Appendix A

Geotechnical Report

SNC Lavalin Inc. (Maritimes)

Geotechnical Investigation
Big Johnny's Turn Culverts Replacement
Cabot Trail, Cape Breton Highlands
National Park, Nova Scotia

Final Report

Date: February 20, 2014
Ref. N°: 18103

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SNC Lavalin Inc. (Maritimes)

Geotechnical Investigation
Big Johnny's Turn Culverts Replacement
Cabot Trail, Cape Breton Highland National Park
Nova Scotia

Final Report | 18103

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REVISION AND PUBLICATION REGISTER		
Revision N°	Date	Modification And/Or Publication Details
0	2013-12-05	Draft Report
1	2014-02-20	Final Report

1 INTRODUCTION

LVM/Maritime Testing Limited (LVM-MTL) at the request of SNC Lavalin Inc. (Maritimes), has carried out a geotechnical investigation at the site of a proposed culvert replacement as identified as Big Johnny's Turn Culverts on the Cabot Trail in the Cape Breton Highlands National Park, Nova Scotia. The purpose of the work was to assess the subsurface conditions at select areas of the site and to make recommendations for the design and costing of earthworks and foundations.

This report presents the observations and engineering recommendations associated with the geotechnical investigation of the site. Included herein are the factual results of the field investigation including discussion of field procedures, subsurface conditions, laboratory analysis and recommendations for site development.

2 SITE AND PROJECT DESCRIPTION

Parks Canada proposes to replace two (2) corrugated steel culverts along the Cabot Trial in the Cape Breton Highlands National Park. The site is identified as the Big Johnny's Turn along the Cabot Trail between the communities of South Harbour and Neils Harbour. Preliminary design indicates that each of the existing culverts will likely be replaced with a pre-cast Shaw Span.

3 INVESTIGATION PROCEDURE

The fieldwork for the investigation was carried out on November 14 and 15, 2013, when four (4) boreholes were drilled at the approximate locations shown on the attached Figure 1. The drilling investigation was carried out using a CME-55 drill rig supplied to the project by Logan Geotech from Stewiacke, Nova Scotia.

The site investigation was carried out by qualified geotechnical engineering personnel who logged the subsurface conditions in the field. The boreholes were advanced using continuous flyte augers and N-casing, with field sampling and testing performed in the open boreholes. Standard Penetration Tests were carried out at regular intervals in each borehole to obtain soil blow counts (i.e. N-values) using a 50 mm O.D. split spoon sampler. Disturbed soil samples were obtained at each borehole using conventional techniques. Bedrock was drilled and sampled using NQ-sized (i.e. 63.5 mm dia.) coring equipment. Following field sampling and visual description, overburden samples were placed in waterproof bags and transported to our Dartmouth laboratory for further examination and laboratory index testing.

4 SUBSURFACE CONDITIONS

An explanation of terms and symbols used in the report is provided in Appendix 1. A summary of the encountered geologic conditions is provided in the Borehole Logs in Appendix 2. Laboratory Testing results are provided in Appendix 3.

It should be noted that the stratigraphic boundaries on the Borehole Logs typically represent a transition of one soil type to another and do not necessarily indicate an exact plane of geologic change. Subsurface conditions may vary between and beyond the borehole locations.

In summary, the subsurface conditions encountered at the site were found to be relatively uniform with respect to material composition and consistency. In general, fill deposits were encountered overlying undisturbed glacial till deposits and bedrock. Bedrock was encountered at all boreholes at depths ranging from 4.0 metres to 5.2 metres. A summary of the subsurface conditions is provided on the borehole logs in Appendix 2 and in the table below. Coordinates are projected to MTM ATS77.

Table 1 Summary of Subsurface Conditions

BOREHOLE NUMBER	NORTHING (metres)	EASTING (metres)	DEPTH TO GROUNDWATER (metres)	DEPTH TO TILL (metres)	DEPTH TO BEDROCK (metres)	DEPTH OF BOREHOLE (metres)
1	4585536.94	5188997.40	3.3	3.3	4.0	7.6
2	4585525.62	5189008.72	-	3.7	5.2	7.6
3	4585675.34	5188825.40	3.6	4.0	4.6	6.9
4	4585674.60	5188842.17	3.6	3.4	4.7	5.3

4.1 Asphalt Pavement

A layer of asphalt pavement was encountered at the surface of borehole BH 1. The asphalt pavement was approximately 100 mm in thickness.

4.2 Fill

In all boreholes, fill deposits have been encountered beneath the asphalt pavement and/or at the ground surface. The fill consisted of either sandy gravel or silty sand, some gravel and occasional cobbles. The fill was typically brown to rusty brown in colour and its moisture content can be described as moist to wet. The fill was proven for a depth of 4.0 metres at BH 3. Standard Penetration N-values for the fill ranged from 10 to 37 at the boreholes indicating a compact to dense compactness.

Laboratory gradation testing of a select fill sample indicated a material with 32 percent gravel, 53 percent sand and a fines (i.e. silt and clay sizes) content of 15 percent. Moisture content testing of select fill samples provided values ranging from 5.4 to 8.5 percent.

