Hwy 5 – Badger Creek CVSE Pullout Geotechnical Assessment

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Acronyms and Abbreviations

AADT	Average Annual Daily Traffic
AASHTO	American Association of State Highway Transportation Officials
ASTM	ASTM International (formerly American Society for Testing and Materials)
BC	(Province of) British Columbia
BC MoTI	British Columbia Ministry of Transportation and Infrastructure
CCIL	Canadian Council of Independent Laboratories
CFEM	Canadian Foundation Engineering Manual
CHBDC	Canadian Highway Bridge Design Code
CPT	Cone Penetration Test
CSA	Canadian Standards Association
CVSE	Commercial Vehicle Safety and Enforcement
EGBC	Engineers and Geoscientists of British Columbia (formerly APEGBC)
ESAL	Equivalent Single Axle Load
GIC	Geographic Information Centre
GSC	Geologic Survey of Canada
HVDF	Heavy Vehicle Design Factor
HVP	Heavy Vehicle Percentage
ID	Inside Diameter
LE	Limit Equilibrium
m asl	meter(s) above (existing) sea level
m bgl	meter(s) below (existing) ground level
MPa	Megapascal
MPMDD	Modified Proctor Maximum Dry Density
NBCC	National Building Code of Canada (2015)
OD	Outside Diameter
OH&S	Occupational Health and Safety
P.Eng.	Professional Engineer (registered with EGBC)
PVC	Polyvinyl Chloride
RST	RST Instruments
Sa	Spectral Accelerations
SCPT	Seismic Cone Penetration Test
SGSB	Select Granular Sub-Base
SLS	Serviceability Limit State
SPMDD	Standard Proctor Maximum Dry Density
SPT	Standard Penetration Test
TDY	Traffic Days per Year
TH	Test Hole
TP	Test Pit
UBC	University of British Columbia
VWP	Vibrating Wire Piezometer
ULS	Ultimate Limit State

1. Introduction

1.1 General

The BC Ministry of Transportation and Infrastructure (BC MoTI) retained Ecora Engineering & Resource Group Ltd. (Ecora) to provide geotechnical engineering services necessary for the detailed design of the Yellowhead Highway 5 Commercial Vehicle Safety and Enforcement (CVSE) pullout located about 4 km south of Barriere, BC.

An intrusive geotechnical investigation of the site has been previously completed by the BC MoTI comprising the advancement of a total of six test holes drilled by Sea to Sky Drilling of Coquitlam, BC in 2018. Currently, the project is at the 100% detail design stage, and from our understanding, will be tendered sometime this year. Geometric cross-sections are attached as Appendix A. There was originally no geotechnical design scope, however, Mr. Michael George, P.Eng. has requested that a geotechnical assessment be completed for the CSVE pullout based on the test hole log data drilled in 2018.

This project will be completed in accordance with the requirements of Contract No. 862CS1840 (Southern Interior Region BC MoTI As-and-When Geotechnical Engineering Services Agreement), December 8, 2022, herein referred to as the "As-and-When".

This report summarizes the background review, site reconnaissance, results of our assessment, analysis, preliminary design options and recommendations.

1.2 Scope of Work

The scope of work summarized in our work plan dated April 12, 2023, includes the following:

- Desktop Review;
- Site Reconnaissance;
- Geotechnical Analysis and Design;
- Comments on Highway Drainage Design Considerations;
- Pavement Recommendations; and,
- Preparation of Geotechnical Assessment Report.

Approval to proceed with the work was granted on April 26, 2023, by Mr. Greg Holtus, the BC MoTI project manager.

1.3 Site Description

The site is located just off Yellowhead Highway, on a side dirt road parallel to the highway with a drainage ditch situated between the dirt road and the highway. The site is mostly covered in tall grass, is bound to the south by Yellowhead Highway, to the east by a ranch, to the west by small to medium sized trees and tall grass and to the north by the CP railroad and agricultural land.

2. Background Review

2.1 Surficial Geology

The 1:250,000 scale GSC map "Surficial Geology Bonaparte Lake, BC" (Tipper, 1971) indicates that the site is composed of large meltwater or outwash channels and river channels bounded by cutbanks and terraces.

2.2 Air Photo Review

A review of aerial photographs was undertaken to assess the historical changes of the site and any large-scale geomorphological features that may not be easily observed from the ground. The earliest air photograph dates back to 1948 and the most recent photos reviewed are from 2005. Table 2.2 lists the aerial photographs used for the report.

A road/ highway existed more-or-less along the same path as the current Yellowhead highway from the start of airphoto records in 1948, running parallel to the meandering Thompson River, which is on the north side of the Highway.

The air photos indicate that the dirt road that parallels the existing Yellowhead Highway was the original alignment of the highway, with the location of that current stretch of highway being repositioned sometime between 1995 and 2005.

The site location appears to be situated on a fluvial terrace, elevated above the river channel. A small gully exists east of the site location cutting into the terrace slope and has remained vegetated with trees throughout the duration of air photo coverage, as has the terrace slope between the existing location of the dirt road and agricultural land below.

At river elevation, directly north of the site agricultural land/ranch is situated on a point bar, access to this point bar/ ranch land appears to have been created between 1952 & 1964 when a small road/driveway was constructed from the highway. The geometry of the point bar has remained relatively consistent whereas the existence and geometry of a persistent midchannel bar has varied over time, indicating differential depositional activity or changes to river elevation of the Thompson River over time. This midchannel bar is not present in the 1952, 1975 and 1981 airphotos.

The terrain immediately to the south of the site, across the highway consists of a relatively sparsely vegetated moderately steep mountain slope with several small roads (presumably logging roads) running across the slope. Surrounding slopes on the southeast side of the Thompson River are more densely vegetated by tree cover until up to the 2005 airphoto. The 2005 airphoto's are markedly less vegetated throughout than previous airphotos aside from gullies and small pockets of standing vegetation. This sharp reduction of vegetation is likely due to wildfire damage from the 2003 McLure Wildfire.

Table 2.2 Summary of Relevant Airphotos

Aerial Photograph Date	Roll Number	Photo Number	Condition	Scale Average
1948	BC75	3	Greyscale	Not Available
1952	BC1502	51-52	Greyscale	1:20,000
1964	BC4250	78-79	Greyscale	1:15,000
1972	BC7437	23-24	Greyscale	1:20,000
1975	BC7741	253-254	Greyscale	1:15,000
1981	15BC81013	154-155	Greyscale	1: 40,000
1986	30BC86092	44-45	Greyscale	1:15,000
1990	30BCC90064	200-201	Greyscale	1:15,000

1995	30BCC95018	4-5	Greyscale	1:15,000
2000	30BCC00046	187-188	Colour	1:15,000
2005	30BCC05099	24-25	Colour	1:20,000

2.3 Water Well Logs

The Provincial Well Database, iMapBC, indicates that there are two wells that have been installed within 200 m southwest of the project limits. The available water well records were reviewed for lithology and static ground water information. The stratigraphy described in the well logs generally reflects the conditions encountered within the test holes.

Table 2.3 below provides a summary of the water well logs. The water well locations are shown on Figures 1.2 and the reports are provided in Appendix B.

Table 2.3 Summary of Water Well Logs

Well Tag No.	Easting (m)	Northing (m)	Static Water Level (m bgl)	Total Well Depth (m bgl)	Recorded Subsurface Conditions
85925	698541	5664004	54.6	59.8	0.0 m-10.7 m: Sand and Gravel
					10.7 m-15.2 m: Boulder
					15.2 m-60.0 m: Sand and Gravel
					60.0 m-61.0 m: Bedrock
121283	698499	5663976	53.2	67.1	0.0 m-10.7 m: Sand and Gravel
					10.7 m-15.2 m: Cobbles and Gravel
					15.2 m-58.5 m: Sand and Gravel
					58.5 m-60.1 m: Silty Sand and Gravel
					60.1 m-67.1 m: Gravel and Bedrock

3. Site Reconnaissance

3.1 General

Ecora conducted a site reconnaissance of the site on June 16, 2023.

Key observations from the site inspection are as follows:

- The site is relatively flat with a single lane access trail that connects to Hwy 5 at the south and north ends of the site. Outside of the gravel trail the site is vegetated with small to medium sized grasses. The narrowest section of the site is at the entrances to the access trail, with the widest part being in the centre of the site, measured at about 35 m. The site is about 2 m below the current highway elevation.
- The west side of the site is bounded by the crest of a slope that is vegetated with small to medium sized tress and grasses. The slope was measured at about 36° at the south end of the site and about 42° at the north end of the site.
- The railroad alignment is about 115 m west of the site at the south end and measured about 32 m below the average site grades at this location. Moving north the railway consistently diverges further north and west away from the site. At the northern extents of the site the railway is about 330 m away.

- Stockpiles of gravel and rock were being stored on the site. The northern stockpile was comprised of gravel with some angular cobble and boulders up to about 1.3 m in diameter. This stockpile, measured in the field had a footprint of about 45 m x 12 m and appeared to be about 33 dump tuck loads. The southern stockpile contained less gravel and was about 20 m x 10 m in footprint and about 10 truck loads. Samples were collected of each stockpile for specific gravity and point load testing. Lab tests on the rock samples will be reported under separate cover when available.

Photographs from the site reconnaissance are included in the attached photography log at the end of this report.

3.2 Laboratory Testing

Following our site reconnaissance rock samples obtained from the two onsite stockpiles were submitted to our Penticton laboratory for point load specific gravity testing. Specific gravity testing was based on the ASTM D6473 designation. Ecora's detailed laboratory testing results are provided in Appendix C.

4. Geotechnical Site Investigation

Six test holes were advanced by Sea to Sky Drilling Services Ltd., of Coquitlam, BC in November of 2018 using a B53 truck mounted drill rig. A site plan showing the test hole locations is attached following the text of this report and labeled Figure 1.2. The test holes ranged in depth from 9.1 mbgs (TH18-04) to 21.2 m (TH18-01). No Ecora representative was present onsite during drilling. All information used in the analysis discussed below was retained from drill logs provided by MoTI as described by Sea to Sky Drilling Services Ltd.

Standard Penetration Testing (SPT) was carried out at regular intervals within the depth zone investigated by the test hole. The SPT is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. It comprises a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of 650 mm. This is driven into the ground at the bottom of a borehole by blows from a drop hammer with a weight of 63.5 kg (140 lb) falling through a distance of 760 mm (30 in). The sample tube is driven into the ground and the number of blows needed for the tube to penetrate increments of 150 mm (6 in) up to a depth of 450 mm (18 in) is recorded. The sum of the number of blows required for the second and third 150 mm (6 in) increments of penetration is termed the "standard penetration resistance" or the "N-value".

A summary of the geotechnical site investigation is provided in Table 4 below. TH18-06 was not drilled for reasons unknown to Ecora. The test hole logs are included in Appendix D.

Table 4 Test Hole Summary

Test Hole Number	Northing (m)	Easting (m)	Elevation (masl)	Termination Depth (mbgl)
TH18-01	5664088.8	698402.6	407.22	21.2
TH18-02	5664186.0	698471.1	411.0	15.5
TH18-03	5664219.9	698526.8	412.33	15.2
TH18-04	5664263.5	698599.1	414.0	9.1
TH18-05	5664293.3	698657.7	414.61	11.7
TH18-07	Not Provided	Not Provided	410.99	15.5

5. Encountered Subsurface Conditions

The soils encountered within the 2018 test hole logs are consistent with the interpreted fluvial terrace assumption from the air photo analysis and site reconnaissance. Within all test hole poorly graded cohesionless material was encountered ranging from sand to gravel. Trace to some fines were indicated within TH18-03 and TH18-05 logs. Relative density of the encountered materials from SPT results generally ranged from compact to dense

becoming very dense below the compact to dense layer. Some SPT blow counts indicate loose material at shallower depths. Bedrock was encountered at 9.3 mbgs in TH18-05 and was not encountered in any of the other five test holes. Groundwater was not indicated on the borehole logs and is expected to be close to the North Thompson River elevation which is consistent with the water well logs 200 m southwest of the site. No laboratory testing was conducted on samples retrieved from the subsurface investigation.

6. Slope Stability Analysis

6.1 General

The results presented herein have been assessed using the BC MoTI Supplement to the Canadian Highway Bridge Design Code S6-19 (CHBDC) (2022).

6.1.1 Geotechnical Model

Limit Equilibrium (LE) stability analyses were carried out to evaluate the long-term static and pseudo-static stability of two proposed sections – one fill slope and one existing slope at stations 119+10 and 119+60, respectively.

It is not known at this time if rock fill or pit run will be used as the embankment fill, therefore two scenarios were modeled for the fill slope. The analysis for the existing slope was used as a back analysis to confirm soil properties.

The cross-sectional geometry used for the analysis was provided by the project geometric designed Urban Systems Ltd. In the slope model, it has been assumed that the stratigraphy derived from the test holes provided by MoTI is consistent throughout the slope. A 12 kPa traffic surcharge was applied to the asphalt surface beginning at the nearest fog line of the pull as depicted on the cross-section's drawings provided by Urban Systems titled L110 Design Sections Yellowhead Highway No. 5 Badger CVSE Pullout and dated 2019-04-12.

Circular (global) factors of safety for the proposed slopes were calculated using the two-dimensional LE analysis program Slide2.0™ by RocScience utilizing the Morgenstern-Price method with a half sine interslice force adopted.

6.1.2 Geotechnical Factors of Safety

Table 4.3.a of the BC MoTI Supplement to the CHBDC (2022) provides the minimum factors of safety of embankments for global stability corresponding to the site consequence and degree of understanding. The table is summarized in Table 6.1a.

Table 6.1a Summary of Geotechnical Factors of Safety for Global Stability of Embankments

Degree of Understanding	Low			Typical			High		
Consequence	High	Typical	Low	High	Typical	Low	High	Typical	Low
Consequence Factor from S6-14	0.90	1.00	1.15	0.90	1.00	1.15	0.90	1.00	1.15
FoS for Global Stability-Permanent	1.85	1.67	1.45	1.71	1.54	1.34	1.59	1.43	1.24
FoS for Global Stability-Temporary	1.59	1.43	1.24	1.48	1.33	1.16	1.39	1.25	1.09

Assuming a typical degree of understanding and low consequence level, given that it is a pullout feature and not the highway, the minimum factor of safety of 1.34 for the permanent global stability and 1.1 for pseudo-static slope stability has been applied in this analysis.

