Geotechnical Investigation Report - 2405 and 2419 Mer-Bleue Road

March 27, 2025

Prepared for:
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1.0 Introduction

Cambium Inc. (Cambium) was retained by Conseil des écoles publiques de l'Est de l'Ontario (CEPEO, the Client) to complete a geotechnical investigation in support of the proposed secondary school located at 2405 and 2419 Mer Bleue Road, Ottawa, Ontario (Site).

This report presents the methodology and findings of the geotechnical investigation at the Site and addresses constraints, requirements, and recommendations relevant to the proposed developments.

1.1 Reviewed Documents

The following project documents were received and reviewed during the drafting of this report:

[1] GRC Architects– 47 Clarence Street, Suite 401, Ottawa, Ontario [K7N 9K1]

Architectural Drawings– Project Name: Proposed High School – ESP Orleans Sud, Project #: 3223, Drawing #: A001, A101 to A103, Dated: Oct. 12, 2023.

[2] GRC Architects – 47 Clarence Street, Suite 401, Ottawa, Ontario [K7N 9K1]

Architectural Drawings– Project Name: Proposed High School – ESP Orleans Sud, Project #: 3024, Drawing #: A002, Dated: May 16, 2011.

[3] GEMTEC Consulting Engineers and Scientists Limited – 32 Steacie Dive, Ottawa, ON [K2K 2A9]

Geotechnical Investigation – Project Name: Proposed School Development, Project #: 62721.07, Drawing #: N/A, Date: May 3, 2018.

[4] City of Ottawa – 110 Laurier Avenue West, Ottawa, ON [L6P 2C3]

Geotechnical Investigation and Reporting Guidelines for Development Applications in the City of Ottawa – Project Name: N/A, Project #: N/A, Drawing #: N/A, Date: N/A.

[5] Callon Dietz Incorporated – 19 Roe St #2, Carleton Place, ON [K7C 0N3]

Topographic Survey – Part of Lot 4, Concession 11, Geographic Township of Cumberland, Citty of Ottawa, File No. 24-26499, Dated: August 15, 2024.

1.2 Standards and Guidelines

Applicable standards, guidelines and other normative documents utilized in preparing geotechnical engineering recommendations for this report are provided below.

[6] Canadian Foundation Engineering Manual – 5th Edition; Canadian Geotechnical Society; 2023.

[7] Ontario Building Code 2024

2.0 Background

2.1 Site Description

The Site location is shown in Figure 1. The Site is bounded to the north and south by neighbouring residential properties, to the east by a future elementary school and residential properties, and to the west by Mer-Bleue Road (chemin Mer-Bleue). The Site is currently occupied a few residential buildings along Mer-Bleue Road, gravel covered and paved surfaced driving and parking areas, soft landscaped areas, and isolated areas of vegetation comprised of bush, trees, and long grass. The residential buildings at the site are currently unoccupied. The immediate investigation area limits were slightly variable in elevation between borehole locations but in general appeared to be relatively flat with a slight decrease in elevation towards the north.

2.2 Project Description

It is Cambium's understanding that the proposed development is the construction of new secondary school. It is understood that the new building will be three (3) stories in height of slab on grade design (no basement). The proposed development will also include new asphalt surfaced parking and driving areas, landscaped areas, and various school facilities such as an area for portable classes, basketball court, and soccer field. It is assumed that the facility will require new municipal site services.

The geotechnical investigation was required to confirm the existing subsurface conditions and soil parameters as input into the design and construction of the proposed developments. Analysis from the investigation, recommendations for the proposed developments, and relevant supporting documents are provided in the following sections and/or appended to this report.

3.0 Methodology

3.1 Borehole Investigation

The geotechnical investigation was conducted at the Site by Cambium on October 7 to 9, 2024. A total of 12 boreholes, designated as boreholes BH101-24 through BH112-24 were strategically placed and advanced throughout the investigation area. The borehole locations relative to existing conditions and proposed site conditions are provided on Figure 2 and Figure 3, respectively. It is noted that borehole locations were adjusted in the field, as needed, to accommodate access constraints. Boreholes were advanced to depths ranging between approximately 1.5 to 41.8 m below ground surface (mbgs) and all boreholes were terminated after target depths were reached.

Drilling and sampling of the boreholes was completed using a track-mounted drill rig operating under the supervision of a Cambium technician. The boreholes were advanced to the sampling depths by means of continuous flight hollow stem augers with 50 mm O.D. split spoon samplers.

Standard Penetration Test (SPT) results (N values) were recorded for the sampled intervals as the number of blows required to drive a split spoon sampler 305 mm into the soil, using a 63.5 kg drop hammer falling 750 mm, as per ASTM D1586 procedures. The SPT N values are used in this report to assess the in-situ relative density of the non-cohesive soils and estimate consistency of cohesive soils. Undrained shear strength was measured in cohesive deposits using a shear vane, as per ASTM D2573 procedures.

Groundwater monitoring wells were installed in BH101-24, BH104-24, and BH105-24 upon drilling completion and bedrock coring was completed in BH102-24 in order to prove bedrock. Open boreholes were checked for groundwater and general stability prior to backfilling. All boreholes, where applicable, were backfilled in accordance with O.Reg. 903, as amended.

Borehole logs are provided in Appendix A. Soil, groundwater, and bedrock conditions are described, as applicable, with relevant geotechnical recommendations discussed in the following sections of this report.

3.2 Physical Laboratory Testing

Laboratory soil testing included Particle Size Distribution Analyses (LS-702, 705) and Atterberg Limit Analyses (LS-703, 704) on select samples, and Natural Moisture Content Analyses (LS-701) were completed on all soil samples. Results are presented in Appendix B and are summarized on the borehole logs and described in the subsequent sections of this report.

Consolidation analysis was completed by a third-party laboratory retained by Cambium on select samples of the silty clay to provide analyses on settlement parameters of the silty clay. The results of the consolidation testing are provided in Appendix C.

3.3 Multi-channel Analysis of Surface Waves

As part of this investigation, Multi-channel Analysis of Surface Waves (MASW) survey was completed on the site in order to evaluate the shear wave velocities of the subsurface materials and determine the seismic site class. The survey was completed on September 26th, 2024, by Frontwave Geophysics Inc. A total of twenty-four (24) geophones in 1 and 3 m spacing were placed at the site in order to acquire shear wave velocities and complete the testing. A report summarizing the testing was provided by Frontwave Geophysics Inc. and included as Appendix D in this report.

3.4 Site Survey

The location of each borehole was referenced locally by a Cambium technician using a Topcon HiPier II GPS+ surveying unit. The top of spindle of an existing fire hydrant, located near the northwest side of the property along Mer Bleue Road. The benchmark is depicted as 'BM' on Figure 2. The elevation of the benchmark was taken from the topographic survey provided by the client [5]. Based on the survey, the benchmark has an elevation of 88.218 metres above sea level (mASL). UTM coordinates and elevations are included on the borehole logs provided in Appendix A.

3.5 Investigations by Others

A previous geotechnical investigation was completed at this site by Others in May 2018 [3]. The previous geotechnical investigation completed ten boreholes across the site, including three boreholes (BH18-2, BH18-4, and BH18-10) within the footprint of the proposed secondary school subject of this investigation, and one borehole adjacent to the proposed building (BH18-3). Two other boreholes were advanced at the site (BH18-1 and BH18-9), while the remaining boreholes advanced as part of this investigation (BH18-5 through BH18-8) were completed adjacent to Jerome Jodoin Drive.

Based on the results of this investigation, the site is underlain by deposits of silty clay. The upper portions of the silty clay have been desiccated forming a weathered crust. The weathered crust in the boreholes advanced within or adjacent to the proposed building footprint have a measured thickness ranging from 2.3 to 3.8 m. BH18-4 completed dynamic cone penetration testing (DCPT) in order to determine the depth of the silty clay deposit. Refusal was encountered at 36.5 mbgs.

The data from BH18-5 through BH18-8 are more relevant for the Elementary school to be completed at that location.

4.0 Subsurface Conditions

The stratigraphy encountered in the boreholes are indicated on the attached borehole logs in Appendix A. It is noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the testing locations. The soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change. In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (drilling speed, shaking/grinding of the augers, etc.).

The subsurface conditions at the Site generally consisted of a topsoil and/or cohesionless fill material at the surface underlain by native silty clay deposits. There is a distinct weathered crust in the upper portions of the silty clay. The various soil strata are described in detail below and are identified on the borehole logs included in Appendix A.

4.1 Topsoil

Topsoil was encountered from the surface at boreholes BH101-24, BH102-24, BH105-24, and BH107-24 through BH112-24. Table 1 summarizes where topsoil was encountered and its associated approximate thickness.

Table 1 Topsoil Thicknesses

Borehole	Approximate Thickness (mm)
BH101-24	75
BH102-24	175
BH105-24	200
BH107-24	125
BH108-24	150
BH109-24	225
BH110-24	225
BH111-24	200
BH112-24	250

4.2 Fill Material

Fill material was encountered in boreholes BH101-23 through BH104-24, BH106-24, and BH109-24. Table 2 summarizes the approximate thicknesses encountered at each borehole location.

Table 2 Fill Material Thicknesses

Borehole	Approximate Thickness (mm)
BH101-24	830
BH102-24	2110
BH103-24	1520
BH104-24	1520
BH106-24	970
BH109-24	230

The fill material varies in compositions between borehole locations, but is predominantly silt and sand, gravelly to trace gravel. The fill materials soils were dark brown to brown in colour. The dark brown colours indicate possible organics within the fill deposits.

The soils have a compact to very dense relative density based on SPT N values of 15 to 54 blows for 305 mm of penetration.

Laboratory particle size distribution analysis was completed for one sample of the fill material soils taken from the borehole and depth indicated below. The analysis results are summarized in Table 3 with full results provided in Appendix B.

Table 3 Particle Size Distribution Analysis – Fill Material Soils

Sample	Depth (mbgs)	Soil	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
BH103-24 SS 1	0.0 – 0.6	Gravelly silty sand	28	50	22	

The grain size distribution of the above sample is compared with the gradation envelopes of Ontario Provincial Standards Specification (OPSS.MUNI) 1010 of Granular A and Granular B Type I. Based on the results, the existing fill does not meet the gradation requirements for the either of these materials due to an elevated fines content (22% vs 8% allowable max).

4.3 Silty Clay

The site is underlain by native deposits of silty clay extending to depths of possibly 39 mbgs. The upper portion of the silty clay has been desiccated to form a weathered crust.

4.3.1 Weathered Crust

Beneath the fill material or topsoil, the weathered crust of the silty clay soils were encountered in all boreholes. The weathered crust material extended to depths ranging between approximately 1.5 to 3.1 mbgs. Boreholes BH109-24 through BH112-24 terminated within the upper crust at a depth of 1.5 mbgs. Table 4 summarizes the approximate depth to the base of the desiccated weathered crust and associated elevations.

Table 4 Weathered Crust Depth and Base Elevation

Borehole	Depth to Base (mbgs)	Thickness (mm)	Base Elevation (mASL)
BH101-24	1.5	0.6	85.8
BH102-24	3.1	0.8	85.1
BH103-24	2.3	0.8	85.1
BH104-24	3.1	1.5	84.5
BH105-24	2.3	2.1	84.5
BH106-24	2.3	1.3	84.8
BH107-24	2.3	2.2	84.8
BH108-24	2.3	2.1	84.5

4.3.2 Clays Underlying Weathered Crust

The native silty clay soils were softer underlying the weathered crust. The silty clay deposit extended to borehole termination depths in all boreholes across the site with the exception of BH102-24. The silty clay below the crust is grey in colour and contains trace sand.

BH102-24 was advanced to the underlying bedrock and bedrock was cored at proven at this location. Sampling as not completed for the deeper borehole beyond 9.8 mbgs. Based on the observations during the drilling, a notable change in resistance delineates a possible glacial till deposit at 36.0 mbgs. Investigations by Others have inferred the base of the silty clay at this site to be at about 36.5 mbgs. The silty clay layer is therefore about 34 m thick.

SPT N values recorded in the deposits below the weathered crust measured 1 or static weight of hammer. The undrained shear strength was then measured in-situ using a shear vane. The soils have a soft to firm relative consistency based on peak undrained shear resistance values of 16 to 36 kPa. Corresponding remoulded values ranged from 2 to 9 kPa, indicative of a medium to low sensitivity, based on the CFEM 2024 [6].

Laboratory particle size distribution analyses were completed for four samples of the silty clay material taken from the borehole and depth indicated below. The analysis results are summarized in Table 5 with full results provided in Appendix B.

Table 5 Particle Size Distribution Analysis – Silty Clay

Sample	Depth (mbgs)	Soil	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Moisture (%)
BH101-24 SS3	1.5 – 2.1	Silty clay, trace sand	0	1	31	68	41.3
BH101-24 SS8	4.6 – 5.2	Silty clay, trace sand	0	1	24	75	85.3
BH102-24 SS4	2.3 – 2.9	Silty clay, trace sand	0	1	28	71	41.6
BH102-24 SS11	6.1 – 6.7	Silty clay	0	0	26	74	88.8

Atterberg Limits testing was completed on three representative samples of the silty clay. The analysis results are summarized in Table 6 with full results provided in Appendix B.

Table 6 Atterberg Limits Tests – Silty Clay

Sample	Depth (mbgs)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Moisture (%)
BH101-24 SS3	1.5 – 2.1	54.3	23.4	30.9	41.3
BH102-24 SS4	2.3 – 2.9	55.7	23.7	32.1	41.6
BH102-24 SS8	4.6 – 5.2	57.3	23.5	33.8	65.4

The results indicate a high plasticity clay with natural moisture contents all above the plastic limit and above the liquid limit below the weathered crust.

Consolidation analysis was completed by a third-party laboratory retained by Cambium on select samples of the silty clay. The testing is performed by applying different loads to a silty clay and measuring the deformation, defined as the change in void ratio. The analysis was completed primarily to determine the preconsolidation pressure of the silty clay deposits. Preconsolidation pressure the maximum effective vertical overburden stress that has been previously placed on the soil strata. The results of the testing are summarized in the table below.

Table 7 Consolidation Analyses – Silty Clay

Sample	Depth (mbgs)	Preconsolidation Pressure (p_c)
BH101-24	6.1 to 6.7	92
BH104-24	4.6 to 5.2	78

4.4 Possible Glacial Till

Borehole BH102-24 was advanced using a casing advancer in order to determine the thickness of the soft clay deposits and prove bedrock with rock coring. Based on observations in drilling resistance, a deposit of sandy gravelly material, likely glacial till, was noted at a depth of 36.0 mbgs. Investigations by Others noted possible glacial till within the building footprint at a depth of 35.1 mbgs.

4.5 Bedrock

Bedrock encountered in one of the boreholes advanced: BH102-24. Rock coring for a length of 2.8 m was completed at this location in order to prove bedrock. Photograph of the rock core is provided in Appendix E.

The top of bedrock surface was measured at a depth of 39.0 mbgs (Elevation 49.2 mASL).

The bedrock beneath the site is of the Lindsay Formation, which is a deposit comprised of limestone bedrock. The rock cores obtained from this site indicate the site is underlain by dark grey limestone. Shale bedding was noted within the rock core. The respective borehole logs provide details on encountered shale beds.

Rock Quality Designation (RQD) refers to the total length of those pieces of sound core which are 100 mm or greater in length in the core run, expressed as a percentage of the total length of that core run. Sound pieces of rock are those pieces separated by natural fractures or bedding. The RQD from the bedrock core taken from BH102-24 measured 55 and 59 %.

Unconfined compression testing was conducted on samples of the bedrock taken from BH102-24. The results of the compression testing are summarised in the table below and provided in Appendix B.

Table 8 Unconfined Compressive Strength – Bedrock

Sample	Depth (mbgs)	Compressive Strength (MPa)
BH102-24 RC1	39.0 to 40.3	58.2
BH102-24 RC2	40.3 to 41.8	122.3

The results indicate that the underlying bedrock is strong to very strong.

4.6 Groundwater

Groundwater level was measured in monitoring wells installed by Cambium on November 4, 2024. The results are summarized in the Table 9 below. The groundwater level was measured in the installed wells with an electronic water level tape.

Table 9 Summary of Groundwater Measurements

Borehole	Depth of well (mbgs)	Groundwater Level/Elevation (mbgs/mASL)
		November 4, 2024
BH101-24	6.1	0.9 / 86.5
BH104-24	6.1	1.2 / 86.3
BH105-24	6.0	0.4 / 86.4

Groundwater levels at the time are pretty consistent between borehole locations and measure at around 86.4 +- 0.1 mASL.

Groundwater levels at the Site are anticipated to fluctuate on a seasonal basis and in response to significant precipitation or snowmelt events.

4.7 Chemical Analysis

One soil sample was submitted to Paracel Laboratories Ltd for chemical corrosivity analysis. The laboratory results are presented in Appendix F. The sample was analysed for chloride, sulphate, pH, resistivity, sulphide concentration, and redox potential. The submitted sample, taken from BH103-24, was taken from a depth of 0.75 to 1.5 mbgs.

To determine the potential for corrosion, the laboratory results were compared to the ANSI/AWWA corrosivity rating system, and the total points were less than 10. Based on the

total points scored, corrosive protective measures on unprotected steel are not considered necessary.

Please note that there may be other overriding factors in the assessment of corrosion potential, such as redox potential, the nature of effluent conveyed, the application of de-icing salts on any access roads and subsequent leaching into the subsoils and stray currents.

The laboratory test results also indicate that the soluble sulphate concentration of the tested sample is less than 0.1%. Based on this concentration, there is a negligible potential for sulphate attack on concrete. Accordingly, normal Type 10 Portland cement can be used.

5.0 Geotechnical Design Considerations

This section of the report provides engineering information on, and recommendations for, the geotechnical design aspects of the project based on our interpretation of the borehole information, the laboratory test data, and our understanding of the project requirements. The information in this portion of the report is provided for planning and design purposes for the guidance of the design engineers and architects. Where comments are made on construction, they are provided only to highlight aspects of construction which could affect the design of the project. Contractors bidding on or undertaking any work at the Site should examine the factual results of the investigation, satisfy themselves as to the adequacy of the information for construction and make their own independent interpretation of the factual data as it affects their proposed construction techniques, schedule, equipment capabilities, costs, sequencing, and the like. Cambium will not assume any responsibility for construction-related decisions made by contractors based on this report. It is possible that subsurface conditions beyond the borehole locations may vary from those observed. If significant variations are found before or during construction, Cambium should be contacted to reassess findings and recommendations, as needed.

