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Geotechnical Engineering

Environmental Engineering

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Landslide Risk Assessment

Proposed Residential Development
Old Montreal Road
Ottawa, Ontario

Prepared For

Taggart Investments

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Appendices

1.0 Introduction

1.1 Purpose of Study and Scope of Work

Paterson Group (Paterson) was commissioned by Taggart Investments to conduct a landslide risk assessment for the proposed residential development considered Cardinal Creek Village South and located south and along Old Montreal Road, in the City of Ottawa, Ontario (reference should be made to Figure 1 - Key Plan in Appendix 2 of this report). The study has been prepared in response to the requirement by the Rideau Valley Conservation Authority (RVCA) as part of the Site Plan Approval process for the City of Ottawa for the subject site.

The objectives of the risk assessment were to:

❑ Demonstrate that any landslide on the sloped areas, including a large "catastrophic landslide", has an annual probability less than 1:10,000.

❑ If the landslide hazard cannot be demonstrated to have an annual probability of less than 1:10,000, it must be demonstrated that the individual risk is $<1x10^{-5}$ per year and group risk falls within the "Acceptable" zone on a suitable group risk chart.

❑ If none of these criteria can be satisfied without mitigation measures, then the mitigation actions required must be demonstrated to reduce the risk below 10^{-5} per year and to "as low as reasonably practicable" (ALARP). If mitigation is required, further discussion with the RVCA will be required to determine what will be acceptable.

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.

1.2 Risk Assessment Methodology

The methodology of this study was undertaken using a combination of the criteria and requirements set out by the following risk assessment guidelines:

❑ Fraser Valley Regional District's Hazard Acceptability Thresholds for Development Applications dated October 2020

❑ The Association of Professional Engineers and Geoscientists of British Columbia's (APEGBC) Guidelines for Legislates Landslide Assessments for Proposed Residential Developments in BC, dated May 2010

❏ Geological Survey of Canada's Open File 7312 - Landslide Risk Evaluation Technical Guidelines and Best Practices, dated 2013

The scope of work used in this assessment included a review of published literature describing local landslides and their associated triggers, geotechnical hazards, inventoried regional landslides and the geological setting of the study area. Desktop review of published topographic mapping, LiDAR imaging, and other geological mapping was also used as part of this assessment.

Field reconnaissance was carried out over several geotechnical field programs that have taken place throughout the subject site, including field review and subsurface investigations. Further, Paterson compensated the subsurface information for the study area with a review of test hole information gathered for nearby sites in close proximity to the subject site which were investigated by Paterson as part of this assessment.

1.3 Proposed Development

It is expected that the proposed development will consist of single and townhouse style residential dwellings with basement or slab-on-grade construction, attached garages, associated driveways, local roadways, mid-rise buildings, and landscaped areas. It is further anticipated that the site will be serviced by future municipal services.

1.4 Review of Previous Geotechnical Investigation

For this assessment, subsurface information was collected from a set of site-specific investigations and several previous investigations carried out by Paterson throughout the surrounding area of the subject site. The results of the previous investigations are presented in the following Paterson reports:

❏ Report prepared for Tamarack (Queen Street) Corp. - Geotechnical Investigation - Proposed Cardinal Creek Village Residential/Commercial Development - Old Montreal Road, Ottawa, Ontario - PG1796-4 dated September 19, 2014.

❏ Report prepared for Taggart Investments - Geotechnical Investigation - Proposed Residential Development Cardinal Creek Village South - Old Montreal Road, Ottawa, Ontario - PG5201-1 Revision 4 dated July 14, 2021.

Relevant test hole information and locations are presented on the Drawing PG5201-2 - Test Hole Location Plan in Appendix 2.

2.0 Background of Study Area

2.1 Field Investigation and Observations

Geotechnical Investigations

Paterson has undertaken several geotechnical investigations throughout the subject site. The initial portion of the geotechnical investigation for the overall development 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. Supplemental investigations were completed between March 27 and April 9, 2012, June 26 and 27, 2012, November 2 to 9, 2012, January 31, February 4 to 6 and 13 to 14 and June 6, 2013. At that time, eighty-six (86) additional boreholes were advanced to depths varying between 1.5 and 15.5 m below ground surface.

An additional geotechnical investigation was carried out in February 2021 and consisted of excavating a total of 20 test pits to a maximum depth of 3.0 m below the existing ground surface. A bedrock delineation program was also carried out in November 2019 to assess the overburden thickness across the subject site.

The test hole locations were placed in a manner to provide general coverage taking into consideration site access, features and underground utilities. The test hole locations were determined by Paterson personnel and surveyed in the field by Paterson or Stantec Geomatics. It is understood that all test hole elevations are referred to the geodetic datum. The test hole locations for the investigations are presented on Drawing PG5201-2 - Test Hole Location Plan included in Appendix 2.

The boreholes were completed using a track mounted drill rig operated by a two-person crew. The test pits were excavated using a rubber-tired backhoe and a hydraulic shovel, respectively. All fieldwork was conducted under the full-time supervision of Paterson personnel under the direction of a senior engineer from the geotechnical division. The testing procedure consisted of augering and excavating to the required depths and at the selected locations, sampling the overburden.

Sampling and In Situ Testing

Soil samples were collected from the boreholes using a 50 mm diameter split-spoon (SS) sampler, or from the auger flights. Grab samples were collected along the excavated sidewalls of the test pits. All samples were visually inspected and initially classified on site and subsequently placed in sealed plastic bags.

All samples were transported to our laboratory for further examination and classification. The depths at which the samples were recovered from the test pits are shown as G and the split-spoon and auger samples recovered from the boreholes are shown as SS and AU, respectively, on the Soil Profile and Test Data sheets presented 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 was carried out in cohesive soils using a field vane apparatus.

The overburden thickness was evaluated by a dynamic cone penetration test (DCPT) completed at BH 52-12, BH 84-13, BH85-13, BH 90-13 and BH 93-14. The DCPT consists of driving a steel drill rod, equipped with a 50 mm diameter cone at the tip, using a 63.5 kg hammer falling from a height of 760 mm. The number of blows required to drive the cone into the soil is recorded for each 300 mm increment.

Subsurface conditions observed in the test holes were recorded in detail in the field. Reference should be made to the Soil Profile and Test Data sheets presented in Appendix 1 for specific details of the soil profile encountered at the test hole locations.

Groundwater

51 mm diameter groundwater monitoring wells were installed in BH 41-12 and BH 48-12 to monitor the groundwater level subsequent to the completion of the sampling program. All other boreholes were fitted with flexible piezometer to allow groundwater level monitoring. Groundwater conditions were noted upon completion of the test pit. The groundwater observations are presented in the Soil Profile and Test Data sheets in Appendix 1.

Geotechnical Laboratory Testing

The soil samples recovered from our field investigation were examined in our laboratory to collaborate the field findings. A fully sampled borehole (BH 89-13) was completed in June 2013 located within the north portion of the site. At the time, four (4) samples were submitted for unidimensional consolidation, five (5) samples were submitted for Atterberg limits testing and moisture content testing was completed on all recovered soil samples from BH 89-13.

Gradation and Atterberg limits testing were also completed on select samples obtained from the geotechnical investigations. The results of our testing are presented on Table 1, below, and on Grain Size Distribution and Hydrometer Testing and Atterberg Limit's Results sheets presented in Appendix 1.

Table 1 - Atterberg Limits Results

Sample	Depth (m)	LL (%)	PL (%)	PI (%)	w (%)	Classification
TP 1-21	2.0	61	31	30	36.0	CH
TP 3-21	1.85	69	31	38	40.7	CH
TP 4-21	1.11	57	32	25	37.6	MH
TP 5-21	2.1	73	37	36	45	MH
TP 6-21	0.94	63	34	29	42.3	MH
TP 7-21	0.70	59	32	27	38.5	MH
TP 8-21	0.95	70	44	26	49.7	MH
TP 9-21	0.6	58	32	26	23.6	MH
TP 10-21	1.5	60	33	27	35.8	MH
TP 11-21	2.11	65	35	30	43.6	MH
TP 12-21	0.8	75	37	38	37.4	MH
TP 16-21	0.3	57	29	28	36.9	CH
TP 17-21	0.6	65	36	29	39.9	MH
TP 17-21	1.3	57	31	26	35.1	MH
TP 18-21	0.4	66	36	30	35.5	MH
TP 19-21	1.5	61	32	29	32.9	MH
TP 20-21	1.0	76	39	37	39.2	MH
BH 4B TW 1	4.19	61	28	33	70.8	CH
BH 57-12 SS 7	5.33	66	27	39	27.1	CH
BH 58-12 SS 6	4.57	63	23	40	23.2	CH
BH 67-13 SS 6	4.57	75	30	46	29.5	CH
BH 89-13 TW 2	4.97	79	30	48	70.7	CH
BH 89-13 TW 3	8.08	54	26	29	67.0	CH
BH 89-13 TW 4	12.65	46	26	20	70.0	CL
BH 89-13 TW 5	18.74	50	23	27	64.4	CL
BH 89-13 TW 6	24.20	43	20	23	n/a	CL

Notes: LL: Liquid Limit; PL: Plastic Limit; PI: Plasticity Index; w: water content; CH: Inorganic Clay of High Plasticity; CL: Inorganic Clay of Low Plasticity; MH: Inorganic Silts of High Plasticity

The results of the shrinkage limit test indicate a shrinkage limit of 22% and a shrinkage ratio of 1.71.

Grain size distribution (sieve and hydrometer analysis) was also completed on selected soil samples. The results of the grain size analysis are summarized in Table 2 and presented on the Grain-Size Distribution and Hydrometer Testing Results sheets in Appendix 1.

Table 2 - Summary of Grain Size Distribution Analysis

Test Hole	Sample	Gravel (%)	Sand (%)	Silt (%)	Clay (%)
TP 2-21	G4	0.0	0.2	27.3	72.5
TP 7-21	G3	0.0	14.4	29.6	56.0
TP10-21	G4	0.0	14.4	31.2	67.5
TP12-21	G2	0.0	2.7	26.8	70.5
TP18-21	G1	0.0	15.4	34.1	50.5

2.2 Existing Conditions

Surface Conditions

The subject site consists mostly of agricultural lands and is presently undeveloped. A series of tributary ravines, which drain into Cardinal Creek are present within the subject site. The slopes of the ravines were noted to be treed and stable based on our most recent site visit. Some signs of toe erosion were noted throughout where the watercourse in close proximity to the valley corridor wall.

Two branches were observed from the south tributary and flowing in an east to west direction throughout the central portion of the subject site. The streams were designated, from south to north, as Mid Branch 1 and Mid Branch 2.

Subsurface Conditions

Generally, the overburden profile consisted of topsoil, fill and/or asphaltic concrete underlain by a stiff to very stiff silty clay layer followed by a glacial till deposit. The fill was mostly encountered in the boreholes located next to Old Montreal Road. Where encountered, the existing fill layer was observed to extend to ranges between 0.7 and 1.4 m in depth. The fill generally consisted of crushed stone followed by brown silty sand with clay, gravel, and cobbles.

The surficial layer of topsoil and/or fill was observed to be underlain by a silty clay deposit. The upper portion of the silty clay has been weathered to a brown desiccated crust. In situ shear vane field tests carried out within the silty clay crust yielded peak undisturbed shear strength values between 80 and 249 kPa. These values reflect a stiff to hard consistency in the silty clay crust.

Unweathered, grey silty clay was encountered below the brown silty clay crust. The silty clay deposit was observed to present a thickness in excess of 9 m at the west portion of the subject site and thinning out towards the east.

Glacial till was observed underlying the above-noted deposits at most locations at the subject site. The fine matrix of the glacial till generally consisted of silty clay with varying amounts of sand. Gravel, cobbles, and boulders were also present throughout the glacial till deposit at the subject site.

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 and Drawing PG5201-2 – Test Hole Location Plan in Appendix 2.

Bedrock

Based on available geological mapping, the depth to bedrock across the site generally ranges from ground surface to 25 m. The depth to bedrock throughout the western portion of the tributary creek has been mapped to range between 15 to 25 m. Limestone of the Bobcaygeon formation is located throughout the majority of the subject site, with the exception of the western portion which is underlain by interbedded limestone and dolomite of the Gull River formation.

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 and Drawing PG5201-1 - Bedrock Contour Plan in Appendix 2 for details of the bedrock.

Groundwater

The long-term groundwater level can be estimated based on the recovered soil samples' moisture levels, colouring and consistency. Based on these observations, the long-term groundwater level is anticipated at a depth of approximately 3 to 4 m below ground surface. Groundwater levels are subject to seasonal fluctuations and could vary at the time of construction.

3.0 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 than 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 for existing conditions were analyzed utilizing the latest topographic mapping and assuming the worst-case-scenario by assigning cohesive soils under fully saturated conditions. Subsoil conditions at the sections were determined based on the findings at borehole locations along the top of slope, field observations during site visits and general knowledge of the area's geology. The soil parameters were determined for the slope soils based on subsoil conditions at the boreholes along the top of slope. The analysis was carried out in accordance with the City of Ottawa's standard guidelines prepared by Golder Associates titled Slope Stability Guidelines for Development Applications in the City of Ottawa, dated 2004.

The effective strength soil parameters used for static analysis were chosen based on the subsoil information recovered during the geotechnical investigation. The effective strength soil parameters used for static analysis are presented in Table 3 below.

Table 3 - Effective Soil and Material Parameters (Static Analysis)			
Soil Layer	**Unit Weight (kN/m^3)**	**Friction Angle (degrees)**	**Cohesion (kPa)**
Brown Silty Clay Crust	17	36	9
Grey Silty Clay	16	36	12
Glacial Till	20	33	1
Bedrock	Impenetrable		

The total strength parameters for seismic analysis were chosen based on the in situ, undrained shear strengths recovered within the open boreholes completed at the time of our geotechnical investigation and based on our general knowledge of the area's geology. The strength parameters used for seismic analysis at the slope cross-sections are presented in Table 4 below.

Table 4 - Total Stress Soil and Material Parameters (Seismic Analysis)			
Soil Layer	**Unit Weight (kN/m^3)**	**Friction Angle (degrees)**	**Undrained Shear Strength (kPa)**
Brown Silty Clay Crust	17	-	100
Grey Silty Clay	16	-	60
Glacial Till	20	33	N/A
Bedrock	Impenetrable		

The location of the cross-sections analyzed are presented on Drawing PG5201-2 - Test Hole Location Plan enclosed.

3.1 Static Loading Analysis

The results for the existing static slope conditions at the slope stability sections are presented in Appendix 2. The slope stability factors of safety were found to be greater than 1.5 at all sections analyzed, except for Sections F and JJ, which are located along the south valley corridor wall of the stable slope allowance from top of slope, respectively.

3.2 Seismic Loading Analysis

An analysis considering seismic loading was also completed as part of our slope stability assessment. A horizontal seismic acceleration, K_h, of 0.21g was considered for the analyzed section and discussed further in Section 4.2.6 of this report.

This acceleration is considered to be higher than half of the peak (horizontal) ground acceleration (PGA) of 0.312g, specified in the National Building Code of Canada (NBCC 2015) Seismic calculator for the subject site. The above-noted specified PGA is considered to have a probability of exceedance of 2% in 50 years (i.e.,1:2,475 years) for the subject site. Based on a trendline considering the PGA values assigned for different probabilities of exceedance, a PGA equal to 0.21g may be approximately estimated to be equivalent to a probability of exceedance of 4% in 50 years (i.e., 1:1,250 years).

A factor of safety of 1.1 is considered to be satisfactory for stability analysis including seismic loading (i.e., pseudo-static) as per the City of Ottawa's Slope Stability Guidelines for Development Applications. The results of the analysis including seismic loading fully saturated conditions (worst-case-scenario) are shown in Appendix 2. The overall slope stability factor of safety at all slope cross-sections when considering seismic loading was found to be greater than 1.1 which is considered to be stable under seismic loading.

3.3 Limit of Hazard Lands

Slope Condition Field Review

The slope stability analysis was completed using topographical mapping, as well as a site visit to review slope condition by Paterson field personnel. The initial site visit for slope condition review was completed in 2012 to document the conditions of the tributaries to the Cardinal Creek (south tributary, mid branch 1 and mid branch 2).

The subject tributaries to Cardinal Creek were observed to be stable based on the slope condition review conducted on April 18, 2012, and current review on September 10, 2020, with some toe erosion noted throughout where the watercourse is in close proximity to the valley corridor wall. Photographs from our site visits are presented in Appendix 2.

Several slope cross-sections were studied along the tributaries' slopes. The cross-section locations are presented on Drawings PG5201-2 - Test Hole Location Plan in Appendix 2.

The existing slopes bordering the watercourses are mainly overgrown with mature trees with grass covered areas along the valley corridor walls. The existing valley corridor of the subject tributaries which meanders throughout the valley floor.

For existing conditions, 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 along the valley floor of the subject tributaries. Some minor to moderate signs of active erosion were noted in the lower portion of the slopes, leaving some exposed root systems along the slope face.

Based on the above-note observations, it is considered that a toe erosion allowance of 5 m is appropriate for the corridor walls confining the subject tributaries. A stable slope allowance in accordance with the requirements outlined for Sections F and JJ should also be taken from the top of slope, as required. The toe erosion allowance should be applied from the top of stable slope. The limit of hazard lands, including a 6 m erosion access allowance, stable slope allowance (where required) and a 5 m toe erosion allowance, is presented on Drawing PG5201-2 - Test Hole Location Plan in Appendix 2.

Seismic Design Considerations

Based on the results of the geotechnical investigation, a seismic **Site Class D** is considered applicable for foundation design within the area of the subject site as per Table 4.1.8.4.A of the OBC 2012.

4.0 Landslide Hazard and Risk Assessment

4.1 General Methodology of Assessment

The methodology for the landside hazard assessment undertaken for this report may be considered as the following:

- ☐ Identification of factors that are documented to contribute to the susceptibility for a landslide to occur throughout sloped terrain.
- ☐ Explore the factor to relate how it would affect the susceptibility for a landslide to occur throughout the subject site.
- ☐ Estimate the probability of a landslide to occur throughout the subject site based on historical regional landslide inventories. A baseline regional probability will be adjusted to a site-specific probability considering the site-specific factors that may promote landslide susceptibility using a Frequency Estimation Method.

If the hazard under consideration cannot be demonstrated to have an annual probability of less than 1:10,000, a group risk assessment estimating the annual probability of loss of lives would be carried out in accordance with the following equation:

$$\text{Risk} = P(H) \times P(S{:}H) \times P(T{:}S) \times V \times E$$

Where R = the risk or annual probability of loss of life of an individual, P(H) = the annual probability that a landslide occurs, P(S:H) = the probability of impacting the elements taking into consideration the scale and location of the landslide events, P(T:S) = the temporal spatial probability of the elements being present at the time of a landslide (i.e.- the probability that a person is present at the location at risk), V = the vulnerability, or likelihood of death or permanent injury of the individual given they are impacted and E = the number of elements that would be impacted. E will also be considered the number of occupants for the grouped areas.

4.2 Factors Affecting Landslide Susceptibility

The following sections discuss factors understood to affect the potential for a landslide to occur. The factors are described briefly and subsequently discussed on their impact to the susceptibility of a landslide throughout the subject site. The study area for the purpose of this discussion is considered as the area bound by the area considered by the Geological Survey of Canada under Open File 5311. The property discussed throughout this report is considered the subject site.

4.2.1 Clay Overburden

Based on the findings of our geotechnical investigation, the slope profiles throughout the subject site consist primarily of a silty clay deposit underlain by a relatively thin layer of glacial till and further by bedrock. Based on geological mapping undertaken by the Geological Survey of Canada under Open File 5311, the local deposit along the south tributary is considered as offshore marine sediments consisting of clays and silts.

The clay deposit encountered throughout the subject site was observed to consist of a very stiff, weathered, brown clay crust extending to depths between 0.9 and 5.9 m below the ground surface. Shallower (i.e., less than 2.0 m in depth) deposits of clay were typically observed to be underlain by compact to dense deposits of glacial till, and not by unweathered, grey silty clay. Sand, with the exception of imported or re-worked site-generated soil fill material, was not encountered above the clay deposit to form a “sand cap” layer as has been documented throughout the Ottawa Valley.

Review of landslides inventoried under Geological Survey of Canada (GSC) Open Files 5311, 7432 and 8600 document approximately 132 large landslide footprints throughout the Ottawa region. There is some overlap between these three inventories given the background for each document. Open File (OF) 5311 identifies these footprints as “*Landslide Area – Reworked Marine Sediments*”. OF8600 identifies these landslide footprints with greater precision, as it is understood to have been carried using digital elevation models (DEM) and LiDAR imaging for the boundary occupied by the City of Ottawa. OF7432 is a compilation of radiocarbon dates for approximately 45 landslides throughout the Ottawa Valley.

Review of the surficial geology for land adjacent to the landslides inventoried by the above-noted sources indicated approximately 83% (i.e., 109 out of 114 landslides captured by the study area published in OF5311) of these landslides may have originated from marine deposits consisting of clay. The remaining five landslides were considered to have consist of alluvial sediments and/or organic deposits.

It has been documented that approximately 10 very large (i.e., surface area greater than 1 km^2) landslides throughout the Ottawa Valley have occurred throughout subsurface profiles containing a surficial sand cap layer (Fransham and Gadd, 1977). This study provided a surficial geology map for the Ottawa Valley identifying areas of sand and gravel overlying clay and areas consisting solely of silt and clay.

The study concluded there is a higher incidence for very large landslides to occur throughout clay deposits with an overlying sand cap. Nearly a hundred additional landslides have been identified by GSC throughout the area of the mapping prepared by Fransham and Gadd. The majority of the more recently documented smaller-sized landslides have occurred throughout the “clay” unit.

The presence of a weathered, clay crust had been considered favorable in resisting the potential for a landslide to occur. However, review of 37 landslides throughout the Ottawa Valley and downstream of the Ottawa River and throughout Champlain Sea marine clay deposits indicate that clay crust and sand-capped clay deposits behave similarly during large retrogressive landslides (Perret, 2019). Based on this, it is inconclusive if the presence of a clay crust may or may not improve the resistance for clay soils to be susceptible to a landslide.

Further, studies have related the retrogression of landslides to the undrained shear strength using Taylor’s stability number (N_s) as indicated below:

$$N_s = yH/S_u$$

Where y = unit weight of clay (kN/m^3), H = bank height (m) and S_u = peak undrained shear strength (kPa). Analysis of forty landslides determined that N_s should be greater than or equal to 6 for the potential of retrogression to occur (Mitchell & Markell, 1974). Shear strength ranges between 40 and 60 kPa for areas where the bank height is observed to be 8 and 20 m, respectively. Based on this, the worse-case scenario N_s values range between 3.2 and 5.3 and are less than 6, **which would not suggest the potential for retrogression**.

Mitchell and Markell have also explored the sensitivity of clays as a factor in retrogression. They concluded sensitivity for retrogressive clays ranges between 10 to 1,000. The majority of the sensitivity of the clay deposit throughout the subject site has been observed to be less than 10. Some sampling intervals yielded a sensitivity ratio as high as 14. Although this is higher than the minimum of 10, the sensitivity of the clay deposit throughout the subject site is considered to be on the lower end for Champlain Sea clay deposits.

Therefore, the potential for a very large retrogressive landslide is not considered to be very likely throughout the subject site. However, it is understood that landslide susceptibility is generally considered higher for clay soils deposited by the Champlain Sea.

4.2.2 Bedrock Depth and Surface Relief

Overburden thickness and surface relief are understood to be significant factors contributing to the potential for a landslide. Landslide susceptibility mapping carried out throughout National Topographic System (NTS) area 31H generally correlated higher values of drift thickness and surface relief to a higher rate of landslide incidence in Champlain Sea clays (Quinn, 2013). The study considered a weights of evidence approach which assigns a positive or negative weight for the ranges in these parameters with respect to the frequency of landslide occurrence.

Similar review was carried out to understand the relationship between overburden thickness and topographic relief for landslides that have occurred throughout the study area (area comprised by OF5311). The results of our interpretation of the available information are summarized in Table 5 and Table 6 below:

Table 5 – Summary of Drift Thickness Throughout Historic Landslide Footprints

Drift Thickness	Number of Incidences	%
0 to 1	0	0.0
1 to 2	0	0.0
2 to 3	0	0.0
3 to 5	0	0.0
5 to 10	8	7.0
10 to 15	7	6.1
15 to 25	34	29.8
25 to 50	49	43.0
50 to 100	16	14.0
Total Landslides Within Study Area	114	94.2
Total Landslides Documented by Open Files	121	

Drift thickness interpreted using Google Earth and is considered subjective, however, appropriate based on the available information for each of the landslides identified by OF5311, OF7432 and OF8600 and the purpose of this assessment.

Table 6 – Summary of Drift Thickness Throughout Historic Landslide Footprints

Topographic Relief	**Number of Incidences**	**%**
<1	0	0.0
1-2	0	0.0
2-3	1	0.9
3-4	2	1.8
4-5	0	0.0
5-6	2	1.8
6-7	0	0.0
7-8	2	1.8
8-9	3	2.7
9-10	3	2.7
10-12	8	7.1
12-14	11	9.7
14-16	16	14.2
16-18	8	7.1
18-20	5	4.4
20-25	21	18.6
25-30	12	10.6
30-40	13	11.5
>40	6	5.3
Total Landslides Within Study Area Capable of Being Measured	113	93.4
Total Landslides Documented by Open Files	121	

Topographic relief was interpreted using DEM provided by Google Earth. Relief was considered as the difference between the lowest and highest elevations between distances extending beyond a landslide footprint. Greater distances were considered where a landslide formed into a slope profile. Significantly large landslides could not be evaluated reasonably due to the highly variable topography beyond their footprint. The measure is considered subjective, however, appropriate based on the available topographic information for each of the landslides identified by OF5311, OF7432 and OF8600 and the purpose of this assessment.

In summary, more frequent incidences of landslides occur in areas with more than 15 m of overburden and 10 m of topographic relief throughout the study area. Based on the current test hole coverage and slope stability sections, it is anticipated that more than 15 m of overburden may be present west of Slope Stability Cross Section I and north of Cross Section NN.

Further, up to 20 m of relief may be observed between the western boundary of the subject site and Slope Stablity Cross Section OO. Between 12 to 14 m of relief may be observed between Slope Stability Cross Section O and NN. Less than 10 m of relief may be observed throughout the remainder of the subject site, including the furthest extension of the tributaries mid-branch extending along the southwestern portion of the subject site (area of Slope Sections L and M).

Based on the above, the potential for a landslide as based on the above-noted factors may increase gradually from east to west along the south tributary and up to the western property boundary. This is discussed in further detail accordingly in *Section 4.3 – Hazard Assessment* of this report.

4.2.3 Groundwater

Groundwater is understood to be a factor contributing to landslide susceptibility. Landslides throughout the Ottawa Valley have been understood to generally occur most frequently during the spring thaw, which results in seasonal increases in the depth of the groundwater table and porewater pressure. It has been documented that larger slopes typically fail by a combination of a downward gradient throughout the table lands and an upward gradient (artesian) throughout the bottom of the slope profile and along the channel (Hugenholtz and Lacelle, 2004).

Groundwater regimes with primarily downward gradients from the table lands to the watercourse typically have stronger stability attributes in resisting the potential for a slope failure. Groundwater regimes may be influence by other factors, such as rising bedrock surfaces (Quinn et al., 2010). The combination of a temporary (seasonal) artesian groundwater table gradient throughout the lower portion of the slope and rising bedrock surface may significantly impact the stability of a slope.

Fully saturated slope conditions have been considered as part of our slope stability assessment in Section 3.1 of this report. Fully saturated slope conditions are anticipated to govern over the downward gradient conditions as a loading case from a slope stability perspective. The slope stability factors of safety were found to be greater than 1.5 at all sections analyzed with the exception of Sections F and JJ. An appropriate stable slope allowance has been incorporated as part of the Limit of Hazard Lands line depicted on Drawing PG5201-2 – Test Hole Location plan in Appendix 2 of this report.

The bedrock surface is generally decreasing in depth from east to west and from the table lands into the tributary throughout the subject site. The bedrock depth is further illustrated on Drawing PG5201-1 – Bedrock Contour Plan in Appendix 2 of this report. Further, given the relatively low topographic relief and depth to the groundwater table being in close proximity to the creek, a relatively low horizontal gradient is expected to be present throughout the groundwater table. It is therefore not expected that the seasonal fluctuations in the groundwater table would impact susceptibility to a landslide.

4.2.4 Toe Erosion

Landslides throughout the Ottawa Valley have been documented to occur most frequently adjacent to a watercourse. The formation of valley corridors by the presence of watercourses permits erosion along the toe of the slope and subsequent down-cutting by the erosional force of the watercourse. Sufficient downcutting, oversteepening and erosion of the slope may result in instability of the slope and the potential for a landslide.

There is a relationship between stream flow (via flow accumulation) and landslide incidence such that larger landslides tend to be associated with larger watercourses (Quinn et al., 2010). The relationship was extrapolated further such that the interpreted flow accumulation may be used as an estimate for mean annual flow and that stream order had been considered a reasonable surrogate for stream flow. Stream order is considered as the degree of a tributary and branch streams with respect to an artery stream. Larger stream order values indicate the degree of closeness a stream is linked to the principal stream, whereas smaller values indicate the streams are considered to be distant tributaries from an artery stream.

Higher values of stream flow are correlated to higher degrees of stream order which are further correlated to older and fully developed watercourses. Smaller values of stream order are correlated to younger and less developed watercourses. Generally, landslide density throughout the study area undertaken throughout NTS 31H was very low for streams up to order 3 and greater than or equal to order 9 (Quinn, 2009). The findings are similar for flow accumulation such that streams with less flow or of smaller degrees of stream orders have a negative weight and correlation associated with landslide incidence (Quinn, 2013). There is some evidence presented by a study area in Norway that younger streams have not fully developed their watercourse morphology and may be more erodible than larger, mature streams. However, the methodology undertaken to assess this for the study area of NTS 31H could not confirm this relationship for local and regional conditions at that time (Quinn, 2013).

Stream sinuosity was also explored as a variable impacting slope stability. Stream sinuosity is defined as the ratio of the total length along a stream segment to the shortest length between its endpoints (Quinn, 2013). Based on the review for the area of NTS 31H, it had been observed that landslides tend to be infrequent along streams with low sinuosity. A negative weight was attributed to streams having a sinuosity less than 1.338 (Quinn, 2013). Higher weights were attributed to watercourses with high indices of sinuosity, indicating channels with wider and more tightly spaced meander belts experience higher rates of erosion. Preferential occurrence of landslides in slopes situated on the outside of meander belts rather than in streams with low levels of sinuosity was similarly observed by Hugenholtz (2004).

A geomorphic study was undertaken by Geomorphic Solutions in 2007 for the Cardinal Creek watershed. The study considers the east-west running watercourse and its tributaries as part of this study. An excerpt of the study area and watershed footprint are depicted on Figure 1 below for reference:

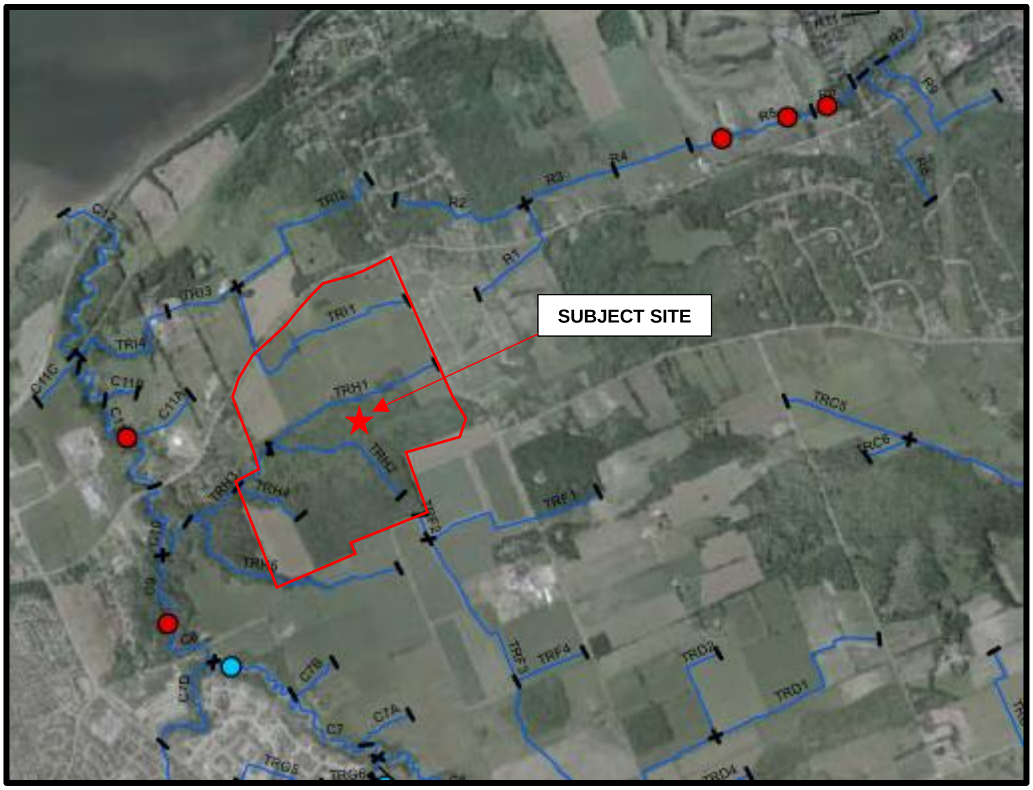

Figure 1 - Cardinal Creek Subwatershed (Geomorphic Solutions, 2007)

Tributaries TRH1, TRH2, TRH3, TRH4 and TRH5 are located throughout the subject site and are considered the areas of interest with regards to landslide susceptibility. TRH1, TRH2 and TRH4 would be considered the “south tributary”, “mid-branch 1” and “mid-branch 2” portions of the tributary discussed throughout this report, respectively. The study provided the following information with respect to the stream order and sinuosity for these reaches of the tributaries:

Table 7 – Summary of Geomorphic Assessment for Tributary H

Reach	**Stream Order**	**Sinuosity**	**Length (m)**
TRH1	1	1.02	939
TRH2	1	1.02	790
TRH3	2	1.01	827
TRH4	1	1.00	361
TRH5	1	1.03	1285

Note: Results provided by Geomorphic Solutions for Geomorphic Assessment of Cardinal Creek Subwatershed (2007)

The stream order and sinuosity of the south tributary and the mid-branches located throughout the subject site are considered less than values that would indicate an increase to landslide susceptibility. It should be acknowledged that some signs of toe erosion have been documented throughout the valley corridor during recent site visits. In our experience, the erosion observed to date is considered normal and tolerable for the surface and subsoil features forming these valley corridors.

It should be noted that it is not our opinion to neglect the factor of toe erosion in consideration of the global stability of the subject slopes. The toe erosion and erosion access allowances recommended as part of the Limit of Hazard Lands provided in our Geotechnical Report PG5201-1 dated November 29, 2021, would be considered an appropriate and sufficient measure to account for the presence of the watercourse at the bottom of the slope. Based on this, the presence of the watercourse throughout the valley corridor is not considered to be factor impacting the probability for a landslide to occur throughout the subject site.

4.2.5 Proximity to Landslides

Landslide inventory mapping published by GSC indicates the presence of potentially up to 4 landslides in proximity to the subject site. The proximity of land to previous landslides has been documented as a significant factor in assessing the susceptibility of potential for future landslides. It had been assessed that the likelihood of the nearest adjacent landslides being within a specified distance ranging between less than 50 and 2,000 m being between 49.2 and 96.7% (Quinn et al., 2011).

This pattern explains that future landslides are more likely in areas that have experienced previous landslides than in areas where no past landslides exist. This was observed by Hugenholtz (2004) in their review of Green’s Creek and the concentration of landslides to re-occur in concentrated areas along the creek alignment.

It is understood up to potentially five landslides have been documented within 2 km of the subject site. Two of these landslides, Oln17 and Oln18, intersect the southwestern boundary of the subject site. Both Oln17 and Oln18 have been reported by GSC to have retrogressed into their respective sides of the incised valley of a tributary of Cardinal Creek (GSC OF8600, 2019), and are depicted on Figure 2 for reference.

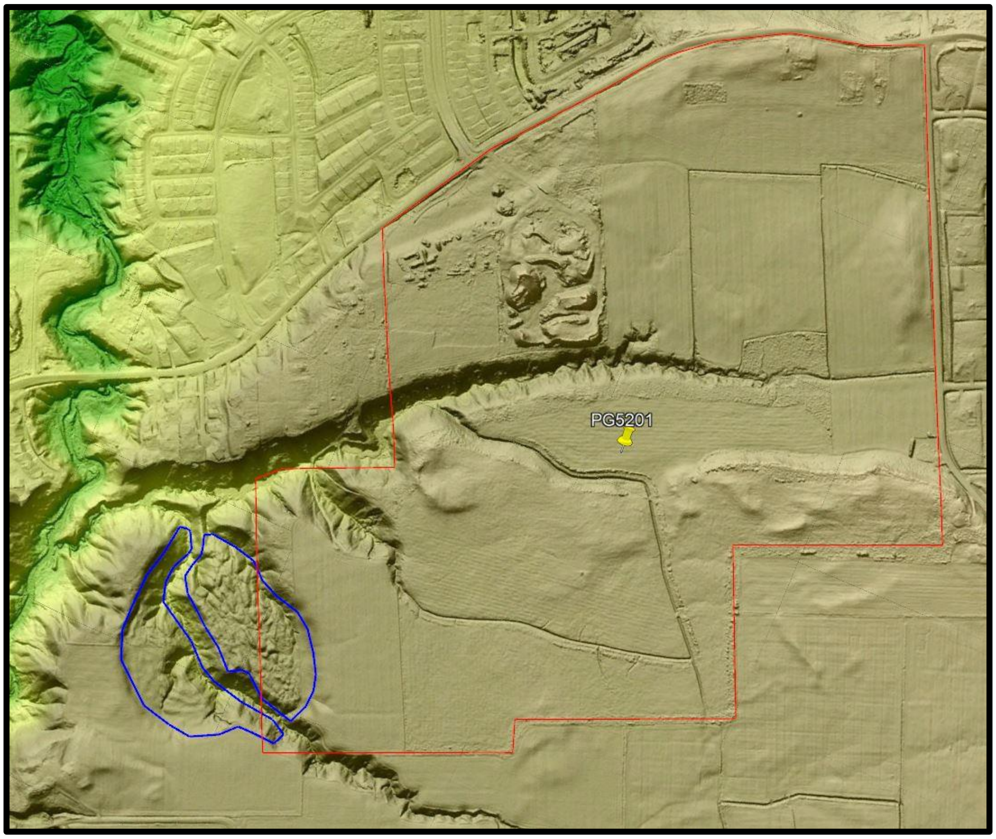

Figure 2 - LiDAR Image of Subject Site and Landslides. From Left to right: Oln17 (blue), Oln18 (blue), Subject Site (red)

Oln15 and Oln16 are located within 500 m of the westernmost boundary of the subject site. Oln15 is considered a "probable landslide" which may have retrogressed into the scarp slope above a terrace surface of the proto-Ottawa River (OF8600, 2019). Cmb1 is located 2 km from the northeastern boundary of the subject site and retrogressed into a scarp slope along the south side of the Ottawa River. The area of Oln15 and Cmb1 experience approximately 19 to 21 m of topographic relief and a relatively steep (i.e., over 20 degrees) slope along their flank. The areas adjacent to Oln17 and Oln18 were measured to experience up to approximately 11 degrees of slope steepness and up to 9 m of relief along their footprints.

Oln16 retrogressed into the western side of the incised valley of Cardinal Creek and has been heavily altered by urban development (OF8600). The area of Oln16 experiences approximately 14 to 16 m of topographic relief and is incised by a creek identified as having a stream order of 4 and sinuosity of 1.39 (Geomorphic Solutions, 2007). Drift thickness throughout the area of Oln15 and Oln16 range between 25 to 50 m. Oln17 and Oln18 has been documented by GSC OF5311 as having a drift thickness ranging between 15 to 25 m. However, drift thickness is anticipated to range between 14 to 16 m for Oln18 as based on site-specific test hole coverage.

Comparatively, Oln15, Oln16 and Cmb1 do not share parameters of susceptibility with Oln17, Oln18. As such, the landslides beyond Oln17 and Oln18 and in proximity to the subject site are not considered indicative of a higher probability for a landslide to occur throughout the subject site. Further, the areas of Oln17 and Oln18 would generally be considered to be more susceptible to a landslide than the tributary located throughout the subject site due to the higher relief and drift thickness throughout their footprints.

Although the subject site does not share many of the attributes that may have contributed to the formation of the nearby landslides, the relatively high incidence and proximity is considered notable. Based on this review, it is considered appropriate and conservative to increase the baseline probability for landslide to occur throughout the subject by one order of magnitude to account for this frequency of local incidences.

4.2.6 Earthquakes

Earthquakes are understood to be a major contributing factor in triggering some of the largest landslides inventoried throughout Champlain Sea clay deposits. Many large landslides have been estimated to have occurred approximately 4,550 years before present (BP) and another significant cluster approximately 7,060 years BP (GSC OF7432, 2021; Aylsworth and Lawrence, 2003). The lower bound of these paleo-earthquakes have been estimated to have consisted of M5.9 to M6.0 earthquakes. Several landslides were triggered by the 1663 M7 Charlevoix and 2010 Val-des-Bois M6.2 earthquakes.

The behavior of clay slopes during earthquakes is uncertain and is a topic of current research. Current research suggests that large earthquakes can propagate failures along pre-existing or partially developed planes of weakness along the slope footprint. The critical length of the propagation is understood to be influenced by the sensitivity and fracture toughness, or brittleness, of the clay deposit (Quinn et al. 2012).

The slopes and clay deposit throughout the subject site have been subject to large historic earthquakes that may have triggered significantly large historic landslides throughout the Ottawa Valley. Earthquake-induced landslides generally occur where the potential for slope failures already exist and has generally been assessed as part of our slope stability analysis. Pseudo-static (seismic) loading of the slope profiles considered a PGA of 0.21g and resulted in factors of safety exceeding 1.1 as discussed in Section 3.0 of this report. This PGA is considered equivalent to a 1:1,250-year earthquake event. This value is considered suitable for assessing the stability of the subject slopes when subject to loading that may be associated with earthquakes experienced locally.

Further, larger landslides are understood to be associated with clay deposits with remolded shear strength is equal to or less than 1 kPa (Quinn et al., 2011). It would be expected clay deposits with such low values of remolded strength to be conductive to propagating planes of weakness and unable to resist high earthquake loads. Review of our test hole coverage, remolded shear strength values typically range between 5 and 30 kPa and exceed the 1 kPa threshold associated with landslides. Based on this, it is not expected a significant shear band would propagate throughout the slopes located throughout the subject site that would increase landslide susceptibility due to earthquake loading.

This conclusion may be extrapolated further to the potential for sources of subsurface vibrations such as those associated with pile driving, shoring, compaction equipment and general earthworks equipment. These sources of vibrations are not anticipated to exceed or be close to the magnitude of vibrations associated with the assessed earthquake load of 0.21g.

Given the above, earthquake loading is not anticipated to impact landslide susceptibility. This would also be considered unlikely given the relatively shallow relief throughout the majority of the tributary. However, a return period of 1,250 years may be considered the upper bound of the baseline probability for landslides to occur throughout the subject site.

4.3 Hazard Assessment

Frequency Estimation Method

Approximately 132 individual landslides have been identified between GSC files OF8600, OF7432 and OF5311. The study area between these files considers an approximate surface area of approximately 11,800 km^2. This surface area may be decreased to approximately 6,845 km^2 when neglecting the area comprised of bedrock. The study area was reduced accordingly to consider the absence of Champlain Sea marine deposits throughout areas of bedrock outcrops and where overburden is not present. An average landslide density of $1.9x10^{-2}$ per km^2 may be extrapolated from this information.

Based on the information provided in OF5311, landslides have not been recorded to have originated from areas comprised of till or glaciofluvial deposits. The study area may be therefore reduced further to approximately 5,354 km^2 and consisting of nearshore and offshore marine deposits, alluvial sediments, organic deposits, and sand dunes. The surficial deposits are considered susceptible to a landslide given their vulnerability to failure by the factors discussed in the preceding sections of this report. Based on this, the baseline landslide frequency, and probability, may be considered as $2.5x10^{-2}$ per km^2 throughout the study area.

The estimated density may vary notably across the study area given that many landslides generally occurred in localized clusters. The distinct clusters of landslides are likely indicative of conditions that are more conducive to landslide hazards in localized zones rather than the entire study area. However, this is considered appropriate as an average density for the purpose of this assessment.

The temporal frequency of landslide occurrence may vary substantially across the study area. OF7432 sought to carbon date 45 separate landslide features throughout the study area. Landslides interpreted by that study documented landslides having occurred potentially between approximately 90 to 7,140 years before present. The results from the study and approximations provided by OF8600, neglecting the potential deviation and range of uncertainty, are summarized in Figure 3 below:

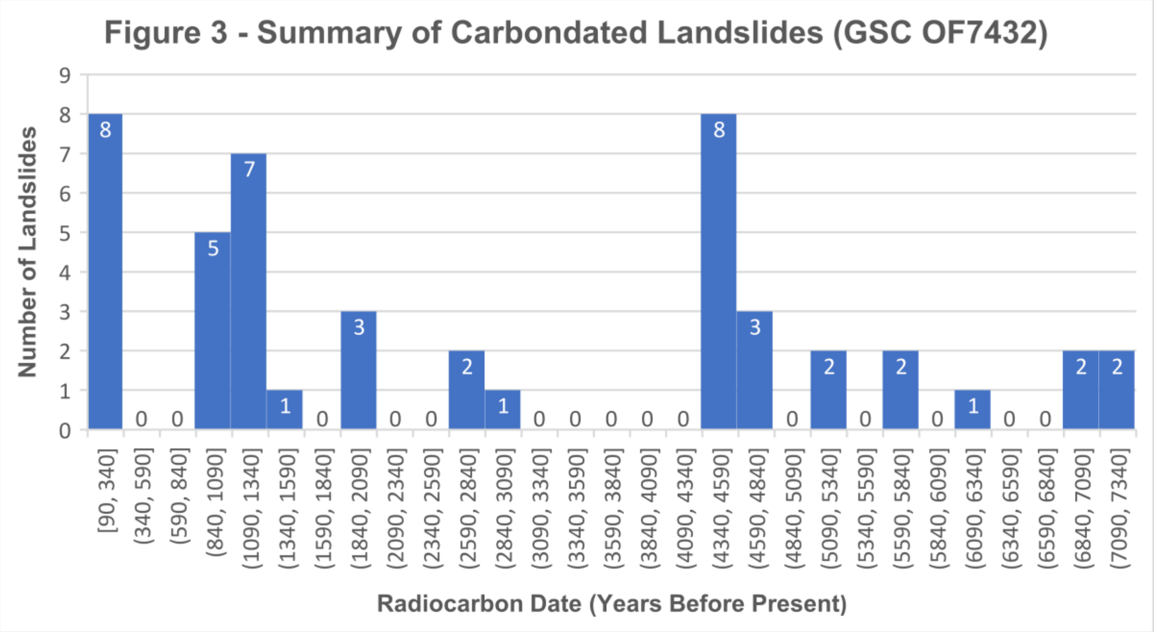

Figure 3 - Summary of Carbondated Landslides (GSC OF7432)

Temporal factors such as periods of increased earthquakes and climatic factors affecting these frequencies have been explored by others. Based on the above, more than half of the carbon dated landslides have occurred within the past 3,090 years, and over a quarter within the past 1,090 years.

Quinn et al. proposed a conservative lower bound of 500 years as a return period for the study area of NTS 31H. This value could be considered appropriate throughout the subject site based on the information presented above. However, the study area of NTS 31H considers a much higher density of landslides (i.e., 1,248 landslides over 75-80,000km^2) than the study area considered for the subject site.

Based on this, a return period equivalent to the average frequency of landslides (i.e., 132 landslides over 7,140 years) provides a smaller lower bound return period of approximately one large landslide every 54.1 years. The upper bound would be considered approximately 1,250 years as indicated in Subsection 4.2.6. of this report. This would consider a baseline landslide probability of $4.6x10^{-4}$ landslides per km^2 per annum over the study area.

The current baseline probability ($4.6x10^{-4}$ per km^2 per annum) assumes uniform susceptibility across the study area. The baseline estimate may be adjusted based on our judgement of a combination of regional landslide inventories, local site attributes and our experience assessing the performance of slopes comprised of Champlain Sea marine deposits throughout the study area. Based on our review, it had been assessed that the proximity of historic landslides to the subject site was of sufficient significance to increase the estimate by one order of magnitude.

Surface relief and drift thickness were also considered notable factors affecting landslide susceptibility, as discussed in Subsection 4.2.2 of this report. The cumulative percentages for each range of these variables were considered as having their own rate of landslide incidence throughout the study area. To consider a percentage as a probability of occurrence, the cumulative percentages were divided by an appropriate return period. The landslide frequency was increased by one order of magnitude accordingly for this purpose (i.e., 5.4 years per landslide).

This was considered appropriate to reflect the potential for smaller localized landslides, or slope failures, to occur on a smaller scale than a large, retrogressive landslide. This return period was not considered as the lower boundary for the occurrence of large landslides (i.e., the baseline probability) as this frequency has not occurred within recent history throughout the study area. However, there is evidence to support smaller localized failures may occur on as little as a summer to winter seasonal basis in some areas.

This was observed by Hugenholtz (2004) in their review of Green’s Creek and the concentration of landslides to re-occur throughout concentrated areas along the creek alignment. They had observed as many as 52 landslides of varying sizes and classes over the period of 1928 and 2001 (73 years) using digital photogrammetric techniques. The conditions observed throughout Green’s Creek are not considered comparable to the subject site, however, is an example of the potential for more frequent smaller-scale landslides beyond the larger-scale retrogressive slides that are more readily identified. Given this, a return period of one tenth of the large landslide return-period is considered appropriate for the relief and drift thickness variables throughout the subject site.

