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Building Science
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April 29, 2019
Report: PG3908-LET.03 - Revision 1

Brigil Construction
98 rue Lois,
Gatineau, Québec
J8Y 3R7

Attention **Mr. Jean-Luc Rivard**

Subject: **Slope Stability Assessment Report (SSAR)**
Proposed Multi-Storey Buildings
Towers 3 and 4 - Petrie's Landing
Inlet Private - Ottawa

Dear Sir,

Further to your request and authorization, Paterson Group (Paterson) prepared a slope stability assessment report (SSAR) and a response to the third-party review comments issued by BGC Engineering (BGC) dated January 23, 2019 for the proposed development at the aforementioned site. The following SSAR was based on our evaluation of the existing slope bordering the north boundary of the site taking into consideration of the proposed development along with the existing development of Towers 1 and 2.

The current SSAR should be read in conjunction with Paterson Report PG3908-2 Revision 1 dated September 14, 2018.

1.0 Historical Information

As part of the current slope stability assessment, Paterson reviewed the available information recovered during the geotechnical investigation from the previous phase of the current development prepared by GHD Limited (GHD) which was formerly Inspec-Sol:

- Geotechnical Preliminary Investigation, Tower B, Highway 174 and Trim Road, Orleans, Ontario, Report T020548-A1 dated August 13, 2013 (Inspec-Sol)

- Additional Slope Stability Assessment, Petrie's Landing I - Tower II (Phase 2), Petrie Island, Ottawa, Ontario, Report T020548-A1 dated June 5, 2014 (Inspec-Sol)

- Geotechnical Investigation, Petrie's Landing Tower 2, 8900 Jeanne D'Arc Boulevard, Ottawa, Ontario, Report T020548-A2 dated June 22, 2016.

- Response to Golder Associates Ltd. Comments, Geotechnical Investigation Report (T020548-A1, dated August 13, 2013), dated June 29, 2016.

In addition, Paterson reviewed the following slope stability comments issued in the following peer review prepared by Golder Associates (Golder):

- Engineering Peer Review, Geotechnical Investigation and Slope Stability Assessment, Inspec-Sol Reports, 8900 Jeanne D'Arc Boulevard - Tower 2, Orleans, Ontario, Project 1650934 dated March 15, 2016.

2.0 Available Information

The current slope stability analysis was completed using the information recovered during our site visit carried out on January 18, 2019, City of Ottawa topographic contour mapping (2001), subsoil information recovered during the previous geotechnical investigations and our general knowledge of the areas geology.

Subsoil Conditions

The subsoil and groundwater conditions used as part of the slope stability analysis was recovered from our geotechnical investigation Report PG3908-2 Revision 1 dated September 14, 2018 and relevant test holes completed by GHD for the previous phase of the current development. Generally, the subsurface profile at the test hole locations consists of a thin layer of topsoil and/or fill consisting of silty sand mixed with clay and/or gravel overlying a very stiff to stiff silty clay deposit extending to depths varying between 25 to 30 m below existing ground surface. The upper portion of the silty clay deposit was weathered to a very stiff brown silty clay crust extending to depths varying between 4 to 7 m which in turn becomes stiff and grey at depth when overlying the bedrock surface.

In situ shear vane field testing carried out within the silty clay deposit during the geotechnical investigation yielded undrained shear strength values ranging from approximately 100 to 150 kPa. These values are indicative of a very stiff consistency.

Two representative soil samples were submitted for grain size analysis from the test holes completed during the geotechnical investigation (by GHD) within the previous phase of the current development. The results of the grain size analysis are summarized in Table 1 below and presented in Particle-Size Analysis of Soils attached to the current report.

Table 1 - Grain Size Distribution (GHD)				
Test Hole	**Sample**	**Gravel (%)**	**Sand (%)**	**Silt and Clay (%)**
BH1-16	SS1	0	1	99
BH1-16	SS5	0	0	100

In addition, 3 representative soil samples were submitted for Atterberg Limits testing from the test holes completed during the geotechnical investigation (by GHD) within the previous phase of the current development. The Atterberg Limits test results are summarized in Table 2 below and presented in the test hole logs prepared by GHD attached to the current report.

Table 2 - Summary of Atterberg Limits Tests (GHD)					
Sample	**Moisture Content %**	**Liquid Limit %**	**Plastic Limit %**	**Plasticity Index %**	**Classification**
BH1-16 - TW1	66.0	27	66	39	CL
BH1-16 - SS2	65.0	26	66	40	CL
BH1-16 - TW2	69.0	26	51	25	CL

Practical refusal to DCPT was encountered at BH 4, BH 5, BH 6, BH 7 and BH 8 at geodetic elevations varying between 23.5 to 27.7 m on inferred bedrock.

Based on the bedrock core samples recovered during the geotechnical investigation completed by GHD on the previous phase of the current development and available geological mapping, the subject site is located in an area where the bedrock consists of interbedded limestone and dolomite of the Gull River formation.

Earthquake Considerations

As part of the geotechnical investigation completed by GHD for the previous phase of the current development, a geophysical (MASW) testing was completed to provide a site specific seismic site classification.

Based on the results of the seismic testing, the average shear wave velocity Vs_{30}, is **277 m/s**. Therefore, a **Site Class D** is applicable for foundation design within that area where similar soil conditions are encountered, as per Table 4.1.8.4.A of the OBC 2012. The results of the site specific geophysial (MASW) testing are presented in Table 1 - Summary of Shear Wave Velocity Measurements and in Figure 1 - Shear Wave Velocity Versus Depth attached to the current report.

Further to the above, it should be noted that liquefaction potential is assessed as part of the seismic design considerations. The silty clay deposit encountered at the subject site has been encountered during numerous geotechnical investigations completed by Paterson across the greater Ottawa area. Based on our experience, and supported by multiple laboratory testing results, this material would typically be considered highly plastic with a plasticity index (PI) greater than 20. Figure 6.15 of the Canadian Foundation Manual (2006) provides criteria for liquefaction assessment of fine-grained soils from Bray et al. (2004) as shown in Figure 2 below.

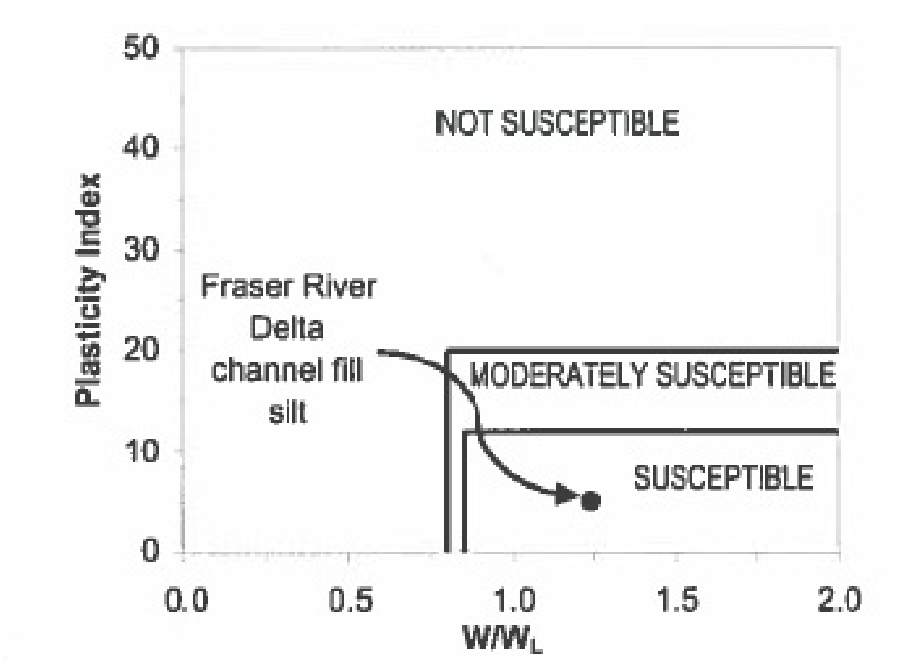

Figure 2 - Bray et al. (2004) criteria for liquefaction assessment of fine-grained soils

Based on the Atterberg Limits testing results conducted on the representative soils samples at the subject site resulting in Plasticity Index (PI) above 20 in conjunction with the site specific shear wave velocity test results, the underlying soils at the subject site not considered susceptible to liquefaction or subsequent ‘earth flows’ from a geotechnical perspective.

3.0 Field Observations

On January 18, 2019, Paterson conducted a site visit to complete a cursory review of the existing slope conditions bordering the north boundary of the subject site. The site was observed to be snow covered at the time of our site visit, but was generally observed to be relatively flat and sloped gradually down toward the north and north-east direction. The site is bordered to the west by a multi-storey building (Tower 2) constructed as part of the previous phase of the current development and to the south by HWY 174. The site is bordered to the north and north-west by a densely treed slope which traverses down to the bottom of the Ottawa River valley corridor to a marsh which outlets to the nearby Ottawa River.

A hand held Abney Level was used to confirm that the slope bordering the north property boundary extended to a maximum height of 10 m and generally varied between 3.7H:1V (15 degrees from horizontal) to 4.2H:1V (13 degrees from horizontal) or flatter as indicated on the available City of Ottawa topographic contour mapping.

Other than some signs of minor erosion along the approximately 100 to 400 mm deep drainage swale located between proposed Tower 4 and Tower 5, no additional signs of active erosion was observed along the slope face nor along the toe of the approximately 10 m high slope.

4.0 Proposed Development

Based on the latest conceptual drawings prepared by Neuf Architect(e)s, it’s our understanding that the proposed two multi-storey structures identified as Tower 3 and Tower 4 will be supported by end-bearing piles driven to the underlying bedrock. It’s also understood a two level of underground parking structure will be shared between the two structures extending beyond the tower footprints and supported with conventional strip and pad footings bearing on the native stiff silty clay.

The excavated soil removed for the two level underground parking structure, which will occupy the majority of the subject site, will reduce the overall weight on the existing slope and stabilize the groundwater level to a lower elevation which will increase the overall stability of the existing slope.

It should be further noted that the root systems of the mature trees along the slope face will remain as part of the proposed development and arguably aids in the stability of the slope and mitigates surficial erosion. However, the benefits of the existing roots systems that occupy the existing slope face have not been including as part of slope stability analysis.

5.0 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.

All three slope cross-sections were analysed utilizing the latest available grading plan prepared by exp. while incorporating the two level underground parking structure presented in the latest conceptual drawings prepared by Neuf Architect(e)s.

The slope stability analysis was completed at each slope cross-section under worst-case-scenario by assigning cohesive soils under fully saturated conditions. In addition, a secondary analysis was completed at each slope cross-section with the stabilized groundwater lowered to the founding level of the proposed structure as a result of the localized groundwater lower from the perimeter foundation drainage system.

The effective strength soil parameters used for static analysis were chosen based on the subsoil information recovered during the geotechnical investigation which also happens to reflect the soil parameters that were used during the slope stability assessment completed for the previous phase of the current development prepared by GHD for Tower 2. 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	Un it Weight (kN/m^3)	Friction Angle (degrees)	Cohesion (kPa)
Fill	18	28	2
Brown Silty Clay Crust	16	33	10
Grey Silty Clay	16	27	7
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 areas geology. The strength parameters used for seismic analysis at the slope cross-sections are presented in Table below.

Table 4 - Total Stress Soil and Material Parameters (Seismic Analysis)			
Soil Layer	**Un it Weight (kN/m^3)**	**Friction Angle (degrees)**	**Undrained Shear Strength (kPa)**
Fill	18	28	2
Brown Silty Clay Crust	16	-	150
Grey Silty Clay	16	-	100
Bedrock	Impenetrable		

The location of the three cross-sections analyzed are presented on Drawing PG3908-2 - Site Plan enclosed.

Static Loading Analysis

The results of the static analysis for the proposed slope udder fully saturated conditions (worst-case-scenario) are shown in Figure 2A, 3A and 4A attached to the current report. In addition, the results of the analysis using stabilized groundwater levels lowered down to the founding level of the proposed building are shown in Figure 2C, 3C and 4C. The minimum analysed slope stability factor of safety under fully saturated conditions (worst-case-scenario) were calculated to range between 1.5 and 1.7 and between 1.7 and 2.4 when calculated with stabilized groundwater conditions.

As a result, the three slope cross-sections analyzed were all above the recommended Factor of Safety of 1.5 and are considered stable under static conditions.

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 0.16G was considered for the analysed section. A factor of safety of 1.1 is considered to be satisfactory for stability analysis including seismic loading.

The results of the analysis including seismic loading under both fully saturated conditions (worst-case-scenario) and stabilized groundwater levels lowered down to the founding level of the proposed structure are shown in Figure 2B, 2D, 3B, 3D, 4B and 4D attached to the current report. The overall slope stability factor of safety at the three slope cross-sections when considering seismic loading was found to be greater than 1.4 which is considered to be stable under seismic loading.

6.0 Limit of Hazard Lands

The limit of hazard lands includes allowances for a geotechnical stable slope, the potential for future toe erosion and access for equipment to remediate a potential slide. Generally, the erosion access allowance is taken as 6 m from the top of stable slope.

A slope stability assessment was carried out to determine the required stable slope allowance setback based on a factor of safety of 1.5 under static analysis and a factor of safety of 1.1 under seismic loading. A toe erosion and 6 m access allowances were also considered in the determination of limits of hazard lands and are further discussed below.

Stable Slope Allowance

The stable slope limit is usually defined by the extent of the lowest slip circle (failure slip plains) analyzed behind the top of slope where the minimum factor of safety calculated is less than 1.5. The minimum factor of safety was calculated for all three slope section analysed to be above the recommended 1.5 under static conditions and above the recommended factor of safety of 1.1 under seismic loading and therefore defined as stable and no stable slope allowance is required from a geotechnical perspective.

Toe Erosion Allowance

The toe erosion allowance for the valley corridor wall slope are based on the cohesive nature of the top layers of the subsoils, the observed current erosional activities, and the width and location of the current watercourse. Since the existing watercourse (Ottawa River) is located greater than 20 m from the toe of the slope and no evidence of erosional activities were observed along the toe of the slope during our site visit. As per “River and Stream System: Erosion Hazard Limit prepared by Ontario Ministry of Natural Resources”, confined systems where the toe of the slope located more than 15 m from the watercourse do not require set back for toe erosion allowance. Based on the measured distance between the toe of the slope and the watercourse, slope geometry and slope stability analysis results, it is our opinion that no toe erosion allowance is required for the subject section of the site.

Erosion Access Allowance

Based on the City of Ottawa guidelines for slope stability, as a general rule, where the development precludes an access for construction equipment such as a parking lot, access lanes, rear yards, etc, a 6 m erosion access allowance must be provided. However, due to the overall stability of the slope in conjunction with the proximity of the watercourse to the toe of the slope, it is considered acceptable to omit the requirement for the 6 m toe erosion access allowance for the subject section of slope. In the unlikely event that minor erosional activities occur in the future along the slope face, the slope could be easily accessed from the toe of the slope (if required).

7.0 Conclusion

Based on our site review, geometry of the slope, results of the slope stability analysis taking into consideration of the proposed development, the slope bordering the north boundary of the subject section of the site is stable and considered satisfactory. The slope is not considered to be susceptible to global failure or “earth flows”.

Therefore, no geotechnical set back is required to be designated as Hazard Lands for toe erosion allowance or slope instability.

We trust that this information satisfies your requirements.

Best Regards,

Paterson Group Inc.

Richard Groniger, C. Tech.

