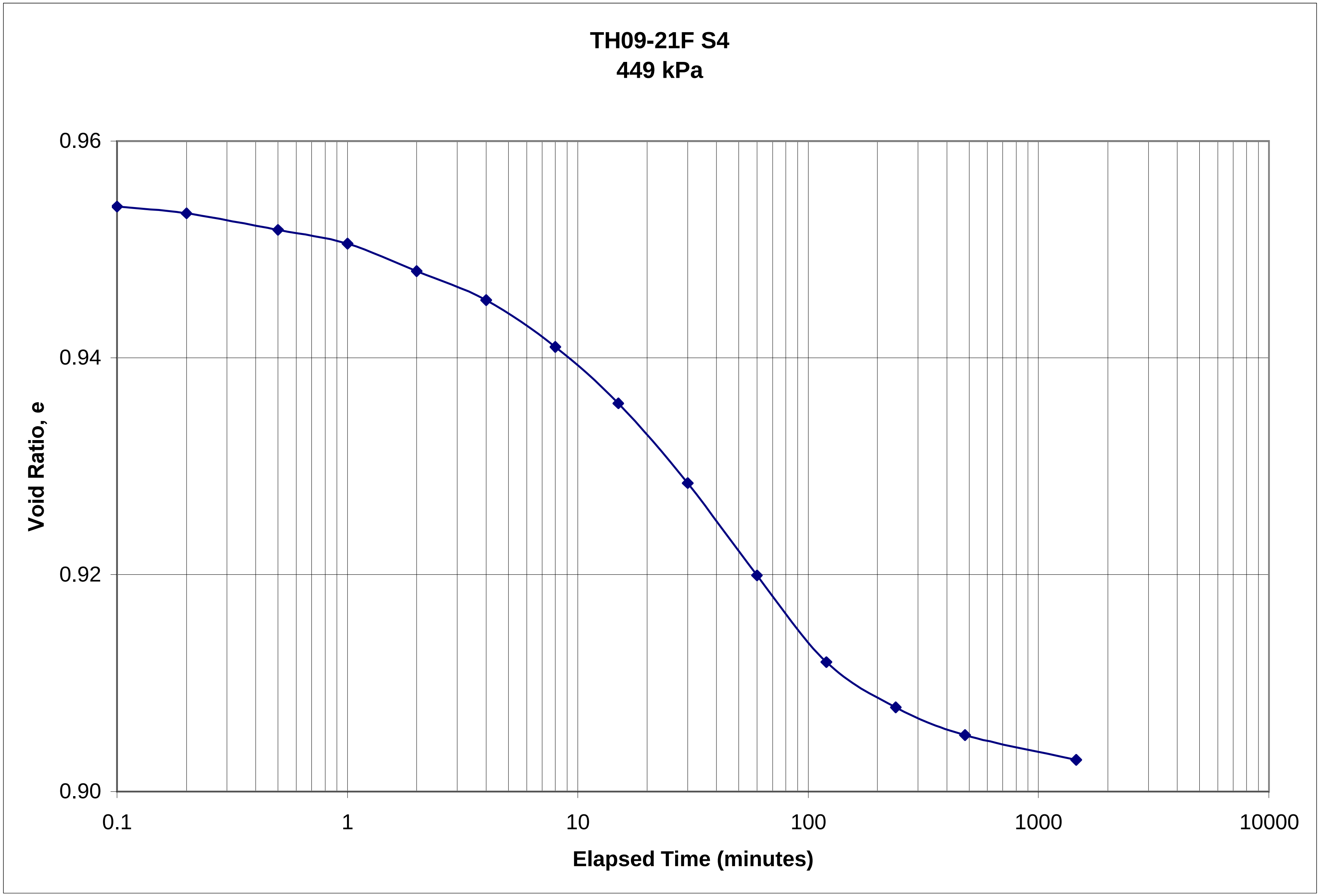
TH09-21F S4
200 kPa
Void Ratio, e
0.95
0.94
0.93
0.92
0.91
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

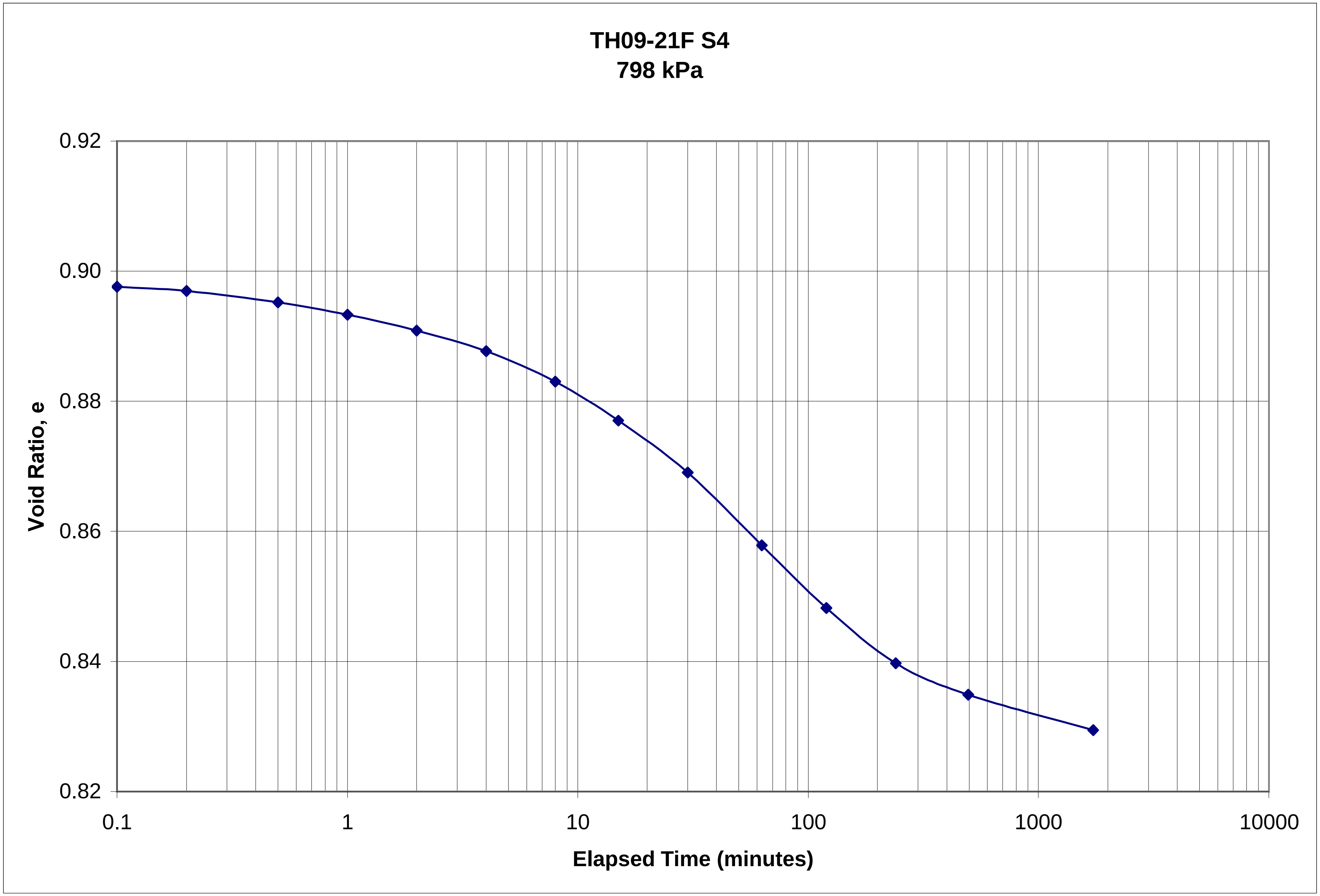


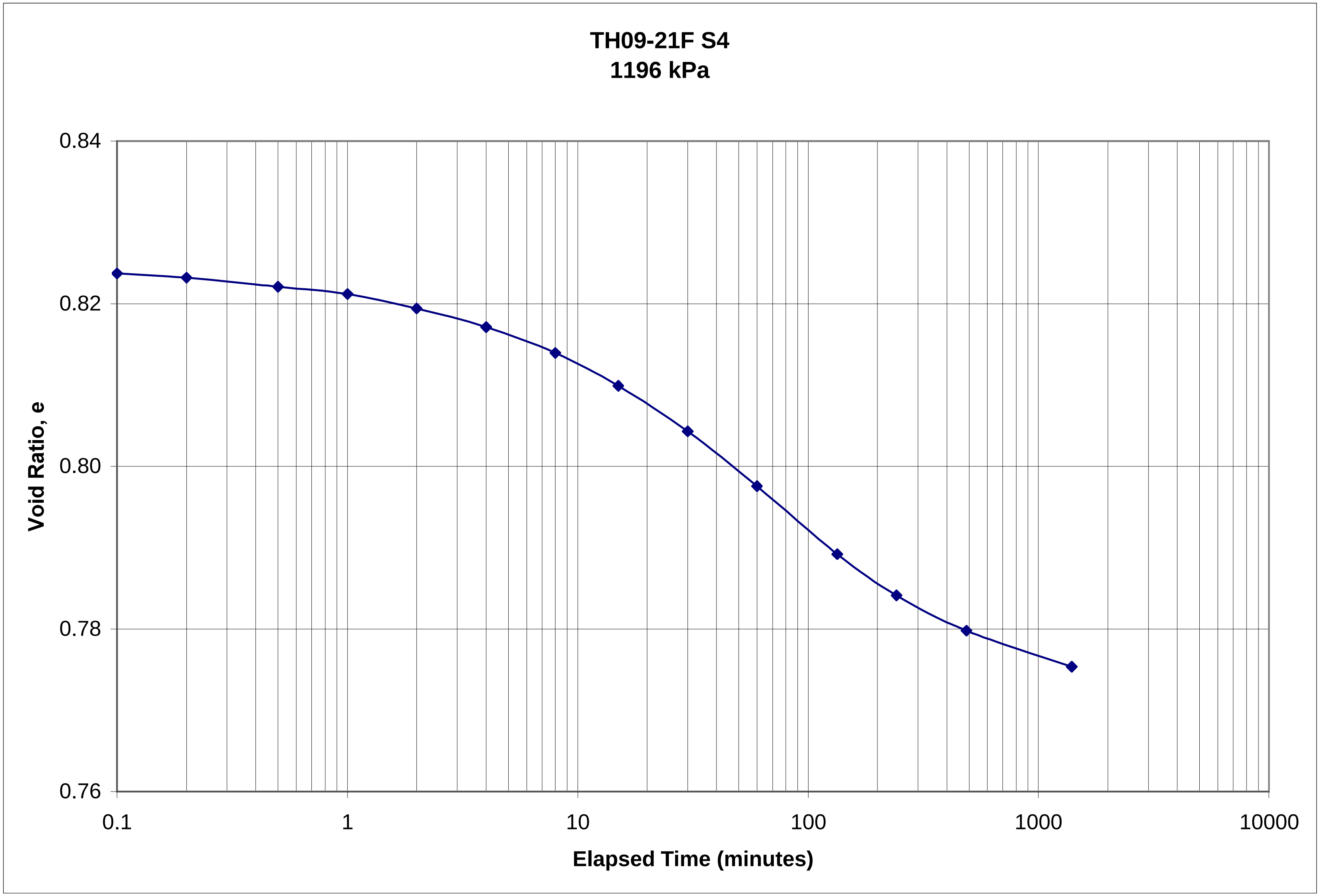
TH09-21F S4
100 kPa
Void Ratio, e
0.99
0.98
0.97
0.96
0.95
0.94
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



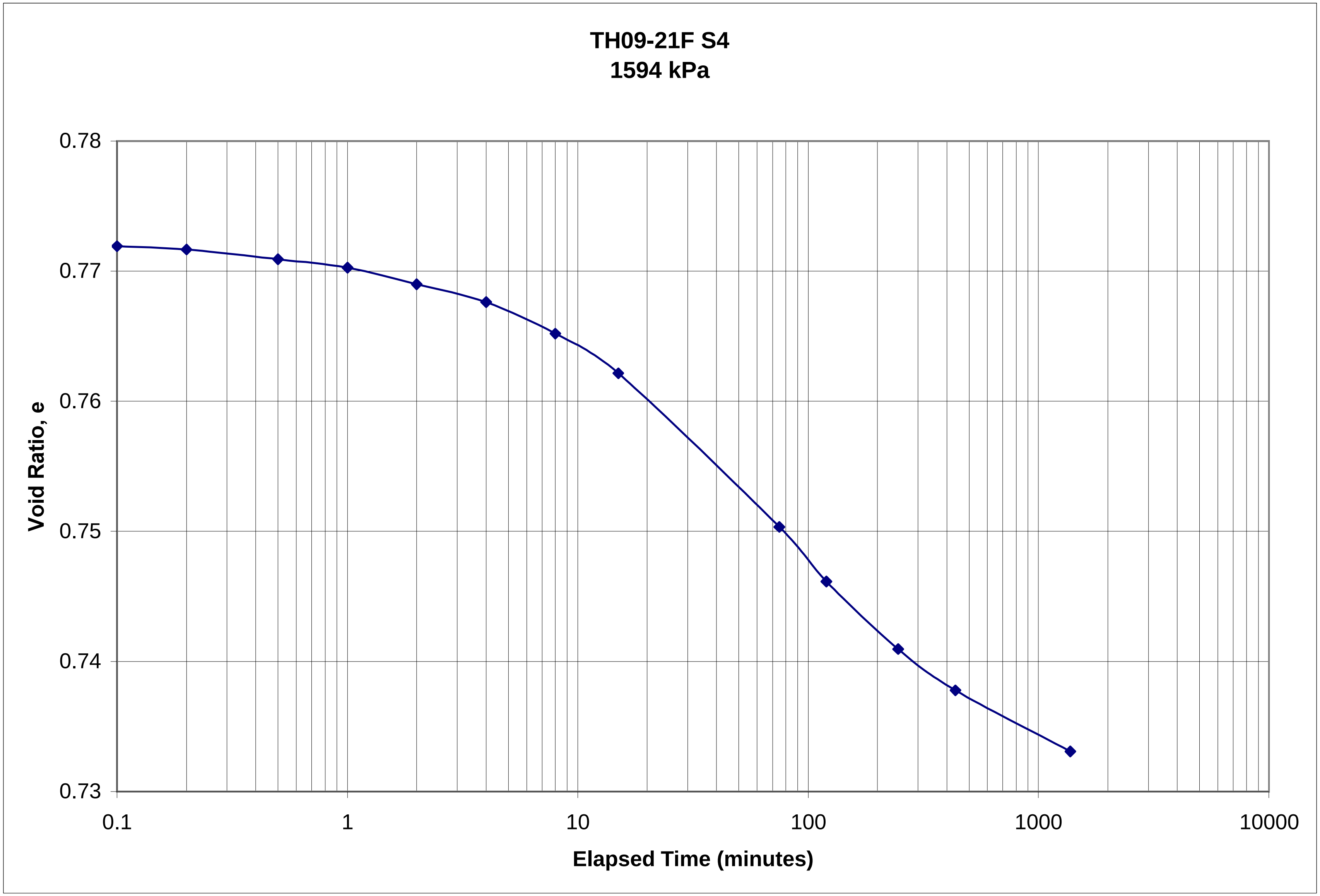
TH09-21F S4
200 kPa
Void Ratio, e
0.98
0.97
0.96
0.95
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-21F S4
449 kPa
Void Ratio, e
0.96
0.94
0.92
0.90
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

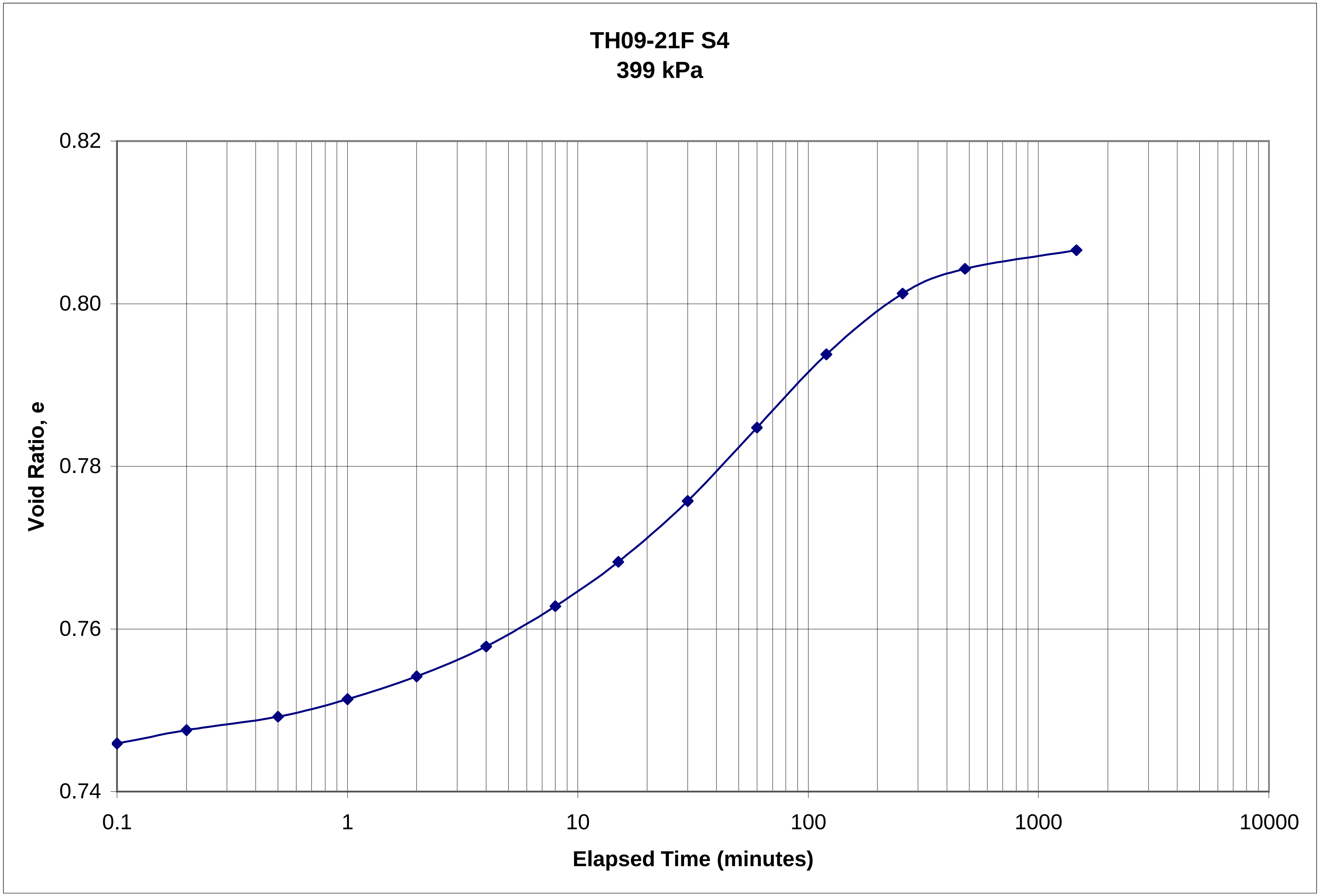

TH09-21F S4
798 kPa
Void Ratio, e
0.92
0.90
0.88
0.86
0.84
0.82
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



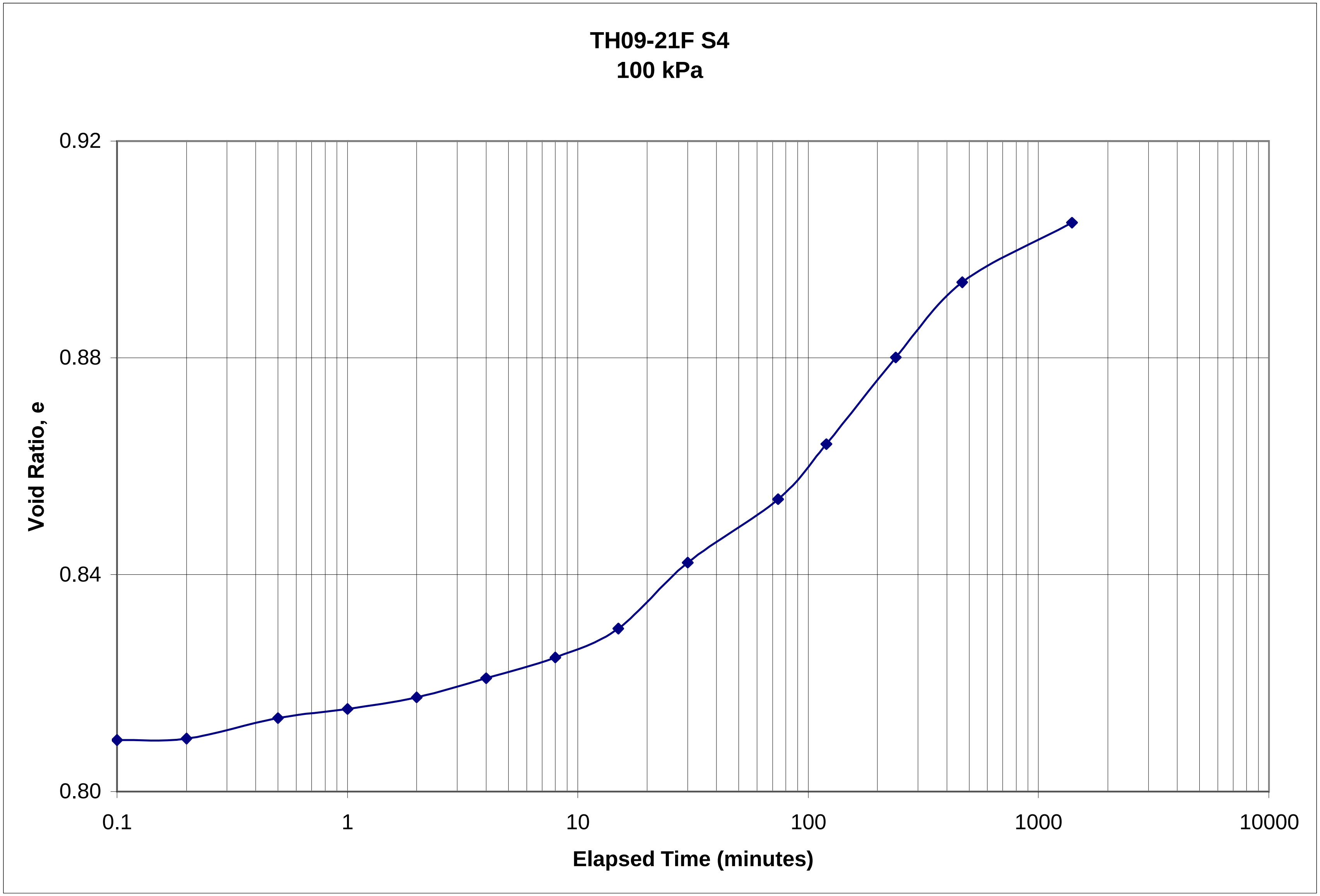
TH09-21F S4
1196 kPa
Void Ratio, e
0.84
0.82
0.80
0.78
0.76
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

