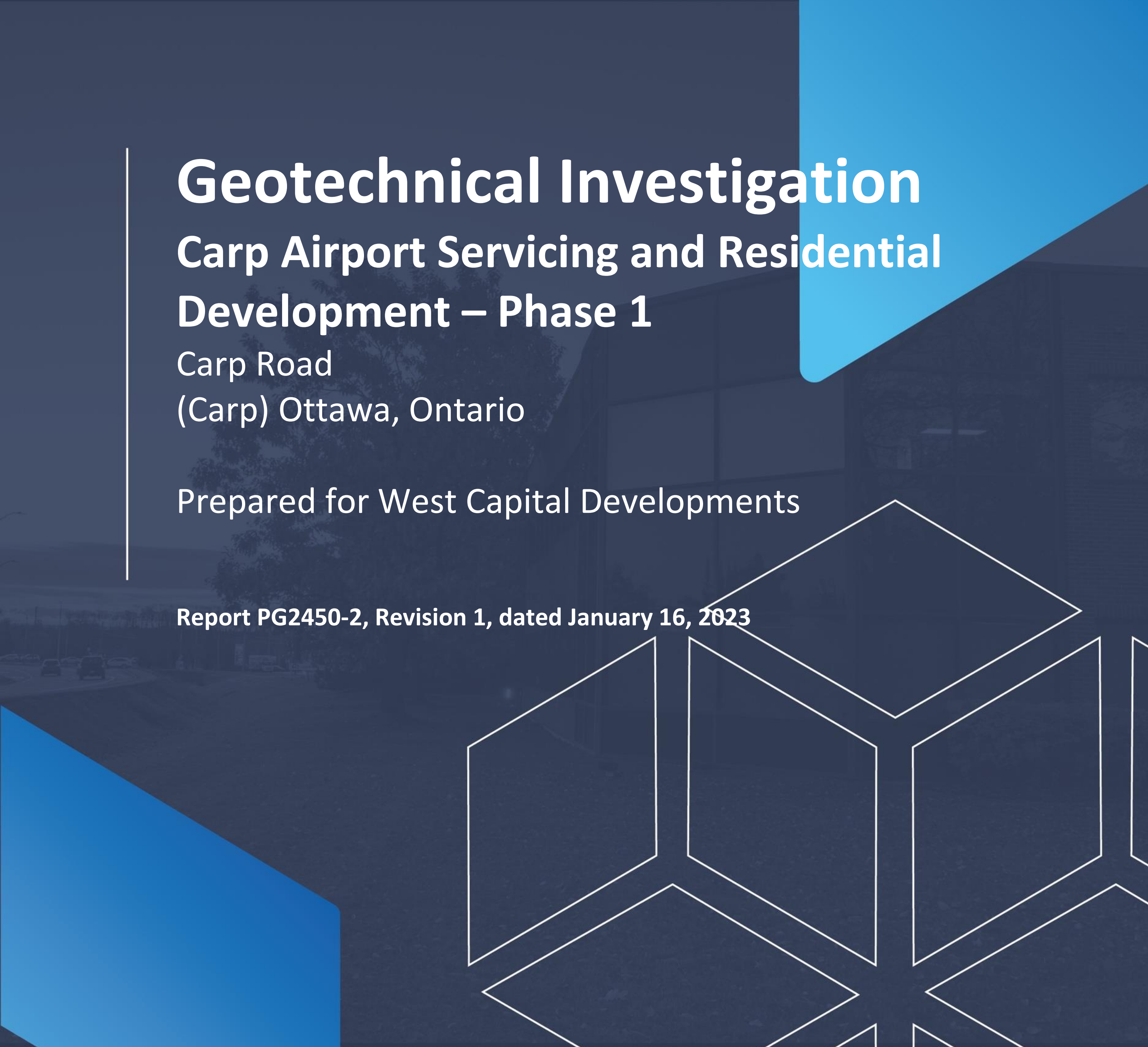

Geotechnical Investigation

Carp Airport Servicing and Residential Development – Phase 1

Carp Road
(Carp) Ottawa, Ontario

Prepared for West Capital Developments

Report PG2450-2, Revision 1, dated January 16, 2023

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Appendices

1.0 Introduction

Paterson Group (Paterson) was commissioned by West Capital Developments to conduct a geotechnical investigation for the proposed Carp Airport servicing and residential development to be located on Carp Road in the City of Ottawa (Carp) (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objective of the geotechnical investigation was to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of test holes.

- ☐ Provide geotechnical recommendations pertaining to design of the proposed development including construction considerations which may affect the design.

The following report has been prepared specifically and solely for the aforementioned project which is described herein. It contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as they are understood at the time of writing this report.

Investigating the presence or potential presence of contamination on the subject property was not part of the scope of work of the present investigation. Therefore, the present report does not address environmental issues.

2.0 Proposed Development

It is understood that the proposed development will consist of single-family residential dwellings with asphaltic car parking, roadways and light aircraft taxiways. The sanitary small-bore sewer and water main will connect to a sewage treatment and water storage facility located at the northeast corner of the residential development at Thomas Argue Road. The project also includes watermain servicing from the Village of Carp and roadway upgrades for Diamondview Road and Russ Bradley Road.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

A supplemental geotechnical investigation was conducted on October 4, 2022, and consisted of advancing 5 test pits to a maximum depth of 3.2 m below ground surface. The test pit locations for the current investigation were selected to provide general coverage of Phase 1B of the residential development, taking into consideration existing site features and underground utilities.

Previous field investigations were completed by this firm in August, 2011 and June, 2013. At that time, a total of 42 boreholes and 19 test pits were advanced to maximum depths of 9.6 m and 4.0 m, respectively. The test hole locations for the historic investigations were chosen by Paterson in a manner to provide general coverage of the subject site and located in the field by Novatech Engineering Consultants. The locations of the test holes are shown on Drawing PG2450-1 – Test Hole Location Plan included in Appendix 2.

The test pits were excavated using a hydraulic excavator and backfilled using the site excavated soil upon completion. The boreholes were drilled using both a track and truck-mounted auger drill rig operated by a two person crew. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer. The test hole procedure consisted of excavating/augering to the required depths at the selected locations and sampling and testing the soil.

Sampling and In Situ Testing

Soil samples were collected from the boreholes either by sampling directly from the auger flights (AU), using a 50 mm diameter split-spoon (SS) sampler, or using a 73 mm diameter thin walled (TW) Shelby tube in conjunction with a piston sampler. Soil samples were recovered from the sidewalls of the test pits. All soil samples were visually inspected and initially classified on site. The split-spoon and grab samples were placed in sealed plastic bags, and the Shelby tubes were sealed at both ends on site. All samples were transported to our laboratory for further review.

The depths at which the grab, auger, split-spoon and Shelby tube samples were recovered from the test holes are shown as G, AU, SS, and TW, respectively, on the Soil Profile and Test Data sheets presented in Appendix 1.

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split-spoon samples and are recorded as “N” values on the Soil Profile and Test Data sheets. The “N” value is the number of blows required to drive the split-spoon sampler 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Undrained shear strength testing, using a vane apparatus, was carried out at regular intervals of depth in cohesive soils.

The overburden thickness was evaluated by a dynamic cone penetration testing (DCPT) completed at BH 42-13. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

The subsurface conditions observed in the test holes were recorded in detail in the field. The soil profiles are logged on the Soil Profile and Test Data sheets in Appendix 1 of this report.

Groundwater

Flexible PVC standpipes were installed in select boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program. Additionally, the depth at which groundwater infiltration was encountered through the sidewalls of the test pits was recorded prior to the completion of excavation.

Sample Storage

All samples will be stored in the laboratory for a period of one month after issuance of this report. They will then be discarded unless we are otherwise directed.

3.2 Field Survey

The current test hole locations and ground surface elevation at each test hole location were surveyed by Paterson using a handheld GPS and referenced to a geodetic datum. The historic test hole locations ground surface elevation at each test hole location were provided by Novatech Engineering Consultants and are referenced to a geodetic datum. The locations and ground surface elevation at each test hole location are presented on Drawing PG2450-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were visually examined in our laboratory to review the results of the field logging. A total of 3 Atterberg limits tests and 2 grain size distribution analysis were attempted on select soil samples during the current investigation. Additionally, 1 Atterberg limits test and 3 grain size distribution analyses were carried out on select soil samples during previous investigations. Three (3) Shelby tube samples were submitted for unidimensional consolidation testing during the historic investigation. Additionally, moisture content testing was carried out on select soil samples during the current and historical investigations. The results of the consolidation laboratory testing are presented in Appendix 1 and further discussed in Section 4 and 5.

3.4 Analytical Testing

Three (3) soil samples were submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures by determining the concentration of sulphate and chloride, the resistivity and the pH of the sample. The results are further discussed in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The site is located to the southwest of the intersection of March and Carp Road in the City of Ottawa (Carp), Ontario. The central portion of the subject site is currently occupied by the Carp Airport facilities. The property is bounded to the north by agricultural lands, to the east by Carp Road, to the south by an active and an expired sand pit, and to the west by Diamondview Road followed by Highway 417.

The general topography of the site is relatively level to slightly undulating. The ground surface slopes generally slopes down towards the north, to northeast and is approximately at grade with the adjoining Carp and Diamondview Roads. A maximum difference in ground surface elevations of approximately 12 m was measured among the boreholes on the subject site. The northern portion of the site is currently occupied by agricultural land and generally free of trees and shrubs, whereas the south portion of the site is heavily treed.

A shallow creek was observed on the west portion of the subject site running in a south to north direction. The lower portions of the meandering creek show some signs of erosion, but the slopes leading down from the tablelands on either side are shallow and do not present any evidence of erosion. Ditches were observed along Carp and Diamondview Roads and along the access roads on the subject site.

4.2 Subsurface Profile

Generally, the subsoil conditions at this site consist of a thin layer of topsoil or asphaltic concrete overlying granular crushed stone and/or in situ native brown silty clay and/or silty sand. The majority of the test holes were terminated in stratified layers of firm clayey silt to silty clay, and loose to compact silty fine sand and sandy silt. It should be noted that a 2.4 m thick layer of organic peat was encountered in BH40-11 at a depth of 2.6 m below existing ground surface. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for details of the soil profiles encountered at the test hole locations.

Bedrock

Based on available geological mapping, the bedrock in this area of the proposed residential development mostly consists of interbedded bioclastic limestone, sublithographic to fine crystalline Limestone and shale of the Verulam formation with an overburden drift thickness of 15 to 50 m depth. Based on the geological mapping, overburden drift thickness along Carp Road along the proposed watermain alignment varies between 5 to 50 m depth.

Atterberg Limit Testing

A total of 4 soil samples were submitted for Atterberg Limit testing. The test results indicate that the silty clay is generally classified as an Inorganic Clay of Low Plasticity (CL). These classifications are in accordance with the Unified Soil Classification System. The results are summarized in Table 1 and presented in Appendix 1

Table 1 – Atterberg Limits Results

Test Hole	Sample	Depth (m)	Liquid Limit (%)	Plastic Limit (%)	Plastic Index (%)	Classification
TP 1-22	G10	3.1-3.3	26	15	11	CL-Inorganic clays of low plasticity
TP 2-22	G6	3.0-3.1	N/A			Non-plastic
TP 3-22	G5	3.1-3.2	N/A			Non-plastic
BH 41-13	TW1	4.6-5.2	21	15	7	CL-Inorganic clays of low plasticity

Grain Size Distribution and Hydrometer Testing

A total of 5 grain size distribution/hydrometer tests were completed to classify select soil samples according to the Unified Soil Classification System (USCS). The results are summarized in Table 2 below and are presented in Appendix 1.

Table 2 – Grain Size Distribution Analysis Results

Borehole	Sample	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP 3-22	G4	2.6 to 2.7	0.0	12.8	71.7	15.5
TP 5-22	G5	2.9 to 3.0	0.0	49.3	41.2	9.5
BH 2-11	AU1	0.2 to 0.4	46.7	40.4	12.8	
BH 26-11	AU1	0.1 to 0.5	39.0	50.5	10.5	
BH 37-11	AU1	0.2 to 0.4	39.0	49.8	11.2	

4.3 Groundwater

The measured groundwater levels in the test holes are presented in Table 3. Groundwater conditions can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that groundwater can be expected between 1.5 to 2.5 m depth. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

Table 3 – Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Measured Groundwater Level		Dated Recorded
		Depth (m)	Elevation (m)	
TP 1-22	114.29	1.55	112.74	October 4, 2022
TP 2-22	114.94	1.50	113.44	October 4, 2022
TP 3-22	115.51	2.10	110.41	October 4, 2022
TP 4-22	115.89	1.65	114.24	October 4, 2022
TP 5-22	116.89	1.30	115.59	October 4, 2022
BH 1-11	114.03	Dry	-	September 21, 2011
BH 3-11	116.29	1.56	114.73	September 21, 2011
BH 5-11	115.67	Blocked	-	September 27, 2011
BH 7-11	115.07	3.18	111.89	September 27, 2011
BH 8-11	114.57	2.98	111.59	September 27, 2011
BH 9-11	116.24	4.28	111.96	September 27, 2011
BH 10-11	116.94	1.55	115.39	September 27, 2011
BH 12-11	115.18	2.63	112.55	September 27, 2011
BH 16-11	116.02	1.22	114.80	September 27, 2011
BH 19-11	113.32	1.79	111.53	September 27, 2011
BH 22-11	111.88	3.88	108.00	September 27, 2011
BH 25-11	112.02	2.49	109.53	September 27, 2011
BH 27-11	112.83	2.53	110.30	September 27, 2011
BH 31-11	110.88	2.48	108.40	September 21, 2011
BH 32-11	110.29	2.66	107.63	September 27, 2011
BH 34-11	105.16	2.57	102.59	September 27, 2011
BH 35-11	100.78	2.88	97.90	September 21, 2011
BH 36-11	98.59	2.35	96.24	September 21, 2011
BH 37-11	95.63	3.02	92.61	September 21, 2011
BH 39-11	93.40	1.32	92.08	September 21, 2011
BH 40-11	93.02	Damaged	-	September 21, 2011
BH 41-13	116.13	1.23	114.90	July 3, 2013
BH 42-13	114.95	1.46	113.49	July 3, 2013
BH 43-13	116.80	1.51	115.29	July 3, 2013

Note: Ground surface elevations at test hole locations are referenced to a geodetic datum.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is considered suitable for the proposed development. It is recommended that the proposed residential buildings be supported on conventional spread footings bearing on an undisturbed, compact silty sand to sandy silt, or stiff silty clay to clayey silt.

Due to the presence of the silty clay layer encountered across the subject site, permissible grade raise restriction have been recommended. The permissible grade raise recommendations are discussed in Subsection 5.3.

The above and other considerations are discussed in the following sections.

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures. Care should be taken not to disturb adequate bearing soils below the founding level during site preparation activities. Disturbance of the subgrade may result in having to sub-excavate the disturbed material and the placement of additional suitable fill material.

Fill Placement

Fill used for grading beneath the proposed residential building areas should consist, unless otherwise specified, of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. This material should be tested and approved prior to delivery to the site. The fill should be placed in lifts no greater than 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the building areas should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill where settlement of the ground surface is of minor concern. These materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD.

Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls, unless used in conjunction with a composite drainage membrane, such as Miradrain G100N or Delta Drain 6000.

Excess Soils

All excess soils generated by construction activities that will be transported off-site should be handled as per Ontario Regulation 406/19: On-Site and Excess Soil Management.

5.3 Foundation Design

Bearing Resistance Values

Conventional spread footings, for the proposed residential dwellings can be designed using the bearing resistance values presented in Table 4. A geotechnical resistance factor of 0.5 was applied to the bearing resistance values at ULS.

Table 4 – Bearing Resistance Values

Materials	Bearing Resistance Values at SLS (kPA)	Bearing Resistance Values at ULS (kPA)
Stiff to very stiff silty clay	125	200
Compact silty sand/clayey silt	100	150
Firm silty clay	75	120
Loose sandy silt/silty sand	60	100

Note: Pad footings, up to 3 m wide, and strip footings, up to 2 m wide, can be designed using the above noted bearing resistance values placed over an undisturbed, silty clay bearing surface.

If the silty sand to sandy silt subgrade is observed to be in a loose state of compactness, the material should be proof rolled using suitable vibratory equipment making several passes under dry conditions and above freezing temperatures and approved by Paterson at the time of construction.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen, or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Footings placed on a soil bearing surface and designed using the bearing resistance values at SLS given above will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

Lateral Support

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a compact silty sand/sandy silt or a stiff to firm silty clay above the groundwater table when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V passes only through in situ soil of the same or higher capacity as the bearing medium soil.

Permissible Grade Raise Recommendations

Consideration must be given to potential settlements which could occur due to the presence of the silty clay deposit and the combined loads from the proposed footings, any groundwater lowering effects, and grade raise fill. The foundation loads to be considered for the settlement case are the continuously applied loads which consist of the unfactored dead loads and the portion of the unfactored live load that is considered to be continuously applied. For dwellings, a minimum value of 50% of the live load is recommended by Paterson.

Generally, the potential long-term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. Three (3) site specific consolidation tests were conducted. The results of the consolidation tests from our investigation are presented in Table 5 and in Appendix 1.

The value for p'_c is the preconsolidation pressure and p'_o is the effective overburden pressure of the test sample. The difference between these values is the available preconsolidation. The increase in stress on the soil due to the cumulative effects of the fill surcharge, the footing pressures, the slab loadings and the lowering of the groundwater should not exceed the available preconsolidation if unacceptable settlements are to be avoided.

The values for C_{cr} and C_c are the recompression and compression indices, respectively. These soil parameters are a measure of the compressibility due to stress increases below and above the preconsolidation pressures. The higher values for the C_c, as compared to the C_{cr}, illustrate the increased settlement potential above, as compared to below, the preconsolidation pressure.

Table 5 – Summary of Consolidation Test Results

Borehole	Sample	Depth	p'_c	p'_o	C_{cr}	C_c	Q
BH 41-13	TW 5	5.00	112	52	0.011	0.412	G
BH 42-13	TW 6	5.03	97	57	0.009	0.370	A
BH 43-13	TW 7	5.56	104	56	0.016	0.390	G

* - Q - Quality assessment of sample - G: Good A: Acceptable P: Likely disturbed

The values of p'_c, p'_o, C_{cr}, and C_c, are determined using standard engineering testing procedures and are estimates only. Natural variations within the soil deposit will affect the results. The p'_o parameter is directly influenced by the groundwater level. Groundwater levels were measured during the site investigation. Groundwater levels vary seasonally which has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The p'_o values for the consolidation tests carried out for the present investigation are based on the long-term groundwater level observed at each borehole location. The groundwater level is based on the colour and undrained shear strength profile of the silty clay.

The total and differential settlements will be dependent on characteristics of the proposed buildings. For design purposes, the total and differential settlements are estimated to be **25 and 20 mm**, respectively. A post-development groundwater lowering of 0.5 m was assumed.

The potential post construction total and differential settlements are dependent on the position of the long-term groundwater level when buildings are situated over deposits of compressible silty clay. Efforts can be made to reduce the impacts of the proposed development on the long-term groundwater level by placing clay dykes in the service trenches, reducing the sizes of paved areas, leaving green spaces to allow for groundwater recharge or limiting planting of trees to areas away from the buildings. However, it is not economically possible to control the groundwater level.

To reduce potential long term liabilities, consideration should be given to accounting for a larger groundwater lowering and to provide means to reduce long term groundwater lowering (e.g. clay dykes, restriction on planting around the dwellings, etc). Buildings on silty clay deposits increases the likelihood of movements and therefore of cracking. The use of steel reinforcement in foundations placed at key structural locations will tend to reduce foundation cracking compared to unreinforced foundations.

The recommended permissible grade raise areas ranging from **1 to 1.5 m** are defined in Drawing PG2450-3 - Permissible Grade Raise Plan in Appendix 2.

Based on the above discussion, several options could be considered to accommodate proposed grade raises with respect to our permissible grade raise recommendations, such as, the use of lightweight fill, which allow for raising the grade without adding a significant load to the underlying soils. Alternatively, it is possible to preload or surcharge the subject site in localized areas provided sufficient time is available to achieve the desired settlements.

Underground Utilities

The underground services will be subjected to similar total or differential settlements as the proposed structures. Once the final grade raises are established, it is expected that underground utilities will be slightly lower that the finished grades surrounding the residential units.

5.4 Design for Earthquakes

Shear wave velocity testing was completed at two locations at the subject site to accurately determine the applicable seismic site classification for the proposed development in accordance with Table 4.1.8.4.A of the Ontario Building Code 2012. The shear wave velocity testing was completed by Paterson personnel. The results of the shear wave velocity tests are provided in Figures 8 and 11 in Appendix 2.

Field Program

The seismic array testing locations were placed within the central areas of the site as presented in Drawing PG2450-1 - Test Hole Location Plan in Appendix 2. Paterson field personnel placed 24 horizontal 2.4 Hz. geophones mounted to the surface by means of two 75 mm ground spikes attached to the geophone land case. The geophones were spaced at 3 m intervals and connected by a geophone spread cable to a Geode 24 Channel seismograph.

The seismograph was also connected to a computer laptop and a hammer trigger switch attached to a 12-pound dead blow hammer. The hammer trigger switch sends a start signal to the seismograph. The hammer is used to strike an I-Beam seated into the ground surface, which creates a polarized shear wave. The hammer shots are repeated between four (4) and eight (8) times at each shot location to improve signal to noise ratio.

The shot locations are also completed in forward and reverse direction (i.e.- striking both sides of the I-Beam seated parallel to the geophone array). The shot locations were 30, 4.5, and 3 m away from the first and last geophones, and at the centre of the seismic array.

Data Processing and Interpretation

Interpretation for the shear wave velocity results were completed by Paterson personnel. Shear wave velocity measurement was made using reflection/refraction methods. The interpretation is performed by recovering arrival times from direct and refracted waves.

The interpretation is repeated at each shot location to provide an average shear wave velocity, V_{s30}, of the upper 30 m profile, immediately below the building's foundation. The layer intercept times, velocities from different layers and critical distances are interpreted from the shear wave records to compute the bedrock depth at each location.

The bedrock velocity was interpreted using the main refractor wave velocity, which is considered a conservative estimate of the bedrock velocity due to the increasing quality of the bedrock with depth. It should be noted that as bedrock quality increases, the bedrock shear wave velocity also increases.

Seismic Site Class

For this scenario, the V_{S30} was calculated as follows for the most recent test:

$$V_{s30} = \frac{Depth_{of\ interest}(m)}{\left(\frac{Depth_{Layer1}(m)}{V_{s_{Layer1}}(m/s)} + \frac{Depth_{Layer2}(m)}{V_{s_{Layer2}}(m/s)}\right)}$$

$$V_{s30=} \frac{30\,m}{\left(\frac{19\,m}{188\,m/s} + \frac{11\,m}{1{,}662\,m/s}\right)}$$

$$V_{s30=}\ 279\ \ m/s$$

The average shear wave velocity, V_{s30}, is **279 m/s** within the eastern portion of the site and **274 m/s** within the western portion of the site. Therefore, a **Site Class D** is applicable for seismic design of the proposed buildings as per Table 4.1.8.4.A of the OBC 2012. The soils underlying the subject site are not susceptible to liquefaction.

5.5 Basement Slab Construction

With the removal of all topsoil and deleterious fill having significant amounts of organic material within the footprints of the proposed residential buildings, the existing soil subgrade, reviewed and approved by Paterson personnel at the time of construction, will be considered an acceptable subgrade surface on which to commence backfilling for floor-slab construction.

OPSS Granular B Type II or Granular A crushed stone, with maximum particle size of 50mm, are recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill is recommended to consist of 19mm OPSS Granular A crushed stone. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose layers and compacted to at least 98% of its SPMDD.

Any soft or poor performing areas should be removed and backfilled with appropriate backfill material prior to placing any fill.

5.6 Pavement Structure

Residential subdivision roadways and private aircraft taxiways are anticipated at this site. For preliminary design purposes, pavement structure guidelines are presented in Tables 6 and 7.

Table 6 – Recommended Pavement Structure - Car Parking Only/Driveways

Thickness (mm)	Material Description
50	**Wear Course** – HL-3 or Superpave 12.5 Asphaltic Concrete
150	**BASE** – OPSS Granular A Crushed Stone
300	**SUBBASE** – OPSS Granular B Type II
SUBGRADE – Either in-situ soil, or acceptable fill or OPSS Granular B Type I or II material over in-situ soil.	

Table 7 – Recommended Pavement Structure - Light Aircraft Taxiways, Local Roadways and Access Lanes

Thickness (mm)	Material Description
40	**Wear Course –** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Wear Course –** HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE –** OPSS Granular A Crushed Stone
450	**SUBBASE –** OPSS Granular B Type II
SUBGRADE – Either in-situ soil, or acceptable fill or OPSS Granular B Type I or II material over in-situ soil.	

Minimum Performance Graded (PG) 58-34 asphalt cement should be used for this project.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with OPSS Granular B Type I or II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment.

Due to the high groundwater conditions at this site, consideration should be given to using a geotextile as a separation layer between the subbase material and the subgrade where service trenches are located beneath the proposed paved area. The geotextile should consists of a woven Terratrack 200w or equivalent.

It is also understood that temporary haul roads are being considered during the construction of the proposed development. For preliminary design purposes, the following Table 8 should be considered.

Table 8 – Recommended Pavement Structure -Proposed Construction Haul Road

Thickness (mm)	Material Description
200	**BASE** – OPSS Granular A Crushed Stone
400	**SUBBASE** – OPSS Granular B Type II
SUBGRADE – Either in-situ soil, or acceptable fill or OPSS Granular B Type I or II material over in-situ soil.	

Consideration could also be given to using a geotextile and biaxial geogrid over the subgrade layer beneath the proposed haul road. The biaxial geogrid should consist of Terrafix BX2500 or Tensar BX1500 overlaying a non-woven Terrafix 270R or equivalent.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on keeping the contact zone between the subgrade material and the base stone in a dry condition. Failure to provide adequate drainage under conditions of heavy wheel loading can result in the fine subgrade soil being pumped into the voids in the stone subbase, thereby reducing its load carrying capacity.

Due to the impervious nature of the subgrade materials, consideration should be given to installing subdrains during the pavement construction. These drains should be installed at each catch basin, be at least 3 m long and should extend in four orthogonal directions or longitudinally when placed along a curb. The subdrain inverts should be approximately 300 mm below subgrade level. The subgrade surface should be shaped to promote water flow to the drainage lines.

6.0 Observations

6.1 Foundation Drainage and Backfill

Foundation Drainage

It is recommended that a perimeter foundation drainage system be provided for the proposed residential dwellings. The system should consist of a 150 mm diameter perforated, corrugated plastic pipe, surrounded on all sides by 150 mm of 10 mm clear crushed stone, placed at the footing level around the exterior perimeter of the structure. The pipe should have a positive outlet, such as a gravity connection to the storm sewer.

Foundation Backfill

Backfill against the exterior sides of the foundation walls should consist of free-draining non-frost susceptible granular materials, such as an OPSS Granular B Type I or clean sand. The greater part of the site excavated materials will be frost susceptible and, as such, are not recommended for re-use as backfill against the foundation walls, unless used in conjunction with a composite drainage blanket, such as Miradrain G100N or Delta Drain 6000, connected to the perimeter foundation drainage system.

6.2 Protection of Footings against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided in this regard.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action of the exterior walls of the heated structure and require additional protection, such as soil cover of 2.1 m or an equivalent combination of soil cover and foundation insulation.

6.3 Excavation Side Slope

The side slopes of excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled. It is expected that sufficient room will be available for the greater part of the excavation to be undertaken by opencut methods (i.e. unsupported excavations).

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be excavated at 1H:1V or shallower. The shallower slope is required for excavation below groundwater level. The subsurface soils are considered to be a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

Excavation Base Stability

The base of supported excavations can fail by three (3) general modes:

☐ Shear failure within the ground caused by inadequate resistance to loads imposed by grade difference inside and outside of the excavation,

☐ Piping from water seepage through granular soils, and

☐ Heave of layered soils due to water pressures confined by intervening low permeability soils.

Shear failure of excavation bases is typically rare in granular soils if adequate lateral support is provided. Inadequate dewatering can cause instability in excavations made through granular or layered soils. The potential for base heave in cohesive soils should be determined for stability of flexible retaining systems.

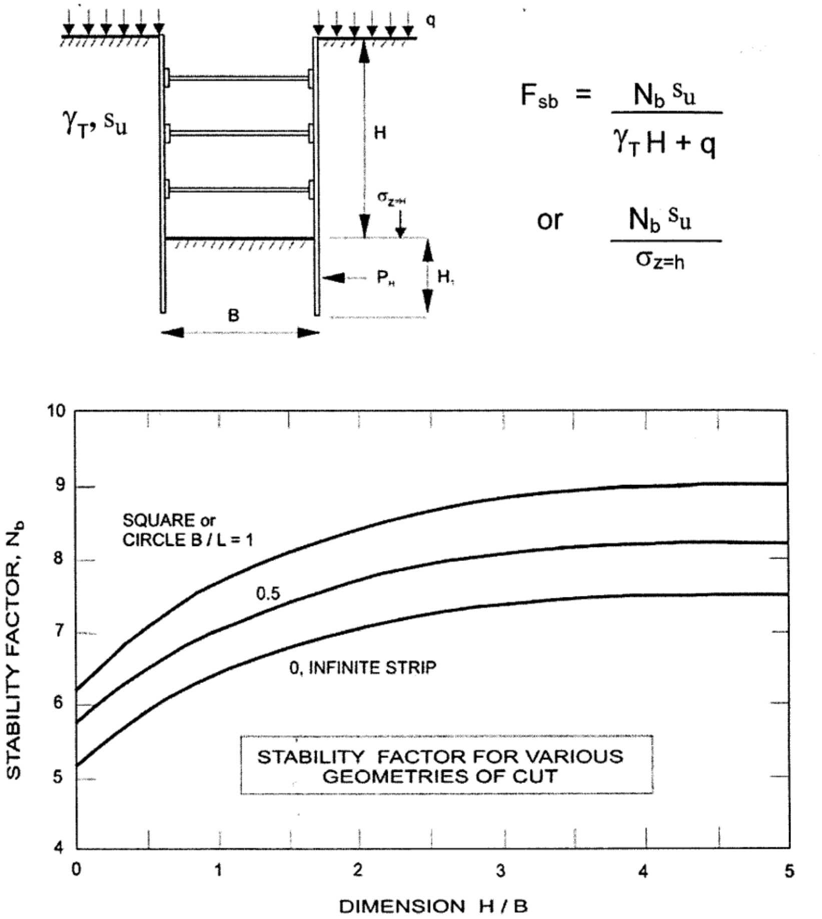
The factor of safety with respect to base heave, FS_b, is:

$$FS_b = N_b s_u / \sigma_z$$

where:

N_b - stability factor dependent upon the geometry of the excavation and given in Figure 1 on the following page.

s_u - undrained shear strength of the soil below the base level
σ_z - total overburden and surcharge pressures at the bottom of the excavation



$$F_{sb} = \frac{N_b s_u}{\gamma_T H + q}$$

$$\text{or} \quad \frac{N_b s_u}{\sigma_{z=h}}$$

Figure 1 - Stability Factor for Various Geometries of Cut

In the case of soft to firm clays, **a factor of safety of 2 is recommended** for base stability.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

The pipe bedding for sewer and water pipes should consist of a minimum of 150 mm of OPSS Granular A material. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

Clay Seals

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

Directional Drilling

Based on the existing borehole information, directional drilling is a suitable option for the proposed sanitary installation below the creek underlying proposed Street Six and the watermain installation below the Carp River located south of the intersection of Carp Road and Rivington Street. Directional drilling is further discussed in Subsection 8.2.

6.5 Groundwater Control

Groundwater Control for Building Construction

Based on our observations, it is anticipated that groundwater infiltration into the excavations should be low to moderate and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations. The contractor should be prepared to direct water away from all bearing surfaces and subgrades, regardless of the source, to prevent disturbance to the founding medium.

Permit to Take Water

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) may be required for this project if more than <u>400,000 L/day</u> of ground and/or surface water is to be pumped during the construction phase. A minimum 4 to 5 months should be allowed for completion of the PTTW application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, typically between 50,000 to 400,000 L/day, it is required to register on the Environmental Activity and Sector Registry (EASR). A minimum of two to four weeks should be allotted for completion of the EASR registration and the Water Taking and Discharge Plan to be prepared by a Qualified Person as stipulated under O.Reg. 63/16. If a project qualifies for a PTTW based upon anticipated conditions, an EASR will not be allowed as a temporary dewatering measure while awaiting the MECP review of the PTTW application.

6.6 Winter Construction

Precautions must be taken if winter construction is considered for this project.

The subsoil conditions at this site consist of frost susceptible materials. In the presence of water and freezing conditions, ice could form within the soil mass. Heaving and settlement upon thawing could occur.

In the event of construction during below zero temperatures, the founding stratum should be protected from freezing temperatures by the use of straw, propane heaters and tarpaulins or other suitable means. In this regard, the base of the excavations should be insulated from sub-zero temperatures immediately upon exposure and until such time as heat is adequately supplied to the building and the footings are protected with sufficient soil cover to prevent freezing at founding level.

Trench excavations and pavement construction are also difficult activities to complete during freezing conditions without introducing frost in the subgrade or in the excavation walls and bottoms. Precautions should be taken if such activities are to be carried out during freezing conditions.

6.7 Corrosion Potential and Sulphate

The results of the analytical testing show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland cement would be appropriate for this site. The chloride content and the pH of the sample indicate that they are not significant factors in creating a corrosive environment for exposed ferrous metals at this site and the resistivity is indicative of a non-aggressive to slightly aggressive corrosive environment.

6.8 Limit of Hazard Lands

The field program for the geotechnical slope stability analysis was carried out on April 27, 2012 with a representative from Novatech Engineering Consultants.

Generally, a 1 to 3 m wide creek meanders through the 2 to 3.5 m high and 40 to 50 m wide valley corridor which bisects the two parcels of land at the aforementioned site. Several small dry tributaries extending into the table lands were noted along the slope face. Some signs of active erosion and minor sloughing were noted along the waters edge, where the watercourse had meandered in close proximity to the toe of the slope.

Subsurface Profile

The soil profile along the subject slope consists of a thin layer of topsoil overlying a loose to compact red to brown silty sand. The silty sand was underlain by a stiff weathered brown silty clay crust and/or a firm grey silty clay to clayey silt.

A total of sixteen (16) cross-sections were completed in the field on April 27, 2012 at the locations where the meandering creek became in close proximity to the valley walls and where the existing slope was less than 6H:1V.

Slope Conditions

A geotechnical limit of hazard lands setback line has been provided from the top of slope for the valley corridor walls of the Carp Creek corridor. Six (6) slope cross-sections were studied as the worst case scenarios. The slope cross-sections analysed are presented on Drawing PG2450-2 - Limit of Hazard Lands presented in Appendix 2. The subject section of Carp Creek is located with a 40 to 50 m wide valley corridor with a 2 to 3.5 m high valley wall varying between a stable 3H:1V to greater than 10H:1V. The valley corridor is less defined within the southwest portion of the site, where the valley walls are close to 2 m or less. The majority of the slope face was noted to be grass covered with sparse brush and small trees with minor surficial erosional activities noted. Some minor sloughing and undercutting along the waters edge where the watercourse has meandered and change direction.

Slope Stability Analysis

The analysis of the stability of the slope was carried out using SLIDE, a computer program which permits a two-dimensional slope stability analysis using several methods including the Bishop’s method, which is a widely used and accepted analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to those favoring failure. Theoretically, a factor of safety of 1.0 represents a condition where the slope is stable. However, due to intrinsic limitations of the calculation methods and the variability of the subsoil and groundwater conditions, a factor of safety greater than one is usually required to ascertain the risks of failure are acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the failure of the slope would endanger permanent structures.

The cross-section was analyzed taking into account a groundwater level at 0.8 m below existing ground surface with cohesive soils in fully saturated conditions. Subsoil conditions at the cross-sections were inferred based on the findings at nearby borehole locations, field observations and general knowledge of the area’s geology.

Static Analysis

The results for the existing slope conditions at Section A, B, C, D, E and F are shown in Figure 2a, 3a, 4a, 5a, 6a and 7a attached to the report. The factor of safety was found to be greater than 1.5 under static conditions.

Seismic Loading Analysis

An analysis considering seismic loading was also completed. A horizontal seismic acceleration, K_h, of 0.21G was considered for the analyzed sections. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

The results of the analyses including seismic loading are shown in Figures 2b, 3b, 4b, 5b, 6b and 7b for the slope sections. The results indicate that the factors of safety for the slope section analyzed is greater than 1.1. Based on these results, the slopes are considered to be stable under seismic loading.

Limit of Hazard Lands

The limit of hazard lands includes a stable slope allowance taken from top of slope. The limit of hazard lands also includes a toe erosion and a 6 m erosion access allowance for slopes greater than 6H:1V. It should be noted that based on our analysis results, the subject slope is considered stable. The limit of hazard lands setback line for the proposed development is indicated on Drawing PG2450-2 - Limit of Hazard Lands in Appendix 2.

The toe erosion allowance for the walls of the valley corridor was based on the cohesive nature of the soils, the observed current erosional activities and the width and location of the current watercourse. Signs of minor erosion were noted along the existing watercourse where the watercourse has meandered in close proximity to the toe of the corridor wall. It is considered that a toe erosion allowance of 2 m is appropriate for the corridor walls confining the existing watercourse. At the worse case scenario, the toe erosion allowance was applied to the full water's edge and still maintaining a stable slope of greater than 3H:1V with a factor of safety of greater than 1.5.

Consideration could be given to infilling the existing drainage areas located to the east and west of the valley corridor with the existing watercourse. The majority of the drainage areas were noted to be dry and some areas with standing water. The existing drainage areas do not require a toe erosion allowance or an erosion access allowance.

The existing vegetation on the slope face should not be removed as it contributes to the stability of the slope and reduces erosion. If the existing vegetation needs to be removed, it is recommended that a 100 to 150 mm of topsoil mixed with a hardy seed or an erosional control blanket be placed across the exposed slope face.

6.9 Landscaping Consideration

Tree Planting Restrictions

Paterson completed a soils review within Phase 1B of the subject development to determine applicable tree planting setbacks, in accordance with the City of Ottawa Tree Planting in Sensitive Marine Clay Soils (2017 Guidelines) for trees planted within a public right-of-way (ROW). Atterberg limits testing was completed on recovered silty clay samples during the supplemental geotechnical investigation as well as during the historical geotechnical investigation, where encountered. Grain size distribution analysis was also completed on 5 soil samples. The above noted test results were completed on samples taken at depths between the anticipated design underside of footing elevation and 3.5 m depth below anticipated finished grade. The results of our testing are presented in Tables 1 and 2 in Subsection 4.2 and in Appendix 1.

A low to medium sensitivity clay soil was encountered intermittently between anticipated underside of footing elevations and 3.5 m below preliminary finished grade as per City Guidelines at the subject site. Based on our Atterberg Limits' test results, the modified plasticity index of the silty clay does not exceed 40% within Phase 1 B of the subject development. Therefore, the following tree planting setbacks are recommended for the low to medium sensitivity area.

Large trees (mature height over 14 m) can be planted within this area provided a tree to foundation setback equal to the full mature height of the tree can be provided (e.g. in a park or other green space). A tree planting setback limit of 4.5 m is applicable for small (mature tree height up to 7.5m) and medium size trees (mature tree height 7.5 m to 14 m) provided that the following conditions are met:

- ❐ The underside of footing (USF) is 2.1 m or greater below the lowest finished grade must be satisfied for footings within 10 m from the tree, as measured from the centre of the tree trunk and verified by means of the Grading Plan as indicated procedural changes below.

- ❐ A small tree must be provided with a minimum 25 m^3 of available soil volume while a medium tree must be provided with a minimum of 30 m^3 of available soil volume, as determined by the Landscape Architect. The developer is to ensure that the soil is generally un-compacted when backfilling in street tree planting locations.

- ❐ The tree species must be small (mature tree height up to 7.5 m) to medium size (mature tree height 7.5 m to 14 m) as confirmed by the Landscape Architect.

- ❐ The foundation walls are to be reinforced at least nominally (minimum of two upper and two lower 15M bars in the foundation wall).
- ❐ Grading surrounding the tree must promote drainage to the tree root zone (in such a manner as not to be detrimental to the tree).

Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 5 m away from the residence foundation and neighboring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Aboveground Hot Tubs

Additional grading around the hot tub should not exceed permissible grade raises. Otherwise, hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Installation of Decks or Additions

Additional grading around proposed deck or addition should not exceed permissible grade raises. Otherwise, standard construction practices are considered acceptable.

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7.0 Geotechnical Considerations – Sewage Treatment and Water Storage Facility

7.1 Excavation Side Slope

The side slopes of excavations in the soil and fill overburden materials should either be cut back at acceptable slopes or should be retained by shoring systems from the start of the excavation until the structure is backfilled.