The probabilities for landslides to occur throughout the subject site considering drift thickness (Table 8) and surface relief (Table 9) are estimated accordingly in Table 10 below:

Table 8 – Summary of Drift Thickness Throughout Historic Landslide Footprints

Drift Thickness (m)	Number of Incidences	%	Probability (5.4-year return period, cumulative)
0 to 1	0	0.0	0.0
1 to 2	0	0.0	0.0
2 to 3	0	0.0	0.0
3 to 5	0	0.0	0.0
5 to 10	8	7.0	0.013
10 to 15	7	6.1	0.024
15 to 25	34	29.8	0.080
25 to 50	49	43.0	0.159
50 to 100	16	14.0	0.185

Table 9 – Summary of Surface Relief Throughout Historic Landslide Footprints

Drift Thickness (m)	Number of Incidences	%	Probability (5.4-year return period, cumulative)
0 to 4	3	2.7	0.005
4 to 6	5	4.4	0.008
6 to 8	7	6.2	0.011
8 to 10	13	11.5	0.021
10 to 12	21	18.6	0.034
12 to 14	32	28.3	0.053
14 to 16	48	42.5	0.079
16 to 18	56	49.6	0.092
18 to 20	61	54.0	0.100
20 to 25	82	72.6	0.135
25 to 30	94	83.2	0.154
30 to 40	107	94.7	0.175
>40	113	100.0	0.185

Table 10 – Estimate of Landslide Probability

Surface Relief (m)	**Drift Thickness (m)**			
	0 to 10	0 to 15	0 to 25	0 to 50
0 to 4	2.9E-07	5.5E-07	1.8E-06	3.6E-06
0 to 6	**4.9E-07**	**9.1E-07**	**3.0E-06**	5.9E-06
0 to 8	**6.8E-07**	**1.3E-06**	**4.1E-06**	8.3E-06
0 to 10	**1.3E-06**	**2.4E-06**	**7.7E-06**	1.5E-05
0 to 12	**2.0E-06**	**3.8E-06**	**1.2E-05**	2.5E-05
0 to 14	**3.1E-06**	**5.8E-06**	**1.9E-05**	3.8E-05
0 to 16	**4.6E-06**	**8.7E-06**	**2.8E-05**	5.7E-05
0 to 18	**5.4E-06**	**1.0E-05**	**3.3E-05**	6.6E-05
0 to 20	**5.9E-06**	**1.1E-05**	**3.6E-05**	7.2E-05
0 to 25	7.9E-06	1.5E-05	4.9E-05	9.7E-05

Note: Bolded text is considered reflective of site-specific conditions.
The above-noted values are considered in units of landslide per annum.

Based on our assessment, the probability for a landslide to occur throughout the subject site has been estimated to range between **1:27,778 and 1:1,098,901 per annum** for a 1:54.1-year return period. Based on the above, the annual probability of a large landslide occurring at or directly impacting the subject site is less than 1:10,000 per annum.

5.0 Conclusion

In summary, a residential development is currently being proposed to occupy the subject site. Several pre-historic landslide events are understood to have taken place throughout and in close proximity to the subject site. Based on our review, these landslides have occurred throughout sections of Cardinal Creek and its tributaries that were more susceptible to these hazards than the subject site.

Field investigations and reconnaissance carried out by Paterson throughout the subject site did not indicate any signs of movement, activity, or cause of concern with respect to landslide susceptibility. The area was also reviewed by means of available published literature of the surrounding inventory, research and studies carried out by others specializing in the field of earthquakes, landslides, and geology. Using a combination of the above and our experience with sites of very similar geology throughout the Ottawa region, the annual probability of a large catastrophic landslide occurring at or directly impacting the subject site is estimated to be less than 1:10,000. Based on our interpretation of the information available to carry out this assessment, the subject site is considered safe and suitable for consideration of the purpose of the proposed development.

6.0 Statement of Limitations

The recommendations made in this report are in accordance with our present understanding of the project and the applicable guidelines.

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

The assessment provided in this report are intended for the use of design professionals associated with this project. 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 Taggart Investments or their agent(s) is not authorized without review by Paterson Group for the applicability of our recommendations to the altered use of the report.

Paterson Group Inc.

LICENSED PROFESSIONAL ENGINEER
March 2, 2022
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

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Report Distribution:

☐ Taggart Investments (email copy)
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7.0 Literature References

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APPENDIX 1

SOIL PROFILE AND TEST DATA SHEETS

SYMBOLS AND TERMS

GRAIN-SIZE DITRIBUTION AND HYDROMETER TESTING RESULTS

ATTERBERG LIMITS TESTING RESULTS

EARTHQUAKES CANADA SEISMIC HAZARD (NBCC 2015)

TABLE 1 – SUMMARY OF REVIEWED LANDSLIDE INVENTORY DATA

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. BH24-12

BORINGS BY CME 55 Power Auger

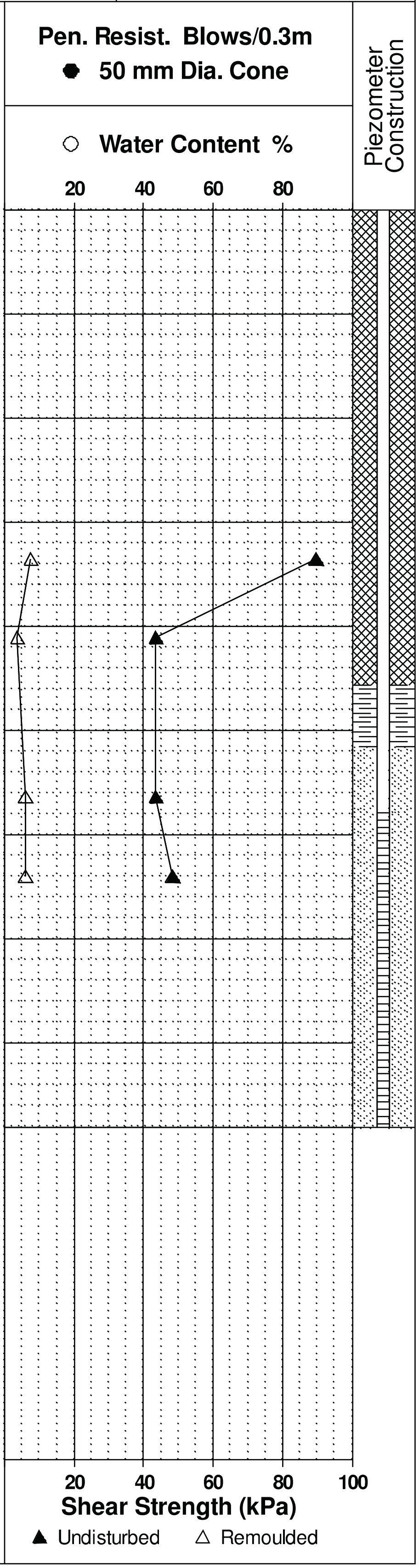
DATE April 2, 2012

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	87.44
Brown **SILTY SAND,** trace clay 0.20	AU	1				
	AU	2				
	SS	3	100	21	1	86.44
	SS	4	100	16	2	85.44
Very stiff to stiff, brown **SILTY CLAY**	SS	5	100	9		
					3	84.44
- firm and grey by 3.6m depth						
					4	83.44
	TW	6	100			
					5	82.44
					6	81.44
6.63						
					7	80.44
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders	SS	7	62	15	8	79.44
8.81						

End of Borehole

Practical refusal to augering @ 8.81m depth

(BH dry - April 13, 2012)



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. **BH25-12**

BORINGS BY CME 55 Power Auger

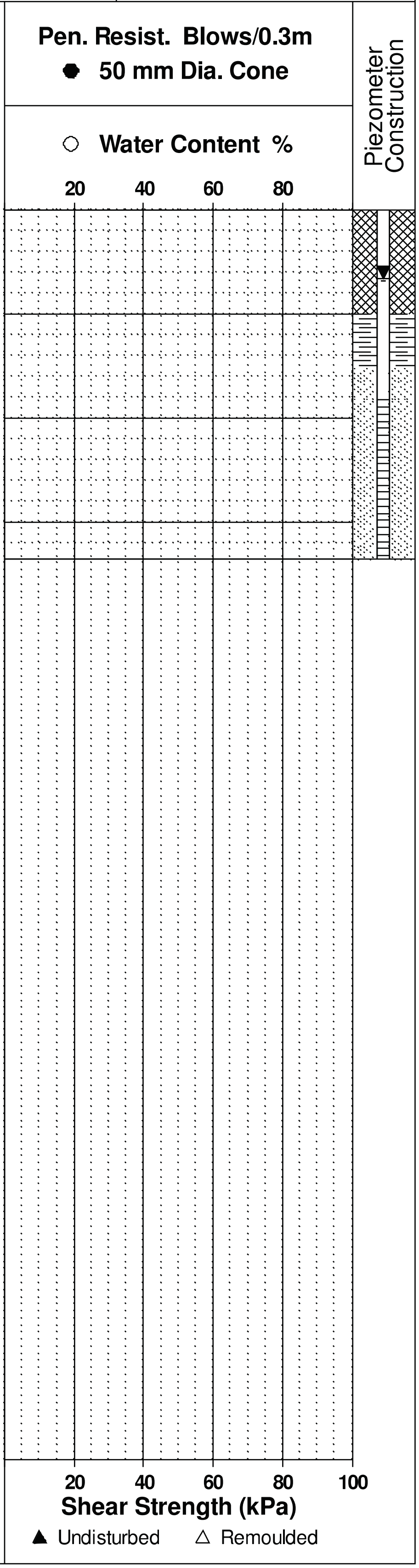
DATE April 2, 2012

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				
		SS	2	50	25	1	80.91
GLACIAL TILL: Brown silty sand with gravel, cobbles and boulders		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)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

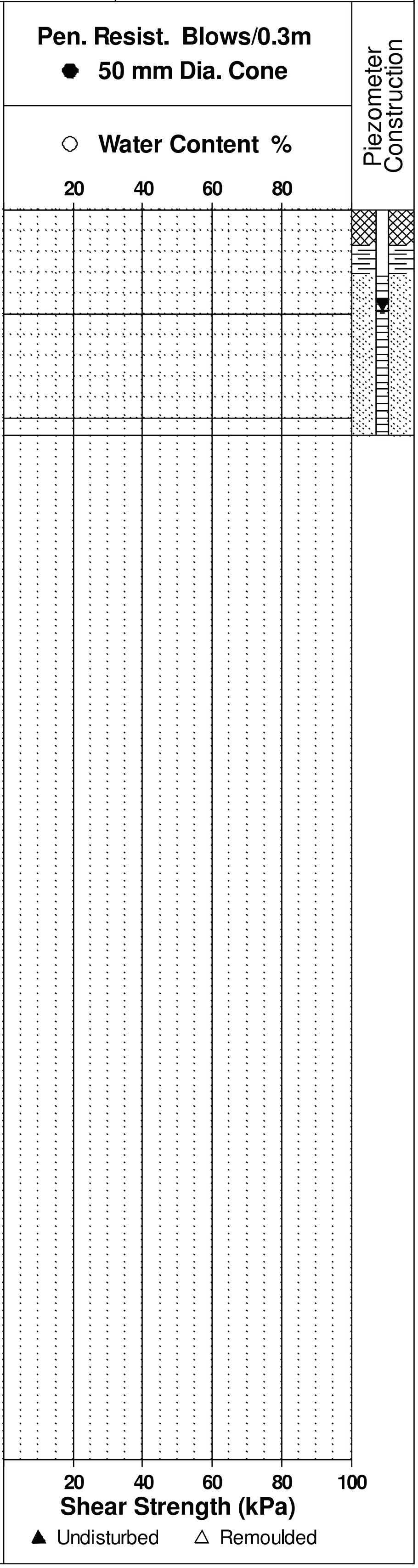
BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

HOLE NO. 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
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

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

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

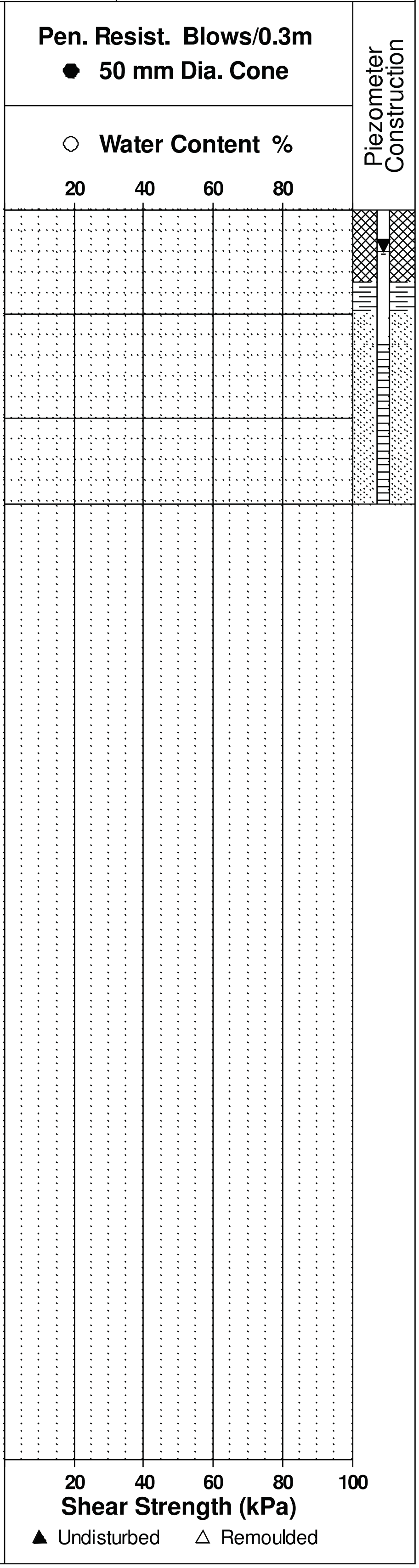
BORINGS BY CME 55 Power Auger

DATE April 3, 2012

FILE NO. PG1796

HOLE NO. BH28-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.10
TOPSOIL 0.30		AU	1				
		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)							



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

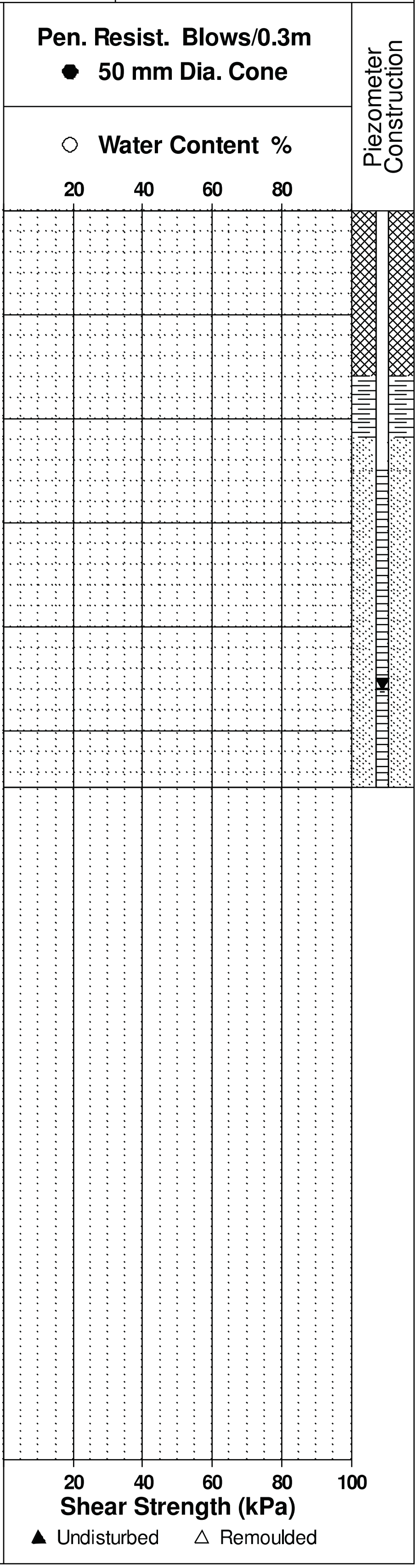
HOLE NO. BH29-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.20
TOPSOIL	0.25						
Very stiff to stiff, brown **SILTY CLAY**		AU	1				
		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)



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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

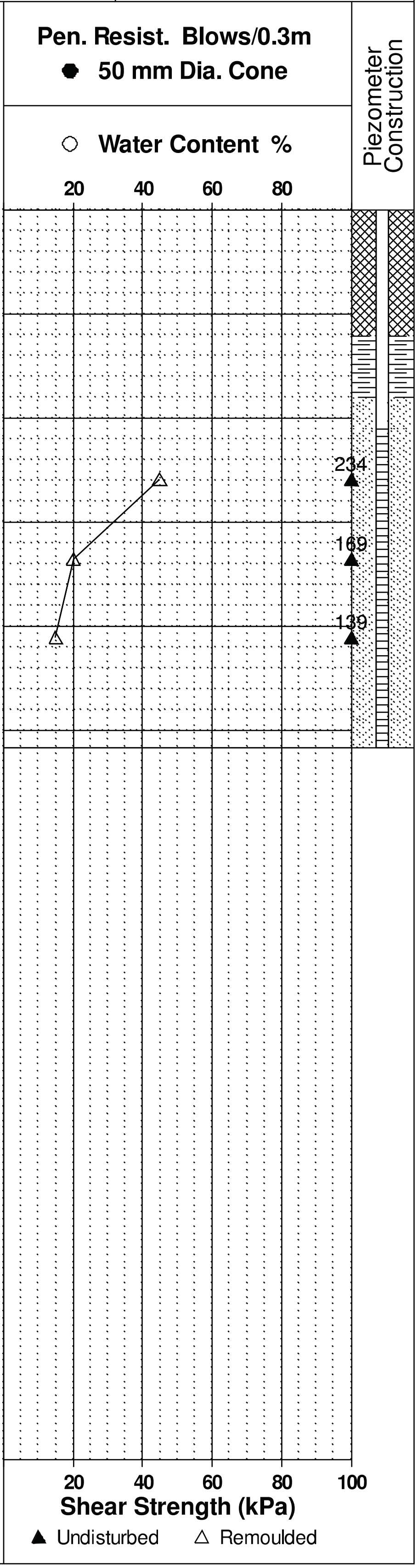
HOLE NO. BH30-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.74
TOPSOIL 0.25							
Hard to very stiff, brown **SILTY CLAY**		AU	1				
		SS	2	83	18	1	87.74
		SS	3	75	12	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
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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	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	86.70
TOPSOIL 0.28						
Very stiff to stiff, brown **SILTY CLAY**	AU	1				
	SS	2	100	12	1	85.70
	SS	3	100	19	2	84.70
2.97	SS	4	100	19		
					3	83.70
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders 3.76	SS	5	82	50+		

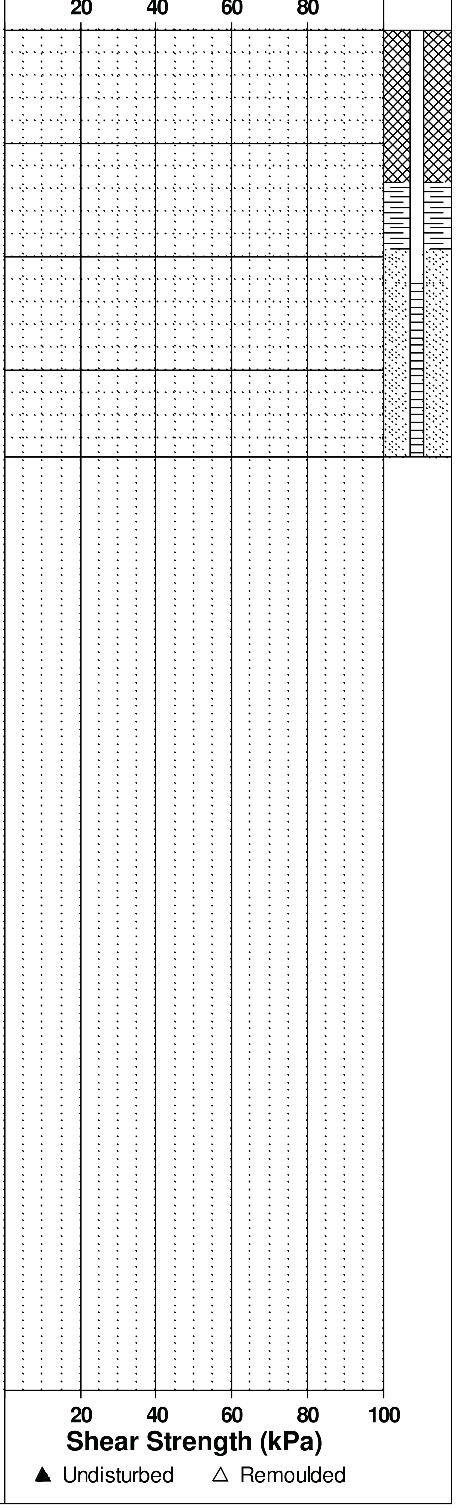
End of Borehole

Practical refusal to augering @ 3.76m depth

(GWL @ 1.12m-April 13, 2012)

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

○ **Water Content %**



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. BH32-12

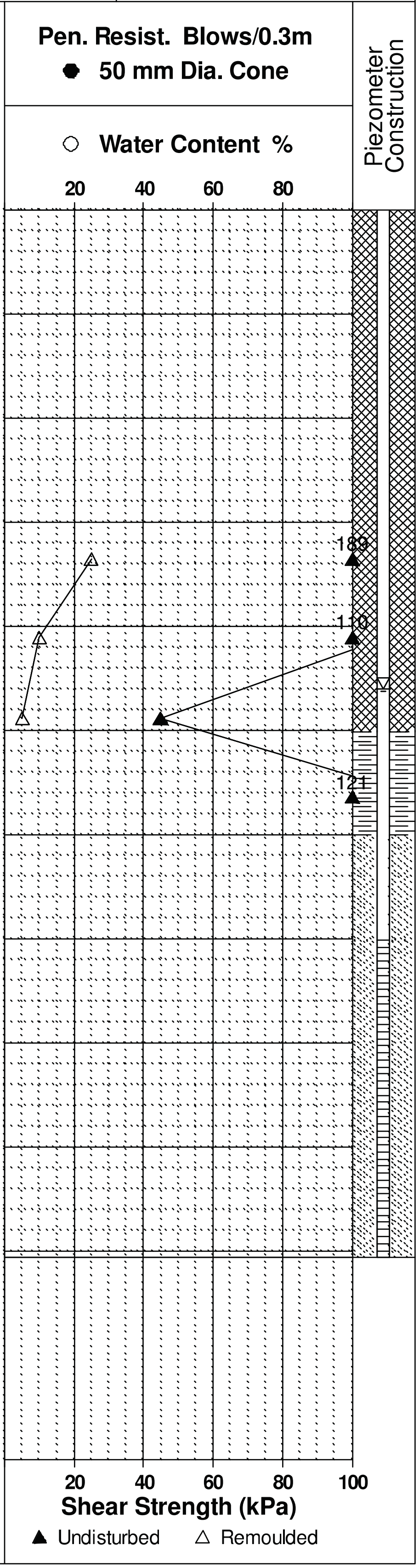
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

SOIL DESCRIPTION	Depth of base (m)
GROUND SURFACE	
Very stiff to stiff, brown **SILTY CLAY** - firm by 4.3m depth	6.60
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles and boulders	10.06
End of Borehole (GWL @ 4.6m depth based on field observations)	

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
SS	1	100	22
SS	2	100	18
SS	3	100	13
SS	4	100	2
SS	5	42	38
SS	6	67	50+
SS	7	100	50+

DEPTH (m)	ELEV. (m)
0	87.94
1	86.94
2	85.94
3	84.94
4	83.94
5	82.94
6	81.94
7	80.94
8	79.94
9	78.94
10	77.94



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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 June 27, 2012

FILE NO. PG1796

HOLE NO. BH33-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE				DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
		TYPE	NUMBER	% RECOVERY	N VALUE or RQD			20 40 60 80	
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)									

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.

REMARKS

BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

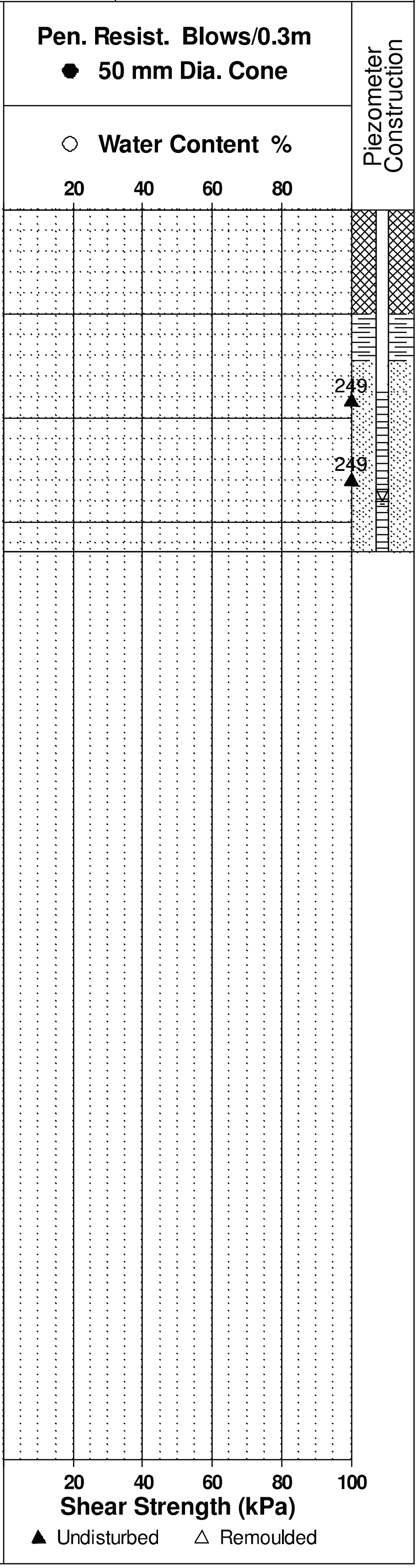
HOLE NO. BH34-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	89.99
	AU	1				
Hard to very stiff, brown **SILTY CLAY**	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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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 June 27, 2012

FILE NO. PG1796

HOLE NO. BH35-12

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
		SS	2	76	50+		
1.90							
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)

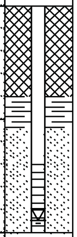
Pen. Resist. Blows/0.3m
● **50 mm Dia. Cone**

○ **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.

REMARKS

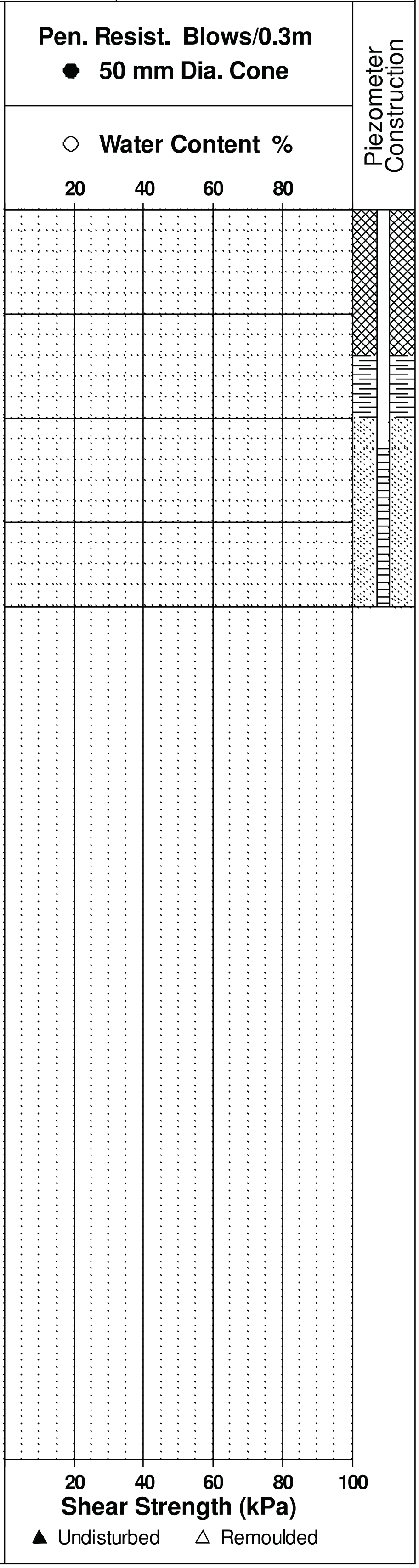
BORINGS BY CME 55 Power Auger

DATE June 26, 2012

FILE NO. PG1796

HOLE NO. BH36-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.15
Brown **SILTY SAND** with clay		AU	1				
0.60							
		SS	2	100	6	1	90.15
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		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)							



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

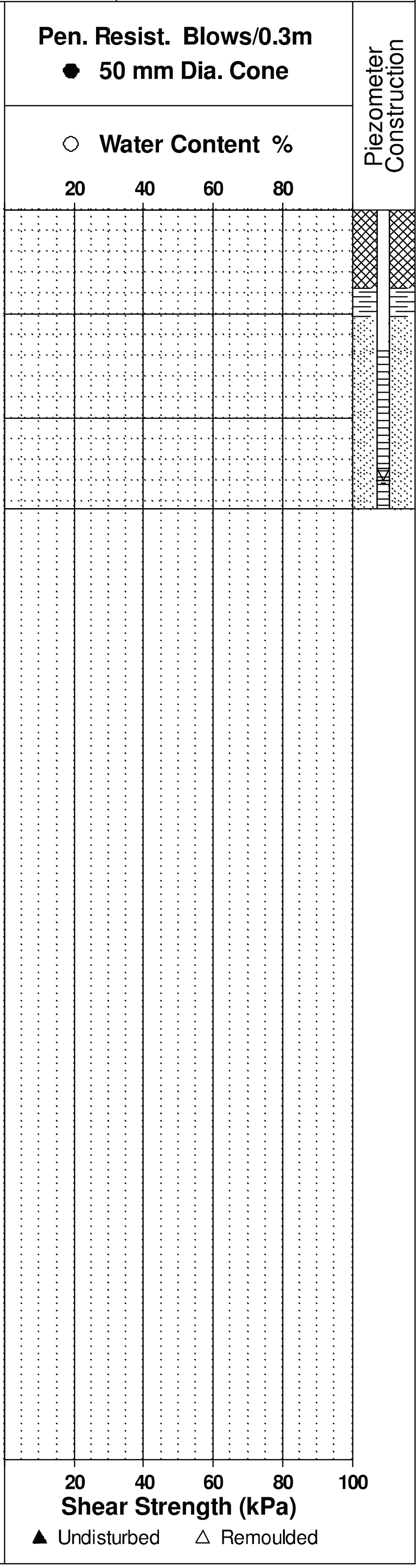
REMARKS

HOLE NO. BH37-12

BORINGS BY CME 55 Power Auger

DATE June 26, 2012

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

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

FILE NO. **PG1796**

REMARKS

HOLE NO. **BH38-12**

BORINGS BY CME 55 Power Auger

DATE June 26, 2012

SOIL DESCRIPTION	STRATA PLOT	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						3	85.92
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		SS	4	100	50+		
		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

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 4, 2013

FILE NO. PG1796

HOLE NO. BH72-12

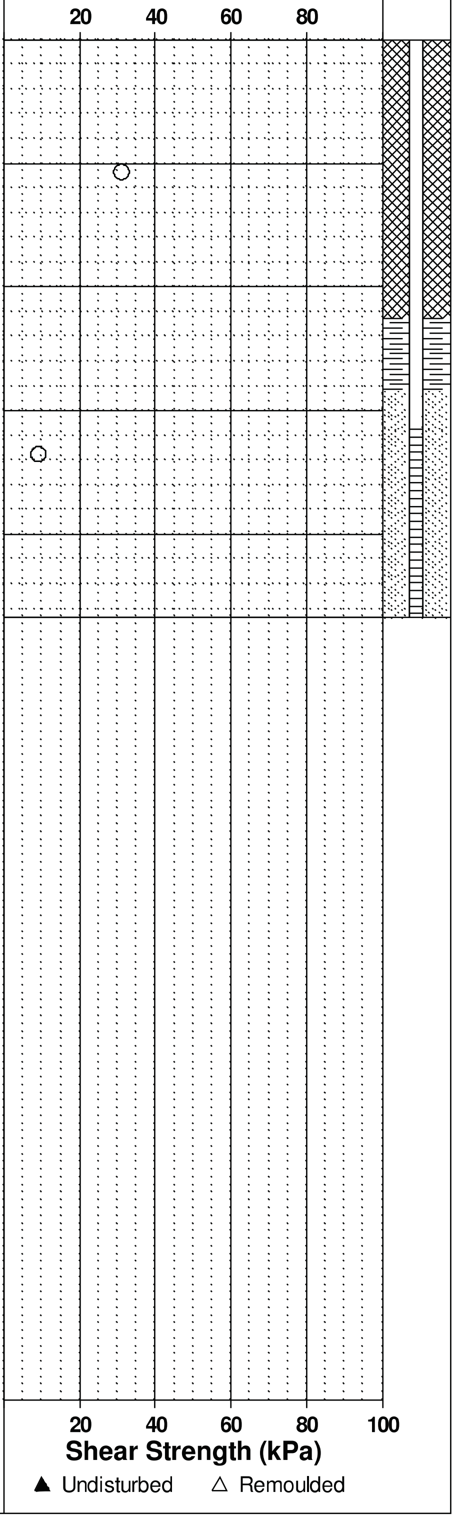
SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE				
Asphaltic concrete 0.20				
FILL: Crushed stone with sand 0.38	AU	1		
FILL: Brown silty sand with gravel 0.69	AU	2		
Stiff, brown **SILTY CLAY** 1.45	SS	3	50	23
GLACIAL TILL: Brown silty clay with sand, gravel, trace cobbles 2.20	SS	4	67	13
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders 4.67	SS	5	43	50+
	SS	6	83	27
	SS	7		50+
End of Borehole				
(BH dry upon completion)				

DEPTH (m)	ELEV. (m)
0	77.23
1	76.23
2	75.23
3	74.23
4	73.23

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

○ Water Content %

Piezometer Construction



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 Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 31, 2013

FILE NO. PG1796

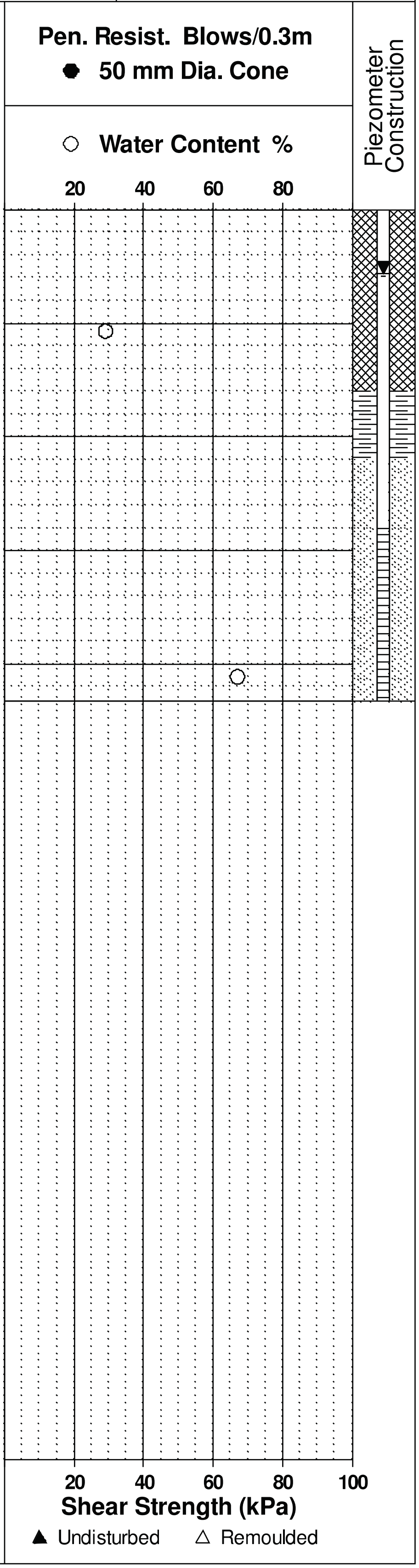
HOLE NO. BH73-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	80.21
FILL: Crushed stone with sand 0.33		AU	1				
FILL: Brown silty sand with clay and gravel 0.69		AU	2				
Very stiff to stiff, brown **SILTY CLAY**		SS	3	33	9	1	79.21
		SS	4	83	13	2	78.21
2.90		SS	5	100	18		
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders 3.73		SS	6	67	10	3	77.21
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders, trace clay 4.32		SS	7		21	4	76.21

End of Borehole

Practical refusal to augering at 4.32m depth

(GWL @ 0.56m-Mar. 27, 2013)



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

REMARKS

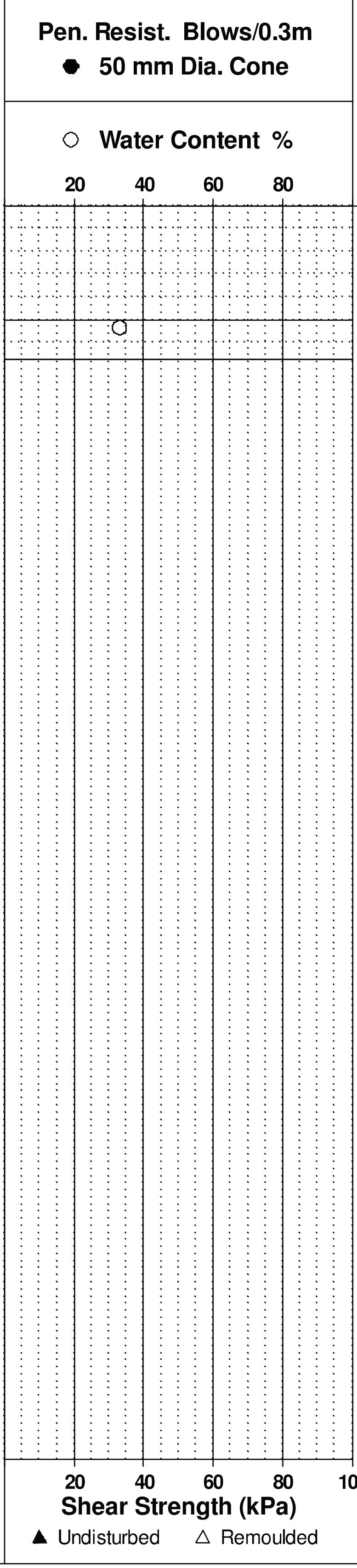
BORINGS BY CME 55 Power Auger

DATE January 31, 2013

FILE NO. PG1796

HOLE NO. BH74-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	81.02
FILL: Crushed stone with sand 0.30	▨						
FILL: Brown silty sand with gravel 0.69	▨						
Very stiff, brown **SILTY CLAY** 0.99	▨						
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders 1.35	▨	SS	1	80	15	1	80.02
End of Borehole Practical refusal to augering at 1.35m depth (BH dry upon completion)							



Piezometer Construction

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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. BH75-12

BORINGS BY CME 55 Power Auger

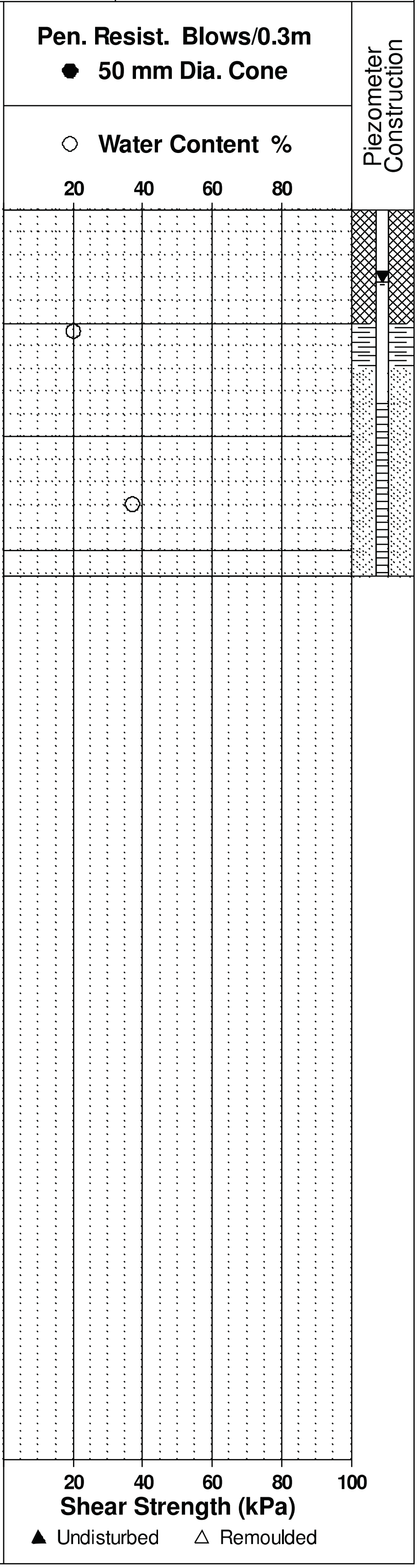
DATE February 1, 2013

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	83.02
Asphaltic concrete 0.20						
FILL: Crushed stone with sand 0.51	AU	1				
FILL: Brown silty sand with gravel 0.81	AU	2				
Compact, brown **SILTY SAND** with gravel 1.45	SS	3	50	10	1	82.02
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders	SS	4	100	50+	2	81.02
3.22	SS	5	0	50+	3	80.02

End of Borehole

Practical refusal to augering at 3.22m depth

(GWL @ 0.64m-Mar. 27, 2013)



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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 Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

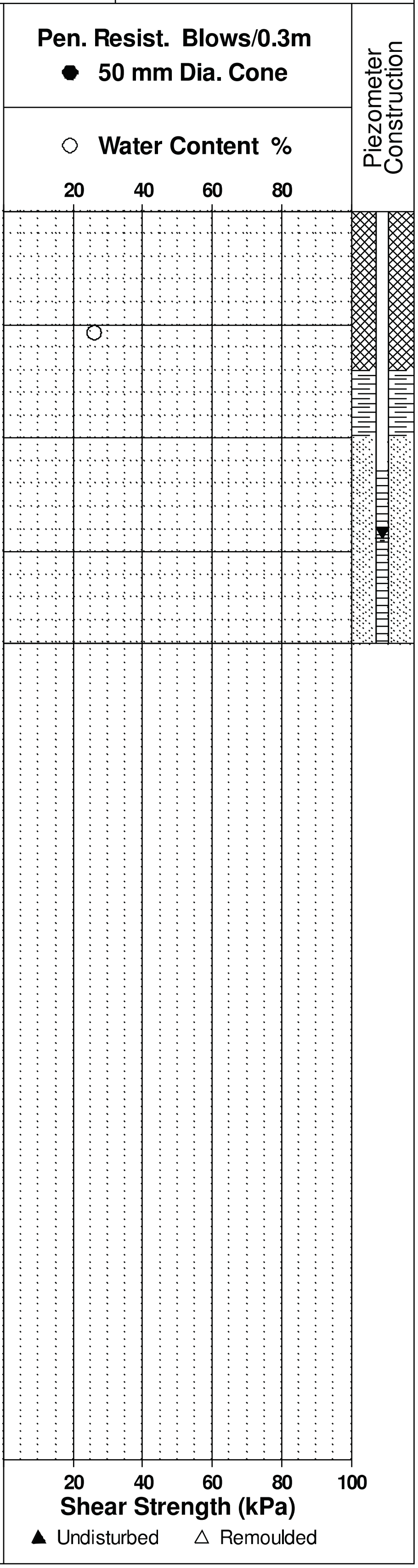
HOLE NO. BH76-12

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	87.83
Asphaltic concrete 0.20						
FILL: Crushed stone with sand 0.46	AU	1				
FILL: Brown silty sand with gravel 0.69	AU	2				
Loose, brown **SILTY SAND** with gravel, trace cobbles 1.45	SS	3	83	6	1	86.83
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders, trace clay - brown silty clay matrix from 1.8 to 3.0m depth	SS	4	100	50+		
					2	85.83
	SS	5	50	1		
					3	84.83
3.81	SS	6	77	50+		

End of Borehole

Practical refusal to augering at 3.81m depth

(GWL @ 2.88m-Mar. 27, 2013)



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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 Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

HOLE NO. BH77-12

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	88.17		
FILL: Crushed stone with sand 0.28		AU	1						
FILL: Brown silty sand with gravel 0.69		AU	2						
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders		SS	3	33	15	1	87.17		
		SS	4	0	14				
2.26						2	86.17		
End of Borehole Practical refusal to augering at 2.26m depth									

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

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

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

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

HOLE NO. BH77A-12

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	88.17		
OVERBURDEN						1	87.17		
2.21						2	86.17		
End of Borehole Practical refusal to augering at 2.21m 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 Limited.

REMARKS

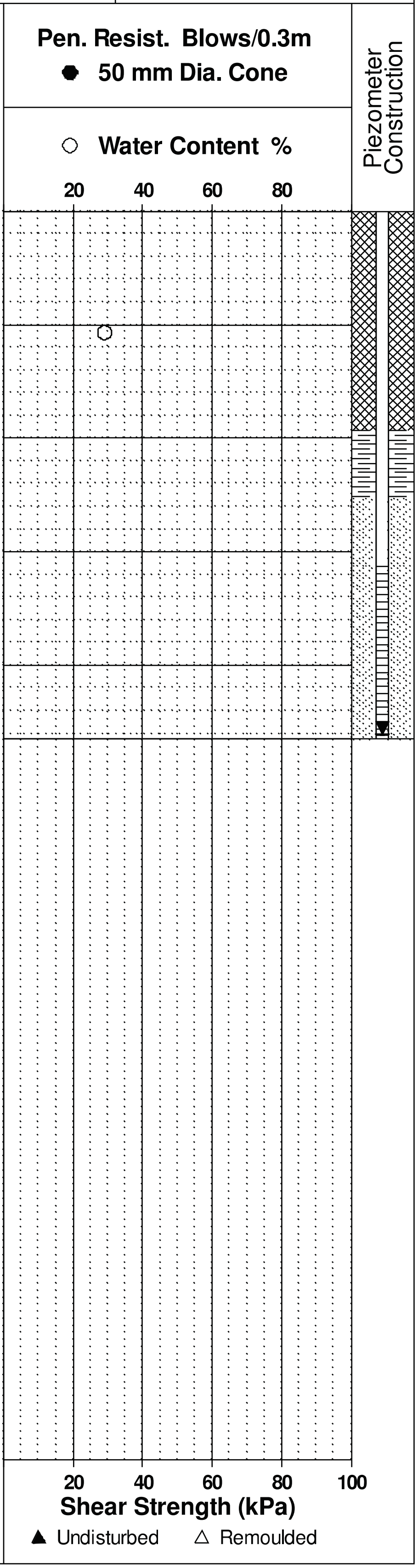
BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

HOLE NO. BH78-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	91.80
FILL: Crushed stone 0.30		AU	1				
FILL: Brown silty sand with gravel 0.69		AU	2				
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles, boulders		SS	3	25	3	1	90.80
1.75							
						2	89.80
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders		SS	4		50+		
		SS	5	100	50+	3	88.80
						4	87.80
4.65		SS	6	0	50+		
End of Borehole							
(GWL @ 2.88m-Mar. 27, 2013)							



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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 Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

HOLE NO. BH79-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone ○ Water Content %	Piezometer Construction
GROUND SURFACE						0	94.45		
FILL: Crushed stone 0.28									
FILL: Brown silty sand with gravel 0.69		AU	1						
GLACIAL TILL: Brown silty sand with gravel, trace clay and organics		SS	2	50	8	1	93.45		
1.68		SS	3	100	50+				
End of Borehole Practical refusal to augering at 1.68m depth (BH dry upon completion)									

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

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE January 31, 2013

FILE NO. PG1796

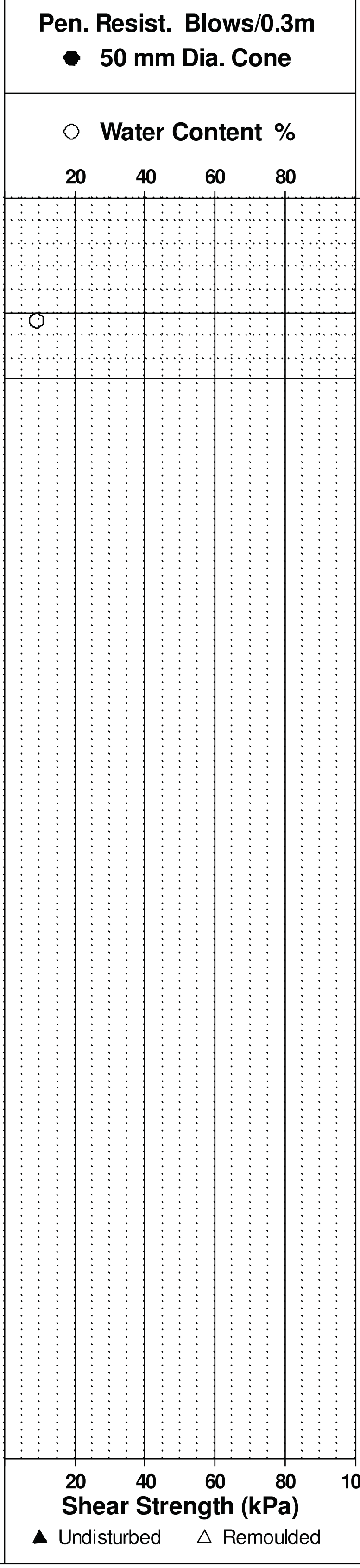
HOLE NO. BH80-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	96.02	
FILL: Crushed stone 0.30	▨	AU	1					
FILL: Brown silty sand with gravel, cobbles, clay 1.07	▨	AU	2					
	▨	SS	3	38	20	1	95.02	
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders 1.58		SS	4	100	50+			

End of Borehole

Practical refusal to augering at 1.58m depth

(BH dry upon completion)



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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 Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

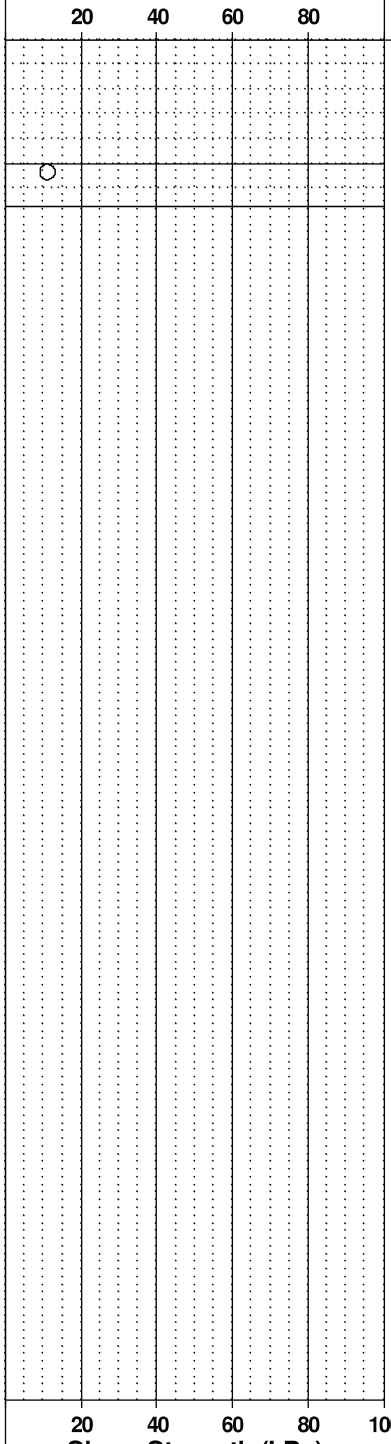
HOLE NO. BH81-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	95.77
FILL: Crushed stone with sand 0.30	▨	AU	1				
FILL: Brown silty sand with gravel 0.69	▨	AU	2				
GLACIAL TILL: Brown silty sand with gravel, cobbles, boulders, trace clay 1.35	^ ^ ^	SS	3	57	15	1	94.77
End of Borehole Practical refusal to augering at 1.35m depth (Piezometer damaged - March 27, 2013)							

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

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Limited.

REMARKS

BORINGS BY CME 55 Power Auger

DATE February 1, 2013

FILE NO. PG1796

HOLE NO. BH81A-12

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	95.77		
OVERBURDEN						1	94.77		
1.35									
End of Borehole Practical refusal to augering at 1.35m depth									

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 Limited.

