TETRA TECH

Kicking Horse River Bridges Replacement Project
Geotechnical Factual Data Report – Phases 1 and 2

PRESENTED TO

Urban Systems Ltd.
British Columbia Ministry of Transportation and Infrastructure

MAY 3, 2022
ISSUED FOR USE
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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Urban Systems Ltd. (USL) and The British Columbia Ministry of Transportation and Infrastructure (MoTI) and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than USL and MoTI, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in Appendix A or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) is pleased to present the following data report to Urban Systems Ltd. (USL) and the British Columbia (BC) Ministry of Transport and Infrastructure (MoTI) for the Highway 95 Kicking Horse River (KHR) Bridges Replacement Project (the Project).

The following report summarizes Phase 1 and Phase 2 of the geotechnical subsurface exploration program carried out by Tetra Tech from March 8 to 22, 2021 and September 13 to 17, 2021 respectively, to support the functional and detailed design phases of the Project.

Phase 1 and Phase 2 of the exploration program were carried out in general accordance with the Site Investigation Work Plan, submitted to MoTI and USL in December 2020, but with changes in Phase 2 due to the required relocation of the testholes out of the CP property, and considering relative costs of different drilling methods and findings of the previous phase of exploration. These changes in the program were discussed with MoTI and USL and agreed upon in July and August 2021.

This report presents the factual data collected during the March and September 2021 exploration programs. Some limited data interpretation is included as part of typical processing of raw data. The analytical components of the design will be presented in milestone Design Reports under a separate cover as the project progresses.

2.0 PROJECT DESCRIPTION

The KHR Bridges are located in Golden, BC, approximately 73 km west of the Alberta border and 148 km east of Revelstoke, BC. The existing KHR Bridges 1 and 2, originally built in 1952, are nearing the end of their service life and have been identified for replacement by MoTI. The bridges cross the KHR on Highway 95 to link the north and south sides of the Town of Golden, including a small stretch of road on Gould's Island. Regionally, these bridges provide a key link between Highway 1 and Highway 3 and several communities along Highway 95 between Golden and Cranbrook.

USL is leading this project along with Tetra Tech and COWI North America Ltd. (COWI) to perform functional and detailed design tasks, including discussions with MoTI regarding alternative bridge alignment option(s). The new bridges will likely be pile-supported structures with abutments on the north and south sides of the KHR with a pier located near the east end of Gould's Island.

The geotechnical exploration was undertaken to obtain additional information regarding soil stratigraphy and geotechnical properties for pile foundation design, embankment stability analyses, and pavement structure design. A previous site exploration program was completed as part of the Preliminary Design work (Golder 2020).

3.0 SUBSURFACE EXPLORATION PROGRAM

3.1 General

A summary of the subsurface exploration completed is provided in Table 3-1 and the testhole locations are presented on Figure 1.

Phase 1 was completed between March 8 to 22, 2021 and consisted of:

- One sonic testhole on Gould's Island to characterize the soil conditions near the proposed pier location of the main bridge.
- One Instrumented Becker Penetration Test (iBPT) testhole to characterize the soil density and compaction properties near the proposed south abutment of the main bridge.
- Two sonic testholes on Highway 95 to obtain asphalt thickness and characterize the pavement structure and materials.
- One sonic testhole in Kumsheen Park to characterize the subsurface conditions below the proposed trenchless watermain crossing.

Phase 2 was completed from September 13 to 17, 2021 and consisted of:

- One sonic testhole to characterize the subsurface conditions near the proposed north abutment.
- Two sonic testholes on Highway 95 north of the river to obtain asphalt thickness and characterize the pavement structure and materials.
- One hydrovac testhole on Highway 95 south of the river to obtain asphalt thickness and characterize the pavement structure and materials.

Caroline Reader and Katrina Berube of Tetra Tech were on site through the duration of the Phase 1 and Phase 2 exploration programs, respectively. They observed drilling conditions, logged soil conditions, recorded in-situ testing data, and collected samples for laboratory testing. Soils were initially classified visually and by texture in accordance with Tetra Tech internal geotechnical soil classification work method. Tetra Tech geotechnical soil classification work method has been developed based on the general guidelines provided in the Canadian Foundation Engineering Manual 4th Edition and ASTM standards. The soil logging was in general conformance with American Society for Testing and Materials (ASTM) standard D2487 and D2488.

Tetra Tech conducted BC One Call information requests to identify potential buried services across the site and retained the services of Okanagan Utility Locators for the locating and marking of all underground services in the field. Buried utility locates for all testholes in Phase 1 and Phase 2 were completed on March 1, 2021 and September 13, 2021 respectively, to minimize the risk of damage to services during the subsurface exploration program. The utility locator used electromagnetic techniques sensitive to buried conductors, such as metal pipes and cables. The Town of Golden Public Works Utilities Team aided in the locating of buried water and sewage pipes, and a member of their team was present on site during the utility locates on March 1, 2021 and September 13, 2021.

For BH21-01 and HV21-07 during Phase 2, where utilities were detected in close proximity during the utility locate, utility clearance by means of hydrovac excavation was used to physically clear the testhole locations to a depth of 2.4 m and 3.5 m, respectively. Kootenay Pumping was subcontracted by Tetra Tech to hydrovac excavate BH21-01 and HV21-07 on September 14 and September 13, 2021, respectively.

Traffic management was required during both phases in areas where the drilling had to be performed on or close to existing roads. Tetra Tech subcontracted Sentry Traffic Control Ltd. to create traffic management plans during Phase 1 and Crossroads Highway Services Ltd. to provide traffic control operations during both Phase 1 and 2.

Cultural monitoring was coordinated by Tetra Tech through MoTI Indigenous Relations and Shuswap Band. Shuswap Band (Kenpesq't Territorial Operations Ltd.) provided cultural monitoring services to inspect the soils for archeological remnants for the duration of both the Phase 1 and Phase 2 exploration programs.

A summary of the testhole locations is presented in Table 3-1, and the geotechnical testhole logs are presented in Appendix B. UTM (NAD83) coordinates and elevations of the testhole locations were surveyed by Geometric Surveys Ltd. on March 18, 2021 (Phase 1), September 17, 2021 (Phase 2) and December 3, 2021 (Phase 2: HV21-07).

Table 3-1. Summary of Testholes

Phase	Testhole ID	Drilling Method	UTM (NAD83, Zone: 11) Coordinates (1)			Drilling Dates		Target Depth (m)	Actual Depth (m)
			Easting	Northing	Elevation (masl)	Start	End		
2	BH21-01	Hydrovac/ Sonic	502544.763	5683077.296	789.029	15-Sep-2021	17-Sep-2021	50	52.3
1	iBPT21-02	iBPT	502573.183	5682957.541	788.948	15-Mar-2021	22-Mar-2021	50	47.5
1	BH21-03	Sonic	502559.621	5683006.745	788.789	09-Mar-2021	12-Mar-2021	60	64.0
2	BH21-04	Sonic	502408.265	5683262.233	786.651	14-Sep-2021	14-Sep-2021	3	3.5
1	BH21-05	Sonic	502346.306	5683377.475	786.372	13-Mar-2021	13-Mar-2021	3	3.5
2	BH21-06	Sonic	502455.388	5683196.769	787.071	14-Sep-2021	14-Sep-2021	3	3.5
2	HV21-07	Hydrovac	502578.518	5682820.613	788.404	13-Sep-2021	13-Sep-2021	3	3.0
1	BH21-08	Sonic	502521.106	5682956.036	789.522	13-Mar-2021	13-Mar-2021	3	3.5
1	BH21-09	Sonic	502626.001	5682957.348	789.576	12-Mar-2021	13-Mar-2021	15	15.2

(1) Coordinates and elevations were surveyed (+/- 0.03 m) and precise values (to three decimal places) were provided by Geometric Surveys Ltd. after completion of each exploration phase.

3.2 Sonic Drilling

Sonic drilling was carried out by Mobile Augers and Research Ltd. (Mobile Augers) using a Fraste Multidrill XL track-mounted rig. Drilling was completed using the method outlined by ASTM D6914 for Sonic Drilling. The soil is recovered in intervals of 1.5 m to 3.0 m, and then laid out in core boxes for the geotechnical engineer to log the recovered material. Core boxes were transported to Tetra Tech's geotechnical laboratory in Calgary, AB.

Sampling in coarse-grained (granular) soils was also carried out by means of the Standard Penetration Test (SPT) split-spoon sampler at 1.5 m intervals down to 15 m depth, then at 3.0 m intervals thereafter where the testhole continued deeper. A 63.5 kg (140 lb) hammer weight was used for SPT in accordance with ASTM D1586-18 with a drop height of 30 inches (76.2 cm). However, during Phase 1 after completion of BH21-03 and during drilling of BH21-09 at about 11 m depth, the automatic trip hammer malfunctioned and required repair. It was discovered that the drilling crew had placed a 300 lb (136 kg) hammer weight inside the automatic trip hammer. This weight is used for performing Large Penetration Tests (LPT). It was replaced with a 140 lb (63.5 kg) weight that is used for SPT in accordance with ASTM D1586-18. Blow counts were recorded by Tetra Tech's field engineer for every 150 mm of

penetration and the split-spoon samples were visually classified and logged in the field. Undisturbed piston sampling using thin-walled Shelby tubes was attempted in a silt and sand layer at about 54.9 m depth in BH21-03 during Phase 1; however, no sample was recovered.

After the samples were inspected and logged, representative disturbed samples were selected for classification testing at Tetra Tech's geotechnical laboratory. Photographs of the core box samples from Phase 1 to 2 and split-spoon samples from Phase 2 are included at the end of this report. The recorded blow counts are shown on the testhole logs attached in Appendix B.

At the request of Tetra Tech, energy transfer measurements were performed by Mobile Augers on March 15, 2021, results of which are shown in Appendix C. These energy measurements can be used to convert the blow counts obtained using LPT hammer to an equivalent SPT hammer blow count.

3.3 Instrumented Becker Penetration Testing

Instrumented Becker Penetration Testing (iBPT) was performed by Foundex Explorations Ltd. (Foundex) during Phase 1, using their truck-mounted Becker rig; and ConeTec Investigations Ltd. (ConeTec) provided and operated the instrumentation used to collect downhole energy measurements and the iBPT blow counts, which can be correlated to equivalent SPT N_{60} values. The results are shown in Appendix D.

iBPT21-02 hit refusal (>250 blow counts in a 150 mm interval during closed, instrumented testing) four times during drilling as shown on the iBPT plots in Appendix D. When refusal occurred, the closed bit was pulled up and then switched to an open bit with the instrumentation removed, and the dense material was drilled through until the blow counts were low enough to return to instrumented testing. When the final refusal occurred at 47.5 m (2.5 m above the target depth of 50 m), the testhole was terminated.

3.4 Testhole Closure

Testhole backfilling varied depending on the testhole location and depth. Table 3-2 details the backfill material used in each testhole. All testholes were backfilled upon completion in accordance with the BC Groundwater Protection Regulations and MoTI requirements.

Table 3-2. Testhole Backfilling

Testhole ID	Location	Backfill
BH21-01	Northeast of existing bridge	Cement-Bentonite grout to 1.5 m topped with bentonite chips to surface
iBPT21-02	Kumsheen Park	Pea gravel and bentonite tablets (time release), compacted base rock to surface
BH21-03	Gould's Island	Cement-Bentonite grout to surface
BH21-04	10th Ave N (Highway 95), north of existing bridge	Bentonite chips and sand topped with compacted cold mix asphalt to surface
BH21-05	Highway 95	Cuttings topped with compacted cold mix asphalt to surface
BH21-06	10th Ave N (Highway 95), north of existing bridge	Bentonite chips and sand topped with compacted cold mix asphalt to surface
HV21-07	10th Ave S (Highway 95), south of existing bridge	Compacted sand topped with compacted cold mix asphalt to surface

Testhole ID	Location	Backfill
BH21-08	Gravel parking area adjacent to Highway 95	Cuttings, compacted base rock to surface
BH21-09	Kumsheen Park	Bentonite chips, compacted base rock to surface

In BH21-01 and BH21-03, the grout mix followed the industry standard Mikkelsen mix ratio of 2 water to 1 cement to 1/3 bentonite (by weight).

4.0 LABORATORY TESTING

4.1 Samples

The samples collected during the drilling were taken to Tetra Tech's geotechnical laboratory in Calgary, AB, for laboratory testing. The samples collected from the SPT testing and sonic cores are disturbed and were used for general classification tests.

The following soil tests were completed as part of the testing program:

- Soil Description and Classification (11, 12)
- Natural Moisture Content (16, 2)
- Sieve Analysis (11, 10)
- Fines Content – Percent Passing #200 Sieve (5, 9)

The numbers in brackets refer to the total number of each test performed on the samples from the testholes in Phase 1 (preceding the comma) and Phase 2 (after the comma). The results of the geotechnical and material testing are presented on the testhole logs in Appendix B and the particle size distribution tests are presented in Appendix E.

Other test results, e.g., those related to corrosion, will be presented in a separate report after testing requirements are provided by other design disciplines and testing is completed.

4.2 Soil Description and Classification

In the field and upon recovery, the soil samples were classified visually and by texture in accordance with MoTI's Notes for Completion of Soil Field Logs (MoTI 2016) and Geotechnical and Materials Engineering Standards for Bridge Foundation Investigations (MoTI 1991).

The detailed soil descriptions include the following information:

- Main soil type
- Secondary soil components
- Qualitative assessment of grading (granular soils)
- Shape and angularity (granular soils)
- Plasticity (cohesive soils)

- Colour
- Structure, texture, or other relevant observations
- Moisture
- Compactness / Consistency

Soils have been classified as coarse-grained (non-cohesive) soils or fine-grained (cohesive) soils. Non-cohesive soils are described in terms of the relative proportions of the mineral constituents. Cohesive soils are classified based on plasticity (Atterberg limits) as per ASTM D2487-17.

On the drilling logs in Appendix B, the field descriptions have been revised to consider the results of the laboratory classification tests at the specific depth of the samples.

4.3 Natural Moisture Content

Moisture content determinations were performed on the samples recovered from the testholes. Natural moisture contents are determined from the difference in measured total and dry weights after oven drying of specimens taken from soil samples recovered from the testhole. Measurements are performed in accordance with the procedures described in ASTM D2216-19.

The results of the natural water content tests are plotted on the testhole logs presented in Appendix B.

4.4 Fines Content and Particle Size Distribution

Particle size distribution tests and fines content determinations were performed on the disturbed soil samples to characterize the granular layers identified within the testholes. Particle size distribution tests were performed in accordance with the ASTM D6913-17 and the results are presented on a semi-logarithmic plot with grain size (log) versus percentage passing by weight finer than the grain (sieve) size. Data from the referred tests were used to verify the visual descriptions made in the field.

For fines content determinations, the proportion of fines (silt and clay) in a specimen was determined by washing the material through the #200 (75 µm) sieve and computing the percentage passing.

The relative proportions of gravel, sand, and fines are indicated on the testhole logs in Appendix B. The results of the particle size distribution tests are tabulated and presented graphically in Appendix E.

5.0 SUMMARY OF GEOTECHNICAL CONDITIONS

5.1 Soil Conditions

The general soil conditions at the site are represented by six (6) soil units. The layers identified are described as follows:

- **Unit I – TOPSOIL:** A layer of topsoil approximately 0.2 m in thickness was encountered near the ground surface in BH21-01, BH21-03, and BH21-09.
- **Unit II – FILL**: A layer of fill was encountered in BH21-05 and BH21-08 to a depth of about 3.5 m and 1.9 m, respectively. The layer consisted of silty sand and gravel, to sandy gravel, to gravelly sand, to sand with some silt, to gravelly sand and silt. Inclusions of tar were observed in both BH21-05 and BH21-08 to depths of about 0.5 m and 0.8 m, respectively.
- **Unit III – GRAVEL / COBBLES:** This unit was encountered underlying topsoil in BH21-01, BH21-03, and BH21-09 to depths ranging from about 1.1 m to 2.4 m. The layer was also encountered underlying the fill in BH21-08 and underlying the road section in BH21-04, BH21-06, and HV21-07, to termination depths. The unit varies in composition from gravel to sandy silty gravel, to sandy gravel. Cobbles up to 250 mm in diameter were observed along with fine to coarse, subangular to rounded gravel, and fine to coarse sand. The unit is compact to very dense, grey-brown in colour, and dry to moist.
- **Unit IV – GRAVEL:** This unit was encountered underlying Unit III and extending to a depth of about 38.7 m and 38.9 m in BH21-03 and BH21-01, respectively. The unit extended to the termination depth (15.2 m) in BH21-09. The unit varies in composition from gravelly sand, to sandy silty gravel, to sandy gravel with some silt, to gravel and silt. The gravel is fine to coarse, subangular to rounded and the sand is fine to coarse. Cobbles were recovered in the unit up to 100 mm in diameter (constrained by the diameter of the sonic drill casing; may be larger in the field). The unit varies in compactness from compact to very dense. It is damp to wet and grey-brown in colour.
- **Unit V – SILTY SAND:** This unit was encountered in BH21-01 and BH21-03 underlying Unit IV and extending to depths of about 39.8 m and 45.5 m, respectively. The unit consisted of silty sand with trace to no gravel. Occasional silt laminations up to 30 mm in thickness and silt inclusions up to 30 mm in diameter were observed throughout the samples from this unit. The sand was fine, yellow-brown in colour, wet, and compact.
- **Unit VI – SAND / SILT:** This unit was encountered in BH21-01 and BH21-03 underlying Unit V and extending to termination depth. The unit is generally comprised of sand and silt. A sandy silt layer about 1.1 m thick was encountered in BH21-03 at about 56.1 m depth. A silt and sand layer was encountered at about 51.5 m depth and extended to the termination depth (52.3 m) of BH21-01. Interbedded silt layers were observed in the lower part of the unit. The sand is fine to medium and the unit is moist to wet and grey-brown in colour. The unit varies in compactness from compact to very dense, becoming very stiff to hard where the fines content increases. In BH21-03, the unit is clearly defined from the overlying silty sand unit (Unit V) by a marked colour change from yellowish brown to grey, along with an increase in silt content.

5.2 Groundwater Conditions

Inferred groundwater levels were taken from the testholes during subsurface exploration. Groundwater levels were inferred to range from approximately 3.0 m to 7.5 m depth in BH21-01, BH21-03, and BH21-09. These observations only reflect the groundwater conditions over the duration of the exploration program. Groundwater levels may vary seasonally or with precipitation; and can vary between testholes or at the time of construction. Inferred groundwater levels observed during the exploration may have been affected by the water used for drilling operations.

6.0 CLOSURE

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

Respectfully Submitted,
Tetra Tech Canada Inc.

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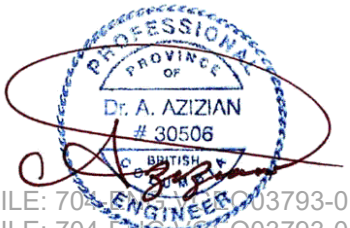

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FIGURES

LEGEND

- Tetra Tech sonic testhole to 3 m
- Tetra Tech hydrovac testhole to 3 m
- Tetra Tech sonic testhole to 15 m
- Tetra Tech sonic testhole to 50 m
- Tetra Tech sonic testhole to 60 m
- Tetratech iBPT to 50 m
- Golder testhole locations
- McIntosh-Lalani testhole locations

NOTES

1. Imagery from Google Earth Pro. Testhole locations on this image are approximate. See report for coordinates.

ISSUED FOR USE

0 100m

Scale: 1:2,000 @ 11"x17"

CLIENT

BRITISH COLUMBIA Ministry of Transportation and Infrastructure

TETRA TECH

KICKING HORSE RIVER BRIDGES REPLACEMENT

TESTHOLE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
ENG.VGEO03793-01	RH	CR	4
OFFICE: VANC	DATE: May 3, 2022		

