CITY OF WINNIPEG

CentrePort South Regional Water & Wastewater Servicing Project
CPKC Mile 6.46 Carberry Subdivision Crossing Geotechnical Report

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PREPARED BY:

Kelly Fordyce, P.Eng.
Geotechnical Engineer

APPROVED BY:

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

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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 provide engineering services to facilitate the detailed design and construction of regional water and wastewater infrastructure to support future industrial and residential developments within CentrePort South. The work includes the design and construction of the proposed force main pipeline beneath the Canadian Pacific Kansas City (CPKC) railway at Mile 6.46 Carberry Subdivision in Winnipeg, Manitoba. The subject CPKC railway line is a Class 4 track which runs east-west at the project site and crosses under CentrePort Canada Way (CCW) adjacent to the project site.

A geotechnical field investigation program was completed along the proposed alignment of the new force main pipeline to characterize the subsurface soil stratigraphy and groundwater conditions. A laboratory testing program was completed to determine relevant soil properties and were carried out on select soil samples from the investigation. This geotechnical evaluation report was prepared to summarize the finding of the geotechnical investigation and provide general design and construction recommendations for the underground trenchless installation. This report was prepared to support the CPKC utility crossing application in accordance with the requirements outlined in CPKC's Geotechnical Protocol for Pipeline and Utility Crossings under Railway Tracks (March 2024).

2.0 BACKGROUND INFORMATION

The proposed force main (FCM) pipeline is being constructed as part of the CentrePort South Regional Water and Wastewater Servicing project for the City of Winnipeg. The proposed FCM is planned to be installed beneath the CPKC dual tracks using trenchless construction methods. KGS Group is requesting an alternative to CPKC's Geotechnical Protocol including installation of the pipeline using Horizontal Directional Drilling (HDD) trenchless construction methods without the use of a steel casing pipe. The proposed FCM will consist of a 600 mm nominal diameter (450 mm ID) DR9 HDPE pipe (i.e. casing pipe) that is lined with a DN500 Primus Line product (i.e. carrier pipe) and is discussed further in Section 6.0. The proposed pipe specifications are summarized on the detailed design drawings in Appendix A and were designed to meet flow capacity requirements as outlined in the hydraulic modeling analysis previously completed by KGS Group.

The crossing profile indicates the elevation of the following at the railway crossing location:

- Top of Rail (TOR) track is at elevation Elev. 239.83 m (average of both tracks). ***Please note that only top of rail data is available and Base of Rail (BOR) was estimated. BOR data will be collected during construction and updated on the as-built drawings.***
- The invert elevation of the 450 mm ID HDPE casing pipe across the CPKC right-of-way is Elev. 219.42 m at both the north and south CPKC property limits. The invert depth below the estimated BOR is approximately 20.2 m .
- Depth from the estimated BOR to the top of the HDPE casing pipe is approximately 19.6 m (i.e., obvert Elev. 220.03 m) below the centreline of the tracks.

The crossing will be completed using HDD construction methods and the assumed locations of the entry and exit pits are indicated on the detailed design drawings in Appendix A. The sizing of the working pits and actual dimensions will be the responsibility of the Contractor based on their means and methods and excavation support structure design. The entry pit is anticipated to be constructed on the south side of the crossing and the exit pit is anticipated to be constructed on the north side of the crossing. The footprints of these working pits will be outside of the CPKC railway right-of-way (ROW).

3.0 2023/2024 GEOTECHNICAL INVESTIGATION PROGRAM

3.1 Borehole Drilling and Soil Sampling

A drilling and sampling investigation program was completed on November 11 and 12, 2023, with drilling services provided by Maple Leaf Drilling Ltd. of Winnipeg, Manitoba under KGS Group's supervision. The drilling and sampling program consisted of drilling two (2) boreholes on either side of the CPKC ROW in the greenfield site as shown in Figure 3-1. The boreholes were both advanced to 12.6 m (El. 225.1 m to 225.3 m) below grade using a track-mounted drill rig equipped with 125 mm diameter solid stem continuous flight augers and HQ size triple tube coring.

A supplementary drilling program was completed from April 10 to 22, 2024, over multiple drilling mobilization with drilling services provided by Maple Leaf Drilling Ltd. under KGS Groups' supervision. The drilling program consisted of additional bedrock coring and sampling at two (2) locations on either side of the CPKC ROW at similar locations to the TH23-17 and TH23-18. Boreholes TH24-01 and TH24-02 were respectively advanced to 19.5 m and 21.5 m (El. 218.2 m to 216.2 m) below grade using a track-mounted drill rig equipped with HQ size triple tube coring. The additional drilling was completed to support detailed design of the proposed deep horizontal directional drilling (HDD) installation through the bedrock. The overburden was drilled out and not logged during this additional investigation.

A supplementary test pitting program was completed on April 15, 2024, with excavation services provided by J Con Civil Ltd. of Winnipeg, Manitoba under KGS Group's supervision. The test pitting program consisted of excavating two (2) test pits on either side of the CPKC ROW as shown in Figure 3-1. Test pits TP24-03 and TP24-04 were advanced to refusal on the bedrock at 5.5 m and 5.2 m below grade, respectively using a rubber-tire excavator. The test pits were completed to assess the glacial till including the composition, size, and frequency of boulders, and to confirm the depth to bedrock along a potential alternate pipeline crossing alignment.

FIGURE 3-1: BOREHOLE / TEST PIT LOCATION PLAN

The location of the boreholes, test pits, and associated stratigraphy are also shown on the detailed design drawings in Appendix A.

Representative disturbed soil samples were obtained from each borehole at 1.5 m (5 ft) intervals, at any change in soil strata, or at the discretion of KGS Group personnel. Soil samples were collected either directly off auger flights or from a driven split spoon sampler. Collected samples were visually classified in the field in general accordance with the modified Unified Soil Classification System (USCS) and placed in resealable plastic bags. Standard Penetration Tests (SPT) were advanced at each split spoon sample depth (typically within the glacial till) to evaluate relative material density, and pocket penetrometer tests were performed on select sample to estimate unconfined compressive strength. Cohesive clay samples were tested with a field Torvane to estimate undrained shear strength.

Upon completion of drilling, the boreholes and test pits were examined for indications of sloughing and seepage and subsequently backfilled to grade. Boreholes were backfilled with grout or auger cuttings and bentonite chips. Test pits were backfilled in lifts with the excavated material.

Summary borehole and test pit log records containing all field observations are provided in Appendix B. Select photos of the drilling samples are provided in Appendix C.

3.2 Instrumentation

One (1) standpipe piezometer was installed in TH23-18 as part of the geotechnical investigation program. The slotted section of the standpipe was installed within the bedrock unit between elevations El. 225.8 m and 226.7 m. A sand pack was installed around the slotted section of the standpipe, and the remainder of the borehole was backfilled with bentonite chips. A protective well cover was installed at ground surface.

3.3 Geotechnical Laboratory Testing

Geotechnical laboratory testing was completed on select representative samples to determine relevant geotechnical engineering index properties. Laboratory testing included:

- Six (6) moisture content tests;
- Three (3) Atterberg limit tests; and
- Two (2) particle size analyses.
- Five (5) uniaxial compressive strength tests

All laboratory testing was completed at a Canadian Council of Independent Laboratories (CCIL) certified soil testing laboratory in Winnipeg, Manitoba. Testing was completed in general accordance with American Society for Testing and Materials (ASTM) standards. A summary of the laboratory testing has been provided in Appendix D and on the borehole log records in Appendix B.

4.0 2023 INVESTIGATION RESULTS

4.1 Stratigraphy

In general, the stratigraphy at the site was interpreted by KGS Group to consist of high plasticity clay deposit overlying glacial silt till and bedrock.

4.1.1 CLAY (CH)

A deposit of high plasticity clay was encountered below a thin layer of topsoil in TH23-17 and TH23-18 and both test pits at elevations ranging from El. 237.4 to 237.9 m± and extended to approximate elevations ranging from El. 232.6 to 235.9 m±. The clay was dark to light brown to grey in colour, firm to hard, of high plasticity, and contained trace sand and gravel, and trace silt inclusions. Some pockets of glacial silt till were encountered within the clay at approximate depths of 2.3 to 3.0 m below ground surface. The undrained shear strength of the clay deposit was estimated to be 40 to 100 kPa.

The moisture content of the high plasticity clay ranged from 26 to 38%. Atterberg limit testing was completed on one sample from each borehole as summarized in Table 4-1.

TABLE 4-1: ATTERBERG LIMITS TESTING – CLAY

Borehole ID	Sample Elevation	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
BH23-17	235.7 m	80	25	55
BH23-18	235.6 m	49	16	33

4.1.2 GLACIAL TILL (CL-ML)

Glacial silt till deposit was encountered below the high plasticity clay in TH23-17 and TH23-18 and test pits extended to elevations ranging from El. 232.0 to 233.3 m±. The thickness of the till deposit was 0.4 m and 1.0 m within TH23-17 and TH23-18, respectively. The thickness of the till deposit was 0.6 m and 2.7 m within TP24-03 and TP24-04, respectively. The silt till was light brown to brown in colour, damp to moist, dense, with sand, some to with clay, and trace gravel.

Cobbles and boulders were encountered in TP24-03 and TP24-04 and were comprised of sedimentary and igneous type rocks. The maximum boulder size observed was 300 mm (12 in). The frequency of boulders (larger or equal to 300 mm diameter) in the test pits was roughly estimated to be up to 2 boulders per cubic meter of excavated till material.

Uncorrected blow counts from one Standard Penetration Tests completed in the till deposit was greater than 100 blows per 300 mm; however, the borehole logs indicate the tests prematurely refused on the bedrock surface. The unconfined compressive strength of the till deposit, as estimated from a pocket penetrometer was 125 kPa based on one test.

The moisture content of the till deposit ranged from 12% to 20%. Atterberg limit testing and particle size analyses were completed on one sample from each borehole as summarized in Table 4-2.

TABLE 4-2: ATTERBERG AND PARTICLE SIZE ANALYSES – GLACIAL TILL

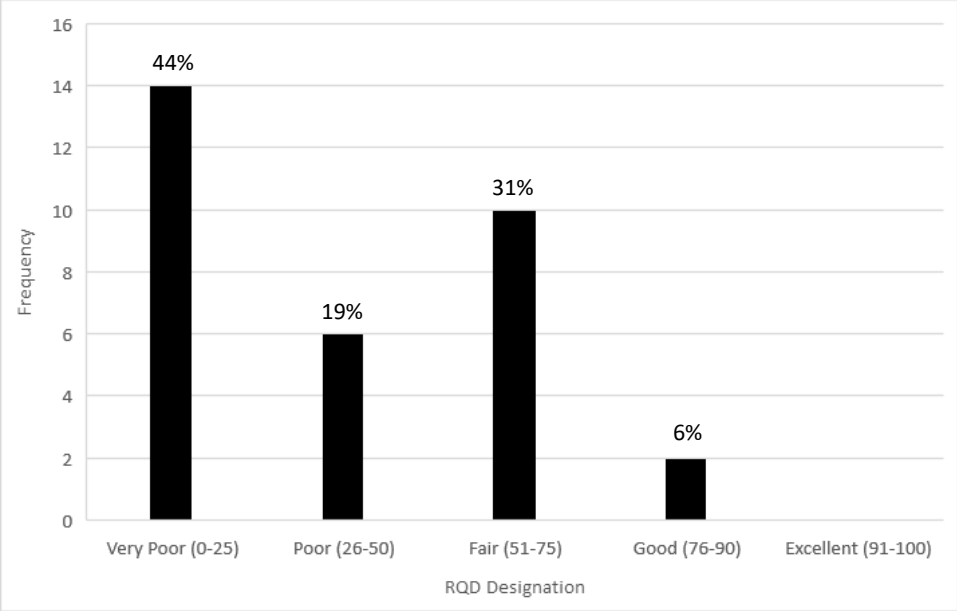
Borehole ID	Sample Elevation	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	%Gravel	%Sand	%Silt	%Clay
BH23-17	233.7 m	--	--	--	4	20	35	40
BH23-18	234.1 m	21	16	5	2	33	47	18

4.1.3 BEDROCK

Bedrock was encountered below the glacial till at elevations of El. 231.6 m± and 233.3 m± in the boreholes (TH23-17, TH23-18, TH24-01, TH24-02). The bedrock was encountered in TP24-03 and TP24-04 at elevations of El. 232.0 m± and 233.2 m± respectively.

Argillaceous limestone with interbedded calcareous shale bedrock was observed in all boreholes from the top of bedrock surface to the end of borehole depth. Similar rock type was observed at the bedrock surface in the test pits. The bedrock was described as reddish-grey to purplish-grey, fine grained, thinly bedded, fossiliferous, and fissile. Limestones beds were moderately strong to strong and shale beds were observed to be very weak to weak. Below approximate El. 221.5 m in TH24-02, the bedrock contained a higher proportion of shale which exhibited characteristics of a mudstone. The RQD of the material ranged from 0% to 88% (i.e. Very Poor to Good). Broken lost core zones were observed throughout the boreholes on either side of rail either near the bedrock surface or at elevations where higher shale content was observed and difficult drilling recovery was experienced. A histogram with the RQD distribution is shown in Figure 4-1.

FIGURE 4-1: HISTOGRAM OF DISTRIBUTION OF RQD WITHIN BOREHOLES



Five uniaxial compressive strength (UCS) tests were performed on the bedrock as summarized in Table 4-3.

