SUBSURFACE INVESTIGATION REPORT

135 LUSK ST., OTTAWA, ON, K2J 4S2

Abstract

This report presents the findings of a Subsurface Investigation completed at the 135 Lusk St. parcel, in the City of Ottawa, ON, K2J 4S2, and issue recommendations for a proposed Commercial 6 Storey Building development. It provides technical information about the subsurface conditions at 5 boreholes locations compiled from field sampling and testing and a subsequent laboratory testing program of soils. The boreholes locations and rough details of the subsurface conditions are shown in figure 1 in page 9. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC) and local climate data from Environment Canada.

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Report number: 52-OI36-R0[1]
August 17, 2020

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[1] For the account of 2441736 Ontario Inc. (OI36).

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1 Introduction

This document reports the findings of a subsurface investigation completed at 135 Lusk St., in the City of Ottawa, ON, K2J 4S2, having extents and geometry shown in figure 1 in page 9. The geotechnical materials in Ottawa and the surrounding areas are largely influenced by a history of glaciation, glacio-fluvial activity and the Champlain Sea. Common overburden materials include clay, very sensitive silty clay, till, boulder till, clean sand and silty sand overlying sedimentary rocks. Igneous and metamorphic rocks are also present. Organic materials have also influenced numerous soil deposits.

The investigation was carried out by advancing 5 boreholess through overburden soils and by proving bedrock depth by available exploration techniques for engineering purposes. The information compiled from the exploration and sampling and testing completed in the boreholess and a subsequent laboratory testing program of soils and rock is to assist in the design and construction of a proposed Commercial 6 Storey Building development. The information reviewed also includes readily available geologic information from the Geological Survey of Canada (GSC), and local climate data from Environment Canada.

2 Report Organization

The body of this report and its appendices constitute the entire report. The discussion presented under sections in the body may refer to further information and/or background and/or details in the appendices. The reader is responsible of reviewing the information in the appendices. Other references may be presented as footnotes.

Future revisions to this report will be referred to as “47-CEI-R#”, where # is the consecutive number of the revision. Additions and/or alterations and/or inclusions to the information provided in this report at the request of any institution and/or body with authority to request the additions and/or alterations and/or inclusion will be provided in a separate “Response to ” (RT) section at the end of the report, before the appendices. The RT section shall state the section that is added and/or altered, the name of the person making the request and the reason. The section altered and or portions added will be provided in full as a subsection of the RT section. Any subsection added under the RT section will be considered a replacement to the original section.

Part I

Investigation

3 Sampling and Testing

The field and laboratory program set out in our proposal is guided by the following standards:

- ASTM D 420-98 Standard Guide to Site Characterization for Engineering Design and Construction Purposes,
- ASTM D5434 - 12 Standard Guide for Field Logging of Subsurface Explorations of Soil and Rock,
- ASTM D1586 - 11 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils,
- ASTM D1586 - 11 based Dynamic Cone Penetration Test (DCPT),
- ASTM D2573 - 08 Standard Test Method for Field Vane Shear Test in Cohesive Soil.

The ASTM D1586 tests were completed using an “auto safety” hammer rated at 60% energy.

The field program consisted in sampling the subsurface profile using boreholess located as shown in fig. 1 in page 9 along with field review, assessments and classification of samples.

The program also included an elevation survey referenced to an elevation of 100 m assigned arbitrarily to the top of the storm sewer manhole (TBM) shown in the Test Hole Locations Plan in fig. 1 in page 9. The program included in addition a laboratory review of samples recovered from the field and one sample submitted to a local laboratory to investigate soluble ions concentration, PH and resistivity.

The laboratory testing, soil sampling and field testing at each location are shown in the soil profile testing and sampling logs (BH) in the appendices.

Note that all references to elevations in this report are with respect to an elevation of 100 m assigned arbitrarily to the top of the storm sewer manhole (TBM) shown in the Test Hole Locations Plan in fig. 1 in page 9.

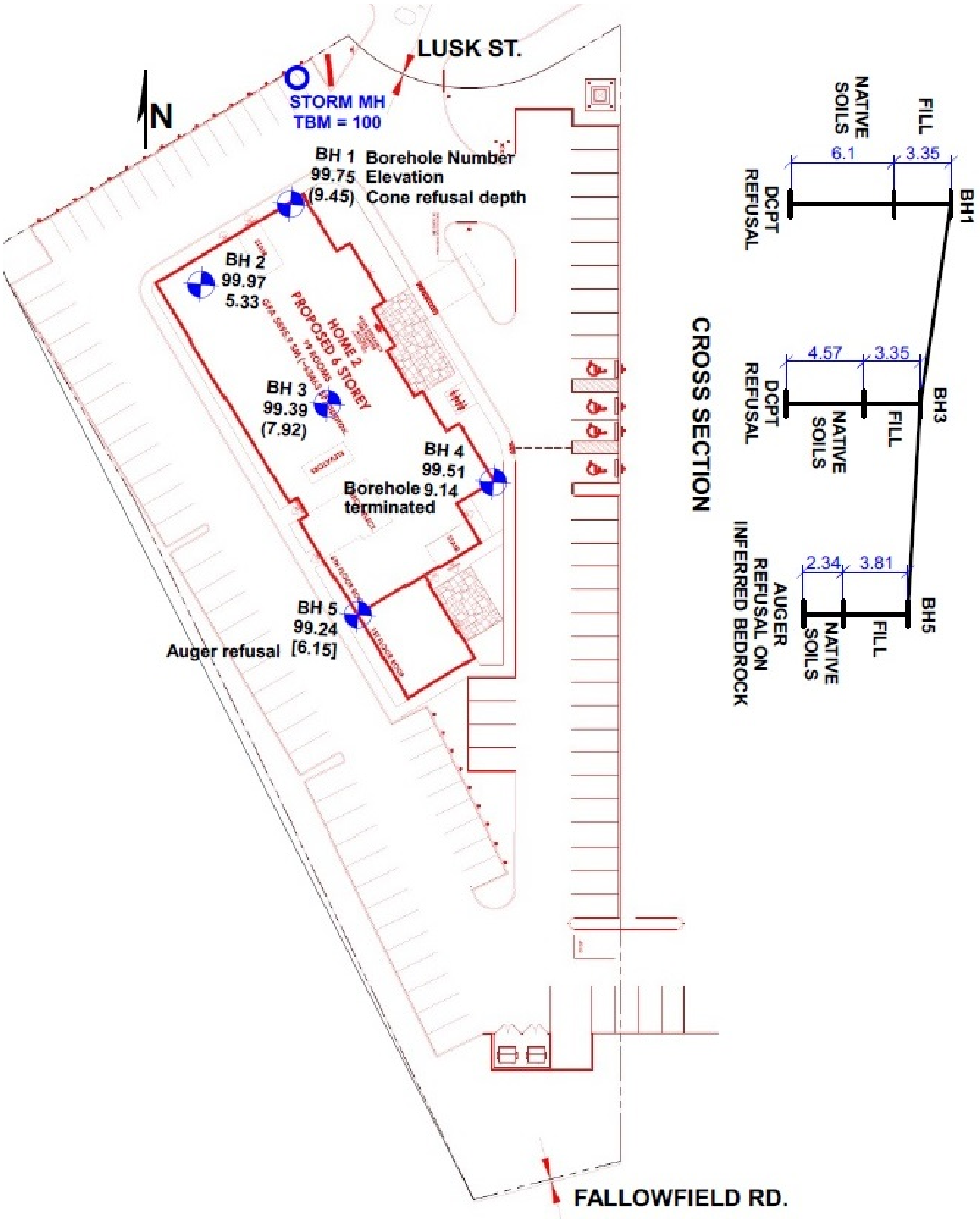

Figure 1: Test hole Locations Plan and cross section

Part II

Findings

4 Physical Settings, Strata and Topography

The site slopes slightly southwest and is bordered along the west property line by a creek. At the time of the field program the site was sparsely covered by grass and shrubs with some areas near its northeast side covered by pavement granular pads and some soil piles along its west side. It consists on the 135 Lusk St. parcel in the City of Ottawa, ON. Figure 1 in page 9 shows a plan view of the site displaying the approximate test hole locations, elevations and depth. Figure 1 in page 9 also presents a schematic site cross section including some boreholes data.

