

CITY OF WINNIPEG

# Armstrong Combined Sewer Relief Project – Contract 1 Geotechnical Baseline Report

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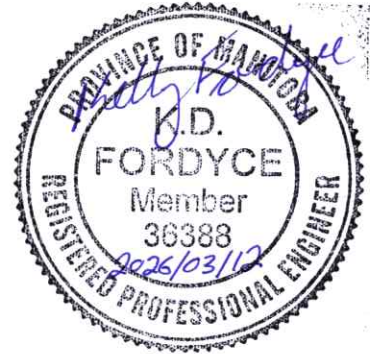
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Client Project:


755-2024

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Certificate of Authorization

KGS Group

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# STATEMENT OF LIMITATIONS AND CONDITIONS

## Limitations

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

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

## Third Party Use of Report

Any use a third party makes of this report or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

## Geotechnical Investigation Statement of Limitations

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

## 1.0 INTRODUCTION

### 1.1 General

The City of Winnipeg Water and Waste Department is completing construction of wastewater infrastructure to provide combined sewer separation for the Armstrong Combined Sewer (CS) district located in Winnipeg, Manitoba.

The Armstrong CS district encompasses an approximate area of 151 ha, located in the West Kildonan neighbourhood in Winnipeg, will be separated via the installation of both new land drainage (LDS) and wastewater sewers (WWS). The Armstrong CS district is bound by McPhillips Street to the west, Kingsbury Avenue to the south, Main Street to the east and the North End Sewage Treatment Plant (NEWPCC) to the north. The district receives land drainage flows from several regional streets in West Kildonan, including McPhillips Street, McGregor Street, Salter Street, Leila Avenue, Partridge Avenue, and Main Street. The district also includes two rail lines: the Canadian Pacific Kansas City (CPKC) Winnipeg Beach Line, which bisects the district, and a spur line along the northern district boundary, just south of NEWPCC. The current sewer system within the Armstrong CS district is a mix of combined sewers and storm relief sewers (SRS). The Armstrong CS district receives land drainage flows from several upstream districts that pass through the 2700 mm CS trunk on Leila Avenue. The combined flows from the Armstrong CS district enter the Leila trunk sewer and are directed to the comminutor station at the intersection of Main Street and Armstrong Avenue, where the flows are redirected to the Main Street Interceptor and ultimately on to NEWPCC.

This Geotechnical Baseline Report (GBR) pertains to Contract 1 of the Armstrong Combined Sewer Relief project which includes the construction of approximately 5,200 m of WWS pipeline with pipe sizes ranging from 300mm diameter to 900mm diameter, and approximately 160 m of LDS pipeline with 250 mm pipe diameter. The WWS and LDS pipelines will consist of both reinforced concrete pipe and PVC and will be primarily constructed using trenchless methods. Installation of the main trunk pipeline includes one crossing location beneath the CPKC railway and right-of-way. The scope of work for the pipelines also includes construction of wastewater and land drainage manholes including a deep chamber on Main Street, reconnection of existing sanity services to the new wastewater system, private sewer separations including the installation of either new wastewater or land drainage infrastructure, encased crossings of the existing 2700 mm CS trunk, and installation of new catch basins and leads connecting to the existing 2700mm diameter combined sewer. Additional details are provided in the Contract Documents.

### 1.2 Purpose of Report and Limitations

The primary purpose of this GBR is to set the anticipated geotechnical baseline conditions to be encountered during the construction of the proposed pipeline, as a common basis for bidding. This GBR presents an interpretation of geotechnical data collected during the project geotechnical exploration (KGS Group, 2026), including estimation /distribution of different materials to be encountered and the anticipated behaviour of these materials during pipeline construction. Baseline conditions described in this report provide a basis for the contractor to prepare construction bids and serve as the reference for the resolution of claims related to

differing site conditions. Proponents must consider this GBR as part of the Contract Documents and it must be read in conjunction with the Specifications and the Design Drawings prepared by KGS Group for the City of Winnipeg. The hierarchy of this document and other documents is indicated in the Project's Contract Documents.

