Government of Canada

Geotechnical Report – Saint Leonard GOCB

Type of Document:
Final

Project Name:
Geotechnical Investigation- Saint Leonard Government of Canada Building (GOCB)

Project Number:
Exp: FRE-00214763-A5
Client: R.069499.001

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Date Submitted:
2015-08-31

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1 Executive Summary

Exp Services Inc. was retained by the Government of Canada to provide engineering services for a geotechnical investigation for a new Government of Canada Building (GOCB) in Saint Leonard, New Brunswick. The scope of work included a geotechnical investigation, including boreholes and rock coring of the native soil and bedrock. This report summarizes the geotechnical investigation and recommendations.

The proposed project consists of a single story 1565 m^2 slab on grade building, and a parking lot of approximately 4000 m^2. Boreholes were advanced and laboratory tests were carried out to provide information on the subsurface conditions for design of the building. The site work was carried out on June 15 to 16, 2015.

The detailed ground conditions can be seen in the borehole records in Appendix 3, but generally the site consists of the following: sandy lean CLAY overlaying shale BEDROCK.

The site is suitable for a slab on grade building and can be supported on conventional spread and strip shallow concrete foundations set on structural fill provided all topsoil, organics, and surficially softened natural soils are excavated and removed from the building footprint.

The scope of this investigation did not include a consideration of the environmental aspects of this site, apart from an olfactory screening of the recovered samples during the field investigation. The information contained in this report does not reflect on the environmental aspects of the soil. If specific information is required about the geo-environmental conditions on the property, additional testing may be required. Reference is made to Appendix 1 of this report, which contains further information necessary for the proper interpretation and use of this report.

2 Site Description, Topography, & Geology

The site is located in the Town of Saint-Leonard and is currently accessed from Laplante Road, approximately 130 m south-east of Highway 17. The property borders private property on either side and is bound by Laplante Road to the south-west, and high voltage overhead transmission line to the north-east.

The site and borehole locations can be seen in the borehole location plan in Appendix 2. The site is currently comprised of small to mature trees and contains a buried water main that runs through the south-west corner of the property, with a slightly overgrown access road.

The site generally carries a consistent slope from north to south. There is a ditch running along the north side of Laplante Road, with a culvert crossing the road at the south-east corner of the property, which continues to drain into a wooded area south of Laplante Road.

A review of available published geological information for the site indicates the surficial materials are from the Late Wisconsinan Era, and composed of glacial till, consisting of silt, sand, gravel, and boulders; generally greater than 1.5 m thick. Surficial materials are discontinuous, but generally range from 0.5 to 3 m in thickness.

The lithology of the bedrock indicates the bedrock mass at the above mentioned site is Early Silurian Bedrock. The bedrock mass is part of the Aroostook Formation, which generally consists of highly indurated siliceous sedimentary rock.

Exp reviewed the following sources:

- New Brunswick Department of Natural Resources and Energy, 2000 Bedrock Geology of New Brunswick, Minerals and Energy Division, Map NR-1 (2008 Edition). Scale 1 : 500,000

- Rampton, V.N. 1984. Generalized surficial geology map of New Brunswick Department of Natural Resources and Energy, Minerals, Policy and Planning Division, NR-8 (scale 1 : 500,000) Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2002 and Courtesy of Natural Resources Canada, Geological Survey of Canada.

3 Site Exploration

3.1 Field Investigation

The field investigation was carried out on June 15 and 16, 2015. The terms of the investigation were in accordance with **exp**'s proposal dated March 19, 2015. Seven (7) boreholes were advanced, applying a grid pattern over the proposed site.

The borehole locations can be seen on the Borehole Location Plan in Appendix 2. The borehole locations were staked in the field using topographic survey equipment. The survey was carried out by **exp** using monument information with horizontal and vertical datum provided by **exp**.

The boreholes ranged in depth from 4.27 m to 6.10 m below ground surface. Standard penetration tests were taken in soil deposits and three (3) rock core samples were taken from the bedrock. A standard auger was advanced until refusal in bedrock at borehole locations where rock cores were not taken. Representative recovered disturbed soil samples were stored in moisture tight containers and transported to our soils laboratory for further classification and testing. Soil classifications are in accordance with visual and laboratory test data, **exp** standard classification procedures, and recommendations in the Canadian Foundation Engineering Manual, 4th Edition.

The borehole investigation was carried out by a specialized geotechnical drilling contractor, under the supervision of an **exp** geotechnical engineer. The equipment used was a CME55 drill mounted on an all-terrain track mounted carrier.

3.2 Laboratory Testing

Laboratory tests were carried out on the recovered disturbed soil samples to determine the nature and index properties of the soils encountered at the site.

The laboratory testing program consisted of seven (7) particle size analyses (ASTM C136 and C117), one (1) hydrometer analysis (ASTM D422) and three (3) plasticity index tests (ASTM D4318). All of the laboratory test results are attached in Appendix 4.

3.3 Site and Subsurface Conditions

The ground conditions described in this report are based on a limited number of widely spaced boreholes outlined by the geotechnical engineer. The nature and extent of variations between these boreholes may not become evident until construction. If variations or other latent conditions become evident, it may be necessary to re-evaluate the scope of this report and carry out further

investigation as necessary. The boring logs and related information depict subsurface conditions only at the specific locations and times indicated.

3.3.1 Soil Strata

The detailed ground conditions can be seen in the borehole records in Appendix 3, but generally the site consists of the following: sandy lean CLAY overlying shale BEDROCK.

3.3.2 TOPSOIL

The site is generally covered by a very thin layer (<150mm) of ROOTMAT and organics. This layer was omitted from the borehole logs.