Figure 1

PHOTOGRAPHS

Phase 1

Photo 1 to Photo 28 Sonic Core Photographs

Phase 2

Photo 1 to Photo 44 Sonic Core and Spilt Spoon Sample Photographs

PHASE 1

Photo 1. BH21-03, Box 1, 0.00 to 3.05 m

Photo 2. BH21-03, Box 2, 3.05 to 6.10 m

Photo 3. BH21-03, Box 3, 6.10 to 10.67 m

Photo 4. BH21-03, Box 4, 10.67 to 15.24 m

Photo 5. BH21-03, Box 5, 15.24 to 19.81 m

Photo 6. BH21-03, Box 6, 19.81 to 22.86 m

Photo 7. BH21-03, Box 7, 22.86 to 25.91 m

Photo 8. BH21-03, Box 8, 25.91 to 28.96 m

Photo 9. BH21-03, Box 9, 28.96 to 32.00 m

Photo 10. BH21-03, Box 10, 32.00 to 35.05 m

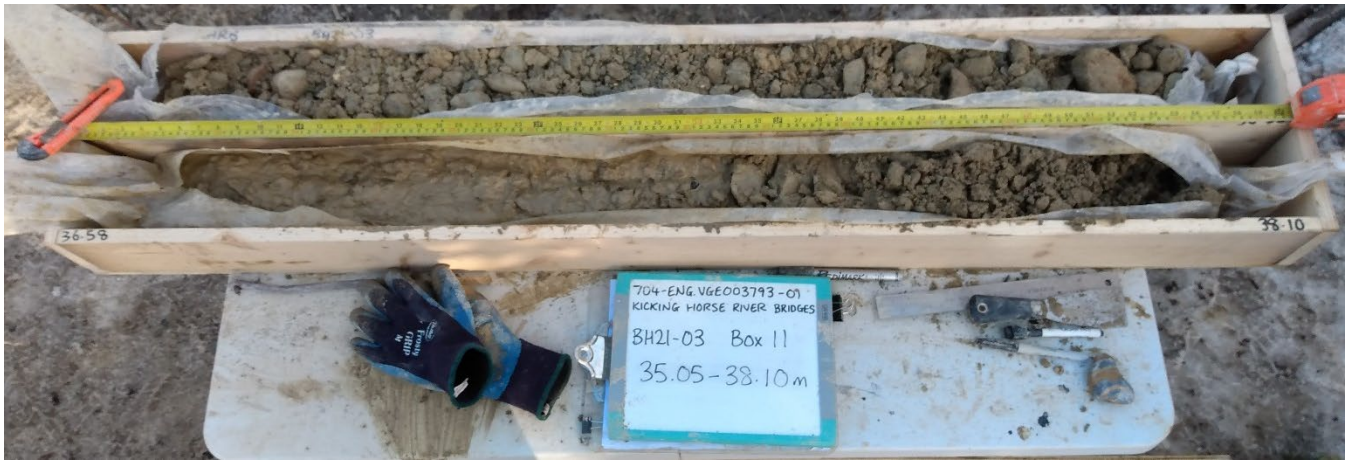

Photo 11. BH21-03, Box 11, 35.05 to 38.10 m

Photo 12. BH21-03, Box 12, 38.10 to 41.50 m

Photo 13. BH21-03, Box 13, 41.50 to 44.20 m

Photo 14. BH21-03, Box 14, 44.20 to 47.24 m

Photo 15. BH21-03, Box 15, 47.24 to 50.29 m

Photo 16. BH21-03, Box 16, 50.29 to 53.34 m

Photo 17. BH21-03, Box 17, 53.34 to 56.39 m

Photo 18. BH21-03, Box 18, 56.39 to 59.44 m

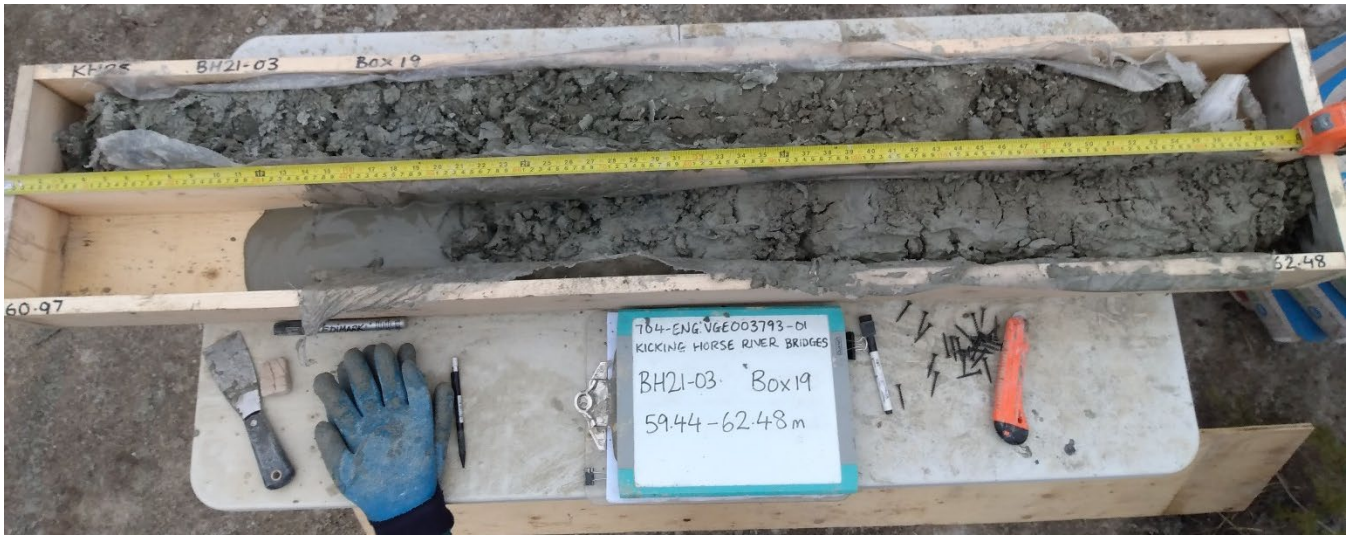

Photo 19. BH21-03, Box 19, 59.44 to 62.48 m

Photo 20. BH21-03, Box 20, 62.48 to 64.01 m

Photo 21. BH21-05, Run 1, 0.00 to 1.52 m

Photo 22. BH21-05, Run 2, 1.52 to 3.05 m

Photo 23. BH21-08, Run 1, 0.00 to 1.52 m

Photo 24. BH21-08, Run 2, 1.52 to 3.05 m

Photo 25. BH21-09, Run 1, 0.00 to 3.60 m

Photo 26. BH21-09, Run 2, 3.60 to 8.25 m

Photo 27. BH21-09, Run 3, 8.25 to 14.00 m

Photo 28. BH21-09, Run 4, 14.00 to 15.24 m

PHASE 2

Photo 1. BH21-01, SPT-01, 3.0 m to 3.5 m

Photo 2. BH21-01, Box 1, 3.0 m to 4.5 m

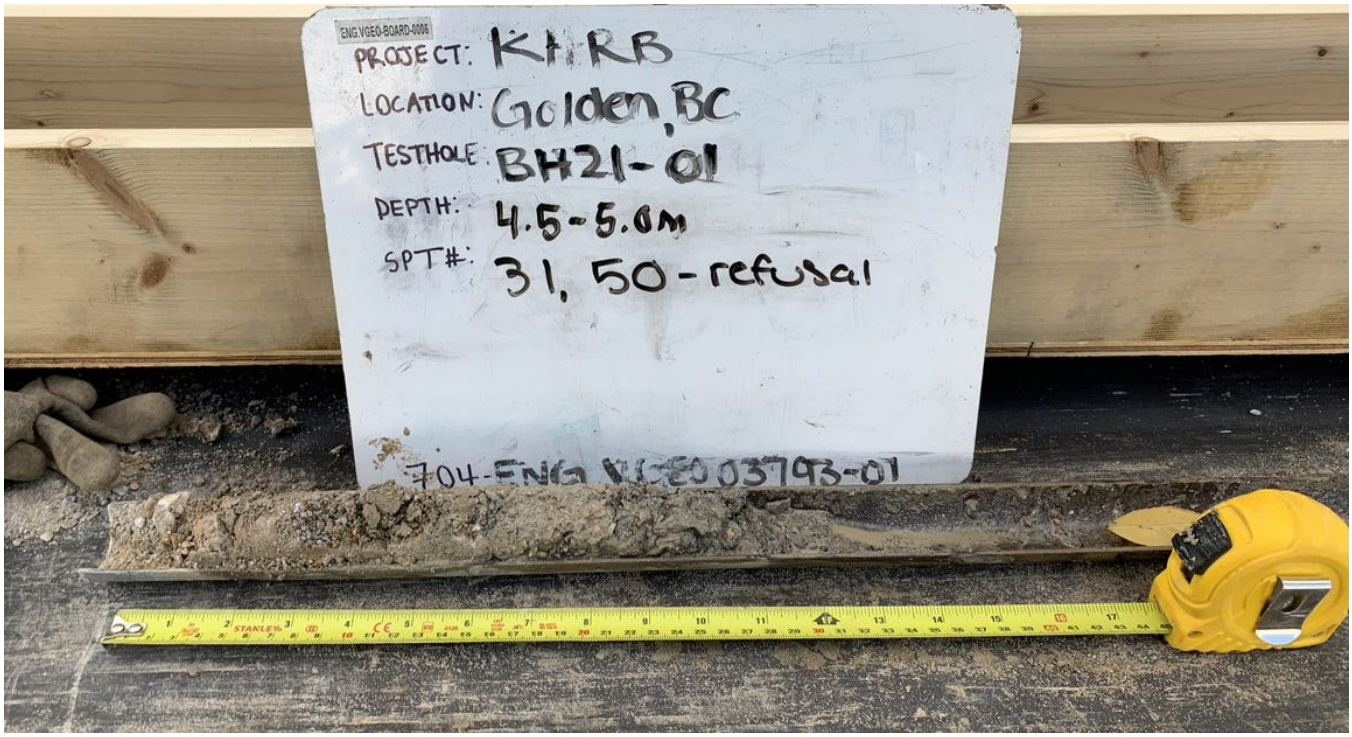

Photo 3. BH21-01, SPT-02, 4.5 m to 5.0 m

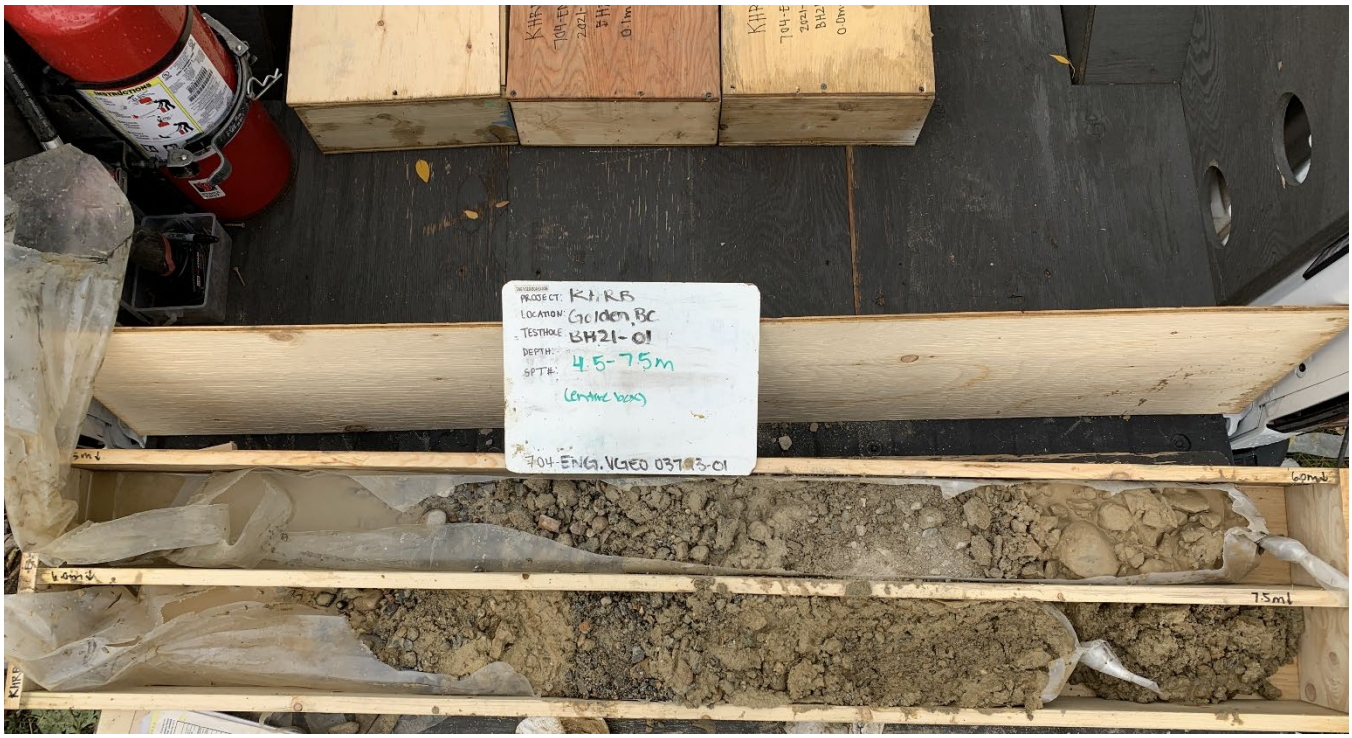

Photo 4. BH21-01, Box 2, 4.5 m to 7.5 m

Photo 5. BH21-01, SPT-03, 6.0 m to 6.5 m

Photo 6. BH21-01, SPT-04, 7.5 m to 8.0 m

Photo 7. BH21-01, Box 3, 7.5 m to 10.5 m

Photo 8. BH21-01, SPT-05, 9.0 m to 9.5 m

Photo 9. BH21-01, SPT-06, 10.5 m to 11.0 m

Photo 10. BH21-01, Box 4, 10.5 m to 13.5 m

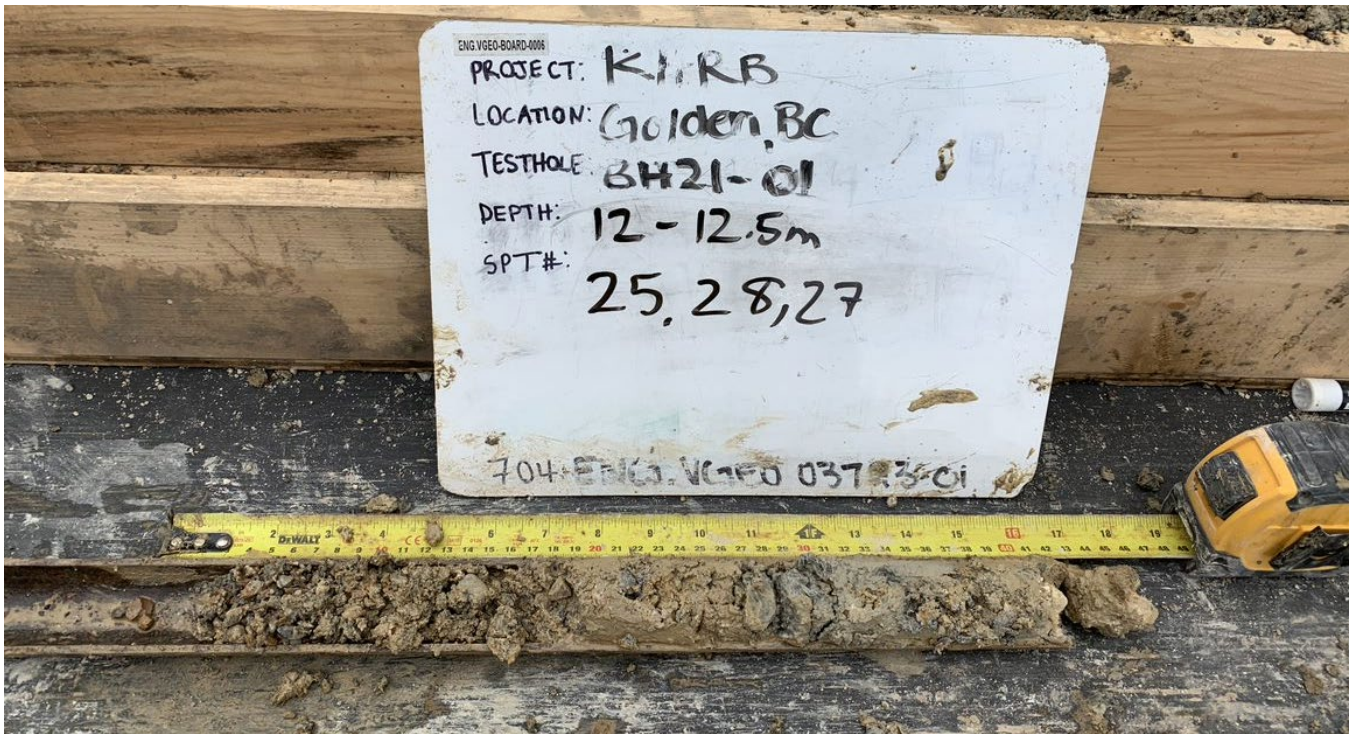

Photo 11. BH21-01, SPT-07, 12.0 m to 12.5 m

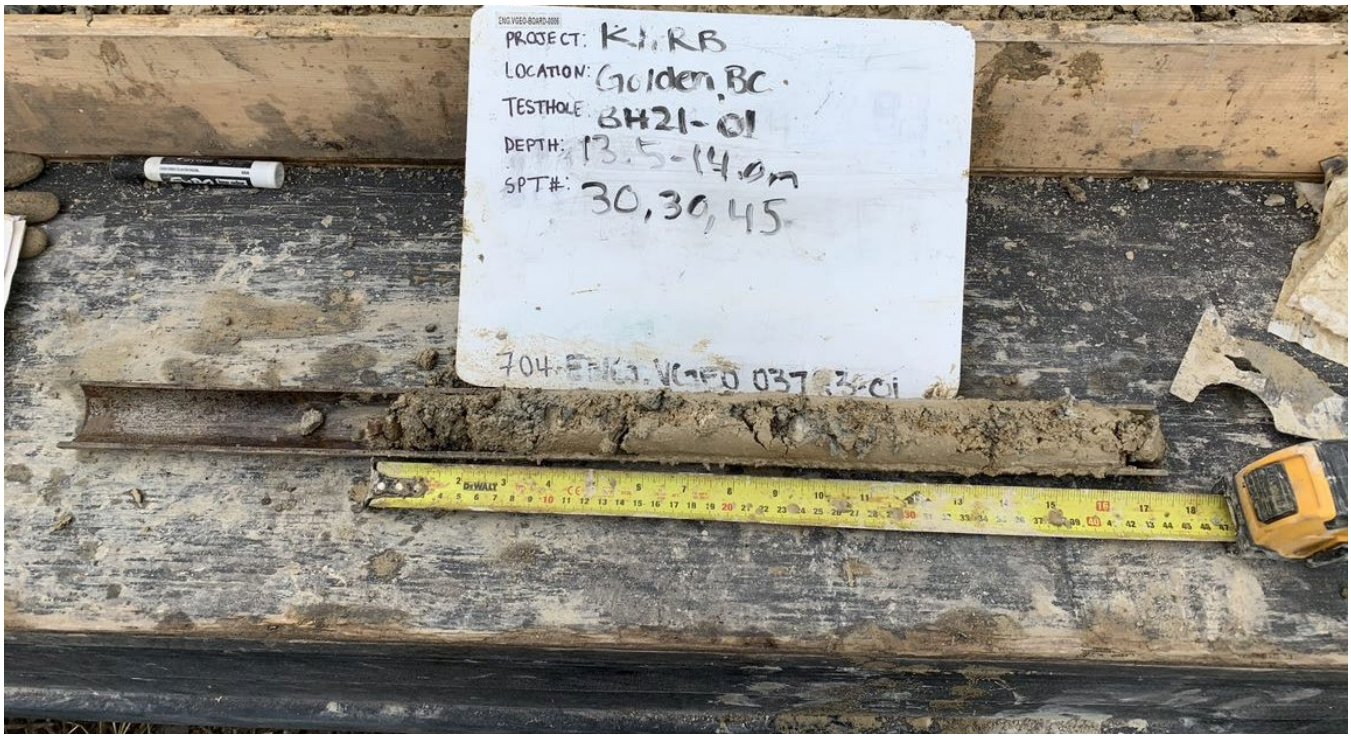

Photo 12. BH21-01, SPT-08, 13.5 m to 14.0 m

Photo 13. BH21-01, Box 5, 13.5 m to 16.5 m

Photo 14. BH21-01, SPT-09, 15.0 m to 15.5 m

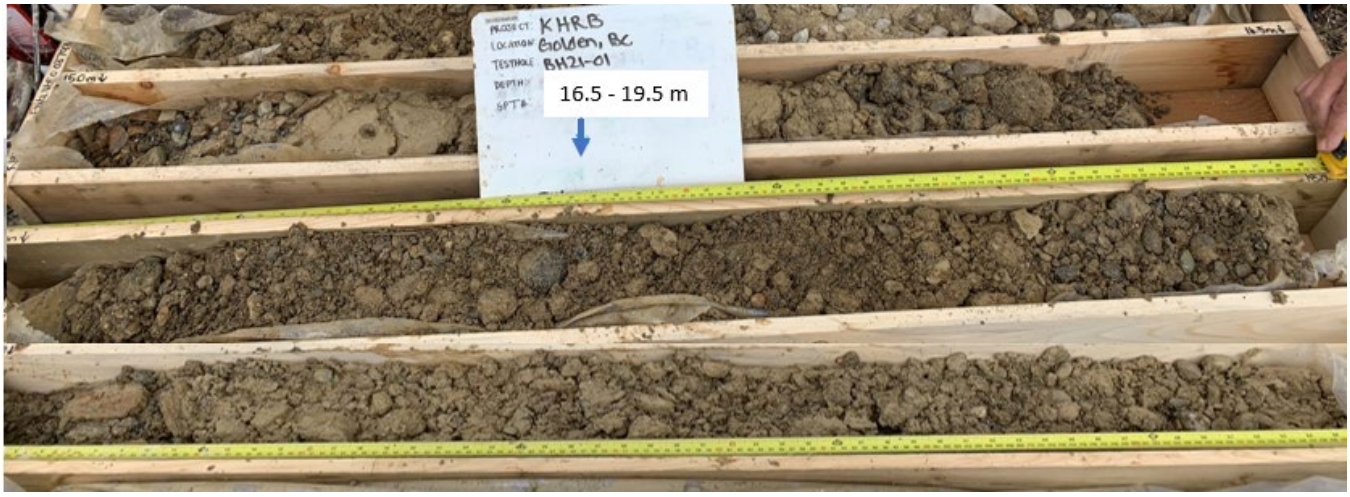

Photo 15. BH21-01, Box 6, 16.5 m to 19.5 m

Photo 16. BH21-01, SPT-10, 18.0 m to 18.5 m

Photo 17. BH21-01, Box 7, 19.5 m to 21.0 m

Photo 18. BH21-01, SPT-11, 21.0 m to 21.5 m

Photo 19. BH21-01, Box 8, 21.0 m to 24.0 m

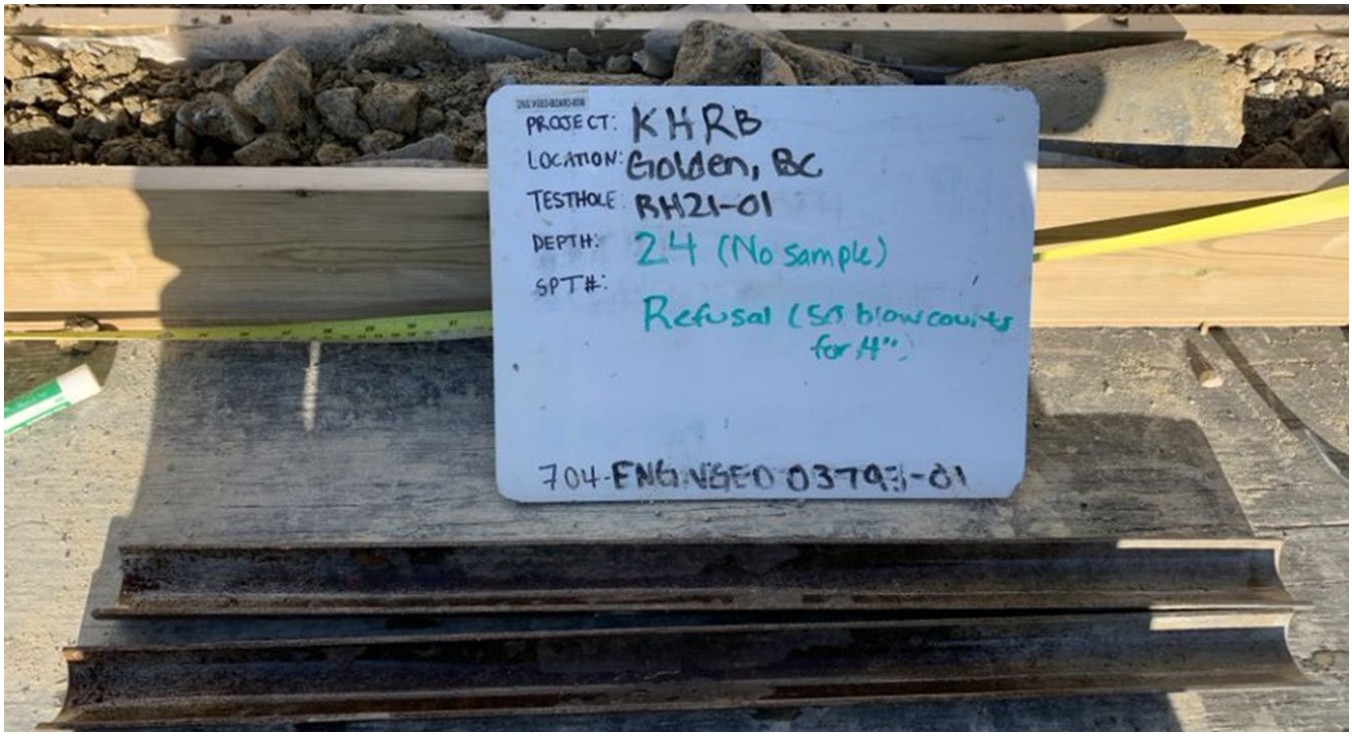

Photo 20. BH21-01, SPT-12, 24.0 m to 24.5 m

Photo 21. BH21-01, Box 9, 24.0 m to 27.0 m

Photo 22. BH21-01, SPT-13, 27.0 m to 27.5 m

Photo 23. BH21-01, Box 10, 27.0 m to 29.8 m

Photo 24. BH21-01, SPT-14, 30.5 m to 31.0 m

Photo 25. BH21-01, Box 11, 30.5 m to 33.5 m

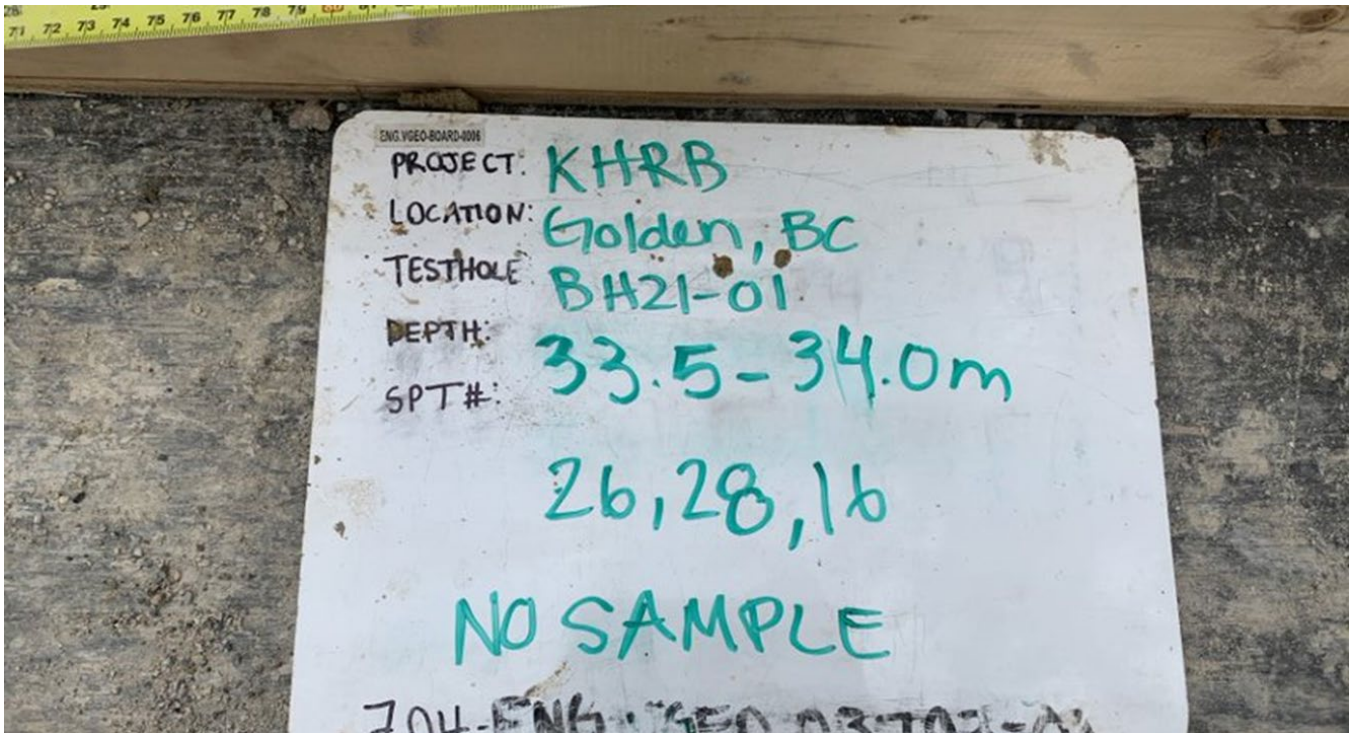

Photo 26. BH21-01, SPT-15, 33.5 m to 34.0 m

Photo 27. BH21-01, Box 12, 33.5 m to 36.6 m

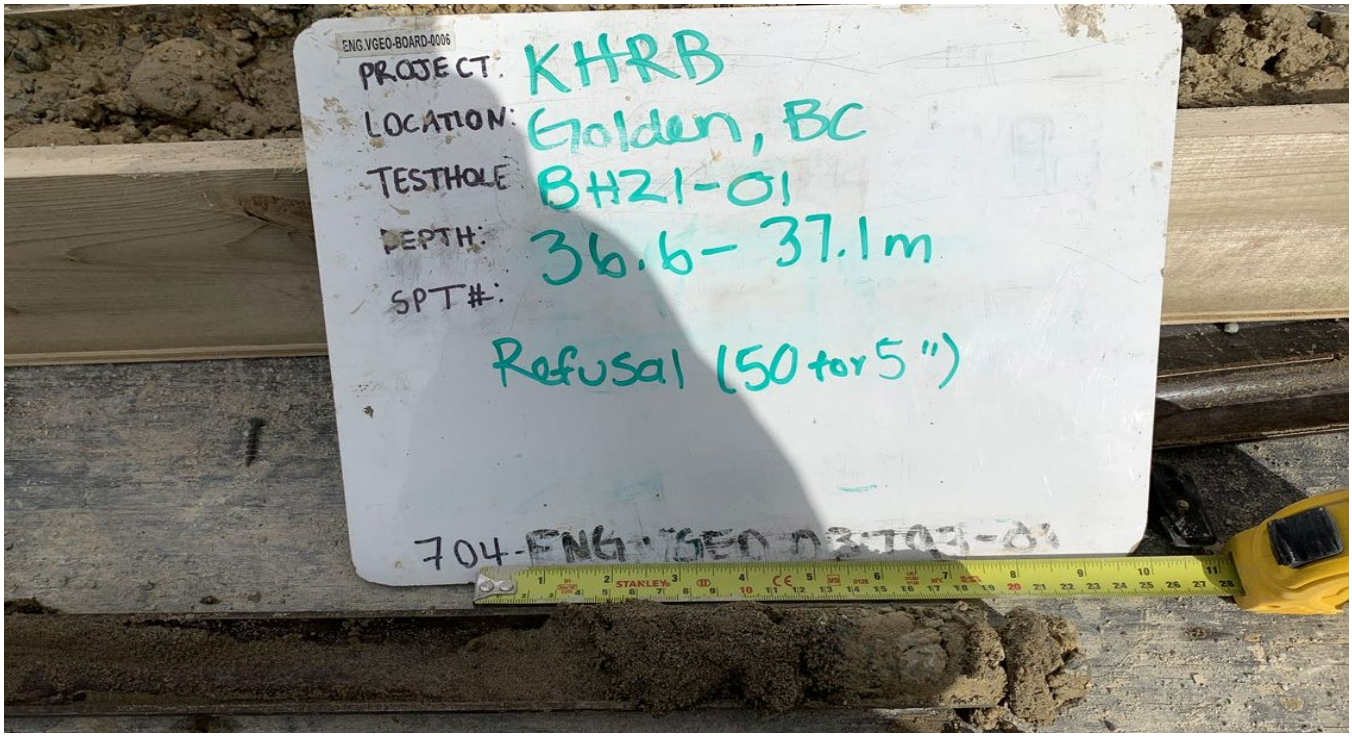

Photo 28. BH21-01, SPT-16, 36.6 m to 37.1 m

Photo 29. BH21-01, Box 13, 36.6 m to 39.6 m

Photo 30. BH21-01, SPT-17, 39.6 m to 40.1 m

Photo 31. BH21-01, Box 14, 39.6 m to 42.7 m

Photo 32. BH21-01, SPT-18, 42.7 m to 43.2 m

Photo 33. BH21-01, Box 15, 42.7 m to 45.7 m

Photo 34. BH21-01, SPT-19, 45.7 m to 46.2 m

Photo 35. BH21-01, Box 16, 45.7 m to 48.8 m

Photo 36. BH21-01, SPT-20, 48.8 m to 49.3 m

Photo 37. BH21-01, Box 17, 48.8 m to 51.8 m

Photo 38. BH21-01, SPT-21, 51.8 m to 52.3 m

Photo 39. BH21-04, Box 1, 0.1 m to 3.0 m

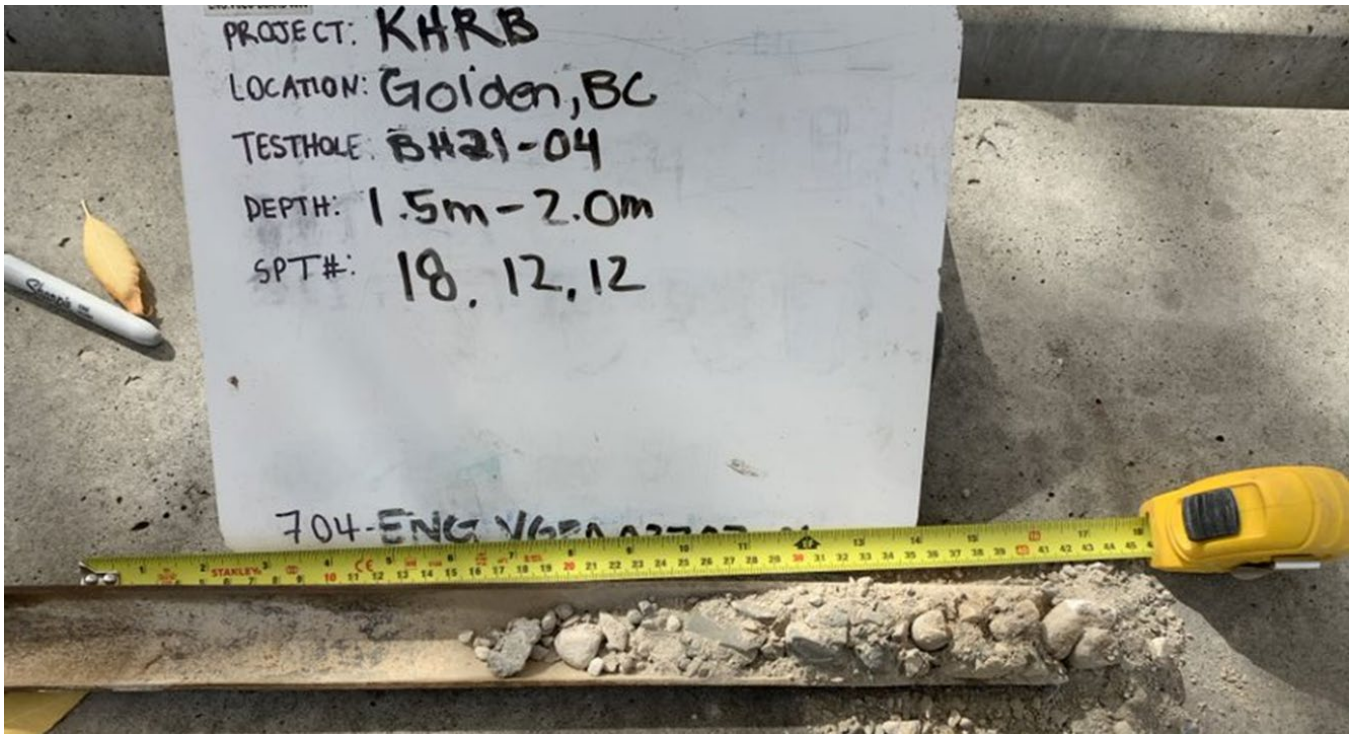

Photo 40. BH21-04, SPT-01, 1.5 m to 2.0 m

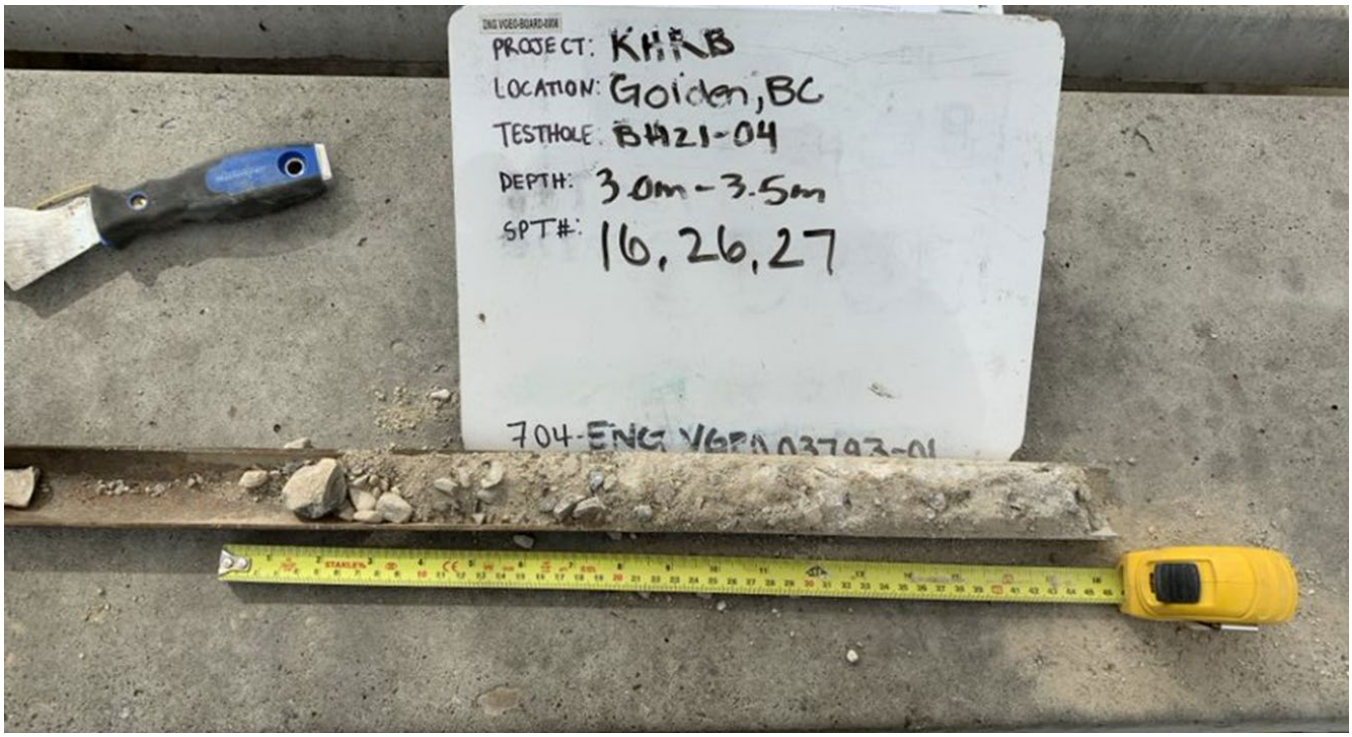

Photo 41. BH21-04, SPT-02, 3.0 m to 3.5 m

Photo 42. BH21-06, Box 1, 0.1 m to 3.0 m

Photo 43. BH21-06, SPT-01, 1.5 m to 2.1 m

Photo 44. BH21-06, SPT02, 3.0 m to 3.5 m

APPENDIX A

LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

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

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

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

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

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

1.4 DISCLOSURE OF INFORMATION BY CLIENT

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

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

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

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

1.6 GENERAL LIMITATIONS OF DOCUMENT

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

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

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

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

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

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

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

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

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

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

1.9 LOGS OF TESTHOLES

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

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

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

1.11 PROTECTION OF EXPOSED GROUND

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

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

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

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

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

1.14 OBSERVATIONS DURING CONSTRUCTION

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

1.15 DRAINAGE SYSTEMS

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

1.16 DESIGN PARAMETERS

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

1.17 SAMPLES

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

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

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

APPENDIX B

GEOTECHNICAL TESTHOLE LOGS

MOTI SOIL CLASSIFICATION TABLE

SOIL CLASSIFICATION

Major Divisions		Symbol	Soil Type
Coarse Grained Soils	Gravel and Gravelly 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-clay mixtures
	Sand and Sandy Soils	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
Fine Grained Soils	Silts and Clays LL<50	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 silt-clays of low palsticity
	Silts and Clays LL>50	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
Organic Soils		Pt	Peat and other highly organic soils
Topsoil		TS	Topsoil with roots, etc.
Cobbles		SB	Rock fragments and cobbles, particle size 75mm to 300mm diameter
Boulders		LB	Boulders, particle size over 300mm in diameter

*GP-GM ; GP-GC; SP-SM; SP-SC;	6-12%	Passing #200 (0.075mm) Sieve
* 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

MoTI Soil Classification table from the document *Notes for Completion of Field Logs* (MoTI, 2016) uploaded to the MoTI website on September 14, 2016. This table was originally based on the MoTI *Geotechnical and Materials Engineering Standards for Bridge Foundation Investigations* (MoTI, 1991).

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683077.296 , 502544.763 Station/Offset:

Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 / SPT "N" (BLOWS/300 mm) / Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0								TOPSOIL, some rootlets and organics, brown	TS		789
								0.2m GRAVEL, gap graded, fine to coarse, subangular to subrounded gravel up to 40 mm in diameter, some coarse sand, some subrounded cobbles up to 250 mm in diameter, trace silt, brown to grey, non-cohesive, dry, dense - Hydrovac excavation to 2.4 m	GP		
1											788
2					G01						787
		27 50	6 50+ for 130mm					2.4m SILTY SAND and GRAVEL, well graded, fine to coarse, subangular to subrounded gravel up to 50 mm in diameter, fine to coarse sand, some subrounded to rounded cobbles up to 100 mm in diameter, grey to brown, non-cohesive, moist, compact to very dense - becomes wet at approximately 3.0 m - iron staining in matrix from 3.5 m to 12.7 m		**Sieve** (Sa#SPT01) G:43% S:41% F:16%	
3	3.0m ▼				SPT01	78					786
					G02						
4											785
		31 50	50+ for 130mm		SPT02	61					
5					G03				SM1-GM1		784
6		18 13 12	8 25		SPT03	100				**Sieve** (Sa#SPT03) G:39% S:46% F:15%	783
7					G04						782
		10 17 18	35		SPT04	100					
8			6		G05			7.9m GRAVEL and SAND, well graded, fine to coarse, subangular to subrounded gravel up to 50 mm in diameter, fine to coarse sand, some subrounded to rounded cobbles up to 100 mm in diameter, some silt, grey to brown, non-cohesive, moist, compact to dense		**Sieve** (Sa#G05) G:53% S:41% F:6%	781
9		8 10 15	25		SPT05	83					780
10											

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

Final Depth of Hole: 52.3 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021

Company: Mobile Augers and Research

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683077.296 , 502544.763 Station/Offset:

Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	SPT "N" (BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
10								GRAVEL and SAND, well graded, fine to coarse, subangular to subrounded gravel up to 50 mm in diameter, fine to coarse sand, some subrounded to rounded cobbles up to 100 mm in diameter, some silt, grey to brown, non-cohesive, moist, compact to dense *(continued)*	GW-GM		
	25 42 34		76		SPT06	100					
11					G06			- becomes very dense from 10.5 m to 12.7 m - trace silt, some sand to sandy from 11.0 m to 12.0 m			778
	4									**Sieve** (Sa#G06) G:% S:% F:4%	
12	25 28 27		55		SPT07	94		- some silt from 12.0 m to 12.7 m			777
								12.7m			
13	9				G07			SILTY GRAVEL, sandy, gap graded, fine to coarse subrounded gravel up to 50 mm in diameter, coarse sand, grey to brown, non-cohesive, moist, very dense		**Sieve** (Sa#G07) G:% S:% F:23%	776
	30 30 45		75		SPT08	100					
14									GM2		775
	5				G08					**Sieve** (Sa#G08) G:40% S:32% F:28%	
15	42 50 6		50+ for 130mm		SPT09	61				**Sieve** (Sa#SPT09) G:% S:% F:12%	774
								16.0m			
16								GRAVEL, sandy, well graded, fine to coarse subangular to subrounded gravel, fine to coarse sand, some silt, some cobbles up to 75 mm in diameter, brown, non-cohesive, wet, very dense			773
17					G09						772
18	20 25 26		51		SPT10	89					771
19									GW-GM		770
								- increasing cobbles at 19.5 m			
20											

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

Final Depth of Hole: 52.3 m
Depth to Top of Rock:

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**
Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021
Company: Mobile Augers and Research
Driller:
Drill Make/Model: Fraste Multidrill XL
Drilling Method: Sonic

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc
Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:
Northing/Easting: 5683077.296 , 502544.763 Station/Offset:
Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 / SPT "N" (BLOWS/300 mm) / W_P% 20 — W% — W_L% 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
20				G10			GRAVEL, sandy, well graded, fine to coarse subangular to subrounded gravel, fine to coarse sand, some silt, some cobbles up to 75 mm in diameter, brown, non-cohesive, wet, very dense *(continued)*			