6.1.3 Seismic Hazard

The Supplement to the CHBDC S6-19 stipulates that seismic design shall be carried out using the performance-based design approach specified in Clause 4.4.6 with criteria based on meeting specific structural, functional, and service performance criteria under specified seismic hazards.

The site classification was determined based on Standard Penetration Values (N_{60}) from the test holes. The N_{60} value used in seismic design is the average value measured for the top 30 meters of soil and/or bedrock. Based on Table 4.1 in CHBDC S6-19 (CSA, 2019), and with consideration to the test hole logs, a seismic site classification of Class 'D' (Stiff Soil) is anticipated.

Peak Ground Accelerations (PGA) and Spectral Accelerations (Sa(T)), for a reference "Class D" site, can be obtained from the Earthquakes Canada website (http://earthquakescanada.nrcan.gc.ca) for various return periods. Hazard values for the project area are presented in Table 6.1b.

Table 6.1b Reference (Class D) Design PGA and Sa(T)

Return Period	PGA (g)	Sa(0.2) (g)	Sa(0.5) (g)	Sa(1.0) (g)	Sa(2.0) (g)
475-year	0.04	0.10	0.11	0.08	0.05
975-year	0.06	0.15	0.15	0.12	0.08
2,475-year	0.10	0.25	0.23	0.18	0.13

6.1.4 Soil Parameters

Geotechnical design parameters used in the analysis are given in Table 6.1c and have been derived based on the soils encountered during the geotechnical site investigation, a back analysis of the existing slope, published correlations, and Ecora's previous local experience.

Several publications provide typical values for a range of different soil types encountered, such as Bowles (1997), which provides representative values of angle of internal friction and the Washington State Department of Transportation (WSDOT) Geotechnical Design Manual which outlines typical material properties for materials similar to those found in the Interior of BC.

The analysis generally assumes that the soil shear strength is governed by the Mohr-Coulomb criteria given by:

$$\tau = c' + \sigma' tan\phi'$$

Where: τ = Soil Shear Strength;
c' = Effective Cohesion;
σ' = Normal Effective Stress; and,
ϕ' = Effective Angle of Internal Friction.

Table 6.1c Summary of Input Parameters

Material Name	Strength Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (°)
Road Gravels	Mohr-Coulomb	21	0	40
Compact Sandy Gravel	Mohr-Coulomb	19	2	36
Loose Sandy Gravel	Mohr-Coulomb	17	1	32
Embankment Fill – Pit Run	Mohr-Coulomb	21	0	38
Embankment Fill – Rockfill	Mohr-Coulomb	21	0	40

6.1.5 Results

The results of the stability analysis for static and pseudo-static conditions for the existing slope and fill slope are summarized in Table 6.1d below and presented on the attached Figures 6.1a to 6.1f.

The fill slope meets the required minimum static FoS for the design criteria.

Table 6.1d Global Stability Results

Model Scenario	Condition	Slope	Calculated Static Minimum FoS	Figure
Existing Slope (Back Analysis) STA. 119+10	Static	1.4H:1V	1.36	6.1a
Fill Slope – Rock Fill STA. 119+60	Static	1.5H:1V	1.42	6.1b
Fill Slope – Pit Run STA. 119+80	Static	1.75H:1V	2.16	6.1c
Existing Slope (Back Analysis) STA. 119+10	Pseudo-static	1.4H:1V	1.21	6.1d
Fill Slope – Rock Fill STA. 119+60	Pseudo-static	1.5H:1V	1.24	6.1e
Fill Slope – Pit Run STA. 119+80	Pseudo-static	1.75H:1V	1.69	6.1f

The analysis is based on cross-sections provided by Urban Systems attached in Appendix A.

7. Discussion and Recommendations

7.1 General

The fill slope proposed in the 100% detail design drawings meet the minimum required FoS as per BC MoTI Supplement to the CHBDC (2022) for a low consequence and typical degree of understanding.

7.2 Site Stripping and Subgrade Preparation

Topsoil, undocumented fills, organics, loose material, or debris are not considered to be suitable subgrades for roads. Unsuitable material shall be sub-excavated and removed to exposed suitable subgrade soils comprising undisturbed, compact granular deposits free of ponding water. Exposed subgrades shall be proof rolled using a large vibratory drum roller and approved by a qualified geotechnical engineer prior to the placement of fill. The anticipated stripping depth is 300 mm to expose a subgrade of compact to dense sandy gravel.

7.3 Embankment Fill

7.3.1 Type D - Granular Fill

Where the embankment fill consists of granular pit run soils the material shall contain less than 15% by volume of rock larger than 150 mm, be free from excess fines (less than 12% by mass passing the 0.075 mm sieve), organics and deleterious matter. Upon subgrade approval from the geotechnical engineer, fill may be placed and shall be moisture conditioned and placed in horizontal lifts and thicknesses being compacted to the required percentage of Standard Proctor Maximum Dry Density obtained by ASTM D698, as specified in the table below (reproduction of Table 201-A (Section 201, BC MoTI Volume 1)).

Table 7.3 Lift Thicknesses and Required Density by Depth Below Subgrade

Depth Below Subgrade (mm)	Maximum Uncompacted Lift Thickness (mm)	Minimum Density (%SPD)
0 to 300	100	100
300 to 500	100	95
Below 500	200	95

As per Section 201.36 and 201.37 of the BC MoTI Standard Specifications for Highway Construction Volume 1 (2020), the slopes of the embankment of the original ground shall be terraced in a continuous series of steps, at a minimum 1.5 m width as the embankment construction rises.

7.3.2 Type A – Rock fill

The maximum particle size of Type A (rock fill) shall be no greater than 450 mm and should not have more than 15% smaller than 125 mm. Based on the testing results of the selected rock samples from the two stockpiles located onsite the material would be considered suitable for use as Type A rockfill where required for embankment construction, provided grading requirements are met.

All embankment fill material is subject to approval by a geotechnical engineer prior to placement and compaction.

7.4 Temporary Excavation and Utility Trenching

Temporary excavation work should be carried out in accordance with requirements specified by the WorkSafe BC Occupational Health & Safety (OH&S) Regulations, Part 20. Soil sloughing, development of tension cracks atop the excavation, groundwater seepage or loose/soft soil conditions encountered during excavation may require flatter excavation slopes than those specified in the WorkSafe BC OH&S Regulations, Part 20. A qualified geotechnical engineer shall review all proposed temporary excavation works during construction, when required by WorkSafe BC.

Excavated material from trenches should either be removed from the site or placed a minimum distance away from the excavation, equal to the depth of the excavation. Where roads, buildings or other structures are near the excavation, additional review of the proposed excavation work should be undertaken by a qualified geotechnical engineer.

All utilities should be bedded as per the BC MoTI SS (2020). General trench backfill above the bedding should be placed in loose lifts not exceeding 300 mm thickness, and each lift should be compacted to a minimum of 95% Modified Proctor Maximum Dry Density (MPMDD).

7.5 Proposed Wildlife Crossing

Ecora understands that a wildlife crossing in the form of a 900 mm diameter buried pipe below Highway 5 is being considered near the sites eastern limit of construction. However, the exact location has not yet been chosen. The crossing is still at the conceptual stage at the time of writing and design drawings have not yet been provided to Ecora with specific details regarding the crossing. Two options have been considered for installing the crossing, an open trench option "cut and cover" and a trenchless option "jack and bore".

The open cut option would involve excavating through the highway, installing a CSP culvert and backfilling. This option will require traffic control and lane closures. It will also require a period with a gravel travel surface at the excavation location once backfilled prior to paving.

The trenchless option would involve horizontally boring the subsurface soils from an excavation adjacent to the highway embankment and jacking a smooth steel pipe below the highway. This option if successful would not require closure to the highway. The subsurface soils within the highway embankment are granular and contain

frequent cobbles. There is also a bedrock outcrop east of the proposed crossing location to which the extents below the highway at the crossing location are unknown. There is significant risk that the trenchless option would encounter an obstruction and either have to change direction to avoid the obstruction or excavate through the highway surface to remove the obstruction. Any location that is bored and then abandoned due to obstruction would also require an excavation and controlled backfill to prevent settlement of the highway, which would require closure to a portion of the travel surface of the highway. There is also significant risk with future settlement of the highway surface with the trenchless option specifically if obstructions are encountered and removed outside of the pipe diameter.

7.6 Erosion and Sediment Control

7.6.1 Erosion Mechanisms

Erosion is the wearing away of material by naturally occurring agents through the detachment and transport of soil materials from one location to another, usually at a lower elevation. Natural agents are mostly responsible for this phenomenon but the extent to which erosion occurs can be considerably accelerated through human activities.

Water is typically the predominant agent of erosion on highway construction sites due to the subgrade soils typically consisting of highly erodible soils. In general, soils containing high proportions of silt and very fine sand are usually the most erodible. Below are three common types of erosion resulting from water transporting soil materials:

- Raindrop Erosion – The effect of dislodging soil particles by the impact of raindrops on unprotected exposed soil surfaces;
- Sheet Erosion – Resulting from overland flow of water and is the initial mechanism for transport of soil dislodged by raindrop erosion; and,
- Rill and Gully Erosion – Movement of soil particles due to concentration of runoff in the depression in the ground surface.

7.6.2 Erosion and Sediment Control

Erosion control is the most successful when measures are implemented to prevent the dislodgement of soil particles. The following is a list of potential temporary and permanent erosion control measures as indicated in the MoTI (1997) "Manual of Control of Erosion and Shallow Slope Movement".

- **Diversion Ditches** – A channel upslope of the crest, usually with a ridge on the lower side, constructed to intercept and divert stormwater runoff away from the slope to a stabilized outlet at non-erosive velocities;
- **Granular / Rock Blankets** – A permanent, erosion-resistant ground cover of large, loose, angular stone installed on the slope face wherever soil conditions, water turbulence and velocity, expected vegetation cover, etc., are in a condition that may allow the soil to erode;
- **Vegetation Covers** – Vegetation covers such as hydro-seeding remains one of the most effective and economical methods for large-scale applications of surface erosion control. Hydro-seeding consist of spraying a slurry of seed and mulch upon the slope face. Where hydroseeding is utilized to revegetate cut slopes, a product must be selected that adheres to the manufacturer's specifications regarding the maximum slope angle for which product is to be utilized for as well as the environmental characteristics of the subject site; and,
- **Slope Roughening** – Consists of grooving slopes or leaving slopes in a roughened state by not finishing the slope with a smooth grade. The roughened slopes will reduce runoff velocity, provide

sediment trapping and increases infiltration, and facilitates the establishment of vegetation on the exposed slope.

7.7 Foundations

7.7.1 General

It is anticipated that the project will likely include the construction of minor structures such as signs, signals and illumination, or other ancillary structures constructed in general accordance with the following BC MoTI Standard Specifications for Highway Construction:

- Section 407 for Foundation Excavations; and
- Section 635 Electrical and Signing.

7.7.2 Shallow Foundation Design Parameters

Typically, the minor structures associated with signs, signals and illumination, etc. are relatively tall and lightweight, as such overturning due to wind loading generally govern the foundation design instead of settlement.

Section 635 in the BC MoTI 2020 Standard Specification has several standard shallow foundation designs for typical highway structures mentioned above. If the typical shallow foundation designs are not applicable for the structure, or a specific foundation design is required, the following geotechnical recommendations and parameters have been provided.

If a sign base, highway marker or ancillary structure with a shallow foundation cannot be designed or constructed in accordance with Drawings in Section 635, the foundation should be designed with the parameters given in Table 7.6 below.

Geotechnical resistance factors for ultimate and serviceability limit states shall be in accordance with Table 6.2 of S6-19 Canadian Highway Bridge Design Code (CHBDC 2019).

Table 7.6a Parameters for the Design of Shallow Foundations in Compression and Sliding

Anticipated Soil Type at Footing Subgrade	Unit Weight (kN/m^3)	Unfactored ULS Ultimate Bearing Resistance (kPa)	Foundation/Soil Interface Angle of Friction[1] (degrees)
Native Sand and Gravel or Compacted Structural Fill	17	550	29

Note: [1] Interface friction angle from Table 24.4 Canadian Foundation Engineering Manual (CFEM)

It is anticipated that excavated on-site materials may be used as a foundation surcharge to resist uplift and overturning forces. Geotechnical design parameters for the re-use of on-site material in the design of shallow foundations in uplift are provided in

Table 7.6 below, assuming these materials are compacted to a minimum of 95% of SPMDD or greater.

Table 7.6b Parameters for the Design of Shallow Foundations in Uplift

Surcharging Material	Unit Weight (kN/m^3)	Angle of Friction (degrees)	Rankine Passive Earth Pressure Coefficient
Native Sand and Gravel or Compacted Structural Fill	17	32°	3.0

A geotechnical engineer shall review the soil conditions at the foundation grade prior to the construction of foundation formwork, to confirm the actual soil conditions encountered at the foundation grade are suitable to support the footings.

A minimum footing width of 600 mm is recommended, and the underside of foundations should also be located below a 2H:1V line projected up from the base of adjacent foundations, underground services, etc. otherwise the bearing resistances provided above may need to be reduced.

7.8 Frost Penetration

Frost susceptibility of soils refers to the propensity of the soil to grow ice lenses and heave during freeze and thaw cycles. Based on publicly available information through ClimateBC Map the unfactored unheated frost depth through the granular roadway fill materials is estimated to be 1.2 m below finished grade at the proposed site location. Therefore, the underside of footings and utilities should be placed at least 1.2 m below the site grade to conform to the frost penetration requirements.

7.9 Pavement Design

7.9.1 General

The pavement design for the pullout was designed based on the traffic data from the daily volume counts at Little Fort South between 08/22/2022 and 09/08/2022. The location of the volume count was on the Highway 5 southbound lane 0.5 km south of Route 24. It has been assumed that 30% of the AADT is heavy vehicles that will use the turnout. It should also be noted that the vehicles will not be traveling at highway speeds and will be braking and parked at times. The traffic data report is included in Appendix E.

7.9.2 Relevant Standards

Ecora used the following design guidelines and relevant background information in pavement design:

- BC MoTI (Jan 26, 2015). "Pavement Structure Design Guidelines – Technical Circular T-01/15";
- AASHTO (1993) "Guide for Design of Pavement Structures"; and,
- Available traffic data located in the vicinity of the project was obtained from the BC Traffic Data Program (https://www.th.gov.bc.ca/trafficData/).

7.9.3 Traffic Assumption and Analysis

According to the BC MoTI "Pavement Structure Guidelines" (Technical Circular T-01/15, 2015), the 20-year design Equivalent Single Axle Loads (ESALs) for the design lane is calculated as follows.

