Hydrogeological Study

Proposed Residential Development

8600 Jeanne D'Arc Boulevard
Ottawa, Ontario

Prepared for 11034936 Canada Inc.

Report PH4866-REP.01
dated April 25, 2024

Table of Conetents

Figures

Appendices

1.0 INTRODUCTION

1.1 Background

Paterson Group (Paterson) was retained by 11034936 Canada Inc. to conduct a hydrogeological study for the proposed residential development located at 8600 Jeanne D'Arc Boulevard in the City of Ottawa (hereinafter referred to as the "subject site"). The location of the subject site is shown on Drawing PH4866-1 - Site Plan appended to this report. This report incorporates the findings of Paterson Report PG6414-1 dated December 23, 2022.

1.2 Scope of Work

Paterson has completed this report in accordance with the scope prepared by Paterson. As per the agreed upon scope, the purpose of this study was to:

- Characterize the hydrogeological setting of the subject site. Consideration was given to bedrock and surficial geology, aquifer systems, groundwater levels, hydraulic properties and catchment characteristics.
- A groundwater impact assessment to determine potential impacts to adjacent infrastructure, well users and the surrounding environment.

Additionally, the study was to include the standard components of a Water Budget Assessment as per the City of Ottawa's Water Budget Assessment Terms of Reference, which included the following:

- Review related higher-level studies.
- Conduct pre and post-development water budget analyses, including water budget equations, to determine the hydrogeological function of the subject site in order to assess the need for supplemental stormwater management measures.
- Develop a model to characterize pre and post-development hydrologic and hydrogeologic site conditions.
- Identify sensitive hydrologic and hydrogeologic features (if any) within the study area.
- Identify water budget targets (if applicable) to mitigate post-development hydrologic and hydrogeologic impacts.
- Identify how climate change projections may impact the water budget.

2.0 PREVIOUS REPORTS

In addition to a review of the general literature summarized in the following sections and in the 'References' section of this report (MECP water well mapping, available geological and physiographic mapping), Paterson reviewed the following site-specific reports:

- ❒ PG1565-1 "Preliminary Geotechnical Investigation – 32 Acre Property – North Service Road – Ottawa" – prepared by Paterson Group – December 10, 2007
- ❒ PG6414-1 "Geotechnical Investigation – Petrie's Landing III" - prepared by Paterson Group – December 23, 2022.
- ❒ PG6414-2 "Landslide Hazard Assessment – Petrie's Landing III" - prepared by Paterson Group – May 5, 2023
- ❒ LOP22-024A "Phase One Environmental Site Assessment – 8599 & 8600 Jeanne D'Arc Boulevard Ottawa, Ontario" – prepared by Lopers & Associates – October 12, 2022
- ❒ A001295 "Environmental Impact Statement - Petrie III 8600 Jean d'Arc Boulevard North" – Prepared CIMA+ – December 2023

3.0 METHOD OF INVESTIGATION

3.1 Records Review

A review of available geological, and hydrogeological data was completed as a part of this assessment. However, the literature review and previous reports did not provide site-specific data regarding overburden and bedrock aquifers, recharge and discharge conditions or flow contributions to the nearby water features. Further detail is provided in the following sections.

3.2 Field Program

The geotechnical and hydrogeological field programs were developed to assess geology, groundwater conditions, hydraulic gradients and the overall hydrologic/hydrogeologic function of the subject site. The test holes were advanced to various depths across the site to assess hydrogeological and geotechnical conditions.

Geotechnical field investigations were completed by Paterson at the subject site between November 2007 and October 2022. During this time, several boreholes were advanced to a maximum depth of 9.6 m below ground surface (bgs). The location of the test holes are shown on Drawing PG6414-1 - Test Hole Location Plan located in Appendix 1.

Soil samples were obtained from the boreholes by means of split spoon sampling, the sampling of shallow soils directly from auger flights, and the sampling of thin wall or shelby tubes. Split-spoon samples were taken at approximately 0.6-0.8 m intervals. The depth at which split-spoon, auger and thin wall samples were obtained from the test holes are shown as "**SS**", "**AU**" and "**TW**", respectively on the Soil Profile and Test Data sheets, appended to this report. All samples were classified on site, placed in sealed plastic bags and were transported to our laboratory for further review and testing. Transportation of the samples was completed in accordance with ASTM D4220-95 (2007) - Standard Practice for Preserving and Transporting Soils.

The Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples. The SPT results are recorded as "N" values on the Soil Profile and Test Data sheets. The "N" value is the number of blows required to drive the split-spoon sampler 300 mm into the ground after an initial penetration of 150 mm using a 63.5 kg hammer falling from a height of 760 mm. This test was done in accordance with ASTM D1586-11 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

The Dynamic Cone Penetration Test (DCPT) was conducted to evaluate the overburden thickness. The DCPT results are recorded on the Soil Profile and Test Data sheets. The recorded values are the number of blows required to drive a steel rod, equipped with a 50 mm diameter cone at its tip, 300 mm into the ground using a 63.5 kg hammer falling from a height of 760 mm. DCPT refusal was encountered at BH9-22 at a depth of 41.0 m bgs.

Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profiles encountered at the test hole locations.

Drawdown Analysis - Hydraulic Conductivity Testing

Hydraulic conductivity testing (slug testing) was completed at all monitoring wells installed during the 2022 geotechnical investigation. Falling head tests (slug tests) were completed in accordance with ASTM Standard Test Method D4404 - Field Procedure for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers.

Slug testing was completed between November 29 and December 1, 2022 by Paterson personnel. The general test method consisted of measuring the static water level in the well, followed by inducing a near-instantaneous change of head in the well and subsequent monitoring of water level recovery with an electronic water level meter and a water level datalogger. The change in head was induced by the introduction of an acetal slug, 0.9 m in length and 38 mm in diameter. The slug was introduced to raise the groundwater level in the monitoring well, following which the decrease in water level over time was monitored (falling head test). Once the water level had stabilized (or nearly stabilized), the test was considered to be complete.

Following the completion of the slug tests, the test data was analyzed as per the method set out by Hvorslev (1951). Assumptions inherent in the Hvorslev method include a homogeneous and isotropic aquifer of infinite extent, zero-storage assumption, and a screen length significantly greater than the monitoring well diameter. The assumption regarding aquifer storage is considered to be appropriate for groundwater flow through the overburden aquifer. The assumption regarding screen length and well diameter is considered to be met based upon a typical length of approximately 1.5 m and a diameter of 0.05 m.

While the idealized assumptions regarding aquifer extent, homogeneity, and isotropy are not strictly met in this case (or in any real-world situation), it has been our experience that the Hvorslev method produces effective point estimates of hydraulic conductivity in conditions similar to those encountered at the subject site. Hvorslev analysis is based on the line of best fit through the field data (hydraulic head recovery vs. time), plotted on a semi-logarithmic scale. In cases where the initial hydraulic head displacement is known with relative certainty, such as in this case where a physical slug has been introduced, the line of best fit is considered to pass through the origin and the trendline from the test data itself is used for the analysis. In cases where the initial hydraulic head displacement is known with less certainty (e.g. a bail test, where water is pumped rapidly from the well), the best-fit line is drawn regardless of the origin.

3.3 Laboratory Testing

All soil samples were retained for laboratory review following the field portion of the subsurface investigation. The soils were classified in general accordance with ASTM D2488-09a, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure). Based on the soil descriptions across the subject site during the geotechnical investigations, these samples are considered to be sufficiently representative of the site.

3.4 Monitoring Well Installations

As part of the October 2022 geotechnical field program, monitoring wells were installed in select boreholes to permit the monitoring of groundwater levels and conduct drawdown analyses. The well installations were compliant with ASTM D5092 standards.

3.5 Water Level Measurements

Following the completion of the November 2007 and October 2022 drilling programs, groundwater levels were measured at the borehole locations equipped with either a monitoring well or piezometer. Water levels were measured using an electronic water level meter relative to the ground surface elevation at each location and are noted on the Soil Profile and Test Data sheets, appended to this report.

3.6 Surveying

The test hole locations and ground surface elevations at each test hole location completed by Paterson were surveyed using a GPS unit with respect to a geodetic datum. The locations and ground surface elevations for each test hole are presented on Paterson Drawing PG6414-1 - Test Hole Location Plan in Appendix 1.

4.0 REVIEW AND EVALUATION

4.1 Physical Setting

At the time of the field investigations, the subject site consisted of mature trees, grass, shrubs, and gravel covered areas. The subject site is located in the City of Ottawa, Ontario and is bordered by Jeanne D'Arc Boulevard to the north, institutional land to the east, Highway 174 to the south and residential developments to the west. The location of the subject site is shown on Drawing PH4866-1 - Site Plan appended to this report.

The subject site is located within the Taylor Creek subwatershed. There are numerous surface water features located within 500 m of the subject site. These include unnamed drainage ditches located between approximately 50 to 500 m to the east, west and south of the site, the Ottawa River located approximately 150 m north of the site and Taylor Creek which transects the subject site along its western edge from the south to the north.

The ground surface at the subject site slopes down towards Taylor Creek and is generally at grade with adjacent roadways and properties. The site is generally sloping from east to west with an elevation difference of 5 m.

According to available mapping from the Ontario Geologic Survey (OGS; MRD228), the subject site is located in a Clay Plains physiographic region. The region is characterized by silty clay deposits, which is generally consistent with field observations at the subject site.

4.2 Geology

Surficial Geology

Overburden mapping provided by the OGS was reviewed as part of this assessment. Available mapping (MRD 128) indicates that overburden soils throughout the subject site consist of fine-textured glaciomarine deposits (silt and clay, minor sand and gravel). Overburden soil mapping is shown on Drawing PH4866-3 - Surficial Geology Plan within Appendix 1.

Overburden soils identified during the geotechnical investigations by Paterson between November 2007 and October 2022 were generally consistent with the available mapping. Soils generally consisted of topsoil, overlying a silty clay deposit.

Specific details are provided on the Soil Profile and Test Data Sheets attached within Appendix 2 of this report. More details regarding the overburden soils can be found in Paterson Report PG6414-1 dated December 23, 2022.

Bedrock Geology

Bedrock was not encountered during either of Paterson's geotechnical field investigations. DCPT refusal was encountered at BH9-22 at 41.0 m bgs.

Bedrock mapping, provided by the OGS was reviewed as a part of this assessment. Available mapping (MRD 219) indicates that bedrock at the subject site consists of limestone and dolostone of the Gull River Formation. Based on available mapping and field observations, the overburden drift thickness at the subject site ranges between approximately 15 to 50 m. Bedrock geology mapping is shown on Drawing PH4866-4 - Bedrock Geology Plan within Appendix 1.

Karst Features

The term "karst" refers to a geologic formation characterized by the dissolution of carbonate bedrock, such as limestone or dolostone. In order for karstification to occur, precipitation must be able to infiltrate the top of the bedrock, causing dissolution which enlarges previously existing joints and bedding planes. Based on available mapping by the OGS (GRS 005), the subject site is located within an area with potential karstic landforms due to areas of carbonate rock units identified as being susceptible to karst processes. However, given the depth of the bedrock at the subject site, any karstification that may be occurring within the site boundary would be at a depth significantly below any part of the proposed development. Therefore, Impacts related to karstification are considered to be negligible.

4.3 Hydrogeological Setting (Conceptual Model)

Based on the field investigations at the subject site, Paterson used borehole data, existing water well records, topography, monitoring well water levels and hydraulic conductivity to develop a conceptual model of the transport fate of surface water and groundwater at the subject site. Information related to the conceptual flow model is listed below.

Existing Aquifer Systems

Aquifer systems may be defined as geological media, either overburden soils or fractured bedrock, which permit the movement of groundwater under hydraulic gradients. In general, aquifer systems may be present in overburden soils or bedrock. Groundwater was observed within the overburden materials. However, water supply wells in the vicinity of the subject site are anticipated to be accessing the underlying glacial till and/or bedrock aquifer given the characteristics and hydraulic properties of the overburden materials.

The bedrock aquifer system consists of limestone and dolostone of the Gull River Formation. Given the thickness and composition of the silty clay overburden soils at the subject site, the clay deposit is considered to act as a confining layer to the underlying glacial till and/or bedrock aquifer.

Groundwater Levels

Following the completion of the November 2007 and October 2022 drilling programs, groundwater levels were measured at the monitoring well and piezometer locations and ranged between 1.5 and 7.4 m bgs.

The groundwater elevations generally follow the topographic profile across the subject site, with the highest groundwater elevations observed within the eastern portion of the site and the lowest groundwater elevations within the western portion of the site. The manual groundwater measurements are displayed on the Soil Profile and Test Data sheets, appended to this report.

Horizontal Hydraulic Gradients

Due to the nature of the water levels obtained from field work conducted at the subject site (groundwater monitoring wells and piezometers), the absolute direction of horizontal hydraulic gradients in the vicinity of the subject site was not determined. However, using the available data, it was possible to approximate the horizontal hydraulic gradients in the overburden materials given that the horizontal hydraulic gradient between any two (2) points is the slope of the hydraulic head between those points:

$$i=h_2-h_1/L$$

Where: i = horizontal gradient
h = water elevation (m asl)
L = horizontal distance between test hole locations

Using the above noted formula, the horizontal hydraulic gradients were observed to be in an approximate southwesterly orientation with a magnitude generally ranging between 0.01 to 0.025 in the silty clay deposit. The approximate hydraulic gradients and groundwater flow directions are presented on Drawing PH4866-5 -

Groundwater Contour Plan. Regional groundwater flow in the overburden is expected to be towards Taylor Creek or surrounding unnamed drains leading to the Ottawa River.

Hydraulic Conductivity

Hydraulic conductivity testing (slug testing) was completed by Paterson as part of the field investigations at the subject site. However, given the slow hydraulic properties of the soils, the tests only reached a maximum of 50% recovery. Therefore, it is interpreted that tests yielded hydraulic conductivity values of ≤ 1.0×10^{-8} m/sec for the silty clay.

Groundwater Recharge and Discharge

In general, groundwater will follow the path of least resistance from areas of higher hydraulic head to areas of lower hydraulic head. While upward and downward hydraulic gradients may be indicative of areas of discharge and recharge respectively, other factors must be considered.

The overburden soils at the subject site consist primarily of topsoil, overlying a deep silty clay deposit. Within the study area, surface water is expected to infiltrate the subsoils and recharge the overburden aquifer or become perched when the soils cannot facilitate adequate infiltration. Where perched conditions are encountered, sheet drainage is expected to occur and water will flow down gradient to nearby surface water features.

Based on the likely low infiltration capacity of the subsoils, it is our interpretation that the subject site provides limited recharge to the shallow overburden water table. However, based on the vertical and lateral extent of the silty clay deposit on site, recharge to the glacial till/bedrock aquifer is not anticipated.

With regards to discharge zones, the geological conditions are not suitable for discharge to be occurring on a large scale at the subject site.

Catchment Areas

The subject site is located within the Taylor Creek subwatershed. The general groundwater and surficial flow direction across the subject site was observed to be in a westerly and southwesterly direction towards Taylor Creek. Therefore, it is Paterson's opinion that the subject site is characterized by one catchment area.

Based on available development plans at the time of report preparation, the subject site will be divided into two catchment areas under post-development conditions. The western portion of the subject site will continue to drain to the west towards Taylor Creek while the central and eastern portion of the subject site will drain towards the catch basins located within the roadways and be directed to the north of Jeanne D'Arc through the storm sewer system.

Groundwater Inflow/Dewatering Requirements

Two potential sources of dewatering have been identified at the subject site. The sources consist of the excavation footprints related to the building foundations/underground parking and servicing trenches. Details regarding the excavation footprints and depths for each potential dewatering source were unavailable at the time of report preparation. Based on available conceptual drawings for the site, excavation sizes were estimated based on proposed building footprints, assuming two (2) levels of underground parking per building and typical servicing excavation sizes based on previous experience at similar sites.

The infiltration rates provided for the following sources were calculated using the Dupuit Forchheimer method:

$$Q = \pi k((h_0^2 - h_p^2)/\ln(R/r))$$

- ❏ k = hydraulic conductivity (m/sec)
- ❏ h_0 = thickness of the aquifer (m)
- ❏ h_p = thickness of the aquifer from the base of the excavation to the base of the aquifer (m)
- ❏ R = effective drawdown radius for the excavation (m)
- ❏ r = equivalent radius of the excavation (m)

The groundwater infiltration calculations for the excavation footprints are provided in Appendix 4 of this report.

The stratigraphy within the anticipated saturated depth of the building excavations generally consists of silty clay. The typical depth of excavation is expected to be approximately 8 m bgs. Calculations are based on an excavation sizing of approximately 5,300 m^2 and a saturated depth of 5.0 m. Using a conservative hydraulic conductivity of 1.0×10^{-8} m/sec, the steady state volume of groundwater anticipated is approximately 25,000 to 45,000 L/day per excavation.

The stratigraphy within the anticipated saturated depth of the servicing excavations generally consists of silty clay. The typical depth of excavation is expected to be approximately 6.5 m bgs. Calculations are based on an excavation sizing of approximately 125 m^2 and a saturated depth of 3.5 m. Using a conservative hydraulic conductivity of 1.0×10^{-8} m/sec, the steady state volume of groundwater anticipated is approximately 6,000 to 7,000 L/day per excavation.

Based on preliminary dewatering calculations and Paterson's experience with other residential developments with similar infrastructure that are built on silty clay subsoils, it is anticipated that groundwater contributions will be < 400,000 L/day per source. It is recommended that source specific dewatering calculations be completed once more specific development details are available.

5.0 SITE SPECIFIC WATER BUDGET ASSESSMENT

The site-specific water budget assessment (SSWB) was conducted to determine the hydrogeological function of the subject site, to identify infiltration potential and to identify opportunities for supplemental stormwater management measures. At the time of the field investigations the study area mainly consisted of mature trees, grass, shrubs and minimal impervious areas. The pre and post-development terrain compositions are illustrated on Drawings PH4866-6 - Pre-Development Terrain Composition Plan and PH4866-7 - Post-Development Terrain Composition Plan appended to this report.

5.1 Calculations

Thornthwaite and Mather Water Balance Calculations

When falling precipitation intercepts the ground, three possible outcomes arise. The water can either evaporate/transpire back into the atmosphere (evapotranspiration), infiltrate into the surface soils (infiltration) or leave the area as runoff.

The method employed by Thornthwaite and Mather (1957) was used along with modelling software by Environment Canada's Engineering Climate Services Unit (EC-ECS) to determine the partitioning of water throughout various portions of the hydrologic cycle. Inputs into the modelling program included monthly temperature, precipitation, water holding capacities and site latitude. Using the long-term averages of these variables, it was possible to calculate annual potential and actual evapotranspiration, change in soil moisture storage and the water surplus.

The formula employed by Thornthwaite and Mather is as follows:

$$S = R + I = P - ET$$

Where:
S = surplus (mm/year)
R = annual runoff (mm/year)
I = annual infiltration (mm/year)
P = annual precipitation (mm/year)
ET = annual evapotranspiration (mm/year).

Shallow unsaturated soils within the subject site generally consisted of topsoil overlying a silty clay deposit. Given the similar soil profiles across the entire subject site, the above noted calculations were carried out for the soil moisture holding capacity of a clay loam.

Based on the location of the site within the Ottawa area, climatic data was obtained from the climate station located at the McDonald-Cartier International Airport covering the period of January 1939 to December 2022. The information was provided by Environment Canada's Engineering Climate Services Unit and is presented in Appendix 2 of the report.

Table 1, below, displays the soil types present within the study area and their associated water holding capacities (WHC) as well as the actual evapotranspiration (AET) and surplus data. For the purposes of this study, AET values were used as they account for accumulated soil moisture deficit. This deficit represents the volume of water retained within the available pore spaces of the soil and is subtracted from the potential evapotranspiration (PET) value to more accurately calculate the water surplus. The monthly/annual water balance is presented in Tables 3-6 in Appendix 2 of the report.

Table 1 - Site Specific Water Surplus Information

Land Use Unit	Water Holding Capacity (mm)	Actual Evapotranspiration (mm/year)	Surplus Water (mm/year)
Impervious Surfaces	5	457	449
Urban Lawn (Clay Loam)	100	545	360
Pasture and Shrubs (Clay Loam)	250	600	304
Mature Forest (Clay Loam)	400	609	292

Table reproduced using WHC values from MOE (2003) - Stormwater Management Planning and Design Manual and modelling data from Environment Canada's Engineering Climate Services Unit.

Infiltration Factors

In order to break down the surplus water values for the various materials into infiltration and runoff, various factors must be considered. The MOE Stormwater Management Planning and Design Manual (2003) lists three main factors that contribute to surface water infiltration rates.

The first factor is topography, which is broken down further into three sections: flat land, rolling land and hilly land. Flat land provides the greatest potential for infiltration and has the largest infiltration factor applied to it (0.3), while the other two have progressively lower infiltration factors (rolling land is 0.2 and hilly land is 0.1).

The second factor is soil, which is also broken down further into three sections: tight impervious clay, medium combinations of clay and loam and open sandy loam. Open sandy loam provides the greatest potential for infiltration (infiltration factor of 0.4) while the other two have progressively lower potential for infiltration to occur (infiltration factor for medium combinations of clay and loam is 0.2 and for tight impervious clay is 0.1).

The final factor the MOE manual uses to partition infiltration from runoff is land cover. It is broken down into two sections: open fields/cultivated lands and woodlands. Woodlands have greater infiltration potential and an infiltration factor of 0.2. Open fields and cultivated lands have lower potential and with an infiltration factor of 0.1. A summary of the MOE manual's descriptors and their associated infiltration factors is shown below in Table 2.

Table 2 - MOE (2003) Infiltration Factors

Description of Area/Development Site	Value of Infiltration Factor
Topography	
Flat land (slope <0.6 m/km)	0.30
Rolling land (slope of 2.8-3.8 m/km)	0.20
Hilly land (slope of 28-47 m/km)	0.10
Soil	
Tight impervious clay	0.10
Medium combinations of clay and loam	0.20
Open sandy loam	0.40
Cover	
Open fields/cultivated lands	0.10
Woodlands	0.20

Table reproduced from MOE (2003) - Stormwater Management Planning and Design Manual.

