Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

patersongroup

Geotechnical Investigation

Proposed Python Building Complex
Citigate Drive
Ottawa, Ontario

Prepared For

Python LP

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Report PG5284-1

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Python LP to conduct a geotechnical investigation for the proposed building complex to be located on Citigate Drive in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2 of this report).

The objectives of the investigation were to:

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

2.0 Proposed Development

Proposed Development

Based on the available drawings, it's our understanding that the proposed building will consist of a multi-storey building with a main floor at grade with no basement level. It's expected that associated paved access lanes, truck loading areas, vehicle parking areas and landscaped areas will surround the proposed building, and the building will be municipally serviced.

A retaining wall will most likely be required along the western boundary due to a proposed significant cut to the existing grade.

Design Criteria

The geotechnical investigation and reporting was carried out in general accordance with the project design criteria. The geotechnical design and recommendations meets the requirements of the project design criteria stipulated in the above sections.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The field program for the initial investigation was conducted during the period of July and August of 2000. The field program consisted of drilling 5 boreholes (BHs 3, 4, 7, 8 and 9) to depths ranging from 2.8 to 8.8 m below the existing grade. Furthermore, a total of 24 test pits (TPs 1, 2, 3, 4, 16, 17, 19, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 37, 38, 39 and 40) to depths ranging from 2.7 to 4.6 m below the existing grade. The test hole locations were distributed in a manner to provide general coverage of the subject site taking into consideration underground utilities and site features. The locations of the test holes are shown on Drawing PG5284-1 - Test Hole Location Plan included in Appendix 2.

The boreholes were completed with a track-mounted auger drill rig operated by a two-person crew. All fieldwork was conducted under the full-time supervision of our personnel under the direction of a senior engineer. The test hole procedure consisted of augering to the required depths at the selected locations, and sampling and testing the overburden.

The test pits were completed with a rubber tired backhoe under the full-time supervision of our personnel under the direction of a senior engineer. The test hole procedure consisted of excavating to the required depths at the selected locations, and sampling and testing the overburden.

Sampling and In Situ Testing

Soil samples were recovered using a 50 mm diameter split-spoon sampler. The split-spoon samples were classified on site and placed in sealed plastic bags. All samples were transported to our laboratory. The depths at which the split-spoon were recovered from the boreholes are shown as SS on the Soil Profile and Test Data sheets in Appendix 1.

A Standard Penetration Test (SPT) was conducted in conjunction with the recovery of the split spoon samples. The SPT results 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. This testing was done in general accordance with ASTM D1586-11 - Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.

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

Inferred bedrock was determined based on auger refusal at all borehole locations. The inferred bedrock depth can also be large boulders which are typically encountered in this general area within the glacial till deposit.

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

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 directed otherwise.

3.2 Field Survey

The test hole locations were selected by Paterson personnel in a manner to provide general coverage of the proposed development, taking into consideration site features.

The borehole and test pit locations and ground surface elevations were surveyed by Webster and Simmonds Surveying Limited and are presented on Drawing PG5284-1 - Test Hole Location Plan in Appendix 2. Boreholes and test holes were surveyed and referenced to geodetic datum.

3.3 Laboratory Testing

Soil samples were recovered from the subject site and visually examined in our laboratory to review the results of the field logging.

3.4 Analytical Testing

One soil sample was submitted for analytical testing to assess the corrosion potential for exposed ferrous metals and the potential of sulphate attacks against subsurface concrete structures. The samples were submitted to determine the concentration of sulphate and chloride, the resistivity and the pH of the samples. The results are presented in Appendix 1 and are discussed further in Subsection 6.8.

4.0 Observations

4.1 Surface Conditions

The majority of the subject site is occupied by agricultural fields and is relatively flat. The west portion of the site slopes gradually upwards to the west. Rows of trees and drainage ditches were noted along the perimeter of the agricultural fields. A 3 to 4 m high slope runs along the west property boundary down to a drainage ditch running along the Highway 416 northbound lane and partially along the Highway 416 exit ramp to Strandherd Drive. The north portion of the exit ramp rises above the subject site within the northwest portion of the subject site.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the test hole locations consists of topsoil underlain by a silty sand to sandy silt and/or a stiff to very stiff silty clay deposit over a dense glacial till layer which in turn overlies bedrock. Specific details of the soil profile at each test hole location are presented on the Soil Profile and Test Data sheets in Appendix 1.

Bedrock

Based on available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River formation. The overburden drift thickness is estimated to be between 0 to 15 m.

4.3 Groundwater

Groundwater levels were measured in the standpipes at the borehole locations on August 22, 2000. The measured groundwater level (GWL) readings ranged from 0.4 to 1.1 m below the existing grade when encountered. Two boreholes were dry to full depth ranging from 2.7 to 3.5 m below the existing grade. Based on our field observations, experience with the local area, moisture levels and the colouring of the recovered samples, it is expected that the long-term groundwater level can be estimated between 3 to 4 m below existing grade. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater level could vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

From a geotechnical perspective, the subject site is suitable for the proposed building. It is expected that the proposed building will be founded on conventional spread footings placed on the dense glacial till deposit. In the western portion of the site, due to the proposed finished floor elevation, bedrock may be encountered at the proposed founding elevation.

Due to the dense nature of the glacial till deposit, the permissible grade raise is acceptable for the proposed finished floor elevation (103.0 m). For the eastern portion, a very stiff silty clay deposit is encountered in the depressed area in the location of the proposed parking lot. Permissible grade raise recommendations are discussed in Subsection 5.3. If higher than permissible grade raises are required, preloading with or without surcharge, lightweight fill and/or other measures should be investigated to reduce the unacceptable long-term post construction total and differential settlements.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and any fill, containing significant amounts of deleterious or organic materials, should be stripped from under the proposed building, paved areas, pipe bedding and other settlement sensitive structures.

Fill Placement

Fill used for grading beneath the building footprint, unless otherwise specified, should consist of clean imported granular fill, such as Ontario Provincial Standard Specifications (OPSS) Granular A or Granular B Type II. Furthermore, the native glacial till material generated from the cut and fill operation on site, can also be used for grading beneath the building footprint and pavement areas. Imported fill should be tested and approved prior to delivery to the site. All fill used for grading should be placed in lifts no greater than 300 mm thick and compacted using heavy vibratory compaction equipment. Fill placed beneath the building area should be compacted to at least 98% of the material's standard Proctor maximum dry density (SPMDD).

Boulders larger than 300 mm in their longest dimensions should be removed from the glacial till prior to being reused.

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. The site-generated silty sand/glacial till material may be used to build up the subgrade level for areas to be paved. This material, under dry and above freezing conditions, should be placed in maximum 300 mm lifts and compacted to a minimum density of 95% of its SPMDD.

Placement of site-generated fill material during winter months increases the risk of placing frozen material which may result in poor performing areas that may require sub-excavation of the material and subsequent reinstatement. 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 blanket connected to a perimeter drainage system.

Permissible Grade Raise

The building area is primarily founded on a dense glacial till deposit. Due to the proposed cut in elevated western portion of the site, the existing grade will be lowered in the glacial till areas and will most likely intercept the bedrock. Permissible grade raise restrictions for both the building footprint and the surrounding pavement areas are not applicable for these areas based on a finished floor elevation of 103.0 m.

Based on the existing borehole coverage and undrained shear strength testing completed within the underlying cohesive soil, a permissible grade raise restriction of **2 to 3 m** is recommended for access roadways and parking areas.

For the silty clay deposit areas, within the proposed **parking lot areas** in the eastern portion of the subject site, preloading should be carried out to consolidate the very stiff silty clay deposit overlying the glacial till layer. It’s expected that the preloading will be carried out during the pre-grading program once the cut and fill operations commence. With this preloading in effect for over 8 to 12 months, the primary settlement due to the preloading will eliminate most of the post construction settlement will be completed by the time asphalt is placed.

The only possible areas affected by a permissible grade raise restriction will be the areas adjacent to the **eastern portion of the building**. Consideration could be given to subexcavating the slightly compressible silty clay deposit to the underlying glacial till in the eastern portion of the building and within a distance of 6 to 10 m from the building foundation where a transition will exist between the building hard scape areas and parking areas along with access roadways.

5.3 Foundation Design

Bearing Resistance Values (Spread Footing Foundation)

Conventional spread footings for the proposed structure can be placed on an undisturbed, dense glacial till deposit designed using a bearing resistance value at Serviceability Limit State (SLS) of **300 kPa** and a factored bearing resistance value at Ultimate Limit State (ULS) of **450 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance at ULS.

In the western portion, where the bedrock surface may be intercepted along the proposed cut section, conventional spread footings for the proposed structure can be placed on the clean surface sounded bedrock designed using a bearing resistance value at Serviceability Limit State (SLS) of **1,500 kPa** and a factored bearing resistance value at Ultimate Limit State (ULS) of **2,500 kPa**. A geotechnical resistance factor of 0.5 was applied to the bearing resistance at ULS.

In transition areas between the bedrock and the glacial till deposit, footings founded directly on the glacial till deposit and transitioning to bedrock will require a treatment to avoid point loads especially along strip footings. The transition treatment could consist of removing a further 150 mm of bedrock and placing an engineered fill or a layer of rigid insulation. This detail can be provided during construction based on site specific conditions.

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 total and differential settlements associated with the footing loading conditions using the bearing resistance value at SLS provided are estimated to be 25 and 20 mm, respectively.

The bearing medium under footing-supported structures is required to be provided with adequate lateral support with respect to excavations and different foundation levels. Satisfactory lateral support is provided to a dense glacial till above the groundwater table when a plane extending horizontally and vertically from the underside of the footing at a minimum of 1.5H:1V passing through in situ soil of the same or higher bearing capacity as the bearing medium soil.

5.4 Design for Earthquakes

It's expected that the proposed development will be founded primarily of the dense glacial till deposit (and bedrock along the western boundary) and the remainder will be on engineered fill extending to the same dense glacial till deposit. Based on this approach, the proposed structure will be considered to be founded directly and indirectly on the same dense glacial till deposit. Therefore, the seismic site classification for this approach will be considered as **Class C** and applicable for design of the proposed building, as per Table 4.1.8.4.A of the OBC 2012. The soil underlying the subject site are not susceptible to liquefaction.

5.5 Slab-on-Grade Construction

Subfloor Granular

With the removal of all topsoil and fill, containing deleterious or organic materials, within the footprint of the proposed building, the native soil and/or approved fill pad will be considered to be an acceptable subgrade surface on which to commence backfilling for the floor slab. The native glacial till deposit is an acceptable subgrade material for building up the subgrade below the slab-on-grade. The upper 300 mm of sub-slab fill should consist of an OPSS Granular A crushed stone. All backfill material within the footprint of the proposed building should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular A or Granular B Type II, with a maximum particle size of 50 mm, are recommended for backfilling below the floor slab.

Modulus of Subgrade Reaction

A modulus of subgrade reaction of **30 MPa/m** can be used for slab design over an approved granular pad as detailed above.

5.6 Rock Anchor Design

The geotechnical design of grouted rock anchors in dolostone bedrock is based upon two possible failure modes. The rock anchor can fail by shear failure along the grout/rock interface or by pullout at 60 to 90 degree cone of rock with the apex of the cone near the middle of the bonded length of the anchor. Interaction may develop between the failure cones of anchors that are relatively close to one another resulting in a total group capacity smaller than the sum of the individual anchor load capacity.

A third failure mode of shear failure along the grout/steel interface should be reviewed by a qualified structural engineer to ensure all typical failure modes have been reviewed. Typical rock anchor suppliers, such as Dywidag Systems International (DSI Canada) or Williams Form Engineering, have qualified personnel on staff to recommend appropriate rock anchor size and materials.

Anchors in close proximity to each other are recommended to be grouted at the same time to ensure any fractures or voids are completely in-filled and grout fluid does not flow from one hole to an adjacent empty one.

Anchors can be of the “passive” or the “post-tensioned” type, depending on whether the anchor tendon is provided with post-tensioned load or not, prior to servicing.

