



**REPORT**

# Highway 1 - Selkirk Mountain 4 Laning - Quartz Creek Rest Area

## *Geotechnical Investigation Factual Report*

Submitted to:

**Ryan Edmonds, PEng**

Ministry of Transportation and Infrastructure  
Southern Interior Region - SIR

Submitted by:

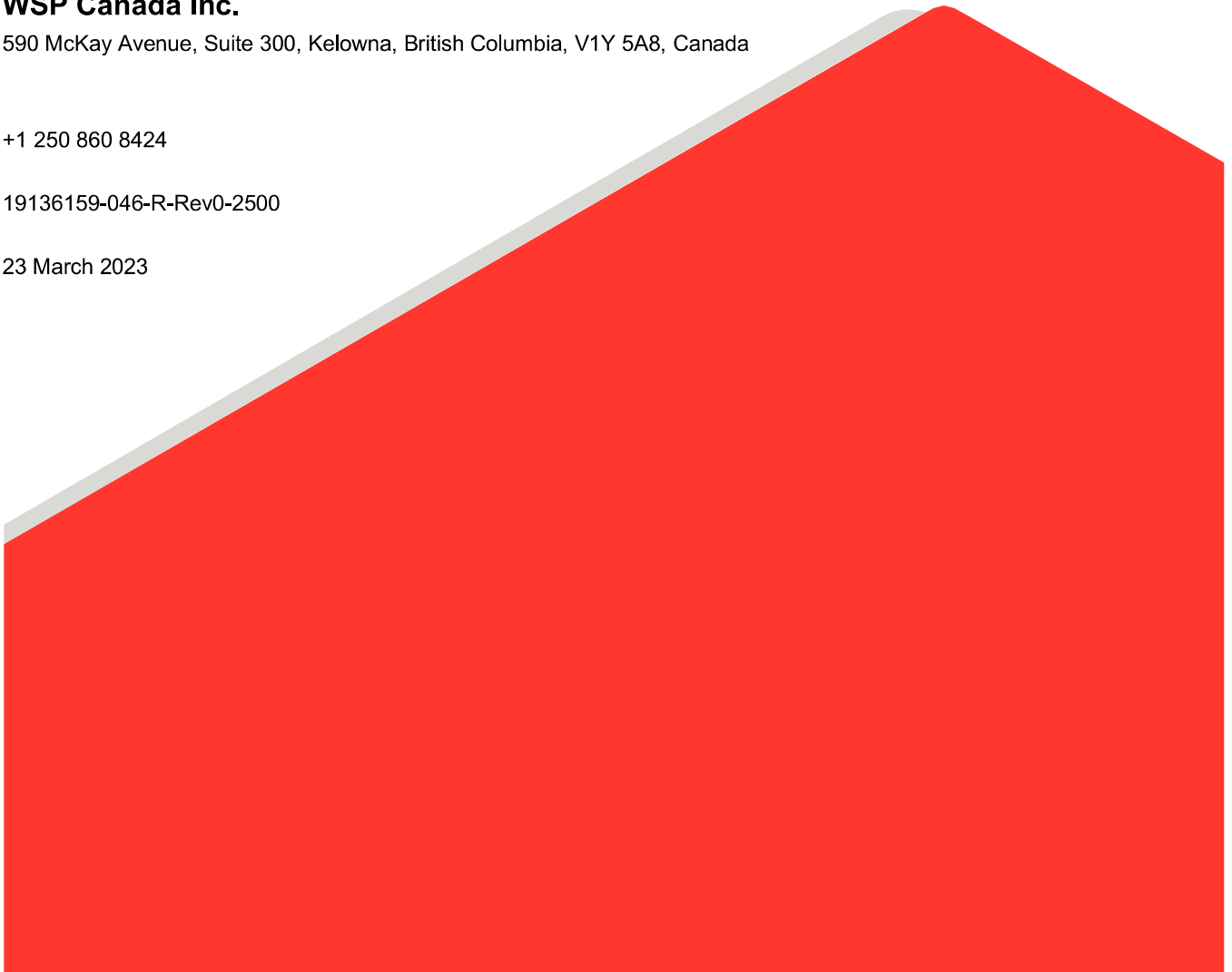
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## Distribution List

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## 1.0 INTRODUCTION

As requested by BC Ministry of Transport and Infrastructure (MoTI), WSP Canada Inc. (WSP), formerly Golder Associates Ltd., completed a detailed geotechnical investigation in April 2022 and October 2022 at the location of the proposed Quartz Creek Rest Area, part of the Trans Canada Highway 4-laning project. The new rest area (the Site) is proposed opposite from the existing Quartz Creek Snowmobile Staging Area off the eastbound lane (south side) of the Trans Canada Highway (TCH), about 40 km west of Golden, BC. The purpose of the investigation was to assess the soil and groundwater conditions to provide a basis for the design and construction of the proposed relocated rest area.

The geotechnical investigation was carried out in accordance with our “*Work Plan for Highway 1 – Quartz Creek Rest Area Geotechnical Investigation, Near Donald, BC*” issued to MoTI in March 2022 (Golder Associates Ltd. reference number 19136159-039-L-Rev0), under our Consulting Services Contract Number 862CS1648. The scope of this report is limited to geotechnical engineering services only and does not include any investigation, testing or assessment of soil and/or groundwater contamination at the site, nor inclusion of bio-environmental or archaeological services. It is understood that others are providing services related to bio-environmental and archaeological services.

This report should be read in conjunction with the “*Important Information and Limitations of this Report*”, provided in APPENDIX A. The reader’s attention is specifically drawn to this information as it is essential for the proper use and interpretation of this report. Further to these limitations, this report also provides written consent to the British Columbia Ministry of Transportation and Infrastructure, the contractors bidding on the Highway 1 - Selkirk Mountain 4 Laning Project and the successful construction contractor for the Highway 1 - Selkirk Mountain 4 Laning Project (the “Authorized Users”) as outlined in the 862CS1648 Contract H0461d form, to rely on this report under the same terms and conditions as WSP has with its Client for the strict purposes of the Project design, only conditional upon and governed by the Authorized User’s acceptance of the conditions presented in Appendix A.

## 2.0 UNDERSTANDING OF PROJECT

An original MoTI Selkirk Route Study along the TCH, including a preliminary and supplemental geotechnical investigation program for the Project, was completed in Fall 2019 and Spring 2021 on a proposed four laning segment of the highway and involves the relocation of the current eastbound and westbound Redgrave Rest Areas. The relocated rest area, known as the Quartz Creek Rest Area, has been proposed on the south side of the TCH adjacent to the Quartz Creek snowmobile staging area, which is approximately 4 km west of the existing Red Grave Rest Area.

Previous geotechnical investigations were also carried out in for the for the Quartz Creek four laning project in spring and fall of 2019 and fall of 2020 which included drilled test holes and mechanically excavated test pits to the north of the proposed Quartz Creek Rest Area. MoTI has requested this detailed geotechnical investigation in the immediate vicinity of the new proposed Rest Area to gather specific information on the soil and groundwater conditions at the Site.

## 2.1 Desktop Study and Preliminary Site Visit

Prior to the geotechnical investigation conducted in April and October 2022, WSP conducted a desktop study that included the review of relevant surficial geology data and investigation data available in our internal library from nearby the Site. The reports reviewed for this scope of work included:

- Geotechnical Report – *Highway 1 – Quartz Creek Four Lining – Detailed Geotechnical Design Report – Highway 1 Quartz Creek Highway Improvement Project (reference number 18103262-025-R-Rev1)* – Golder Associates Ltd., 9 November 2022.
- Geotechnical Report – *Selkirk Geotechnical Data Report (reference number 19136159-R-RevA)* – Golder Associates Ltd., 04 August 2021.

A preliminary site visit was conducted at the Site on 31 March 2022 by Brady Rush of WSP to observe the site conditions and assess access for the excavator and drill rig. During the site visit WSP determined that the excavator would be required to fall several small diameter trees in order to create access to TH22-03, TH22-04 and TP22-05. Access for TP22-06 through TP22-08 had already been cleared of trees during the right of way clearing phase of the Quartz Creek Highway Improvement project, located immediately north of the Site. Due to the scheduling constraints of the investigation program, the Site was covered with snow during the site visit and therefore the requirement for rig mats to access TH22-03 and TH22-04 was not able to be assessed during the preliminary site visit.

## 2.2 Utility Clearance

Prior to any ground disturbance, a BC One Call was submitted for the Site to identify the location(s) of potential buried utilities. The utility locates information from the Quartz Creek Highway Improvement project, located immediately north of the Site, was also reviewed. There was no evidence of buried utilities throughout the Site and therefore a private utility locator was not employed for either the test pitting or drilling portions of the investigation.

Immediately prior to ground disturbance WSP inspected the Site for evidence of buried utilities including the presence of “street furniture”. The only observed structure in the area was a small shed owned by the Golden Snowmobile Club, which was understood to be powered by a generator. No overhead utilities were observed at the Site.

## 2.3 Subsurface Investigation

### 2.3.1 Access and Trail Clearing

Prior to mobilizing to site WSP understands MoTI contacted the Shuswap Indian Band (SIB) to notify them of the upcoming subsurface investigation. Based on conversations with MoTI, WSP understands the SIB reviewed the proposed investigation locations and elected to not have an SIB representative on site to observe the ground disturbance activities.

Access trail and snow clearing for TH22-03 and TP22-05 through TP22-08 was performed by CS Mclean Contracting out of Invermere, BC on 5 April 2022 as the excavator moved from test pit location to test pit location.

Trails were cleared using minimal disturbance techniques. Following use, all equipment access trails were re-covered with stripped topsoil and fallen trees were placed to block access at locations easily accessed by the public.

Access trail clearing for TH22-04 was conducted on 11 October 2022 by an excavator subcontractor hired by MoTI. It is WSP's understanding that the access trail was decommissioned by the excavator subcontractor sometime following the completion of the drilling investigation on 13 October 2022.

### 2.3.2 Test Pit Investigation

The excavation of four (4) test pits was performed by CS Mclean Contracting with a John Deere 345G steel-tracked excavator on 5 April 2022. The test pits labelled TP22-0X were completed at the proposed toe of the embankment fill slope on the north and northwest sector of the Site, to a depth of approximately 5 metres below ground surface (mbgs). The purpose of these test pits was to investigate the existing ground conditions in proposed fill areas and provide further information on the local geotechnical conditions. A summary of information regarding the test pits is provided in the Table 2-1 below.

**Table 2-1: Summary of Test Pits from the Quartz Creek Rest Area Geotechnical Investigation**

Test ID	Date	Excavation Method	UTM Coordinates (m) NAD83 11U		Ground Surface Elevation (m)	Final Depth (mbgs)
			Northing	Easting		
TP22-05	April 5, 2022	Tracked Excavator	5703621	476532	1085	5
TP22-06	April 5, 2022	Tracked Excavator	5703651	476572	1086	5
TP22-07	April 5, 2022	Tracked Excavator	5703677	476642	1087	5
TP22-08	April 5, 2022	Tracked Excavator	5703691	476675	1087	5

### 2.3.3 Drilling Investigation

Geotechnical drilling was conducted between October 11<sup>th</sup> and October 13<sup>th</sup>, 2022, using an ODEX drill rig operated by Geotech Drilling Services Ltd. Four (4) test holes labelled TH22-0X were advanced down 9.75 to 12.65 meters below ground surface (mbgs). Bedrock was not intercepted in any hole. The purpose of these holes was to drill through anticipated dense granular material and investigate underlying soil and groundwater conditions to obtain sufficient geotechnical information for the design of the proposed rest area. Standard Penetration Tests (SPTs) were performed at selected depth intervals and disturbed soil samples were collected for visual identification and laboratory testing. A summary of information regarding the test holes is provided in the Table 2-1 below.

**Table 2-2: Summary of Test Holes from the Quartz Creek Rest Area Geotechnical Investigation**

Test ID	Date	Drilling Method	UTM Coordinates (m) NAD83 11U		Ground Surface Elevation (m)	Depth (mbgs)
			Northing	Easting		
TH22-01	October 11, 2022	ODEX	5703611	476695	1093	9.75
TH22-02	October 12, 2022	ODEX	5703629	476648	1092	12.65
TH22-03	October 12, 2022	ODEX	5703637	476602	1089	9.75
TH22-04	October 13, 2022	ODEX	5703581	476560	1087	9.75

### 2.3.3.1 Standpipe and Data Logger Installation

Upon completion of drilling, 50 mm diameter PVC standpipe piezometers were installed in test holes TH22-03 and TH22-04 to observe the current groundwater elevations relative to the existing ground surface. Solinst Levellogger dataloggers were installed in each standpipe piezometer to continuously monitor groundwater level fluctuations. A summary of the monitoring well and data logger installation is provided in the table 2-3 below.

**Table 2-3: Summary of the groundwater monitoring installations from the Quartz Creek Rest Area Geotechnical Investigation**

Test ID	Installation Date	Installation type	Screen depth (m)	Water level readings	Start of Record	Reading interval
TH22-03	October 13, 2022	Single screen, 50 mm PVC standpipe piezometer	2.5 – 8.5	Downhole Solinst Levellogger and Barometer	October 13, 2022	1 hr
TH22-04	October 13, 2022	Single screen, 50 mm PVC standpipe piezometer	3.0 – 6.0	Downhole Solinst Levellogger	October 13, 2022	1 hr

## 3.0 LABORATORY TESTING

The following laboratory tests were carried out on selected soil samples obtained from the split-spoon samples and grab samples from ODEX drilling and test pits:

- Water Content Determination (ASTM D2216) – 32 tests
- Plasticity Index (ASTM D4318) – 4 tests
- Particle Size Sieve Analysis (ASTM D6913) – 6 tests
- Water-Soluble Chloride/Sulphate Ion Content (CSA A23.2-3B/ CSA A23.2-4B) – 1 test

The laboratory testing procedures are presented in the following sections and complete testing results are provided in Appendix C.

