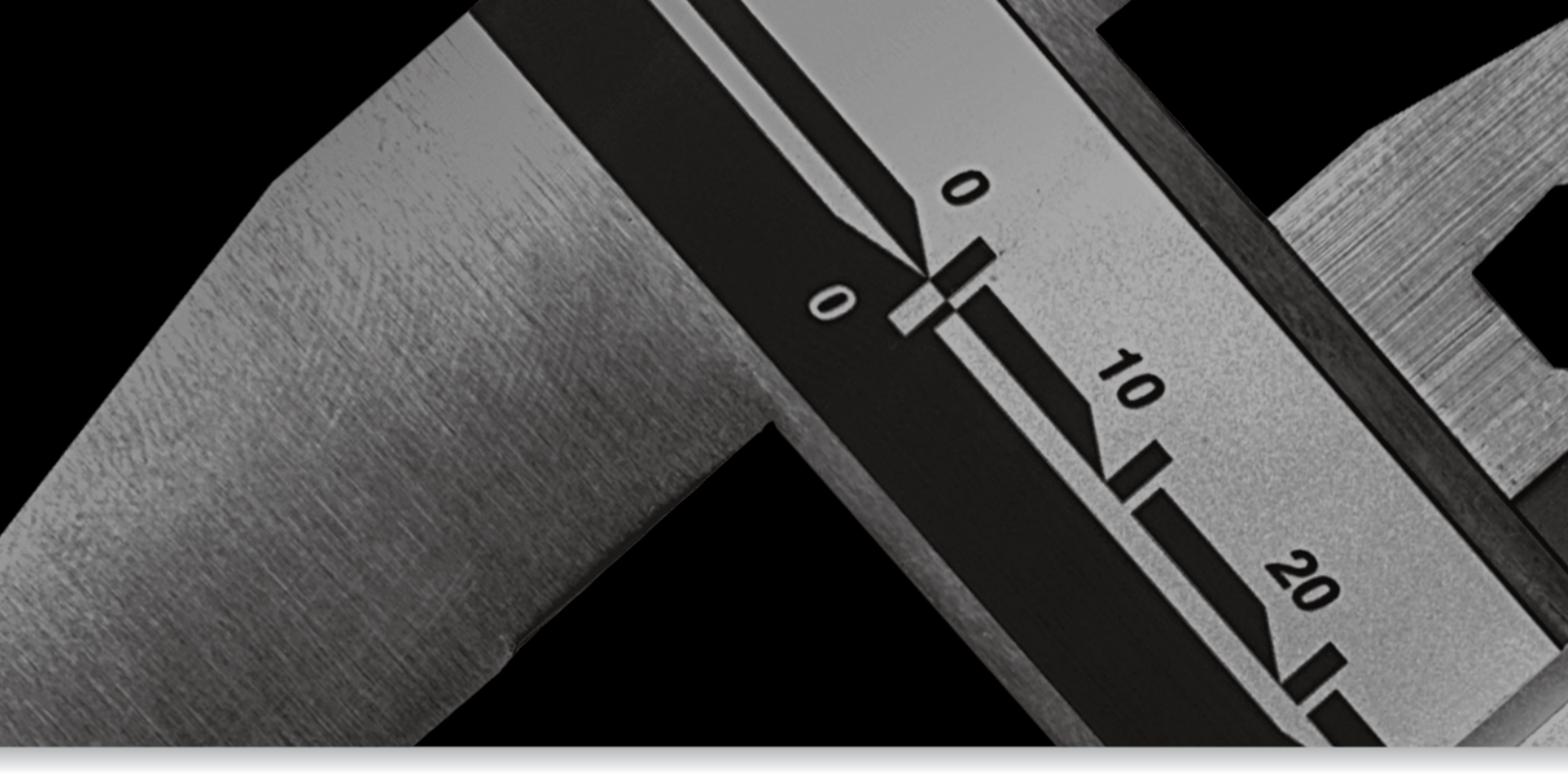

REPORT: T021204-A1

Public Works and Government Services Canada
Geotechnical Investigation Report
National War Memorial Structural Upgrade Phase I
Confederation Square
Ottawa, Ontario

September 20, 2013

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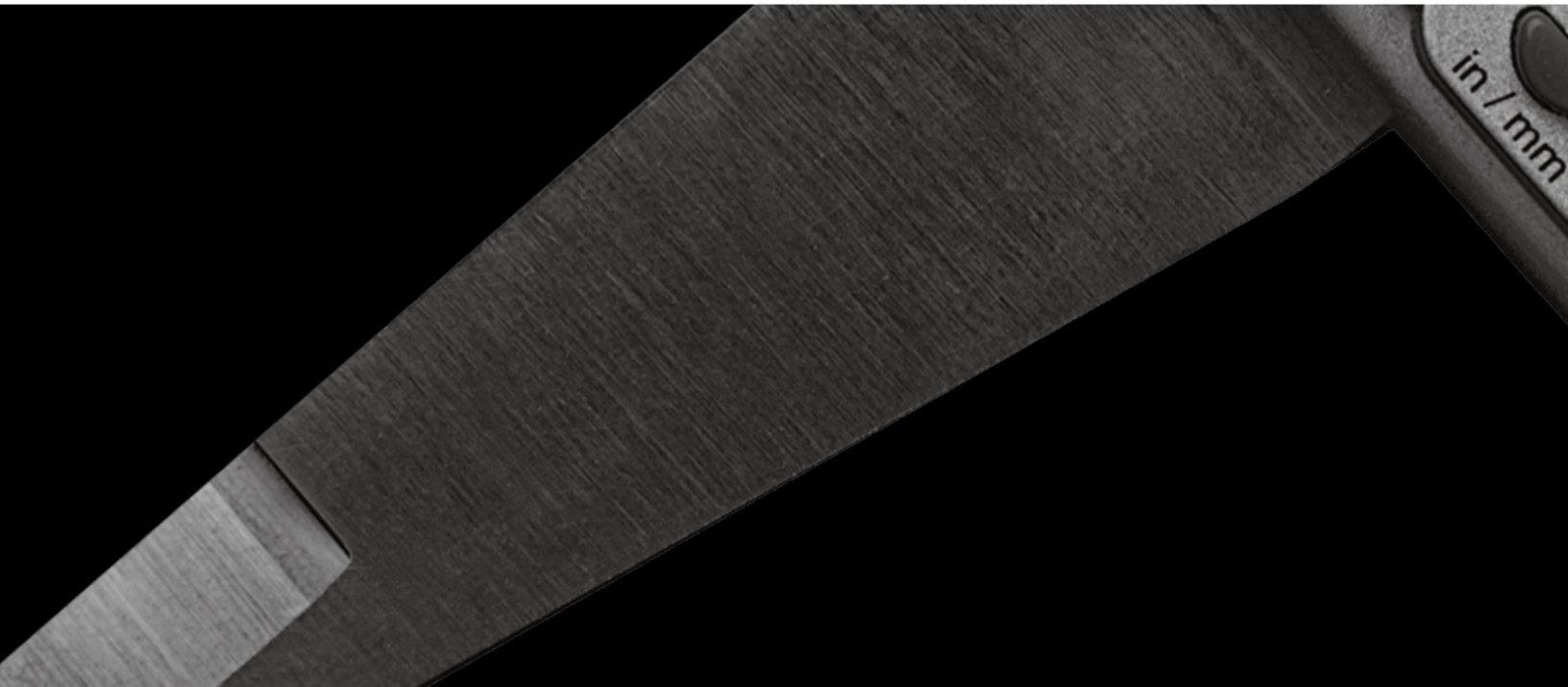

Ottawa, September 20, 2013

Mr. Armand Solomonescu, BA, BArch., OAA
Project Manager
Public Works and Government Services Canada
340 Albert Street, 10th Floor, 10-042
Ottawa, Ontario
K1A 0S5

Subject: Geotechnical Investigation
National War Memorial Structural Upgrade Phase I
Confederation Square
Ottawa, Ontario

Dear Mr. Solomonescu:

It is with pleasure that we provide you with our Geotechnical Investigation report T021204-A1, regarding the structural upgrade of National War Memorial located at Confederation Square, Ottawa, Ontario.

We thank you for having retained **Inspec-Sol** Inc. (**Inspec-Sol**) for technical and professional services and we hope to have the privilege of serving you again in the future.

The **Inspec-Sol** team is committed to exceeding the expectations of its clients.

Do not hesitate to contact us for any further information.

Best regards.

INSPEC-SOL INC.

Joseph B. Bennett, P. Eng.
Vice-President

BV/nc

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Public Works and Government Services Canada

Geotechnical Investigation
National War Memorial Structural Upgrade Phase I
Confederation Square
Ottawa, ON

Date :	**September 20, 2013**	Our Ref. :	**T021204-A1**

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Public Works and Government Services Canada
340 Albert Street 10th Floor – 10-042
Ottawa, ON

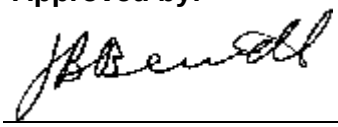
Geotechnical Investigation
National War Memorial Structural Upgrade (Phase I)
Confederation Square
Ottawa, ON

Ref.: T021204-A1
September 20, 2013

Prepared by :

Bahareh Vazhbakht, M.A.Sc.

Approved by:



Joseph B. Bennett, P. Eng.

Distribution: **Client –** Mr. Armand Solomonescu
(Copy by e-mail: armand.solomonescu@tpsgc-pwgsc.gc.ca)

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1.0 INTRODUCTION

Inspec-Sol Inc. (**Inspec-Sol**) was retained by Mr. Armand Solomonescu of Public Works and Government Services Canada (PWGSC) (Client) to undertake a geotechnical investigation for structural upgrade of National War Memorial (Site) located at Confederation Square, in Ottawa, Ontario.

The purpose of the investigation was to complete an evaluation of the subsurface stratigraphy within a subsurface structure that supports the podium surrounding the National War Memorial. Based upon the subsurface conditions found at borehole locations, and other data, **Inspec-Sol** was to provide recommendations concerning settlement, seismic site classification, as well as comment on site preparation, concrete fill, and construction field review.

This report has been prepared with the understanding that the design will be as described in *Section 2.0* and will be carried out in accordance with all applicable codes and standards. Any changes to the project described herein will require that **Inspec-Sol** be retained to assess the impact of the changes on the report recommendations provided herein.