21	7 14 50	64		SPT11	33		- becomes gap graded at 21.0 m			768
22							22.0m GRAVEL and SILT, low plastic, fine to coarse subangular to subrounded gravel up to 50 mm in diameter, trace fine sand, brown to grey, iron staining in matrix, non-cohesive, damp, dense to very dense			767
23								GM3		766
	7			G11						
24							24.0m SILTY GRAVEL, sandy, well graded, fine to coarse subrounded gravel up to 50 mm in diameter, fine to coarse sand, brown, non-cohesive, wet, very dense			765
	50	50+ for 100mm		SPT12	0					
25							- pockets of silt and gravel, some sand from 25.0 m to 27.7 m			764
26	7			G12				GM1	**Sieve** (Sa#G12) G:52% S:35% F:13%	763
27										762
	50	50+ for 130mm		SPT13	28					
				G13			27.7m GRAVEL and SILT, low plastic, fine to coarse subangular to subrounded gravel up to 70 mm in diameter, some fine sand, brown to grey, iron staining in matrix, non-cohesive, damp, dense to very dense			
28	5			G14					**Sieve** (Sa#G14) G:% S:% F:36%	761
29								GM3		760
							29.8m			
30										

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: 52.3 m
Depth to Top of Rock:

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
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Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683077.296 , 502544.763 Station/Offset:

Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 40 W% 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
30							NO RECOVERY from 29.8 m to 30.5 m - difficult drilling conditions *(continued)*			
							30.5m SILTY GRAVEL, sandy, well graded, fine to coarse subrounded gravel up to 60 mm in diameter, fine to coarse sand, brown, non-cohesive, wet, very dense - increase in silt content with depth from 31.0 m to 32.7 m	GM1	**Sieve** (Sa#G16) G:56% S:31% F:13%	
31	50	50+ for 100mm		SPT14	22					758
	7			G16						
32										757
							32.7m GRAVEL and SILT, low plastic, fine to coarse subangular to subrounded gravel up to 20 mm in diameter, trace fine sand, brown, iron staining in matrix, non-cohesive, damp, dense to very dense	GM3		
33	8			G17			33.5m SILTY GRAVEL, sandy, well graded, fine to coarse subrounded gravel up to 75 mm in diameter, fine to coarse sand, brown, non-cohesive, wet, dense - increase in silt content with depth from 33.6 m to 37.1 m - pockets of well graded sand, trace gravel from 34.0 m to 37.1 m			756
34	26 28 16	44		SPT15	0					755
35								GM1		754
36				G18						753
37	50	50+ for 100mm		SPT16	22		37.1m GRAVEL and SILT, low plastic, fine to coarse subangular to subrounded gravel up to 50 mm in diameter, some fine sand, brown to grey, iron staining in matrix, non-cohesive, damp, dense to very dense			752
	6			G19					**Sieve** (Sa#G19) G:% S:% F:34%	
38							- becomes non-plastic at 38.3 m	GM3		751
39							38.9m SAND, well graded, fine to medium sand, trace fine to coarse gravel, trace silt, brown, non-cohesive, wet, dense to very dense - decrease in gravel content with depth, no gravel at 39.5 m	SW		750
40	26 22 38	60		SPT17	100		39.8m - some silt from 39.6 m to 39.8 m			

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: 52.3 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683077.296 , 502544.763 Station/Offset:

Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 ; SPT "N" (BLOWS/300 mm) ; Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
40		19		G20			SAND and SILT, poorly graded, fine to medium sand, brown to grey, non-cohesive, moist to wet, dense to very dense *(continued)*		**Sieve** (Sa#G20) G:0% S:64% F:36%	
41										748
42										747
43	5 20 32	52		SPT18	100					746
44										745
45				G21						744
46	16 25 33	58 20		SPT19	100		- becomes grey at 45.9 m - some interbedded silt seams up 10 mm thick from 46.0 m to 51.5 m, silt is low plastic, moist, grey, firm	SM3	**Sieve** (Sa#SPT19) G:% S:% F:37%	743
47										742
48				G22						741
49	7 15 26	41		SPT20	100					740
50										

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: 52.3 m

Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-01**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - East of 10th Ave N, north of river

Date(s) Drilled: 09/15/2021 to 09/17/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683077.296 , 502544.763 Station/Offset:

Elevation: 789.03 m *Coordinates Surveyed September 17, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20, W% 40 60, WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
50							SAND and SILT, poorly graded, fine to medium sand, brown to grey, non-cohesive, moist to wet, dense to very dense *(continued)*			
51		20	G23							738
	27 34 50	84	SPT	21	100		SILT and SAND, low plastic, fine to medium sand, brown to grey, non-cohesive, w < PL, very stiff to hard - layer of fine to medium sand from 51.8 m to 52.0 m	ML	**Sieve** (Sa#G23) G:% S:% F:59%	
52							51.5m 52.3m End of borehole (target depth reached) at 52.3 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. - All SPTs in this borehole were completed using a 63.5 kg (140 lb) SPT hammer. - Upon completion, the borehole was tremie grouted to 1.5 m depth with cement-bentonite grout and topped with bentonite chips to surface in accordance with BC Groundwater Protection regulations.			737
53										736
54										735
55										734
56										733
57										732
58										731
59										730
60										

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: 52.3 m

Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683006.745 , 502559.621 Station/Offset:

Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0							TOPSOIL, brown, some rootlets and organics. 0.23m	TS		788
1							COBBLES (POSSIBLE FILL), gravelly, subrounded to rounded cobbles up to 100 mm in diameter, well graded, fine to coarse subrounded to rounded gravel, some fine to coarse sand, trace silt, grey, non-cohesive, moist, very dense.	SB		
2	50	50+ for 0 mm		SPT1	0		1.7m SAND, gravelly, fine to coarse sand, well graded, fine to coarse subrounded to rounded gravel, some subrounded to rounded cobbles up to 100 mm in diameter, some silt, non-cohesive, moist, very dense.			787
3	17 28 33	6 61		SPT2	80		-becomes medium to coarse sand at 2.8 m -becomes cobbley at 3.2 m, trace silt	SM1	**Sieve** (Sa#SPT2) G:33% S:48% F:19%	786
4	3 9 15	24		SPT3	50		-iron staining in matrix at 4.6 m			785
5							5.2m SAND and GRAVEL, fine to coarse sand, well graded, fine to coarse subrounded to rounded gravel, some silt, some subrounded to rounded cobbles up to 90 mm in diameter, light orange-brown, iron staining on gravel, cobbles, and in the matrix, non-cohesive, dense.			784
6	8 5 7	12		SPT4	50					783
7		7.5m								782
8	3 4 2	6		SPT5	40		-becomes wet at 7.5 m -becomes compact at 7.6 m, no cobbles, sand is medium to coarse	SW-SM / GW-GM		781
9	10 10 8	18		SPT6	65		-becomes dense at 9.1 m			780
10							-becomes trace cobbles at 9.7 m, some silt			779

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: 64.0 m

Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683006.745 , 502559.621 Station/Offset:

Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 ; SPT "N" (BLOWS/300 mm) ; Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
10										778
11	2 7 11	18 (11)	SPT7		70		SAND and GRAVEL, medium to coarse sand, well graded, fine to coarse subrounded to rounded gravel, some silt, trace subrounded to rounded cobbles up to 90 mm in diameter, light orange-brown, iron staining on gravel, cobbles, and in the matrix, non-cohesive, wet, dense. *(continued)* -becomes trace silt at 10.7 m		**Sieve** (Sa#SPT7) G:37% S:53% F:10%	
12	8 11 9	20	SPT8		50			SW-SM / GW-GM		777
13										776
14										775
15	9 13 11	24 (7)	SPT9		70		10.0m SILTY GRAVEL and SAND, fine to coarse subrounded to rounded gravel, well graded, medium to coarse sand, trace subrounded to rounded cobbles up to 90 mm in diameter, yellow-brown, iron staining on gravel, cobbles, and in the matrix, non-cohesive, wet, dense.		**Sieve** (Sa#SPT9) G:41% S:41% F:18%	774
16										773
17							-some cobbles from 16.8 to 17.6 m, up to 100 mm diameter			772
18	5 9 10	19	SPT10		40		14.9m	GM1 / SM1		771
19										770
20										769

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: 64.0 m

Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683006.745 , 502559.621 Station/Offset:

Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
20							SILTY GRAVEL and SAND, fine to coarse subrounded to rounded gravel, well graded, medium to coarse sand, trace subrounded to rounded cobbles up to 90 mm in diameter, yellow-brown, iron staining on gravel, cobbles, and in the matrix, non-cohesive, wet, dense. *(continued)*			
21							-some silt from 20.75 to 21.10 m			768
	10 10 14	24	SPT	SPT11	70		21.3m SILTY SAND, gravelly, medium to coarse sand, well graded, fine to coarse subrounded to rounded gravel, yellow-brown, non-cohesive, wet, dense.			
22										767
23										766
							-becomes trace cobbles, subrounded to rounded up to 100 mm diameter			
24										765
	20 50	50+ for 76 mm	SPT	SPT12	30		-becomes very dense at 24.4 m			
25										764
								SM2		
26										763
27										762
	19 19 16	35	SPT	SPT13	75		-some cobbles, subrounded to rounded up to 110 mm diameter			
28										761
29										760
30										759

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: 64.0 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**
Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021
Company: Mobile Augers and Research
Driller:
Drill Make/Model: Fraste Multidrill XL
Drilling Method: Sonic

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc
Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:
Northing/Easting: 5683006.745 , 502559.621 Station/Offset:
Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	SPT "N" (BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
30								SILTY SAND, gravelly, medium to coarse sand, well graded, fine to coarse subrounded to rounded gravel, some subrounded to rounded cobbles up to 110 mm diameter, yellow-brown, non-cohesive, wet, very dense. *(continued)*			
	7 19 16		35	SPT14						**Sieve** (Sa#SPT14) G:28% S:51% F:21%	758
31											
											757
32								-sand becomes fine to coarse at 32.4 m, some silt			
											756
33									SM2		
											755
34											
											754
35											
											753
36											
	17 26 5		31	SPT15		40		36.8m			752
37								SAND, gravelly, fine sand, poorly graded, some silt, trace fine to coarse subrounded to rounded gravel, yellow-brown, non-cohesive, wet, dense.	SP-SM		
								37.5m			
								SAND, fine to medium sand, poorly graded, some silt, trace fine to coarse subrounded to rounded gravel, yellow-brown, non-cohesive, moist, dense.	SP-SM		751
38								38.3m			
								GRAVEL, sandy, fine to coarse subrounded to rounded gravel, well graded, fine to coarse sand, some silt, yellow-brown, non-cohesive, wet, dense.	GW-GM		
								38.7m			750
39								SILTY SAND, fine to medium sand, well graded, trace fine to coarse subrounded to rounded gravel, yellow-brown, non-cohesive, compact. -becomes trace gravel at 39.4 m	SM3		
	5 7 9		16 17	SPT16		90		39.9m		**Sieve** (Sa#SPT16)	749
40											