Regardless of whether an anchor is a passive or the post tensioned type, it is recommended that the anchor is provided with a fixed anchor length at the base, which will provide the capacity, and a free anchor length between the rock surface and the top of the bonded length. As the depth at which the apex of the shear failure cone develops midway along the bonded length, a fully bonded anchor would tend to have a much shallower cone, and therefore less geotechnical resistance, than one where the bonded length is limited to the bottom part of the overall anchor.

Permanent anchors should be provided with corrosion protection. As a minimum, this requires that the entire drill hole be filled with cementitious grout. The free anchor length is provided by installing a sleeve to act as a bond break, with the sleeve filled with grout. Double corrosion protection can be provided with factory assembled systems, such as those available from Dywidag Systems International or Williams Form Engineering Corp.

Grout to Rock Bond

The unconfined compressive strength of dolostone at the subject site ranges between 80 and 120 MPa, which is stronger than most routine grouts. A factored tensile grout to rock bond resistance value at ULS of **1.0 MPa**, incorporating a resistance factor of 0.3, should be provided. A minimum grout strength of 40 MPa is recommended.

Rock Cone Uplift

The rock anchor capacity depends on the dimensions of the rock anchors and the anchorage system configuration. Based on existing bedrock information, a **Rock Mass Rating (RMR) of 69** was assigned to the bedrock, and Hoek and Brown parameters (**m and s**) were taken as **0.575 and 0.00293**, respectively.

Recommended Grouted Rock Anchor Lengths

Parameters used to calculate grouted rock anchor lengths are provided in Table 1.

Table 1 - Parameters used in Rock Anchor Review

Grout to Rock Bond Strength - Factored at ULS	1.0 MPa
Compressive Strength - Grout	40 MPa
Rock Mass Rating (RMR) - Good quality Dolostone Hoek and Brown parameters	69 m=0.575 and s=0.00293
Unconfined compressive strength - Limestone	80 MPa
unit weight - Bedrock	22 kN/m^3
Apex angle of failure cone	60°
Apex of failure cone	mid-point of fixed anchor length

The fixed anchor length will depend on the diameter of the drill holes. Recommended anchor lengths are provided in Table 2. The factored tensile resistance values provided are based on a single anchor with no group influence effects.

Table 2 - Recommended Rock Anchor Lengths - Grouted Rock Anchor

Diameter of Drill Hole (mm)	Anchor Lengths (m)			Factored Tensile Resistance (kN)
	Bonded Length	Unbonded Length	Total Length	
75	3.2	1.2	4.4	1000
	4.5	2	6.5	1500
	7.5	2.5	10	2000
	9.8	3	12.8	2500
125	2.3	0.9	3.2	1000
	3	1.3	4.3	1500
	6	2.2	8.2	3000
	8.6	2.8	11.4	4000

Other Considerations

It is recommended that the anchor drill hole diameter be within 1.5 to 2 times the rock anchor tendon diameter. The anchor drill holes should be inspected by geotechnical personnel and should be flushed clean prior to grouting. A tremie pipe is recommended to place grout from the bottom to top of the anchor holes.

The geotechnical capacity of each rock anchor should be proof tested at the time of construction. More information on test procedures can be provided upon request. Compressive strength testing is recommended to be completed for the rock anchor grout. A set of grout cubes should be tested for each day grout is prepared.

5.7 Pavement Structure

Pavement Structures

Car only parking areas, heavy truck parking areas, access lanes, fire lanes, gravel roads and concrete aprons are anticipated at this site. The proposed pavement structures are presented in Tables 3 to 5 are based on a 20 year life cycle for flexible pavement structures and 30 year life cycle on rigid pavement structures:

Table 3
Recommended Light Duty Flexible Pavement Structure for Car Only Parking Areas

Thickness (mm)	Material Description
50	Wear Course - HL-3 or Superpave 12.5 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
450	SUBBASE - OPSS Granular B Type II
Separation Layer	Woven geotextile - Terrafix 200W or equivalent
SUBGRADE - It’s expected that most of the parking areas will be infilled with cut native material from the western portion of the development	

Table 4
Recommended Flexible Pavement Structure for Access Lanes and Heavy Truck Parking Areas

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
50	Base Course - HL-8 or Superpave 19.0 Asphaltic Concrete
150	BASE - OPSS Granular A Crushed Stone
550	SUBBASE - OPSS Granular B Type II
Separation Layer	Woven geotextile - Terrafix 200W or equivalent

SUBGRADE - It's expected that most of the parking areas will be infilled with cut native material from the western portion of the development

Table 5
Recommended Rigid Pavement Structure for Concrete Aprons

Thickness (mm)	Material Description
200	Concrete slab (project specifications)
150	BASE - OPSS Granular A Crushed Stone
600	SUBBASE - OPSS Granular B Type II
100	HI-40 Rigid Insulation

SUBGRADE - It's expected that most of the parking areas will be infilled with cut native material from the western portion of the development.

If soft spots develop in the subgrade during compaction or due to construction traffic, the affected areas should be excavated and replaced with an OPSS Granular B Type II material. The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 98% of the material's SPMDD using suitable vibratory equipment.

Rigid Pavement Apron - Frost Protection Recommendations

To improve the long term performance of the concrete apron and lessen the effects of frost penetration and movement, the following insulation detail is suggested:

- ❏ Insulation type required. . . . . HI-40 or equivalent
- ❏ HI-40 Insulation thickness (directly under the concrete apron) . . . . 100 mm
- ❏ HI-60 Insulation thickness (0 to 1.2 m beyond the edge of the apron) . . . . . 75 mm
- ❏ HI-60 Insulation thickness (1.2 to 2.4 m beyond the edge of the apron) . . . . 50 mm
- ❏ HI-60 Insulation thickness (2.4 to 3.6 m beyond the edge of the apron) . . . . 25 mm

Frost Tapers

For utility trenches and other subgrade structures backfilled with non-frost susceptible granular material or at the interface between the concrete apron and flexible pavement structure, consideration should be given to installing a 1V:5H frost tapers in hard landscaped areas and below pavement structures to lessen the effects of differential frost heaving. Consideration could also be given to installing rigid insulation which requires tapering with various insulation thicknesses.

Pavement Structure Drainage

The pavement structure performance is dependent on the moisture condition at the contact zone between the subgrade material and granular base. Failure to provide adequate drainage under conditions of heavy wheel loading could result in the subgrade fines pumped into the stone subbase voids, thereby reducing the load bearing capacity.

Due to the impervious nature of the subgrade materials and transitions between various pavement structures, consideration should be provided to installing subdrains during the pavement construction. At transition zones between various pavement structures, subdrains will be installed longitudinally to drain any potential water trapped in the granular layers. The subdrains at catch basins should extend in four orthogonal directions and longitudinally when placed along a curb. The clear crushed stone surrounding the drainage lines or the pipe, should be wrapped with suitable filter cloth. 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. Discharge of the subdrains should be directed by gravity to storm sewers or deeper drainage ditches.

6.0 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

Foundation Drainage

A perimeter foundation drainage system is considered optional for the proposed building. If implemented, 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. 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 drainage geocomposite, such as Delta Drain 6000, connected to the perimeter foundation drainage system. Imported granular materials, such as clean sand or OPSS Granular B Type I granular material, should otherwise be used for this purpose.

6.2 Protection of Footings Against Frost Action

Perimeter footings of heated structures are required to be insulated against the deleterious effects of frost action. A minimum of 1.5 m of soil cover should be provided for adequate frost protection of heated structures.

Exterior unheated footings, such as those for isolated exterior piers, are more prone to deleterious movement associated with frost action than 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 Slopes

The side slopes of excavations at the site should be either 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 excavation to be undertaken by open-cut methods.

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 (1.5H:1V).

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.

A trench box is recommended to protect personnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations should not remain open for extended periods of time

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.

At least 150 mm of OPSS Granular A should be used for pipe bedding for sewer and water pipes. The bedding should extend to the spring line of the pipe. Cover material, from the spring line to at least 300 mm above the obvert of the pipe, should consist of OPSS Granular A or Granular B Type II with a maximum size of 25 mm. The bedding and cover materials should be placed in maximum 225 mm thick lifts compacted to 95% of the material’s standard Proctor maximum dry density.

It should generally be possible to re-use the site materials above the cover material if the operations are carried out in dry weather conditions.

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) and above the cover material should match the soils exposed at the trench walls to minimize differential frost heaving. The trench backfill should be placed in maximum 225 mm thick loose lifts and compacted to a minimum of 95% of the material standard Proctor maximum dry density.

6.5 Groundwater Control

It is anticipated that groundwater infiltration into the excavations should be 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.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) Category 3 may be required for this project if more than 400,000 L/day of ground and/or surface water is to be pumped during the construction phase. A minimum of 4 to 5 months should be allowed for completion of the PTTW Category 3 application package and issuance of the permit by the MECP.

For typical ground or surface water volumes being pumped during the construction phase, between 50,000 to 400,000 L/day, it's 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 mostly 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, 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.

The trench excavations should be carried out in a manner to avoid the introduction of frozen materials, snow or ice into the trenches.

6.7 Slope Stability Analysis

A slope stability analysis was completed for the slopes along the west property boundary of the subject site. Two worst case sections of the slope were completed as part of our analysis. The cross section locations are presented on Drawing PG5284-1 - Test Hole Location Plan in Appendix 2.

Slope Stability Analysis

The analysis of the slope stability was completed 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 favouring 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 subsurface soil and groundwater conditions, a factor of safety greater than one is usually required to ascertain than the risks of failure are minimized. A minimum factor of safety of 1.5 is generally required for conditions where the failure of the slope would endanger permanent structures.

Static Condition Results

The results for the existing slope conditions at Sections A and B are shown in Figures 2 and 4 in Appendix 2. The factor of safety under static conditions was found to be greater than 1.5 for Section B. However, a 2.4 m stable slope setback from top of slope is required for Section A to achieve a factor of safety of 1.5.

Seismic Loading Results

An analysis considering seismic loading was also completed. A horizontal seismic acceleration, K_h, of 0.16G 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 3 and 5 for the slope sections. The results indicate that the factor of safety for Section B is greater than 1.1. However, a stable slope allowance of 8.3 m from top of slope is required for Section A to achieve a factor of safety of greater than 1.1.

Recommendations

Therefore, a limit of hazard lands setback of 8.3 m is required from top of slope in the immediate area of Section A. The limit of hazard lands setback line will be confirmed once the project design is confirmed. However, no geotechnical setback from top of slope is required for the remainder of the slope. It should also be noted that all other slopes within the site and slopes adjacent to the property boundaries are considered stable and do not require a geotechnical setback.

6.8 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. This result is indicative that Type 10 Portland cement (normal 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, whereas the resistivity is indicative of a moderate to slightly aggressive corrosive environment.

7.0 Recommendations

A materials testing and observation services program is a requirement for the provided foundation design data to be applicable. The following aspects of the program should be performed by the geotechnical consultant:

- Observation of all bearing surfaces prior to the placement of concrete.
- Review of the grading plan from a geotechnical perspective.
- Sampling and testing of the concrete and 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.

A report confirming that these works have been conducted in general accordance with our recommendations could be issued, upon request, following the completion of a satisfactory materials testing and observation program by the geotechnical consultant.

8.0 Statement of Limitations

The recommendations provided in this report are in accordance with our present understanding of the project. We request permission to review our recommendations when the drawings and specifications are completed.

