Preliminary Geotechnical Investigation Report

Costco Gloucester Conversion to Business Center – Fuel Station Addition
1900 Cyrville Road, Gloucester, Ontario

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Project No. 121626297

May 2025

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1.0 INTRODUCTION

Stantec Consulting Ltd. was retained by Costco Wholesale to carry out a geotechnical investigation as part of the construction of a new fuel facility in the northeast portion of the parking lot of the Costco Business Center parking lot in Gloucester, Ontario.

The work was carried out in general accordance with the scope of work for a geotechnical investigation as outlined in Stantec's proposal dated February 24, 2025, to Costco Wholesale.

This report has been prepared specifically and solely for the project described herein. It presents the factual results of the geotechnical investigation and provides geotechnical recommendations for the design and construction of the gas bar canopy, underground storage tanks (UST), pavement surfacing, and foundations.

Limitations associated with this report and its contents are provided in the statement of general conditions included in Appendix A.

2.0 PROJECT DESCRIPTION AND BACKGROUND

It is understood that a new fuel facility is proposed at the Costco Wholesale Business Center located at 1900 Cyrville Road in Gloucester, Ontario. The property occupies approximately 5 hectares of land and currently consists of 603 parking stalls with commercial properties to the east, residential properties to the north, gas station and truck yard to the west, and commercial property to the south. The site location is shown in Drawing No. 1 – Borehole Location Plan. The site has grade elevations varying between 63 m and 67 m. The proposed fuel facility addition will be located in the northeast portion of the Costco Wholesale parking lot.

It is understood that the objective of the project is to design and construct a new fuel facility that consist of a new apron, underground storage tanks, and a redesigned parking lot and access roads. The project layout was provided in Site Plan SP11, dated April 29, 2022, prepared by WSP. The borehole locations were selected based on this layout.

According to Ontario Geological Survey (OGS) mapping (Ontario Geological Survey 2010. Surficial geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128-REV), the subsurface conditions at the site consist of fine-textured glaciomarine deposits of silt and clay with minor sand and gravel. The OGS historical borehole records reviewed reported encountering sand and silty sand to depths exceeding 8 m. According to the bedrock geological mapping (Ontario geological Survey 2011. 1:250 000 scale bedrock geology of Ontario; Ontario Geological Survey, Miscellaneous Release—Data 126 Revision 1), the bedrock in the area consists of shale, limestone, dolostone, or siltstone of Georgian Bay, Blue Mountain, and Billings formations. The depth to bedrock in the area is expected to range from approximately 4 m to 9 m below ground surface (BGS).

3.0 SCOPE OF WORK

The scope of work for this geotechnical investigation is presented below:

- Advance four (4) boreholes at the site; including three (3) boreholes for the gas bar canopy and pumps to depths of 3.0 m, 6.0 m, and 8.0 m BGS, respectively, or auger refusal, and one (1) borehole at the location of the underground storage tank to a depth of 12.0 m BGS. If refusal is encountered prior to reaching the target depth in the 12 m borehole, up to 1.5 m of rock coring to confirm the presence of bedrock.
- Install one monitoring well in the 12 m borehole to measure the stabilized groundwater level and to carry out hydrogeological testing.
- Conduct Standard Penetration Tests (SPT) at regular intervals while collecting soil samples.
- Perform laboratory tests including moisture content, grain size analysis, Atterberg Limits, and soil corrosivity testing.
- Preparation of a geotechnical investigation report that summarizes the results of the field investigations and laboratory test results and provides recommendations for design and construction of the proposed fuel facility addition.

4.0 METHOD OF INVESTIGATION

4.1 GEOTECHNICAL FIELD INVESTIGATION

The field investigation for this project was carried out over the course of two days between February 27th and February 28th, 2025. A total of four (4) boreholes, identified as BH25-01 to BH25-04, were advanced at the locations shown in Drawing No. 2 – Borehole Location Plan in Appendix B. The boreholes were advanced using a truck mounted CME-55 drill rig supplied and operated by George Downing Estate Drilling Ltd. The boreholes were advanced to depths ranging from 3.7 m to 9.6 m BGS. Auger refusal was encountered in boreholes BH25-01 and BH25-02 at 7.7 m BGS.

Soil samples were collected at regular intervals while conducting Standard Penetration Tests (SPT) in accordance with the procedures outlined in ASTM specification D1586.

A monitoring well was installed in one borehole (BH25-1) to allow for hydraulic response testing and groundwater level measurement. The monitoring well consisted of a 50 mm inside diameter, Schedule 40 PVC pipe, with a No.10 slot screen (0.01-inch slot) and screen length of 1.5 m. The annular space between the monitoring well pipe and surrounding geological formation was backfilled with sand to 0.3 m above the top of screen, with bentonite seal filling the annular space up to 0.6 m above the sand, and the remaining annular space backfilled with soil cuttings. The bentonite seal minimizes the potential for hydraulic connection from occurring between the soil layers along the length of the casing. The groundwater measurement was carried out on March 31st, 2025. Boreholes BH25-2, BH25-3, and BH25-4 were backfilled with a mixture of soil cutting and granular bentonite and surfaced with cold patch asphalt.

The fieldwork was supervised by Stantec's geotechnical personnel who located the boreholes, directed the drilling operations, and recorded the subsurface stratigraphy encountered in each borehole. All recovered soil samples were transported to the Stantec Ottawa laboratory for detailed geotechnical classification and testing.

The coordinates and elevations of the boreholes were collected by Stantec's geomatics team.

4.2 LABORATORY TESTING

All samples returned to the laboratory were subjected to detailed visual examination and classification by a geotechnical engineer. Selected soil samples were tested for moisture content, grain size analyses, Atterberg Limits testing, and corrosivity testing. All laboratory testing except for the corrosivity tests was completed at Stantec's geotechnical and materials testing laboratory to determine engineering properties in accordance with American Society for Testing and Materials (ASTM) and Canadian Council of Independent Laboratories (CCIL) applicable standards. One sample of soil from borehole BH24-3 was submitted to Paracel Laboratories in Ottawa, Ontario for basic chemical analysis to determine the potential soil corrosivity potential.

The results of the laboratory tests are discussed in the text of this report and are provided on the Borehole Records in Appendix C, and on the laboratory testing figures in Appendix D.

Soil samples will be stored for three (3) months after the issuance of the final report unless directed by the client.

4.3 SURVEYING

Stantec's geomatics team was retained to complete a property survey including the services and the surrounding streets. The borehole surface elevations were also recorded as part of this survey event. The survey was completed on April 3rd, 2025, and the resulting borehole elevations are recorded in Table 4-1.

Table 4-1 : Borehole elevations based on survey completed April 3rd, 2025

Borehole ID	Northing	Easting	Elevation (m)
BH25-01	5031036	375032	66.45
BH25-02	5031019	375044	66.38
BH25-03	5031037	375053	66.65
BH25-04	5031010	375068	66.62

5.0 RESULTS OF INVESTIGATION

5.1 SUBSURFACE INFORMATION

During the current investigation, boreholes BH25-2 to BH25-4, were advanced within the parking lot area in the northeast portion, south of the access road to Cyrville Road. BH25-1 was advanced within the northeast access road from Cyrville Road.

The subsurface conditions observed in the boreholes and results of the laboratory tests performed on representative soil samples are presented on the Borehole Records provided in Appendix C. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix C.

The stratigraphic boundaries on the borehole records are inferred from non-continuous sampling and therefore represent transitions between soil types rather than exact boundaries between geological units. The subsoil conditions will vary between and beyond the borehole locations.

The subsurface profile encountered at the boreholes generally consists of asphalt and granular fill material overlying a native sand with silt layer, followed by a glacial till comprised of sandy silt to silty sand with gravel over shale bedrock. Bedrock was confirmed by 1.5 m of rock coring in BH25-1. Auger refusal (inferred to be a result of encountering either bedrock or a boulder) was encountered in borehole BH25-02 at a depth of 7.7 m.

5.1.1 Asphalt and Fill

All boreholes were drilled through the existing asphalt. The thickness of the asphalt was 65 mm in BH25- 01 and BH25-03, 75 mm in BH25-02, and 100 mm in BH25-04. A granular fill material consisting of brown silty sand with gravel was encountered beneath the asphalt in borehole BH25-01 and a granular fill material consisting of brown sand with gravel was observed beneath the asphalt in the remaining boreholes. The granular fill extended to depths ranging from 1.8 to 2.3 m. Cobbles were inferred from auger cuttings in BH25-04.

The thickness of asphalt and granular fill at each borehole location is provided in Table 5.1. A distinction between base, subbase, or subgrade fill was not evident in the boreholes, therefore, the thickness of granular fill may include the sum of the thicknesses of base, subbase and/or subgrade fill.

Table 5-1: Existing Asphalt Thickness

Borehole ID	Test Hole Location	Asphalt Thickness (mm)	Granular Fill (m)
BH25-01	Parking Lot Entrance – UST Location	65	1.8
BH25-02	Parking Lot – Canopy and Pumping Location	75	2.2
BH25-03	Parking Lot – Canopy and Pumping Location	65	2.2
BH25-04	Parking Lot – Canopy and Pumping Location	100	2.2

The Standard Penetration Test (SPT) "N"-values for the fill ranged from 9 to more than 50 indicating a loose to very dense compactness state.

The moisture content of the samples of the fill tested ranged from 3% to 10%.

One (1) representative sample of the fill was selected for grain size distribution testing and the results are summarized in Table 5.2 and the grain size distribution curve is shown in Figure No. 1 in Appendix D.

Table 5-2: Summary of Grain Size Analysis of Fill

Borehole No.	Sample ID	Depth (m)	Moisture Content %	Gravel (%)	Sand (%)	Fines (%) – Silt and Clay
BH25-01	SS1	0.75 – 1.0	10	11	67	22

5.1.2 Sand with Silt to Silty Sand

A sand with silt to silty sand layer was encountered beneath the fill material in all boreholes. The sand with silt layer was encountered between depths of 1.8 to 2.3 m and the silty sand layer was encountered at a depth of 2.3 m. The sand with silt to silty sand deposit extended to depths ranging from 3.2 m to 4.6 m.

The SPT N-values in the sand with silt to silty sand layer ranged from 12 to 24, indicating a compact state.

The moisture content of the samples of the soil tested ranged from 5% to 20%.

Three (3) representative samples were selected for grain size distribution testing. The results are summarized in Table 5.3 and the grain size distribution curve is shown in Figure No. 2 in Appendix D.

Table 5-3: Summary of Grain Size Analysis of Sand with Silt to Silty Sand Layer

Borehole No.	Sample ID	Depth (m)	Moisture Content %	Gravel (%)	Sand (%)	Fines (%) – Silt and Clay
BH25-02	SS3	2.3 – 2.9	10	12	74	14
BH25-03	SS3	2.3 – 2.9	6	14	76	10
BH25-04	SS4	3.1 – 3.7	5	9	82	9

According to the Unified Soil Classification System (USCS), the samples tested are classified as poorly-graded sand with silt (SP-SM), well-graded sand with silt (SW-SM), or silty sand (SM).

