

Jaime Harper
14-636 Clyde Avenue
West Vancouver, BC

October 6, 2022
File: 1558 Rev 2

Attention: Jaime Harper

**RE: Preliminary Landslide Hazard Assessment – Proposed Subdivision
5600 Block, Daffodil Drive, West Vancouver, BC**

1.0 INTRODUCTION

We understand that it is proposed to subdivide the subject property¹ into thirty-six residential units and that the District of West Vancouver requires that a landslide hazard assessment is completed in accordance with EGBC² guidelines.

This report provides a preliminary qualitative landslide hazard assessment of the subject property. It has been prepared exclusively for our client, for their use, the use of others on their design team and the District of West Vancouver for use in the development and permitting process, however it remains the property of Frontera.

2.0 SITE DESCRIPTION

The site encompasses an area of 1.8 hectares situated on a southwest facing slope with an average slope of approximately 1V:3H. It is bound by a BC Rail Right of Way to the north, Westport Road to the east, Eagle Creek, Daffodil Drive and residential lots to the south, and residential lots to the west.

Private roadways currently cross the site, which is largely undeveloped and forested with cedar trees, to provide access from Westport Road and Daffodil Drive to the residential property at 5665 Daffodil Drive. There is some evidence of historic site usage, most likely related to forestry.

3.0 DESKTOP REVIEW

Review of published geological maps for the area indicate the site is likely to be underlain by glacio-marine ice contact deposits described as; sand and gravel, stratified to massive and commonly faulted; generally greater than three metres thick; forming hummocky surfaces, may be fossiliferous.

Major infrastructure projects have been constructed adjacent the proposed subdivision with similar topographic and geological conditions including Westport Road and the BC Rail line.

The site is not in the BC landslide inventory and review of publicly available LiDAR information and site survey plans shows no visual signs of land instability.

¹ Lot C (Reference Plan 3355), Group 1 New Westminster District excerpt part in Reference Plan 11716 District Lot 1374 Group 1 New Westminster District.

² Guidelines for Legislated Landslide Assessments for Proposed Residential Developments in BC (May 2010).



4.0 FIELD REVIEW

4.1 General

A site reconnaissance was completed by Frontera on 24 February 2021 and included a site walk-over, measurement of slope angles, surface observations of rock outcrops and two sub-surface penetration tests (Scala Penetrometer) to determine the relative strength and thickness of near-surface soils.

Test locations are identified on Drawing 1558-01 following the text of this report.

Detailed results from the penetration tests are provided in Appendix A and photos from the reconnaissance in Appendix B.

4.2 Discussion

Based upon the results of the field review the general subsurface conditions are expected to comprise of relatively loose organic rich colluvium and topsoil, in the order of one metre thick, overlying relatively dense native soil or granitic bedrock.

Steeper terrain, defined as greater than 35 degrees, was generally isolated to natural rock-outcropping or disturbed ground related to the BC Rail Line or existing roadway from Westport Road. No active or historic evidence of landslide were noted. Surficial soil creep was evident in juvenile and mature trees across the slope.

Rock outcrops were noted on proposed Lot's B5, B6, G6, B4, G5, G4, D4, D3, B3. The rock can generally be described as blocky with several persistent joint sets with a possibility for toppling on west aspect cuts. No major rock instability was noted at the time of the review.

The rock outcrops also lie within the proposed alignment for the roads into the development via Westport Road and Daffodil Drive.

Shot rock forming the southwest embankment of the BC Rail line on the upslope side of the proposed development is sloped at approximately 45 degrees.

Persistent groundwater seepage was noted at the bedrock contact in the northern corner of the property adjacent to a small creek (north side of proposed Lot B6).

A summary of the field review observations are provided on a marked up plan of the proposed sub-division on Drawing 1558-1 following the text of this report.

5.0 LANDSLIDE ASSESSMENT

The objectives of the landslide assessment were to; review and characterize landslides (active, inactive, dormant and potential) within or beyond the proposed subdivision development, estimate associated landslide hazards and compare the estimates with a level of landslide safety adopted by the approving jurisdiction.

Based on the results of our desktop and field reviews, there are no obvious signs of recent or historic landslide activity on, or in immediate areas beyond the property.

The District of West Vancouver does not specify a risk tolerance criteria for landslide hazard for new developments. For the purposed of this report, we have adopted the risk tolerance criteria used by the District of North Vancouver (2009), which species a maximum 1:100,000 risk of fatality per year, and or a static factor of safety greater than 1.5 for slopes associated with new developments.



