

### REPORT

## **Geotechnical Data Report**

Cariboo Roads Recovery Project - Cache Creek Culvert Replacement

Submitted to:

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### **1.0 INTRODUCTION**

As per the request from Urban Systems Ltd. (USL), WSP Canada Inc. (WSP) has conducted a supplementary geotechnical investigation to obtain additional soil samples as well as to complement the findings of WSP E&I's Cache Creek Culvert Replacement Geotechnical Report dated 28 September 2022.

This supplementary investigation took place on 09 August 2023, as part of the Multi-Disciplinary Team (MDT) engaged in the 'Caribou Roads Recovery Project' contract. This contract, dated 28 October 2022, is between the Ministry of Transportation and Infrastructure (MoTI) and USL, identified by the contract reference number 268 CS 1825. Specifically, the focus of this report is on the Cache Creek culvert site (the Site).

WSP was granted authorization to carry out this supplementary geotechnical investigation following acceptance of WSP's work plan, reference number 26239\_ge\_sow\_sampling\_work-plan\_20230809. This supplementary investigation involved drilling a single borehole (BH23-01) along the centerline of Highway 97, situated about 6.0 m north of the existing Cache Creek culvert. This effort complements the previous September 2021 investigation which entailed two boreholes (BH21-01 and BH21-02) drilled along Highway 97's centerline, about 1.0 m north and 2.5 m south of the existing culvert, respectively.

The primary objective of these investigations was to obtain soil samples and assess the sub-surface soil and groundwater conditions at the site. Based on our analysis of this information, we present the factual results of the geotechnical investigation.

It is important to note that the scope of work associated with this report is confined to geotechnical engineering services exclusively. It does not encompass investigations or interpretations of potential soil or groundwater contamination, archaeological findings, hydrogeological and hydrotechnical considerations, or bio-environmental factors.

We urge readers to review the "Important Information and Limitations of this Report" outlined in Appendix A. This section is pivotal for the accurate utilization and interpretation of this report.

### 2.0 SITE DESCRIPTION

The site is positioned approximately 120 meters north of the junction between Highway 97 and Highway 1 in Cache Creek, BC. At present, it features a single pipe culvert designed to facilitate the east-to-west flow of Cache Creek beneath Highway 97. This existing culvert intersects Highway 97 at a slight skew of approximately 75 to 80 degrees in relation to the highway's centerline and is approximately 1,900 mm by 2,400 mm in size. The highway's road surface spans roughly 20 meters in width, encompassing four lanes along with a delineated divider lane situated above the culvert crossing.

On the upstream side, the northern bank of the creek channel is vegetated and ascends to the adjacent parking lot with a slope gradient of roughly 2 horizontal units to 1 vertical unit (2H:1V). Conversely, the southern bank of the creek, situated upstream of the highway culvert crossing, is bordered by a nearly vertical gabion wall reaching heights of about 3 to 4 meters.

Moving downstream, the slopes flanking both sides of the creek channel maintain an inclination of approximately 2H:1V. These slopes adjacent to the highway culvert crossing are fortified by riprap and nonwoven geotextile. Notably, sections of these slope areas have experienced significant erosion, leading to the full exposure of the

underlying nonwoven geotextile material. Specifically, the southern side of the creek channel, perpendicular to Highway 97, has eroded to an extent where the asphalt of an adjoining parking lot has been substantially compromised. The chain-link fence that once bordered the side slope has also collapsed into the eroded area.

For visual reference, please consult Figure 1 following the text of this report, which displays the site location as well as the designated borehole positions.

### 3.0 PROJECT UNDERSTANDING

WSP recognizes that MoTI and the MDT are responsible for executing the functional design of the culvert replacement with a single span bridge to accommodate design flows of 46.2 m<sup>3</sup>/s. This geotechnical data report's purpose is to bolster these endeavors by supplying supplementary factual geotechnical investigation data closer to the planned north bridge abutment.

At the time preparing this report, detailed design information pertaining to the culvert replacement design were in draft form; however, it is understood that the culvert replacement will be a single span 4-lane bridge supported by a deep foundation system which will be described under separate cover.

### 4.0 SCOPE OF WORK

WSP's scope of work comprised the following tasks:

- Desktop review of available information pertaining to the geotechnical aspects of the proposed culvert replacement
- Supplementary geotechnical drilling investigation using a track mounted drill rig capable of mud rotary techniques to depths up to approximately 18.1 metres below ground surface (mbgs)
- Geotechnical index testing, soil resistivity, chloride content, and sulphate content on selected soil samples obtained from the investigation program
- Environmental water testing (excluding engineering interpretation or opinion)
- Provision of this geotechnical data report summarizing the investigation results.

### 5.0 BACKGROUND

WSP carried out a review of available background information on the Site to develop an understanding of geotechnical conditions that may impact the Project. The study consisted of a desktop review of information originating from internal WSP libraries and publicly available sources including:

- Surficial geology maps and papers
- Previous geotechnical reports

The findings of WSP's background information review are summarized in the following subsections.

### 5.1 Surficial Geology

WSP conducted a review of surficial geology maps from the British Columbia Geological Survey. The available map<sup>1</sup> indicated that the surficial geology at the site generally comprises of alluvial plain/floodplain deposits of gravels, sands, and minor overbank silt.

### 5.2 Existing Geotechnical Information

From 17-18 September 2021, WSP E&I completed a geotechnical investigation for MoTI comprising two drill holes completed within the vicinity of the existing culvert and general area of the south abutment for the proposed new bridge. Site-specific factual information from the 2021 investigation's report<sup>2</sup> dated 28 September 2022 were reviewed. The 2021 drilling was conducted by use of a sonic drill rig with large penetration test (LPT) capabilities.

### 6.0 GEOTECHNICAL INVESTIGATION

The supplementary geotechnical subsurface investigation was conducted between 9-10 August 2023. It consisted of the advancement of a single borehole within the centreline of Highway 97. The location of the 2023 borehole and the previous 2021 boreholes are presented in Table 1 below, and Figure 1.

Prior to commencement of the investigation, WSP completed a BC1Call and contacted the Village of Cache Creek for as-built records. The provided materials were reviewed in the assessment of the proposed borehole location for potential utilities and other infrastructure. With the proposed borehole location established, WSP retained Universal Traffic Management to develop and implement a traffic management plan in addition to acquiring the permits required for the investigation's scope of work. WSP contracted Quadra Utility Locating Ltd. to complete a utility sweep of the proposed borehole locations using Electromagnetic and Ground Penetrating Radar methods.

WSP retained Westech Drilling Corp. (Westech) to supply, mobilize and operate a Fraste Multidrill PL G trackmounted mini rotary drill rig for the duration of the investigation.

The geotechnical subsurface investigation was conducted with the full-time presence of a member of WSP's geotechnical team and two Bonaparte First Nation cultural monitors. The WSP geotechnical team member located the borehole in the field, logged the soil and groundwater conditions, and collected soil samples for visual classification and geotechnical laboratory testing.

Upon completion of the investigation, WSP located the as-drilled borehole locations using a hand-held GPS typically capable of +/- 5 m accuracy.

<sup>&</sup>lt;sup>1</sup> Ryder, J.M. 1976. Surficial Geology, Ashcroft British Columbia. Geological Survey of Canada, Map 1405A, scale 1:126,720.

<sup>&</sup>lt;sup>2</sup> Banks, C., Mohlmann, E. 2022. Geotechnical Data Report, Highway 97 – Cache Creek Culvert Replacement. WSP Canada Inc, project number KX13772C20.

	Coordinats (UTM	NAD83 Zone 9N) <sup>[1]</sup>	Geodetic Ground	Termination Depth (mbgs**)	
Borehole No.	Northing (m)	Easting (m)	Surface Elevation (masl*) <sup>[2]</sup>		
BH23-01	5630040	617985	463.2	18.1	
BH21-01	5630030	617991	463.2	15.2	
BH21-02	5630024	617992	463.2	30.2	

#### Table 6.1: Summary of Borehole Locations and Depths

masl\* = meters above sea level

mbgs\*\* = meters bellow ground surface

<sup>[1]</sup> UTM NAD 83 10U

<sup>[2]</sup> Based on 2022 Geotechnical Report

### 6.1 Drilling Methodology

The drilling methodology for BH23-01 was a combination of solid stem auger and mud rotary drilling. The initial 3.3 m of the borehole was drilled by use of solid stem auger. To advance the borehole and maintain verticality, a combination of fishtail and claw bits was used to penetrate the sandy gravel fill with cobbles up to 125 mm nominal diameter observed. To maintain borehole integrity, casing was then advanced to a depth of 3.3 m before the borehole was setup for mud rotary drilling. Mud rotary drilling in combination with standard penetration tests (SPT) with split-spoon sampling were continued to the termination depth of 18.1 m.

### 6.2 Standard Penetration Test

Standard Penetration Tests (SPT) were generally completed at 1.5 metre depth intervals after the first 3.3 metres to determine the relative density/compaction of overburden soils and to recover split-spoon samples. The split spoon sampling was carried out in general accordance with ASTM D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.

The recorded blow counts for the individual soundings are presented on the Record of Borehole sheets in Appendix B. The relative density or consistency reported in the logs were generally based on the measured blow counts. It should be noted that in certain strata (i.e., where gravel or cobble-sized particles were encountered), the recorded blow counts may not be representative of the relative density or stiffness of the soil matrix, and a combination of engineering judgement and laboratory testing is required to evaluate the compactness/consistency of the material. The reader is also cautioned to consider overburden and energy loss effects (as well as other correction factors) when interpreting raw penetration test results.

Caution and judgement should therefore be exercised in the interpretation of the recorded blow counts presented on the Record of Borehole sheets and their correlation with standard or corrected "N" values.

It should be noted that the SPT tooling and samplers (50 mm OD split-spoon) utilized during the investigations limit the maximum particle size of recovered samples, and as such would not be representative of cobble or boulder contents.

### 6.3 Borehole Abandonment

BH23-01 was backfilled immediately after drilling with bentonite grout to 3.3 m depth. On August 10<sup>th</sup>, 2023 (07:30) the borehole was backfilled with bentonite chips to 1.4 m depth, road base to 0.4 m depth, and cold mix asphalt to surface.