5.1.3 Till

A deposit of fluvioglacial till was encountered beneath the native sand layer in boreholes BH25-01, BH25-02, and BH25-03. The till layer was encountered at depths ranging from 3.2 m to 4.6 m and extended to

depths ranging from 6.7 m to 7.7 m. Rock fragments were observed within the till layer at boreholes BH25-01 and BH25-02. The till was inferred to contain cobbles and boulders.

The SPT N-values for the till ranged from 8 to greater than 50 indicating a loose to very dense compaction state.

The moisture content of the samples of the till soils tested ranged from 6% to 20%.

Four (4) representative samples were selected for grain size analysis testing. The results are summarized below in Table 5.4 and the grain size distribution curves are shown on Figure No. 3 in Appendix D.

Table 5-4: Summary of Grain Size Analysis of Till

Borehole No.	Sample ID	Depth (m)	Water Content %	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH25-01	SS8	6.1 – 6.7	15	5	18	72	5
BH25-02	SS6	4.6 – 5.0	7	7	33	53	7
BH25-02	SS8	6.1 – 6.2	6	18	41	41	
BH25-03	SS4B	3.2 – 3.7	9	29	39	24	8

Silt – fraction of particles with sizes smaller than 0.075 mm and greater than 0.002 mm.
Clay – fraction of particles with sizes smaller than 0.002 mm.

According to the Unified Soil Classification System (USCS), the till samples tested can be classified as either a sandy silt (ML), silt with sand (ML), or silty sand with gravel (SM).

Samples SS8 from BH25-01 and SS4B from BH25-03 were also selected for Atterberg Limits testing. The test results for sample SS8 from BH25-01 indicated that the soil is non-plastic (NP). The results are summarized in Table 5.1 below and the respective plasticity index chart is shown on Figure No. 4 in Appendix D.

Table 5-5: Summary of Atterberg Limits Testing of Till

Borehole No.	Sample ID	Depth (m)	Liquid Limit %	Plastic Limit %	Plasticity Index
BH25-1	SS8	6.1 – 67	NP	NP	NP
BH25-03	SS4B	3.2 – 3.7	14	10	4

5.1.4 Bedrock

Bedrock was encountered at a depth of 7.7 m in borehole BH25-01 and was cored to a depth of 9.6 m BGS. The rock core consisted of dark grey shale characterized by horizontal bedding and very close joint spacing. The Rock Quality Designation (RQD) values recorded were 80%, 28% and 67%, indicating a poor to good quality rock.

The bedrock depth encountered is generally consistent with the bedrock depths indicated by the geological mapping for this area.

Auger refusal was encountered in borehole BH25-02 at 7.7 m below ground surface level; this may be the result of encountering the bedrock surface or could be the result of a large cobble or boulder within the glacial till layer

A detailed description of the rock core is provided in the bedrock core log in Appendix C. Rock core photographs are also provided in Appendix C.

5.1.5 Groundwater

A monitoring well was installed in BH25-01. The groundwater level was recorded at a depth of 6.35 m below ground surface. Additional details on the groundwater level in the monitoring well installation and observed groundwater levels are provided in the borehole logs presented in Appendix C.

Table 5-6: Summary of Monitoring Well Readings

Borehole No.	Ground Surface Elevation (m)	Date of Measurement	Depth to Groundwater (m)	Groundwater Elevation (m)
BH25-01	66.37	2025-04-01	6.35	60.02

It should be noted that groundwater levels at the site will be subject to fluctuations due to seasonal changes, snowmelt, water level in the river and precipitation events. The water levels should be expected to be higher during the spring season, as well as during and following periods of heavy precipitation or snow melt.

5.2 CHEMICAL ANALYSIS

One (1) representative soil sample was submitted to Paracel Laboratories in Ottawa, Ontario, for analysis of pH, water soluble sulphate, chloride concentrations, and resistivity. The testing was completed to determine the potential for degradation of the concrete in the presence of soluble sulphates and the potential for corrosion of exposed steel used in foundations and buried infrastructure.

The analysis results are summarized in Table 5-7.

Table 5-7: Chemical Testing Results

Borehole No.	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
BH25-02	SS3	3.05 – 3.66	7.99	248	494	10.5

The results of the tests received from the laboratory are provided in Appendix D.

The pH, resistivity and chloride concentration provide an indication of the degree of corrosiveness of the subsurface environment. The neutral pH value is 7.0 and the normal range of soils is from 4.0 to 8.5. The pH value of 7.99 measured on the soil sample is within the normal range, though it is on the upper end.

The chloride concentration threshold value of 500 µg/g is typically used to designate soil or water as being corrosive. The chloride concentration for the sample is 248 µg/g, indicating a low corrosivity potential.

A scale of soil corrosiveness based on resistivity is as follows (British Standard BS-1377)

- Resistivity > 100 Ohm-m: slightly corrosive
- 50 < resistivity < 100 Ohm-m: moderately corrosive
- 10 < resistivity < 50 Ohm-m: corrosive
- Resistivity < 10 Ohm-m: severely corrosive

The degree of soil corrosiveness based on resistivity result should be considered corrosive. It should be noted that the resistivity measured is marginally within the corrosive range and could be considered severely corrosive.

The pH, chloride, and resistivity values presented in the table above may be used by structural designers in assessing the potential for chemical attacks on buried steel and as an aid in selecting coating and corrosion protection systems for buried steel objects.

5.2.1 Cement Type for Use in Buried Concrete

The concentration of soluble sulphate provides an indication of the degree of sulphate attach that is expected for concrete in contact with soil and groundwater. Soluble sulphate concentrations of less than 1000 µg/g generally indicate that a low degree of sulphate attach is expected for concrete in contact with soil and groundwater.

The results of the tests for soluble sulphate in the sample referenced in the preceding section yielded a concentration of 494 µg/g. Based on the test results, there is a low degree of potential sulphate attack for concrete in contact with the soil. Type GU Portland Cement can therefore be considered suitable for use in buried concrete.

6.0 DISCUSSION AND RECOMMENDATIONS

This section of the report provides geotechnical engineering input related to the design and construction of the gas bar canopy, the pavement surfacing, and for the underground storage tanks at the Costco Wholesale Business Centre located at 1900 Cyrville Road, Gloucester, Ontario.

The following geotechnical input is based on the subsurface information that was available at the time of writing this report and our understanding of the project requirements. Where comments are made on construction, they are provided to highlight the aspects which could affect the design. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction, and make their own interpretation of the factual data with respect to the profile provided at the time of tendering, as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

No preliminary structural plans were available for review at the time of this report. It is assumed that the underside of the footings will be approximately 1.8 m below finished ground elevation, and that the storage tanks will installed at a depth of 5.5 m below finished ground elevation.

Boreholes BH25-01 was advanced at the location of the proposed underground storage tanks and boreholes BH25-02, BH25-03, and BH25-04 were advanced for the proposed pavement structures, pump foundations, and canopy foundations within the footprint of site plan SP-11.

The Site is currently developed, and the general soil stratigraphy at the proposed gas bar location comprises of asphalt pavement structure underlain by fill ranging in thickness from approximately 1.8 to 2.3 m, underlain by a layer of silty sand to sand with silt soil with thicknesses varying between 0.9 m and 2.9 m. This layer was underlain by a layer of sandy silt to silty sand with gravel till encountered at a depth of 3.3 m to 4.6 m below ground surface extending to shale bedrock. The sandy silt to silty sand till frequently encountered refusal blow counts during the SPT testing, likely due to presence of cobbles and boulders. When sampler refusal was not encountered, the till was assessed as having as loose to dense relative compaction. Beneath the overburden, sedimentary bedrock comprising of shale was encountered at a depth of 7.7 m below ground surface (Elevation 58.67 meters above sea level (masl)).

Groundwater level was measured by Stantec on April 1st, 2025, from the monitoring well installed during the February 2025 drilling program. A stabilized groundwater level was measured at a depth of 6.35 m below ground surface (Elevation 60.02 masl).

6.1 SITE GRADING AND PREPARATION

6.1.1.1 General

The program for grading and earthworks should be designed in advance and carefully executed in consideration of the time of year of execution, prevailing weather conditions, construction stormwater management control and associated issues and concerns, and the intended end-use of the subject property as described herein.

We understand that the majority of the site grading work will generally involve minor gradation changes within the footprint of the gas bar canopy. Engineered fill will be required within the footprint of both the gas bar canopy and the underground storage tanks to replace the existing fill.

The native soils at this Site are predominantly granular sand with a high silt content. Due to the significant silt content, the native soils are susceptible to softening when exposed to water and during construction activities. Therefore, site grading activities should be monitored and maintained in stable conditions. Prepared surfaces should be protected to minimize the amount of degradation during wet weather conditions. In addition, the native soils that have been successfully compacted and approved, may require removal should they become wet and softened from water infiltration, precipitation or thawing. Therefore, it is recommended to plan and control ground surface runoff away from areas of construction.

In addition to meeting Costco's requirements, all fill materials imported must comply to all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

6.1.2 Erosion and Sediment Control and Regulatory Constraints

As erosion and sediment control should be developed and implemented prior to commencement of construction, to direct precipitation and ground surface runoff away from the areas of construction. Identification of an outfall/discharge location will be required for this purpose. All erosion sedimentation control should be conducted in accordance with the approved for construction design drawings.

6.1.3 Grading and Earthworks

6.1.3.1 Sub-Excavation and Proof Rolling

The majority of the Site is developed, comprised of buildings, concrete curb and sidewalks, median green spaces, and asphalt. At the time of this report, utilities (electrical, gas, water, wastewater, storm water) for all buildings within the Site are operational and will need to be protected from damage during construction activities. Costco's requirements for engineered fill are shown below in Table 6.1. If a stockpile of material meeting Costco's engineered fill gradation requirements is to be created on-site, the earthworks contractor must ensure that fines from the underlying native soils are not mixed into the fill during stockpiling operations.

All pre-existing fill must be removed from construction area footprints prior to grading and foundation construction activities. In the areas of the boreholes where fill was observed to be silty, the fill material will not be suitable for reuse as engineered fill. These materials should be inspected by geotechnical personnel at the time of construction. It is recommended that any traces of topsoil, organics, and/or rootlets noted within the fill at the time of removal operations be removed prior to placing engineered fill. Cobbles and boulders were inferred to be present in the fill material and should be removed beneath all foundations.

Following stripping, the subgrades in areas of proposed fill are to be inspected by geotechnical personnel to ensure that all unsuitable materials are removed. Any fill, organics, excessively loose/soft materials,

wet zones, or disturbed/softened areas identified during site preparation or during general construction activities, are to be removed and replaced with approved engineered fill, as referenced in Section 6.2.3.2. Engineered Fill Placement

Engineered fill is required below the proposed gas bar canopy. Prior to engineered fill placement, any existing fill material and unsuitable native soils must be removed plus a horizontal distance beyond the periphery sufficient to allow engineered fill pad construction. The engineered fill must extend horizontally 1 m beyond the edge of proposed footings, and then downwards and outwards at a slope of 1 horizontal to 1 vertical to competent soil. Geotechnical comments with respect to excavations are provided in Section 7.4.

The existing fill that is not silty, such as gravel with sand fill may be suitable for reuse as engineered fill, but further testing during construction is recommended. Native soils will generally not meet Costco's gradation requirements for engineered fill, which is summarized in Table 6.1.