It can be seen in fig. 1 and in the testhole logs in appendix A that the site is covered by fill underlain by various materials including dark gray clay, brown clay and gray clayey sand with gravel at greater depths. Inferred bedrock was encountered at a 6.15 m depth in BH5 (Borehole 5) while DCPT tests suggest the depth of bedrock at 9.45 and 7.92 m at BHS 1 and 3 respectively as seen in fig. 9.

The geology data base by Belanger J. R. 1998 suggests 3 to 10 m of overburden soils underlain by interbedded sandstone and dolomite bedrock at this site.

5 Surface and Subsurface Materials

The site is sparsely covered by grass and shrubs with some areas near its northwest side covered by pavement granular pads and some soil piles along its west side. The arrangement of strata found in our investigation is shown in the borehole logs in appendix A and presented graphically in the schematic cross section in figure 1 in page 9. Generally, the materials within 3.3 to 3.8 m depth beneath the surface consist of fill underlain by various soil types including dark gray clay, brown clay and gray clayey sand with gravel. Bedrock is inferred at a 6.1 m depth at BH5 while DCPT tests suggest bedrock depths of 9.45, 7.92 and 6.15 at BH1, BH3 and BH5. Refer to the borehole logs in appendix A for specific details.

5.1 Gray to Dark Gray Clay

The gray to dark gray clay is stiff to very stiff (50 to more than 100 kPa of shear strength). Excavated clay cannot be used for purposes other than landscaping.

5.2 Brownish Gray and Brownish Clay

The brownish clay was found to be of 57 kPa of shear strength of 57 kPa at BH1 at 7.1 m depth.

5.3 Gray Sandy and Silty Clay with gravel

This materials are generally found at greater depths approaching inferred bedrock and refusals. Because of its high clay content and the N(60) recorded in BH5, it is estimated to be stiff to very stiff.

5.4 DCPT Tested Strata

The mechanical properties to the 9.45, 7.92 and 6.15 m depth of the DCPT tests completed in BH1, BH3 and BH5 can be estimated based on its results shown in the borehole logs in appendix A which have been used in combination with other field tests to determined the site class assigned in this report.

5.5 Groundwater and Moisture

The water level was measured on August 27, 2021 in monitoring wells installed in BH1, BH3 and BH4 at 5.08, 3.82 and 3.75 m depths respectively and shown in the boreholes logs. Ground water measurements in stand pipe installations often require numerous assessments in combination with boreholes data.

Given the findings in the BHs YME's understanding of the water table depth and elevation at this site relies entirely on the water level measurements which suggest an average depth and elevation of 4.2 and 95.33 m respectively. Moisture contents vary above the ground water table.

5.6 Freezing Index, Frost Depth and Frost Susceptibility

It is generally assumed that the frost depth for the 1,000 degree Celsius-days freezing index applicable to Ottawa will reach no deeper than 1.8 m on bare ground (snow free) or pavement. It is also assumed that frost depth will reach no deeper than 1.5 m on snow covered ground.

The soil materials encountered at this site are frost susceptible and thus will heave upon exposure to freezing temperatures. Heaving destroys the mechanical properties of soils so that any soil which has been frozen is considered disturbed.

Part III

Recommendations

The following set of the recommendations result from sampling and testing outlined in section 3 and from geotechnical engineering evaluation and assessments.

It is understood that the proposed development will consist of a Commercial 6 Storey Building with an at grade slab and no basement.

6 Foundations General

Generally speaking, code compliant OBC Part 9 and Part 4 buildings founded on deep foundations can be considered for the proposed Commercial 6 Storey Building.

6.1 Load and Resistance Factors

For the purpose of computations related to the service (SLS) and strength limits (ULS) note:

- A resistance factor is applied to the computed or estimated (nominal) bearing resistance from field or lab tests to obtain the strength limit for factored loads (ULS). The value of the resistance factor is stated for each option.
- An average load factor of 1.5 is assumed to compute the service limit (SLS).

6.2 Bearing Capacity of Strip and/or Pad Footings

Based on the findings of this investigation and geotechnical assessments, the following bearing capacity can be used *for strip footings up to 1.0 m wide and pad footings up to 2 m wide placed on undisturbed native undisturbed soils or engineered fill placed on native soils encountered in the testholes*:

- 150 kPa at service limit (SLS).
- 225 kPa for factored loads (ULS).

6.3 Settlements

For the footing loads provided in section 6.2 building settlements for foundations on undisturbed very stiff silty clay are not to exceed service limit values (SLS) of 25 mm and 20 mm total and differential settlements respectively at this site.

6.4 Deep Foundation Alternatives

Where building loads can not be accommodated with the bearing capacity described in section 6.2 deep foundations, such as driven or bored piles need to be considered.

Piles are generally driven to refusal and/or drilled to bedrock and proof tested.

Where the friction angle of the bedrock is required for design 30 degrees can be used.

Specific geotechnical resistance for specific pile systems will be provided if requested as part of this report.

6.5 Frost Protection for Foundations

Shallow foundations on frost susceptible which may be required on the perimeter of the building for canopies or other structures are considered to be frost protected when placed at sufficient depth to prevent supporting soils from freezing. Foundations in the perimeter of heated buildings where snow is not cleared are considered frost protected at 1.5 m depth (as having a soil cover of 1.5 m). Foundations away from heated buildings or in areas where snow is cleared, need to be at about 1.8 m depth to be frost protected. On the alternative frost protection can be provided by using foundation insulation for shallower foundations.

6.6 Foundation Insulation

To meet the required frost protection in section 6.5 for foundations for canopies or other structures in the perimeter of the building and in unheated areas in otherwise heated buildings 50 mm of extruded polystyrene insulation (XPS) type V, VI or VII meet foundation insulation requirements for the freezing index in the Ottawa area.

6.7 Foundation Wall Dampproofing and Drainage

Foundation walls dampproofing and foundation drainage are not required for foundations serving buildings of slab on grade construction not having floor levels lower than the finished grade on the perimeter.

Elevatior shafts often require drainage along their exterior perimeter. Appendix D.1 presents page 2 of NRC Construction Evaluation Reports CCMC 12658-R showing dampproofing and foundation wall drainage system details satisfying the provisions under OBC 2012 and suitable for drainage along the perimeter of elevator shafts. Other available similar systems having the components shown in CCMC 12658-R may be used. Foundation drainage must be provided to daylight or a positive outlet, or sump.

7 Site Class for Seismic Design

At this site, the geotechnical testing completed along with the estimated 9.45, 7.92 and 6.15 m depth of bedrock (or hard strata) via Dynamic Cone Penetration (DCPT) conducted in BH1, BH3 and BH5 are indicative of a Vs(30) exceeding 360 m/s. As such, site class C is assigned under the provisions in section 4.1.8.4 of the Ontario Building Code 2012 (OBC 2012) for seismic design.

It is hence recommended to refer to the following information in appendix B.1:

1. The 2010 National Building Code Seismic Hazard Calculation for the *reference site* in page 28.
2. Figure 2 in page 27 showing the design spectral accelerations.

8 Roadbed Soils and Pavement Structure

The flexible pavement structures supplied in this report follow the guidelines set out in AASHTO 1993 Guide for Design of Pavement Structures (AASHTO) for climatic Region III. Under AASHTO pavements are designed to withstand 20 year accumulated design Equivalent Single Axle 80 kN (18,000 pounds) load applications (ESALs). ESALs are a measure of mix traffic loads including vehicle loads and truck loads. The number of ESALs applications depend on traffic class and use.

Roadbed denotes the materials beneath pavement structures. The term pavement is used to denote the layered structure that forms a road carriageway or vehicle parking. *The general quality of the near surface undisturbed soil to serve as foundation for pavement structure (Roadbed soil) are assumed to be very poor* as defined in the AASHTO guide. It is hence recommended to refer to the following information in appendix C:

- *Yuri Mendez Engineering's pavement catalog in appendix C.1 to select pavement structures* for traffic classes on the very poor roadbed soils encountered at this site.
- Appendix C.2 for guidelines regarding frost heave.
- Appendix C.3 for frost protection recommendations for manholes and catch basin construction.

