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Proposed Cardinal Creek Village
Residential/Commercial Development
Old Montreal Road
Ottawa, Ontario

Prepared For

Tamarack Homes

November 7, 2012

Report PG1796-1R

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1.0 INTRODUCTION

Paterson Group (Paterson) was commissioned by Tamarack Homes (Tamarack) to conduct a geotechnical investigation for the proposed residential development to be located along Old Montreal Road at Frank Kenny Road, in the City of Ottawa, Ontario (refer to Figure 1 - Key Plan, presented in Appendix 2).

The objectives of the investigation were to:

- ☐ Determine the subsoil and groundwater conditions at this site by means of boreholes.
- ☐ Provide geotechnical recommendations for the design of the proposed development including construction considerations which may affect its design.

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

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

2.0 PROPOSED DEVELOPMENT

The details of the proposed development were not known at the time of writing this report. It is expected that the development will consist of residential dwellings with associated local roadways and serviced by municipal services. It is further anticipated that commercial buildings will be located within the proposed development, as well as, an arterial roadway through the development.

3.0 METHOD OF INVESTIGATION

3.1 Field Investigation

Field Program

The field program for the investigation was carried out between March 27 and April 9, 2012 and June 26 and 27, 2012. At that time, 38 additional boreholes were advanced to depths varying between 1.5 and 10.2 m below ground surface. The original field investigation was carried out between January 19 and 26, 2009. At that time, twenty-one (21) boreholes were advanced to depths varying between 0.7 and 9.8 m below ground surface. The borehole locations were distributed across the site in a manner to provide general coverage at the subject site. The locations of the boreholes are shown on Drawing PG1796-3 - Test Hole Location Plan included in Appendix 2.

The boreholes were put down using a track-mounted auger drill rig operated by a crew of two. All fieldwork was conducted under the full-time supervision of personnel from Paterson's geotechnical division under the direction of a senior engineer. The drilling procedure consisted of augering to the required depths at the selected locations and sampling the overburden.

Sampling and In Situ Testing

Soil samples were recovered from auger flights, a 50 mm diameter split-spoon sampler or 75 mm diameter thin walled Shelby tubes recovered using a piston sampler. The soil samples were classified on site and placed in sealed plastic bags. The Shelby tubes were sealed at both ends. All samples were transported to our laboratory. The depths at which the auger, split-spoon and Shelby tube samples were recovered from the boreholes are shown as AU, SS and TW, respectively, on the Soil Profile and Test Data sheets in Appendix 1.

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

Undrained shear strength testing, using a field vane apparatus, was carried out in cohesive soils.

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.

Groundwater

Flexible standpipes were installed in all boreholes to permit monitoring of the groundwater levels subsequent to the completion of the sampling program.

Sample Storage

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

3.2 Field Survey

The borehole locations were selected by Paterson personnel to provide general coverage of the site. The locations of these boreholes in the field and the ground surface elevation at the borehole locations were determined by Stantec Geomatics. It is understood that the elevations are referenced to Geodetic datum.

The locations of the boreholes and the ground surface elevation at each borehole location are presented in Drawing PG1796-3 - Test Hole Location Plan included in Appendix 2.

3.3 Laboratory Testing

The soil samples recovered from the subject site were examined in our laboratory to review the results of the field logging.

During the previous investigation, two (2) Shelby tube samples were submitted for unidimensional consolidation and Atterberg limits testing.

The results of the consolidation and Atterberg limits testing are presented on the Consolidation Test and Atterberg Limits' Results sheets, respectively, presented in Appendix 1 and are further discussed in Sections 4 and 5.

3.4 Analytical Testing

One (1) 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 soil. The results are provided in Appendix 1, and are discussed further in Subsection 6.8.

4.0 OBSERVATIONS

4.1 Surface Conditions

The subject site consists mostly of undeveloped land consisting of agricultural land, grass areas or densely wooded areas. Residential dwellings, associated laneways and landscaped areas are present along Old Montreal Road.

4.2 Subsurface Profile

Generally, the overburden profile consists of topsoil or fill overlying a stiff to very stiff silty clay deposit. Glacial till, consisting of silty clay with sand, gravel, cobbles and boulders was generally encountered below the silty clay. Bedrock was noted below the glacial till at several boreholes.

Reference should be made to the Soil Profile and Test Data sheets in Appendix 1 for the details of the soil profiles encountered at each test hole location. The upper 3 m of the subsurface profile at the test hole locations are graphically presented in Drawing PG1796-5 - 3 m Subsurface Profile at Test Hole Locations in Appendix 2.

Silty Clay

A total of two (2) silty clay samples collected during the previous investigation were subjected to unidimensional consolidation testing. The results are presented in Subsection 5.3 and indicate that the silty clay is overconsolidated with overconsolidation ratios of 2.7 and 2.0 in BH 4B and BH 5, respectively.

One (1) silty clay sample was submitted for Atterberg Limits testing. The tested material was classified as Inorganic Clays of High Plasticity (CH). The results are summarized in Table 1 and presented on the Atterberg Limits Results sheet in Appendix 1.

Table 1 - Summary of Atterberg Limits Tests

Sample	Liquid Limit %	Plastic Limit %	Plasticity Index %	Classification
BH 4B TW 1	61	28	33	CH - Clays of High Plasticity

Practical Refusal to Augering

Practical refusal to augering and/or bedrock was observed at depths ranging from 0.7 to 9.3 m below the ground surface at BH 2-12 to BH 8-12, BH 11-12 to 15-12, BH 17-12, BH 18-12, BH 20-12, BH 22-12 to BH 31-12, BH 3, BH 6, BH 7, BH 11, BH 14, BH 16, BH 17 and BH 18.

Based on available geological mapping, the depth to bedrock in the area is expected to range from 15 to 50 m within the west portion of the site and ground surface to 10 m depth within the east portion of the site. Available geological mapping indicates that Dolomite, Limestone and Shale is present in the subject area. Bedrock contour mapping based on our existing borehole information is presented in Drawing PG1796-4 - Bedrock Contour Plan in Appendix 2.

4.3 Groundwater

Groundwater levels (GWLs) were measured in the standpipes installed in the boreholes and the results are summarized in Table 2. It should be noted that surface water can become perched within the borehole backfill material. The groundwater level can also be estimated based on moisture levels and colour of the recovered soil samples. Based on these observations at the borehole locations, the groundwater table is expected between a 3 to 5 m below original ground surface. It should be noted that groundwater levels are subject to seasonal fluctuations. Therefore, the groundwater levels could be different at the time of construction.

Table 2
Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Groundwater Level		Recording Date
		Depth (m)	Elevation (m)	
BH 1-12	67.86	6.75	61.11	April 13, 2012
BH 2-12	64.29	0.40	63.89	April 13, 2012
BH 3-12	65.38	0.43	64.95	April 13, 2012
BH 4-12	65.15	1.07	64.08	April 13, 2012
BH 5-12	62.37	0.40	61.97	April 13, 2012
BH 6-12	61.27	2.31	58.96	April 13, 2012
BH 7-12	70.88	1.42	69.46	April 13, 2012
BH 8-12	90	0.62	89.38	April 13, 2012
BH 9-12	53.33	7.01	46.32	April 13, 2012
BH 10-12	55.6	1.25	54.35	April 13, 2012
BH 11-12	67.84	0.40	67.44	April 13, 2012
BH 12-12	71	0.47	70.53	April 13, 2012
BH 13-12	73.24	0.59	72.65	April 13, 2012
BH 14-12	70.34	1.24	69.10	April 13, 2012
BH 15-12	71.07	2.77	68.30	April 13, 2012
BH 16-12	56.07	Dry	n/a	April 13, 2012
BH 17-12	73.11	0.61	72.50	April 13, 2012
BH 18-12	76.69	2.50	74.19	April 13, 2012
BH 19-12	53.92	5.80	48.12	April 13, 2012
BH 20-12	76.36	0.72	75.64	April 13, 2012
BH 21-12	53.89	8.55	45.34	April 13, 2012
BH 22-12	78.53	Dry	n/a	April 13, 2012
BH 23-12	55.5	2.12	53.38	April 13, 2012
BH 24-12	87.44	Dry	n/a	April 13, 2012
BH 25-12	81.91	0.66	81.25	April 13, 2012
BH 26-12	89.45	0.97	88.48	April 13, 2012

Table 2 (continued)
Summary of Groundwater Levels

Test Hole Number	Ground Surface Elevation (m)	Groundwater Level		Recording Date
		Depth (m)	Elevation (m)	
BH 27-12	96.23	Dry	n/a	April 13, 2012
BH 28-12	89.1	0.40	88.70	April 13, 2012
BH 29-12	87.2	Damaged	n/a	April 13, 2012
BH 30-12	88.74	Damaged	n/a	April 13, 2012
BH 31-12	86.7	1.12	85.58	April 13, 2012
BH 1	67.45	0.61	66.84	February 3, 2009
BH 2	60.07	0.69	59.38	February 3, 2009
BH 3	63.94	Damaged	n/a	February 3, 2009
BH 4	53.72	0.87	52.85	February 3, 2009
BH 5	53.28	1.30	51.98	February 3, 2009
BH 6	77.71	Damaged	n/a	February 3, 2009
BH 7	72.32	0.50	71.82	February 3, 2009
BH 8	87.11	0.82	86.29	February 3, 2009
BH 9B	57.53	0.53	57.00	February 3, 2009
BH 10	86.36	1.52	84.84	February 3, 2009
BH 11	89.75	Damaged	n/a	February 3, 2009
BH 12	80.38	0.61	79.77	February 3, 2009
BH 14	88.88	0.61	88.27	February 3, 2009
BH 15	88.13	1.86	86.27	February 3, 2009
BH 16	67.96	0.50	67.46	February 3, 2009
BH 17	86.28	0.88	85.40	February 3, 2009
BH 18	54.83	Damaged	n/a	February 3, 2009
BH 19	71.73	Damaged	n/a	February 3, 2009

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Geotechnical Assessment

The subject site is adequate for the proposed development. It should be noted that where silty clay is present below underside of footing of the proposed buildings, a permissible grade raise restriction is required. Also, in areas where shallow auger refusals were noted, buried services may require trenching through bedrock.

For the subject lands bordering along Cardinal Creek and associated tributaries of Cardinal Creek, a study to determine the geotechnical limit of hazard lands was completed. The results of our study are discussed in Subsection 6.9.

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

5.2 Site Grading and Preparation

Stripping Depth

Topsoil and deleterious fill, such as those containing organic materials, should be stripped from under any buildings, paved areas, pipe bedding and other settlement sensitive structures.

If encountered, existing foundation walls and other construction debris should be entirely removed from within the building perimeters. Under paved areas, existing construction remnants such as foundation walls should be excavated to a minimum of 1 m below final grade.

Fill Placement

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

Non-specified existing fill along with site-excavated soil can be used as general landscaping fill and beneath parking areas where settlement of the ground surface is of minor concern. In landscaped areas, these materials should be spread in thin lifts and at least compacted by the tracks of the spreading equipment to minimize voids. If these materials are to be used to build up the subgrade level for areas to be paved, they should be compacted in thin lifts to a minimum density of 95% of their respective SPMDD. Non-specified existing fill and site-excavated soils are not suitable for use as backfill against foundation walls unless a composite drainage blanket connected to a perimeter drainage system is provided.

Bedrock Removal

Based on the volume of the bedrock encountered in the area, it is expected that line-drilling in conjunction with hoe-ramming or controlled blasting will be required to remove the bedrock. In areas of weathered bedrock and where only a small quantity of bedrock is to be removed, bedrock removal may be possible by hoe-ramming.

5.3 Foundation Design

Table 3 presents the bearing resistance values for footings founded on the anticipated subgrade materials.

Table 3 - Bearing Resistance Values

Bearing Surface	Bearing Resistance Values	
	Serviceability Limit State (kPa)	Ultimate Limit State (kPa)
Undisturbed, Stiff Silty Clay	150	225
Undisturbed, Compact Glacial Till	150	225
Clean, Weathered Bedrock	500	750

A geotechnical resistance factor of 0.5 was applied to the reported bearing resistance values at ULS. The bearing resistance value at SLS will be subjected to potential post-construction total and differential settlements of 25 and 20 mm, respectively, for footings placed on a silty clay or glacial till bearing surface. A negligible total and differential settlement will be applicable for footings placed on the clean, weathered bedrock surface. A post-development groundwater lowering of 0.5 m was assumed.

It should be noted that the maximum width for footings placed on an undisturbed, silty clay bearing surface will be 3 m for strip footings and 5 m by 5 m for pad footings.

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.

Settlement/Grade Raise

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

Generally, the potential long term settlement is evaluated based on the compressibility characteristics of the silty clay. These characteristics are estimated in the laboratory by conducting unidimensional consolidation tests on undisturbed soil samples collected using Shelby tubes in conjunction with a piston sampler. Two (2) site specific consolidation tests were carried out for this project. The results of the consolidation tests are presented in Table 4 and in Appendix 1.

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

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

Table 4
Summary of Consolidation Test Results

Borehole No.	Sample	Depth (m)	p'_c (kPa)	p'_o (kPa)	C_{cr}	C_c	Q (*)
BH4B	TW 1	4.19	174	64	0.015	2.432	G
BH5	TW 1	5.69	147	74	0.021	1.863	G

* - Q - Quality assessment of sample - G: Good F: Fair P: Poor

It should be noted that the values of p'_c, p'_o, C_{cr} and C_c are determined using standard engineering practices and are estimates only. In addition, natural variations within the soil deposit would also affect the results. Furthermore, the p'_o parameter is directly influenced by the groundwater level. While the groundwater levels were measured at the time of the fieldwork, the levels vary with time and this has an impact on the available preconsolidation. Lowering the groundwater level increases the p'_o and therefore reduces the available preconsolidation. Unacceptable settlements could be induced by a significant lowering of the groundwater level. The p'_o values for the consolidation tests carried out for the present investigation are based on the long term groundwater level observed at each borehole location. The groundwater level is based on the colour and undrained shear strength profile of the silty clay.

Based on the existing borehole information and testing results, a permissible grade raise restriction of 2 m is recommended for the north portion of the subject site, where the existing ground surface ranges between geodetic elevations of 53 to 56 m. A permissible grade raise restriction of 3 m is applicable for the remainder of the subject site where silty clay is present below proposed underside of footing elevation.

Lateral Support

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

Where the grade raise restrictions can be accommodated, the design of the footings can be carried out based on the bearing resistance values provided in Table 3. Where the grade raise is close to, but below, the maximum permissible grade raise, consideration should be given to using more reinforcement in the design of the foundation (footings and walls) to reduce the risks of cracking in the concrete foundation. The use of control joints within the brick work between the garage and basement area should also be considered.

5.4 Design for Earthquakes

For foundations constructed within the north portion of the subject site, where the ground surface elevations range between 53 to 56 m geodetic elevation, a seismic Site Class D is applicable for design. The remainder of the subject site can be designed using a seismic Site Class C as defined in the Ontario Building Code 2006 (OBC 2006; Table 4.1.8.4.A). For footings placed on the bedrock surface, Site Class A and B may apply for would have to be determined based on site specific shear wave velocity testing. The soils encountered at borehole locations are not susceptible to liquefaction.

5.5 Basement Slab

With the removal of all topsoil and fill containing organic matter within the footprints of the proposed buildings, the native soil surface or engineered fill will be considered to be an acceptable subgrade surface on which to commence backfilling for floor slab construction. Provision should be made for proof-rolling the soil subgrade using heavy vibratory compaction equipment prior to placing any fill. Any soft areas should be removed and backfilled with appropriate backfill material. OPSS Granular B Type II is recommended for backfilling below the floor slab. It is recommended that the upper 200 mm of sub-slab fill consist of 19 mm clear crushed stone.

5.6 Pavement Design

For design purposes, the pavement structure presented in the following tables could be used for the design of car parking areas and local roadways.

Table 5 - Recommended Pavement Structure - Driveways

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

Table 6 - Recommended Pavement Structure - Local Residential Roadways

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

Table 7 - Recommended Pavement Structure - Roadways with Bus Traffic

Thickness (mm)	Material Description
40	**Wear Course -** HL-3 or Superpave 12.5 Asphaltic Concrete
50	**Upper Binder Course -** HL-8 or Superpave 19.0 Asphaltic Concrete
50	**Lower Binder Course** - HL-8 or Superpave 19.0 Asphaltic Concrete
150	**BASE** - OPSS Granular A Crushed Stone
450	**SUBBASE** - OPSS Granular B Type II
SUBGRADE - Either fill, 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 I or II material. Weak subgrade conditions may be experienced over service trench fill materials. This may require the use of a geotextile, thicker subbase or other measures that can be recommended at the time of construction as part of the field observation program.

The pavement granular base and subbase should be placed in maximum 300 mm thick lifts and compacted to a minimum of 100% of the material's SPMDD using suitable vibratory equipment.

Pavement Structure Drainage

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

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

6.0 DESIGN AND CONSTRUCTION PRECAUTIONS

6.1 Foundation Drainage and Backfill

It is recommended that a perimeter foundation drainage system be provided for proposed structures. The system should consist of a 100 to 150 mm diameter, geotextile-wrapped, 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.

Backfill against the exterior sides of the foundation walls should consist of free-draining, non frost susceptible granular materials. The site materials will be frost susceptible and, as such, are not recommended for re-use as backfill unless a composite drainage system (such as system Platon or Miradrain G100N) connected to a drainage system is provided.

6.2 Protection Against Frost Action

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

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 excavation for the proposed development will be mostly through silty clay and/or glacial till. Above the groundwater level, for excavations to depths of approximately 3 m, the excavation side slopes should be stable in the short term at 1H:1V. The lowermost 1.2 m can be vertical provided the material consists of stiff in situ silty clay. Flatter slopes could be required for deeper excavations or for excavation below the groundwater level. Where such side slopes are not permissible or practical, temporary shoring should be used. The subsoil at this site is considered to be mainly a Type 2 and 3 soil according to the Occupational Health and Safety Act and Regulations for Construction Projects.

The slope cross-sections recommended above are for temporary slopes. Excavated soil should not be stockpiled directly at the top of excavations and heavy equipment should be kept away from the excavation sides.

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

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

6.4 Pipe Bedding and Backfill

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

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

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

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

To reduce long-term lowering of the groundwater level at this site, clay seals should be provided in the service trenches. The seals should be at least 1.5 m long (in the trench direction) and should extend from trench wall to trench wall. 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

Due to the relatively impervious nature of the silty clay, it is expected that groundwater infiltration into the excavations should be controllable using open sumps and pumps for the relatively 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.

6.6 Winter Construction

The subsoil conditions at this site mostly consist of frost susceptible materials. In presence of water and freezing conditions ice could form within the soil mass. Heaving and settlement upon thawing could occur. Precautions should be taken if winter construction is considered for this project.

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 that will avoid the introduction of frozen materials into the trenches. As well, pavement construction is difficult during winter. The subgrade consists of frost susceptible soils which will experience total and differential frost heaving as the work takes place. In addition, 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. Additional information could be provided, if required.

6.7 Landscaping and Outdoor Structures Considerations

Tree Planting Restrictions

Tree planting for this subject development should be limited to low water demand trees. The minimum permissible distance from the foundation will depend on the nature of the tree, the depth of the clay crust and the final grade raise in relation to the permissible grade raise. A minimum permissible distance of 5 m from the foundation wall is recommended for a tree planting setback within the development where proposed building footings are placed over the silty clay deposit.

It is well documented in the literature, and is our experience, that fast-growing trees located near buildings founded on cohesive soils that shrink on drying can result in long-term differential settlements of the structures. Tree varieties that have the most pronounced effect on foundations are seen to consist of poplars, willows and some maples (i.e. Manitoba Maples) and, as such, they should not be considered in the landscaping design.

Swimming Pools

The in-situ soils are considered to be acceptable for swimming pools. Above ground swimming pools must be placed at least 4 m away from the residence foundation and neighbouring foundations. Otherwise, pool construction is considered routine, and can be constructed in accordance with the manufacturer`s requirements.

Aboveground Hot Tubs

Hot tub construction is considered routine, and can be constructed in accordance with the manufacturer’s specifications.

Installation of Decks or Additions

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

6.8 Corrosion Potential and Sulphate

The results of analytical testing show that the sulphate content is less than 0.1%. These results are indicative that Type 10 Portland cement (normal cement) would be appropriate for this site. The results of the chloride content, pH and resistivity indicate the presence of a non-aggressive environment for exposed ferrous metals at this site.

6.9 Limit of Hazard Lands

Review of Existing Reports

A review of available reports was completed by Paterson. The reviewed reports included:

- “Cardinal Creek - Geomorphic Assessment - City of Ottawa” dated April 2007 and prepared by Geomorphic Solutions.
- “Erosion Study and Slope Stability Evaluation, Cardinal Creek, Cumberland, Ontario” dated January 1990 and prepared by Golder Associates.
- “Greater Cardinal Creek Subwatershed Study - Existing Conditions Report” dated August 2009 and prepared by AECOM on behalf of City of Ottawa.

Based on these reports reviewed by Paterson, the subject section of Cardinal Creek bordering the west property limits were labeled as Reach C11 and Reach C12. The subject section of the Cardinal Creek labeled as C12 is located from the mouth of the creek to the former Rail Line and section of watercourse documented as C11 is located between the form Rail Line and Old Montreal Road. The tributaries to the Cardinal Creek located on the south portion of the subject site traveling from the east to west were labeled as TRH1, TRH2, TRH3, TRH4 and TRH5 intersect the Cardinal Creek to the southwest of the subject site.

Section C12 was considered to be (S-Stable), In Regime and Section C11 is considered to be (M-Lateral Migration), In Transition based on the Downs Evolution Model completed in 2006, with a Rapid Geomorphic Assessment (RGA) score of 0.14 and 0.34, respectively. The Rapid Speed Assessment Technique (RSAT) provides a score of 23.5 for C11 and C12 which is considered a moderate (20-35) degree of stream health. Sections TRH1, TRH2, TRH3, TRH4 and TRH5 were not classified by the report conducted by Geomorphic Solutions due to access restrictions.

Section C11 and C12 of the Cardinal Creek is considered a Stream Order No.4 (Strahler, 1952), with gradient(%) of 0.47 and 0.54 (Geomorphic Solutions, April, 2007), respectively. The tributaries to the Cardinal Creek located throughout the south portion of the subject site (TRH1, TRH2, TRH3, TRH4 and TRH5) were considered a Stream Order No. 1 and 2 (Strahler, 1952) with gradient(%) of 0.74 in TRH2 to 5.07 in TRH4 of 5.07 (Geomorphic Solutions, April, 2007).

Slope Condition Field Review

The slope stability analysis was completed using topographical mapping, as well as, a slope condition review by Paterson field personnel. The initial slope condition review was completed on April 9, 2009 of the existing conditions of Cardinal Creek (Section C11 and C12) located along the west property limits. The second slope condition review was completed on April 18, 2012 throughout the south portion of the subject site documenting the conditions of the tributaries (TRH1, TRH2, TRH3, TRH4 and TRH5) to the Cardinal Creek.

Photograph 11 and Photograph 12 taken during the initial slope condition review on April 9, 2009 presented in Appendix 2 illustrates where the Cardinal Creek (C11) has meandering in close proximity of the valley corridor wall causing erosion and exposing the clay surface from consequent slip failures. Photograph 13 and Photograph 14 taken from the north banks of the Cardinal Creek (Section C12) on April 9, 2009 illustrates the water cresting over the meandering watercourse and covering the valley corridor from the mouth of the Cardinal Creek to the former Rail Line. It is noted that the subject section of watercourse is considered stable to moderately stable. However, it is recommended that a monitoring program be initiated and a possible toe erosion protection program for areas where the watercourse is in close proximity of the valley walls, primarily along Reach C11.

The majority of the tributary to the Cardinal Creek (Section TRH1, TRH2, TRH3, TRH4 and TRH5) were observed to be stable based on the slope condition review conducted on April 18, 2012 with some toe erosion noted throughout where the watercourse is located in close proximity to the valley corridor wall. Minor surface erosion was also noted along the east bank near Slope Cross-Section K (Section TRH5) illustrated in Photograph 7 in Appendix 2.

A total of fifteen (15) slope cross-sections were studied as the worst case scenarios. The cross section locations are presented on Drawing PG1796-3 - Test Hole Location Plan. The existing slopes bordering the watercourse is mainly overgrown with mature trees with grass covered areas along the valley corridor walls. The existing valley corridor of Cardinal Creek and the subject tributaries contain a 1 to 18 m wide watercourse, which meanders throughout the valley floor. Currently, the water depth was noted to be approximately 0.1 to 1.5 m.

For specific details at the borehole locations in close proximity to the existing slopes, reference should be made to the Soil Profile and Test Data sheets in Appendix 1.

Slope Stability Analysis

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

The cross-sections were analyzed taking into account a groundwater level at ground surface. Subsoil conditions at the cross-sections were inferred based on the findings at nearby borehole locations and general knowledge of the area’s geology.

The results for the existing static slope conditions at Sections A, B, C, D, E, F, G, H, I, J, K, L, M, N and O are shown in Figures 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 and 30 in Appendix 2. The factors of safety was found to be greater than 1.5 at all Sections analyzed, except for Sections A and F, which require a 5.6 and 5.1 m stable slope allowance from top of slope, respectively.

Seismic Loading Analysis

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

The results of the analyses including seismic loading are shown in Figures 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29 and 31 for the slope sections. The results indicate that the factors of safety for all the sections are greater than 1.1. Based on these results, the slopes are considered to be stable under seismic loading.

Limit of Hazard Lands

The limit of hazard lands includes a stable slope allowance, toe erosion allowance and a 6 m erosion access allowance. The limit of hazard lands for the subject site is indicated on Drawing PG1796-3 - Test Hole Location Plan. The toe erosion allowance for the valley corridor slopes was based on the cohesive nature of the soils, the observed current erosional activities and the width and location of the current watercourse. Signs of erosion were noted in areas where the existing watercourse has meandered in close proximity to the toe of the corridor wall. Some minor to moderate sloughing failures were noted in the lower portion of the slopes, leaving some exposed root systems along the slope face. It is considered that a toe erosion allowance of 5 to 7 m is appropriate for the corridor walls confining the existing watercourse. The toe erosion allowance should be applied from the top of stable slope, where the watercourse has meandered in close proximity to the toe of the corridor wall/existing slope. The toe erosion allowance should be taken from the bank full water’s edge in areas where the greater than 10 m from the toe of the existing slope.

Consideration could be given to in-filling the existing drainage ravines areas located outside the valley corridor with the existing watercourse. The majority of the drainage areas were noted to be dry. It is recommended that the local conservation authority be contacted to discuss the acceptability of this option. The existing drainage areas do not require a toe erosion allowance or an erosion access allowance. The limit of hazard lands for these drainage areas should be taken from the top of stable slope, as presented in Drawing PG1796-3 - Test Hole Location Plan.

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

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 master grading plan 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.

☐ 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 preliminary recommendations made in this report are in accordance with our present understanding of the project. We request that further geotechnical investigation and analysis be carried out in stages during the proposed development of the subject property.

The client should be aware that any information pertaining to soils and all test hole logs are furnished as a matter of general information only and test hole descriptions or logs are not to be interpreted as descriptive of conditions at locations other than those of the test holes.

A soils investigation is a limited sampling of a site. Should any conditions at the site be encountered which differ from those at the test locations, we request that we be notified immediately in order to permit reassessment of our recommendations.

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 Tamarack Homes or their agent(s) is not authorized without review by this firm for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

David J. Gilbert, P.Eng.

LICENSED PROFESSIONAL ENGINEER
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Carlos P. Da Silva, P.Eng.

Report Distribution:

☐ Tamarack Homes (3 copies)
☐ Paterson Group (1 copy)

APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

CONSOLIDATION TEST RESULTS

ATTERBERG LIMITS RESULTS

ANALYTICAL TEST RESULTS

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

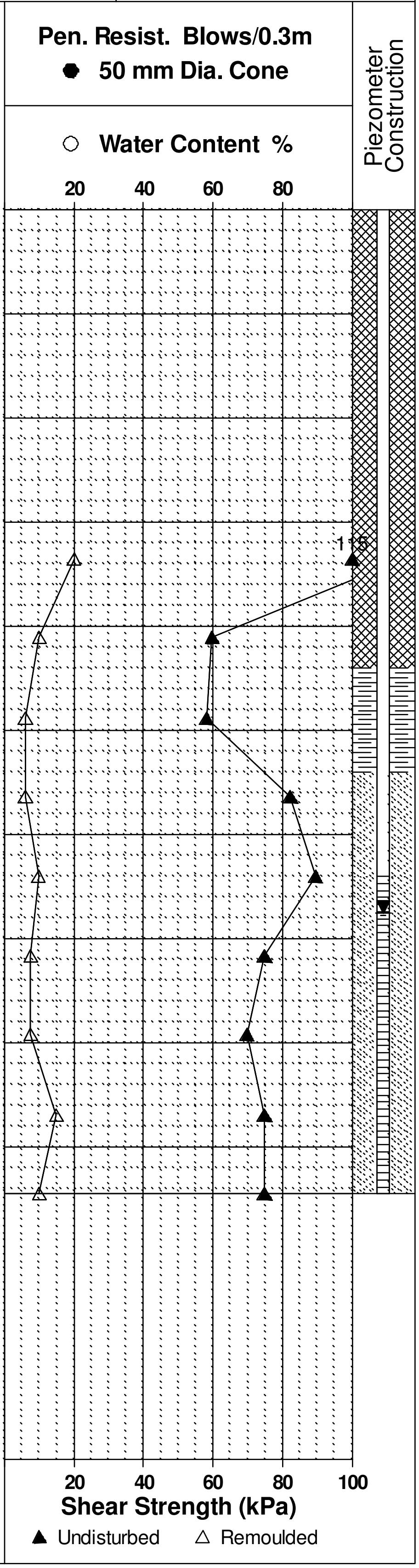
REMARKS

HOLE NO. **BH 1-12**

BORINGS BY CME 55 Power Auger

DATE March 27, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.86
Brown **SILTY CLAY,** trace sand	▨	AU	1				
0.51							
	▨	SS	2	83	19	1	66.86
	▨	SS	3	100	15	2	65.86
	▨	SS	4	100	8		
	▨					3	64.86
Very stiff to stiff, brown **SILTY CLAY**	▨						
- grey by 4.3m depth	▨					4	63.86
	▨					5	62.86
	▨					6	61.86
	▨					7	60.86
	▨					8	59.86
	▨					9	58.86
9.45							
End of Borehole (GWL @ 6.75m-April 13, 2012)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

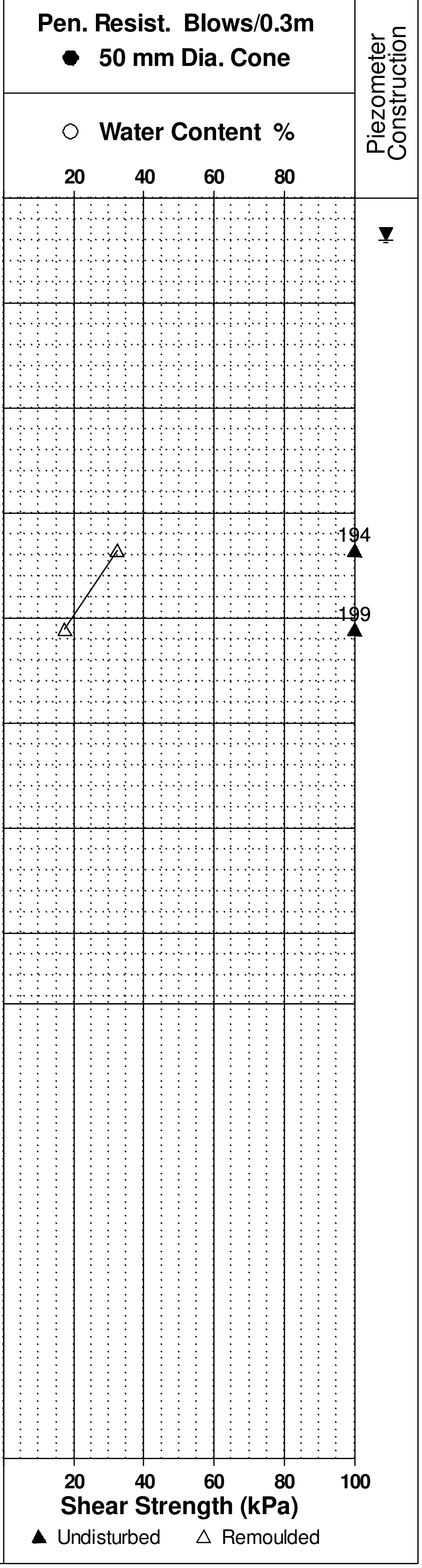
HOLE NO. BH 2-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	64.29
TOPSOIL 0.28		AU	1				
Brown **SILTY CLAY**, trace sand 0.76		AU	2				
		SS	3	100	24	1	63.29
		SS	4	100	18	2	62.29
Very stiff, brown **SILTY CLAY**		SS	5	100	14	3	61.29
						4	60.29
4.95		SS	6	62	16	5	59.29
		SS	7	0	50+		
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		SS	8	29	16	6	58.29
7.67						7	57.29

End of Borehole

Practical refusal to augering @ 7.67m depth

(GWL @ 0.40m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH 3-12**

BORINGS BY CME 55 Power Auger

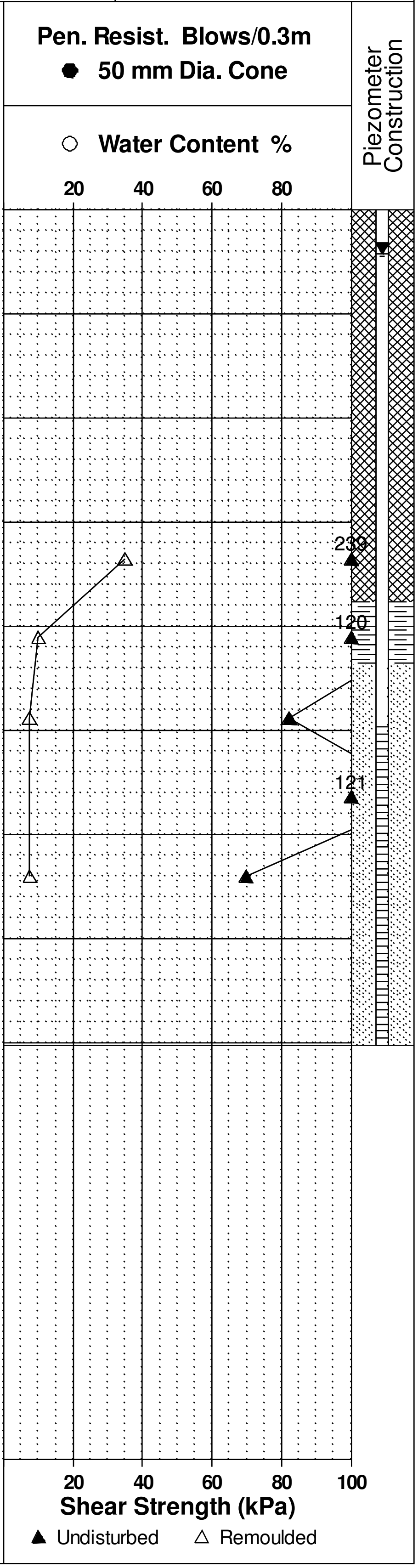
DATE March 27, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	65.38
TOPSOIL 0.33		AU	1				
		AU	2				
		SS	3	100	21	1	64.38
		SS	4	100	19	2	63.38
		SS	5	100	14	3	62.38
Hard to very stiff, brown **SILTY CLAY**						4	61.38
- stiff and grey by 4.3m depth						5	60.38
						6	59.38
6.63							
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		SS	6	67	50+	7	58.38
		SS	7	100	50+		
8.02						8	57.38

End of Borehole

Practical refusal to augering @ 8.02m depth

(GWL @ 0.43m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 27, 2012

FILE NO. PG1796

HOLE NO. BH 4-12

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	65.15
TOPSOIL	0.38						
Brown **SILTY CLAY,** trace sand	0.60	AU	1				
Hard, brown **SILTY CLAY**		SS	2	100	25	1	64.15
	1.90	SS	3	83	22		
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders, trace clay		SS	4	62	41	2	63.15
	2.97						
BEDROCK: Black shale		SS	5	25	50+	3	62.15
	3.86						
End of Borehole							
(GWL @ 1.07m-April 13, 2012)							

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

○ **Water Content %**

20 40 60 80

Piezometer Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

REMARKS

HOLE NO. BH 5-12

BORINGS BY CME 55 Power Auger

DATE March 27, 2012

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	62.34
TOPSOIL 0.28						
Hard to very stiff, brown **SILTY CLAY**	AU	1				
	SS	2	58	25	1	61.34
	SS	3	100	19	2	60.34
	SS	4	100	24		
3.73	SS	5	100	17	3	59.34
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders	SS	6	75	49	4	58.34
5.64	SS	7	50	34	5	57.34
GLACIAL TILL: Grey silty sand with gravel, cobbles and boulders 6.40	SS	8	100	50+	6	56.34

End of Borehole

Practical refusal to augering @ 6.40m depth

(GWL @ 0.40m-April 13, 2012)