Table 6-1: Costco Engineered Fill Gradation Requirements

Sieve Size	Percent Passing
75 mm	100%
0.075 mm	0 – 10%

OPSS.MUNI 1010 Granular 'A' or Granular 'B' with 100% passing the 75 mm sieve are commonly used materials in Ontario that would meet Costco's requirements for engineered fill. Once site grading is complete, additional care would be needed to protect the finished surface from the environment during building construction.

We refer to Section 7.1 of this report for additional commentary on the re-use of on-site materials.

Engineered fill should be placed in maximum 300 mm thick loose lifts compacted to at least 95% Modified Proctor maximum dry density (MPMDD) below the canopy structure, as per Costco requirements.

The engineered fill material should be within 2% of optimum moisture for compaction at the time of placement. If on-site materials are to be re-used as engineered fill, earth grading operations should only be carried out during the dry summer months to minimize the exposure to rain and promote drying of soil.

6.2 PROPOSED GAS BAR

6.2.1 Foundation Design

6.2.1.1 Seismic Site Class

The selection of the seismic site classification is based on the average soil conditions encountered in the upper 30 m of the stratigraphy. For this project, the boreholes were terminated at a maximum depth of 9.6 m below ground surface in bedrock. The stratigraphy below this depth has therefore been inferred to consist of bedrock.

The recommended site classification for seismic site response for this Site for structures with shallow foundations founded on compact to very dense native soils and/or engineered fill is Site Class C in accordance with Table 4.1.8.4.B of the 2020 National Building Code (NBC).

A copy of the NBC Seismic Hazard Calculation Data sheet prepared by Natural Resources Canada is provided in **Appendix E** for reference.

6.2.1.2 Frost Design

The design frost depth for the Ottawa Area is 1.8 m below grade. All footings for structures should be protected from frost action by a minimum soil cover of 1.8 m. Where footings have insufficient soil cover for frost protection, the use of manufactured insulation will be required.

Frost resistant fill is required by Costco in some areas. Costco's gradation requirements for frost-free fill are provided in the Table 6-2 below.

Table 6-2: Costco Frost Resistant Fill Gradation Requirements

Sieve Size	Percent Passing
37.5 mm	100%
19.0 mm	40 – 80%
13.2 mm	30 – 70%
4.75 mm	0 - 10%
0.075 mm	0 – 3%

The above-noted gradation does not align with common aggregates typically available in Ontario. As such, it is recommended utilizing OPSS.MUNI 10 Granular 'B', with 100% of the material passing the 75 mm sieve, as frost-resistant backfill. It is recommended that where required, frost resistant fill extend 1.8 m below finished grade. Transitions between frost-resistant fill and soils that are not frost resistant should be made at 3H:1V. If the transition between frost-resistant fill and soils that are not frost resistant is in a landscaped area, the transition may be made at 1 horizontal to 1 vertical.

6.2.1.3 Geotechnical Resistance at Ultimate and Serviceability Limit States (ULS & SCS)

Boreholes BH25-02, BH25-03, and BH25-04 were advanced in the area of the proposed gas bar canopy and BH25-01 was advanced in the area of the underground storage tanks.

The native soils generally consist of sand with silt to silty sand underlain by a glacial till deposit reposing on bedrock. Deposits of sandy silt to silty sand till were contacted in all boreholes except BH25-04 and extended to depths ranging from 4.6 m to 7.7 m. Groundwater level was measured in the monitoring well installed at BH25-01 at a depth of 6.35 m below ground surface.

Depending on the concept chosen, the finished grades in the area of the gas bar canopy will range from Elevations 65 to 67 masl. It is anticipated that the excavations for installation of the underground storage tanks will extend to approximately 6 m below finished grade to the compact to dense till. The bedrock was encountered below Elevation 58.67 masl at borehole BH25-01 and the groundwater level was measured at Elevation 60.02 masl in the monitoring well. It is recommended that the underground storage tanks be designed to resist uplift from groundwater when they are emptied to mitigate the impact of potentially significant groundwater fluctuations. For the design of the tanks, it is recommended that the groundwater level be taken at Elevation 61.8 masl, to account for seasonal variations in groundwater levels. Additional groundwater monitoring could be completed to better define the seasonal changes of the groundwater regime at the Site.

Footings for the proposed gas bar canopy are assumed to be at or below Elevation 64.6 masl. The bearing pressures provided in Table 6.5 are recommended for footing sizes up to 2.5 m by 2.5 m. Most of the gas bar canopy will encounter the fill material at the anticipated footing level. It is recommended that the footings be extended to the till layer, where high blow counts were obtained.

Table 6-3: Footing Bearing Pressures

Footing Subgrade	Factored ULS Resistance	SLS Reaction
Silty Sand Till	300 kPa	150 kPa

The geotechnical bearing resistance, ULS incorporates a resistance factor of 0.5. The SLS complies with Costco's requirements to limit total settlements to 25 mm and differential settlements to 12.5 mm over 15 m.

6.3 TEMPORARY SHORING

It is possible that temporary shoring may be used to facilitate the excavations for the underground storage tanks for the proposed gas bar. Comments regarding the design of the temporary shoring system are therefore provided below.

The shoring system should be designed in accordance with the methods described in the Canadian Foundation Engineering Manual (2024, 5th Edition).

The selection and design of the temporary shoring system should consider whether deflection of the supported soils is permitted (i.e., no structures or infrastructure sensitive to deformation exist within the zone of influence of the planned excavation) and whether penetration below the prevailing groundwater table or groundwater infiltration is an issue. The selection and design should further consider related structural and serviceability requirements.

The design of the shoring system should also consider any surcharges or loads from adjacent buildings, road embankment, and machinery or stockpiled materials that may be present within the zone of influence of the excavation and shoring system.

The design of the shoring and anchorage system should be carried out by a professional engineer specialized in shoring design.

The soil parameters presented in Table 6-4 can be used for design of temporary shoring as well as lateral pressure acting on the underground tanks. These coefficients of lateral pressure values are evaluated for a horizontal back slope. The earth pressure coefficients should be adjusted (i.e. increased) where sloping ground will be present behind the walls.

At-rest earth pressures should be used in the design of retaining structures that are restrained from movement. The thrust acts at a point one third up the height of the wall.

Table 6-4: Non-Seismic Lateral Earth Pressure Parameters (Horizontal Backfill)

Parameter	OPSS Granular B - Type I	Existing Fill	SAND with silt and SILT with sand TILL
Bulk Unit Weight, γ (kN/m^3)	22	21	21
Effective Friction Angle	32º	30º	30º
Coefficient of Earth Pressure at Rest (K_o)	0.47	0.50	0.50
Coefficient of Active Earth Pressure (K_a)	0.31	0.33	0.33
Coefficient of Passive Earth Pressure (K_p)	3.25	3.00	3.00

The groundwater level was measured at a depth of 6.35 m below ground surface, however, the potential presence of perched water within the fill materials should be considered.

6.4 PAVEMENT DESIGN RECOMMENDATIONS

New pavement will be constructed for this project. Based on the Costco's development requirements, the pavement is to be designed for a 20-year life, with 30 trucks per day on heavy duty pavement and. 6,600 cars per day on standard duty pavement.

The pavement subgrade soils are expected to comprise of native sand with silt to silty sand or historical grade raised engineering fill, in most areas. Where required, site grades below pavement structures are to be raised using subgrade fill. Details pertaining to site reparation below pavements structures are

provided in Sections 6.2.3.1 and 6.2.3.3. The following pavement structures provided in Table 6-5 are based on the anticipated subgrade conditions and provided preliminary traffic data.

Table 6-5: Pavement Structures

Material	Design Pavement Structure Thicknesses	
	Heavy Duty	Standard Duty
Costco Surface Asphalt Mix PG 58-28 for standard duty PG 64-28 for heavy duty Surface course	40 mm	40 mm
Costco Base Asphalt Mix PG 58-28 for standard duty PG 64-28 for heavy duty Base course	75 mm	55 mm
OPSS.MUNI 1010 Granular ‘A’ Base	150 mm	150 mm
OPSS.MUNI 1010 Granular ‘B’ Subbase	550 mm	400 mm

Concrete pavements may be considered for sections of the Site, such as near the pumping area. Table 6-6 summarizes the recommended concrete pavement structure thicknesses. The concrete should have an strength of at least 32 MPa and be designed to resist freezing and thawing and chlorides. Control joints at appropriate distances should be sawed into the concrete pavement following placement.

Expansion joints should be used to isolate fixed objects abutting or within the pavement.

Table 6-6: Recommended Concrete Pavement Structure

Material	Design Pavement Structure Thicknesses
Portland Cement Concrete	200 mm
OPSS.MUNI 1010 Granular ‘A’ Base	150 mm
OPSS.MUNI 1010 Granular ‘B’ Subbase	400 mm

These structures should provide the design 20-year service life, provided regular maintenance is carried out during the life cycle of the pavements.

The pavement subgrade must be proof rolled under the supervision of geotechnical personnel prior to Granular ‘B’ placement to confirm whether the design subbase thickness is sufficient. Any soft areas identified during proof rolling may require sub-excavation and replacement with additional Granular ‘B’ subbase.

The base and subbase materials should be compacted to a minimum of 100% SPMDD. The asphaltic concrete should be compacted to a minimum of 92% of Maximum Relative Density (MRD). Asphalt compaction must be carried out as required by Costco's specifications.

Asphalt mixes must meet the requirements of Costco's specifications, and the proposed Job Mix Formula must be reviewed and approved by Costco's consultants.

A tack coat is recommended between all asphalt layers and should meet OPSS 308 – Construction Specifications for Tack Coating and Joint Painting.

The finished subgrade surface and the pavement surface should be crowned and graded to direct runoff water away from the development and associated infrastructure. The pavement subgrade will comprise primarily of native sandy silt to silty sand. These non-cohesive, generally coarse-grained materials will not require the installation of pavement subdrains due to the sufficient hydraulic conductivity and drainage capabilities.

6.4.1 Pavement Transitions

Where new grades do not match existing at the end limits of the project, the new grade will need to be tapered out at the project ends. The transition from the new pavement surfaces and the existing asphalt should be carried out in accordance with Costco's specifications.

7.0 GEOTECHNICAL CONSIDERATIONS AND CONSTRAINTS

7.1 SITE MATERIAL REUSE

7.1.1 Topsoil

The existing topsoil, visually identified at the ground surface at the parking lot and road shoulders would need to be stripped from below the proposed pavement, road structures, and site servicing areas, where present. The topsoil can either be removed from site or be re-used in landscaped areas. The excavated organic soils are not suitable for reuse as engineered fill, trench backfill, granular base, and sub-base materials.

7.1.2 Fill and Native Soils

The fill contacted at the site ranged in composition from sand with silt to silty sand, and sand with gravel fill. The predominant native soils were comprised of sand with variable amounts of silt and some gravel.

Based on Costco requirements for engineered fill and subgrade fill, the silty fill as well as inorganic on-site native soils may not be considered suitable for reuse during the site preparation, other than potentially in landscaping areas. Where site servicing excavations extend into native soils, the native soils may be re-used in a portion of the trench as backfill. We refer to Section 7.7.3 for further details on the suitability of native soils as trench backfill.

Provided additional gradation analyses are completed during construction and the results satisfy Costco requirements, the existing gravel with sand fill can be reused for engineered fill and subgrade fill.