A geotechnical investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test hole locations, we request 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 Python LP or their agents is not authorized without review by Paterson for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

Carlos P. Da Silva, P.Eng., ing., QP_{ESA}

LICENSED PROFESSIONAL ENGINEER
April 2, 2020
C. P. DA SILVA
PROVINCE OF ONTARIO

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

ANALYTICAL TESTING RESULTS

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Geotechnical and Environmental Engineers
28 Concourse Gate, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Strandherd Drive @ Highway 416
Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 12 August 00

FILE NO. **G7892**

HOLE NO. **BH 3**

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
Brown silty sand TOPSOIL	0.20
Very stiff, brown SILTY **CLAY**	2.29
Firm to stiff, grey SILTY **CLAY**	6.86
GLACIAL TILL: Soft to firm, grey clayey silt, some sand, gravel, cobbles and boulders -Sandy silt till by 8.1m depth	8.84

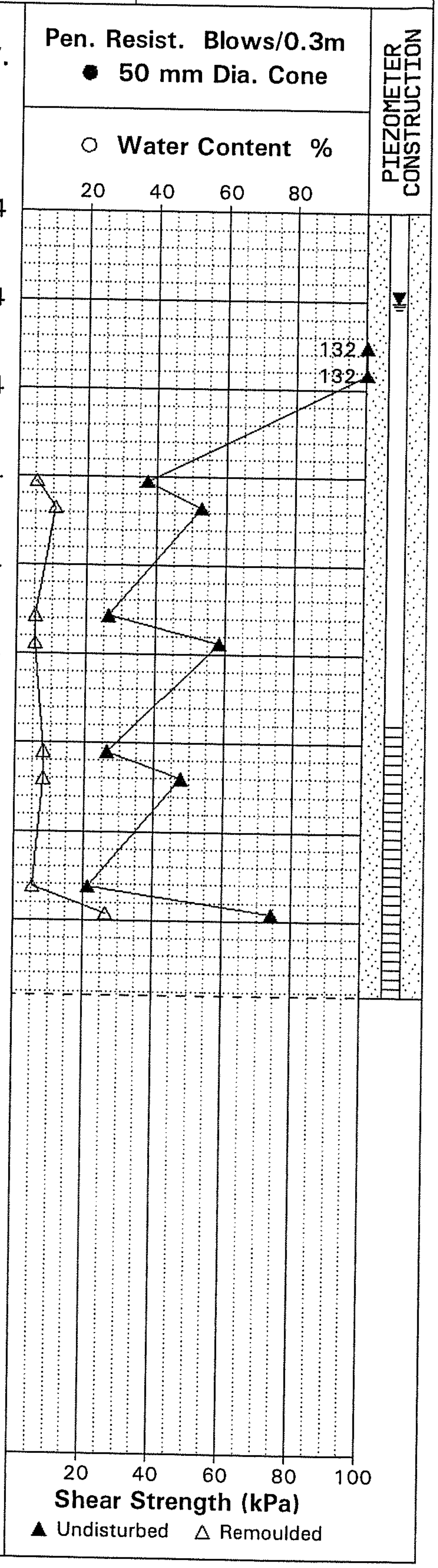
End of Borehole

Auger refusal @ 8.84m depth

(GWL @ 1.01m-Aug. 22/00)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	14	58	9
SS	15	100	3
SS	16	100	1
SS	17	100	1
SS	18	100	3

DEPTH (m)	ELEV. (m)
0	97.44
1	96.44
2	95.44
3	94.44
4	93.44
5	92.44
6	91.44
7	90.44
8	89.44



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REMARKS

BORINGS BY CME 55 Power Auger

DATE 12 August 00

FILE NO. G7892

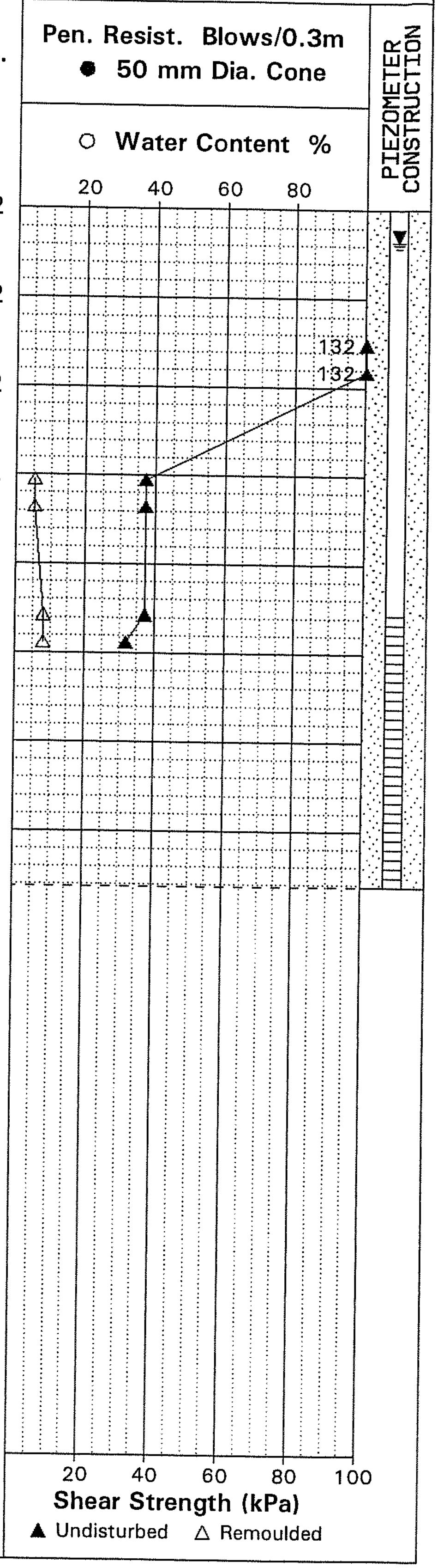
HOLE NO. BH 4

SOIL DESCRIPTION	Depth (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.10				
Brown **SANDY SILT**	0.60				
Very stiff, brown **SILTY CLAY**		SS	19	75	11
	2.29				
Firm, grey **SILTY CLAY**		SS	20	100	3
	3.66				
GLACIAL TILL: Firm, grey clayey silt, some sand, gravel, cobbles and boulders		SS	21	83	1
		SS	22	38	22
	7.62				
End of Borehole					

Auger refusal @ 7.62m depth

(GWL @ 0.36m-Aug. 22/00)

DEPTH (m)	ELEV. (m)
0	98.92
1	97.92
2	96.92
3	95.92
4	94.92
5	93.92
6	92.92
7	91.92



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REMARKS

BORINGS BY CME 55 Power Auger

DATE 15 August 00

FILE NO. **G7892**

HOLE NO. **BH 7**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	107.77
Brown silty **TOPSOIL** 0.13						
Brown **SILTY SAND**, some gravel and organics 0.68						
GLACIAL TILL: Dense to very dense, brown silty sand, some gravel, cobbles and boulders	SS	37	33	29	1	106.77
	SS	38	33	50+		
					2	105.77
	SS	39	67	50+	3	104.77
3.48						
End of Borehole						
Auger refusal @ 3.48m depth						
(BH dry-Aug. 22/00)						

STRATA PLOT

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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DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE 16 August 00

FILE NO. **G7892**

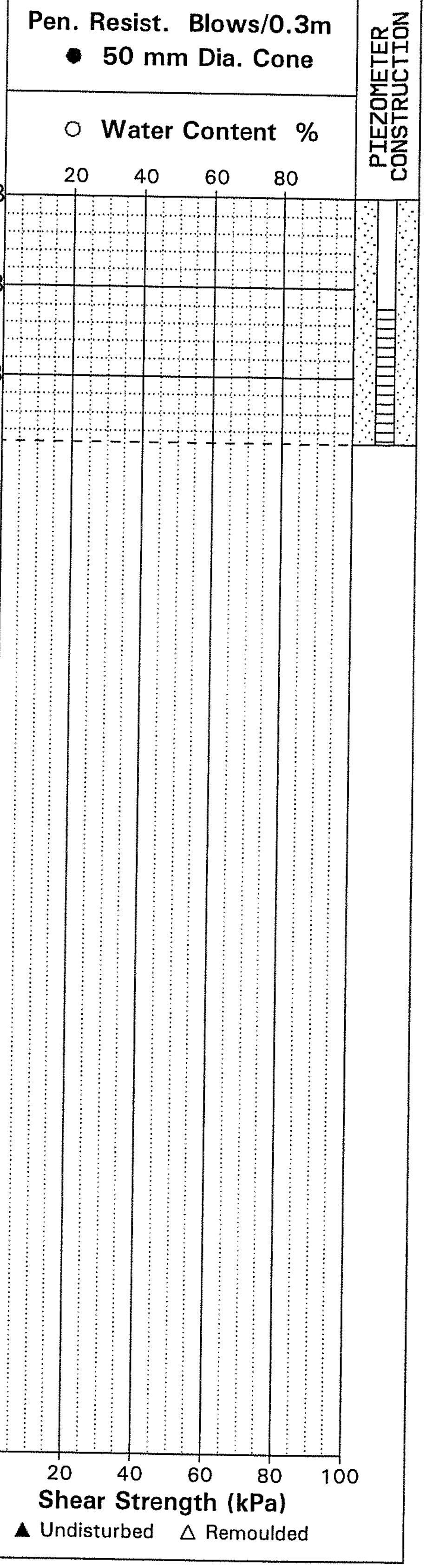
HOLE NO. **BH 8**

SOIL DESCRIPTION		SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	111.33
Dark brown **TOPSOIL**	0.15						
Compact to dense, brown **SANDY SILT**, some gravel		SS	40	44	20	1	110.33
	1.65	SS	41	71	50		
GLACIAL TILL: Dense, brown silty sand-gravel		SS	42	14	50	2	109.33
	2.74						

End of Borehole

Auger refusal @ 2.74m depth

(BH dry-Aug. 22/00)



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SOIL PROFILE & TEST DATA

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REMARKS

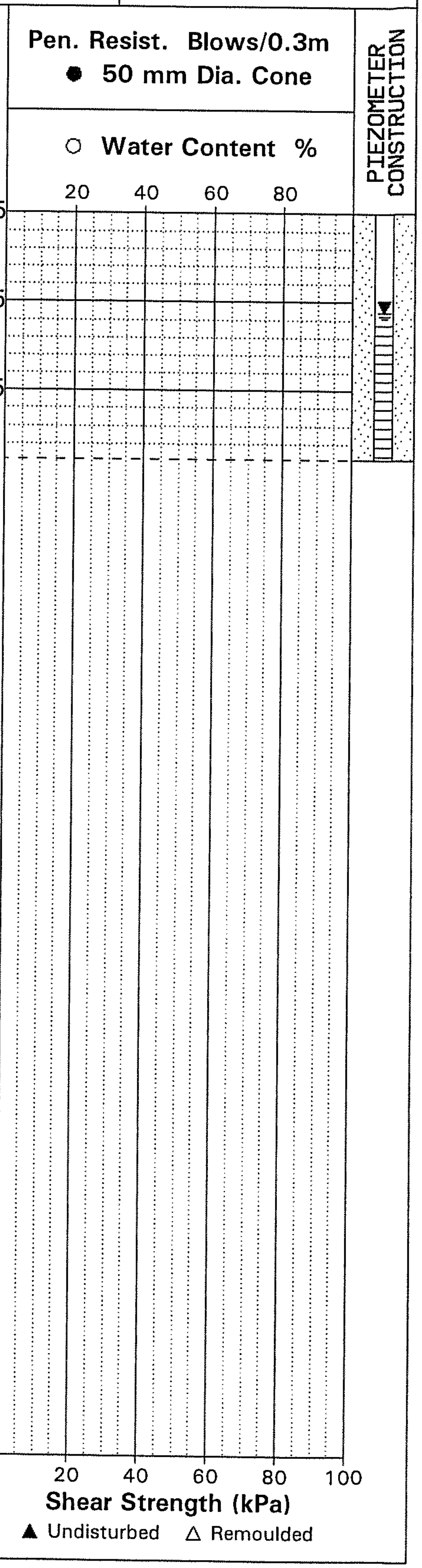
BORINGS BY CME 55 Power Auger

DATE 16 August 00

FILE NO. G7892

HOLE NO. BH 9

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	103.15
Dark brown **TOPSOIL**	0.18						
Very stiff, grey **SILTY CLAY**, trace sand	1.42	SS	43	62	12	1	102.15
GLACIAL TILL: Dense, grey silty sand, some gravel. Boulders from 2.13 to 2.74m depth	2.78	SS	44	54	37	2	101.15
End of Borehole Auger refusal @ 2.78m depth (GWL @ 1.12m-Aug. 22/00)							