For the portion of the work affected by subsurface conditions, bids shall be based on baseline conditions presented in this GBR and the project plans/contract documents. Risks associated with conditions consistent with, or less adverse than the baseline conditions are allocated to the contractor. Those risks associated with conditions more adverse than the baseline conditions are accepted by the Owner. The provision of baseline conditions is not a warranty that baseline conditions will be encountered. These baseline conditions are rather the contractual standard that the Owner and the successful bidder will agree to use when interpreting differing or unusual site conditions. The Owner accepts the risks for conditions that are more adverse than the stated baseline conditions and will negotiate with the contractor for additional compensation if these four conditions exist:

- i. The contractor has demonstrated that they were able to perform the work within the baseline conditions prior to encountering a change in conditions.
- ii. The actual conditions encountered are more adverse than baseline conditions.
- iii. The contractor can document that the geotechnical conditions are more adverse than those described in this GBR and that exposed conditions materially and significantly increased the cost and/or time required to complete the work.
- iv. The contractor has made diligent efforts to complete the work described in the contract documents, including any changes to methods, equipment, labor and materials made necessary by the more adverse conditions.

If all the foregoing conditions are met, then additional compensation will be negotiated as prescribed in the contract agreement. These general criteria shall be consistent with and negotiated in accordance with the contract's general terms and conditions. Notwithstanding the foregoing, nothing in this GBR shall invalidate or supersede any of the terms and conditions of the contract agreement.

This Geotechnical Baseline Report (GBR) summarizes the geotechnical condition observed along the proposed pipe alignments and provides construction considerations that form part of the basis of design for the Work and is intended for use by bidders as an aid in bid preparation. This report includes:

- Description of the project;
- Interpretations of the geologic and geotechnical data collected from the project;
- Summary of encountered subsurface conditions along the alignment;

The factual results of the geotechnical and hydrogeological investigations carried out at the proposed site are presented in the Geotechnical Data Report (GDR) ("Armstrong Combined Sewer Relief Project – Geotechnical Data Report – Final – Rev 1" KGS Group, 2026) which is under a separate cover.

This GBR presents the geotechnical engineer's best judgement of the subsurface and ground conditions anticipated to be encountered at the project site during construction. The soil stratigraphy and bedrock have been interpolated between the test holes that were drilled along the alignment. To facilitate the project, certain assumptions were made with respect to the construction methods and the level of workmanship that

can reasonably be expected for this project. It should be noted that the Contractor's selected equipment, means, methods, and workmanship will influence the behaviour of the subsurface soils and rock at the site.

The geotechnical data related to the subsurface conditions contained herein and in the GDR are intended for exclusive use of the City and the Contractor, if necessary, in evaluating the merits of differing site condition considerations that may arise during construction. Some of the technical concepts, terminologies, and descriptions in this report may not be fully understood by Bidders. The Contract documents require that Bidders confer with a qualified geotechnical engineer or engineering geologist who is familiar with all aspects of this report and the GDR. This engineer should have experience under conditions similar to those described herein and should carefully review and explain this information so that a complete understanding of the information presented can be developed prior to submitting a Bid.



## 2.0 PROJECT DESCRIPTION

### 2.1 General

The description and dimensions for the various components of the project provided in this report are approximate and for illustration purposes only. The Contractor should refer to the Contract Documents and Drawings for precise information on the dimensions and project layout.

### 2.2 Project Location

The project site is located in Winnipeg, Manitoba. The proposed WWS pipeline for Contract 1 runs along Leila Avenue from McPhillips Street to Aikins Street; north on Aikins Street to Armstrong Avenue; then east on Armstrong Avenue to the proposed deep chamber tie-in at the intersection of Armstrong Avenue and Main Street. The WWS pipeline crosses the CPKC Winnipeg Beach Spur right-of-way on Leila Avenue just to the west of McGregor Street. The pipeline alignments are shown in detail on the Contract Drawings.

### 2.3 Winnipeg Climate

Winnipeg is located in central southern Manitoba at the bottom of the Red River Valley, a low-lying flood plain with flat topography. Winnipeg has a humid continental climate with a wide range of temperatures throughout the year. The monthly average temperature ranges from -18°C in January to 20°C in July. Winter is defined as the time which the daily mean temperature remains below 0°C and typically lasts from the beginning of November to the beginning of April. The freezing index in Winnipeg is about 2680°C days, and the associated depth of frost penetration is 2.5 m. Spring and autumn are defined as the time period that the mean daily temperature ranges from 0° to 6°C and are typically short in duration, lasting only a couple of weeks.