3.3.3 GLACIAL TILL

Underlying the TOPSOIL is a layer of GLACIAL TILL. This layer consists of Sandy Lean CLAY containing traces of gravel and cobbles and ranged from gray to light brown in color. The material was generally found to be firm in terms of compactness, with SPT N-Values ranging from 2 to 35. Numerous laboratory tests were completed to determine index properties of the soil and can be found in Appendix 4.

3.3.4 BEDROCK

Underlying the TOPSOIL and GLACIAL TILL layers is gray fine-grained SHALE BEDROCK. The bedrock contains bedding planes oriented at 0 to 10 degrees off of vertical (dip) with fractures spaced no more than 50 mm apart. The depth of bedrock varies from 1.5 meters to 2.5 meters below ground surface at the borehole locations, and the top 150 mm of bedrock is very weathered.

3.3.5 Groundwater Conditions

Water level readings were made in the exploratory borings at the times and under the conditions stated in the scope of services. This data was reviewed and exp's interpretation is discussed in the text of the report. Note that fluctuations in the level of the groundwater may occur due to seasonal variations, including precipitation, snowmelt, rainfall, construction activities and other factors not evident at the time of measurement.

At the time of drilling, the shallow groundwater table was found in all of the borehole locations, between 0.30 m and 2.69 m below ground surface, and was generally observed in close proximity to the top of bedrock. Subsurface conditions and water levels at other locations may differ from conditions at the test locations. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted.

4 Geotechnical Recommendations

4.1 Foundation Recommendations

4.1.1 Shallow Foundations

Based on the assumption that the project will consist of a 1565 m^2 slab-on-grade building, it can be supported on conventional spread and strip foundation set on structural fill. Structural fill shall be placed on natural undisturbed glacial till and/or bedrock. This statement is valid provided that all topsoil, organics, and surficially softened natural soils are excavated and removed from the building footprint.

The factored geotechnical resistance, in terms of bearing capacity, for shallow, normal size footings at the ultimate limit state (ULS) is shown in the following table. These values include a resistance factor of 0.5 in accordance with recommendations made in the National Building Code of Canada (NBCC 2010).

Table 1: Factored Geotechnical Resistance at the Ultimate Limit State (ULS)- Strip Footings

Footing Depth (m)	Strip Footing Width (m)			
	0.6	0.75	0.9	1.2
1.2	219	215	212	218
1.5	234	231	229	224
1.8	249	246	244	240
2.1	263	261	258	255
	Factored Geotechnical Resistance at ULS (kPa)			

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Table 2: Factored Geotechnical Resistance at the Ultimate Limit State (ULS)- Spread Footings

Footing Depth (m)	Spread Footing Width (m)			
	1.2	1.5	1.8	2.1
1.2	246	237	231	228
1.5	250	258	250	245
1.8	265	261	269	262
2.1	279	275	270	279
	Factored Geotechnical Resistance at ULS (kPa)			

The geotechnical resistance for the foundations for this structure has been assumed to result in a differential settlement of 15 mm, with total settlement not exceeding 25 mm. This is based on the assumption that the footing along the north side of the structure will be founded on un-weathered bedrock, while the footing on the southern side will be founded in glacial till. The serviceability limit

pressure (SLS) that will produce this settlement is outlined in the following table. These values are unfactored and assume that the footings are founded as outlined in this report.

Table 3: Serviceability Limit Pressure (SLS) Values

Footing Depth (m)	Strip Footing Width (m)			
	0.6	0.75	0.9	1.2
1.2	118	105	98	82
1.5	119	106	99	83
1.8	120	107	100	84
2.1	122	108	101	85
	Serviceability Limit Pressure at SLS (kPa)			

Table 4: Serviceability Limit Pressure (SLS) Values

Footing Depth (m)	Spread Footing Width (m)			
	1.2	1.5	1.8	2.1
1.2	116	96	82	73
1.5	117	97	83	74
1.8	118	98	84	75
2.1	119	99	85	76
	Serviceability Limit Pressure at SLS (kPa)			

4.1.1.1 Site Preparation for Foundations

The following procedures should be followed for site preparation under all structural foundations **founded in native soil (bottom of footing above top of rock)**:

- All topsoil must be stripped and removed from the areas. It can be separately stockpiled for re-use in landscape areas.
- Existing ground within the bearing splay (see Fig.1 for extents of bearing splay) of shallow foundations shall be undercut 1000 mm below underside of footings.
- The exposed subgrade surface must be proof rolled and examined by a geotechnical technician under the supervision of a geotechnical engineer. Any soft areas detected during the proof rolling process should be over-excavated.
- NB DOT Type W2 geotextile shall be placed on all excavated glacial till surfaces prior to placement of crushed rock, extending a minimum of 1000mm up either side of the excavation.
- The region within the bearing splay of foundations must be brought up to underside of footing elevation with NBDTI 75 mm minus crushed rock placed in lifts not exceeding 300 mm (un-compacted thickness) and compacted to 98% SPMDD.

The following procedures should be followed for site preparation under all structural foundations **founded in bedrock (bottom footing below top of rock elevation)**:

- All topsoil must be stripped and removed from the areas. It can be separately stockpiled for re-use in landscape areas.
- Bedrock within 600 mm of the bottom of strip and spread footing elevation must be excavated within the bearing splay of foundations. Surface of excavated bedrock shall be approved by a geotechnical technician under the supervision of a geotechnical engineer prior to placement of crushed rock.
- The region within the bearing splay of foundations shall be brought up to final grade with NBDTI 75 mm minus crushed rock placed in lifts not exceeding 300 mm (uncompacted thickness) and compacted to 98% SPMDD.