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

LICENSED PROFESSIONAL ENGINEER
April 29, 2019
C. P. DA SILVA
PROVINCE OF ONTARIO

Attachments

- ❏ Soil Profile and Test Data Sheets
- ❏ Symbols and Terms
- ❏ Soil Profile and Test Data Sheets (by others)
- ❏ Grain Size Distribution Analysis (by others)
- ❏ Table 1 - Summary of Shear Wave Velocity Measurements (GHD)
- ❏ Figure 1 - Shear Wave Velocity Versus Depth (GHD)
- ❏ Figure 2A - Section A - Proposed Conditions - Fully Saturated - Static Analysis.
- ❏ Figure 2B - Section A - Proposed Conditions - Fully Saturated - Seismic Loading
- ❏ Figure 2C - Section A - Proposed Conditions - Stabilized Groundwater - Static Analysis.
- ❏ Figure 2D - Section A - Proposed Conditions - Stabilized Groundwater - Seismic Loading
- ❏ Figure 3A - Section B - Proposed Conditions - Fully Saturated - Static Analysis.
- ❏ Figure 3B - Section B - Proposed Conditions - Fully Saturated - Seismic Loading
- ❏ Figure 3C - Section B - Proposed Conditions - Stabilized Groundwater - Static Analysis.
- ❏ Figure 3D - Section B - Proposed Conditions - Stabilized Groundwater - Seismic Loading
- ❏ Figure 4A - Section C - Proposed Conditions - Fully Saturated - Static Analysis.
- ❏ Figure 4B - Section C - Proposed Conditions - Fully Saturated - Seismic Loading
- ❏ Figure 4C - Section C - Proposed Conditions - Stabilized Groundwater - Static Analysis.
- ❏ Figure 4D - Section C - Proposed Conditions - Stabilized Groundwater - Seismic Loading
- ❏ PG3908-2 - Site Plan

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

REMARKS

HOLE NO. BH 4

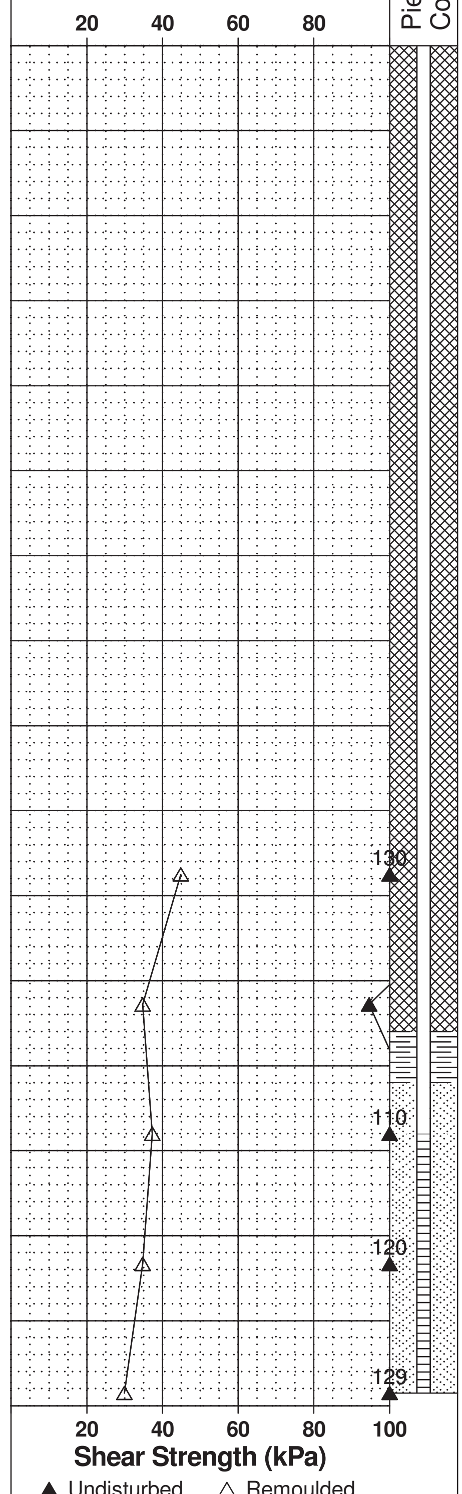
BORINGS BY CME 55 Power Auger

DATE July 17, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.26
FILL: Brown silty clay with crushed stone and organics 0.18		AU	1				
						1	52.26
						2	51.26
						3	50.26
						4	49.26
						5	48.26
						6	47.26
Very stiff, brown **SILTY CLAY**						7	46.26
- grey by 7.6m depth						8	45.26
						9	44.26
						10	43.26
						11	42.26
						12	41.26
						13	40.26
						14	39.26
						15	38.26
15.85						16	37.26

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

Piezometer Construction



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

REMARKS

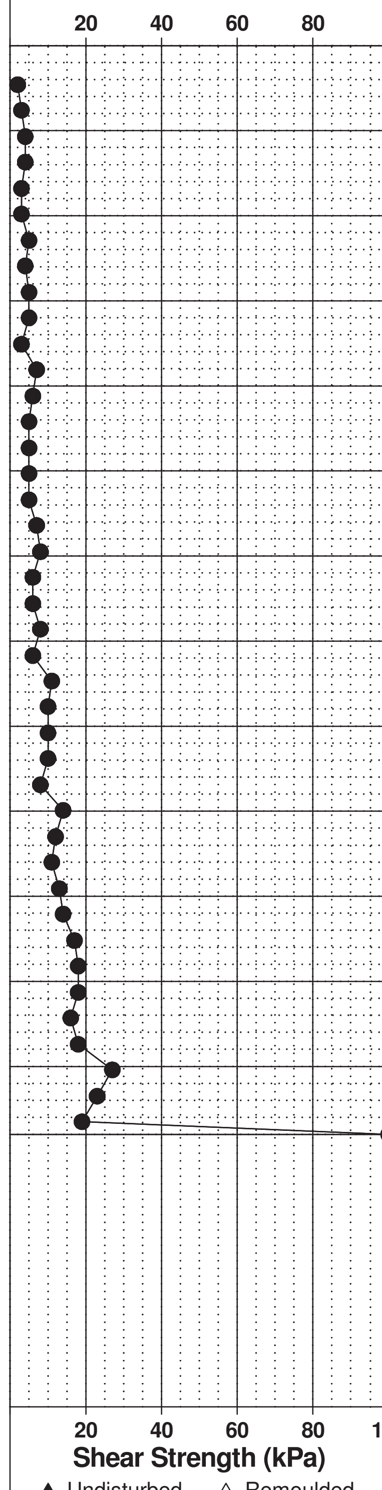
BORINGS BY CME 55 Power Auger

DATE July 17, 2018

FILE NO. PG3908

HOLE NO. BH 4

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)	Pen. Resist. Blows/0.3m ● 50 mm Dia. Cone / ○ Water Content %	Piezometer Construction
GROUND SURFACE									
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	37.26		
						17	36.26		
						18	35.26		
						19	34.26		
						20	33.26		
						21	32.26		
						22	31.26		
						23	30.26		
						24	29.26		
						25	28.26		
						26	27.26		
						27	26.26		
						28	25.26		
28.80									
End of Borehole Practical DCPT refusal at 28.80m depth. (BH dry - July 24, 2018)									



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

REMARKS

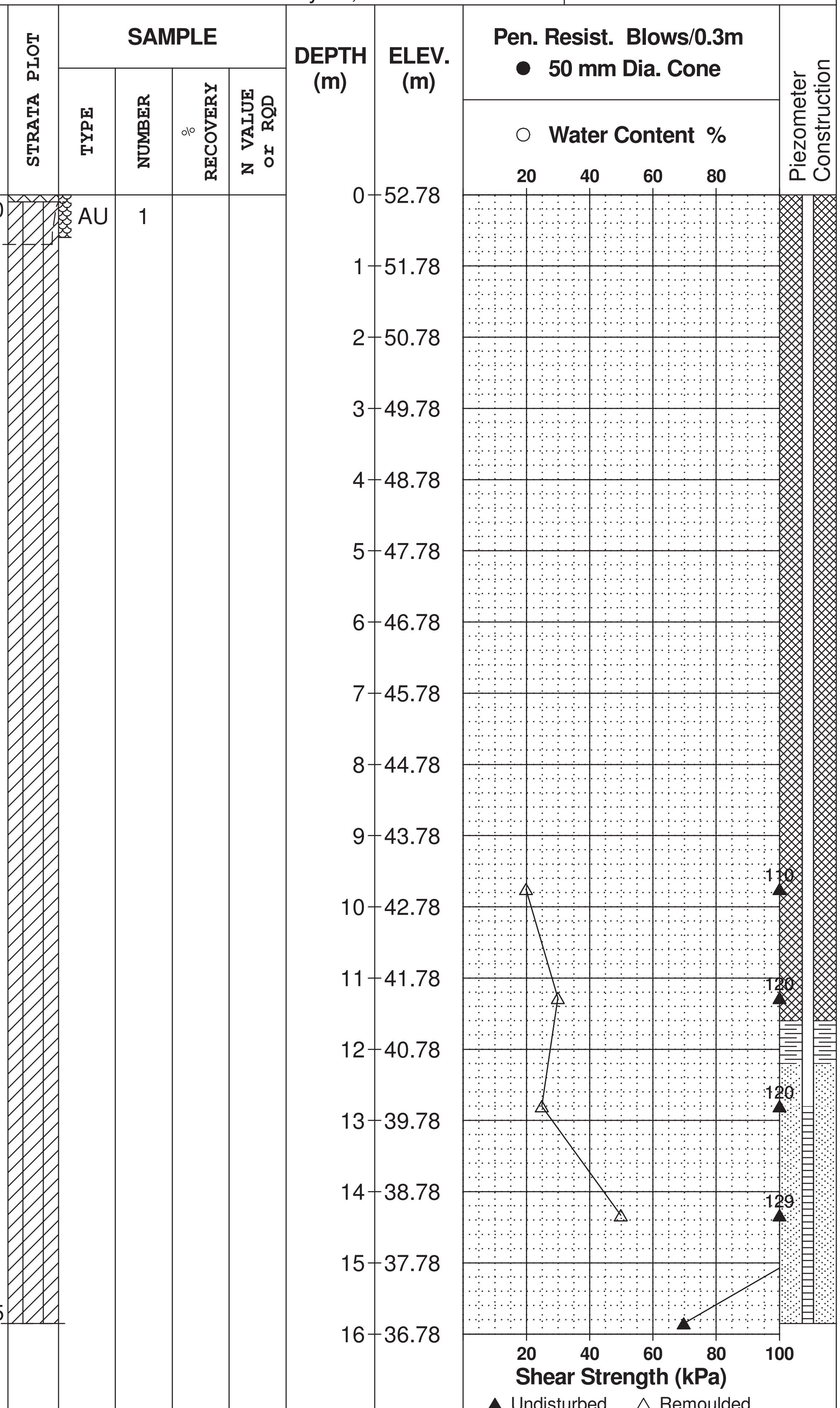
HOLE NO. BH 5

BORINGS BY CME 55 Power Auger

DATE July 17, 2018

SOIL DESCRIPTION	Depth to base (m)	SAMPLE TYPE	NUMBER	% RECOVERY	N VALUE or RQD
GROUND SURFACE					
FILL: Brown silty clay, trace gravel and organics	0.10	AU	1		
Very stiff, brown **SILTY CLAY** - grey by 6.8m depth	15.85				

DEPTH (m)	ELEV. (m)
0	52.78
1	51.78
2	50.78
3	49.78
4	48.78
5	47.78
6	46.78
7	45.78
8	44.78
9	43.78
10	42.78
11	41.78
12	40.78
13	39.78
14	38.78
15	37.78
16	36.78



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

REMARKS

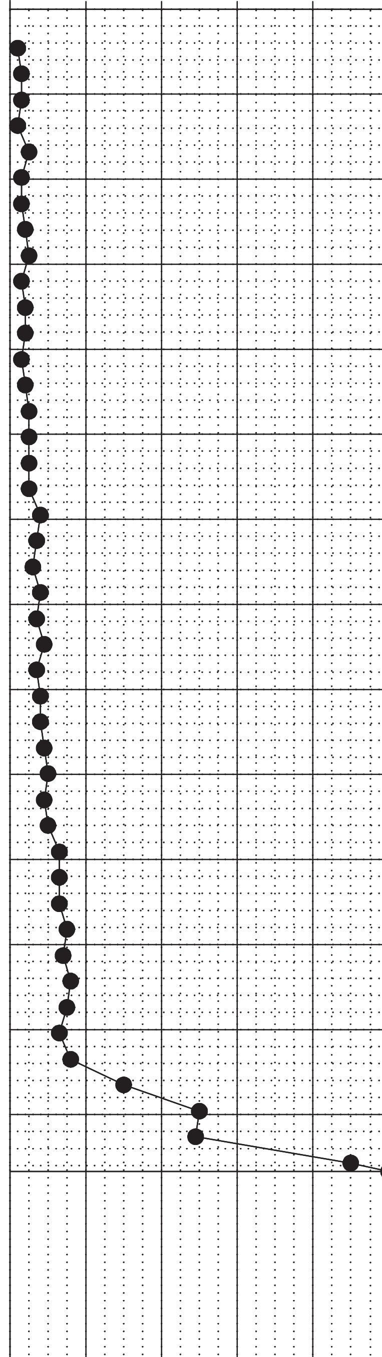
BORINGS BY CME 55 Power Auger

DATE July 17, 2018

FILE NO. PG3908

HOLE NO. BH 5

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								20 40 60 80	
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	36.78		
						17	35.78		
						18	34.78		
						19	33.78		
						20	32.78		
						21	31.78		
						22	30.78		
						23	29.78		
						24	28.78		
						25	27.78		
						26	26.78		
						27	25.78		
						28	24.78		
						29	23.78		
29.67									
End of Borehole Practical DCPT refusal at 29.67m depth. (BH dry - July 24, 2018)									



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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

REMARKS

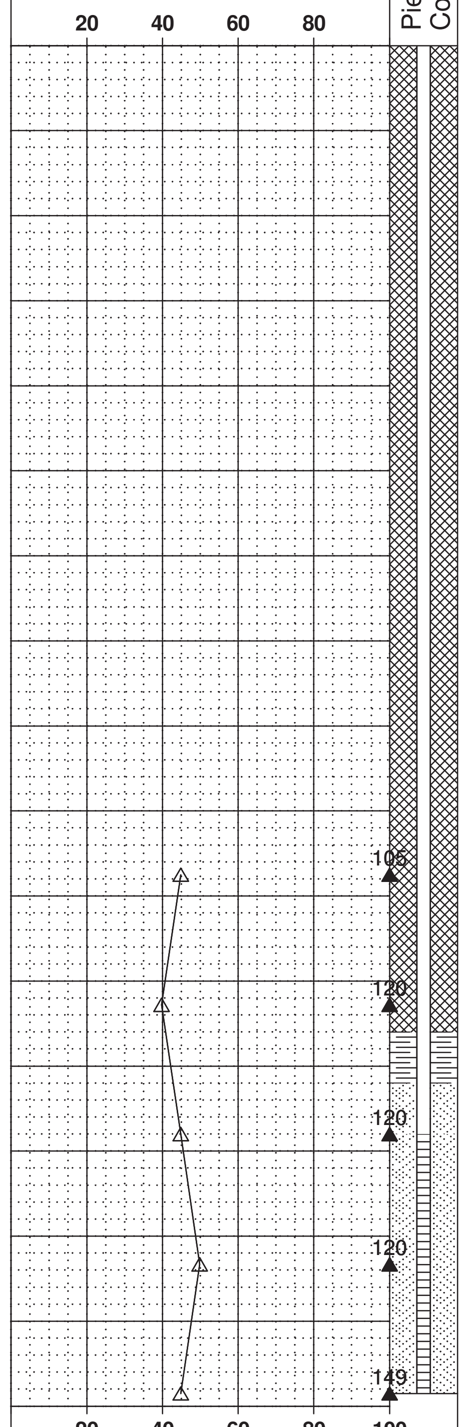
HOLE NO. BH 6

BORINGS BY CME 55 Power Auger **DATE** July 18, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	53.09
FILL: Brown silty sand with crushed stone and organics (to 0.46)		AU	1				
						1	52.09
						2	51.09
						3	50.09
						4	49.09
Very stiff, brown **SILTY CLAY**						5	48.09
- grey by 6.4m depth						6	47.09
						7	46.09
						8	45.09
						9	44.09
						10	43.09
						11	42.09
						12	41.09
						13	40.09
						14	39.09
						15	38.09
(to 15.85)						16	37.09

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
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DATUM Geodetic

FILE NO. PG3908

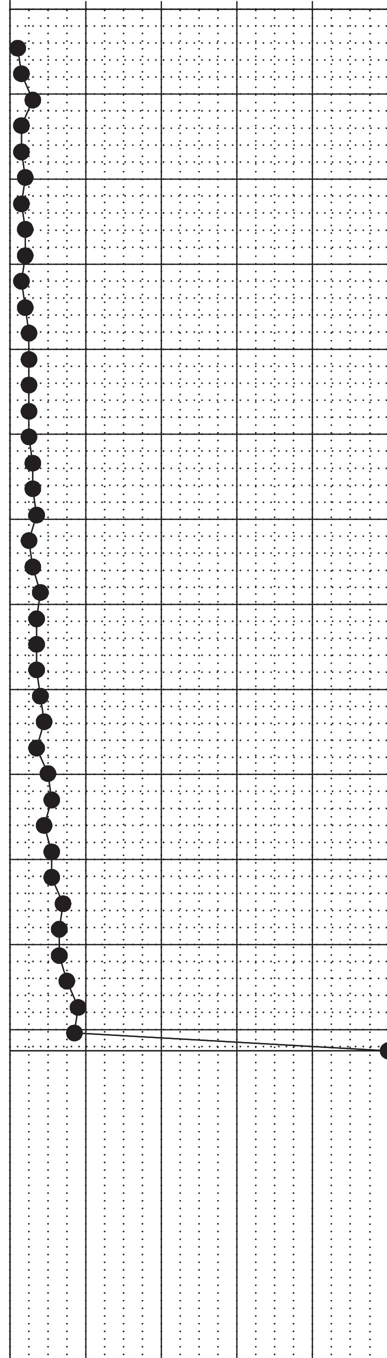
REMARKS

HOLE NO. BH 6

BORINGS BY CME 55 Power Auger

DATE July 18, 2018

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								20 40 60 80	
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	37.09		
						17	36.09		
						18	35.09		
						19	34.09		
						20	33.09		
						21	32.09		
						22	31.09		
						23	30.09		
						24	29.09		
						25	28.09		
						26	27.09		
						27	26.09		
28.25						28	25.09		
End of Borehole Practical DCPT refusal at 28.25m depth. (BH dry - July 24, 2018)									



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

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DATE July 18, 2018

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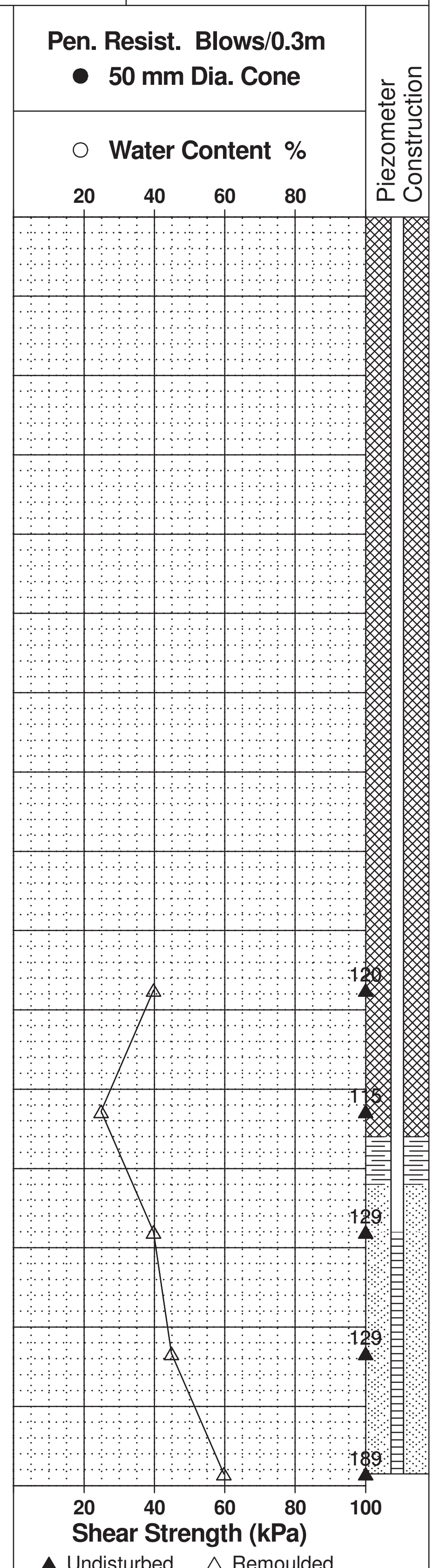
HOLE NO. BH 7

