TETRA TECH

March 29, 2023

ISSUED FOR USE
FILE: 704-ENG.VGEO04287-01

Ministry of Transportation and Infrastructure
1500 Woolridge Street – Suite 300
Coquitlam, BC V3K 0B8

Via Email: scott.b.cosman@gov.bc.ca

Attention: Scott Cosman, P.Eng.
Lead Geotechnical Engineer, Material and Standards

Subject: Chilliwack Lake Road Flood Recovery – Sandhill Slide
Factual Items

Tetra Tech Canada Inc. (Tetra Tech) is providing the following factual geotechnical information with reference to the Chilliwack Lake Road Flood Recovery Sandhill Slide project:

- Borehole Records;
- Drilling and Sampling Methodology;
- Summary of Laboratory Tests and Standards; and
- Vibrating Wire Piezometer Installations

Table 1 below provides a summary of the locations and drilling depth and dates for each of the boreholes. The borehole locations are also shown on the Tender Drawings titled “Chilliwack Lake Road Flood Recovery Sandhill Slide, Grading and Paving”, provided by Stantec Consulting Ltd.

Table 1: Borehole Location, Elevation, Depth and Date Summary

Borehole ID	Easting[1,2] (m)	Northing[1,2] (m)	Collar Elevation[2] (masl)	Depth (m)	Date Drilled
BH22-01	594997.6	5437158.9	282.6	48.8	July 4, 2022 – July 7, 2022
BH22-02	594971.5	5437222.1	255.8	20.4	July 8, 2022
BH22-03	594898.7	5437110.0	269.8	15.9	December 13, 2022
BH22-04	594884.5	5437115.3	261.6	12.8	December 14, 2022
BH22-05	594856.3	5437083.6	258.5	9.1	December 14, 2022

(1) Coordinates are in UTM NAD83 Zone 10
(2) Coordinates and collar elevations were provided by Van Bower Construction Services Ltd.

Boreholes were advanced using sonic drill rigs, equipped with a 108 mm inner diameter core barrel. Boreholes BH22-01 and BH22-02 were advanced using a Boart Longyear LS600 drill rig, and boreholes BH22-03, BH22-04 and BH22-05 were advanced using a Boart Longyear LS250 drill rig.

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Standard Penetration Tests (SPT) were carried out at various intervals in all the boreholes, as indicated on the attached logs. SPT split spoon samples were collected using a AWJ (to 15.2 m depth) and NWJ (below 15.2 m) sampling rods connected to a 38.1 mm (inner) diameter split spoon.

All boreholes were backfilled with cement bentonite grout in accordance with the Province of British Columbia's Groundwater Protection Regulation.

Table 2 summarizes the types of laboratory tests undertaken as part of the drilling program, and the associated ASTM standard. The testing results are provided on the borehole logs.

Table 2: Summary of Laboratory Tests

Laboratory Test	ASTM Standard
Water (Moisture) Content of Soil and Rock by Mass	D2216
Amount of Material Finer than 75-µm (No. 200) Sieve in Soils	D1140
Particle-Size Distribution (Gradation) of Soils	D6913
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	D4318

Vibrating Wire Piezometers (VWP) supplied by RST Instruments Ltd. were installed in boreholes BH22-01 and BH22-02. The approximate depth of installation of each VWPs, along with the associated serial number and borehole in which the VWP was installed, is provided in Table 3 below.

Table 3: Summary of VWP Installations

Serial Number	Approximate Installation Depth	Installation Borehole ID
VW148119	7.6 m	BH22-01
VW148172	24.1 m	BH22-01
VW148105	19.5 m	BH22-02

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
A. L. SHEPPARD
48807
March 29, 2023

FILE: 704-ENG.VGEO04287-01

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/sy

Attachments: Appendix A – Tetra Tech's Limitations on the use of this Document
Appendix B – Borehole Logs

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

PERMIT NUMBER: 1001972

ATTACHMENT A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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1.3 STANDARD OF CARE

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If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.