ESAL = AADT * HVP * HVDF * NALV * TDY

Where:

ESAL – Equivalent single axle loads per lane per year (for the base year)

AADT – Average annual daily traffic (all lanes & both directions)

HVP – Heavy vehicle percentage

HVDF – Heavy vehicle factor (percent of heavy vehicles in the design lane)

TDY – Traffic days per year

Note: ESAL's (base year) x 20-year traffic growth rate factor = 20-year Design ESAL's

Calculations of the 20-year design lane traffic ESAL's are based on review of BC MoTI traffic count site "Little Fort South 21-011NS-NY". The growth factor is estimated at 2% for the 20-year design.

It should be noted that specific data on the percentage of AADT that are trucks as well as how many days the pullout will be open per year is unknown. In lieu of this information conservative estimates of 30% truck traffic and every truck that passes pulls into the pullout was considered in the traffic analysis.

A summary of the traffic design parameters and the 20-Year Design Lane ESALs is provided in Table 7.8a below.

Table 7.9a Design ESAL's

Design Parameter	Southbound
Current Average Annual Daily Traffic (AADT)	2,140
Traffic Days per Year (TDY)	365
Heavy Vehicle Factor (HVP)	0.3
Heavy Vehicle Lane Factor (HVDF)	1.0
ESALs per Vehicle (NALV)	2
20-Year Design Lane Traffic (ESALs x 10^6)	**11.38**

7.9.4 Minimum Required Pavement Design Structural Number

The required minimum pavement design Structural Number has been calculated based on the "AASHTO Guide for Design of Pavement Structures" (AASHTO, 1993) formula for flexible pavements using the recommended design parameters provided in Table 3 of the MoTI "Pavement Structure Design Guidelines" (2015). A subgrade resilient modulus (M_R) of 75 MPa was assumed in the analysis based on likely fill materials and correlation with soil index properties of the encountered pavement subgrade soils as summarized in Table 2 of Appendix CC-1 of the National Cooperative Highway Research Program (NCHRP) publication "Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures" (2004).

A summary of the AASHTO (1993) design parameters and the minimum required pavement design structural number is provided in Table 7.8b.

Table 7.9b Minimum Required Pavement Design Structural Number (based on AASHTO, 1993)

Design Parameter	Design Lane
20-Year Design Lane Traffic (ESALs x 10^6)	11.38
Analysis Period (Years)	20
Reliability (R)	90%
Standard Deviation (S_0)	0.45
Initial Serviceability Index (pi)	4.2
Terminal Serviceability Index (pt)	2.5
Design Resilient Modulus (M_R)	60
Minimum Required Pavement Design Structural Number (S_N) mm	**122**

7.9.5 Pavement Structure Type & Design

Of the four typical pavement structures provided in the MoTI "Pavement Structure Design Guidelines" (Type A, B, C, and D), the applicable pavement structure type, determined by traffic loading, anticipated subgrade type,

drainage, local climate etc. is considered to be 'Type B'. The typical pavement types and their respective attributes are shown in Table 7.8c below.

Table 7.9c Pavement Structure Type

Pavement Structure Type	Roadway Designation	20 yr. Design ESAL Criteria	Typical Asphalt Concrete Pavement Thickness
A	High volume roads, truck lanes, specialty locations	> 20,000,000	≥ 150 mm
B	Medium to high volume roads	100,000 to 20,000,000	75 to 150 mm
C	Low volume & subdivision roads	< 100,000	50 to 75 mm
D	Low volume sealcoat or gravel road	< 100,000	Graded aggregate sealcoat layer(s)

Based on a review of available traffic data/ESAL's, the required minimum pavement design structural number, anticipated subgrade conditions, and using the recommended AASHTO (1993) structural layer and drainage coefficients provided in Table 3 of the MoTI "Pavement Structure Design Guidelines" (2015) to determine the pavement design structural number, Ecora recommends the following minimum pavement structure thicknesses as summarized in Table 7.8d.

Table 7.9d Pavement Structure Design Thickness

Pavement Structure Type	Minimum Thickness
Hot Mix Asphalt	125 mm
Crushed Granular Base (25 mm Well-Graded Base -WGB)	300 mm
Select Granular Subbase (SGSB)	300 mm

Construction of granular surfacing, granular base and SGSB shall follow Section 202 of the "Standard Specifications for Highway Construction" (MoTI, 2020).

Granular surface materials shall be placed in loose 300 mm thick (150 mm compacted thickness) lifts, adequately moisture conditioned and compacted to 100% of the SPMDD (ASTM D698).

Asphalt pavement construction shall follow Section 502 of the "Standard Specifications for Highway Construction" (MoTI, 2020).

7.9.6 Pavement Joints and Transitions

In areas of transition between existing and new pavement construction some areas of asphalt levelling course or overlay may be required to compensate for irregularities in the existing surface. In areas where asphalt levelling course or overlay is required it is recommended that this consists of Class 1 Medium 16 mm asphalt mix placed in lift thickness between 50 mm and 75 mm.

We recommend during detailed design, the extraction of additional asphalt cores within the transition areas from the new construction to the old construction as this would assist in ensuring adequate transition treatments.

Where asphalt levelling course or overlay is not required at transitions between existing and new pavement construction the formation of a butt joint is recommended. The butt joint shall be milled within the existing pavement a minimum of 300 mm in width and approximately 50 mm deep and repaved inconjunct ion with the new asphalt placement. For longitudinal pavement and traverse pavement details, see Diagrams 7.1 and 7.2, respectively, below.

Where new pavement construction is to occur adjacent to lanes of existing pavement, care shall be taken that construction of the new pavement will not impede drainage of the existing pavement base and sub-base layers. In

situations where an increase of the vertical alignment of the road profile results in an overlay of the existing pavement it may be necessary to increase the thickness of the sub-base layers of the new pavement structure to ensure adequate drainage.

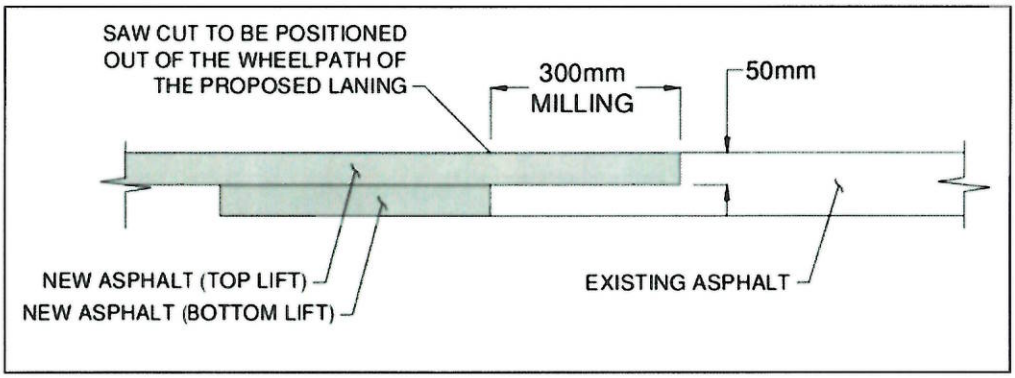

Diagram 7.1 Longitudinal Pavement Joint Detail

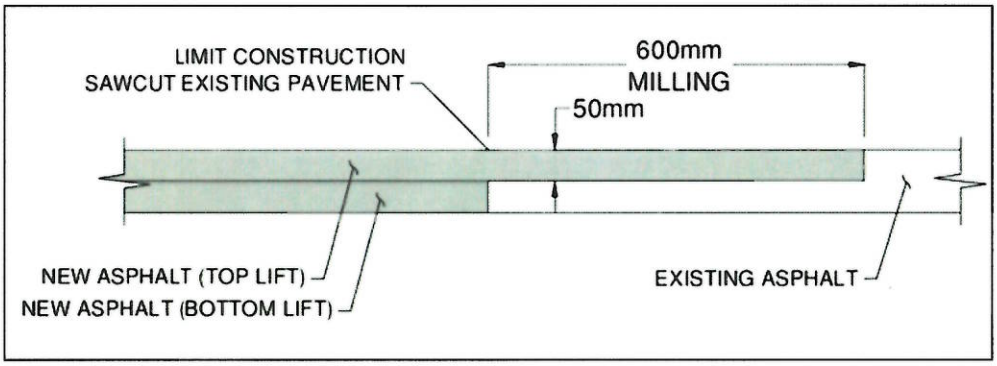

Diagram 7.2 Traverse Pavement Joint Detail

7.9.7 Deceleration Lane

In the deceleration lane the forces due to braking by heavy traffic can be very significant and may shove the pavement resulting in rutting. On the lane itself, shear stress imposed by heavy traffic due to centrifugal forces can be high and regular asphalt mixes may not be able to cope with them resulting in lateral deformation and cracking. Ecora is of the opinion that modifications to the layer in the deceleration lane should be implemented in aim to reduce the higher potential for rutting.

While the pavement strength design is designed to accommodate the heavy vehicle loading. The slow-moving trucks and their deceleration while entering the facility may challenge the performance of the asphalt layer. In an effort to reduce the impact of the heavy vehicles on the performance of the pavements, the following modifications to the asphalt layer are recommended:

1. Avoid asphalt mixes with finer gradations and higher sand contents to mitigate rutting. It is recommended that the 37.5 mm coarse mix provided in Table 502-D be selected for the lower base lift of asphalt. It should be placed and compacted in 1 layer. The 16 mm medium mix is recommended for the top lift surface course.
2. While a 120/200A Pen. (PG 58-28) asphalt cement grade is typically used for projects in the Southern Interior Region, it is recommended that the 80/100A Pen (PG 64-22) grade be used for this project. The stiffer asphalt cement will provide a mix better suited to rut resistance.
3. Polymer Modified asphalt is commonly used in areas subjected to slow moving, heavy truck traffic and will improve the rut resistance of the mix and is recommended for the top lift of asphalt.

8. Closure

We trust that this report satisfies your present requirements. If you have any questions or comments, please feel free to contact our office at your earliest convenience.

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Figures


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TH18-06
TH18-05
TH18-04
TH18-03
TH18-02
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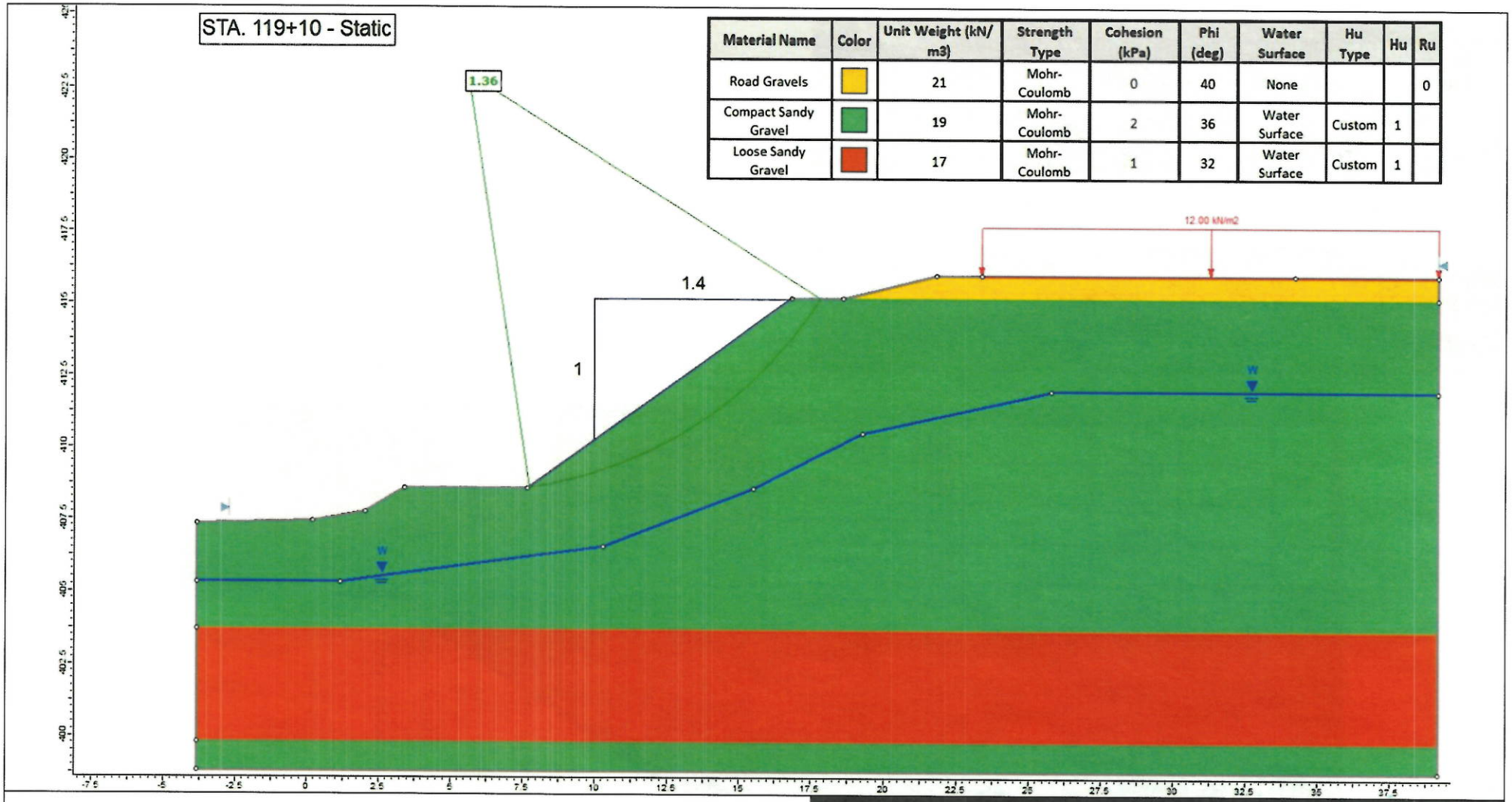

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Road Gravels		21	Mohr-Coulomb	0	40	None			0
Compact Sandy Gravel		19	Mohr-Coulomb	2	36	Water Surface	Custom	1	
Loose Sandy Gravel		17	Mohr-Coulomb	1	32	Water Surface	Custom	1	