The average yearly precipitation in Winnipeg is 505 mm of precipitation per year although the precipitation can vary greatly. The average annual snow fall in Winnipeg is 115 cm, with the most snow typically accumulating in January and February.

### 2.4 Key Components of the Project

The WWS pipeline consists of both PVC and concrete pipe depending on the size which ranges from 250mm to 900mm diameter. The proposed total length of WWS is approximately 5.3 km. The WWS pipeline extends from the west limit of the site at McPhillips Street; along Leila Avenue to Aikens Street, north to Armstrong Avenue, and east to Main Street where the WWS ties into the existing 2250mm interceptor sewer in the middle of the intersection between Armstrong Avenue and Main Street. The proposed horizontal and vertical alignments of the pipeline including the invert elevations are shown on the Contract Drawings.

The pipelines will primarily be installed using trenchless construction methods. The portion of the pipeline to the west of the CPKC right-of-way is anticipated to be installed using conventional pipe jacking techniques with temporary construction shafts located at regular intervals along the pipeline alignment.

Pilot-Tube Guided Auger Boring is required to construct the proposed pipeline crossing through the CPKC right-of-way which includes the installation of approximately 45 m of 600 mm diameter DR35 PVC carrier pipe within a 900 mm steel casing pipe below the railway. The trenchless installation alignment includes installation through the high plasticity clay overburden. The Contractor can expect to encounter clay and silt overburden during construction of the temporary launch and receiving shafts.

The pipeline east of the CPKC right-of-way is anticipated to require more advanced trenchless construction methods due to the overall vertical alignment. Deep temporary construction shafts will be required for this portion of the project and the Contractor can expect to encounter clay and silt overburden during construction.

There are multiple instances of the new piping systems crossing beneath an existing 2700mm diameter concrete trunk sewer. Appropriate methods for crossing the 2700mm trunk is dependent on the diameter of the new piping as identified in the Contract Documents. For the larger diameter carrier pipe crossings (i.e. 900 mm diameter and up), pilot tube auger boring will be required to install a steel casing pipe prior to the installation of the carrier pipe.

An approximate 15 m deep shaft will be required to facilitate the construction of an approximate 5 m by 3.5 m concrete manhole chamber to tie into the existing 2250mm diameter interceptor wastewater sewer at the intersection of Main Street and Armstrong Avenue, as shown on the Contract Drawings. The existing sewer is a monolithic cast-in-place concrete pipe, and the Contractor's shoring system must be installed in accordance with the requirements identified in the Contract Documents to minimize vibrations to the existing pipe.

The Contractor can expect to encounter mixed ground conditions along the pipeline alignments and at shaft locations including clay and granular fills; silt; high plastic clay, and glacial till identified in the GDR and on the Contract Drawings. The Contractor shall ensure that the trenchless construction equipment and tooling selected can navigate these mixed ground conditions.

The Contractor can expect to encounter groundwater for excavations that penetrate near and into the glacial till deposit. Of particular note are approximate Stations 5+00 to 17+00 (along Leila Ave.) on Figure 2 within the Geotechnical Data Report where the clay overburden thickness between the design invert of the pipeline and glacial till is smallest. The Contractor will be responsible for reviewing the groundwater baseline values, and the geotechnical data provided within the GDR to understand the risks to basal stability and uplift for construction of the temporary shafts and for the trenchless construction operations. Depressurization requirements are outlined in Contract Documents.

The scope also includes but not limited to the construction of wastewater manholes including a deep chamber on Main Street to tie into existing infrastructure, and the construction of private wastewater services as shown on the Contract Drawings.

## 3.0 SOURCE OF INFORMATION

The following documents were referred to in the preparation of this GBR.

### 3.1 Geotechnical Investigations

1. KGS Group, 2026. Armstrong Combined Sewer Relief Project – Geotechnical Data Report – Final Rev 1. March 2026.
2. KGS Group, 2025. Armstrong Detailed Design and Contract Administration – CPKC Mile 2.93 Winnipeg Beach Spur Crossing Geotechnical Report – Final Rev 0. August 2025.
3. Trek Geotechnical, 2023. Armstrong Combined Sewer Preliminary Design - Geotechnical Investigation Report – Final Rev 3. October 2023.
4. Trek Geotechnical, 2024. CP Rail Pipe Crossing Mile 3.05 Winnipeg Beach Subdivision - Geotechnical Investigation Report – Final Rev 2. July 2024.
5. Trek Geotechnical, 2024. CP Rail Pipe Crossing Mile 2.93 Winnipeg Beach Subdivision - Geotechnical Investigation Report – Final Rev 1. July 2024.