It is anticipated that consideration may be given to the use of the on-site fill and native soils as engineered fill even if they do not meet Costco's engineered fill gradation requirements. These soils may be suitable for re-use as engineered fill provided all organic and other deleterious materials are removed, and the soils are placed and compacted near optimum moisture for compaction.

High percentages of silt observed in some of the stratigraphy could make these soils difficult to handle, place, and compact, in any "less-than-ideal" weather conditions. Disturbance and loss of strength in the presence of excess moisture and/or construction traffic is a concern. It is recommended that the reuse of this soil be limited to prevailing "dry" conditions and during favorable seasons. The material can be blocky and if used will require breaking down during placement. It should be ensured that the material be placed in thin lifts and compacted using a sheepsfoot roller. If these soils are placed without being sufficiently broken down or placed in thick lifts, inter-lump voids could occur which will cause long term settlement.

This material should be placed with moisture contents that are within +/- 2.0% of the optimum moisture content level. It is recommended that the material be approved at the time of placement by qualified geotechnical personnel.

This fill and silty sand material is assessed as having a low to moderate frost susceptibility in accordance with Section 3.1.5 of the MTO's Pavement Design and Rehabilitation Manual. The sandy silt to sand with silt material is assessed as having a moderate to high frost susceptibility. Despite this layer being well below the frost depth for the Ottawa area, should the material be exposed to the atmosphere in the winter months during excavations, care should be taken to limit the time of exposure to minimize frost penetration.

7.2 IMPORTED FILL MATERIALS

All materials imported to the Site must meet all applicable municipal, provincial, and federal guidelines and requirements associated with environmental characterization of the materials.

Imported soils for use as engineered fill and subgrade fill should comprise OPSS.MUNI 1010 Granular 'A' or Granular 'B' with 100% passing the 75 mm sieve to meet Costco's requirements. Imported fill materials should contain no recycled materials such as concrete or asphalt. The imported fill material should be tested and approved by geotechnical personnel prior to delivery to the Site.

7.3 ADVERSE WEATHER CONDITIONS

Additional precautions, effort, and measures may be required, when and where construction is undertaken during late fall, winter, and early spring when the temperature and climatic conditions have an adverse influence on the standard construction practices or during periods of inclement weather.

With respect to all earthwork activities undertaken during the late fall through to late spring, when less-than-ideal construction conditions may prevail, the following comments are provided:

1. Engineered fill under buildings should comprise granular materials, such as imported sand or sand and gravel, Granular 'B'.
2. The intended area of fill should be clearly identified in the field prior to commencing the work.
3. Temporary ramps or roads for construction access must be constructed outside of the limits of intended fill.
4. Fill placement should be inspected by qualified field personnel on a full-time basis under the supervision of a geotechnical engineer, with the authority to stop the placement of fill at any time when conditions are considered to be unfavourable.
5. Imported materials that contain ice, snow, or any frozen material should not be accepted for use.
6. Overnight frost penetration may occur, even in granular fill materials, where precipitation and ground surface runoff pools and accumulates, and freezing temperatures exist. Any frozen materials must be removed prior to placing subsequent lifts of engineered fill. Breaking the frost in-situ is not considered acceptable.
7. It may be necessary to stop the placement of engineered fill during periods of cold, where ambient temperatures of -5°C or less, occur.

It should be noted that the placement of engineered fill materials during cold weather conditions requires extra effort beyond that typical when better climatic conditions prevail. At any time where conditions are deemed unfavourable, the engineered fill operation must be suspended. Any frost accumulating in placed fill must be removed prior to re-starting fill operations.

Appropriate scheduling of the work may also require specific consideration and revision from the typical adopted. The scope of work intended may have to be reduced or adjusted, and/or only select construction activities are undertaken during specific climatic conditions. The areas of planned engineered fill may have to be reduced on a daily basis, the extent of excavations may have to be limited, with all excavating and associated backfilling completed without delay.

7.4 TEMPORARY EXCAVATIONS

Temporary excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety (OH&S) Act & Regulations for Construction Projects.

The fill materials should be classified as Type 3 soils. In accordance with the OH&S Act, the maximum excavation side slope for a Type 3 soil is 1H:1V (Horizontal: Vertical) extending from the base of the excavation or the top of the trench box.

The undisturbed native soils comprising largely sand with silt, silty sand or sandy silt till encountered in the boreholes can be classified as Type 3 soils. The excavation side slopes for a Type 3 soil must have a maximum inclination of 1H:1V, in accordance with the OHSA regulation, in accordance with the OSHA regulation.

Any excavations that extend into any soft to very soft soils or below the groundwater level and exhibit seepage should be classified as Type 4 soil. The maximum excavation side slope for a Type 4 soil is 3H:1V in accordance with the OSHA regulation.

If an excavation contains more than one soil type, the soil shall be classified as the type with the highest type number.

The side slopes of the excavations should be protected from exposure to precipitation and associated ground surface runoff, to prevent further softening and loss of strength of native soils and fill materials placed during the area grading activities that could lead to additional sloughing and caving.

Some sloughing and caving must be anticipated for excavations without lateral support, particularly where excess moisture (precipitation, ground surface runoff, and/or presence of groundwater table) is present. Unsupported excavation slopes that extend below the groundwater table may slough to angles as flat as 3H:1V. If localized instability is noted at the time of excavation or while an excavation remains open, or if wet conditions are encountered, the side slopes of the excavations should be flattened as required to maintain safe working conditions.

For the purpose of this report and the comments provided above, we have presumed that temporary excavations without lateral support will remain open for relatively short periods (e.g. typically 48 hours to 72 hours).

For excavations without lateral support that remain open for longer periods (such as for construction of the underground storage tanks at the gas bar) sloughing and caving of side slopes must be anticipated, particularly if left exposed to periods of precipitation, ground surface runoff, or freeze-thaw cycles. The

slopes of these excavations should be protected from erosion and the slopes should be inspected frequently for signs or indications of erosion and/or instability.

Stockpiling of any materials adjacent to excavations should be avoided. Similarly, traffic should not be permitted in proximity to open excavations. For this purpose, it is recommended that all storage of materials and traffic be restricted from a 3 m wide strip around the excavations, measured from the crest of the excavation designed and constructed in accordance with the OH&S Act.

A temporary shoring system can be used to maintain safe working conditions if space is restricted such that the side slope cannot be safely cut back in accordance with the OH&S Act & Regulations, if sloughing and cave-in are encountered in the excavations, or if the excavations are to remain open for a longer period. Reference is made to Section 6.6 for recommendations regarding temporary shoring.

7.5 TEMPORARY CONSTRUCTION DEWATERING AND PERMANENT DEWATERING

7.5.1 Temporary Construction Dewatering

The groundwater conditions observed and measured in the monitoring wells installed for the current investigation indicated the presence of stabilized groundwater in the till at 6.35 m below ground surface (Elevation 60.02 masl).

Minor groundwater seepage within the glacial till deposit, or perched water from the fill overlying the silty till deposits may be encountered during foundation construction, excavations for the underground storage tanks, as well as site servicing to conventional depths. This seepage is expected to be successfully handled using conventional sump pumping techniques, if required.

7.6 CONSTRUCTION REQUIREMENTS FOR FOUNDATIONS

The founding surfaces should be inspected by geotechnical personnel prior to placing concrete to confirm the founding conditions are consistent with the recommendations described herein, and to ensure that there is no disturbance of the soil at the founding surface. Any deleterious materials, organics, or excessively loose/soft or wet conditions observed, should be sub-excavated and removed and the excavations backfilled with engineered fill in accordance with the recommendations provided in Section 6.2.3.2.

Where construction is undertaken during winter conditions, the subgrade at the founding elevation and below, must be protected from freezing.

7.7 BACKFILL MATERIALS AND METHODS

7.7.1 Bedding and Cover Material for Buried Services & Utilities

Should the uncovering or replacement of services be required, bedding for those services should consist of OPSS.MUNI 1010 Granular 'A' material. In general, a minimum of 150 mm of bedding and 300 mm of cover material is recommended.

The bedding and cover material should be placed in loose lifts that do not exceed 300 mm. Each lift should be uniformly compacted to achieve a minimum of 100% of the material's SPMDD. Cover material should be placed and compacted to 900 mm over the crown of the pipe / utility prior to permitting ride-on compaction equipment to be used. Care must be taken in all cases to avoid incurring damage to the services and utilities. This may require the use of alternative equipment from the norm and/or adjustment to the typical placement and compaction methodologies.

These recommendations should be confirmed with the pipe manufacturer and care must be taken to avoid incurring damage to the services. Pipe manufactures may have additional / alternative requirements that should be reviewed by the Designer and Contractor prior to installation of the services.

A discussion of seepage, infiltration, accumulation, and the general presence of groundwater is provided in Section 7.5. If standing water is present in any open excavation where services and utilities are to be installed, the use of a geosynthetic separator fabric and clear stone bedding/cover is recommended to mitigate concerns with handling, placing and compacting granular bedding and backfill materials.

7.7.2 Service and Utility Trench Backfill

Service trench backfill placed over the pipe bedding and cover material can consist of the excavated non-organic soils, or approved imported backfill, subject to inspection and approval by the geotechnical consultant to confirm the condition at the time of backfilling. The comments provided in Section 7.1 with respect to the reuse of the onsite soils apply in this respect.

The trench backfill should be placed in loose lifts having a maximum thickness of 300 mm. Each lift should be uniformly compacted using suitable compaction equipment for the purpose intended, to achieve a minimum of 98% of the material's SPMDD.

All trench backfill placed beyond the limits of planned development, such as in landscaped areas, should be placed in 300 mm thick loose lifts and compacted to a minimum of 95% SPMDD up to 1.0 m below the sub-grade level and 98% above this level.

Sewer and storm lines installed outside of heated areas should be provided with a minimum of 1.8 m of soil cover for adequate frost protection.

7.7.3 Municipal Infrastructure Backfill

Where manholes and catch basins are required or where construction or grading is required around existing manholes, these components should be constructed and backfilled in accordance with the City of Ottawa standards.

Due care should be taken in compacting backfill materials around structures to achieve the required compaction, thus avoiding future settlement around the installations.

7.8 SERVICE ROAD CONSTRUCTION

It is recommended that the Granular ‘A’ and Granular ‘B’ be sampled and tested prior to use on site to confirm that they meet the appropriate OPSS specifications. The Granular ‘A’ and ‘B’ material should meet the requirements of OPSS.MUNI 1010. The base and subbase layers should be compacted to 100% SPMDD.

8.0 CLOSURE

Use of this report is subject to the Statement of General Conditions provided in Appendix A. This report documents work that was performed in accordance with generally accepted professional standards at the time and location in which the services were provided. No other representations, warranties or guarantees are made concerning the accuracy or completeness of the data or conclusions contained within this report, including no assurance that this work has uncovered all potential liabilities associated with the identified property.

This report provides an evaluation of selected geotechnical conditions associated with the identified portion of the property that was assessed at the time the work was conducted and is based on information obtained by and/or provided to Stantec at that time. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties in the preparation of this report has been assumed by Stantec to be correct. Stantec assumes no responsibility for any deficiency or inaccuracy in information received from others.