TABLE 4-3: UNIAXIAL COMPRESSIVE TESTING – BEDROCK

Borehole ID	Sample Elevation	UCS (MPa)	Unit Weight (kN/m³)
TH23-17	232.8	28.2	25.4
TH23-17	232.5	28.1	24.6
TH23-18	233.0	26.8	25.4
TH24-01	224.1	34.3	25.5
TH24-01	222.2	23.2	24.8

4.2 Groundwater Conditions and Monitoring Results

One (1) standpipe monitoring well was installed within the bedrock at TH23-18 as part of the investigation activities. Details of the well installation are provided in Table 4-4 below and on the borehole logs provided in Appendix B.

Boreholes TH23-17 and TH23-18 were observed to be dry both during drilling and immediately upon completion of drilling. Minor water seepage at the base of test pits TP24-03 and TP24-04 was observed immediately upon completion of excavation. Groundwater level readings were collected five (5) times between November 2023 and June 2024, and are summarized in Table 4-4. As fluctuations can occur in response to seasonal conditions and following heavy precipitation or spring snow melt events, current

groundwater levels may differ from those provided in this report. As such, water levels should be monitored both prior to and during construction activities.

It is important to note that the Winnipeg area experienced approximately 240 mm of precipitation between the April 2024 and June 2024 groundwater readings and elevated groundwater pressures will be anticipated at the site.

TABLE 4-4: GROUNDWATER MONITORING RESULTS

Borehole ID	TH23-18
Ground Elevation (m)	238.01
Piezometer No.	Standpipe 1
Tip Elevation (m)	225.82
Monitoring Zone	Bedrock
Groundwater Elevation Monitoring Data (m)	
Date	
2023-11-20	237.06
2023-12-01	236.99
2023-12-13	237.16
2024-01-17	237.41
2024-04-15	frozen
2024-05-01	237.63
2024-06-21	237.60

4.3 Potential Difficult Ground Conditions

Cobbles have been observed within the lacustrine clay near the interface with the silt till and within the silt till in a majority of the boreholes that have been completed in the larger regional project area. Cobbles and boulders were encountered in the glacial till deposit in test pits TP24-03 and TP24-04 and other test pits (TP24-01 and TP24-02) that were completed at another pipeline crossing of Sturgeon Road and the CPKC Glenboro Subdivision. An average boulder size of 300 to 380 mm (12 to 15 in) was observed in the TP24-01 and TP24-02 with maximum size up to 600 mm (24 in) observed. The boulders were sub-angular to rounded and contained sedimentary and igneous rock types. 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 during excavation and trenchless installation.

A trenchless crossing of the railway is considered a critical crossing. The geotechnical condition of this crossing is unique in its challenges. Omand's Creek runs through this crossing location and the Province of Manitoba requires the pipeline to be installed a minimum of 3 m below the channel thalweg. Installation at

the minimum required depth would result in an installation horizon at the till and bedrock interface which presented additional construction risks. Due to these construction risks, easement constraints involving private property and highway overpass embankments, existing dry pond infrastructure, and the shallow bedrock at the site, this crossing was designed as a deep HDD installation through the bedrock. The bedrock appears to be highly weathered with a large variance in the bedrock's strength; however, the bedrock core recovery in the boreholes is generally high and the bedrock formation was interpreted to be suitable for the proposed HDD installation.

Installation within the bedrock placed the depth of the invert of HDPE casing pipe around El. 219.42 m and the obvert of the casing pipe around El. 220.03 m. This elevation was selected based on pipeline operational risks and the HDD bore path design geometry to place the deepest part of the installation within the CPKC right-of-way, and to provide the most clearance between the railway tracks and the top of the carrier pipe to minimize the risk of construction-induced and long-term settlements to the railway.

Further discussion on the proposed HDD design is provided in Section 6.0.

5.0 FORCE MAIN DESIGN CRITERIA

Table 5-1 provides the general requirements for CPKC Geotechnical Protocol Requirement for Process 2 – Intermediate and the proposed design parameters based on the detailed design drawing in Appendix A.

TABLE 5-1: CPKC GEOTECHNICAL PROTOCOL REQUIREMENT AND PROPOSED DESIGN PARAMETERS

Parameter/Criteria	CPKC Protocol Requirement	Proposed Design
Dimension Criteria		
Outside Pipe Diameter	300 mm to 1500 mm	600 mm
Cover between BOR and top of pipe (Note 2): measurements are from estimated BOR and BOR data will be collected during construction to update on the as-built drawings)	Greater than 1.5 m or 2 pipe diameters, whichever is greater	19.6 m (greater than 1.5 m and greater than 2 * 600 mm)
Adjacent structures, including switches and signals	Within 2.5 times, cover between BOR and top of pipe	None
Depth of pipes outside Zone of Potential Track Loading (ZPTL)	Less than 0.91 m burial within ZPTL	Approx min. depth of pipe outside ZPTL (north) = 18 m Approx min depth of pipe outside ZPTL (south) = 17 m
Excavation Criteria		
Excavation close to CPKC track(s)	Excavation or jacking/access pits within 10 m of the closest track centreline	Centreline of double track to face of Entry Pit = 130 m Centreline of double track to face of Exit Pit = 120 m
Crossing Angle	More than 45 degrees off perpendicular to the track	59.3 degrees
Construction Method Criteria		
	Trenchless method – Auger Boring, Pipe Jacking, Pipe Ramming, HDD	Horizontal Directional Drilling (HDD)
Other Criteria		
Settlement for Class 4 track	Level 1 Warning/Alert: >8 mm Level 2 Critical/Review: >16 mm	See Section 6.2.5

Notes:

1) CPKC Geotechnical Protocol for Pipeline and Utility Crossing(s) under Railway Tracks Criteria for Process 2 – Intermediate.
2) Cover measurements are from the estimated Base of Rail (BOR) data. BOR data will be collected during construction to update on the as-built drawings for consistency with CPKC documentation.

6.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

6.1 Considerations for Pipe Installation at CPKC Rail Crossing

Construction of the FCM pipeline that will be installed beneath the existing CPKC railway at Mile 6.46 Carberry Subdivision will be completed using horizontal direction drilling (HDD) as described in Section 6.2 and will comply with the following specifications and standards.

- CPKC document "CPKC Geotechnical Protocol for Pipeline and Utility Crossing(s) under Railway Tracks" March 2024.
- Transport Canada document "Standards Respecting Pipeline Crossings Under Railways TC E-10 (June 21, 2000)".
- ASTM F 1962, Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, including River Crossings.

6.2 Trenchless Pipe Installation Method

HDD is a technique used for installing pipes and utility lines below the ground surface that uses a surface-mounted drill rig that launches a drill string at an essentially horizontal or shallow angle relative to the ground surface and has tracking and steering capabilities achieved by controlling the orientation of the drill head. The procedure uses either fluid jet, mechanical cutting, or both, with a controlled volume of drilling fluid to help stabilize the borehole, remove cuttings, provide lubricant for the drilling string and pipe, and cools the drill head. The drill string creates a pilot bore hole which is incrementally reamed during subsequent drilling passes. The pipe or utility line is then pulled back through the borehole once the desired diameter is achieved. HDD is a viable installation method for variable ground conditions and below the water table.

KGS Group is proposing to complete the installation using HDD methods. The installation will consist of the 450 mm ID DR9 HDPE casing pipe with a DN500 Kevlar reinforced HDPE carrier pipe (Primus Line product). Key geometry parameters of the proposed HDD crossing are summarized below:

- Total length of HDD bore = 256 m
- Length of HDD bore through the CPKC right-of-way = 35.5 m
- Entry angle = 14 degrees
- Exit angle = 14 degrees
- Depth below estimated BOR within CPKC right-of-way = 19.6 m
- Maximum HDD reaming diameter size = 900 mm

KGS Group is requesting that the CPKC requirements for a steel casing pipe be waived for this crossing application for the following reasons.

- KGS Group has designed the crossing to enter the bedrock outside the CPKC ROW and ZPTL and remain within that formation until we pass beyond the ROW and ZPTL. The proximity of the rail line to the highway overpass embankment, private property, dry ponds, and the adjacent Omand's Creek pose

unique challenges for a rail crossing. By using HDD and entering into the bedrock outside of these physical barriers, we overcome several unique challenges resulting in a safe rail crossing solution from both a construction and long-term operational perspective.

- Joints between the HDPE casing pipe segments will be fused and inspected prior to insertion into the HDD borehole. Once the HDPE casing pipe is pulled through, the casing pipe will be lined with a Primus Line carrier pipe product, which is a flexible three-layer liner made from polyethylene and Kevlar fibers. The HDPE casing and Primus Line carrier will act as a dual containment system to address long-term operational risks of the force main. The force main will also be pressure tested to approximately 30% higher than the standard operating pressure before being commissioned. Isolation valves are included at the force main tie-in locations near the entry and exit pits.
- The HDD bore is designed to be at an approximate elevation of 220.03 m within the CPKC right-of-way. This equates to approximately 19.6 m depth below the BOR and approximately 13 m depth into the bedrock. The proposed installation is significantly deeper within the bedrock than most routine railway crossing installations within overburden soils in the Winnipeg area that would require a steel casing pipe. For completeness, a settlement analysis for the installation is provided in Section 6.2.2.
- Based on KGS Group's assessment of the drilled bedrock core quality (RQD) and core recovery lengths, the bedrock formation at the proposed installation horizon is suitable for supporting the HDD installation without the use of a steel casing pipe. The high shale content within the bedrock formation at this crossing location will aid in maintaining a seal in the HDD borehole during the reaming process.
- The estimated change in vertical stress from Cooper E90 live loads at the crown of the proposed HDPE casing pipe directly below the railway tracks is minimal and estimated to be less than 10 kPa based on Boussinesq theory (Budhu, 2000). The potential deformation effects on the carrier pipeline from train loading is considered negligible based on the bedrock characteristics and engineering properties at and above the installation horizon.
- Steel conductor casings will be utilized for this proposed rail crossing at the entry and exit locations to sleeve the overburden and mitigate risks to hydraulic fracturing of the overburden soils. These casings would be located well outside of CPKC's right-of-way based on the design bore path geometry.
- The HDD drilling fluid will be designed to interact with the limestone and clay shale to limit fluid loss to the bedrock formation.

6.2.1 HYDRAULIC FRACTURING ASSESSMENT

HDD utilizes drilling fluid to cool the downhole tooling during drilling, support the open borehole throughout the installation, and transport soil cuttings. Downhole pressure is required to circulate the drilling fluid and soil cuttings out of the hole and is a function of the installation depth (static head of the drilling fluid) and length (pressure drop due to the frictional shear forces in the borehole). The downhole pressure is typically largest during the pilot drilling process when the annulus is the smallest and the length of drilling fluid return is the longest. Following the pilot hole drilling, the borehole is enlarged through a progressive series of pre-reams until it is suitably sized to install the product pipe. Drilling fluid continues to be used throughout the reaming process; however, the downhole pressure is much smaller as the annular space is enlarged and the fluid and cuttings can circulate to the surface at both the entry and exit locations (there is a cross-over effect in the borehole).

The geotechnical conditions beneath the CPKC and Omand's Creek crossings consists of roughly 5 to 7 m of overburden soils (clay and silt tills) overlying alternating layers of limestone and clay shale bedrock. At the CPKC rail crossing, the proposed depth of the installation is approximately 19 to 20 m below the ground surface and 13 to 14 m below the bedrock topography. Bedrock generally provides a stable stratum for drilled installations with little deformation.

The installation depth of the proposed crossing is based on several factors including the required bore radii and setback for steering, preferred strata or ground conditions, the risk of inadvertent returns of drilling fluid to surface (hydrofracture or "frac-out"), and the potential magnitude of ground deformation resulting from the installation. The risk of hydrofracture was assessed considering the ground and groundwater conditions, and the potential mechanism of confinement, and compared against the drilling pressure expected to be required for proper circulation. The bedrock at the crossing is expected to be of varying quality with the potential for fractured zones. As such, the formation limiting pressure for the installation was evaluated based on shear failure of the overburden material rather than tensile failure of the bedrock material.

Based on the hydrofracture assessment conducted, the potential for hydrofracture at the CPKC rail crossing is evaluated to be low; however, we note that regardless of the results of the assessment, there remains the potential for hydrofracture if preferential paths exist in the bedrock formation and the overburden material. We recommend monitoring of the drilling process (measuring downhole pressures, observing returns and circulation, recording make-up water volume, etc.) and conducting environmental surface monitoring ("frac-walks"). Additionally, a properly formulated drilling fluid for the anticipated ground conditions with provisions to mitigate formation losses (i.e., loss control materials) is recommended. These recommendations will be included in the technical specifications of the construction contract.