### 7.0 LABORATORY TESTING

### 7.1 Geotechnical Testing

The following geotechnical tests were carried out on disturbed soil samples collected as part of the geotechnical investigation:

- Particle-Size Distribution (gradation) of Soils Using Sieve Analysis (ASTM D6913)
- Laboratory Determination of Water (moisture) Content of Soil and by Mass (ASTM D2216)
- Soil Resistivity using the Two-Electrode Soil Box Method (ASTM G187)
- Determination of Organic Material Content of Soil (ASTM D2974)

The results of the geotechnical soil testing conducted on disturbed samples collected during the subsurface geotechnical investigation are presented in Appendix C and summarized in Table 7.1 and Table 7.2.

Hole ID	Sample	Sample Depth Interval (mbgs)		Sieve Analysis			Moisture Content
	ID	Тор	Bottom	Gravel (%)	Sand (%)	Fines (%)	(%)
BH23-01	2	2.44	2.59	-	-	-	3.5
BH23-01	5A	7.01	7.25	-	-	-	8.7
BH23-01	5B	7.25	7.47	-	-	-	13.6
BH23-01	6	8.53	8.99	40.9	43.2	15.9	11.3
BH23-01	7	10.06	10.52	-	-	-	9.0
BH23-01	8	11.58	12.04	-	-	-	12.3
BH23-01	9	13.11	13.56	32.2	57.1	10.7	13.5
BH23-01	10	14.95	15.39	-	-	-	10.1
BH23-02	11	16.15	16.61	-	-	-	10.0
BH23-02	12	17.68	18.14	45.9	45.5	8.6	10.6

	Sample ID	Sample Depth	Interval (mbgs)	Measured Resistance (ohm)	Calculated Resistivity (ohm-cm)
Hole ID		Тор	Bottom		
BH23-01	1	0.76	0.91	5,070	3,397
BH23-01	4	5.49	5.94	8,850	5,930

Table 7.2: Summary of Soil Resistivity Testing Results

### 7.2 Environmental

The following primary analytical tests were carried out on disturbed soil samples collected as part of the geotechnical investigation:

- Water Soluble Chloride Ion Content (CSA A23.2-4B)
- Water Soluble Sulphate in Soil (CSA A23.2-3B)
- Soil pH Analysis (ASTM D4972)
- Organic content testing (ASTM D2974)

Additionally, surface water samples were taken from the creek for sulphate and pH testing.

The results of environmental analytical laboratory testing, including soil pH, water soluble chloride, sulphate content are presented in Appendix D. Testing of the materials was conducted in general accordance with ASTM and/or Canadian Standards Association (CSA) methods. The testing was carried out by CARO Analytical Services and WSP of Burnaby, BC.

### 8.0 SUBSURFACE GEOTECHNICAL CONDITIONS

Detailed descriptions of the subsurface soil and groundwater conditions encountered at the time of the field investigation are presented on the Summary Log sheets in Appendix B along with the MoTI 'Notes for Completion of Soil Field Logs' description of the soil classification system used and a list of symbols and abbreviations for the proper interpretation of the soil information. Classification and identification of soil involves judgment and WSP does not guarantee descriptions as exact but infers accuracy to the extent that is common in current geotechnical practice. The depths of stratigraphic changes are generally approximate and inferred since there is often a gradual transition between soil types. It should be noted that it is expected that variations in the subsurface conditions may occur between and beyond the location of the boreholes. The following presents a summary of the subsurface conditions encountered in the boreholes.

The subsurface soil stratigraphy encountered within BH23-01 generally comprised, in order of increasing depth:

FILL – road structure and embankment fills were encountered to about 3.8 mbgs. Fill was found to consist of well graded sandy gravel, some fines, some cobbles. The compactness of the fill was inferred as dense soil based on drilling resistance and the presence of cobbles and boulders.

 Gravel and Sand – underlying the road and embankment fills, well graded gravel and sand, some fines, trace boulders and cobbles were encountered to termination depth of 18.1 mbgs. SPT N values indicated compact to very dense compactness for the granular deposit.

This stratigraphy was generally in agreement with the stratigraphy described in WSP E&I's 2022 report. The Summary Logs for the boreholes completed in 2021 have also been included in Appendix B.

### 8.1 Fill

Layers of fill were encountered at all borehole locations (both the 2022 and 2023 report). Generally, the thickness of this unit is in the order of 3.7 to 4.0 mbgs. In the case of BH23-01, the pavement structure and road embankment fill could only be broadly characterized due to the sloughing and churning of the soil upon extraction. Although the thicknesses of the base, subbase, and variable road embankment fill can be inferred from the 2022 report. BH23-01 encountered fills to a depth of about 3.8 mbgs.

### 8.2 Granular Deposits

Underlying the highway pavement structure and embankment fills were granular deposits of well graded gravel and sand with trace to some fines, and trace boulders. Based on SPT results, the granular soils were inferred to be in a compact to very dense state of relative density.

### 8.3 Groundwater

Groundwater levels generally could not be assessed while drilling due to the drill methodology that involved introduction of water into the borehole. Based on the 2021 drilling records, the groundwater level was approximately 6.1 to 6.2 m below surface. However, it is expected that the groundwater level is inherently variable at any given time and directly related to time of year and the flow of Cache Creek. Characterization of this variability would require a long-term groundwater monitoring program.

### 9.0 CLOSURE

We trust the foregoing provides you with the information that you require at this time. Should you require additional information or have any questions, please do not hesitate to contact the undersigned at your earliest convenience.

WSP Canada Inc.

Patrick Machibroda, MASc, EIT Associate Geotechnical Engineer

Ben Dorsey, PEng Senior Geotechnical Engineer

Reviewed By:

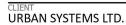
Nick Polysou, PEng Senior Principal Geotechnical Engineer

PM/BD/NP/asd

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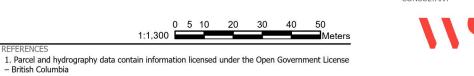


٠ BOREHOLE LOCATION



PROJECT CARIBOO ROADS RECOVERY PROJECT CACHE CREEK CULVERT REPLACEMENT HWY 97, CACHE CREEK, BC

#### TITLE SITE PLAN



REFERENCES

Spatial Reference: NAD 1983 UTM Zone 10N

CONSULTANT YYYY-MM-DD 2023-09-19 DESIGNED BD PREPARED MY REVIEWED BD APPROVED NP FIGURE 1 PROJECT NO. REV. 0 PHASE 26239

APPENDIX A

Important Information and Limitation of this Report

### IMPORTANT INFORMATION AND LIMITATIONS OF THIS REPORT

**Standard of Care**: WSP Canada Inc. (WSP) has prepared this report in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering and science professions currently practising under similar conditions in the jurisdiction in which the services are provided, subject to the time limits and physical constraints applicable to this report. No other warranty, expressed or implied is made.

**Basis and Use of the Report:** This report has been prepared for the specific site, design objective, development and purpose described to WSP by the Client. The factual data, interpretations and recommendations pertain to a specific project as described in this report and are not applicable to any other project or site location. Any change of site conditions, purpose, development plans or if the project is not initiated within eighteen months of the date of the report may alter the validity of the report. WSP can not be responsible for use of this report, or portions thereof, unless WSP is requested to review and, if necessary, revise the report.

The information, recommendations and opinions expressed in this report are for the sole benefit of the Client. No other party may use or rely on this report or any portion thereof without WSP's express written consent. If the report was prepared to be included for a specific permit application process, then upon the reasonable request of the client, WSP may authorize in writing the use of this report by the regulatory agency as an Approved User for the specific and identified purpose of the applicable permit review process. Any other use of this report by others is prohibited and is without responsibility to WSP. The report, all plans, data, drawings and other documents as well as all electronic media prepared by WSP are considered its professional work product and shall remain the copyright property of WSP, who authorizes only the Client and Approved Users to make copies of the report, but only in such quantities as are reasonably necessary for the use of the report or any portion thereof to any other party without the express written permission of WSP. The Client acknowledges that electronic media is susceptible to unauthorized modification, deterioration and incompatibility and therefore the Client cannot rely upon the electronic media versions of WSP's report or other work products.

The report is of a summary nature and is not intended to stand alone without reference to the instructions given to WSP by the Client, communications between WSP and the Client, and to any other reports prepared by WSP for the Client relative to the specific site described in the report. In order to properly understand the suggestions, recommendations and opinions expressed in this report, reference must be made to the whole of the report. WSP can not be responsible for use of portions of the report without reference to the entire report.

Unless otherwise stated, the suggestions, recommendations and opinions given in this report are intended only for the guidance of the Client in the design of the specific project. The extent and detail of investigations, including the number of test holes, necessary to determine all of the relevant conditions which may affect construction costs would normally be greater than has been carried out for design purposes. Contractors bidding on, or undertaking the work, should rely on their own investigations, as well as their own interpretations of the factual data presented in the report, as to how subsurface conditions may affect their work, including but not limited to proposed construction techniques, schedule, safety and equipment capabilities.

**Soil, Rock and Groundwater Conditions:** Classification and identification of soils, rocks, and geologic units have been based on commonly accepted methods employed in the practice of geotechnical engineering and related disciplines. Classification and identification of the type and condition of these materials or units involves judgment, and boundaries between different soil, rock or geologic types or units may be transitional rather than abrupt. Accordingly, WSP does not warrant or guarantee the exactness of the descriptions.

Special risks occur whenever engineering or related disciplines are applied to identify subsurface conditions and even a comprehensive investigation, sampling and testing program may fail to detect all or certain

subsurface conditions. The environmental, geologic, geotechnical, geochemical and hydrogeologic conditions that WSP interprets to exist between and beyond sampling points may differ from those that actually exist. In addition to soil variability, fill of variable physical and chemical composition can be present over portions of the site or on adjacent properties. The professional services retained for this project include only the geotechnical aspects of the subsurface conditions at the site, unless otherwise specifically stated and identified in the report. The presence or implication(s) of possible surface and/or subsurface contamination resulting from previous activities or uses of the site and/or resulting from the introduction onto the site of materials from off-site sources are outside the terms of reference for this project and have not been investigated or addressed.

Soil and groundwater conditions shown in the factual data and described in the report are the observed conditions at the time of their determination or measurement. Unless otherwise noted, those conditions form the basis of the recommendations in the report. Groundwater conditions may vary between and beyond reported locations and can be affected by annual, seasonal and meteorological conditions. The condition of the soil, rock and groundwater may be significantly altered by construction activities (traffic, excavation, groundwater level lowering, pile driving, blasting, etc.) on the site or on adjacent sites. Excavation may expose the soils to changes due to wetting, drying or frost. Unless otherwise indicated the soil must be protected from these changes during construction.