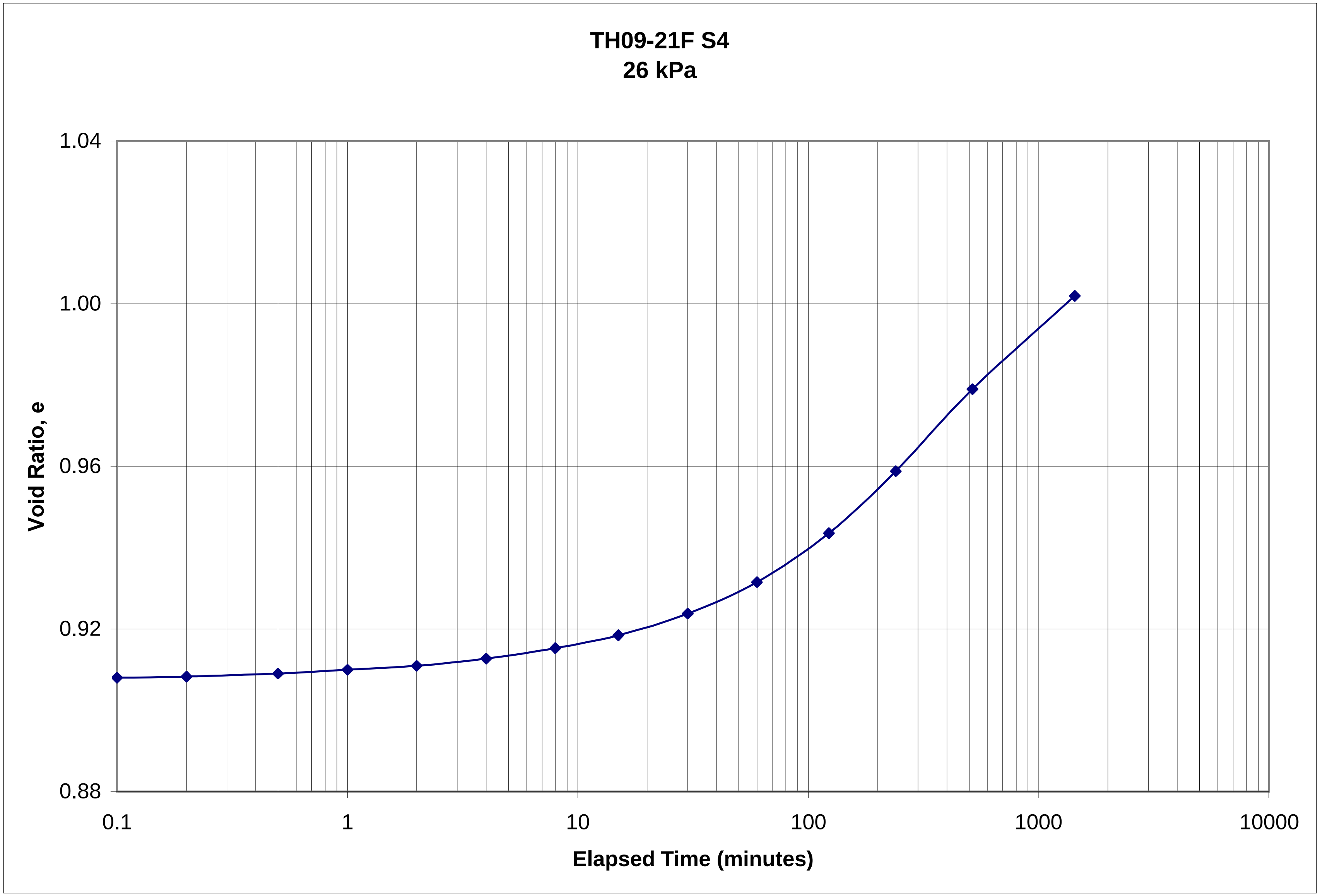


TH09-21F S4
1594 kPa
Void Ratio, e
0.78
0.77
0.76
0.75
0.74
0.73
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

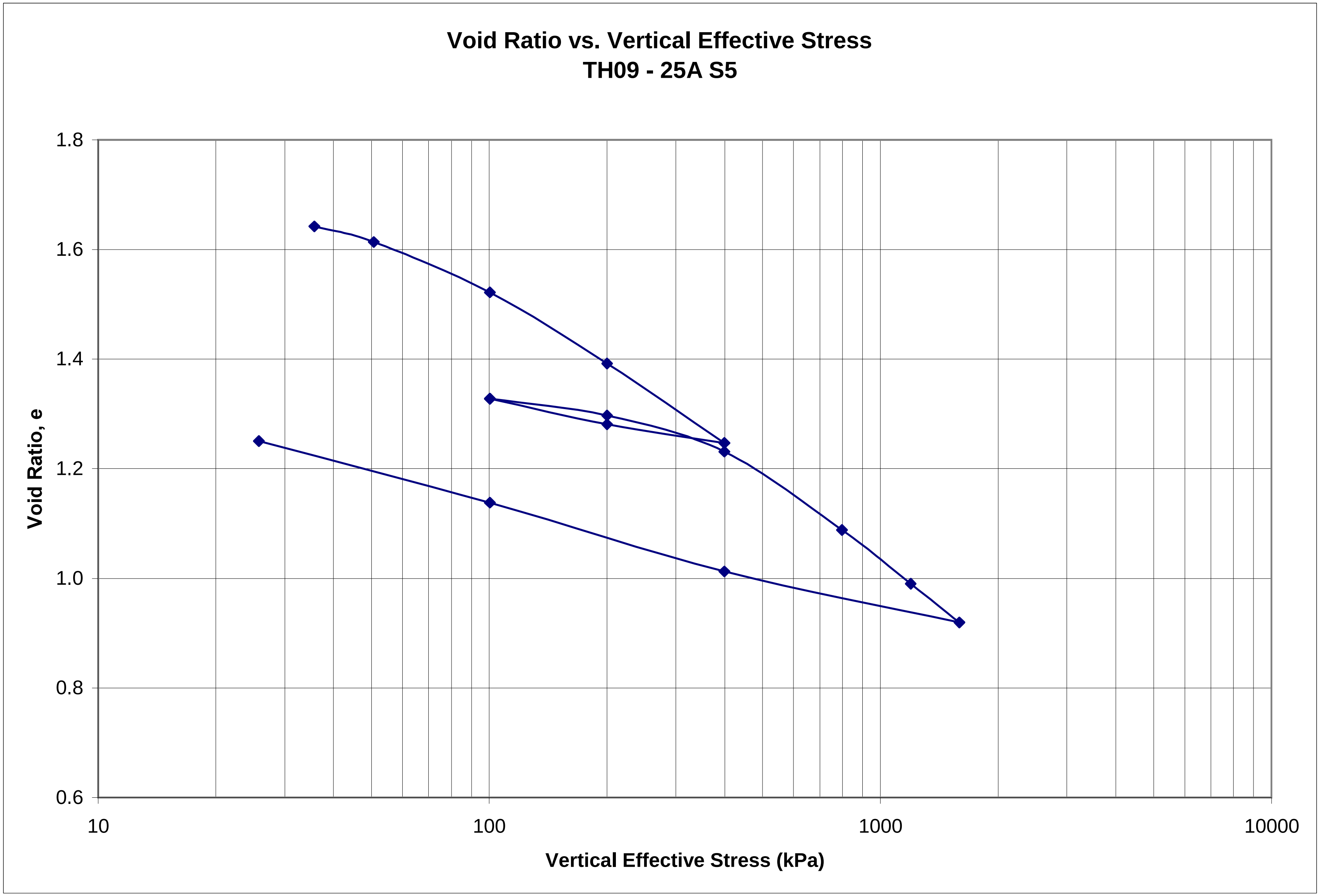


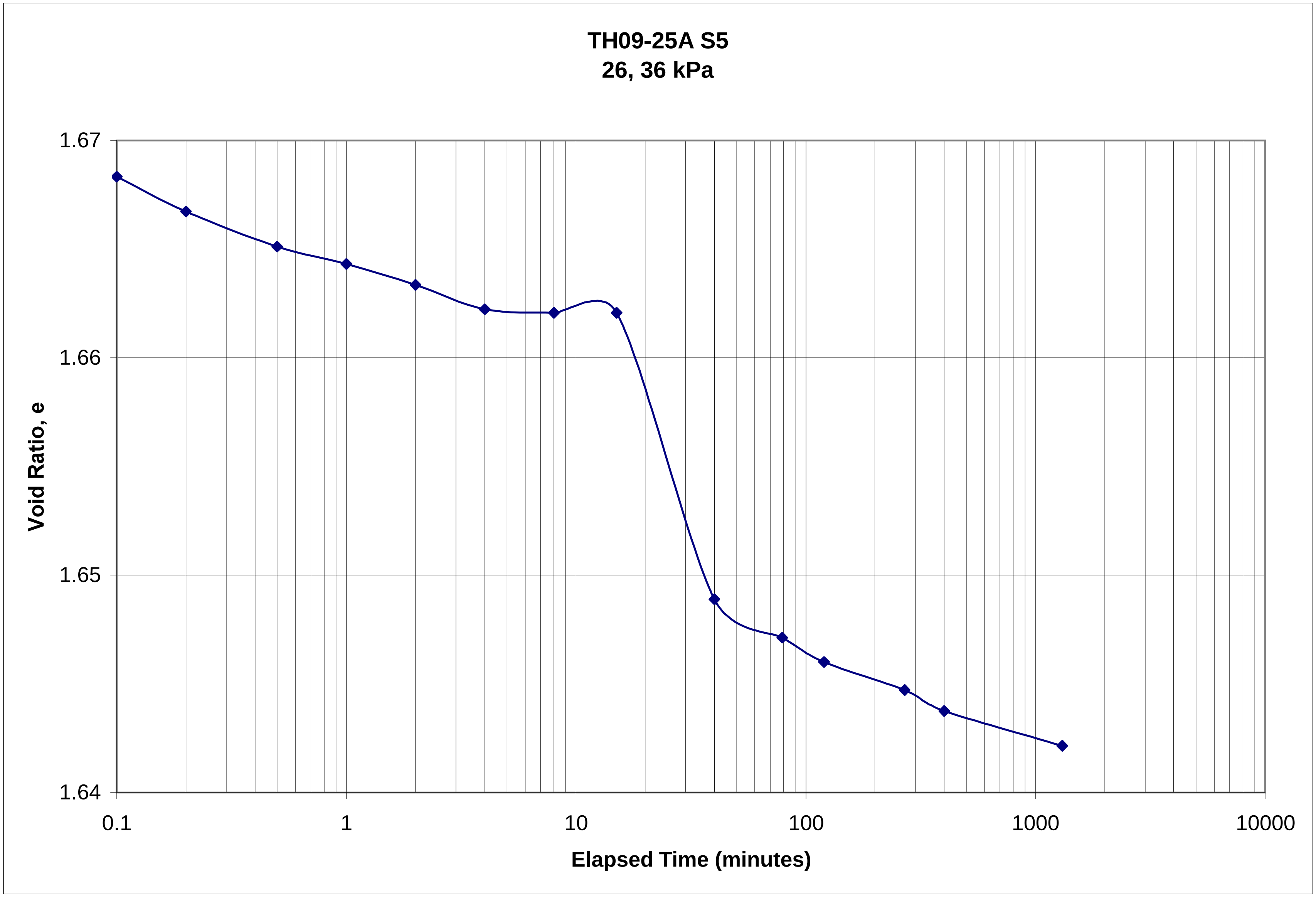
TH09-21F S4
399 kPa
Void Ratio, e
0.82
0.80
0.78
0.76
0.74
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

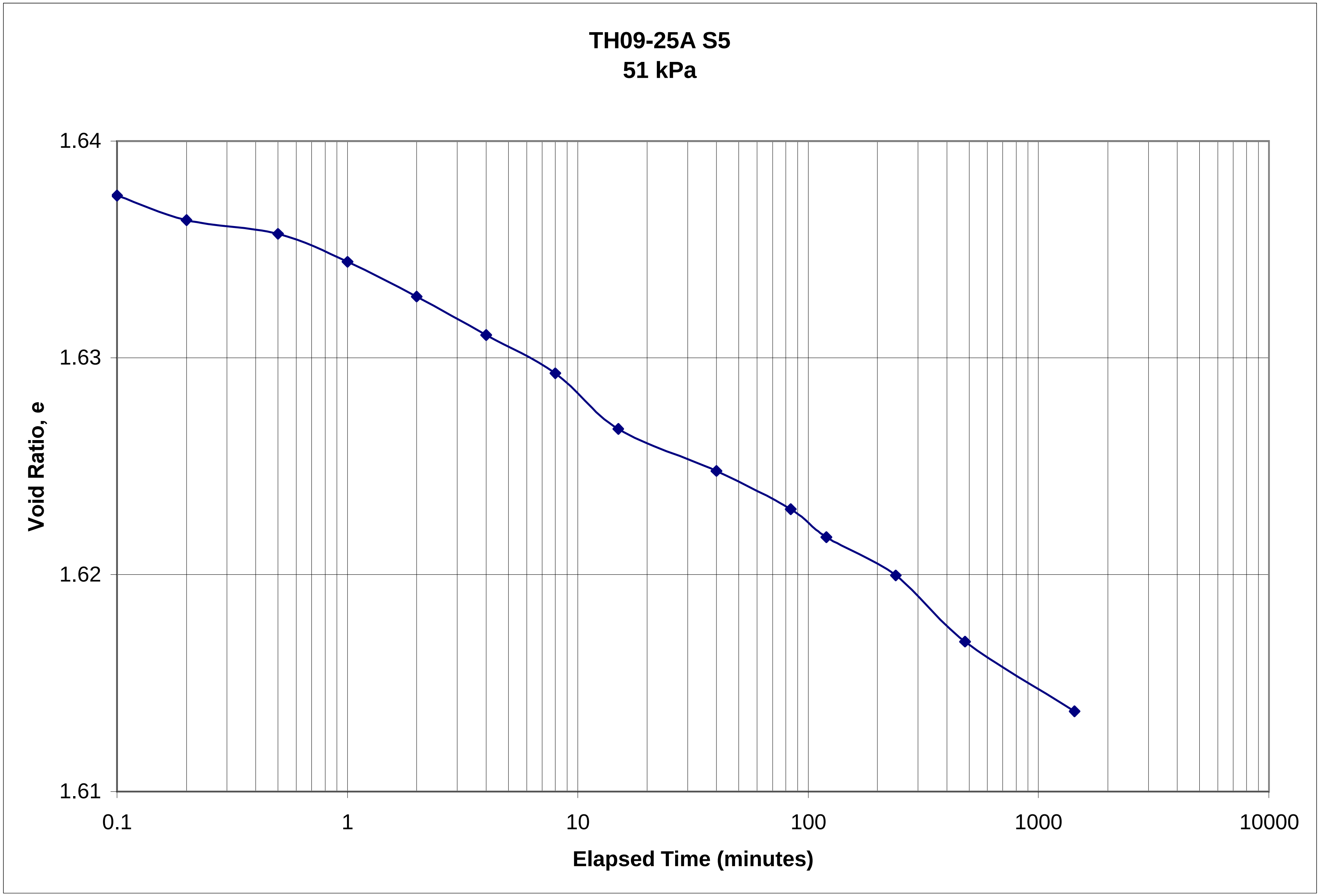

TH09-21F S4
100 kPa
Void Ratio, e
0.92
0.88
0.84
0.80
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



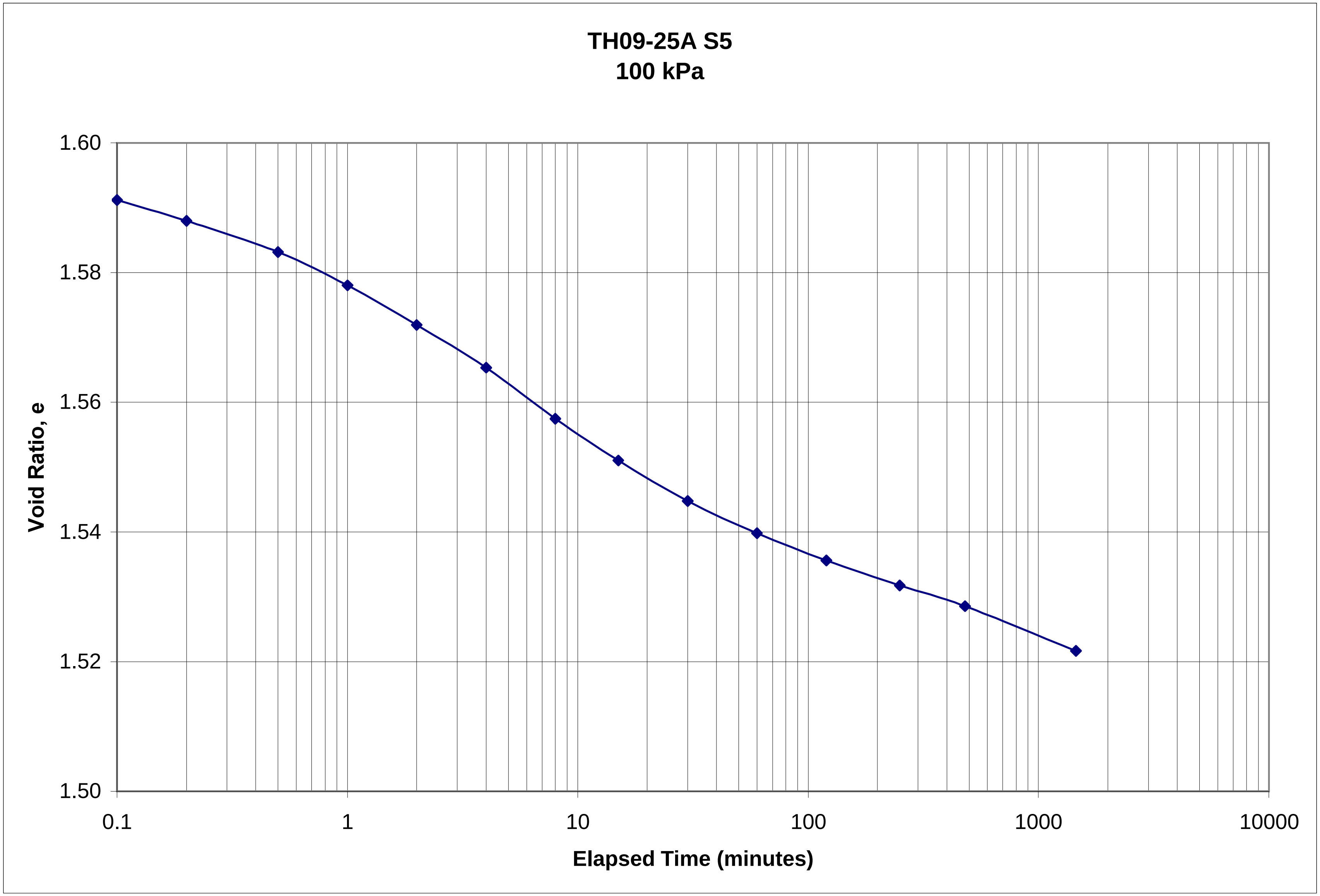
TH09-21F S4
26 kPa
1.04
1.00
0.96
0.92
0.88
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


Void Ratio vs. Vertical Effective Stress
TH09 - 25A S5
1.8
1.6
1.4
1.2
1.0
0.8
0.6
Void Ratio, e
10
100
1000
10000
Vertical Effective Stress (kPa)

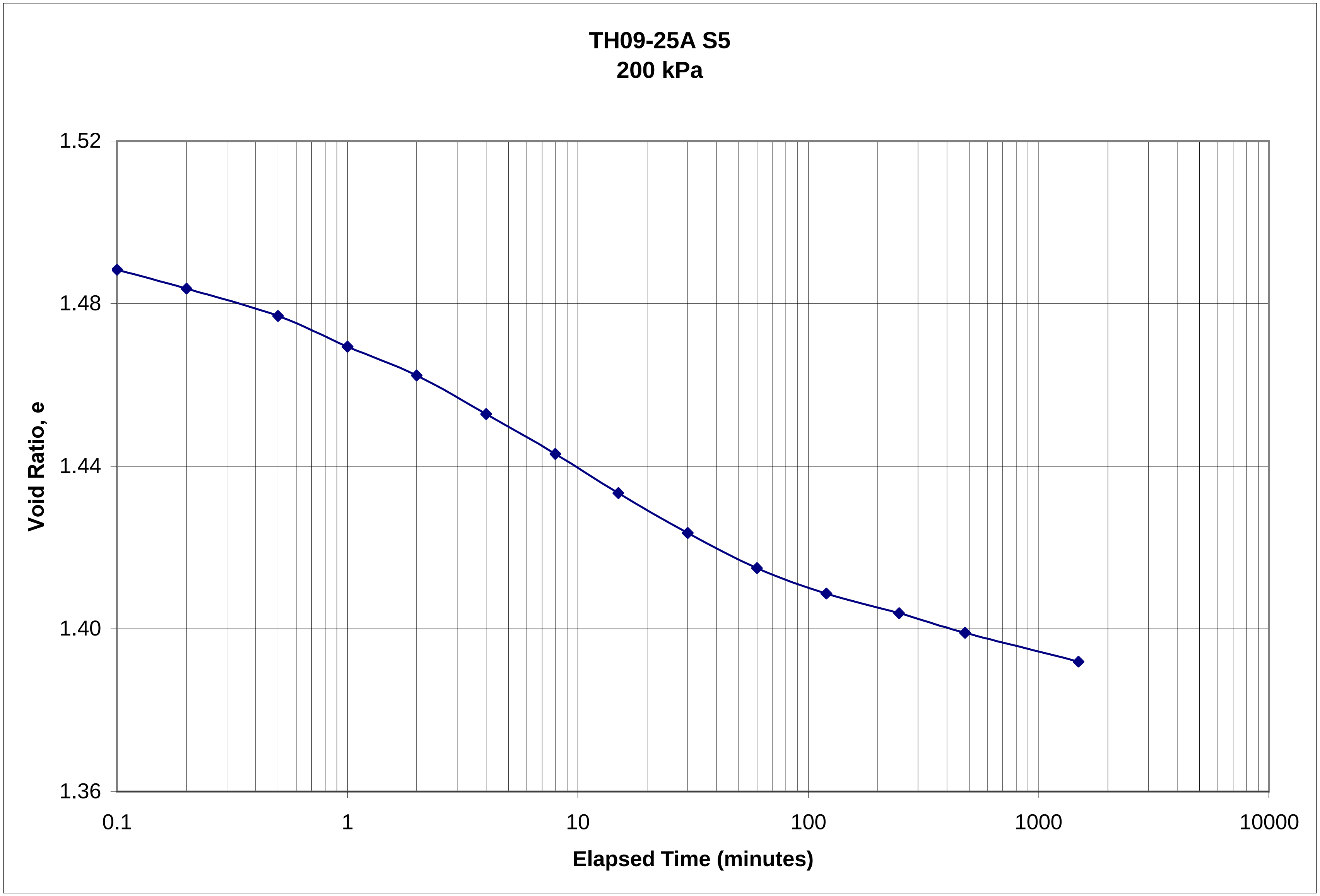

TH09-25A S5
26, 36 kPa
Void Ratio, e
1.67
1.66
1.65
1.64
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

