FRASER VALLEY ENGINEERING LTD. 101 – 33465 Maclure Road Abbotsford, B.C. V2S 0C4
CIVIL - STRUCTURAL - GEOTECHNICAL **E**: info@fvel.com **O**: 604.850.0364 **F**: 604.557.0390

November 12th 2017

File: 17-0572

Big Daddy's Capital Inc.
31981 Bench Ave
Mission, BC V4S 1E6
Attention: Mike Bruic

Via email: mikebruic@gmail.com

Dear Mr. Bruic,

Re: Geotechnical Assessment for the Proposed Restaurant
33321 1st Ave, Mission, BC

1.0 Introduction

Fraser Valley Engineering Ltd. (FVEL) conducted a geotechnical assessment for the proposed restaurant located at 33321 1st Ave in Mission, BC. There are slopes on site, and geotechnical assessment is required.

The purposes of FVEL's assessment are:

- To identify potential geohazards on the site, and to provide geotechnical recommendations for mitigation of the geohazards and protection of the natural environment.

- To identify subsurface conditions, to determine the suitability of the site for the proposed building, and to prepare geotechnical recommendations for structural design and construction of the project.

This report has been prepared in accordance with the current District's Guidelines, and the "Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in British Columbia", revised May 2010, by the Association of Professional Engineers and Geoscientists of British Columbia.

This report does not address environmental considerations.

2.0 Proposed Development

The legal description of the property is Lots 6, 7, 8, 9 and 10, Block 74, District Lot 411, Group 1, New Westminster District Plan 664. The proposed development consists of a restaurant building and parking lots as shown in Figure 1. Retaining structures will be built at the north, west and east of the property.

Site surface conditions including surficial soil, slopes, and surface drainage were visually examined. Field observations are summarized below.

- The surface runoff appears in the south direction.
- A 1.5H:1V to 2H:1V slope is located at the north of the site.

3.0 Background Information

FVEL has collected and reviewed the following documents:

- The Geological Survey of Canada map 1485A titled "Surficial Geology Mission" with a scale of 1:50,000
- Seismic information (parameters) obtained from the National Resources Canada website: http://www.earthquakescanada.nrcan.gc.ca
- British Columbia Building Code 2012
- GIS map data, District of Mission
- A survey drawing by Wade & Associates Land Surveying Ltd. dated October 5th, 2017

4.0 Geotechnical Investigation

4.1 Surficial Geology

According to the Geological Survey of Canada map 1485A "Surficial Geology Mission" with a scale of 1:50,000, the soils in the study area consist of:

Sj, Advance Glaciofluvial Deposits:
Gravel and sand up to 40 m thick, proglacial channel fill, floodplain, and deltaic sediments probably all include here.

4.2 Borehole Drilling and Field Tests

The fieldwork was carried out on October 31st 2017. Four boreholes (BH01, BH02, BH03 and BH04) were drilled using a track mounted drill rig. The approximate borehole locations are shown in Figure 1. FVEL field representatives laid out the borehole locations and logged the soil and groundwater conditions. Soil samples were taken for classification and laboratory tests. Borehole logs showing soil types and depths are presented in Appendix A.

Boreholes, BH01, BH02 and BH03 were drilled at the locations of the proposed restaurant and BH04 was drilled over the top of the slope at the north of the property. Drilling refusal was encountered in BH02 and BH03 at depths shown in borehole logs.

SPT and DCPT tests were performed and the results are shown in the Borehole logs. SPT/DCPT refusal was encountered in all boreholes at depths shown in borehole logs.

The soils encountered in our investigation generally consist of fill overlying silty sand with some gravel. The silty sand is in a compact to dense condition. Groundwater seepage was encountered in all boreholes at depths shown in borehole logs.

4.3 Laboratory Tests

Particle size analysis tests were performed on selected samples and the results are shown in Figure 2.

5.0 Interpretation and analysis

The native soil encountered during our investigation is compact dense silty sand. Ground water was encountered in all boreholes at relatively shallow depths.

5.1 Soil Strength

The main engineering parameter for the proposed development is the strength (friction angle) of the silty sand. The correlation developed by Peck et al. (1974) was used to estimate the friction angle based on SPT/DCPT blow counts. The interpreted results are presented in Figure 3. FVEL considers that a friction angle of 33 degrees may be conservatively assigned for the silty sand.

5.2 Liquefaction Potential

Liquefaction, and the corresponding decrease in soil strength due to increased pore water pressure in response to seismic shaking, will generally only occur under saturated conditions (i.e., below the groundwater table). Any loose zone in granular soils that may exist below the groundwater table has the potential to liquefy during the design seismic event.

The silty sand at the subject site is in compact to dense condition. Figure 2 indicates that the fine contents of the silty sand are approximately 40 %. Therefore, this site has a non-potential to very low potential for liquefaction during seismic events and liquefaction is not a concern for the proposed development.

6.0 Discussion and Geotechnical Recommendations

Based on the project information and the results of our investigation, FVEL considers that the site is feasible for the proposed development. As discussed before, liquefaction is not a concern for the proposed development. Slope stability is the only potential geohazard identified for the site and will be discussed below. Other geohazards are not expected, and will not be included in the discussion.

6.1 Slope Stability

A slope stability analysis was conducted for the current geometry of the slope using the commercial software SoilWorks 2013, V.2.1. A conservative slope profile with a height of 8 m and the steep slope inclination of 1.5H:1V was chosen. The Limit Equilibrium Method was selected in the analysis. Both static and seismic (pseudo-static) conditions were taken into account in compliance with the “Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC”, revised May 2010, by the Association of Professional Engineers and Geoscientists of BC. Based on our investigation, assumed soil properties for the silty sand are: unit weight of 20 kN/m^3, friction angle of 33°, and cohesion of 3 kPa. The water table is conservatively assumed to be 8 feet below the crest of the slope and 3 feet below the toe of the slope as shown in Figures 4 and 5.

The peak ground acceleration (PGA) at a probability of 2% in 50 years (0.000404 per annum) for the area is 0.45 g, which was obtained from the web-site of National Resources Canada. A seismic acceleration coefficient k_{15} of 0.15g was used in the analysis. The k_{15} value was calculated using the Bray Travasarou Method, and is compatible with 15 cm of slope displacement along the slip surface in compliance with the APEGBC landslide assessment guidelines.

