Geotechnical Data Report

Highway 97 – Cache Creek Culvert Replacement
Cache Creek, BC
Project # KX13772C20

Prepared for:

BC Ministry of Transportation and Infrastructure
447 Columbia Street Kamloops, BC, V2C 2T3
Canada

Prepared by:

WSP E&I Canada Limited
3456 Opie Crescent
Prince George, BC, V2N 2P9
Canada
T: +1 (250) 564-3243

28 September 2022

Geotechnical Data Report

Highway 97 – Cache Creek Culvert Replacement
Cache Creek, BC
Project # KX13772C20

Prepared for:

BC Ministry of Transportation and Infrastructure
Attention: Mr. Michael George, P.Eng.
Senior Geotechnical Engineer
447 Columbia Street
Kamloops, BC, V2C 2T3
Canada

Prepared by:

WSP E&I Canada Limited
3456 Opie Crescent
Prince George, BC, V2N 2P9
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Third-party disclaimer

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List of Appendices

1.0 Introduction

As requested by the British Columbia Ministry of Transportation and Infrastructure (MoTI), WSP E&I Canada Limited (WSP E&I), formerly Wood Environment & Infrastructure Solutions Canada Limited, conducted a geotechnical subsurface investigation for the Highway 97 – Cache Creek Culvert Replacement project. This report summarizes the geotechnical data collected from our geotechnical subsurface investigation. Interpretation of this data, geotechnical assessment and design services are not included within our scope of work and are not included within this report.

Our scope of work was outlined in our proposal document titled Work Plan and Budget Estimate for Geotechnical Engineering Services, Highway 97 over Cache Creek Crossing Culvert Replacement, Cache Creek, BC (Wood File # PK21-016) dated 1 September 2021. Authorization to proceed was provided by Mr. Michael George, P.Eng., Senior Geotechnical Engineer representing MoTI via email on 9 September 2021. This work is being undertaken in accordance with the terms and conditions outlined in Contract 863CS1127 between MoTI and WSP E&I.

2.0 Background

The project site is located along Highway 97 approximately 120 m north of the intersection between Highway 97 and Highway 1 in Cache Creek, BC. The site currently consists of a single pipe arch culvert that accommodates east to west flow of Cache Creek beneath Highway 97. The current culvert crosses beneath Highway 97 at a slight skew of approximately 75 to 80 degrees relative to the highway centerline. The highway road surface is approximately 20 m wide and consists of four lanes and a painted divider lane above the culvert crossing. Upstream of the culvert (east of the highway), the creek is bordered by a gas station and parking lot to the north, and a Dairy Queen restaurant and parking lot to the south. The north bank of the creek channel is vegetated and rises to the adjacent parking lot at a slope of approximately 2H:1V. The south bank of the creek on the upstream side of the highway culvert crossing is lined by a near vertical gabion wall that is approximately 3 m to 4 m in height. The gabion wall retains soils underlying the Dairy Queen parking lot and entranceway. On the downstream side of the highway, the creek is bordered by Cache Creek Secondary School to the north and another gas station and parking area to the south. The creek is generally about 3 m below the elevation of the highway, with approximate side slopes of 2H:1V. The highway alignment through the site is relatively flat with the highway gently decreasing in elevation from north to south towards Highway 1.

It is understood that MoTI is proposing to upgrade the existing culvert to accommodate increasing flow rates that are expected following improvements that the Village of Cache Creek are proposing to culverts located upstream of the highway crossing.

Our geotechnical investigation was conducted to provide subsurface information on each side of the existing culvert (north and south of the culvert) to support future design and construction phases.

3.0 Geotechnical Investigation Methodology

Our geotechnical investigation comprised subsurface drilling and laboratory index testing, as detailed in the following sections.

3.1 Subsurface Drilling Investigation

A total of two boreholes were drilled through centerline of Highway 97 on either side of the existing culvert. Prior to the completing the drilling investigation, WSP E&I obtained tickets and underground utility information from BC One Call and DigShaw. WSP E&I also retained Quadra Utility Locating Ltd. to

conduct a third-party scan of the proposed borehole locations prior to drilling to verify clearance of underground utilities on 17th September 2021. WSP E&I prepared and communicated a site-specific Health and Safety Plan to our field representatives and subcontractors prior to engaging in field activities. The field work was conducted under the supervision of a member of WSP E&I's geotechnical staff who managed the Health and Safety of the site, managed subcontractors, observed borehole drilling including recording soil and groundwater conditions within the boreholes, and obtained representative samples for further classification and laboratory testing.

The first borehole (BH21-01) was advanced to a depth of 15.2 m on the south side of the existing culvert, and the second borehole was advanced to a depth of 30.2 m on the north side of the existing culvert. Both boreholes were drilled in the painted separator lane located between the northbound and southbound traffic lanes because there were buried utilities identified below the other highway lanes. The two boreholes were advanced using a track-mounted sonic drill rig owned and operated by Mud Bay Drilling Co. Ltd. on the 17th and 18th of September 2021. The approximate location of each borehole was obtained in the field using hand-held GPS (typically accurate to +/- 5 m). The borehole locations are included in Figure 1 and UTM coordinates of the boreholes are included on the borehole logs, presented in Appendix A.

Soil samples were collected using a large diameter split barrel sampler (76 mm diameter) driven into the ground by a 63.5 kg weight falling 0.76 m. After the sampler is driven 150 mm into the ground, the number of blows required for the sampler to penetrate an additional 300 mm is recorded. For the purposes of this project this type of sampling was referred to as LPT sampling. The LPT values shown on the borehole logs in Appendix A are directly recorded values and as such, are uncorrected for energy, hammer size, efficiency, and other influencing factors. It should be noted that the use of Sonic drilling with the large diameter split spoon sampler does not satisfy the American Standards Testing Method (ASTM) requirement for this type of in-situ testing and as such, caution and engineering judgement should be applied when interpreting the blow counts obtained by this method.

Upon completion, the boreholes were backfilled with a combination of cuttings and bentonite in general conformance with the BC Groundwater Protection Regulations.

3.2 Laboratory Index Testing

Following completion of the drilling investigation, select representative samples were submitted to WSP's Kamloops laboratory for soils index testing. The index testing conducted included:

- Natural Moisture Content Determinations (ASTM D2216-19)
- Grain Size Distribution Analyses (ASTM C117-17)

The results of the index testing are summarized in the following section and are included on both the borehole logs presented in Appendix A and the detailed laboratory result sheets provided in Appendix B.

4.0 Subsurface Conditions

The following subsurface conditions are summarized from observations and results of the geotechnical drilling and laboratory index testing conducted. These conditions are not considered a comprehensive site characterization, but rather a factual summary of the data obtained.

Fills: In BH22-02, up to 0.9 m of pavement structure sand and gravel fill was identified directly below the highway asphalt pavement. The pavement structure sand and gravel fill was underlain by variable road embankment fill to a depth of approximately 4.0 m below the road surface. In BH22-01, pavement

structure fill could not be distinguished from the embankment fill, with fill being identified to a depth of approximately 3.7 m below the road surface.

The road pavement structure fill appeared to be dense and consisted of mainly sand and gravel with trace silt. The road embankment fill mainly consisted of sand and gravel with trace to some silt and isolated cobbles. The road embankment fill was generally compact to dense, damp, and light grey to brown in colour.

Uncorrected LPT blow counts recorded in the fill ranged from 11 to 43, and a grain size distribution test completed on a sample of the embankment fill from BH21-02 indicated that this material consisted of 67% gravel, 29% sand and 4% fines (material passing the 0.075 mm sieve). Natural moisture contents for the fill ranged from 4% to 6%.