The excavation side slopes above the groundwater level extending to a maximum depth of 3 m should be cut back at 1H:1V or flatter. The flatter slope is required for excavation below the groundwater level. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

It is recommended that a trench box be used at all times to protect personnel working in trenches with steep or vertical sides. It is expected that services will be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

7.2 Foundation Design

Footings placed on undisturbed, firm grey clayey silt to silty clay bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **75 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **120 kPa**. A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

Footings designed using the above-noted bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively.

The modulus of subgrade reaction was estimated to be **1.1 MPa/m** for a contact pressure of **40 kPa**.

A permissible grade raise restriction ranging from 1 to 1.5 m at the proposed structures should be considered for design purposes.

An undisturbed soil bearing surface consists of a surface from which all topsoil and deleterious materials, such as loose, frozen or disturbed soil, whether in situ or not, have been removed, in the dry, prior to the placement of concrete for footings.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Adequate lateral support is provided to a firm clayey silt to silty clay bearing medium when a plane extending down and out from the bottom edge of the footing at a minimum of 1.5H:1V, passes only through in situ soil or engineered fill of the same or higher capacity as the soil.

7.3 Design for Earthquakes

The site class for seismic site response for the proposed wet foundation can be taken as **Class D** for the proposed building. The soils underlying the proposed wet well are not susceptible to liquefaction.

7.4 Uplift Resistance

The proposed sewage storage facility will be subjected to uplift forces due to the presence of groundwater. The long term groundwater level is expected at a depth of 3 m below the existing grade. However, the groundwater level fluctuates throughout the year and could be encountered seasonally at higher levels at the time of construction. Several design options are available for the proposed wet well to resist uplift forces. The following options are suggested for uplift resistance design:

Option 1 – Extended Sewage Storage Base Footing

The uplift resistance can be provided by the weight of the structure plus the weight of soil backfill placed above the perimeter of the base of the structure. Table 9 provides acceptable geotechnical parameters for resistance to uplift force design. The dry unit weight of the material should be used above the groundwater level and the effective unit weight should be used below the groundwater level. A minimum factor of safety of 1.5 against uplift should be provided.

Table 9 – Geotechnical Parameters for the Resistance to Uplift Pressures and Temporary Shoring Design

Material Description	Unit Weight (kN/m ^{3})		Friction Angle (°) φ'	Earth Pressure Coefficients		
	Dry γ_{dr}	Effective γ'		Active K_A	At-Rest K_O	Passive K_P
OPSS Granular A Fill (Crushed Stone)	22	13.5	40	0.22	0.36	4.58
OPSS Granular A Fill (Well-Graded Sand- Gravel)	21.5	13.5	36	0.26	0.41	3.85
OPSS Granular B Type II Fill (Crushed Stone)	22.5	14	42	0.2	0.33	5.04
OPSS Granular B Type I Fill (Well-Graded Sand-Gravel)	21.5	13.5	35	0.27	0.43	3.69
OPSS Granular B Type I Fill (Well-Graded Sand)	21.5	11.5	32	0.31	0.47	3.25
Silty Sand	19	12	42	0.29	0.46	3.39
Silty Clay	16.5	7	28	0.36	0.53	2.77

Notes: Properties for fill materials are for condition of 95% of Standard Proctor maximum dry density (i.e. moderately compacted).

Option 2 – Thickened Storage Tank Base Slab

This option can be completed in conjunction with a rubberized waterproofing membrane, if required. For uplift resistance design, the dry unit weight of concrete can be taken as 23.5 kN/m^3.

7.5 Storage Tank Walls

There are several combinations of backfill materials and retained soils that could be applicable for the wet well walls. The unit weights and friction angles for the applicable soils are presented in Table 10. The earth pressures acting on the shoring system may be calculated using the following parameters:

Table 10 – Soil Parameters

Parameters	Values
Active Earth Pressure Coefficient (K_a)	0.33
Passive Earth Pressure Coefficient (K_p)	3
At-Rest Earth Pressure Coefficient (K_o)	0.5
Unit Weight ɣ, kN/m ^{3}	20
Submerged Unit Weight ɣ, kN/m ^{3}	13

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

Static Earth Pressure

The static horizontal earth pressure (P_o) can be calculated using a triangular earth pressure distribution equal to $K_o \cdot$ ɣ $\cdot H$ where:

K_o = at-rest earth pressure coefficient of the applicable retained soil (0.5)
ɣ = unit weight of fill of the applicable retained soil (kN/m3)
H = height of the wall (m)

An additional pressure having a magnitude equal to $K_o \cdot q$ and acting on the entire height of the wall should be added to the above diagram for any surcharge loading, q (kPa), that may be placed at ground surface adjacent to the wall. The surcharge pressure will only be applicable for static analyses and should not be used in conjunction with the seismic loading case.

Actual earth pressures could be higher than the “at-rest” case if care is not exercised during the compaction of the backfill materials to maintain a minimum separation of 0.3 m from the walls with the compaction equipment.

Seismic Earth Pressure

The total seismic force (P_{AE}) includes both the earth force component (P_o) and the seismic component (ΔP_{AE}).

The seismic earth force (ΔP_{AE}) can be calculated using $0.375 \cdot a \cdot H^2/g$ where:

$a_c = (1.45 - a_{max}/g)a_{max}$
ɣ = unit weight of fill of the applicable retained soil (kN/m^3)
H= height of the wall (m)
g = gravity, 9.81 m/s^2

The peak ground acceleration, (a_{max}), for the Ottawa area is 0.32g according to OBC 2012. Note that the vertical seismic coefficient is assumed to be zero.

The earth force component (P_o) under seismic conditions can be calculated using $P_o = 0.5\ K_o \cdot \gamma \cdot H^2$, where K = 0.5 for the soil conditions noted above.

The total earth force (P_{AE}) is considered to act at a height, h (m), from the base of the wall, where:

$$h = \{P_o \cdot (H/3) + \Delta P_{AE} \cdot (0.6 \cdot H)\}/P_{AE}$$

The earth forces calculated are unfactored. For the ULS case, the earth loads should be factored as live loads, as per OBC 2012.

8.0 Geotechnical Considerations – Watermain and Sanitary Service Alignment

It is expected that the majority of the construction of the watermain and sanitary services will be completed using conventional open cut methods and will most likely be carried out within the confines of properly braced steel trench box. Groundwater infiltration through the sides of the excavations should be controllable using sumps and pumps.

It is understood that directional drilling will be utilized for the watermain installation below the existing bridge at the intersection of Rivington Street and Carp Road.

The above and other considerations are further discussed in the following sections

8.1 Excavation Side Slopes

Overburden

Side slopes of excavations in the overburden materials should either be cut back at acceptable slopes or should be shored from the start of the excavation until the structure is backfilled. It is assumed that the excavations will be carried out within the confines of a fully-braced steel trench box or other acceptable shoring system.

For open cut situations, above the groundwater level, the excavation side slopes extending to a maximum depth of 4 m in soil should be cut back at 1H:1V. The subsoil at this site is considered to be mainly Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

Excavated soil should not be stockpiled at the top of excavations and heavy equipment should be kept away from the excavation sides.

Slopes in excess of 3 m in height should be periodically inspected by the geotechnical consultant in order to detect if the slopes are exhibiting signs of distress.

Trench boxes should be designed for at least “at rest” earth pressures considering that the boxes will be pulled along the trench and will often be in contact with the soils. A quasi-hydrostatic earth pressure diagram can be used for the box design using an at rest earth pressure coefficient of 0.5 and a drained soil unit weight of 20 kN/m^3 above the groundwater level.

Where trenching below the groundwater level without controlling the groundwater, an effective soil unit weight of 11.5 kN/m^3 can be used below the groundwater level in conjunction with the hydrostatic pressure.

A surcharge pressure due to embankments, vehicle surcharges, construction equipment, adjacent structures, etc. should be added to the earth pressures using the at rest earth pressure coefficient of 0.5. If the top of the trench box is to be located below the ground surface, the extra soil weight above the box should be treated as a surcharge.

8.2 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance with the most recent Material Specifications and Standard Detail Drawings from the Department of Public Works and Services, Infrastructure Services Branch of the City of Ottawa.

The pipe bedding for sewer and water pipes should consist of a minimum of 150 mm of OPSS Granular A material. Where the bedding is located within the firm grey silty clay, the thickness of the bedding material should be increased to a minimum of 300 mm. The material should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of its SPMDD. The bedding material should extend at least to the spring line of the pipe.

The cover material, which should consist of OPSS Granular A, should extend from the spring line of the pipe to at least 300 mm above the obvert of the pipe. The material should be placed in maximum 300 mm thick lifts and compacted to a minimum of 95% of its SPMDD.

It should generally be possible to re-use the moist (not wet) brown silty clay above the cover material if the excavation and filling operations are carried out in dry weather conditions. Wet silty clay materials will be difficult to re-use, as the high water contents make compacting impractical without an extensive drying period.

Where hard surface areas are considered above the trench backfill, the trench backfill material within the frost zone (about 1.8 m below finished grade) should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 300 mm thick loose lifts and compacted to a minimum of 95% of the material's SPMDD.

Clay Seals

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. The seals should extend from the frost line and fully penetrate the bedding, subbedding and cover material. The barriers should consist of relatively dry and compactable brown silty clay placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the SPMDD. The clay seals should be placed at the site boundaries and at strategic locations at no more than 60 m intervals in the service trenches.

Directional Drilling

Based on the existing borehole information, directional drilling is a suitable option for the proposed sanitary installation below the creek underlying proposed Street Six and the watermain installation below the Carp River located south of the intersection of Carp Road and Rivington Street.

It is anticipated that the horizontal drilling at the location of the sanitary installation will be through a stiff brown silty clay and/or firm grey silty clay. Directional drilling, if considered, underlying the Carp River will encounter compact silty fine to medium sand, organic peat, firm grey silty clay and overlying fill materials. Loose to dense silty fine to coarse sand with gravel was encountered at depths ranging between 5.3 and 6.8 m in BH 39-11 and BH 40-11, respectively. It should be noted that running sand and high groundwater infiltration was encountered at 4.5 m and 6.8 m depths. Although gravel and smaller cobbles may not be a problem with this technique, cobbles and boulders would be problematic for directional drilling. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for details of the soil profiles encountered at the test hole locations.

A minimum soil cover for frost protection of 2.4 m should be provided between the top of the pipe and finished grade and below the underside of the pipe and the top of the culvert. Alternatively, the watermain could be positioned at a higher elevation below the watercourse crossing at Rivingston Street and Carp Road to avoid contact with the glacial till layer and the watermain could be insulated to compensate for the reduced soil cover.

8.3 Maintenance Holes

Maintenance holes or chambers may be founded on engineered fill placed on an undisturbed, clayey silt to silty clay or sandy silt to silty sand bearing surface and can be designed using an allowable bearing pressure of **60 kPa**. Engineered fill under maintenance holes or chambers should consist of OPSS Granular A (crushed stone) or Granular B Type II material placed in maximum 300 mm thick layer and compacted to a minimum of 98% of its SPMDD.

9.0 Geotechnical Consideration – Diamondview Road

9.1 Introduction

Further to your request and authorization, Paterson Group (Paterson) conducted an assessment of the existing pavement structure of Diamondview Road from March Road extending approximately 800 m south of March by completed four (4) boreholes as illustrated in Drawing PG2450-1 - Test Hole Location Plan, included in Appendix 2.

The objectives of the assessment were to:

☐ Determine the existing pavement structure and subgrade conditions at borehole locations

☐ Access the pavement structure condition

☐ Prepare pavement rehabilitation options

The following section presents a summary of our findings and our recommendations pertaining to the rehabilitation of the aforementioned roadway.

9.2 Surface Conditions

Generally, the pavement surface is in fair to poor condition with some cracking along the edge of the existing roadway. It is understood that the aforementioned section of the roadway was resurfaced with 25 mm of asphaltic concrete approximately between 2001 and 2003.

9.3 Subsurface Conditions

Field Program

A total of four (4) boreholes were completed for this portion of roadway. The boreholes were advanced to depths of 2.9 m below the existing grade and were sampled at regular intervals to recover soil samples for further laboratory review and testing. Standpipe piezometers were installed in two (2) boreholes to measure stabilized water levels. All boreholes were backfilled and the pavement surface sealed with cold patch asphalt.

Pavement Structure

The subsurface conditions observed at the borehole locations were recorded in detail in the field. The soil profiles are logged in the Soil Profile and Test Data sheets accompanying this report. The borehole locations are shown on Drawing PG2450-1 – Test Hole Location Plan appended to this report.

Generally, the subsoil conditions consist of a flexible asphaltic pavement structure with a granular crushed stone base layer overlying native in situ brown silty clay and/or silty sand.

A summary of the pavement structure and subgrade encountered at each borehole location is presented in Table 11.

Table 11 – Summary of Pavement Structure Thickness

Borehole	Asphaltic Concrete (mm)	Base and Subbase (mm)	Subgrade Type
BH 1-11	25	380	Brown silty clay with sand
BH 2-11	25	460	Brown silty clay with sand
BH 3-11	25	330	Brown silty fine sand
BH 4-11	25	380	Brown silty fine to medium sand
Average	**25**	**388**	

9.4 Recommendations

The section of Diamondview Road from March Road to approximately 800 m south of the intersection March Road and Diamondview Road was observed to be in fair to good condition with areas of deteriorated asphaltic concrete along the edges of the existing roadway. The two (2) options for preliminary discussion are provided for potential pavement rehabilitation.

Option A: Complete Reconstruction

The complete reconstruction of the existing pavement structure is only recommended if a pavement service life expectancy greater than 20 years is required. This option will consist of the removal and disposal of the existing asphaltic concrete and existing subgrade to 690 mm to accommodate the proposed new heavy duty pavement structure as described in the following Table 12.

Table 12 – Recommended Pavement Structure – Diamondview Road

Thickness (mm)	Material Description
40	**Wear Course** – HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** – HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** – OPSS Granular A Crushed Stone
450	**SUBBASE** – OPSS Granular B Type II
SUBGRADE – Either in situ soils, acceptable fill or OPSS G granular B Type I or II m material placed over in situ soil.	

Option B: Pulverization

Pulverization of the existing pavement structure is recommended if a pavement service life expectancy of approximately 15 years is acceptable. This option will consist of pulverization of the existing asphaltic concrete and scarifying pulverized asphalt with underlying granular material, adding a further 150 mm of OPSS Granular A and resurfacing with heavy duty pavement structure as described in the following Table 13:

Table 13 – Pulverization Pavement Structure – Diamondview Road

Thickness (mm)	Material Description
40	**Wear Course** – HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** – HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** – OPSS Granular A Crushed Stone
BASE - Pulverized asphaltic concrete and existing granular material re-shaped to promote adequate surface drainage and compact the granular base to 98% of the material's SPMDD	

10.0 Geotechnical Consideration – Russ Bradley and Huisson Road

10.1 Introduction

Further to your request and authorization, Paterson Group (Paterson) conducted an assessment of the pavement structure of Russ Bradley Road and the granular base and subbase of Huisson Road by completed six (6) boreholes as illustrated in Drawing PG2450-1 - Test Hole Location Plan, included in Appendix 2.

The objectives of the assessment were to:

- ☐ Determine the existing pavement structure and subgrade conditions at borehole locations
- ☐ Access the pavement structure condition
- ☐ Prepare pavement rehabilitation options

The following section presents a summary of our findings and our recommendations pertaining to the rehabilitation of the aforementioned roadway.

10.2 Surface Conditions

Generally, the pavement surface on Russ Bradley Road was observed to be in good condition with some traverse cracking of the existing roadway. The existing surface of Huisson Road consists of granular crushed stone and/or brown silty sand with crushed stone varying in thickness between 560 to 610 mm.

10.3 Subsurface Conditions

Field Program

A total of six (6) boreholes were completed for this section of roadway. The boreholes were advanced to depths of 2.9 m below the existing grade and were sampled at regular intervals to recover soil samples for further laboratory review and testing. Standpipe piezometers were installed in two (2) boreholes to measure stabilized water levels. All boreholes were backfilled and the pavement surface sealed with cold patch asphalt.

Pavement Structure

The subsurface conditions observed at the borehole locations were recorded in detail in the field. The soil profiles are logged in the Soil Profile and Test Data sheets accompanying this report. The borehole locations are shown on Drawing PG2450-1 – Test Hole Location Plan appended to this report.

Generally, the subsoil conditions of Russ Bradley Road consist of a flexible asphaltic pavement structure with a granular crushed stone and/or brown silty sand with crushed stone base layer overlying native in situ brown silty clay and/or silty sand. Huisson Road consisted of a granular crushed stone and/or brown silty sand with crushed stone overlying in situ redish brown to brown silty find sand.

A summary of the pavement structure and subgrade encountered at each borehole location is presented in Table 14. The base layer consists mainly of crushed stone to silty sand with crushed stone.

Table 14 – Summary of Pavement Structure Thickness

Borehole	Asphaltic Concrete (mm)	Base and Subbase (mm)	Subgrade Type
BH 26-11	25	580	Brown silty clay / silty sand
BH 27-11	25	580	Brown silty fine sand trace clay
BH 28-11	25	430	Brown silty fine sand
BH 29-11	none	610	Brown silty find sand trace clay
BH 30-11	none	610	Reddish brown silty find sand
BH 31-11	none	560	Reddish brown silty fine sand
Average	**25**	**562**	

10.4 Recommendations

Russ Bradley Road and Huisson Road was observed to be in good condition with some transverse cracking on Russ Bradley Road. The base materials and thickness observed during our field investigation was satisfactory. The following option is for preliminary discussion are provided for potential pavement rehabilitation.

Pulverization

Pulverization of the existing pavement structure is recommended if a pavement service life expectancy of approximately 15 to 20 years is acceptable. This will consist of pulverization of the existing asphaltic concrete on Russ Bradley Road and scarifying pulverized asphalt with underlying granular material and resurfacing with a heavy duty pavement structure as described in the following Table 15.

Table 17 – Pavement Structure - Russ Bradley Road and Huisson Road

Thickness (mm)	Material Description
40	**Wear Course** – HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Binder Course** – HL-8 or Superpave 19.0 Asphaltic Concrete
BASE - Pulverized asphaltic concrete and existing granular material re-shaped to promote adequate surface drainage and com pact the granular base to 98% of the material's SPMDD	

11.0 Recommendations

It is a requirement for the foundation design data provided herein to be applicable that the following material testing and observation program be performed by the geotechnical consultant.

☐ Review detailed grading plan(s) from a geotechnical perspective.

☐ Observation of all bearing surfaces prior to the placement of concrete.

☐ Sampling and testing of the concrete and granular fill materials used.

☐ Periodic observation of the condition of unsupported excavation side slopes in excess of 3 m in height, if applicable.

☐ Observation of all subgrades prior to backfilling.

☐ Field density tests to determine the level of compaction achieved.

☐ Sampling and testing of the bituminous concrete including mix design reviews.

All excess soils, with the exception of engineered crushed stone fill, generated by construction activities that will be transported on-site or off-site should be handled as per *Ontario Regulation 406/19: On-Site and Excess Soil Management.*

A report confirming that these works have been conducted in general accordance with our recommendations could be issued upon the completion of a satisfactory inspection program by the geotechnical consultant.

12.0 Statement of Limitations

The recommendations provided are in accordance with the present understanding of the project. Paterson requests permission to review the recommendations when the drawings and specifications are completed.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, Paterson requests immediate notification to permit reassessment of our recommendations.

The recommendations provided herein should only be used by the design professionals associated with this project. They are not intended for contractors bidding on or undertaking the work. The latter should evaluate the factual information provided in this report and determine the suitability and completeness for their intended construction schedule and methods. Additional testing may be required for their purposes.

The present report applies only to the project described in this document. Use of this report for purposes other than those described herein or by person(s) other than Novatech Engineering Consultants, West Capital Developments. or their agents is not authorized without review by Paterson for the applicability of our recommendations to the alternative use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
Jan. 16, 2023
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Kevin A. Pickard, EIT

David J. Gilbert, P.Eng.

Report Distribution:

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ATTERBERG LIMITS TESTING RESULTS

GRAIN SIZE DISTRIBUTION AND HYDROMETER TESTING RESULTS

UNIDIMENSIONAL CONSOLIDATION TESTING SHEETS

ANALYTICAL TESTING RESULTS

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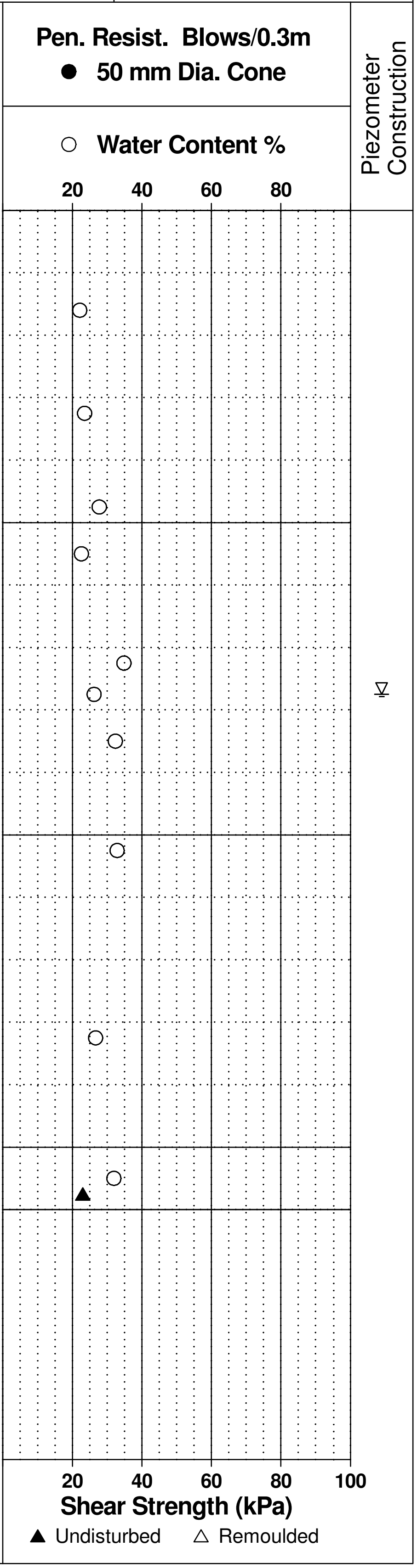
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Residential Development
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Backhoe
DATE October 4, 2022
FILE NO. PG2450
HOLE NO. TP 1-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	114.29
FILL: Brown silty sand to sandy silt with organics, trace topsoil		G G	1 2				
0.70							
FILL: Grey-brown silty sand to sandy silt with clay, trace organics and topsoil - clay content increasing with depth		G G G G G	3 4 5 6 7			1	113.29
1.90							
Compact to loose, brown **SILTY SAND to SANDY SILT,** trace to some clay - grey by 2.3m depth		G G	8 9			2	112.29
3.00						3	111.29
Firm to soft, grey **SILTY CLAY to CLAYEY SILT** with stratified layers of silty sand		G	10				
3.20							
End of Test Pit (Groundwater infiltration at 1.55m depth)							



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SOIL PROFILE AND TEST DATA

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Carp Airport Residential Development
Ottawa, Ontario

DATUM Geodetic

REMARKS

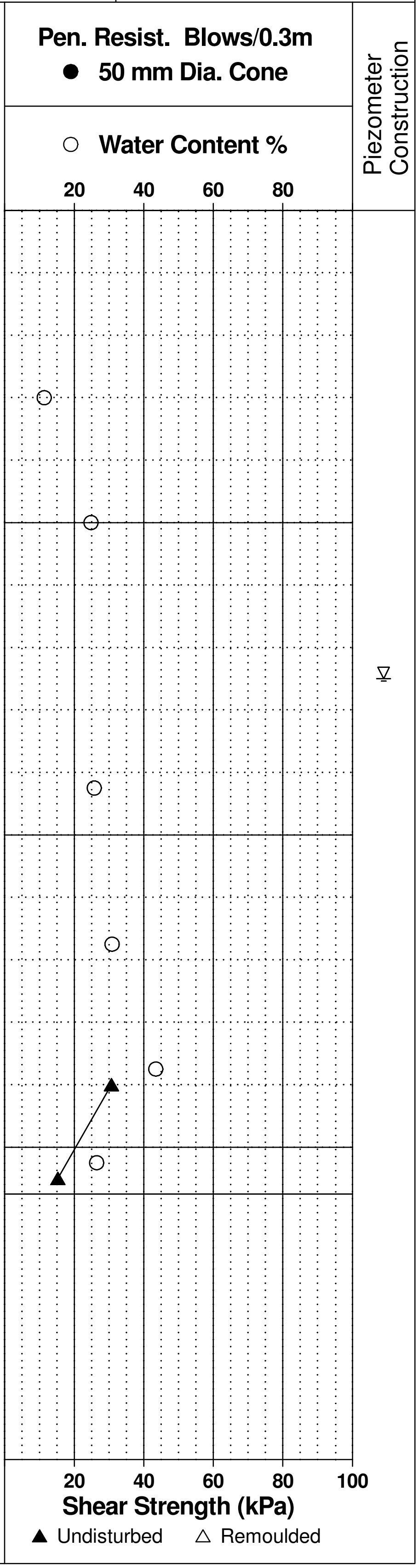
BORINGS BY Backhoe

DATE October 4, 2022

FILE NO. PG2450

HOLE NO. TP 2-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	114.94
TOPSOIL 0.34							
Compact, brown **SILTY SAND** 0.85		G	1				
Compact, brown **SILTY SAND to SANDY SILT,** trace to some clay - grey by 1.6m depth - some seashells by 1.8m depth 2.00		G G	2 3			1	113.94
Compact, grey **SANDY SILT** with stratified layers of silty clay/clayey silt 2.60		G	4			2	112.94
Firm to soft, grey **SILTY CLAY to CLAYEY SILT** with stratified layers of silty sand 3.15		G G	5 6			3	111.94
End of Test Pit (Groundwater infiltration at 1.5m depth)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Residential Development
Ottawa, Ontario

DATUM Geodetic

REMARKS

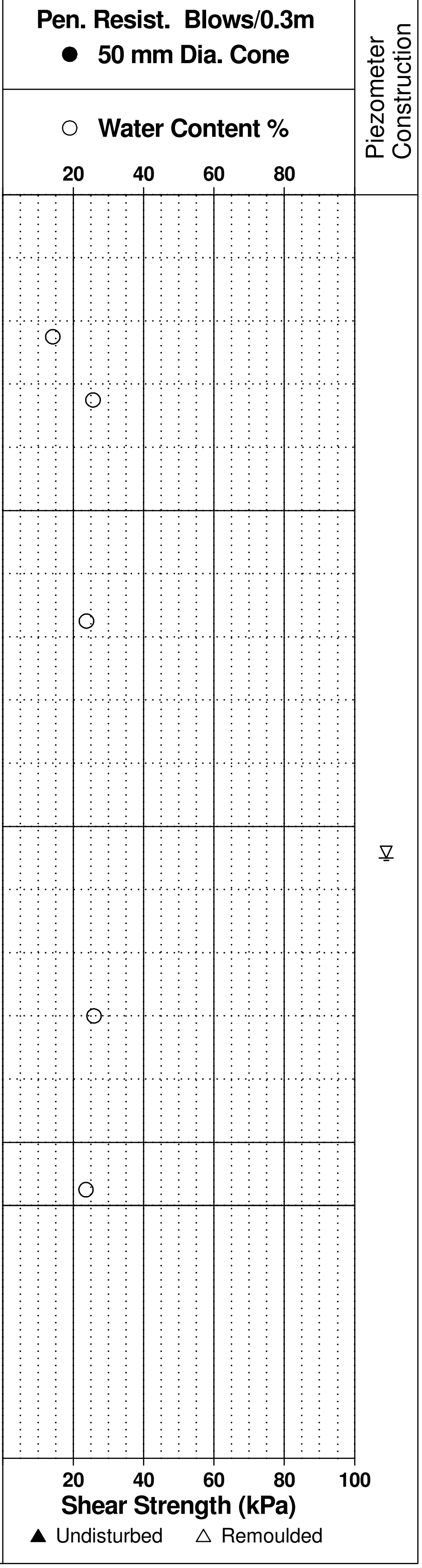
BORINGS BY Backhoe

DATE October 4, 2022

FILE NO. PG2450

HOLE NO. TP 3-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	115.51
TOPSOIL 0.35							
Compact, reddish brown **SILTY SAND** 0.55		G	1				
Compact, brown **SILTY SAND to SANDY SILT,** some to trace clay 2.45		G G	2 3			1 2	114.51 113.51
Comapct, grey **SILTY SAND to SANDY SILT** - stratified layers of silty clay to clayey silt by 0.3m depth 3.20		G G	4 5			3	112.51
End of Test Pit (Groundwater infiltration at 2.1m depth)							



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DATUM Geodetic

REMARKS

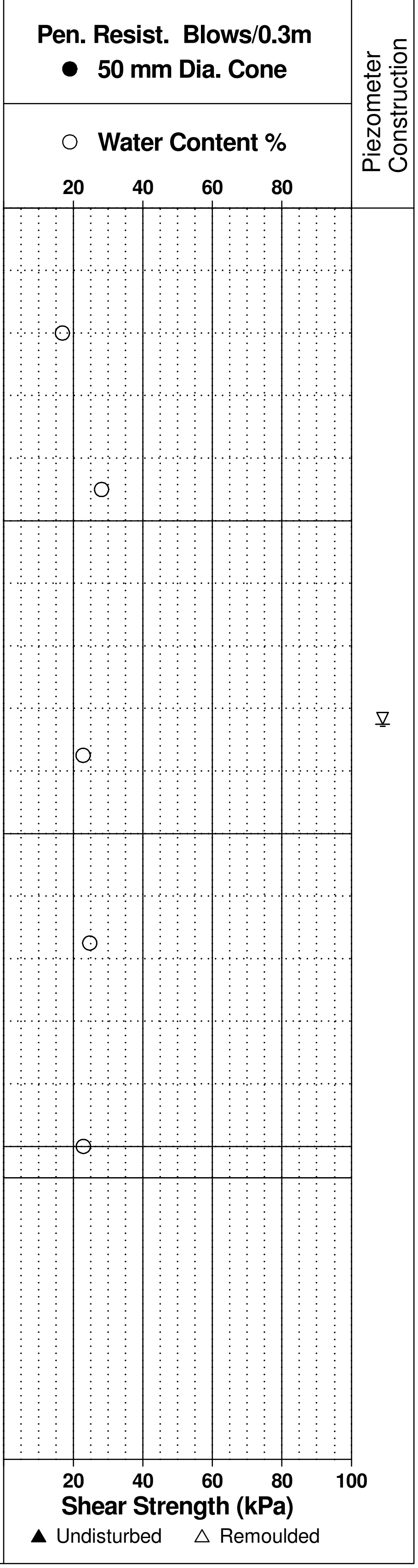
BORINGS BY Backhoe

DATE October 4, 2022

FILE NO. PG2450

HOLE NO. TP 4-22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	115.89
TOPSOIL 0.31							
Compact, brown **SILTY SAND,** trace clay 0.71		G	1				
Compact to dense, brown **SILTY SAND to SANDY SILT,** trace clay - grey with some to trace seashells by 1.6m depth		G	2			1	114.89
		G	3			2	113.89
		G	4				
3.10		G	5			3	112.89
End of Test Pit (Groundwater infiltration at 1.65m depth)							

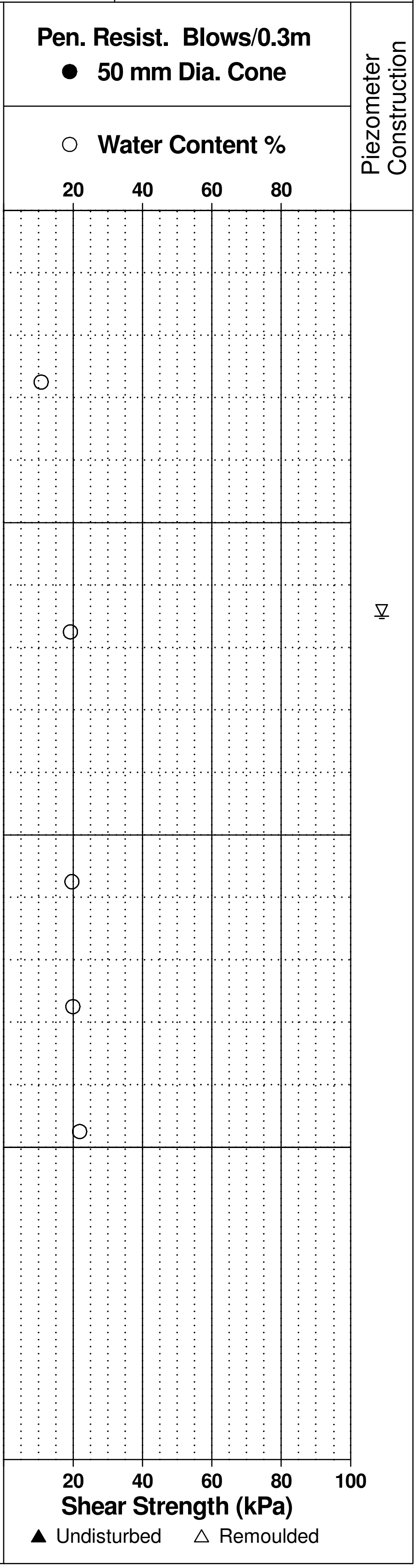


SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Residential Development
Ottawa, Ontario

DATUM Geodetic
REMARKS
BORINGS BY Backhoe
DATE October 4, 2022
FILE NO. **PG2450**
HOLE NO. **TP 5-22**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	116.59
TOPSOIL							
0.28							
Loose to compact, brown **SILTY SAND**		G	1				
						1	115.59
		G	2				
2.00						2	114.59
Loose to compact, grey **SILTY SAND to SANDY SILT** - some seashells by 1.9m depth - stratified layers of silty clay/clayey silt by 2.8m depth		G	3				
		G	4				
3.00		G	5			3	113.59
End of Test Pit (Groundwater infiltration at 1.3m depth)							



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SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

HOLE NO. **BH 1-11**

BORINGS BY CME 55 Power Auger

DATE 18 August 2011

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	114.03
25mm Asphaltic concrete over crushed stone	0.15						
FILL: Crushed stone, trace sand	0.36	AU	1				
Very stiff to firm, brown **SILTY CLAY** with sand		SS	2	67	14	1	113.03
		SS	3	75	6	2	112.03
	2.97	SS	4	100	W		
End of Borehole (BH dry - Sept. 21/11)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotehnical Investigation
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Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 18 August 2011

FILE NO. PG2450

HOLE NO. BH 2-11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	115.14		
25mm Asphaltic concerete over crushed stone 0.48		AU	1						
Brown **SILTY CLAY** with sand 1.45		SS	2	92	4	1	114.14		▽
Loose to very loose, brown **SILTY SAND** with clay - grey with trace clay by 2.2m depth 2.97		SS	3	83	5	2	113.14		
		SS	4	0	W				
Grey **CLAYEY SILT** to **SILTY CLAY** 3.73		SS	5	100	W	3	112.14		
End of Borehole (GWL @ 1.5m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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REMARKS

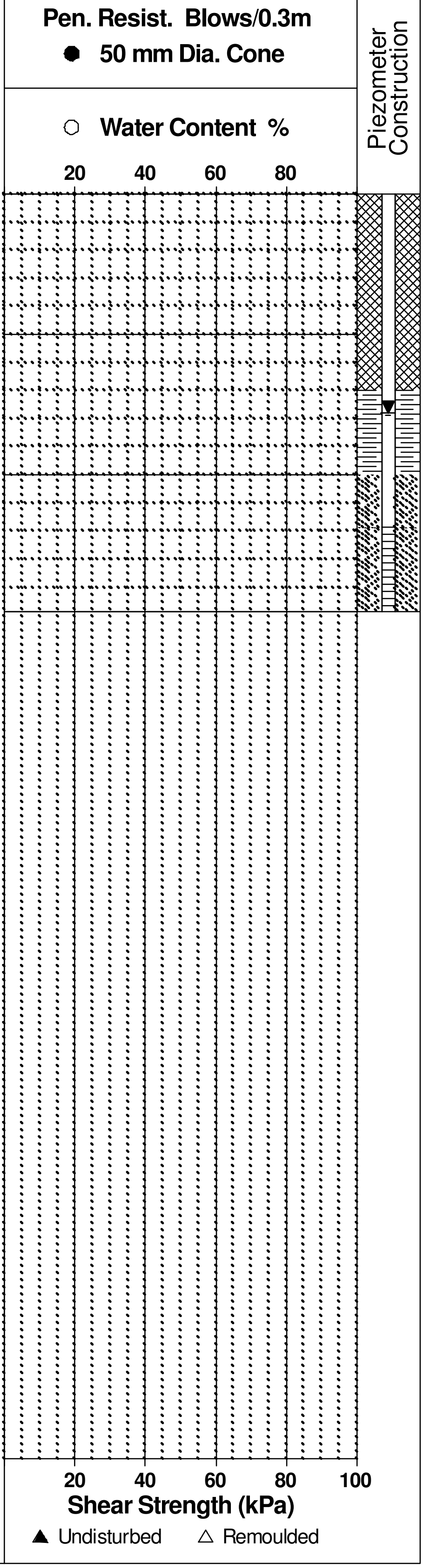
BORINGS BY CME 55 Power Auger

DATE 18 August 2011

FILE NO. PG2450

HOLE NO. BH 3-11

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	116.29
25mm Asphaltic concrete over crushed stone 0.36	AU	1				
Compact, brown **SILTY** fine to medium **SAND** 1.45	SS	2	50	19	1	115.29
Compact, grey **SANDY SILT** 1.98	SS	3	67	11		
Firm, grey **CLAYEY SILT** to **SILTY CLAY** 2.97	SS	4	100	1	2	114.29
End of Borehole (GWL @ 1.56m-Sept. 21/11)						



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REMARKS

BORINGS BY CME 55 Power Auger

DATE 18 August 2011

FILE NO. **PG2450**

HOLE NO. **BH 4-11**

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	117.28	
Asphaltic concrete	0.05							
FILL: Crushed stone	0.18							
FILL: Crushed stone with sand	0.41							
		SS	1	67	21	1	116.28	
Compact, brown **SILTY** fine to medium **SAND**								▽
- grey by 1.4m depth		SS	2	50	11	2	115.28	
		SS	3	67	19			
	2.97							
End of Borehole (GWL @ 1.5m depth based on field observations)								

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

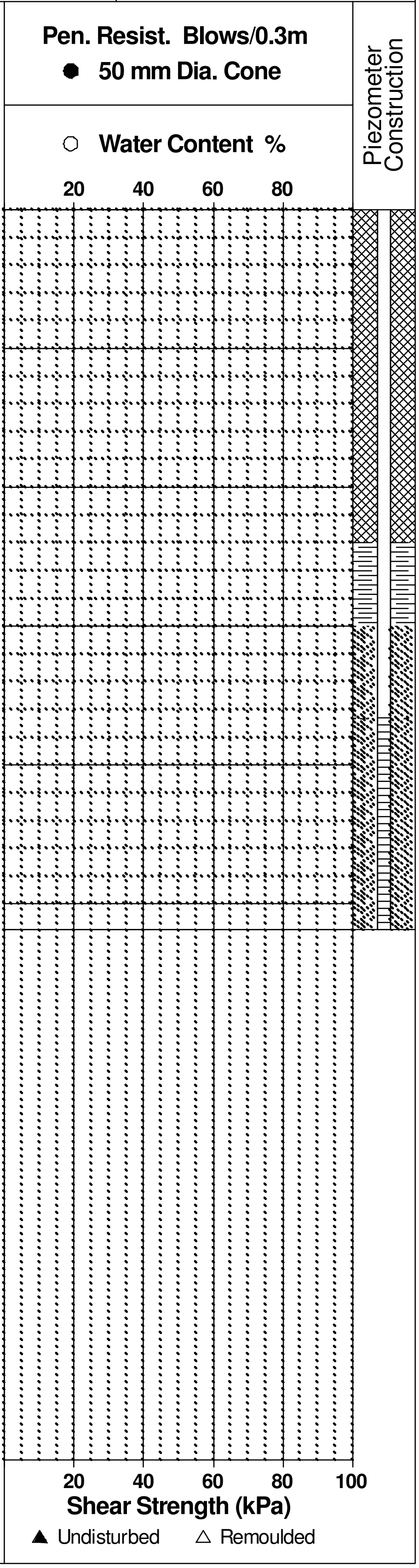
REMARKS

HOLE NO. **BH 5-11**

BORINGS BY CME 55 Power Auger

DATE 21 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	115.67
TOPSOIL 0.15	AU	1				
compact, brown **SILTY** fine to medium **SAND**	SS	2	25	18	1	114.67
1.45						
Firm, grey **CLAYEY SILT** to **SILTY CLAY** with sand	SS	3	42	2	2	113.67
	SS	4	67	5		
2.97					3	112.67
Loose, grey **SANDY SILT**	SS	5	21	7		
3.73					4	111.67
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	6	75	2		
	SS	7	83	2	5	110.67
5.18						
End of Borehole (Piezometer blocked - Sept. 27/11)						