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

○ Water Content %

20 40 60 80

Piezometer Construction

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

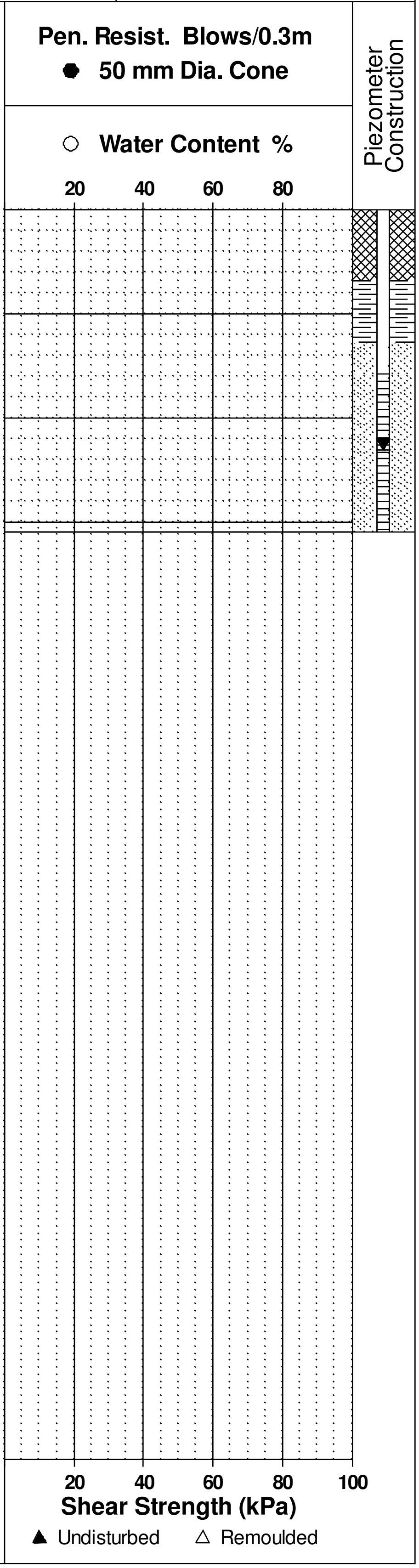
BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

HOLE NO. BH 6-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	61.27
TOPSOIL 0.30							
Brown **SILTY CLAY** 0.69							
GLACIAL TILL: Brown silty clay with sand, gravel and rock fragments		SS	1	67	20	1	60.27
1.68		SS	2	100	50+		
						2	59.27
GLACIAL TILL: Grey silty sand with gravel and rock fragments		SS	3	67	50+		
3.10		SS	4	50	50+	3	58.27
End of Borehole Practical refusal to augering @ 3.10m depth (GWL @ 2.31m-April 13, 2012)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

REMARKS

HOLE NO. BH 7-12

BORINGS BY CME 55 Power Auger

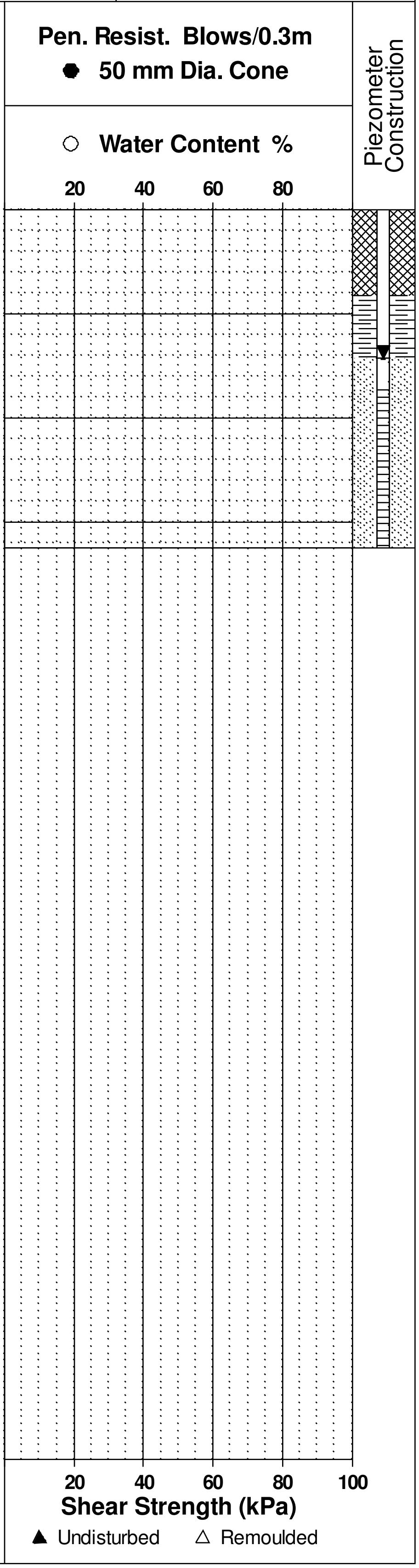
DATE April 5, 2012

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	70.88
TOPSOIL 0.08	AU	1				
	SS	2	50	14	1	69.88
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders	SS	3	75	66		
					2	68.88
3.25	SS	4	100	50+	3	67.88

End of Borehole

Practical refusal to augering @ 3.25m depth

(GWL @ 1.42m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 4, 2012

FILE NO. PG1796

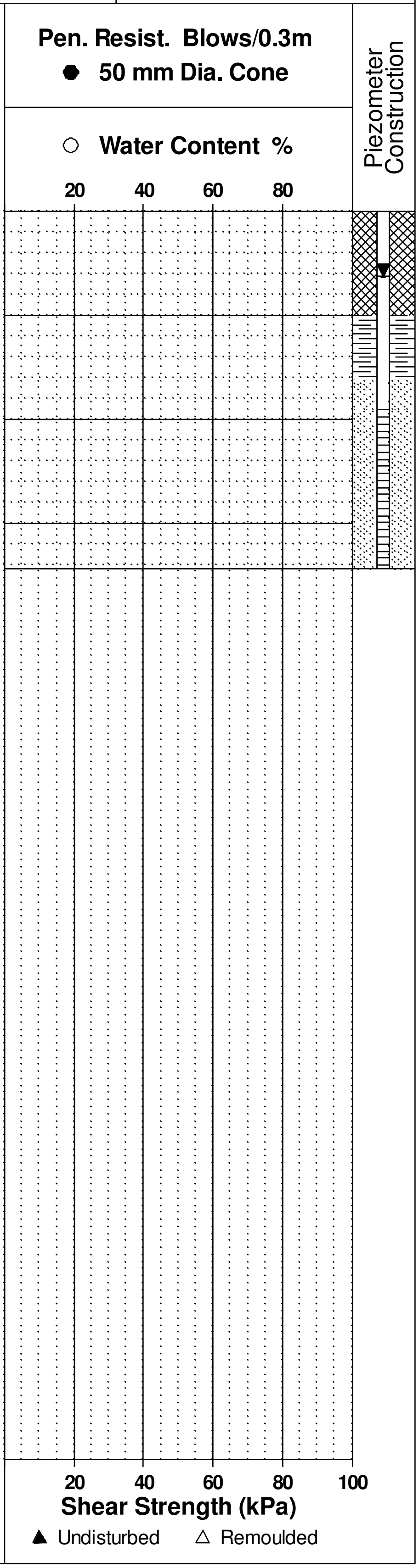
HOLE NO. BH 8-12

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	90.00
TOPSOIL 0.23						
Hard, brown **SILTY CLAY**	AU	1				
	SS	2	100	34	1	89.00
1.45						
GLACIAL TILL: Very dense, brown silty sand with gravel, cobbles, boulders, trace clay	SS	3	82	50+		
					2	88.00
					3	87.00
3.43	SS	4	100	50+		

End of Borehole

Practical refusal to augering @ 3.43m depth

(GWL @ 0.62m-April 13, 2012)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

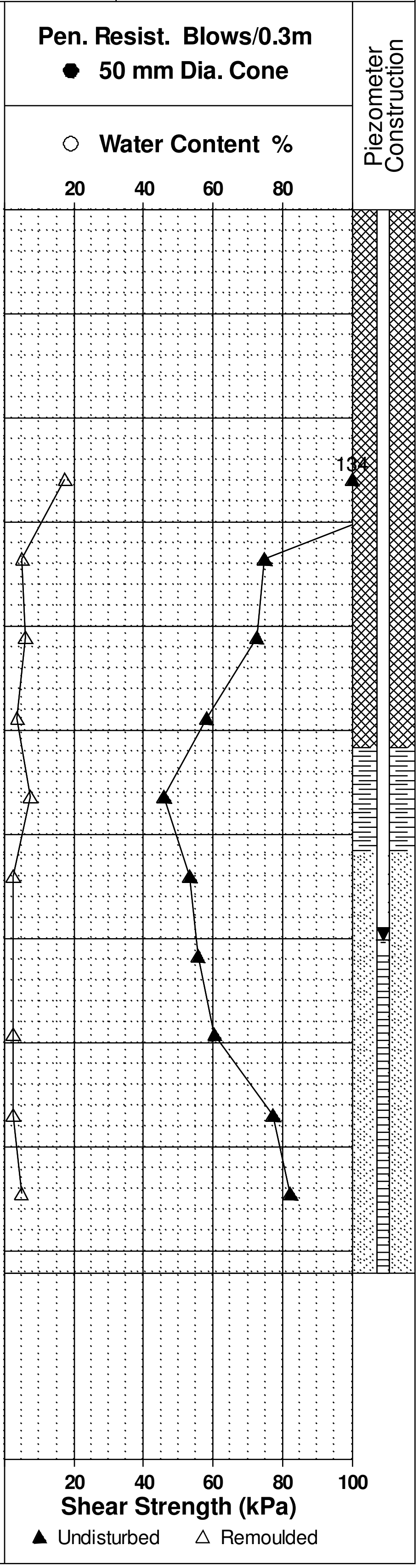
BORINGS BY CME 55 Power Auger

DATE April 5, 2012

FILE NO. **PG1796**

HOLE NO. **BH 9-12**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.33
TOPSOIL 0.23							
		SS	1	100	14	1	52.33
		SS	2	100	16	2	51.33
Very stiff to stiff, brown **SILTY CLAY**						3	50.33
- grey by 3.6m depth						4	49.33
						5	48.33
						6	47.33
						7	46.33
						8	45.33
						9	44.33
						10	43.33
10.21							
End of Borehole							
(GWL @ 7.01m-April 13, 2012)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

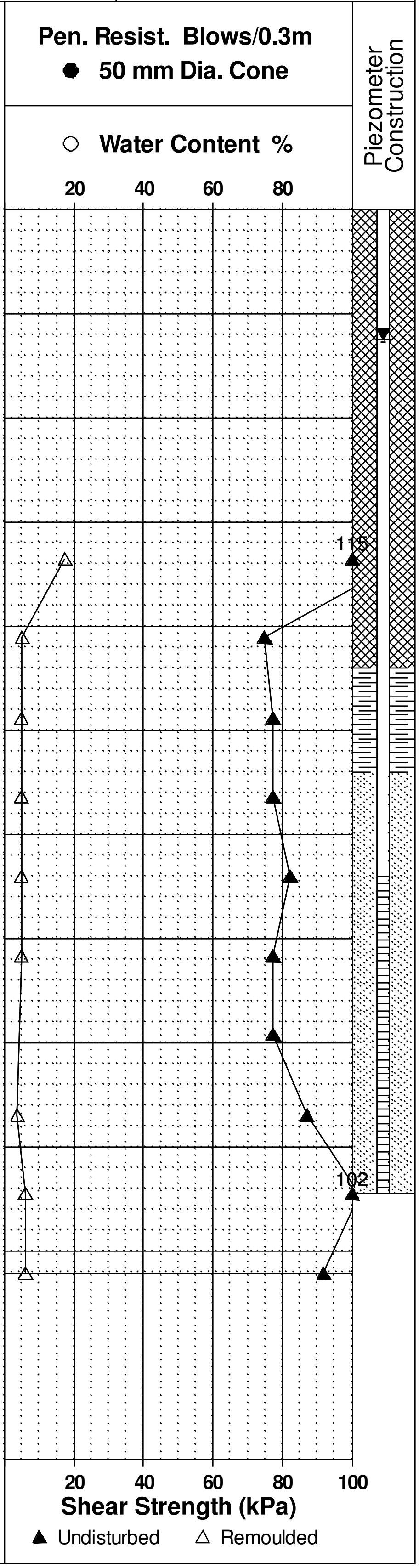
BORINGS BY CME 55 Power Auger

DATE April 5, 2012

FILE NO. **PG1796**

HOLE NO. **BH10-12**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	55.60
FILL: Brown silty sand with gravel, roots, trees, plants	AU	1				
	AU	2				
1.14	SS	3	62	8	1	54.60
Very stiff to stiff, brown **SILTY CLAY**	SS	4	100	18		
					2	53.60
	SS	5	100	12		
					3	52.60
- grey by 4.3m depth					4	51.60
					5	50.60
					6	49.60
					7	48.60
					8	47.60
					9	46.60
					10	45.60
10.21						
End of Borehole (GWL @ 1.25m-April 13, 2012)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

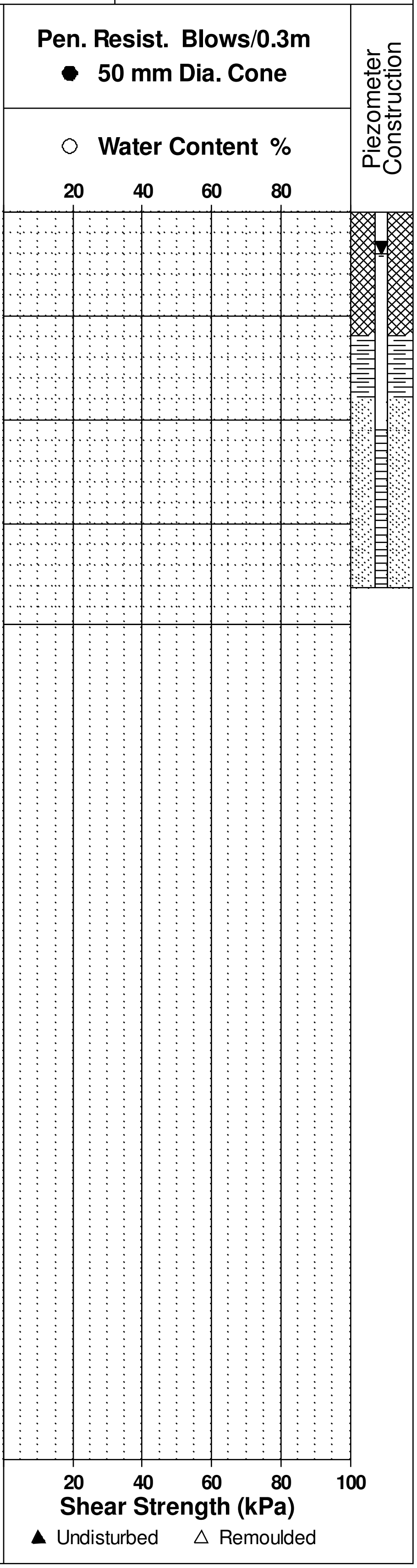
HOLE NO. BH11-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	67.84
FILL: Brown silty sand 0.13		AU	1				
TOPSOIL 0.36							
Very stiff, brown **SILTY CLAY**		SS	2	100	18	1	66.84
		SS	3	100	25	2	65.84
2.21							
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders		SS	4	100	50+	3	64.84
		SS	5	55	48		
3.96							

End of Borehole

Practical refusal to augering @ 3.96m depth

(GWL @ 0.40m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

HOLE NO. BH12-12

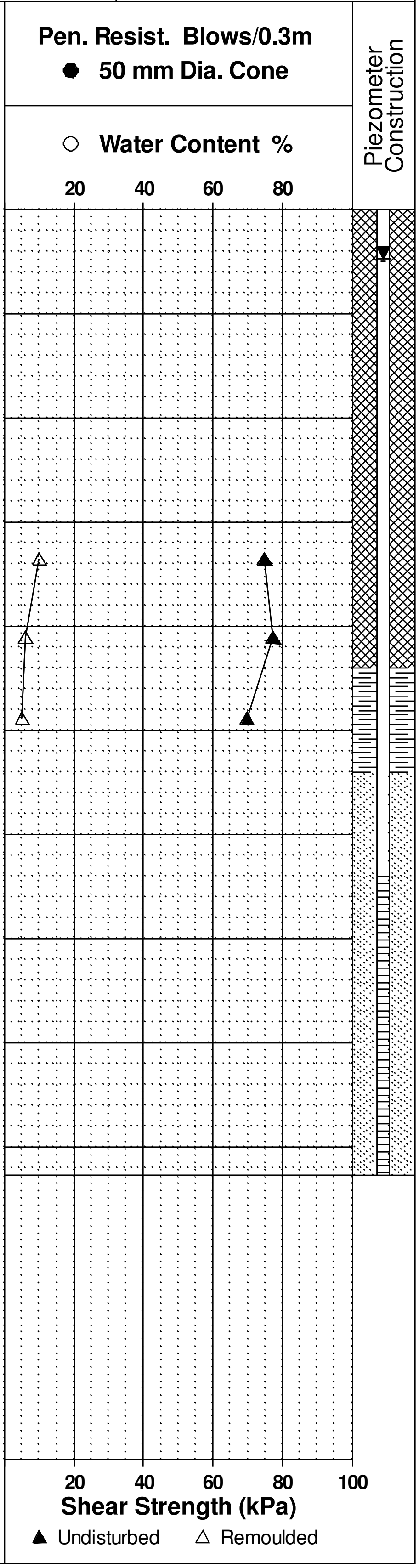
SOIL DESCRIPTION		TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.30				
Very stiff to stiff, brown **SILTY CLAY** - grey by 3.0m depth		SS	1	100	22
		SS	2	100	16
		SS	3	58	6
	5.11				
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		SS	4	100	13
		SS	5	100	5
		SS	6	100	15
		SS	7	100	15
	9.27	SS	8	50	50+

End of Borehole

Practical refusal to augering @ 9.27m depth

(GWL @ 0.47m-April 13, 2012)

DEPTH (m)	ELEV. (m)
0	71.00
1	70.00
2	69.00
3	68.00
4	67.00
5	66.00
6	65.00
7	64.00
8	63.00
9	62.00



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 29, 2012

FILE NO. PG1796

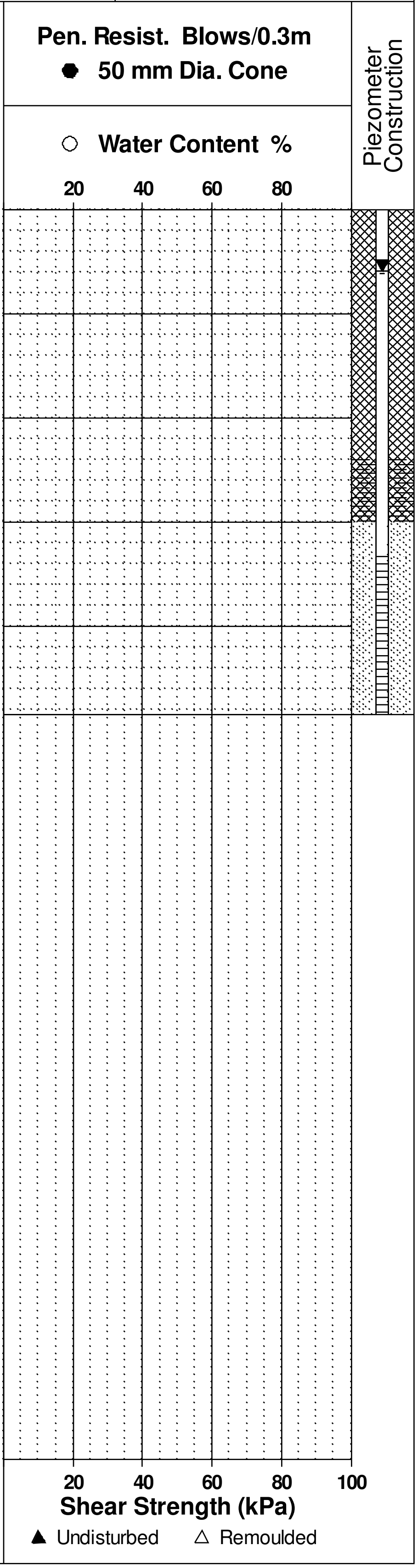
HOLE NO. BH13-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	73.24
TOPSOIL (0.25)	AU	1				
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles and boulders	SS	2	62	12	1	72.24
	SS	3	73	50+	2	71.24
	SS	4	83	50+		
	SS	5	80	50+	3	70.24
					4	69.24
(4.85)	SS	6	75	50+		

End of Borehole

Practical refusal to augering @ 4.85m depth

(GWL @ 0.59m-April 13, 2012)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

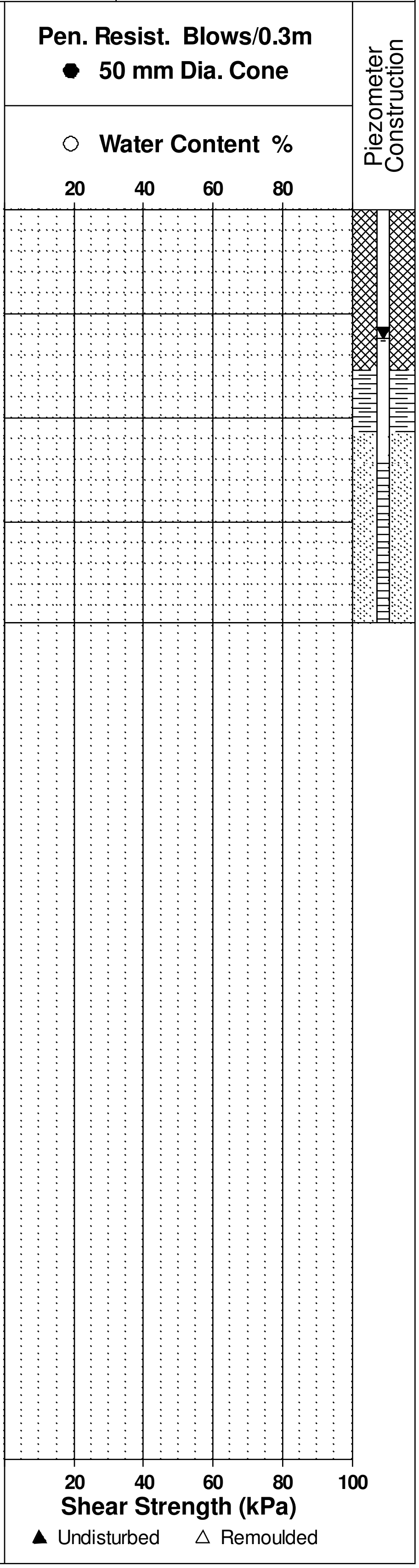
HOLE NO. BH14-12

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	70.34
TOPSOIL (to 0.41)						
Very stiff, brown **SILTY CLAY** (0.41 to 2.54)	SS	1	100	15	1	69.34
	SS	2	100	27	2	68.34
	SS	3	89	50+		
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders (2.54 to 3.73)					3	67.34
	SS	4	62	3		
BEDROCK: Black shale (3.73 to 3.96)	SS	5	33	50+		

End of Borehole

Practical refusal to augering @ 3.96m depth

(GWL @ 1.24m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

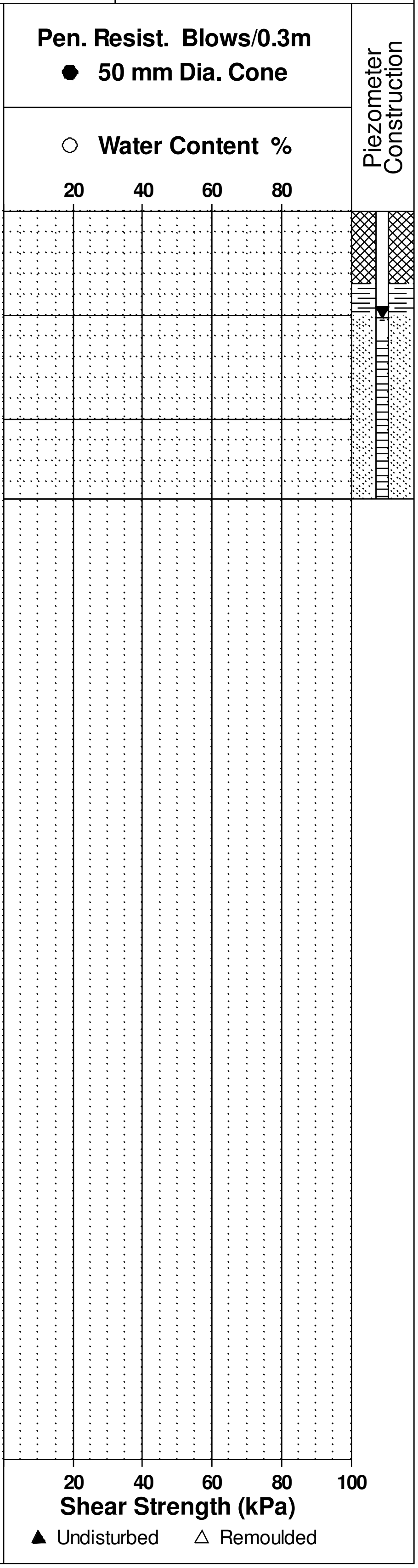
HOLE NO. BH15-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	71.07
TOPSOIL 0.28							
Very stiff, brown **SILTY CLAY**		AU	1				
1.45		SS	2	100	27	1	70.07
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders 2.21		SS	3	83	27	2	69.07
BEDROCK: Black shale		SS	4	100	50+		
2.77		SS	5	0	50+		

End of Borehole

Practical refusal to augering @ 2.77m depth

(GWL @ 1.03m-April 13, 2012)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH16-12**

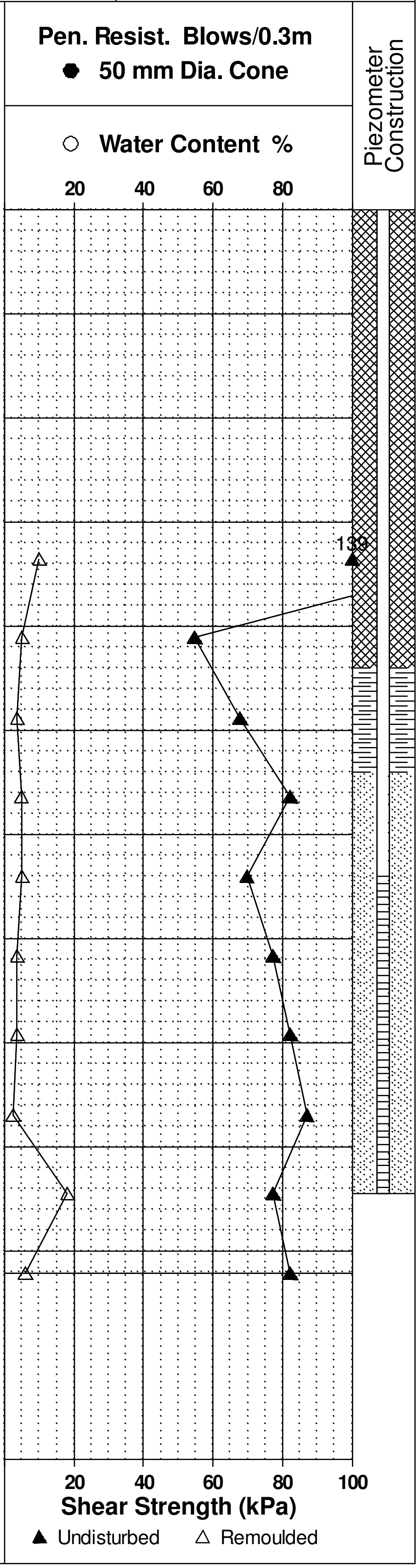
BORINGS BY CME 55 Power Auger

DATE March 30, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	56.07
TOPSOIL 0.30		AU	1				
		SS	2	100	24	1	55.07
		SS	3	100	10	2	54.07
		SS	4	100	6		
						3	53.07
Very stiff to stiff, brown **SILTY CLAY** - grey by 4.3m depth						4	52.07
						5	51.07
						6	50.07
						7	49.07
						8	48.07
						9	47.07
10.21						10	46.07

Dynamic Cone Penetration Test commenced at 10.21m depth. Cone pushed to 24.4m depth. Practical cone refusal at 24.41m depth.

(BH dry - April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
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REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

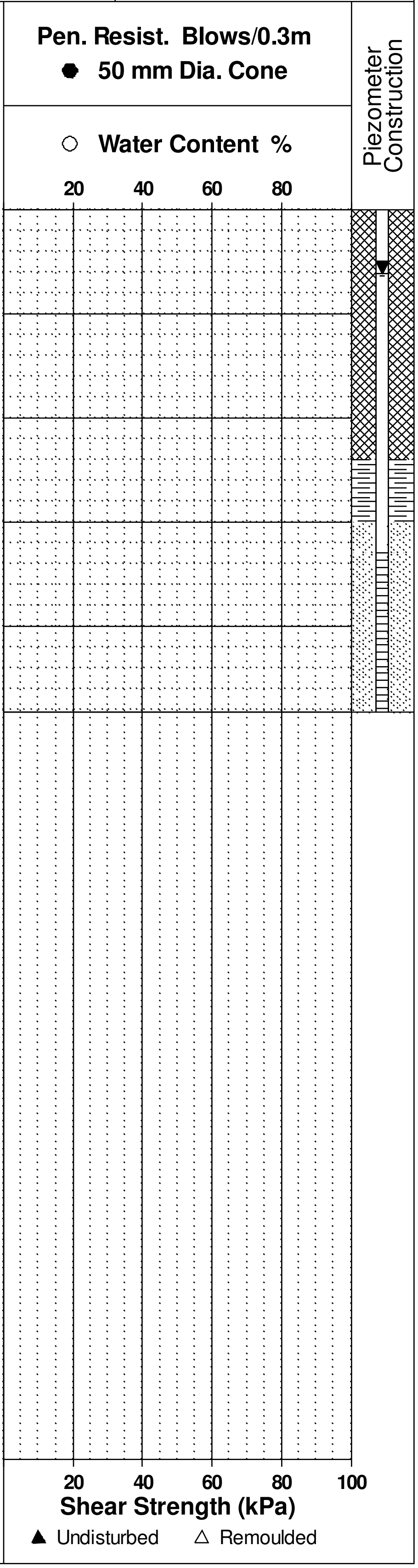
HOLE NO. BH17-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	73.11
TOPSOIL 0.28	AU	1				
Very stiff, brown **SILTY CLAY**	SS	2	100	31	1	72.11
1.45						
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders	SS	3	100	17	2	71.11
	SS	4	44	50+		
	SS	5	83	50+	3	70.11
3.86					4	69.11
BEDROCK: Black shale	SS	6	100	50+		
4.82	SS	7	100	50+		

End of Borehole

Practical refusal to augering @ 4.82m depth

(GWL @ 0.61m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

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Proposed Residential Development - Queen Street
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FILE NO. **PG1796**

REMARKS

HOLE NO. **BH18-12**

BORINGS BY CME 55 Power Auger

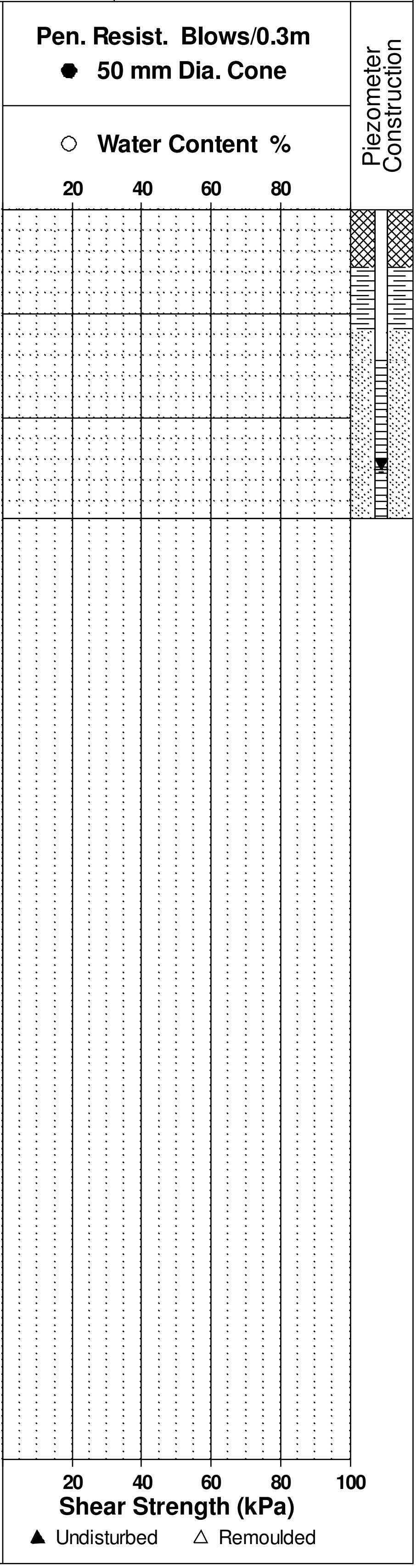
DATE March 30, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	76.69
TOPSOIL 0.30		AU	1				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders		SS	2	62	12	1	75.69
		SS	3	71	33	2	74.69
2.97		SS	4	100	50+		

End of Borehole

Practical refusal to augering @ 2.97m depth

(GWL @ 2.50m-April 13, 2012)



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Geotechnical Investigation
Proposed Residential Development - Queen Street
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REMARKS

BORINGS BY CME 55 Power Auger

DATE March 30, 2012

FILE NO. PG1796

HOLE NO. BH19-12

SOIL DESCRIPTION

GROUND SURFACE

TOPSOIL 0.20

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

- grey by 2.8m depth

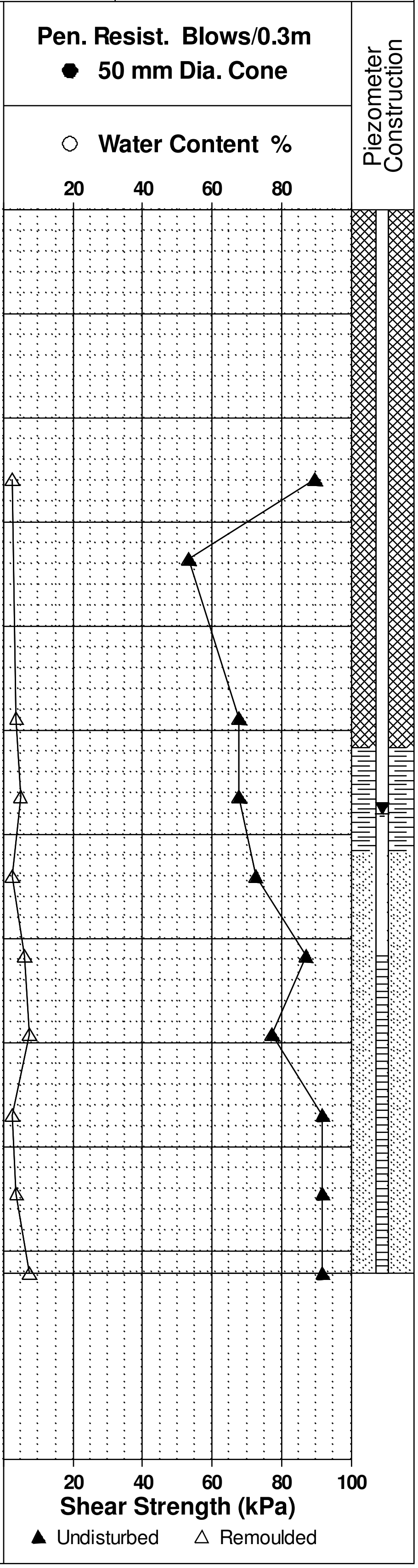
10.21

End of Borehole

(GWL @ 5.80m-April 13, 2012)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	100	24
SS	3	100	7
TW	4	83	

DEPTH (m)	ELEV. (m)
0	53.92
1	52.92
2	51.92
3	50.92
4	49.92
5	48.92
6	47.92
7	46.92
8	45.92
9	44.92
10	43.92



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SOIL PROFILE AND TEST DATA

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Proposed Residential Development - Queen Street
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REMARKS

BORINGS BY CME 55 Power Auger

DATE March 28, 2012

FILE NO. PG1796

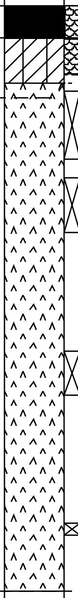
HOLE NO. BH20-12

SOIL DESCRIPTION	Depth to base (m)
GROUND SURFACE	
TOPSOIL	0.28
Very stiff, brown **SILTY CLAY,** trace sand	0.69
GLACIAL TILL: Very dense, brown silty sand with gravel, cobbles and boulders	5.16

End of Borehole

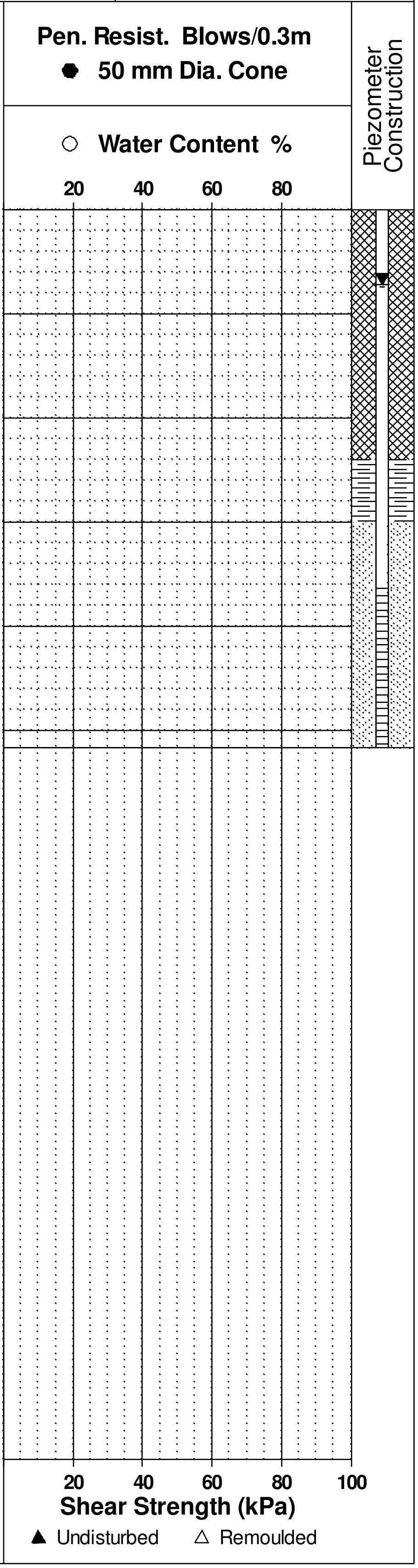
Practical refusal to augering @ 5.16m depth

(GWL @ 0.72m-April 13, 2012)



SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
AU	2		
SS	3	62	44
SS	4	53	78
SS	5	67	50+
SS	6	50	50+

DEPTH (m)	ELEV. (m)
0	76.36
1	75.36
2	74.36
3	73.36
4	72.36
5	71.36



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 2, 2012

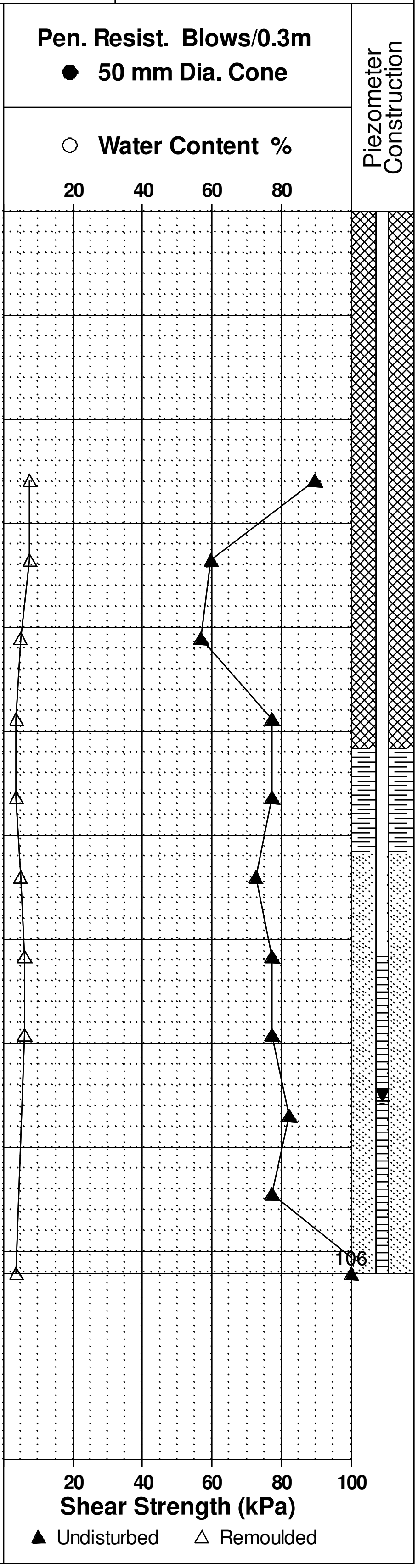
FILE NO. **PG1796**

HOLE NO. **BH21-12**

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	53.89
TOPSOIL 0.25	AU	1				
	SS	2	100	16	1	52.89
	SS	3	100	8	2	51.89
Very stiff to stiff, brown **SILTY CLAY**					3	50.89
- grey by 3.6m depth					4	49.89
					5	48.89
					6	47.89
					7	46.89
					8	45.89
					9	44.89
10.21					10	43.89

Dynamic Cone Penetration Test commenced at 10.21m depth. Cone pushed to 26.4m depth. Practical cone refusal at 26.39m depth.