The scope of work for **Inspec-Sol** consisted of the following activities:

- **Underground Service Clearances**;
- **Ground Penetrating Radar (GPR) Mapping :** GPR scanning of the soil inside the crawl space to identify voids and buried foundations;
- **Boreholes:** Advancement of a total of three (3) boreholes to practical refusal and coring the bedrock at all the borehole locations across the Site;
- **Lab Testing:** Five (5) moisture content, two (2) grain size analysis, one (1) hydrometer, nine (9) uniaxial unconfined compressive strength testing, and three (3) chemical analysis;
- **Geophysical Testing:** MASW survey to assist in the assignment of a site classification for seismic site response according to Table 4.1.8.4 of the Ontario Building Code (OBC-2006); and
- **Reporting:** Prepare a Geotechnical Report, which summarizes the findings of the fieldwork programs and presents recommendations for the design and construction of the structure.

2.0 SITE AND PROJECT DESCRIPTION

The Site is the National War Memorial located at Confederation Square in the City of Ottawa, Ontario which is a triangular shaped park that and is bordered to the north by Wellington Street, to the east and west by driving lanes of Elgin Street.

It is our understanding that the existing monument is supported by a raft or mass concrete foundation bearing directly on bedrock. The surrounding podium is constructed of a 2-way structural slab elevated on beams and columns. These columns are in turn supported on an array of piers or pad footings founded directly on bedrock. The structured slab supports the landscaping and paving stone park that surrounds the war memorial structure. The open space beneath the structural slab has a number of "temporary" jack posts placed randomly to provide additional support to the slab. It is unknown what material these jack posts bear upon.

The 'open' space is accessed by a manhole connected to a short tunnel. The open space has headroom varying from less than 1 m to approximately 2 m beneath the underside of the structural beams.

The condition of the concrete structure is not part of **Inspec-Sol**'s scope of work. The exposed ground surface within the open space or room in question is an "earthen floor" but varies from sand and gravel, surface water collected in depressed areas, stalagmites rubble (brick/block), filled local excavated areas with evidence of concrete possibly representing foundation structures from previous buildings.

Inspec-Sol understands that the project will consist of two (2) phases. In Phase One of the project (which is the current phase under which **Inspec-Sol** is retained) the existing crawl space will be filled with non-shrink concrete. Phase Two of the project will consist of structural upgrades on the podium section and monument. The top of the slab will then be repaired and resurfaced with interlock paving and other landscaping features.

The location of the Site is shown on the *Site Location Map* attached as, *Dwg. No.: T021204-A1-1*, at the end of this report.

3.0 FIELD INVESTIGATION

The fieldwork component of this Geotechnical Investigation was as follows:

- **Boreholes**: Advancement of a total of three (3) boreholes to practical refusal across the Site and core the bedrock
- **Geophysical Testing:** MASW survey to assist in the assignment of a site classification for seismic site response according to Table 4.1.8.4 of the Ontario Building Code (OBC-2006); and
- **Ground Penetrating Radar (GPR) Mapping:** Using the GPR method, the overburden material will be scanned to identify voids, changes in materials and any buried structures.

It should be noted that all the fieldwork as performed inside the crawl space beneath the podium section and using confined space entry procedures when personnel entered the space.

3.1 Boreholes

The borehole fieldwork component of this Geotechnical Investigation consisted of the advancement of three (3) boreholes, BH1 to BH3. Boreholes were advanced to depths varying between 1.8 to 3.9 m below the existing surface grade. The boreholes were outfitted with 1.5 to 4.0 m long standpipes installed to measure the groundwater level. The location of the boreholes is shown in the *Borehole Location Plan* attached as *Dwg No.: T021204-A1-3*, at the end of this report.

The fieldwork program was undertaken on August 15 and 16, 2013 with a manual portable drill rig adapted for soil sampling, under the supervision of **Inspec-Sol** field staff. Boreholes were advanced into the overburden using casing. Standard Penetration Tests (SPTs) were performed before casing drilling at regular intervals using a 50 mm diameter split-spoon sampler and a 20 kg manual hammer, to collect soil samples. The number of drops required to drive the sampler 0.3 m is corrected and recorded on the borehole logs as “N” value; however these values are not representative of “N” value and care should be taken to use these values for any analysis. Where applicable, the undrained shear strength of the soil was estimated using a, pocket penetrometer. All boreholes were advanced to practical refusal (on assumed bedrock) and further advanced into bedrock using diamond coring equipment, in order to confirm the existence of bedrock and comment on rock quality. Boreholes were

equipped with 1.5 m to 4.0 m standpipes and backfilled with sand and bentonite seal upon completion.

The elevations of the boreholes were determined by **Inspec-Sol** and were related to a temporary benchmark defined as the survey nail No. 626 at the bottom of the tunnel as per the Dwg. No. PPB_021_C_01_13 provided by the Client. The bench mark was reported to have a geodetic elevation of 72.70 m. The elevations of the boreholes are for use within the context of this report only.

3.2 Geophysical Testing

The geophysical testing component was carried out on August 13, 2013. The purpose of this testing was to determine the average shear wave velocity of the soil to a depth of 30 m.

The test was carried out using a 24 channel seismograph (Geometrics Geode 24 consol #3389) consisting of twenty-four (24), 4.5 Hz geophones, connected to a 24 take-out cable with 0.5 m spacing. The data was collected using Geometrics single Geode OS controller version 9.14.0.0 and a field laptop.

The geophone arrays were laid down using multi-station approach, where data along each investigation line (Lines 1 and 2) was collected using short array geophone spacing geometries. Commonly multiple geophone spacing geometries using a long array (2 m geophone spacing) and short array (1 m geophone spacing) are being performed; however do to the site condition and limited flat area only one set of data was collected for each line using geophones mounted every 0.5 m (short array). In general, the longer array length provides information over a greater depth and shorter arrays provide more detail information at shallower depths. It is noted that in all the geometries the midpoint of the geophone arrays was kept the same so that the collected data can be combined.

Table 1 below shows the details of the geometry along each investigated line. The approximate locations of investigation lines are shown in the *MASW Line Layout* attached as *Dwg. No.: T021204-A1-2*, at the end of this report.

TABLE 1: MASW Line Geometry

Line No.	Short Array	
	Spacing (m)	Hammer Offset (m)
L1	0.5	14.5, 7.5, 3.5
L2	0.5	10, 7, 4

A 9 kg sledge hammer hitting a steel base plate was used for active data acquisition. For each active survey, the ground vibration was recorded for 4 seconds at a sampling rate of one sample per 0.25 m.

The results of the geophysical testing program can be found in *Seismic Site Classification* attached as *Appendix: A* at the end of this report.

3.3 Ground Penetrating Radar (GPR) Mapping

It was agreed that **Inspec-Sol** would hire a subcontractor to scan the overburden material inside the crawl space using Ground Penetrating Radar (GPR) method; however as the soil on site was saturated and due to the likely presence of salt residue within the overburden soil the GPR scanning results were of poor quality and the results could not be used to generate a scanning report. The GPR field reports can be found in Ground Penetrating Radar (GPR) mapping report attached as Appendix: A at the end of this letter.

3.4 Laboratory testing

Laboratory testing on recovered soil samples and bedrock cores included moisture contents, grain size analysis, hydrometer, and uniaxial unconfined compressive strength testing. In total, five (5) moisture contents, two (2) grain size analysis, one (1) hydrometer and nine (9) uniaxial unconfined compressive strength testing were performed. A summary of the testing results are described graphically on the borehole logs, as *Enclosures Nos. 1-3*. The results of the laboratory testing were used in providing the subsoil descriptions provided below in *Section 4.0.*

Analytical testing was carried out on three (3) representative soil samples collected from boreholes BH1 and BH3 to determine corrosion potential of the subsurface soils at the site. The results of the chemical analyses are discussed in S*ection 6.6.*

4.0 SUBSURFACE CONDITIONS

In general, soils encountered at the borehole locations varied significantly from one location to the other. Native soils were encountered at two (2) locations. Fill material was encountered in all of the boreholes; the fill material extended to the top of bedrock only in one location. Bedrock was encountered in all of the boreholes.

General descriptions of the subsurface conditions are summarized in the following sections, with a graphical representation of each borehole on the *Borehole Logs*, attached as *Appendix A* at the end of this report. *Notes on Boreholes* are provided as *Appendix B*, at the end of this report.

4.1 Fill Material

The fill within the boreholes ranged in depth from about 0.2 m to 1.5 m. The fill material at the location of borehole BH1 consisted of a 200 mm thick layer of mixture of sand, silt and clay. A 1.7 m thick layer of old building rubble (bricks and concrete) was encountered at the location of borehole BH2. Fill material at the location of borehole BH3 consisted of a 150 mm thick layer of brown silty sand recovered in moist condition.

4.2 Silty Clay

A native silty clay deposit was encountered at the location of borehole BH1. This silty clay was brownish grey in colour and very stiff in consistency. The silty clay layer has moisture contents of 38% to 48% in samples tested.

4.3 Sandy Silt

Beneath the fill material at the location of borehole BH3, a native sandy silt deposit was encountered. This sandy silt was brown in colour and compact to dense in relative compaction and was recovered in wet condition.

4.4 Glacial Till

A sandy silt till deposit was observed in boreholes BH1 beneath the clay deposit and in borehole BH3 beneath the sand deposit. In this area, glacial till commonly refers to a deposit which exhibits a full range of particle sizes including cobbles and boulders and directly overlies bedrock. This till was very dense in relative compaction, was grey in colour at borehole BH3 and brown in colour at borehole BH1, and was recovered in a wet condition.

4.5 Bedrock

Practical refusal was encountered in all boreholes below the overburden soils and was found to range in depth from 1.4 m in BH3 to 1.7 m in BH2. The type of rock and its quality was confirmed by retrieving rock samples from all the boreholes by diamond coring techniques. Bedrock is described as medium grey fossiliferous micritic limestone cut by numerous stylolitic seams. The quality of this rock ranged from very poor to excellent depending on location and depth. The result of the uniaxial unconfined compressive strength test on nine (9) representative core samples revealed that bedrock has an unconfined compressive strength of between 90 Mpa to 160 Mpa. The photos of the rock cores are attached as *Appendix D* at the end of this report.

The depths of bedrock and corresponding elevations are presented in Table 2.

TABLE 2: Bedrock Depth Based on Drilled Boreholes

Location	Ground Elevation (m)	Depth to Bedrock (m)	Bedrock Elevation (m)
BH1	73.93	1.57	72.36
BH2	73.89	1.7	72.19
BH3	74.01	1.35	72.66

5.0 GROUNDWATER

Soils encountered at the location of boreholes BH1 and BH3 were found in moist to wet condition. As part of the mandate, PVC standpipes were installed in all of the boreholes. Standpipes were installed within bedrock at boreholes BH1 and BH2 and within the overburden soil at borehole BH3. The water levels were measured on August 26, 2013 and were found to have the following elevations at the time of sampling.