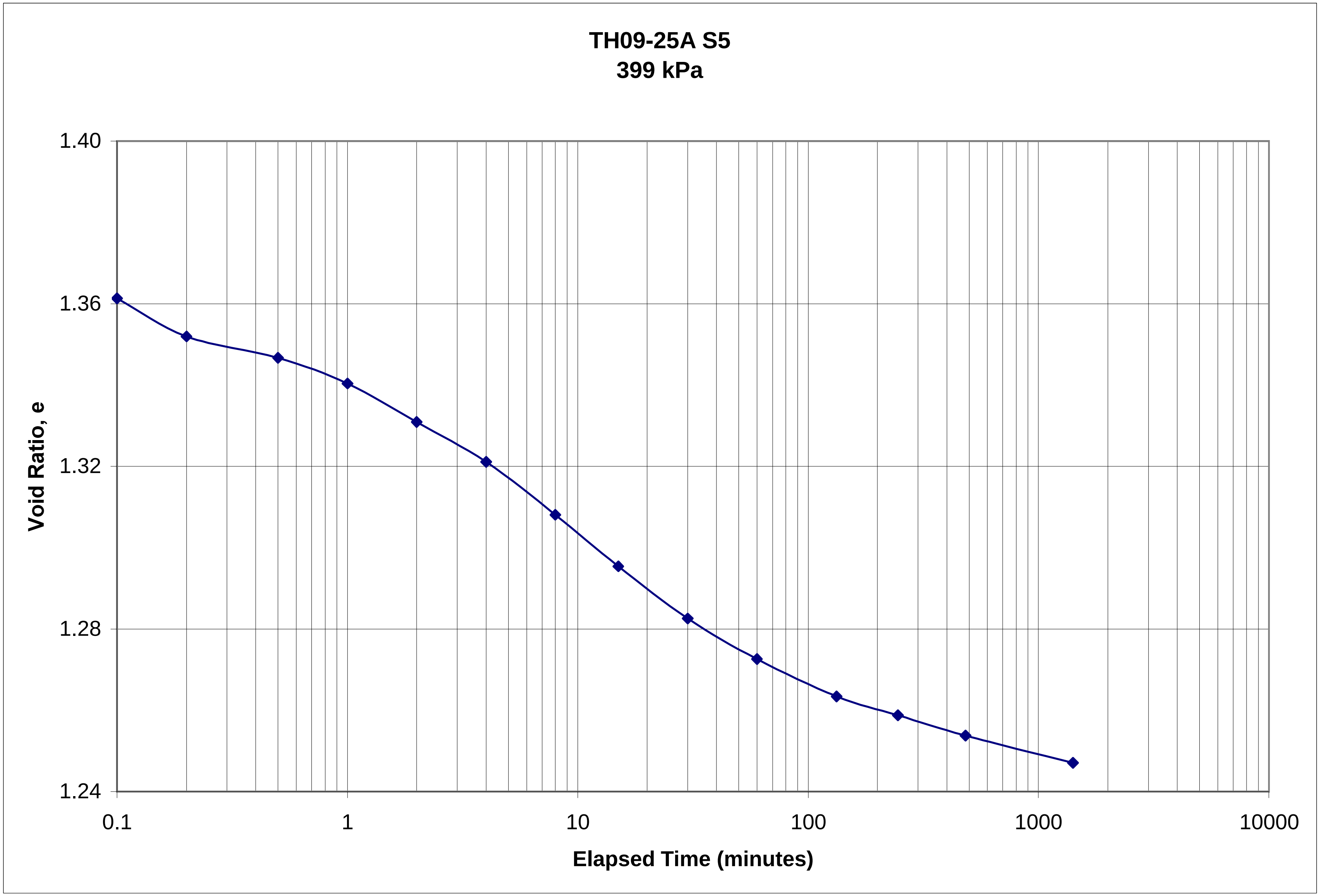


TH09-25A S5
51 kPa
1.64
1.63
1.62
1.61
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

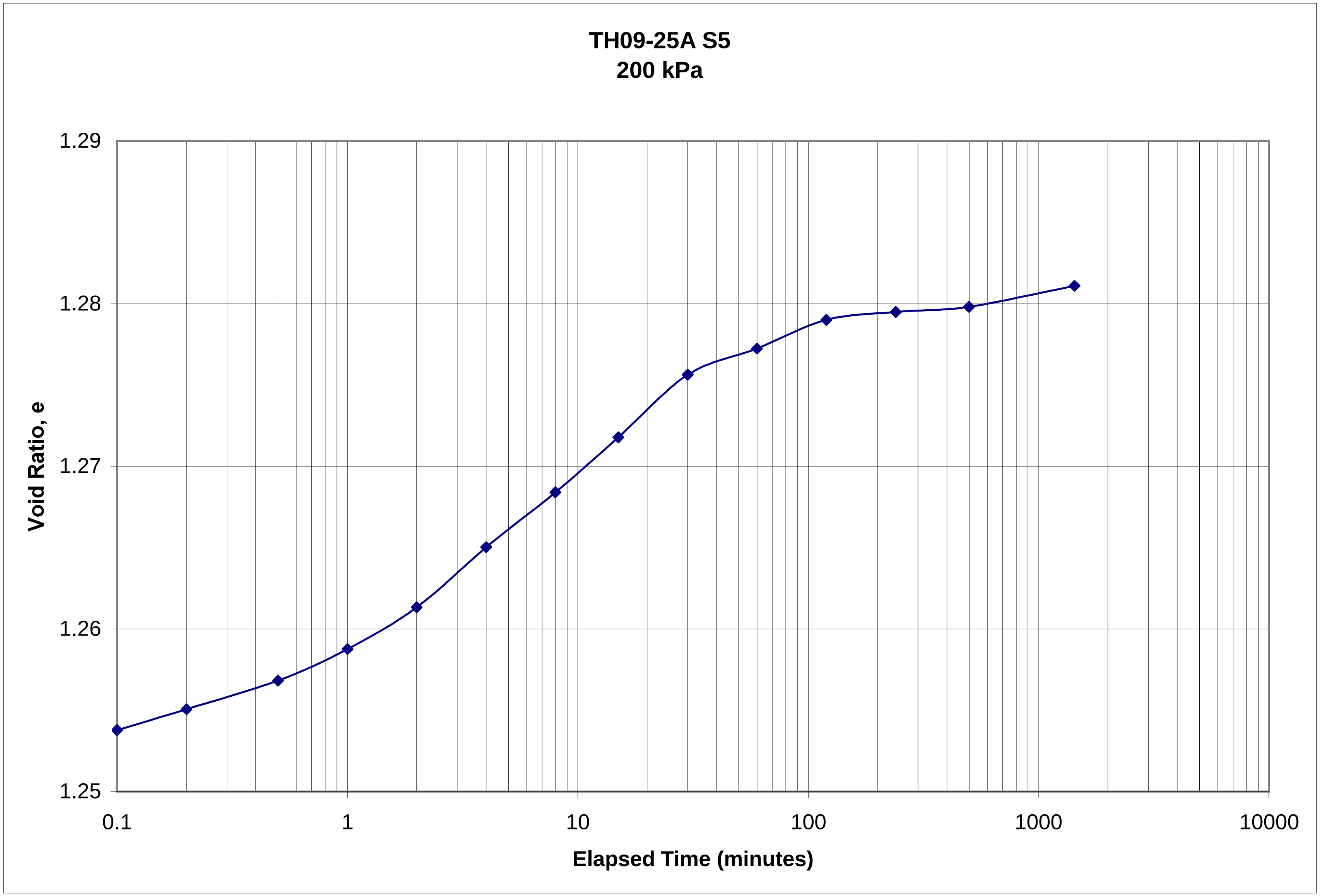


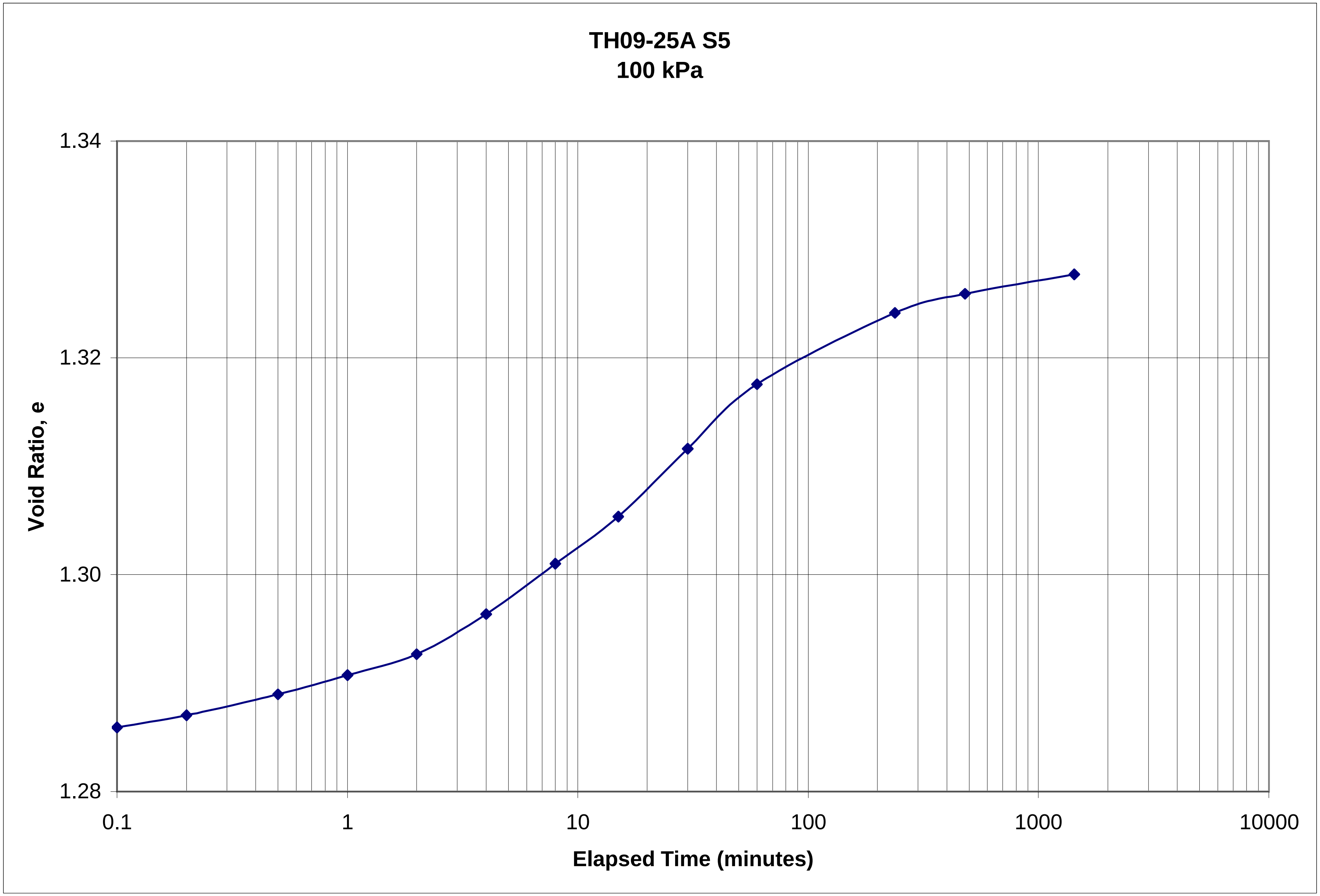
TH09-25A S5
100 kPa
Void Ratio, e
1.60
1.58
1.56
1.54
1.52
1.50
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S5
200 kPa
1.52
1.48
1.44
1.40
1.36
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

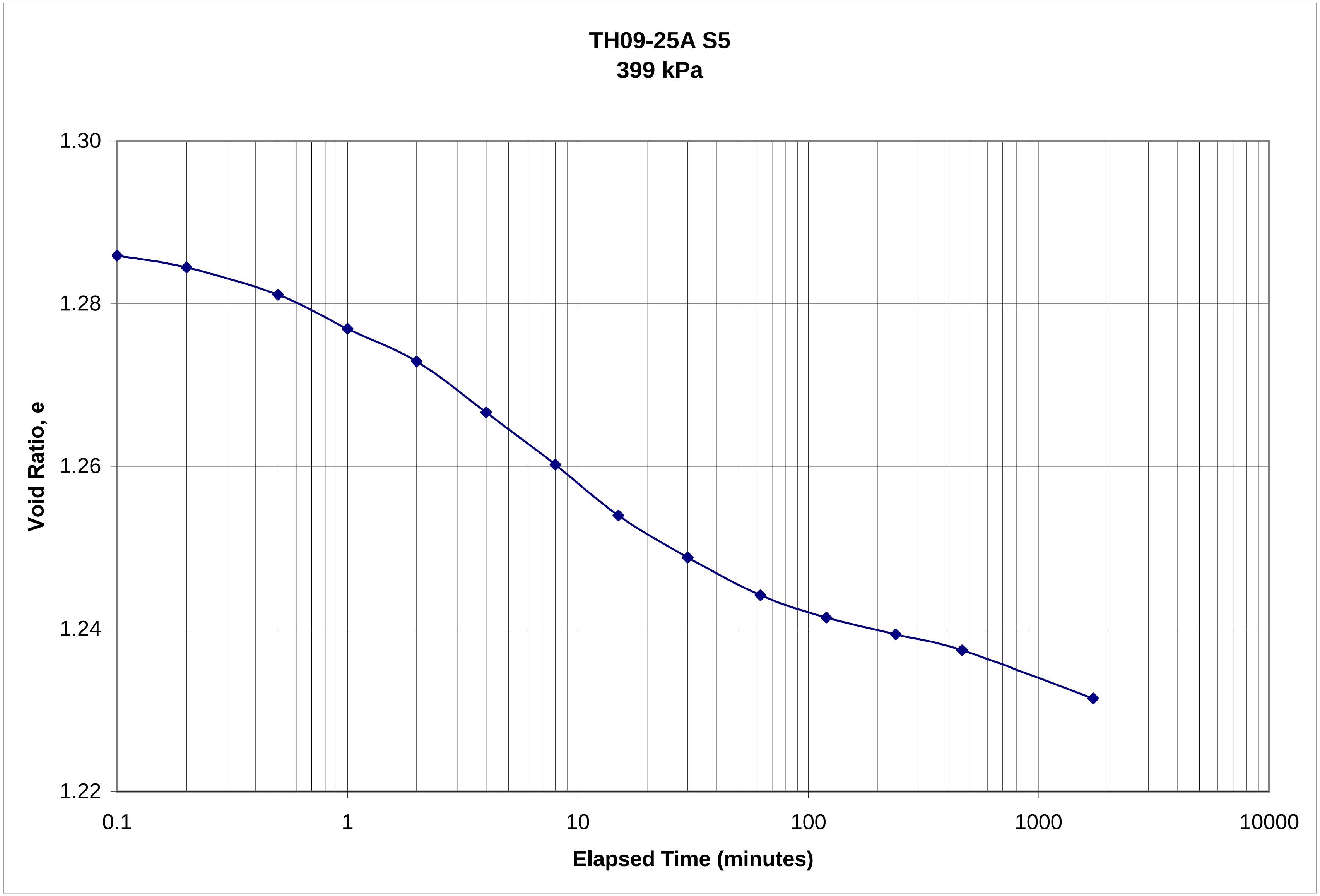


TH09-25A S5
399 kPa
1.40
1.36
1.32
1.28
1.24
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

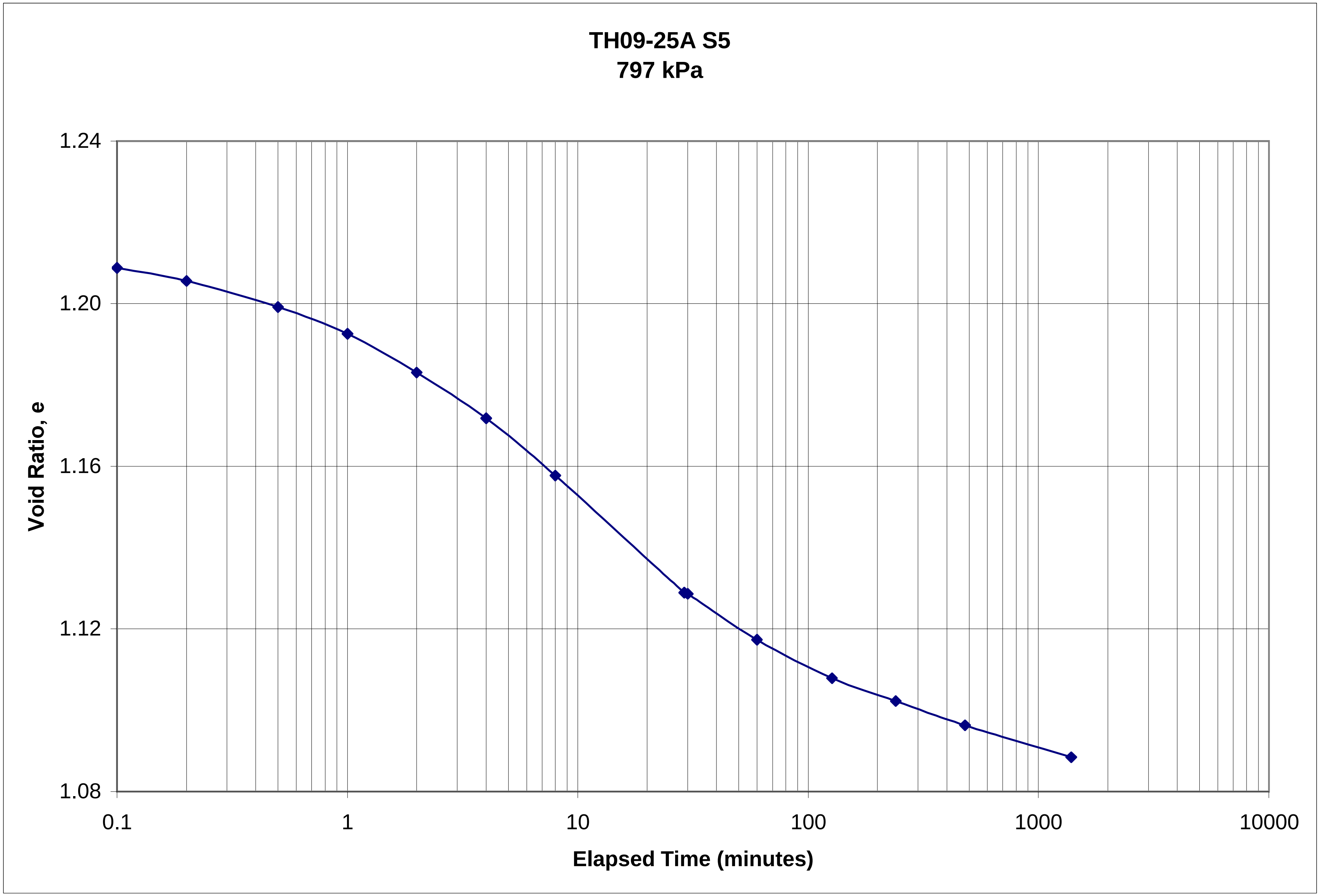

TH09-25A S5
200 kPa
Void Ratio, e
1.29
1.28
1.27
1.26
1.25
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S5
100 kPa
1.34
1.32
1.30
1.28
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

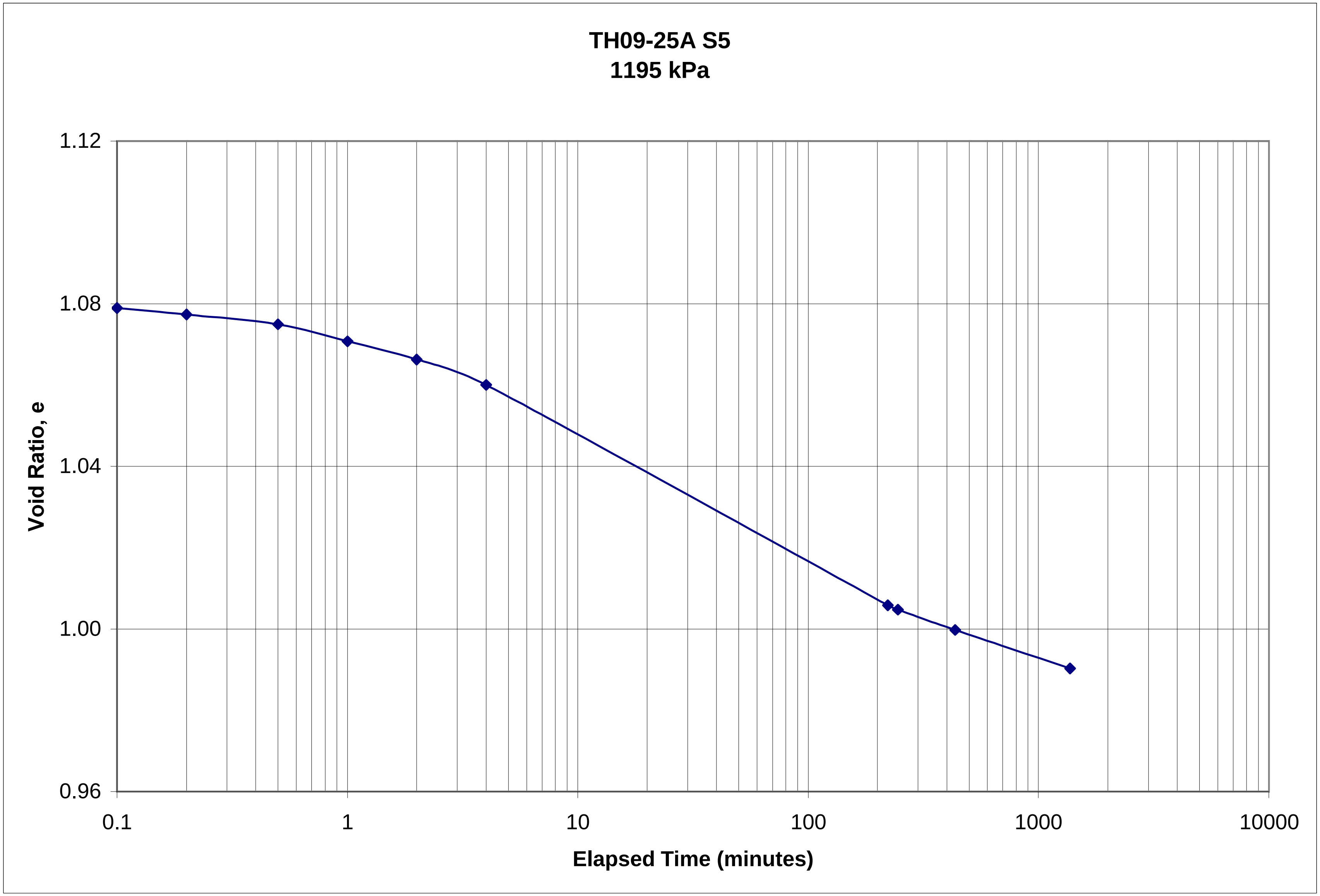
TH09-25A S5
200 kPa
Void Ratio, e
1.33
1.32
1.31
1.30
1.29
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

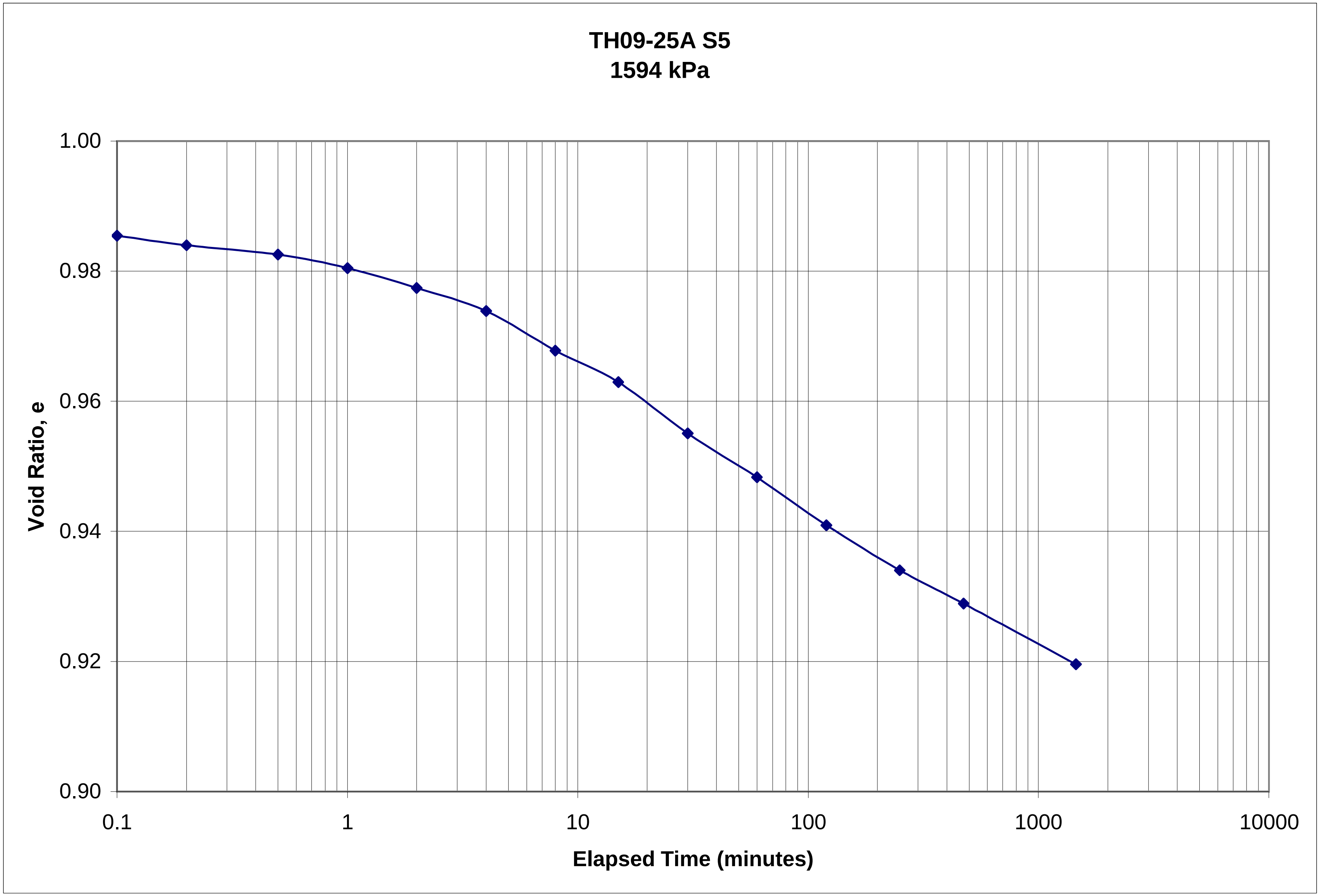


TH09-25A S5
399 kPa
Void Ratio, e
1.30
1.28
1.26
1.24
1.22
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