REMARKS

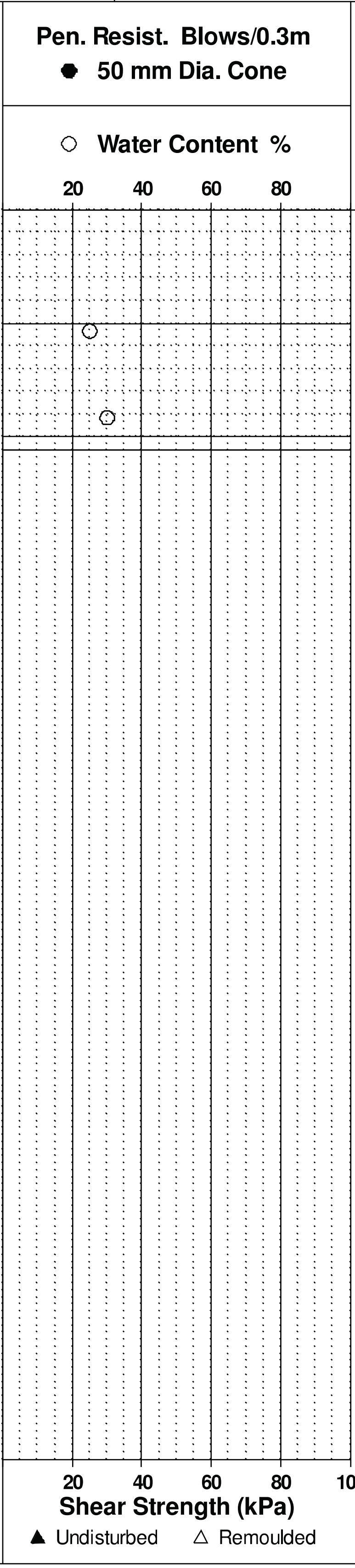
BORINGS BY CME 55 Power Auger

DATE January 31, 2013

FILE NO. PG1796

HOLE NO. BH82-12

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	95.86	
FILL: Crushed stone with gravel 0.30	▨	AU	1					
FILL: Brown silty sand with gravel 1.45	▨	SS	2	58	31	1	94.86	
GLACIAL TILL: Brown silty sand with gravel, trace clay 2.11	^ ^ ^	SS	3	78	31	2	93.86	
End of Borehole Practical refusal to augering at 2.11m depth (BH dry upon completion)								



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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

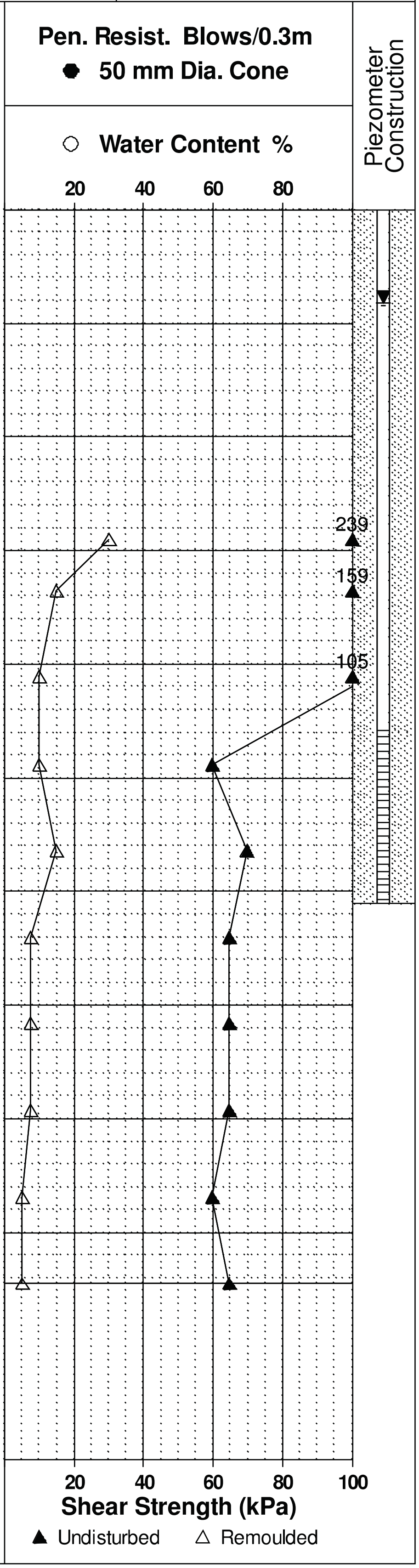
BORINGS BY CME 55 Power Auger

DATE January 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							
TIOPSOIL 0.30		AU	1			0	87.11
		SS	2	42	9	1	86.11
		SS	3	67	5	2	85.11
Hard to very stiff, brown **SILTY CLAY**						3	84.11
						4	83.11
- stiff and grey-brown by 4.3m depth						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)							



SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development - Queen Street
Ottawa, Ontario

DATUM Ground surface elevations provided by Stantec Geomatics Ltd.

REMARKS

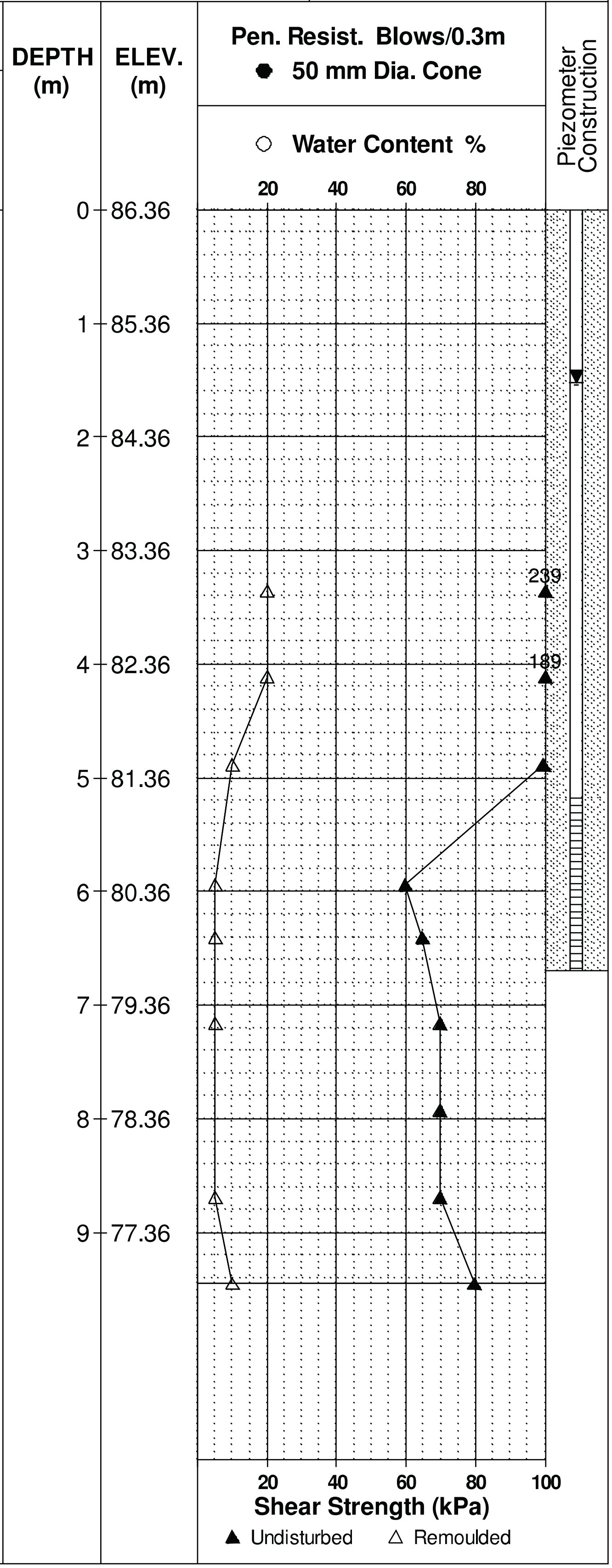
BORINGS BY CME 55 Power Auger

DATE January 22, 2009

FILE NO. PG1796

HOLE NO. BH10

SOIL DESCRIPTION		SAMPLE			
	STRATA PLOT	TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
TOPSOIL 0.20		AU	1		
Hard to very stiff, brown **SILTY CLAY** - stiff and grey by 4.3m depth		SS	2	58	10
		SS	3	75	11
		SS	4	83	8
9.45					
End of Borehole (GWL @ 1.52m-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 23, 2009

FILE NO. PG1796

HOLE NO. BH11

SOIL DESCRIPTION		SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.75
TOPSOIL	0.30	AU	1				
Very stiff, brown **SILTY CLAY** with organic matter	0.69						
		SS	2	75	8	1	88.75
GLACIAL TILL: Compact to dense, brown silty sand with clay, gravel, cobbles and boulders		SS	3	50	20	2	87.75
	2.95	SS	4	80	50+		
End of Borehole Practical refusal to augering @ 2.95m depth							

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

○ **Water Content %**
20 40 60 80

Piezometer Construction

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

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SOIL PROFILE 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

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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

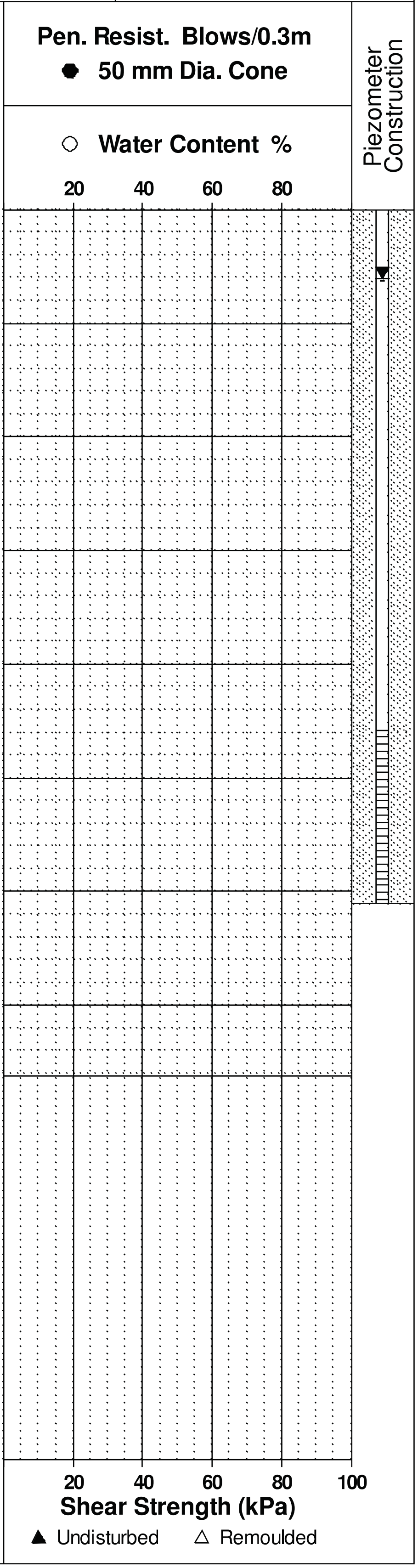
HOLE NO. **BH14**

BORINGS BY CME 55 Power Auger

DATE January 26, 2009

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD
GROUND SURFACE				
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
	SS	3	33	54
2.21				
GLACIAL TILL: Very stiff, grey silty clay with sand, gravel, cobbles and boulders	SS	4	50	24
	SS	5	50	13
	SS	6	33	16
	SS	7	38	30
	SS	8	25	31
	SS	9	38	44
	SS	10	42	42
7.62				
End of Borehole (GWL @ 0.61m-Feb. 3/09)				

DEPTH (m)	ELEV. (m)
0	88.88
1	87.88
2	86.88
3	85.88
4	84.88
5	83.88
6	82.88
7	81.88



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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	
GROUND SURFACE	
TOPSOIL	0.25
Stiff, brown **SILTY CLAY**, some organic matter to 1.4m depth	2.82
GLACIAL TILL: Grey silty clay with sand, gravel, cobbles	5.13
GLACIAL TILL: Compact, grey silty sand with gravel, cobbles and boulders	5.39

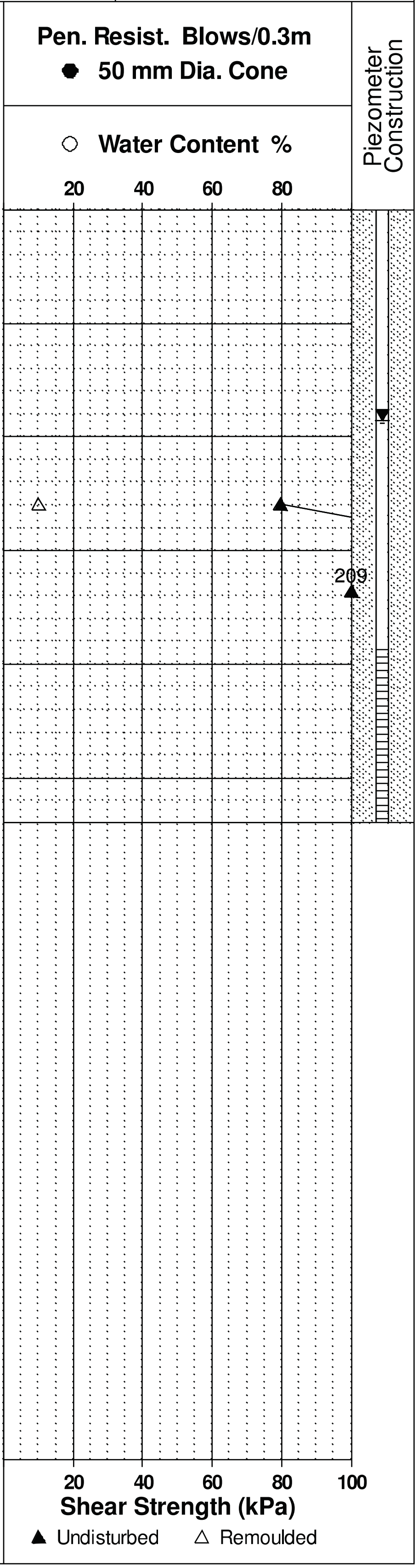
End of Borehole

Practical refusal to augering @ 5.39m depth

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

SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
AU	1		
SS	2	8	9
SS	3	42	4
SS	4	100	2
SS	6	42	14
SS	7	0	50+

DEPTH (m)	ELEV. (m)
0	88.13
1	87.13
2	86.13
3	85.13
4	84.13
5	83.13



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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

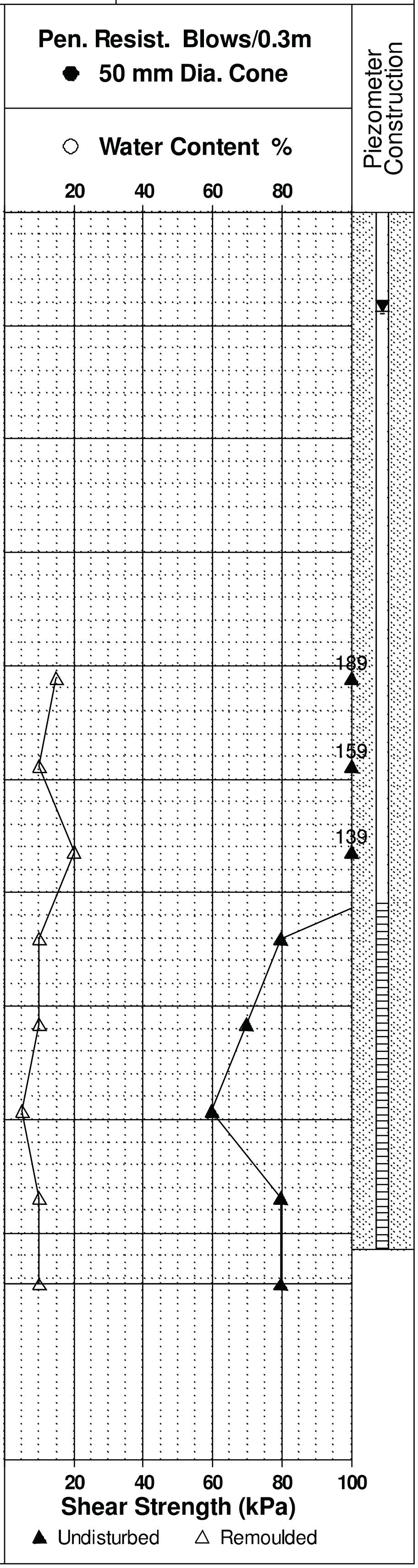
REMARKS

HOLE NO. BH17

BORINGS BY CME 55 Power Auger

DATE January 23, 2009

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.28
TOPSOIL 0.20		AU	1				
		SS	2	54	14	1	85.28
		SS	3	50	12	2	84.28
		SS	4	71	9	3	83.28
		SS	5	75	5		
Very stiff, brown **SILTY CLAY**						4	82.28
						5	81.28
- stiff and grey-brown by 5.9m depth						6	80.28
- grey by 6.6m depth						7	79.28
						8	78.28
						9	77.28
9.45							
End of Borehole							
(GWL @ 0.88m-Feb. 3/09)							



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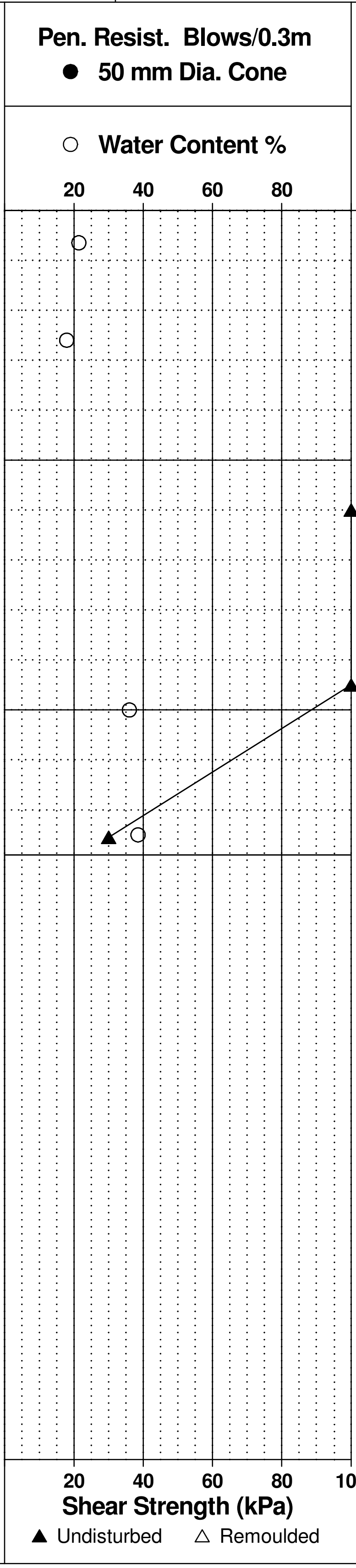
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic
FILE NO. PG5201
REMARKS
HOLE NO. TP 1-21
BORINGS BY Excavator
DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	82.71
TOPSOIL 0.13	■	G	1				
Brown **SILTY CLAY** 0.52	▨	G	2				
Very stiff brown **SILTY CLAY** some silty sand	▨	G	3				
	▨					1	81.71
	▨	G	4			2	80.71
2.58	▨	G	5				
End of Test Pit							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

REMARKS

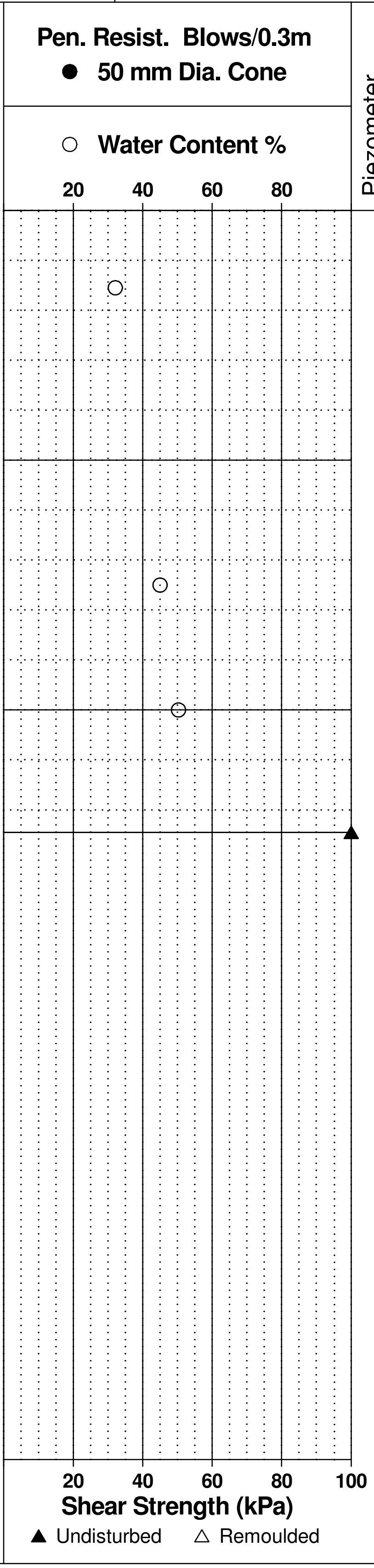
BORINGS BY Excavator

DATE 2021 February 26

FILE NO. PG5201

HOLE NO. TP 2-21

SOIL DESCRIPTION		STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE							0	86.51	
TOPSOIL	0.19		G	1					
Brown **SILTY CLAY** with sand	0.31								
Very stiff brown **SILTY CLAY**			G	2					
							1	85.51	
			G	3					
							2	84.51	
			G	4					
	2.49								
End of Test Pit									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

REMARKS

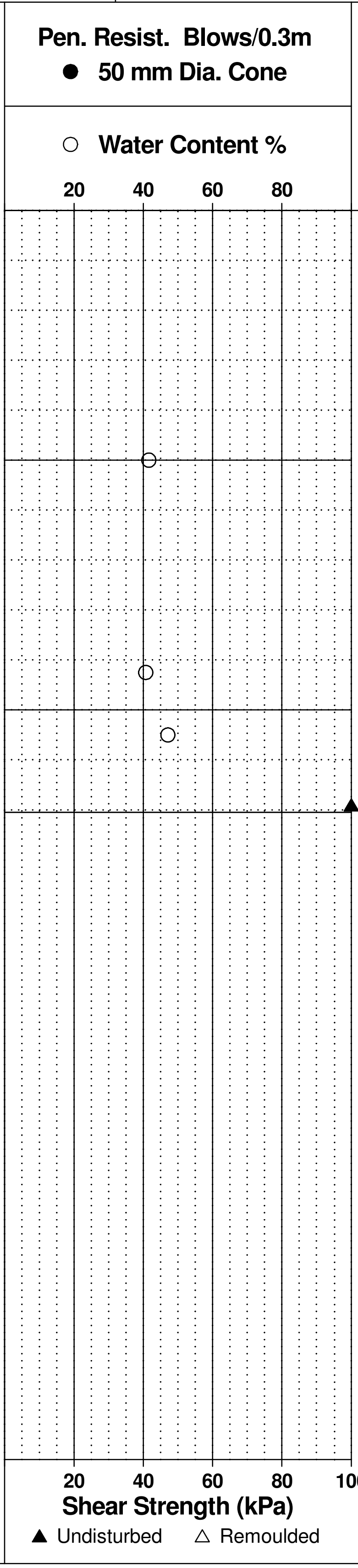
BORINGS BY Excavator

DATE 2021 February 26

FILE NO. PG5201

HOLE NO. TP 3-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	86.26
TOPSOIL 0.14	■	G	1				
Brown **SILTY CLAY** some sand 0.31	▨						
Very stiff brown **SILTY CLAY**	▨					1	85.26
	▨	G	2				
	▨	G	3			2	84.26
2.38	▨	G	4				
End of Test Pit							



Piezometer Construction

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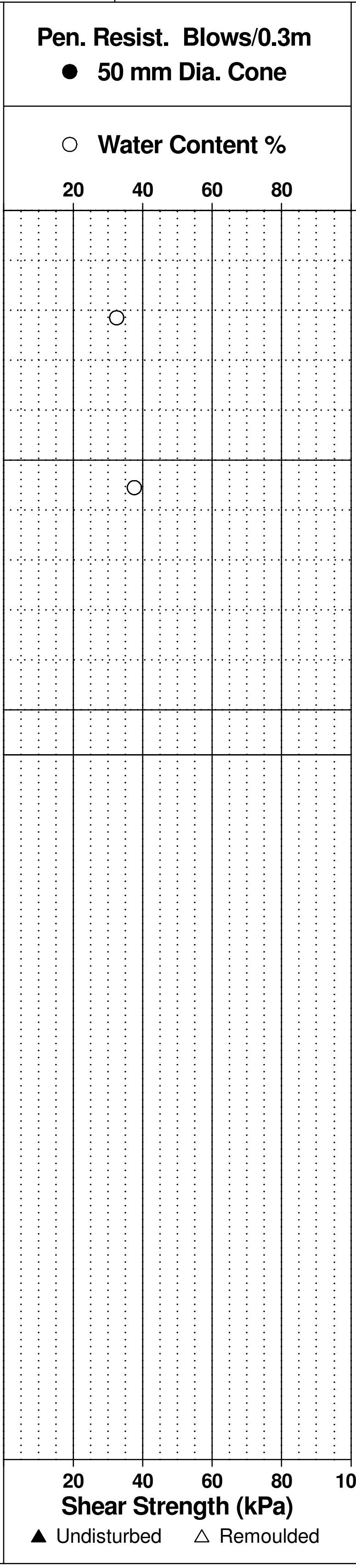
SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic
FILE NO. **PG5201**
REMARKS
HOLE NO. **TP 4-21**
BORINGS BY Excavator
DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.13
FILL: Brown silty sand with crushed stone, gravel, cobbles and boulders	▨	G	1				
	▨	G	2				
0.98						1	86.13
Stiff brown **SILTY CLAY**	▨	G	3				
	▨					2	85.13
2.18	▨	G	4				
End of Test Pit							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5201

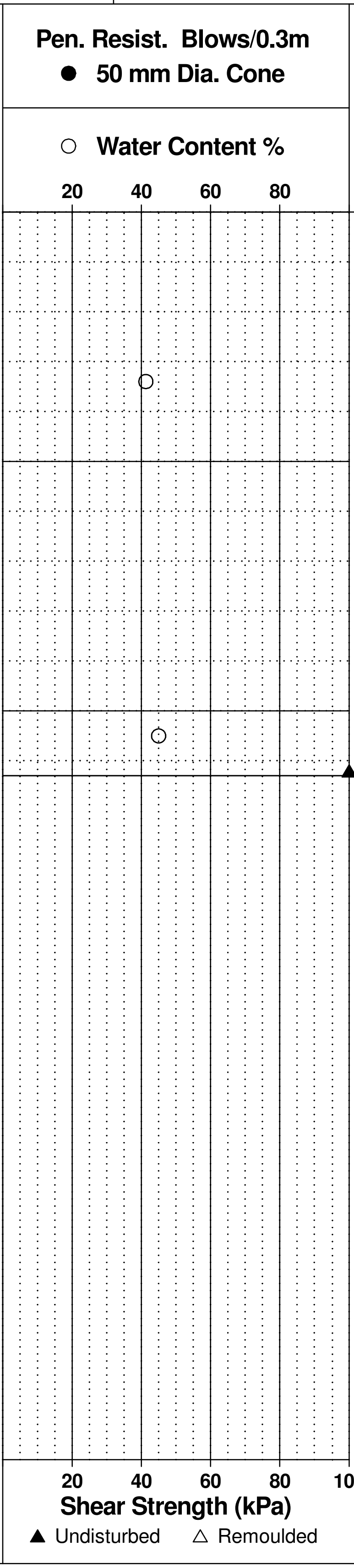
REMARKS

HOLE NO. TP 5-21

BORINGS BY Excavator

DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.15	■	G	1			0	86.65
Very stiff brown **SILTY CLAY**	▨	G	2			1	85.65
2.24	▨	G	3			2	84.65
End of Test Pit							



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5201

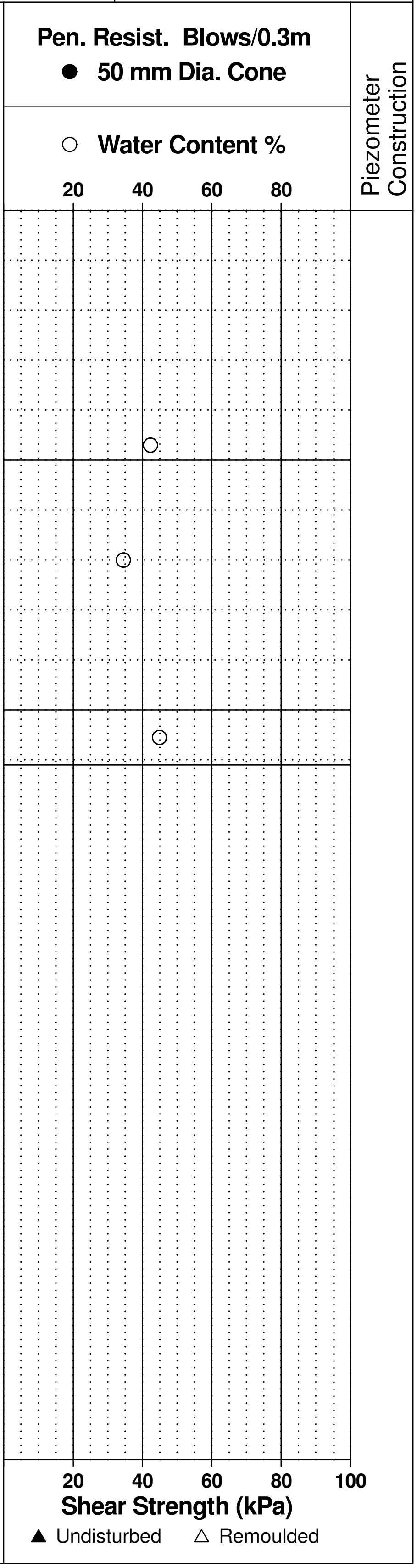
REMARKS

HOLE NO. TP 6-21

BORINGS BY Excavator

DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
TOPSOIL 0.19		G	1			0	87.93
Brown **SILTY CLAY**						1	86.93
		G	2				
1.79		G	3				
GLACIAL TILL: Brown silty clay with some sand, gravel, cobbles and boulders						2	85.93
2.22		G	4				
End of Test Pit							



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

FILE NO. PG5201

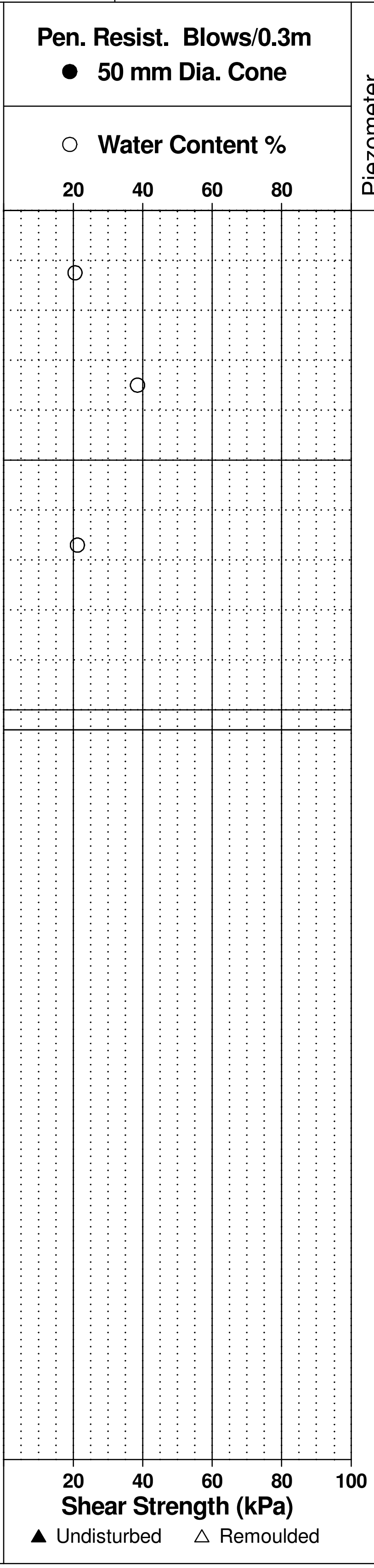
REMARKS

HOLE NO. TP 7-21

BORINGS BY Excavator

DATE 2021 February 26

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	88.71
TOPSOIL 0.25	G	1				
Brown **SILTY SAND** 0.46	G	2				
Stiff brown **SILTY CLAY** 1.35	G	3			1	87.71
GLACIAL TILL: Brown silty clay, with gravel, cobbles and boulders 2.08	G	4			2	86.71
End of Test Pit						



Piezometer Construction

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

REMARKS

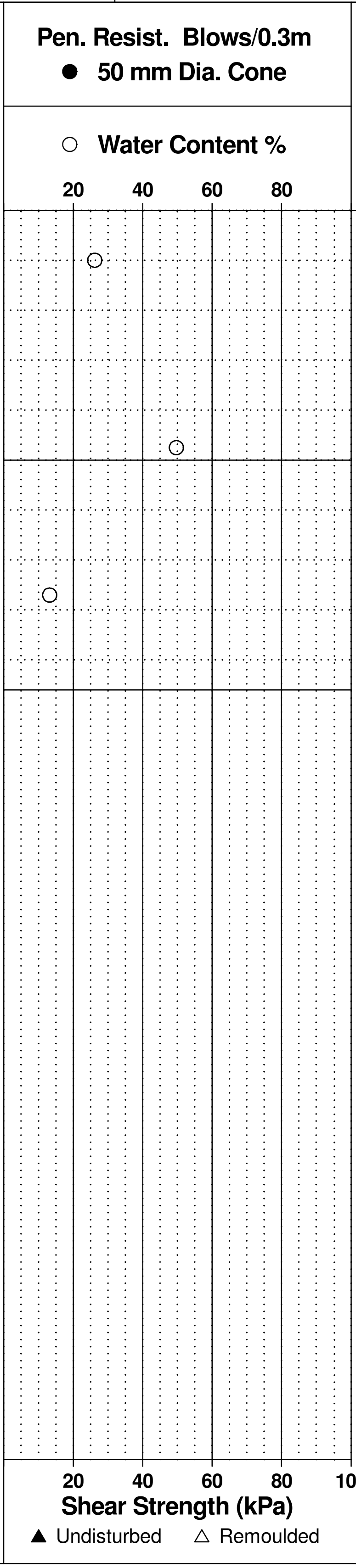
BORINGS BY Excavator

DATE 2021 February 26

FILE NO. **PG5201**

HOLE NO. **TP 8-21**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE								
TOPSOIL		G	1			0	89.57	
0.19								
Brown **SILTY SAND**		G	2					
0.95								
Stiff brown **SILTY CLAY**		G	3			1	88.57	
1.54								
GLACIAL TILL: Brown silty clay with sand, gravel, cobbles and boulders		G	4					
1.92								
End of Test Pit Refusal to excavation on bedrock surface at 1.92 m depth								



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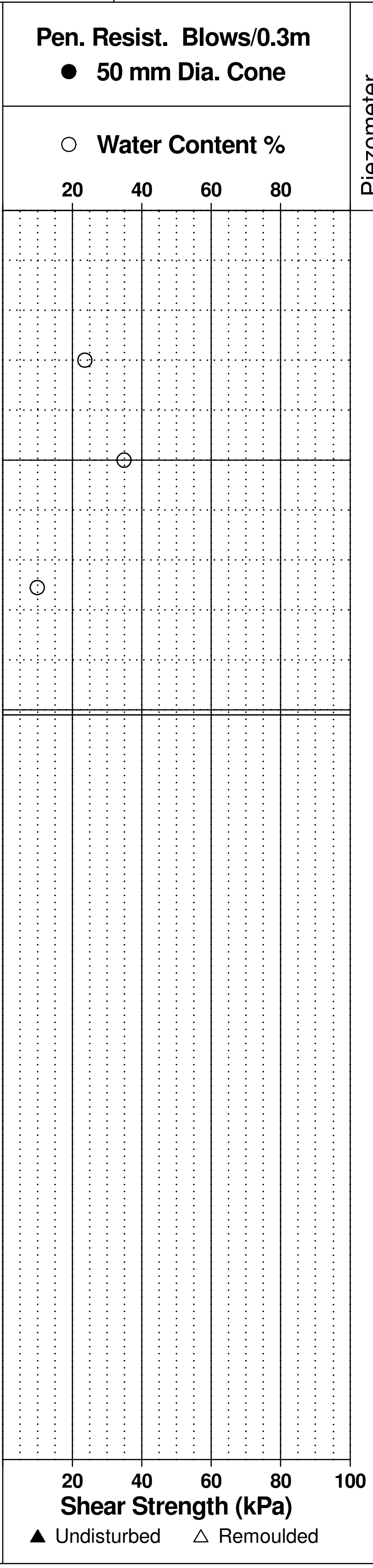
BORINGS BY Excavator

DATE 2021 February 26

FILE NO. PG5201

HOLE NO. TP 9-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.24
TOPSOIL 0.16							
Stiff brown **SILTY CLAY**		G	1				
		G	2				
						1	88.24
		G	3				
1.81		G	4				
GLACIAL TILL: Brown silty clay with brown silty sand, gravel, cobbles and boulders 2.02						2	87.24
End of Test Pit Refusal to excavation on bedrock surface at 2.02 m depth							



Piezometer Construction

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

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FILE NO. PG5201

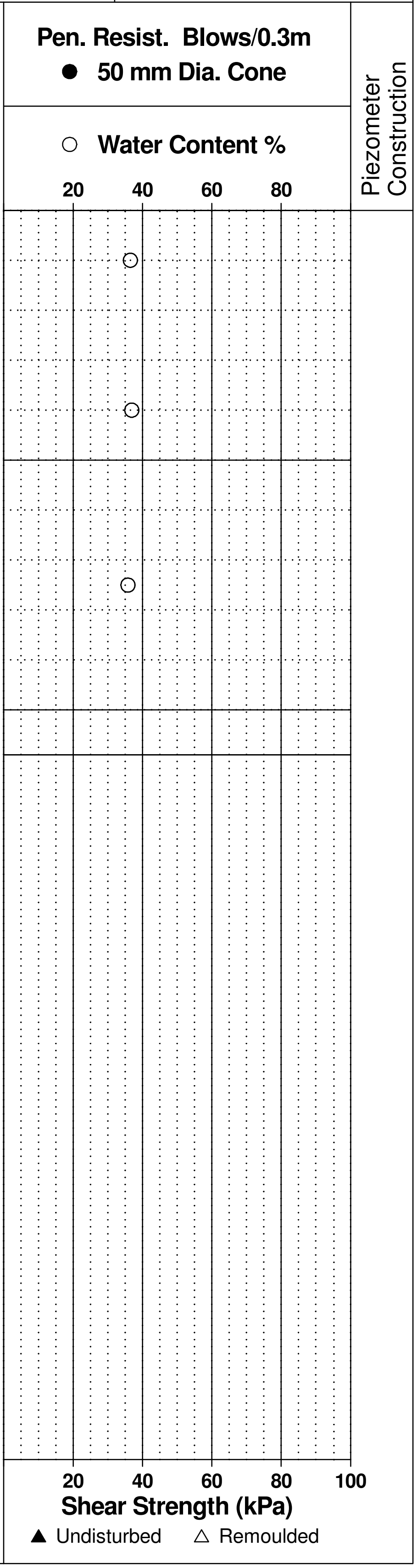
REMARKS

HOLE NO. TP10-21

BORINGS BY Excavator

DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.32
TOPSOIL 0.19	■	G	1				
Brown **SILTY CLAY**	▨	G	2				
	▨	G	3			1	87.32
	▨	G	4			2	86.32
2.18							
End of Test Pit Refusal to excavation on bedrock surface at 2.18 m depth							



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FILE NO. PG5201

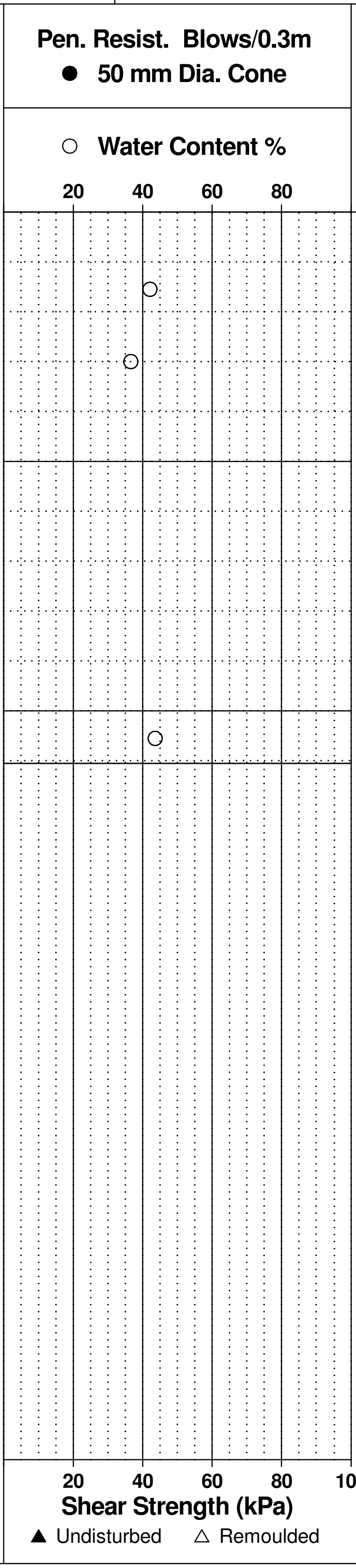
REMARKS

HOLE NO. TP11-21

BORINGS BY Excavator

DATE 2021 February 26

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	86.87	
TOPSOIL	■	G	1					
0.21								
Brown **SILTY CLAY**	▨	G	2					
	▨	G	3			1	85.87	
	▨					2	84.87	
2.21	▨	G	4					
End of Test Pit								



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Geotechnical Investigation
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REMARKS

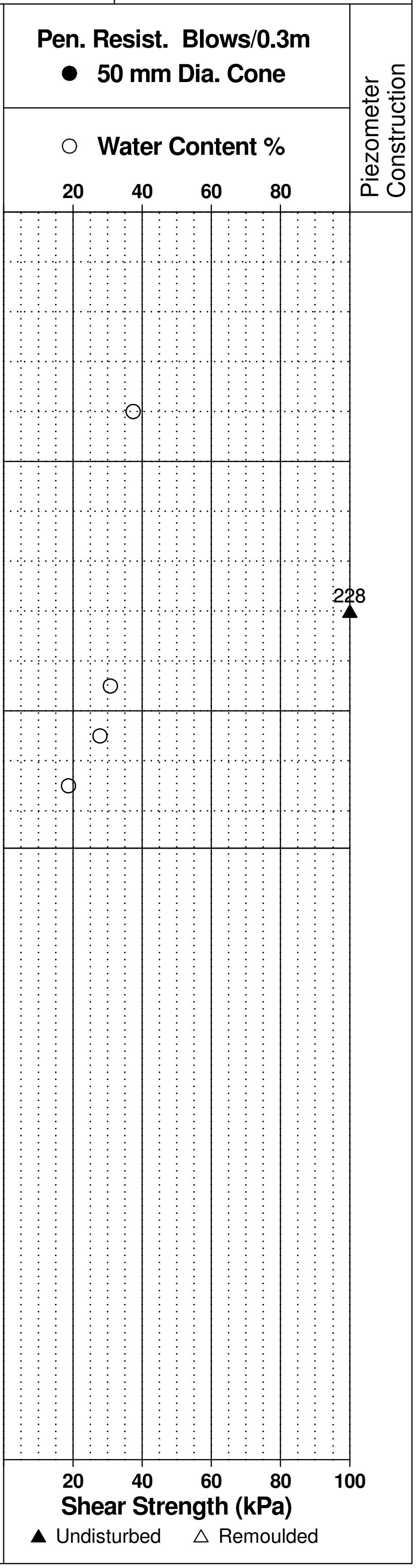
BORINGS BY Excavator

DATE 2021 March 1

FILE NO. PG5201

HOLE NO. TP12-21

SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE					0	82.56
FILL: Fragmented rock with brown silty sand	G	1				
0.45						
Hard brown **SILTY CLAY**	G	2			1	81.56
	G	3			2	80.56
	G	4				
2.30						
GLACIAL TILL: Brown silty sand, some clay, gravel, cobbles and boulders	G	5				
2.55						
End of Test Pit Refusal to excavation on bedrock surface at 2.55 m depth						



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FILE NO. **PG5201**

REMARKS

BORINGS BY Excavator

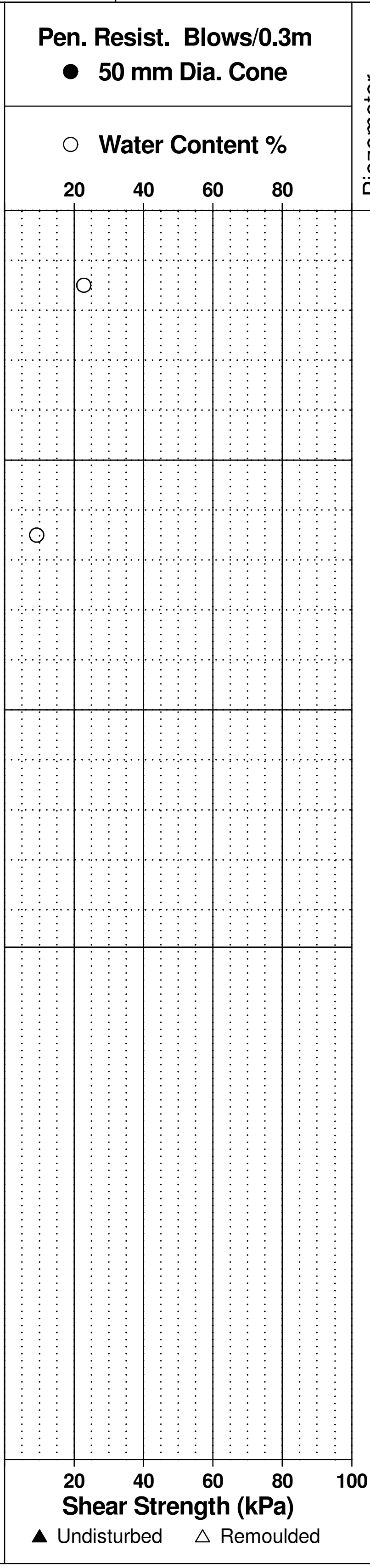
DATE 2021 March 1

HOLE NO. **TP13-21**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.22
TOPSOIL 0.22							
GLACIAL TILL: Brown silty clay some sand, trace gravel, cobbles and boulders 0.60		G	1				
GLACIAL TILL: Brown silty sand some gravel, cobbles and boulders						1	86.22
		G	2				
2.95						2	85.22

End of Test Pit

Refusal to excavation on bedrock surface at 2.95 m depth



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SOIL PROFILE AND TEST DATA

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FILE NO. **PG5201**

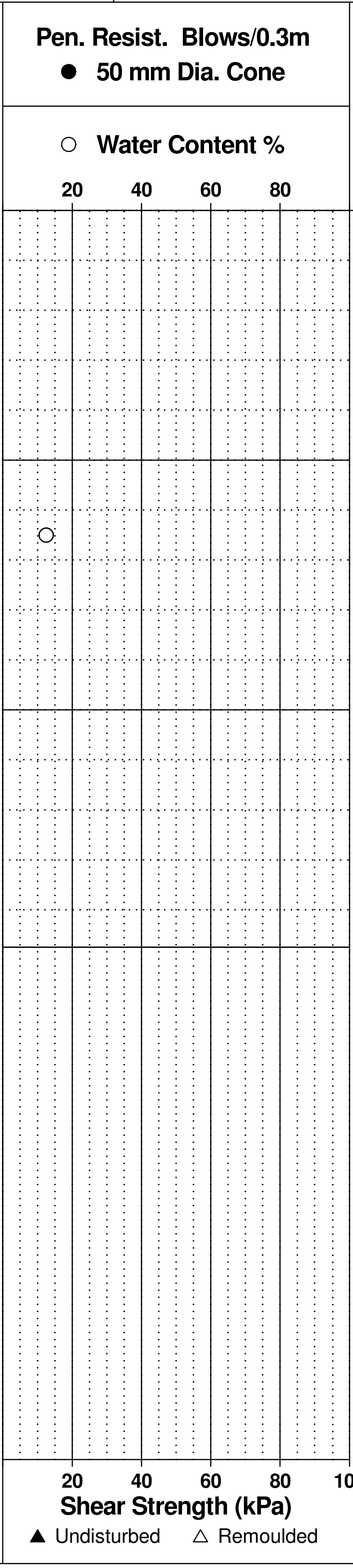
REMARKS

HOLE NO. **TP14-21**

BORINGS BY Excavator

DATE 2021 March 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	93.44
TOPSOIL 0.25		G	1				
GLACIAL TILL: Brown silty sand some gravel, cobbles and boulders						1	92.44
		G	2				
2.95						2	91.44
End of Test Pit Refusal to excavation on bedrock surface at 2.95 m depth							



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REMARKS

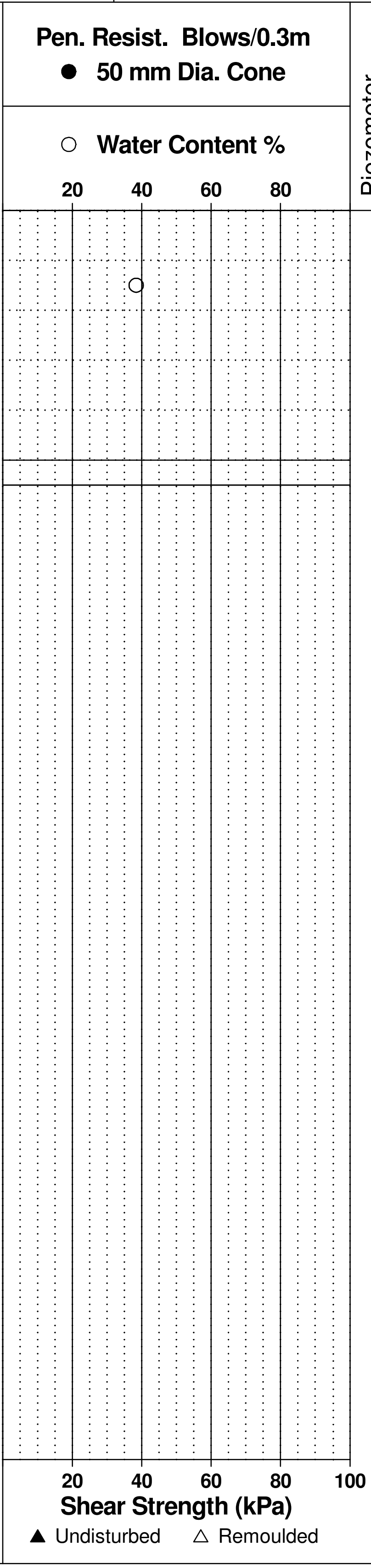
BORINGS BY Excavator

DATE 2021 March 1

FILE NO. PG5201

HOLE NO. TP15-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)	Piezometer Construction
GROUND SURFACE						0	94.54	
TOPSOIL								
0.27								
GLACIAL TILL: Brown silty sand some gravel, cobbles and boulders		G	1					
						1	93.54	
1.10								
End of Test Pit Refusal to excavation on bedrock surface at 1.10 m depth								