9 Excavations, Open Cuts, Trenches and Safety

Typically, the main concern when excavating soils or rock is the stability of the sides of excavations. The stability of the sides is achieved by either cutting the sides to safe slopes or by providing shoring. It is also an issue of safety because of imminent hazards to the safety of workers and to property. As such, excavations are governed by the provisions in the Occupational Health and Safety Act of Ontario (O. Reg. 213/91). The application of O. Reg. 213/91 requires a classification of soils in one or several of four types (type I to type IV).

At this site for soils can be considered type II under O. Reg. 213/91. As such, the following key aspects of O. Reg. 213/91 are applicable to excavations:

- Safe open cut is 1 vertical to 1 horizontal.
- Within 1.2 m of the bottom of open cut areas or trenches, the soil can be cut vertical.

Where the safe open cut is not provided, either the shoring systems described in O. Reg. 213/91 or engineered shoring systems need be used. Information regarding physical and mechanical properties of subsurface materials which will be required for shoring design are provided in this report.

9.1 Conditions Requiring Engineered Shoring

O. Reg. 213/91 describe the conditions in which engineered shoring systems are required. Some key aspects of O.Reg. 213/91 regarding the conditions in which an engineered shoring system is required are:

- Where soils are type I to III and the prescribed safe open cuts are not provided and
  - The excavation is not a trench or
  - The excavation is a trench either deeper than 6 m or wider than 3.6 m or both
- For trench excavations or open cut, where soils are type IV and the safe open cuts are not provided.

Note that along with the descriptions in O. Reg. 213/91 for soils type IV, any difficult soil having significant seepage and/or strength loss upon excavation such as caving soils can be rendered as type IV.

Note also that since excavation and safety are usually in control of the contractor, *shoring design and construction is done by the contractor.*

10 Reinstatement of Excavated Soils

As stated in appendix E the suitability of material for specific purposes is determined by the geotechnical engineer. To the extent they are needed, suitable material from the excavations can be used in the construction of required permanent earthfill or rockfill.

11 Stripping, Excavation to Undisturbed Soils and rock, Earth and Rock Fill Placement. Asphalt Placement and Compaction

Appendix E presents recommended geotechnical specifications and guidelines for stripping, earth and rock excavation to undisturbed surfaces, earth and rock fill placement, asphalt placement, compacted lifts thicknesses for equipment type and compaction for different placements.

11.1 Winter Construction

Winter construction is not recommended. Many construction practices are inadequate to provide protection for all the details and geometries which could allow exposure of frost susceptible soils to freezing temperatures rendering them disturbed.

In situations where YME is required for guidance and inspections during winter, YME will provide its best approach with the resources available for protections during construction in real time and its expected that the contractors will act in real time to provide the protections. YME has insufficient control of the contractor operations and and/or the construction tasks and/or the method of protection to provide any warranties in those situations. Irresponsive contractors add great potential to induce damage.

Disclaimer

2441736 Ontario Inc. OI36 and other professionals understand that soils and groundwater information in this report has been collected in boreholess guided by standards and practice guidelines generally accepted for engineering characterization of ground conditions in Ontario and in no case boreholes data and their interpretation warrant understanding of conditions away from the boreholes locations. OI36 accepts that as development will have spread away from the boreholess other designers will need the best opinion from the geotechnical consultant based on the findings of the investigation so that any statements which could be implicitly or explicitly depart from the conditions at boreholes may be given to fulfill this need in good faith as best available opinion with the information available at the time without any warranties.

User Agreement

Acknowledgment of Duties

In this 52-OI36-R0 report, Yuri Mendez Engineering (YME) has pursued to fulfill every aspect of the obligations of professional engineers. As a part of those duties, from field work, operations, testing, analyses, application of knowledge and report, YME has ensured that it meats a high standard of Geotechnical engineering practice and care in the province of Ontario. Obligations under R.R.O. 1990, Reg. 941: Professional Engineers Act, R.S.O. 1990, c. P.28, further referred to as Reg. 941 which are of immediate interest to this service are:

"77. 7. A practitioner shall,

i. act towards other practitioners with courtesy and good faith,

ii. not accept an engagement to review the work of another practitioner for the same employer except with the knowledge of the other practitioner or except where the connection of the other practitioner with the work has been terminated,

iii. not maliciously injure the reputation or business of another practitioner,

8. A practitioner shall maintain the honour and integrity of the practitioners profession and without fear or favour expose before the proper tribunals unprofessional, dishonest or unethical conduct by any other practitioner."

Communications

52-OI36-R0 is to be used solely in connection with the Commercial 6 Storey Building by 2441736 Ontario Inc. (OI36) and thus subject of communications amongst other professionals (OP), government bodies and authorities, and OI36 for that purpose. YME demands great care in precluding damage to the integrity of this professional work which may arise from careless communications from engineers of Canada. OP and OI36 acknowledge understanding that where any such communication occur in connection with this report, they are bound by this agreement as an extension to the standard of care embodied in R.R.O. 1990, Reg. 941 and thus accept that any correspondence from OP or the public seen to add any bad connotations to the breadth, depth, typesetting, typography, formal semantics and scope of this report or otherwise diminish the breadth of services and knowledge delivered in this report which in any way raise concerns or insecurities to the qualities and/or the *reasonable completeness* delivered to OI36 in this report will be forwarded to YME.

Reasonable Completeness

OP and 2441736 Ontario Inc. acknowledge understanding that said care and said standard has been applied equality to the reasonable completeness of this report relative to the information available from the field program and acknowledge understanding that is neither feasible nor possible to convey geotechnical information in this report that would cover for every possible consideration by OP and/or OI36 and that upon issuance it will be subject to reviews which may trigger the need to add information which at the discretion of YME will be added when considered within the practice obligations under Reg. 941. The geotechnical information here provided is thus envisioned as to cover for the scope and breadth of design figures and assessments generally foreseeable as needed by other designers at the time of issuance and which could be amended as needed within the context of services provided by other designers. YME agrees to issue revised versions of this 52-OI36-R0 report by adding R# to each revision where # is the number of the revision. OP covenant to conduct all communications in connection with these reviews following great care to preclude the suggestion of a breach to the reasonable completeness acknowledged herein. Written communications which may trigger reviews under this agreement will be acknowledged as requests for "review under the 52-OI36-R0 report user agreement". This reasonable completeness is also relative to the scope of services generally accepted in geotechnical engineering work in Ontario

Errors

Where errors are found during reviews under the 52-OI36-R0 report user agreement, OP covenant great care in communications to preclude the suggestion of a breach to the duties acknowledge herein which could induce damages to YME. Communications triggered by errors or any such communication which would render the person doing the request in a position of technical authority above the author implies an unauthorized review and constitute a serious breach of the code of ethics under Reg. 941 and damages to YME and so subject to disciplinary measures and/or liability for damages to YME. OI36 is thus acquainted that correction of errors will be made and acknowledged by YME as they may arise in any professional work but in no way OP will purport or render such corrections as omissions departing away from the correction of errors set forth in this agreement. Where communications in connection with the correction of errors process set forth in this agreement raise concerns or insecurities to the qualities and/or the reasonable completeness delivered to OI36 in this report occur, OI36 covenants to inform YME. OI36 is acquainted that such corrections are part of the natural processes associated with the applied sciences nature of this report and so typified explicitly in this agreement to protect YME from inappropriate manipulation of those processes by OP and others.

Disclaimer

OI36 and OP understand that soils and groundwater information in this report has been collected in boreholess guided by standards and practice guidelines generally accepted for engineering characterization of ground conditions in Ontario and in no case boreholes data and their interpretation warrant understanding of conditions away from the boreholes locations. OI36 accepts that as development will have spread away from the boreholess other designers will need the best opinion from the geotechnical consultant based on the findings of the investigation so that any statements which could be implicitly or explicitly depart from the conditions at boreholes may be given to fulfill this need in good faith as best available opinion with the information available at the time without any warranties.