All backfilling and compaction operations should be monitored on a full-time basis by geotechnical personnel to approve material and confirm that the specified degree of compaction has been obtained.

4.1.1.2 Foundations at Different Elevations

Where there is a possibility of foundation interference, such as foundations at different elevations, or in close proximity to service trenches, the following recommendations are made: The native undisturbed soils in the bearing splay of the foundations shall not be disturbed prior to the placement of concrete.

Footings at different elevations, for interior columns, as well as service trenches shall be located such that they do not extend into a 10 horizontal to 7 vertical bearing splay for building foundations. Lower footings and deep service trenches should be placed prior to upper foundations to prevent undermining conditions. The following figure shows the recommended geometry for footings at different elevations to avoid interference with adjacent foundations and describes the bearing splay of the shallow foundations:

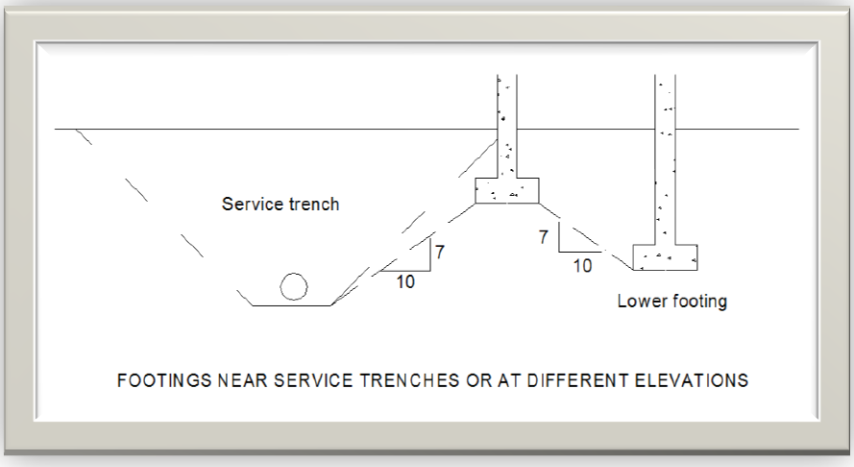

Figure 1: Bearing splay for foundations at different elevations

4.1.1.3 Frost Depth

Any footings exposed to seasonal freezing conditions should be protected from frost action by at least 1.8 m of soil cover or equivalent insulation, depending on the final design requirements. The insulation should extend laterally from the protected footings 1.8 m and minimum 300 mm of soil cover is required over the insulation. Spread footings should be founded at a depth of at least 1.2m below grade to mitigate movement due to frost action during construction. Heating or additional frost protection may be required during this period.

4.1.1.4 Drainage

The exterior grade around any building should be sloped away from the walls to prevent surface runoff from entering the building. Permanent perimeter weeping tile should be installed. The drainage tile should have a minimum diameter of 100 mm, and be surrounded by well-draining filter material i.e. 20 mm clear stone gravel. The filter material should be surrounded with a non-woven geotextile.

4.1.1.5 Total and Differential Settlements

Provided that the footing bases are not disturbed due to construction activity, precipitation, freezing and thawing action and the like, and the aforementioned bearing pressures are not exceeded, the total and differential settlements of footings designed in accordance with the recommendations of this report and with careful attention to construction detail are expected to be less than 25 mm and 15 mm respectively.

4.1.2 Slab Construction

4.1.2.1 Site Preparation – Slab on grade

- All topsoil and organics shall be excavated and removed from inside the building footprint.
- The area within the slab footprint must be undercut a minimum of 450 mm. After completion of the excavation, the subgrade should be proof rolled in the full time presence of a geotechnical technician under the supervision of a geotechnical engineer. Any soft areas identified during the proof rolling operations must be over-excavated.
- Grades must be raised to within 300 mm of underside of slab with NBDTI 75 mm Minus pit run gravel placed in lifts not exceeding 300 mm (un-compacted thickness), and compacted to 98% SPMDD.
- The floor slab may then be cast on a well packed bedding of clear stone 300 mm thick. Stone should be compacted to the satisfaction of the geotechnical engineer. The clear stone bedding will minimize the capillary rise of moisture from the subsoil to the floor slab (moisture barrier) and provide a depressurized zone for mitigation of soil gases. Adequate joints should be provided in the floor slab to control cracking. The exterior grade should be below finished floor slab and sloped to ensure positive drainage of surface water away from the structure.

4.1.3 Parking Areas and Driveways

The anticipated subgrade consists of sandy lean CLAY (glacial till). The recommended parking lot and driveway structures have been provided below for areas of light traffic, mainly passenger cars, and parking areas for passenger vehicles.

- Driveways:
  - 150mm of NBDTI 31.5mm crushed rock base
  - 450mm of NBDTI 75mm crushed rock subbase
  - Over woven geotextile (NBDTIType W1) separation from the proof rolled soils

- Parking Lots:
  - 150mm of NBDTI 31.5mm crushed rock base
  - 300mm of NBDTI 75mm crushed rock subbase
  - Over woven geotextile (NBDTI Type W1) separation from the proof rolled soils

4.1.3.1 Site Preparation for Driveways and Parking Areas

The following procedures should be followed within the building area and under paved areas:

- All topsoil or unsuitable materials must be removed. Excavation of a minimum of 450mm below existing grade is required.
- The exposed subgrade surface should be proof rolled with a drum roller and examined by a geotechnical technician under the supervision of a geotechnical engineer. Any soft areas detected during the proof rolling process should be over-excavated.
- Grades must be raised to final subgrade elevation using NBDTI 75 mm minus pit run gravel placed in lifts not exceeding 300 mm (un-compacted thickness) and compacted to 98% SPMDD.