TABLE 3: Groundwater Observations

Location	Ground Elevation (m)	Observed Groundwater Depth (m)	Observed Groundwater Elevation (m)
		August 26, 2013	August 26, 2013
BH1	73.93	2.04	71.89
BH2	73.89	2.77	71.12
BH3	74.01	0.85	73.16

6.0 DISCUSSION AND RECOMMENDATIONS

Based on our understanding of the proposed structural upgrade and the subsurface conditions encountered in the boreholes the most important geotechnical considerations for the project are discussed in following sections. In presenting these discussion points we understand the purposed remediation plan for Phase One of the project to be:

6.1 Site Preparation

It should be noted that the topography of the earth floor of the open space site is not flat; there are open excavations, fill material stockpiles, and accumulations (stalagmite) of salts and leachate drippings. Deep building rubble fill material was reported by the client to be present as backfill in local areas.

As mentioned in Section 2.3.1 the fill material encountered at borehole BH2 consists of building rubble which can also be observed on the surface and around the pad footings founded on west side of the Site. The building rubble may have voids within the matrix of the material.

Site preparation recommendations for placement of geotextile and drainage layer, are as follows:

- It is our understanding that currently there are drainage pipes installed within the existing podium slab which prevents the paving stones and any underlying layers from becoming saturated. The proposed structural upgrade program should be designed to ensure this drainage of the existing slab is preserved to prevent reduced drainage of the paving layers.

- Contractors should be aware of the difficulties of the working conditions and material placement due to insufficient headroom in some areas inside the crawl space.
- The general surface and areas of loose surfical fill should receive some effort to level out the subgrade and apply compacted effort. It should be noted that the soil encountered in boreholes were found in a saturated condition. There will be a need to install temporary sump pits to allow the soils to be drained prior to compaction.
- The existing areas of local excavations should be backfilled either with compactable fill material or clear stone. The clear stone may be a 19 m in clear stone or an HL8 stone that meet a gradation requirement of the Ontario Provinical Standard Specification.
- A geotextile should be placed at all interfaces of the soil and clear stone; geotextile should be cut around rigid surfaces to ensure that there are no gaps between the geotextile and the soil subgrade surface. The geotextile should be a non-woven product and meet AASHTO M288 High survivability property (Class I in Canadian Engineering Foundation Manual) such as a Terrafix 800R or equilavent.
- Once the existing local excavation are back filled and surfaces leveled and compacted to the owner's engineers satisfaction, then the exposed subgrade should be covered with the same geotextile mentioned above.
- This will be covered with a layer of clearstone (19 mm or HL8 type) as specified by the designers and this final surface in turn covered with the geotextile products in preparation for concrete placement.
- The volume of voids within the rubble fill material should be reduced. One of the following options can be used:
  - Option 1 - The rubble fill material can be removed or replaced with compacted suitable fill material which will be challenging due to the site condition;
  - Option 2 - The voids can be filled with grout prior to pouring concrete; this can be done once the site preparations completed.

The compactive effort should be with as large a vibratory plate type packer as possible. In low headroom areas, special or unique methods will need to be produced by the contractor to achieve a level of effort acceptable to the owner's engineer.

6.2 Concrete Placement

Inspec-Sol understands that the client, through previous studies, assessed that an economical and practical method of the structural upgrade of the National War Memorial will

include backfilling the entire open space with a Portland cement based concrete fill. It is our understanding that a 4.0 MPa concrete mix has been selected. The following notes and recommendations should be considered for concrete placement procedure:

- The clear stone layer placed beneath the concrete fill will act as a receiver of excess bleed water from the concrete. The designers should ensure there are measures to accommodate the drainage of the excess water and the clear stone acting as a drainage layer should be in a drained condition at all times. The void ratio of the clear stone is assumed to be 0.3 to 0.4 to assist in this aspect of the design.
- Considering the elevation change across the site, the concrete placement procedure and mix properties should be planned to allow for the horizontal movement of concrete.
- Engineers and contractors should be aware of the potential for trapped air between the concrete fill and existing concrete slab due to cells created by existing beams and the flowability of the concrete fill. The concrete placement process must be planned to account for and manage both issues.
- Drawing No. A103 dated April 9, 2013 shows bond break details around the existing grade beams with the use of styrofoam. The bond breaker placed horizontally at the bottom of the existing grade beams should be a polyethylene sheet and not styrofoam to eliminate the risk of settlement due to compression of the styrofoam under load.
- A grouting program should be included as part of the overall work program to ensure any voids between new and old concrete are filled to 100% support to the underside of the existing slab.

6.3 Settlement

The total settlement of the concrete mass will depend on the settlement of the subsurface soils under the load of the concrete mass and the shrinkage of the concrete. As previously mentioned **Inspec-Sol** was not provided with the concrete mix design at the time of submitting this report. The shrinkage of the concrete will depend on the water cement ratio of the concrete mix. It is our understanding that the 4.0 Mpa concrete mix will have a low cement and super plasticizer, content therefore the shrinkage of this concrete mix is estimated to be minimal.

A settlement analyses was carried out for materials encountered in boreholes BH1 and BH3. The total load from the concrete fill and the dead/live loads on the slab on the existing grade were stated by the structural engineer to be approximately 75 kPa. Based upon the data it is recommended that designers plan for the total settlement estimated to be between 5 mm to 10 mm. Based upon this, it is our recommendation that a grouting program must be considered for the project.

Based upon the fieldwork findings, only elastic or short term settlement is expected to occur. This settlement should occur during a short period of time after placement of concrete. Therefore the grouting program should be carried out no sooner than one month after concrete placement to allow any concrete shrinkage and elastic concrete to be virtually compacted.

6.4 Infiltration Rate

As part of our mandate, grain size analysis was performed on three samples collected from boreholes BH1 and BH3. Bail test was performed for all of the installed wells. Based on the results of the grain size analysis and the bail test (coefficient of permeability) the estimated percolation times for materials on site are listed in Table 4.

TABLE 4: Estimated Percolation Time

Material	Percolation Time (Min/Cm)
Clear Stone	< 1
Sand Fill	≈ 10-15
Sandy Silt	≈ 10-15
Clay	>50
Till	≈ 15-25
Bedrock	≈ 20-50

6.5 Seismic Classification

In accordance with OBC-2006, the building and its structural elements must be designed to resist a minimum earthquake force. In order to provide a site class, a geophysical (MASW) testing program that included the generation of dispersion curves, inversion of the obtained dispersion curves, and development of one dimensional (1-D) shear wave velocity profiles using SurfSeis® version 2.05. The dispersion curves obtained from active data using short arrays along each investigation line were investigated and integrated to obtain a combined

dispersion curve. It should be noted that due to the poor data the wave penetration depth was relatively shallow (up to 10 m or so). Considering that the bedrock is shallow, the velocity measured for the last depth to 30 m below was extrapolated to obtain the average shear wave velocity. This is in line with Code recommendation.

In accordance with the requirements of OBC-2006, the variation of the measured shear wave velocity versus depth up to 30.6 m below existing ground elevation was obtained at each station, and is shown in *Seismic Site Classification* attached as *Appendix: A*, at the end of this report. The average shear wave velocity along each line was obtained utilizing the averaging scheme shown in Sentence 4.1.8.4 (2) of Commentary J of National Building Code (NBC-2005) User's Guide.

It should be noted that due to the poor data the wave penetration depth was relatively shallow (up to 10 m or so). Considering that the bedrock is shallow, the velocity measured for the last depth to 30 m below was extrapolated to obtain the average shear wave velocity. This is in line with Code recommendation.

Based upon the results of the geophysical testing program, we recommend that the building be designed to **Site Class 'B'**, with respect to Table 4.1.8.4.A of the OBC-2006. The results of the geophysical testing program as wall as the Site Class calculation can be found in *Seismic Site Classification* attached as *Appendix: C* at the end of this report.

6.6 Corrosion Potential of Soils

Analytical testing was carried out on soil samples collected from borehole BH2 to determine corrosion potential of the subsurface soils at each site. The selected soil sample was tested for pH, resistivity, chlorides, sulphides, sulphates, and redox potential. The test results are summarized in the following table.

TABLE 5: Corrosion Parameter Results

Sample ID	BH3-SS2	BH1-SS1	BH1-SS2
pH	7.87	7.65	7.44
Redox Potential (mV)	+106	+131	+167
Resistivity (ohm-cm)	430	650	700
Sulphide (µg/g)	0.86	0.37	0.30
Sulphate (µg/g)	58	31	29
Chloride (µg/g)	1300	790	770

The American Water Works Association (AWWA) publication 'Polyethylene Encasement for Ductile-Iron Pipe Systems' ANSI/AWWA C105/A21.5-10 dated October 1, 2010 assigns points based on the results of the above tests. A soil that has a total point score of 10 or more is considered to be potentially corrosive to ductile iron pipe. Based on the results obtained for the sample submitted, the Site soils are considered to be potentially corrosive to cast iron pipe.

Table 3 of the Canadian Standards Association (CSA) document A23.1-04/A23.2-04 'Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete' divides the degree of exposure into the following three (3) classes:

Degree (Class) of Exposure	Water Soluble (SO_4) in Soil Sample (%)
Very Severe (S-1)	> 2.0
Severe (S-2)	0.20 – 2.0
Moderate (S-3)	0.10 – 0.20

A review of the analytical test results shows the sulphate content in the tested samples was found to be less than 0.006 percent. Based upon the test results, the degree of exposure of the subsurface concrete structures to sulphate attack is low. Therefore, normal Portland cement can be used for the below grade concrete structures.

6.7 Construction Field Review

The recommendations provided in this report are based on an adequate level of construction monitoring being conducted during construction phase of the proposed building. **Inspec-Sol** requests to be retained to review the drawings and specifications, once complete, to verify that the recommendations within this report have been adhered to, and to look for other geotechnical problems. Due to the nature of the proposed development, an adequate level of construction monitoring is considered to be as follows:

- Prior to concrete fill placement subgrade should be examined by a Geotechnical Engineer or a qualified Technologist acting under the supervision of a Geotechnical Engineer, to assess whether the subgrade conditions correspond to those encountered in the boreholes, and the recommendations provided in this report have been implemented;

- Site preparation should be conducted in the presence of a qualified Technologist on a part time basis, to ensure that proper material is employed and specified compaction is achieved;
- The concrete mix design should be reviewed by **Inspec-Sol** in order to review our comments regarding the bleed water and shrinkage of the concrete.