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SOIL PROFILE AND TEST DATA

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Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 21 September 2011

FILE NO. **PG2450**

HOLE NO. **BH 6-11**

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	115.88
TOPSOIL 0.15	AU	1				
Compact brown **SILTY FINE SAND** 0.45						
Compact, brown **SILTY SAND** with clay 1.45	SS	2	50	12	1	114.88
Firm, grey **CLAYEY SILT** to **SILTY CLAY,** trace sand	SS	3	75	7	2	113.88
	SS	4	25	5		
	SS	5	42	6	3	112.88
3.73						
Firm, grey **SILTY CLAY**	SS	6	42	5	4	111.88
4.50						
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	7	50	2	5	110.88
5.18						
End of Borehole (GWL @ 2.7m depth based on field observations)						

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

Piezometer Construction

∇

20 40 60 80 100
Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

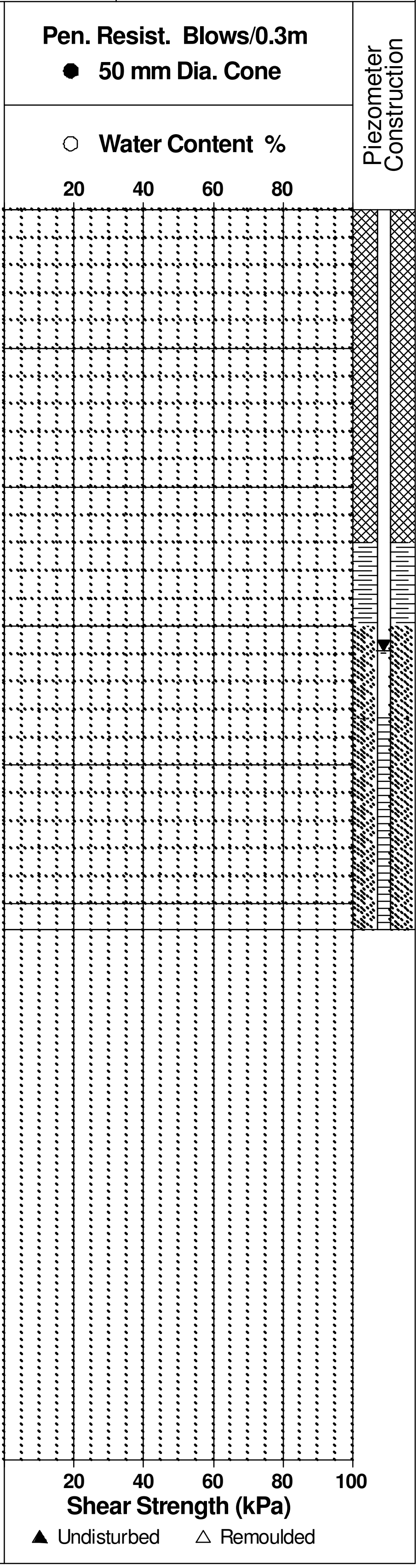
DATE 21 September 2011

FILE NO. PG2450

HOLE NO. BH 7-11

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.15					
Compact, red-brown **SILTY SAND** 0.60		AU	1		
Very stiff, brown **SILTY CLAY** with sand		SS	2	67	15
2.21		SS	3	58	11
Compact, brown **SILTY SAND,** some clay 2.97		SS	4	67	30
Compact, grey **CLAYEY SILT,** some sand 3.73		SS	5	58	8
Firm, grey **CLAYEY SILT** to **SILTY CLAY**		SS	6	83	2
5.18		SS	7	100	P
End of Borehole (GWL @ 3.18m-Sept. 27/11)					

DEPTH (m)	ELEV. (m)
0	115.07
1	114.07
2	113.07
3	112.07
4	111.07
5	110.07



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

HOLE NO. **BH 8-11**

BORINGS BY CME 55 Power Auger

DATE 20 September 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	114.57
TOPSOIL 0.15							
Loose, red-brown **SILTY SAND** 0.60		AU	1				
Stiff, brown **SILTY CLAY** with sand		SS	2	67	9	1	113.57
		SS	3	0	4	2	112.57
		SS	4	75	4	3	111.57
3.35		SS	5	67	4		
Firm, grey **CLAYEY SILT** to **SILTY CLAY,** some sand		SS	6	83	3	4	110.57
5.18		SS	7	83	1	5	109.57
End of Borehole							
(GWL @ 2.98m-Sept. 27/11)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ **Water Content %**
20 40 60 80

Piezometer Construction

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 19 September 2011

FILE NO. PG2450

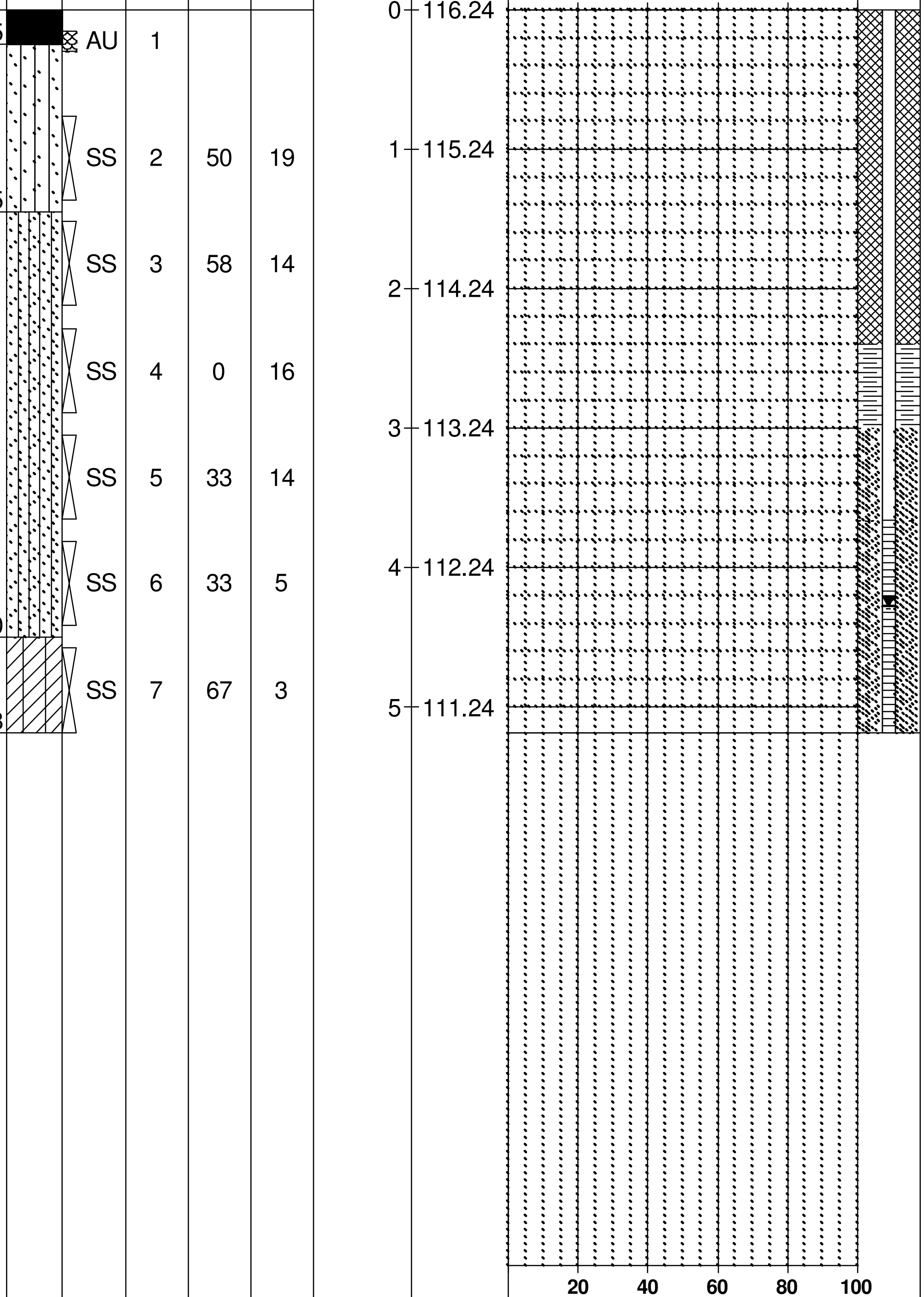
HOLE NO. BH 9-11

SOIL DESCRIPTION	Depth (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.25	AU	1		
Compact, red-brown **SILTY** fine to medium **SAND** - brown by 1.2m depth	1.45	SS	2	50	19
Compact to loose, grey **SILTY FINE SAND** to **SANDY SILT**	4.50	SS	3	58	14
		SS	4	0	16
		SS	5	33	14
		SS	6	33	5
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	5.18	SS	7	67	3

End of Borehole

(GWL @ 4.28m-Sept. 27/11)

DEPTH (m)	ELEV. (m)
0	116.24
1	115.24
2	114.24
3	113.24
4	112.24
5	111.24



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SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. PG2450

REMARKS

HOLE NO. BH10-11

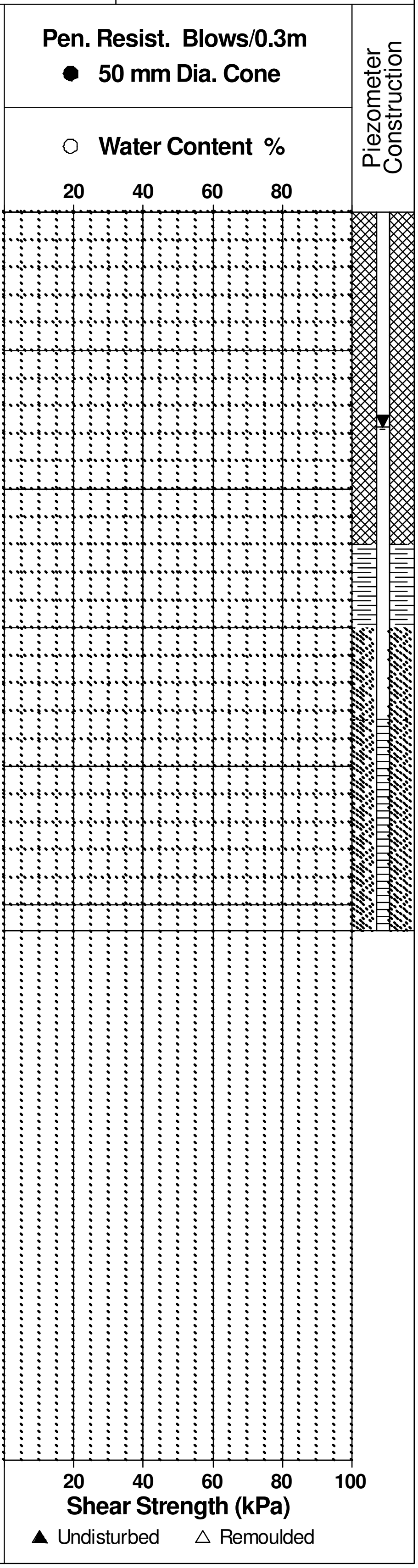
BORINGS BY CME 55 Power Auger

DATE 16 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	116.94
TOPSOIL 0.20	AU	1				
Compact, red-brown **SILTY** fine to medium **SAND** - brown by 0.6m depth	SS	2	0	11	1	115.94
2.21	SS	3	25	2	2	114.94
Compact, grey **SILTY FINE SAND**	SS	4	50	24	3	113.94
3.73	SS	5	58	20		
Compact, grey **SANDY SILT** 4.72	SS	6	42	13	4	112.94
Grey **SANDY SILT** to **CLAYEY SILT** 5.18	SS	7	50	12	5	111.94

End of Borehole

(GWL @ 1.55m-Sept. 27/11)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

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FILE NO. **PG2450**

REMARKS

HOLE NO. **BH11-11**

BORINGS BY CME 55 Power Auger

DATE 16 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE					0	115.73	
TOPSOIL 0.25	AU	1					
Compact, red-brown **SILTY** fine to medium **SAND** 0.60							
Compact, brown **SILTY FINE SAND** with clay	SS	2	75	23	1	114.73	
	SS	3	75	15	2	113.73	
2.51							∇
Stiff, grey **CLAYEY SILT** with sand	SS	4	33	13	3	112.73	
3.73	SS	5	50	5			
Firm, grey **CLAYEY SILT** to **SILTY CLAY,** trace sand	SS	6	67	6	4	111.73	
5.18	SS	7	100	2	5	110.73	
End of Borehole (GWL @ 2.4m depth based on field observations)							

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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REMARKS

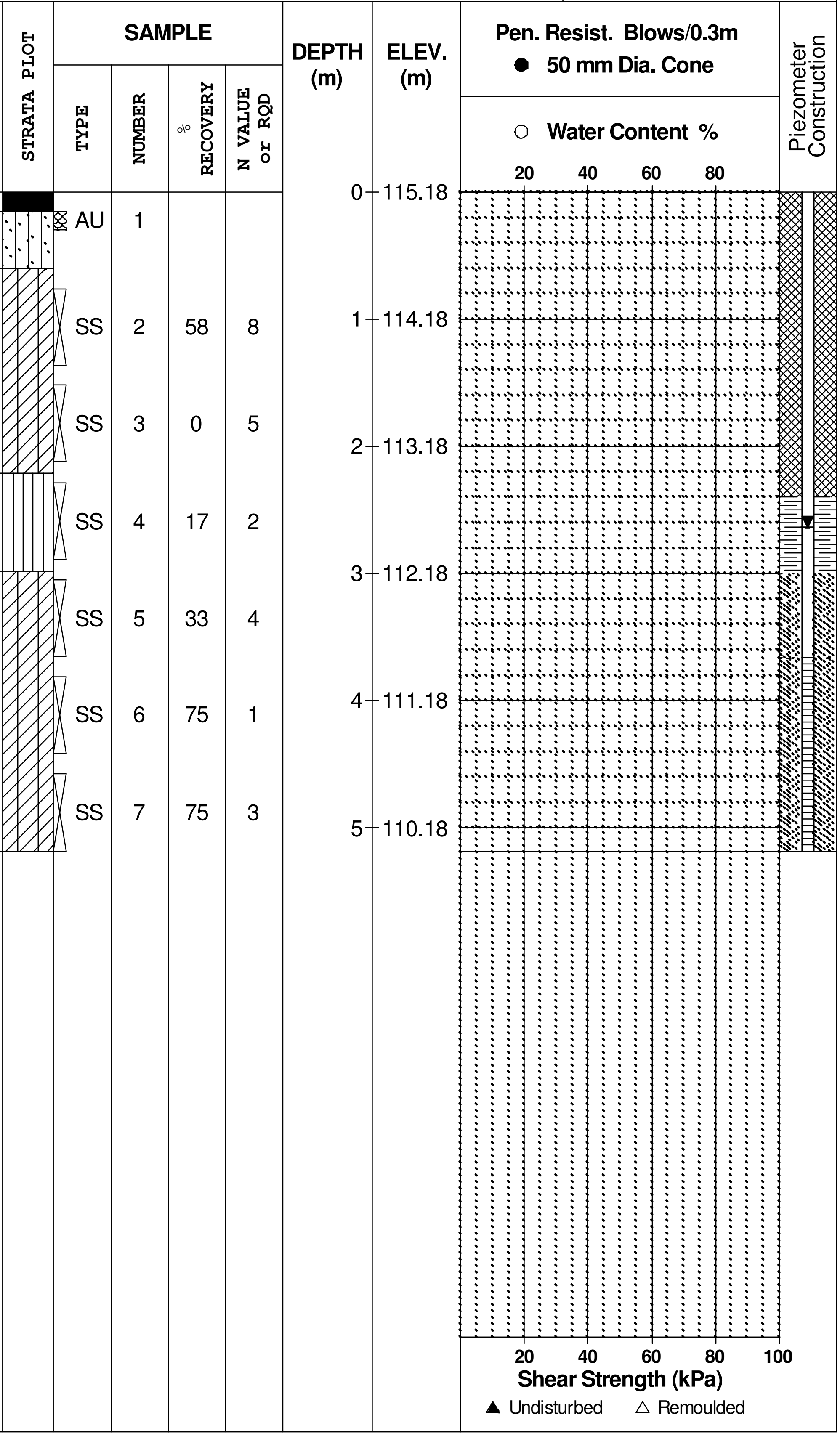
BORINGS BY CME 55 Power Auger

DATE 16 September 2011

FILE NO. PG2450

HOLE NO. BH12-11

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	115.18
TOPSOIL 0.15						
Loose, red-brown **SILTY** fine to medium **SAND** 0.60	AU	1				
Very stiff to stiff, brown **SILTY CLAY** with sand	SS	2	58	8	1	114.18
	SS	3	0	5		
2.21					2	113.18
Loose, grey **CLAYEY SILT** 2.98	SS	4	17	2		
Firm, grey **CLAYEY SILT** to **SILTY CLAY**					3	112.18
	SS	5	33	4		
	SS	6	75	1	4	111.18
5.18	SS	7	75	3	5	110.18
End of Borehole (GWL @ 2.63m-Sept. 27/11)						



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REMARKS

BORINGS BY CME 55 Power Auger

DATE 16 September 2011

FILE NO. PG2450

HOLE NO. BH13-11

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.20
Compact, red-brown **SILTY** fine to medium **SAND**	0.60
Compact, brown **SILTY FINE SAND,** trace clay	0.91
Compact, grey **CLAYEY SILT** with sand	3.65
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	5.18
End of Borehole (GWL @ 3.0m depth based on field observations)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	42	20
SS	3	67	22
SS	4	58	6
SS	5	33	9
SS	6	17	4
SS	7	25	2

DEPTH (m)	ELEV. (m)
0	115.98
1	114.98
2	113.98
3	112.98
4	111.98
5	110.98

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

∇ (at 3.0 m)

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SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE 15 September 2011

FILE NO. **PG2450**

HOLE NO. **BH14-11**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	116.96		
TOPSOIL 0.20									
Compact, red-brown **SILTY** fine to medium **SAND**		SS	1	8	12				
- brown by 0.6m depth		SS	2	50	20	1	115.96		▽
- grey by 1.4m depth									
		SS	3	50	27	2	114.96		
2.21									
Compact, grey **CLAYEY SILT,** trace sand		SS	4	58	15				
2.97						3	113.96		
Compact, grey **CLAYEY SILT** to **SANDY SILT**		SS	5	50	20				
		SS	6	50	15	4	112.96		
		SS	7	42	18	5	111.96		
5.18									
End of Borehole									
(GWL @ 1.2m depth based on field observations)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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FILE NO. **PG2450**

REMARKS

HOLE NO. **BH15-11**

BORINGS BY CME 55 Power Auger

DATE 15 September 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	116.34	
TOPSOIL 0.15	■							
Loose, red-brown **SILTY** fine to medium **SAND** 0.60		SS	1	0	6			
Compact, grey **CLAYEY SILT,** trace sand								∇
		SS	2	42	8	1	115.34	
		SS	3	50	14	2	114.34	
		SS	4	50	13	3	113.34	
3.73		SS	5	58	12			
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	▨	SS	6	83	4	4	112.34	
5.18	▨	SS	7	100	4	5	111.34	
End of Borehole (GWL @ 0.9m depth based on field observations)								

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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FILE NO. **PG2450**

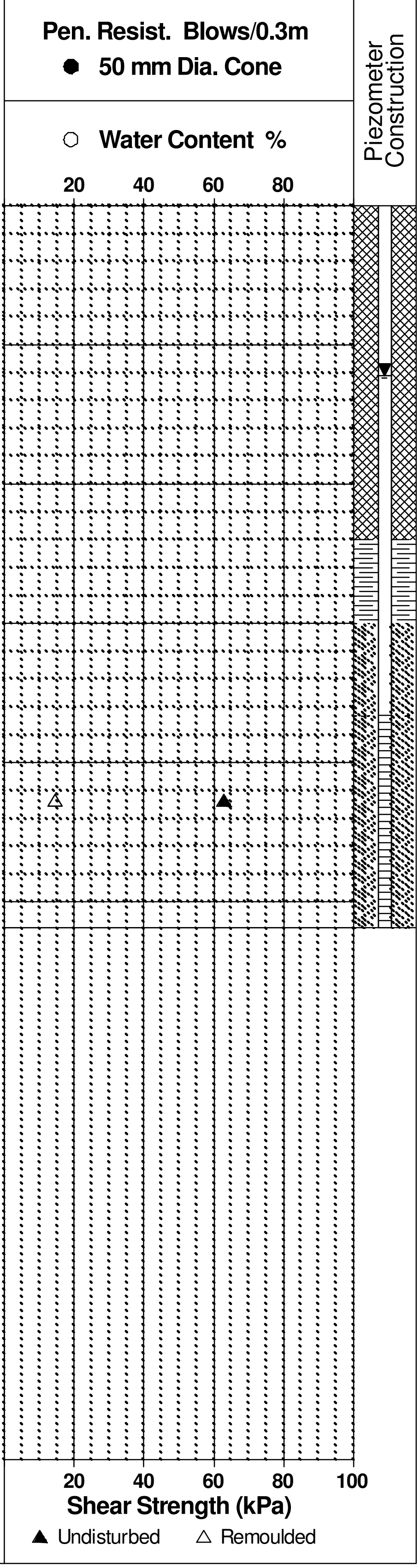
REMARKS

HOLE NO. **BH16-11**

BORINGS BY CME 55 Power Auger

DATE 15 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	116.02
TOPSOIL 0.15						
Loose, red-brown **SILTY FINE SAND** 0.60	SS	1		7		
Compact, grey **CLAYEY SILT,** trace sand and seashells	SS	2	33	14	1	115.02
	SS	3	58	10		
2.21					2	114.02
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	4	33	4		
					3	113.02
	SS	5	67	2		
4.49					4	112.02
Loose, grey **CLAYEY SILT,** trace sand 5.18	SS	6	83	4	5	111.02
End of Borehole						
(GWL @ 1.22m-Sept. 27/11)						



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SOIL PROFILE AND TEST DATA

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FILE NO. **PG2450**

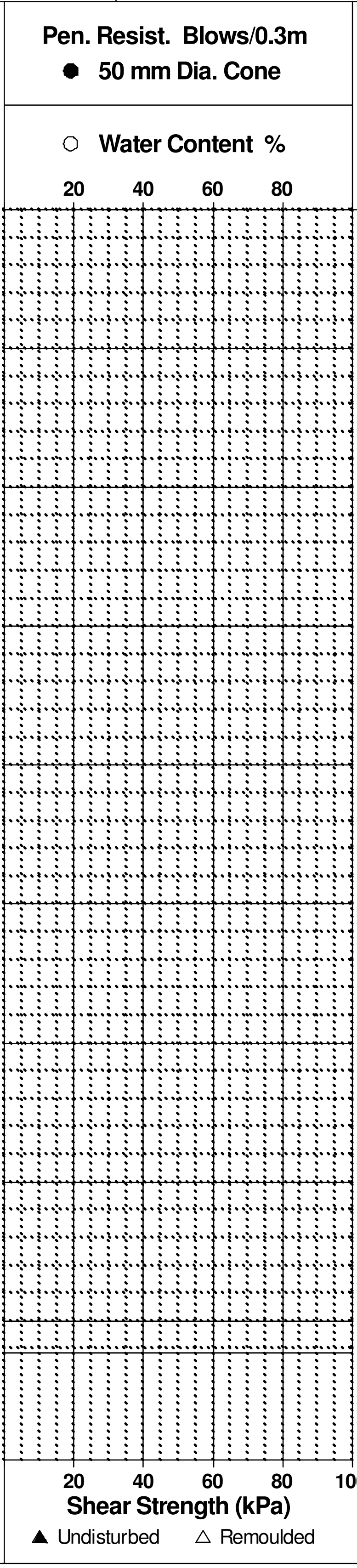
REMARKS

HOLE NO. **BH17-11**

BORINGS BY CME 55 Power Auger

DATE 21 September 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	112.24	
TOPSOIL 0.15								
Brown **SILTY FINE SAND,** trace clay 0.46		AU	1					
		SS	2	75	7	1	111.24	▽
		SS	3	83	1	2	110.24	
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	4	83	2			
- firm and grey by 3.4m depth						3	109.24	
		SS	5	92	3			
		SS	6	100	P	4	108.24	
		SS	7	100	P	5	107.24	
5.86		SS	8	100	P			
Firm, grey **CLAYEY SILT** to **SILTY CLAY**		SS	9	92	P	6	106.24	
		SS	10	83	P	7	105.24	
8.23		SS	11	100	P	8	104.24	
End of Borehole (GWL @ 1.2m depth based on field observations)								



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SOIL PROFILE AND TEST DATA

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FILE NO. **PG2450**

REMARKS

HOLE NO. **BH18-11**

BORINGS BY CME 55 Power Auger

DATE 20 September 2011

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.15
Loose, red-brown **SILTY FINE SAND,** trace clay	0.60
Stiff, brown **SILTY CLAY,** some sand - firm and grey by 2.2m depth	5.26
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	8.23
End of Borehole	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	4
SS	3	83	3
SS	4	50	2
SS	5	79	1
SS	6	92	P
SS	7	92	P
SS	8	92	P
SS	9	83	P
SS	10	83	P
SS	11	100	P

DEPTH (m)	ELEV. (m)
0	111.04
1	110.04
2	109.04
3	108.04
4	107.04
5	106.04
6	105.04
7	104.04
8	103.04

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**
○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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FILE NO. **PG2450**

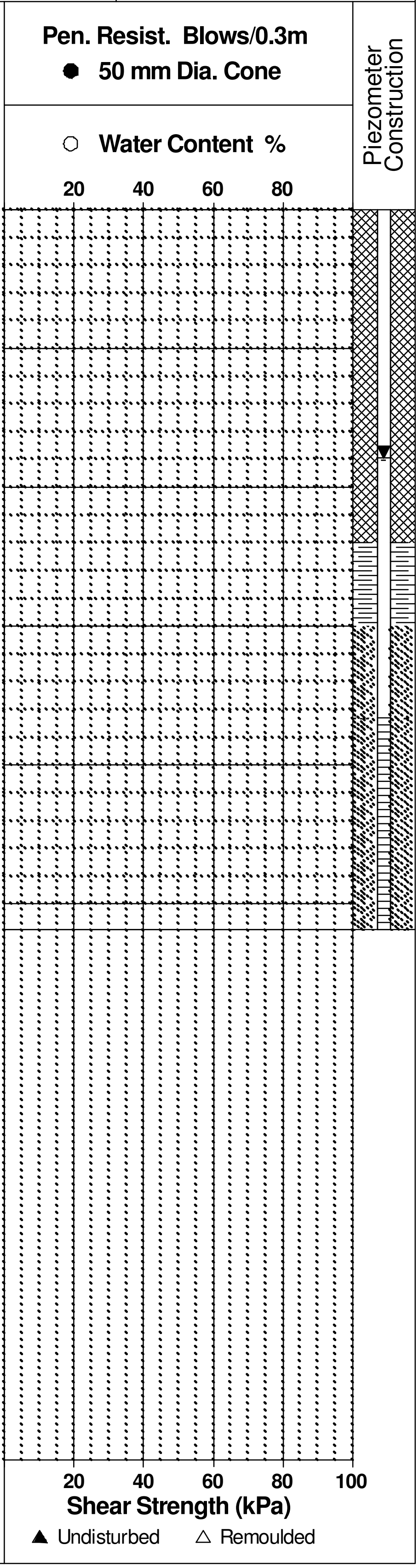
REMARKS

HOLE NO. **BH19-11**

BORINGS BY CME 55 Power Auger

DATE 21 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	113.32
TOPSOIL 0.15						
Loose, brown **SILTY FINE SAND** 0.46	AU	1				
	SS	2	50	7	1	112.32
	SS	3	100	4	2	111.32
Very stiff to stiff, brown **SILTY CLAY,** trace sand - firm and grey by 3.0m depth	SS	4	50	4	3	110.32
	SS	5	25	1	4	109.32
	SS	6	67	P		
5.18	SS	7	75	P	5	108.32
End of Borehole (GWL @ 1.79m-Sept. 27/11)						



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Ottawa, Ontario

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FILE NO. **PG2450**

REMARKS

HOLE NO. **BH20-11**

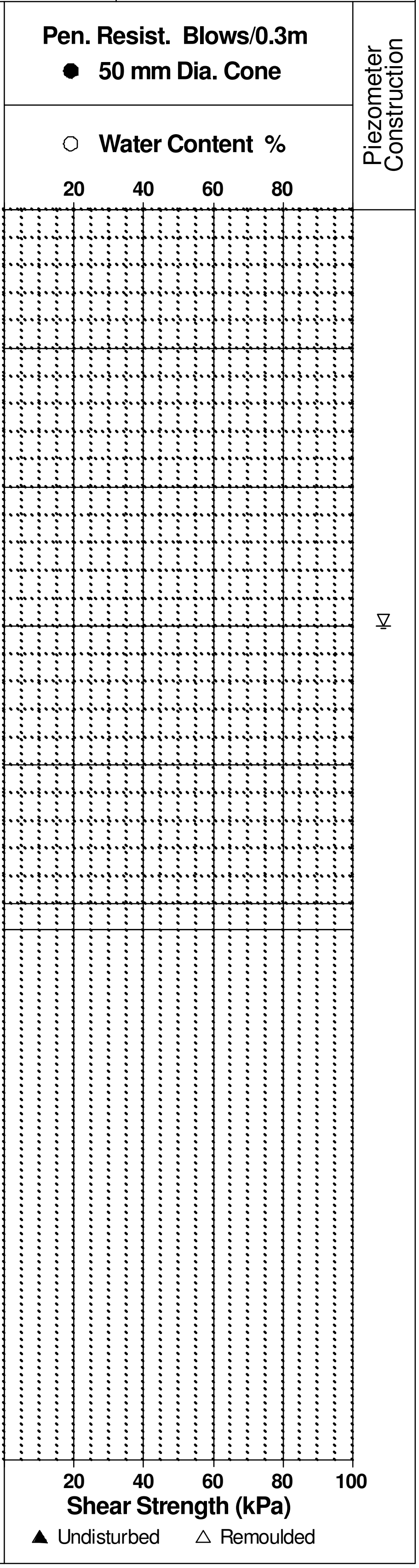
BORINGS BY CME 55 Power Auger

DATE 20 September 2011

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
TOPSOIL	0.15
Loose, red-brown **SILTY FINE SAND**	0.60
Very stiff to stiff, brown **SILTY CLAY,** some sand - fimr and grey by 3.0m depth	5.18
End of Borehole (GWL @ 3.0m depth based on field observations)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	8	9
SS	3	92	3
SS	4	83	2
SS	5	83	1
SS	6	83	1
SS	7	83	P

DEPTH (m)	ELEV. (m)
0	113.22
1	112.22
2	111.22
3	110.22
4	109.22
5	108.22



SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

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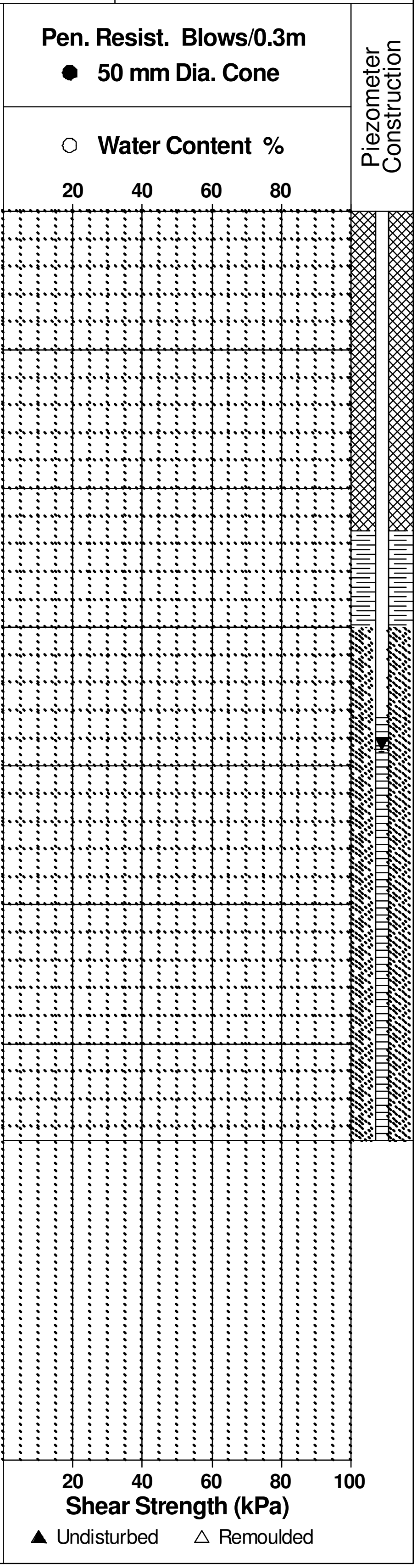
REMARKS
BORINGS BY CME 55 Power Auger
DATE 19 September 2011
FILE NO. PG2450
HOLE NO. BH22-11

SOIL DESCRIPTION	STRATA DEPTH (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	111.88
TOPSOIL	0.20	AU	1				
Compact to loose, brown **SILTY FINE SAND**		SS	2	8	16	1	110.88
	2.13	SS	3	8	7	2	109.88
Stiff, brown **SILTY CLAY** with sand	2.97	SS	4	0	4		
Firm, grey **CLAYEY SILT** to **SILTY CLAY**		SS	5	75	3	3	108.88
		SS	6	0	3	4	107.88
		SS	7	92	1	5	106.88
		SS	8	92	1	6	105.88
	6.70	SS	9	100	P		
End of Borehole							
(GWL @ 3.88m-Sept. 27/11)							



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SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

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FILE NO. **PG2450**

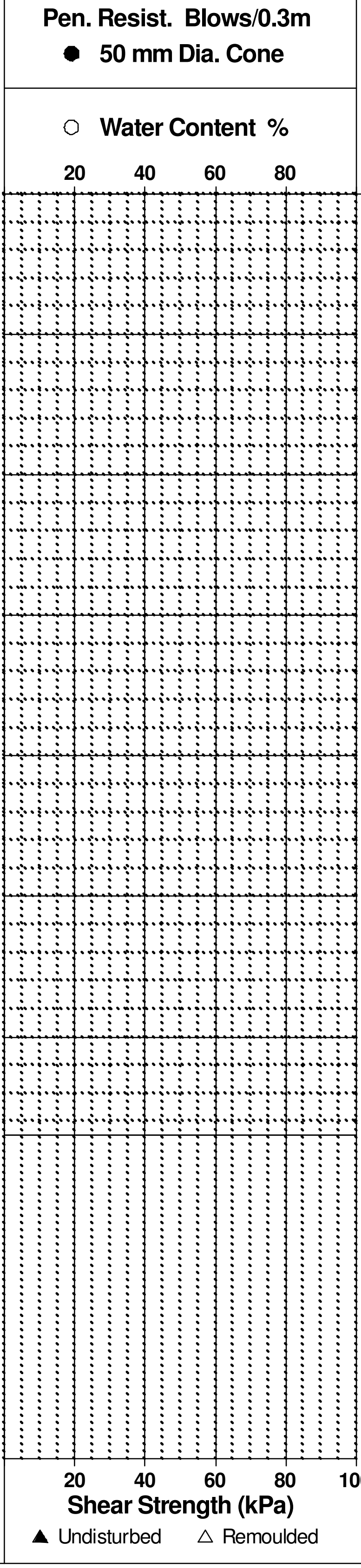
REMARKS

HOLE NO. **BH23-11**

BORINGS BY CME 55 Power Auger

DATE 19 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE					0	111.75	
TOPSOIL 0.20							
Compact to loose, brown **SILTY FINE SAND,** trace clay	AU	1					
	SS	2	8	13	1	110.75	
	SS	3	8	4	2	109.75	
2.21							
Stiff, brown **SILTY CLAY,** trace clay - firm and grey by 3.0m depth	SS	4	25	2			
					3	108.75	∇
	SS	5	83	2			
3.73							
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	6	75	1	4	107.75	
	SS	7	17	1	5	106.75	
	SS	8	83	P	6	105.75	
	SS	9	67	P			
6.70							
End of Borehole (GWL @ 3.0m depth based on field observations)							



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REMARKS

BORINGS BY CME 55 Power Auger

DATE 20 September 2011

FILE NO. PG2450

HOLE NO. BH24-11

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	112.03
TOPSOIL 0.15	AU	1				
Stiff, brown **SILTY CLAY** with sand	SS	2	12	7	1	111.03
	SS	3	8	4		
2.21					2	110.03
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	4	75	2		
					3	109.03
	SS	5	100	W		
	SS	6	83	W	4	108.03
	SS	7	75	1		
					5	107.03
	SS	8	50	W		
					6	106.03
	SS	9	50	W		
6.70						
End of Borehole (GWL @ 2.4m depth based on field observations)						

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction
∇

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FILE NO. **PG2450**

REMARKS

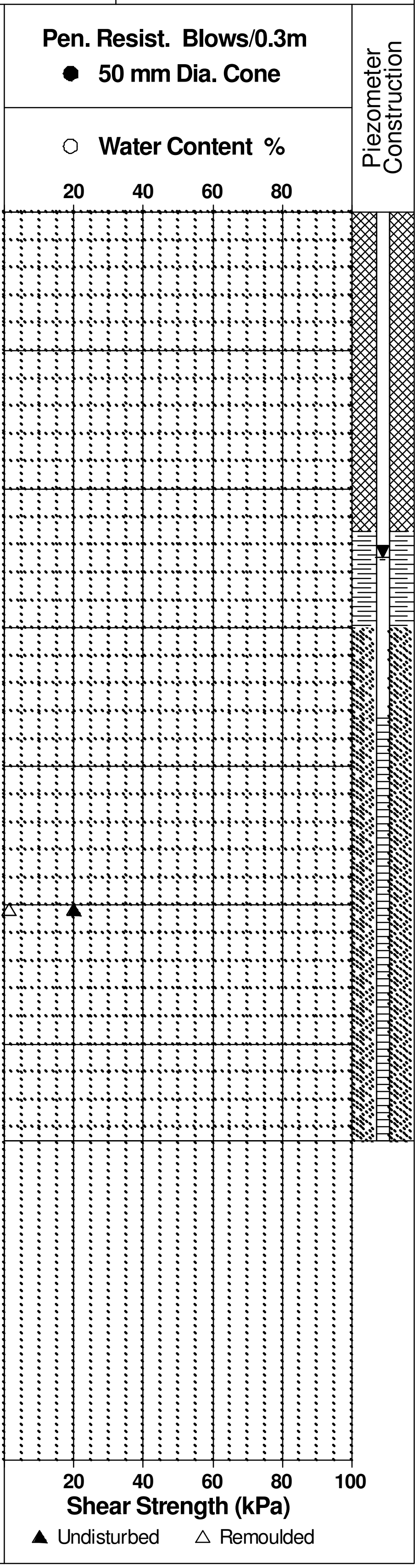
HOLE NO. **BH25-11**

BORINGS BY CME 55 Power Auger

DATE 20 September 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.20	AU	1		
Loose, brown **SILTY FINE SAND** 1.45	SS	2	12	5
Stiff, brown **SILTY CLAY** with sand - firm and grey by 2.2m depth 2.97	SS	3	50	2
	SS	4	75	1
Firm, grey **CLAYEY SILT** to **SILTY CLAY**	SS	5	83	W
	SS	6	83	W
	SS	7	83	P
6.70	SS	8	83	P
End of Borehole (GWL @ 2.49m-Sept. 27/11)				

DEPTH (m)	ELEV. (m)
0	112.02
1	111.02
2	110.02
3	109.02
4	108.02
5	107.02
6	106.02



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SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

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FILE NO. PG2450

REMARKS

HOLE NO. BH26-11

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE					0	113.14	
25mm Asphaltic concrete **FILL:** Crushed stone — 0.60	AU	1					
FILL: Brown silty sand, trace crushed stone — 1.22	SS	2	50	9	1	112.14	
FILL: Brown silty clay, trace sand and organics — 1.45							
Compact, brown **SILTY SAND,** some clay	SS	3	42	10			⊻
- grey and fine by 2.2m depth	SS	4	50	13	2	111.14	
End of Borehole — 2.97							

(GWL @ 1.8m depth based on field observations)

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone
○ Water Content %
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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FILE NO. **PG2450**