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REMARKS

BORINGS BY Backhoe

DATE 31 July 00

FILE NO. **G7892**

HOLE NO. **TP 1**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
Dark brown **TOPSOIL** 0.15				
Brown **SILTY SAND**, some gravel 0.76				
GLACIAL TILL: Dense, light grey silty sand-gravel, some cobbles 3.81	G	1		
End of Test Pit (TP dry upon completion)				

DEPTH (m)	ELEV. (m)
0	110.32
1	109.32
2	108.32
3	107.32

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 31 July 00

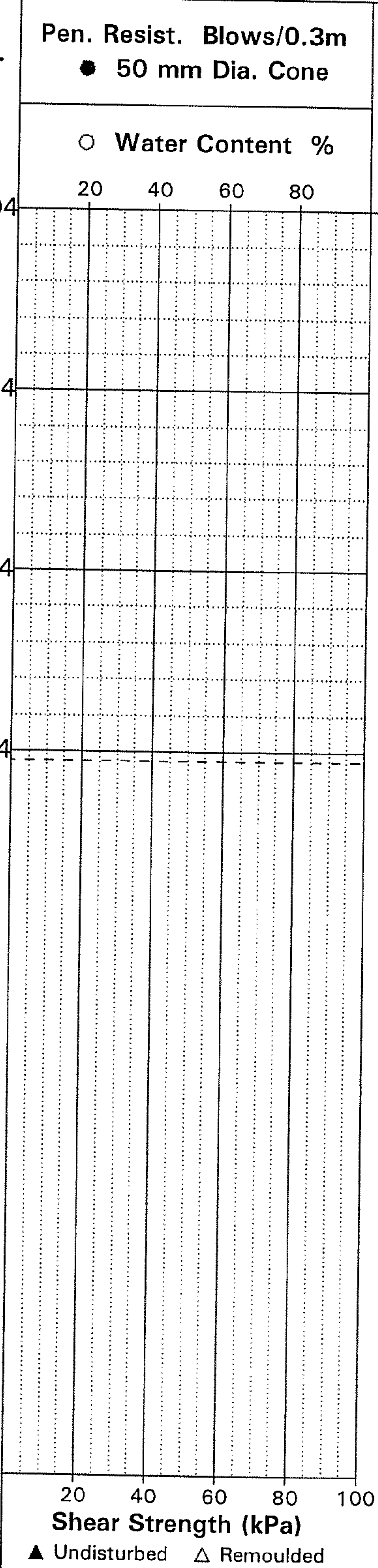
FILE NO. **G7892**

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	111.04
Dark brown **TOPSOIL** 0.15							
Brown **SILTY SAND**, some gravel 0.60							
GLACIAL TILL: Dense, light grey silty sand-gravel, some cobbles						1	110.04
						2	109.04
3.05		G	2			3	108.04
End of Test Pit							

TP terminated on inferred bedrock @ 3.05m depth

(TP dry upon completion)



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REMARKS

BORINGS BY Backhoe

DATE 31 July 00

FILE NO. **G7892**

HOLE NO. **TP 3**

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	98.79		
Dark brown **TOPSOIL** 0.20	■								
	▨					1	97.79		
Very stiff to stiff, brown to bluish grey **SILTY CLAY**	▨	G	3						
	▨					2	96.79		
	▨	G	4						
3.00	▨					3	95.79		
Stiff to firm, grey SILTY **CLAY**, some sand and gravel	▨	G	5						
3.66									
End of Test Pit (Water infiltration @ ~1.4m depth)									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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REMARKS

BORINGS BY Backhoe

DATE 31 July 00

FILE NO. G7892

HOLE NO. TP 4

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	99.13		
Dark brown **TOPSOIL** 0.20	■								
Very stiff, brown **SILTY CLAY**	▨					1	98.13		
	▨	G	6						
2.20	▨					2	97.13		
Grey **SILT** with trace clay, occasional sand seams, gravel and cobbles	▥					3	96.13		
	▥	G	7						
	▥	G	8						
4.11	▥					4	95.13		
End of Test Pit Refusal on inferred bedrock/possible boulder @ 4.11m depth (Water infiltration @ ~1.4m depth)									

20 40 60 80

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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REMARKS

BORINGS BY Backhoe

DATE 1 August 00

FILE NO. G7892

HOLE NO. TP16

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	99.19
Brown TOPSOIL 0.15						
Reddish brown SANDY SILT, some gravel 0.60						
					1	98.19
GLACIAL TILL: Light brown to dark grey silty sand-gravel, some boulders	G	31				
					2	97.19
	G	32				
3.05					3	96.19
End of Test Pit						

TP terminated on inferred bedrock surface @ 3.05m depth

(TP dry upon completion)

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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REMARKS

BORINGS BY Backhoe

DATE 1 August 00

FILE NO. G7892

HOLE NO. TP17

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	97.46
Brown TOPSOIL 0.20							
Very stiff, brown to bluish grey SILTY CLAY						1	96.46
		G	33			2	95.46
2.90							
GLACIAL TILL: Compact, grey, mixture of silt, sand and gravel, occasional cobbles and boulders 3.35		G	34			3	94.46
End of Test Pit							

Refusal on large boulder @ 3.35m depth

(Water infiltration @ ~1.4m depth)

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 & TEST DATA

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REMARKS

BORINGS BY Backhoe

DATE 1 August 00

FILE NO. **G7892**

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	98.20
Dark brown TOPSOIL 0.20	■						
Very stiff, brown to brownish grey SILTY CLAY	▨					1	97.20
1.98	▨	G	37			2	96.20
GLACIAL TILL: Grey silty sand-gravel, some cobbles and large boulders	⁘					3	95.20
	⁘	G	38				
3.81							
End of Test Pit (Water infiltration @ ~1.4m depth)							

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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REMARKS

BORINGS BY Backhoe

DATE 2 August '00

FILE NO. G7892

HOLE NO. TP21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	109.63
Dark brown **TOPSOIL** 0.15							
Reddish brown SANDY **SILT**, some gravel 0.76							
						1	108.63
						2	107.63
GLACIAL TILL: Compact to dense, grey silty sand-gravel, some large boulders							
						3	106.63
		G	41				
						4	105.63
						5	104.63
		G	42				
5.79 End of Test Pit							
(Open hole WL @ 4.7m 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

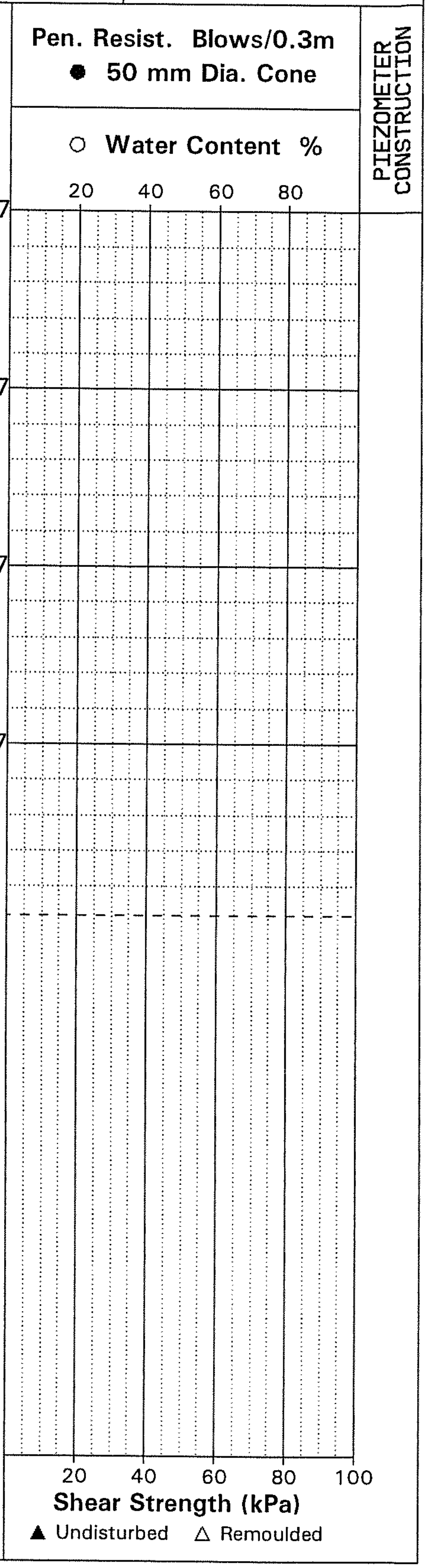
BORINGS BY Backhoe

DATE 2 August 00

FILE NO. G7892

HOLE NO. TP22

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	108.07
Dark brown **TOPSOIL** 0.15							
Reddish brown SANDY **SILT**, some gravel 0.76							
						1	107.07
GLACIAL TILL: Dense, grey silty sand-gravel, some boulders						2	106.07
						3	105.07
		G	43				
3.96							
End of Test Pit							
(TP dry upon completion)							



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REMARKS

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DATE 2 August 00

FILE NO. G7892

HOLE NO. TP23

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
Dark brown **TOPSOIL**	0.15				
Reddish brown SANDY **SILT**, some gravel	0.81				
GLACIAL TILL: Dense, light to dark grey silty sand-gravel, some cobbles and boulders	4.88	G	44		

End of Test Pit

Refusal on inferred bedrock/boulder @ 4.88m depth

(TP dry upon completion)

DEPTH (m)	ELEV. (m)
0	103.16
1	102.16
2	101.16
3	100.16
4	99.16

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

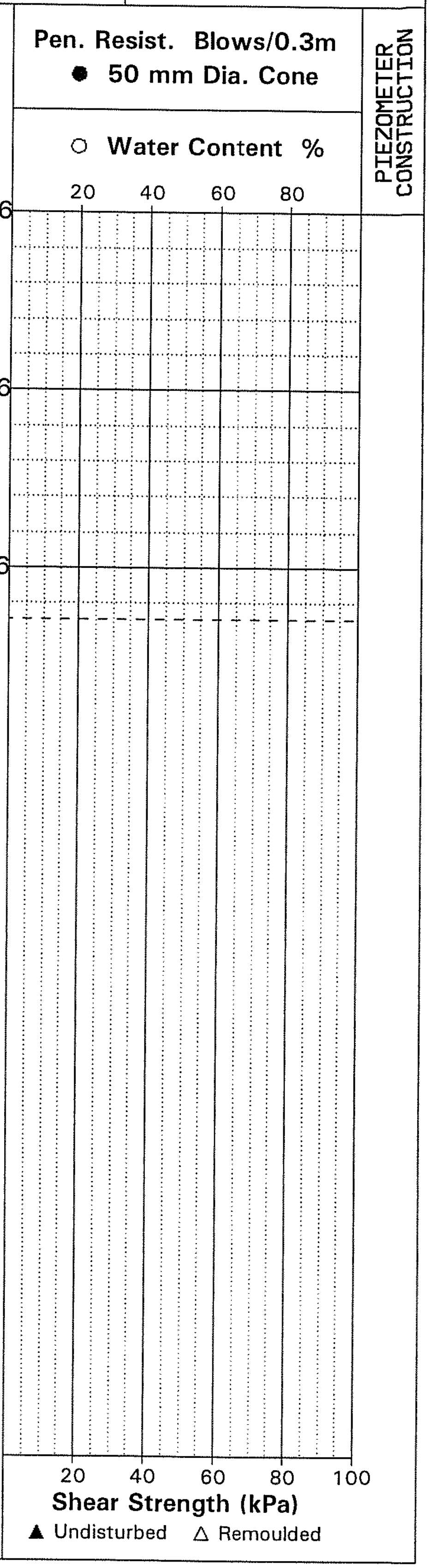
BORINGS BY Backhoe

DATE 2 August 00

FILE NO. G7892

HOLE NO. TP24

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	102.86
Dark brown **TOPSOIL** 0.15							
Reddish brown SANDY **SILT**, some gravel 0.60							
GLACIAL TILL: Grey silty sand-gravel, some cobbles						1	101.86
						2	100.86
2.29		G	45				
End of Test Pit TP terminated on bedrock surface @ 2.29m depth (TP dry upon completion)							



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REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. G7892