4.3 Till (Site-Native Glacial Soil)

At all borehole locations, undisturbed glacial till was encountered beneath the fill deposits. These typically compact to dense soils are described on the Borehole Logs in Appendix 2 as gravely sand, some silt and occasional cobbles. Observations of the *insitu* deposits indicated that the material was brown and pink in colour and its moisture content was described as moist to wet. Standard penetration N-values for the till deposits at the boreholes ranged from 15 to 91 blows per 300 mm penetration, indicating a compact to very dense material. The high N-values recorded in the till deposit may be attributed to the gravel and cobble content and generally not representative of the *in situ* relative density. The till was proven to a total depth of 5.2 metres below the existing ground surface at borehole BH 2.

Laboratory gradation testing of a select till sample indicated a material with 41 percent gravel, 49 percent sand and a fines (i.e. silt and clay sizes) content of 10 percent. Moisture content testing of select till samples provided values ranging from 5.1 to 7.4 percent.

4.4 Bedrock

Geologic mapping of the proposed development area indicates that the site is underlain by granite bedrock.

Bedrock was encountered in all boreholes at depths of between 4.0 metres and 5.2 metres. During the field investigation, bedrock was core-drilled at all boreholes, except BH 4. Examination of bedrock core samples indicates that the site is underlain by granite bedrock.

The bedrock has been observed to be moderately to highly fractured, medium strong and pink in colour. The Rock Quality Designation (RQD) values of core samples ranged from 0% to 55% with an average value of 24%, indicating a poor to very poor quality rock.

4.5 Groundwater

Groundwater observations were made during the field investigation through open-hole measurement at the borehole locations. A summary of the accumulated ground water information is provided on the borehole Logs in Appendix 2.

During the site investigation, groundwater was encountered at select boreholes ranging from 3.3 to 3.6 metres below ground surface. Groundwater levels will be influenced by the water levels in the adjacent brooks and are expected to be within the fill deposit. Some "perched" groundwater may be encountered during construction. Seasonal fluctuations in groundwater levels can be expected.

5 DISCUSSION AND RECOMMENDATIONS FOR DESIGN

5.1 Site Development – General

In the following paragraphs, a discussion of site development is presented in light of the observed subsurface conditions. Currently, detailed design information is not available; however, it is likely that the existing culverts will be replaced with a pre-cast concrete type structure (e.g. Shaw Span) with retaining walls extending from the structure along each side of the roadway. The most feasible foundations supporting the structures will be utilizing spread footings. For reporting, it has been necessary to make some assumptions regarding the extent of development, particularly, the type of structure, site grades, construction methodology, etc. As a result, some of the recommendations outlined below are of a preliminary nature and can only be confirmed as specific designs are presented for the site.

5.2 Spread Footings

The area of the proposed foundations are underlain by fill materials, compact to dense glacial soils and bedrock. Given the nature of the subsurface conditions in these areas, it is recommended that the fill materials, and any loose/wet soils should be subexcavated to the level of competent bearing stratum, (i.e. soil described on the Borehole Logs as “compact to dense TILL or BEDROCK”). This excavation is expected to be approximately 3.3 metres at BH 1 to 4.0 metres at BH 3. This excavation may extend below the water table in some areas, so inflow of groundwater into the excavation should be anticipated. All work will require diversion of the water flow from the brook utilizing cofferdams, diversion piping and pumps of suitable capacity so that structure foundation installation work can be carried out in the dry.

If loose/wet soil conditions are encountered at proposed design grades, further subexcavation followed by placement of a properly prepared engineered fill may be required. Structural fill materials may consist of varied material types, subject to approval, which can be compacted to the required density. Structural fill should consist of a well-graded rockfill or, if conditions require, clear rockfill. The material should have a maximum particle size of 200 mm and a nominal "fines" content (i.e. minus 0.08 mm size). Fill should be placed in lifts not exceeding 300 mm thickness and should be compacted to the equivalent of 100 percent of the materials standard Proctor maximum dry density or equivalent for rockfill. Water and loose/soft soils should be removed from excavations, and bearing stratum approved prior to fill placement. It is strongly recommended that an approved clean rockfill be used for the bottom lift(s) (i.e. 1 metres thickness), due to expected wet conditions. Placement of alternative structural fill materials can be utilized upon approval from the geotechnical engineer. Geotechnical inspection and certification of engineered fill material placement is recommended.

Generally, foundations on the site soil, structural fill or fractured bedrock should be placed at a minimum depth of 1.2 metres below finished outside grade to maintain adequate frost protection. Preliminary design indicates that the footing will be at a burial depth of approximately 0.6 metres. It is our understanding that the stream flows continuously year round thus frost is not expected to extend beneath the footings and heaving of the footing is not a concern.

For design of foundations by Limit States Design, the factored soil bearing resistance (using a bearing resistance factor of 0.5) of footings with a minimum width of 0.6 metres and at a minimum depth of 1.2 metres are as follows:

Table 2 Limit States Design Parameters

LIMIT STATES DESIGN PARAMETER	GLACIAL TILL OR STRUCTURAL FILL	BEDROCK
Factored Geotechnical Bearing Resistance at Ultimate Limit States (ULS)	300 kPa	900 kPa
Geotechnical Resistance at Serviceability Limit States (SLS)	200 kPa	600 kPa

The serviceability limit states are based on a maximum allowable settlement of 25 mm. Unfactored loads should be used with the SLS bearing pressures in accordance with the 2010 National Building Code of Canada (NBCC).