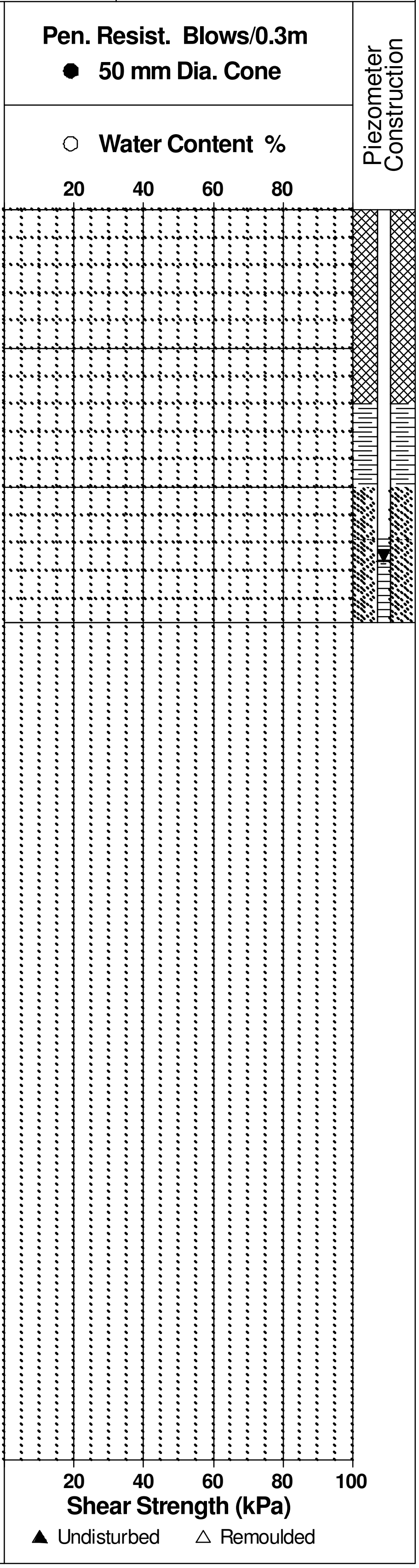
REMARKS

HOLE NO. **BH27-11**

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	112.83
25mm Asphaltic concrete over crushed stone with some sand	AU	1				
0.60						
Loose to compact, brown **SILTY FINE SAND**	SS	2	58	9	1	111.83
- trace clay from 0.6 to 1.4m depth	SS	3	42	19	2	110.83
- grey by 2.2m depth	SS	4	50			
2.97						
End of Borehole (GWL @ 2.53m-Sept. 21/11)						



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

HOLE NO. **BH28-11**

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	113.49		
25mm Asphaltic concrete over brown silty sand with crushed stone 0.46		AU	1						
		SS	2	58	15	1	112.49		
Compact, brown **SILTY FINE SAND**									
		SS	3	67	23				
						2	111.49		⊽
- grey by 2.2m depth									
2.90		SS	4	58	11				
End of Borehole (GWL @ 2.1m depth based on field observations)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

HOLE NO. **BH29-11**

BORINGS BY CME 55 Power Auger **DATE** 19 August 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	112.93		
FILL: Crushed stone with silty sand 0.60		AU	1						
FILL: Brown silty sand, trace clay and gravel 1.22		SS	2	17	5	1	111.93		
Compact, brown **SILTY FINE SAND** - trace clay from 1.2 to 2.2m depth		SS	3	67	11	2	110.93		▽
- loose and grey by 2.2m depth 2.97		SS	4	50	7				
End of Borehole (GWL @ 1.8m depth based on field observations)									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

HOLE NO. **BH30-11**

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	112.00		
FILL: Crushed stone 0.60		AU	1						
Compact, red-brown **SILTY FINE SAND**		SS	2	33	19	1	111.00		
- brown by 1.4m depth		SS	3	67	16	2	110.00		▽
- trace clay by 2.2m depth 2.97		SS	4	50	11				
End of Borehole (GWL @ 1.8m depth based on field observations)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

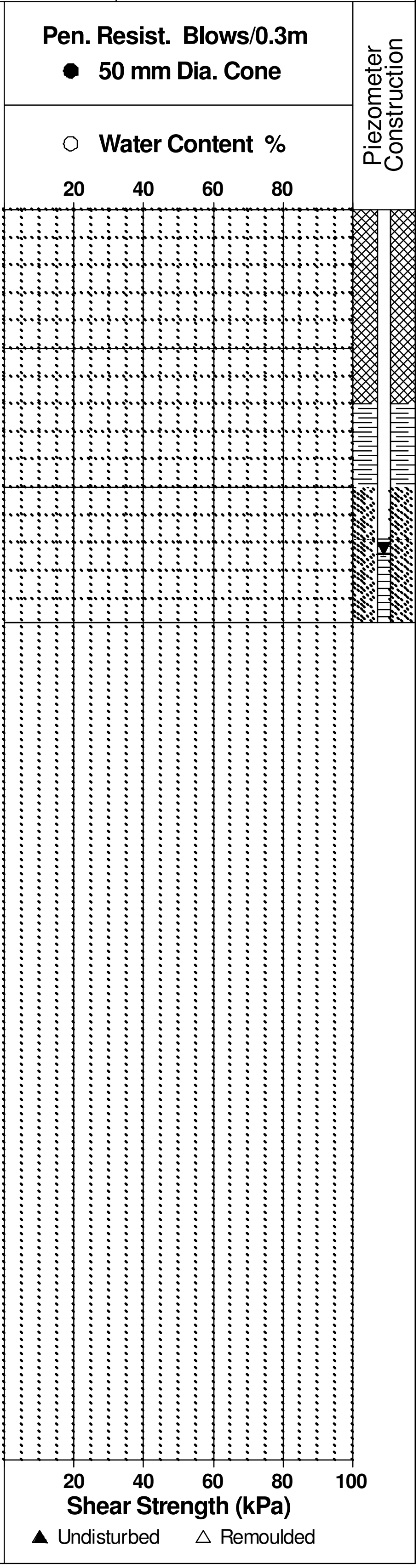
REMARKS

HOLE NO. **BH31-11**

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	110.88
FILL: Brown silty sand with crushed stone (0.56)	AU	1				
Compact to loose, red-brown **SILTY FINE SAND** - brown with trace to some clay by 1.4m depth	SS	2	67	22	1	109.88
	SS	3	75	15	2	108.88
(2.97)	SS	4	75	4		
End of Borehole (GWL @ 2.48m-Sept. 21/11)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

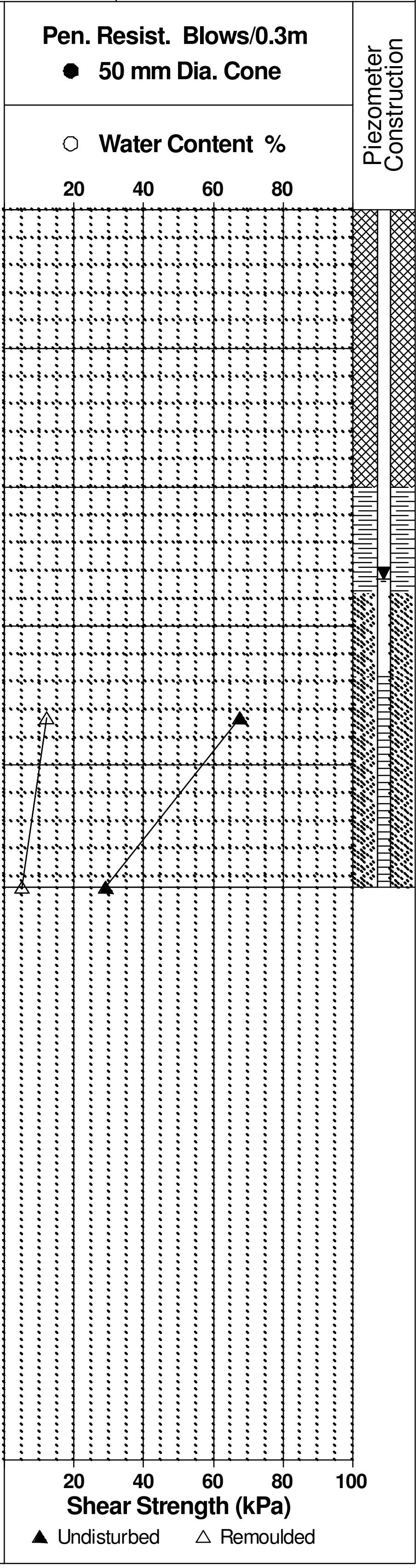
REMARKS

HOLE NO. **BH32-11**

BORINGS BY CME 55 Power Auger

DATE 20 September 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	110.29
TOPSOIL 0.25		SS	1	83	14		
Stiff, brown **SILTY CLAY** with sand		SS	2	100	9	1	109.29
		SS	3	0	5	2	108.29
		SS	4	100	4	3	107.29
- firm and grey by 3.7m depth		SS	5	42	1	4	106.29
4.88							
End of Borehole (GWL @ 2.66m-Sept. 27/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. PG2450

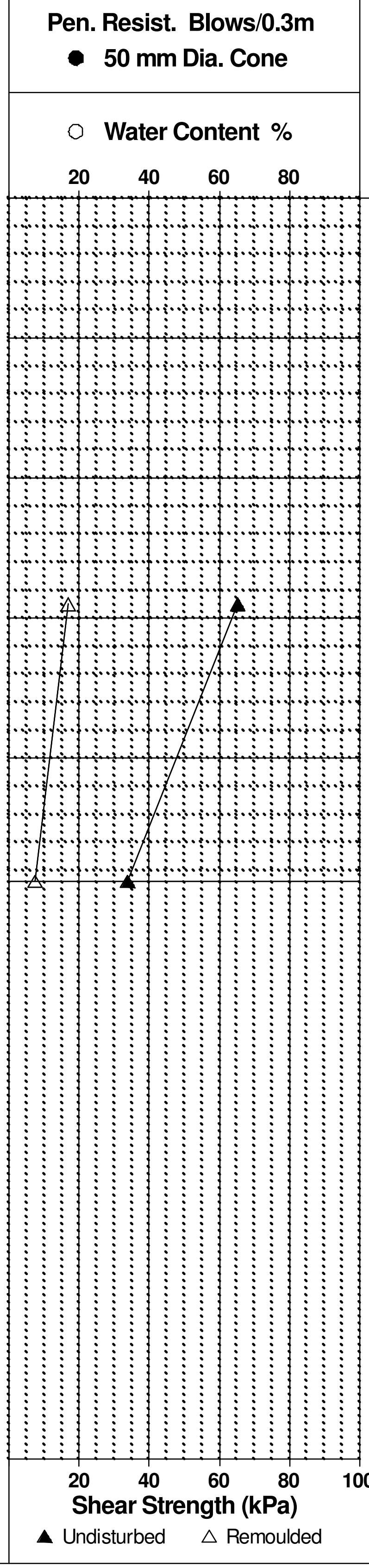
REMARKS

HOLE NO. BH33-11

BORINGS BY CME 55 Power Auger

DATE 15 September 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	108.46	
TOPSOIL 0.25	■							
	▨	SS	1	12	9			
	▨					1	107.46	
	▨	SS	2	50	9			
	▨	SS	3	42	3			
Stiff, brown **SILTY CLAY,** some sand	▨					2	106.46	
- firm and grey by 3.0m depth	▨					3	105.46	⊽
	▨	SS	4	50	4			
	▨					4	104.46	
4.88	▨	SS	5	100	2			
End of Borehole (GWL @ 3.0m depth based on field observations)								



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

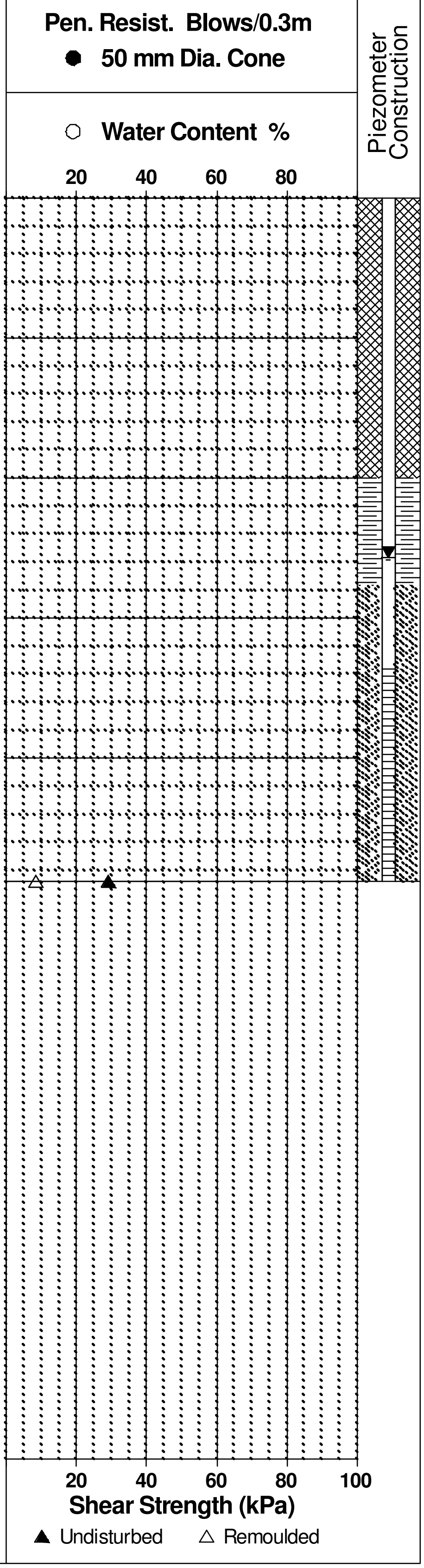
BORINGS BY CME 55 Power Auger

DATE 15 August 2011

FILE NO. PG2450

HOLE NO. BH34-11

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	105.16
TOPSOIL 0.25	SS	1	42	7		
Stiff, brown **SILTY CLAY,** some sand	SS	2	25	5	1	104.16
	SS	3	42	6	2	103.16
	SS	4	58	7	3	102.16
3.65	SS	5	25	4		
Firm, grey **SILTY CLAY**	SS	6	100	1	4	101.16
4.88						
End of Borehole (GWL @ 2.57m-Sept. 27/11)						



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. PG2450

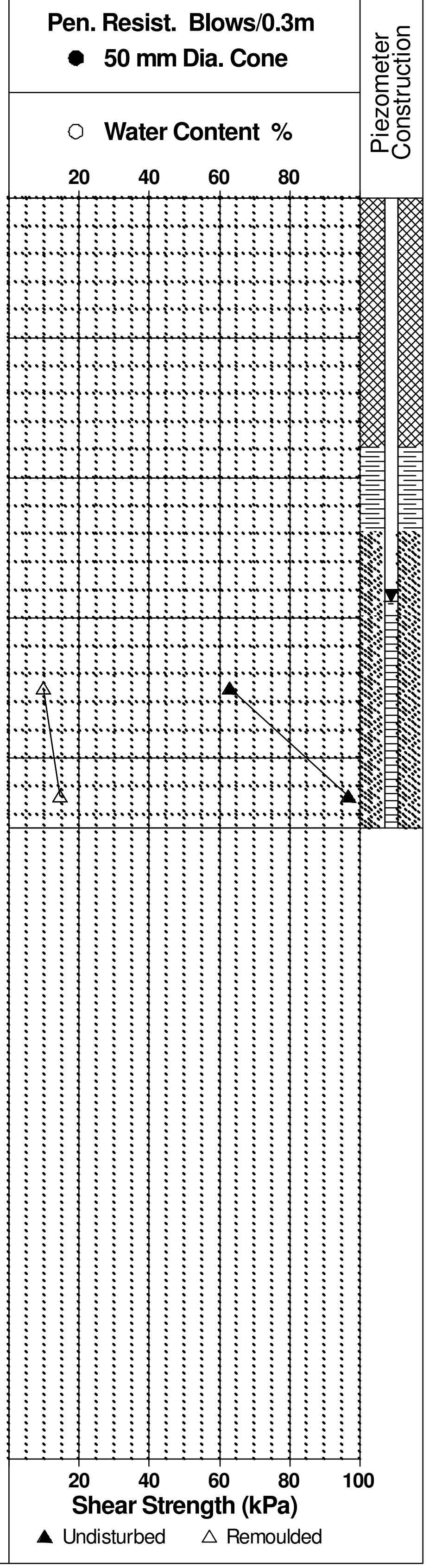
REMARKS

HOLE NO. BH35-11

BORINGS BY CME 55 Power Auger

DATE 19 August 2011

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	100.78
Asphaltic concrete 0.08							
FILL: Brown silty sand with crushed stone 0.59		AU	1				
FILL: Brown silty sand with crushed stone, trace clay 1.45		SS	2	25	20	1	99.78
Stiff, brown **SILTY CLAY,** trace sand - grey by 3.0m depth 4.50		SS	3	50	5	2	98.78
		SS	4	100	1		
						3	97.78
						4	96.78
End of Borehole (GWL @ 2.88m-Sept. 21/11)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

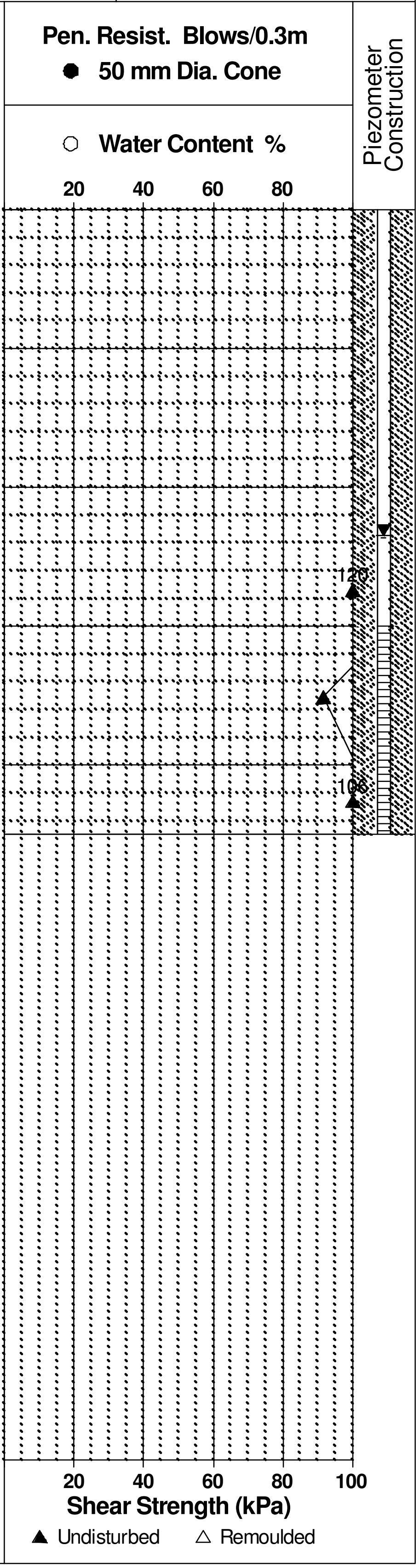
HOLE NO. **BH36-11**

BORINGS BY CME 55 Power Auger

DATE 25 August 2011

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
Asphaltic concrete	0.08				
FILL: Crushed stone	0.91	AU	1		
FILL: Brown silty sand, some gravel, trace clay	1.45	SS	2	17	9
Very stiff, brown **SILTY CLAY**	4.50	SS	3	42	3
End of Borehole (GWL @ 2.35m-Sept. 21/11)					

DEPTH (m)	ELEV. (m)
0	98.59
1	97.59
2	96.59
3	95.59
4	94.59



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. PG2450

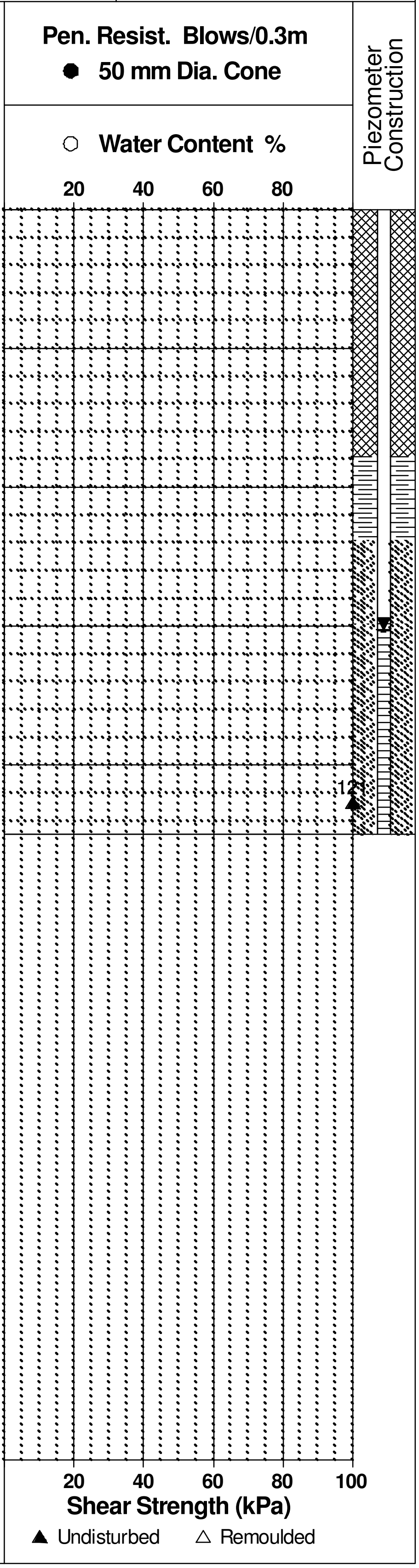
REMARKS

HOLE NO. BH37-11

BORINGS BY CME 55 Power Auger

DATE 18 August 2011

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	95.63
FILL: Crushed stone 0.15						
FILL: Brown silty sand with crushed stone 0.60	AU	1				
FILL: Brown silty clay with sand, trace gravel and organics 1.45	SS	2	42	10	1	94.63
Very stiff to stiff, brown **SILTY CLAY** 4.50	SS	3	75	7	2	93.63
	SS	4	100	8	3	92.63
	SS	5	100	7	4	91.63
End of Borehole (GWL @ 3.02m-Sept. 21/11)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

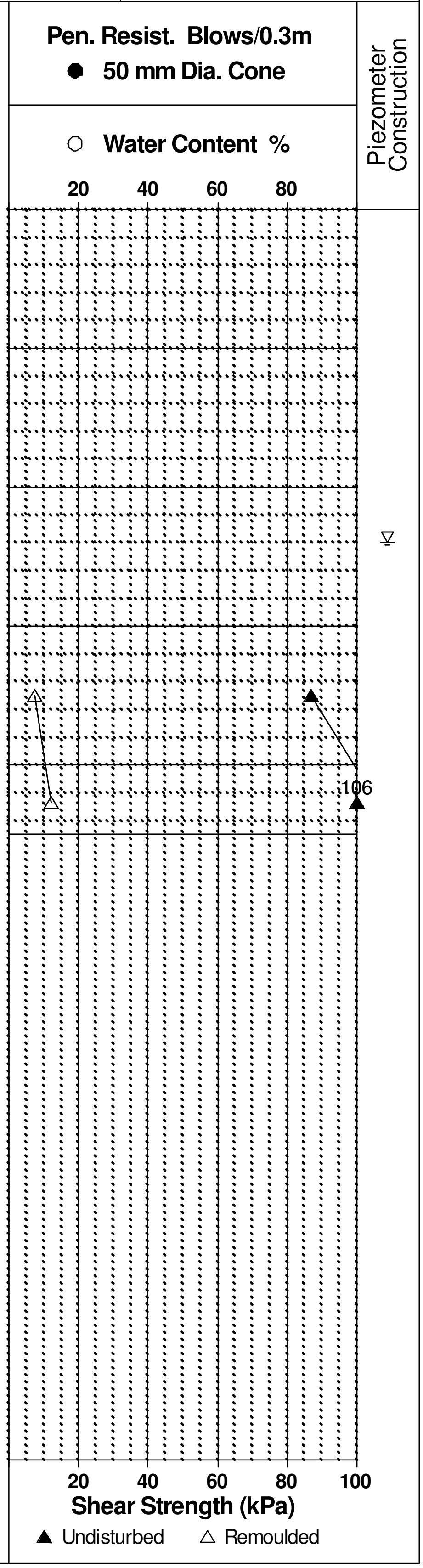
REMARKS

HOLE NO. **BH38-11**

BORINGS BY CME 55 Power Auger

DATE 18 August 2011

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	93.03
FILL: Crushed stone 0.20	AU	1				
TOPSOIL 0.36						
	SS	2	67	12	1	92.03
	SS	3	100	9	2	91.03
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.0m depth	SS	4	100	3		
					3	90.03
4.50					4	89.03
End of Borehole (GWL @ 2.4m depth based on field observations)						



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

REMARKS

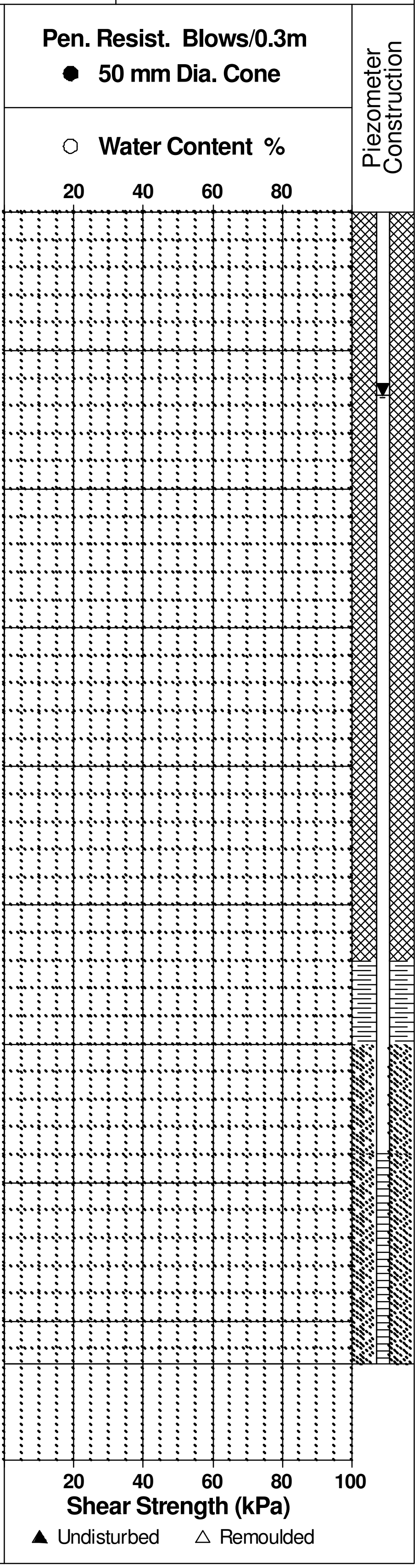
HOLE NO. **BH39-11**

BORINGS BY CME 55 Power Auger **DATE** 18 August 2011

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
FILL: Crushed stone	0.15
FILL: Brown silty sand, some crushed stone	1.45
FILL: Brown silty sand, trace clay and crushed stone	2.21
FILL: Brown silty clay with sand, some topsoil, trace gravel	2.74
Compact, grey **SILTY** fine to medium **SAND** - running sand encountered at 4.5m depth - high groundwater infiltration level observed at 4.5m depth	5.25
Dense, grey **SILTY** fine to coarse **SAND,** trace gravel	8.31
End of Borehole (GWL @ 1.32m-Sept. 21/11)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	42	9
SS	2	17	8
SS	3	8	5
SS	4	42	19
SS	5	67	13
SS	6	100	17
SS	7	50	26
SS	8	83	35
SS	9	100	41
SS	10	100	45

DEPTH (m)	ELEV. (m)
0	93.40
1	92.40
2	91.40
3	90.40
4	89.40
5	88.40
6	87.40
7	86.40
8	85.40



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 25 August 2011

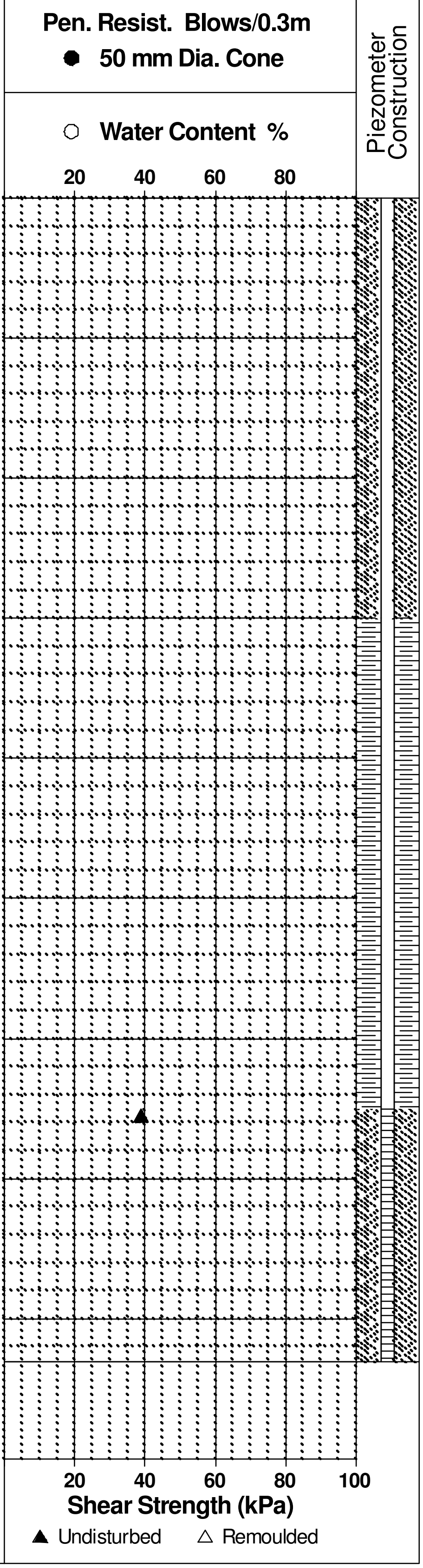
FILE NO. **PG2450**

HOLE NO. **BH40-11**

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
50mm Asphaltic concrete over crushed stone with silty sand	0.41
FILL: Brown silty sand with gravel, come clay	2.59
PEAT	5.03
Firm, grey **SILTY CLAY**	6.78
Grey **SILTY** fine to coarse **SAND** trace gravel - high groundwater infiltration level observed at 6.8m depth - running sand encountered at 6.8m depth	8.31
End of Borehole (Piezometer damaged)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	42	9
SS	3	25	5
SS	4	4	1
SS	5	50	4
SS	6	83	1
SS	7	83	2
SS	8	100	W
SS	9	83	1
SS	10	67	6

DEPTH (m)	ELEV. (m)
0	93.02
1	92.02
2	91.02
3	90.02
4	89.02
5	88.02
6	87.02
7	86.02
8	85.02



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

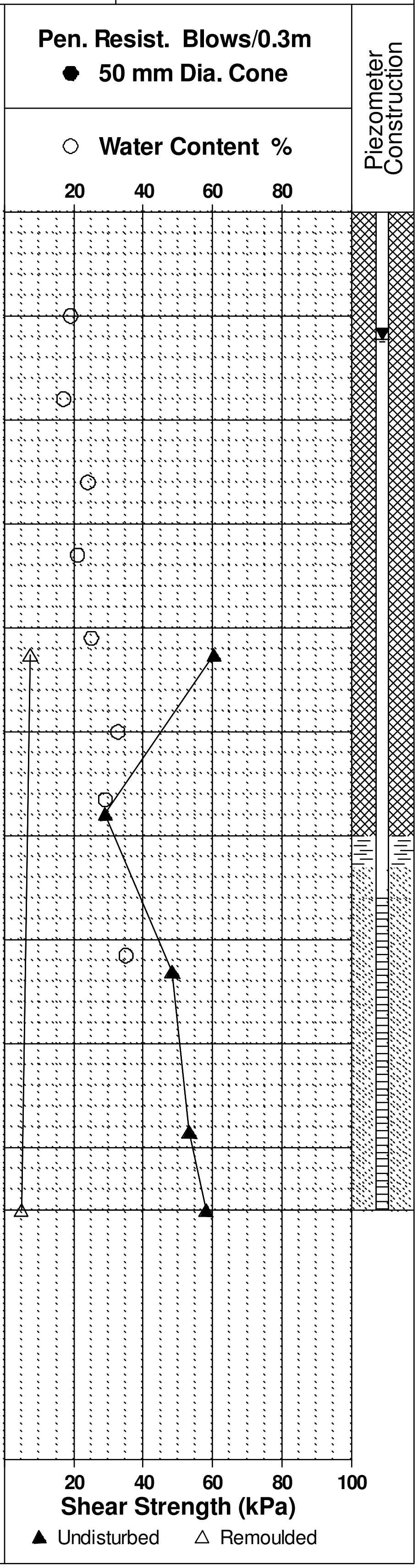
REMARKS

HOLE NO. **BH41-13**

BORINGS BY CME 55 Power Auger

DATE June 25, 2013

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
UNDERSIDE OF FOOTING						
TOPSOIL 0.30					0	116.13
Brown **SILTY SAND**	SS	1	83	10	1	115.13
-grey by 1.45m depth 2.21	SS	2	100	9	2	114.13
Grey, **SILT** to **CLAYEY SILT** 2.97	SS	3	83	2	3	113.13
Grey **CLAYEY SILT** to **SILTY CLAY**, frequent silt / sand seams	SS	4	83	7	4	112.13
	TW	5	100		5	111.13
	TW	6	75		6	110.13
	TW	7	92		7	109.13
					8	108.13
9.60					9	107.13
End of Borehole						
GWL @ 1.23m depth on July 3, 2013						



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

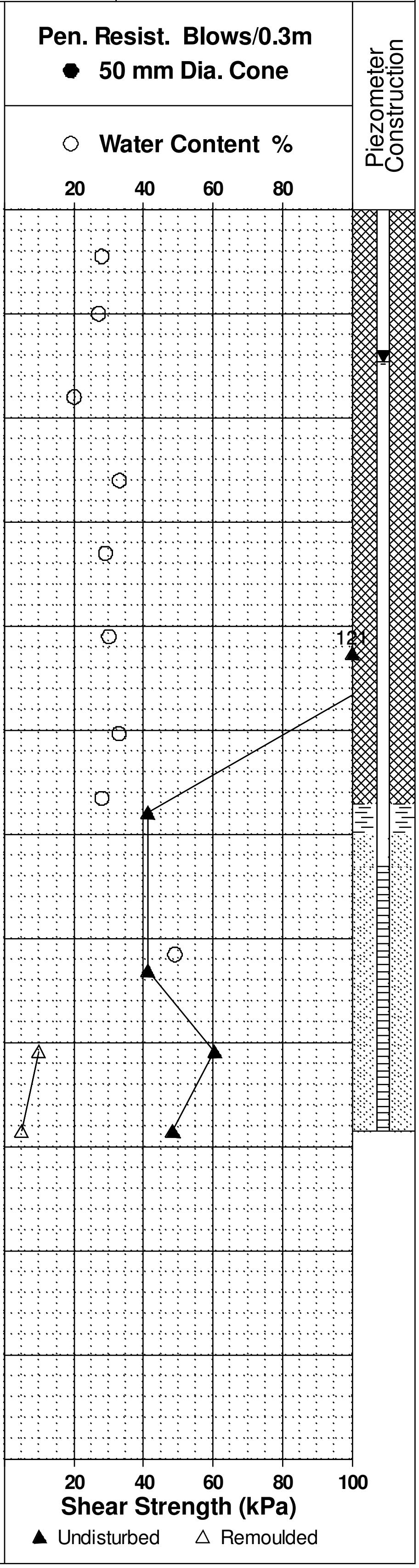
REMARKS

HOLE NO. **BH42-13**

BORINGS BY CME 55 Power Auger

DATE June 24, 2013

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
UNDERSIDE OF FOOTING						0	114.95
TOPSOIL 0.30							
		AU	1				
Compact, brown **SILTY SAND** trace clay		SS	2	83	10	1	113.95
		SS	3	100	14		
2.21						2	112.95
Grey **SILT** to **CLAYEY SILT**		SS	4	100	3		
2.97						3	111.95
		SS	5	100	W		
Grey **CLAYEY SILT** to **SILTY CLAY**, frequent silt / sand seams						4	110.95
		TW	6	92		5	109.95
						6	108.95
		TW	7	100			
						7	107.95
						8	106.95
8.84							
Start of DCPT						9	105.95
Inferred grey **CLAYEY SILT** to **SILTY CLAY**						10	104.95
						11	103.95
						12	102.95



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

FILE NO. **PG2450**

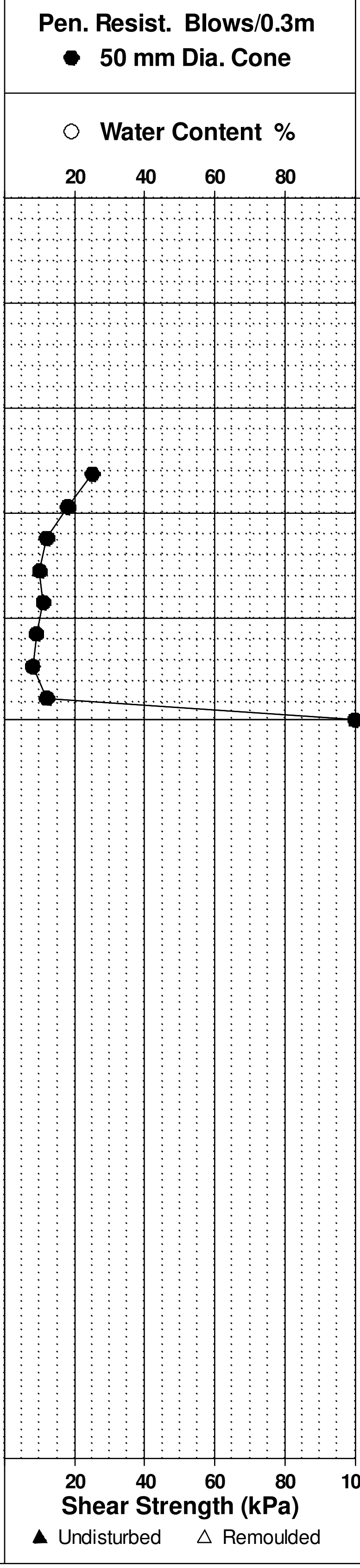
REMARKS

HOLE NO. **BH42-13**

BORINGS BY CME 55 Power Auger

DATE June 24, 2013

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			
UNDERSIDE OF FOOTING						12	102.95	
Inferred grey **CLAYEY SILT** to **SILTY CLAY**						13	101.95	
						14	100.95	
						15	99.95	
						16	98.95	
16.97								
End of Borehole Practical refusal to DCPT @ 16.97m depth GWL @ 1.46m depth on July 3, 2013								



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotehnical Investigation
Carp Airport Servicing and Residential Development
Ottawa, Ontario

DATUM Ground surface elevations provided by Novatech Engineering Consultants Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 24, 2013

FILE NO. **PG2450**

HOLE NO. **BH43-13**

SOIL DESCRIPTION	Depth to base (m)
UNDERSIDE OF FOOTING	
TOPSOIL	0.33
Loose, brown **SILTY SAND** -grey by 1.45m depth	3.73
Grey **SILT** to **CLAYEY SILT**	5.13
Grey **CLAYEY SILT** to **SILTY CLAY**, frequent silt / sand seams	8.84

End of Borehole

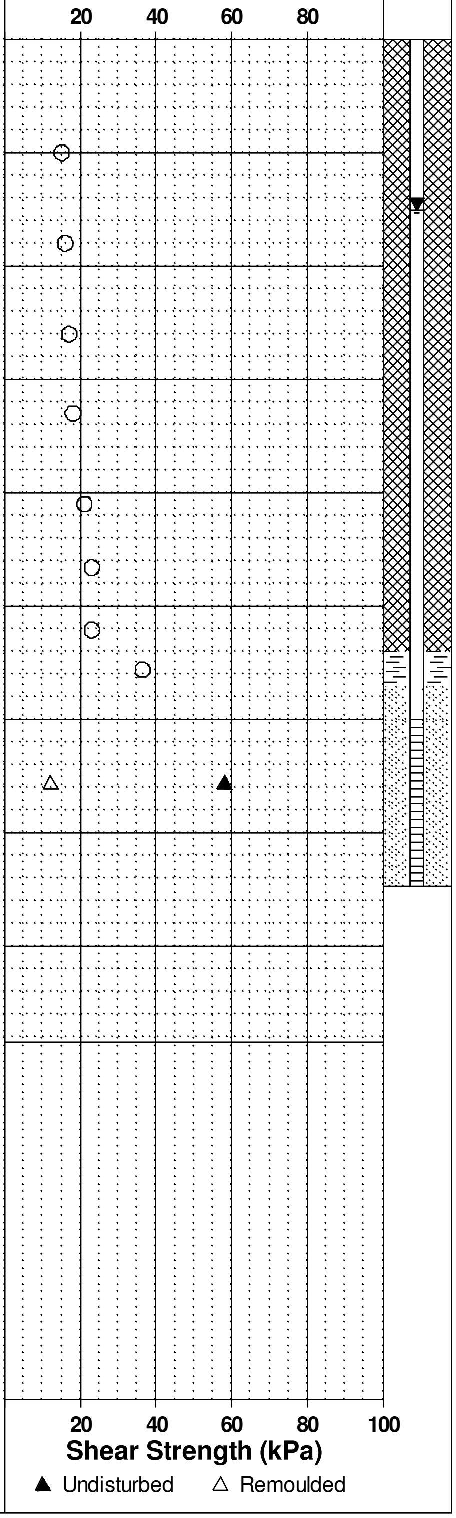
GWL @ 1.51m depth on July 3, 2013

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	83	6
SS	2	83	7
SS	3	100	14
SS	4	100	10
SS	5	100	6
SS	6	100	3
TW	7	100	
TW	8	0	

DEPTH (m)	ELEV. (m)
0	116.80
1	115.80
2	114.80
3	113.80
4	112.80
5	111.80
6	110.80
7	109.80
8	108.80

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %



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28 Concourse Gate, Unit 1, Ottawa, ON K2E 7T7

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Residential/Business Park Development, Carp Airport
Ottawa, Ontario

DATUM Geodetic, as provided by Novatech Engineering Consultants Ltd.