All backfilling and compaction operations should be monitored on a full-time basis by geotechnical personnel to approve material and confirm that the specified degree of compaction has been obtained.

4.1.4 Fill Materials

4.1.4.1 Structural Fill Under Building Foundations – Strip and Spread footings

Backfill used to raise grades under the building foundations should consist of a NBDTI 75mm minus crushed rock subbase and shall be produced by the crushing and processing of rock to conform to the grading limits as set out below in Table 3, when tested in accordance with ASTM C136 and C117. Rock shall be quarried from a source that is solid in situ.

Table 3: Recommended Gradation limits for Structural Fill under Building Foundations:

ASTM Sieve Size (mm)	Gradation Limits (Percent Passing)
90	100
75	95 - 100
63	85 - 100
50	73 - 95
37.5	58 - 87
31.5	----
19	35 - 69
12.5	----
9.5	25 - 54
4.75	17 - 43
2.36	12 - 35
1.18	8 - 28
0.3	4 - 16
0.075	0 - 9

4.1.4.2 Backfill Material

Material used to raise grades under slabs-on-grade, foundation backfill, and raise grades below parking area and driveway structure shall be a crushed rock, screened pit run, or screened stone, consisting of hard durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious materials. The gradation of foundation backfill shall be within the limits outlined in Table 1 when tested in accordance with ASTM C136 and C117.

Table 1: Gradation Limits for Foundation Backfill Material:

ASTM Sieve Size (mm)	Gradation Limits (Percent Passing)
125	100
100	95 - 100
75	82 - 100
50	62 - 100
37.5	52 – 100
31.5	----
19	30 - 90
12.5	----
9.5	22 – 79
4.75	16 - 66
2.36	12 - 55
1.18	9 - 44
0.3	4 – 25
0.075	0 – 7

4.1.4.3 19mm Clear Stone for under Slab Construction

Immediately under the floor slab should be a 300 mm lift of 19mm clear stone. The clear stone shall be clean, hard, durable crushed or screened pit run gravel or stone, free of shale, clay, friable materials, organic matter and other deleterious substances and shall meet the following gradation limits when tested in accordance with ASTM C117, and ASTM C136:

Table 4: Recommended Gradation limits for Structural Fill under Building Foundations:

ASTM Sieve Size (mm)	Gradation Limits (Percent Passing)
50	100
25	90 - 100
19	15 - 85
12.5	0 - 53
9.5	0 - 30
4.75	0 - 4
1.18	0 - 2

4.2 Excavation

4.2.1 Dewatering

Shallow groundwater dewatering may be required depending on the elevation of building foundations. Any groundwater seepage which may occur from precipitation or from water which may be perched in more pervious seams in the native soils can be controlled using conventional sump pump techniques and ditches.

Although this investigation has estimated the groundwater levels at the time of the field work and commented upon dewatering and general construction problems, certain conditions are difficult to establish from standard boring techniques. Such conditions may impact the type and nature of dewatering procedures used by the contractor in practice. These conditions include local and seasonal fluctuations in the groundwater table, erratic changes in the soil profile, thin layers of soil with significantly different hydraulic conductivities from the general soil mass and the like. Only carefully controlled tests using pumped wells and observation wells will yield the quantitative data on groundwater volumes and pressures that are necessary to adequately engineer construction dewatering systems.

4.2.2 Excavation Slopes

The excavations may be undertaken as open cut, provided they comply with the current requirements of the Occupational Health and Safety Act (OHSA) particularly sections 180 to 188 of the General Regulation 91-191.

Based on these requirements, the native soils may be cut back at 1H:1V to within 1.2 m of the excavation base. The contractor should be aware that slope height, slope inclination or excavation depths (including utility trench excavations) should in no case exceed those specified in local, provincial or federal safety regulations. Such regulations are strictly enforced. If not followed, the owner, the contractor or earthwork or utility subcontractors could be liable for substantial penalties.

4.3 Earthquake/Seismic Recommendations

4.3.1 General

The building must be designed to resist a minimum earthquake force. The following recommendations are made for the geotechnical aspects to determine the earthquake loading for design using the National Building Code of Canada 2010 (NBCC 2010).

4.3.2 Subsoil Conditions

The subsoil and groundwater information at this site have been examined in relation to Section 4.1.8.4 of the NBCC 2010. The subsoil generally consists of sandy lean CLAY; glacial till. The reported N-values for the soils below the founding level (assumed to be minimum 1.5 m below ground surface) ranged from about 10 to 30 blows per 300 mm. There has been no shear wave velocity measurements carried out at this site. Therefore, N-values will have to be used to determine the site classification.

4.3.3 Corrected N-Values

The Average Standard Penetration Resistance shown in Table 4.1.8.4.A: Site Classification for Seismic Site Response in the NBCC 2010 ("Site Classification Table") refers to N60. This is defined as "Average Standard Penetration Resistance for the top 30m, corrected to a rod energy efficiency of 60% of the theoretical maximum". It should be noted that the drillers in the New Brunswick area do not have their rod energy efficiencies measured and therefore, computed N60 values are not available for this site.

For the CME automatic hammer used by the drilling subcontractor for the boreholes at this site, the energy transfer compiled by Utah State and reported by GRL in Cleveland, Ohio indicated that the range would be 67-83%, and 59-91% for one and two standard deviations, respectively. In our opinion, the reported N-values may therefore be assumed approximately equivalent to the normalized N60 values as noted in the NBCC 2010 for the purpose of establishing site classification.