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

Final Depth of Hole: 64.0 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683006.745 , 502559.621 Station/Offset:

Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 ; SPT "N" (BLOWS/300 mm) ; Wp% W% WL% 20 40 60 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
40							SILTY SAND, fine sand, uniformly poorly graded, yellow-brown, occasional laminations of silt up to 30 mm thick, non-cohesive, wet, compact. *(continued)*		G:0% S:69% F:31%	
41										748
42							-green-grey silt inclusion, 30 mm in diameter			747
43	3 4 2	6	SPT	17	80		-yellow-brown silt laminations up to 20 mm in thickness	SM2		746
44										745
45							45.5m			744
46	4 6 8	14 23	SPT	18	90		SAND and SILT, fine sand, uniformly poorly graded, grey with some dark grey mottling, some inclusions and laminations of dark grey silt up to 20 mm thick, non-cohesive, moist, compact.		**Sieve** (Sa#SPT18) G:% S:% F:45%	743
47										742
48								SM4		741
49	2 2 7	9 25	SPT	19	100		-dark grey silt inclusion, 20 mm diameter		**Sieve** (Sa#SPT19) G:0% S:54% F:46%	740
50										739

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: 64.0 m

Depth to Top of Rock:

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**
Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021
Company: Mobile Augers and Research
Driller:
Drill Make/Model: Fraste Multidrill XL
Drilling Method: Sonic

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc
Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:
Northing/Easting: 5683006.745 , 502559.621 Station/Offset:
Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
50										738
							50.5m SILTY SAND, fine sand, uniformly poorly graded, grey, non-cohesive, moist to wet, compact.			
51										737
52	7 6 8	14	SPT	SPT20	100			SM2		
							-grey silt inclusion, 30 mm diameter			736
53							-bed of fine to medium sand from 53.45 to 53.65 m -dark grey silt inclusion, 40 mm diameter			
54							54.1m SAND and SILT, fine sand, uniformly poorly graded, grey, non-cohesive, moist to wet, compact.			735
			SH	SH21	100		-attempted to take a Shelby tube sample from 54.86 to 55.32 m - no recovery	SM3		734
55	6 8 10	18 22	SPT	SPT22	100				**Sieve** (Sa#SPT22) G:0% S:65% F:35%	
56							56.1m SANDY SILT, low plastic silt, fine sand, uniformly poorly graded, grey, cohesive, wet, very stiff.	ML		733
										732
57							57.1m SAND and SILT, fine sand, uniformly poorly graded, low plastic silt, grey, occasional dark grey silt inclusions up to 20 mm in diameter, non-cohesive, wet, compact.			731
58	4 6 13	19 25	SPT	SPT23	100				**Sieve** (Sa#SPT23) G:% S:% F:46%	
							-green-grey lamination of silt, 40 mm in thickness			730
59							-green-grey lamination of silt, 100 mm in thickness			
60										729

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: 64.0 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-03**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Gould's Island

Date(s) Drilled: 3/9/2021 to 3/12/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683006.745 , 502559.621 Station/Offset:

Elevation: 788.79 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
60							SAND and SILT, fine sand, uniformly poorly graded, low plastic silt, grey, occasional dark grey silt inclusions up to 20 mm in diameter, non-cohesive, wet, compact. *(continued)*	SM4		728
61										727
62							-some interbedding between more silt- and sand-rich layers from 62.2 m to 64.0 m			726
63										725
64							64.0m End of borehole (target reached) at 64.0 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. - All 'SPTs' in this hole were completed using a 300 lb LPT hammer. - Upon completion, the borehole was backfilled with bentonite grout to surface.			724
65										723
66										722
67										721
68										720
69										719
70										

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: 64.0 m
Depth to Top of Rock:

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-04**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - 10th Ave N, north of river

Date(s) Drilled: 09/14/2021

Company: Mobile Augers and Research

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683262.233 , 502408.265 Station/Offset:

Elevation: 786.65 m *Coordinates Surveyed September 17, 2021*

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	SPT "N" (BLOWS/300 mm)	Wp% 20	W% 40 60	WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0											ASPHALT (130 mm thick) 0.1m	AS		786
1								G1			GRAVEL, sandy, gap graded, fine to coarse, subangular to subrounded gravel up to 60 mm in diameter, fine sand, some cobbles up to 100 mm in diameter, some silt to silty, light brown, non-cohesive, dry, compact to dense			
2	18 12 12		24					SPT1	100			GW - GM	**Sieve** (Sa#SPT1) G:55% S:34% F:11%	785
3								G2						784
4	16 26 27		53					SPT2	100		3.5m		**Sieve** (Sa#SPT2) G:% S:% F:16%	783
5											End of borehole (target depth reached) at 3.5 m			782
6											- Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys.			781
7											- Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected.			780
8											- All SPTs in this borehole were completed using a 63.5 kg (140 lb) SPT hammer.			779
9											- Upon completion, the borehole was backfilled with sand and bentonite chips in accordance with BC Groundwater Protection regulations. The road section was reinstated with cold patch asphalt			778
10														777

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: 3.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-05**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - 10th Ave N and Park Drive

Date(s) Drilled: 3/13/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683377.475 , 502346.306 Station/Offset:

Elevation: 786.37 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	SPT "N" (BLOWS/300 mm) Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0	5				G1			SILTY SAND and GRAVEL (FILL), fine to coarse sand, well graded, fine to coarse angular to subrounded gravel, brown, occasional rootlets, non-cohesive, moist, very dense. -inclusions of black tar from 0.48 to 0.53m	SM1 / GM1	**Sieve** (Sa#G1) G:% S:% F:19%	786
					G2			0.5m			
1	2				G3			SAND (POSSIBLE FILL), fine to coarse sand, well graded, some silt, trace fine to coarse subangular to subrounded gravel, light brown (dry), occasional rootlets, non-cohesive, moist, very dense.	SM1	**Sieve** (Sa#G3) G:% S:% F:12%	
	26 38 40		78 3		SPT1	85		1.4m			785
2					G4			SILTY SAND and GRAVEL (POSSIBLE FILL), fine to coarse sand, well graded, fine to coarse subangular to subrounded gravel, light grey-brown, non-cohesive, dry, very dense. -becomes light grey at 1.9 m	SM2 / GM2	**Sieve** (Sa#SPT1) G:38% S:42% F:20%	
								2.4m			784
3	20 20 21		41		SPT2	80		SAND (POSSIBLE FILL), gravelly, fine to coarse sand, well graded, fine to coarse subangular to subrounded gravel, trace silt, light grey-brown (dry), non-cohesive, dry, dense. -becomes very dense at 3.1 m	SW		783
								3.5m			
4								End of borehole (target reached) at 3.5 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. - All SPTs in this hole were completed using a 140 lb SPT hammer. - Upon completion, the borehole was backfilled with cuttings and bentonite chips to surface.			782
5											
6											781
7											780
8											779
9											778
10											777

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: 3.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

SUMMARY LOG

TETRA TECH

Drill Hole #: **BH21-06**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - 10th Ave N, north of river

Date(s) Drilled: 09/14/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5683196.769 , 502455.388 Station/Offset:

Elevation: 787.07 m *Coordinates Surveyed September 17, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	SPT "N" (BLOWS/300 mm)	Wp% 20	W% 40 60	WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0											ASPHALT (110 mm thick) 0.1m	AS		787
											SILTY GRAVEL, sandy, gap graded, fine to coarse, subangular to subrounded gravel up to 40 mm in diameter, fine sand, some cobbles up to 90 mm in diameter, light brown, non-cohesive, dry, dense			
1		2						G1					**Sieve** (Sa#G1) G:% S:% F:15%	786
2			84					SPT1	100			GM1		785
3		2						G2					**Sieve** (Sa#G2) G:64% S:23% F:13%	784
			52					SPT2	100		3.5m			
4											End of borehole (target depth reached) at 3.5 m			783
5											- Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys.			782
6											- Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected.			781
7											- All SPTs in this borehole were completed using a 63.5 kg (140 lb) SPT hammer.			780
8											- Upon completion, the borehole was backfilled with sand and bentonite chips in accordance with BC Groundwater Protection regulations. The road section was reinstated with cold patch asphalt			779
9														778
10														

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

Final Depth of Hole: 3.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-08**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - 10th Ave N, north of existing bridge

Date(s) Drilled: 3/13/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5682956.036 , 502521.106 Station/Offset:

Elevation: 789.52 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS SPT	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 — SPT "N" (BLOWS/300 mm) — Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0				G1			ASPHALT 0.05m	ASPH		
							0.2m	SW		
				G2			SAND (FILL), gravelly, fine to coarse sand, well graded, fine to coarse subangular to subrounded gravel, trace silt, grey-brown, non-cohesive, moist, dense.	GW		789
1							0.8m			
				G3			GRAVEL (FILL), sandy, fine to coarse subangular to subrounded gravel, well graded, fine to coarse sand, trace silt, grey, inclusions of tar, non-cohesive, moist, dense.	SM4		788
	9 23 17	14 40		SPT1	85				**Sieve** (Sa#SPT1) G:18% S:40% F:42%	
2							SAND and SILT (POSSIBLE FILL), gravelly, fine to coarse sand, well graded, fine to coarse subangular to subrounded gravel, light grey-brown, occasional rootlets, non-cohesive, moist, very dense. 1.9m -becomes light brown at 1.8 m			
				G4						787
3							GRAVEL (POSSIBLE FILL), cobbley, sandy, fine to coarse subangular to subrounded gravel, well graded, fine to coarse sand, subangular to subrounded cobbles up to 90 mm diameter, trace silt, non-cohesive, moist, dense.	GW		
	18 50	50+ for 120 mm		SPT2	0		3.5m -becomes very dense at 3.1 m			786
4							End of borehole (target reached) at 3.5 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. - All SPTs in this hole were completed using a 140 lb SPT hammer. - Upon completion, the borehole was backfilled with cuttings and bentonite chips, and capped with compacted cold mix asphalt.			
										785
5										
										784
6										
										783
7										
										782
8										
										781
9										
										780
10										

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

Final Depth of Hole: 3.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-09**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Kumsheen Park, east of parking lot

Date(s) Drilled: 3/12/2021 to 3/13/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5682957.348 , 502626.001 Station/Offset:

Elevation: 789.58 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 40 60 80 WL%	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0							TOPSOIL, brown, some rootlets and organics. 0.25m	TS		789
							GRAVEL and COBBLES (FILL), fine to coarse subangular to subrounded gravel, well graded, subangular to subrounded cobbles up to 90 mm in diameter, some fine to coarse sand, trace silt, grey-brown, non-cohesive, dry to moist, compact. 1.1m	GW		
1										
2	6 6 9	15 ▲ 6 ●		SPT1	65		SILTY SAND and GRAVEL, fine to coarse sand, well graded, fine to coarse subangular to subrounded gravel, trace subangular to subrounded cobbles up to 90 mm in diameter, grey, non-cohesive, dry to moist, very dense. -encountered cobble >120 mm in diameter, subrounded	SM1 / GM1	**Sieve** (Sa#SPT1) G:% S:% F:26%	788
3	16 18 50	68 ▲ 8 ●		SPT2	70		3.5m		**Sieve** (Sa#SPT2) G:41% S:45% F:14%	787
4							GRAVEL, cobbley, fine to coarse subangular to subrounded gravel, well graded, subangular to subrounded cobbles up to 90 mm in diameter, some silt, some fine to coarse sand, grey-brown, non-cohesive, dry to moist, very dense. -some iron staining in matrix at 4.3 m	GW-GM1		786
5	5 50	50+ for 75 mm ▲		SPT3	50		-large cobble (>120 mm diameter) at 4.7 m 5.0m			785
6		5.9m ▼					GRAVEL, sandy, fine to coarse subangular to rounded gravel, well graded, fine to coarse sand, some subangular to rounded cobbles up to 120 mm in diameter, trace silt, yellow-brown, iron staining in the matrix, non-cohesive, dry to moist, very dense. -becomes damp at 5.2 m -becomes wet at 5.9 m	GW		784
7	50	50+ for 130 mm ▲		SPT4	30					783
8	50	50+ for 25 mm ▲		SPT5	0		7.6m			782
9	16 11 10	21 ▲		SPT6	45		SAND, gravelly, fine to coarse sand, well graded, fine to coarse subangular to rounded gravel, some silt, trace subangular to subrounded cobbles up to 100 mm in diameter, grey-brown, non-cohesive, wet, very dense. -becomes no cobbles at 9.0 m -becomes dense at 9.0 m			781
10										780

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

Final Depth of Hole: 15.2 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **BH21-09**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - Kumsheen Park, east of parking lot

Date(s) Drilled: 3/12/2021 to 3/13/2021

Company: Mobile Augers and Research

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: CR Reviewed by: TM

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5682957.348 , 502626.001 Station/Offset:

Elevation: 789.58 m *Coordinates Surveyed March 18, 2021*

Driller:

Drill Make/Model: Fraste Multidrill XL

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 ; SPT "N" (BLOWS/300 mm) ; Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
10							SAND, gravelly, fine to coarse sand, well graded, fine to coarse subangular to rounded gravel, some silt, trace subangular to subrounded cobbles up to 100 mm in diameter, grey-brown, non-cohesive, wet, very dense. *(continued)*			779
11	3 7 6	13		SPT7	90		-becomes sandy at 10.6 m -becomes compact at 10. 6 m	SW-SM	**Sieve** (Sa#SPT7) G:18% S:70% F:12%	778
12	33 25 17	42		SPT8	50		-becomes dense at 12.2 m			777
13										776
14	24 22 38	60		SPT9	70		-becomes very dense at 13.7 m			775
15							15.2m			
16							End of borehole (target reached) at 15.2 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. -'SPTs' numbered SPT1 to SPT7 were completed using a 300 lb LPT hammer. SPT8 and SPT9 were completed using a 140 lb SPT hammer. - Upon completion, the borehole was backfilled with bentonite chips to surface.			774
17										773
18										772
19										771
20										770

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

Final Depth of Hole: 15.2 m
Depth to Top of Rock:

TETRA TECH

SUMMARY LOG

Drill Hole #: **HV21-07**

Project: **Highway 95 Kicking Horse River Bridges**

Location: Golden, BC - 10th Ave S, south of river

Date(s) Drilled: 09/13/2021

Company: Kootenay Pumping Systems

Prepared by: 704-ENG.VGEO03793-01
Tetra Tech Canada Inc

Logged by: KB Reviewed by: TG

Datum: UTM 11 (NAD83) Alignment:

Northing/Easting: 5682820.613 , 502578.518 Station/Offset:

Elevation: 788.4 m *Coordinates Surveyed December 3, 2021*

Driller:

Drill Make/Model:

Drilling Method: Hydrovac

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 40 60 80 WL%	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING	ELEVATION (m)
0				G1			ASPHALT (90 mm thick) 0.1m	AS		788
1		3		G2			sandy GRAVEL, gap graded, fine to coarse, subangular to subrounded gravel up to 40 mm in diameter, some subrounded cobbles up to 250 mm in diameter, some silt, brown to grey, non-cohesive, dry, dense	GP-GM	**Sieve** (Sa#G2) G:61% S:34% F:6%	787
2										786
3				G3			3.0m End of hydrovac excavation (target depth reached) at 3.0 m - Coordinates and ground surface elevations (+/- 0.03 m) are based on points collected from a survey completed by Geometric Surveys. - Soil descriptions are based on visual classifications and field observations, in combination with laboratory testing. Some variation through the interpreted soil layers is expected. - Upon completion, the borehole was backfilled with sand and bentonite chips in accordance with BC Groundwater Protection regulations. The road section was reinstated with cold patch asphalt			785
4										784
5										783
6										782
7										781
8										780
9										779
10										

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

Final Depth of Hole: 3.0 m
Depth to Top of Rock:

MOTI-SOIL-REV3 ENG.VGEO03793-01 - KHRB (PHASE 1-2) 20220502.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/3/22

APPENDIX C

ENERGY MEASUREMENT REPORTS

Certificate of Test

MARL Technologies Inc.
5603 - 54 St. NW
Edmonton, AB T6B 3G8

Client:

Mobile Augers
5603 - 54 st.
Edmonton, Alberta

Test Details:

Description:	SPT Hammer Test Certificate
ASTM Testing Standard:	D4633-05
Test Date:	2021-03-15
Test Locaton:	MARL Technologies Inc.
Drill Rig #:	Unit 189
Hammer Type:	300lb Auto-Hammer
Hammer Manufacturer:	MARL Technologies Inc.
Hammer Serial #:	
Rod Type:	AW
Test Depth:	0.00 - 15.00 ft
Average ETR:	**73.6 %**

This certificate shows the **average** energy transfer for the hammer above on the above date at the above location.

Technician:

Name: Scott Hughes Date: 2021-03-16
Signature:

MARL Technologies Inc. does not guarantee that this represents the average value at different locations, with different operators, under different weather conditions and different rig configurations.

Certificate of Test

MARL Technologies Inc.
5603 - 54 St. NW
Edmonton, AB T6B 3G8

Client:

Mobile Augers
5603 - 54 st.
Edmonton, Alberta

Test Details:

Description:	SPT Hammer Test Certificate
ASTM Testing Standard:	D4633-05
Test Date:	2021-03-15
Test Locaton:	MARL Technologies Inc.
Drill Rig #:	Unit 189
Hammer Type:	140lb Auto-Hammer
Hammer Manufacturer:	MARL Technologies Inc.
Hammer Serial #:	
Rod Type:	AW
Test Depth:	0.00 - 15.00 ft
Average ETR:	**75.4 %**

This certificate shows the **average** energy transfer for the hammer above on the above date at the above location.

Technician:

Name: Scott Hughes Date: 2021-03-16
Signature:

MARL Technologies Inc. does not guarantee that this represents the average value at different locations, with different operators, under different weather conditions and different rig configurations.

APPENDIX D

iBPT RESULTS

PRESENTATION OF SITE INVESTIGATION RESULTS

Kicking Horse River Bridge

Prepared for:

Tetra Tech Canada Inc.

ConeTec Job No: 21-02-21991

Project Start Date: 15-Mar-2021
Project End Date: 20-Mar-2021
Report Date: 30-Mar-2021

Prepared by:

ConeTec Investigations Ltd.
201-8327 Eastlake Drive
Burnaby, BC V5A4W2

Tel: (604) 273-4311
Fax: (604) 273-4066
Toll Free: (800) 567-7969

ConeTecYVR@conetec.com
www.conetec.com
www.conetecdataservices.com

Introduction

The enclosed report presents the results of the site investigation program conducted by ConeTec Investigations Ltd. for Tetra Tech Canada Inc. at Kicking Horse River bridge in Golden, BC. The program consisted of one instrumented Becker Penetration Test (iBPT). Please note that this report, which also includes all accompanying data, are subject to the 3rd Party Disclaimer and Client Disclaimer that follow in the 'Limitations' section of this report.

Project Information

Project	
Client	Tetra Tech Canada Inc.
Project	Kicking Horse River Bridge
ConeTec project number	21-02-21991

An aerial overview from Google Earth including the iBPT test location is presented below.

Rig Description	Deployment System	Test Type
Becker drill rig (AP 1000)	ICE 180 diesel pile driving hammer	iBPT

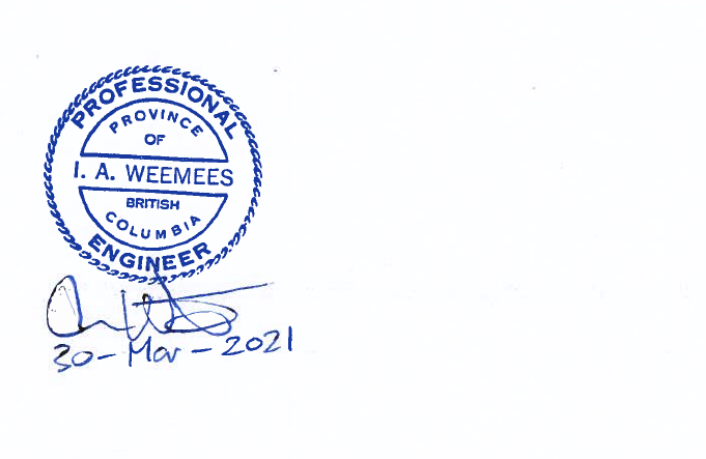
Coordinates		
Test Type	Collection Method	EPSG Number
iBPT	Consumer grade GPS	32611

Instrumented Becker Penetration Test (iBPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Additional information	Tabular results are provided in Excel format files in the data release package. Plots with iBPT results and Harder & Seed (1986) results are provided in the appendices.

Closure

Thank you for the opportunity to work on this project. The equipment used and the field procedures followed complied with current accepted practice standards. This report has been prepared under my supervision and I have reviewed and approved the content.

ConeTec Investigations Ltd.



Ilmar Weemees, P.Eng.

Limitations

3rd Party Disclaimer

This report titled “Kicking Horse River Bridge”, referred to as the (“Report”), was prepared by ConeTec for Tetra Tech Canada Inc.. The Report is confidential and may not be distributed to or relied upon by any third parties without the express written consent of ConeTec. Any third parties gaining access to the Report do not acquire any rights as a result of such access. Any use which a third party makes of the Report, or any reliance on or decisions made based on it, are the responsibility of such third parties. ConeTec accepts no responsibility for loss, damage and/or expense, if any, suffered by any third parties as a result of decisions made, or actions taken or not taken, which are in any way based on, or related to, the Report or any portion(s) thereof.

Client Disclaimer

ConeTec was retained by Tetra Tech Canada Inc. to collect and provide the raw data (“Data”) and to provide analysis of the raw data to extract Becker Test tip and head residual energy, which is included in this report titled “Kicking Horse River Bridge”, which is referred to as the (“Report”). ConeTec has collected and reported the Data in accordance with current industry standards. No other warranty, express or implied, with respect to the Data is made by ConeTec. In order to properly understand the Data included in the Report, reference must be made to the documents accompanying and other sources referenced in the Report in their entirety. Any analysis, interpretation, judgment, calculations and/or geotechnical parameters (collectively “Interpretations”) included in the Report, including those based on the Data, are outside the scope of ConeTec’s retainer and are included in the Report as a courtesy only. Other than the Data, the contents of the Report (including any Interpretations) should not be relied upon in any fashion without independent verification and ConeTec is in no way responsible for any loss, damage or expense resulting from the use of, and/or reliance on, such material by any party.

The instrumented Becker Penetration Test (iBPT) system was developed to obtain direct measurements of force and acceleration at the drill tip required to compute the energy delivered to the soil beneath the drill tip during penetration (DeJong et al. (2017)). Coupled with the measured blow counts, this provides an energy normalized blow count based on direct measurements. This direct measurement based method eliminates the long-standing challenge of estimating, and then correcting for, the shaft friction that develops along the drill string length which absorbs hammer energy.

The iBPT is an instrumentation and data acquisition system that provides automated measurements of force and acceleration at the tip and head of a drill string, in addition to measurements of bounce chamber pressure and drill string position. The system is comprised of two 12'' long instrumented pipe sections located at the head and tip of the drill string that contain redundant acceleration and strain measurements. The redundant instrumentation enables continued penetration even if one sensor malfunctions.

Data from the instrumented tip section is acquired by a data acquisition module located in the tip module while data from the head section is acquired in the iBPT trailer. The instrumented pipe sections are mechanically integrated within the conventional 6 5/8" outer diameter Becker drill system. Dynamic measurements are obtained during hammer impacts as the drill string is advanced into the ground. Continuous measurements of air pressure in the hammer bounce chamber and the string potentiometer position are also obtained during operation.

The dynamic measurements of strain and acceleration at the head and tip are processed to compute the energy delivered to each respective location. The acceleration records are integrated to obtain velocity, and then integrated a second time to obtain displacement. The force measurements account for both the dynamic force imparted during dynamic hammer blows as well as the residual locked-in force that develops at the tip due to shaft friction. Temperature correction is also applied to the tip force measurements.

Following conventional pile dynamic analysis (e.g. Rausche et al. (1972)) and the ASTM standard for energy measurement of dynamic penetrometers (D4633-16, (2016)), energy is calculated following:

$$E\ (kJ) = \int FVdt$$

The energy computed and reported is the residual energy measured at the tip, as this measurement is representative of the total energy absorbed by the soil. This is different than the maximum energy delivered at the head as is conventionally used with SPT and Sy and Campanella's (S&C) Becker analysis. The iBPT energy efficiency is computed as a percentage of the theoretical hammer energy as:

$$E\ (\%) = \frac{\int FVdt}{11.0\ kJ}$$

The energy normalization of penetration resistance is consistent in form with SPT (ASTM D4633-16) and BPT (Sy and Campanella (1994)) methods.

The BPT measured blow counts, N_B, are then normalized to a reference hammer energy of 30% using:

$$N_{B30}=N_B \frac{E\ (\%)}{30}$$

The normalized to 30% hammer energy is a typical efficiency for double acting diesel hammers and is consistent with Sy and Campanella (1994).

The delivered energy ratio (DER), the ratio of the residual energy delivered to the tip of the drill string, normalized to the residual energy delivered to the head of the drill string, provides an indication of the amount of energy absorbed along the drill string due to the shaft friction. In general, the DER decreases with penetration depth and when underlying soft layers are encountered (DeJong et al. (2017)).