(GWL @ 8.55m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

REMARKS

HOLE NO. BH22-12

BORINGS BY CME 55 Power Auger

DATE April 2, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	78.53
TOPSOIL 0.30		AU	1				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders		SS	2	60	50+	1	77.53
1.52		SS	3	100	50+		
BEDROCK: Black shale 2.23						2	76.53

End of Borehole

Practical refusal to augering @ 2.23m depth

(BH 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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

REMARKS

HOLE NO. BH23-12

BORINGS BY CME 55 Power Auger

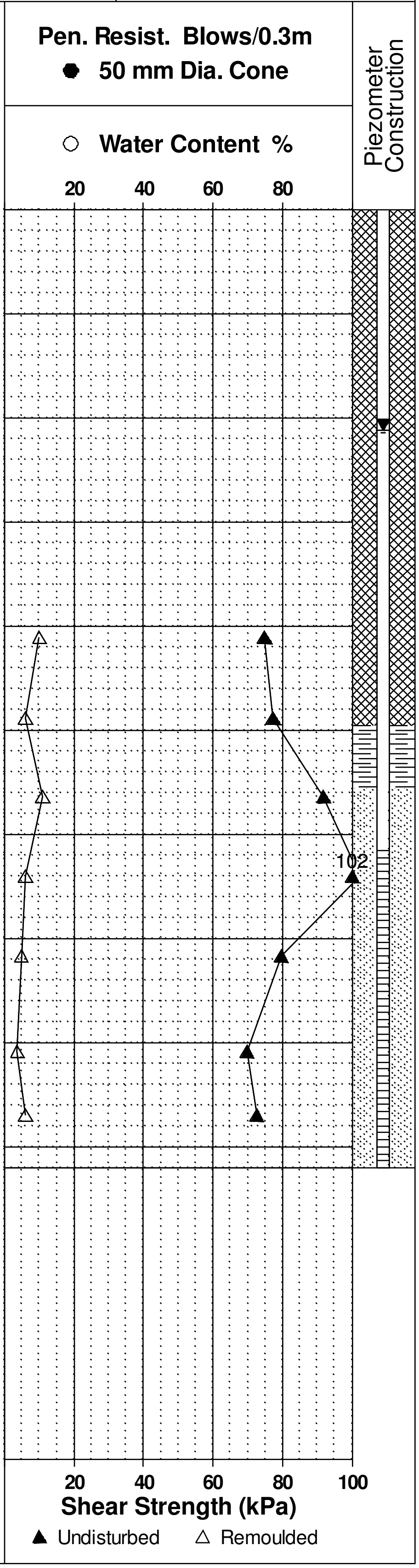
DATE April 4, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	55.50
TOPSOIL 0.20							
		SS	1	83	15	1	54.50
		SS	2	100	20	2	53.50
		SS	3	100	20	3	52.50
Very stiff to stiff, brown **SILTY CLAY** - grey by 4.3m depth		SS	4	100	8	4	51.50
						5	50.50
						6	49.50
						7	48.50
8.92						8	47.50
GLACIAL TILL: Grey silty sand with gravel, cobbles and boulders 9.20		SS	5		50+	9	46.50

End of Borehole

Practical refusal to augering @ 9.20m depth

(GWL @ 2.12m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
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DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 2, 2012

FILE NO. PG1796

HOLE NO. BH24-12

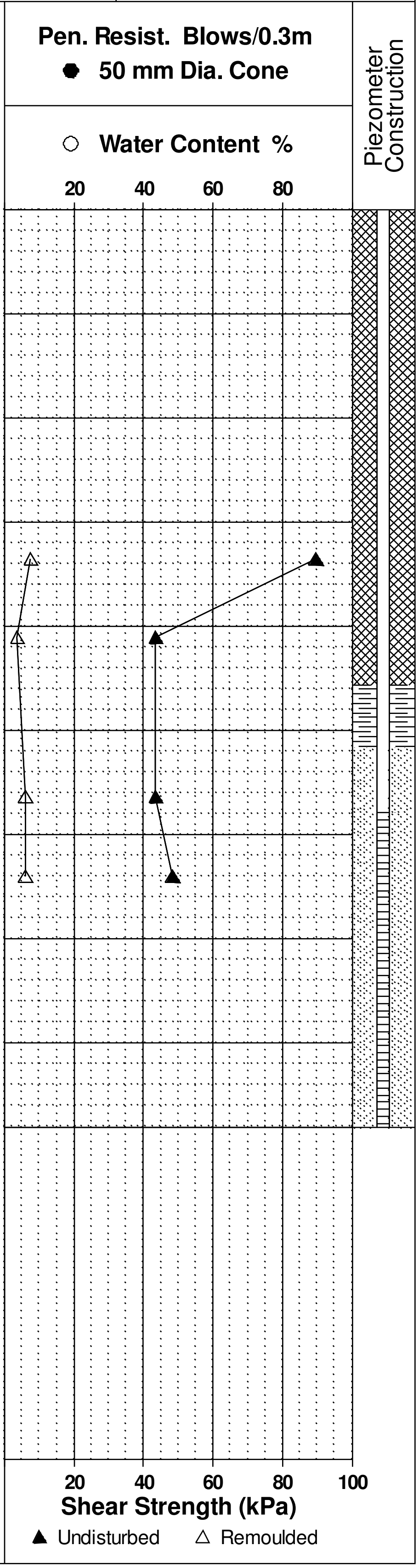
SOIL DESCRIPTION	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
Brown **SILTY SAND,** trace clay 0.20	AU	1		
Very stiff to stiff, brown **SILTY CLAY** - firm and grey by 3.6m depth	AU	2		
	SS	3	100	21
	SS	4	100	16
	SS	5	100	9
6.63	TW	6	100	
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders 8.81	SS	7	62	15

DEPTH (m)	ELEV. (m)
0	87.44
1	86.44
2	85.44
3	84.44
4	83.44
5	82.44
6	81.44
7	80.44
8	79.44

End of Borehole

Practical refusal to augering @ 8.81m depth

(BH dry - April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH25-12**

BORINGS BY CME 55 Power Auger

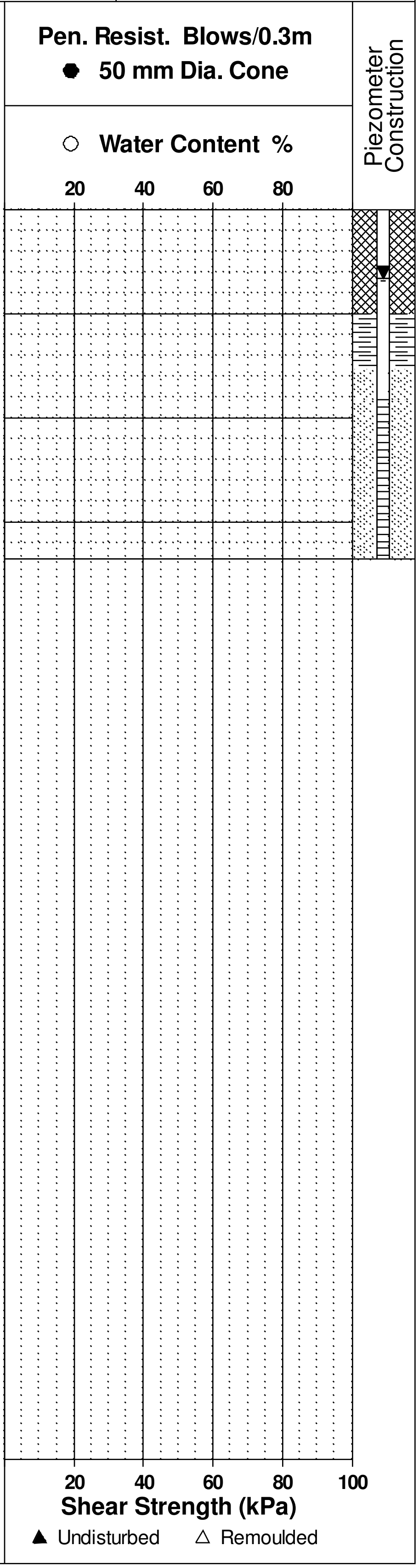
DATE April 2, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	81.91
TOPSOIL 0.20							
		AU	1				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders		SS	2	50	25	1	80.91
		SS	3	20	50+		
						2	79.91
		SS	4	67	50+		
						3	78.91
3.35		SS	5	71	50+		

End of Borehole

Practical refusal to augering @ 3.35m depth

(GWL @ 0.66m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

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REMARKS

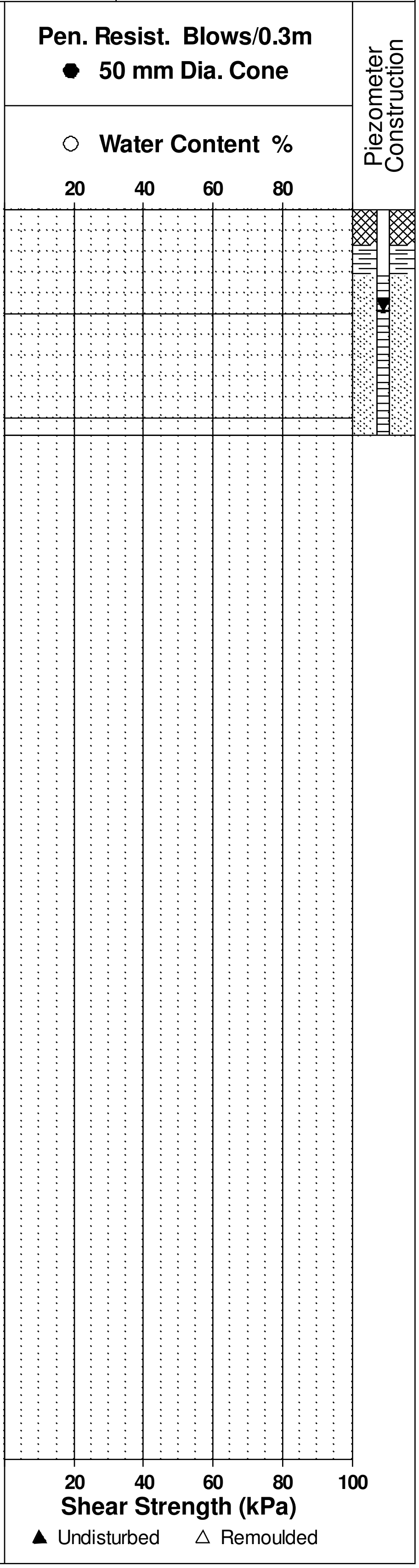
BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

HOLE NO. BH26-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.45
TOPSOIL 0.30							
Very stiff, brown **SILTY CLAY,** trace sand 1.45		SS	1	100	18	1	88.45
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders 2.16		SS	2	100	50+	2	87.45
End of Borehole Practical refusal to augering @ 2.16m depth (GWL @ 0.97m-April 13, 2012)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
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FILE NO. **PG1796**

REMARKS

HOLE NO. **BH27-12**

BORINGS BY CME 55 Power Auger

DATE April 9, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	96.23
TOPSOIL 0.20		AU	1				
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders 1.45		SS	2	60	50+	1	95.23
End of Borehole Practical refusal to augering @ 1.45m depth (BH 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 AND TEST DATA

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Proposed Residential Development - Queen Street
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

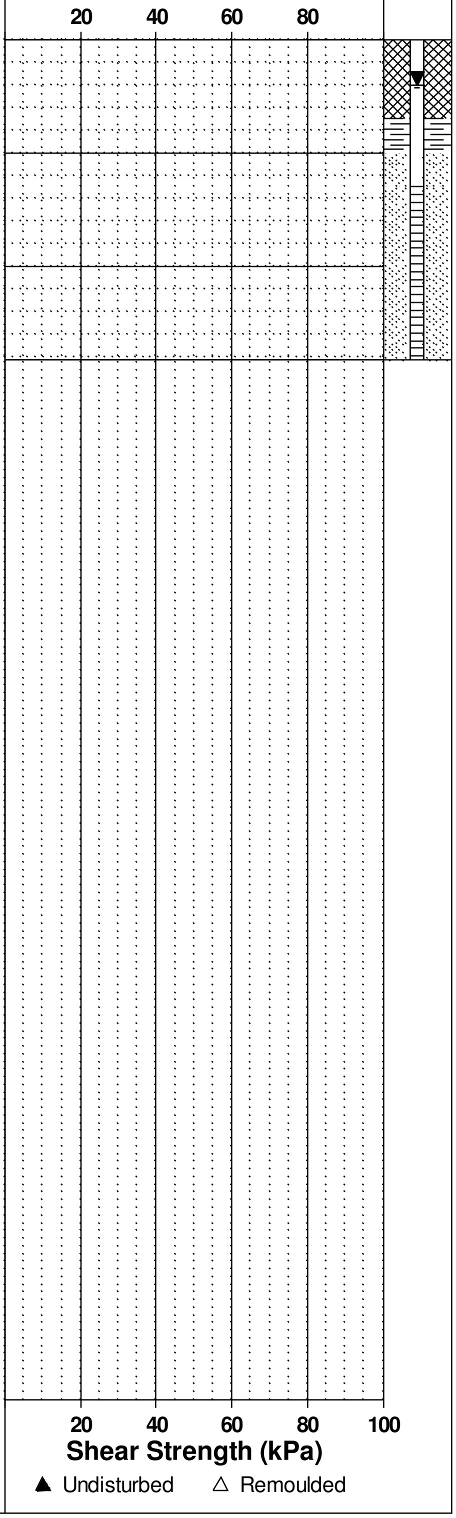
HOLE NO. BH28-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.30		AU	1			0	89.10
		AU	2				
Very stiff, brown **SILTY CLAY**		SS	3	100	23	1	88.10
2.21		SS	4	100	15	2	87.10
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders 2.82		SS	5	79	49		
End of Borehole Practical refusal to augering @ 2.82m depth (GWL @ 0.40m-April 13, 2012)							

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

○ Water Content %

Piezometer Construction



Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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Proposed Residential Development - Queen Street
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

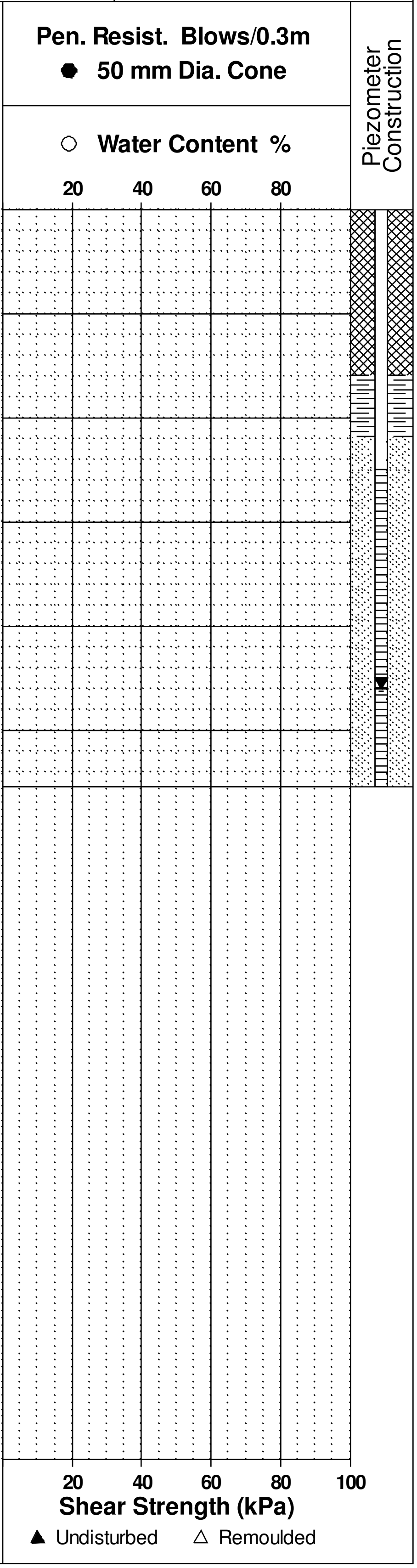
HOLE NO. BH29-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	87.20
TOPSOIL 0.25	AU	1				
Very stiff to stiff, brown **SILTY CLAY**	SS	2	100	21	1	86.20
	SS	3	100	20	2	85.20
	SS	4	100	17	3	84.20
3.73	SS	5	100	12		
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders	SS	6	50	34	4	83.20
5.26	SS	7	4	9	5	82.20
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders 5.54	SS	8	100	50+		

End of Borehole

Practical refusal to augering @ 5.54m depth

(Piezometer damaged - April 13, 2012)



SOIL PROFILE AND TEST DATA

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Proposed Residential Development - Queen Street
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DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

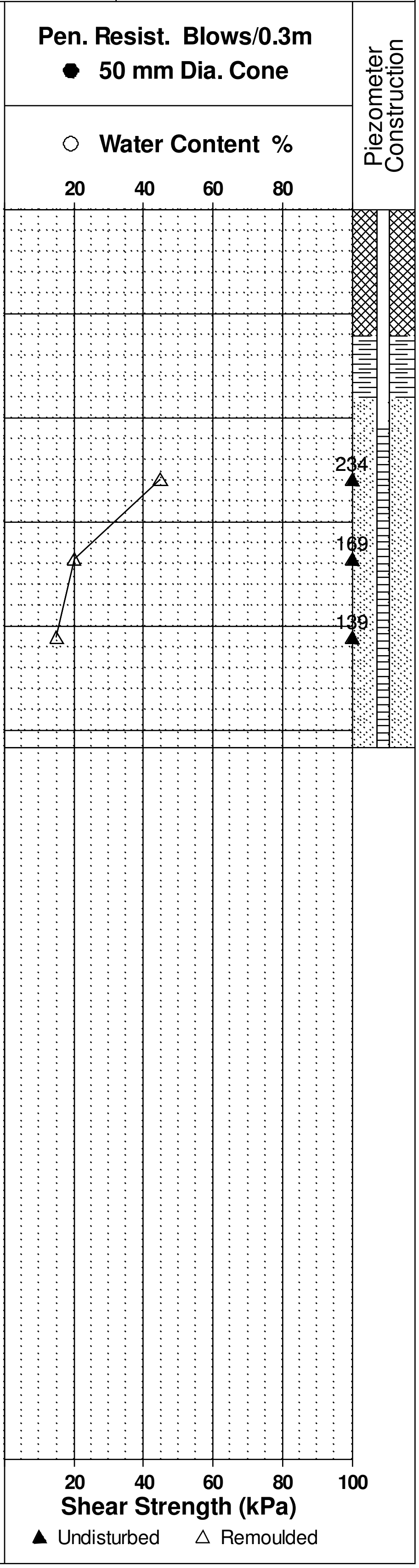
REMARKS

HOLE NO. **BH30-12**

BORINGS BY CME 55 Power Auger

DATE April 3, 2012

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	88.74
TOPSOIL 0.25						
	AU	1				
	SS	2	83	18	1	87.74
	SS	3	75	12		
Hard to very stiff, brown **SILTY CLAY**					2	86.74
					3	85.74
4.34					4	84.74
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders	SS	4	100	50+		
5.16					5	83.74
End of Borehole Practical refusal to augering @ 5.16m depth (Piezometer damaged-April 13,2012)						



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

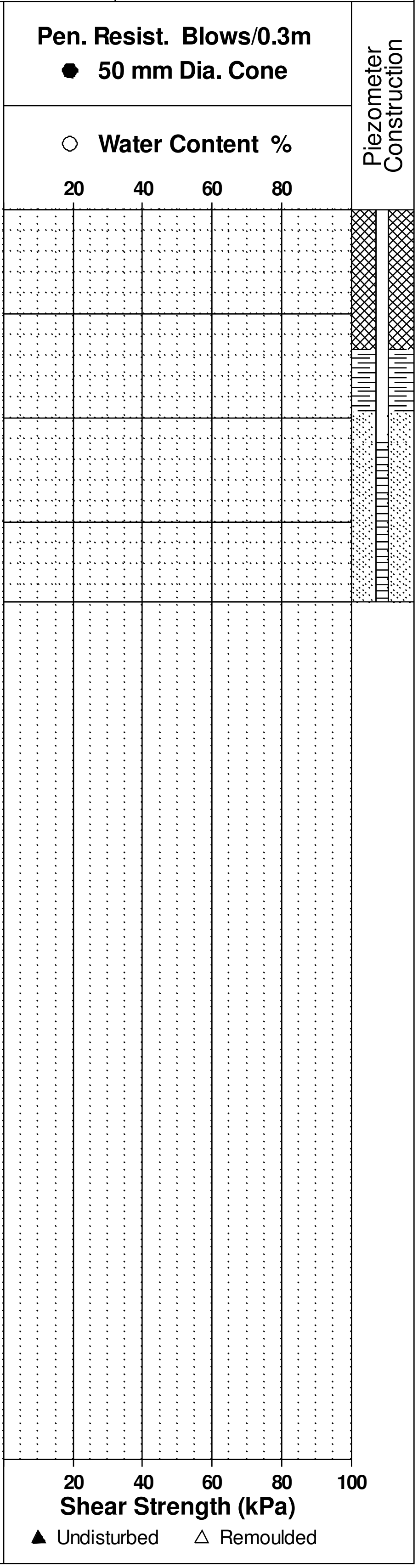
HOLE NO. BH31-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.70
TOPSOIL 0.28		AU	1				
Very stiff to stiff, brown **SILTY CLAY**		SS	2	100	12	1	85.70
		SS	3	100	19	2	84.70
2.97		SS	4	100	19		
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders 3.76		SS	5	82	50+	3	83.70

End of Borehole

Practical refusal to augering @ 3.76m depth

(GWL @ 1.12m-April 13, 2012)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

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REMARKS

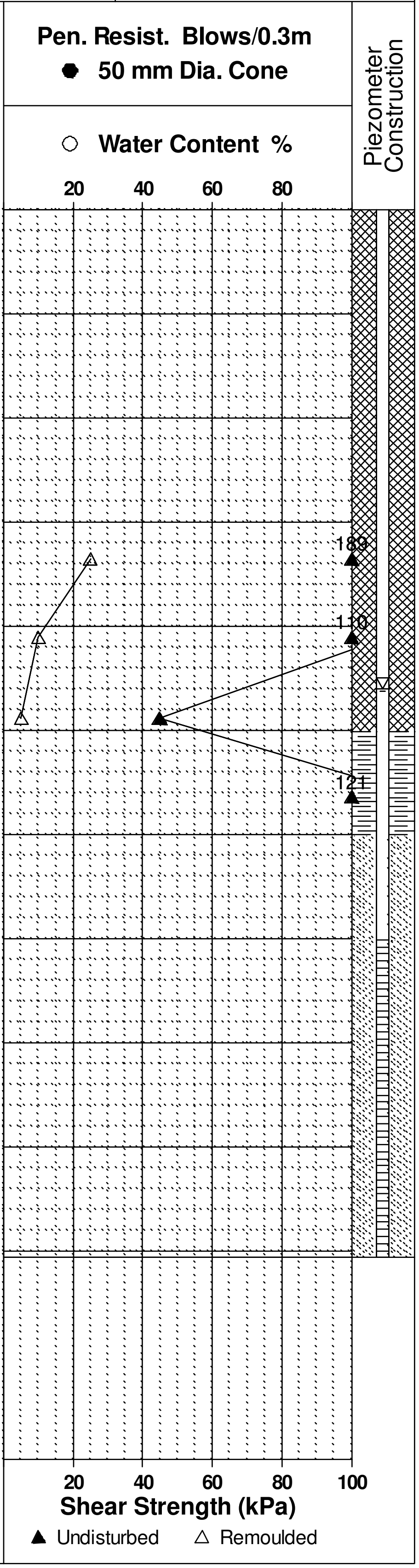
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

HOLE NO. BH32-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.94
Very stiff to stiff, brown **SILTY CLAY**		SS	1	100	22	1	86.94
		SS	2	100	18	2	85.94
		SS	3	100	13	3	84.94
- firm by 4.3m depth						4	83.94
						5	82.94
						6	81.94
6.60		SS	4	100	2		
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders		SS	5	42	38	7	80.94
		SS	6	67	50+	8	79.94
		SS	7	100	50+	9	78.94
10.06						10	77.94
End of Borehole (GWL @ 4.6m depth based on field observations)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 27, 2012

FILE NO. PG1796

HOLE NO. BH33-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.15
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders		AU	1				
0.86		SS	2	33	50+		
End of Borehole Practical refusal to augering at 0.86m depth (BH 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

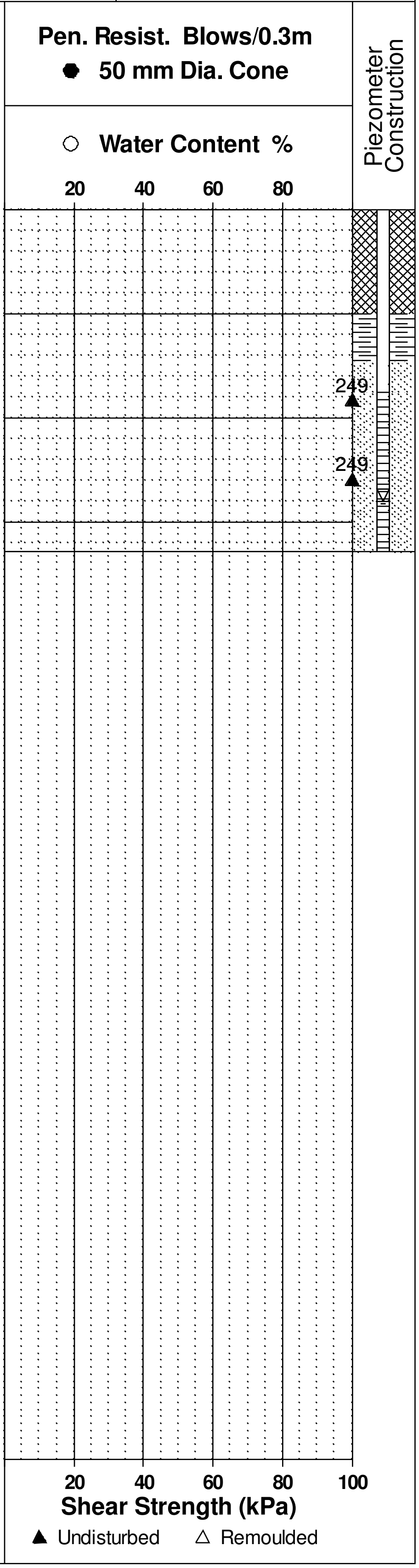
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. **PG1796**

HOLE NO. **BH34-12**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.99
Hard to very stiff, brown **SILTY CLAY**		AU	1				
		SS	2	100	17	1	88.99
						2	87.99
2.82							
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders 3.28		SS	3	33	50+	3	86.99
End of Borehole Practical refusal to augering at 3.28m depth (GWL @ 2.8m depth based on field observations)							



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FILE NO. **PG1796**

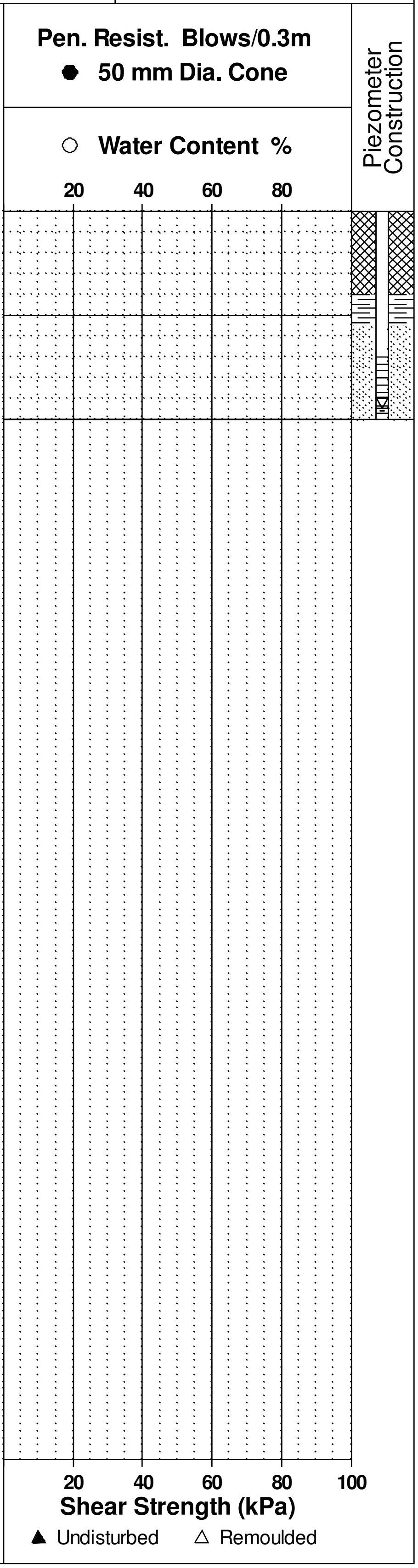
REMARKS

HOLE NO. **BH35-12**

BORINGS BY CME 55 Power Auger

DATE June 27, 2012

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.07
Hard, brown **SILTY CLAY**		SS	1	100	23	1	89.07
1.90		SS	2	76	50+		
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders 2.00						2	88.07
End of Borehole Practical refusal to augering at 2.00m depth (GWL @ 1.9m depth based on field observations)							



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DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

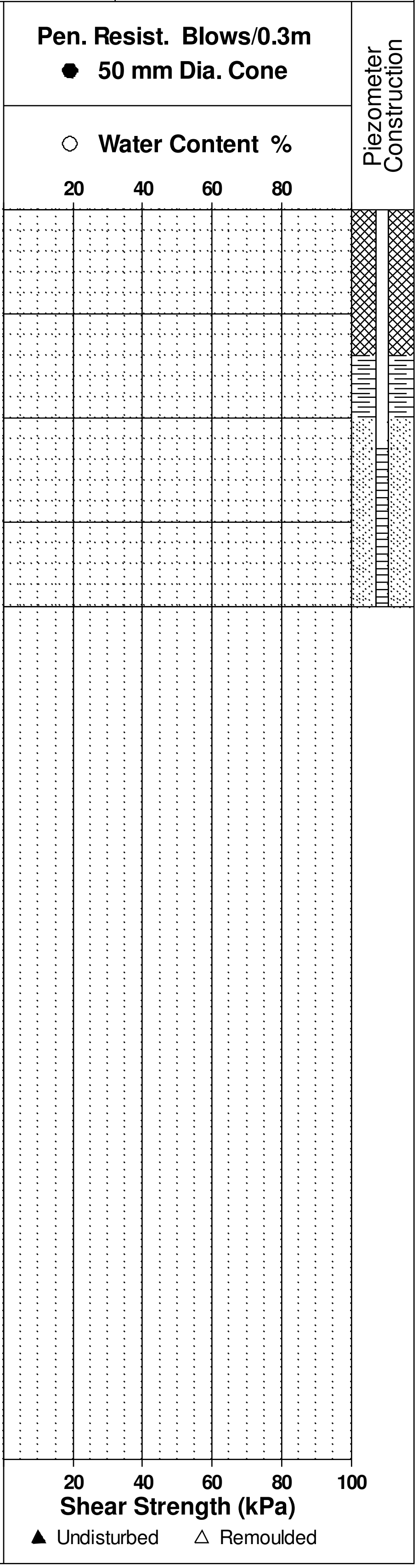
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

HOLE NO. BH36-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD		
GROUND SURFACE						0	91.15
Brown **SILTY SAND** with clay		AU	1				
0.60							
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		SS	2	100	6	1	90.15
		SS	3	67	16	2	89.15
		SS	4	54	39		
						3	88.15
		SS	5	56	50+		
3.81							
End of Borehole Practical refusal to augering at 3.81m depth (BH dry upon completion)							



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REMARKS

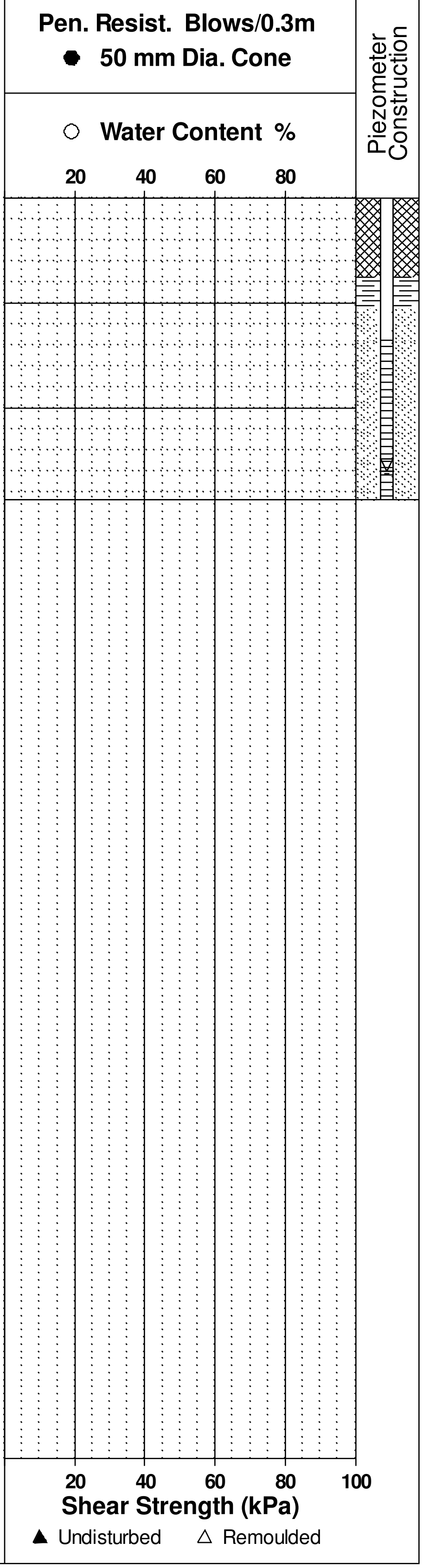
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

HOLE NO. BH37-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.42
Hard, brown **SILTY CLAY**		SS	1	100	22	1	88.42
		SS	2	100	16	2	87.42
2.21							
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		SS	3	75	50+		
2.87							
End of Borehole Practical refusal to augering at 2.87m depth (GWL @ 2.6m depth based on field observations)							



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SOIL PROFILE AND TEST DATA

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REMARKS

BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

HOLE NO. BH38-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	88.92
Very stiff to stiff, brown **SILTY CLAY**	SS	1	100	19	1	87.92
	SS	2	100	16	2	86.92
	SS	3	100	20		
2.97						
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders	SS	4	100	50+	3	85.92
	SS	5	50	50+	4	84.92
4.22						

End of Borehole

Practical refusal to augering at 4.22m depth

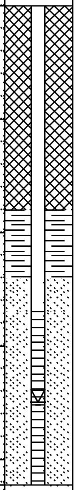
(GWL @ 3.5m depth based on field observations)

