BRIARWOOD DRIVE, MILL BAY, BC

Geotechnical Report – Temporary Repair Condition

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25 February 2022

WSP File No.: 20M-01141-06

BC Ministry of Transportation and Infrastructure
240-4460 Chatterton Way
Victoria, BC
V8X 5J2

Attention: **Mr. Jeff Ray**

Subject: **Geotechnical Site Characterization of Road Failure at Briarwood Drive, Mill Bay, BC**

1. INTRODUCTION

WSP Canada Inc. (WSP) was engaged by the Ministry of Transportation and Infrastructure (MoTI, the Owner) to provide a geotechnical review of a road failure on Briarwood Drive, Mill Bay, BC (Figure 1 - site location plan shown in Appendix A). The failure was a result of heavy rainfall that occurred in November 2021 that washed out a section of Briarwood Drive located southeast of the intersection of Shawnigan Lake Mill Bay Rd and Briarwood Drive, where Hollings Creek flowed through culverts under the road. WSP's work is part of an emergency response and our geotechnical review is in support of providing recommendations for emergency repair to the area such that normal residential vehicle traffic can safely pass along the road. Recommendations for temporary repair were provided in WSP's report, "Briarwood Drive, Mill Bay, BC – Geotechnical Site Review Report", dated 13 December 2021. This document should be read in conjunction with our 13 December 2021 report.

Subsequent to the above, WSP learned that the MoTI would carry out WSP's recommended repairs in the summer of 2022, but in the meantime, they would design and carry out their own short term remedial work to reduce the erosion potential on the exposed soil banks.

In addition, WSP was tasked with carrying out a soil characterization drilling program to assist in refining the emergency repairs and to aid in the permanent solution design in the future. Future drilling is expected to prove bedrock as part of the permanent design solution that may consist of a bridge crossing.

2. SOIL CHARACTERIZATION

2.1 DRILLING PROGRAM

WSP coordinated and logged the ground conditions in a drilling program that was carried out by Drillwell Enterprises Ltd. at the Briarwood Road site on 21 December 2021. Prior to drilling, the area was cleared of services by a private

utility locator. The day of drilling, traffic control services were provided to safely direct traffic around the drilling equipment.

Two boreholes were advanced using solid stem augers with Standard Penetration Testing (SPT) conducted every 0.75m in the upper 3.0m, and every 1.5m below that to a depth of auger refusal. The site and borehole locations are shown on Figure 1.

Details of the encountered subsurface conditions are presented on the borehole logs in Appendix B. The following provides a general description of the ground conditions in summary of the logs.

NW BANK SLOPE (BH21-01)

- Sand and Gravel FILL (0 to 0.2m depth); over
- Silty SAND and GRAVEL (0.2 to 1.0m depth); over
- Stiff sandy CLAY that transitioned to very stiff SILT (1.0 to 6.0m depth); over
- Very dense to hard glacial TILL (6.0m to auger refusal at 7.2m).

WSP notes that the exposed loose sand that was observed in the NW bank slope in the 21 December 2021 report was further reviewed and was determined to be isolated and likely backfill that was part of the former culvert installation.

SE BANK SLOPE (BH21-02)

- Sand and Gravel FILL (0 to 0.7m depth); over
- Stiff silty clay FILL (0.7 to 1.5m depth); over
- Loose, transitioning to dense SAND and GRAVEL (1.5 to 3.0m depth); over
- Very dense to hard glacial TILL (3.0m to auger refusal at 5.7m).

A cross-section showing the borehole logs and the observed exposed soil conditions is shown on Figure 2. Note that the elevations shown on Figure 2 are relative only and are based on an assumed Temporary Benchmark (TMB) elevation of 100.00m. The TBM was a nail placed at the base of a Hydro pole located on the north side of the road, east of the temporary bridge crossing.

2.2 LABORATORY TESTING

Laboratory testing comprised of moisture content determination, Atterberg Limits, aggregate gradation analysis, and direct shear testing on representative samples. From a slope stability modelling point of view, it was determined that the soils from the NW slope were more critical to carry out direct shear testing as the observed relative density of these soils appeared to be lower as compared to the exposed dense glacial soils that were observed on the SE side.

The results of the laboratory testing are shown graphically in Appendix C and summarized in the tables below.

Table 1 - Results of Aggregate Gradation Analyses

BH #	Depth (m)	% Gravel	% Sand	% Fines*
BH21-01	1.3	39.4	25.2	35.4
BH21-01	2.8	2.5	33.7	63.8
BH21-02	2.0	28.8	40.5	30.7
BH21-02	4.0	28.2	47.0	24.8

* Includes silt and clay sized particles

Table 2 - Results of Atterberg Limits

BH#	Depth (m)	Plastic Limit	Liquid Limit	Moisture Content	Soil Type**
BH21-01	4.2	15	43	25.2	Sandy Lean Clay

** Unified Soil Classification System

Table 3 - Direct Shear Testing (Drained Condition)

BH21-01 sampled at 1.0m depth						
Normal Stress (kPa)	Peak Strength (kPa)	Avg. Mob Phi (deg)	Avg. Peak Cohesion (kPa)	Residual Strength (kPa)	Avg. Mob Phi Residual (deg)	Avg. Residual Cohesion (kPa)
50	74	35.7	37.4	54	45.9	5.0
100	108	35.7	37.4	100	45.9	5.0
150	146	35.7	37.4	151	45.9	5.0

Table 4 - Direct Shear Testing (Drained Condition)

BH21-01 sampled at 3.0m depth						
Normal Stress (kPa)	**Peak Strength (kPa)**	**Avg. Mob Phi (deg)**	**Avg. Peak Cohesion (kPa)**	**Residual Strength (kPa)**	**Avg. Mob Phi Residual (deg)**	**Avg. Residual Cohesion (kPa)**
50	98	24.2	78.4	49	33.0	17.4
100	129	24.2	78.4	84	33.0	17.4
150	143	24.2	78.4	114	33.0	17.4

2.3 VS30 ANALYSIS

Shear wave velocities (Vs30) of the soils in the vicinity of boreholes BH21-01 and BH21-02 at the northwest and southeast abutments were measured using WSP's Tromino Micro Tremor. The results are presented in Appendix D. The following tables provide a summary of the measurements.

Table 5 - Interpreted Shear Wave Velocities – Northwest Abutment

Layer (m)	**Thickness (m)**	**Shear Wave Velocity (m/s)**	**Poisson Ratio**	**Material**
0 to 0.7	0.7	110	0.45	Sand and gravel
0.7 to 6.0	5.3	235	0.42	Stiff silty clay
6.0 to 12.0	6.0	350	0.42	Glacial till
12 to Inf.	inf	520	0.42	To be determined

Table 6 - Interpreted Shear Wave Velocities – Southeast Abutment

Layer (m)	Thickness (m)	Shear Wave Velocity (m/s)	Poisson Ratio	Material
0 to 3.0	3.0	172	0.45	Sand and gravel
3.0 to 12.0	9.0	416	0.42	Glacial till
12.0 to 17.0	5.0	510	0.42	To be determined
17 to Inf.	inf	640	0.42	To be determined

3. TEMPORARY REPAIR

WSP understands that the MoTI did not want to attempt to carry out WSP's recommended temporary repair during the wet winter months. Instead, they would carry out their own temporary protection measure of the exposed soils on each abutment and carry out the more detailed temporary repair once water levels were lower during the drier summer months.

The MoTI's temporary protection measures consisted of placing armour stone on the failed slopes. A non-woven geotextile was to be placed between the armour stone and the exposed soils.

The temporary slope protection measures were carried out by Emcon Services Inc. between 10 January 2022 and 14 January 2022. WSP was on site periodically during that timeframe to observe the conditions and take measurements of the final configuration. In summary, a non-woven geotextile was placed over both exposed soil slopes and at the toe of the slopes. Larger rock armouring (up to 1.5m in diameter) was placed at the toe of the slopes up to about 0.5m below the crest. Smaller 0.3m diameter rock armouring was placed towards the crest. The overall face angle of the armoured slopes ranged from about 45° to 60° as measured from the horizontal. Field review reports taken at the time are included in Appendix E. A cross section of the repair is shown in Figure 3.

4. SLOPE STABILITY - UPDATED

WSP updated the stability analyses for the failed creek abutments in support of the temporary protection measures that were designed by MoTI and carried out by Emcon and the more detailed remediation to be carried out in the summer months.

WSP used the information obtained from the drilling program, laboratory analyses, and field observations and assigned representative parameters to the

soil. The slope stability was modelled using SlopeW[1] commercial software. As before for loading, WSP was given the bridge load to be 404.8kN distributed evenly over the two footings; assumed a large SUV as a standard vehicle (26kN); a loaded full size school bus (133kN), and a fully loaded fire truck (assumed 200 kN). Since this is to be a temporary condition, WSP modelled it for one vehicle at a time and static conditions (non seismic) only to achieve a minimum factor of safety of 1.5. These loads were applied unfactored and this analysis was performed as a working stress design method to achieve the minimum factor of safety.

WSP's slope review is summarized in the following Table 7. Note that the factors of safety (FS) are applicable to the area between the crest of the slope and the nearest bridge abutment.

Table 7 - Results of Updated Stability Analysis

Condition	Applied Load (kN)	FS (NW)	FS (SE)
Initial Condition – bridge load only	202	1.4*	1.6*
Initial Condition – bridge and fire truck load	402	1.1*	1.2*
Temporary armouring of slope – bridge load only	202	2.7**	2.0**
Temporary armouring of slope – bridge and car load only	232	2.6**	2.0**
Temporary armouring of slope – bridge and bus load only	335	2.3**	1.8**
Temporary armouring of slope – bridge and fire truck load only	402	2.0**	1.7**
Proposed remediated slope – bridge load only	202	2.6	2.0
Proposed remediated slope – bridge and car load only	232	2.5	1.9
Proposed remediated slope – bridge and bus load only	335	2.2	1.7
Proposed remediated slope – bridge and fire truck load only	402	1.8	1.6

[1] GeoStudio 2018 R2

* this factor of safety is not representative of the near surface soil on the slope that will have a factor of safety close to 1.0 representing a failed condition.

** this factor of safety is not representative of the rock armouring that has a slope face between 45˚ and 60˚. A stable rock armouring will have a slope angle of about 33˚ or flatter.

5. COMMENTS AND RECOMMENDATIONS

5.1 TEMPORARY CONDITION

The existing condition (temporary armouring of slope) has improved the local stability of the scarped soil face on both abutments as well as provides soil protection from surface erosion. The drilling and laboratory testing program has demonstrated that the near surface soils (sands and gravels) are in a compact state, while the underlying silty clay and glacial till soils are in a stiff to very stiff, and very dense condition, respectively. The results allowed for a better understanding of the soil conditions and indicate an improved overall static slope stability of each abutment slope as compared to our previous analysis where inferred soil parameters were used.

As noted in Table 7, the stability analysis for the existing condition demonstrates that the static factor of safety is acceptable for the current temporary bridge supports. As such, WSP no longer requires setting back queueing traffic 10m from the bridge foundations through enforcement by signage. However, the current loading limit (20 tonnes (44,000lbs)) limits should remain in place.

In addition, the riprap facing that has been temporarily placed is over-steepened and locally the factor of safety of this riprap slope is less than 1.5. To restabilize the slopes in a temporary condition that meets the minimum factors of safety for the riprap facing, the riprap would need to have a slope not steeper than 1.5H:1V and be keyed into the toe of the slope. In addition, it is important that the sloughed soils be removed, and a non-woven geotextile placed under the riprap and be in close contact with the underlying fill and natural soil. To achieve this, the soil slope cuts should be in a smooth and even condition before placing the non-woven geotextile. WSP's recommended revised temporary condition is presented in Figure 4. As noted, we understand that this revised temporary condition be implemented this summer when creek water levels are low. WPS should be present to review the conditions before and during placement of geotextile and rock armouring for the revised condition.

WSP understands that the temporary bridge could be in place for a year or more until a permanent bridge is put in place. Potentially, some or all the proposed slope armouring could be used in the permanent solution as well.

WSP's Hydrotechnical Group will need to review this configuration to determine if it meets their design intent. They will also need to determine the lateral extent the armoring is to extend upstream and downstream of the bridge and how it

ties into the existing terrain. Once the flood modelling is complete the design flood hydrograph should be provided to WSP Geotechnical Group to review the flood condition and potential rapid drawdown scenario which may affect the factor of safety and should be reviewed before this design is finalised.

5.2 PERMANENT SOLUTION

This report is not intended for the permanent solution. However, the information that was gathered in preparation of this report could be used in part to support the permanent solution. Based on the information obtained, consideration could be given to potentially designing a permanent shallow foundation system for the proposed road crossing at Hollings Creek. Our limited geotechnical drilling program along with the Tromino micro tremor Vs30 review of the area indicated that stiff soils (Vs 235m/s) were encountered at a depth of about 1.0m, followed by dense glaciated soils (Vs 350m/s) at a depth at about 6m on the northwest side. On the southeast side, dense glacial till (Vs 416m/s) was encountered at a depth of about 3m.