4.3.4 Depth of Boreholes

The Site Classification Table provides that in order to determine the site classification the average properties in the top 30 m are to be used. The seven boreholes advanced for building construction at this site ranged from 4.27 m to a maximum of 6.10 m in depth. All boreholes were extended to auger refusal at inferred bedrock or cored to a depth of 3.0 m below top of rock.

4.3.5 Site Classification

Our recommendation is based on the assumption that the soil below the lowest floor elevations is similar to that encountered at the borehole locations. Based on the above assumptions and interpretations and the known soil conditions, the Site Class for this site is deemed to be "Site Class C: Stiff Soil" as per the Site Classification Table.

5. Construction Control

The influence of all anticipated construction activity at this site on adjacent sites must be considered by the contractor and the Client. Although construction methodology is not within the control of exp, it is recommended that exp be consulted prior to commencement of earthwork construction activities after such methods have been proposed by the contractor.

Construction quality control of the earthworks should be provided by experienced geotechnical personnel. This includes inspection of the excavation and subgrade prior to the placement of the structural fill, pipe bedding, site grading fill or backfill, to confirm that any deleterious materials have been removed and that the actual conditions are not markedly different than those on which the recommendations in this report are based. All backfilling and compaction operations must be closely examined by qualified geotechnical personnel to ensure uniform compaction to specification requirements. This is particularly the case adjacent to foundation walls, near the ends of compaction runs and in all areas not readily accessible to compaction equipment.

If winter construction is undertaken, care should be taken to ensure that structural fill, concrete or bedding material is not placed on ground that is frozen and that the fill does not itself contain frozen soil or ice chunks. Freezing of the subgrade, structural fill, pipe bedding and concrete should also be prevented as appropriate.

5 Closing

We trust that this report satisfies your current requirements. If you have any questions on the above material in the report, please do not hesitate to contact the undersigned at your convenience.

Regards,

Matthew Bernard, P.Eng.
Project Manager

Client: Government of Canada
Project Name: Saint Leonard GOCB
Client Project Number: R.069499.001
Date: August 31, 2015

Appendix 1 –
Limitations and Use of Geotechnical Report

LIMITATIONS AND USE OF REPORT

BASIS OF REPORT

This report ("Report") is based on site conditions known or inferred by the geotechnical investigation undertaken as of the date of the Report. Should changes occur which potentially impact the geotechnical condition of the site, or if construction is implemented more than one year following the date of the Report, the recommendations of exp may require re-evaluation.

The Report is provided solely for the guidance of design engineers and on the assumption that the design will be in accordance with applicable codes and standards. Any changes in the design features which potentially impact the geotechnical analyses or issues concerning the geotechnical aspects of applicable codes and standards will necessitate a review of the design by exp. Additional field work and reporting may also be required.

Where applicable, recommended field services are the minimum necessary to ascertain that construction is being carried out in general conformity with building code guidelines, generally accepted practices and exp's recommendations. Any reduction in the level of services recommended will result in exp providing qualified opinions regarding the adequacy of the work. exp can assist design professionals or contractors retained by the Client to review applicable plans, drawings, and specifications as they relate to the Report or to conduct field reviews during construction.

Contractors contemplating work on the site are responsible for conducting an independent investigation and interpretation of the borehole results contained in the Report. The number of boreholes necessary to determine the localized underground conditions as they impact construction costs, techniques, sequencing, equipment and scheduling may be greater than those carried out for the purpose of the Report.

Classification and identification of soils, rocks, geological units, contaminant materials, building envelopment assessments, and engineering estimates are based on investigations performed in accordance with the standard of care set out below and require the exercise of judgment. As a result, even comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations or building envelope descriptions involve an inherent risk that some conditions will not be detected. All documents or records summarizing investigations are based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated. Some conditions are subject to change over time. The Report presents the conditions at the sampled points at the time of sampling. Where special concerns exist, or the Client has special considerations or requirements, these should be disclosed to exp to allow for additional or special investigations to be undertaken not otherwise within the scope of investigation conducted for the purpose of the Report.

RELIANCE ON INFORMATION PROVIDED

The evaluation and conclusions contained in the Report are based on conditions in evidence at the time of site inspections and information provided to exp by the Client and others. The Report has been prepared for the specific site, development, building, design or building assessment objectives and purpose as communicated by the Client. exp has relied in good faith upon such representations, information and instructions and accepts no responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of any misstatements, omissions, misrepresentation or fraudulent acts of persons providing information. Unless specifically stated otherwise, the applicability and reliability of the findings, recommendations, suggestions or opinions expressed in the Report are only valid to the extent that there has been no material alteration to or variation from any of the information provided to exp.

STANDARD OF CARE

The Report has been prepared in a manner consistent with the degree of care and skill exercised by engineering consultants currently practicing under similar circumstances and locale. No other warranty, expressed or implied, is made. Unless specifically stated otherwise, the Report does not contain environmental consulting advice.

COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment form part of the Report. This material includes, but is not limited to, the terms of reference given to exp by its client ("Client"), communications between exp and the Client, other reports, proposals or documents prepared by exp for the Client in connection with the site described in the Report. In order to properly understand the suggestions, recommendations and opinions expressed in the Report, reference must be made to the Report in its entirety. exp is not responsible for use by any party of portions of the Report.