FILE NO. PG0739

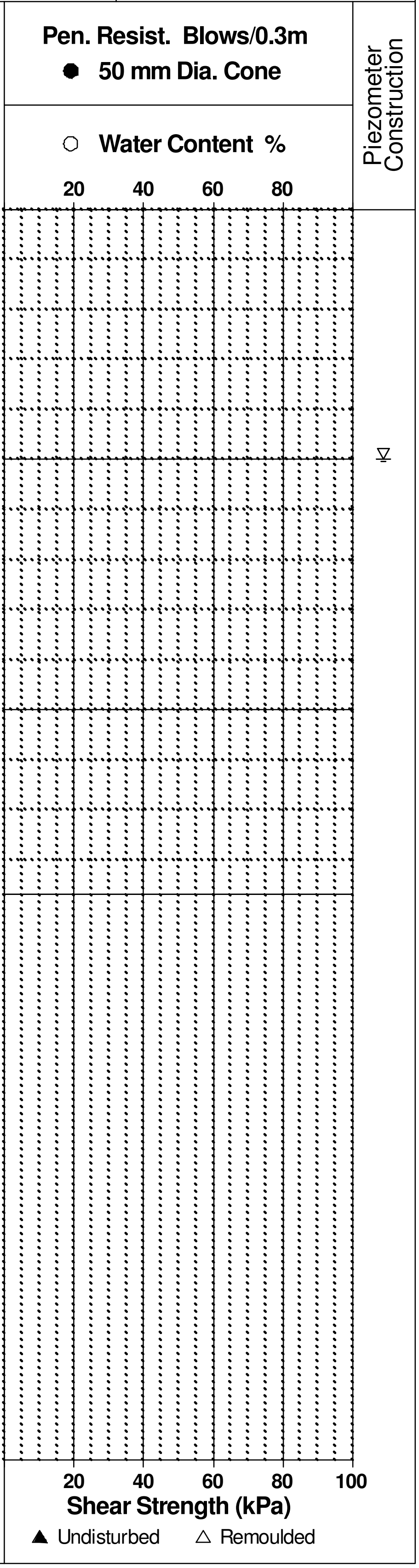
REMARKS

HOLE NO. TP 1

BORINGS BY Backhoe

DATE 8 Dec 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	114.30
TOPSOIL (to 0.15)	■						
Compact, brown medium **SAND** (0.15 to 0.41)	⁘	G	1				
Compact, grey fine to medium **SAND** with seashells (0.41 to 1.02)	⁘	G	2			1	113.30
Very loose, brown medium to coarse **SAND** with gravel and cobbles (1.02 to 2.74)	⁘	G	3			2	112.30
End of Test Pit (2.74) (Water infiltration @ 1.0m depth)							



SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Residential/Business Park Development, Carp Airport
Ottawa, Ontario

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REMARKS

BORINGS BY Backhoe

DATE 8 Dec 05

FILE NO. PG0739

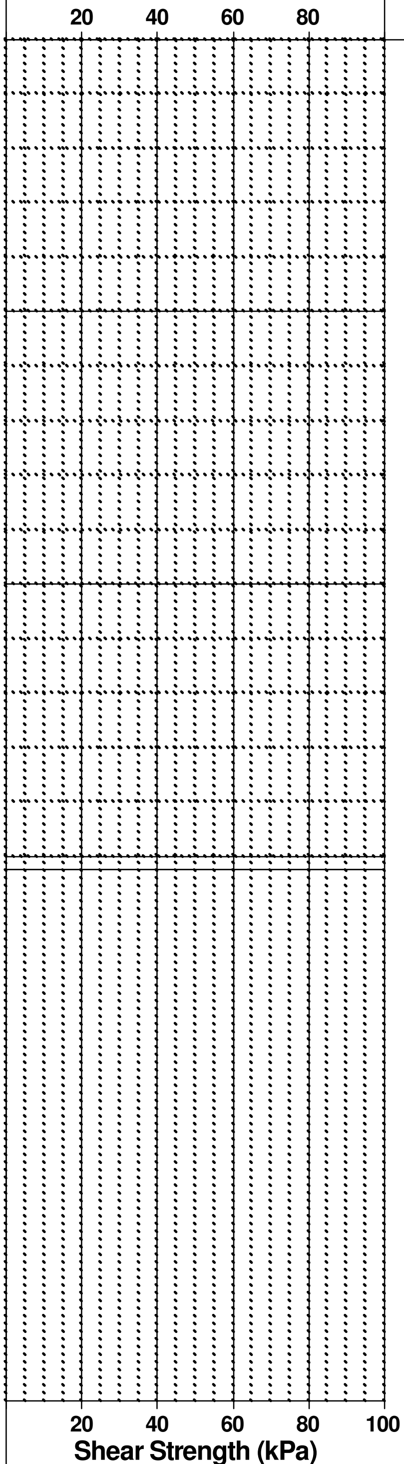
HOLE NO. TP 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	111.50
TOPSOIL 0.38							
Compact, mottled brown and grey **SILTY** fine **SAND**							
- grey by 1.1m depth		G	1			1	110.50
- seashells and occasional gravel and cobbles by 1.7m depth						2	109.50
2.74		G	2				
Loose to compact, dark grey **SANDY SILT/SILTY** fine **SAND** with seashells 3.05						3	108.50
End of Test pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

Piezometer Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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REMARKS

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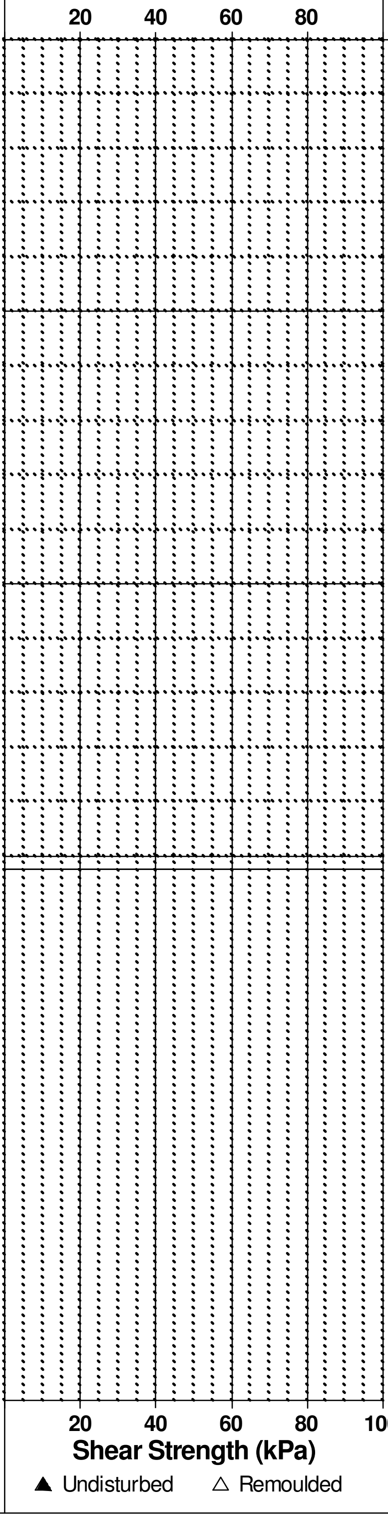
DATE 8 Dec 05

FILE NO. PG0739

HOLE NO. TP 3

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	108.15
TOPSOIL							
0.36							
Compact, mottled brown and grey **SILTY** fine **SAND/SANDY SILT**, trace clay		G	1				
- compact to dense and grey with seashells by 0.9m depth		G	2			1	107.15
- compact, trace seashells by 1.8m depth						2	106.15
2.74							
Loose, grey **SANDY SILT** with clay		G	3			3	105.15
3.04							
End of Test Pit (TP dry upon completion)							



Piezometer Construction

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FILE NO. **PG0739**

REMARKS

HOLE NO. **TP 4**

BORINGS BY Backhoe

DATE 8 Dec 05

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	108.15	
TOPSOIL 0.23								
Compact, mottled brown and grey **SILTY** fine **SAND/SANDY SILT** with clay		G	1					
						1	107.15	
- compact to dense by 1.1m depth								▽
		G	2					
- some seashells by 1.5m depth								
						2	106.15	
- grey by 2.7m depth		G	3					
3.05						3	105.15	
Loose, dark grey **SANDY SILT** with clay 3.81								
End of Test Pit (Slow water infiltration @ 1.4m depth)								

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ **Water Content %**
20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

SOIL PROFILE AND TEST DATA

Preliminary Geotechnical Investigation
Residential/Business Park Development, Carp Airport
Ottawa, Ontario

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REMARKS

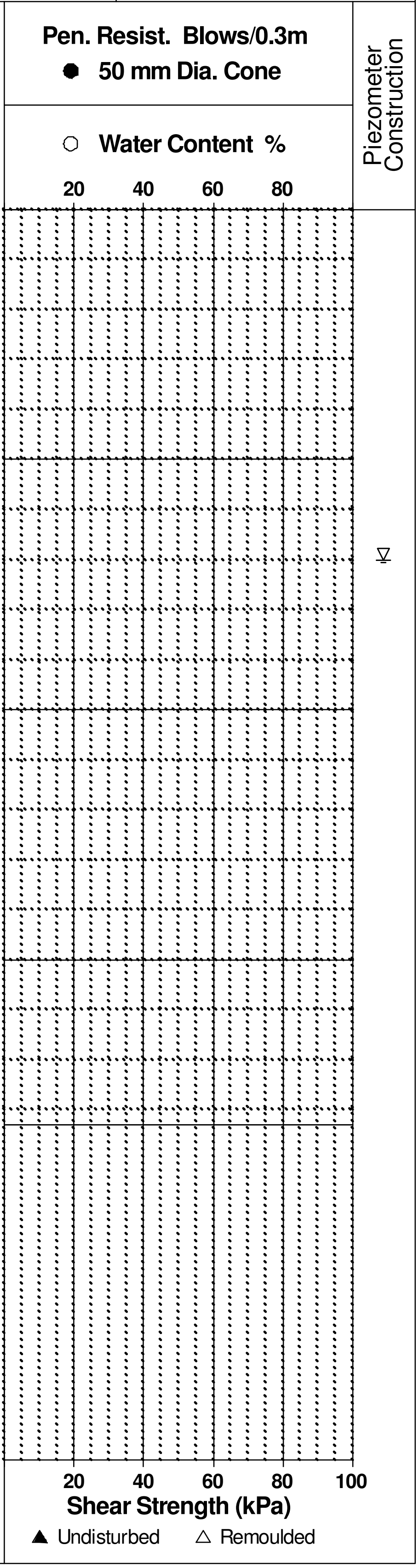
BORINGS BY Backhoe

DATE 8 Dec 05

FILE NO. PG0739

HOLE NO. TP 6

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	110.65
TOPSOIL 0.56	■						
Stiff, mottled brown and grey **SILTY CLAY** with sand - grey by 0.9m depth	▨						
	▨	G	1			1	109.65
- firm by 1.8m depth	▨					2	108.65
	▨					3	107.65
3.66	▨	G	2				
End of Test Pit (Moderate water infiltration @ 1.4m depth)							



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REMARKS

BORINGS BY Backhoe

DATE 8 Dec 05

FILE NO. PG0739

HOLE NO. TP 7

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	114.36
TOPSOIL 0.30						
Compact, mottled brown and grey **SILTY** fine **SAND/SANDY SILT** with clay - grey by 0.8m depth - compact to dense by 1.1m depth	G	1			1	113.36
- some seashells by 2.0m depth					2	112.36
2.44						
Soft, grey stratified layer of **SILTY CLAY, SILTY** fine **SAND** and **SILT**	G	2			3	111.36
3.66						
End of Test Pit (Slow water infiltration @ 1.1m depth)						

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

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REMARKS

BORINGS BY Backhoe

DATE 8 Dec 05

FILE NO. PG0739

HOLE NO. TP 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	116.90	
TOPSOIL 0.13								
Compact, brown medium **SAND** 0.46		G	1					
Loose, grey medium to coarse **SAND**		G	2					▽
						1	115.90	
						2	114.90	
2.74 End of Test Pit (Heavy water infiltration @ 0.8m depth)								

Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **Water Content %**

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY Backhoe

DATE 14 Dec 05

FILE NO. PG0739

HOLE NO. TP 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	116.25		
TOPSOIL 0.08									
Compact to loose, red-orange fine to medium **SAND** - grey by 0.6m depth 0.84		G	1						
Dense, grey **SILTY** fine **SAND/SANDY SILT** 3.05		G	2			1 2 3	115.25 114.25 113.25		∇
Soft, grey stratified layers of **SILTY CLAY, SILTY** fine **SAND** and **SILT** 3.66									
End of Test Pit (Slow water infiltration @ 1.1m depth)									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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REMARKS

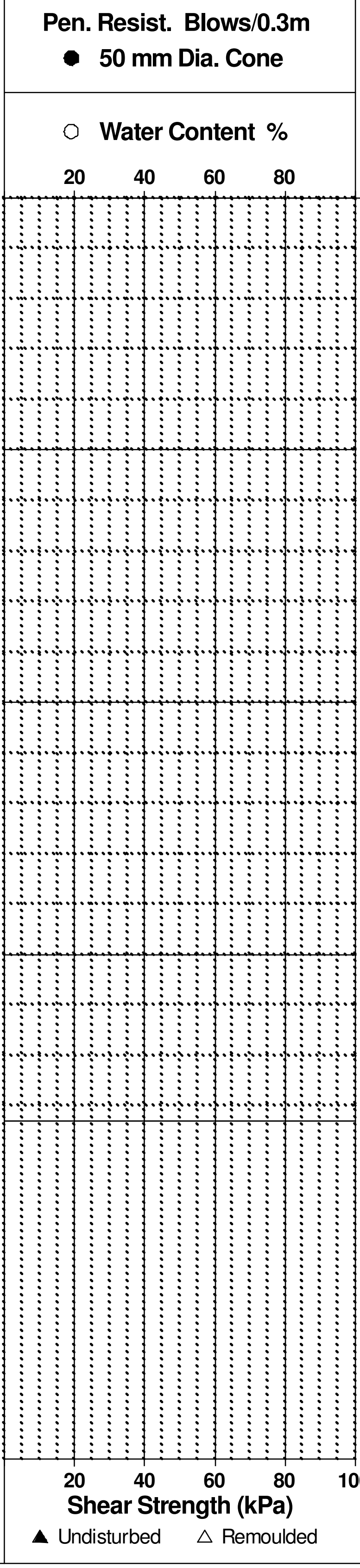
BORINGS BY Backhoe

DATE 14 Dec 05

FILE NO. PG0739

HOLE NO. TP10

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	114.60	
TOPSOIL 0.20								
Compact, brown **SILTY** fine **SAND/SANDY SILT** - grey by 0.8m depth						1	113.60	
- some clay by 1.6m depth						2	112.60	
- occasional seashells by 2.7m depth 3.05						3	111.60	
Soft, grey stratified layers of **SILTY CLAY, SILTY** fine **SAND** and **SILT** 3.66								
End of Test Pit (TP dry upon completion)								



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REMARKS

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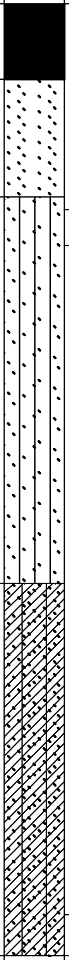
DATE 14 Dec 05

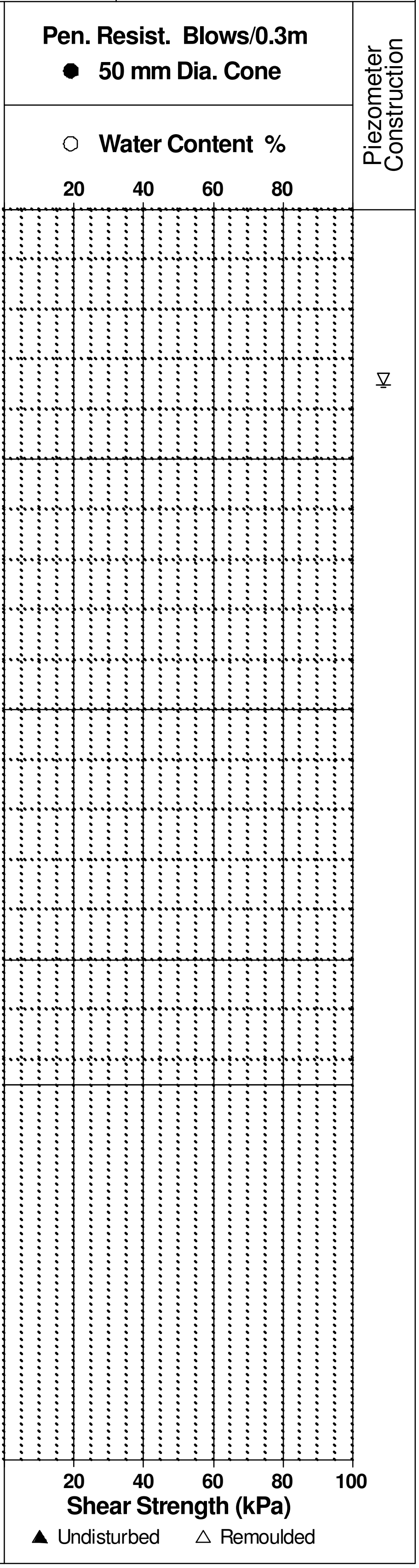
FILE NO. PG0739

HOLE NO. TP11

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.28				
Loose to compact, brown medium **SAND**	0.71				
Compact, grey **SILTY** fine **SAND/SANDY SILT** with seashells, some clay	2.13	G	1		
Soft, grey stratified layers of **SILTY CLAY, SILTY** fine **SAND** and **SILT**	3.50	G	2		
End of Test Pit (Slow water infiltration @ 0.7m depth)					



DEPTH (m)	ELEV. (m)
0	115.75
1	114.75
2	113.75
3	112.75



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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY Backhoe

DATE 14 Dec 05

FILE NO. PG0739

HOLE NO. TP14

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content % (20 40 60 80)	Piezometer Construction
GROUND SURFACE						0	117.35		
TOPSOIL 0.24									
Loose to compact, brown medium **SAND** - grey by 0.6m depth 0.86		G	1						▽
Compact, grey **SILTY** fine to medium **SAND** with seashells		G	2			1	116.35		
						2	115.35		
- layers of sandy silty clay by 3.4m depth 3.66						3	114.35		
End of Test Pit (Slow water infiltration @ 0.9m depth)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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REMARKS

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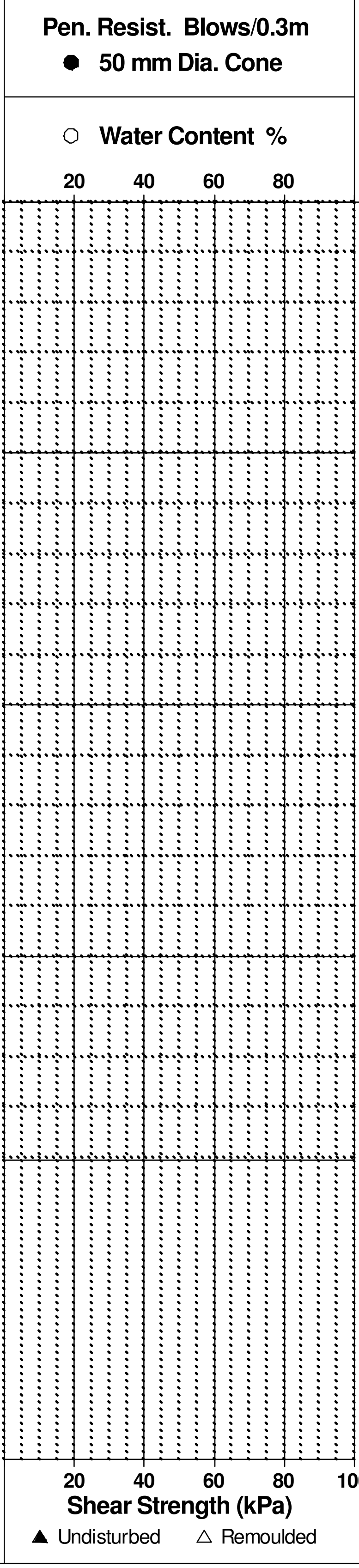
DATE 14 Dec 05

FILE NO. PG0739

HOLE NO. TP16

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	113.80	
TOPSOIL 0.22								
Compact, mottled brown and grey **SANDY SILT** with clay - grey by 0.7m depth		G	1					
						1	112.80	
						2	111.80	
2.74								
						3	110.80	
Soft, grey stratified layers of **SILTY CLAY, SILTY** fine **SAND** and **SILT**								
3.81		G	2					
End of Test Pit (TP dry upon completion)								



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REMARKS

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FILE NO. PG0739

HOLE NO. TP17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	113.60		
TOPSOIL 0.24									
Compact, brown **SILTY** fine **SAND/SANDY SILT**		G	1						
- with trace clay and grey by 0.8		G	2			1	112.60		
									▽
						2	111.60		
3.05						3	110.60		
Soft, grey, stratified **SILTY CLAY, SILT** and **SANDY SILTY CLAY**		G	3						
3.96									
End of Test Pit (Slow water infiltration @ 1.5m depth)									

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

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REMARKS

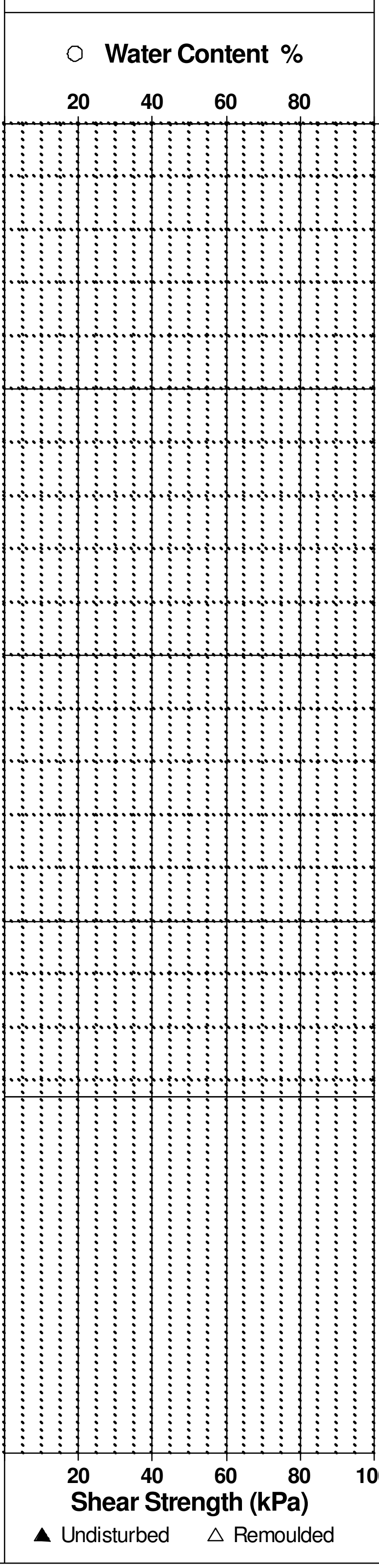
BORINGS BY Backhoe

DATE 8 Dec 05

FILE NO. PG0739

HOLE NO. TP18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	106.00
TOPSOIL 0.22							
Compact, mottled brown and grey **SILTY** fine **SAND** with clay		G	1			1	105.00
- grey by 2.0m depth						2	104.00
- some seashells by 2.4m depth						3	103.00
3.66							
End of Test Pit (TP dry upon completion)							



Piezometer Construction

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FILE NO. PG0739

HOLE NO. TP19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	104.60
TOPSOIL 0.25							
Compact, mottled brown and grey **SANDY SILT/SILTY** fine **SAND** with clay							
- grey by 0.9m depth						1	103.60
		G	1				
						2	102.60
- loose to compact by 2.4m depth							
- some seashells by 3.0m depth						3	101.60
3.35							
End of Test Pit (TP dry upon completion)							

Pen. Resist. Blows/0.3m
● 50 mm Dia. Cone

○ Water Content %

20 40 60 80

20 40 60 80 100
Shear Strength (kPa)
▲ Undisturbed △ Remoulded

Piezometer Construction

SYMBOLS AND TERMS

SOIL DESCRIPTION

Behavioural properties, such as structure and strength, take precedence over particle gradation in describing soils. Terminology describing soil structure are as follows:

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 of 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 (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

The standard terminology to describe the strength of cohesionless soils is the relative density, usually inferred from the results of the Standard Penetration Test (SPT) 'N' value. The SPT N value is the number of blows of a 63.5 kg hammer, falling 760 mm, required to drive a 51 mm O.D. split spoon sampler 300 mm into the soil after an initial penetration of 150 mm.

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 the strength of cohesive soils is the consistency, which is based on the undisturbed undrained shear strength as measured by the in situ or laboratory vane tests, penetrometer tests, unconfined compression tests, or occasionally by Standard Penetration Tests.

Consistency	Undrained Shear Strength (kPa)	'N' Value
Very Soft	<12	<2
Soft	12-25	2-4
Firm	25-50	4-8
Stiff	50-100	8-15
Very Stiff	100-200	15-30
Hard	>200	>30

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

Cohesive soils can also be classified according to their "sensitivity". The sensitivity is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil.

Terminology used for describing soil strata based upon texture, or the proportion of individual particle sizes present is provided on the Textural Soil Classification Chart at the end of this information package.

ROCK DESCRIPTION

The structural description of the bedrock mass is based on the Rock Quality Designation (RQD).

The RQD classification is based on a modified core recovery percentage in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be a result of closely-spaced discontinuities (resulting from shearing, jointing, faulting, or weathering) in the rock mass and are not counted. RQD is ideally determined from NXL size core. However, it can be used on smaller core sizes, such as BX, if the bulk of the fractures caused by drilling stresses (called "mechanical breaks") are easily distinguishable from the normal in situ fractures.

RQD %	**ROCK QUALITY**
90-100	Excellent, intact, very sound
75-90	Good, massive, moderately jointed or sound
50-75	Fair, blocky and seamy, fractured
25-50	Poor, shattered and very seamy or blocky, severely fractured
0-25	Very poor, crushed, very severely fractured

SAMPLE TYPES

SS	-	Split spoon sample (obtained in conjunction with the performing of the Standard Penetration Test (SPT))
TW	-	Thin wall tube or Shelby tube
PS	-	Piston sample
AU	-	Auger sample or bulk sample
WS	-	Wash sample
RC	-	Rock core sample (Core bit size AXT, BXL, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC% - Natural moisture content or water content of sample, %
LL - Liquid Limit, % (water content above which soil behaves as a liquid)
PL - Plastic limit, % (water content above which soil behaves plastically)
PI - Plasticity index, % (difference between LL and PL)

Dxx - Grain size which xx% of the soil, by weight, is of finer grain sizes
These grain size descriptions are not used below 0.075 mm grain size
D10 - Grain size at which 10% of the soil is finer (effective grain size)
D60 - Grain size at which 60% of the soil is finer

Cc - Concavity coefficient = $(D30)^2 / (D10 \times D60)$
Cu - Uniformity coefficient = D60 / D10

Cc and Cu are used to assess the grading of sands and gravels:
Well-graded gravels have: $1 < Cc < 3$ and $Cu > 4$
Well-graded sands have: $1 < Cc < 3$ and $Cu > 6$
Sands and gravels not meeting the above requirements are poorly-graded or uniformly-graded.
Cc and Cu are not applicable for the description of soils with more than 10% silt and clay (more than 10% finer than 0.075 mm or the #200 sieve)

CONSOLIDATION TEST

p'_o - Present effective overburden pressure at sample depth
p'_c - Preconsolidation pressure of (maximum past pressure on) sample
Ccr - Recompression index (in effect at pressures below p'_c)
Cc - Compression index (in effect at pressures above p'_c)

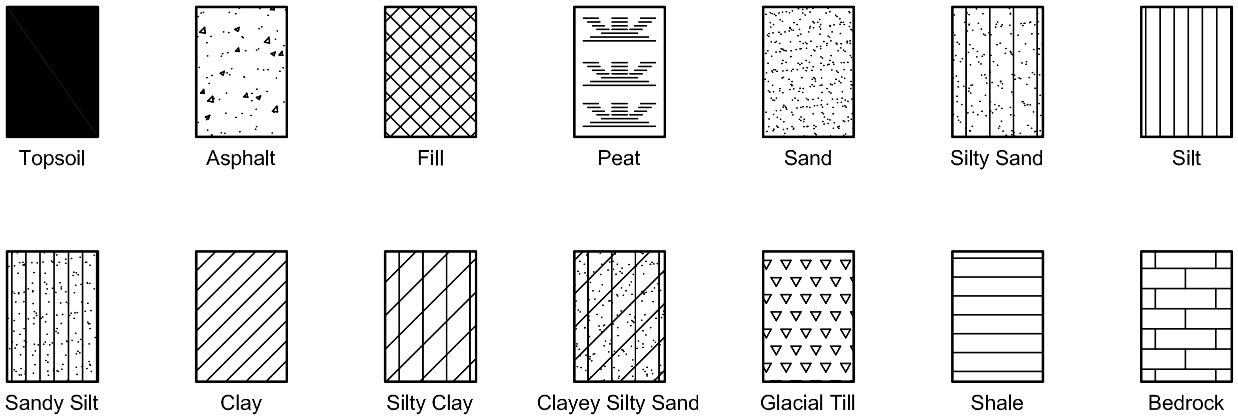
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

k - Coefficient of permeability or hydraulic conductivity is a measure of the ability of water to flow through the sample. The value of k is measured at a specified unit weight for (remoulded) cohesionless soil samples, because its value will vary with the unit weight or density of the sample during the test.

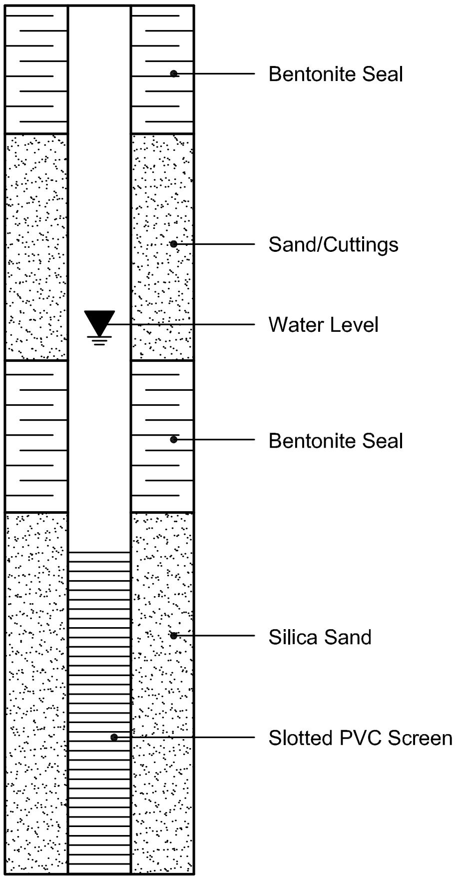
SYMBOLS AND TERMS (continued)

STRATA PLOT

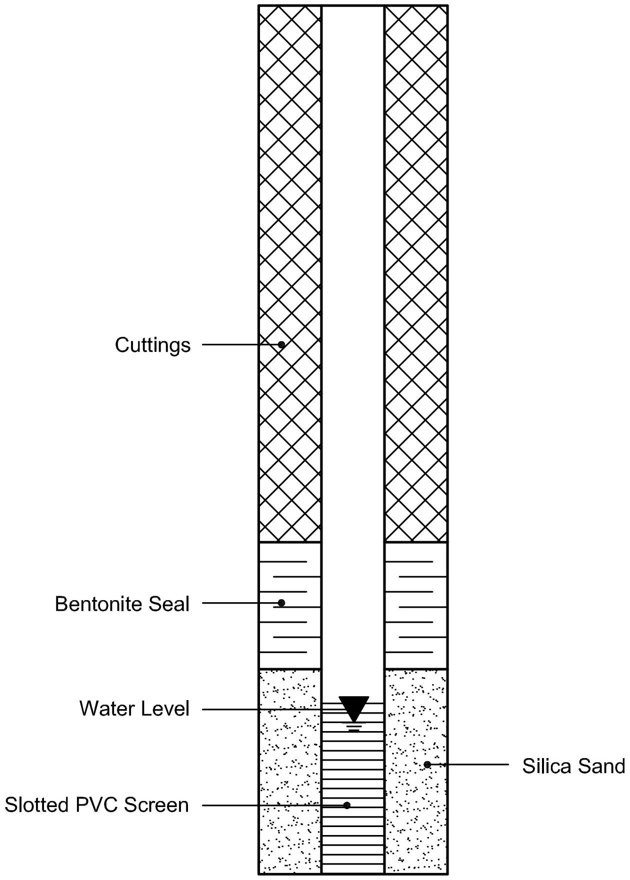


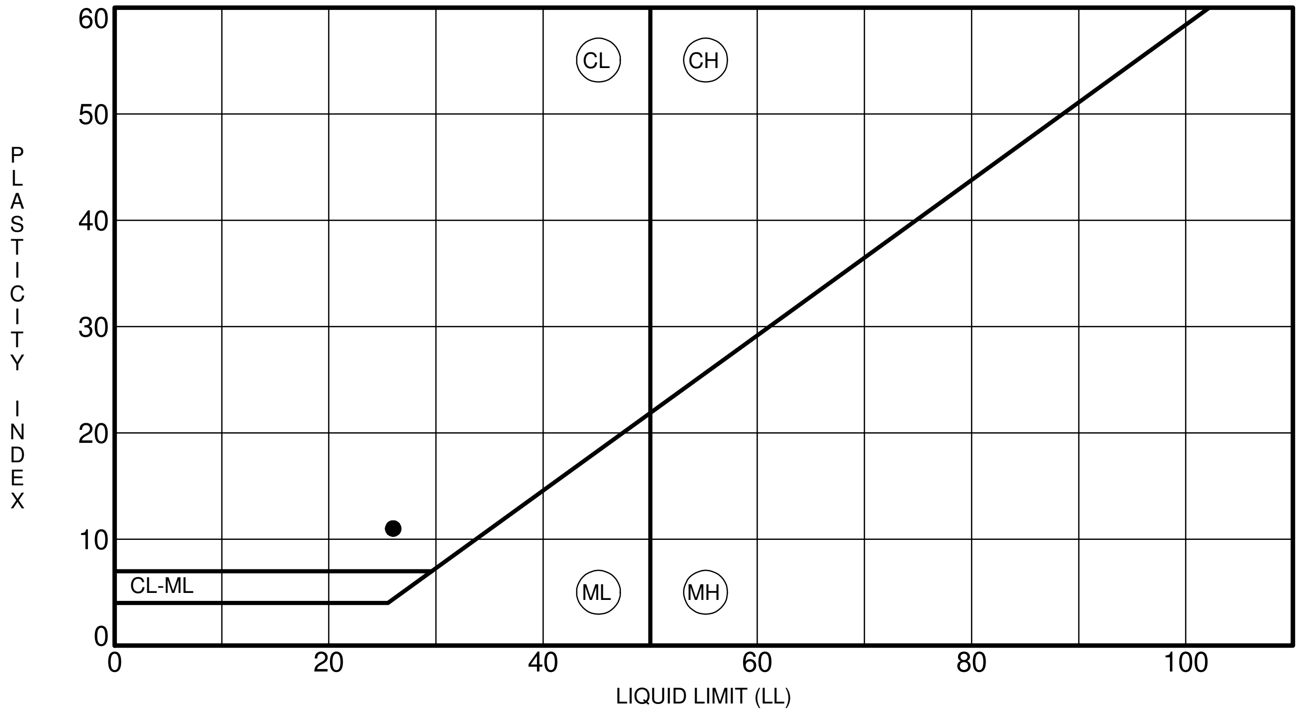
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





	Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP 1-22**	**G10**	**26**	**15**	**11**		**CL - Inorganic clay of low plasticity**

CLIENT **West Capital Development**

PROJECT **Geotechnical Investigation - Carp Airport Residential Development**

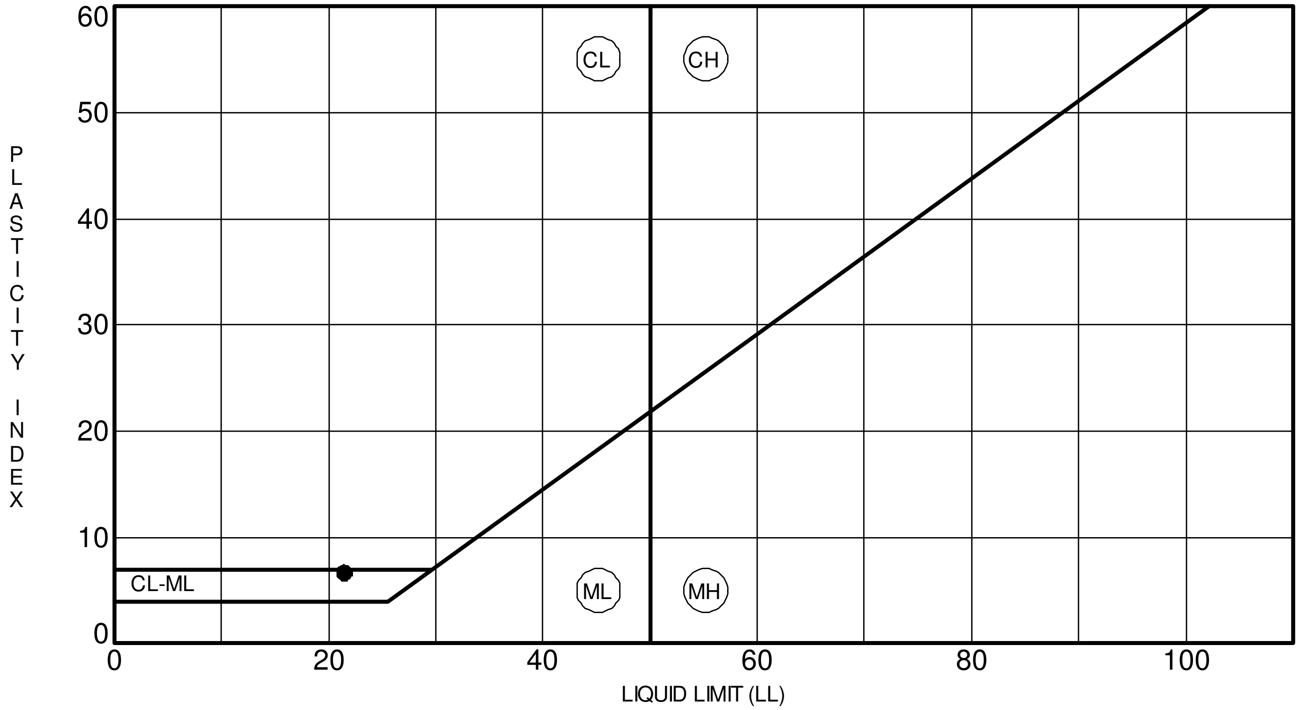
FILE NO. **PG2450**

DATE **4 Oct 22**

patersongroup **Consulting Engineers**

9 Auriga Drive, Ottawa, Ontario K2E 7T9

ATTERBERG LIMITS' RESULTS



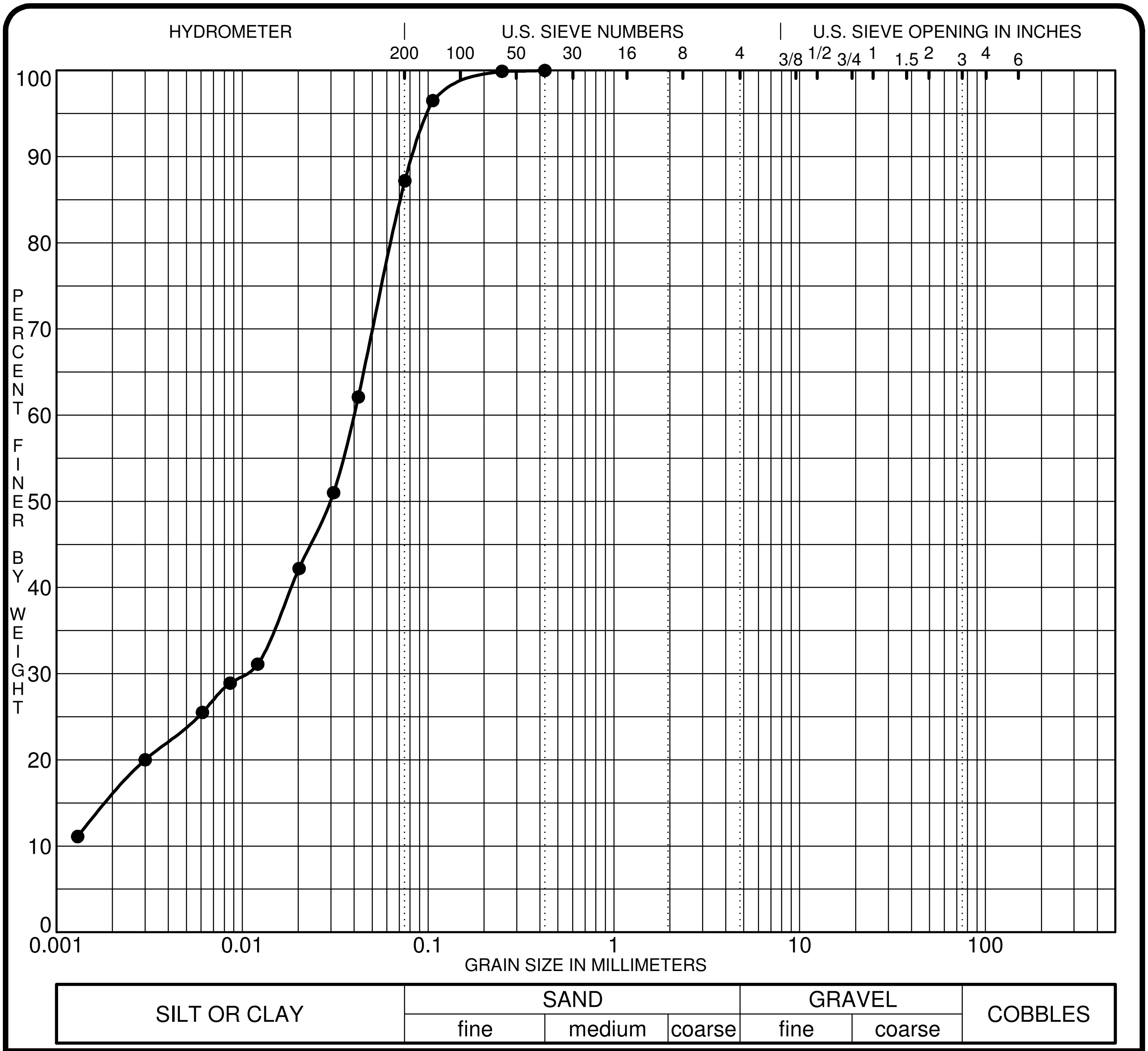
	Specimen Identification	LL	PL	PI	Fines	Classification
●	**BH41-13**	**21**	**15**	**7**		**CL - Inorganic Clays of Low Plasticity**