The following minimum Factors of Safety (FS) used for the global stability analyses are adopted:

- Global Stability under Static Conditions = 1.5
- Global Stability under Seismic Conditions = 1.0

The results of the slope stability analysis indicate that under the static and seismic conditions, the safety factors for slope sliding through the silty sand is 1.1 and 0.8 (Figures 4 and 5), respectively. It can be concluded that the FS of this slope does not satisfy the minimum requirement and a setback or retaining wall system is required for the proposed development. FVEL understands that the client prefers a retaining wall system and the retaining wall design recommendations are provided in next section.

6.2 Retaining Walls

A retaining structure is necessary for the static and seismic stability of the slope. It is our understanding that, excavation into the existing slope to accommodate for the proposed building is considered by the property owner. FVEL understands that a combination of a cast in place concrete wall and a segmental retaining wall are proposed for this site. The parameters in Table 1 can be used for the retaining wall design.

The backfill to be placed behind the retaining walls should consist of free draining granular soil with fines content of less than 3 %. The backfill materials shall be compacted to a minimum of 100% relative to the Standard Proctor Maximum Dry Density, (SPMDD) except for 1 m immediately behind the walls, where the required compaction shall be reduced to 95% of the SPMDD.

Figures 6 and 7 show the lateral earth pressure distribution acting on rigid and flexible retaining walls, respectively. The lateral pressures are estimated based on the backfill materials recommended above. Should other materials be used as the backfill of the walls, FVEL must be informed and updated recommendations will be provided.

Figures 6 and 7 are estimated base on the lateral earth pressure induced by soils only. Surcharge loads from the nearby structures and traffics if expected must be considered during the design of the walls. In addition, the pressure distributions are provided based on an assumption of full drainage behind the walls to relieve hydrostatic pressures. If the long-term drainage is questionable, hydrostatic pressures should be considered.

6.3 Geotechnical Hazard Statement

It is understood that the District of Mission requires that the proposed development meets requirements under Section 86 of the Land Title Act concerning development on land that is, likely to be subject to geohazards.

Fraser Valley Regional District hazard acceptability criteria applicable to residential developments considered for the project have also been adopted by the District of Mission. The criteria are presented in the government document, "Hazard Acceptability Thresholds for Development Approvals by Local Government, 1993". Based on these criteria, approval without conditions or mitigation relating to hazards is considered appropriate for the project.

Using the Cave's Criteria, the proposed building site is therefore considered to be safe for the use intended provided the recommendations in this report are followed. In accordance with Section 86 of the Land Title Act, safe site use is defined as a rural residential dwelling as designated by the District.

The APEGBC Landslide Assessment Assurance Statement Appendix D is attached.

6.4 General Site Preparation

FVEL understands that excavation is required for the construction of retaining walls. Safe cut and fill slopes will be defined by the geotechnical engineer field judgement.

The existing topsoil, fill, or organic soil (if any) must be removed down into the native silty sand. The excavation base should be reviewed by geotechnical personnel from our office. It is not anticipated, but if during the excavation process the soils are substantially disturbed, the sub-grade must be compacted after excavating to a minimum density of 100% based on the Standard Proctor Maximum Dry Density Test (SPMDDT).

Should the grade be raised to the design subgrade elevations, granular structural fill should be used subject to approval by the geotechnical engineer. The structural fill should be placed in lifts. Each lift should not be greater than 300 mm in thickness, and compacted to a minimum density of 100% based on the Standard Proctor Maximum Dry Density Test (SPMDDT).

FVEL must review the subgrade once the excavation is completed, and monitor field densities during placement of structural fill. FVEL must review the structural backfilling activities, prior to placing formwork, in order to verify its adequacy to support the proposed structure and to provide additional compaction recommendations, if required.

6.5 Foundation Consideration and Bearing Capacity Estimation

Footings for the proposed restaurant founded on the native silty sand or structural fill as discussed above, can be designed with a factored Ultimate Limit State (ULS) bearing pressure of 3000 psf (150 kPa). The Serviceability Limit State (SLS) pressure is 2000 psf (100 kPa). The minimum width of continuous footings should not be less than 0.45 m (18 inches) and the minimum dimension of column footings should not be less than 0.90 m (36 inches). A minimum embedment depth of 0.45 m (1.5 feet) must be provided for frost protection.

In terms of seismic design, the Site Classification for this property is D – stiff soil (in accordance with the BC Building Code 2012, Table 4.1.8.4.A). The Peak Ground Acceleration (PGA), for Site Class C, is 0.45 g for a probability of occurrence of 2% in 50 years (0.000404 per annum), which was obtained from the web-site

http://www.earthquakescanada.nrcan.gc.ca of National Resources Canada. The Spectral Response Acceleration Values Sa(T), for Site Class C, are:

Sa(0.2) = 0.92, Sa(0.5) = 0.62, Sa(1.0) = 0.31, Sa(2.0) = 0.17

6.6 Concrete Slab on Grade

Concrete slab-on-grade must be underlain by 19-mm free draining (containing less than 3% fines) granular material. The thickness of the granular layer should be a minimum of 100 mm. A vapour barrier membrane consisting of minimum 0.15 mm polyethylene sheeting should be placed between the slab and the bedding layer. A thin layer of sand may be placed on top of the vapour barrier to protect the polyethylene sheeting from tearing during construction of footing forms and concrete pouring.

6.7 Pavement Structure

The driveway and parking lot pavement could be designed as summarized in Table 2:

7.0 Review and Construction Inspections

FVEL should review the final design to ensure that our recommendations have been incorporated. We recommend that FVEL be retained for the following purposes:

- Subgrade field review prior to footings construction
- Review of excavation slopes
- Review of structural fill material and its compaction, if required
- Field monitoring of pile installation if the pile foundation is selected
- Review of compaction under slab on grade, if required
- Retaining wall backfill material compaction

8.0 Conclusion

It is our professional opinion that, by following our geotechnical recommendations provided in this report, the land for the proposed development may be used safely for the use intended.

9.0 Limitation and closure

This report is based on the geotechnical investigation with borehole drilling, review of background information and our knowledge of the area of the proposed project. We have prepared this report in substantial accordance with generally accepted geotechnical engineering practice, as it exists in the site area at the time of our study. No warranty is expressed or implied. This report may be used only by the client and only for the purposes stated, within a reasonable time from its issuance. The District of Mission may also rely on the findings of our report.

We trust that this report provides you with the information required for the final design. If you have any questions, please do not hesitate to call.