**Sample Disposal:** WSP will dispose of all uncontaminated soil and/or rock samples 90 days following issue of this report or, upon written request of the Client, will store uncontaminated samples and materials at the Client's expense. In the event that actual contaminated soils, fills or groundwater are encountered or are inferred to be present, all contaminated samples shall remain the property and responsibility of the Client for proper disposal.

**Follow-Up and Construction Services:** All details of the design were not known at the time of submission of WSP's report. WSP should be retained to review the final design, project plans and documents prior to construction, to confirm that they are consistent with the intent of WSP's report.

During construction, WSP should be retained to perform sufficient and timely observations of encountered conditions to confirm and document that the subsurface conditions do not materially differ from those interpreted conditions considered in the preparation of WSP's report and to confirm and document that construction activities do not adversely affect the suggestions, recommendations and opinions contained in WSP's report. Adequate field review, observation and testing during construction are necessary for WSP to be able to provide letters of assurance, in accordance with the requirements of many regulatory authorities. In cases where this recommendation is not followed, WSP's responsibility is limited to interpreting accurately the information encountered at the borehole locations, at the time of their initial determination or measurement during the preparation of the Report.

**Changed Conditions and Drainage:** Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or construction activities, it is a condition of this report that WSP be notified of any changes and be provided with an opportunity to review or revise the recommendations within this report. Recognition of changed soil and rock conditions requires experience and it is recommended that WSP be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

Drainage of subsurface water is commonly required either for temporary or permanent installations for the project. Improper design or construction of drainage or dewatering can have serious consequences. WSP takes no responsibility for the effects of drainage unless specifically involved in the detailed design and construction monitoring of the system.

APPENDIX B

# Borehole Summary Logs



### Notes for Completion of Soil Field Logs

#### Soil Type/ Description Order

1	CLASSIFICATION	CAPITAL LETTERS eg; GP, SP-SM, SC4, ML
2	SOIL GROUP	CAPITAL LETTERS eg GRAVEL, SAND and GRAVEL, SILTY CLAY
3	Description of Primary Components	Coarse Grained Soils: Particle size, grading and shape (optional) Fine Grained Soils: Plasticity
4	Description of Secondary / Minor Components	Coarse Grained Soils: estimate percentage (optional), particle size Fine Grained Soils: Plasticity
5	Minor Components	any other minor components
6	Colour	Note primary colour in its moist condition, note if soil is dry
7	Structure	eg. Fissuring, cementation
8	Contamination	if applicable; staining and odour
9	Additional Observations	Presence of cobbles/boulders, origin of geological notes (FILL, Glacial TILL, Alluvium) or mineralogy (calcareous, micaceous)
10	Behaviour	non-cohesive or cohesive
11	11 Moisture Non-cohesive Soils: field moisture condition Cohesive soils: water content	
12	Compactness or Consistency	Non-cohesive Soils: Compactness Cohesive soils: Consistency

Sample Type

A AUGER

C CORE

G GRAB

w

L LAB SAMPLE ODEX

S SPILT SPOON

T SHELBY TUBE

ASH (MUD RETURN)

GANIC

#### 1. Classification

Majo	r Divisions	Symbo	bl	Soil Type		
	and Soils	GW		Well-graded gravels or gravel-sand mixtures, little or no fines		
is.	y Sc	GP		Poorly-graded gravels or gravel-sand mixtures, little or no fines		
d Sc	Gravel and Gravelly Soil	GM*		Silty gravels, gravel-sand-silt mixtures		
Coarse Grained Soils	0 20	GC*		Clayey gravels, gravel-sand-clay mixtures		
ō	<u>S</u>	SW*		Vell-graded sands or gravelly sands, little to no fines		
arse	/ So	SP		Poorly-graded sands or gravelly sands, little or no fines		
Ő	Sand and Sandy Soils	SM*		Silty sands, sand-silt mixtures		
	°, °,	SC*		Clayey sands, sand-clay mixtures		
ø	nd -<50	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity		
Fine Grained Soils	Silts and Silts and ays LL>50 Clays LL<50	CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
inec		OL		Organic silts and organic silt-clays of low palsticity		
le Gra		мн		Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
Ē		Silts a Clays L HO			Inorganic clays of high plasticity, fat clays	
	s Cla	он		Organic clays of medium to high plasticity, organic silts		
Org	anic Soils	Pt		Peat and other highly organic soils		
1	ГорѕоіІ	TS		Topsoil with roots, etc.		
C	obbles	SB		Rock fragments and cobbles, particle size 75mm to 300mm diameter		
В	oulders	LB		Boulders, particle size over 300mm in diameter		
	*GP-GM ; 0	GP-GC; SP	-SM;	SP-SC; 6-12% Passing #200 (0.075mm) Sieve		
	* GM1; G0	C1; SM1;	SC	1; 12-20% Passing #200 (0.075mm) Sieve		
	* GM2; G0	C2; SM2;	SC	2; 20-30% Passing #200 (0.075mm) Sieve		
	* GM3; G0	C3; SM3;	SC	3; 30-40% Passing #200 (0.075mm) Sieve		
	* GM4; G0	C4; SM4;	SC	4; 40-50% Passing #200 (0.075mm) Sieve		

#### 2. Soil Group (Organic Soils)

Category	ORGANIC CONTENT (% by Weight)	NAME	DISTINGUISHING CHARACTERISTICS FOR VISUAL IDENTIFICATION
	75% to 100%	Fibrous PEAT	Light weight, spongy and often elastic at natural water content. Plant structure easily identifiable. Shrinks considerably upon air drying. Much water squeeze from sample
Highly	75% to 100%	Amorphous PEAT	Light weight, spongy but not usually elastic at natural water content. Plant structure visiably altered to unidentifiable. Shrinks considerably upon air drying. Much water squeeze from sample
Organic Soils	30% to 75%	SILTY PEAT	Relatively light weight, spongy. Thread usually weak and spongy near plastic limit. Shrinks on air drying; medium dry strength. Usually can squeeze water from sample readily. Low dilatancy.
	30% to 75%	SANDY PEAT	Sand fraction visible. Thread weak and friable near palstic limit, shrinks on air drying; low dry strength. Usually can squeeze water from sample readilty, high dilatancy, "gritty"
Organic Soils	5% to 30%	ORGANIC CLAYEY SILT	Often has a strong $\rm H_2S$ odour. Thread may be tough depending on clay fraction. Medium dry strength, low dilatancy.
	5% to 30%		Threads weak and friable near plastic limit, or threads may not be rolled. Low dry strength; medium to high dilatancy

#### 3. Description of Primary Components

Soil Consituent	Particle Size	Millimeters (Sieve Size)
BOULDERS	Not applicable	>300
COBBLES	Not applicable	75 to 300
GRAVEL	Coarse Grained	19 to 75
GRAVEL	Fine Grained	4.75 to 19
	Coarse Grained	2.00 to 4.75
SAND	Medium Grained	0.425 to 2.00
	Fine Grained	0.075 to 0.425
SILT/CLAY Not applicable		<0.075

Particle Sha	pe & Angularity	DESCRIPTION				
	Rounded	Smoothly curved sides, no edges, smooth or polished surfaces				
Angularity	Sub-rounded	Plane sides, Well-rounded edges, Partially polished surfaces				
Angularity	Sub-angular	Plane sides, Partially rounded edges, unpolished surfaces				
	Angular	Plane sides, sharp edges, unpolished surfaces				
Shape	Flat	Width to thickness ration >3				
(Gravel)	Elongated	Length to width ratio >3				
Particle Siz	e Distribution	DESCRIPTION				
Well	Graded	Even distribution of particle sizes				
	-	Uneven distribution of particle sizes				
Poorly Graded	Gap Graded	Intermediate particle sizes absent				
	Uniformly	Primarily one particle size				
4. Descript	4. Description of Secondary Components					

#### Description of Minor Components

5. Description of Minor Components						
Components	% (by mass)	MODIFIER				
Minor	< 5	use "trace" or omit				
WITTO	5 to 12	use "some"				
Secondary	12 to 35	Prefix primary soil name eg. gravelly, clayey				
Gecondary	>35	use "and" to combine major consituents eg. SAND and GRAVEL				

#### 6. Colour

COLOUR Describe the colour of the soil in its moist condition Note if soil represents dry condition eg. grey (dry) Use primary colour modified, if appropriate, with single adjective Border cases can be hyphenated eg. grey-brown Describe streaks or splotches of other colors as "mottled"

#### 7. Structure ZONING & DESCRIPTION FISSURES Heterogeneous Soil mass of non-uniform, variable composition or structure Homogeneous Soil mass is of uniform compostion or structure REPETITIVE STRUCTURES Closely spaced, alternating layers of differing soils and/or differing colours or shades of soils of similar gradation, usually arranged in Laminated regular pattern Thinly Laminated: spacing under 6mm Thickly Laminated: spacing 6mm to 20mm Differing soils or visible variations in soil consituents or colour arranged in layers, generally but not necessarily parallel to one anothei Stratified Very Thinly Bedded: 20mm to 60mm or Thinly Bedded: 60mm to 200mm Layered Medium Bedded: 200mm to 600mm Thickly Bedded: 600mm to 2m Very thickly Bedded: over 2m DISCRETE LAYERS OR FEATURES A laminated soil consisting of two distinct soils (usually clay and

Varved	silt) occuring in a regularly repeating pattern resulting from seasonal variations in sediment load in a lacustrine environment
Lens	An inclusion of a different soil type within surrounding soils, which thins out laterally (horizontally) and may not be continuous over any significant distance. Typically identified by test pits or correlations between boreholes
Parting	Paper thin separation of one soil type by another. Usually applied to fine grained soils.
Pocket	A different soil type of very limited thickness or lateral extent (a small lens)
Seam	A soil layer of considerable extent but with a thickenss of less than about 10mm
Fissured	Generally applied to dried or overconsolidated fine grained soils (silts or clays) containing cracks or physical discontinuities which can be vertical, horizontal or inclined. Described as highly, moderately and slightly fissured
Friable, Blocky or Platy	Otherwise cohesive soil breaks into small (friable), larger (blocky), or thin plate like (platy) fragments with little effort
Slickensided	Polished or striated surfaces. Often an indication of an existing failure or slip surface. If continuous slickensided shear zones are found an estimate should be made of their angle in relation to the horizontal plane