5.1 Project Understanding and Assumptions

As previously stated, it is Cambium's understanding that the proposed development is the construction of new secondary school. It is understood that the new building will be three (3) stories in height of slab on grade design (no basement). The proposed development will also include new asphalt surfaced parking and driving areas, landscaped areas, and various school facilities such as an area for portable classes, basketball court, and soccer field. It is assumed that the facility will require new municipal site services.

Based on the most recent site plans [2], the finished floor elevation for the proposed main school building is 88.0 mASL.

5.2 Frost Penetration

Based on climate data and design charts, the maximum frost penetration depth below the surface at the site is estimated at 1.8 mbgs. Any footings and utilities, for both heated and unheated structures, should be founded at or below a depth of 1.8 mbgs or be adequately insulated.

5.3 Excavations

All excavations must be carried out in accordance with the latest edition of the Occupational Health and Safety Act (OHSA) and Ontario Regulation 213/91 (as amended).

Soils at the site can be considered Type 4 soils and as such, excavation side slopes should be no steeper than 3H:1V.

Fill materials at this site can be considered Type 3 soils and excavation side slopes in the fill can therefore be steepened to 1H:1V, however the extent of the fill material will likely be limited to just the upper portions. Where the side slopes consist of more than one soil type, the soil shall be classified as the type with the highest number among the soil types present. Please note that the soil type classifications indicated above are provisional and are subject to change based on field observations of the actual conditions at the time of exposure.

Excavation side slopes should be protected from exposure to precipitation and associated ground surface runoff and should be inspected regularly for signs of instability. If localized instability is noted during excavation or if wet conditions are encountered, the side slopes should be flattened as required to maintain safe working conditions or the excavation sidewalls must be fully supported (shored).

Stockpiles of excavated materials should be kept at least at the same distance as the excavation depth from the top edge of the excavation to prevent slope instability.

5.4 Dewatering

Groundwater was measured at 3 borehole locations to be at 86.4 +/- 0.1 mASL. Based on frost penetration depths, it is anticipated that excavations foundations and site services will advance slightly below this elevation.

The native clays at this site will preclude groundwater flow and therefore it anticipated that groundwater can be controlled using filtered sumps and pumps. Hydraulic conductivity of the silty clay is estimated to be between 10^{-6} and 10^{-7} cm/s. It is therefore not anticipated that positive dewatering will be possible due to the low permeability of the silty clay. Sump pumps should be sized according to excavation size. Groundwater seepage will likely be continuous from the sidewalls and excavation base. It is recommended, if possible, that the excavation is graded to allow for water to runoff and collect at a single low point.

It is noted that water takings in excess of 50 m^3/day are regulated by the Ministry of the Environment, Conservation and Parks (MECP). Certain takings of groundwater and storm water for construction site dewatering purposes with a combined total less than 400 m^3/day qualify for self-registration on the MECP's Environmental Activity and Sector Registry ("EASR"). Registry on the EASR replaces the need to obtain a PTTW and a Section 53 approval. A Category 3 PTTW is required where the proposed water taking is greater than 400 m^3/day. It is recommended that construction is staged to not require greater water volumes than 400 m^3/day. An EASR will likely be required and should be completed in advance of construction to avoid delays.

Any patterns of groundwater flow trends were not recognized based on the borehole observations and a hydrogeological assessment would be required to better understand groundwater patterns and specific dewatering requirements throughout the site. It is noted that the elevation of the groundwater table will vary due to seasonal conditions and in response to heavy precipitation events.

Any dewatering measures should be accordingly provided and designed by the Contractor.

5.5 Grade Raise Restriction

The site is underlain by a deposit of cohesive deposits which are sensitive to secondary settlement. The cohesive soils have a limited capacity to support loads imposed by grade raise fill material in combination with the loads from structures.

The settlement response of the cohesive deposits to the increase in loading is influenced by variables such as the existing effective overburden pressure, the past preconsolidation pressure of the material, the compressibility characteristics of the deposit, and the presence or absence of drainage paths within the deposit. The settlement response can be significant when the stress increase is at or near the difference between the preconsolidation pressure and the existing overburden stress.

Based on our analysis of the cohesive deposits, any grade raise to the site should be limited depending on the location of the grade raise and permissible settlement in the area. The following table provides a summary of the maximum allowable grade raises and the context to which they apply.

Table 10 Summary of Grade Raise Restrictions

Location	Maximum Allowable Grade Raise (m)	
	Silty Clay Fill	Granular Fill
Within 3 m of any structure supported on the native materials or over utility trenches	0.9	0.6
Parking area	1.0	0.9
Landscaped areas	1.2	1.0

Cambium must be retained to review site grading plans to confirm that the grade raise restrictions have been appropriately followed. Alternatively, grade raises can be restricted to 0.6 m across the entire site.

For design purposes, we have assumed groundwater will be lowered by 1 m due to the development of the site. Ongoing groundwater monitoring pre and post development is recommended to confirm extent of groundwater lowering.

It is important to note that if excessive fills are placed on the site, greater than the recommended maximum, the long-term settlement of the ground could be significant. For buildings supported on deep foundations, this excess settlement could damage site services entering the building or significant grade drops between the structure and exterior grades.

5.6 Foundation Design

It is Cambium's understanding that the proposed development will be 3 storey school building of slab on grade design. It is estimated that FFE for the main building will be set at 88.0 mASL. Based on the anticipated building loads, it is likely that allowable bearing capacities for shallow foundations will not be sufficient for support. End bearing pile recommendations are provided below. Shallow spread footing recommendations are also provided and may be used for auxiliary structures.

5.6.1 End Bearing Piles

Deep foundations consisting of concrete fille steel tubes driven to refusal on bedrock could be used to support the building loads. Bedrock was measured at one location at the site at 39.0 mbgs (49.2 mASL). Investigations by other encountered refusal from DCPT at a depth of 36.5 mbgs. It is likely DCPT refusal was encountered within the glacial till, and depth to bedrock should be taken around 39 +/- mbgs.

Load capacity of piles should be based on in-situ full scale load testing following installation.

SLS design does not apply for piles driven to sound bedrock, since the bedrock is considered non-yielding and the loads required for unacceptable settlements to occur would be much larger than the factored ULS.

Piles in group should be spaced so that the load-bearing capacity of the group is not less than the sum of the bearing capacity of individual piles, or the load-bearing capacity of the piles must be reduced based on the pile spacing. A group efficiency factor of 1.0 (i.e., no reduction) may be applied to the vertical capacity of the piles if the spacing are greater than 2 times the diameter size. Piles spaced closer than 2 times the diameter size will reduce the efficiency factor, which will depend on diameter size and separation distance.

Piles should be fitted with either driving shoes or OSLO points to set the piles in the bedrock, to minimize pile tip damage when driving into the bedrock, and to reduce the risk of horizontal pile movement during driving on potential sloping bedrock surface. This; however, should be determined by the pile installer during construction.

If pile caps are constructed below grade, a minimum 1.5 m earth cover or equivalent insulation will be required for adequate protection against frost.

The pile installations should be monitored on a full-time basis by qualified geotechnical personnel to ensure uniformity of set, record pile toe and cut off elevations, and to check the pile condition, alignment, splices, and plumbness. All pile driving techniques should be reviewed and approved prior to the installation of the piles. The set criterion for each pile should be confirmed by a full-time qualified piling inspector.

5.6.1.1 Uplift Resistance

The uplift resistance may be estimated using Section 9.4.1 and Section 9.2.1.2.2 of the Canadian Foundation Engineering Manual [6], an undrained shear strength of 30 kPa, and adhesion factor of 0.7. An additional resistance factor of 0.3 should be applied to the ultimate shaft resistance. The uplift resistance of the pile should be confirmed on a representative number of piles by uplift testing.

5.6.1.2 Construction Recommendations

The native soils at this site are highly sensitive to construction traffic, particularly if pile driving is completed at or near final grades, it is recommended that a 50 mm concrete mud slab is placed on the subgrade to support pile driving equipment.

5.6.2 Conventional Shallow Footings

Any shallow foundations placed on site should be set at a depth greater than frost penetration depths for the site, which is noted as 1.8 mbgs. Foundations must be placed on the brown to grey brown weathered crust, which may not provide adequate frost depth. Insulated foundations will likely be required.

Conventional shallow spread footings placed directly on the native deposits should be sized using a net reaction at **SLS** of **50 kPa**, and a factored geotechnical resistance at **ULS** of **125 kPa**. Where subexcavation is required to due fill material or unsuitable bearing surfaces, the grade may be raised using engineered fill up to the underside of the footing.

Engineered fill must be placed directly on the undisturbed native deposits and the pad of engineered fill should conform to Ontario Provincial Standards Specification (OPSS.MUNI) 1010 Granular B Type II. The imported engineered fill should be placed in maximum 200 mm thick lifts to at least 99 % of the standard proctor maximum dry density (SPMDD) value. To allow for adequate spread of the loading below and beyond the footings, the engineered fill should extend a horizontal distance of at least 300 mm beyond the edge of the footings and then down and away from the edges at an angle of 1H:1V, or flatter. Excavations should be sized to accommodate fill placement.

The quality of the subgrade should be inspected by Cambium during construction, prior to constructing the footings, to confirm bearing capacity estimates. If loose or deleterious material is encountered, the material should be subexcavated and replaced with approved engineered fill placed in maximum 200 mm thick lifts and compacted to at least 98 % SPMDD value. Soft or disturbed clayey soils should not be considered suitable for support of the foundations and should be subexcavated to underlying competent material.

5.7 Rock Anchors

It is understood that tension resistance is required at some locations at the site, and that the design tension exceeds the estimated uplift resistance provided by the piles. As a result, rock anchors will be included in the design and socketed into the underlying bedrock.

Anchors made into the bedrock may be designed using a ULS working adhesion of **305 kPa**. The unconfined compressive strength of the grout used should be at least 30 times the design working adhesion. The installation of the anchors should be tested to at least 133 % of the design load. Embedment depth of the rock anchors will depend on required loads and anchor size.

Minimal distance between 2 anchors should be at least 4 times the diameter of the anchor hole to negate group effects. Two adjacent rock anchors will have to be tested simultaneously to observe group effect conditions.

5.8 Seismic Site Classification

The Ontario Building Code (2024) stipulates the methodology for earthquake design analysis, as set out in Subsection 4.1.8. The determination of the type of analysis is predicated on the importance of the structure, the spectral response acceleration, and the site classification.

An MASW survey has been completed at this site to measure the average V_s of the upper 30 m of the site stratigraphy. The results of this survey indicate an average V_s of **133 m/s** for the equivalent single layer response between the surface and 30 m in depth.

The designation of the seismic analysis can be taken as **Site Class E.**

5.9 Liquefaction Potential

Based on the investigation results, the native soils at this site have no potential for liquefaction.

5.10 Backfill and Compaction

The existing sand and silt fills across the site may be useable as backfill against foundation elements, provided they are free of organics or deleterious materials. The material should be stockpiled, inspected, and approved by Cambium personnel prior to reuse.

The native soils at this site should not be used as backfill against exterior or unheated foundation elements or below settlement sensitive structures. All material containing organics should not be used as backfill against the foundation walls.

To avoid frost adhesion and possible heaving, all foundation walls are to be backfilled with non-frost susceptible granular material such as imported material meeting OPSS Granular B Type I or II.

Backfill adjacent to the structural elements (i.e., foundation walls) should be placed evenly in lifts not exceeding 200 mm loose thickness and should be compacted to at least 95% of

SPMDD taking care not to damage the adjacent structures. Light compaction equipment such as small vibratory or hand operated ram equipment should be used immediately adjacent to the wall; otherwise, compaction stresses on the wall may be greater than that imposed by the backfill material.

5.11 Slab-on-Grade Construction

It is anticipated that the floor slabs can be designed as a concrete slab-on-grade.

The slab may be supported on compacted engineered fill such as material meeting OPSS.MUNI 1010 Granular A or B Type II placed directly on the underlying native deposits.

The exposed subgrade should be inspected by Cambium. Remedial work should be carried out on any softened, disturbed, wet or poorly performing zones as directed by Cambium. Any low areas may then be brought up to within at least 200 mm of the underside of the floor slabs, as required, using OPSS Granular B, Type I material or other approved material, placed in maximum 200 mm loose lifts and uniformly compacted to at least 98% of SPMDD.

The final lift of granular fill beneath floor slabs should consist of a minimum thickness of 200 mm of OPSS Granular A material, uniformly compacted, acting as a moisture barrier. Any filling operations should be inspected and tested by Cambium. A woven geotextile separator (such as Terrafix 270R or equivalent) must be placed between the top of the native silty clay and the underside of the granular layers.

The floor slabs should be structurally separate from the foundation walls and columns. Sawcut control joints should be provided at regular intervals and along column lines to minimize shrinkage cracking and to allow for any differential settlement of the floor slabs.

For initial analyses, the moduli of subgrade reaction appropriate for slab on grade design on the soils at the site are as follows:

- Engineered Fill: 18 MPa/m

5.12 Lateral Earth Pressure

The design of walls subjected to unbalanced earth pressures should consider the horizontal soil loads, as well as surcharge loads that may occur during or after construction. The backfill materials should consist of imported free-draining granular soils (e.g. OPSS Granular B, Type I or Granular A and Granular B Type II) as approved by a Geotechnical Engineer. The backfill materials should be placed in lifts not exceeding 200 mm thick. The layers should be compacted to at least 95% of SPMDD. Lateral earth pressure coefficients (K) are shown in Table 11.

Table 11 Lateral Earth Pressure Coefficients

Soil	Bulk Unit Weight γ (kN/m3)	Internal Friction Angle* Φ' (°)	Active earth pressure coefficient Ka (Rankine)	Passive earth pressure coefficient Kp (Rankine)	At-rest earth pressure coefficient Ko (Rankine)
Compacted Imported Engineered Fill (Granular A or B)	22	35	0.27	3.69	0.43
Existing Earth Fill	21	30	0.33	3.0	0.50

**Values derived from empirical relationships based on soil types and SPT N-values*

The earth pressure coefficient adopted will depend on whether the retaining structure is restrained, or some movement can occur such that the active state of earth pressure can develop. The use of vibratory compaction equipment immediately behind the retaining walls should be restricted in size.

The coefficients provided in Table 11 assume that the surface of the granular backfill or native material is horizontal against any proposed wall, and the wall is vertical and smooth. Cambium should be contacted to provide updated lateral earth pressure coefficients should the assumptions differ to those noted.

The following formula may be used to calculate active lateral thrust (Pa) on yielding retaining structures.

$$P_a = (\mathrm{H}/2)(\mathrm{K_a})(\gamma\mathrm{H}+2\mathrm{q})$$

where,

H = Height of retaining structure (m)

γ = unit weight of retained soil (kN/m³)

q = surcharge (kPa)

Unit weights found in Table 11 should be used for compacted loadings of the appropriate material.

Where traffic loads are expected within 3 meters of the foundation walls, a vehicle surcharge pressure of at least 3 and up to 6 kPa should be applied; the actual surcharge pressure should depend on the type of traffic.

5.13 Perimeter Drainage

A perimeter foundation drainage system should consist of geotextile wrapped perforated 100 mm diameter pipes surrounded by a trench of 19 mm clear stone around the foundations. The perimeter drains should connect to underfloor drainage system.

Any drainage system should outlet to a suitable discharge point under gravity flow away from the structures, or to a sump pit and pumped out. The design of the system must conform to applicable plumbing code requirements.

5.14 Buried Utilities

Cambium should be retained to review site servicing plan to confirm the following recommendations.

5.14.1 Frost Protection for Underground Services

It is recommended to place water services at a minimum depth of 300 mm below the frost penetration depth with the top of the pipe located at 1.8 mbgs or lower as dictated by municipal service requirements. If a minimum of 1.8 m of soil cover cannot be provided, then the pipe should be insulated with a rigid polystyrene insulation (DOW Styrofoam HI40, or equivalent) or a pre-insulated pipe be installed.

5.14.2 Subgrade Preparation

Excavation and dewatering recommendations are provided in the section below. The subgrades will consist of soft silty clay. Care should be taken to reduce construction traffic directly on the silty clay. Geotextile and pipe bedding should be placed immediately following excavation.

5.14.3 Excavation and Dewatering

Excavation and dewatering for trenches should adhere to the recommendations provided in Sections 5.3 and 5.4, respectively.

5.14.4 Pipe Bedding and Cover Materials

Bedding and cover material for any services should conform to Ontario Provincial Standard Drawings (OPSD) 802.010 and 802.013 (flexible pipes) and OPSD 802.031 to 802.033 (rigid pipes). The pipe bedding should consist of 200 mm of OPSS.MUNI 1010 Granular A wrapped by a geotextile (Terrafix 270R or similar). The bedding and cover material shall be placed in maximum 200 mm thick lifts and should be compacted to at least 95% SPMDD. The cover material shall extend a minimum of 300 mm above the top of the pipe and be compacted to a minimum of 95% of SPMDD, taking care not to damage the utility pipes during compaction. The use of clear stone should not be permitted.

5.14.5 Pipe Backfill

Above the pipe cover material, the pipe can be backfilled by using imported granular fill material such as OPSS.MUNI 1010 Granular B, Type I. An alternative select subgrade material

(SSM) may be used as well, provided that the material is approved by Cambium prior to use. The re-using of excavated organic free native soils is likely not feasible due to the high moisture content and composition of the material. The cohesionless fill materials located from the surface of the site may be re-useable. The soils should be placed in maximum 300 mm thick lifts compacted to 95% SPMDD.

5.14.6 Seepage Barriers

Seepage barrier or barriers should be constructed along the services trench to reduce the potential for groundwater flow along the granular bedding and surround for the proposed services and mitigate groundwater table lowering. The seepage barriers should begin at subgrade level and extend vertically through the granular pipe bedding and granular surround to within the native backfill materials, and horizontally across the full width of the service trench excavation. The seepage barriers could consist of 0.6 m wide dykes of compacted silty clay. The silty clay should be compacted in maximum 300 mm thick lifts to at least 95% of the SPMDD value.

