OFFICE COMPLEX_1037 CARP ROAD
GEOTECHNICAL REPORT

Project No.: CP-19-0125

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FOUNDATION DESIGN AND RECOMMENDATION REPORT
Proposed Office Complex at 1037 Carp Road, Stittsville, Ontario

1.0 INTRODUCTION

This report presents the factual findings obtained from a geotechnical investigation performed at the above-mentioned site for a proposed two-storey office complex with parking lot and no basement. The fieldwork was carried out on October 14, 2020, to October 15, 2020, and comprised of five foundation boreholes to a maximum depth of 9.3 m, and one pavement borehole in the parking lot to a depth of 2.1m below existing surface.

The purpose of the investigation was to explore the subsurface conditions at this site and to provide borehole location plans, a record of borehole logs, and laboratory test results. This report provides anticipated geotechnical conditions influencing the design and construction of the proposed two-storey office buildings and the parking lot. The report also includes recommendations for the foundation and parking lot pavement design. Recommendations are offered based on the authors' interpretation of the subsurface investigation and test results. The readers are referred to Appendix A, Limitations of Report, which is an integral part of this document.

The investigation was performed at the request of the Jim Bell Architectural Design Inc.

2.0 SITE DESCRIPTION

The site is located in a mixed residential and commercial area. It is bounded by residential dwellings with chain link fence from the northeast side, and commercial properties at the northwest and southeast. The site is accessible from Carp Road at the southwest side through a gravel driveway. A drainage ditch is bounded the site along Carp Road and a corrugated steel pipe side culvert connects the ditch under the gravel driveway.

At the time of the investigation the lot was heavily vegetated with mature trees, dead logs, and bushes and the ground is covered with limestone, wood chips, roots, and tree leaves. Trees and bushes were partially cleared from the middle of the lot to provide access to the lot. The property and borehole locations are shown in Figure 2, in Appendix B.

3.0 PROJECT UNDERSTANDING

It is understood that the proposed office complex includes three buildings with 1750, 3500, and 3500 square feet of footprint area which may be constructed through separate phases. All three phases are proposed as two storey buildings without a basement. A total number of 46 parking spots are provisioned.

4.0 FIELD PROCEDURES

The staff of McIntosh Perry Consulting Engineers (McIntosh Perry) visited the site before the drilling investigation to mark out the proposed borehole locations to obtain utility clearance to identify the location of underground infrastructures. Utility clearance was carried out by Underground Service Locators (USL-1) on behalf of McIntosh Perry. Public and private utility authorities were informed, and all utility clearance documents were obtained before the commencement of drilling work.

The equipment used for drilling was owned and operated by CCC Geotechnical & Environmental Drilling Ltd. of Ottawa, Ontario. Boreholes were advanced using hollow stem augers aided by track-mounted CME 850 drill rig. Boreholes were advanced to a maximum depth of 9.3 m (El. 114.2 m) below the ground level. Soil samples were obtained at 0.75 m intervals in boreholes up to 3.7 m (El. 119.9 m). Below this level, due to the uniformity of the sand layer, samples were obtained at 1.5 m intervals between 3.7 m depth (El. ~ 114.2 m) and 7.6 m depth (El. ~ 116.0 m). below this level, the sample collection interval was changed back to 0.75 m as the soil stratigraphy changed. The samples were collected using a 51 mm outside diameter split spoon sampler following the Standard Penetration Test (SPT) procedure. Boreholes were backfilled with auger cuttings and restored to the original surface. Borehole locations are shown in Figure 2, included in Appendix B.

5.0 IDENTIFICATION AND TEST PROCEDURES

All samples were logged as retrieved, and visual description and soil type identification were added to the logs. Subsequently, soil descriptions were confirmed by additional tactile examination of the soils in the laboratory. Laboratory grain-size distribution analysis on representative SPT samples was performed at McIntosh Perry geotechnical lab in accordance with the American Society for Testing Materials (ASTM) test procedures.

Paracel Laboratories Ltd., in Ottawa, carried out chemical tests on two representative soil samples to determine the soil corrosivity characteristics.

Test procedures are listed below;

ASTM C136 – Sieve Analysis of Fine and Coarse Aggregates (LS-602)
LS-702 – Determination of Particle Size Analysis of Soils
ASTM D1586 – Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils

The rest of the soil samples recovered will be stored in McIntosh Perry storage facility for a period of one month after submission of the final report. Samples will be disposed of after this time unless otherwise requested in writing by the Client.

6.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

6.1 Site Geology

Based on published physiography maps of the area (Ontario Geological Survey), the site is located within the boundary region between Ottawa Valley Clay Plains and Smiths Falls Limestone Plain. Surficial geology maps of southern Ontario indicate the site is situated on glaciofluvial deposits, between organic deposits to the east and southwest, coarse-textured glaciomarine deposits to the northwest, and Paleozoic bedrock formation to the northeast and southeast. The glaciofluvial deposits in this region are predominantly river deposits, gravel, sand, silt and clay, and delta topset facies.

6.2 Subsurface Conditions

In general, the site stratigraphy consists of four layers of shallow topsoil, followed by a thick deposit of sand with different portions of silt and gravel. A till layer composes of silty sand with different portions of gravel and clay was encountered below the sand layer. It was inferred the till layer is underlain by bedrock at ~ El 115.0 m. For classification purposes, the soils encountered at this site can be divided into four distinctive strata.

a) Topsoil
b) Sand
c) Till
d) Inferred Bedrock

The soils encountered during the investigation, together with the field and laboratory test results, are shown on the Record of Borehole sheets included in Appendix C. Laboratory test results are included in Appendix D. Description of the strata encountered are given below.

6.2.1 Topsoil

A layer of topsoil was encountered at the existing surface that extends to an approximate depth of 0.9 (El. ~ 122.5 m). The topsoil layer was observed to be dark brown and composes of organic maters including peat, roots, and wood chips. Gravel and cobbles "Limestone" were encountered at the surface in BH20-3 and 20-06. The topsoil was observed to be dry to damp, very loose to loose with SPT 'N' value ranges from 2 to 9 blows/300mm.

6.2.2 Sand

Underlying the topsoil, was a thick layer of sand with traces of silt and gravel, observed to be light brown, dry to moist, and loose to compact. The SPT 'N' value ranges from 7 to 30 blows/300mm. The sand layer is followed by a till layer.

Five samples underwent grain size analysis testing, and the layer was observed to contain, on average, 2.0% gravel, 90% sand, 9% silt and clay. In BH20-03 between 4.5 m and 5.5 m depths (El. 118.9 m to 117.9 m), the sand gradation changes to gravelly sand with traces of silt. The grainsize distribution of the soil between these levels changes to contain 22% gravel, 68% sand and 10% fins. Below level 117.9, the soil change back to sand.

A summary of the grain size distribution for this layer is shown in Table 6-1. Test results are shown in Figures 4 and 5, included in Appendix B.

Table 6-1: Grain Size Distribution of the Sand Layer

Grain Size	Range (%)
Gravel	0 – 4
Sand	82 – 96
Fines	4 – 15

6.2.3 Till: Silty Sand, Some Gravel and Clay

A till layer composes of silty sand with different portions of gravel and clay was encountered below the sand at an approximate El. 116.0 m. The till was observed grey, wet, and very loose to dense, with SPT 'N' values ranging from 1 to 54 blows/300mm. Two representative sample underwent grain size analysis testing, and the layer was observed to contain 15% gravel, 47% sand, 14% silt and clay. A summary of the grain size distribution for this layer is shown in Table 6-2.

Table 6-2: Grain Size Distribution of the Silty Sand Layer in BH20-1

Grain Size	(%)
Gravel	13 – 17
Sand	51 – 52
Silt	26 – 23
Clay	8 – 11

6.3 Groundwater

Groundwater was observed in five open boreholes. At the time of investigation, October 14 and 15, 2020, the depth of the groundwater ranged between 5.8 m (El. 117.8 m) to 6.1 m (El. 117.2 m). The depth and level of groundwater in five boreholes are summarized in Table 6-3. The groundwater level may be expected to fluctuate due to seasonal changes.

Table 6-3: Groundwater Level Readings in Open Boreholes

Borehole	Measuring Date	Surface El. (m)	Groundwater Depth (m)	Water Table El. (m)
BH20-01	2020-10-14	123.6	5.8	117.8
BH20-02	2020-10-14	124.1	5.8	118.3
BH20-03	2020-10-14	123.4	5.7	117.7
BH20-04	2020-10-15	123.5	5.8	117.7
BH20-05	2020-10-15	123.3	6.1	117.2

6.4 Chemical Analysis

The chemical test results conducted by Paracel Laboratories in Ottawa, Ontario, to determine the resistivity, pH, sulphate and chloride content of two representative soil samples are shown in Table 6-4 below. Chemical test results are included in Appendix D and summarized in below table.

Table 6-4: Soil Chemical Analysis Results

Borehole	Sample	Depth / El. (m)	pH	Sulphate (%)	Chloride (%)	Resistivity (Ohm-m)
BH20-01	SS-03	1.5 ~ 2.1	8.06	<0.0005	0.0009	126
BH20-03	SS-03	1.5 ~ 2.1	7.92	<0.0005	0.0007	92

7.0 DISCUSSIONS AND RECOMMENDATIONS

7.1 General

This section of the report provides engineering recommendations on the geotechnical design aspect of the project based on the project requirements and our interpretation of the subsurface soil information. The recommendations presented herein are subject to the limitations noted in Appendix A “Limitations of Report” which forms an integral part of this document.

The foundation engineering recommendations presented in this section have been developed following Part 4 of the 2015 National Building Code of Canada (NBCC) and 2012 Ontario Building Code (OBC) extending the Limit State Design approach.

7.2 Overview

It is understood that the proposed office complex consists of two-storey structures without a basement. It is also understood that the finished floor elevation for the proposed development will be approximately at El. 125.5 m to 126.0 m.

For the current project, the following list summarizes some key geotechnical facts that were considered in the suggested geotechnical recommendations:

- Topsoil is not a competent engineering material for construction and can undergo significant volume changes that can adversely affect the integrity of the structure, utilities as well as the parking lot pavement. Therefore, any loose materials, topsoil and organic maters need to be cleared from the footprint of the proposed buildings, the parking lot, and any form of hard landscaping.
- Considering the order of structural loads expected at the foundation level, the provision of conventional spread and strip footings is adequate. Footings are expected to be buried to resist overturning, sliding, and also to provide protection against frost action.
- The proposed structure can be designed using a seismic Site Class D provided that the boundary zones of the shear walls and all column loads are extended to and supported on the compact to dense sand layer by spread footings.
- Excavation for foundations will be advanced below the existing ground level through the topsoil and sand deposits. The sand deposit can exhibit collapsing behavior upon excavation. The sides of excavation shall be sloped from its bottom at a minimum gradient of 3H:1V. For trench excavation that is deeper than 1.2 m or a worker is required to enter, excavation shall be carried out within trench boxes, which is fully braced to resist lateral earth pressure.
- In addition, the footprint of the proposed development is adjacent to occupied residential and commercial buildings on the south, north and east, and Carp Road at west side. If excavations depth near adjacent building extend below their foundation depth, shoring system, such as sheet piles is required.
- The surface and groundwater inflow to the excavation can be handled by pumping from well-filtered sumps established on the floor of the excavation. The actual inflow into the excavation will depend on many factors including, but not limited to, the contractor's schedule, the rate of excavation, the size of the excavation, and the time of the year at which the excavation is to occur. Based on the encountered stratigraphy and the amount of groundwater intake, application for PTTW will be required only if excavations extend below groundwater level (El. ~ 119.0 m). If more precise information on potential

groundwater seepage is needed, a separate permeability test can be carried in the existing monitoring well as part of a separate scope of work.

7.3 Foundations

In general, the subsurface conditions in the area of the proposed low-rise building consists of a thick layer of sand that is followed by a till layer composed of silty sand with some gravel and clay layer. The depth of the bedrock is approximately at 8.6 to 9.4 m (El. ~ 114.8 m) from the existing ground surface.