Conclusions made within this report consist of Stantec's professional opinion as of the time of the writing of this report and are based solely on the scope of work described in the report, the limited data available and the results of the work. They are not a certification of the property's environmental condition. This report should not be construed as legal advice.

This report has been prepared for the exclusive use of the client identified herein and any use by any third party is prohibited. Stantec assumes no responsibility for losses, damages, liabilities, or claims, howsoever arising, from third party use of this report.

Should additional information become available which differs significantly from our understanding of conditions presented in this report, Stantec requests that this information be brought to our attention so that we may reassess the conclusions provided herein.

We trust that the information contained in this report is adequate for your present purposes. If you have any questions about the contents of the report or if we can be of any other assistance, please contact us at your convenience.

Respectfully submitted;

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APPENDIX A

A.1 STATEMENT OF GENERAL CONDITIONS

Stantec

STATEMENT OF GENERAL CONDITIONS

USE OF THIS REPORT: This professional work product ("hereinafter referred to as the Report") has been prepared for the sole benefit of the Client in accordance with Stantec's contract with the Client. While the Report may be provided by the Client to applicable authorities having jurisdiction and to other third parties in connection with the project, Stantec disclaims any legal duty based upon warranty, reliance, or any other theory to any third party, and will not be liable to such third party for any damages or losses of any kind that may result.

BASIS OF THIS REPORT: This Report relates solely to the site-specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The information, opinions, conclusions and/or recommendations made in this Report are in accordance with Stantec's present understanding of the site-specific project as described by the Client. The applicability of these is restricted to the site conditions encountered at the time the scope of work was conducted and do not take into account any subsequent changes. If the proposed site-specific project differs or is modified from what is described in this Report or if the site conditions are altered, this Report is no longer valid unless Stantec is requested by the Client to review and revise the Report to reflect the differing or modified project specifics and/or the altered site conditions. This Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose or site, and any unauthorized use or reliance is at the recipient's own risk.

STANDARD OF CARE: Preparation of this Report, and all associated work, was carried out in accordance with the normally accepted standard of care in the state or province of execution for the specific professional service provided to the Client. No other warranty is made.

PROVIDED INFORMATION: Stantec has assumed all information received from the Client and third parties in the preparation of this Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

INTERPRETATION OF SITE CONDITIONS: Soil, rock, or other material descriptions, and statements regarding their condition, made in this Report are based on site conditions encountered by Stantec at the time of the scope of work and at the specific testing and/or sampling locations. Classifications and statements of condition have been made in accordance with normally accepted practices which are judgmental in nature; no specific description should be considered exact, but rather reflective of the anticipated material behaviour. Extrapolation of in-situ conditions can only be made to some limited extent beyond the sampling or test points. The extent depends on variability of the soil, rock and groundwater conditions as influenced by geological processes, construction activity, and site use.

VARYING OR UNEXPECTED CONDITIONS: Should any site or subsurface conditions be encountered that are different from those described in this Report or encountered at the test and/or sample locations, Stantec must be notified immediately to assess if the varying or unexpected conditions are substantial and if reassessments of the Report conclusions or recommendations are required. Stantec will not be responsible to any party for damages incurred as a result of failing to notify Stantec that differing site or subsurface conditions are present upon becoming aware of such conditions.

PLANNING, DESIGN, OR CONSTRUCTION: Development or design plans and specifications should be reviewed by Stantec geotechnical engineers, sufficiently ahead of initiating the next project stage (e.g., property acquisition, tender, construction, etc.), to confirm that this Report completely addresses the elaborated project specifics and that the contents of this Report have been properly interpreted. Specialty quality assurance services (e.g., field observations and testing) during construction are a necessary part of the evaluation of subsurface conditions and site work. Site work relating to the recommendations included in this Report should only be carried out in the presence of a qualified geotechnical engineer; Stantec cannot be responsible for site work carried out without being present.

APPENDIX B

B.1 DRAWING NO. 1 – BOREHOLE LOCATION PLAN

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Printed: Apr 04, 2025 By: G. Briones

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LEGEND

- BOREHOLE (STANTEC, 2025)
- MONITORING WELL (STANTEC, 2025)

KEY PLAN 1 : 20 000

NOTES

1. COORDINATE SYSTEM: NAD 1983 UTM ZONE 18N.
2. BASE PLAN: PDF COPY OF THE SITE PLAN PREPARED BY WSP, DWG. No. SP-11, DATED APRIL 29, 2022.
3. IMAGERY: © 2025 MICROSOFT CORPORATION © 2025 TOM TOM.

10m 0 10 20m
1 : 1000

MARCH 2025
Project No. 121626297

Client/Project
COSTCO WHOLESALE
GEOTECHNICAL INVESTIGATION, FUEL STATION ADDITION
1900 CYRVILLE ROAD, OTTAWA, ONTARIO

Drawing No.
1

Title
BOREHOLE LOCATION PLAN

APPENDIX C

C.1 SYMBOLS AND TERMS USED ON BOREHOLE RECORDS

C.2 BOREHOLE RECORDS

C.3 BEDROCK CORE LOG

C.4 BEDROCK CORE PHOTO

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

Rootmat	- vegetation, roots and moss with organic matter and topsoil typically forming a mattress at the ground surface
Topsoil	- mixture of soil and humus capable of supporting vegetative growth
Peat	- mixture of visible and invisible fragments of decayed organic matter
Till	- unstratified glacial deposit which may range from clay to boulders
Fill	- material below the surface identified as placed by humans (excluding buried services)

Terminology describing soil structure:

Desiccated	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
Fissured	- having cracks, and hence a blocky structure
Varved	- composed of regular alternating layers of silt and clay
Stratified	- composed of alternating successions of different soil types, e.g. silt and sand
Layer	- > 75 mm in thickness
Seam	- 2 mm to 75 mm in thickness
Parting	- < 2 mm in thickness

Terminology describing soil types:
The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488) which excludes particles larger than 75 mm. For particles larger than 75 mm, and for defining percent clay fraction in hydrometer results, definitions proposed by Canadian Foundation Engineering Manual, 4th Edition are used. The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):
Terminology describing materials outside the USCS, (e.g. particles larger than 75 mm, visible organic matter, and construction debris) is based upon the proportion of these materials present:

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 20%

Terminology describing compactness of cohesionless soils:
The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test (SPT) N-Value - also known as N-Index. The SPT N-Value is described further on page 3. A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>50

Terminology describing consistency of cohesive soils:
The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests. Consistency may be crudely estimated from SPT N-Value based on the correlation shown in the following table (Terzaghi and Peck, 1967). The correlation to SPT N-Value is used with caution as it is only very approximate.

Consistency	Undrained Shear Strength		Approximate SPT N-Value
	kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25 - 0.5	12.5 - 25	2-4
Firm	0.5 - 1.0	25 - 50	4-8
Stiff	1.0 - 2.0	50 – 100	8-15
Very Stiff	2.0 - 4.0	100 - 200	15-30
Hard	>4.0	>200	>30

ROCK DESCRIPTION

Except where specified below, terminology for describing rock is as defined by the International Society for Rock Mechanics (ISRM) 2007 publication "The Complete ISRM Suggested Methods for Rock Characterization, Testing and Monitoring: 1974-2006"

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor Quality*
25-50	*Poor Quality*
50-75	*Fair Quality*
75-90	*Good Quality*
90-100	*Excellent Quality*

Alternate (Colloquial) Rock Mass Quality	
Very Severely Fractured	*Crushed*
Severely Fractured	*Shattered or Very Blocky*
Fractured	*Blocky*
Moderately Jointed	*Sound*
Intact	*Very Sound*

RQD (Rock Quality Designation) denotes the percentage of intact and sound rock retrieved from a borehole of any orientation. All pieces of intact and sound rock core equal to or greater than 100 mm (4 in.) long are summed and divided by the total length of the core run. RQD is determined in accordance with ASTM D6032.

SCR (Solid Core Recovery) denotes the percentage of solid core (cylindrical) retrieved from a borehole of any orientation. All pieces of solid (cylindrical) core are summed and divided by the total length of the core run (It excludes all portions of core pieces that are not fully cylindrical as well as crushed or rubble zones).

Fracture Index (FI) is defined as the number of naturally occurring fractures within a given length of core. The Fracture Index is reported as a simple count of natural occurring fractures.

Terminology describing rock with respect to discontinuity and bedding spacing:

Spacing (mm)	Discontinuities	Bedding
>6000	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

Strength Classification	Grade	Unconfined Compressive Strength (MPa)
Extremely Weak	R0	<1
Very Weak	R1	1 – 5
Weak	R2	5 – 25
Medium Strong	R3	25 – 50
Strong	R4	50 – 100
Very Strong	R5	100 – 250
Extremely Strong	R6	>250

Terminology describing rock weathering:

Term	Symbol	Description
Fresh	W1	No visible signs of rock weathering. Slight discoloration along major discontinuities
Slightly	W2	Discoloration indicates weathering of rock on discontinuity surfaces. All the rock material may be discolored.
Moderately	W3	Less than half the rock is decomposed and/or disintegrated into soil.
Highly	W4	More than half the rock is decomposed and/or disintegrated into soil.
Completely	W5	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.
Residual Soil	W6	All the rock converted to soil. Structure and fabric destroyed.

STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.

Boulders Cobbles Gravel | Sand | Silt | Clay | Organics | Asphalt | Concrete | Fill | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary Bedrock

SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

WATER LEVEL MEASUREMENT

measured in standpipe, piezometer, or well

inferred

RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (63.5 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (300 mm) into the soil. In accordance with ASTM D1586, the N-Value equals the sum of the number of blows (N) required to drive the sampler over the interval of 6 to 18 in. (150 to 450 mm). However, when a 24 in. (610 mm) sampler is used, the number of blows (N) required to drive the sampler over the interval of 12 to 24 in. (300 to 610 mm) may be reported if this value is lower. For split spoon samples where insufficient penetration was achieved and N-Values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N-values corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to 'A' size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (300 mm) into the soil. The DCPT is used as a probe to assess soil variability.

OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
γ	Unit weight
G_s	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
Q_u	Unconfined compression
I_p	Point Load Index (I_p on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer

BOREHOLE RECORD

BH25-01

CLIENT: **Costco Wholesale Canada Ltd.** BH COORDINATES PROJECT NO. : **121626297**

PROJECT: **Fuel Station Addition** BH ELEVATION: **66.37m**

LOCATION: **1900 Cyrville Road, Gloucester, Ontario** 5029311.3N 452846.5E DATUM: **Geodetic**

DATE BORED: **February 27, 2025** WATER LEVEL: **6.4 m on April 1st, 2025**

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
0	66.4							
	66.3	ASPHALT (65 mm)						
		FILL: brown, silty sand, moist		SS	1	254	-	Sieve at 0.8 m G S Fines 11% 67% 22%
1								
	64.6			SS	2	406	24	
2		Compact, brown, SAND with silt (SP-SM), trace of gravel, moist						
				SS	3	356	21	
3								
				SS	4	508	22	
4								
	61.8			SS	5	508	15	
5		TILL: compact to very dense, grey, SILT with sand (ML), trace of clay, wet, contains cobbles and boulders		SS	6	508	22	
				SS	7	76	50	
6								
				SS	8	457	41	Sieve/Hydro at 6.1 m G S M C 5% 18% 72% 5% Non-Plastic
7				SS	9	152	-	
	58.7	Rock fragments encountered below 7.6 m		SS	10	25	-	
		SHALE BEDROCK, dark grey to black, moderately to highly weathered (W2-W3), poor to good quality.		RC	11	100	80	
8				RC	12	100	28	
9				RC	13	100	67	
	56.8							
10		End of Borehole at 9.6 m						
11								

UNDRAINED SHEAR STRENGTH, Cu (kPa)

LABORATORY TEST ▲ FIELD VANE TEST ◆

POCKET PEN. ★ POCKET SHEAR VANE ◘

50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

SPT (N-value) BLOWS/0.3m

Water Content (%) and Blow Count

10 20 30 40 50 60 70 80

50/254mm

50/230mm

50/25mm

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m)

66 65 64 63 62 61 60 59 58 57 55

▼ Water Level Measured On Date Indicated

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing | Logged By: OE

Drilling Method: HSA | Reviewed By: GC

Completion Depth: 9.6 m | Page 1 of 1

Printed Apr 4 2025 11:1:49 STANTEC GEO 2016 121626297_COSTCO GLOUCESTER_BOREHOLE LOGS.GPJ GINT_1233_SOIL_2018_DATA_TEMP_REV2.GDT 4/4/25

BOREHOLE RECORD

BH25-02

CLIENT: **Costco Wholesale Canada Ltd.** BH COORDINATES PROJECT NO. : **121626297**

PROJECT: **Fuel Station Addition** BH ELEVATION: **66.65m**

LOCATION: **1900 Cyrville Road, Gloucester, Ontario** 452867.2N 5029312.7E DATUM: **Geodetic**

DATE BORED: **February 28, 2025** WATER LEVEL:

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS	UNDRAINED SHEAR STRENGTH, Cu (kPa) / WATER CONTENT & ATTERBERG LIMITS / SPT (N-value) BLOWS/0.3m	BACKFILL/ MONITOR WELL/ PIEZOMETER	ELEVATION (m)
0	66.7										66
	66.6	ASPHALT (75 mm)									
		FILL: grey, sand with gravel, moist		SS	1	102	-		50/127mm		
1											65
				SS	2	330	27				
2	64.4										64
		Compact, grey, Silty SAND (SM), moist		SS	3	356	12	Sieve at 2.3 m G 12% S 74% Fines 14%			
3				SS	4	356	22				63
	62.7										
4		TILL: dense to very dense, grey, Sandy SILT (ML), trace clay, moist		SS	5	381	35				
				SS	6	381	-	Sieve/Hydro at 4.6 m G 7% S 33% M 53% C 7%	50/432mm		62
5	61.3										
		TILL: very dense, grey, Silty SAND with gravel (SM), moist - contains cobbles and boulders		SS	7	381	-		50/432mm		
6				SS	8	127	-	Sieve at 6.1 m G 18% S 41% Fines 41%	50/127mm		61
											60
7				SS	9	356	-		50/356mm		
	59.0			SS	10	50	-		50/50mm		59
		Auger Refusal and End of Borehole at 7.7 m									
8											58
9											
10											57
											56
11											

UNDRAINED SHEAR STRENGTH, Cu (kPa)
LABORATORY TEST ▲ FIELD VANE TEST ◆
POCKET PEN. ★ POCKET SHEAR VANE ◘
50 kPa 100 kPa 150 kPa 200 kPa
WATER CONTENT & ATTERBERG LIMITS W_P W W_L
SPT (N-value) BLOWS/0.3m
Water Content (%) and Blow Count
10 20 30 40 50 60 70 80

Drilling Contractor: Downing | Logged By: OE

Drilling Method: HSA | Reviewed By: GC

Completion Depth: 7.7 m | Page 1 of 1

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

BOREHOLE RECORD

BH25-03

CLIENT: **Costco Wholesale Canada Ltd.** BH COORDINATES PROJECT NO. : **121626297**

PROJECT: **Fuel Station Addition** BH ELEVATION: **66.38m**

LOCATION: **1900 Cyrville Road, Gloucester, Ontario** 452858.1N 5029294.5E DATUM: **Geodetic**

DATE BORED: **February 27, 2025** WATER LEVEL:

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
0	66.4							
	66.3	ASPHALT (65 mm)						
		FILL: brown, sand with gravel, moist		SS	1	330	22	
1				SS	2	330	22	
2	64.1							
		Loose to compact, light brown, SAND with silt (SW-SM), moist		SS	3	356	15	Sieve at 2.3 m G 14% S 76% Fines 10%
3	63.2							
		TILL: loose to dense, grey, Silty SAND with gravel (SM), wet		SS	4	305	9	Sieve/Hydro at 3.2 m G 29% S 39% M 24% C 8%
4				SS	5	330	8	
5				SS	6	406	16	
				SS	7	406	22	
6				SS	8	381	40	
	59.7							
7		End of Borehole at 6.7 m						
8								
9								
10								
11								

UNDRAINED SHEAR STRENGTH, Cu (kPa)

LABORATORY TEST ▲ FIELD VANE TEST ◆

POCKET PEN. ★ POCKET SHEAR VANE ◘

50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

SPT (N-value) BLOWS/0.3m

Water Content (%) and Blow Count

10 20 30 40 50 60 70 80

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m)

66 65 64 63 62 61 60 59 58 57 56 55

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing | Logged By: OE

Drilling Method: HSA | Reviewed By: GC

Completion Depth: 6.7 m | Page 1 of 1

BOREHOLE RECORD

BH25-04

CLIENT: **Costco Wholesale Canada Ltd.** BH COORDINATES PROJECT NO. : **121626297**

PROJECT: **Fuel Station Addition** BH ELEVATION: **66.62m**

LOCATION: **1900 Cyrville Road, Gloucester, Ontario** 452881.8N 5029284.6E DATUM: **Geodetic**

DATE BORED: **February 28, 2025** WATER LEVEL:

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION (USCS)	STRATA PLOT	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm) or TCR %	SAMPLES N-VALUE or RQD %	OTHER TESTS / REMARKS
0	66.6							
	66.5	ASPHALT (100 mm)						
		FILL: brown, sand with gravel, moist - contains cobbles		SS	1	610	89	
1				SS	2	152	9	
2	64.3							
		Compact, light brown, SAND with silt (SP-SM), moist		SS	3	356	14	
3				SS	4	508	21	Sieve at 3.1 m G 9% S 82% Fines 9%
	62.9							
4		End of Borehole at 3.7 m						

UNDRAINED SHEAR STRENGTH, Cu (kPa)

LABORATORY TEST ▲ FIELD VANE TEST ◆

POCKET PEN. ★ POCKET SHEAR VANE ◘

50 kPa 100 kPa 150 kPa 200 kPa

WATER CONTENT & ATTERBERG LIMITS W_P W W_L

SPT (N-value) BLOWS/0.3m

Water Content (%) and Blow Count

10 20 30 40 50 60 70 80

BACKFILL/ MONITOR WELL/ PIEZOMETER

ELEVATION (m)

66 65 64 63 62 61 60 59 58 57 56

BACKFILL SYMBOL: ASPHALT, GROUT, CONCRETE, BENTONITE, DRILL CUTTINGS, SAND, SLOUGH

Drilling Contractor: Downing | Logged By: OE

Drilling Method: HSA | Reviewed By: GC

Completion Depth: 3.7 m | Page 1 of 1

Stantec

Bedrock Core Log

Client:	Costco Wholesale	**Project No.:**	121626297
Project:	Costco - Fuel Station Addition	**Date:**	27-Feb-25
Contractor:	George Downing Estate Drilling Ltd.	**Borehole No.:**	BH25-01
		Logger:	Omar El-Ghazal

DEPTH FROM (m)	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO (m)	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
7.65	1	100	80	8.23	SHALE bedrock, moderately to highly weathered, good quality, dark grey to black	R4	W2 - W3	1	BD	F	C	RP	G	T-O		
8.23	2	100	28	8.64	SHALE bedrock, moderately to highly weathered, poor quality, dark grey to black	R4	W2 - W3	1	BD	F	C	RP	G	T-O		
8.64	3	100	67	9.55	SHALE bedrock, slightly to moderately weathered, fair quality, dark grey to black	R4	W2 - W3	1	BD	F	C	RP	G	T-O		

STRENGTH (MPa)

Grade/Classification	Est. Strength (MPa)
R0 Extremely Week	0.25 - 1.0
R1 Very Weak	1.0 - 5.0
R2 Weak	5.0 - 25.0
R3 Medium Strong	25.0 - 50.0
R4 Strong	50.0 - 100.0
R5 Very Strong	100.0 - 250.0
R6 Extremely Strong	>250.0

JOINT TYPE

BD = Bedding
JN = Joint
FOL = Foliation
CON = Contact
FLT = Fault
VN = Vein

ORIENTATION

F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

JOINT APERTURE

C = Closed = < 0.5 mm
G = Gapped = 0.5 to 10 mm
O = Open = > 10 mm

FILLING

T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

WEATHERING

Grade/Classification	Description
W1 Fresh	No Visible Signs of Weathering
W2 Slightly	Discoloration, Weathering on Discontinuities
W3 Moderately	<50% of Rock Material is Decomposed, Fresh Core Stones
W4 Highly	>50% Decomposed to soil: Fresh Core Stones
W5 Completely	100% Decomposed to Soil: Original Structure Intact
W6 Residual Soil	All Rock Converted to Soil, Structure and Fabric Destroyed

DISCONTINUITY SPACING

Spacing (mm)	
EW = >6000	Extremely Wide
VW = 2000 - 6000	Very Wide
W = 600 - 2000	Wide
M = 200 - 600	Moderate
C = 60 - 200	Close
VC = 20 - 60	Very Close
EC = <20	Extremely Close

JOINT ROUGHNESS

Jr	Description
4	DJ = Discontinuous Joints
3	RU = Rough, Irregular, Undulating
1.5	SU = Smooth, Undulating
1.5	LU = Slickensided, Undulating
1.0	RP = Rough or Irregular, Planar
0.5	SP = Smooth, Planar
2	LP = Slickensided, Planar