The topography of the eastern portion of the subject site is classified as rolling land (generally 2 to 4 m/km throughout that portion), largely covered by pasture and shrubs. The topography of the western portion of the subject site is classified as hilly land, as the land slopes sharply towards Taylor Creek, largely covered by mature forests. Therefore, pre-development topography infiltration factors of 0.2 and 0.1 were given to the eastern portion (pasture and shrubs area) and the western portion (mature forested area), respectively. In order for development to proceed, it is expected that alterations will be made to the topography of the site. In general, it is expected that the overall slope of the site will be reduced to accommodate buildings and parking areas. However, the topography of the post-development site will still consist of rolling land and was therefore assigned a post-development topography infiltration factor of 0.2. This excludes the western portion of the subject site which will largely remain unchanged and was therefore assigned a post-development topography factor of 0.1. A topography infiltration factor of 0 was assigned to the impervious surfaces due to its negligible infiltration capacity.

As previously discussed, soils within the subject site generally consisted of topsoil overlying a silty clay deposit. Therefore, a pre-development soil infiltration factor of 0.15 was given for the materials analysed on this property. Under post-development conditions, the majority of the site will consist of landscaped areas, impervious surfaces and mature forests, with soil infiltration factors of 0.2 for urban lawn (clay loam), 0.15 for mature forests (clay loam) and 0 for impervious surfaces.

At the time of the field investigations, the subject site generally consisted of pasture and shrubs and mature forests. Pre-development vegetation infiltration factors of 0.1 and 0.2 were assigned to the eastern portion with pasture and shrubs and the western portion with mature trees, respectively. Post-development, it is expected that the majority of the mature trees on site will be undisturbed as the majority of trees are in the sloped area adjacent to Taylor Creek and development is required to maintain a 15 m setback from the top of slope. The remaining area of pasture and shrubs is expected to be removed to accommodate buildings, landscaped areas and roadways. As such, a post-development vegetation infiltration factor of 0.1 was assigned to the developed areas with the exception of the tree covered areas which were given a vegetation infiltration factor of 0.2. Impervious surfaces were given a vegetation infiltration factor of 0 due to its negligible potential to benefit from vegetation cover.

The pre and post-development infiltration factors for all materials considered are included in the water budget calculations provided in Table 7 and Table 8 included in Appendix 2 of this report.

5.2 Pre and Post-Construction Water Budget

The pre-development water budget analysis conducted for the study area determined that an estimated 13,881,045 L/year of surplus water currently infiltrates the surface soils. The remaining estimated 17,618,221 L/year of surplus leaves the site as runoff, draining towards localized surface water features the subject site or to nearby existing municipal storm sewer systems.

The post-development water budget analysis determined that an estimated 11,575,344 L/year of surplus water will infiltrate the surface soils and approximately 26,099,822 L/year will leave the site as runoff. These values equate to an approximate decrease in infiltration of 16.6% and an increase in runoff of 48.1%.

The main variable that changed from pre-development conditions to post-development conditions was the addition of approximately 28,410 m^2 of impervious surfaces. This results in reducing the area of pervious materials throughout the subject site, therefore, reducing the overall infiltration potential of the subject site. The remaining areas that are not being converted to impervious surfaces will become landscaped surfaces characterized by urban lawn (clay loam) material. Despite these landscaped areas having slightly higher infiltration potential than the native silty clay soils, the overall impact of converting the native silty clay soils to urban lawn (clay loam) material with regards to the overall infiltration potential of the subject site will be limited when compared to the addition of impervious surfaces.

It is important to note that the post-development water budget analysis for the subject site does not consider any potential infiltration of the anthropogenic sources (100% runoff was taken as a conservative approach). In reality, some portion (15 to 30%) of surface water that lands on impervious surfaces either evaporates, infiltrates (asphalt is not 100% impervious) or is diverted to grassed areas where additional infiltration may occur. As such, the post-development runoff volumes should be considered a conservative estimate, and not expected to definitively represent future conditions.

Details of pre-development water budget analyses are presented in Table 7 and 8 included in Appendix 2 of this report.

6.0 GROUNDWATER IMPACT ASSESSMENT

6.1 Impact of Proposed Development on Surrounding Infrastructure

As previously discussed, soils within the subject site generally consisted of topsoil overlying a silty clay deposit followed by an inferred glacial till. Due to the low hydraulic properties of the silty clay, there are no structures located within the projected steady state radius of influence calculated in the following section of this report. Furthermore, dewatering activities are expected to be short term in duration and will generally require only low levels of pumping due to the nature of the materials on site. Any large quantities of water removed from the site will be in relation to precipitation events or if areas of perched water are encountered above the silty clay deposit. As such, the impacts of the proposed development on the surrounding infrastructure are expected to be negligible.

6.2 Impact of Proposed Development on Existing Well Users

A search of the Ontario Water Well Records database indicated that there are several wells within a 500 m radius of the proposed development. However, it is expected that these wells are either no longer in use due to their installation dates and developed nature of the region or are monitoring well installations. Additionally, the area surrounding the site is serviced by municipal water supplies. Any wells that may still be in use are cased well below the anticipated excavation depths associated with the proposed development and are accessing the deeper glacial till and/or bedrock aquifer. Therefore, it is anticipated that the existing wells have adequate vertical and horizontal separation from proposed construction activities. Dewatering activities at the subject site are therefore not expected to cause any interference to the water supply of surrounding properties or other negative impacts.

The steady-state radius of influence calculations completed were based upon the Sichardt equation as shown below. The assumed setting for the analytical solution was an open excavation for the proposed buildings/underground parking at the subject site, creating an unconfined condition which would allow use of the equation to determine the radius of influence.

$$R = r_e + 3000 * \Delta h(K^{0.5})$$

Where: R = radius of influence (m)
r_e = equivalent radius of influence (m)
Δh = expected groundwater drawdown (m)

K = hydraulic conductivity (m/sec).

For the purposes of completing the calculations, the following values were used in the analysis:

- ❒ r_e = 49.0 m, based on the typical dimensions (52 x 102 m) of the servicing excavations at the subject site.
- ❒ Δh = 4 to 6 m, to account for variable minimum/maximum drawdown conditions
- ❒ K = 5.86 x 10^{-9} to 1.00 x 10^{-8} m/sec, based on site specific hydraulic conductivity values of the silty clay.

Using the above equation and assumptions, a radius of influence of <1 to 1.8 m will develop as a steady state condition, extending from the edge of the excavation, in the area of the subject site, depending on the groundwater levels and hydraulic properties of the specific soils encountered.

6.3 Impact of Proposed Development on the Environment

A search of the MECP Brownfields Environmental Site Registry was conducted as part of the assessment of the site, neighbouring properties and the general area. No brownfields were identified within the 500 m buffer from the subject site.

There are numerous surface water features located within 500 m of the subject site. These include unnamed drainage ditches, Taylor Creek which transects the subject site from south to north, and the Ottawa River, north of the subject site. However, given the minimal radius of influence that may develop as a result of potential water taking activities and the required development set back from the aforementioned water courses, impacts to surface water features are anticipated to be negligible.

Considerations relevant to the water budget analyses are discussed in Section 7.5 below. Additional details of the potential environmental impacts with regards to terrestrial habitat, wildlife and species at risk are provided in the Environmental Impact Assessment prepared by CIMA+ dated December 2023.

6.4 Adjacent PTTW/EASRs/ECAs

A search of the MECP Permit to Take Water database provided no active PTTW within a 500 m radius of the subject site. Therefore, the risk of cumulative impacts resulting from multiple PTTW in proximity to each other is considered negligible.

A search of the MECP Environmental Activity and Sector Registry (EASR) database provided no active EASRs within a 500 m radius of the subject site. Therefore, the risk of cumulative impacts resulting from multiple EASRs in proximity to the subject site is considered negligible.

With respect to Environmental Compliance Approvals (ECAs), given the nature of the development in the area (institutional, residential and commercial), there are a large number of ECAs that exist for various purposes in the areas bordering the site. Upon review of the ECAs, thirteen (13) were found to be in relation to existing relevant stormwater management systems in the area. As this is the type of ECA that relates to the hydrogeological conditions in the surrounding area, the following ECAs were included in this study.

ECA number 0115-7FRL4A relates to the stormwater management facility at 775 Taylor Creek Drive located south of the subject site. The ECA describes a grassed storage area with a design minimum retention area of 223 cubic meters for a 100-year storm event with additional storage in the pipe system for a 5-year and 100-year storm event. The storage area outlets to an existing storm sewer.

ECA number 1138-5TAQKA relates to the stormwater management system for the Office and Warehouse building located on the northern portion 780 Taylor Creek Drive. The ECA describes the stormwater storage on site by ponding on the parking lot and grass swale with a maximum storage of 116 m^3.

ECA number 5383-9QQKQF relates to the stormwater management works for the Trimterra Business Park Site and the VW Orleans Site. The ECA describes the stormwater runoff storage and treatment for each site. The Trimterra Business Park's rooftops, surface area and underground has maximum storage areas of 156.1 m^3, 221.44 m^3 and 143.9 m^3, respectively. The VW Orleans' rooftops, surface area and underground has maximum storage areas of 158.3 m^3, 58.2 m^3 and 284.8 m^3, respectively. Stormwater management was designed up to a 100-year storm and an oil/grit separator is equipped for the stormwater runoff of each site. The runoff outlets to an existing storm sewer system.

ECA number 6271-95KN7Q relates to the stormwater management works for the site located at 3545 St. Joseph Boulevard. The ECA describes one enhanced grassed swale for the southern area and one dry pond for the northern area. The grassed swale and dry pond have maximum storage volumes of approximately 47 m^3 and 1083.2 m^3, respectively. Stormwater management manages post-development runoff up to 100-year storm events.

ECA number 3380-7RCG67 relates to the stormwater management works for the stormwater runoff at 790 Taylor Creek Drive. The ECA describes one stormwater dry pond with a total effective storage volume of approximately 54 m^3. The stormwater runoff discharges to an oil/grit separator to a storm sewer on Taylor Creek Drive.

ECA number 9725-6KRQWD relates to the stormwater management works for the stormwater runoff at 701 Taylor Creek Drive. The ECA describes an L-shaped swale with a minimum liquid retention volume of approximately 383 m^3 for a 100-year storm event. The flow from the swale is controlled by an orifice plate with a discharge flow rate of 38 L/s during a 100-year storm event.

ECA number 5474-8HNKEY relates to the stormwater management works for the office building located at the Taylor Creek Business Park. The ECA describes on-site surface and underground storage with a combined volume of 245 m^3 for a 100-year storm event. The post-development storm flow is controlled by an inlet control device which discharges to an oil/grit separator followed by existing storm sewers on Lacolle Way.

ECA number 4107-AS8LFE relates to the stormwater management works for an automobile warehouse facility located at 571 Lacolle Way. The ECA describes surface ponding and an on-site storm sewer system with a total storage volume of approximately 93 m^3. Stormwater is discharged via a flow restrictor to an oil/grit separator with a maximum treatment flow rate of 20 L/s to an existing storm sewer on Taylor Creek Boulevard.

ECA number 5372-835QP7 relates to the stormwater management works and facility for the Royal Ridge Subdivision along Old Montreal Road. The ECA describes a 4.19 ha drainage area with a storage capacity of 77 m^3 through road sags and 260 m^3 through a catch basin discharging to unnamed tributary, a 5.43 ha drainage area with a storage capacity of 699.2 m^3 through a storage tank discharging to Cardinal Creek via Montreal Road, and a 3.22 ha drainage area with a storage capacity of 260 m^3 through ditches discharging to the Trim Road Ditch.

The ECA number 8425-AEENSK relates to the stormwater management works serving the industrial site located at 1680 Vimont Court. The ECA describes a dry pond with a total detention storage volume of 298.2 m^3 and surface storage with a total storage volume of 588.8 m^3. Post-development runoff is discharged to oil/grit separators followed by municipal storm sewers on Vimont Court and Lacolle Way.

The ECA number 8907-63SQGY relates to the stormwater management works serving the manufacturing and distribution facility at 790 Taylor Creek Drive. The ECA describes catch basins, rooftop, parking lot and landscape ponding areas with a total storage volume of 272 m^3. The stormwater management works can provide retention for a 5-year storm event.

The ECA number 1098-6Z4QZ4 relates to the stormwater management works for the stormwater runoff on Vimont Court. The ECA describes a storage pipe and parking lot storage with a total storage volume of 97.9 m^3. Discharge is controlled with an inlet control device with a flow rate of 14.8 L/s, designed up to a 100-year storm event.

The ECA number 9261-9WFR7D relates to the stormwater management works for the 0.40 ha area located along Taylor Creek Drive between Lacolle Way and Vimont Court. The ECA describes the expansion of an existing grassed swale with a maximum storage volume of 66.9 m^3 during a 5-year storm event. Discharge is regulated using a vortex flow regulator and flows through an oil/grit separator to municipal storm sewers on Taylor Creek Drive.

7.0 ASSESSMENT AND RECOMMENDTIONS

7.1 Sources of Contamination

A Phase I Environmental Site Assessment (ESA) was completed by others for the subject site. The Phase I ESA found that a Phase II ESA was not required. Any potentially contaminating activities (PCAs) identified were determined to not be areas of potential concern due to separation distances from the subject site. The site has historically remained undeveloped or been used for agriculture, therefore no PCAs were identified on the subject site.

Prior to and during site development, it is recommended that construction best management practices with respect to fuels and chemical handling, spill prevention, and erosion and sediment control be followed. This will minimize the potential for the introduction of contaminants to the soil, surface water, or groundwater at the subject site.

With respect to stormwater runoff quality, it is recommended that best management practices with respect to operational standards be maintained for any stormwater management facilities constructed for the proposed development. It is also recommended that adherence to the City of Ottawa Salt Management Plan - Appendix A (October, 2011) included in Appendix 5 is enforced to ensure that chloride levels in stormwater runoff are minimized.

7.2 Surface Water Features

There are numerous surface water features located within 500 m of the subject site. However, as previously mentioned, it is anticipated that construction activities will be located at a distance from surface water features greater than the radius of influence that may develop as a result of potential water taking activities.

With respect to water discharge, water that is pumped from on site excavations must be managed in an appropriate manner. The contractor will be required to implement a water management program to dispose of the pumped water. If the discharge point for the pumped water is directed to overland drainage, it is expected that a multi-barrier approach (such as hay bales, geosocks, silt fence, etc.) to a non-frozen, well vegetated area will be utilized in order to promote re-infiltration prior to reaching a watercourse. Furthermore, if the discharged water is to be directed to overland drainage within 30 m of a water body/watercourse, the turbidity of the water shall not exceed 8 NTU above background levels of the nearest water body. The contractor will be required to maintain appropriate BMPs with respect to sediment and erosion control to ensure negative effects to the surrounding environment are minimized. If the water is to be directed to the existing City of Ottawa sewer system via sewer connections, the pumped water will be subject to the City of Ottawa Sewer Use Bylaws and a discharge permit will be required in order to discharge the water to the sewer system.

Based on the distance between surface water features and proposed water taking activities, impacts to nearby surface water features are anticipated to be negligible provided proper site BMPs are maintained.

7.3 Existing Wells

Any wells within the subject site must be decommissioned prior to construction in accordance with Ontario Regulation 903.

If construction activities are shown to cause negative impacts to the water supplies of existing well users, the contractor shall take action to make available a supply of water equivalent in quality and quantity of their typical takings or shall compensate those affected for reasonable costs for doing so, or shall reduce water taking amounts to alleviate the negative impacts. The contractor shall provide temporary water supplies, to those affected, to meet their typical takings or compensate such persons for reasonable costs associated to do so until permanent restoration of the affected water supply or an equivalent source. As the potential to interfere with the water quality/quantity of existing well users in the area is negligible, a water well monitoring program is not recommended for the proposed development.

7.4 Permit To Take Water

If water taking volumes are greater than 50,000 L/day, a MECP water taking permit will be required. The permit can be registered as an Environmental Activity and Sector Registry (EASR) water taking permit if the water taking volumes are < 400,000 L/day per water taking source. If dewatering volumes are > 400,000 L/day per water taking source, a Permit to Take Water (PTTW) is required. Depending on the nature of the proposed water takings, an additional hydrogeological investigation may be required.

7.5 Infiltration Potential

As previously discussed, surficial soils within the study area generally consisted of topsoil overlying a silty clay deposit. Theoretical infiltration rates for silty clay soils generally range between <10 to 30 mm/hr. Infiltration testing may be required once additional development details become available.

As noted above, the results of the water budget analyses completed at the subject site indicated that 13,881,045 L/year of infiltration and 17,618,221 L/year of runoff are occurring under pre-development conditions. Under post development conditions, it is expected that there will be a 16.6% infiltration deficit and a 48.1% increase in runoff. While efforts may still be made to further limit the infiltration deficit expected as a result of the proposed development, it is Paterson's opinion that LIDs are not necessary as part of the overall stormwater management strategy. It should be noted that Paterson's water budget assessment is based on mean water budget values for the soil types at the subject site that were calculated by modeling conducted by EC-ECS. The EC-ECS model is calibrated to historical climate data and does not account for climate change predictions. Therefore, based on the National Capital Commission and City of Ottawa climate change predictions, the stormwater management design team could consider potential seasonal changes (longer spring and shorter winter) and increases in temperature and precipitation when developing their stormwater management strategy. Regarding the increase in runoff and alterations to the catchment areas, the Environmental Impact Assessment prepared by CIMA+ dated December 2023 did not identify any risks associated with post-development drainage.

Given that the minimal infiltration deficit under post-development conditions and that LIDs are not recommended, a post-development water budget target, implementation plan and monitoring recommendations are not required for this development. However, it is recommended that the stormwater management design team follow standard Best Management Practices related to stormwater management.

8.0 CLOSURE

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only, and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than 11034936 Canada Inc. or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Michael Laflamme, P.Geo.

Zavian Buchanan, EIT.

9.0 REFERENCES

Chapman, L.J., and Putnam, D. F. "The Physiography of Southern Ontario, Third Edition". Ontario Ministry of Natural Resources, 1984.

Freeze, R.A., and Cherry, J.A. "Groundwater". Prentice-Hall, Inc., 1979.

Ontario Geologic Survey Mapping - https://www.geologyontario.mndm.gov.on.ca/ogsearth.html

Ontario Regulation 387/04.

FIGURES

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

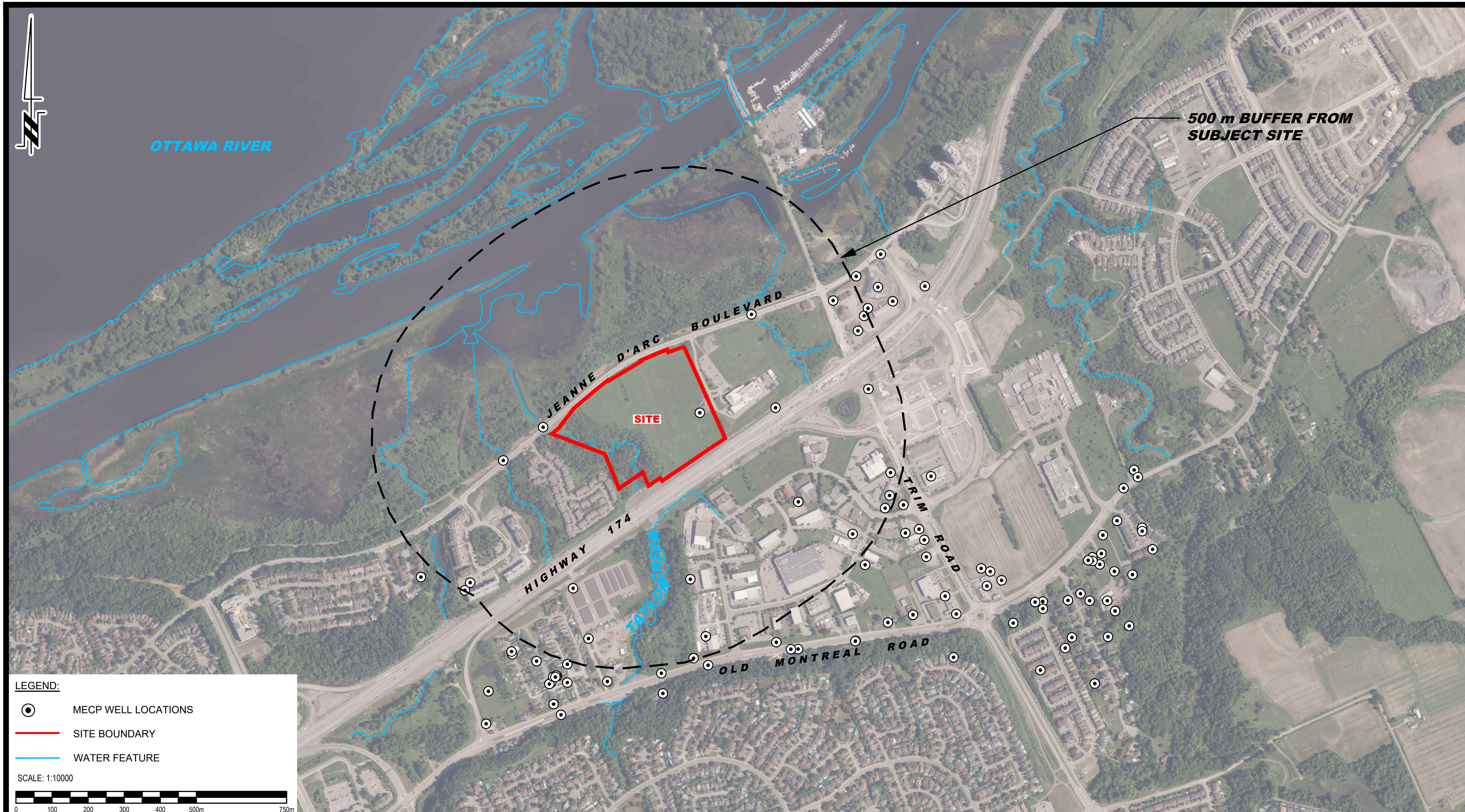
Title:

SITE PLAN

Scale: 1:2000	Date: 02/2024
Drawn by: ZS	Report No.: PH4866-REP.01
Checked by: OB	Dwg. No.: PH4866-1
Approved by: ML	Revision No.:

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-1-site plan.dwg

11x17



PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

MECP WATER WELL LOCATION PLAN

Scale: 1:10,000
Date: 02/2024
Drawn by: ZS
Report No.: PH4866-REP.01
Checked by: OB
Dwg. No.: PH4866-2
Approved by: ML
Revision No.:

11x17

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-2-mecp water well location plan.dwg

LEGEND:

- FINE-TEXTURED GLACIOMARINE DEPOSITS; SILT AND CLAY, MINOR SAND AND GRAVEL MASSIVE TO WELL LAMINATED
- MODERN ALLUVIAL DEPOSITS - CLAY, SILT, SAND, GRAVEL, MAY CONTAINS ORGANIC MATTER
- OLDER ALLUVIAL DEPOSITS - CLAY, SILT, SAND, GRAVEL, MAY CONTAIN ORGANIC REMAINS
- ORGANIC DEPOSITS - PEAT, MUCK, MARL
- COLLUVIAL DEPOSITS - BOULDERS, SCREE, TALUS, UNDIFFERENTIATED LANDSLIDE MATERIALS
- PALEOZOIC BEDROCK

SCALE: 1:7500

0 100 200 300 500m

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

SURFICIAL GEOLOGY PLAN

Scale: 1:7500	Date: 02/2024
Drawn by: ZS	Report No.: PH4866-REP.01
Checked by: OB	Dwg. No.: PH4866-3
Approved by: ML	Revision No.:

11x17

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-3-surficial geology plan.dwg

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

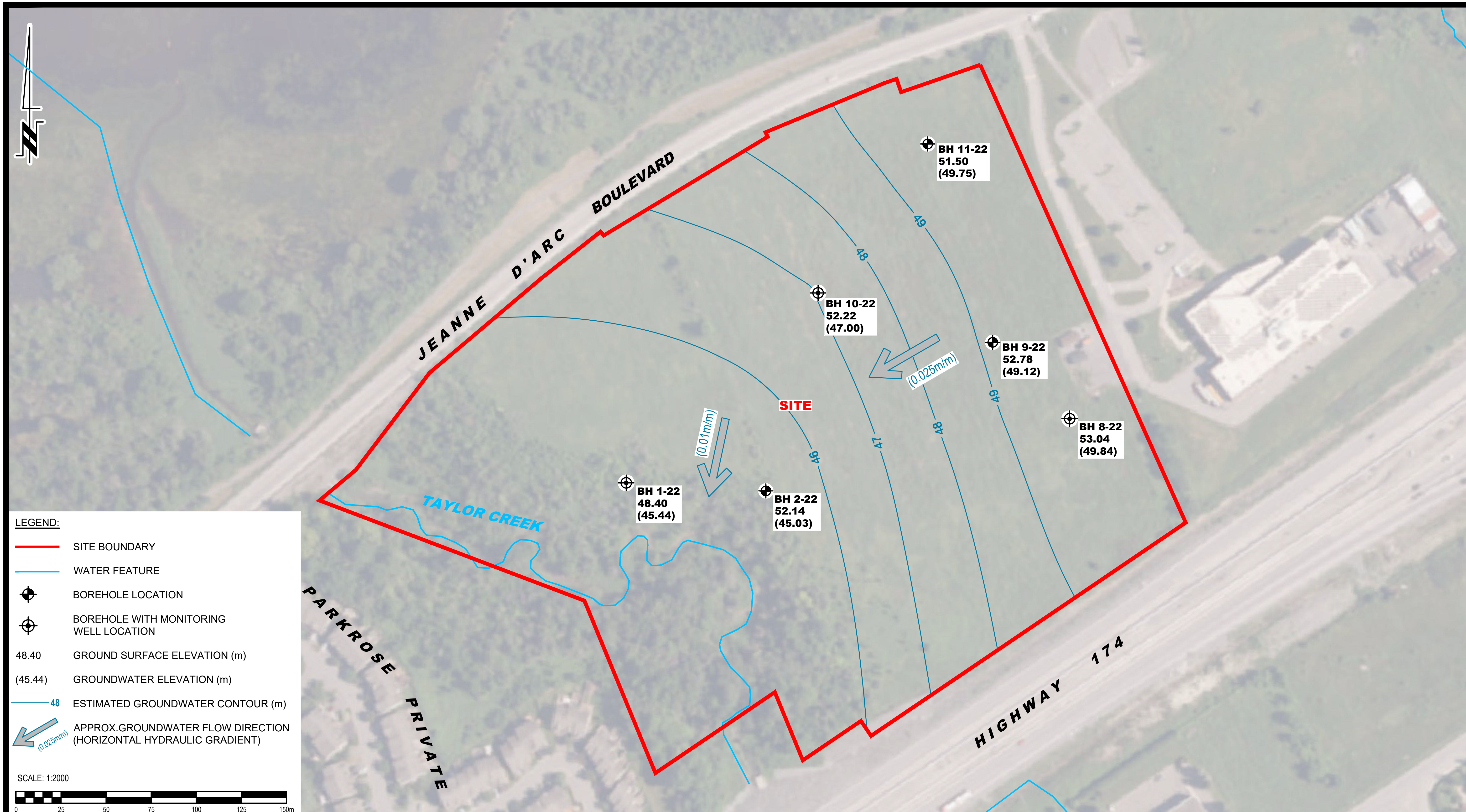
Title:

BEDROCK GEOLOGY PLAN

Scale: 1:7500	Date: 02/2024
Drawn by: ZS	Report No.: PH4866-REP.01
Checked by: OB	Dwg. No.: PH4866-4
Approved by: ML	Revision No.:

11x17

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-4-bedrock geology plan.dwg



PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

GROUNDWATER CONTOUR PLAN

Scale: 1:2000	Date: 02/2024
Drawn by: ZS	Report No.: PH4866-REP.01
Checked by: OB	Dwg. No.: PH4866-5
Approved by: ML	Revision No.:

11x17

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-5-gw contour plan.dwg

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

PRE-DEVELOPMENT TERRAIN COMPOSITION PLAN

Scale: 1:2000	Date: 02/2024
Drawn by: ZS	Report No.: PH4866-REP.01
Checked by: OB	Dwg. No.: PH4866-6
Approved by: ML	Revision No.:

11x17

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-6-pre-development terrain composition plan.dwg

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

11034936 CANADA INC.
HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL DEVELOPMENT
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:
POST-DEVELOPMENT TERRAIN COMPOSITION PLAN

Scale:	1:2000	Date:	02/2024
Drawn by:	ZS	Report No.:	PH4866-REP.01
Checked by:	OB	Dwg. No.:	PH4866-7
Approved by:	ML	Revision No.:	

p:\autocad drawings\hydrogeology\ph48xx\ph4866 - brigil - 8600 jeanne d'arc blvd\ph4866-7-post-development terrain composition plan.dwg

11x17

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

DRAWING PG6414-1 - TEST HOLE LOCATION PLAN

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

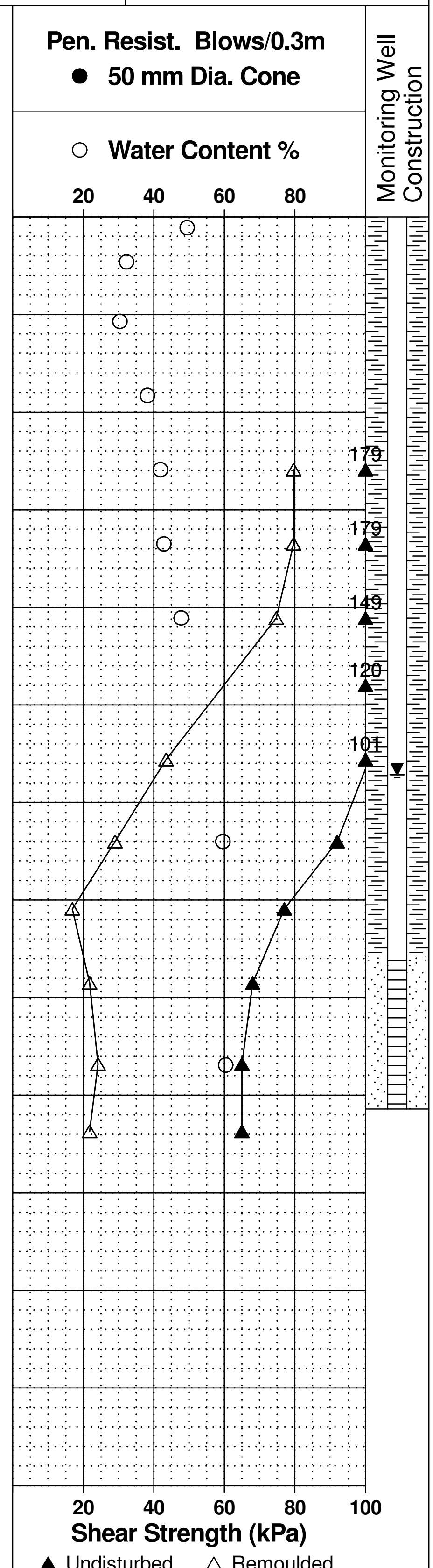
BORINGS BY CME-55 Low Clearance Drill **DATE** October 20, 2022

FILE NO. **PG6414**

HOLE NO. **BH 1-22**

SOIL DESCRIPTION	Layer base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.23	AU	1		
Hard to very stiff, brown **SILTY CLAY**	5.94	AU	2		
		SS	3	75	17
		SS	4	100	13
		SS	5	100	P
		SS	6	100	P
		SS	7	100	P
Stiff, grey **SILTY CLAY**	9.60	SS	8	100	P
		SS	9	100	P
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.					

DEPTH (m)	ELEV. (m)
0	51.16
1	50.16
2	49.16
3	48.16
4	47.16
5	46.16
6	45.16
7	44.16
8	43.16
9	42.16
10	41.16
11	40.16
12	39.16
13	38.16



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Monitoring Well Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						13	38.16		
						14	37.16		
						15	36.16		
						16	35.16		
						17	34.16		
						18	33.16		
						19	32.16		
						20	31.16		
						21	30.16		
						22	29.16		
						23	28.16		
						24	27.16		
						25	26.16		
						26	25.16		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

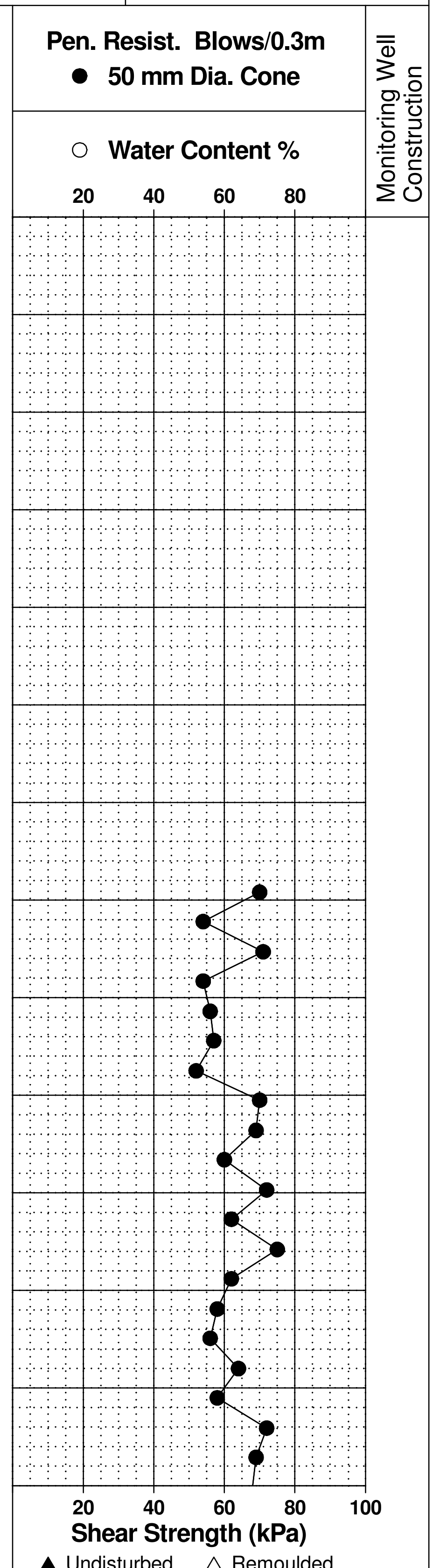
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						26	25.16
						27	24.16
						28	23.16
						29	22.16
						30	21.16
						31	20.16
						32	19.16
						33	18.16
						34	17.16
						35	16.16
						36	15.16
						37	14.16
						38	13.16
						39	12.16



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

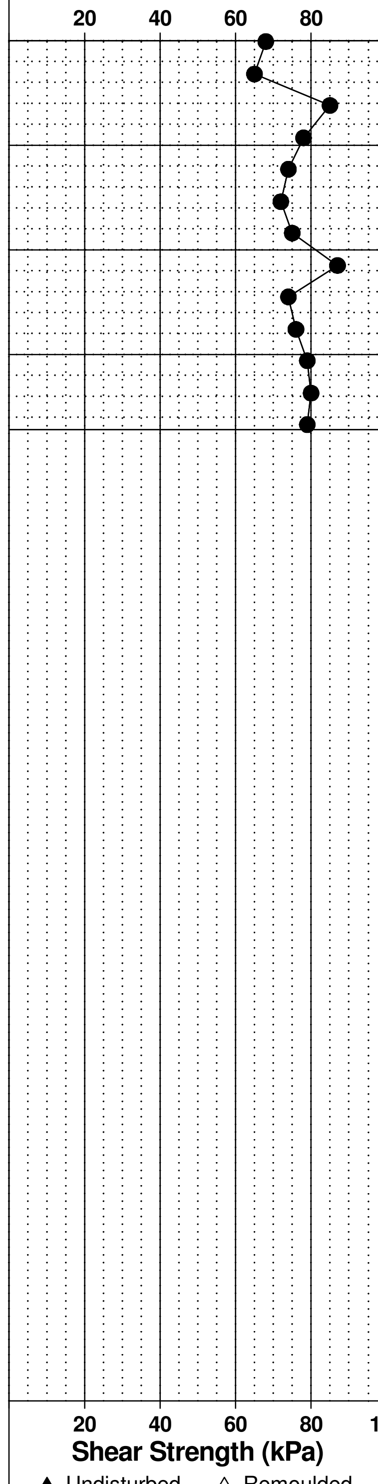
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 20, 2022

FILE NO. PG6414

HOLE NO. BH 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Monitoring Well Construction
GROUND SURFACE						39	12.16		
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.6m depth.						40	11.16		
						41	10.16		
42.72						42	9.16		
No DCPT refusal encountered by 42.72m depth, borehole terminated. (GWL @ 5.72m - Nov. 7, 2022)									



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

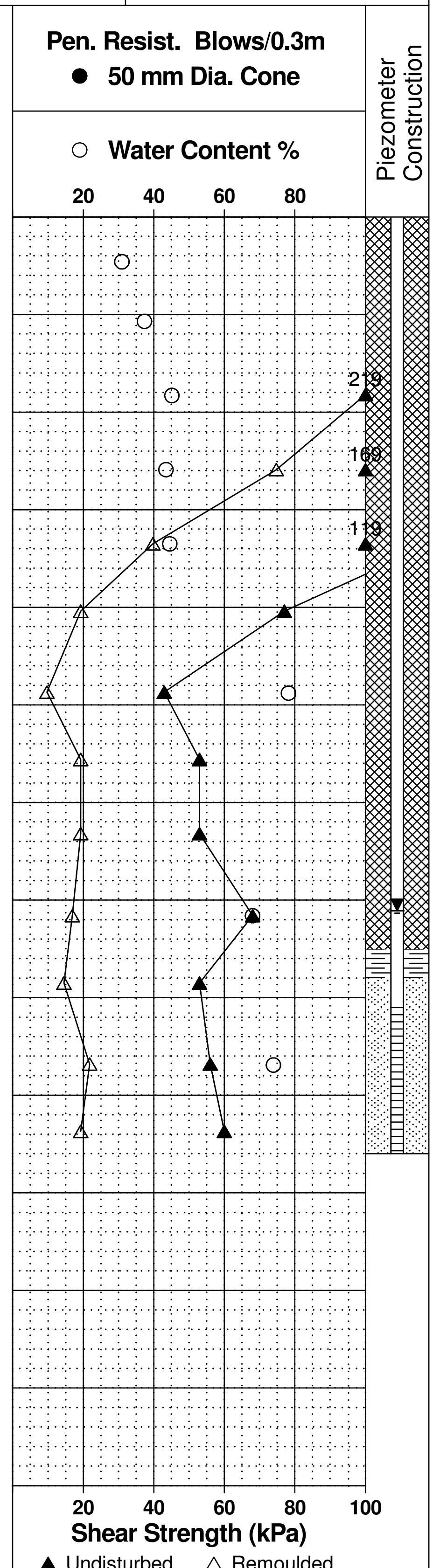
DATE October 20, 2022

FILE NO. **PG6414**

HOLE NO. **BH 2-22**

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.20				
Hard to stiff, brown **SILTY CLAY**	4.42	AU	1		
		SS	2	67	14
		SS	3	75	P
		SS	4	83	P
		SS	5	100	P
Stiff, grey **SILTY CLAY**	9.60	SS	6	100	P
		SS	7	100	P
		SS	8	100	P
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.					

DEPTH (m)	ELEV. (m)
0	52.14
1	51.14
2	50.14
3	49.14
4	48.14
5	47.14
6	46.14
7	45.14
8	44.14
9	43.14
10	42.14
11	41.14
12	40.14
13	39.14



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

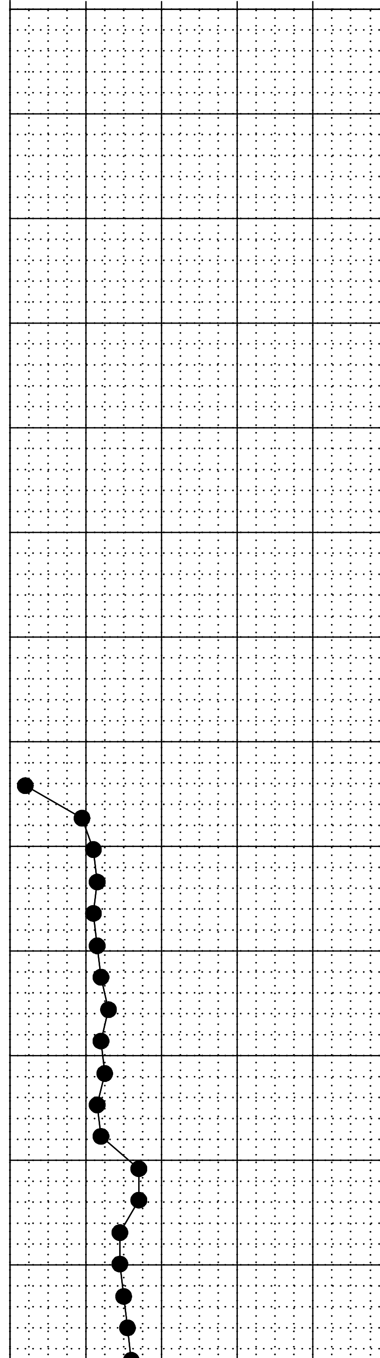
BORINGS BY CME-55 Low Clearance Drill

DATE October 20, 2022

FILE NO. PG6414

HOLE NO. BH 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE								20 40 60 80	
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.						13	39.14		
						14	38.14		
						15	37.14		
						16	36.14		
						17	35.14		
						18	34.14		
						19	33.14		
						20	32.14		
						21	31.14		
						22	30.14		
						23	29.14		
						24	28.14		
						25	27.14		
						26	26.14		



20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 20, 2022

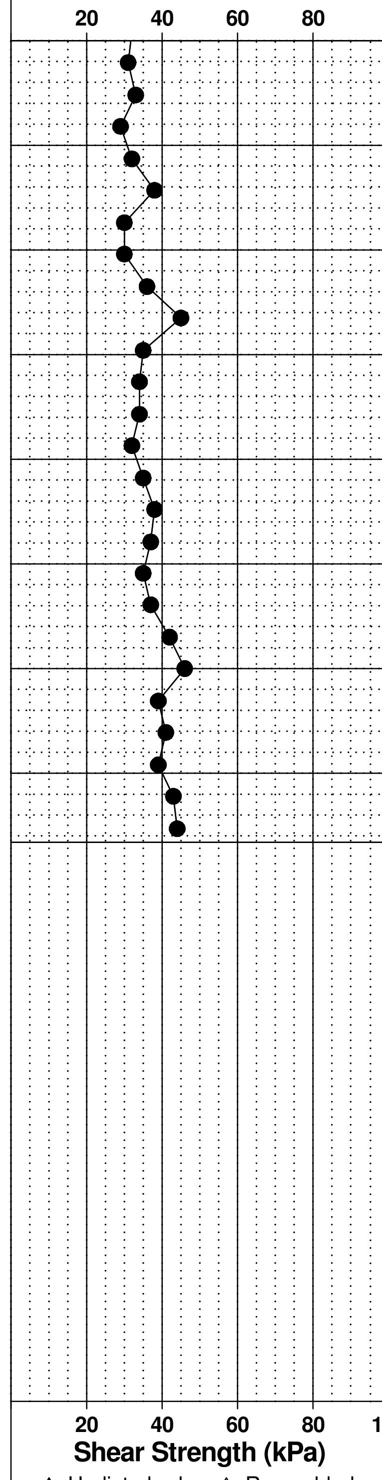
FILE NO. PG6414

HOLE NO. BH 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 20.1m depth.						26	26.14
						27	25.14
						28	24.14
						29	23.14
						30	22.14
						31	21.14
						32	20.14
						33	19.14
33.66							
No DCPT refusal encountered by 33.66m depth, borehole terminated. (GWL @ 7.11m - Nov. 7, 2022)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %



Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 3-22

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL (0.25)				
Hard to stiff, brown **SILTY CLAY**	AU	1		
	SS	2	67	15
	SS	3	67	9
	SS	4	100	P
(3.73)	SS	5	100	P
Firm to stiff, grey **SILTY CLAY**	SS	6	100	P
	SS	7	100	P
(9.60)	SS	8	100	P

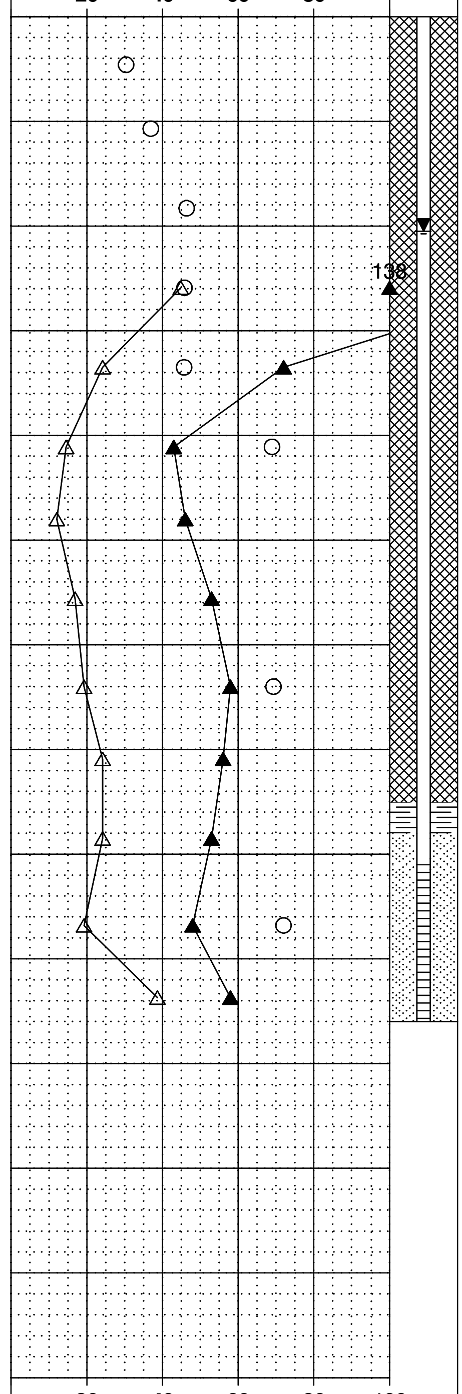
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.

