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Geotechnical Engineering

Environmental Engineering

Hydrogeology

Geological Engineering

Materials Testing

Building Science

Archaeological Services

Geotechnical Investigation
Proposed Commercial Development
Terry Fox Drive at Kanata Avenue
Ottawa, Ontario

Prepared For

Trimterra Development Corporation

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Report PG4564-1 Revision 3

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1.0 Introduction

Paterson Group (Paterson) was commissioned by Trimterra Development Corporation to conduct a geotechnical investigation for the proposed commercial development to be located at 471 Terry Fox Drive, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan in Appendix 2).

The investigation objectives were to:

☐ determine the subsurface soil and groundwater conditions by means of boreholes.

☐ 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. This report contains our findings and includes geotechnical recommendations pertaining to the design and construction of the subject development as understood at the time of writing this report.

2.0 Proposed Development

It is understood that the proposed development consists of several slab-on-grade buildings, with associated at-grade parking areas and access lanes. A gas station is also anticipated to be constructed as part of the proposed development.

3.0 Method of Investigation

3.1 Field Investigation

Field Program

The geotechnical data for the current investigation was gathered from previous investigations, conducted in July 2015 and June 2008. A total of 11 boreholes were advanced to a maximum depth of 11 m. Four supplemental boreholes were drilled on October 14, 2018 to a maximum depth of 17.4 m. The locations of the boreholes are provided on Drawing PG4564-1 - Test Hole Location Plan included in Appendix 2.

Four supplemental boreholes were drilled to provide additional information on October 4, 2018. The boreholes were advanced to a maximum depth of 17.4 m.

Four test pits were excavated along the northeast slope face on March 27, 2019 to identify the subsoil information within the subject slope.

The boreholes were drilled with a track-mounted drill rig operated by a two-person crew and the test pits were excavating using a mechanical excavator. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from the geotechnical department. The drilling procedures consisted of advancing each test hole to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered from auger flights or a 50 mm diameter split-spoon sample. The soil samples were classified on site, placed in sealed bags and transported to our laboratory. The depths at which the auger and split-spoon samples were recovered from the boreholes are shown as AU and SS, respectively, on the Soil Profile and Test Data sheets.

The 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 300 mm into the soil after a 150 mm initial penetration using a 63.5 kg hammer falling from a height of 760 mm.

Overburden thickness was evaluated by dynamic cone penetration tests (DCPT) at BH 2-15, BH 4-15 and at BH1-18 to BH4-18. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone 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 every 300 mm increment.

Undrained shear strength tests were completed in cohesive soils with a shear vane apparatus.

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

Groundwater

Flexible polyethylene standpipes were installed in all boreholes to permit monitoring of the groundwater subsequent to the completion of the geotechnical drilling program.

3.2 Field Survey

The test hole locations were determined in the field by Paterson personnel with consideration of underground and aboveground services. The location and ground surface elevation at each borehole location completed as part of the 2015 investigation was surveyed by Annis O'Sullivan Vollebekk Ltd. and are understood to be referenced to a geodetic datum. All other borehole locations were determined in the field by Paterson personnel at the time of the respective investigations. The borehole locations and available geodetic elevations are provided on Drawing PG4564-1 - Test Hole Location Plan in Appendix 2.

3.3 Laboratory Testing

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

Consolidation testing and Atterberg Limits testing was completed on select soil samples as part of the previous investigations. Results are provided in Appendix 1 and are discussed in Subsections 4.2 and 5.3.

3.4 Analytical Testing

One soil sample from the previous investigation 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 results of the analytical testing are provided in Appendix 1 and discussed further in Subsection 6.7.

4.0 Observations

4.1 Surface Conditions

The subject site is currently vacant and grass covered. The majority of the ground surface across the subject site is at grade with the surrounding roadways. A grassed and stable slope is located along the north property boundary with the north neighbouring buildings located at the top of slope. Signs of in-filling were observed across the subject site based on historical aerial photographs. Based on the site conditions observed during previous investigations, the original ground surface sloped downward to the south.

4.2 Subsurface Profile

Overburden

Generally, the subsurface profile at the borehole locations consists of silty sand fill overlying a stiff brown silty clay (weathered crust) and a firm grey silty clay deposit. A glacial till layer, consisting of a silty sand matrix with gravel, cobbles and boulders was encountered below the silty clay deposit. Practical refusal to augering was encountered at BH 1-15 at 6.2 m and practical refusal to DCPT was encountered at BH 2-15 and BH 4-15 at 11 m and 8.8 m depths, respectively. Practical refusal to DCPT was encountered at depths ranging from 10.5 to 17.4 m in BH1-18 to BH4-18. In vegetated areas, it is expected that roots extend between 200 to 300 mm below ground surface.

Based on available geological mapping, the local consists of sandstone of the Nepean Formation with an anticipated overburden thickness of 3 to 10 m.

Sensitive Silty Clay

Based on a previous geotechnical investigation on the subject site, three silty clay samples were selected for unidimensional consolidation testing. The results are presented in Appendix 1. The results indicate that the silty clay is overconsolidated with overconsolidation ratios between 1.7 to 2.2.

The results of Atterberg Limits tests conducted on samples of silty clay obtained from BH1, BH3 and BH5 are presented in Table 1 and on the Atterberg Limits Results sheet in Appendix 1. The tested silty clay samples classify as an inorganic clays of high plasticity (CH) in accordance with the Unified Soil Classification System.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Symbol
BH 1 TW 5	5.7	42	21	21	52	CH
BH 3 TW 6	12.6	39	20	18	50	CH
BH 5 TW 4	5.7	49	23	26	65	CH

LL: Liquid Limit PL: Plastic Limit PI: Plasticity Index w: water content
CH: Inorganic Clays of High Plasticity

4.3 Groundwater

Groundwater levels were measured in the standpipes installed in the boreholes upon completion of the sampling program. The groundwater level readings are presented in Table 2 and on the Soil Profile and Test Data Sheets in Appendix 1.

Table 2 - Summary of Groundwater Level Readings

Borehole Number	Ground Surface Elevation (m)	Groundwater Levels (m)		Recording Date
		Depth	Elevation	
BH 1-15	96.02	2.69	93.33	August 10, 2015
BH 2-15	94.81	1.76	93.05	August 10, 2015
BH 3-15	95.97	3.49	92.48	August 10, 2015
BH 4-15	95.98	2.15	93.83	August 10, 2015
BH 5-15	96.05	2.63	93.42	August 10, 2015
BH 6-15	95.66	Dry	--	August 10, 2015
BH 1-18	96.07	2.56	93.51	October 10, 2018
BH 2-18	96.08	2.41	93.67	October 10, 2018
BH 3-18	94.10	0.42	93.68	October 10, 2018
BH 4-18	93.95	0.35	93.60	October 10, 2018

Note: Ground surface elevations at the test hole locations were provided by Annis O’Sullivan Vollebekk Ltd and are assumed to be referenced to a geodetic datum.

It should be noted that groundwater levels can be influenced by surface water infiltrating the backfilled boreholes.

Long-term groundwater levels can also be estimated based on the observed colour and consistency of the recovered soil samples. Based on these observations, it is estimated that the long-term groundwater table can be expected at approximately 3 to 4 m below ground surface.

It should be noted that groundwater levels are subject to seasonal fluctuations, and could therefore vary at the time of construction.

5.0 Discussion

5.1 Geotechnical Assessment

The subject site is satisfactory for the proposed development from a geotechnical perspective. However, due to the presence of the silty clay layer, the proposed development will be subjected to grade raise restrictions.

A significant slope presently exists along the north property line. Depending on the finished grading for the proposed development, a retaining wall or slope stabilization may be required.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and fill, containing significant amounts of deleterious materials, should be stripped from under any buildings and other settlement sensitive structures. Care should be taken not to disturb adequate bearing soils below the subgrade level during site preparation activities.

The existing fill material, free of deleterious material and significant amounts of organics and approved by Paterson personnel at the time of construction, can be left in place below the proposed building footprint (outside of footing lateral support zones), proposed car parking areas and access lanes. However, it is recommended that the existing fill layer be proof-rolled using heavy vibratory equipment and approved by Paterson at the time of construction. Any poor performing areas noted during the proof-rolling operation should be removed and replaced with Ontario Provincial Standard Specifications (OPSS) Granular B Type II, placed in maximum 300 mm thick lifts and compacted to 98% of its standard Proctor maximum dry density (SPMDD).

Fill Placement

Fill used for grading beneath the proposed buildings, unless otherwise specified, should consist of clean imported granular fill, such as OPSS Granular A or Granular B Type II. The fill should be tested and approved prior to delivery to the site. The granular material should be placed in lifts at a maximum of 300 mm thick and compacted using suitable compaction equipment for the lift thickness. Fill placed beneath the buildings should be compacted to 98% of its SPMDD.

Non-specified existing fill along with site-excavated soil could 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 compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be placed to build up the subgrade level for areas to be paved, the material should be compacted in thin lifts to of 95% of the SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

5.3 Foundation Design

Conventional Shallow Foundation

Strip footings, up to 3 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, stiff silty clay (within the weathered crust) bearing surface can be designed using a bearing resistance value at serviceability limit states (SLS) of **150 kPa** and a factored bearing resistance value at ultimate limit states (ULS) of **250 kPa**.

Strip footings, up to 3 m wide, and pad footings, up to 4 m wide, placed on an undisturbed, firm silty clay bearing surface can be designed using a bearing resistance value at SLS of **100 kPa** and a factored bearing resistance value at ULS of **180 kPa**.

A geotechnical resistance factor of 0.5 was applied to the above noted bearing resistance value at ULS.

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 resistance values at SLS will be subjected to potential post-construction total and differential settlements of 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. Adequate lateral support is provided to the native soils above the groundwater table when a plane extending horizontally and vertically away from the footing perimeter 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 Restrictions

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. A minimum value of 50% of the live load is often recommended by Paterson.

Due to the presence of the underlying silty clay layer and existing fill layers in areas across the site, a permissible grade raise restriction using geodetic elevations has been prepared for the site. The permissible grade raise areas are presented in Drawing PG4564-2 - Permissible Grade Raise Plan in Appendix 2. A post-development groundwater lowering of 0.5 m was considered in our permissible grade raise restriction calculations. If higher than permissible grade raises are required, preloading with or without a surcharge, lightweight fill and/or other measures should be investigated to reduce the risks of unacceptable long-term post construction total and differential settlements.

5.4 Design for Earthquakes

The site class for seismic site response is a **Class D** for the foundations considered. The soils underlying the subject site are not susceptible to liquefaction. Reference should be made to the latest revision of the Ontario Building Code for a full discussion of the earthquake design requirements.

5.5 Slab on Grade Construction

With the removal of the topsoil and deleterious fill, containing organic matter, within the footprint of the proposed buildings, the native soil surface or existing fill approved by Paterson as per Subsection 5.2 will be considered to be an acceptable subgrade on which to commence backfilling for floor slab construction.

It is recommended that a concrete floor slab be poured over a minimum 200 mm thick layer of sub-slab fill, consisting of a 19 mm clear crushed stone to allow drainage of any water which may have accumulated below the floor slab.

Any soft or poor performing areas should be removed and backfilled with appropriate backfill material prior to placing any fill. OPSS Granular B Type II, with a maximum particle size of 50 mm, is recommended for backfilling below the floor slab. All backfill material within the footprint of the proposed buildings should be placed in maximum 300 mm thick loose lifts and compacted to at least 98% of its SPMDD.

5.6 Pavement Structure

Minimum Pavement Structure Requirements

Car only parking and heavy truck parking areas, as well as access lanes are anticipated. The proposed pavement structures are presented in Tables 3 and 4.

Table 3 - Recommended Pavement Structure - 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
300	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - In situ soil, or OPSS Granular B Type I or II material placed over in situ soil

Table 4 - Recommended Pavement Structure 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
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
	SUBGRADE - In situ soil, or OPSS Granular B Type I or II material placed 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 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 SPMDD with suitable vibratory equipment.

Pavement Structure Drainage

Satisfactory performance of the pavement structure is largely dependent on 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 could result in the subgrade soil being pumped into the voids in the stone subbase, thereby reducing load bearing 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. The subdrains should consist of 150 mm perforated corrugated plastic pipe, wrapped in a suitable filter cloth and surrounded on all sides by at least 150 mm of 19 mm clear crushed stone. 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 Design and Construction Precautions

6.1 Foundation Drainage and Backfill

A perimeter drainage system is recommended to be provided for the proposed structures to provide an outlet for any water trapped within the backfill material below any paved areas or sidewalk structures. Trapped water within subgrade soils can lead to more significant frost heave for sidewalks adjacent to slab-on-grade buildings. The system should consist of a 150 mm geotextile-wrapped, perforated corrugated plastic pipe, surrounded on all sides by 150 mm of 19 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.

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 composite drainage blanket, 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 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 effect of frost action. A minimum of 1.5 m thick soil cover (or equivalent) should be provided.

A minimum of 2.1 m thick soil cover (or equivalent) should be provided for other exterior unheated footings.

6.3 Excavation Side Slopes

The side slopes of excavations in the soil and fill overburden materials should either be excavated to acceptable slopes or should be retained by shoring systems from the beginning of the excavation until the structure is backfilled. It is assumed that sufficient room will be available for the greater part of the excavation to be constructed by open-cut 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 flatter. The flatter slope is recommended 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 maintain a safe distance 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 pe```rsonnel working in trenches with steep or vertical sides. Services are expected to be installed by “cut and cover” methods and excavations will not be left open for extended periods of time.

6.4 Pipe Bedding and Backfill

Bedding and backfill materials should be in accordance wit the most recent Material Specifications & 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 at least 150 mm of OPSS Granular A material. The material should be placed in a maximum loose lift thickness of 300 mm and compacted to 95% of the 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 the SPMDD.

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 95% of the SPMDD.

To reduce the 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 and should extend from trench wall to trench wall. Generally, 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 layers and compacted to a minimum of 95% of the material's 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.

6.5 Groundwater Control

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. It is anticipated that groundwater infiltration into the excavations should be low and controllable using open sumps. Pumping from open sumps should be sufficient to control the groundwater influx through the sides of shallow excavations.

A temporary Ministry of the Environment, Conservation and Parks (MECP) permit to take water (PTTW) 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 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 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 subsurface soil at this site consists mostly 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.

The trench excavations should be carried out in a manner to avoid introduction of frozen materials, snow or ice into the trenches. Furthermore, pavement construction is difficult during the winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. Also, the introduction of frost, snow or ice into the pavement materials, which is difficult to avoid, could adversely affect the performance of the pavement structure.

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 (i.e. normal cement) would be appropriate for this site. The results of the chloride and sulphate content, pH and resistivity indicate the presence of a non-aggressive to slightly aggressive environment for exposed ferrous metals at this site.

6.8 Slope Stability Analysis

It is understood that a retaining wall is proposed along the slope on the northeast portion of the site. Supplemental test pits were conducted to evaluate the stability of the slope and provide design information for the retaining wall.

Slope Conditions

Based on our field observations and available topographic mapping, the subject slopes along the northeast border of the site is stable with no signs of active erosion and are sloped at 3H:1V slope or less. Test pits within the existing slopes were conducted to determine the subsurface soil conditions for our analysis.

Slope Stability Analysis

The slope stability analysis was modeled in SLIDE, a computer program which permits a two-dimensional slope stability analysis calculating several methods including the Bishop's method, which is a widely accepted slope analysis method. The program calculates a factor of safety, which represents the ratio of the forces resisting failure to forces 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 subsurface soil and groundwater conditions, a factor of safety greater than 1.0 is generally required for the failure risk to be considered acceptable. A minimum factor of safety of 1.5 is generally recommended for conditions where the slope failure would comprise permanent structures. An analysis considering seismic loading was also completed. A horizontal acceleration of 0.16 g was considered for the sections for the seismic loading condition. A factor of safety of 1.1 is considered to be satisfactory for stability analyses including seismic loading.

Four slope cross-sections (Sections A, B, C and D) were studied as the worst case scenarios. The cross section locations are presented on Drawing PG4564-1 - Test Hole Location Plan in Appendix 2. It should be noted that details of the slope height and slope angle at the cross-section locations are presented in Figures 2A through 5C in Appendix 2 from the topographic data identified on Drawing PG4564-1 - Test Hole Location Plan in Appendix 2.

The following parameters were used for the slope stability analysis under static and seismic conditions:

Table 5 - Slope Stability Soil Parameters

Soil Layer	Unit Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Topsoil	16	33	5
Glacial Till	20	35	3
Silty clay with sand and gravel	20	35	1
Stiff Brown Silty Clay	17	33	10
Stiff Grey Silty Clay	16	33	5
Bedrock	25	-	-

Stable Slope

The static analysis results for slope sections A, B, C and D are presented in Figures 2A, 3A, 4A, and 5A , respectively, provided in Appendix 2. The factor of safety for the slopes was greater than 1.5 for the slope sections analysed.

The results of the analyses with seismic loading are shown in Figures 2B, 3B, 4B and 5B presented in Appendix 2. The results indicate that the factor of safety for the sections are greater than 1.1. Based on these results, the slopes are considered to be stable under seismic loading.

Retaining Wall

A preliminary static analysis was conducted for the proposed retaining wall along the northeast portion of the site. The results are presented in Figures 2C, 3C, 4C and 5C in Appendix 2. The results indicate that the factor of safety fo the sections are greater that 1.5. It should be noted that the property line is located in close proximity to the proposed retaining wall alignment. The construction of the retaining wall will require the contractor to excavate a safe slope behind the wall which may require permission from the neighbouring properties to complete if the proposed wall alignment does not permit sufficient space.

For design purposes, the earth pressures acting on the retaining wall may be calculated using the parameters presented in the table below. Any additional loading due to street traffic, construction equipment, adjacent structures and facilities, etc., should be added to the earth pressures described below.

Table 6 - Soil Parameters for Retaining Wall Design

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 (γ), kN/m^3	20
Submerged Unit Weight (γ), kN/m^3	13

A sliding resistance factor of 0.4 is recommended for formed or precast wall units placed on an engineered fill base over an approved native or bedrock bearing surface.

A geotechnical resistance factor of 0.8 was applied to the above noted sliding resistance factor.

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:

☐ 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 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 these works have been completed in general accordance with our recommendations could be issued 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 the grading plan once available and our recommendations when the drawings and specifications are complete.

A geotechnical investigation of this nature is a limited sampling of a site. The recommendations are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around the test locations. The extent of the limited area depends on the soil, bedrock and groundwater conditions, as well as the history of the site reflecting natural, construction and other activities. Should any conditions at the site be encountered which differ from those at the test locations, we request notification immediately in order to permit reassessment of our recommendations.

The recommendations provided in this report are intended for the use of design professionals associated with this project. Contractors bidding on or undertaking the work should examine the factual information contained in this report and the site conditions, and satisfy themselves as to the adequacy of the information provided for construction purposes, supplement the factual information if required, and develop their own interpretation of the factual information based on both their and their subcontractors construction methods, equipment capabilities and schedules.