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	52.67
		AU	1				
						1	51.67
						2	50.67
Very stiff, brown **SILTY CLAY**						3	49.67
- grey by 3.8m depth						4	48.67
						5	47.67
						6	46.67
						7	45.67
						8	44.67
						9	43.67
						10	42.67
						11	41.67
						12	40.67
						13	39.67
						14	38.67
						15	37.67
15.85							
						16	36.67



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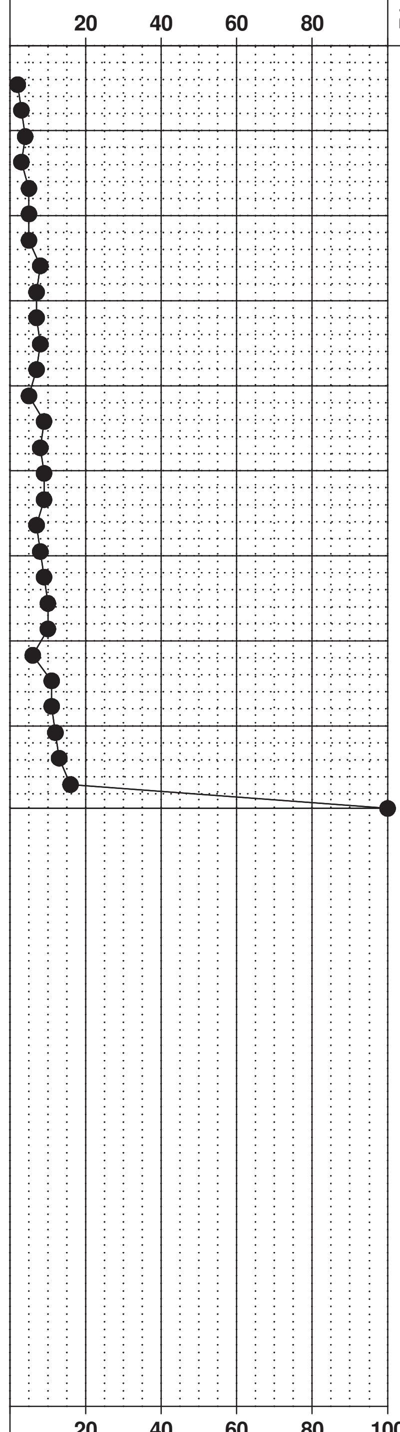
BORINGS BY CME 55 Power Auger

DATE July 18, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	SAMPLE % RECOVERY	SAMPLE N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE							
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	36.67
						17	35.67
						18	34.67
						19	33.67
						20	32.67
						21	31.67
						22	30.67
						23	29.67
						24	28.67
24.97							
End of Borehole Practical DCPT refusal at 24.97m depth. (BH dry - July 24, 2018)							

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 Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

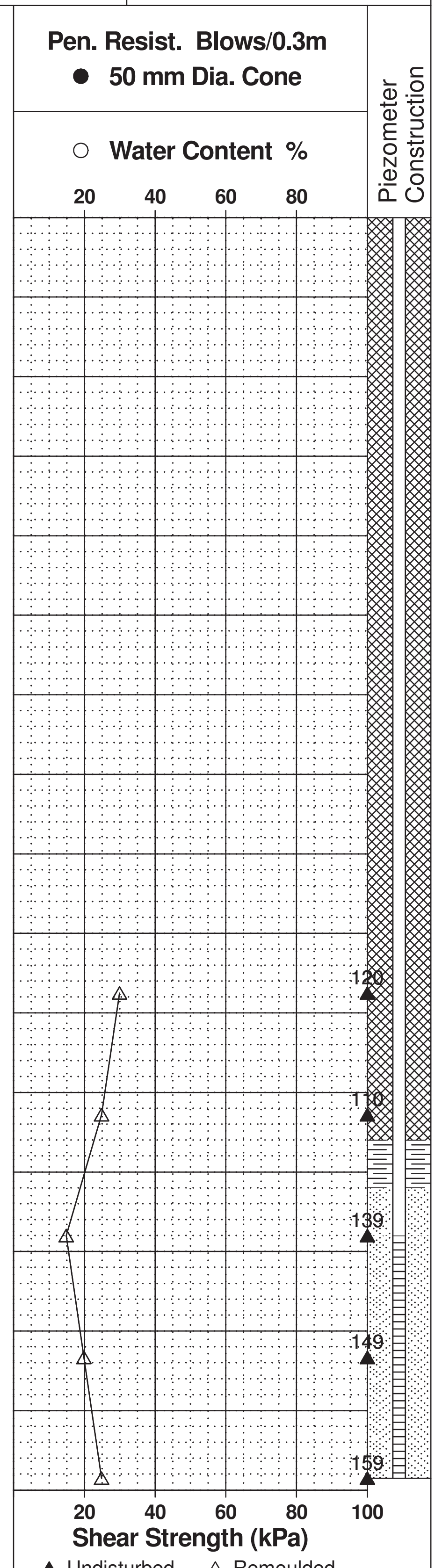
REMARKS

HOLE NO. BH 8

BORINGS BY CME 55 Power Auger

DATE July 18, 2018

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	52.25
Very stiff, brown **SILTY CLAY**		AU	1				
- grey by 7.5m depth		SS	2	75	9	1	51.25
						2	50.25
						3	49.25
						4	48.25
						5	47.25
						6	46.25
						7	45.25
						8	44.25
						9	43.25
						10	42.25
						11	41.25
						12	40.25
						13	39.25
						14	38.25
						15	37.25
15.85						16	36.25



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154 Colonnade Road South, Ottawa, Ontario K2E 7J5

SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

REMARKS

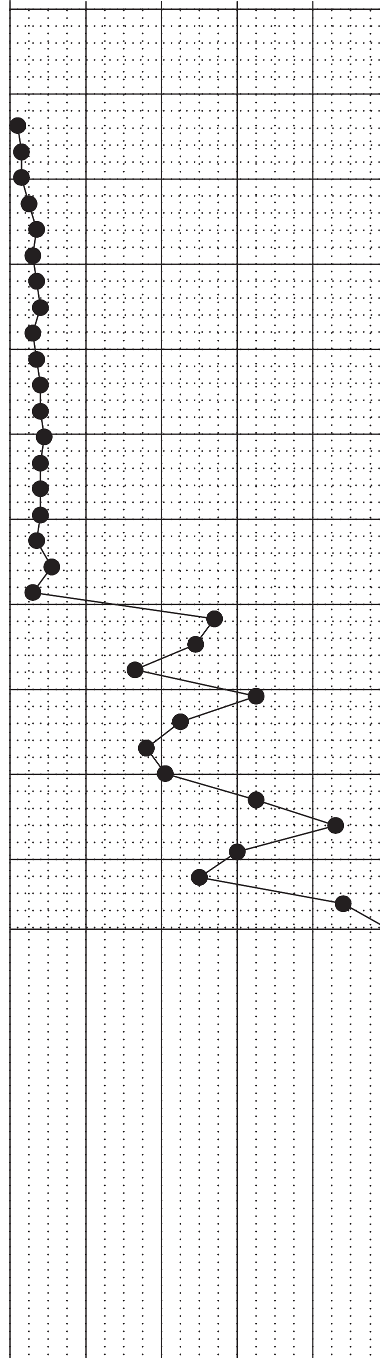
BORINGS BY CME 55 Power Auger

DATE July 18, 2018

FILE NO. PG3908

HOLE NO. BH 8

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								20 40 60 80	
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	36.25		
						17	35.25		
						18	34.25		
						19	33.25		
						20	32.25		
						21	31.25		
						22	30.25		
						23	29.25		
						24	28.25		
						25	27.25		
						26	26.25		
26.82									
End of Borehole Practical DCPT refusal at 26.82m depth. (BH dry - July 24, 2018)									



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

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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

REMARKS

BORINGS BY CME 55 Power Auger

DATE July 19, 2018

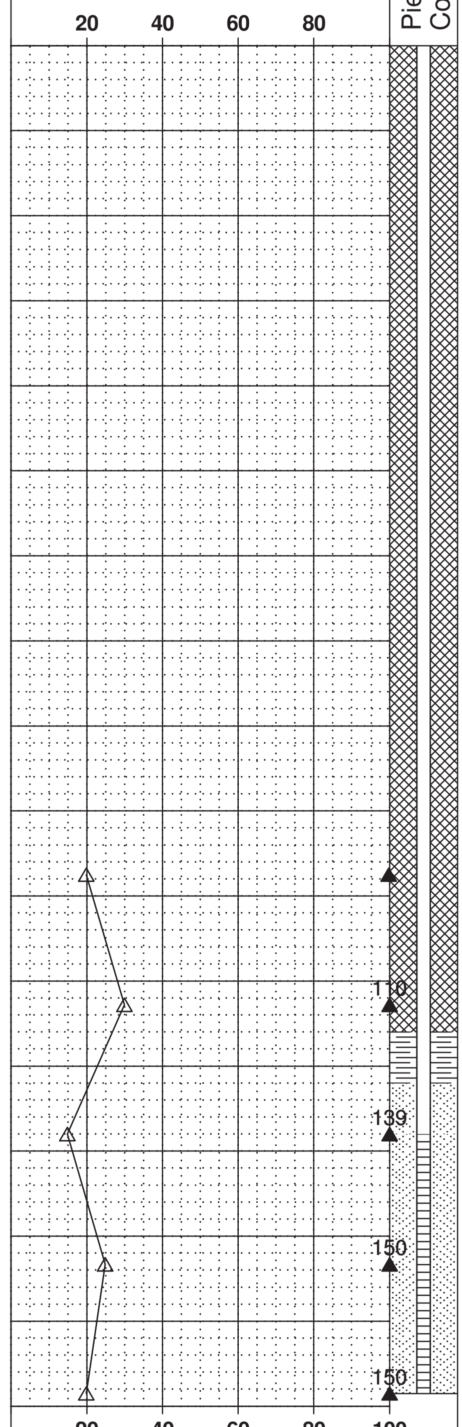
FILE NO. PG3908

HOLE NO. BH 9

SOIL DESCRIPTION	STRATA PLOT	SAMPLE TYPE	SAMPLE NUMBER	% RECOVERY	N VALUE or RQD	DEPTH (m)	ELEV. (m)
GROUND SURFACE						0	52.81
FILL: Brown silty sand with gravel, concrete, cobbles, boulders — 0.51		AU	1				
						1	51.81
						2	50.81
Very stiff, brown **SILTY CLAY**						3	49.81
- grey by 3.8m depth						4	48.81
						5	47.81
						6	46.81
						7	45.81
						8	44.81
						9	43.81
						10	42.81
						11	41.81
						12	40.81
						13	39.81
						14	38.81
						15	37.81
15.85						16	36.81

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 Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

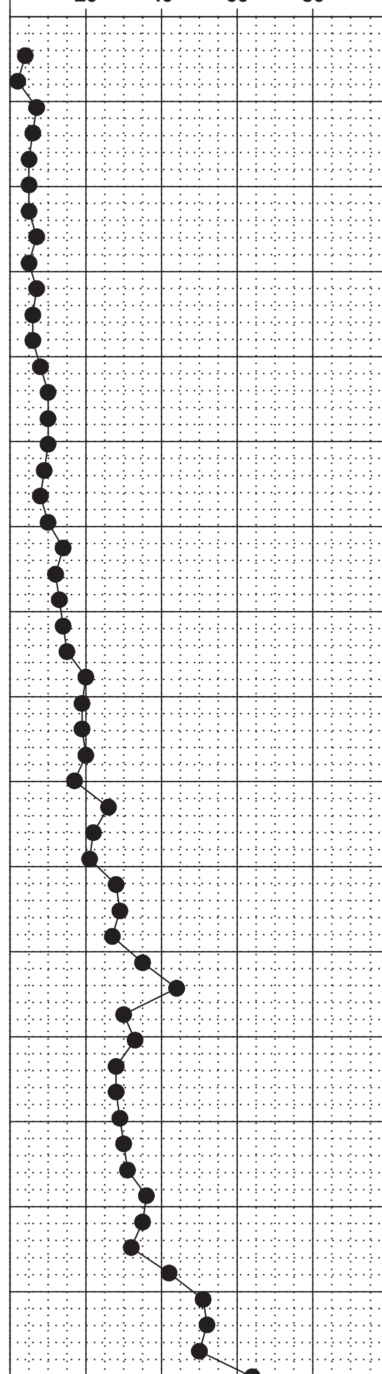
REMARKS

HOLE NO. BH 9

BORINGS BY CME 55 Power Auger

DATE July 19, 2018

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									
Dynamic Cone Penetration Test commenced at 15.85m depth.						16	36.81		
						17	35.81		
						18	34.81		
						19	33.81		
						20	32.81		
						21	31.81		
						22	30.81		
						23	29.81		
						24	28.81		
						25	27.81		
						26	26.81		
						27	25.81		
						28	24.81		
						29	23.81		
						30	22.81		
						31	21.81		
32.00						32	20.81		



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SOIL PROFILE AND TEST DATA

Geotechnical Investigation
Proposed Development - Petrie's Landing I
100 Inlet Private, Ottawa, Ontario

DATUM Geodetic

FILE NO. PG3908

REMARKS

HOLE NO. BH 9

BORINGS BY CME 55 Power Auger

DATE July 19, 2018

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									
End of Borehole (BH dry upon completion)									

Shear Strength (kPa): 20 40 60 80 100

▲ Undisturbed △ Remoulded

SYMBOLS AND TERMS

SOIL DESCRIPTION

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

Desiccated	-	having visible signs of weathering by oxidation of clay minerals, shrinkage cracks, etc.
Fissured	-	having cracks, and hence a blocky structure.
Varved	-	composed of regular alternating layers of silt and clay.
Stratified	-	composed of alternating layers of different soil types, e.g. silt and sand or silt and clay.
Well-Graded	-	Having wide range in grain sizes and substantial amounts of all intermediate particle sizes (see Grain Size Distribution).
Uniformly-Graded	-	Predominantly of one grain size (see Grain Size Distribution).

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

Relative Density	‘N’ Value	Relative Density %
Very Loose	<4	<15
Loose	4-10	15-35
Compact	10-30	35-65
Dense	30-50	65-85
Very Dense	>50	>85

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

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

SYMBOLS AND TERMS (continued)

SOIL DESCRIPTION (continued)

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

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

ROCK DESCRIPTION

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

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

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

SAMPLE TYPES

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

SYMBOLS AND TERMS (continued)

GRAIN SIZE DISTRIBUTION

MC%	-	Natural moisture content or water content of sample, %
LL	-	Liquid Limit, % (water content above which soil behaves as a liquid)
PL	-	Plastic limit, % (water content above which soil behaves plastically)
PI	-	Plasticity index, % (difference between LL and PL)
Dxx	-	Grain size which xx% of the soil, by weight, is of finer grain sizes These grain size descriptions are not used below 0.075 mm grain size
D10	-	Grain size at which 10% of the soil is finer (effective grain size)
D60	-	Grain size at which 60% of the soil is finer
Cc	-	Concavity coefficient = $(D30)^2$ / (D10 x D60)
Cu	-	Uniformity coefficient = D60 / D10

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

CONSOLIDATION TEST

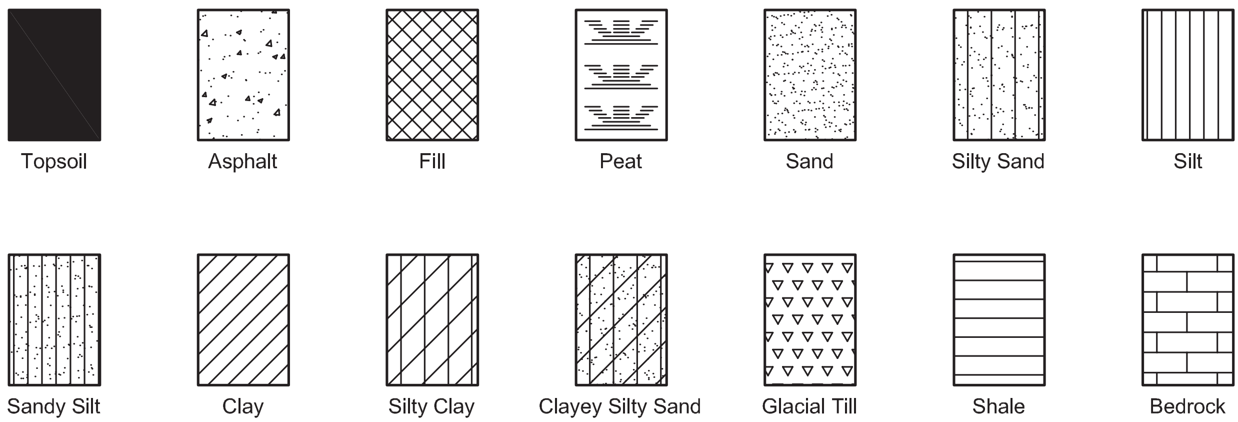
p'_o	-	Present effective overburden pressure at sample depth
p'_c	-	Preconsolidation pressure of (maximum past pressure on) sample
Ccr	-	Recompression index (in effect at pressures below p'_c)
Cc	-	Compression index (in effect at pressures above p'_c)
OC Ratio		Overconsolidaton ratio = p'_c / p'_o
Void Ratio		Initial sample void ratio = volume of voids / volume of solids
Wo	-	Initial water content (at start of consolidation test)