DEPTH (m)	ELEV. (m)
0	52.67
1	51.67
2	50.67
3	49.67
4	48.67
5	47.67
6	46.67
7	45.67
8	44.67
9	43.67
10	42.67
11	41.67
12	40.67
13	39.67

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

Piezometer Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 21, 2022

FILE NO. PG6414

HOLE NO. BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE								20 40 60 80	
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.						13	39.67		
						14	38.67		
						15	37.67		
						16	36.67		
						17	35.67		
						18	34.67		
						19	33.67		
						20	32.67		
						21	31.67		
						22	30.67		
						23	29.67		
						24	28.67		
						25	27.67		
						26	26.67		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

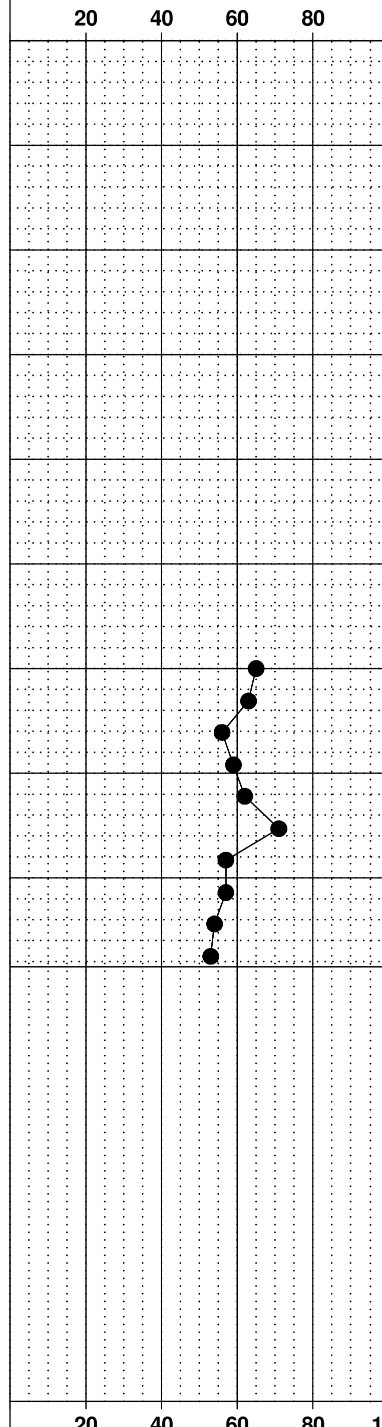
BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 31.7m depth.						26	26.67		
						27	25.67		
						28	24.67		
						29	23.67		
						30	22.67		
						31	21.67		
						32	20.67		
						33	19.67		
						34	18.67		
34.85									
No DCPT refusal encountered by 34.85m depth, borehole terminated. (GWL @ 2.05m - Nov. 7, 2022)									



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

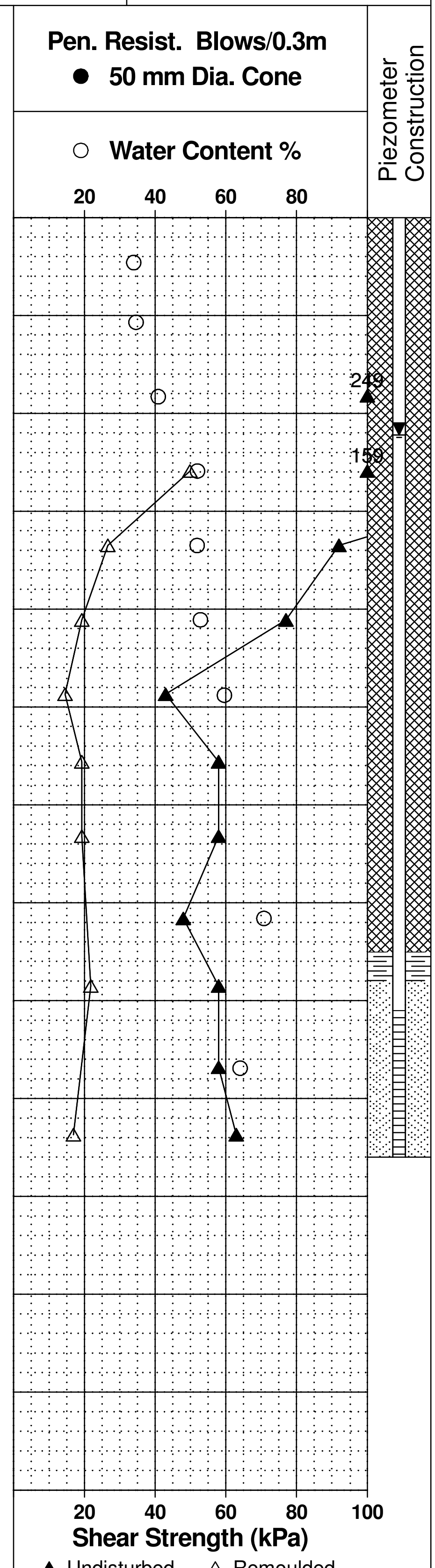
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 21, 2022

FILE NO. PG6414

HOLE NO. BH 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	51.32
TOPSOIL 0.18		AU	1				
Hard to stiff, brown **SILTY CLAY**		SS	2	83	18	1	50.32
		SS	3	83	P	2	49.32
		SS	4	67	P	3	48.32
		SS	5	67	P		
4.50		SS	6	75	P	4	47.32
Firm to stiff, grey **SILTY CLAY**		SS	7	50	P	5	46.32
						6	45.32
		SS	8	92	P	7	44.32
						8	43.32
9.60		SS	9	67	P	9	42.32
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.						10	41.32
						11	40.32
						12	39.32
						13	38.32



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.						13	38.32		
						14	37.32		
						15	36.32		
						16	35.32		
						17	34.32		
						18	33.32		
						19	32.32		
						20	31.32		
						21	30.32		
						22	29.32		
						23	28.32		
						24	27.32		
						25	26.32		
						26	25.32		

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

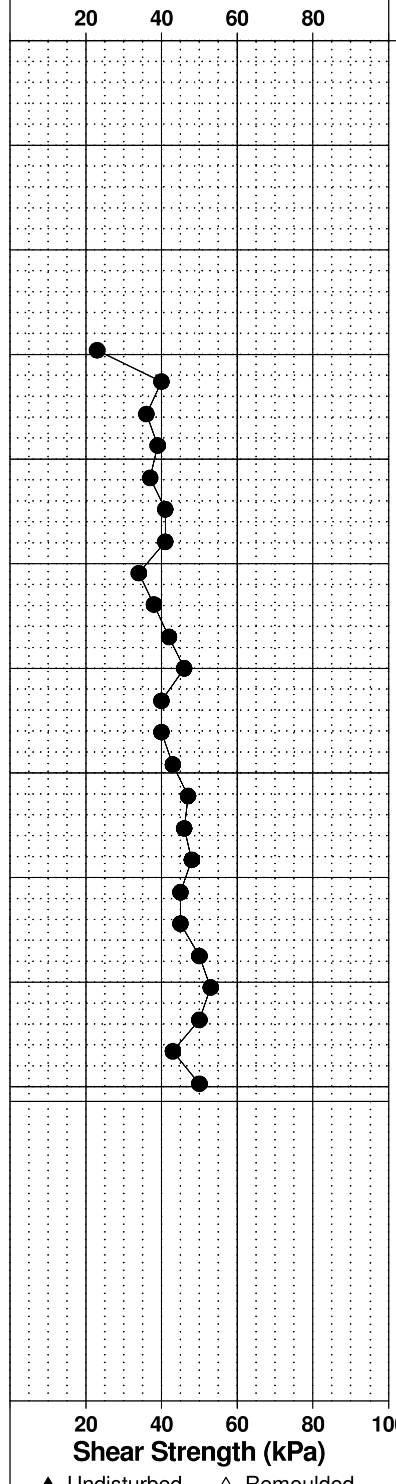
BORINGS BY CME-55 Low Clearance Drill

DATE October 21, 2022

FILE NO. PG6414

HOLE NO. BH 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 28.9m depth.						26	25.32		
						27	24.32		
						28	23.32		
						29	22.32		
						30	21.32		
						31	20.32		
						32	19.32		
						33	18.32		
						34	17.32		
						35	16.32		
36.14						36	15.32		
No DCPT refusal encountered by 36.14m depth, borehole terminated. (GWL @ 2.22m - Nov. 7, 2022)									



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

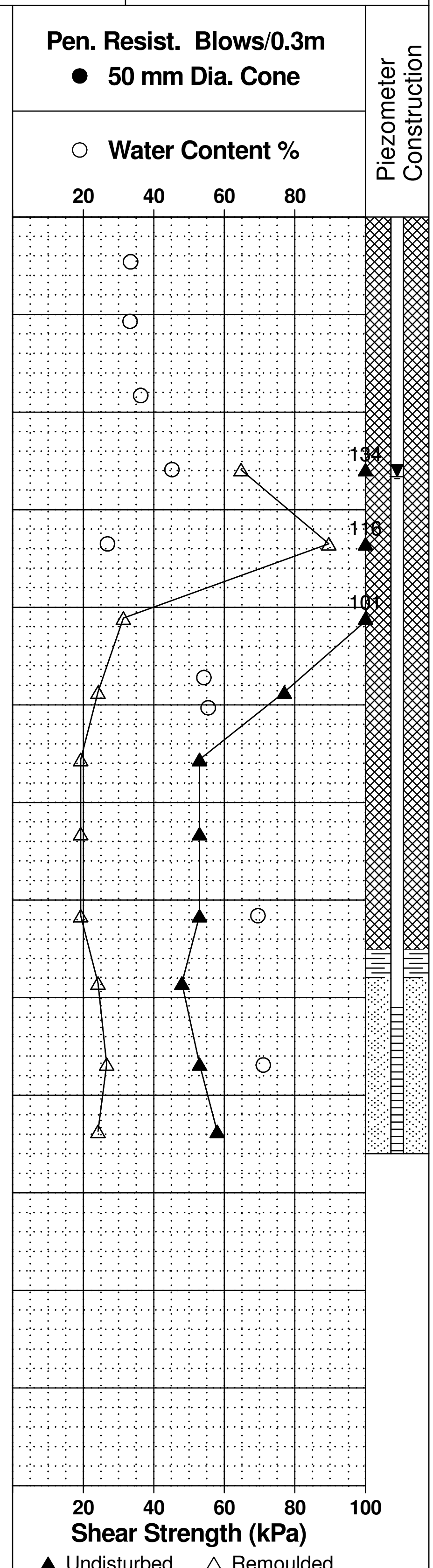
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	51.18
TOPSOIL (to 0.20)							
Hard to stiff, brown **SILTY CLAY** (0.20 to 4.88)		AU	1				
		SS	2	75	18	1	50.18
		SS	3	83	16	2	49.18
		SS	4	83	P		
		SS	5	75	P	3	48.18
		SS	6	0	P	4	47.18
Stiff, grey **SILTY CLAY** (4.88 to 9.60)		SS	7	100	P	5	46.18
						6	45.18
		SS	8		P	7	44.18
						8	43.18
		SS	9		P	9	42.18
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth. (from 9.60)						10	41.18
						11	40.18
						12	39.18
						13	38.18



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth.						13	38.18		
						14	37.18		
						15	36.18		
						16	35.18		
						17	34.18		
						18	33.18		
						19	32.18		
						20	31.18		
						21	30.18		
						22	29.18		
						23	28.18		
						24	27.18		
						25	26.18		
						26	25.18		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

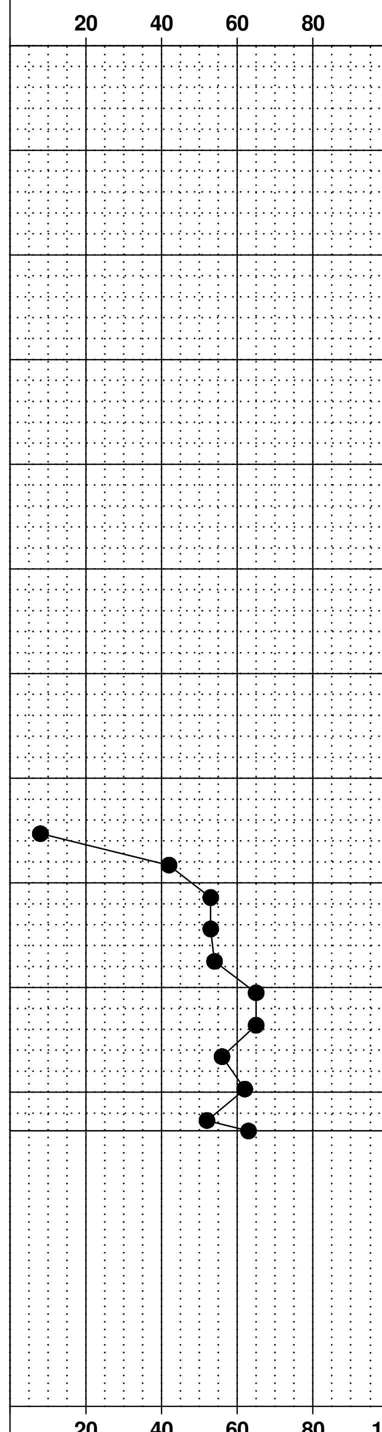
DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 5-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.3m depth.						26	25.18
						27	24.18
						28	23.18
						29	22.18
						30	21.18
						31	20.18
						32	19.18
						33	18.18
						34	17.18
						35	16.18
36.37						36	15.18
No DCPT refusal encountered by 36.37m depth, borehole terminated. (GWL @ 2.66m - Nov. 7, 2022)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

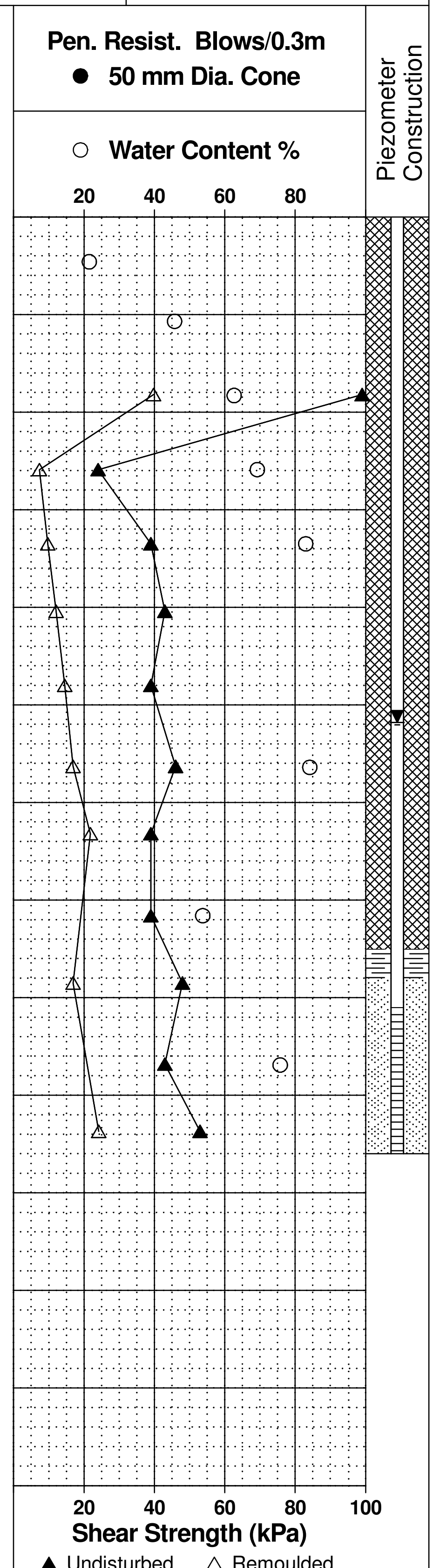
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	Strata depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.46
TOPSOIL	0.20						
Very stiff to stiff, brown **SILTY CLAY**		AU	1				
		SS	2	100	7	1	52.46
	2.29	SS	3	67	P	2	51.46
Soft to firm, grey **SILTY CLAY**		SS	4	83	P		
		SS	5	100	P	3	50.46
						4	49.46
						5	48.46
		SS	6	100	P	6	47.46
		SS	7	100	P	7	46.46
						8	45.46
- stiff by 9.1m depth	9.60	SS	8	100	P	9	44.46
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						10	43.46
						11	42.46
						12	41.46
						13	40.46



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE								20 40 60 80	
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						13	40.46		
						14	39.46		
						15	38.46		
						16	37.46		
						17	36.46		
						18	35.46		
						19	34.46		
						20	33.46		
						21	32.46		
						22	31.46		
						23	30.46		
						24	29.46		
						25	28.46		
						26	27.46		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

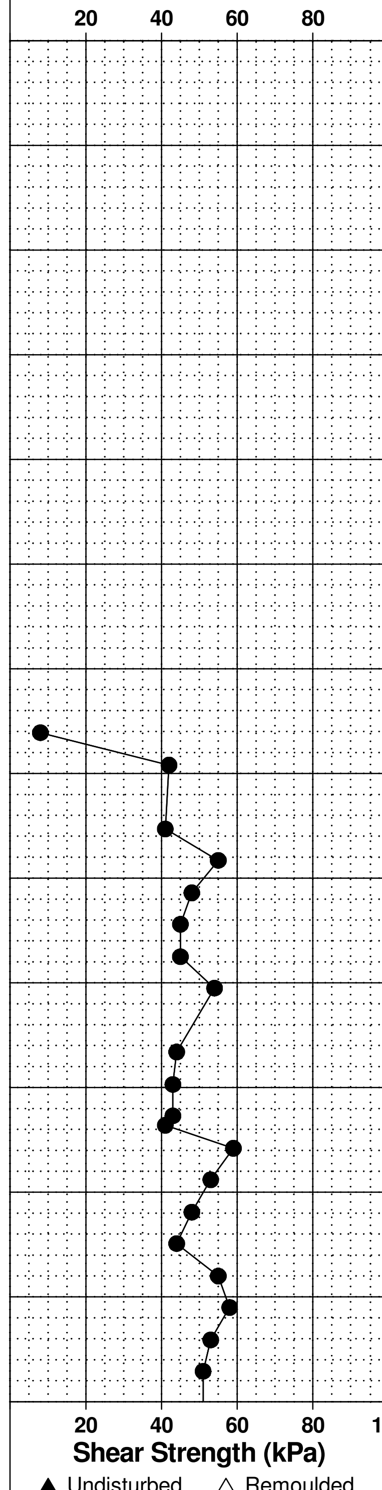
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						26	27.46		
						27	26.46		
						28	25.46		
						29	24.46		
						30	23.46		
						31	22.46		
						32	21.46		
						33	20.46		
						34	19.46		
						35	18.46		
						36	17.46		
						37	16.46		
						38	15.46		
						39	14.46		