It is understood that the level of finished floor for the new proposed buildings is approximately at 125.5 m to 126.0 m. Based on the freezing index for the Southern Ontario Region provided for this site, the frost penetration depth is expected at 1.8 m below the ground surface. Frost depth can be reduced to 1.5 m below finished surface for those buildings constantly heated during winter season. The underside of the foundations will likely be at an elevation of 123.7 to 124.2 m. Based on these elevations, grade raise on engineered fill is required. Granular A conforming to OPSS 1010 compacted to minimum 100% Standard Proctor Maximum Dry Density (SPMDD) shall be used for grade raise below the footings.

The SPT field test results, ‘N’ values within the expected depth and influence zone (twice of the footing width) of a spread footing range between 4 to 24 blows/300mm. The sand layer can be classified according to the Canadian Foundation Engineering Manual (CFEM) (2006) as loose to compacted sand. The estimated average angle of internal friction (ϕ') within the stress influence zone below the footing is approximately 28°. The sand layer is a competent layer and can provide suitable support to the expected loads from the structure.

7.3.1 Foundation Excavation

Excavation for the construction of the foundation will proceed through the native topsoil and sand deposits. Excavating of overburden soil shall be performed using conventional hydraulic excavating equipment. The Occupational Health and Safety Act (OHSA) of Ontario indicated that side slopes in the sand above the water table could be classified as Type 3 soil and below the water table as Type 4 soil and sloped no steeper than 3H:1V or be shored. If space restrictions exist, the excavations of depth greater than 1.2 m can be carried out within trench boxes, which is fully braced to resist lateral earth pressure.

In order to limit the amount of differential settlement, all footings shall be bearing on similar subgrade conditions. The subgrade shall be cleaned from all deleterious material and to be proof rolled to reduce loose spots and to prepare a smooth surface before receiving the foundation concrete. Granular A conforming to OPSS 1010 compacted to minimum of 100% SPMDD shall be used for grade raise or to level any over excavation below the foundation level.

Excavation shall be kept reasonably free of water or dry and cobbles or boulders larger than 300 mm in diameter, if encountered, should be removed from the side slopes for worker safety.

7.3.2 Shallow Foundations

For shallow spread footings, the overburden soil below the columns and foundation walls can be excavated to the level of founding. The subgrade shall be proof rolled before constructing the spread footings.

7.3.2.1 Bearing Resistance

Due to the presence of a competent sand layer, shallow footings with a minimum of 1.2 m for strip footings and 1.5 m for spread footings in a shorter dimension bearing on the sand may be considered to support the structural loads of the proposed development if recommended bearing capacities are adequate.

Bearing capacities are calculated based on the methodology recommended by the Canadian Foundation Engineering Manual (CFEM). The mechanical properties of the sand layer were derived from SPT field test. The average value of SPT 'N' blows for 2B distance below the foundation level was used to estimate the effective soil friction angle, ϕ'. The ϕ'-value and the horizontal soil-footing interface friction angle, δ' are given in Table 8-2. Load and Resistance Factor Design (LRFD) approach following the National Building Code of Canada (NBCC) (2015) recommendations were used to determine the Ultimate Limit State (ULS) and Serviceability Limit State (SLS) geotechnical resistances. For ULS conditions, the unfactored ULS bearing capacity of the spread footing was determined using the general bearing capacity formula as per the CFEM (2006) using the effective soil friction angle, ϕ' value in Table 7-2. A geotechnical resistance factor of 0.5 as per the NBCC recommendations can be used to obtain the factored ULS bearing resistance. Furthermore, For SLS bearing capacity, allowable bearing capacity based on SPT test results and 25 mm settlement was determined.

Bearing capacities are calculated for an undisturbed subgrade. The bearing capacity of footings is also a function of the soil surcharge above the footing. Footings shall not be designed for any elevation above those noted in the bearing capacity table.

Geotechnical resistance values at the founding level (bearing capacities) are provided for Ultimate Limit State (ULS) and Serviceability Limit State (SLS). Bearing capacities are listed in the below table;

Table 7-1: Factored ULS and SLS Bearing Resistance

Footing Type	Max. El. (m)	Min. Soil Cover (m)	Min dim. (m)	ULS (kPa)	SLS (kPa)
Spread footing	121.5	1.8	1.5	300	175
Strip footing	121.5	1.8	1.2	250	150

Table 7-2: Unfactored Shearing Parameters for the Sand and Till based on SPT 'N' values

Soil Layer	ϕ' §		δ' *
	Hatanaka and Uchida (1996)	Schmertmann (1975)	
Sand	28°	28°	21°
Till	30°	30°	21°

§ ϕ': Effective Soil Friction Angle

* δ': Horizontal Soil-Footing Interface Friction Angle ($\delta' = 0.75\phi'$)

7.3.2.2 Frost Protection

Based on the freezing index for the Southern Ontario Region provided for this site, the frost penetration depth is expected at 1.8 m below the ground surface. Frost penetration depth is estimated based on the OPSD 3090.101, Foundation Frost Penetration Depths for Southern Ontario.

The encountered native sand is classified as low frost susceptibility material based on provincial guidelines.

All perimeter and exterior foundation elements or interior foundation elements in unheated areas should be provided with a minimum of 1.8 meters of earth cover for frost protection purposes. Frost protection depth can be reduced to 1.5 m for those buildings constantly heated during the cold season.

7.4 Seismic Site Classification

Seismic site classification is completed based on NBCC (2015) and OBC (2012) Section 4.1.8.4 and Table 4.1.8.4.A. This classification system is based on the average soil properties in the upper 30 m and accounts for site-specific shear wave velocity, standard penetration resistance, and plasticity parameters of cohesive soils.

Selected spectral responses in the general vicinity of the site for 2% chance of exceedance in 50 years (2500 years return period) are as indicated in Table 7-3, shown below and in Appendix E;

Table 7-3: Selected Seismic Spectral Responses (2% in 50 Yrs) – NRCan 2010

Sa(0.2)	Sa(0.5)	Sa(1.0)	Sa(2.0)	PGA
0.630	0.305	0.136	0.046	0.322

Based on the subsurface condition and field and SPT values, the site can be classified as Seismic Site Class (D).

7.4.1 Liquefaction Potential

Soil stratigraphy for the site consists of a thick sand deposit that extends to approximately 7.6 m below the existing ground level. The native sand layer is followed by a till layer that is approximately 1.3 m thick and followed by inferred bedrock. The groundwater is approximately at 5.7 m depth below the existing ground surface.

Liquefaction susceptibility of the native sand and till was evaluated. The native sand and till were found non-susceptible to liquefaction. The results of the analysis are presented in Appendix E.

7.5 Engineered Fill

Footings shall be installed on native soil. Any over excavation shall be leveled by engineered fill. Granular A conforming to OPSS 1010 compacted to 100% Standard Proctor Maximum Dry Density (SPMDD) shall be used to level any over excavation below the foundation level. The proposed engineered fill, beyond footings influence zone, can be any material conforming to granular criteria as outlined in OPSS 1010. Material conforming to 'Granular' criteria are considered free draining and compactable and can be utilized as the engineered fill. This can apply to the backfill beyond foundation walls and engineered fill in between the footings. The engineered fill shall be compacted to a minimum of 98% SPMDD.

All fill should be placed in horizontal lifts of uniform thickness of no more than 300 mm before compaction at appropriate moisture content determined by the Proctor test. The requirement for fill material and compaction may be addressed with a note on the structural drawing for foundation or grading drawing, and with a Non-Standard Special Provision (NSSP). Any topsoil, organics, or loose sand should be removed before placing engineered fill material.

7.6 Slabs-on-Grade

Slab-on-grades are considered free-floating (not attached to the foundation walls) and should be supported on a minimum of 200 mm of Granular A bedding compacted to 100% SPMDD. The requirements of the fill underneath slab-on-grade is noted in section 7.7 Engineered Fill.

If the slab on grade is proposed to support concentrated linear or point loads, the design loading shall be indicated in the structural specifications.

It is recommended that subgrade preparation and compaction efforts are approved under the supervision of a geotechnical representative.

For the design of the slab-on-grade, the modulus of subgrade reaction (k) is required. Modulus of subgrade reaction is a multi-function complex correlation that varies with the subgrade material, grade-raise fill material, and the flexural stiffness of the structural slab. However, simplified assumptions were made to estimate the spring modulus for slab-on-grade on compacted Granular A. To estimate the modulus of subgrade reaction, it was assumed that a 2 m square section of the concrete slab-on-grade under the applied loads. Since the modulus of subgrade reaction is needed for the ultimate failure design of the slab, it is assumed the failure can occur at a 25 mm deformation. Considering these assumptions, a subgrade reaction modulus of 20,000 kN/m^2/m can be used for the design of the interior slab-on-grade. This k-value is only valid for the construction of slab-on-grade on compacted Granular A bedding. This value shall not be used for the native subgrade.

7.7 Lateral Earth Pressure

Free draining material should be used as backfill material for foundation walls. If proper drainage is provided, "at rest" condition may be assumed for calculation of earth pressure on foundation walls. The following parameters are recommended for the granular backfill.

Table 7-4: Lateral Pressure parameters for Granular A and B and Horizontal Backfill

Pressure Parameter		Expected Value			
		Granular A	Granular B	Other OPSS1010 'Granular'	Native Sand
Unit Weight (γ) kN/m^3	Above groundwater	22.5	21.7	21.7	17.0
	Below groundwater	12.7	11.9	11.9	7.19
Angle of Internal Friction (ϕ)		35°	32°	31°	28°
Coefficient of Active Earth Pressure (k_a)		0.27	0.31	0.32	0.36
Coefficient of Passive Earth Pressure (k_p)		3.69	3.23	3.12	2.77
Coefficient of Earth Pressure at Rest (k_o)		0.43	0.47	0.48	0.53

7.8 Sidewalks and Hard Surfacing

The width and extent of the sidewalks will be defined as per the architectural drawings. The designer shall provision adequate slope, based on applicable codes, to provide appropriate runoff discharge. Expansion, construction, and dummy joints shall be spaced as required by the applicable standards. Sidewalks can be categorized under residential/commercial use, and therefore, the concrete sidewalks should have a thickness of 150 to 200 mm. Requirements of OPSD 310.010 'Concrete Sidewalk', OPSD 310.020 'Concrete Sidewalks Adjacent to Curb and Gutter' and OPSD 310.030 'Concrete Sidewalk Ramps at intersection' are recommended for the construction of the concrete sidewalk. A minimum of 150 mm bedding of OPSS Granular A compacted to 100% SPMDD is required for the concrete sidewalk panels.

All proposed new curbs shall be constructed as per applicable standards. It is recommended to follow City of Ottawa detail provided in SC3, Concrete Curb, and Sidewalk as a minimum requirement. All curbs shall receive a minimum of 150 mm Granular A bedding on approved subgrade free from soft, loose, and organic material.

7.9 Cement Type and Corrosion Potential

Seven soil samples were submitted to Parcel laboratories for testing of chemical properties relevant to exposure of concrete elements to sulphate attacks as well as potential soil corrosivity effects on buried metallic structural elements. Test results are presented in Table 6-4.

The potential for sulphate attack on concrete structures is moderate to low. Therefore, Type GU Portland cement may be adequate to protect buried concrete elements in the subsurface conditions encountered.

Based on electrical resistivity results and chloride content, the corrosion potential for buried steel elements is within the nonaggressive range.

8.0 PAVEMENT STRUCTURE

No details are provided on the traffic loads but it is understood that the parking lot and surrounding paved area is to be used frequently by light to heavy weight vehicles, and transport trucks on a daily basis. Pavement structure most likely to be placed on engineered fill material overlaying native soil. If the native soil is peat or contains high organic matter, it is recommended to be replaced with compacted Granular A or Granular B Type II and compacted to 98% SPMDD. If excavation through native subgrade is required to accommodate the pavement structure, then the subgrade should be proof rolled under the supervision of a geotechnical engineer. Should grade raise be required, compacted Granular B Type II or Granular A should be placed as needed and compacted to 98% SPMDD prior to construction of pavement structure.

The proposed pavement structure for light vehicles parking area and access road is included in Table 8-1:

Table 8-1: “Light Duty” Pavement Structure

Material		Thickness (mm)
Surface	Superpave 12.5 mm, PG 58-34	50
Base	OPSS Granular A	150
Sub-base	OPSS Granular B Type II	350

A heavier pavement structure is needed for access roads and loading docs which are known for heavy transport truck access.