HOLE NO. TP25

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	107.16
Dark brown **TOPSOIL** 0.18							
Reddish brown SANDY **SILT**, some gravel 0.76							
						1	106.16
GLACIAL TILL: Dense, light brown silty sand-gravel, some cobbles and boulders						2	105.16
						3	104.16
		G	46				
3.96							
End of Test Pit (TP dry upon completion)							

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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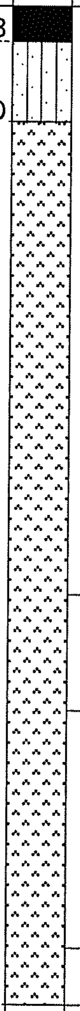
REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. **G7892**

HOLE NO. **TP26**



SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	106.15
Dark brown **TOPSOIL** 0.18						
Reddish brown SANDY **SILT**, some gravel 0.60						
					1	105.15
					2	104.15
GLACIAL TILL: Grey to bluish grey silty sand-gravel, some cobbles and boulders						
					3	103.15
	G	47				
					4	102.15
5.18	G	48			5	101.15
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

JOHN D. PATERSON & ASSOCIATES LTD.
Consulting Geotechnical and Environmental Engineers
28 Concourse Gate, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Strandherd Drive @ Highway 416
Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. **G7892**

HOLE NO. **TP28**

SOIL DESCRIPTION		STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							0	104.44
Brown **TOPSOIL**	0.15							
Reddish brown SANDY **SILT**, some gravel	0.81						1	103.44
GLACIAL TILL: Compact to dense, brown silty sand-gravel, some cobbles and boulders	4.57		G	52			2 3 4	102.44 101.44 100.44
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

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REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. **G7892**

HOLE NO. **TP29**

SOIL DESCRIPTION		STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
			TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE							0	103.63
Brown TOPSOIL	0.15							
Reddish brown SANDY **SILT**, some gravel	0.60							
							1	102.63
							2	101.63
GLACIAL TILL: Compact to dense, grey silty sand-gravel, some cobbles and boulders								
							3	100.63
							4	99.63
	4.88		G	53				
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

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SOIL PROFILE & TEST DATA

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Nepean, Ontario

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REMARKS

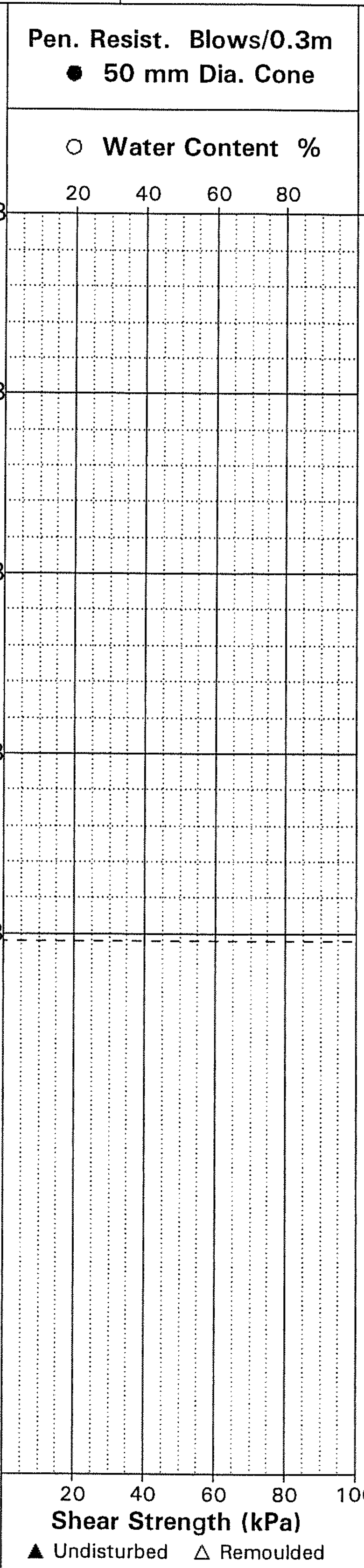
BORINGS BY Backhoe

DATE 2 August 00

FILE NO. G7892

HOLE NO. TP30

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	PIEZOMETER CONSTRUCTION
GROUND SURFACE						0	104.63	
Brown TOPSOIL — 0.20								
Reddish brown SANDY **SILT**, some gravel — 0.71								
						1	103.63	
						2	102.63	
GLACIAL TILL: Dense, grey silty sand-gravel, some cobbles and boulders								
						3	101.63	
— 4.04						4	100.63	
End of Test Pit (TP dry upon completion)								



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REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. **G7892**

HOLE NO. **TP31**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	PIEZOMETER CONSTRUCTION
GROUND SURFACE								
Brown **TOPSOIL** 0.18						0	102.12	
Reddish brown SANDY **SILT**, some gravel 0.71								
						1	101.12	
GLACIAL TILL: Dense, grey silt, some sand, gravel, cobbles and boulders						2	100.12	
						3	99.12	
		G	54					
3.81								
End of Test Pit TP terminated on bedrock surface @ 3.81m depth (Water infiltration @ 3.7m 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 & TEST DATA

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Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

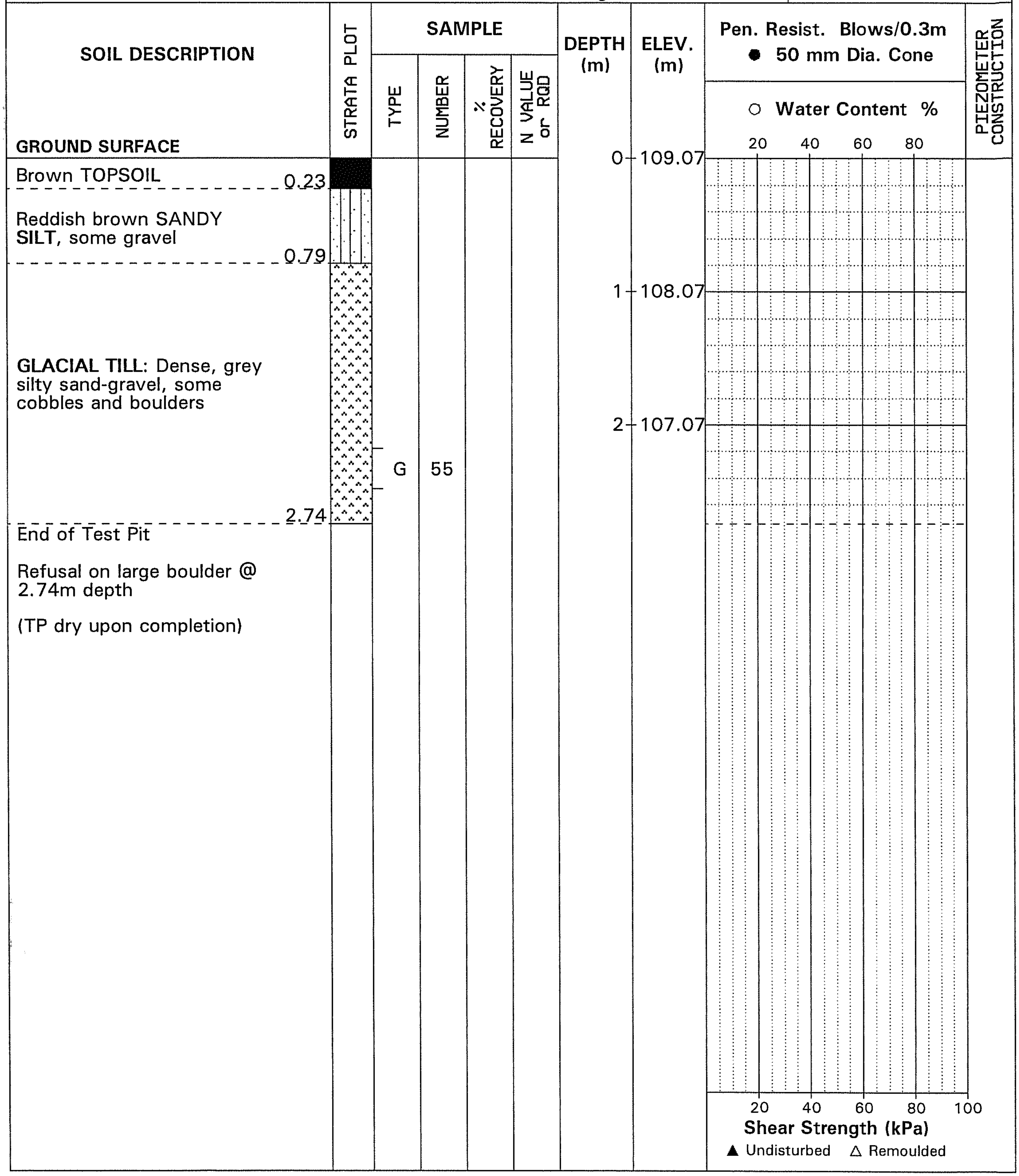
REMARKS

BORINGS BY Backhoe

DATE 2 August 00

FILE NO. **G7892**

HOLE NO. **TP32**



SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	109.07
Brown TOPSOIL 0.23						
Reddish brown SANDY SILT, some gravel 0.79						
					1	108.07
GLACIAL TILL: Dense, grey silty sand-gravel, some cobbles and boulders						
					2	107.07
	G	55				
2.74						

End of Test Pit

Refusal on large boulder @ 2.74m depth

(TP dry upon completion)

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SOIL PROFILE & TEST DATA

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Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP33**

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	110.74		
Dark brown **TOPSOIL** 0.18									
Reddish brown SANDY **SILT** 0.91									
						1	109.74		
GLACIAL TILL: Dense, grey silty sand-gravel, some cobbles and boulders						2	108.74		
2.82		G	56						
End of test Pit TP terminated on bedrock surface @ 2.82m depth (TP dry upon completion)									

Pen. Resist. / Water Content scale: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE & TEST DATA

Geotechnical Investigation
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Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

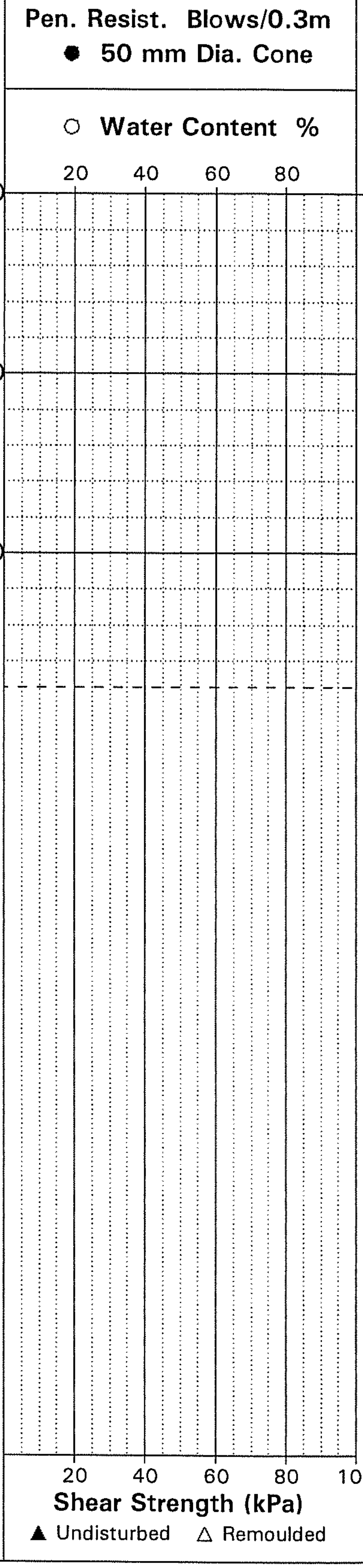
BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP34**

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	108.50
Dark brown **TOPSOIL**	0.18						
Reddish brown SANDY SILT	0.79					1	107.50
GLACIAL TILL: Dense, grey silty sand-gravel, some cobbles and boulders						2	106.50
		G	57				
	2.74						
End of Test Pit Refusal on large boulder @ 2.74m depth (TP dry upon completion)							



PIEZOMETER CONSTRUCTION

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SOIL PROFILE & TEST DATA

Geotechnical Investigation
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Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