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 Trimterra Development Corporation or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

CONSOLIDATION TESTING RESULTS

ATTERBERG LIMIT TESTING RESULTS

ANALYTICAL TESTING RESULTS

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

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY Hydraulic Shovel

DATE March 26, 2019

FILE NO. PG4564

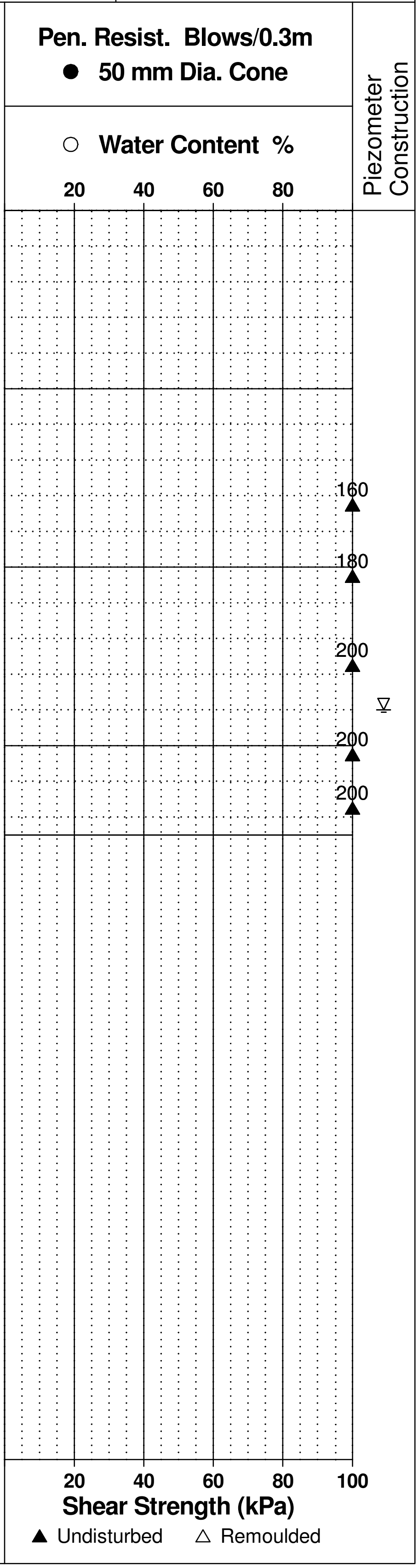
HOLE NO. TP 1-19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	98.28
FILL: Topsoil 0.30	▨						
FILL: Dark brown silty clay with gravel and cobbles, some sand, trace organics 1.30	▨	G	1				
						1	97.28
TOPSOIL 1.50	■						
Very stiff, grey-brown **SILTY CLAY**	▨	G	2				
		G	3			2	96.28
- grey by 2.6m depth		G	4				
		G	5			3	95.28
3.50		G	6				

End of Test Pit

Practical shovel refusal at 3.50m depth on bedrock surface. Bedrock sloped east to west from 3.5m to 5.3m over 2.0m.

(Groundwater infiltration at 2.8m depth)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY Hydraulic Shovel

DATE March 26, 2019

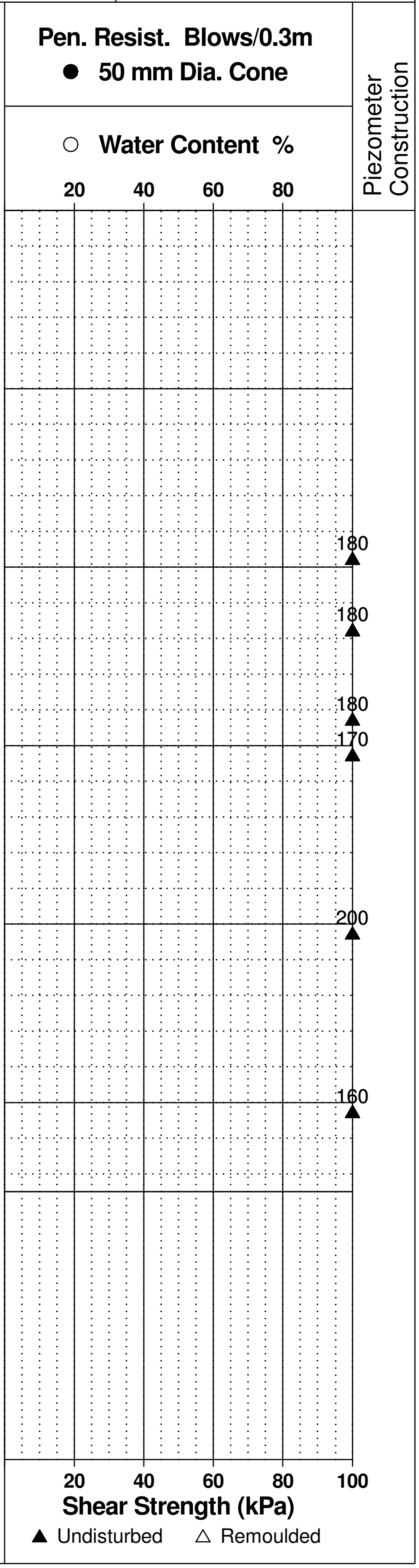
FILE NO. PG4564

HOLE NO. TP 2-19

SOIL DESCRIPTION	
GROUND SURFACE	
FILL: Topsoil	0.20
FILL: Brown silty clay with sand, gravel, cobbles and boulders	1.60
TOPSOIL	1.80
Very stiff, grey-brown **SILTY CLAY,** trace sand - grey by 3.0m depth	5.50
End of Test Pit Test pit terminated on bedrock surface at 5.50m depth. Bedrock sharply slope from east to west. (TP dry upon completion)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
G	1		
G	2		
G	3		
G	4		
G	5		
G	6		
G	6		

DEPTH (m)	ELEV. (m)
0	98.82
1	97.82
2	96.82
3	95.82
4	94.82
5	93.82



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY Hydraulic Shovel

DATE March 26, 2019

FILE NO. PG4564

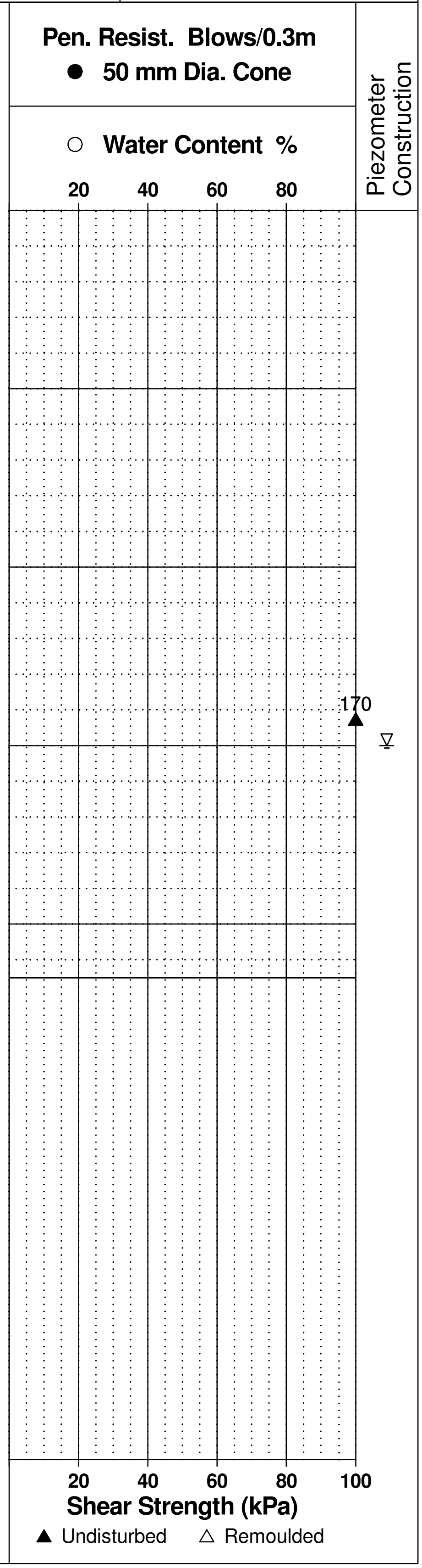
HOLE NO. TP 3-19

SOIL DESCRIPTION		STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							0	99.00
FILL: Brown sand, some clay, gravel, cobbles and organics	0.20							
TOPSOIL	0.45							
							1	98.00
Very stiff, brown **SILTY CLAY** with sand, cobbles and boulders			G	1				
							2	97.00
- grey by 2.6m depth - no sand, cobbles and boulders by 2.6m depth			G	2				
							3	96.00
							4	95.00
	4.30							

End of Test Pit

TP terminated on bedrock surface at 4.30m depth. Bedrock sharply sloped from east to west.

(Groundwater infiltration at 3.0m depth)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY Hydraulic Shovel

DATE March 26, 2019

FILE NO. PG4564

HOLE NO. TP 4-19

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	99.57		
TOPSOIL 0.30									
GLACIAL TILL: Dense, grey-brown sand with gravel, cobbles and boulders		G	1						
1.00		G	2			1	98.57		
End of Test Pit TP terminated on bedrock surface at 1.00m depth. Bedrock sharply sloped from east to west. (TP dry upon completion)									

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

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 4, 2018

FILE NO. PG4564

HOLE NO. BH 1-18

SOIL DESCRIPTION

GROUND SURFACE

FILL: Brown silty clay with topsoil, organics, trace sand, gravel, occasional cobbles 1.52

Very stiff to stiff, brown **SILTY CLAY,** trace sand

- some sand between 2.3 and 2.9m depth

- sand content decreasing with depth 4.88

Dynamic Cone Penetration Test (DCPT) commenced at 4.88m depth.

10.52

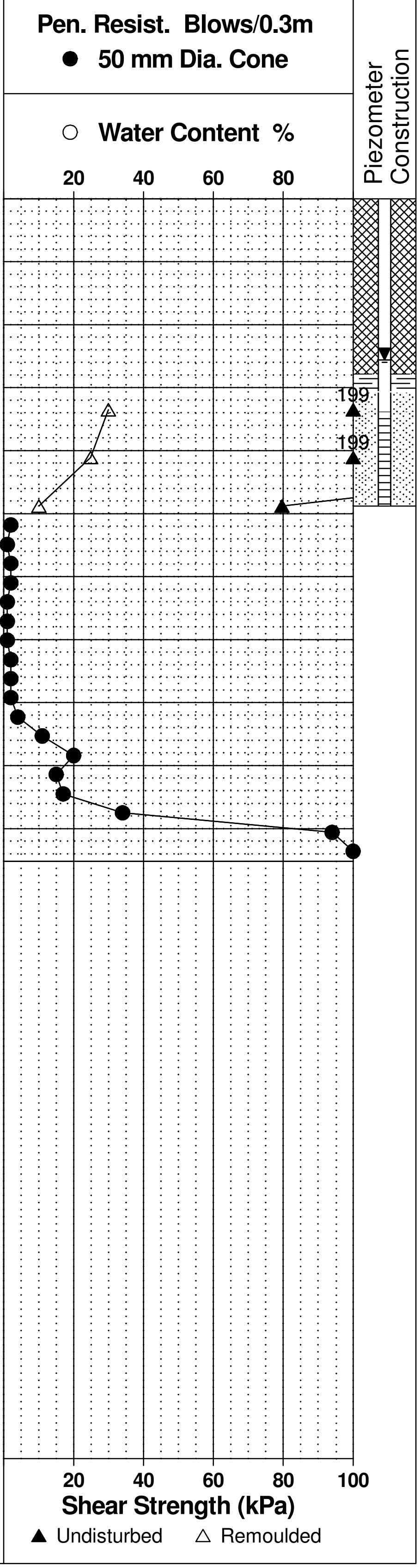
End of Borehole

Practical DCPT refusal at 10.52m depth

(GWL @ 2.56m - Oct. 10, 2018)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	67	12
SS	3	88	7
SS	4	100	5

DEPTH (m)	ELEV. (m)
0	96.07
1	95.07
2	94.07
3	93.07
4	92.07
5	91.07
6	90.07
7	89.07
8	88.07
9	87.07
10	86.07



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

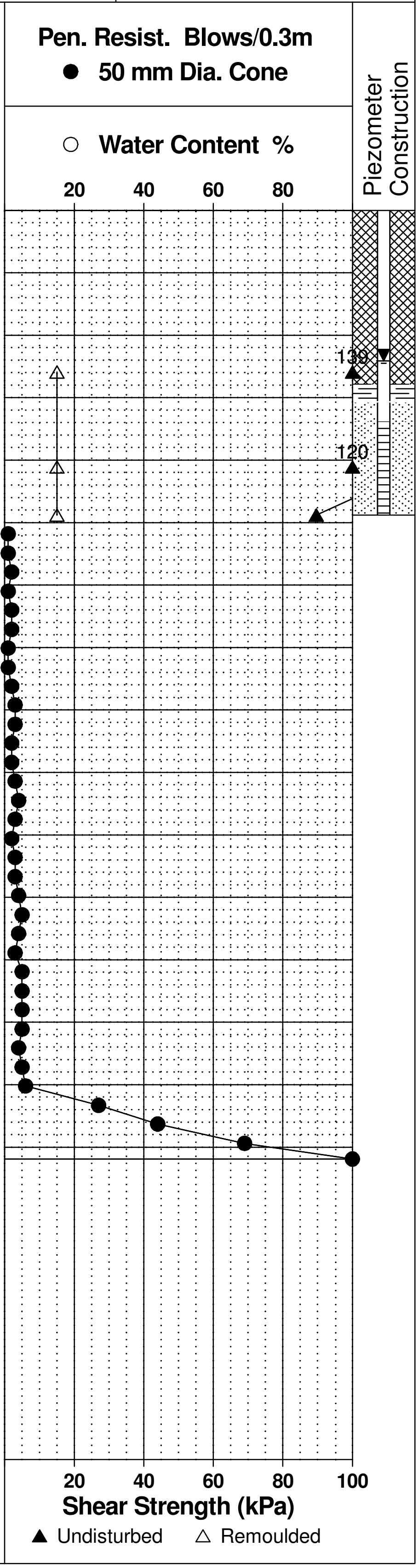
BORINGS BY CME 55 Power Auger

DATE October 4, 2018

FILE NO. PG4564

HOLE NO. BH 2-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.08
Topsoil and organics 0.15		AU	1				
FILL: Brown silty clay, some sand, trace topsoil and organics 1.52		SS	2	75	8	1	95.08
Very stiff to stiff, brown **SILTY CLAY,** some sand - sand content decreasing with depth 4.88		SS	3	83	7	2	94.08
		SS	4	100	4	3	93.08
						4	92.08
Dynamic Cone Penetration Test (DCPT) commenced at 4.88m depth.						5	91.08
						6	90.08
						7	89.08
						8	88.08
						9	87.08
						10	86.08
						11	85.08
						12	84.08
						13	83.08
						14	82.08
15.19						15	81.08
End of Borehole Practical DCPT refusal at 15.19m depth (GWL @ 2.41m - Oct. 10, 2018)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY CME 55 Power Auger

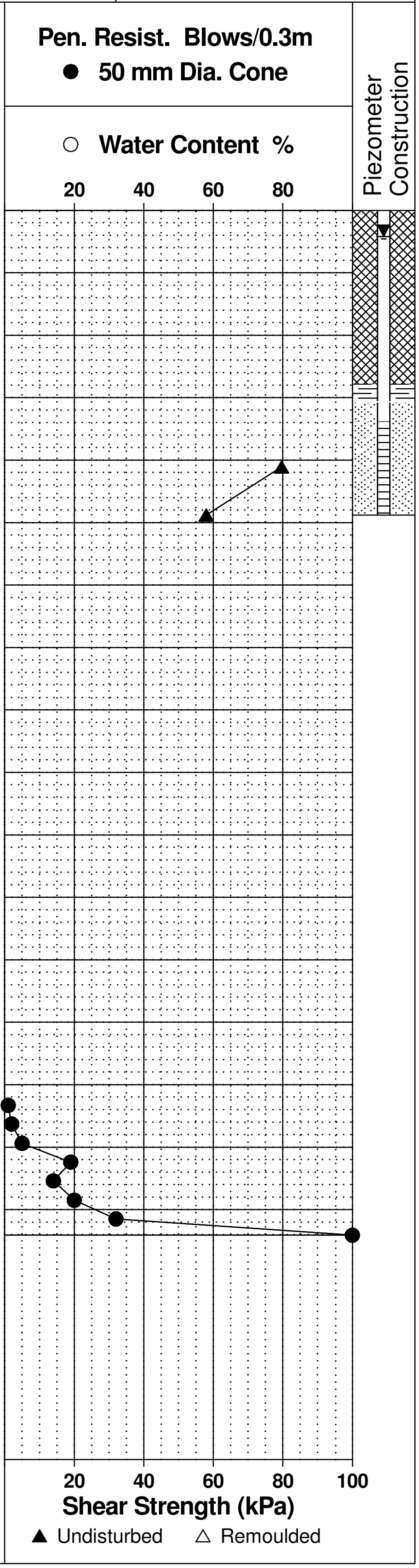
DATE October 4, 2018

FILE NO. PG4564

HOLE NO. BH 3-18

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
Topsoil and organics 0.38		AU	1		
Brown **SILTY CLAY/CLAYEY SILT** with sand - interbedded silty sand seams from 1.5 to 2.1m depth 2.29		SS	2	88	2
		SS	3	100	2
Stiff, brown **SILTY CLAY** 4.88		SS	4	100	W
Dynamic Cone Penetration Test (DCPT) commenced at 4.88m depth. Cone pushed to 13.7m depth. 16.41					
End of Borehole Practical DCPT refusal at 16.41m depth (GWL @ 0.42m - Oct. 10, 2018)					

DEPTH (m)	ELEV. (m)
0	94.10
1	93.10
2	92.10
3	91.10
4	90.10
5	89.10
6	88.10
7	87.10
8	86.10
9	85.10
10	84.10
11	83.10
12	82.10
13	81.10
14	80.10
15	79.10
16	78.10



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Supplemental Geotechnical Investigation
Proposed Heritage Hills Commercial Development
Terry Fox Drive, Ottawa, Ontario

DATUM TBM - Mag nail in sidewalk. Elevation = 95.98m, as per plan provided by Trimterra Dev. Corp.

REMARKS

BORINGS BY CME 55 Power Auger

DATE October 4, 2018

FILE NO. PG4564

HOLE NO. BH 4-18

SOIL DESCRIPTION

GROUND SURFACE

Topsoil and organics, trace silty clay and sand — 0.33

Brown **SILTY CLAY/CLAYEY SILT** with sand

- interbedded layers of silty sand from 2.3 to 2.7m depth

- sand content decreasing with depth

- grey silty clay by 3.0m depth

4.88

Dynamic Cone Penetration Test (DCPT) commenced at 4.88m depth. Cone pushed to 13.7m depth.