Interbedded Sand and Gravel to Gravelly Sand Deposits: Underlying the highway pavement structure and road embankment fill were granular deposits that ranged from sand and gravel to gravelly sand. These deposits generally consisted of sand and gravel with some silt and isolated cobbles, though there were occasional interbeds of silty sand with trace to some clay. There were also thin clay interbeds up to 300 mm thick observed within the coarser sand and gravel deposits in BH21-02 between depths of 9.5 m to 17.7 m below the current road surface.

The sand and gravel deposits where typically compact to very dense, moist to wet, and light grey to brown. Uncorrected LPT blow counts recorded in the sand and gravels ranged from 8 to greater than 50. A total of six grain size distribution tests were completed on samples of the sand and gravel that were collected from various depths in the two boreholes. The grain size distribution tests indicated that the soil samples consisted of 35% to 67% gravel, 25% to 44% sand and 3% to 24% fines (particles passing the 0.075 mm sieve). Moisture contents of these sand and gravel deposits generally ranged from 3% to 19%, with one higher water content of 30% being recorded in a siltier seam encountered at a depth of approximately 24.2 m in BH21-02.

Interbedded Sand, Silt and Clay: In BH22-02, below 27 m depth, interbedded sand, silt, and clay was encountered. The interbedded layers were generally less than 1 m thick and varied in composition between fine grained sand, sand with trace silt, and low plastic silty clay. An uncorrected LPT blow count of 6 was recorded in the low plastic silty clay. The silty clay had a measured natural water content of 42%. The interbedded sand, silt and clay was encountered to the bottom of BH22-02 at 30.2 m depth.

Groundwater: Groundwater is likely influenced by the water level in the creek, about 3 m to 4 m below the elevation of the highway.

5.0 Closure

This report is subject to the attached limitations in Appendix C.

This report has been prepared for the exclusive use of the BC Ministry of Transportation and Infrastructure, for the specific application described herein. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. WSP E&I Canada Limited accepts no responsibility for damages suffered by any third party as a result of decisions made or actions based on this report.

Respectfully Submitted,

WSP E&I Canada Limited

Prepared by:

2022-09-28

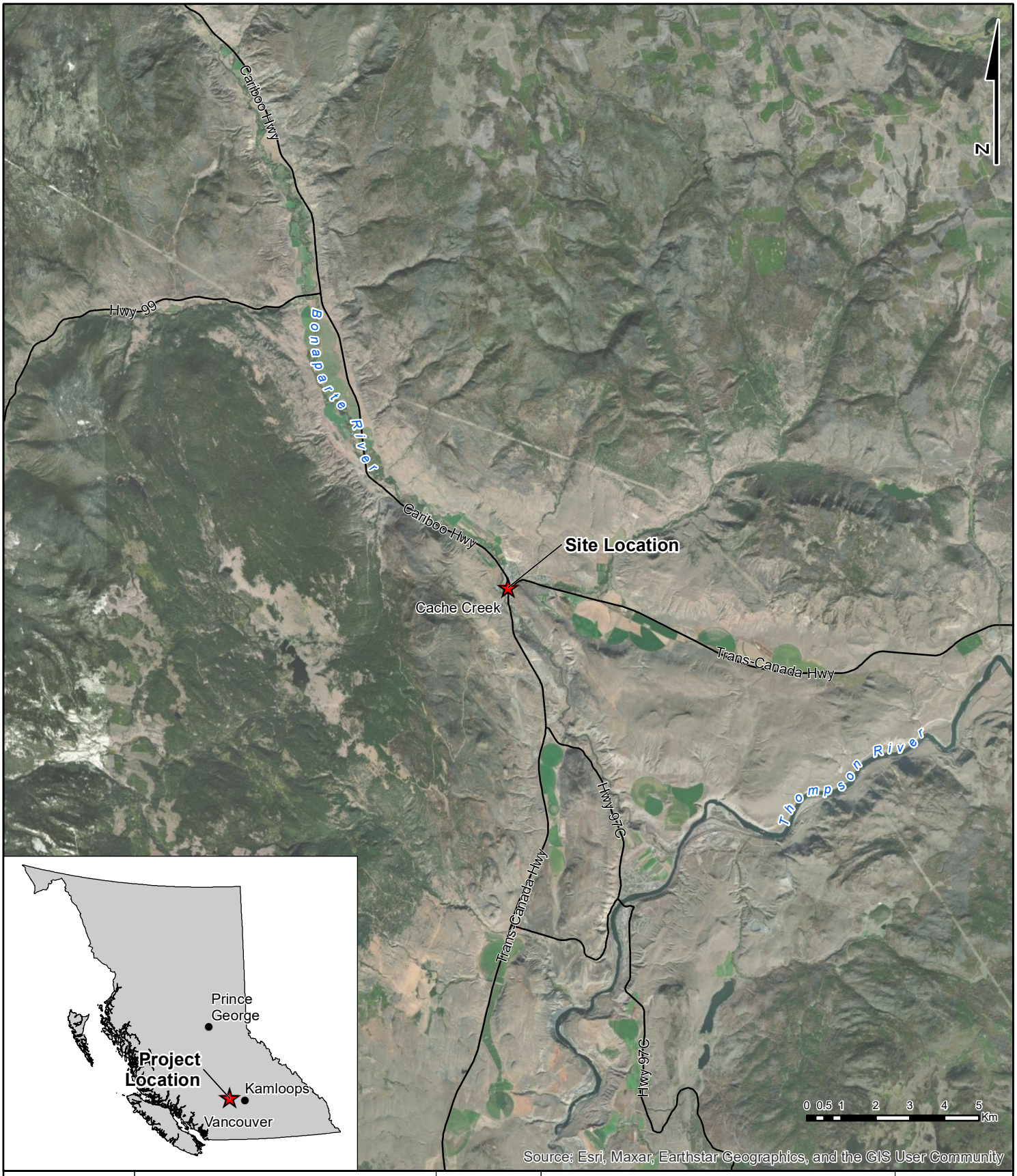
Craig Banks, P.Eng.
Senior Geotechnical Engineer

Reviewed by:

Eric Mohlmann, P.Eng.
Associate Geotechnical Engineer

PERMIT TO PRACTICE
WSP E&I Canada Limited
Authorized By: Craig Banks
Signature:
Date: 2022-09-28
PERMIT NUMBER: 1004452
Engineers and Geoscientists
British Columbia

Figures



WSP	CLIENT: BC MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE	DWN BY: BB CHK'D BY: CB	TITLE: SITE LOCATION PLAN	DATE: SEPTEMBER 2022 PROJECT NO.: KX13772C20
	WSP E&I Canada Limited 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	DATUM: NAD 83 PROJECTION: UTM Zone 10 MAIN VIEW SCALE: 1:150,000	PROJECT: CACHE CREEK CULVERT REPLACEMENT	REV NO.: A FIGURE 1

S:\External\KX13772C20-MoTI-CacheCreek-Hwy97-CulvReplacem-GIS\KX13772C20-Fig1-SiteLocationPlan.mxd

This drawing was originally produced in colour.

CLIENT: BC MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE	DWN BY: BB	TITLE: SITE PLAN	DATE: SEPTEMBER 2022	
	CHK'D BY: CB		PROJECT NO.: KX13772C20	
WSP E&I Canada Limited 3456 Opie Crescent Prince George, BC, CANADA V2N 2P9 Tel. (250) 564-3243 Fax (250) 562-7045	DATUM: NAD 83	PROJECT: CACHE CREEK CULVERT REPLACEMENT	REV NO.: A	
	PROJECTION: UTM Zone 10			
	SCALE: 1:1,250		FIGURE 2	

S:\External\KX13772C20-MoTI-CacheCreek-Hwy97-CulvReplacem-GIS\KX13772C20-Fig2-SitePlan.mxd

This drawing was originally produced in colour.