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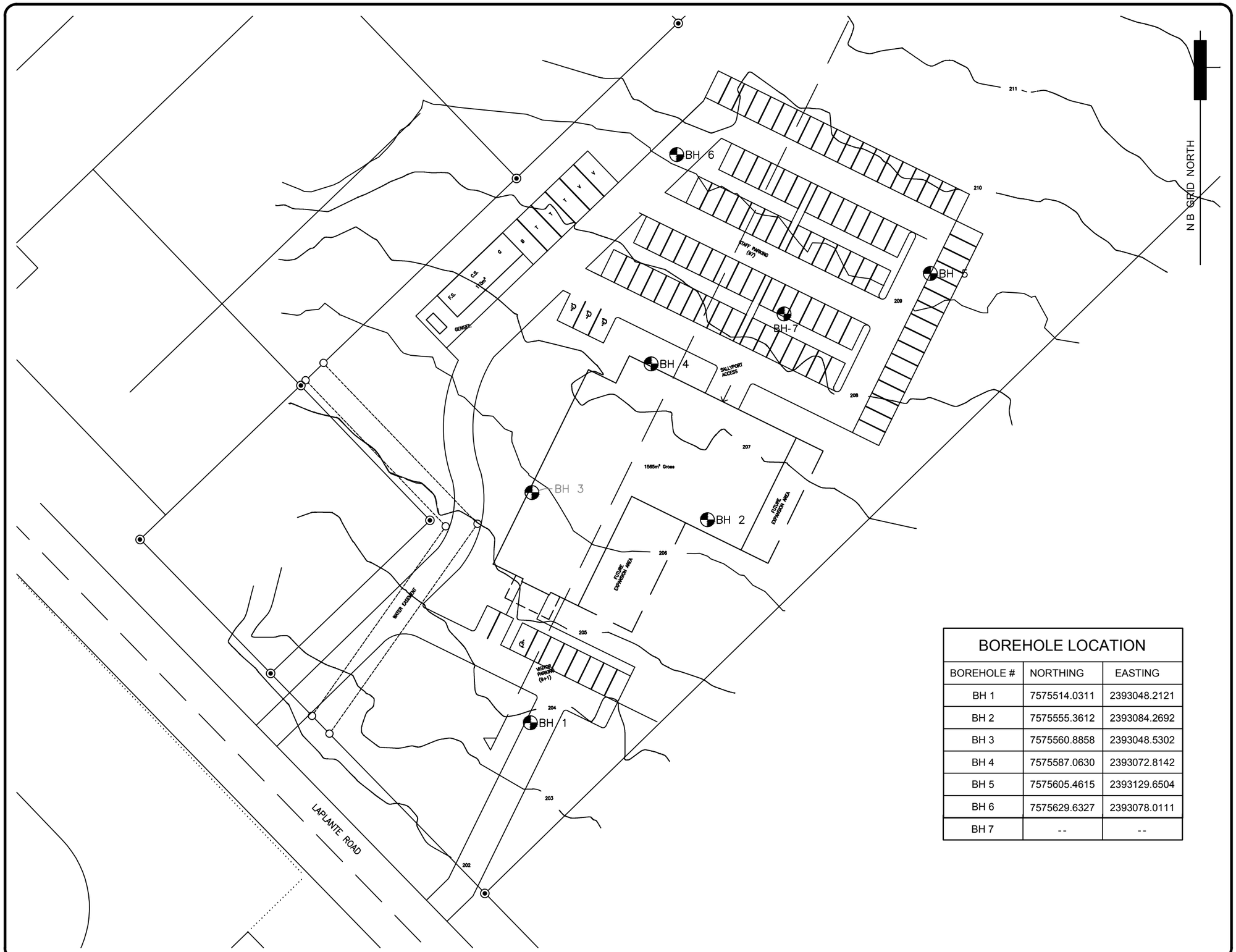
REPORT FORMAT

Where exp has submitted both electronic file and a hard copy of the Report, or any document forming part of the Report, only the signed and sealed hard copy shall be the original documents for record and working purposes. In the event of a dispute or discrepancy, the hard copy shall govern. Electronic files transmitted by exp have utilize specific software and hardware systems. exp makes no representation about the compatibility of these files with the Client's current or future software and hardware systems. Regardless of format, the documents described herein are exp's instruments of professional service and shall not be altered without the written consent of exp.

Client: Government of Canada
Project Name: Saint Leonard GOCB
Client Project Number: R.069499.001
Date: August 31, 2015

Appendix 2 –
Borehole Location Plan



BOREHOLE LOCATION		
BOREHOLE #	NORTHING	EASTING
BH 1	7575514.0311	2393048.2121
BH 2	7575555.3612	2393084.2692
BH 3	7575560.8858	2393048.5302
BH 4	7575587.0630	2393072.8142
BH 5	7575605.4615	2393129.6504
BH 6	7575629.6327	2393078.0111
BH 7	--	--

No.	Revision	Ckd. By	Date

FOR INFORMATION ONLY

Const. North

Drawn By: KW

Dwg. Standards Ckd. By:

Designed By: MAB

Date Printed

Dwg. Design Ckd. By:

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BUILDINGS • EARTH & ENVIRONMENT • ENERGY • INDUSTRIAL • INFRASTRUCTURE • SUSTAINABILITY