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

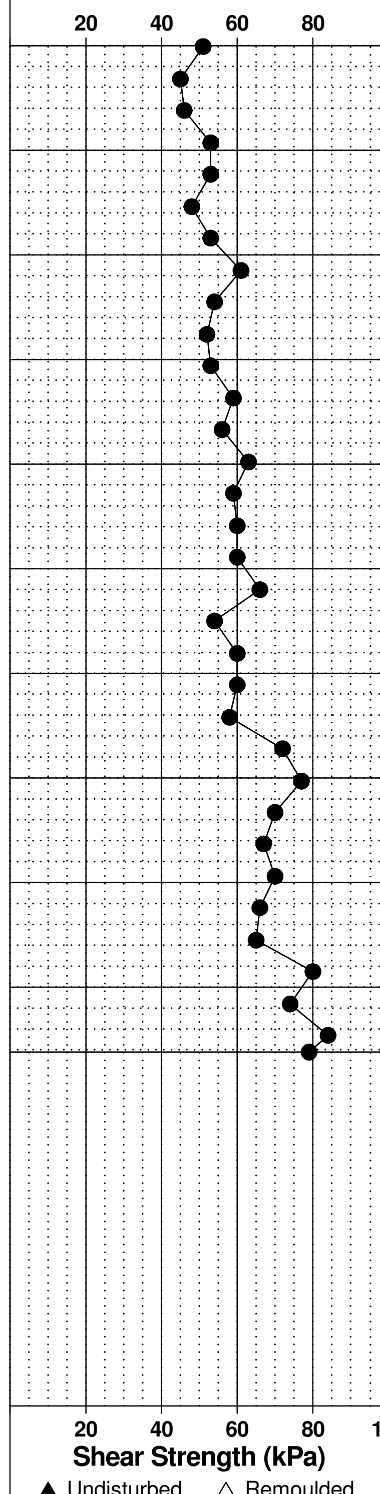
BORINGS BY CME-55 Low Clearance Drill

DATE October 24, 2022

FILE NO. PG6414

HOLE NO. BH 6-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE: TYPE	SAMPLE: NUMBER	SAMPLE: % RECOVERY	SAMPLE: N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 32.3m depth.						39	14.46		
						40	13.46		
						41	12.46		
						42	11.46		
						43	10.46		
						44	9.46		
						45	8.46		
						46	7.46		
						47	6.46		
						48	5.46		
48.62									
No DCPT refusal encountered by 48.62m depth, borehole terminated. (GWL @ 5.18m - Nov. 7, 2022)									



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

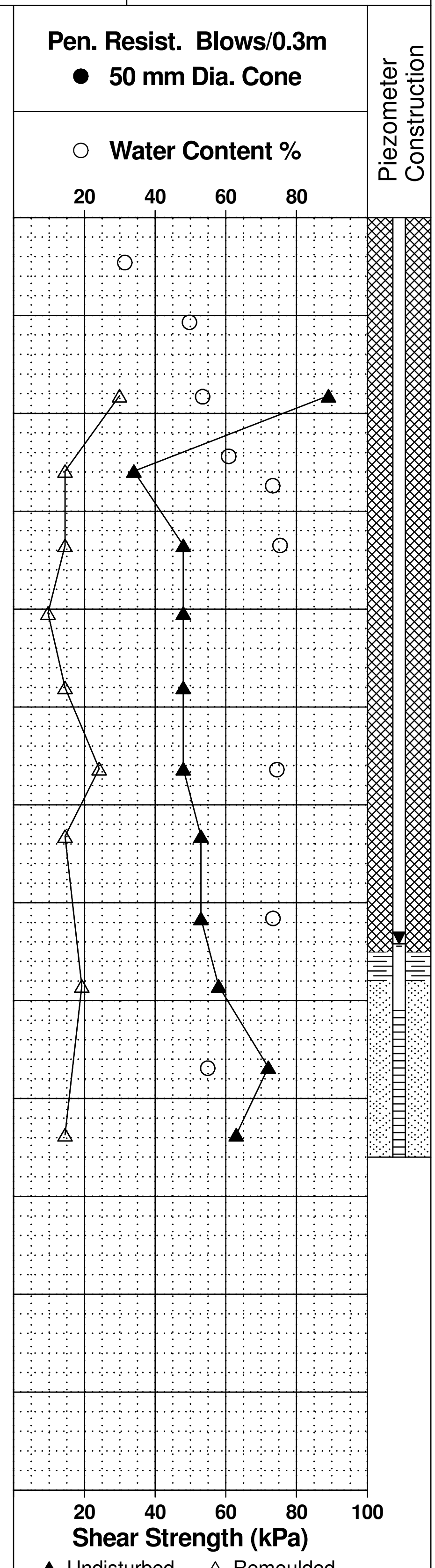
BORINGS BY CME-55 Low Clearance Drill **DATE** October 25, 2022

FILE NO. PG6414

HOLE NO. BH 7-22

SOIL DESCRIPTION	Strata depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.15				
Hard to stiff, brown **SILTY CLAY**		AU	1		
		SS	2	67	6
		SS	3	75	P
	2.67	SS	4	83	P
Firm to stiff, grey **SILTY CLAY**		SS	5	83	P
		SS	6	100	P
		SS	7	100	P
	9.60	SS	8	100	P
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.					

DEPTH (m)	ELEV. (m)
0	53.33
1	52.33
2	51.33
3	50.33
4	49.33
5	48.33
6	47.33
7	46.33
8	45.33
9	44.33
10	43.33
11	42.33
12	41.33
13	40.33



patersongroup Consulting Engineers 9 Auriga Drive, Ottawa, Ontario K2E 7T9	SOIL PROFILE AND TEST DATA Geotechnical Investigation Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd. Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20, 40, 60, 80)	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.						13	40.33		
						14	39.33		
						15	38.33		
						16	37.33		
						17	36.33		
						18	35.33		
						19	34.33		
						20	33.33		
						21	32.33		
						22	31.33		
						23	30.33		
						24	29.33		
						25	28.33		
						26	27.33		

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

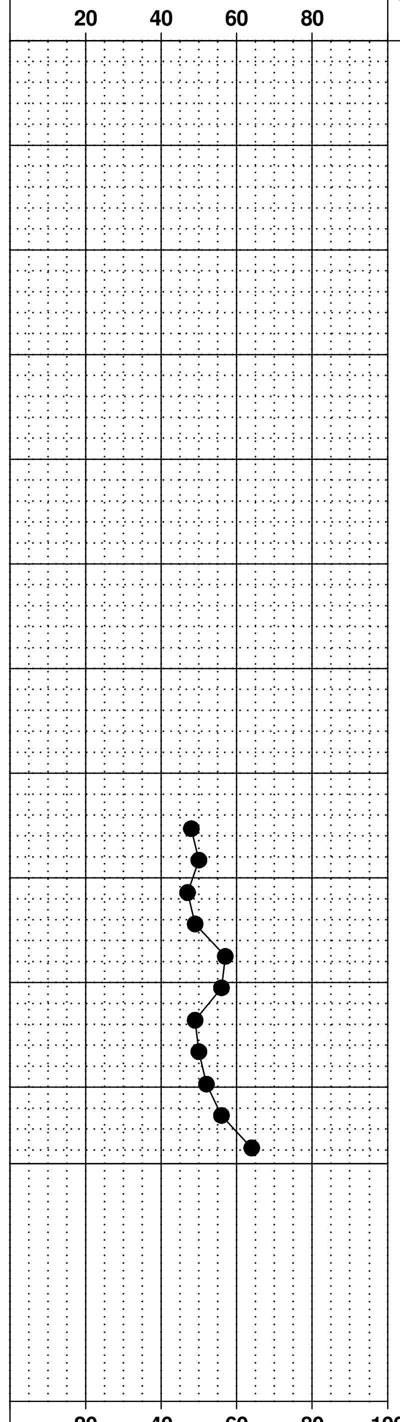
FILE NO. PG6414

HOLE NO. BH 7-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 33.2m depth.						26	27.33
						27	26.33
						28	25.33
						29	24.33
						30	23.33
						31	22.33
						32	21.33
						33	20.33
						34	19.33
						35	18.33
						36	17.33
36.73							
No DCPT refusal encountered by 36.73m depth, borehole terminated. (GWL @ 7.42m - Nov. 7, 2022)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

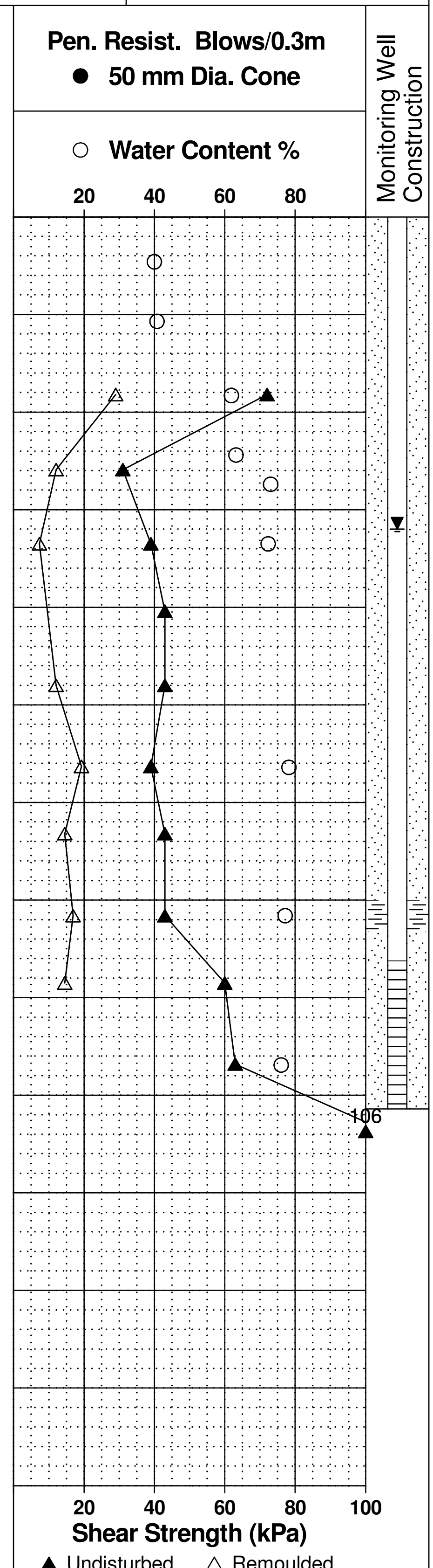
BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.04
TOPSOIL	0.13						
		AU	1				
Hard to stiff, brown **SILTY CLAY**		SS	2		8	1	52.04
		SS	3	83	P	2	51.04
	2.51	SS	4	83	P		
Firm to stiff, grey **SILTY CLAY**		SS	5	100	P	3	50.04
						4	49.04
						5	48.04
		SS	6	100	P	6	47.04
		SS	7	67	P	7	46.04
		SS	8		P	8	45.04
	9.60					9	44.04
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.						10	43.04
						11	42.04
						12	41.04
						13	40.04



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Monitoring Well Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.						13	40.04		
						14	39.04		
						15	38.04		
						16	37.04		
						17	36.04		
						18	35.04		
						19	34.04		
						20	33.04		
						21	32.04		
						22	31.04		
						23	30.04		
						24	29.04		
						25	28.04		
						26	27.04		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

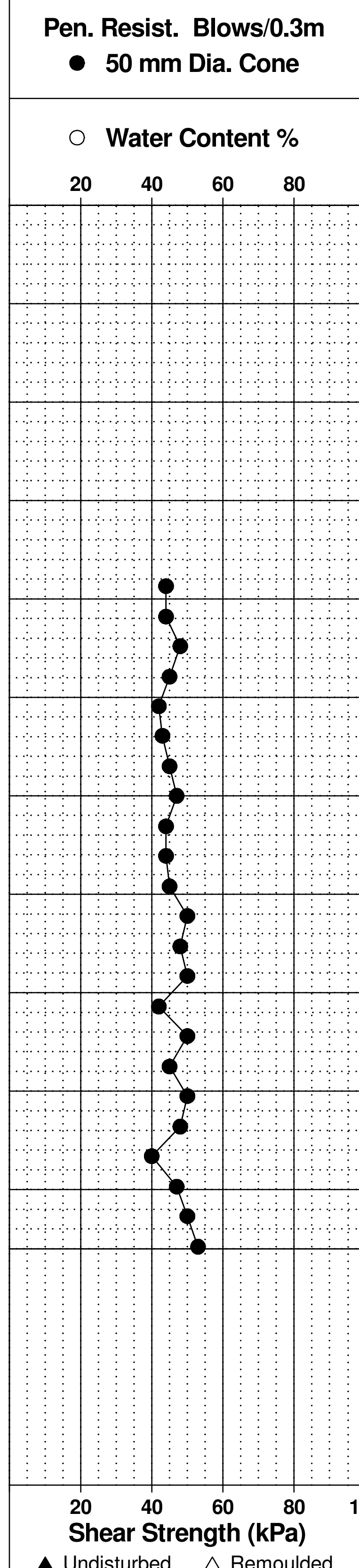
REMARKS

BORINGS BY CME-55 Low Clearance Drill **DATE** October 25, 2022

FILE NO. PG6414

HOLE NO. BH 8-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.6m depth.						26	27.04
						27	26.04
						28	25.04
						29	24.04
						30	23.04
						31	22.04
						32	21.04
						33	20.04
						34	19.04
						35	18.04
						36	17.04
36.60							
No DCPT refusal encountered by 36.60m depth, borehole terminated. (GWL @ 3.20m - Nov. 7, 2022)							



Monitoring Well Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

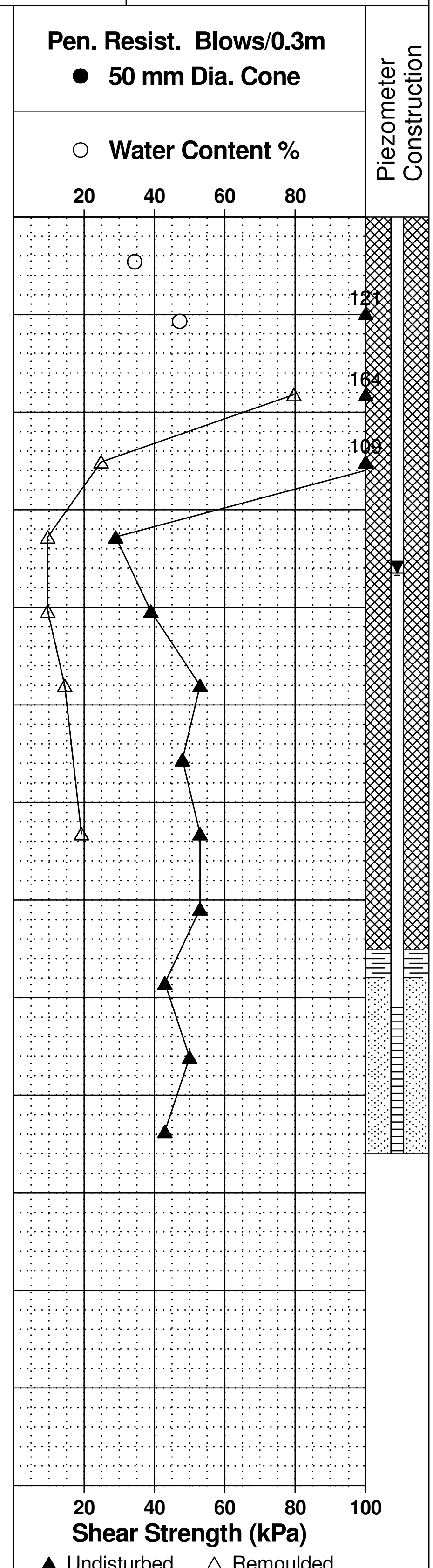
BORINGS BY CME-55 Low Clearance Drill **DATE** October 26, 2022

FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.13				
Hard to very stiff, brown **SILTY CLAY**	2.97	AU	1		
		SS	2	67	P
Firm to stiff, grey **SILTY CLAY**	9.60				
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.					

DEPTH (m)	ELEV. (m)
0	52.77
1	51.77
2	50.77
3	49.77
4	48.77
5	47.77
6	46.77
7	45.77
8	44.77
9	43.77
10	42.77
11	41.77
12	40.77
13	39.77



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						13	39.77		
						14	38.77		
						15	37.77		
						16	36.77		
						17	35.77		
						18	34.77		
						19	33.77		
						20	32.77		
						21	31.77		
						22	30.77		
						23	29.77		
						24	28.77		
						25	27.77		
						26	26.77		

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

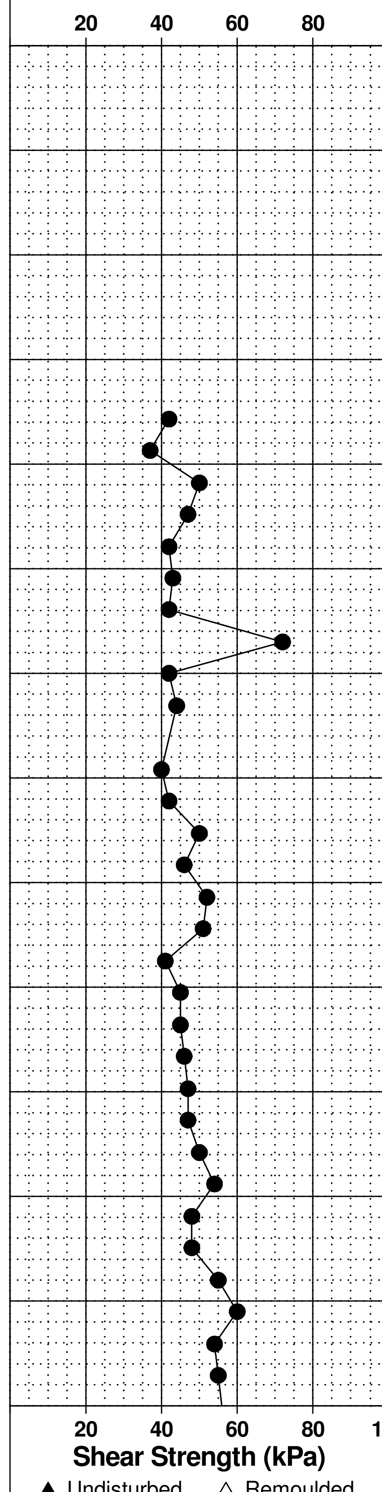
BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						26	26.77		
						27	25.77		
						28	24.77		
						29	23.77		
						30	22.77		
						31	21.77		
						32	20.77		
						33	19.77		
						34	18.77		
						35	17.77		
						36	16.77		
						37	15.77		
						38	14.77		
						39	13.77		



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

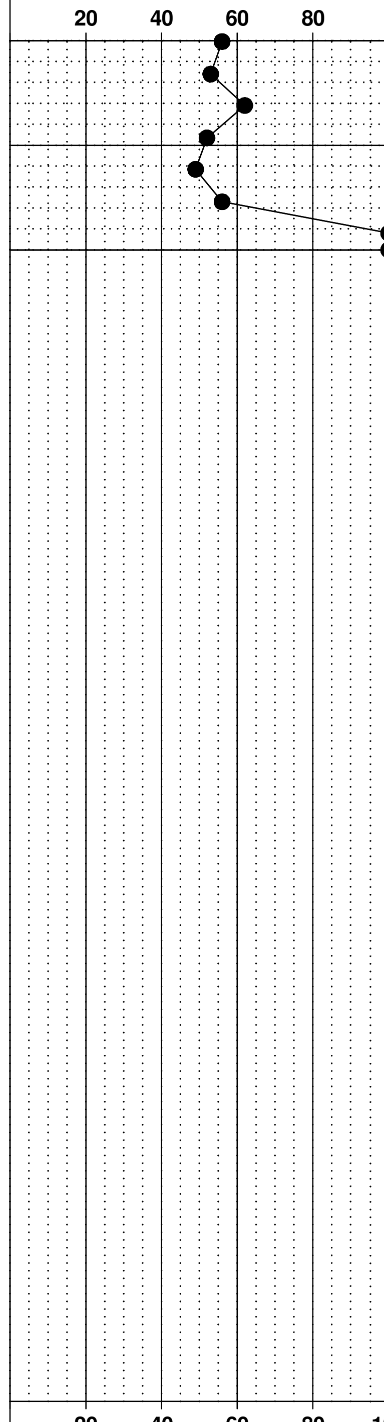
FILE NO. PG6414

HOLE NO. BH 9-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 9.60m depth. Cone pushed to 29.3m depth.						39	13.77
						40	12.77
41.00						41	11.77
End of Borehole Practical DCPT refusal at 41.00m depth. (GWL @ 3.65m - Nov. 7, 2022)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %



Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

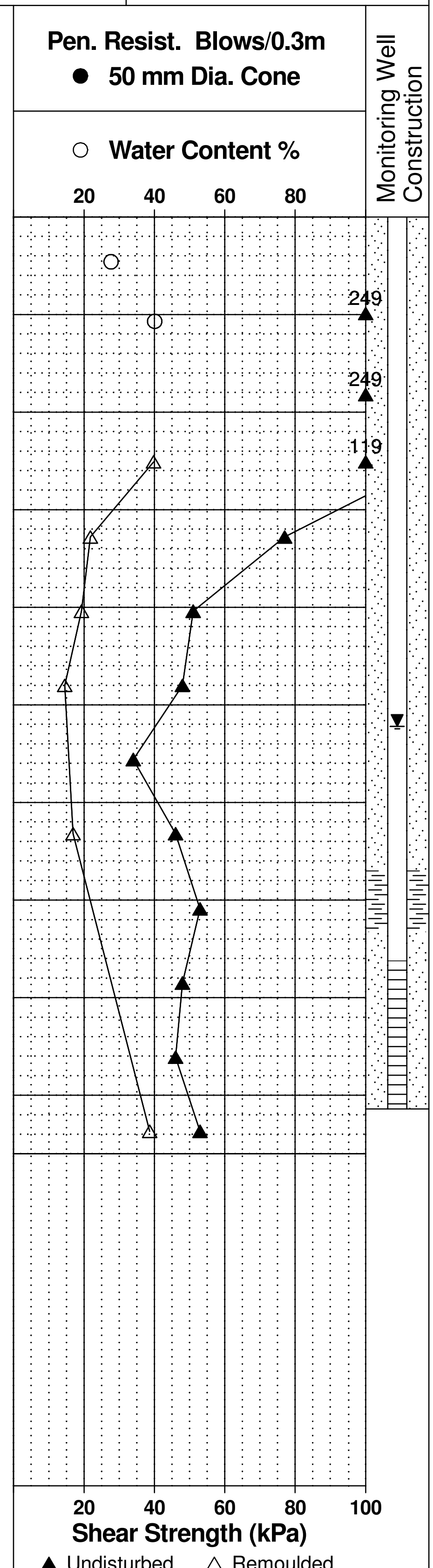
BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH10-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	52.22
TOPSOIL 0.18		AU	1				
Hard to stiff, brown **SILTY CLAY**						1	51.22
		SS	2	67	P	2	50.22
3.66						3	49.22
Stiff to firm, grey **SILTY CLAY**						4	48.22
						5	47.22
						6	46.22
						7	45.22
						8	44.22
9.60						9	43.22
End of Borehole							
(GWL @ 5.22m - Nov. 7, 2022)							



patersongroup Consulting Engineers

9 Auriga Drive, Ottawa, Ontario K2E 7T9

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Multi-Storey Buildings - 8600 Jeanne D'Arc Blvd.
Ottawa, Ontario