### 3.1.1 Soil Index Testing

The index laboratory testing results are summarized on the Records of Test Holes and Test Pits in Appendix B and complete results can be seen in Appendix C. Soil index testing was conducted at WSP's Kelowna laboratory in general conformance with American Society for Testing Materials (ASTM) standards as follows:

- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- ASTM D2216 Standard Test Method for Determination of Water (Moisture) Content of Soil and Rock by Mass;
- ASTM D6913 Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis;
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils.

Sample preparation was carried out in general conformance with ASTM D421 Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants. It is important to recognize that the drilling and sampling methods in the field limit the maximum particle size that can be recovered



from the test holes, typically to a maximum size of 51 mm. As such, the laboratory gradation test results shown may not incorporate larger particle sizes that were present within the in-situ soils and may not be representative of coarse gravel, cobble or boulder content.

It is also important to recognize that sampling of fine-grained soils may cause some compression, swelling or heating of the native soils and as such, Atterberg limits and water content results may reflect these disturbances.

### 3.1.2 Soil Specialized Testing

Testing for water soluble chloride and sulphate content on overburden soil deposits was conducted by CARO Analytics in general accordance with the following Canadian Standards Association (CSA) methods:

- CSA A23.2-3B Determination of Total or Water-Soluble Sulphate Content of Soil.
- CSA A23.2-4B Determination of Water-Soluble Chloride Ion Content of hardened grout or concrete.

The results of the laboratory testing can be seen in Appendix C.

## 4.0 SUBSURFACE GEOLOGICAL CONDITIONS

Detailed descriptions of the subsurface soil and groundwater conditions encountered at the time of the field investigation are presented in the Record of Test Hole and Test Pit Log Sheets in Appendix B. The soil descriptions are based on the BC MoTI modified Unified Soil Classification System (USCS).

Classification and identification of soil requires judgement 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 investigation locations.

A summary of the encountered soil and groundwater conditions is provided in the sections 4.1 to 4.4 below. Generally, a 0.2 - 1.8 m thick layer of embankment fill or topsoil was found overlying mineral overburden deposits. Bedrock was not encountered during the investigation.

### 4.1 Embankment Fill

Embankment fill was encountered at the ground surface in TH-22-01 and TH22-02 to a depth of 0.91 mbgs and 1.8 mbgs, respectively. The fill is described as SITLY SAND to SAND and GRAVEL, moist to wet and inferred compact to very dense. Trace to some of non-plastic fines were identified. A 250 mm thick layer of asphalt was encountered below the fill at TH22-02. The asphalt layer was not observed in TH22-01.

### 4.2 Topsoil

A layer of 0.2 to 0.4 m thick topsoil consisting of overburden, organics, roots and rootlets was encountered at the ground surface in all test pit locations. Topsoil was also encountered in TH22-04, described as sandy silt with organics, non-cohesive and inferred very loose to loose.

### 4.3 Mineral Overburden Soils

Below the embankment fill and topsoil, mineral overburden materials were encountered on a thickness of 5 m to 11 m for the remaining depth to the bottom of the holes/pits. The mineral deposits generally comprised non-cohesive sand and gravel, with varying amounts of fine-grained material (trace silt to silty), with a relative density generally ranging from compact to very dense based on recorded SPT N-Values from 14 to over 50 blows per 0.3 m advance. Locally in TH22-04 between 0.3 mbgs to approximately 2.0 mbgs, a layer of silty sand and gravel was encountered in a loose state based on observations and on SPT N-value of 7 per 0.3 m advance.

Some cohesive materials described as silts and clays with a varying content of sand and gravel were also encountered in thicknesses ranging from 0.4 m to 5 m, often interlayered between the coarse-grained deposits described above. The consistency of these materials was generally firm to stiff with recorded SPT N-Values ranging from 6 to 30 blows per 0.3 m advance. The following relatively soft cohesive layers were observed during the field investigation:

- 2 m thick layer of cohesive SILT with consistency of firm was encountered in TH22-02 around 6 mbgs;
- 0.6 m thick layer of cohesive SILTY CLAY with consistency of very soft to soft was encountered in TH22-03 around 8 mbgs; and,
- 0.8 m thick layer of cohesive sandy SILT with consistency of soft to firm was encountered in TP22-05 around 0.2 mbgs.

The overburden materials are generally considered to be glacial blanket sediments that are and generally over-consolidated, mainly due to the high relative density and high fines content observed. Bedrock was not encountered within the investigated depth.

### 4.4 Groundwater

Where observed, the depth to groundwater was measured in the open test holes and seepage zones/ groundwater levels were recorded in the test pits at the time of the investigation. Groundwater depths observed at the time of the investigation can be seen in the Record of Test Holes and Test Pits in Appendix B and are summarized in the table below. Recorded groundwater levels from the downhole dataloggers had not yet been collected at the time of this report.

**Table 4-1: Groundwater level and/or seepage observed during the geotechnical investigation**

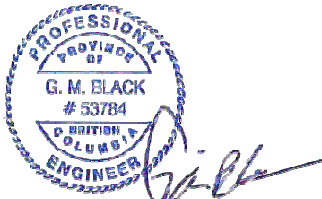
Test ID	Date	Groundwater level (mbgs)	Groundwater Elevation (m)
TH22-01	October 11, 2022	2.7 <sup>a</sup>	1089.3 <sup>a</sup>
TH22-02	October 12, 2022	11.2	1080.9
TH22-04	October 13, 2022	4.0	1083.5
TP22-05	April 5, 2022	3.0	1082

<sup>a</sup> Water return was observed at this depth/elevation during drilling; no water was observed in the hole after drilling.

## 5.0 CLOSURE

We trust that this factual report meets your current requirements. WSP will review the factual information collected, analyse the data and provide engineering comments and recommendations in the *Highway 1 – Selkirk Mountain 4-Laning 100% Geotechnical Design Report*. If you have any questions or comments regarding the content of this report, please do not hesitate to contact the undersigned.

### WSP Canada Inc.



2023-03-27

Gavin Black, PEng  
*Intermediate Geotechnical Engineer*

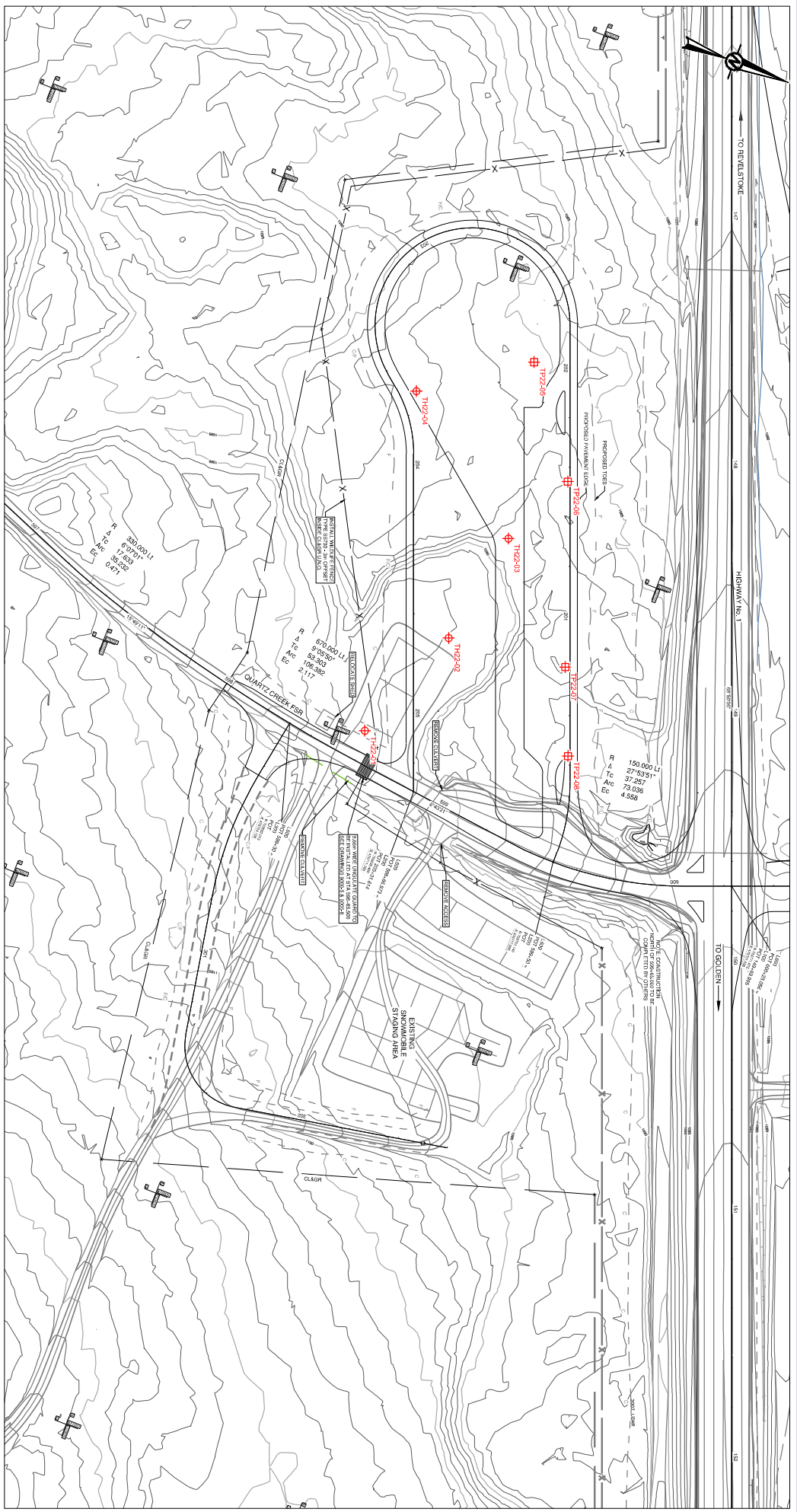
A handwritten signature in black ink, appearing to read "G. Rutherford".

Glen Rutherford, PEng  
*Senior Principal Geotechnical Engineer*

SD/GB/GR/lih

[https://golderassociates.sharepoint.com/sites/120660/project files/6 deliverables/issued to client\\_for wp/19136159-046-r-rev0/19136159-046-r-rev0-qaurtz rest area geotech data rpt 23mar\\_23.docx](https://golderassociates.sharepoint.com/sites/120660/project%20files/6%20deliverables/issued%20to%20client_for_wp/19136159-046-r-rev0/19136159-046-r-rev0-qaurtz%20rest%20area%20geotech%20data%20rpt%2023mar_23.docx)

**PERMIT TO PRACTICE #1000200**  
Engineers & Geoscientists BC



- NOTES)**
1. ALL DIMENSIONS IN METERS UNLESS OTHERWISE NOTED.
  2. ELEVATION ARE RELATIVE TO GEODETIC DATUM.
  3. ALL TEST HOLE LOCATIONS AND ELEVATIONS HAVE BEEN SURVEYED USING HANDHELD GPS/ACQUACCT 0.7M ± 5 CM.

- LEGEND**
- ⊕ BOREHOLE LOCATION
  - ⊕ TEST PIT LOCATION

- REFERENCES)**
1. BASE MAP RECEIVED FROM MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE. FILE NAME: XREF-Base\_Data.dwg RECEIVED DATE: NOV 24, 2022.
  2. INVESTIGATION LOCATIONS RECEIVED FROM MINISTRY OF TRANSPORTATION AND FILE NAME: XREF-2022\_Investigation\_Location.dwg RECEIVED DATE: NOV 24, 2022.

**NOT FOR CONSTRUCTION**

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SCALE 1:200 0 5 10 METERS 0 5 10 FEET		CONFIDENTIAL - UNCLASSIFIED DATE: 2022-11-24	
REVISIONS A. 2022-11-24 FOR CLIENT REVIEW, NOT FOR CONSTRUCTION		PROJECT NUMBER: 19136159_2500	
TRANSPORTATION AND INFRASTRUCTURE SOUTHERN INTERVENTION		PROJECT NUMBER: 19136159	
QUARTZ CREEK REST AREA		SHEET NUMBER: 01	
PLAN		DRAWN BY: [Name] CHECKED BY: [Name] DATE: 2022-11-24	

**APPENDIX A**

**Important Information and  
Limitations 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 by those parties. The Client and Approved Users may not give, lend, sell, or otherwise make available 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**

**Record of Test Holes and Test Pits**



## Notes for Completion of Soil Field Logs

### Soil Type/Description Order

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

### Sample Type

AUGER	SOIL TYPE
C CORE	GRAVEL
G GSB	GRAVEL
L LAB SAMPLE	GRAVEL
O ODEX	GRAVEL
S SPLIT SPOON	GRAVEL
T SHELFY TUBE	GRAVEL
W WASH (MUD RETURN)	GRAVEL

### 1. Classification

Major Divisions	Symbol	Soil Type
Fine Grained Soils	GW	Well-graded gravels or gravel-sand mixtures, little or no fines
	GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines
	GM*	Silty gravels, gravel-sand-silt mixtures
	GC*	Clayey gravels, gravel-sand-silt mixtures
	SW*	Well-graded sands or gravelly sands, little to no fines
	SP	Poorly-graded sands or gravelly sands, little or no fines
	SM*	Silty sands, sand-silt mixtures
	SC*	Clayey sands, sand-clay mixtures
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	OL	Organic silts and organic silts-clays of low plasticity
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays	
OH	Organic clays of medium to high plasticity, organic silts	
PT	Peat and other highly organic soils	
TS	Topsoil with roots, etc.	
Organic Soils	SB	Rock fragments and cobbles, particle size 75mm to 300mm diameter
	LS	Boulders, particle size over 300mm in diameter
	LB	Boulders, particle size over 300mm in diameter

\* GM1: GC1, SM1, SC1: 12-20% Passing #200 (0.075mm) Sieve  
 \* GM2: GC2, SM2, SC2: 20-30% Passing #200 (0.075mm) Sieve  
 \* GM3: GC3, SM3, SC3: 30-40% Passing #200 (0.075mm) Sieve  
 \* GM4: GC4, SM4, SC4: 40-50% Passing #200 (0.075mm) Sieve

### 2. Soil Group (Organic Soils)

Category	ORGANIC CONTENT (% by weight)	NAME	DISTINGUISHING CHARACTERISTICS FOR VISUAL IDENTIFICATION
Highly Organic Soils	75% to 100%	Fibrous PEAT	Light weight, spongy and often elastic at natural water content. Plant structure easily identifiable. Shrinkage considerably upon air drying. Much water squeeze from sample.
	75% to 100%	Amorphous PEAT	Light weight, spongy but not usually elastic at natural water content. Plant structure not easily identifiable. Shrinkage considerably upon air drying. Much water squeeze from sample.
	30% to 75%	SILTY PEAT	Relatively light weight, spongy. Threat usually weak and spongy, rare plastic from sample. Swell on drying. Low dilatancy. Usual can squeeze water from sample readily. Low dilatancy.
Organic Soils	5% to 30%	SANDY PEAT	Sand fraction visible. Threat weak and friable near plastic limit, shrinks on air drying. Low dry strength. Usually can squeeze water from sample readily, high dilatancy, spiny.
	5% to 30%	ORGANIC CLAYEY SILT	Often has a strong H <sub>2</sub> S odour. Threat may be tough depending on clay fraction. Medium dry strength, low dilatancy.
	5% to 30%	ORGANIC SAND	Threats weak and friable near plastic limit, or threats may not be rolled. Low dilatancy, spiny.
	5% to 30%	ORGANIC SILT	Dry strength, medium to high dilatancy.