It is noted that DER values larger than 100% are possible as the residual energy at the tip is computed based on both the dynamic and locked-in force components. Small DER values (e.g. less than about 10%) indicate that practically all of the hammer energy (and thus penetration resistance) is being absorbed by shaft resistance along the drill string; this occurs when shaft friction is very high relative to tip resistance. This can occur in competent soils when shaft friction is high and/or in very weak soils when the soil resistance below the tip is very small. When the DER is very small (e.g. < 10%), the absolute tip measurements of force and acceleration used to compute energy can be near the performance limit, resulting in a very small ratio of E(%)/30.

When minimal energy is delivered to the tip a significant normalization factor is required to compute N_{B30}. For data reduction, a threshold limit of 2% is set for the tip residual energy, which corresponds to a normalization factor of 15. Due to the proportional form of the equation, a tip residual energy of 3% significantly reduces the normalization factor to 10 while a tip residual energy of 1% significantly increases the normalization factor to 30. Currently, application of the equation down to tip residual energies of 2% is reasonable though confidence increases rapidly with greater tip residual energy. Application of the equation to measurements with tip residual energies less than 2% extends the developed correlation beyond the database upon which it was developed.

The correlation developed by Ghafghazi et al. (2017a) is used to estimate equivalent SPT N_{60} values as follows:

$$N_{60}=1.8 \times N_{B30}$$

The median correlation factor of 1.8 is the best fit to the data collected and analyzed by Ghafghazi et al. (2017a), producing an estimate close to the expected 50th percentile value. This correlation value was determined based on comparisons of 364 pairs of side-by-side SPT N_{60} and iBPT N_{B30} measurements in soils that are free of gravel (Ghafghazi et al. (2017a)). More conservative estimates of SPT N_{60} values corresponding to a 33rd percentile value could be obtained using a correlation factor of about 1.6 or a 16th percentile value using a correlation factor of about 1.3. As detailed in Ghafghazi et al. (2017a), most of the scatter in the developed correlation is attributed to lateral spatial variability commonly present in fluvial depositional environments. As a result, and as evident in the published correlation plots, it is reasonable to observe penetration resistance differences between two adjacent soundings/borings performed at a spacing of 10 to 20 feet, regardless of whether it is two iBPT N_{B30} soundings, two SPT N_{60} borings, or two cone penetration test (CPTu) corrected tip resistance (q_t) soundings.

Additional analysis was performed to compute equivalent SPT N_{60} values based on the Harder and Seed (1986) method. This method requires measured blows per foot (N_B), average hammer bounce chamber pressure (BCP), and correction of the measured air pressure for project elevation. The effect of shaft friction is not explicitly accounted for; instead, the accumulation of shaft friction with depth is embedded in the correction of N_B to N_{BC} even though the accumulation of shaft friction with depth depends on stratigraphy and soil type. Further discussion of the Harder and Seed method and the differences compared to the iBPT method are discussed in Ghafghazi et al. (2017b).

A summary of the iBPT soundings along with test results and individual plots are provided in the relevant appendices.

References

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The appendices listed below are included in the report:

- Instrumented Becker Penetration Test Borehole Summary and Tabular Results
- Instrumented Becker Penetration Test Plots with Energy Results and iBPT Equivalent N_{60}
- Instrumented Becker Penetration Test Plots with Harder & Seed (1986) Results

Instrumented Becker Penetration Test Borehole Summary and Tabular Results

CONETEC

Job No:	21-02-21991
Client:	Tetra Tech Canada Inc.
Project:	Kicking Horse River Bridge
Start Date:	15-Mar-2021
End Date:	20-Mar-2021

iBPT BOREHOLE SUMMARY

Borehole ID	File Name	Date From	Date To	Predrill Depth (ft)	Start Depth (ft)	Final Depth (ft)	Northing[1] (m)	Easting[1] (m)	Refer To Notation
iBPT21-02	21-02-21991_BH02	15-Mar-2021	20-Mar-2021	0.0	0.0	156.0	5682958	502572	

1. Coordinates were acquired using consumer grade GPS equipment, datum: WGS 1984 / UTM Zone 11 North.

CONETEC

Job No: 21-02-21991
Client: Tetra Tech Canada Inc
Project: Kicking Horse River Bridge
Start Date: 15-Mar-2021
End Date: 20-Mar-2021

Borehole ID: iBPT21-02
Rig: AP 1000

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Start Depth (m)	End Depth (m)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC} [1]	N_{60} [1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
0.0	1.1	0.0	0.3	9.0	5	5	7	10.2	10.1	5.4	5.3	52.8	1	2	
1.1	2.0	0.3	0.6	11.0	7	8	15	38.4	37.1	26.2	25.9	69.7	13	23	
2.0	3.0	0.6	0.9	15.6	20	19	37	34.6	30.7	25.7	25.5	83.0	31	57	
3.0	4.0	0.9	1.2	19.5	42	35	57	29.0	26.7	25.1	24.0	89.9	46	82	
4.0	5.0	1.2	1.5	19.8	43	36	58	25.2	21.0	24.4	23.3	110.9	45	81	
5.0	6.0	1.5	1.8	19.3	38	33	51	28.5	22.4	23.9	23.0	102.8	39	70	
6.0	7.3	1.8	2.2	18.6	31	28	43	24.3	18.5	23.3	22.4	121.1	32	58	
7.3	8.0	2.2	2.4	17.7	33	29	53	21.0	14.3	21.4	20.6	143.7	36	65	
8.0	9.0	2.4	2.7	18.5	48	39	81	19.5	13.1	19.3	17.9	136.6	48	87	
9.0	10.0	2.7	3.1	22.6	94	67	135	25.9	16.6	20.9	17.8	107.2	80	144	
10.0	11.0	3.1	3.4	24.0	145	97	212	26.9	17.0	20.0	17.0	100.0	120	216	
11.0	12.0	3.4	3.6	23.3	171	113	276	28.6	18.2	18.4	15.3	84.3	141	254	
27.2	28.0	8.3	8.5	14.9	19	18	39	29.6	27.4	24.0	23.1	84.4	30	54	
28.0	29.0	8.5	8.8	15.1	20	19	40	29.8	26.6	24.8	23.7	89.0	32	57	
29.0	30.0	8.8	9.1	15.6	21	20	40	30.0	26.3	24.7	23.8	90.6	32	57	
30.0	31.0	9.1	9.5	16.5	25	23	44	31.6	27.4	24.6	23.7	86.5	35	62	
31.0	32.0	9.5	9.8	16.0	24	22	44	33.1	29.8	23.4	22.4	75.1	33	59	
32.0	33.0	9.8	10.1	16.1	24	23	45	29.5	25.5	23.2	21.9	86.0	33	59	
33.0	34.0	10.1	10.4	15.1	20	19	41	27.5	22.9	22.6	21.3	93.4	29	52	
34.0	35.0	10.4	10.7	14.4	17	17	37	28.7	27.2	24.0	23.9	87.5	29	53	
35.0	36.0	10.7	11.0	16.3	24	22	43	29.6	26.1	23.6	23.0	88.0	33	59	
36.0	37.0	11.0	11.3	16.5	25	23	45	31.7	28.7	22.9	21.8	75.7	33	59	
37.0	38.0	11.3	11.6	17.1	18	18	25	33.0	30.6	22.5	21.3	69.7	18	32	
38.0	39.0	11.6	11.9	16.5	26	24	47	30.1	26.1	20.5	19.9	76.4	31	56	
39.0	40.0	11.9	12.2	17.0	39	33	70	31.1	24.4	19.5	19.1	78.0	44	80	
40.0	41.0	12.2	12.5	16.8	37	32	68	31.7	25.2	20.2	19.8	78.7	45	81	
41.0	42.0	12.5	12.8	17.8	47	38	85	29.7	20.1	18.9	18.1	90.0	51	92	
42.0	43.0	12.8	13.1	19.2	51	41	81	35.8	24.8	20.5	19.5	78.7	53	95	
43.0	44.0	13.1	13.4	17.8	45	37	80	31.8	23.1	19.4	18.4	79.5	49	88	
44.0	45.0	13.4	13.7	17.8	41	35	67	33.8	27.8	20.4	19.4	70.0	43	78	
45.0	46.0	13.7	14.0	18.4	41	35	63	34.7	28.1	21.1	20.1	71.6	42	76	
46.0	47.0	14.0	14.3	17.8	37	32	59	34.0	28.3	21.7	20.6	72.7	40	73	
47.0	48.0	14.3	14.6	16.3	22	20	37	31.9	26.8	21.7	20.7	77.4	26	46	
48.0	49.0	14.6	14.9	15.7	21	19	38	35.6	32.4	23.3	23.2	71.5	29	53	
49.0	50.0	14.9	15.2	15.6	22	20	42	33.7	30.3	22.1	21.9	72.1	31	55	

CONETEC

Job No: 21-02-21991
Client: Tetra Tech Canada Inc
Project: Kicking Horse River Bridge
Start Date: 15-Mar-2021
End Date: 20-Mar-2021

Borehole ID: iBPT21-02
Rig: AP 1000

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Start Depth (m)	End Depth (m)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC} [1]	N_{60} [1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
50.0	51.0	15.2	15.5	14.9	19	18	40	32.2	29.2	20.9	20.7	70.8	28	50	
51.0	52.0	15.5	15.9	14.5	19	18	41	31.1	27.2	19.5	18.7	68.9	26	46	
52.0	53.0	15.9	16.2	14.2	17	16	37	30.2	27.9	18.5	18.1	65.1	22	40	
53.0	54.0	16.2	16.5	15.2	20	19	41	32.9	29.7	18.8	18.4	62.0	25	45	
54.0	55.0	16.5	16.8	16.8	29	26	51	35.6	30.8	19.2	18.5	60.2	31	57	
55.0	56.0	16.8	17.1	17.1	29	26	49	36.0	30.7	20.2	19.4	63.1	32	57	
56.0	57.0	17.1	17.4	15.5	25	23	52	32.8	27.2	19.1	18.4	67.6	32	57	
57.0	58.0	17.4	17.7	16.3	22	20	37	34.7	28.8	19.6	19.1	66.2	24	42	
58.0	59.0	17.7	18.0	17.9	31	28	48	40.6	33.9	22.0	21.8	64.1	35	63	
59.0	60.0	18.0	18.3	17.2	31	27	52	36.3	29.7	19.5	19.2	64.7	33	60	
60.0	61.0	18.3	18.6	16.6	27	25	48	35.2	29.9	18.8	18.4	61.7	29	53	
61.0	62.0	18.6	18.9	16.1	21	20	36	36.9	33.1	22.0	21.2	63.9	25	46	
62.0	63.0	18.9	19.2	15.1	18	17	33	34.8	32.1	21.8	21.3	66.5	23	42	
63.0	64.0	19.2	19.5	14.7	18	17	36	32.2	29.7	19.7	19.4	65.2	23	42	
64.0	65.0	19.5	19.8	14.3	18	17	41	31.1	28.7	18.0	17.6	61.4	24	43	
65.0	66.0	19.8	20.1	14.2	20	19	47	30.8	27.9	17.4	17.0	61.1	27	48	
66.0	67.0	20.1	20.4	14.1	18	17	41	31.1	28.6	17.8	17.5	61.1	24	43	
67.0	68.0	20.4	20.7	14.8	17	17	33	30.4	26.1	16.9	16.7	64.3	18	33	
68.0	69.0	20.7	21.0	16.5	41	35	82	32.8	23.6	15.0	14.8	62.7	40	73	
69.0	70.0	21.0	21.3	17.7	63	48	142	33.5	20.0	13.3	12.4	62.1	59	106	
70.0	71.0	21.3	21.6	17.9	75	55	182	34.7	19.5	13.9	12.6	64.7	77	138	
71.0	72.0	21.6	21.9	18.6	93	66	221	35.2	18.3	13.7	12.4	68.0	91	165	
72.0	73.0	21.9	22.3	18.9	91	65	203	38.8	22.4	14.6	14.0	62.5	94	170	
73.0	74.0	22.3	22.6	18.3	74	55	165	36.0	17.1	14.0	12.5	73.2	69	124	
74.0	75.0	22.6	22.9	18.2	56	44	107	36.3	22.4	16.2	15.5	69.2	55	99	
75.0	76.0	22.9	23.2	18.5	51	41	89	37.0	24.8	16.6	15.8	63.7	47	84	
76.0	77.0	23.2	23.5	17.7	59	46	129	35.3	22.8	15.8	14.5	63.4	62	112	
77.0	78.0	23.5	23.8	18.2	69	51	148	36.2	24.8	14.0	12.8	51.6	63	114	
78.0	79.0	23.8	24.1	19.4	90	65	186	38.6	26.4	15.8	13.3	50.4	83	149	
79.0	80.0	24.1	24.4	19.2	83	60	169	38.5	26.3	15.6	14.6	55.6	82	148	
80.0	81.0	24.4	24.7	17.5	57	45	124	35.9	26.0	14.6	13.3	51.2	55	99	
81.0	82.0	24.7	25.0	17.7	56	44	118	37.0	26.9	14.9	14.2	52.8	56	100	
82.0	83.0	25.0	25.3	18.1	57	45	114	36.6	27.4	14.7	13.5	49.4	51	93	
83.0	84.0	25.3	25.6	19.0	78	57	159	39.0	27.1	17.0	16.0	59.1	85	153	
84.0	85.0	25.6	25.9	17.3	73	54	198	35.9	25.0	16.8	14.9	59.7	98	177	

CONETEC

Job No: 21-02-21991
Client: Tetra Tech Canada Inc
Project: Kicking Horse River Bridge
Start Date: 15-Mar-2021
End Date: 20-Mar-2021

Borehole ID: iBPT21-02
Rig: AP 1000

INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Start Depth (m)	End Depth (m)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC} [1]	N_{60} [1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
85.0	86.0	25.9	26.2	17.8	76	56	191	34.8	27.1	13.3	12.0	44.4	77	138	
86.0	87.0	26.2	26.5	19.0	71	53	140	37.5	26.5	15.4	14.0	52.9	65	118	
87.0	88.0	26.5	26.8	17.2	43	36	80	37.9	30.8	15.8	15.4	50.1	41	74	
88.0	89.0	26.8	27.1	18.8	70	53	140	38.8	32.0	17.3	17.2	53.7	80	145	
89.0	90.0	27.1	27.4	19.0	102	72	239	38.1	28.5	15.5	15.4	53.8	122	220	
90.0	90.8	27.4	27.7	19.4	130	88	313	37.6	26.1	14.0	13.9	53.3	145	261	
112.0	113.0	34.1	34.4	13.8	39	33	160	25.1	17.9	12.7	12.0	67.3	64	115	
113.0	114.0	34.4	34.7	12.7	27	25	120	23.6	19.5	12.9	12.4	63.4	49	89	
114.0	115.0	34.7	35.1	13.0	23	22	86	25.7	22.5	14.3	13.7	61.2	39	71	
115.0	116.0	35.1	35.4	14.2	24	22	63	30.9	29.5	17.8	17.7	59.9	37	67	
116.0	117.0	35.4	35.7	15.2	34	30	81	31.9	26.1	17.0	16.5	63.3	45	80	
117.0	118.1	35.7	36.0	16.4	34	30	66	33.9	26.8	17.1	16.4	61.0	36	65	
118.1	119.0	36.0	36.3	16.9	37	32	67	37.1	33.1	16.0	15.5	46.8	35	62	
119.0	120.0	36.3	36.6	17.4	55	43	119	39.8	32.9	14.2	13.8	41.8	55	98	
120.0	121.0	36.6	36.9	18.1	96	68	253	39.6	25.8	13.8	13.2	51.0	111	200	
121.0	122.0	36.9	37.2	16.5	59	46	170	33.9	25.5	13.6	13.3	52.1	75	136	
122.0	123.0	37.2	37.5	17.2	69	52	187	40.6	31.1	14.9	14.3	45.8	89	160	
123.0	124.0	37.5	37.8	17.2	81	59	243	45.0	37.2	13.6	11.4	30.7	92	166	
124.0	125.0	37.8	38.1	16.5	74	55	255	43.4	30.4	14.3	12.2	40.1	103	186	
125.0	126.0	38.1	38.4	17.2	66	50	172	39.1	34.1	16.7	15.5	45.4	89	160	
126.0	127.0	38.4	38.7	17.1	33	29	58	47.6	42.8	22.0	21.2	49.6	41	74	
127.0	128.0	38.7	39.0	16.9	30	27	53	53.1	49.7	21.8	20.6	41.4	36	65	
128.0	129.0	39.0	39.3	16.5	30	27	56	43.2	43.1	20.6	19.3	44.9	36	65	
129.0	130.0	39.3	39.6	16.8	40	34	74	36.2	33.9	17.3	16.1	47.5	40	71	
130.0	131.0	39.6	39.9	17.2	61	47	152	34.3	27.9	11.9	10.7	38.5	54	98	
131.0	132.0	39.9	40.2	16.2	53	42	145	29.1	24.9	11.1	10.3	41.1	50	89	
132.0	133.0	40.2	40.5	15.5	50	40	157	30.6	25.0	10.7	10.1	40.3	53	95	
133.0	134.0	40.5	40.8	15.8	41	34	91	36.9	33.3	11.6	11.0	32.9	33	60	
134.0	135.0	40.8	41.1	16.2	45	37	102	36.3	32.9	13.6	13.4	40.7	45	82	
135.0	136.0	41.1	41.5	17.4	55	44	119	38.1	33.3	12.5	12.1	36.4	48	86	
136.0	137.0	41.5	41.8	17.8	64	49	144	38.5	34.5	10.3	10.0	29.0	48	86	
137.0	138.0	41.8	42.1	17.9	80	58	202	38.3	33.1	9.7	9.1	27.4	61	110	
138.0	139.0	42.1	42.4	18.0	69	52	156	39.6	34.5	9.9	9.4	27.2	49	88	
139.0	140.0	42.4	42.7	17.9	83	60	211	39.5	33.8	8.7	8.0	23.7	56	101	
140.0	141.0	42.7	43.0	18.4	100	70	259	33.7	28.1	8.2	6.8	24.2	59	106	

Job No:	21-02-21991
Client:	Tetra Tech Canada Inc
Project:	Kicking Horse River Bridge
Start Date:	15-Mar-2021
End Date:	20-Mar-2021
Borehole ID:	iBPT21-02
Rig:	AP 1000

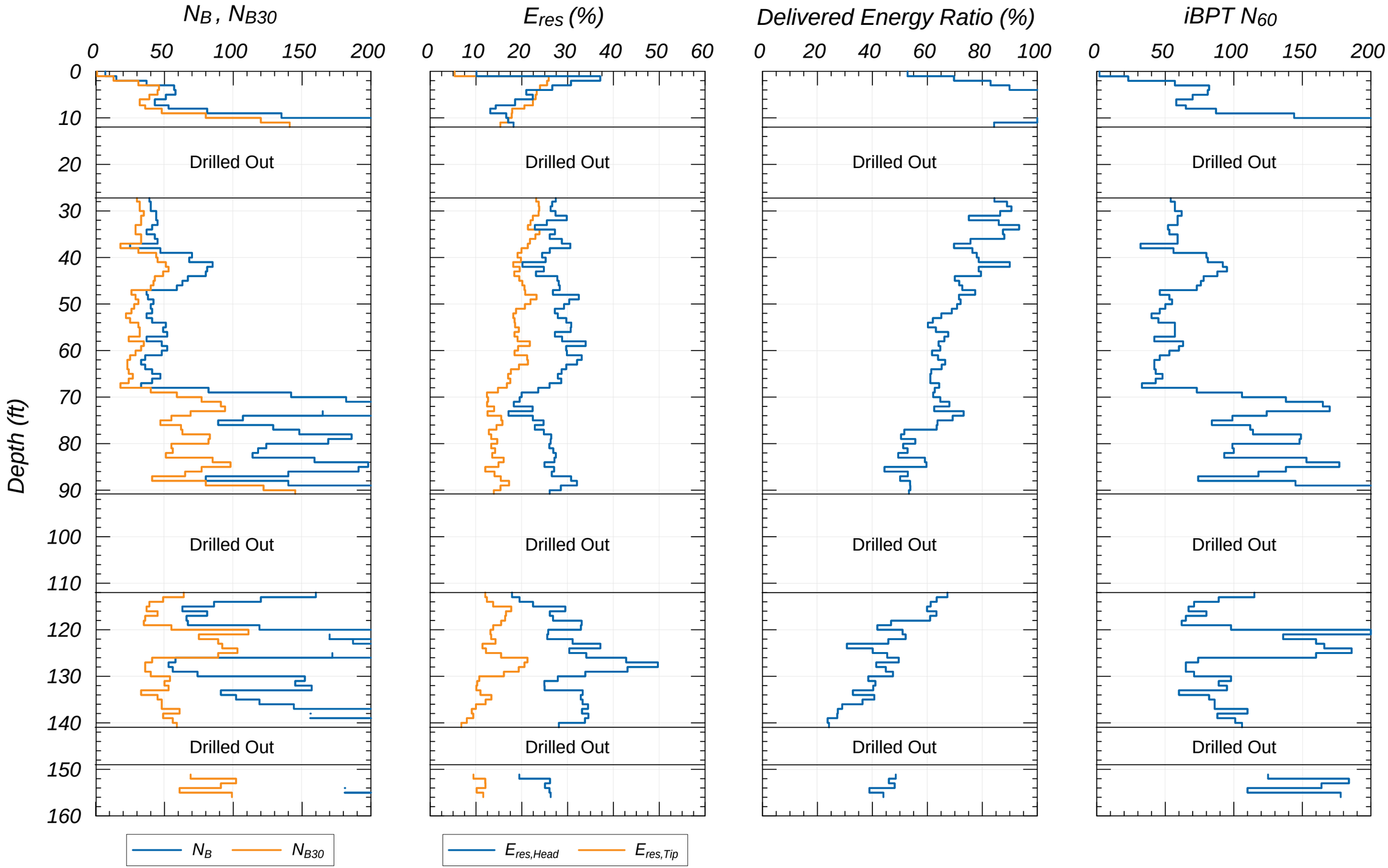
INSTRUMENTED BECKER PENETRATION TEST RESULTS

Start Depth (ft)	End Depth (ft)	Start Depth (m)	End Depth (m)	Average Bounce Chamber Pressure (BCP) (psi)	N_{BC} [1]	N_{60} [1]	N_B (blows per foot)	Average Head Max Energy $E_{max,head}$ (%)	Average Head Residual Energy $E_{res,head}$ (%)	Average Tip Max Energy $E_{max,tip}$ (%)	Average Tip Residual Energy $E_{res,tip}$ (%)	Delivered Energy Ratio (DER)	N_{B30}	iBPT N_{60}	Refer to Notation Number
151.1	152.0	46.1	46.3	13.8	44	37	220	23.9	19.5	12.8	9.4	48.5	69	125	
152.0	153.0	46.3	46.6	15.1	57	45	255	33.6	26.2	13.7	12.0	46.0	102	184	
153.0	154.0	46.6	46.9	15.4	57	45	227	30.8	25.1	13.5	12.1	48.1	91	164	
154.0	155.0	46.9	47.2	16.3	60	46	181	34.5	26.0	10.8	10.1	38.9	61	110	
155.0	156.0	47.2	47.5	16.9	81	59	256	35.3	26.3	13.7	11.6	44.0	99	178	

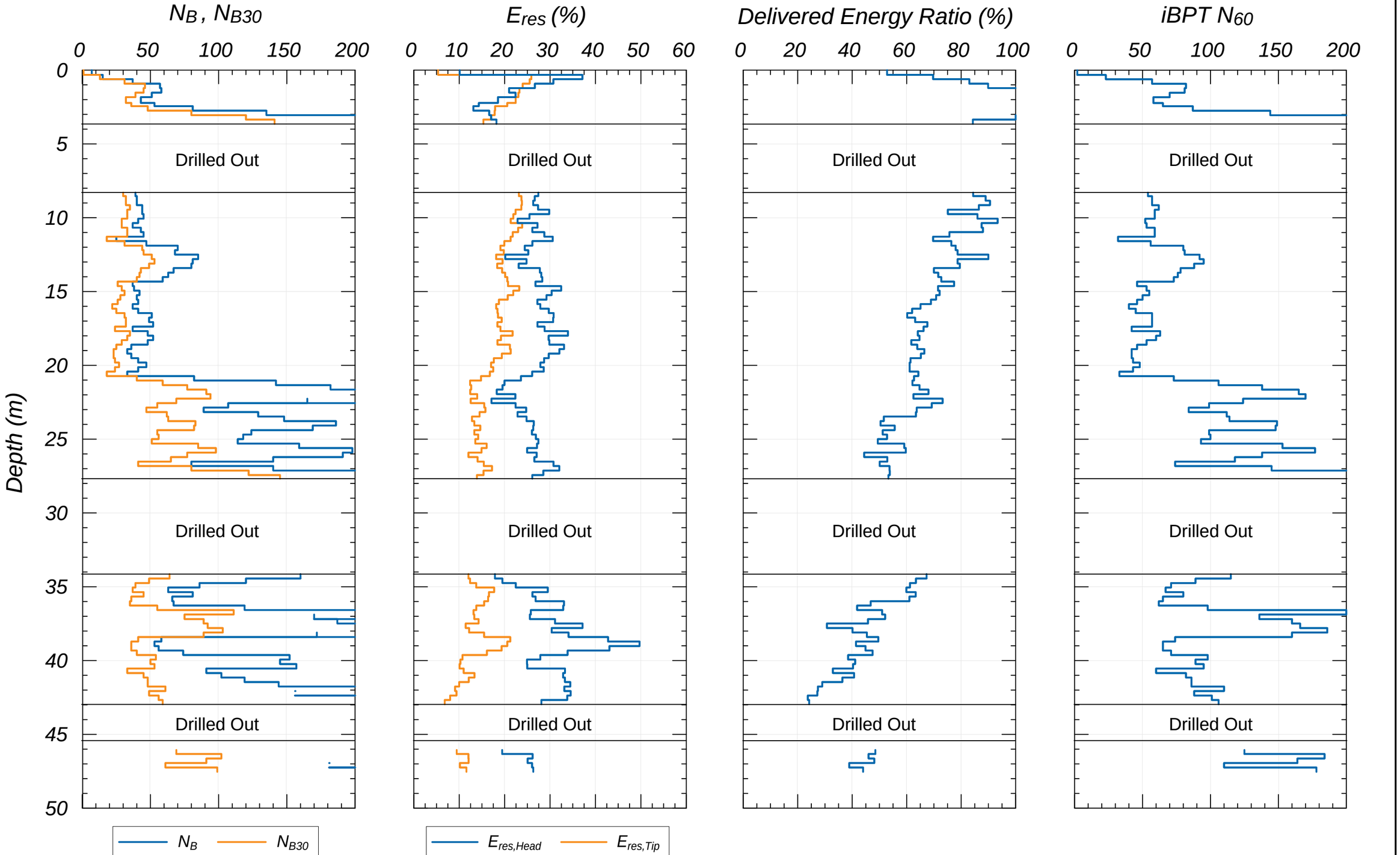
1. Harder & Seed, 1986.