Project Title

SAINT LEONARD
GOCB

Dwg. Title

BOREHOLE LOCATION

Project No.	FRE-00214763-A5	
Dwg. No.	100	Rev. No. 0
Scale	1:750	

This drawing is not to be scaled

FILE: Q:\FRE-00214763-A5\2.0 DESIGN & PLANNING SERVICES\2.5 CAD\CONT01\BOREHOLE LOCATION PLAN.DWG

PLOTTED BY: KEVIN WARD

DATE: 2015/Jun/3 9:13:45 AM

Appendix 3 – Borehole Records

BOREHOLE RECORD

CLIENT Government of Canada
PROJECT No. FRE-00214763-A5
PROJECT Saint Leonard Government of Canada Building (GOCB)
BOREHOLE No. BH-01
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR RQD	SAMPLES OTHER TESTS
0		Light Gray Sandy Lean CLAY			SS	1	410	12	
1					SS	2	430	20	Sieve
		Grayish - Light Brown Sandy Lean CLAY			SS	3	250	80+	
2		Highly weathered Gray Fine-grained SHALE BEDROCK Highly Fractured Gray Fine-grained SHALE BEDROCK Hard augering from 3.96m to 5.08m. Auger refusal at 5.08 m.							
3									
4									
5									
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT Saint Leonard Government of Canada Building (GOCB)
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015

PROJECT No. FRE-00214763-A5
BOREHOLE No. BH-02
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY mm	N-VALUE OR RQD	OTHER TESTS
0		Light Gray/Bown Sandy Lean CLAY			SS	1	210	7	
1					SS	2	510	10	Sieve Hydro
					SS	3	460	11	Attrbg
2		Broken BEDROCK							
		Highly Weathered Gray Fine-grained SHALE BEDROCK							
3		Gray Fine-grained SHALE BEDROCK Hard augering from 4.88 m to 6.10 m. Auger refusal at 6.10 m.							
4									
5									
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT No. FRE-00214763-A5
PROJECT Saint Leonard Government of Canada Building (GOCB)
BOREHOLE No. BH-03
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY mm	N-VALUE OR RQD	OTHER TESTS
0		Grayish - Light Brown Sandy Lean CLAY			SS	1	380	4	
1					SS	2	530	13	Sieve
		Brownish - Light Gray Sandy Lean CLAY		▼	SS	3	610	21	Sieve Attrbg.
2					SS	4	610	34	
					SS	5	50	80+	
		Highly Weather Gray Fine-grained SHALE BEDROCK			RC			0	
3		Highly Fractured Gray Fine-grained SHALE BEDROCK							
		Steeply Dipping, Thimly Bedded							
4					RC			0	
5					RC			0	
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT No. FRE-00214763-A5
PROJECT Saint Leonard Government of Canada Building (GOCB)
BOREHOLE No. BH-04
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR RQD	SAMPLES OTHER TESTS
0		Grayish - Light Brown Sandy Lean CLAY			SS	1	330	4	
1					SS	2	460	12	Sieve
					SS	3	430	30	
2		Highly Weathered Gray Fine-grained SHALE BEDROCK							
		Highly Fractured Gray Fine-grained SHALE BEDROCK			RC			0	
3		Steeply Dipping, Thimly Bedded							
4					RC			0	
5					RC			39	
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT Saint Leonard Government of Canada Building (GOCB)
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015

PROJECT No. FRE-00214763-A5
BOREHOLE No. BH-05
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY mm	N-VALUE OR RQD	OTHER TESTS
0		Grayish - Light Brown Lean CLAY with Sand		▼	SS	1	330	4	
1					SS	2	460	12	Sieve Attrbg
					SS	3	430	30	
2		Highly Weathered Gray Fine-grained SHALE BEDROCK							
		Highly Fractured Gray Fine-grained SHALE BEDROCK Steeply Dipping, Thimly Bedded			RC			0	
3									
					RC			0	
4					RC			0	
5									
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT No. FRE-00214763-A5
PROJECT Saint Leonard Government of Canada Building (GOCB)
BOREHOLE No. BH-06
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	SAMPLES N-VALUE OR RQD	SAMPLES OTHER TESTS
0		Grayish - Light Brown Sandy Lean CLAY			SS	1	330	2	
1					SS	2	150	30	Sieve
				▼	SS	3	0	81	
2		Highly Weathered Gray Fine-grained SHALE BEDROCK							
		Highly Fractured Gray Fine-grained SHALE BEDROCK							
		Steeply Dipping, Thimly Bedded							
3		Auger refusal at 4.27 m							
4									
5									
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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BOREHOLE RECORD

CLIENT Government of Canada
PROJECT No. FRE-00214763-A5
PROJECT Saint Leonard Government of Canada Building (GOCB)
BOREHOLE No. BH-07
DATE OF BOREHOLE (dd-mm-yy): 15/06/2015
WATER LEVEL June 15, 2015
DATUM Below Ground Surface

DEPTH (m)	ELEV. (m)	DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY mm	N-VALUE OR RQD	OTHER TESTS
0		Grayish - Light Brown Sandy Lean CLAY							
1				▼					
2		Highly Weathered Gray Fine-grained SHALE BEDROCK				None Taken		-	
		Highly Fractured Gray Fine-grained SHALE BEDROCK							
3		Auger refusal at 4.27 m							
4									
5									
6									

Undrained Shear Strength, kPa
20 40 60 80
Water Content & Atterberg Limits W_p W W_l
Dynamic Penetration Test, blows/0.3m ★
Standard Penetration Test, blows/0.3m ●
10 20 30 40 50 60 70 80 90

△ Unconfined Compression Test
□ Field Vane Test ■ Remoulded

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506.452.9000

Client: Government of Canada
Project Name: Saint Leonard GOCB
Client Project Number: R.069499.001
Date: August 31, 2015