6.2.2 SETTLEMENT ANALYSIS

KGS Group conducted settlement analysis using O'Reilly and New (1982) to estimate the potential surface settlement of the proposed pipeline installation based on the assumed volume of ground loss within the HDD borehole. The settlements for a single tunnel installation can be estimated from the formula as shown below:

$$S_{(y,z)} = S_{(max,y,z)}\, e^{-y^2/2i^2} = \frac{V_s}{i\sqrt{2\pi}}\, e^{-y^2/2(i)^2}$$

where

$S_{(y,z)}$ = vertical displacement at a transverse distance y and a vertical distance z (m)

V_s = volume of settlement trough per unit length of tunnel (m^3)

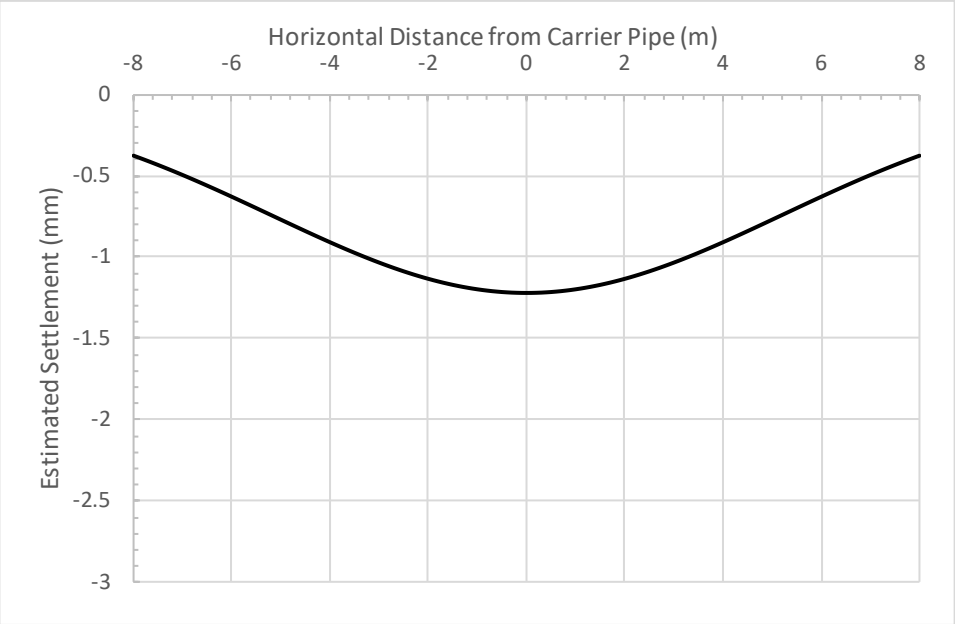
i = trough width parameter, taken as 0.28 z + 1.1 (m) for cohesionless soils

z = depth of the tunnel axis (m)

The maximum surface settlement, S_{max}, can be estimated when y = 0 (along the bore axis), which is a function of vertical distance z to the tunnel axis. For a single bore, the estimated settlement obtained below was based on the crown of the HDPE casing profile located at 19 m below the base of the CPKC railway track. Because the ground above the HDD bore will primarily be bedrock, the trough width parameter (i) for cohesionless soil estimated from empirical correlations was used and is considered an acceptable representation of the weathered bedrock observed. It is typical to assume ground loss of approximately 1% in

discontinuous or weak rocks masses (Wang et al., 2021); however, the settlement analysis was completed with an assumed ground loss of 2.5% due to the highly fractured and weak rock observed during the drilling. The estimated settlement profile directly over the alignment of the carrier pipe within the CPKC right-of-way is shown in Figure 6-1.

FIGURE 6-1: ESTIMATED SURFACE SETTLEMENT



The CPKC rail line for this project is defined as a Class 4 track. Settlement thresholds of 8 mm (Warning) and 16 mm (Critical) are recommended in accordance with CPKC's Geotechnical Protocol.

Based on the results as outlined Figure 6-1, the estimated maximum settlement over the alignment of the HDPE casing pipe is negligible and approximately 1.5 mm, and is less than the allowable Warning threshold prescribed by CPKC.

Lowering the water table will not be required since the recommended HDD construction method is capable of managing groundwater flows, particularly in full face drilling applications. Based on groundwater observations, groundwater will be encountered at the tunnel horizon. Groundwater levels are prone to fluctuations depending on the amount of precipitation and the time of year of the construction.

It is KGS Group's opinion that the estimated surface settlements associated with HDD installation of the HDPE casing pipe are negligible and unlikely to impact the railway operation, provided good construction practices are followed. It is recommended to monitor ground movements during the casing installation to confirm the permissible settlement thresholds are not exceeded.

6.2.3 SETTLEMENT AND CONSTRUCTION MONITORING

Installation of the proposed pipeline and associated infrastructure using the trenchless construction methods outlined above should not result in any adverse effects to CPKC operations or property. Since the proposed pipeline is greater than 300 mm (12 inches) OD, the installation falls under CPKC Process 2 – Intermediate,

and a KGS Group engineer will be on-site for the entirety of the installation process to monitor construction. The ground surface above the trenchless pipe installation alignment will be monitored for movement / settlement during the installation via the following:

- Track monitoring points installed at approximate spacings of 1.18 m, 2.34 m, 4.72 m, 7.08 m, and 9.45 m extending in both directions along both sets of tracks from the intersection point of the pipe alignment and railway track. The layout and details of the settlement monitoring program are shown on the sealed drawings in Appendix A.
- A minimum of two (2) sub-surface monitoring points will be installed along the alignment near the CPKC track, one (1) on either side of the dual track system. KGS Group recommends installing the sub-surface monitoring points no deeper than the bottom of Omand's Creek (approximate El. 236.0 m) to mitigate the risks of creating a preferential path for drilling fluid loss from the HDD bore, which could potentially result in the collapse of the borehole. The recommended installation corresponds to approximately 3 m above the bedrock surface and 12 m above the pipe obvert. It is KGS Group's opinion that the sub-surface settlement points installed at this depth will still provide valuable settlement indicators of the overburden within the ZPTL.
- A baseline survey of all survey points conducted and submitted to CPKC prior to the installation of the pipeline infrastructure.
- Daily surveying of all monitoring locations and submission of values to CPKC for review. The required frequency of survey monitoring and reporting will be confirmed by CPKC in writing: however, based on the Class 4 track classification, we anticipate the following in accordance with CPKC's "Track Movement Monitoring Guidelines for Trenchless Pipe Installation" (March 2024):
    - **Pre-construction:** Baseline survey monitoring will occur two (2) days prior to construction for both surface and subsurface monitoring points and will be measured by means of a total station twice per day to establish reliable methodology and demonstrate accuracy.
    - **During Construction:** Daily monitoring will proceed during the duration of construction in which survey monitoring will be captured a minimum of twice per day while the HDD boring string is within the ZPTL (i.e. from start of the pilot hole until the HDPE casing pipe is pulled through).
    - **Post Construction:** Seven (7) days of additional monitoring (readings collected once per day) will be conducted after completion of the installation (i.e. HDPE casing pipe pulled through). KGS Group recommends post-construction monitoring longer than the typical requirements to capture any delayed settlement with this unique crossing design.

Based on the underground utility drawings and upon KGS Group field observations of the proposed pipeline alignment option, there is no major building / infrastructure identified in the vicinity of the pipeline alignment. Upon receipt of the crossing permit, KGS Group will request CPKC buried utility locates to determine the presence of utilities within the railway corridor (e.g. fiber optic cables). The risk of potential conflicts with subsurface facilities is anticipated to be very low. Should the selected trenchless installation methods encounter any obstructions or premature refusal of any kind, work should stop immediately for reassessment, and CPKC will be notified.

6.2.4 GEOTECHNICAL PERSONNEL

Mr. Dami Adedapo, Ph.D., P.Eng. will be the Geotechnical Engineer of Record for this project. He will be responsible for reviewing the shop drawings submitted by the pipeline Contractor to determine if the proposed installation method (and dewatering method, if required) could cause any track settlement.

Mr. Kelly Fordyce, P.Eng., will be the geotechnical representative responsible for day-to-day review and inspection of the work to ensure that the geotechnical requirements are satisfied during construction.

6.2.5 EMERGENCY RESPONSE AND CONTINGENCY PLAN

The railway tracks at this crossing fall under Track Class 4. Two (2) alarm levels (Level 1 Warning/Alert and Level 2 Critical/Review) have been established for the installation of the pipe under the tracks.

Level 1 Warning/Alert

Warning/Alert level indicates a measurement of 8 mm of settlement or heave has been measured at a surface/subsurface monitoring point. The contractor's work method will be reviewed at this stage and necessary adjustments will be made to mitigate any additional movements. A survey of the monitoring points will be completed prior to commencing further work and work will only proceed if the magnitude of movement has stabilized from the previous readings. If movement is observed, work will be discontinued until movement is stopped at which point the pipe installation will be authorized to proceed.

Level 2 Critical/Review

Critical/Review level indicates a measurement of 16 mm of settlement or heave has been measured at a surface/subsurface monitoring point. A survey of the monitoring points will be conducted and work will only be authorized to proceed if there is no movement between at least two readings taken 12 hours apart. If movement is recorded, survey monitoring will continue until movement has stopped and a new pipe procedure has been submitted. In all cases, CPKC will have the right to carry out maintenance of the track upon completion of the works and during any agreed warranty period to restore the track at the expense of the City of Winnipeg's contractor to the same or better condition as was established in the baseline survey.

If a critical defect is detected, an on-site meeting would be held between all parties including the Contractor, Geotechnical Engineer of Record, City of Winnipeg, and CPKC representative to determine the cause of the defect and remedial action based on the contingency plan. A contingency plan will be developed prior to the start of construction including potential local sources of ballast rock and fill materials to aid in an emergency. The contingency plan may also include pressure injected grout to fill any potential voids to prevent further settlement. As aforementioned, the risk that such a problem will occur with the installation methodology is unlikely.

A copy of the emergency response plan will be posted on site and will reside with key personnel including the on-site geotechnical representative. An example emergency response contact list is presented in Table 6-2 below.

TABLE 6-2: EMERGENCY RESPONSE CONTACT LIST

Department / Title	Name	Email	Phone Number
Project Manager – Overseeing Utility Installation	Tim Turzak	tturzak@winnipeg.ca	c. 204-232-2674
Geotechnical Engineer of Record for Utility Owner	Dami Adedapo, P.Eng	Dadedapo@kgsgroup.com	c. 204-770-6088
CPKC Geotechnical Engineer or Service Provider	TBD by CPKC		
CPKC Roadmaster	TBD by CPKC		
CPKC Signal & Communication Supervisor	TBD by CPKC		
CPKC Director Geotechnical Engineering	Danny Wong	Dannyj_Wong@cpkcr.com	c. 403-826-3313
CPKC Utilities Supervisor – ON, MB	Jack Carello	Jack_Carello@cpkcr.com	c. 416-992-2676
CPKC Call Before You Dig - Canada	Main Desk	call_b4udig@cpkcr.com	1-800-387-1833
CPKC 24HR Utility Owner Emergency Response			204-986-2511

Notes:

1) A complete list of contacts will be provided prior to construction and once the construction has been awarded to a Contractor.

6.2.6 CONSTRUCTION AND POST INSTALLATION REPORTING

The Geotechnical Engineer of Record or their on-site representative will prepare daily construction inspection/monitoring reports in accordance with Section 12.0 of the CPKC's Geotechnical Protocol document. The reports will be issued to CPKC and their geotechnical service provider.

The Geotechnical Engineer of Record will compile a final memorandum to summarize the daily construction and monitoring activities and provide results of the survey monitoring data. The final memo and survey monitoring data will be submitted to CPKC. In addition, the Geotechnical Engineer of Record shall provide confirmation in writing that the work was conducted in accordance with the detailed plan reviewed and accepted by CPKC. The report shall include as-constructed drawings sealed by the Engineer of Record, and should confirm that there are no expected issues of the railway track due to the installation.

6.3 Temporary Excavations

Excavations for the trenchless installation pits will be required to facilitate installation of the pipeline at the entry and exit locations. This may require temporary shoring or bracing to allow safe entry by workers and minimize adverse effects to any adjacent infrastructure.

All excavations must not be located within the ZPTL which is defined as the area under the track and within a 1V:1.5H soil zone extending down from a point at the level of the Base of Rail and 2 m (6.6 ft) from the centerline of the track. All excavation work should be performed in accordance with the latest version of the Manitoba Workplace Safety and Health Regulation.

Suitable options include steel piling and timber lagging or driven steel sheet piling. All excavations deeper than 1.5 m should be reviewed and designed prior to construction by an experienced professional engineer with an expertise in geotechnical engineering. Openings and voids behind shoring lagging or sheet piles should be backfilled with free draining granular material.

All open excavation side slopes should be covered to prevent saturation and raveling of the soil, and all surface runoffs should be directed away from excavations. All surcharge loads such as stockpiled soil, equipment, etc. should be kept a minimum horizontal distance of 10 m away from the edge of excavations.

There may be the potential of localized groundwater inflows into the excavations from the cohesionless overburden layers as well as below the water table, which may require temporary pumping as well as potential shoring. Additionally, groundwater levels will fluctuate seasonally and following precipitation events and should be monitored regularly prior to, and during construction. Design of the above measures depends on the size, depth, and extent of excavation during construction.

6.3.1 GROUND MOVEMENT

Excavation support systems should be designed to control ground movement / subsidence around the perimeter of the excavation. The magnitude of ground movement could be affected by the procedure and workmanship applied during construction. Potential settlement of the ground surface adjacent to temporary shoring systems should be recognized and accounted for. Any resulting movement / settlement around the perimeter of the excavation must be kept within acceptable limits as specified in the contract document.

The excavation and shoring system should be designed by a professional engineer with extensive relevant experience and the works must be inspected and certified by the same professional engineer to verify that the temporary structure has been installed according to the design.

6.4 Base Heave

The base of excavation and shoring is recommended to be designed to achieve a minimum factor of safety of 1.5 with respect to basal heave.

6.5 Care and Control of Water

To maintain safe working conditions in excavations/shafts and to protect against instability of the excavation base, water should not be allowed to accumulate anywhere within excavations or to within 0.5 m below the lowest point within the excavation. It will be important to have an effective drainage and sump pump system below the base of excavation and to maintain a firm, dry working surface.

The drainage system should be designed to efficiently collect potential groundwater seepage and surface water drainage within the excavation so it can be pumped out and treated before being released into the environment. Surface run-off resulting from rainfall should be controlled and prevent ed from entering the excavation.

6.6 Lateral Earth Pressures

For design purposes, they may be assigned active, passive and at-rest lateral earth pressure coefficients as shown in Table 6-3.