7.0 LIMITATION OF THE INVESTIGATION

This report is intended solely for Public Works and Government Services Canada or other party explicitly identified in this report, and is prohibited for use by others without **Inspec-Sol**'s prior written consent. This report is considered **Inspec-Sol**'s professional work product and shall remain the sole property of **Inspec-Sol**. Any unauthorized reuse, redistribution of or reliance on the report shall be at the Client and recipient's sole risk, without liability to **Inspec-Sol**. Client shall defend, indemnify and hold **Inspec-Sol** harmless from any liability arising from or related to Client's unauthorized distribution of the report. No portion of this report may be used as a separate entity; it is to be read in its entirety and shall include all supporting drawings and appendices.

The recommendations made in this report are in accordance with our present understanding of the project, the current site use, ground surface elevations and conditions, and are based on the work scope approved by the Client and described in the report. The services were performed in a manner consistent with that level of care and skill ordinarily exercised by members of Geotechnical Engineering professions currently practicing under similar conditions in the same locality. No other representations, and no warranties or representations of any kind, either expressed or implied, are made. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties.

All details of design and construction are rarely known at the time of completion of a geotechnical study. The recommendations and comments made in the study report are based on our subsurface investigation and resulting understanding of the project, as defined at the time of the study. We should be retained to review our recommendations when the drawings and specifications are complete. Without this review, **Inspec-Sol** will not be liable for any misunderstanding of our recommendations or their application and adaptation into the final design.

By issuing this report, **Inspec-Sol** is the Geotechnical Engineer of record. It is recommended that **Inspec-Sol** be retained during construction of all foundations and during earthwork operations to confirm the conditions of the subsoil are actually similar to those observed during our study. The intent of this requirement is to verify that conditions encountered during construction are consistent with the findings in the report and that inherent knowledge developed as part of our study is correctly carried forward to the construction phases.

It is important to emphasize that a soil investigation is, in fact, a random sampling of a site and the comments included in this report are based on the results obtained at the three (3) borehole locations only. The subsurface conditions confirmed at these test locations may vary at other locations. Soil and groundwater conditions between and beyond the three (3) test locations may differ both horizontally and vertically from those encountered at the test locations and conditions may become apparent during construction, which could not be detected or anticipated at the time of our investigation. Should any conditions at the site be encountered which differ from those found at the test locations, we request that we be notified immediately in order to permit a reassessment of our recommendations.

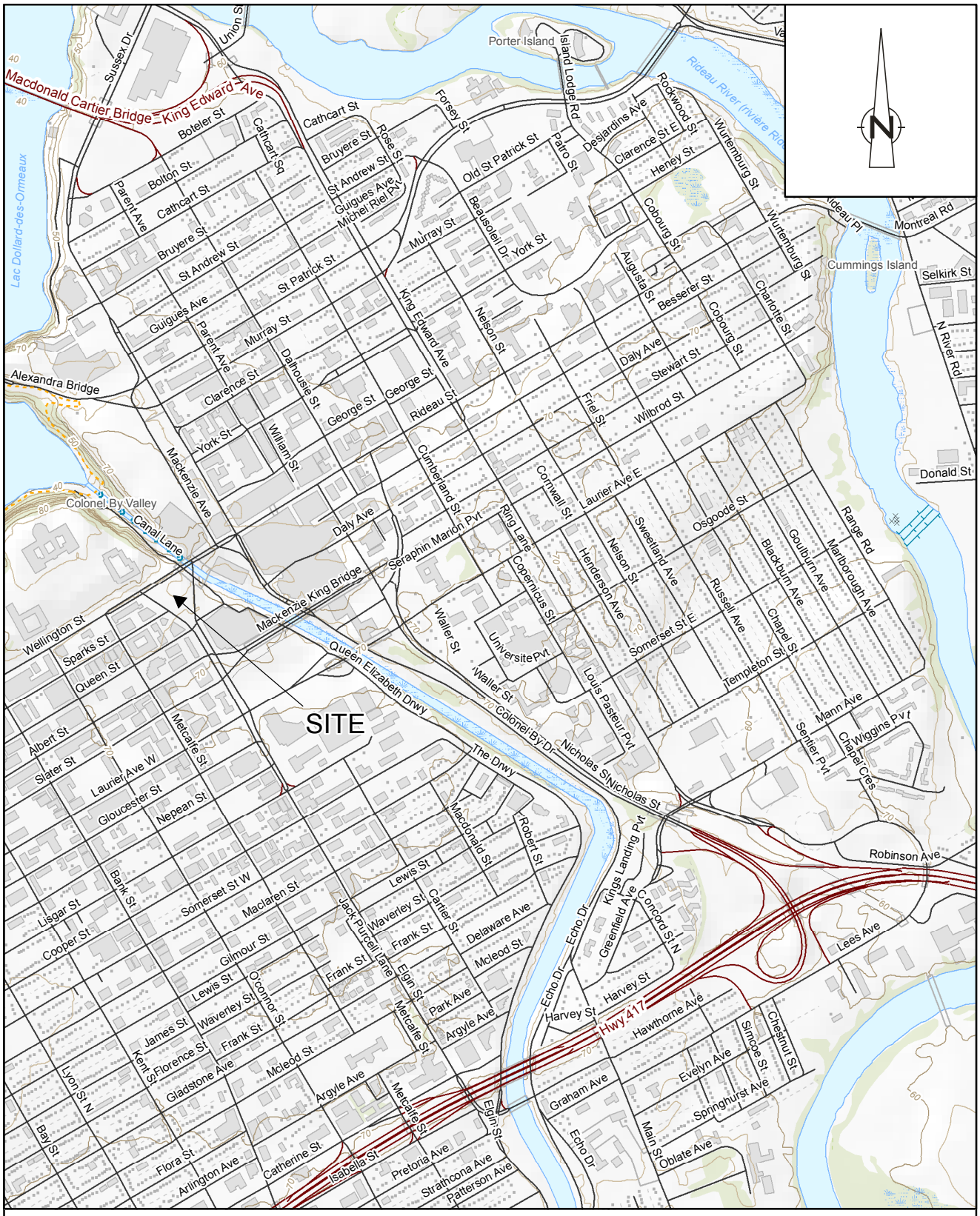
If changed conditions are identified during construction, no matter how minor, the recommendations in this report shall be considered invalid until sufficient review and written assessment of said conditions by **Inspec-Sol** is completed.

BV/nc

Enclosures

Drawings

- T021204-A1-1 Site Location Plan
- T021204-A1-2 Borehole Location Plan
- T021204-A1-3 MASW Line Layout



Source: MNR NRVIS, 2011. Produced by CRA under licence from Ontario Ministry of Natural Resources, © Queen's Printer 2011;
Coordinate System: NAD 1983 UTM Zone 18N

SITE LOCATION MAP

GEOTECHNICAL INVESTIGATION
NATIONAL WAR MEMORIAL
CONFEDERATION SQUARE, OTTAWA, ONTARIO
PWGSC
Dwg. No. T021204-A1-1

INSPEC-SOL

T021204-A1(001)GIS-OT001 August 13, 2013

Source: Bing Maps Aerial, Acquisition Date Unknown, Accessed 2013; Coordinate System: NAD 1983 UTM Zone 18N

MASW LINES

GEOTECHNICAL INVESTIGATION
NATIONAL WAR MEMORIAL
CONFEDERATION SQUARE, OTTAWA, ONTARIO
PWGSC
Dwg. No. T021204-A1-2

INSPEC-SOL

T021204-A1(001)GIS-OT002 August 20, 2013

Source: Bing Maps Aerial, Acquisition Date Unknown, Accessed 2013; Coordinate System: NAD 1983 UTM Zone 18N

BOREHOLE PLAN

GEOTECHNICAL INVESTIGATION
NATIONAL WAR MEMORIAL
CONFEDERATION SQUARE, OTTAWA, ONTARIO
PWGSC
Dwg. No. T021204-A1-3

INSPEC-SOL

T021204-A1(001)GIS-OT003 August 19, 2013

Appendix A

- Borehole Logs – Nos. 1 to 3

REFERENCE No.: T021204-A1 ENCLOSURE No.:

INSPEC·SOL

BOREHOLE No.: BH-1

ELEVATION: 73.93 m

BOREHOLE LOG

Page: 1 of 1

CLIENT: Public Works and Government Services Canada

PROJECT: Geotechnical Investigation

LOCATION: National War Memorial, Confederation Square, Ottawa

DESCRIBED BY: B. Vazhbakht CHECKED BY: J. Bennett

DATE (START): August 15, 2013 DATE (FINISH): August 15, 2013

LEGEND

- SS Split Spoon, GS Grab Sample
- ST Shelby Tube, ODEX
- RC Rock Core
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	MONITOR WELL	State	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)
	73.93			0.48					
	73.73		**FILL** - mix of sand, silt and gravel, brownish grey, moist.						
0.5			**CLAY** - brownish grey, very stiff, moist.			SS1	100		7
1.0				Bentonite seal		SS2	100		17
	72.73		**SANDY SILT (TILL)** - trace gravel, trace to some clay, compact, grey, wet.	PVC riser		SS3	50		R
1.5	72.36		**LIMESTONE** - fair quality, becoming excellent with depth, medium grey fossiliferous micritic Limestone cut by numerous stylolitic seams.			RC1	100		65
				1.83					
2.0				WL 2.04 Aug 26/13 2.13					
				PVC screen		RC2	82		60
2.5									
				Sand pack					
3.0						RC3	100		94
3.5									
	70.27		End of borehole at 3.6m.	3.66					
4.0									
4.5									

SCALE FOR TEST RESULTS

50kPa 100kPa 150kPa 200kPa

10 20 30 40 50 60 70 80 90

NOTES:

The SPT blow values are from a manual hammer weight

BOREHOLE LOG T021204-A1 - BH LOGS.GPJ INSPEC_SOL.GDT 9/20/13

REFERENCE No.: T021204-A1 ENCLOSURE No.:

INSPEC·SOL

BOREHOLE No.: BH-2

ELEVATION: 73.89 m

BOREHOLE LOG

Page: 1 of 1

CLIENT: Public Works and Government Services Canada

PROJECT: Geotechnical Investigation

LOCATION: National War Memorial, Confederation Square, Ottawa

DESCRIBED BY: B. Vazhbakht CHECKED BY: J. Bennett

DATE (START): August 15, 2013 DATE (FINISH): August 15, 2013

LEGEND

- SS Split Spoon; GS Grab Sample
- ST Shelby Tube; ODEX
- RC Rock Core
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- Shear Strength based on Pocket Penetrometer

Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	MONITOR WELL	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	73.89			0.35			%	ppm	N
0.5			**FILL** - building rubble, brick and concrete.			SS1	17		7
1.0				Bentonite seal		SS2	0		23
1.5						RC1			
	72.19		**LIMESTONE** - fair quality, becoming excellent quality with depth, medium grey fossiliferous micritic Limestone cut by numerous stylolitic seams.						
2.0				2.03 PVC riser		RC2	100		0
2.5				2.34 PVC screen		RC3	89		72
3.0				Sand pack WL 2.77 Aug 26/13					
3.5						RC4	00		92
	70.03		End of borehole at 3.8m.	3.86					
4.0									
4.5									

SCALE FOR TEST RESULTS

50kPa 100kPa 150kPa 200kPa

10 20 30 40 50 60 70 80 90

NOTES:
The SPT blow values are from a manual hammer weight

BOREHOLE LOG T021204-A1 - BH LOGS.GPJ INSPEC_SOL.GDT 9/20/13

REFERENCE No.: T021204-A1 ENCLOSURE No.:

INSPEC·SOL

BOREHOLE No.: BH-3

ELEVATION: 74.01 m

BOREHOLE LOG

Page: 1 of 1

CLIENT: Public Works and Government Services Canada

PROJECT: Geotechnical Investigation

LOCATION: National War Memorial, Confederation Square, Ottawa

DESCRIBED BY: B. Vazhbakht CHECKED BY: J. Bennett

DATE (START): August 16, 2013 DATE (FINISH): August 16, 2013

LEGEND

- SS Split Spoon, GS Grab Sample
- ST Shelby Tube, ODEX
- RC Rock Core
- Water Level
- Water content (%)
- Atterberg limits (%)
- N Penetration Index based on Split Spoon sample
- N Penetration Index based on Dynamic Cone sample
- Cu Shear Strength based on Field Vane
- Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	MONITOR WELL	State	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)
	74.01			0.38					
	73.81		**FILL** - sand, brown, saturated.	PVC riser					
0.5			**SANDY SILT** - compact, brown, saturated.	0.30 Sand pack		SS1	67		16
	73.26		**SANDY SILT (TILL)** - trace gravel, compact to dense, grey.	WL 0.85 Aug 26/13		SS2	83		43
1.0				PVC screen					
	72.66		**LIMESTONE** - good quality, medium grey fossiliferous micritic Limestone cut by numerous stylolitic seams.	1.37		SS3	100		
1.5						RC1	100		80
	72.21		End of borehole 1.8m.	1.83					
2.0									
2.5									
3.0									
3.5									
4.0									
4.5									

SCALE FOR TEST RESULTS

50kPa 100kPa 150kPa 200kPa

10 20 30 40 50 60 70 80 90

NOTES:
The SPT blow values are from a manual hammer weight

BOREHOLE LOG T021204-A1 - BH LOGS.GPJ INSPEC_SOL.GDT 9/20/13

Appendix B

- Site Classification for Seismic Site Response

TABLE 1
SHEAR WAVE VELOCITY VS. DEPTH
SEISMIC SITE CLASS DETERMINATION

Table 1: Average shear wave velocity along Line 1

Line 1					
Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	0.6	0.8	0.21	626	0.0003
2	0.8	1.2	0.34	407	0.0008
3	1.2	1.6	0.43	518	0.0008
4	1.6	2.1	0.53	196	0.0027
5	2.1	2.8	0.67	188	0.0036
6	2.8	3.6	0.84	440	0.0019
7	3.6	4.7	1.04	864	0.0012
8	4.7	6.0	1.31	955	0.0014
9	6.0	7.6	1.63	955	0.0017
10	7.6	9.7	2.05	983	0.0021
11	9.7	30.6	20.95	1477	0.0142
Total			30.0		0.0307
Average Shear Wave Velocity Along the Line (m/s)					***976***

Table 2: Average shear wave velocity along Line 2

Line 2					
Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	0.6	1.3	0.7	765	0.0008
2	1.3	1.9	0.6	673	0.0010
3	1.9	2.6	0.7	541	0.0012
4	2.6	3.2	0.7	469	0.0014
5	3.2	3.9	0.6	488	0.0013
6	3.9	4.5	0.6	645	0.0010
7	4.5	5.2	0.6	730	0.0009
8	5.2	5.8	0.6	793	0.0008
9	5.8	6.5	0.6	854	0.0007
10	6.5	7.1	0.6	873	0.0007
11	7.1	7.7	0.6	878	0.0007
12	7.7	8.4	0.7	912	0.0007
13	8.4	9.0	0.6	952	0.0007
14	9.0	9.7	0.7	993	0.0007
15	9.7	10.3	0.6	1037	0.0006
16	10.3	30.6	20.3	1577	0.0129
Total			30.0		0.0261
Average Shear Wave Velocity Along the Line (m/s)					***1146***

Approximate investigation line locations

MASW TEST INVESTIGATION LINE PLAN
SHEAR WAVE VELOCITY PROFILE, LINES 1 and 2

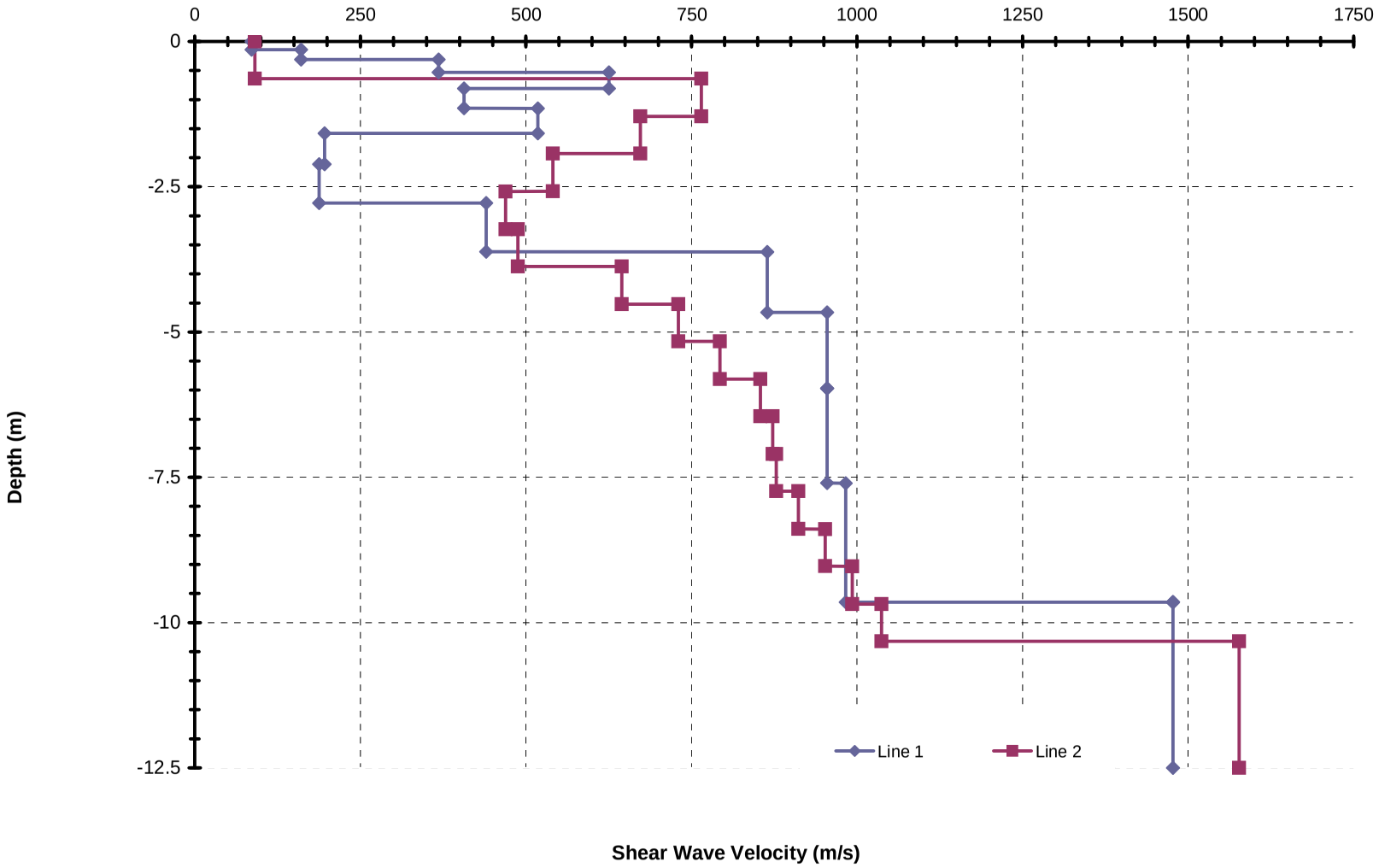
NATIONAL WAR MEMORIAL

CONFEDERATION SQUARE, OTTAWA, ONTARIO

iNSPEC·SOL

DRAWN BY: A.(Z).G	SCALE: N.T.S	REFERENCE NO: T021204-A1
CHECKED BY: A.N.M	DATE: August 2013	FIGURE NO: 1

Shear Wave Velocity versus Depth - Line 1 and 2



MASW TEST RESULTS
SHEAR WAVE VELOCITY PROFILE, LINES 1 and 2
NATIONAL WAR MEMORIAL
CONFEDERATION SQUARE, OTTAWA, ONTARIO

iNSPEC·SOL

DRAWN BY: A.(Z).G	SCALE: N.T.S	REFERENCE NO: T021204-A1
CHECKED BY: A.N.M	DATE: August 2013	FIGURE NO: 2

Appendix C

- Laboratory Analysis Results

INSPEC-SOL
ENGINEERING SOLUTIONS

MOISTURE CONTENT OF SOILS (ASTM D 2216)

CLIENT: PWGSC

PROJECT No.: National War Memorial SAMPLE No.: N/A

APPARATUS USED FOR TESTING

Oven No.: 1 Scale No.: 1

Time Samples Placed in Oven: Time Removed from Oven:

SAMPLE No.	BH1 SS1	BH1 SS2	BH1 SS3	BH3 SS1	BH3 SS2			
CONTAINER No.	S11	S12	S13	S14	S15			
MASS OF CONTAINER + WET SOIL (g)	51.0	53.3	55.4	56.2	59.2			
MASS OF CONTAINER + DRY SOIL (g)	41.4	44.4	51.2	50.7	53.6			
MASS OF CONTAINER (g)	21.3	21.1	21.3	21.3	21.4			
MASS OF DRY SOIL (g)	20.1	23.3	29.9	29.4	32.2			
MASS OF WATER (g)	9.6	8.9	4.2	5.5	5.6			
MOISTURE CONTENT (%)	47.8	38.2	14.0	18.7	17.4			