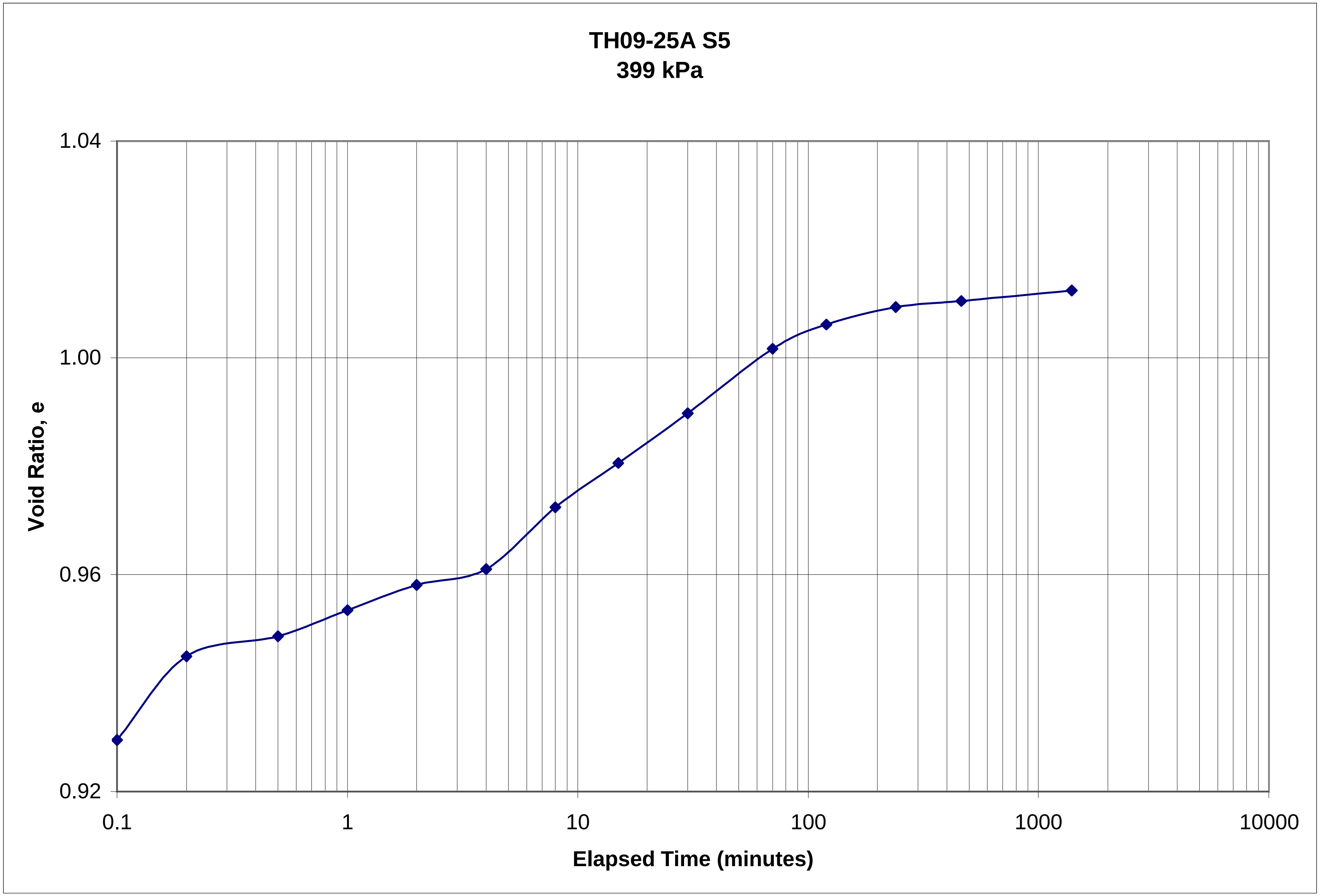


TH09-25A S5
797 kPa
1.24
1.20
1.16
1.12
1.08
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

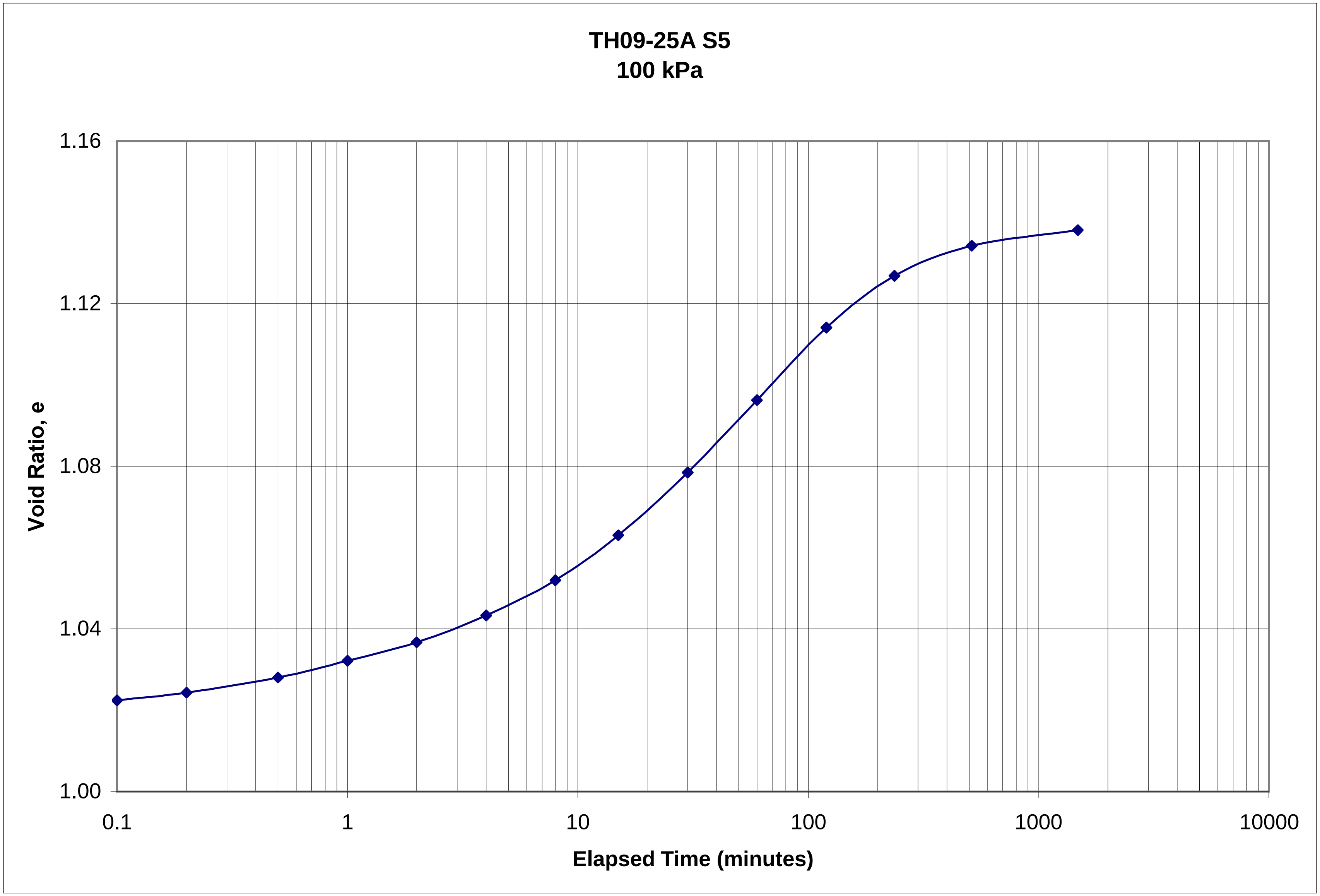

TH09-25A S5
1195 kPa
Void Ratio, e
1.12
1.08
1.04
1.00
0.96
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

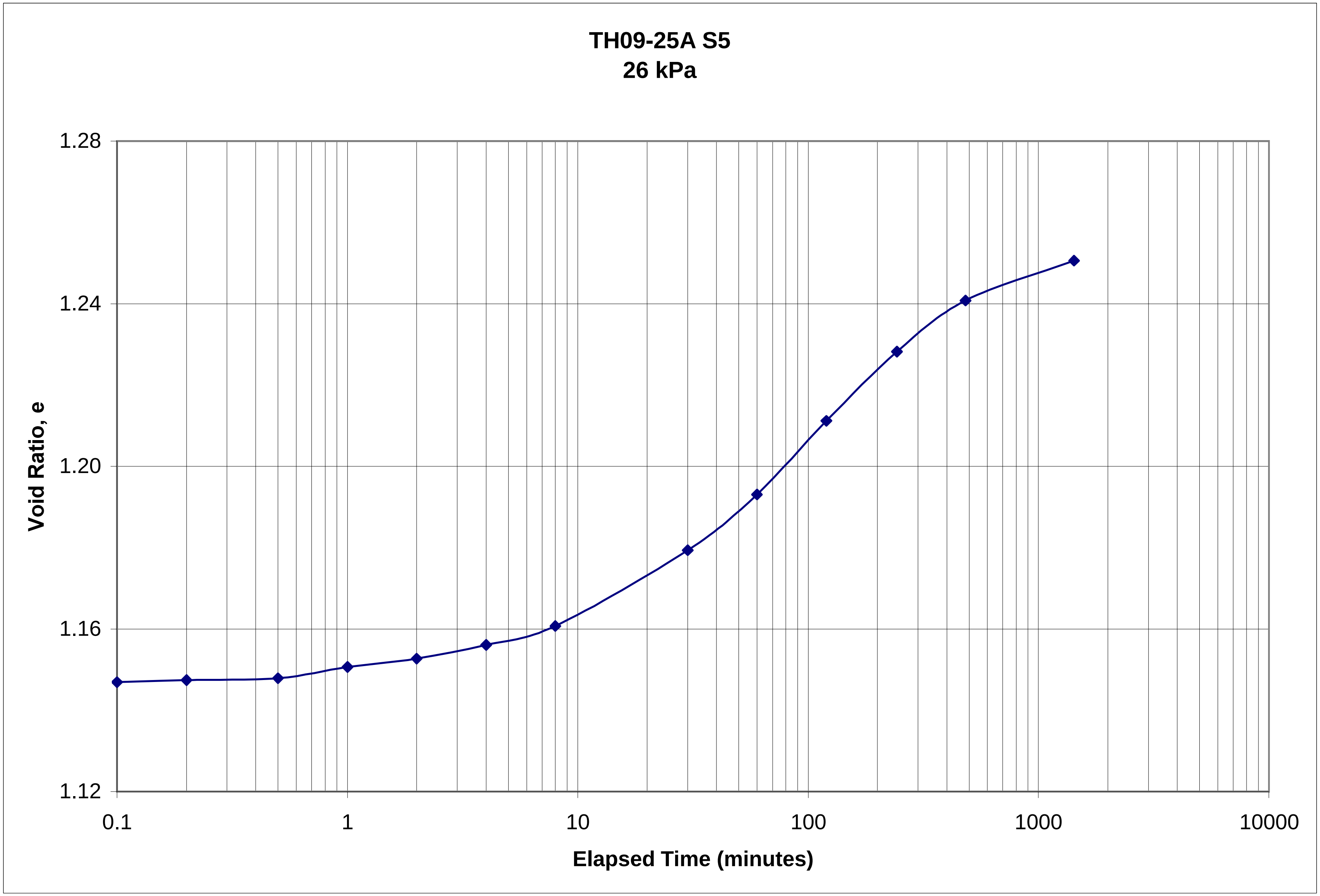


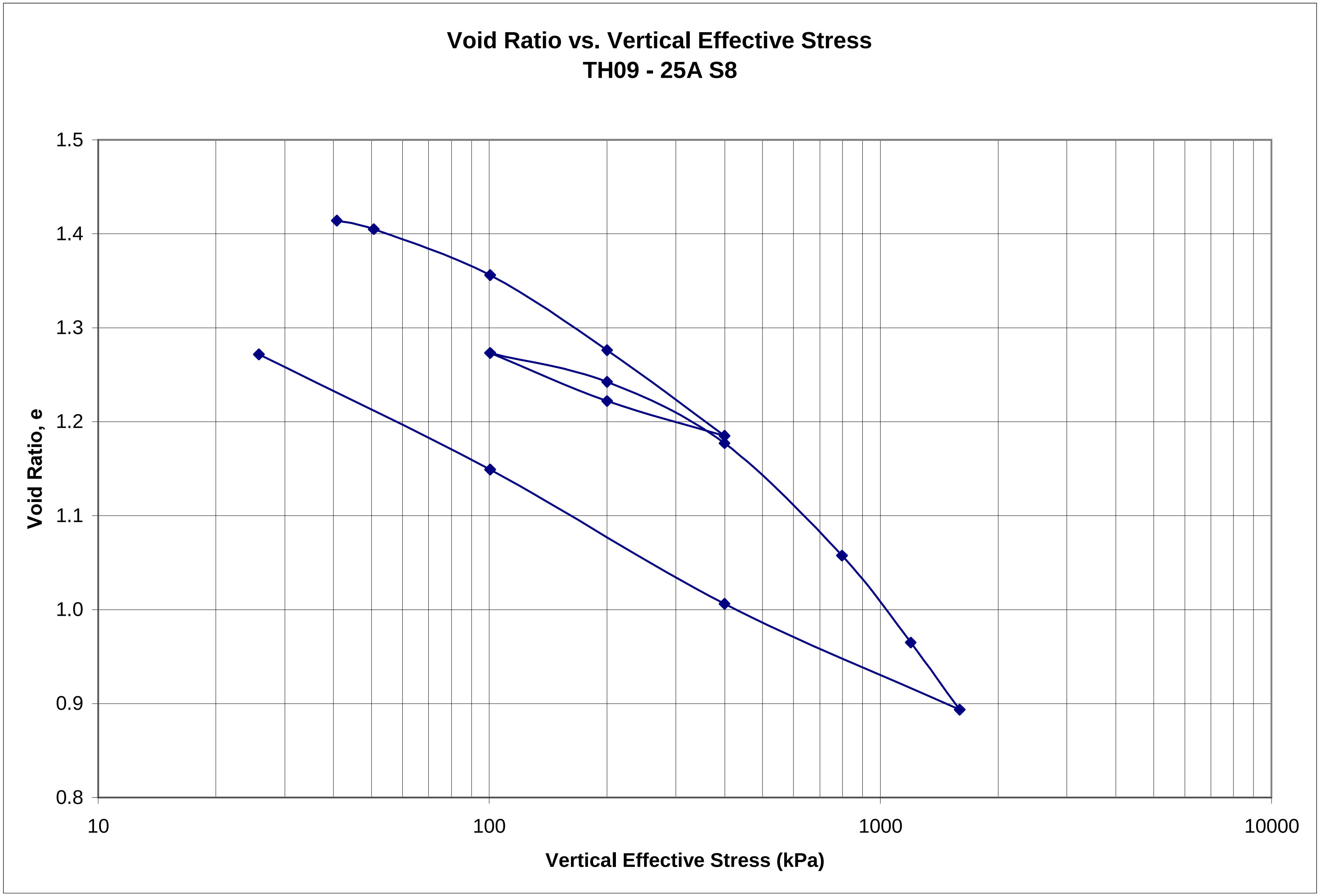
TH09-25A S5
1594 kPa
Void Ratio, e
1.00
0.98
0.96
0.94
0.92
0.90
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



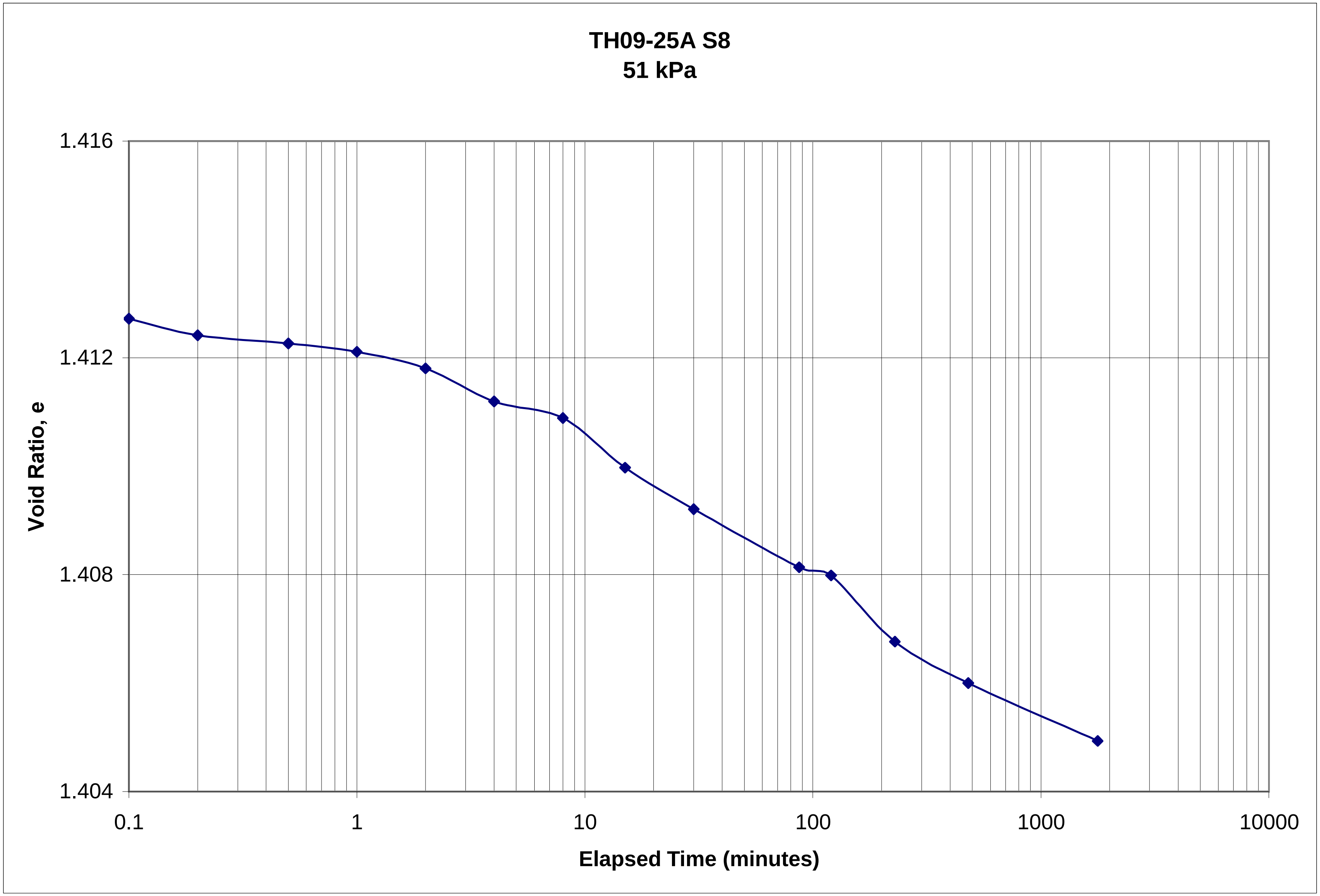
TH09-25A S5
399 kPa
Void Ratio, e
1.04
1.00
0.96
0.92
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S5
100 kPa
Void Ratio, e
1.16
1.12
1.08
1.04
1.00
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S5
26 kPa
Void Ratio, e
1.28
1.24
1.20
1.16
1.12
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

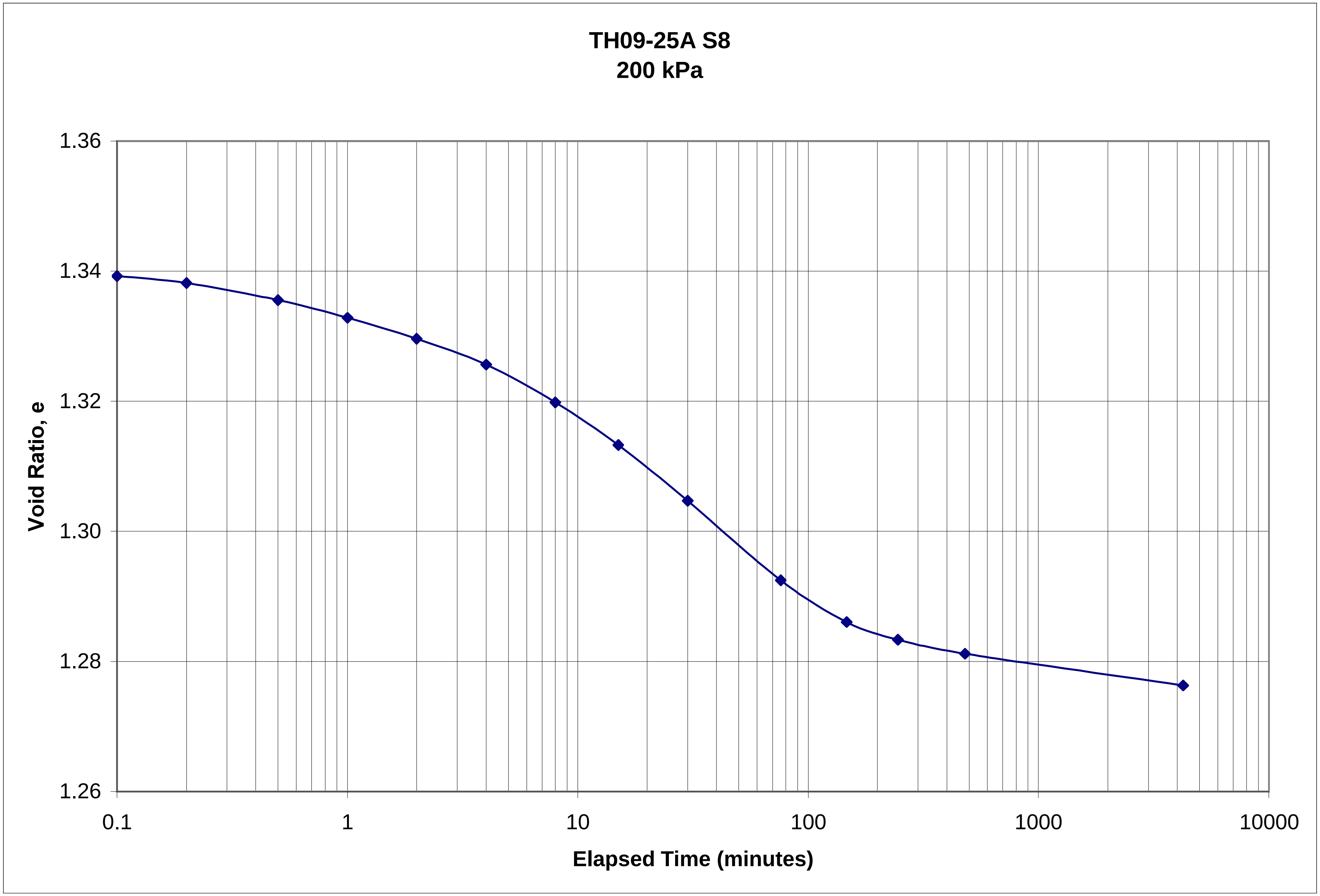

Void Ratio vs. Vertical Effective Stress
TH09 - 25A S8
Void Ratio, e
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
10
100
1000
10000
Vertical Effective Stress (kPa)