17.35

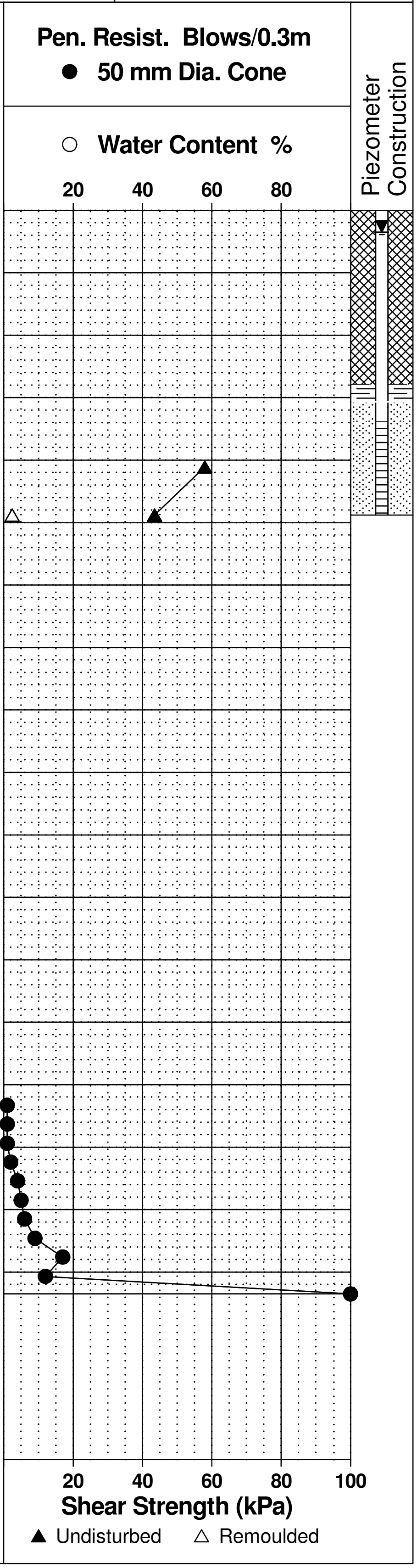
End of Borehole

Practical DCPT refusal at 17.35m depth

(GWL @ 0.35m - Oct 10, 2018)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	100	1
SS	3	100	1
SS	4	100	2
SS	5	100	W

DEPTH (m)	ELEV. (m)
0	93.95
1	92.95
2	91.95
3	90.95
4	89.95
5	88.95
6	87.95
7	86.95
8	85.95
9	84.95
10	83.95
11	82.95
12	81.95
13	80.95
14	79.95
15	78.95
16	77.95
17	76.95



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

REMARKS

BORINGS BY CME 55 Power Auger

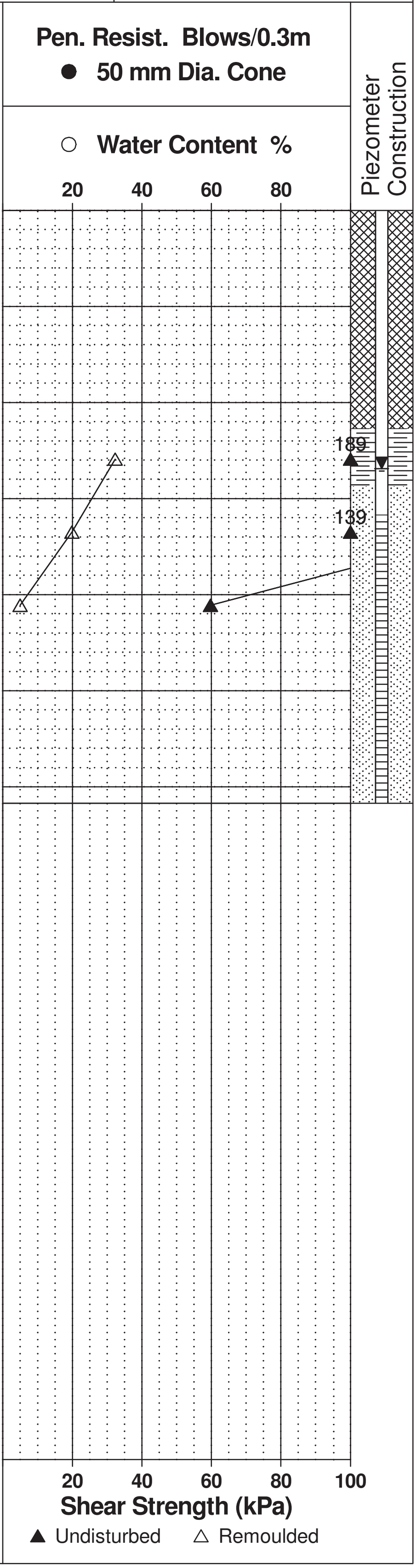
DATE July 30, 2015

FILE NO. PG3562

HOLE NO. BH 1-15

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
FILL: Brown silty sand with crushed stone and blast rock 0.71	AU	1		
FILL: Brown clayey sand, some silt, trace gravel	SS	2	67	14
1.80	SS	3	79	8
Very stiff to stiff, brown **SILTY CLAY,** some sand 4.57				
GLACIAL TILL: Grey silty sand with gravel, cobbles, trace clay	SS	4	54	24
	SS	5	46	27
6.17	SS	6	100	50+
End of Borehole Practical refusal to augering at 6.17m depth (GWL @ 2.69m-August 10, 2015)				

DEPTH (m)	ELEV. (m)
0	96.02
1	95.02
2	94.02
3	93.02
4	92.02
5	91.02
6	90.02



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

REMARKS

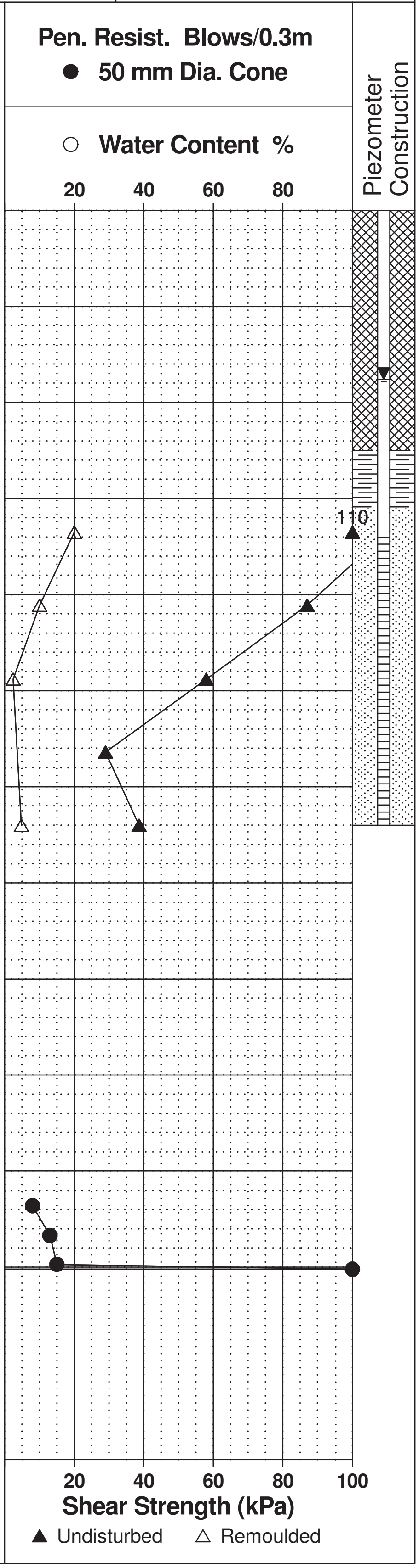
BORINGS BY CME 55 Power Auger

DATE July 30, 2015

FILE NO. PG3562

HOLE NO. BH 2-15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	94.81
TOPSOIL 0.20		AU	1				
Very stiff to stiff, brown **SILTY CLAY,** some sand		SS	2	88	8	1	93.81
		SS	3	79	4	2	92.81
		SS	4	100	4	3	91.81
						4	90.81
- grey by 4.6m depth						5	89.81
6.40						6	88.81
Dynamic Cone Penetration Test commenced at 6.40m depth. Cone pushed to 10.1m depth.						7	87.81
						8	86.81
						9	85.81
						10	84.81
11.02						11	83.81
End of Borehole Practical DCPT refusal at 11.02m depth (GWL @ 1.76m-August 10, 2015)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 30, 2015

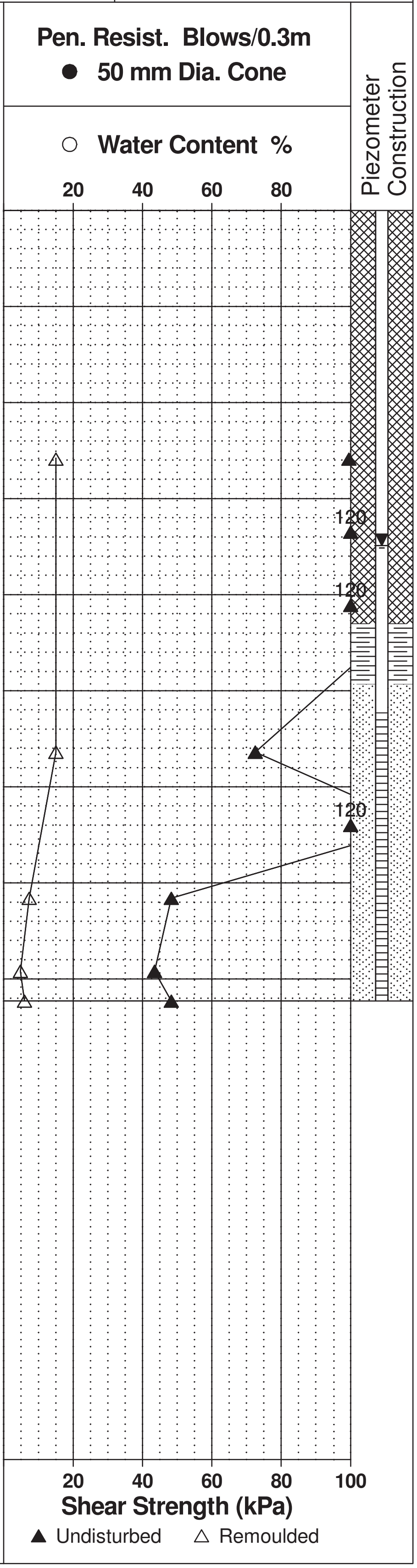
FILE NO. PG3562

HOLE NO. BH 3-15

SOIL DESCRIPTION	Depth (m)
GROUND SURFACE	
FILL: Brown silty sand with gravel, some cobbles and boulders	0.97
FILL: Grey silty sand, some clay, trace gravel	2.13
Very stiff to stiff, brown **SILTY CLAY** - grey at 4.6m depth - firm by 7.2m depth	8.23
End of Borehole (GWL @ 3.49m-August 10, 2015)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	7
SS	3	83	8
SS	4	100	2

DEPTH (m)	ELEV. (m)
0	95.97
1	94.97
2	93.97
3	92.97
4	91.97
5	90.97
6	89.97
7	88.97
8	87.97



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 30, 2015

FILE NO. PG3562

HOLE NO. BH 4-15

SOIL DESCRIPTION	
GROUND SURFACE	
FILL: Brown silty sand with gravel and cobbles, some blast rock	0.90
FILL: Brown silty clay, some sand and gravel	2.18
Stiff to firm, grey **SILTY CLAY,** some sand	6.40
GLACIAL TILL: Grey silty sand, some gravel, trace cobbles	8.23
Dynamic Cone Penetration Test commenced at 8.23m depth.	8.81
Inferred **GLACIAL TILL**	

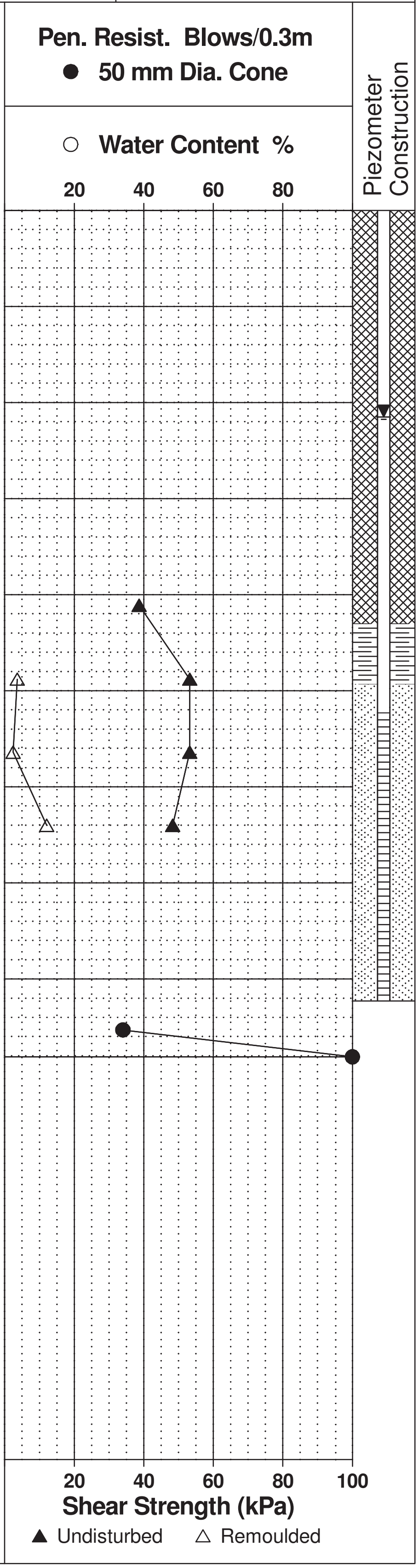
End of Borehole

Practical DCPT refusal at 8.81m depth

(GWL @ 2.15m-August 10, 2015)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	25	23
SS	2	100	3
SS	3	100	2
SS	4	100	2
SS	5	50	7
SS	6	42	3

DEPTH (m)	ELEV. (m)
0	95.98
1	94.98
2	93.98
3	92.98
4	91.98
5	90.98
6	89.98
7	88.98
8	87.98



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

FILE NO. PG3562

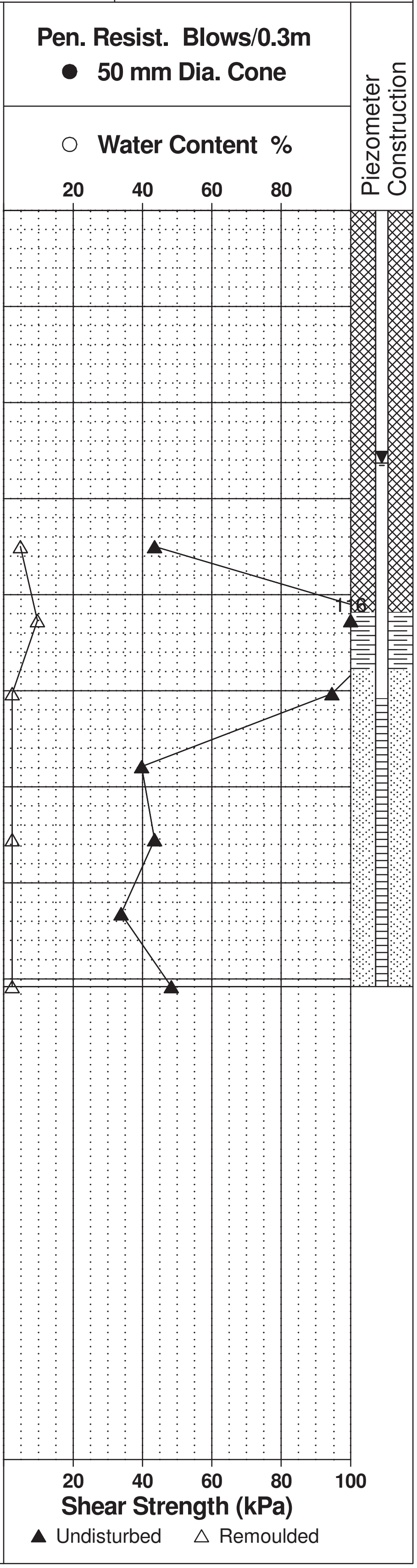
REMARKS

HOLE NO. BH 5-15

BORINGS BY CME 55 Power Auger

DATE July 31, 2015

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	96.05
FILL: Brown silty clay, trace sand and gravel	▨	SS	1	58	10	1	95.05
1.52							
Brown **SILTY CLAY** with sand lenses	▨	SS	2	100	7	2	94.05
2.13							
Very stiff to firm, grey **SILTY CLAY**	▨	SS	3	83	2	3	93.05
						4	92.05
						5	91.05
						6	90.05
						7	89.05
8.08						8	88.05
End of Borehole (GWL @ 2.63m-August 10, 2015)							



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Prop. Development - Terry Fox Drive at Kanata Ave.
Ottawa, Ontario

DATUM Ground surface elevations provided by Annis, O'Sullivan, Vollebekk Limited.

FILE NO. PG3562

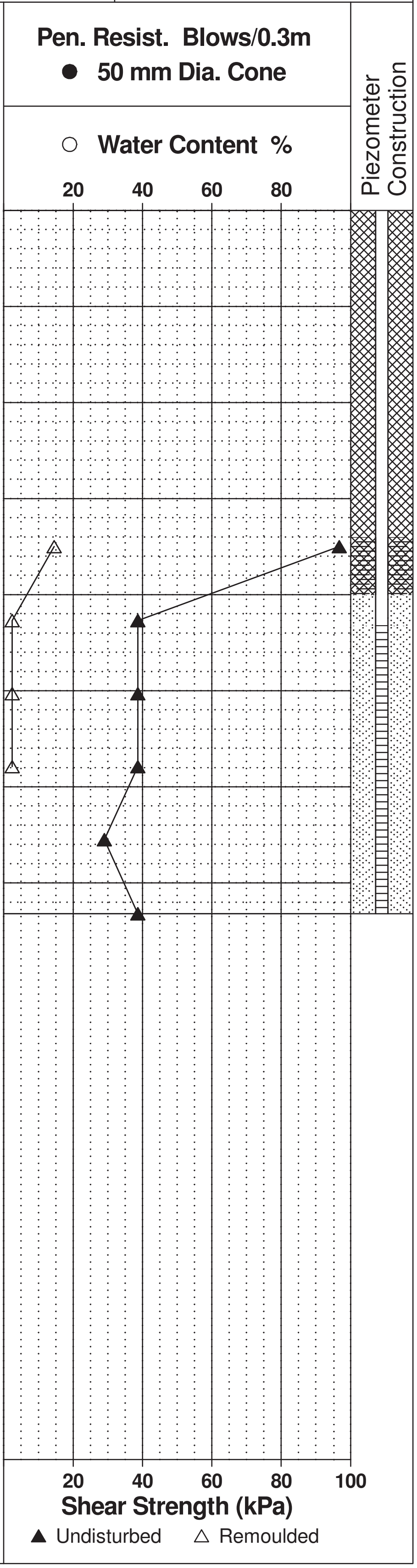
REMARKS

HOLE NO. BH 6-15

BORINGS BY CME 55 Power Auger

DATE July 31, 2015

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	95.66
FILL: Brown silty clay with gravel, sand, trace cobbles and boulders 0.60						
Loose, brown **SANDY SILT,** trace clay	SS	1	75	8	1	94.66
2.13	SS	2	83	4	2	93.66
Grey **CLAYEY SILT** with sand lenses 3.05	SS	3	92	2	3	92.66
Stiff to firm, grey **SILTY CLAY**					4	91.66
					5	90.66
					6	89.66
7.32					7	88.66
End of Borehole (BH dry - August 10, 2015)						



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development - Broughton Lands
Ottawa, Ontario

DATUM

REMARKS

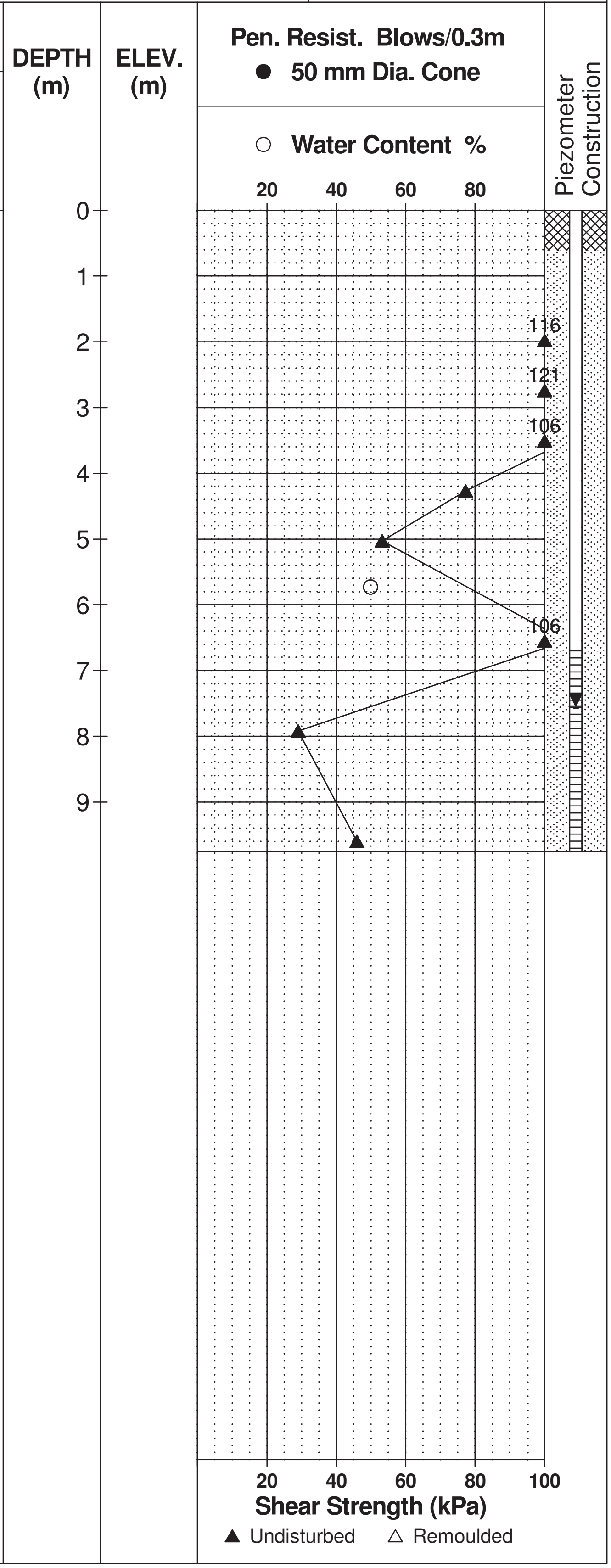
BORINGS BY CME 55 Power Auger

DATE June 24, 2008

FILE NO. PG1703

HOLE NO. BH 1

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.15	AU	1		
Brown **SILTY CLAY** with sand seams	SS	2	58	5
1.83	SS	3	100	5
Stiff to very stiff, brown **SILTY CLAY**	SS	4	100	1
- firm to stiff and grey by 5.0m depth	TW	5	100	
	SS	6	100	1
	TW	7	100	
9.75	SS	8	88	1
End of Borehole				
(GWL @ 7.54m - July 9/08)				