Part IV

Appendices

A Borehole Logs

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Project: **Proposed 6 Storey Building**		YME Yuri Mendez Engineering.
Location: **135 Lusk St.**	Client: **2441736 Ontario Inc.**	**Test Hole No.: BH1 of 5**
Job No.: **52-OI36**	Test Hole Type: **8" OD Auger.**	Date: **August 16, 2021**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 99.75	Lithology and color	Material Description	Samples or Blows/Ft	Water	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0		▩	Fill: Brown silty sand with gravel						
0.25	99.5			**28**					
0.5									
0.75	99								
1				**24**					
1.25	98.5								
1.5		▩	Fill: Brown silty sand with gravel						
1.75	98			**4**					
2									
2.25	97.5	▩	Fill: Brown clay with silt, sand and gravel						
2.5				**5**					
2.75	97								
3									
3.25	96.5	▨		**5**					
3.5			Dark gray silty clay						
3.75	96								
4				**7**					
4.25	95.5								
4.5		▨							
4.75	95		Brownish silty clay with trace gravel	**4**					
5					▼				
5.25	94.5								
5.5				**1**					
5.75	94								
6									
6.25	93.5			**0**					
6.5									
6.75	93								
7									
7.25	92.5					✚ 57			
7.5			Brownish sandy clay	**33**					
7.75	92	▥	Strata tested using Dynamic Cone Penetration Test (DCPT)	**36**					
8				**39**					
8.25	91.5								
8.5				**45**					
8.75	91			**54**					
9				**60**					
9.25	90.5			**105**					
			Cone refusal						

YME Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed 6 Storey Building**		YME Yuri Mendez Engineering.
Location: **135 Lusk St.**	Client: **2441736 Ontario Inc.**	**Test Hole No.: BH2 of 5**
Job No.: **52-OI36**	Test Hole Type: **8" OD Auger.**	Date: **August 16, 2021**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 99.97	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 99.97	Depth (m)	Shear Strength (kPa)	Laboratory Tests Moisture Content (%)	Rock Quality RQD %	Other Lab Tests
0	99.9	▩	Fill: Brown silty sand with gravel			99.9	0				
0.25							0.25				
0.5	99.4					99.4	0.5				
0.75							0.75				
1	98.9	▩	Fill: dark gray to black silty clay with organic soils	**27**		98.9	1				
1.25							1.25				
1.5	98.4					98.4	1.5				
1.75				**7**			1.75				
2	97.9					97.9	2				
2.25							2.25				
2.5	97.4			**2**		97.4	2.5				
2.75							2.75				
3	96.9					96.9	3				
3.25				**6**			3.25				
3.5	96.4					96.4	3.5				
3.75		▨	Dark gray to brownish silty clay				3.75				
4	95.9			**9**		95.9	4				
4.25							4.25				
4.5	95.4					95.4	4.5				
4.75				**6**			4.75				
5	94.9					94.9	5				
5.25							5.25				

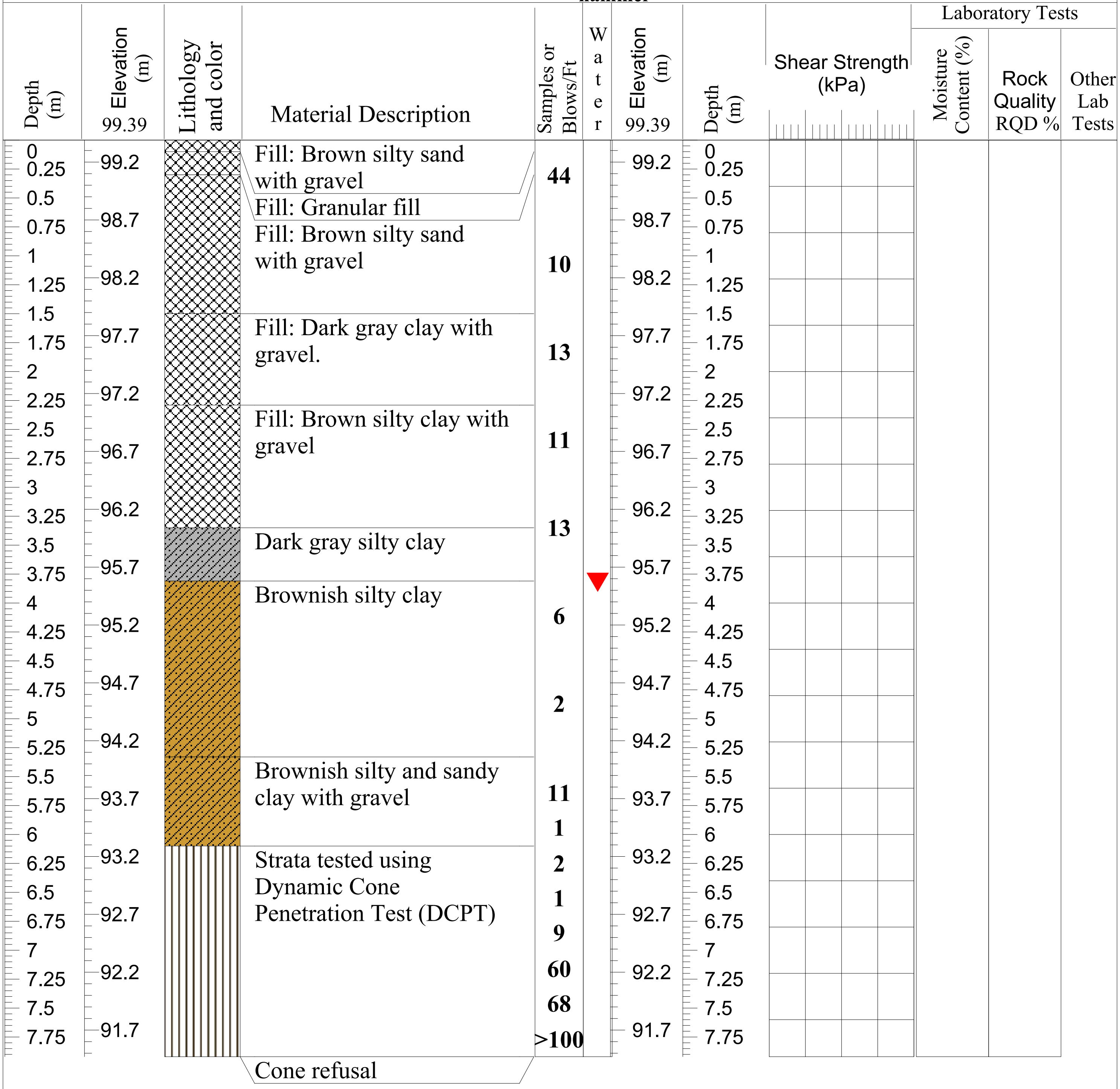
Borehole terminaged

YME
Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed 6 Storey Building**		YME Yuri Mendez Engineering.
Location: **135 Lusk St.**	Client: **2441736 Ontario Inc.**	**Test Hole No.: BH3 of 5**
Job No.: **52-OI36**	Test Hole Type: **8" OD Auger.**	Date: **August 16, 2021**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Fill: Brown silty sand with gravel

Fill: Granular fill

Fill: Brown silty sand with gravel

Fill: Dark gray clay with gravel.