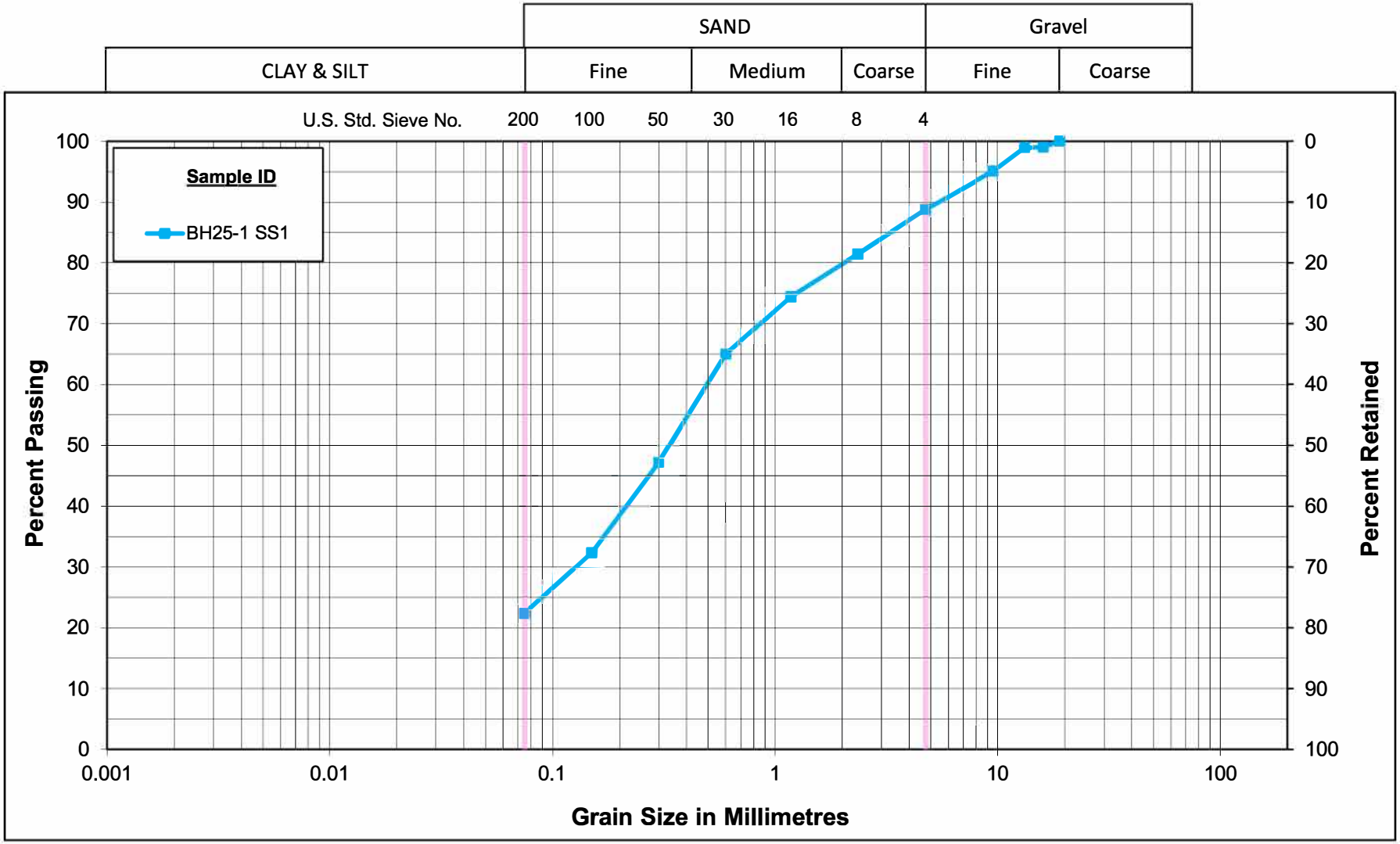
Stantec	Project No.: 121626297 Project Name: Costco – Fuel Station Addition	Rock Core Photograph

Rock Core Photo No.: 1	Borehole: BH25-01	Depth: 7.65 to 9.55 m

APPENDIX D

D.1 LABORATORY RESULTS

Unified Soil Classification System



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Grain Size Distribution of Fill (SILTY SAND (SM))

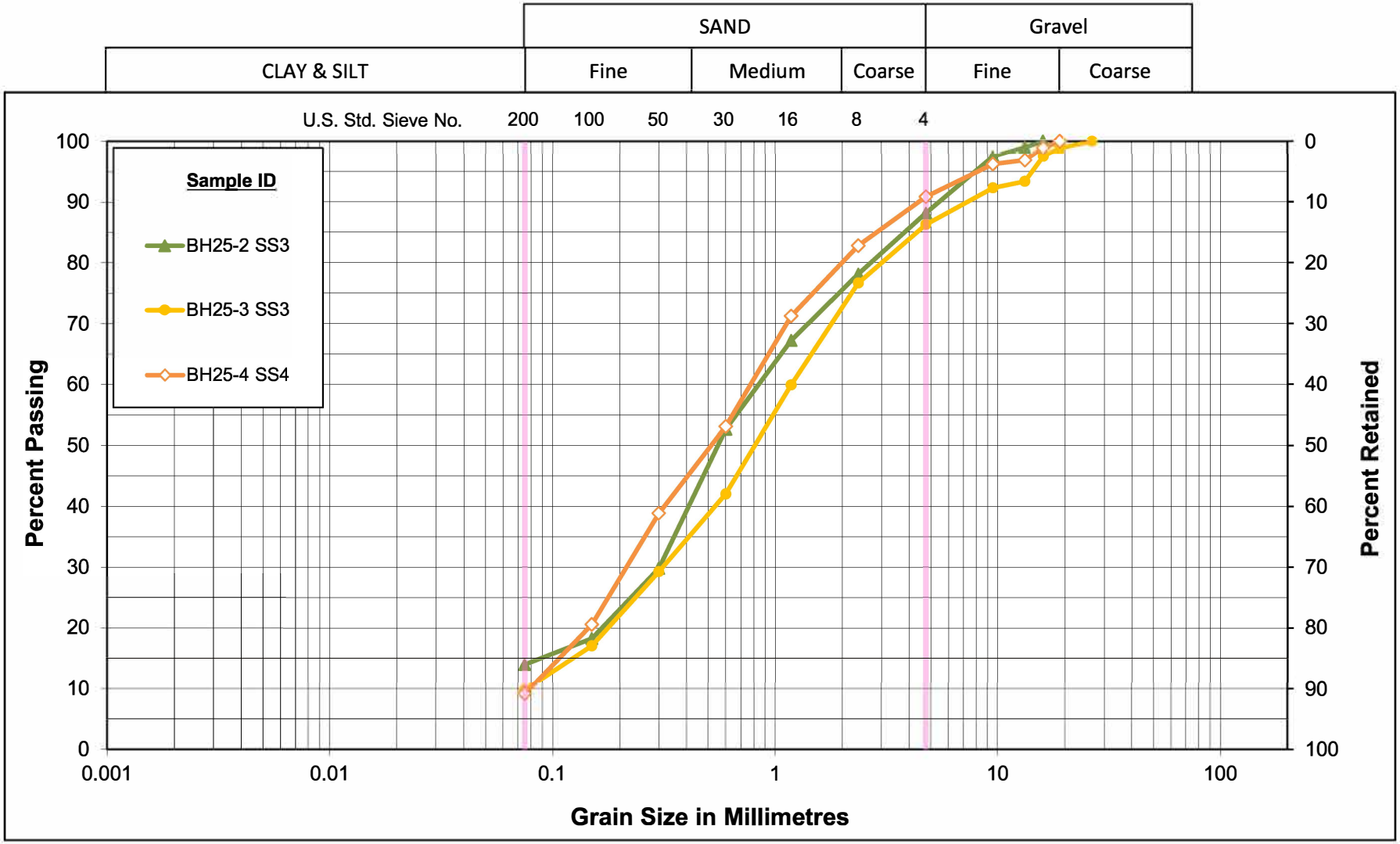
Costco Wholesale Canada Ltd.

Costco Fuel Station

Figure No. 1

Project No. 121626297

Unified Soil Classification System



Stantec

Grain Size Distribution of SAND with Silt (SP-SM)

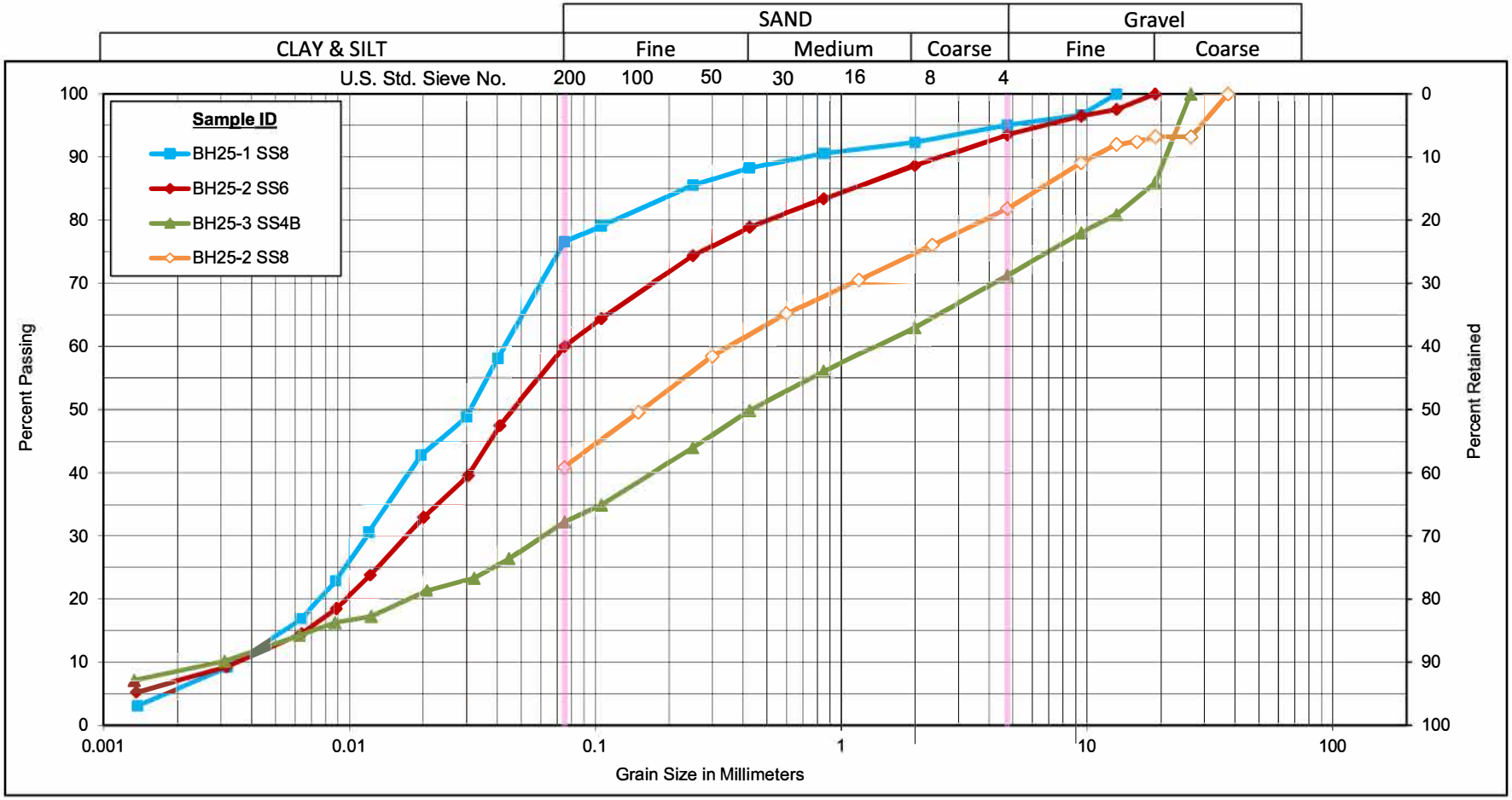
Costco Wholesale Canada Ltd.