Appendix A – Borehole Logs

SUMMARY LOG

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Drill Hole #: BH21-01

Project: **Cache Creek Culvert Replacement**
Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd
Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a
Northing/Easting: 5630030 , 617991 Station/Offset: Hwy C/L
Elevation: 463.2 m *Coordinates taken with GPS*

Date(s) Drilled: 09/17/2021
Company: MudBay Drilling
Driller:
Drill Make/Model: Track
Drilling Method: Sonic with LPT

DEPTH (m)	DRILLING DETAILS (L P T)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 — LPT(BLOWS/300 mm) — Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate {G % S % F %}	ELEVATION (m)
0							ASPHALT			463
							0.3m			
1	9 15 19 18	4 · 34 · 15		G-1 G-2			SAND and GRAVEL, trace silt, isolated cobbles, compact to dense, maximum particle size = 100 mm, round to sub-rounded, light grey to brown, damp. [FILL]			462
				LPT1	90					
2				G-3				FI		461
3	13 20 23 32	6 · 43 · 19		LPT2	50					460
							3.7m			
4		3		G-4			SAND and GRAVEL, trace silt, isolated cobbles, dense to very dense, maximum particle size = 100 mm, round to sub-rounded, grey-brown, moist. - below 4.3 m; wet	SP-GP		459
	7 29 64	>50		LPT3	67					
5							4.9m			458
							SAND and GRAVEL to Gravelly SAND, some silt, isolated cobbles, very dense, sub-rounded, light grey-brown, wet. - below 5.2 m; damp	SP-GP		
		7		G-5			- below 5.6 m; light brown			
6	12 15 11 8	26 · 11		LPT4	67		5.8m SAND, gravelly to some gravel, some silt to silty, occasional cobbles, compact, sub-rounded, brown, wet.		**Sieve** (Sa#G-5) G:35% S:41% F:24%	457
	6.2m ▼									
7		7		G-6			- at 6.7 m; some silt, wet			456
	12 22 27 15	49 · 21		LPT5	55					
8							- at 7.9 m; some gravel, some silt, round to sub-rounded			455
				G-7						
9	16 25 18 11	43 · 19		LPT6	60		- at 9.1 m; isolated cobbles			454
10				G-8						

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: 15.2 m
Depth to Top of Rock:

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

SUMMARY LOG

Drill Hole #: **BH21-01**

Ministry of Transportation and Infrastructure

Project: **Cache Creek Culvert Replacement**

Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd

Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a

Northing/Easting: 5630030 , 617991 Station/Offset: Hwy C/L

Elevation: 463.2 m *Coordinates taken with GPS*

Date(s) Drilled: 09/17/2021

Company: MudBay Drilling

Driller:

Drill Make/Model: Track

Drilling Method: Sonic with LPT

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 ; LPT(BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10	6 11 11 11	22 9		G-9			SAND, gravelly to some gravel, some silt to silty, occasional cobbles, compact, sub-rounded, brown, wet. *(continued)*	SM3-SM4		453
				LPT7	15		- at 10.2 m; 200 mm olive grey weathered boulder			
11		19		G-10			- from 11.0 to 11.9 m; silty sand, light brown			452
12	6 16 30 16	46 20		LPT8	50					451
				G-11			- from 12.5 m to 12.8 m; trace to some gravel, round, trace silt			
13										450
14				G-12						449
15				G-13			15.2m			448
							End of borehole at 15.2 m. Backfilled with bentonite. Asphalt patch used.			
16										447
17										446
18										445
19										444
20										

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: 15.2 m

Depth to Top of Rock:

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

SUMMARY LOG

Drill Hole #: **BH21-02**

Ministry of Transportation and Infrastructure

Project: **Cache Creek Culvert Replacement**

Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd

Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a

Northing/Easting: 5630024 , 617992 Station/Offset: Hwy C/L

Elevation: 463.2 m *Coordinates taken with GPS*

Date(s) Drilled: 09/16/2021

Company: MudBay Drilling

Driller:

Drill Make/Model: Track

Drilling Method: Sonic with LPT

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 / LPT(BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							ASPHALT 0.3m	AS		463
				G-1			SAND and GRAVEL, trace silt, compact to desne, maximum particle size = 25 mm, brown, damp. [Base Course] 0.6m	GW-SW		
				G-2						
1				G-3			SAND and GRAVEL, trace silt, compact to dense, maximum particle size = 75 mm, light brown to brown, damp. [Sub Base Course] 0.9m	GW-SW		462
	4									
	15 20 22 20	42 18 18.0		LPT1	67		SAND and GRAVEL, trace to some silt, compact to dense, light brown-grey, damp. [FILL]			
2										461
	5			G-4				GW-SW	**Sieve** (Sa#G-4) G:67% S:29% F:4%	
	7 6 5 6	rock in split spoon		LPT2	0					
3										460
4				G-5			Gravelly SAND, trace to some fines, occasional cobbles, compact, maximum particle size = 130 mm, light grey, damp. 4.0m			459
	3									
5				G-6						458
				G-7					**Sieve** (Sa#G-7) G:64% S:25% F:11%	
	5									
6	17 37 30 15	rock in split spoon		LPT3	5					457
	6.1m ▼			G-8					**Sieve** (Sa#G-8) G:57% S:26% F:17%	
	8									
7				G-9			- from 6.9 m to 8.2 m; sand and gravel, trace to some fines, maximum particle size = 75 mm, dark grey-brown, wet.			456
	6									
8										455
				G-10						
9	8 3 5 13	8 3 18 15 13.3		LPT4	60					454
				G-11			- from 9.5 m to 15 m; gravelly sand with no fines alternating with up to 0.3 m thick layers of clayey, gravelly sand, wet.			
10										

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: 30.2 m

Depth to Top of Rock:

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

SUMMARY LOG

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Drill Hole #: BH21-02

Project: **Cache Creek Culvert Replacement**
Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd
Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a
Northing/Easting: 5630024 , 617992 Station/Offset: Hwy C/L
Elevation: 463.2 m *Coordinates taken with GPS*

Date(s) Drilled: 09/16/2021
Company: MudBay Drilling
Driller:
Drill Make/Model: Track
Drilling Method: Sonic with LPT

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 / LPT(BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate {G % S % F %}	ELEVATION (m)
10							Gravelly SAND, trace to some fines, occasional cobbles, compact, maximum particle size = 130 mm, light grey, damp. *(continued)*			453
11		11		G-12						
				G-13			- below 11.5 m; trace fines		**Sieve** (Sa#G-13) G:47% S:44% F:9%	452
12	24 23 23 35	rock in split spoon >>		LPT5	0					451
13				G-14						
		10		G-15						450
14										
				G-16						449
15	18 25 27 23	9 52 22 18 18.3		LPT6	67		- below 15 m; trace to some fines, occasional cobbles, maximum particle size = 130 mm.	GP-SP		448
16				G-17						447
17				G-18						
							- at 17.5 m; 200 mm clay layer.			446
18	15 18 9 12	10 27 11 16 17.4		LPT7	67					445
19				G-19						444
20										

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: 30.2 m
Depth to Top of Rock:

SUMMARY LOG

Ministry of Transportation and Infrastructure

Drill Hole #: **BH21-02**

Project: **Cache Creek Culvert Replacement**

Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd

Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a

Northing/Easting: 5630024 , 617992 Station/Offset: Hwy C/L

Elevation: 463.2 m *Coordinates taken with GPS*

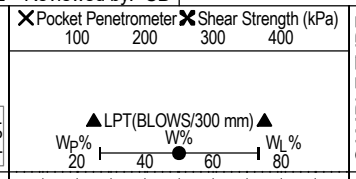
Date(s) Drilled: 09/16/2021

Company: MudBay Drilling

Driller:

Drill Make/Model: Track

Drilling Method: Sonic with LPT



DEPTH (m)	DRILLING DETAILS	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
20			G-20			Gravelly SAND, trace to some fines, occasional cobbles, compact, maximum particle size = 130 mm, light grey, damp. *(continued)*			443
21	10 11 10 13		LPT8	57		- below 21.6 m; trace silt, isolated cobbles, loose, maximum particle size = 100 mm, dark grey, wet.			442
22			G-21					**Sieve** (Sa#G-21) G:64% S:33% F:3%	441
23			G-22			- below 22.7 m; 500 mm sand (fine grained) layer, some silt to silty, loose, light brown, wet.			
24	8 6 8 9		G-23			- below 23.2 m; sand, occasional cobbles, some gravel, trace silt, loose, light brown.		**Sieve** (Sa#G-23) G:58% S:36% F:6%	440
			G-24						
			LPT9	40		- below 23.9 m; sand (fine to coarse grained), some silt, compact, dark grey with some olive colouring, moist, slow dilatency			439
25			G-25						438
26			G-26						437
27	3 2 4 9		LPT10	100		27.0m Silty CLAY, low plastic, very stiff, brown, moist.	CL		436
28			G-27			27.7m SAND (fine grained), trace silt, compact, dark grey, moist.	SM1		435
29			G-28			28.4m Sandy SILT (fine grained), compact, grey-brown, moist.	SM4		434
30			G-29			29.3m SAND (fine grained), trace silt, compact, dark grey, moist.	SM1		

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: 30.2 m

Depth to Top of Rock:

SUMMARY LOG

Ministry of Transportation and Infrastructure

Drill Hole #: **BH21-02**

Project: **Cache Creek Culvert Replacement**

Location: Cache Creek, BC

Prepared by: KX13772C20 WSP E&I Canada Ltd

Logged by: DL Reviewed by: CB

Datum: NAD83 Alignment: n/a

Northing/Easting: 5630024 , 617992 Station/Offset: Hwy C/L

Elevation: 463.2 m *Coordinates taken with GPS*

Date(s) Drilled: 09/16/2021

Company: MudBay Drilling

Driller:

Drill Make/Model: Track

Drilling Method: Sonic with LPT

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; LPT(BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
30							30.2m End of borehole at 30.2 m. Backfilled with bentonite. Asphalt patch used.			433
31										432
32										431
33										430
34										429
35										428
36										427
37										426
38										425
39										424
40										

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: 30.2 m

Depth to Top of Rock:

MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPJ MOTI_DATATEMPLATE_REV3.GDT 9/28/22

Appendix B – Laboratory Testing Results

MOISTURE CONTENT DETERMINATION

Project: KX13772C20.02
Lab 21- 277 / Cache Creek
Technician: RS
Date: October 8, 2021

Hole No.	BH21-01 G2	BH21-01 LPT2	BH21-01 G4	BH21-01 G4	BH21-01 G6
Depth(ft)	3-4	9-11	12-14	18-19	22-23
Tare No.	GJ23	FORD14	STS16	ETCH	FORD18
Wt. Sple. Wet + Tare	717.1	611.5	693.7	2247.5	824.1
Wt. Sple. Dry + Tare	693.0	580.3	671.6	2122.0	774.8
Wt. Water	24.1	31.2	22.1	125.5	49.3
Tare Container	14.7	14.9	14.7	303.2	14.9
Wt. Dry Sample	678.3	565.4	656.9	1818.8	759.9
Moist. Cont. %	3.6%	5.5%	3.4%	6.9%	6.5%
Hole No.	BH21-01 G10	BH21-02 G3	BH21-02 G4	BH21-02 G5	BH21-02 G7
Depth(ft)	37-39	3-4	7.5-8.5	13-14	18-19
Tare No.	STS35	206	VI	GM46	XY3
Wt. Sple. Wet + Tare	419.2	783.0	2251.1	925.1	2433.4
Wt. Sple. Dry + Tare	353.9	756.2	2171.3	899.0	2333.0
Wt. Water	65.3	26.8	79.8	26.1	100.4
Tare Container	14.7	15.0	394.3	15.5	405.1
Wt. Dry Sample	339.2	741.2	1777.0	883.5	1927.9
Moist. Cont. %	19.3%	3.6%	4.5%	3.0%	5.2%
Hole No.	BH21-02 G8	BH21-02 G9	BH21-02 LPT4	BH21-02 G15	BH21-02 LPT6
Depth(ft)	21-22	23-24	29-31	44.5-46	49-51
Tare No.	22C	220	GM441	FORD20	113
Wt. Sple. Wet + Tare	4006.3	957.2	698.1	1371.9	801.3
Wt. Sple. Dry + Tare	3756.3	905.3	607.9	1254.2	734.8
Wt. Water	250.0	51.9	90.2	117.7	66.5
Tare Container	403.8	15.1	15.4	15.0	15.1
Wt. Dry Sample	3352.5	890.2	592.5	1239.2	719.7
Moist. Cont. %	7.5%	5.8%	15.2%	9.5%	9.2%
Hole No.	BH21-02 LPT7	BH21-02 LPT8	BH21-02 G23	BH21-02 LPT9	BH21-02 LPT10
Depth(ft)	59-61	69-71	77-78	79-81	89-91
Tare No.	GJ46	STS31	BIGTOE	GM02	GM05
Wt. Sple. Wet + Tare	701.1	604.0	3096.0	454.3	706.8
Wt. Sple. Dry + Tare	636.6	548.0	2885.7	352.9	503.4
Wt. Water	64.5	56.0	210.3	101.4	203.4
Tare Container	14.8	15.3	430.8	15.1	14.7
Wt. Dry Sample	621.8	532.7	2454.9	337.8	488.7
Moist. Cont. %	10.4%	10.5%	8.6%	30.0%	41.6%
Hole No.	BH21-02 G13	BH21-02 G21			
Depth(ft)	37-38	72-73			
Tare No.	TS5	J12			
Wt. Sple. Wet + Tare	2561.4	2735.8			
Wt. Sple. Dry + Tare	2358.8	2594.0			
Wt. Water	202.6	141.8			
Tare Container	474.3	541.8			
Wt. Dry Sample	1884.5	2052.2			
Moist. Cont. %	10.8%	6.9%			

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T9

Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-1

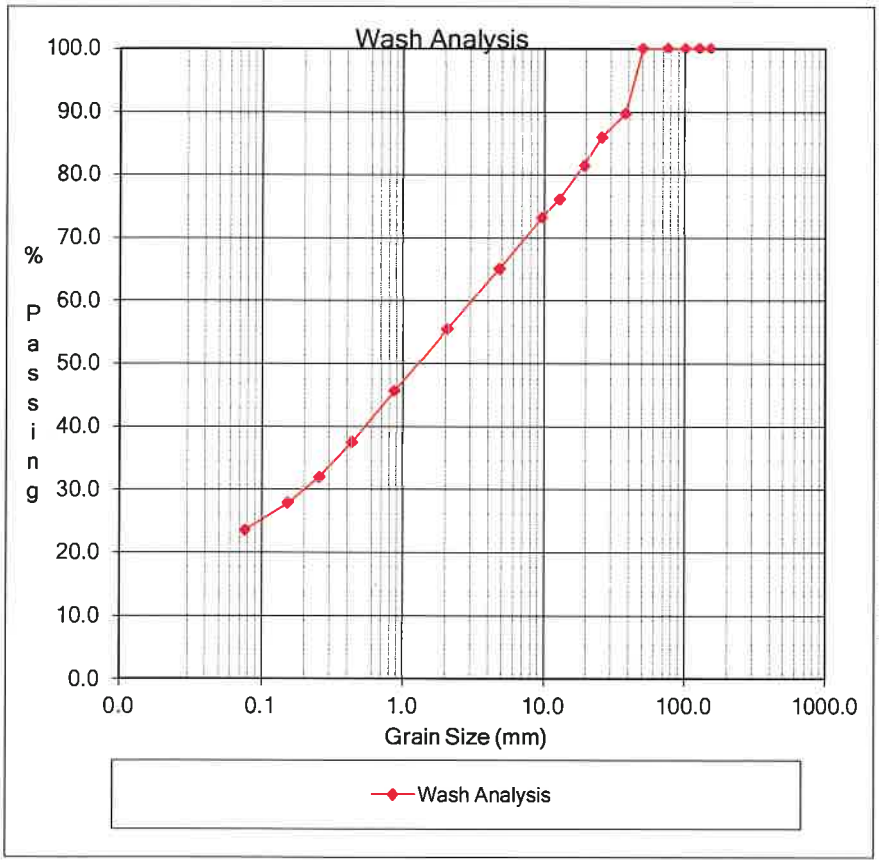
Source: BH 21-01 Sample #4 18'-19'