ATTACHMENT B

BOREHOLE LOGS

BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-01**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 282.591 m
Chilliwack, B.C.	UTM: 594997.581 E; 5437158.929 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm) SPT	Field Vane (kPa) Post-Peak / Peak	Plastic Limit / Moisture Content / Liquid Limit	VW148119	VW149172	Elevation (m)
0			ASPHALT (50 mm)														282
			SP - SAND (FILL), some gravel, poorly graded, dry, brown; medium to coarse sand; fine gravel.			S1											
1			GW - GRAVEL (FILL), some sand, well graded, dry, grey; fine to coarse sand; fine to coarse gravel, angular to subangular, maximum size 25 mm diameter.														281
			SB - COBBLES, trace gravel, trace sand; subangular to subrounded cobbles, maximum size 100 mm diameter.			S2											
2						SPT01											280
			SP - SAND, trace gravel, occasional wood debris, poorly graded, moist, very dense, brown to grey; fine to medium sand.			S3	12	71	17								
3			SPT01 - 16/24/19/24														279
			SM - SAND, silty, some to trace gravel, trace cobbles, well graded, moist, very dense, brown to grey; fine to coarse sand; fine gravel to coarse gravel, subangular to subrounded, maximum size 75 mm diameter.			SPT02											
4						S4											278
			SPT02 - 12/34/23/24			S5											
5			SPT03 - 25/30/43/50 - (SPT Refusal below 45 cm penetration)			SPT03											277
						S6											
6			SM - SAND, silty, some gravel, trace cobbles, loose, wet, brown and grey; fine to medium sand; fine to coarse gravel, subrounded to rounded, maximum size 38 mm diameter.			S7											276
	2022-Jul-04															2022-Jul-04	
7						S8	0	1	99								
			CL - CLAY, trace gravel, trace sand, occasional silt seams 25 mm thick, occasional wood pieces, w>PL, soft, medium to high plastic, brown to grey.			SPT04											275
8			SPT04 - 0/1/1/1			S9											
			- grey below 7.6 m														274
			SPT05 - 0/1/2/7			SPT05											
9						S10			86.1								273
			ML - SILT and SAND, moist, compact, non-plastic, brown to grey; fine sand.			S11	0	39	61								
10						SPT06A											272
			SPT06 - 1/8/21/25			SPT06B											
			SW-SM/GW-GM - SAND, gravelly, silty, to SAND and GRAVEL, silty, well graded, wet, very dense, grey; fine to coarse sand; fine gravel subangular to subrounded, maximum size 50 mm diameter.			S12											
11						S13	26	47	27								271
			SPT07 - SPT Refusal (50 blows in 10 cm)			SPT07											
12						S14	49	38	13								270
						S15											
			SP/GP - SAND and GRAVEL, some fines, some cobbles, poorly graded, moist, very dense, brown to grey; fine to medium sand; fine to coarse gravel, subangular to rounded, maximum size 63 mm diameter.			SPT08											
13																	269
			- boulder at 13.1 m (700 mm diameter)			S16	39	49	12								
14			SPT08 - SPT Refusal (50 blows in 2.5 cm)														268
			- cobble at 13.9 m (200 mm diameter)			SPT09A											
15	Sonic																

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Contractor: Foundex	Completion Depth: 48.8 m
Equipment Type: Boart Longyear LS 600	Start Date: July 4, 2022
Logged By: AL	Completion Date: July 7, 2022
Reviewed By: AS	Page 1 of 4

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Ministry of Transportation & Infrastructure