Costco Fuel Station

Figure No. 2

Project No. 121626297

Unified Soil Classification System



Stantec

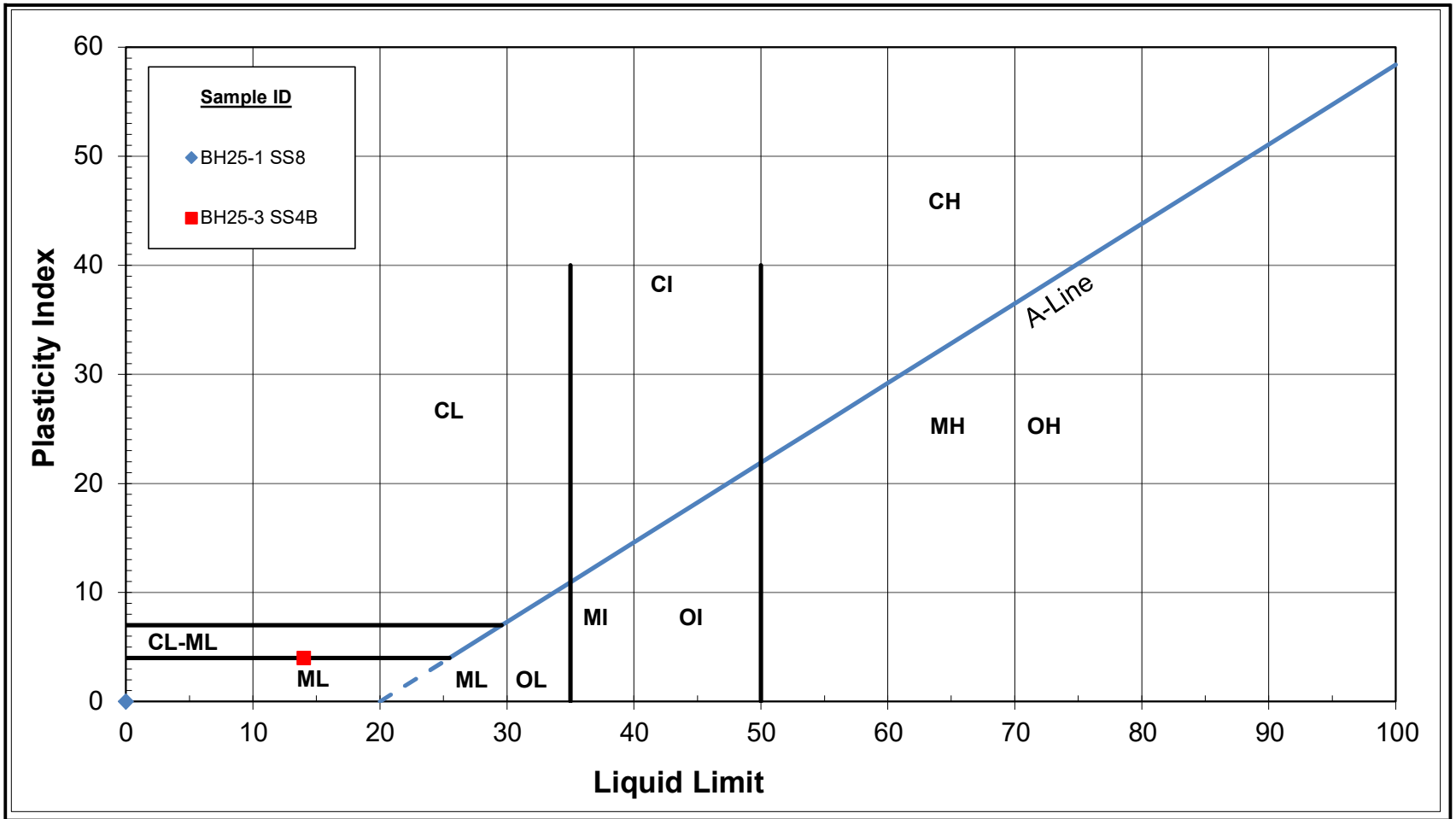
Grain Size Distribution of Till
(SANDY SILT (ML) to SILTY SAND with Gravel (SM))

Costco Wholesale Canada Ltd.

Costco Fuel Station

Figure No. 3

Project No. 121626297



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Costco Wholesale Canada Ltd.

Costco Fuel Station

PLASTICITY CHART

Figure No. 4

Project No. 121626297

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Certificate of Analysis

Stantec Consulting Ltd. (Ottawa)
1331 Clyde Avenue Suite 300
Ottawa, ON K2C 3G4
Attn: Brian Prevost

Client PO:
Project: 121626297
Custody:

Report Date: 2-Apr-2025
Order Date: 1-Apr-2025

Order #: 2514162

This Certificate of Analysis contains analytical data applicable to the following samples as submitted:

Paracel ID	Client ID
2514162-01	BH25-02 SS5B

Approved By:

Mark Foto, M.Sc.
Laboratory Director

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	2-Apr-25	2-Apr-25
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	2-Apr-25	2-Apr-25
Resistivity	EPA 120.1 - probe, water extraction	2-Apr-25	2-Apr-25
Solids, %	CWS Tier 1 - Gravimetric	1-Apr-25	2-Apr-25

	Client ID:	BH25-02 SS5B	-	-	-		
	Sample Date:	27-Feb-25 09:00	-	-	-	-	-
	Sample ID:	2514162-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	93.6	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.99 [1]	-	-	-	-	-
Resistivity	0.1 Ohm.m	10.5 [1]	-	-	-	-	-
Anions							
Chloride	10 ug/g	248 [1]	-	-	-	-	-
Sulphate	10 ug/g	494 [1]	-	-	-	-	-

Method Quality Control: Blank

Analyte	Result	Reporting Limit	Units	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions								
Chloride	ND	10	ug/g					
Sulphate	ND	10	ug/g					
General Inorganics								
Resistivity	ND	0.1	Ohm.m					

Certificate of Analysis

Report Date: 02-Apr-2025

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 1-Apr-2025

Client PO:

Project Description: 121626297

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	671	10	ug/g	706			5.1	35	
Sulphate	66.4	10	ug/g	64.1			3.5	35	
General Inorganics									
pH	8.04	0.05	pH Units	7.99			0.6	2.3	
Resistivity	9.25	0.1	Ohm.m	9.29			0.4	20	
Physical Characteristics									
% Solids	79.7	0.1	% by Wt.	78.6			1.3	25	

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	795	10	ug/g	706	89.2	82-118			
Sulphate	161	10	ug/g	64.1	96.7	80-120			

Certificate of Analysis

Report Date: 02-Apr-2025

Client: **Stantec Consulting Ltd. (Ottawa)**

Order Date: 1-Apr-2025

Client PO:

Project Description: 121626297

Qualifier Notes:

Login Qualifiers :

Sample - One or more parameter received or added past hold time. Directed by client to proceed with analysis - Chloride, Ph, Resistivity, Sulphate

Applies to Samples: BH25-02 SS5B

Sample Qualifiers :

1: Holding time had been exceeded upon receipt of the sample at the laboratory or prior to the analysis being requested.

Sample Data Revisions:

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable

ND: Not Detected

MDL: Method Detection Limit

Source Result: Data used as source for matrix and duplicate samples

%REC: Percent recovery.

RPD: Relative percent difference.

NC: Not Calculated

Soil results are reported on a dry weight basis unlesss otherwise noted.

Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

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Page 1 of 1

Client Name:	Stantec Consulting Ltd.	Project Reference:	Costco - Fuel Station
Contact Name:	Brian Prevost & Katurah Firdawsi	Task #:	200
Address:	100A&B-2781 Lancaster Rd. Ottawa ON. K1B-1A7	PO #	121626297
Telephone:	613-738-6075	Email Address:	brian.prevost@stantec.com katurah.firdawsi@stantec.com

TAT: [ ] Regular [ ] 3 Day [ ] 2 Day [X] 1 Day

Date Required: _____

Criteria: [ ] O. Reg. 153/04 Table __ [ ] O. Reg. 153/11 (Current) Table __ [ ] RSC Filing [ ] O. Reg. 558/00 [ ] PWQO [ ] CCME [ ] SUB (Storm) [ ] SUB (Sanitary) Municipality: _____ [ ] Other: _____

Matrix Type: S (Soil/Sed.) GW (Ground Water) SW (Surface Water) SS (Storm/Sanitary Sewer) P (Paint) A (Air) O (Other)

Required Analyses

Paracel Order Number: 2514162

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	Resistivity	PH	Sulphate & Chloride								
1	BH25-02 SS5B	Soils		1	27-Feb-25		X	X	X								
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	

Comments:

Method of Delivery: SWIFT

Relinquished By (Print & Sign): Sagar Khatri	Received by Driver/Depot:	Received at Lab: LTJ	Verified By: SD
Date/Time: 25-Mar-25	Date/Time:	Date/Time: 01/04/25 - 03:56PM	Date/Time: Apr 1, 2025 4:04pm
	Temperature: _____ °C	Temperature: 23 °C	pH Verified [ ] By:

APPENDIX E

E.1 NBC SEISMIC HAZARD CALCULATION DATA SHEET

Government of Canada / Gouvernement du Canada

Canada.ca › Natural Resources Canada › Earthquakes Canada

2020 National Building Code of Canada Seismic Hazard Tool

This application provides seismic values for the design of buildings in Canada under Part 4 of the National Building Code of Canada (NBC) 2020 as prescribed in Article 1.1.3.1. of Division B of the NBC 2020.

Seismic Hazard Values

User requested values

Code edition	NBC 2020
Site designation X_S	X_C
Latitude (°)	45.415
Longitude (°)	-75.602

Please select one of the tabs below.

NBC 2020 | Additional Values | Plots | API | Background Information

The 5%-damped spectral acceleration ($S_a(T,X)$, where T is the period, in s, and X is the site designation) and peak ground acceleration (PGA(X)) values are given in units of acceleration due to gravity (g, 9.81 m/s^2). Peak

ground velocity (PGV(X)) values are given in m/s. Probability is expressed in terms of percent exceedance in 50 years. Further information on the calculation of seismic hazard is provided under the *Background Information* tab.

The 2%-in-50-year seismic hazard values are provided in accordance with Article 4.1.8.4. of the NBC 2020. The 5%- and 10%-in-50-year values are provided for additional performance checks in accordance with Article 4.1.8.23. of the NBC 2020.

See the *Additional Values* tab for additional seismic hazard values, including values for other site designations, periods, and probabilities not defined in the NBC 2020.

NBC 2020 - 2%/50 years (0.000404 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.685	0.405	0.215	0.0985	0.026	0.00854	0.368	0.277

The log-log interpolated 2%/50 year $S_a(4.0, X_C)$ value is : **0.0360**

▼ Tables for 5% and 10% in 50 year values

NBC 2020 - 5%/50 years (0.001 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.397	0.234	0.119	0.0534	0.0135	0.00447	0.217	0.152

The log-log interpolated 5%/50 year $S_a(4.0, X_C)$ value is : **0.0189**

NBC 2020 - 10%/50 years (0.0021 per annum) probability

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$

$S_a(0.2, X_C)$	$S_a(0.5, X_C)$	$S_a(1.0, X_C)$	$S_a(2.0, X_C)$	$S_a(5.0, X_C)$	$S_a(10.0, X_C)$	$PGA(X_C)$	$PGV(X_C)$
0.252	0.148	0.0733	0.0319	0.00766	0.00256	0.137	0.0916

The log-log interpolated 10%/50 year $S_a(4.0, X_C)$ value is : **0.0108**

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Date modified: 2021-04-06