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

○ Water Content %

20 40 60 80

Piezometer Construction



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

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REMARKS

BORINGS BY CME 55 Power Auger

DATE January 20, 2009

FILE NO. PG1796

HOLE NO. BH 1

SOIL DESCRIPTION

GROUND SURFACE

FILL: Grey-brown silty clay with topsoil — 1.45

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

- grey-brown by 3.6m depth

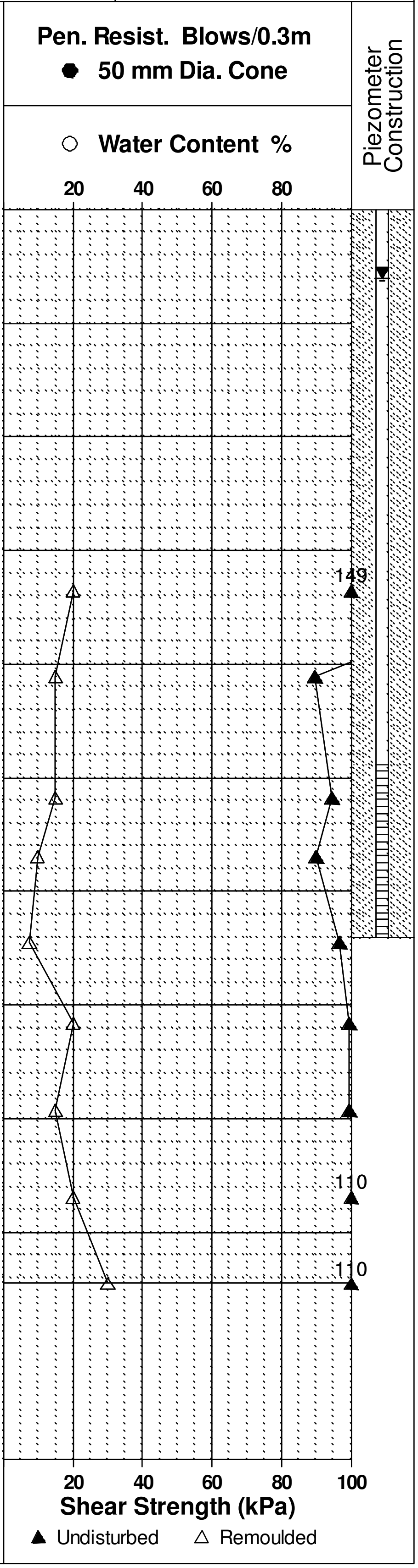
- stiff to very stiff and grey by 5.2m depth — 9.45

End of Borehole

(GWL @ 0.61m-Feb. 3/09)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	83	10
SS	3	100	11
SS	4	100	4

DEPTH (m)	ELEV. (m)
0	67.45
1	66.45
2	65.45
3	64.45
4	63.45
5	62.45
6	61.45
7	60.45
8	59.45
9	58.45



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SOIL PROFILE AND TEST DATA

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Ottawa, Ontario

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REMARKS

BORINGS BY CME 55 Power Auger

DATE January 20, 2009

FILE NO. PG1796

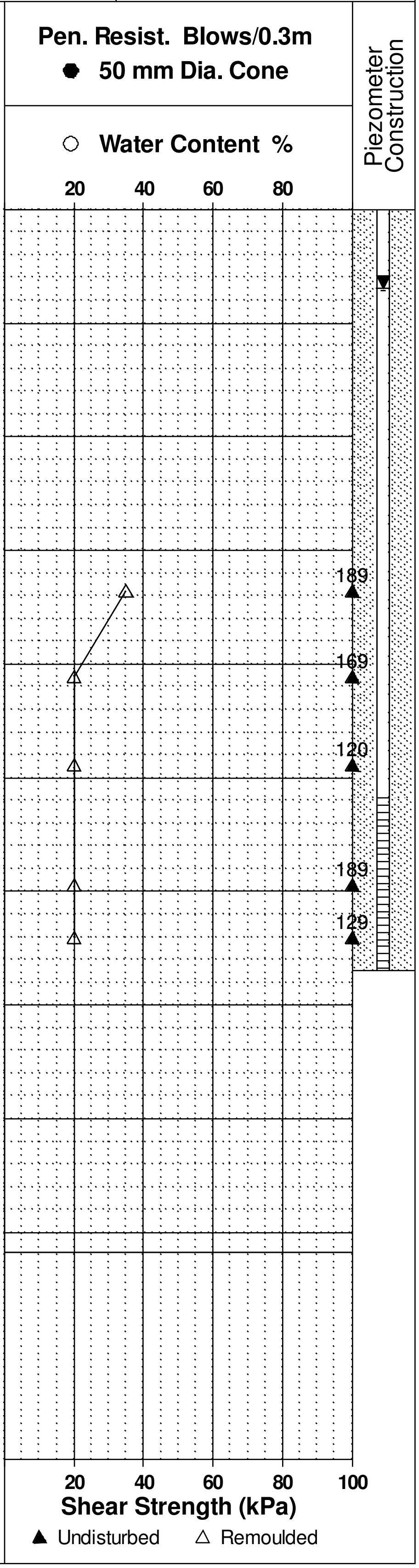
HOLE NO. BH 2

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL	0.04	AU	1		
Very stiff, brown **SILTY CLAY** - grey-brown by 2.2m depth	6.71	SS	2	75	10
		SS	3	100	13
		SS	4	100	6
GLACIAL TILL: Grey-brown silty clay with sand, gravel, cobbles and boulders	9.17	SS	5	38	33
		SS	6	67	41
		SS	7	0	50+
		SS	8	0	50+

End of Borehole

(GWL @ 0.69m-Feb. 3/09)

DEPTH (m)	ELEV. (m)
0	60.07
1	59.07
2	58.07
3	57.07
4	56.07
5	55.07
6	54.07
7	53.07
8	52.07
9	51.07



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 20, 2009

FILE NO. PG1796

HOLE NO. BH 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 % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	63.94		
TOPSOIL 0.20		AU	1						
Very stiff, brown **SILTY CLAY**		SS	2	58	12	1	62.94		
1.60		SS	3	50	50+				
BEDROCK: Weathered black shale						2	61.94		
2.29		AU	4						

End of Borehole

Practical refusal to augering @ 2.29m depth

(BH dry upon completion)

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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

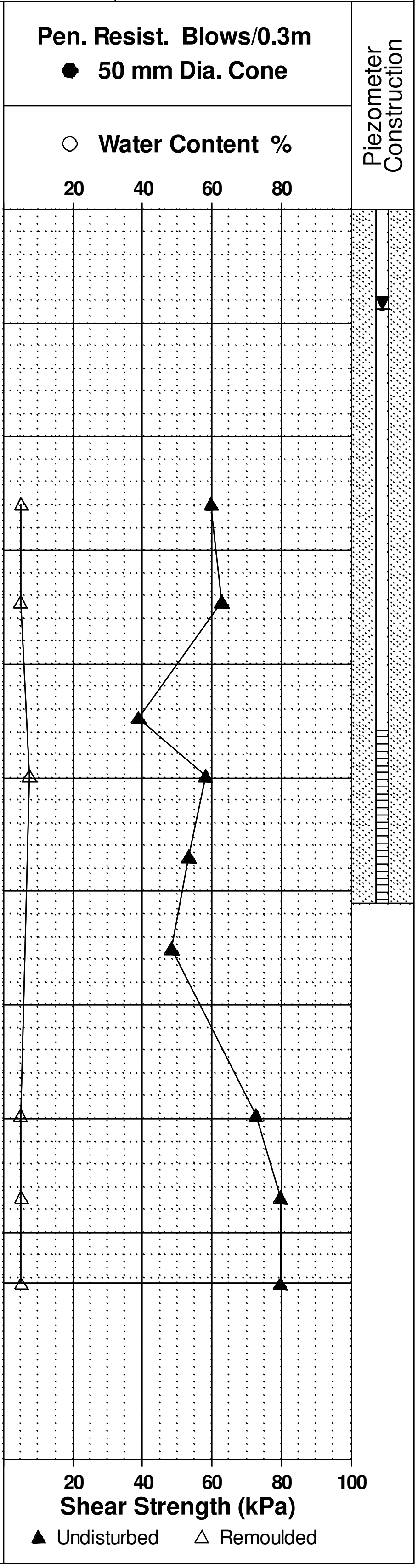
REMARKS

HOLE NO. **BH 4**

BORINGS BY CME 55 Power Auger

DATE January 21, 2009

SOIL DESCRIPTION		SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.72
TOPSOIL	0.20	AU	1				
		SS	2	75	9	1	52.72
		SS	3	92	4	2	51.72
Stiff, brown **SILTY CLAY**						3	50.72
- grey-brown by 3.0m depth		SS	4		P		
- grey by 3.7m depth						4	49.72
						5	48.72
						6	47.72
		TW	1			7	46.72
						8	45.72
	9.45					9	44.72
End of Borehole							
(GWL @ 0.87m-Feb. 3/09)							



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REMARKS

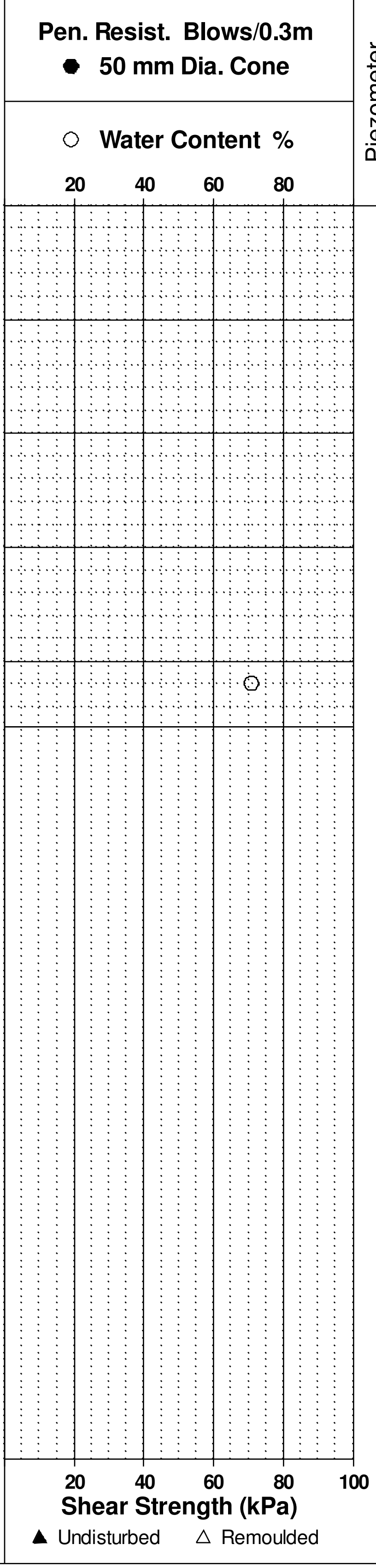
BORINGS BY CME 55 Power Auger

DATE January 21, 2009

FILE NO. PG1796

HOLE NO. BH 4B

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	53.72	
						1	52.72	
OVERBURDEN						2	51.72	
						3	50.72	
3.81								
Grey **SILTY CLAY**	▨	TW	1			4	49.72	
4.42								
End of Borehole (BH 4B located 1.5m south of BH 4 location)								



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
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FILE NO. **PG1796**

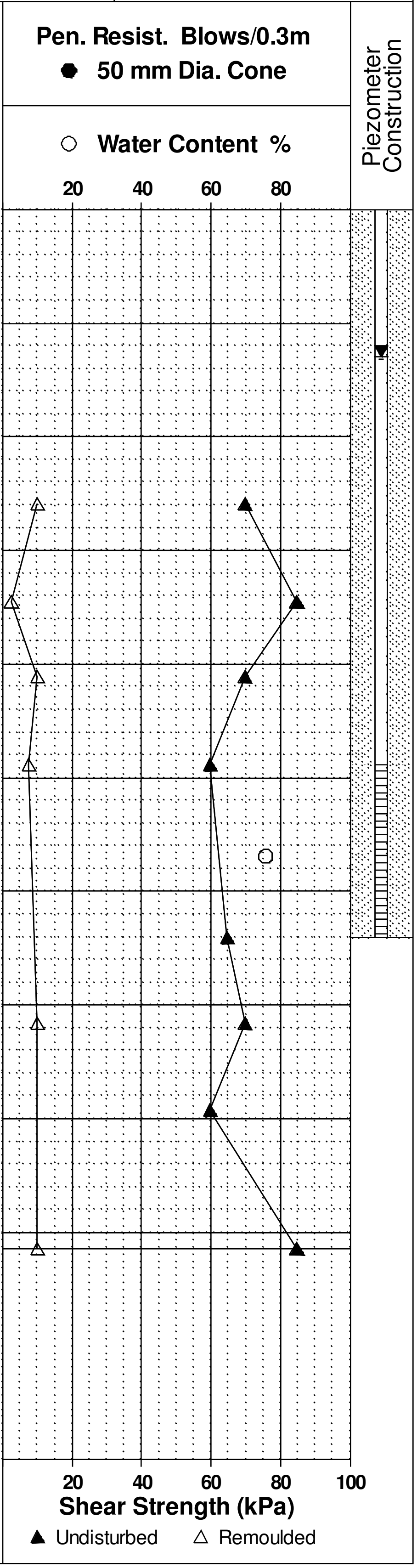
REMARKS

HOLE NO. **BH 5**

BORINGS BY CME 55 Power Auger

DATE January 21, 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	53.28
TOPSOIL 0.25	AU	1				
Stiff, brown **SILTY CLAY**	SS	2	62	8	1	52.28
- red-brown by 1.4m depth	SS	3	100	6		
					2	51.28
- grey-brown by 2.8m depth					3	50.28
- grey by 3.7m depth						
					4	49.28
					5	48.28
	TW	1	62			
					6	47.28
					7	46.28
					8	45.28
	TW	2	67			
					9	44.28
9.14 End of Borehole						
(GWL @ 1.30m-Feb. 3/09)						



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REMARKS

BORINGS BY CME 55 Power Auger

DATE January 20, 2009

FILE NO. PG1796

HOLE NO. BH 6

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	77.71		
TOPSOIL 0.30									
GLACIAL TILL: Grey silty sand with clay, gravel, cobbles and boulders 1.01		SS	1	92	10	1	76.71		
BEDROCK: Weathered, black shale 1.75		SS	2	67	50+				
		AU	3						
End of Borehole Practical refusal to augering @ 1.75m depth (BH dry upon completion)									

Water content scale: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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Proposed Residential Development - Queen Street
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DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 20, 2009

FILE NO. PG1796

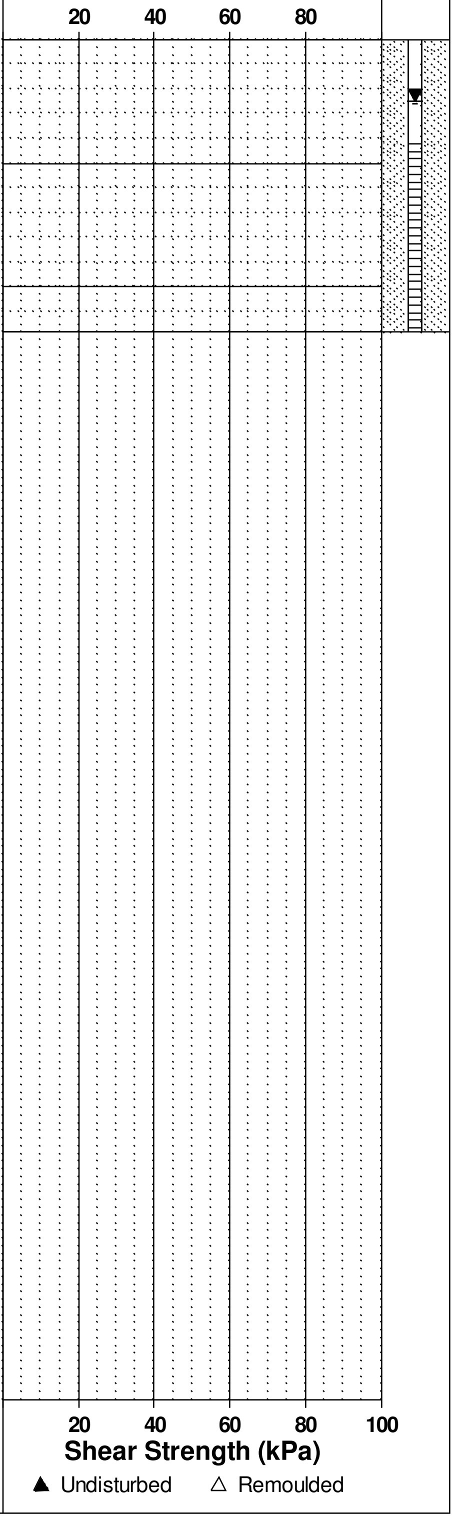
HOLE NO. BH 7

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	72.32
TOPSOIL 0.30	AU	1				
25mm Topsoil Very stiff, grey-brown **SILTY CLAY**	SS	2	100	11	1	71.32
1.93	SS	3	83	9	2	70.32
GLACIAL TILL: Very dense, brown sandy silt with gravel, cobbles and boulders 2.36	SS	4	0	50+		
End of Borehole Practical refusal to augering @ 2.36m depth (GWL @ 0.50m-Feb. 3/09)						

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

○ **Water Content %**

Piezometer Construction



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REMARKS

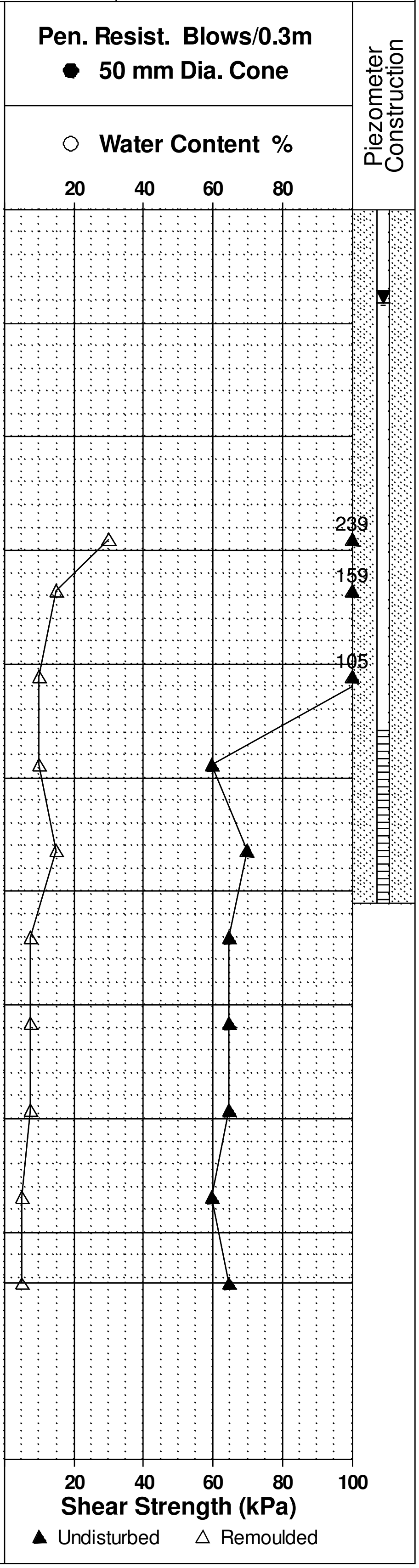
BORINGS BY CME 55 Power Auger

DATE January 23, 2009

FILE NO. PG1796

HOLE NO. BH 8

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.11
TIOPSOIL 0.30		AU	1				
		SS	2	42	9	1	86.11
		SS	3	67	5	2	85.11
Hard to very stiff, brown **SILTY CLAY**						3	84.11
- stiff and grey-brown by 4.3m depth						4	83.11
						5	82.11
						6	81.11
						7	80.11
- grey by 7.9m depth						8	79.11
						9	78.11
9.45							
End of Borehole							
(GWL @ 0.82m-Feb. 3/09)							



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REMARKS

BORINGS BY CME 55 Power Auger

DATE January 22, 2009

FILE NO. PG1796

HOLE NO. BH 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	57.53		
TOPSOIL 0.20		AU	1						
FILL: Brown silty clay with sand and gravel 1.45		SS	2	50	20	1	56.53		
End of Borehole Practical refusal to augering @ 1.45m depth									

Water Content %: 20 40 60 80

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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FILE NO. **PG1796**

REMARKS

HOLE NO. **BH 9B**

BORINGS BY CME 55 Power Auger

DATE January 22, 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	57.00
TOPSOIL 0.20						
Very stiff, brown **SILTY CLAY**					1	56.00
	SS	1	71	17	2	55.00
2.29						
GLACIAL TILL: Dense, brown silty sand with gravel, cobbles and boulders	SS	2	54	35		
	SS	3	75	50+	3	54.00
3.73						

End of Borehole

Practical refusal to augering @ 3.73m depth

(GWL @ 0.53m-Feb. 3/09)

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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

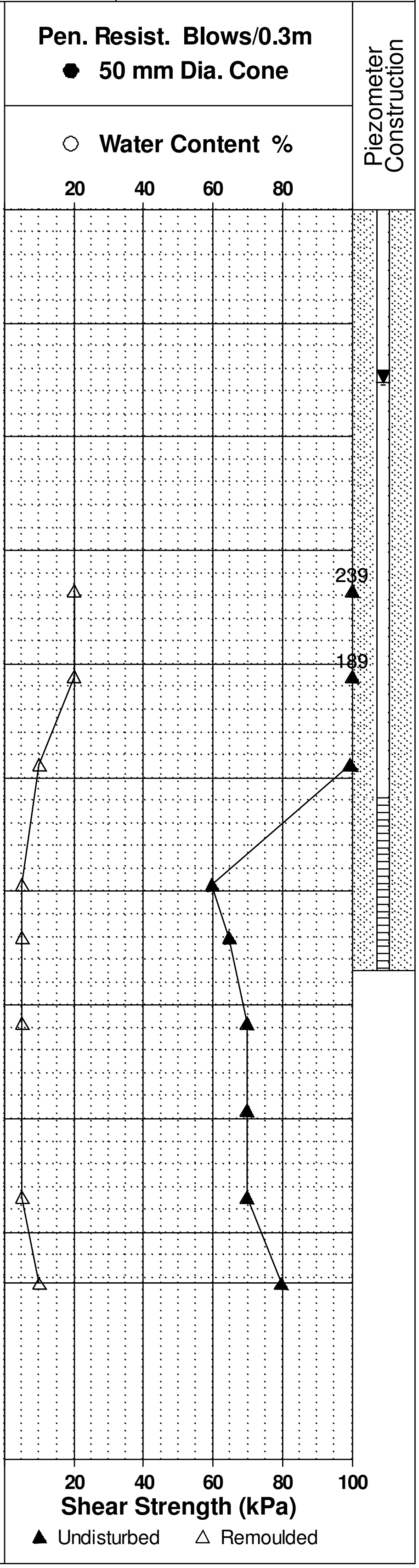
HOLE NO. **BH10**

BORINGS BY CME 55 Power Auger

DATE January 22, 2009

SOIL DESCRIPTION	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.20	AU	1		
	SS	2	58	10
	SS	3	75	11
	SS	4	83	8
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 4.3m depth				
9.45 End of Borehole (GWL @ 1.52m-Feb. 3/09)				

DEPTH (m)	ELEV. (m)
0	86.36
1	85.36
2	84.36
3	83.36
4	82.36
5	81.36
6	80.36
7	79.36
8	78.36
9	77.36



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 23, 2009

HOLE NO. **BH11**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	89.75		
TOPSOIL 0.30		AU	1						
Very stiff, brown **SILTY CLAY** with organic matter 0.69									
GLACIAL TILL: Compact to dense, brown silty sand with clay, gravel, cobbles and boulders		SS	2	75	8	1	88.75		
		SS	3	50	20	2	87.75		
2.95		SS	4	80	50+				
End of Borehole Practical refusal to augering @ 2.95m depth									

20 40 60 80 100

Shear Strength (kPa)

▲ Undisturbed △ Remoulded

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

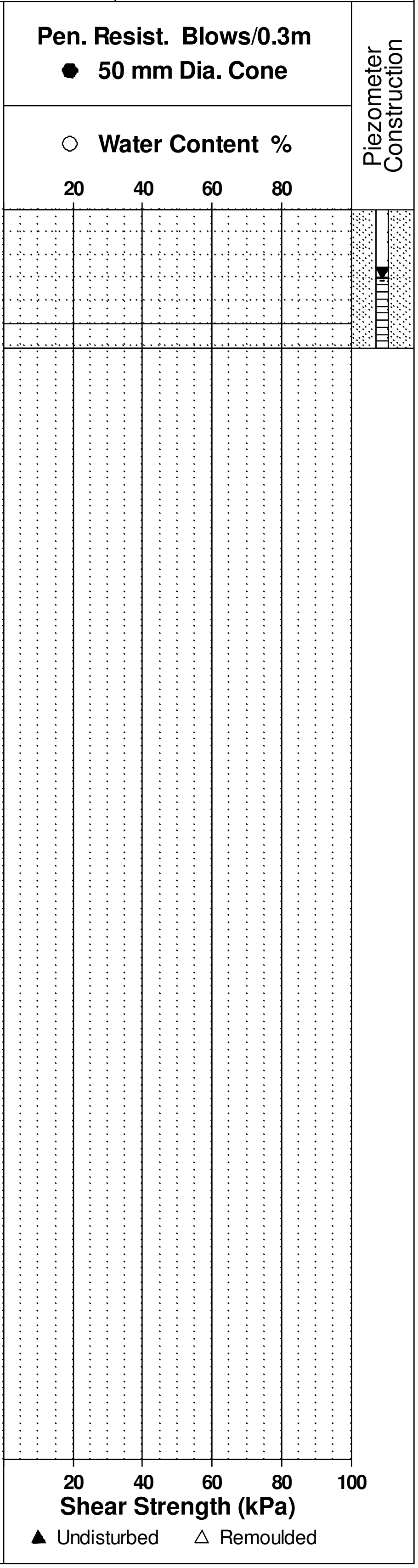
REMARKS

HOLE NO. **BH12**

BORINGS BY CME 55 Power Auger

DATE January 22, 2009

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	80.38
TOPSOIL 0.20		AU	1				
GLACIAL TILL: Very dense, brown silty sand with clay, gravel, cobbles and boulders 1.22		SS	2		50+	1	79.38
End of Borehole Practical refusal to augering @ 1.22m depth (GWL @ 0.61m-Feb. 3/09)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH13**

BORINGS BY CME 55 Power Auger

DATE January 26, 2009

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	92.03		
TOPSOIL 0.30		AU	1						
Very stiff, brown **SILTY CLAY**, some sand 0.71									
End of Borehole Practical refusal to augering @ 0.71m depth									

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

patersongroup Consulting Engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

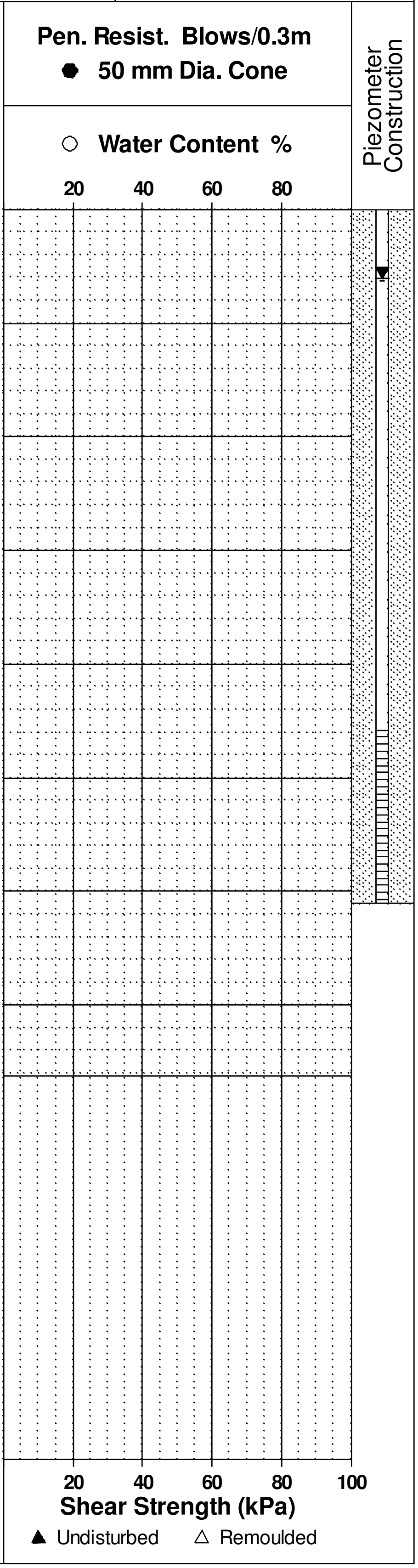
REMARKS

HOLE NO. BH14

BORINGS BY CME 55 Power Auger

DATE January 26, 2009

SOIL DESCRIPTION	Strata depth (m)	TYPE	NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.88
TOPSOIL	0.20	AU	1				
Very stiff, brown **SILTY CLAY**	0.91						
GLACIAL TILL: Very dense, brown silty sand with clay, gravel, cobbles and boulders		SS	2	67	54	1	87.88
	2.21	SS	3	33	54	2	86.88
GLACIAL TILL: Very stiff, grey silty clay with sand, gravel, cobbles and boulders		SS	4	50	24	3	85.88
		SS	5	50	13		
		SS	6	33	16	4	84.88
		SS	7	38	30	5	83.88
		SS	8	25	31	6	82.88
		SS	9	38	44		
	7.62	SS	10	42	42	7	81.88
End of Borehole							
(GWL @ 0.61m-Feb. 3/09)							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 26, 2009

FILE NO. PG1796

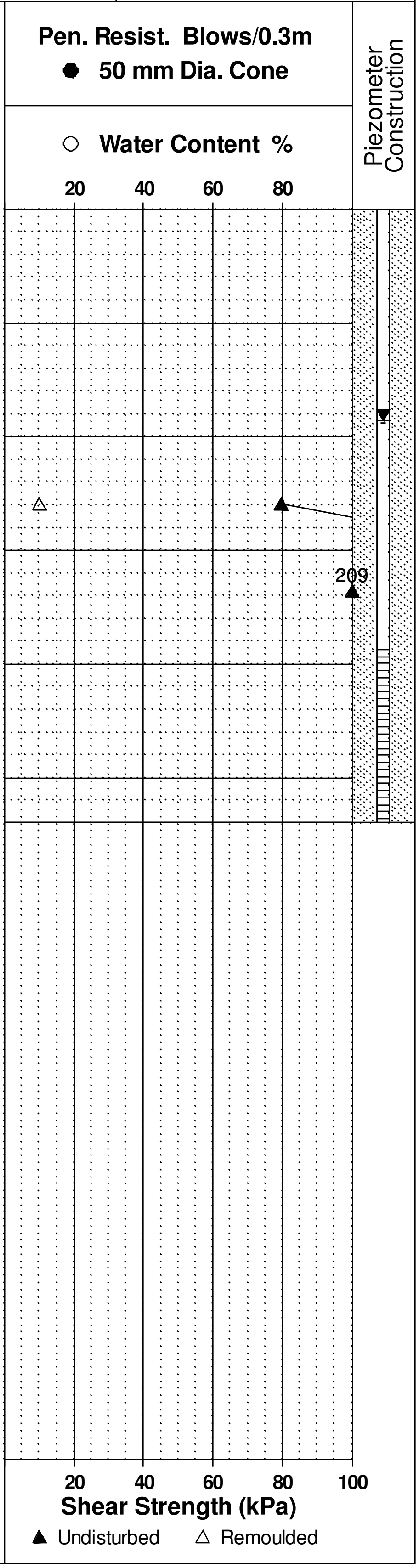
HOLE NO. BH15

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.13
TOPSOIL	0.25	AU	1				
Stiff, brown **SILTY CLAY**, some organic matter to 1.4m depth		SS	2	8	9	1	87.13
		SS	3	42	4	2	86.13
	2.82						
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles		SS	4	100	2	3	85.13
						4	84.13
	5.13	SS	6	42	14	5	83.13
GLACIAL TILL: Compact, grey silty sand with gravel, cobbles and boulders	5.39	SS	7	0	50+		

End of Borehole

Practical refusal to augering @ 5.39m depth

(GWL @ 1.86m-Feb. 3/09)



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

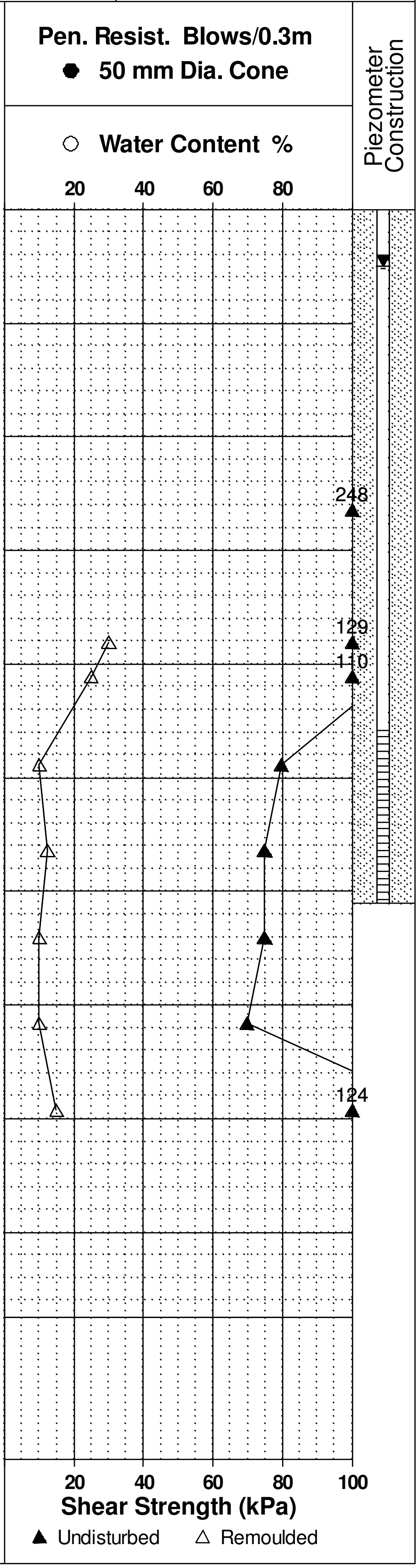
DATE January 26, 2009

FILE NO. PG1796

HOLE NO. BH16

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
TOPSOIL 0.30	AU	1		
Hard to very stiff, brown **SILTY CLAY**	SS	2	79	10
	SS	3	100	10
	SS	4	100	8
	SS	5	100	5
- grey by 4.0m depth				
8.08				
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders	SS	6	42	4
9.75				
End of Borehole				
(GWL @ 0.50m-Feb. 3/09)				

DEPTH (m)	ELEV. (m)
0	67.96
1	66.96
2	65.96
3	64.96
4	63.96
5	62.96
6	61.96
7	60.96
8	59.96
9	58.96



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH17**

BORINGS BY CME 55 Power Auger

DATE January 23, 2009

SOIL DESCRIPTION

GROUND SURFACE

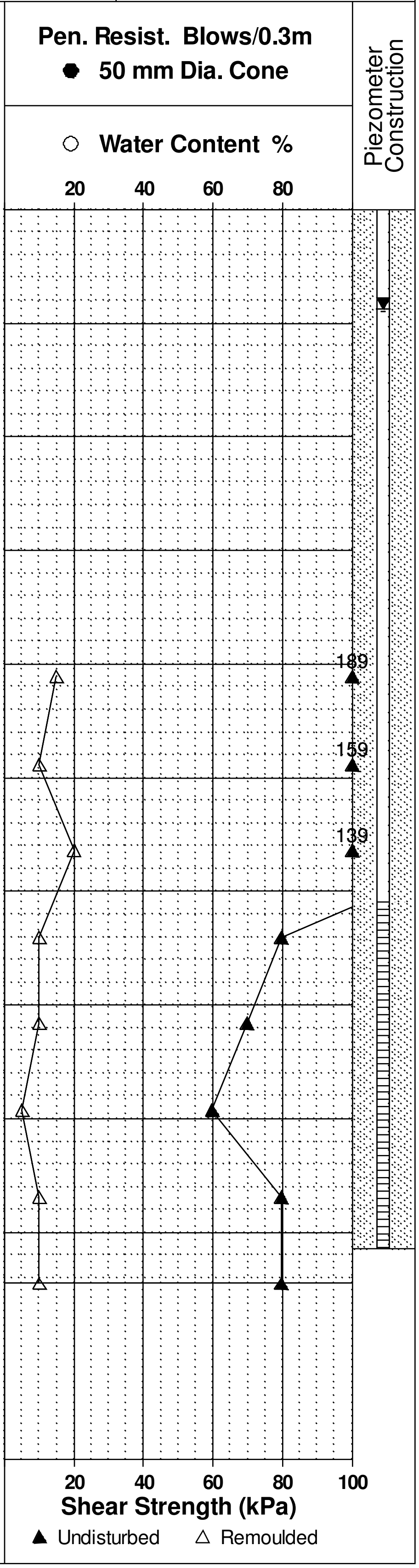
SOIL DESCRIPTION	Depth to base (m)
TOPSOIL	0.20
Very stiff, brown **SILTY CLAY** - stiff and grey-brown by 5.9m depth - grey by 6.6m depth	9.45

End of Borehole

(GWL @ 0.88m-Feb. 3/09)

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	54	14
SS	3	50	12
SS	4	71	9
SS	5	75	5

DEPTH (m)	ELEV. (m)
0	86.28
1	85.28
2	84.28
3	83.28
4	82.28
5	81.28
6	80.28
7	79.28
8	78.28
9	77.28



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. PG1796

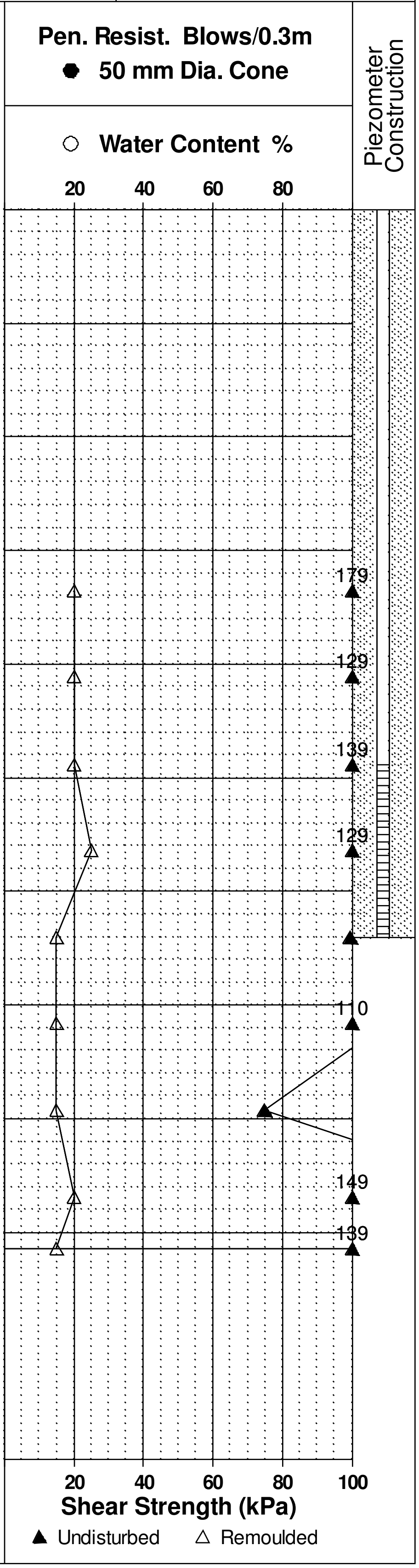
REMARKS

HOLE NO. BH18

BORINGS BY CME 55 Power Auger

DATE January 19, 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	54.83
TOPSOIL 0.25 25mm Topsoil	AU	1				
	SS	2	50	8	1	53.83
	SS	3	83	8	2	52.83
	SS	4	58	7	3	51.83
Very stiff to stiff, brown **SILTY CLAY**					4	50.83
- grey-brown by 4.9m depth					5	49.83
					6	48.83
- grey by 6.6m depth					7	47.83
					8	46.83
9.14 End of Borehole (Piezometer blocked - Feb. 3/09)					9	45.83



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 22, 2009

FILE NO. PG1796

HOLE NO. BH19

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content % 20 40 60 80	Piezometer Construction
GROUND SURFACE						0	71.73		
TOPSOIL 0.30		AU	1						
GLACIAL TILL: Brown silty sand with clay, gravel, cobbles		SS	2	33	16	1	70.73		
1.91		SS	3	76	50+				
						2	69.73		
		SS	4	50	50+				
BEDROCK: Weathered, black shale		SS AU	5 6	0	50+	3	68.73		
4.09						4	67.73		

End of Borehole

Practical refusal to augering @ 4.09m depth

(BH dry - Feb. 3/09)

(GWL @ 1.5m depth 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)

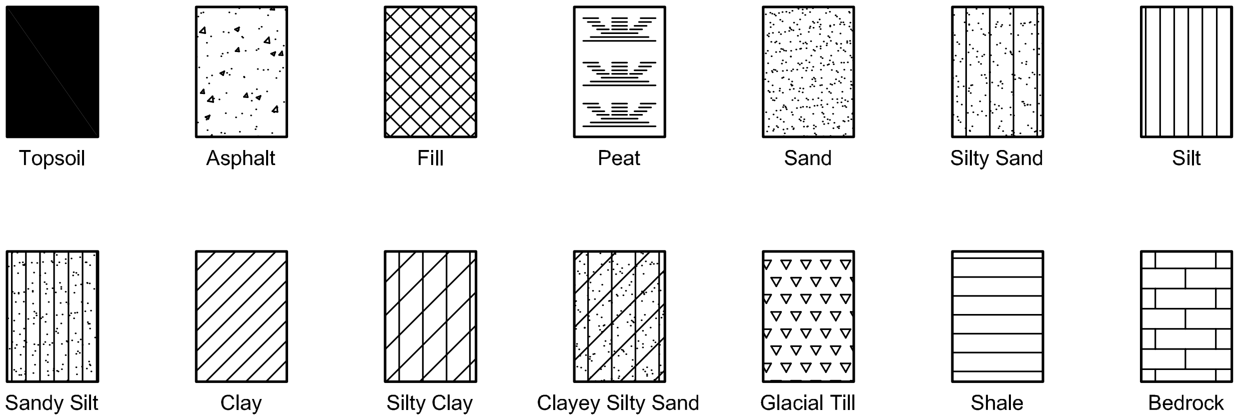
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

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.