### 3.2 Geotechnical Guidelines and Standards

1. American Society of Civil Engineers, 2022. Geotechnical Baseline Reports, Suggested Guidelines. Essex R. J.
2. Canadian Geotechnical Society, 2023. Canadian Foundation Engineering Manual, 5<sup>th</sup> Edition.
3. International Society of Rock Mechanics, ISRM (1981). Suggested Methods for Rock Characterization, Testing and Monitoring. ISRM Commission on Testing Methods, Pergamon Press, Oxford.
4. City of Winnipeg, 2025. Standard Construction Specifications.

### 3.3 Publications

1. Bannatyne, B. B., 1975. High Calcium Limestone Deposits of Manitoba, Manitoba Mines Branch Publications 75-1.
2. Broms, B.B., Bennemark, H., 1967. Stability of clay at vertical openings. ASCE, Journal of Soil Mechanics and Foundation Engineering Division, SMI 93, 71—94.
3. Deere, D., 1964. Technical Description of Rock Cores for Engineering Purposes. Rock Mechanics and Engineering Geology, V.1, No. 1.
4. Department of Geological Engineering, University of Manitoba, 1983. Geological Engineering Report for Urban Development of Winnipeg.
5. Graham, J., and Shields, D.H., 1985. Influence of geology and geological processes on the geotechnical properties of plastic clay. Engineering Geology.

6. Hollman, F., Thewes, M., 2013. Assessment method for clay clogging and disintegration of fines in mechanised tunnelling. TUST 37, 96-106.
7. Hunt, S. W., 2017. Tunneling in Cobbles and Boulders. Breakthroughs in Tunneling Short Course, Chicago, IL, August 2017.
8. KGS Group, Acres Engineering, UMA Engineering, 2004. Appendix B, Floodway Channel Pre-Design, Floodway Expansion Project, Project Definition and Environmental Assessment, Preliminary Engineering Report.
9. Peck, R.B., 1969. Deep excavations and tunnelling in soft ground. In: 7<sup>th</sup> International Conference on Soil Mechanics and Foundation Engineering, Mexico City State-of-the-Art volume, pp. 225-290.
10. Thewes M., Burger W., June 2004. Clogging risks for MTBM drives in clay, Tunnels & Tunnelling International, pp.28-31.
11. KGS Group Ltd, 2025. CentrePort South Regional Water & Wastewater Servicing – Force Main – Geotechnical Baseline Report – Final Rev 1. Report for the City of Winnipeg. August 2025.
12. KGS Group Ltd., 2019. Cockburn and Calrossie Combined Sewer Relief Works, C5 – Taylor Ave Trunk Sewer Geotechnical Baseline Report – Final Rev 1. Report for the City of Winnipeg. January 2019.
13. AECOM Canada Ltd., 2018. Northeast Interceptor Sewer Geotechnical Baseline Report - Final. Report for the City of Winnipeg. April 2018.

## 4.0 GEOLOGICAL SETTING

This Section of the report contains regional geology, general site and subsurface conditions including soil, rock, and groundwater along the proposed alignment. Please refer to the Geotechnical Data Report (GDR) for additional information on geological setting.

### 4.1 Regional Geology

The regional geology of the site is outlined in the Geotechnical Data Report. Additional information on Winnipeg geology is included in the following references:

1. Baracos, A., Shields, D.H., and Kjartanson, B., 1983. Geological engineering report for urban development of Winnipeg. University of Manitoba.
2. Baracos, A., Graham, J., Kjartanson, B., and Shields, D.H., 1983. Geology and soil properties of Winnipeg. In ASCE Conference on Geologic Environment and Soil Properties, Houston TX: 39—56.
3. Baracos, A., 1977. Compositional and structural anisotropy of Winnipeg soils – study based on scanning electron microscopy and X-ray diffraction analyses, Canadian Geotechnical Journal, 14: 125-137.
4. Baracos, A., Graham, J., and Domaschuk, L., 1980. Yielding and rupture in a lacustrine clay, Canadian Geotechnical Journal, 17: 559-573.
5. Quigley, R.M., 1968. Soil Mineralogy Winnipeg Swelling Clays. Canadian Geotechnical Journal 5(2), pp. 120—122.
6. Render, F.W., 1970. Geohydrology of the metropolitan Winnipeg area as related to groundwater supply and construction. Canadian Geotechnical Journal, 7(3): 243—274.
7. Skatfeld, K., 2014. Experience as a Guide to Geotechnical Practice in Winnipeg (Masters of Science Thesis). University of Manitoba, Winnipeg, Manitoba.