REMARKS:

SAMPLE No.								
CONTAINER No.								
MASS OF CONTAINER + WET SOIL (g)								
MASS OF CONTAINER + DRY SOIL (g)								
MASS OF CONTAINER (g)								
MASS OF DRY SOIL (g)								
MASS OF WATER (g)								
MOISTURE CONTENT (%)								

REMARKS:

PERFORMED BY: Stephanie Plourde DATE: 21-Aug-13

REVIEWED BY : DATE: 21-Aug-13

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT: PNGSC
PROJECT: National War Memorial(NWM)
Ottawa, Ontario

PROJECT No.: T021204-A1
SAMPLE No.: BH-1
DEPTH: 5' 3" to 5' 9"
SAMPLING DATE:

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	48.5	48.5	(mm)
Length :	98.1		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 15'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 129.0 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 22nd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 22nd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-1
	Ottawa, Ontario	**DEPTH:**	7' 0" to 7' 7"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	46.5	46.5	(mm)
Length :	105.0		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 15'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 159.1 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr, B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-1
	Ottawa, Ontario	**DEPTH:**	9' 8" to 10' 1"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	48.0	48.0	(mm)
Length :	88.8		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 5'	90° 10'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 123.3 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B.Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-1
	Ottawa, Ontario	**DEPTH:**	11' 0" to 11' 7"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	49.7	49.7	(mm)
Length :	105.6		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 10'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Shear		

Unconfined compressive strength: 131.6 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-2
	Ottawa, Ontario	**DEPTH:**	6' 0' to 6' 6"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	49.6	49.6	(mm)
Length :	99.5		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 10'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Shear		

Unconfined compressive strength: 107.3 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr, B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT: PNGSC
PROJECT: National War Memorial(NWM)
Ottawa, Ontario

PROJECT No.: T021204-A1
SAMPLE No.: BH-2
DEPTH: 6' 6" to 7' 0"
SAMPLING DATE:

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	49.2	49.2	(mm)
Length :	97.6		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 0'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 138.7 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-2
	Ottawa, Ontario	**DEPTH:**	9' 3" to 9' 7"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	48.4	48.4	(mm)
Length :	84.9		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 25'	90° 25'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Shear		

Unconfined compressive strength: 88.8 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT: PNGSC
PROJECT: National War Memorial(NWM)
Ottawa, Ontario

PROJECT No.: T021204-A1
SAMPLE No.: BH-2
DEPTH: 10' 6" to 10' 11"
SAMPLING DATE:

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	48.9	48.9	(mm)
Length :	104.9		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 25'	90° 0'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 97.7 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL

UNCONFINED COMPRESSIVE STRENGTH OF INTACT ROCK CORE SPECIMEN
ASTM D 2938, ASTM D 4543

CLIENT:	PNGSC	**PROJECT No.:**	T021204-A1
PROJECT:	National War Memorial(NWM)	**SAMPLE No.:**	BH-3
	Ottawa, Ontario	**DEPTH:**	5' 4" to 5' 9"
		SAMPLING DATE:	

TESTING APPARATUS USED: Loading device no. 500QCP9804 Caliper no.: PAC-LAB-001

TECHNICAL DATA

Diameter :	49.9/	49.9	(mm)
Length :	105.9		(mm)
Flatness :	< 0,05	< 0,05	(mm)
Straightness:			
Procedure A:	< 0,025	< 0,025	(mm)
Procedure B:			(mm)
Perpendicularity :	90° 0'	90° 15'	(°)
Moisture condition:	Dry		
Rate of loading:	18		(MPa/min)
Type of failure:	Columnars		

Unconfined compressive strength: 147.7 (MPa)

VIEW OF TEST SPECIMEN

MACROSCOPIC DESCRIPTION:

Fine grain limestone with thin argilaceous beddings

REMARKS:

ANALYSED BY: F. Adenot. **DATE:** August 23rd, 2013

VERIFIED BY: B. Cyr. B. Sc. Geology. **DATE:** August 23rd, 2013

INSPEC-SOL
ENGINEERING SOLUTIONS

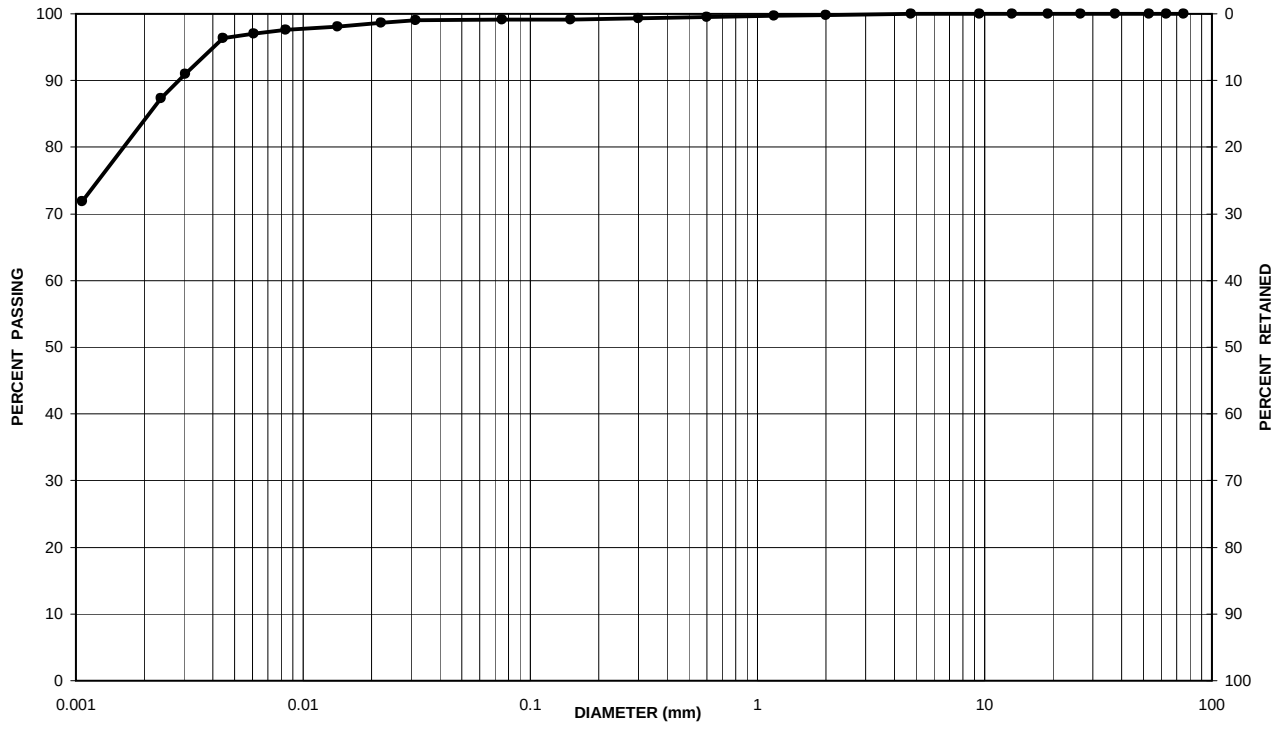
PARTICLE-SIZE ANALYSIS OF SOILS
(USCS) (ASTM D422)

CLIENT: P.W.G.S.C. **LAB No.:** G-13-025

PROJECT/ SITE: National War Monument **PROJECT No.:** T021204-A1

Borehole No.: 1 Sample No.: 2

Depth: 2' - 4' Enclosure:



CLAY & SILT	SAND			GRAVEL	
	FINE	MEDIUM	COARSE	FINE	COARSE
UNIFIED SOIL CLASSIFICATION SYSTEM					

Soil Description	Gravel	Sand	Clay & Silt
Clay some Silt trace Sand	0	1	99

REMARKS:

PERFORMED BY: S. Plourde **DATE:** August 22, 2013

VERIFIED BY: **DATE:** August 22, 2013

INSPEC-SOL
ENGINEERING SOLUTIONS

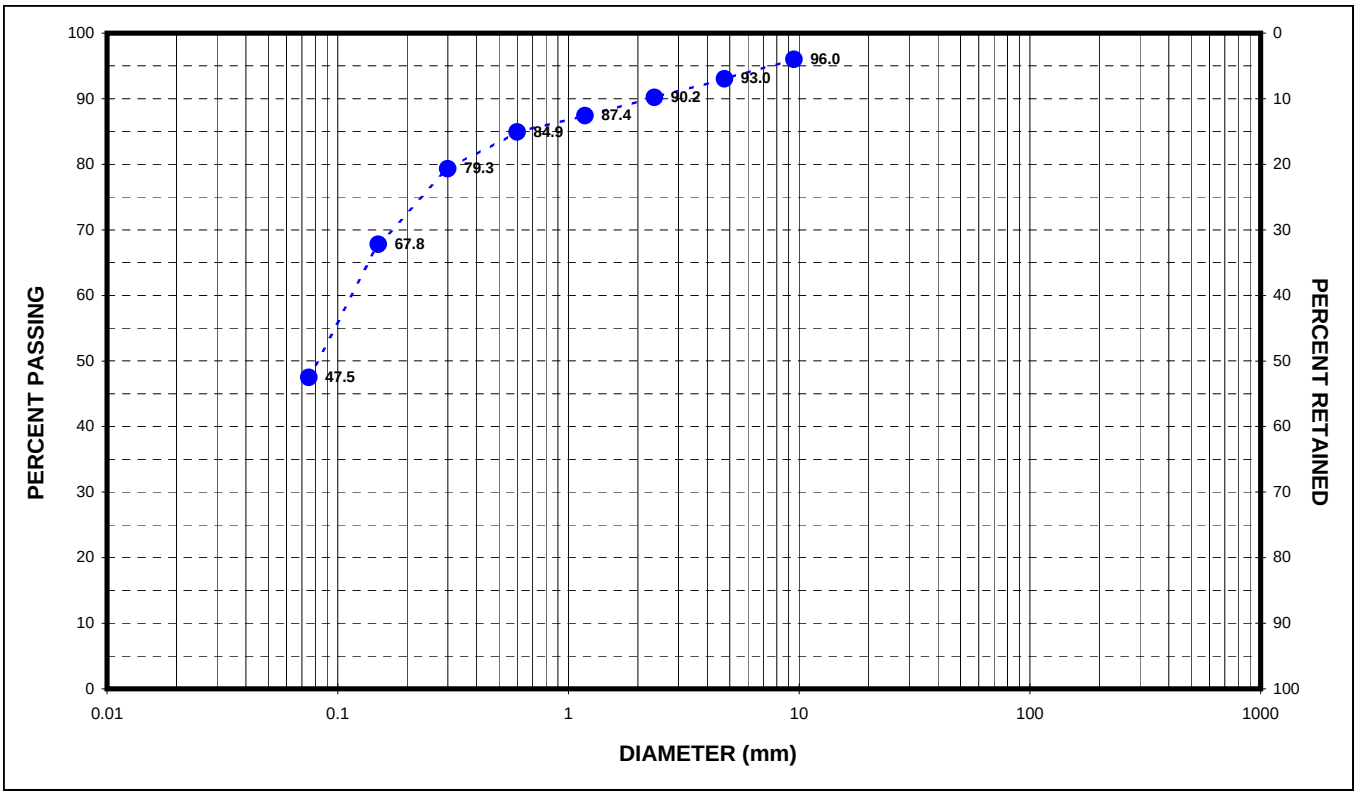
SIEVE ANALYSIS (LS-602)