Table 8-2: Truck Traffic Pavement Structure

Material		Thickness (mm)
Surface	Superpave 12.5 mm, PG 58-34	40
Binder	Superpave 19.0 mm, PG 58-34	50
Base	OPSS Granular A	150
Sub-base	OPSS Granular B Type II	450

The proposed pavement structures are designed for proof rolled subgrades or proper grade raise using granular material conforming to OPSS 1010 Granular criteria.

The base and sub base materials, i.e., Granular A for base and Granular Type B or SSM for subbase, shall be in accordance with OPSS 1010. Both base and sub-base should be compacted to 100% SPMDD. Asphalt layers should be compacted to comply with OPSS 310. Where the pavement structure is to be placed on engineered fill, the upper 600 mm of the fill should be compacted to 98% SPMDD to act as subbase.

Above recommended Superpave 12.5 and 19.0 can be replaced with HL-3 and HL-8 if required. If the required quantity of SP-19/HL-8 is small, and to avoid providing multiple asphalt mix designs, SP-19 can be replaced with SP-12.5 as long as they are placed in two separate layers. McIntosh Perry will not be responsible for cost implications of such decision.

9.0 CONSTRUCTION CONSIDERATIONS

Any organic material and loose sand of any kind should be removed from the footprint of the footings and all structurally load-bearing elements. Site preparation and requirements of engineered fill placement are noted in through previous sections. Refer to relevant sections for material and compaction requirements.

As noted in the previous sections, all grade adjustments due to over-excavation, within the shallow footings influence zone, shall be done using OPSS Granular A.

All backfilling shall comply with the City of Ottawa Special Provision General No. D-029 for compaction requirements, unless the design recommendations included in this report exceed provisions of D-029.

Foundation walls should be backfilled with free-draining material with granular material conforming to OPSS 1010 Granular criteria. However, the native soil can provide drainage if it is proposed to be used for any portion of the design with no compaction requirement.

A geotechnical engineer or technician should attend the site to confirm the native subgrade, type of fill material, and level of compaction. All bearing surfaces should be inspected by experienced geotechnical personnel prior to placing the footings to ensure the excavated subgrade it as the reported and recommended condition.

Vibration monitoring should be carried out during excavation and construction phases to ensure that the vibration levels at the existing surrounding structures and utilities are maintained below tolerable levels.

10.0 GROUNDWATER SEEPAGE

The groundwater is expected to be below the depth of the foundation level. However, depending on the construction season, surface runoff can seep into the excavation due to high hydraulic permeability of the native sand and groundwater may present above the depth of excavation. Hydraulic conductivity value of the native sand is expected approximately 1x10E-3. This hydraulic conductivity values are estimated based on soil gradation analysis. In-situ percolation tests were not performed as part of this investigation. The provided hydraulic conductivity value can be used for the selection of the pump capacity for dewatering. The excavated subgrade must be kept dry at all times to minimize the disturbance of the subgrade. If excavation proceeds below the groundwater level, the water level shall be lowered to a minimum of 1 m below the proposed bottom of excavation before excavation and compaction. Groundwater elevation is expected to fluctuate seasonally. Any surface water infiltrating into the open excavation can be removed through conventional sump and pump methods. The subgrade shall be kept dry at all times, especially before compaction and proof rolling.

Under the new regulations (O.Reg 63/16 and O.Reg 387/04), a Permit to Take Water (PTTW) is required from the Ministry of the Environment, Conservation and Parks (MOECP) if a volume of water greater than 400,000 liters per day is pumped from the excavation under normal operation, but more than 50,000 liters per day, the water taking will not require a PTTW, but will need to be registered in the EASR as a prescribed activity. Since the excavations will likely be above the groundwater level, it is considered unlikely that a PTTW would be required. The site designer shall decide on the permit application based on the expected excavation volume.

The design of the dewatering system should be the responsibility of the contractor. An outlet(s) should be identified, which the contractor can use to dispose of the pumped groundwater and incident precipitation. In order for pumped groundwater to be discharged to a City sewer, the groundwater quality needs to meet the City of Ottawa Sewer Use By-law limits, and a separate sewer discharge permit or City approval is required.

11.0 SITE SERVICES

At the subject site, the burial depth of water-bearing utility lines is typically 2.4 m below the ground surface. If this depth is not achievable, equivalent thermal insulation should be provided. The contractor should retain a professional engineer to provide detailed drawings for excavation and temporary support of the excavation walls during construction.

The Occupational Health and Safety Act (OHSA) of Ontario indicated that side slopes in the sand above the water table could be classified as Type 3 soil and below the water table as Type 4 soil and sloped no steeper than 3H:1V or be shored. If space restrictions exist, the excavations can be carried out within trench boxes, which is fully braced to resist lateral earth pressure.

Due to the potential for long term settlement of topsoil and organic materials and the effects of this settlement on service lines sensitive to level change, the existing topsoil, and organic materials are not considered suitable for the support of site services. Utilities should be supported on a minimum of 150 mm bedding of Granular A compacted to a minimum of 98% of SPMDD. Utility cover can be Granular A or Granular B type II compacted to 96% SPMDD. All covers are to be compacted to 100% SPMDD if they are intersecting structural elements. The engineer designing utilities shall ensure the proposed utility pipes can tolerate compaction loads.

To extend the life of buried utilities, it is recommended utility bedding and backfill to be separated from the native soil by filter geotextile.

12.0 CLOSURE

We trust this geotechnical investigation report meets the requirements of your project. The “Limitations of Report” presented in Appendix A are an integral part of this report. Please contact the undersigned should you have any questions or concerns.

McIntosh Perry Consulting Engineers Ltd.

Mohammed Al-Khazaali, Ph.D., P.Eng.
Geotechnical Engineer

N’eem Tavakkoli, M.Eng., P.Eng.
Senior Geotechnical Engineer

LICENSED PROFESSIONAL ENGINEER
NT
N. AZIZI TAVAKKOLI
100150911
Sep 10/2021
PROVINCE OF ONTARIO

REFERENCES

1) Canadian Geotechnical Society, "Canadian Foundation Engineering Manual", 4th Edition, 2006.

2) Ontario Ministry of Natural Resources (OMNR), Ontario Geological Survey, Special Volume 2, "The Physiography of Southern Ontario", 3rd Edition, 1984.

3) Google Earth, Google, 2015.

4) Government of Canada, National Building Code of Canada (NBCC), "Seismic Hazard Calculation" (online), 2010.

5) Canadian Standards Association (CSA), "Concrete Materials and Methods of Concrete Construction", A23.1, 2009

6) Government of Ontario, "Ontario Building Code (OBC)," (online), 2012.

7) MTO – Pavement Design and Rehabilitation Manual

8) Natural Resources Canada – Seismic Hazard Calculator

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

APPENDIX A
LIMITATIONS OF REPORT

LIMITATIONS OF REPORT

McIntosh Perry Consulting Engineers Ltd. (McIntosh Perry) carried out the field work and prepared the report. This document is an integral part of the Foundation Investigation and Design report presented.

The conclusions and recommendations provided in this report are based on the information obtained at the borehole locations where the tests were conducted. Subsurface and groundwater conditions between and beyond the boreholes may differ from those encountered at the specific locations where tests were conducted and conditions may become apparent during construction, which were not detected and could not be anticipated at the time of the site investigation. The benchmark level used and borehole elevations presented in this report are primarily to establish relative differenced in elevations between the borehole locations and should not be used for other purposes such as to establish elevations for grading, depth of excavations or for planning construction.

The recommendations presented in this report for design are applicable only to the intended structure and the project described in the scope of the work, and if constructed in accordance with the details outlined in the report. Unless otherwise noted, the information contained in this report does not reflect on any environmental aspects of either the site or the subsurface conditions.

The comments or recommendation provided in this report on potential construction problems and possible construction methods are intended only to guide the designer. The number of boreholes advanced at this site may not be sufficient or adequate to reveal all the subsurface information or factors that may affect the method and cost of construction. The contractors who are undertaking the construction shall make their own interpretation of the factual data presented in this report and make their conclusions, as to how the subsurface conditions of the site may affect their construction work.

The boundaries between soil strata presented in the report are based on information obtained at the borehole locations. The boundaries of the soil strata between borehole locations are assumed from geological evidences. If differing site conditions are encountered, or if the Client becomes aware of any additional information that differs from or is relevant to the McIntosh Perry findings, the Client agrees to immediately advise McIntosh Perry so that the conclusions presented in this report may be re-evaluated.

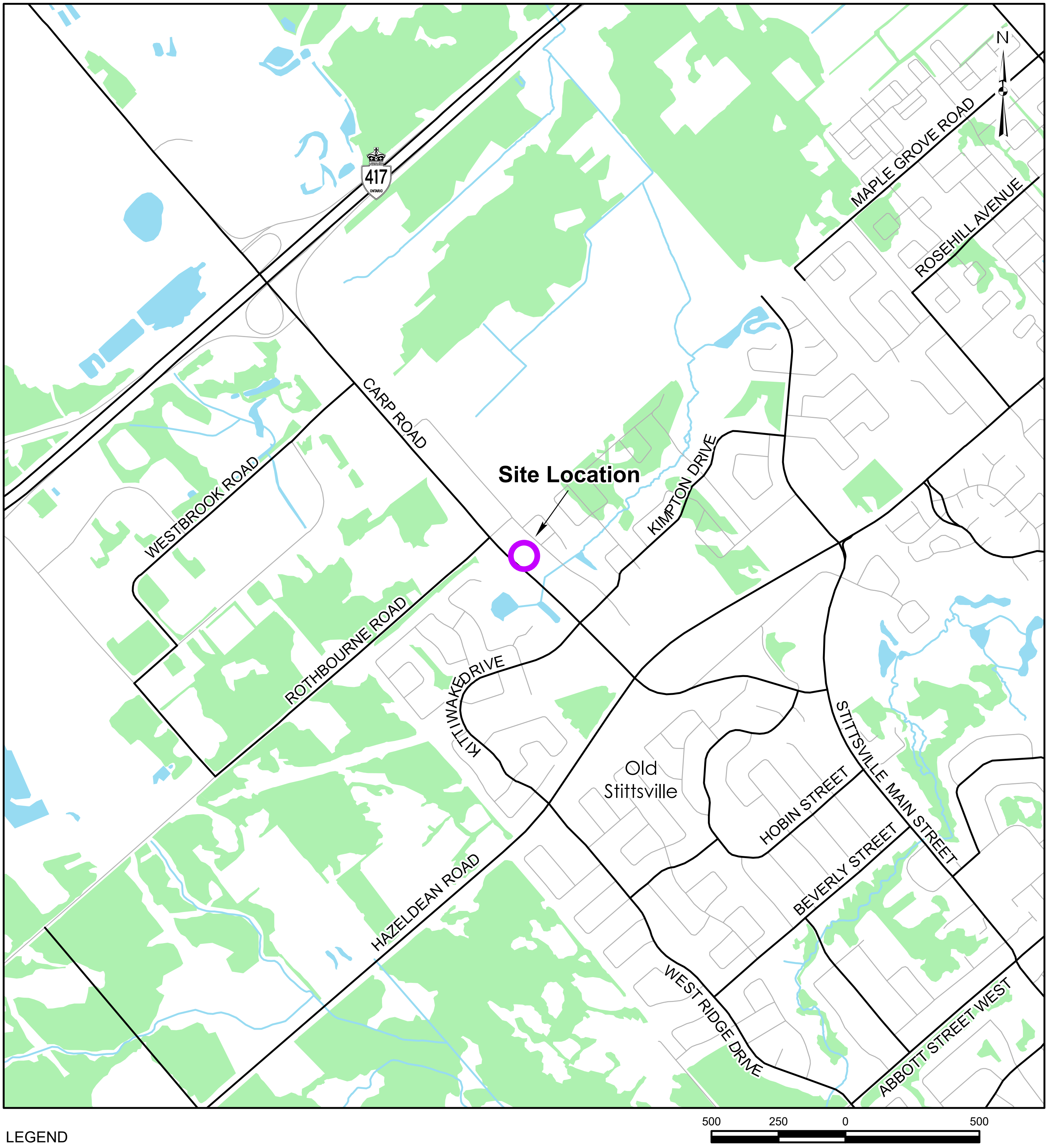
Under no circumstances shall the liability of McIntosh Perry for any claim in contract or in tort, related to the services provided and/or the content and recommendations in this report, exceed the extent that such liability is covered by such professional liability insurance from time to time in effect including the deductible therein, and which is available to indemnify McIntosh Perry. Such errors and omissions policies are available for inspection by the Client at all times upon request, and if the Client desires to obtain further insurance to protect it against any risks beyond the coverage provided by such policies, McIntosh Perry will co-operate with the Client to obtain such insurance.