TH09-25A S8
26, 36, 41 kPa
Void Ratio, e
1.432
1.428
1.424
1.420
1.416
1.412
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

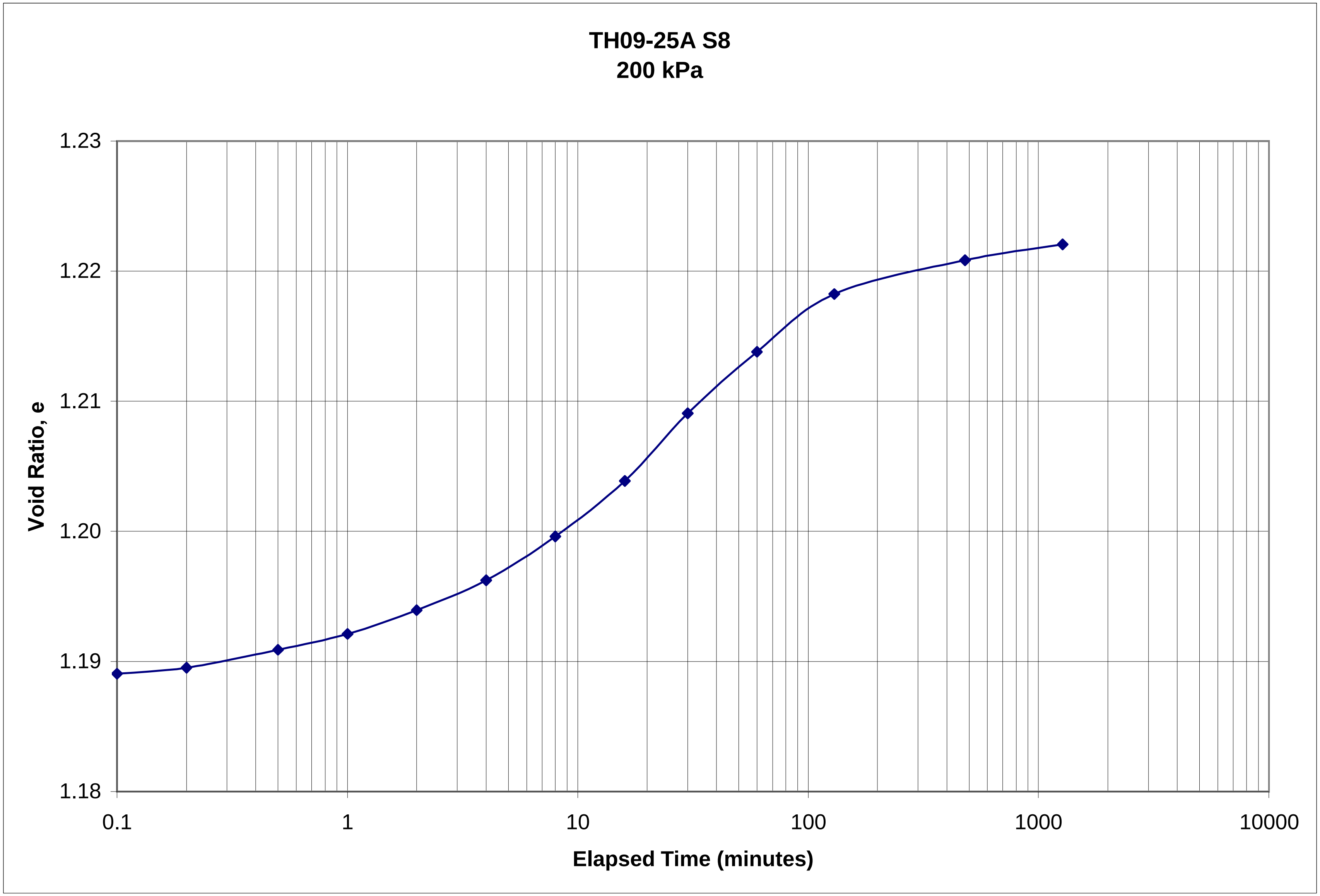


TH09-25A S8
51 kPa
Void Ratio, e
1.416
1.412
1.408
1.404
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

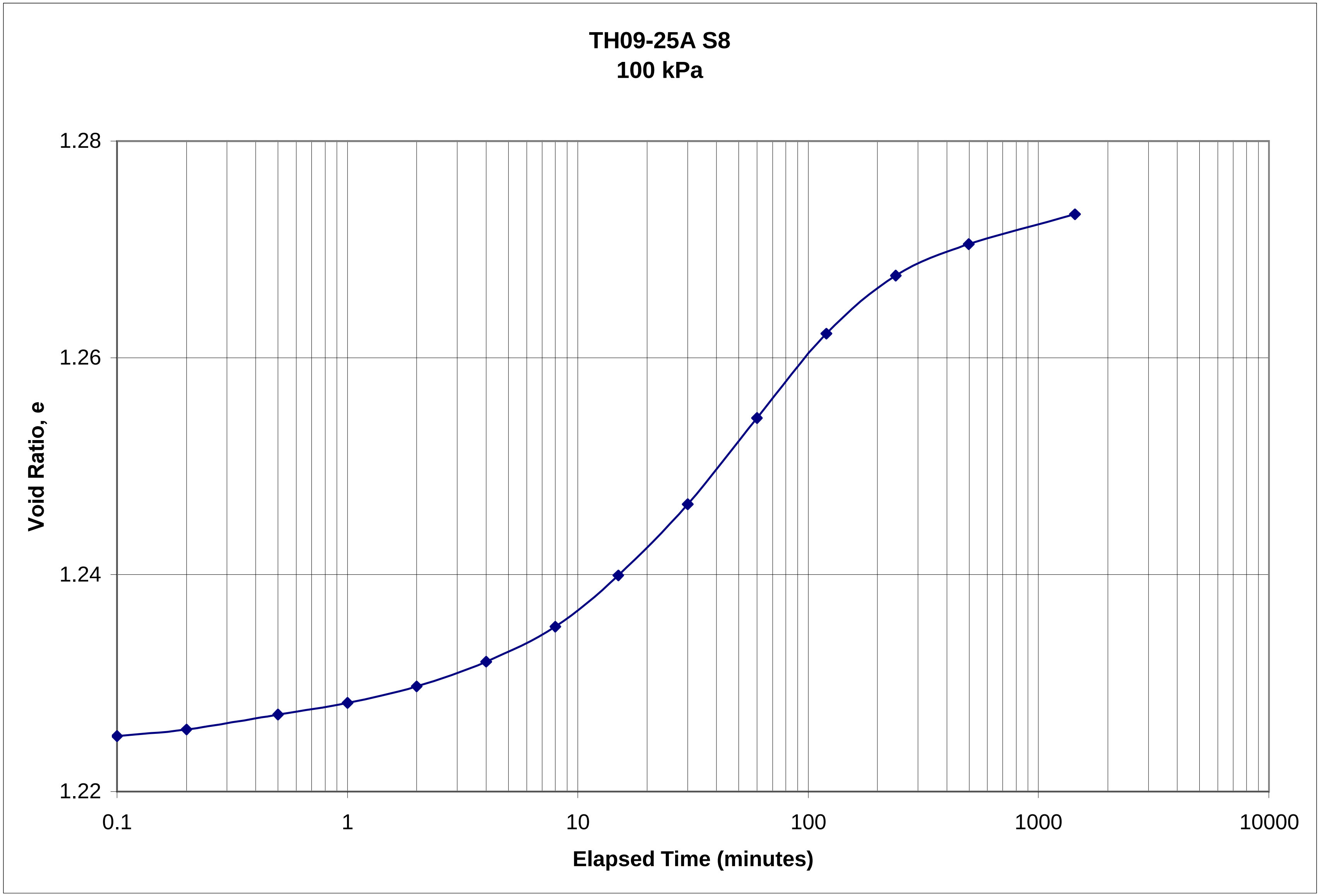

TH09-25A S8
100 kPa
Void Ratio, e
1.40
1.38
1.36
1.34
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

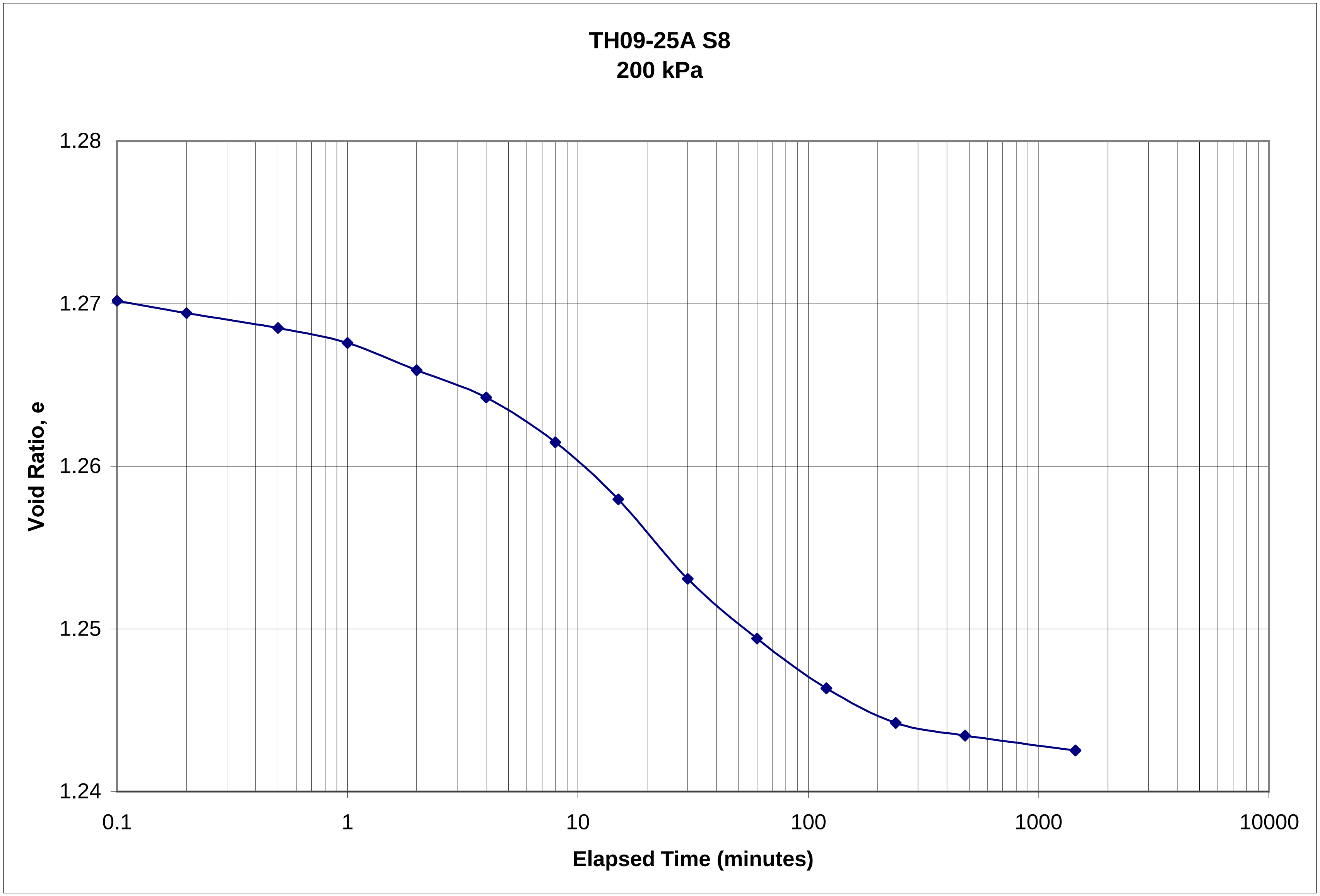

TH09-25A S8
200 kPa
Void Ratio, e
1.36
1.34
1.32
1.30
1.28
1.26
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

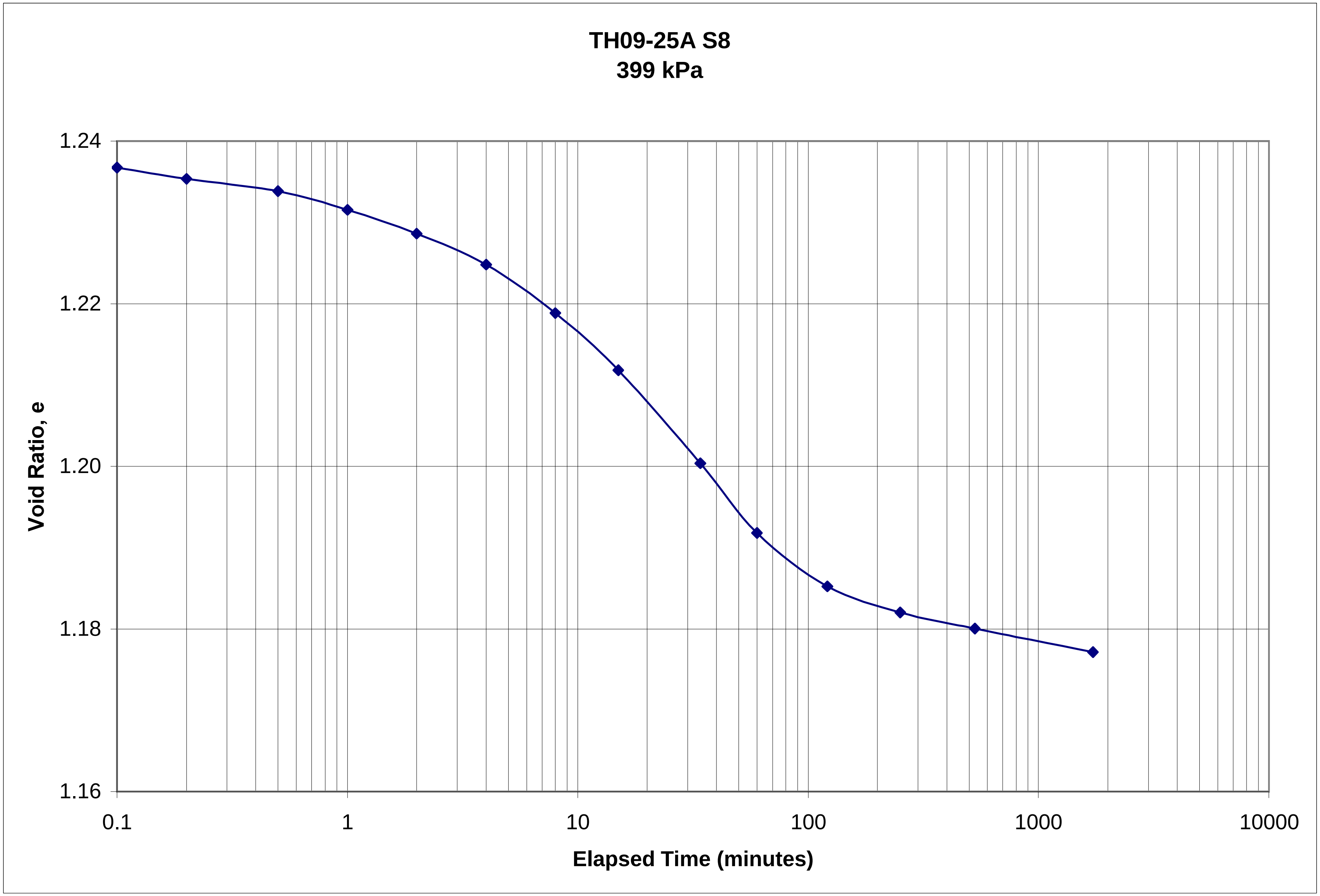

TH09-25A S8
399 kPa
1.28
1.24
1.20
1.16
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

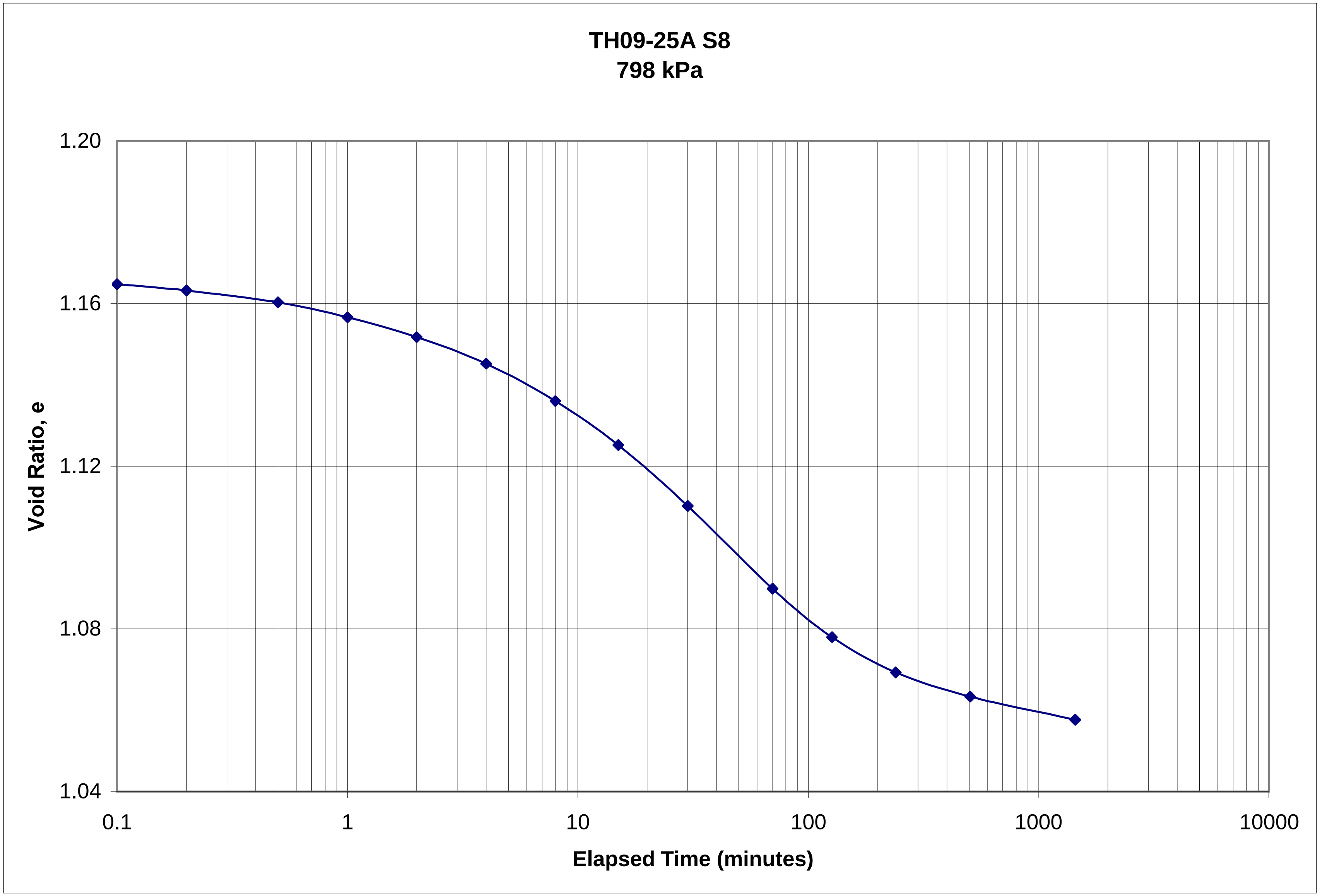


TH09-25A S8
200 kPa
Void Ratio, e
1.23
1.22
1.21
1.20
1.19
1.18
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

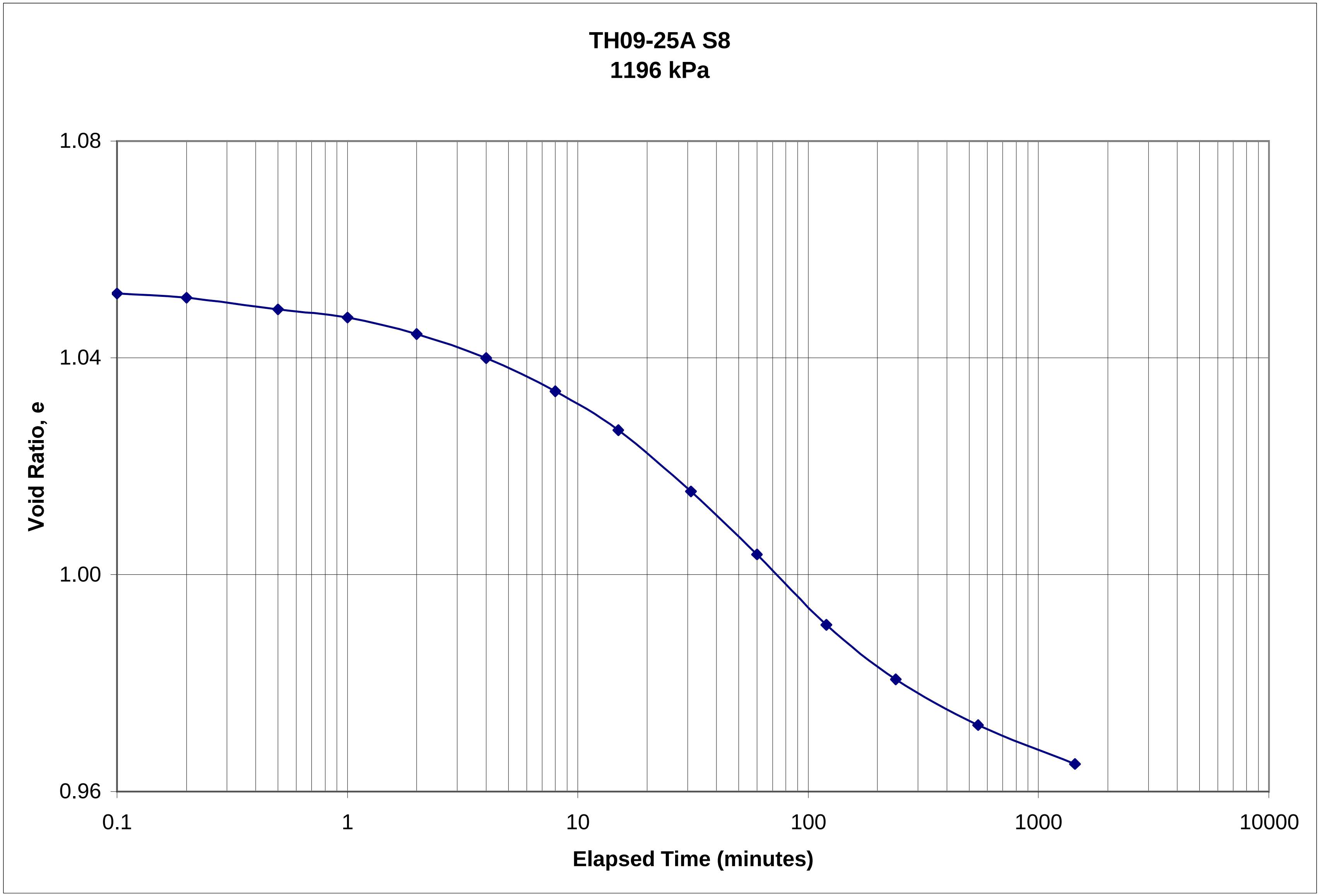

TH09-25A S8
100 kPa
Void Ratio, e
1.28
1.26
1.24
1.22
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S8
200 kPa
Void Ratio, e
1.28
1.27
1.26
1.25
1.24
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