Follow up geotechnical work for a shallow or deep foundation design would need to reference the MoTI Supplement to CHBDC S6-14 and would likely require additional follow up drilling to confirm groundwater table, and test for end bearing conditions for deep foundations, and potentially determination of settlements for shallow foundations. The current assessment results appear favourable from a seismic stability perspective, but this would need to be studied in more detail.

6. FUTURE GEOTECHNICAL WORK

Future geotechnical work for this project is expected to comprise:

- Field reviews during construction of the modified temporary slope condition;
- Additional geotechnical drilling, analyses, and reporting to support the permanent solution; and
- Discussions with the design team and client representatives on this document and future works.

7. CLOSING

This report was prepared in accordance with our services agreement with the Ministry of Transportation and Infrastructure. All other users of this report are subject to the same contract terms. If you have any questions or concerns, please contact the signatories at your convenience.

Yours Sincerely,

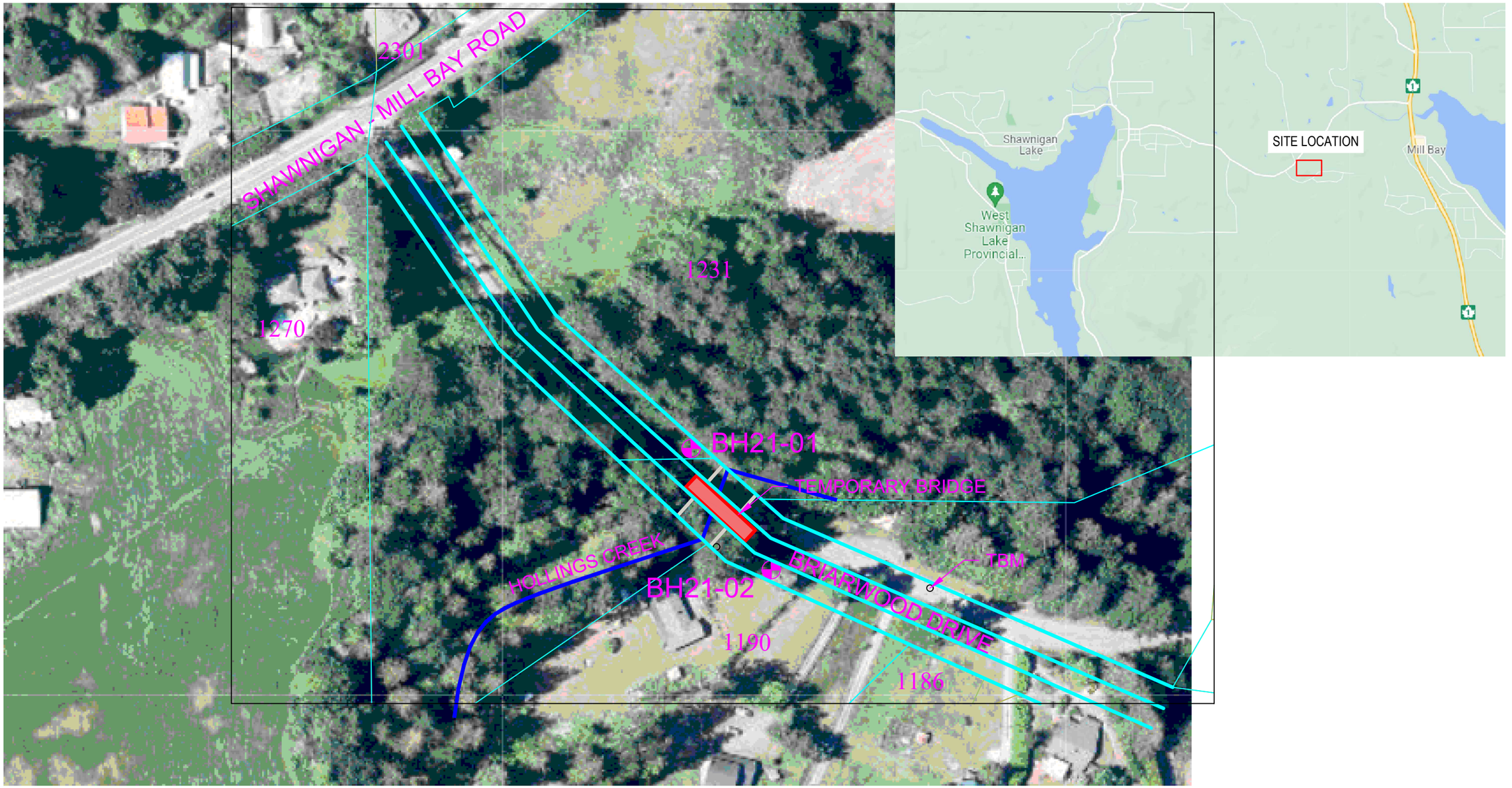
WSP Canada Inc.

Prepared by:	Reviewed by:
Don Kaluza, P. Eng. Senior Geotechnical Engineer	Russell Scott, M.Sc., P. Eng. Senior Geotechnical Engineer

Attachments: Appendix A Figures
Appendix B – Soil Logs
Appendix C – Lab Testing
Appendix D – Vs30 Analysis
Appendix E – Field Reviews
Appendix F – Stability Review
Appendix G – Standard Limitations

APPENDIX

A FIGURES



BASE MAP OBTAINED FROM IMAP BC ON 2021-12-02 VIA https://maps.gov.bc.ca/ess/hm/imap4m/

REVISION:

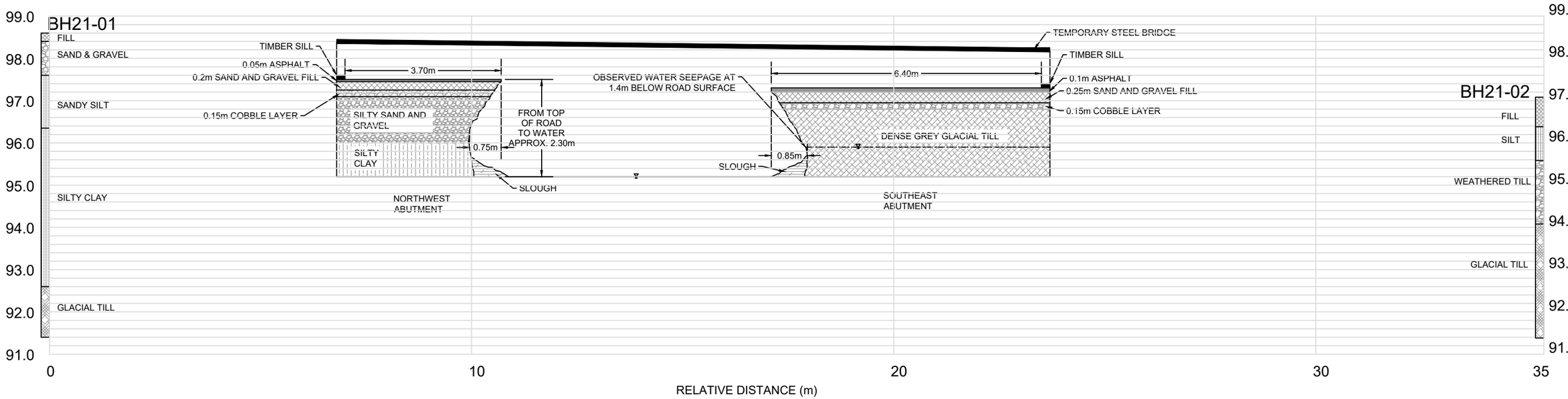
REV	DATE	DESCRIPTION	BY
0A	2021-12-02	ISSUED FOR REVIEW	DK

760 Enterprise Crescent, Victoria, BC, V8Z 6R4
T 250-475-1000 | www.wsp.com

PROJECT NO: 211-13329-00

SCALE: NTS
DATE: 2021-12-02
DESIGNED BY: DK
DRAWN BY: LL
CHECKED BY: SD

PROJECT: BRIARWOOD DRIVE
CLIENT: MINISTRY OF TRANSPORTATION AND INFRASTRUCURE
TITLE: SITE LOCATION PLAN
DRAWING: 01



REVISION:

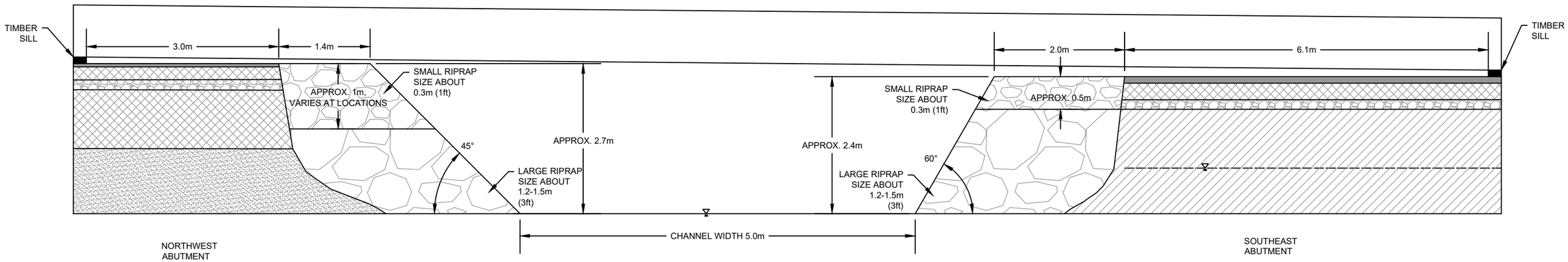
REV	DATE	DESCRIPTION	BY
0A	2021-12-02	ISSUED FOR REVIEW	DK

760 Enterprise Crescent, Victoria, BC, V8Z 6R4
T 250-475-1000 | www.wsp.com

PROJECT NO: 211-13329-00

SCALE: NTS
DATE: 2021-12-02
DESIGNED BY: DK
DRAWN BY: LL
CHECKED BY: SD

PROJECT: BRIARWOOD DRIVE
CLIENT: MINISTRY OF TRANSPORTATION AND INFRASTRUCURE
TITLE: FAILED SLOPE CONDITIONS
DRAWING: 02



REVISION:

REV	DATE	DESCRIPTION	BY

760 Enterprise Crescent, Victoria, BC, V8Z 6R4
T 250-475-1000 | www.wsp.com

PROJECT NO: 211-13329-00

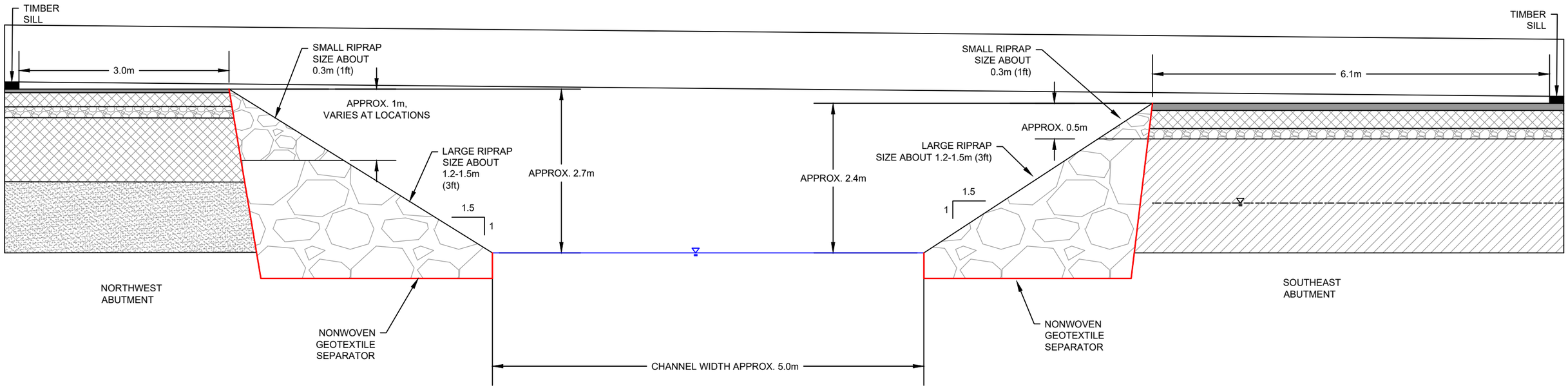
SCALE:	NTS
DATE:	2022-01-14
DESIGNED BY:	DK
DRAWN BY:	LL
CHECKED BY:	??