Yours truly,

Fraser Valley Engineering Ltd.

Reviewed by,

Yan Cui, P.Eng.
Senior Geotechnical Engineer

Larry Deng, M.Sc, P.Eng.
Senior Geotechnical Engineer, Principal

References

- Peck, R.B., W.E. Hanson and T.H. Thornburn, 1974. Foundation engineering. 2nd Edn.: John Wiley and Sons, Inc

Table 1 Retaining Wall Design Parameters

Soil	Unit Weight (kN/m^3)	Friction Angle (degrees)	K_0	K_a	K_p
Silty Sand	20	33	0.46	0.30	3.39

Table 2 Pavement Structure

Material	Thickness (mm)
Asphalt (mm)	75
25 mm Minus Crushed Base Course (mm)	150
75 mm Minus Select Granular Sub-Base (mm)	300
Pavement Total Thickness (mm)	525

Attachments

Figure 1 Approximate borehole Location Plan

Figure 2 Particle Size Distribution

Figure 3 Friction Angle Interpretation

Figure 4 Slope Stability Analysis (Static)

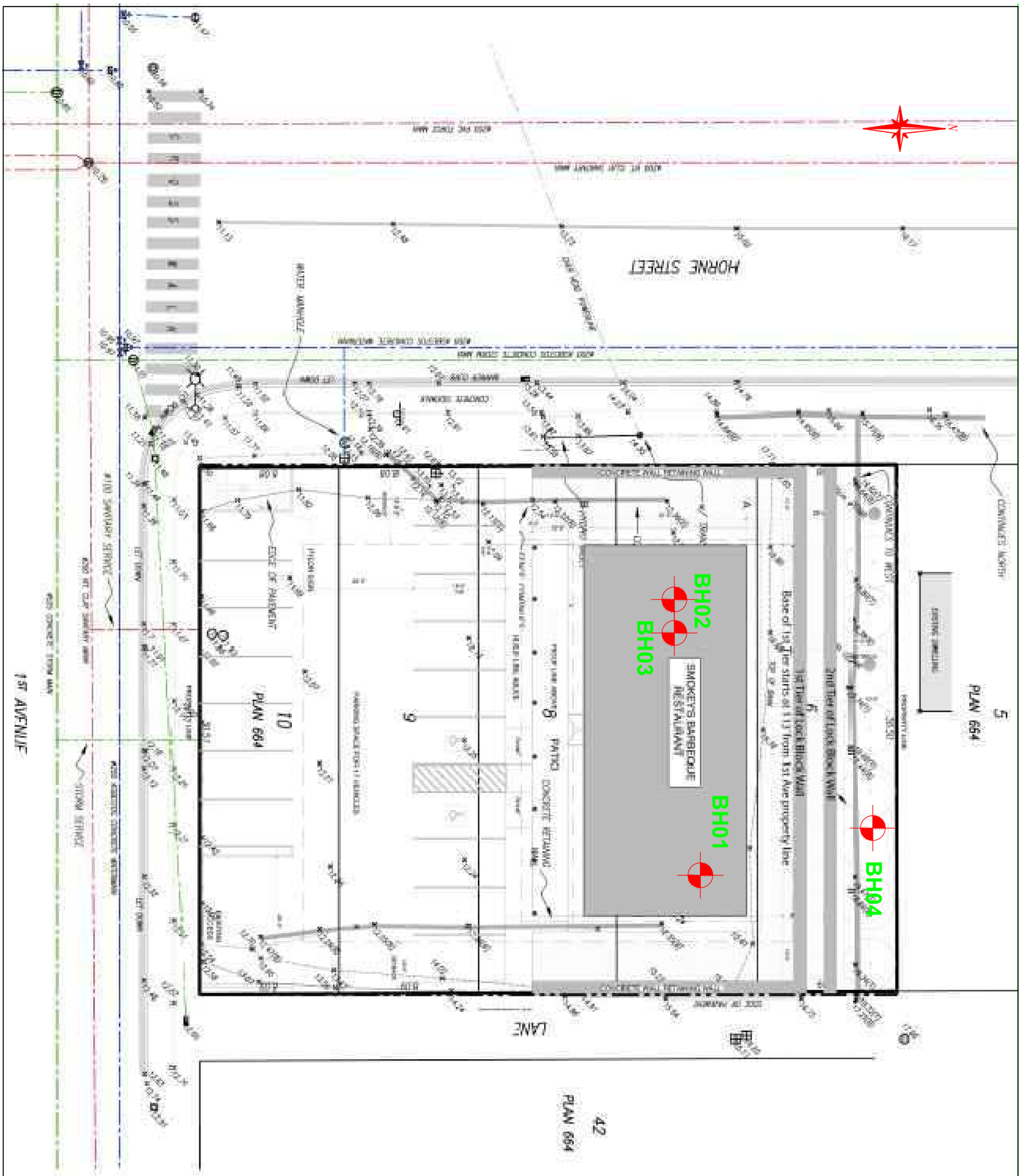
Figure 5 Slope Stability Analysis (Seismic)

Figure 6 Lateral Earth Pressure Distribution (Rigid)

Figure 7 Lateral Earth Pressure Distribution (Flexible)