Instrumented Becker Penetration Test Plots with Energy Results and iBPT Equivalent N_{60}

CONETEC



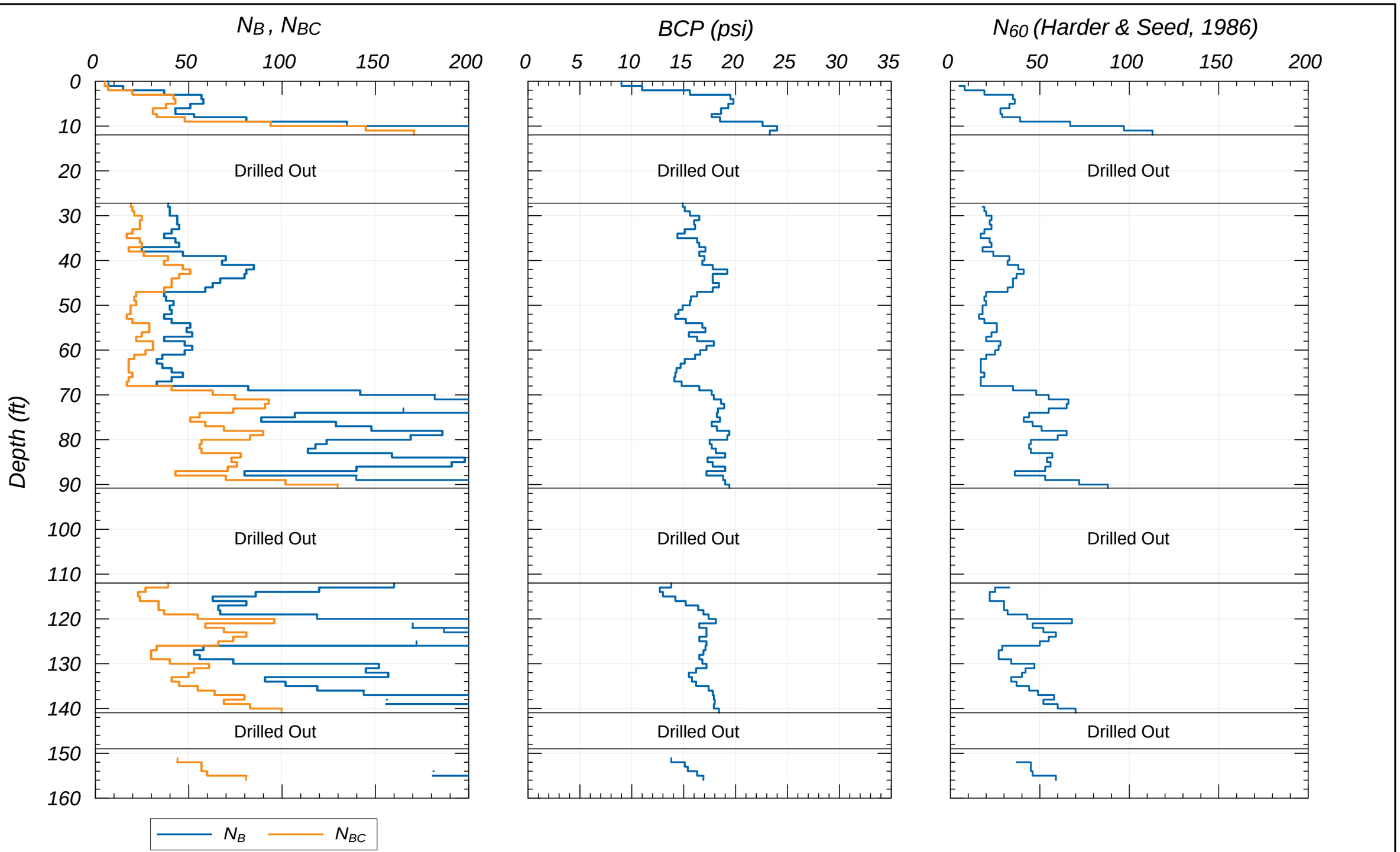
CONETEC	*iBPT Results*	JOB NO: 21-02-21991 SITE: Kicking Horse River Bridge	SOUNDING: iBPT21-02 DATE: 15-Mar-2021



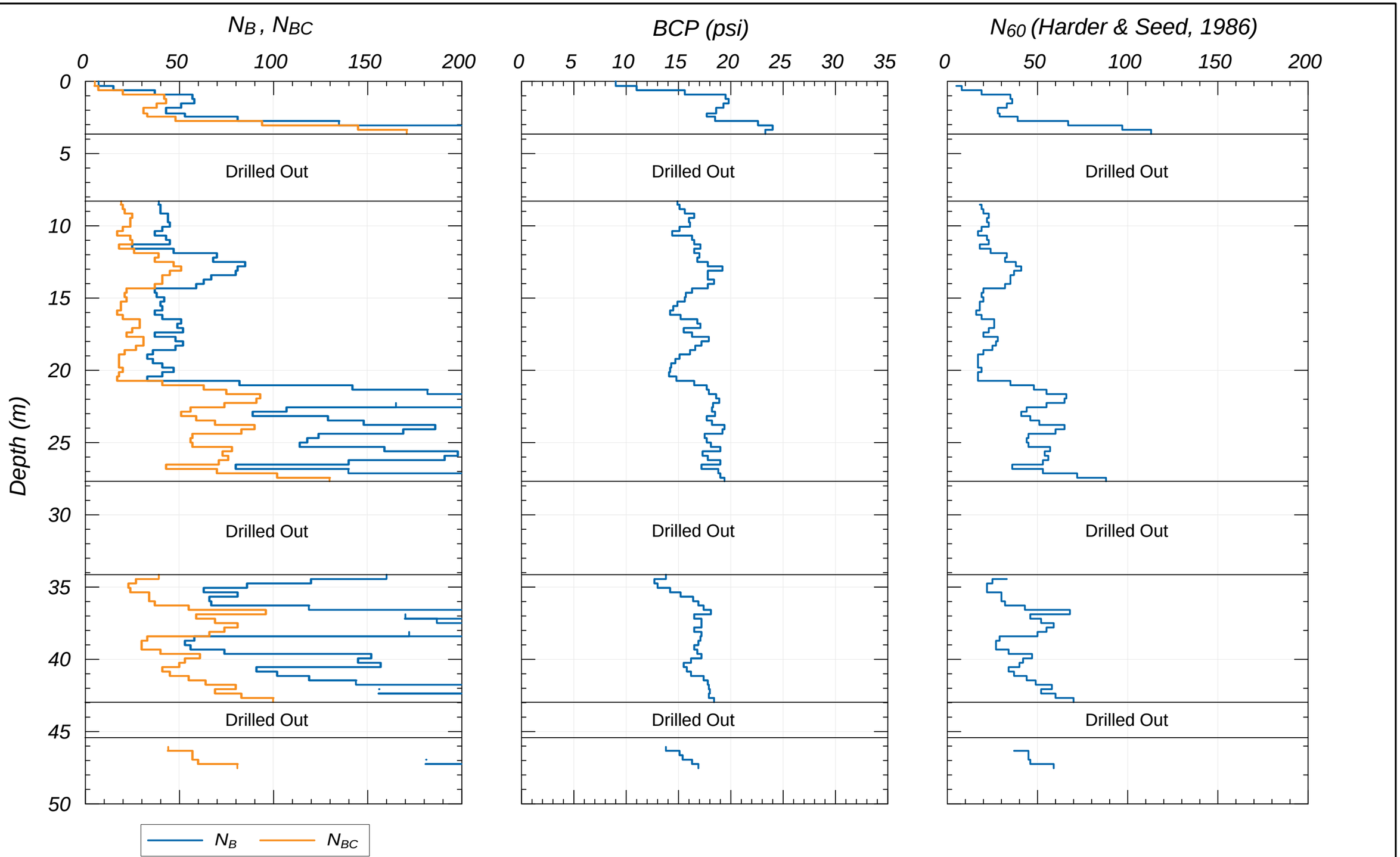
CONETEC	*iBPT Results*	JOB NO: 21-02-21991 SITE: Kicking Horse River Bridge	SOUNDING: iBPT21-02 DATE: 15-Mar-2021

Instrumented Becker Penetration Test Plots with Harder & Seed (1986) Results

CONETEC



ConeTec	*Harder & Seed (1986) Results*	JOB NO: 21-02-21991 SITE: Kicking Horse River Bridge	SOUNDING: iBPT21-02 DATE: 15-Mar-2021



CONETEC	*Harder & Seed (1986) Results*	JOB NO: 21-02-21991 SITE: Kicking Horse River Bridge	SOUNDING: iBPT21-02 DATE: 15-Mar-2021

APPENDIX E

LABORATORY TEST RESULTS

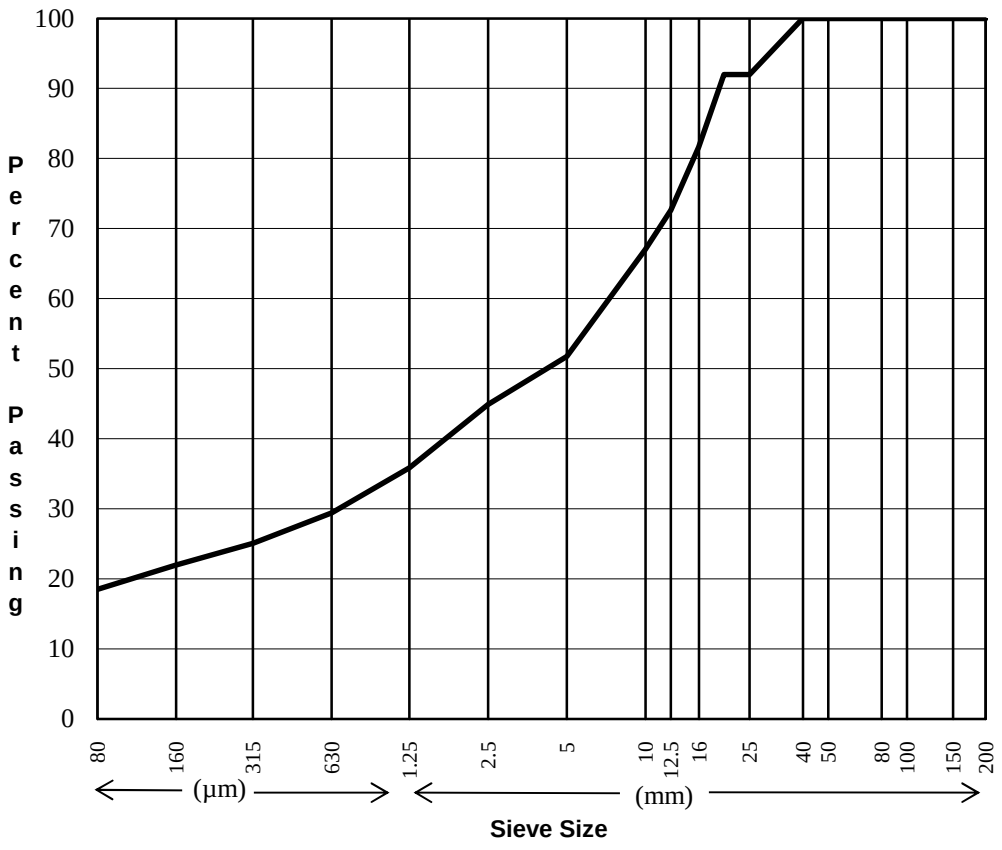
Particle Size Distribution Test Reports

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 2
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	GRAVEL and SAND, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	6.1%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	92
20 mm	92
16 mm	82
12.5 mm	73
10 mm	67
5 mm	52
2.5 mm	45
1.25 mm	36
630 µm	29
315 µm	25
160 µm	22
80 µm	18.5



Remarks:

Reviewed By: _____ P.Eng.

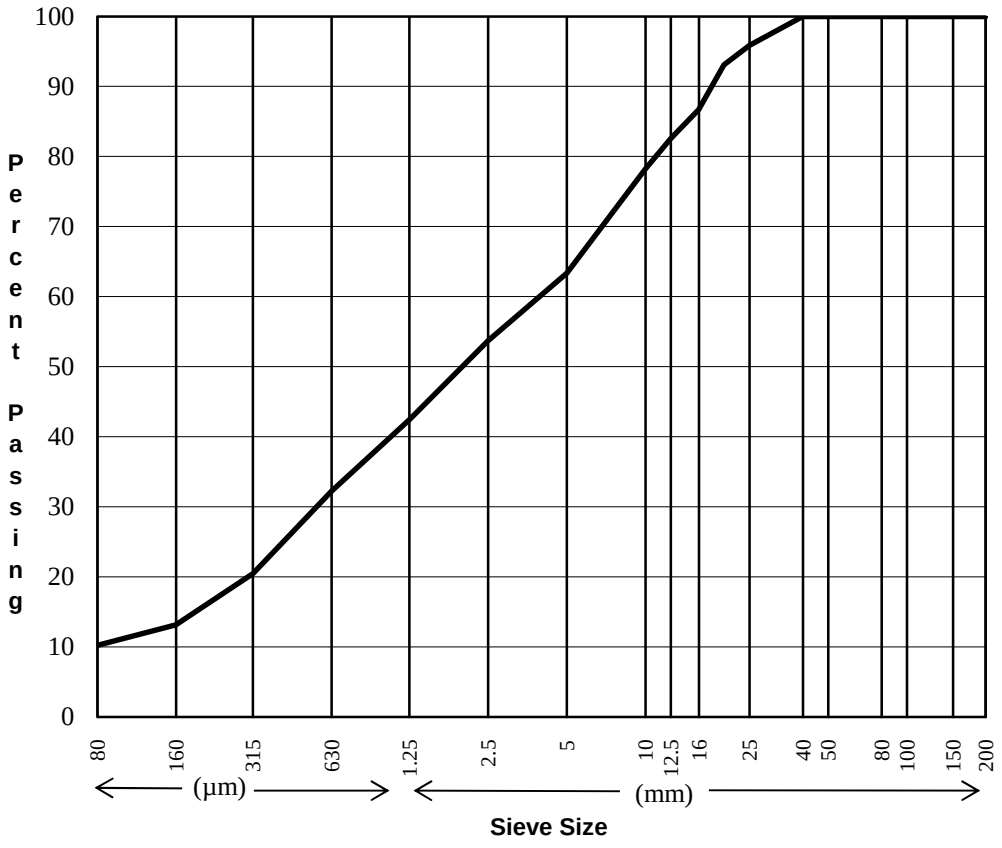
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 7
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND and GRAVEL, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	10.6%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	96
20 mm	93
16 mm	87
12.5 mm	83
10 mm	78
5 mm	63
2.5 mm	54
1.25 mm	42
630 µm	32
315 µm	20
160 µm	13
80 µm	10.3



Remarks:

Reviewed By: _____ P.Eng.

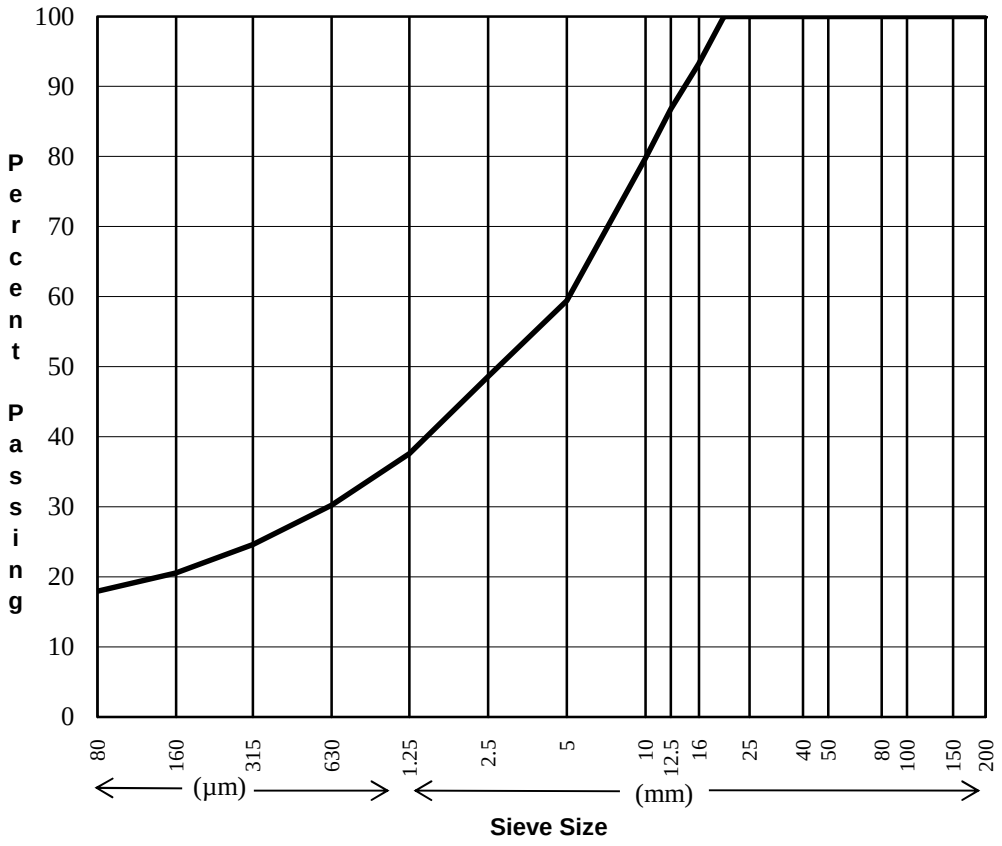
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 9
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND and GRAVEL, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	6.7%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	100
16 mm	93
12.5 mm	87
10 mm	80
5 mm	59
2.5 mm	49
1.25 mm	38
630 µm	30
315 µm	25
160 µm	21
80 µm	18.0



Remarks:

Reviewed By: _____ P.Eng.

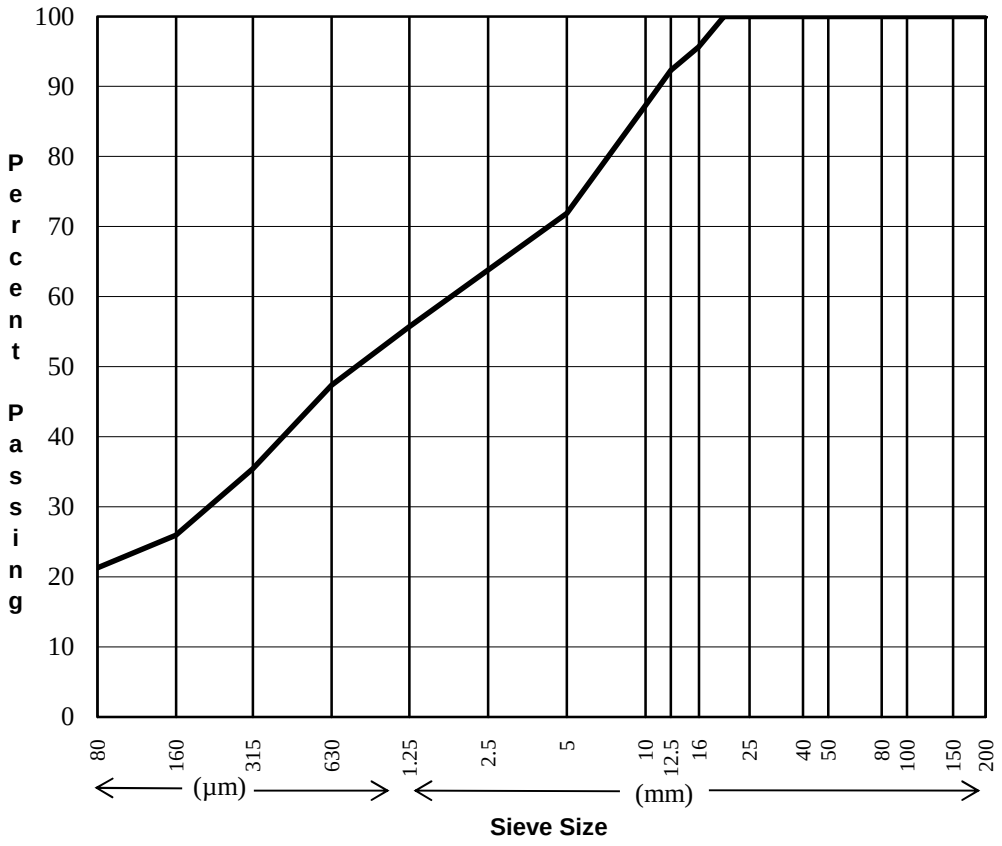
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 14
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, gravelly, silty	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	9.2%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	100
16 mm	96
12.5 mm	92
10 mm	87
5 mm	72
2.5 mm	64
1.25 mm	56
630 µm	47
315 µm	35
160 µm	26
80 µm	21.3



Remarks:

Reviewed By: _____ P.Eng.

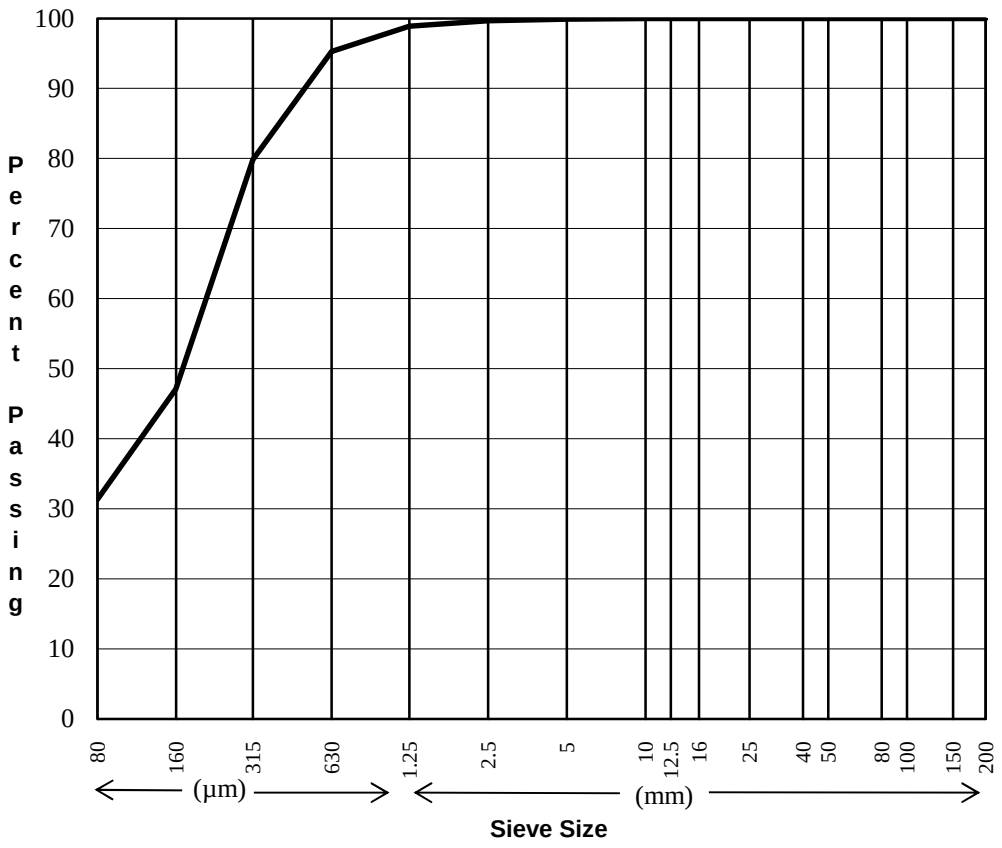
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 16
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, silty	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	17.0%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	
16 mm	
12.5 mm	
10 mm	100
5 mm	100
2.5 mm	100
1.25 mm	99
630 µm	95
315 µm	80
160 µm	47
80 µm	31.4



Remarks:

Reviewed By: _____ P.Eng.