5.3 Re-use of On-site Materials and Backfilling

Select portions of the glacial till and fill deposits may be considered suitable for reuse at the site as common material or, in some applications, as engineered fill. Any organic sols, and loose/wet soils are not suitable to reuse for engineered fill, these may be reused at the site in general site grading and landscaping (i.e. in non-settlement sensitive areas). The reuse of on-site materials will be contingent to a large extent on the condition of the materials after excavation, handling and stockpiling.

To qualify as engineered wall backfill, all boulders, debris and deleterious inclusions should be removed. Wall backfill should be placed in lifts not exceeding 250 mm thickness and compacted in-place to 95 percent standard Proctor maximum dry density.

5.4 Seismic Response

The effect of site conditions on seismic response should be considered in the design of foundations. Based on the subsurface soil and bedrock conditions encountered in the boreholes, the site coefficient is 1.0 (CHBDC clause 4.4.6) based on “Soil Profile Type 1”.

5.5 Fill Against Structures

Backfill placed against structures should conform to Nova Scotia Transportation and Infrastructure Renewal Standard Specifications for fill against structures. A drainage system with a positive outlet should be included to prevent water from backing up against the retaining structure. Backfill should be placed in suitable lifts and compacted to 95 percent maximum standard Proctor dry density. Depending on the selected backfill materials, geotextile may be required between the granular /

rockfill backfill and the site-native soils and/or existing embankment fill. Compaction immediately adjacent to the wall should be accomplished with relatively thin lifts and light compaction equipment to prevent overstressing of the wall. The following design parameters may be used for imported granular backfill and sand and gravel.

Table 3 Interpreted Soil and Backfill Parameters

PARAMETER	UNDISTURBED TILL	GRANULAR BACKFILL
Bulk Unit Weight, kN/m3	21	22
Moisture Content, %	11	8
Effective Unit Weight, kN/m^3	11	12
Soil Cohesion (C_u), kN/m^3	0	0
Effective Angle of Internal Friction	32˚	36˚
Active Earth Pressure Coeff.(K_a)	0.31	0.26
Passive Earth Pressure Coeff.(K_p)	3.3	3.8
At Rest Earth Pressure Coeff. (K_o)	0.47	0.38

5.6 De-watering

All work will require diversion of the water flow from the brook(s) around the construction site utilizing (as necessary) cofferdams, diversion piping and pumps of suitable capacity (i.e. minimum 150 mm diameter) so that foundation installation work can be carried out in the dry. The rate of infiltration into the foundation excavations is expected to be moderate to high and can be controlled by conventional dewatering techniques consisting of 100 to 150 mm diameter portable pumps and grading of excavations to sump locations. Water pumped from excavations is expected to contain “fines” and will require care in disposal. Provision for proper site drainage in accordance with applicable municipal, provincial, and federal environmental requirements should be made at the construction stage.

6 COMMENTS ON CONSTRUCTION

The following comments on specific construction aspects of the project are provided for the guidance of designers. The contractor undertaking the work should make their own interpretation of the factual information provided in this report as it affects their construction procedures and scheduling.

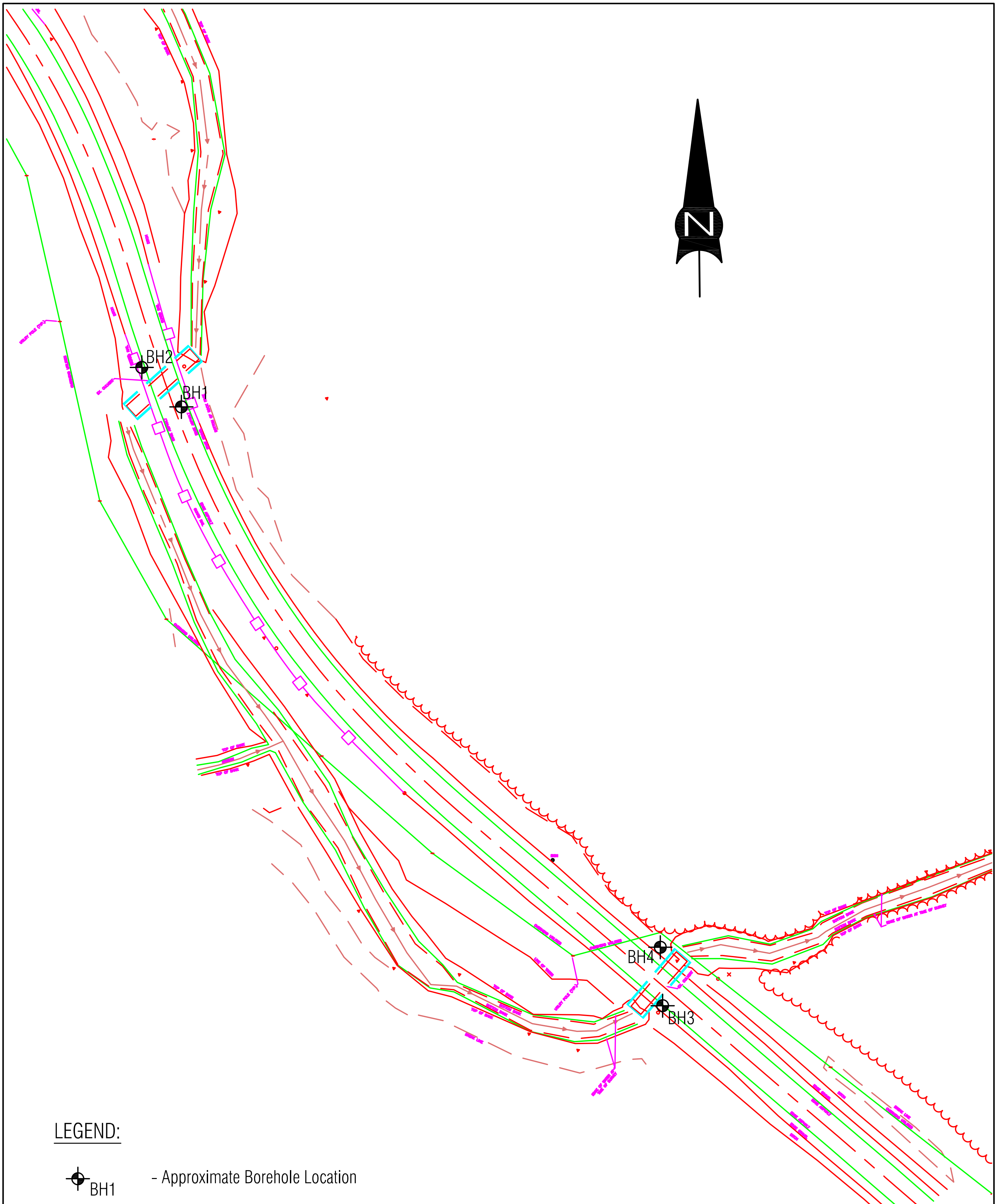
The in situ soils are subject to loosening and softening in the presence of water. Construction methods and scheduling should reflect this. If construction takes place in the winter months care must be taken not to allow freezing of subsoil. Any fill or native soil that freezes must be sub excavated and replaced.