CLIENT	**Novatech Engineering Consultants Ltd.**	FILE NO.	**PG2450**
PROJECT	**Geotehnical Investigation - Carp Airport Servicing and Residential Development**	DATE	**25 Jun 13**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS



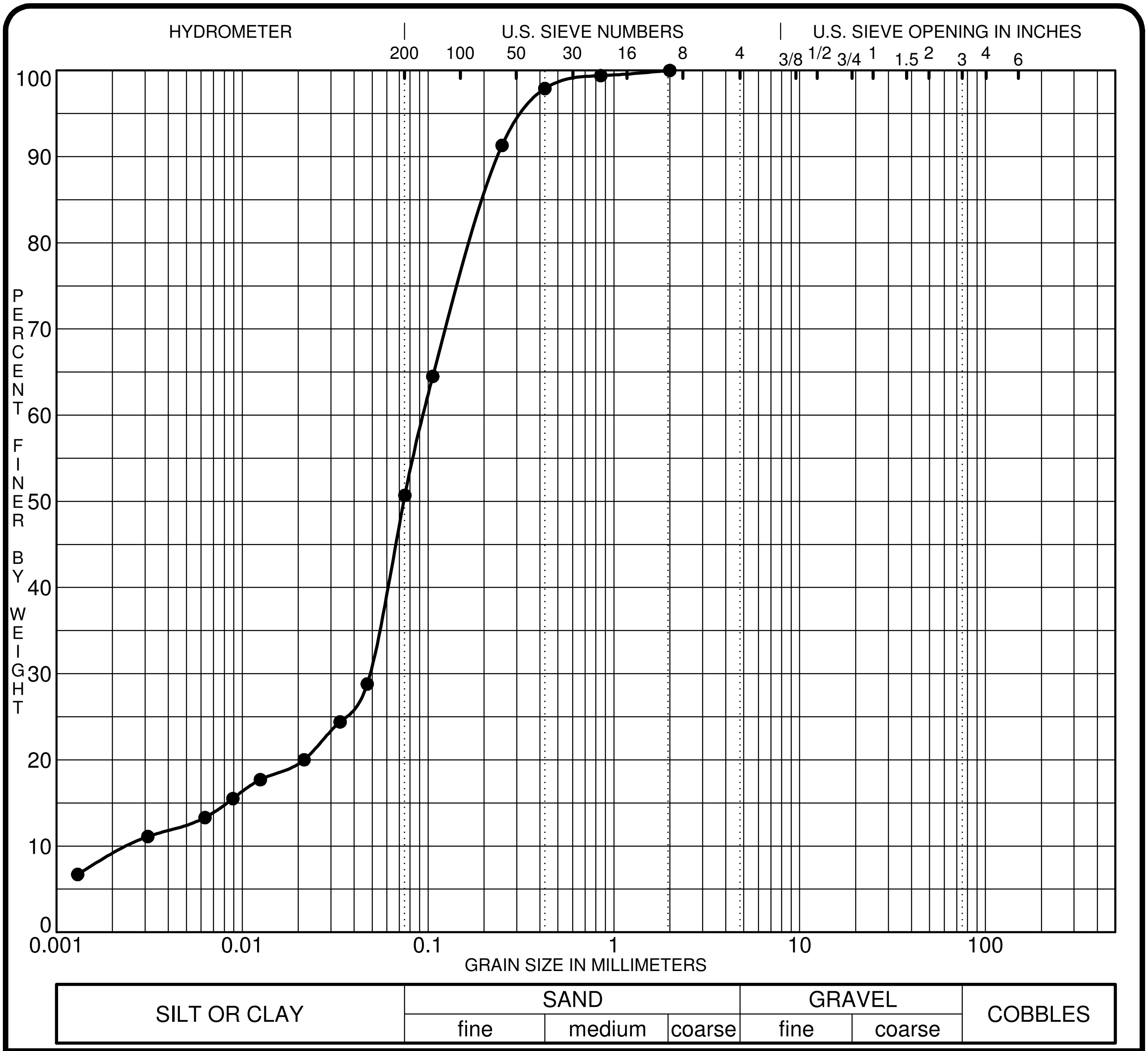
	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 3-22**	**G4**	**Silty Sand to Sandy Silt**	**22.1**					
☒									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 3-22**	**G4**	**0.43**	**0.04**	**0.010**		**0.0**	**12.8**	**71.7**	**15.5**
☒										
▲										
★										

CLIENT **West Capital Development**
FILE NO. **PG2450**
PROJECT **Geotechnical Investigation - Carp Airport**
Residential Development
DATE **4 Oct 22**

patersongroup **Consulting Engineers**
9 Auriga Drive, Ottawa, Ontario K2E 7T9

GRAIN SIZE DISTRIBUTION



	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 5-22**	**G5**	**Silty Sand to Sandy Silt**	**22.2**				**9.84**	**38.0**
⌧									
▲									
★									

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 5-22**	**G5**	**2.00**	**0.09**	**0.048**	**0.0025**	**0.0**	**49.3**	**41.2**	**9.5**
⌧										
▲										
★										

CLIENT **West Capital Development**

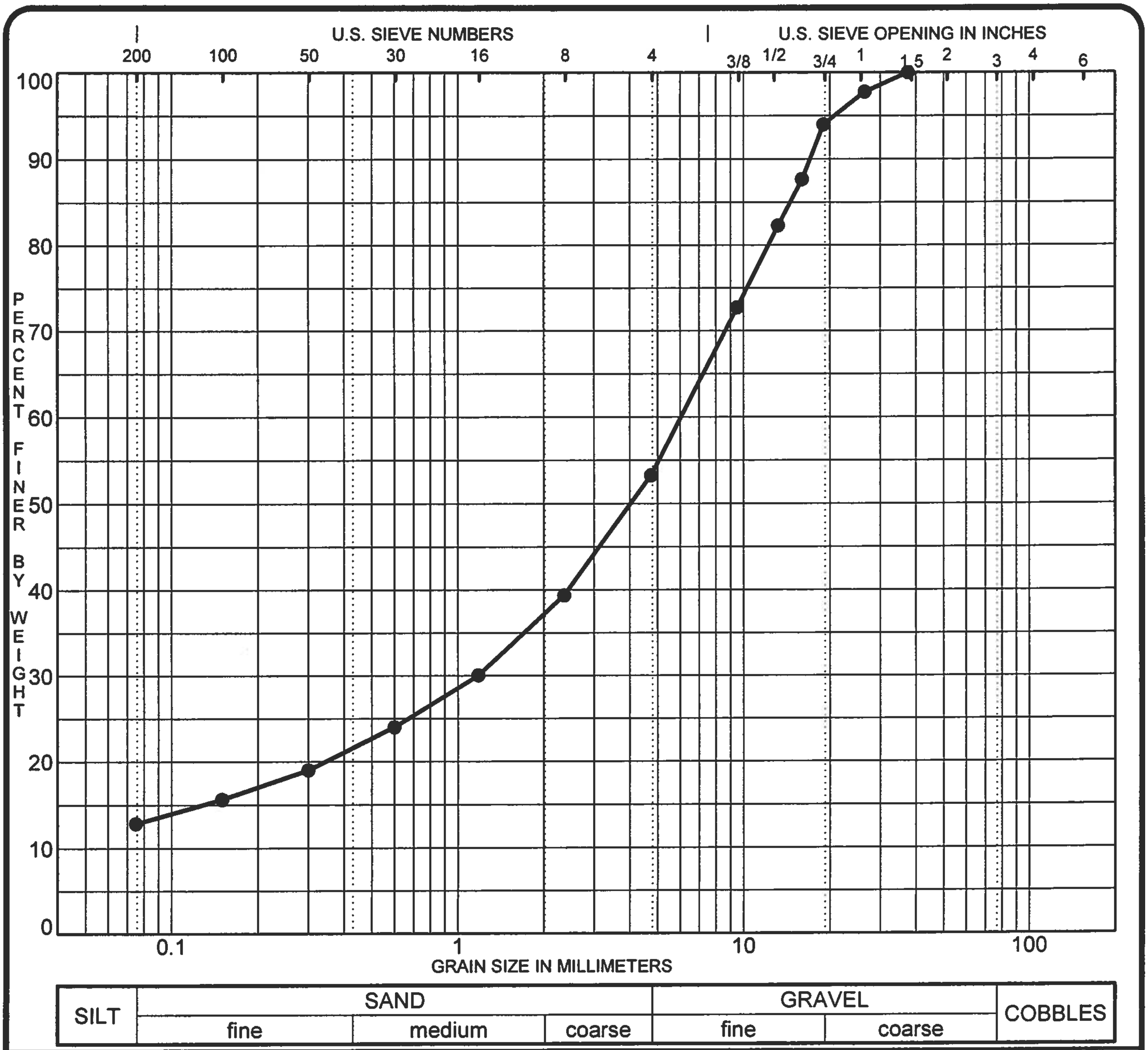
PROJECT **Geotechnical Investigation - Carp Airport**
Residential Development

FILE NO. **PG2450**

DATE **4 Oct 22**

patersongroup **Consulting Engineers**
9 Auriga Drive, Ottawa, Ontario K2E 7T9

GRAIN SIZE DISTRIBUTION



Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH 2-11 AU 1**	**Granular crushed stone with silty sand**						
☒								
▲								
★		Based on ASTM D 2487						

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH 2-11 AU 1**	**37.50**	**6.04**	**1.174**		**46.7**	**40.4**	**12.8**	
☒									
▲									
★									

CLIENT **Novatech Engineering Consultants Ltd.**

PROJECT **Geotehnical Investigation - Carp Airport Servicing and Residential Development**

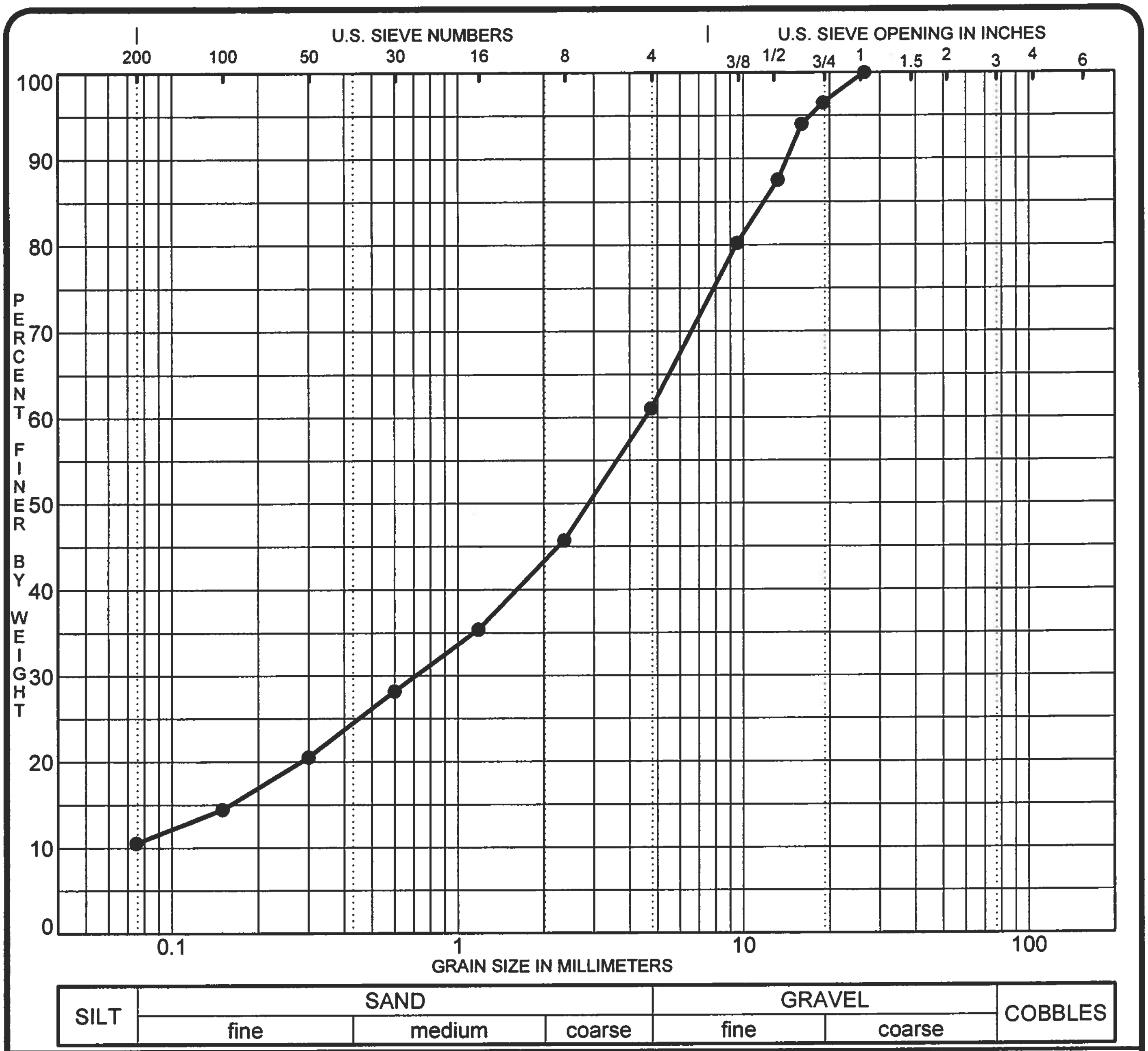
FILE NO. **PG2450**

DATE **18 Aug 11**

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH26-11 AU 1**	**Silty sand with granular crushed stone**					**1.64**	**66.3**
☒								
▲								
★		Based on ASTM D 2487						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH26-11 AU 1**	**26.50**	**4.53**	**0.712**		**39.0**	**50.5**	**10.5**	
☒									
▲									
★									

CLIENT **Novatech Engineering Consultants Ltd.**

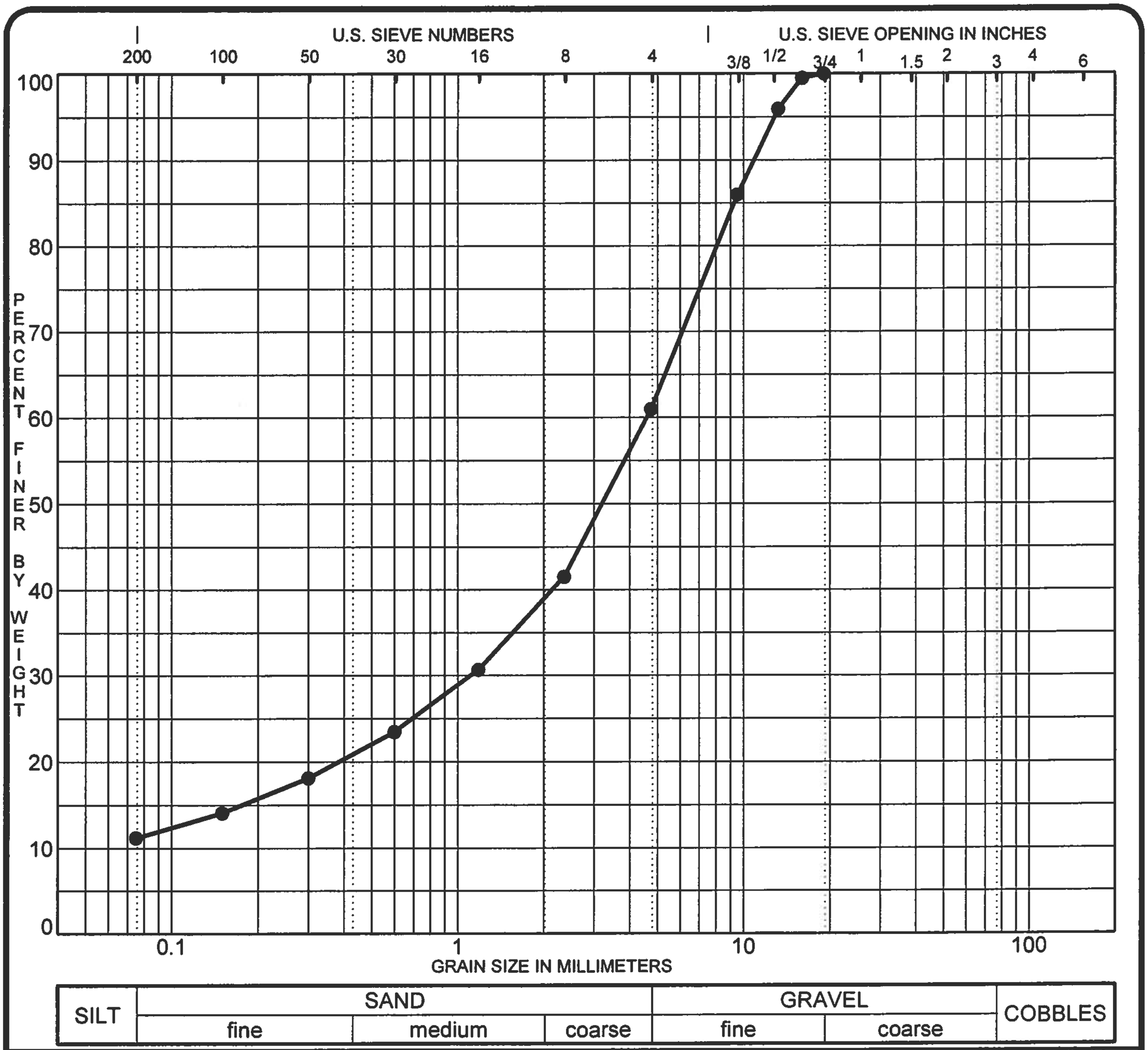
PROJECT **Geotehnical Investigation - Carp Airport Servicing**
and Residential Development

FILE NO. **PG2450**

DATE **19 Aug 11**

patersongroup **Consulting Engineers**
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**BH37-11 AU 1**	**Silty sand with granular crushed stone**					**4.77**	**81.7**
☒								
▲								
★		Based on ASTM D 2487						

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**BH37-11 AU 1**	**19.00**	**4.59**	**1.108**		**39.0**	**49.8**	**11.2**	
☒									
▲									
★									

CLIENT **Novatech Engineering Consultants Ltd.**

PROJECT **Geotehnical Investigation - Carp Airport Servicing and Residential Development**

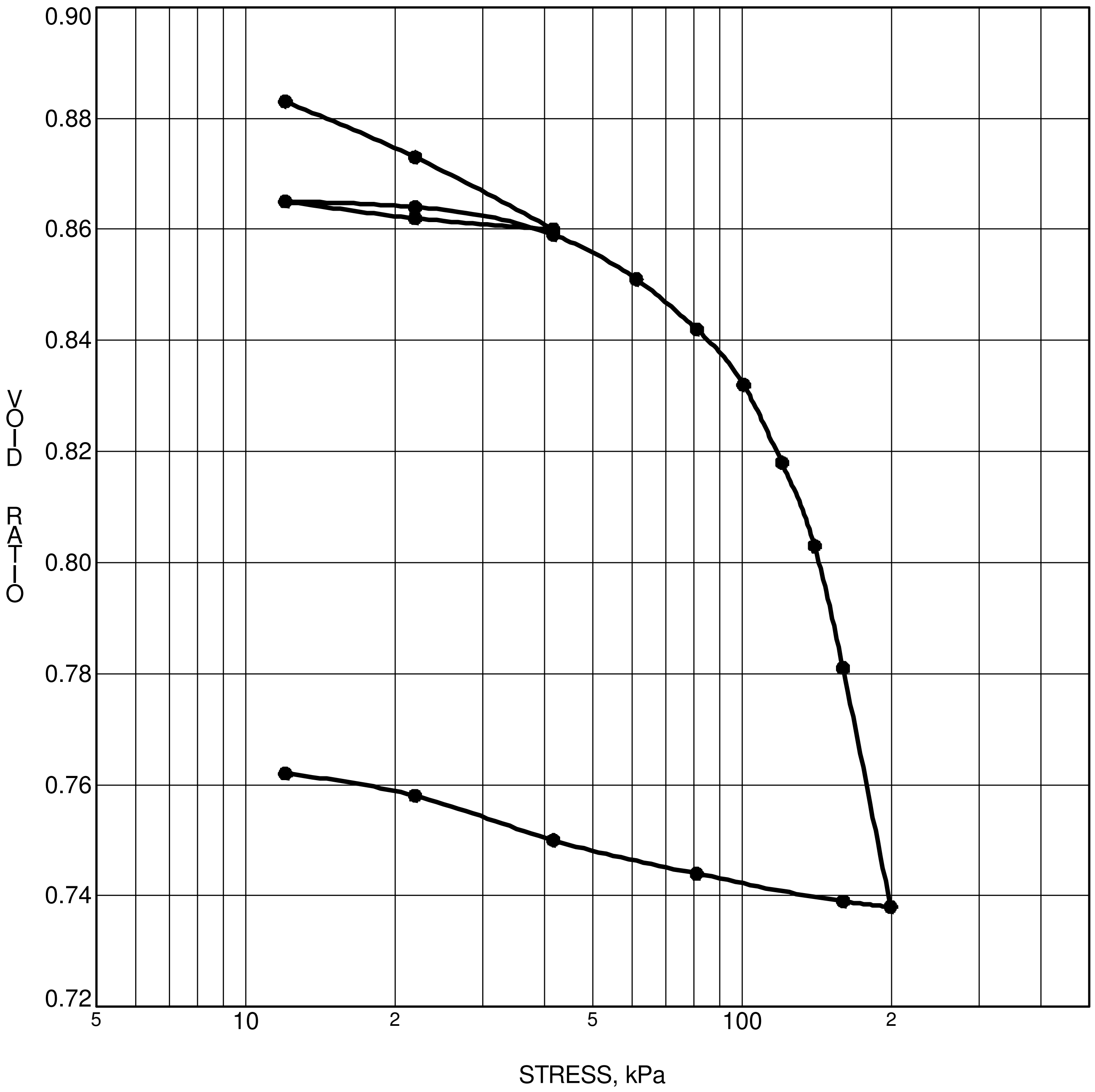
FILE NO. **PG2450**

DATE **18 Aug 11**

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH41-13**	p'_o	**52** kPa	Ccr	**0.011**
Sample No.	**TW 5**	p'_c	**112** kPa	Cc	**0.412**
Sample Depth	**5.00** m	OC Ratio	**2.2**	Wo	**32.6** %
Sample Elev.	**111.13** m	Void Ratio	**0.762**	Unit Wt.	**18.0** kN/m^3

CLIENT **Novatech Engineering Consultants Ltd.**

FILE NO. **PG2450**

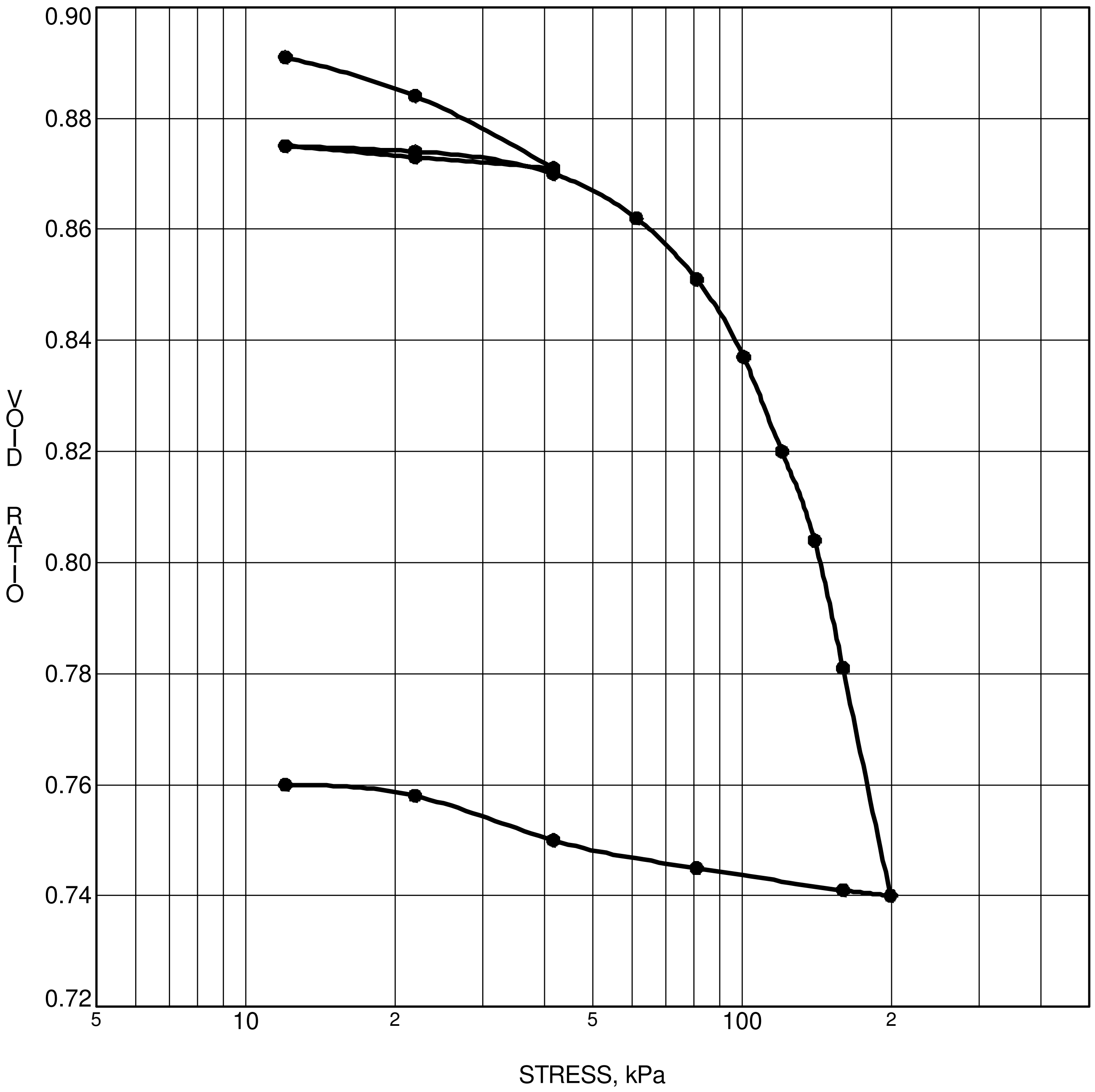
PROJECT **Geotehnical Investigation - Carp Airport Servicing and Residential Development**

DATE **02/07/13**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH42-13**	p'_o	**57** kPa	Ccr	**0.009**
Sample No.	**TW 6**	p'_c	**97** kPa	Cc	**0.370**
Sample Depth	**5.03** m	OC Ratio	**1.7**	Wo	**32.9** %
Sample Elev.	**109.92** m	Void Ratio	**0.905**	Unit Wt.	**18.0** kN/m^3

CLIENT **Novatech Engineering Consultants Ltd.**

FILE NO. **PG2450**

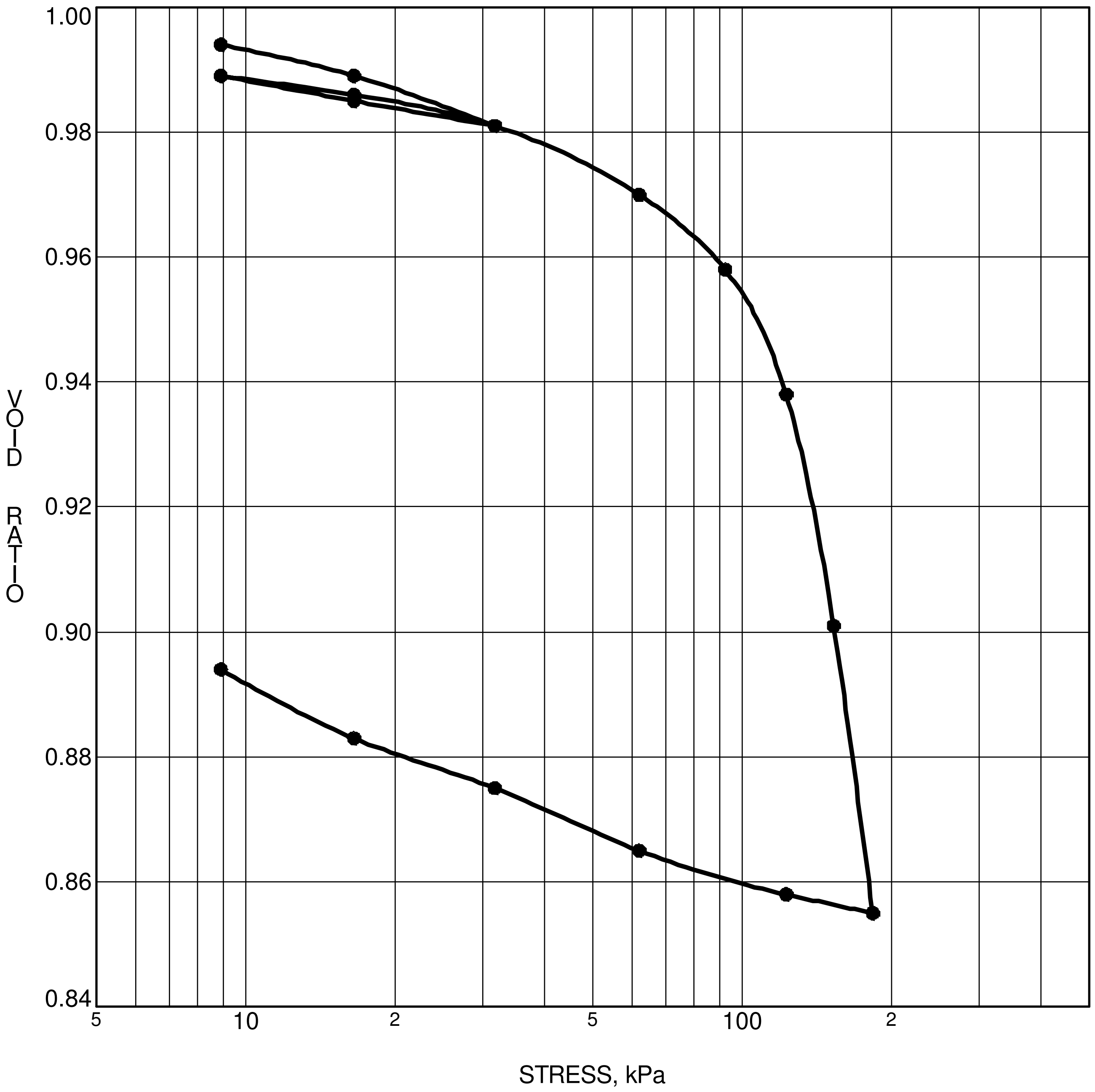
PROJECT **Geotehnical Investigation - Carp Airport Servicing and Residential Development**

DATE **02/07/13**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH43-13**	p'$_o$	**56** kPa	Ccr	**0.016**
Sample No.	**TW 7**	p'$_c$	**104** kPa	Cc	**0.390**
Sample Depth	**5.56** m	OC Ratio	**1.9**	Wo	**36.4** %
Sample Elev.	**111.24** m	Void Ratio	**1.001**	Unit Wt.	**18.0** kN/m^3

CLIENT **Novatech Engineering Consultants Ltd.**
FILE NO. **PG2450**
PROJECT **Geotehnical Investigation - Carp Airport Servicing and Residential Development**
DATE **02/07/13**

patersongroup **Consulting Engineers**
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

CONSOLIDATION TEST

Certificate of Analysis

Client: **Paterson Group Consulting Engineers**

Client PO: 11646

Report Date: 28-Sep-2011

Order Date:22-Sep-2011

Project Description: PG2450

	Client ID:	BH11-11 - SS3	BH23-11 - SS5	-	-
	Sample Date:	16-Sep-11	19-Sep-11	-	-
	Sample ID:	1139201-01	1139201-02	-	-
	MDL/Units	Soil	Soil	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	82.4	75.6	-	-
General Inorganics					
pH	0.1 pH Units	7.6	7.7	-	-
Resistivity	0.10 Ohm.m	98.1	48.3	-	-
Anions					
Chloride	5 ug/g dry	<5	15	-	-
Sulphate	5 ug/g dry	14	36	-	-

Order #: 1135019

Certificate of Analysis

Report Date: 25-Aug-2011

Client: **Paterson Group Consulting Engineers**

Order Date:22-Aug-2011

Client PO: 11691

Project Description: PG2450

	Client ID:	BH38-11 SS4	-	-	-
	Sample Date:	18-Aug-11	-	-	-
	Sample ID:	1135019-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	66.8	-	-	-
General Inorganics					
pH	0.1 pH Units	7.2	-	-	-
Resistivity	0.10 Ohm.m	13.3	-	-	-
Anions					
Chloride	5 ug/g dry	656	-	-	-
Sulphate	5 ug/g dry	66	-	-	-

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURES 2a TO 7b – SLOPE STABILITY ANALYSIS SHEETS