### 4.2 Sources of Geologic and Geotechnical Information

Geological data for the project site is available from several sources, including the GDR, and published maps and reports. A compilation of the available information and data including results of the geotechnical drilling, laboratory test data, groundwater monitoring, and hydrogeological pump testing from the 2025 and 2026 field investigations are presented in the GDR.

### 4.3 Geotechnical Investigations

A geotechnical investigation was performed in 2025 for the Armstrong Combined Sewer Relief project. The investigation consisted of drilling a total of eight (8) boreholes located along the approximate alignment of the Contract 1 pipeline as shown on the Contract Drawings. Historical geotechnical data also exists within the Contract area from previous investigations completed in 2022, 2023, and 2024; some of which is located along the approximate alignment of the Contract 1 pipeline.

Laboratory testing was performed on representative soil samples obtained from the geotechnical drilling investigation. Details of the 2025 field and laboratory programs are presented in the GDR including a compilation of geotechnical data obtained from the 2025 investigation and other relevant projects within the regional project site since 2022.

## 4.4 Groundwater Monitoring

A compilation of the groundwater measurements from geotechnical instrumentation for the regional CentrePort South project area is presented in the GDR.

## 4.5 Hydrogeological Investigation

KGS Group conducted a hydrogeological investigation in 2026 to assess the hydraulic characteristics of the carbonate bedrock aquifer for depressurization that will be required to facilitate deep shaft excavations within the project area. Three (3) pump test investigations were completed at key areas of interest within the project area including:

- Near the downstream tie-in location at the intersection of Armstrong Avenue and Main Street.
- On the east side the CPKC crossing location
- Near the intersection of Jack Donner Drive and Leila Avenue within an area where the clay thickness between the pipeline vertical alignment and the top of the till deposit is expected to be a minimum.

The investigation included test well drilling, aquifer pump testing, and technical analysis of aquifer parameters. The results of the hydrogeological investigations are presented in the GDR.

## 5.0 PREVIOUS CONSTRUCTION EXPERIENCE

Select case histories which have relevance to the design and construction of the current project, and lessons learned from trenchless construction in the Winnipeg area are presented in the following sections. The following lessons learned are relevant to the Armstrong Combined Sewer Relief Project – Contract 1.

### 5.1 Lessons Learned from Trenchless Projects

Upon assessment of the case histories, the following key lessons learned are summarized from the previous tunneling projects in Winnipeg.

- Settlement has occurred as a result of tunneling. When tunneling below key infrastructure such as railways and roadways, the tunnel excavation face should be left in a state at the end of working shifts where uncontrolled instability cannot occur.
- Contact grouting was effective in restoring the ground surface elevation to pre-tunneling conditions with proper lubrication and grout port spacing (KGS Group, 2017).
- Ground vibrating from pile installation does not attenuate quickly within the glaciolacustrine clay layer and has resulted in structural damage to adjacent structures. Alternative installation methods should be explored for the installation of sheet piling, if required for the shaft locations (KGS Group, 2017).
- The concrete caisson shaft design and self-sinking installation methodology produced negligible vibrations through the glaciolacustrine clay layer and was comparatively non-intrusive to the surrounding environment (KGS Group, 2017).
- Two Microtunnel Boring Machine (MTBM) rescue shafts were excavated for the NW Interceptor Sewer Project (City of Winnipeg Contract 481-2014). The rescue shafts extended into the glacial till deposit and geotechnical records indicate that cobbles/ boulders ranging in size from 100 mm to 500 mm diameter were encountered. Figure 5-1 below shows boulders that were removed from the boring machine while excavating in the glacial till.
- For the CentrePort Water and Wastewater Servicing Project (City of Winnipeg Contract 990-2023B), boulders in excess of 2 m diameter (sedimentary and igneous rock types) were encountered during shaft construction through the glacial till deposit. Boulders can occasionally be encountered within the clay overburden deposit near the interface with the glacial till. Figure 5-2 below shows boulders that were removed during excavation within the secant pile shoring.
- High groundwater transmissivity was observed in the limestone bedrock in close proximity to rivers running through Winnipeg and piezometric levels in the bedrock are often connected to the river levels. Based on local experience, a grout curtain installed around the perimeter of shafts that extend into the bedrock may not be completely successful in providing adequate groundwater cutoff.
- During the CentrePort Water and Wastewater Servicing Project (City of Winnipeg Contract 900-2023B), high groundwater transmissivity and flows within the bouldery glacial till and the upper weathered and fractured sections of the bedrock were addressed adequately using secant pile shoring systems that penetrated into the underlying competent bedrock.
- Groundwater conditions fluctuate seasonally and typically rise during the spring melt and after significant rainfall events and/or snowmelts. The Winnipeg area experienced approximately 240 mm of