McIntosh Perry prepared this report for the exclusive use of the Client. Any use which a third party makes of this report, or any reliance on or decision to be made based on it, are the responsibility of such third parties. McIntosh Perry accepts no responsibility and will not be liable for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

APPENDIX B
FIGURES

McINTOSH PERRY



LEGEND

○	Site Location	—	Watercourse
—	Local Road	🟦	Waterbody
—	Major Road	🟩	Wooded Area

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2020.

CLIENT:
JIM BELL ARCHITECTURAL DESIGN INC.

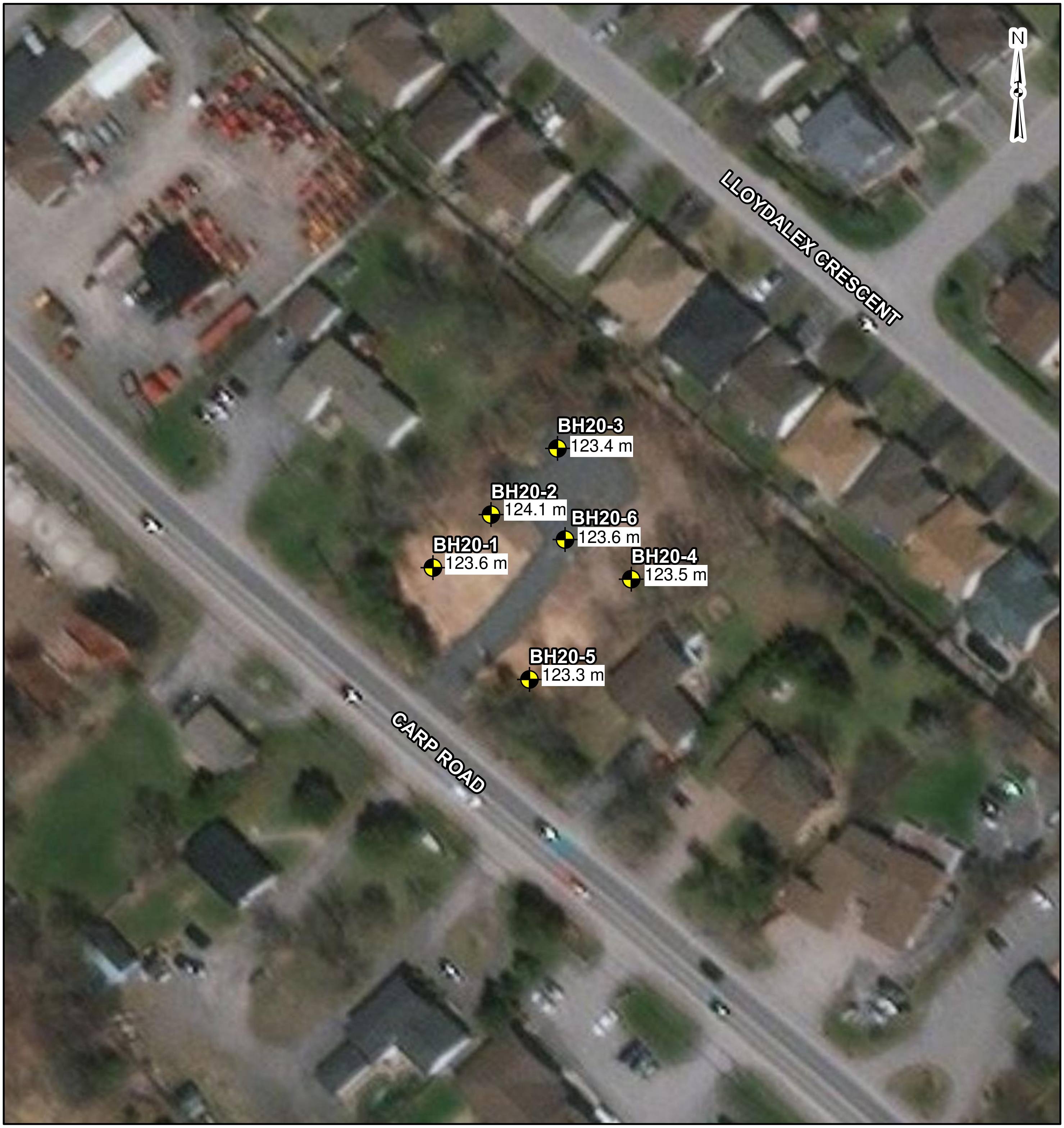
PROJECT: GEOTECHNICAL INVESTIGATION
OF OFFICE BUILDINGS AT 1037 CARP ROAD

TITLE:
SITE LOCATION

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

PROJECT NO:CCO-19-0125		FIGURE:
Date	Nov., 12, 2020	1
GIS	EU	
Checked By	MA	

C:\Users\e.ungun\McIntosh Perry\GIS - Documents\Projects\2019\CCO\CCO-19-0125 Bekim Concrete Inc. - 1037 Carp Road\aprx\Geotech\CCO-19-0125-Geotech.aprx



LEGEND

⊕ Borehole Location

CLIENT:
JIM BELL ARCHITECTURAL DESIGN INC.

PROJECT: GEOTECHNICAL INVESTIGATION
OF OFFICE BUILDINGS AT 1037 CARP ROAD

TITLE:
BOREHOLE LOCATIONS

McINTOSH PERRY
115 Walgreen Road, RR3, Carp, ON K0A1L0
Tel: 613-836-2184 Fax: 613-836-3742
www.mcintoshperry.com

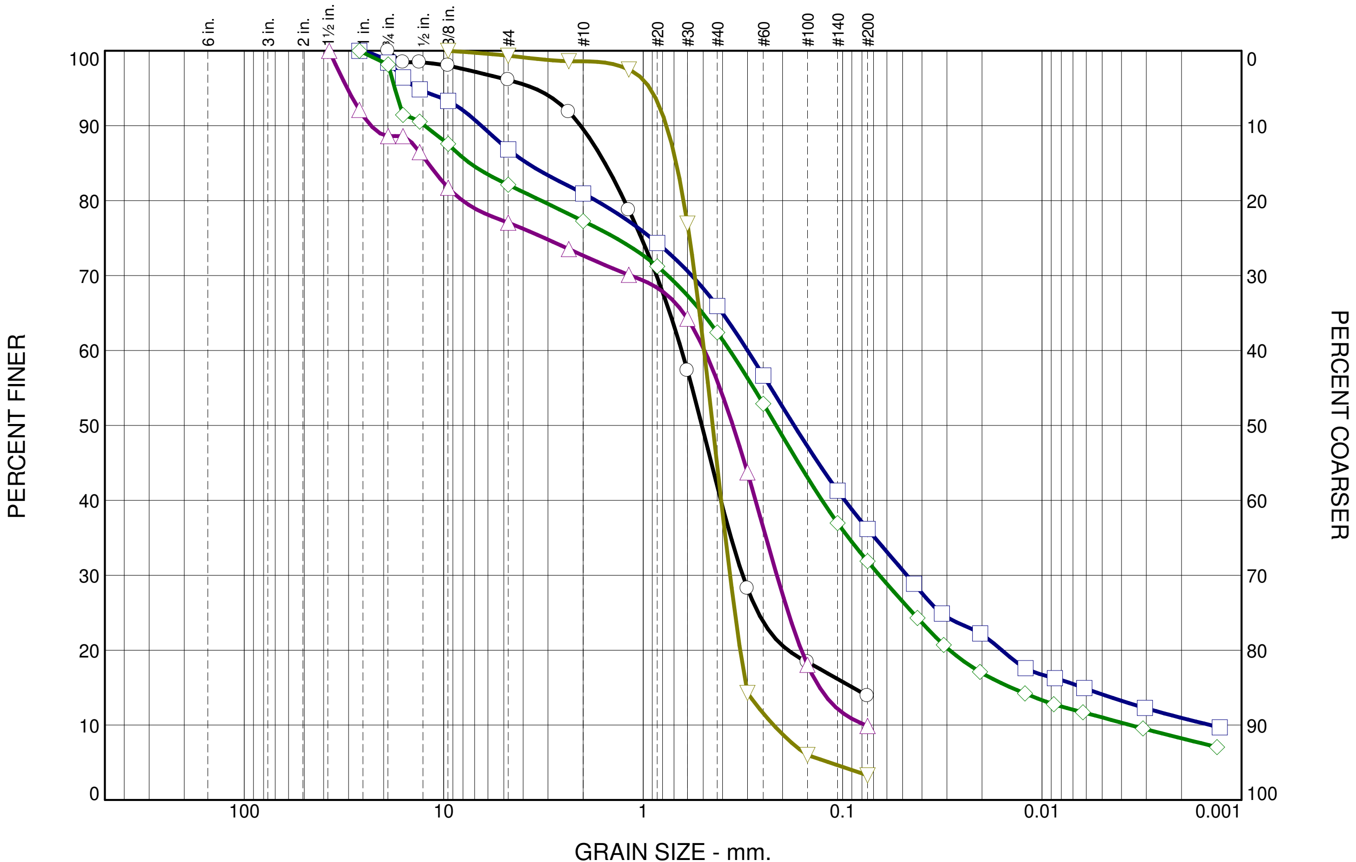
PROJECT NO:CCO-19-0125		FIGURE:
Date	Nov., 12, 2020	2
GIS	EU	
Checked By	MA	

REFERENCE

GIS data provided by the Ontario Ministry of Natural Resources and Forestry, 2020.

C:\Users\e.ungun\McIntosh Perry\GIS - Documents\Projects\2019\CCO\CCO-19-0125 Bekim Concrete Inc. - 1037 Carp Road\aprx\Geotech\CCO-19-0125-Geotech.aprx

Particle Size Distribution Report



	% +75mm	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	3.9	6.5	47.7	28.0	13.9	
□	0.0	1.5	11.7	5.8	15.1	29.7	25.2	11.0
△	0.0	11.4	11.5	4.4	16.8	46.0	9.9	
◇	0.0	1.8	16.1	4.8	14.9	30.5	23.7	8.2
▽	0.0	0.0	0.7	0.7	54.1	41.2	3.3	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	1037 Carp. Rd.	BH2001SS05	10.0-12.0'	Sand some Silt trace Gravel	
□	1037 Carp. Rd.	BH2001SS09	27.5'-29.5'	Silty Sand some Gravel some Clay	
△	1037 Carp. Rd.	BH2003SS06	15.0-17.0'	Gravelly Sand trace Silt	
◇	1037 Carp. Rd.	BH2003SS09	27.5-29.0'	Silty Sand some Gravel trace Clay	
▽	1037 Carp. Rd.	BH2005SS04	7.5-9.5'	Sand trace Silt	SP

McINTOSH PERRY

Client: Jim Bell Architectural Design Inc.