Appendix A Borehole logs

APEGBC Landslide Assessment Assurance Statement Appendix D

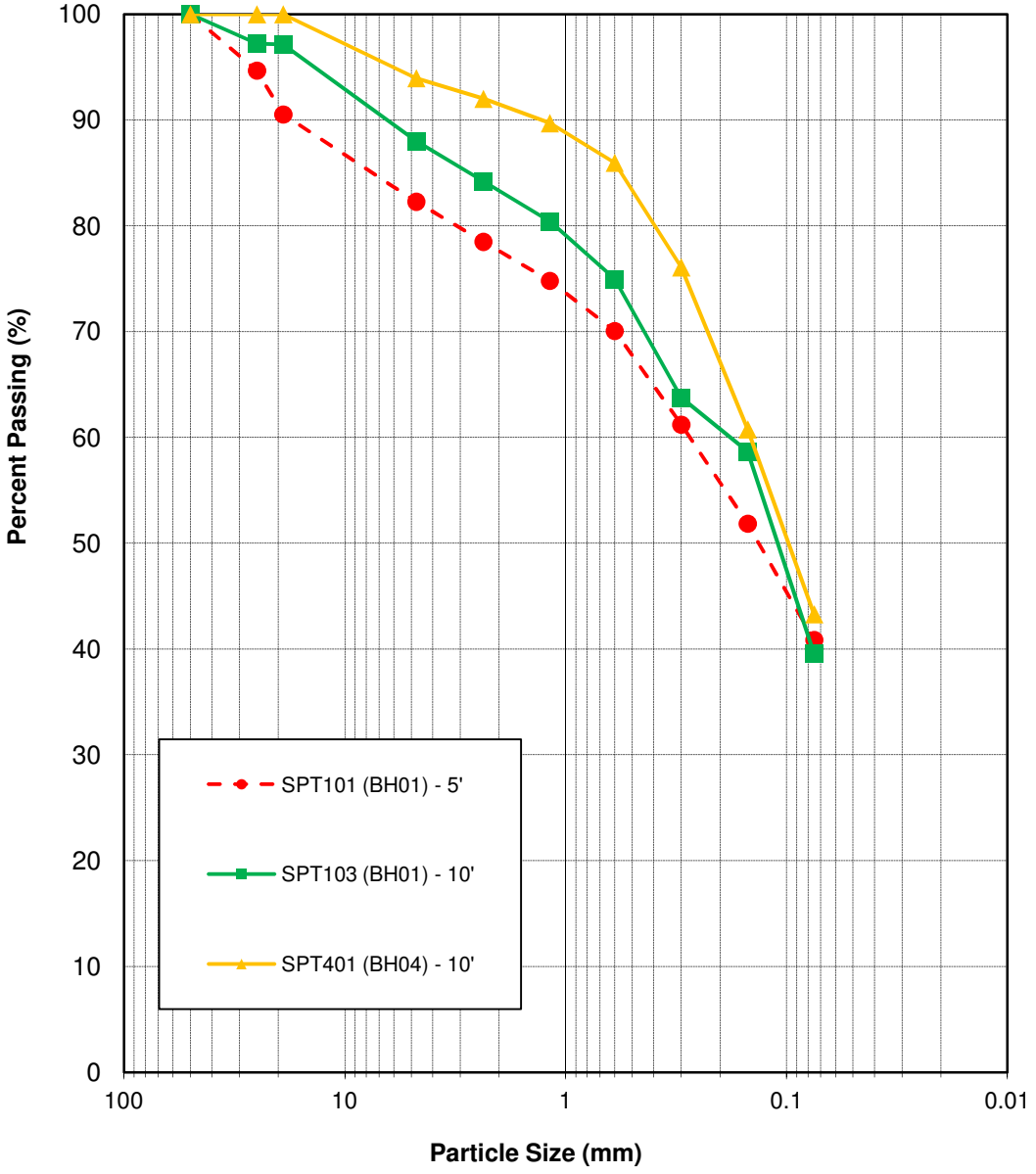


LEGEND

BH##: Borehole

REV No.:	SITE: 33321 1st Ave. Mission, BC	FILE: PR:17-0526	Figure 1	FRASER VALLEY ENGINEERING LTD. #101-33465 MACLURE RD., ABBOTSFORD, B.C., V2S 0C4 TEL: 604-850-0364 FAX: 604-557-0390	No.:	DATE:	REVISIONS:
		DRAWN: YC					
		CHECKED: LD					
SHEET: 1/1	DRAWING: APPROXIMATE BOREHOLE LOCATION PLAN	DATE: 08Nov2017		CLIENT:			
		SCALE: N.T.S.					