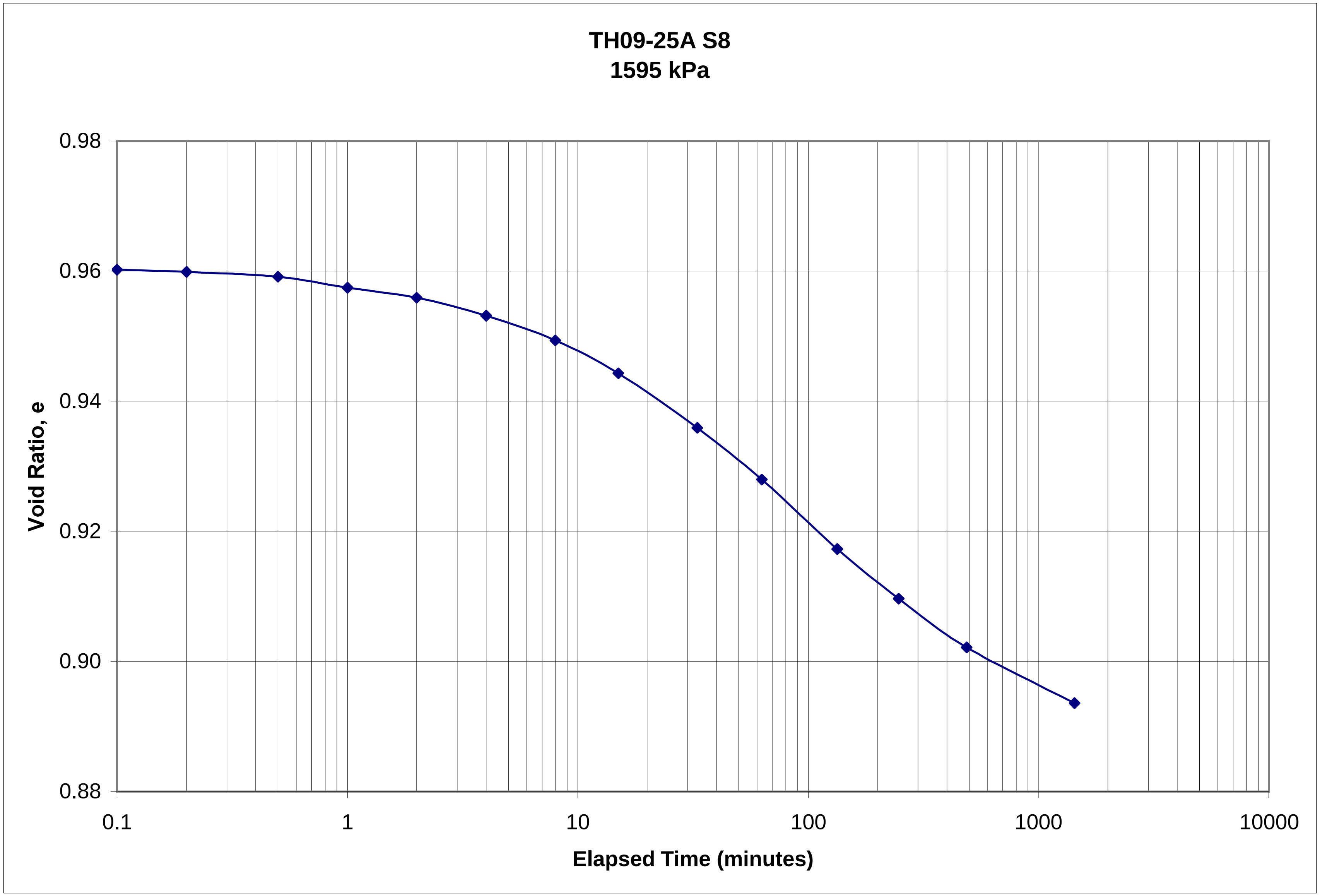

TH09-25A S8
399 kPa
Void Ratio, e
1.24
1.22
1.20
1.18
1.16
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



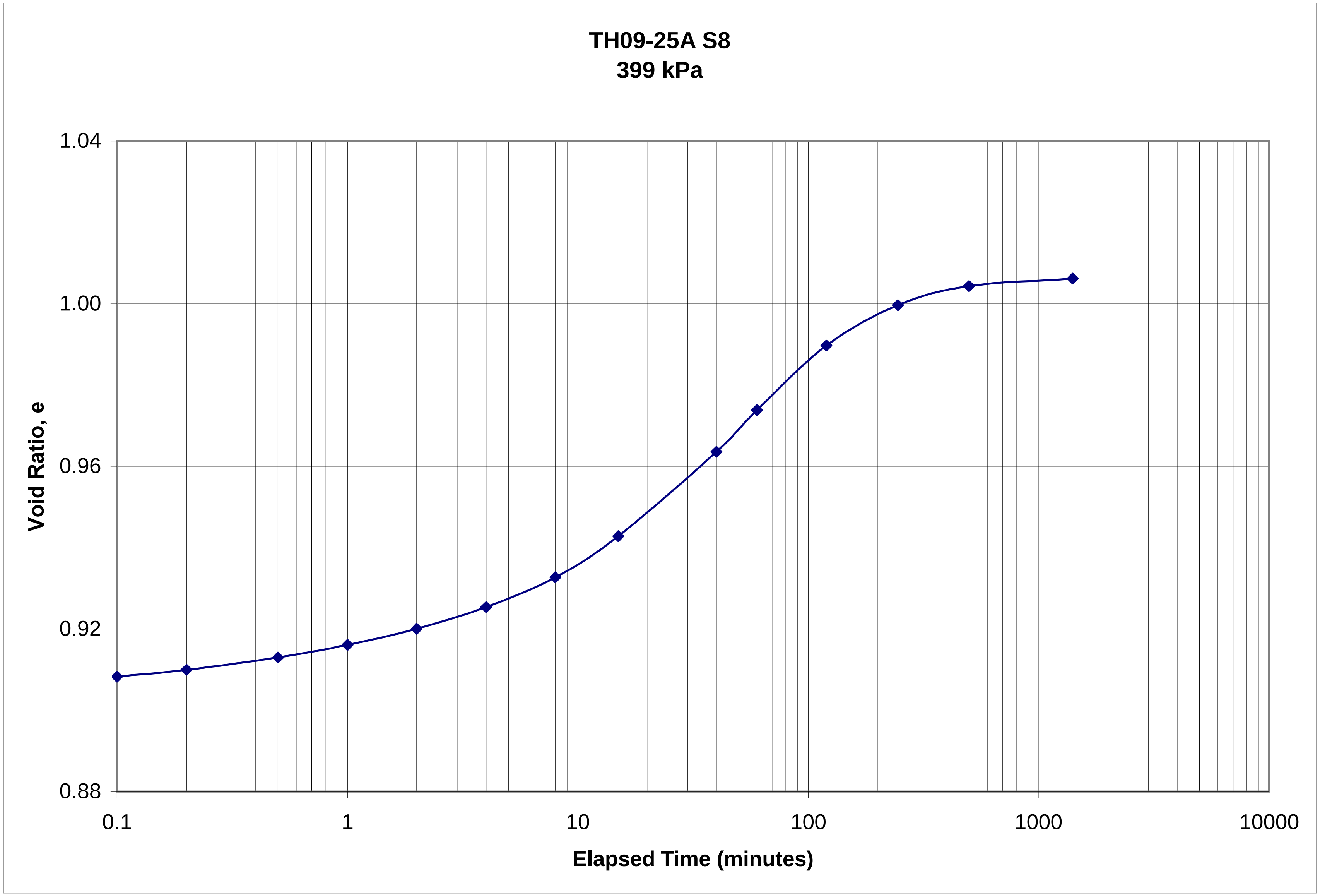
TH09-25A S8
798 kPa
Void Ratio, e
1.20
1.16
1.12
1.08
1.04
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



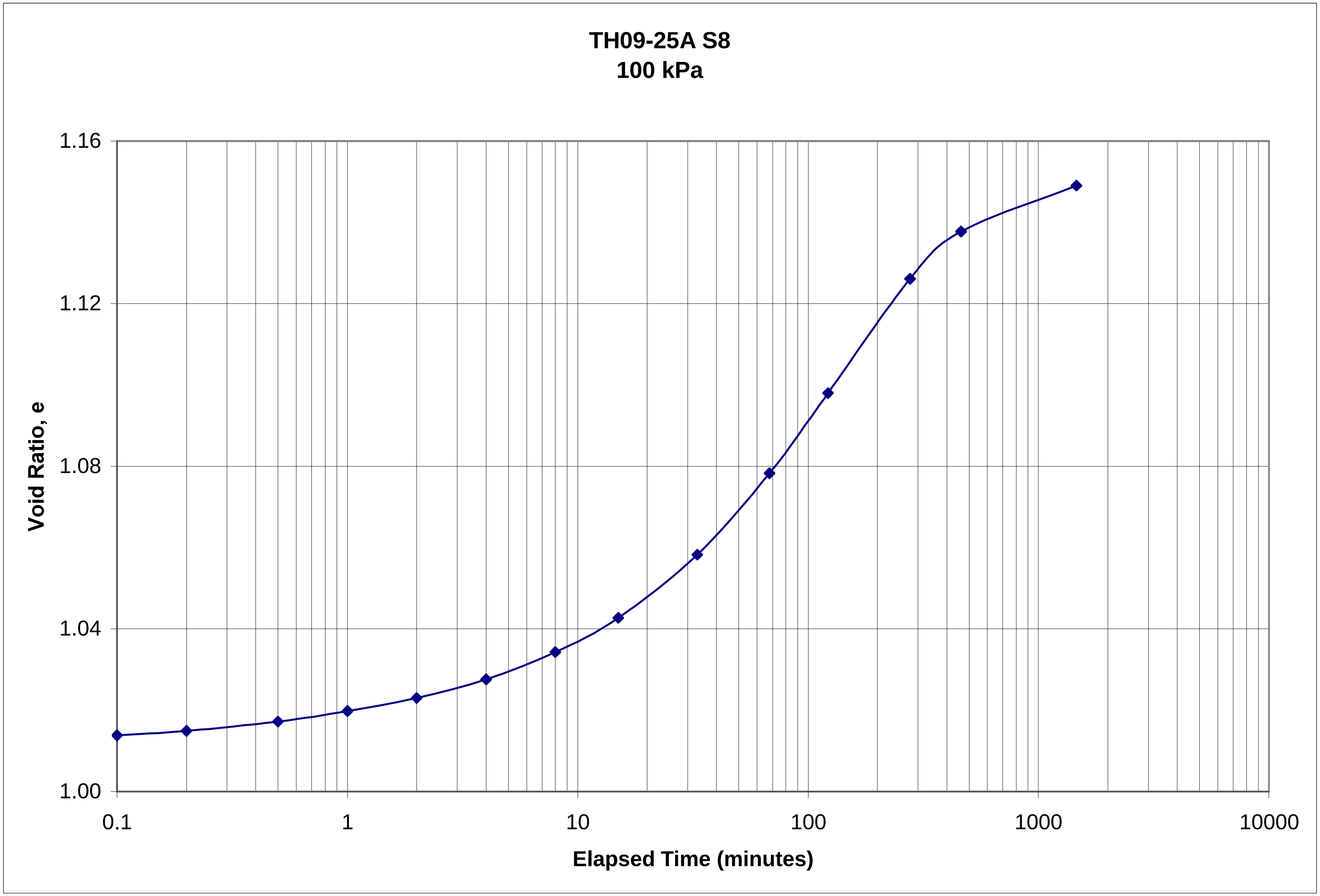
TH09-25A S8
1196 kPa
1.08
1.04
1.00
0.96
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

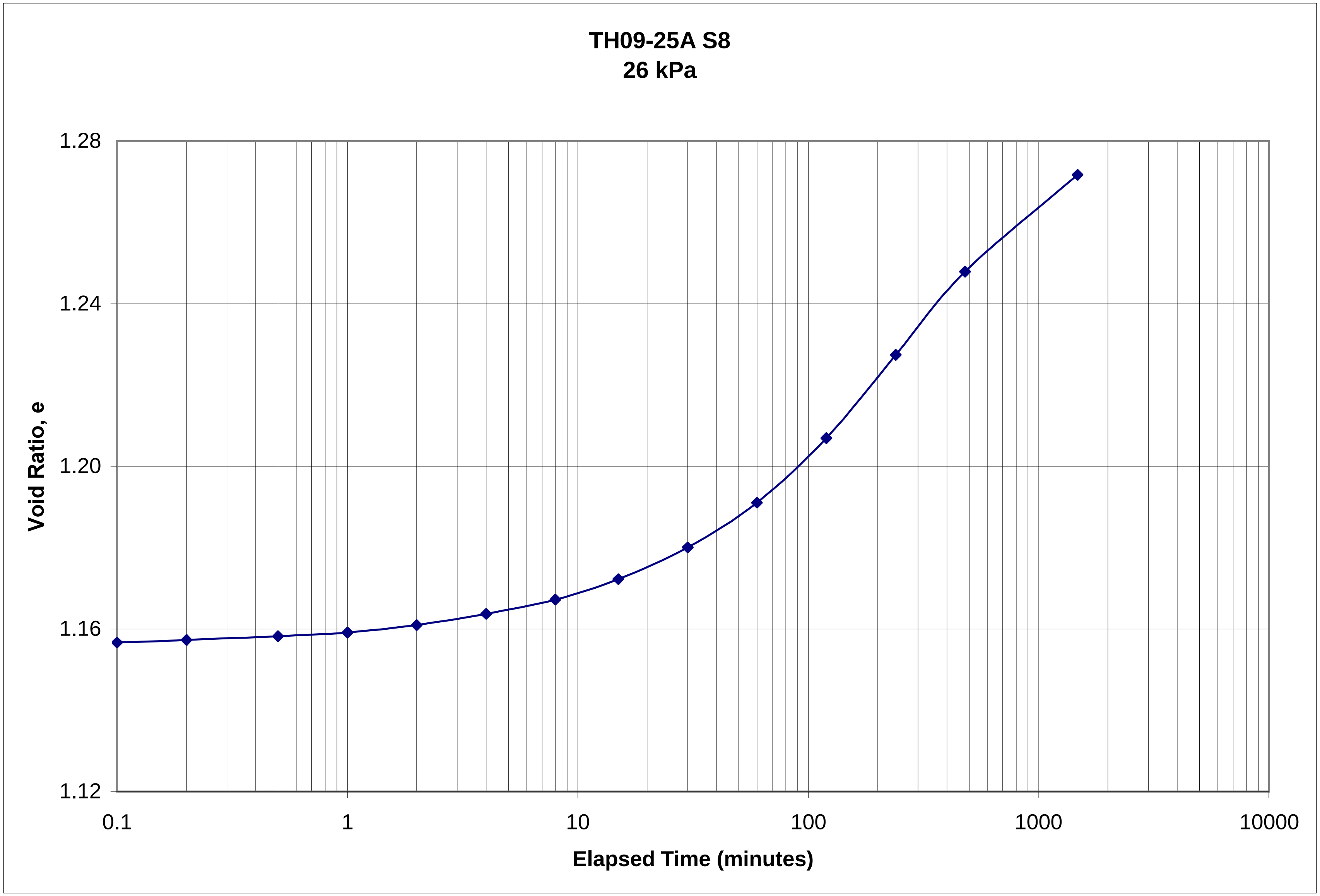


TH09-25A S8
1595 kPa
Void Ratio, e
0.98
0.96
0.94
0.92
0.90
0.88
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



TH09-25A S8
399 kPa
Void Ratio, e
1.04
1.00
0.96
0.92
0.88
0.1
1
10
100
1000
10000
Elapsed Time (minutes)


TH09-25A S8
100 kPa
1.16
1.12
1.08
1.04
1.00
Void Ratio, e
0.1
1
10
100
1000
10000
Elapsed Time (minutes)



TH09-25A S8
26 kPa
Void Ratio, e
1.28
1.24
1.20
1.16
1.12
0.1
1
10
100
1000
10000
Elapsed Time (minutes)

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

237 St. Georges Ave.
North Vancouver, B.C.
V7L 4T4

604 987 3037

Table of Contents

Illustrations

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.

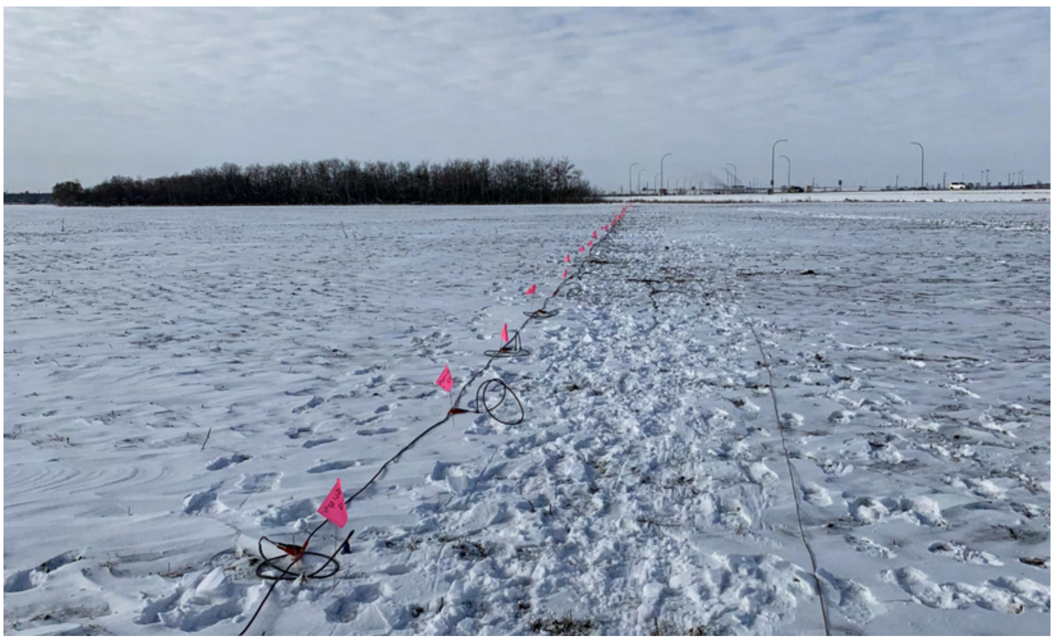
2.3 Interpretive Method

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.Geo.

PROVINCE OF MANITOBA
C.M. GUGINS
Member
46920G
REGISTERED PROFESSIONAL GEOSCIENTIST

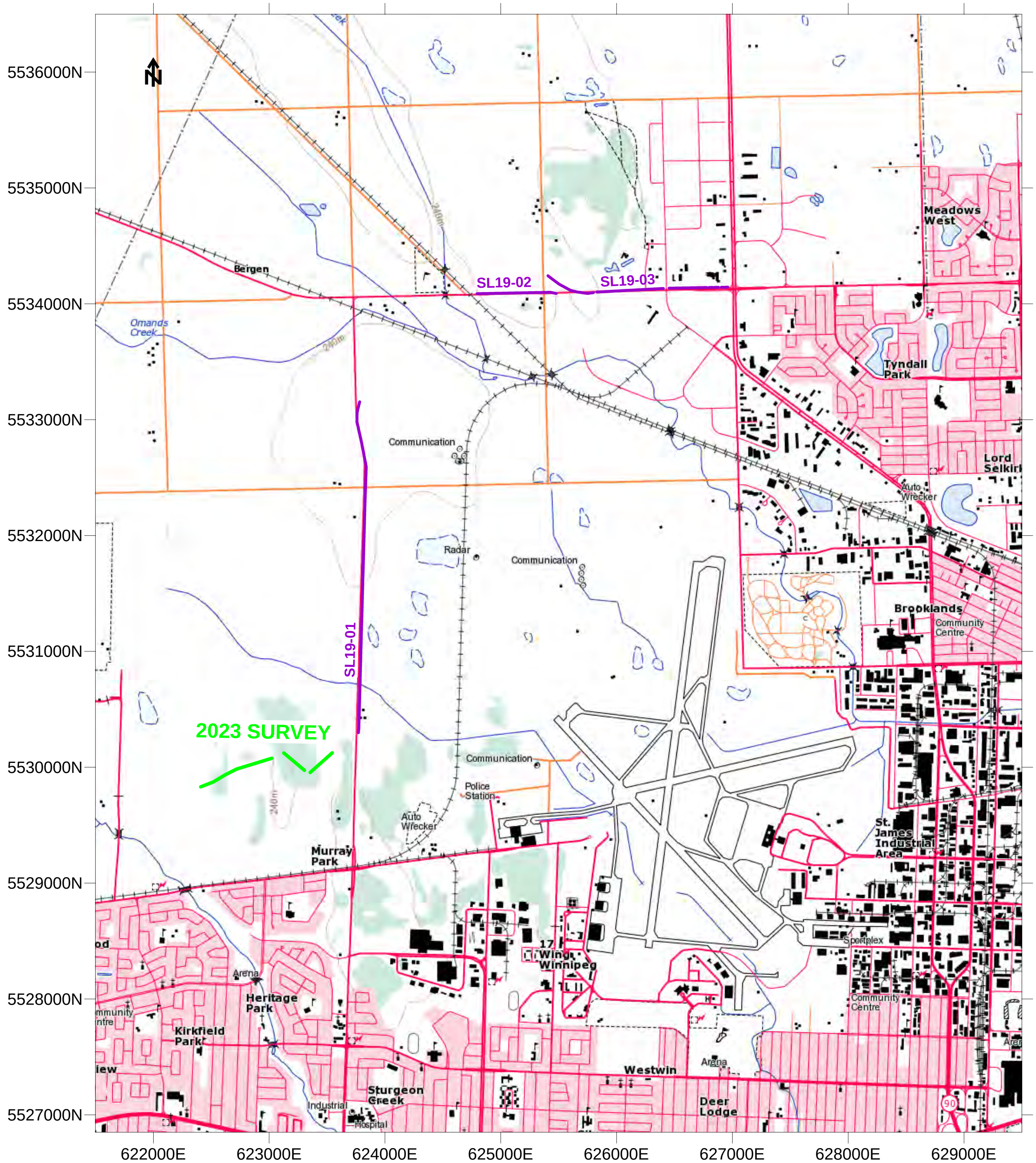
Jan. 25, 2024

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



0 500 1000 1500 2000

METRES

NATURAL RESOURCES CANADA
TOPORAMA MAPSHEET 62H14
UTM NAD83 ZONE 14

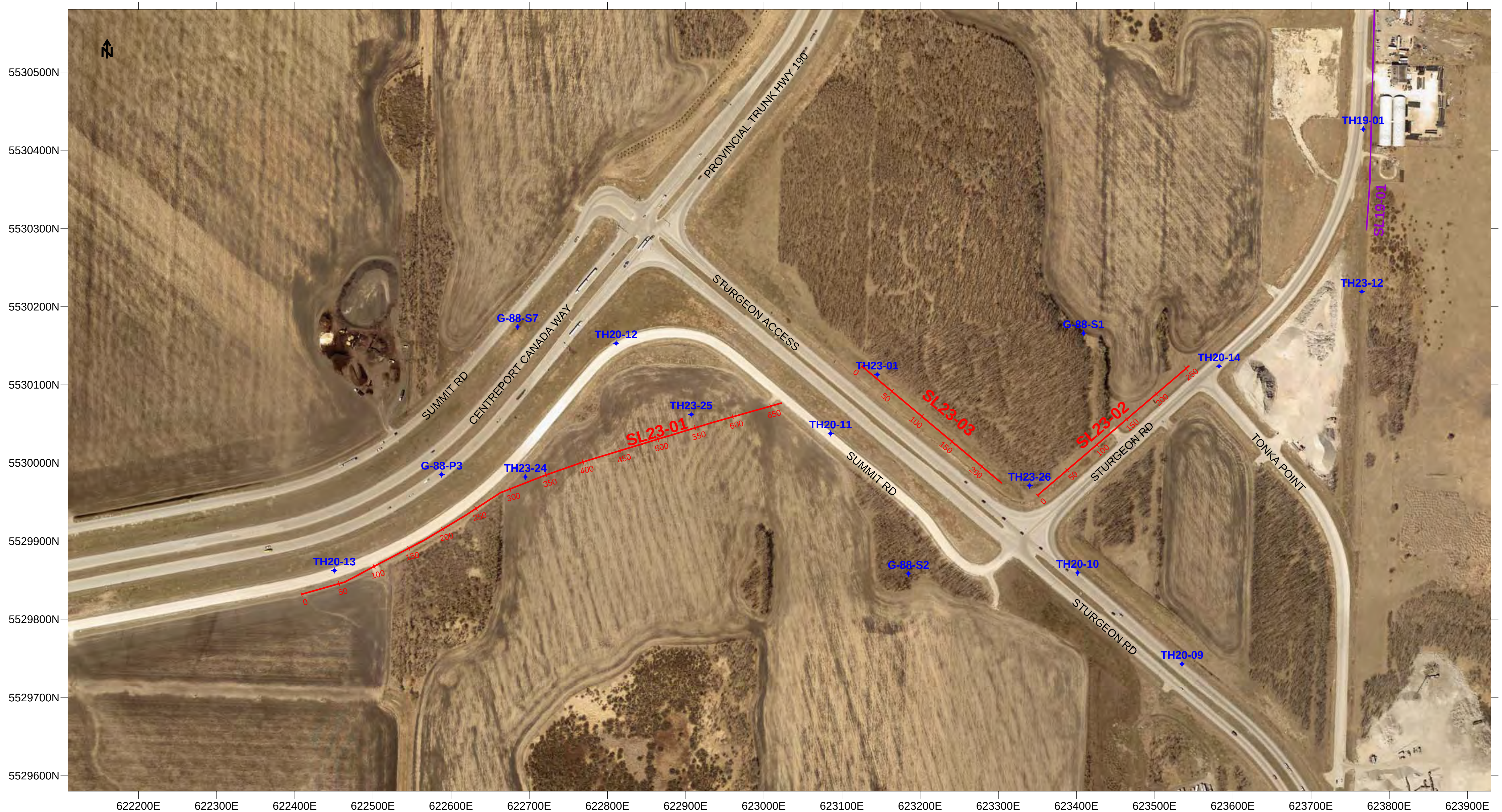
KGS GROUP
CENTREPORT REGIONAL S&W SERVICING
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