The silty clay at the site will have too high moisture contents for re-use immediately following excavation. This material, if intended for re-use will have to be stockpiled and allowed to dry prior to placement.

5.15 Pavement Design

5.15.1 Subgrade Preparation

The performance of the pavement is dependent upon proper subgrade preparation. All organic materials should be removed and backfilled with approved engineered fill, compacted to 98% SPMDD. The subgrade should be inspected by a Geotechnical Engineer. The most severe loading conditions on pavement subgrades will likely occur during construction, and subgrades may become disturbed due to construction operations, particular with construction traffic driving over unpaved granular subbase or base roadways.

Depending on the construction traffic and the effect on the pavement materials, increasing the thickness of the subbase and/or base materials may become necessary. The requirements for increase can be assessed by geotechnical personnel as needed.

5.15.2 Pavement Structure

The recommended minimum pavement structure design has been developed for two traffic loading scenarios, light duty and heavy duty. The heavy-duty design is appropriate for school bus lanes and emergency vehicle routes, while the light duty design is appropriate for areas where no heavy traffic is anticipated. The recommended minimum pavement structure is provided in Table 12.

Table 12 Pavement Structure

Pavement Layer	Light Duty	Heavy Duty
Surface Course Asphalt	40 mm SP12.5	40 mm SP12.5
Binder Course Asphalt	60 mm SP19	120 mm SP19 (2 lifts of 60 mm)
Granular Base	150 mm OPSS1010 Granular A	200 mm OPSS1010 Granular A
Geogrid	Tensar InterAx NX850 or approved equivalent	Tensar InterAx NX850 or approved equivalent
Granular Subbase	300 mm OPSS1010 Granular B Type II	300 mm OPSS1010 Granular B Type II
Geotextile	Terrafix 270R or approved equivalent	Terrafix 270R or approved equivalent

Material and thickness substitutions must be approved by the Design Engineer. Compaction of the subgrade should be verified by the Engineer prior to placing the granular base. Granular layers should be placed in 150 mm maximum loose lifts and compacted to at least 98 % of the SPMDD value. The granular materials should conform to OPSS standards, as confirmed by appropriate materials testing.

5.15.3 Asphaltic Cement Type

Performance grade PG 58-34 asphaltic cement, Traffic Level C, should be specified for Superpave asphaltic concrete mixes.

5.15.4 Pavement Drainage

Adequate drainage of the pavement granular materials and subgrade is important for the long-term performance of the pavement at this site. The subgrade surface should be crowned and shaped to drain to ditches and/or catch basins to promote drainage of the granular material.

5.16 Effects of Trees

The entire site is underlain by marine clay deposits, a material that is susceptible to shrinkage with reduction in the moisture content. Trees can create this reduction in the volume of the native silty clays under foundations, depending on the size and type of tree and proximity to the foundations. The reduction in volume may result in significant settlement and subsequent damage to buildings and structures founded on the silty clay.

Field measurements of the undrained shear strength of the native silty clays at this site indicate a low to medium sensitivity. Additionally, Atterberg limits tests indicate a plasticity index that ranges from 31 to 34 % (less than 40%).

No deciduous trees should be permitted closer to structures founded on the silty clay, sensitive to excess settlement, less than the ultimate height of the tree species. For small trees (mature height up to 7.5 m), and medium sized trees (mature tree height up to 14 m), this setback may be reduced to 4.5 m, provided that all other conditions outlined in "*City of Ottawa Tree Planting in Sensitive Marine Clay Soils – 2017 Guidelines*" are met. It should therefore be noted that underside of footing (USF) elevation will be governed in part by the proximity of trees to footings. Landscaping design must consider the required tree separations and offsets from the proposed structures.

Hard scaped surfaces such as concrete or asphaltic concrete covered surfaces will not reduce the setback requirements outlined above. It should be noted by the developer that the 2017 guidelines outline the required available soil volumes for trees, and that the soil must be

generally uncompacted. Hardscaped surfaces are generally underlain by compacted granular material.

5.17 Winter Construction

In order to carry out the work during freezing temperatures and maintain adequate performance of the founding soils and subgrades, excavations should be opened for as short a time as practicable and the excavations for site services should be carried out only in lengths which allow all of the construction operations, including backfilling, to be fully completed in one working day. The materials on the sides of the excavations should not be allowed to freeze.

Stockpiles materials stored and replaced without being disturbed by frost or contaminated by snow or ice. For excavations below foundations, soils should be protected immediately from frozen conditions using heaters, insulated tarps, straw, or other appropriate methods. Provisions should be arranged to prevent freezing or frost build up within soils situated below the level of any existing structures or services. Frozen soil may result in damages to structures or services.

6.0 Limitations and Use of Report

This geotechnical engineering report intended for planning and design purposes only. This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by engineering practitioners. The discussion and recommendations that have been presented are based on factual data obtained from this investigation.

6.1 Design Review and Inspections

It is recommended that Cambium be contacted to review and approve design drawings, prior to tendering or commencing construction, to ensure that all pertinent geotechnical-related factors have been addressed. In particular the grading plan should be provided for review to confirm grade raise restrictions.

It is important that onsite geotechnical supervision be provided at this site for excavation and backfill procedures, deleterious soil removal, subgrade inspections and compaction testing.

6.2 Changes in Site and Project Scope

Subsurface conditions can be altered by the passage of sufficient time, natural occurrences, and human intervention. In particular, consideration should be given to contractual responsibilities as they relate to control of groundwater seepage, disturbance of soils, and frost protection.

The design parameters provided, and the engineering advice offered in this report are intended for use by the owner and its retained design consultants. If there are changes to the project scope and development features, these interpretations made of the subsurface information, for geotechnical design parameters, advice, and comments relating to constructability issues and quality control may not be complete for the project. Cambium should be retained to conduct further review to interpret the implications of such changes with respect to this report.

7.0 Closing

Please note that this work program and report are governed by the attached Qualifications and Limitations. If you have questions or comments regarding this document, please do not hesitate to contact the undersigned at (613) 389-2323.

Respectfully submitted,

Cambium Inc.

Signed by:

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Rob Gethin, P.Eng.
Group Manager - Geotechnical

DS

LICENSED PROFESSIONAL ENGINEER
B. VIJAYABASKARAN
100216716
PROVINCE OF ONTARIO

2025-03-27

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Blasco Vijayabaskaran, P.Eng.
Project Manager - Geotechnical

BV

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8.0 Standard Limitations

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Site Assessments

A site assessment is created using data and information collected during the investigation of a site and based on conditions encountered at the time and particular locations at which fieldwork is conducted. The information, sample results and data collected represent the conditions only at the specific times at which and at those specific locations from which the information, samples and data were obtained and the information, sample results and data may vary at other locations and times. To the extent that Cambium's work or report considers any locations or times other than those from which information, sample results and data was specifically received, the work or report is based on a reasonable extrapolation from such information, sample results and data but the actual conditions encountered may vary from those extrapolations.

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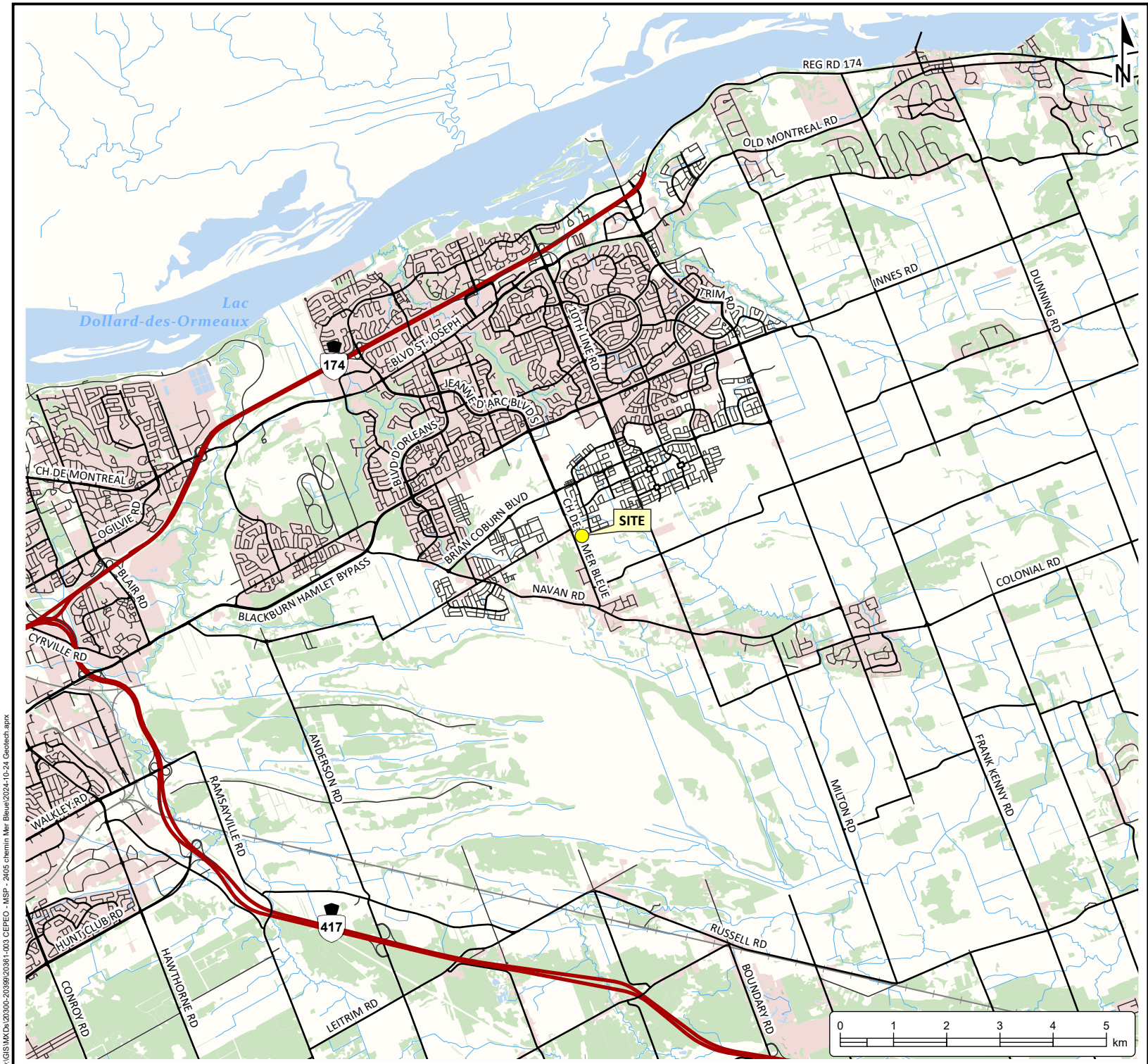
Figures



GEOTECHNICAL INVESTIGATION

CONSEIL DES ÉCOLES PUBLIQUES DE L'EST DE L'ONTARIO
2405 chemin Mer Bleue
Orleans, Ontario

LEGEND

- Highway
- Major Road
- Minor Road
- Railway
- Watercourse
- Water Area
- Wooded Area
- Built Up Area

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SITE LOCATION PLAN

Project No.: 20361-001		Date: October 2024	Rev.:
Scale: 1:100,000		Projection: NAD 1983 UTM Zone 18N	
Created by: DBB	Checked by: BV	Figure: 1	

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GEOTECHNICAL INVESTIGATION

CONSEIL DES ÉCOLES PUBLIQUES DE L'EST DE L'ONTARIO
2405 chemin Mer Bleue
Orleans, Ontario

LEGEND

- Benchmark
- Borehole
- Site (approximate)

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BOREHOLE LOCATION PLAN

Project No.: 20361-001		Date: October 2024 Rev.:	
Scale: 1:1,750		Projection: NAD 1983 UTM Zone 18N	
Created by: DBB	Checked by: BV	Figure:	2

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GEOTECHNICAL INVESTIGATION

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LEGEND

- Benchmark
- Borehole
- Site (approximate)

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BOREHOLE LOCATION PLAN PROPOSED CONDITIONS

Project No.: 20361-001		Date: November 2024 Rev.:	
Scale: 1:1,750		Projection: NAD 1983 UTM Zone 18N	
Created by: DBB	Checked by: BV	Figure: 3	

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Appendix A

Borehole Logs

CAMBIUM

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH101-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	87.35 mASL	**Date Completed:**	Oct. 8, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031609 **E:** 461426		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m)	Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V. rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
87.4	0		**TOPSOIL:** 75 mm (87.27 / 0.08)							Cap	
			(ML) SILT and SAND: dark brown, moist, compact, trace gravel [FILL]	1	SS	50	16	10.2%	16		
86.8	0.5										
			(86.44 / 0.91)	2A	SS			17%			
86.4	1		**(CL) SILTY CLAY:** grey-brown, w~PL, soft, some sand [WEATHERED CRUST]	2B	SS	54	12	28.8%	12	Bentonite Plug	
85.8	1.5		(85.83 / 1.52)							Riser	
			(CL) SILTY CLAY: grey-brown, soft, trace sand	3	SS	54	1	41.3%	1		
85.4	2										
84.8	2.5			4	SS	4	0	50.9%			
84.4	3										
			colour change to grey	5	SS	100	0	77.9%			
83.8	3.5			6							
83.4	4			7					3 24		
									3 24	Sand Pack	
82.8	4.5									PVC Screen	
			w>PL	8	SS	100	0	85.3%			
82.4	5			9							
81.8	5.5			10					3 24		
									3 24		
81.4	6									Cap	
				11							Shelby Tube Sample from 6.10 to 6.70 mbgs.
80.8	6.5		(80.64 / 6.71)								Borehole caving not observed. Groundwater encountered not encountered. Standing water observed 6.0 mbgs.
80.4	7		Borehole terminated @ 6.7 mbgs due to target depth achieved.								
79.8											

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS3	0	1	31	68
SS8	0	1	24	75

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH102-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 6
Project No.:	20361-003	**Elevation:**	88.11 mASL	**Date Completed:**	Oct. 9, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031649 **E:** 461426		

Elevation (m)	Depth	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
88.1	0	**TOPSOIL:** 175 mm	87.93								
		(ML) gravelly SILT and SAND: brown, moist, compact [FILL]	0.18	1	SS	63	26	7.6%	26		
87.6	0.5										
87.1	1	increase in silt content		2	SS	67	16	8.1%	16		
86.6	1.5	becomes dark brown, decrease in gravel		3	SS	50	15	20%	15		
86.1	2		85.82								
85.6	2.5	**(CL) SILTY CLAY:** brown, moist, w~PL, firm, trace sand [WEATHERED CRUST]	2.29	4	SS	100	4	41.6%	4		
85.1	3		85.06								
		(CL) SILTY CLAY: brown, moist, w~PL, firm	3.05	5	SS	100	1	44.6%	1		
84.6	3.5			6							
84.1	4			7					9 30		
83.6	4.5								6 30		
83.1	5	w>PL		8	SS	100	0	65.4%			
82.6	5.5	becomes soft		9					3 30		
82.1	6			10					3 24		
81.6	6.5			11	SS	100	0	88.8%			
81.1	7	becomes firm		12					3 27		
				13					3 30		
80.6			80.61								
			7.50								

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH102-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	2 of 6
Project No.:	20361-003	**Elevation:**	88.11 mASL	**Date Completed:**	Oct. 9, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031649 **E:** 461426		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
80.6 / 7.5		**(CL) SILTY CLAY:** brown, moist, w~PL, firm								
80.1 / 8			14	SS	100	0	72.1%			
79.6 / 8.5			15							
79.1 / 9			16					3 36		
								3 36		
78.6 / 9.5			17	SS	100	0	84.2%			
		78.36 / 9.75								
78.1 / 10		**(CL) SILTY CLAY:** PRESSUMED								
77.6 / 10.5										
77.1 / 11										
76.6 / 11.5										
76.1 / 12										
75.6 / 12.5										
75.1 / 13										
74.6 / 13.5										
74.1 / 14										
73.6 / 14.5										
73.1		73.11 / 15.00								

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH102-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	3 of 6
Project No.:	20361-003	**Elevation:**	88.11 mASL	**Date Completed:**	Oct. 9, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031649 **E:** 461426		

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
73.1 / 15		**(CL) SILTY CLAY:** PRESSUMED								
72.6 / 15.5										
72.1 / 16										
71.6 / 16.5										
71.1 / 17										
70.6 / 17.5										
70.1 / 18										
69.6 / 18.5										
69.1 / 19										
68.6 / 19.5										
68.1 / 20										
67.6 / 20.5										
67.1 / 21										
66.6 / 21.5										
66.1 / 22										
65.6		65.61 / 22.50								

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH102-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	4 of 6
Project No.:	20361-003	**Elevation:**	88.11 mASL	**Date Completed:**	Oct. 9, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031649 **E:** 461426		

SUBSURFACE PROFILE			SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa nat V. rem V.; 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
65.6 / 22.5		**(CL) SILTY CLAY:** PRESSUMED								
65.1 / 23										
64.6 / 23.5										
64.1 / 24										
63.6 / 24.5										
63.1 / 25										
62.6 / 25.5										
62.1 / 26										
61.6 / 26.5										
61.1 / 27										
60.6 / 27.5										
60.1 / 28										
59.6 / 28.5										
59.1 / 29										
58.6 / 29.5										
58.1		58.11 / 30.00								

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH102-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	5 of 6
Project No.:	20361-003	**Elevation:**	88.11 mASL	**Date Completed:**	Oct. 9, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031649 **E:** 461426		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa nat V. rem V.; 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
58.1 / 30		**(CL) SILTY CLAY:** PRESSUMED								
57.6 / 30.5										
57.1 / 31										
56.6 / 31.5										
56.1 / 32										
55.6 / 32.5										
55.1 / 33										
54.6 / 33.5										
54.1 / 34										
53.6 / 34.5										
53.1 / 35										
52.6 / 35.5										
52.1 / 36		52.14 / 35.97 **(GW) GRAVEL:** POSSIBLE GLACIAL TILL								Change in drilling consistency.
51.6 / 36.5										
51.1 / 37										
50.6		50.61 / 37.50								

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

CAMBIUM

Client: Conseil des ecoles publiques de l'Est de l'Ontario
Contractor: Downing Drilling
Project No.: 20361-003
Location: 2405 chemin Mer Bleue, Ottawa ON