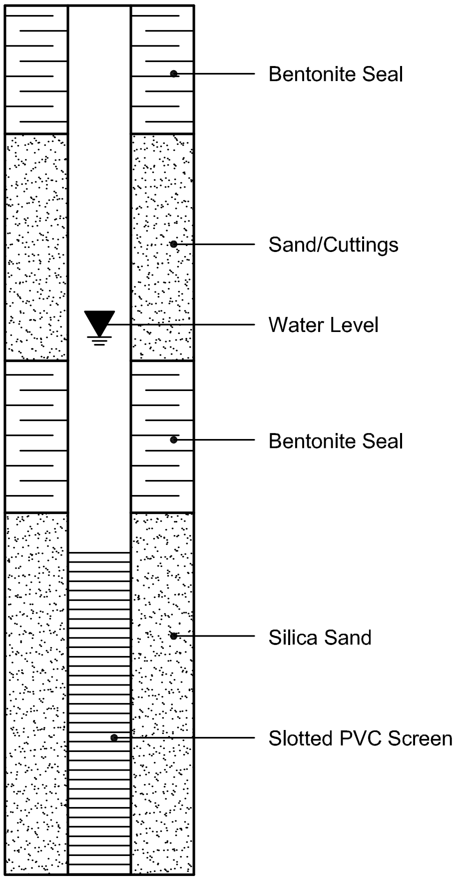
SYMBOLS AND TERMS (continued)

STRATA PLOT

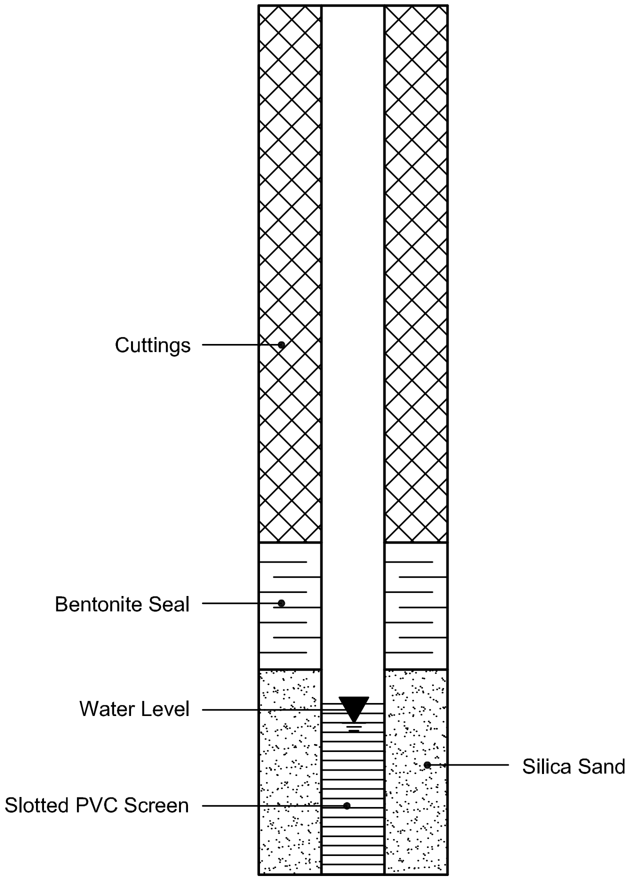


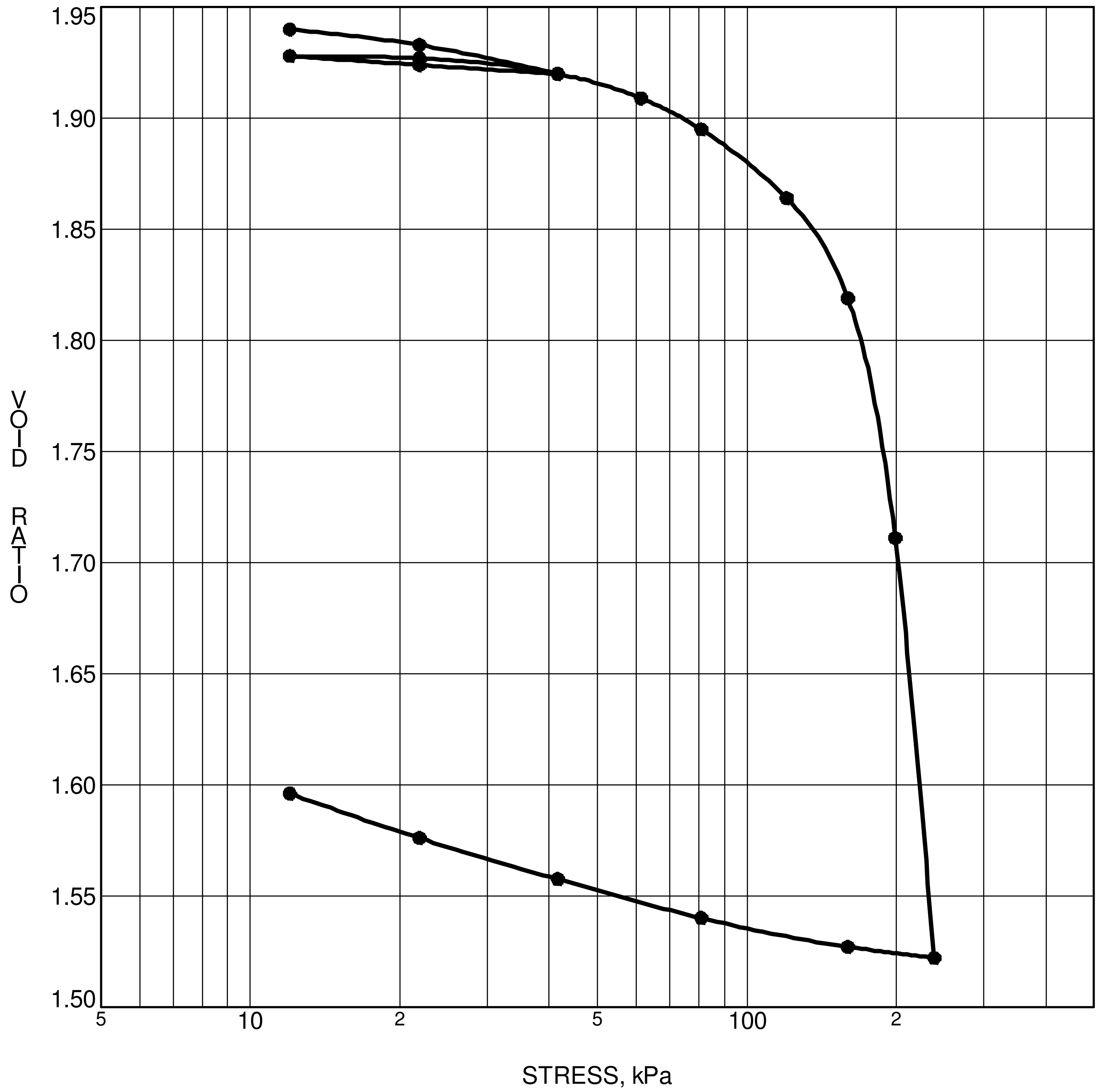
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





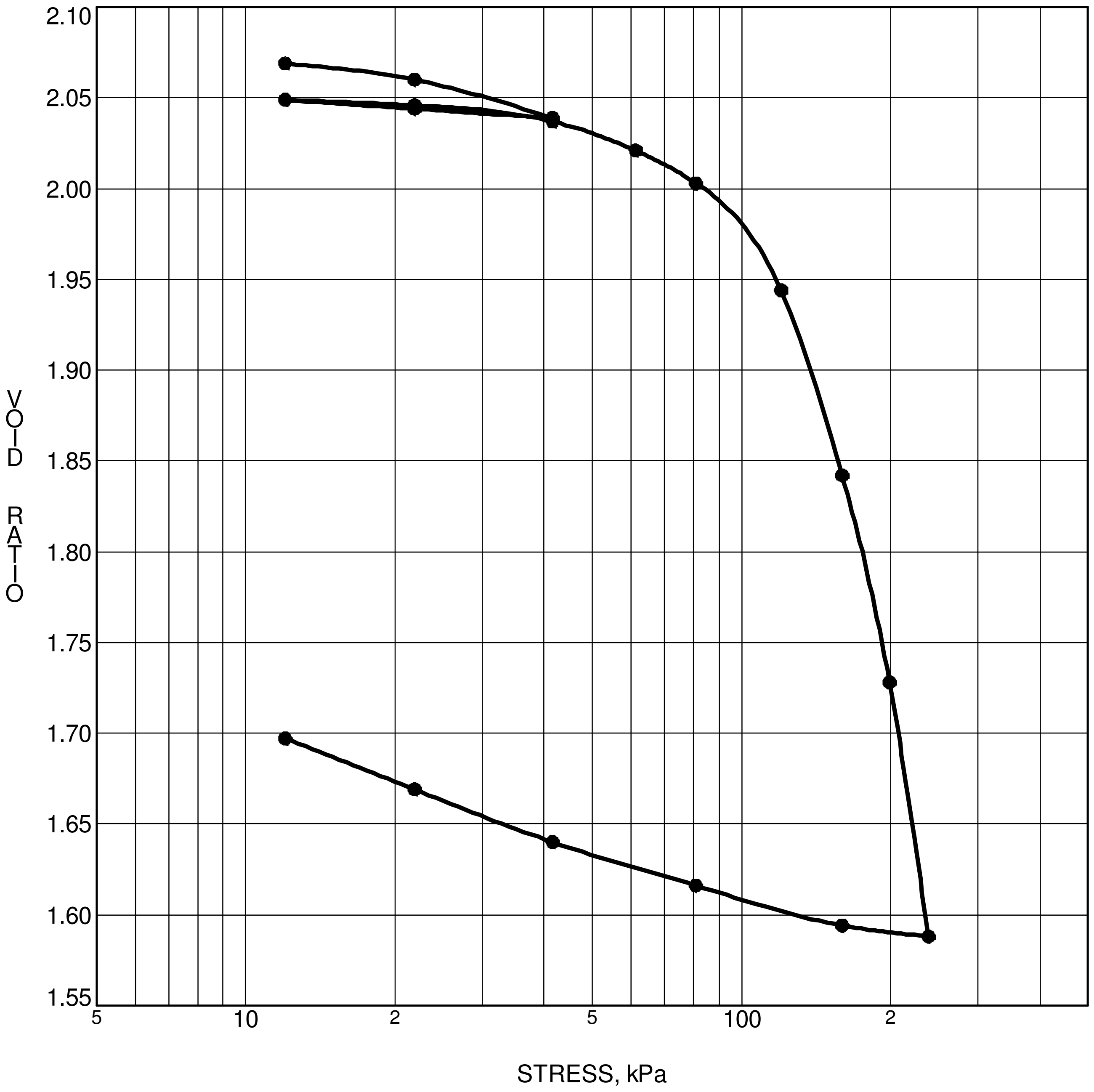
CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	BH 4B	p'$_o$	64 kPa	Ccr	0.015
Sample No.	TW 1	p'$_c$	174 kPa	Cc	2.432
Sample Depth	4.19 m	OC Ratio	2.7	Wo	70.8 %
Sample Elev.	49.53 m	Void Ratio	1.948	Unit Wt.	15.9 kN/m^3

CLIENT	**Taggart Group of Companies**	FILE NO.	**PG1796**
PROJECT	**Geotechnical Investigation - Prop. Residential Development-Queen Street**	DATE	**02/02/09**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



CONSOLIDATION TEST DATA SUMMARY					
Borehole No.	**BH 5**	p'$_o$	**74** kPa	Ccr	**0.021**
Sample No.	**TW 1**	p'$_c$	**147** kPa	Cc	**1.863**
Sample Depth	**5.69** m	OC Ratio	**2.0**	Wo	**75.7** %
Sample Elev.	**47.59** m	Void Ratio	**2.081**	Unit Wt.	**15.7** kN/m ^{3}

CLIENT **Taggart Group of Companies**

FILE NO. **PG1796**

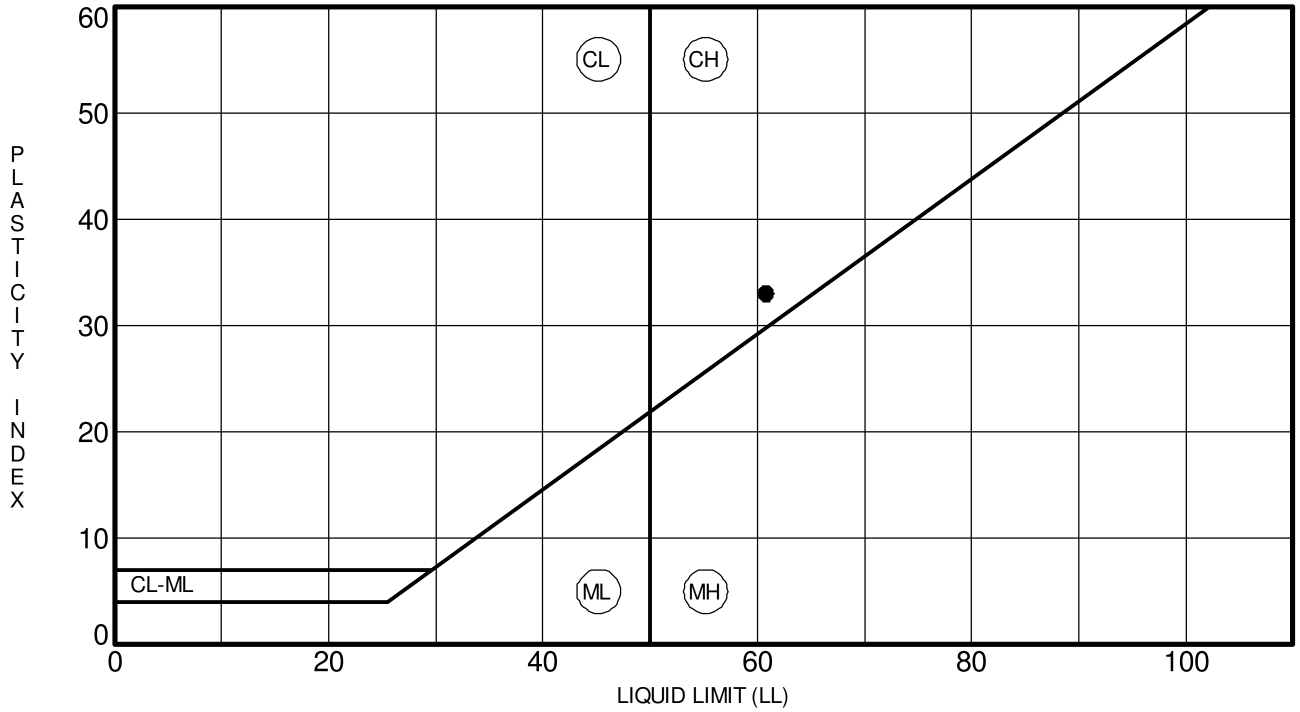
PROJECT **Geotechnical Investigation - Prop. Residential Development-Queen Street**

DATE **29/01/09**

patersongroup **Consulting Engineers**

28 Concouse Gate, Unit 1, Ottawa, Ontario K2E 7T7

CONSOLIDATION TEST



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BH 4B**	**TW 1**	**61**	**28**	**33**		**Clays of high plasticity-CH**

CLIENT **Taggart Group of Companies**

PROJECT **Geotechnical Investigation - Prop. Residential Development-Queen Street**

FILE NO. **PG1796**

DATE **21 Jan 09**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

Order #: 0905037

Certificate of Analysis

Report Date: 02-Feb-2009
Order Date:27-Jan-2009

Client: **Paterson Group Consulting Engineers**

Client PO: 7712 Project Description: PG1796

	Client ID:	BH4-SS3	-	-	-
	Sample Date:	21-Jan-09	-	-	-
	Sample ID:	0905037-01	-	-	-
	MDL/Units	Soil	-	-	-
Physical Characteristics					
% Solids	0.1 % by Wt.	65.0	-	-	-
General Inorganics					
pH	0.05 pH Units	8.00	-	-	-
Resistivity	0.10 Ohm.m	45.4	-	-	-
Anions					
Chloride	5 ug/g dry	16	-	-	-
Sulphate	5 ug/g dry	110	-	-	-

APPENDIX 2

FIGURE 1 - KEY PLAN

FIGURES 2 to 31 - SLOPE STABILITY SECTIONS

SITE PHOTOS OF SLOPE CONDITIONS

DRAWING PG1796-3 - TEST HOLE LOCATION PLAN

DRAWING PG1796-4 - BEDROCK CONTOUR PLAN

DRAWING PG1796-5 - 3 m SUBSURFACE PROFILE AT TEST HOLE LOCATIONS

DRAWING PG1796-6 - PERMISSIBLE GRADE RAISE PLAN

LEGEND:

▬ ▬ STUDY AREA

▬ ▬ ▬ URBAN GROWTH BOUNDARY

Client:

TAMARACK HOMES

Consultant:

patersongroup
consulting engineers

Project:

CARDINAL CREEK VILLAGE

OTTAWA, ONTARIO

Drawing:

KEY PLAN

Scale: N.T.S.
Date: NOV. 07, 2012
Drawn by: BA
Checked by: DG
File: PG1796
Seal:

Drawing No.:

PG1796-FIG.1

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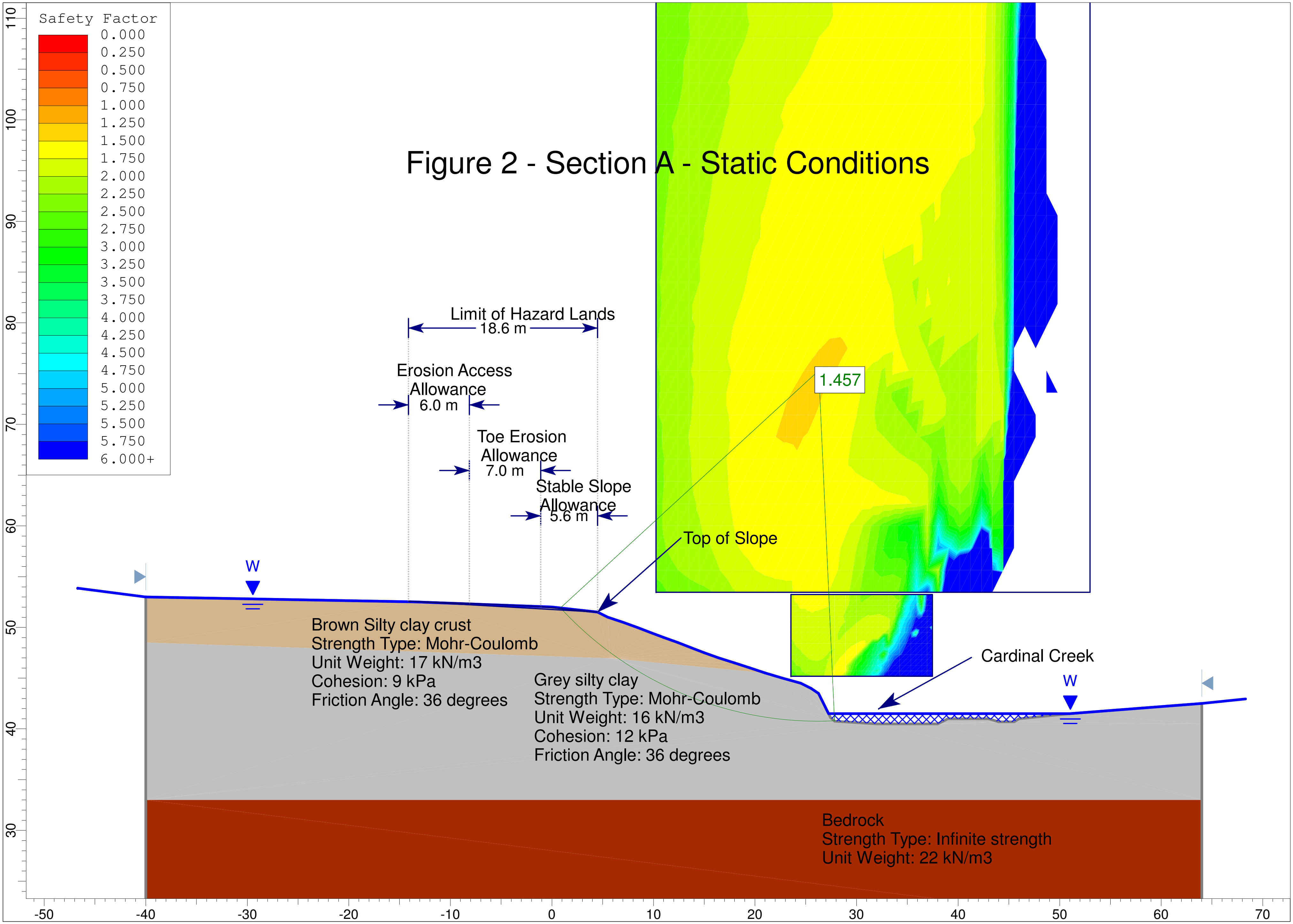


Figure 2 - Section A - Static Conditions

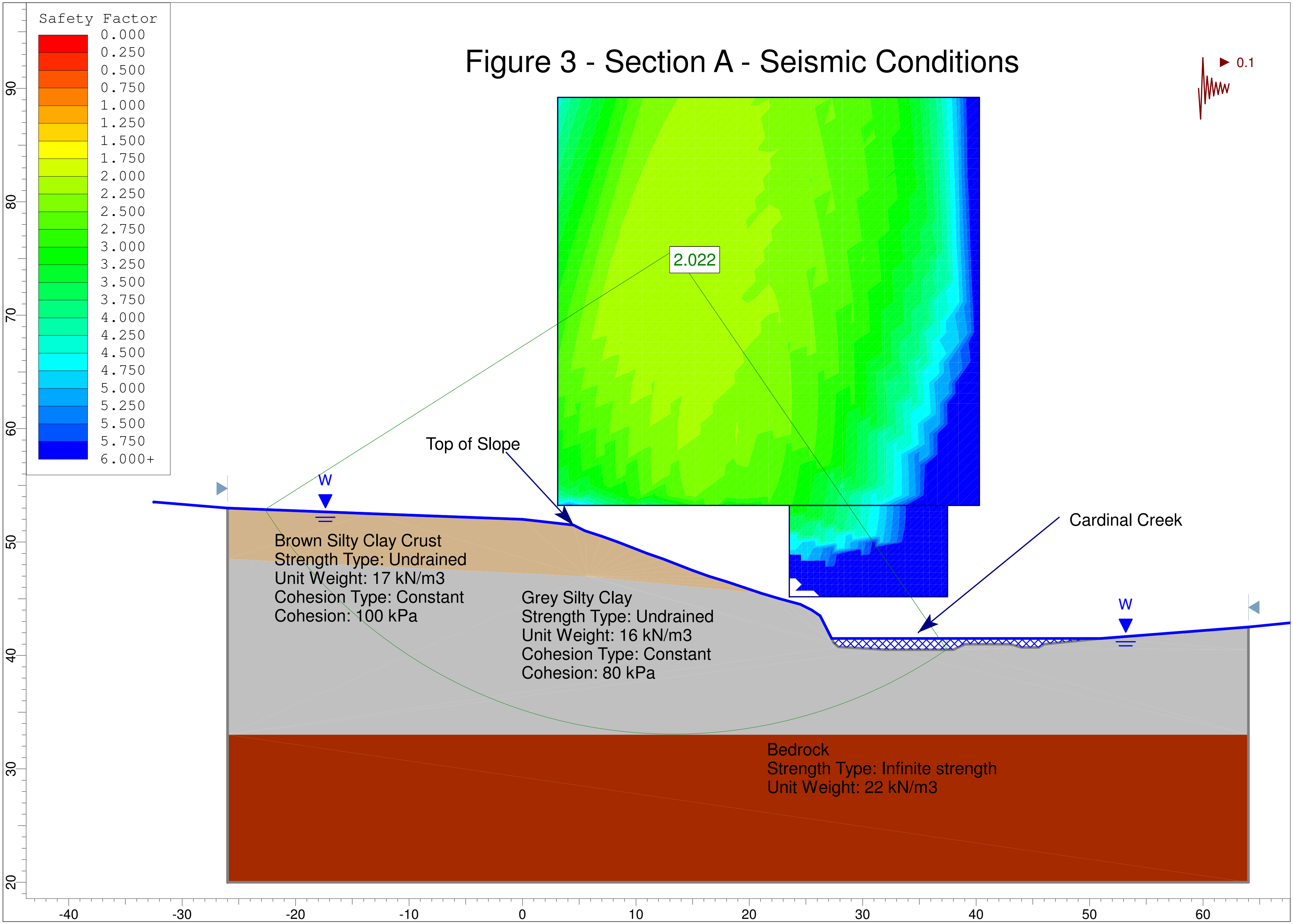
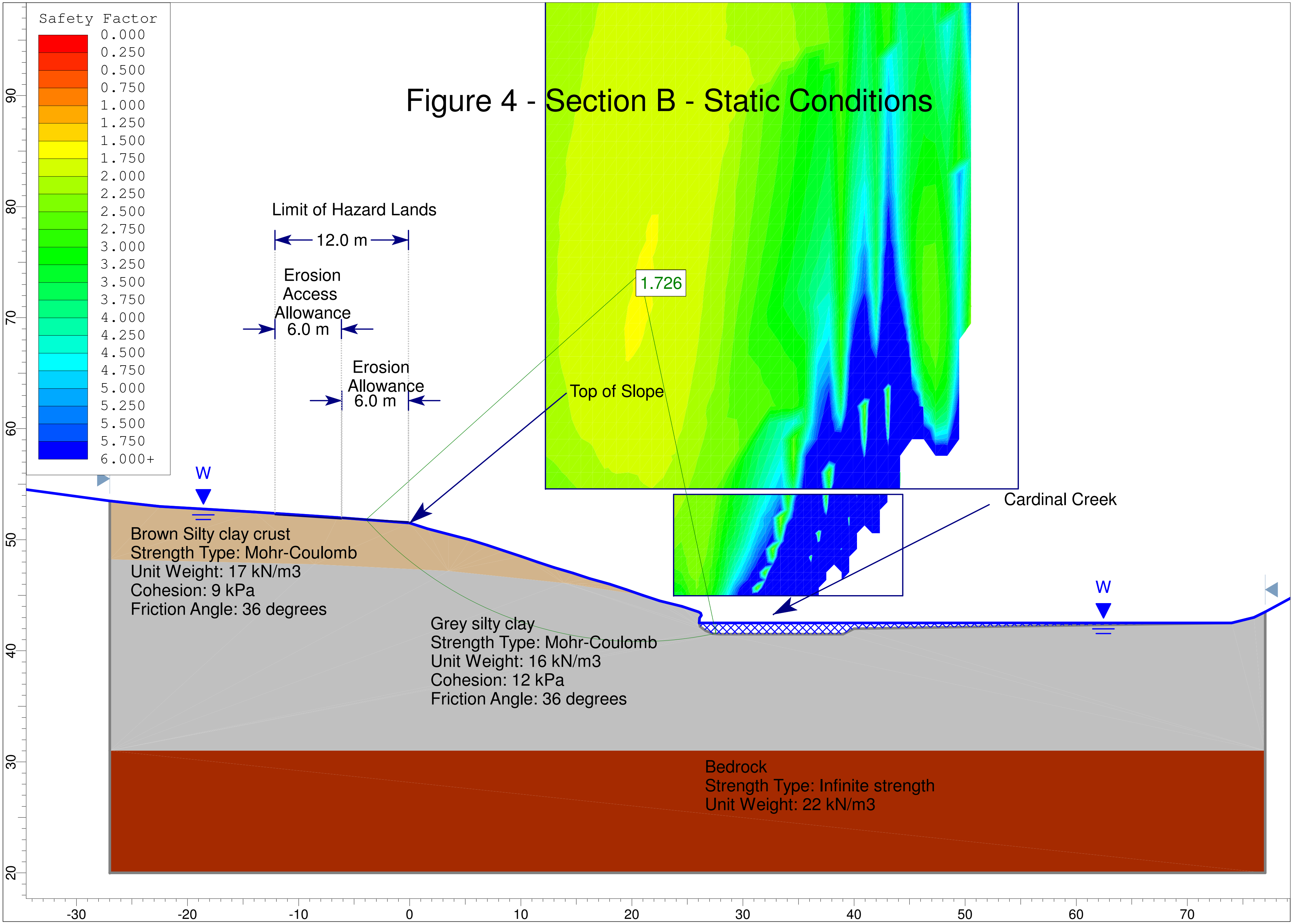