#### 8. Contamination

if applicable; note staining and/or odour

#### 9. Additional Observations

See note in Soil Type/Decsription order table

#### 10. Behaviour

Non-Cohesive or Cohesive

#### 2. Soil Group continued (Fine and Coarse Grained Soils)

	CLASSIFICATION	СН	CI	CL	ОН	МН	OL	ML	ML
ILS	SOIL NAME	CLAY	SILTY CLAY	SILTY CLAY	ORGANIC SILT	CLAYEY SILT	ORGANIC SILT	CLAYEY SILT	SILT
ED SOIL	Dilatancy	None	None	None	None	Slow to Very Slow	Slow to Very Slow	Slow	Rapid
GRAINED	Dry Strength	High	Medium to High	Low to Medium	Medium to High	Low to Medium	Low to Medium	None to Low	None
FINE (	Thread diameter(mm)	<1	1 to 3	~3	1 to 3	3 to 6	3 to 6	3 to 6	>6
Ε	Toughness (of 3mm thread)	High	Medium	Low to Medium	Medium to High	Low to Medium	Low	None to Low	Can't roll 3mm
	Organic Content (%)	0 to 30	0 to 30	0 to 30	5 to 30	<5	5 to 30	<5	<5
S		<b></b>							
SOILS	CLASSIFICATION	SW	SP	SC	SM	GW	GP	GC	GM
	SOIL NAME	SAND	SAND	CLAYEY SAND	SILTY SAND	GRAVEL	GRAVEL	CLAYEY GRAVEL	SILTY GRAVEL
GRAINED	Size of Coarse Fraction	(>50% of		NDS is smaller thar	n 4.75mm)	(>50% of	GRAN coarse fraction	VELS n is larger than	4.75mm)
RSE (	Fines Content	<12%	<12% fines		Fines	<12%	Fines	>12%	Fines
COAR	Gradation or Plasticity	Well Graded	Poorly Graded	Plastic Fines	Non-plastic Fines	Well Graded	Poorly Graded	Plastic Fines	Non-plastic Fines

#### 11. Moisture

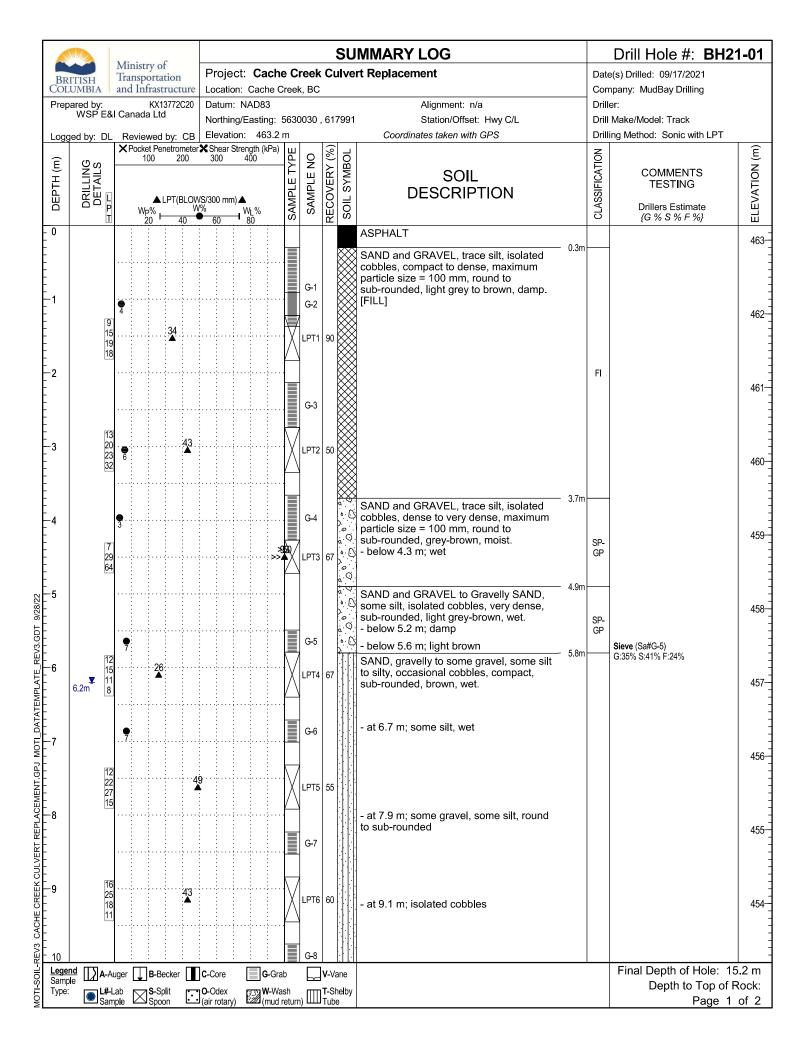
TERM	FIELD MOISTURE IDENTIFICATION (Non-Cohesive)
Dry	Soil flows freely through fingers
Moist	Soils are darker than in the dry condition and may feel cool
Wet	As moist, but with free water forming on hands when handled
TERM	WATER CONTENT IDENTIFICATION (Cohesive)
w < PL	Material is estimated to be drier than the Plastic Limit (cannot be rolled to a thread diameter of 4mm)
w ~ PL	Material is estimated to be close to the Plastic Limit (can be rolled to a thread diameter of between 2mm & 4mm
w > PL	Material is estimated to be wetter than the Plastic Limit (can be rolled to a thread diameter of less than 2mm)

#### 12. Compactness (Non-Cohesive)

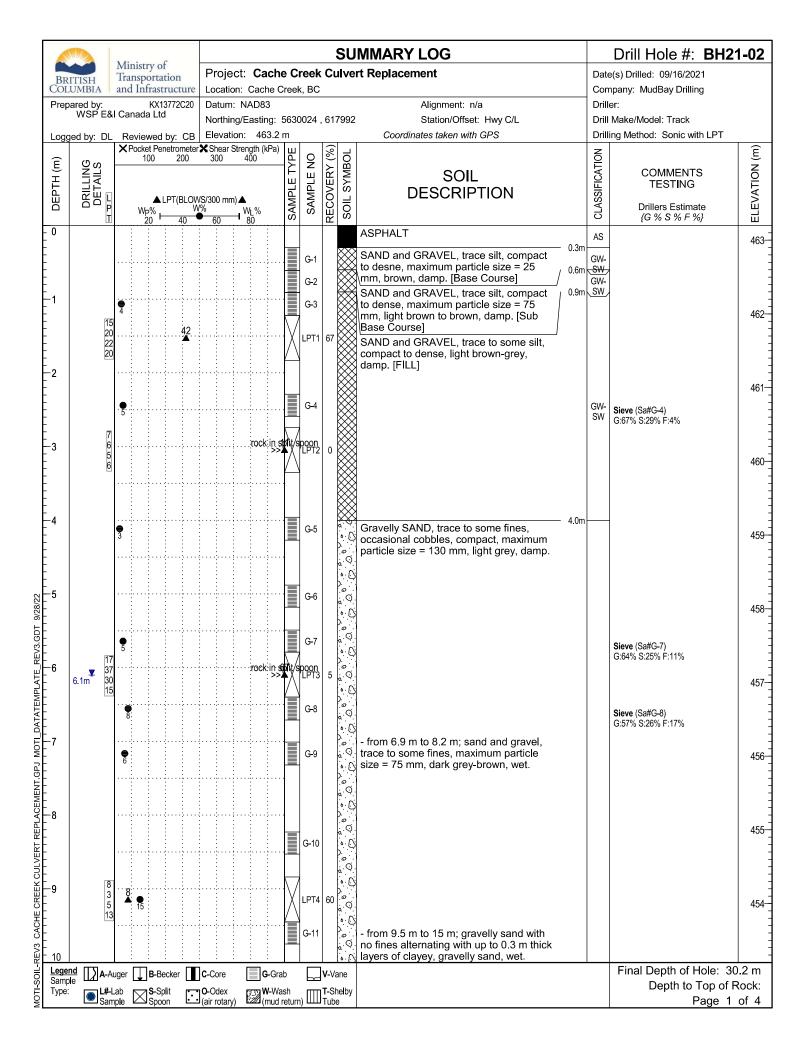
TERM	SPT "N" (Blows/ 0.3m)	FIELD IDENTIFICATION OF SOIL EXPOSURES
Very Loose	0 to 4	Easily penetrated with shovel handle
Loose	4 to 10	Easily excavated with hand shovel.
Compact	10 to 30	Difficult to excavate with hand shovel
Dense	30 to 50	Must be loosened with pick to excavate
Very Dense	>50	Very difficult to excavate even with pick

#### 12. Consistency (Cohesive)

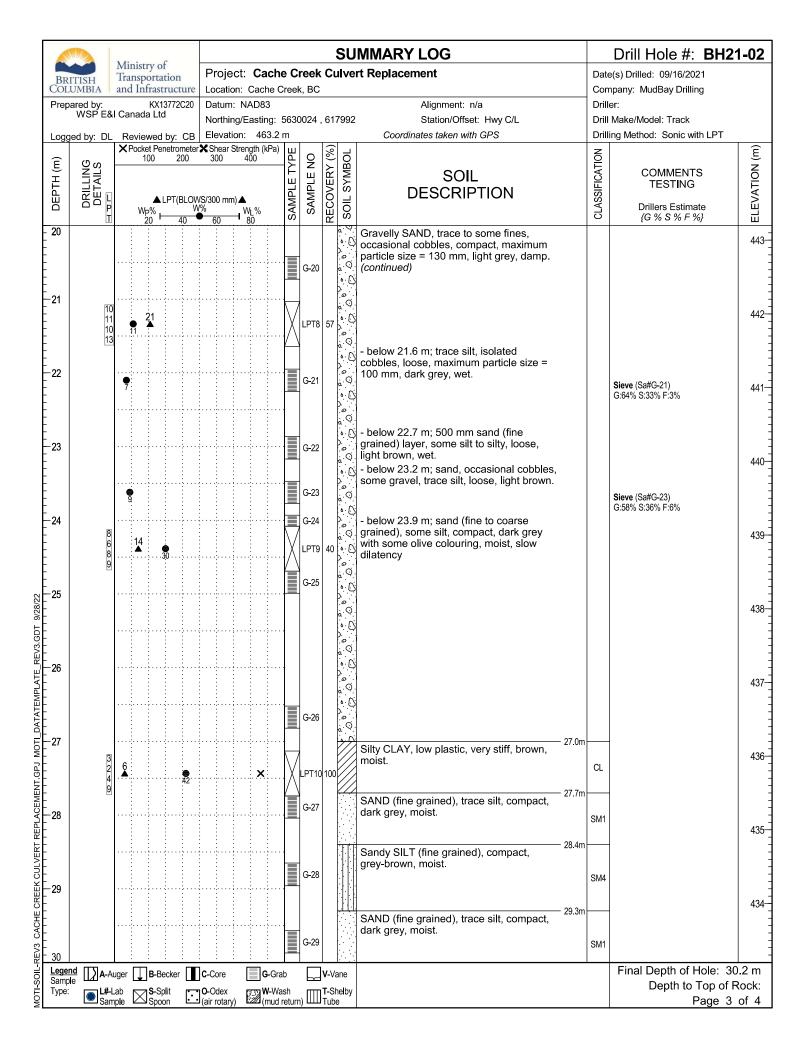
TERM	FIELD IDENTIFICATION	Undrained Shear Strength (KPa)	Unconfined Compressive Strength (KPa)	SPT "N" (blows /0.3m)
Very Soft	Extrudes between fingers when squeezed	<12	<25	0 to 2
Soft	Moulded by light finger pressure	12 to 25	25 to 50	2 to 4
Firm	Moulded by strong finger pressure	25 to 50	50 to 100	4 to 8
Stiff	Indented by thumb	50 to 100	100 to 200	8 to 15
Very Stiff	Indented by thumbnail	100 to 200	200 to 400	15 to 30
Hard	Difficult to indent with thumbnail	>200	>400	30