### 3. Description of Primary Components

Soil Constituent	Particle Size	Millimetres (Sieve Size)
BOULDERS	Not applicable	>300
COBBLES	Not applicable	75 to 300
GRAVEL	Coarse Grained	19.0 to 75
	Fine Grained	4.75 to 19
SAND	Coarse Grained	2.00 to 4.75
	Medium Grained	0.425 to 2.00
SILT/CLAY	Fine Grained	0.075 to 0.425
	Not applicable	<0.075

### 7. Structure

ZONING & FEATURES	DESCRIPTION
Heterogeneous	Soil mass of non-uniform, variable composition or structure
Homogeneous	Soil mass is of uniform composition or structure
REPEITIVE STRUCTURES	Clearly spaced, alternating layers of differing soils and/or differing colours or shades of similar gradation, usually arranged in a regular pattern
Laminated	Thinly laminated, spacing under 5mm
	Thickly laminated, spacing from 5mm to 20mm
	Differing soils or visible variations in soil constituents or colour arranged in layers, generally but not necessarily parallel to one another
Stratified	Very Thinly Bedded: 20mm to 60mm Thinly Bedded: 60mm to 200mm Medium Bedded: 200mm to 600mm Thickly Bedded: 600mm to 2m Very thickly Bedded: over 2m
Layered	DISCRETE LAYERS OR FEATURES
Varved	A laminated soil consisting of two distinct soils (usually clay and silt) occurring 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.
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 thickness of less than about 10mm
Fissured	Generally applied to dried or overconsolidated fine grained soils (silt or clay) containing cracks or physical discontinuities which can be vertical, horizontal or inclined. Described as highly, moderately and slightly fissured
Frable, Blocky or Flaky	Overconservative soil breaks into small (table), larger (brick), or thin plate like (slaty) fragments with little friction
Slickensided	Polished or striated surfaces. Often an indication of an existing failure or slip surface. If continuous slickensided shear zones are present, they should be made of their angle in relation to the horizontal plane

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

CLASSIFICATION	CH	CI	CL	OH	MH	OL	ML	ML
CLAY	SILTY CLAY	SILTY CLAY	ORGANIC SILT	CLAYEY SILT	ORGANIC SILT	CLAYEY SILT	ORGANIC SILT	SILT
Dilatancy	None	None	None	None	None	Slow to Very Slow	None to Very Slow	Rapid
Dry Strength	High	Medium to High	Low to High	Medium to High	Low to Medium	None to Low	None to Low	None
Thread diameter(mm)	<1	1 to 3	~3	1 to 3	3 to 6	3 to 6	3 to 6	>6
Toughness (or 3mm Thread)	High	Medium	Low to Medium	Medium to High	Low to Medium	None to Low	None to Low	Cart roll 3mm
Organic Content (%)	0 to 30	0 to 30	0 to 30	5 to 30	<5	5 to 30	<5	<5

### COARSE GRAINED SOILS

CLASSIFICATION	SW	SP	SC	SM	GW	GP	GC	GM
SAND	SAND	SAND	CLAYEY SAND	SILTY SAND	GRAVEL	GRAVEL	GRAVEL	SILTY GRAVEL
Size of coarse fraction	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm	<50% of coarse fraction is smaller than 4.75mm
Fines Content	<12% fines	<12% fines	>12% Fines	>12% Fines	>12% Fines	>12% Fines	>12% Fines	>12% Fines
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

### 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	Excuses 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	Included by thumb nail	100 to 200	200 to 400	15 to 30
Hard	Difficult to indent with thumbnail	>200	>400	30

### 4. Description of Secondary Components

Component	% (by mass)	MODIFIER
Minor	5 to 12	use "trace" or "omit"
Secondary	12 to 35	Prefix primary soil name use "and" to combine major constituents eg. SAND and GRAVEL
	>35	

### 6. Colour

COLOUR
Describe the colour of the soil in its most 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 spots of other colours as "mottled"

### 8. Contamination

Additional Observations
See note in Soil Type/Description order table
Non-Cohesive or Cohesive

### 9. Additional Observations

Behaviour
Non-Cohesive or Cohesive



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### SUMMARY LOG

Drill Hole#: **TH22-01**

Project: **Quartz Creek Rest Area**

Date(s) Drilled: 11 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N, NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703611.0 m, 476695.0 m

Drill Make/Model: Fraste MDML

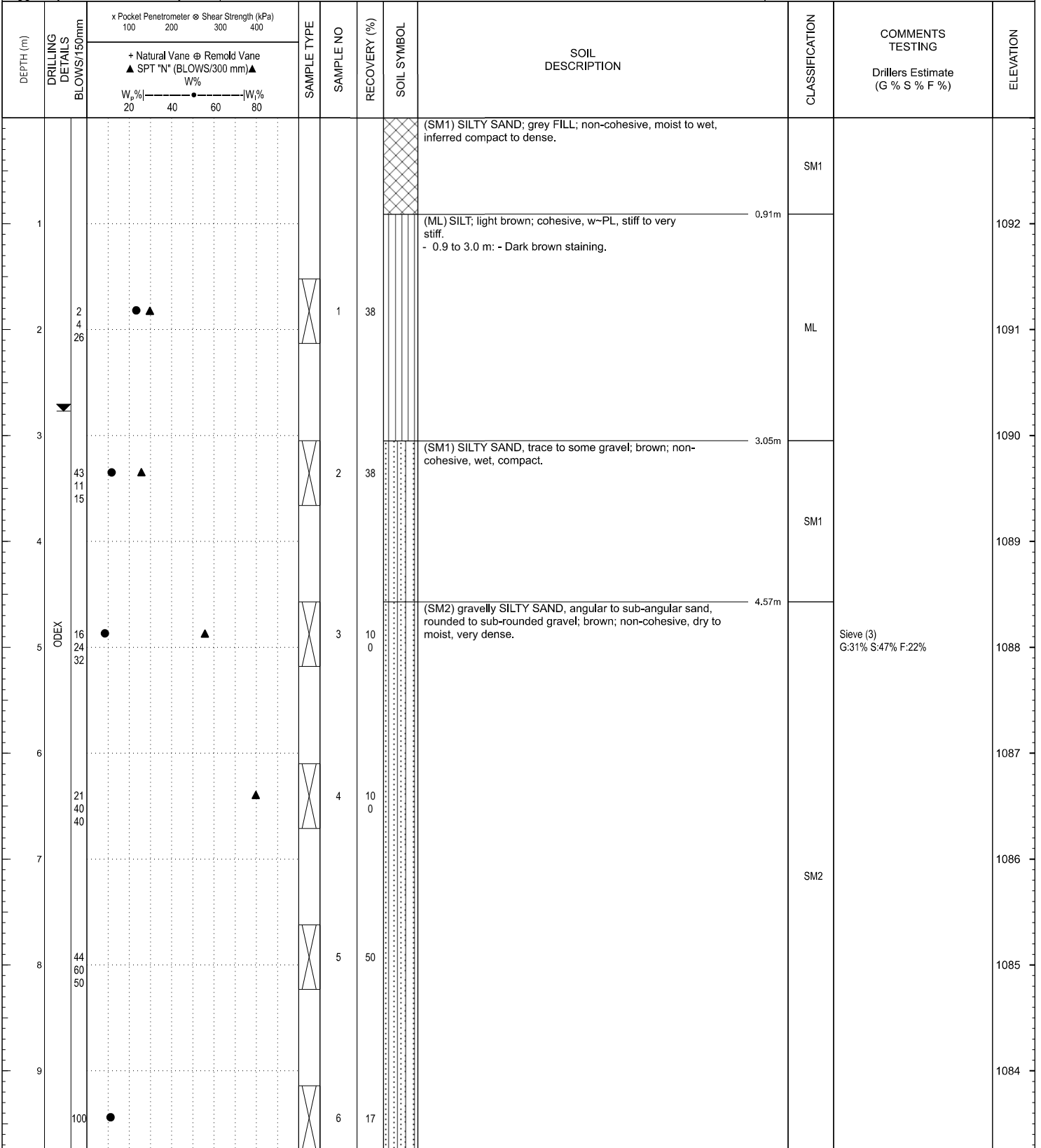
Logged by: BR

Reviewed by: KG

Elevation: 1093.0 m

Handheld GPS

Drilling Method: ODEX



End of hole at 9.75 m.

Backfilled with bentonite chips.

Final Depth of Hole: 9.8

Depth to Top of Rock:

Page 1 of 1

- Legend
- 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



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### SUMMARY LOG

Drill Hole#: TH22-02

Project: Quartz Creek Rest Area

Date(s) Drilled: 12 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N, NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703629.0 m, 476648.0 m

Drill Make/Model: Fraste MDML

Logged by: BR

Reviewed by: KG

Elevation: 1092.0 m

Handheld GPS

Drilling Method: ODEX

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer @ Shear Strength (kPa)		SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate (G % S % F %)	ELEVATION
		100	200								
1								(SP-SM) SAND and GRAVEL, trace to some non-plastic fines; grey, FILL; non-cohesive, moist, dense to very dense.	SP-SM		1091
2	16 38 19				1A	92		ASPHALT			1.83m
					1B			(CL) SILTY CLAY, trace to some gravel; brown; cohesive, w < PL, inferred stiff to very stiff.	CL		2.08m
3											1089
4	9 13 12				2	75		(SM1) SILTY SAND, trace to some gravel; brown; non-cohesive, dry to moist, compact.	SM1		3.05m
5	5 8 6				3	51		(GM2) SILTY SAND and GRAVEL, angular to sub-angular sand, rounded to sub-rounded gravel; brown; non-cohesive, moist, compact.	GM2	Sieve (3) G:40% S:40% F:20%	4.57m
6											1086
7	3 3 3				4	83		(ML) SILT, some sand; light brown; cohesive, w < PL, firm.	ML		6.10m
8	5 4 3				5A	10					1084
					5B	0		(ML) CLAYEY SILT; light brown; cohesive, w > PL, firm to stiff.			8.08m
9											1083
10	2 3 4				6	10		- 9.6 m: - Trace to some sand.	ML		

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

Continued on Next Page

Final Depth of Hole: 12.6

Depth to Top of Rock:



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**SUMMARY LOG**

**Drill Hole#: TH22-02**

**Project: Quartz Creek Rest Area**

Date(s) Drilled: 12 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703629.0 m , 476648.0 m

Drill Make/Model: Fraste MDML

Logged by: BR

Reviewed by: KG

Elevation: 1092.0 m

Handheld GPS

Drilling Method: ODEX

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer ⊗ Shear Strength (kPa) 100    200    300    400  + Natural Vane ⊕ Remold Vane ▲ SPT "N" (BLOWS/300 mm)▲  W%  -----  W% 20    40    60    80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING  Drillers Estimate (G % S % F %)	ELEVATION
11	2 3 8	▲ ●	⊗	7	100	(ML) CLAYEY SILT; light brown; cohesive, w > PL, firm to stiff.				1081
12	3 22 60	● ▲	⊗	8	100	(GM1) SILTY SAND and GRAVEL, angular gravel; brown; non-cohesive, wet, compact to very dense.	GM1			1080
13						End of hole at 12.65 m. Backfilled with bentonite chips.				1079
14										1078
15										1077
16										1076
17										1075
18										1074
19										1073

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: 12.6  
Depth to Top of Rock:  
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### SUMMARY LOG

Drill Hole#: TH22-03

Project: Quartz Creek Rest Area

Date(s) Drilled: 12 Oct 2022 - 01 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N, NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703637.0 m, 476602.0 m