In periods of inclement weather or during extended work delays, foundation excavations within the site native soils should be protected by a working mat of lean concrete placed over the bearing soil immediately following excavation and preparation of the foundation contact area. It may be also necessary to insulate the founding strata during periods of subzero temperatures.

Geotechnical inspection and testing by qualified personnel is recommended during earthworks construction.

7 CLOSURE

The geotechnical investigation undertaken has involved random sampling of site conditions. Should any conditions be encountered during constructions that are contrary to those reported herein, we request immediate notification so that reassessment can be undertaken.



LEGEND:

BH1 - Approximate Borehole Location

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Site Plan Showing Approximate Borehole Locations
Proposed Culvert Replacement
Cabot Trail, Cape Breton Highlands
National Park, NS

DATE: November 2013	SCALE: NTS	DRAWN BY: JJ	CKD BY: TKM	JOB No. 18103	FIGURE 1

Appendix 1 Explanation of Terms and Symbols

SYMBOLS AND TERMS USED ON THE BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Behavioural properties (i.e. plasticity, permeability) take precedence over particle gradation in describing soils.

Terminology describing soil structure:

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

Terminology used for describing soil strata based upon the proportion of individual particle size present:

Trace, or occasional	Less than 10%
Some	10-20%
Adjective (e.g. silty or sandy)	20-35%
And (e.g. silt and sand)	35-50%

The standard terminology to describe cohesionless soils includes the relative density, as determined by laboratory test or by the Standard Penetration Test ‘N’ - value: the number of blows of 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil.

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

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by insitu vane tests, penetrometer tests, unconfined compression test, or occasionally by standard penetration tests.

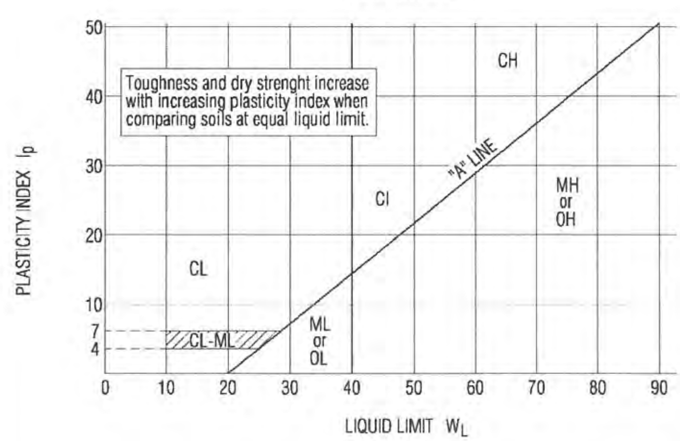
Consistency	Undrained Shear Strength		‘N’ Value
	Kips/sq.ft.	kPa	
Very Soft	<0.25	<12.5	<2
Soft	0.25-0.5	12.5-25	2-4
Firm	0.5-1.0	25-50	4-8
Stiff	1.0-2.0	50-100	8-15
Very Stiff	2.0-4.0	100-200	15-30
Hard	>4.0	>200	>30

SOIL CLASSIFICATION SYSTEM (MODIFIED U.S.C.)