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development - Broughton Lands
Ottawa, Ontario

DATUM

REMARKS

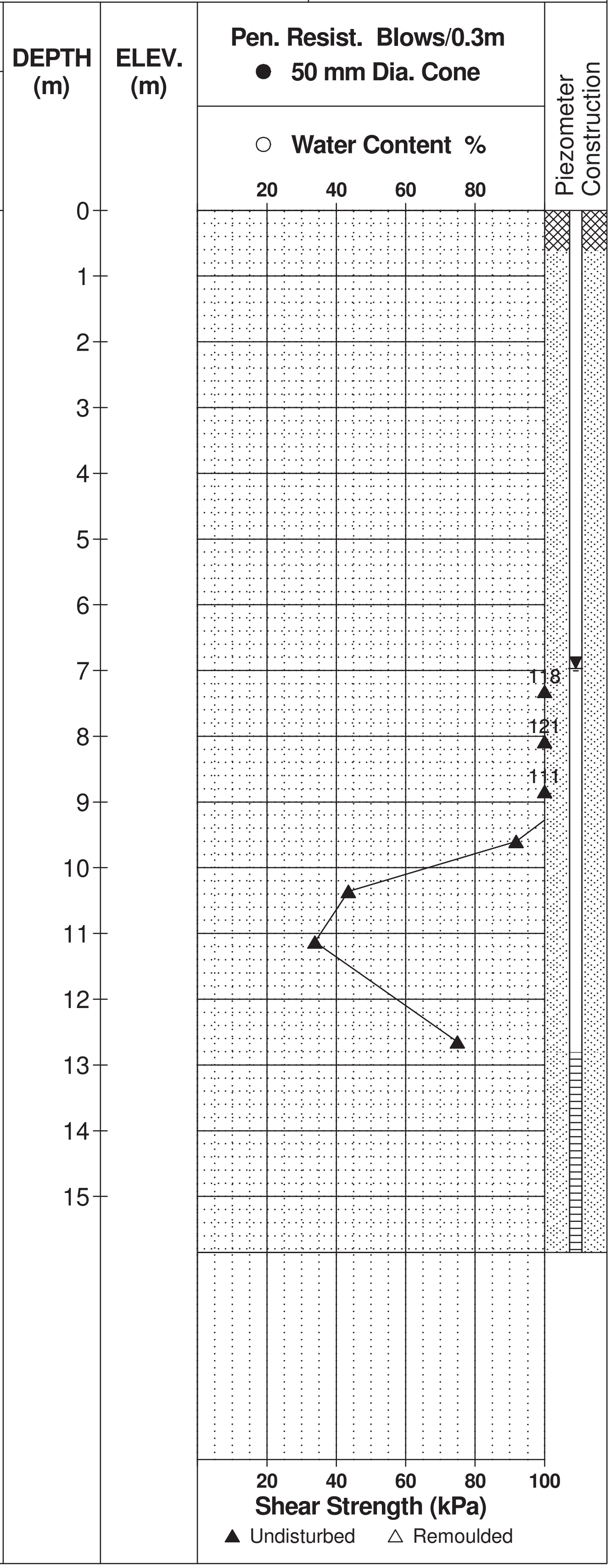
BORINGS BY CME 55 Power Auger

DATE June 24, 2008

FILE NO. PG1703

HOLE NO. BH 2

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE					
FILL: Brown organic opsoil with cobbles and boulders		SS	1	25	18
5.49		SS	2	50	15
Stiff to very stiff, brown **SILTY CLAY**, trace sand		SS	3	83	5
		SS	4	100	3
- firm to stiff and grey by 10.4m depth		TW	5	98	
12.65					
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles, and boulders		SS	6	33	12
		SS	7	25	20
		SS	8	50	+50
15.85					
End of Borehole					
(GWL @ 6.97m - July 9/08)					



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development - Broughton Lands
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 25, 2008

FILE NO. PG1703

HOLE NO. BH 3

SOIL DESCRIPTION

GROUND SURFACE

FILL: Brown organic topsoil with sand, cobbles and boulders throughout

7.62

Stiff to very stiff, brown **SILTY CLAY**

- firm and grey by 12.0m depth

15.01

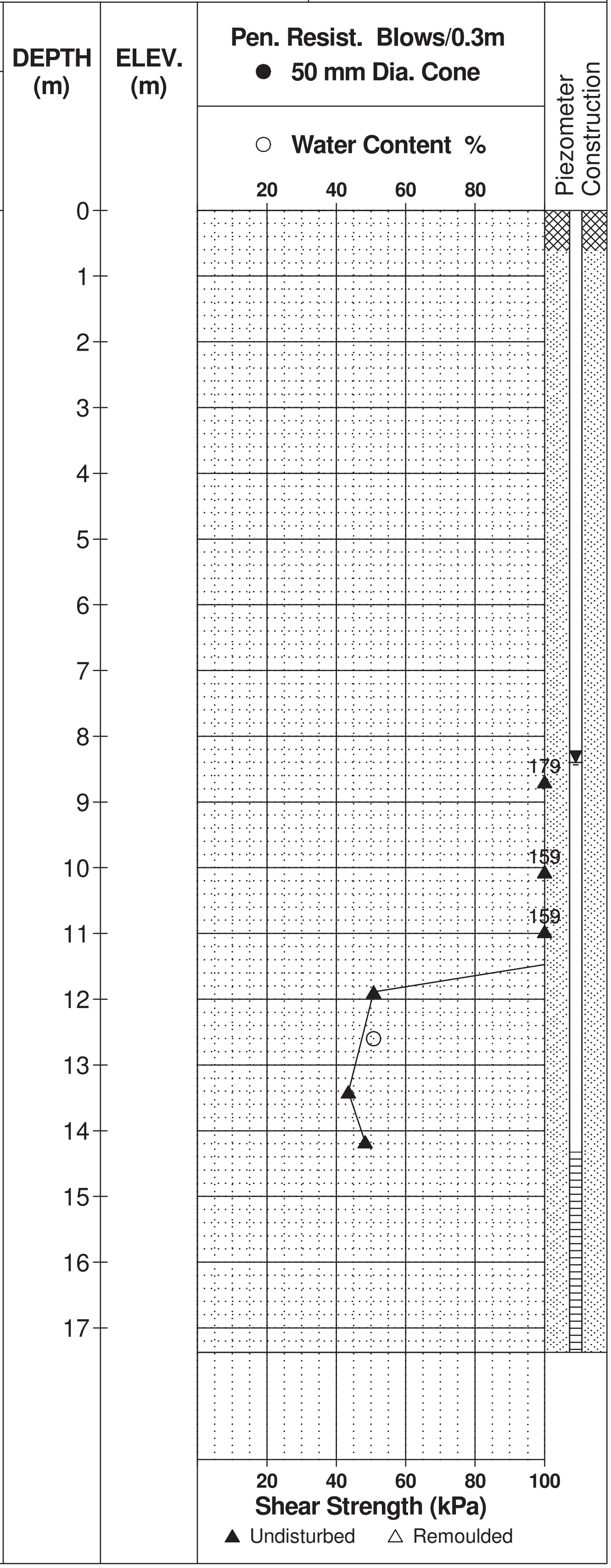
GLACIAL TILL: Grey silty clay with gravel, cobbles, and boulders

17.37

End of Borehole

(GWL @ 8.40m - July 9/08)

TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	50	35
SS	2	100	20
SS	3	42	12
SS	4	100	6
SS	5	100	6
TW	6	100	
TW	7	96	
SS	8	33	9
SS	9	58	26



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development - Broughton Lands
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 25, 2008

FILE NO. PG1703

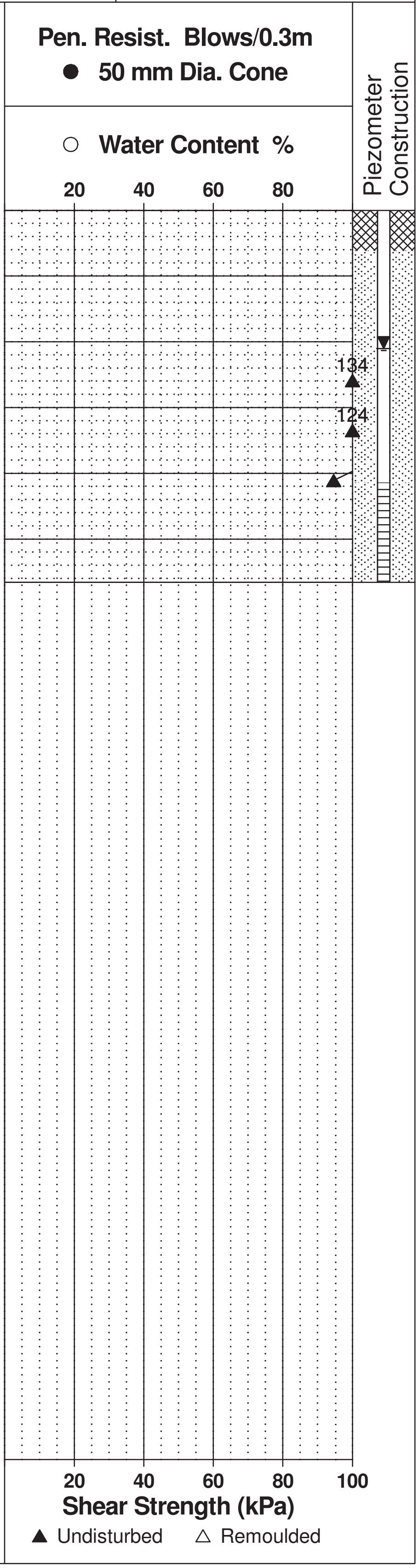
HOLE NO. BH 4

SOIL DESCRIPTION	SAMPLE				DEPTH (m)	ELEV. (m)
	TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE					0	
FILL: Brown silty clay with sand	AU	1				
	SS	2	33	7	1	
1.52	SS	3	100	5	2	
Stiff to very stiff, brown **SILTY CLAY** with sand					3	
4.27					4	
GLACIAL TILL: Brown silty sand with sand, cobbles, and boulders	SS	4	40	+50	5	
5.66	SS	5	62	+50		

End of Borehole

Practical refusal to augering @ 5.33m depth

(GWL @ 2.10m - July 9/08)



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Commercial Development - Broughton Lands
Ottawa, Ontario

DATUM

REMARKS

BORINGS BY CME 55 Power Auger

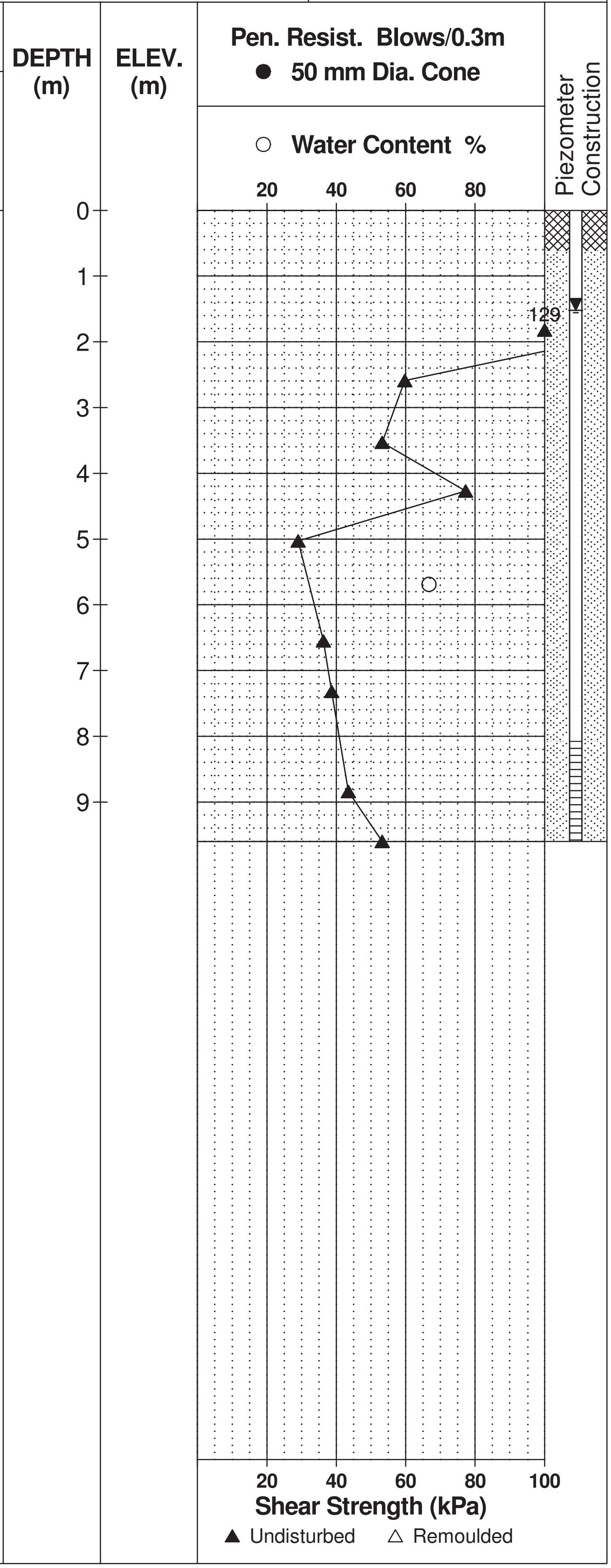
DATE June 26, 2008

FILE NO. PG1703

HOLE NO. BH 5

SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.15	AU	1		
Stiff to very stiff, brown **SILTY CLAY**	SS	2	88	7
	SS	3	100	3
- firm to stiff and grey by 5.0m depth	TW	4	100	
	TW	5	100	
9.60 End of borehole				

(GWL @ 1.52m - July 9/08)



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)

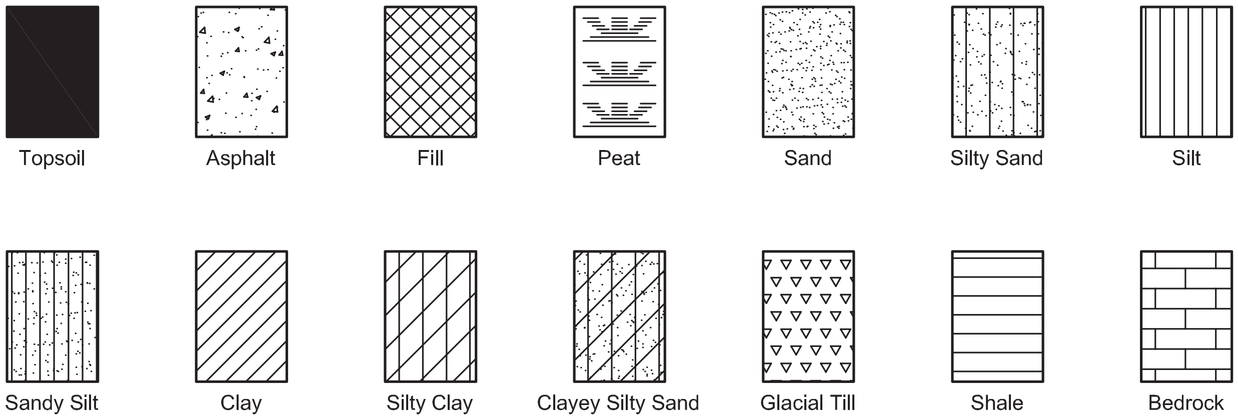
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

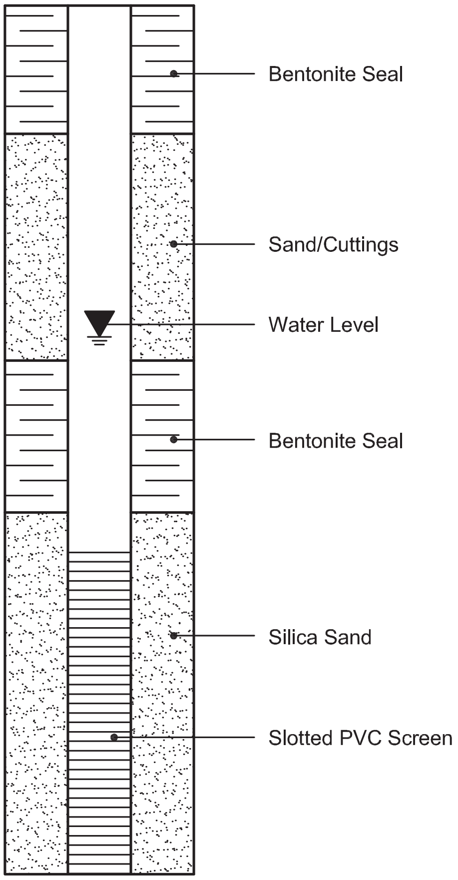
SYMBOLS AND TERMS (continued)