Appendix 4 –
Laboratory Test Results

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB/RAB
Sample Source:	Borehole 1 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Gradation			
Tests Conducted in accordance with ASTM C117 & C136			
Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
19	100.0	-	
12.5	96.8	-	
9.5	92.4	-	
4.75	85.5	-	
2.36	80.3	-	
1.18	75.8	-	
0.6	71.7	-	
0.3	66.1	-	
0.15	59.4	-	
0.075	52.6	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Combined Sieve & Hydrometer Analysis

Client: Government of Canada
Project: Saint Leonard GOCB
Material: Sandy Lean CLAY
Sample Source: Borehole2 SA2 - Depth: 2' to 4'

Project #: FRE-00214763-A5
Date Tested: July 9, 2015
Tested By: RAB/CWB
exp Sample #: N/A

Combined Sieve & Hydrometer Analysis	
Tests conducted in accordance with ASTM C136 & D422	
Sieve Size (mm)	Percent Passing (%)
25	100.0
19	94.2
12.5	93.3
9.5	91.3
4.75	87.5
2.36	85.0
1.18	82.4
0.600	79.8
0.300	76.4
0.150	72.8
0.075	69.3
0.052	65.3
0.037	63.9
0.026	62.5
0.017	58.3
0.010	51.4
0.008	45.8
0.006	40.3
0.003	27.8
0.001	18.1

Moisture Content: 14.3%

Tested By: Campbell Barlow
RAB/CWB

Reviewed By: Matt
Matt Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Atterberg Limits

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 21, 2015
Material:	Sandy Lean CLAY	Tested By:	RAB/CWB
Sample Source:	Borehole 2 SA3 - Depth: 4' to 6'	exp Sample #:	N/A

Atterberg Limits

Tests conducted in accordance with ASTM D4318

Moisture Content	20.2%
Plastic Limit	20.2%
Liquid Limit	28.1%
Plasticity Index	7.9%
Identification	CL

Tested By: Campbell Blen
RAB/CWB

Reviewed By: Matt
Matt Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB/RAB
Sample Source:	Borehole 3 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Gradation

Tests Conducted in accordance with ASTM C117 & C136

Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
19	100.0	-	
12.5	98.8	-	
9.5	93.8	-	
4.75	87.2	-	
2.36	81.5	-	
1.18	75.7	-	
0.6	71.4	-	
0.3	65.8	-	
0.15	59.7	-	
0.075	54.0	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB/RAB
Sample Source:	Borehole 3 SA3 - Depth: 4' to 6'	exp Sample #:	N/A

Gradation			
Tests Conducted in accordance with ASTM C117 & C136			
Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
25	100.0	-	
19	96.7	-	
12.5	92.7	-	
9.5	90.9	-	
4.75	87.2	-	
2.36	82.9	-	
1.18	78.2	-	
0.6	74.5	-	
0.3	69.6	-	
0.15	64.3	-	
0.075	59.1	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Atterberg Limits

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 9, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB
Sample Source:	Borehole 3 SA3 - Depth: 4' to 6'	exp Sample #:	N/A

Atterberg Limits

Tests conducted in accordance with ASTM D4318

Moisture Content	17.5%
Plastic Limit	17.5%
Liquid Limit	25.5%
Plasticity Index	8.1%
Identification	CL

Tested By: _____
CWB

Reviewed By: _____
Matt Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB/RAB
Sample Source:	Borehole 4 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Gradation			
Tests Conducted in accordance with ASTM C117 & C136			
Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
19	100.0	-	
12.5	98.7	-	
9.5	98.7	-	
4.75	96.7	-	
2.36	92.6	-	
1.18	88.5	-	
0.6	84.8	-	
0.3	79.5	-	
0.15	73.6	-	
0.075	67.1	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Lean CLAY with Sand	Tested By:	CWB/RAB
Sample Source:	Borehole 5 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Gradation			
Tests Conducted in accordance with ASTM C117 & C136			
Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
25	100.0	-	
19	97.2	-	
12.5	97.2	-	
9.5	96.0	-	
4.75	95.0	-	
2.36	93.0	-	
1.18	91.4	-	
0.6	89.7	-	
0.3	87.7	-	
0.15	85.3	-	
0.075	82.6	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Atterberg Limits

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 9, 2015
Material:	Lean CLAY with Sand	Tested By:	CWB
Sample Source:	Borehole 5 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Atterberg Limits

Tests conducted in accordance with ASTM D4318

Moisture Content	17.3%
Plastic Limit	17.3%
Liquid Limit	26.6%
Plasticity Index	9.3%
Identification	CL

Tested By: _____
CWB

Reviewed By: _____
Matt Bernard

Exp Services Inc.
1133 Regent Street, Fredericton, NB, E3B 3Z2
Tel: (506) 452-9000 Fax: (506) 459-3954

Sieve Analysis

Client:	Government of Canada	Project #:	FRE-00214763-A5
Project:	Saint Leonard GOCB	Date Tested:	July 8, 2015
Material:	Sandy Lean CLAY	Tested By:	CWB/RAB
Sample Source:	Borehole 6 SA2 - Depth: 2' to 4'	exp Sample #:	N/A

Gradation			
Tests Conducted in accordance with ASTM C117 & C136			
Sieve Size (mm)	Percent Passing (%)	Specification Limits	
		Minimum (%)	Maximum (%)
25	100.0	-	
19	97.9	-	
12.5	96.4	-	
9.5	94.9	-	
4.75	89.6	-	
2.36	84.0	-	
1.18	78.7	-	
0.6	74.5	-	
0.3	68.2	-	
0.15	60.7	-	
0.075	52.9	-	

Tested By: _____
CWB/RAB

Reviewed By: _____
Matthew Bernard