Figure 2 Particle Size Distribution



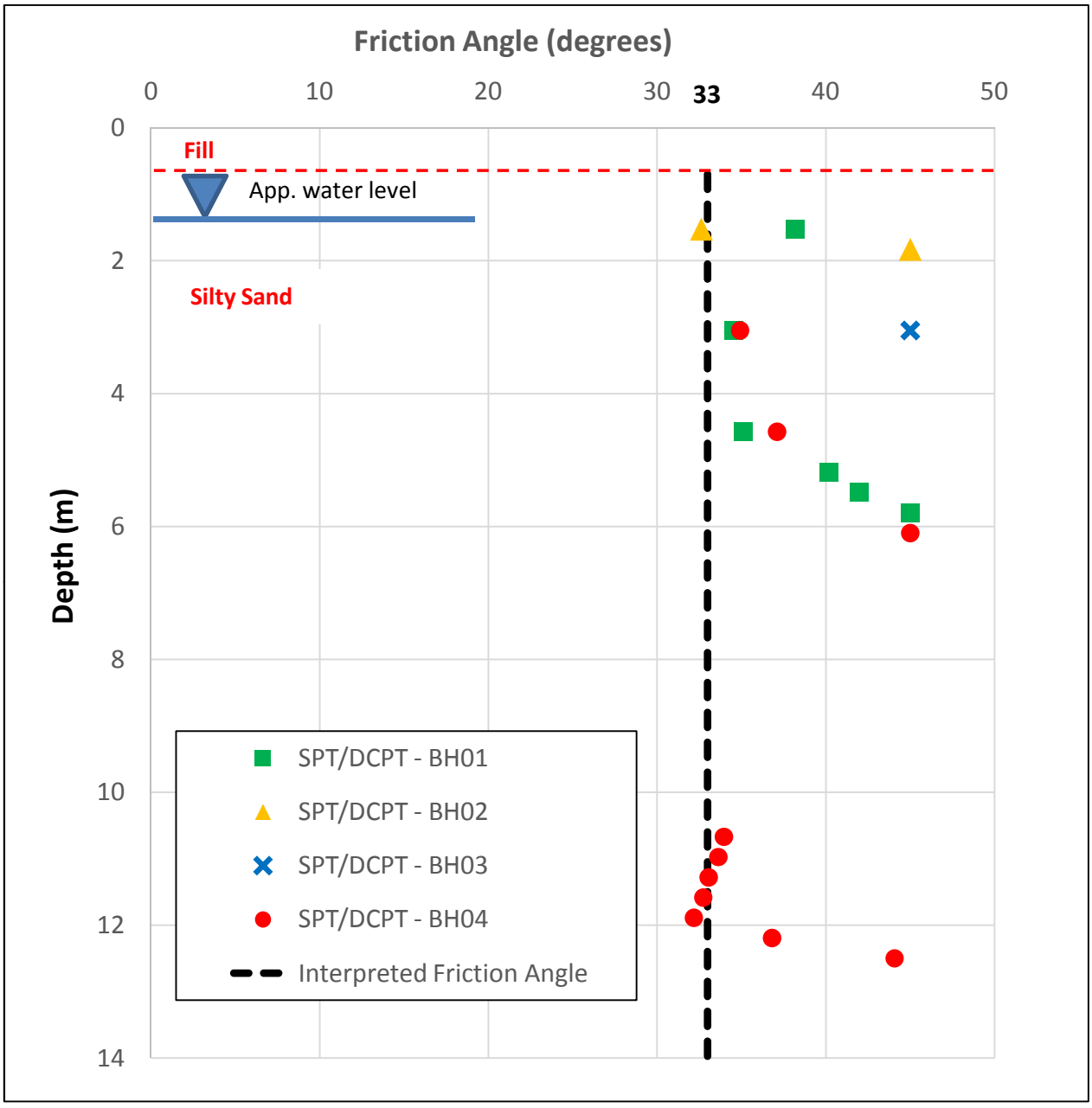


Figure 3
Friction Angle

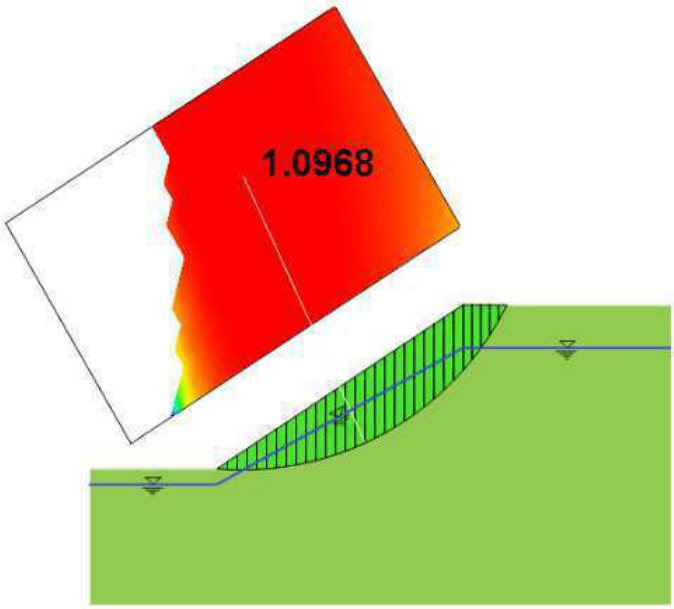


Figure 4 Slope Stability Analysis (Static)

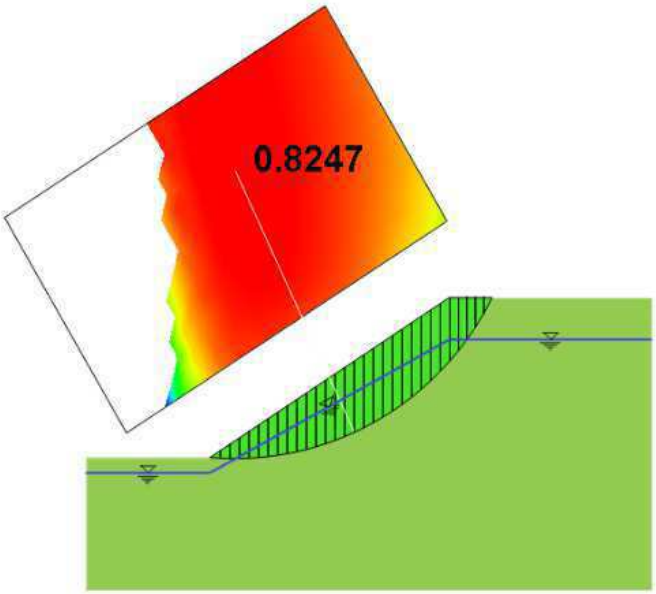


Figure 5 Slope Stability Analysis (Seismic)

Figure 6 Lateral Earth Pressure Distribution (Rigid)