TABLE 6-3: LATERAL EARTH PRESSURE COEFFICIENTS

Material	Bulk Unit Weight	Φ'	K_a	K_p	K_o
Well-Graded Granular Fill	20 kN/m^3	35°	0.27	3.69	0.43
Clay (CH)	18 kN/m^3	18°	0.49	2.04	0.66
Glacial Till	22 kN/m^3	23°	0.43	2.28	0.61

6.7 Groundwater Management and Spoil Disposal

The Contractor is expected to be familiar with, and follow, all local spoil disposal regulations including all monitoring, analysis, permits, and treatment required by the City of Winnipeg. Transportation and disposal of the spoil material is required to comply with all applicable laws and regulations. The Contractor will be required to obtain any and all necessary permits/approvals for the discharge of groundwater. Routine monitoring of groundwater discharge quality by the Contractor may be required during construction.

6.8 Frost Penetration

The depth of frost penetration will vary depending on air temperature, ground cover, the type of fill material used during development and other factors. The expected depth of frost penetration has been estimated assuming a design freezing index of 2680°C days, taken as the coldest winter over a ten (10) year period. The estimated maximum depth of frost penetration is 2.5 m assuming bare ground and no insulation cover.

7.0 CLOSURE

The proposed force main is to be installed beneath the CPKC dual track mainline at Mile 6.46 Carberry Subdivision using Horizontal Direction Drilling (HDD) construction methods. KGS Group is requesting an alternative to CPKC's Geotechnical Protocol including installation of the pipeline using HDD trenchless construction methods without the use of a steel casing pipe. The proposed force main will consist of a 600 mm nominal diameter HDPE casing pipe that is lined with a DN500 Kevlar reinforced HDPE liner (Primus Line product) carrier pipe and will act as a dual containment system. The force main crossing was designed to be installed deep within the bedrock formation to address settlement and operational risks with respect to the railway. The deepest part of the installation is within the CPKC right-of-way to provide the most clearance between the railway tracks and the top of the carrier pipe to minimize the settlement risks. By using HDD through the bedrock, we overcome several unique challenges resulting in a safe rail crossing solution from both a construction and long-term operational perspective.

The geotechnical investigation conducted by KGS Group describes the underlying soil and groundwater conditions along the proposed alignment of the force main pipeline beneath the CPKC railway tracks at Mile 6.46 Carberry Subdivision. This report presents the geotechnical engineer's best judgement of the subsurface and ground conditions anticipated to be encountered at the project site during construction. To develop this report, it was necessary to interpolate between the boreholes that were drilled at the site.

While the actual conditions encountered in the field are expected to be within the range of conditions discussed in this document, the spatial variability of subsurface and groundwater conditions that would be encountered at the site may be more complex than the simplified interpretation presented in this report.

To facilitate project design, certain assumptions were made with respect to the construction method and on the level of workmanship that can be reasonably expected for the installation of the pipelines. It should be noted that the Contractor's selected equipment, means and methods, and workmanship will influence the behaviour and performance of the subsurface soils encountered at the site.

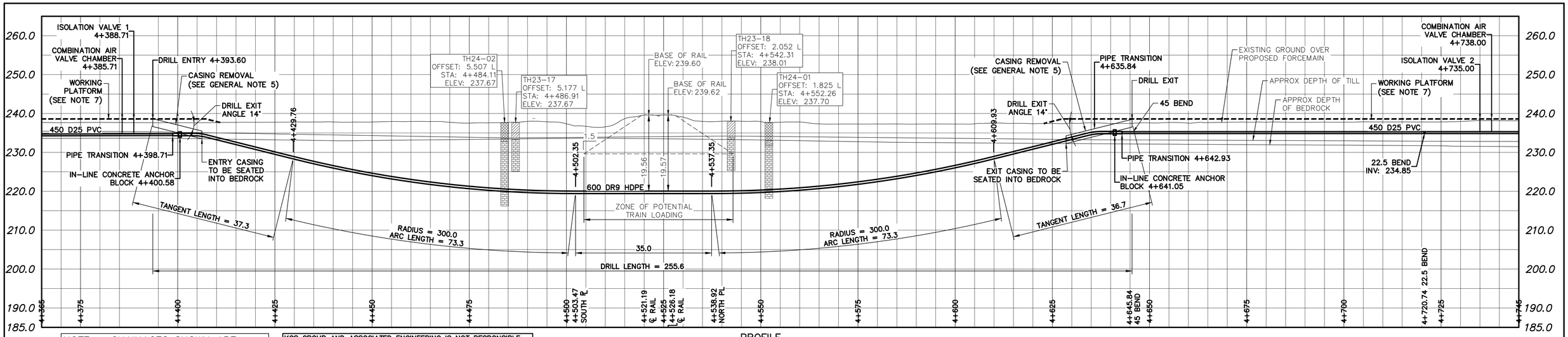
In accordance with CPKC's Geotechnical Protocol, full time inspection by qualified geotechnical personnel is recommended during construction to ensure the design intent is achieved, and to address any issues that may arise due to variability in soil conditions.

8.0 REFERENCES

1. KGS Group (2020). Airport Area West Regional Water and Wastewater Servicing Preliminary Engineering, 2019/2020 Preliminary Geotechnical Investigation Report, Final Version 02. March 2020.
2. KGS Group, May 2024. CentrePort South Regional Water & Wastewater Servicing – Geotechnical Data Report – Final Rev 1.
3. Department of Geological Engineering, the University of Manitoba, (1983). Geological Engineering Report for Urban Development of Winnipeg.
4. O'Reilly, M.P., & New, B.M. (1982). Settlements above tunnels in the United Kingdom -their magnitude and prediction. In: Tunnelling 82. Proceedings of the 3rd international symposium (pp. 173-181), Brighton 7-11 June 1982.
5. Wang, X., et al (2022). Prediction of ground settlements induced by twin shield tunnelling in rock and soil – A case study. In: Underground Space 7 (pp. 623-635), January 2022.
6. Ahmed, A., et al (2022). Surface settlement induced by horizontal directional drilling. In: Underground Space 8 (pp. 94-108), September 2022.

APPENDIX A

Detailed Design Drawings



PROFILE
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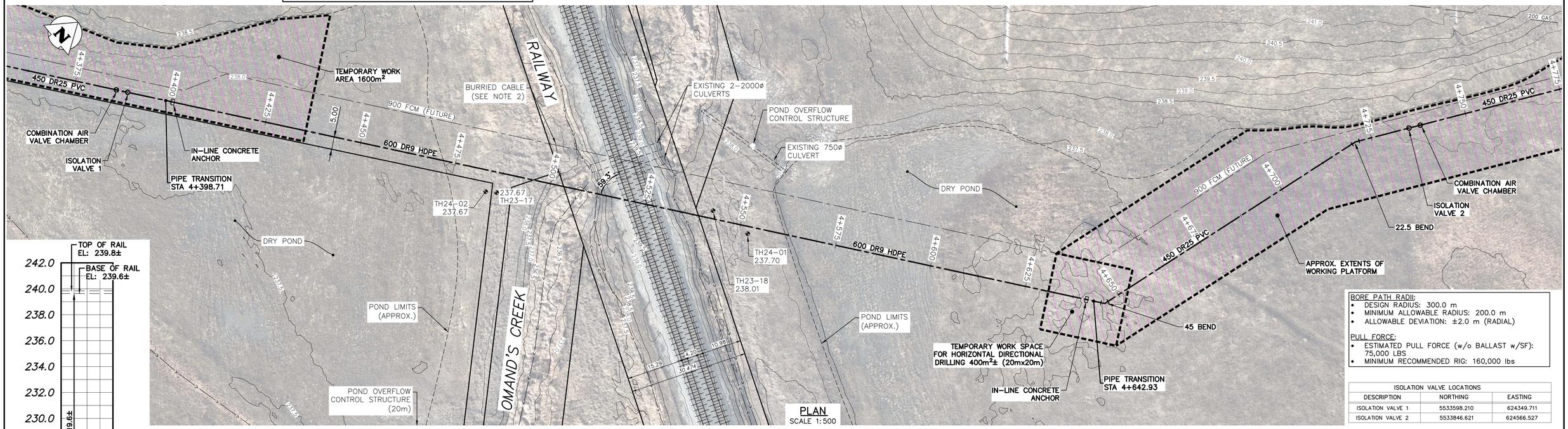
NOTE: CHAINAGES SHOWN ARE ALONG ℄ OF PROPOSED FCM

KGS GROUP AND ASSOCIATED ENGINEERING IS NOT RESPONSIBLE FOR ANY CLAIMS, DAMAGES, OR LIABILITY ASSOCIATED WITH INTERPRETATION OF SUBSURFACE DATA OR FOR REUSE OF SUBSURFACE DATA.



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SECTION ALONG TRACK
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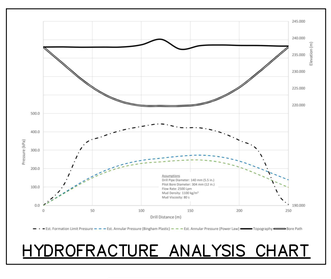

HYDROFRACTURE ANALYSIS CHART

GENERAL NOTES:

1. THIS DRAWING DEPICTS THE DESIGN OF THE TRENCHLESS CROSSING. FORCE MAIN DESIGN ELEMENTS ARE SHOWN FOR INFORMATION ONLY.
2. ALL UTILITIES SHOWN ARE APPROXIMATE ONLY. LOCATIONS OF ALL UTILITIES TO BE CONFIRMED IN FIELD BY THE CONTRACTOR.
3. RAILWAY MILEAGE AND SUBDIVISION: MILE 6.46 CARBERRY SUBDIVISION CROSSING.
4. GEOTECHNICAL REPORT: CENTREPORT SOUTH REGIONAL WATER & WASTEWATER SERVICING PROJECT CPKC MILE 6.46 CARBERRY SUBDIVISION CROSSING GEOTECHNICAL REPORT (KGS GROUP MAY 2024).
5. CASING REMOVAL SHALL BE AT THE DISCRETION OF THE CONTRACTOR. IF THE CASING IS TO BE ABANDONDED IN PLACE, THE CASING SHALL BE REMOVED TO A MINIMUM OF 1.0m HORIZONTALLY DOWN SLOPE OF THE LOCATION OF THE 600 DR9 HDPE TO 450 DR25 PVC TRANSITION. THE CONTRACTOR MUST MAKE PROVISIONS TO CUT THE CASING WITHOUT DAMAGING THE HDPE FORCEMAIN.
6. CONTRACTOR TO CONFIRM BASE OF RAIL ELEVATION UPON LAYOUT OF THE WORKS.
7. THIS AREA IS A DRY POND THAT WILL SURCHARGE DURING WET WEATHER EVENTS. WORKING PLATFORM TO BE CONSTRUCTED AT ELEV. 238.6. CONTRACTOR TO VERIFY WORKING PLATFORM ELEVATIONS PRIOR TO CONSTRUCTION.

NOTES FOR HDD:

- HDD DESIGN PARAMETERS SHOWN ON THE DRAWINGS OUTLINE THE ASSUMPTIONS UTILIZED IN DEVELOPING THE DESIGN BOREPATH.
- DEPTH OF COVER FOR CROSSING IS BASED ON THE ENTRY AND EXIT LOCATIONS NOTED ON THE DRAWINGS, AND SELECTED TO MINIMIZE RISK OF HYDROFRACTURE.
- IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO CONFIRM THE ENTRY AND EXIT LOCATIONS, ENTRY AND EXIT ANGLES, AND BEND RADII ARE SUITABLE FOR THEIR PROPOSED EQUIPMENT, TOOLING AND METHODOLOGY.
- CONTRACTOR TO REVIEW THE PROJECT GEOTECHNICAL INFORMATION AND CONFIRM THE FEASIBILITY OF HDD INSTALLATION METHOD.
- IF THE CONTRACTOR DETERMINES THE BOREPATH NOT TO BE FEASIBLE, IT IS THE CONTRACTOR'S RESPONSIBILITY TO SUBMIT AN ALTERNATIVE BOREPATH AND/OR ALIGNMENT FOR CONSIDERATION AT THE TIME OF TENDER.
- IF THE CONTRACTOR PROPOSES DIFFERENT ENTRY AND EXIT LOCATIONS, THE CONTRACTOR WILL SUBMIT A REVISED STAMPED ENGINEERED DESIGN DRAWING WITH HYDROFRACTURE CALCULATION DETERMINING THE APPROPRIATE DEPTH OF COVER FOR THE CROSSING.
- CONTRACTOR SHALL ASSESS THE INSTALLATION METHODOLOGY FOR ENTRY AND EXIT CONDUCTOR CASING BASED ON THE CONDITIONS OUTLINED IN THE GEOTECHNICAL REPORT. ENTRY AND EXIT CONDUCTOR CASING TO BE SEATED INTO BEDROCK. CASING SIZE AND LENGTH TO BE DETERMINED BY THE CONTRACTOR.
- CONTRACTOR SHALL ASSESS THE NEED FOR GROUTING BEDROCK SECTIONS ALONG THE BOREPATH IN THE FRACTURED ZONES TO MAINTAIN CIRCULATION.
- THE PILOT HOLE SHALL BE INSTALLED ALONG THE DESIGN BOREPATH ALIGNMENT WITH THE DESIGN CURVE RADII SHOWN ON THE DRAWING. THE BOREPATH SHALL BE INSTALLED WITHIN +/- 2m RADIAL DISTANCE OF THE DESIGN ALIGNMENT.
- CONTRACTOR TO ENSURE THAT THE FORCE APPLIED TO THE PRODUCT PIPE DURING PULLBACK DOES NOT EXCEED THE MANUFACTURER'S RECOMMENDED ALLOWABLE TENSILE LOAD.
- CROSSING TO BE CONSTRUCTED, MAINTAINED AND OPERATED IN ACCORDANCE WITH TRANSPORT CANADA STANDARD TC E-10 AND THE LATEST EDITION OF CSA STANDARD Z662.
- PIPE TO BE DEBEADED PRIOR TO INSTALLATION TO FACILITATE INSTALLATION OF THE LINER.