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Proposed Residential Development
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DATUM Geodetic

FILE NO. **PG5201**

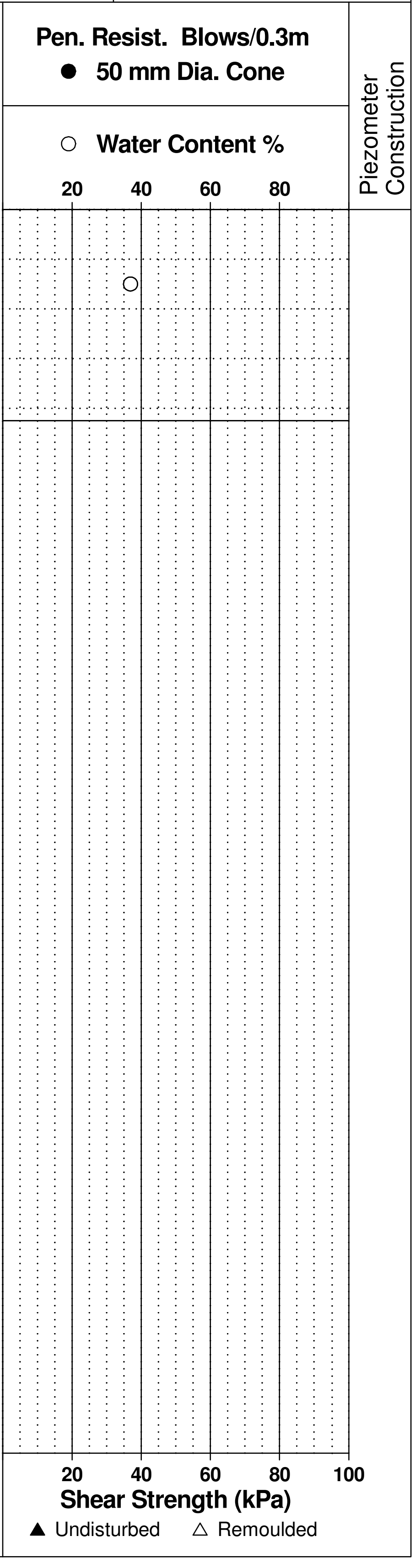
REMARKS

HOLE NO. **TP16-21**

BORINGS BY Excavator

DATE 2021 March 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	90.42
TOPSOIL 0.26							
GLACIAL TILL: Brown silty clay, some sand, gravel, cobbles and boulders 0.85		G	1				
End of Test Pit							



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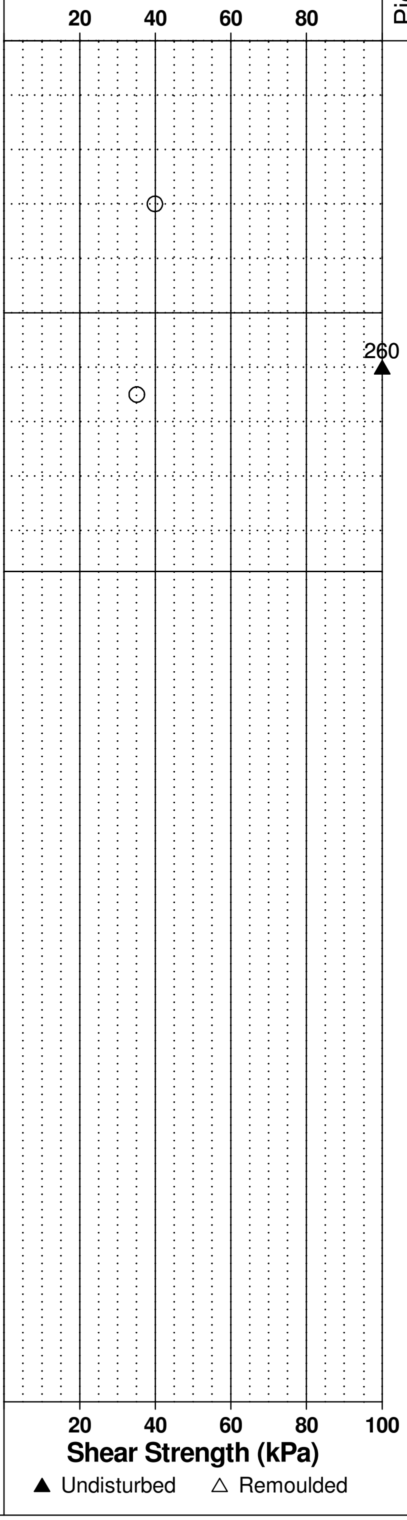
HOLE NO. TP17-21

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.57
TOPSOIL	■						
0.27							
Hard brown **SILTY CLAY**	▨	G	1				
						1	88.57
	▨	G	2				
1.95							
End of Test Pit Refusal to excavation on bedrock surface at 1.95 m depth							

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

○ Water Content %



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SOIL PROFILE AND TEST DATA

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Proposed Residential Development
Cardinal Creek Village South - Ottawa, Ontario

DATUM Geodetic

FILE NO. **PG5201**

REMARKS

HOLE NO. **TP18-21**

BORINGS BY Excavator

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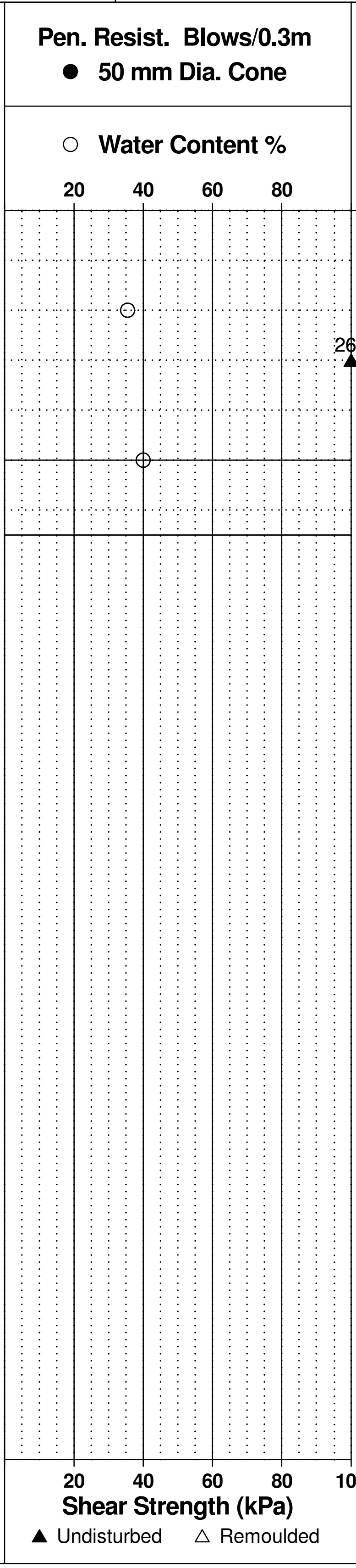
SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	89.96
TOPSOIL 0.26							
Hard brown **SILTY CLAY**		G	1				
		G	2			1	88.96
1.30							
End of Test Pit Refusal to excavation on bedrock surface at 1.30 m depth							



Piezometer Construction

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FILE NO. PG5201

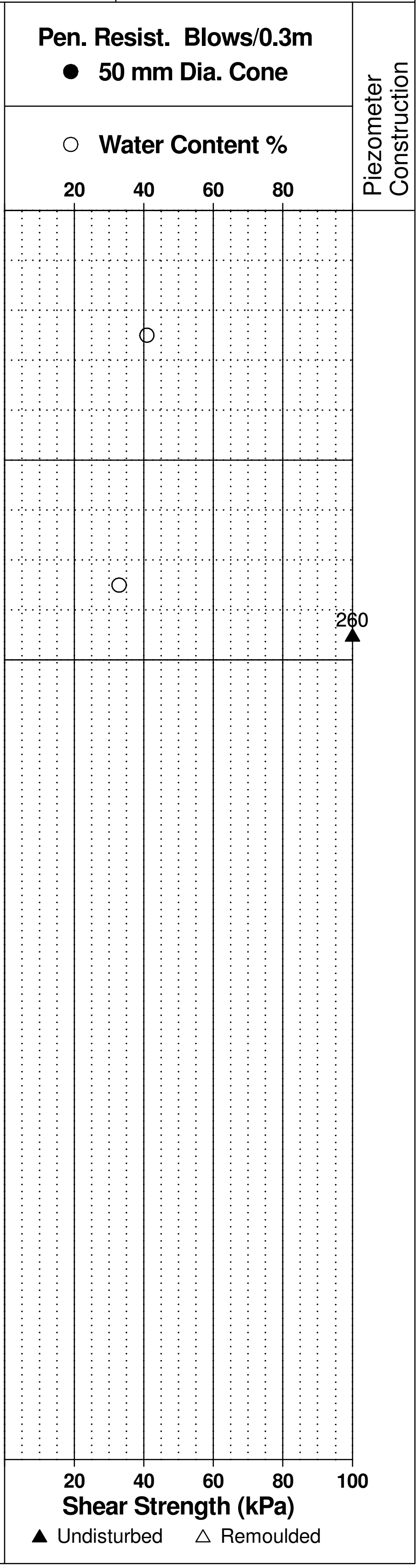
REMARKS

HOLE NO. TP19-21

BORINGS BY Excavator

DATE 2021 March 1

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	88.27
TOPSOIL 0.28	■						
ard brown **SILTY CLAY**	▨	G	1				
	▨					1	87.27
1.80	▨	G	2				



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Proposed Residential Development
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REMARKS

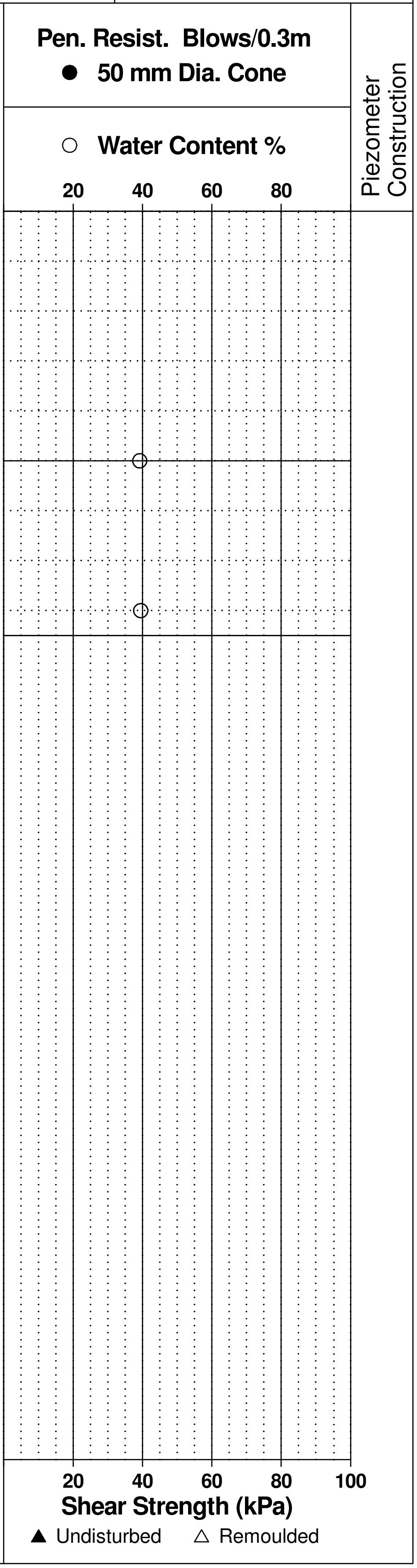
BORINGS BY Excavator

DATE 2021 March 1

FILE NO. **PG5201**

HOLE NO. **TP20-21**

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	87.43
TOPSOIL	■						
0.29							
Hard brown **SILTY CLAY**	▨						
		G	1			1	86.43
1.70		G	2				
End of Test Pit Refusal to excavation on bedrock surface at 1.70 m depth							



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 relative strength of cohesionless soils is the compactness condition, 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. An SPT N value of “P” denotes that the split-spoon sampler was pushed 300 mm into the soil without the use of a falling hammer.

Compactness Condition	‘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 shear vane tests, unconfined compression tests, or occasionally by the Standard Penetration Test (SPT). Note that the typical correlations of undrained shear strength to SPT N value (tabulated below) tend to underestimate the consistency for sensitive silty clays, so Paterson reviews the applicable split spoon samples in the laboratory to provide a more representative consistency value based on tactile examination.

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, S_t, is the ratio between the undisturbed undrained shear strength and the remoulded undrained shear strength of the soil. The classes of sensitivity may be defined as follows:

Low Sensitivity: $S_t < 2$
Medium Sensitivity: $2 < S_t < 4$
Sensitive: $4 < S_t < 8$
Extra Sensitive: $8 < S_t < 16$
Quick Clay: $S_t > 16$

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 NQ or larger size core. However, it can be used on smaller core sizes, such as BQ, 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, generally recovered using a piston sampler
G - "Grab" sample from test pit or surface materials
AU - Auger sample or bulk sample
WS - Wash sample
RC - Rock core sample (Core bit size BQ, NQ, HQ, etc.). Rock core samples are obtained with the use of standard diamond drilling bits.

SYMBOLS AND TERMS (continued)

PLASTICITY LIMITS AND GRAIN SIZE DISTRIBUTION

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

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

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

CONSOLIDATION TEST

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

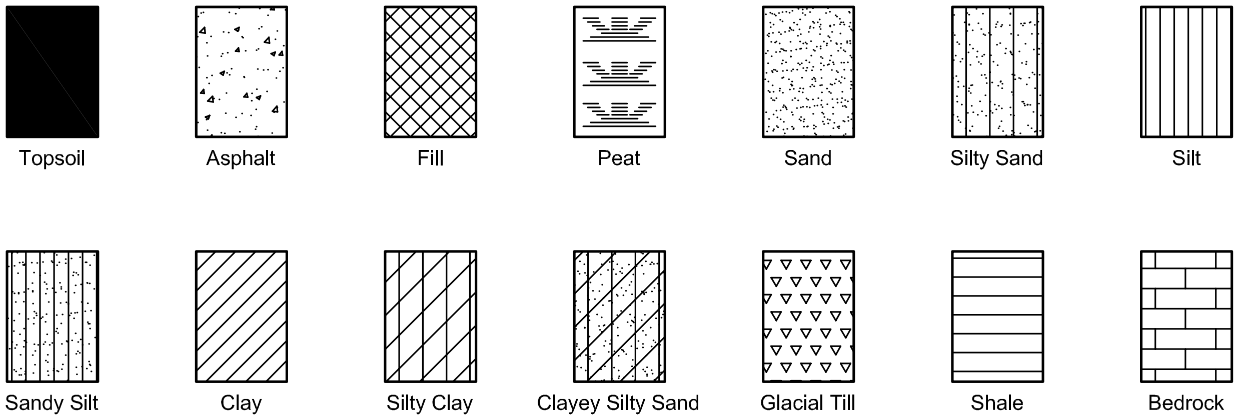
OC Ratio Overconsolidaton ratio = p'_c / p'_o
Void Ratio Initial sample void ratio = volume of voids / volume of solids
Wo - Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

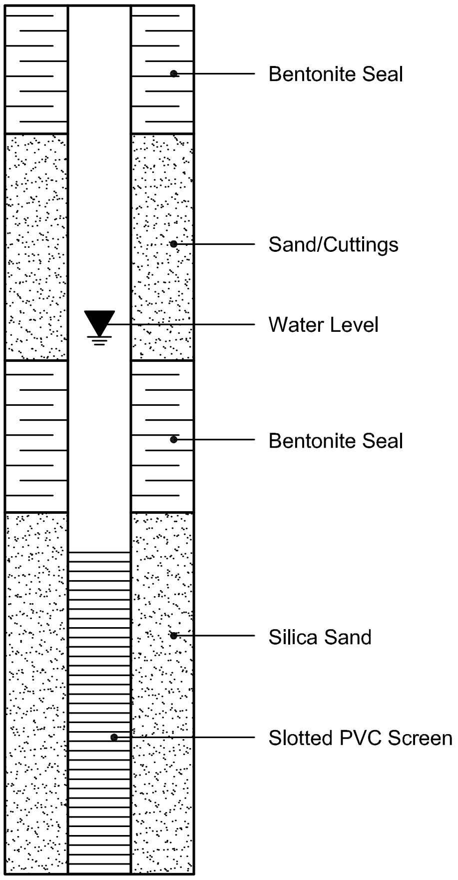
SYMBOLS AND TERMS (continued)

STRATA PLOT

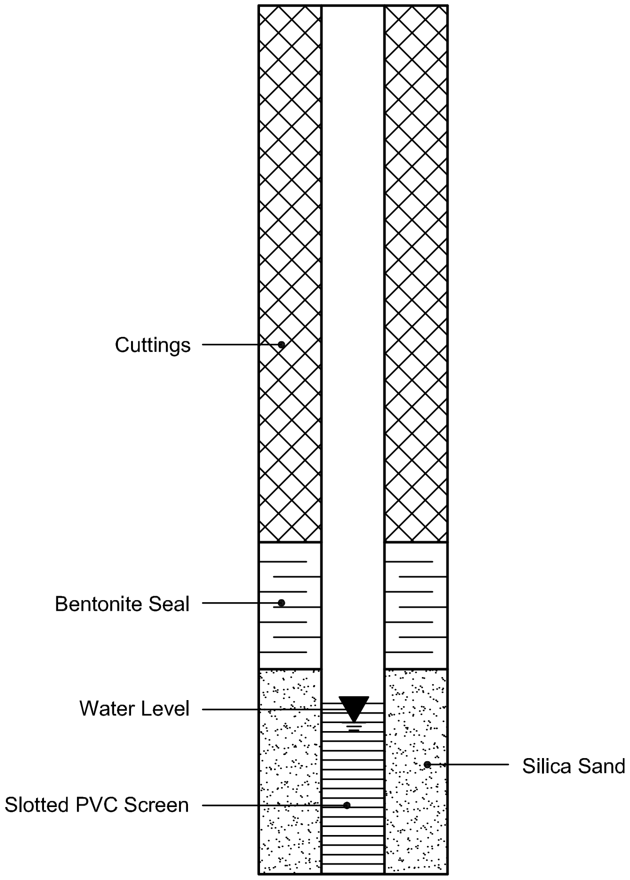


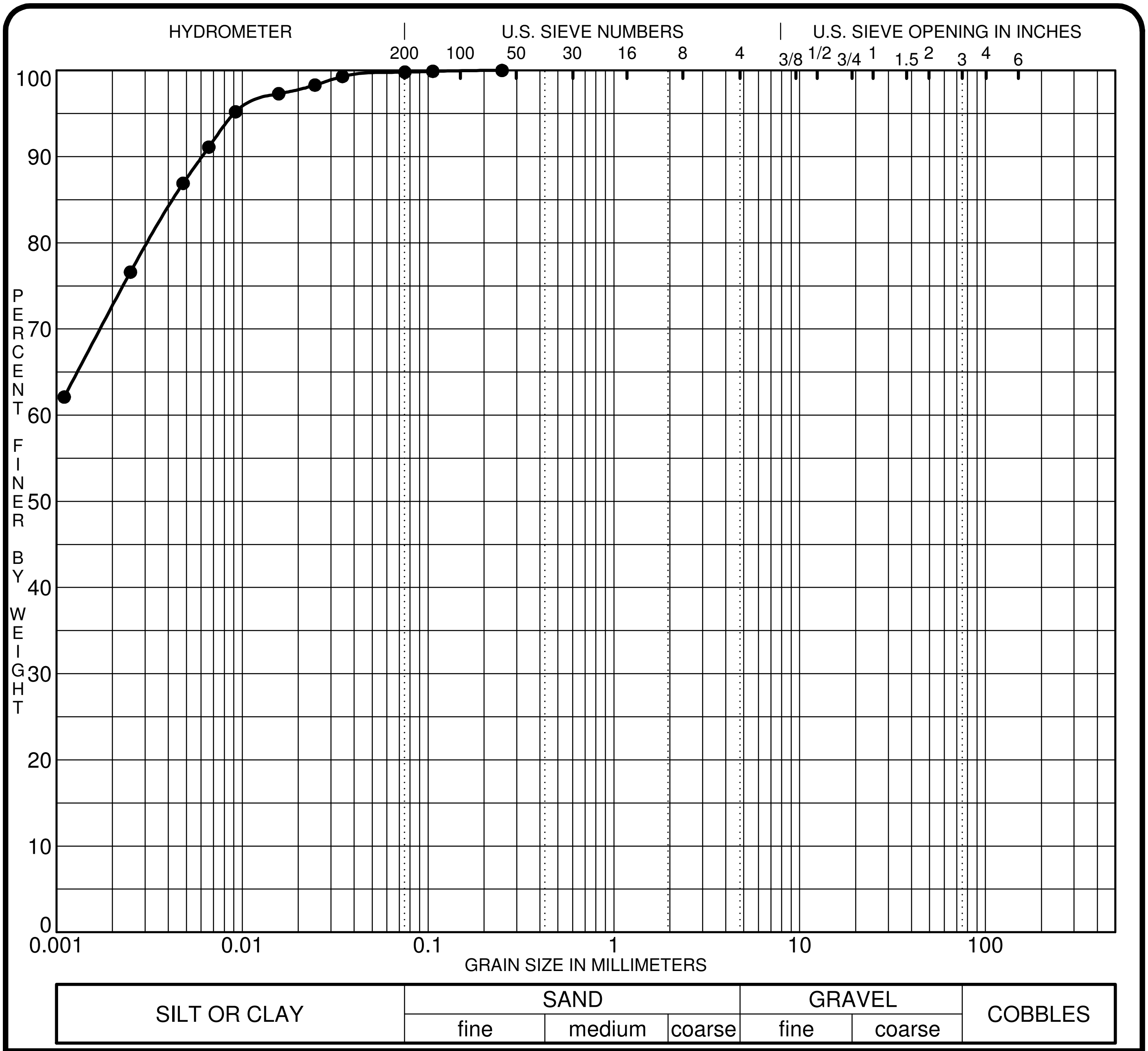
MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION





	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 2-21 G4**	**CH = Inorganic Clays of High Plasticity**		**71**	**29**	**42**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 2-21 G4**	**0.25**				**0.0**	**0.2**	**99.8**	

CLIENT **Taggart Investments**
FILE NO. **PG5201**
PROJECT **Geotechnical Investigation - Proposed Residential Development**
DATE **26 Feb 21**

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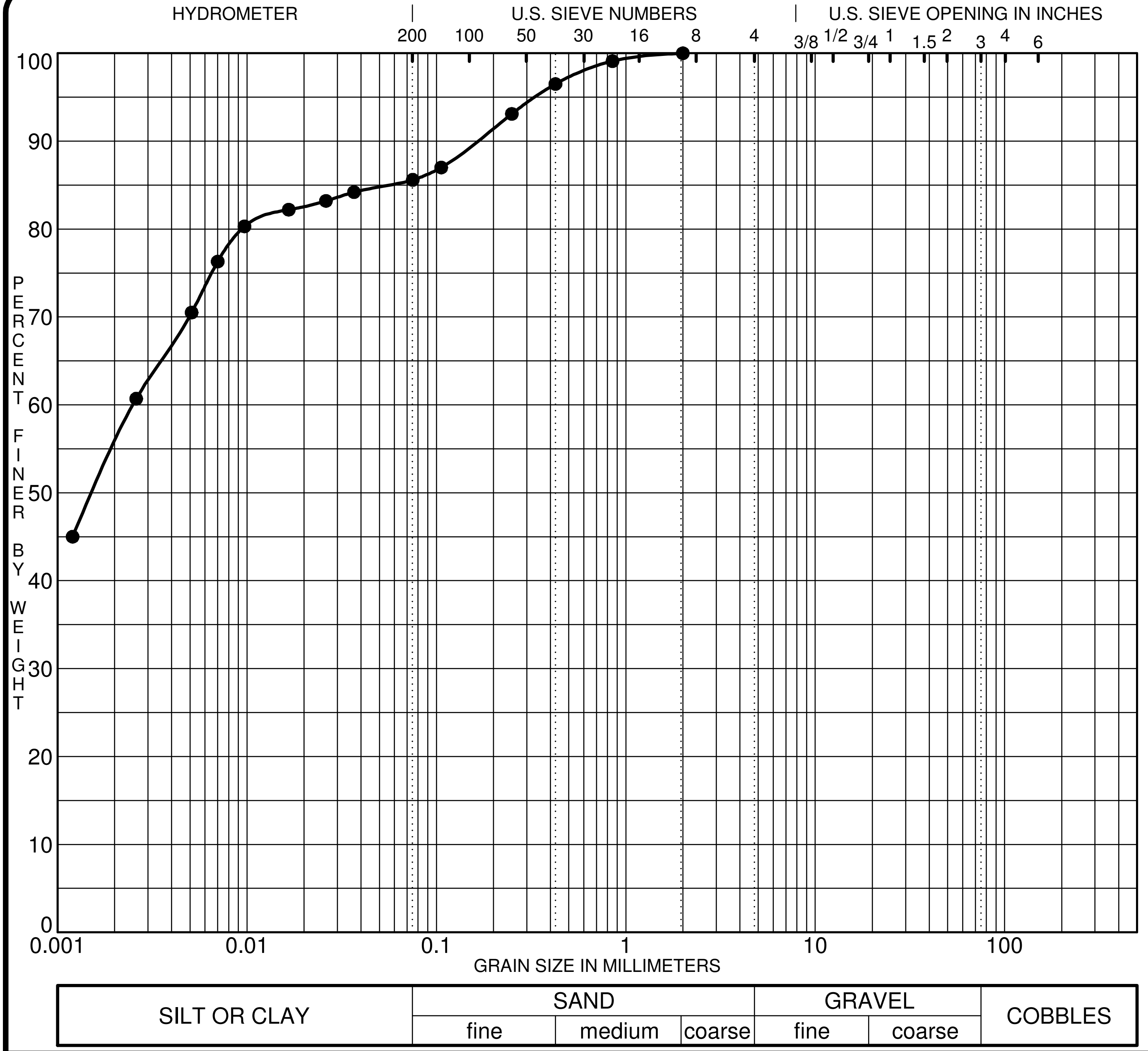
GRAIN SIZE DISTRIBUTION



Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP 7-21 G3**	**MH = Inorganic Silts of High Plasticity**		**59**	**32**	**27**		

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP 7-21 G3**	**2.00**	**0.00**			**0.0**	**14.4**	**85.6**	

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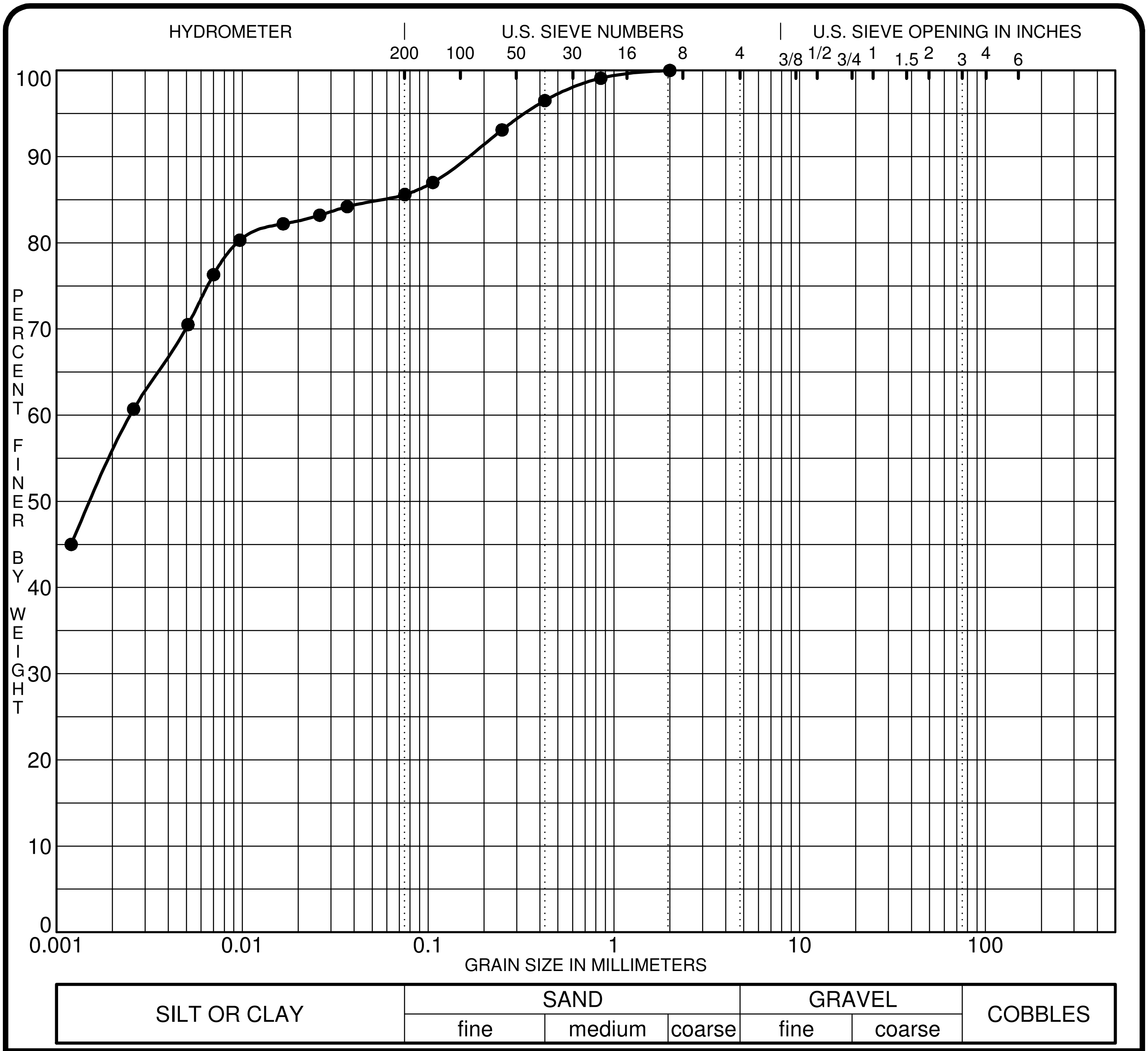
GRAIN SIZE DISTRIBUTION



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP10-21 G4**	**MH = Inorganic SIlts of High Plasticity**		**60**	**33**	**27**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP10-21 G4**	**2.00**	**0.00**			**0.0**	**14.4**	**85.6**	

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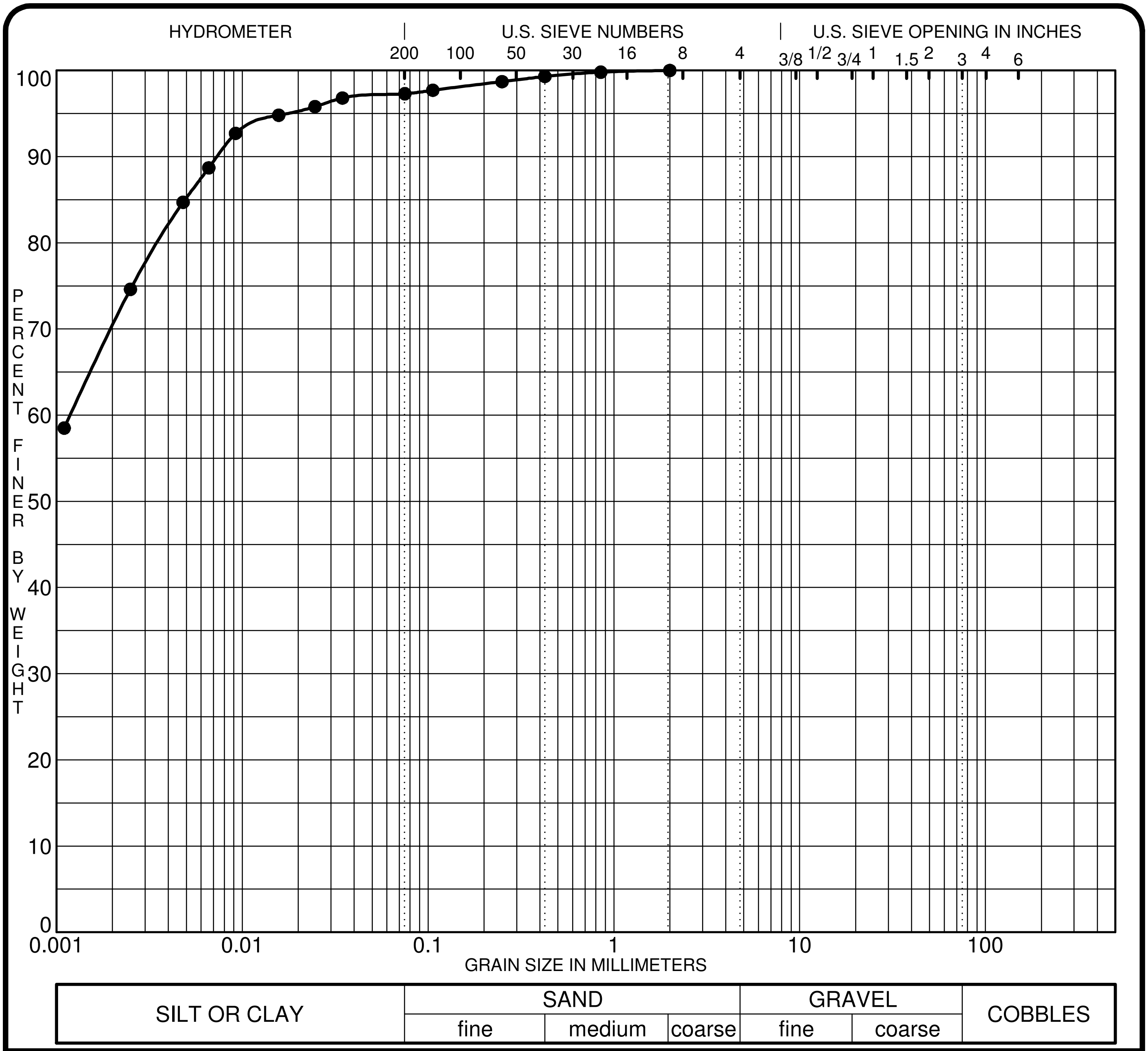
GRAIN SIZE DISTRIBUTION



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP12-21 G2**	**MH = Inorganic Silts of High Plasticity**		**75**	**37**	**38**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP12-21 G4**	**2.00**	**0.00**			**0.0**	**2.7**	**97.3**	

CLIENT **Taggart Investments**

PROJECT **Geotechnical Investigation - Proposed Residential Development**

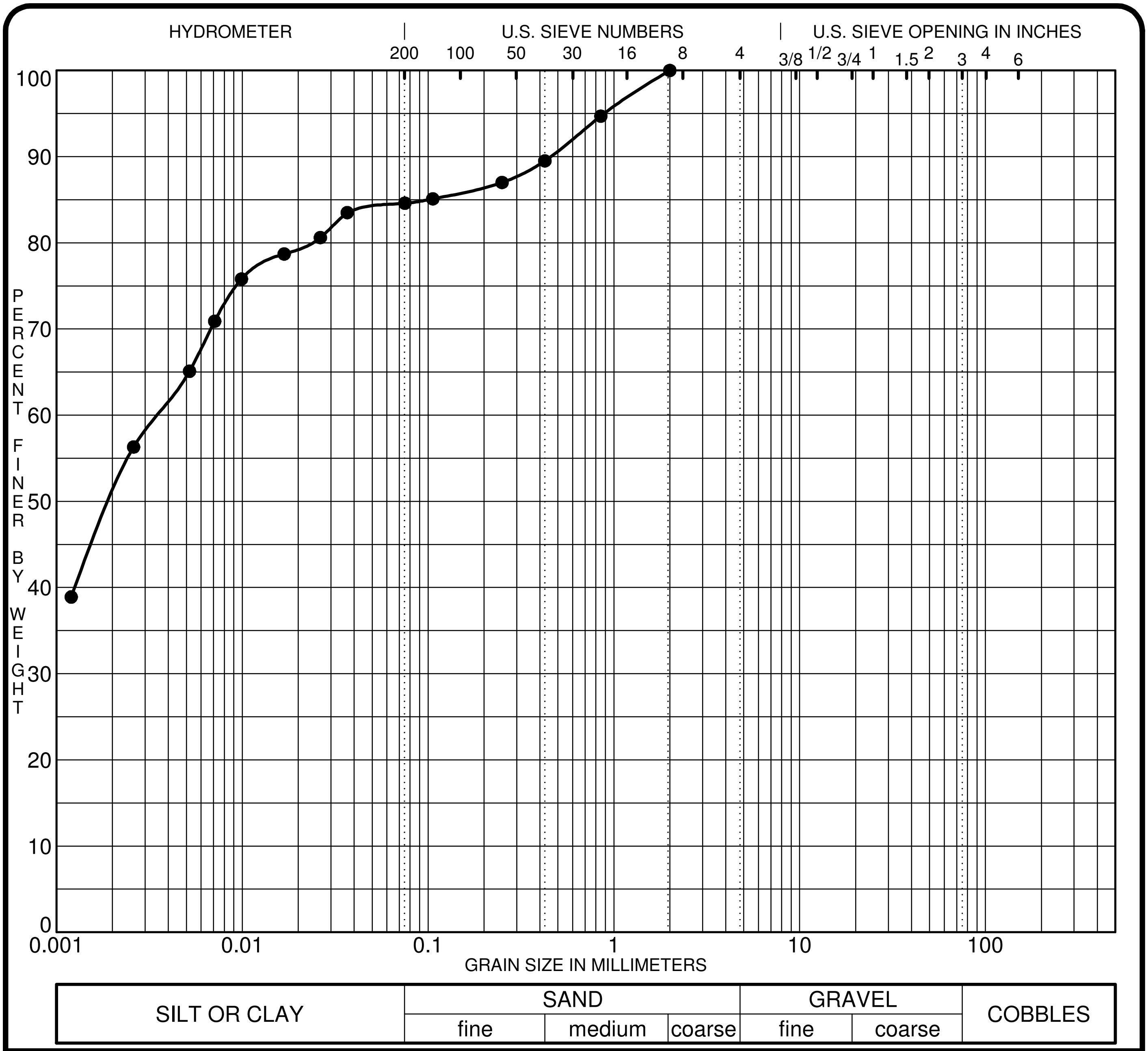
FILE NO. **PG5201**

DATE **1 Mar 21**

patersongroup **Consulting Engineers**

154 Colonnade Road South, Ottawa, Ontario K2E 7J5

GRAIN SIZE DISTRIBUTION



	Specimen Identification	Classification	MC%	LL	PL	PI	Cc	Cu
●	**TP18-21 G1**	**MH = Inorganic Silts of High Plasticity**		**66**	**36**	**30**		

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP18-21 G1**	**2.00**	**0.00**			**0.0**	**15.4**	**84.6**	

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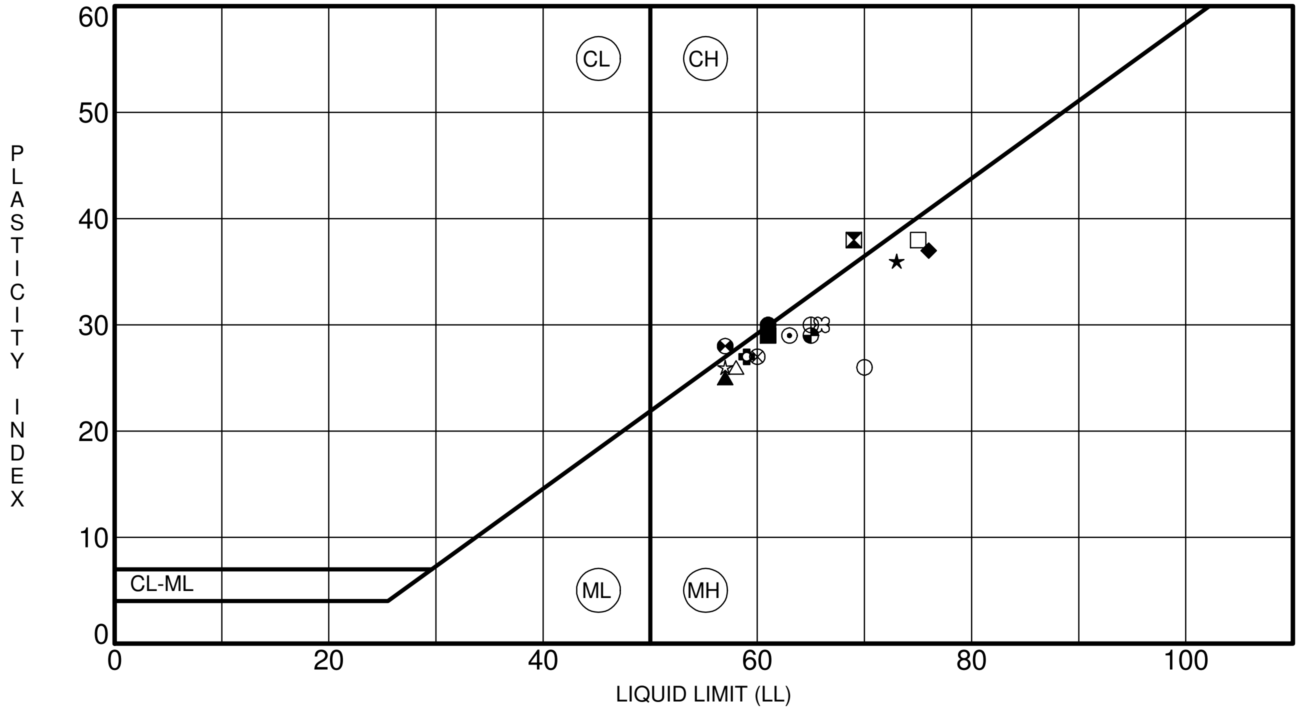

Specimen Identification		LL	PL	PI	Fines	Classification
●	**TP 1-21 G4**	**61**	**31**	**30**		**CH = Inorganic Clays of High Plasticity**
⧗	**TP 3-21 G3**	**69**	**31**	**38**		**CH = Inorganic Clays of High Plasticity**
▲	**TP 4-21 G3**	**57**	**32**	**25**		**MH = Inorganic Silts of High Plasticity**
★	**TP 5-21 G3**	**73**	**37**	**36**		**MH = Inorganic Silts of High Plasticity**
⊙	**TP 6-21 G2**	**63**	**34**	**29**		**MH = Inorganic Silts of High Plasticity**
✿	**TP 7-21 G3**	**59**	**32**	**27**	**85.6**	**MH = Inorganic Silts of High Plasticity**
○	**TP 8-21 G3**	**70**	**44**	**26**		**MH = Inorganic Silts of High Plasticity**
△	**TP 9-21 G2**	**58**	**32**	**26**		**MH = Inorganic Silts of High Plasticity**
⊗	**TP10-21 G4**	**60**	**33**	**27**	**85.6**	**MH = Inorganic SIlts of High Plasticity**
⊕	**TP11-21 G4**	**65**	**35**	**30**		**MH = Inorganic Silts of High Plasticity**
□	**TP12-21 G2**	**75**	**37**	**38**	**97.3**	**MH = Inorganic Silts of High Plasticity**
☢	**TP16-21 G1**	**57**	**29**	**28**		**CH = Inorganic Clays of High Plasticity**
◕	**TP17-21 G1**	**65**	**36**	**29**		**MH = Inorganic Silts of High Plasticity**
☆	**TP17-21 G2**	**57**	**31**	**26**		**MH = Inorganic Silts of High Plasticity**
✤	**TP18-21 G1**	**66**	**36**	**30**	**84.6**	**MH = Inorganic Silts of High Plasticity**
■	**TP19-21 G2**	**61**	**32**	**29**		**MH = Inorganic Silts of High Plasticity**
◆	**TP20-21 G1**	**76**	**39**	**37**		**MH = Inorganic Silts of High Plasticity**

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FILE NO. **PG5201**

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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

ATTERBERG LIMITS' RESULTS

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 45.497N 75.458W **User File Reference:** PG5201

2022-02-06 21:38 UT

Requested by: Paterson Group

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.523	0.288	0.170	0.049
Sa (0.1)	0.604	0.343	0.211	0.067
Sa (0.2)	0.497	0.287	0.180	0.060
Sa (0.3)	0.373	0.217	0.137	0.047
Sa (0.5)	0.261	0.152	0.096	0.033
Sa (1.0)	0.127	0.074	0.047	0.016
Sa (2.0)	0.059	0.034	0.021	0.006
Sa (5.0)	0.016	0.008	0.005	0.001
Sa (10.0)	0.006	0.003	0.002	0.001
PGA (g)	0.319	0.185	0.114	0.036
PGV (m/s)	0.217	0.121	0.074	0.023

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

Natural Resources Canada Ressources naturelles Canada

Canada

Table 1 - Cardinal Creek Village South - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mississippi River	OF8600	Mss1	45.41279	-76.24891	Landslide	Source area with truncated debris field	0.08	Unknown	15.00	65.80	Marine Deposits	15 to 25	Granite
Mississippi River	OF8600	Mss2	45.41224	-76.25685	Landslide	Source area with debris field	0.03	Unknown	11.00	66.46	Marine Deposits	15 to 25	Granite
Mississippi River	OF8600	Mss3	45.40384	-76.24579	Landslide	Source area with debris field	0.11	Unknown	23.00	65.72	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss4	45.40073	-76.25147	Landslide	Truncated source area	0.01	Unknown	14.00	66.25	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss5	45.39957	-76.24593	Landslide	Source area with truncated debris field	0.02	Unknown	20.00	65.82	Erosional Terraces	15 to 25	Marble
Mississippi River	OF8600	Mss6	45.39906	-76.25294	Landslide	Source area with truncated debris field	0.04	Unknown	15.00	66.40	Marine Deposits	15 to 25	Marble
Mississippi River	OF8600	Mss7	45.39121	-76.25506	Landslide	Truncated source area	0.01	Unknown	15.00	66.74	Erosional Terraces	10 to 15	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss8	45.38970	-76.25421	Landslide	Source area with truncated debris field	0.03	Unknown	12.00	66.71	Erosional Terraces	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss9	45.38953	-76.25872	Landslide	Source area with truncated debris field	0.02	Unknown	15.00	67.07	Organic Deposits	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss10	45.38715	-76.25825	Landslide	Source area with truncated debris field	0.01	Unknown	15.00	67.09	Erosional Terraces	5 to 10	Interbedded Limestone and Shale
Mississippi River	OF8600	Mss11	45.37849	-76.26739	Landslide	Truncated source area	0.03	Unknown	13.00	68.04	Erosional Terraces	50 to 100	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss12	45.37130	-76.26864	Landslide	Truncated source area	0.02	Unknown	11.00	68.32	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi Valley	OF8600	Mss13	45.36543	-76.27229	Landslide	Truncated source area	0.02	Unknown	12.00	68.77	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss14	45.36519	-76.27788	Landslide	Source area with truncated debris field	0.02	Unknown	12.00	69.22	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss15	45.36304	-76.27430	Landslide	Source area with truncated debris field	0.03	Unknown	15.00	68.99	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss16	45.36359	-76.26926	Landslide	Truncated source area	0.01	Unknown	17.00	68.57	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss17	45.36075	-76.26736	Landslide	Source area with debris field	0.06	Unknown	20.00	68.50	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss18	45.36124	-76.27193	Landslide	Truncated source area	0.01	Unknown	12.00	68.85	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss19	45.36122	-76.27561	Landslide	Source area with debris field	0.04	Unknown	10.00	69.15	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite

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			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mississippi River	OF8600	Mss20	45.36267	-76.28135	Landslide	Source area with debris field	0.02	Unknown	10.00	69.57	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss21	45.35604	-76.26640	Landslide	Source area with debris field	0.11	Unknown	15.00	68.55	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss22	45.35416	-76.27441	Landslide	Truncated source area	0.01	Unknown	17.00	69.25	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss23	45.35244	-76.27982	Landslide	Truncated source area	0.01	Unknown	25.00	69.73	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss24	45.35168	-76.28166	Landslide	Truncated source area	0.01	Unknown	25.00	69.90	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Mississippi River	OF8600	Mss25	45.35103	-76.28318	Landslide	Truncated source area	0.02	Unknown	20.00	70.04	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy1	45.35143	-76.26277	Landslide	Source area with truncated debris field	0.01	Unknown	16.00	68.40	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy2	45.35023	-76.26130	Landslide, possibly	Source area with debris field	0.01	Unknown	***	68.32	***	***	***
Cody Creek	OF8600	Cdy3	45.34522	-76.26452	Landslide	Truncated source area	0.01	Unknown	21.00	68.73	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy4	45.34223	-76.26721	Landslide	Truncated source area	0.02	Unknown	17.00	69.04	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy5	45.33939	-76.25827	Landslide	Source area with truncated debris field	0.07	Unknown	17.00	68.42	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy6	45.33979	-76.24991	Landslide	Source area with truncated debris field	0.06	Unknown	13.00	67.74	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy7	45.34175	-76.24524	Landslide, possibly	Source area with truncated debris field	0.10	Unknown	***	67.30	***	***	***
Cody Creek	OF8600	Cdy8	45.33762	-76.24262	Landslide	Source area with truncated debris field	0.03	Unknown	23.00	67.23	Marine Deposits	10 to 15	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy9	45.33822	-76.23647	Landslide	Source area with truncated debris field	0.01	Unknown	17.00	66.73	Marine Deposits	5 to 10	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy10	45.33477	-76.23220	Landslide	Source area with truncated debris field	0.06	Unknown	12.00	66.50	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy11	45.33386	-76.23415	Landslide, probably	Source area with truncated debris field	0.04	Unknown	**	66.69	**	**	**
Cody Creek	OF8600	Cdy12	45.32989	-76.22645	Landslide, probably	Source area with truncated debris field	0.04	Unknown	**	66.22	**	**	**
Cody Creek	OF8600	Cdy13	45.32654	-76.22004	Landslide, probably	Source area with truncated debris field	0.03	Unknown	**	65.83	**	**	**