PROJECT: BRIARWOOD DRIVE

CLIENT: MINISTRY OF TRANSPORTATION AND INFRASTRUCURE

TITLE: RIPRAP ARMORED SLOPE

DRAWING: 03



REVISION:

REV	DATE	DESCRIPTION	BY
0A	2021-12-10	ISSUED FOR REVIEW	DK

760 Enterprise Crescent, Victoria, BC, V8Z 6R4
T 250-475-1000 | www.wsp.com

PROJECT NO: 211-13329-00

SCALE: NTS
DATE: 2021-12-02
DESIGNED BY: DK
DRAWN BY: AB / LL
CHECKED BY: SD

PROJECT: BRIARWOOD DRIVE
CLIENT: MINISTRY OF TRANSPORTATION AND INFRASTRUCURE
TITLE: REMEDIATED SLOPE
DRAWING: 04

APPENDIX

B SOIL LOGS

SUMMARY LOG

Ministry of Transportation and Infrastructure — British Columbia

Drill Hole #: BH21-01

Project: **Briarwood Drive - Temporary Repair**

Location: Shawnigan Lake, BC

Prepared by: 20M-01141-06 WSP Canada Inc

Logged by: AB Reviewed by:

Datum: Geodetic

Northing/Easting: 46.6464 , -123.587

Elevation:

Alignment:

Station/Offset:

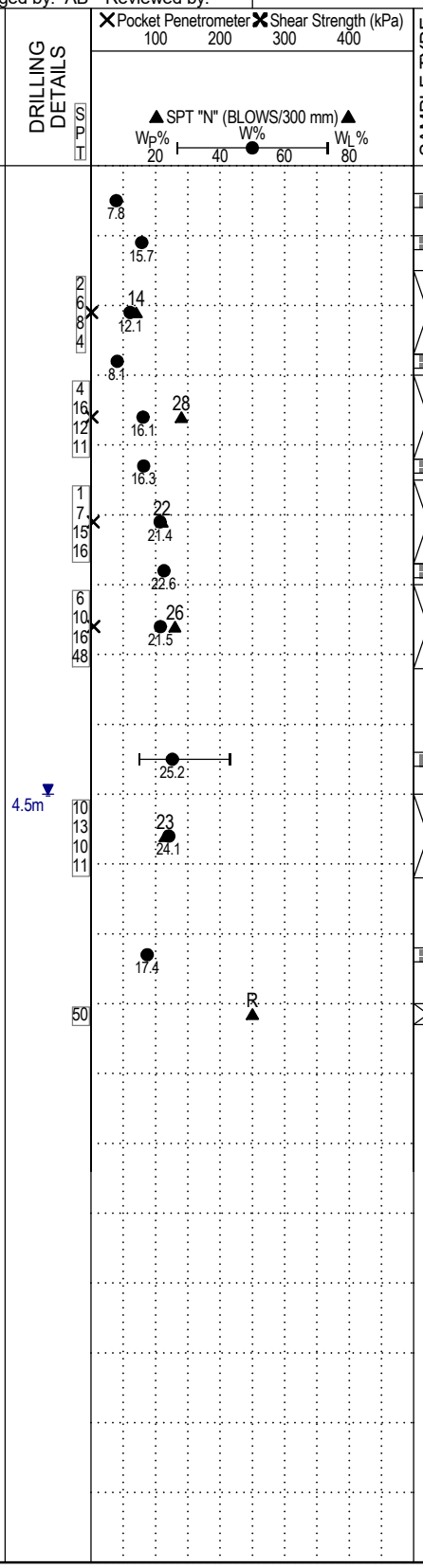
Date(s) Drilled: 2021-12-21

Company: Drillwell Enterprises

Driller:

Drill Make/Model:

Drilling Method: Solid Stem Auger



SOIL DESCRIPTION

		CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*
Brown Sand and Gravel FILL, non plastic, moist, trace silt and rootlets. Gravel is subrounded to rounded	0.2m		*{G:15 S:80 F:5}*
Brown silty SAND AND GRAVEL, medium plasticity, moist			*{G:10 S:40 F:50}*
Light brown stiff silty CLAY, some sand, trace gravel, low plasticity, moist. Gravel is subrounded to subangular	1.0m		*{G:10 S:40 F:50}*
... becoming increasingly silty			*{G:10 S:40 F:50}* *{G:5 S:15 F:80}*
Stiff to very stiff light brownish grey silty CLAY, tace sand, moist	2.25m		*{G:5 S:15 F:80}* *{G:0 S:10 F:90}*
... becoming grey			*{G:0 S:10 F:90}* *{G:0 S:5 F:95}*
			Atterberg (Sa#GS6): PL:15% LL:43% *{G:0 S:5 F:95}*
			{G:0 S:5 F:95} *{G:0 S:5 F:95}*
Grey Sand and Gravel TILL, trace cobbles, moist	6.0m		*{G:0 S:5 F:95}*
Borehole terminated on assumed bedrock at 7.2m Borehole terminated on refusal in assumed dense glacial till / bedrock	7.2m		

Legend

Sample Type: A-Auger; B-Becker; C-Core; G-Grab; V-Vane; L#-Lab Sample; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube

Final Depth of Hole: 7.2 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **BH21-02**

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Briarwood Drive - Temporary Repair**

Location: Shawnigan Lake, BC

Prepared by: 20M-01141-06
WSP Canada Inc

Logged by: AB Reviewed by:

Datum: Geodetic

Northing/Easting: 46.6466 , -123.588

Elevation:

Alignment:

Station/Offset:

Date(s) Drilled: 2021-12-21

Company: Drillwell Enterprises

Driller:

Drill Make/Model:

Drilling Method: Solid Stem Auger

DEPTH (m)	DRILLING DETAILS	SPT "N" (BLOWS/300 mm) Wp% W% WL%	Pocket Penetrometer / Shear Strength (kPa)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	DEPTH (m)
0								Brown silty Sand and Gravel FILL, trace silt, non plastic, moist ... trace organics in upper 0.3m			0
					GS1					{G:20 S:75 F:5}	
								0.7m			
1	3 6 5 3	11			SPT1	75		Brownish grey FILL, trace gravel, trace sand, moist		{G:10 S:10 F:80}	1
					GS2					{G:10 S:10 F:80}	
								1.5m			
	4 3 2 8	5			SPT2	25		Brown silty SAND AND GRAVEL, low plasticity, trace cobbles, moist		{G:30 S:45 F:25}	
2		15.9			GS3					{G:30 S:45 F:25}	2
	2 5 29 50	11.3			SPT3	67				{G:30 S:45 F:25}	
					GS4					{G:30 S:45 F:25}	
3	33 50	7.6	R		SPT4	0		Grey Sand and Gravel TILL, trace silt, trace cobbles, moist		{G:45 S:45 F:10}	3
								3.0m			
4		9.9			GS5					{G:45 S:45 F:10}	4
5											5
		8.9			GS6					{G:45 S:45 F:10}	
								5.7m			
6								Borehole terminated on refusal in assumed dense glacial till / bedrock			6
7											7
8											8
9											9
10											

1.8m ▼

Legend

Sample Type:

A-Auger; B-Becker; C-Core; G-Grab; V-Vane; L#-Lab Sample; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube

Final Depth of Hole: 5.7 m

Depth to Top of Rock:

MOTI-SOIL-REV3 BRIARWOOD DRIVE SOIL LOGS 2021-12-22.GPJ MOTI_DATATEMPLATE_REV3.GDT 2-24-22

APPENDIX

C LAB TESTING

WSP Canada Inc.
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WSP.com

Atterberg Limits

CLIENT: **Ministry of Transportation & Infrastructure**

PROJECT: **Briarwood Drive**

FILE: **20M-01141-06**
DATE: **January 12, 2022**
REPORT NO.: **1**
SAMPLE #: **GS6**

Plasticity Index 27.99
Liquidity Index 0.36

Class: CI

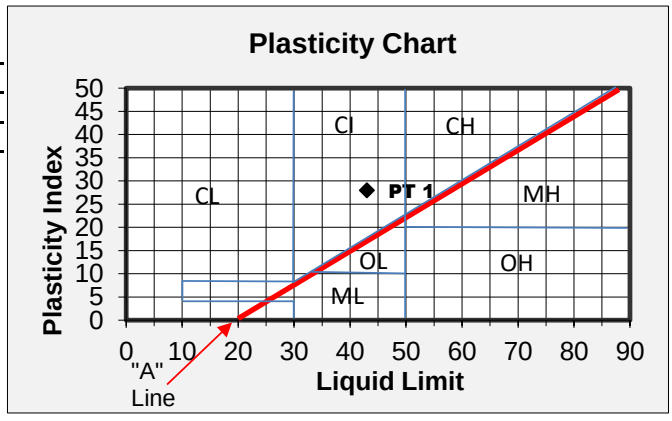
TP/BH: 21-Jan
Grab Number: 6
Sample Depth: 4.2m

Natural MC: 25.2

Plastic Limit				Liquid Limit				
Trial	1	2	3	**Trial**	1	2	3	4
Wt of Wet + T	110.64	97.56	97.3	Number of Blows	32	26	24	17
Wt of Dry + T	110.27	97.33	97.13	Wt of Wet + T	10.54	11.32	10.84	103.39
Wt of Tare	107.81	95.52	96.07	Wt of Dry + T	8.65	9.11	8.85	101.1
Mass of Water	0.37	0.23	0.17	Wt of Tare	4.11	4.07	4.1	96.16
Mass of Dry Soil	2.46	1.81	1.06	Mass of Water	1.89	2.21	1.99	2.29
Moisture Content	15.04	12.71	16.04	Mass of Dry Soil	4.54	5.04	4.75	4.94
Average	15.04			Moisture Content	41.63	43.85	41.89	46.36
Material Passing 425µm:				Corrected Limit	43.03	44.09	41.69	44.15
Material Retained 425µm:				Average	43.03			

Sample Description: Lean Clay
Grey intermediate plastic
Comments:

Legend
ML = Silt
CL = Lean Clay
OL = Organic Clay
CI = CL or OL
CH = Fat Clay
MH = Elastic Silt
OH = Organic Clay



WSP Canada Inc.
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Phone +1 250-475-1000
WSP.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Ministry of Transportation & Infrastrucutre
Project: Briarwood Drive
Sample Location: BH21-01 @ 1.3m

File No.: 20M-01141-06
Report No.: 1
Date: 13-Jan-22

SAMPLING INFORMATION:

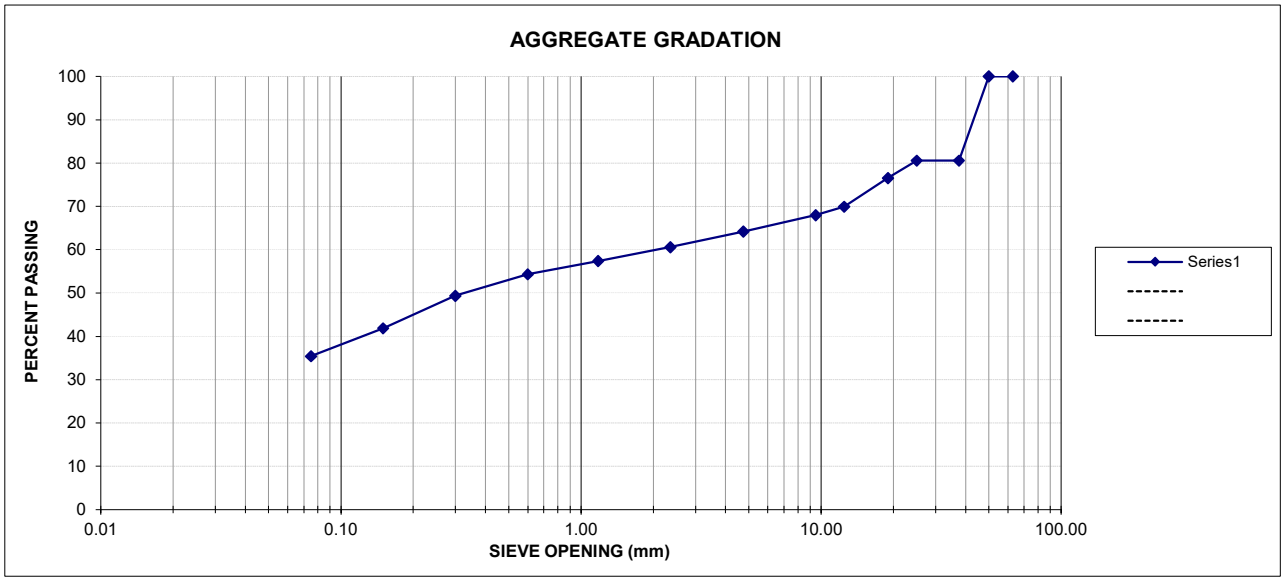
Material: Silty brown sand with some gravel
Specification: N/A

Date Sampled 21-Dec-21
Date Tested 05-Jan-22
Sample No: 1
Fracture by mass n/a
Supplier: N/A
Sampled by: AB
Tested by: BK

Sieve Analysis

Sieve	% Passing
75.0	
63.0	100.0
50.0	100.0
37.5	80.5
25.0	80.5
19.0	76.6
12.5	70.0
9.5	68.0
4.75	64.2
2.36	60.6
1.18	57.4
0.600	54.3
0.300	49.4
0.150	41.9
0.075	35.4

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per: _____

WSP Canada Inc.
760 Enterprise Crescent
Victoria, BC V8Z 6R4
Phone +1 250-475-1000
WSP.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Ministry of Transportation & Infrastrucutre
Project: Briarwood Drive
Sample Location: BH21-01 @ 2.8m

File No.: 20M-01141-06
Report No.: 2
Date: 13-Jan-22

SAMPLING INFORMATION:

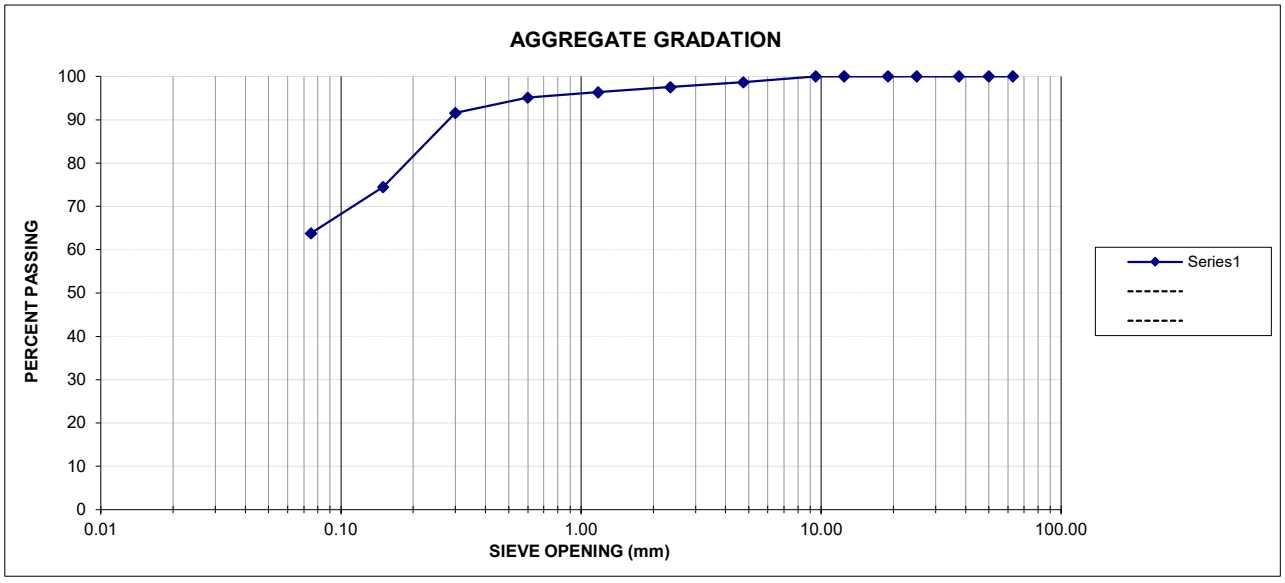
Material: Silt, some sand, trace gravel
Specification: N/A

Date Sampled 21-Dec-21
Date Tested 05-Jan-22
Sample No: 1
Fracture by mass n/a
Supplier: N/A
Sampled by: AB
Tested by: BK

Sieve Analysis

Sieve	% Passing
75.0	
63.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	100.0
12.5	100.0
9.5	100.0
4.75	98.7
2.36	97.5
1.18	96.4
0.600	95.1
0.300	91.6
0.150	74.5
0.075	63.8

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per: _____

WSP Canada Inc.
760 Enterprise Crescent
Victoria, BC V8Z 6R4
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WSP.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Ministry of Transportation & Infrastrucutre
Project: Briarwood Drive
Sample Location: BH21-02 @ 2.0m

File No.: 20M-01141-06
Report No.: 3
Date: 14-Jan-22

SAMPLING INFORMATION:

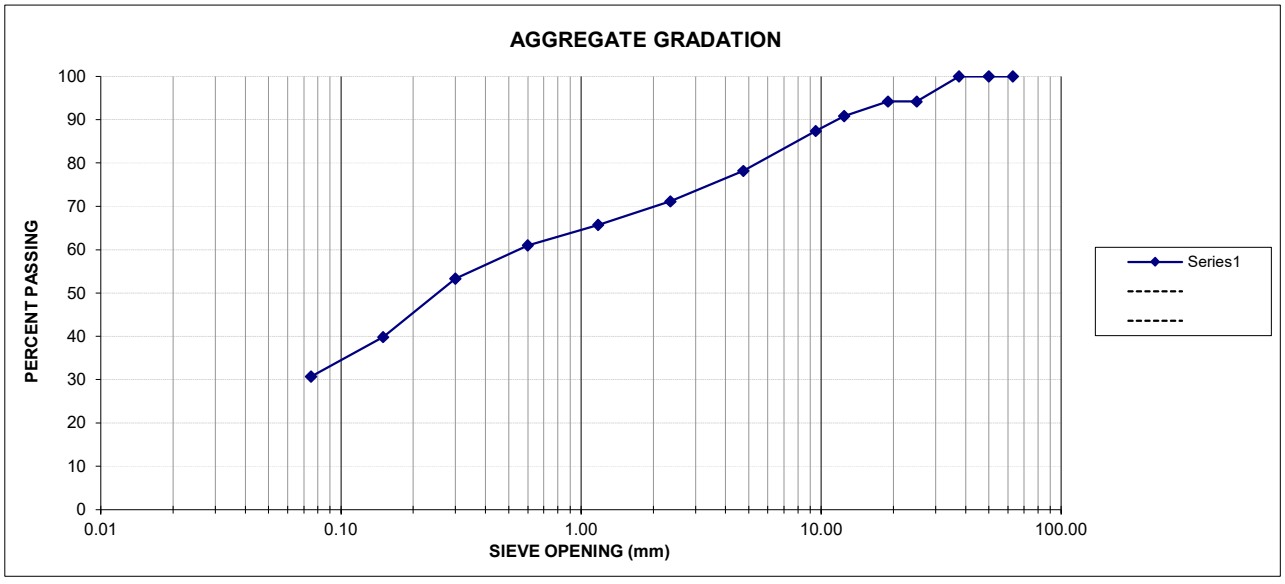
Material: Sand, gravelly, clayey, brown.
Specification: N/A

Date Sampled	21-Dec-21
Date Tested	13-Jan-22
Sample No:	3
Fracture by mass	n/a
Supplier:	N/A
Sampled by:	AB
Tested by:	BK

Sieve Analysis

Sieve	% Passing
75.0	
63.0	100.0
50.0	100.0
37.5	100.0
25.0	94.2
19.0	94.2
12.5	90.9
9.5	87.4
4.75	78.2
2.36	71.2
1.18	65.7
0.600	61.0
0.300	53.3
0.150	39.8
0.075	30.7

AGGREGATE GRADATION:



REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

WSP CANADA INC.

per:

WSP Canada Inc.
760 Enterprise Crescent
Victoria, BC V8Z 6R4
Phone +1 250-475-1000
WSP.com

AGGREGATE GRADATION CHART

IDENTIFICATION:

Client: Ministry of Transportation & Infrastrucutre
Project: Briarwood Drive
Sample Location: BH21-02 @ 4.0m

File No.: 20M-01141-06
Report No.: 4
Date: 14-Jan-22

SAMPLING INFORMATION:

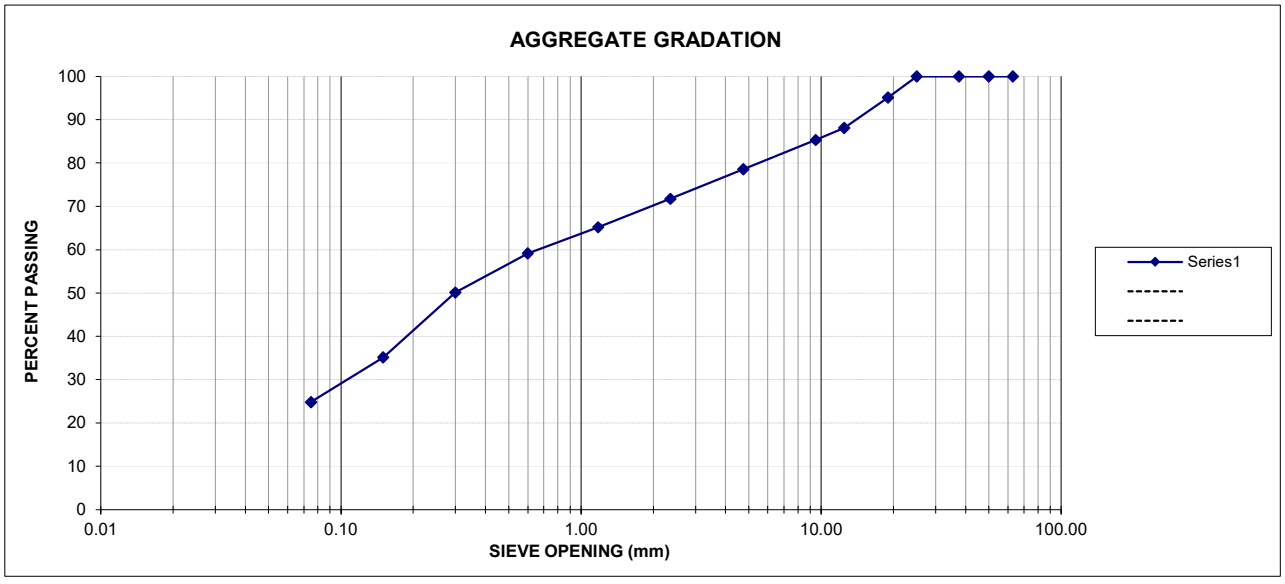
Material: Sand, gravelly, clayey, trace organics, grey.
Specification: N/A

Date Sampled	21-Dec-21
Date Tested	13-Jan-22
Sample No:	4
Fracture by mass	n/a
Supplier:	N/A
Sampled by:	AB
Tested by:	BK

Sieve Analysis

Sieve	% Passing
75.0	
63.0	100.0
50.0	100.0
37.5	100.0
25.0	100.0
19.0	95.1
12.5	88.2
9.5	85.4
4.75	78.6
2.36	71.8
1.18	65.2
0.600	59.1
0.300	50.1
0.150	35.2
0.075	24.8

AGGREGATE GRADATION:



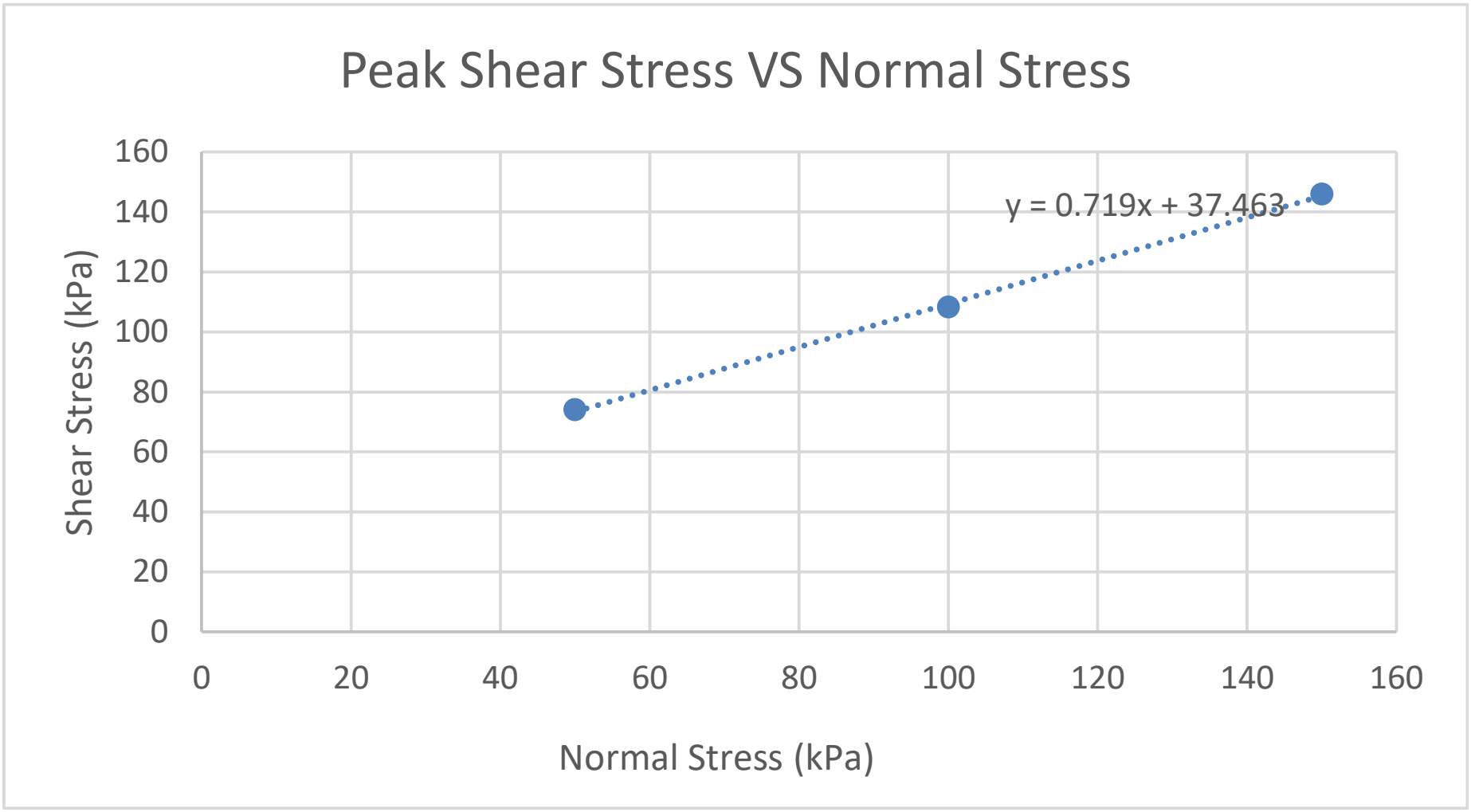
REMARKS: Tested according to ASTM C-: 136 and C-117

REPORTS TO:

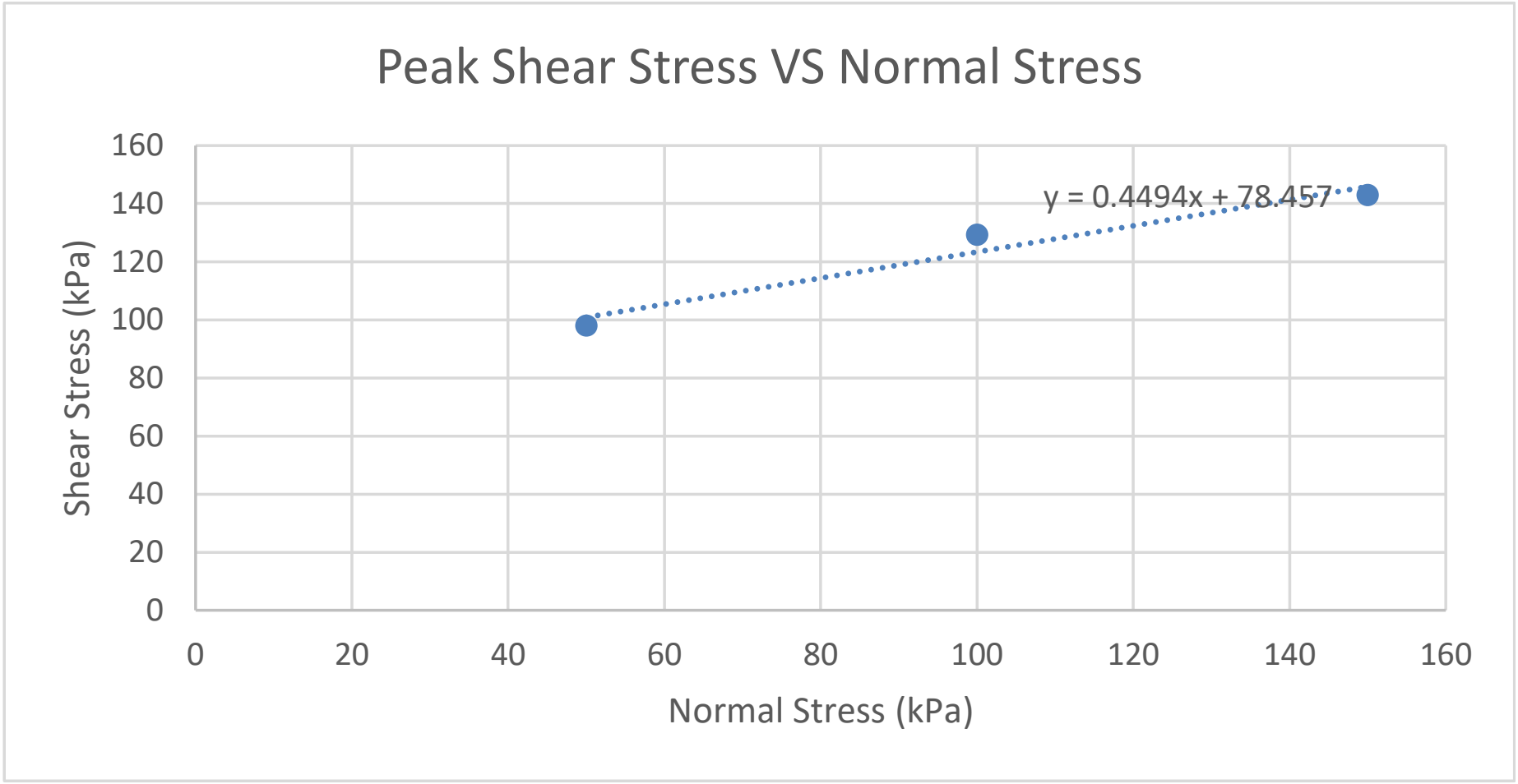
WSP CANADA INC.

per:

BH21-01
Sample from 1.0m depth



BH21-01
Sample Depth 3.0m



APPENDIX

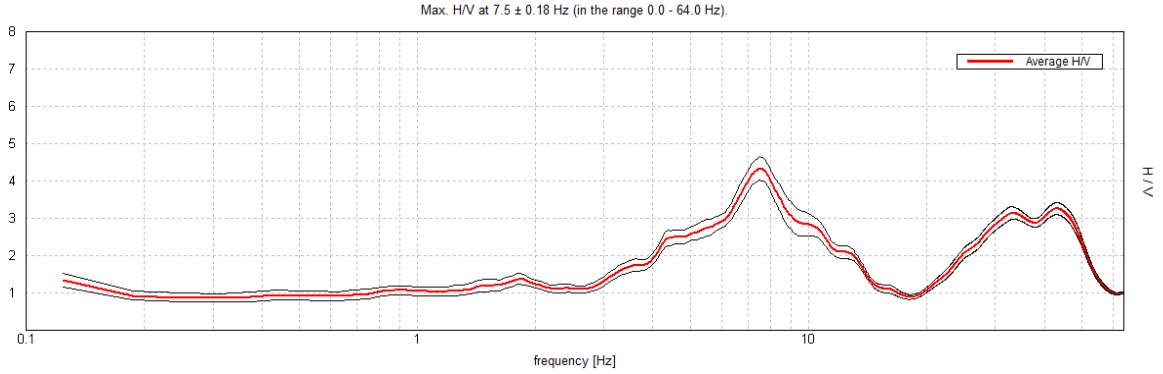
D V_S30 ANALYSIS

BRIARWOOD DR, NW ABUTMENT

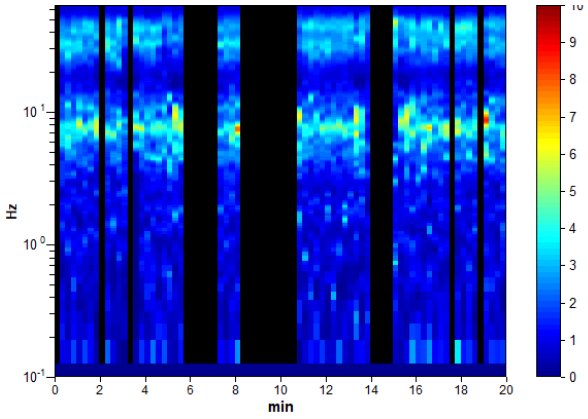
Instrument: TEB-0626/01-21
Data format: 16 bit
Full scale [mV]: 179
Start recording: 21/12/2021 12:13:15 End recording: 21/12/2021 12:33:15
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h20'00". Analyzed 69% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 15 s
Smoothing type: Triangular window
Smoothing: 10%

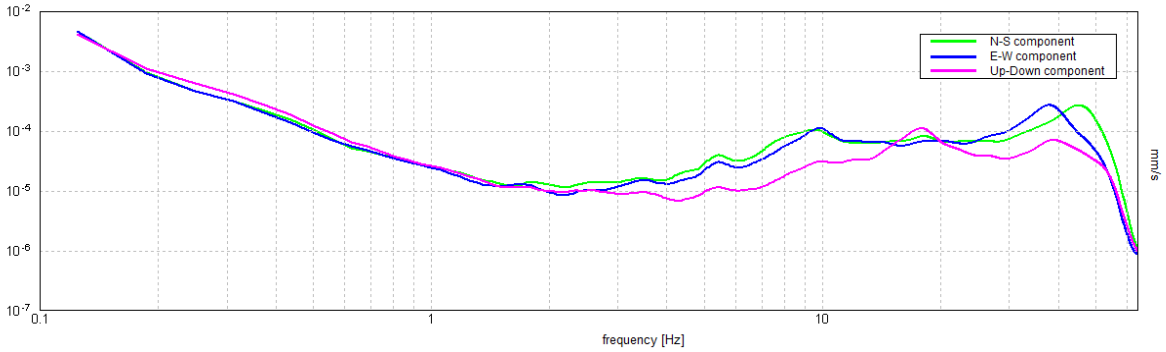
HORIZONTAL TO VERTICAL SPECTRAL RATIO



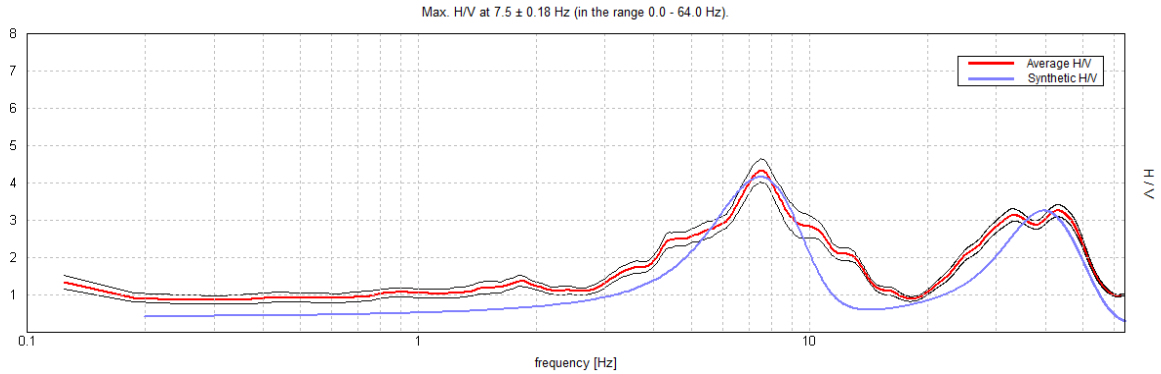
H/V TIME HISTORY



SINGLE COMPONENT SPECTRA

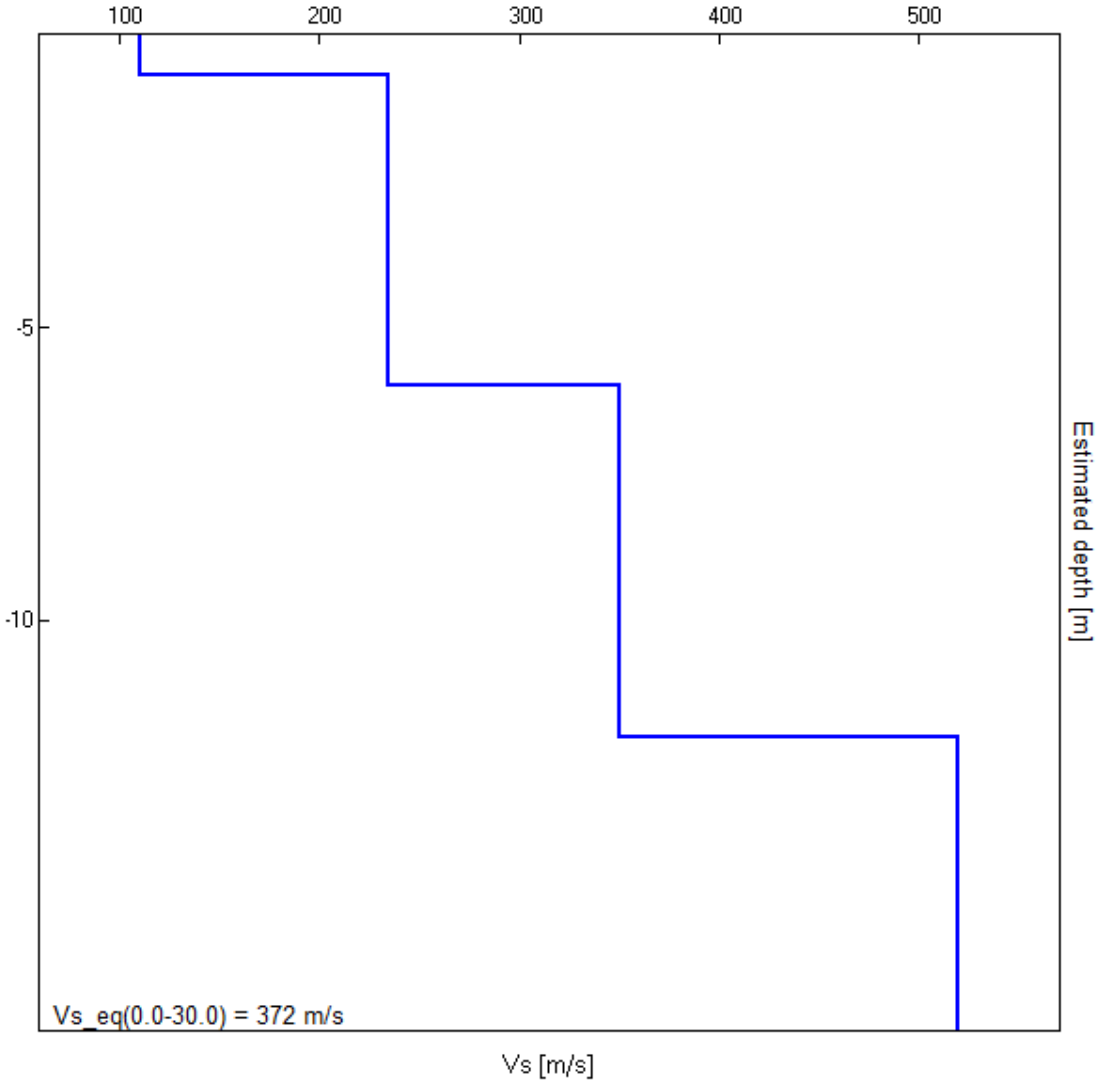


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
0.70	0.70	110	0.45
6.00	5.30	235	0.42
12.00	6.00	350	0.42
inf.	inf.	520	0.42