Borehole No: **BH22-01**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 282.591 m
Chilliwack, B.C.	UTM: 594997.581 E; 5437158.929 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm) SPT	Field Vane (kPa) Post-Peak / Peak	Plastic Limit / Moisture Content / Liquid Limit	VW148119	VW149172	Elevation (m)
15												20 40 60 80	10 20 30 40	20 40 60 80			
15	Sonic	100	SP/GP - SAND and GRAVEL, some fines, some cobbles, poorly graded, moist, very dense, brown to grey; fine to medium sand; fine to coarse gravel, subangular to rounded, maximum size 63 mm diameter.			SPT09B											267
16			SPT09 - 6/28/50 - (SPT Refusal below 30 cm penetration)			S17											
16			SPT10 - 21/25/15/11			SPT10A											266
17			SP-SM/ML - SAND, some silt, to SAND and SILT, trace cobbles, poorly graded, wet, compact, brown to grey; fine to medium sand; non-plastic fines.			SPT10B											
17						S18											265
18						S19			40.3								264
19						S20											
19			SPT11 - 2/3/10/12			SPT11											263
20						S21											
20						S22											262
21			SPT12 - 3/6/8/9			SPT12A											
21			- sand becomes fine below 21.2 m			SPT12B											261
22						S23											
23						S24											260
24			SPT13 - 10/7/9/14			SPT13											259
24			CL - CLAY, silty, w>PL, stiff to very stiff, low to medium plastic, grey.			S25											
25																	258
26						S26			98.6								257
27			SPT14 - 5/5/8/8			SPT14											256
27						S27											
28																	255
28			- fine sand at 28.6 m														254
29						S28											
30																	253

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Contractor: Foundex	Completion Depth: 48.8 m
Equipment Type: Boart Longyear LS 600	Start Date: July 4, 2022
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Borehole No: **BH22-01**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 282.591 m
Chilliwack, B.C.	UTM: 594997.581 E; 5437158.929 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm) SPT	Field Vane (kPa) Post-Peak / Peak	Plastic Limit / Moisture Content / Liquid Limit	VW148119	VW149172	Elevation (m)
30			SPT15 - 6/12/17/19		SPT	SPT15											252
			CL - CLAY, occasional lenses of fine sand, w>PL, very stiff to hard, low to medium plastic, grey.			S29											
31																	251
32						S30				99.5							250
33			SPT16 - 6/7/8/20		SPT	SPT16											249
34						S31											
35						S32											248
36			SPT17 - 37/23/24/32		SPT	SPT17											247
			- fine sand, silty at 36.6 m														
37	Sonic					S33											246
38																	
39						S34				99.3							245
			SPT18 - 4/6/7/8		SPT	SPT18											244
40																	243
41			- fine sand at 41.1 m			S35											242
42			- fine sand at 41.8 m														241
			SPT19 - 4/7/8/16		SPT	SPT19											240
43			- fine sand at 42.7 m			S36											239
44																	238
45						S37											

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Contractor: Foundex	Completion Depth: 48.8 m
Equipment Type: Boart Longyear LS 600	Start Date: July 4, 2022
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Borehole No: **BH22-01**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 282.591 m
Chilliwack, B.C.	UTM: 594997.581 E; 5437158.929 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Silt & Clay (%): Clay (%)	Field Blowcount (blows/300 mm) □ SPT (20 40 60 80)	Field Vane (kPa) Post-Peak / Peak (10 20 30 40); Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	VW148119	VW149172	Elevation (m)
45															
46	Sonic		CL - CLAY, occasional lenses of fine sand, w>PL, very stiff to hard, low to medium plastic, grey. SPT20 - 1/3/9/12			SPT20 S38					□				237
47						S39									236
48			SPT21 - 3/4/8/22 - fine sand at 48.5 m			SPT21					□				235 234
49			END OF BOREHOLE AT 48.8 m DEPTH - Soil descriptions are based on visual classifications, field observations and testing, drill performance, and laboratory testing. Some variation through the interpreted soil layers is expected. - Soil consistency and density descriptions based on SPT blow counts where available, and are otherwise based on drill performance and visual observation. - SPT blow counts shown on logs are uncorrected field N-values. SPTs were carried out using an automatic trip hammer and AWJ (to 15.2 m) and NWJ (below 15.2 m) rods. - Upon completion of drilling two vibrating wire piezometers (VW148119 and VW148172) were installed at this location to a depth of 7.6 m and 24.1 m. - Upon completion the borehole was tremie grouted to surface with cement/bentonite grout. The hole was finished at the surface with a flush mount cover. - UTM coordinates and elevations were collected by Van Bower Construction Services Ltd.												233
50															232
51															231
52															230
53															229
54															228
55															227
56															226
57															225
58															224
59															223
60															