Figure 3 - Section A - Seismic Conditions

Figure 4 - Section B - Static Conditions



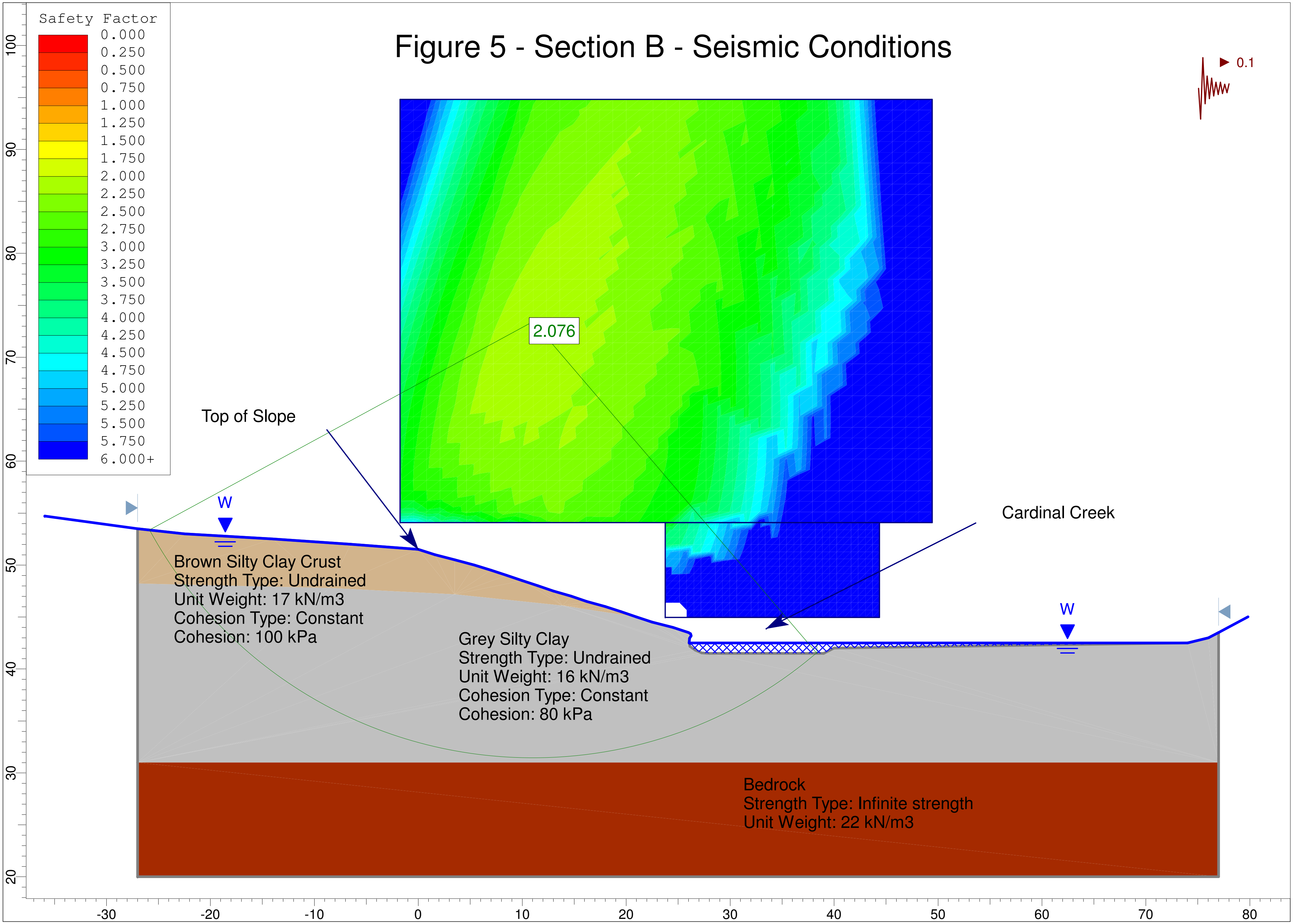


Figure 5 - Section B - Seismic Conditions

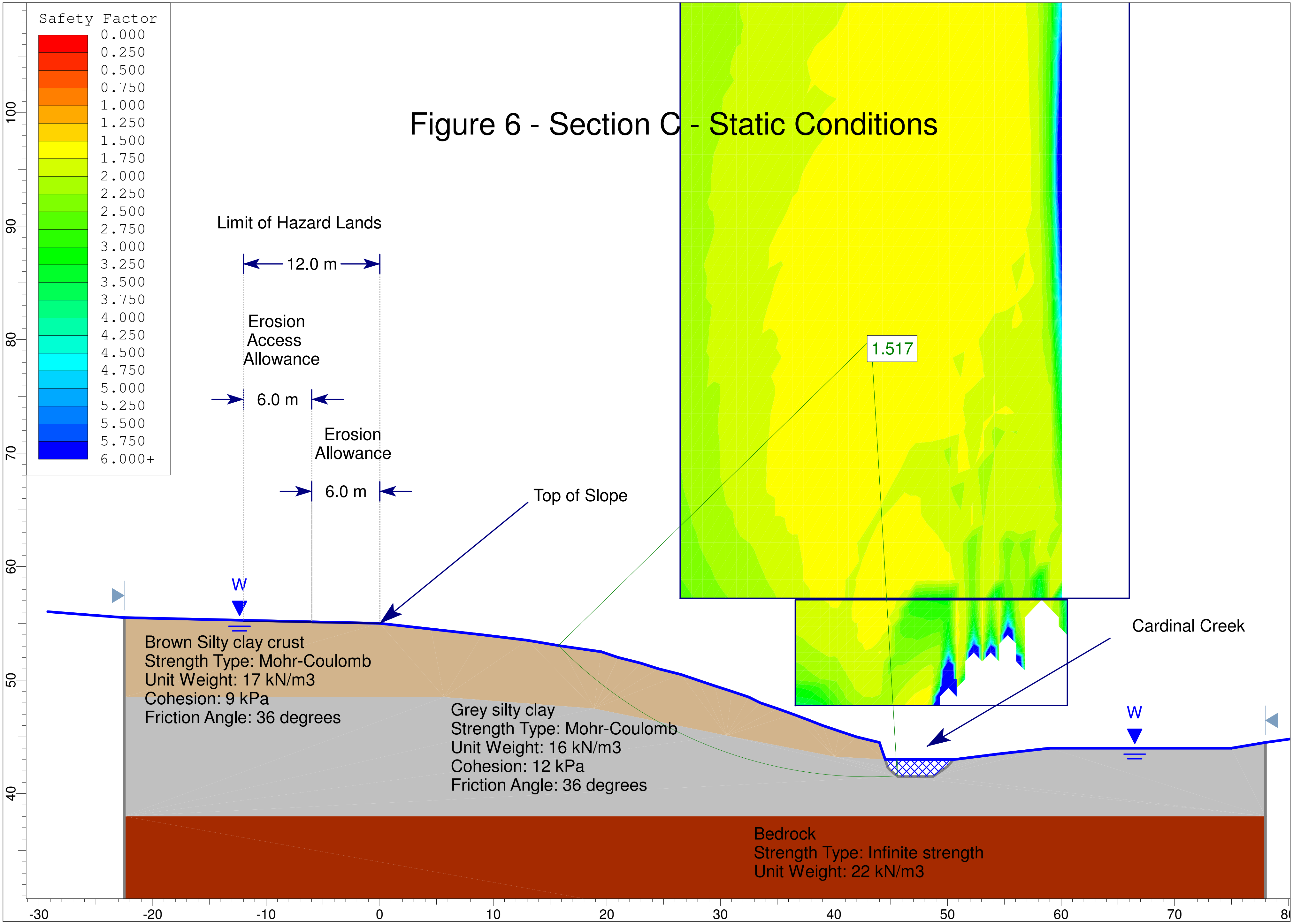
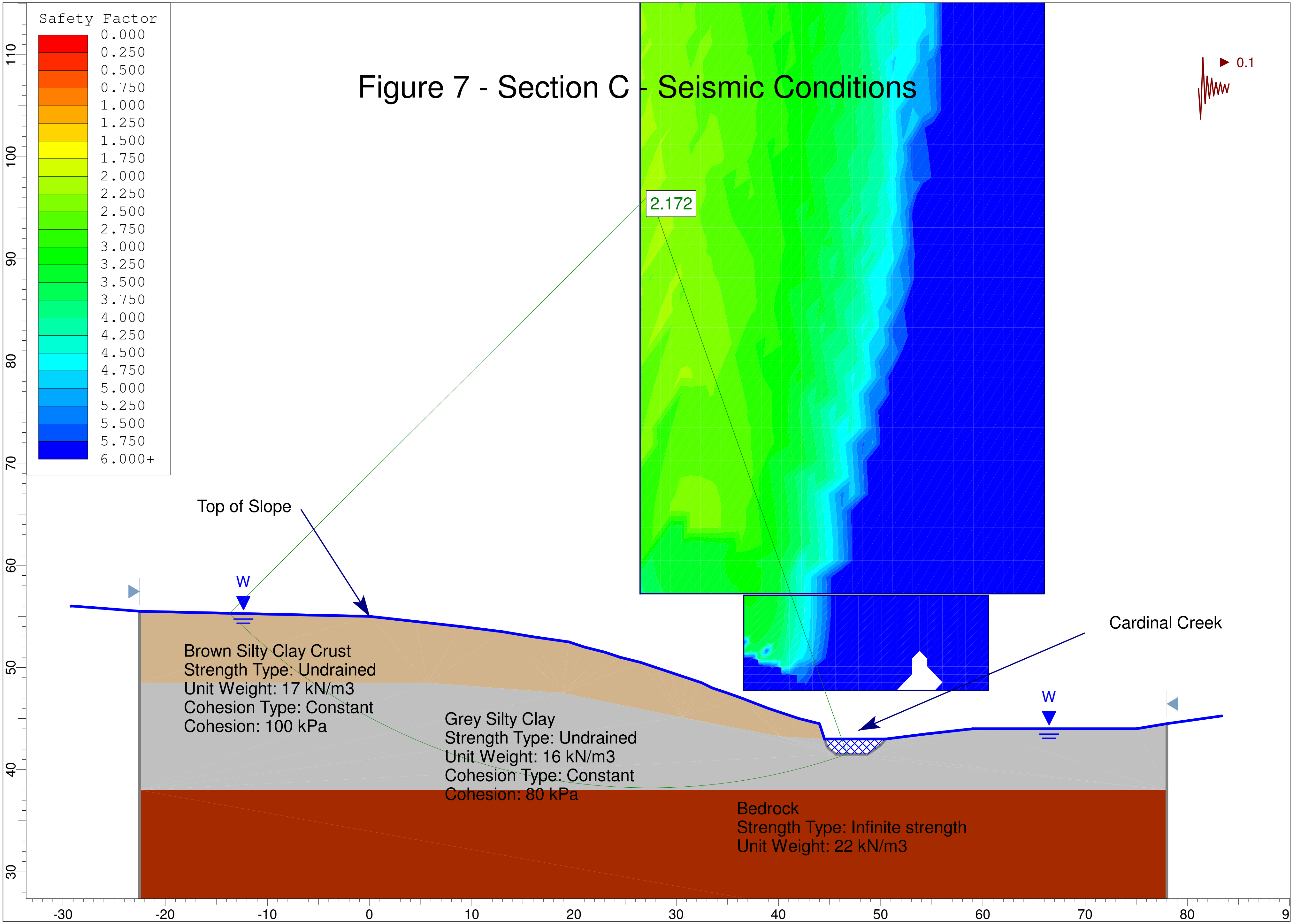


Figure 6 - Section C - Static Conditions

Figure 7 - Section C - Seismic Conditions



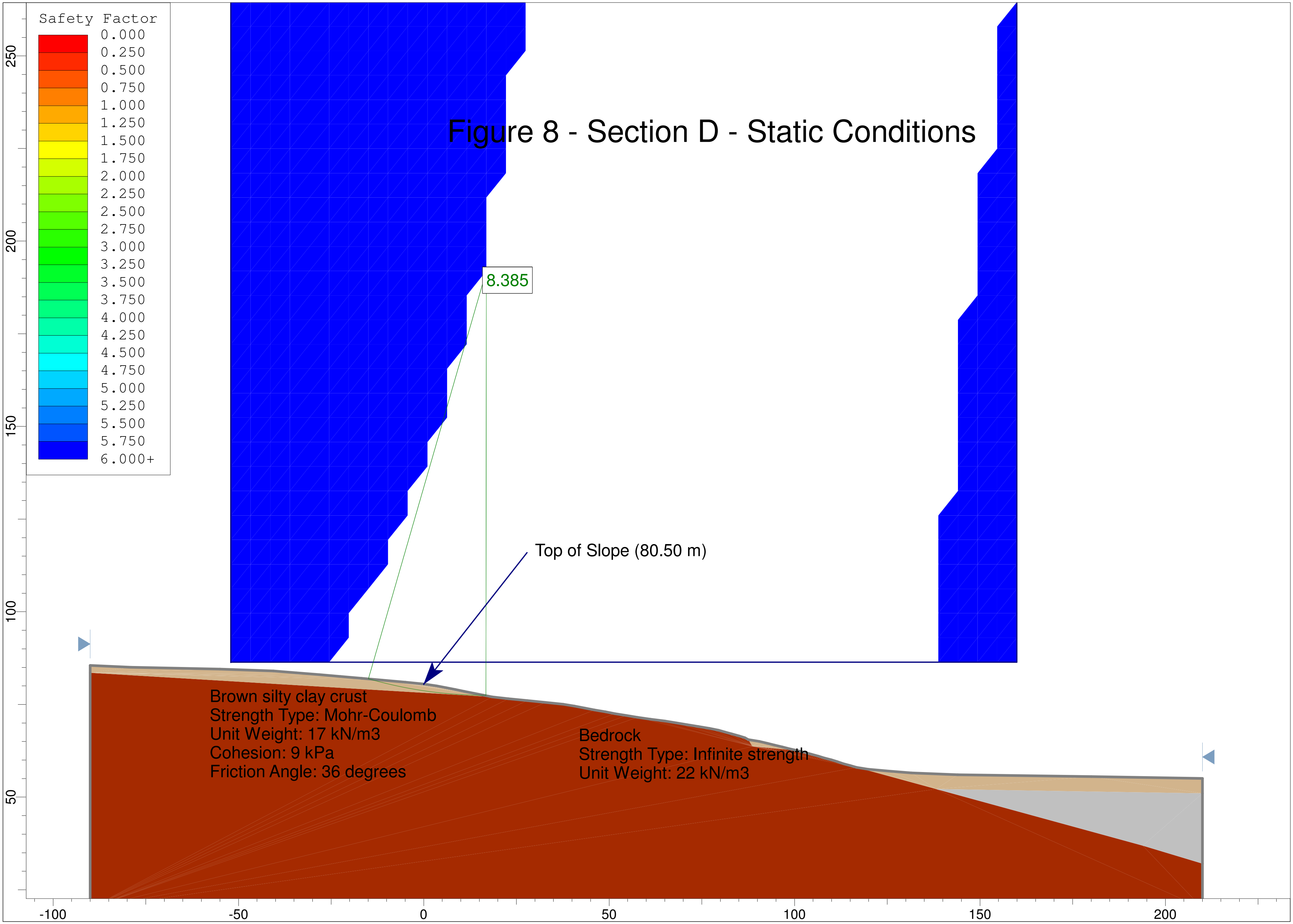


Figure 8 - Section D - Static Conditions

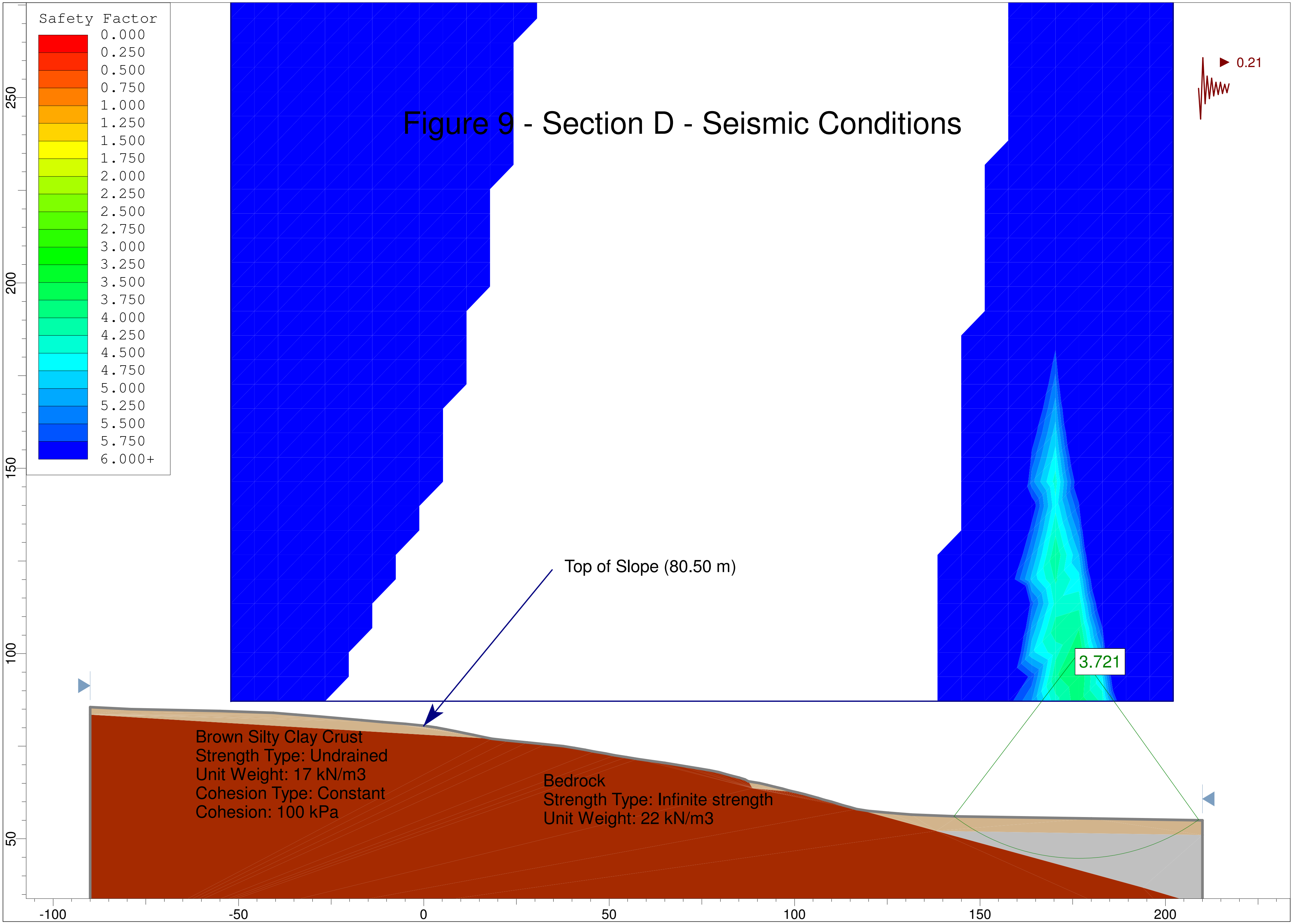


Figure 9 - Section D - Seismic Conditions

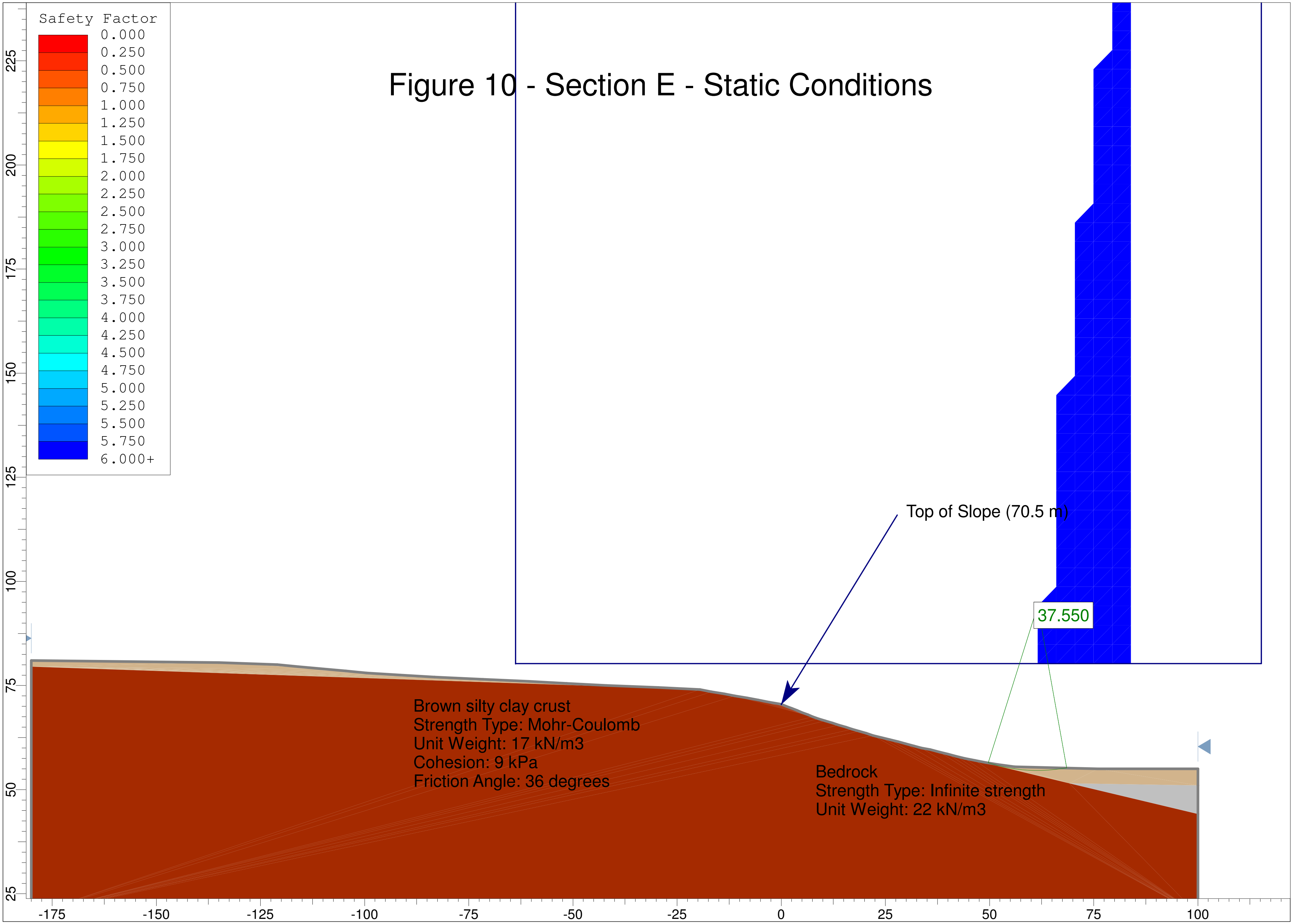
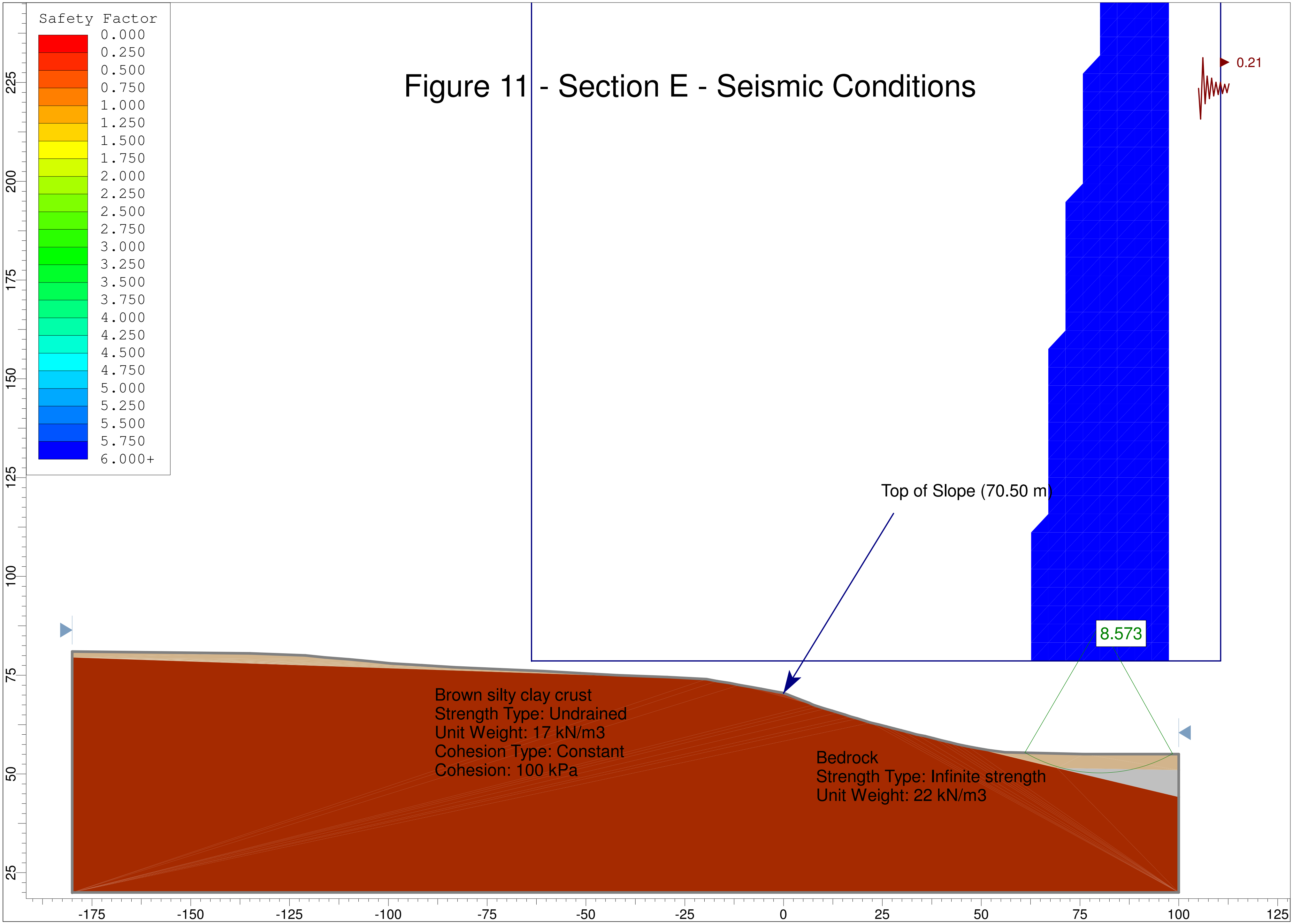