Project Name: 2405 chemin Mer Bleue, Orléans
Method: Track Mounted Hollow Stem Auger
Elevation: 88.11 mASL
UTM: 18 T **N:** 5031649 **E:** 461426

Log of Borehole: BH102-24
Page: 6 of 6
Date Completed: Oct. 9, 2024

Elevation (m)	Depth	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa nat V. rem V. 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
50.6	37.5	**(GW) GRAVEL:** POSSIBLE GLACIAL TILL	49.15								
50.1	38										
49.6	38.5										Borehole caving observed at 15.2 mbgs. Groundwater not encountered at 4.6 mbgs. Standing water not observed.
49.1	39	**Limestone:** grey, moderate field strength, medium to thinly bedded, moderately fractured, slightly decomposed, slightly disintegrated, fair quality, 0.05 to 0.15 m thick shale bedding spaced every 0.15-0.2 m.	38.96								Rock coring initiated.
48.6	39.5			18		100					RUN 1 - TCR: 100% SCR: 100% RQD: 55% FI: 3, 2, 3, 4
48.1	40										
47.6	40.5			19		100					RUN 2 - TCR 100% SCR: 100% RQD: 59% FI: 3, 2, 3, 4
47.1	41										
46.6	41.5										Rock coring terminated.
46.1	42	Borehole terminated @ 41.8 mbgs due to target depth achieved.									
45.6	42.5										
45.1	43										
44.6	43.5										
44.1	44										
43.6	44.5										
43.1											

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS4	0	1	28	71
SS11	0	0	26	74

Logged By: RR **Input By:** RR

CAMBIUM

Client: Conseil des ecoles publiques de l'Est de l'Ontario
Contractor: Downing Drilling
Project No.: 20361-003
Location: 2405 chemin Mer Bleue, Ottawa ON

Project Name: 2405 chemin Mer Bleue, Orléans
Method: Track Mounted Hollow Stem Auger
Elevation: 87.43 mASL
UTM: 18 T **N:** 5031648 **E:** 461470

Log of Borehole: BH103-24
Page: 1 of 1
Date Completed: Oct. 8, 2024

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) / % Moisture	Shear Strength Cu, kPa / SPT (N)	Well Installation	Log Notes
87.4	0	**(SM) gravelly SILTY SAND:** brown, moist, compact [FILL]	1	SS	67	27	8.9%	27		
86.9	0.5									
86.4	1	becomes dark brown	2	SS	16	17	11.5%	17		ENV: BH103_0.75-1.5: Corrosivity, Sulphides and Redox Potential
85.91										
85.9	1.5	**(CL) SILTY CLAY:** grey-brown, w~PL, firm, trace sand [WEATHERED CRUST]	3	SS	38	6	37.3%	6		
1.52										
85.4	2									
85.14										
84.9	2.5	**(CL) SILTY CLAY:** grey-brown, w~PL, firm, trace sand	4	SS	0	1		1		
2.29										
84.4	3	becomes grey, w>PL	5	SS	50	0	80%			
83.9	3.5		6							
83.4	4		7					3 30		
82.9	4.5							3 30		
82.4	5		8	SS	100	0	73.4%			
81.9	5.5	becomes soft	9					3 24		
81.4	6		10					3 24		
80.9	6.5		11	SS	100	0	84.6%			
80.72										
80.4	7	Borehole terminated @ 6.7 mbgs due to target depth achieved.								Borehole caving not observed. Groundwater not encountered. Standing water observed at 6.0 mbgs.
6.71										
79.9										

GRAINSIZE DISTRIBUTION

SAMPLE	GRAVEL	SAND	SILT	CLAY
SS1	28	50	22	

Logged By: RR **Input By:** RR

CAMBIUM

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH104-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	87.54 mASL	**Date Completed:**	Oct. 8, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031643 **E:** 461532		

Elevation (m)	Depth	Description	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) / % Moisture	Shear Strength Cu, kPa / SPT (N)	Well Installation	Log Notes
87.5	0	**(ML) gravelly SILT and SAND:** dark brown, moist, compact [FILL]	1	SS	75	28	12.3%	28	Cap	
87	0.5									
86.5	1	increase in silt content	2	SS	50	27	15.2%	27	Bentonite Plug	1.2m: Water level measured on November 4, 2024.
86	1.5	86.02							Riser	
		1.52 **(CL) SILTY CLAY:** brown-grey, w~PL, stiff, trace sand [WEATHERED CRUST]	3	SS	58	10	38.7%	10		
85.5	2									
85	2.5		4	SS	83	2	52.3%	2		
84.5	3	84.49								
		3.05 **(CL) SILTY CLAY:** grey, w~PL, soft, trace sand	5	SS	100	0	63.6%			
84	3.5		6							
83.5	4		7					3 24		
								3 24	Sand Pack	
83	4.5								PVC Screen	Shelby Tube Sample from 4.57 to 5.18 mbgs.
82.5	5		8							
82	5.5	becomes firm	9							
			10					3 30		
81.5	6							3 30		
81	6.5	w>PL	11	SS	100	0	84.3%		Cap	
		80.83								
80.5	7	6.71 Borehole terminated @ 6.7 mbgs due to target depth achieved.								Borehole caving not observed. Groundwater not encountered. Standing water observed at 6.0 mbgs.
80										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

CAMBIUM

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH105-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	86.78 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031683 **E:** 461475		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes

Elevation (m)	Depth	Description	Elevation	Depth
86.8	0	**TOPSOIL:** 200 mm	86.58	0.20
86.3	0.5	**(CL) SILTY CLAY:** brown, w~PL, firm, trace sand [WEATHERED CRUST]		
85.8	1			
85.3	1.5	colour change to grey-brown, becomes very soft		
84.8	2		84.49	2.29
84.3	2.5	**(CL) SILTY CLAY:** grey, w~PL, firm, trace sand		
83.8	3			
83.3	3.5	w>PL, becomes soft		
82.8	4			
82.3	4.5			
81.8	5			
81.3	5.5	becomes firm		
80.8	6			
80.3	6.5		80.07	6.71
79.8	7	Borehole terminated @ 6.7 mbgs due to target depth achieved.		
79.3				

Number	Type	% Recovery	SPT (N)	% Moisture	SPT (N)
1	SS	54	5	30.1%	5
2	SS	100	4		4
3	SS	100	1	52.5%	1
4	SS	100	0	79.7%	2, 30
5	SS	100	0	75.6%	2, 16
6					2, 24
7	SS	100	0	80.9%	
8					2, 30
9	SS	100	0	82.2%	2, 24

Well Installation: Cap; Bentonite Plug; Riser; Sand Pack; PVC Screen; Cap

Log Notes:
- 0.4m: Water level measured on November 4, 2024.
- Borehole caving not observed. Groundwater not encountered. Standing water not observed.

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH106-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	87.08 mASL	**Date Completed:**	Oct. 8, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031672 **E:** 461565		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
87.1 / 0		**(ML) gravelly SILT and SAND:** dark brown, moist, very dense [FILL]	1	SS	71	54	16.4%	54		
86.6 / 0.5										
86.11			2A	SS			28.2%			
86.1 / 1		**(CL) SILTY CLAY:** brown-grey, w~PL, stiff, trace sand [WEATHERED CRUST]	2B	SS	50	11	29.1%	11		
85.6 / 1.5		becomes firm								
85.1 / 2			3	SS	92	6	33.9%	6		
84.79										
84.6 / 2.5		**(CL) SILTY CLAY:** brown, w~PL, firm, trace sand	4	SS	100	2	52.2%	2		
84.1 / 3										
83.6 / 3.5		w>PL	5	SS	100	0	74.6%	3 30		
83.42										
83.1 / 4		Borehole terminated @ 3.7 mbgs due to target depth achieved.								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
82.6 / 4.5										
82.1 / 5										
81.6 / 5.5										
81.1 / 6										
80.6 / 6.5										
80.1 / 7										
79.6										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

CAMBIUM

Client: Conseil des ecoles publiques de l'Est de l'Ontario
Contractor: Downing Drilling
Project No.: 20361-003
Location: 2405 chemin Mer Bleue, Ottawa ON

Project Name: 2405 chemin Mer Bleue, Orléans
Method: Track Mounted Hollow Stem Auger
Elevation: 87.06 mASL
UTM: 18 T **N:** 5031795 **E:** 461504

Log of Borehole: BH107-24
Page: 1 of 1
Date Completed: Oct. 7, 2024

Elevation (m)	Depth	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI — 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) — 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
87.1	0	**TOPSOIL:** 125 mm	86.93 / 0.13								
		(CL) SILTY CLAY: brown, w~PL, firm, some sand [WEATHERED CRUST]		1	SS	50	7	25.9%	7		
86.6	0.5										
86.1	1	becomes very stiff		2	SS	92	18	26.9%	18		
85.6	1.5										
		becomes firm		3	SS	100	6	36.9%	6		
85.1	2		84.77								
		(CL) SILTY CLAY: grey, w~PL, firm, trace sand	2.29	4	SS	100	1	66%	1		
84.6	2.5										
84.1	3										
				5	SS	100	0	73.9%	3 + 36		
83.6	3.5		83.40								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
		Borehole terminated @ 3.7 mbgs due to target depth achieved.	3.66								
83.1	4										
82.6	4.5										
82.1	5										
81.6	5.5										
81.1	6										
80.6	6.5										
80.1	7										
79.6											

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH108-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	86.76 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031724 **E:** 461484		

Elevation (m)	Depth	Lithology	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI / % Moisture 25 50 75	Shear Strength Cu, kPa nat V. rem V. / SPT (N) 20 40 60 80	Well Installation	Log Notes
86.8	0		**TOPSOIL:** 150 mm	86.61								
			(CL) SILTY CLAY: brown, w~PL, very stiff, trace sand [WEATHERED CRUST]	0.15	1	SS	42	15	18.5%	15		
86.3	0.5											
85.8	1				2	SS	17	6	18.1%	6		
85.3	1.5				3	SS	21	2	45.3%	2		
84.8	2			84.47								
			(CL) SILTY CLAY: grey, w~PL, firm, trace sand	2.29	4	SS	100	0	81.3%	3 30		
84.3	2.5											
83.8	3											
			w~PL, becomes soft		5	SS	100	0	71.6%	2 24		
83.3	3.5			83.10								
			Borehole terminated @ 3.7 mbgs due to target depth achieved.	3.66								Borehole caving not observed. Groundwater not encountered. Standing water observed at 3.0 mbgs.
82.8	4											
82.3	4.5											
81.8	5											
81.3	5.5											
80.8	6											
80.3	6.5											
79.8	7											
79.3												

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH109-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	87.34 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031709 **E:** 461429		

Elevation (m)	Depth	Lithology	Description	Elevation / Depth	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
87.3	0		**TOPSOIL:** 225 mm	87.11								
			(ML) SILT and SAND: brown, moist, some clay [FILL]	0.23 / 86.88	1	GB			18.5%			
86.8	0.5		**(CL) SILTY CLAY:** brown, w~PL, some sand [WEATHERED CRUST]	0.46								
86.3	1				2	GB			28.6%			
85.8	1.5			85.82								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
			Borehole terminated @ 1.5 mbgs due to target depth achieved.	1.52								
85.3	2											
84.8	2.5											
84.3	3											
83.8	3.5											
83.3	4											
82.8	4.5											
82.3	5											
81.8	5.5											
81.3	6											
80.8	6.5											
80.3	7											
79.8												

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH110-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	86.76 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031745 **E:** 461453		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
86.8 / 0		**TOPSOIL:** 225 mm (86.53)								
86.3 / 0.5		**(CL) SILTY CLAY:** brown, w~PL, some sand [WEATHERED CRUST] (0.23)	1	GB			43.4%			
85.8 / 1										
85.3 / 1.5		(85.24) Borehole terminated @ 1.5 mbgs due to target depth achieved. (1.52)								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
84.8 / 2										
84.3 / 2.5										
83.8 / 3										
83.3 / 3.5										
82.8 / 4										
82.3 / 4.5										
81.8 / 5										
81.3 / 5.5										
80.8 / 6										
80.3 / 6.5										
79.8 / 7										
79.3										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH111-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	86.97 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031726 **E:** 461405		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI; 25 50 75; % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.); 20 40 60 80; SPT (N) 20 40 60 80	Well Installation	Log Notes
87 / 0		**TOPSOIL:** 200 mm — 86.77								
86.5 / 0.5		**(CL) SILTY CLAY:** brown, w~PL, some sand [WEATHERED CRUST] — 0.20	1	GB			37.3%			
86 / 1										
85.5 / 1.5		85.45								
85 / 2		Borehole terminated @ 1.5 mbgs due to target depth achieved. — 1.52								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
84.5 / 2.5										
84 / 3										
83.5 / 3.5										
83 / 4										
82.5 / 4.5										
82 / 5										
81.5 / 5.5										
81 / 6										
80.5 / 6.5										
80 / 7										
79.5										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Client:	Conseil des ecoles publiques de l'Est de l'Ontario	**Project Name:**	2405 chemin Mer Bleue, Orléans	**Log of Borehole:**	BH112-24
Contractor:	Downing Drilling	**Method:**	Track Mounted Hollow Stem Auger	Page:	1 of 1
Project No.:	20361-003	**Elevation:**	87.07 mASL	**Date Completed:**	Oct. 7, 2024
Location:	2405 chemin Mer Bleue, Ottawa ON	**UTM:**	18 T **N:** 5031761 **E:** 461403		

SUBSURFACE PROFILE				SAMPLE							
Elevation (m) / Depth	Lithology	Description (Elevation / Depth)	Number	Type	% Recovery	SPT (N)	Atterberg Limits (%) LL PL PI — 25 50 75 / % Moisture 25 50 75	Shear Strength Cu, kPa (nat V., rem V.) — 20 40 60 80 / SPT (N) 20 40 60 80	Well Installation	Log Notes
87.1 / 0		**TOPSOIL:** 250 mm — 86.82								
86.6 / 0.5		**(CL) SILTY CLAY:** brown, w~PL, some sand [WEATHERED CRUST] — 0.25	1	GB			24.5%			
86.1 / 1			2	GB			36.5%			
85.6 / 1.5		85.55 — Borehole terminated @ 1.5 mbgs due to target depth achieved. — 1.52								Borehole caving not observed. Groundwater not encountered. Standing water not observed.
85.1 / 2										
84.6 / 2.5										
84.1 / 3										
83.6 / 3.5										
83.1 / 4										
82.6 / 4.5										
82.1 / 5										
81.6 / 5.5										
81.1 / 6										
80.6 / 6.5										
80.1 / 7										
79.6										

GRAINSIZE DISTRIBUTION: SAMPLE | GRAVEL | SAND | SILT | CLAY

Logged By: RR **Input By:** RR

Peterborough, Barrie, Whitby, Kingston, Ottawa

Appendix B

Physical Laboratory Results

Grain Size Distribution Chart

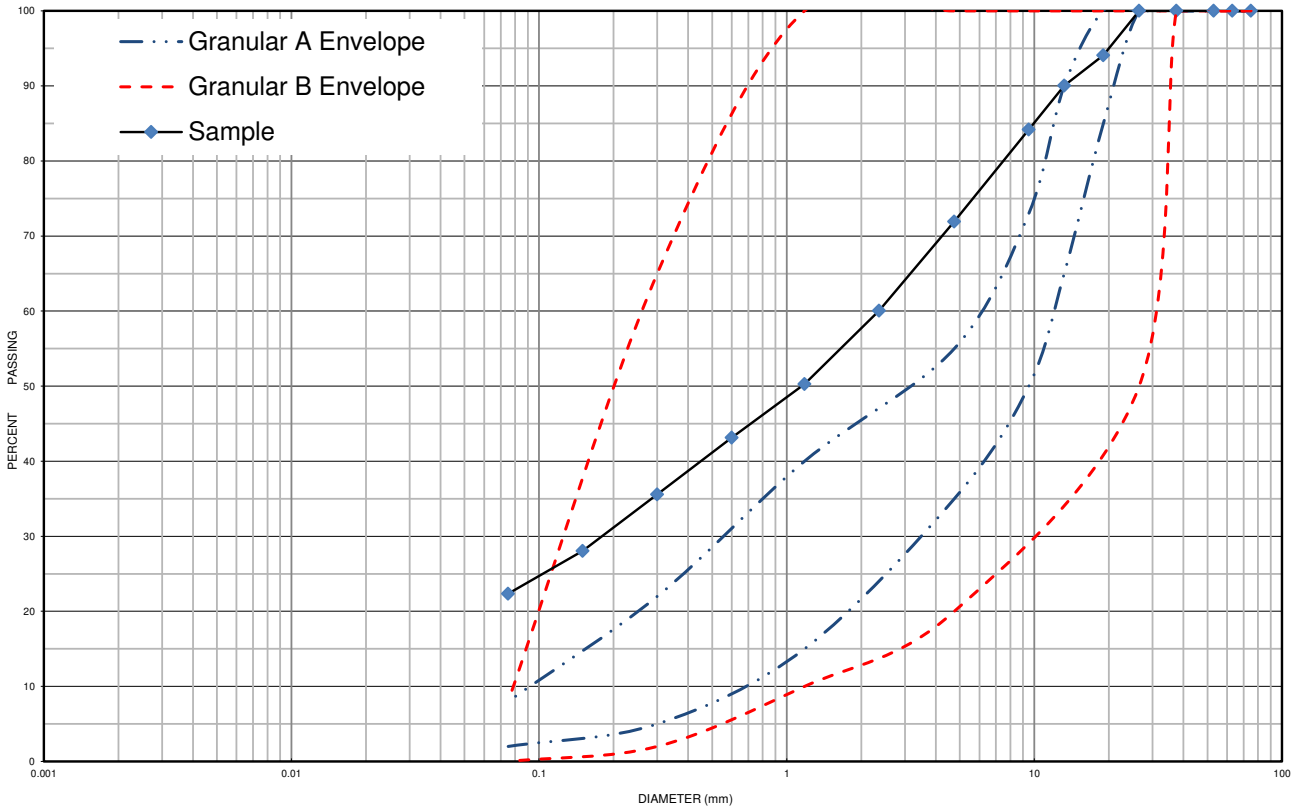
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'Ontario*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sample Date: *October 8 & 9, 2024* **Sampled By:** *Rory Ryan - Cambium Inc.*