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Contractor: Foundex	Completion Depth: 48.8 m
Equipment Type: Boart Longyear LS 600	Start Date: July 4, 2022
Logged By: AL	Completion Date: July 7, 2022
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BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-02**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 255.785 m
Chilliwack, B.C.	UTM: 594971.526 E; 5437222.075 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm) □ SPT	Field Vane (kPa) Post-Peak ◇ Peak	Plastic Limit	Moisture Content ●	Liquid Limit	VW148105	Elevation (m)
0												20 40 60 80	10 20 30 40	20 40 60 80				
1	Sonic	100	SW-SM - SAND (SLIDE DEBRIS), gravelly, silty, occasional wood pieces, well graded, moist, compact, brown; fine to coarse sand; angular to subrounded gravel, maximum size 50 mm diameter.			S1	20	66	14									255
2			SPT01 - 3/6/7/5			SPT01												254
3			WOOD DEBRIS (SLIDE DEBRIS)															253
			SPT02 - SPT Refusal (50 blows in 15 cm)			SPT02												
			SAND and WOOD DEBRIS (SLIDE DEBRIS); moist, grey; fine to medium sand.			S2												
4			WOOD DEBRIS (SLIDE DEBRIS)															252
5			SW - SAND (SAND DEBRIS), trace to some gravel, trace fines, well graded, moist, loose, brown; fine to coarse sand; fine gravel.			SPT03												251
			SPT03 - 5/6/3/4															
			WOOD DEBRIS and SAND (SAND DEBRIS); fine to medium sand.			S3												
6			SW - SAND (SLIDE DEBRIS), trace gravel, trace fines, well graded, moist, compact, brown to grey; fine to medium sand; fine to coarse gravel subangular to subrounded, maximum size 50 mm diameter.			SPT04												250
7	2022-Jul-08		SPT04 - 4/7/4/5			S4	4	92	4									249
			SW - SAND, trace gravel, well graded, moist to wet, compact, reddish brown to tan; fine to medium sand; fine to coarse gravel up to 25 mm diameter.			SPT05												
8			SPT05 - 6/10/6/8			S5												248
9			GP - GRAVEL, sandy, trace cobbles, moist, very dense, brown to grey; coarse gravel, subrounded to rounded up to 75 mm diameter; fine to coarse sand.			SPT06												247
10			SPT06 - SPT Refusal (50 blows in 5 cm) - No Recovery on SPT-06 at 9.1 m - cobble at 9.8 m			S6												246
11			SPT07 - 34/23/22/18			SPT07												245
12			NO RECOVERY															244
13																		243
14			SW - SAND, trace to some gravel, well graded, wet, loose to compact, grey-brown; fine to coarse sand; fine to coarse gravel, subrounded to rounded up to 75 mm diameter.			SPT08												242
15			SPT08 - 1/2/10/14															241

TETRA TECH

Contractor: Foundex	Completion Depth: 20.4 m
Equipment Type: Boart Longyear LS 600	Start Date: July 8, 2022
Logged By: AL	Completion Date: July 8, 2022
Reviewed By: AS	Page 1 of 2

BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-02**

Project: Chilliwack Lake Road - Sandhill Slide	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 255.785 m
Chilliwack, B.C.	UTM: 594971.526 E; 5437222.075 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Silt & Clay (%): Clay (%)	Field Blowcount (blows/300 mm) □ SPT	Field Vane (kPa) Post-Peak ◇ Peak	Plastic Limit / Moisture Content / Liquid Limit	VW148105	Elevation (m)
15											20 40 60 80	10 20 30 40	20 40 60 80		
16	Sonic		SW - SAND, trace to some gravel, well graded, wet, loose to compact, grey-brown; fine to coarse sand; fine to coarse gravel, subrounded to rounded up to 75 mm diameter.			S7									240
17			SPT09 - 1/2/7/8			S8 SPT09					□	●			239
18															238
19			- some gravel to gravelly beow 19.2 m			S9									237
			CL - CLAY, silty, trace sand, w>PL, hard, low to medium plastic, brown to grey.			S10									
20			SPT10 - 1/21/12/18			SPT10A SPT10B					□	● ●			236
			- becomes grey below 20.3 m												
21			END OF BOREHOLE AT 20.4 m DEPTH - Soil descriptions are based on visual classifications, field observations and testing, drill performance, and laboratory testing. Some variation through the interpreted soil layers is expected. - Soil consistency and density descriptions based on SPT blow counts where available, and are otherwise based on drill performance and visual observation. - SPT blow counts shown on logs are uncorrected field N-values. SPTs were carried out using an automatic trip hammer and AWJ (to 15.2 m) and NWJ (below 15.2 m) rods. - Upon completion of drilling one vibrating wire piezometer (VW148105) was installed at this location to a depth of 19.5 m. - Upon completion the borehole was tremie grouted to surface with cement/bentonite grout. The hole was finished at the surface with a flush mount cover - UTM coordinates and elevations were collected by Van Bower Construction Services Ltd.											235
22															234
23															233
24															232
25															231
26															230
27															229
28															228
29															227
30															226

TETRA TECH

Contractor: Foundex	Completion Depth: 20.4 m
Equipment Type: Boart Longyear LS 600	Start Date: July 8, 2022
Logged By: AL	Completion Date: July 8, 2022
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BRITISH COLUMBIA
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Borehole No: **BH22-03**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 269.832 m
Chilliwack, B.C.	UTM: 594898.661 E; 5437110.012 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0												SPT 20 40 60 80	Post-Peak / Peak 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80	
			SW/GW - SAND and GRAVEL (FILL), fine to coarse, gravel up to 38 mm, well graded, trace silt, brown, non-cohesive, moist.			G-01								
1			SM - SAND, silty, fine to coarse, well graded, some fine to coarse subrounded gravel up to 64mm, brown, non-cohesive, moist, loose.			G-02	7	79	14					269
			SPT01 - 5/4/4/7			SPT-01								
2														268
						G-03								
			SW - SAND, gravelly, fine to coarse, fine to coarse subrounded to angular gravel, well graded, trace fines, trace fibrous organics (wood), occassional cobbles up to 76 mm, grey, non-cohesive, moist, compact.			G-04								
3			SPT02 - 11/12/8/7			SPT-02								267
			- no recovery in SPT-02; wood stuck in base of SPT tip											
			- wet throughout third sonic run (3.0 m-4.3 m)											
4						G-05								266
			SW - SAND, gravelly to some gravel, fine to coarse, well graded, fine to coarse subrounded to subangular flat and elongated gravel, brown to orange-brown, non-cohesive, moist to wet, loose to compact.			G-06	20	71	9					
						SPT-03								
5	Sonic		SPT03 - 10/5/3/4											265
			- no recovery in fourth sonic run (4.6 m to 6.1 m); material type inferred based on drilling and sample collected above and below this depth.											
6														264
			SPT04 - 6/7/7/6			G-07								
						SPT-04								
7			- approximately 75 mm thick black sand layer at 6.9 m			G-08	20	71	9					263
			- grey coarse sand to fine gravel seams from 7.3 to 7.5 m.											
			SPT05 - 15/11/5/6			SPT-05								
8														262
						G-09								
			- grey from approximately 8.5 to 8.8 m.			G-10								
9			SM - SAND, silty, fine to coarse, well graded, trace gravel, orange, non-cohesive, wet, compact.			G-11								261
			SPT06 - 3/4/14/25			SPT-06								
10														260