Drill Make/Model: Fraste MDML

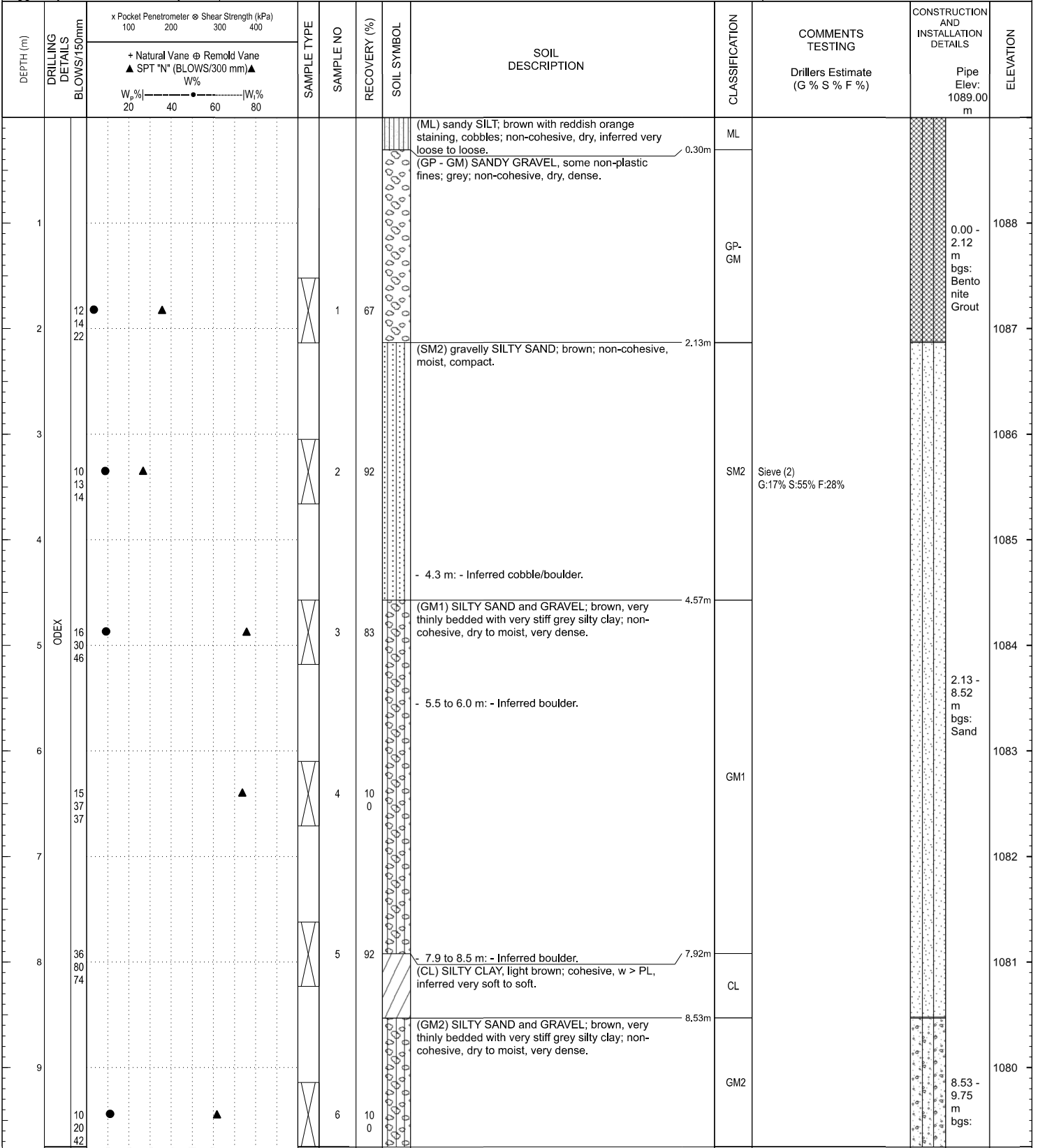
Logged by: BR

Reviewed by: KG

Elevation: 1089.0 m

Handheld GPS

Drilling Method: ODEX



End of hole at 9.75 m. Continued on Next Page

Final Depth of Hole: 9.8

Depth to Top of Rock:

- 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



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**SUMMARY LOG**

**Drill Hole#: TH22-03**

**Project: Quartz Creek Rest Area**

Date(s) Drilled: 12 Oct 2022 - 01 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703637.0 m , 476602.0 m

Drill Make/Model: Fraste MDML

Logged by: BR

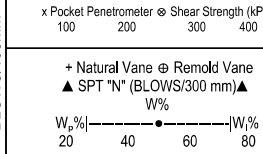
Reviewed by: KG

Elevation: 1089.0 m

Handheld GPS

Drilling Method: ODEX

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer @ Shear Strength (kPa)		SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING  Drillers Estimate (G % S % F %)	CONSTRUCTION AND INSTALLATION DETAILS  Pipe Elev: 1089.00 m	ELEVATION
		100	200									
10											Cuttings Single screen 50mm PVC SPIE, screen depth at 2.5 to 8.5m	1079
11												1078
12												1077
13												1076
14												1075
15												1074
16												1073
17												1072
18												1071
19												1070



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: 9.8  
Depth to Top of Rock:  
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SUMMARY LOG

Drill Hole#: TH22-04

Project: Quartz Creek Rest Area

Date(s) Drilled: 13 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N, NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703581.0 m, 476560.0 m

Drill Make/Model: Fraste MDML

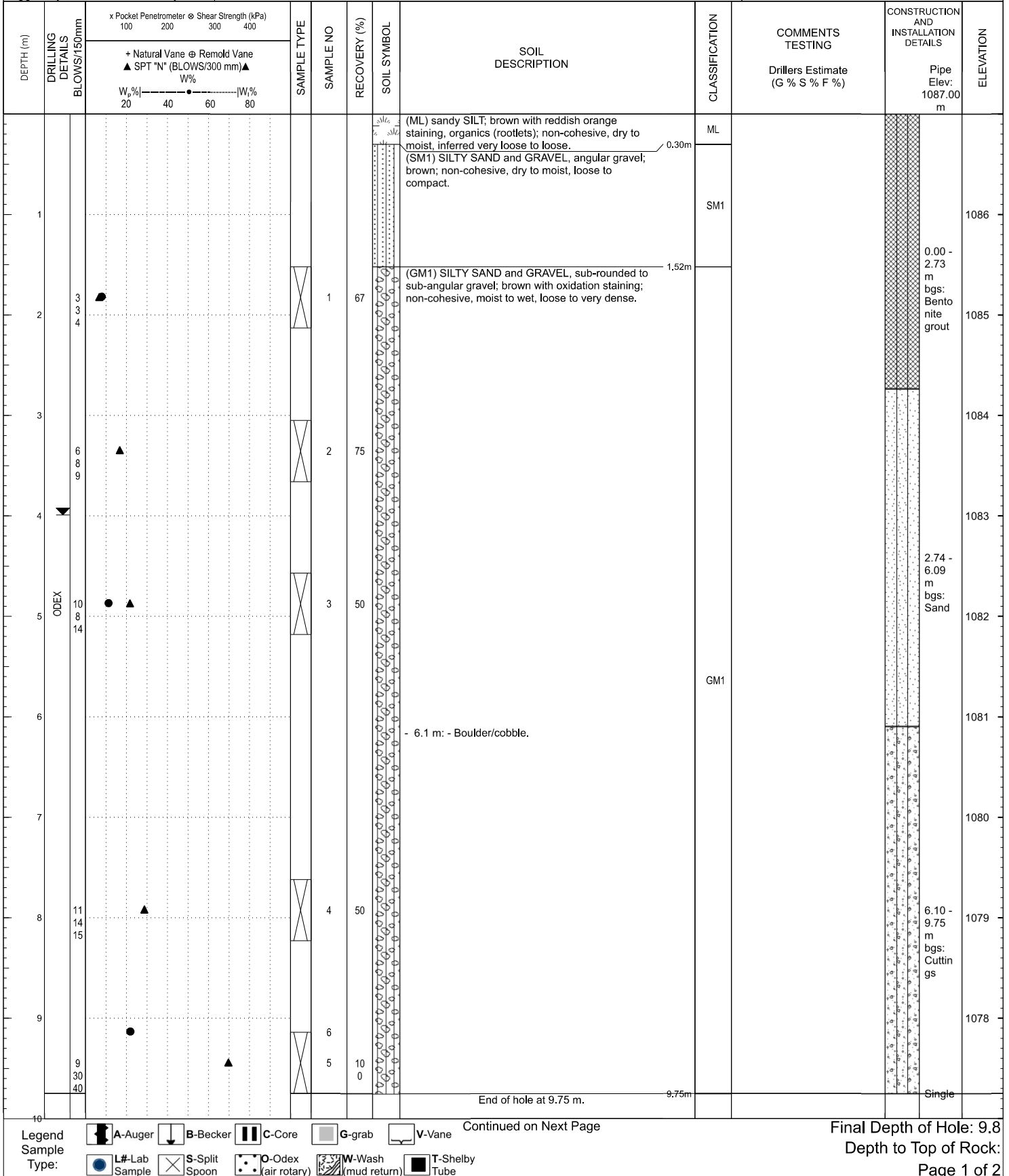
Logged by: BR

Reviewed by: KG

Elevation: 1087.0 m

Handheld GPS

Drilling Method: ODEX



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

Continued on Next Page

Final Depth of Hole: 9.8

Depth to Top of Rock:



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**SUMMARY LOG**

**Drill Hole#: TH22-04**

**Project: Quartz Creek Rest Area**

Date(s) Drilled: 13 Oct 2022

Location: Donald, BC

Company: Geotech Drilling Services Ltd.

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment: N/A

Driller: Christian Cameron

Golder Associates Ltd.

Northing/Easting: 5703581.0 m , 476560.0 m

Drill Make/Model: Fraste MDML

Logged by: BR

Reviewed by: KG

Elevation: 1087.0 m

Handheld GPS

Drilling Method: ODEX

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer ⊕ Shear Strength (kPa) 100    200    300    400  + Natural Vane ⊕ Remold Vane ▲ SPT "N" (BLOWS/300 mm)▲  W <sub>p</sub> %  -----  W <sub>l</sub> % 20    40    60    80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING  Drillers Estimate (G % S % F %)	CONSTRUCTION AND INSTALLATION DETAILS	ELEVATION
11										Screen 50mm PVC SPIE, screen depth at 3.0 to 6.0m	1076
12											1075
13											1074
14											1073
15											1072
16											1071
17											1070
18											1069
19											1068
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-Tube

Final Depth of Hole: 9.8  
 Depth to Top of Rock:  
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### SUMMARY LOG

Drill Hole#: **TP22-05**

Project: **Quartz Creek Rest Area**

Date(s) Drilled: 05 Apr 2022

Location: Donald, BC

Company: CS Mclean Contracting

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment:

Driller: Darren Schuck

Golder Associates Ltd.

Northing/Easting: 5703621.0 m , 476532.0 m Station/Offset:

Drill Make/Model: John Deere 345G

Logged by: BR

Reviewed by: KG

Elevation: 1085.0 m

Handheld GPS

Drilling Method: Mechanical Excavation

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer $\odot$ Shear Strength (kPa) 100 200 300 400	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate (G % S % F %)	ELEVATION
0.00							TS; Organics, roots and rootlets, black.	TS		
0.20				1			(MH) sandy SILT; light brown, roots and rootlets; cohesive, w ~ PL, inferred soft to firm.	MH	Sieve (1) G:0% S:26% F:74%	1084
1.00				2			(GP-GC) SAND and GRAVEL, angular to sub-angular sand, rounded to sub-rounded gravel, trace to some plastic fines; brown, cobbles/boulders; non-cohesive, moist to wet, inferred compact to dense.	GP-GC		1083
2.00				3						
3.00				4						1082
3.60				5			(GP - GC) sandy GRAVEL, trace to some plastic fines; brown; non-cohesive, wet, inferred compact to dense.	GP-GC		1081

Mechanical Excavation

End of hole at 5.00 m.

Final Depth of Hole: 5.0

Depth to Top of Rock:

Legend

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



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### SUMMARY LOG

Drill Hole#: **TP22-06**

Project: **Quartz Creek Rest Area**

Date(s) Drilled: 05 Apr 2022

Location: Donald, BC

Company: CS Mclean Contracting

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment:

Driller: Darren Schuck

Golder Associates Ltd.

Northing/Easting: 5703651.0 m , 476572.0 m Station/Offset:

Drill Make/Model: John Deere 345G

Logged by: BR

Reviewed by: KG

Elevation: 1086.0 m

Handheld GPS

Drilling Method: Mechanical Excavation

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer ⊗ Shear Strength (kPa) 100 200 300 400	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING  Drillers Estimate (G % S % F %)	ELEVATION
0.20				1			TS; Organics, roots and rootlets, black.	TS		1085
1.80				2			(SM1) SILTY SAND and GRAVEL, sub-rounded to sub-angular sand, rounded to sub-rounded gravel; brown, cobbles/boulders; non-cohesive, moist, inferred compact to dense.	SM1		1084
3.40				3			(GP-GM) SAND and GRAVEL, sub-rounded to sub-angular sand, rounded to sub-rounded gravel, some non-plastic fines; brown and mottled reddish brown, with roots/rootlets; non-cohesive, moist, inferred compact to dense.	GP-GM		1083
3.80				4			(SM3) gravelly SILTY SAND, sub-angular to angular sand; brown, cobbles/boulders; non-cohesive, moist to wet, inferred firm to stiff.	SM3	Sieve (3) G:20% S:41% F:39%	1082
5.00				4			(GP-GM) SAND and GRAVEL, sub-angular to angular sand, rounded to sub-rounded gravel, some non-plastic fines; brown, cobbles/boulders; non-cohesive, moist, inferred compact to dense.	GP-GM		1082

Legend

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

End of hole at 5.00 m.

Final Depth of Hole: 5.0  
Depth to Top of Rock:  
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### SUMMARY LOG

Drill Hole#: **TP22-07**

Project: **Quartz Creek Rest Area**

Date(s) Drilled: 05 Apr 2022

Location: Donald, BC

Company: CS Mclean Contracting

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment:

Driller: Darren Schuck

Golder Associates Ltd.