Notes: STA. 119+10

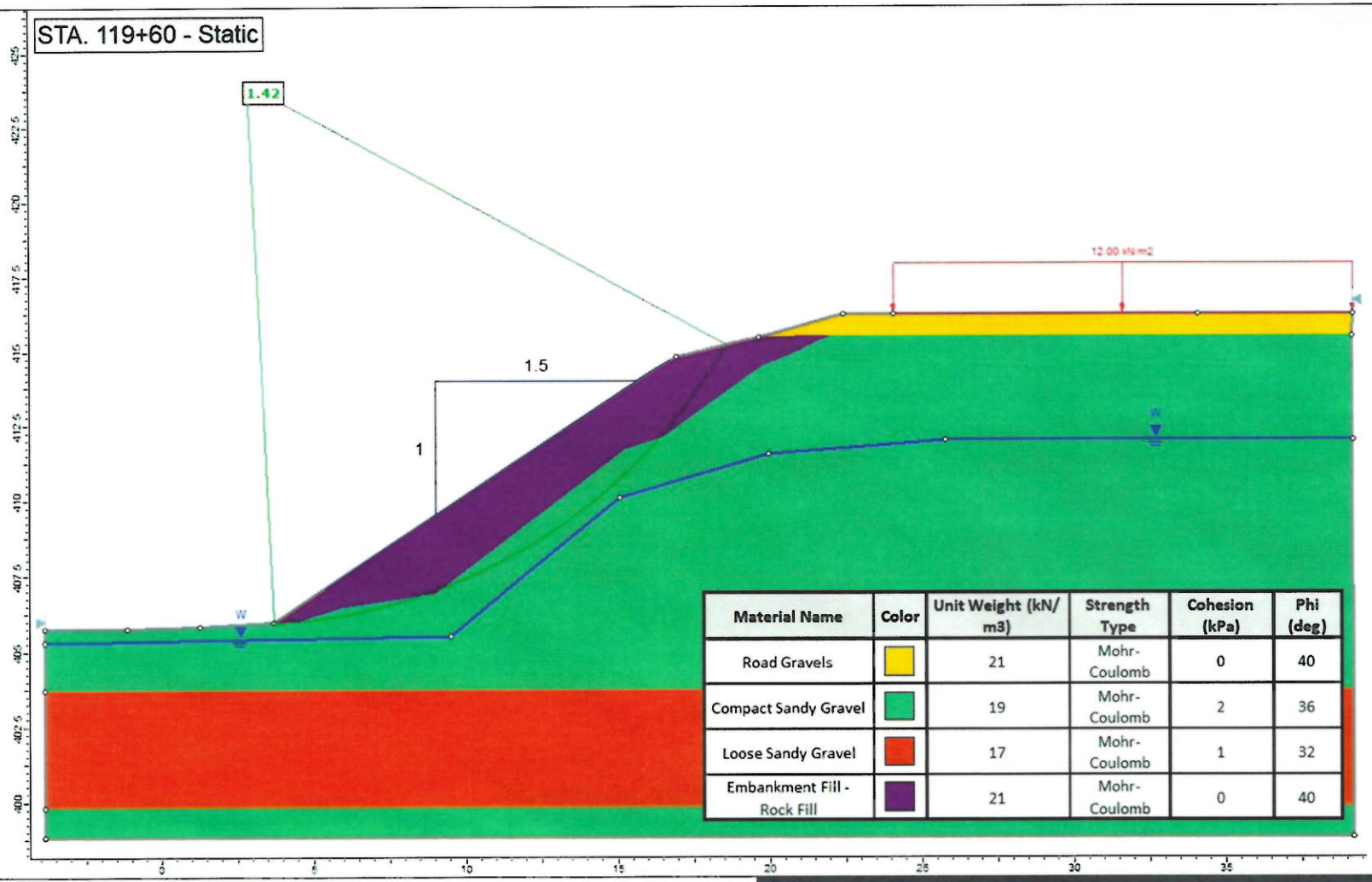
Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Static Slope Stability – Existing Slope

Project No. 221266-27
Client: BC MoTI
Office: Kelowna
Scale: NTS
Date: JULY 4, 2023
DWN: NF CHK: MJL

ecora

Figure 6.1a



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)
Road Gravels		21	Mohr-Coulomb	0	40
Compact Sandy Gravel		19	Mohr-Coulomb	2	36
Loose Sandy Gravel		17	Mohr-Coulomb	1	32
Embankment Fill - Rock Fill		21	Mohr-Coulomb	0	40

Notes: STA. 119+60

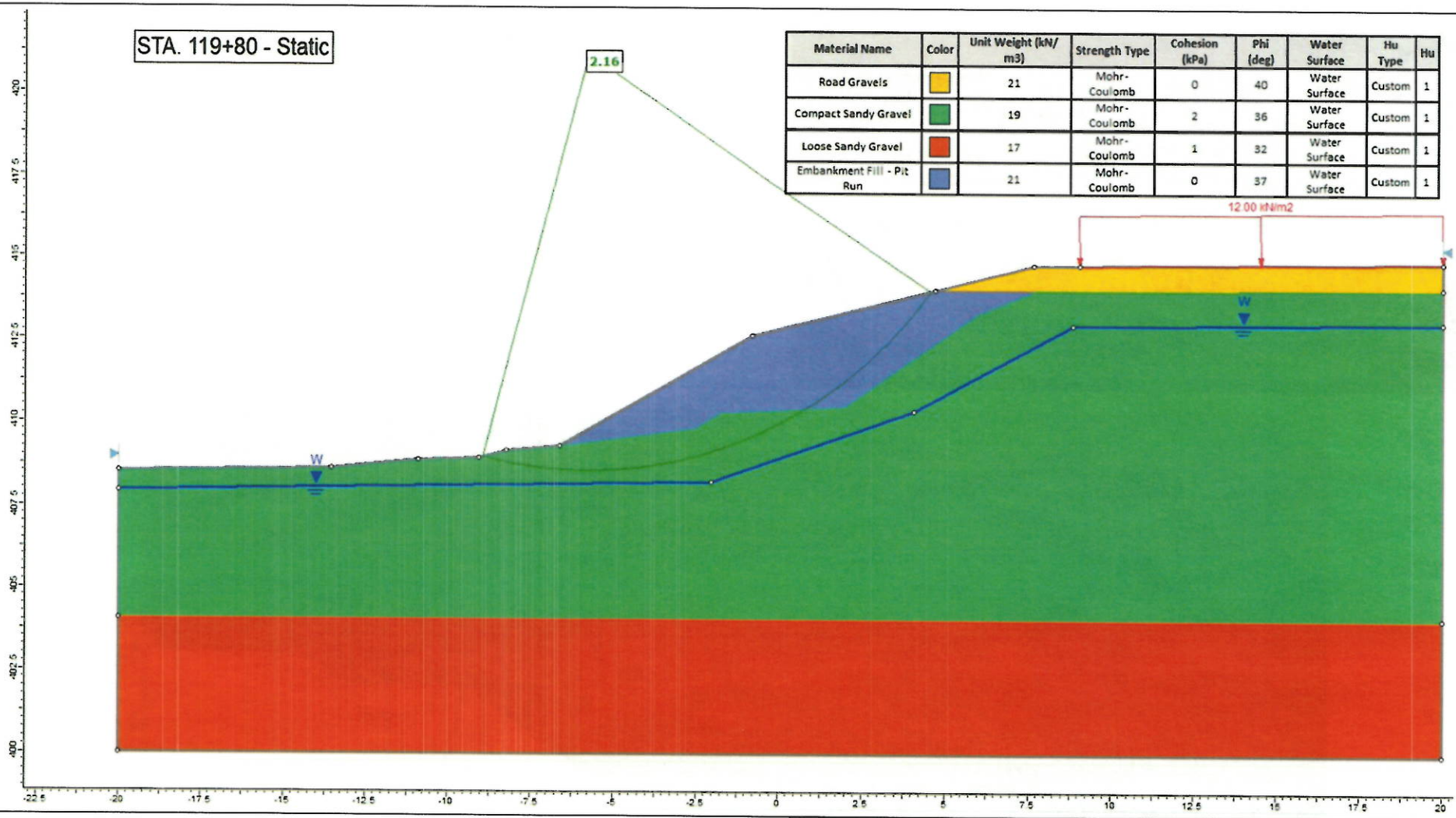
Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Static Slope Stability – Rock Fill Slope

Project No. 221266-27
Client: BC MoTI
Office: Kelowna
Scale: NTS
Date: JULY 4, 2023
DWN: NF CHK: MJL

ecora

Figure 6.1b



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Road Gravels		21	Mohr-Coulomb	0	40	Water Surface	Custom	1
Compact Sandy Gravel		19	Mohr-Coulomb	2	36	Water Surface	Custom	1
Loose Sandy Gravel		17	Mohr-Coulomb	1	32	Water Surface	Custom	1
Embankment Fill - Pit Run		21	Mohr-Coulomb	0	37	Water Surface	Custom	1

Notes: STA. 119+80

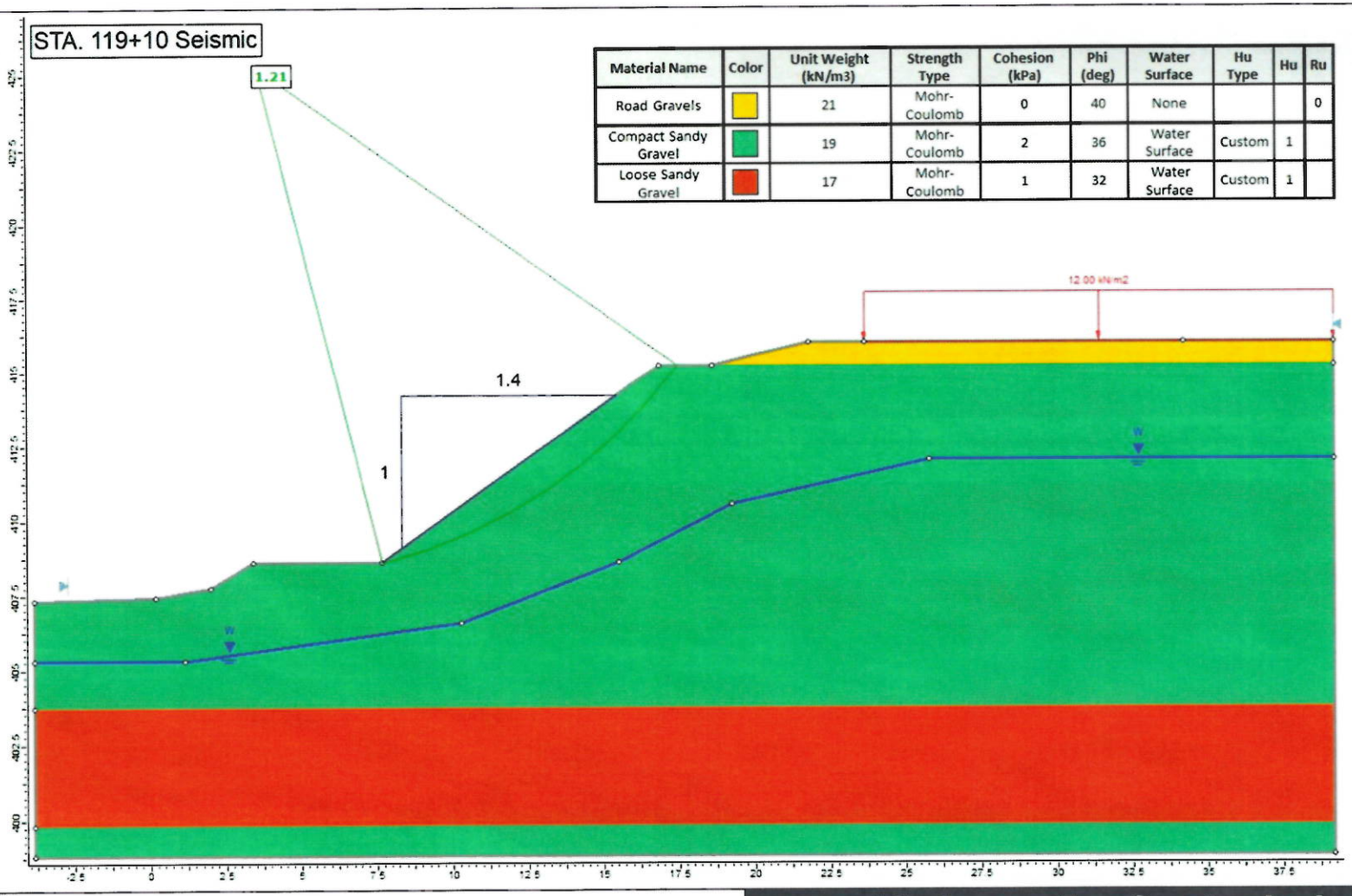
Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Static Slope Stability – Pit Run Fill Slope

Project No. 221266-27
Client: BC MoTI
Office: Kelowna
Scale: NTS
Date: JULY 4, 2023
DWN: NF CHK: MJL

ecora

Figure 6.1c



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Compact Sandy Gravel		19	Mohr-Coulomb	2	36	Water Surface	Custom	1	
Loose Sandy Gravel		17	Mohr-Coulomb	1	32	Water Surface	Custom	1	