Based upon the available information, Frontera estimates that landslide hazards at the proposed site exceed the DNV's risk tolerance criteria for new developments and subsequently certify that the land may be safely used as intended, provided that the recommendations provided in this report are completed in subsequent stages of design.

6.0 RECOMMENDATIONS

The proposed tree removal works, earthworks and rock blasting will not significantly increase the risk of a major, deep-seated landslide on the property. However, they may increase rockfall hazard and cause areas of isolated slope instability. Rockfall hazard and the stability of cut slopes should be assessed and demonstrated to meet accepted risk tolerance criteria by a geotechnical engineer during detailed design of the subdivision. Further, a geotechnical engineer should be engaged to provide recommendations for permanent and temporary slope batters, potential blasting requirements, retaining walls, fill placement, compaction, and pavement recommendations.

We recommend ongoing use of the District of North Vancouver (2009) natural hazard risk tolerance criteria is adopted when demonstrating appropriate levels of slope stability for the final design.

Development of the site should also consider hazards associated with rockfall from excavation or existing sources during detailed design. Rockfall risk may be increased as a direct result of construction activities or naturally due to climatic or biological events that cause a change in forces acting on a rock including; changes in the groundwater regime, erosion during heavy rainstorms, freeze-thaw processes during winter, chemical degradation or weathering of the rock over time, root growth or leverage of roots moving in high winds. It should be noted that the proposed tree removal works may significantly increase the rockfall risk; proposed tree removal should be considered in the rockfall hazard assessment.

Once grades and rock cut depths have been finalized, we recommend that the rockfall risk is reviewed and that recommendations are provided with respect to rockfall mitigation as required during the detailed design phase of the subdivision.

7.0 SUMMARY

Frontera was engaged to complete a preliminary landslide hazard assessment for the proposed subdivision of 5600 Block, Daffodil Drive in West Vancouver.

The objective of the assessment was to review and characterize landslides within or beyond the proposed subdivision and comprised of a desktop review of available relevant information and a site reconnaissance. Details are provided in Sections three and four respectively.

Relevant notes from the site reconnaissance are provided on Drawing 1558-1 including the identification of an area of groundwater seepage, rock-outcropping and areas that may provide a potential rockfall hazard for the proposed development.

Frontera is of the opinion that there are no obvious signs of recent or historic landslide activity on, or in immediate areas beyond the property and estimates the likelihood of a landslide occurring and affecting the proposed subdivision is low and exceeds the DNV's acceptable risk tolerance criteria for new developments.

During detailed design of the subdivision, demonstration of appropriate levels of landslide and rockfall stability risk should be completed by professional engineers for the final layout and proposed grades.



8.0 CLOSURE

This report is prepared solely for use by our client and their design team for this project as described to the general standards of similar work for similar projects in this area and no other warranty of any kind is expressed or implied. Frontera Geotechnical Inc. accepts no responsibility for any other use of this report.

We are pleased to assist you with this project, and we trust this information is helpful and sufficient for your purposes at this time. Please do not hesitate to call the undersigned if you require clarification or additional details.