Fill: Brown silty clay with gravel

Dark gray silty clay

Brownish silty clay

Brownish silty and sandy clay with gravel

Strata tested using Dynamic Cone Penetration Test (DCPT)

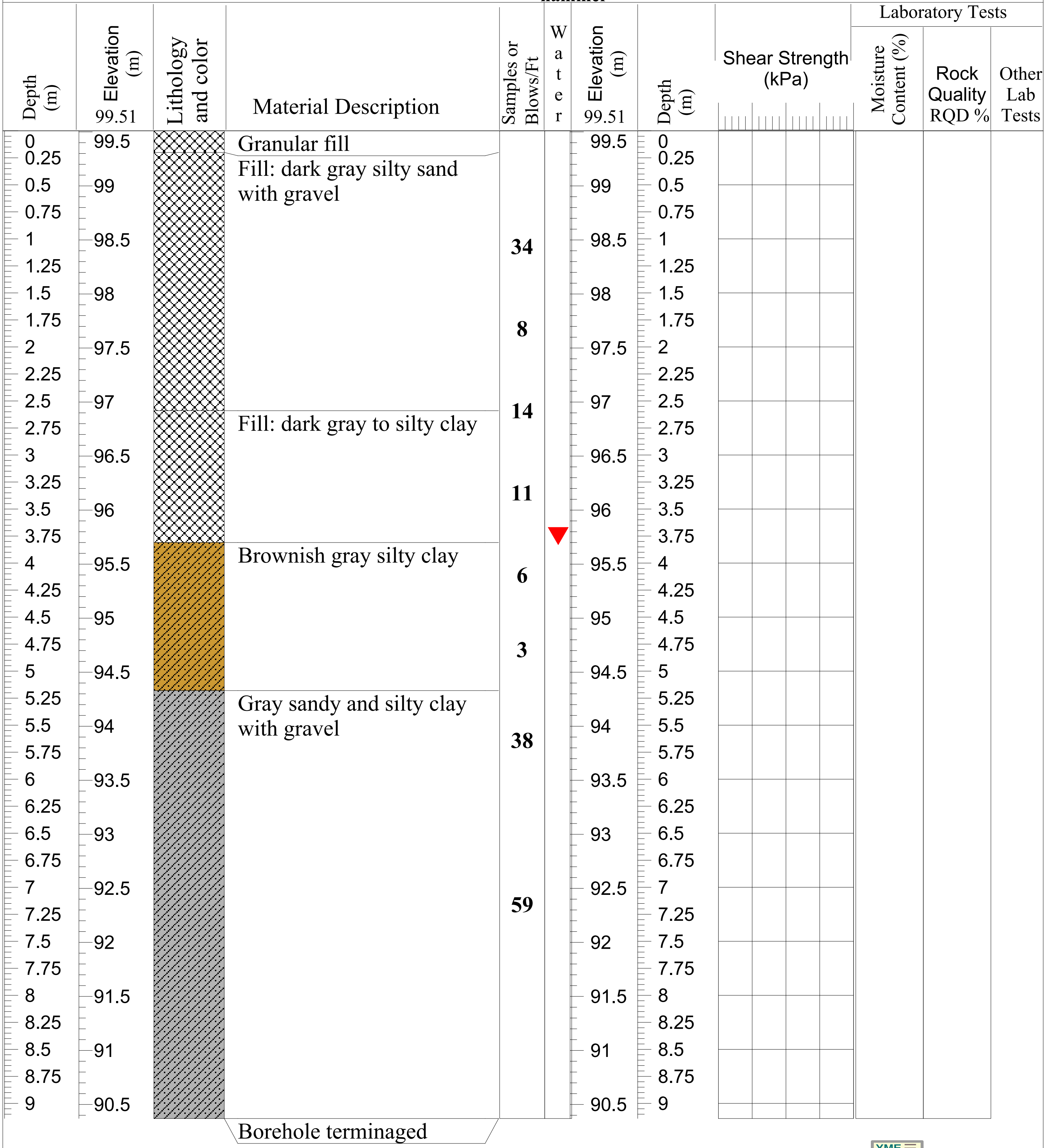
Cone refusal

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed 6 Storey Building**		YME Yuri Mendez Engineering.
Location: **135 Lusk St.**	Client: **2441736 Ontario Inc.**	**Test Hole No.: BH4 of 5**
Job No.: **52-OI36**	Test Hole Type: **8" OD Auger.**	Date: **August 16, 2021**
"7" OD Auger."	SPT Hammer Type: **Safety auto hammer**	Logged By: **Yuri Mendez**



Granular fill

Fill: dark gray silty sand with gravel

Fill: dark gray to silty clay

Brownish gray silty clay

Gray sandy and silty clay with gravel

Borehole terminaged

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

Project: **Proposed 6 Storey Building**

YME Yuri Mendez Engineering.

Location: **135 Lusk St.**

Client: **2441736 Ontario Inc.**

Test Hole No.: BH5 of 5

Job No.: **52-OI36**

Test Hole Type: **8" OD Auger.**

Date: **August 16, 2021**

"7" OD Auger."

SPT Hammer Type: **Safety auto hammer**

Logged By: **Yuri Mendez**

Depth (m)	Elevation (m) 99.24	Lithology and color	Material Description	Samples or Blows/Ft	Water	Elevation (m) 99.24	Depth (m)	Shear Strength (kPa)	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Rock Quality RQD %	Laboratory Tests: Other Lab Tests
0		▨	Granular fill				0				
0.25		▨		**26**			0.25				
0.5	98.8	▨	Fill: Brown silty sand with gravel and boulders			98.8	0.5				
0.75		▨					0.75				
1	98.3	▨		**66**		98.3	1				
1.25		▨					1.25				
1.5	97.8	▨	Fill: dark gray clay with sand gravel and organic matter			97.8	1.5				
1.75		▨		**17**			1.75				
2	97.3	▨				97.3	2				
2.25		▨					2.25				
2.5	96.8	▨		**48**		96.8	2.5				
2.75		▨					2.75				
3	96.3	▨				96.3	3				
3.25		▨		**14**			3.25				
3.5	95.8	▨				95.8	3.5				
3.75		▨					3.75				
4	95.3	▧	Dark gray clay	**7**		95.3	4				
4.25		▧					4.25				
4.5	94.8	▧	Gray silty clay with sand and gravel			94.8	4.5				
4.75		▧		**2**			4.75				
5	94.3	▧				94.3	5				
5.25		▧					5.25				
5.5	93.8	▧				93.8	5.5				
5.75		▧		**2**			5.75				
6	93.3	▧				93.3	6				
			Auger refusal								

Yuri Mendez Engineering

S = Sample for lab review and moisture content

▼ Interpreted water level

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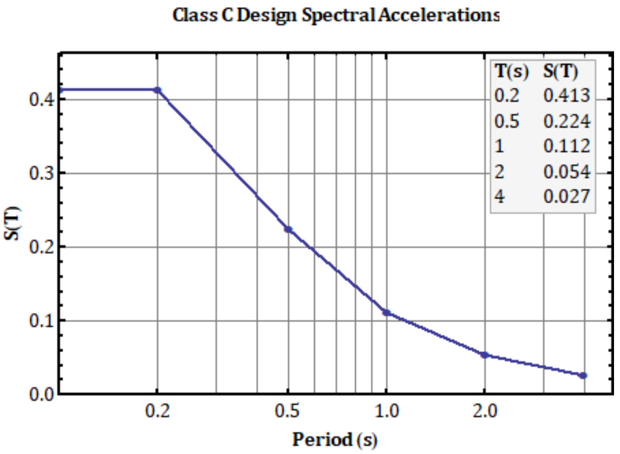

Figure 2:

Appendix

B Geotechnical Site Class Assignment

The ground motion transfered from earthquakes to buildings depend largely on ground conditions. Current seismic provisions in building codes recognize seismic waves as oscillations and buildings as oscillators having natural periods and damping. The role of soils engineering is to assign a site class which defines the interpolations prescribed under the code to obtain a spectrum of period versus damped accelerations using a base *reference site* for design of buildings at a given site. The soils information required to do this site class assignment is the velocity at which a seismic shear wave travels upward 30 meters (or downward) in a given site (Vs(30)). The Vs(30) is estimated based on standard geotechnical testing along with experience and available local data bases. Seismic tests can also be completed to determine the Vs(30) with greater accuracy.

B.1 Reference Site and Design Spectral Accelerations

Details of the *reference site* spectral and peak seismic hazard values applicable to this site are presented in the 2010 National Building Code Seismic Hazard Calculation in page 28 of this appendix. Figure 2 in page 27 presents the design spectral accelerations computed under section 4.1.8.4 of the Ontario Building Code 2012 (OBC 2012) for the site class C assigned to this site.