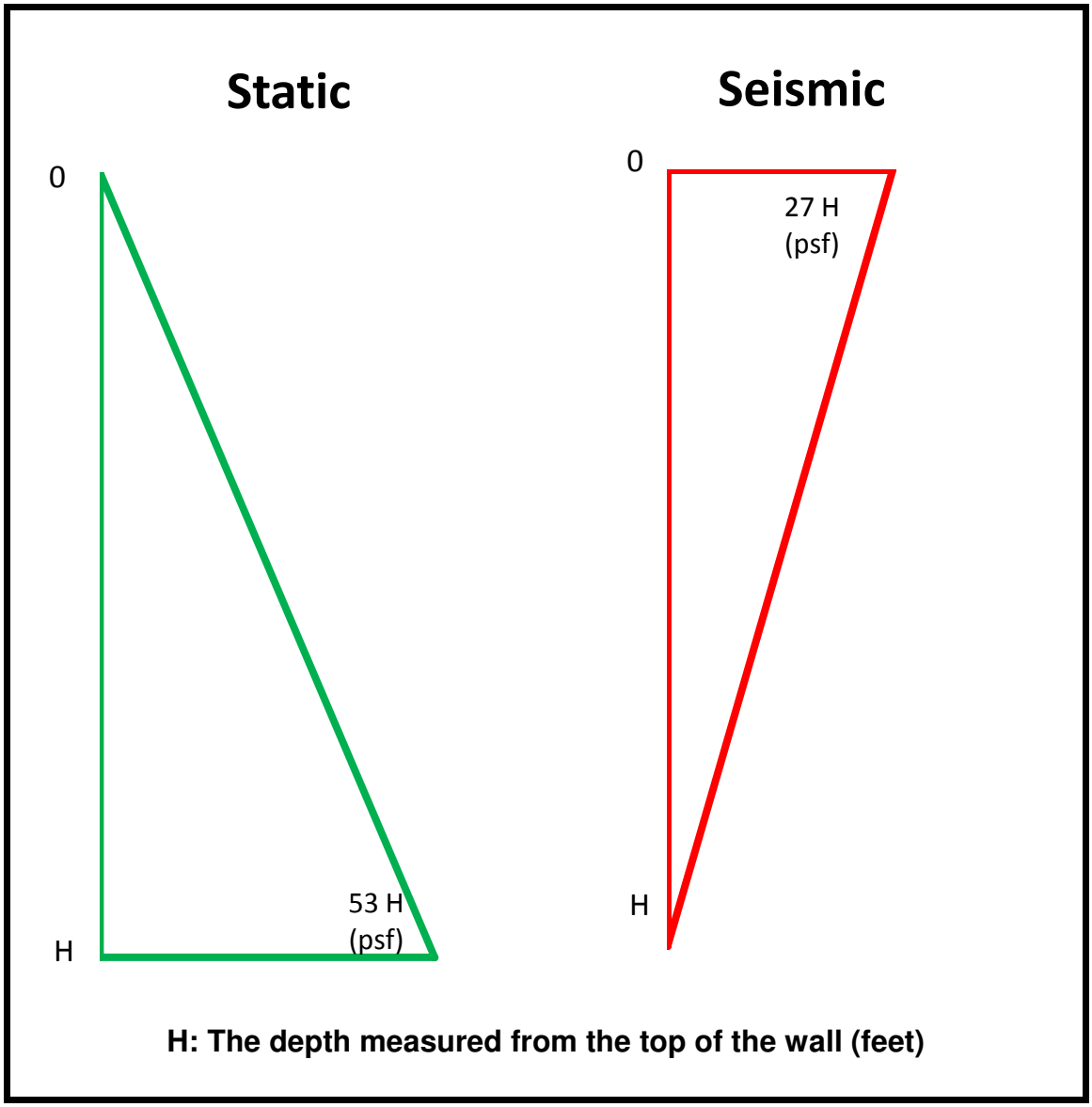
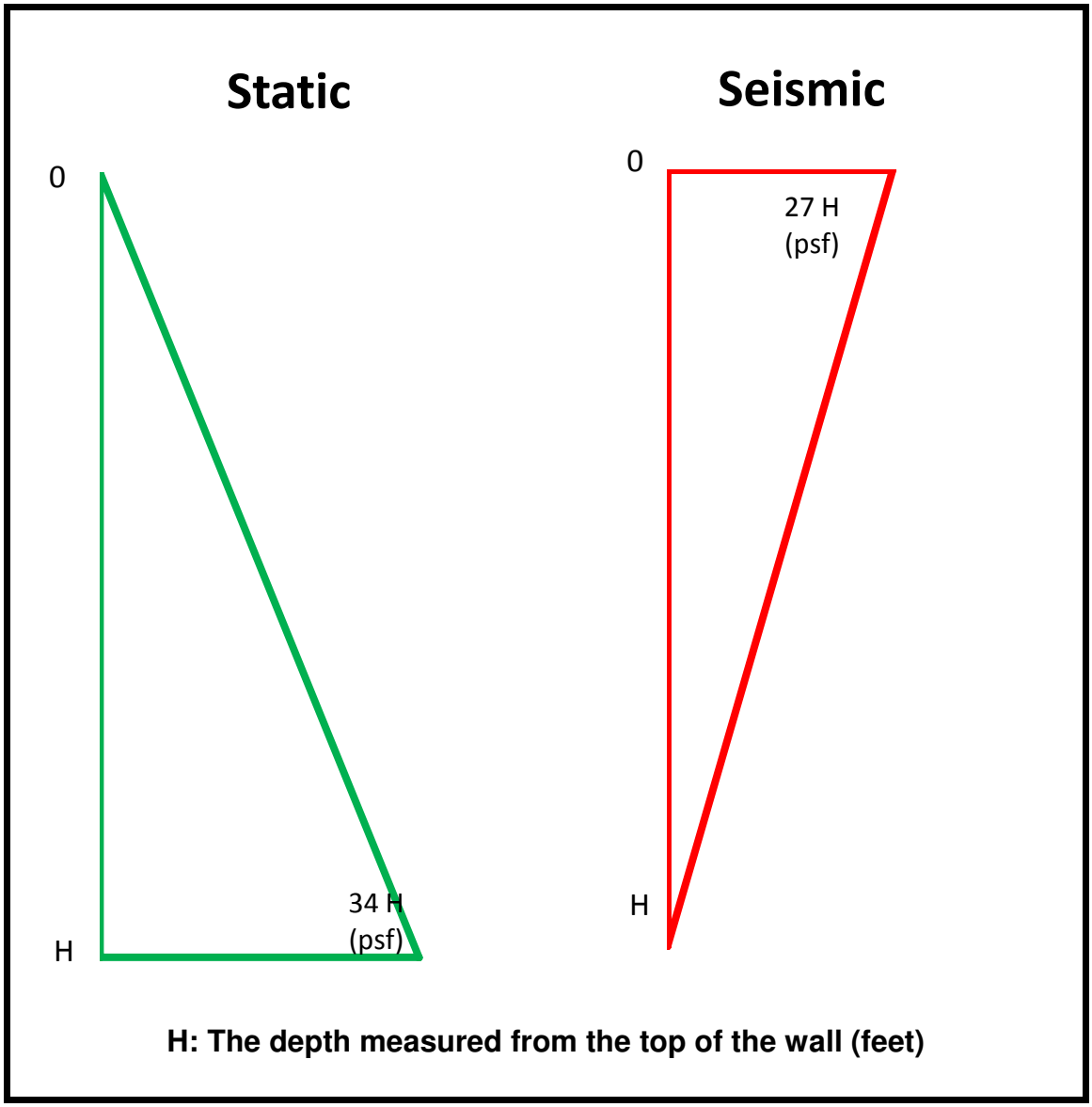


Figure 7 Lateral Earth Pressure Distribution (Flexible)

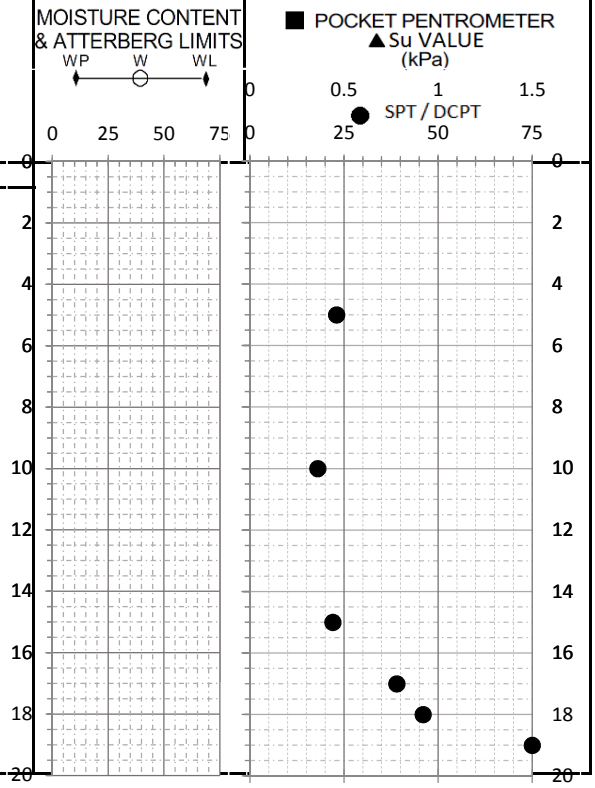


SOIL LOG

BH01

CLIENT NAME: Big Daddy's Capital Inc.
PROJECT NO. 17-0572
PROJECT NAME: Smokey's Barbeque Restaurant
ELEVATION:
LOCATION: 33321 1st Ave
GWT (ft): 6
NORTHING:
TEST METHOD: Track Mounted Solid Stem Auger Rig
TEST DATE: 31-Oct-17
EASTING:

SOIL SYMBOL	SOIL CLASSIFICATION	DEPTH IN METER	DEPTH IN FEET	SOIL DESCRIPTION
	ASP	0.08		Asphalt
	SM			Silty sand, some gravel, trace clay, brown, well graded, moist, compact to dense
				@ 6' seepage, becomes wet to saturated
				@ 10' becomes grey
				@ 20' DCPT refusal
		6.1	20	



Note: Backfilled with excavated soil & bentonite

Logged by: YC

SOIL LOG

BH02

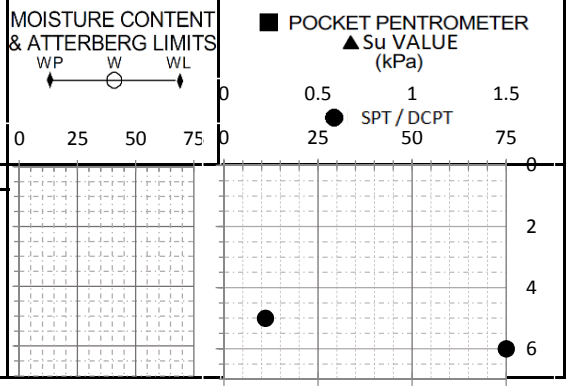
CLIENT NAME: Big Daddy's Capital Inc. **PROJECT NO.** 17-0572

PROJECT NAME: Smokey's Barbeque Restaurant **ELEVATION:**

LOCATION: 33321 1st Ave **GWT (ft):** 3 **NORTHING:**

TEST METHOD: Track Mounted Solid Stem Auger Rig **TEST DATE:** 31-Oct-17 **EASTING:**

SOIL SYMBOL	SOIL CLASSIFICATION	DEPTH IN METER	DEPTH IN FEET	SOIL DESCRIPTION
	ASP	0.1		Asphalt
	SM	2.13	7	Silty sand, some gravel, trace clay, brown, well graded, moist, compact to dense @ 3' seepage, becomes wet to saturated @ 7' DCPT and drilling refusal



Note: Backfilled with excavated soil & bentonite

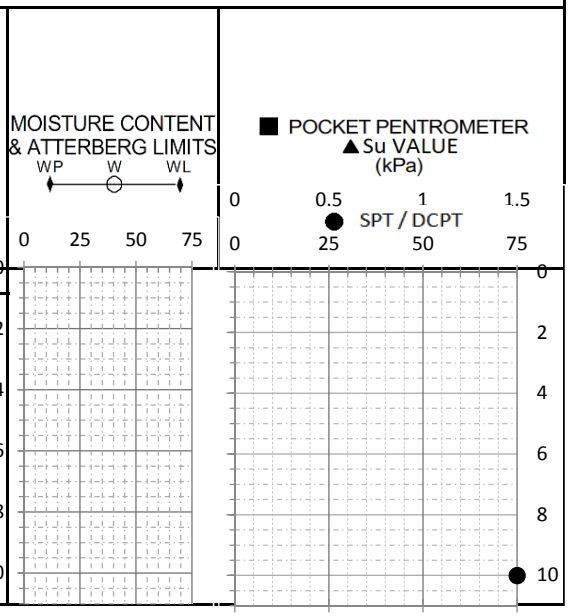
Logged by: YC

SOIL LOG

BH03

CLIENT NAME: Big Daddy's Capital Inc.
PROJECT NO. 17-0572
PROJECT NAME: Smokey's Barbeque Restaurant
ELEVATION:
LOCATION: 33321 1st Ave
GWT (ft): 3
NORTHING:
TEST METHOD: Track Mounted Solid Stem Auger Rig
TEST DATE: 31-Oct-17
EASTING:

SOIL SYMBOL	SOIL CLASSIFICATION	DEPTH IN METER	DEPTH IN FEET	SOIL DESCRIPTION
	ASP	0.1		Asphalt
	SM	3.35	11	Silty sand, some gravel, trace clay, brown, well graded, moist, compact to dense @ 3' seepage, becomes wet to saturated @ 11' DCPT and drilling refusal