STRATA PLOT

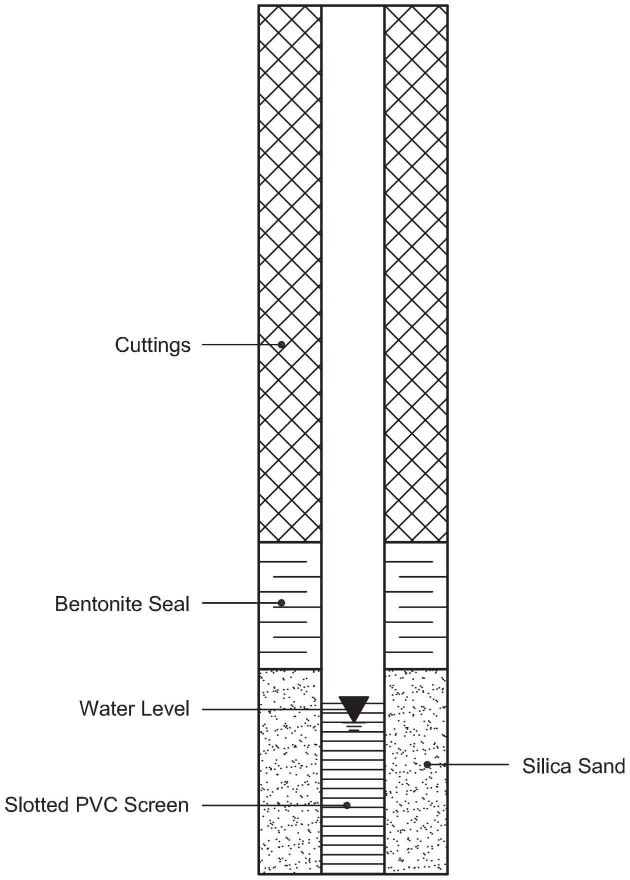


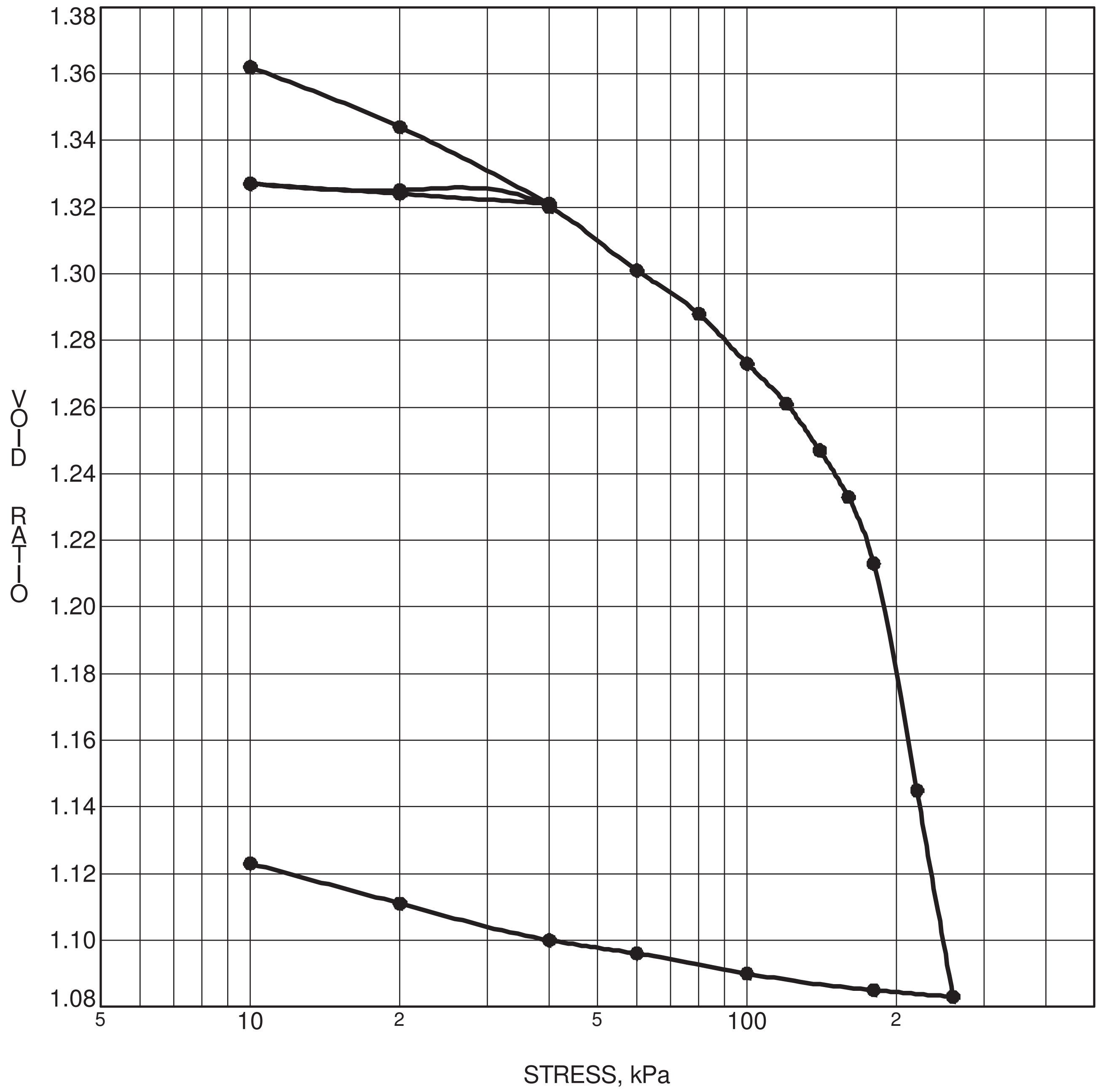
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH 1	p'_o	78 kPa	Ccr	0.011
Sample No.	TW 5	p'_c	174 kPa	Cc	0.864
Sample Depth	5.73 m	OC Ratio	2.2	Wo	49.9 %
Sample Elev.	93.52 m	Void Ratio	1.371	Unit Wt.	17.3 kN/m^3

CLIENT **Richcraft Group of Companies**

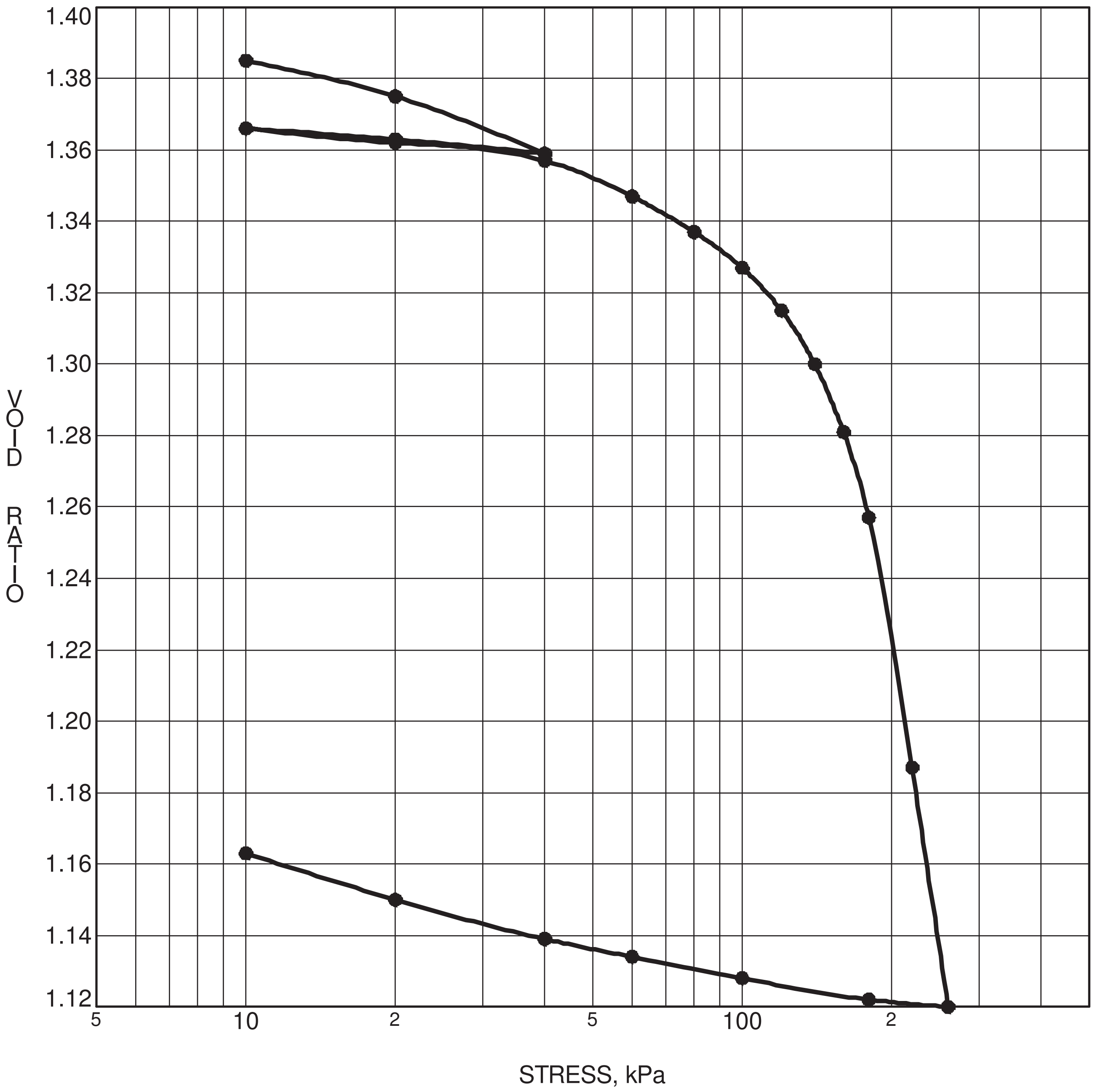
PROJECT **Geotechnical Investigation - Proposed**
Commercial Development - Broughton Lands

FILE NO. **PG1703**

DATE **June 27, 2008**

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

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 3**	p'_o	**74** kPa	Ccr	**0.013**
Sample No.	**TW 6**	p'_c	**164** kPa	Cc	**1.260**
Sample Depth	**12.60** m	OC Ratio	**2.2**	Wo	**50.7** %
Sample Elev.	**93.41** m	Void Ratio	**1.395**	Unit Wt.	**17.2** kN/m^3

NOTE: Overburden stress calculated from original ground surface (~98.4m)

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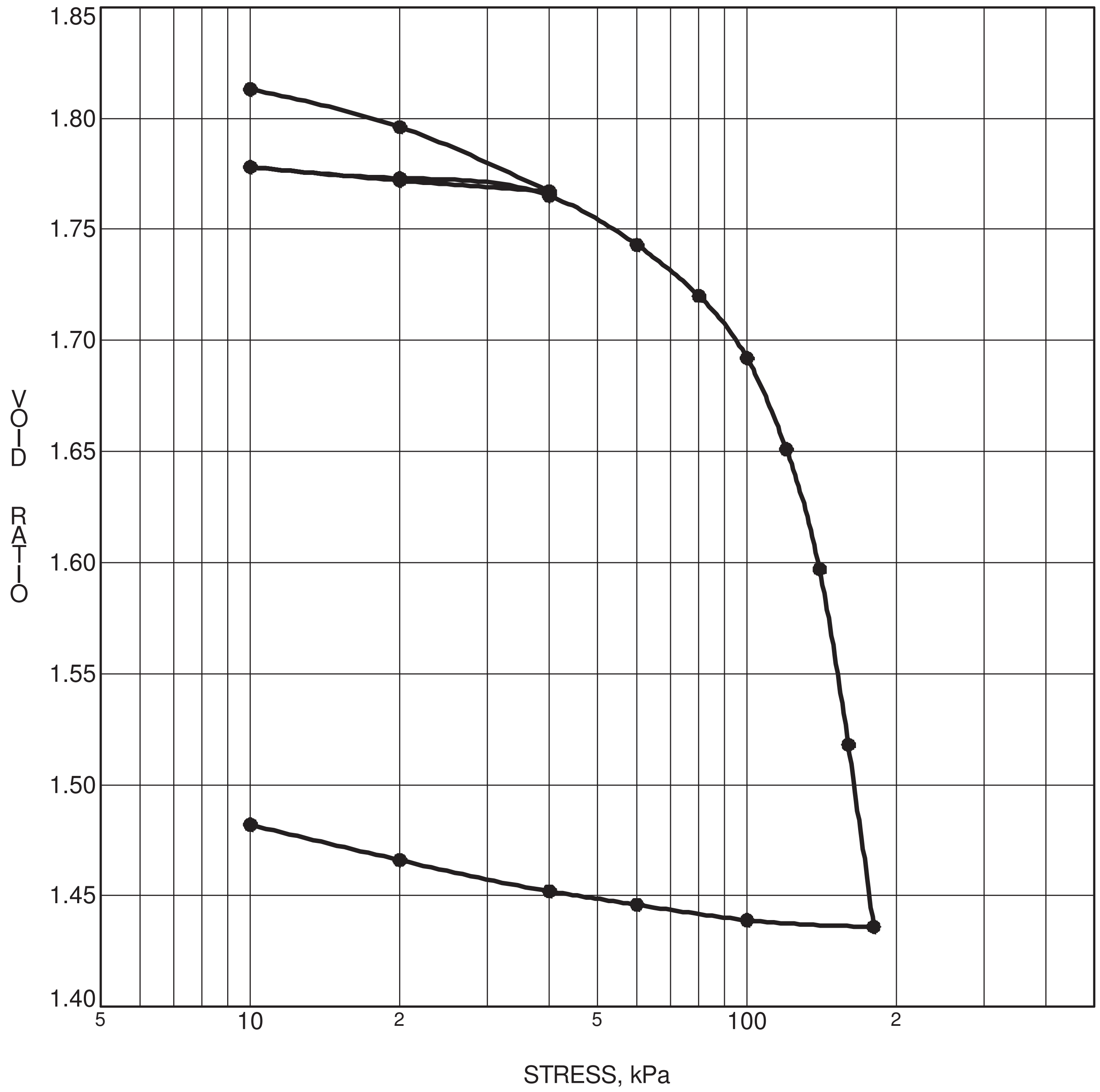
CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5**	p'$_o$	**72** kPa	Ccr	**0.021**
Sample No.	**TW 4**	p'$_c$	**124** kPa	Cc	**1.906**
Sample Depth	**5.69** m	OC Ratio	**1.7**	Wo	**66.7** %
Sample Elev.	**94.12** m	Void Ratio	**1.834**	Unit Wt.	**16.1** kN/m ^{3}

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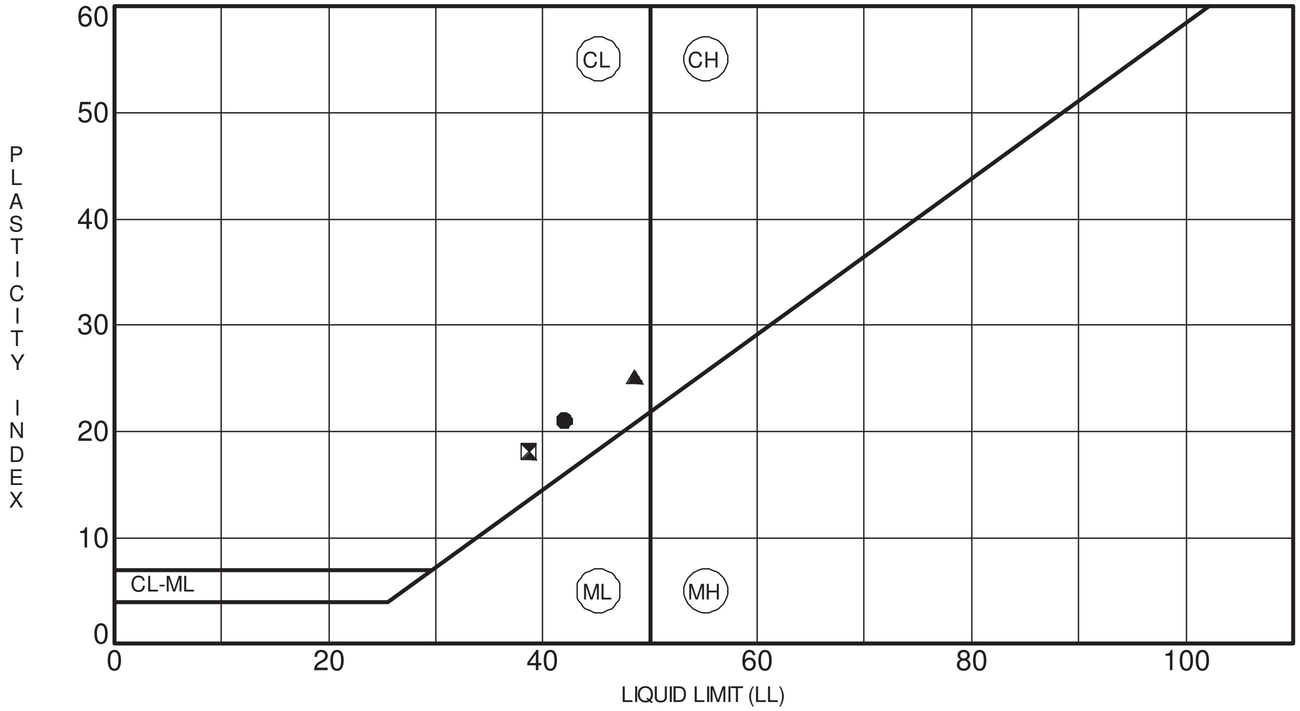
CONSOLIDATION TEST



	Specimen Identification	LL	PL	PI	Fines	Classification
●	**BH 1**	**42**	**21**	**21**		**CL - Clay with low plasticity (TW 5)**
☒	**BH 3**	**39**	**21**	**18**		**CL - Clay with low plasticity (TW 6)**
▲	**BH 5**	**49**	**23**	**25**		**CL - Clay with low plasticity (TW 4)**

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PROJECT **Geotechnical Investigation - Proposed**
Commercial Development - Broughton Lands