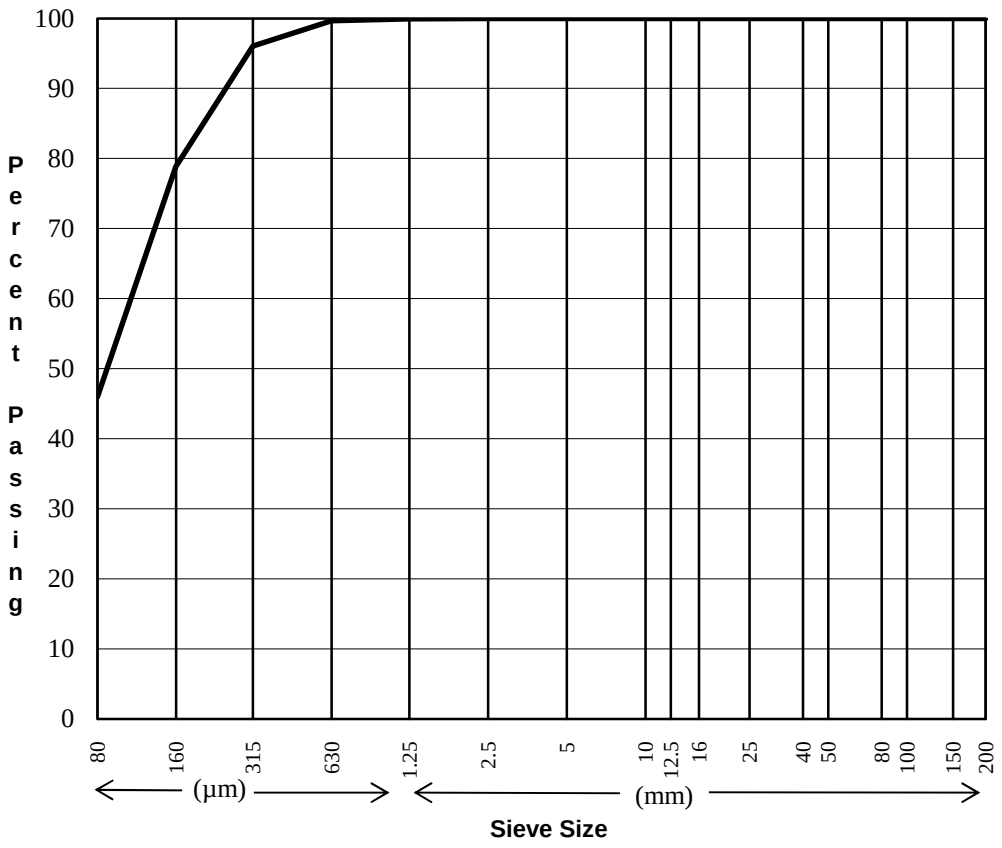
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 19
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, silty, trace clay	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	24.5%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	
16 mm	
12.5 mm	
10 mm	
5 mm	
2.5 mm	100
1.25 mm	100
630 µm	100
315 µm	96
160 µm	79
80 µm	46.0



Remarks:

Reviewed By: _____ P.Eng.

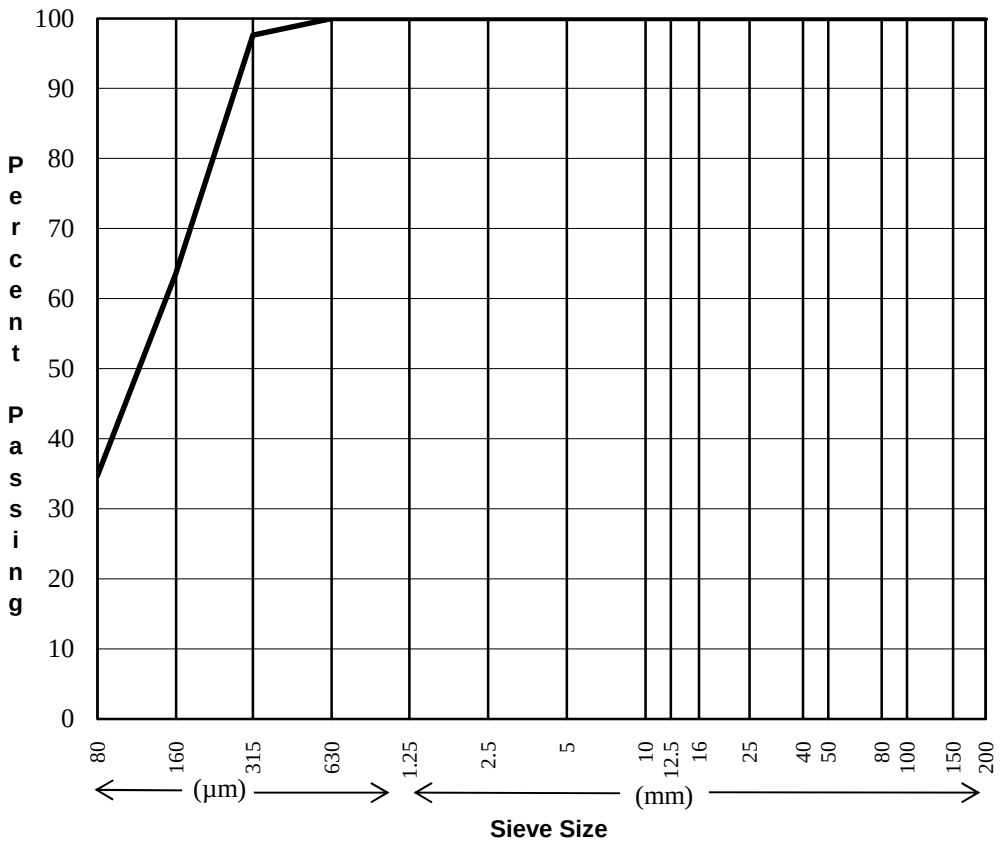
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 22
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, silty, trace clay	Tested By: MS	Lab: Calgary
Source:	BH21-03	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	21.8%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	
16 mm	
12.5 mm	
10 mm	
5 mm	
2.5 mm	
1.25 mm	
630 µm	100
315 µm	98
160 µm	64
80 µm	34.7



Remarks:

Reviewed By: _____ P.Eng.

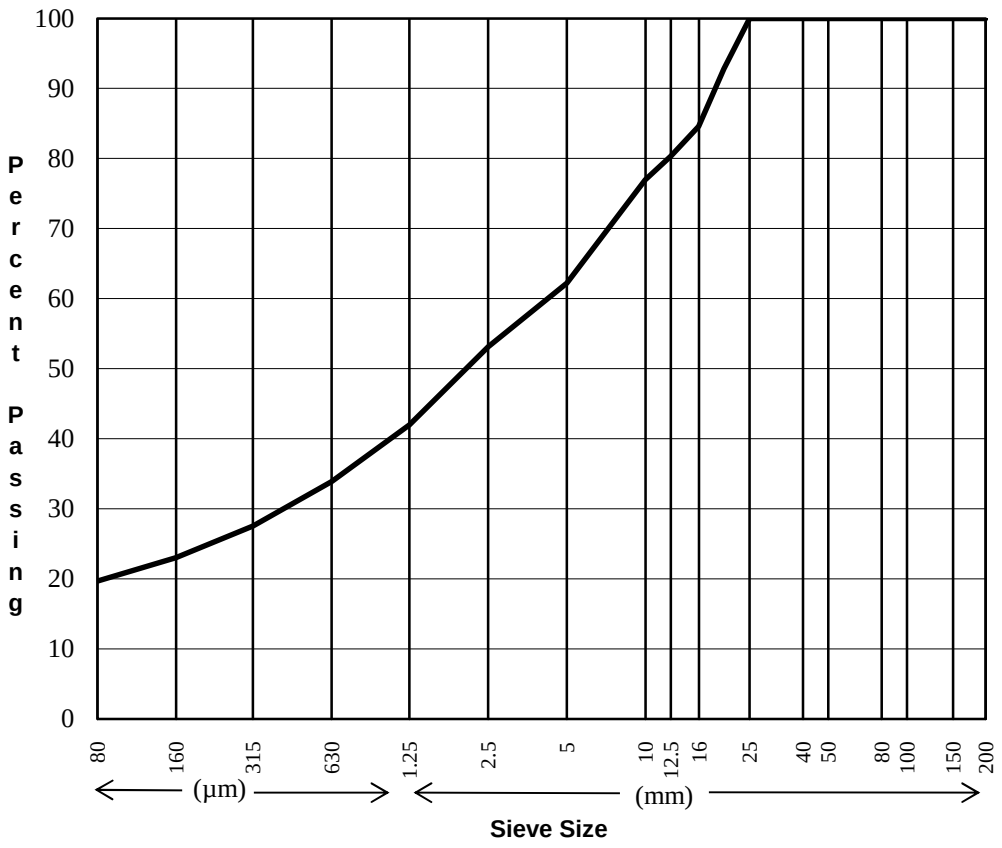
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 1
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND and GRAVEL, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-05	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	3.1%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	93
16 mm	85
12.5 mm	80
10 mm	77
5 mm	62
2.5 mm	53
1.25 mm	42
630 µm	34
315 µm	28
160 µm	23
80 µm	19.7



Remarks:

Reviewed By: _____ P.Eng.

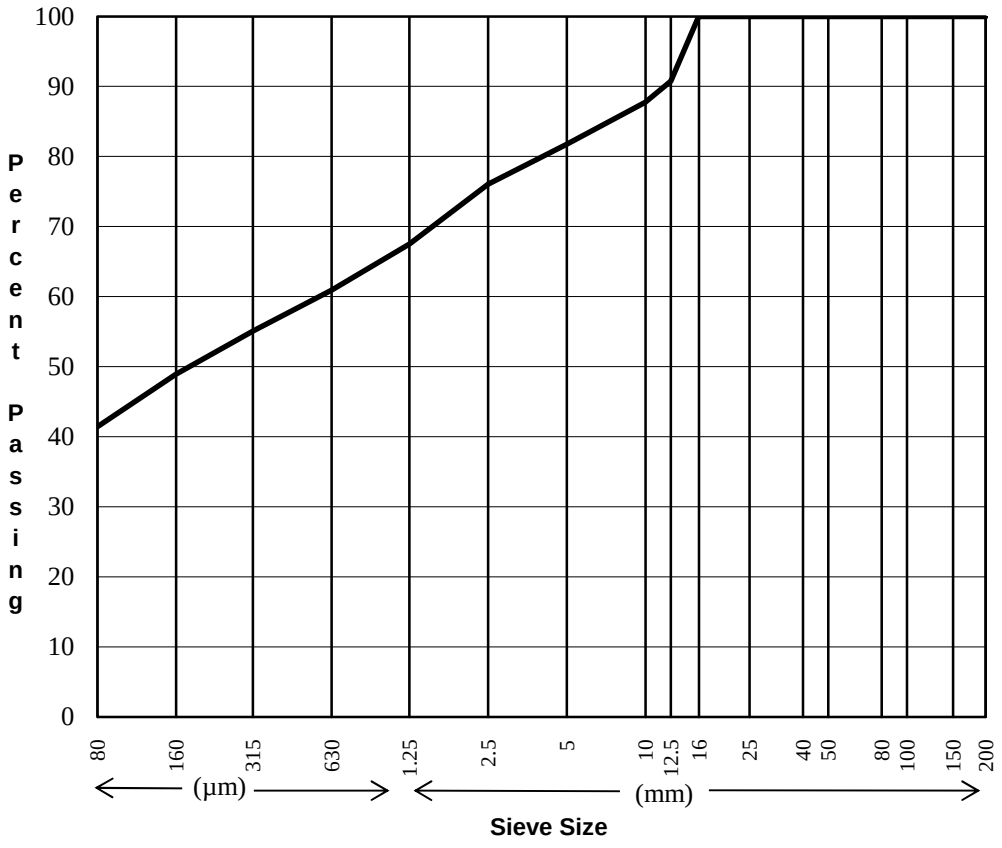
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 1
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, silty, some gravel	Tested By: MS	Lab: Calgary
Source:	BH21-08	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	13.6%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	
16 mm	100
12.5 mm	91
10 mm	88
5 mm	82
2.5 mm	76
1.25 mm	68
630 µm	61
315 µm	55
160 µm	49
80 µm	41.5



Remarks:

Reviewed By: _____ P.Eng.

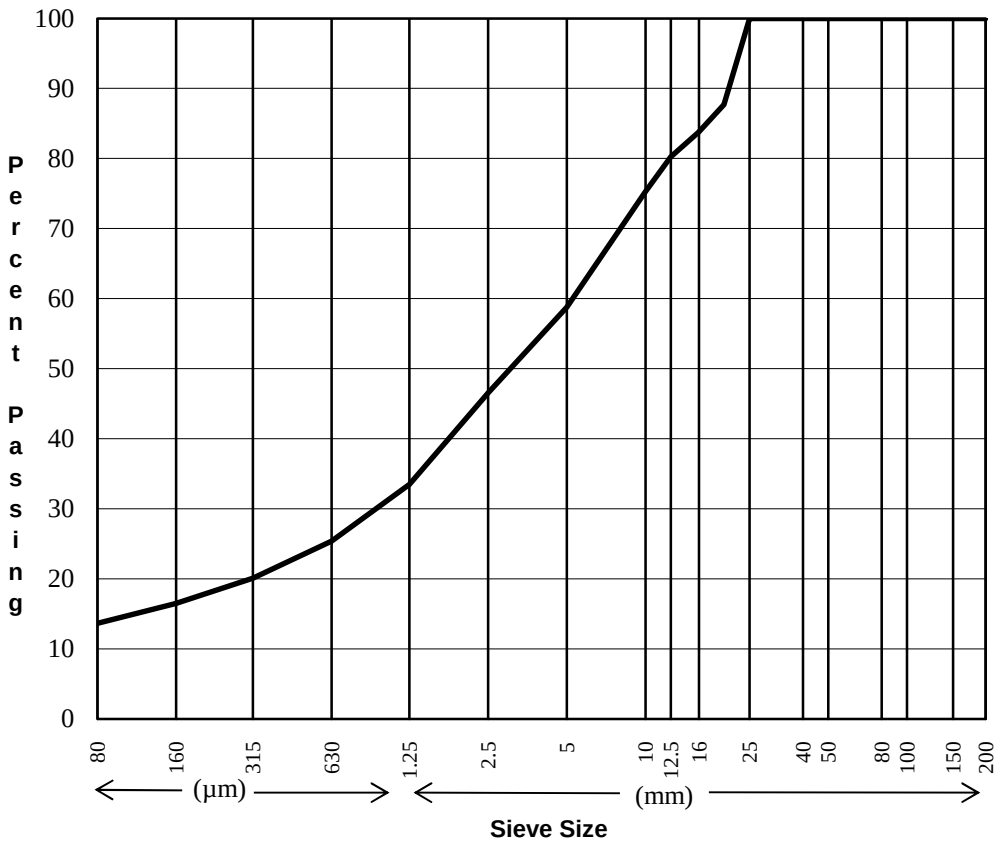
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 2
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	GRAVEL and SAND, trace silt	Tested By: MS	Lab: Calgary
Source:	BH21-09	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	8.1%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	88
16 mm	84
12.5 mm	80
10 mm	75
5 mm	59
2.5 mm	47
1.25 mm	33
630 µm	25
315 µm	20
160 µm	16
80 µm	13.7



Remarks:

Reviewed By: _____ P.Eng.

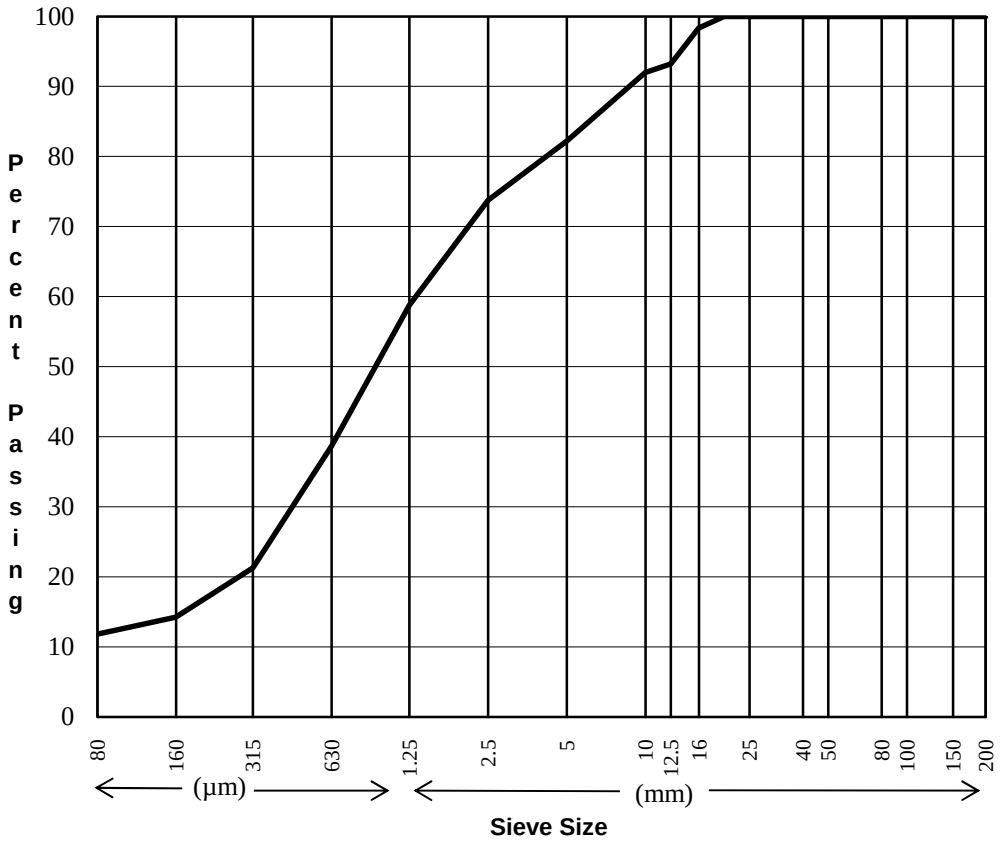
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	SPT 7
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	March, 2021
Project No.:	704-ENG.VGEO03793-01.107	Sampled By:	TTC Inc.
Attention:		Date Tested:	April 27, 2021
Description:	SAND, some gravel, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-09	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	8.4%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	100
16 mm	98
12.5 mm	93
10 mm	92
5 mm	82
2.5 mm	74
1.25 mm	59
630 µm	39
315 µm	21
160 µm	14
80 µm	11.8



Remarks:

Reviewed By: _____ P.Eng.

TETRA TECH

PERCENT FINER THAN # 200 SIEVE FORM

ASTM C117 Aggregate, ASTM D1140 Soils

Project:	Kicking Horse Bridges	Sample Number:	Various
Client:	Ministry of Transportation and Infrastructure	Sampled By:	TTC Inc.
Location	Golden, BC	Date Tested:	27-Apr
Project Number:	704-ENG.VGEO03793-01.107	Tested By:	MS/IB

Borehole:	BH21-03	BH21-03	BH21-05	BH21-05	BH21-09		
Depth	SPT 18	SPT 23	G1	G3	SPT 1		
Wet Mass & Tare (g)	995.4	670.3	1823.4	2512.8	324.3		
Tare Mass (g)	489	0	0	0	0		
Wet Mass (g)	506.4	670.3	1823.4	2512.8	324.3		
Initial Mass & Tare (g)	412.7	537.96	1730.1	2466	307.1		
Tare Mass (g)	0	0	0	0	0		
Initial Mass (g)	412.7	537.96	1730.1	2466	307.1		
Washed Mass & Tare (g)	715.6	779.1	1396.2	2160.9	227.5		
Tare Mass (g)	489	488.7	0	0	0		
Washed Mass (g)	226.6	290.4	1396.2	2160.9	227.5		
Moisture Content (%)	22.7	24.6	5.4	1.9	5.6		
Mass Passing #200 (g)	186.1	247.56	333.9	305.1	79.6		
Percent Passing #200	**45.1**	**46.0**	**19.3**	**12.4**	**25.9**		

Remarks:

Reviewed By: _____ P.Eng.

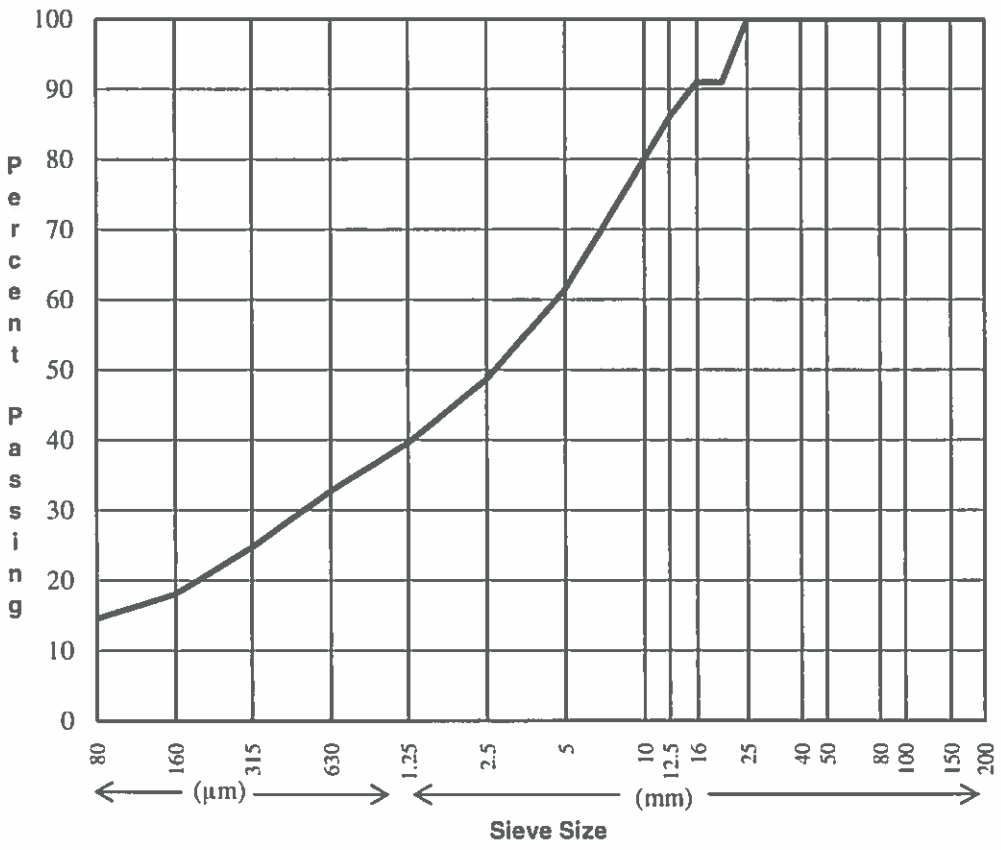
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S6
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	SAND and GRAVEL, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	8.0%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	91
16 mm	91
12.5 mm	86
10 mm	80
5 mm	61
2.5 mm	49
1.25 mm	40
630 µm	33
315 µm	25
160 µm	18
80 µm	14.6



Remarks:

Reviewed By: _____ P.Eng.

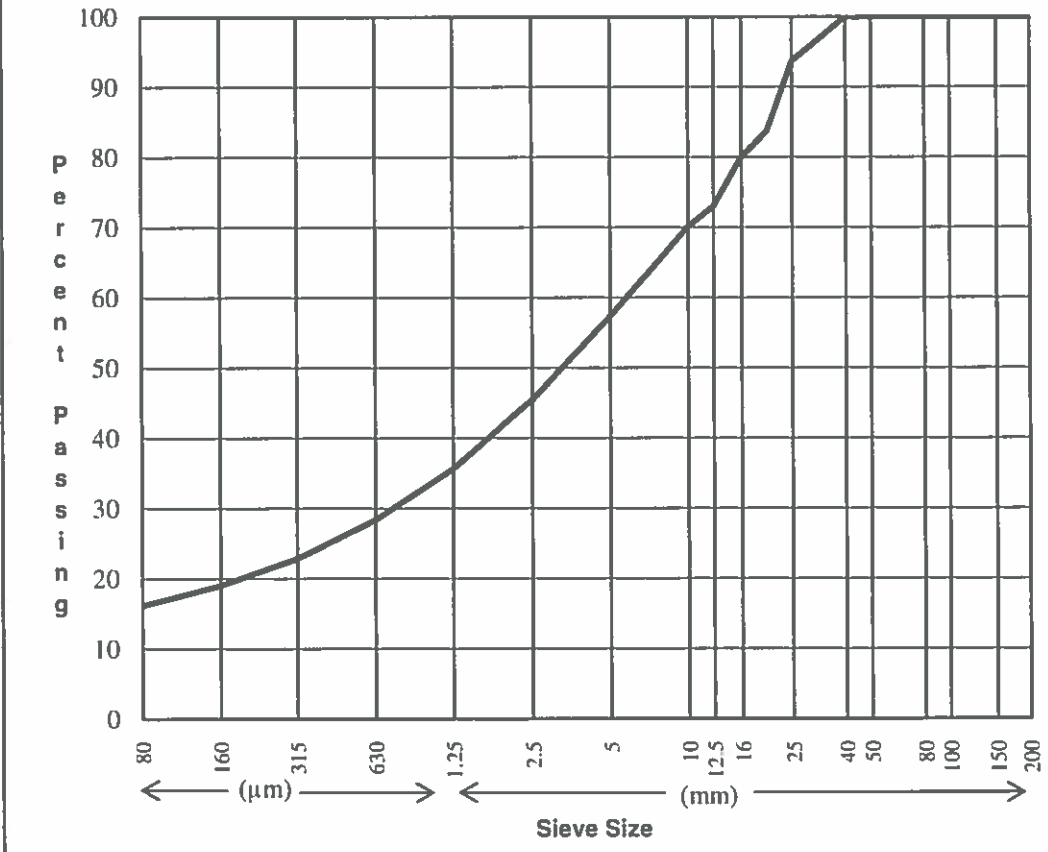
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S2
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	SAND and GRAVEL, some silt	Tested By:	MS Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	6.2%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	94
20 mm	84
16 mm	80
12.5 mm	73
10 mm	70
5 mm	57
2.5 mm	45
1.25 mm	36
630 µm	28
315 µm	23
160 µm	19
80 µm	16.2



Remarks:

Reviewed By: _____ P.Eng.