precipitation between April and June 2024, and piezometers installed within the overburden and bedrock for the CentrePort Water and Wastewater Servicing project (City of Winnipeg Contract 990-2023B) experienced ground water level changes up to 3 m. Design of construction shafts will be greatly influenced by groundwater conditions.

- Groundwater depressurization of the glacial till deposit and bedrock aquifer to achieve excavation base and uplift stability within the clay overburden deposit has been successful in Winnipeg using active or passive depressurization methods. For a sewer relief project in Winnipeg (City of Winnipeg Contract 1067-2018), passive standpipe wells were drilled through the base of a large tunnel shaft excavation to relieve groundwater pressures within the underlying glacial till deposit to successfully address basal heave concerns. Figure 5-3 shows an example layout of passive wells in a construction shaft base that are connected to an underslab drainage layer.

**FIGURE 5-1: BOULDERS REMOVED DURING OPEN FACE TUNNELLING FOR THE NW INTERCEPTOR SEWER PROJECT (2015)**

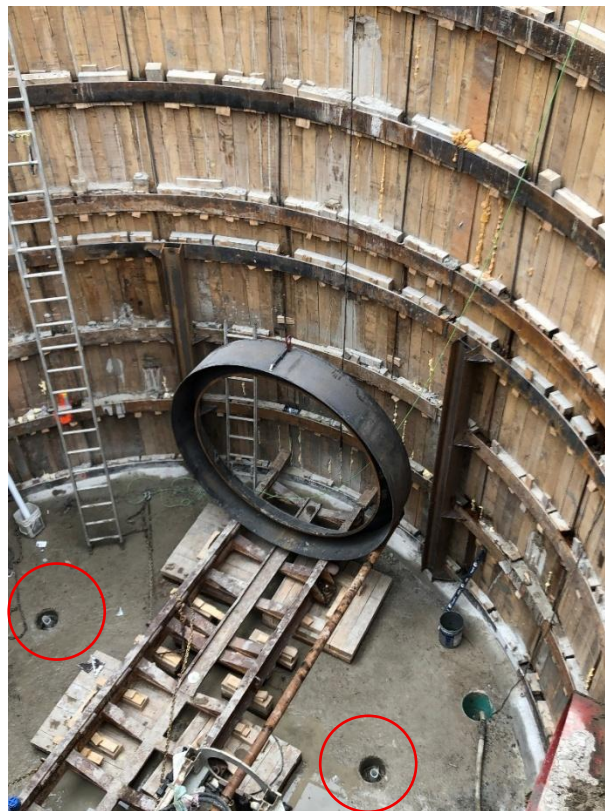




**FIGURE 5-2: BOULDERS REMOVED DURING SHAFT EXCAVATION FOR THE CENTREPORT SERVICING PROJECT (2025)**



**FIGURE 5-3: PASSIVE RELIEF WELLS IN SHAFT BASE FOR COCKBURN SEWER RELIEF PROJECT (2022)**



## 6.0 SUBSURFACE CHARACTERIZATION

The stratigraphy for the project site was developed based on the information obtained from the 2025 and 2026 exploratory boreholes and wells, and supplemented with the historical geotechnical investigation data in the general project area, laboratory test data, and KGS Group's experience with the local geology. The stratigraphy and baseline engineering properties of the overburden soil deposits, and bedrock unit are presented in this Section. Detailed descriptions of the soil and bedrock, borehole log records and results of laboratory tests are provided in the GDR. The approximate horizons and thicknesses of the overburden and bedrock layers are shown on figures within the GDR and on the Contract Drawings.