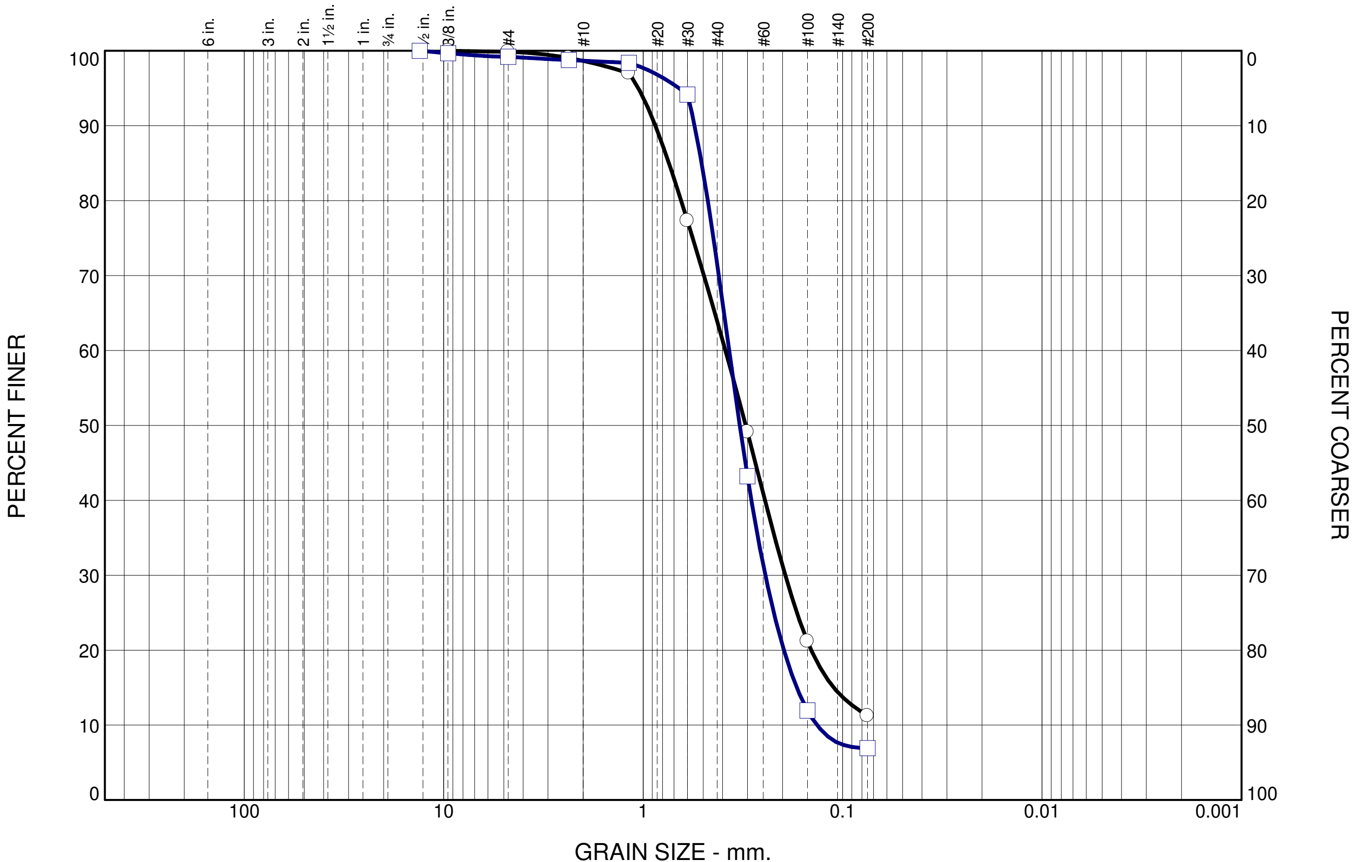
Project: Geotech Investigation - Proposed Office Buildings 1037 Carp. Rd. Ottawa, ON.

Project No.: CP19-0125 **Figure** 3

These results are for the exclusive use of the client for whom they were obtained.

Checked By: H.Smith

Particle Size Distribution Report



	% +75mm	% Gravel		% Sand			% Fines	
		Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
○	0.0	0.0	0.1	1.2	34.8	52.7	11.2	
□	0.0	0.0	0.8	0.5	27.2	64.6	6.9	

SOIL DATA

SYMBOL	SOURCE	SAMPLE NO.	DEPTH (ft.)	Material Description	USCS
○	1037 Carp. Rd.	BH2005SS08	22.5-24.5'	Sand some Silt	
□	1037 Carp. Rd.	BH2006SS03	5.0-7.0'	Sand trace Silt	

McINTOSH PERRY

Client: Jim Bell Architectural Design Inc.

Project: Geotech Investigation - Proposed Office Buildings 1037 Carp. Rd. Ottawa, ON.

Project No.: CP19-0125 **Figure** 4

Checked By: H.Smith

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

APPENDIX C
BOREHOLE LOGS

McINTOSH PERRY

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5 kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS $\overline{N}$.

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

ROCKS ARE DESCRIBED BY THEIR COMPOSION AND STRUCUTRAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_l, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ε	%	LINEAR STRAIN
$\varepsilon_1, \varepsilon_2, \varepsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICALL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
$\Phi_{'}$	$-^o$	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
Φ_u	$-^o$	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_t	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1,%	VOID RATIO	e_{min}	1,%	VOID RATIO IN DENSEST STATE
Υ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1,%	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{min}}$
P_w	kg/m^3	DENSITY OF WATER	w	1,%	WATER CONTENT	D	mm	GRAIN DIAMETER
Υ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
P	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
Υ	kN/m^3	UNIT WEIGHT OF SOIL	w_P	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
P_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
Υ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_P	%	PLASTICITY INDEX = $(W_L – W_L)$	v	m/s	DISCHARGE VELOCITY
P_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(W – W_P)/ I_P$	i	1	HYDAULIC GRADIENT
Υ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(W_L – W) / 1_P$	k	m/s	HYDRAULIC CONDUCTIVITY
P'	kg/m^3	DENSITY OF SUBMERED SOIL	$e_{,max}$	1,%	VOID RATIO IN LOOSEST STATE	j	kN/m^3	SEEPAGE FORCE
Υ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

McINTOSH PERRY

BOREHOLE No 20-1

Page 1 of 2

DATE: 14/10/2020 - 14/10/2020
PROJECT: 19-0125_1037_CARP
CLIENT: Jim Bell Architectural Design Inc.
ELEVATION: 123.60 m

LOCATION: 1037 Carp Road, Ottawa
COORDINATES: Lat: 45.271821 , Lon: -75.944760
DATUM: Geodetic
REMARK:

ORIGINATED BY: A.L.
COMPILED BY: AL
CHECKED BY: NT
REPORT DATE: 13/11/2020

SOIL PROFILE

ELEVATION - m DEPTH - m	DESCRIPTION
123.6	Natural ground surface
0.0	Topsoil: Peat, dark brown, loose. Presence of organic matter.
123.0 0.6	Sand, some silt, traces of gravel, light brown, dry, compact.
116.0 7.6	Silty sand, some clay and gravel, grey, wet, compact.
114.2	

SAMPLES

TYPE AND NUMBER	RECOVERY	"N" or RQD	REMARKS & GRAIN SIZE DISTRIBUTION (%) G	S	M	C
SS-01	0	4				
SS-02	54	9				
SS-03	58	21				
SS-04	54	16				
SS-05	87	7	4	82	15	
SS-06	83	24				
SS-07	79	12				
SS-08	71	34				
SS-09	87	9	13	51	26	11
SS-10		REF				

GROUNDWATER CONDITIONS: ▼ 5.8 m

DEPTH - feet: 5, 10, 15, 20, 25, 30
DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

SYMBOL | STATE

DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80

SHEAR STRENGTH (kPa)
Vane test: ◇ Intact ◆ Remolded
Lab vane: ☐ Intact ■ Remolded
20 40 60 80 100

WATER CONTENT and LIMITS (%)
W_P W W_L
25 50 75

\\LICENSES7\Sobek\Geotec80\Style\Log_Borehole_v5_NEW.sty

BOREHOLE No 20-1

DATE: 14/10/2020 - 14/10/2020
PROJECT: 19-0125_1037_CARP
CLIENT: Jim Bell Architectural Design Inc.
ELEVATION: 123.60 m

LOCATION: 1037 Carp Road, Ottawa
COORDINATES: Lat: 45.271821 , Lon: -75.944760
DATUM: Geodetic
REMARK:

ORIGINATED BY: A.L.
COMPILED BY: AL
CHECKED BY: NT
REPORT DATE: 13/11/2020

DEPTH - feet	DEPTH - meters	SOIL PROFILE: ELEVATION - m / DEPTH - m	SOIL PROFILE: DESCRIPTION	SYMBOL	SAMPLES: TYPE AND NUMBER	SAMPLES: STATE	SAMPLES: RECOVERY	SAMPLES: "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT (20 40 60 80) / SHEAR STRENGTH (kPa) Vane test ◇ Intact ◆ Remolded; Lab vane ☐ Intact ■ Remolded (20 40 60 80 100)	WATER CONTENT and LIMITS (%) W_P W W_L (25 50 75)	REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C
			Inferred Bedrock **END OF BOREHOLE** **Water was mesured in open borehole**									Spoon Refusal at 9.4 m

DEPTH - feet: 35, 40, 45, 50, 55, 60
DEPTH - meters: 10, 11, 12, 13, 14, 15, 16, 17, 18

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McINTOSH PERRY

BOREHOLE No 20-2

Page 1 of 1

DATE: 14/10/2020 - 14/10/2020
PROJECT: 19-0125_1037_CARP
CLIENT: Jim Bell Architectural Design Inc.
ELEVATION: 124.10 m

LOCATION: 1037 Carp Road, Ottawa
COORDINATES: Lat: 45.271908 , Lon: -75.944623
DATUM: Geodetic
REMARK:

ORIGINATED BY: A.L.
COMPILED BY: AL
CHECKED BY: NT
REPORT DATE: 13/11/2020

DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80

SHEAR STRENGTH (kPa) Vane test: ◇ Intact, ◆ Remolded; Lab vane: ☐ Intact, ■ Remolded; 20 40 60 80 100

WATER CONTENT and LIMITS (%) W_P W W_L; 25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C

ELEVATION - m	DEPTH - m	SOIL PROFILE – DESCRIPTION	TYPE AND NUMBER	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%)
124.1		Natural ground surface					
	0.0	Topsoil: Peat, dark brown, dry, loose. Presence of organic matter.	SS-01	29	9		
123.5	0.6	Sand, traces of silt, light brown, dry, compact.	SS-02	79	22		
			SS-03	79	20		
			SS-04	79	22		
			SS-05	75	9		
			SS-06	71	17		
						5.8 m	
			SS-07	79	18		
116.5	7.6	Silty sand, grey, wet, very loose to loose.	SS-08	100	2		
			SS-09	44	REF		Split spoon sampler refusal at 8.8 m Auger refusal at 8.9 m
115.2	8.9	**Inferred Bedrock** **END OF BOREHOLE** **Water was measured in open**					

\\LICENSES7\Sobek\Geotec80\Style\Log_Borehole_v5_NEW.sty

McINTOSH PERRY

BOREHOLE No 20-3

DATE: 14/10/2020 - 14/10/2020
PROJECT: 19-0125_1037_CARP
CLIENT: Jim Bell Architectural Design Inc.
ELEVATION: 123.40 m

LOCATION: 1037 Carp Road, Ottawa
COORDINATES: Lat: 45.272017 , Lon: -75.944466
DATUM: Geodetic
REMARK:

ORIGINATED BY: A.L.
COMPILED BY: M.A.
CHECKED BY: NT
REPORT DATE: 13/11/2020

ELEVATION - m DEPTH - m	SOIL PROFILE DESCRIPTION	SAMPLES TYPE AND NUMBER	RECOVERY	"N" or RQD	GROUNDWATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) G S M C
123.4	Natural ground surface					
0.0	Topsoil: Gravel, peat, Presence of cobbles and organic matter.					
123.2 0.2	Topsoil: Peat and organic matter, dark brown, dry to moist.	SS-01	0	5		
122.5 0.9	Sand, traces of silt and gravel, light brown, dry, compact.	SS-02	29	7		
		SS-03	87	28		
		SS-04	96	22		
		SS-05	100	26		
119.0 4.4	Gravelly sand, traces of silt, light brown, damp to moist, compact. Presence of cobbles.	SS-06	92	58		22 68 10 Auger ruttling
117.9 5.5	Sand, traces of silt and gravel, brown, wet, compact.				5.7 m	
		SS-07	92	23		
115.8 7.6	Silty sand, some gravel, traces of clay, grey, wet, loose.	SS-08	29	6		
		SS-09	95	REF		17 52 23 8
114.5 8.9	**Inferred Bedrock** **END OF BOREHOLE** **Water was measured in open**					

DEPTH - feet: 5, 10, 15, 20, 25, 30
DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

DYNAMIC CONE PEN. RESISTANCE PLOT: 20 40 60 80

SHEAR STRENGTH (kPa): Vane test ◇ Intact ◆ Remolded; Lab vane ☐ Intact ■ Remolded; 20 40 60 80 100