MAJOR DIVISION			GROUP SYMBOL	GRAPHIC SYMBOL	COLOR CODE	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA
HIGHLY ORGANIC SOILS			Pt		ORANGE	PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE
COARSE-GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE SIZE)	GRAVELS MORE THAN HALF COARSE FRACTION LARGER THAN NO.4 SIEVE SIZE	CLEAN GRAVELS	GW		RED	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, <5% FINES	$Cu = \frac{D_{60}}{D_{10}} > 4$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			GP		RED	POORLY-GRADED GRAVELS, AND GRAVEL-SAND MIXTURES, <5% FINES	NOT MEETING ALL ABOVE REQUIRMENTS
		DIRTY GRAVELS	GM		YELLOW	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $I_p < 4$
			GC		YELLOW	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE OR $I_p > 7$
	SANDS MORE THAN HALF COARSE FRACTION SMALLER THAN NO.4 SIEVE SIZE	CLEAN SANDS	SW		RED	WELL-GRADED SANDS, GRAVELLY SANDS, <5% FINES	$Cu = \frac{D_{60}}{D_{10}} > 6$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3
			SP		RED	POORLY-GRADED SANDS, OR GRAVELLY SANDS, <5% FINES	NOT MEETING ALL ABOVE REQUIRMENTS
		DIRTY SANDS	SM		YELLOW	SILTY SANDS, SAND-SILT MIXTURES >12% FINES	ATTERBERG LIMITS BELOW "A" LINE OR $I_p < 4$
			SC		YELLOW	CLAYEY SANDS, SAND-CLAY MIXTURES >12% FINES	ATTERBERG LIMITS ABOVE "A" LINE OR $I_p > 7$
FINE - GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO.200 SIEVE SIZE)	SILTS BELOW "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		ML		GREEN	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY SANDS OF SLIGHT PLASTICITY	$W_L < 50$ — SEE CHART BELOW
			MH		BLUE	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS	$W_L > 50$
	CLAYS ABOVE "A" LINE ON PLASTICITY CHART; NEGLIGIBLE ORGANIC CONTENT		CL		GREEN	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS	$W_L < 30$
			CI		GREEN-BLUE	INORGANIC CLAYS OF MEDIUM PLASTICITY SILTY CLAYS	$W_L > 30, < 50$
			CH		BLUE	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS	$W_L > 50$
	ORGANIC SILTS & ORGANIC CLAYS BELOW "A" LINE ON PLASTICITY CHART		OL		GREEN	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY	$W_L < 50$
			OH		BLUE	ORGANIC CLAYS OF HIGH PLASTICITY	$W_L > 50$

FILL TILL BEDROCK

PLASTICITY CHART



1. All sieve sizes mentioned on this chart are U.S. Standard, ASTM E11.
2. Boundary classifications possessing characteristics of two groups are given combined group symbols eg GW-GC is a well-graded gravel-sand mixture wtih clay binder between 5% and 12%.
3. Soil fractions and limiting textural boundaries are in accordance with the Unified Soil Classification System, except that an inorganic clay of medium plasticity (CI) is recognized.
4. The following adjectives may be employed to define percentage ranges by weight of minor components:

and	50 - 36%
gravelly, sandy, silty, clayey, ect.	35 - 21%
some	20 - 11%
trace	10 - 1%

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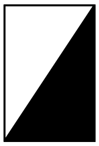
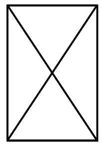
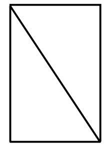
SOIL SAMPLES

CONDITION – This column graphically indicates the depth and condition of the sample:

 undisturbed  disturbed  not recovered

TYPE – The type of sample is indicated in this column as follows:

A auger sample
B block sample
C rock core, or frozen soil core
D drive sample
G grab sample
SS split spoon
P Pitcher tube sample
U tube sample (usually thin-walled)
W wash or air return sample
O other (see report text)

PENETRATION RESISTANCE – Unless otherwise noted this column refers to the number of blows (N) of a 140 pound (63.5 kg) hammer freely dropping 30 inches (0.76 m) required to drive a 2 inch (50.8 mm) O.D. open-end sampler 0.5 feet (0.15 m) to 1.5 feet (0.45 m) into the soil, or until 100 blows have been applied, in which case, the penetration is stated. This is the standard penetration test referred to in ASTM D 1586.

OTHER TESTS

In this column are tabulated results of other laboratory tests as indicated by the following symbols:

*C	Consolidation test
Fines	Percentage by weight smaller than #200 sieve
D_R	Relative density (formerly specific gravity)
k	Permeability coefficient
*MA	Mechanical grain size analysis and hydrometer test (if appropiate)
pp	Pocket pentrometer strength
*q	Triaxial compression test
q_U	Unconfined compressive strength
*SB	Shearbox test
SO_4	Concentration of water-soluble sulphate
*ST	Swelling test
TV	Torvane shear strength
VS	Vane Shear Strength (undistrubed-remolded)
ε_f	Unit strain at failure
γ	Unit weight of soil or rock
γ_d	Dry unit weight of soil or rock
ρ	Density of soil or rock
ρ_d	Dry density of soil or rock

* The results of these tests usually are reported separately

Appendix 2 Borehole Logs

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BOREHOLE LOG

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PROJECT
Geotechnical Investigation -
Proposed Culvert Replacement, CBHNP, NS