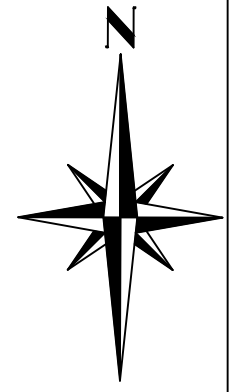
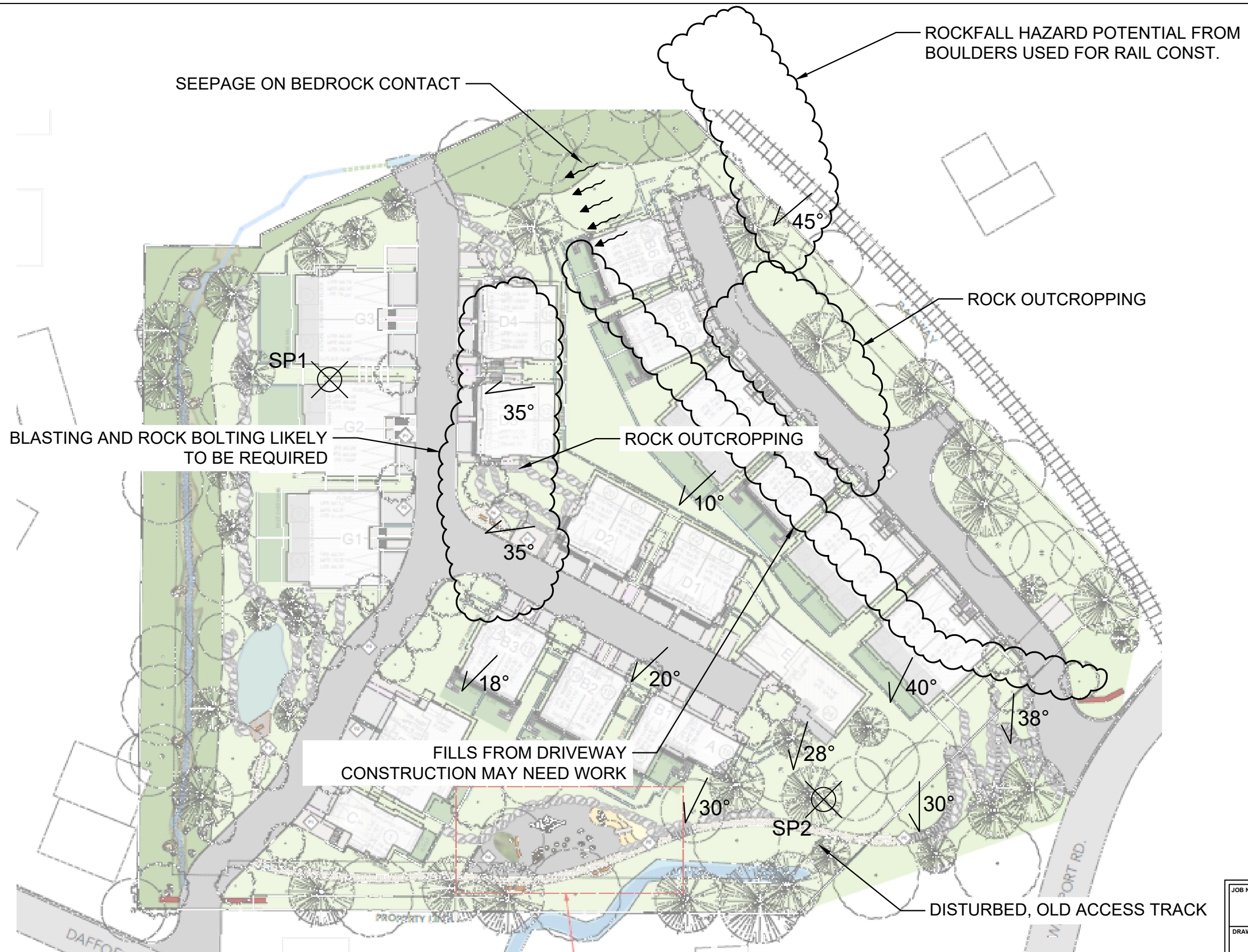
Yours truly,

Frontera Geotechnical Inc.

Reviewed by:

Ralph Burden, EIT
Geotechnical Engineer

Daniel Sims, P.Eng.
Geotechnical Engineer



**FRONTERA
GEOTECHNICAL INC.**
#1 - 38920 Queens Way
Squamish, BC V8B 0K8
604 898 1093

PROJECT: **PROPOSED SUBDIVISION
DAFFODIL LANE, WEST VANCOUVER, BC**

TITLE: **LANDSLIDE ASSESSMENT
PLAN VIEW**

REVISION NO.	DESCRIPTION	DATE
A	ISSUED FOR REVIEW	10/03/21
B	ISSUED FOR REVIEW	19/08/21

JOB NO: 1558	
DRAWING NO: 1558-1	
SCALE: NTS	DATE: MARCH 10, 2020
DRAWN BY: RB	DESIGNED BY: DS
CHECKED BY: SF	

APPENDIX A
Scala Penetration Logs



#1 - 38920 Queens Way
 Squamish BC
 Tel: (604) 898 1093

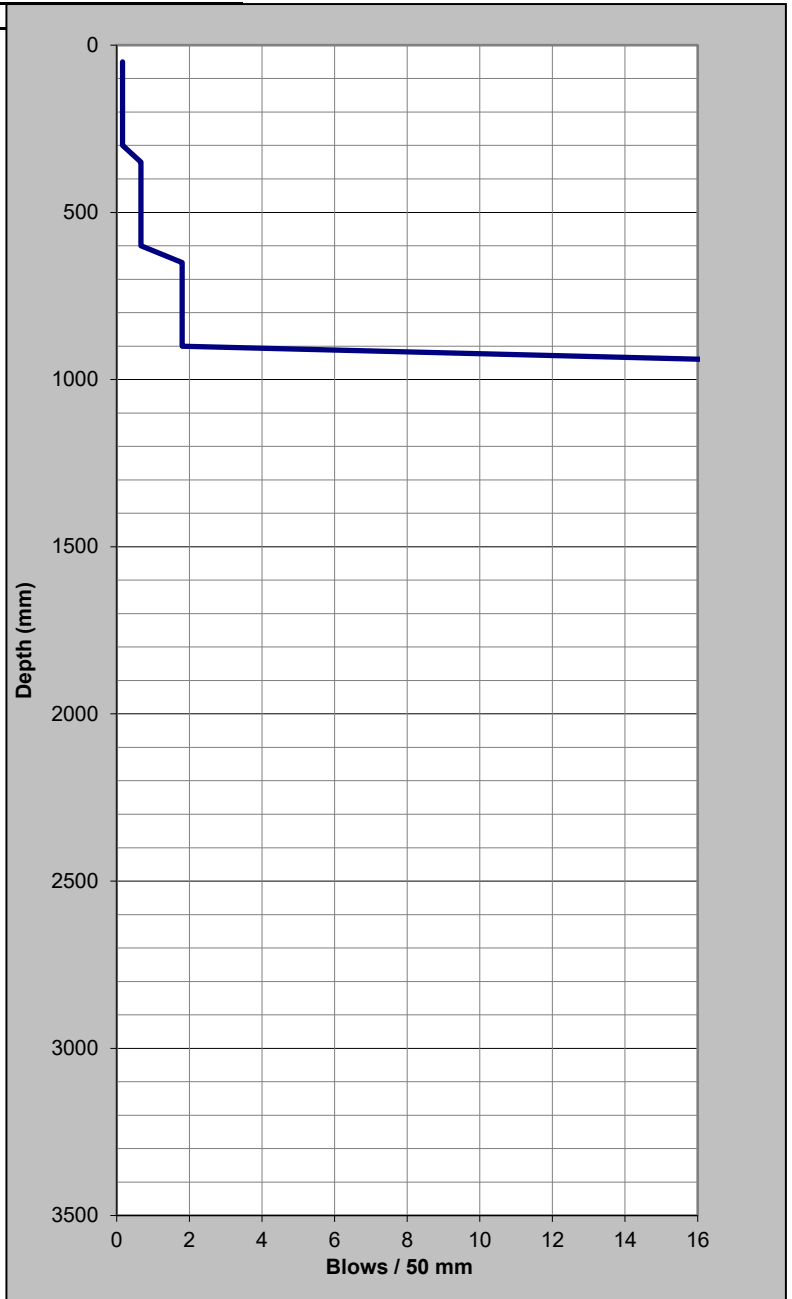
SCALA PENETROMETER LOG

Job No: **1558**
 Project: **Proposed subdivision 5600 Block**
 Location: **Daffodil Lane, West Vancouver, BC**
 Level: **Existing grade**

Date: **2021-02-24**
 Operated by: **DS**
 Logged by: **DS**
 Checked by:

Test No. **SP2**
 Sheet **1**
 of **1**

mm Driven	No. of Blows	mm Driven	No. of Blows
50	0.16	2550	
100	0.16	2600	
150	0.16	2650	
200	0.16	2700	
250	0.16	2750	
300	0.16	2800	
350	0.67	2850	
400	0.67	2900	
450	0.67	2950	
500	0.67	3000	
550	0.67	3050	
600	0.67	3100	
650	1.8	3150	
700	1.8	3200	
750	1.8	3250	
800	1.8	3300	
850	1.8	3350	
900	1.8	3400	
950	20	3450	
1000		3500	
1050		3550	
1100		3600	
1150		3650	
1200		3700	
1250		3750	
1300		3800	
1350		3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
1700		4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	