Vs_eq(0.0-30.0) = 372 m/s


100
200
300
400
500
-5
-10
Estimated depth [m]
Vs_eq(0.0-30.0) = 372 m/s
Vs [m/s]

[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 7.5 ± 0.18 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	7.50 > 0.67	OK	
$n_c(f_0) > 200$	6187.5 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz **$\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz**	Exceeded 0 out of 181 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	4.125 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	11.688 Hz	OK	
$A_0 > 2$	4.33 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.02415| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.18114 < 0.375	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.3151 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

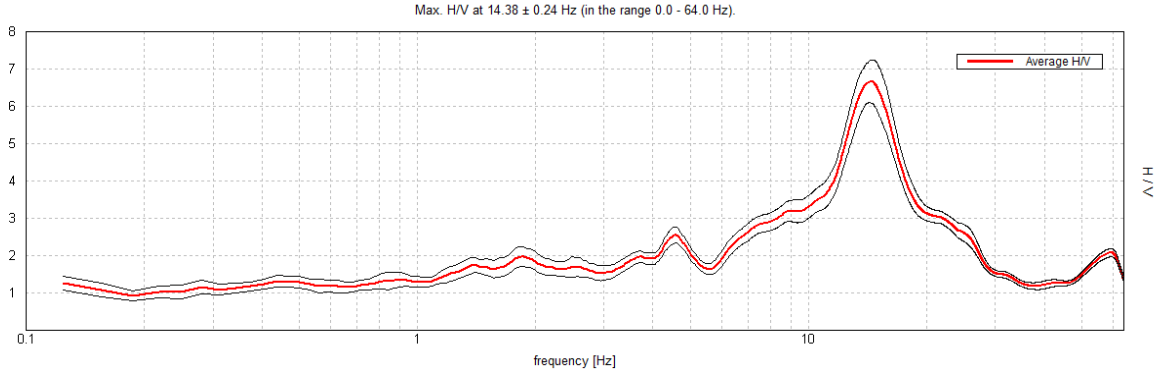
Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

BRIARWOOD DR, SE ABUTMENT

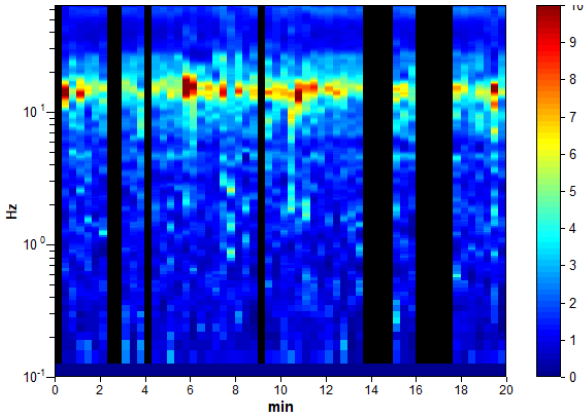
Instrument: TEB-0626/01-21
Data format: 16 bit
Full scale [mV]: 179
Start recording: 21/12/2021 11:11:19 End recording: 21/12/2021 11:31:19
Channel labels: NORTH SOUTH; EAST WEST ; UP DOWN
GPS data not available

Trace length: 0h20'00". Analyzed 77% trace (manual window selection)
Sampling rate: 128 Hz
Window size: 20 s
Smoothing type: Triangular window
Smoothing: 10%

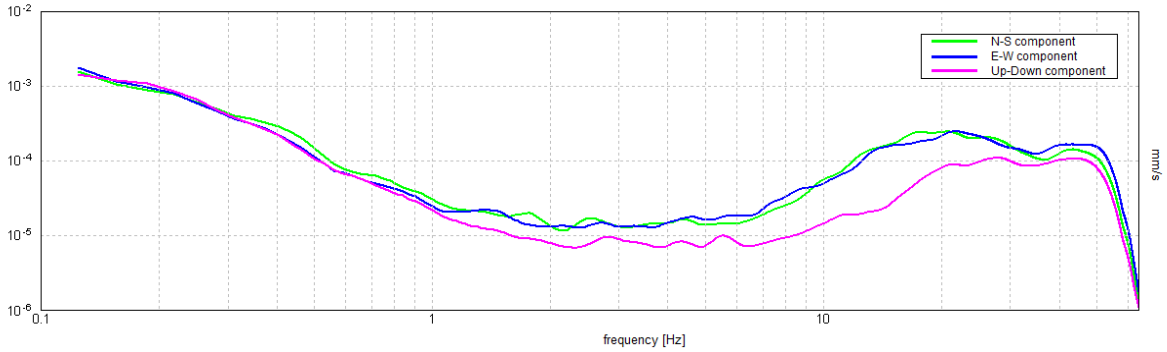
HORIZONTAL TO VERTICAL SPECTRAL RATIO



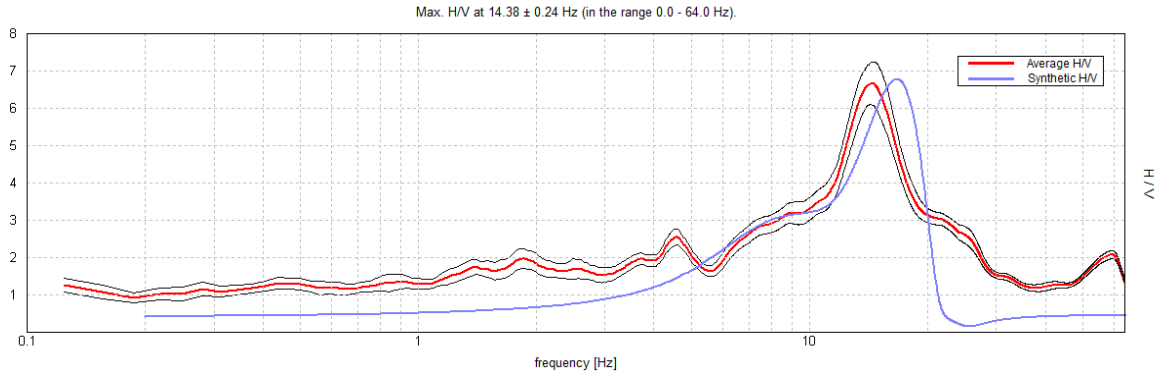
H/V TIME HISTORY



SINGLE COMPONENT SPECTRA

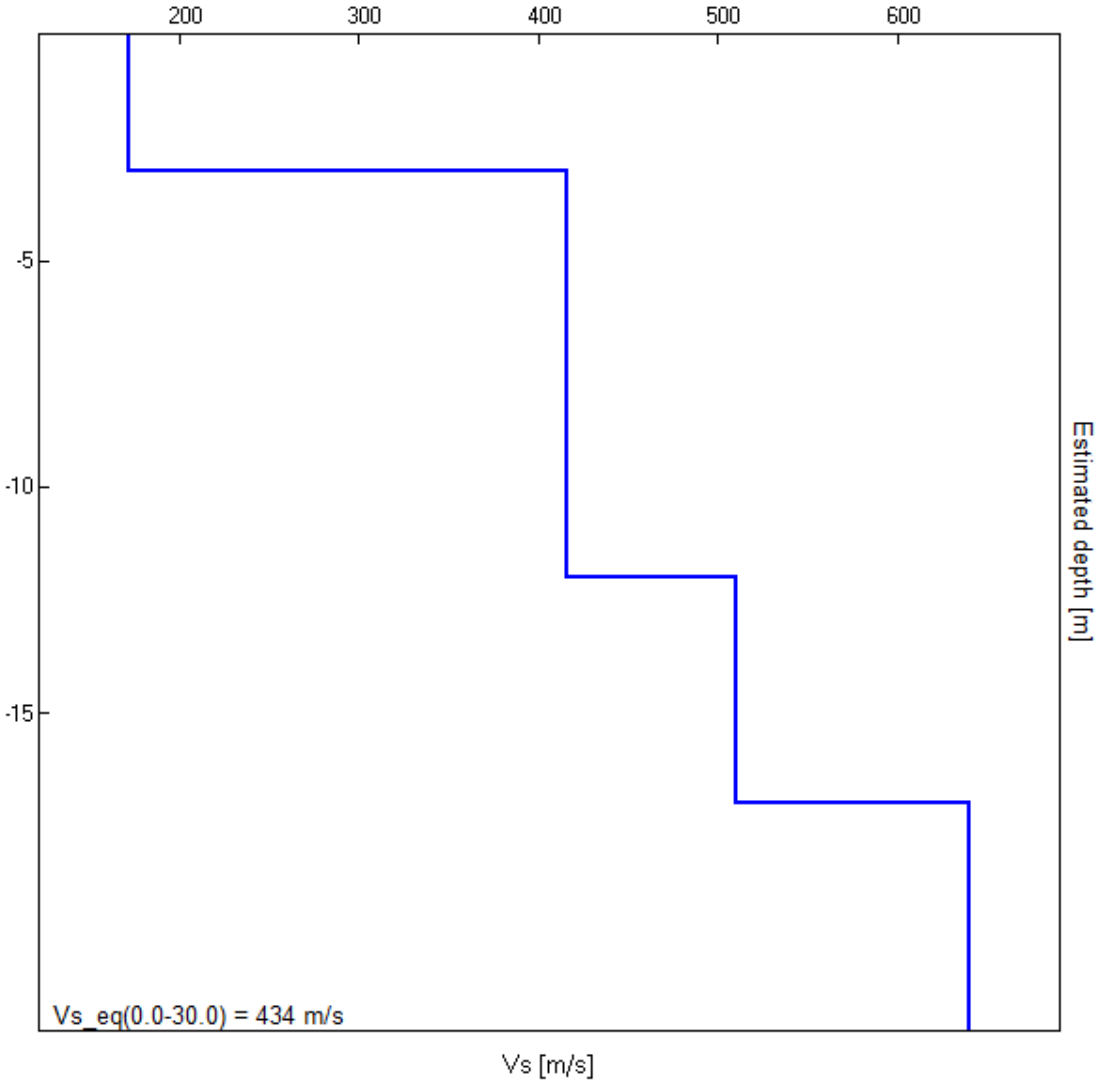


EXPERIMENTAL vs. SYNTHETIC H/V



Depth at the bottom of the layer [m]	Thickness [m]	Vs [m/s]	Poisson ratio
3.00	3.00	172	0.45
12.00	9.00	416	0.42
17.00	5.00	510	0.42
inf.	inf.	640	0.42

Vs_eq(0.0-30.0) = 434 m/s


200
300
400
500
600
-5
-10
-15
Estimated depth [m]
Vs_eq(0.0-30.0) = 434 m/s
Vs [m/s]

[According to the SESAME, 2005 guidelines. **Please read carefully the *Grilla* manual before interpreting the following tables**.]

Max. H/V at 14.38 ± 0.24 Hz (in the range 0.0 - 64.0 Hz).

Criteria for a reliable H/V curve [All 3 should be fulfilled]			
$f_0 > 10 / L_w$	14.38 > 0.50	OK	
$n_c(f_0) > 200$	13225.0 > 200	OK	
$\sigma_A(f) < 2$ for $0.5f_0 < f < 2f_0$ if $f_0 > 0.5$Hz $\sigma_A(f) < 3$ for $0.5f_0 < f < 2f_0$ if $f_0 < 0.5$Hz	Exceeded 0 out of 691 times	OK	
Criteria for a clear H/V peak [At least 5 out of 6 should be fulfilled]			
Exists f^- in $[f_0/4, f_0]$ | $A_{H/V}(f^-) < A_0 / 2$	10.031 Hz	OK	
Exists f^+ in $[f_0, 4f_0]$ | $A_{H/V}(f^+) < A_0 / 2$	19.063 Hz	OK	
$A_0 > 2$	6.66 > 2	OK	
$f_{peak}[A_{H/V}(f) \pm \sigma_A(f)] = f_0 \pm 5\%$	|0.01699| < 0.05	OK	
$\sigma_f < \varepsilon(f_0)$	0.24424 < 0.71875	OK	
$\sigma_A(f_0) < \theta(f_0)$	0.5649 < 1.58	OK	

L_w	window length
n_w	number of windows used in the analysis
$n_c = L_w n_w f_0$	number of significant cycles
f	current frequency
f_0	H/V peak frequency
σ_f	standard deviation of H/V peak frequency
$\varepsilon(f_0)$	threshold value for the stability condition $\sigma_f < \varepsilon(f_0)$
A_0	H/V peak amplitude at frequency f_0
$A_{H/V}(f)$	H/V curve amplitude at frequency f
f^-	frequency between $f_0/4$ and f_0 for which $A_{H/V}(f^-) < A_0/2$
f^+	frequency between f_0 and $4f_0$ for which $A_{H/V}(f^+) < A_0/2$
$\sigma_A(f)$	standard deviation of $A_{H/V}(f)$, $\sigma_A(f)$ is the factor by which the mean $A_{H/V}(f)$ curve should be multiplied or divided
$\sigma_{logH/V}(f)$	standard deviation of log $A_{H/V}(f)$ curve
$\theta(f_0)$	threshold value for the stability condition $\sigma_A(f) < \theta(f_0)$