FILE NO. **PG1703**

DATE **26 Jun 08**

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ATTERBERG LIMITS' RESULTS

APPENDIX 2

FIGURE 1 - KEY PLAN

HISTORICAL AERIAL PHOTOGRAPHS

FIGURE 4A TO 7C - SLOPE STABILITY ANALYSIS SECTIONS

DRAWING PG4564-1 - TEST HOLE LOCATION PLAN

DRAWING PG4564-2 - PERMISSIBLE GRADE RAISE PLAN

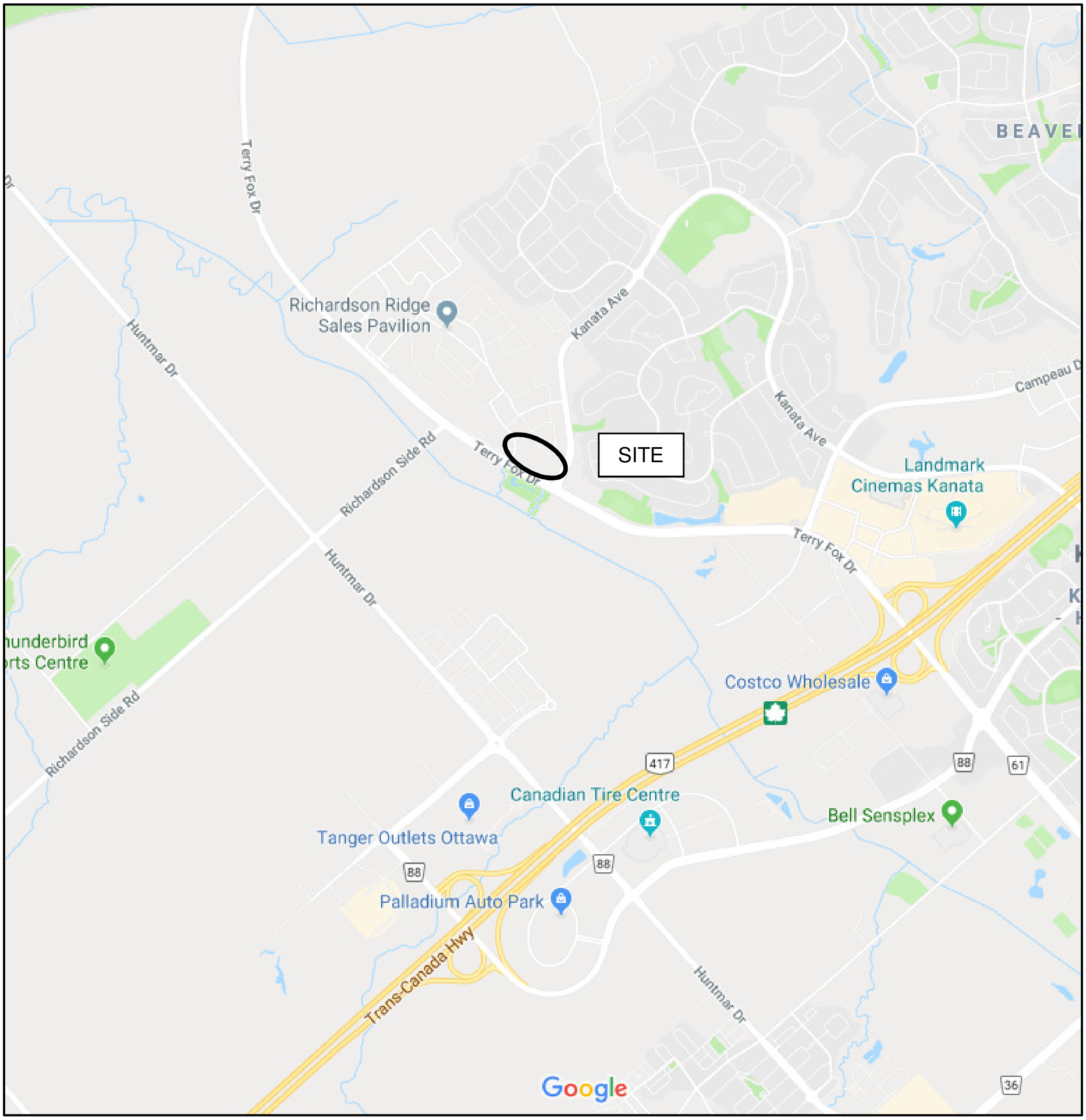

FIGURE 1

KEY PLAN

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FIGURE 2

2008 AERIAL PHOTOGRAPH

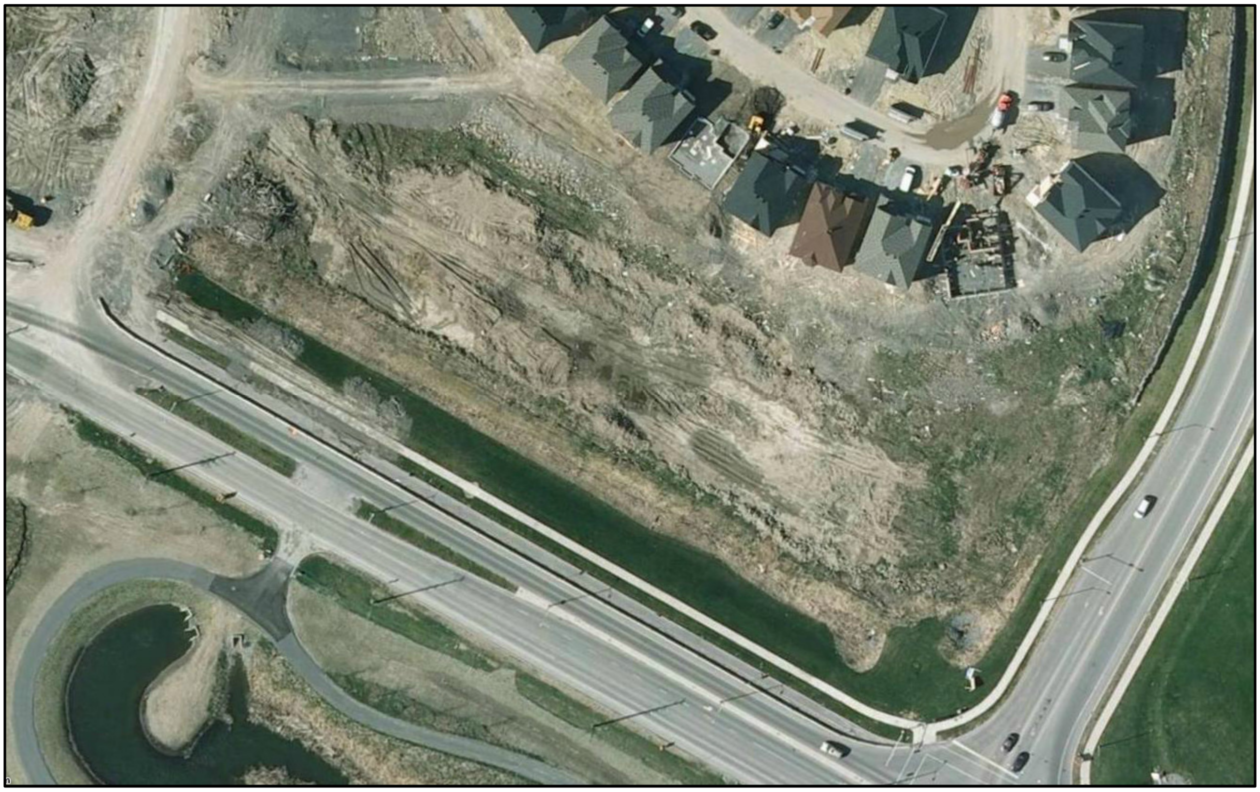


FIGURE 3

2011 AERIAL PHOTOGRAPH

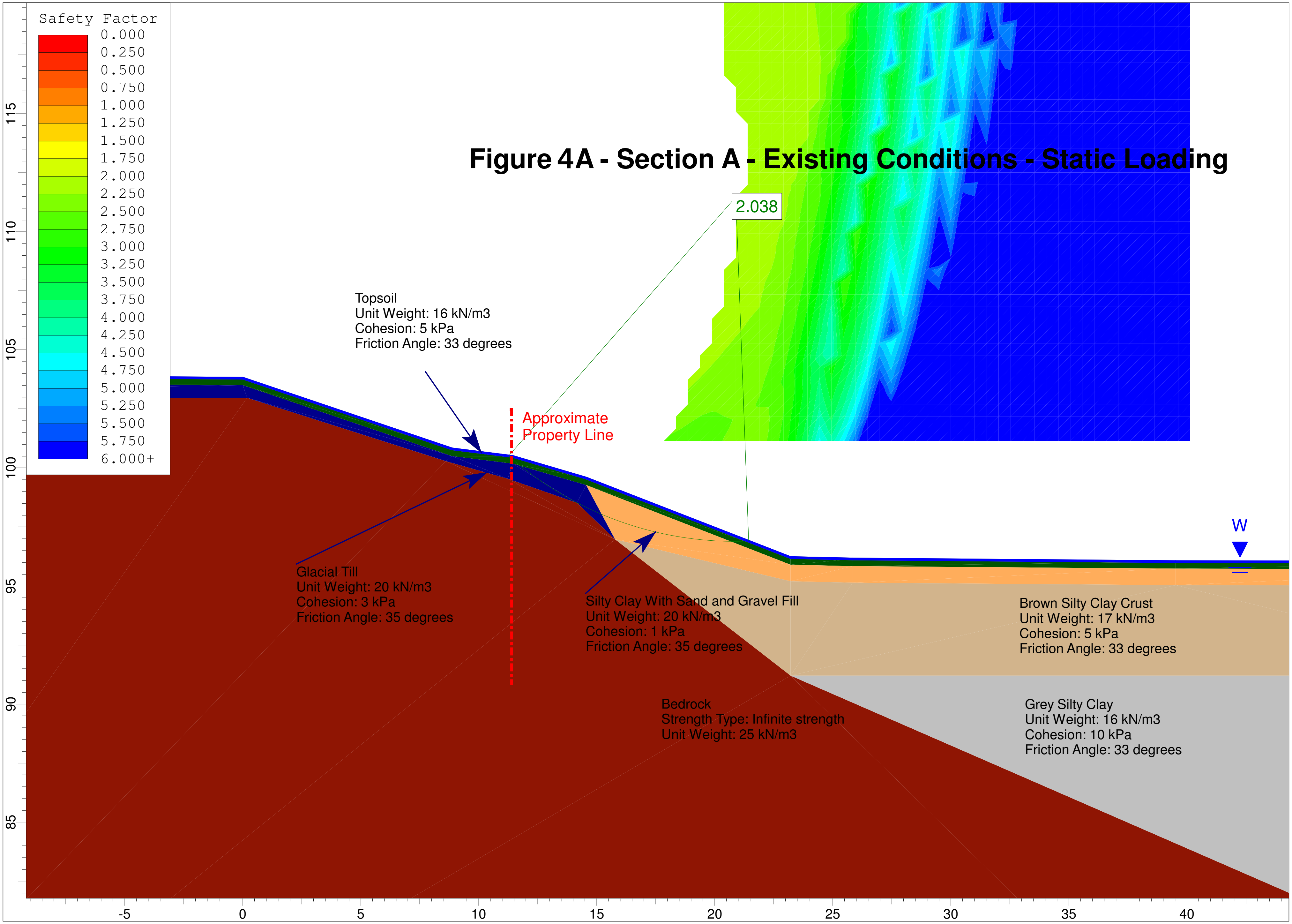


Figure 4A - Section A - Existing Conditions - Static Loading

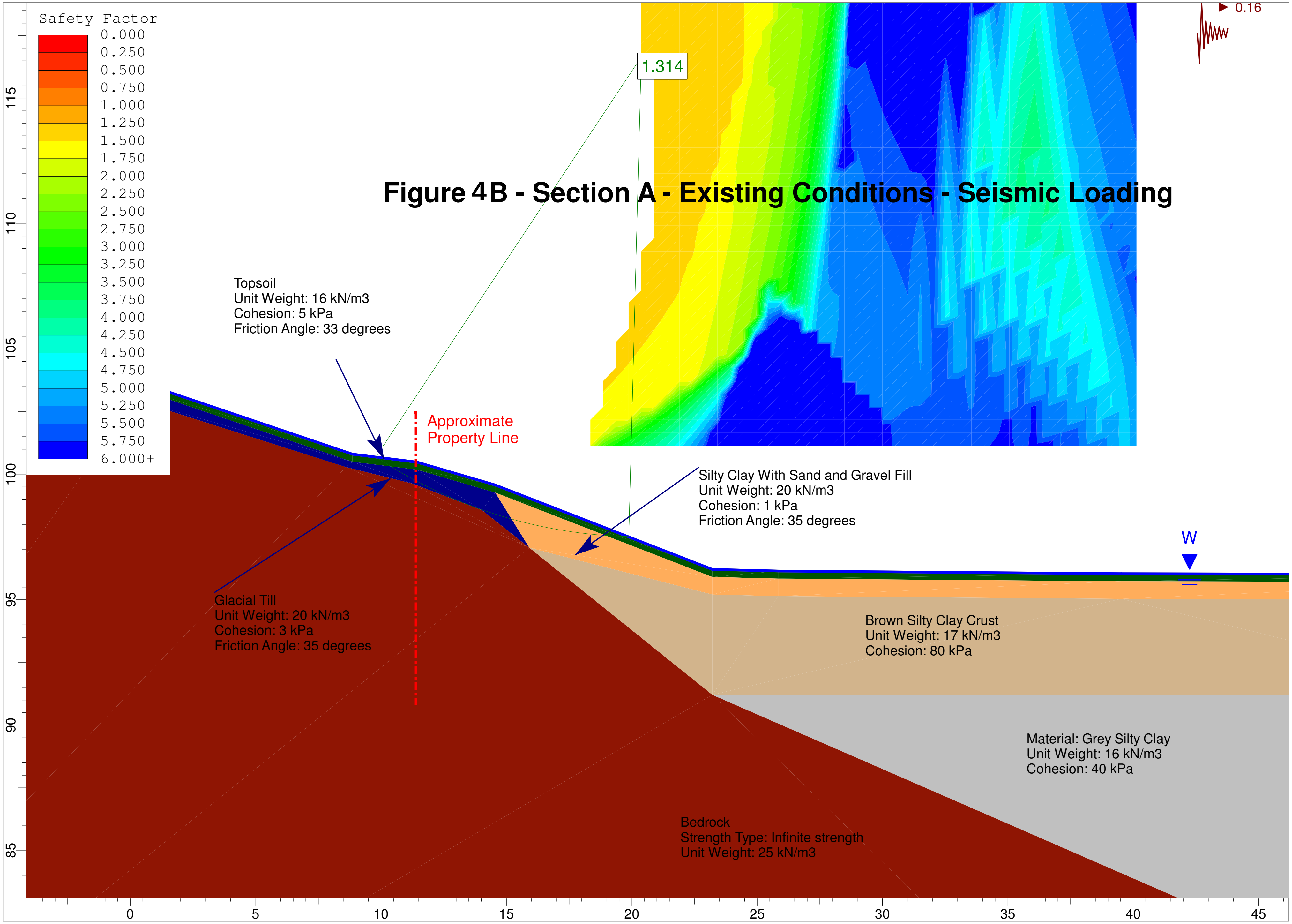


Figure 4B - Section A - Existing Conditions - Seismic Loading

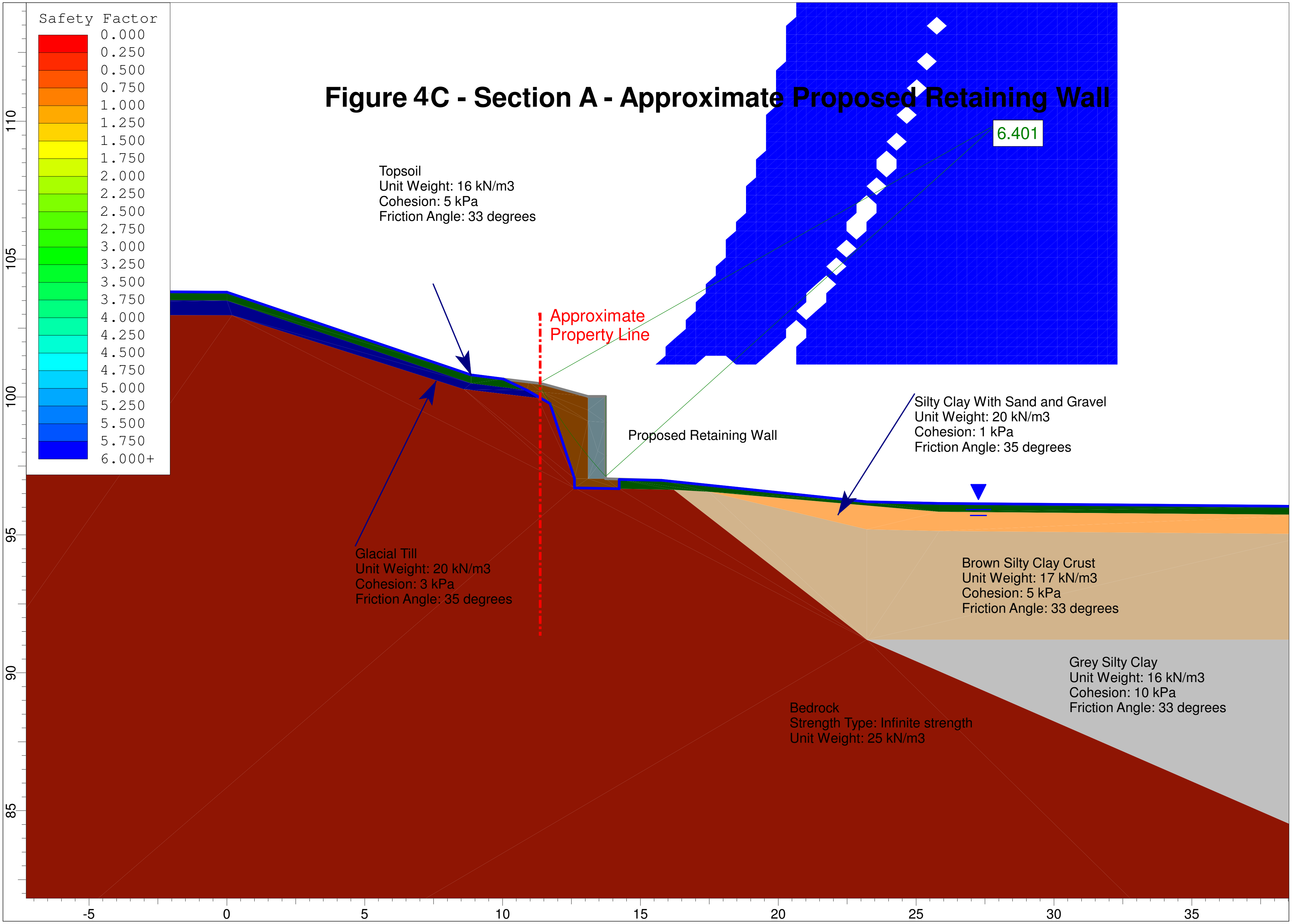


Figure 4C - Section A - Approximate Proposed Retaining Wall

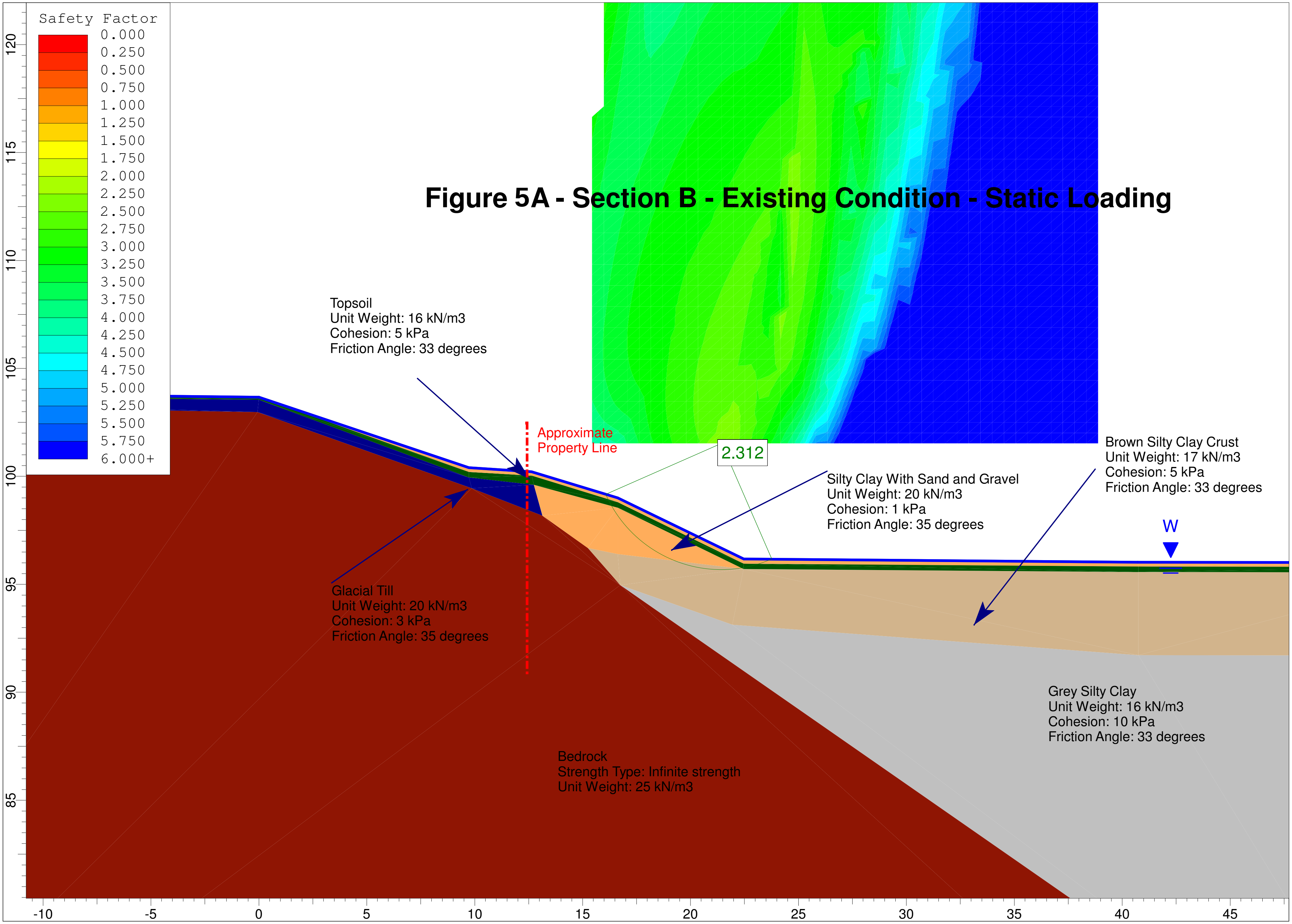


Figure 5A - Section B - Existing Condition - Static Loading

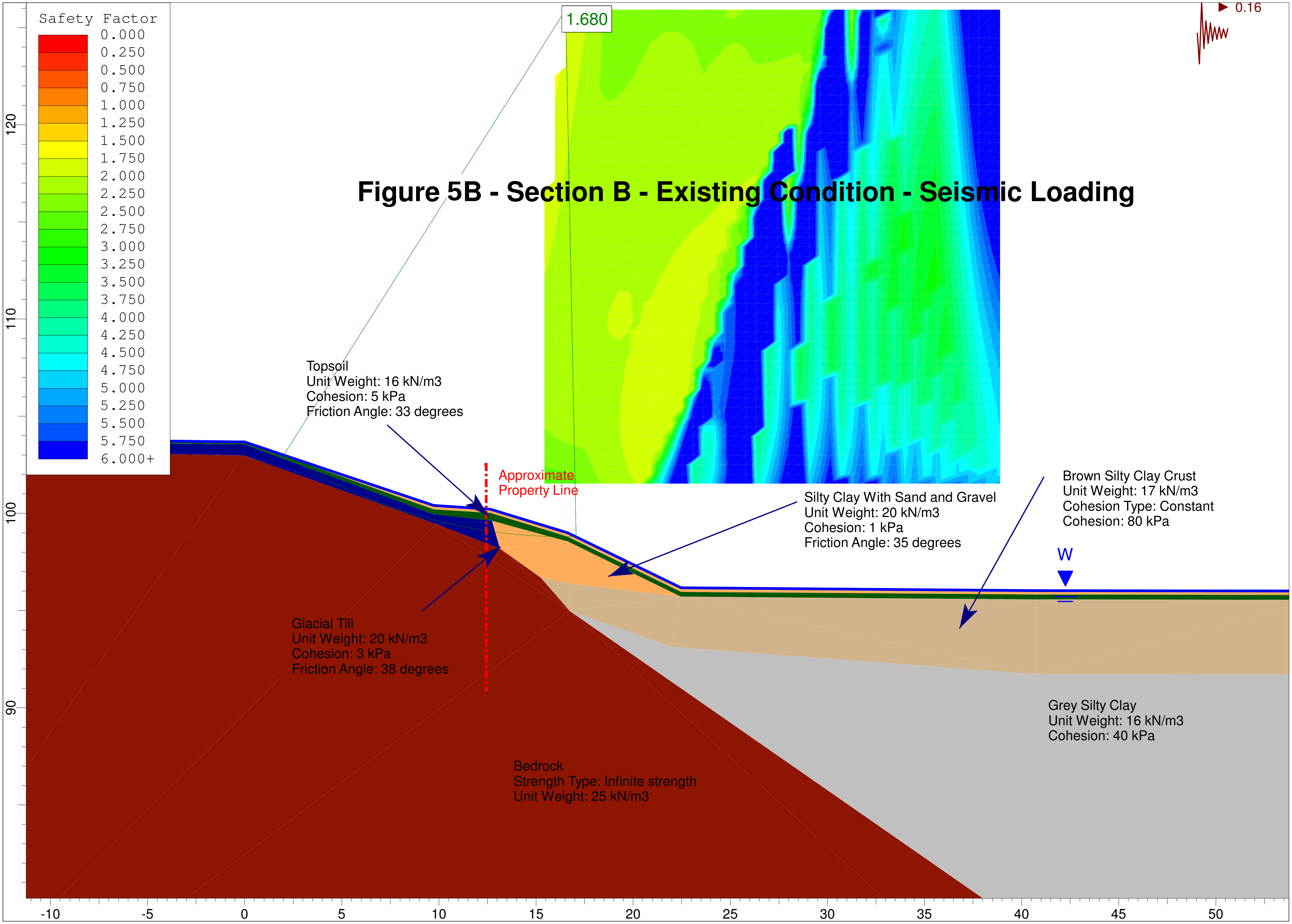


Figure 5B - Section B - Existing Condition - Seismic Loading

Topsoil
Unit Weight: 16 kN/m3
Cohesion: 5 kPa
Friction Angle: 33 degrees

Approximate
Property Line

Silty Clay With Sand and Gravel
Unit Weight: 20 kN/m3
Cohesion: 1 kPa
Friction Angle: 35 degrees