Note: Backfilled with excavated soil & bentonite

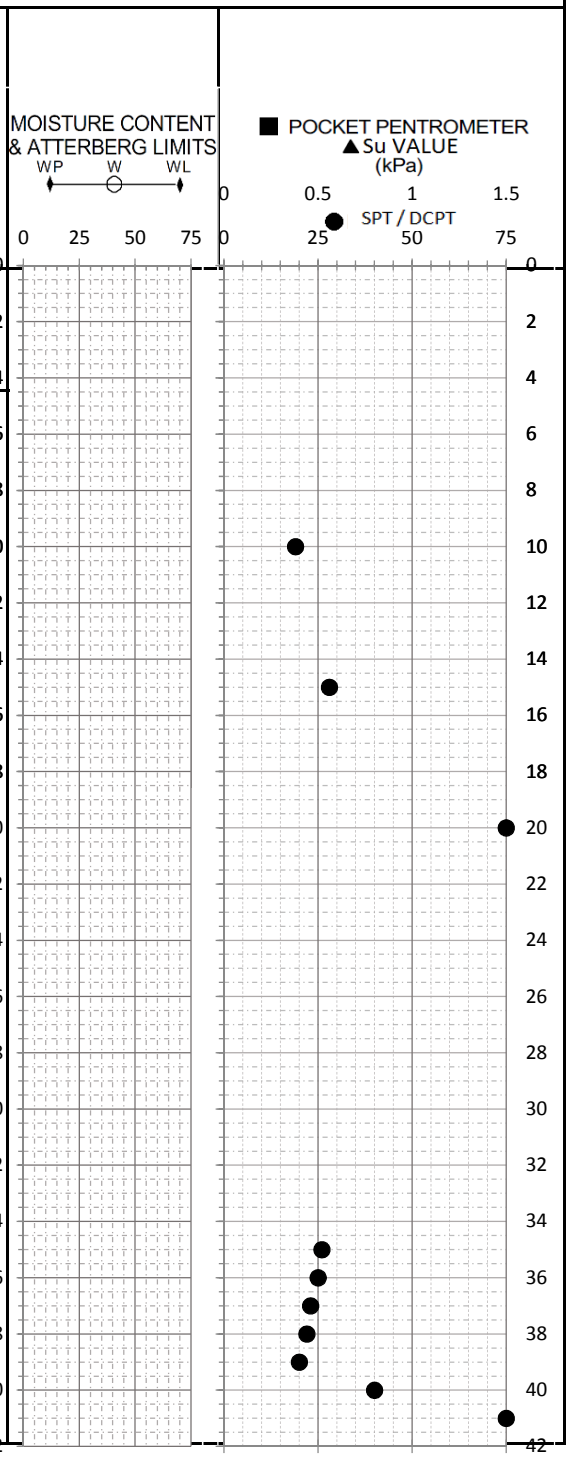
Logged by: YC

SOIL LOG

BH04

CLIENT NAME: Big Daddy's Capital Inc.
PROJECT NO. 17-0572
PROJECT NAME: Smokey's Barbeque Restaurant
ELEVATION:
LOCATION: 33321 1st Ave
GWT (ft): 9
NORTHING:
TEST METHOD: Track Mounted Solid Stem Auger Rig
TEST DATE: 31-Oct-17
EASTING:

SOIL SYMBOL	SOIL CLASSIFICATION	DEPTH IN METER	DEPTH IN FEET	SOIL DESCRIPTION
	Fill	1.22	4	Fill, silt and sand, some gravel, trace clay, brown, compact, well graded, moist, trace roots.
	SM	12.8	42	Silty sand, some gravel, trace clay, brown, well graded, moist, compact to dense @ 9' seepage, becomes wet to saturated @ 20' DCPT refusal @ 42' DCPT refusal



Note: Backfilled with excavated soil & bentonite

Logged by: YC

APPENDIX D: *LANDSLIDE ASSESSMENT ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia*", March 2006/Revised September 2008 ("*APEGBC* Guidelines"*)* and the "2006 BC Building Code (BCBC 2006)" and is to be provided for *landslide assessments* (not floods or flood controls) for the purposes of the Land Title Act, Community Charter or the Local Government Act. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: November 12, 2017

District of Mission
8645 Stave Lake St., Mission, BC V2V 4L9

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☒ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☐ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption
- ☐ British Columbia Building Code 2006 sentences 4.1.8.16 (8) and 9.4 4.4.(2) (Refer to BC Building and Safety Policy Branch Information Bulletin B10-01 issued January 18, 2010)

For the Property: Lots 6, 7, 8, 9 and 10, Block 74, District Lot 411, Group 1, New Westminster District Plan 664 / 33321 1st Ave. Mission, BC

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist.*

I have signed, sealed and dated, and thereby certified, the attached *landslide assessment* report on the Property in accordance with the *APEGBC Guidelines*. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

- X 1. Collected and reviewed appropriate background information
- X 2. Reviewed the proposed *residential development* on the Property
- X 3. Conducted field work on and, if required, beyond the Property
- X 4. Reported on the results of the field work on and, if required, beyond the Property
- X 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a *landslide hazard analysis* or *landslide risk analysis* I have:
  - X 6.1 reviewed and characterized, if appropriate, any *landslide* that may affect the Property
  - X 6.2 estimated the *landslide hazard*
  - X 6.3 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
  - X 6.4 estimated the potential *consequences* to those *elements at risk*
- 7. Where the *Approving Authority* has adopted a *level of landslide safety* I have:
  - X 7.1 compared the *level of landslide safety* adopted by the *Approving Authority* with the findings of my investigation
  - X 7.2 made a finding on the *level of landslide safety* on the Property based on the comparison
  - X 7.3 made recommendations to reduce *landslide hazards* and/or *landslide risks*

8. Where the *Approving Authority* has **not** adopted a *level of landslide safety* I have:

___8.1 described the method of *landslide hazard analysis* or *landslide risk analysis* used

___8.2 referred to an appropriate and identified provincial, national or international guideline for *level of landslide safety*

___8.3 compared this guideline with the findings of my investigation

___8.4 made a finding on the *level of landslide safety* on the Property based on the comparison

___8.5 made recommendations to reduce *landslide hazards* and/or *landslide risks*

_x_ 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

☒ the findings from the investigation and the adopted *level of landslide safety* (item 7.2 above)

☐ the appropriate and identified provincial, national or international guideline for *level of landslide safety* (item 8.4 above)

I hereby give my assurance that, based on the conditions[1] contained in the attached *landslide assessment* report,

Check one

☐ for subdivision approval, as required by the Land Title Act (Section 86), "that the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☒ without any registered covenant.

☒ for a development permit, as required by the Local Government Act (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".

☐ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended"

Check one

☐ with one or more recommended registered covenants.

☐ without any registered covenant.

☐ for flood plain bylaw variance, as required by the "Flood Hazard Area Land Use Management Guidelines" associated with the Local Government Act (Section 910), "the development may occur safely".

☐ for flood plain bylaw exemption, as required by the Local Government Act (Section 910), "the land may be used safely for the use intended".

Yan Cui
Name (print)

November 12, 2017
Date

Signature

[1] When seismic slope stability assessments are involved, *level of landslide safety* is considered to be a "life safety" criteria as described in the National Building Code of Canada (NBCC 2005*),* Commentary on Design for Seismic Effects in the User's Guide, Structural Commentaries, Part 4 of Division B. This states:

"The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse".

101–33465 Maclure Rd

Address

Abbotsford, BC V2S 0C4

604–850–0364

Telephone

(Affix Professional seal here)

If the *Qualified Professional* is a member of a firm, complete the following.

I am a member of the firm Fraser Valley Engineering Ltd
and I sign this letter on behalf of the firm. (Print name of firm)