WATER CONTENT and LIMITS (%): W_P W W_L; 25 50 75

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McINTOSH PERRY

BOREHOLE No 20-4

Page 1 of 1

DATE: 15/10/2020 - 15/10/2020
PROJECT: 19-0125_1037_CARP
CLIENT: Jim Bell Architectural Design Inc.
ELEVATION: 123.50 m

LOCATION: 1037 Carp Road, Ottawa
COORDINATES: Lat: 45.271800 , Lon: -75.944295
DATUM: Geodetic
REMARK:

ORIGINATED BY: A.L.
COMPILED BY: M.A.
CHECKED BY: N.T.
REPORT DATE: 13/11/2020

SOIL PROFILE

ELEVATION - m DEPTH - m	DESCRIPTION
123.5	Natural ground surface
0.0	Topsoil: Peat and organic matter, dark brown, dry, loose.
123.0 0.5	Sand, traces of silt and gravel, light brown, dry to moist, compact.
115.9 7.6	Silty sand, grey, wet, very loose.
114.9 8.6	**Inferred Bedrock** **END OF BOREHOLE** **Water was measured in open**

SAMPLES

TYPE AND NUMBER	RECOVERY	"N" or RQD
SS-01	29	7
SS-02	100	24
SS-03	100	25
SS-04	75	30
SS-05	100	24
SS-06	79	18
SS-07		14
SS-08	25	1
SS-09	83	REF

GROUNDWATER CONDITIONS: 5.8 m ▼

DEPTH - feet: 5, 10, 15, 20, 25, 30
DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80

SHEAR STRENGTH (kPa)
Vane test: ◇ Intact ◆ Remolded
Lab vane: ☐ Intact ■ Remolded
20 40 60 80 100

WATER CONTENT and LIMITS (%)
W_P W W_L
25 50 75

REMARKS & GRAIN SIZE DISTRIBUTION (%)
G S M C

McINTOSH PERRY

BOREHOLE No 20-5

DATE:	15/10/2020 - 15/10/2020	**LOCATION:**	1037 Carp Road, Ottawa	**ORIGINATED BY:**	A.L.
PROJECT:	19-0125_1037_CARP	**COORDINATES:**	Lat: 45.271635 , Lon: -75.944536	**COMPILED BY:**	M.A.
CLIENT:	Jim Bell Architectural Design Inc.	**DATUM:**	Geodetic	**CHECKED BY:**	NT
ELEVATION:	123.30 m	**REMARK:**		**REPORT DATE:**	13/11/2020

SOIL PROFILE

ELEVATION - m DEPTH - m	DESCRIPTION
123.3	Natural ground surface
0.0	Topsoil: Peat, wood chips, organic matter.
122.7 0.6	Sand, traces of silt and gravel, light brown to brown, dry, Loose to compact.
117.2 6.1	Sand, some silt, grey, wet, compact to dense.
115.1 8.2	**END OF BOREHOLE** **Water was measured in open borehole**

SAMPLES

TYPE AND NUMBER	RECOVERY	"N" or RQD	REMARKS & GRAIN SIZE DISTRIBUTION (%) G	S	M	C
SS-01	0	2				
SS-02	54	8				
SS-03	75	15				
SS-04	71	15	1	96	4	
SS-05	33	27				
SS-06	75	15				
SS-07	92	16				
SS-08	62	32	0	89	11	
SS-09	71	54				

GROUNDWATER CONDITIONS: ▼ 6.1 m

DEPTH - feet: 5, 10, 15, 20, 25, 30

DEPTH - meters: 1, 2, 3, 4, 5, 6, 7, 8, 9

SYMBOL

STATE

DYNAMIC CONE PEN. RESISTANCE PLOT
20 40 60 80

SHEAR STRENGTH (kPa)
Vane test: ◇ Intact, ◆ Remolded
Lab vane: ☐ Intact, ■ Remolded
20 40 60 80 100

WATER CONTENT and LIMITS (%)
W_P W W_L
25 50 75

\\LICENSES7\Sobek\Geotec80\Style\Log_Borehole_v5_NEW.sty

McINTOSH PERRY

BOREHOLE No 20-6

DATE: 15/10/2020 - 15/10/2020
LOCATION: 1037 Carp Road, Ottawa
ORIGINATED BY: A.L.
PROJECT: 19-0125_1037_CARP
COORDINATES: Lat: 45.271866 , Lon: -75.944450
COMPILED BY: M.A.
CLIENT: Jim Bell Architectural Design Inc.
DATUM: Geodetic
CHECKED BY: NT
ELEVATION: 123.60 m
REMARK:
REPORT DATE: 13/11/2020

DEPTH - feet	DEPTH - meters	SOIL PROFILE ELEVATION - m DEPTH - m	SOIL PROFILE DESCRIPTION	SYMBOL	SAMPLES TYPE AND NUMBER	SAMPLES STATE	SAMPLES RECOVERY	SAMPLES "N" or RQD	GROUNDWATER CONDITIONS	DYNAMIC CONE PEN. RESISTANCE PLOT 20 40 60 80 SHEAR STRENGTH (kPa) Vane test ◇ Intact ◆ Remolded; Lab vane ☐ Intact ■ Remolded 20 40 60 80 100	WATER CONTENT and LIMITS (%) W_P W W_L 25 50 75	REMARKS & GRAIN SIZE DISTRIBUTION (%) G	S	M	C
		123.6	Natural ground surface												
		0.0	Topsoil: Gravel, loose. Presence of cobbles and organic matter.		SS-01		12	6							
		123.3 0.3	Topsoil: Peat,organic matter.												
	1	122.8 0.8	Sand, traces of silt and gravel, light brown, dry, loose to compact.		SS-02		42	4							
5	2				SS-03		71	19				1	93	7	
		121.5 2.1	**ENF OF BOREHOLE**												
10	3														
	4														
15	5														
20	6														
	7														
25	8														
	9														
30															

\\LICENSES7\Sobek\Geotec80\Style\Log_Borehole_v5_NEW.sty

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

APPENDIX D
LAB RESULTS

Only selected pages from the third-party lab are included in this appendix

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Certificate of Analysis

McIntosh Perry Consulting Eng. (Nepean)

215 Menten Place, Unit 104
Nepean, ON K2H 9C1
Attn: Harrison Smith

Client PO:
Project: CP19-0125
Custody: 128663

Report Date: 2-Nov-2020
Order Date: 28-Oct-2020

Order #: 2044382

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

Paracel ID	**Client ID**
2044382-01	BH20-01 SS03 - Carp Rd.
2044382-02	BH20-03 SS03 - Carp Rd.

Approved By: Mark Foto

Mark Foto, M.Sc.
Lab Supervisor

Certificate of Analysis
Client: McIntosh Perry Consulting Eng. (Nepean)
Client PO:

Report Date: 02-Nov-2020
Order Date: 28-Oct-2020
Project Description: CP19-0125

Analysis Summary Table

Analysis	Method Reference/Description	Extraction Date	Analysis Date
Anions	EPA 300.1 - IC, water extraction	30-Oct-20	30-Oct-20
pH, soil	EPA 150.1 - pH probe @ 25 °C, CaCl buffered ext.	28-Oct-20	29-Oct-20
Resistivity	EPA 120.1 - probe, water extraction	30-Oct-20	30-Oct-20
Solids, %	Gravimetric, calculation	29-Oct-20	29-Oct-20

Certificate of Analysis

Client: McIntosh Perry Consulting Eng. (Nepean)

Client PO:

Report Date: 02-Nov-2020

Order Date: 28-Oct-2020

Project Description: CP19-0125

Client ID:		BH20-01 SS03 - Carp Rd.	BH20-03 SS03 - Carp Rd.	-	-
Sample Date:		15-Oct-20 09:00	15-Oct-20 09:00	-	-
Sample ID:		2044382-01	2044382-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	96.6	94.3	-	-
General Inorganics					
pH	0.05 pH Units	8.06	7.92	-	-
Resistivity	0.10 Ohm.m	126	92.0	-	-
Anions					
Chloride	5 ug/g dry	9	7	-	-
Sulphate	5 ug/g dry	<5	<5	-	-

Qualifier Notes:

None

Sample Data Revisions

None

Work Order Revisions / Comments:

None

Other Report Notes:

n/a: not applicable
ND: Not Detected
MDL: Method Detection Limit
Source Result: Data used as source for matrix and duplicate samples
%REC: Percent recovery.
RPD: Relative percent difference.
NC: Not Calculated

Soil results are reported on a dry weight basis when the units are denoted with 'dry'.
Where %Solids is reported, moisture loss includes the loss of volatile hydrocarbons.

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

APPENDIX E
SEISMIC HAZARD CALCULATION

McINTOSH PERRY

2010 National Building Code Seismic Hazard Calculation

INFORMATION: **Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836**
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.272N 75.945W **User File Reference:** 1037 Carp Road 2020-11-12 15:13 UT

Requested by: McIntosh Perry

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.2)	0.600	0.369	0.234	0.083
Sa (0.5)	0.293	0.178	0.117	0.041
Sa (1.0)	0.132	0.084	0.053	0.017
Sa (2.0)	0.044	0.027	0.017	0.006
PGA (g)	0.308	0.191	0.115	0.034

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada Ressources naturelles Canada

Canada

Liquefaction Evaluation for the Proposed Development on

1037 Carp Road

Project #: CP-19-0125

Soil stratigraphy for the site consists of a thick sand deposit that extends to approximately 7.6 m below the existing ground level. The native sand layer is followed by a till layer that is approximately 1.3 m thick and followed by inferred bedrock. The groundwater is approximately at 5.7 m depth below the existing ground surface. Herein liquefaction susceptibility of the native sand layer and the till layer is evaluated.

For coarse-grained soils with fines content up to 35%, the corrected SPT resistance can be used to determine the susceptibility of the coarse-grained soil to liquefaction according to Canadian Foundation Engineering Manual CFEM (2006). Seven representative samples from the native sand and till layers underwent grain size analysis. The percentage of gravel, sand, silt and clay are presented in Table 1.

Table 1: Grain Size Distribution of native Sand/Silty Sand

Borehole No.	Sample No.	$(N_1)_{60}$	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	r_d	*CSR*
BH20-01	○ SS-05	9	3.0 – 3.6	4	82	15		0.97	0.020
BH20-01	△ SS-09	11	8.3 – 8.9	13	51	26	11	0.93	0.024
BH20-03	◇ SS-06	64	4.5 – 5.1	22	68	10		0.96	0.020
BH20-03	□ SS-09	8	7.6 – 8.2	17	52	23	8	0.94	0.023
BH20-05	▽ SS-04	23	2.3 – 2.9	1	96	4		0.98	0.020
BH20-05	⬢ SS-08	40	8.3 – 8.9	0	89	11		0.93	0.024
BH20-05	✚ SS-03	34	1.5 – 2.1	1	93	7		0.99	0.020

To evaluate the liquefaction susceptibility of the native sand and till layers using SPT test results, Cyclic Stress Ratio (CSR) has to be estimated based on site seismicity characteristics that were obtained from seismic calculator available on Natural Resources Canada website. CSR can be calculated using the following formula:

$$CSR = 0.65 \times \frac{a_{max} . \sigma_v}{g . \sigma'_{v0}} \times r_d$$

where a_{max} is the peak ground surface acceleration for the designed earthquake, *g* is gravity acceleration (9.81 m/s^2), σ_v is total vertical overburden pressure, σ'_{v0} is the initial effective overburden pressure and r_d is stress reduction factor at the depth of interest. r_d and *CSR* values are presented in Table 1.

Based on the calculated CSR and corrected SPT values, Figure 1 from CFEM can be used to evaluate the native sand and till layers susceptibility to liquefaction. The CSR results and the corrected SPT ‘N’ values were plotted on the figure and the native sand and till layers were found to be non-susceptible to liquefaction.