	MWARA -	11.	in		c										SI	U	MMARY LOG		Drill Hole #: BH21	1 <b>-</b> 0′
	ITISH	Mir Trai	ispo	ortat	tion			-							ulv	er	t Replacement		e(s) Drilled: 09/17/2021	
	UMBIA	and	Canada Ltd         Northing/Easting:         5630030         617991         Stat           Reviewed by:         CB         Elevation:         463.2 m         Coordinates to														All successions of a	4	npany: MudBay Drilling	
Prep	ared by: WSP E&	Car				620						56	10030	. 61	1799	91	Alignment: n/a Station/Offset: Hwy C/L	Drill	ler:   Make/Model: Track	
Logo	ged by: DL						E	leva	tion	: 4	163.2	2 m		, 5			Coordinates taken with GPS		ling Method: Sonic with LPT	
DEPTH (m)	DRILLING DETAILS	XP	ocket 10 Wp	00 ▲ L	2	00	3	Shear 300 00 m	m) 🖌	400			SAMPLE NO	RECOVERY (%)	SOIL SYMBOL		SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate	ELEVATION (m)
10	T		20	<u>0</u> °⊢		10	•	60	-	WL% 80		U.					SAND, gravelly to some gravel, some silt	U U	{G % S % F %}	
	6 11 11 11		4	22					•••••				G-9		5		to silty, occasional cobbles, compact, sub-rounded, brown, wet. <i>(continued)</i> - at 10.2 m; 200 mm olive grey weathered boulder	SM3- SM4		4
-11						· · · · ·											- from 11.0 to 11.9 m; silty sand, light brown			4
-12	6		19	}									G-10 7							
	6 16 30 16					46							1	3 50	0  . .   . .		- from 12.5 m to 12.8 m; trace to some			4
-13							· · · · ·	· · · · ·									gravel, round, trace silt			4
									•				G-12	2						
14																				4
-15													G-13	3						
																	End of borehole at 15.2 m. Backfilled with bentonite. Asphalt patch used.			4
-16									•											4
-17						· · · ·														
							· · · · · · ·	· · · ·												
18						· · · ·														4
19																				
20						· · · · ·	· · · · · ·		• • • • •											
20 Lege Samp	nd Da A-A	i Jaer		B-Be	ecker	<b>  </b>	] <b>c</b> .c	Core	<u>.</u>		: ] <b>G</b> -G	l rab		]v-\	Vane	+		I	Final Depth of Hole: 15	5.2 r
Samp	le LL21477 L#-L Sam			<b>S</b> -Sp Spoo			] <b>0</b> -0 ](air			-			يط []] (n						Depth to Top of R Page 2	



		Ministry of			S	SUI	MMARY LOG		Drill Hole #: BH2	21-0
	ITISH	Transportation	Project: Cache C			ver	t Replacement		e(s) Drilled: 09/16/2021	
	UMBIA	and Infrastructure		ek, BC				_	npany: MudBay Drilling	
Prep	ared by: WSP E&	KX13772C20 Canada Ltd	Datum: NAD83 Northing/Easting: 563	20024	6170	າດວ	Alignment: n/a Station/Offset: Hwy C/L	Drill	er: Make/Model: Track	
loga	ed by: DI	. Reviewed by: CB		50024	, 0173	552	Coordinates taken with GPS		ing Method: Sonic with LPT	
LUgg		×Pocket Penetromete			<u>@</u> .	_				
DEPTH (m)	ပ်လုပ်	100 200	rXShear Strength (kPa) 300 400 ↓	SAMPLE NO	RECOVERY (%)	SYMBOL		CLASSIFICATION	COMMENTS	
푸	TAIL		ц Ц	빌꾼		∑	SOIL	FIC/	TESTING	
Щ		▲ LPT(BLO)		AMI	0	SOIL	DESCRIPTION	ASSI	Drillers Estimate	
	DRILLING DETAILS			S	۲ ۳	မ္ဂ		5	{G % S % F %}	
10					0. 6		Gravelly SAND, trace to some fines,			
			·····		Þ.		occasional cobbles, compact, maximum particle size = 130 mm, light grey, damp			
				G-12		.0. 	(continued)			
					). 					
11					ö.'	0.				
		•		G-13	þ.				<b>e</b> : (0, 110, 40)	
					o.	.0.	- below 11.5 m; trace fines		Sieve (Sa#G-13) G:47% S:44% F:9%	
					þ.	. <u> </u>				
12	24 23 23 35	3	rock:in statit	/spoon_	0 0.					
	23 35	5	<b>I</b>	$\sqrt{-10}$	).	Ö				
					 0.	0				
40					o	ß				
13					0	.0.				
				G-14		Ŋ				
						, .				
,		10		G-15		- Li				
14				-		, . .0.				
					0.   0	ß				
					). .c	0				
4-				G-16	0.   0					
15	18 25 27	3	52	/	07		- below 15 m; trace to some fines,			
					67 		occasional cobbles, maximum particle size = 130 mm.			
	23				). 			GP- SP		
40					l ŀ.	0.				
16				G-17	). 	»				
					i.	.0.				1
					). 	ب و				1
47					0. ·	Ö.				
17				G-18	). 	· •				
						0				
					).		- at 17.5 m; 200 mm clay layer.			
40					ö.'	0.				
18	15	27	$\square$	/	) ).					
	15 18 9 12		X		67 ." o.'	0				
	12		-		o	Q				
10						0				
19				G-19	ہ   D.					
					 0.					
						Ŋ				
20										
		luger 🔲 <b>B</b> -Becker 🗌	C-Core		V-Van	e			Final Depth of Hole: 3	
Sampi Type:	₩ L#-									
<b>Leger</b> Sampl Type:	nd le DA-A San		C-Core G-Grab C-Odex (mud retu (air rotary)						Final Depth of Hole: 30 Depth to Top of I Page 2	F



					6			Project: Cache Creek Cul Location: Cache Creek, BC										ç	SU	JMMARY LOG		Drill Hole #: BH21	1-02
BR	ITISH JUMBIA	Tra	nist	ort	ati	on												Cu	lve	ert Replacement		e(s) Drilled: 09/16/2021	
	ared by:	and	i In		stru (137			_			on: 1: N				ree	k, B(	2			Alignment: n/a	Con Drill	npany: MudBay Drilling ler:	
	WSP E8			a L	td				Noi	rthir	ng/l	Ea	stin	g:		0024	I, 6	617	'992	-		Make/Model: Track	
Log	ged by: DL	R	evie Pock	we	d b	y: tron	CB		Ele	vati	ion:	: nat	46;	3.2	m 1	1	-	ন		Coordinates taken with GPS		ling Method: Sonic with LPT	
DEPTH (m)	DRILLING DETAILS	R	W				SLO'			) mn	n) 🔺				SAMPLE TYPE	SAMPLE NO			SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
- 30 -			-		-						-							-		End of borehole at 30.2 m.	<u> </u>		433-
31																				Backfilled with bentonite. Asphalt patch used.			
												·····											432-
-32												•••••••••••••••••••••••••••••••••••••••											431-
- 33 											 												430-
-34										••••													
			· · · · · ·								 	·····											429
3.GDT 9/28/22																							428-
EMPLATE_REV																							427-
																							426-
ACEMENT.GPJ																							
JLVERT REPLA												· · · · · · · · · · · · · · · · · · ·											425-
MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPU MOTIL DATATEMPLATE REV3.GDT 9/28/22 MOTI-SOIL-REV3 CACHE CREEK CULVERT REPLACEMENT.GPU MOTIL DATATEMPLATE REV3.GDT 9/28/22 add 1960 add 1960 but solutions of the second se																							424-
£ 1 1 2 3			-	-	-			-			-	÷											
		uger		B-I	Becl	ker		Пс	-Co	re	<u>.</u>	·	]G	-Gra	ıb		 ]v	-Va	ne		L	Final Depth of Hole: 30	
Samp E Type:							_	_				-				_ ∏∏						Depth to Top of R	
¥	💌 Sar	nple	Spoon COdex (mud return)								⊠ <b>l</b> (n	nud I	returi	η)Ш	ШΤι	ube	)			Page 4	ot 4		