SETTLEMENT MONITORING NOTES:

- MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN, SEE TECHNICAL SPECIFICATIONS AND KGS GROUP GEOTECHNICAL CROSSING REPORT.
- SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER AND CPKC FOR REVIEW.

CASING PIPE SPECIFICATION:

- CONTENTS: WASTEWATER
- PIPE MATERIAL: HDPE (PE 4710)
- SPECIFICATION: AWWA C906
- NOMINAL DIAMETER: 600 mm (IPS)
- OUTSIDE DIAMETER: 610 mm
- DIMENSION RATIO: DR 9
- INSIDE DIAMETER: 474 mm
- OPERATING PRESSURE: 524 kPa
- SURGE/TEST PRESSURE: 690 kPa
- JOINT: BUTT FUSED (ASTM F2620)
- INSTALLATION METHOD: HORIZONTAL DIRECTIONAL DRILLING (HDD)

CARRIER PIPE SPECIFICATION:

- CONTENTS: WASTEWATER
- PIPE MATERIAL: ARAMID REINFORCED HDPE LINER (PRIMUS)
- SPECIFICATION: AWWA M28
- NOMINAL DIAMETER: 500 mm
- OUTSIDE DIAMETER: 454 mm
- INSIDE DIAMETER: 442 mm
- OPERATING PRESSURE: 524 kPa
- SURGE/TEST PRESSURE: 690 kPa
- JOINT: JOINTLESS
- INSTALLATION METHOD: WINCH SYSTEM

BORE PATH RADII:

- DESIGN RADIUS: 300.0 m
- MINIMUM ALLOWABLE RADIUS: 200.0 m
- ALLOWABLE DEVIATION: ±2.0 m (RADIAL)

PULL FORCE:

- ESTIMATED PULL FORCE (w/o BALLAST w/SF): 75,000 LBS
- MINIMUM RECOMMENDED RIG: 160,000 lbs

ISOLATION VALVE LOCATIONS		
DESCRIPTION	NORTHING	EASTING
ISOLATION VALVE 1	5533598.210	624349.711
ISOLATION VALVE 2	5533846.621	624566.527

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
Associated Engineering (Sask) Ltd.
No. 396 Date: 07/02/2024

FOR INDEX SEE 13458

5 0 5 10m
SCALE: 1:150 (A1)
10 0 10 20 30 40m
SCALE: 1:500 (A1)
WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

PROPERTY LIMITS DELINEATION

DELINEATION OF PROPERTY LIMITS AS SHOWN ON THIS DWG DOES NOT REPRESENT A "LEGAL SURVEY". KGS GROUP AND ASSOCIATED ENGINEERING MAKES NO REPRESENTATION OR WARRANTY AS TO THE ACCURACY OF PROPERTY LIMITS DELINEATED ON THIS DWG, NOR ON THE DIMENSIONAL ACCURACY OF DWG FEATURES RELATIVE TO THOSE PROPERTY LIMITS.

WARNING

IF POWER EQUIPMENT OR EXPLOSIVES ARE TO BE USED FOR EXCAVATION ON THIS PROJECT THE CONTRACTOR MUST:

1) NOTIFY THE GAS COMPANY OF THE PROPOSED LOCATION OF EXCAVATION.

2) TAKE PRECAUTION TO AVOID DAMAGE TO GAS COMPANY INSTALLATIONS.

SEE PROVINCIAL REGULATION 210/72 FOR DETAILS

LOCATION APPROVED

UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE — DATE

NOTE:

LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

VERTICAL DATUM: CGVD28 (HT2.0 Geoid)

HORIZONTAL DATUM: NAD83 (June 1990), Zone 14

NO.	REVISIONS	DATE (YYYY/MM/DD)	BY
0	ISSUED FOR CONSTRUCTION	2024/06/28	JL

KGS GROUP — Associated Engineering

DESIGNED BY	SS	CHECKED BY	CL
DRAWN BY	GH	APPROVED BY	JL
SCALE: HORIZONTAL	1:500	RELEASED FOR CONSTRUCTION	
VERTICAL		DATE	2024/06/28
DATE	2024/05/08		

PLOT DATE: 2024 06 28

ENGINEER'S SEAL
PROVINCE OF MANITOBA — J. S. LUEKE — Member 36827 — REGISTERED PROFESSIONAL ENGINEER
2024-Jul-02

CONSULTANT DRAWING NUMBER
C-2A-150

BID OPP: 427-2024
CONTRACT NUMBER: 2A

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING SERVICES DIVISION

CENTREPORT SOUTH REGIONAL WATER AND WASTEWATER SERVICING – PHASE 1A CONTRACT 2A – FORCEMAIN

RAILWAY AND OMAND'S CREEK CROSSING
CPKC RAILWAY MILE 6.46
CARBERRY SUBDIVISION CROSSING

SHEET 1 OF 2

CITY DRAWING NUMBER
13495

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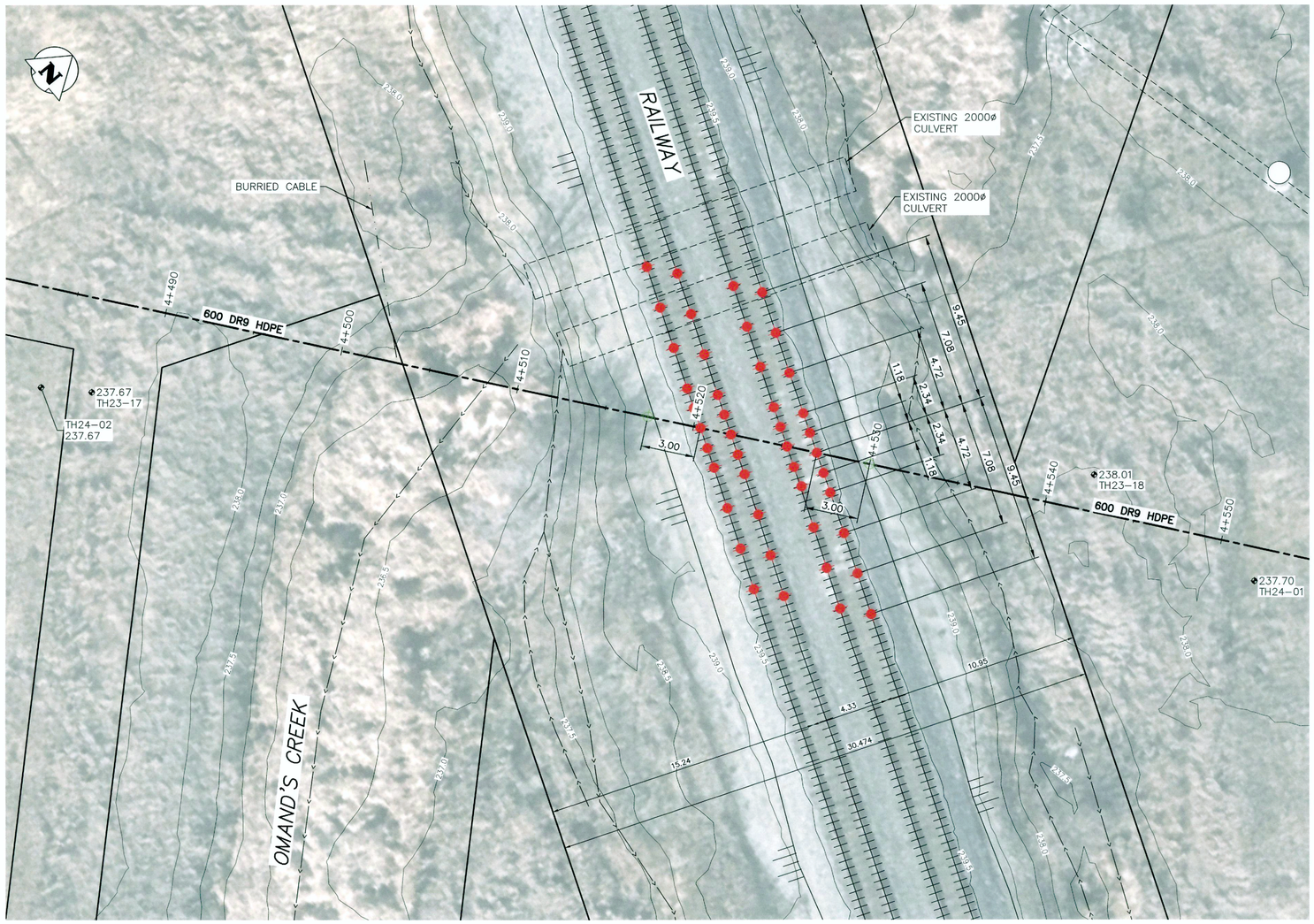

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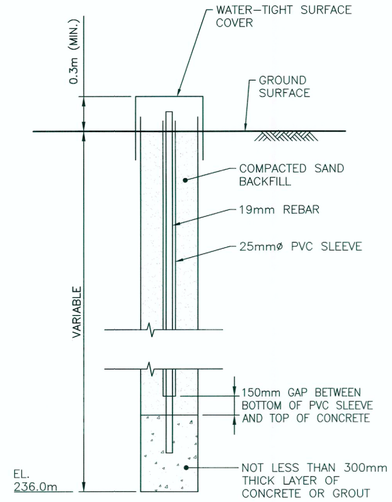

SUB-SURFACE MONITORING POINT INSTALLATION DETAIL
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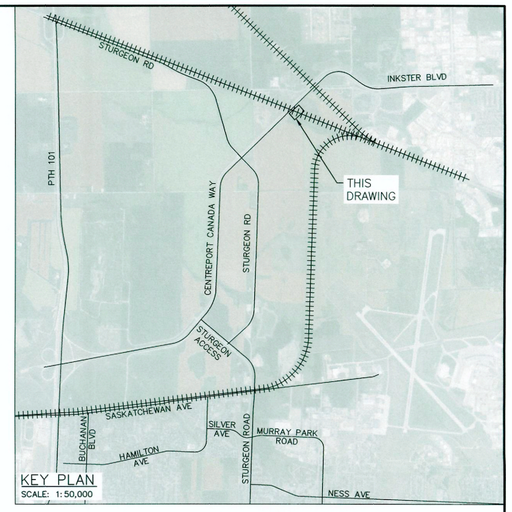

LEGEND:

- SURFACE MONITORING LOCATION
- SUB-SURFACE MONITORING LOCATION

NOTES:

1. SUB-SURFACE MONITORING POINTS TO BE INSTALLED TO EL. 236m (APPROXIMATE BASE ELEVATION OF OMAND'S CREEK).
2. EXACT LOCATION OF SUB-SURFACE MONITORING POINTS TO BE DETERMINED FOLLOWING LOCATION OF UTILITIES WITHIN THE RAILWAY CORRIDOR.

TRACK MONITORING:

- MONITOR RAIL TRACK IN ACCORDANCE WITH TRACK MONITORING PLAN, SEE TECHNICAL SPECIFICATIONS AND KGS GROUP GEOTECHNICAL CROSSING REPORT.
- SETTLEMENT MONITORING THRESHOLDS:
  - CRITICAL/REVIEW THRESHOLD: >16 mm
  - ALERT/WARNING THRESHOLD >8 mm
- SURVEY RESULTS SHALL BE SUBMITTED DAILY TO GEOTECHNICAL ENGINEER AND CPKC FOR REVIEW.

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
KGS Group
No. 245

5 0 5 10m
SCALE: 1:150 (A1)

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

PROPERTY LIMITS DELINEATION

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SEE PROVINCIAL REGULATION 210/72 FOR DETAILS.