Sample Type: Grab

Date Sampled: September 17, 2021

Sampled By: DL

Date Tested: October 7, 2021



Wash Sieve Analysis				
Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	0.0	100.0		
37.5	10.3	89.7		
25.0	3.9	85.8		
19.0	4.3	81.5		
12.5	5.5	76.0		
9.5	2.8	73.2		
4.75	8.2	65.1		
2.000	9.7	55.4		
0.850	9.8	45.6		
0.425	8.2	37.4		
0.250	5.5	31.9		
0.150	4.1	27.8		
0.075	4.3	23.5		
PAN	23.5			

Sieve Mass (g): 2958.5

Gravel	34.9 %
Sand	41.6 %
Fines	23.5 %

COMMENTS As Rec'd Wt: 3.15Kg

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T9

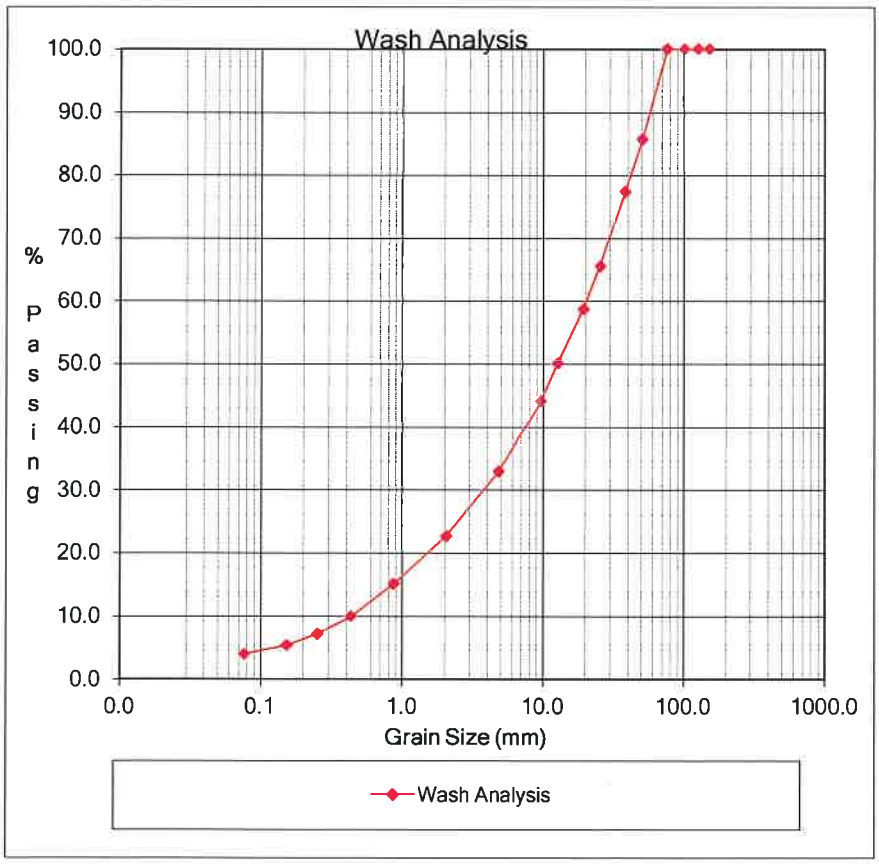
Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-2
Source: BH 21-02 Sample #4 7.5'-8.5'
Sample Type: Grab

Date Sampled: September 18, 2021
Sampled By: DL
Date Tested: October 7, 2021



Wash Sieve Analysis				
Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	14.3	85.7		
37.5	8.4	77.3		
25.0	11.8	65.6		
19.0	6.8	58.8		
12.5	8.7	50.1		
9.5	6.0	44.1		
4.75	11.2	33.0		
2.000	10.3	22.6		
0.850	7.5	15.1		
0.425	5.1	9.9		
0.250	2.8	7.2		
0.150	1.7	5.4		
0.075	1.4	4.0		
PAN	4.0			

Sieve Mass (g): 4041.3

Gravel	67.0 %
Sand	28.9 %
Fines	4.0 %

COMMENTS As Rec'd Wt: 4.2Kg

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T9

Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-3

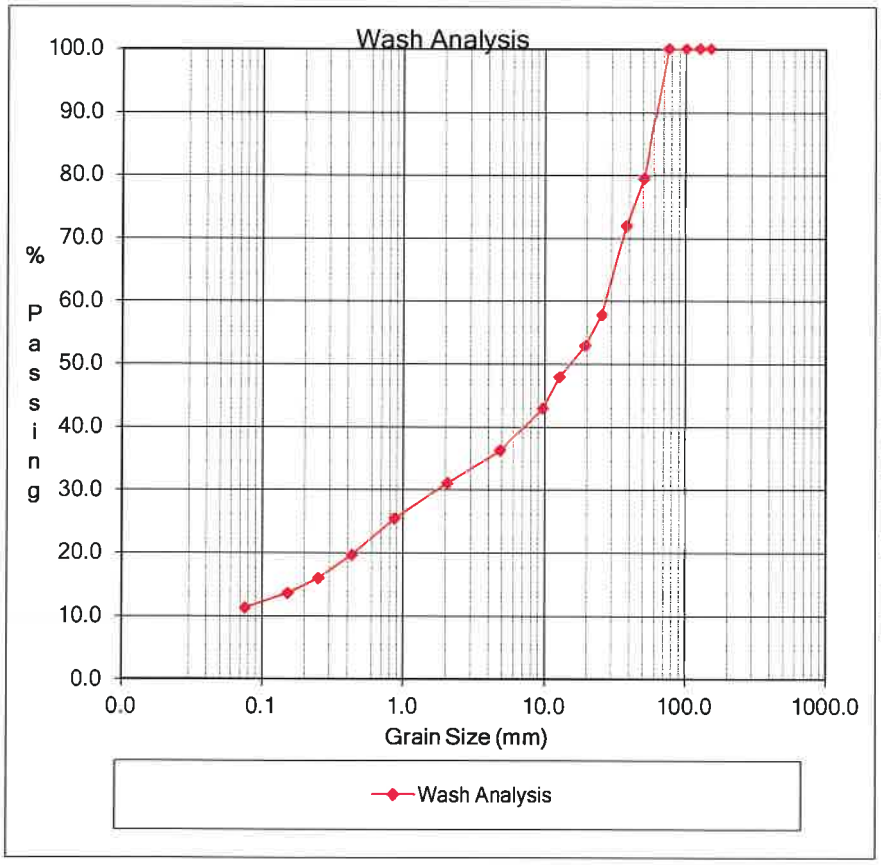
Source: BH21-02 Sample #7 18'-19'

Sample Type: Grab

Date Sampled: September 18, 2021

Sampled By: DL

Date Tested: October 7, 2021



Wash Sieve Analysis				
Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	20.5	79.5		
37.5	7.6	71.9		
25.0	14.1	57.8		
19.0	4.9	52.9		
12.5	4.9	48.0		
9.5	5.0	42.9		
4.75	6.7	36.3		
2.000	5.2	31.1		
0.850	5.6	25.5		
0.425	5.8	19.6		
0.250	3.6	16.0		
0.150	2.5	13.6		
0.075	2.3	11.3		
PAN	11.3			