CLIENT:	P.W.G.S.C.	**LAB No.:**	G-13-025
PROJECT/SITE:	National War Monument	**PROJECT No.:**	T021204-A1

Source: BH 1 SS3

Sampled By: Inspec-Sol Date Sampled: August 19, 2013

SIEVE SIZE (mm)	SAMPLE % PASSING	
9.50	**96.0**	
4.75	**93.0**	
2.36	**90.2**	
1.18	**87.4**	
0.600	**84.9**	
0.300	**79.3**	
0.150	**67.8**	
0.075	**47.5**	



REMARKS:

PERFORMED BY: S. Plourde **DATE:** August 22, 2013

VERIFIED BY: **DATE:** August 22, 2013

INSPEC-SOL
ENGINEERING SOLUTIONS

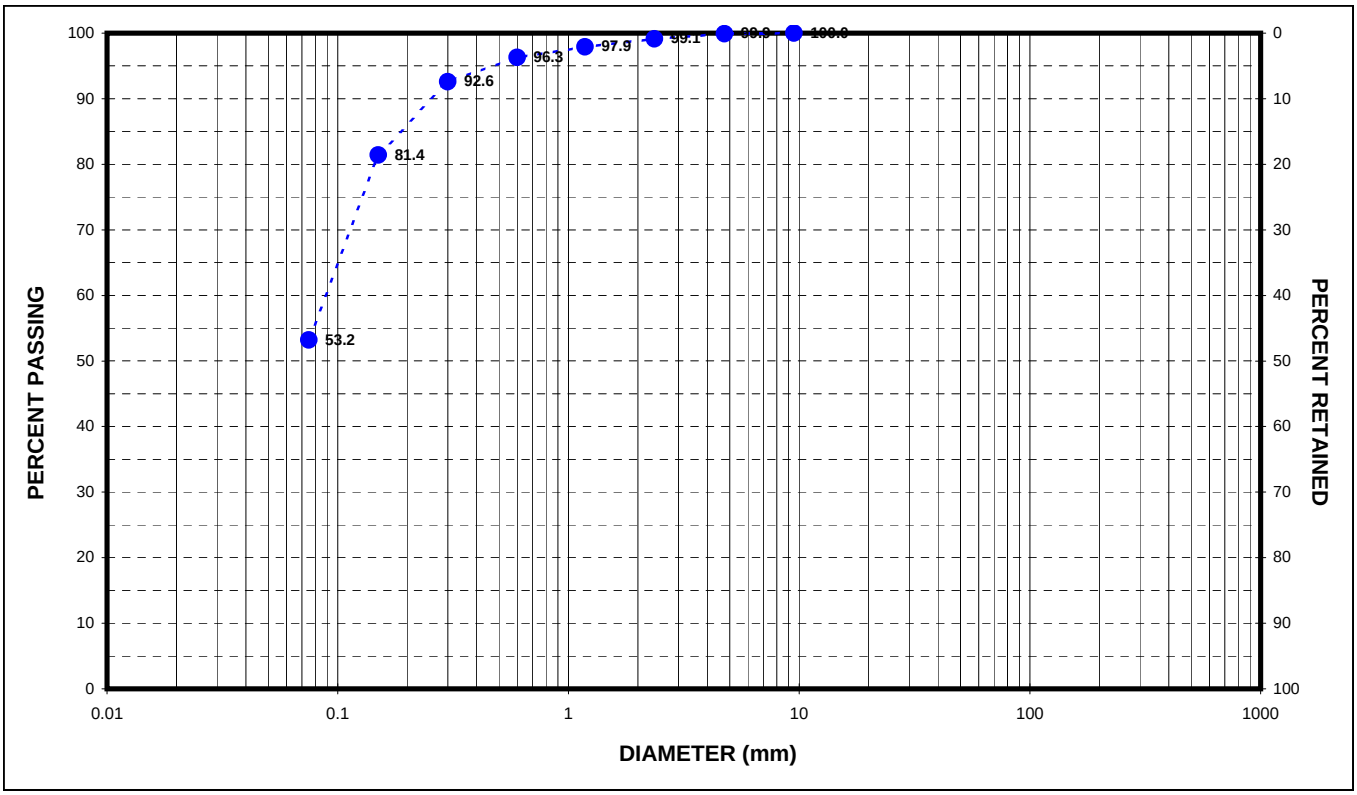
SIEVE ANALYSIS (LS-602)

CLIENT:	P.W.G.S.C.	**LAB No.:**	G-13-025
PROJECT/SITE:	National War Monument	**PROJECT No.:**	T021204-A1

Source: BH 3 SS1

Sampled By: Inspec-Sol Date Sampled: August 19, 2013

SIEVE SIZE (mm)	SAMPLE % PASSING	
9.50	**100**	
4.75	**99.9**	
2.36	**99.1**	
1.18	**97.9**	
0.600	**96.3**	
0.300	**92.6**	
0.150	**81.4**	
0.075	**53.2**	



REMARKS:

PERFORMED BY:	S. Plourde	**DATE:**	August 22, 2013
VERIFIED BY:		**DATE:**	August 22, 2013

Appendix D

- Rock Core Photo Logs

Public Works and Government Services Canada
NATIONAL WAR MEMORIAL STRUCTURAL UPGRADE
CONFEDERATION SQUARE
OTTAWA, ONTARIO

Photo 1: Borehole BH1 Rock Core

Photo 2: Borehole BH2 Rock Core

Public Works and Government Services Canada
NATIONAL WAR MEMORIAL STRUCTURAL UPGRADE
CONFEDERATION SQUARE
OTTAWA, ONTARIO

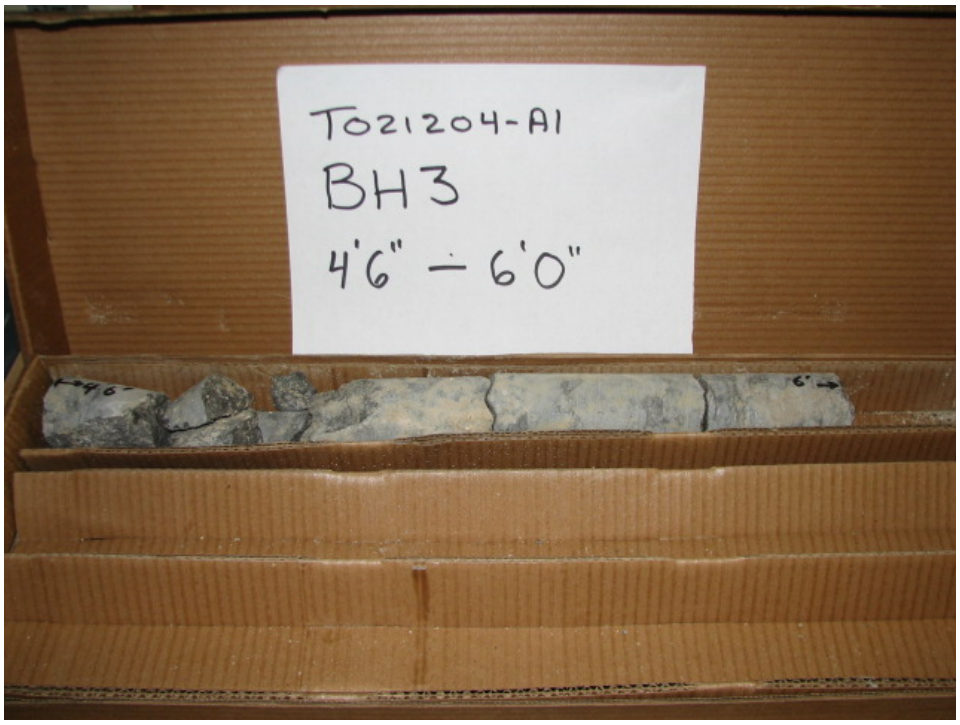


Photo 3 – Borehole BH3 Rock Core

Appendix E

- Ground Penetrating Radar (GPR) Mapping Reports

multiVIEW Locates Inc.
Phone: 1-800-363-3116
Fax: 1-866-571-5946
www.multiview.ca

Primary Locate Report

multiVIEW Locate Sheet 1 of 2
Project # 24774
Locate valid for: ☑ Excavation ☑ Design

A copy of this Locate Report must be on site and in possession of the machine operator during excavation

REQUEST

Customer: Inspec-Sol Inc. Site Address: Confederation Square / War Memorial
Contact Name: Bahara Phone: 613 266-3207 City: Ottawa
Reference: Type of Work: Excavation - Soil Testing
Project Description: GPR mapping for foundations and utility locating

UTILITY	Gas	Electrical	Water	Sanitary Sewer	Storm Sewer	Communications	Other/Unknown
Status*	C	C	C	Abandoned/C	Abandoned/C	C	Foundations NL
Page #							

This table summarizes the private property utilities requested to be located. Any public utilities will be sent as separate documents if requested by the customer.

*Status: M - Marked on site C - Clear for all locate areas NL - Not Locatable (see Terms & Conditions) SP - See Page # NR - Not Requested

NOTES/WARNINGS

* Could not complete GPR survey because of terrain. Surface of ground was not flat enough to survey 95% of Area
* Areas that were flat enough to survey were sampled. However the data was of such poor quality that no information could be used.
* The GPR survey was abandoned and No reliable data could be recorded
* Utility Survey was completed.