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			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Cody Creek	OF8600	Cdy14	45.32031	-76.21358	Landslide	Source area with truncated debris field; isolated areas of debris field	0.05	Unknown	24.00	65.56	Marine Deposits	10 to 15	Interbedded Limestone and Dolomite
Cody Creek	OF8600	Cdy15	45.34728	-76.23587	Landslide, probably	Debris field within a narrow stream valley	0.01	Unknown		66.38			
Madawaska Lake reservoir	OF8600	Mdw1	45.40855	-76.35190	Landslide, former site of	Inundated beneath lake waters	**	Unknown	7.00	74.28	Marine Deposits	10 to 15	Marble
Fitzroy	OF8600	Ftz1	45.50319	-76.22097	Landslide	Truncated source area	0.03	Unknown	10.00	62.72	Alluvial Sediments	5 to 10	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz2	45.50437	-76.21394	Landslide	Truncated source area	0.02	Unknown	16.00	62.14	Alluvial Sediments	5 to 10	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz3	45.49835	-76.15980	Landslide	Source area with truncated debris field	0.16	Unknown	27.00	57.68	Erosional Terraces	10 to 15	Interbedded Limestone and Dolomite
Fitzroy	OF8600	Ftz4	45.50664	-76.13974	Landslide	Truncated source area	0.23	Unknown	11.00	56.03	Erosional Terraces	5 to 10	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB1	45.48572	-76.10521	Landslide	Source area with truncated debris field	0.49	Unknown	34.00	53.20	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB2	45.48122	-76.10138	Landslide	Source area with truncated debris field	0.13	Unknown	30.00	52.90	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Buckhams Bay	OF8600	BkB3	45.47977	-76.09564	Landslide	Source area with truncated debris field	0.10	Unknown	30.00	52.44	Erosional Terraces	15 to 25	Interbedded Limestone and Dolomite
Carp Creek	OF8600	Crp1	45.34812	-76.04299	Landslide	Source area with debris field	0.10	Unknown	20.00	51.18	Marine Deposits	25 to 50	Interbedded Limestone and Shale
Rideau River	OF8600	Rid1	45.38818	-75.70428	Landslide	Truncated source area	0.05	Unknown	15.00	23.86	Erosional Terraces	5 to 10	Limestone
Rideau River	OF8600	Rid2	45.32436	-75.69166	Landslide	Source area with debris field	0.06	Unknown	30.00	27.86	Alluvial Sediments	15 to 25	Interbedded Dolomite and Sandstone
Rideau River	OF8600	Rid3	45.28377	-75.69606	Landslide, possibly	Truncated source area?	0.01	Unknown		31.72			
Rockcliffe	OF8600	Rkf1	45.45147	-75.67312	Landslide, probably	Truncated source area	0.02	Unknown		18.39			
Gloucester	OF8600	Glt1	45.44963	-75.59729	Landslide	Source area with debris field	0.12	About 1000 cal yr BP	30.00	12.63	Erosional Terraces	25 to 50	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln1	45.45962	-75.55209	Landslide, possibly	Truncated source area?	0.02	Unknown		8.78			
Orleans	OF8600	Oln2	45.45719	-75.54766	Landslide	Debris field within a narrow stream valley	0.11	Unknown	17.00	8.62	Marine Deposits	25 to 50	Shale
Orleans	OF8600	Oln3	45.46016	-75.54108	Landslide	Debris field within a narrow stream valley	0.05	Unknown	5.00	7.97	Marine Deposits	50 to 100	Shale

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			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Orleans	OF8600	Oln4	45.45726	-75.54049	Landslide	Debris field within a narrow stream valley	0.02	Unknown	5.00	8.12	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln5	45.45487	-75.53897	Landslide	Debris field within a narrow stream valley	0.02	Unknown	9.00	8.18	Marine Deposits	50 to 100	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln6	45.45863	-75.53838	Landslide	Debris field within a narrow stream valley	0.01	Unknown	3.00	7.89	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln7	45.45977	-75.53858	Landslide	Debris field within a narrow stream valley	0.00	Unknown	2.00	7.82	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln8	45.46051	-75.53690	Landslide	Debris field within a narrow stream valley	0.01	Unknown	7.00	7.66	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln9	45.46092	-75.53424	Landslide	Debris field within a narrow stream valley	0.02	Unknown	3.00	7.45	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln10	45.46378	-75.53684	Landslide	Truncated source area	0.07	Unknown	20.00	7.45	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln11	45.46497	-75.53146	Landslide	Truncated source area	0.06	Unknown	18.00	7.00	Nearshore Marine	50 to 100	Shale
Orleans	OF8600	Oln12	45.46706	-75.52809	Landslide	Truncated source area	0.05	Unknown	18.00	6.64	Nearshore Marine	25 to 50	Shale
Orleans	OF8600	Oln13	45.47042	-75.52019	Landslide, probably	Truncated source area	0.07	Unknown		5.87			
Orleans	OF8600	Oln14	45.48981	-75.50782	Landslide	Source area with debris field	0.08	Late Holocene?	18.00	4.07	Alluvial Sediments	15 to 25	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln15	45.48871	-75.47487	Landslide, probably	Truncated source area	0.08	Unknown		1.57			
Orleans	OF8600	Oln16	45.48586	-75.47170	Landslide	Debris field within a narrow stream valley	0.07	Unknown	29.00	1.61	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln17	45.48877	-75.46692	Landslide	Debris field within a narrow stream valley	0.04	Unknown	8.00	1.10	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Orleans	OF8600	Oln18	45.49016	-75.46497	Landslide	Debris field within a narrow stream valley	0.03	Unknown	10.00	0.88	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cumberland	OF8600	Cmb1	45.51313	-75.43362	Landslide	Truncated source area	0.14	Unknown	35.00	2.88	Erosional Terraces	15 to 25	Shale
Cumberland	OF8600	Cmb2	45.51302	-75.40335	Landslide	Source area with debris field	0.04	Unknown	24.00	5.00	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
Cumberland	OF8600	Cmb3	45.51737	-75.38140	Landslide	Source area with debris field	0.53	relatively young, less than 2000(?)	30.00	6.87	Erosional Terraces	50 to 100	Dolomite
Cumberland	OF8600	Cmb4	45.51651	-75.33631	Landslide	Source area with debris field	0.02	Unknown	49.00	10.40	Nearshore Marine	25 to 50	Interbedded Limestone and Dolomite

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			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Mer Bleue paleochannel	OF8600	MBu1	45.43409	-75.53765	Landslide	Truncated source area	0.02	Unknown	13.00	9.77	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Mer Bleue paleochannel	OF8600	MBu2	45.43092	-75.51828	Landslide	Source area with debris field	0.12	Unknown	15.00	9.11	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu3	45.42843	-75.51485	Landslide	Source area with debris field	0.01	Unknown	12.00	9.22	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu4	45.42782	-75.51290	Landslide	Truncated source area	0.01	Unknown	**	9.20	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu5	45.42639	-75.50741	Landslide, former site of	Completely altered	N.A.	Unknown	**	9.14	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu6	45.42500	-75.50289	Landslide, former site of	Completely altered	N.A.	Unknown	**	9.14	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu7	45.42364	-75.49702	Landslide, former site of	Completely altered	N.A.	Unknown	**	9.11	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu8	45.42335	-75.49197	Landslide, former site of	Completely altered	N.A.	Unknown	**	9.01	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu9	45.42158	-75.48102	Landslide	Truncated source area	0.03	Unknown	15.00	8.98	Erosional Terraces	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu10	45.42089	-75.47444	Landslide	Truncated source area	0.03	Unknown	15.00	8.97	Nearshore Marine	25 to 50	Shale
Mer Bleue paleochannel	OF8600	MBu11	45.41891	-75.46077	Landslide	Truncated source area	0.03	Unknown	14.00	9.12	Nearshore Marine	15 to 25	Shale
Mer Bleue paleochannel	OF8600	MBu12	45.41829	-75.45649	Landslide	Truncated source area	0.01	Unknown	15.00	9.20	Nearshore Marine	15 to 25	Shale
Mer Bleue paleochannel	OF8600	MBu13	45.41206	-75.27053	Landslide	Source area with debris field	1.42	about 5200 cal yrBP	19.00	18.46	Nearshore Marine	25 to 50	Interbedded Limestone and Shale
Beta-90881	OF7432	1	45.46110	-75.26110	Landslide	*	*	3050±70	20.00	16.85	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-122473	OF7432	1	45.44170	-75.22220	Landslide	*	*	4590±40	8.00	20.57	Nearshore Marine	25 to 50	Interbedded Limestone and Shale
Beta-122475	OF7432	1	45.44240	-75.19240	Landslide	*	*	2760±50	20.00	22.90	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Beta-127281	OF7432	1	45.54160	-75.24160	Landslide	*	*	5130±60	53.00	18.69	Nearshore Marine	10 to 15	Limestone
Beta-127284	OF7432	1	45.52080	-75.26670	Landslide	*	*	4440±80	21.00	16.12	Erosional Terraces	25 to 50	Interbedded Limestone and Shale
Beta-127244	OF7432	1	45.50000	-75.20280	Landslide	*	*	4570±70	30.00	21.13	Erosional Terraces	25 to 50	Interbedded Limestone and Shale

Table 1 - Cardinal Creek Village South - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
Beta-122472	OF7432	1	45.48330	-75.19170	Landslide	*	*	4520±50	30.00	22.10	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-127282	OF7432	1	45.47500	-75.12920	Landslide	*	*	4540±90	24.00	27.31	Nearshore Marine	15 to 25	Interbedded Limestone and Shale
Beta-127283	OF7432	1	45.52500	-75.01110	Landslide	*	*	4530±60	12.00	37.06	Erosional Terraces	10 to 15	Interbedded Limestone and Shale
Beta-122478	OF7432	1	45.51390	-75.00280	Landslide	*	*	4700±50	15.00	37.65	Erosional Terraces	15 to 25	Interbedded Limestone and Shale
Beta-122471	OF7432	1	45.51850	-74.95570	Landslide	*	*	1870±40	26.00	41.55	**	**	**
Beta-127242	OF7432	1	45.51380	-74.93750	Landslide	*	*	4820±70	26.00	43.02	**	**	**
Beta-122474	OF7432	1	45.53610	-75.15830	Landslide	*	*	4470±50	**	25.22	Nearshore Marine	25 to 50	Limestone
GSC-1922	OF7432	2	45.54370	-75.40110	Landslide	*	*	4620±80	81.00	7.33	Marine Deposits	15 to 25	Felsic Intrusive Rocks
GSC-2068	OF7432	4	45.52080	-75.49170	Landslide	*	*	6240±70	59.00	3.90	Marine Deposits	25 to 50	Dolomite
UCIAMS-71217	OF7432	6	45.57980	-75.04260	Landslide	*	*	7105±20	35.00	35.66	Erosional Terraces	50 to 100	Shale
UCIAMS-71211	OF7432	7	45.57020	-75.11560	Landslide	*	*	7140±20	31.00	29.58	Marine Deposits	50 to 100	Interbedded Limestone and Dolomite
GSC-1741	OF7432	10	45.46500	-75.75130	Landslide	*	*	120±150	**	24.33	Marine Deposits	25 to 50	Dolomite
UCIAMS-88796	OF7432	11	45.48290	-75.93490	Landslide	*	*	1125±15	29.00	39.20	Marine Deposits	25 to 50	Felsic Intrusive Rocks

Table 1 - Cardinal Creek Village South - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
UCIAMS-88704	OF7432	11	45.48530	-75.93630	Landslide	*	*	2805±20	29.00	39.30	Marine Deposits	25 to 50	Felsic Intrusive Rocks
GSC-6233	OF7432	11	45.48310	-75.93320	Landslide	*	*	7050±80	25.00	39.05	Marine Deposits	25 to 50	Felsic Intrusive Rocks
UCIAMS-88816	OF7432	11	45.48020	-75.93090	Landslide	*	*	200±15	24.00	38.88	Marine Deposits	15 to 25	Felsic Intrusive Rocks
GSC-6449	OF7432	11	45.47180	-75.91290	Landslide	*	*	1080±70	15.00	37.47	Marine Deposits	15 to 25	Interbedded Limestone and Dolomite
UCIAMS-88703	OF7432	11	45.47990	-75.91740	Landslide	*	*	180±20	26.00	37.77	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6318	OF7432	11	45.47860	-75.91180	Landslide	*	*	1030±70	24.00	37.32	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
UCIAMS-88806	OF7432	11	45.47730	-75.90280	Landslide	*	*	1895±25	12.00	36.59	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6482	OF7432	11	45.48120	-75.90670	Landslide	*	*	1210±50	8.00	36.88	Marine Deposits	25 to 50	Interbedded Limestone and Dolomite
GSC-6433	OF7432	11	45.48540	-75.89640	Landslide	*	*	1440±50	18.00	36.02	Marine Deposits	15 to 25	Felsic Intrusive Rocks
UCIAMS-88818	OF7432	11	45.48520	-75.90600	Landslide	*	*	2755±20	22.00	36.81	Marine Deposits	25 to 50	Felsic Intrusive Rocks
GSC-6355	OF7432	11	45.48250	-75.91180	Landslide	*	*	1170±50	27.00	37.30	Marine Deposits	25 to 50	Felsic Intrusive Rocks
Beta-139135	OF7432	11	45.49650	-75.92780	Landslide	*	*	310±40	10.00	38.57	Marine Deposits	50 to 100	Felsic Intrusive Rocks
UCIAMS-122468	OF7432	12	45.53530	-76.03060	Landslide	*	*	1095±20	21.00	47.24	Marine Deposits	15 to 25	Felsic Intrusive Rocks
UCIAMS-106656	OF7432	13	45.54090	-76.04890	Landslide	*	*	1150±15	22.00	48.81	Marine Deposits	25 to 50	Felsic Intrusive Rocks
UCIAMS-171460	OF7432	14	45.55390	-76.13020	Landslide	*	*	1305±20	9.00	55.62	Nearshore Marine	50 to 100	Felsic Intrusive Rocks
UCIAMS-171459	OF7432	15	45.55130	-76.14060	Landslide	*	*	185±20	9.00	56.44	Nearshore Marine	50 to 100	Felsic Intrusive Rocks
UCIAMS-106587	OF7432	16	45.55190	-76.28630	Landslide	*	*	1180±20	24.00	68.37	Erosional Terraces	15 to 25	Felsic Intrusive Rocks
UCIAMS-106575	OF7432	17	45.61920	-76.37190	Landslide	*	*	955±15	32.00	76.43	**	**	**

Table 1 - Cardinal Creek Village South - Summary of Reviewed Landslide Inventory Data

Location	Source	Site Code	Geographical Coordinate		Feature	Morphology	Scar Area	Age	Relief	Distance from PG5201	Surface Geology	Drift Thicknes	Bedrock
			Latitude	Longitude			(km2)		(m)	(m)		(m)	
UCIAMS-106650	OF7432	18	45.50140	-76.28260	Landslide	*	*	1145±20	52.00	67.79	Nearshore Marine	15 to 25	Felsic Intrusive Rocks
UCIAMS-106581	OF7432	19	45.51700	-76.27470	Landslide	*	*	5830±20	34.00	67.17	Nearshore Marine	15 to 25	Felsic Intrusive Rocks
UCIAMS-122453	OF7432	20	45.54620	-76.52600	Landslide	*	*	5745±20	**	87.99	**	**	**
UCIAMS-137113	OF7432	21	45.72570	-75.89150	Landslide	*	*	4525±20	52.00	44.56	**	**	**
UCIAMS-137101	OF7432	22	45.69440	-75.89960	Landslide	*	*	90±20	23.00	43.01	**	**	**
UCIAMS-122455	OF7432	23	45.80960	-75.95980	Landslide	*	*	940±15	25.00	55.15	**	**	**

'*' - Indicates information not provided by source (Geological Survey of Canada Open File 7432)

'' Indicates information could not be interpreted from available mapping.**

APPENDIX 2

FIGURE 1 – KEY PLAN

FIGURES 6A THROUGH 41B – SLOPE STABLITY ANALYSIS CROSS-SECTIONS

PHOTOGRAPHS FROM SITE VISITS

DRAWING PG5201-1 – BEDROCK CONTOUR PLAN

DRAWING PG5201-2 – TEST HOLE LOCATION PLAN

DRAWING PG5201-FIG.A – CROSS SECTION A-A'

DRAWING PG5201-FIG.B – CROSS SECTION B-B'

DDRAWING PG5201-FIG.C – CROSS SECTION C-C'

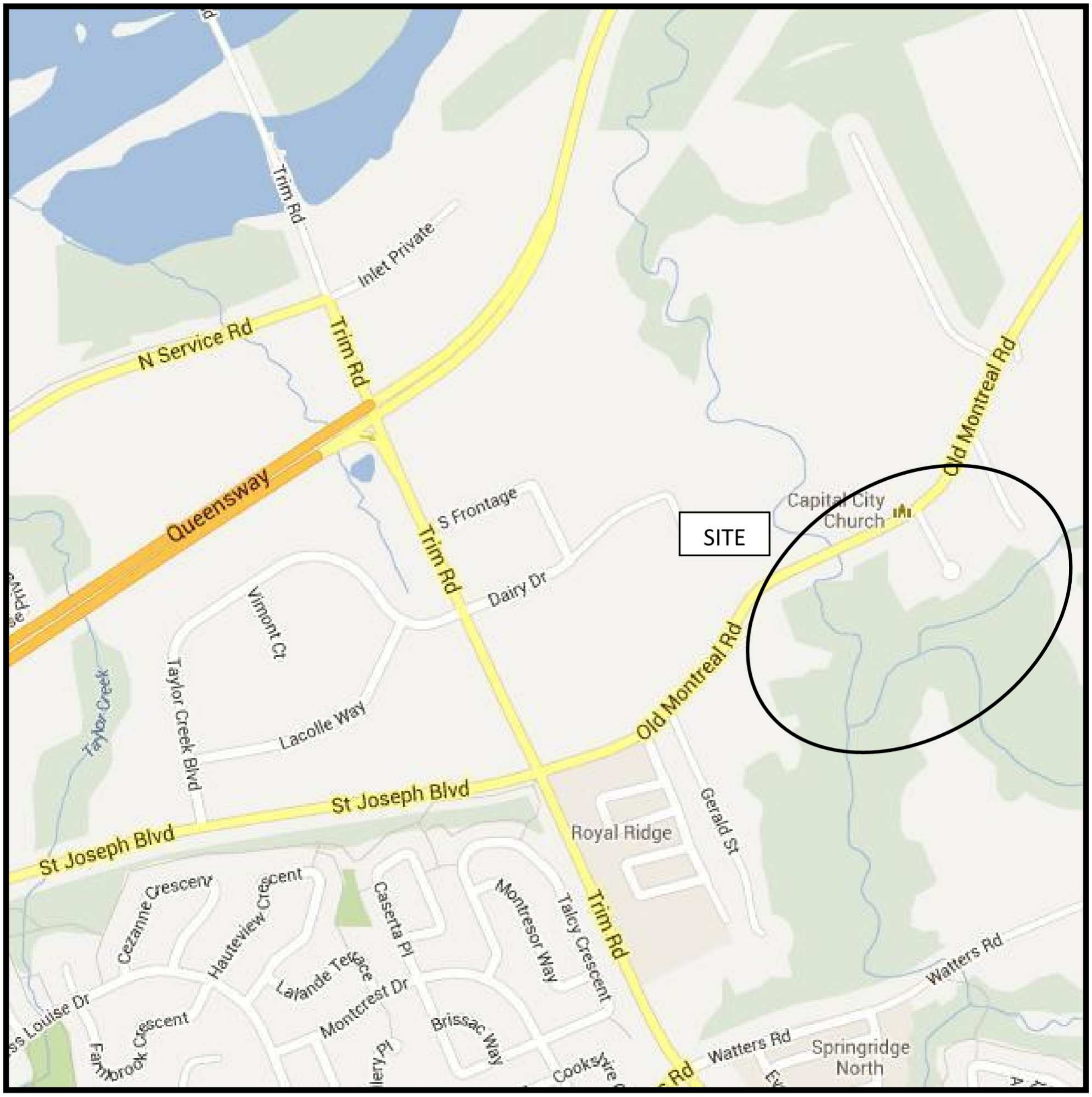


FIGURE 1

KEY PLAN

patersongroup

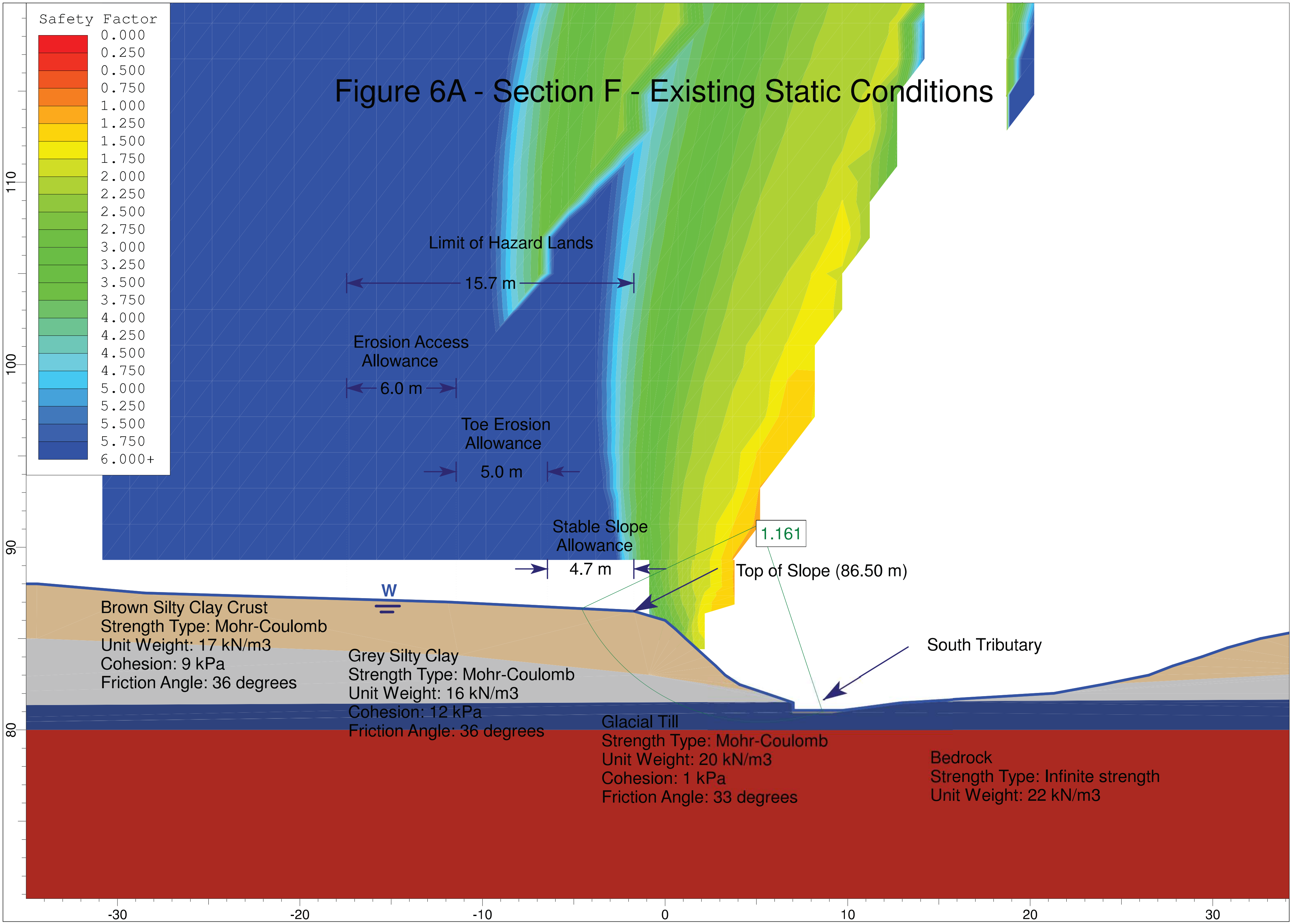


Figure 6A - Section F - Existing Static Conditions

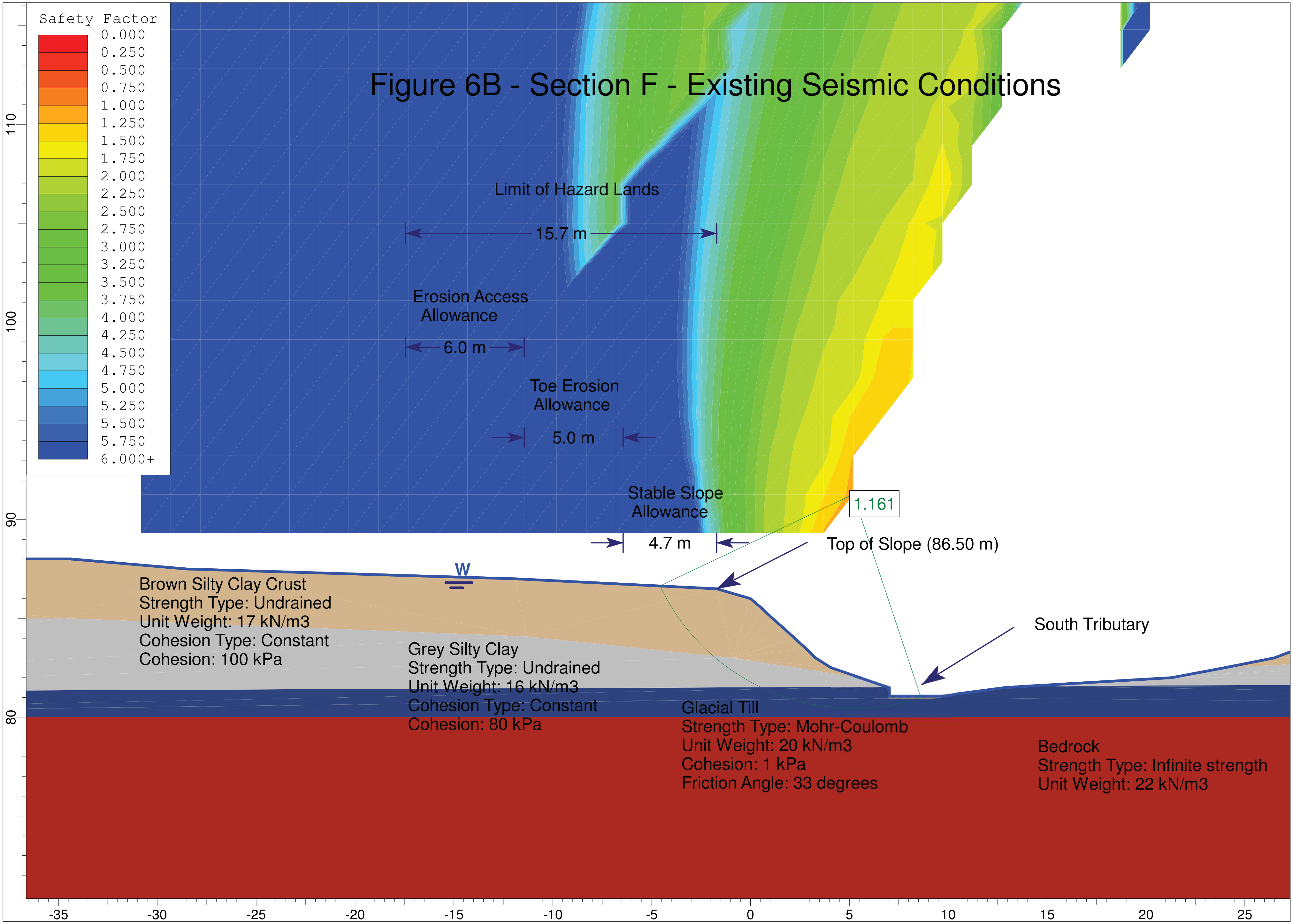


Figure 6B - Section F - Existing Seismic Conditions

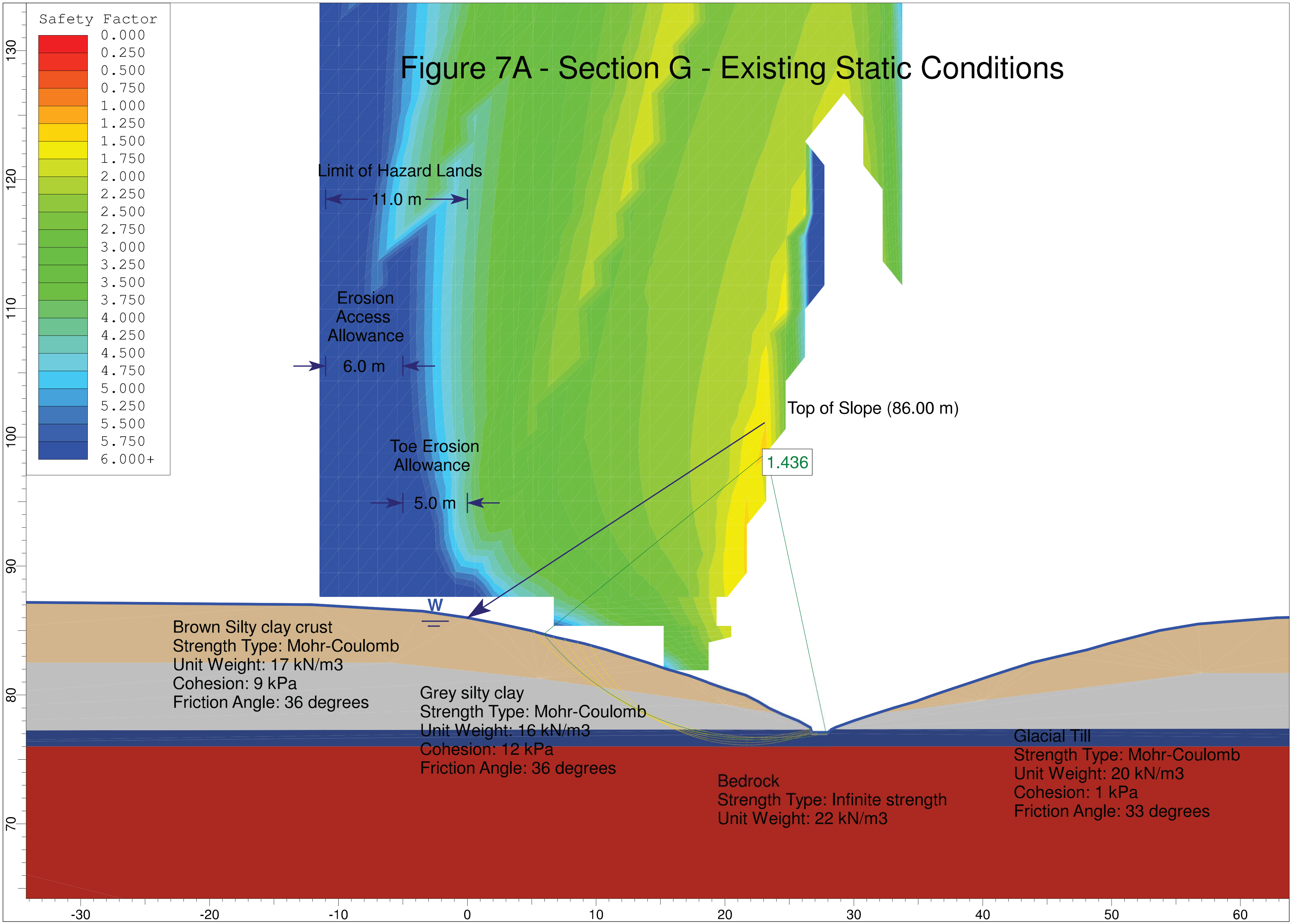


Figure 7A - Section G - Existing Static Conditions

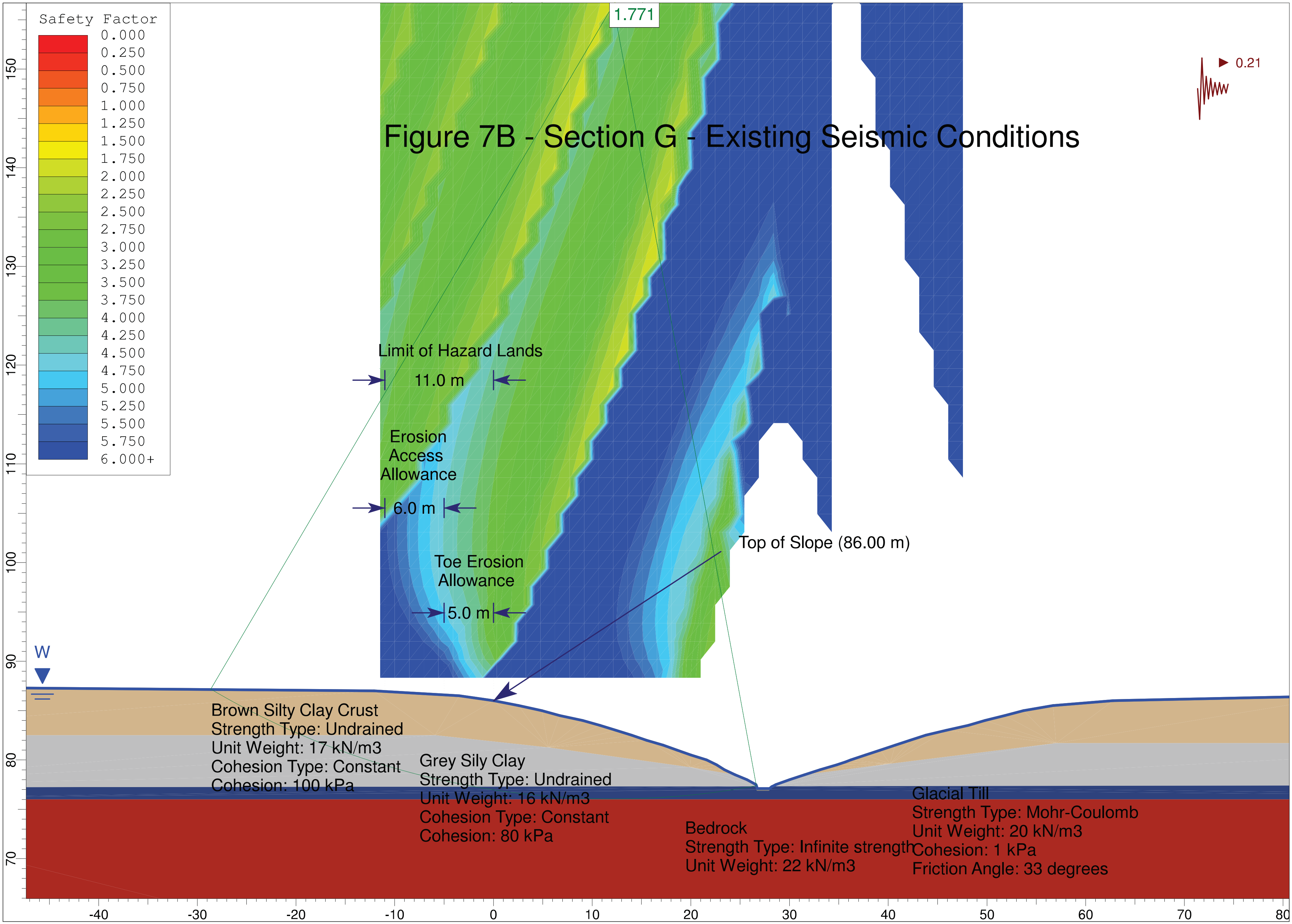


Figure 7B - Section G - Existing Seismic Conditions

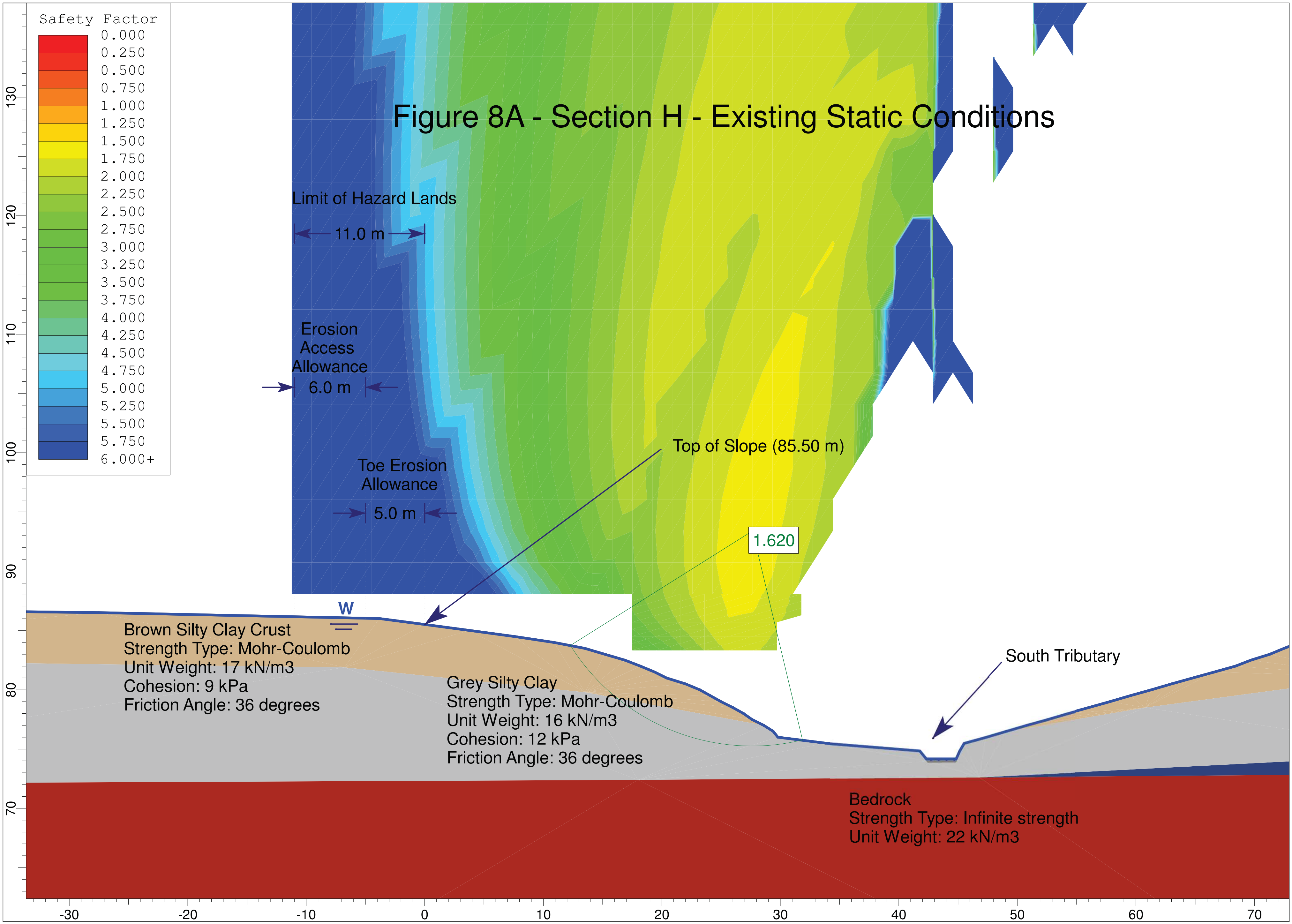


Figure 8A - Section H - Existing Static Conditions

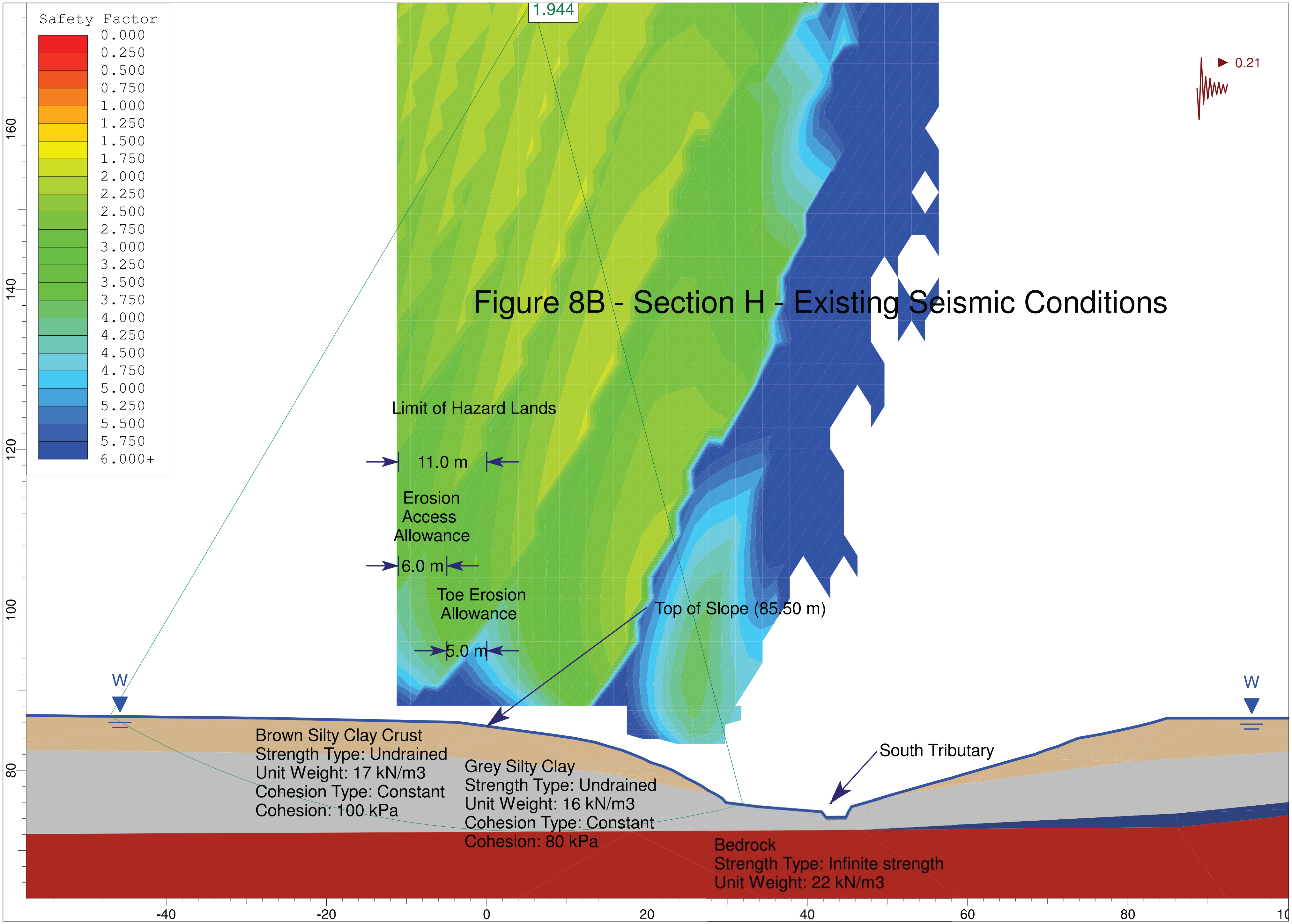


Figure 8B - Section H - Existing Seismic Conditions

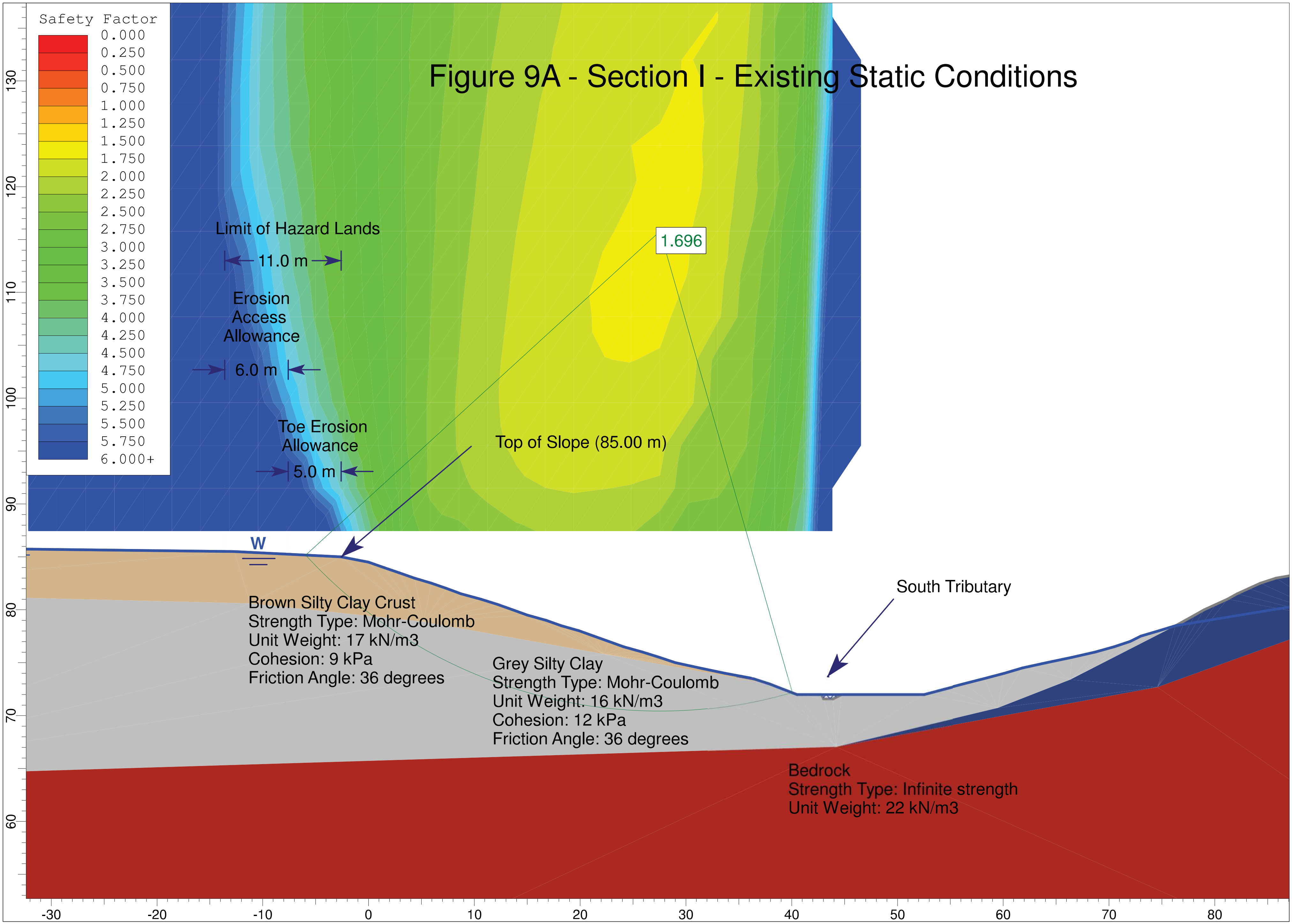


Figure 9A - Section I - Existing Static Conditions

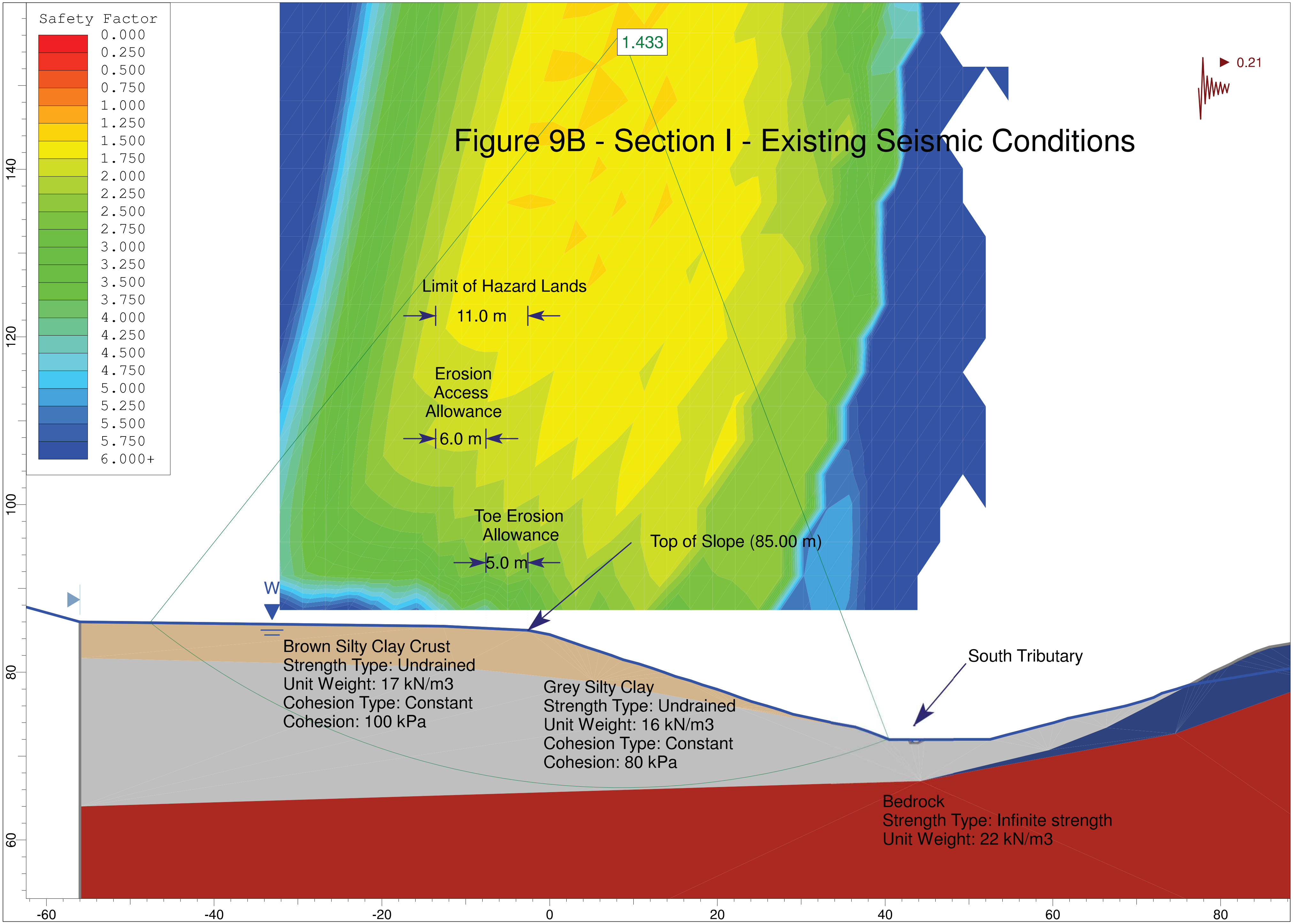


Figure 9B - Section I - Existing Seismic Conditions

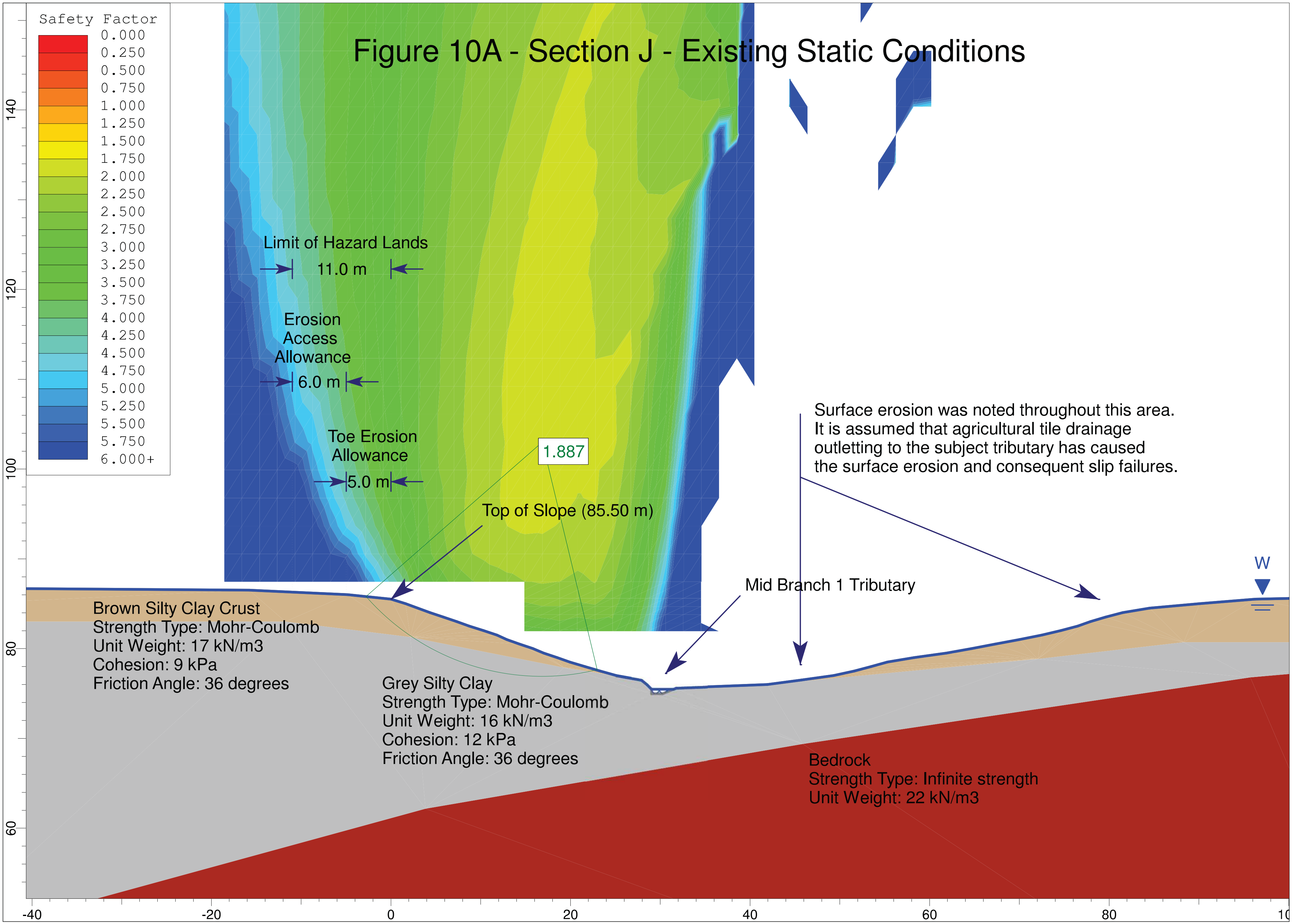
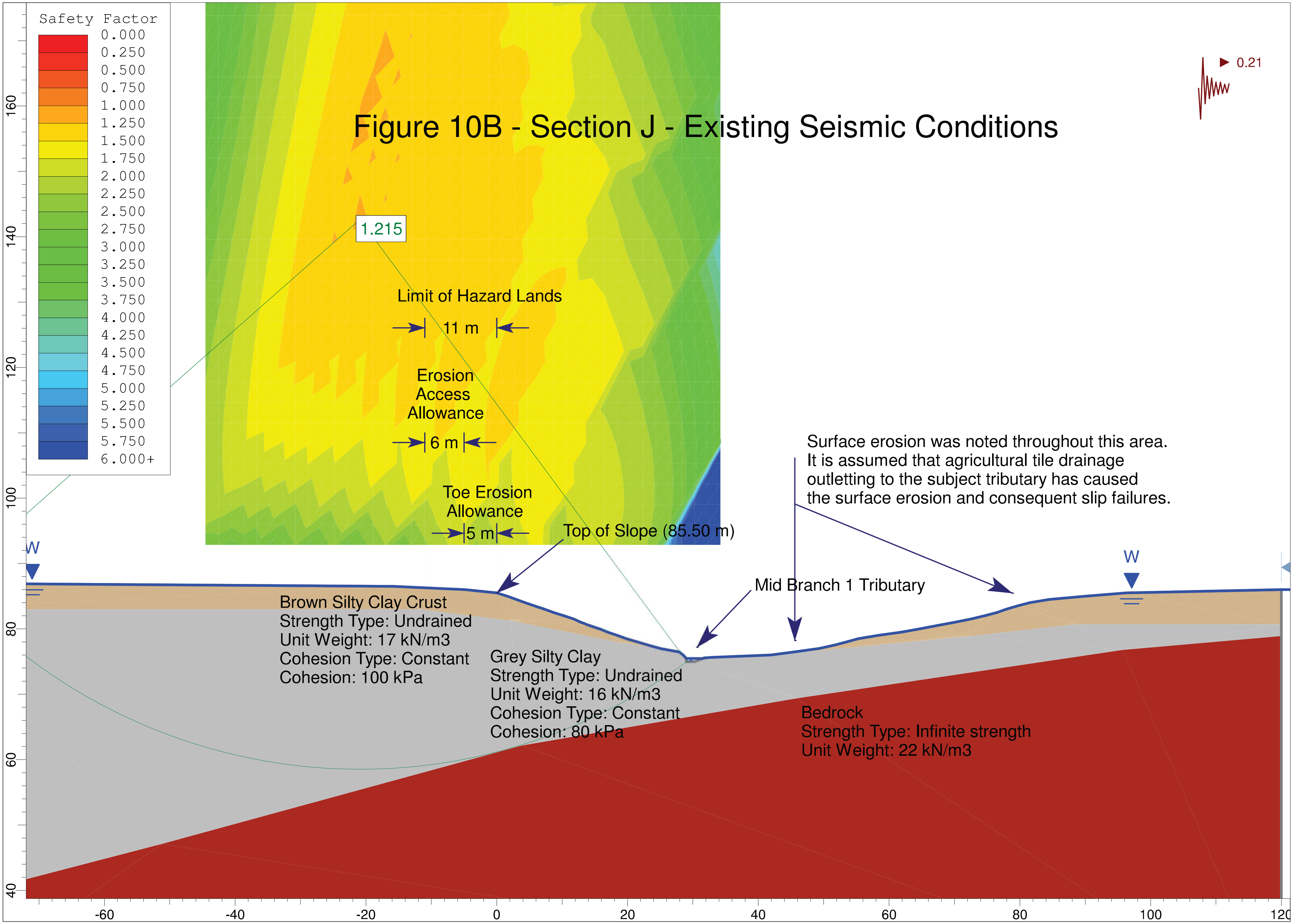


Figure 10A - Section J - Existing Static Conditions

Figure 10B - Section J - Existing Seismic 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.