Location: *BH 103-24 SS 1* **Depth:** *0 m to 0.6 m* **Lab Sample No:** *S-24-1935*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 103-24	SS 1	0 m to 0.6 m	28	50	22		8.9

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Gravelly Silty Sand	SM	2.400	0.180	-	-	-

Additional information available upon request

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(Senior Project Manager)

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Grain Size Distribution Chart

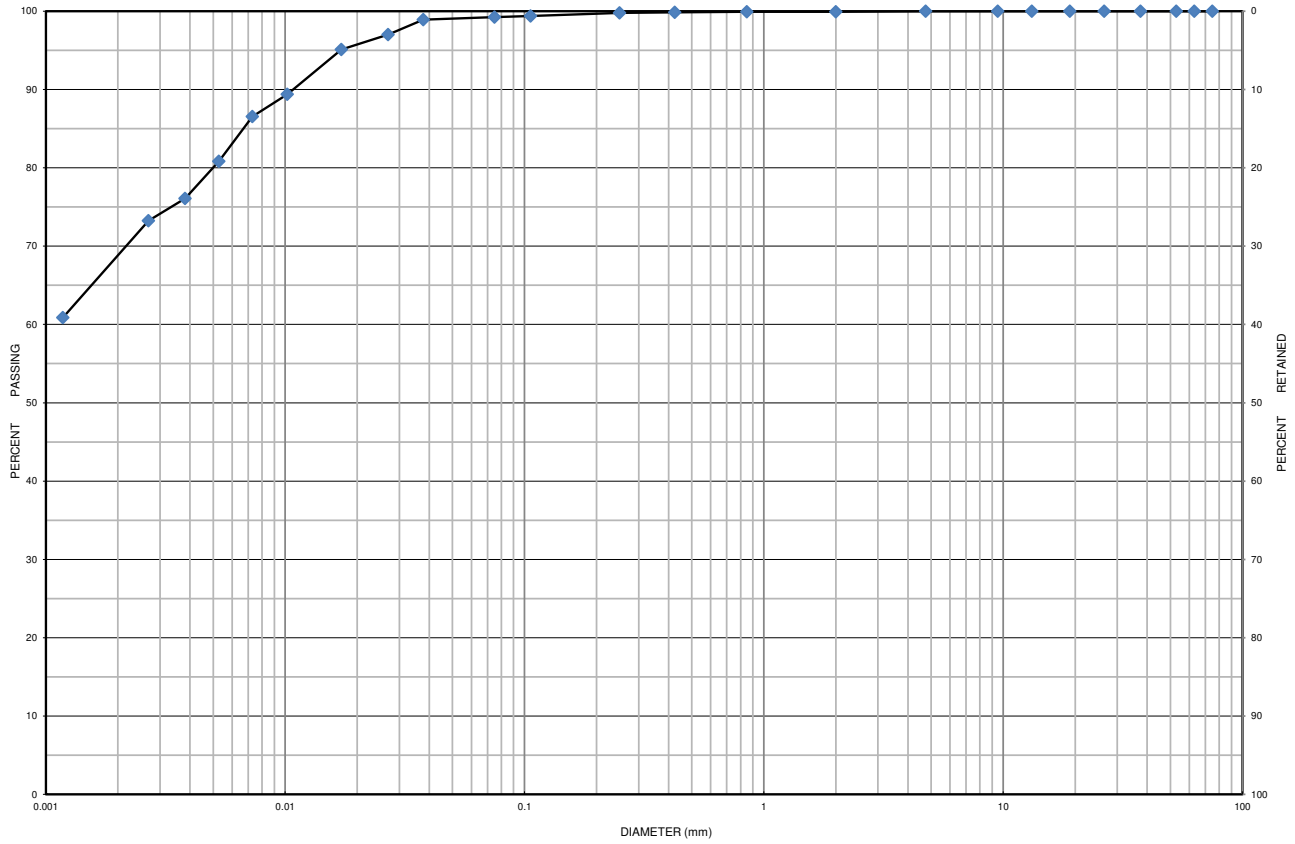
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'Ontario*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sample Date: *October 8 & 9, 2024* **Sampled By:** *Rory Ryan - Cambium Inc.*

Location: *BH 101-24 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-24-1933*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-24	SS 3	1.5 m to 2.1 m	0	1	31	68	41.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Clay trace Sand	CL	-	-	-	-	-

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Grain Size Distribution Chart

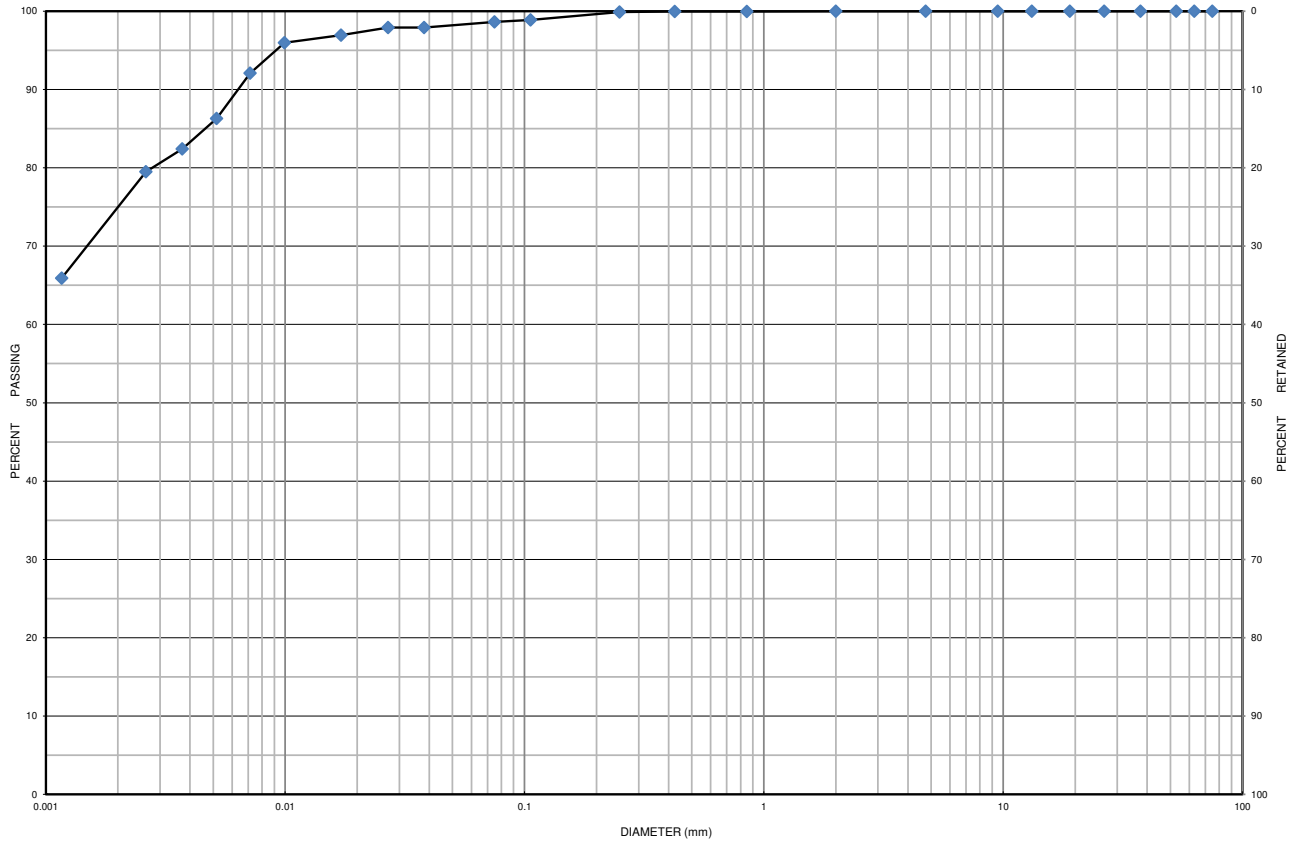
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'Ontario*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sample Date: **Sampled By:** *Rory Ryan - Cambium Inc.*

Location: *BH 101-24 SS 8* **Depth:** *4.6 m to 5.2 m* **Lab Sample No:** *S-24-1934*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 101-24	SS 8	4.6 m to 5.2 m	0	1	24	75	85.3

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Clay trace Sand	CL	-	-	-	-	-

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Grain Size Distribution Chart

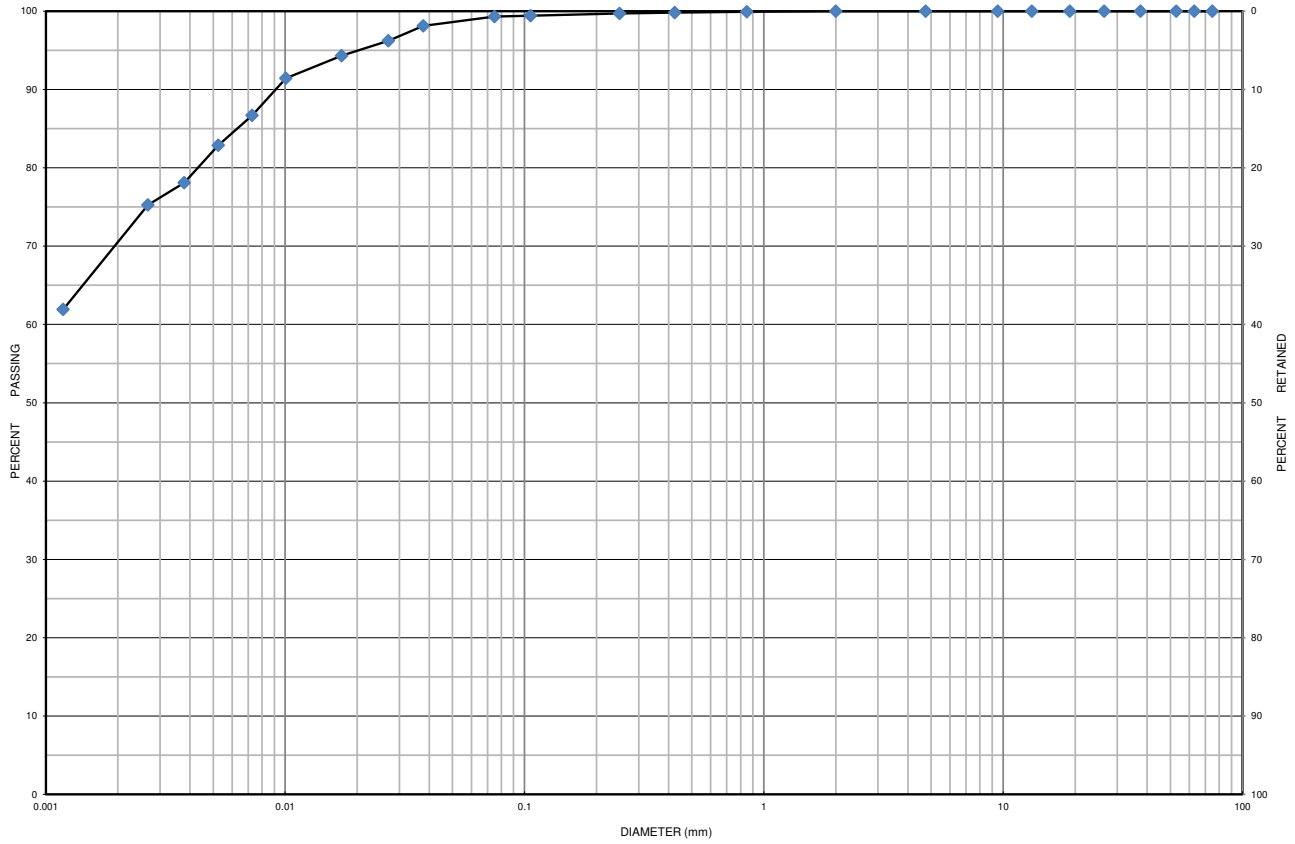
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'Ontario*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sample Date: *October 8 & 9, 2024* **Sampled By:** *Rory Ryan - Cambium Inc.*

Location: *BH 102-24 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-24-1936*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-24	SS 4	2.3 m to 2.9 m	0	1	28	71	41.6

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Clay trace Sand	CL	-	-	-	-	-

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Grain Size Distribution Chart

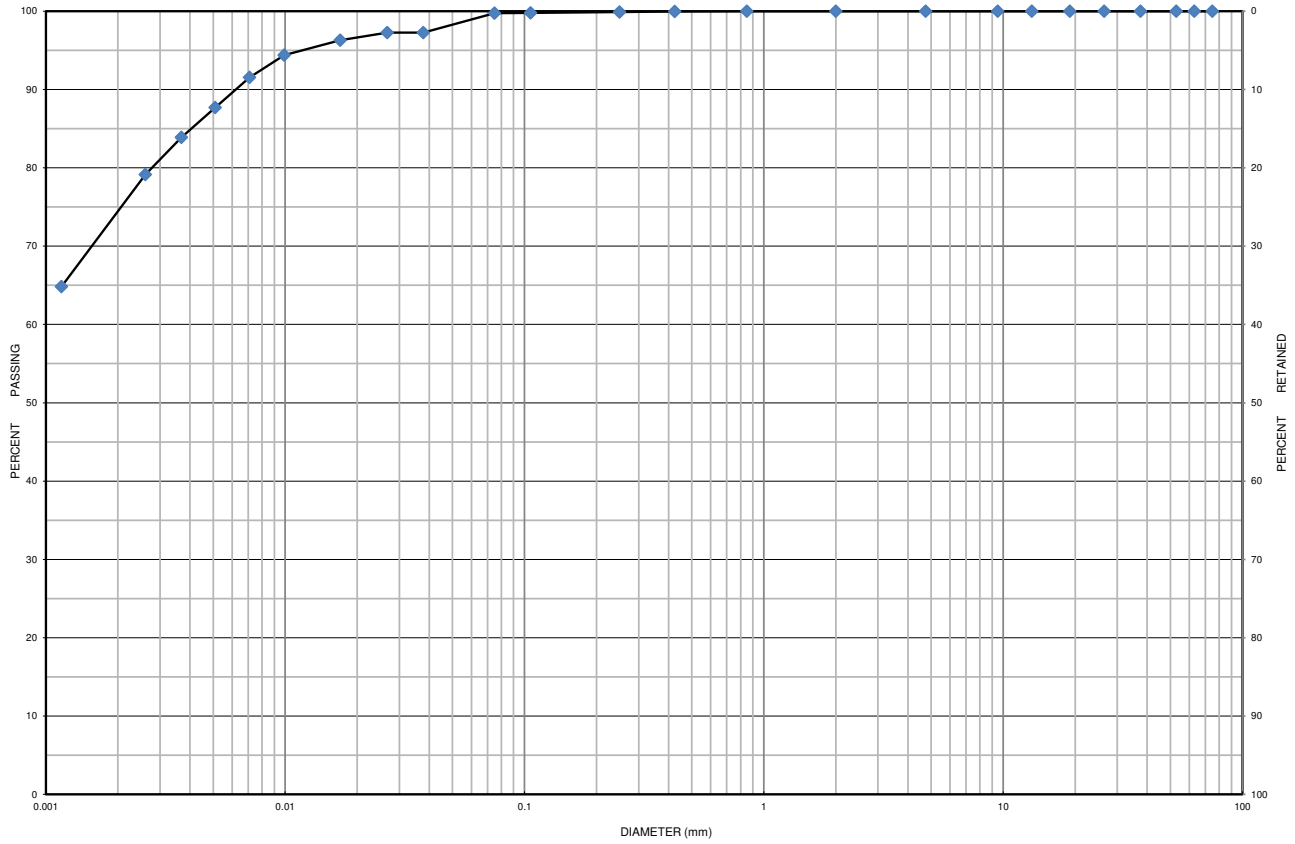
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'Ontario*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sample Date: *October 8 & 9, 2024* **Sampled By:** *Rory Ryan - Cambium Inc.*

Location: *BH 102-24 SS 11* **Depth:** *6.1 m to 6.7 m* **Lab Sample No:** *S-24-1937*

UNIFIED SOIL CLASSIFICATION SYSTEM					
CLAY & SILT (<0.075 mm)	SAND (<4.75 mm to 0.075 mm)			GRAVEL (>4.75 mm)	
	FINE	MEDIUM	COARSE	FINE	COARSE



MIT SOIL CLASSIFICATION SYSTEM								
CLAY	SILT	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	BOULDERS
		SAND			GRAVEL			

Borehole No.	Sample No.	Depth	Gravel	Sand	Silt	Clay	Moisture
BH 102-24	SS 11	6.1 m to 6.7 m	0	0	26	74	88.8