2015 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: 45.273N 75.790W

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Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.419	0.227	0.135	0.040
Sa (0.1)	0.492	0.277	0.171	0.056
Sa (0.2)	0.413	0.238	0.149	0.051
Sa (0.3)	0.314	0.183	0.116	0.041
Sa (0.5)	0.224	0.131	0.083	0.029
Sa (1.0)	0.112	0.066	0.043	0.015
Sa (2.0)	0.054	0.031	0.020	0.006
Sa (5.0)	0.014	0.008	0.005	0.001
Sa (10.0)	0.005	0.003	0.002	0.001
PGA (g)	0.264	0.151	0.093	0.030
PGV (m/s)	0.186	0.105	0.064	0.020

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

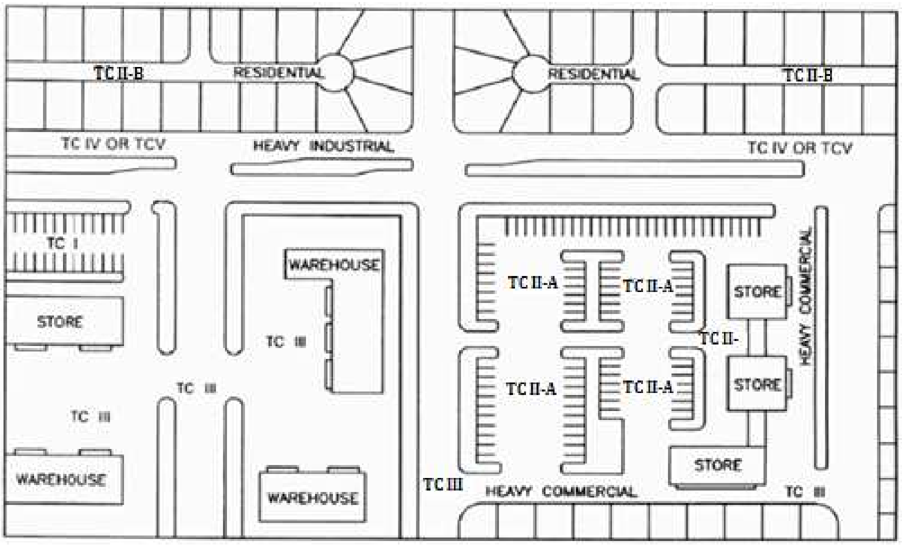

Figure 3: Traffic Classes

Appendix

C Pavement

C.1 Traffic Classes and Pavement Catalog

Figure 3 in page 29 presents a schematic site plan differentiating example uses for five traffic classes developed by the Wisconsin Asphalt Pavement Association and presented in their Design Guide May, 2001.

1. Refer to figure 3 in page 29 to differentiate pavement classes for the proposed Commercial 6 Storey Building.
2. Refer to table 1 in page 30 for additional information and design ESALs.
3. Refer to Tables 2, 3 and 4 in page 30 to select pavement structures for each traffic class on very poor soils encountered at this site.

Consult Yuri Mendez Engineering for pavement structures on roadbed consisting of newly placed engineered fill, underground parking or as required, where the roadbed is not the near surface very poor soil encountered at this site.

Ontario Category	Classes	ESALs	Uses
A	I	50,000	Residential dead end and parking lots 50 stalls or less.
A	II-A	100,000	Parking lots 51 to 500 stalls.
A	II-B	200,000	Residential streets, parking lots more than 500 stalls.
B	III	600,000	Minor colectors, local streets and light industrial lots.
B	IV	900,000	Collector Streets and heavy industrial parking lots.
B	V	2,200,000	Minor Arterial.

Table 1: Design ESALs (20 years) and uses for traffic classes

Material	Specification	Thicknesses			
		Class I		Class II-A	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5	50.8	2	50.8	2
Surface course	OPSS 1151 Superpave 12.5				
Binder course	OPSS 1151 Superpave 19.0				
Base	OPSS 1010 Granular A	152.4	6	152.4	6
Subbase	OPSS 1010 Granular B Type II	228.6	9	279.4	11
Subgrade	Undisturbed In situ Soil				

Table 2: Flexible Pavement Structure Classes I and II-A

Material	Specification	Thicknesses			
		Class II-B		Class III	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5				
Surface course	OPSS 1151 Superpave 12.5	63.5	2.5	76.2	3
Binder course	OPSS 1151 Superpave 19.0				
Base	OPSS 1010 Granular A	152.4	6	152.4	6
Subbase	OPSS 1010 Granular B Type II	330.2	13	406.4	16
Subgrade	Undisturbed In situ Soil				

Table 3: Flexible Pavement Structure Classes II-B and III

Material	Specification	Thicknesses			
		Class IV		Class V	
Class		mm	in	mm	in
Surface course	OPSS 1151 Superpave 9.5	31.8	1.25		
Surface course	OPSS 1151 Superpave 12.5				
Binder course	OPSS 1151 Superpave 19.0	57.2	2.25		
Base	OPSS 1010 Granular A	152.4	6		
Subbase	OPSS 1010 Granular B Type II	457.2	18		
Subgrade	Undisturbed In situ Soil				

Table 4: Flexible Pavement Structure Classes IV and V

C.2 Frost Heave in Pavements

Frost heave of founding materials for pavement induces reduction (serviceability losses) of the performance period (along with traffic ESALs) for which the structure was designed. Generally speaking, AASHTO 1993 does not provide for an increase in thicknesses (structural number) for reduction of losses, as such increase has very small influence in the detrimental effects of frost heave. Frost heave affects pavements by roughness induced by differential frost heave, i.e., if the longitudinal vertical alignment is all equally frost susceptible, there is negligible detrimental effect. This is difficult to achieve in urban developments in which services trenches are backfilled with non frost susceptible materials. For long lasting pavements on frost susceptible soils, the general guideline is, where possible; ensure that all soils serving as pavement foundation are equally frost susceptible. This could be achieved by providing frost susceptible backfill within 1.4 m of the pavement foundation in service trenches. Where measures to mitigate the effect of frost heave are not undertaken, decrease of the performance period is accepted to occur.

C.3 Frost Protection for Manholes, Catch Basins and Others

Manholes and catch basin type structures provide a cold bridge to a deeper portion of the soil profile and create localized areas prompt to pavement failure by excessive frost heave roughness in frost susceptible soils. This can be prevented by providing insulation extending downward around the structure and horizontally outward to create a transition from the varying pavement elevation to the more stable catch basin elevation. On the alternative, non frost susceptible backfill can be provided tapered outward from the structure to the surrounding pavement.

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Appendix

D Foundation Drainage

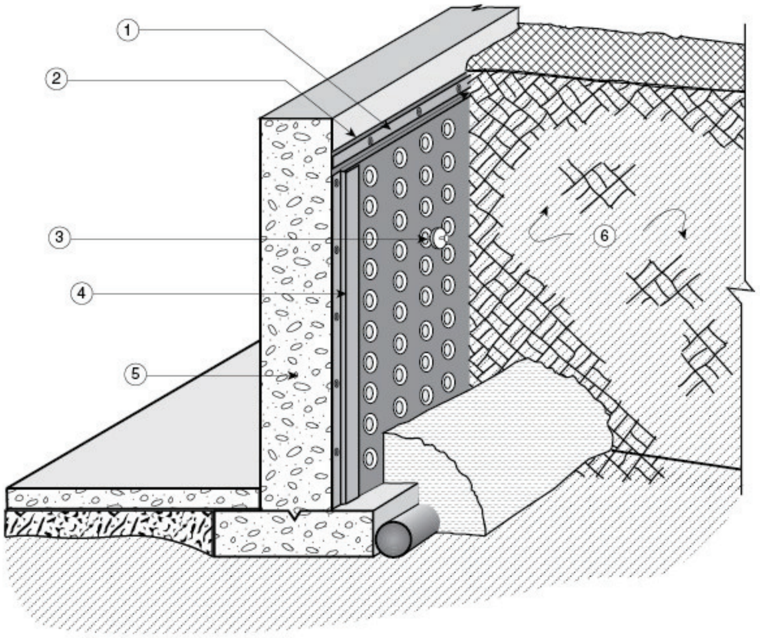

Figure 1. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the soil

1. **termination bar**
2. **caulking (behind membrane)**
3. **fastener**
4. **mould strip**
5. **concrete foundation**
6. **backfill**