Northing/Easting: 5703677.0 m , 476642.0 m Station/Offset:

Drill Make/Model: John Deere 345G

Logged by: BR

Reviewed by: KG

Elevation: 1087.0 m

Handheld GPS

Drilling Method: Mechanical Excavation

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer ⊙ Shear Strength (kPa) 100 200 300 400	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate (G % S % F %)	ELEVATION
0.0							TS; Organics, roots and rootlets, black.	TS		
0.4				1			(GP) SAND and GRAVEL, sub-angular to sub-rounded sand, rounded to sub-rounded gravel; greyish brown, cobbles/boulders; non-cohesive, dry to moist, inferred compact to dense.	GP		1086
2.3				2			(SC4) gravelly CLAYEY SAND; low plasticity fines, greyish brown, thinly laminated; cohesive, w < PL, inferred firm to stiff.	SC4	Atterberg (2) PL:17% LL:23% Sieve (2) G:20% S:40% F:40%	1085
2.7				3			(GM2) SILTY SAND and GRAVEL, sub-angular to sub-rounded sand, rounded to sub-rounded gravel; brown; non-cohesive, moist, inferred compact to dense.	GM2		1084
4.0				4						1083

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

End of hole at 5.00 m. Final Depth of Hole: 5.0  
Depth to Top of Rock:



Ministry of  
Transportation  
and Infrastructure

### SUMMARY LOG

Drill Hole#: **TP22-08**

Project: **Quartz Creek Rest Area**

Date(s) Drilled: 05 Apr 2022

Location: Donald, BC

Company: CS Mclean Contracting

Prepared by: 19136159 (2000/2500)

Datum: UTM Zone 11N , NAD83

Alignment:

Driller: Darren Schuck

Golder Associates Ltd.

Northing/Easting: 5703691.0 m , 476675.0 m Station/Offset:

Drill Make/Model: John Deere 345G

Logged by: BR

Reviewed by: KG

Elevation: 1087.0 m

Drilling Method: Mechanical Excavation

DEPTH (m)	DRILLING DETAILS BLOWS/150mm	x Pocket Penetrometer ⊗ Shear Strength (kPa)		SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate (G % S % F %)	ELEVATION
		100	200								
		+ Natural Vane ⊕ Remold Vane ▲ SPT "N" (BLOWS/300 mm)▲ W%  -----  W% 20 40 60 80						TS; Organics, roots and rootlets, black.	TS		
1					1			(SM1) SILTY SAND, some angular gravel; brown; non-cohesive, dry to moist, inferred loose.	SM1		1086
2					2			(GM1) sandy SILTY GRAVEL, angular gravel; brown, cobbles/boulders; non-cohesive, dry to moist, inferred dense.	GM1		1085
3					3			(SC2) gravelly CLAYEY SAND, rounded to sub-rounded gravel, low plasticity fines; brown, cobbles/boulders; non-cohesive, w < PL, inferred compact to dense.	SC2		1084
4					4						1083

End of hole at 5.00 m.

Final Depth of Hole: 5.0  
Depth to Top of Rock:

Legend

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

**APPENDIX C**

**Laboratory Testing Results**



Test Request # K22-160  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area

Project Number: 19136159 (2000/2500)  
 Project Location: Donald, BC

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
TH22-01	1	1.52	2.13	SS	SILT, light brown	23.6	B	
TH22-01	2	3.05	3.66	SS	SILTY SAND, trace to some gravel, brown	12.0	B	
TH22-01	3	4.57	5.18	SS	gravelly SILTY SAND, brown	8.8	B	
TH22-01	6	9.14	9.75	SS	gravelly SILTY SAND, brown	11.5	B	
TH22-02	1A	1.52	2.08	SS	SAND and GRAVEL, trace to some non-plastic fines, grey	3.0	B	
TH22-02	1B	2.09	2.13	SS	SILTY CLAY, trace to some gravel, brown	13.4	B	
TH22-02	2	3.05	3.66	SS	SILTY SAND, trace to some gravel, brown	7.6	B	
TH22-02	3	4.57	5.18	SS	SILTY SAND and GRAVEL, brown	11.4	B	
TH22-02	4	6.10	6.71	SS	SILT, some sand, light brown	39.1	B	
TH22-02	5A	7.62	8.08	SS	CLAYEY SILT, some sand, light brown	12.7	B	
TH22-02	5B	8.08	8.23	SS	CLAYEY SILT, light brown	33.1	B	
TH22-02	6	9.14	9.75	SS	CLAYEY SILT, light brown	31.5	B	
TH22-02	7	10.67	11.28	SS	CLAYEY SILT, light brown	24.7	B	
TH22-02	8	12.19	12.65	SS	SILTY SAND and GRAVEL, brown	15.5	B	
TH22-03	1	1.52	2.13	SS	SANDY GRAVEL, some non-plastic fines, grey	3.7	B	
TH22-03	2	3.05	3.66	SS	gravelly SILTY SAND, brown	9.1	B	
TH22-03	3	4.57	5.18	SS	SILTY SAND and GRAVEL, brown	9.5	B	
TH22-03	6	9.14	9.75	SS	SILTY SAND and GRAVEL, brown	11.4	B	
TH22-04	1	1.52	2.13	SS	SILTY SAND and GRAVEL, brown	8.3	B	
TH22-04	3	4.57	5.18	SS	SILTY SAND and GRAVEL, brown	11.6	B	
TH22-04	6	9.14	9.75	SS	SILTY SAND and GRAVEL, brown	22.2	B	
TP22-05	1	0.20	0.50	GS	sandy SILT, light brown	26.1	B	

**Notes:**

**Tested by:** KSingh  
**Checked by:** BRush

**Date:** 21 Apr 2022  
**Date:** 16 Nov 2022

**Disclaimer:**

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**Reviewed by:** JStotz

**Date:** 17 Nov 2022



Test Request # K22-040  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area

Project Number: 19136159 (2000/2500)  
 Project Location: Donald, BC

Sample Location	Sample				Soil Description	Water Content %	Method	Remarks
	Ref	Top (m)	Base (m)	Type				
TP22-05	2	1.00	1.40	GS	SAND and GRAVEL, trace to some plastic fines, brown	12.8	B	
TP22-05	3	1.40	2.00	GS	SAND and GRAVEL, trace to some plastic fines, brown	14.6	B	
TP22-06	2	1.80	2.10	GS	SAND and GRAVEL, some non-plastic fines, brown	9.9	B	
TP22-06	3	3.40	3.80	GS	gravelly SILTY SAND, brown	12.3	B	
TP22-06	4	4.40	4.80	GS	SAND and GRAVEL, some non-plastic fines, brown	7.2	B	
TP22-07	2	2.30	2.70	GS	gravelly CLAYEY SAND, greyish brown	11.9	B	
TP22-07	3	2.70	3.00	GS	SILTY SAND and GRAVEL, brown	11.0	B	
TP22-07	4	3.80	4.20	GS	SILTY SAND and GRAVEL, brown	11.6	B	
TP22-08	2	1.70	2.00	GS	sandy SILTY GRAVEL, brown	10.5	B	
TP22-08	3	3.10	3.40	GS	gravelly CLAYEY SAND, brown	14.8	B	

**Notes:**

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**Tested by:** BRush      **Date:** 21 Apr 2022  
**Checked by:** BRush      **Date:** 25 Apr 2022

**Reviewed by:** DMackie      **Date:** 28 Apr 2022



# PARTICLE SIZE DISTRIBUTION

ASTM D6913

Method B

Test Request # K22-160  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area  
 Source: Native  
 Soil Description: gravelly SILTY SAND, brown

Project Number: 19136159 (2000/2500)

Project Location: Donald, BC

Sample Location: TH22-01

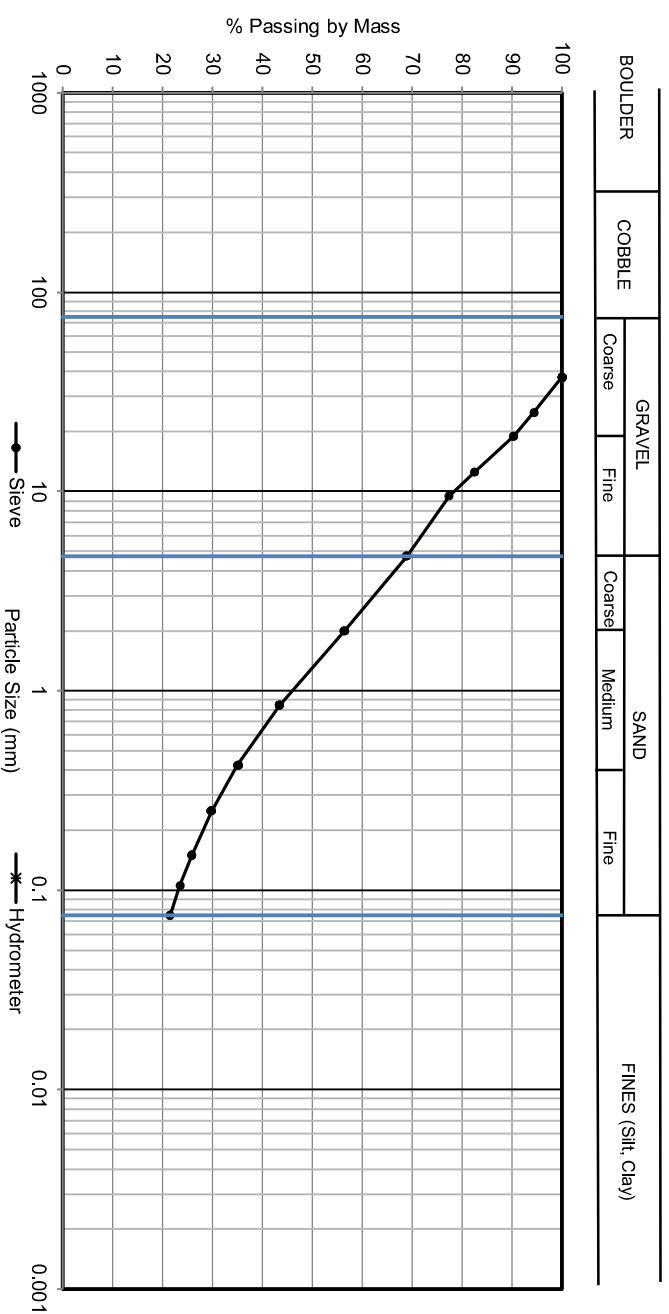
Sample No.: 3

Type: SS

Depth (m): 4.57 - 5.18

Specimen Reference Specimen Description: NA NA NA  
 Specimen Depth (m): NA  
 Date of Test: 11/10/2022

Grain Size Distribution (%)  
 BOULDER: 31.1  
 GRAVEL: 47.4  
 SAND: 21.5  
 FINES (Silt, Clay)



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0		
1"	25	94.4		
3/4"	19	90.3		
1/2"	12.5	82.5		
3/8"	9.5	77.4		
#4	4.75	68.9		
#10	2	56.4		
#20	0.85	43.4		
#40	0.425	35.1		
#60	0.25	29.8		
#100	0.15	25.9		
#140	0.106	23.5		
#200	0.075	21.5		
			0.005 mm	
			0.002 mm	
			D60	2.57
			D30	0.26
			D10	
			Cu	
			Cc	

**Notes:**

Tested by: KSingh Date: 10-Nov-22

Checked by: BRush Date: 16-Nov-22

Reviewed by: JStotz Date: 17-Nov-22

**Disclaimer:**

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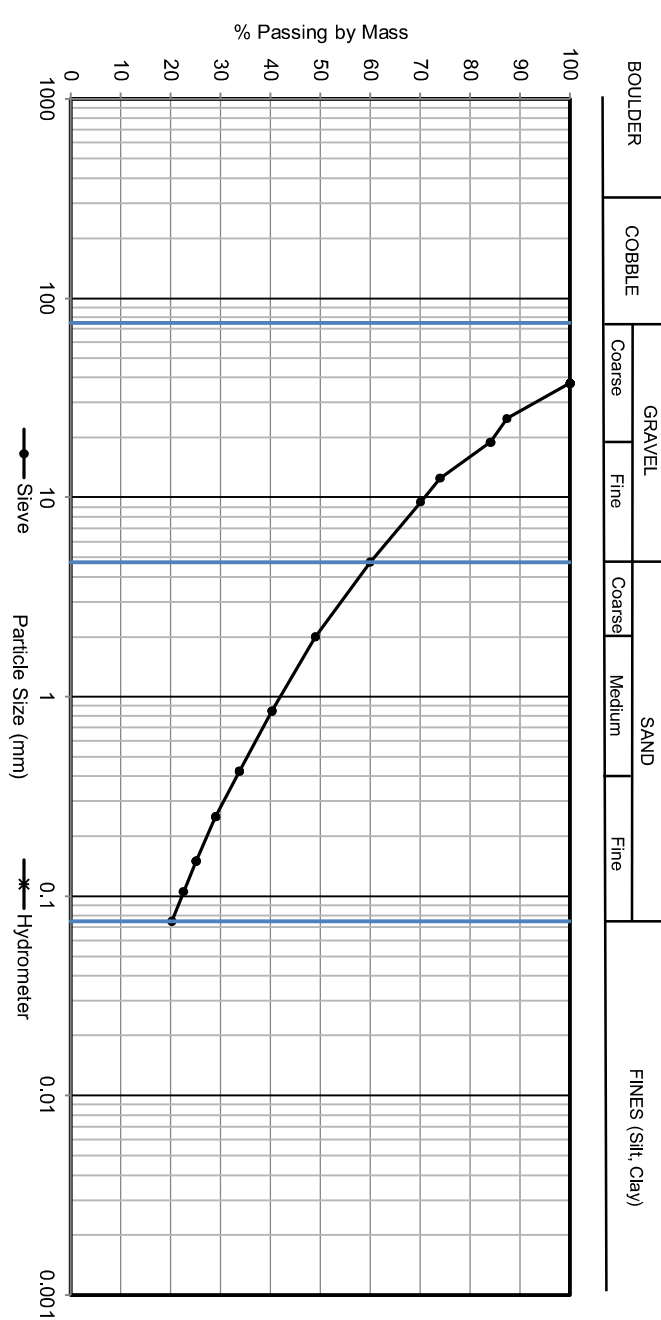
**PARTICLE SIZE DISTRIBUTION**