Description	Classification	D_{60}	D_{30}	D_{10}	C_u	C_c
Silty Clay	CL	-	-	-	-	-

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Plasticity Chart

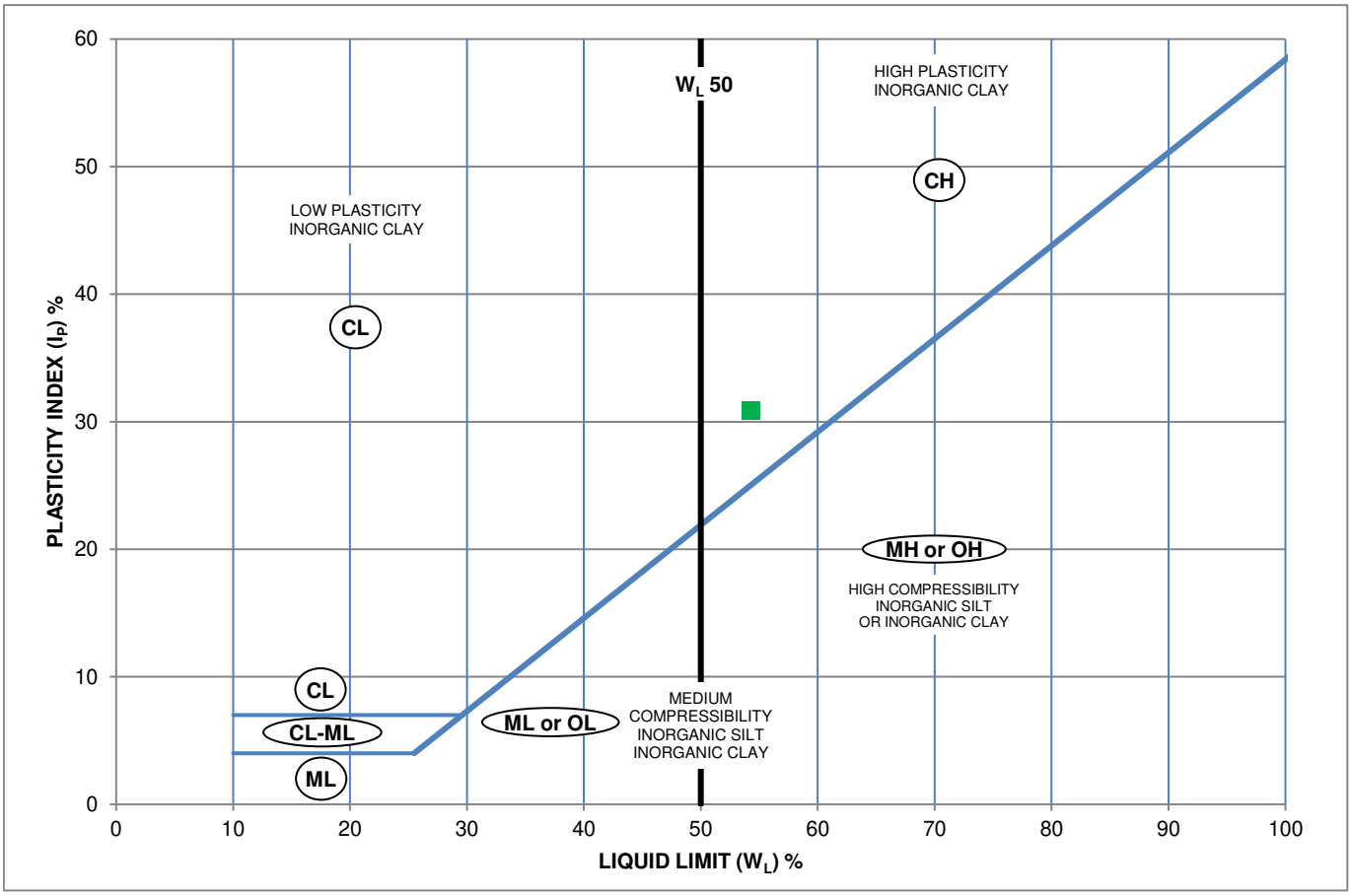
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'O*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sampled By: *Rory Ryan - Cambium Inc.* **Sample Date:** *October 8 & 9, 2024*

Hole No.: *BH 101-24 SS 3* **Depth:** *1.5 m to 2.1 m* **Lab Sample No:** *S-24-1933*

Low Plasticity	High Plasticity



Symbol	Borehole	Sample	Depth	Description
■	BH 101-24	SS 3	1.5 m to 2.1 m	High Plasticity Clay

Liquid Limit (%)	Plastic Limit	Plasticity Index (%)
54.3	***23.4***	***30.9***

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Plasticity Chart

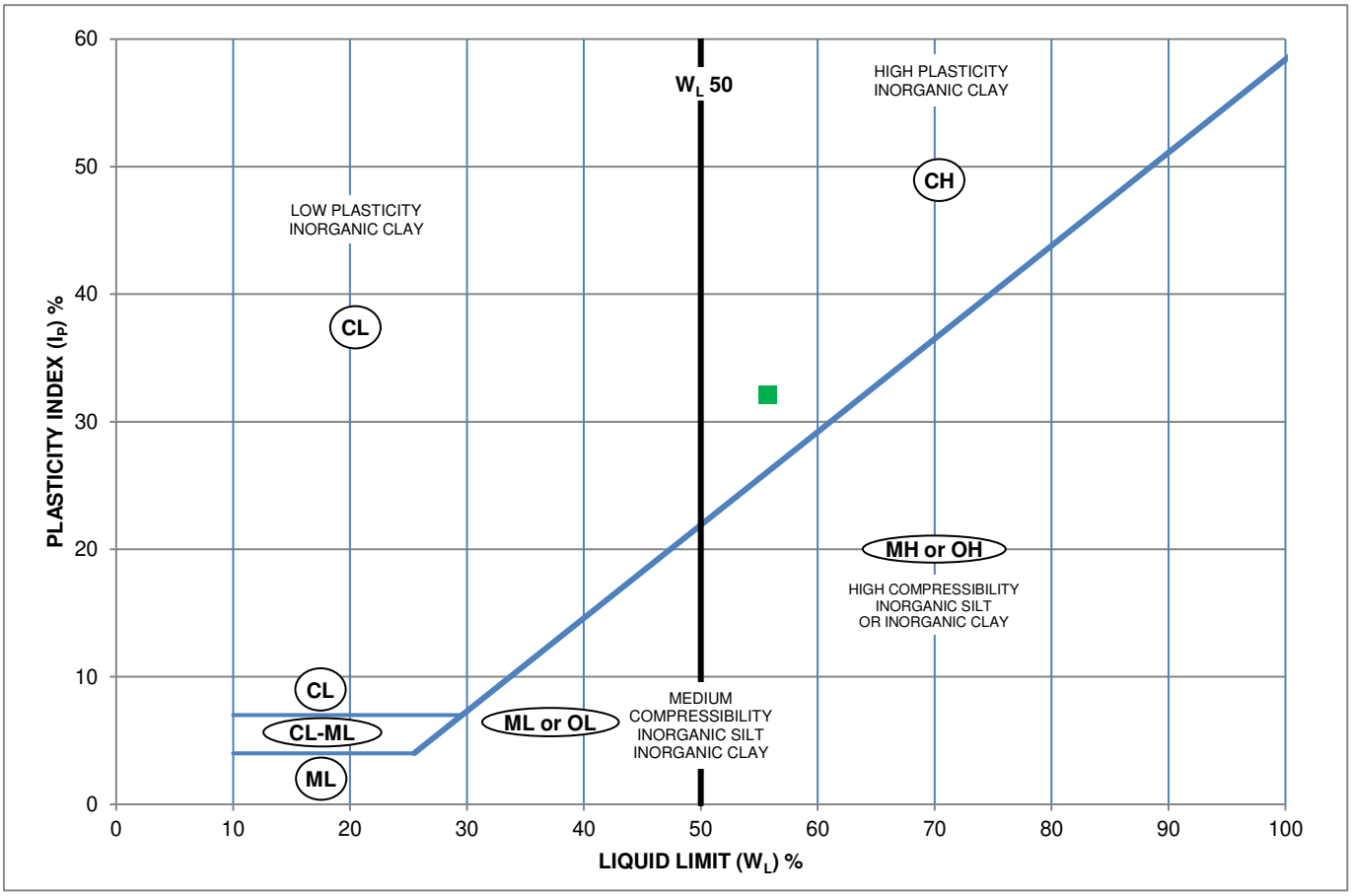
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'O*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sampled By: *Rory Ryan - Cambium Inc.* **Sample Date:** *October 8 & 9, 2024*

Hole No.: *BH 102-24 SS 4* **Depth:** *2.3 m to 2.9 m* **Lab Sample No:** *S-24-1936*

Low Plasticity	High Plasticity



Symbol	Borehole	Sample	Depth	Description
■	BH 102-24	SS 4	2.3 m to 2.9 m	High Plasticity Clay

Liquid Limit (%)	Plastic Limit	Plasticity Index (%)
55.7	***23.7***	***32.1***

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Plasticity Chart

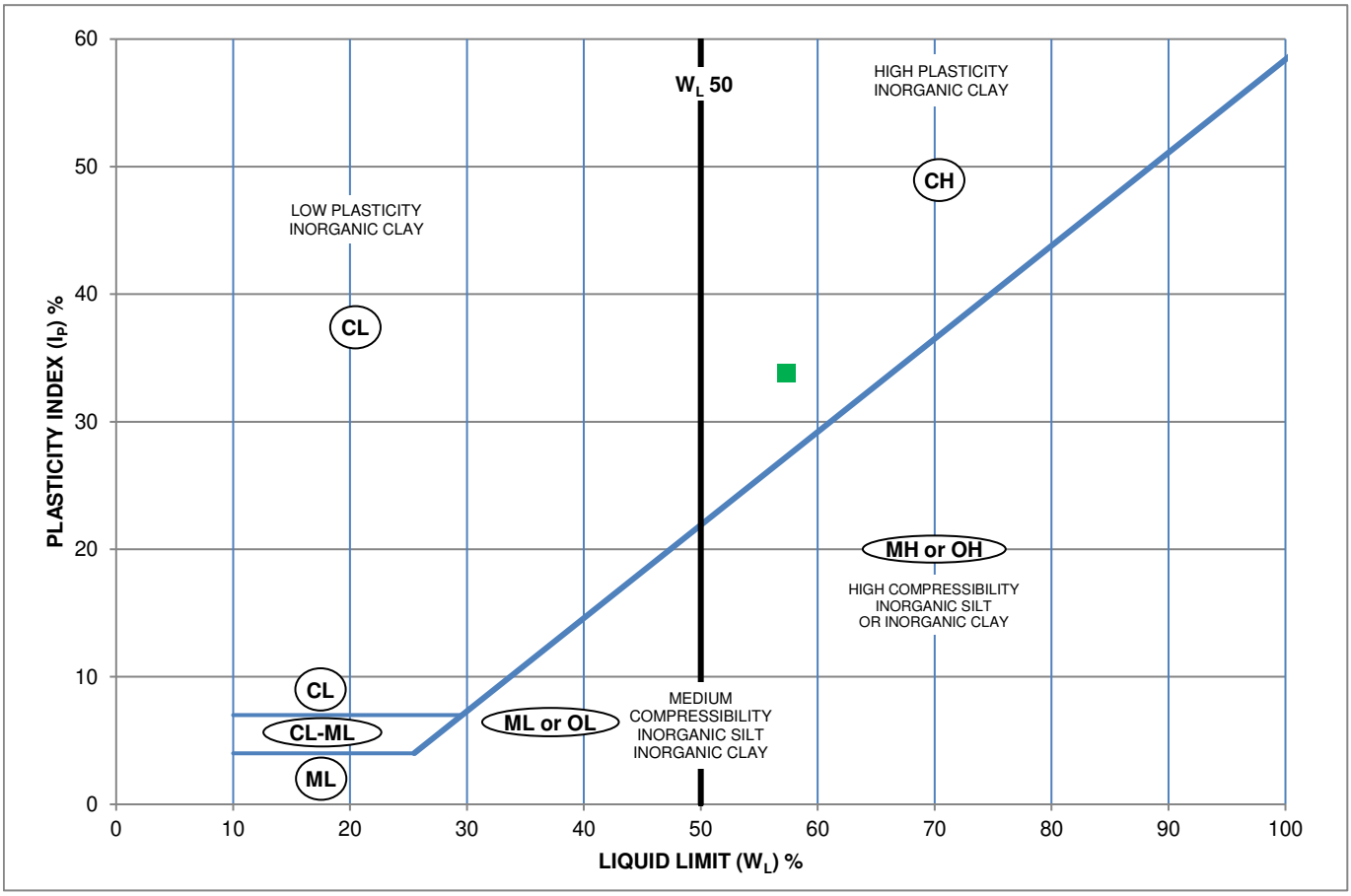
Project Number: *20361-003* **Client:** *Conseil des ecoles publiques de l'Est de l'O*

Project Name: *2405 chemin Mer Bleue, Orléans (Project ST0918) CEPEO*

Sampled By: *Rory Ryan - Cambium Inc.* **Sample Date:** *October 8 & 9, 2024*

Hole No.: *BH 102-24 SS 8* **Depth:** *4.6 m to 5.2 m* **Lab Sample No:** *S-24-1958*

Low Plasticity	High Plasticity



Symbol	Borehole	Sample	Depth	Description
■	BH 102-24	SS 8	4.6 m to 5.2 m	High Plasticity Clay

Liquid Limit (%)	Plastic Limit	Plasticity Index (%)
57.3	***23.5***	***33.8***

Additional information available upon request

Issued By: _____ *Date Issued:* *November 8, 2024*

(Senior Project Manager)

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Concrete Core Compressive Strength Report

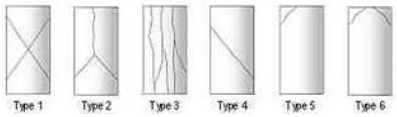
Project Number: *20361-003* **Client:** *CEPEO*
Project Name: *Orleans Secondary School Chemin Mer-Bleue*
Contractor: *-*

Location on Structure: *-*
Date Cored: *2024-10-09*
Date Received: *-*
Concrete Supplier: *-*
Cylinders Cored By: *Rory Ryan - Cambium Inc.*
Conditioning Type: *Dry*

Remarks:
1694A - BH102-24 RC1
1694B - BH102-24 RC2

Spec. 28 Day: *MPa*

Type of Fracture:



Lab Core Number	Client Core ID	Tested On	Diameter (mm)	Weight (kg)	L/D Ratio	L/D Correction Factor	Density (kg/m^3)	Load (kN)	Type of Fracture	Compressive Strength (MPa)	Corrected Compressive Strength (MPa)
1694A	*BH102-24 RC1*	*2024-11-20*	*47.5*	*0.36*	*1.62*	*0.9694*	*2650*	*106.3*	*1*	*60.0*	*58.2*
1694B	*BH102-24 RC2*	*2024-11-20*	*47.5*	*0.38*	*1.66*	*0.9727*	*2700*	*222.8*	*1*	*125.7*	*122.3*

Issued By: **(Senior Project Manager)** ***Date Issued:*** ***November 20, 2024***

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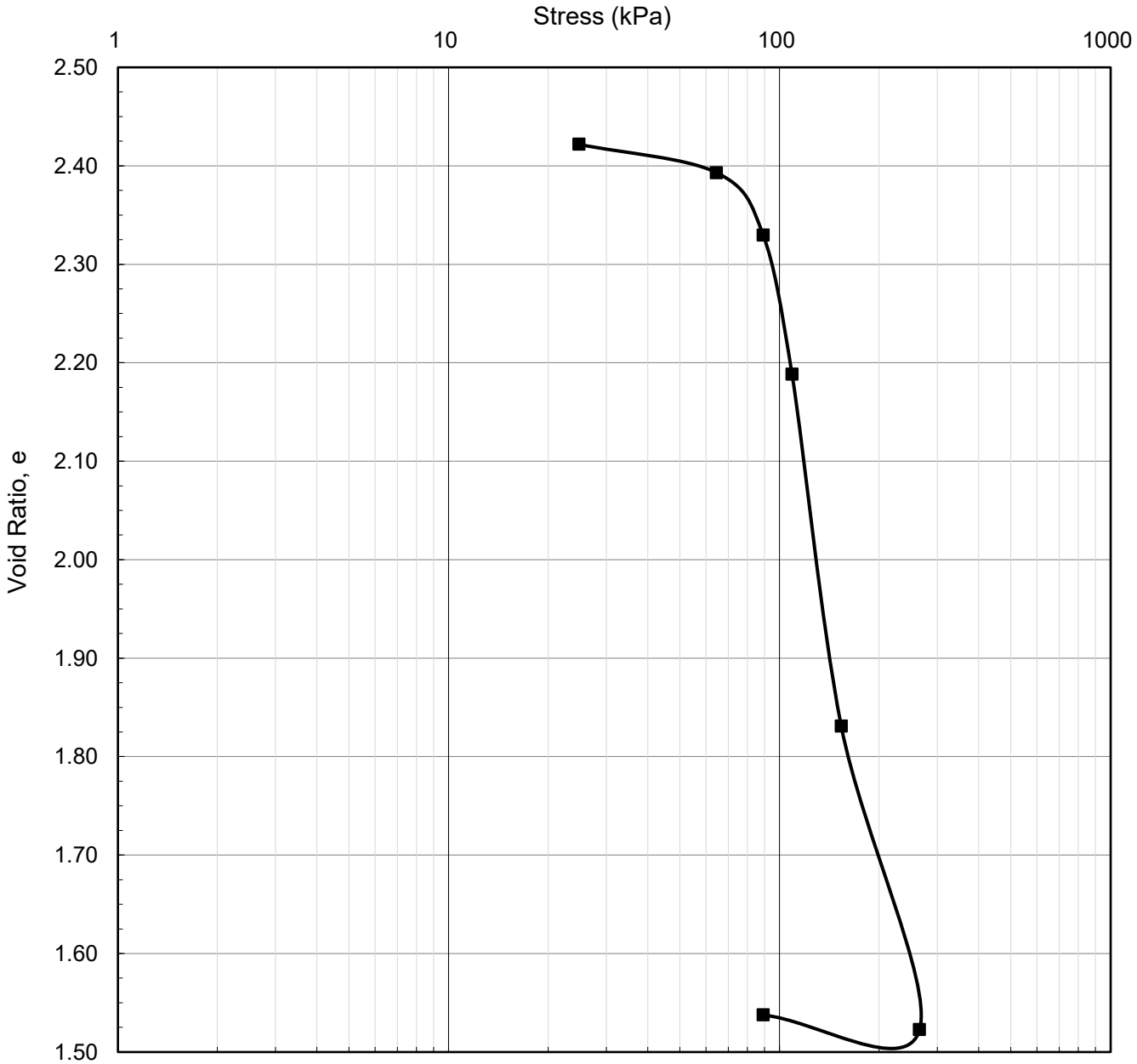
Appendix C

Consolidation Testing Results

σ'_{vo}= ** kPa
CALCULATED EXISTING EFFECTIVE OVERBURDEN PRESSURE

σ'_{p} = ** kPa
MOST PROBABLE APPARENT PRECONSOLIDATION PRESSURE



LEGEND

Borehole:	101-24	w_i =	89%	S_o =	100%	γ =	14.9 kN/m³
Sample:	(003)	w_f =	59%	e_o =	2.44	G_s =	2.77
Depth (m):	6.66	w_l =		C_c =			
Elevation (m):	TB Supplied	w_p =		C_r =			