Brown Silty Clay Crust
Unit Weight: 17 kN/m3
Cohesion Type: Constant
Cohesion: 80 kPa

Glacial Till
Unit Weight: 20 kN/m3
Cohesion: 3 kPa
Friction Angle: 38 degrees

Grey Silty Clay
Unit Weight: 16 kN/m3
Cohesion: 40 kPa

Bedrock
Strength Type: Infinite strength
Unit Weight: 25 kN/m3

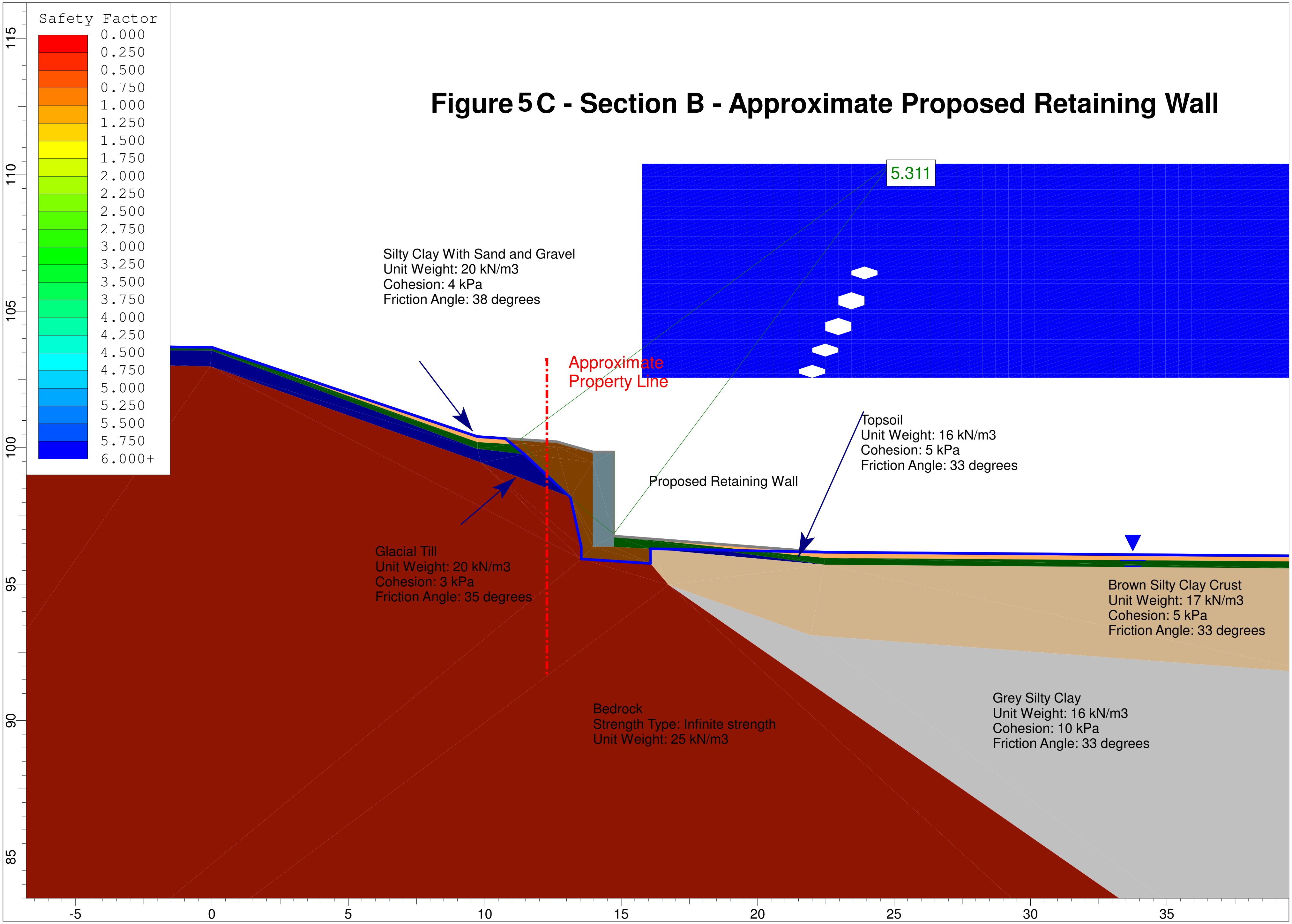


Figure 5C - Section B - Approximate Proposed Retaining Wall

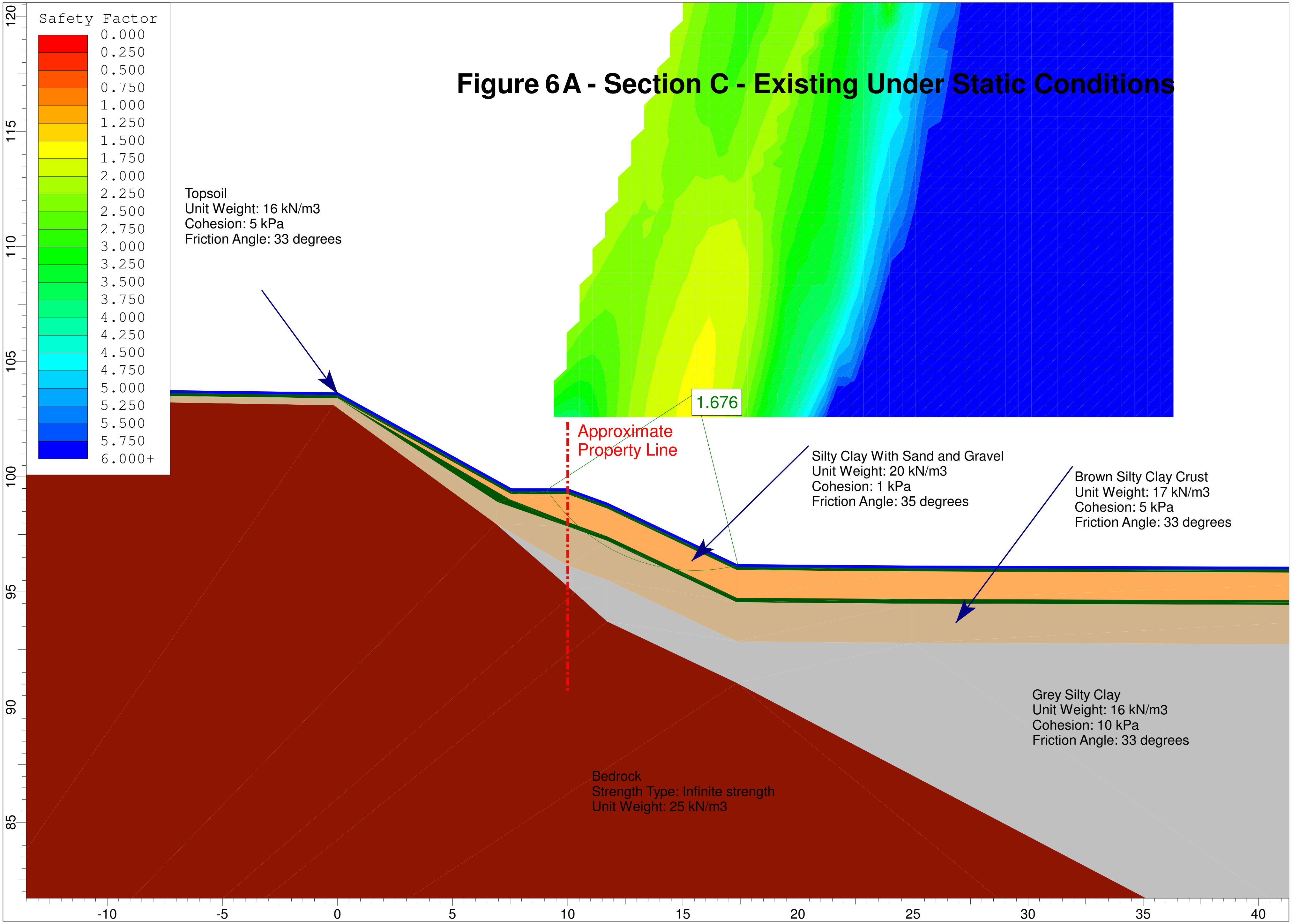


Figure 6A - Section C - Existing Under Static Conditions

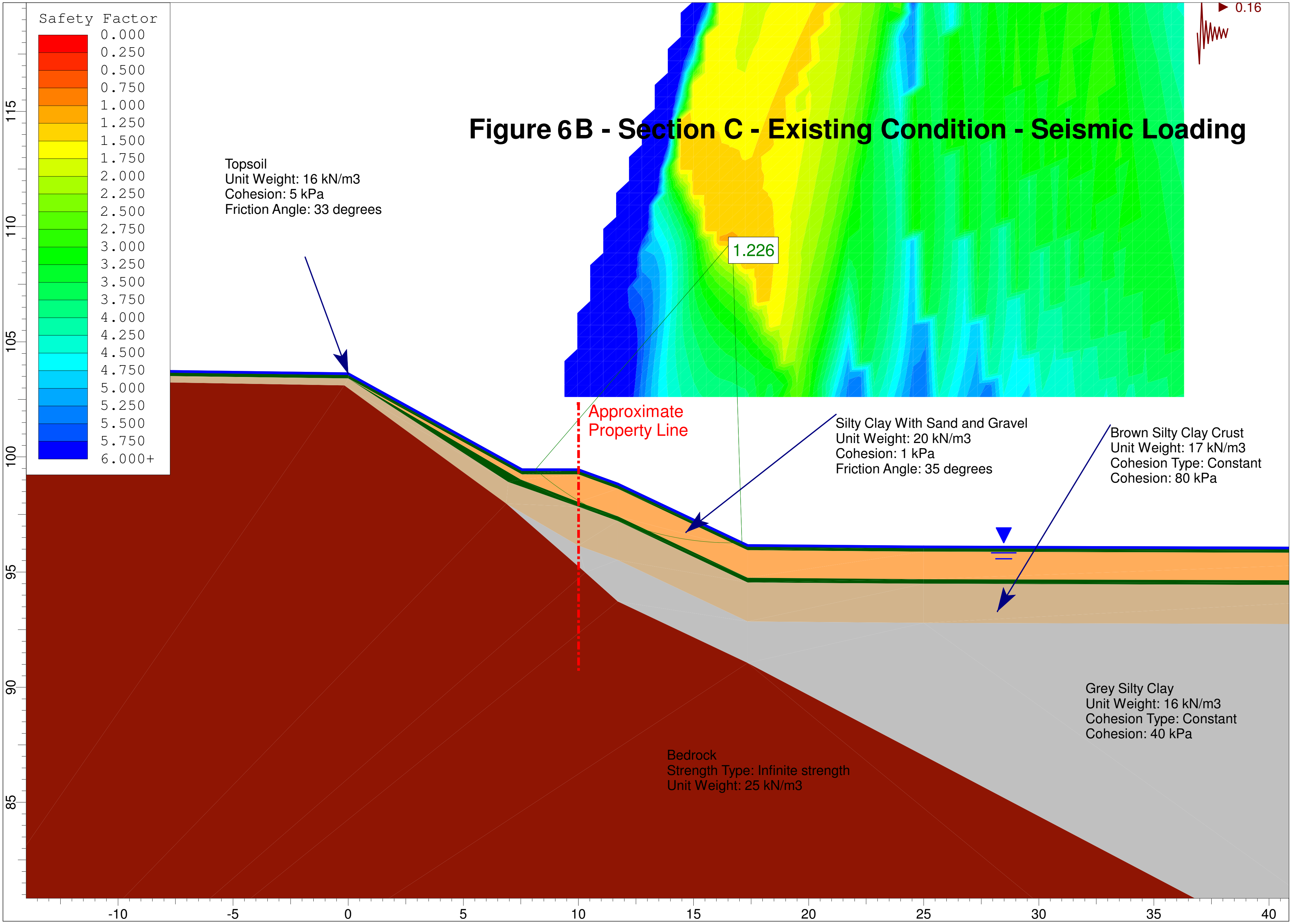


Figure 6B - Section C - Existing Condition - Seismic Loading

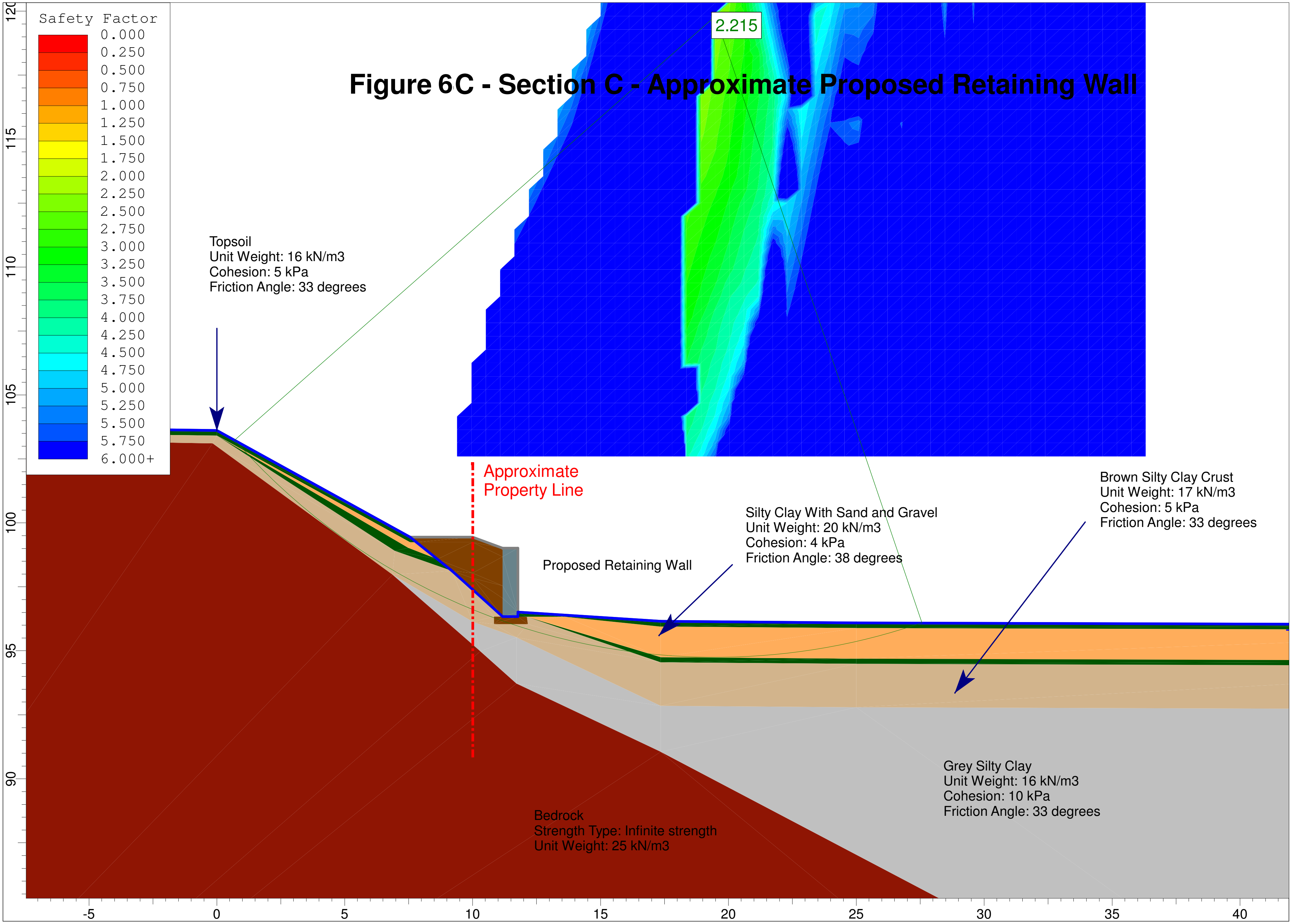


Figure 6C - Section C - Approximate Proposed Retaining Wall

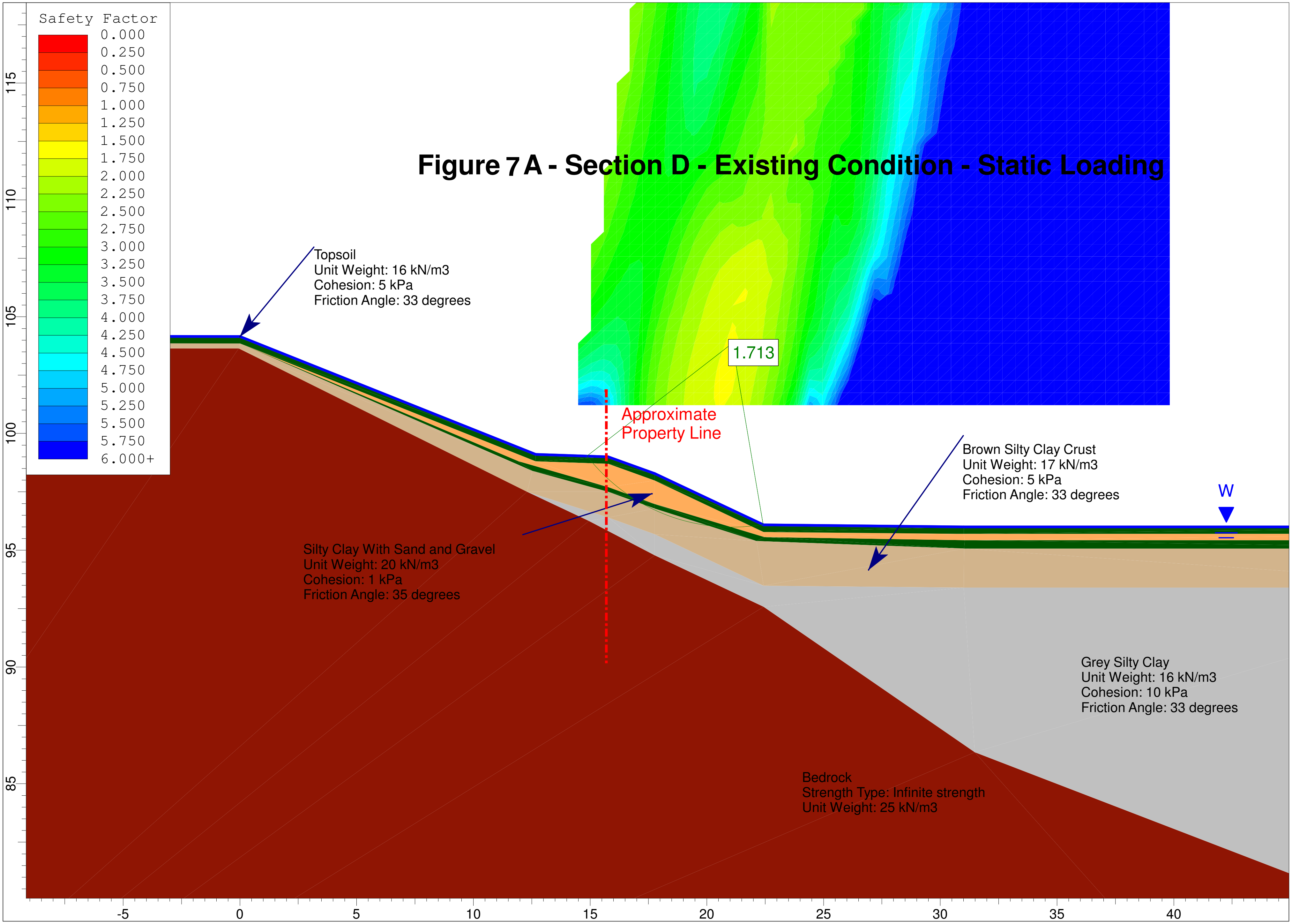


Figure 7A - Section D - Existing Condition - Static Loading

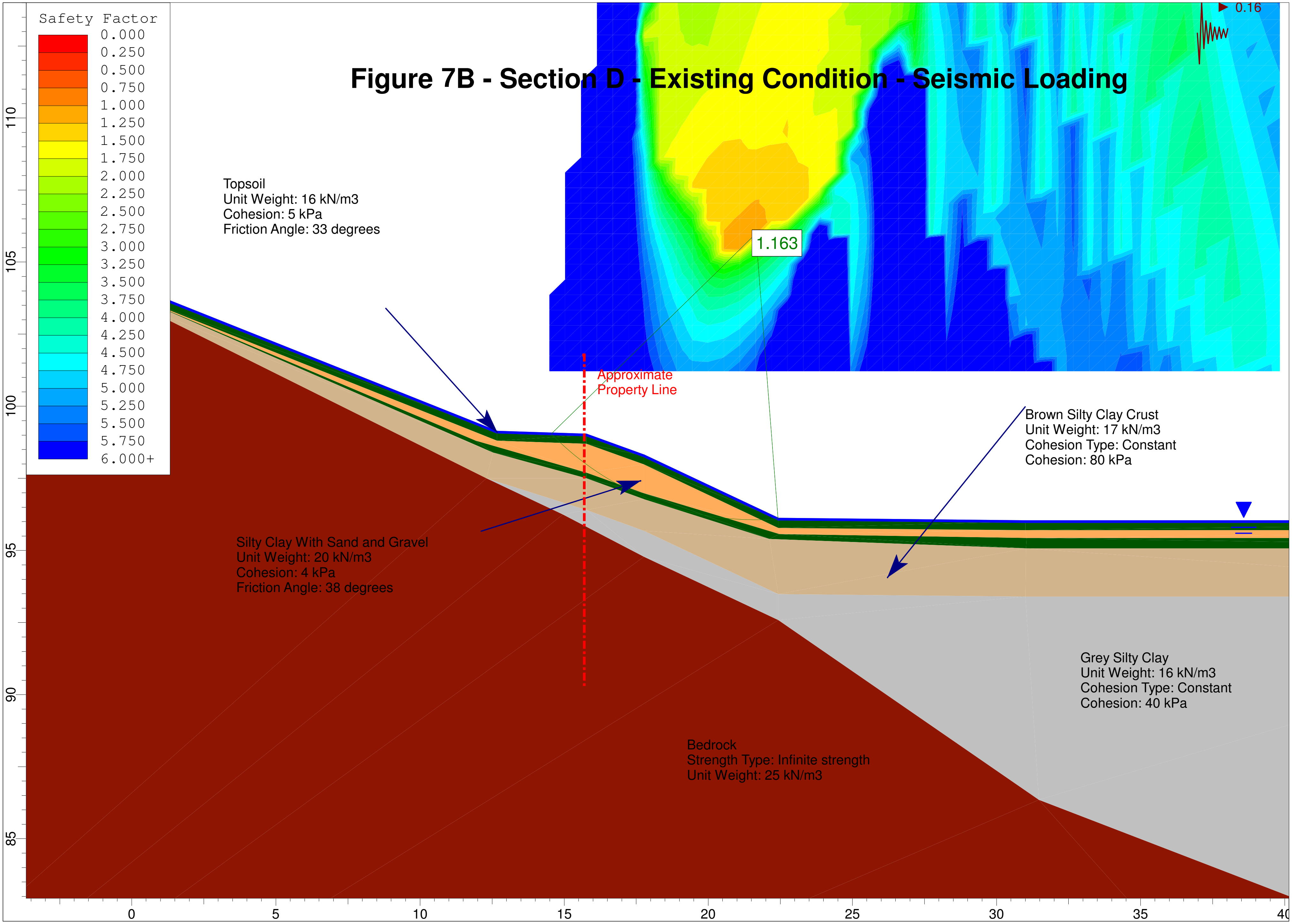


Figure 7B - Section D - Existing Condition - Seismic Loading

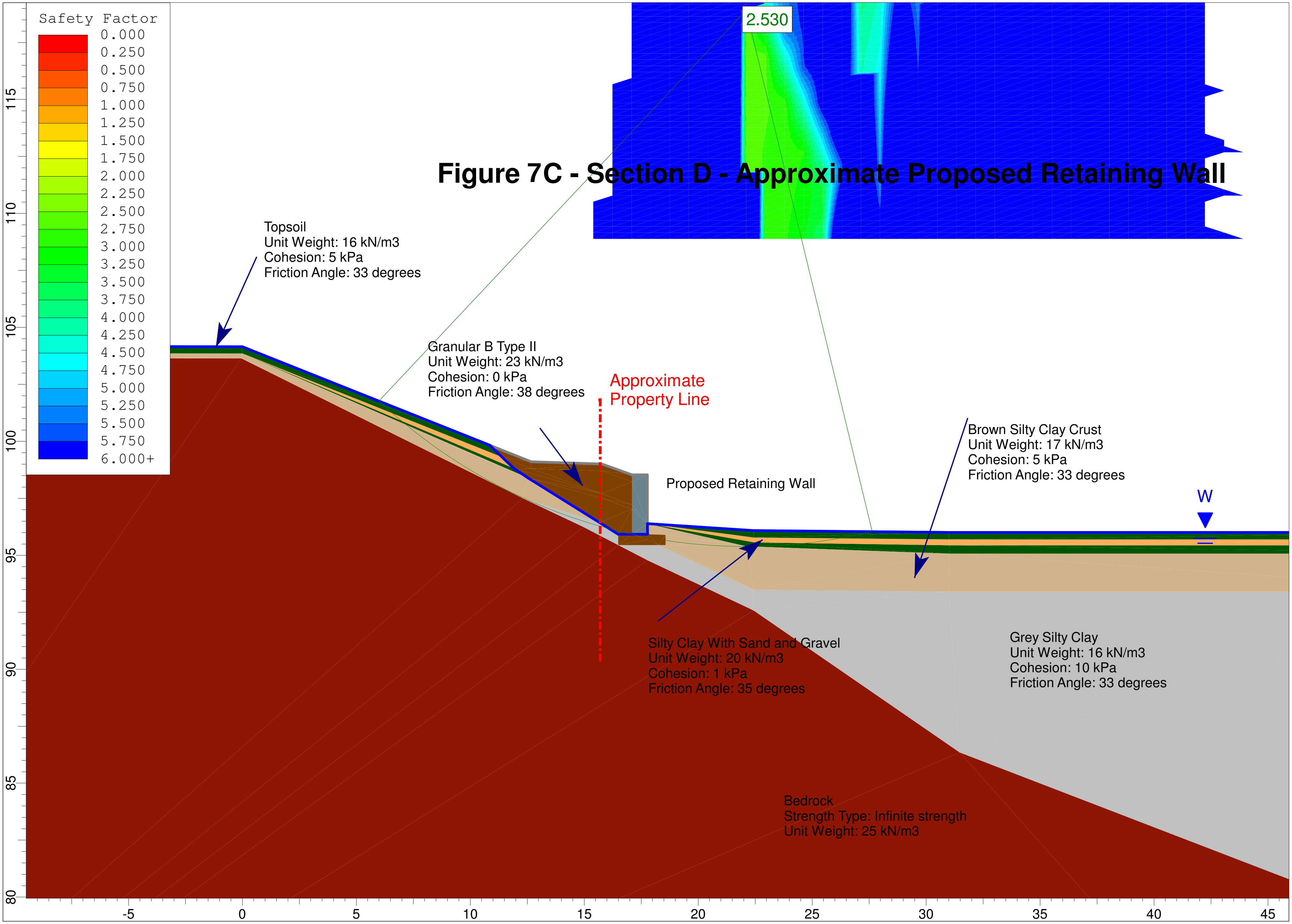
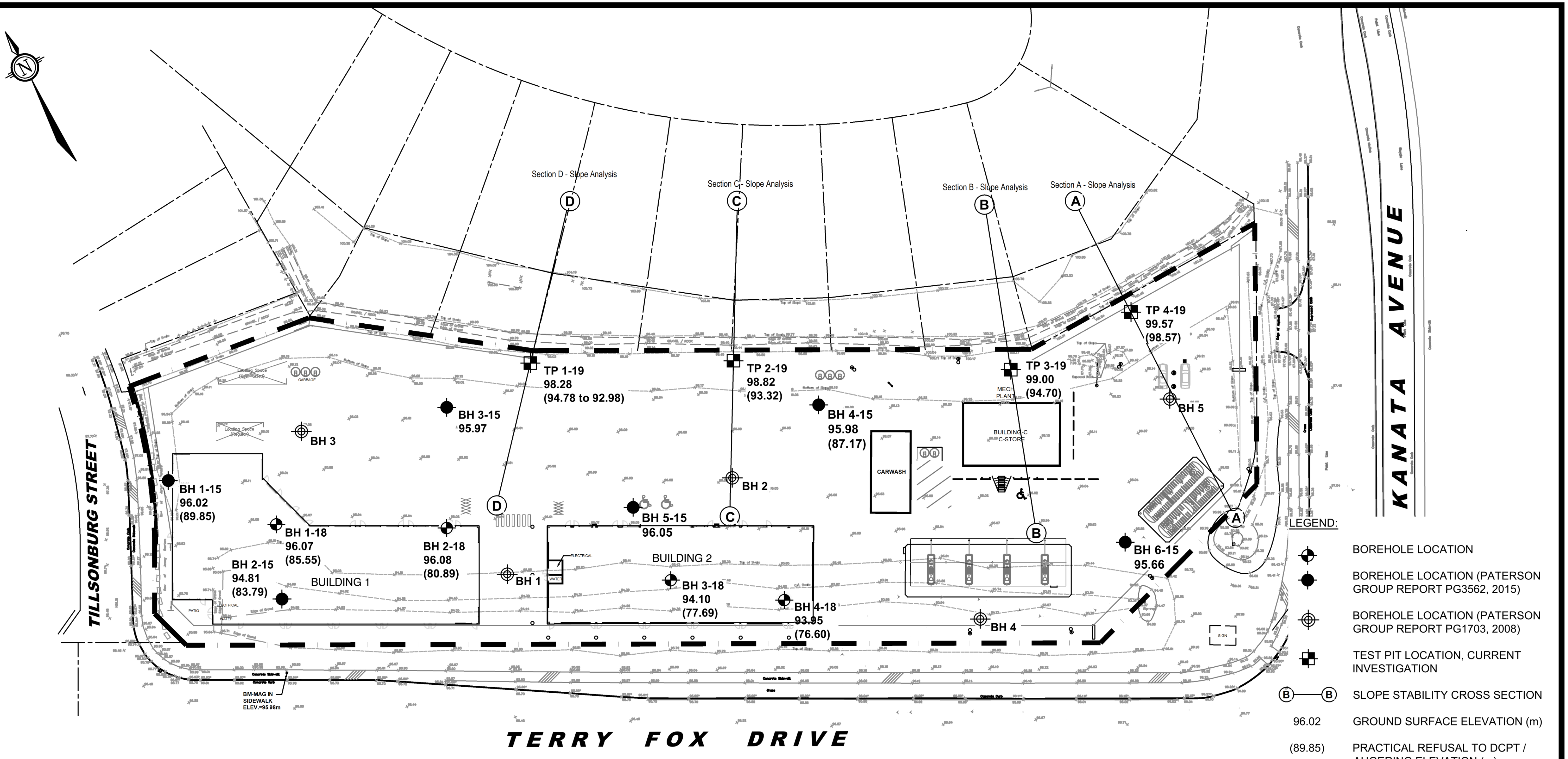


Figure 7C - Section D - Approximate Proposed Retaining Wall



LEGEND:

⊕	BOREHOLE LOCATION
●	BOREHOLE LOCATION (PATERSON GROUP REPORT PG3562, 2015)
⊕	BOREHOLE LOCATION (PATERSON GROUP REPORT PG1703, 2008)
▣	TEST PIT LOCATION, CURRENT INVESTIGATION
B——B	SLOPE STABILITY CROSS SECTION
96.02	GROUND SURFACE ELEVATION (m)
(89.85)	PRACTICAL REFUSAL TO DCPT / AUGERING ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

SCALE: 1:750

0 10 20 30 50m

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Ottawa, Ontario K2E 7J5
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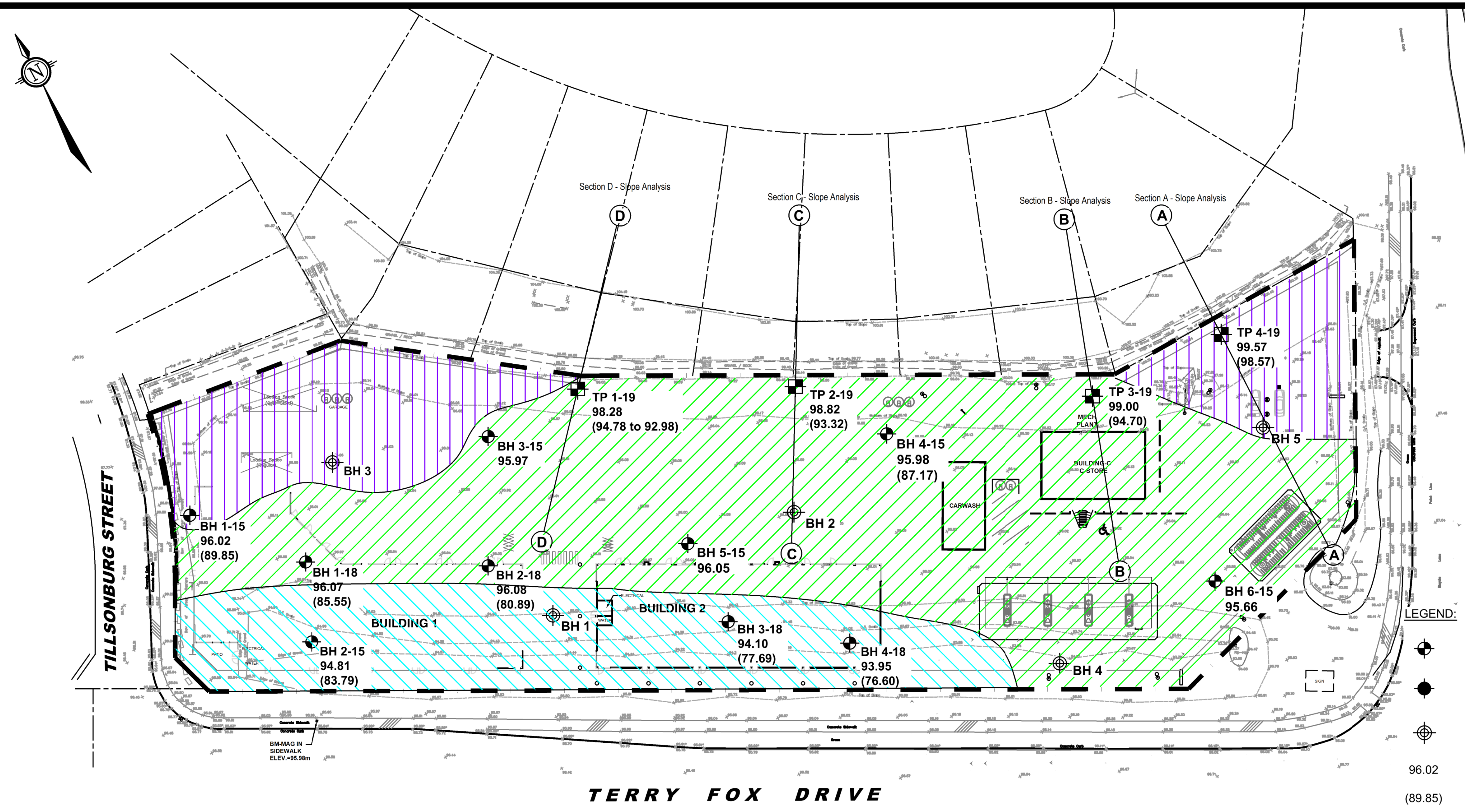