LOGGED/DWN. BAM	CKD. TKM	DATE OF INVEST. 11/13/13	JOB NO. 18103	HOLE NO. BH 1

DATUM: Topographic Survey Plan provided by SNC Lavalin

SURFACE ELEVATION 160.50 meters

DRILL TYPE: DRill Rig

CASING RESISTANCE blows/300mm

WC % wp- □ w- ● wl- △ (10 20 30 40 50)

Depth (m)	Soil Description	Cond.	Type	Pene. Resist.	Other Tests
0.0–0.25	Asphalt Pavement (250 mm)				TCR - Total Core Recovery RQD - Rock Quality Designation
0.25–1.8	FILL : sandy gravel, trace silt, compact, moist, brown.		SS	N=16	
			SS	N=26	
1.8–3.4	FILL : silty sand, some gravel, occasional cobble, compact, moist, brown to rusty brown.		SS	N=37	
			SS	N=17	
3.4–4.0	TILL : gravelly sand, trace to some silt, some cobbles, compact to dense, moist to wet, brown and pink.		SS	N=91	
4.0–7.6	BEDROCK : Granite, highly to moderately fractured, pink to black/white.		RC		TCR = 90% RQD = 0%
			RC		TCR = 88% RQD = 33%
			RC		TCR = 92% RQD = 55%

End of Borehole at 7.6 metres in Granite Bedrock.

Groundwater seepage encountered in Borehole during drilling at 3.3 metres below existing ground surface.

PLATE 1

BOREHOLE LOG

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PROJECT: Geotechnical Investigation - Proposed Culvert Replacement, CBHNP, NS

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
BAM	TKM	11/14/13	18103	BH 2

DRILL TYPE: DRill Rig

DATUM: Topographic Survey Plan provided by SNC Lavalin

SURFACE ELEVATION: 160.00 meters

CASING RESISTANCE blows/300mm

WC % wp- □ w- ● wl- △ (10, 20, 30, 40, 50)

DEPTH (ft)	DEPTH (m)	SOIL DESCRIPTION	COND.	TYPE	PENE. RESIST.	OTHER TESTS
0–1.8	0–0.6	FILL : sandy gravel, trace silt, compact, moist, brown.		SS	N=15	TCR - Total Core Recovery RQD - Rock Quality Designation
1.8–11.9	0.6–3.7	FILL : silty sand, some gravel, occasional cobble, compact, moist, brown to rusty brown.		SS	N=16	
				SS	N=26	
				SS	N=26	
				SS	N=22	
11.9–16.9	3.7–5.2	TILL : gravelly sand, trace to some silt, some cobbles, compact to dense, moist to wet, brown and pink.		SS	N=43	
				SS	N=23	
16.9–25.0	5.2–7.6	BEDROCK : Granite, highly to moderately fractured, pink.		SS	50/50	
				RC		TCR = 100% RQD = 0%
				RC		TCR = 92% RQD = 55%
		End of Borehole at 7.6 metres in Granite Bedrock. No groundwater encountered in Borehole during drilling.				

PLATE 2

BOREHOLE LOG

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PROJECT
Geotechnical Investigation -
Proposed Culvert Replacement, CBHNP, NS

LOGGED/DWN. BAM	CKD. TKM	DATE OF INVEST. 11/14/13	JOB NO. 18103	HOLE NO. BH 3

DATUM: Topographic Survey Plan provided by SNC Lavalin

SURFACE ELEVATION 149.60 meters

DRILL TYPE: DRill Rig

CASING RESISTANCE blows/300mm

WC % wp- □ w- ● wl- △ (10 20 30 40 50)

Depth (m)	Soil Description	Type	Pene. Resist.	Other Tests
0 – 1.5	FILL : sandy gravel, trace silt, compact, moist, brown.	SS	N=12	TCR - Total Core Recovery RQD - Rock Quality Designation
		SS	N=15	
1.5 – 3.9	FILL : silty sand, some gravel, occasional cobble, traces of wood, compact with loose zones, moist to wet, brown to black.	SS	N=37	
		SS	N=23	
		SS	N=17	
3.9 – 4.6	TILL : gravelly sand, trace to some silt, some cobbles, compact to dense, moist to wet, brown and pink.	SS	N=68	
4.6 – 6.9	BEDROCK : Granite, highly fractured, pink.	RC		TCR = 100% RQD = 16%
		RC		TCR = 100% RQD = 10%

End of Borehole at 6.9 metres in Granite Bedrock.

Groundwater seepage encountered in Borehole during drilling at 3.6 metres below existing ground surface.

PLATE 3

BOREHOLE LOG

LVM | MARITIME TESTING

PROJECT
Geotechnical Investigation -
Proposed Culvert Replacement, CBHNP, NS

LOGGED/DWN.	CKD.	DATE OF INVEST.	JOB NO.	HOLE NO.
BAM	TKM	11/14/13	18103	BH 4

DATUM: Topographic Survey Plan provided by SNC Lavalin

SURFACE ELEVATION: 149.50 meters

DRILL TYPE: DRill Rig

CASING RESISTANCE blows/300mm

WC % wp- □ w- ● wl- △ (10, 20, 30, 40, 50)

DEPTH	SOIL DESCRIPTION	TYPE	PENE. RESIST.
0–1.5 m	FILL : sandy gravel, trace silt, compact, moist, brown.	SS	N=10
		SS	N=15
1.5–3.4 m	FILL : silty sand, some gravel, occasional cobble, traces of wood, compact with loose zones, moist to wet, brown to black.	SS	N=21
		SS	N=36
		SS	N=69
3.4–4.7 m	TILL : gravelly sand, trace to some silt, some cobbles, compact to dense, moist to wet, brown and pink.	SS	85/200
4.7–5.3 m	Inferred Bedrock Level : Granite		

End of Borehole at 5.3 metres in Granite Bedrock.