TETRA TECH

Contractor: VanMars	Completion Depth: 15.8 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 13
Logged By: ST	Completion Date: 2022 December 13
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BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-03**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 269.832 m
Chilliwack, B.C.	UTM: 594898.661 E; 5437110.012 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Silt & Clay (%): Clay (%)	Field Blowcount (blows/300 mm) □ SPT	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
10											20 40 60 80	Post-Peak ◇ Peak 10 20 30 40; Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80	
	Sonic		SW/GW - SAND and GRAVEL, fine to coarse, well graded, trace silt, orange-brown, non-cohesive, moist.			G-12							
						G-13							
			CL - SILTY CLAY, low to medium plasticity, grey, cohesive, w~PL.			G-14			44.5				
11			SP/ML - SILT and SAND, low-plasticity, fine sand, some to trace fine to coarse subangular gravel up to 38 mm, orange with dark bands, non-cohesive, moist, loose to compact.			SPT-07					□		259
			- cobbles at 10.6 m depth.										
			SPT07 - 6/5/5/5										
12						G-15							258
			CH - CLAY, medium to high plasticity, trace gravel and cobbles, grey, cohesive, w~PL, firm to very stiff.			SPT-08					□		
			SPT08 - 21/12/9/8										
13													257
						G-16							
			SPT09 - 4/3/3/4			SPT-09					□		256
14													
						G-17							
15													255
			SW - SAND, fine to coarse, some gravel, well graded, grey, non-cohesive, wet to moist, compact.			SPT-10					□		
			SPT10 - 9/10/4/3										
16			END OF BOREHOLE at 15.9 m DEPTH										254
			- Soil descriptions are based on visual classifications, field observations and testing, drill performance, and laboratory testing. Some variation through the interpreted soil layers is expected.										
17			- Soil consistency and density descriptions based on SPT blow counts where available, and are otherwise based on drill performance and visual observation.										253
			- SPT blow counts shown on logs are uncorrected field N-values. SPTs were carried out using an automatic trip hammer and AWJ rods.										
18			- Upon completion the borehole was tremie grouted to surface with cement/bentonite grout. The hole was finished at the surface with sand.										252
			- UTM coordinates and elevations were collected by Van Bower Construction Services Ltd.										
19													251
20													250

TETRA TECH

Contractor: VanMars	Completion Depth: 15.8 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 13
Logged By: ST	Completion Date: 2022 December 13
Reviewed By: AS	Page 2 of 2

BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-04**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 261.602 m
Chilliwack, B.C.	UTM: 594884.539 E; 5437115.298 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0			TOPSOIL										261
			SW - SAND, gravelly, silty, fine to coarse, fine to coarse angular to subangular gravel up to 75 mm, trace organics (rootlets), brown, non-cohesive, moist, compact.										
1						G-01							
			SPT01 - 6/8/8/8			SPT-01							260
2			- some gravel and silt, higher moisture, and lighter brown colour below 2.0 m.										
						G-02	6	86		8			259
3			- grey gravel layer from approximately 2.8 m to 2.9 m.			G-03							
			- inferred boulder encountered at 3.0 m based on drill response. Borehole abandoned and re-drilled directly adjacent to initial borehole location.			SPT-02a							
						SPT-02b							
			CH - CLAY, medium to high plasticity, tan, cohesive, w>PL, very stiff.			G-04							258
4			SPT02 - 4/5/12/9			G-05							
			- 150 mm thick gravel layer at 3.3 m depth; gravel appears granitic in origin.										
			SW/GW - SAND and GRAVEL, fine to coarse,angular to subangular gravel up to 19 mm, well graded, trace to some silt, brown, non-cohesive, moist, compact to dense.			G-06							257
5	Sonic		SPT03 - 41/30/8/6			SPT-03							
			LB/SB - BOULDER/COBBLE (inferred from 4.6 m to 4.7 m).										
			- Granite fragment (larger than sonic bit) recovered in sonic run four (4.6 m to 6.1 m).										
			SP/ML - SILT/SAND, sandy/silty, fine, grey, non-cohesive, wet, loose to compact.										256
6			- subsurface stratigraphy inferred based on drilling response, split spoon recovery and adjacent boreholes; little to no recovery from sonic core from 4.6 m to 9.0 m depth. Drilling conditions described as very soft by driller.			SPT-04				69			
			SPT04 - 2/2/3/5										255
7			CH - CLAY, medium to high plasticity, trace organics (rootlets), tan, trace orange sand pockets, cohesive, w~PL to w>PL, soft to firm.										
			- subsurface stratigraphy inferred based on drilling response, split spoon recovery and adjacent boreholes; little to no recovery from sonic core from 4.6 m to 9.0 m depth. Drilling conditions described as very soft by driller.			SPT-05							254
8			SP - SAND, fine to coarse, well graded, trace to some gravel, trace silt, grey, non-cohesive, moist, loose.										
			- subsurface stratigraphy inferred based on drilling response, split spoon recovery and adjacent boreholes; little to no recovery from sonic core from 4.6 m to 9.0 m depth. Drilling conditions described as very soft by driller.										253
9			SPT05 - 1/2/4/50			G-07	12	84		4			
			ML - SILT, sandy, medium to fine sand, poorly graded, tan, non-cohesive, moist to wet, compact to very dense.			SPT-06							
			SPT06 - SPT Refusal (50 blows in 75 mm), no recovery										252
10													