			10.1						SUMMARY LOG		Dril	l Hole#: <b>BH23-01</b>	
BRI	TIS	H	Ministry of Transportation	-					ulvert Replacement			lled: 09 Aug 2023	
COLI Prepa	JME	BIA	and Infrastructure 221-11730-00.3680								npany: er: Dan	Westech	
		-	Canada Inc.						Alignment: 617985.37 m Station/Offset:	Drill	Make/I	Model: MULTIDRILL PL-G	
Logge			Reviewed by: BD	Elevation: 46			1	,	1	Drill Aug		hod: Mud Rotary / Solid Ste	em
		ш	x Pocket Penetrometer & She 100 200 3	ar Strength (kPa) 300 400	Щ	0	(%)	Ы			NOI	COMMENTS	7
DEPTH (m)		/150n	+ Natural Vane ⊕ Re	mold Vane	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL		CLASSIFICATION	TESTING	ELEVATION
DEPT	DRIL	OWS	▲ SPT "N" (BLOWS/3 W%		MPL	AMP	COV	OIL S'	DESCRIPTION		SSIF	Drillers Estimate (G % S % F %)	ELEW
		BL	W <sub>p</sub> %  20 40 6	W <sub>1</sub> % 0 80	Ş	S	RE	) X			CLA		
-									ASPHALT.				463
-								$\bigotimes$	(GW) sandy GRAVEL, well graded, some fines, some cobbles;	0.30m			400
Ē								$\bigotimes$	FILL; brown; moist; compact.				
ł.						1		$\bigotimes$	×				
								$\bigotimes$					462
-	ger							$\bigotimes$					
	tem Au							$\bigotimes$					
÷.	Solid Stem Auger							$\otimes$					
	0							$\bigotimes$			GW		461 ·
F								$\bigotimes$					
Ē					-	2		$\bigotimes$					
÷.								$\bigotimes$	×				
- 3								$\bigotimes$	X				460 ·
-	-							$\bigotimes$					
								$\bigotimes$					
-								×.	GW) GRAVEL and SAND; well graded, some fines, trace	3.84m			
- 4		47 52			$\times$	3	98		<ul> <li>boulders; greyish brown; FLUVIAL; wet; very dense.</li> <li>4.2 to 4.6 m: Encountered boulder, pulverized using tricone</li> </ul>				459 ·
-									drill bit.				400
-								******					
ŀ													
- 5 [													458 -
-													400
-		27			V	4	73						
-		27 33 50		-	Δ	4	13						
- 6		39											457 ·
-	ary												437
	Mud Rotary										GW		
ŀ	ML												
- 7			•		Χ	5A							456 ·
-		20 19	• •		X	5B	87		- 7.2 m: Brown below depth				400
-		16 30											
L.													
- 8													455 ·
È.													400
Ē					$\nabla$								
ŀ		20 7	• •		Å	6	47		- 8.8 m: Compact below depth			Sieve (6) G:41% S:43% F:16%	
- 9	1	19 19											454 ·
ŀ													
Ē													
	end	<u>   </u> 	A-Auger B-Be	cker	re l		G-grab		Continued on Next Page			Final Depth of Hole	: 18.1
Sar	nple	L										Page	
iy	pe:		Sample Spoo	lit <b>0</b> -Ode n (air ro	tary)	1	(mud re	turn)	T-Shelby Tube				

				<i>c</i>							SUMMARY LOG		Dril	l Hole#: <b>BH23-01</b>	
BRI	ITISI	H	Ministry o Transporta	ation	-						ulvert Replacement			lled: 09 Aug 2023	
COLI			and Infras 221-11730		Locatio								npany: ler: Dan	Westech	
гтера		-	Canada Inc.	-00.3000							Alignment: 18362.2 m Station/Offset:	Dril	l Make/I	Model: MULTIDRILL PL-G	
Logge				l by: BD	Elevatio	-	-			, e		Dril Auc		hod: Mud Rotary / Solid Ste	em
		E	x Pocket Penetr 100	rometer   Shea 200 3	r Strength (kl	(Pa)	ш	•	(%	_		-	NO		
DEPTH (m)	DRILLING DFTAILS	150m		I Vane ⊕ Ren			SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL		CLASSIFICATION	COMMENTS TESTING	ELEVATION
ĒPT	DFTA	WS/		V" (BLOWS/30 W%			MPLE	AMPL	COVE	IL SY	DESCRIPTION		SSIFI	Drillers Estimate	LEVA
		BLO	W <sub>p</sub> %  20	40 60	W <sub>1</sub> %	6	SAI	1S	REC	So			CLA	(G % S % F %)	Ξ
			20	-0 00	, 00										
— 10 -	)						$\nabla$			2.					453
-		18 19	•	<b>A</b>			XI	7	47		- 10.3 m: Dense below depth				400
-	otary	26 18					$\square$								
	Mud Rotary														
- 11															452
															452
-							$\overline{\mathbf{n}}$								
		13	• •				IXI	8	22						
- 12	2	12 23 20					Ш								
		20													451
-															
- 13	3			•											
		21	• •				W	9	52				GW	Sieve (9)	450
-		16 17					Δ						GW	G:32% Ś:57% F:11%	
		11													
- 14	ı														
															449
-															
- 15	5						$\overline{\nabla}$								
		32 26	•	<b>A</b>			XI	10	57						448
		26 15 15					$\square$								
- 16	6														
							$\nabla$				- 16.2 m: Very dense below depth				447
-		28 36	•				IXI	11	20						
		34 27					$\square$								
- 17	,														
															446
		28													
-		35 28	•		<b>۱</b>		IXI	12	90					Sieve (12)	
- 18	, 	34					Щ			-	End of hole at 18.14 m.	18.14m		G:46% S:45% F:9%	445
											Borehole backfilled immediately with bentonite grout to 3.35 m				
-										1	depth. On August 10, 2023 (07:30) borehole backfilled with bentonite chips to 1.42 m depth, road base to 0.37 m depth, and				
										1	cold mix asphalt to surface.				
- 19	,						1			1					444
										1					
				<u> </u>				1						Final Depth of Hole	) 2: 18
Sar	jend nple	l	A-Auger	B-Bec		C-Cor			-grab					Page	
	pe:		Sample	× Spoor	it 🚺	• (air ro	ex tarv)	1	N-Wasl	n eturn)	T-Shelby Tube				

APPENDIX C

# **Geotechnical Laboratory Testing**



### Water Content Summary ASTM D2216

 Test Request #
 K23-116

 Client:
 MoTI

 Project Name:
 Cache Creek Culvert Replacement

Project Number: Project Location:

221-11730-00.3680 Cache Creek, British Columbia

		Sample						
Sample Location	RefTop (m)Base (m)22.442.59				Soil Description	Water Content %	Method	Remarks
BH23-01	2	2.44     2.59       7.01     7.25				3.5	В	
BH23-01	5A	7.01	7.25	SS		8.7	В	
BH23-01	5B	7.25	7.47	SS		13.6	В	
BH23-01	6	8.53	8.99	SS		11.3	В	
BH23-01	7	10.06	10.52	SS		9.0	В	
BH23-01	8	11.58	12.04	SS		12.3	В	
BH23-01	9	13.11	13.56	SS		13.5	В	
BH23-01	10	14.94	15.39	SS		10.1	В	
BH23-01	11	16.15	16.61	SS		10.0	В	
BH23-01	12	17.68	18.14	SS		10.6	В	

Notes:

#### Disclaimer:

Tested by:JSinghChecked by:JSingh

Date: 24 Aug 2023 Date: 28 Aug 2023 The laboratory testing services reported herein have been performed in accordance with the terms of a contract with WSP's client, and with the recognized standards indicated in this report, or local industry practice. This laboratory testing services report is for the sole use of WSP's client, relates only to the sample(s) tested and does not represent any (actual or implied) interpretation or opinion regarding specification compliance or materials suitability for any specific purpose.

Reviewed by: BRush

Date: 28 Aug 2023

WSP Canada Inc. 590 McKay Avenue, Suite 300 Kelowna, British Columbia, V1Y 5A8 Canada [+1] (250) 860 8424



#### PARTICLE SIZE DISTRIBUTION

### **ASTM D6913**

															Method B
Test Request #	K23-116										Project Nurr	iber:	221-11730-	00.3680	
Client:	MoTI										Project Loca	ation:	Cache Cree	ek, British Co	lumbia
Project Name:	Cache Creek	Culvert Re	placement								Sample Loc	ation:	BH23-01		
Source:											Sample No.:		6		
Soil Description:											Type:		SS		
Soli Description.											Depth (m):		8.53	-	8.99
Specimen								cimen							
Reference	NA						Dept	th (m):	NA		D	ate of Test	8/2	5/2023	
Specimen	NA														
Description	INA.														
												Sieve			ometer
Grain Size			10.0		40.0				15.0			5.41			entation
Distribution (%)			40.9		43.2				15.9		Sieve No.	Particle	% Passing	Particle	% Passing
		G	RAVEL		SAND	T					1.1/0"	Size mm	100.0	Size mm	
BOULDER	COBBLE	Coarse	Fine	Coarse		Fine		FINES (	(Silt, Clay)		1 1/2" 1"	37.5 25	100.0 93.0	┣────	
		Coarse	Fine	Coarse	Medium	Fille					3/4"	25 19		<b> </b>	
100											3/4	19	86.6 77.9	<b> </b>	
											3/8"	9.5	71.7	┣────	
90			$\mathbf{N}$								3/8	9.5 4.75	59.1	<b> </b>	
80											#4	4.75	44.2	<b> </b>	
80											#10	∠ 0.85	33.3	<u> </u>	
70			N								#20	0.85	26.7	<u> </u>	
ass											#40	0.425	20.7	<b> </b>	
ssering by Massing by											#100	0.25	19.8	<b> </b>	
යි ව 50											#140	0.106	17.8	<b> </b>	
sing 20											#200	0.075	15.9		
<sup>80</sup> 40					$\mathbf{i}$						#200	0.070	10.0		
														0.005 mm	
30														0.002 mm	
20														D60	4.99
20														D30	0.60
10														D10	
														Cu	
0	100		10		1	0.1		0.01		0.001				Сс	
1000	100		10 ————————————————————————————————————	Dort	icle Size (mm)	0.1 ————————————————————————————————————	ydrometer	0.01		0.001				L	
				Fait			, a. o								
Notes:								Di	isclaimer:						
										ng services reported her	ein have been perfo	rmed in accordar	nce with the terms	of a contract with	WSP's client, and
								use	e of WSP's client,	standards indicated in th , relates only to the samp ion compliance or mater	ole(s) tested and doe	es not represent a	any (actual or impli	ng services report ed) interpretation	t is for the sole or opinion
Tested by: JS	Singh Date	e: 25-Aug	-23			Checked by	: JSingh	Date:	28-Aug-23	3	Reviewed	by: BRush	Date:	28-Aug-23	
						WS	SP Canada I	nc.							
					590 McKay A	venue, Suite 30			lumbia, V1Y	′ 5A8					
							Canada								
						r. 4	1 (250) 000	0404						5	50000