DATUM Geodetic

REMARKS

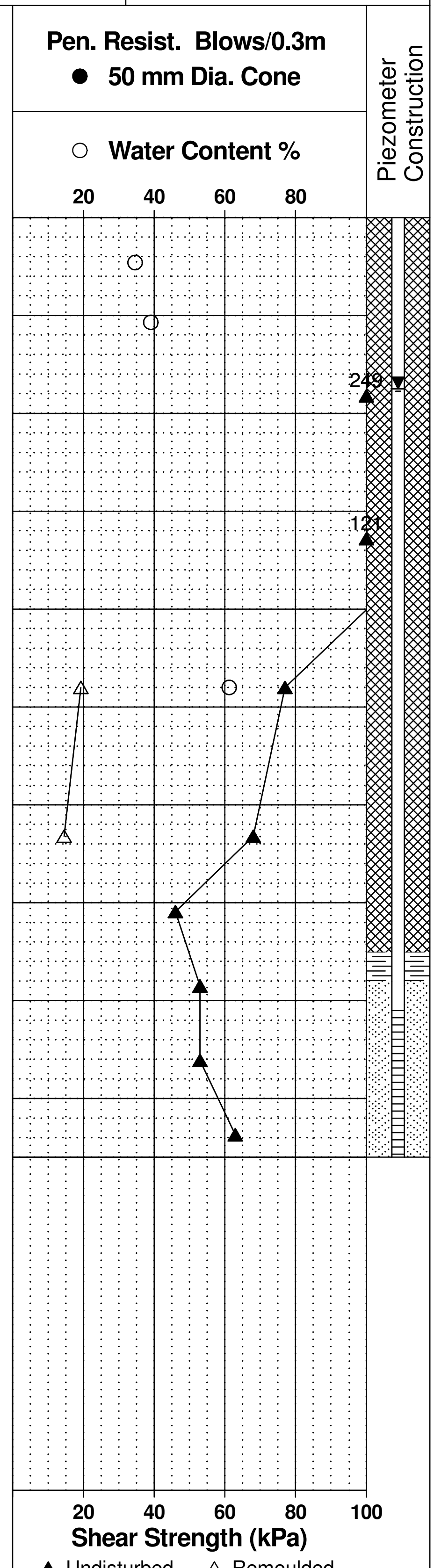
BORINGS BY CME-55 Low Clearance Drill

DATE October 26, 2022

FILE NO. PG6414

HOLE NO. BH11-22

SOIL DESCRIPTION	Strata depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	51.50
TOPSOIL	0.18	AU	1				
Hard to stiff, brown **SILTY CLAY**						1	50.50
		SS	2	75	P	2	49.50
						3	48.50
						4	47.50
	5.18	G	3			5	46.50
Firm to stiff, grey **SILTY CLAY**						6	45.50
						7	44.50
						8	43.50
	9.60					9	42.50
End of Borehole							
(GWL @ 1.75m - Nov. 7, 2022)							



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

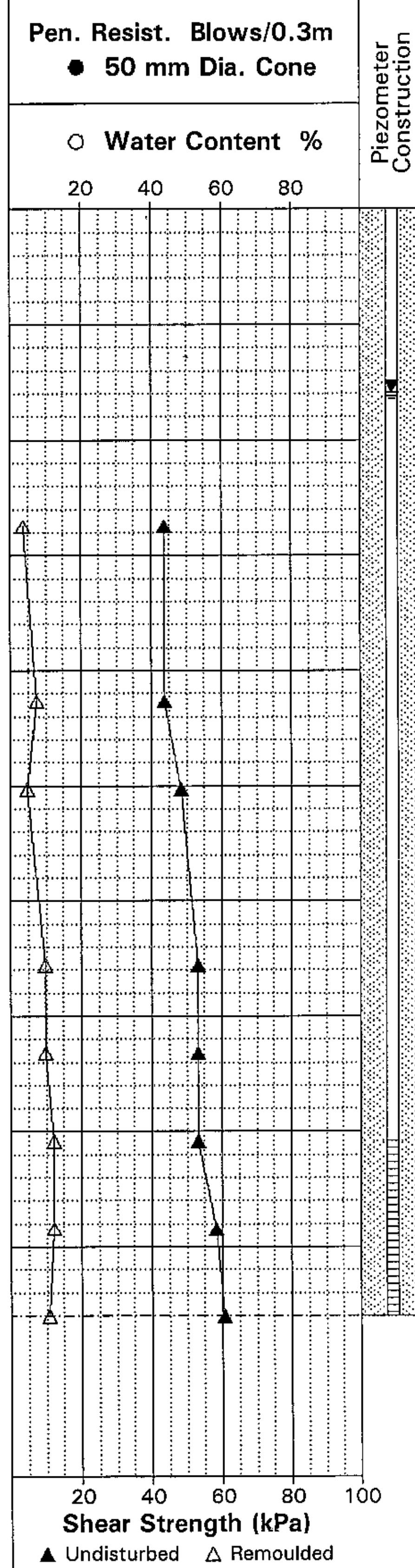
FILE NO. PG1565

REMARKS

HOLE NO. BH 1

BORINGS BY CME 55 Power Auger **DATE** 8 NOV 07

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.07
TOPSOIL	0.13						
Brown SILTY CLAY with organic matter	0.46	AU	1				
Stiff to firm, brown SILTY CLAY, some sand seams		SS	2	75	11	1	52.07
		SS	3	100	5	2	51.07
- grey by 2.3m depth						3	50.07
		TW	4	67		4	49.07
						5	48.07
- stiff by 5.6m depth		TW	5	96		6	47.07
						7	46.07
						8	45.07
						9	44.07
End of Borehole	9.60						
(GWL @ 1.59m-Nov. 13/07)							



patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

REMARKS

BORINGS BY CME 55 Power Auger

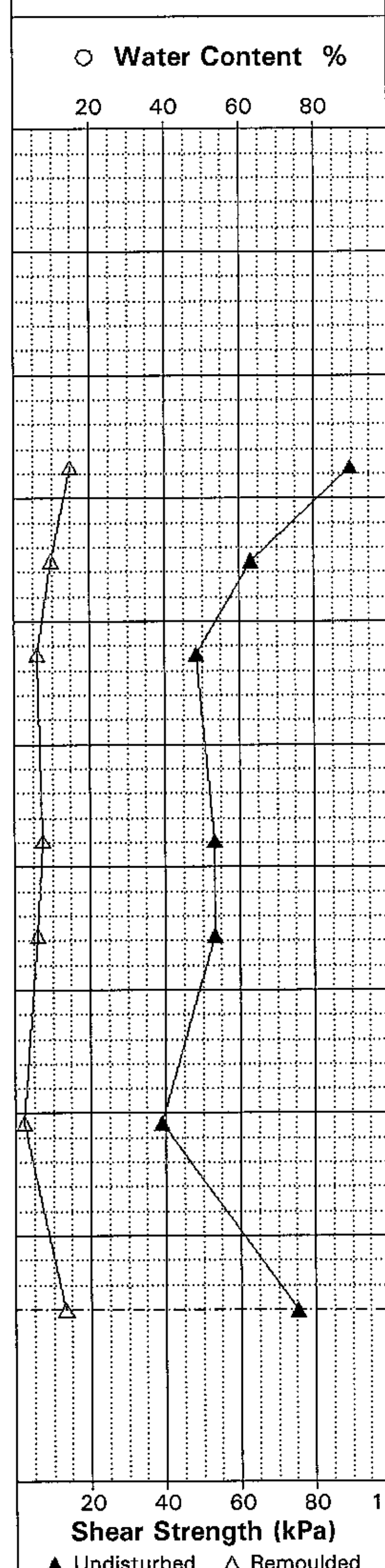
DATE 8 NOV 07

FILE NO. PG1565

HOLE NO. BH 2

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.10				
Brown SILTY CLAY with organic matter	0.46	AU	1		
Very stiff to stiff, brown SILTY CLAY		SS	2	75	14
		SS	3	100	9
- grey by 3.0m depth		TW	4	88	
		TW	5	98	
	9.60	TW	6	100	
End of Borehole					
(GWL @ 2.70m-Nov. 13/07)					

DEPTH (m)	ELEV. (m)
0	52.31
1	51.31
2	50.31
3	49.31
4	48.31
5	47.31
6	46.31
7	45.31
8	44.31
9	43.31



Piezometer Construction

patersongroup Consulting Engineers

28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Prop. Residential Subdivision, North Service Road
Ottawa, Ontario

DATUM Ground surface elevations provided by McIntosh Perry Surveying Inc.

REMARKS

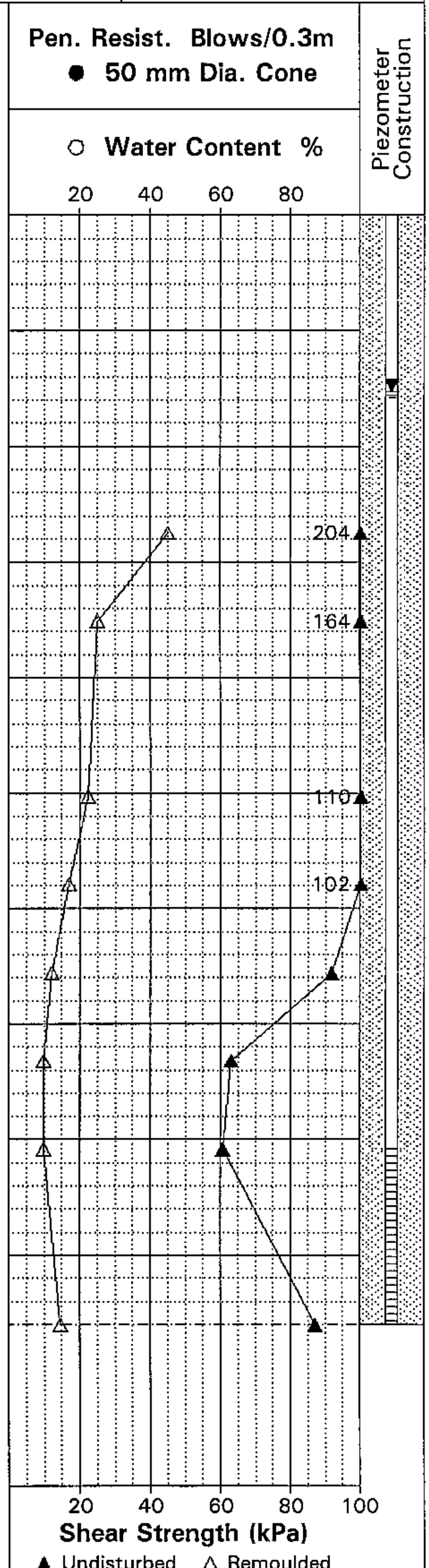
BORINGS BY CME 55 Power Auger DATE 8 NOV 07

FILE NO. **PG1565**

HOLE NO. **BH 3**

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	49.65
TOPSOIL 0.10	AU	1				
	SS	2	100	17	1	48.65
	SS	3	100	16		
					2	47.65
					3	46.65
Hard to very stiff, brown **SILTY CLAY**						
	SS	4	58	11	4	45.65
- very stiff to stiff and grey by 5.0m depth					5	44.65
					6	43.65
					7	42.65
					8	41.65
	TW	5	92			
					9	40.65
9.60 End of Borehole						

(GWL @ 1.53m-Nov. 13/07)



SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

Relative Density	'N' Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

The standard terminology to describe the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their “sensitivity”. The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called “mechanical breaks”) are easily distinguishable from the normal in situ fractures.

RQD %	ROCK QUALITY
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu	-	Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

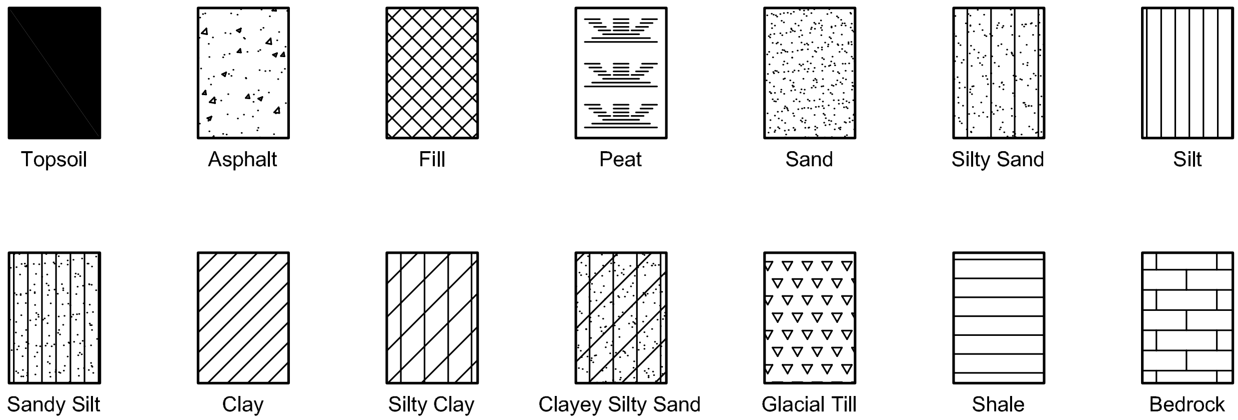
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

k	-	Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

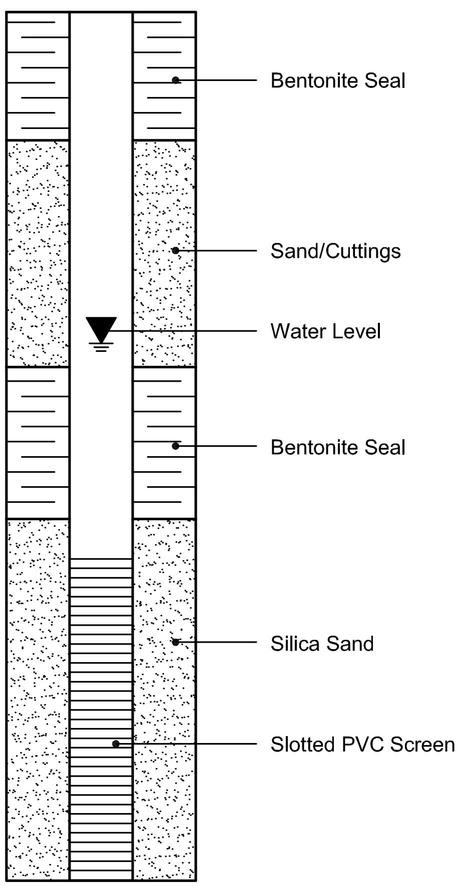
SYMBOLS AND TERMS (continued)

STRATA PLOT

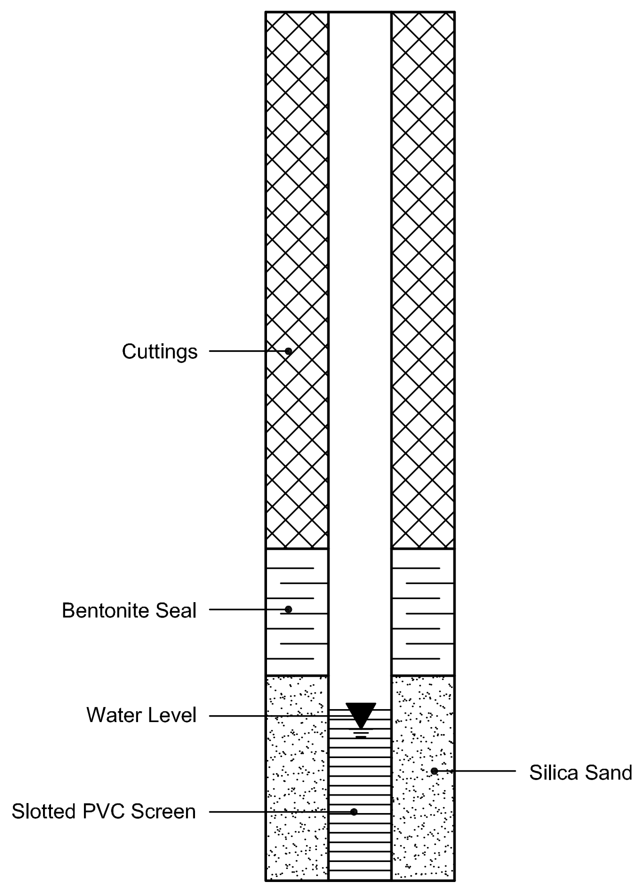


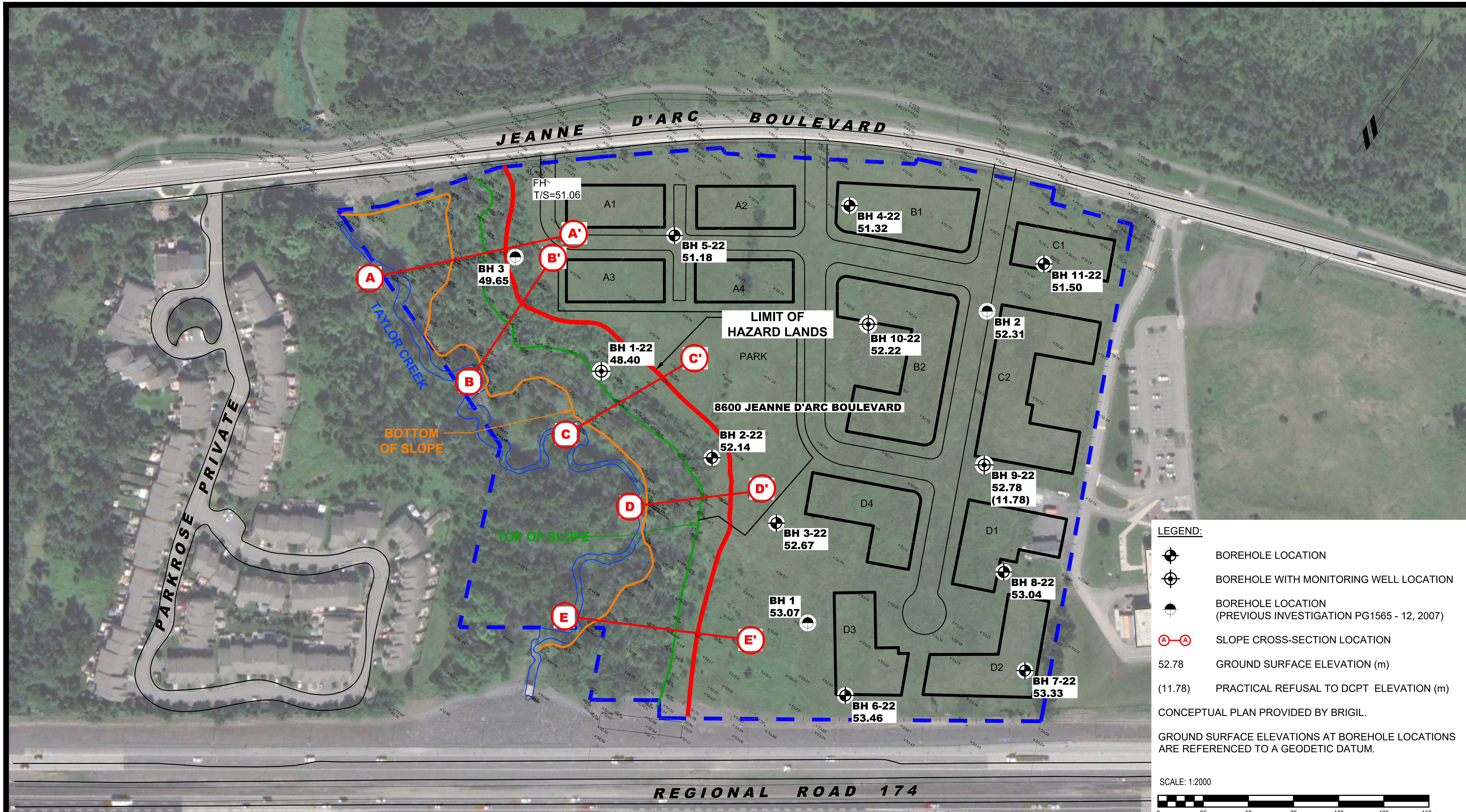
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL

BRIGIL

GEOTECHNICAL INVESTIGATION
PROPOSED MULTI-STOREY BUILDING
8600 JEANNE D'ARC BOULEVARD

OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:2000	Date: 10/2022
Drawn by: GK	Report No.: PG6414-1
Checked by: JV	Dwg. No.: PG6414-1
Approved by: DJG	Revision No.:

p:\autocad drawings\geotechnical\pg64xx\pg6414\pg6414-1 test hole location plan.dwg