Figure 10 - Section E - Static Conditions

Figure 11 - Section E - Seismic Conditions



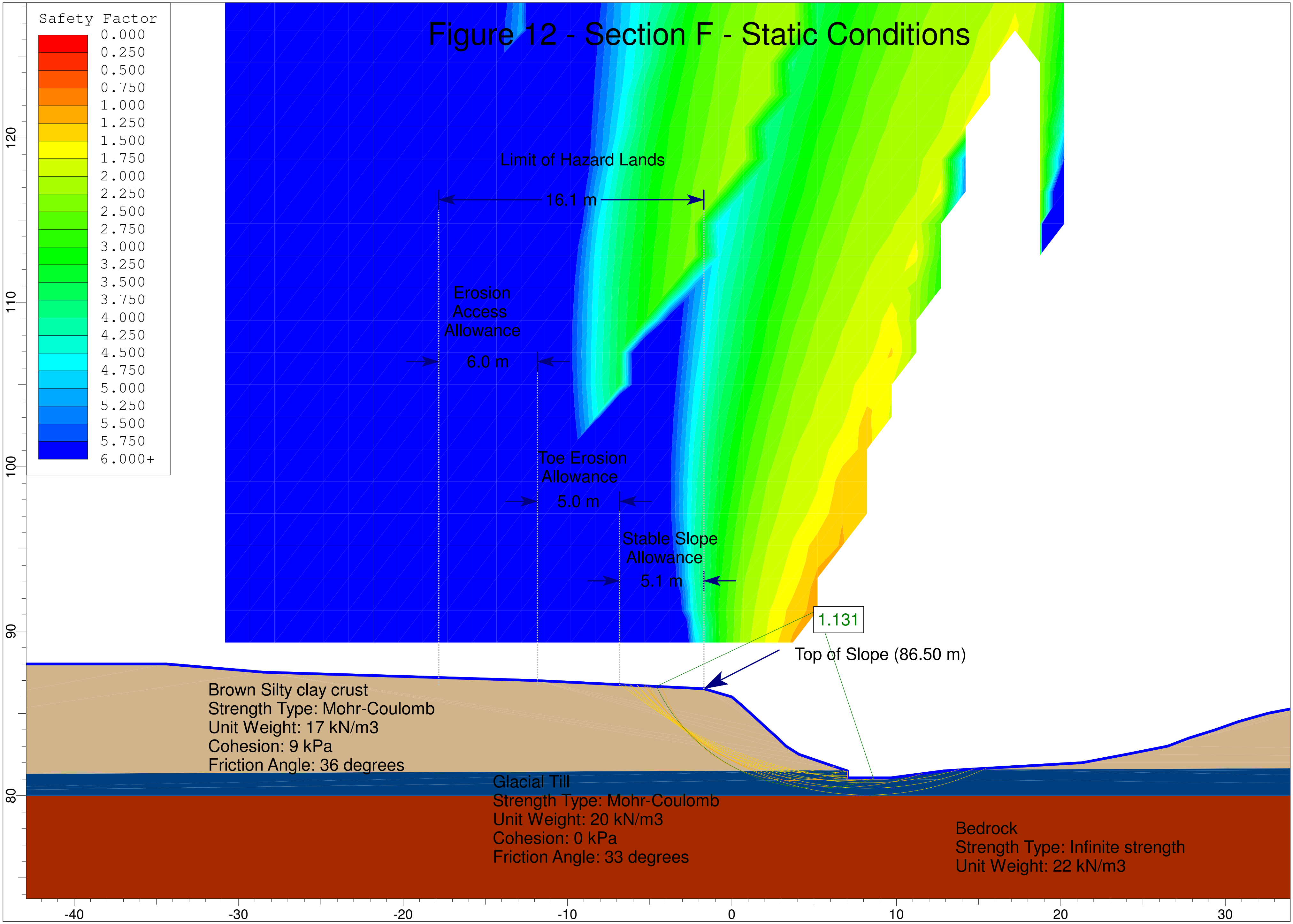


Figure 12 - Section F - Static Conditions

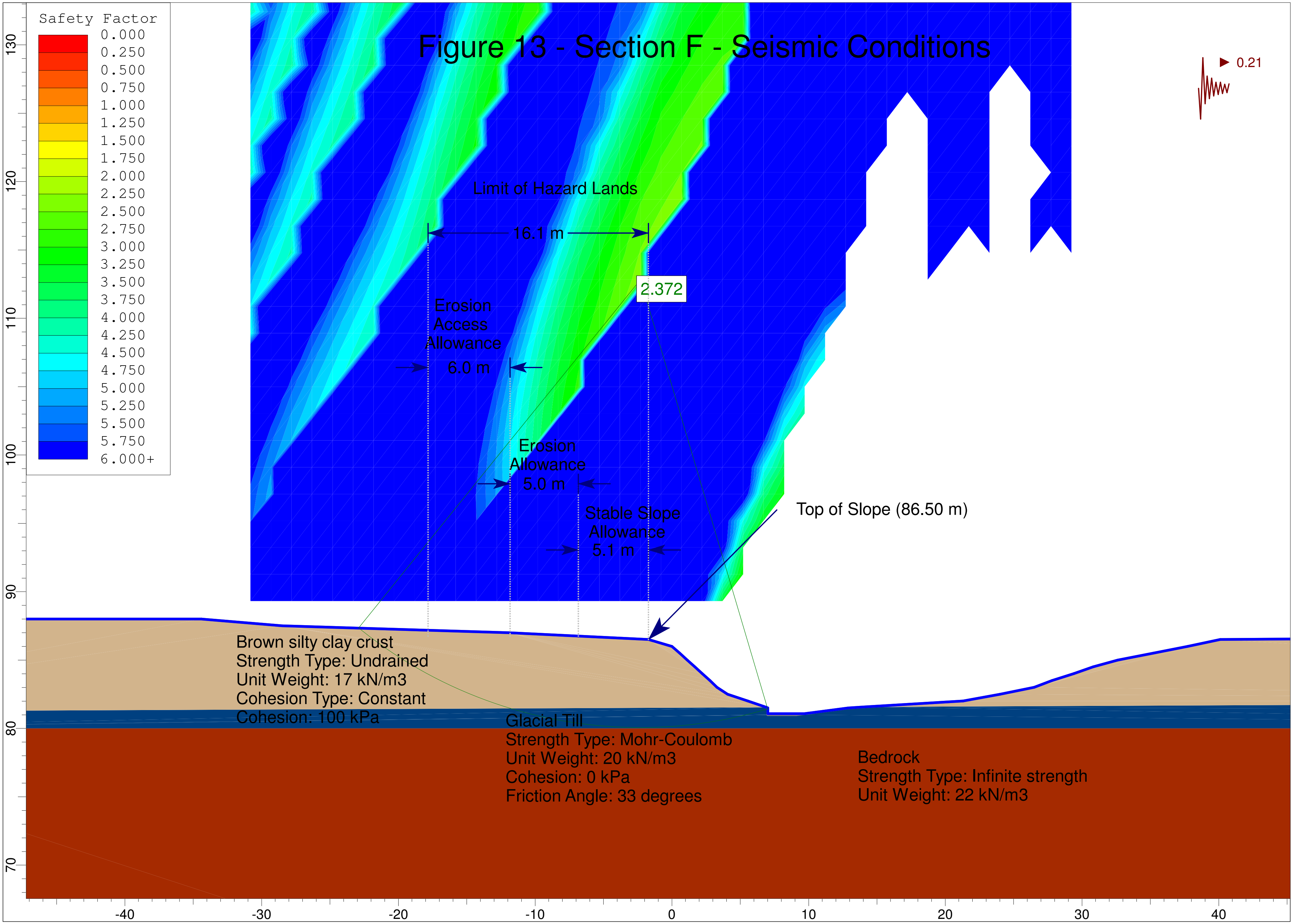


Figure 13 - Section F - Seismic Conditions

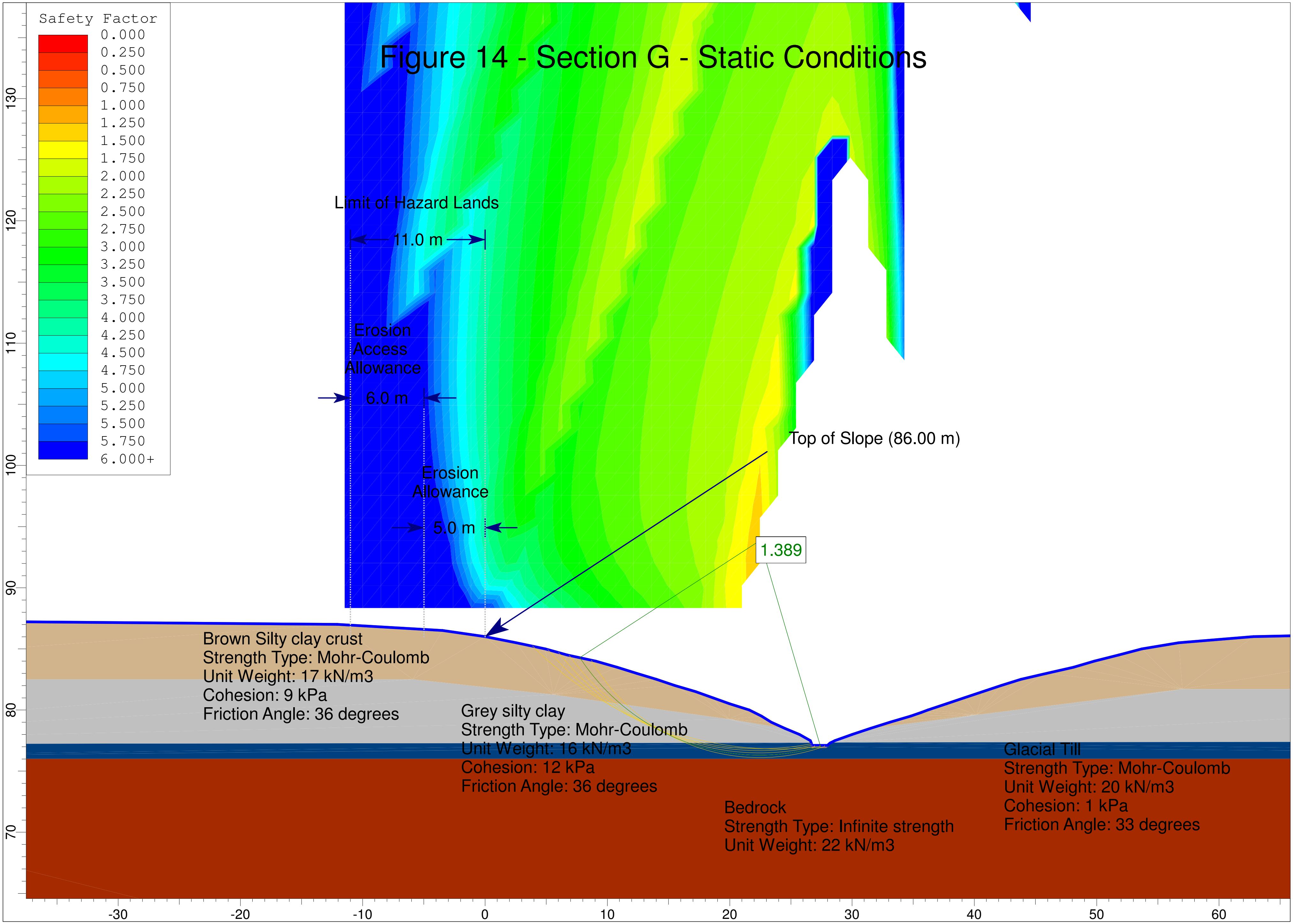


Figure 14 - Section G - Static Conditions

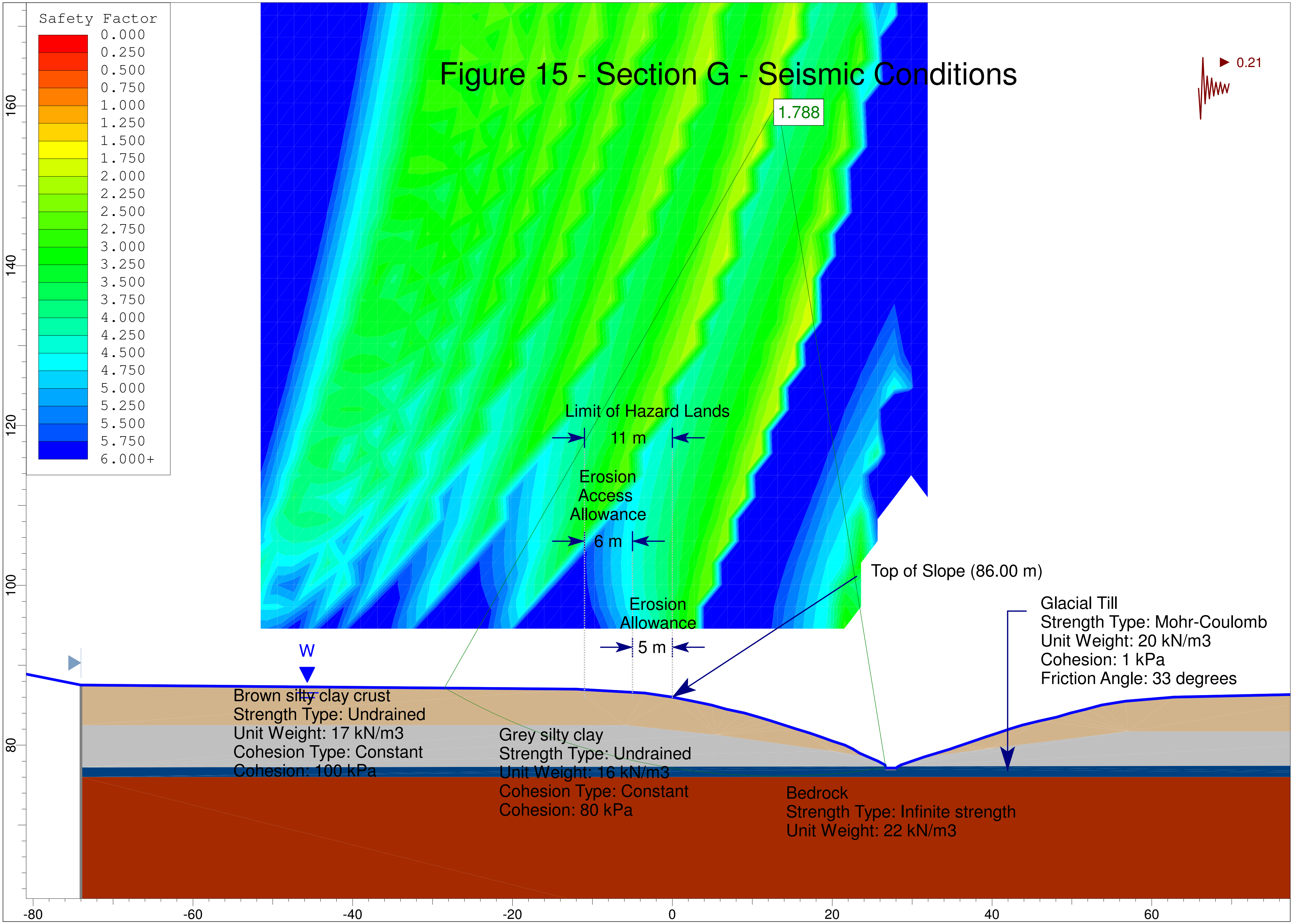


Figure 15 - Section G - Seismic Conditions

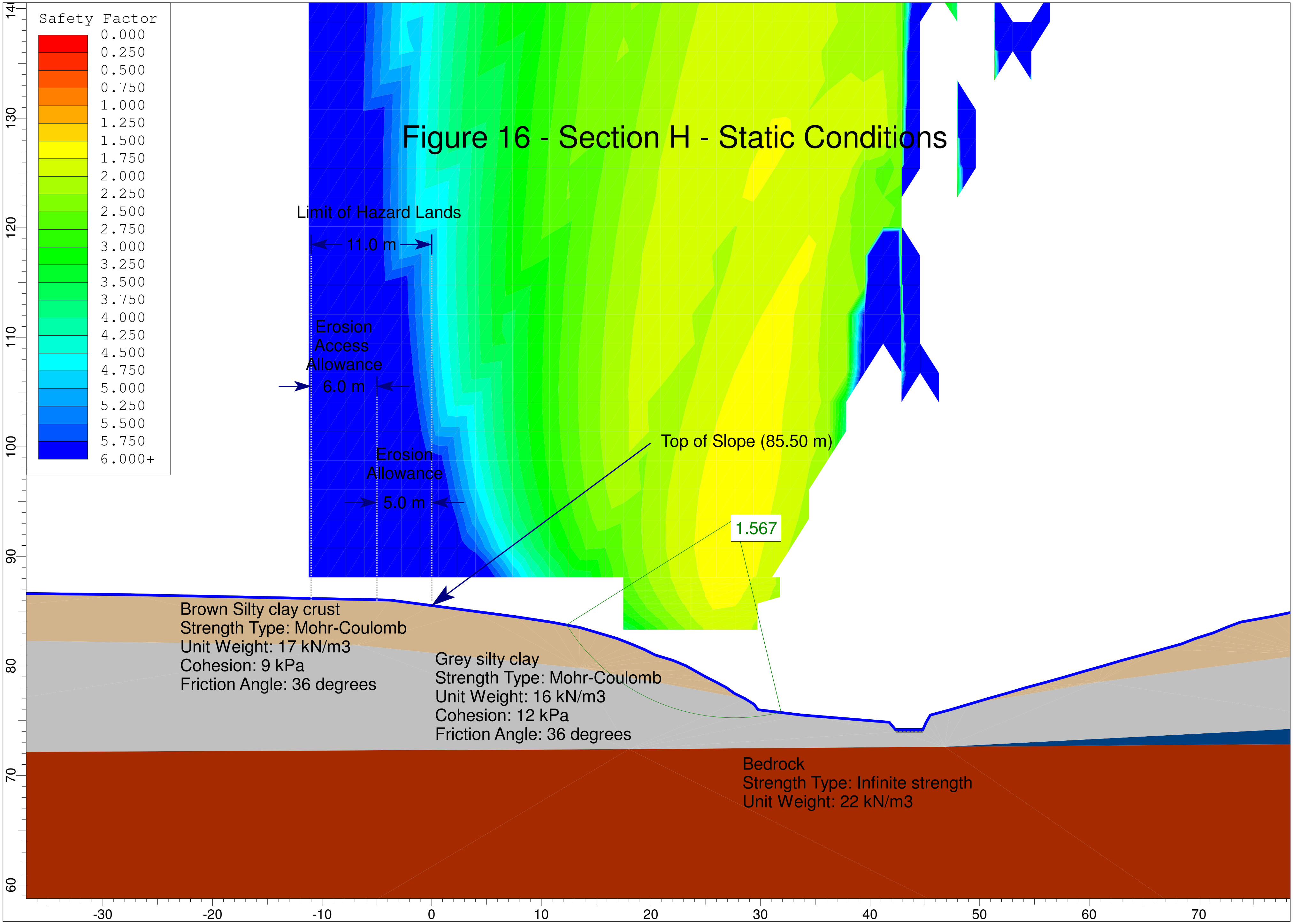


Figure 16 - Section H - Static Conditions

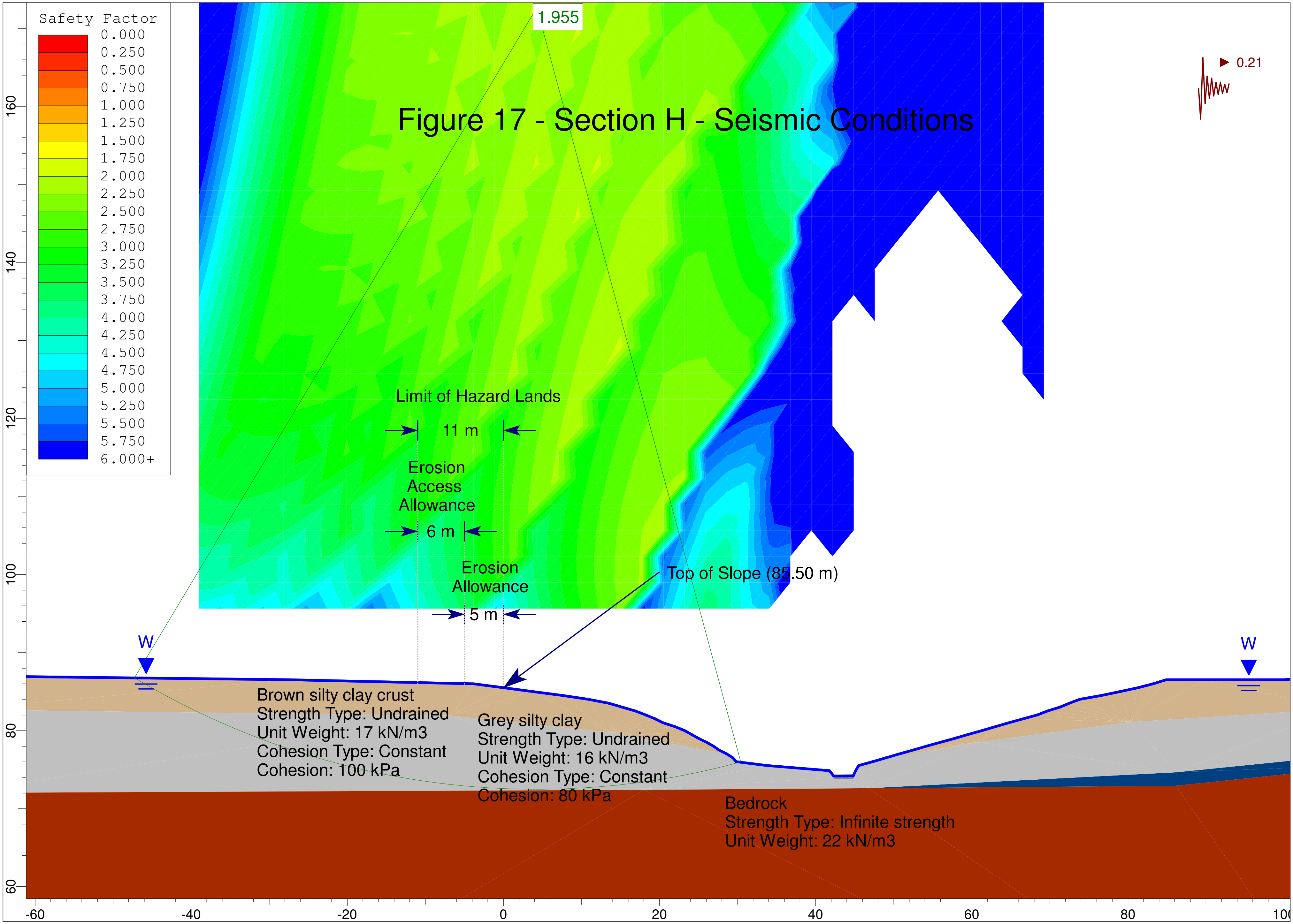


Figure 17 - Section H - Seismic Conditions

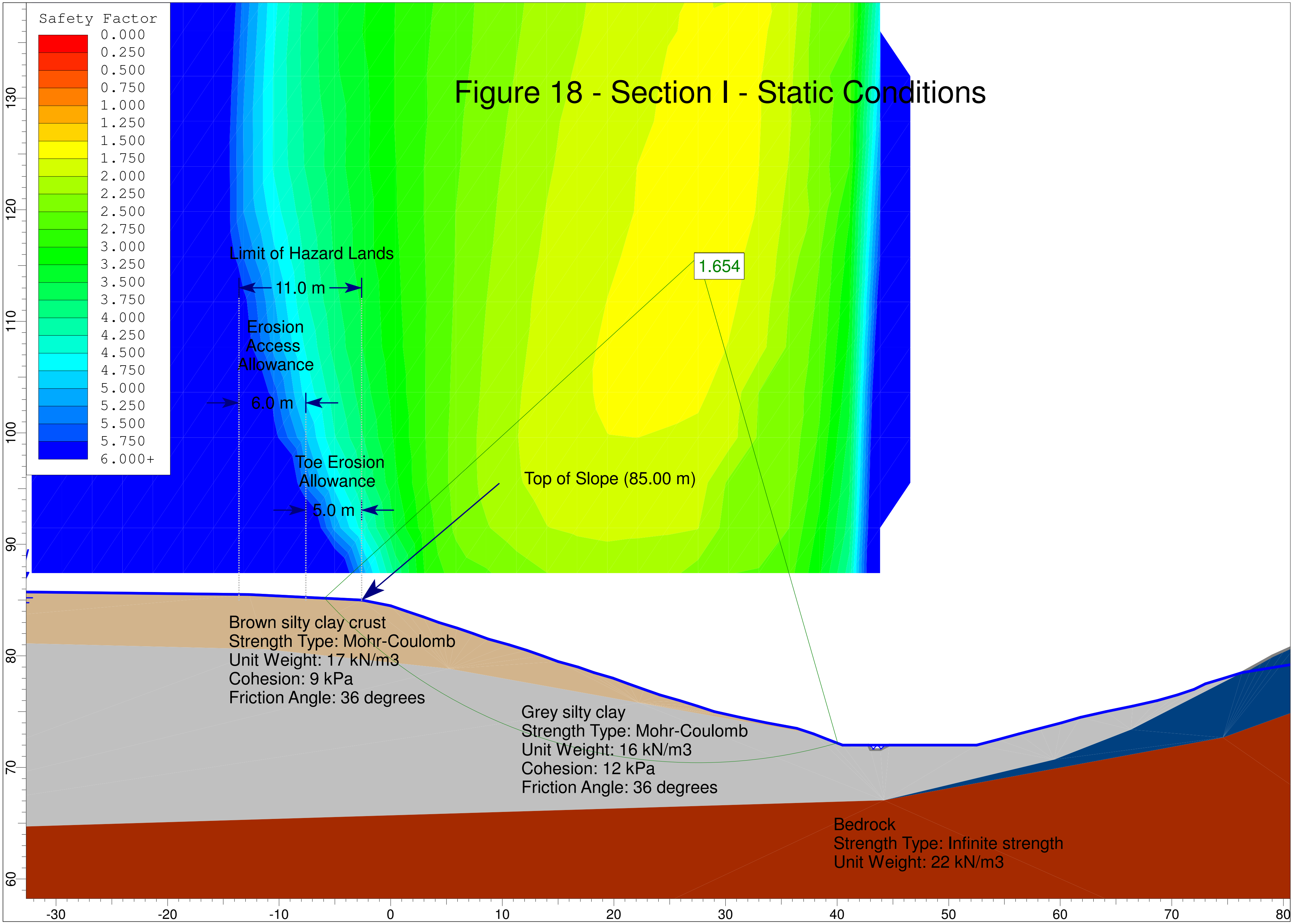


Figure 18 - Section I - Static Conditions

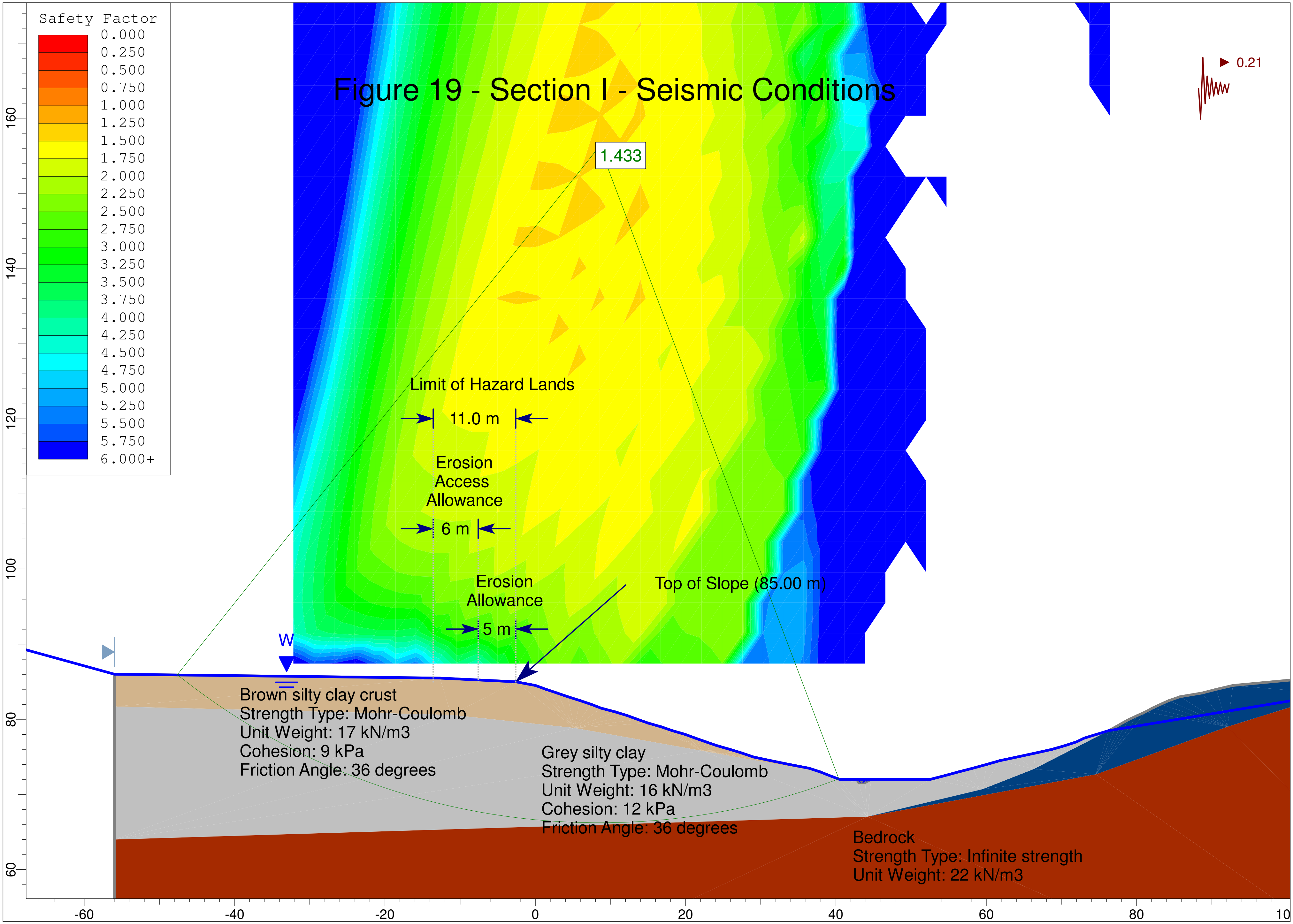


Figure 19 - Section I - Seismic Conditions

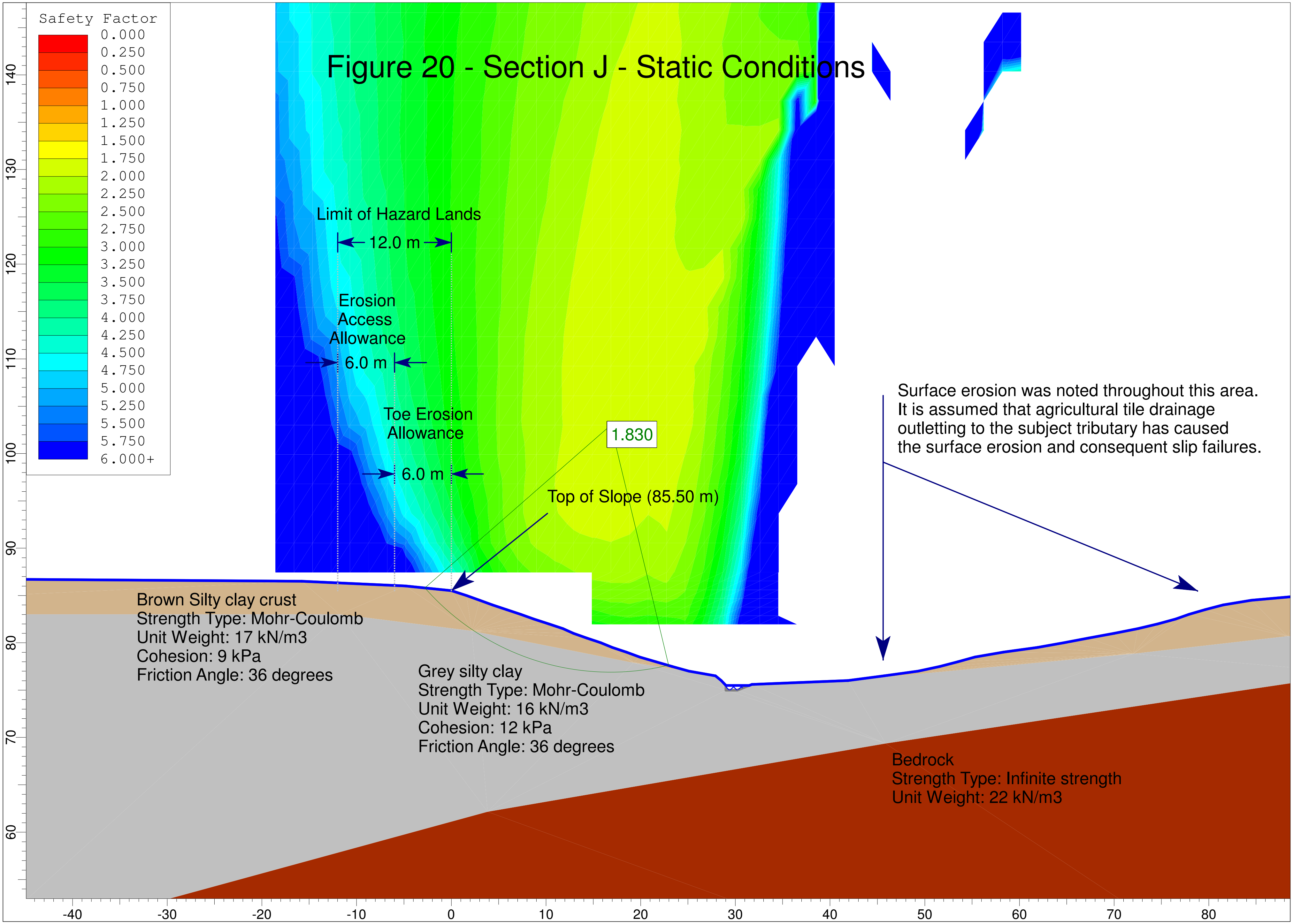


Figure 20 - Section J - Static Conditions

Surface erosion was noted throughout this area. It is assumed that agricultural tile drainage outletting to the subject tributary has caused the surface erosion and consequent slip failures.

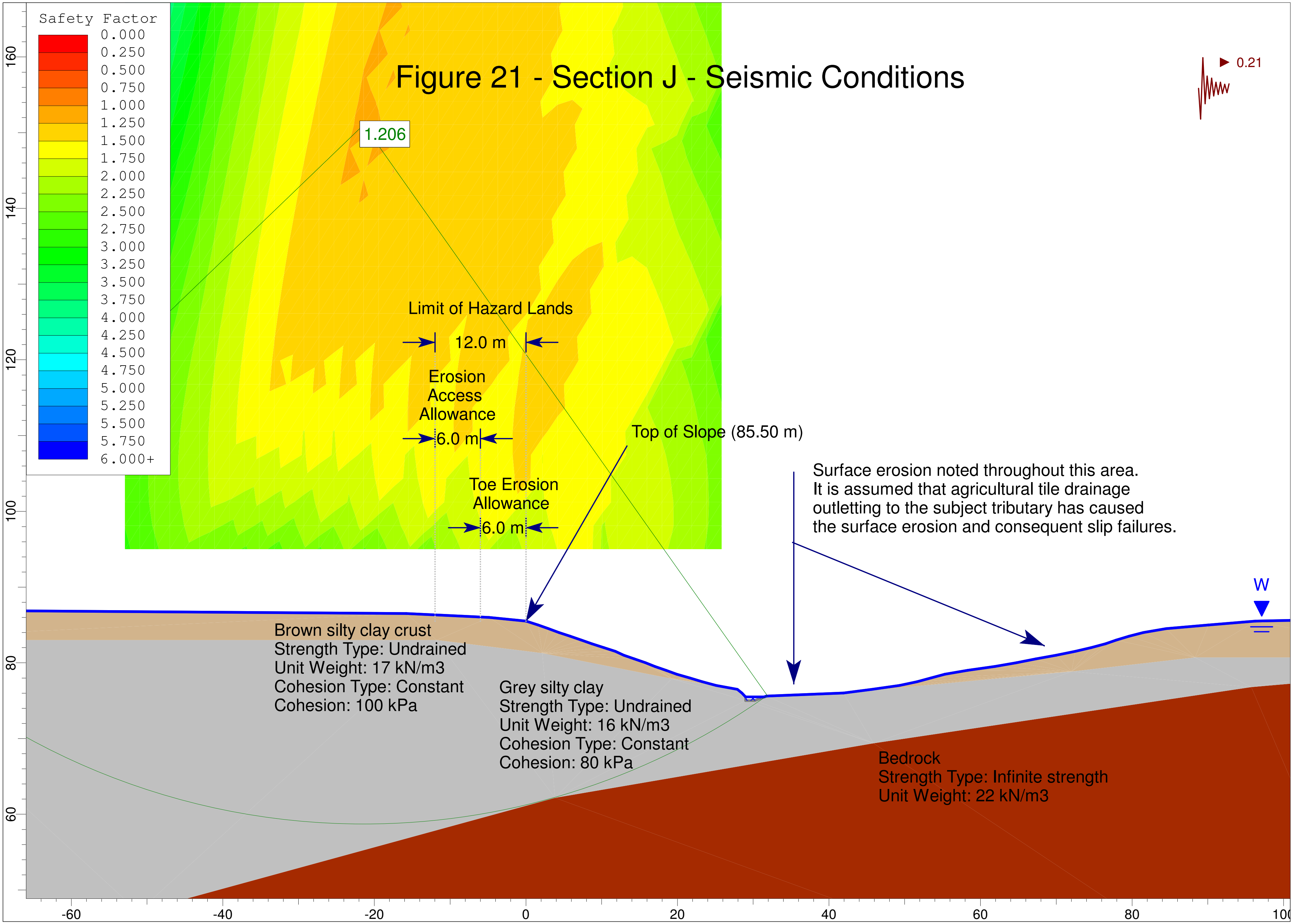


Figure 21 - Section J - Seismic Conditions

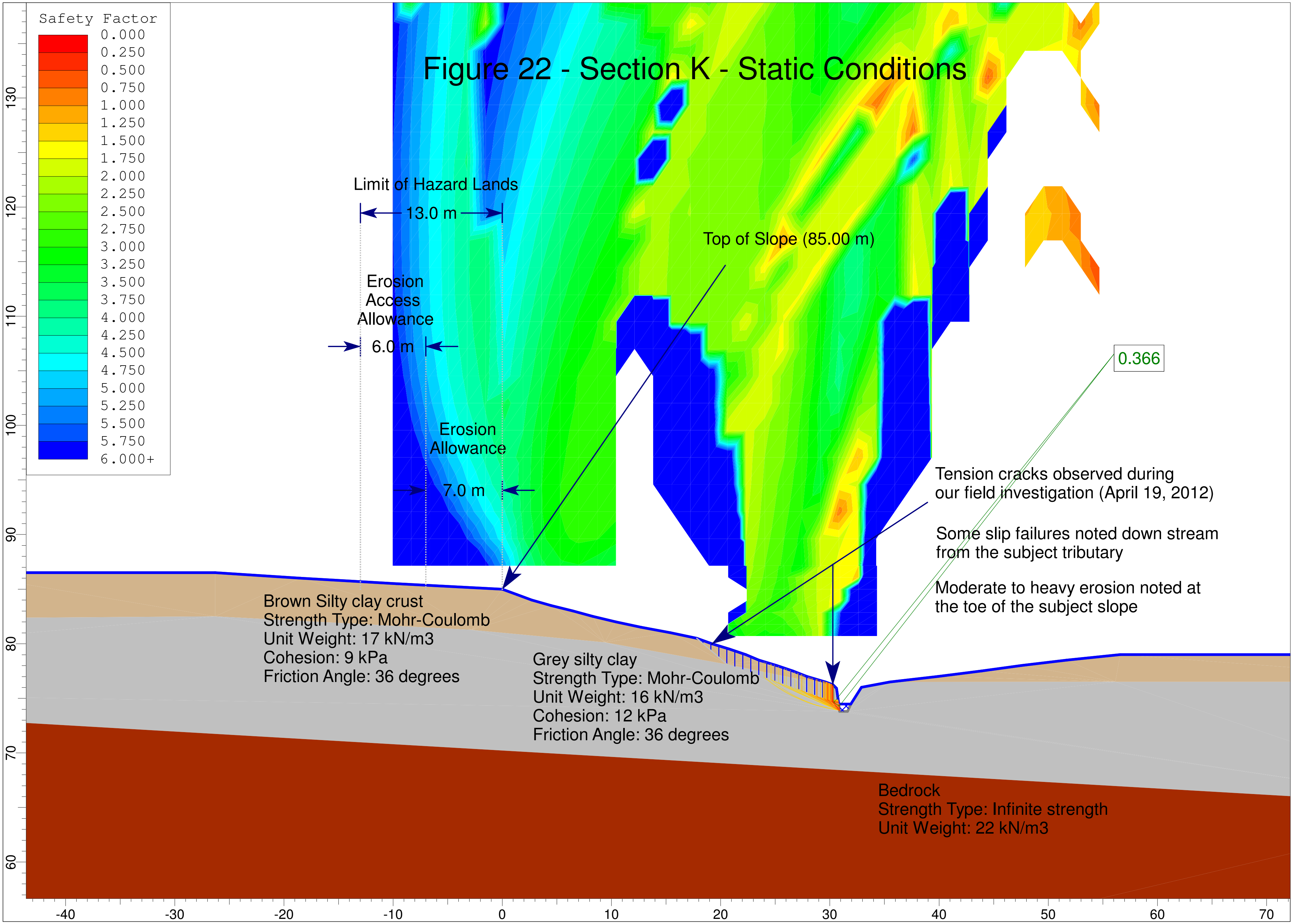


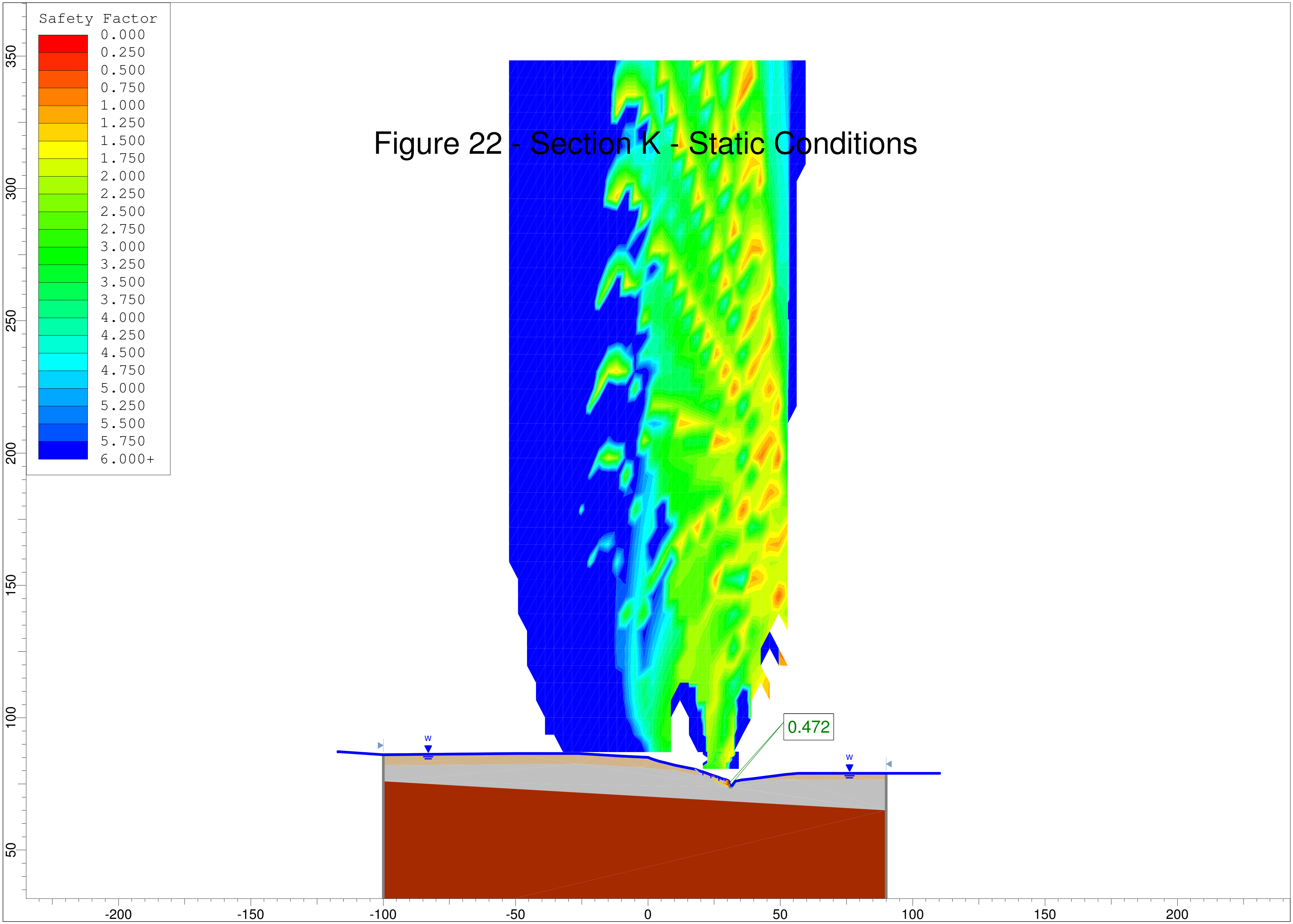
Figure 22 - Section K - Static Conditions

Tension cracks observed during our field investigation (April 19, 2012)