LOCATION APPROVED
UNDERGROUND STRUCTURES

SUPV. U/G STRUCTURES COMMITTEE _____ DATE _____

NOTE:

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VERTICAL DATUM: CGVD28 (HT2.0 Geoid)
HORIZONTAL DATUM: NAD83 (June 1990), Zone 14

NO.	REVISIONS	DATE (YYYY/MM/DD)	BY
0	ISSUED FOR CPKC APPROVAL	2024/06/19	KF

KGS GROUP

DESIGNED BY	KF	CHECKED BY	DAA
DRAWN BY	GEL	APPROVED BY	KF
SCALE: HORIZONTAL	1:150	RELEASED FOR CONSTRUCTION	
VERTICAL			
DATE	2024/04/30	DATE	2024/06/19
PLOT DATE:	2024 06 18		

ENGINEER'S SEAL
PROVINCE OF MANITOBA
K.D. FORDYCE
Member 36388
2024/06/19
REGISTERED PROFESSIONAL ENGINEER

CONSULTANT DRAWING NUMBER
C-2A-FIGURE01

BID OPP: 427-2024
CONTRACT NUMBER: 2A

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT
ENGINEERING SERVICES DIVISION

CENTREPORT SOUTH REGIONAL WATER AND WASTEWATER SERVICING - PHASE 1A CONTRACT 2A - FORCEMAIN

SETTLEMENT MONITORING
CPKC RAILWAY MILE 6.46
CARBERRY SUBDIVISION CROSSING

SHEET 1 OF 1
CITY DRAWING NUMBER
13497

FILE PATH: U:\FMS\23-0107-009\
FILE NAME: 23-0107-009_C2A_Forcemain_Rail Xings_FIGs.dwg

APPENDIX B

2023/2024 Geotechnical Investigation Borehole Logs

KGS GROUP

TEST HOLE LOG

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		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
				TOPSOIL - Black, moist, with organics, some rootlets.	237.5					
237				**CLAY (CH)** - Dark brown, moist, stiff, high plasticity, trace fine to coarse grained sand, some silt inclusions.						
	1.0						S1			
236		5		- Brown, very stiff, trace fine grained gravel, trace silt inclusions below 1.5 m.						
	2.0			- LL=80, PL=25, PI=55 at 2.0 m.			S2			
235				- Stiff below 2.4 m.						
	3.0	10		- 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.						
234				- Predominantly clay below 3.4 m.			S3			
					233.7					
	4.0			**SILT TILL** - Brown, moist, compact, non-plastic, and clay, some fine to coarse grained sand, trace fine grained gravel.	233.3		S4			
		15		- PSA: 4% gravel, 21% sand, 35% silt, 40% clay at 4.0 m.						
233	5.0			**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.				R1	94	75 (2)
				- Strong below at 4.6 m.						
232	6.0	20		- 40 mm horizontal joint infilled with shale at 4.7 m.				R2	97	65 (12)
				- UCS: 28.2 MPa at 4.9 m.						
				- UCS: 28.1 MPa at 5.2 m.						
231				- 75 mm horizontal joint infilled with shale at 6.6 m.						
	7.0	25						R3	95	70 (10)
230										
	8.0			- Increased shale content, weak from 8.0 m to 8.1 m.						
229				- Three closely spaced joints partially infilled with shale from 8.6 m to 8.8 m.				R4	100	47 (17)
	9.0	30								
				- Increased shale content / shale interbeds from 9.4 m to 11.6 m.						
228				- Very weak with significant shale content from 9.5 m to 10.1 m.						
	10.0							R5	98	21 (23)
227		35		- Three 25 - 75 mm shale beds spaced 0.3 to 0.4 m apart from 10.6 m to 11.4 m.						
	11.0									
226										
	12.0	40						R6	100	60 (15)
				- Decreasing shale content, increasing limestone from 12.2 m to 12.4 m.						

PL MC LL
Cu TORVANE (kPa) ◆
qu POCKET PEN (kPa) ★
SPT (N) BLOWS/0.30 m ▲
20 40 60 80
125

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

CONTRACTOR **Maple Leaf Drilling Ltd.**
INSPECTOR **S. GARG**
APPROVED
DRAFT
DATE

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-17

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)
225				- Increasing shale content, fissile from 12.4 m to 12.6 m.	225.1						
				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.							
224	13.0	45									
223	14.0										
222	15.0	50									
221	16.0										
220	17.0	55									
219	18.0										
218	19.0	60									
217	20.0										
216	21.0	65									
215	22.0										
214	23.0	70									
213	24.0										
212	25.0	75									
211	26.0										
	27.0	80									
		85									

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

CONTRACTOR **Maple Leaf Drilling Ltd.**

INSPECTOR **S. GARG**

APPROVED
DRAFT

DATE

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		E 624,469 Zone 14
	4.7 m to 12.6 m: Water Rotary HQ Core - switched due to encountering boulders/suspected bedrock		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	LOG OF INSTALLS: DIAGRAM	LOG OF INSTALLS: DEPTH (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)	BLOWS/0.15 m	N-VALUE
				TOPSOIL - Black, moist, with organics, with rootlets.	237.9								
237	1.0	5		**CLAY (CH)** - Dark brown, moist, stiff, high plasticity, trace fine grained sand. - Brown below 0.5 m.					S1				
236	2.0								S2				
				- Light brown, moist, with silt, trace fine to coarse grained sand, trace coarse grained gravel below 2.3 m.					S3				
235	3.0	10		- 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, with silt, trace fine to coarse grained gravel below 3.4 m.	234.2				S4				
234	4.0	15		**SILT TILL** - Light brown, moist, dense, low plasticity, with fine to coarse grained sand, some clay, trace fine grained gravel.					S5	100		30/ 100mm	+100
				- 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				R1	67	88		
233	5.0			**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.					R2	86	63 (7)		
232	6.0	20		- 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.					R3	98	52 (15)		
231	7.0												
230	8.0	25		- Several shale beds 25 - 50 mm thick, very weak from 8.5 m to 9.0 m.					R4	102	54 (15)		
229	9.0	30											
228	10.0			- 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.			10.52		R5	98	20 (25)		
227	11.0	35					11.28						
				- Increased shale content, fissile, weak from 11.6 m to 12.0 m.					R6	100	39 (14)		
226	12.0	40		- Decreasing shale, moderate strength to the full exploration depth.			12.19						

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

>>▲

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
S. GARG

APPROVED
DRAFT

DATE

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH23-18

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	LOG OF INSTALLS: DIAGRAM	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
			ELEV (m)									
225.3					12.62							
225	13.0 — 45		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.									
224	14.0											
223	15.0 — 50											
222	16.0											
221	17.0 — 55											
220	18.0 — 60											
219	19.0											
218	20.0 — 65											
217	21.0											
216	22.0 — 70											
215	23.0 — 75											
214	24.0											
213	25.0 — 80											
212	26.0 — 85											
211	27.0											

WATER LEVELS

CONTRACTOR **Maple Leaf Drilling Ltd.**

INSPECTOR **S. GARG**

APPROVED
DRAFT

DATE

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-01

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.70 m
LOCATION	Winnipeg, Manitoba	**START DATE**	4-10-2024
DESCRIPTION	~3 m north of TH23-18	**UTM (m)**	N 5,533,698.12
DRILL RIG / HAMMER	Mobile B37X Track Mounted Drill Rig with Auto-Hammer		E 624,479.21 Zone 14
METHOD(S)	0.0 m to 19.5 m: Water Rotary HQ Core		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	DRILLING/ DIGGING REMARKS	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
237	1.0	5		**DRILL OUT** - Overburden drilled out.					
236	2.0								
235	3.0	10							
234	4.0								
233	5.0	15		233.0 **COBBLES AND LIMESTONE FRAGMENTS** - Reddish-gray to purplish-gray, some silt till.			R1	25	0
232	6.0	20		231.6 **ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong.			R2	96	56 (14)
231	7.0	25		- Three closely spaced shale beds ~7 - 13 mm thick from 7.1 m to 7.6 m.					
230	8.0			- Increasing joint frequency; spaced ~ 12 mm apart from 8.1 m to 8.5 m. - Increasing shale content, weak below 8.5 m. - 100 mm thick shale bed at 8.8 m.			R3	89	52 (15)
229	9.0	30		- Increasing fissility from 9.3 m to 11.4 m.					
228	10.0			- Multiple shale interbeds ~12 - 50 mm thick from 9.6 m to 9.8 m. - Decreasing shale content, moderately strong from 9.8 m to 10.0 m. - Two ~ 60 mm thick shale beds spaced ~ 150 mm apart, weak from 10.2 m to 10.5 m.			R4	98	43 (13)
227	11.0	35							
226				- Broken lost core zone; suspected due to drilling issues / action from 11.4 m to 12.3 m.			R5	52	0 (9)

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

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
M. RODRIGUEZ

APPROVED
K. FORDYCE

DATE
5-3-2024

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-01

ELEVATION (m)	DEPTH (m) (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	DRILLING/ DIGGING REMARKS	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
			ELEV (m)					
225	13.0 (40)		- Decreasing shale content, moderately strong below 12.4 m. - Four 12 - 25 mm thick shale beds evenly spaced from 12.7 m to 13.0 m.			R6	100	60 (10)
224	14.0 (45)		- 25 mm thick shale bed at 13.4 m. - UCS: 34.3 MPa at 13.6 m. - 65 mm thick shale bed at 13.7 m. - Increasing shale content, increasing joint frequency, three ~ 7 - 25 mm thick shale beds from 13.8 m to 14.3 m. - Broken lost core zone from 14.4 m to 15.1 m.			R7	53	22 (10)
223	15.0 (50)		- Decreasing shale content, decreasing fissility, strong below 15.1 m. - UCS: 23.2 MPa at 15.5 m.					
222	16.0					R8	98	87 (6)
221	17.0 (55)		- Limited to no recovery below 17.1 m.	- Sample from R9 became stuck in core sampler and had to be removed forcefully		R9	0	0
220	18.0 (60)							
219	19.0			- Approx 0.3 m of rock and poor recovery due to drilling issues. Coring bit lost at bottom of hole		R10	0	0
218	20.0 (65)		218.2 Notes: 1. End of test hole at 19.5 m. 2. Test hole backfilled with grout.					
217	21.0 (70)							
216	22.0							
215	23.0 (75)							
214	24.0 (80)							
213	25.0							
212	26.0 (85)							

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

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
M. RODRIGUEZ

APPROVED
K. FORDYCE

DATE
5-3-2024

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-02

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**	4-22-2024
DESCRIPTION	~3 m south of TH23-17	**UTM (m)**	N 5,533,653
DRILL RIG / HAMMER	Mobile B37X Track Mounted Drill Rig with Auto-Hammer		E 624,428 Zone 14
METHOD(S)	0.0 m to 21.5 m: Water Rotary		

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
237				**DRILL OUT** - Overburden drilled out.					
	1.0								
236		5							
	2.0								
235									
	3.0	10							
234									
	4.0								
233		15		- Limestone and boulders, trace fine grained gravel, some silt till in sampler during R1..	232.8				
	5.0			**ARGILLACEOUS LIMESTONE/CALCAREOUS SHALE** - Reddish-gray to purplish-gray, fine grained, thinly bedded, fossiliferous, fissile, moderately strong. - Poor core condition, unable to determine depths and zones of broken lost core from 4.9 m to 9.1 m. - Moderately weak, increasing shale content towards end of Run 1.			R1	60	17
232									
	6.0	20							
231				- Moderately weak, three soft shale beds 51 - 76 mm thick observed in recovered core for Run 2.			R2	62	27
	7.0								
230		25							
	8.0			- Moderately weak, increased shale interbedding observed in recovered core for Run 3.			R3	47	7
229									
	9.0	30		- Very weak to weak, increasing shale content, increasing shale interbeds, increasing fissility below 9.1 m. - Soft shale bed from 9.4 m to 9.4 m. - Eleven soft shale beds 25 - 50 mm thick spaced 50 - 150 mm apart from 9.5 m to 10.6 m.			R4	92	14 (24)
228									
	10.0								
227		35		- Two 100 - 150 mm thick soft shale beds from 10.7 m to 11.0 m.					
	11.0								
226				- Increased shale content, very weak from 11.4 m to 12.0 m.			R5	93	15 (26)

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

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
M. RODRIGUEZ

APPROVED
K. FORDYCE

DATE
5-3-2024

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KGS GROUP

TEST HOLE LOG

HOLE NO.
TH24-02

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	SAMPLE TYPE	NUMBER / RUN	RECOVERY %	RQD (JOINTS/RUN)
				- Decreased shale content from 12.0 m to 12.2 m. - Broken lost core zone, significant soft shale observed in recovered portion of Run 6 from 12.2 m to 13.0 m.		R6	20	0
225	13.0	40		- Decreasing shale content, moderately strong from 13.0 m to 13.4 m.				
224	14.0	45		- Four 50 - 100 mm thick shale beds spaced 125 - 150 mm apart, moderately weak to weak from 13.4 m to 14.4 m.		R7	95	7 (21)
223	15.0	50		- Increased shale content, increased fissility, very weak from 14.4 m to 15.0 m. - Weak from 15.0 m to 15.7 m.		R8	100	33 (9)
222	16.0	55		- Increased fissility from 15.7 m to 16.1 m. - Decreased shale content, moderately strong from 16.1 m to 16.4 m. - Very weak / soft thinly bedded clacareous shale to mudstone with occassional limestone beds of moderate strength from 16.4 m to 21.0 m.		R9	92	23 (14)
221	17.0	60		- Decreased shale / mud content from 17.5 m to 17.9 m. - Decreased shale / mud content from 18.0 m to 18.3 m.		R10	97	10 (25)
220	18.0	65		- Decreased shale / mud content from 19.1 m to 19.6 m.		R11	97	23 (25)
219	19.0	70		- Decreased shale / mud content from 20.0 m to 20.4 m. - Three 25 -75 mm thick limestone beds from 20.6 m to 21.0 m.				
218	20.0	75		- Decreasing shale / mud content, weak, no longer soft below 21.0 m.		R12	60	28
217	21.0	80		216.2				
216	22.0	85		Notes: 1. End of test hole at 21.5 m. 2. Test hole backfilled with grout.				
215	23.0							
214	24.0							
213	25.0							
212	26.0							

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

WATER LEVELS

CONTRACTOR
Maple Leaf Drilling Ltd.