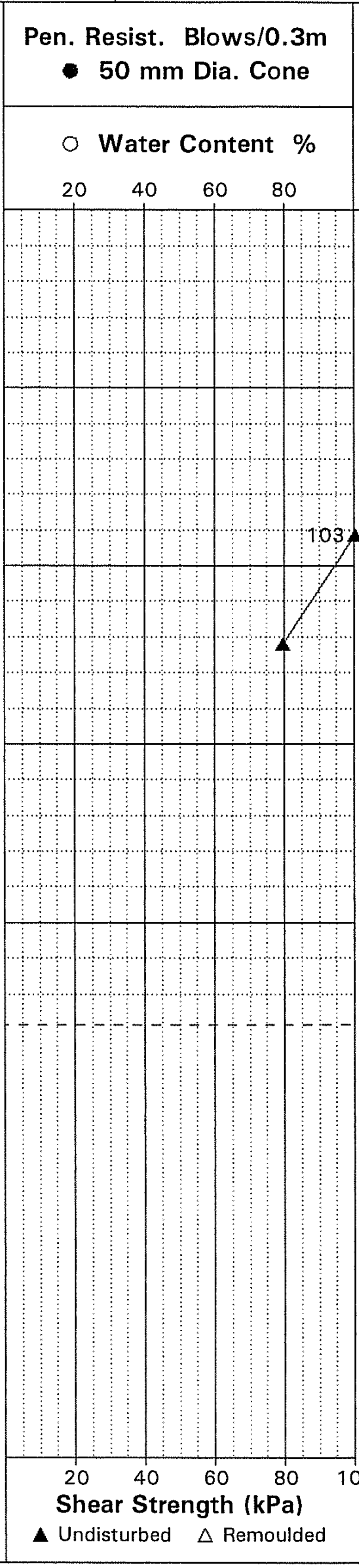
BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP37**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dark brown **TOPSOIL** 0.20	■					0	97.52
Very stiff to stiff, brown to brownish grey, blocky **SILTY CLAY**	▨					1	96.52
	▨					2	95.52
	▨	G	62			3	94.52
3.96	▨						
GLACIAL TILL: Bluish grey sand-gravel, some clay and boulders	⁘	G	63			4	93.52
4.57	⁘						
End of Test Pit (TP dry upon completion)							



PIEZOMETER CONSTRUCTION

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SOIL PROFILE & TEST DATA

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DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP38**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	99.16
Brown **TOPSOIL** 0.18							
Brown **SANDY SILT**, some gravel 0.68							
						1	98.16
GLACIAL TILL: Compact to dense, bluish grey silty sand-gravel, some cobbles and boulders						2	97.16
		G	64				
						3	96.16
3.50		G	65				
End of Test Pit Refusal on large boulder @ 3.50m depth							

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 & TEST DATA

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REMARKS

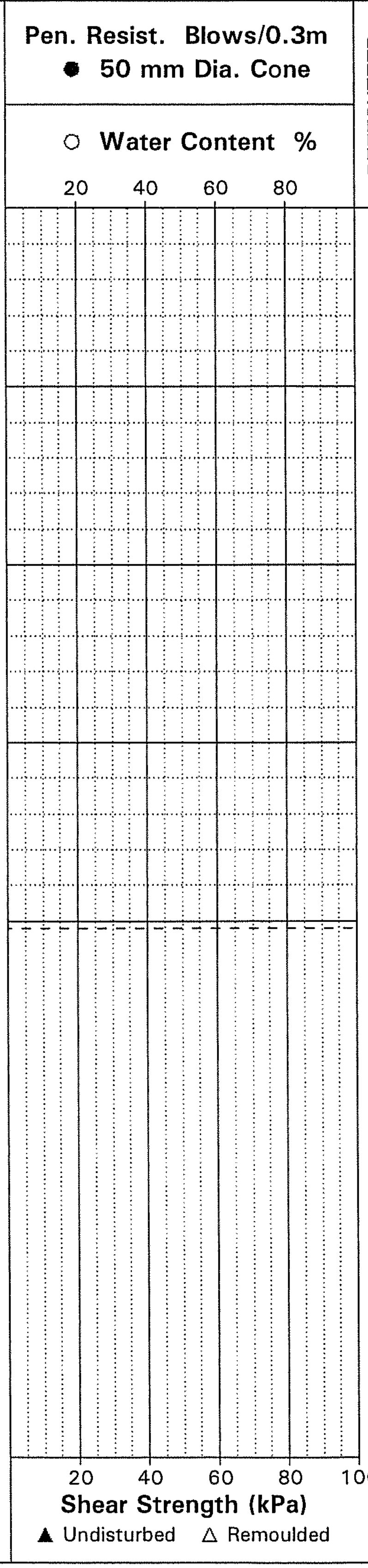
BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP39**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.66
Dark brown **TOPSOIL** 0.23	■						
Very stiff, brown to greyish brown SILTY CLAY	▨					1	97.66
1.62	▨	G	66				
GLACIAL TILL: Bluish grey silty sand-gravel, some cobbles and boulders	⁘					2	96.66
	⁘	G	67				
	⁘					3	95.66
4.04	⁘					4	94.66
End of test Pit (Water infiltration @ 1.5m depth)							



PIEZOMETER CONSTRUCTION

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Consulting Geotechnical and Environmental Engineers
28 Concourse Gate, Nepean, Ont. K2E 7T7

SOIL PROFILE & TEST DATA

Geotechnical Investigation
Strandherd Drive @ Highway 416
Nepean, Ontario

DATUM Ground surface elevations provided by Webster and Simmonds Surveying Limited.

REMARKS

BORINGS BY Backhoe

DATE 3 August 00

FILE NO. **G7892**

HOLE NO. **TP40**

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	97.06		
Dark brown **TOPSOIL** 0.18	■								
Very stiff, greyish brown **SILTY CLAY**	▨					1	96.06		
1.60									
GLACIAL TILL: Compact to dense, light grey to bluish grey silty sand-gravel, some cobbles and boulders		G	68			2	95.06		
						3	94.06		
		G	69			4	93.06		
4.11									
End of Test Pit (TP dry upon completion)									

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

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 x 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)

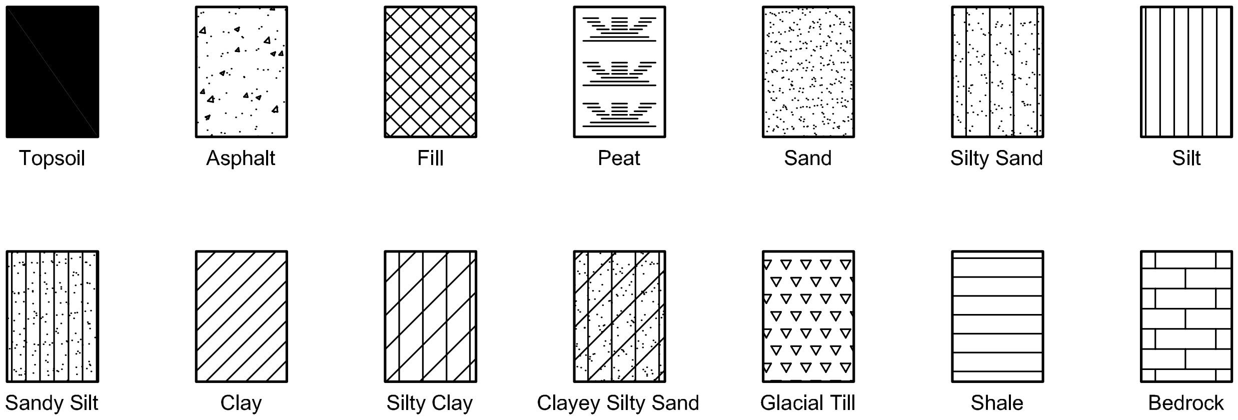
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

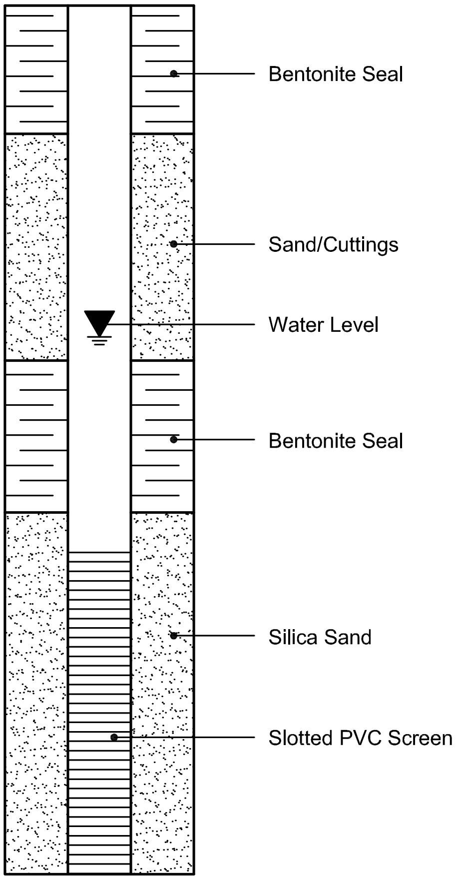
SYMBOLS AND TERMS (continued)

STRATA PLOT

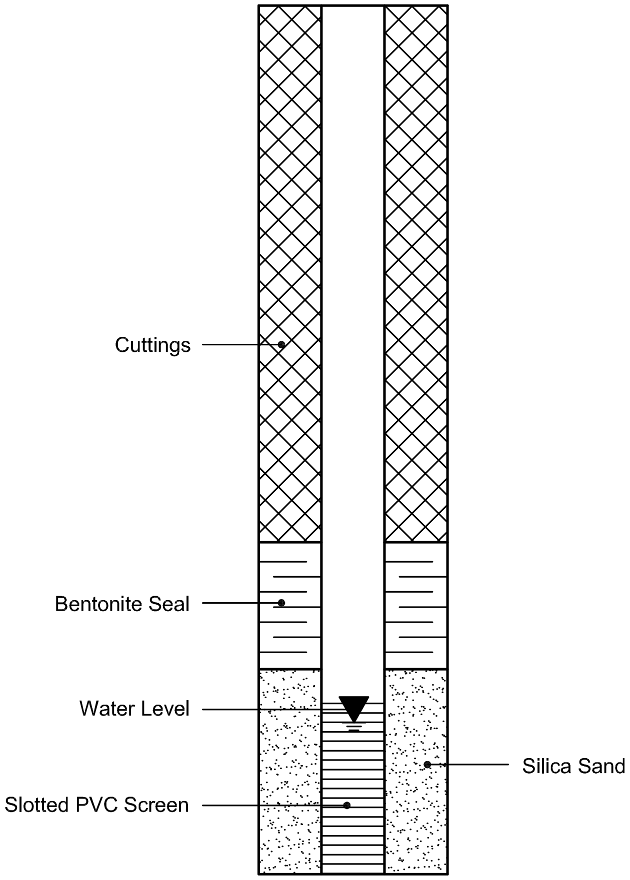


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



Certificate of Analysis

Report Date: 11-Jun-2012
Order Date:5-Jun-2012

Client: **Paterson Group Consulting Engineers**

Client PO: 12005

Project Description: PG2449

	Client ID:	TP11-G2	-	-	-
	Sample Date:	04-Jun-12	-	-	-
	Sample ID:	1223126-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	72.1	-	-	-
General Inorganics					
pH	0.05 pH Units	7.59	-	-	-
Resistivity	0.10 Ohm.m	72.9	-	-	-
Anions					
Chloride	5 ug/g dry	8	-	-	-
Sulphate	5 ug/g dry	18	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURES 2 TO 5 - SLOPE STABILITY ANALYSIS SECTIONS