Groundwater seepage encountered in Borehole during drilling at 3.6 metres below existing ground surface.

OTHER TESTS

PLATE 4

Appendix 3 Laboratory Test Results

LVM | MARITIME TESTING

TABLE 3: SUMMARY OF LABORATORY DATA
Geotechnical Investigation
Proposed Culvert Replacement, Big Johnny's Turn, CBHNP, NS
Project No. 18103

Borehole No.	Sample No.	Depth (m)	Description	Moisture Content (%)	Particle Size Distribution: Gravel (%)	Sand (%)	Fines (silts and clays) (%)	Atterberg Limits wL, wP, IP
BH 1	2	1.2-1.8		5.4				
	4	3-3.6		5.1				
BH 2	6	3.6-4.2	TILL : gravely sand some silt	7.4	41	49	10	
BH 3	3	1.5-2.1	FILL : silty Sand, some gravel	8.5	32	53	15	
BH 4	4	2.1-2.7		6.3				

LVM | MARITIME TESTING

METRIC SIEVE ANALYSIS REPORT

97 TROOP AVE., DARTMOUTH, N.S. B3B 2A7 - TEL (902) 468-6486 FAX 468-4919

Client:

SNC Lavalin Inc. (Maritimes)
Suite 200, Park Lane Terraces
5657 Spring Garden Road
Halifax, NS B3J 3R4

Our Project No: 18103

Client Contract No.:

Client PO.:

CC:

Attn: Norm Landry

PHONE (902) 492-4544 **FAX:** (902) 492-4540

Project: Geotechnical Investigation - Big Johnny's Turn Culverts, CBHNP, NS

Source: BH #2

Sampled by: BAM

Sample No: 6 **Date Sampled:** 14-Nov-13 **Date Received:** 15-Nov-13

Location: 3.6 - 4.2m **Date Tested:** 18-Nov-13

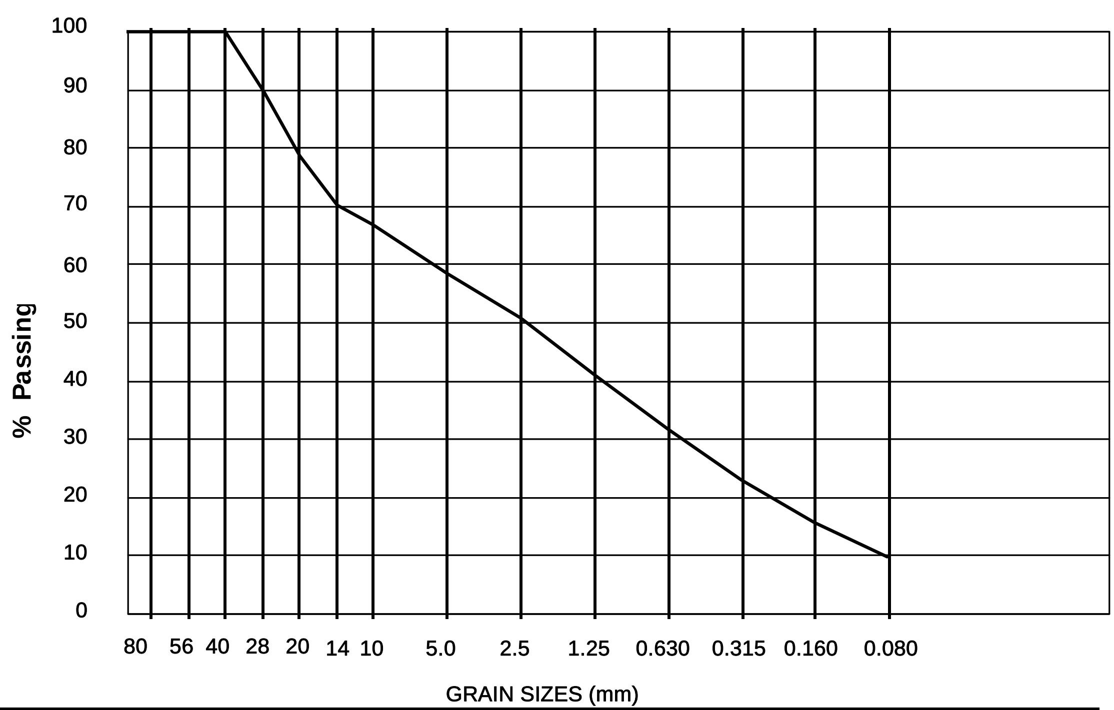
PHYSICAL PROPERTY TESTS					
Soil Type	Till	**Liquid Limit**		**Flat and Elongated Particles, %**	
Gravel, %	41	**Plastic Limit**		**Coarse Spec. Gravity**	
Sand, %	49	**Plasticity Index**		**Fractured Faces, %**	
Silt and Clay, %	10	**Coarse Absorption, %**		**Petrographic No.**	
Moisture Cont., %	7.4	**Fine Absorption, %**		**Max. Dry Density, (kg/m3)**	
Abrasion Loss, %		**Micro Deval Loss, %**		**Optimum Moisture, %**	