11x17

APPENDIX 2

TABLE 3 - MONTHLY WATER BALANCE FOR MATERIAL WITH 5 mm WATER HOLDING CAPACITY AT THE OTTAWA INTERNATIONAL AIRPORT

TABLE 4 - MONTHLY WATER BALANCE FOR SOIL WITH 100 mm WATER HOLDING CAPACITY AT THE OTTAWA INTERNATIONAL AIRPORT

TABLE 5 - MONTHLY WATER BALANCE FOR SOIL WITH 250 mm WATER HOLDING CAPACITY AT THE OTTAWA INTERNATIONAL AIRPORT

TABLE 6 - MONTHLY WATER BALANCE FOR SOIL WITH 400 mm WATER HOLDING CAPACITY AT THE OTTAWA INTERNATIONAL AIRPORT

TABLE 7 - PRE-DEVELOPMENT ANNUAL WATER BUDGET FOR 8600 JEANNE D'ARC BOULEVARD

TABLE 8 - POST-DEVELOPMENT ANNUAL WATER BUDGET FOR 8600 JEANNE D'ARC BOULEVARD

Table 3 - Monthly Water Balance for Material With 5 mm Water Holding Capacity at the Ottawa International Airport

Month	Temperature (°C)	Total Precipitation (mm)	Actual Evapotranspiration (mm)	Water Surplus (mm)
January	-10.6	62	0	25
February	-9	56	1	27
March	-2.8	65	6	103
April	5.7	73	31	110
May	13.1	75	64	14
June	18.3	85	82	5
July	20.9	88	83	5
August	19.7	85	80	5
September	14.8	82	64	17
October	8.3	77	35	41
November	1.3	76	10	56
December	-6.8	79	1	41
Annual	**6**	**904**	**457**	**449**

Table 4 - Monthly Water Balance for Soil With 100 mm Water Holding Capacity at the Ottawa International Airport

Month	Temperature (°C)	Total Precipitation (mm)	Actual Evapotranspiration (mm)	Water Surplus (mm)
January	-10.6	62	0	24
February	-9	56	1	26
March	-2.8	65	6	102
April	5.7	73	31	110
May	13.1	75	80	14
June	18.3	85	113	4
July	20.9	88	114	3
August	19.7	85	87	1
September	14.8	82	66	3
October	8.3	77	36	9
November	1.3	76	10	30
December	-6.8	79	1	34
Annual	**6**	**904**	**545**	**360**

Table 5 - Monthly Water Balance for Soil With 250 mm Water Holding Capacity at the Ottawa International Airport

Month	Temperature (°C)	Total Precipitation (mm)	Actual Evapotranspiration (mm)	Water Surplus (mm)
January	-10.6	62	0	18
February	-9	56	1	22
March	-2.8	65	6	92
April	5.7	73	31	107
May	13.1	75	80	14
June	18.3	85	116	4
July	20.9	88	135	3
August	19.7	85	111	1
September	14.8	82	72	2
October	8.3	77	37	6
November	1.3	76	10	16
December	-6.8	79	1	19
Annual	**6**	**904**	**600**	**304**

Table 6 - Monthly Water Balance for Soil With 400 mm Water Holding Capacity at the Ottawa International Airport				
Month	**Temperature (°C)**	**Total Precipitation (mm)**	**Actual Evapotranspiration (mm)**	**Water Surplus (mm)**
January	-10.6	62	0	16
February	-9	56	1	20
March	-2.8	65	6	89
April	5.7	73	31	104
May	13.1	75	80	14
June	18.3	85	116	4
July	20.9	88	136	3
August	19.7	85	117	1
September	14.8	82	74	2
October	8.3	77	37	6
November	1.3	76	10	16
December	-6.8	79	1	17
Annual	**6**	**904**	**609**	**292**

Table 7 - Pre-Development Annual Water Budget Calculations - 8600 Jeanne D'Arc Boulevard

Land Use Unit	Area (m^2)	Water Surplus (mm)	Topography Factor	Soil Factor	Vegetation Factor	Infiltration Factor	Runoff Factor	Total Infiltration (mm/year)	Total Infiltration (L/year)	Total Runoff (mm/year)	Total Runoff (L/year)
Impervious Surfaces	1,453	449	0	0	0	0	1	0	0.00	449	652,500.27
Pasture and Shrubs (Clay Loam)	73,348	304	0.2	0.15	0.1	0.45	0.55	136.8	10,034,029.66	167.2	12,263,814.02
Mature Forest (Clay Loam)	29,277	292	0.1	0.15	0.2	0.45	0.55	131.4	3,847,014.88	160.6	4,701,907.08
Total	**104,079**								**13,881,044.54**		**17,618,221.37**

Table 8 - Post-Development Annual Water Budget Calculations - 8600 Jeanne D'Arc Boulevard

Land Use Unit	Area (m^2)	Water Surplus (mm)	Topography Factor	Soil Factor	Vegetation Factor	Infiltration Factor	Runoff Factor	Total Infiltration (mm/year)	Total Infiltration (L/year)	Total Runoff (mm/year)	Total Runoff (L/year)
Impervious Surfaces	29,863	449	0	0	0	0	1	0	0.00	449	13,408,666.60
Urban Lawn (Clay Loam)	36,412	360	0.2	0.2	0.1	0.5	0.5	180	6,554,192.40	180	6,554,192.40
Pasture and Shrubs (Clay Loam)	9,950	304	0.2	0.15	0.1	0.45	0.55	136.8	1,361,160.00	167.2	1,663,640.00
Mature Forest (Clay Loam)	27,854	292	0.1	0.15	0.2	0.45	0.55	131.4	3,659,991.95	160.6	4,473,323.49
Totals	**104,079**								**11,575,344.35**		**26,099,822.49**
Difference (L/year)									**-2,305,700.19**		**8,481,601.12**
Percentage Variation									**-16.61%**		**48.14%**

APPENDIX 3

SAMPLE CALCULATIONS – DUPUIT FORCHHEIMER

Estimated Groundwater Inflow

Brigil Homes - 8600 Jeanne D'Arc Boulevard - Building Excavation

Dupuit-Forchheimer Equation **$Q = \pi K((h_0^2 - h_p^2)/\ln(R/r))$**

Equivalent Radius of Excavation = A+B=Pi*r

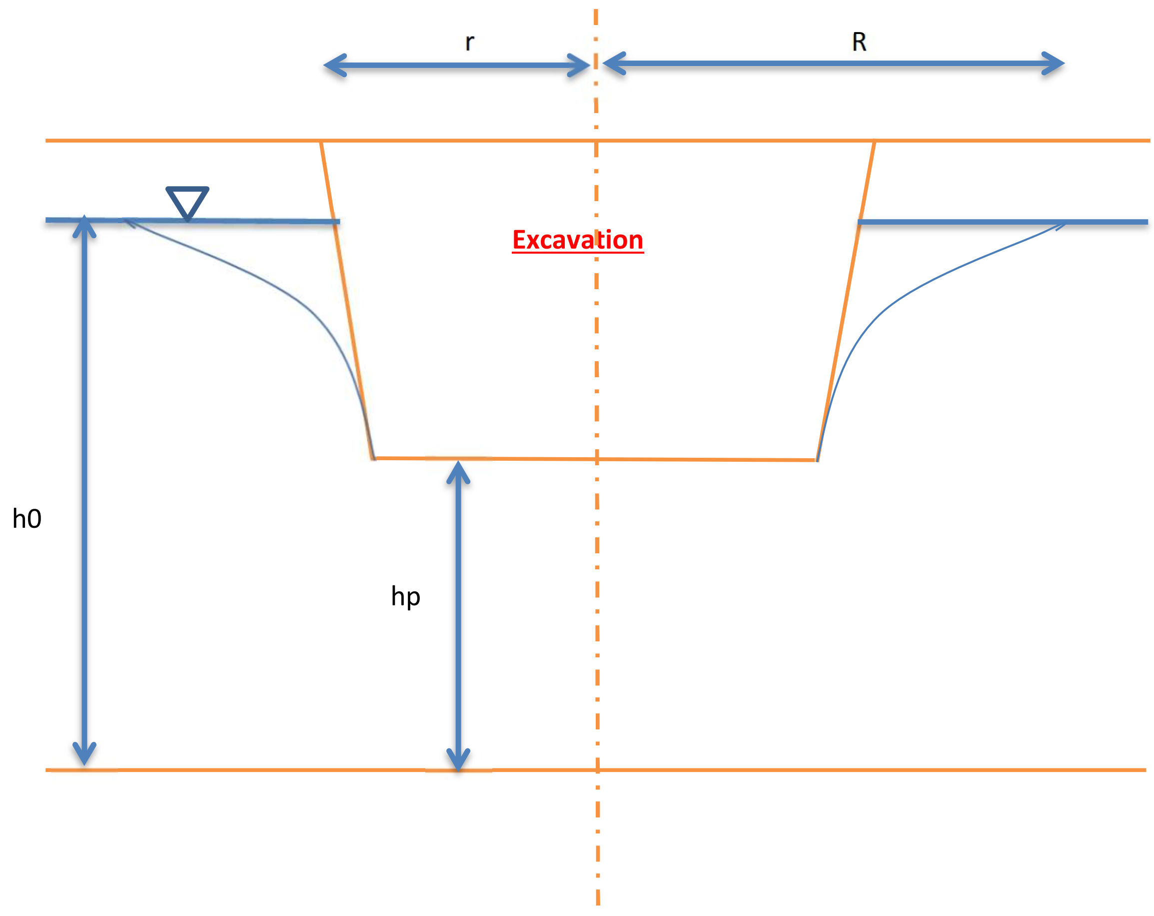
K (m/sec) = 1.00E-08
h0 (m) = 37
hp (m) = 32
r (m) = 49.02

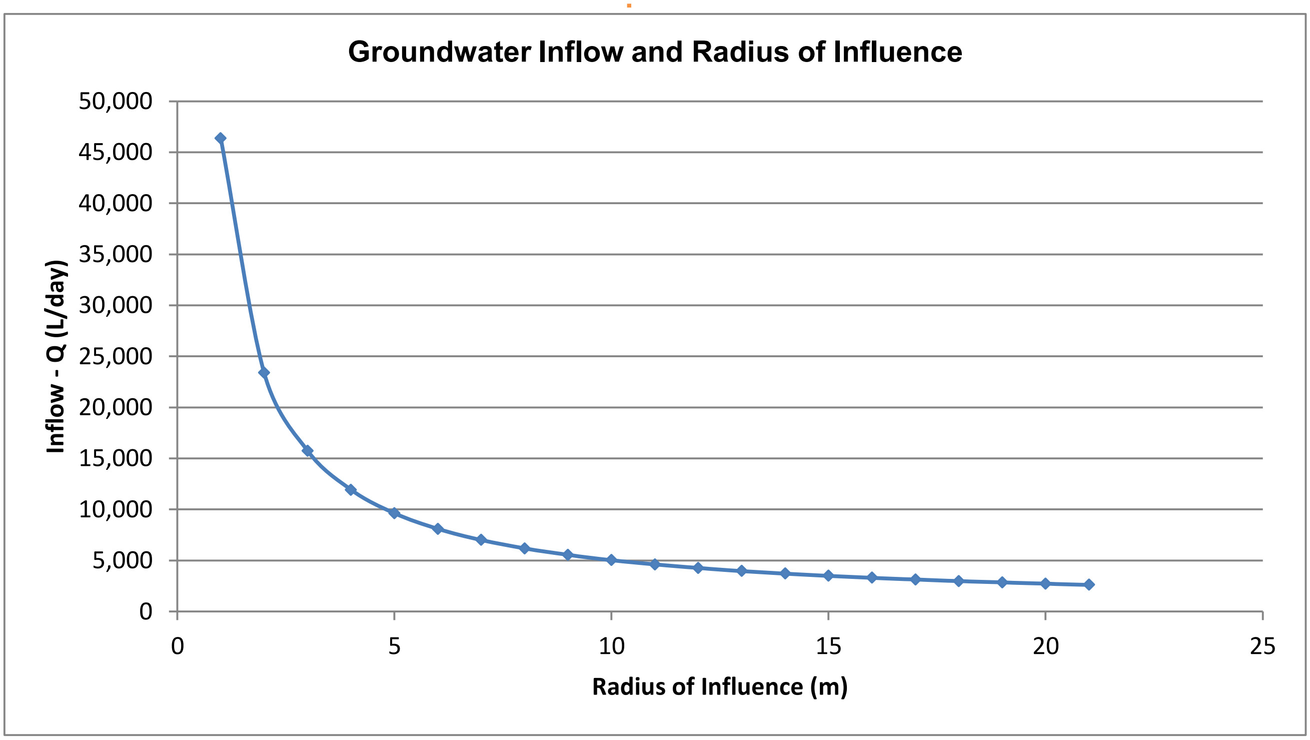
Excavation Width (A) = 52 m
Excavation Length (B) = 102 m
Perimeter Length = 308 m
Equivalent Radius (r) = 49.02 m

R	Distance to edge of excavation
50.02	**1.00**
51.02	**2.00**
52.02	3.00
53.02	4.00
54.02	5.00
55.02	6.00
56.02	7.00
57.02	8.00
58.02	9.00
59.02	10.00
60.02	11.00
61.02	12.00
62.02	13.00
63.02	14.00
64.02	15.00
65.02	16.00
66.02	17.00
67.02	18.00
68.02	19.00
69.02	20.00
70.02	21.00

Q (m^3/s)	Q (m^3/day)	Q (L/day)
0.0005	**46**	**46,371**
0.0003	**23**	**23,417**
0.0002	16	15,765
0.0001	12	11,938
0.0001	10	9,642
0.0001	8	8,110
0.0001	7	7,016
0.0001	6	6,194
0.0001	6	5,556
0.0001	5	5,044
0.0001	5	4,626
0.0000	4	4,277
0.0000	4	3,981
0.0000	4	3,728
0.0000	4	3,508
0.0000	3	3,315
0.0000	3	3,145
0.0000	3	2,994
0.0000	3	2,859
0.0000	3	2,737
0.0000	3	2,626

PATERSON GROUP


r
R
Excavation
h0
hp


Groundwater Inflow and Radius of Influence
Inflow - Q (L/day)
Radius of Influence (m)
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
0
5
10
15
20
25

Estimated Groundwater Inflow

Brigil Homes - 8600 Jeanne D'Arc Boulevard - Servicing Excavation

Dupuit-Forchheimer Equation $Q = \pi K((h_0^2 - h_p^2)/\ln(R/r))$

Equivalent Radius of Excavation = A+B=Pi*r

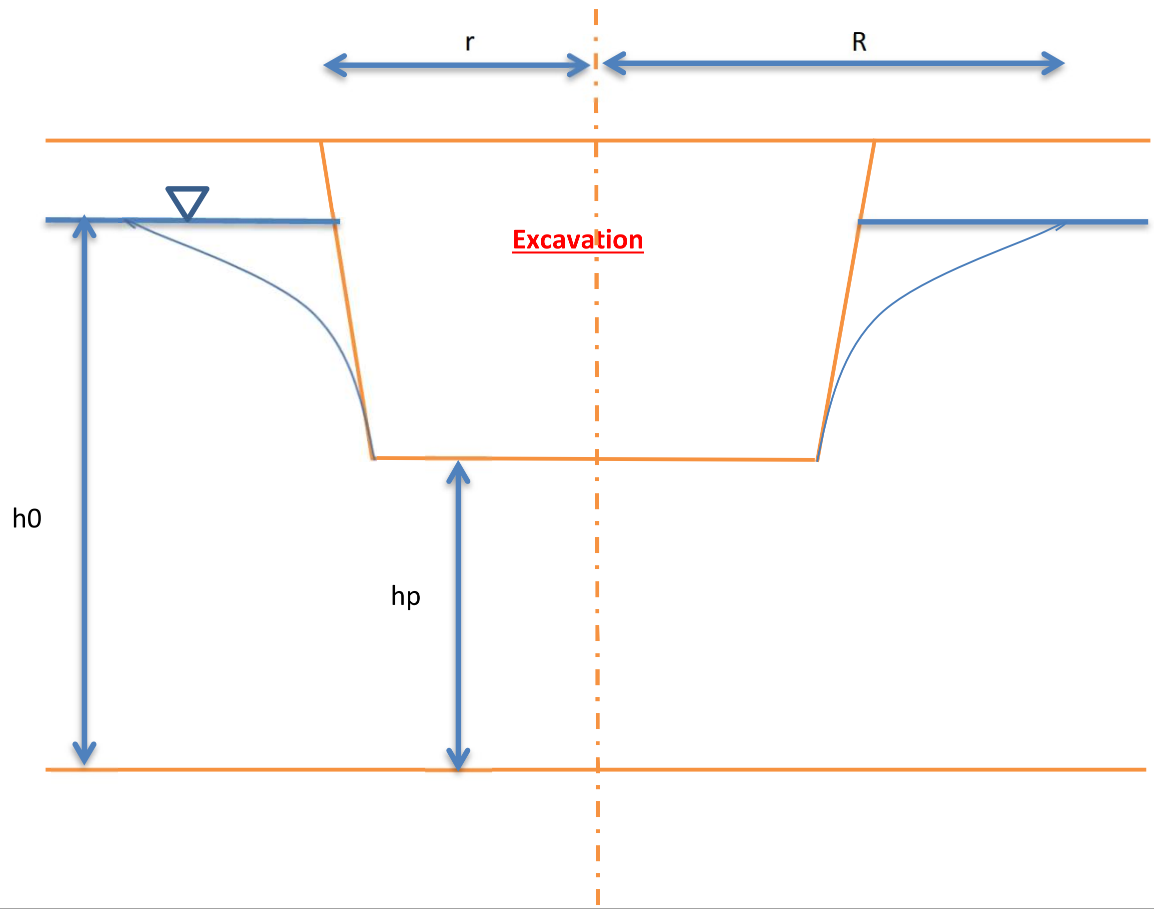
K (m/sec) = 1.00E-08
h0 (m) = 37
hp (m) = 33.5
r (m) = 9.55

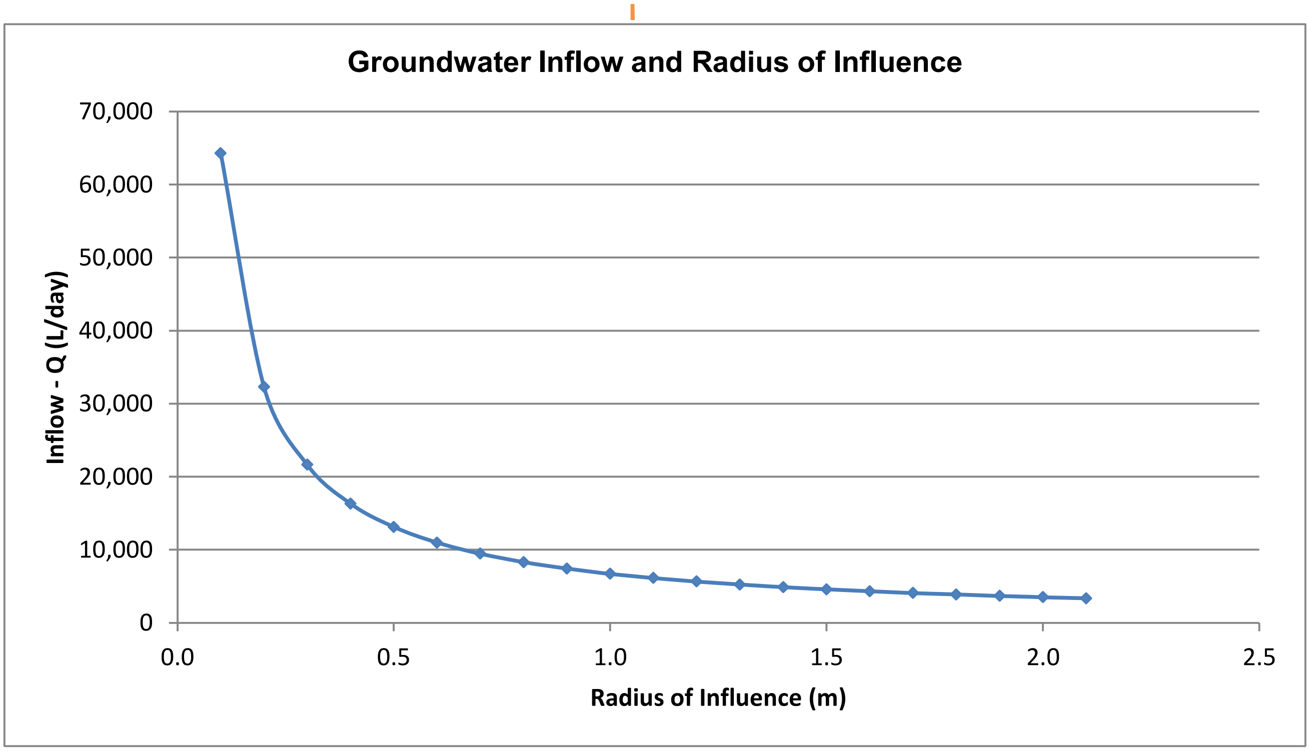
Excavation Width (A) = 5 m
Excavation Length (B) = 25 m
Perimeter Length = 60 m
Equivalent Radius (r) = 9.55 m

R	Distance to edge of excavation
9.65	0.10
9.75	0.20
9.85	0.30
9.95	0.40
10.05	0.50
10.15	0.60
10.25	0.70
10.35	0.80
10.45	0.90
10.55	**1.00**
10.65	**1.10**
10.75	1.20
10.85	1.30
10.95	1.40
11.05	1.50
11.15	1.60
11.25	1.70
11.35	1.80
11.45	1.90
11.55	2.00
11.65	2.10

Q (m^3/s)	Q (m^3/day)	Q (L/day)
0.0007	64	64,292
0.0004	32	32,313
0.0003	22	21,652
0.0002	16	16,322
0.0002	13	13,124
0.0001	11	10,991
0.0001	9	9,468
0.0001	8	8,325
0.0001	7	7,436
0.0001	**7**	**6,725**
0.0001	**6**	**6,143**
0.0001	6	5,658
0.0001	5	5,248
0.0001	5	4,896
0.0001	5	4,591
0.0001	4	4,324
0.0000	4	4,088
0.0000	4	3,878
0.0000	4	3,691
0.0000	4	3,522
0.0000	3	3,369

PATERSON GROUP





PATERSON GROUP

APPENDIX 4

CITY OF OTTAWA - SALT MANAGEMENT PLAN - APPENDIX A (October, 2011)

City of Ottawa

Public Works and Services Department
Surface Operations Branch

Salt Management Plan
Appendix A

MATERIAL APPLICATION POLICY

CONTENT

The Surface Operations Branch District Managers, Area Managers and Zone Supervisors have been consulted through the development of this document.