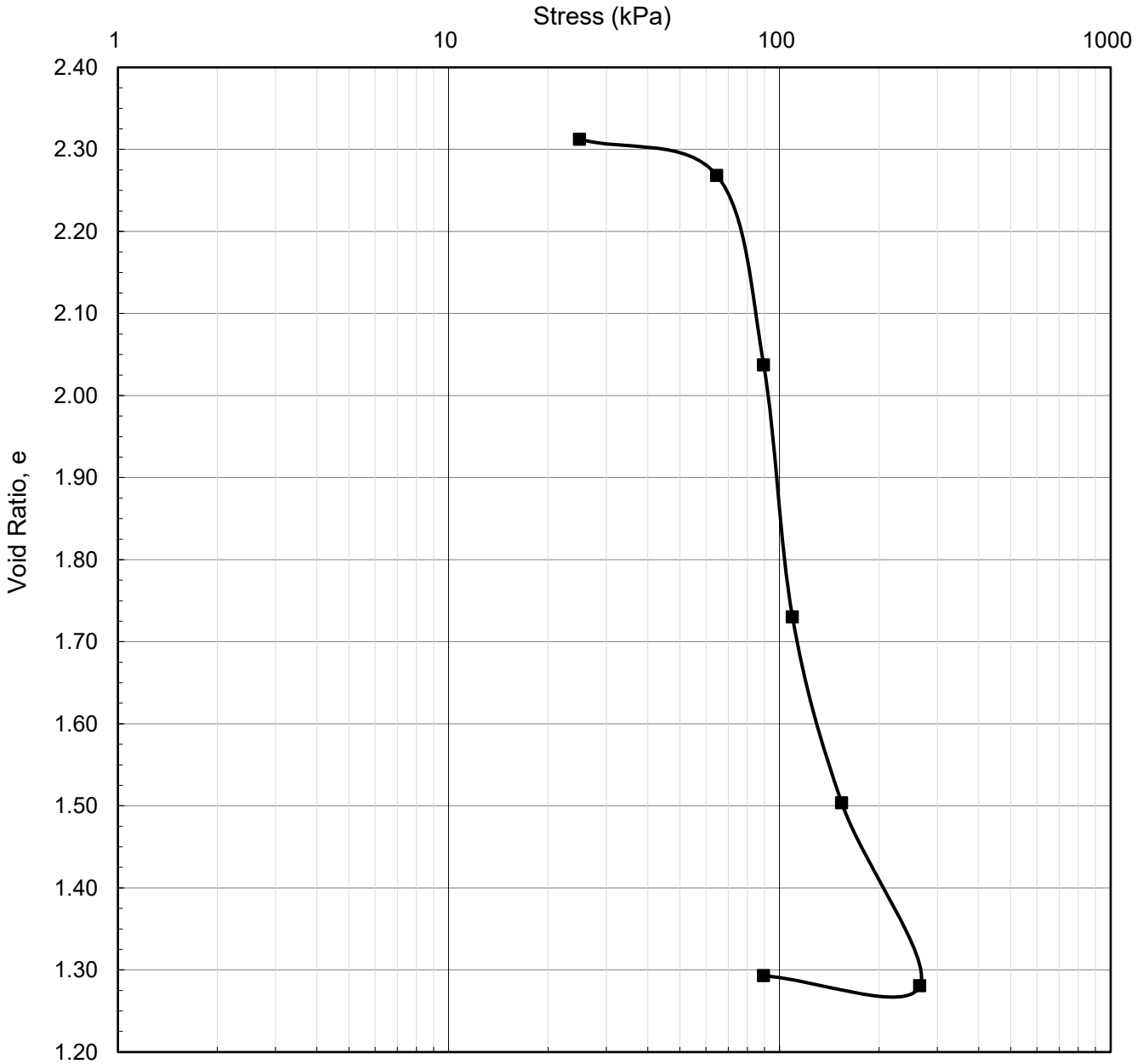
Consolidation Test Results

Void Ratio vs Stress

Figure No.	
Revision	
Project No.	CA0043574.8750
Created By	CW
Checked By	MI

σ'_{vo}= ** kPa
CALCULATED EXISTING EFFECTIVE OVERBURDEN PRESSURE

σ'_{p} = ** kPa
MOST PROBABLE APPARENT PRECONSOLIDATION PRESSURE



LEGEND

Borehole:	104-24	w_i =	86%	S_o =	100%	γ =	15 kN/m³
Sample:	(003)	w_f =	49%	e_o =	2.34	G_s =	2.74
Depth (m):	5.13	w_l =		C_c =			
Elevation (m):	TB Supplied	w_p =		C_r =			

Consolidation Test Results

Void Ratio vs Stress

Figure No.	
Revision	
Project No.	CA0043574.8750
Created By	CW
Checked By	MI

Appendix D

Multichannel Analysis of Surface Waves

Frontwave Geophysics Inc.

FRONTWAVE
GEOPHYSICS

SHEAR WAVE VELOCITY TESTING
FOR SEISMIC SITE CLASSIFICATION
2405 MER-BLEUE ROAD, ORLÉANS, ONTARIO

Submitted to:

Cambium Inc.
31 Hyperion Court, Suite 102
Kingston, Ontario K7K 7G3

Attention:

Mr. Blasco Vijayabaskaran, P.Eng. Email: Blasco.Vijayabaskaran@cambium-inc.com

File No. F-24225

October 1, 2024

Frontwave Geophysics Inc.
Brampton, ON
(647) 514-4724
www.frontwave.ca

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1 INTRODUCTION

Frontwave Geophysics Inc. was retained by Cambium Inc. to carry out a geophysical investigation for a proposed new school to be constructed at 2405 Mer-Bleue Road in Orléans, Ontario.

The objective of the survey was to determine site class (designation) for seismic site response based on average shear wave velocity value measured in the upper 30 m (V_S30). The multi-channel analysis of surface waves (MASW) method was used to obtain shear wave velocity profile.

The fieldwork was conducted on September 26, 2024. The location of the MASW survey line is shown in Figure 1.

This report describes the basic principles of MASW, survey design, interpretation method, and presents the results of the investigation in the chart and table format.

2 INVESTIGATION METHODOLOGY

Overview

The Multi-channel Analysis of Surface Waves (MASW) is a seismic method widely applied to produce shear wave velocity (V_S) profiles. It is based on the dispersive nature of Rayleigh or Love surface waves in layered media. Surface waves with longer wavelengths propagate deeper in the subsurface, hence, their phase velocity is more influenced by the elastic properties of deeper layers. The velocity of surface waves depends mainly on the shear wave velocity of the medium. The distribution of surface waves phase velocities as a function of wavelength (or frequency) can be visualized as a dispersion curve. The inverse problem is then solved by modelling the experimental data with a theoretical dispersion curve; the model parameters are typically limited to layer thickness and shear wave velocity with an assumption of horizontally layered strata. As a result of the inversion, a shear wave velocity depth profile is obtained. Figure 2 illustrates the overall procedure of the MASW method.

Two approaches different in data acquisition and processing can be implemented. The active method involves using artificial sources (e.g., sledgehammer, drop weight) to generate seismic energy, whereas the passive method utilizes energy generated by natural sources (wind, waves, microseismicity) and human activities (mostly vehicle traffic). The energy that can be generated with easily accessible active sources such as sledgehammers is typically concentrated within a relatively high frequency range, and the maximum depth of penetration for active surveys is limited to approximately 15-30 m, depending on the mass of the source and geology of the site. Ambient vibrations registered with the passive acquisition are usually of lower frequency and provide better resolution at greater depths. When survey logistics allow, the active and passive source methods are combined for obtaining well-resolved dispersion images over a wide frequency range, thus increasing the depth of investigation while retaining high resolution at shallow depths.

Legend

MASW Location of MASW survey line (69 m geophone spread)

Image: Google Earth 2024

Date:	2024-10-01
File No:	F-24225
Title:	Survey location plan
Location:	2405 Mer-Bleue Rd Orléans, ON

FRONTWAVE GEOPHYSICS

Figure: **1**

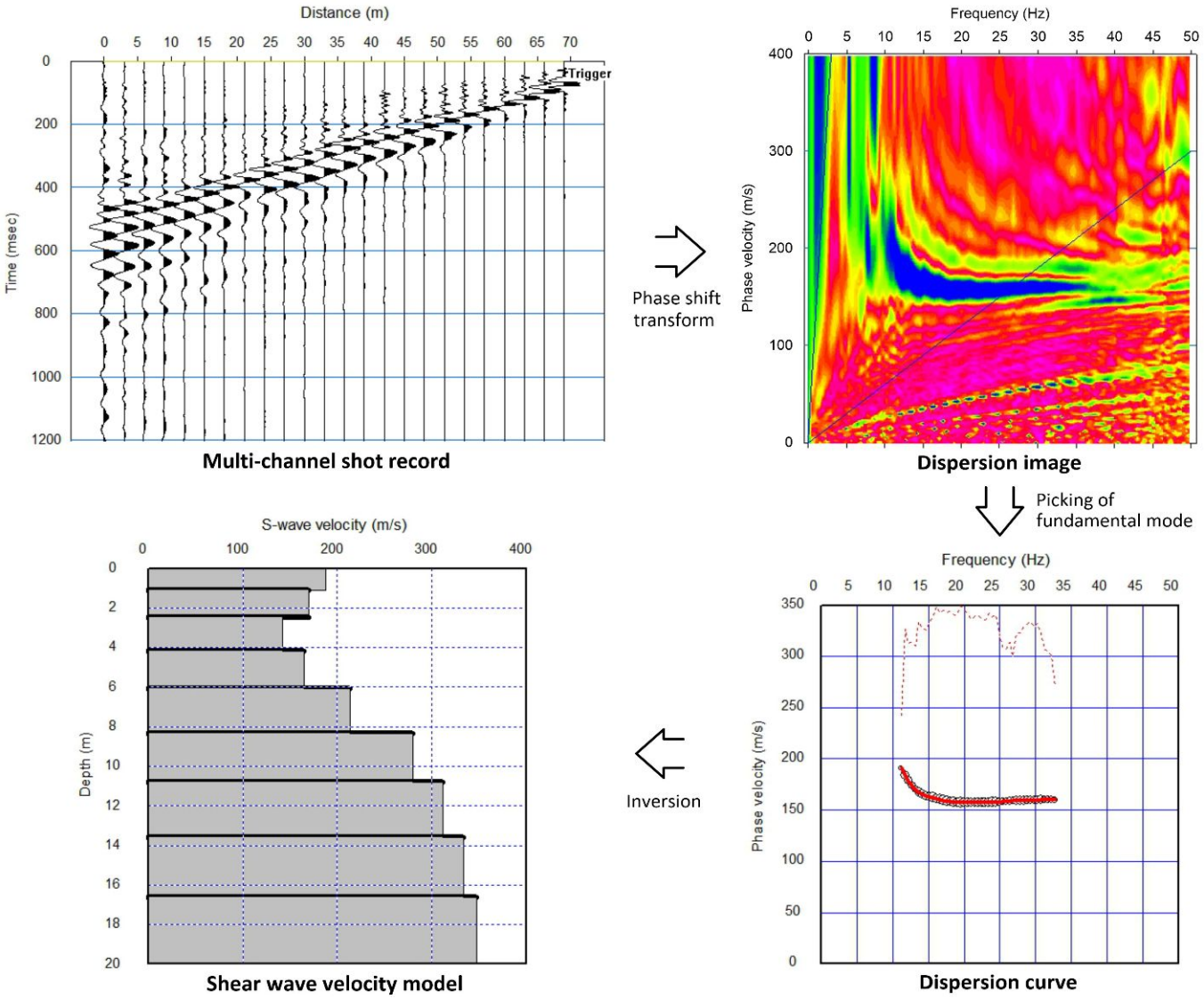

Figure 2 *The procedure of MASW data processing using the SeisImager SW software package.*

Survey Design

The acquisition layout consisted of 24 receivers in a linear array (spread), connected with a multicore cable to P.A.S.I. Gea-24 seismograph. 4.5 Hz natural frequency vertical geophones were used for this survey. To optimize sampling of different wavelengths, two sets of measurements were conducted with spread lengths of 23 m and 69 m (1 m and 3 m spacing between geophones, respectively). Data collected with longer spreads provide a greater depth of investigation, whereas data collected with shorter geophone spacings ensure better resolution in the uppermost few meters of the subsurface.

An 8-kg sledgehammer was used as an energy source for active acquisition. Shots were executed at three to five locations per spread: two shots close to the ends of the spread, and one to three

shots within the spread. A total of 8 shot records was collected. The record length was set to 1500 ms with a 0.05 ms sampling interval.

For passive acquisition, a linear 24-channel array with 3 m spacing between geophones was used. Ambient wavefield was recorded for 10 minutes with a sampling interval of 2 ms.

Interpretation

A dispersion curve is obtained from each field record by converting the shot gather into a dispersion image and then identifying and picking the fundamental mode. A shear wave velocity profile is obtained through inversion of the dispersion curve by modelling the subsurface as a horizontally layered medium with the model parameters limited to the number of layers, their thickness and shear-wave velocity.

SeisImager SW software package was used for processing, picking and inversion of the MASW data.

Some variability among the dispersion curves and resulting models obtained from different shot records is always observed due to lateral velocity variations, near and far field effects, different signal-to-noise ratio, etc. Combining independent inversion results from multiple shot records improves the estimation of the actual shear wave velocity and provides an assessment of uncertainty. The results of the interpretation are presented in the form of the average shear wave velocity profile; the observed variability of the MASW data is reported as upper and lower bound velocity profiles.

Accuracy of the results

The accuracy of MASW generally depends on the complexity of the subsurface and specific site conditions (noise levels, topography, etc.). Lateral velocity variations and steeper bedrock topography increase the dispersion uncertainty. The presence of high velocity contrast layers such as bedrock will require the use of a-priory information to optimize model parameters for more accurate results. Hence, if the a-priory information is not available (e.g., when the data are overly noisy to carry out refraction analysis), the accuracy decreases.

The uncertainty of the resulting S-wave velocity depth profile is evaluated using the upper and lower bound velocity profiles. In practice, it means that the MASW data can be used to provide reliable site classification if the calculated upper and lower bound V_S30 values fall into the same site class range.

3 RESULTS

The collected surface wave data were of very good quality; the dispersion images showed good resolution and covered a frequency range of approximately 3 to 50 Hz. Example shot record and MASW dispersion images obtained at this site are presented in Figure 3.

Seismic refraction analysis indicated that the depth to bedrock at this site was beyond the investigation depth of the refraction method (which was estimated to be approximately 25 m below the ground surface). Compressional (P) wave velocities in the overburden ranged from 100-330 m/s above the water table to 1440 m/s below the water table.

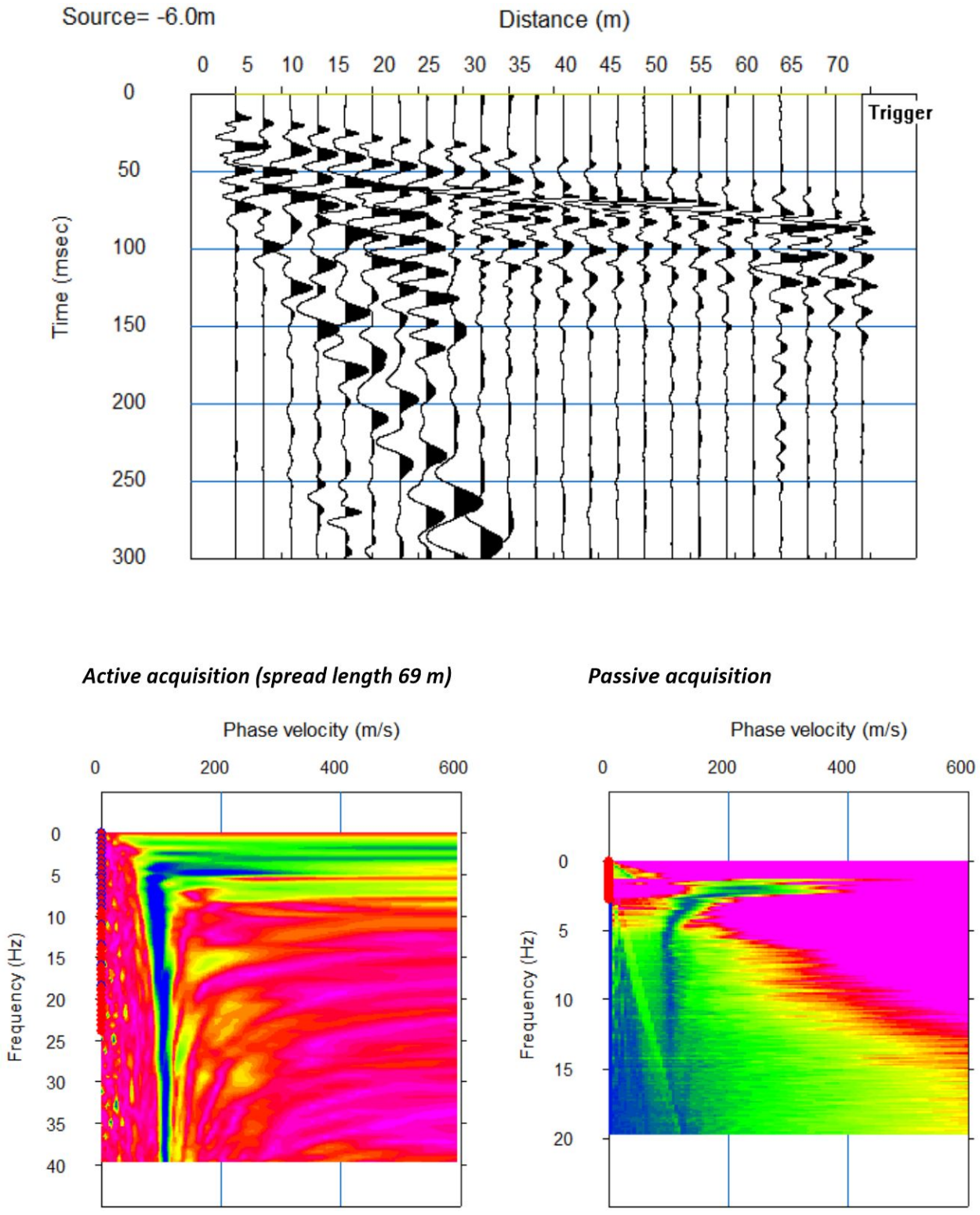

Figure 3 *Example shot record (top) and MASW dispersion images (bottom).*

The results of the MASW sounding are presented in Figure 4. The average shear wave velocity profile from the active shot records and passive data is plotted in the chart as a solid line. The dashed lines represent the upper and lower bound S-wave velocity profiles.