DRAWING PG5284-1 - TEST HOLE LOCATION PLAN

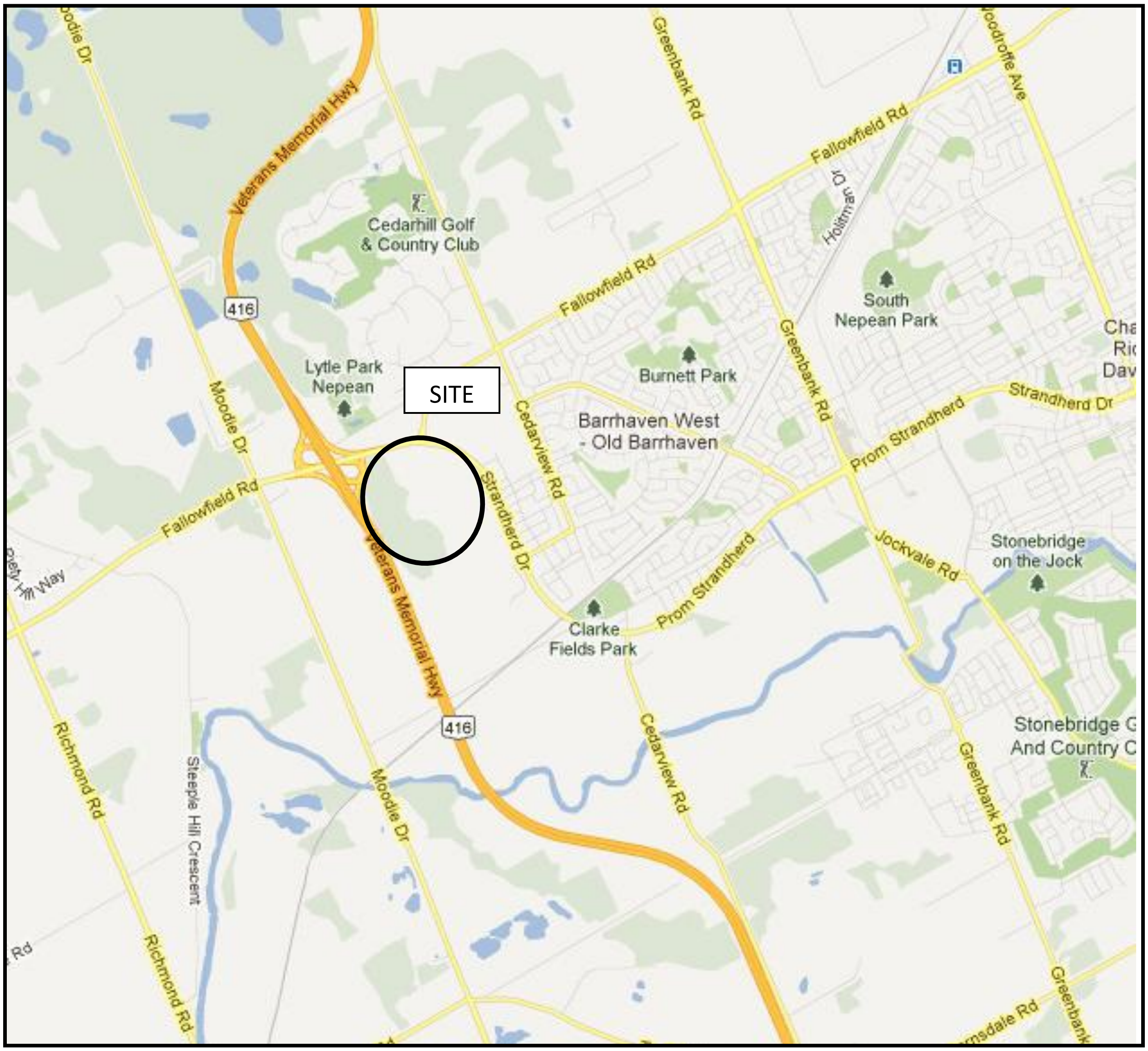
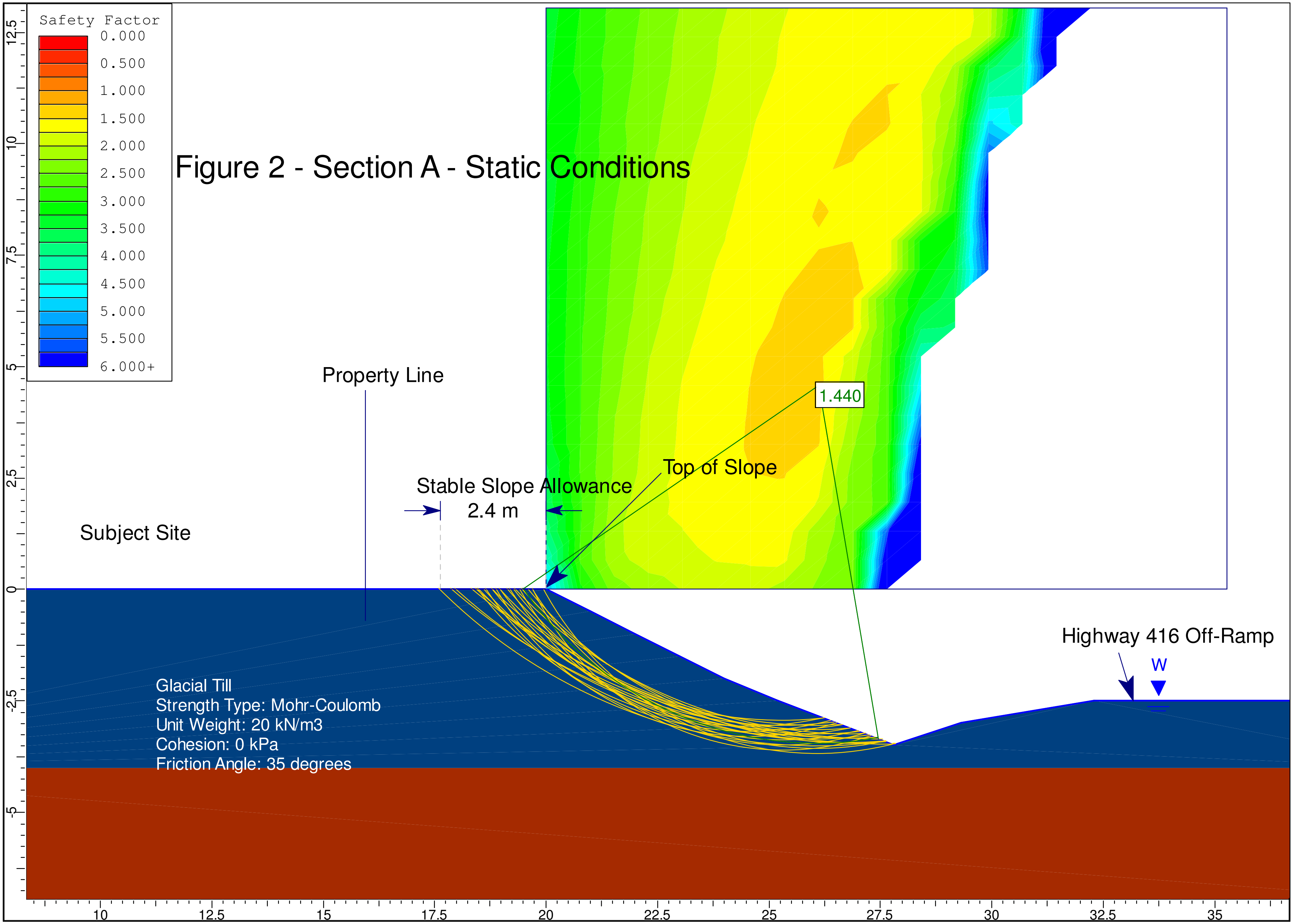