REVISION INFO

Rev	Date	By	Description
3.1	Jan 10 2007		
3.2	Oct 31 2011	D Vander Wal	• Removed 50/50 mix per Dan O'Keefe. • Removed specific references to Sodium and Calcium Chloride as new product for 2011 is a Multi-Chloride Brine. Changed liquid application rate from 46 (6%) to 39L/tonne (5%). • Removed Dry and Wet salt rates for pavement temperatures below -18C. • Updated Epoke rates to match Appendix B and added wet rates to obtain 20% reduction when pre-wetting. • Removed separate rate table for Hwy 174 Epoke spreaders since the resulting lane-km rates are the same as other bare pavement.

COUNCIL APPROVED MAINTENANCE QUALITY STANDARDS

For snow clearing, resources are to be deployed and snow clearing completed as defined in the Table below. If the depth of snow accumulation is less than the minimum for deployment, then resources may be deployed subject to road conditions resulting from previous snow accumulations or from forecasted weather conditions.

For treating icy roads, resources are to be deployed as soon as practicable after becoming aware of the icy conditions. Icy roads are to be treated within the times defined in the Table below after becoming aware of the icy conditions.

MAINTENANCE QUALITY STANDARD
SNOW AND ICE CONTROL ON ROADS

Road Maintenance Class		Road Type	Minimum Depth of Snow Accumulation for Deployment of Resources *(Depth as per MMSMH)*	Time to Clear Snow Accumulation From the End of Snow Accumulation or Time to Treat Icy Conditions *(Time as per MMSMH)*	Treatment Standard: Bare Pavement	Treatment Standard: Centre Bare	Treatment Standard: Snow Packed
1	A	High Priority Roads	As accumulation begins *(2.5-8 cm depending on class)*	2 h *(3-4 h)*	√		
	B				√		
2	A	Most Arterials		3 h *(3-6 h)*	√		
	B				√		
3	A	Most Major Collectors		4 h *(8-12 h)*	√		
	B				√		
4	A	Most Minor Collectors	5 cm *(8 cm)*	6 h *(12-16 h)*	√		
	B					√	
	C						√
5	A, C	Residential Roads and Lanes	7 cm *(10 cm)*	10 h *(16-24 h)*			√
	B		10 cm *(not defined)*	16 h *(not defined)*			√

Note - MMSMH refers to Ontario Regulation 239/02, Minimum Maintenance Standards for Municipal Highways shown for comparison purposes.

- **Bare Pavement:** requires that snow and ice be controlled, cleared and/or prevented for the full traveled road pavement width, including flush medians of 2 m width or less, paved shoulders and/or adjacent cycling lanes. It does not include parking lanes.
- **Centre-Bare:** requires that snow and ice be controlled, cleared and/or prevented in a strip down the middle of the road pavement width for a minimum width of 2.5 m on each side of centre-line.
- **Snow-Packed:** requires that snow and ice be cleared and that ruts and/or potholes that may cause poor vehicle control be leveled off. Abrasive or deicing materials are applied at intersections, hills and sharp curves.

LIQUID CHEMICALS

Application Rates and Reductions

USE OF LIQUID CHEMICALS					
Chemical	**Use**	**Application Ratio**	**Chemical Concentration**	**Application Rate**	**Dry Salt Reduction**
CaCl, MgCl, or Multi-Chloride	Pre-Wetting	5% by weight	Varies (28%-35%)	39L / t	20%[1]
CaCl, MgCl, or Multi-Chloride	Straight Liquid Application	N/A	Varies	60 to 100L/ lane-km	-

[1] The Epoke controller does not support setting a separate reduction percentage – the rate will only be reduced by the set liquid application ratio (5%).

Pre-Wetted Salt

- Pre-wetting salt is a recommended practice to enhance the performance of the road salt.
- When salt is pre-wet, the brine solution is formed quicker than dry salt and more material is retained on the road surface. It is the brine solution that prevents or breaks the bond between the road surface and snow/ice.
- The enhanced performance of the salt as well as the retention of salt on the road surface facilitates achieving a bare road more quickly and maintains bare pavement longer. As a result, a reduction in salt application rates can achieve the same effectiveness as dry salt application at traditional rates.

Practical temperature ranges for Pre-Wetted Salt (WET SALT)

- Sodium Chloride Brine (NaCl):
  - From 0 to –9ºC (0 to -12ºC as per pre-wetting practices in urban areas)
- Calcium Chloride ($CaCl_2$), Magnesium Chloride (MgCl), and Multi-Chloride Brines with a minimum eutectic temperature of -30°C:
  - From 0 to –15ºC (0 to -18ºC as per pre-wetting practices in urban areas)

Direct Liquid Applications (DLA)

- Anti-icing by Direct Liquid Application is a recommended practice to treat frost and black ice conditions in the shoulder seasons at pavement temperatures between 0 and –10ºC.
- Liquid should be applied to treat forecasted conditions at the following rates:

Winter Event	**Litres / LaneKm**	**mL / m^2 (at 3m width)**
Frost	60	20
Light Snow	60 to 80	25
Moderate to Heavy Snow, Freezing Rain	80 to 100	30

- DLA should be applied:
  - As close to the beginning of the winter event as possible
  - When the air and pavement temperatures are both below +5°C currently and forecasted to remain below +5°C within the next 12 hours.
  - When the air and pavement temperatures are a minimum of 10°C above the eutectic temperature of the DLA liquid and forecasted to do so for the next 24 hours.
- DLA should NOT be applied:

- When the relative humidity is below 60% and the air and pavement temperatures are between 0°C and +5°C.
- More than once in a three-day period unless a Winter Event (frost, snow, freezing rain or rain) has removed the product from the pavement. Note that DLA liquid can remain on the pavement up to several days after the initial application.

GENERAL INFORMATION

When the Pavement Temperature is below –18ºC

- Below –18ºC, the salt melting action is close to none.
- Below –18ºC, the use of salt shall be discontinued and replaced by an abrasive.
- Multiple factors can affect the performance of de-icing chemicals and abrasives below pavement temperature of –18ºC. Under such conditions, supervisors shall select the most appropriate material based on the current and expected traffic volume, current and forecasted weather and road conditions.

Abrasives

- Accepted abrasives are Sand and Grit
- Straight abrasive does contain salt to prevent the stockpile from freezing. The goal is to minimize the amount of salt mixed with the abrasives. The objective is to use an engineered abrasive of 5% salt / 95% sand or grit by volume. The following interim abrasive ratios are accepted (where the engineered ratio cannot be achieved due to equipment and material storage constraints)
  - 10% salt / 90% sand or grit by volume

Rush Hours and Forecasted Conditions

- Supervisors are responsible for making timely material application calls based on forecasted conditions and expected traffic peak hours.

Freezing Rain

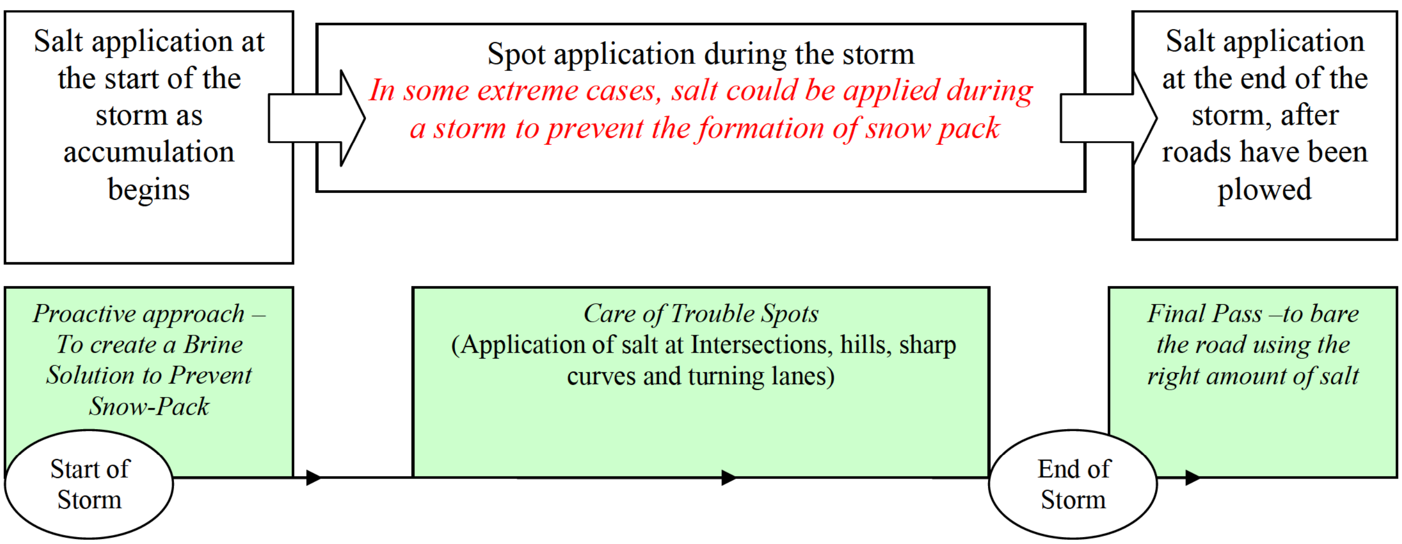
- When Freezing Rain occurs, abrasive materials (sand or grit) will be applied on snow packed roads on a continuous basis (to the full Road Width).
- Snow Packed Roads – where available, graders with ice blades shall drag the roads to aid traction.

MATERIAL APPLICATION POLICY BARE PAVEMENT					
Pavement Temperature ºC	**Material**	**Frost and Black Ice** ***Kg/2-lane km***	**Light Snow <1cm/hr** ***Kg/2-lane km***	**Heavy Snow >1cm/hr** ***Kg/2-lane km***	**Freezing Rain** ***Kg/2-lane km***
0 to –5ºC	DRY SALT	70	100	140	230
	WET SALT	55	80	110	185
-5 to –10ºC	DRY SALT	85	140	180	230
	WET SALT	70	110	145	185
-10 to –18ºC	DRY SALT	85	180	230	230
	WET SALT	70	145	185	185
< -18ºC*	ABRASIVE	350	350	350	-

* Refer to the General Information Section for additional information when the Pavement Temperature is below –18ºC. When forecasted warming conditions are expected, dry/wet rates of 180/145, and 230/185 may provide some baring-off benefit.

* Note: Use wet rates where pre-wetting capable spreaders and liquid supply is available.

Timing of Application – BARE PAVEMENT ROADS



Start of the Storm
Salt shall be spread just at the beginning of the icy precipitation.

End of Storm
Salt shall not be spread once bare pavement is achieved and when no further precipitation is forecasted.

MATERIAL APPLICATION POLICY
BARE PAVEMENT
(EPOKE SPREADERS)

Pavement Temperature °C	Material	Frost and Black Ice		Light Snow <1cm/hr		Heavy Snow >1cm/hr		Freezing Rain	
		g/m2	*Width*	*g/m2*	*Width*	*g/m2*	*Width*	*g/m2*	*Width*
0 to –5°C	DRY Salt (WET Salt)*	70kg/2ln-km		100kg/2ln-km		140kg/2ln-km		230kg/2ln-km	
		35 (30)	2m	50 (43)	2m	70 (60)	2m	115 (98)	2m
		23 (20)	3m	35 (30)	3m	45 (38)	3m	77 (65)	3m
		17 (14)	4m	23 (20)	4m	35 (30)	4m	58 (49)	4m
		17 (14)	5m	20 (17)	5m	28 (24)	5m	45 (38)	5m
-5 to –10°C	DRY Salt (WET Salt)*	85kg/2ln-km		140kg/2ln-km		180kg/2ln-km		230kg/2ln-km	
		45 (38)	2m	70 (60)	2m	90 (77)	2m	115 (98)	2m
		28 (24)	3m	45 (38)	3m	58 (49)	3m	77 (65)	3m
		20 (17)	4m	35 (30)	4m	45 (38)	4m	58 (49)	4m
		17 (14)	5m	28 (24)	5m	35 (30)	5m	45 (38)	5m
-10 to –18°C	DRY Salt (WET Salt)*	85kg/2ln-km		180kg/2ln-km		230kg/2ln-km		230kg/2ln-km	
		45 (38)	2m	90 (77)	2m	115 (98)	2m	115 (98)	2m
		28 (24)	3m	58 (49)	3m	77 (65)	3m	77 (65)	3m
		20 (17)	4m	45 (38)	4m	58 (49)	4m	58 (49)	4m
		17 (14)	5m	35 (30)	5m	45 (38)	5m	45 (38)	5m
< -18°C†	ABRASIVE	350kg/2ln-km		350kg/2ln-km		350kg/2ln-km		-	
		175	2m	175	2m	175	2m	-	-
		115	3m	115	3m	115	3m		
		88	4m	88	4m	88	4m		
		70	5m	70	5m	70	5m		

* When the pre-wetting system is engaged, the dry material output is reduced. The Epoke controller does not support setting a separate reduction percentage – the rate is only reduced by the set liquid application ratio (5%). Material 2 was therefore configured with rates reduced by 15%.
* Use wet rates where pre-wetting capable spreaders and liquid supply is available.
† Refer to the General Information Section for additional information when the Pavement Temperature is below –18°C. When forecasted warming conditions are expected, dry/wet rates of 180/145, and 230/185 may provide some baring-off benefit.

Notes
There are 2 variables affecting the material output on an Epoke salt spreader:
-Material Application Rate in **g/m^2** AND Application Width in **m**.

Examples:

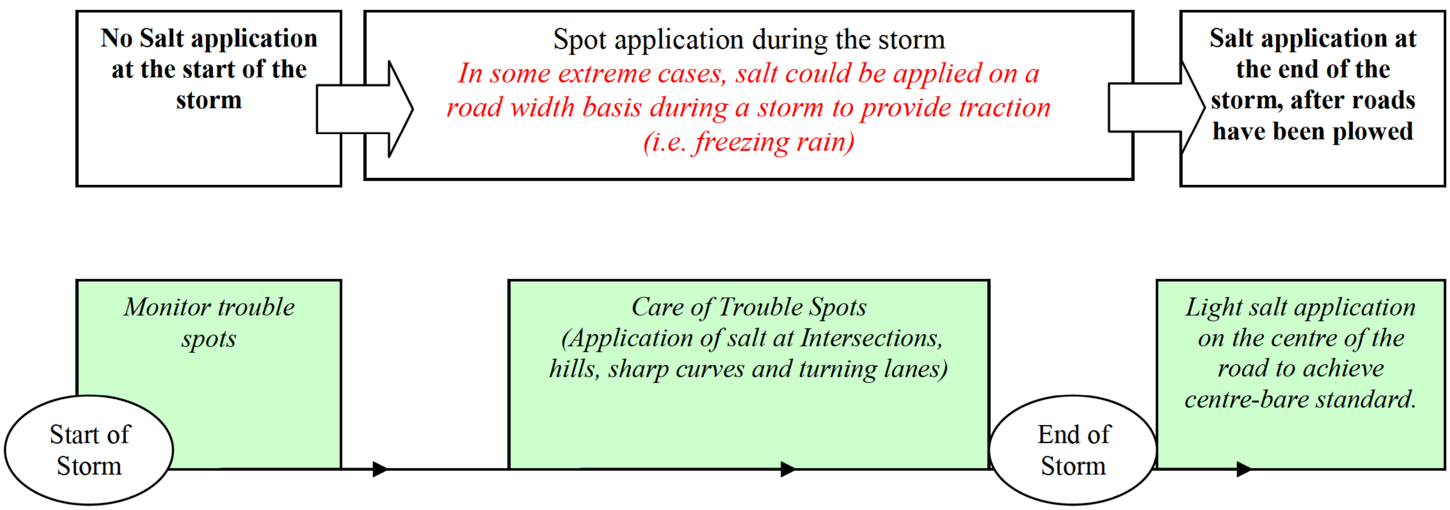
1- For a rate of 100kg/2ln-km, the Epoke Setup would be 25g/m^2 at a Width of 4m. **OR** a rate of 50g/m^2 at a Width of 2m.

2- For a rate of 170kg/2ln-km, the Epoke Setup would be 42g/m^2 at a Width of 4m. **OR** a rate of 57g/m^2 at a Width of 3m.

MATERIAL APPLICATION POLICY **CENTRE-BARE PAVEMENT**				
Pavement Temperature °C	**Material**	**Frost and Black Ice** ***Kg/2-lane km***	**Snow** ***Kg/2-lane km***	**Freezing Rain** ***Kg/2-lane km***
0 to –5°C	DRY SALT	70	100	230
	WET SALT	55	80	185
-5 to –18°C	DRY SALT	85	140	230
	WET SALT	70	110	185
< -18°C	ABRASIVE	350	350	-

Note: Use wet rates where pre-wetting capable spreaders and liquid supply is available.

<u>Timing of Application – CENTRE-BARE PAVEMENT ROADS</u>

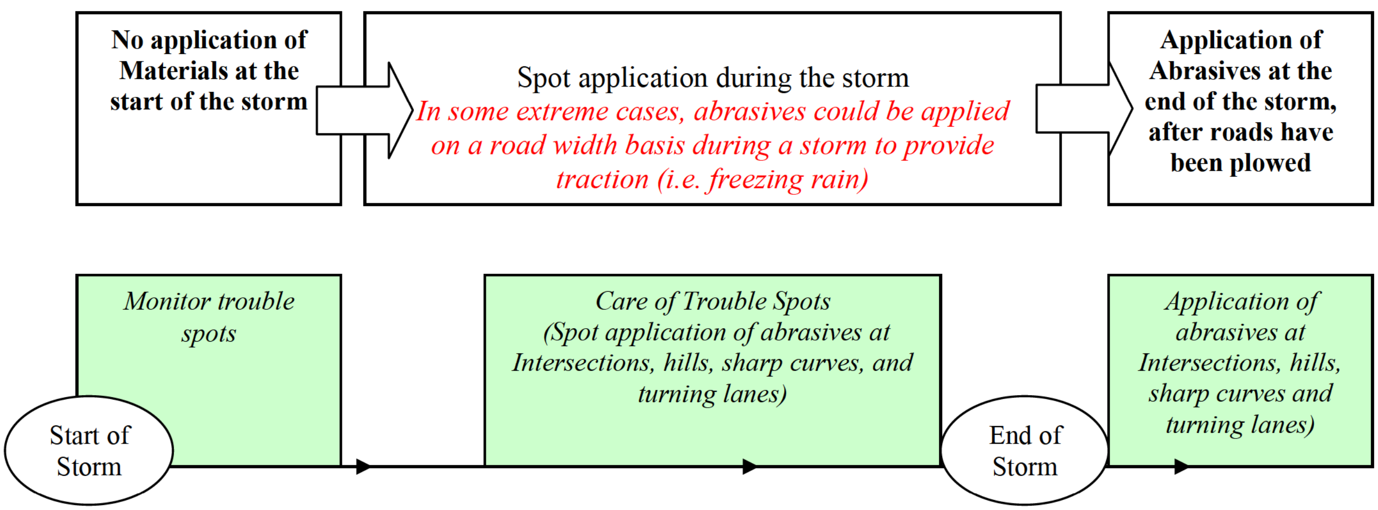


<u>Start of the Storm</u>
No Salt application at the start of the storm. Monitor trouble spots.

<u>End of Storm</u>
Salt shall not be spread once centre-bare pavement is achieved and when no further precipitation is forecasted.

MATERIAL APPLICATION POLICY (Intersections, Hills and Sharp Curves) SNOW PACKED				
Pavement Temperature °C	**Material**	**Frost and Black Ice** *Kg/2-lane km*	**Snow** *Kg/2-lane km*	**Freezing Rain** *Kg/2-lane km*
0 to –30°C and below	ABRASIVE	350	350	500

Timing of Application – SNOW PACKED ROADS



Start of the Storm
No application of abrasives at the start of the storm. Monitor trouble spots.

End of Storm
Abrasives shall not be spread once traction is provided.

BLASTING POLICY

The On-Board Electronic Controller's Blast function is an important tool for roadway de-icing operations. It allows operational staff to timely increase the amount of spread material at trouble locations such as steep hills and sharp curves. Although the blast function is indispensable, it should be used with care as it its liberal use can lead to significant increases in salt consumption and environmental impacts.

- Supervisory staff shall work toward minimizing the amount of salt being spread using the Blast function to achieve the required maintenance quality standard.
- Many variables come into play during a winter weather event. As such, the call to allow the use of the Blast Function during a winter event is left to the judgment of the supervisory staff, as the first priority is the safety of the traveling public.

The Blast function shall only be used at the following locations:

- Steep Hills
- Elevated Curves
- Intersections (within 30m of the stop line on the approach side only)
- Shade areas
- Right and Left Turning Lanes
- Bus Bays
- Railways (within 30m of the railway crossing on the approach side only)
- Bridge Decks

  Caution: when blasting salt on a bridge deck. Rock salt needs heat to dissolve. Spreading salt on a bridge deck could lower its surface temperature to a point where the brine solution will refreeze.

Application:

- The Blast function shall only be used under severe winter conditions
- The Blast function shall not be used during light winter weather events such as light snow, frost, etc.
- The blast function shall not be used while clearing the roads (stripping) at the end of a storm.

On-Board Electronic Controller's Blast function

- The Epoke controllers will blast at the highest material calibration setting.
- The CS-230 controller will blast to its maximum hydraulic power (which can be adjusted if too high)
- The CS-440 controller can be calibrated at a defined Blast rate for each material.
  - The Blast Rate for Salt is to be set at 300kg/2 lane-km
  - The Blast Rate for Abrasive is to be set at 500kg/2 lane-km. Note: Suburban/Rural District has a requirement to Blast Abrasives on gravel roads at a rate of 700kg/2 lane-km. To achieve this rate, the spreaders need to be calibrated using two gate settings. The District will provide, every fall, a list of spreaders requiring this specific calibration.