Sieve Mass (g): 3644.2

Gravel	63.7 %
Sand	25.0 %
Fines	11.3 %

COMMENTS As Rec'd Wt: 3.75Kg

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T9

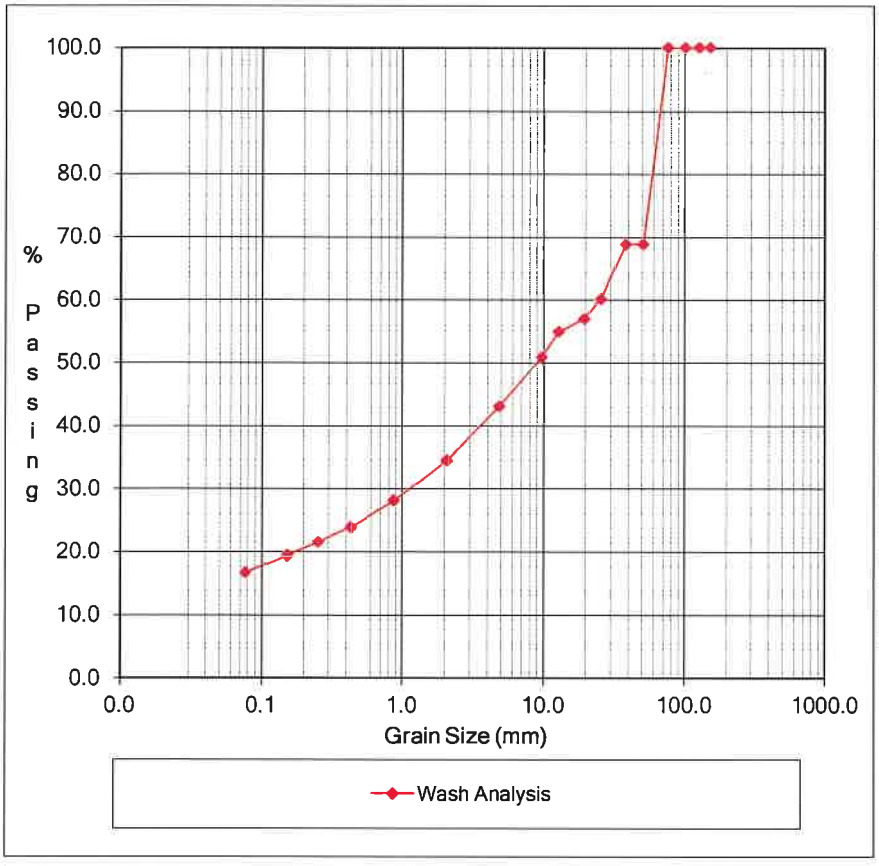
Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-4 Source: BH21-02 Sample #8 21'-22' Sample Type: Grab

Date Sampled: September 18, 2021 By: DL Date Tested: October 7, 2021



Wash Sieve Analysis

Wash Sieve Analysis

Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	31.1	68.9		
37.5	0.0	68.9		
25.0	8.7	60.2		
19.0	3.2	57.0		
12.5	2.1	54.9		
9.5	4.0	50.9		
4.75	7.8	43.1		
2.000	8.6	34.5		
0.850	6.4	28.1		
0.425	4.2	23.9		
0.250	2.4	21.5		
0.150	2.1	19.5		
0.075	2.8	16.7		
PAN	16.7			

Sieve Mass (g): 3352.8

Gravel	56.9 %
Sand	26.4 %
Fines	16.7 %

COMMENTS

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
Kamloops, BC
V2C 2T9

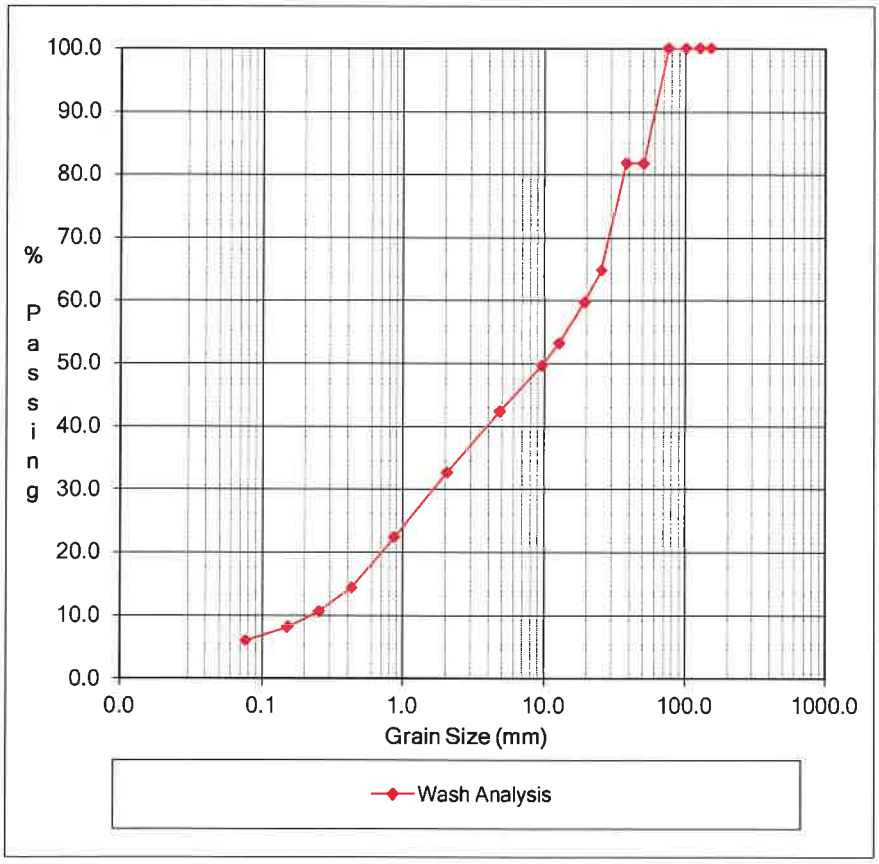
Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-5 Source: BH21-02 Sample #23 77'-78' Sample Type: Grab

Date Sampled: September 18, 2021 By: DL Date Tested: October 7, 2021



Wash Sieve Analysis

Wash Sieve Analysis

Sieve Size(mm)	Percent Retained	Percent Passing	Limits	
			Upper	Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	18.2	81.8		
37.5	0.0	81.8		
25.0	17.0	64.8		
19.0	5.1	59.7		
12.5	6.5	53.2		
9.5	3.5	49.7		
4.75	7.3	42.4		
2.000	9.7	32.6		
0.850	10.3	22.4		
0.425	7.9	14.4		
0.250	3.8	10.6		
0.150	2.5	8.2		
0.075	2.1	6.0		
PAN	6.0			

Sieve Mass (g): 2454.7

Gravel	57.6 %
Sand	36.3 %
Fines	6.0 %

COMMENTS

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

Ministry of Transportation & Infrastructure
447 Columbia Street
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V2C 2T9