**ASTM D6913**

Method B

Test Request #	K22-160	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TH22-02
Source:	Native	Sample No.:	3
Soil Description:	SILTY SAND and GRAVEL, brown	Type:	SS
Specimen Reference	NA	Depth (m):	4.57 - 5.18
Specimen Description	NA	Date of Test	11/10/2022

Grain Size Distribution (%)	GRAVEL		SAND		FINES (Silt, Clay)
	Coarse	Fine	Coarse	Medium	Fine
Boulder					
Cobble					
	40.0		39.8		20.2



Sieve	Sieve No.	Particle Size mm	% Passing	Hydrometer Sedimentation
	1 1/2"	37.5	100.0	
	1"	25	87.4	
	3/4"	19	84.1	
	1/2"	12.5	74.0	
	3/8"	9.5	70.1	
	#4	4.75	60.0	
	#10	2	49.0	
	#20	0.85	40.3	
	#40	0.425	33.8	
	#60	0.25	29.0	
	#100	0.15	25.1	
	#140	0.106	22.6	
	#200	0.075	20.2	
				0.005 mm
				0.002 mm
				D60
				D30
				D10
				Cu
				Cc

**Notes:**

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Tested by: KSingh Date: 10-Nov-22 Checked by: BRush Date: 16-Nov-22 Reviewed by: JStotz Date: 17-Nov-22

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**PARTICLE SIZE DISTRIBUTION**

**ASTM D6913**

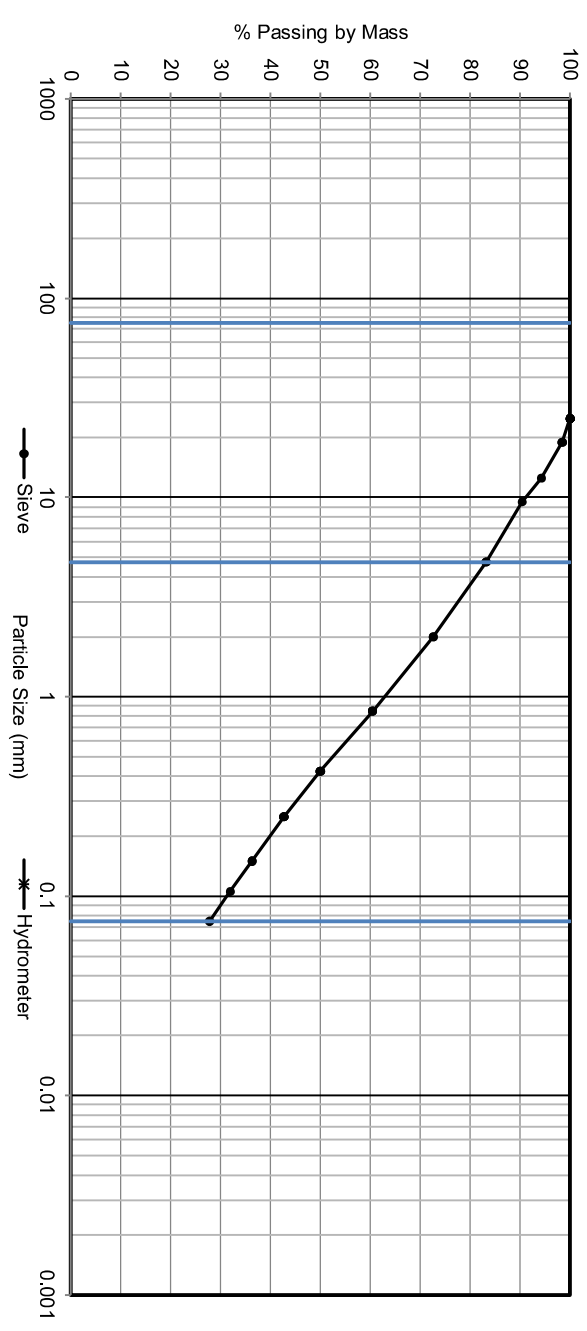
Method B

Test Request # K22-160  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area  
 Source: Native  
 Soil Description: gravelly SILTY SAND, brown

Project Number: 19136159 (2000/2500)  
 Project Location: Donald, BC  
 Sample Location: TH22-03  
 Sample No.: 2  
 Type: SS  
 Depth (m): 3.05 - 3.66

Specimen Reference: NA  
 Specimen Description: NA  
 Specimen Depth (m): NA  
 Date of Test: 11/10/2022

Grain Size Distribution (%)	GRAVEL		SAND		FINES (Silt, Clay)
	Coarse	Fine	Coarse	Medium	Fine
BOULDER					
COBBLE					
	16.8		55.4		27.8



Sieve	Particle Size mm	% Passing	Hydrometer	Particle Size mm	% Passing
1"	25	100.0			
3/4"	19	98.5			
1/2"	12.5	94.3			
3/8"	9.5	90.4			
#4	4.75	83.2			
#10	2	72.6			
#20	0.85	60.5			
#40	0.425	50.0			
#60	0.25	42.7			
#100	0.15	36.3			
#140	0.106	31.9			
#200	0.075	27.8			
				0.005 mm	
				0.002 mm	
				D60	0.82
				D30	0.09
				D10	
				Cu	
				Cc	

**Notes:**

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Tested by: KSingh Date: 10-Nov-22  
 Checked by: BRush Date: 16-Nov-22  
 Reviewed by: JStotz Date: 17-Nov-22

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**PARTICLE SIZE DISTRIBUTION**

**ASTM D6913**

Method B

Test Request # K22-040  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area  
 Source: Native  
 Soil Description: sandy SILT, light brown

Project Number: 19136159 (2000/2500)

Project Location: Donald, BC

Sample Location: TP22-05

Sample No.: 1

Type: GS

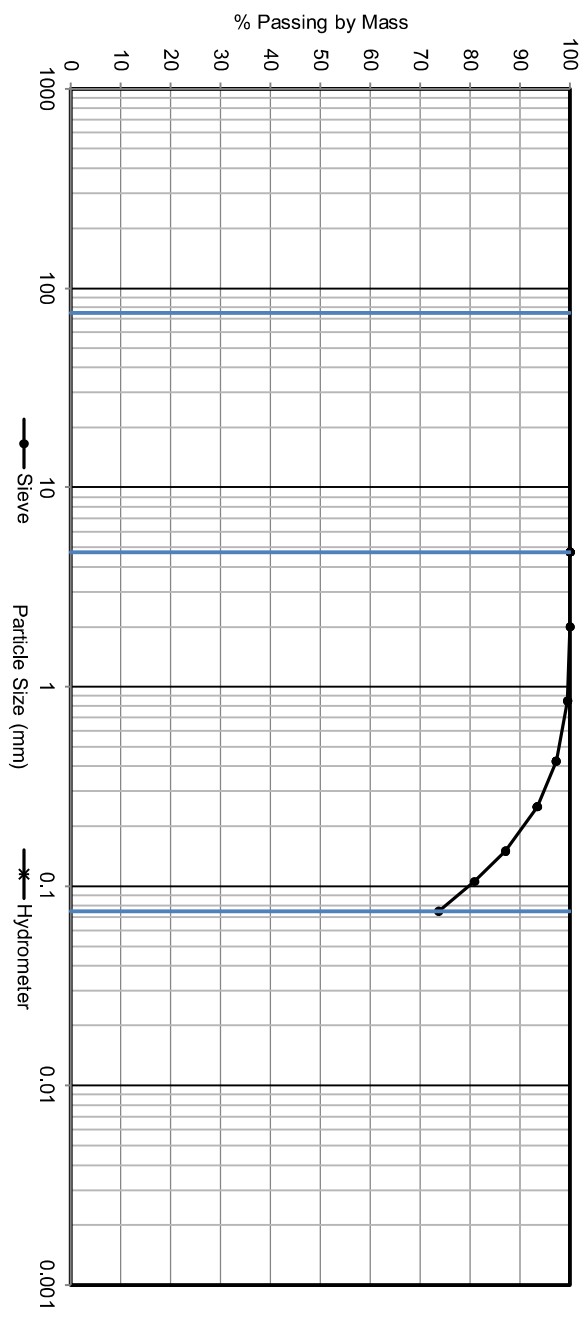
Depth (m): 0.20 - 0.50

Specimen Reference: NA  
 Specimen Description: NA  
 Specimen Depth (m): NA

Date of Test: 4/25/2022

**Grain Size Distribution (%)**

Boulder	Cobble	Gravel		Sand		Fines (Silt, Clay)
		Coarse	Fine	Coarse	Medium	Fine
		0.0		26.3		73.7



Sieve	Sieve No.	Particle Size mm	% Passing	Hydrometer Sedimentation
	#4	4.75	100.0	
	#10	2	100.0	
	#20	0.85	99.5	
	#40	0.425	97.3	
	#60	0.25	93.5	
	#100	0.15	87.1	
	#140	0.106	80.9	
	#200	0.075	73.7	
				0.005 mm
				0.002 mm
				D60
				D30
				D10
				Cu
				Cc

Notes:

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Tested by: BRush      Date: 25-Apr-22      Checked by: BRush      Date: 25-Apr-22      Reviewed by: DMackie      Date: 28-Apr-22

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**PARTICLE SIZE DISTRIBUTION**

**ASTM D6913**

Method B

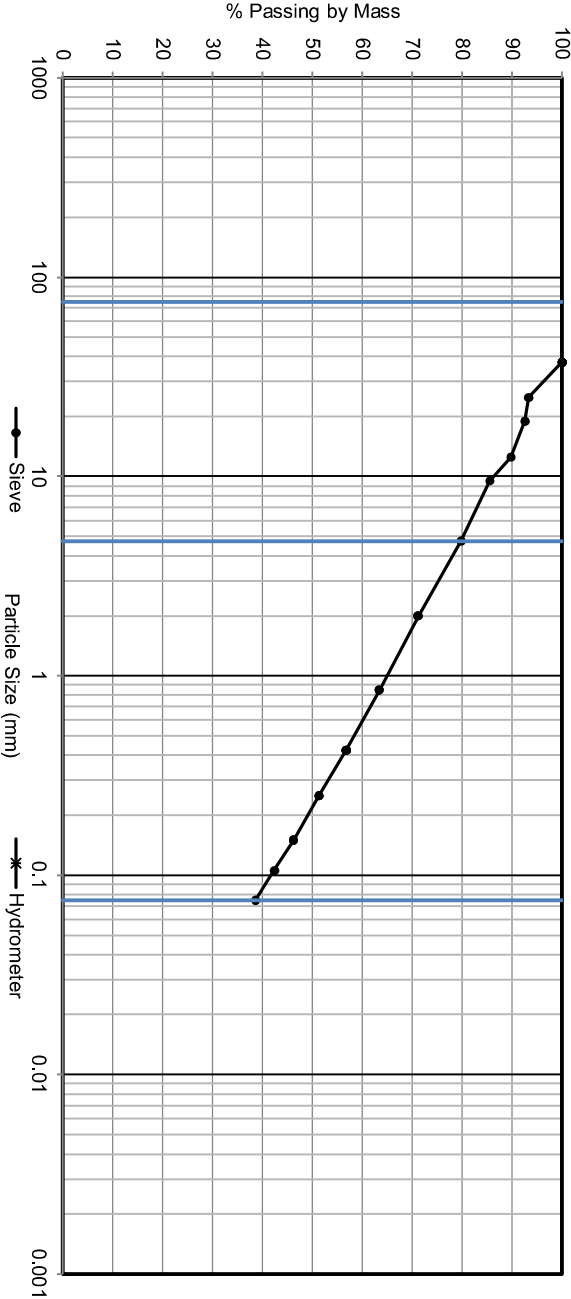
Test Request # K22-040  
 Client: Ministry of Transportation  
 Project Name: Quartz Creek Rest Area  
 Source: Native  
 Soil Description: gravelly SILTY SAND, brown

Project Number: 19136159 (2000/2500)  
 Project Location: Donald, BC  
 Sample Location: TP22-06  
 Sample No.: 3  
 Type: GS  
 Depth (m): 3.40 - 3.80

Specimen Reference: NA  
 Specimen Description: NA  
 Specimen Depth (m): NA  
 Date of Test: 4/25/2022

**Grain Size Distribution (%)**

BOULDER	COBBLE	GRAVEL		SAND		FINES (Silt, Clay)
		Coarse	Fine	Coarse	Medium	
		20.2		41.2		38.6



Sieve			Hydrometer Sedimentation	
Sieve No.	Particle Size mm	% Passing	Particle Size mm	% Passing
1 1/2"	37.5	100.0		
1"	25	93.4		
3/4"	19	92.6		
1/2"	12.5	89.8		
3/8"	9.5	85.5		
#4	4.75	79.8		
#10	2	71.2		
#20	0.85	63.4		
#40	0.425	56.8		
#60	0.25	51.3		
#100	0.15	46.2		
#140	0.106	42.4		
#200	0.075	38.6		
			0.005 mm	
			0.002 mm	
			D60	0.60
			D30	
			D10	
			Cu	
			Cc	

**Notes:**

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Tested by: BRush Date: 25-Apr-22  
 Checked by: BRush Date: 25-Apr-22  
 Reviewed by: DMackie Date: 28-Apr-22