Field Blowcount (blows/300 mm): SPT; 20 40 60 80

Field Vane (kPa): Post-Peak, Peak; 10 20 30 40

Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80

TETRA TECH

Contractor: VanMars	Completion Depth: 12.8 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 14
Logged By: ST	Completion Date: 2022 December 14
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BRITISH COLUMBIA
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Borehole No: **BH22-04**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 261.602 m
Chilliwack, B.C.	UTM: 594884.539 E; 5437115.298 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Silt & Clay (%): Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
10													
	Sonic		SP - SAND, silty, medium to fine, poorly graded, tan, non-cohesive, moist to wet, compact.			G-08			72.3				
			- Occassional increased fines content and orange/grey colour mottling from 10.7 m depth.			G-09			32.4				251
11			SPT07 - 6/7/8/9			SPT-07					□		
						G-10							250
12			ML - SILT, sandy, medium to fine sand, poorly graded, tan, non-cohesive, moist to wet, compact.										
			- occassional bands of orange/grey										
			SPT08 - 3/4/7/11			SPT-08					□		
			- increasing sand content and mottled orange/grey below 12.2 m										249
13			END OF BOREHOLE at 12.8 m DEPTH										
			- Soil descriptions are based on visual classifications, field observations and testing, drill performance, and laboratory testing. Some variation through the interpreted soil layers is expected.										248
14			- Soil consistency and density descriptions based on SPT blow counts where available, and are otherwise based on drill performance and visual observation.										
			- SPT blow counts shown on logs are uncorrected field N-values. SPTs were carried out using an automatic trip hammer and AWJ rods.										247
15			- Upon completion the borehole was tremie grouted to surface with cement/bentonite grout. The hole was finished at the surface with sand.										
			- UTM coordinates and elevations were collected by Van Bower Construction Services Ltd.										246
16													
													245
17													
													244
18													
													243
19													
													242
20													

Field Blowcount (blows/300 mm): □ SPT; 20 40 60 80

Field Vane (kPa): Post-Peak ◇ — Peak ◆; 10 20 30 40

Plastic Limit — Moisture Content ● — Liquid Limit; 20 40 60 80

TETRA TECH

Contractor: VanMars	Completion Depth: 12.8 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 14
Logged By: ST	Completion Date: 2022 December 14
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BRITISH COLUMBIA
Ministry of Transportation & Infrastructure