INSPECTOR
M. RODRIGUEZ

APPROVED
K. FORDYCE

DATE
5-3-2024

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KGS GROUP

TEST PIT LOG

HOLE NO.
TP24-03

CLIENT	**CITY OF WINNIPEG - WATER AND WASTE DEPARTMENT**	**PROJECT NO.**	23-0107-009
PROJECT	**CentrePort Regional S&W Servicing**	**SURFACE ELEV.**	237.44 m
LOCATION	Winnipeg, Manitoba	**START DATE**	4-15-2024
DESCRIPTION	North of CPKC ROW and East of TH23-18	**UTM (m)**	N 5,533,683.99
EXCAVATOR	CAT 320 Excavator		E 624,558.95 Zone 14
METHOD(S)			

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
237				**CLAY** - Brown, moist, firm, intermediate to high plasticity, some silt, trace silt nodules.				
	1.0			- Stiff, high plasticity, trace silt below 0.9 m.				
236		5						
	2.0							
235								
	3.0	10		- Large silt till inclusion (~300 mm diameter) around 3.1 m.				
234								S1
				- Grey below 3.7 m.				
	4.0							
233		15						
					232.6			
	5.0			**SILT TILL** - Light brown, dry to damp, dense, some gravel, some sand, some clay, some cobbles, trace boulders (up to 300 mm diameter).				
232				- Trace water encountered at 5.3 m.	232.0	▼		S2
				BEDROCK - mottled yellow grey dolomite, hard, strong.	231.8			
	6.0	20		Notes: 1. End of test pit at 5.5 m. 2. Refusal encountered on suspected bedrock at a depth of 5.5 m. 3. Test pit backfilled with excavated material.				
231								
	7.0							
230		25						
	8.0							
229								
	9.0	30						
228								
	10.0							

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

WATER LEVELS ▼ **Upon Completion** 5.46 m

CONTRACTOR **J CON Civil**	INSPECTOR **C. FRIESEN**
APPROVED K. FORDYCE	DATE 5-3-2024

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KGS GROUP

TEST PIT LOG

HOLE NO.
TP24-04

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.**	238.36 m
LOCATION	Winnipeg, Manitoba	**START DATE**	4-15-2024
DESCRIPTION	South of CPKC ROW and East of TH23-17	**UTM (m)**	N 5,533,583.04
EXCAVATOR	CAT 320 Excavator		E 624,491.12 Zone 14
METHOD(S)			

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHICS	DESCRIPTION AND CLASSIFICATION	ELEV (m)	WATER LEVEL	SAMPLE TYPE	NUMBER
238				**ORGANIC SOIL FILL** - 910 mm, Black, damp to moist, stiff, intermediate to high plasticity, with clay, some sand.				
					237.5			
	1.0			**CLAY** - Brown, moist, stiff, high plasticity.				
237		5						
	2.0							
236					235.9			
				SILT TILL - Light brown, damp, compact, some gravel, some sand, some clay, some cobbles, trace boulders (up to 300 mm diameter).				
	3.0	10						
235								
	4.0			- Dry, very dense below 4.0 m.				S1
234		15						
	5.0				233.2	▼		S2
233				- Increased sand/gravel and cobble content below 5.1 m. - Trace water encountered at 5.2 m.	233.0			
				BEDROCK - Reddish brown, fairly hard but fractured slightly with bucket.				
	6.0	20						
232								
	7.0							
231		25						
	8.0							
230								
	9.0	30						
229								
	10.0							

PL MC LL

Cu TORVANE (kPa) ◆

qu POCKET PEN (kPa) ★

SPT (N) BLOWS/0.30 m ▲
20 40 60 80

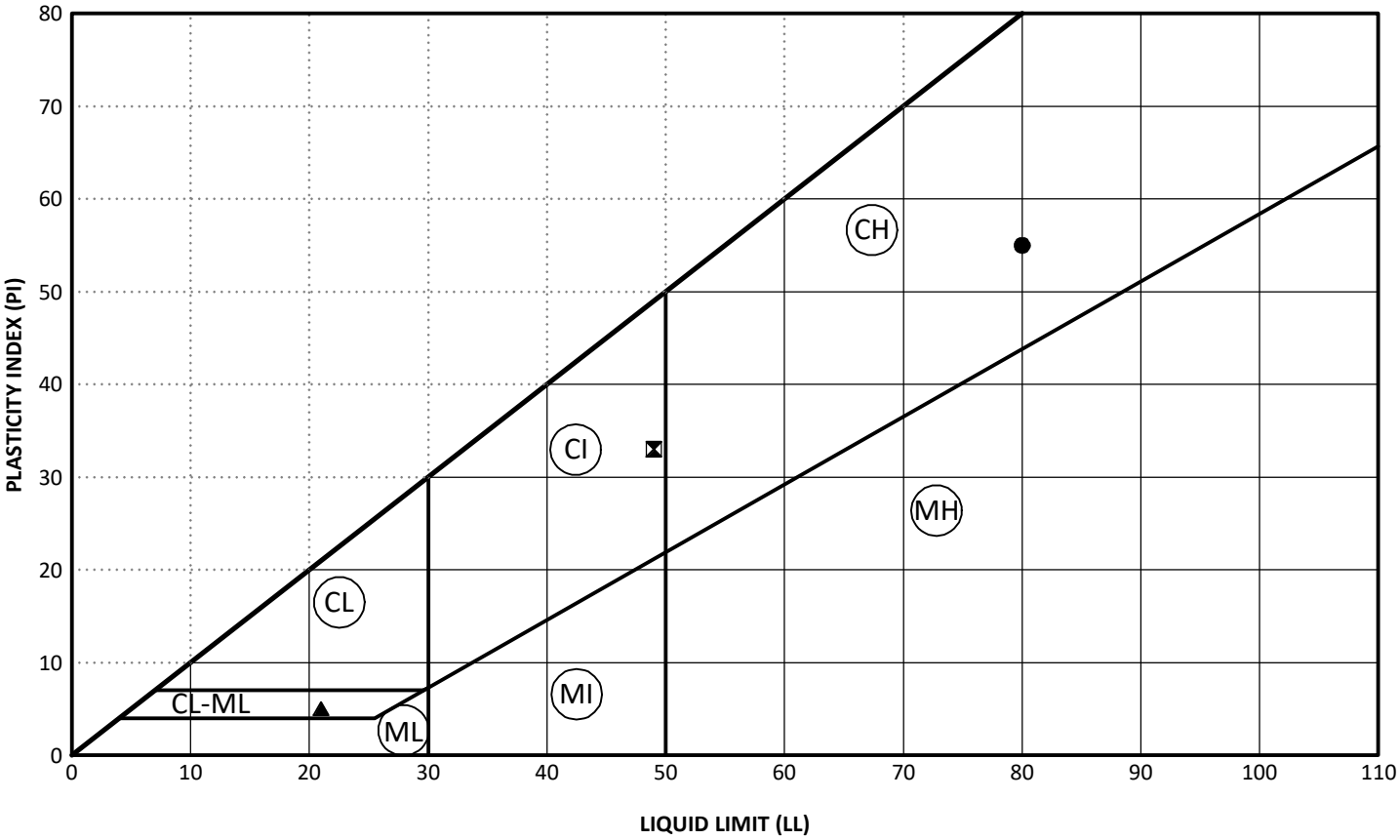
Notes:
1. End of test pit at 5.2 m.
2. Refusal encountered on suspected bedrock at a depth of 5.2 m.
3. Test pit backfilled with excavated material.

WATER LEVELS ▼ **Upon Completion** 5.18 m

CONTRACTOR **J CON Civil**	INSPECTOR **C. FRIESEN**
APPROVED K. FORDYCE	DATE 5-3-2024

KGS_LOG_C:\USERS\KFORDYCE\DESKTOP\FMS\23-0107-009\CENTREPORT TESTPITS.GPJ

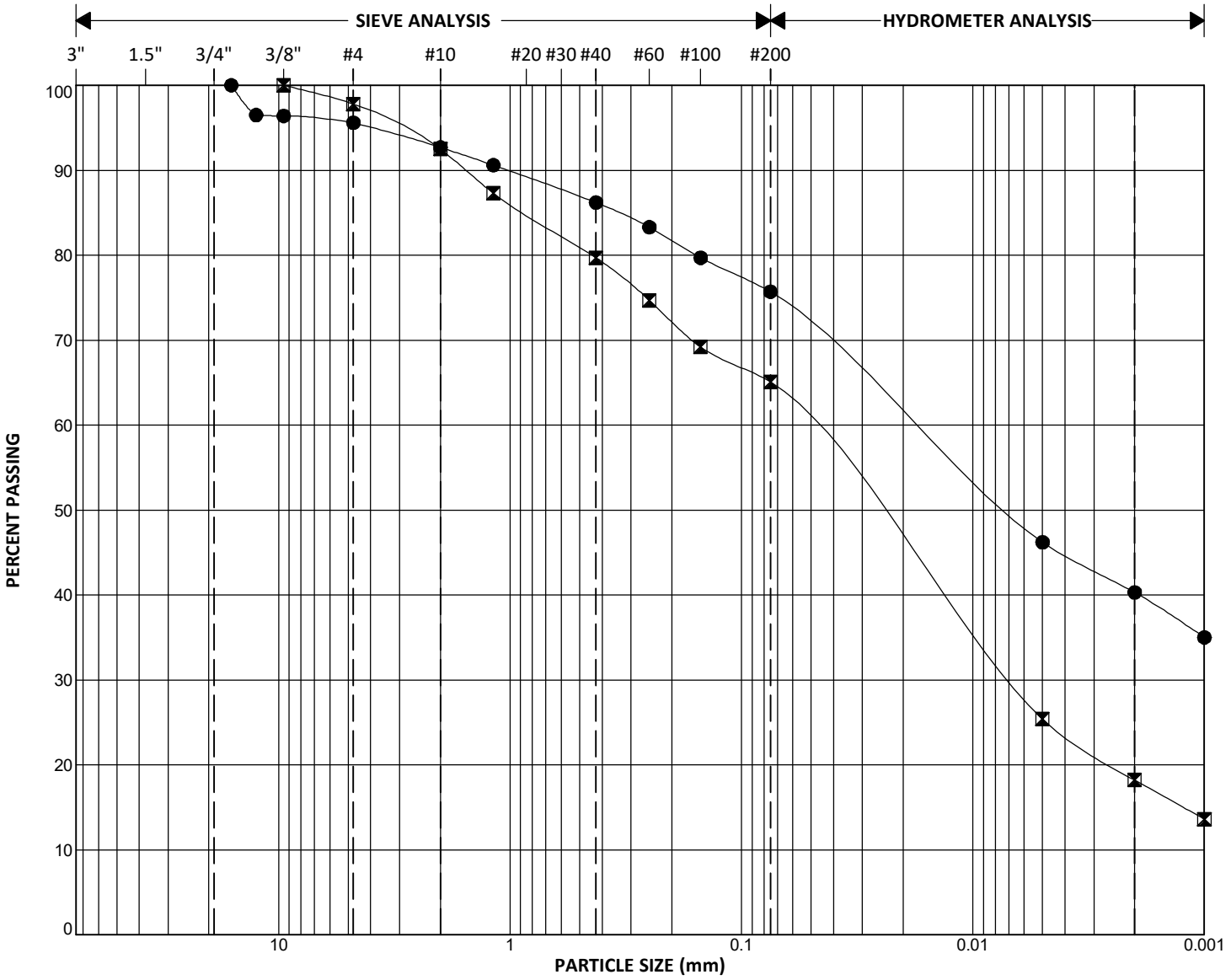
ATTERBERG LIMITS



	HOLE	DEPTH (m)	SAMPLE #	LL	PL	PI	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	MC (%)	CLASSIFICATION
●	TH23-17	2.0		80	25	55					34	
⊠	TH23-18	2.4		49	16	33					26	
▲	TH23-18	4.0		21	16	5	33	47	18	65	12	CL-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**	10/24/2023

GRAIN SIZE DISTRIBUTION



GRAVEL		SAND			SILT	CLAY
coarse	fine	coarse	medium	fine		

	HOLE	DEPTH (m)	SAMPLE #	GRAVEL (%)	SAND (%)	SILT (%)	CLAY (%)	SILT & CLAY (%)	Cu	Cc	CLASSIFICATION
●	TH23-17	4.0		4	20	35	40	76			
⊠	TH23-18	4.0		2	33	47	18	65			CL-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

KEY TO SYMBOLS

LITHOLOGIC SYMBOLS


Clay (CH, high plasticity)


Dolomite


Dolomite Shaley


Fill


Limestone


Silt (MH)


Silt (ML)


Silt Till


No Recovery


Organics


Silt Till


Topsoil

SAMPLER SYMBOLS


Auger Grab


Core Barrel


SPT Split Spoon

WELL CONSTRUCTION SYMBOLS


Sand Backfill


Standpipe (bentonite pellets)


Standpipe (cement/bentonite grout)


Standpipe (filter sand)


Screen (filter sand)

ABBREVIATIONS

LL - Liquid Limit
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
▼ Water Level Upon Completion of Drilling
▼ Water Level Remeasured/Static

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

APPENDIX C

2023/2024 Select Drilling Photos

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)

TH24-01 Photo 1: Bedrock core from 5.9 m to 19.5 m (19 ft – 6 in to 64 ft – 0 in)

TH24-02 Photo 1: Bedrock core from 4.9 m to 21.5 m (16 ft to 70 ft – 6 in)

TP24-03 Photo 1: Top of bedrock encountered at 4.6 m

TP24-03 Photo 2: Cobbles encountered in silt till

TP24-04 Photo 1: Top of bedrock encountered at 5.2 m

TP24-04 Photo 2: Gravel and cobbles encountered in silt till

TP24-04 Photo 3: Cobbles and trace boulders in silt till

APPENDIX D

2023 Geotechnical Laboratory Testing Results

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

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

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

REPORT NO. 2

DATE SAMPLED: 2023.Nov.15
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Nov.28
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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

REPORT NO. 5

DATE SAMPLED: 2023.Nov.15
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.06
TESTED BY: Carson Cockwell