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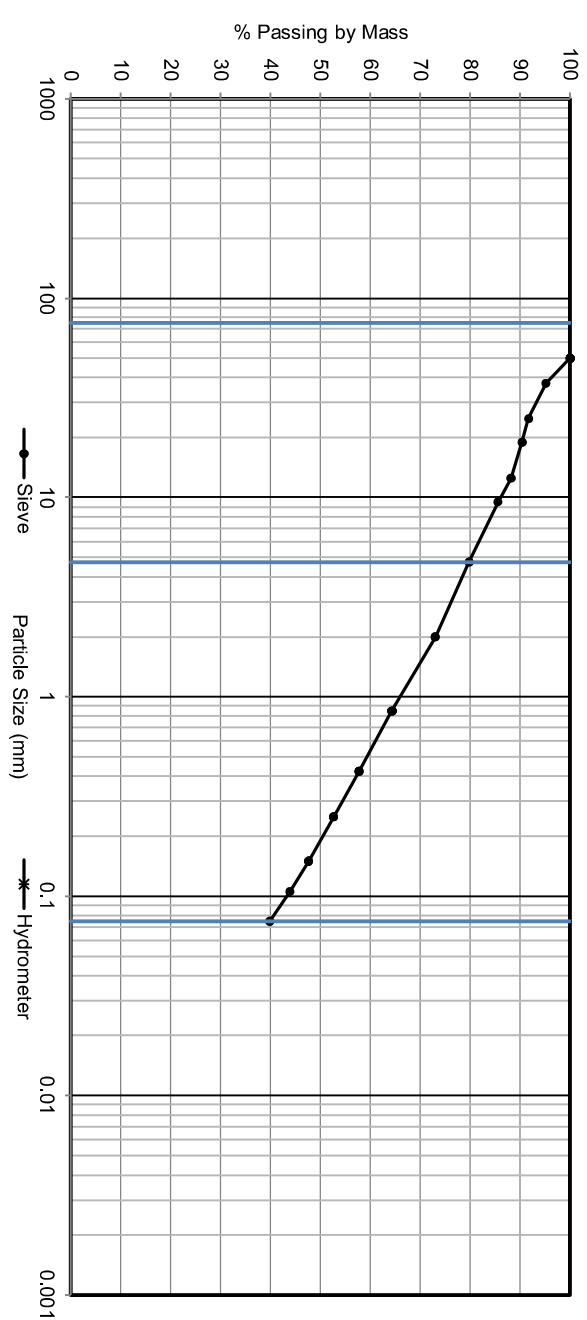
**PARTICLE SIZE DISTRIBUTION**

**ASTM D6913**

Method B

Test Request #	K22-040	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TP22-07
Source:	Native	Sample No.:	2
Soil Description:	gravelly CLAYEY SAND, greyish brown	Type:	GS
Specimen Reference	NA	Depth (m):	2.30 - 2.70
Specimen Description	NA	Date of Test	4/25/2022

Grain Size	GRAVEL		SAND		FINES (Silt, Clay)
Distribution (%)	20.2	39.9	39.9		
BOULDER					
	COBBLE				
		Coarse	Fine	Coarse	Medium
				Medium	Fine



Sieve	Sieve No.	Particle Size mm	% Passing	Hydrometer	Particle Size mm	% Passing
	2"	50	100.0			
	1 1/2"	37.5	95.2			
	1"	25	91.7			
	3/4"	19	90.4			
	1/2"	12.5	88.2			
	3/8"	9.5	85.6			
	#4	4.75	79.8			
	#10	2	73.0			
	#20	0.85	64.3			
	#40	0.425	57.8			
	#60	0.25	52.7			
	#100	0.15	47.7			
	#140	0.106	43.9			
	#200	0.075	39.9			
					0.005 mm	
					0.002 mm	
					D60	0.54
					D30	
					D10	
					Cu	
					Cc	

**Notes:**

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Tested by: BRush      Date: 25-Apr-22      Checked by: BRush      Date: 25-Apr-22      Reviewed by: DMackie      Date: 28-Apr-22

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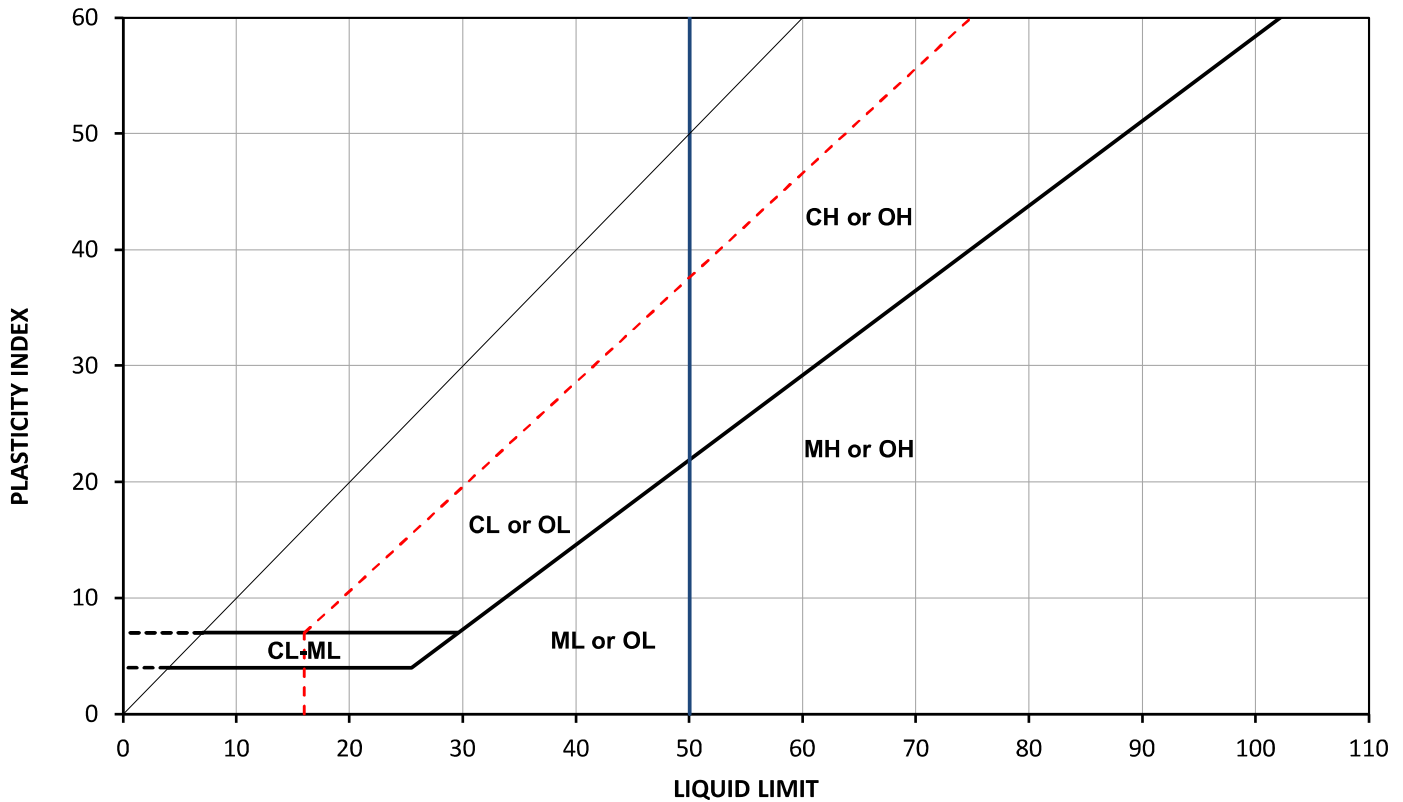


# LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

## ASTM D4318

Test Request #	K22-160	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TH22-01
Source:	Native	Sample No.:	1
Soil Description:	SILT, light brown	Type:	SS
		Depth (m):	1.52 - 2.13

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	16 Nov 2022
Specimen Description	NA				



**Legend**  
 — A-Line  
 - - U-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
TH22-01	1	1.52	2.13	ND	23.6		NP		

NP = Non-Plastic  
 ND = Not Determined

### Test Preparation

<b>Notes:</b>	<b>Disclaimer:</b>
<b>Tested by:</b> KSingh	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.
<b>Checked by:</b> BRush	<b>Date:</b> 16 Nov 2022
	<b>Date:</b> 16 Nov 2022
	<b>Reviewed by:</b> JStotz
	<b>Date:</b> 17 Nov 2022

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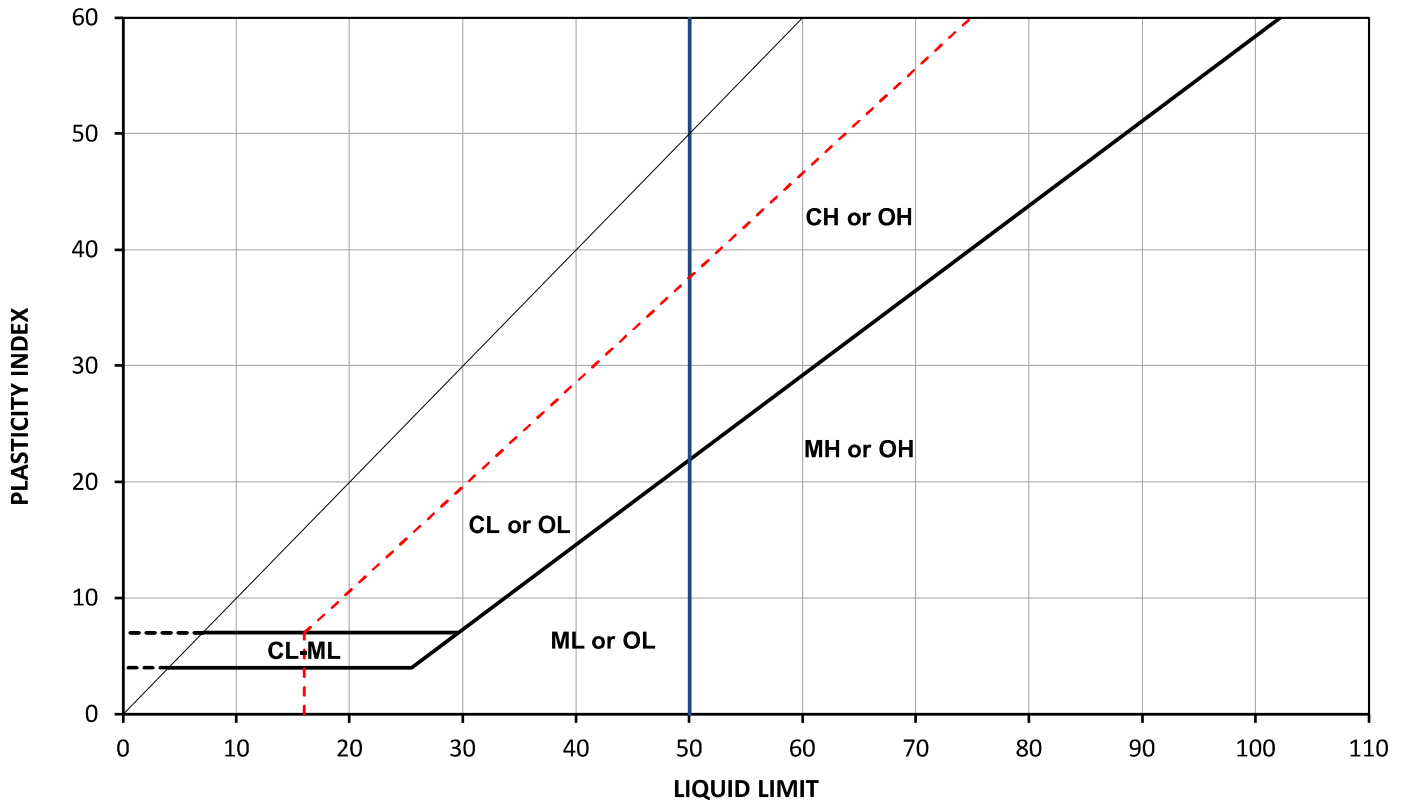


# LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Test Request #	K22-160	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TH22-02
Source:	Native	Sample No.:	4
Soil Description:	SILT, some sand, light brown	Type:	SS
		Depth (m):	6.10 - 6.71

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	16 Nov 2022
Specimen Description	NA				



**Legend**  
 — A-Line  
 - - U-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
TH22-02	4	6.10	6.71	ND	39.1		NP		

NP = Non-Plastic  
 ND = Not Determined

### Test Preparation

**Notes:**

**Disclaimer:**  
 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.

**Tested by:** KSingh      **Date:** 16 Nov 2022  
**Checked by:** BRush      **Date:** 16 Nov 2022      **Reviewed by:** JStotz      **Date:** 17 Nov 2022