SURVEY LOCATION PLAN

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:50,000	FIG. 1



2023 SEISMIC REFRACTION LINE

2019 SEISMIC REFRACTION LINE

TESTHOLE

0 50 100 150 200

METRES

CITY OF WINNIPEG IMAGERY
UTM ZONE 14 NAD83

KGS GROUP
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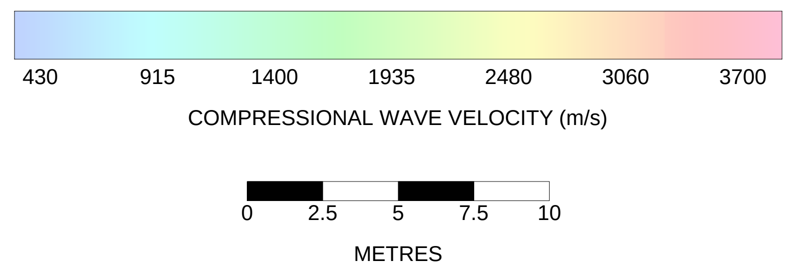
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

SITE PLAN

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:5,000	FIG. 2



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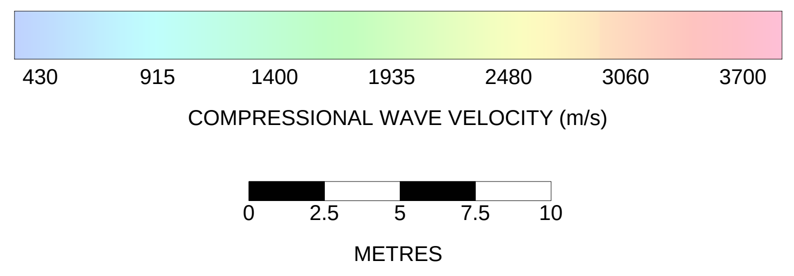
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION DEPTH SECTION
SL23-01A

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 3



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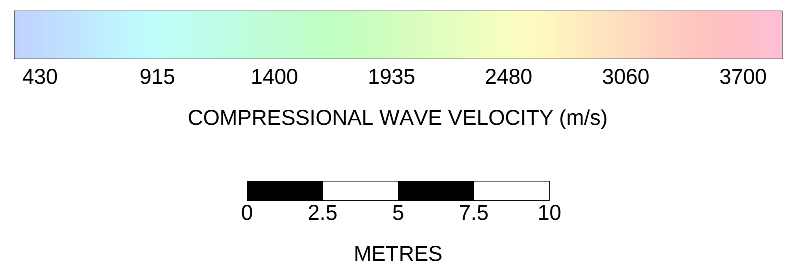
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-01B

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 4



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WINNIPEG, MB

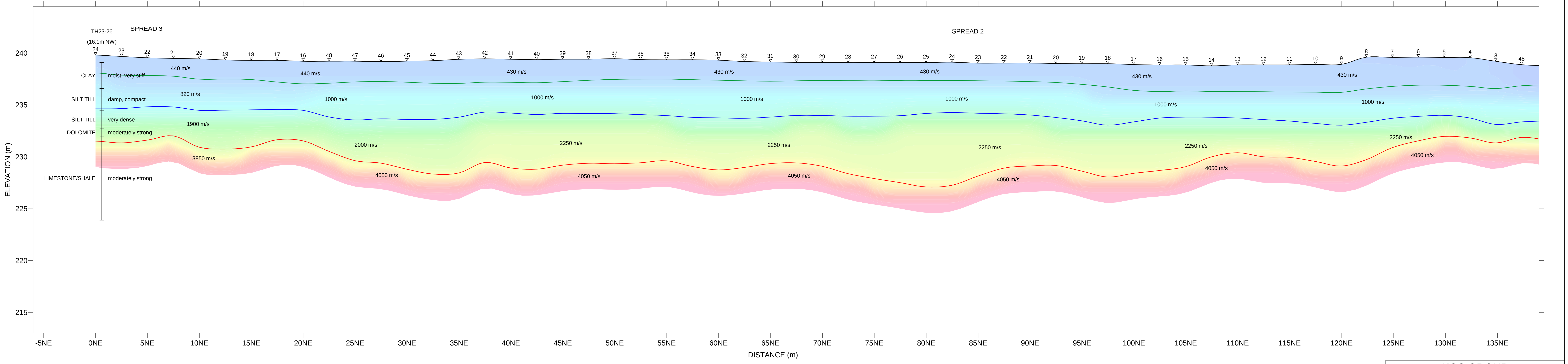
SEISMIC REFRACTION SURVEY

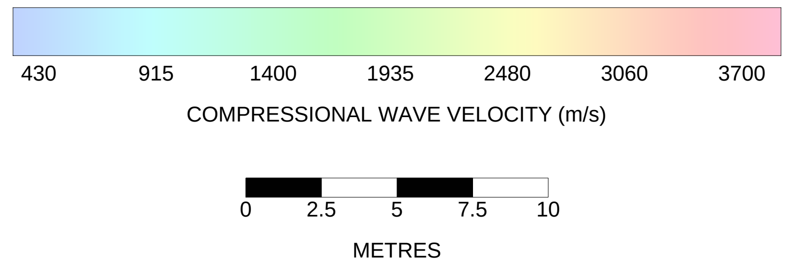
INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-01C

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 5

SPREAD 5
TH23-25
(17.8m)
SPREAD 6
TOPSOIL damp
CLAY damp, very stiff
SILT TILL moist, compact
SILT TILL wet, dense
LIMESTONE/SHALE moderately strong
370 m/s
870 m/s
1950 m/s
3750 m/s
3950 m/s
360 m/s
900 m/s
2000 m/s
3900 m/s
ELEVATION (m)
240
235
230
225
220
215
495NE
500NE
505NE
510NE
515NE
520NE
525NE
530NE
535NE
540NE
545NE
550NE
555NE
560NE
565NE
570NE
575NE
580NE
585NE
590NE
595NE
600NE
605NE
610NE
615NE
620NE
625NE
630NE
635NE
640NE
645NE
650NE
655NE
660NE
665NE
DISTANCE (m)
430 915 1400 1935 2480 3060 3700
COMPRESSIONAL WAVE VELOCITY (m/s)
0 2.5 5 7.5 10
METRES
KGS GROUP
CENTREPORT REGIONAL S&W SERVICING
WINNIPEG, MB
SEISMIC REFRACTION SURVEY
INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-01D
FRONTIER GEOSCIENCES INC.
DATE: NOV. 2023
SCALE 1:250
FIG. 6





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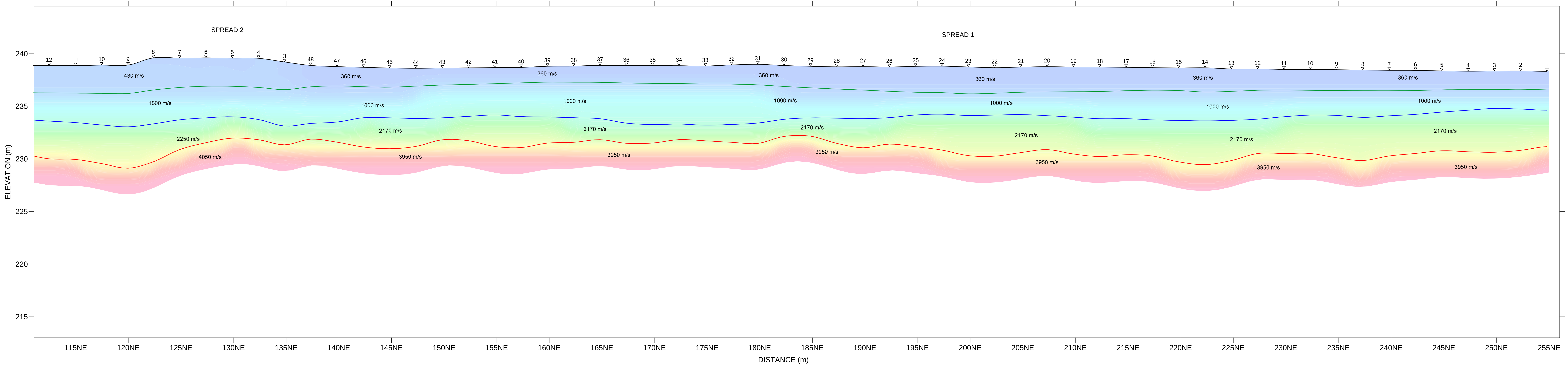
WINNIPEG, MB

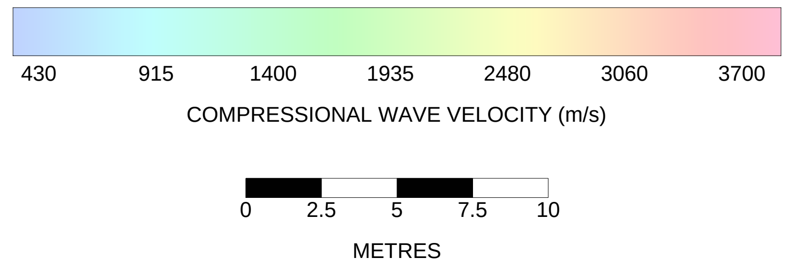
SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-02A

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 7





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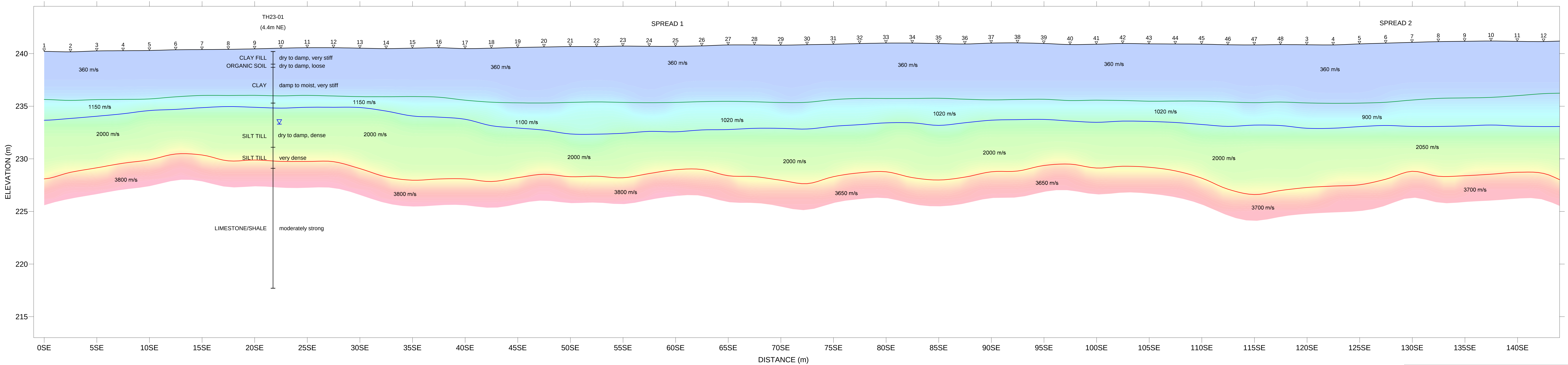
CENTREPORT REGIONAL S&W SERVICING
WINNIPEG, MB

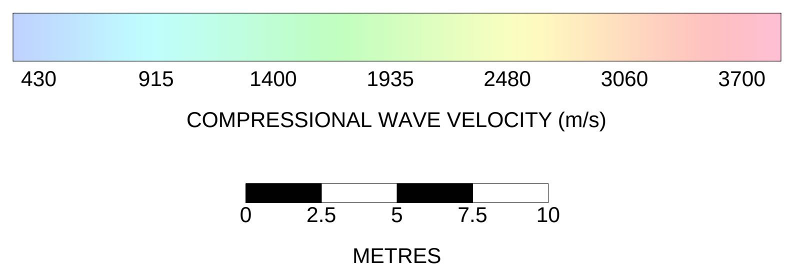
SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-02B

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 8





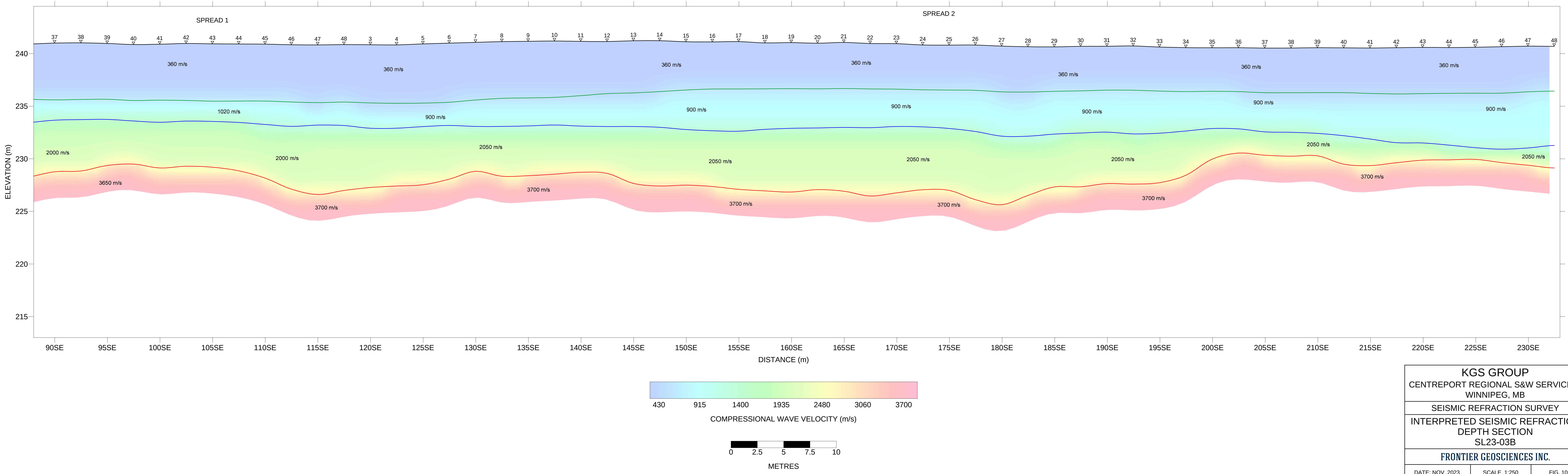
KGS GROUP
CENTREPORT REGIONAL S&W SERVICING
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-03A

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 9



KGS GROUP
CENTREPORT REGIONAL S&W SERVICING
WINNIPEG, MB

SEISMIC REFRACTION SURVEY

INTERPRETED SEISMIC REFRACTION
DEPTH SECTION
SL23-03B

FRONTIER GEOSCIENCES INC.

DATE: NOV. 2023	SCALE 1:250	FIG. 10

APPENDIX G

2023 KGS Group Hydrogeological Assessment Memo

Memorandum

To:	**Ray Offman** Municipal Department Head KGS Group	**Date:**	March 7, 2024
		Project No.:	23-0107-009
From:	**Paul Lindell, B.Sc., P.Eng.** KGS Group **Simratpal Singh, M.Sc. EIT** KGS Group	**Cc:**	**Dami Adedapo, Ph.D., P.Eng.** Principal & Geotechnical Department Head **Kelly Fordyce, B.Sc., P.Eng.** Geotechnical Engineer, KGS Group **Jason Mann, M.Sc., P.Geo., FGC** Principal, KGS Group
Re:	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 (the "Site") to understand the bedrock aquifer conditions for the deep shaft excavations that will be required for construction.

An observation well TH23-01 was installed at the Site on September 28, 2023, to a total depth of 22.5 m below ground surface (bgs) using a GeoProbe 3230 track mounted drill rig. At this location, a 2-inch standpipe piezometer was installed within the bedrock, along with a vibrating wire piezometer (SN# VW171370) installed at an elevation of 231.7 m above sea level (asl) within the silt till.

A 0.13 m (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. The PVC well casing was installed through the overburden soil into the bedrock until competent bedrock was encountered. The bottom of PVC casing was installed at 12.5 m bgs with an open hole drilled in the limestone bedrock from 12.5 m to 22.3 m bgs. The preliminary yield testing on this well resulted in a calculated specific capacity of less than 1 USgpm, which was low, and therefore a second pumping well (PW23-02) was installed closer to TH23-01 on November 17, 2023. Pumping Well, PW23-01 was used as an additional observation well during the pumping test at PW23-02.

PW23-02 was installed approximately 35 m southwest of PW23-01, and with similar depth specifications and well makeup as PW23-01. The specific capacity of this well was calculated at 5 USgpm. The geographical location of each of these wells is 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 ϕ PVC	12.9	22.3	623136	5530157
PW23-02	5-inch ϕ PVC	11.7	22.3	623154	5530127
TH23-01	2-inch ϕ PVC	21.4	22.5	623145	5530113

4.2.2. Aquifer Monitoring and Aquifer Testing

A 2-hour pumping test was conducted at 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 0.08 m (3-inch) diameter submersible pump was installed in PW23-02 at a depth of 10.9 m below grade. Power was supplied by an on-site portable generator. The 2-hour pumping test commenced on November 20, 2023, at 15:00 and was completed at 17:00. 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 1.7 m was achieved within the first 26 minutes of pumping. The pumping rate was then increased to 10 USgpm to test and monitor the well response. The increased pumping rate (10 USgpm) lowered the groundwater elevation close to the pump elevation within approximately 10 minutes of pumping at this rate, so pumping rate was then adjusted to 8 USgpm and a stabilized drawdown of 5.3 m was achieved for the remaining duration of the pumping test.

Water levels in TH23-01 and PW23-01 were monitored during the pumping test at PW23-02 using Heron DipperLog non-vented M30/F100 and M10/F30 automatic data logging pressure transducers, respectively, to record how the aquifer responds 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. The transducers and the barologger were installed in the respective wells at least one hour prior to the start of pumping to collect the static water level and barometric pressure 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.

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 above 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 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. Since, pumping was being carried out in the limestone bedrock, this suggests that a hydraulic disconnect exists between the silt till and the deeper bedrock aquifer 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 ID	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	-	6.07	233.42	5.57
TH23-01	Standpipe	21.40	Bedrock	~ 13	7.93	233.15	0.08
TH23-01	Vibrating wire	9.10	Silt Till	~ 13	7.84	233.28	None
PW23-01	Standpipe	12.95	Bedrock	~ 35	9.07	230.28	None

Note: The GW Elevations were calculated using the ground elevations from the Lidar elevation 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^2/day)	Storativity
PW23-02	Residual Drawdown vs Elapsed Time	Cooper-Jacob (1946)	1.47	-
PW23-02 and TH23-01	Distance-Drawdown	Cooper-Jacob (1946)	2.90	0.0032
Average Transmissivity (m^2/day)			2.18	

In general, the aquifer was inferred to have an approximate transmissivity of 2.18 m^2/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 was 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 calculated to be approximately 0.003.

Drawdown versus time for the pumping well PW23-02 is shown as Figure 4.2.3. 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 resulting in a stabilized drawdown of 5.3 m for the remaining 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 4.2.5) that the maximum drawdown at this well location was 0.08 m. It can be estimated 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.

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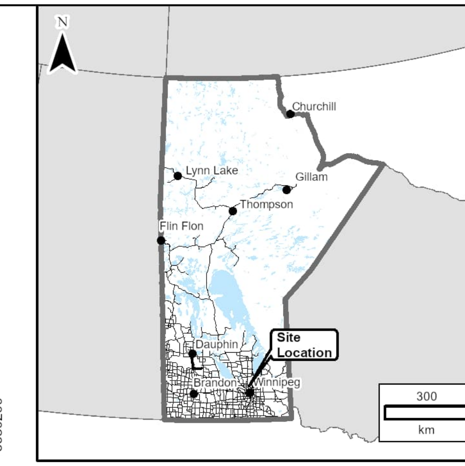
SPS/PJL/jdm/jr
Attachments

FIGURES



LEGEND:

PW23-01 (238.77 m) Centreport Hole Locations (Ground Elevation)

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.