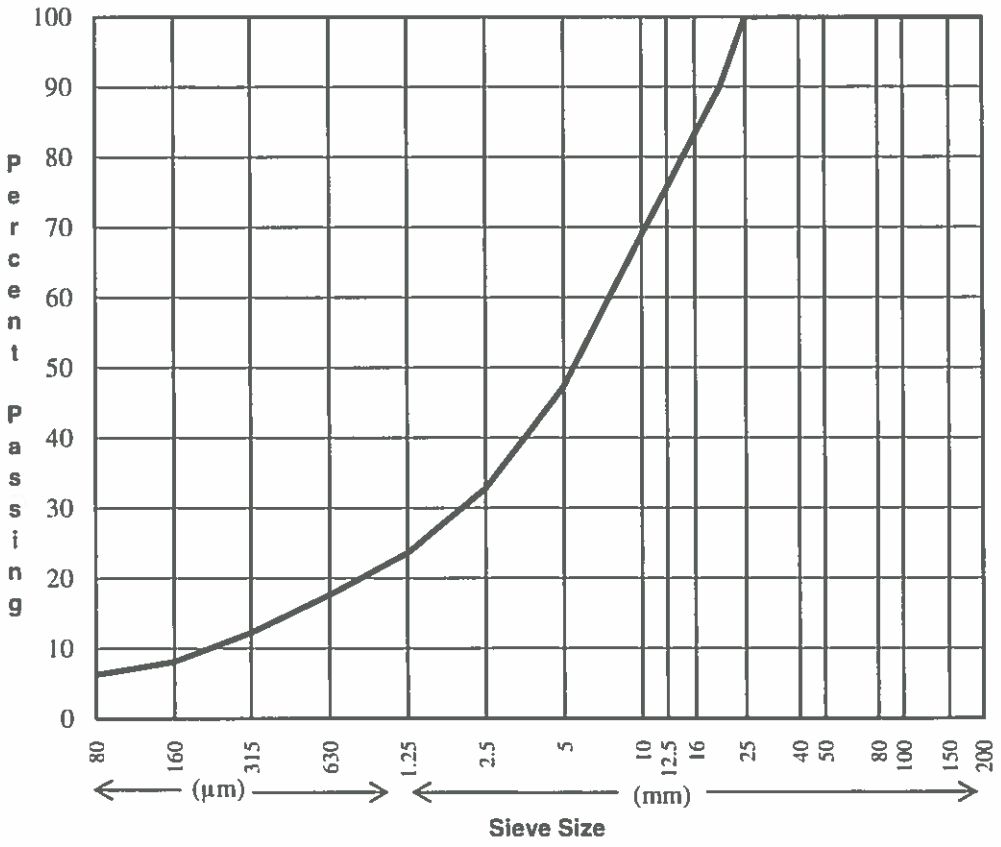
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S9
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL and SAND, trace silt	Tested By: MS	Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	5.9%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	90
16 mm	83
12.5 mm	76
10 mm	69
5 mm	47
2.5 mm	33
1.25 mm	24
630 µm	18
315 µm	12
160 µm	8
80 µm	6.3



Remarks:

Reviewed By: _____ P.Eng.

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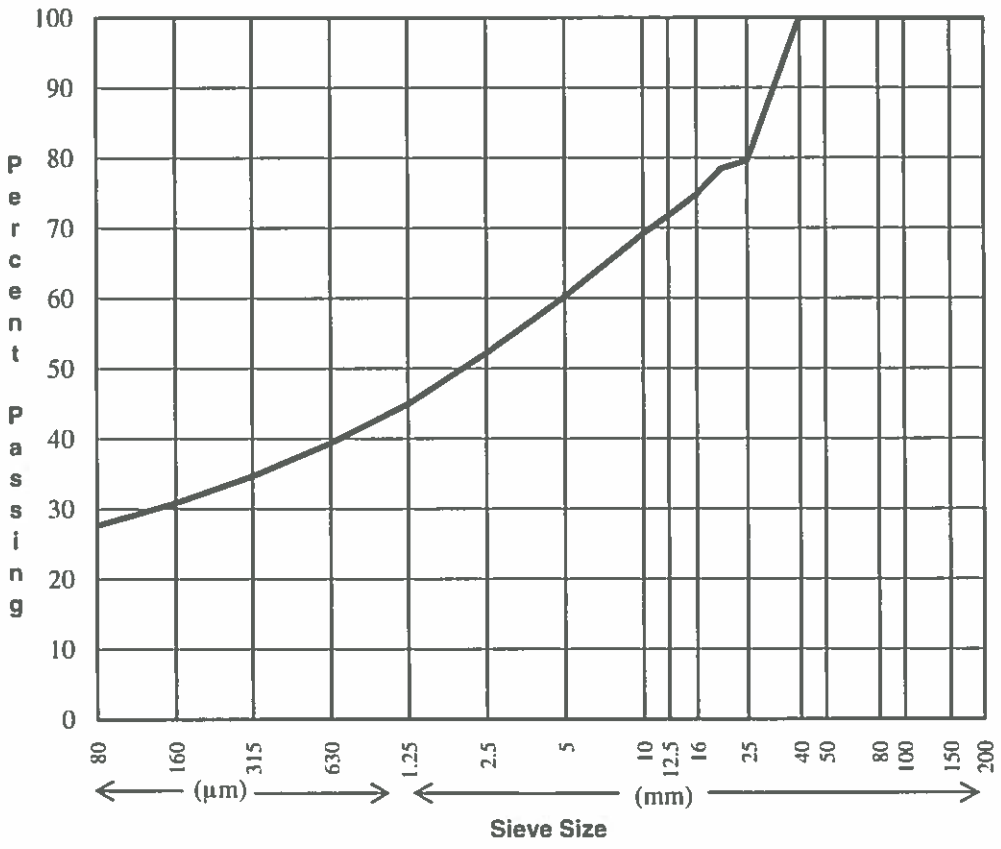
SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S-16
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL and SAND, silty, some clay	Tested By: MS	Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	4.8%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	80
20 mm	78
16 mm	75
12.5 mm	72
10 mm	69
5 mm	60
2.5 mm	52
1.25 mm	45
630 µm	39
315 µm	35
160 µm	31
80 µm	27.6



Remarks:

Reviewed By: _____ P.Eng.

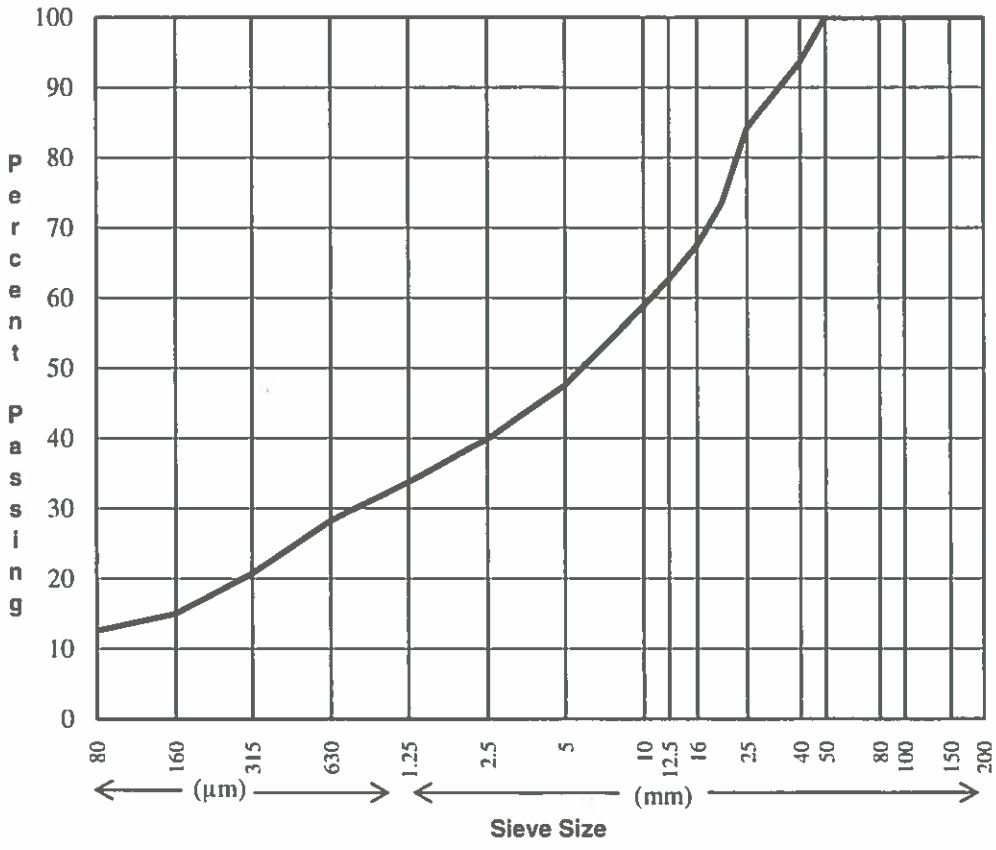
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S23
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL, sandy, some silt	Tested By:	MS Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	6.9%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	100
40 mm	94
25 mm	84
20 mm	74
16 mm	67
12.5 mm	63
10 mm	59
5 mm	48
2.5 mm	40
1.25 mm	34
630 µm	28
315 µm	21
160 µm	15
80 µm	12.6



Remarks:

Reviewed By: _____ P.Eng.

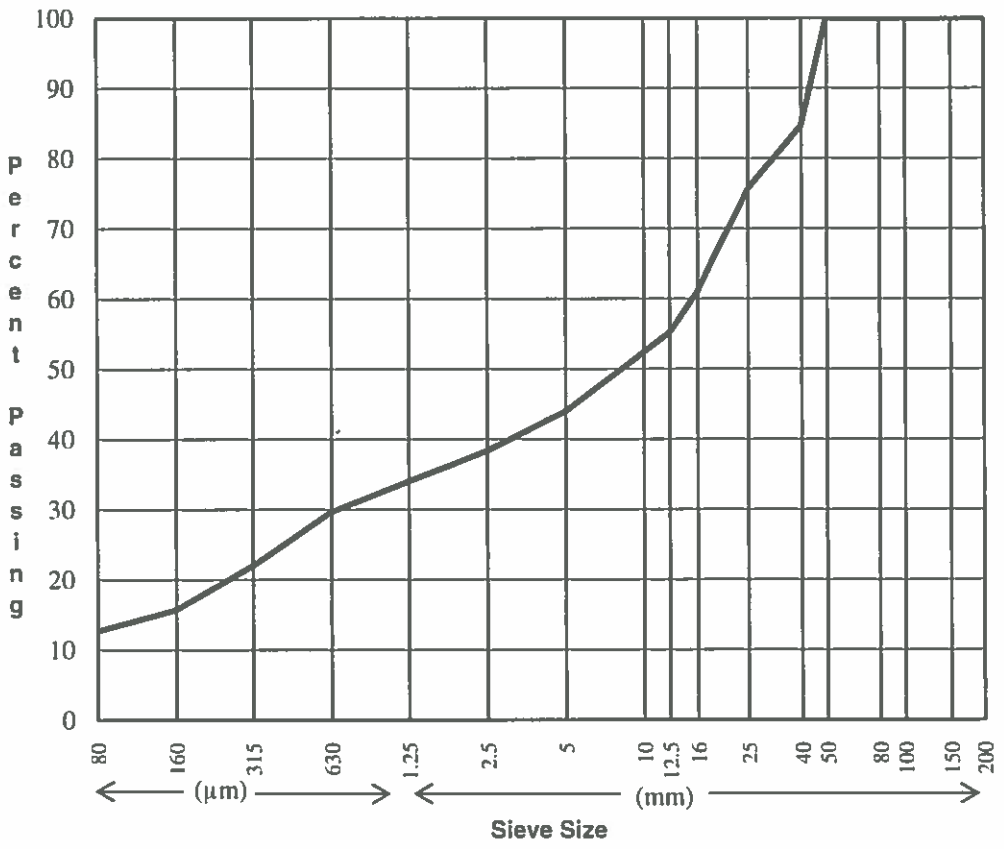
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S28
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL, sandy, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	5.6%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	100
40 mm	85
25 mm	76
20 mm	69
16 mm	61
12.5 mm	55
10 mm	52
5 mm	44
2.5 mm	38
1.25 mm	34
630 µm	30
315 µm	22
160 µm	16
80 µm	12.7



Remarks:

Reviewed By: _____ P.Eng.

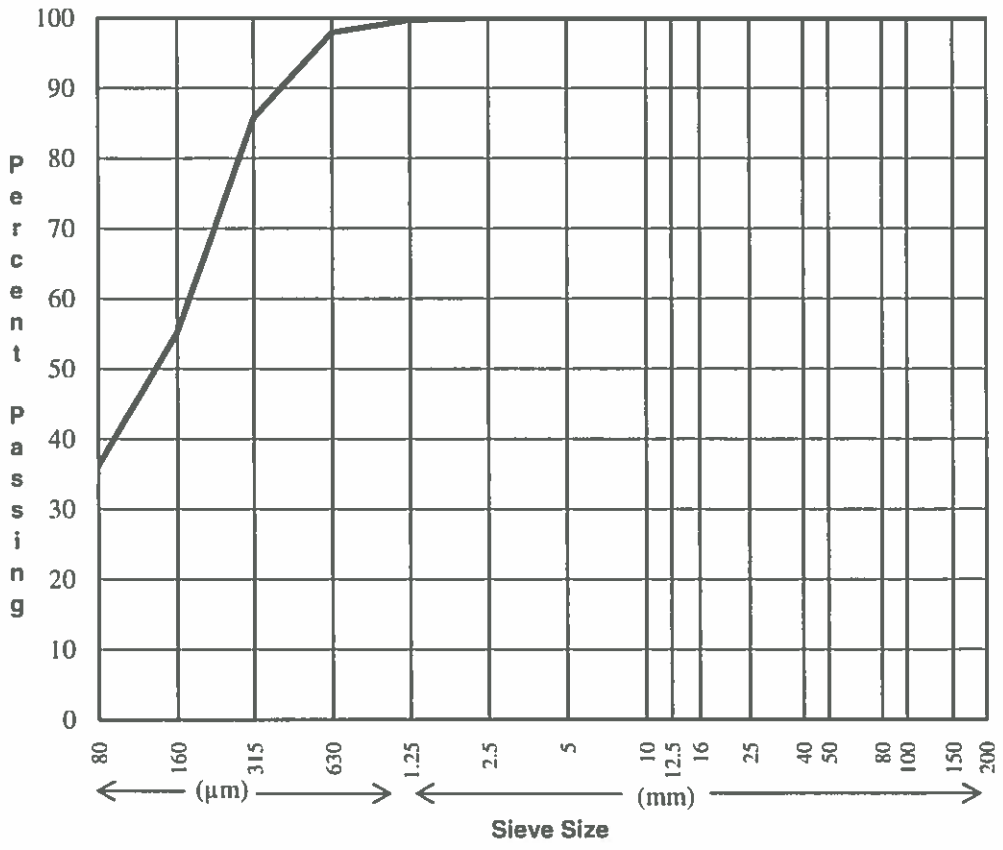
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S34
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	SAND, silty, some clay	Tested By: MS	Lab: Calgary
Source:	BH21-01	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	19.2%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	
20 mm	
16 mm	
12.5 mm	
10 mm	
5 mm	
2.5 mm	100
1.25 mm	100
630 µm	98
315 µm	86
160 µm	55
80 µm	36.3



Remarks:

Reviewed By: _____ P.Eng.

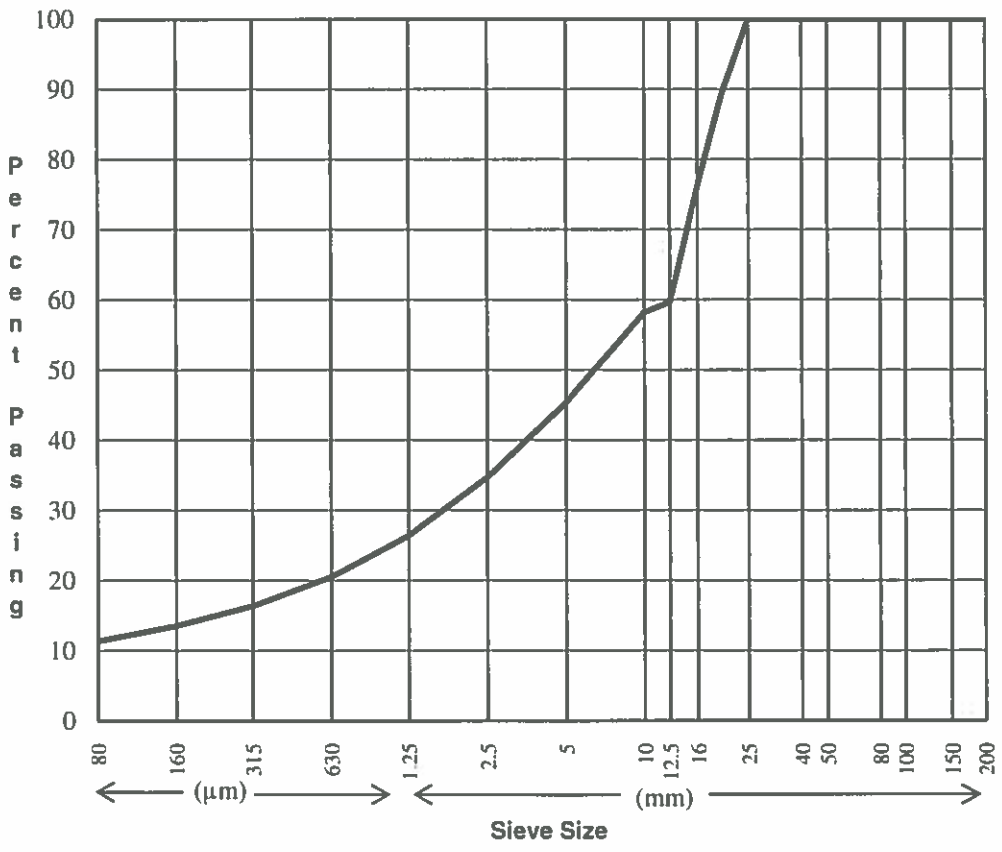
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S2
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL, sandy, some silt	Tested By: MS	Lab: Calgary
Source:	BH21-04	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	0.7%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	90
16 mm	76
12.5 mm	60
10 mm	58
5 mm	45
2.5 mm	35
1.25 mm	26
630 µm	21
315 µm	16
160 µm	14
80 µm	11.4



Remarks:

Reviewed By: _____ P.Eng.

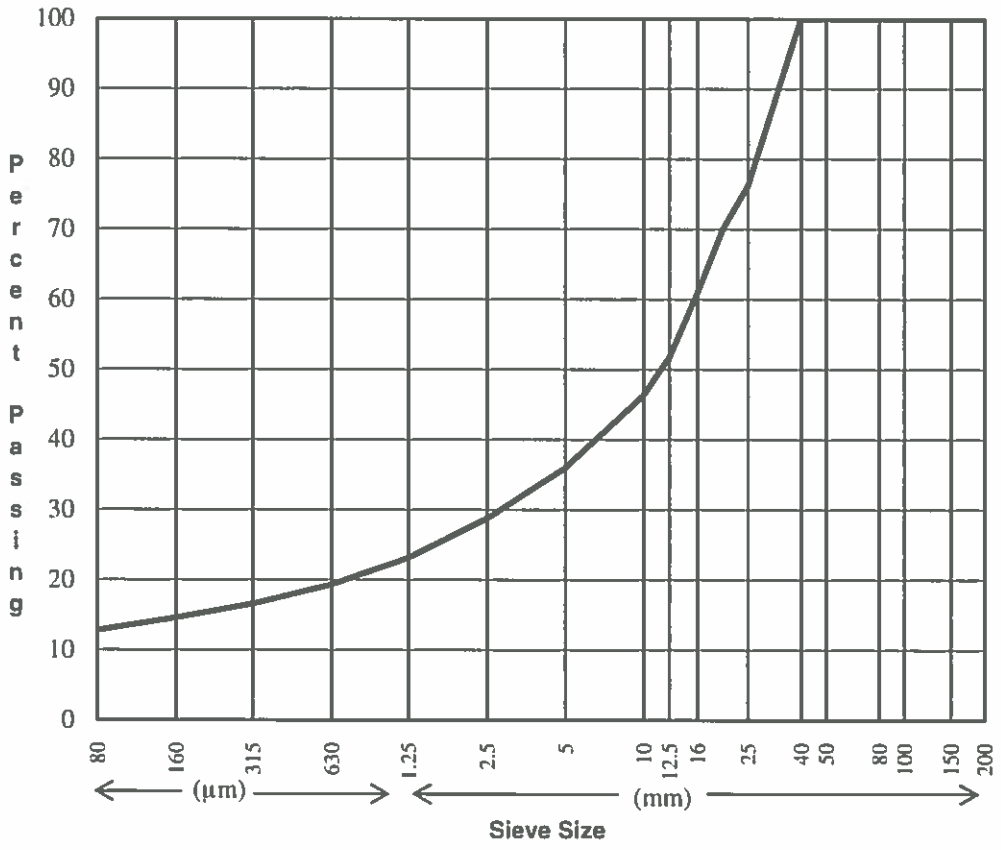
TETRA TECH

SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S3
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL, sandy, some silt	Tested By:	MS Lab: Calgary
Source:	BH21-06	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	1.6%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	100
25 mm	76
20 mm	70
16 mm	61
12.5 mm	52
10 mm	46
5 mm	36
2.5 mm	29
1.25 mm	23
630 µm	19
315 µm	17
160 µm	15
80 µm	12.8



Remarks:

Reviewed By: _____ P.Eng.

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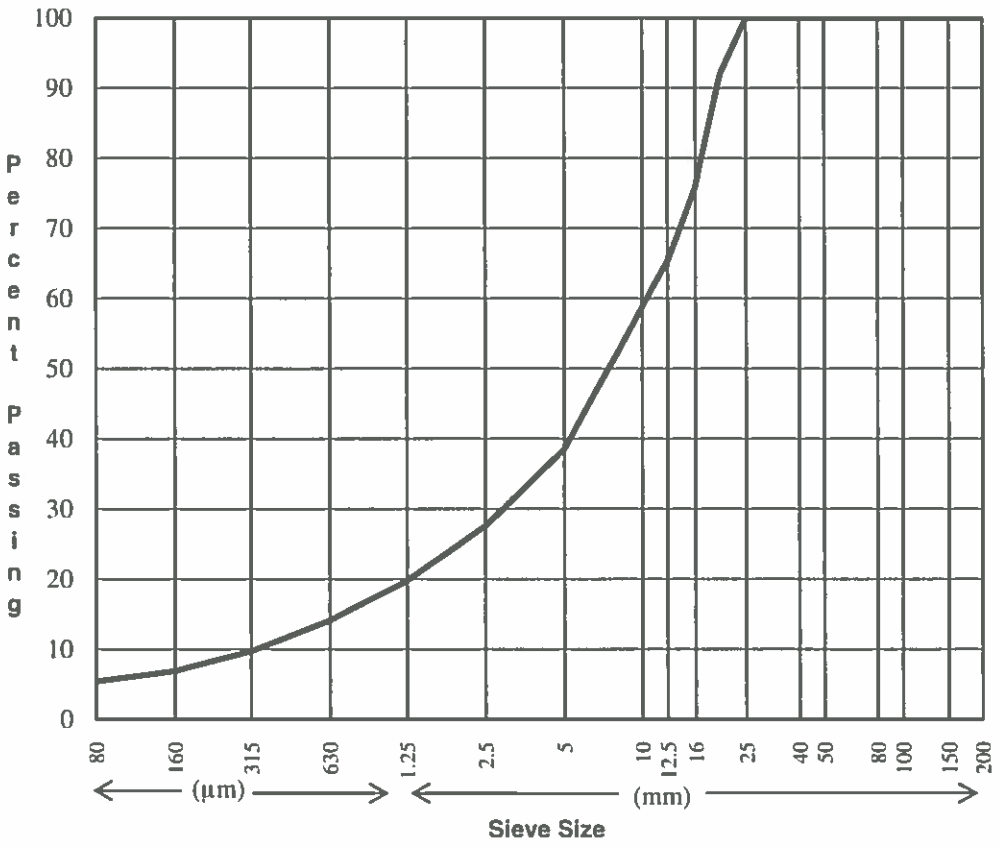
SIEVE ANALYSIS REPORT

ASTM C136, C117

Project:	Kicking Horse Bridges	Sample No.:	S2
Client:	Ministry of Transportation and Infrastructure	Date Sampled:	September 17, 2021
Project No.:	704-ENG.VGEO03793-01.203	Sampled By:	KB
Attention:		Date Tested:	October 7, 2021
Description:	GRAVEL, sandy, trace silt	Tested By: MS	Lab: Calgary
Source:	BH21-07	No. Crushed Faces:	
Location:	Golden, BC	Moisture Content:	2.5%
Specification:			

Sieve Size	Percent Passing
200 mm	
150 mm	
100 mm	
80 mm	
50 mm	
40 mm	
25 mm	100
20 mm	92
16 mm	76
12.5 mm	65
10 mm	59
5 mm	39
2.5 mm	28
1.25 mm	20
630 µm	14
315 µm	10
160 µm	7
80 µm	5.5



Remarks:

Reviewed By: _____ P.Eng.

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