NO.	REVISIONS	DATE	INITIAL
2	2019 TEST PITS AND SLOPE STABILITY CROSS SECTIONS ADDED TO PLAN	17/04/2019	JV
1	2018 BOREHOLES ADDED TO PLAN	10/10/2018	RG

TRIMTERRA DEVELOPMENT CORPORATION
GEOTECHNICAL INVESTIGATION
PROP. COMMERCIAL DEVELOPMENT - TERRY FOX DRIVE AT KANATA AVENUE
OTTAWA, ONTARIO

Title:
TEST HOLE LOCATION PLAN

Scale: 1:750
Date: 09/2018
Drawn by: RCG
Report No.: PG4564-1
Checked by: JV
Dwg. No.: PG4564-1
Approved by: DJG
Revision No.: 2



LEGEND:

⊕	BOREHOLE LOCATION, CURRENT INVESTIGATION
●	BOREHOLE LOCATION (PATERSON GROUP REPORT PG3562, 2015)
⊕	BOREHOLE LOCATION (PATERSON GROUP REPORT PG1703, 2008)
96.02	GROUND SURFACE ELEVATION (m)
(89.85)	PRACTICAL REFUSAL TO DCPT / AUGERING ELEVATION (m)

BOREHOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT BOREHOLE LOCATIONS PROVIDED BY ANNIS, O'SULLIVAN, VOLLEBEKK LTD.

PERMISSIBLE GRADE RAISE

▥	UP TO ELEVATION 99.0m
▨	UP TO ELEVATION 97.0m
▨	UP TO ELEVATION 96.0m

SCALE: 1:750

0 10 20 30 50m

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consulting engineers

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

NO.	REVISIONS	DATE	INITIAL
2	2019 TEST PITS AND SLOPE STABILITY CROSS SECTIONS ADDED TO PLAN	17/04/2019	JV
1	2018 BOREHOLES ADDED TO PLAN	10/10/2018	RG

TRIMTERRA DEVELOPMENT CORPORATION
GEOTECHNICAL INVESTIGATION
PROP. COMMERCIAL DEVELOPMENT - TERRY FOX DRIVE AT KANATA AVENUE
OTTAWA, ONTARIO

Title:
PERMISSIBLE GRADE RAISE PLAN

Scale: 1:750
Date: 09/2018
Drawn by: RCG
Report No.: PG4564-1
Checked by: NC
Dwg. No.: PG4564-2
Approved by: DJG
Revision No.: 1