Some slip failures noted down stream from the subject tributary

Moderate to heavy erosion noted at the toe of the subject slope

Figure 22 - Section K - Static Conditions



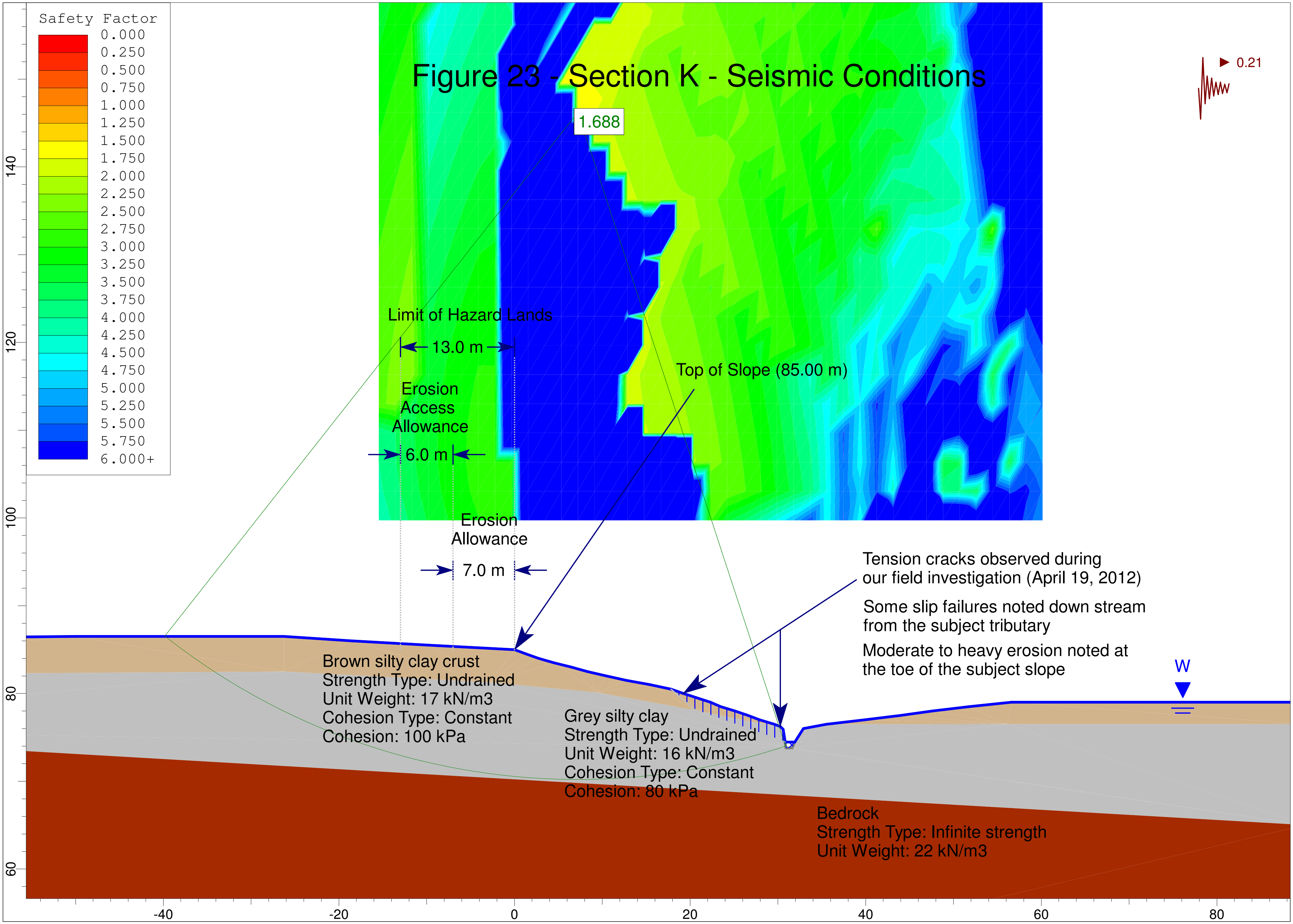


Figure 23 - Section K - Seismic Conditions

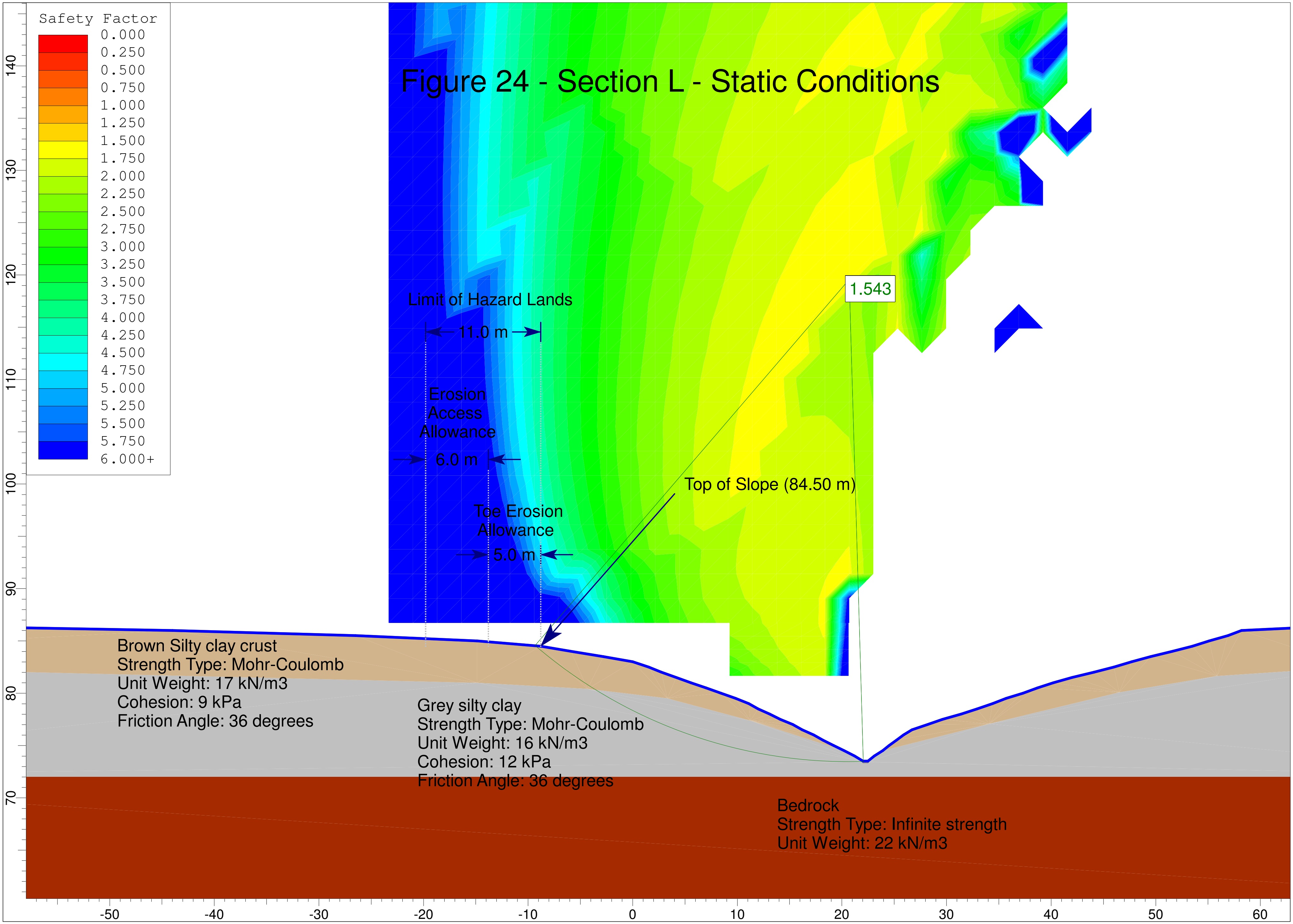


Figure 24 - Section L - Static Conditions

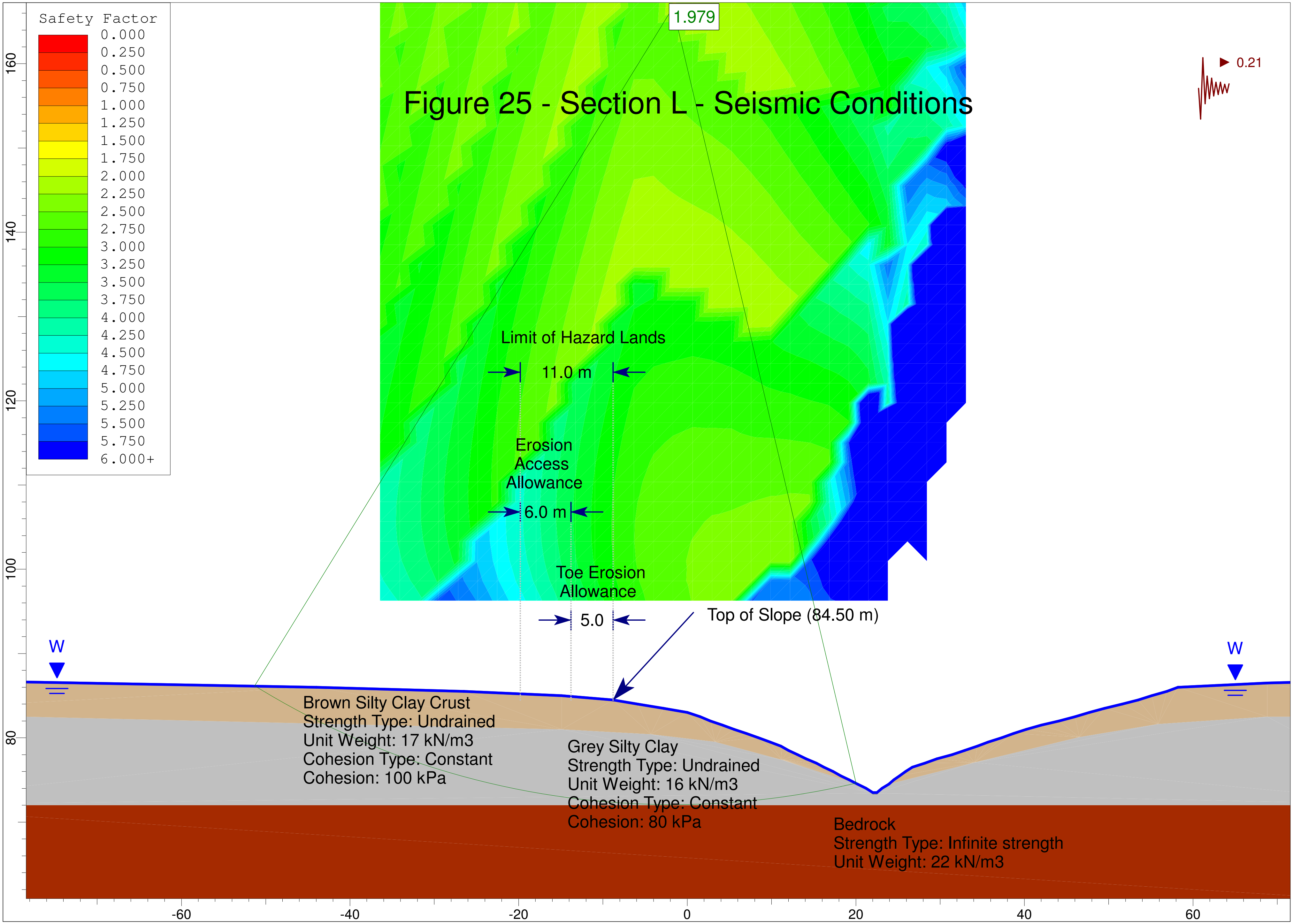


Figure 25 - Section L - Seismic Conditions

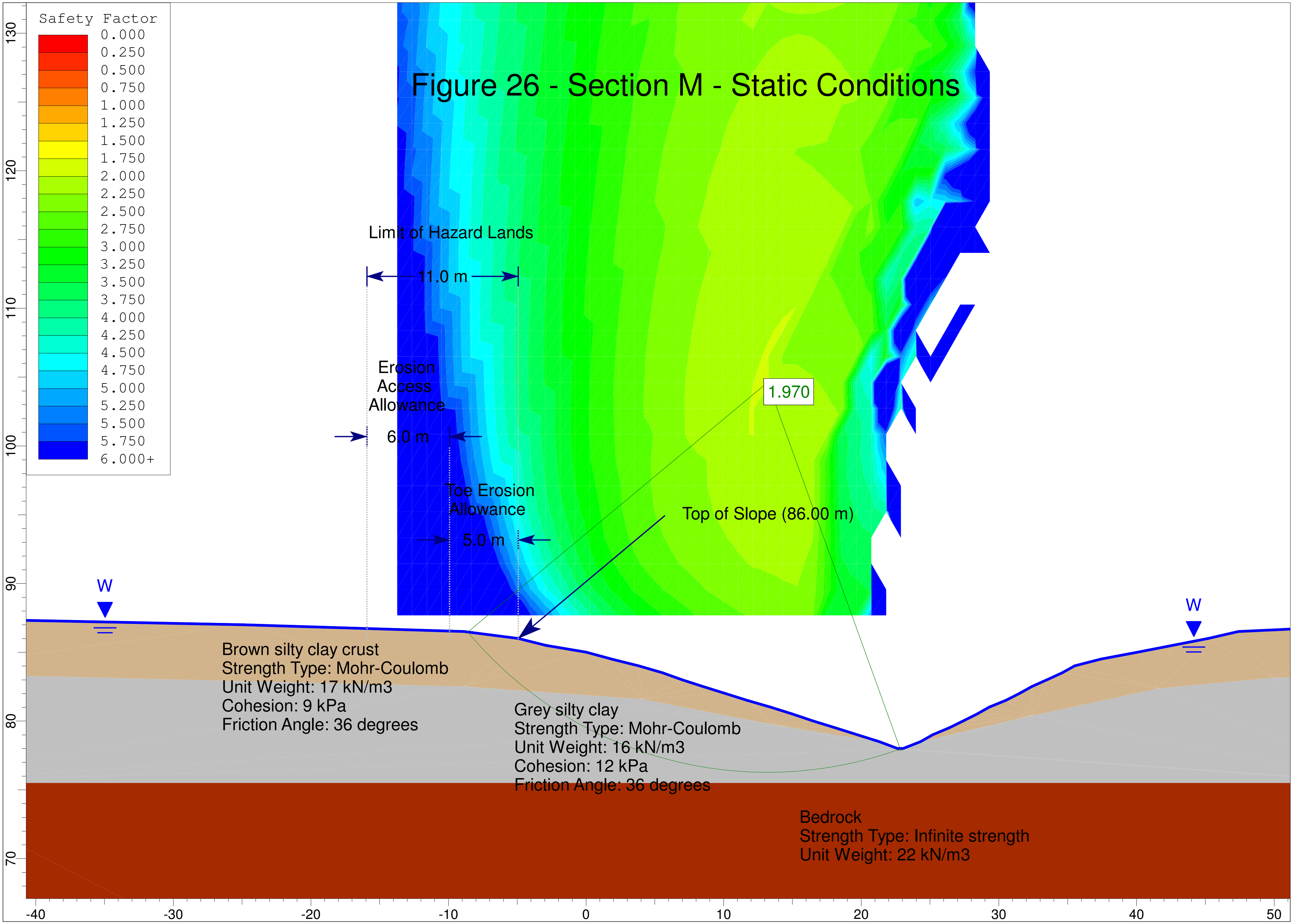


Figure 26 - Section M - Static Conditions

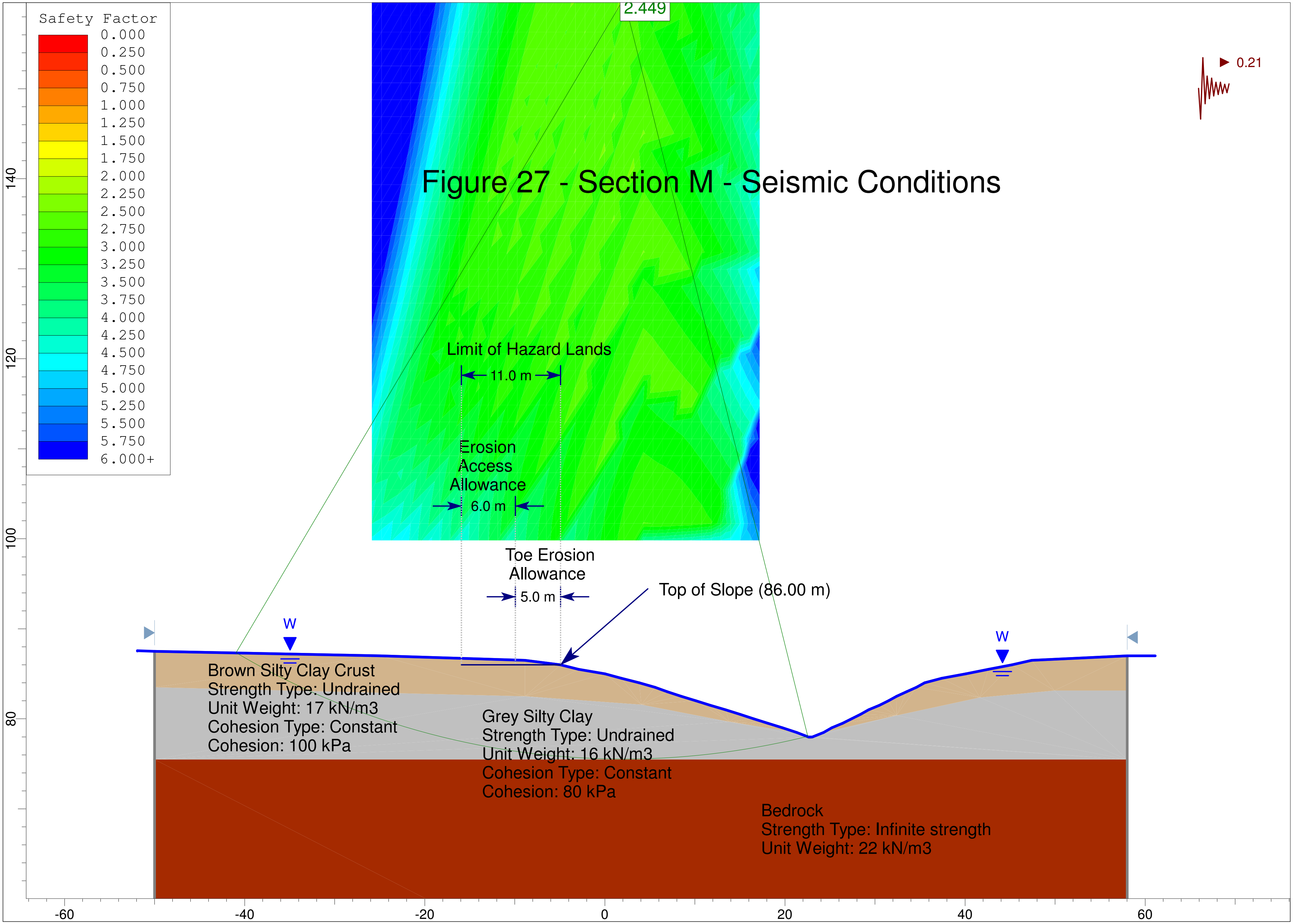


Figure 27 - Section M - Seismic Conditions

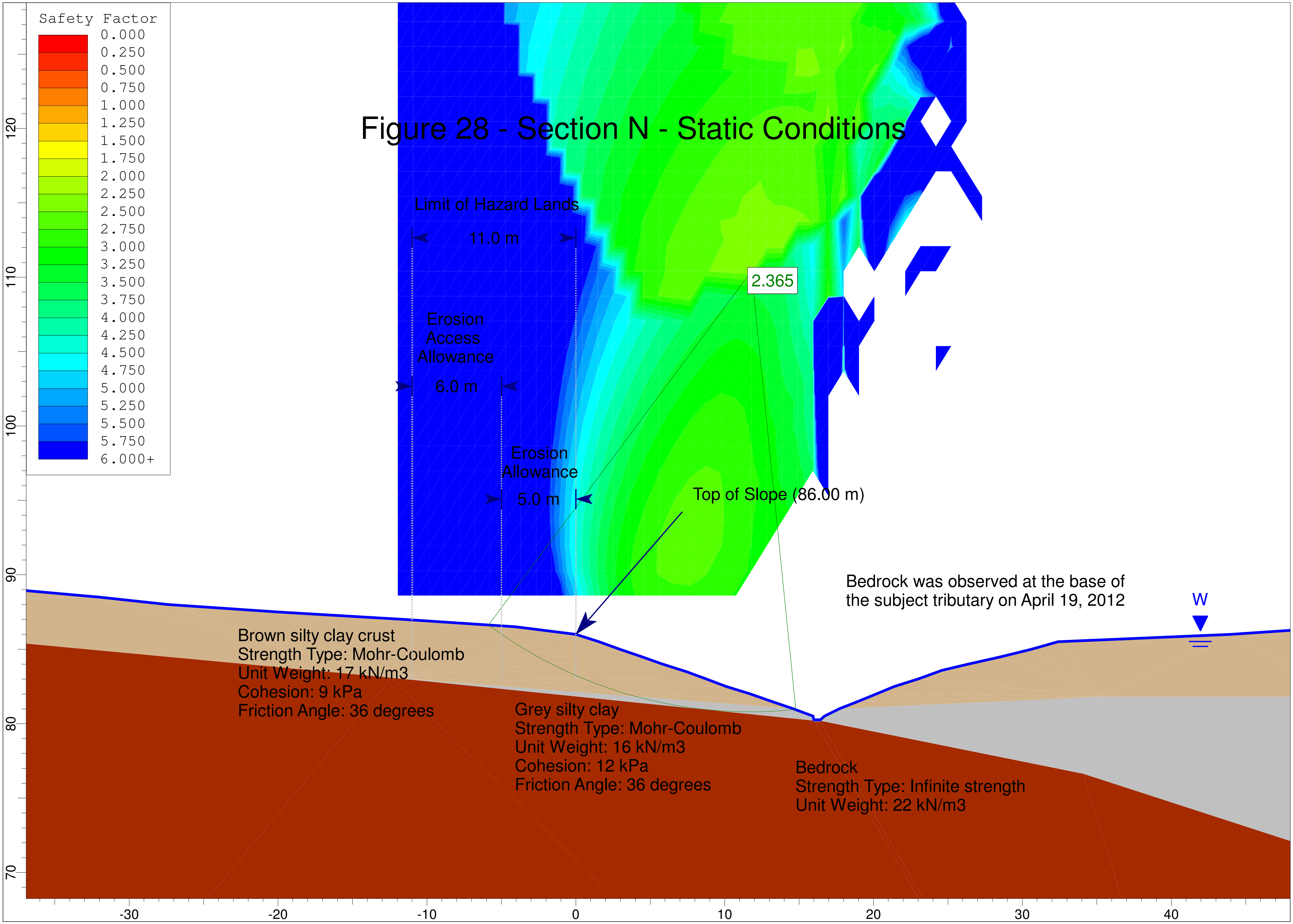


Figure 28 - Section N - Static Conditions

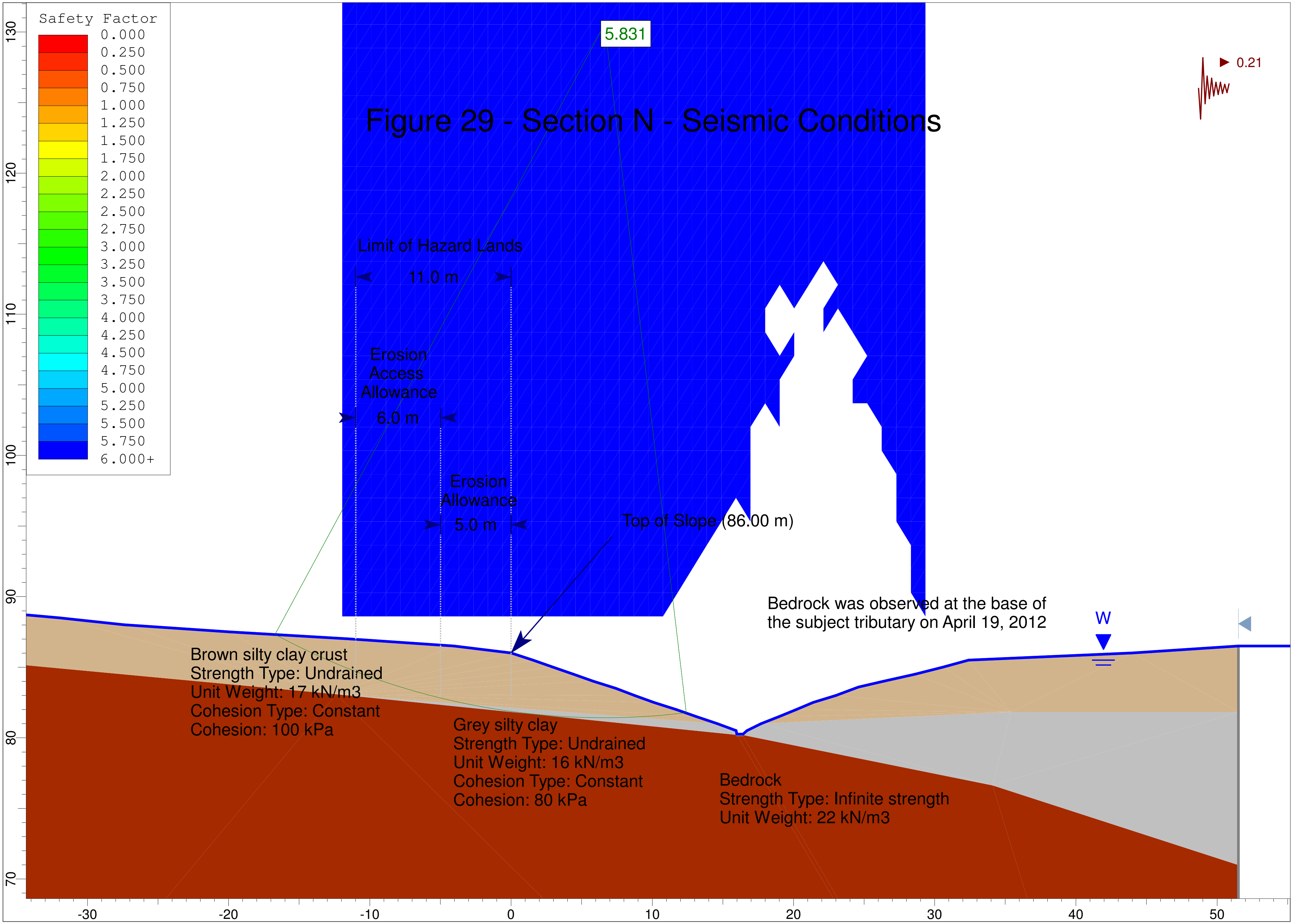


Figure 29 - Section N - Seismic Conditions

Bedrock was observed at the base of the subject tributary on April 19, 2012

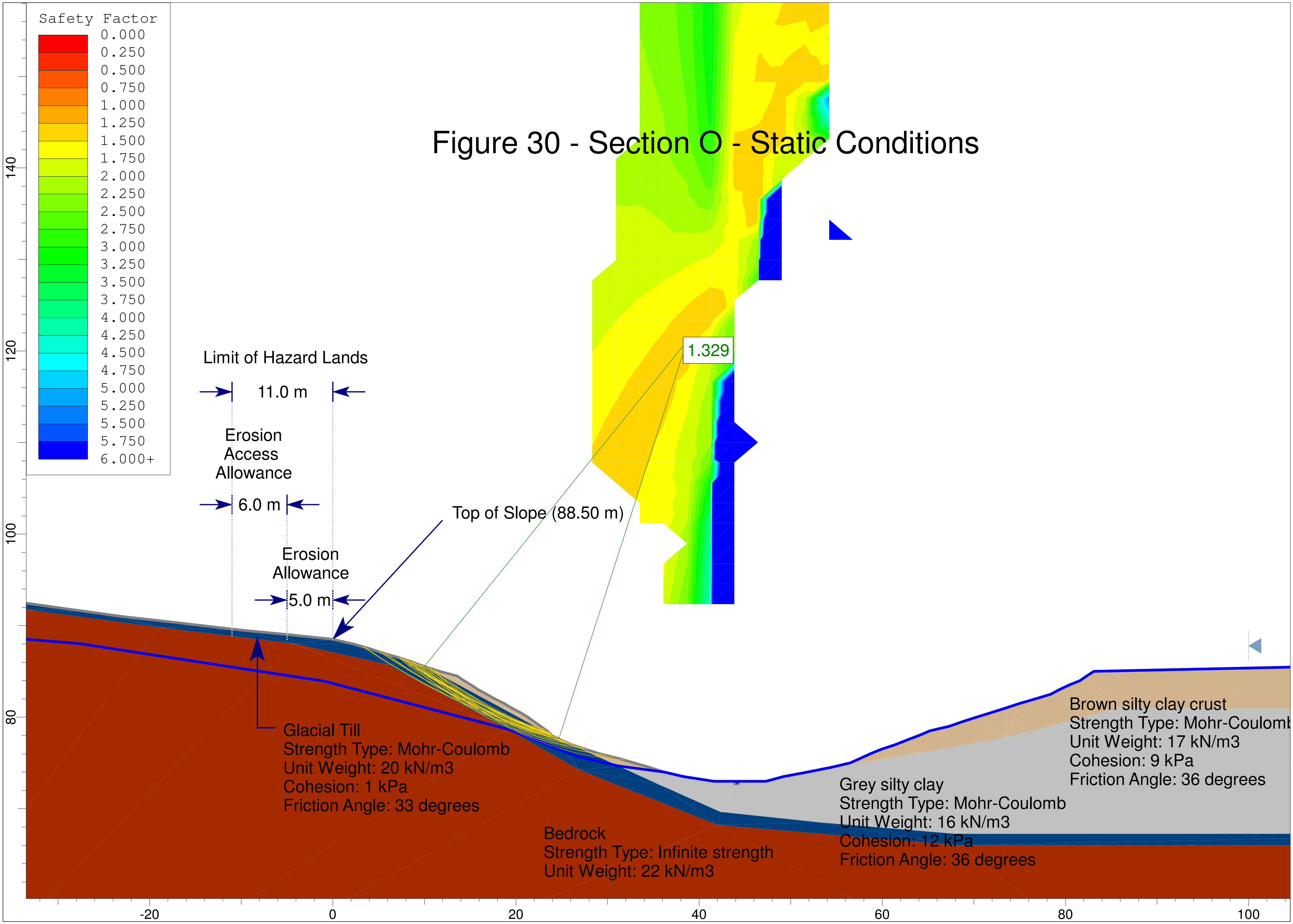


Figure 30 - Section O - Static Conditions

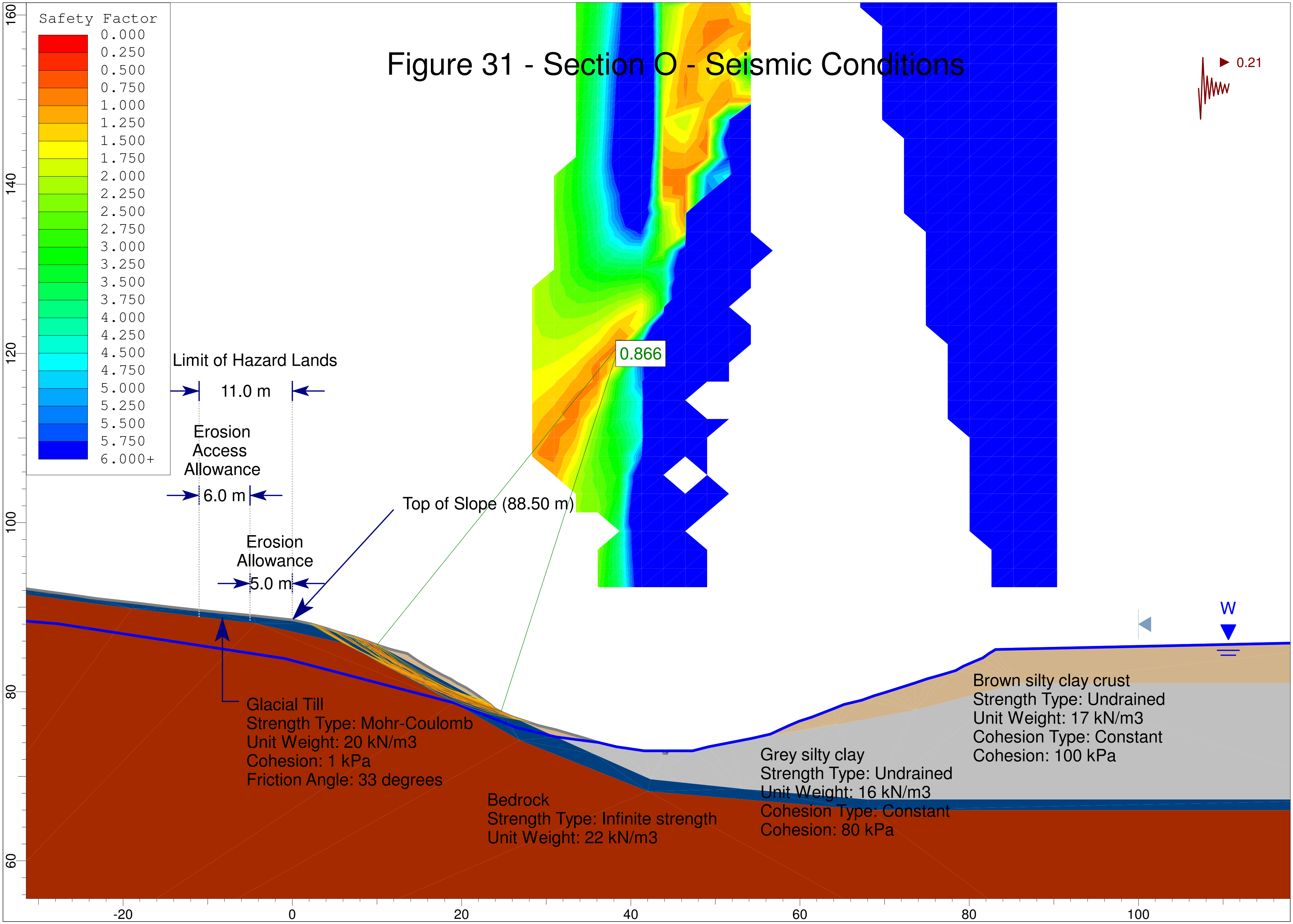


Figure 31 - Section O - Seismic Conditions

Photo 1: Photo taken on April 18, 2012 from the north bank of the valley corridor wall along Reach TRH2 looking east (upstream) near Section I.

Photo 2: Photo taken on April 18, 2012 from the centre of the watercourse along Reach TRH1 looking west (downstream) near Section H.

Photo 3: Photo taken on April 18, 2012 from the north bank of the valley corridor wall along Reach TRH1 looking west (downstream) at Section G.

Photo 4: Photo taken on April 18, 2012 from the south bank of the valley corridor looking west (downstream) near Section F.

Photographs

Photo 5: Photo taken on April 18, 2012 of the east bank of the valley corridor along Reach TRH2, north of Section J.

Photo 6: Photo taken on April 18, 2012 along the watercourse along Reach TRH4 looking east (upstream) near Section N.

Photo 7: Photo taken on April 18, 2012 of the drainage ravine near Section K.

Photo 8: Photo taken on April 18, 2012 from the north bank of the valley corridor along Reach TRH 5 looking west (downstream) near Section M.

Photo 9: Photo taken on April 18, 2012 from the south bank of the valley corridor wall along Reach TRH5 looking east (upstream) near Section M.

18.04.2012 18:44

Photo 10: Photo taken of bedrock outcrop at Section D.

18.04.2012 14:58

Photo 11: Photo taken on April 9, 2009 from the east bank of the valley corridor wall along Reach C11 looking north (downstream) near Section C.

Photo 12: Photo taken on April 9, 2009 from the east bank of the valley corridor wall along Reach C11 looking north (downstream) approximately 150 m south of the former Rail Line.

Photo 13: Photo taken on April 9, 2009 from the east bank of the valley corridor along Reach C12 looking north (downstream) near Section B.

Photo 14: Photo taken on April 9, 2009 from the east bank of the valley corridor wall along Reach C12 looking north (downstream) near Section A.

SOIL STRATIGRAPHY (SCALE 1:100 V):

▩	FILL
■	TOPSOIL
▥	SILTY SAND
▨	SILTY CLAY
▦	GLACIAL TILL
⩕	BEDROCK / PRACTICAL REFUSAL DEPTH

LEGEND:

⊕	BOREHOLE LOCATION
71.07	GROUND SURFACE ELEVATION (m)
[68.86]	INFERRED BEDROCK SURFACE ELEVATION (m)
(68.30)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)
▬ ▬	STUDY AREA
▬ ▬ ▬	URBAN GROWTH BOUNDARY
—	TOP OF SLOPE
—	LIMIT OF HAZARD LANDS

SCALE - 1:4000

0 50 100 150 300m

GENERAL NOTES:

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS PROVIDED BY STANTEC GEOMATICS.

NO.	REVISIONS	DATE	INITIAL
0	ISSUED FOR REPORT No. PG1796-1R	07/11/2012	DG

patersongroup

consulting engineers

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SCALE: 1:4000

DESIGN: DG

DRAWN: BA

CHECKED: DG

DATE: NOV. 7, 2012

GEOTECHNICAL INVESTIGATION
CARDINAL CREEK VILLAGE
OTTAWA, ONTARIO

DWG. NO. PG1796-3

TAMARACK HOMES

TEST HOLE LOCATION PLAN

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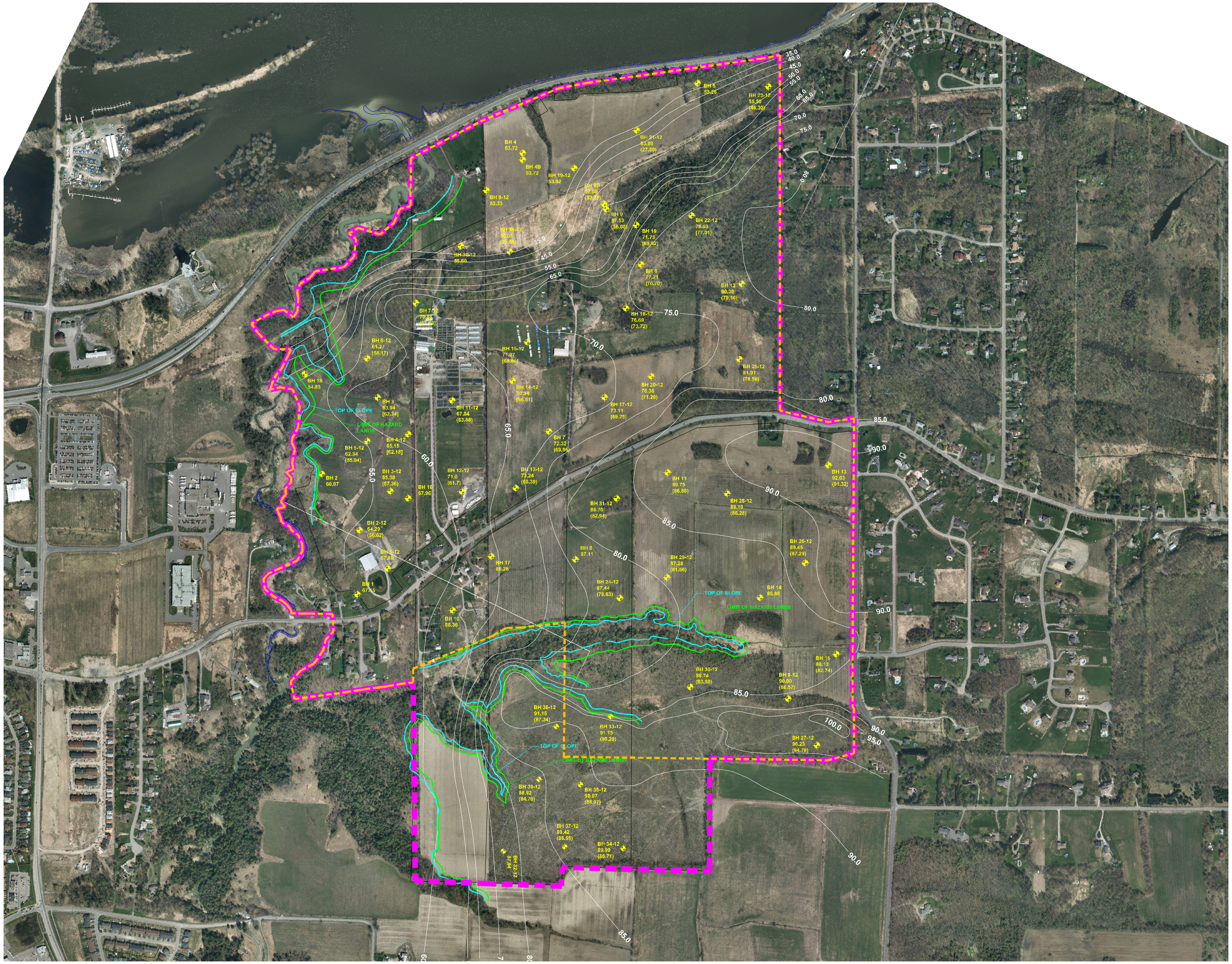

LEGEND:

⊕	BOREHOLE LOCATION
71.07	GROUND SURFACE ELEVATION (m)
[68.86]	INFERRED BEDROCK SURFACE ELEVATION (m)
(68.30)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)
— 55.0 —	BEDROCK SURFACE CONTOUR (m)
▬ ▬	STUDY AREA
▬ ▬ ▬ ▬ ▬	URBAN GROWTH BOUNDARY
——	TOP OF SLOPE
——	LIMIT OF HAZARD LANDS

SCALE

0 100 500 1000

GENERAL NOTES:

1. BEDROCK CONTOURS HAVE BEEN INTERPOLATED FROM BEST AVAILABLE INFORMATION AND ARE APPROXIMATE ONLY.
2. BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS PROVIDED BY STANTEC GEOMATICS.

0	ISSUED FOR REPORT No. PG1796-1R	07/11/2012	DG
NO.	REVISIONS	DATE	INITIAL

paterson group
consulting engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SCALE: AS SHOWN
DESIGN: DG
DRAWN: BA
CHECKED: DG
DATE: NOV. 7, 2012

GEOTECHNICAL INVESTIGATION
CARDINAL CREEK VILLAGE
OTTAWA, ONTARIO

DWG. NO. PG1796-4

TAMARACK HOMES

PRELIMINARY BEDROCK CONTOUR PLAN

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SOIL STRATIGRAPHY (SCALE 1:100 V):

▩	FILL
■	TOPSOIL
▥	SILTY SAND
▨	SILTY CLAY
▦	GLACIAL TILL
⩕	BEDROCK / PRACTICAL REFUSAL DEPTH

LEGEND:

⊕	BOREHOLE LOCATION
71.07	GROUND SURFACE ELEVATION (m)
[68.86]	INFERRED BEDROCK SURFACE ELEVATION (m)
(68.30)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)
▬ ▬	STUDY AREA
▬ ▬	URBAN GROWTH BOUNDARY
—	TOP OF SLOPE
—	LIMIT OF HAZARD LANDS

SCALE - 1:4000
0 50 100 150 300m

GENERAL NOTES:

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS PROVIDED BY STANTEC GEOMATICS.

NO.	REVISIONS	DATE	INITIAL
0	ISSUED FOR REPORT No. PG1796-1R	07/11/2012	DG

paterson group
consulting engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SCALE: 1:4000
DESIGN: DG
DRAWN: BA
CHECKED: DG
DATE: NOV. 7, 2012

GEOTECHNICAL INVESTIGATION
CARDINAL CREEK VILLAGE, OLD MONTREAL ROAD
OTTAWA, ONTARIO

DWG. NO. PG1796-5

TAGGART GROUP OF COMPANIES

3m SUBSURFACE PROFILE AT TEST HOLE LOCATIONS

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PERMISSIBLE GRADE RAISE:

▨	UP TO 2.0m
▨	UP TO 3.0m

LEGEND:

●	BOREHOLE LOCATION
71.07	GROUND SURFACE ELEVATION (m)
[68.86]	INFERRED BEDROCK SURFACE ELEVATION (m)
(68.30)	PRACTICAL REFUSAL TO AUGERING/DCPT ELEVATION (m)
Ⓕ Ⓕ	SLOPE CROSS-SECTION FOR SLOPE STABILITY ANALYSIS
⑨	PHOTOGRAPH TAKEN DURING SITE VISIT - APRIL 18, 2012
⑫	PHOTOGRAPH TAKEN DURING SITE VISIT - APRIL 9, 2009
▬	STUDY AREA
▬	URBAN GROWTH BOUNDARY
―	TOP OF SLOPE
―	LIMIT OF HAZARD LANDS

SCALE - 1:4000
0 50 100 150 300m

GENERAL NOTES:

BASE PLAN, TEST HOLE LOCATIONS AND GROUND SURFACE ELEVATIONS AT TEST HOLE LOCATIONS PROVIDED BY STANTEC GEOMATICS.

NO.	REVISIONS	DATE	INITIAL
0	ISSUED FOR REPORT No. PG1796-1R	07/11/2012	DG

paterson group
consulting engineers
154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SCALE: 1:4000
DESIGN: DG
DRAWN: BA
CHECKED: DG
DATE: NOV. 07, 2012

GEOTECHNICAL INVESTIGATION
CARDINAL CREEK VILLAGE, OLD MONTREAL ROAD
OTTAWA, ONTARIO

DWG. NO. PG1796-6

TAGGART GROUP OF COMPANIES

PERMISSIBLE GRADE RAISE PLAN

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