Notes: STA. 119+10

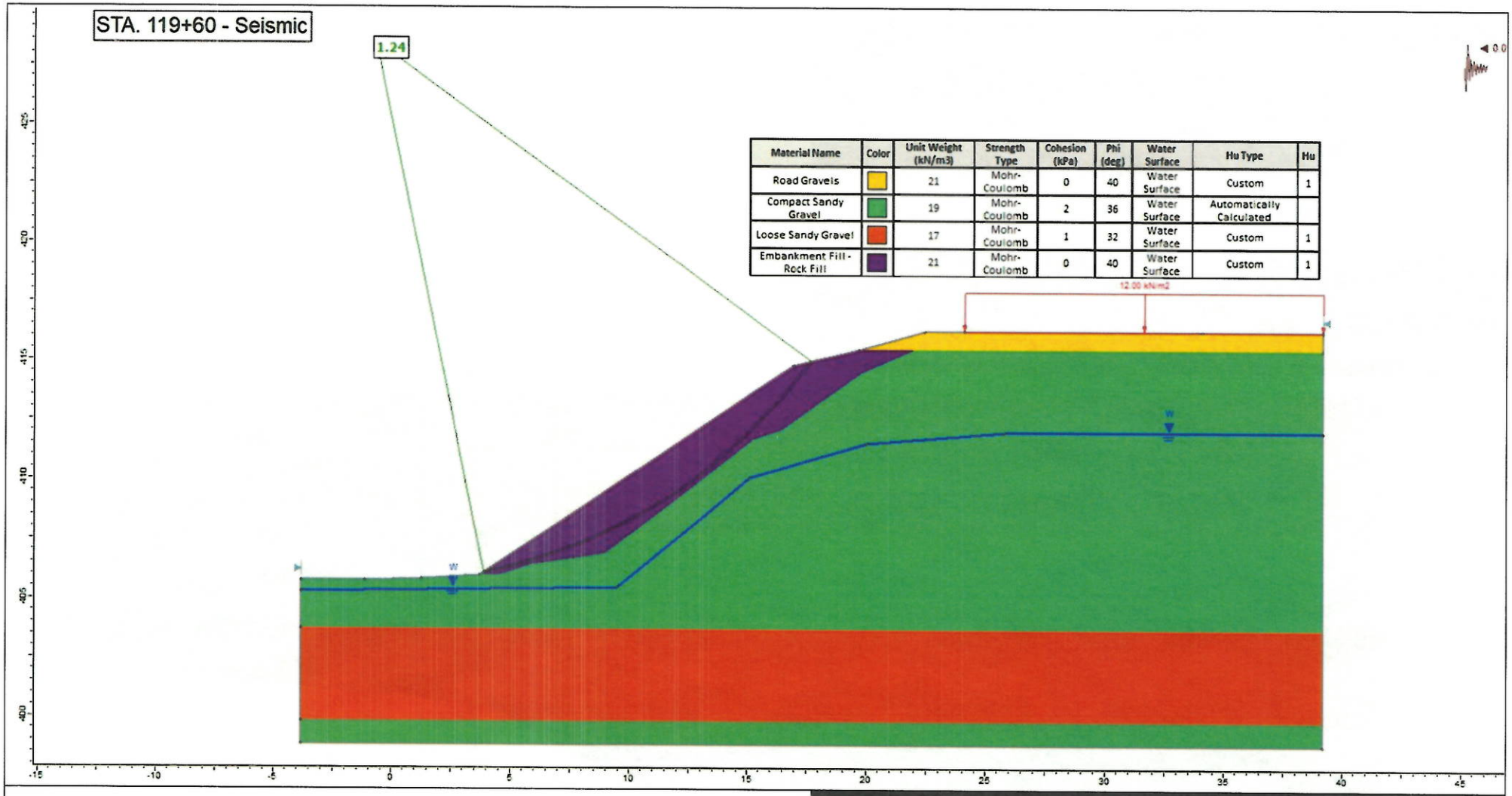
Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Pseudo-Static Slope Stability – Existing Slope

Project No. 221266-27
Client: BC MoTI
Office: Kelowna
Scale: NTS
Date: JULY 4, 2023
DWN: NF CHK: MJL

ecora

Figure 6.1d



Notes: STA 119+60

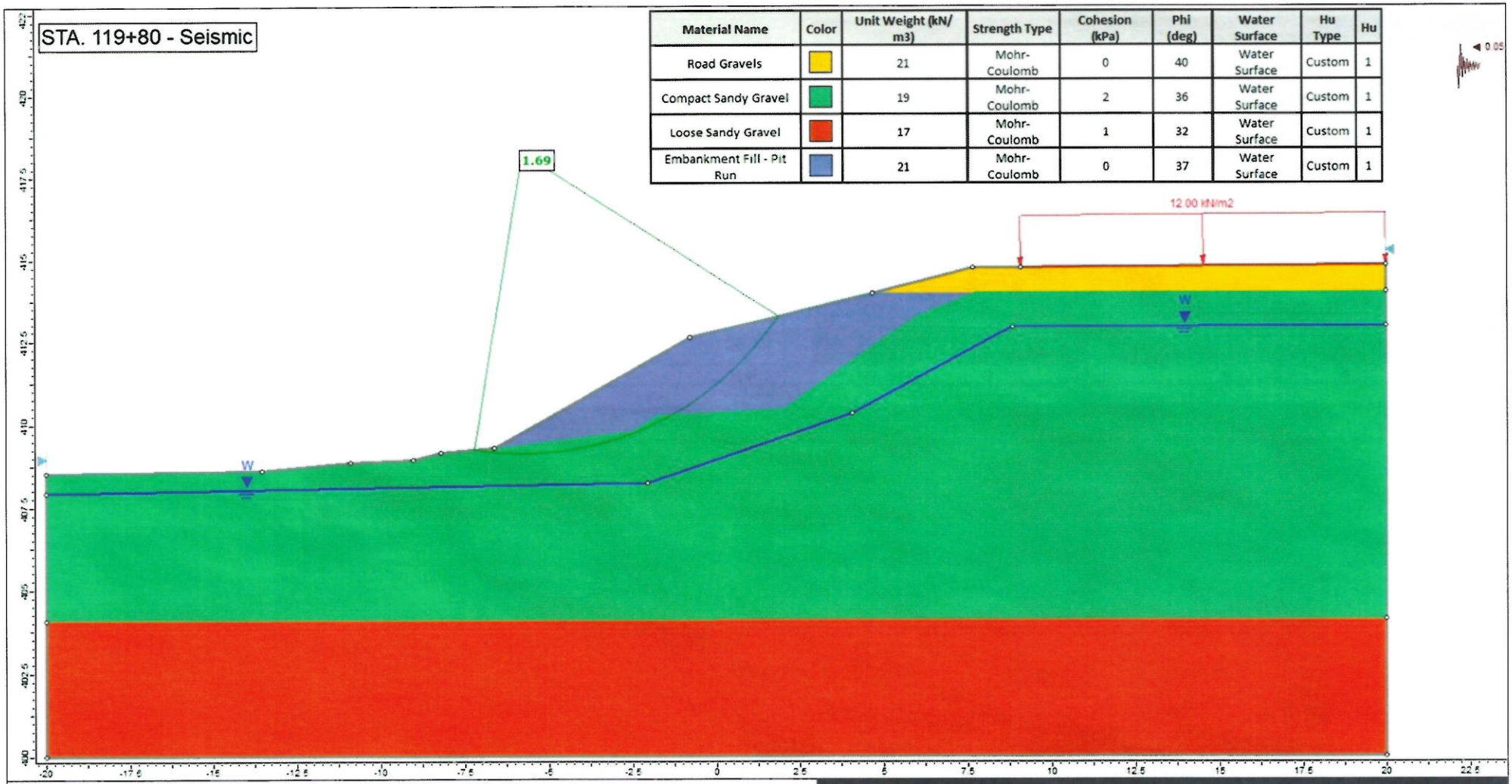
Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Pseudo-Static Slope Stability – Rock Fill Slope

Project No.	221266-27
Client:	BC MoTI
Office:	Kelowna
Scale:	NTS
Date:	JULY 4, 2023
DWN:	NF CHK: MJL

ecora

Figure 6.1e



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Compact Sandy Gravel		19	Mohr-Coulomb	2	36	Water Surface	Custom	1
Loose Sandy Gravel		17	Mohr-Coulomb	1	32	Water Surface	Custom	1
Embankment Fill - Pit Run		21	Mohr-Coulomb	0	37	Water Surface	Custom	1

Notes: STA. 119+80

Highway 5 – Geotechnical Assessment, Badger Creek CVSE Pullout

Pseudo-Static Slope Stability – Pit Run Fill Slope

Project No. 221266-27
Client: BC MoTI
Office: Kelowna
Scale: NTS
Date: JULY 4, 2023
DWN: NF CHK: MJL

ecora

Figure 6.1f

Photographs

Photo 1 - Existing access trail at southern end of site, looking northeast.

Photo 2 – Western slope at southern extent of site, looking southwest.

Photo 3 – Northern stockpile of gravel and rock, looking north.

Photo 4 – Southern stockpile of rock, looking north.

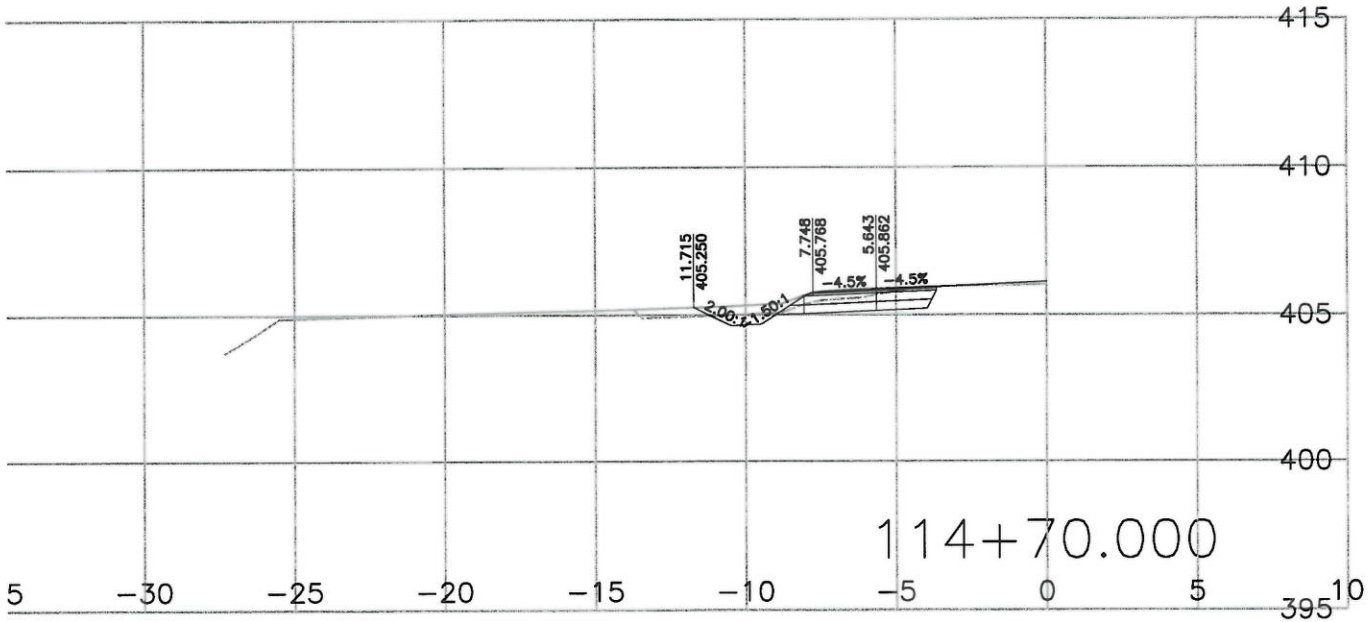
Photo 5 – Aerial view of site, looking northeast (2023-06-16).

Photo 6 – Aerial view of southern portion of slope, looking south (2023-06-16).

Photo 7 – Aerial view of central portion of site, looking north (2023-06-16).