FIGURES 8 TO 11 – SHEAR WAVE VELOCITY PROFILES

DRAWING PG2450-1 – TEST HOLE LOCATION PLAN

DRAWING PG2450-2 – LIMIT OF HAZARD LANDS

DRAWING PG2450-3 – PERMISSIBLE GRADE RAISE PLAN

DRAWING PG2450-4 – TREE PLANTING SETBACK PLAN

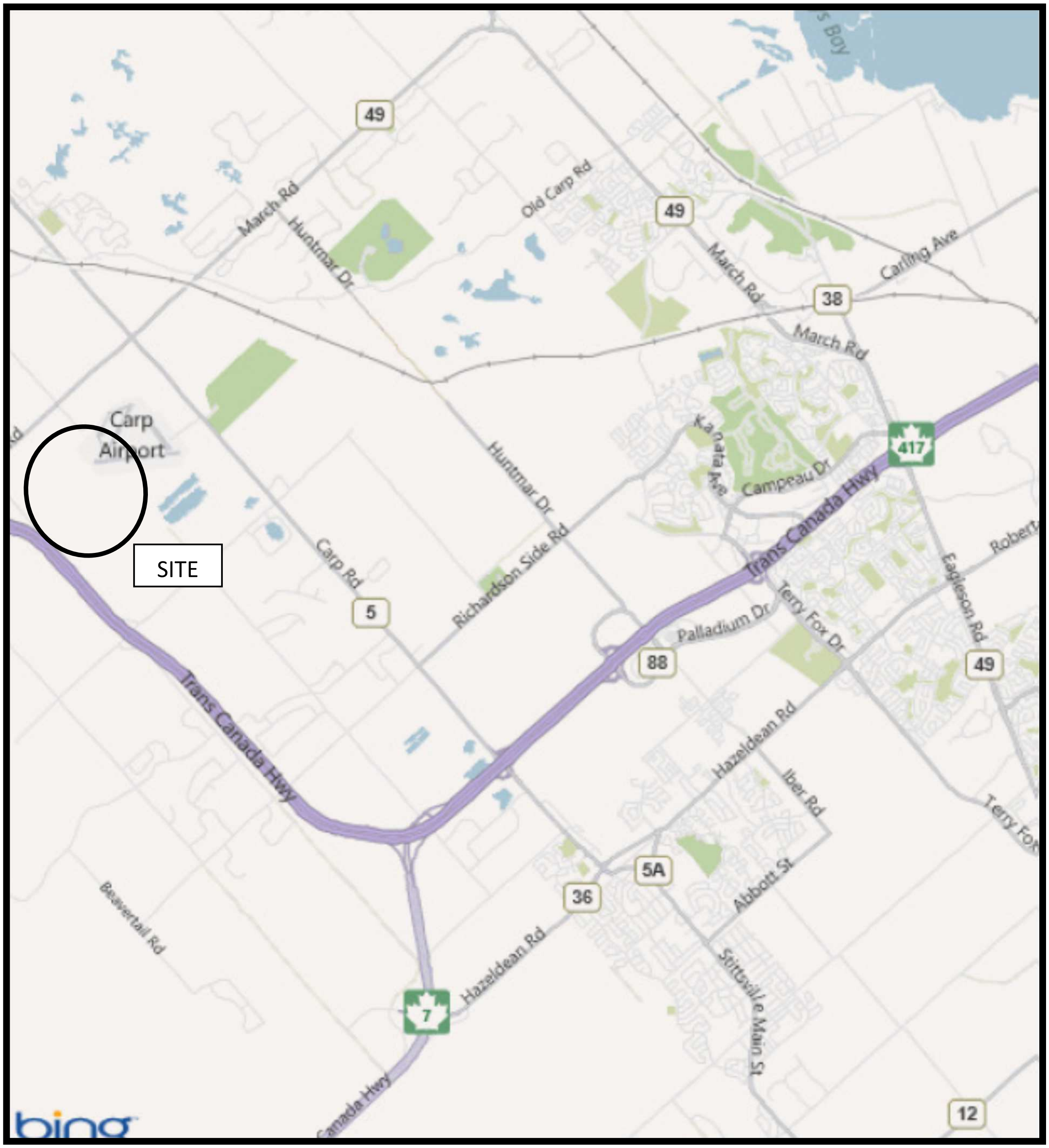


FIGURE 1

KEY PLAN

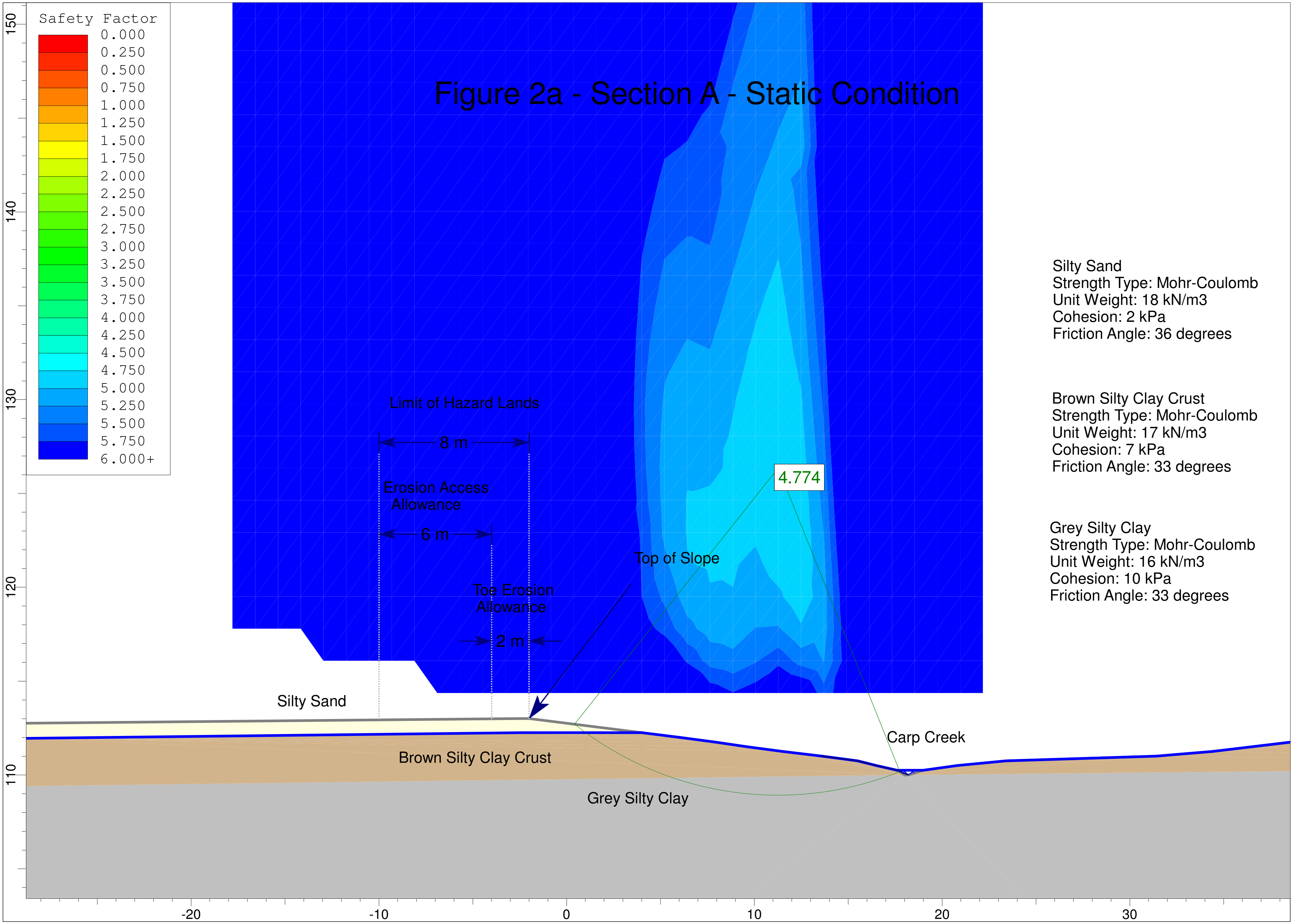


Figure 2a - Section A - Static Condition

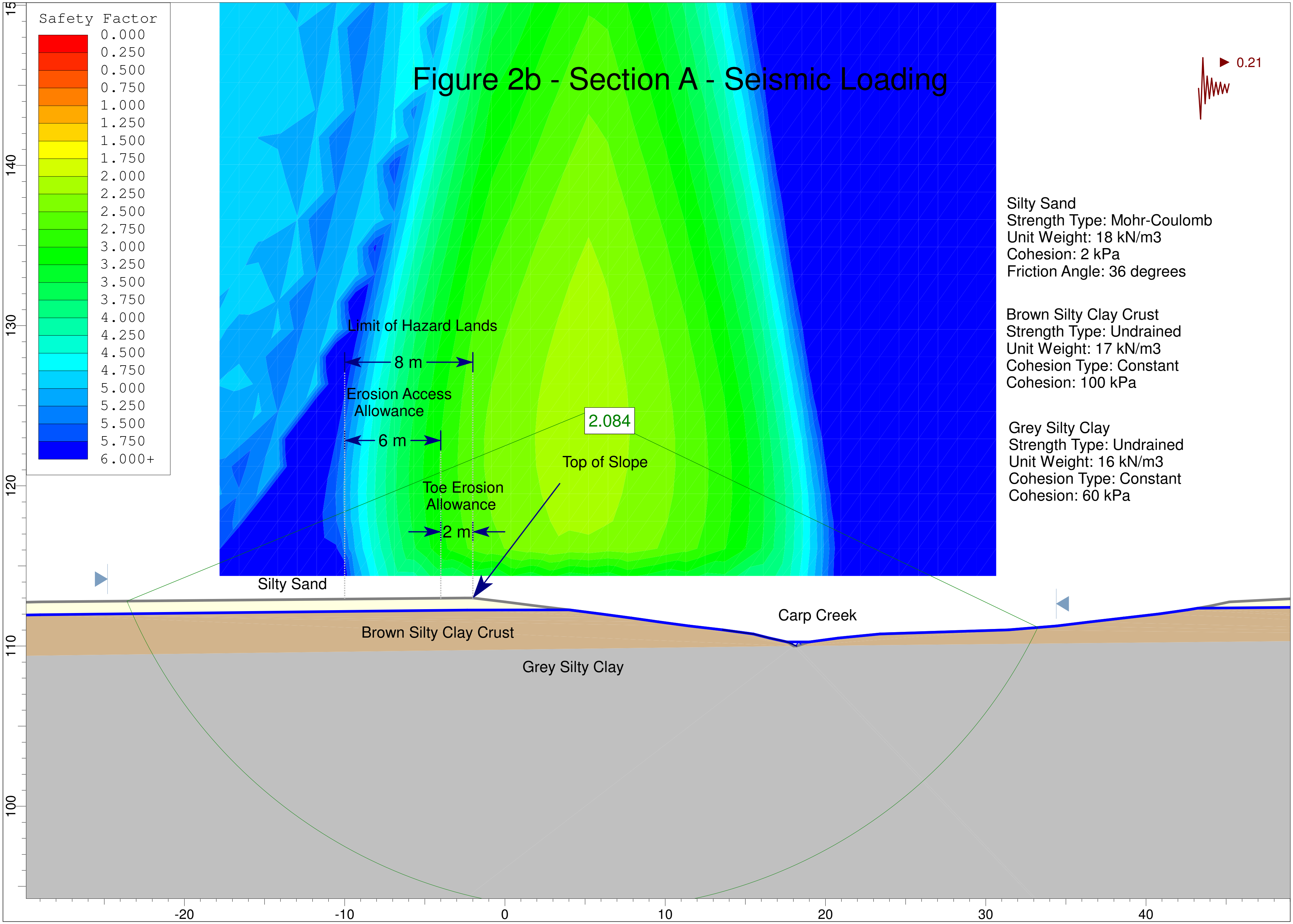


Figure 2b - Section A - Seismic Loading

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust
Strength Type: Undrained
Unit Weight: 17 kN/m3
Cohesion Type: Constant
Cohesion: 100 kPa

Grey Silty Clay
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 60 kPa

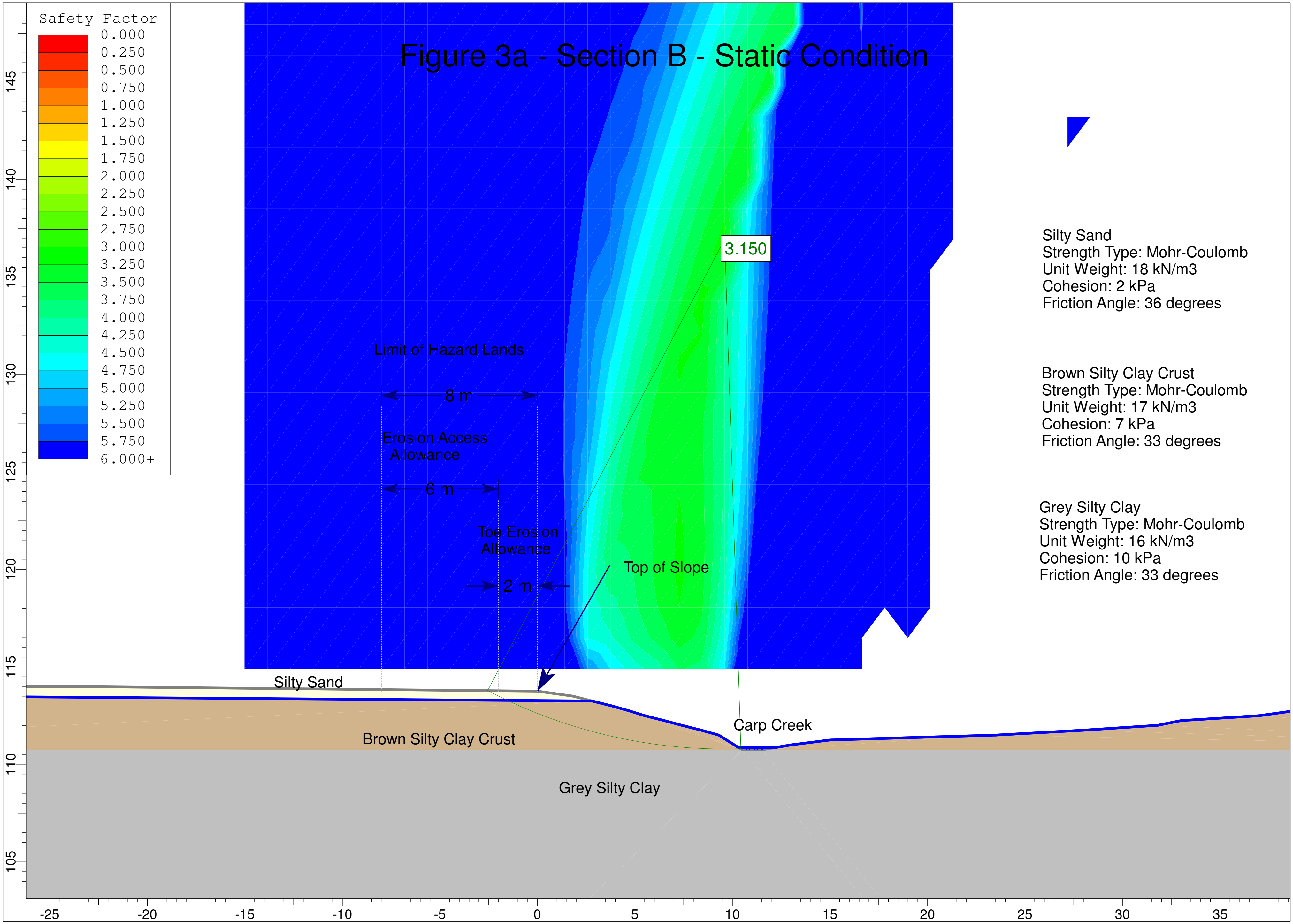
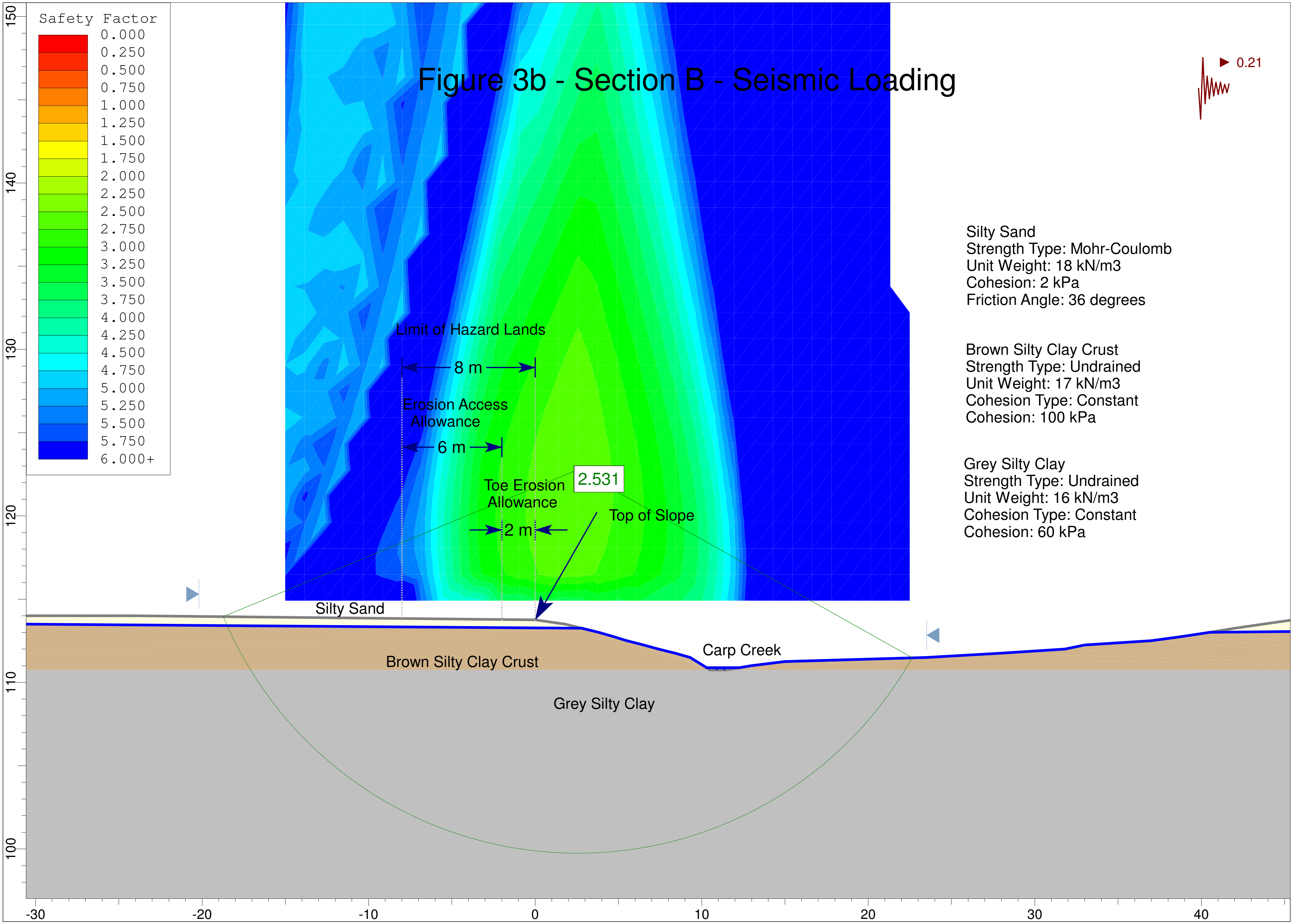


Figure 3a - Section B - Static Condition

Figure 3b - Section B - Seismic Loading



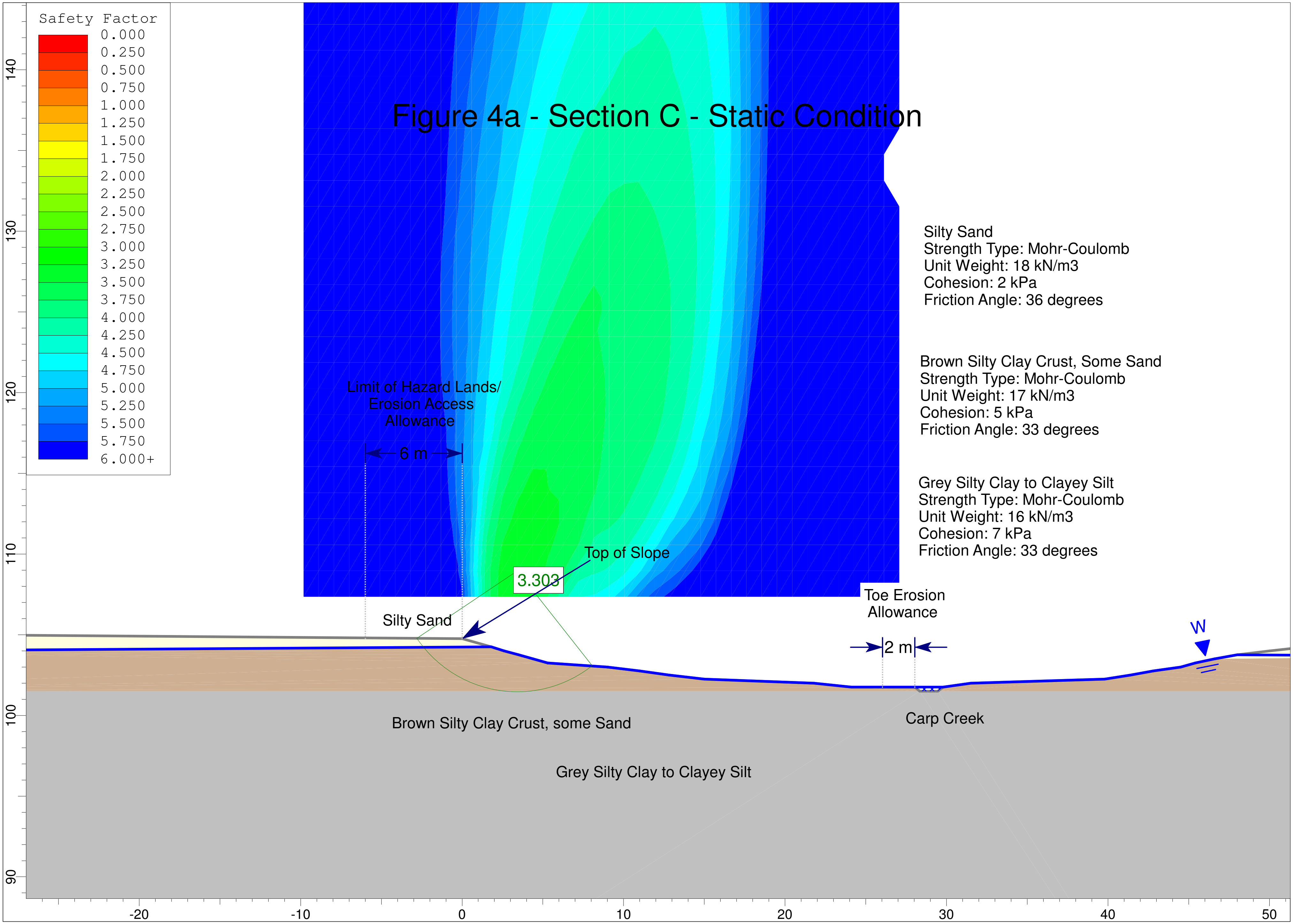
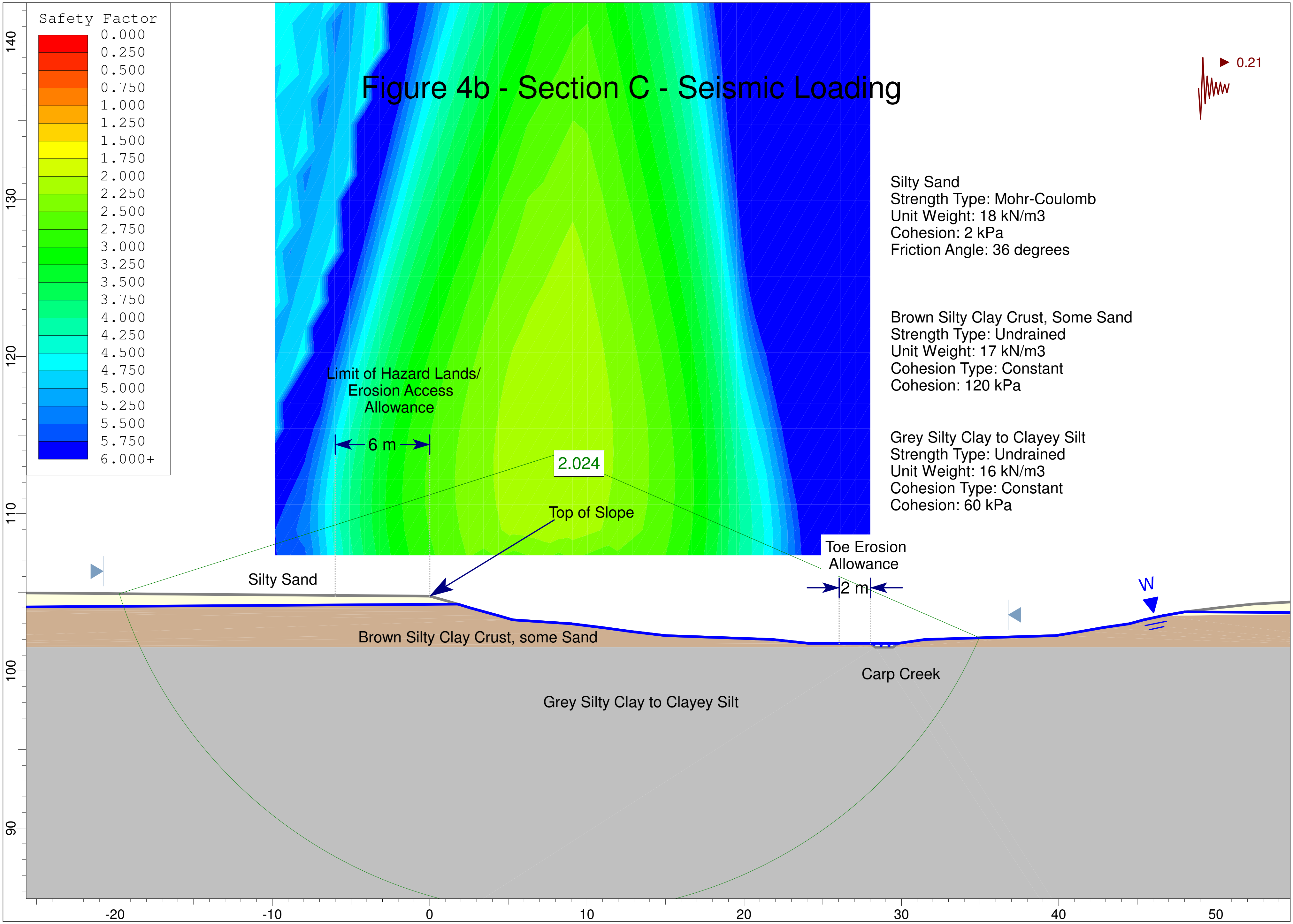


Figure 4a - Section C - Static Condition

Figure 4b - Section C - Seismic Loading



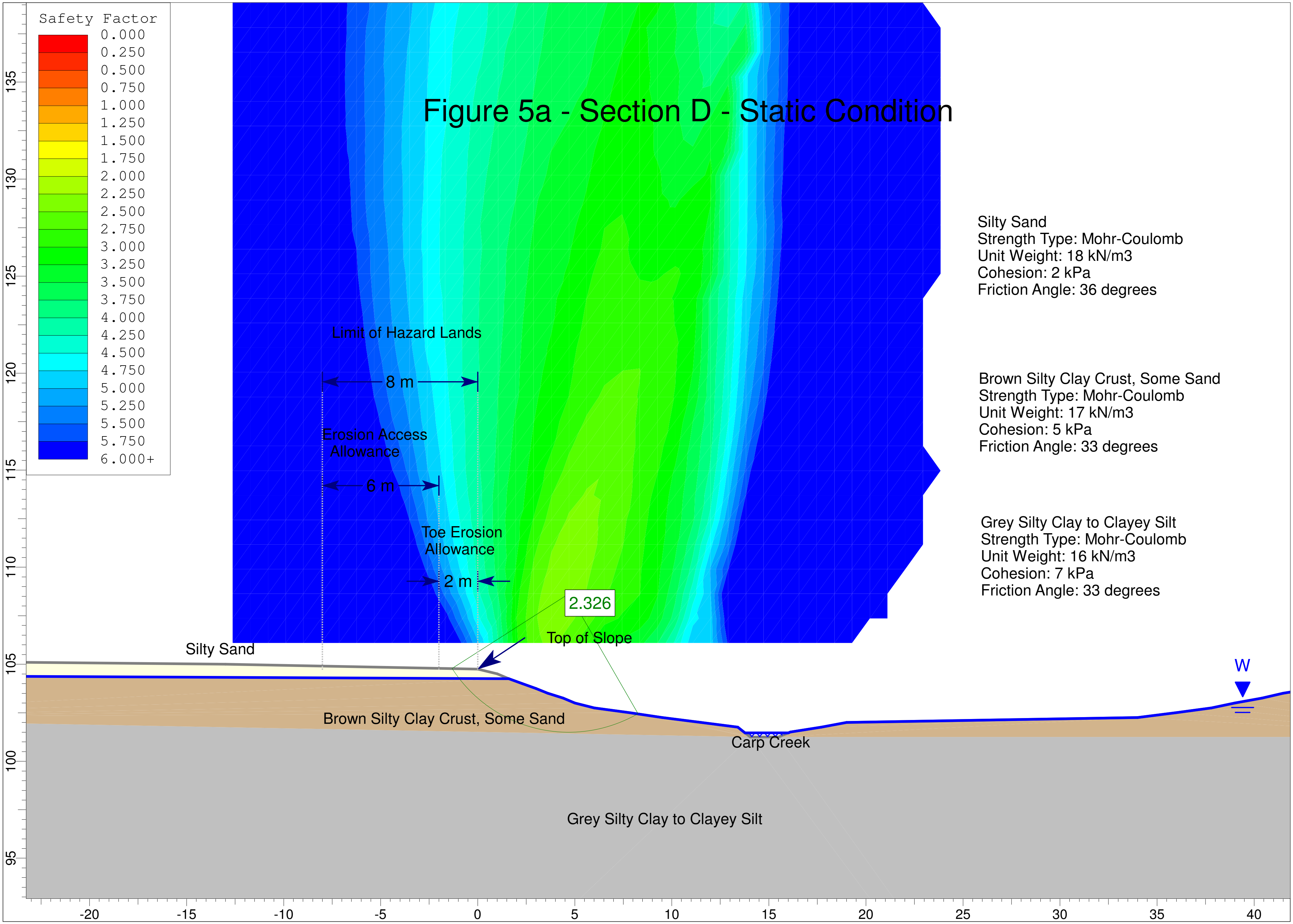


Figure 5a - Section D - Static Condition

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust, Some Sand
Strength Type: Mohr-Coulomb
Unit Weight: 17 kN/m3
Cohesion: 5 kPa
Friction Angle: 33 degrees

Grey Silty Clay to Clayey Silt
Strength Type: Mohr-Coulomb
Unit Weight: 16 kN/m3
Cohesion: 7 kPa
Friction Angle: 33 degrees

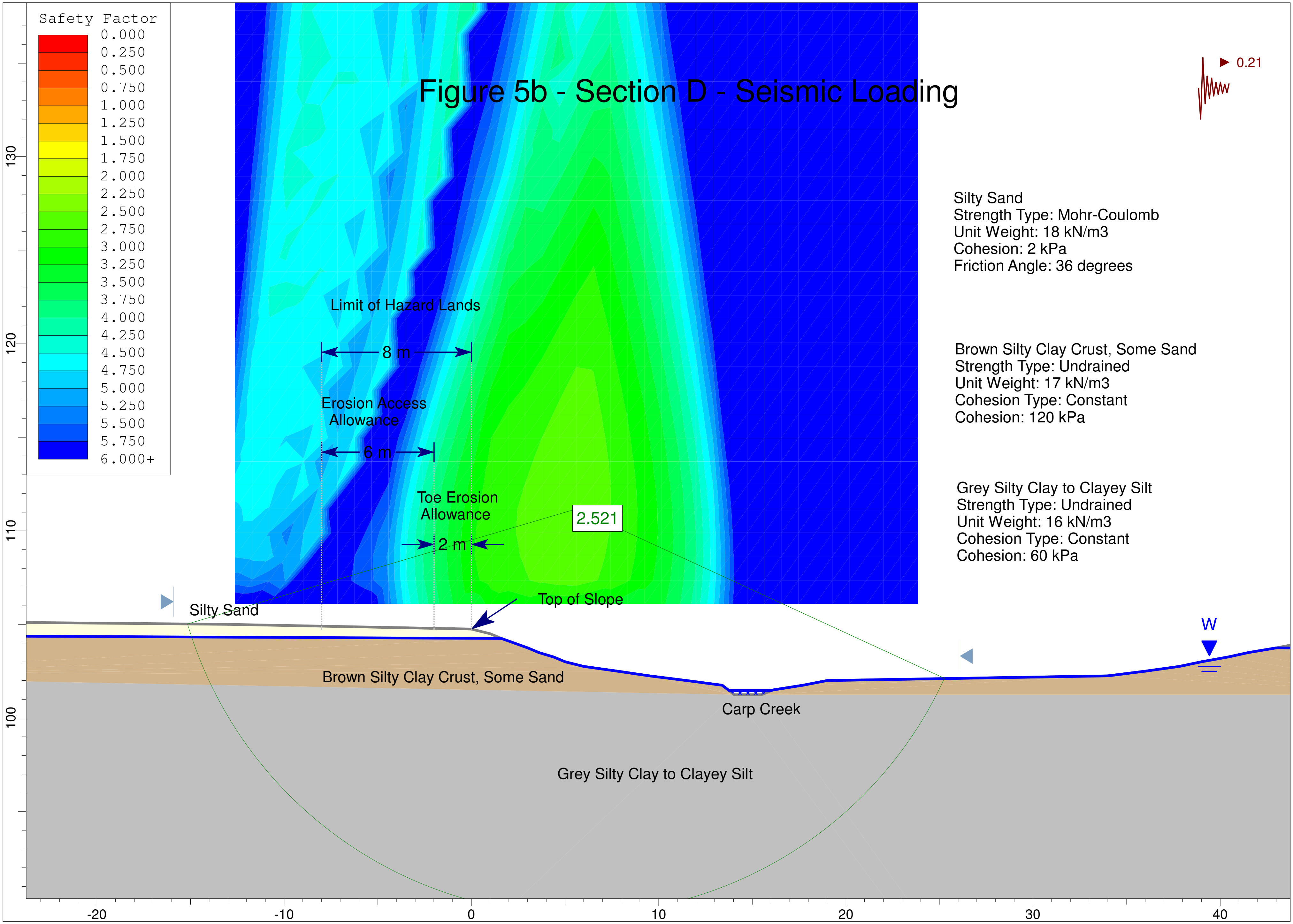


Figure 5b - Section D - Seismic Loading

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust, Some Sand
Strength Type: Undrained
Unit Weight: 17 kN/m3
Cohesion Type: Constant
Cohesion: 120 kPa

Grey Silty Clay to Clayey Silt
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 60 kPa

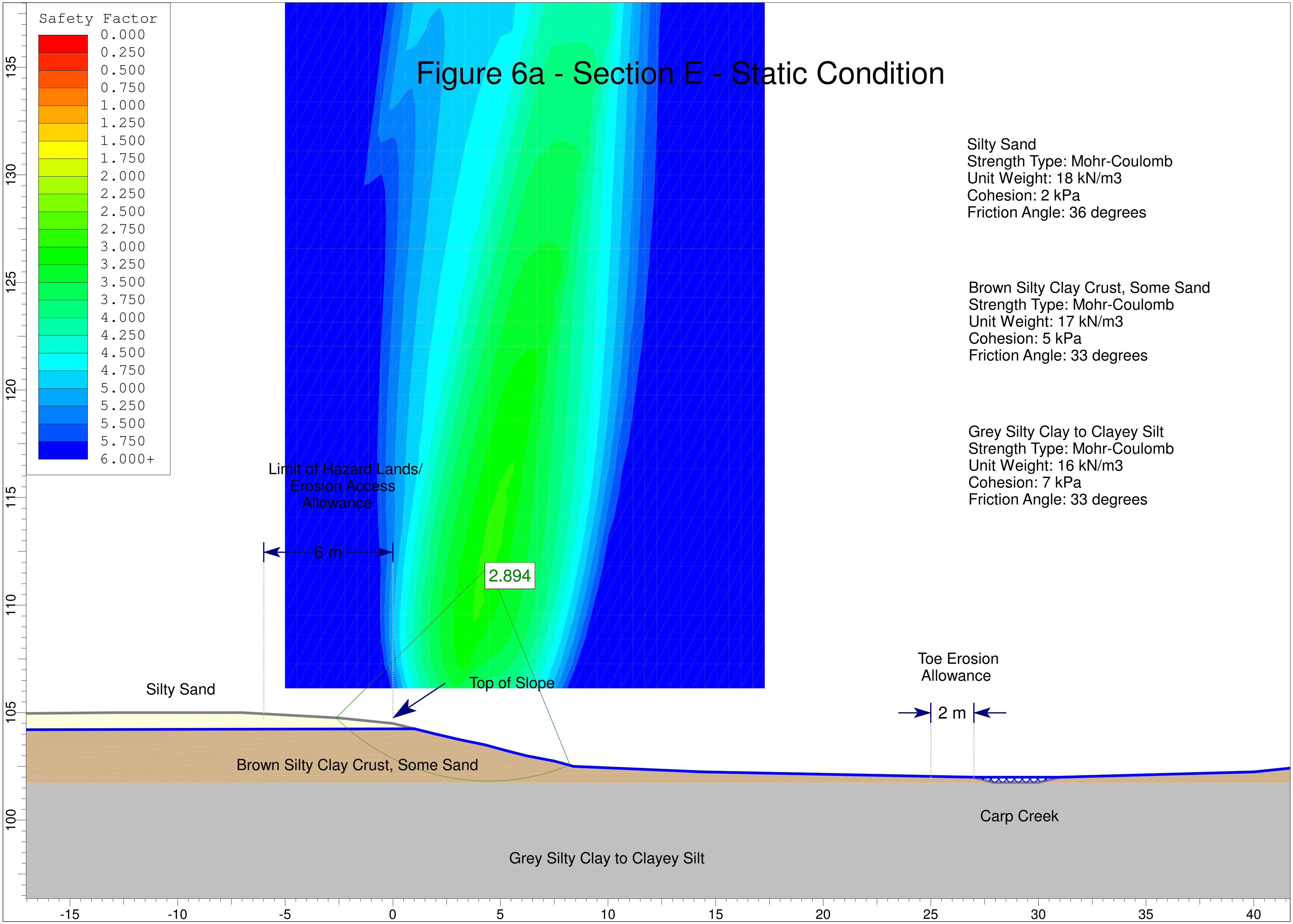


Figure 6a - Section E - Static Condition

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust, Some Sand
Strength Type: Mohr-Coulomb
Unit Weight: 17 kN/m3
Cohesion: 5 kPa
Friction Angle: 33 degrees

Grey Silty Clay to Clayey Silt
Strength Type: Mohr-Coulomb
Unit Weight: 16 kN/m3
Cohesion: 7 kPa
Friction Angle: 33 degrees

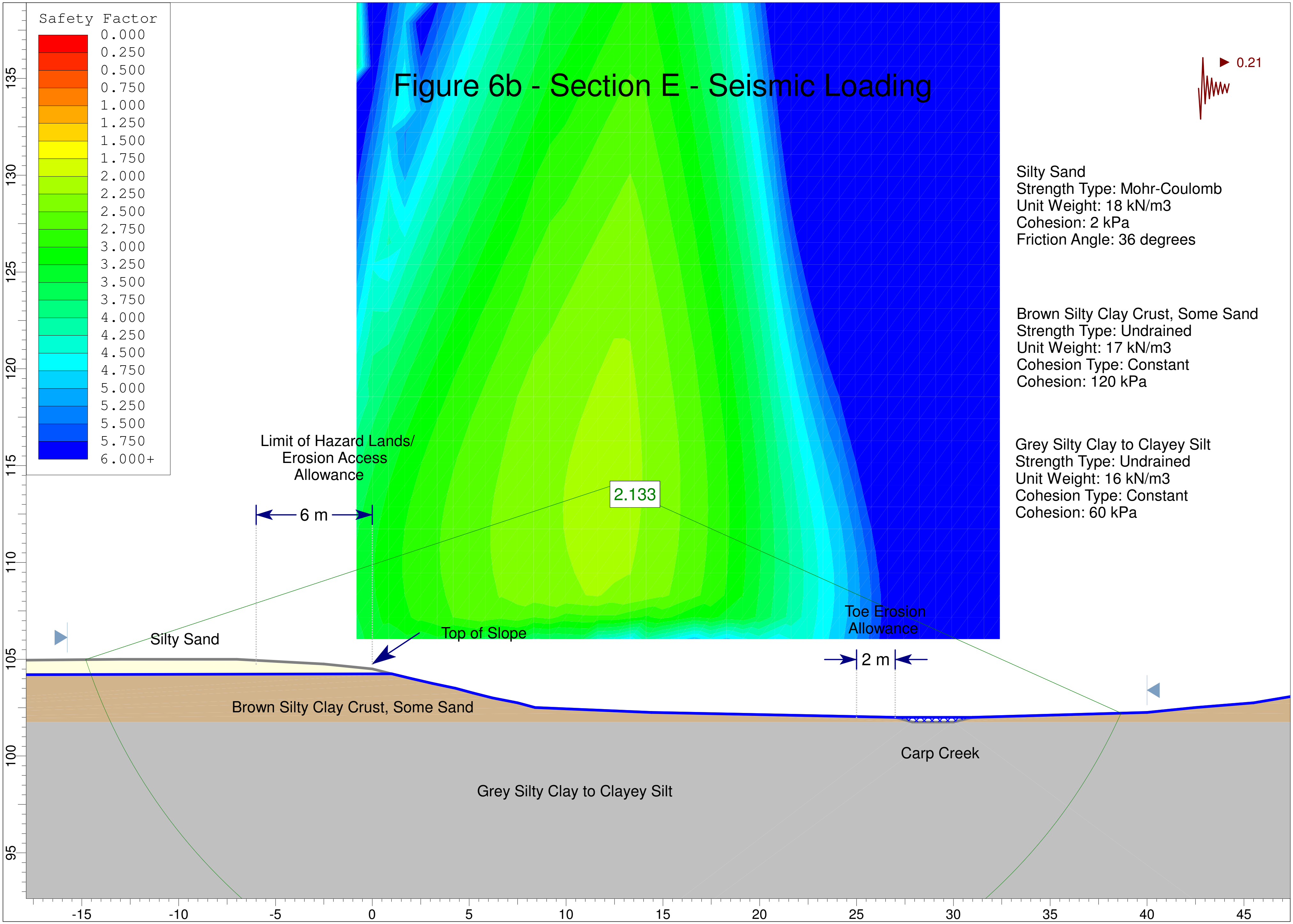


Figure 6b - Section E - Seismic Loading

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust, Some Sand
Strength Type: Undrained
Unit Weight: 17 kN/m3
Cohesion Type: Constant
Cohesion: 120 kPa

Grey Silty Clay to Clayey Silt
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 60 kPa