PERMEABILITY TEST

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

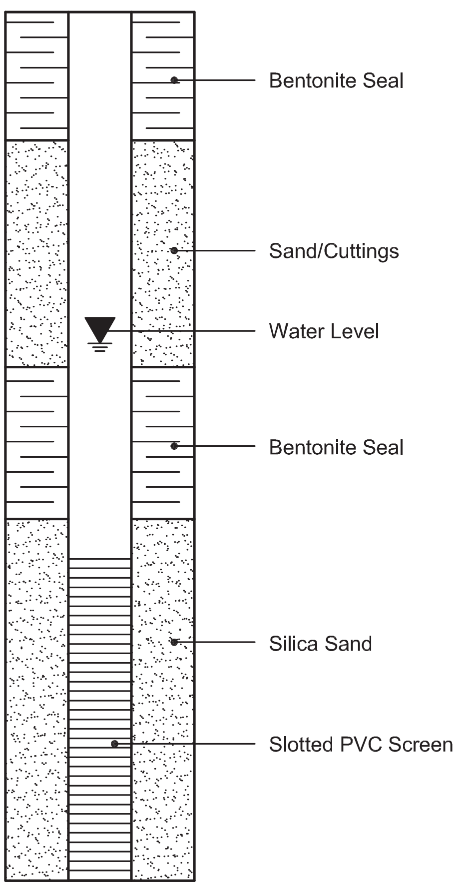
SYMBOLS AND TERMS (continued)

STRATA PLOT

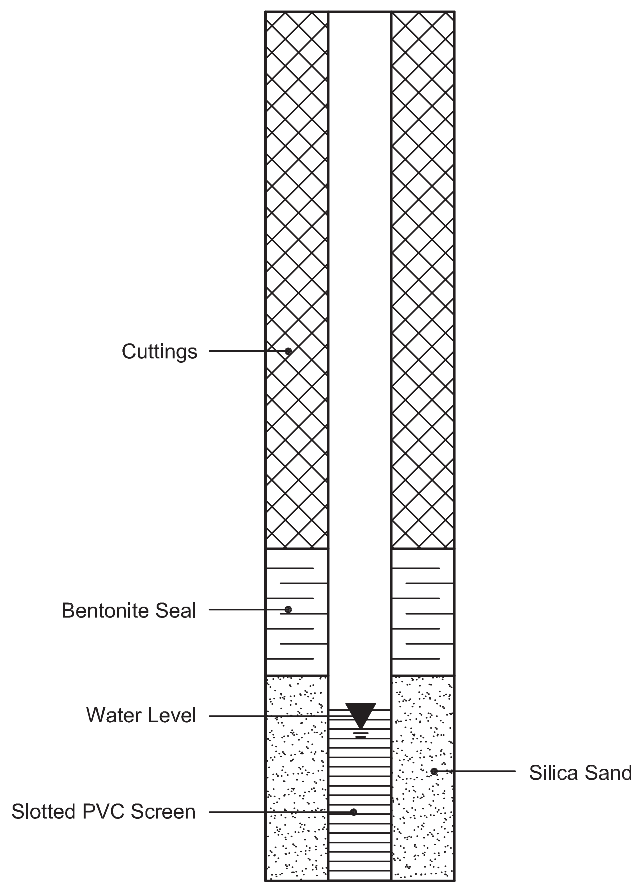


MONITORING WELL AND PIEZOMETER CONSTRUCTION

MONITORING WELL CONSTRUCTION



PIEZOMETER CONSTRUCTION



REFERENCE No.: T020548-A1 ENCLOSURE No.: 1

BOREHOLE No.: BH-1
ELEVATION: 52.16 m

BOREHOLE LOG

CLIENT: Brigil Construction
PROJECT: Petrie's Landing - Phase II
LOCATION: Cumberland, Ontario
DESCRIBED BY: B.Beveridge CHECKED BY: J.Bennett
DATE (START): October 9, 2008 DATE (FINISH): October 9, 2008

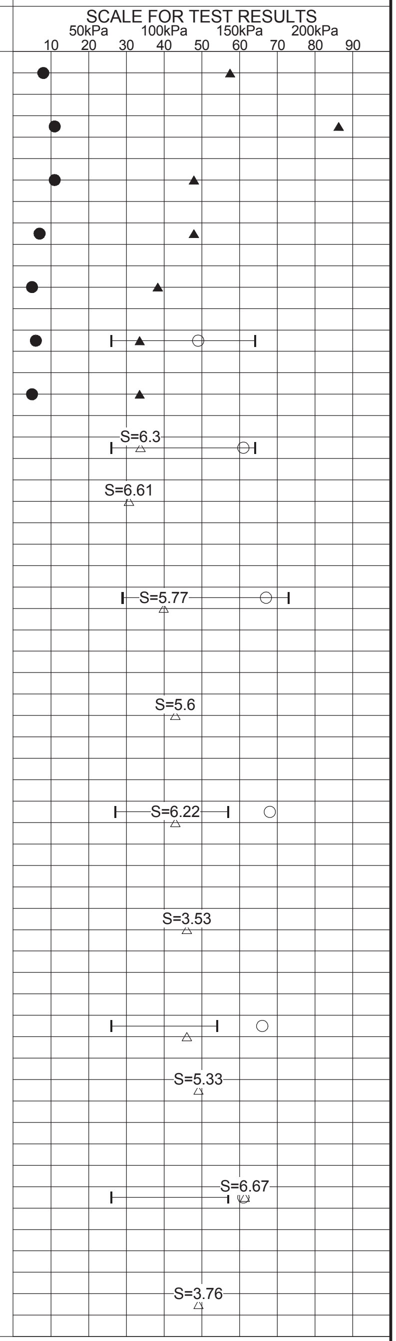
LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Description of Soil and Bedrock
0	52.16	GROUND SURFACE
0		CLAY SOME SILT- trace organics, brownish grey, hard, moist
3.0	49.1	CLAY SOME SILT- trace sand, trace oxidation, brownish grey, very stiff, moist
5.0	47.0	CLAY SOME SILT- grey, stiff, wet
9.0	43.0	CLAY SOME SILT- grey, very stiff, wet

Monitor well: 55.21; WL 1.78; 3.66; Bentonite; 4.27; 4.57; Screen; 7.62; 8.08

Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)
SS1	71		8
SS2	88		11
SS3	88		11
SS4	100		7
SS5	100		5
SS6	100		6
SS7	100		5
SS8	100		
GS9	100		
GS10	100		
GS11	100		
GS12	100		
GS13	100		
GS14	100		
GS15			
GS16			
GS17			



NOTES:

BOREHOLE LOG T020548-A1-BH(OCT-09-08).GPJ INSPEC_SOL.GDT 6/20/16

INSPEC·SOL

BOREHOLE No.: BH-1
ELEVATION: 52.16 m

BOREHOLE LOG

CLIENT: Brigil Construction
PROJECT: Petrie's Landing - Phase II
LOCATION: Cumberland, Ontario
DESCRIBED BY: B.Beveridge CHECKED BY: J.Bennett
DATE (START): October 9, 2008 DATE (FINISH): October 9, 2008

LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- Water content (%)
- Atterberg limits (%)
- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Description of Soil and Bedrock	Sample Type and Number	Penetration Index / RQD (N)	Test Results
0	52.16	GROUND SURFACE			
19.0	33.1	CLAY SOME SILT- grey, stiff, wet	GS18		S=2.85
20.5	31.6	CLAY SOME SILT- grey, very stiff, wet	GS19		S=6.25
			GS20		S=5
23.6	28.5	CLAY SOME SILT- trace dissolved organics, very stiff, wet	GS21		
24.9	27.3	LIMESTONE- grey, slightly weathered, medium hard, close shale partings		91	
26.0	26.2	LIMESTONE- grey, slightly weathered, medium hard, close shale partings		73	
27.5	24.7	LIMESTONE- grey, slightly weathered, medium hard, close shale partings		72	
29.0	23.1	End of Borehole			

MONITOR WELL: Clay Cuttings; 29.03; BOREHOLE

SCALE FOR TEST RESULTS: 50kPa, 100kPa, 150kPa, 200kPa; 10 20 30 40 50 60 70 80 90

NOTES:

REFERENCE No.: T020548-A1 ENCLOSURE No.: 2

iNSPEC·SOL

BOREHOLE No.: BH-2

ELEVATION: 52.46 m

BOREHOLE LOG

Page: 1 of 1

CLIENT: Brigil Construction

PROJECT: Petrie's Landing - Phase II

LOCATION: Cumberland, Ontario

DESCRIBED BY: B.Beveridge CHECKED BY: J.Bennett

DATE (START): October 16, 2008 DATE (FINISH): October 16, 2008

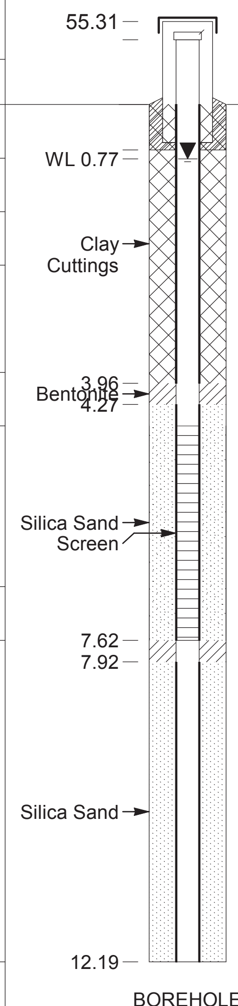
LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- ○ Water content (%)
- Atterberg limits (%)
- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

Stratigraphy

Depth BGS (meters)	Elevation (m)	Description of Soil and Bedrock
0.0	52.46	GROUND SURFACE
		CLAY SOME SILT- trace organics, trace oxidation, greenish grey, hard, moist
	51.7	CLAY SOME SILT- trace organics, trace oxidation, trace sand, greenish grey, hard, moist
	50.9	CLAY SOME SILT- trace oxidation, trace sand, greenish grey, very stiff, moist
	50.2	CLAY SOME SILT- trace silt layers, trace oxidation, trace sand, greenish grey, very stiff, moist
	48.6	CLAY SOME SILT- trace silt layers, trace organics, trace oxidation, greenish grey, stiff, moist
	47.9	CLAY SOME SILT- trace organics, grey. stiff, wet
	45.6	CLAY SOME SILT- trace organics, trace silt seams, grey, stiff, wet
	44.8	CLAY SOME SILT- trace organics, grey, stiff, wet
	40.3	End of Borehole

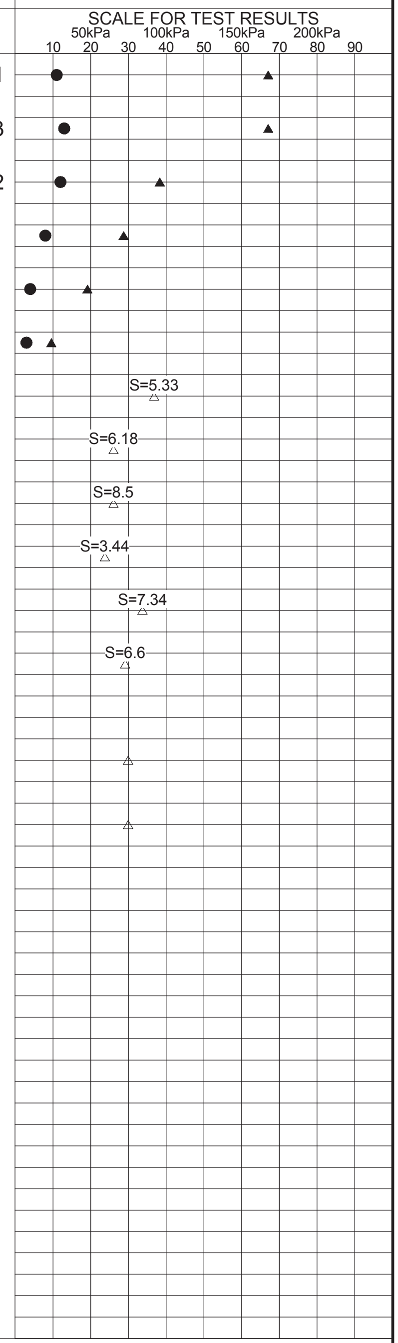
Monitor Well



Sample Data

State	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)
SS	SS1	53		11
SS	SS2	96		13
SS	SS3	92		12
SS	SS4	100		8
SS	SS5	100		4
SS	SS6	100		3
SS	SS7	100		
SS	SS8	100		
SS	SS9	100		
SS	SS10	75		
SS	SS11	100		
SS	SS12	100		
ST	ST-1			
SS	SS13	100		
ST	ST-2			
SS	SS14	100		

Scale for Test Results



NOTES:

REFERENCE No.: T020548-A1 ENCLOSURE No.: 3

INSPEC·SOL

BOREHOLE No.: BH-3

ELEVATION: 53.35 m

BOREHOLE LOG

CLIENT: Brigil Construction

PROJECT: Petrie's Landing - Phase II

LOCATION: Cumberland, Ontario

DESCRIBED BY: B.Beveridge CHECKED BY: J.Bennett

DATE (START): October 14, 2008 DATE (FINISH): October 14, 2008

LEGEND

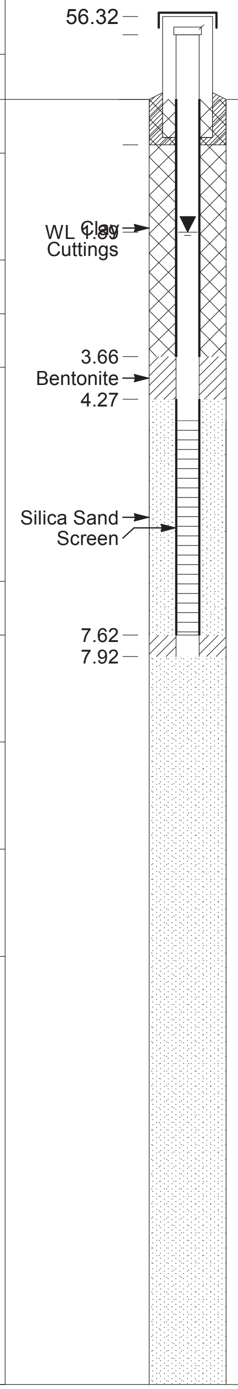
☒	SS	Split Spoon
▮	GS	Auger Sample
▨	ST	Shelby Tube
▼		Water Level
○		Water content (%)
├─┤		Atterberg limits (%)
●	N	Penetration Index based on Split Spoon sample
•	N	Penetration Index based on Dynamic Cone sample
△	Cu	Shear Strength based on Field Vane
□	Cu	Shear Strength based on Lab Vane
S		Sensitivity Value of Soil
▲		Shear Strength based on Pocket Penetrometer

SCALE / STRATIGRAPHY

Depth BGS (meters)	Elevation (m)	DESCRIPTION OF SOIL AND BEDROCK
	53.35	GROUND SURFACE
		TOPSOIL- some organics, black, wet, very soft,
1.0	52.6	CLAY SOME SILT- trace organics, brownish grey, hard, moist
2.0	51.1	CLAY SOME SILT- trace oxidation, brownish grey, very stiff, moist
3.0	50.3	CLAY SOME SILT- trace oxidation, brownish grey, stiff, moist
4.0	49.5	CLAY SOME SILT- trace oxidation, grey, stiff, wet
7.0	46.5	CLAY SOME SILT- trace organics, trace silt, stiff, wet
8.0	45.7	CLAY SOME SILT- trace oxidation, trace organics, grey, stiff, wet
9.0	44.2	CLAY SOME SILT- trace organics, trace silt, grey, stiff, wet
11.0	42.7	CLAY SOME SILT- trace organics, trace silt, grey, very stiff, wet
12.0	41.2	CLAY SOME SILT- trace organics, grey, stiff, wet

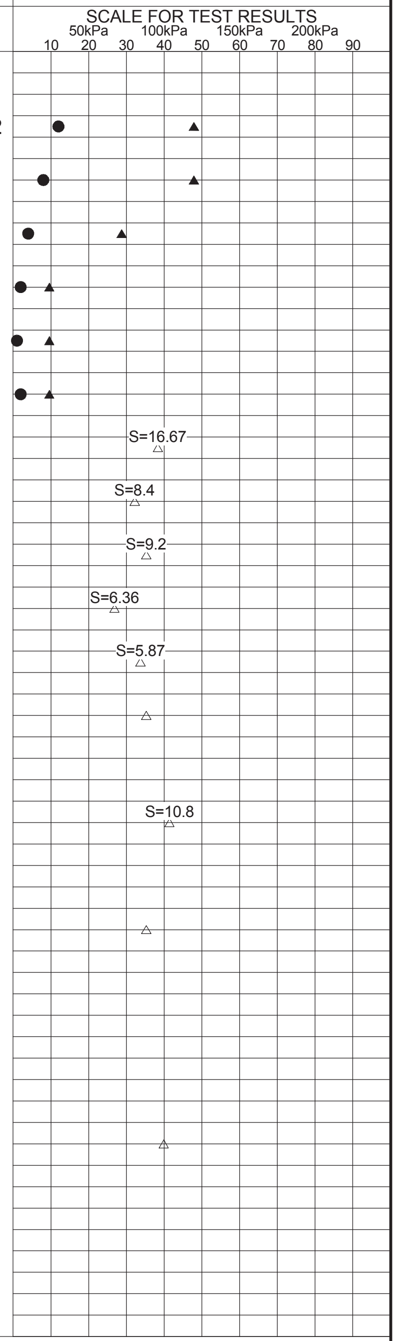
Depth scale: 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0