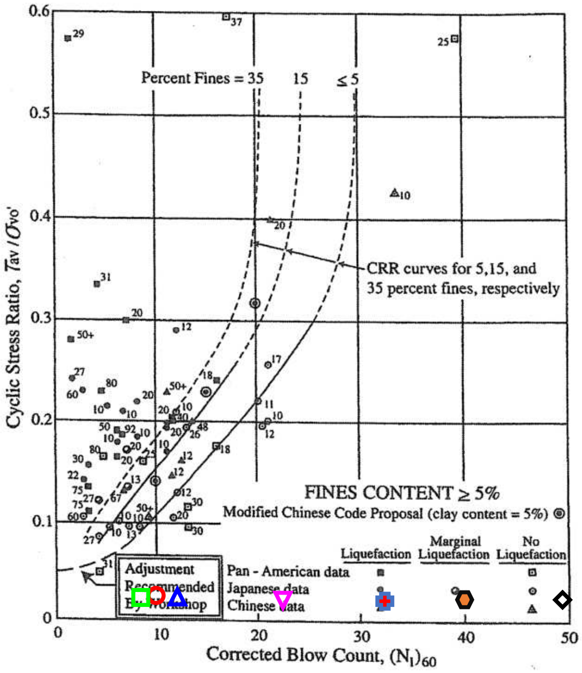
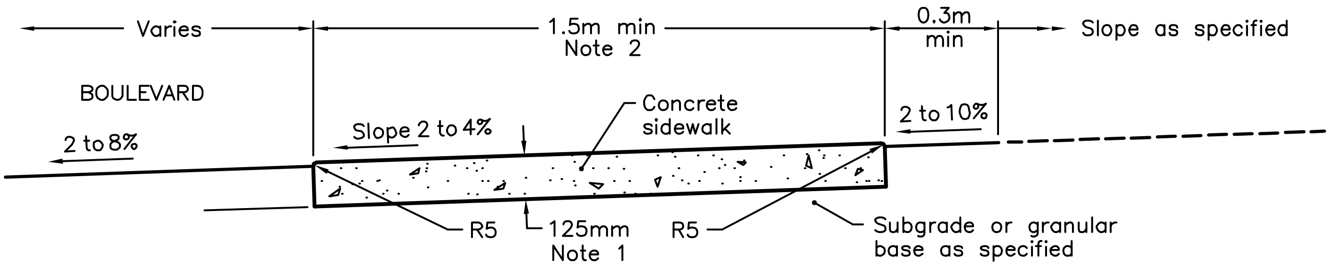


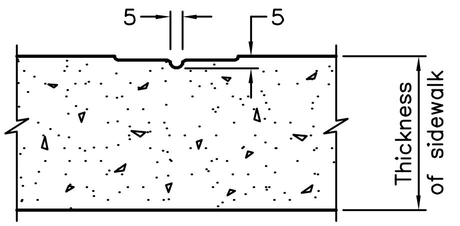
Figure 1: CRS vs Corrected SPT N value, $(N_1)_{60}$ (modified from CFEM 2006)

GEOTECHNICAL INVESTIGATION OF OFFICE BUILDNG AT 1037 CARP ROAD

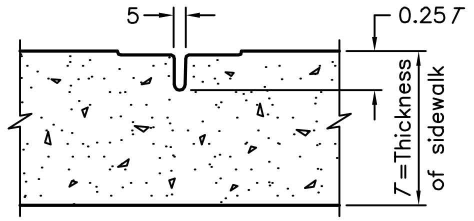
APPENDIX F
RELEVANT STANDARDS



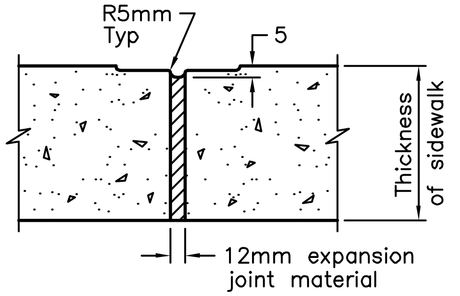
TYPICAL SECTION



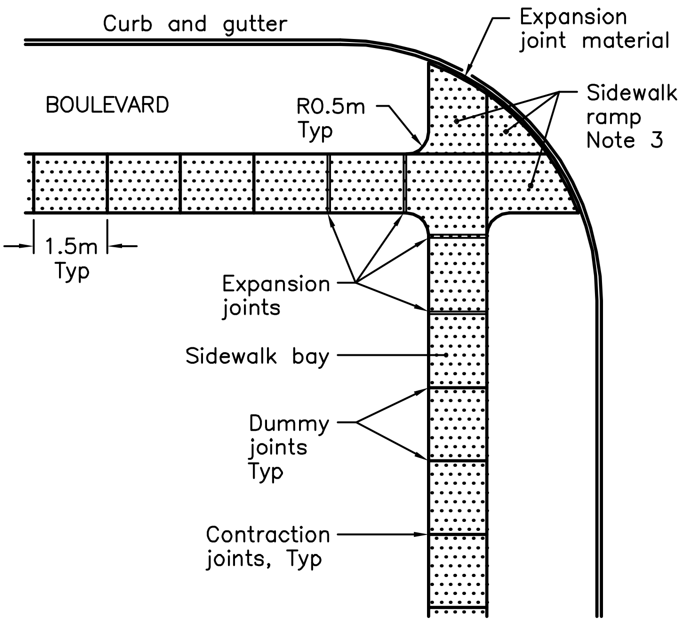
DUMMY JOINT (OPTIONAL)



CONTRACTION JOINT



EXPANSION JOINT



JOINT LAYOUT

NOTES:

1 Sidewalk thickness at residential driveways and adjacent to curb shall be 150mm. At commercial and industrial driveways, the thickness shall be 200mm.

2 Sidewalk width shall be wider when specified.

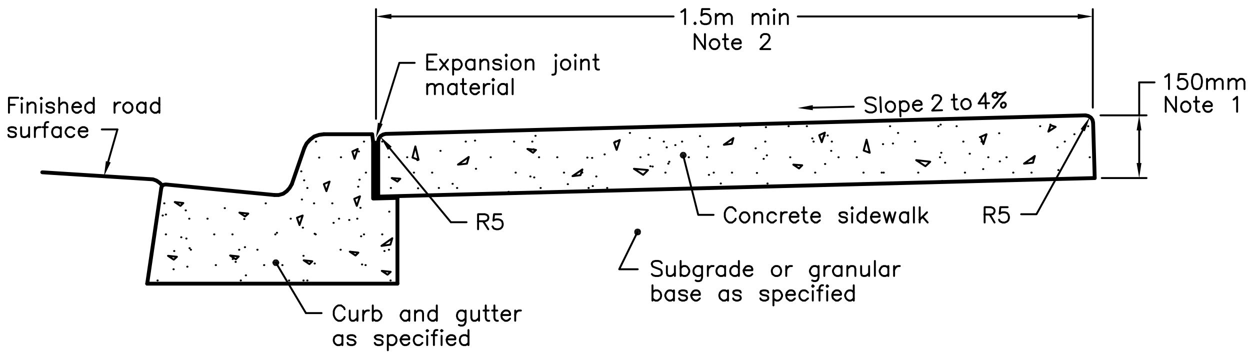
3 This OPSD shall be read in conjunction with OPSD 310.030, 310.031, 310.032, 310.033 and 310.039.

A All dimensions are in millimetres unless otherwise shown.

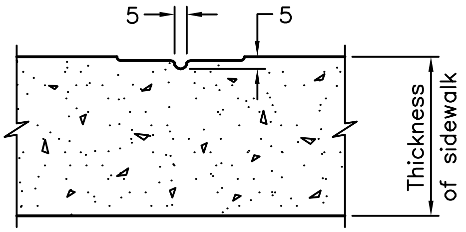
ONTARIO PROVINCIAL STANDARD DRAWING
Nov 2015
Rev 2

CONCRETE SIDEWALK

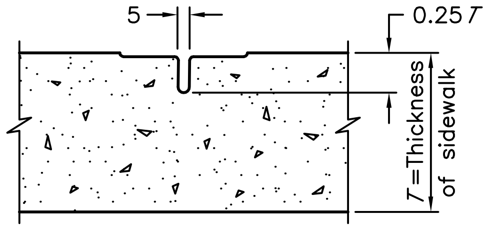
OPSD 310.010



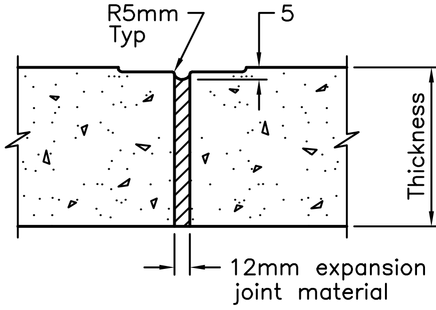
TYPICAL SECTION



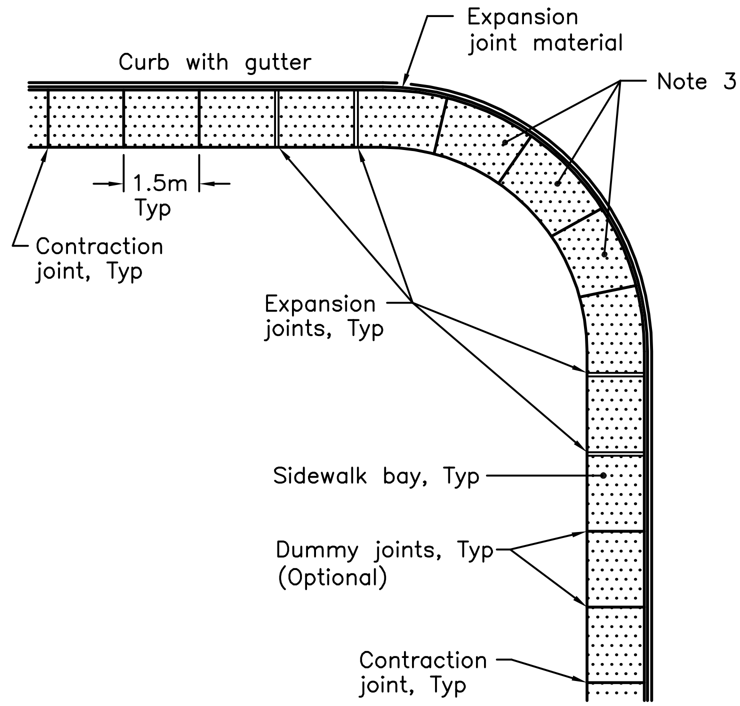
DUMMY JOINT



CONTRACTION JOINT



EXPANSION JOINT



JOINT LAYOUT

NOTES:

1 At commercial and industrial driveways, the thickness shall be 200mm.

2 Sidewalk width shall be wider when specified.

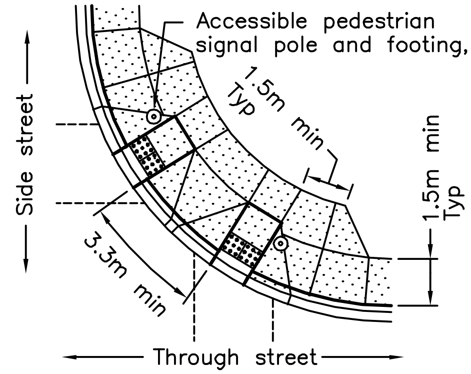
3 This OPSD shall be read in conjunction with OPSD 310.030, 310.031, 310.033, and 310.039.

A All dimensions are in millimetres unless otherwise shown.