Appendix A

L110 Design Sections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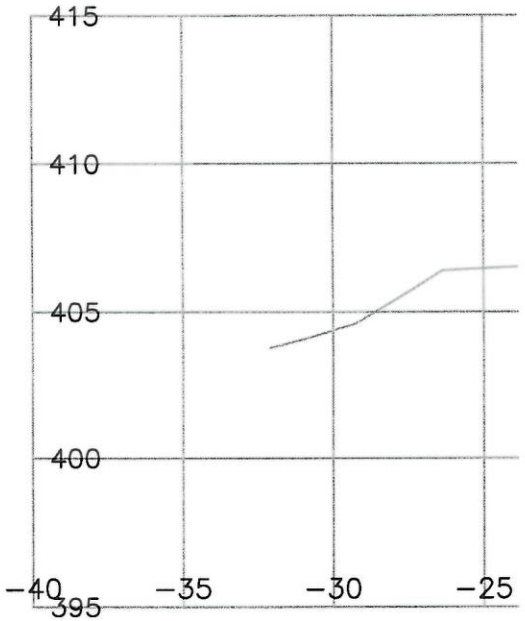
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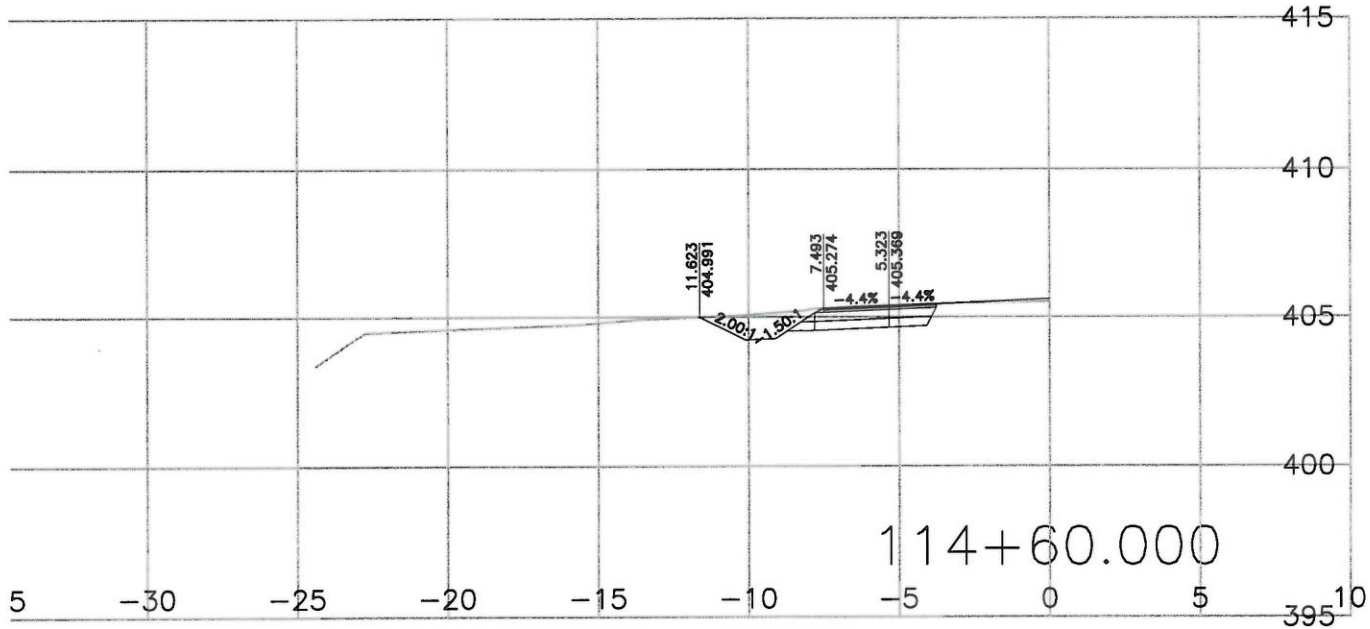
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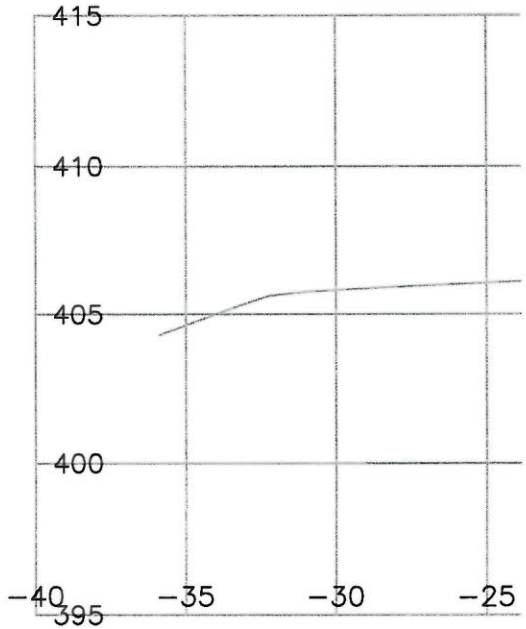
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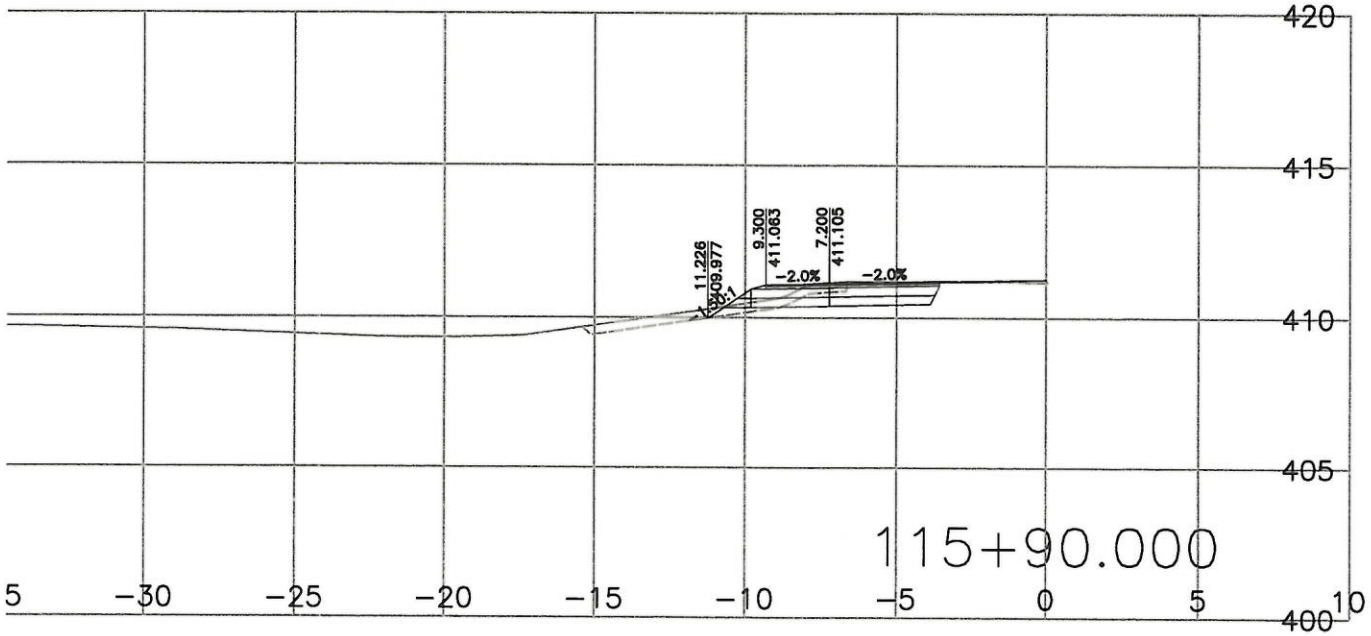
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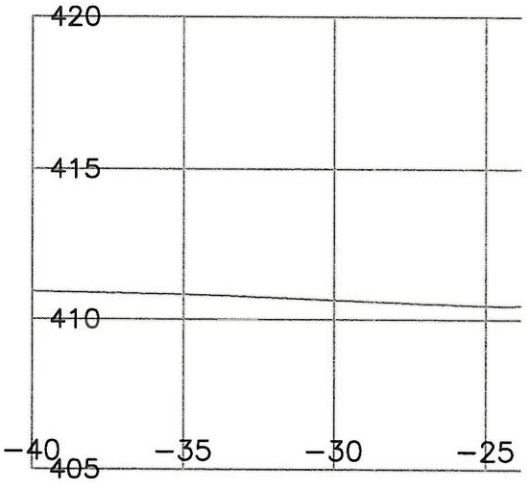
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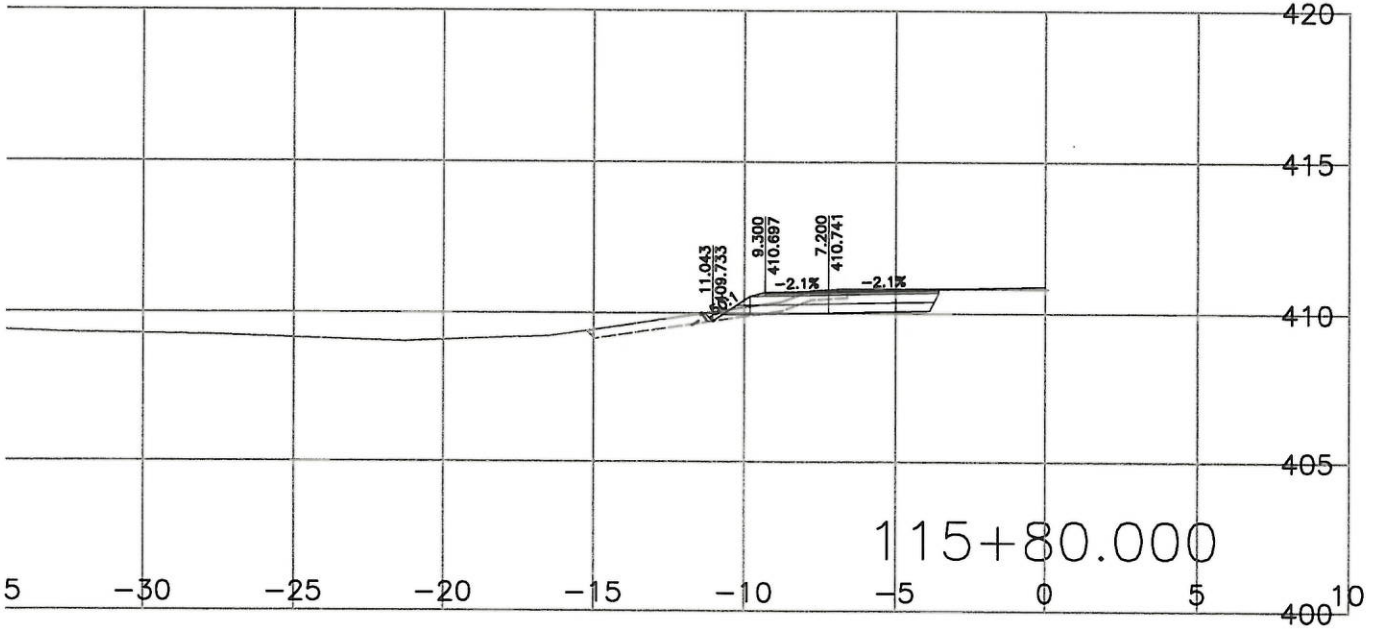
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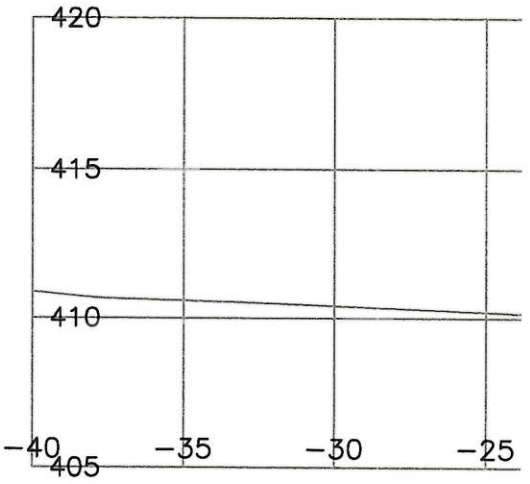
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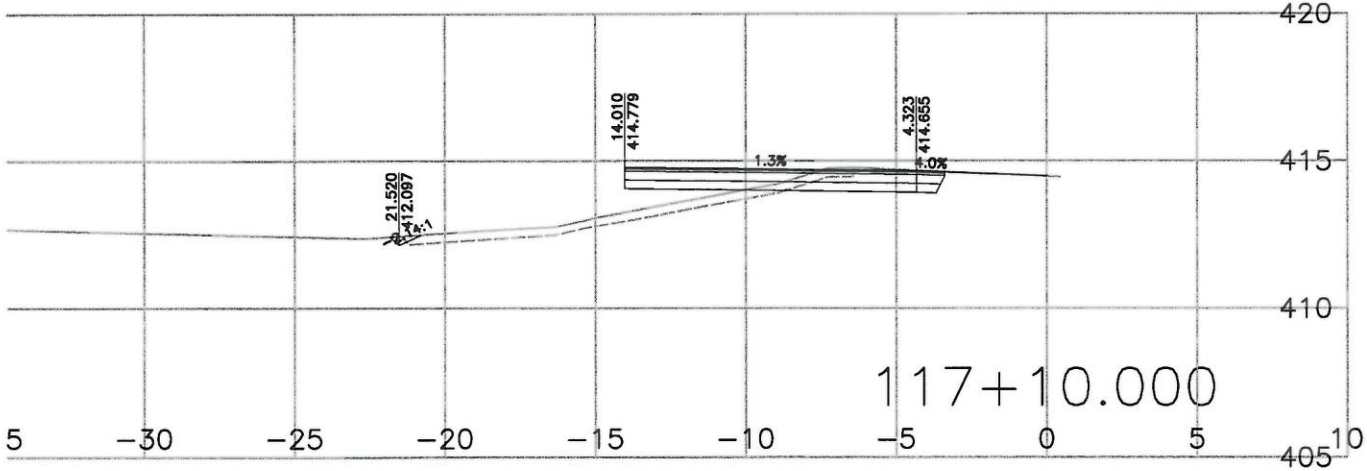
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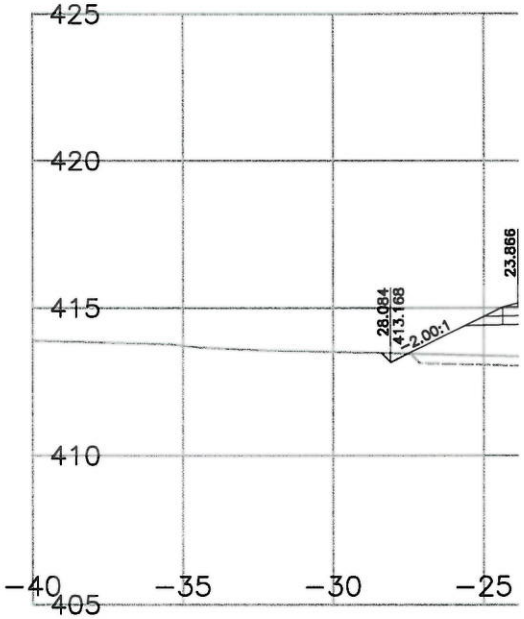
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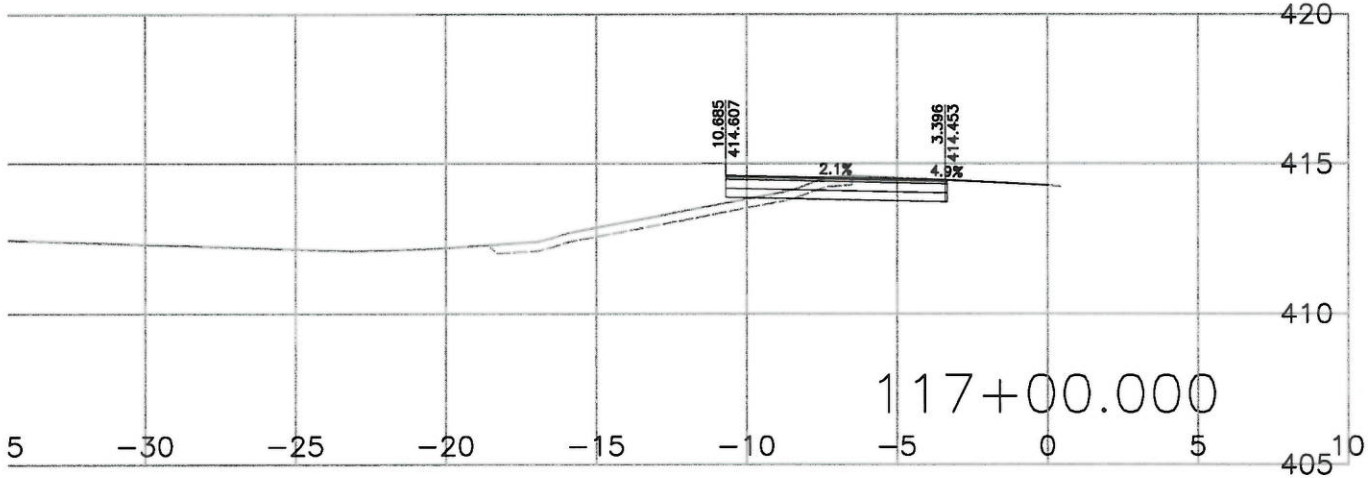
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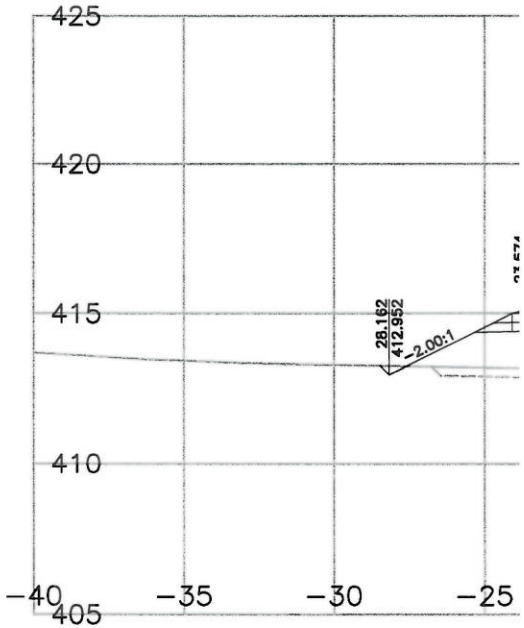
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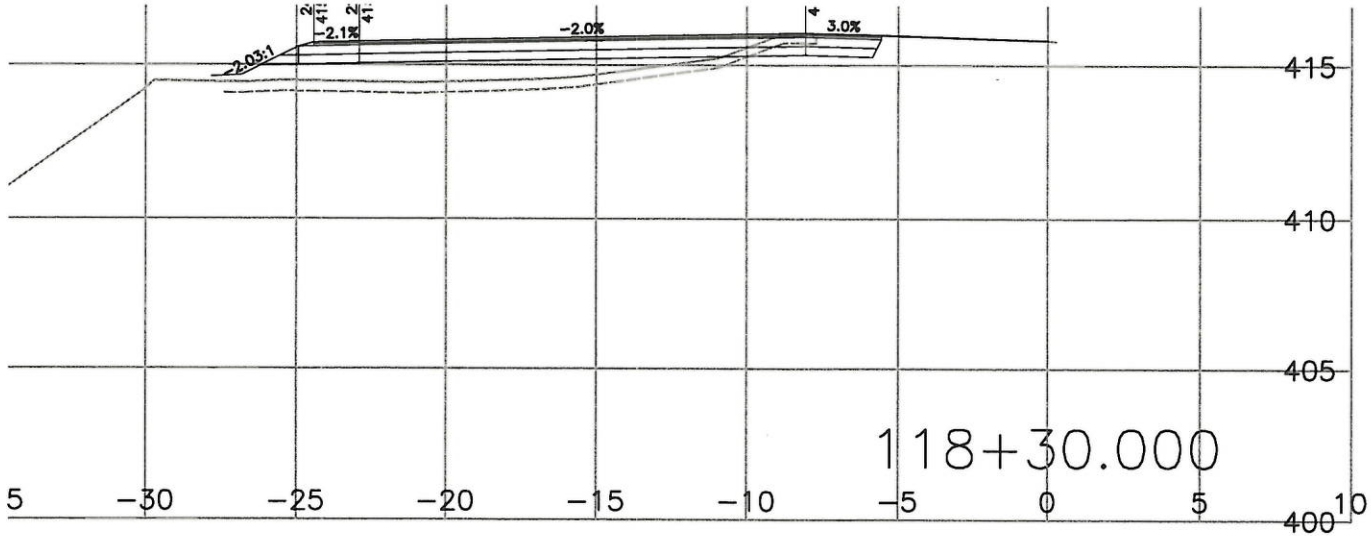
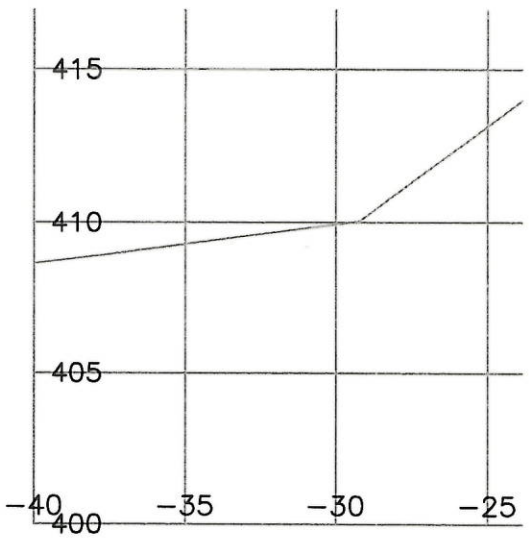
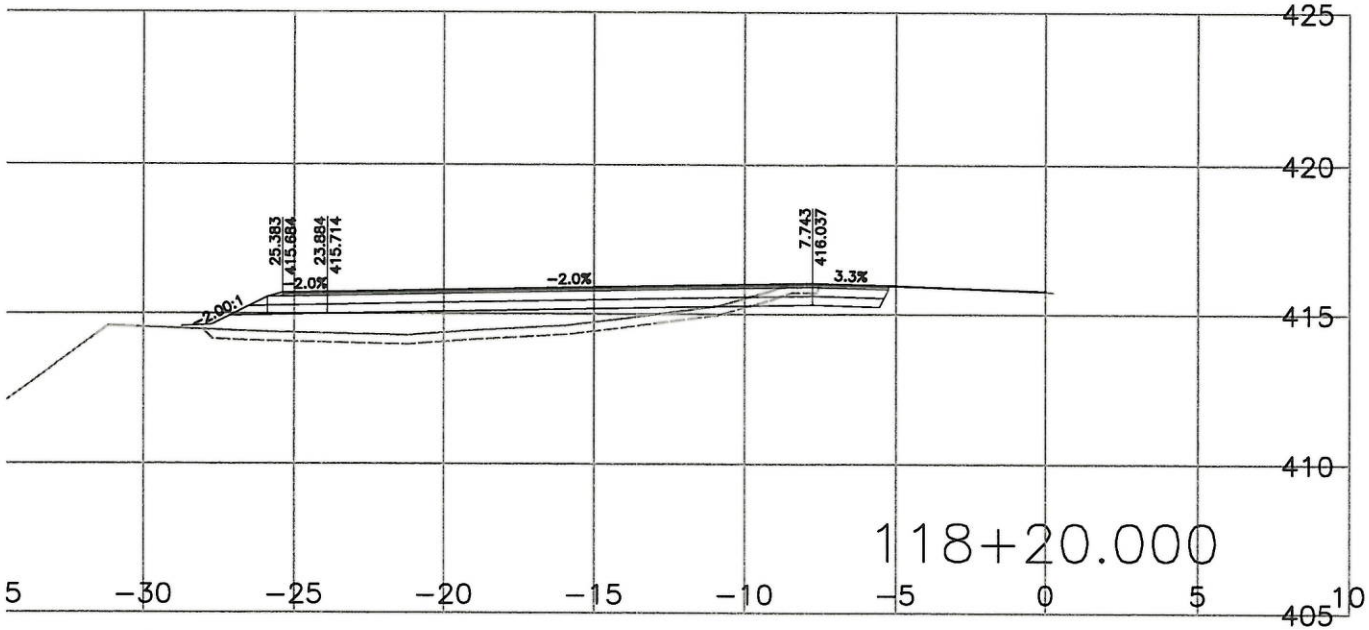
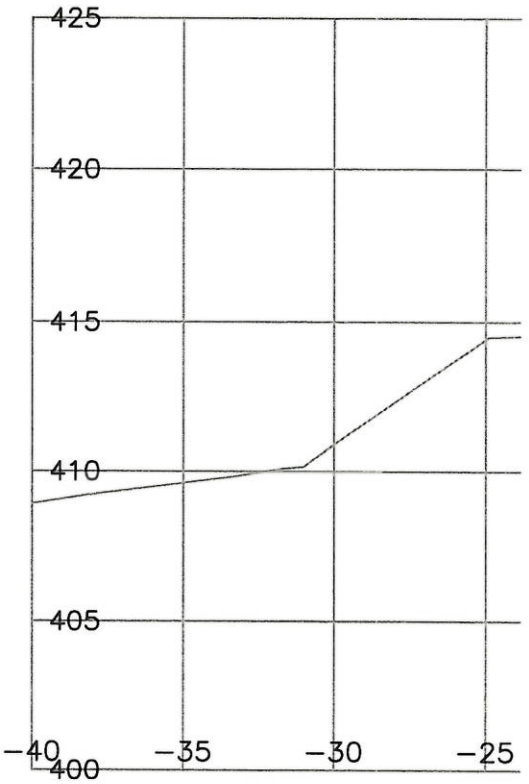
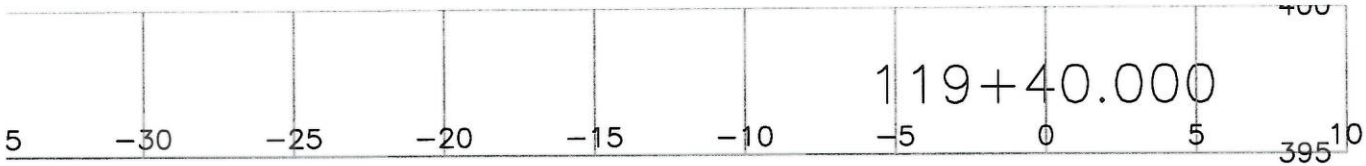
−40
−35
−30
−25