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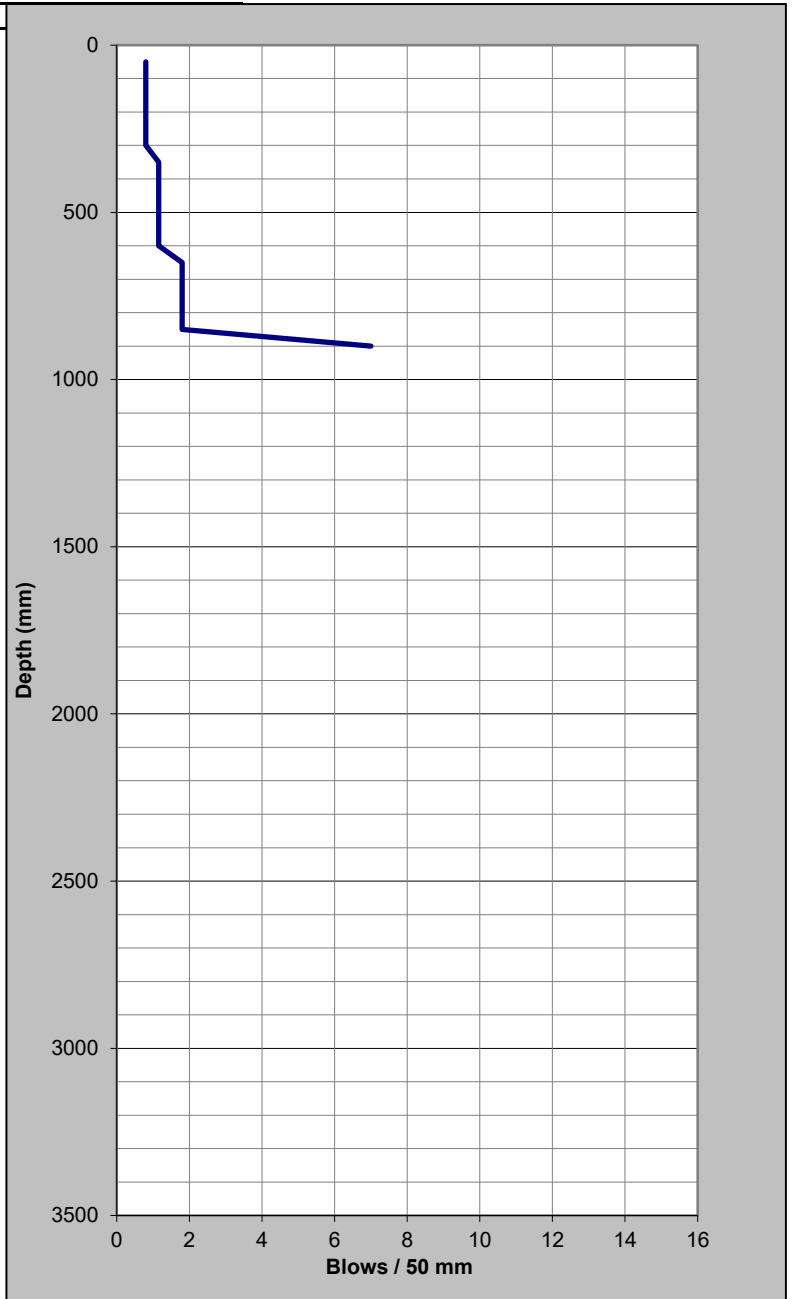
SCALA PENETROMETER LOG

Job No: **1558**
 Project: **Proposed subdivision 5600 Block**
 Location: **Daffodil Lane, West Vancouver, BC**
 Level: **Existing grade**

Date: **2021-02-24**
 Operated by: **DS**
 Logged by: **DS**
 Checked by:

Test No. **SP1**
 Sheet **1**
 of **1**

mm Driven	No. of Blows	mm Driven	No. of Blows
50	0.8	2550	
100	0.8	2600	
150	0.8	2650	
200	0.8	2700	
250	0.8	2750	
300	0.8	2800	
350	1.16	2850	
400	1.16	2900	
450	1.16	2950	
500	1.16	3000	
550	1.16	3050	
600	1.16	3100	
650	1.8	3150	
700	1.8	3200	
750	1.8	3250	
800	1.8	3300	
850	1.8	3350	
900	7	3400	
950		3450	
1000		3500	
1050		3550	
1100		3600	
1150		3650	
1200		3700	
1250		3750	
1300		3800	
1350		3850	
1400		3900	
1450		3950	
1500		4000	
1550		4050	
1600		4100	
1650		4150	
1700		4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	



APPENDIX B

Photos



Slope beneath the driveway off Westport Road, looking northwest



Pistol-butting of mature Cedar indicating shallow surface creep



Rock-outcropping upslope of proposed road from Daffodil



Rockfall hazard potential from BC Rail construction



Rock outcropping Lot 4.



Rock outcropping Lot 5, entrance from Westport Rd.