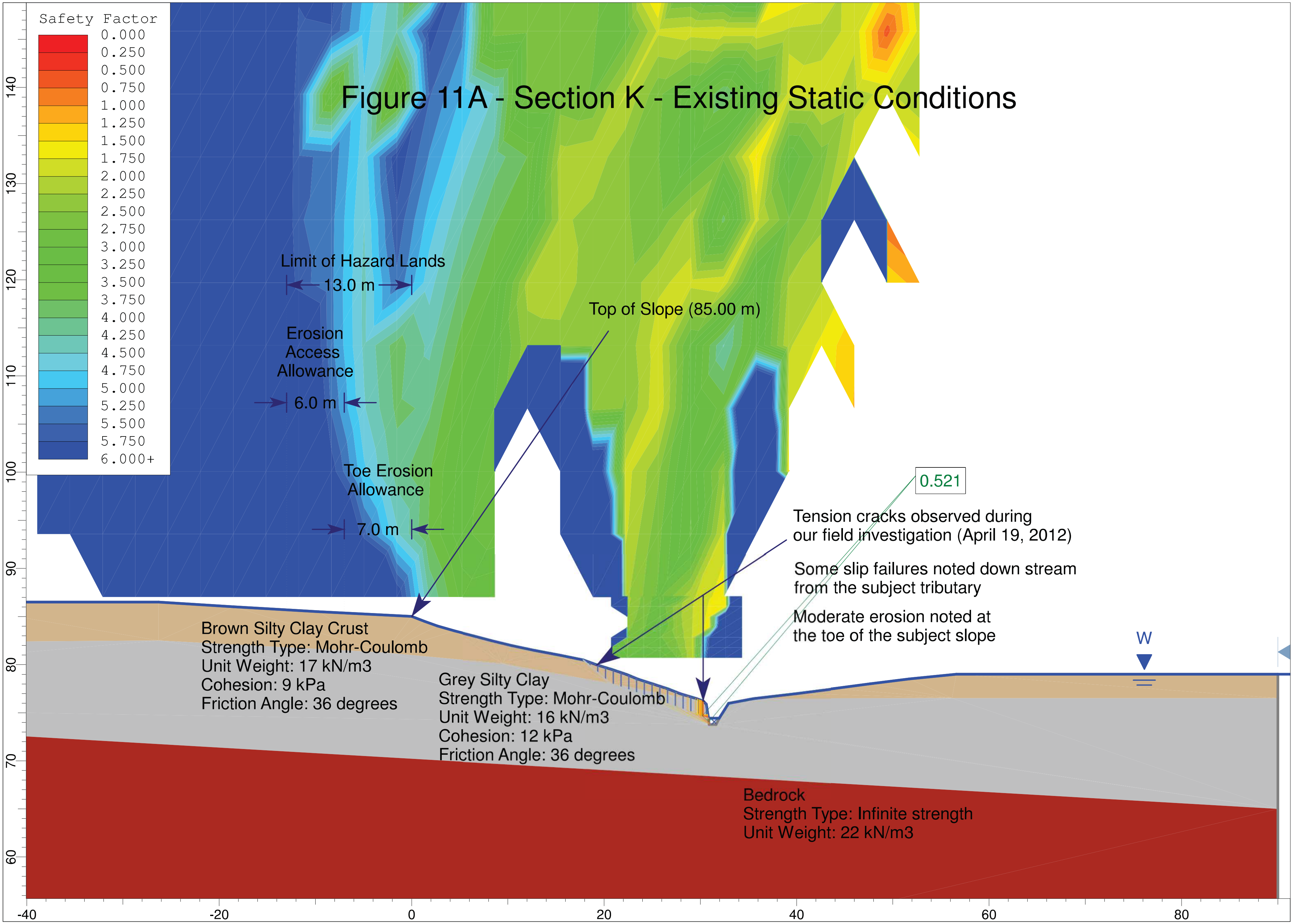


Figure 11A - Section K - Existing Static Conditions

Limit of Hazard Lands

13.0 m

Erosion Access Allowance

6.0 m

Toe Erosion Allowance

7.0 m

Top of Slope (85.00 m)

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

Some slip failures noted down stream from the subject tributary

Moderate erosion noted at the toe of the subject slope

Brown Silty Clay Crust
Strength Type: Mohr-Coulomb
Unit Weight: 17 kN/m3
Cohesion: 9 kPa
Friction Angle: 36 degrees

Grey Silty Clay
Strength Type: Mohr-Coulomb
Unit Weight: 16 kN/m3
Cohesion: 12 kPa
Friction Angle: 36 degrees

Bedrock
Strength Type: Infinite strength
Unit Weight: 22 kN/m3

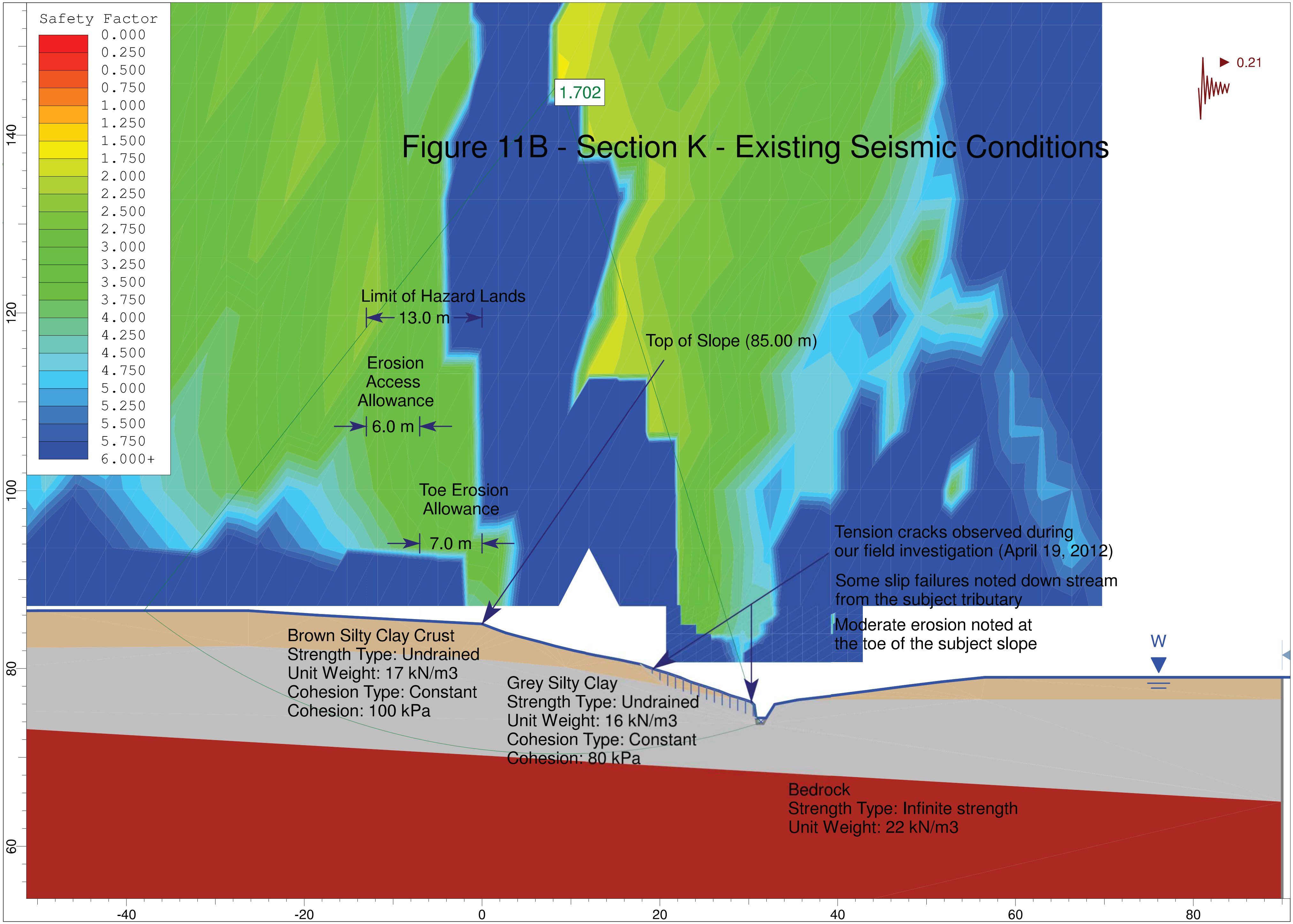


Figure 11B - Section K - Existing Seismic Conditions

Limit of Hazard Lands

13.0 m

Erosion Access Allowance

6.0 m

Toe Erosion Allowance

7.0 m

Top of Slope (85.00 m)

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

Some slip failures noted down stream from the subject tributary

Moderate erosion noted at the toe of the subject slope

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

Grey Silty Clay
Strength Type: Undrained
Unit Weight: 16 kN/m3
Cohesion Type: Constant
Cohesion: 80 kPa

Bedrock
Strength Type: Infinite strength
Unit Weight: 22 kN/m3

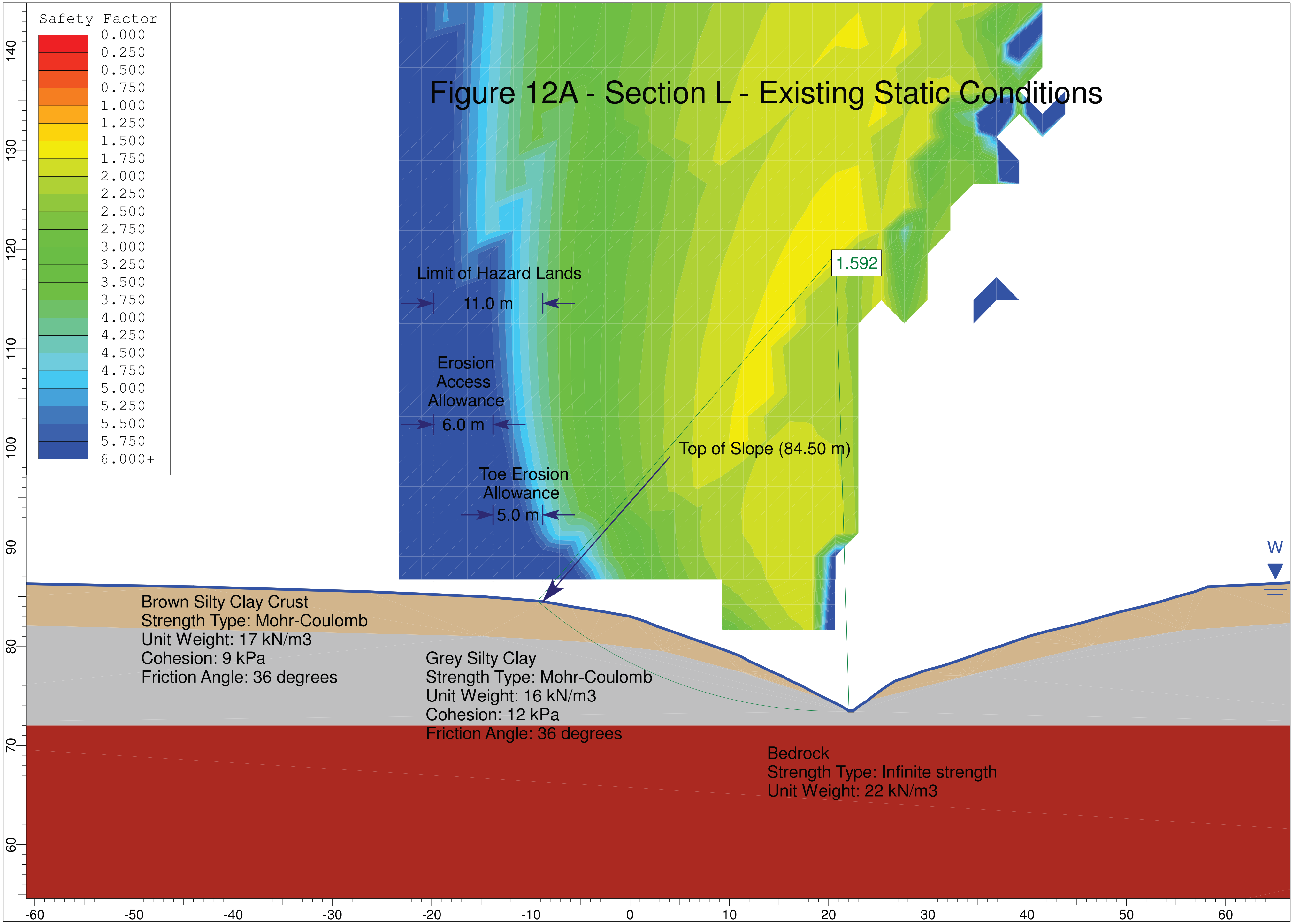


Figure 12A - Section L - Existing Static Conditions

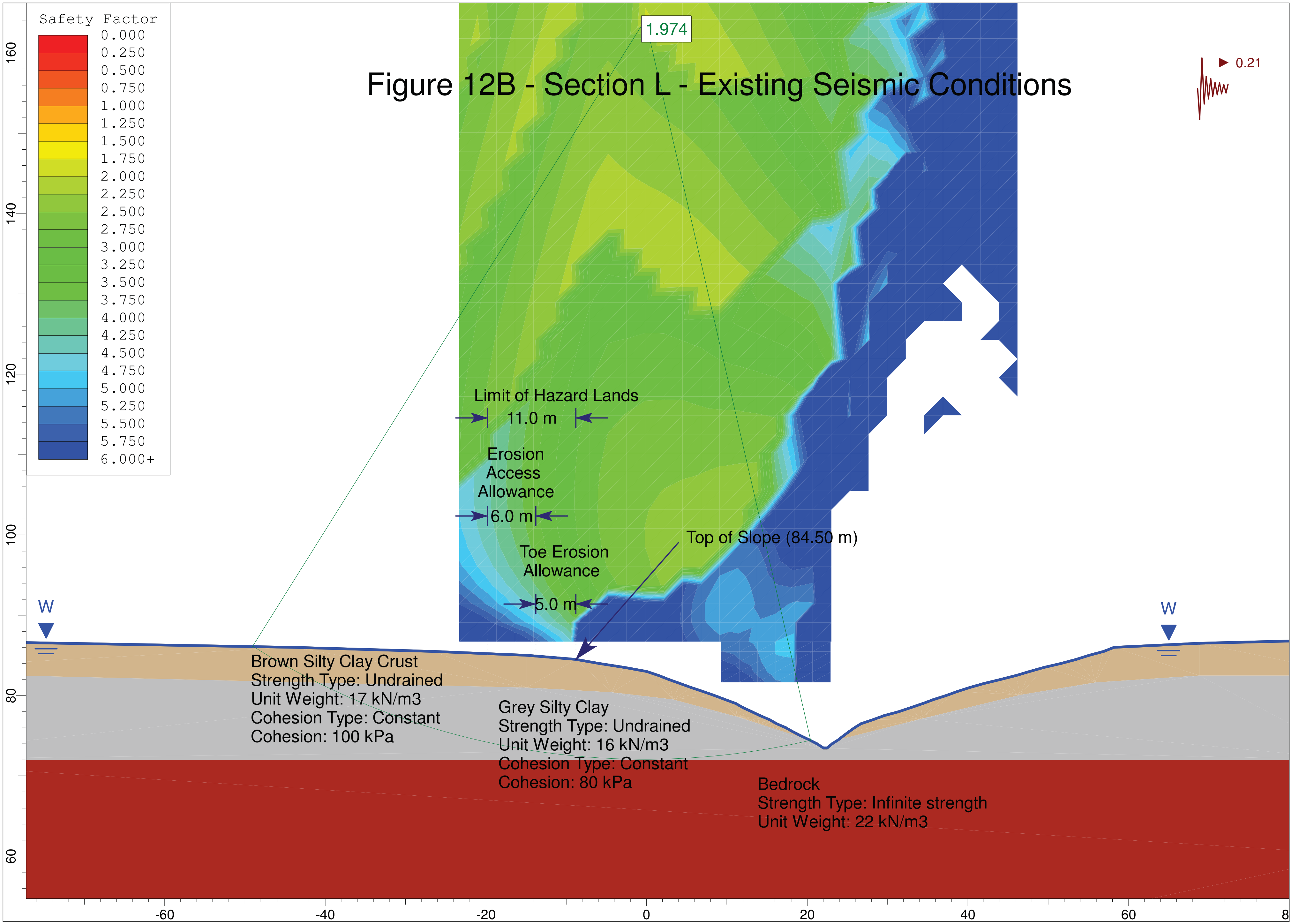


Figure 12B - Section L - Existing Seismic Conditions

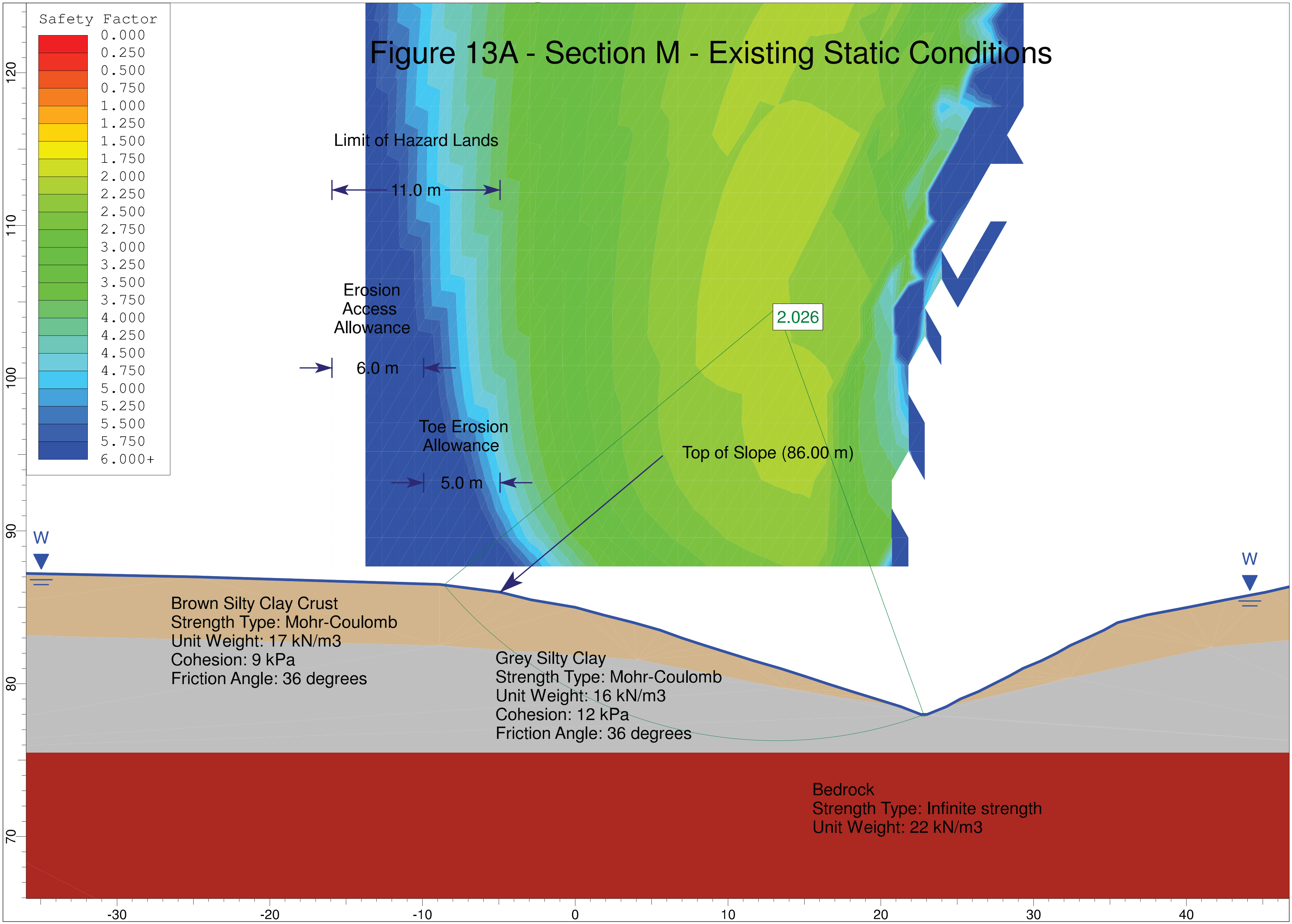
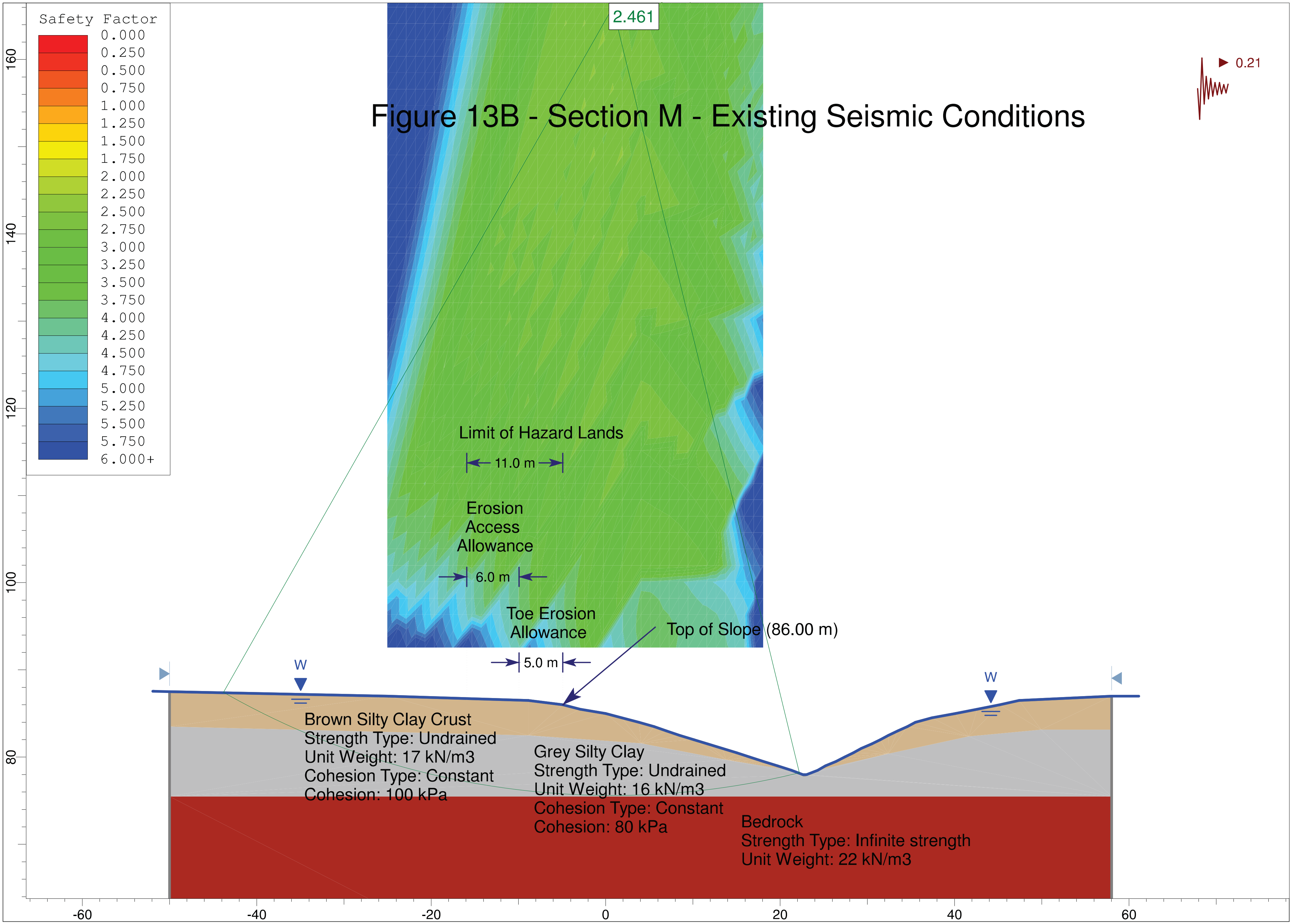