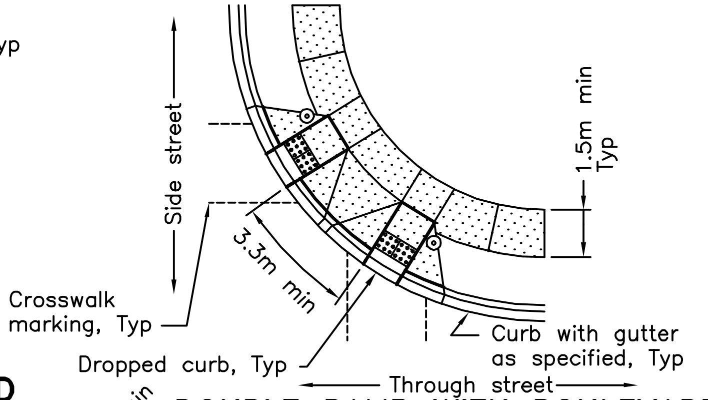
ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2019 | Rev 3

CONCRETE SIDEWALK
ADJACENT TO CURB WITH GUTTER

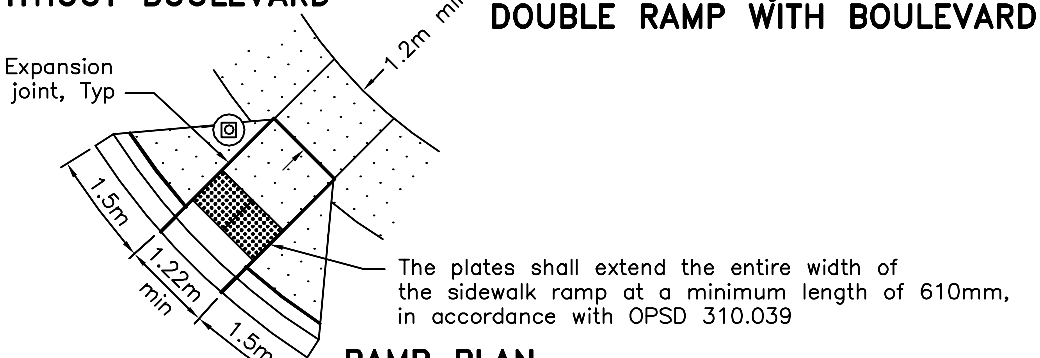
OPSD 310.020



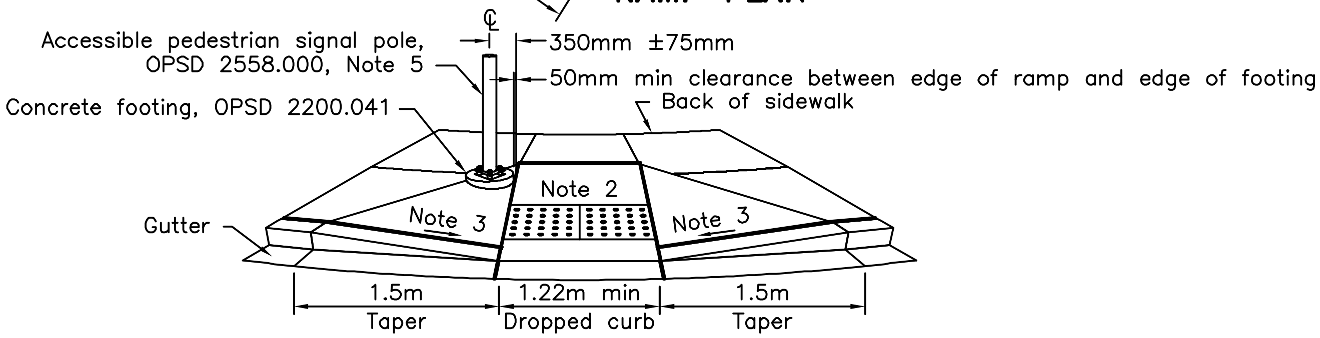
DOUBLE RAMP WITHOUT BOULEVARD



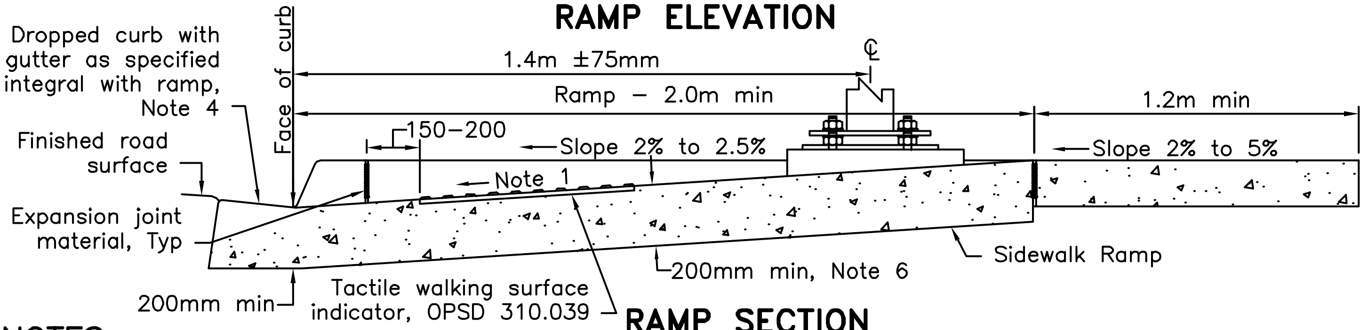
DOUBLE RAMP WITH BOULEVARD



RAMP PLAN



RAMP ELEVATION



RAMP SECTION

NOTES:

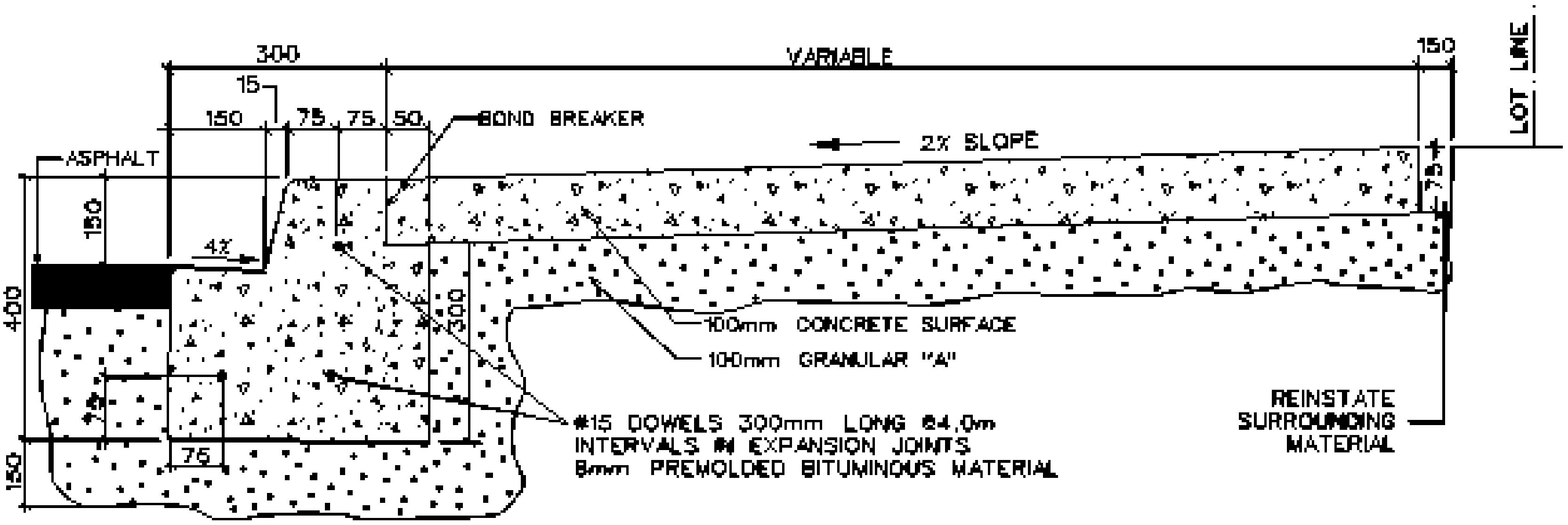
1 Slope of ramp shall not exceed 8%.
2 Cross slope of ramp shall not exceed 2% in either direction.
3 Cross slope of flared side of ramp shall not exceed 8%.
4 Dropped curb at ramp shall be modified to eliminate 30 mm step at gutter.
5 Accessible pedestrian signal to have tactile arrow that aligns with direction of crosswalk.
6 Minimum thickness of ramp is 200mm. Minimum thickness of sidewalk and flared sides adjacent to ramp is 150mm.
A Where only one crosswalk is present at an intersection, only one curb ramp is required.
B All dimensions are in millimetres unless otherwise shown.

ONTARIO PROVINCIAL STANDARD DRAWING

Nov 2015 Rev 1

CONCRETE SIDEWALK RAMPS AT SIGNALIZED INTERSECTIONS

OPSD 310.030



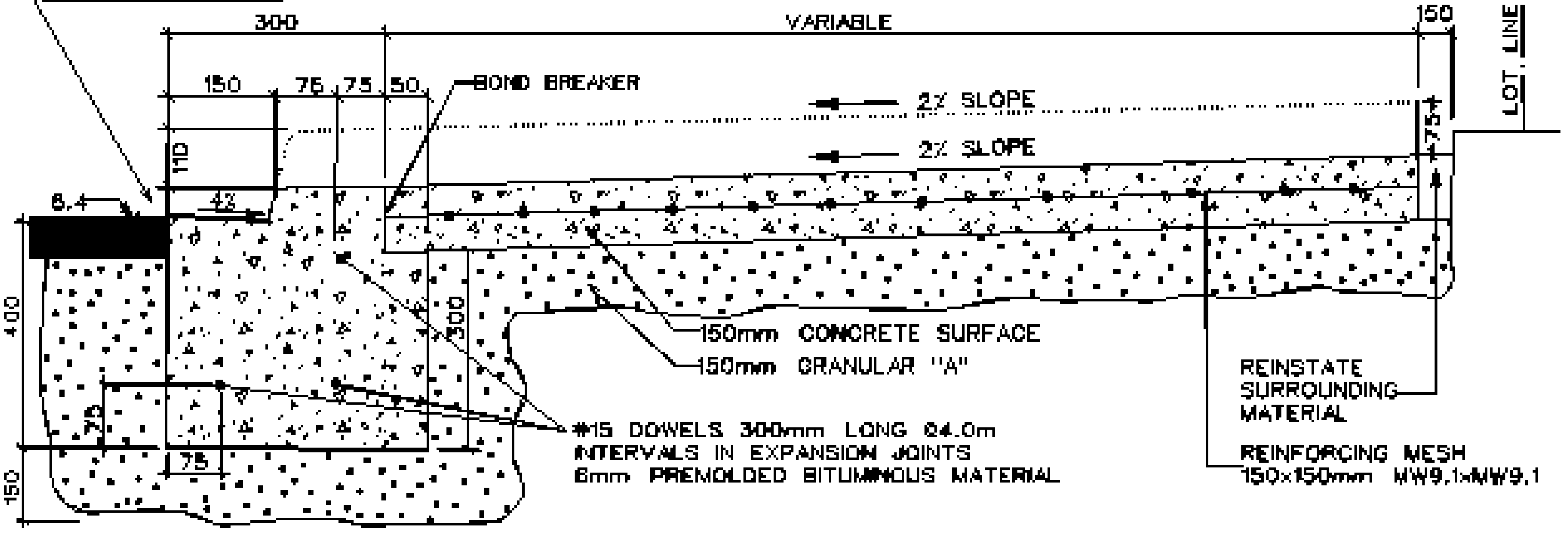
TYPICAL SIDEWALK SECTION

PEDESTRIAN

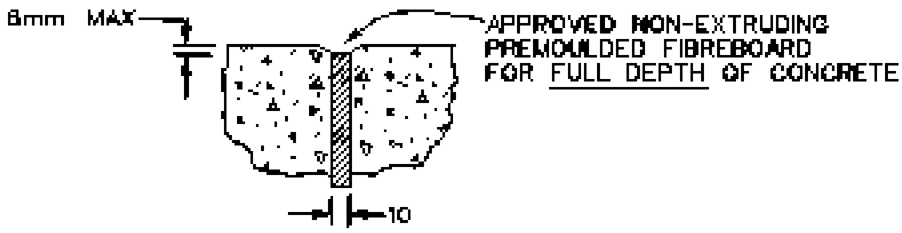
MINIMUM	0mm
DESIRED	15mm
MAXIMUM	25mm

VEHICULAR

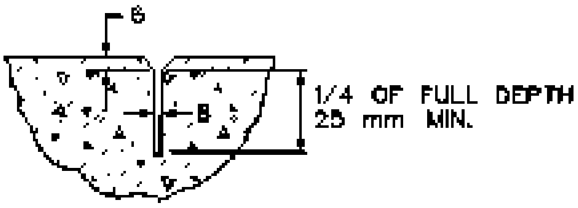
MINIMUM	15mm
DESIRED	25mm
MAXIMUM	40mm



SECTION AT DRIVEWAY AND PEDESTRIAN RAMPS



EXPANSION JOINT PROFILE



DUMMY JOINT PROFILE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS SHOWN OTHERWISE.

Ottawa

CONCRETE CURB AND GUTTER WITH SIDEWALK

DATE: MAY 2001

REV. DATE: MARCH 2002

DWG. No.: SC3