MONITOR WELL



SAMPLE DATA

State	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)
☒	SS0			
☒	SS1	100		12
☒	SS2	100		8
☒	SS3	100		4
☒	SS4	100		2
☒	SS5	100		1
☒	SS6	100		2
▮	GS7	100		
▮	GS8	100		
▮	GS9	100		
▮	GS10	100		
▮	GS11	100		
▮	GS12	100		
▮	GS13	100		
▮	GS14	100		
▨	ST-1			
▮	GS15	100		



NOTES:

INSPEC·SOL

BOREHOLE No.: BH-3
ELEVATION: 53.35 m

BOREHOLE LOG

CLIENT: Brigil Construction
PROJECT: Petrie's Landing - Phase II
LOCATION: Cumberland, Ontario
DESCRIBED BY: B.Beveridge CHECKED BY: J.Bennett
DATE (START): October 14, 2008 DATE (FINISH): October 14, 2008

LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- ○ Water content (%)
- Atterberg limits (%)
- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Description of Soil and Bedrock	Monitor Well	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)	Test Results
	53.35	GROUND SURFACE						
	35.1	CLAY SOME SILT- trace organics, grey, very stiff, wet	Silica Sand	GS16	100			△
				GS17	100			S=3.52 △
	29.0	CLAY SOME SILT- trace organics, grey, stiff, wet		GS18	50			△
	27.8	LIMESTONE- grey, slighty weathered, medium hard, close, shale partings		RC19	63		60	
	26.5	LIMESTONE- grey, slightly weathered, medium hard, close shale partings		RC20	95		73	
	25.0	LIMESTONE- grey, slightly weathered, medium hard, close shale partings		RC21	87		79	
30.0	23.5	End of Borehole	29.90 BOREHOLE					

Depth scale: 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0

SCALE FOR TEST RESULTS: 50kPa 100kPa 150kPa 200kPa; 10 20 30 40 50 60 70 80 90

NOTES:

REFERENCE No.: T020548-A2 ENCLOSURE No.: 1

BOREHOLE No.: BH1-16

ELEVATION: 53.10 m

BOREHOLE LOG

CLIENT: Brigil Construction

PROJECT: Additional Geotechnical Investigation

LOCATION: 8900 Jeanne D'Arc Blvd., Ottawa (Orleans)

DESCRIBED BY: S. Wallis CHECKED BY: B. Vazhbakht

DATE (START): April 20, 2016 DATE (FINISH): April 20, 2016

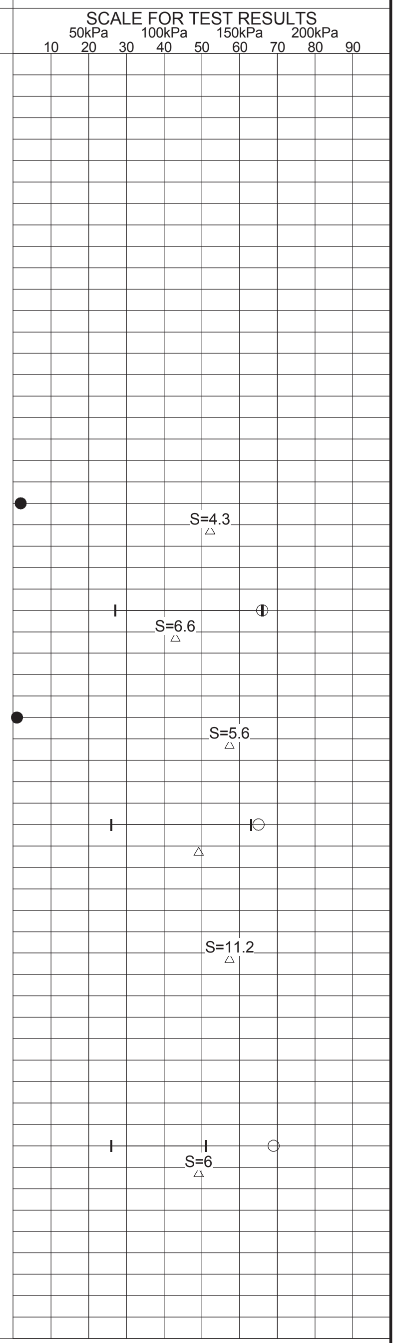
LEGEND

- SS Split Spoon
- GS Auger Sample
- ST Shelby Tube
- Water Level
- ○ Water content (%)
- Atterberg limits (%)
- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

SCALE		STRATIGRAPHY		SAMPLE DATA				
Depth BGS	Elevation (m)	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery	OVC	Penetration Index / RQD
meters	53.10		GROUND SURFACE			%	ppm	N
			AUGERED TO 6m					
6.0	47.0		**CLAY SOME SILT** - grey, very stiff, moist to wet		SS1 V1	96		2
					TW1 V2			
					SS2 V3	100		1
					SS3 V4	100		
					SS4 V5	100		
					TW2 V6			

Depth scale: 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0

SCALE FOR TEST RESULTS



NOTES:

BOREHOLE No.: BH1-16

ELEVATION: 53.10 m

BOREHOLE LOG

CLIENT: Brigil Construction

PROJECT: Additional Geotechnical Investigation

LOCATION: 8900 Jeanne D'Arc Blvd., Ottawa (Orleans)

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LEGEND

- SS Split Spoon
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- Water Level
- ○ Water content (%)
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- ● N Penetration Index based on Split Spoon sample
- • N Penetration Index based on Dynamic Cone sample
- △ Cu Shear Strength based on Field Vane
- □ Cu Shear Strength based on Lab Vane
- S Sensitivity Value of Soil
- ▲ Shear Strength based on Pocket Penetrometer

Depth BGS (meters)	Elevation (m)	Description of Soil and Bedrock	State	Type and Number	Recovery (%)	OVC (ppm)	Penetration Index / RQD (N)	Scale for Test Results
	53.10	GROUND SURFACE						
18.7–19.0			SS	SS5	100			
19.0			Vane	V7				S=4.7 (△ at ~75)
21.7–22.0			SS	SS6	100			
22.0			Vane	V8				S=13.6 (△ at ~77)
24.0		-Becoming some gravel, some sand, and some silt						
24.5			SS	SS7	100		R	
24.6	28.5	Borehole terminated with practical refusal at approximately 24.6m						

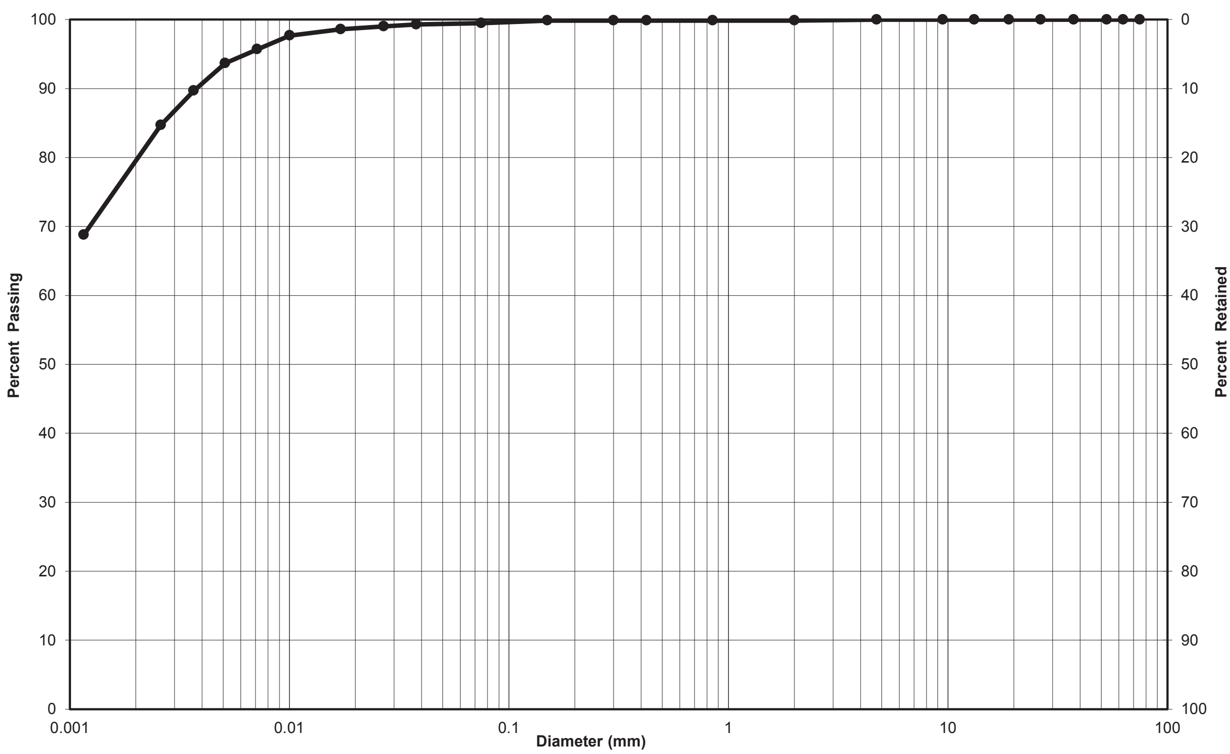
Scale for test results: 50kPa, 100kPa, 150kPa, 200kPa; 10, 20, 30, 40, 50, 60, 70, 80, 90

Depth scale: 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0

NOTES:

Particle-Size Analysis of Soils
ASTM D422 (Geotechnical)

Client:	Brigil	**Lab No.:**	G-16-001
Project, Site:	8900 Jeanne D'Arc Blvd, Ottawa, ON	**Project No.:**	T020548-A2
Borehole No.:	BH1-16	Sample No.:	SS1
Depth:	6.0 - 6.6m	Enclosure:	



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Particle-Size Limits as per USCS (ASTM D-2487)					

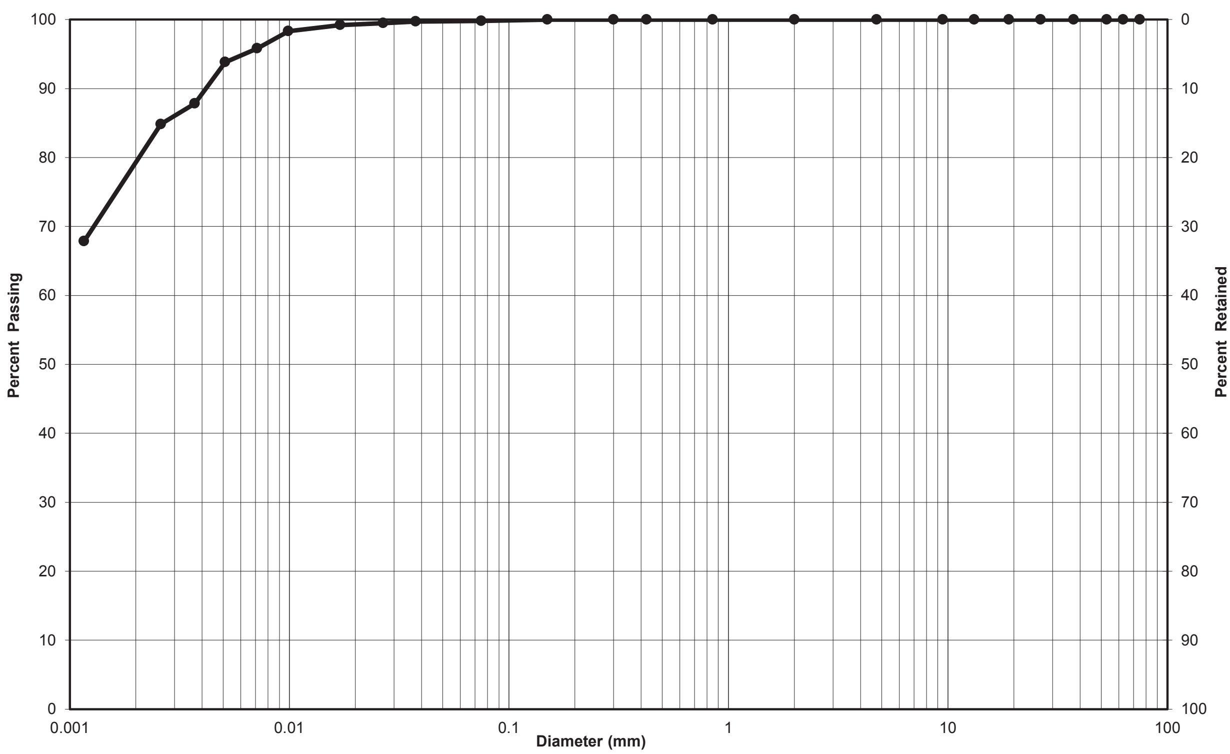
Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
Clay, some Silt, trace Sand	0	1	99

Remarks:

Performed by:	Momen Siam	**Date:**	May 11, 2016
Verified by:	[signature]	**Date:**	May 11, 2016

Particle-Size Analysis of Soils
ASTM D422 (Geotechnical)

Client:	Brigil	**Lab No.:**	G-16-001
Project, Site:	8900 Jeanne D'Arc Blvd, Ottawa, ON	**Project No.:**	T020548-A2
Borehole No.:	BH1-16	Sample No.:	SS5
Depth:	18.0 - 18.6	Enclosure:	



Clay & Silt	Sand			Gravel	
	Fine	Medium	Coarse	Fine	Coarse
Particle-Size Limits as per USCS (ASTM D-2487)					

Soil Description	Gravel (%)	Sand (%)	Clay & Silt (%)
Clay, some Silt	0	0	100

Remarks:

Performed by:	M. Siam	**Date:**	May 11, 2015
Verified by:	[signature]	**Date:**	May 11, 2015

TABLE 1
SUMMARY OF SHEAR WAVE VELOCITY MEASUREMENTS
SEISMIC SITE CLASS DETERMINATION
PETRIE'S LANDING - PHASE II
CUMBERLAND, ON

Table 1-A: Average Shear Wave Velocity (VS_{30})
(Assumed founding level at 6.0 m below ground surface)

Line 1					
Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	6.0	6.5	0.5	163	0.0028
2	6.5	8.3	1.8	158	0.0115
3	8.3	10.5	2.3	144	0.0157
4	10.5	13.4	2.8	203	0.0139
5	13.4	16.9	3.5	262	0.0135
6	16.9	36.0	19.1	345	0.0554
Total			30.0		0.1127
Average Shear Wave Velocity Along the Line (m/s)					***266***

Table 1-B: Average Shear Wave Velocity (VS_{30})
(Assumed founding level at 6.0 m below ground surface)

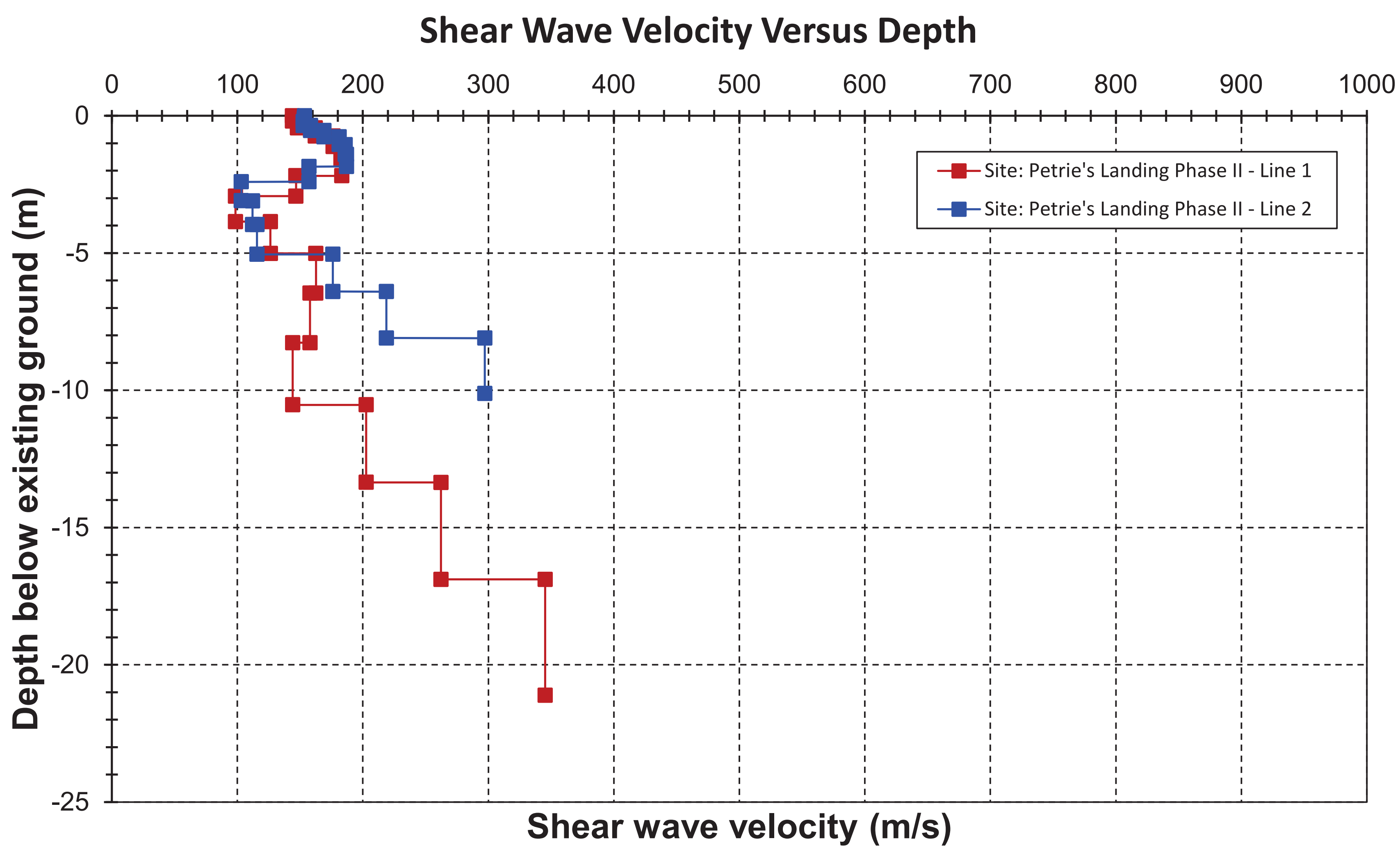
Line 2					
Layer No.	Depth (m bgs)		Thickness	V_s	d_i/V_{si}
	From	To	m	m/s	
1	6.0	6.4	0.4	176	0.0023
2	6.4	8.1	1.7	219	0.0077
3	8.1	36.0	27.9	297	0.0939
Total			30.0		0.1039
Average Shear Wave Velocity Along the Line (m/s)					***289***

Average VS_{30} = **277** **m/s**

Recommended Site Class: **D** Subjected to Code requirements

Notes:

1 - The Seismic Site class is recommended in accordance to Table 4.1.8.4.A of the National Building code of Canada 2010 and based on the lowest measured average shear wave velocity measured along the investigated lines.
2 - VS_{30} is calculated based on the average shear wave velocity below the proposed founding elevation.
3 - Site Classes A and B are only applicable if footings are founded on bedrock or there is no more than 3.0 m of soil between founding elevation and bedrock.
4 - The recommended site class is only applicable if site conditions for Site Class F (liquefiable soil/soft soil layers more than 3.0 m thick) are not applicable.