#### PARTICLE SIZE DISTRIBUTION

### **ASTM D6913**

															Method B
Test Request #	K23-116										Project Num	iber:	221-11730-	00.3680	
Client:	MoTI										Project Loca	ation:	Cache Cree	k, British Col	lumbia
Project Name:	Cache Creek	Culvert Re	placement								Sample Loc	ation:	BH23-01		
Source:											Sample No.:		9		
											Type:		SS		
Soil Description:											Depth (m):		13.11	-	13.56
Specimen							Spe	cimen							
Reference	NA							th (m):	NA		D	ate of Test	8/2	5/2023	
Specimen															
Description	NA														
												Sieve			ometer
Grain Size															entation
Distribution (%)			32.2		57.1			1	0.7		Sieve No.	Particle	% Passing	Particle	% Passing
	1											Size mm	-	Size mm	,e i deenig
BOULDER	COBBLE		RAVEL		SAND			FINES (	Silt, Clay)		1"	25	100.0		
		Coarse	Fine	Coarse	Medium	Fine					3/4"	19	98.1		
100											1/2"	12.5	85.7		
100			<         <   <   <   <   <   <   <   <								3/8"	9.5	82.9		
90			- <b>\</b>								#4	4.75	67.8		
											#10	2	45.7		
80											#20	0.85	29.1		
70											#40	0.425	21.8		
				X							#60	0.25	17.9		
SSE 60											#100	0.15	14.6		
þyl											#140	0.106	12.6		
වු 50											#200	0.075	10.7		
assi				•											
40															
30														0.005 mm	
00														0.002 mm	
20						∽								D60	3.50
														D30	0.89
10														D10	
0														Cu	
1000	100		10		1	0.1		0.01		0.001				Cc	
				Par	ticle Size (mm)		Hydrometer								
Notes:								Di	sclaimer:						
										sting services reported he					
										ed standards indicated in t ent, relates only to the san					
										ation compliance or mate				su) interpretation	
<b>T</b>		05.4					10. 1	<b>D</b> i t i		22					
Tested by: JS	Singh Date	e: 25-Aug	-23			Checked k	by: JSingh	Date:	28-Aug-2	23	Reviewed	by: BRush	Date:	28-Aug-23	
						W	SP Canada	Inc.							
					590 McKay A	venue, Suite 3	300 Kelowna	, British Co	lumbia, V1	IY 5A8					
							Canada								



#### PARTICLE SIZE DISTRIBUTION

### ASTM D6913

											Method B
Test Request #	K23-116						Project Num		221-11730-		
Client:	MoTI						Project Loca		Cache Cree	k, British Co	lumbia
Project Name:	Cache Creek	Culvert Replacement					Sample Loca	ation:	BH23-01		
Source:							Sample No.:		12		
							Type:		SS		
Soil Description:							Depth (m):		17.68	-	18.14
Specimen				Spec	imen						
Reference	NA				h (m): NA		D	ate of Test	8/2	5/2023	
Specimen											
Description	NA										
								Sieve		Hydro	ometer
Grain Size								Sieve		Sedime	entation
Distribution (%)		45.9	45.5		8.6		Sieve No.	Particle	% Passing	Particle	% Passing
	-						Sieve INU.	Size mm	70 Fassing	Size mm	70 Fassing
BOULDER	COBBLE	GRAVEL	SAND		FINES (Silt, Clay)		1 1/2"	37.5	100.0		
DOOLDER	COBBLE	Coarse Fine	Coarse Medium	Fine			1"	25	94.2		
							3/4"	19	87.5		
100							1/2"	12.5	75.1		
90		▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶ ▶					3/8"	9.5	68.7		
30							#4	4.75	54.1		
80							#10	2	39.1		
		<b>↓</b>     <b>↓</b>					#20	0.85	27.8		
70							#40	0.425	20.3		
sser 60 . bi Sto . A 40 .							#60	0.25	15.4		
≚ 60							#100	0.15	11.9		
ວັ ໘ 50							#140	0.106	10.1		
sin							#200	0.075	8.6		
<sup>80</sup> 40							#200	0.070	0.0		
%										0.005 mm	
30										0.002 mm	
										D60	6.29
20				<b>N</b>						D30	1.00
10										D30	0.10
										Cu	61.00
0	Į_									Cu	1.50
1000	100		1	0.1	0.01	0.001				CC	1.50
		Sieve	Particle Size (mm)								
					<b>-</b> ····						
Notes:					Disclaimer:						
						ng services reported herein standards indicated in this					
					use of WSP's client	, relates only to the sample	(s) tested and doe	s not represent a	any (actual or impli		
					regarding specificat	ion compliance or material	s suitability for any	specific purpose	э.		
Tested by: JS	Sinch Date	e: 25-Aug-23		Checked by: JSingh	Date: 28-Aug-23	3	Reviewed I	bv: BRush	Date:	28-Aug-23	
rested by: of	Dangri Dan	20 / lug 20			-		Refletted	Sy. Dittain	Dute.	20 / lug 20	
				WSP Canada I							
			590 McKay Av	enue, Suite 300 Kelowna,	British Columbia, V1Y	′ 5A8					
				Canada							
				[+1] (250) 860	3424					Rev57-120	52023



### MEASUREMENT OF SOIL RESISTIVITY USING THE TWO-ELECTRODE SOIL BOX METHOD ASTM G187

Project No.:	221-11730-00.3680	Lab Sch No.: B23-248
Client:	MoTI	Sheet: 1 of 1
Project:	Cache Creek Culvert Replacement	Sampled By: WSP - PM
Location:	Cache Creek, British Columbia	Date Sampled: Not Given

BOREHOLE ID	SAMPLE ID	DEPTH (m)	MEASURED RESISTANCE (ohm)	CALCULATED RESISTIVITY (ohm-cm)	TEMPERATURE (°C)	REMARKS
BH23-01	GS1	0.76 - 0.91	5,070	3,397	21.0	Saturated
BH23-01	GS4	5.49 - 5.94	8,850	5,930	21.0	Saturated
otes: 1. Miller 400D Dig . Soil box factor: 0.67 cr	n.					
<u>. Material retained on 4.</u> SJohn				Chung	C t l	5 2022
		August 28, 2023			September	
TESTED BY		DATE		ECKED BY	DATE	



### **CERTIFICATE OF ANALYSIS**

REPORTED TO	WSP Canada Inc - Burnaby Lab 300-3811 North Fraser Way Burnaby, BC V5J 5J2		
ATTENTION	Siny John	WORK ORDER	23H3720
PO NUMBER PROJECT PROJECT INFO	CA-WSP-221-11730-00.3680 MoTI Cache Creek Culvert Replacement	RECEIVED / TEMP REPORTED COC NUMBER	2023-08-29 14:30 / 19.1°C 2023-09-06 14:11 No #

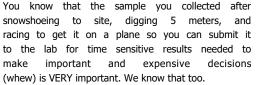
#### Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

#### Big Picture Sidekicks



We've Got Chemistry



It's simple. We figure the more you enjoy

Work Order Comments: Results for pH ASTM D4972 with DDI:

23H3720-01: 7.82 23H3720-03: 7.89 DUP (3720-01): 7.84

working with fun and our engaged team the more members; likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre the for knowledge technical you need, BEFORE you need it, so you can stay up to date and in the know.

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: https://www.caro.ca/terms-conditions

If you have any questions or concerns, please contact me at rpshyk@caro.ca

Authorized By:

Regan Pshyk Account Manager

1-888-311-8846 | www.caro.ca #110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4



### **TEST RESULTS**

REPORTED TO PROJECT	WSP Canada Ind CA-WSP-221-11	,		WORK ORDER REPORTED	23H3720 2023-09-0	6 14:11
Analyte		Result	RL	Units	Analyzed	Qualifie
BH23-01 GS1 at (	0.76-0.91m (23H37)	20-01)   Matrix: Soil   Sampled: 2023	8-08-29			
General Parameter	rs					
Sulfate, Water-So	bluble	0.089	0.050	%	2023-09-05	
pН		7.65	0.10	pH units	2023-09-06	CST2
Chloride, Water-S	Soluble	0.014	0.002	%	2023-09-06	
General Parameter		20-02)   Matrix: Soil   Sampled: 2023				
Sulfate, Water-So	oluble	< 0.050	0.050	%	2023-09-05	
Chloride, Water-S	Soluble	0.018	0.002	%	2023-09-06	
BH23-01 GS4 at		20-03)   Matrix: Soil   Sampled: 2023	3-08-29			
Sulfate, Water-So	bluble	< 0.050	0.050		2023-09-05	007-
pH Chloride, Water-S		7.33	0.10	pH units	2023-09-06	CST2
		0.003	0.002	0/	2023-09-06	

Sample 0	Qualifiers:
----------	-------------

CST2 These results are with CaCl2



### **APPENDIX 1: SUPPORTING INFORMATION**

REPORTED TO	WSP Canada Inc - Burnaby Lab
PROJECT	CA-WSP-221-11730-00.3680

WORK ORDER23H3720REPORTED2023-09-06 14:11

Analysis Description	Method Ref.	Technique	Accredited	Location
Chloride, Water Soluble in Soil	ASTM C1218-17	Hot Water Extraction / Hot Water Extraction		Richmond
pH in Soil	ASTM D4972-01*	1:1 Soil/Water Slurry / Electrode		Richmond
Sulfate, Water-Soluble in Soil	CSA A23.2-3B / CSA A23.2-2B	Extraction (HCI) / Gravimetry (Barium Sulfate Precipitation)		Richmond

Note: An asterisk in the Method Reference indicates that the CARO method has been modified from the reference method

#### **Glossary of Terms:**

RL	Reporting Limit (default)
%	Percent
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
pH units	pH < 7 = acidic, ph > 7 = basic
ASTM	ASTM International Test Methods
CSA	Canadian Standards Association Chemical Test Methods

#### **General Comments:**

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline (s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



### **APPENDIX 2: QUALITY CONTROL RESULTS**

<b>REPORTED TO</b>	WSP Canada Inc - Burnaby Lab	WORK ORDER	23H3720
PROJECT	CA-WSP-221-11730-00.3680	REPORTED	2023-09-06 14:11

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- Method Blank (Blk): A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- Blank Spike (BS): A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- Matrix Spike (MS): A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifie
General Parameters,Batch B3H3135									
Blank (B3H3135-BLK1)			Prepared	1: 2023-08-3	80, Analyze	d: 2023-0	9-05		
Sulfate, Water-Soluble	< 0.050	0.050 %							
General Parameters, Batch B3H3368									
Blank (B3H3368-BLK1)			Prepared	1: 2023-08-3	31, Analyze	d: 2023-0	9-06		
Chloride, Water-Soluble	< 0.002	0.002 %							
Duplicate (B3H3368-DUP1)	Sou	rce: 23H3720-01	Prepared	1: 2023-08-3	31, Analyze	d: 2023-0	9-06		
Chloride, Water-Soluble	0.014	0.002 %		0.014			< 1	20	
General Parameters, Batch B3l0342									
	0	rce: 23H3720-01	Prepared						
Duplicate (B3I0342-DUP1)	Sou	100.2010/20-01							