Spec Band

NO SPEC

Sieve Size (mm)	Percent Passing	Spec. Band
112		
80		
56		
40	100	
28	90	
20	79	
14	70	
10	67	
5.0	59	
2.5	51	
1.25	41	
0.630	32	
0.315	23	
0.160	16	
0.080	9.9	

GRAIN SIZE CURVE



Comments:

Record No: 8367 MTL Tech: DB PER

CERTIFIED LABORATORY FOR TESTING CONCRETE

Reporting of these test results constitutes a testing service only. Engineering interpretation or evaluation of test results is provided only on reques

pm: KM

LVM | MARITIME TESTING

METRIC SIEVE ANALYSIS REPORT

97 TROOP AVE., DARTMOUTH, N.S. B3B 2A7 - TEL (902) 468-6486 FAX 468-4919

Client:

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Suite 200, Park Lane Terraces
5657 Spring Garden Road
Halifax, NS B3J 3R4

Our Project No: 18103

Client Contract No.:

Client PO.:

CC:

Attn: Norm Landry

PHONE (902) 492-4544 **FAX:** (902) 492-4540

Project: Geotechnical Investigation - Big Johnny's Turn Culverts, CBHNP, NS

Source: BH #3 **Sampled by:** BAM

Sample No: 3 **Date Sampled:** 14-Nov-13 **Date Received:** 15-Nov-13

Location: 1.5 - 2.1m **Date Tested:** 18-Nov-13

PHYSICAL PROPERTY TESTS

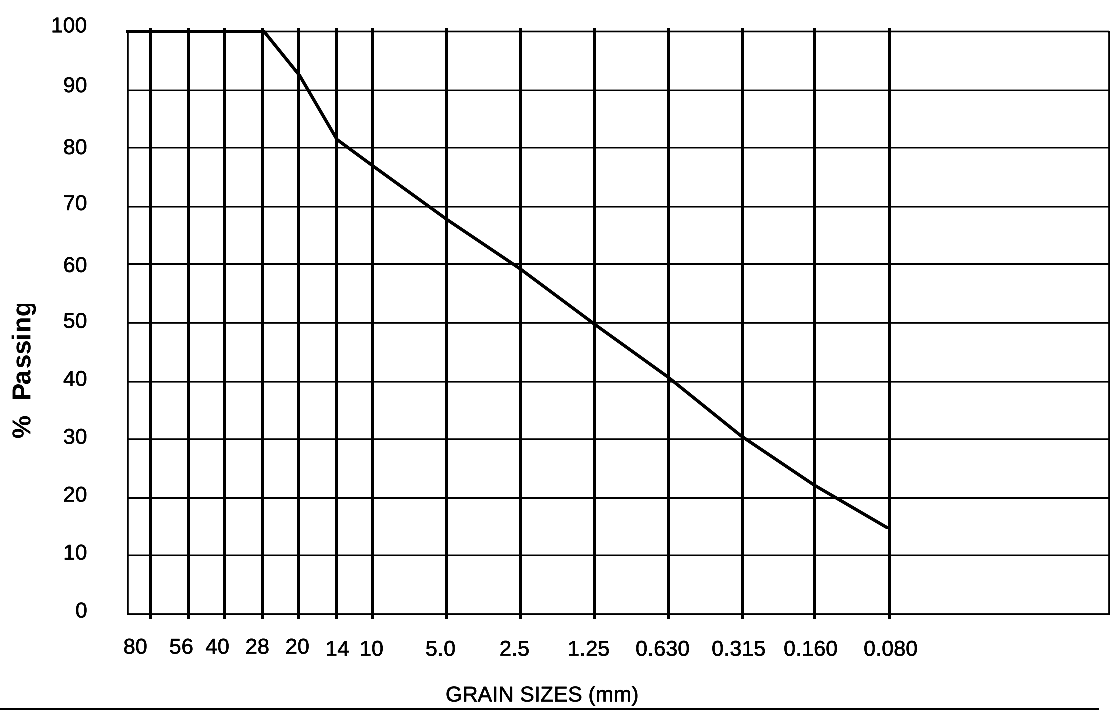
Soil Type	Fill	**Liquid Limit**		**Flat and Elongated Particles, %**	
Gravel, %	32	**Plastic Limit**		**Coarse Spec. Gravity**	
Sand, %	53	**Plasticity Index**		**Fractured Faces, %**	
Silt and Clay, %	15	**Coarse Absorption, %**		**Petrographic No.**	
Moisture Cont., %	8.5	**Fine Absorption, %**		**Max. Dry Density, (kg/m3)**	
Abrasion Loss, %		**Micro Deval Loss, %**		**Optimum Moisture, %**	

Sieve Size (mm)	Percent Passing	Spec. Band
112		
80		
56		
40		
28	100	
20	92	
14	81	
10	77	
5.0	68	
2.5	59	
1.25	50	
0.630	41	
0.315	31	
0.160	22	
0.080	15.0	

Spec Band

NO SPEC

GRAIN SIZE CURVE



Comments:

Record No: 8366 MTL Tech: DB PER

CERTIFIED LABORATORY FOR TESTING CONCRETE

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pm: KM