Threshold values for σ_f and $\sigma_A(f_0)$					
Freq. range [Hz]	< 0.2	0.2 – 0.5	0.5 – 1.0	1.0 – 2.0	> 2.0
$\varepsilon(f_0)$ [Hz]	0.25 f_0	0.2 f_0	0.15 f_0	0.10 f_0	0.05 f_0
$\theta(f_0)$ for $\sigma_A(f_0)$	3.0	2.5	2.0	1.78	1.58
log $\theta(f_0)$ for $\sigma_{logH/V}(f_0)$	0.48	0.40	0.30	0.25	0.20

APPENDIX

E FIELD REVIEWS

WSP Canada Inc.
760 Enterprise Crescent
Victoria, BC V8Z 6R4
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WSP.COM

Field Review Report

Project:	Flood Emergency Response for Briarwood Drive – Temp Repair	**Project Number:**	20M-01141-06
Location:	Briarwood Dr, Mill Bay, BC	**Report Number:**	1
Contractor:	Matt.T Excavating	**Date:**	As shown below
Owner:	The Ministry of Transportation and Infrastructure	**Time:**	As shown below
In Attendance:	Matt (Matt.T), Jeff Ray (MOTI), Lexi Lin (WSP)	**Weather:**	As shown below

OBSERVATIONS/REMARKS/ACTIONS BY: Lexi Lin, EIT

Jan 10, 2022, 8:00 AM Overcast, 3˚C

1. WSP attended the site to observe the remediation work directed by the Contractor on the NW and SE slope for the road failure at Briarwood Drive as requested by the client.
2. WSP understands that Emcon Services Inc. is the Contractor assigned by MOTI, and Matt.T Excavating is the subcontractor of Emcon for the temporary slope stabilization construction.
3. No work activity was performed during the site visit, as no equipment could be hauled in due to icy and slippery road conditions. The Contractor advised that the work for today would mainly be cleaning up the site for access.
4. WSP observed fragments of the 1.5m-diameter steel culverts, asphalt pavement and concrete under the bridge, in the middle of the creek, and along the toes of both the NW and SE slopes.
5. The Contractor noted to WSP that the temporary stabilization would consist of creating a temporary berm at the toe of the slope with riprap, cover the exposed soil with geotextile on the slope, and armour the slope with riprap. The riprap slope might be in the order of 1H:1V. WSP noted to the Contractor that we would take measurements of the slope after the remediation work to update the geotechnical report.
6. The client mentioned that the current remediation is to prevent erosion of the exposed soils and the remediation design recommended by WSP will be constructed in summer when drier conditions are expected.

Jan 11, 2022, 8:30 AM Rainy, 9˚C

1. Upon arrival to the site, WSP observed the removal of road failure materials, including the fragments of steel culvert, asphalt, and concrete. This was done by a Hitachi 245 excavator working from the temporary bridge.
2. WSP observed two types of riprap hauled into the site. The size of the large riprap was about 1.5m, and smaller ones were measured at about 0.3m.
3. WSP observed the Contractor covering the NW slope from crest to toe with non-woven geotextile and temporarily holding the geotextile in place by placing some riprap at the crest and the toe.

4. WSP observed the placement riprap armouring on top of the geotextile. The Contractor started by the placement of large riprap at the toe of the southwest end of the NW slope. Riprap was placed with the Hitachi excavator from the bridge.

Jan 11, 2022, 13:10 PM Rainy, 9°C

1. WSP returned to site in the afternoon to observe the progress of riprap placement.
2. WSP observed the bottom half of the southwest side of the NW slope had been armoured with large riprap. The Contractor continued placement of riprap on the northeast side of the slope.
3. WSP noted to the Contractor that a section of geotextile under the bridge was pulled down and the soil near the crest was exposed. Since the riprap placement would continue up the slope, the Contractor brought in extra geotextile to cover the exposed section prior to riprap placement.
4. The Contractor noted to WSP that the upper half of the slope will be armoured with smaller riprap up to approximately 0.5m below the crest.

Jan 12, 2022 8:40 AM Rainy, 7°C

1. Upon arrival to the site, WSP observed the upper half of the southwest side of the NW slope had been armoured with small riprap up to the crest. A row of large riprap had been placed along the toe of the northeast side of the NW slope.
2. WSP observed 75 mm minus crushed gravel was placed on the northeast side of the NW slope to allow equipment to access down the slope. The Contractor advised that a layer of geotextile was placed between the soil and the gravel, and an additional layer of geotextile will be placed on top of the gravel prior to the placement of riprap. A CAT 303.5E excavator was working on the access ramp to place the smaller riprap under the bridge.
3. WSP observed the Contractor hand-placing the small riprap on the slope to fill in the gaps between the larger riprap.
4. WSP observed the Hitachi excavator starting to place large and small riprap on the southwest side of the SE slope at its toe. After a discussion with the Contractor, WSP understood that this was to provide a platform for workers to stand on while removing the asphalt overhang from the crest of the SE slope. Riprap will not be placed on the slope until a geotextile is in place.
5. WSP to return to site to witness the riprap placement on the SE slope.

Attachments – Photo table

Distribution: MoTI

WSP CANADA INC.

Per: Lexi Lin

Reviewed by: D Kobza

PHOTO TABLE

Photo	Description
	Photo 1: Jan 10, 2022 Overview of the SE slope. Observed asphalt and concrete fragments under the bridge. Photo looking southeast.
	Photo 2: Jan 10, 2022 Overview of the NW slope. Observed steel drainpipe fragments under the bridge. Photo looking northwest.

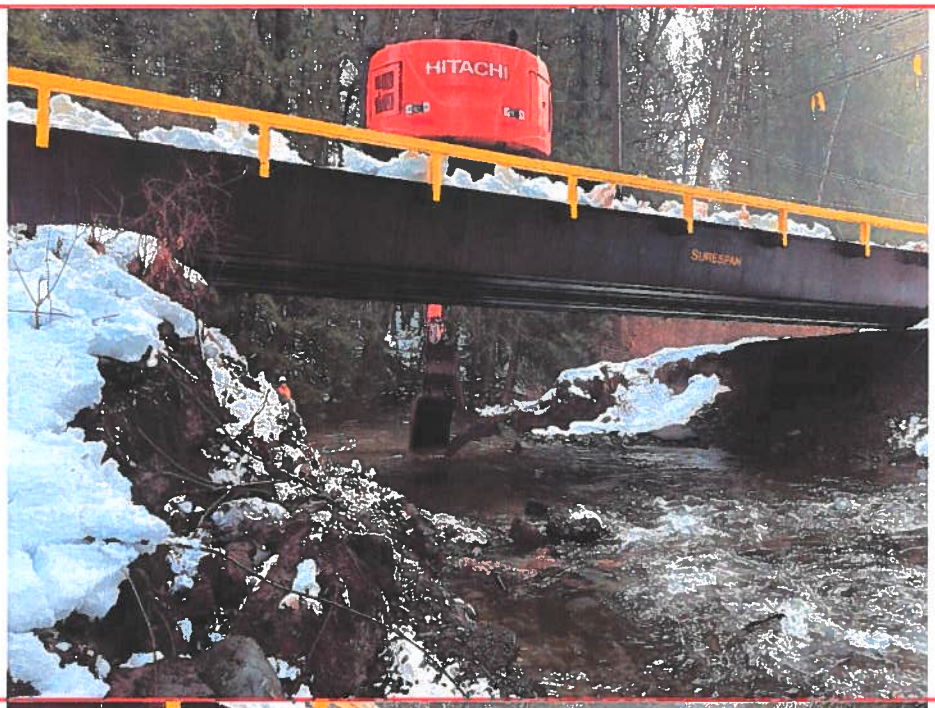

Photo 3:

Jan 11, 2022

Observed removal of road failure fragments in process.

Photo looking east.

Photo 4:

Jan 11, 2022

The entire NW slope was covered by geotextile.

Photo looking northwest.

Photo 5:

Jan 11, 2022

Large ripraps armoured the bottom half of the NW slope on its southwest side.

Photo looking northwest.

Photo 6:

Jan 11, 2022

The large riprap with dimension up to 1.5m.

Photo 7:

Jan 11, 2022

The small riprap with dimension of about 0.3m (1ft riprap).

Photo 8:

Jan 12, 2022

Upper half of the southwest side of the NW slope was armoured with small ripraps.

Photo looking northwest.

Photo 9:

Jan 12, 2022

A row of large riprap was placed along the toe of the northeast side of the NW slope.

Access ramp with 75 mm crushed gravel was placed to allow excavator to place riprap under the bridge.

Photo looking northwest.

Photo 10:

Jan 12, 2022

Ripraps were placed along the toe of the SE slope to provide a platform for workers to remove the asphalt overhang.

Photo looking northeast.

WSP Canada Inc.
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WSP.COM

Field Review Report

Project:	Flood Emergency Response for Briarwood Drive – Temp Repair	**Project Number:**	20M-01141-06
Location:	Briarwood Dr, Mill Bay, BC	**Report Number:**	2
Contractor:	Matt.T Excavating	**Date:**	Jan 13, 2022
Owner:	The Ministry of Transportation and Infrastructure	**Time:**	8:40 AM
In Attendance:	Matt (Matt.T), Lexi Lin (WSP)	**Weather:**	8°C

OBSERVATIONS/REMARKS/ACTIONS BY: Lexi Lin, EIT

1. Upon arrival to the site, WSP observed a Hitachi 245 excavator placing small diameter riprap with a size of about 0.3m onto the crest of the northeast side of the NW slope, where a temporary access ramp was made with 75 mm crushed gravel. The Contractor advised that a layer of non-woven geotextile had been placed on top of the gravel before placing the riprap.
2. As requested by the environmental monitor, extra geotextile was placed and extended beyond the crest at this location to cover the disturbed soil.
3. WSP observed that riprap armouring on the NW slope was generally completed. WSP noted to the Contractor that a small section about 0.5m deep under the bridge was not covered with riprap. The Contractor advised that due to limited workspace, that section under the bridge could not be reached but could be done if the bridge was lifted in the future.
4. WSP observed that riprap armouring on the southwest side of the SE slope had been completed. Geotextile was placed on the entire SE slope, extending about 0.8 - 1.0m beyond the crest. Large diameter riprap (with size up to about 1.5m) were placed from toe to about 0.5m below the crest on the southwest side of the SE slope and topped with 0.3m diameter riprap up to the crest. Large riprap placement on the other side of the SE slope was in progress during the time of site visit. This was performed by a Hitachi excavator operating on the bridge.
5. WSP observed two large boulders (from the large riprap) were placed on the crest on the northeast side of the SE slope to hold the geotextile in place. WSP noted to the Contractor that it could be a potential hazard as the slope was not considered totally stable. The Contractor advised that the two boulders were only placed on the crest temporarily and would be removed before finishing the riprap placement.
6. The Contractor advised that riprap armouring on the SE slope might be finished by the end of today and they would return tomorrow to clean up the site. WSP to return to the site and perform a final review upon the completion.

Attachments – Photo table
Distribution: MoTI

WSP CANADA INC.

Per: Lexi Lin

Reviewed by: D Kelly

PHOTO TABLE

Photo	Description
	Photo 1: Overview of the NW slope. Riprap armouring on the NW slope was finished. Photo looking northwest.
	Photo 2: Overview of the NW slope. Photo looking north.

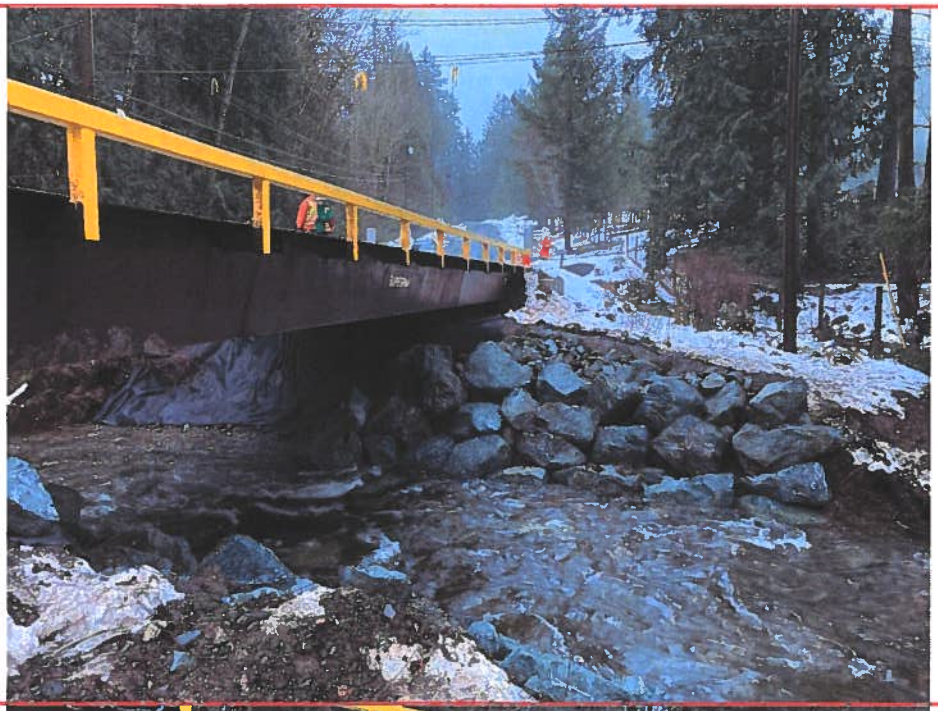

Photo 3:

Overview of the SE slope.