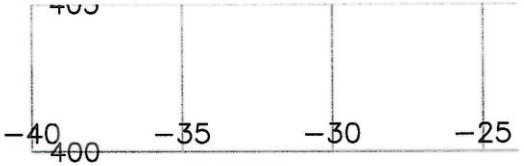

-2.03:1
2.1%
-2.0%
3.0%
415
410
405
400
118+30.000
5
-30
-25
-20
-15
-10
-5
0
5
10

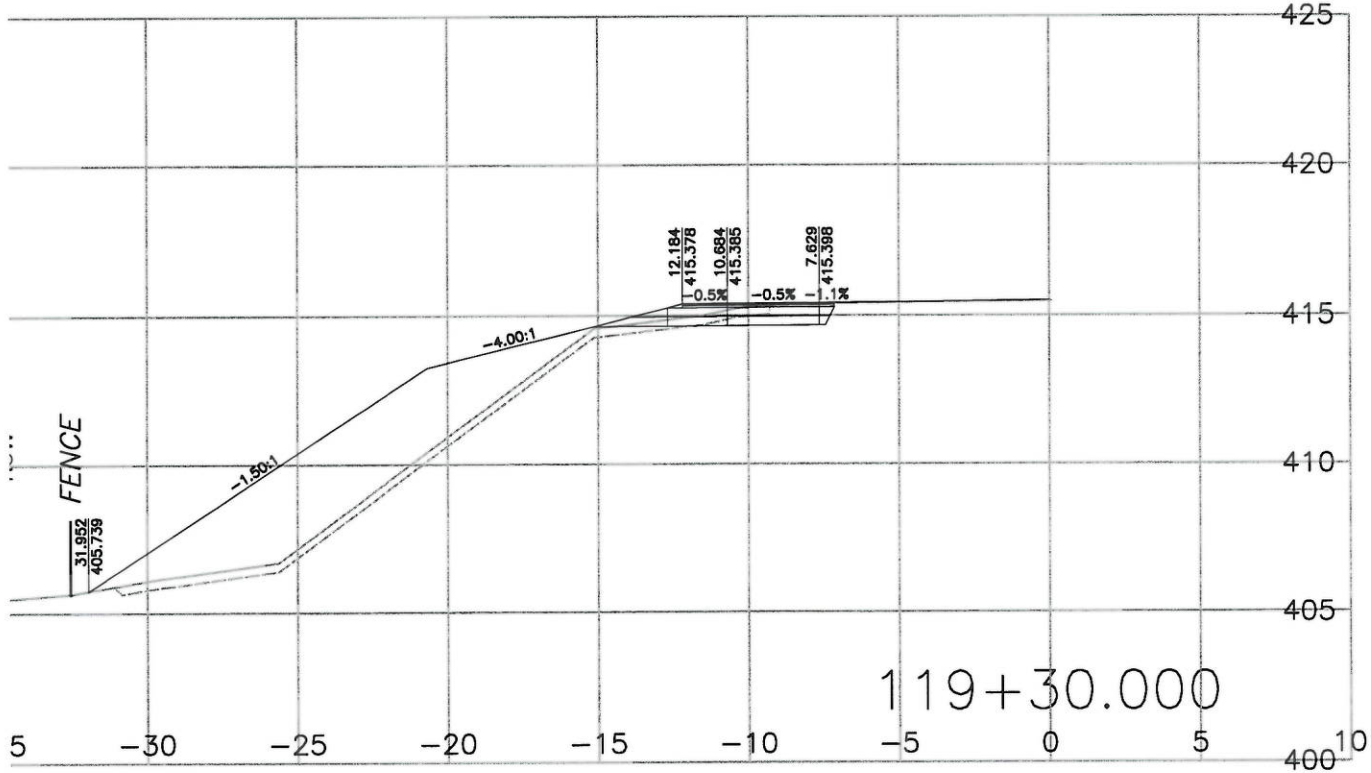

415
410
405
400
-40
-35
-30
-25

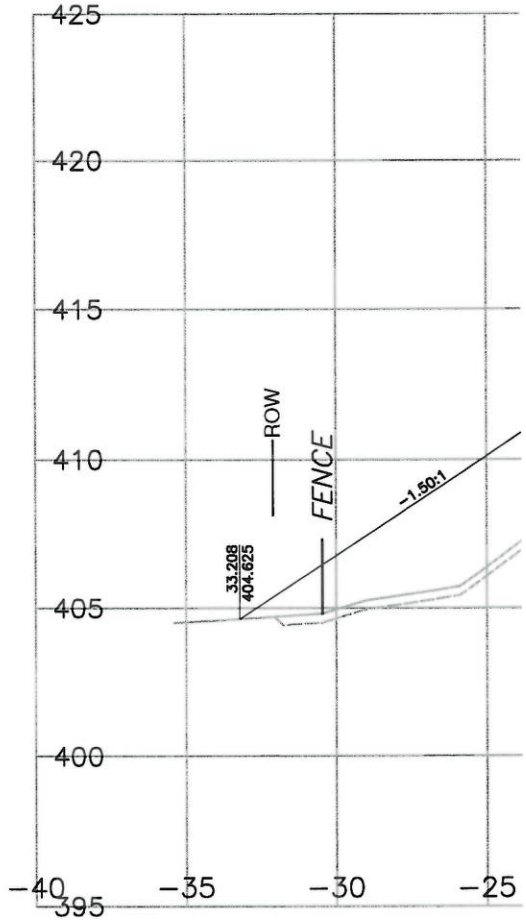

25.383
415.684
23.884
415.714
7.743
416.037
-2.00:1
2.0%
-2.0%
3.3%
425
420
415
410
405
400
118+20.000
5
-30
-25
-20
-15
-10
-5
0
5
10