10 0 10 20 30
Metres

SCALE: 1:750 METRIC 11"x17"

NO	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	24/03/07	ISSUED WITH FINAL MEMO	SPS	PJL

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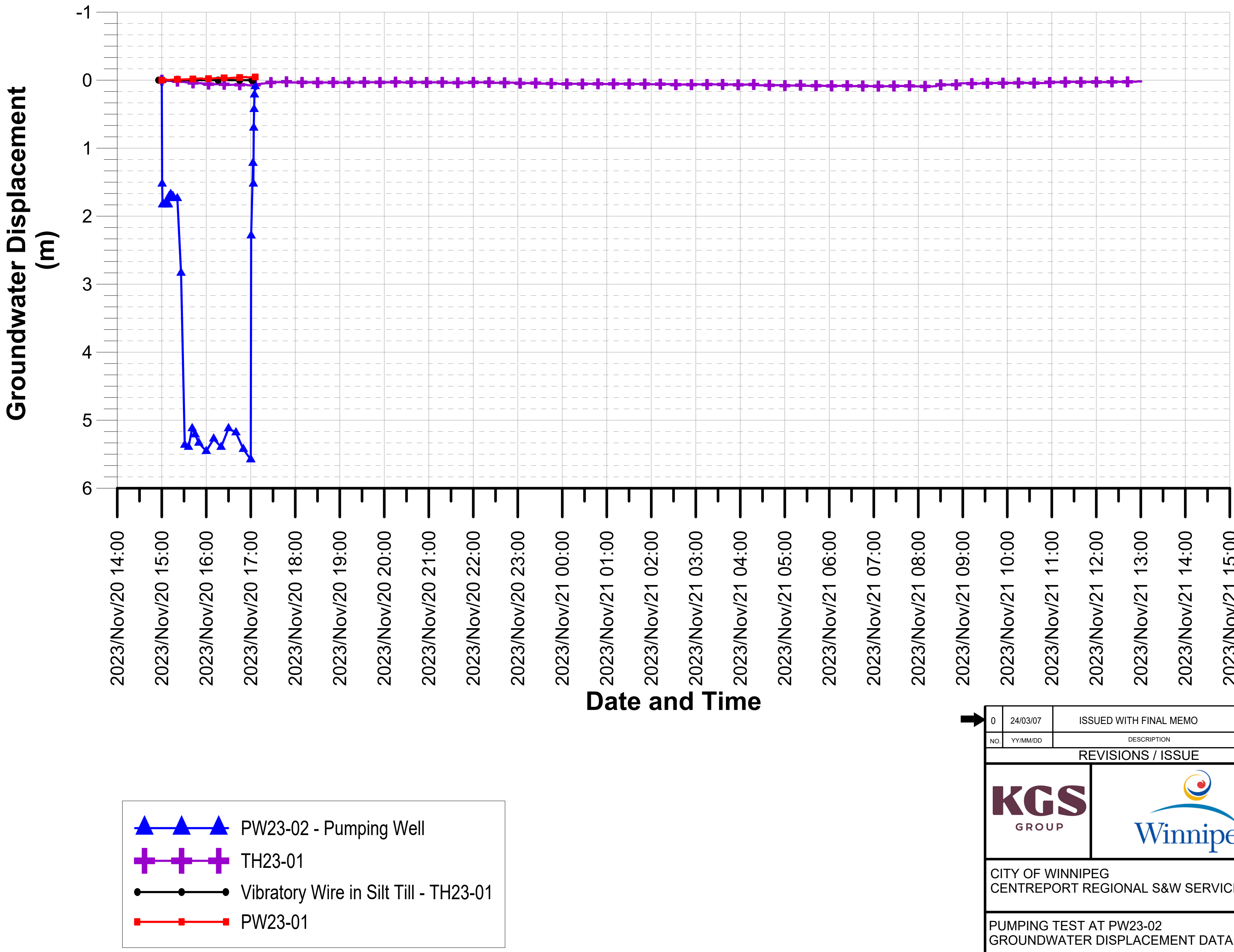
CITY OF WINNIPEG
CENTREPORT REGIONAL S&W SERVICING

CENTREPORT PUMPING TEST AT PW23-02

MARCH 2024 FIGURE 4.2.1 REV: 0

FileName: R:\Projects\2023\23-0107-009\Design\GIS\Data\ArcPro\Centreport_Elevations\Centreport_Elevations.aprx 23-0107-009_Fig01
11"x17" PLOT SCALE 1:1



NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	24/03/07	ISSUED WITH FINAL MEMO	SPS	PJL

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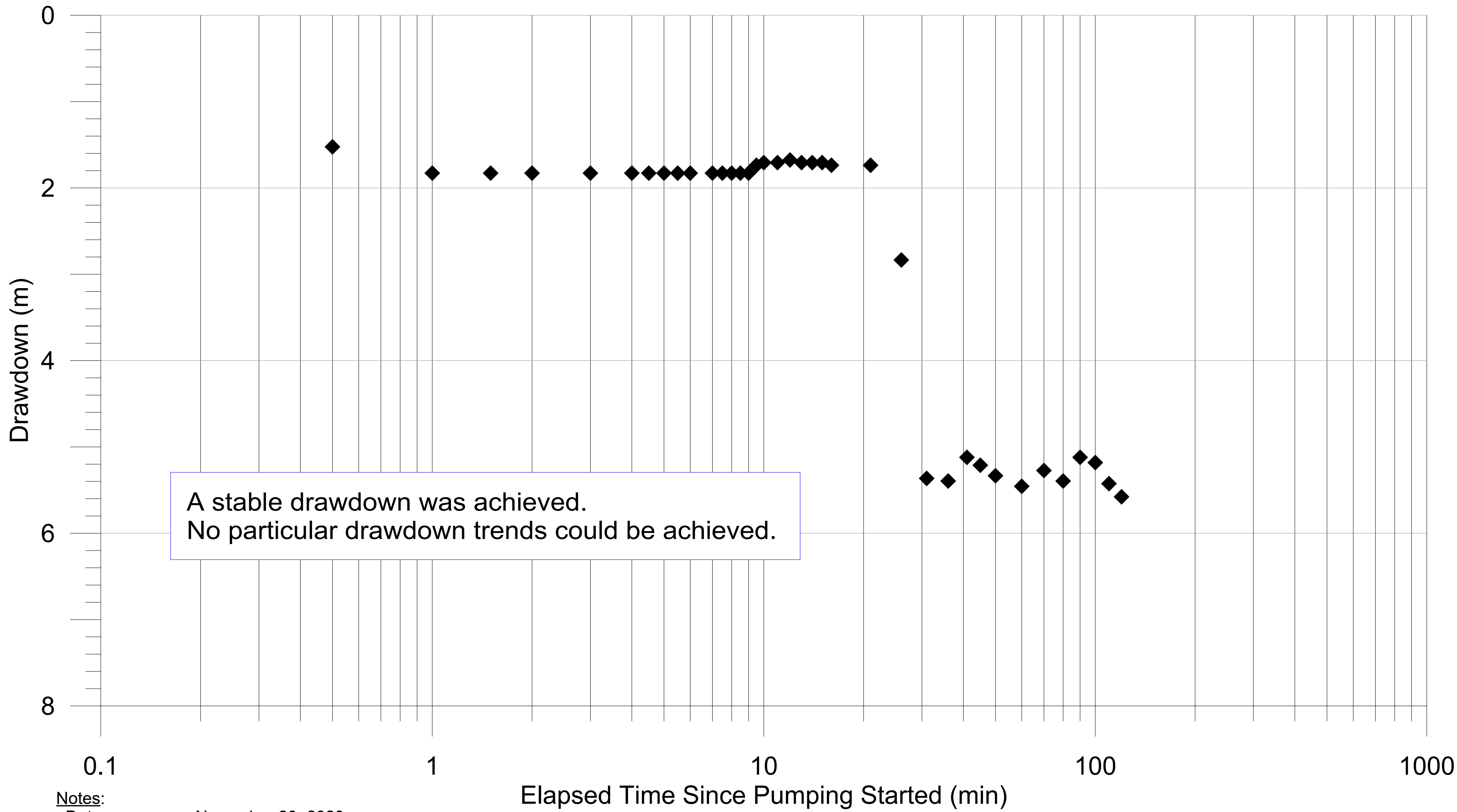
CITY OF WINNIPEG
CENTREPORT REGIONAL S&W SERVICING

PUMPING TEST AT PW23-02
GROUNDWATER DISPLACEMENT DATA

MARCH 2024 | FIGURE 4.2.2 | REV: 0



<u>Notes</u>:

Date:	November 20, 2023
Pumping Well:	PW23-02
Observation:	PW23-02
Drawdown:	5.57 m
Pump Rate (Q):	27.2 - 43.6 m³/day (5 - 8 USgpm)

Transmissivity calculations were not carried using this data.

NO.	YY/MM/DD	DESCRIPTION	Design By	Design Check
0	24/03/07	ISSUED WITH FINAL MEMO	SPS	PJL

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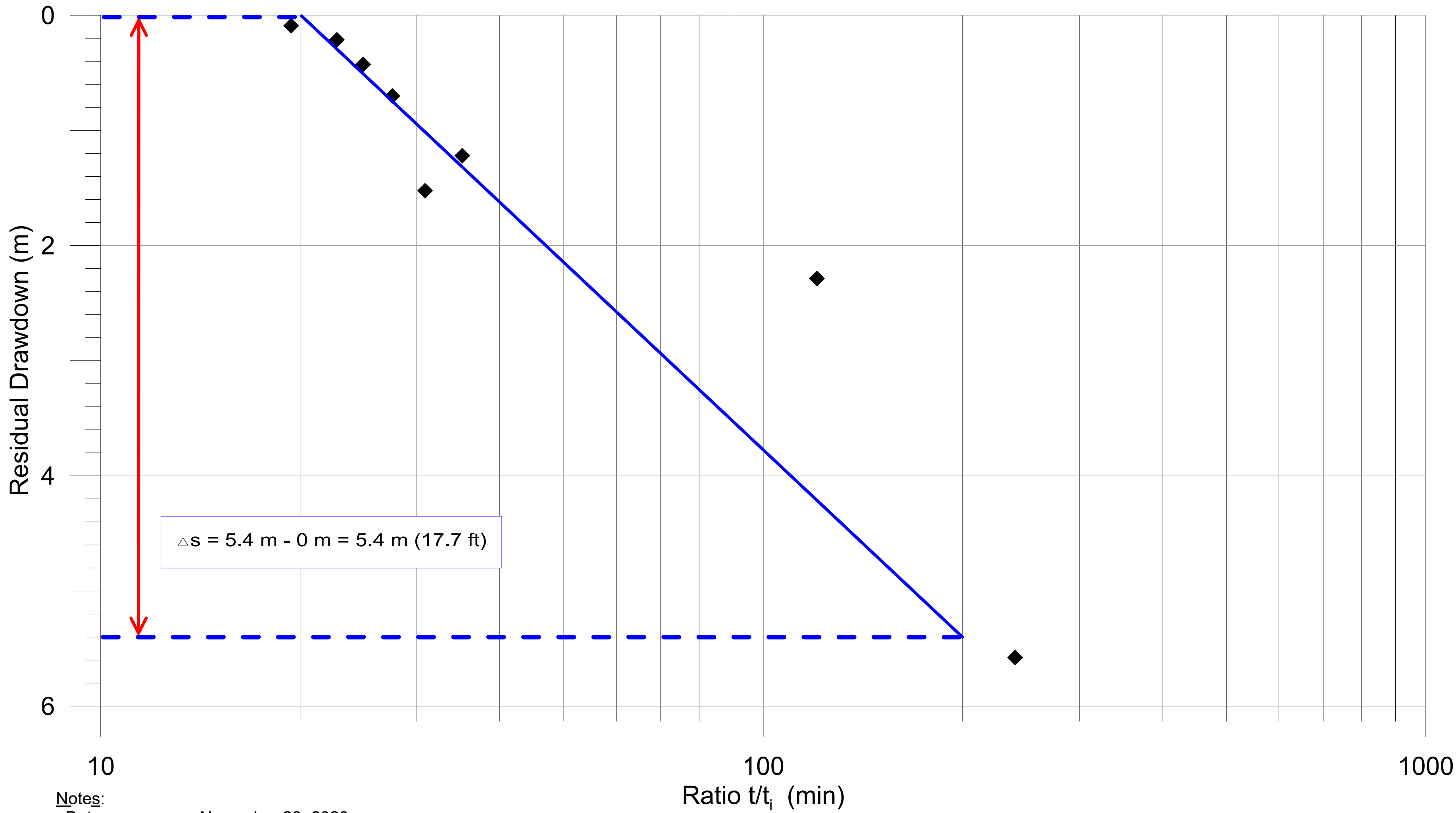
CITY OF WINNIPEG
CENTREPORT REGIONAL S&W SERVICING

PUMPING AT PW23-02
TIME VS DRAWDOWN
OBSERVATION AT PW23-02

MARCH 2024 | FIGURE 4.2.3 | REV: 0



Notes:
Date: November 20, 2023
Pumping Well: PW23-02
Observation: PW23-02
Drawdown: 5.57 m
Pump Rate (Q): 43.6 m³/day (8 USgpm)

Transmissivity

T = (0.183)(Q)/△s   Q = 43.6 m^3/day (8 USgpm)

△s = 5.4 m (17.7 ft)   **T = 1.47 m^2/day (118.9 gpd/ft)**

◆ TH21-03-Manual

NO.	YY/MM/DD	DESCRIPTION	Design By	Design Check
0	24/03/07	ISSUED WITH FINAL MEMO	SPS	PJL

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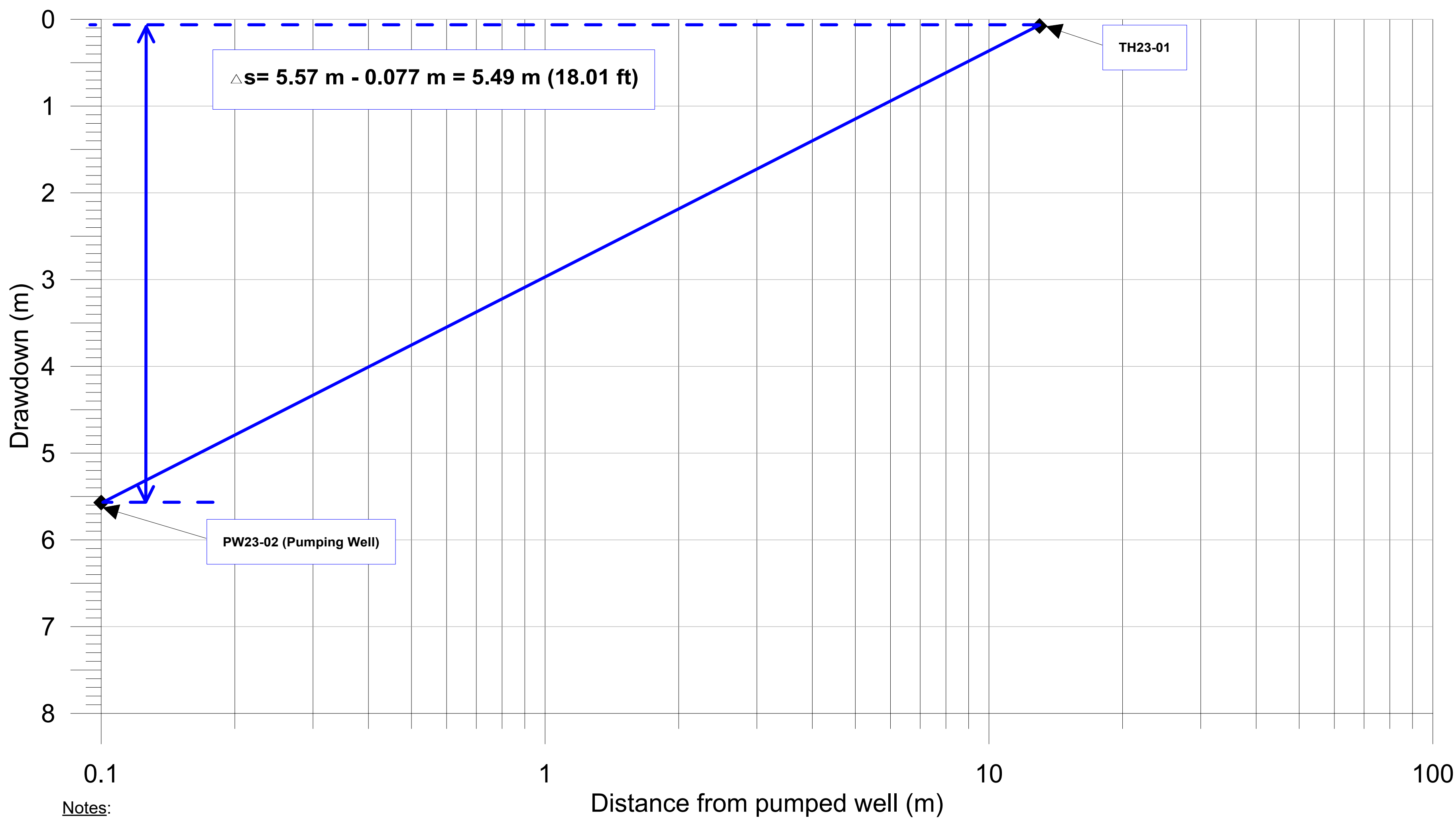
CITY OF WINNIPEG
CENTREPORT REGIONAL S&W SERVICING

PUMPING AT PW23-02
RESIDUAL DRAWDOWN -
OBSERVATION AT PW23-02

MARCH 2024 | FIGURE 4.2.4 | REV: 0



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^3/day (8 USgpm)

Transmissivity

$T = (0.366)(Q)/\triangle s$ 　 $Q = 43.6\ m^3/day$ (8 USgpm)

$\triangle s = 5.49$ m 　 **T = 2.9 m^2/day (241 gpd/ft)**

Storativity

$S = 2.25Tt/r_o^2$

T = 2.9 m^2/day
r_o = 13 m
t = 0.083 days (120 min)

S = 0.0032

◆ Drawdown

UTM collected with hand-held GPS
(horizontal accuracy +/- 4m)

NO.	YY/MM/DD	DESCRIPTION	Design By	Design Check
0	24/03/07	ISSUED WITH FINAL MEMO	SPS	PJL

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CITY OF WINNIPEG
CENTREPORT REGIONAL S&W SERVICING

PUMPING TEST AT PW23-02
DISTANCE DRAWDOWN

MARCH 2024 | FIGURE 4.2.5 | REV: 0

APPENDIX A

Borehole Logs

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-01**

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.20 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.91 m / 241.12 m (Standpipe)
DESCRIPTION	Southwest corner of lift station	**START DATE**	9-28-2023
DRILL RIG / HAMMER	GeoProbe 3230 Track Mounted Drill Rig with Auto-Hammer	**UTM (m)**	N 5,530,113
METHOD(S)	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		E 623,145 Zone 14

ELEV (m)	DESCRIPTION AND CLASSIFICATION
	CLAY FILL - 1219 mm, Grey and black, dry to damp, very stiff, trace to some organics.
239.0	**ORGANIC SOIL** - 305 mm, Black, dry to damp, loose, trace wood, organics.
238.7	**CLAY (CH)** - Black, damp to moist, very stiff, high plasticity, trace organics. - Brown to grey, trace to some gypsum and silt pockets below 2.0 m. - Stiff below 4.1 m. - LL=66, PL=21, PI=45 at 4.3 m.
235.3	**SILT TILL (ML)** - Light grey, dry to damp, dense, with coarse grained sand, trace gravel, some clay. - PSA: 7% gravel, 34% sand, 45% silt, 14% clay at 5.8 m. - Light brown to grey below 6.1 m. - Very dense below 9.1 m. - Hard drilling/grinding below 10.0 m. - Grey and black boulders and cobbles, trace to some weathered limestone in sampler from 10.1 m to 11.1 m.
229.1	**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.

Log of installs: Vibrating Wire VW171370 at 8.53 m; 9.40; 10.46

NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE	qu POCKET PEN (kPa)
S1					350
S2					
S3					300
S4					275, 250, 250
S5					225
S6					
S7	100		9 14 21	35	
S8					
S9	100		14 19 19	38	
S10					
S11	55		49 50/ 100mm	+100	>>
R1	32				
R2	97	78			

PL — MC — LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

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

KGS GROUP

TEST HOLE LOG

HOLE NO. **TH23-01**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	LOG OF INSTALLS DEPTH (m)	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
228		40	- Good quality from 11.2 m to 12.6 m. - ~30 mm soft shale/clay seam at 12.1 m.					(10)
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	45	- Decreased shale/clay content from 13.1 m to 14.3 m. - Broken/Fractured core zone infilled with soft reddish-purple shale/clay at 13.9 m. - ~125 mm Fractured zone infilled with soft shale/clay, very weak at 14.3 m.			R4	92	65 (15)
225	15.0	50	- 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	55	- UCS: 17.6 MPa at 16.9 m.					
222	18.0	60				R6	93	40 (18)
221	19.0					R7	93	64 (16)
220	20.0	65	- Fair quality below 20.3 m.					
219	21.0	70	- 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.		21.44	R8	100	65 (14)
218	22.0			217.7	22.50	R9	93	70 (3)
217	23.0	75						
216	24.0	80						
215	25.0							
214	26.0	85						

Other columns: GRAPHICS, WATER LEVEL, DIAGRAM, SAMPLE TYPE, 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).

Notes:
1. End of test hole at 22.5 m.
2. Refusal encountered on suspected boulder at a depth of 9.1 m.
3. Protective well cover installed at surface.
4. 50.8 mm or two (2) inches diameter standpipe installed.
5. Vibrating wire piezometer (VW171370) installed at 8.53 m below grade.

WATER LEVELS
- ∇ **During Drilling/Digging** on 9-28-2023 None Encountered
- ▼ **Upon Completion** 6.71 m on 9-29-2023

CONTRACTOR	INSPECTOR
Maple Leaf Drilling Ltd.	**M. RODRIGUEZ**
APPROVED	DATE
K. FORDYCE	1-22-2024

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TEST HOLE LOG

HOLE NO. **PW23-01**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.11 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.61 m / 240.72 m (Standpipe)
DESCRIPTION	W side of lift station; 40m NNW of TH23-01	**START DATE**	11-14-2023
DRILL RIG / HAMMER	Canterra CT 250 Truck Mounted Drill Rig	**UTM (m)**	N 5,530,157
METHOD(S)	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		E 623,136 Zone 14

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	LOG OF INSTALLS: DIAGRAM	LOG OF INSTALLS: DEPTH (m)	SAMPLE TYPE	NUMBER	PL MC LL / Cu TORVANE (kPa) ◆ / qu POCKET PEN (kPa) ★ / SPT (N) BLOWS/0.30 m ▲ 20 40 60 80
240–237.1	0.0–3.0		**CLAY** - Grey and black, damp, very stiff, trace to some organics.							
237.1–232.2	3.0–7.9		**SILT TILL** - Greyish brown. - Limestone boulder from 4.8 m to 5.6 m.	237.1						
232.2–230.1	7.9–10.0		**WELL GRADED GRAVEL WITH SAND (GW)**.	232.2	▼					
230.1–227.6	10.0–12.5		**CALCAREOUS SHALE** - Red.	230.1			12.95			
227.6–217.9	12.5–22.3		**LIMESTONE**.	227.6			13.56 22.25			
			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.	217.9						

WATER LEVELS ▼ **Remeasured/Static** 9.07 m on 11-20-2023 Monitoring Well

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **L. MCALLISTER**
APPROVED K. FORDYCE	DATE 3-4-2024

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TEST HOLE LOG

HOLE NO. **PW23-02**

SHEET 1 of 1

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	240.11 m
LOCATION	Winnipeg, Manitoba	**TOC STICK-UP / ELEV.**	0.61 m / 240.72 m (Standpipe)
DESCRIPTION	S side of lift station; 16m NE of TH23-01	**START DATE**	11-17-2023
DRILL RIG / HAMMER	Canterra CT 250 Truck Mounted Drill Rig	**UTM (m)**	N 5,530,127
METHOD(S)	0.0 m to 11.7 m: Mud Rotary/Air Hammer 11.7 m to 12.3 m: Mud Rotary, 150 mm ø Tricone Bit - switched due to encountering bedrock 12.3 m to 22.3 m: Mud Rotary, 125 mm ø Tricone Bit		E 623,154 Zone 14

ELEVATION (m)	DEPTH (m)	DESCRIPTION AND CLASSIFICATION	ELEV (m)	INSTALL DEPTH (m)
240.11	0.0	**CLAY** - Grey and black, damp, stiff.		
	2.1	**SILT TILL** - Greyish brown, with boulders. - Limestone and granite boulders from 4.0 m to 4.7 m.	238.0	
	8.8	**CALCAREOUS SHALE** - Red. - Broken Purple Limestone below 11.4 m.	231.3	
	11.6	**LIMESTONE**.	228.5	11.73 12.34
	22.2	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.	217.9	22.25

Column headings: WATER LEVEL; LOG OF INSTALLS (DIAGRAM, DEPTH (m)); SAMPLE TYPE; NUMBER; PL MC LL; Cu TORVANE (kPa) ◆; qu POCKET PEN (kPa) ★; SPT (N) BLOWS/0.30 m ▲ 20 40 60 80

WATER LEVELS Remeasured/Static 6.10 m on 11-20-2023 Monitoring Well

CONTRACTOR **Maple Leaf Drilling Ltd.**	INSPECTOR **S. SINGH**
APPROVED K. FORDYCE	DATE 3-4-2024

KGS GROUP

Experience in Action