SHEAR WAVE VELOCITY VERSUS DEPTH
SITE: PETRIE'S LANDING - PHASE II
CUMBERLAND, ONTARIO

DRAWN BY:	SCALE	REFERENCE NO:
HA	N.T.S	T020548-A2
CHECKED BY:	DATE:	FIGURE NO:
ANM	May, 2016	1

Figure 2A - Section A - Fully Saturated Conditions Static Analysis

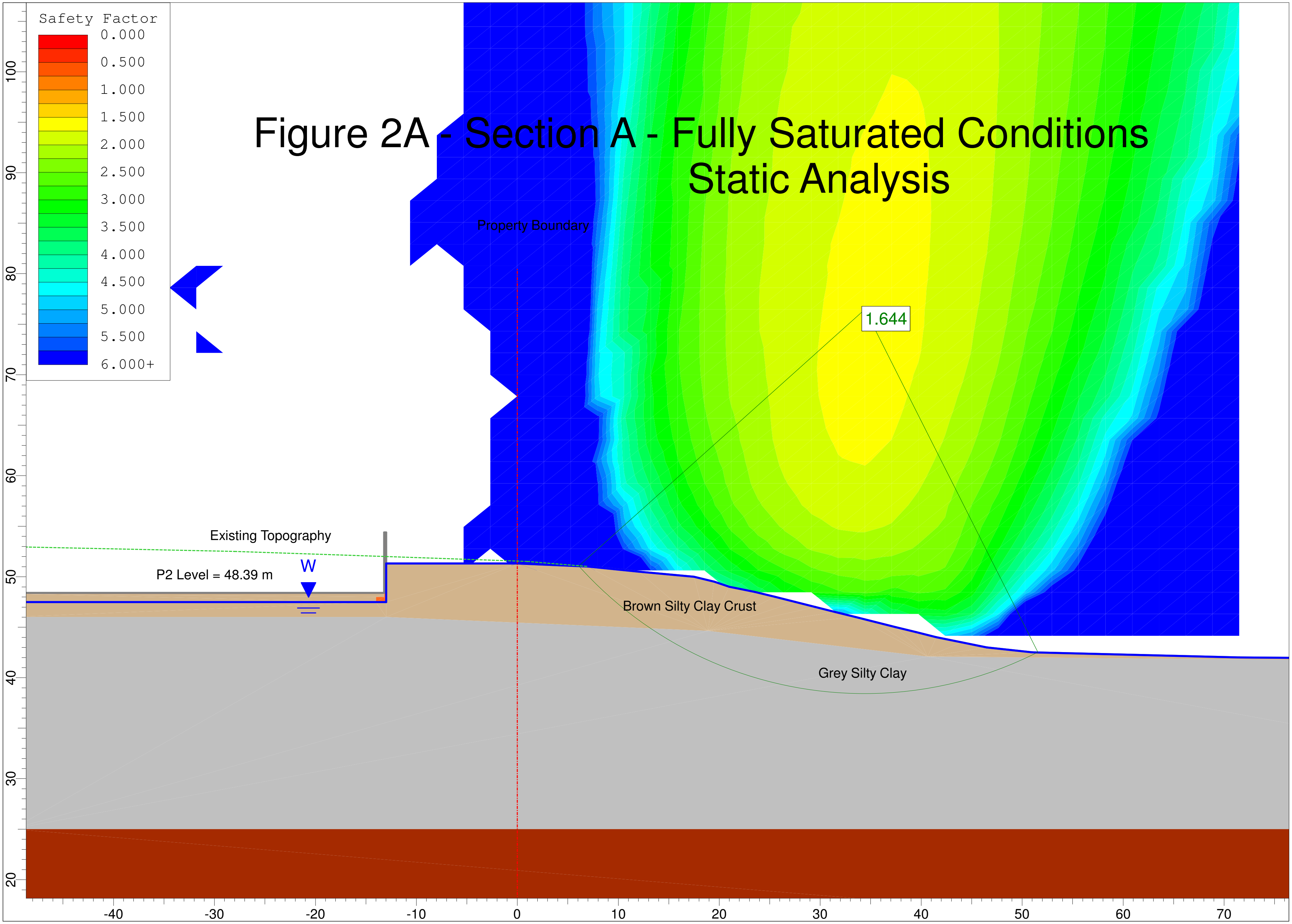
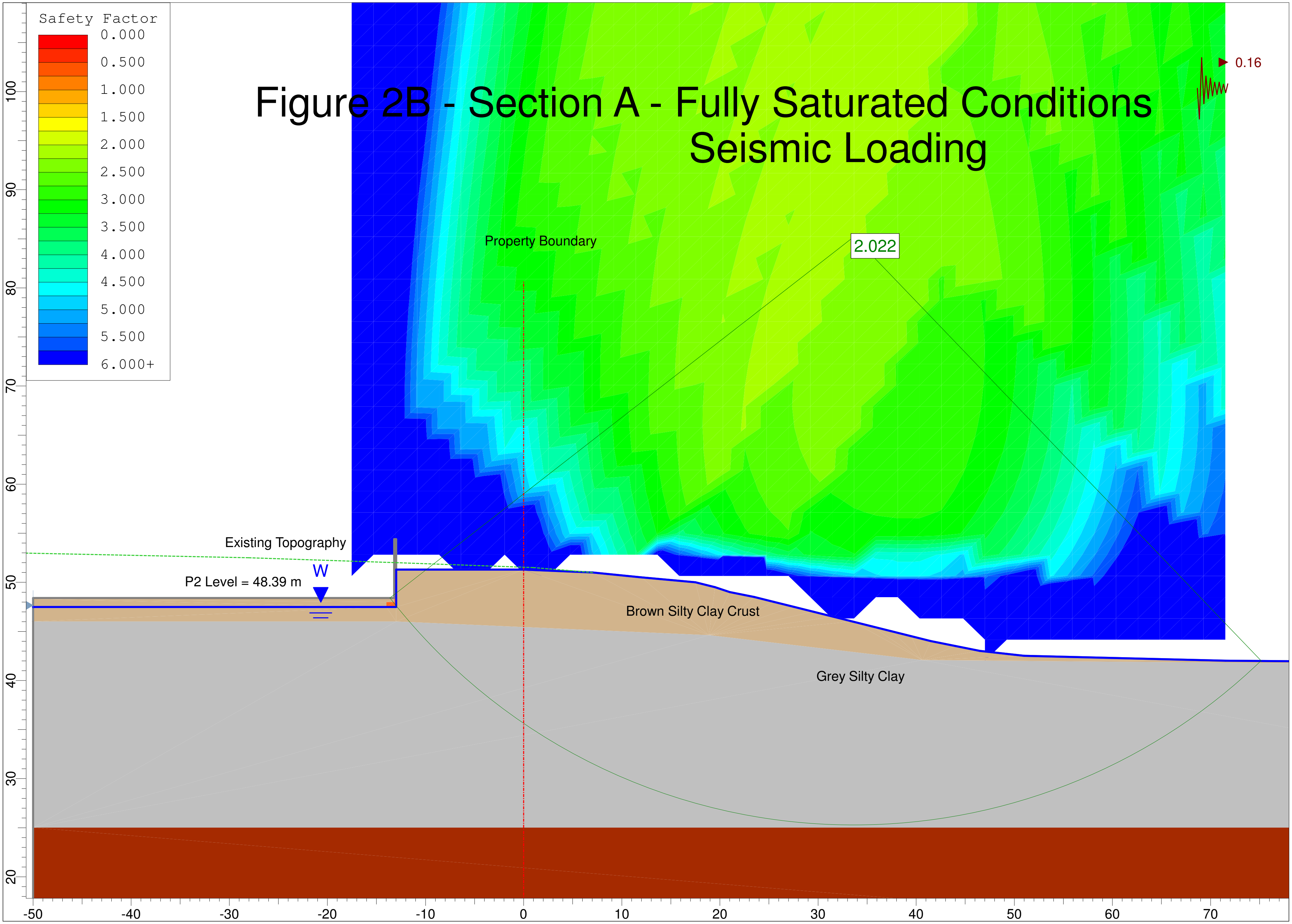


Figure 2B - Section A - Fully Saturated Conditions Seismic Loading



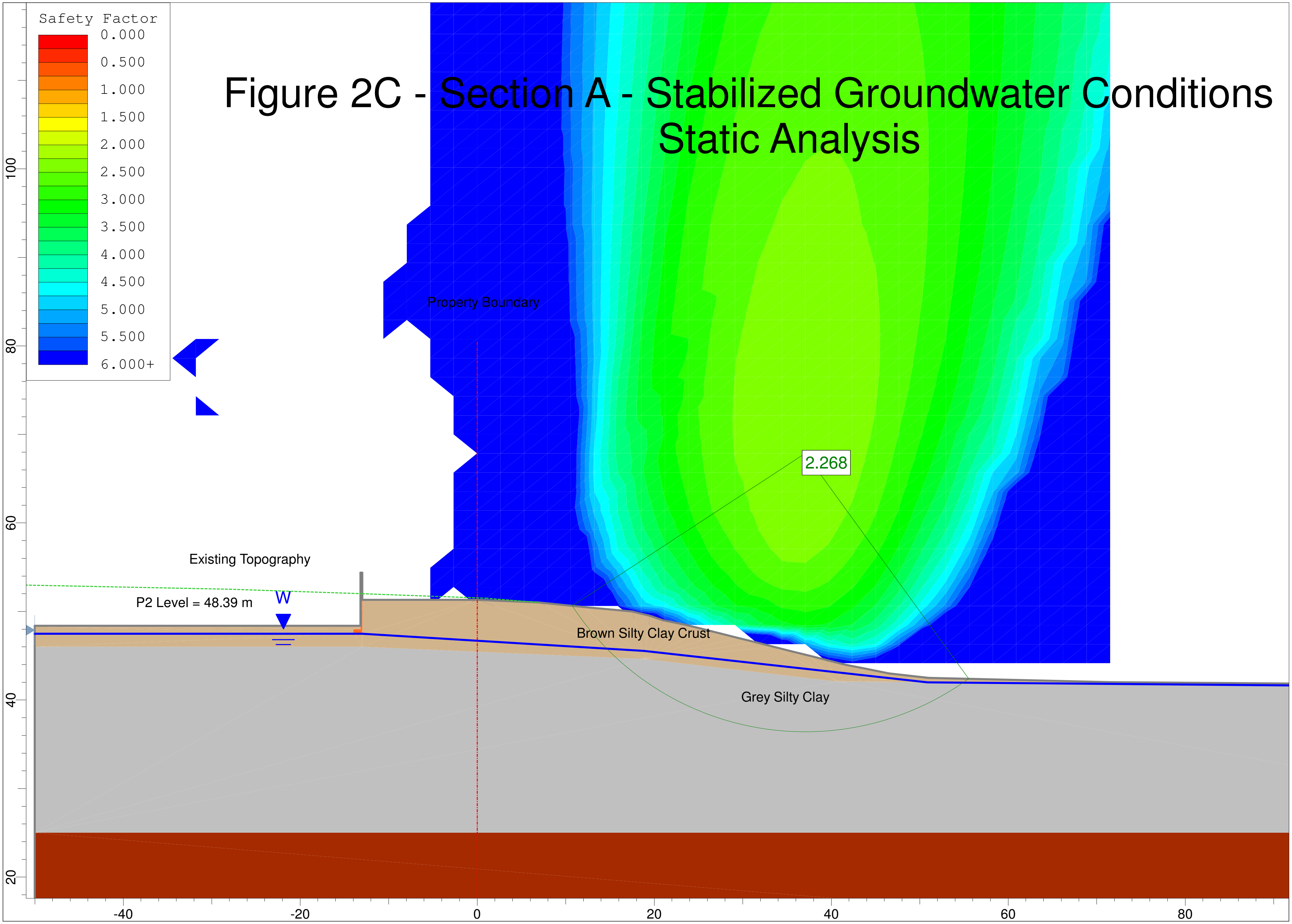


Figure 2C - Section A - Stabilized Groundwater Conditions
Static Analysis
Safety Factor
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000+
Property Boundary
2.268
Existing Topography
P2 Level = 48.39 m
W
Brown Silty Clay Crust
Grey Silty Clay

Figure 2D - Section A - Stabilized Groundwater Conditions Seismic Loading

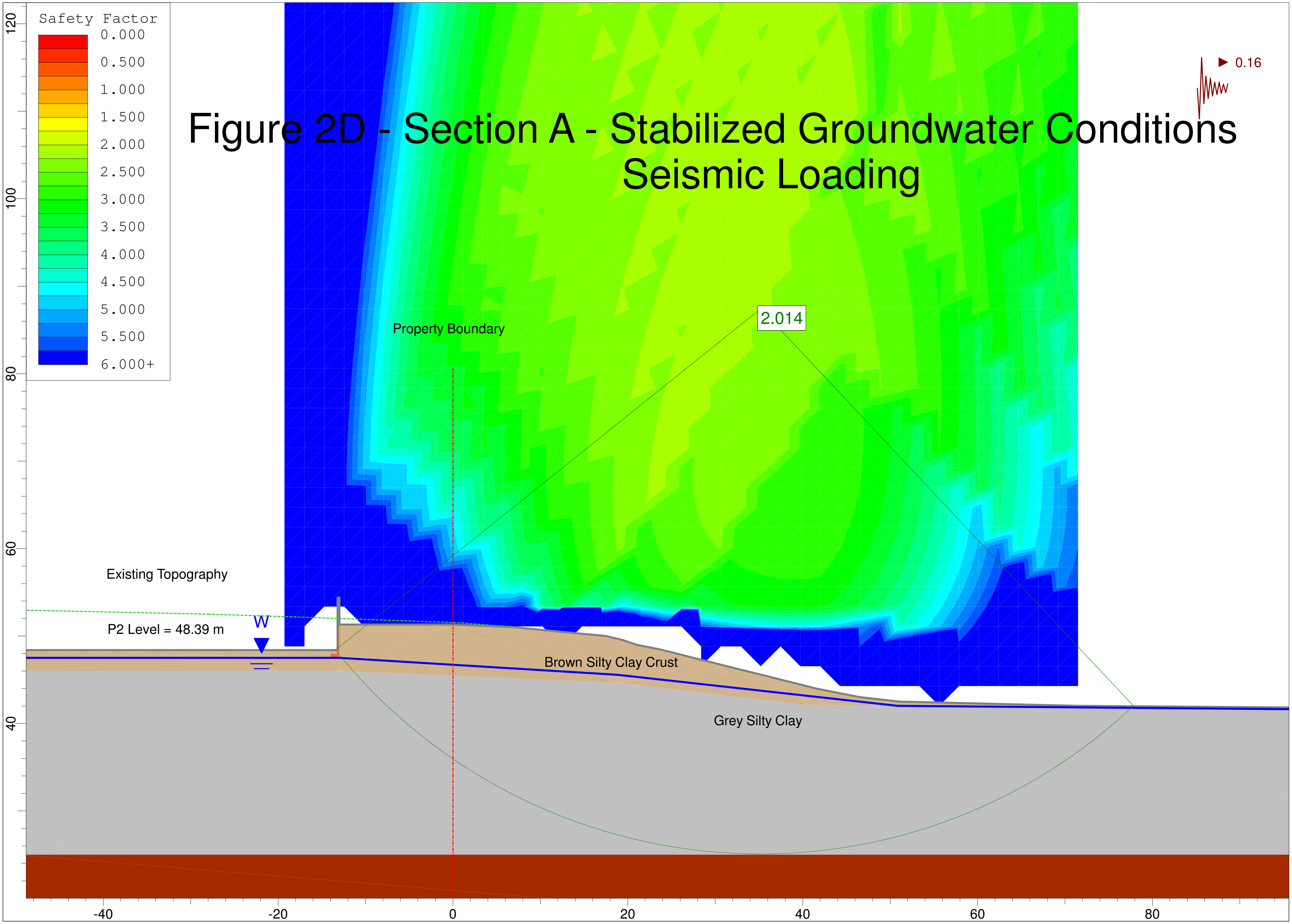
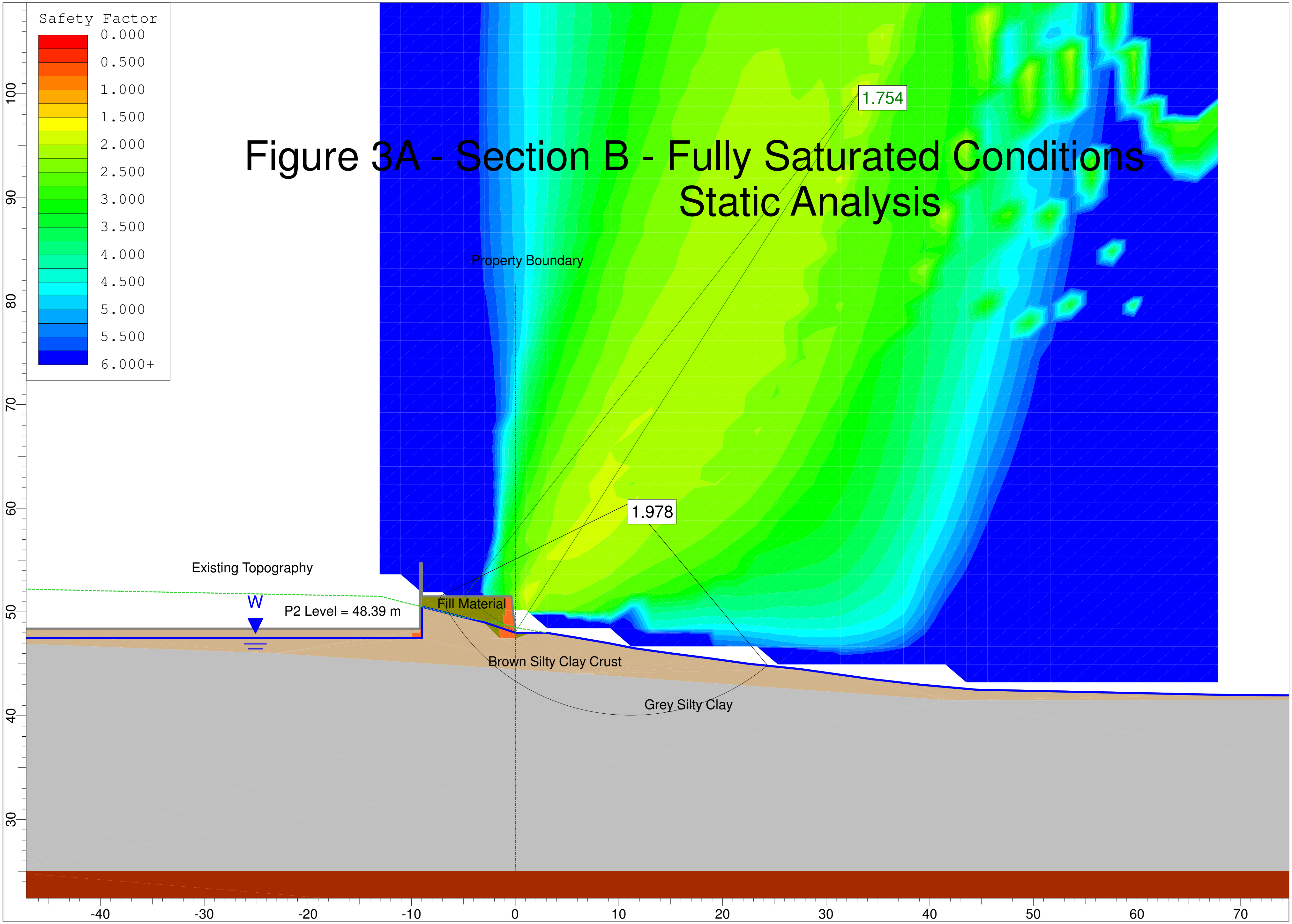