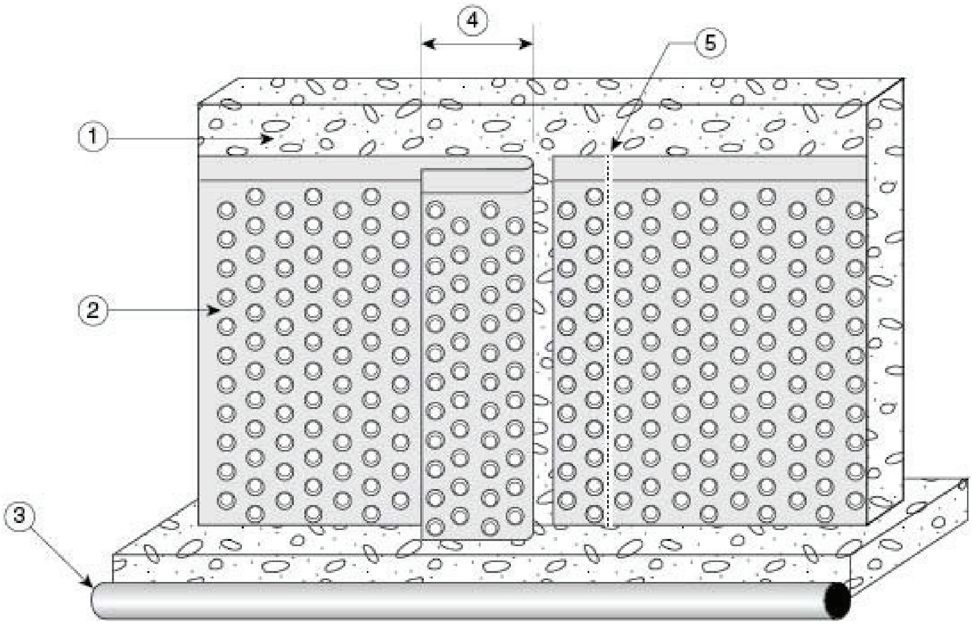

Figure 2. "Cosella-Dörken DELTA®-MS and DELTA®-MS CLEAR Dampproofing Membranes" – face in contact with the wall

1. **concrete foundation**
2. **membrane**
3. **drainage tile**
4. **minimum 6" overlap**
5. **caulking**

Appendix

E Construction Recommendations for Stripping, Earth and Rock Excavation to Undisturbed Soils, Earth and Rock Fill Placement, Asphalt Placement and Compaction

In the event that any of the following recommendations conflict with municipal and or provincial specifications, the most restrictive applies. For the case when products involving ground conditions are used, the manufacturer's specifications take precedence.

The contractor shall be prepared to proceed as directed by the geotechnical consultant within the framework of these recommendations. Construction methods will abide to these recommendations and/or be discussed and agreed upon with the consultant on site in real time or as expressed in writing.

E.1 Field Briefings

At any time in which the geotechnical consultant is required in the field for inspections, the contractor shall brief the consultant in real time about any work in progress or work to proceed at the time requiring excavation, rock excavation, placement, hauling in or out, re-working, compaction equipment weight and nature, equipment passes, moisture, stock piling, sorting of materials, stock piling, etc. of geotechnical materials. The briefing will sick approval of the methods and materials and will involve discussions regarding the source, nature and/or specifications of any source of materials brought or removed, and/or placed and/or stock piled and/or excavated from the site and discussions to meet geotechnical requirements. The consultant may choose to instate a log book in the field which may include the persons having authority to log as representative of the contractor.

E.2 Removal of Water

Removal and diversion of surface water and ground water will be planed prior to all earthwork within the scope of these recommendations. All surfaces in which to commence construction will be maintained dry and free of muddy conditions.

E.3 Earth Excavation

Earth excavations are subject to the provisions in O. Reg. 213/91: Construction Projects under Occupational Health and Safety Act. Refer to section 9 for key aspect of O. Reg. 213/91 applicable to the findings in testholes at this site.

For the purpose of these recommendations earth materials will be refer to as one or more of the general material classes: topsoil and organic soils, non engineered fill, granular fill, native soils and rock. Topsoil and organic soils and non engineered fill are the subject of striping in subsection E.3.3.

E.3.1 Suitability of Earth Materials

The suitability of material for specific purposes is determined by the geotechnical engineer. To the extent they are needed, suitable material from the excavations can be used in the construction of required permanent earthfill or rockfill.

E.3.2 Stockpiling and Sorting

Stockpiling is not an acceptable mean to build up the subgrade beneath the perimeter of structures of any kind. For stock piling, with the exception of native soils, material will be sorted in piles belonging exclusively to each material class. For native soils, sorting will be as determined by the geotechnical engineer. Mixed materials will be rendered unusable for uses other than the buildup of the subgrade in landscaped areas.

E.3.3 Striping

Topsoil and/or organic soils and/or existing fill must be removed from the perimeter of all proposed structures, including retaining wall, buildings, pavement, parking areas and earth or fill banks for grading.

E.3.4 Excavation to Undisturbed Soil Surface

All soil surfaces in which to commence construction for all structures are to be preserved in undisturbed condition (Undisturbed Soil Surface (USS)). Native soil surfaces exposed to the weather for a period exceeding 72 hours are considered disturbed. Where rainy weather and/or equipment operation and/or labor make impractical or difficult the preservation of USS a working-leveling granular pad may be used. Use the compaction requirements and materials in Table 5.

Except as otherwise indicated for select earthfill materials (subsection E.8) at this site, reinstatement of excavated soil is not allowed. When excavation exceeds the depth of the proposed USS, a granular pad using the compaction requirements and materials in Table 5.

It can be assumed that it is impractical to conduct excavations to an even USS. In such case a granular pad not less than 150mm thick must be used to remedy for irregularities caused by the operation of equipment.

E.4 Foundations Placement

Native soil surfaces exposed to the weather for a period exceeding 72 hours are considered disturbed. Place foundations on a OPSS.MUNI 1010 granular B type 2 granular pad that is at least 150 mm thick placed on undisturbed soils.

E.5 Retaining Wall Foundations

Retaining wall foundations are to be placed on a OPSS.MUNI 1010 granular B type 2 granular pad that is at least 150 mm thick.

E.6 Imported Materials

Materials to be imported are subject to prior approval by the geotechnical engineer. The exceptions are granular materials having 12 % or less fines including clean sands. Fines are materials passing the # 200 sieve (70 μm).

E.7 Overexcavation

Excavation in rock beyond the specified lines and grades shall be corrected by filling the resulting voids with portland cement concrete which will be cured by spraying water twice a day for 7 days. Excavation in earth beyond the specified lines and grades shall be corrected by filling the resulting voids with approved, compacted earthfill.

E.8 Earthfill

The type of Earthfill materials will be as indicated in plans and specifications. Suitability of earth materials will be determined by the geotechnical engineer.

Earthfill materials shall contain no frozen soil, sod, brush, roots, or other perishable material. Rock particles larger than 2/3 of the maximum approved lift thickness shall be removed prior to compaction of the fill.

For the purpose of this subsection all suitable materials will belong to one of the following two classes: *granular earthfill* and *select earthfill*. Granular eathfill will be any natural or crushed earth materials containing 12% or less passing the #200 sieve (70 μm). Select earthfill will be materials for which more than 12% passes the #200 sieve *and* have water content close to the optimum *and* have been rendered as suitable by the geotechnical engineer.

E.8.1 Granular Earthfill Placement

E.8.1.1 Moisture for Granular Earthfill

For granular earthfill it is to be assumed that moisture will be added for placement. Compaction in wet of optimum condition is preferred for granulars.

E.8.1.2 Compacted Lifts Thicknesses Equipment and Passes for Granular Eathfill

Compacted lifts will not exceed 250 mm. Subject to test trials a maximum compacted lift of 300 mm may be accepted provided vibratory compaction equipment rated at 60,000 lb-f (27,300 kg-f) of dynamic force is used.

For road construction passes are to overlap by 300 mm for full coverage.

Where non vibratory pneumatic compactors with ballast an tire pressure of 100 psi (7 kg/cm2) are used (9 or 13 ply) the compacted lift thicknesses will not exceed 150 mm for granular.