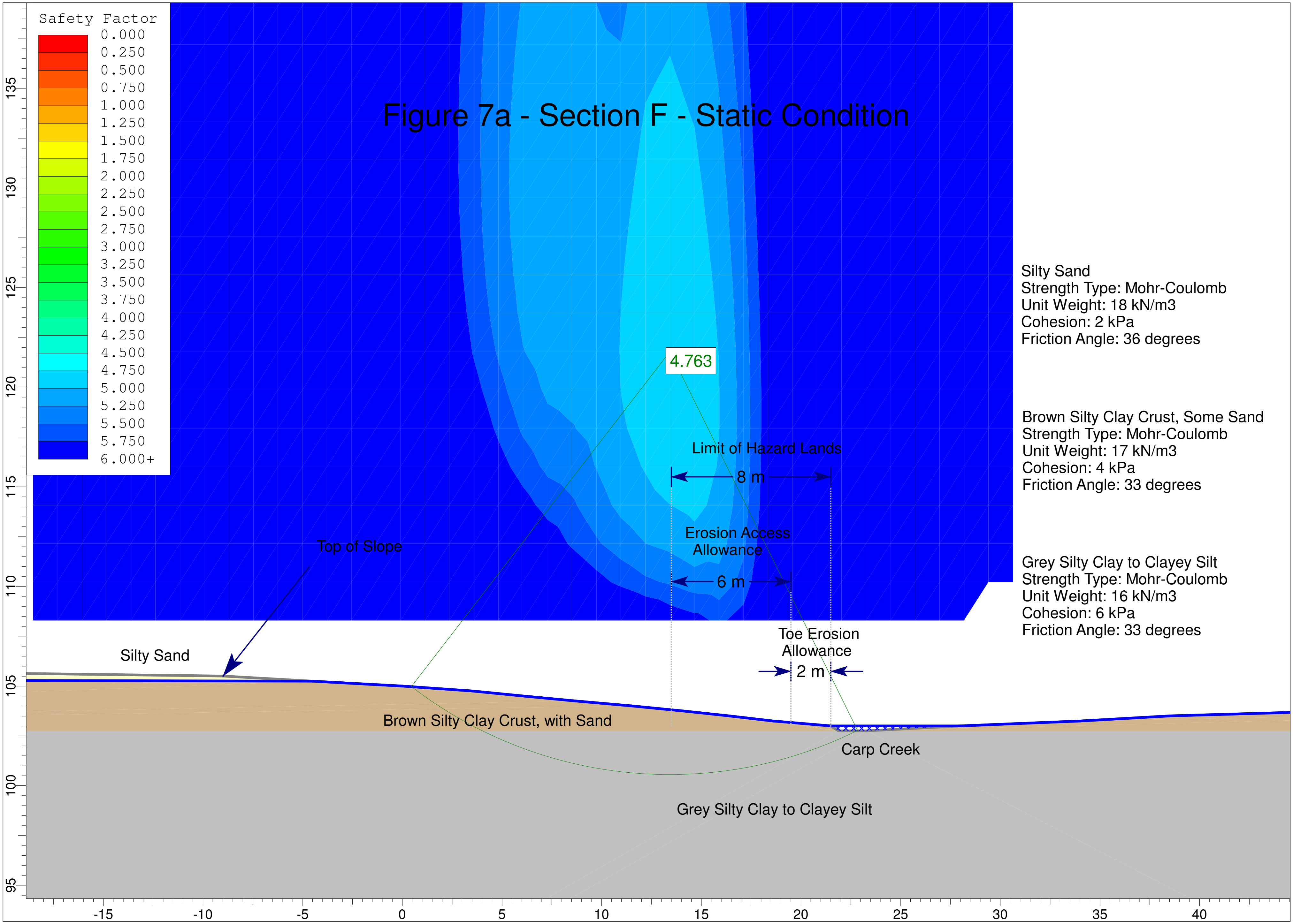


Figure 7a - Section F - Static Condition

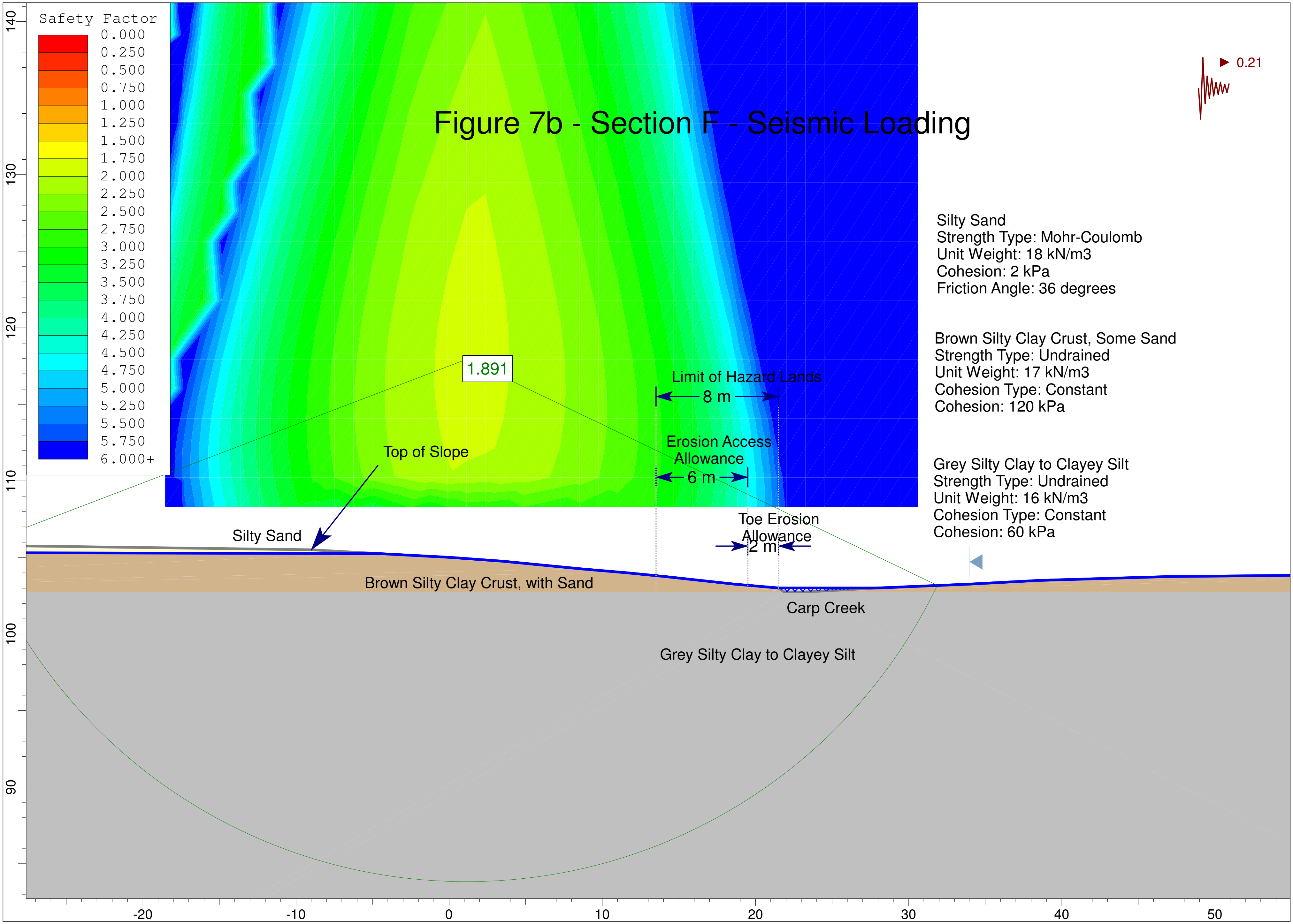


Figure 7b - Section F - Seismic Loading

Silty Sand
Strength Type: Mohr-Coulomb
Unit Weight: 18 kN/m3
Cohesion: 2 kPa
Friction Angle: 36 degrees

Brown Silty Clay Crust, Some Sand
Strength Type: Undrained
Unit Weight: 17 kN/m3
Cohesion Type: Constant
Cohesion: 120 kPa

Grey Silty Clay to Clayey Silt
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 60 kPa

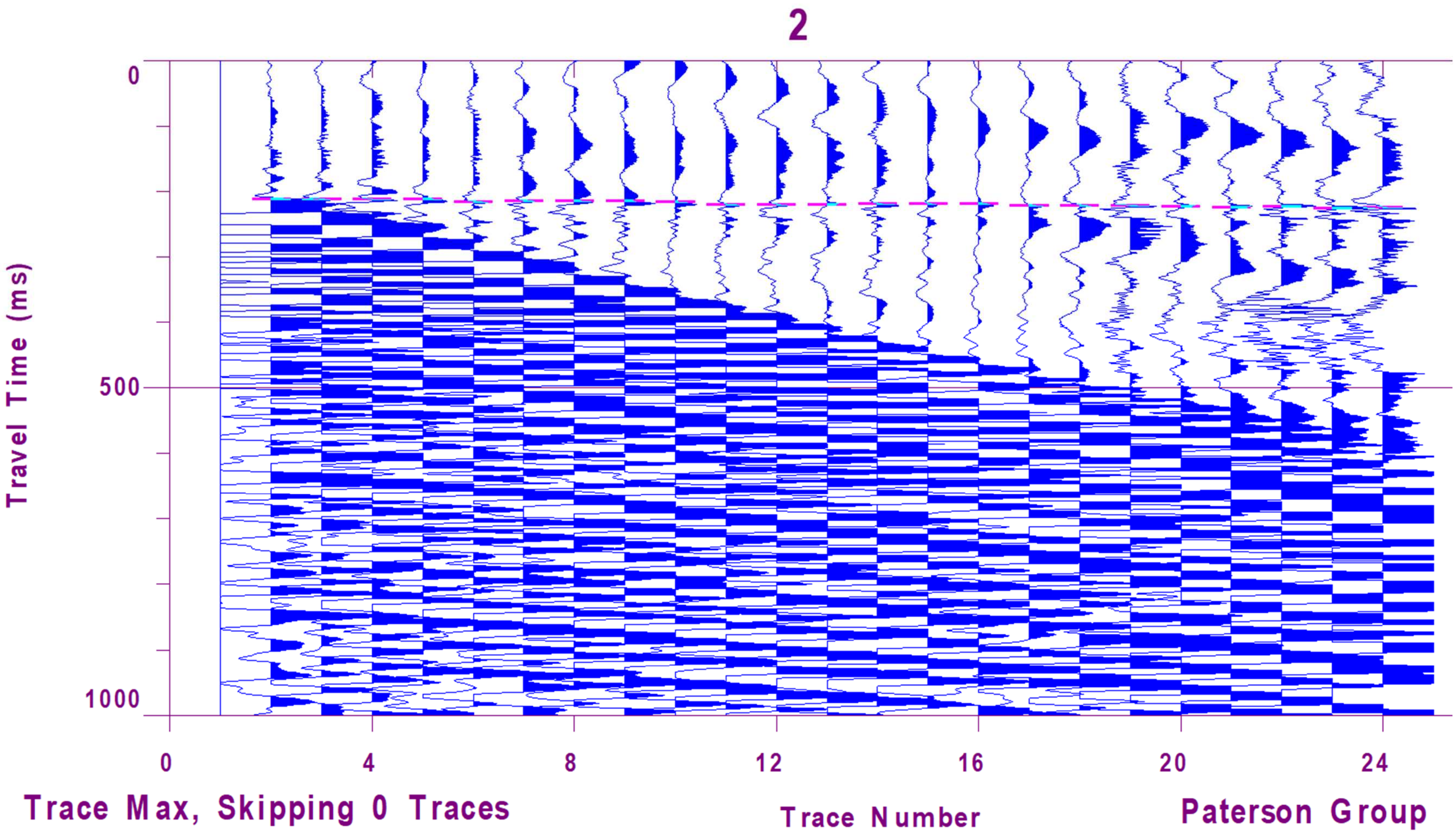


Figure 8 - West Array – Shear Wave Velocity Profile at Shot Location -30 m

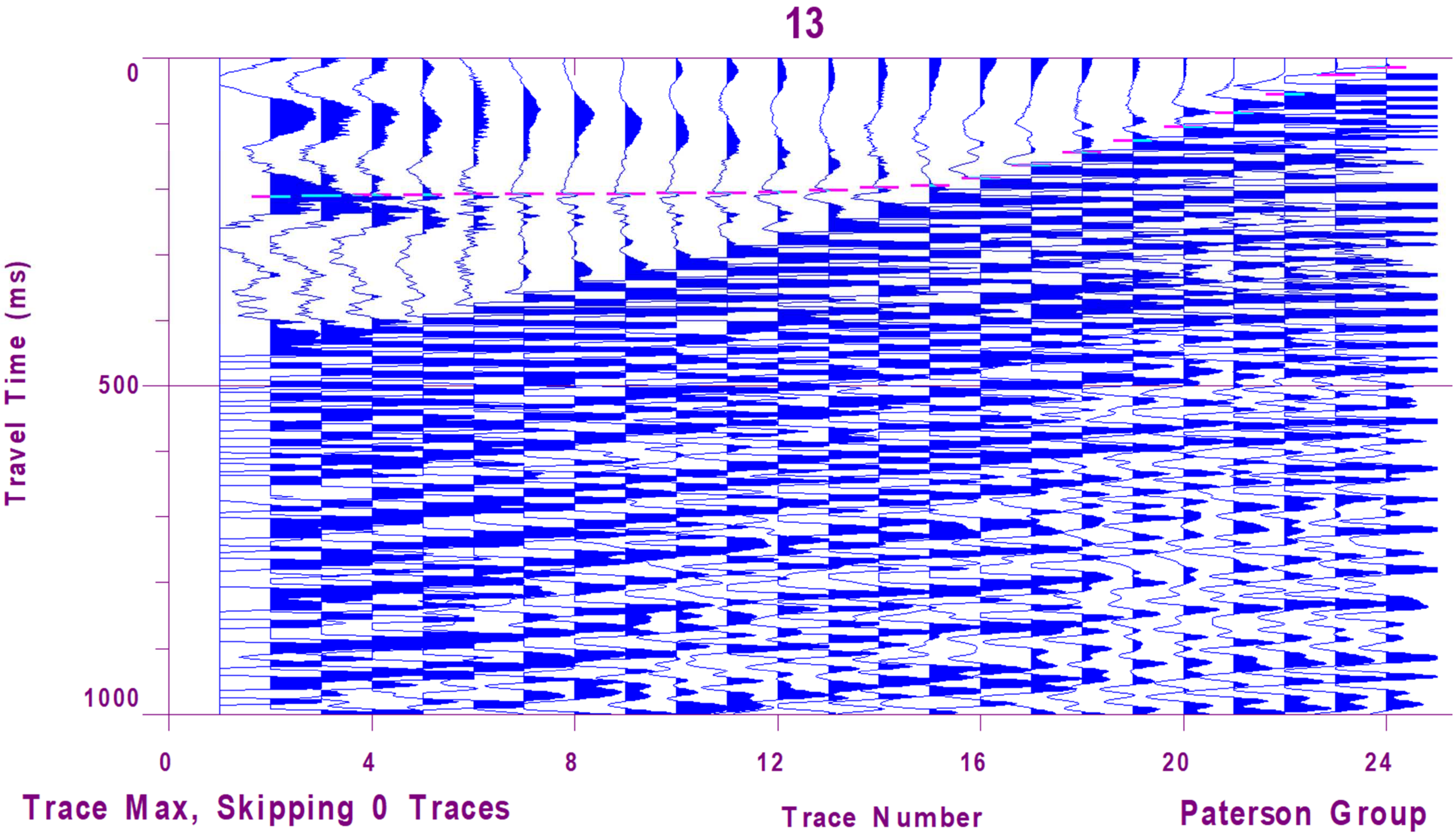


Figure 9 - West Array – Shear Wave Velocity Profile at Shot Location 3 m

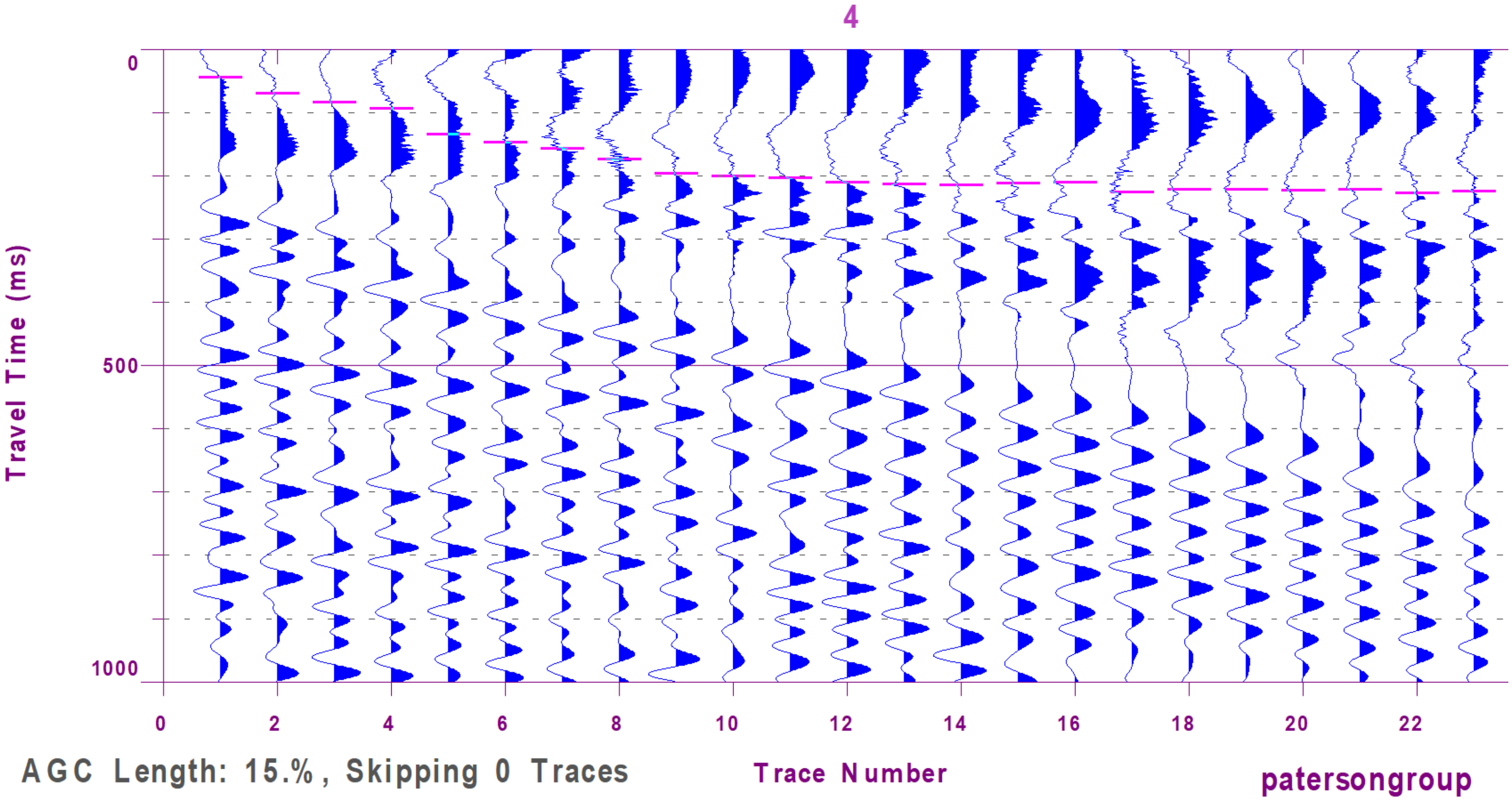


Figure 10 - East Array – Shear Wave Velocity Profile at Shot Location -30 m

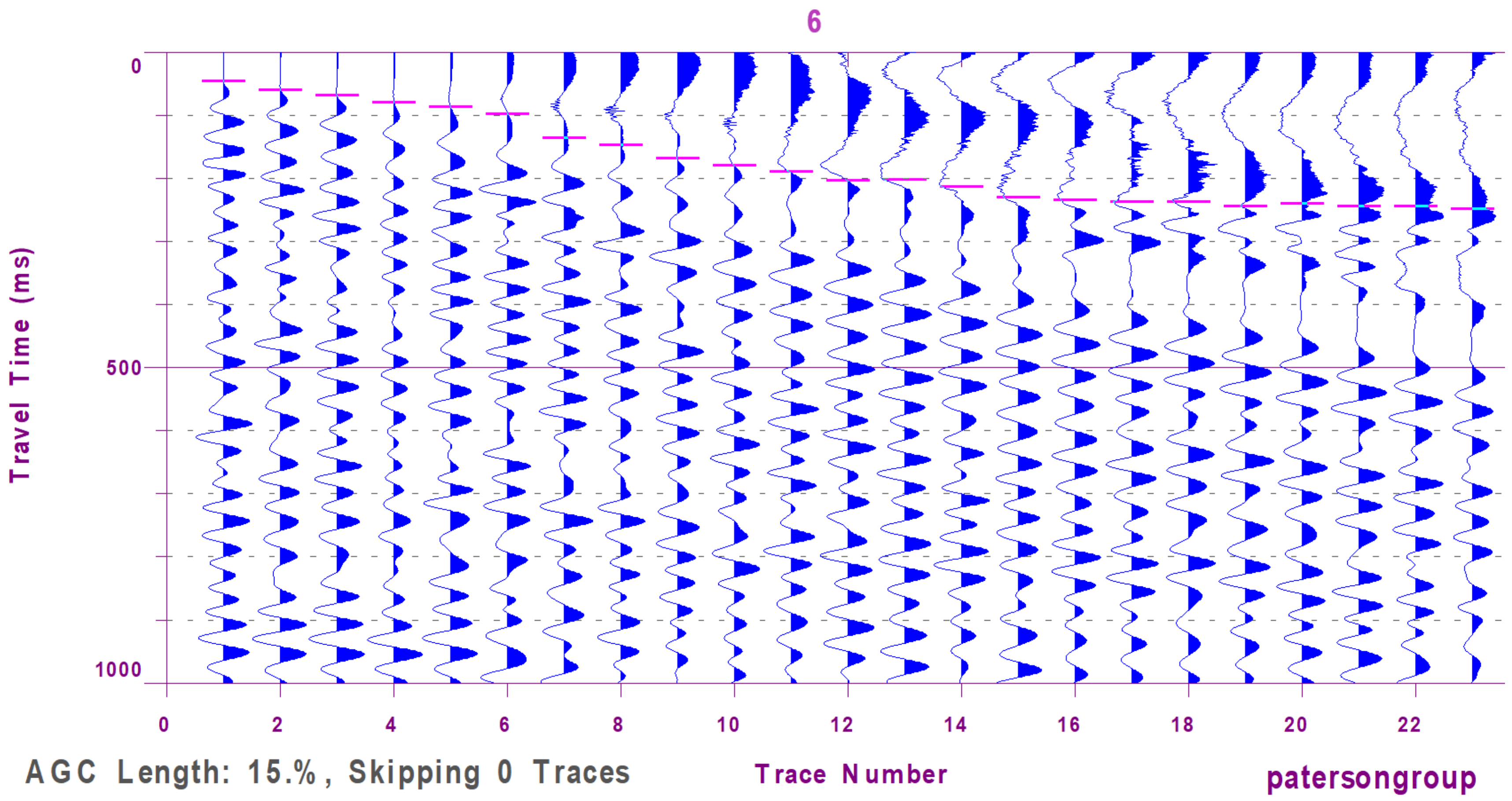
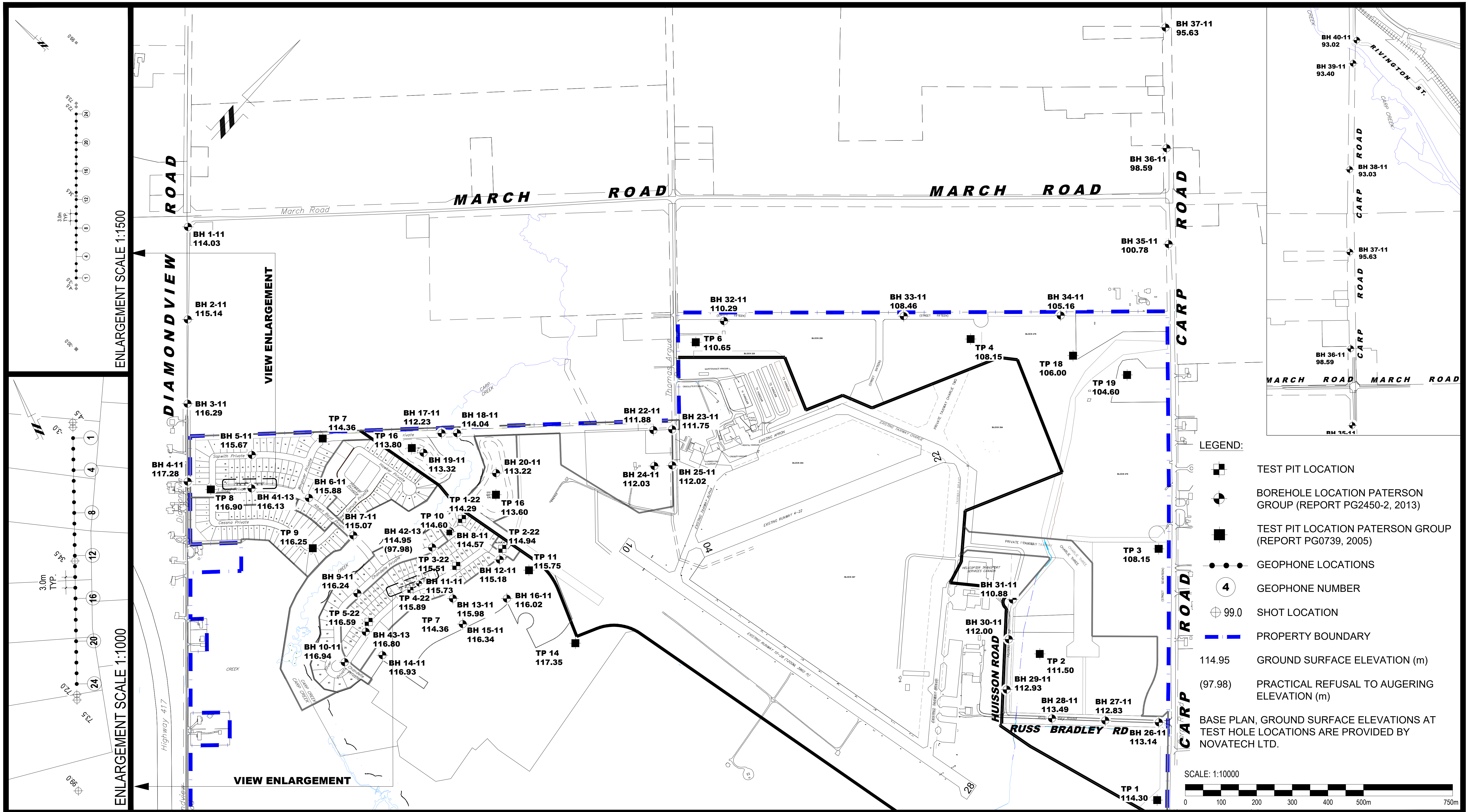


Figure 11 - East Array – Shear Wave Velocity Profile at Shot Location -4.5 m



PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
3	CONCEPTUAL PLAN UPDATED	12/13/2022	KP
2	ADDED TEST PITS TP 1-22 TO TP 5-22	10/11/2022	KP
1	SEISMIC SHEAR WAVE VELOCITY ADDED TO PLAN	08/11/2022	FC

WEST CAPITAL DEVELOPMENTS

GEOTECHNICAL INVESTIGATION
CARP AIRPORT RESIDENTIAL DEVELOPMENT

CARP,
ONTARIO

Title:

TEST HOLE LOCATION PLAN

Scale: 1:10000
Date: 10/2022
Drawn by: GK
Report No.: PG2450-2
Checked by: KP
Dwg. No.: PG2450-1
Approved by: DJG
Revision No.: 3

11x17

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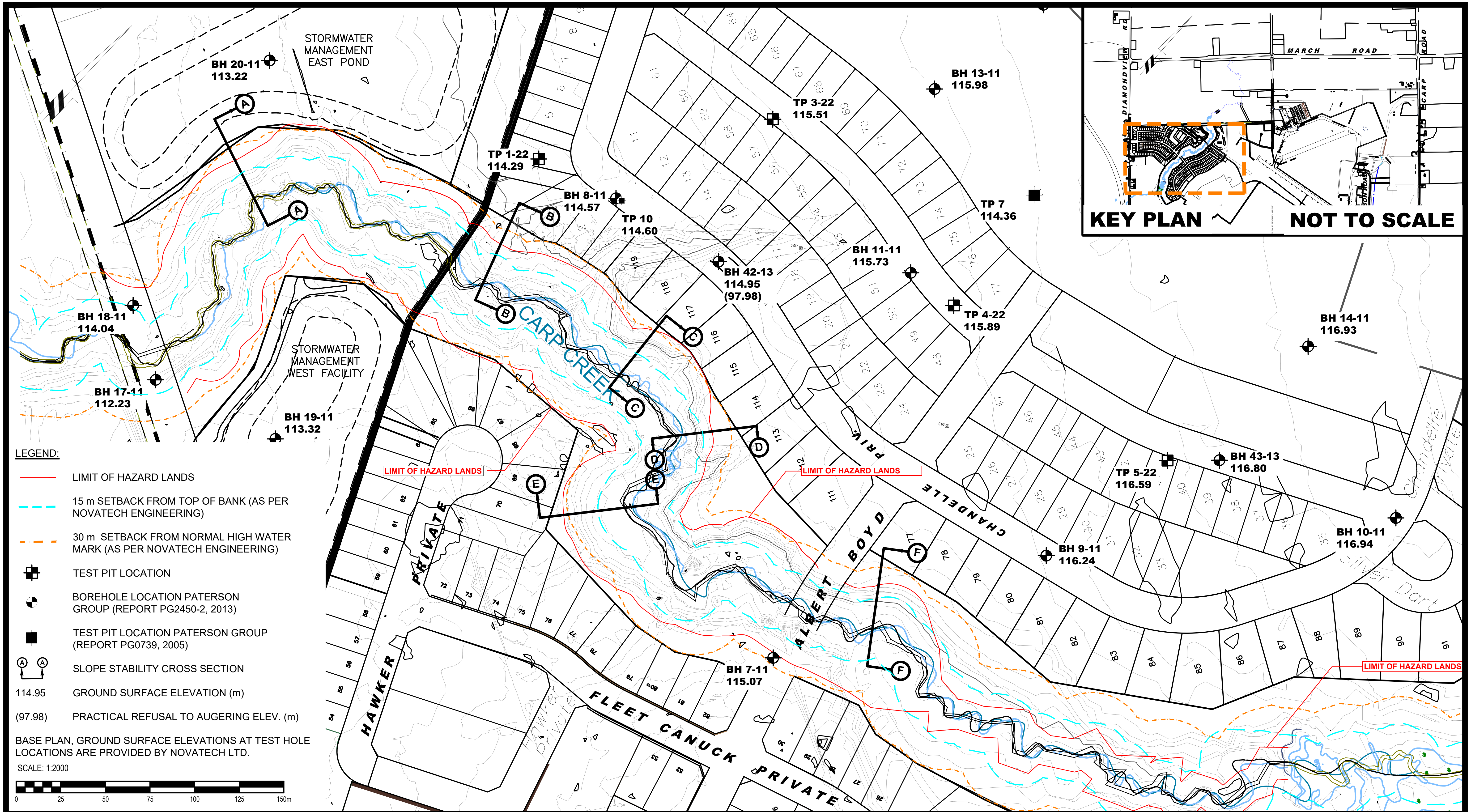


LEGEND:

—	LIMIT OF HAZARD LANDS
– –	15 m SETBACK FROM TOP OF BANK (AS PER NOVATECH ENGINEERING)
- - -	30 m SETBACK FROM NORMAL HIGH WATER MARK (AS PER NOVATECH ENGINEERING)
⊞	TEST PIT LOCATION
⊕	BOREHOLE LOCATION PATERSON GROUP (REPORT PG2450-2, 2013)
■	TEST PIT LOCATION PATERSON GROUP (REPORT PG0739, 2005)
Ⓐ Ⓐ	SLOPE STABILITY CROSS SECTION
114.95	GROUND SURFACE ELEVATION (m)
(97.98)	PRACTICAL REFUSAL TO AUGERING ELEV. (m)

BASE PLAN, GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS ARE PROVIDED BY NOVATECH LTD.

SCALE: 1:2000

0 25 50 75 100 125 150m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	ADDED TEST PITS TP 1-22 TO TP 5-22	10/11/2022	KP
1	CONCEPTUAL PLAN UPDATED	12/13/2022	KP

WEST CAPITAL DEVELOPMENTS

GEOTECHNICAL INVESTIGATION
CARP AIRPORT RESIDENTIAL DEVELOPMENT

OTTAWA, ONTARIO

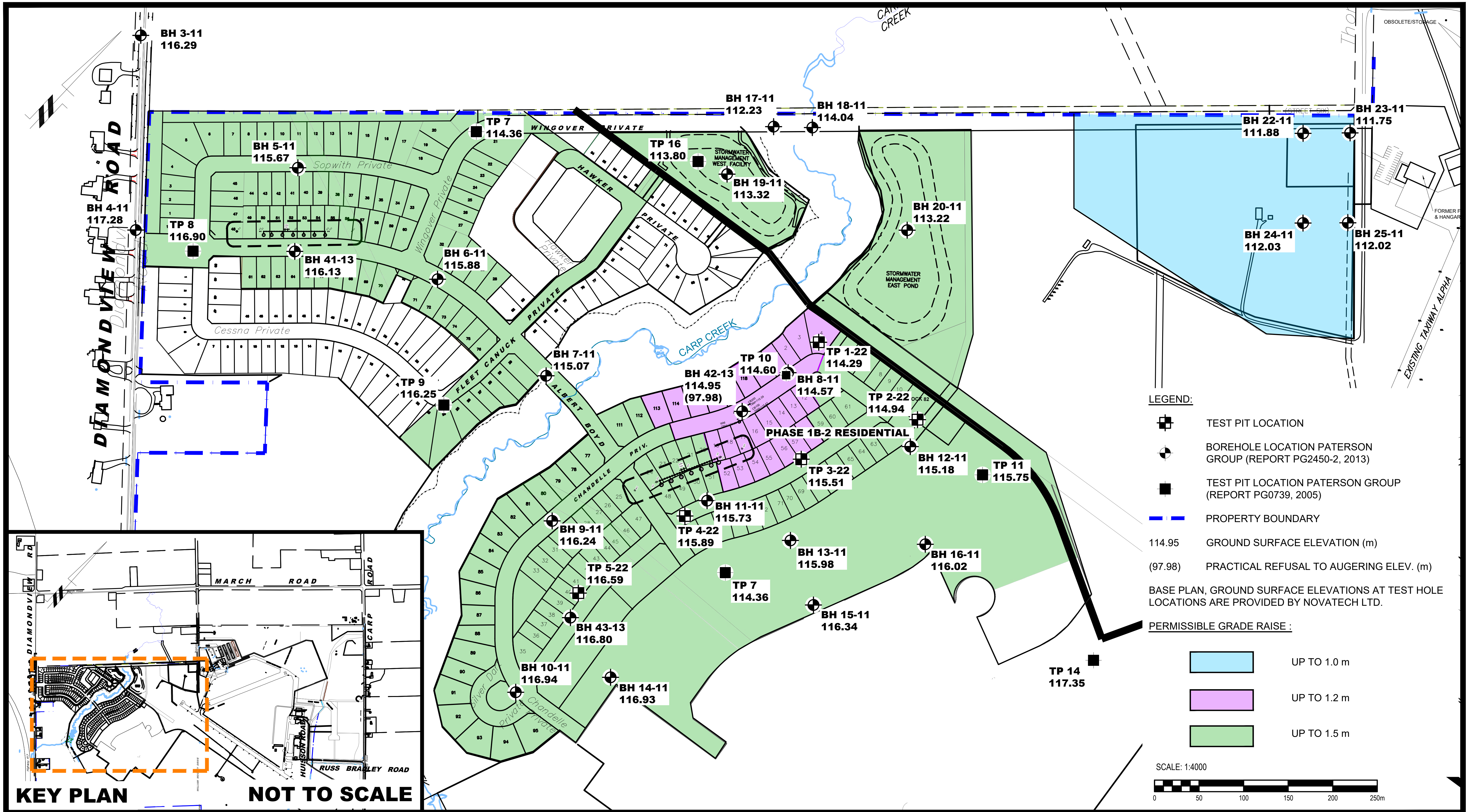
Title:

LIMIT OF HAZARD LANDS

Scale: 1:2000	Date: 05/2013
Drawn by: GK	Report No.: PG2450-2
Checked by: KP	Dwg. No.: PG2450-2
Approved by: DJG	Revision No.: 2

p:\autocad drawings\geotechnical\pg24xx\pg2450\pg2450-2-limit of hazard lands (rev.01) 2.dwg

11x17



LEGEND:

⊕	TEST PIT LOCATION
◐	BOREHOLE LOCATION PATERSON GROUP (REPORT PG2450-2, 2013)
■	TEST PIT LOCATION PATERSON GROUP (REPORT PG0739, 2005)
— · —	PROPERTY BOUNDARY
114.95	GROUND SURFACE ELEVATION (m)
(97.98)	PRACTICAL REFUSAL TO AUGERING ELEV. (m)

BASE PLAN, GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS ARE PROVIDED BY NOVATECH LTD.

PERMISSIBLE GRADE RAISE :

🟦	UP TO 1.0 m
🟪	UP TO 1.2 m
🟩	UP TO 1.5 m

SCALE: 1:4000

0 50 100 150 200 250m

PATERSON GROUP

9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
2	CONCEPTUAL PLAN UPDATED	12/13/2022	KP
1	ADDED TEST PITS TP 1-22 TO TP 5-22	10/11/2022	KP

WEST CAPITAL DEVELOPMENTS

GEOTECHNICAL INVESTIGATION
CARP AIRPORT RESIDENTIAL DEVELOPMENT

CARP, ONTARIO

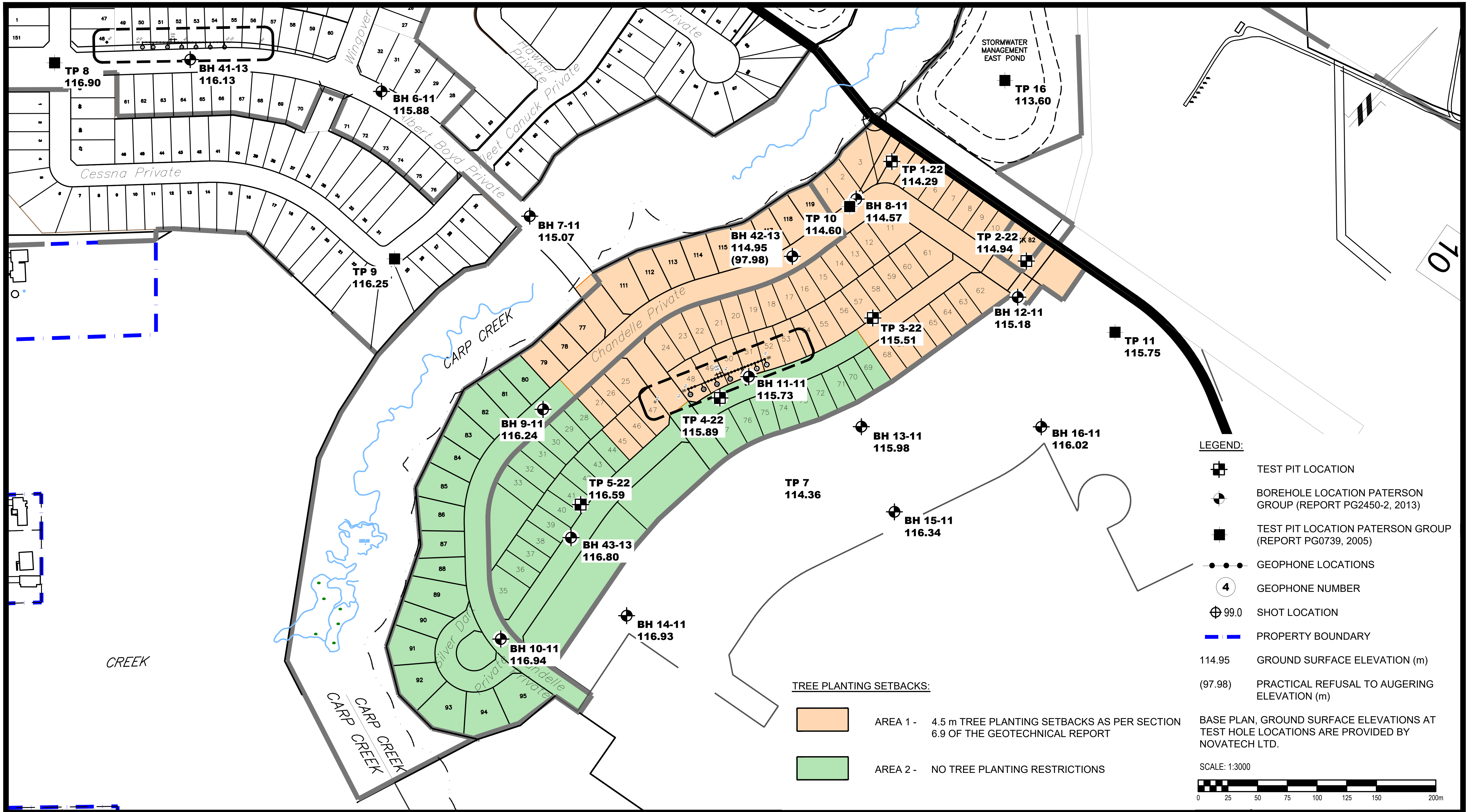
Title:

PERMISSIBLE GRADE RAISE PLAN

Scale: 1:4000
Date: 07/2013
Drawn by: GK
Report No.: PG2450-2
Checked by: KP
Dwg. No.: PG2450-3
Approved by: DJG
Revision No.: 2

p:\autocad drawings\geotechnical\pg24xx\pg2450\pg2450 -3 permissible grade raise plan (nov 2022).dwg

11x17



LEGEND:

⊕	TEST PIT LOCATION
◐	BOREHOLE LOCATION PATERSON GROUP (REPORT PG2450-2, 2013)
■	TEST PIT LOCATION PATERSON GROUP (REPORT PG0739, 2005)
●–●–●	GEOPHONE LOCATIONS
4	GEOPHONE NUMBER
⊕ 99.0	SHOT LOCATION
▬ · ▬	PROPERTY BOUNDARY
114.95	GROUND SURFACE ELEVATION (m)
(97.98)	PRACTICAL REFUSAL TO AUGERING ELEVATION (m)

BASE PLAN, GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS ARE PROVIDED BY NOVATECH LTD.

TREE PLANTING SETBACKS:

🟧	AREA 1 -	4.5 m TREE PLANTING SETBACKS AS PER SECTION 6.9 OF THE GEOTECHNICAL REPORT
🟩	AREA 2 -	NO TREE PLANTING RESTRICTIONS

PATERSON GROUP
9 AURIGA DRIVE
OTTAWA, ON
K2E 7T9
TEL: (613) 226-7381

NO.	REVISIONS	DATE	INITIAL
1	CONCEPTUAL PLAN UPDATED	12/13/2022	KP

WEST CAPITAL DEVELOPMENTS

GEOTECHNICAL INVESTIGATION
CARP AIRPORT RESIDENTIAL DEVELOPMENT

CARP, ONTARIO

Title:

TREE PLANTING SETBACK PLAN

Scale: 1:3000
Date: 11/2022
Drawn by: GK
Report No.: PG2450-2
Checked by: KP
Dwg. No.: PG2450-4
Approved by: DJG
Revision No.: 1

11x17

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