CAUTION

- ☐ Hand dig within 3 metres of all terminal poles, splice pits + pad mounted equipment (transformers, etc)
- Exposed or damaged utilities must be immediately reported to multiVIEW @ 1-800-363-3116 and the utility owner as soon as possible
- Each Locate Sketch is only valid for 30 days from the date of completion
- The markings may disappear or be misplaced. Should sketch markings not coincide, a new stakeout must be obtained
- Please read the warnings/terms/guidelines on the back of all individual utility locate forms attached
- The CLIENT must not work outside the indicated Locate Area without a new locate

INFO

* Site time + Sheet report 3hours

Start Time	End Time	Crew size:	Chargeable Time	Overtime	Mobilization	Photos
9:00 am/pm	11:00 am/pm	1	3 hrs.	Y/N	1 units	NIL

multiVIEW

2024 ITK
Locator I.D. / Initials

09/07/2013
(mmm / dd / yyyy) Date

3 hours GPR

Client Company Acknowledgements

I have read and fully understand the Terms and Conditions shown on the reverse side of this form under which this information was provided. I further understand that this information is provided only for the convenience of the Client and does not relieve the Client for any claims or damages associated with subsequent activities and that multiVIEW shall not be liable for any amount in excess of the fees paid by the Client under any circumstances. I understand that this information does not substitute for an authorized location by the owners of any underground plant. multiVIEW Locates Inc. cannot locate underground facilities unless the Client provides direct physical access to each individual underground facility. In the event that a credit card has been taken for backup, and, payment hast NOT been received within 10 business days of commencement of the field work, then the credit card will be charged.

Print name of client company representative

Client company representative signature

This form revised: July 2012 White - Excavator Yellow - Customer Pink - multiVIEW

multiVIEW Locates Inc.
Phone: 1-800-363-3116
Fax: 1-866-571-5946
www.multiview.ca

Auxiliary Locate Report

multiVIEW Locate Sheet 1 of 2

Project # 24774

Locate valid for: ☑ Excavation ☑ Design

DPT Initials/Date: JH 08/07/2013 (mmm / dd / yyyy)

Customer: Inspec-Sol Inc.

Marking Method: N/L ☐ Paint ☐ Pin Flags ☐ Wood Stakes ☐ Marker/Crayon ☐ Chalk ☐ Other: _____

LOCATE AREA Entire under ground Room around Cenotaph

From: _____ To: _____

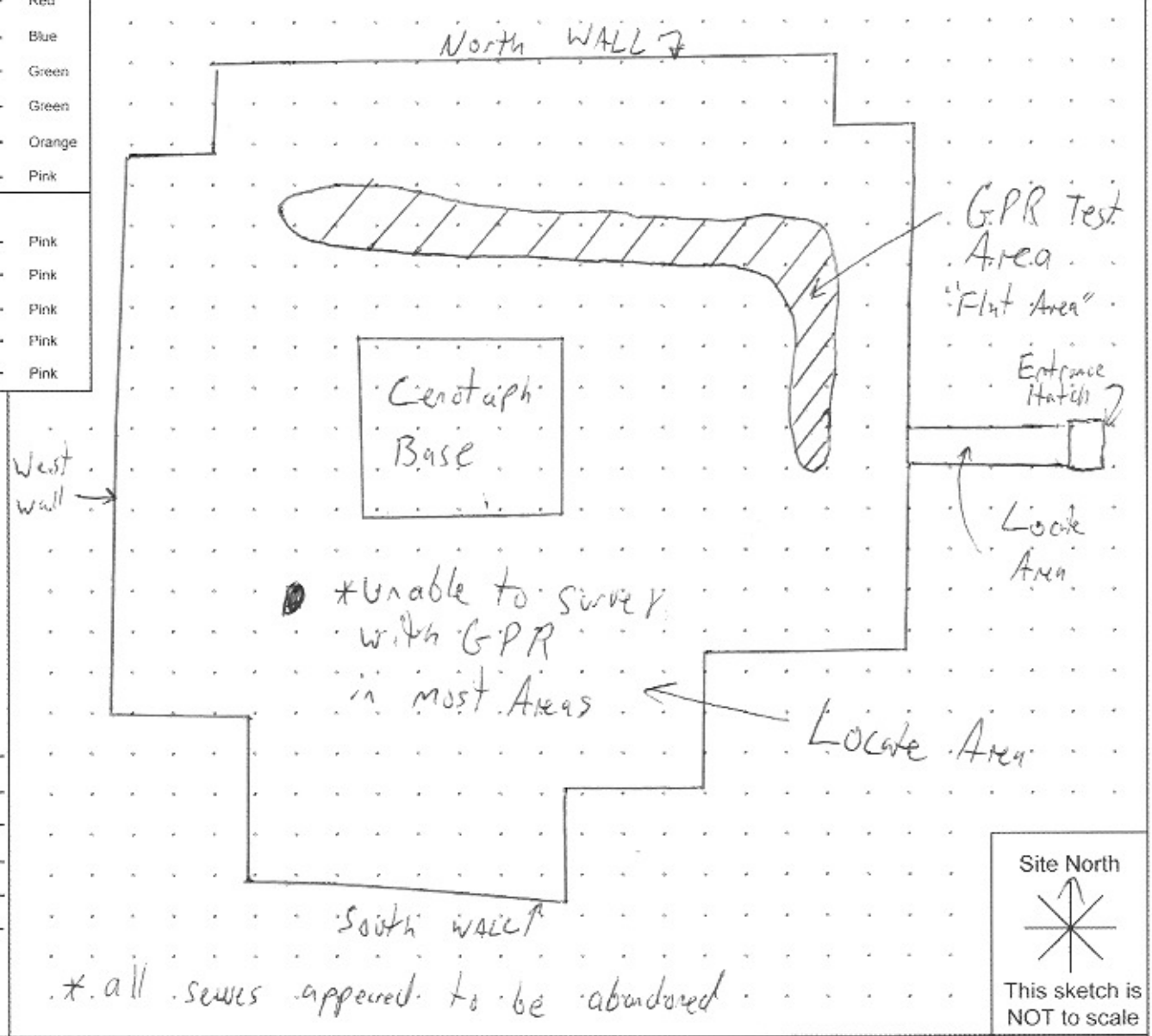
From: _____ To: _____

LEGEND

FEATURE	SYMBOL	PAINT
Gas	— G —	Yellow
Electric	— E —	Red
Water	— W —	Blue
Sanitary Sewer	— SAN —	Green
Storm Sewer	— ST —	Green
Communications	— COMM —	Orange
Unknown	— ? —	Pink
DESIGN only		
Gas Main	— GM —	Pink
Toronto Hydro	— H —	Pink
Traffic Lights	— TL —	Pink
Street Lights	— SL —	Pink
Bell	— BT —	Pink
Transformer		
Street Light		
Pole		
Hand Well	HW	
Pedestal		
Hydrant		
Valve		
Valve Chamber		
Manhole		
Catch Basin		
Curb Line	— CL —	
Building Line	— BL —	
Fence Line	-X--X-	
Sidewalk	— SW —	
Centre Line	— ℄ —	
Railway	HHHHH	
Tree/Bush		
BH/Test Pit		

HAND DIG WITHIN 1m AS MEASURED HORIZONTALLY FROM THE FIELD MARKINGS UNLESS OTHERWISE NOTED. DEPTH TO BURIED PLANT VARIES AND MUST BE VERIFIED BY HAND DIGGING.

☐ Locate Area has been altered as per: _____ APPR. _____



☐ Raining/Wet Ground ☐ Loose Dirt/Soil ☐ Snow/Ice Covered ☐ Outline Mark & Fax ☐ Offsets Used

☐ Locate marks by measurement from maps ☐ Easement present ☐ Buried utility maps provided

☐ Drill within ___ m radius of centre mark of proposed BH location (unless otherwise noted) ☐ Access NOT provided for proper locating

Appendix F

- Notes on Borehole Reports

INSPEC•SOL

NOTES ON BOREHOLE AND TEST PIT REPORTS

SOIL DESCRIPTION:

Each subsoil stratum is described using the following terminology. The relative density of granular soils is determined by the standard penetration index ("N" value), while the consistency of clayey soils is measured by the value of the undrained shear strength (Cu).

CLASSIFICATION (UNIFIED SYSTEM)

Clay	< 0,002mm		
Silt	0,002 to 0,075mm		
Sand	0,075 to 4,75mm	fine	0,075 to 0,425mm
		medium	0,425mm to 2,0mm
		coarse	2,0 to 4,75mm
Gravel	4,75 to 75mm	fine	4,75mm to 19mm
		coarse	19 to 75mm
Cobbles	75 to 300mm		
Boulders	> 300mm		

TERMINOLOGY

"traces"	1 - 10%
"some"	10 - 20%
adjective (silty, sandy)	20 - 35%
"and"	35 - 50%

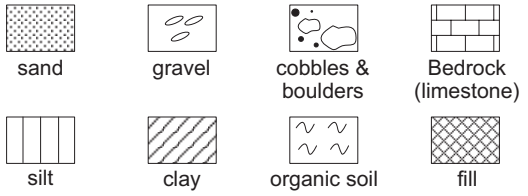
RELATIVE DENSITY OF GRANULAR SOILS	STANDARD PENETRATION INDEX "N" VALUE (BLOWS/ft - 300mm)
Very loose	0 - 4
Loose	4 - 10
Compact	10 - 30
Dense	30 - 50
Very dense	> 50

CONSISTANCY OF COHESIVE SOILS	UNDRAINED SHEAR STRENGTH (Cu) (P.S.F.)	(kPa)
Very soft	< 250	< 12
Soft	250 - 500	12 - 25
Firm	500 - 1000	25 - 50
Stiff	1000 - 2000	50 - 100
Very stiff	2000 - 4000	100 - 200
Hard	> 4000	> 200

ROCK QUALITY DESIGNATION

"RQD" (%) VALUE	QUALITATIVE
< 25	very poor
25 - 50	poor
50 - 75	fair
75 - 90	good
> 90	excellent

STRATIGRAPHIC LEGEND



SAMPLES:

TYPE AND NUMBER

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

SS: Split spoon
SSE, GSE, AGE: Environmental sampling
ST: Shelby tube
PS: Piston sample (Osterberg)
AG: Auger
RC: Rock core
GS: Grab sample

RECOVERY

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil.

RQD

The "Rock Quality Designation" or "RQD" value, expressed as a percentage, is the ratio of the total length of all core fragments of 4 inches (10cm) or more to the total length of the run.

IN-SITU TESTS:

N: Standard penetration index
R: Refusal to penetration
N_C: Dynamic cone penetration index
Cu: Undrained shear strength
Pr: Pressuremeter
k: Permeability
ABS: Absorption (Packer test)

LABORATORY TESTS:

I_P: Plasticity index
W_l: Liquid limit
W_P: Plastic limit
H: Hydrometer analysis
GSA: Grain size analysis
A: Atterberg limits
w: Water content
γ: Unit weight
C: Consolidation
CS: Swedish fall cone
CHEM: Chemical analysis
O.V.: Organic vapor