SAMPLE ID: TH23-17, S2

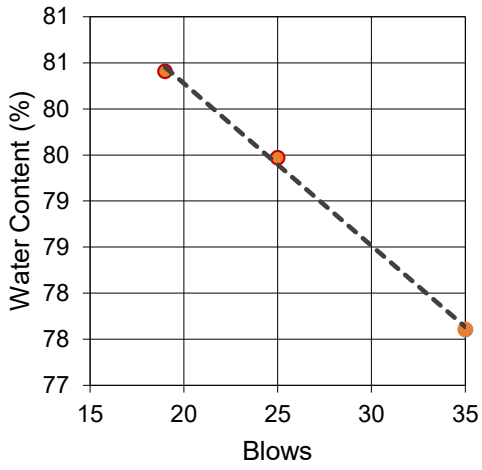
LIQUID LIMIT

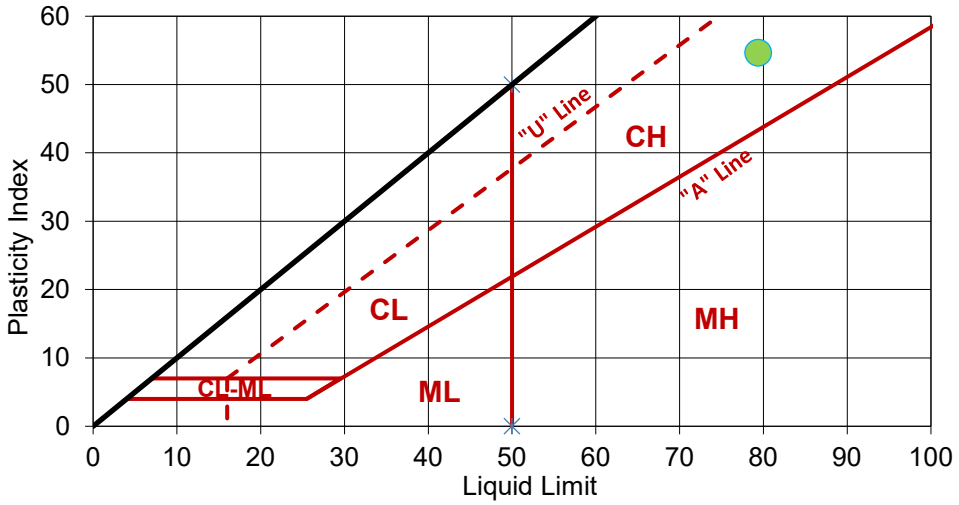
TRIAL	1	2	3
BLOWS	35	25	19
MC (%)	78	79	80

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

ATTN: Grace Gitzel

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

PROJECT NO. 123316822

REPORT NO. 6

DATE SAMPLED: 2023.Nov.15
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.06
TESTED BY: Carson Cockwell

SAMPLE ID: TH23-18, S3

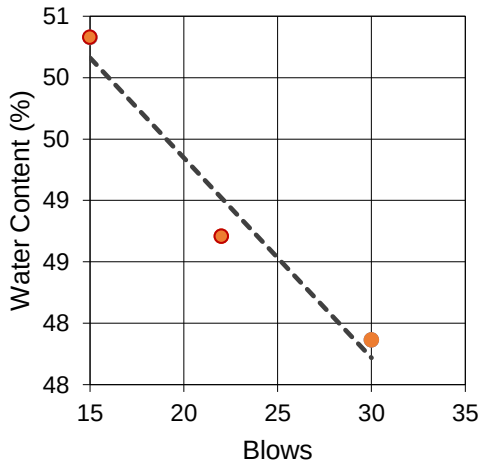
LIQUID LIMIT

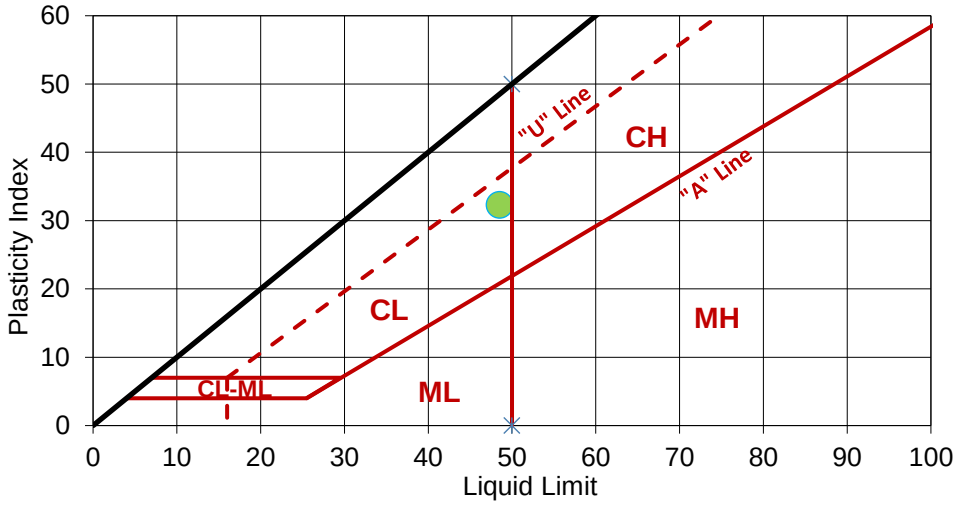
TRIAL	1	2	3
BLOWS	30	22	15
MC (%)	48	49	50

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

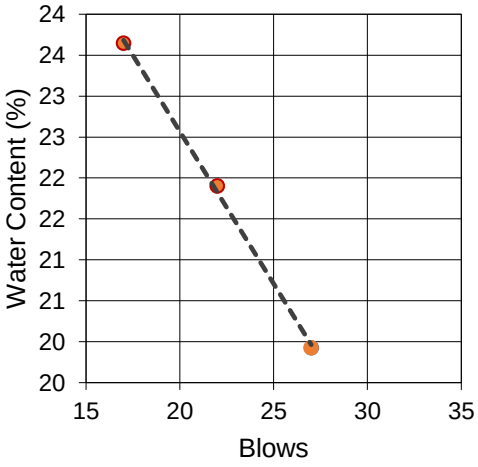
LIQUID LIMIT

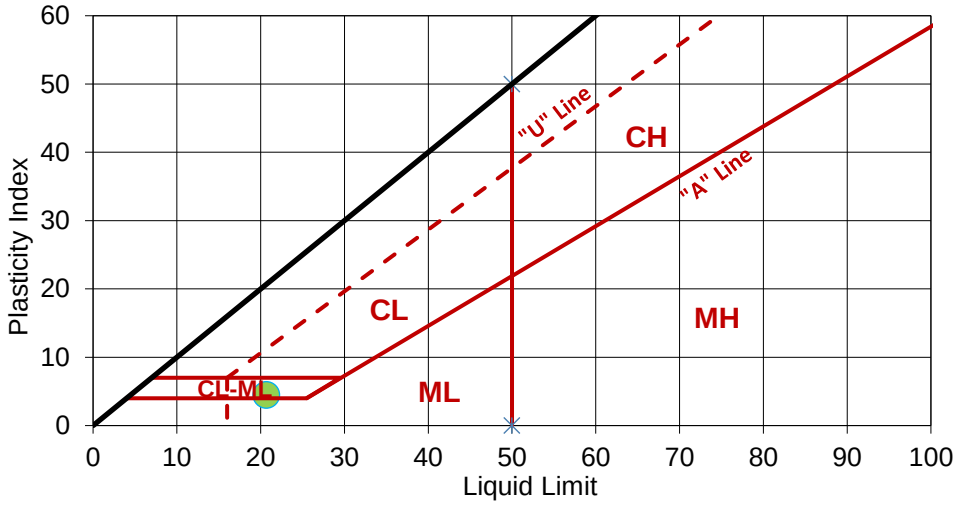
TRIAL	1	2	3
BLOWS	27	22	17
MC (%)	20	22	24

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

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)

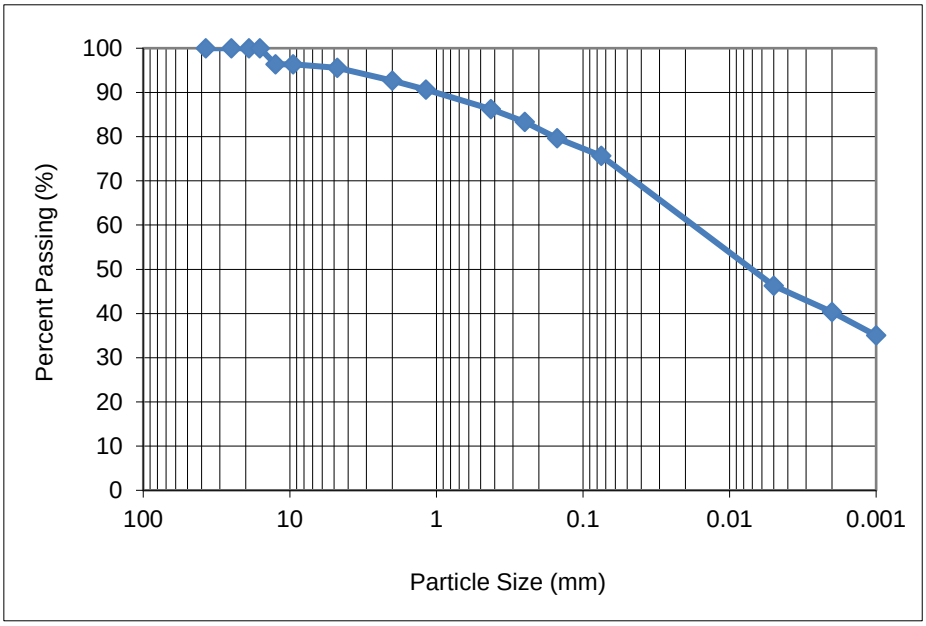
PROJECT NO. 123316822

REPORT NO. 6

DATE SAMPLED: 2023.Nov.15
SAMPLED BY: KGS Group Inc.

DATE RECEIVED: 2023.Nov.27
SUBMITTED BY: KGS Group Inc.

DATE TESTED: 2023.Dec.04
TESTED BY: Larry Presado



SIEVE SIZE (mm)	% PASSING
37.5	100.0
25.0	100.0
19.0	100.0
16.0	100.0
12.5	96.4
9.5	96.4
4.75	95.6
2.00	92.7
1.18	90.6
0.425	86.2
0.250	83.3
0.150	79.7
0.075	75.7
0.005	46.2
0.002	40.3
0.001	35.0

Gravel	Sand			Silt	Clay	Colloids
	Coarse	Medium	Fine			
4.4	2.9	6.5	10.5	35.4	40.3	35.0

COMMENTS:
Material tested was identified as TH23-17, S4.

REPORT DATE 2023.Dec.07

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

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)

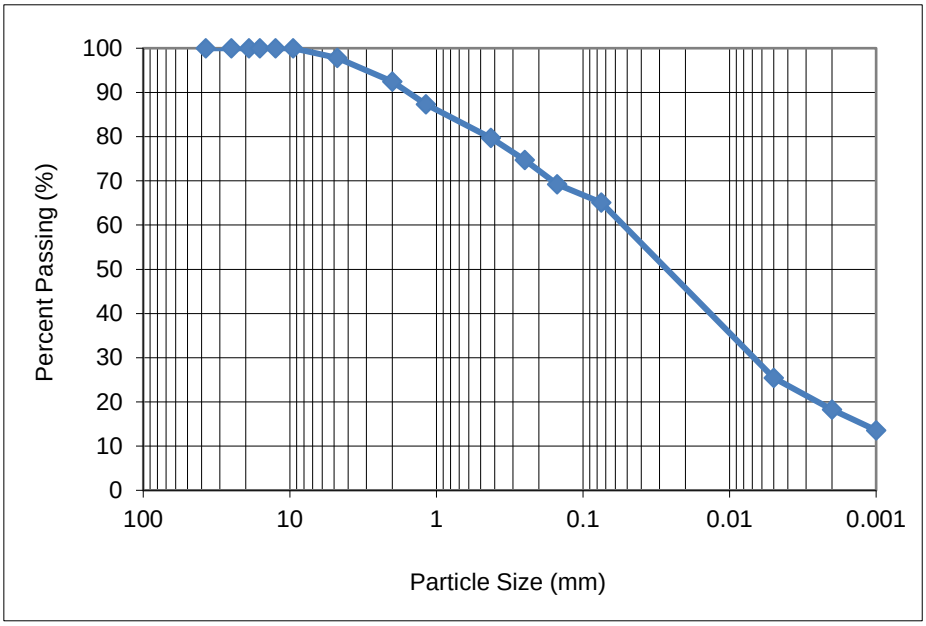
PROJECT NO. 123316822

REPORT NO. 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

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 Pfeiffer

Date: December 11, 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	**TH23-25**	**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 Prewer

Date: December 11, 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.:	123370015
Project:	CentrePort AAW Regional S&W Servicing		
Material Type:	Rock Core; Diameter ≥ 47.0 mm	Date Received:	April 17, 2024
Sampled By:	NA	Tested By:	Sagar Khatri
Date Sampled:	NA	Date Tested:	April 22, 2024

Sample Information				
Borehole Location	TH24-01	TH24-01		
Sample Number	4194	4195		
Sample Depth	44'2" - 45'0"	50'7" - 51'7"		
Compressive Strength Test Data				
Physical Description	As per Geotechnical Report	As per Geotechnical Report		
Average Sample Diameter (mm) (≥47.0)	61	61		
Average Sample Length (mm)	149	148		
Density (kg/m^3)	2598	2531		
Unit Weight (kN/m^3)	**25.5**	**24.8**		
L/D Ratio (2.0-2.5)	2.45	2.44		
Failure Load (lbs)	22390	15140		
Compressive Strength (MPa)	**34.3**	**23.2**		
Straightness by Procedure S1 (≤0.02inch)	<0.02	<0.02		
Flatness by Procedure FP2 (≤0.001inch)	<0.001	<0.001		
Parallelism by Procedure FP2 (≤0.25°)	0.136	-0.005		
Perpendicularity by Procedure P2 (≤0.0043)	<0.0043	<0.0043		
Moisture Condition	As-Received	As-Received		
Description of Break D7012/11.1.13	Well formed cone on one end. Vertical cracks running through caps, no	Diagonal fracture.		
Note				

Remarks:

Reviewed by: 

Date: May 2, 2024

KGS
GROUP

Experience in Action