Figure 3A - Section B - Fully Saturated Conditions Static Analysis



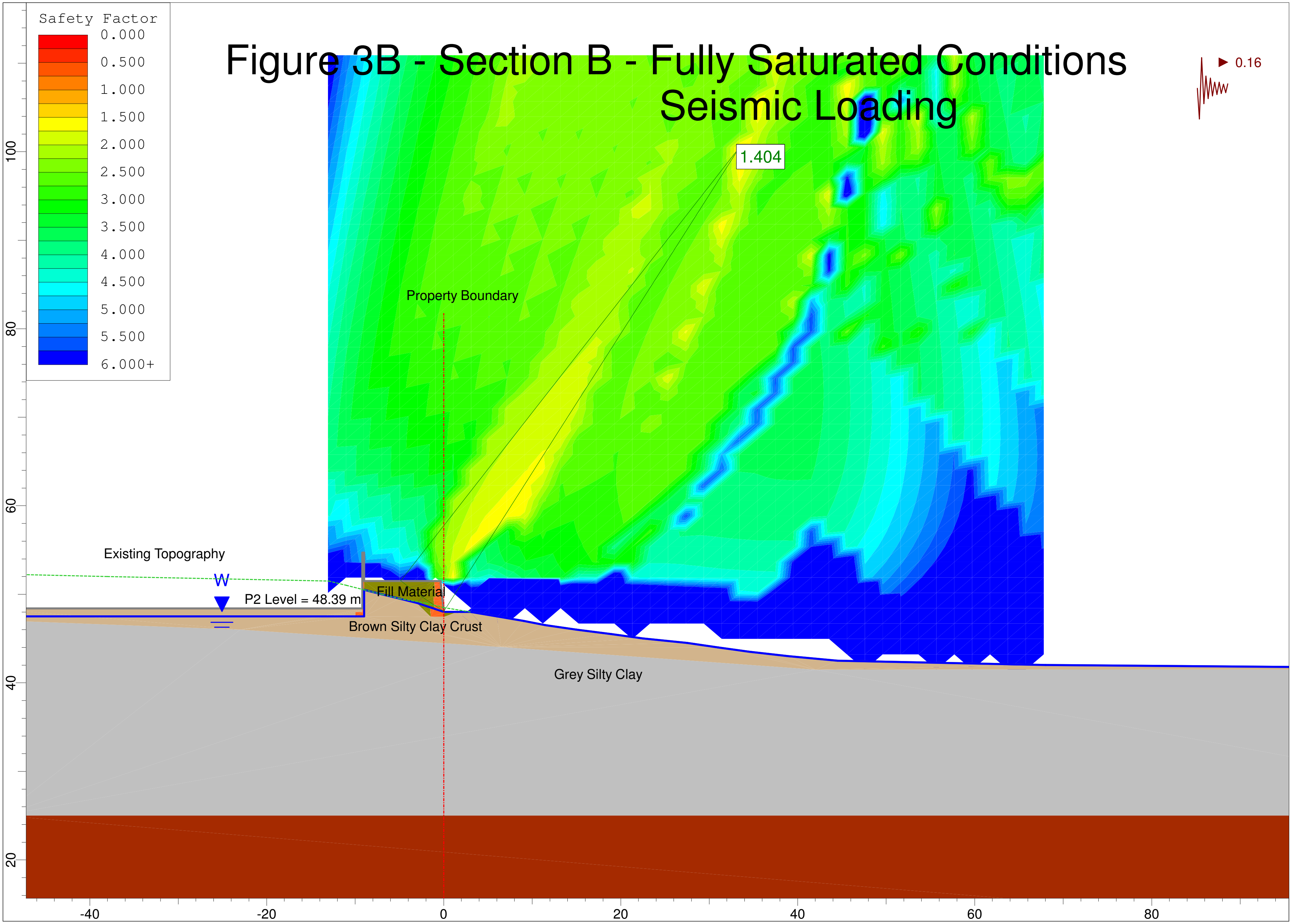


Figure 3B - Section B - Fully Saturated Conditions
Seismic Loading
Safety Factor
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000+
0.16
1.404
Property Boundary
Existing Topography
W
P2 Level = 48.39 m
Fill Material
Brown Silty Clay Crust
Grey Silty Clay
100
80
60
40
20
-40
-20
0
20
40
60
80

Figure 3C - Section B - Stabilized Groundwater Conditions Static Analysis

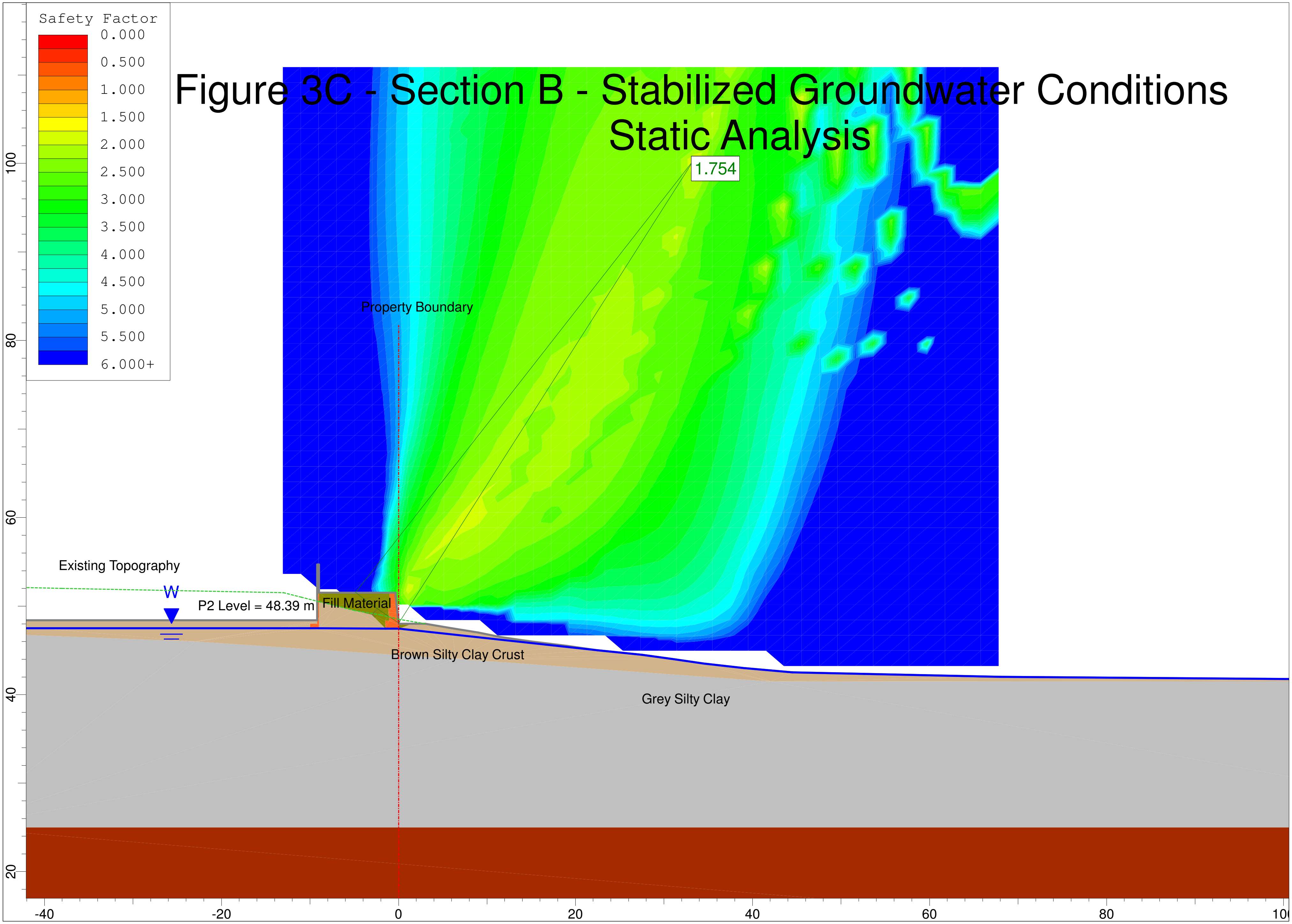
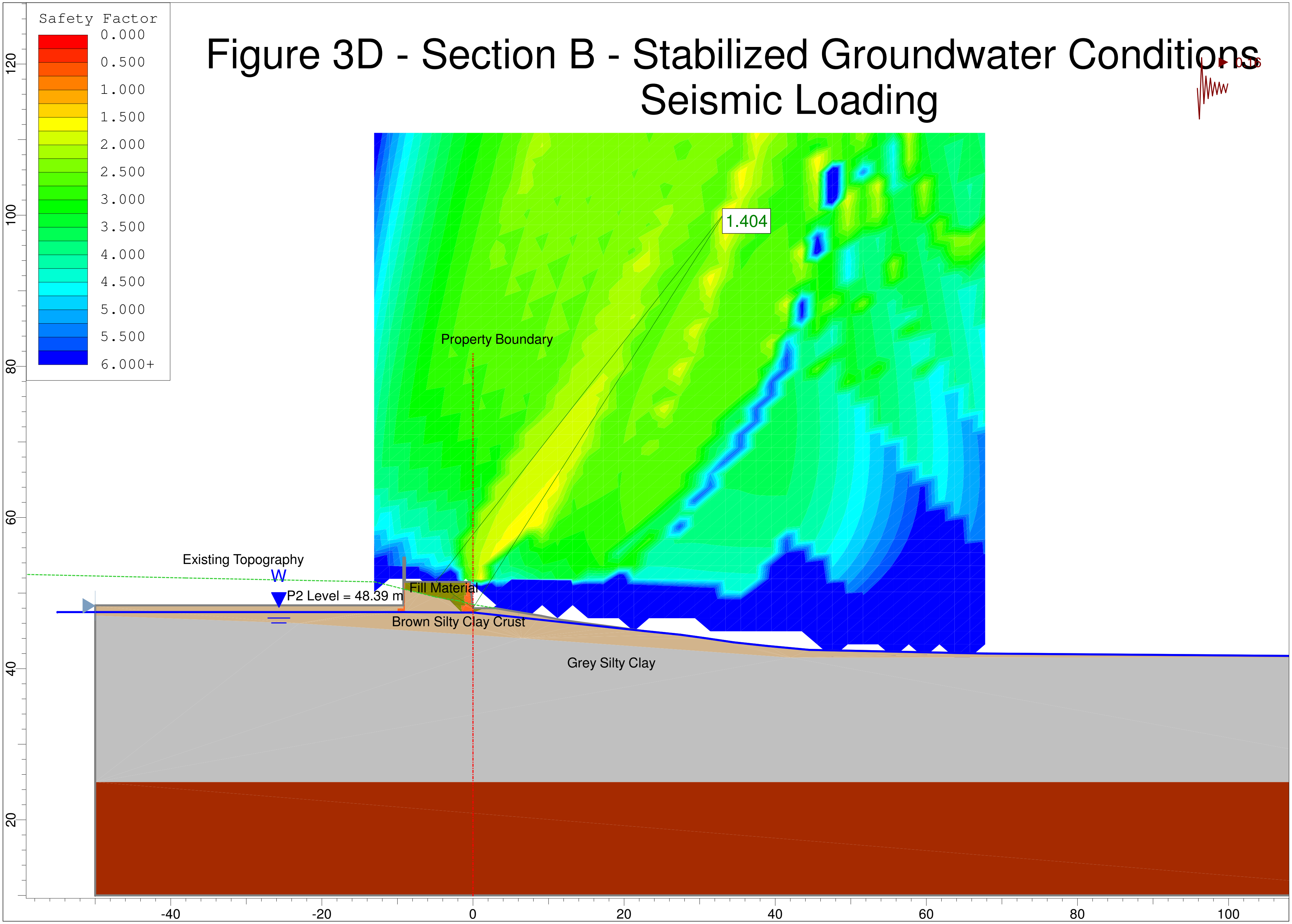


Figure 3D - Section B - Stabilized Groundwater Conditions
Seismic Loading



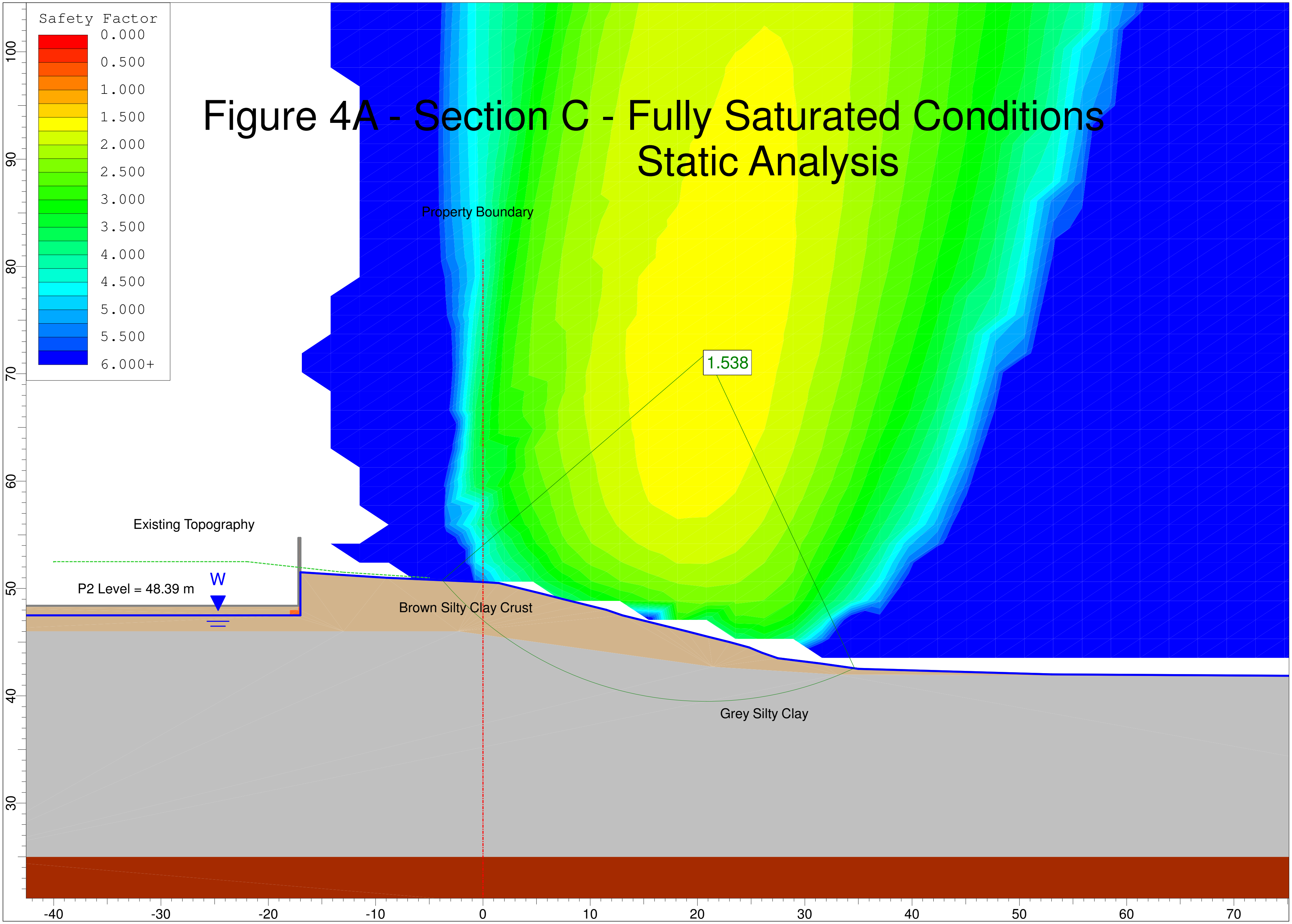


Figure 4A - Section C - Fully Saturated Conditions
Static Analysis
Safety Factor
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000+
Property Boundary
1.538
Existing Topography
P2 Level = 48.39 m
W
Brown Silty Clay Crust
Grey Silty Clay
100
90
80
70
60
50
40
30
-40
-30
-20
-10
0
10
20
30
40
50
60
70