Figure 13A - Section M - Existing Static Conditions

Figure 13B - Section M - Existing Seismic Conditions



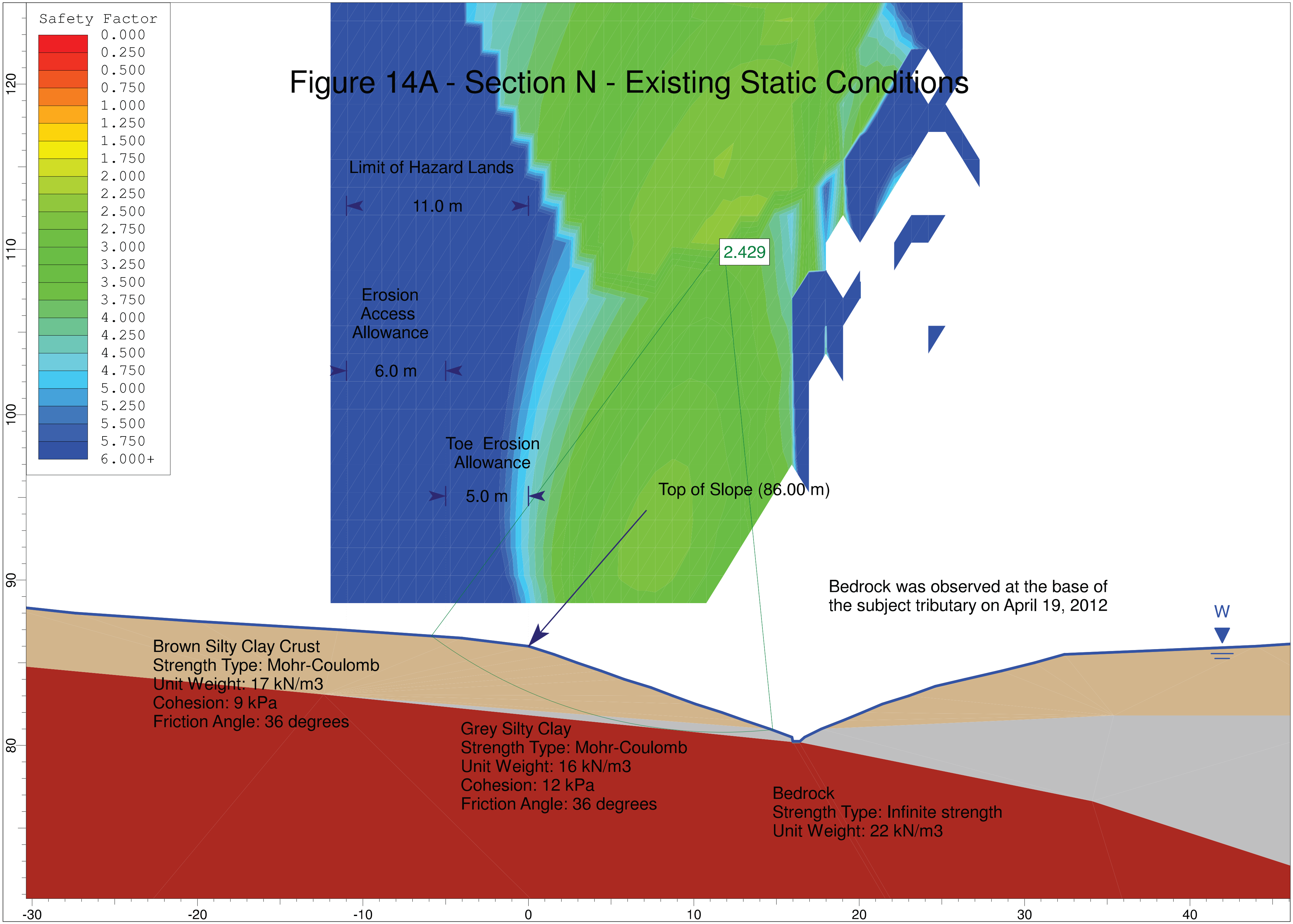


Figure 14A - Section N - Existing Static Conditions

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

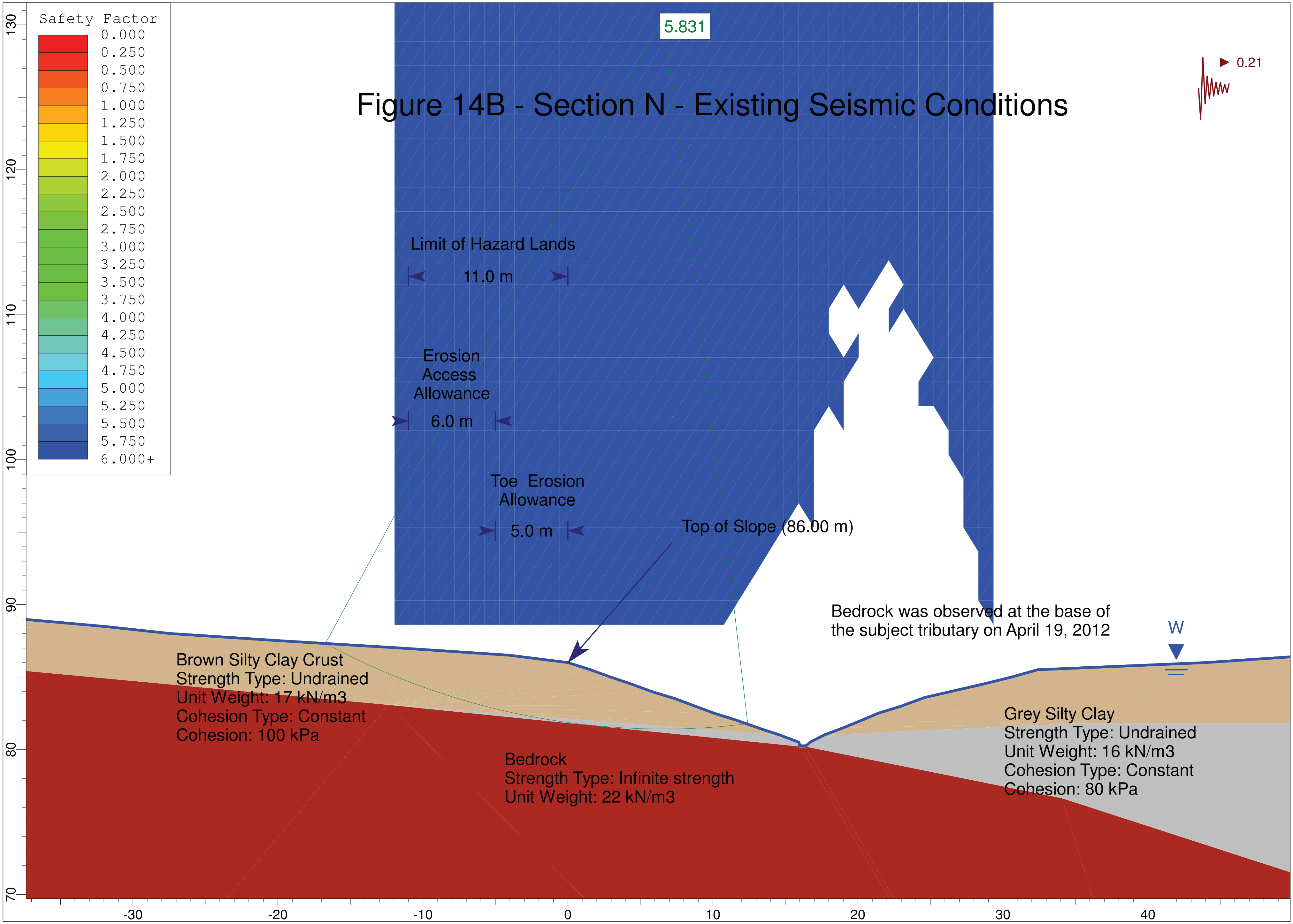


Figure 14B - Section N - Existing Seismic Conditions

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

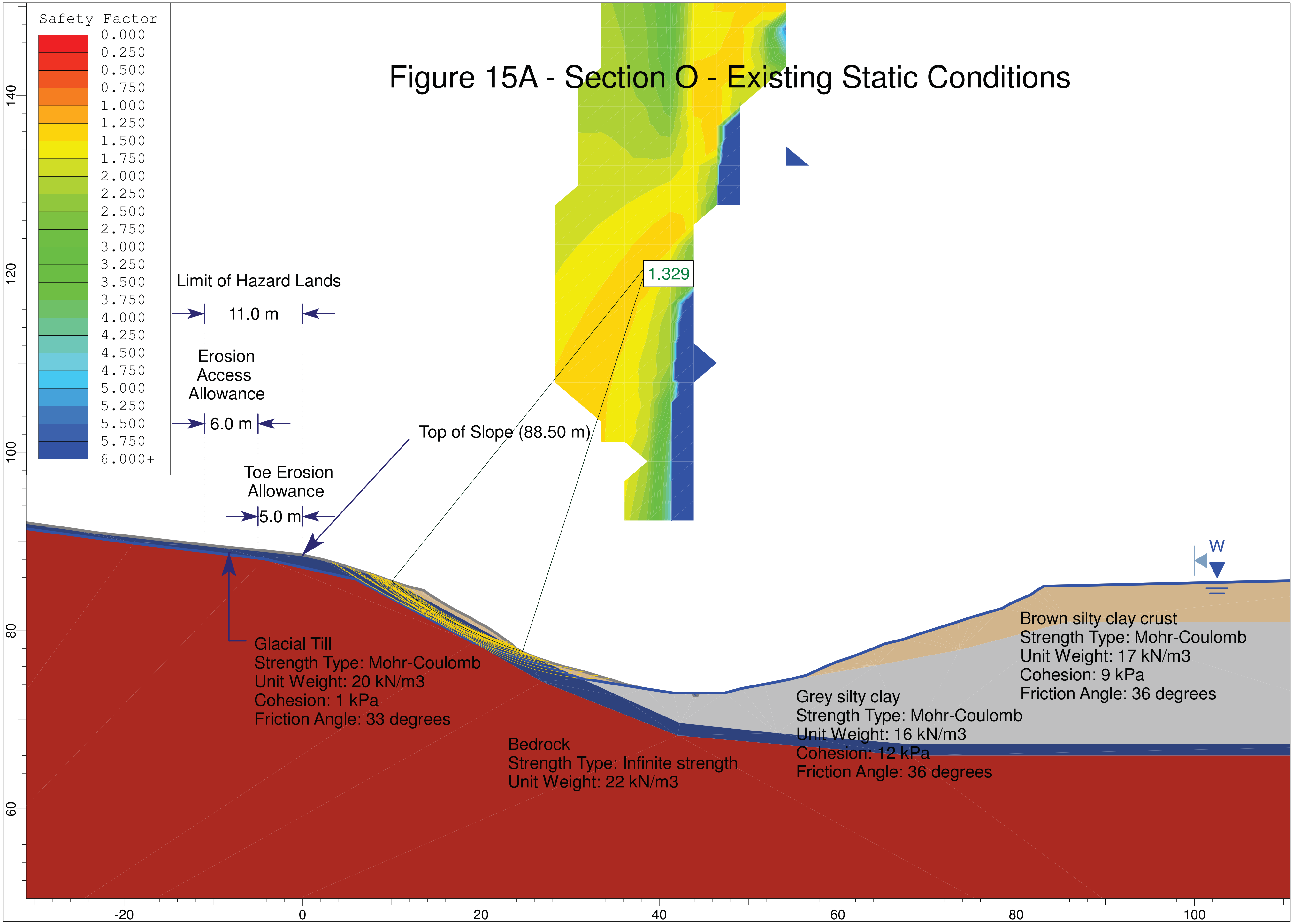


Figure 15A - Section O - Existing Static Conditions

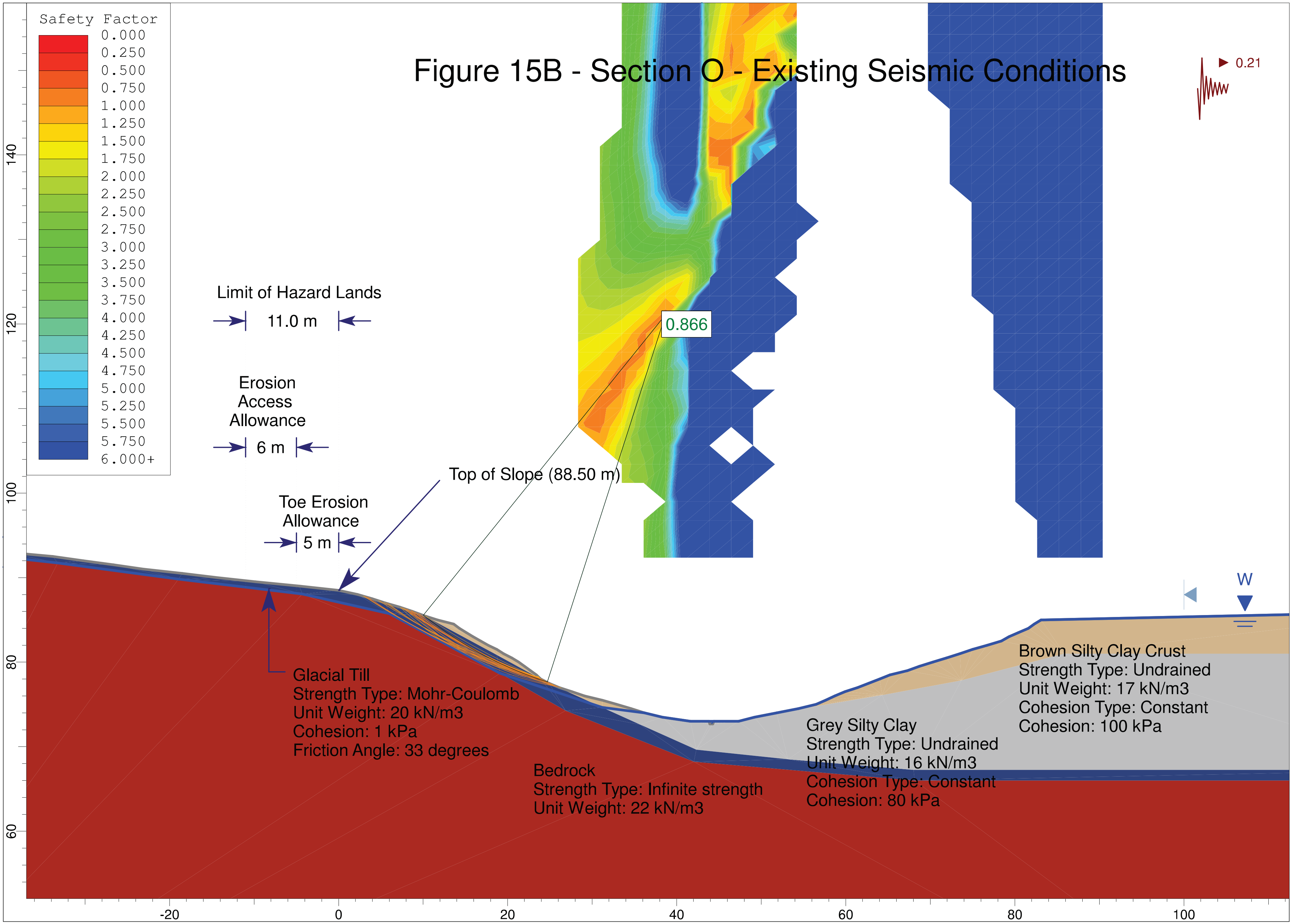


Figure 15B - Section O - Existing Seismic Conditions

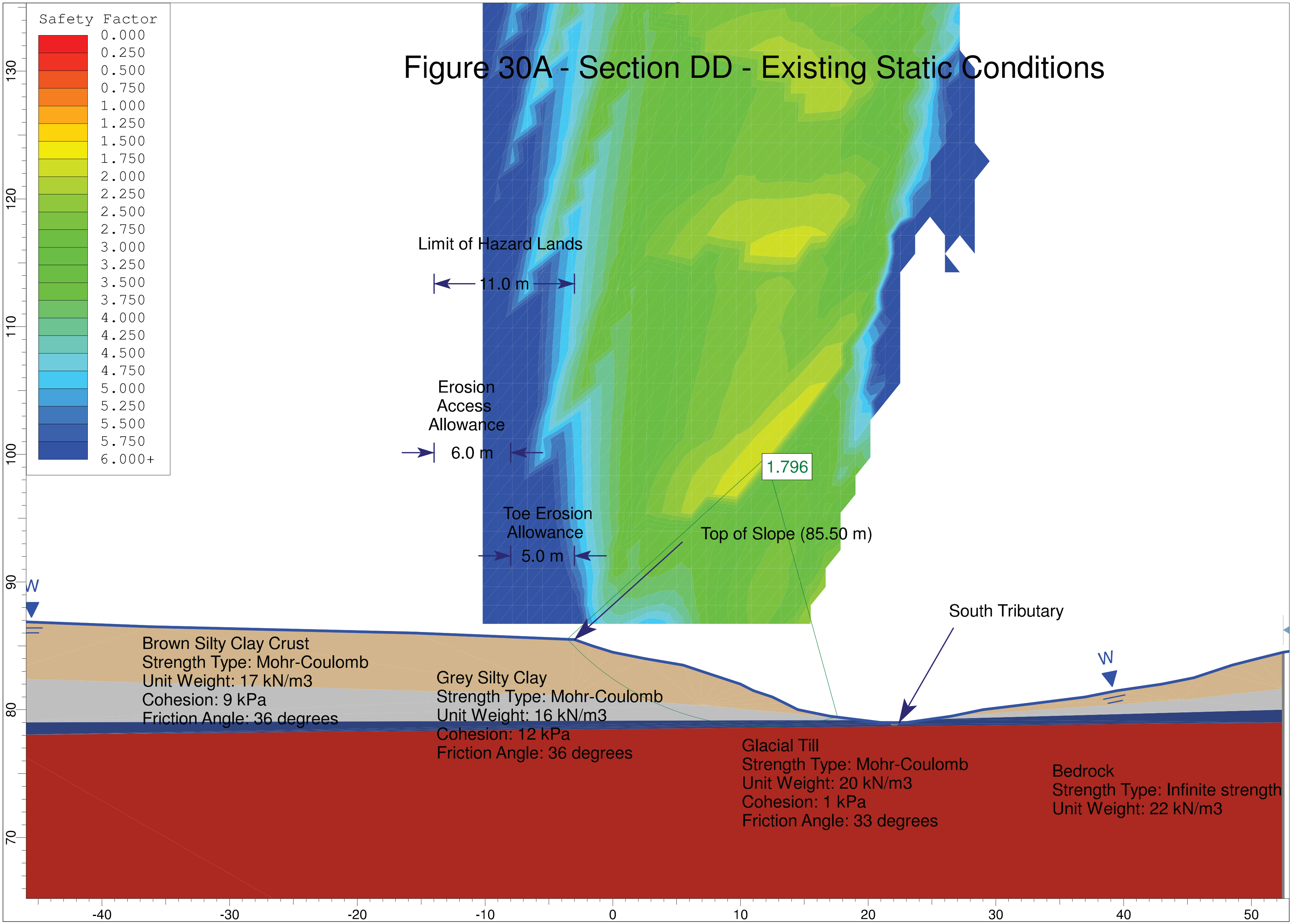


Figure 30A - Section DD - Existing Static Conditions

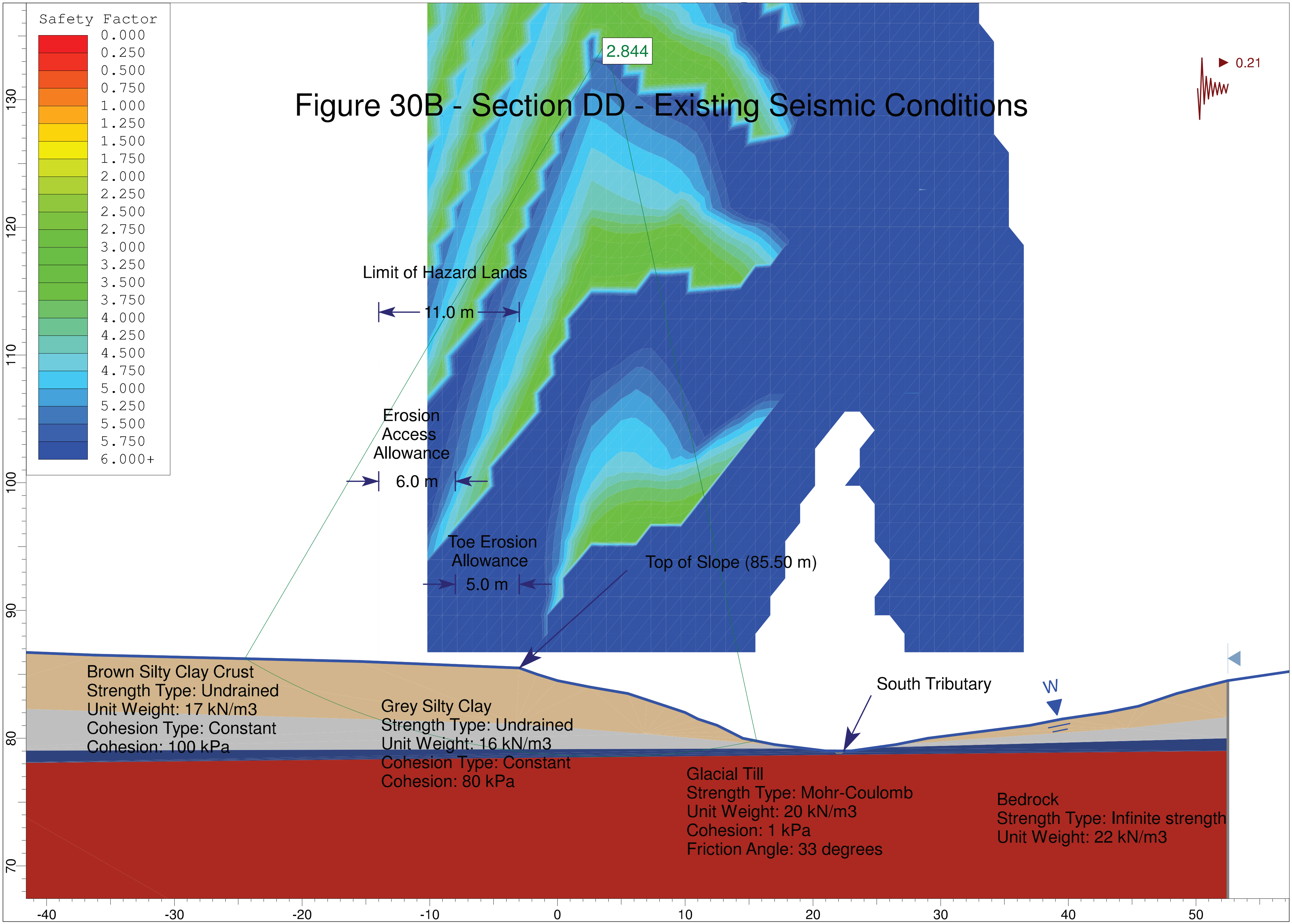


Figure 30B - Section DD - Existing Seismic Conditions

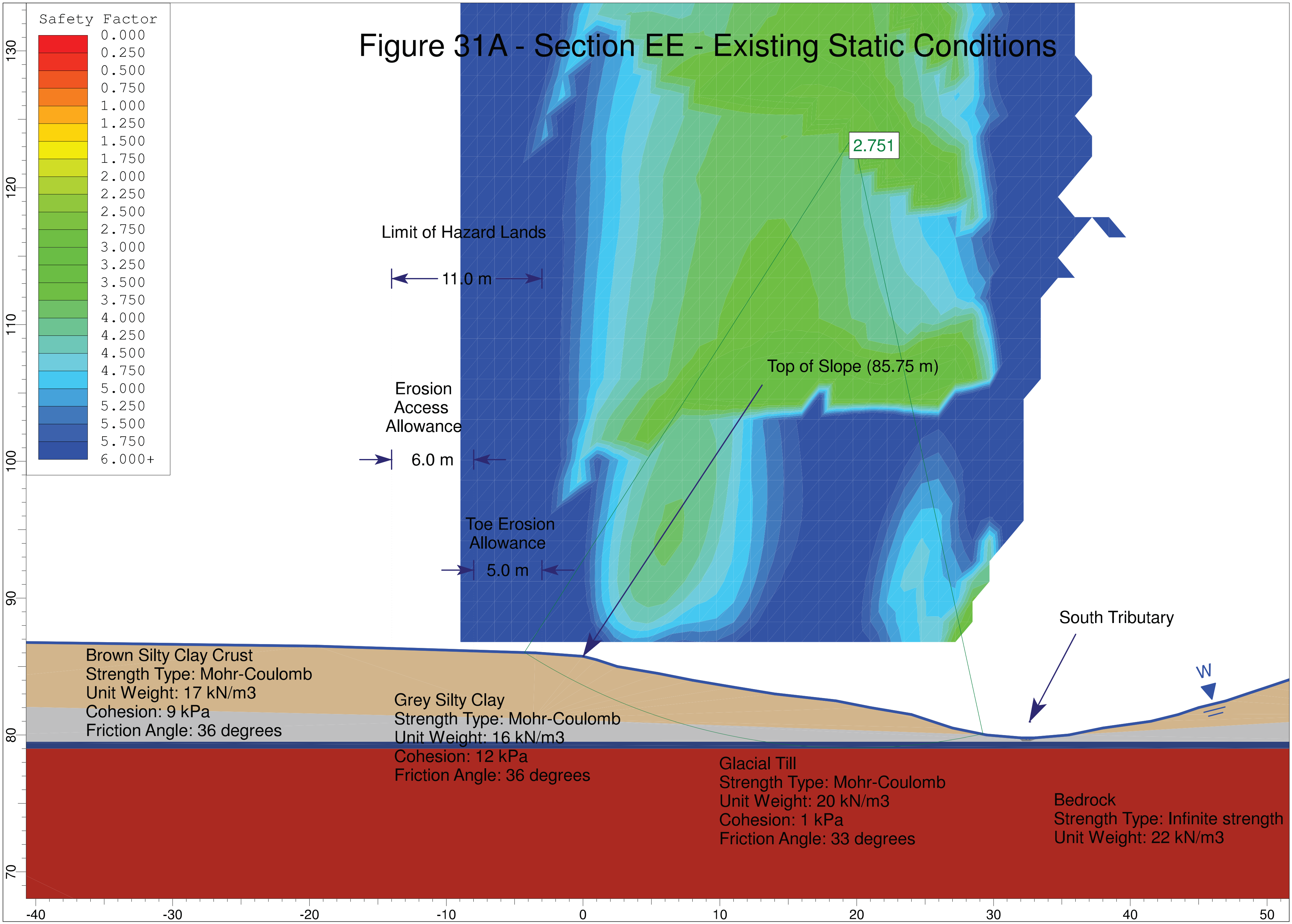


Figure 31A - Section EE - Existing Static Conditions

Figure 31B - Section EE - Existing Seismic Conditions

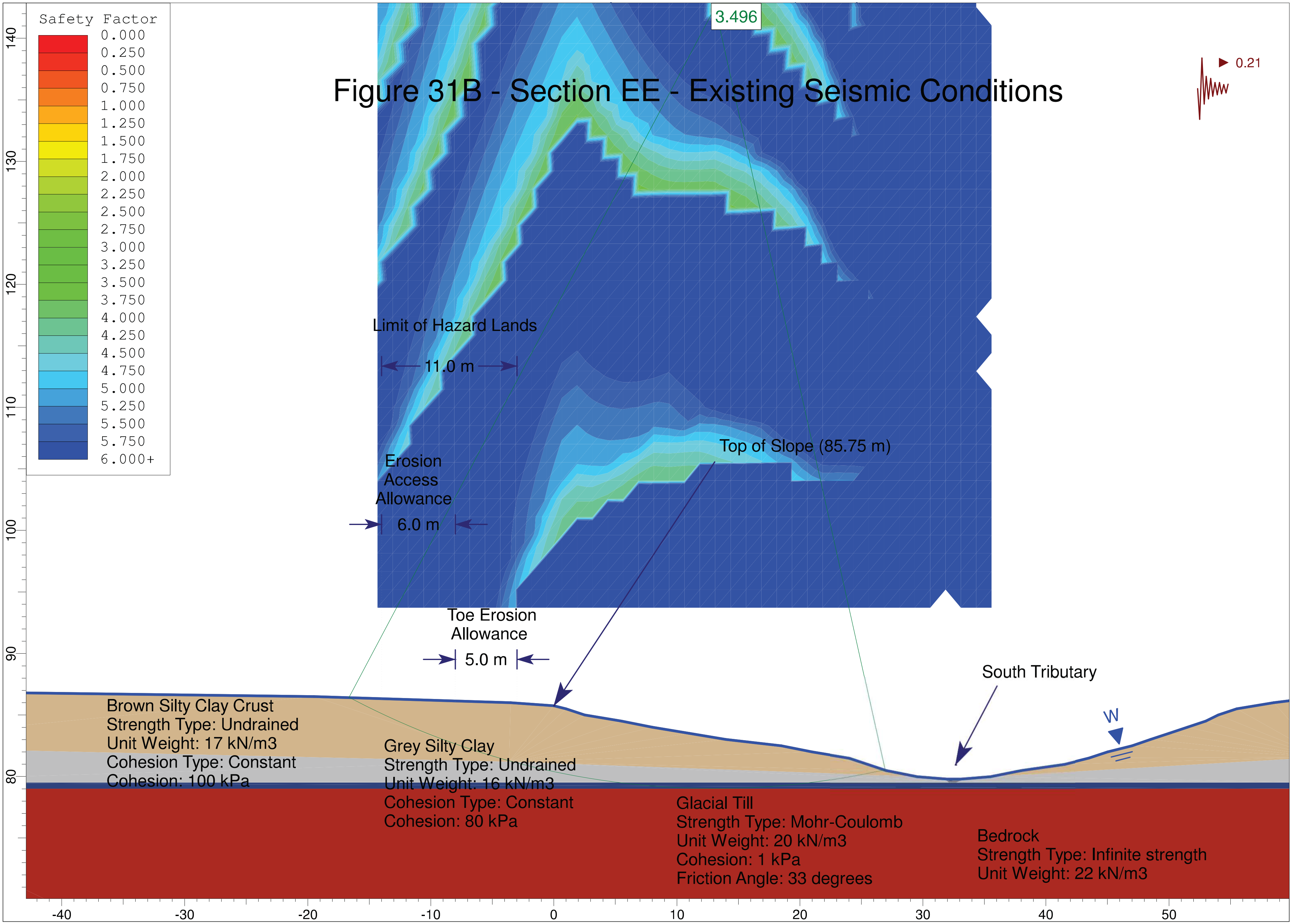
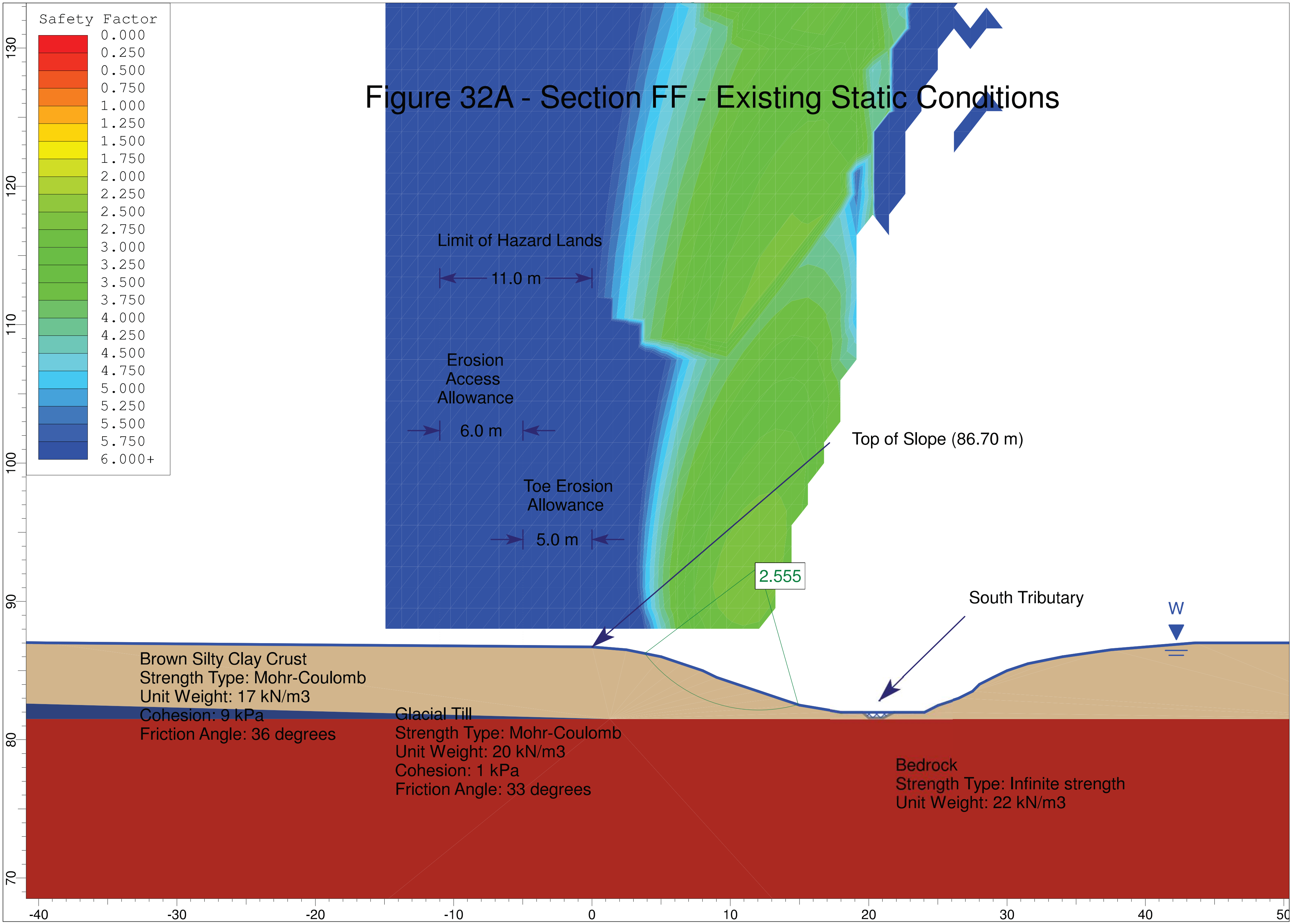


Figure 32A - Section FF - Existing Static Conditions



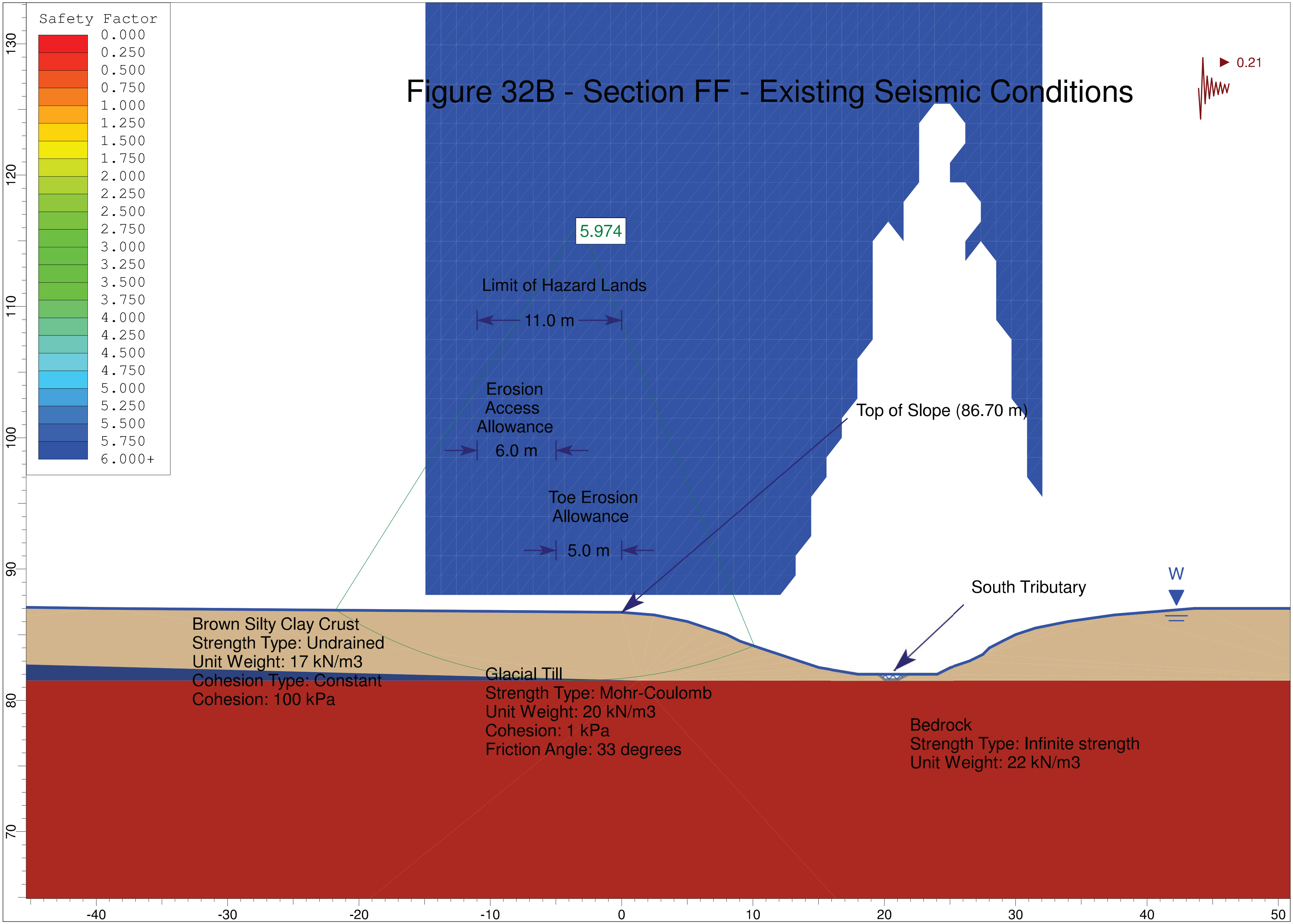
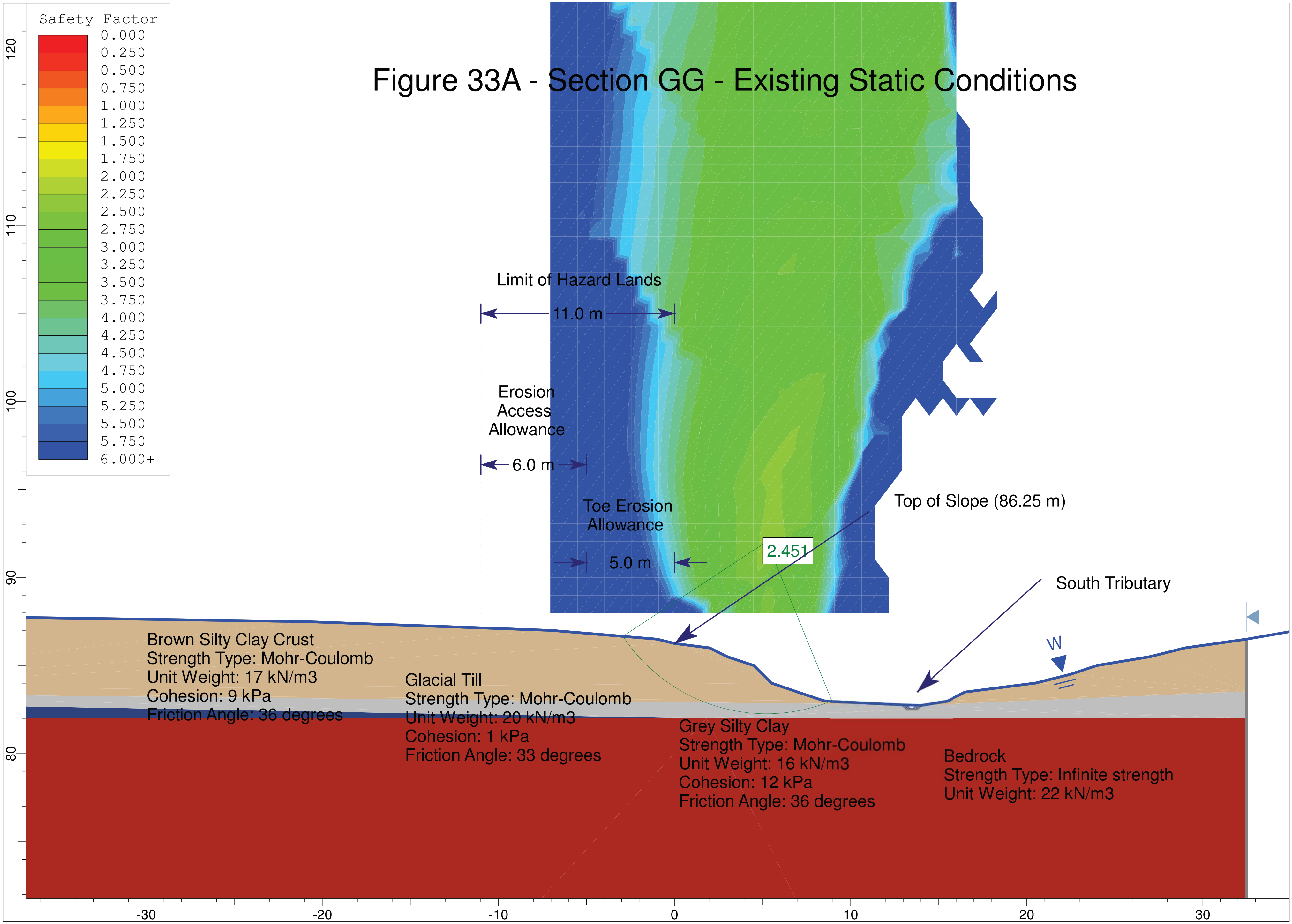


Figure 32B - Section FF - Existing Seismic Conditions

Figure 33A - Section GG - Existing Static Conditions



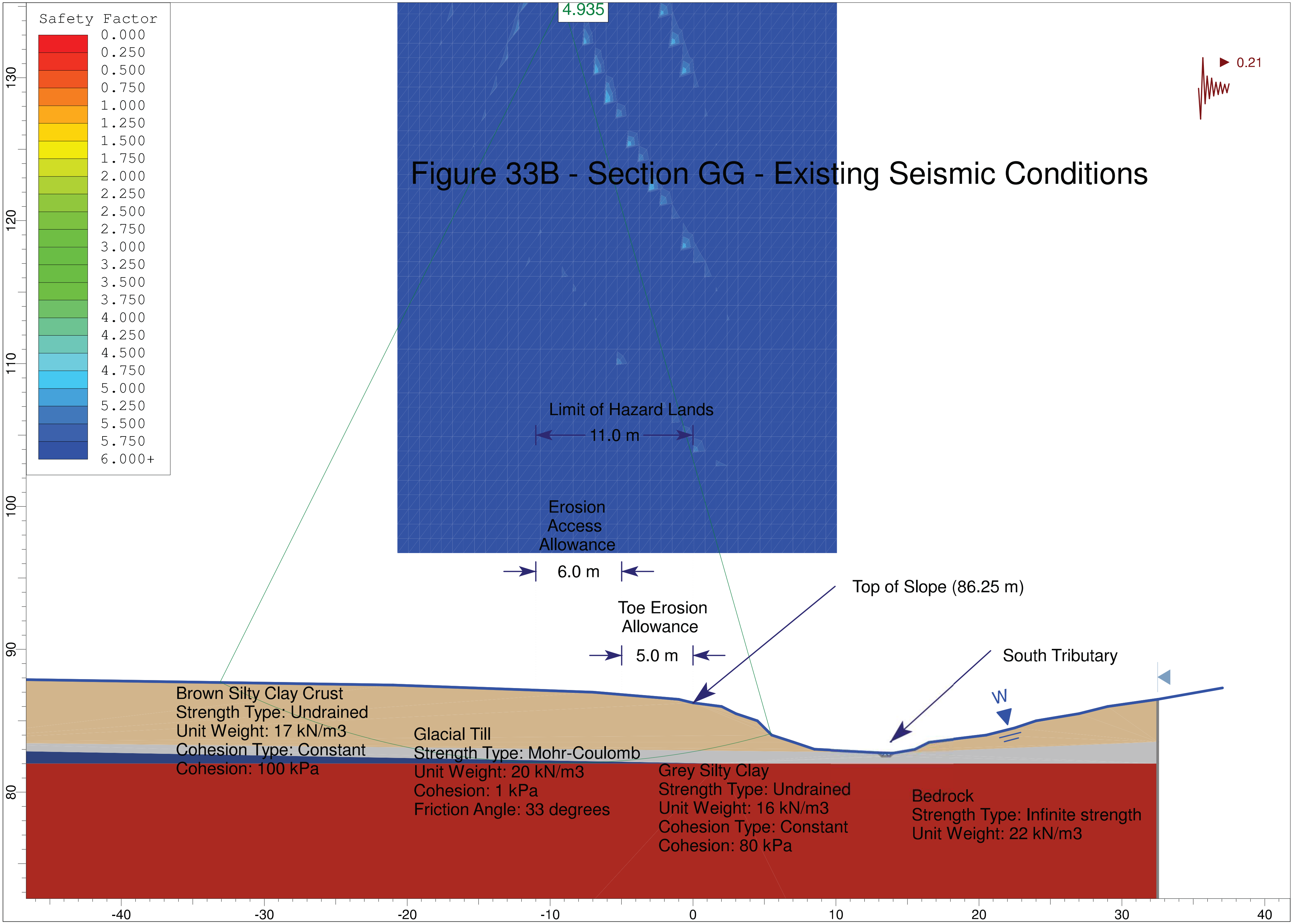


Figure 33B - Section GG - Existing Seismic Conditions

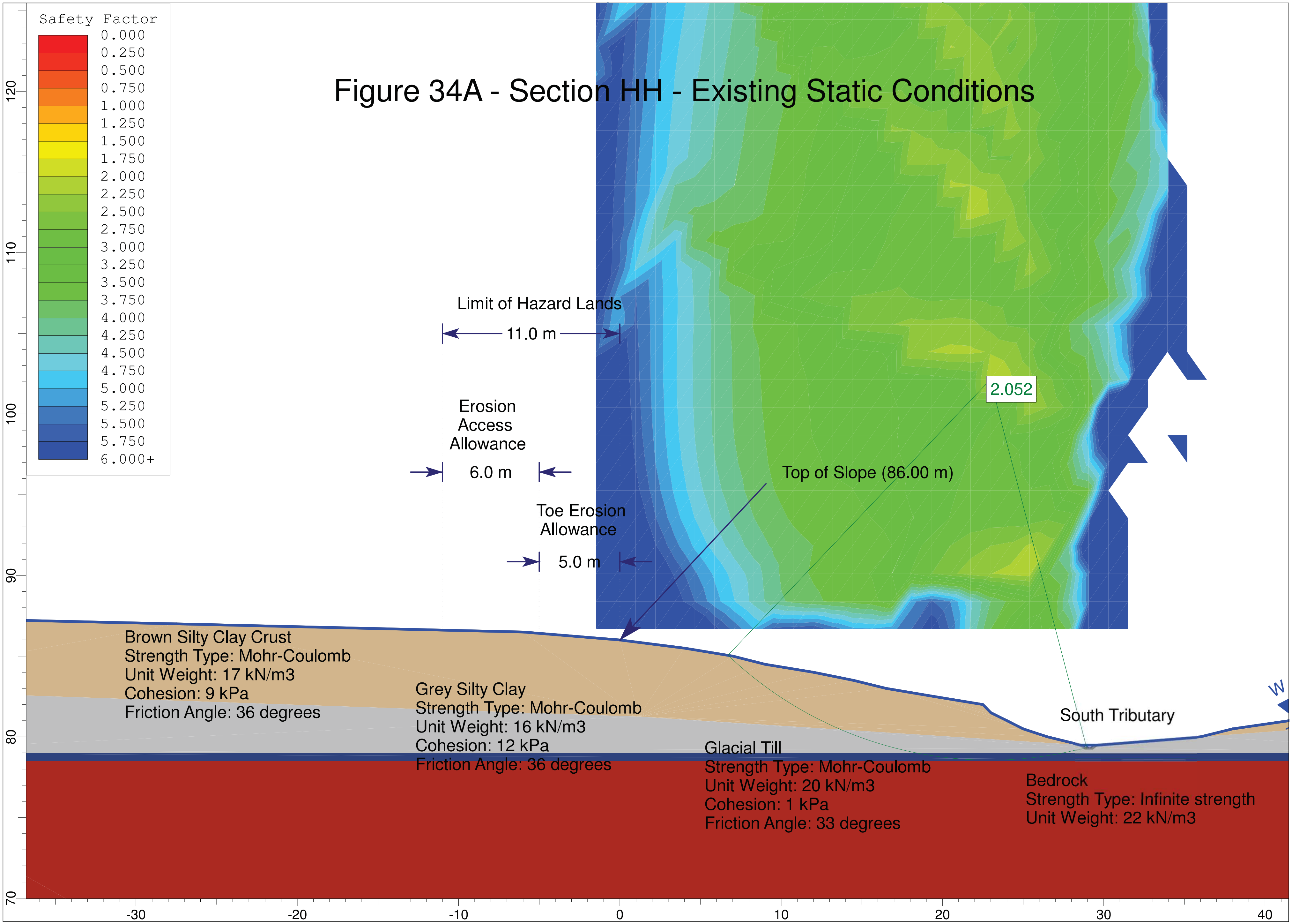
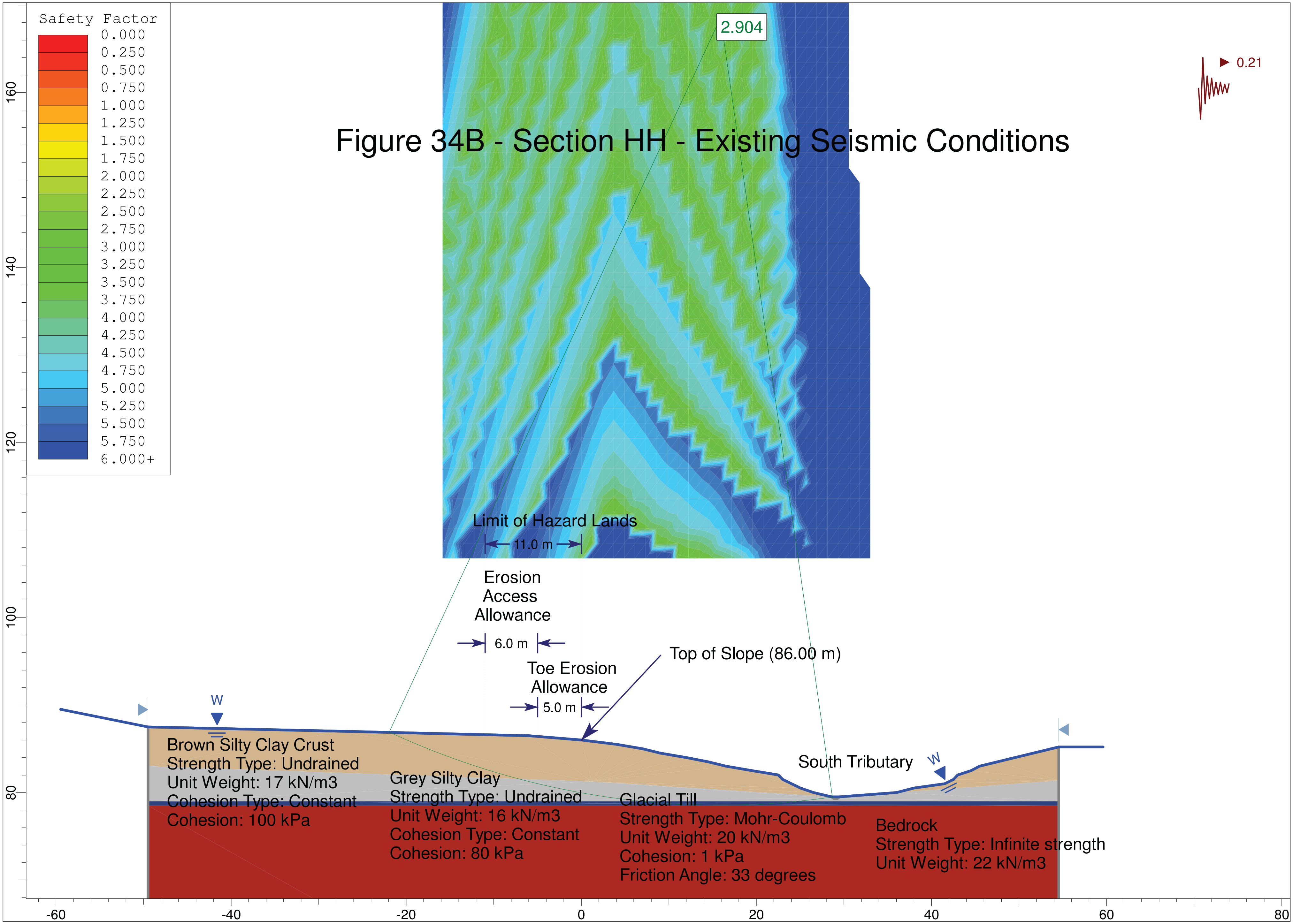


Figure 34A - Section HH - Existing Static Conditions

Figure 34B - Section HH - Existing Seismic Conditions



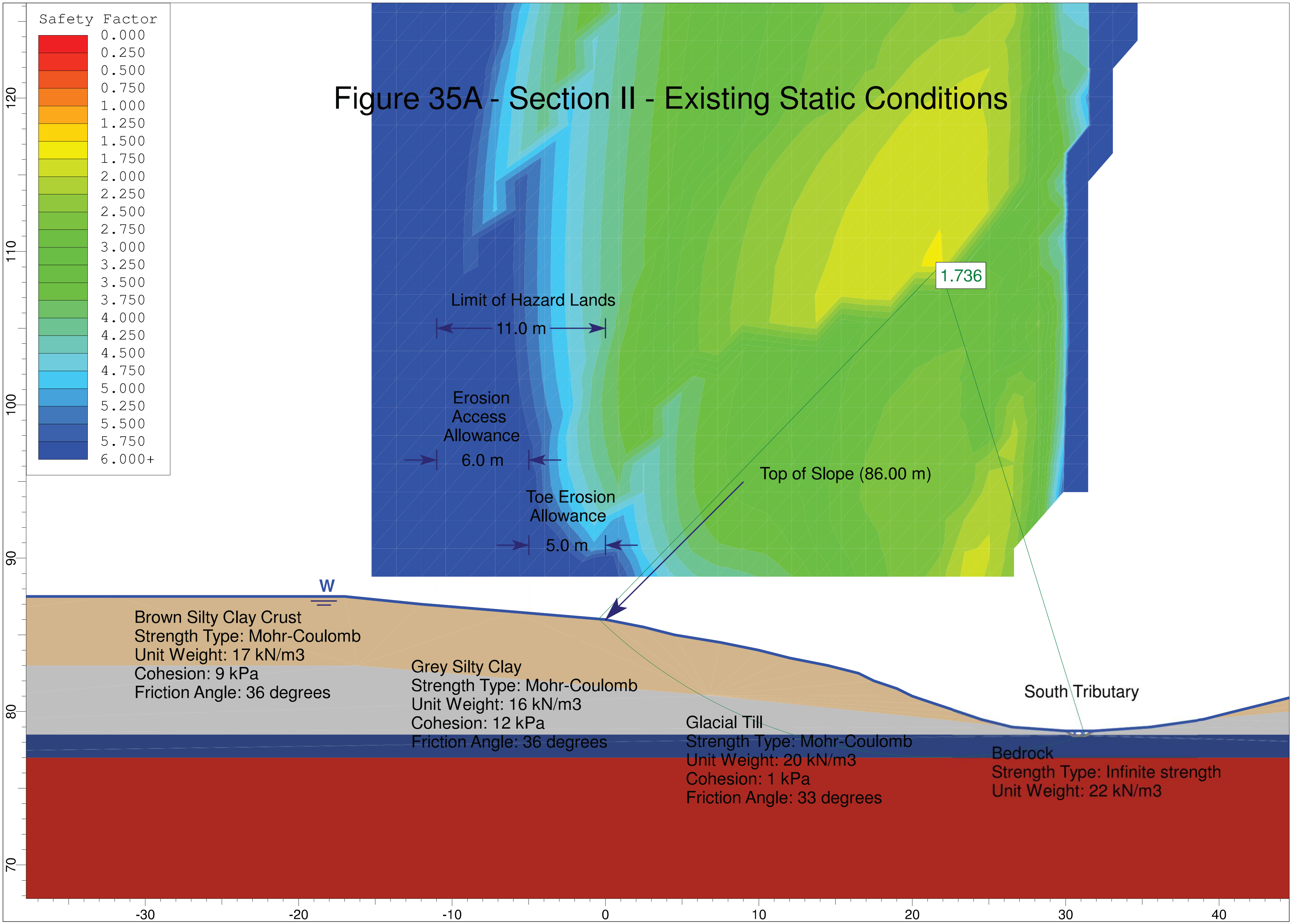


Figure 35A - Section II - Existing Static Conditions

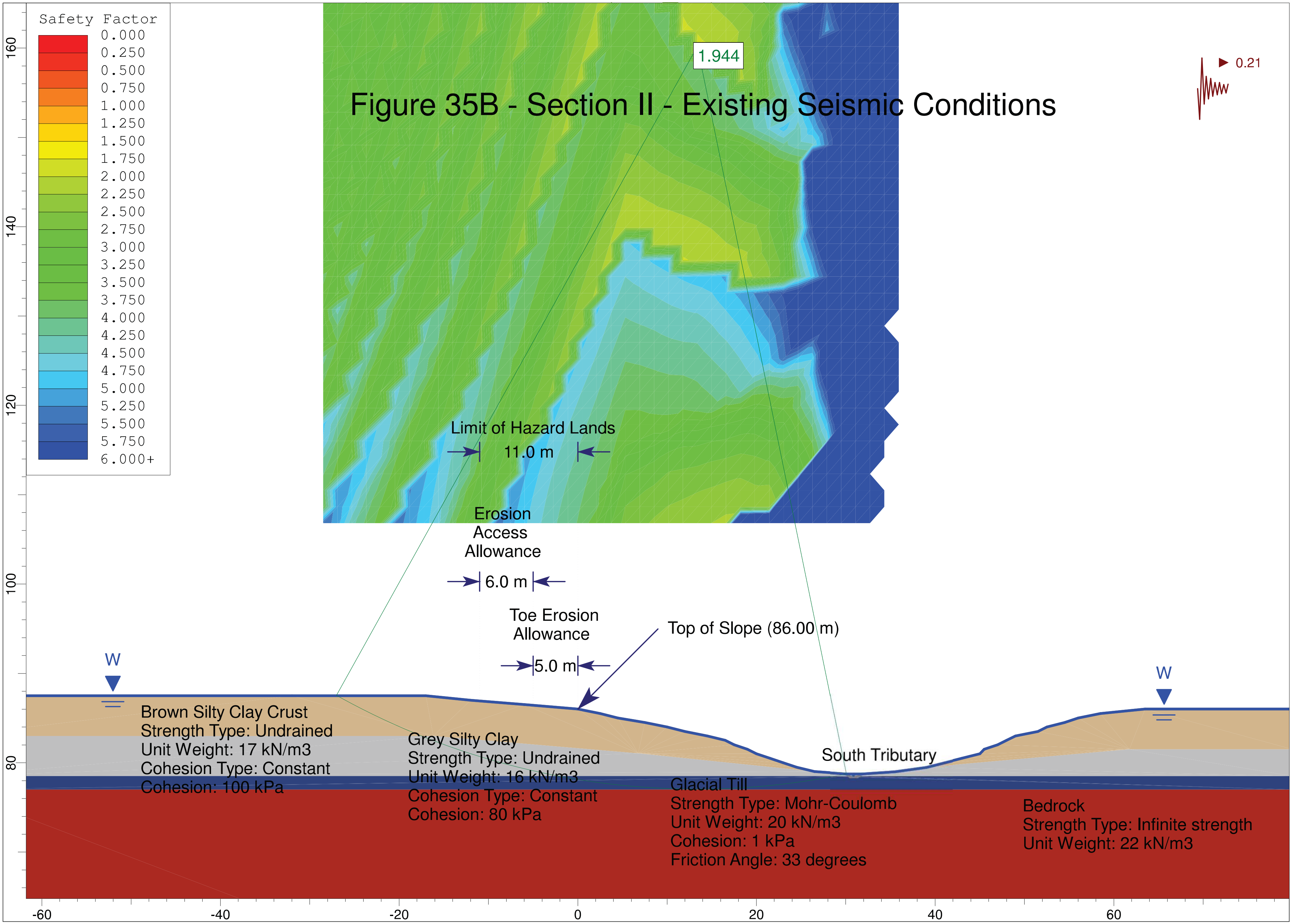
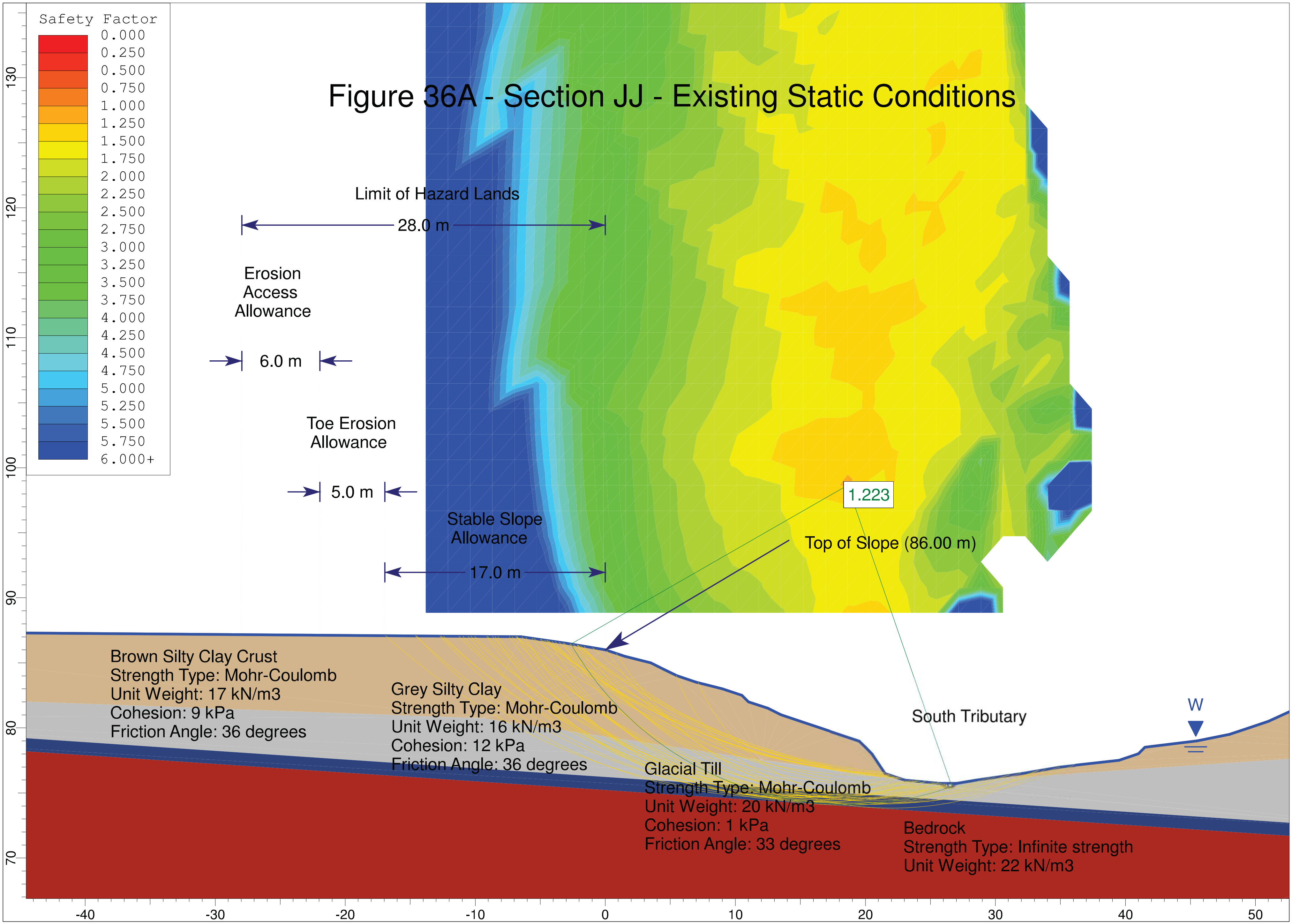


Figure 35B - Section II - Existing Seismic Conditions

Figure 36A - Section JJ - Existing Static Conditions



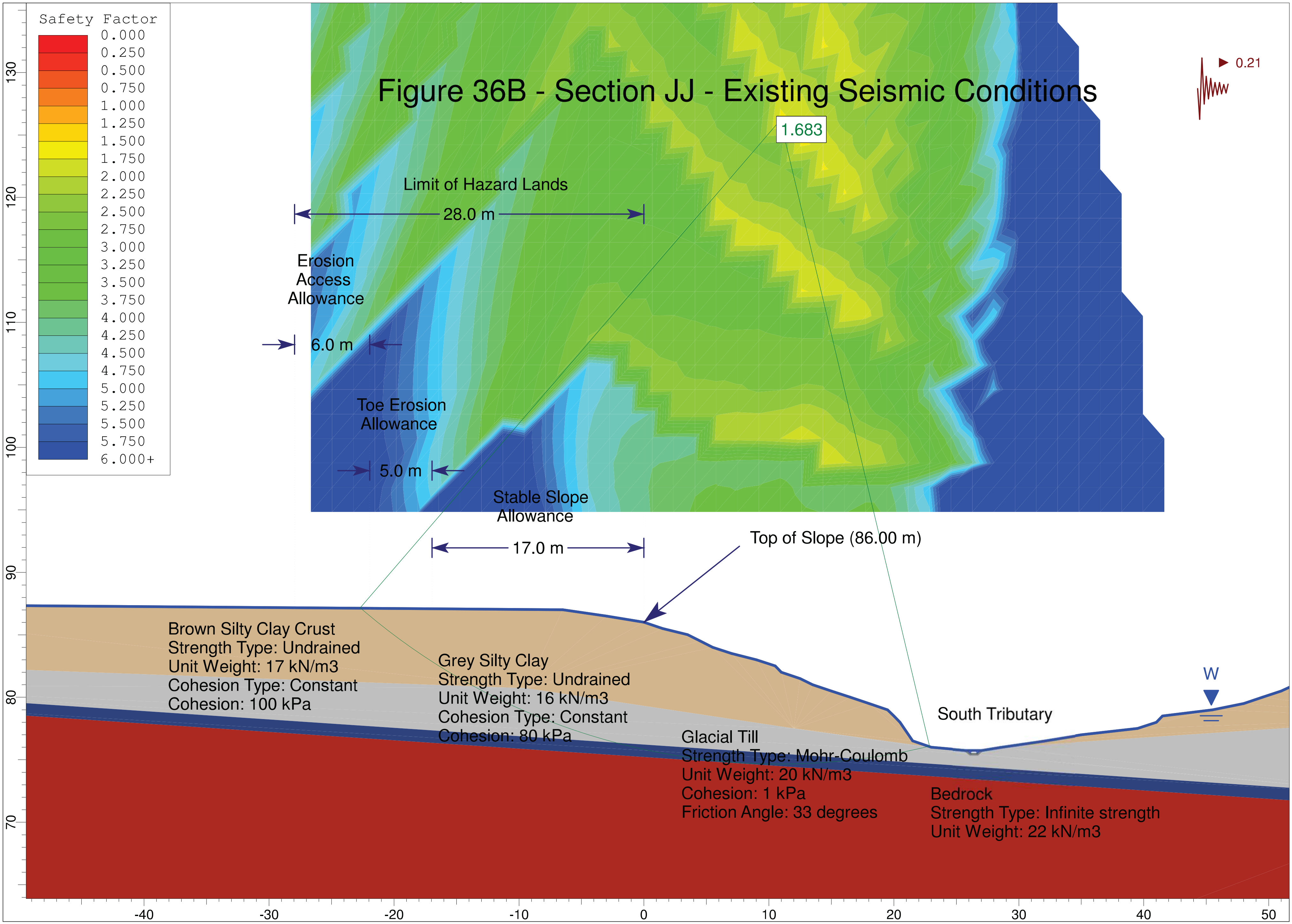


Figure 36B - Section JJ - Existing Seismic Conditions

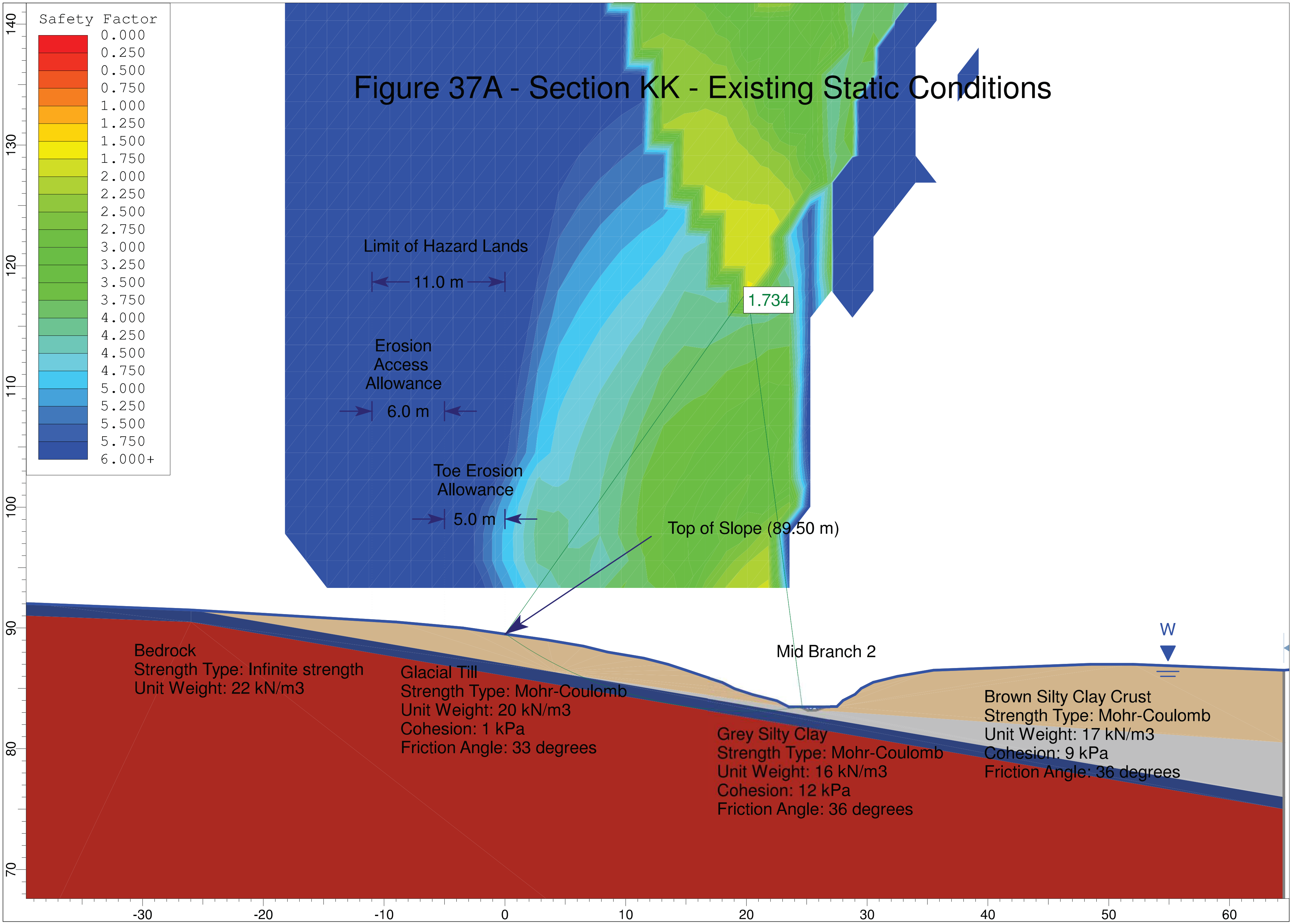
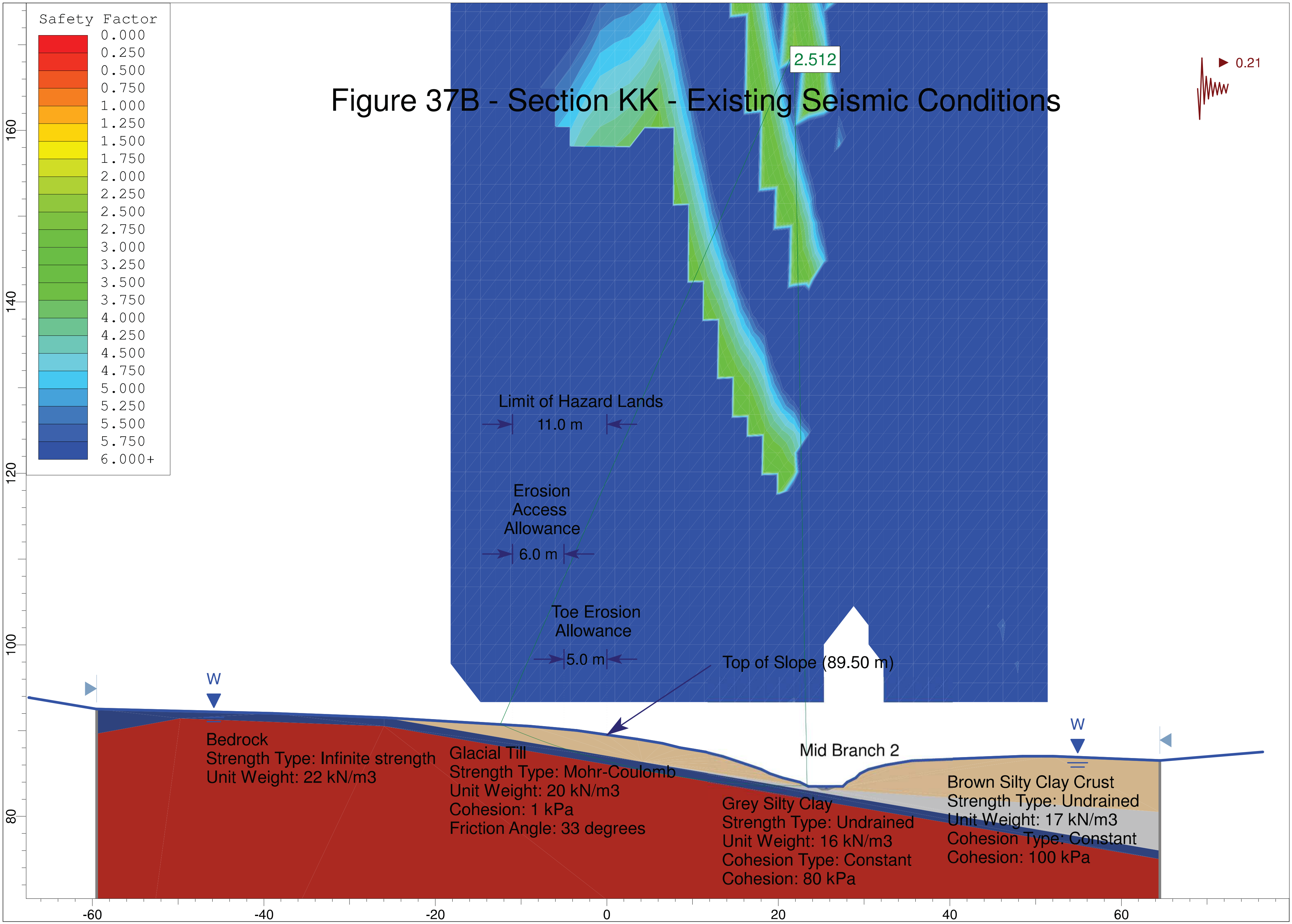