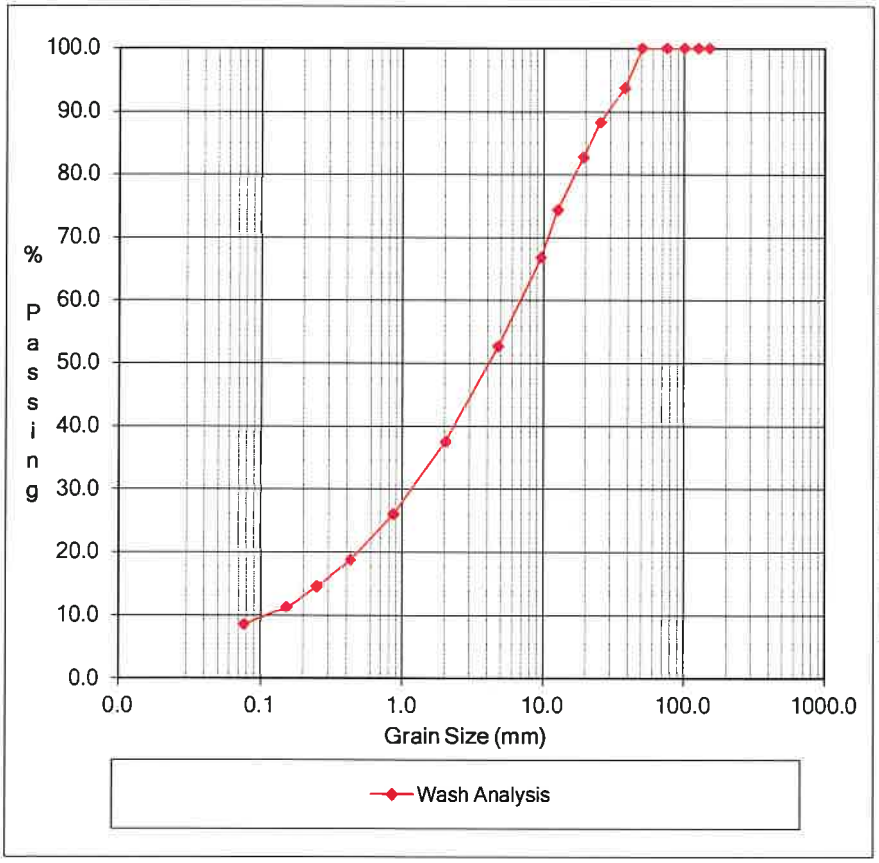
Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-6 Source: BH21-02 Sample #13 37'-38' Sample Type: Grab

Date Sampled: September 18, 2021 By: DL Date Tested: October 7, 2021



Wash Sieve Analysis

Wash Sieve Analysis

Sieve Size(mm)	Percent Retained	Percent Passing	Limits Upper	Limits Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	0.0	100.0		
37.5	6.3	93.7		
25.0	5.5	88.1		
19.0	5.4	82.7		
12.5	8.4	74.4		
9.5	7.6	66.8		
4.75	14.1	52.7		
2.000	15.1	37.6		
0.850	11.6	26.0		
0.425	7.2	18.8		
0.250	4.2	14.6		
0.150	3.2	11.4		
0.075	2.8	8.5		
PAN	8.5			

Sieve Mass (g): 1885.3

Gravel	47.3 %
Sand	44.2 %
Fines	8.5 %

COMMENTS

Wood Environment & Infrastructure Solutions

Per: B. Jackman

GRAIN SIZE DISTRIBUTION

wood.

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447 Columbia Street
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V2C 2T9

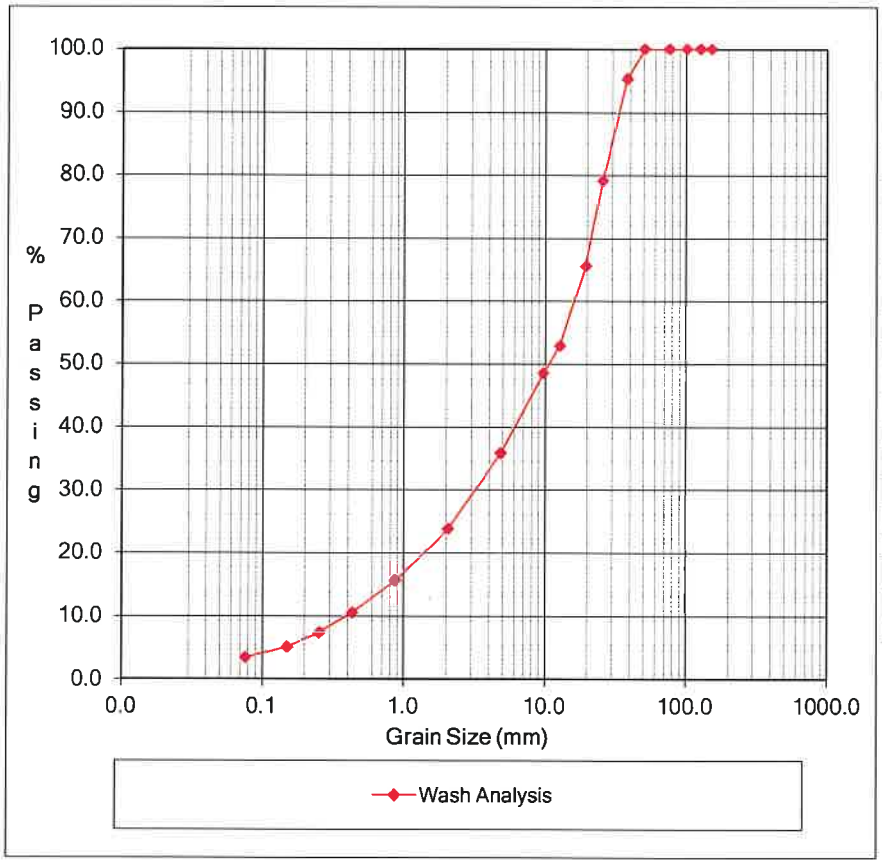
Project No: KX13772C20.02
Date: October 8, 2021
Office: 913 Laval Cres
Kamloops, BC

Attn: David Lang

Project Name: Cache Creek Geo

Test No.: 21-277-7 Source: BH21-02 Sample #21 72'-73' Sample Type: Grab

Date Sampled: September 18, 2021 By: DL Date Tested: October 7, 2021



Wash Sieve Analysis

Wash Sieve Analysis

Sieve Size(mm)	Percent Retained	Percent Passing	Limits Upper	Limits Lower
150.0	0.0	100.0		
125.0	0.0	100.0		
100.0	0.0	100.0		
75.0	0.0	100.0		
50.0	0.0	100.0		
37.5	4.7	95.3		
25.0	16.2	79.1		
19.0	13.5	65.6		
12.5	12.6	53.0		
9.5	4.4	48.5		
4.75	12.7	35.9		
2.000	12.0	23.8		
0.850	8.2	15.6		
0.425	5.1	10.6		
0.250	3.1	7.5		
0.150	2.2	5.3		
0.075	1.9	3.4		
PAN	3.4			

Sieve Mass (g): 2052.5

Gravel	64.1 %
Sand	32.5 %
Fines	3.4 %

COMMENTS

Wood Environment & Infrastructure Solutions

Per: B. Jackman

Appendix C – Limitations

Limitations:

1. The work performed in the preparation of this report and the conclusions presented are subject to the following:

   a) The contract between WSP E&I Canada Limited and the Client, including any subsequent written amendment or Change Order duly signed by the parties (hereinafter together referred as the "Contract");

   b) Any and all time, budgetary, access and/or site disturbance, risk management preferences, constraints or restrictions as described in the contract, in this report, or in any subsequent communication sent by Wood to the Client in connection to the Contract; and

   c) The limitations stated herein.

2. **Standard of care:** WSP E&I Canada Limited has prepared this report in a manner consistent with the level of skill and are ordinarily exercised by reputable members of WSP E&I Canada Limited profession, practicing in the same or similar locality at the time of performance, and subject to the time limits and physical constraints applicable to the scope of work, and terms and conditions for this assignment. No other warranty, guaranty, or representation, expressed or implied, is made or intended in this report, or in any other communication (oral or written) related to this project. The same are specifically disclaimed, including the implied warranties of merchantability and fitness for a particular purpose.

3. **Limited locations:** The information contained in this report is restricted to the site and structures evaluated by WSP E&I Canada Limited and to the topics specifically discussed in it, and is not applicable to any other aspects, areas, or locations.