Borehole No: **BH22-05**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 258.468 m
Chilliwack, B.C.	UTM: 594856.27 E; 5437083.564 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%)	Silt (%)	Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit / Moisture Content / Liquid Limit	Elevation (m)
0			TOPSOIL											258
			SW - SAND, fine to coarse, well graded, trace to some gravel, trace silt, trace cobble up to 100 mm, occassional organics (twigs/rootlets), light brown, non-cohesive, moist.			G-01								
1														
			SW - SAND, gravelly, silty, fine to coarse, well graded, trace cobbles, black-brown, earthy odour, non-cohesive, moist, compact, lightweight.			G-02	21	65	14					257
						SPT-01a								
			GW - SAND and GRAVEL to gravelly, fine to coarse, subrounded to angular gravel up to 60 mm, gap graded, occassional organics (twigs), some silt, brown-grey to brown, non-cohesive, moist.			SPT-01b								
2														
			SPT01 - 2/5/13/8			G-03	30	59	11					256
3						G-04								
			CH - CLAY, medium to high plasticity, trace organics (rootlets), tan, trace orange sand pockets, cohesive, w~PL to w>PL, soft to firm.			SPT-02								
			- grey, w>PL from approximately 4.6 to 5.2 m											
			- reddish brown tan from approximately 5.2 m											
4			SPT02 - 1/1/2/3			G-05			98.9					255
	Sonic													
			SPT03 - 2/2/3/5			SPT-03								254
5						G-06								
						G-07								253
			SP - SAND, silty to some silt, fine to coarse, poorly graded, trace fine gravel, pockets of clay up to 40 mm diameter, brown, non-cohesive, moist.			G-08	2	84	14					
6			- grey from 5.8 to 6.1 m.			G-09								
			- inferred granite boulder/cobble from 6.1 m to 6.2 m.			SPT-04								
			SPT04 - SPT Refusal (50 blows in 75 mm), no recovery											
			ML - SILT, non-plastic, trace sand, light brown, non-cohesive, moist to dry.			G-10			95.7					252
7														
			CI - CLAY, medium plasticity, tan, cohesive, w~PL to w>PL, firm.			G-11								251
			- grey from 7.6 m.			SPT-05a								
			- 50 mm thick gravel seam at 7.7m			SPT-05b								
8			- no sonic recovery from 7.6 to 9.1 m.											
			SPT05 - 3/4/4/3											250
9														
			END OF BOREHOLE at 9.1 m DEPTH											249
			- Soil descriptions are based on visual classifications, field observations and testing, drill performance, and laboratory testing. Some variation through the interpreted soil layers is											
10														

Field Blowcount (blows/300 mm): SPT; 20 40 60 80

Field Vane (kPa): Post-Peak ◇ Peak; 10 20 30 40

Plastic Limit / Moisture Content / Liquid Limit; 20 40 60 80

TETRA TECH

Contractor: VanMars	Completion Depth: 9.1 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 14
Logged By: ST	Completion Date: 2022 December 14
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Borehole No: **BH22-05**

Project: Chilliwack Lake Road - Sandhill Slide - Phase II	Project No: 704-ENG.VGEO04287-01
Location: Chilliwack Lake Road	Ground Elev: 258.468 m
Chilliwack, B.C.	UTM: 594856.27 E; 5437083.564 N; Z 10 NAD83

Depth (m)	Method	Core Diameter (mm)	Soil Description	Graphical Representation	Sample Type	Sample Number	Particle Size Distribution: Gravel (%)	Sand (%)	Silt & Clay (%): Silt (%)	Silt & Clay (%): Clay (%)	Field Blowcount (blows/300 mm)	Field Vane (kPa) / Plastic Limit, Moisture Content, Liquid Limit	Elevation (m)
10			expected. - Soil consistency and density descriptions based on SPT blow counts where available, and are otherwise based on drill performance and visual observation. - SPT blow counts shown on logs are uncorrected field N-values. SPTs were carried out using an automatic trip hammer and AWJ rods. - Upon completion the borehole was tremie grouted to surface with cement/bentonite grout. The hole was finished at the surface with sand. - UTM coordinates and elevations were collected by Van Bower Construction Services Ltd.								SPT 20 40 60 80	Post-Peak / Peak 10 20 30 40 Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80	
11													248
12													247
13													246
14													245
15													244
16													243
17													242
18													241
19													240
20													239

TETRA TECH

Contractor: VanMars	Completion Depth: 9.1 m
Equipment Type: Boart Longyear LS250	Start Date: 2022 December 14
Logged By: ST	Completion Date: 2022 December 14
Reviewed By: AS	Page 2 of 2