### 6.1 Overburden Characterization

The stratigraphy generally consists of fill materials and Upper Complex Zone clay overlying glaciolacustrine clay, glacial silt till deposit, and limestone sedimentary bedrock.

The two main overburden components at the site are:

- Glaciolacustrine clay; and
- Glacial till deposit

#### 6.1.1 GLACIOLACUSTRINE CLAY

Glaciolacustrine clay was encountered in all boreholes beneath the low plasticity clay of the Upper Complex Zone and overlying the cobbly, bouldery glacial till. A description of the clay is provided in the GDR and the approximate horizon/thickness along the proposed alignment is shown on the boreholes on the Contract Drawings, and Figure 02 in the GDR. The clay was typically brown to grey in colour, damp to moist, soft to very stiff in consistency, of high plasticity, and contained trace silt inclusions, and trace sand. In general, the consistency of the clay was stiff and decreased uniformly with depth to the interface with the glacial till deposit.

A summary of field observation and laboratory testing data for the high plastic glaciolacustrine clay is outlined in the GDR.

The glaciolacustrine clay will be encountered during all temporary excavations for the Work. The proposed trenchless installation beneath the CPKC Winnipeg Beach Spur railway right-of-way is anticipated to be constructed fully in the glaciolacustrine clay using pilot tube guided auger boring construction methods. The trenchless crossings of the existing 2700mm concrete trunk sewer are anticipated to be constructed in the glaciolacustrine clay using pilot tube guided auger boring construction methods. The deep excavation shafts anticipated for the Work east of the CPKC right-of-way are anticipated to be constructed fully within the glaciolacustrine clay.

Baseline values that apply to the glaciolacustrine clay are summarized in Table 6-1:

TABLE 6-1: BASELINE VALUES FOR GLACIOLACUSTRINE CLAY

Parameter	Value
Unsupported vertical tunnel face behaviour under atmospheric conditions	<p><b>Soil Type:</b> High Plastic Clay</p> <p><b>Anticipated Ground Behaviour:</b> The upper brown layer of the glaciolacustrine clay will be stable and exhibit Firm behaviour upon excavation and quickly in-turn become Slow Ravelling depending upon the degree of fissuring. The lower grey layer will begin to Squeeze and yield plastically with increased depth upon excavation. The shear strength of both the upper brown and lower grey high plastic clay will progressively decrease over a short period of time due to changes in effective stress and moisture conditions, resulting in Swelling and yielding conditions if the soil is left unsupported.</p>
Undrained Shear Strength	<ul style="list-style-type: none"> <li>Above El. 228 m: 50 kPa</li> <li>From El. 228 to 222 m: 50 kPa decreasing linearly to 20 kPa with depth</li> <li>Below El. 222 m: 20 kPa</li> </ul>
Bulk Unit Weight	18 kN/m <sup>3</sup>
Liquid Limit	Upper Limit – 110% Lower Limit – 55 %
Plastic Limit	Upper Limit – 35% Lower Limit – 15%
Effective Friction Angle, $\Phi'$	14 degrees
Effective Cohesion, $c'$	5.0 kPa
Coefficient of Earth Pressure at Rest	0.75
Hydraulic Conductivity, $K_{sat}$	$1 \times 10^{-8}$ m/s
Overconsolidation Ratio, OCR	Upper Limit – 5 Lower Limit – 1
Compression Index	Upper Limit – 1.0 Lower Limit – 0.5
Swelling Pressure (refer to GDR for discussion)	100 kPa Very high swelling potential
Stickiness and Clogging Potential (refer to GDR for discussion)	High stickiness potential Strong clogging potential

### 6.1.2 GLACIAL TILL

Glacial silt till deposit was encountered below the glaciolacustrine clay. A description of the glacial till deposit is provided in the GDR and the approximate horizon is shown on the boreholes on the Contract Drawings, and Figure 02 in the GDR. The silt till was light brown to grey in colour, damp to wet, compact to very dense, with sand, and contained trace to some fine to coarse gravel, and some clay. Boulders and cobbles are commonly found within the till layer and should be anticipated within the deposit at this project site.

A summary of field observation and laboratory testing data for the glacial till is outlined in the GDR.