Figure 37A - Section KK - Existing Static Conditions

Figure 37B - Section KK - Existing Seismic Conditions



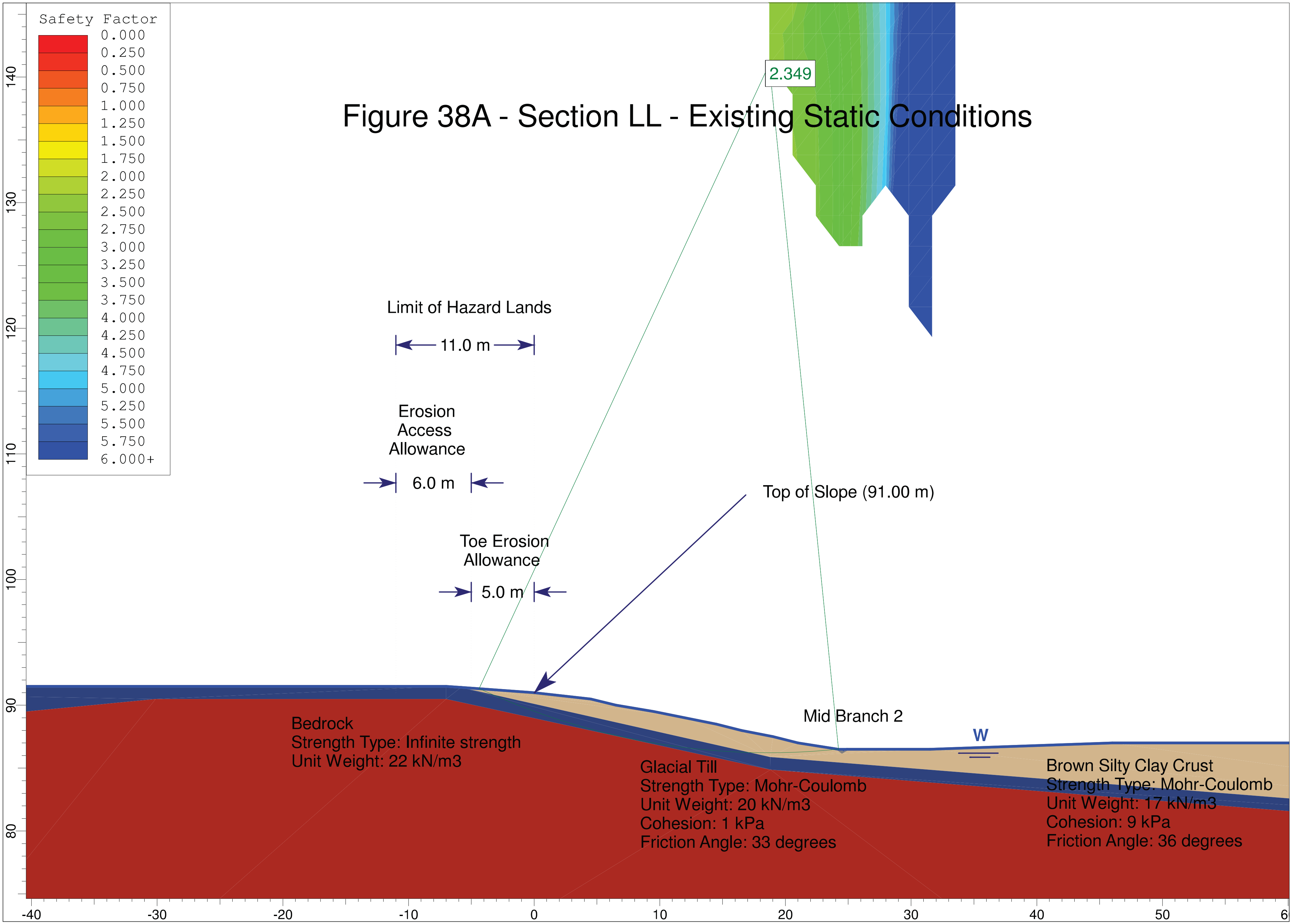


Figure 38A - Section LL - Existing Static Conditions

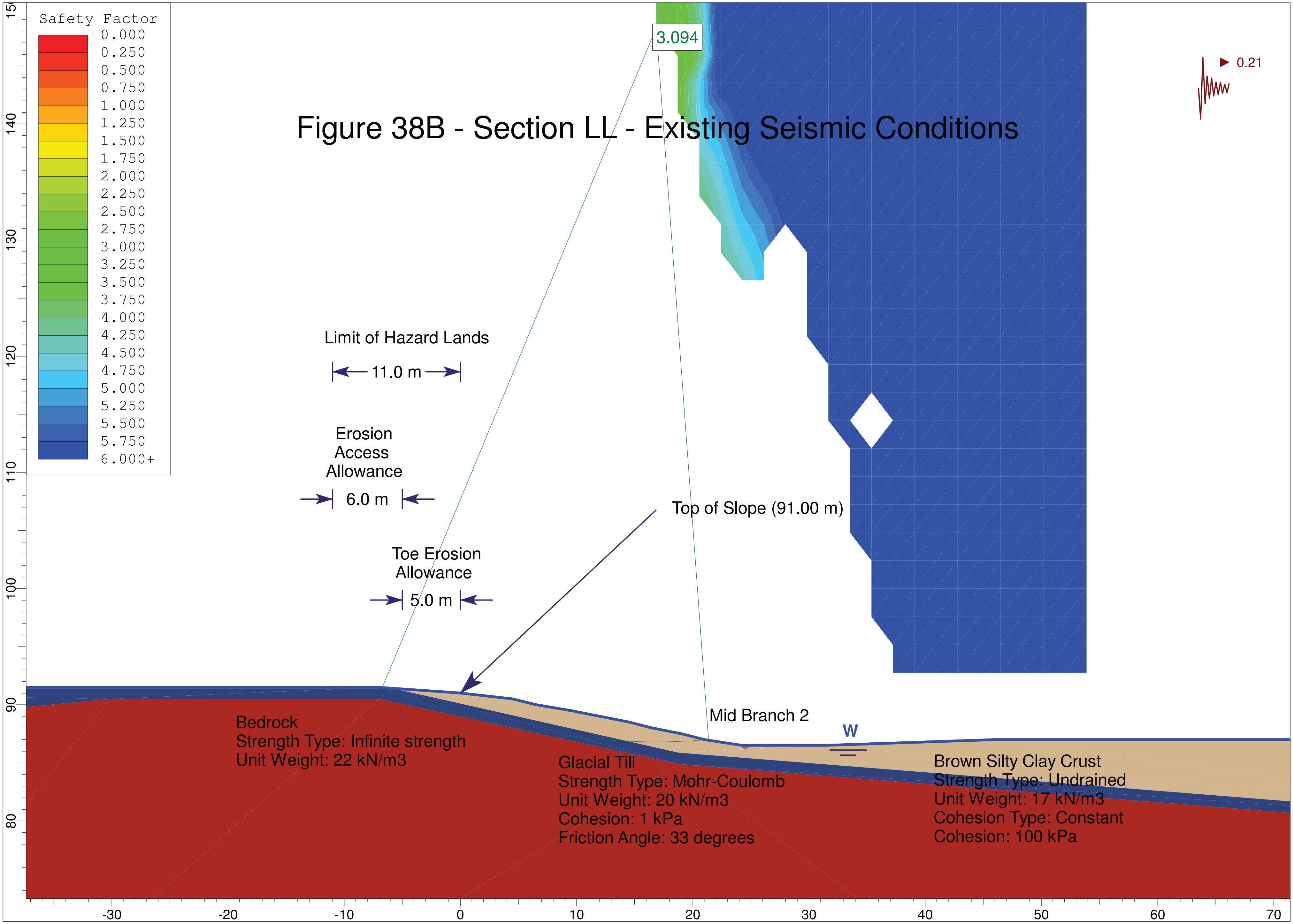


Figure 38B - Section LL - Existing Seismic Conditions

Figure 39A - Section MM - Existing Static Conditions

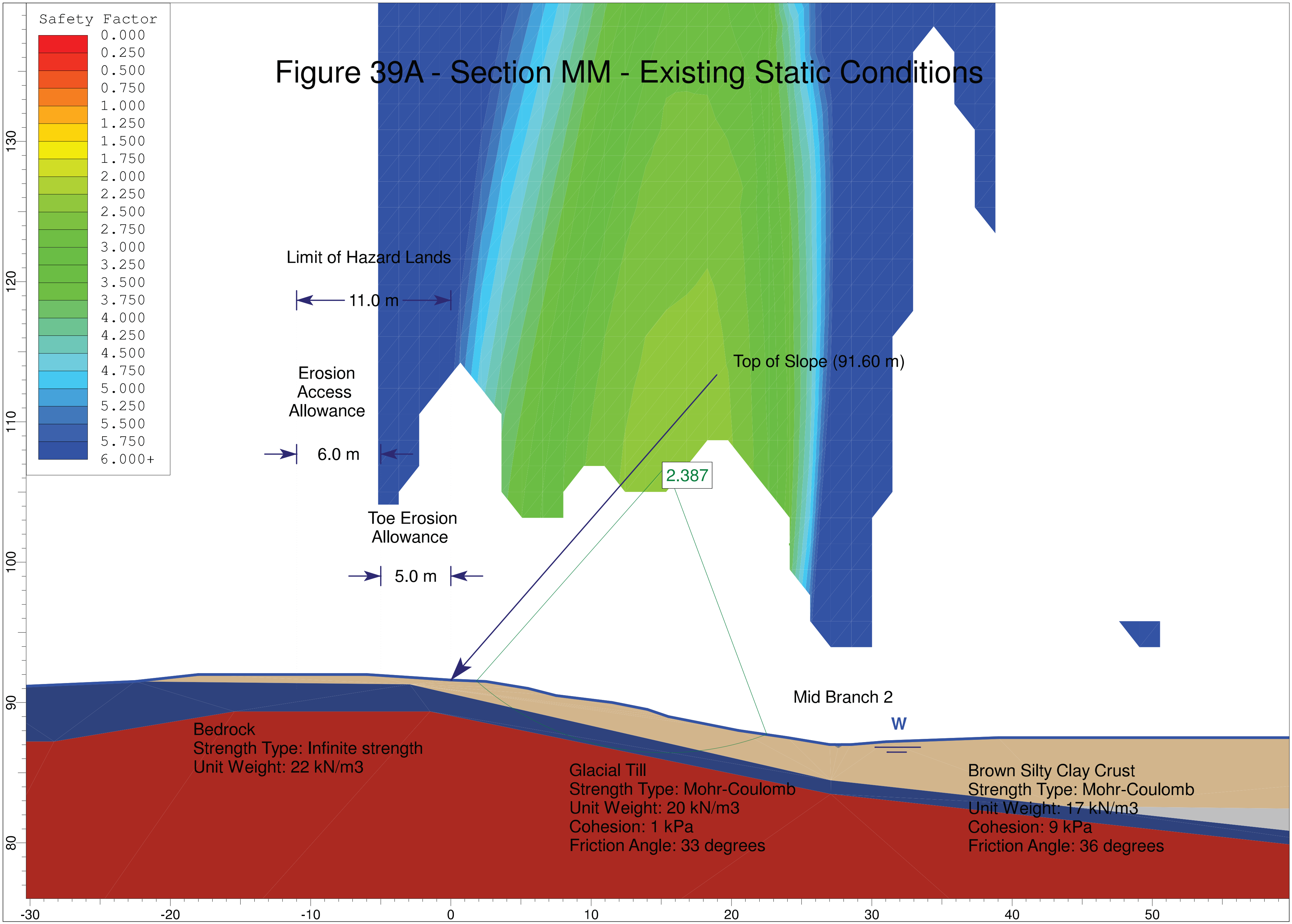
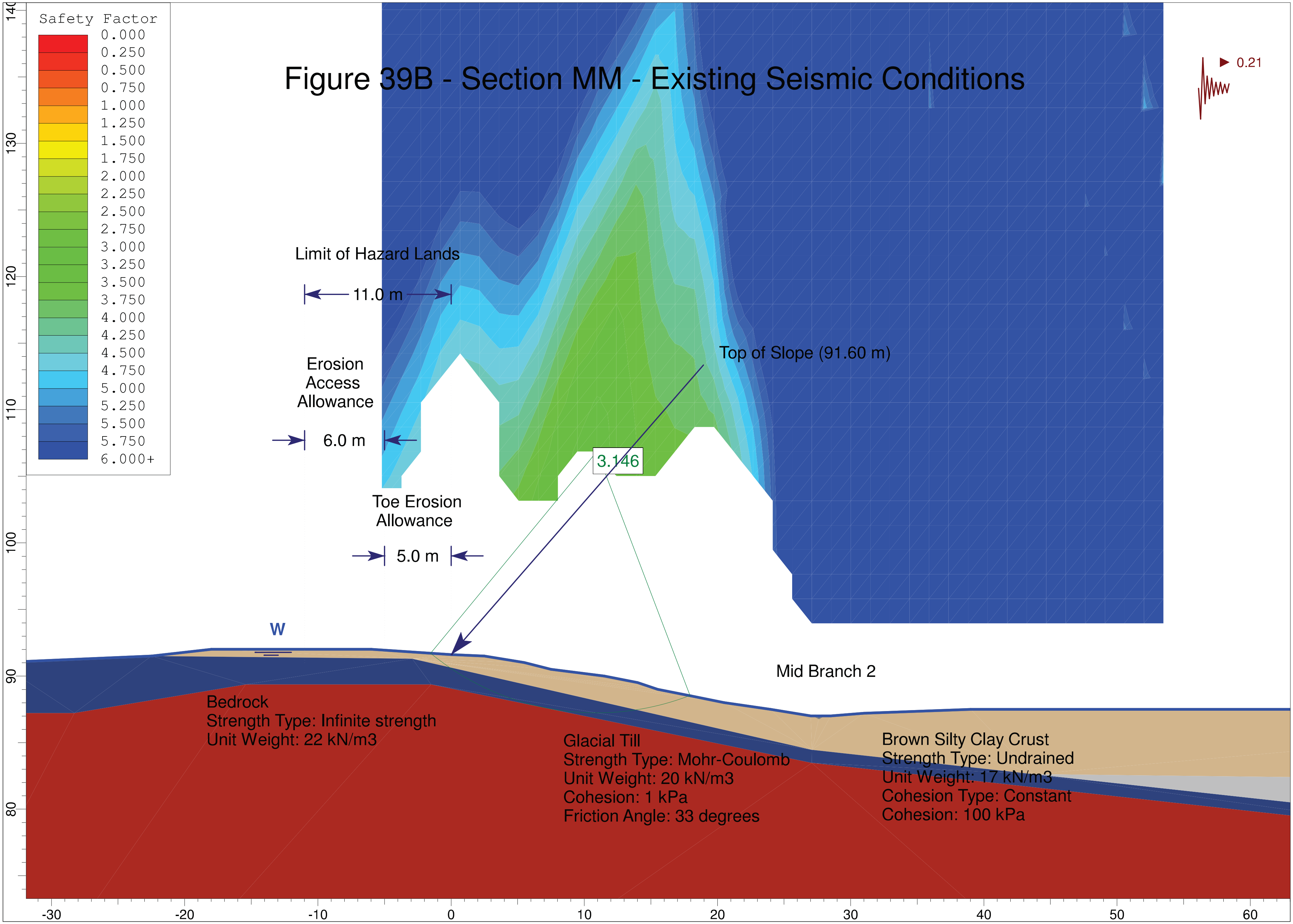


Figure 39B - Section MM - Existing Seismic Conditions



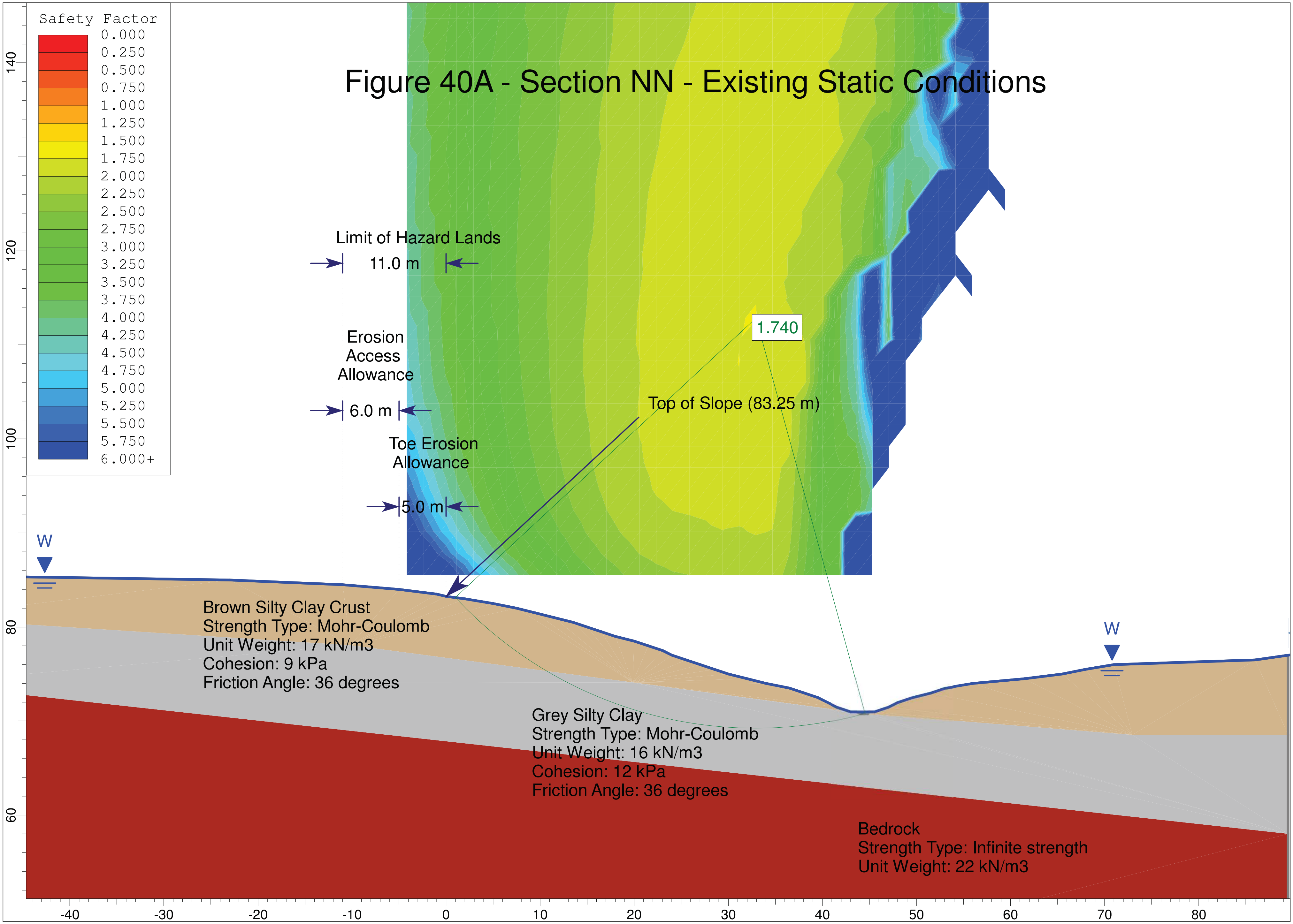
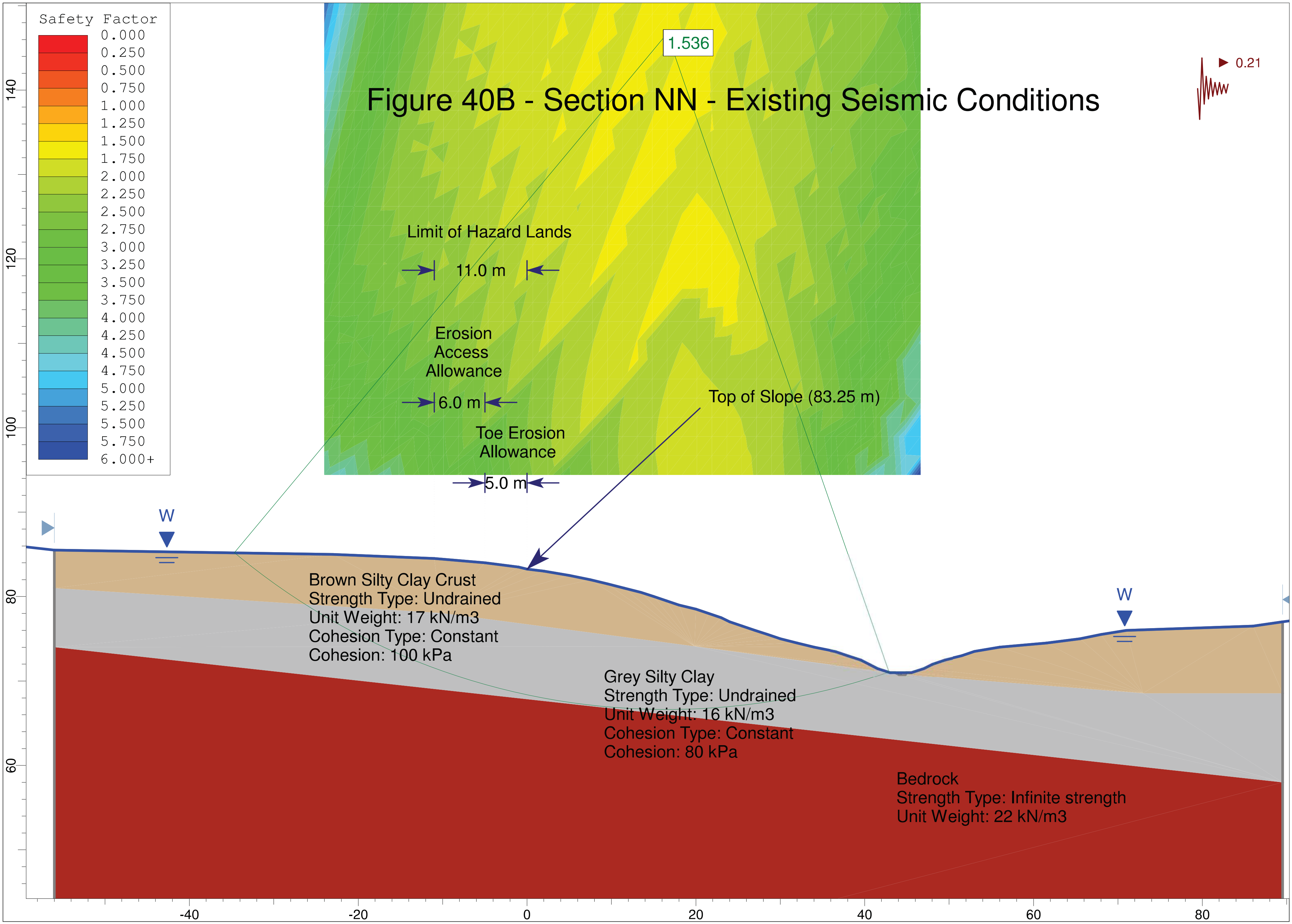


Figure 40A - Section NN - Existing Static Conditions

Figure 40B - Section NN - Existing Seismic Conditions



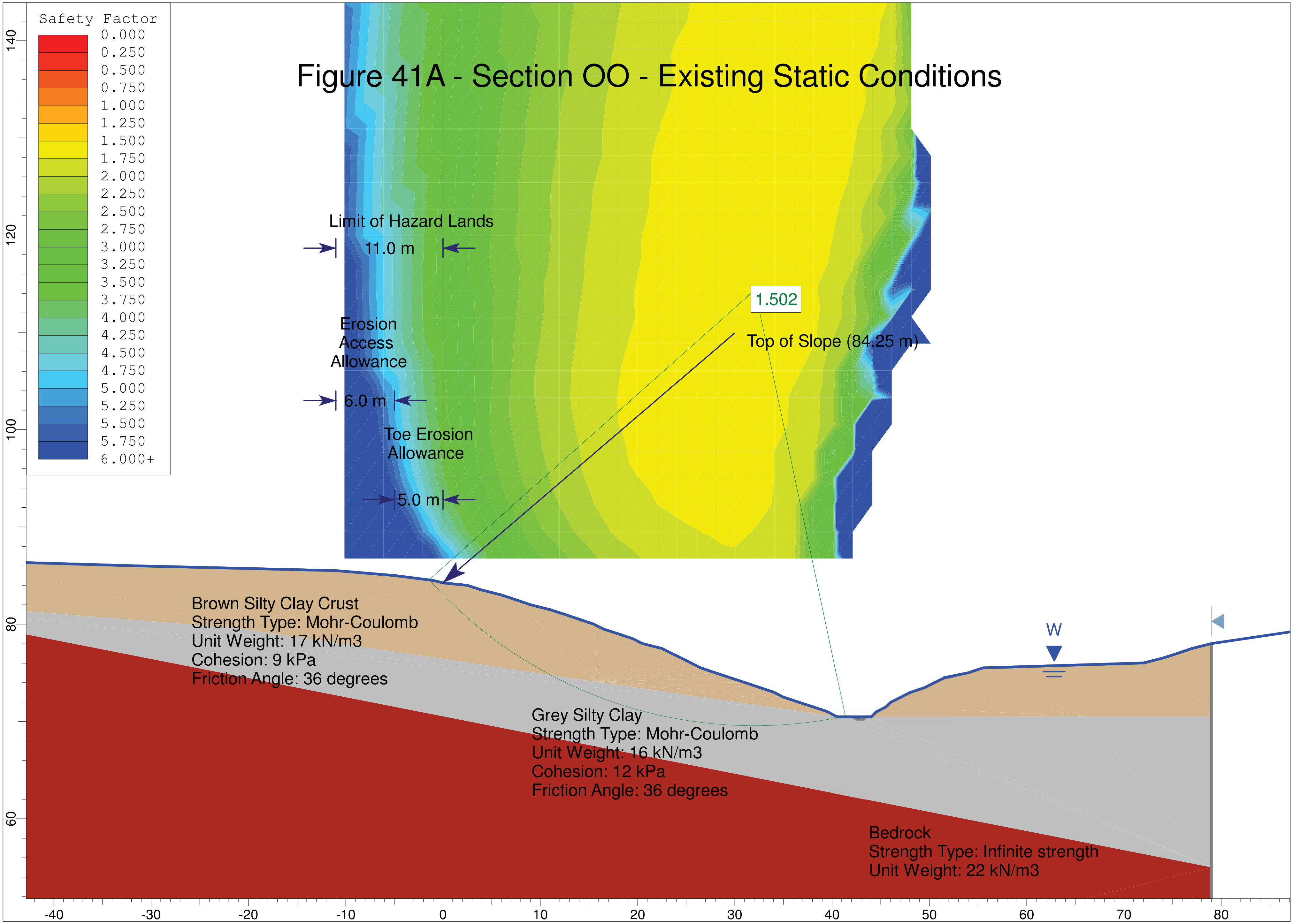


Figure 41A - Section OO - Existing Static Conditions

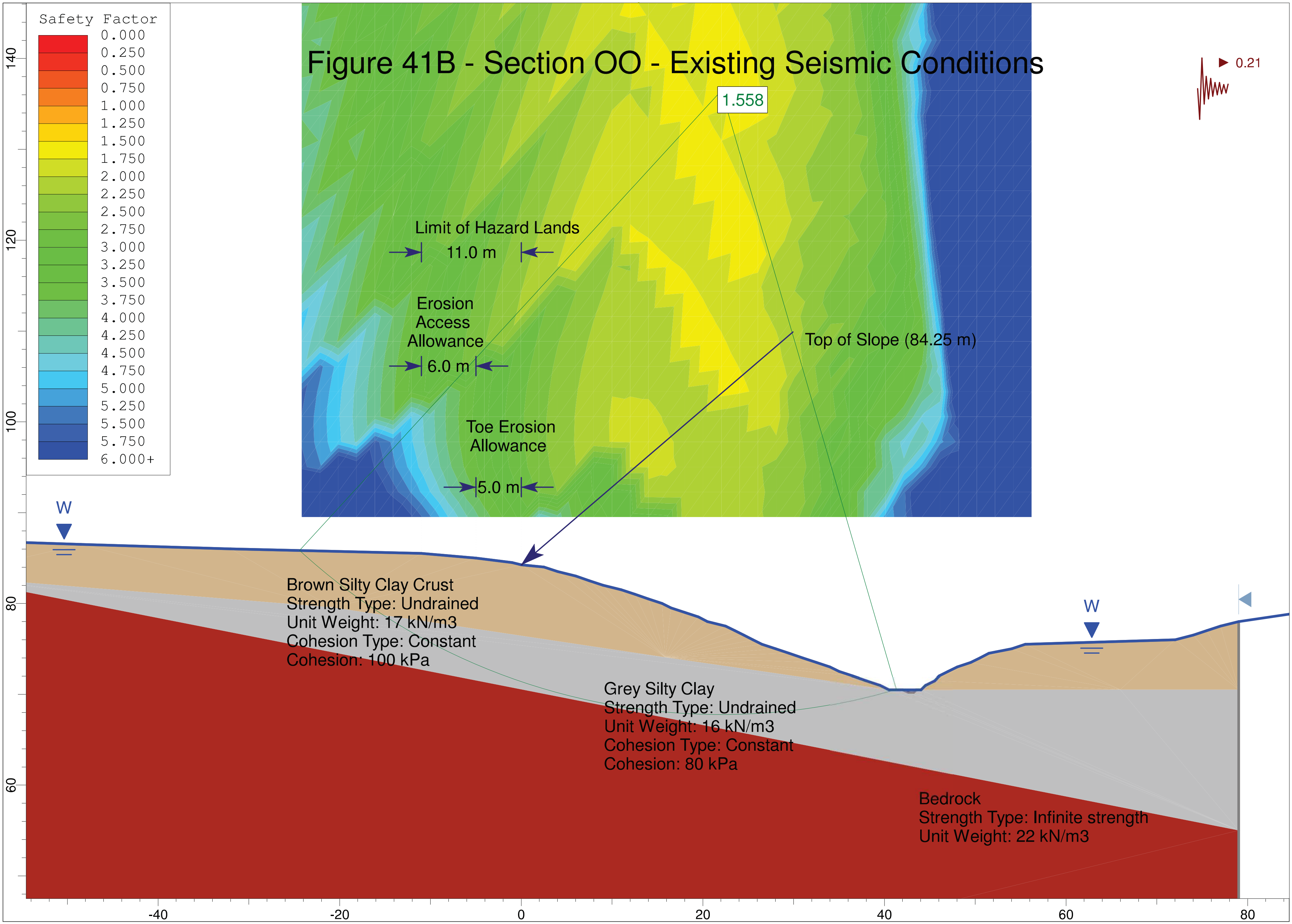


Figure 41B - Section OO - Existing Seismic Conditions

Photographs from Site Visit

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

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

Photographs from Site Visit

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

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

Photo 5: Photo taken on April 18, 2012 of the east bank of the valley corridor along Mid-Branch 1, north of Section J.

Photo 6: Photo taken on April 18, 2012 along the watercourse along Mid-Branch 1 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 September 10, 2020 of the north slope face, looking northwest.

Photo 9: Photo taken on September 10, 2020 of the north slope face, looking northwest.

Photo 10: Photo taken on September 10, 2020 of the north slope face, looking north.

Photo 11: Photo taken on September 10, 2020 of the south slope face, looking southeast near Section O

Photo 12: Photo taken on September 10, 2020 of the north slope face, looking northwest.

Photographs from Site Visit

Photo 13: Photo taken on September 10, 2020 of the north slope face, looking east (upstream) near Section H.

Photo 14: Photo taken on September 10, 2020 of the north slope face, looking northwest near Section CC.

Photo 15: Photo taken on September 10, 2020 of the north slope face, looking northwest near sections G and II

Photo 16: Photo taken on September 10, 2020 of the south slope face near section HH.

Photographs from Site Visit

Photo 17: Photo taken on September 10, 2020 along the watercourse, looking east (upstream).

Photo 18: Photo taken on September 10, 2020 of the north slope face, looking north at section GG.

Photo 19: Photo taken on September 10, 2020 along the watercourse, looking east (upstream).

Photo 20: Photo taken on September 10, 2020 along the watercourse along Mid-Branch 1 looking east (upstream) near Section OO.

Photo 21: Photo taken on September 10, 2020 along the watercourse along Mid-Branch 1 looking east (upstream) near Section N.

Photo 22: Photo taken on September 10, 2020 along the watercourse along Mid-Branch 1 looking north.

LEGEND:

⊕	BOREHOLE LOCAITON (PREVIOUS INVESTIGATION)
⊕	PROBEHOLE LOCATION (CURRENT INVESTIGATION)
●	BOREHOLE BY OTHERS LOCATION (EXP)
97.47	GROUND SURFACE ELEVATION(m)
(94.78)	PRACTICAL REFUSAL TO AUGERING ELEV.(m)
[83.46]	BEDROCK SURFACE ELEVATION(m)
—— 94.00	BEDROCK CONTOUR (m)

TOPOGRAPHIC MAPPING FOR CITY OF OTTAWA (2005)

SCALE: 1:3000

0 25 50 75 100 125 150 200m

NOTE:

THE BEDROCK CONTOURS ARE BASED ON PROBE HOLES COMPLETED AT AN APPROXIMATE SPACING OF 100m CENTRE TO CENTRE. BEDROCK MAY VARY IN DEPTH IN SOME AREAS. THE MAJORITY OF THE PROBE HOLES WERE TERMINATED AT A DEPTH OF 6.5m(DEEPER THAN ALL THE PROPOSED SERVICES). BEDROCK DEEPER THAN 6.5m MAY RANGE FROM 7 TO 12m IN DEPTH. RANDOM PROBE HOLES WERE ADVANCED TO REFUSALS WHERE BEDROCK WAS NOT ENCOUNTERED WITHIN THE UPPER 6.5m BELOW EXISTING GRADE.

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NO.	REVISIONS	DATE	INITIAL
2	BASE PLAN UPDATED	03/03/2022	DP
1	UPDATED TO INCLUDE BOREHOLES BY OTHERS (EXP)	05/21/2021	FA

TAGGART INVESTMENTS

GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVLELOPMENT
CARDINAL CREEK VILLAGE SOUTH
OTTAWA, ONTARIO

Title:

BEDROCK CONTOUR PLAN

Stamp:

Scale: 1:3000
Drawn by: RCG
Checked by: FA
Approved by: FA
Date: 03/2020

Report No.: PG5201-1
Drawing No.: PG5201-1
Revision No.: 2

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LEGEND:

⊕	BOREHOLE LOCAITON (PREVIOUS INVESTIGATION)
⊕	PROBEHOLE LOCATION (CURRENT INVESTIGATION)
▚	TEST PIT LOCATION (PREVIOUS INVESTIGATION)
97.47	GROUND SURFACE ELEVATION(m)
(94.78)	PRACTICAL REFUSAL TO AUGERING ELEV.(m)
[83.46]	BEDROCK SURFACE ELEVATION(m)

TOPOGRAPHIC MAPPING FOR CITY OF OTTAWA (2005)

F F	SLOPE CROSS-SECTION FOR SLOPE STABILITY ANALYSIS
⑤	PHOTOGRAPH TAKEN DURING SITE VISIT - APRIL 18, 2012
⑳	PHOTOGRAPH TAKEN DURING SITE VISIT - SEPT. 10, 2020
🟧	URBAN GROWTH BOUNDARY
🟦	TOP OF SLOPE
🟩	6m EROSION ACCESS ALLOWANCE
🟪	TOE EROSION ALLOWANCE / LIMIT OF HAZARD LANDS
🟥	STABLE SLOPE ALLOWANCE
🟦	APPROX. 100 YEAR WATER LEVEL (JFSA, MARCH 2013)
🟦	APPROX. NHWM (2 YR WATER LEVEL) (JFSA, MARCH 2013)
🟥	30m SETBACK FROM NHWM (DSEL, MARCH 2013)
🟪	MEANDER BELT WIDTH (PARISH, MARCH 2013 - CARDINAL CREEK BASED ON VALUES FROM GEOMORPHIC SOLUTIONS, 2007)

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NO.	REVISIONS	DD/MM/YYYY	INITIAL
1	NEW PHOTO LOCATION ADDED TO PLAN	14/09/2020	KP

TAGGART INVESTMENTS

GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVLELOPMENT
CARDINAL CREEK VILLAGE SOUTH
OTTAWA, ONTARIO

Title:

TEST HOLE LOCATION PLAN

Stamp:

Scale: 1:2000
Drawn by: RCG
Checked by: FA
Approved by: FA
Date: 08/2020

Report No.: PG5201-1
Drawing No.: PG5201-2
Revision No.: 1

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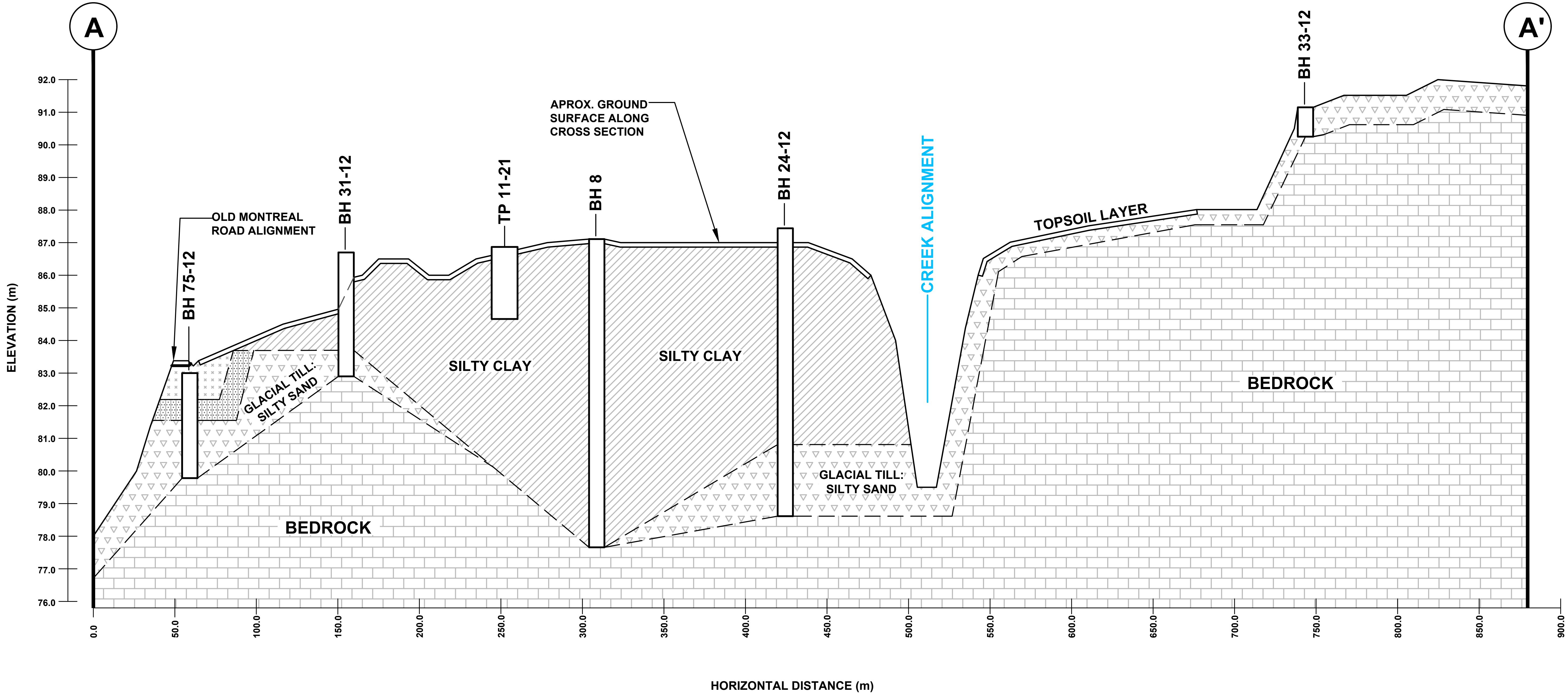

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NO.	REVISIONS	DATE	INITIAL

TAGGART INVESTMENTS
GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT
CARDINAL CREEK VILLAGE SOUTH
OTTAWA, ONTARIO

Title:
CROSS SECTION A-A'

Scale: 1:2500 H
Date: 08/2021
Drawn by: RCG
Report No.: PG5201
Checked by: FC
Approved by: DJG
PG5201-FIG.A
Revision No.:

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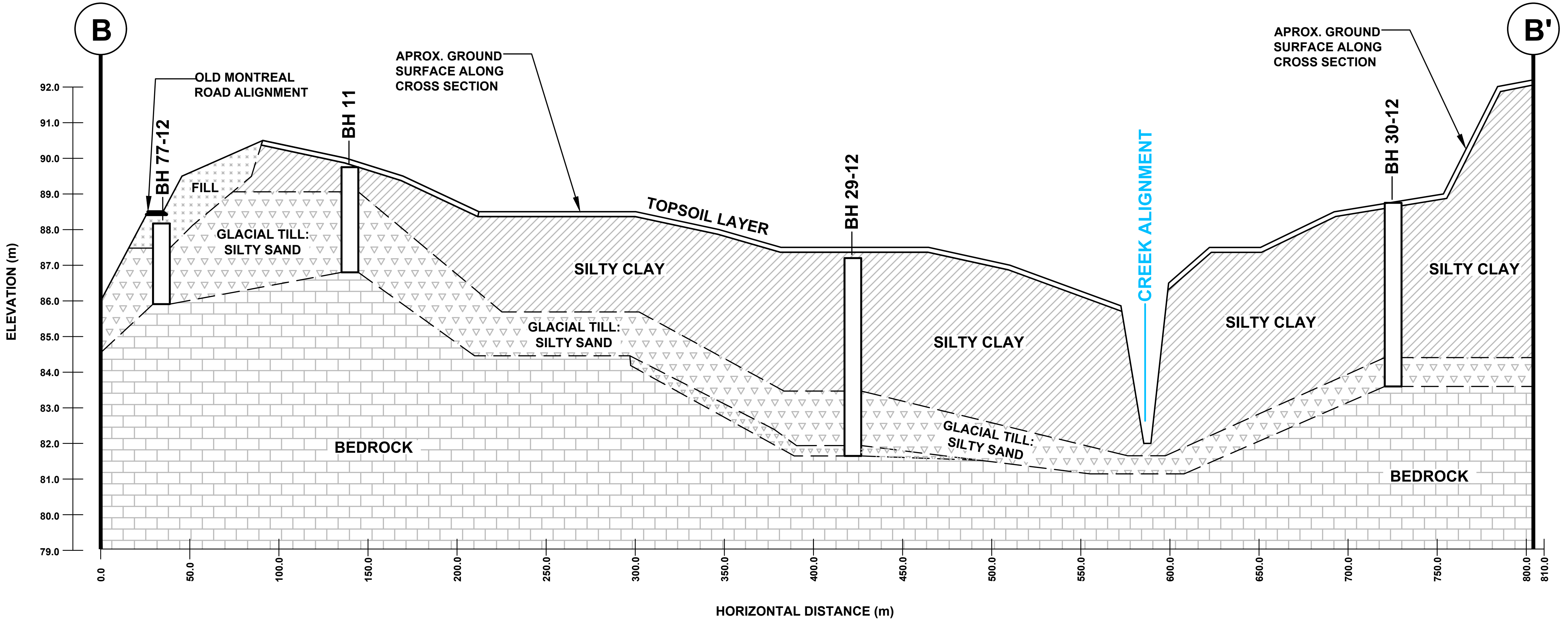

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Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

TAGGART INVESTMENTS
GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT
CARDINAL CREEK VILLAGE SOUTH
OTTAWA, ONTARIO

Title:
CROSS SECTION B-B'

Scale: 1:2500 H
Date: 08/2021
Drawn by: RCG
Report No.: PG5201
Checked by: FC
Approved by: DJG

PG5201-FIG.B

Revision No.:

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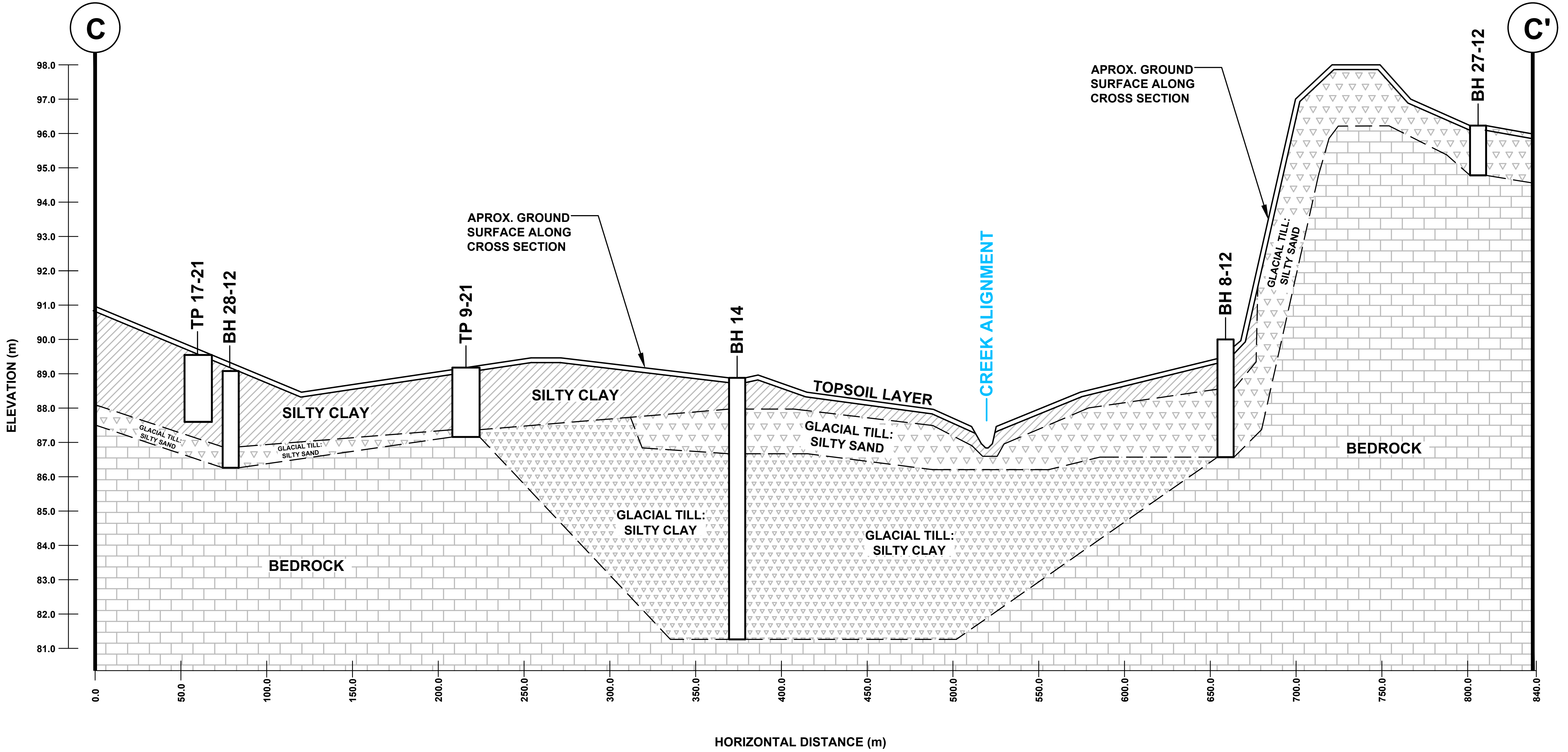

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Tel: (613) 226-7381 Fax: (613) 226-6344

NO.	REVISIONS	DATE	INITIAL

TAGGART INVESTMENTS
GEOTECHNICAL INVESTIGATION - PROPOSED RESIDENTIAL DEVELOPMENT
CARDINAL CREEK VILLAGE SOUTH
OTTAWA, ONTARIO

Title:
CROSS SECTION C-C'

Scale: 1:2500 H
Drawn by: RCG
Checked by: FC
Approved by: DJG
Date: 08/2021
Report No.: PG5201
PG5201-FIG.C
Revision No.:

p:\autocad drawings\geotechnical\pg52xx\pg5201\pg5201-2 sections and thlp(jm).dwg