4. **Information utilized:** The information, conclusions and estimates contained in this report are based exclusively on: i) information available at the time of preparation, ii) the accuracy and completeness of data supplied by the Client or by third parties as instructed by the Client, and iii) the assumptions, conditions, and qualifications/limitations set forth in this report.

5. **Accuracy of information:** No attempt has been made to verify the accuracy of any information provided by the Client or third parties, except as specifically stated in this report (hereinafter "Supplied Data"). WSP E&I Canada Limited cannot be held responsible for any loss or damage, of either contractual or extra-contractual nature, resulting from conclusions that are based upon reliance on the Supplied Data.

6. **Report interpretation:** This report must be read and interpreted in its entirety, as some sections could be inaccurately interpreted when taken individually or out-of-context. The contents of this report are based upon the conditions known and information provided as of the date of preparation. The text of the final version of this report supersedes any other previous versions produced by WSP E&I Canada Limited.

7. **No legal representations:** WSP E&I Canada Limited makes no representations whatsoever concerning the legal significance of its findings, or as to other legal matters touched on in this report, including but not limited to, ownership of any property, or the application of any law to the facts set forth herein. With respect to regulatory compliance issues, regulatory statutes are subject to

interpretation and change. Such interpretations and regulatory changes should be reviewed with legal counsel.

8. **Decrease in property value:** WSP E&I Canada Limited shall not be responsible for any decrease, real or perceived, of the property or site's value or failure to complete a transaction, as a consequence of the information contained in this report.

9. **No third-party reliance:** This report is for the sole use of the party to whom it is addressed unless expressly stated otherwise in the report or Contract. Any use or reproduction which any third party makes of the report, in whole or in part, or any reliance thereon or decisions made based on any information or conclusions in the report is the sole responsibility of such third party. WSP E&I Canada Limited does not represent or warrant the accuracy, completeness, merchantability, fitness for purpose or usefulness of this document, or any information contained in this document, for use or consideration by any third party. WSP E&I Canada Limited accepts no responsibility whatsoever for damages or loss of any nature or kind suffered by any such third party as a result of actions taken or not taken or decisions made in reliance on this report or anything set out therein. including without limitation, any indirect, special, incidental, punitive, or consequential loss, liability or damage of any kind.

10. **Assumptions:** Where design recommendations are given in this report, they apply only if the project contemplated by the Client is constructed substantially in accordance with the details stated in this report. It is the sole responsibility of the Client to provide to WSP E&I Canada Limited changes made in the project, including but not limited to, details in the design, conditions, engineering, or construction that could in any manner whatsoever impact the validity of the recommendations made in the report. WSP E&I Canada Limited shall be entitled to additional compensation from Client to review and assess the effect of such changes to the project.

11. **Time dependence:** If the project contemplated by the Client is not undertaken within a period of 18 months following the submission of this report, or within the time frame understood by WSP E&I Canada Limited to be contemplated by the Client at the commencement of WSP E&I Canada Limited's assignment, and/or, if any changes are made, for example, to the elevation, design or nature of any development on the site, its size and configuration, the location of any development on the site and its orientation, the use of the site, performance criteria and the location of any physical infrastructure, the conclusions and recommendations presented herein should not be considered valid unless the impact of the said changes is evaluated by WSP E&I Canada Limited, and the conclusions of the report are amended or are validated in writing accordingly.

    Advancements in the practice of geotechnical engineering, engineering geology and hydrogeology and changes in applicable regulations, standards, codes or criteria could impact the contents of the report, in which case, a supplementary report may be required. The requirements for such a review remain the sole responsibility of the Client or their agents.

    WSP E&I Canada Limited will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

12. **Limitations of visual inspections:** Where conclusions and recommendations are given based on a visual inspection conducted by WSP E&I Canada Limited, they relate only to the natural or man-made structures, slopes, etc. inspected at the time the site visit was performed. These conclusions cannot

and are not extended to include those portions of the site or structures, which were not reasonably available, in WSP E&I Canada Limited's opinion, for direct observation.

13. **Limitations of site investigations:** Site exploration identifies specific subsurface conditions only at those points from which samples have been taken and only at the time of the site investigation. Site investigation programs are a professional estimate of the scope of investigation required to provide a general profile of subsurface conditions.

    The data derived from the site investigation program and subsequent laboratory testing are interpreted by trained personnel and extrapolated across the site to form an inferred geological representation and an engineering opinion is rendered about overall subsurface conditions and their likely behaviour with regard to the proposed development. Despite this investigation, conditions between and beyond the borehole/test hole locations may differ from those encountered at the borehole/test hole locations and the actual conditions at the site might differ from those inferred to exist, since no subsurface exploration program, no matter how comprehensive, can reveal all subsurface details and anomalies.

    Final sub-surface/bore/profile logs are developed by geotechnical engineers based upon their interpretation of field logs and laboratory evaluation of field samples. Customarily, only the final bore/profile logs are included in geotechnical engineering reports.

    Bedrock, soil properties and groundwater conditions can be significantly altered by environmental remediation and/or construction activities such as the use of heavy equipment or machinery, excavation, blasting, pile-driving or draining or other activities conducted either directly on site or on adjacent terrain. These properties can also be indirectly affected by exposure to unfavorable natural events or weather conditions, including freezing, drought, precipitation and snowmelt.

    During construction, excavation is frequently undertaken which exposes the actual subsurface and groundwater conditions between and beyond the test locations, which may differ from those encountered at the test locations. It is recommended that WSP E&I Canada Limited be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered at the test locations, that construction work has no negative impact on the geotechnical aspects of the design, to adjust recommendations in accordance with conditions as additional site information is gained, and to deal quickly with geotechnical considerations if they arise.

    Interpretations and recommendations presented herein may not be valid if an adequate level of review or inspection by WSP E&I Canada Limited is not provided during construction.

14. **Factors that may affect construction methods, costs and scheduling:** The performance of rock and soil materials during construction is greatly influenced by the means and methods of construction. Where comments are made relating to possible methods of construction, construction costs, construction techniques, sequencing, equipment or scheduling, they are intended only for the guidance of the project design professionals, and those responsible for construction monitoring. The number of test holes may not be sufficient to determine the local underground conditions between test locations that may affect construction costs, construction techniques, sequencing, equipment, scheduling, operational planning, etc.

    Any contractors bidding on or undertaking the works should draw their own conclusions as to how the subsurface and groundwater conditions may affect their work, based on their own investigations and interpretations of the factual soil data, groundwater observations, and other factual information.

15. **Groundwater and Dewatering:** WSP E&I Canada Limited will accept no responsibility for the effects of drainage and/or dewatering measures if WSP E&I Canada Limited has not been specifically consulted and involved in the design and monitoring of the drainage and/or dewatering system.
16. **Environmental and Hazardous Materials Aspects:** Unless otherwise stated, the information contained in this report in no way reflects on the environmental aspects of this project, since this aspect is beyond the Scope of Work and the Contract. Unless expressly included in the Scope of Work, this report specifically excludes the identification or interpretation of environmental conditions such as contamination, hazardous materials, wild life conditions, rare plants or archeology conditions that may affect use or design at the site. This report specifically excludes the investigation, detection, prevention or assessment of conditions that can contribute to moisture, mould or other microbial contaminant growth and/or other moisture related deterioration, such as corrosion, decay, rot in buildings or their surroundings. Any statements in this report or on the boring logs regarding odours, colours, and unusual or suspicious items or conditions are strictly for informational purposes.
17. **Sample Disposal:** WSP E&I Canada Limited will dispose of all uncontaminated soil and rock samples after 30 days following the release of the final geotechnical report. Should the Client request that the samples be retained for a longer time, the Client will be billed for such storage at an agreed upon rate. Contaminated samples of soil, rock or groundwater are the property of the Client, and the Client will be responsible for the proper disposal of these samples, unless previously arranged for with WSP E&I Canada Limited or a third party.