It is not anticipated that the trenchless works will encounter the glacial till deposit; however, pockets of till material can be expected in the lower half of the glaciolacustrine clay deposit. Temporary excavations and shafts for the trenchless construction may approach the interface between the clay and glacial till for the Works.

#### 6.1.2.1 Boulders

Premature refusal of SPT spoons in the boreholes within the till deposit typically indicates the presence of cobbles and boulders in the silt till or at the bedrock surface. Cobbles and boulders have been observed within the glaciolacustrine clay layer during previous trenchless construction projects within Winnipeg. The composition of the cobbles/boulders will contain igneous and sedimentary rock types of variable strength. The percent volume of boulders per excavated volume of glacial till from previous tunnelling experience in Winnipeg has been measured to be more than 15% in some cases.

The contractors should expect to encounter some boulders within the glaciolacustrine clay layer. Baseline values that apply to the glacial till are summarized in Table 6-2:

TABLE 6-2: BASELINE VALUES FOR GLACIAL TILL

Parameter	Value
Unsupported vertical tunnel face behaviour under atmospheric conditions	<b>Soil Type:</b> Sandy Silt Till  <b>Anticipated Ground Behaviour:</b> Below the groundwater table, Fast Ravelling to Flowing conditions will occur. Unstable [Running or Flowing] conditions can be expected where cohesionless granular layers or pockets are present in the till. Cobbles and boulders will be encountered.
Bulk Unit Weight	22 kN/m <sup>3</sup>
Liquid Limit	Upper Limit – 30% Lower Limit – 10%
Plastic Limit	Upper Limit – 15% Lower Limit – 2%
Effective Friction Angle,	23 degrees
Effective Cohesion, c'	5.0 kPa
Coefficient of Earth Pressure at Rest	0.60
Hydraulic Conductivity, K <sub>sat</sub>	1x10 <sup>-5</sup> m/s
Stickiness and Clogging Potential	Medium stickiness potential Medium clogging potential
Excavatability/Rippability (Kirsten, 1988)	Hard ripping
Boulder – Size (Trenchless construction)	1200 mm diameter
Boulder – Size (Open cut / Shaft construction)	1500 mm diameter
Boulder – Frequency	20% by excavated volume of glacial till
Cobble/Boulder – Uniaxial Compressive Strength (UCS)	250 MPa
Cobble/Boulder – CERCHAR Abrasiveness Index (CAI)	5.0 – Extreme Abrasiveness

## 6.2 Bedrock Characterization

The bedrock consists of dolomitic limestone, and is further described in the GDR. The bedrock is not anticipated to be encountered for this project (except where depressurization wells are determined to be required), but it is important to note that the bedrock is a confined aquifer and piezometric pressure conditions within the bedrock and the glacial till deposit are interconnected and typically similar. The upper bedrock units are water bearing, weathered, fractured, and will contain rubble zones.

No baseline values are presented for the bedrock within the project site.

## 6.3 Groundwater

Groundwater monitoring data within the overburden clay and glacial till deposits for the 2025 KGS Group geotechnical investigation and the historical investigations is presented in the GDR.

It is important to note that groundwater levels fluctuate seasonally and contractors should expect the levels to rise higher than the current measurements during the spring snow melt and after significant rainfall events and/or snowmelts.

Site specific hydrogeological data for the bedrock aquifer at three (3) key locations within the project area is presented in the GDR. Contractor's should understand that the bedrock aquifer is highly variable within Winnipeg and should expect a broad range of aquifer conditions to be encountered during construction of the Works. Aquifer conditions are known to vary significantly over short distances.

For baseline purposes, the groundwater elevation within the various strata is presented in Tables 6-3 and 6-4. The baseline groundwater levels are approximately 2.0 m higher than the highest groundwater readings recorded during the 2025 and 2026 groundwater monitoring periods, and the historical geotechnical investigations.

**TABLE 6-3: BASELINE GROUNDWATER LEVELS – WEST OF THE CPKC CROSSING**

Parameter	Value
Clay	Ground Surface
Glacial Till and Bedrock	El. 232 m

**TABLE 6-4: BASELINE GROUNDWATER LEVELS – EAST OF AND INCLUDING THE CPKC CROSSING**

Parameter	Value
Clay	Ground Surface
Glacial Till and Bedrock	El. 229 m



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