FIGURE 1

KEY PLAN

Figure 2 - Section A - Static Conditions



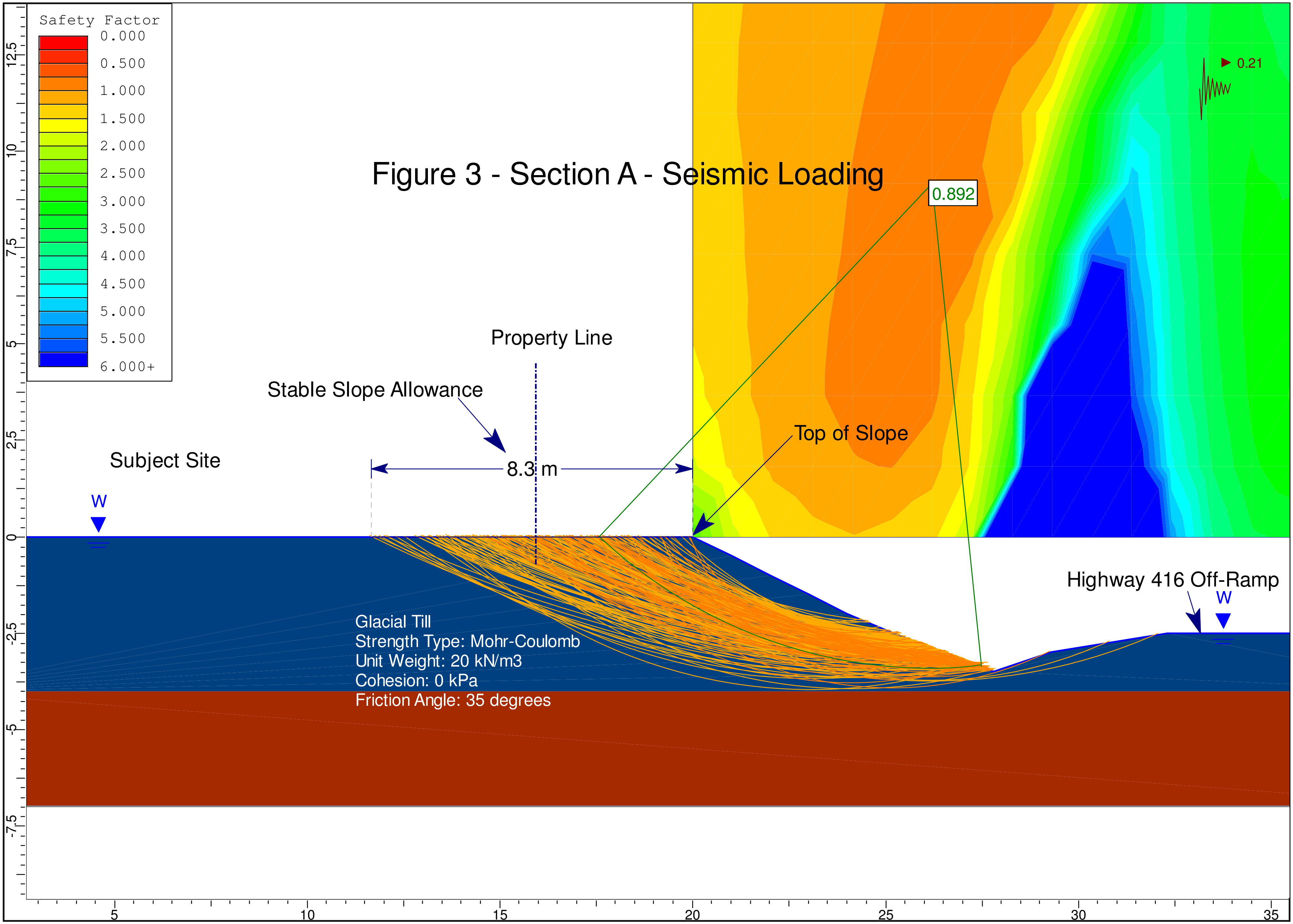


Figure 3 - Section A - Seismic Loading

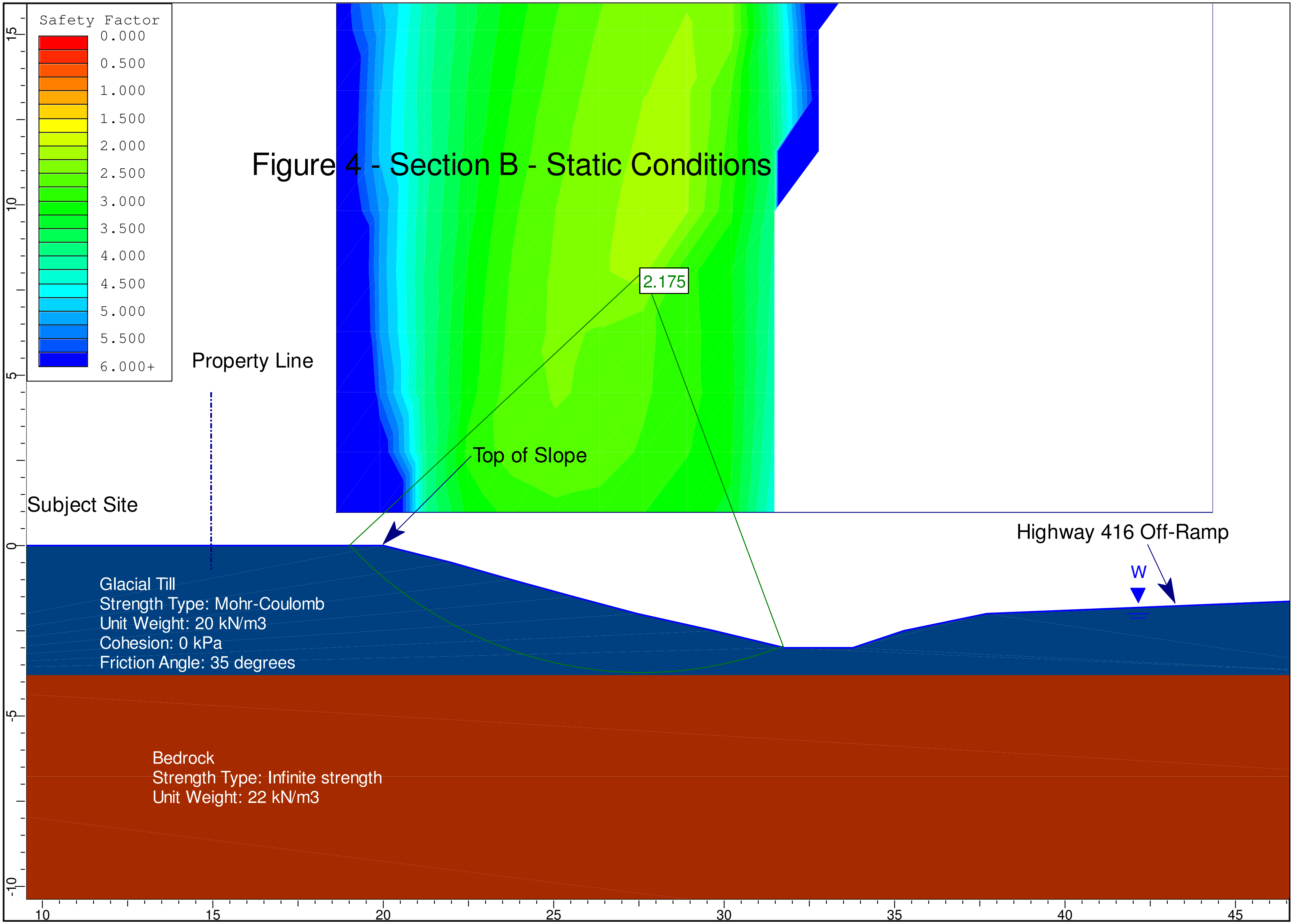


Figure 4 - Section B - Static Conditions

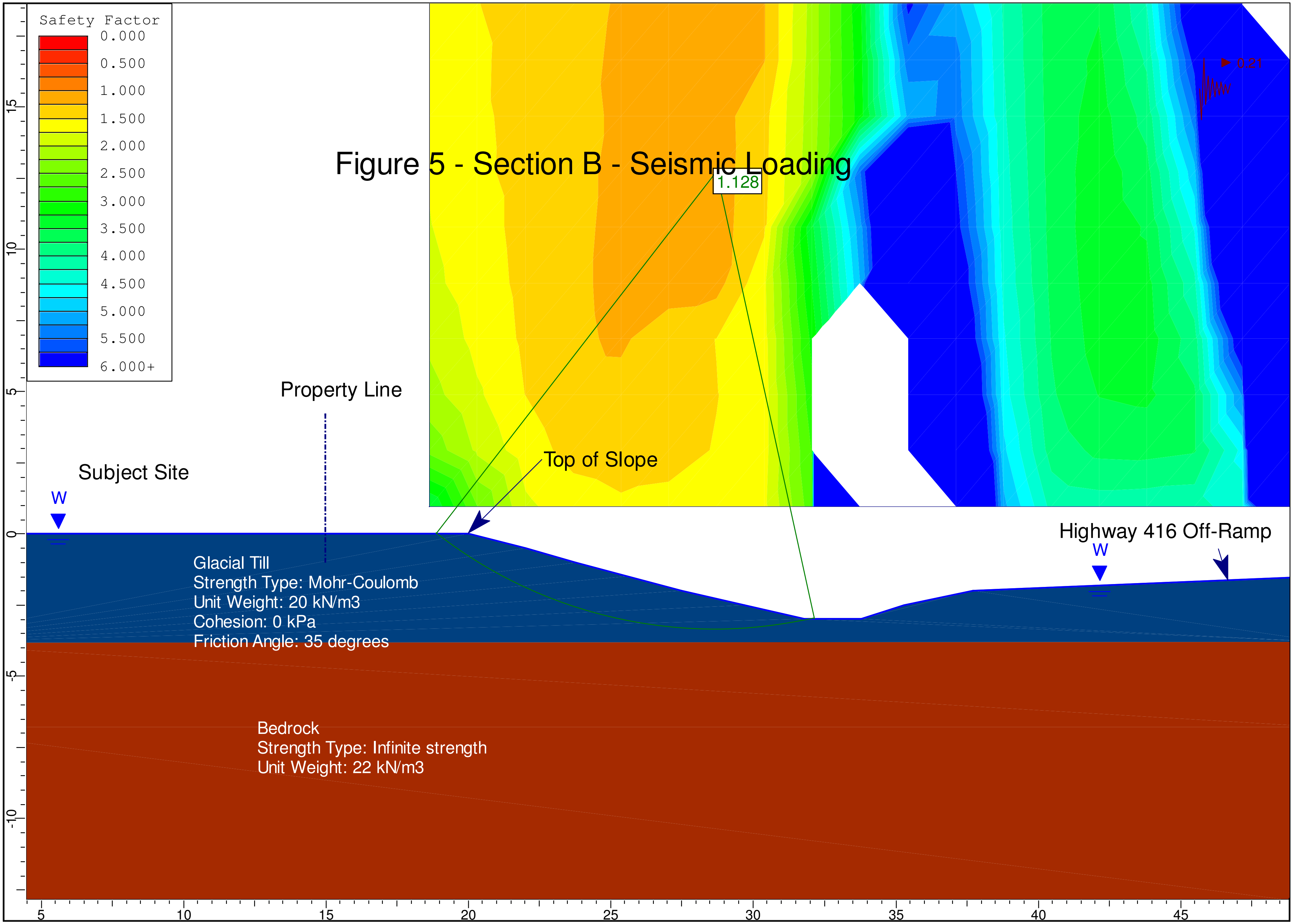
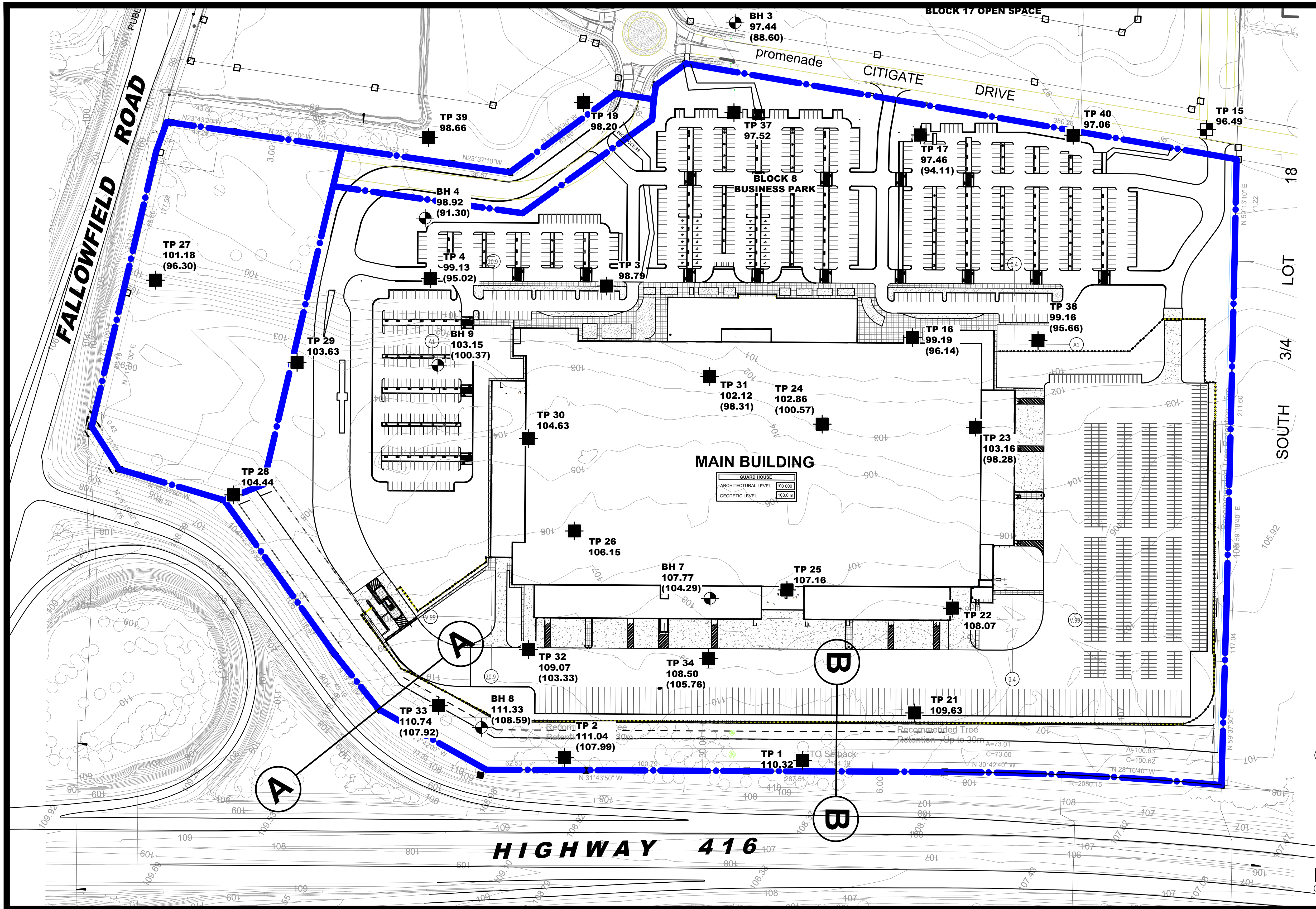


Figure 5 - Section B - Seismic Loading



LEGEND:

⊞	TEST PIT LOCATION, PREVIOUS PATERSON GROUP INVESTIGATION (PG2449, 2012)
■	TEST PIT LOCATION, PREVIOUS INVESTIGATION, JDPA REPORT G7892, 2000
⊕	BOREHOLE LOCATION, PREVIOUS INVESTIGATION, JDPA REPORT G7892, 2000
95.81	GROUND SURFACE ELEVATION (m)
(86.97)	PRACTICAL REFUSAL TO AUGERING / EXCAVATION ELEVATION (m)
Ⓐ——Ⓐ	CROSS SECTION LOCATION

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS (CURRENT INVESTIGATION) PROVIDED BY NOVATECH ENGINEERING CONSULTANTS LIMITED.

SCALE: 1:2500

0 25 50 75 100 125 150 175m

patersongroup
consulting engineers

154 Colonnade Road South
Ottawa, Ontario K2E 7J5
Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

PYTHON LP
GEOTECHNICAL INVESTIGATION
PROPOSED PYTHON COMPLEX - FALLOWFIELD AT HIGHWAY 416
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:2500	Date: 03/2020
Drawn by: RCG	Report No.: PG5284
Checked by: DP	Dwg. No.: PG5284-1
Approved by: CDS	Revision No.: 0

p:\autocad drawings\geotechnical\pg52xx\pg5284\pg5284-proposed test holes (external use).dwg