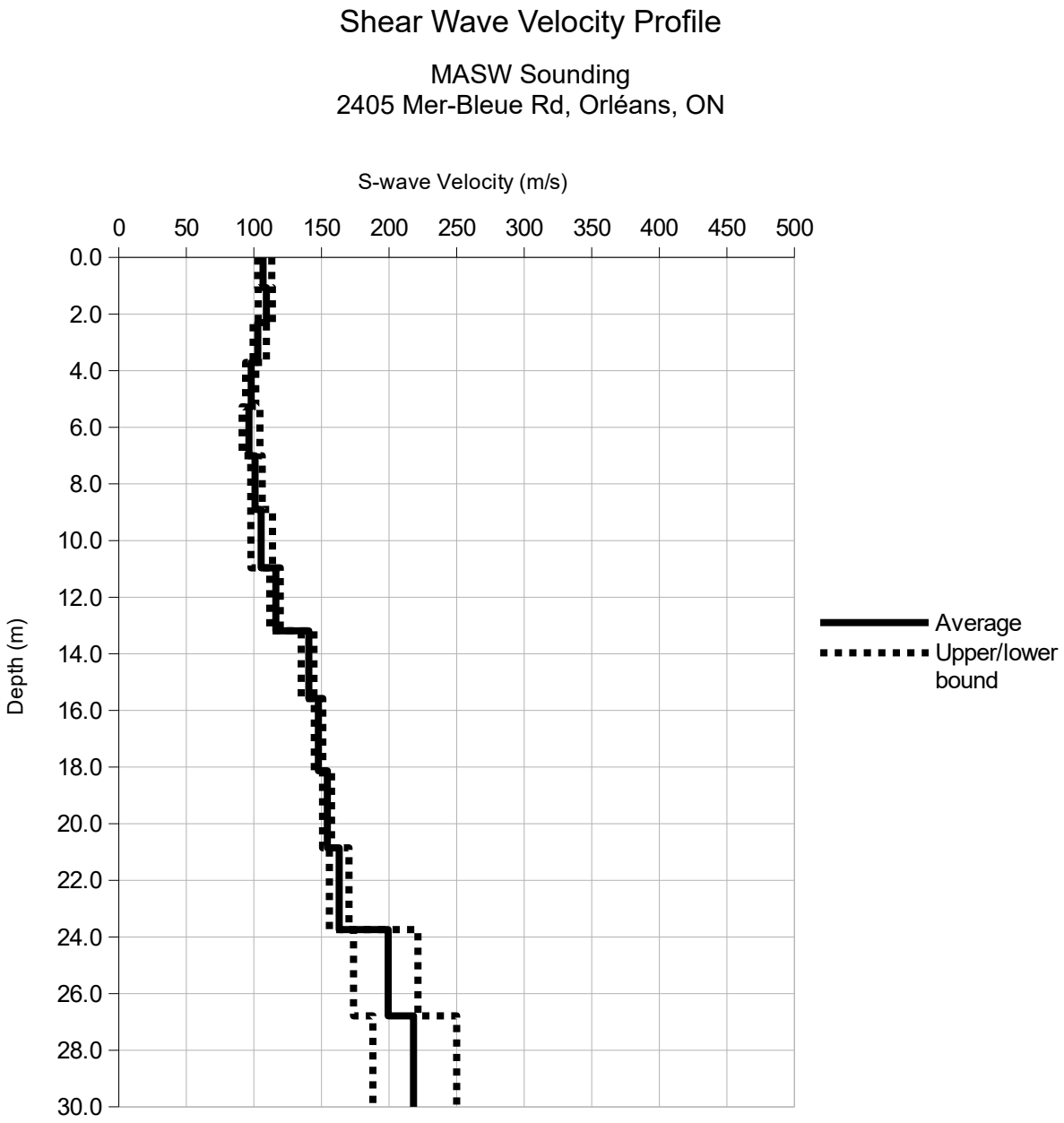

Figure 4 *Shear wave velocity profile from MASW sounding.*

The tabulated shear wave velocity model is presented in Table 1.

Table 1 *Shear wave velocities from MASW sounding.*

Depth Interval (m)		S-wave Velocity (m/s)
From	To	
0.0	1.1	107
1.1	2.3	109
2.3	3.7	103
3.7	5.3	98
5.3	7.0	96
7.0	8.9	101
8.9	11.0	105
11.0	13.2	116
13.2	15.6	141
15.6	18.1	148
18.1	20.9	154
20.9	23.7	163
23.7	26.8	199
26.8	30.0	218

The average shear wave velocity within the upper 30 meters (V_S30) is defined as the travel-time weighted average velocity from surface to a depth of 30 m and calculated using the following formula:

$$V_S30 = 30 / \Sigma (d/V_S),$$

where d is the thickness of any layer and V_S is the layer S-wave velocity. In other words, V_S30 is calculated as 30 m divided by the sum of the S-wave travel times for each layer within the topmost 30 m.

The calculated V_S30 values are presented in Table 2.

Table 2 *V_S30 values from MASW sounding.*

Depth Range (m)	Minimum V_S30 (m/s)	Average V_S30 (m/s)	Maximum V_S30 (m/s)	NBC 2015 Site Class	NBC 2020 Site Designation
0 to 30	125	**133**	140	**E**	**X_F**

The V_S30 values obtained from the MASW sounding varied from 125 m/s to 140 m/s with an average of 133 m/s.

Based on the Site Classification for Seismic Site Response (Table 4.1.8.4.-A) of the National Building Code of Canada 2015 (NBC 2015), the investigated area is in **Site Class E** ($V_S30 < 180$ m/s).

Based on the Sentence 4.1.8.4.(2b) and Table 4.1.8.4.-A of the National Building Code of Canada 2020 (NBC 2020), the **Site Designation** is **X_F**.

4 CLOSURE

Shear wave velocity testing involving the multi-channel analysis of surface waves (MASW) method was carried out for a proposed new school at 2405 Mer-Bleue Road in Orléans, Ontario.

The average shear wave velocity (V_S30) value calculated from in situ shear wave velocity measurements was **133 m/s**. Based on the Site Classification for Seismic Site Response (Table 4.1.8.4.-A) of the National Building Code of Canada 2015 (NBC 2015), the investigated area is in **Site Class E** ($V_S30 < 180$ m/s).

It must be noted that other geotechnical information may supersede the seismic site classification determined through the seismic test. The site must be assessed as Site Class F if it has any of the following four soil types:

- liquefiable soil, quick and highly sensitive clay, collapsible weakly cemented soil, or other soil susceptible to failure or collapse under seismic loading,
- more than 3 m of peat and/or highly organic clay,
- more than 8 m of highly plastic soil (with PI > 75), or
- more than 30 m of soft to medium-stiff clay.

Based on the Sentence 4.1.8.4.(2b) and Table 4.1.8.4.-A of the National Building Code of Canada 2020 (NBC 2020), the **Site Designation** is **X_F**.

We hope you find this report satisfactory. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Frontwave Geophysics Inc.

Ilia Gusakov, P.Geo.
Geophysicist
(647) 514-4724
ilia.gusakov@frontwave.ca

PROFESSIONAL GEOSCIENTIST
ILIA GUSAKOV
PRACTISING MEMBER
3161
ONTARIO

Appendix E

Rock Core Photographs

Photo 1: Rock Core Run 1 & 2, BH105-24, 39.0 to 41.8 mbgs

Appendix F
Chemical Testing

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Certificate of Analysis

Cambium Inc. (Ottawa)
343 Preston St, 11th Floor
Ottawa, ON K7K 7G3
Attn: Blasco Vijayabaskaran

Client PO:
Project: 20361-003
Custody: 70544

Report Date: 15-Oct-2024
Order Date: 9-Oct-2024

Order #: 2441197

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

Paracel ID	Client ID
2441197-01	BH103_0.75 -1.5

Approved By:

Mark Foto, M.Sc.
Lab Supervisor

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	10-Oct-24	10-Oct-24
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	9-Oct-24	9-Oct-24
Resistivity	EPA 120.1 - probe, water extraction	10-Oct-24	10-Oct-24
Solids, %	CWS Tier 1 - Gravimetric	9-Oct-24	10-Oct-24

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

	Client ID:	BH103_0.75 -1.5	-	-	-		
	Sample Date:	08-Oct-24 12:00	-	-	-	-	-
	Sample ID:	2441197-01	-	-	-		
	Matrix:	Soil	-	-	-		
	MDL/Units						
Physical Characteristics							
% Solids	0.1 % by Wt.	81.7	-	-	-	-	-
General Inorganics							
pH	0.05 pH Units	7.48	-	-	-	-	-
Resistivity	0.1 Ohm.m	17.4	-	-	-	-	-
Anions							
Chloride	10 ug/g	186	-	-	-	-	-
Sulphate	10 ug/g	59	-	-	-	-	-

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

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					

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

Method Quality Control: Duplicate

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	17.5	10	ug/g	19.8			12.5	35	
Sulphate	26.4	10	ug/g	27.5			4.0	35	
General Inorganics									
pH	6.56	0.05	pH Units	6.54			0.3	2.3	
Resistivity	54.2	0.1	Ohm.m	55.0			1.5	20	
Physical Characteristics									
% Solids	97.2	0.1	% by Wt.	97.3			0.1	25	

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

Method Quality Control: Spike

Analyte	Result	Reporting Limit	Units	Source Result	%REC	%REC Limit	RPD	RPD Limit	Notes
Anions									
Chloride	118	10	ug/g	19.8	98.6	82-118			
Sulphate	125	10	ug/g	27.5	97.7	80-120			

PARACEL LABORATORIES LTD.

Order #: 2441197

Certificate of Analysis

Report Date: 15-Oct-2024

Client: **Cambium Inc. (Ottawa)**

Order Date: 9-Oct-2024

Client PO:

Project Description: 20361-003

Qualifier Notes:

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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Paracel ID: 2441197

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Paracel Order Number (Lab Use Only)	Chain Of Custody (Lab Use Only)
2441197	№ 70544

Client Name: Cambium Inc
Contact Name: Blasco Vijayabaskaran
Address: 343 Preston St, Ottawa, ON 11th Floor
Telephone: 613-979-1507

Project Ref: 20361-003
Quote #:
PO #:
E-mail: blasco.vijayabaskaran@cambium-inc.com

Page 1 of 1

Turnaround Time
☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required:

☐ REG 153/04 ☐ REG 406/19

Other Regulation
☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table
For RSC: ☐ Yes ☐ No
☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun:
☐ Other:

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

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken Date	Sample Taken Time	Corrosivity	Sulphides	Redox Potential
1	BH103_0.75-1.5	S		3	Oct 8/24	PM	X	X	X
2									
3									
4									
5									
6									
7									
8									
9									
10									

Comments:

Method of Delivery: Drop Box

Relinquished By (Sign):	Received By Driver/Depot:	Received at Lab:	Verified By: SD
Relinquished By (Print): Rory Ryan	Date/Time:	Date/Time: Oct. 9; 7:59	Date/Time: Oct 9, 2024 8:37am
Date/Time: Oct 8, 2024 1:40 PM	Temperature: °C	Temperature: 4.8 °C	pH Verified: ☐ By:

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Subcontracted Analysis

Cambium Inc. (Ottawa)
343 Preston St, 11th Floor
Ottawa, ON K7K 7G3
Attn: Blasco Vijayabaskaran

Paracel Report No.	**2441197**
Client Project(s):	**20361-003**
Client PO:	
Reference:	**Standing Offer - ENV**
CoC Number:	**70544**

Order Date:	09-Oct-24
Report Date:	15-Oct-24

Sample(s) from this project were subcontracted for the listed parameters. A copy of the subcontractor's report is attached

Paracel ID	Client ID	Analysis
2441197-01	BH103_0.75 -1.5	Redox potential, soil Sulphide, solid

TESTMARK Laboratories Ltd.
Committed to Quality and Service

CERTIFICATE OF ANALYSIS

Client:	Dale Robertson	Work Order Number:	553367
Company:	Paracel Laboratories Ltd. - Ottawa	PO #:	
Address:	300-2319 St. Laurent Blvd. Ottawa, ON, K1G 4J8	Regulation: Project #:	Information not provided 2441197
Phone/Fax:	(613) 731-9577 / (613) 731-9064	DWS #:	
Email:	drobertson@paracellabs.com	Sampled By:	
Date Order Received:	10/11/2024	Analysis Started:	10/21/2024
Arrival Temperature:	21.4 C	Analysis Completed:	10/21/2024

WORK ORDER SUMMARY

ANALYSES WERE PERFORMED ON THE FOLLOWING SAMPLES. THE RESULTS RELATE ONLY TO THE ITEMS TESTED.

Sample Description	Lab ID	Matrix	Type	Comments	Date Collected	Time Collected
BH103_0.75_1.5	2067506	Soil	None		10/8/2024	12:00 PM

METHODS AND INSTRUMENTATION

THE FOLLOWING METHODS WERE USED FOR YOUR SAMPLE(S):

Method	Lab	Description	Reference
RedOx - Soil (T06)	Mississauga	Determination of RedOx Potential of Soil	Modified from APHA-2580B

REPORT COMMENTS

Sample received past hold time for Redox, proceed with analysis as per client TJ 10/11/24

This report has been approved by:

Brad Halvorson, B.Sc.
Laboratory Director

TESTMARK Laboratories Ltd.
Committed to Quality and Service

CERTIFICATE OF ANALYSIS

Paracel Laboratories Ltd. - Ottawa

Work Order Number: 553367

WORK ORDER RESULTS

Sample Description	**BH103 _ 0.75 _ 1.5**
Sample Date	10/8/2024 12:00 PM
Lab ID	2067506

General Chemistry	Result	MDL	Units
RedOx (vs. S.H.E.)	291 [289]	N/A	mV

LEGEND

Dates: Dates are formatted as mm/dd/year throughout this report.

MDL: Method detection limit or minimum reporting limit.

[ ]: Results for laboratory replicates are shown in square brackets immediately below the associated sample result for ease of comparison.

Organic Soil Analysis: Data reported for organic analysis in soils samples are corrected for moisture content.

Quality Control: All associated Quality Control data is available on request.

Field Data: Reports containing Field Parameters represent data that has been collected and provided by the client. Testmark is not responsible for the validity of this data which may be used in subsequent calculations.

Sample Condition Deviations: A noted sample condition deviation may affect the validity of the result. Results apply to the sample(s) as received.

Reproduction of Report: Report shall not be reproduced, except in full, without the approval of Testmark Laboratories Ltd.

ICPMS Dustfall Insoluble: The ICPMS Dustfall Insoluble Portion method analyzes only the particulate matter from the Dustfall Sampler which is retained on the analysis filter during the Dustfall method.

Regulation Comparisons: Disclaimer: Please note that regulation criteria are provided for comparative purposes, however the onus on ensuring the validity of this comparison rests with the client.

6820 Kitimat Road Unit 4, Mississauga, ON, L5N 5M3
Phone: (905) 821-1112 Fax: (905) 821-2095 Web: www.testmark.ca

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

17-October-2024

Paracel Laboratories
Attn : Dale Robertson

300-2319 St.Laurent Blvd.
Ottawa, ON
K1G 4K6, Canada

Phone: 613-731-9577
Fax:613-731-9064

Date Rec. : 10 October 2024
LR Report: **CA13597-OCT24**
Reference: Project#: 2441197

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report

Sample ID	Sample Date & Time	Sulphide (Na_2CO_3) %
1: Analysis Start Date		17-Oct-24
2: Analysis Start Time		12:35
3: Analysis Completed Date		17-Oct-24
4: Analysis Completed Time		12:42
5: RL		0.01
6: BH103_0.75-1.5	08-Oct-24 12:00	0.02

RL - SGS Reporting Limit

Kimberley Didsbury
Project Specialist,
Environment, Health & Safety

OnLine LIMS

0003894959

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA13597-OCT24**

Quality Control Report

Inorganic Analysis													
Parameter	Reporting Limit	Unit	Method Blank	Duplicate				LCS / Spike Blank			Matrix Spike / Reference Material		
				Result 1	Result 2	RPD	Acceptance Criteria	Spike Recovery (%)	Recovery Limits (%)		Spike Recovery (%)	Recovery Limits (%)	
							%		Low	High		Low	High
Carbon/Sulphur - QCBatchID: ECS0041-OCT24													
Sulphide (Na2CO3)	0.01	%	< 0.01										

OnLine LIMS

0003894959

PARACI LABORATORIES

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Paracel Order Number (Lab Use Only): 2441197

Chain Of Custody (Lab Use Only) № 70544

Client Name: Cambium Inc
Contact Name: Blasco Vijayabaskaran
Address: 343 Preston St, Ottawa, ON 11th Floor
Telephone: 613-989-1507

Project Ref: 20361-003
Quote #:
PO #:
E-mail: blasco.vijayabaskaran@cambium-inc.com

Page 1 of 1

Turnaround Time
☐ 1 day ☐ 3 day
☐ 2 day ☒ Regular
Date Required:

☐ REG 153/04 ☐ REG 406/19

☐ Table 1 ☐ Res/Park ☐ Med/Fine
☐ Table 2 ☐ Ind/Comm ☐ Coarse
☐ Table 3 ☐ Agri/Other
☐ Table
For RSC: ☐ Yes ☐ No

Other Regulation
☐ REG 558 ☐ PWQO
☐ CCME ☐ MISA
☐ SU - Sani ☐ SU - Storm
Mun:
☐ Other:

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

Required Analysis

	Sample ID/Location Name	Matrix	Air Volume	# of Containers	Sample Taken: Date	Sample Taken: Time	Corrosivity	Sulphides	Redox Potential
1	BH103_0.75-1.5	S		3	Oct 8/24	PM	X	X	X
2									
3									
4									
5									
6									
7									
8									
9									
10									

Comments:

Method of Delivery: Drop Box

Relinquished By (Sign): K. Ryan
Relinquished By (Print): Rory Ryan
Date/Time: Oct 8, 2024 1:40 PM

Received By Driver/Depot:
Date/Time:
Temperature: °C

Received at Lab:
Date/Time: Oct. 9; 7:59
Temperature: 4.8 °C

Verified By: SD
Date/Time: Oct 9, 2024 8:37 am
pH Verified: ☐ By:

Chain of Custody (Blank).xlsx
Revision 4.0