The southwest side of the SE slope had been armoured.

Photo looking southeast.

Photo 4:

Looking northeast at the SE slope.

Geotextile was extended beyond the crest for about 0.8-1.0m.

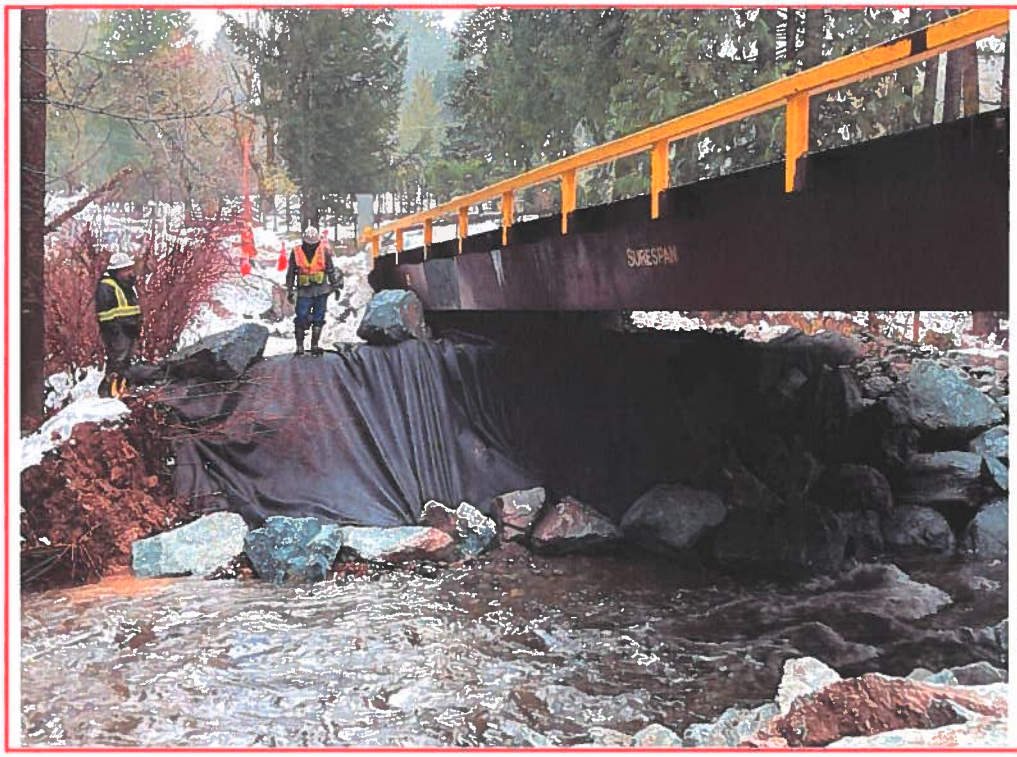

Photo 5:

Observed two large boulders placed to hold geotextile in place on the northeast side of the SE slope.

The Contractor to remove them before the construction finishes.

Photo looking southeast.

WSP Canada Inc.
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WSP.COM

Field Review Report

Project:	Flood Emergency Response for Briarwood Drive	**Project Number:**	20M-01141-06
Location:	Briarwood Dr, Mill Bay, BC	**Report Number:**	3
Contractor:	Matt.T Excavating	**Date:**	Jan 14, 2022
Owner:	The Ministry of Transportation and Infrastructure	**Time:**	11:40 AM
In Attendance:	Matt (Matt.T), Lexi Lin (WSP)	**Weather:**	Cloudy, Foggy 7°C

OBSERVATIONS/REMARKS/ACTIONS BY: Lexi Lin, EIT

1. Upon arrival to the site, WSP observed riprap armouring had been complete at both the NW slope and the SE slope.
2. During the time of site visit, WSP observed the Contractor cleaning up the site on the NW side of the bridge. Loose 75 mm minus crushed gravel was placed on both sides of the road on the NW side to reduce muddy water entering the creek. 19 mm minus crushed gravel was placed on the NW end of the bridge and compacted with a small diesel handheld compactor to smooth the surface for vehicular traffic. Large riprap (about 1.2m in diameter) were placed along the roadside on the NW side. No material placement was observed on the SE side of the bridge.
3. WSP observed the Contractor placing straw along the side ditch behind the NW slope as requested by the environmental monitor.
4. WSP measured the dimension of both the NW slope and the SE slope after the riprap placement and included a sketch with the report.

Attachments – Photo table

Distribution: MoTI

WSP CANADA INC.

Per: Lexi Lin

Reviewed by:

PHOTO TABLE

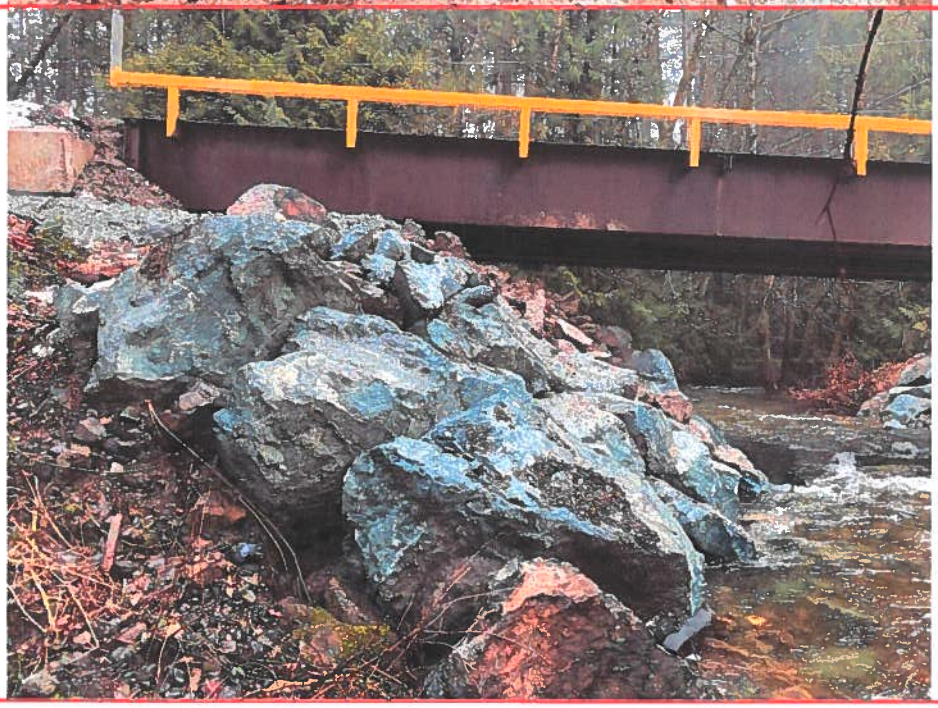
Photo	Description
	Photo 1: Overview of the NW slope. Photo looking northwest.
	Photo 2: Looking northeast at the NW slope.

Photo 3:

Overview of the SE slope.

Photo looking southeast.

Photo 4:

Looking northeast at the SE slope.

Photo 5:

The northeast side of the NW of the bridge.

Photo looking northwest.

Photo 6:

The southwest side of the NW of the bridge.

Photo looking northwest.

Photo 7:

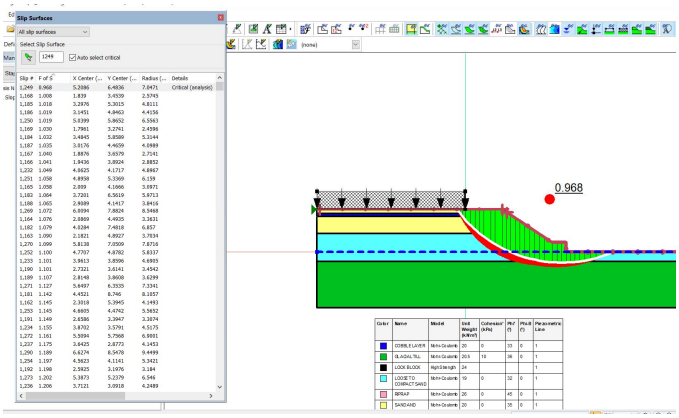
Overview of the NW side of the bridge

Photo looking southeast.

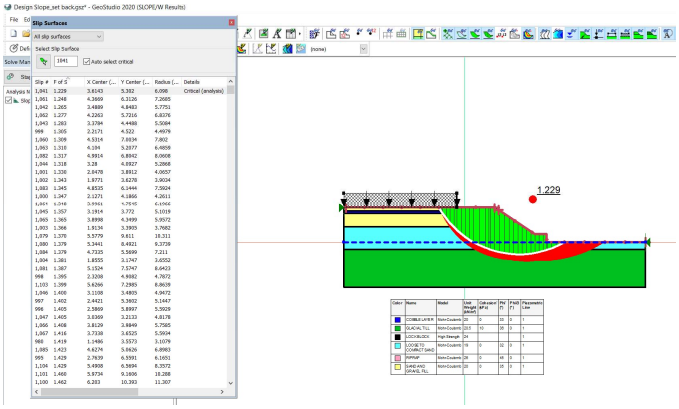
APPENDIX

F STABILITY REIVEW

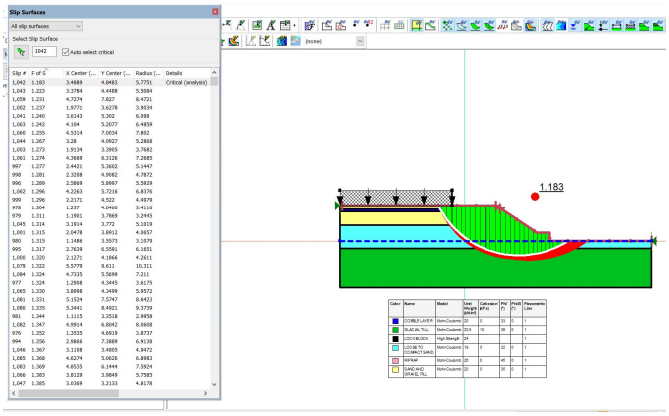
At 0m



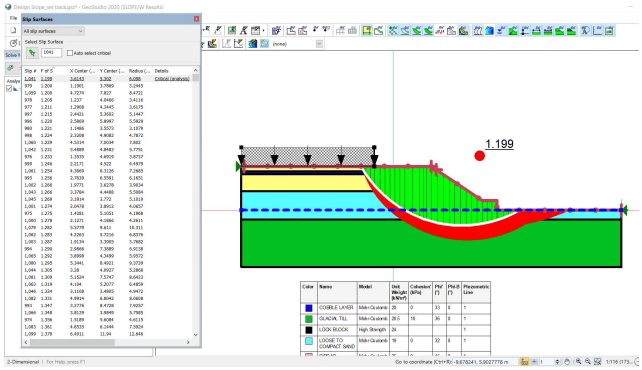
At 0.5m



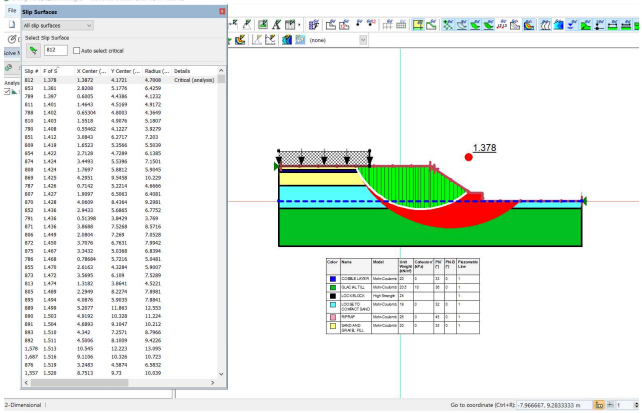
At 0.8m



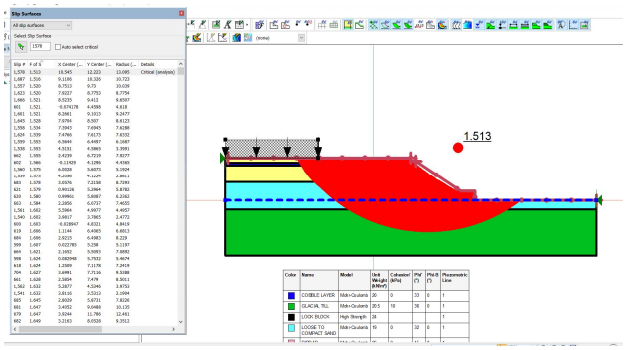
At 1.0m



At 2.0m



At 3.0m



APPENDIX

G STANDARD LIMITATIONS

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The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

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Standard Limitations

Design recommendations given in this report are applicable only to the project and areas as described in the text and then only if constructed in accordance with the details stated in this report. The comments made in this report on potential construction issues and possible methods are intended only for the guidance of the designer. The number of testing and/or sampling locations may not be sufficient to determine all the factors that may affect construction methods and costs. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.

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