Figure 4B - Section C - Fully Saturated Conditions Seismic Loading

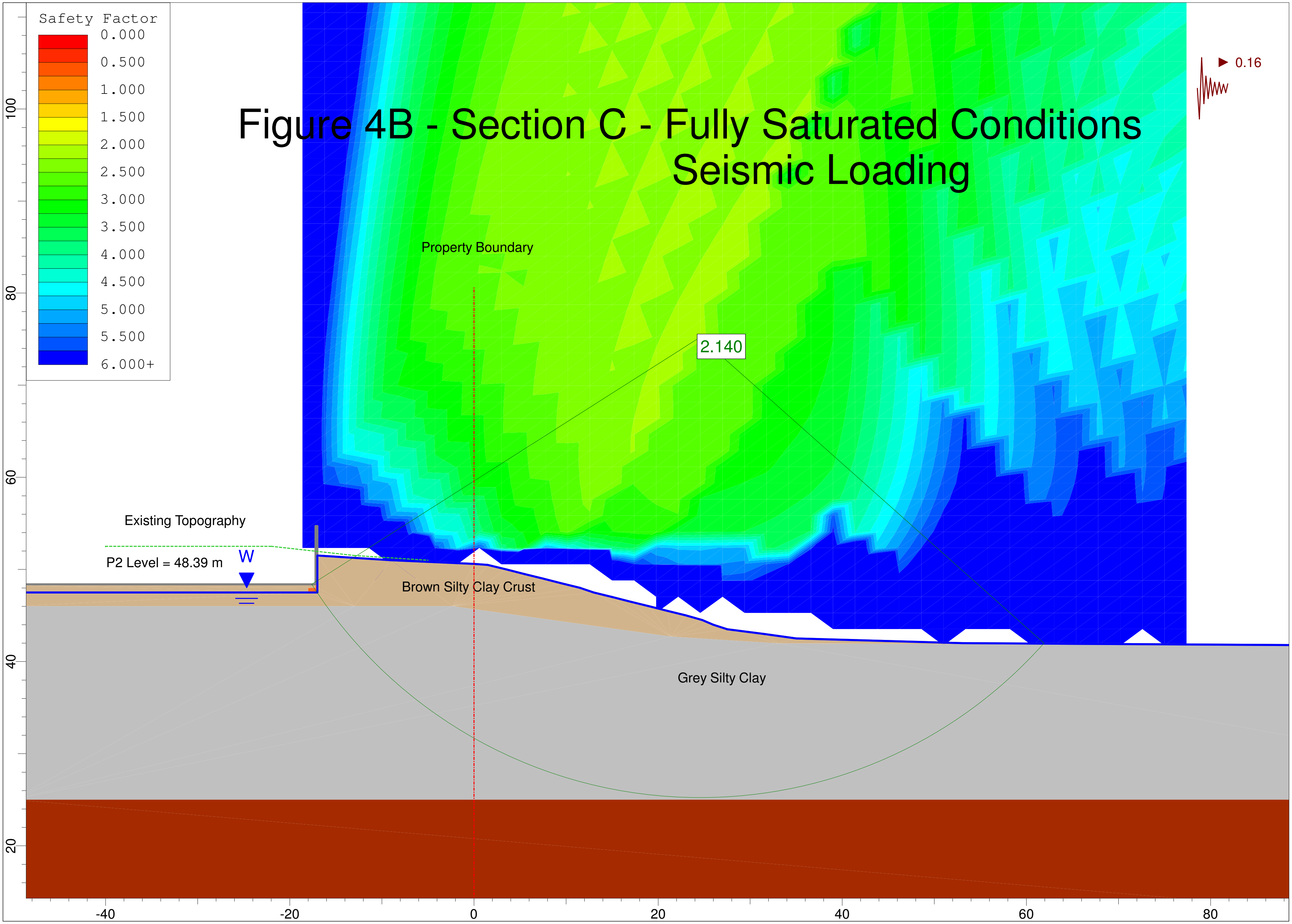


Figure 4C - Section C - Stabilized Groundwater Conditions Static Analysis

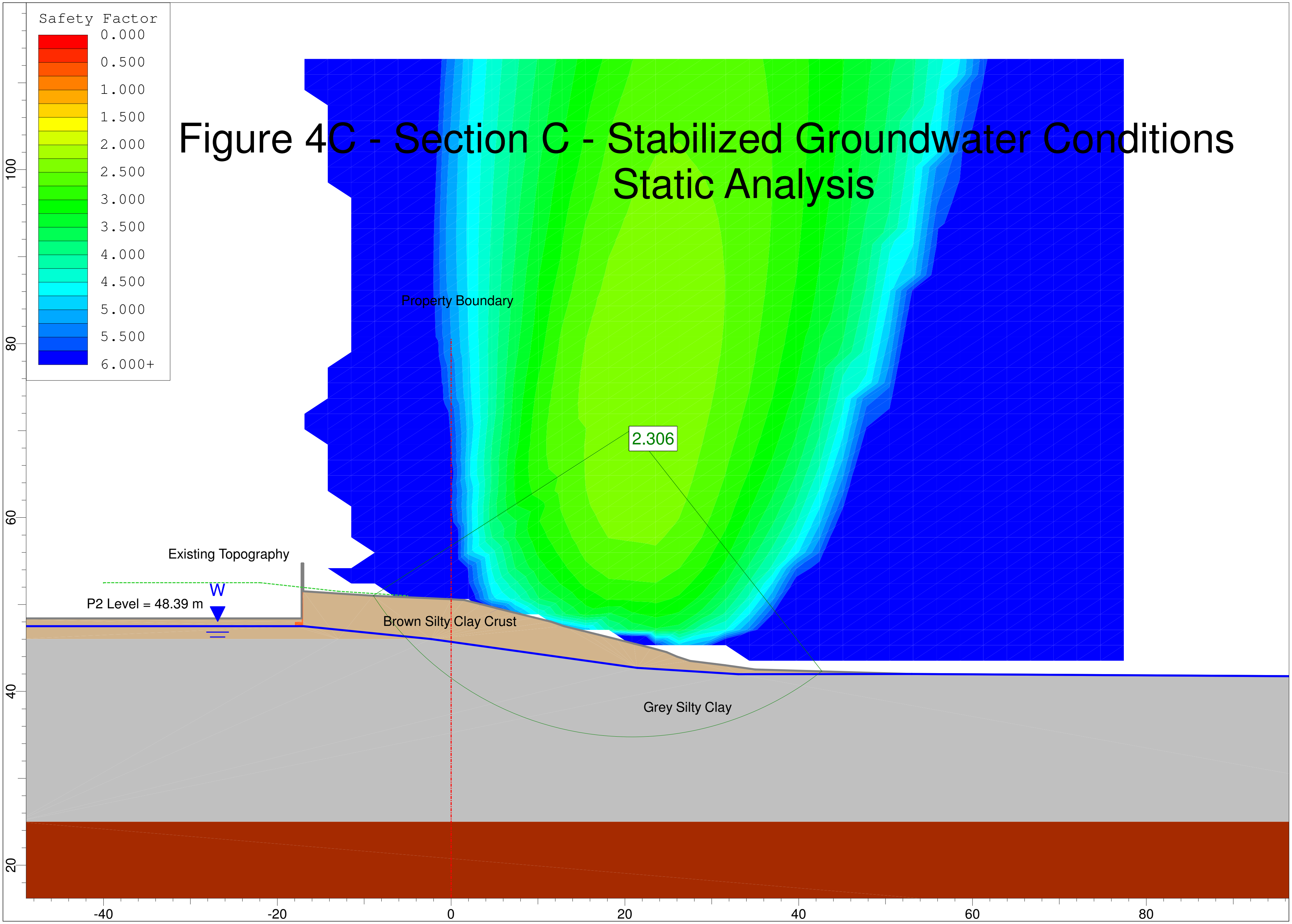
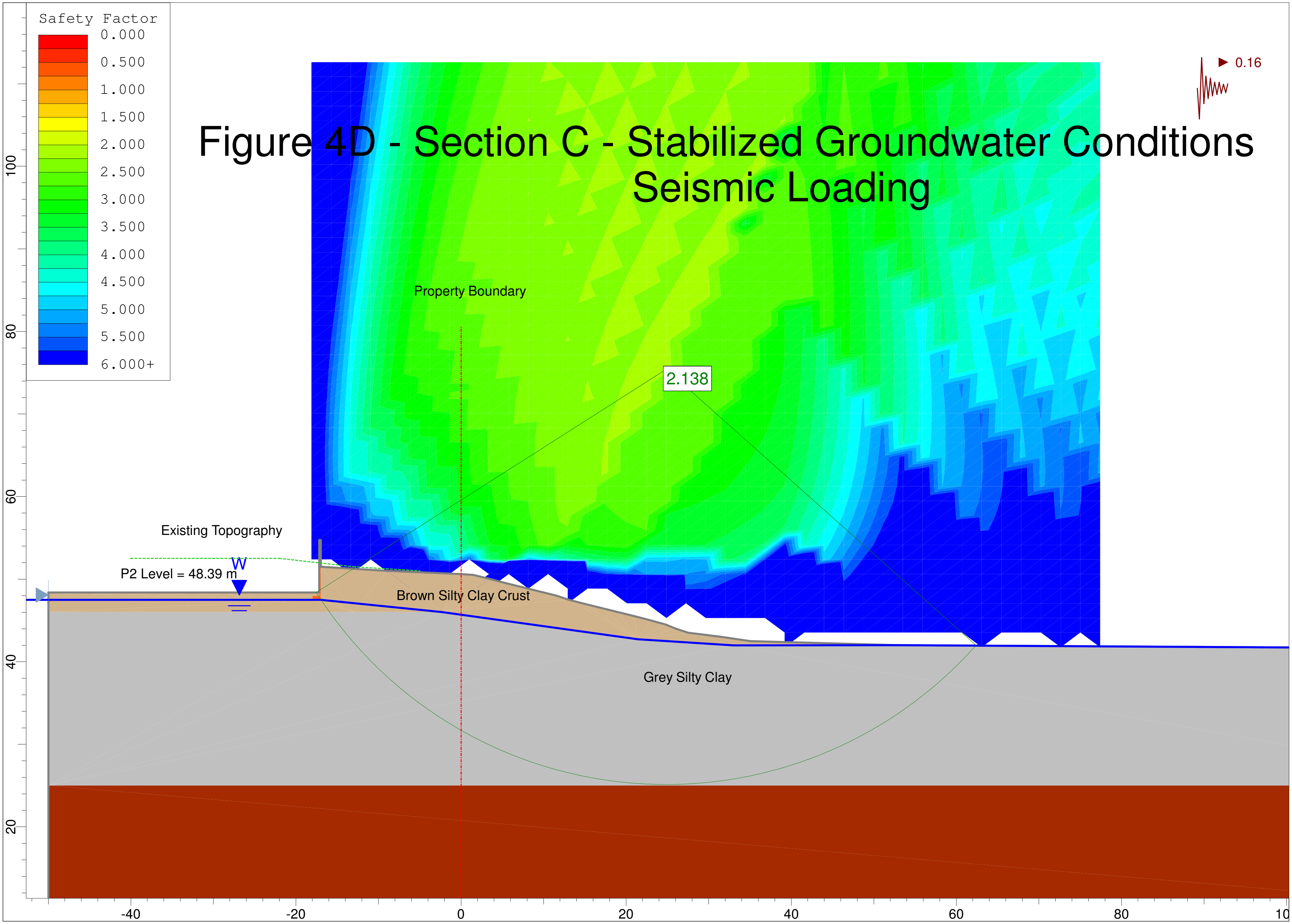
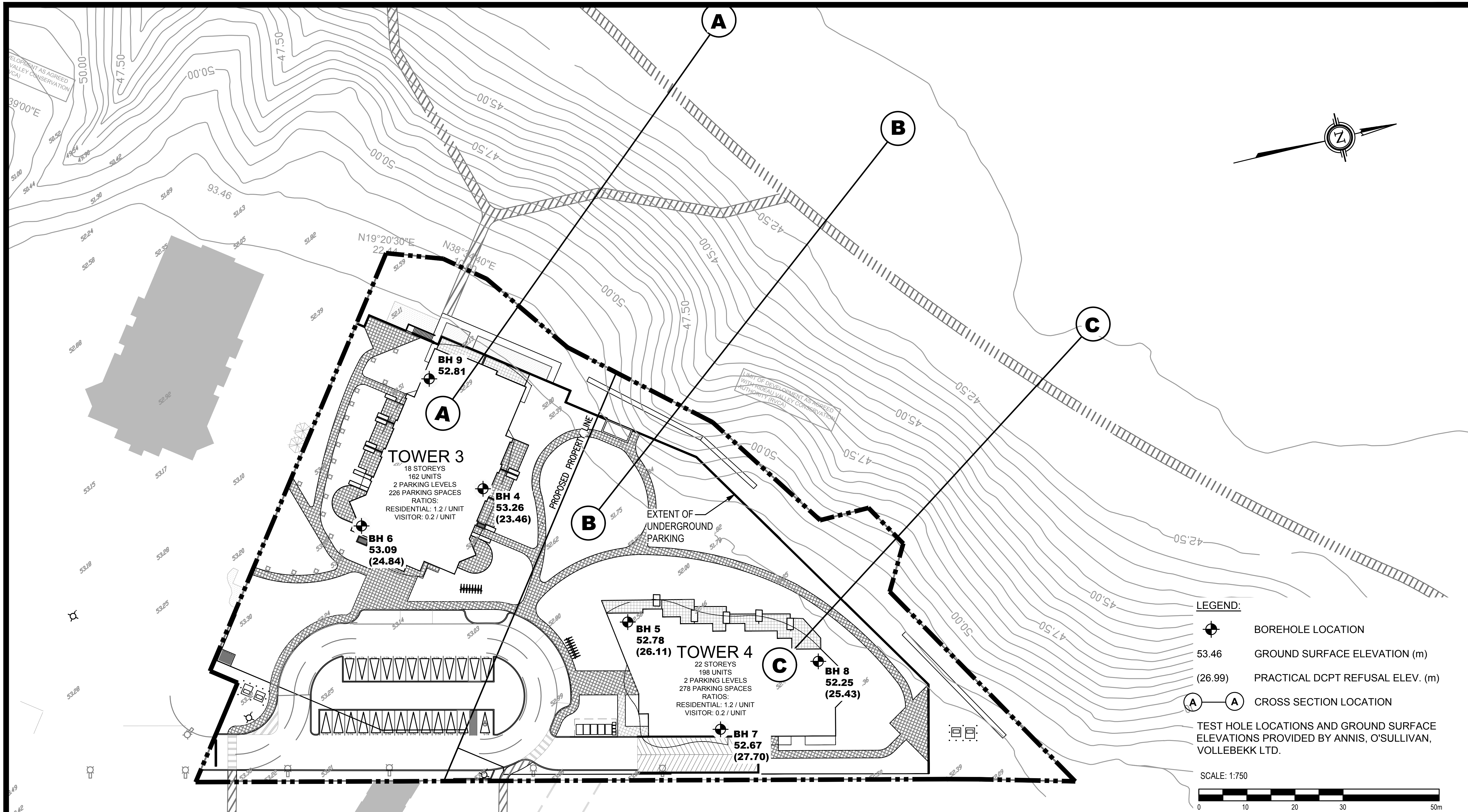


Figure 4D - Section C - Stabilized Groundwater Conditions
Seismic Loading





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NO.	REVISIONS	DATE	INITIAL
1	BASE PLAN UPDATED	26/04/2019	RG

BRIGIL CONSTRUCTION

GEOTECHNICAL INVESTIGATION
PROP. MULTI-BUILDING DEVELOPMENT - PETRIE LANDING

OTTAWA, ONTARIO

Title:

SITE PLAN

Scale: 1:750	Date: 04/2019
Drawn by: RCG	Report No.: PG3908-LET.03
Checked by: FA	Dwg. No.: PG3908-2
Approved by: FA	Revision No.: 1