ADC	(ang			C						11	8846																		CA	RO B	ic co	:, Rev	2017	7-05
			ł	#1							6V 2K9	C	HA	IN	0	<b>- C</b>	US	ТО	D	( R.	EC	<b>DRI</b>	<b>)</b>	сос	#						PAC	iE 1	OF	1
	1	ger		#1							/1X 5C3	R		juli	HED	BY:				DAT	: 202	3-08-	29	RECE	IVED	BY:					DA	TE:	81	<u>29'</u>
ANALY FICAL SERVI Caring About Results, Obvio				1		* 2 3					[5S 1H7		-1	iry	<u> </u>						: 11.	15 am			<u>B1</u>				De	(ta	TIM			
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COMPANY:WSP Canada Inc.						PANY:					•	R	ush:	1 Da				Γ	3 Da	у* Г	-	BC C	SR So	il: N	WL	AL	ΓP	۲Ľ	RL-L	D <b>I</b>	RL-HI			
ADDRESS: 300 - 3811 North Fraser Way	,					ESS:							ther' onta	_	b To (	Confi	m. S	urcha		May 6	nnlv	BC C CCM	SR Wa E:	ater: A	AW <b>F</b>	- IW			Fii C her:	w <b>r</b>				
Burnaby, BC V5J 5J2			_									P	ROJ	CTI	NUM	BER/	INF	0:				1		A: Bioł	nazare	d (	D: Asb			G:	Strong	Odoi	Jr	<u> </u>
CONTACT: Siny John				со	NT	ACT:												)-00. 't Re		-				B: Cyai I: PCB			E: Hea F: Flan				High C Other (			
TEL/FAX: 604-412-6729				TEI	L/F	AX:						-	acr		icer		VCI	( NC	μια			SES		-										٦́ ٦
				DEL	IVE	RY METHOD: E		M	AIL	Г	OTHER* J	_								Г		<u> </u>	T									Τ		
DATA FORMAT: EXCEL 🔽 WATERTRAX 🦵 ES EQUÍS 🖵 BC EMS 🗖 O		t ER*	······	EM/		teres 75, 100 100 100 100 100 100 100 100 100 10											ļ	5	Нg	БН		ľ				<b>–</b>								DE(
EMAIL 1: siny.john@wsp.com				EM/ EM/								- _				Non-Chlor.		B		1	inc. pH					ا چ								00
EMAIL 2:						J	·					╵╙				No N	HAA	ERBI		LVED					HPC	E. coli								ZAR
EMAIL 3: ** if you would like to sign up for ClientConnect and	101	Envl		PO		O'r online reruit	ro offering			cho	ekhava E	- H		14			Г	ACID HERBICIDES	DTAL	ISSO	Ξľ	-  ~	:		$ \Gamma $	Г			218)	2-38				HA
SAMPLED BY: WSP - PM		MAT				SAMPLI		<u>т</u>			MMENTS:		Г	PHC F2-F4	Hd	Chlorinated	GLYCOLS	Т Т	ER T(	ERD	Soil (SALM)		11 -	Г	RMS	RMS		(72)	U S	A23.				MPLE
SAMPLED BY: WSP-PM	TER -	E E			RQTY			TED				HdV	VPH	H	L/HEPH	hlori	GLY	S I	WAT	WAT	ğ	-  - SS  -	60	90M	LIFO	ILFO	<u> </u>	D49	AS	S				SA
	IG WA	WAT			AINE	DATE	TIME	RINA	ED	RVEC	6 . A	r	ΙΓ	- ا	·   🗖	210	Г	E	- 51	5	-	- ୮ 2 5		F	0	2	Š	STM	ide (	ate			6	IBLE
CLIENT SAMPLE ID:	DRINKING WAT	OTHER WATER	ы	THE	ONT	YYYY-MM-DD	HH:MM	HLO	FILTERED	PRESERVED	(e.g. flow/volume media ID/notes)	BTEX	N N	EPH	PAH	PHENOLS (	В В	PESTICIDES	METALS - WATER TOTAL	METALS - WATER DISSOLVED		TS ST	BOD	70G	FECAL COLIFORMS	TOTAL COLIFORMS	ASBESTOS	pH (ASTM D4972)	Chloride (ASTM C1218)	Sulphate (CSA A23.2-3B)			НОГD	POSSIBLE SAMPLE HAZARD CODE(S)
BH23-01 GS1 at 0.76 - 0.91 m	0		< S	0	0					<u>е</u>			-	+-	+-		╞			_		- ,-				,	-+		- -				1-	
BH23-01 GS3 at 3.96 - 4.22 m	$\square$	+	1									+	+						-				-									+	-	-
BH23-01 GS4 at 5.49 - 5.94 m			<ul> <li>Image: A start of the start of</li></ul>									-	+																	/				
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APPENDIX D

# **Environmental Laboratory Testing**



### **CERTIFICATE OF ANALYSIS**

REPORTED TO	WSP Canada Inc Kelowna 108-3677 Highway 97N Kelowna, BC_V1X 5C3		
ATTENTION	Patrick Machibroda	WORK ORDER	23H1650
PO NUMBER PROJECT PROJECT INFO	221-11730-00.3680	RECEIVED / TEMP REPORTED COC NUMBER	2023-08-10 13:58 / 21.2°C 2023-08-17 12:41 B134947

#### Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO/IEC 17025:2017 for specific tests listed in the scope of accreditation approved by CALA.

#### Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too. It's simple. We figure the more you

We've Got Chemistry

enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

칠 A

Ahead of the Curve

Through research, regulation and instrumentation, knowledge, we are your analytical centre the for knowledge technical you need, BEFORE you need it, so you can stay up to date and in the know.

By engaging our services, you are agreeing to CARO Analytical Service's Standard Terms and Conditions outlined here: https://www.caro.ca/terms-conditions

If you have any questions or concerns, please contact me at rpshyk@caro.ca

Authorized By:

Regan Pshyk Account Manager

1-888-311-8846 | www.caro.ca #110 4011 Viking Way Richmond, BC V6V 2K9 | #102 3677 Highway 97N Kelowna, BC V1X 5C3 | 17225 109 Avenue Edmonton, AB T5S 1H7 | #108 4475 Wayburne Drive Burnaby, BC V5G 4X4



### **TEST RESULTS**

REPORTED TO PROJECT	WSP Canada Inc Kelowna 221-11730-00.3680			WORK O REPORT		7 12:41
Analyte	R	esult	R	L Units	Analyzed	Qualifie
1A (23H1650-01)	Matrix: Water   Sampled: 2023-0	08-10 06:30				
Anions						
Sulfate		117	1	.0 mg/L	2023-08-11	
General Parameter	s					
рН		8.40	0.1	10 pH units	2023-08-12	HT2
Anions	Matrix: Water   Sampled: 2023-(	08-10 06:31				
Sulfate		115	1	.0 mg/L	2023-08-11	
General Parameter	S					
рН		8.41	0.1	10 pH units	2023-08-12	HT2
Sample Qualifie	rs:					
HT2 The 1 recomm	5	time (from sampling	ı to analysis)	has been	exceeded - field	analysis is



### **APPENDIX 1: SUPPORTING INFORMATION**

REPORTED TO PROJECT		ada Inc Kelowna 0-00.3680		WORK ORDER REPORTED	23H1650 2023-08-1	7 12:41
Analysis Descrip	otion	Method Ref.	Technique		Accredited	Location
Anions in Water		SM 4110 B (2020)	Ion Chromatography		$\checkmark$	Kelowna
pH in Water		SM 4500-H+ B (2021)	Electrometry		✓	Kelowna

#### Glossary of Terms:

RL	Reporting Limit (default)
mg/L	Milligrams per litre
pH units	pH < 7 = acidic, ph > 7 = basic
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

#### General Comments:

The results in this report apply to the received samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Caro will dispose of all samples within 30 days of sample receipt, unless otherwise agreed.

Results in **Bold** indicate values that are above CARO's method reporting limits. Any results that are above regulatory limits are highlighted **red**. Please note that results will only be highlighted red if the regulatory limits are included on the CARO report. Any Bold and/or highlighted results do <u>not</u> take into account method uncertainty. If you would like method uncertainty or regulatory limits to be included on your report, please contact your Account Manager:rpshyk@caro.ca

Please note any regulatory guidelines applied to this report are added as a convenience to the client, at their request, to help provide some initial context to analytical results obtained. Although CARO makes every effort to ensure accuracy of the associated regulatory guideline(s) applied, the guidelines applied cannot be assumed to be correct due to a variety of factors and as such CARO Analytical Services assumes no liability or responsibility for the use of those guidelines to make any decisions. The original source of the regulation should be verified and a review of the guideline (s) should be validated as correct in order to make any decisions arising from the comparison of the analytical data obtained to the relevant regulatory guideline for one's particular circumstances. Further, CARO Analytical Services assumes no liability or responsibility for any loss attributed from the use of these guidelines in any way.



### **APPENDIX 2: QUALITY CONTROL RESULTS**

<b>REPORTED TO</b>	WSP Canada Inc Kelowna	WORK ORDER	23H1650
PROJECT	221-11730-00.3680	REPORTED	2023-08-17 12:41

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- Method Blank (Blk): A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup)**: An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- Blank Spike (BS): A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- Matrix Spike (MS): A second aliquot of sample is fortified with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM)**: A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
Anions, Batch B3H1176									
Blank (B3H1176-BLK1)			Prepared	I: 2023-08-1	I1, Analyze	d: 2023-0	08-11		
Sulfate	< 1.0	1.0 mg/L							
Blank (B3H1176-BLK2)			Prepared	I: 2023-08-1	13, Analyze	d: 2023-0	08-13		
Sulfate	< 1.0	1.0 mg/L							
LCS (B3H1176-BS1)			Prepared	I: 2023-08-1	11, Analyze	d: 2023-(	08-11		
Sulfate	16.0	1.0 mg/L	16.0		100	90-110			
LCS (B3H1176-BS2)			Prepared	I: 2023-08-1	13, Analyze	d: 2023-(	08-13		
Sulfate	16.0	1.0 mg/L	16.0		100	90-110			

#### General Parameters, Batch B3H1238

Reference (B3H1238-SRM1)			Prepared: 20	23-08-12, Analyzed: 2	2023-08-12	
рН	7.04	0.10 pH units	7.01	100 9	8-102	
Reference (B3H1238-SRM2)			Prepared: 20	23-08-12, Analyzed: 2	2023-08-12	
PΗ	7.04	0.10 pH units	7.01	100 9	8-102	