For services and culvert trenches, when using rammers and light vibratory plates weighing less than 115 kg (250 lbs) the compacted lift thicknesses will not exceed 100 and 125 mm respectively. For heavier trench equipment the compacted lifts will not exceed 250 mm.

No heavy equipment will be operated above the crown of pipes or culverts unless 1.2 m of fill has been placed or the subgrade elevation has been reached.

For all trenches below the water table, trench foundation not less than 200 mm will be provided as per materials and specification in Table 5 in page 40.

Materials lift placement beneath foundations, slabs or any placement not specified above must abide to the above specifications as they relate to the equipment being used.

E.8.2 Select Earthfill Placement

It is to be assumed that suitable select fill will be materials that will be excavated from the bank to be put directly on hauling equipment transported and dumped directly for spreading in lifts by push tractors, be added water and compacted. Stockpiling at the source or on site is not acceptable.

E.8.2.1 Moisture for Select Earthfill

It is to be assumed that moisture will be added for placement.

E.8.2.2 Compacted Lifts Thicknesses Equipment and Passes for Select Earthfill

Compacted lifts will not exceed 200 mm for heavy sheep foot rollers. Suitability of smooth vibratory rollers for the materials will be determined by the geotechnical engineer.

For road construction passes are to overlap by 300 mm for full coverage.

Where non vibratory pneumatic compactors with ballast an tire pressure of 100 psi (7 kg/cm2) are used (9 or 13 ply) the compacted lift thicknesses will not exceed 150 mm.

For services and culvert trenches, when using rammers and light vibratory plates weighing less than 115 kg (250 lbs) the compacted lift thicknesses will not exceed 100 and 125 mm respectively. For heavier trench equipment the compacted lifts will not exceed 200 mm.

No heavy equipment will be operated above the crown of pipes or culverts unless 1.2 m of fill has been placed or the subgrade elevation has been reached.

For all trenches below the water table, trench foundation not less than 200 mm will be provided as per materials and specification in Table 5 in page 40.

Materials lift placement beneath foundations, slabs or any placement not specified above must abide to the above specifications as they relate to the equipment being used.

E.8.2.3 Re-working and/or Re-stripping for Select Earthfill

Re-stripping of 75 mm for select fill surfaces expose to rain or the environment for more than 24 hours is required. Areas of water ponding shall be stripped-off and backfilled.

E.8.3 Compaction Guide for Passes and Level of Compaction

The contents of this section are provided as guidelines for construction. The resulting compaction densities and compacted lift thicknesses can only be verified by actual testing and field trials respectively.

For equipment passes the contractor may consider not less than 4, 5 or 6 passes for 95, 98 or 100 % Proctor Standard compaction.

For granular materials loose lifts may be approximately 150, 175 and 235 mm for compacted lift thicknesses 125, 150 and 200 mm respectively.

For select earthfill materials loose lifts may be approximately 125 and 190 mm for compacted lift thicknesses 100 and 150 mm respectively.

E.8.3.1 Compacted Lifts Thicknesses Equipment and Passes for Rockfill

Compacted lifts will not exceed 400 mm. Subject to test trials a maximum compacted lift of 550 mm may be accepted provided vibratory compaction equipment rated at 60,000 lb-f (27,300 kg-f) of dynamic force is used.

For road construction passes are to overlap by 300 mm for full coverage.

E.9 Compaction General

It is to be assumed that water will be added for compaction and that the required maximum grain size shall be 3/4 of the compacted lift thickness.

Obtain the approximate loose lift thickness by dividing the compacted lift by 0.88. Compacted lifts are approximately 12% less than the loose lift thickness.

Each lift shall be compacted by the specified number of passes of the approved type and weight of roller or other equipment.

Table 5 in page 40 presents Proctor Standard (PS) compaction requirements for specified placement and materials.

E.10 Compaction Specific

E.10.1 Compaction Along Basement Walls, Retaining Walls and Structures

No heavy compaction equipment is to be operated within 0.9 m of any structure. The consolidation zone is defined as the zone within 0.9 m of the exterior edge

Material Placement	Material Description	% PS
Base	OPSS.MUNI 1010 Granular A	100
Subbase	OPSS.MUNI 1010 Granular B Type II	100
Subgrade	Granular earthfill (with 12 % or less fines) and 100% passing 106 mm sieve	95
	Select earthfill	95
Backfill for trenches under pavement	Granular earthfill (with 12 % or less fines) and 100% passing 106 mm sieve.	95
	Select earthfill	95
Under sidewalks top 200 mm	Any OPSS.MUNI 1010 Granular specification for which 100% passes the 26.5 mm sieve	95
Under foundations	OPSS.MUNI 1010 Granular B type 2 with 12% or less fines and for which 100% passes the 106 mm sieve	98
Backfill under slabs on grade	Cohesionless (with 12 % or less fines) and 100% passing 106 mm sieve.	100
	Select earthfill	100
Top 100 mm under slabs	Crushed stone 9.5 to 19 mm (use one or several sizes).	90
Pipe bedding and cover (150 mm for bedding to 150 mm above the crown)	Any OPSS.MUNI 1010 Granular specification for which 100% passes the 26.5 mm sieve	95
Trench foundation (stabilization minimum 200 mm)	Any OPSS 1010.MUNI Granular specification for which 100% passes the 106 mm sieve except Granular B Type I	95
Backfill for non building, non traffic and/or non parking areas	Granular (with 12 % or less fines) and 100% passing 106 mm sieve	90
	Select earthfill	90
Placement not specified above	Granular (with 12% or less fines) and 100% passing 106 mm sieve	95
	Select earthfill	95

Table 5: Proctor Standard (PS) compaction requirements for specified placement and materials.

of basements or the interior edge of retaining walls or any structure. Only light to very light compaction is to be applied along the consolidation zone with no more than 2 passes of light vibratory equipment.

E.10.2 Self Compacting Materials

There are no self compacting materials. Total fill thickness of 200 mm of granular materials consisting of more than 90% of one nominal size referred to as crushed stone are acceptable without compaction under concrete slabs.

E.10.3 Settlement Allowance and Overfill

The settlement (consolidation) of lightly compacted earthfill can be excessive. Overfill to compensate for settlement allowance will be discussed with the geotechnical engineer.

E.10.4 Compaction Quality Control

Provide moisture density relationships for Standard Proctor compaction for the proposed materials and source. Conduct one in situ test at randomly selected locations per 60 m3 of fill. This is approximately one test, each 300 m2 of lift in place. Nuclear or non-nuclear density probes testing can be used. Density probes will only measure the density within 0.12 m depth at the point of the measurement.

E.11 Asphalt Pavement

Place asphalt mix only when base course, or previous course is dry and air temperature is 7 degrees C and increasing.

Asphalt pavement mix temperatures at the time of placement will be within the range of 120 to 160 degrees C.

Do not place asphalt on a surface which is wet or covered by snow or ice or if the ground is frozen.

E.11.1 Surface Preparation for Asphalt Pavement

It is to be assumed that rough grading and fine grading shall take place before asphalt placement. Rough grading will be completed to within ± 25 mm of the underside of asphalt and tested to meet the specified density. Fine grading and rolling will completed by the paving contractor. The granular material for fine grading will meet OPSS.MUNI 1010 Granular M.

E.11.2 Proof Rolling Prior to Asphalt Pavement

Conduct proof rolling using a single pass of a tandem-axle dump truck or a tri-axle dump truck with the third axle raised loaded to a minimum gross vehicle weight of 26 metric tons at walking speed. Rutting in excess of 25 mm is considered failure. Where proof rolling reveals areas of defective subgrade, Remove base, Sub-base and subgrade material to depth and extent and width that will allow reconstruction using the available equipment or as directed by the Consultant.

E.11.3 Asphalt compaction

The compacted lifts are accepted to be 80% of the loose lift thickness (the loose lift reduces thickness by 20% when compacted). Divide the compacted lift thickness by 0.8 to obtain the thickness of the loose lift.

Compaction will consist on at least three passes at approximately walking speed (5.4 km/hr) as follows: *break down rolling* using a vibratory steel drum roller, *intermediate rolling* with a static (non-vibrating) roller or a pneumatic roller and *finish rolling* with a smooth static roller.