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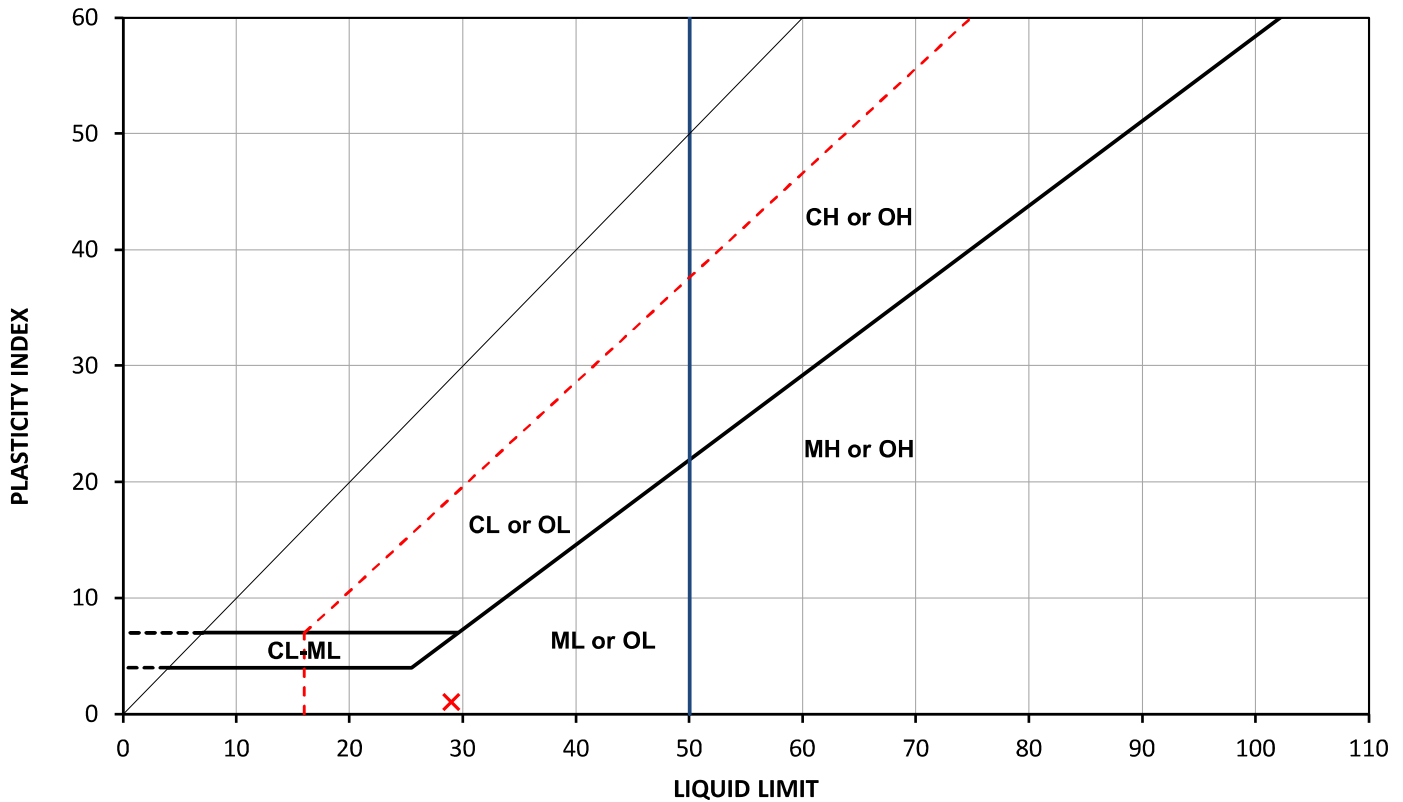
# LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

## ASTM D4318

### Method A - Multipoint Test

Test Request #	K22-160	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TH22-02
Source:	Native	Sample No.:	6
Soil Description:	CLAYEY SILT, light brown	Type:	SS
		Depth (m):	9.14 - 9.75

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	21 Nov 2022
Specimen Description	NA				



**Legend**  
 — A-Line  
 - - - U-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
TH22-02	6	9.14	9.75	100	31.5	29	28	1	3.50

NP = Non-Plastic  
 ND = Not Determined

#### Test Preparation

Dry Preparation Tested after >425um removed

#### Notes:

#### Disclaimer:

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**Tested by:** KSingh  
**Checked by:** BRush

**Date:** 21 Nov 2022  
**Date:** 22 Nov 2022

**Reviewed by:** JStotz **Date:** 22 Nov 2022

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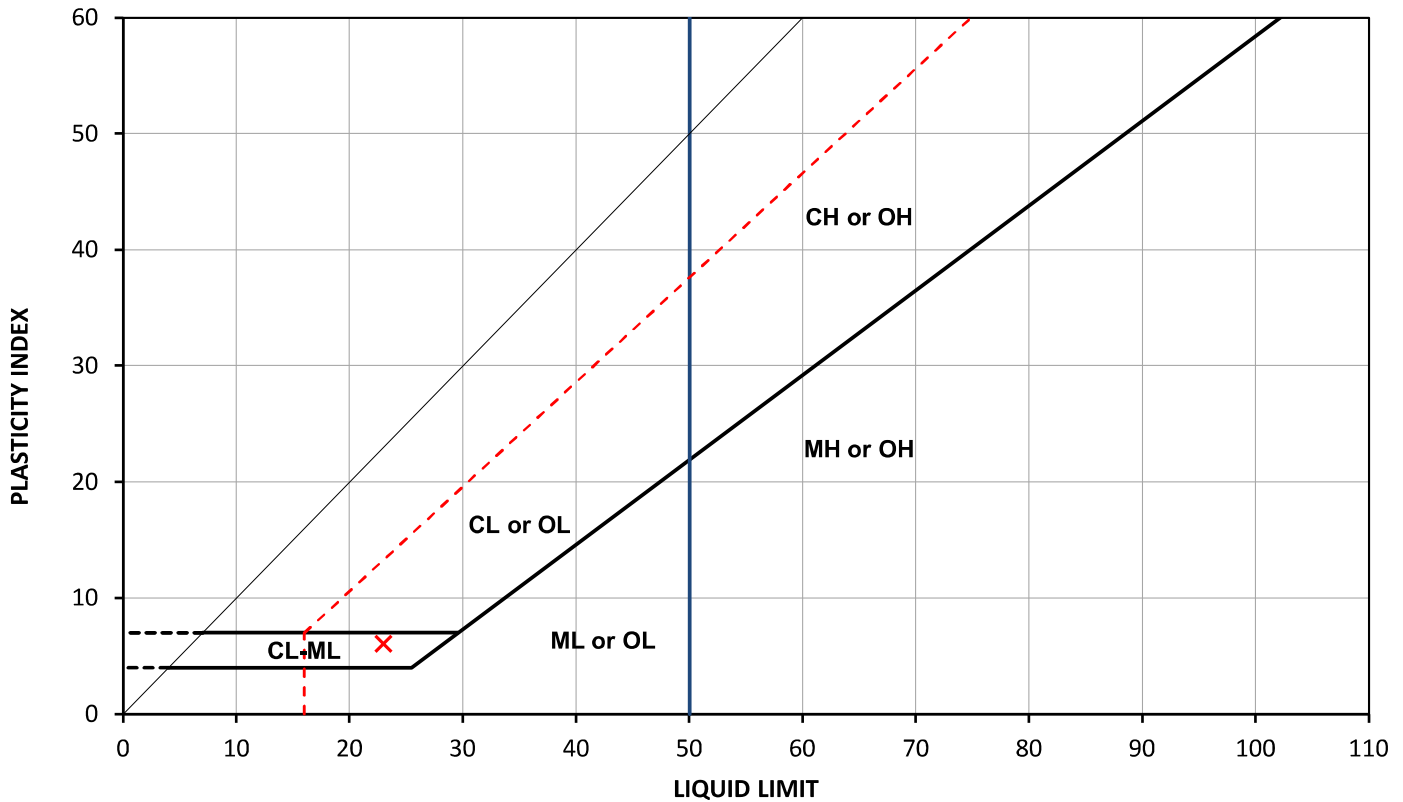
# LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

ASTM D4318

Method A - Multipoint Test

Test Request #	K22-040	Project Number:	19136159 (2000/2500)
Client:	Ministry of Transportation	Project Location:	Donald, BC
Project Name:	Quartz Creek Rest Area	Sample Location:	TP22-07
Source:	Native	Sample No.:	2
Soil Description:	gravelly CLAYEY SAND, greyish brown	Type:	GS
		Depth (m):	2.30 - 2.70

Specimen Reference	NA	Specimen Depth (m):	NA	Date of Test	25 Apr 2022
Specimen Description	NA				



**Legend**  
 — A-Line  
 - - - U-Line

Sample Location	Sample / Specimen Number	Top Depth (m)	Base Depth (m)	Percent Passing #40 Sieve	Natural Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Liquidity Index
TP22-07	2	2.30	2.70	62	11.9	23	17	6	-0.85

NP = Non-Plastic  
 ND = Not Determined

**Test Preparation**

Dry Preparation Tested after >425um removed

**Notes:**

**Disclaimer:**

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**Tested by:** BRush  
**Checked by:** BRush

**Date:** 25 Apr 2022  
**Date:** 26 Apr 2022

**Reviewed by:** DMackie  
**Date:** 28 Apr 2022

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**CERTIFICATE OF ANALYSIS**

<b>REPORTED TO</b>	Golder Associates Ltd. (Kelowna) 590 McKay Avenue, Suite 300 Kelowna, BC V1Y 5A8	<b>WORK ORDER</b>	22D2872
<b>ATTENTION</b>	Gavin Black	<b>RECEIVED / TEMP REPORTED</b>	2022-04-25 10:10 / 19.0°C 2022-05-04 13:22
<b>PO NUMBER</b>		<b>COC NUMBER</b>	No Number
<b>PROJECT</b>	19136159/2000/2510		
<b>PROJECT INFO</b>	Golder - Master Bid		

**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.

*We've Got Chemistry*



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more 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 for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

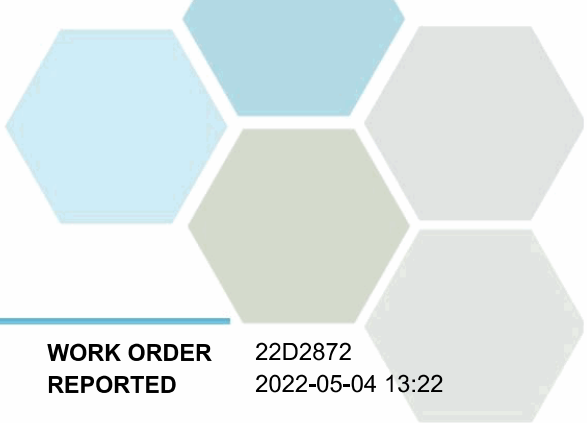
If you have any questions or concerns, please contact me at [nyjpp@caro.ca](mailto:nyjpp@caro.ca)

**Authorized By:**

Nicole Yipp  
Client Service Team Lead

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## TEST RESULTS

**REPORTED TO** Golder Associates Ltd. (Kelowna)  
**PROJECT** 19136159/2000/2510

**WORK ORDER** 22D2872  
**REPORTED** 2022-05-04 13:22

Analyte	Result	RL	Units	Analyzed	Qualifier
<b>19136159 (2000/2508) TP22-07 / Sa 1 / (0.4-0.8m) (22D2872-01)   Matrix: Solid   Sampled: 2022-04-05 12:00</b>					
<i>General Parameters</i>					
Sulfate, Water-Soluble	< 0.050	0.050	%	2022-05-03	
Chloride, Water-Soluble	< 0.010	0.010	% dry	2022-05-02	



## APPENDIX 1: SUPPORTING INFORMATION

**REPORTED TO** Golder Associates Ltd. (Kelowna)  
**PROJECT** 19136159/2000/2510

**WORK ORDER** 22D2872  
**REPORTED** 2022-05-04 13:22

Analysis Description	Method Ref.	Technique	Accredited	Location
Chloride, Water-Soluble in Solid	CSA A23.2-4B	Hot Water Extraction / Potentiometric Titration		Richmond
Sulfate, Water-Soluble in Solid	CSA A23.2-3B / CSA A23.2-2B	Extraction (HCl) / Gravimetry (Barium Sulfate Precipitation)		Richmond

### Glossary of Terms:

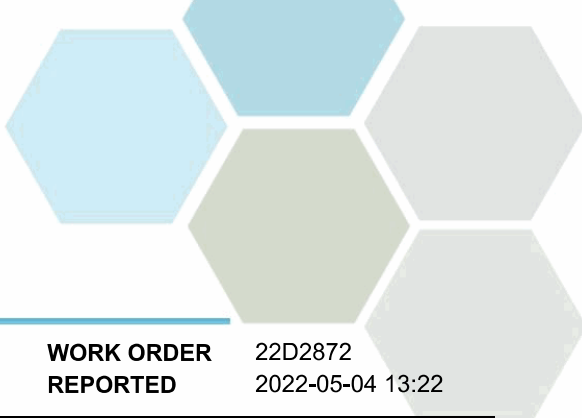
RL	Reporting Limit (default)
%	Percent
% dry	Percent (dry weight basis)
<	Less than the specified Reporting Limit (RL) - the actual RL may be higher than the default RL due to various factors
CSA	Canadian Standards Association Chemical Test Methods

### General Comments:

The results in this report apply to the 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. Samples will be disposed of 30 days after the test report has been issued or once samples expire, whichever comes first. Longer hold is possible if agreed to in writing.

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 not 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: [nyjpp@caro.ca](mailto:nyjpp@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

**REPORTED TO** Golder Associates Ltd. (Kelowna)  
**PROJECT** 19136159/2000/2510

**WORK ORDER** 22D2872  
**REPORTED** 2022-05-04 13:22

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
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### General Parameters, Batch B2D2917

<b>Blank (B2D2917-BLK1)</b>		Prepared: 2022-04-28, Analyzed: 2022-05-03							
Sulfate, Water-Soluble	< 0.050	0.050 %							
<b>Matrix Spike (B2D2917-MS1)</b>		Source: 22D2872-01 Prepared: 2022-04-28, Analyzed: 2022-05-03							
Sulfate, Water-Soluble	0.595	0.050 %	0.667	< 0.050	89	63-117			

### General Parameters, Batch B2D3054

<b>Blank (B2D3054-BLK1)</b>		Prepared: 2022-04-30, Analyzed: 2022-05-02							
Chloride, Water-Soluble	< 0.010	0.010 % dry							
<b>Duplicate (B2D3054-DUP1)</b>		Source: 22D2872-01 Prepared: 2022-04-30, Analyzed: 2022-05-02							
Chloride, Water-Soluble	< 0.010	0.010 % dry		< 0.010				25	



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