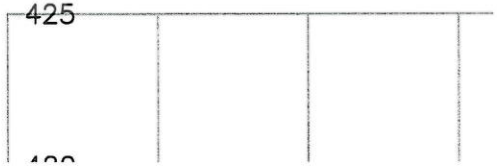

425
420
415
410
405
400
-40
-35
-30
-25

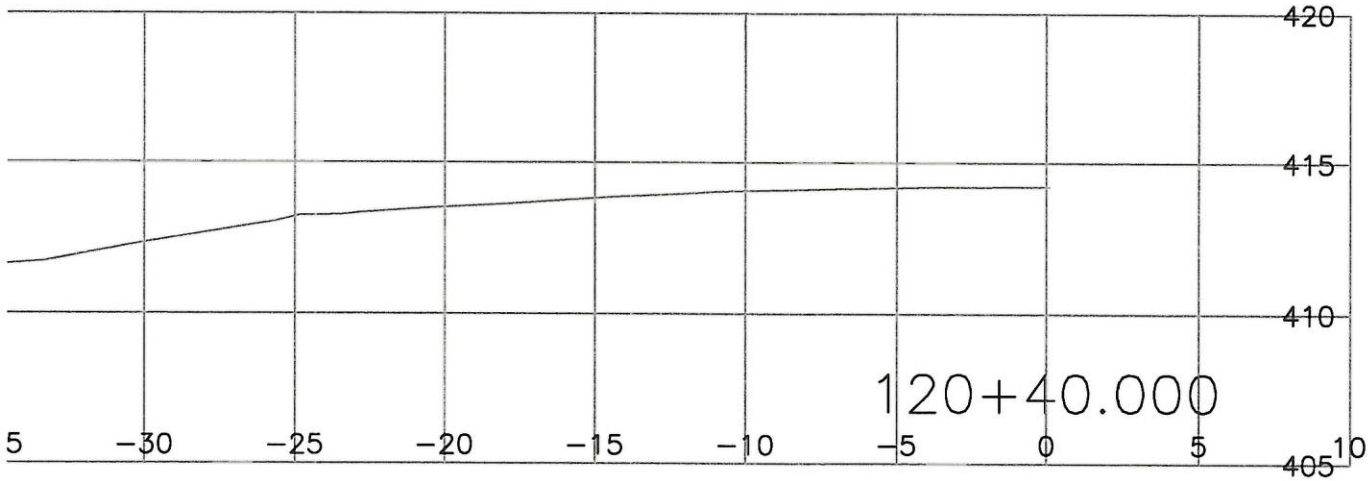

119+40.000
5
−30
−25
−20
−15
−10
−5
0
5
10
395


−40
−35
−30
−25
400


425
420
415
410
405
400
12.184
415.378
10.684
415.385
7.629
415.398
0.5%
−0.5%
−1.1%
−4.00:1
−1.50:1
FENCE
31.952
405.739
119+30.000
5
−30
−25
−20
−15
−10
−5
0
5
10


425
420
415
410
405
400
395
ROW
FENCE
−1.50:1
33.208
404.625
−40
−35
−30
−25


425


420
415
410
405
120+40.000
5
−30
−25
−20
−15
−10
−5
0
5
10

Appendix B

Water Well Logs

ɛr Use: Private Domestic
ition: No

Aquifer Number:
Technical Report: N/A

Alternative specs submitted: No

Information

ıs: Unlicensed

Licence Number:

Information

: 2559 HIGHWAY 5
RRIERE

ion:

ıtification Description 004487427

Well Location: DL 47 KDYD EXCEPT PLAN A221 A249 17504 H
20

Geographic Coordinates - North American Datum of 1983 (NAD 8

Latitude: 51.09295
Longitude: -120.166
UTM Easting: 698446
UTM Northing: 5663982
Zone: 10
Coordinate Acquisition Code: (10 m accuracy) Handheld GPS with accuracy of +/- 10 metres

ɪity

	Work Start Date	Work End Date	Drilling Company	Date Entered
ɪ	2006-09-08	2006-09-08	J. R. Drilling Central Ltd. Partnership	February 2nd 2007 at 6:18 /

: Dates

35	SAND & GRAVEL
50	
197	SAND & GRAVEL
200	

etails

To (ft bgl)	Casing Type	Casing Material	Diameter (in)	Wall Thickness (in)	Drive
194		Steel	6	0.219	Insta

eal and Backfill Details

laterial: Bentonite clay
nstallation Method:
nickness:
epth: 20 feet

Backfill Material Above Surface Seal:
Backfill Depth:

ails

r:

Liner Thickness:
Liner to:

Liner perforations

From (ft bgl)	To (ft bgl)
There are no records to show	

etails

l: Screen
e
less

inuous

Installed Screens

From (ft bgl)	To (ft bgl)	Diameter (in)	Assembly Type	S
192.00	196.00	6.00	SCREEN	3

elopment

: Jetting

Development Total Duration:

thod: Air Lifting
evel Before Test:
ng Performed: No

Estimation Rate: 4.5 USgpm
Drawdown:
Increase in Yield Due to Hydrofracturing:

Estimation Duration: 2 hours

ommission Information

ır Use: Private Domestic
ition: No

Aquifer Number:
Technical Report: N/A

Alternative specs submitted: No

Information

ıs: Unlicensed

Licence Number:

Information

: 2550 YELLOWHEAD HIGHWAY
RRIERE

ion:

	1
	KAP 89805
	47
	25
ıtification Description	028042174

Well Location:

Geographic Coordinates - North American Datum of 1983 (NAD 8

Latitude: 51.09297
Longitude: -120.16619
UTM Easting: 698433
UTM Northing: 5663984
Zone: 10
Coordinate Acquisition Code: (10 m accuracy) Handheld GPS with accuracy of +/- 10 metres

ıity

	Work Start Date	Work End Date	Drilling Company	Date Entered
report	2018-07-18	2018-07-20	Bud's Water Wells Ltd.	September 3rd 2020 at 9:51 AM

ı Dates

35	SAND & GRAVEL	brown	Medium
50	COBBLES & GRAVEL	brown	Medium
192	SAND & GRAVEL	brown	Medium
200	SILTY SAND & GRAVEL	brown	Medium
220	GRAVEL, SLIDE ROCK, GRAY & BLACK		Medium

etails

To (ft bgl)	Casing Type	Casing Material	Diameter (in)	Wall Thickness (in)	Driv
216	Production casing	Steel	6.625	0.219	Inst

eal and Backfill Details

laterial: Bentonite clay
ıstallation Method: Poured
ıickness: 2 inches
epth: 20 feet

Backfill Material Above Surface Seal:
Backfill Depth:

ails

r:

Liner Thickness:
Liner to:

Liner perforations

From (ft bgl)	To (ft bgl)
There are no records to show	

etails

l:

Installed Screens

From (ft bgl)	To (ft bgl)	Diameter (in)	Assembly Type	S
There are no records to show				

elopment

: Air lifting

Development Total Duration: 3 hours

thod: Air Lifting
evel Before Test: 174.33 ft (btoc)
ıg Performed: No

Estimation Rate: 30 USgpm
Drawdown:
Increase in Yield Due to Hydrofracturing:

Estimation Duration: 3 hours

ommission Information

Appendix C

Laboratory Test Results

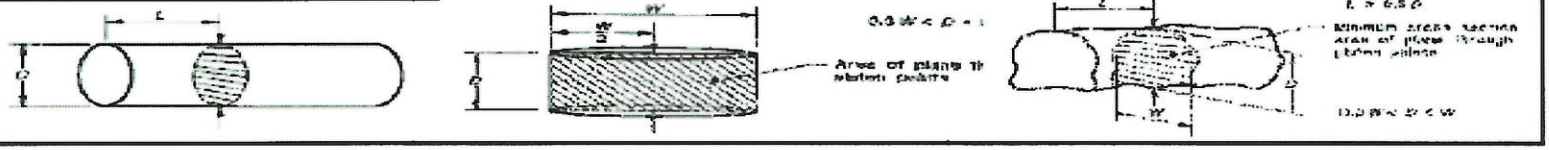
ecora

POINT LOAD STRENGTH INDEX

AS 4133.4.1 - 1994

Client:	BC Ministry of Transportation & Infastructure	**Project No:**	221266-27	**Date:**	Aug. 2, 2023
Project:	Hwy 5, Badger Creek Pullout Geotechnical	**Borehole/Test Pit No:**	N/A	**Tested By:**	S. Kraetzer
Location:	Kamloops, BC	**Borehole/Pit Location:**	On Site stockpiles	**Checked By:**	N. Felsing

Depth (m)	Sample Number	Rock Description (Including nature and orientation of any defects or planes of weakness)	Moisture Condition	Dimetral					Axial / Irregular Lump						Photo of Failed Sample
				L (mm)	D (mm)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	W (mm)	D (mm)	D_e^2 (mm^2)	P (kN)	I_s (MPa)	$I_{s(50)}$ (MPa)	
N/A	N1	North Stockpile	Air Dry						49	110	6863	10.854	1.58	1.26	
N/A	N2	North Stockpile	Air Dry						60	145	11077	28.518	2.57	1.40	
N/A	N3	North Stockpile	Air Dry						37	150	7066	16.261	2.30	1.26	
N/A	S1	South Stockpile	Air Dry						41	120	6264	31.054	4.96	1.23	
N/A	S2	South Stockpile	Air Dry						48	155	9473	34.592	3.65	1.35	
N/A	S3	South Stockpile	Air Dry						32	145	5908	24.326	4.12	1.21	

Shape of Specimen	Cylinder Core	Irregular Lump
Direction of Loading	Diametral / Axial	
Required Shape Proportions of Test Specimens		

Ecora Engineering and Resource Group Ltd.
201–284 Main Street, Penticton, BC

Specific Gravity and Absorbtion of Rock for Erosion Control

ASTM D6473

Project:	Hwy 5 Badger Creek Pullout Geotechnical	**Project No:**	221266-27
Client:	BC Ministry of Transportation & Infastructure	**Sample No:**	23-302
Source:	North Stockpile		
Date Sampled:	22-Jun-23	**Sampled by:**	NF
Date Tested:	31-Jul-23	**Tested by:**	SQ
Description:			

Test Results

Rock ID	Mass (g)	Specific Gravity (Dry Basis)	Specific Gravity (SSD Basis)	Specific Gravity (Apparent)	Absorbtion (%)
N1	1117.5	2.726	2.740	2.765	0.53
N2	1234.2	2.975	3.012	3.089	1.24
N3	877.0	2.696	2.709	2.732	0.49

Comments:

Report By: S. Kratzer

Reviewed By: N. Felsing

Ecora Engineering and Resource Group Ltd.
201–284 Main Street, Penticton, BC

Specific Gravity and Absorbtion of Rock for Erosion Control

ASTM D6473

Project:	Hwy 5 Badger Creek Pullout Geotechnical	**Project No:**	221266-27
Client:	BC Ministry of Transportation & Infastructure	**Sample No:**	23-303
Source:	South Stockpile		
Date Sampled:	22-Jun-23	**Sampled by:**	NF
Date Tested:	31-Jul-23	**Tested by:**	SQ
Description:			

Test Results

Rock ID	Mass (g)	Specific Gravity (Dry Basis)	Specific Gravity (SSD Basis)	Specific Gravity (Apparent)	Absorbtion (%)
S1	974.8	2.797	2.801	2.809	0.15
S2	1170.3	2.786	2.795	2.811	0.32
S3	1932.2	2.808	2.814	2.827	0.24

Comments:

Report By: S. Kratzer

Reviewed By: N. Felsing

Appendix D

Test Hole Logs

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-01

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:
Datum:
Northing/Easting: 5664088.835 , 698402.599
Elevation: 407.22 m
Alignment:
Station/Offset:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Date(s) Drilled: November 10, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% W% WL % (20 40 60 80)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							Compact to dense, GRAVEL, poorly graded, grey-brown.			407
1	10 14 10 6	24		1	0			GP		406
2										405
3	10 8 9 10	17		2	0					404
4							3.96m			
	10 13 36 23	49		3	20		Compact to dense, sandy GRAVEL, poorly graded, damp, brown.		{G:65 S:35 F:}	403
5										402
6	8 8 6 9	14		4	0		Between 6.1 m to 6.7 m: Becomes compact to loose.	GP GP		401
7										400
	8 9 6 6	15		5	10				{G:70 S:30 F:}	
8										399
9	26 26 22 19	48		6	40		9.3m		{G:65 S:35 F:}	398
10							Compact to dense, SAND, poorly graded, damp, grey to grey-brown.			

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: 21.2 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA | Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-01

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:

Prepared by: 221266-27
Ecora Engineering & Resource Group
Logged by: Reviewed by:

Datum: Alignment:
Northing/Easting: 5664088.835 , 698402.599 Station/Offset:
Elevation: 407.22 m

Date(s) Drilled: November 10, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS S P H	▲ SPT "N" (BLOWS/300 mm) ▲ W_P% 20 W% 40 60 W_L % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10	20 18 20 21	38		7	60		Compact to dense, SAND, poorly graded, damp, grey to grey-brown. *(continued)*		{G: S:100 F:}	397
11										396
12	12 13 14 17	27		8	70				{G: S:100 F:}	395
13										394
14	12 14 14 14	28		9	70				{G: S:100 F:}	393
15	9 11 14 17	25		10	60			SP	{G: S:100 F:}	392
16										391
17										390
18	18 18 19 17	37		11	70				{G: S:100 F:}	389
19										388
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: 21.2 m
Depth to Top of Rock:

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: **TH18-01**

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:
Datum:
Northing/Easting: 5664088.835 , 698402.599
Elevation: 407.22 m
Alignment:
Station/Offset:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Date(s) Drilled: November 10, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 — W% 40 60 — WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
20							Compact to dense, SAND, poorly graded, damp, grey to grey-brown. *(continued)*			387
							20.42m Very dense, GRAVEL, poorly graded, brown.	GP		
21	47 50	>50 for 2"	X	12	0		21.26m			386
22										385
23										384
24										383
25										382
26										381
27										380
28										379
29										378
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: 21.2 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-02

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:
Datum:
Northing/Easting: 5664185.969 , 698471.12
Elevation: 411.0 m
Alignment:
Station/Offset:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Date(s) Drilled: November 8, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS	SPT "N" (BLOWS/300 mm) W_P% 20 W% 40 60 W_L% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							GRAVEL, poorly graded, grey-brown.	GP		411
1	5 4 4 5	8		1	0		0.91m Loose to compact, sandy GRAVEL, poorly graded, damp to saturated, brown.			410
2										409
3	7 4 4 4	8		2	0					408
4										407
5	6 4 6 5	10		3	10				{G:80 S:20 F:}	406
6	4 4 4 4	8		4	0					405
7										404
8	6 5 6 3	11		5	15			GP	{G:80 S:20 F:}	403
9	7 6 6 10	12		6	20				{G:70 S:30 F:}	402
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: 15.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: **TH18-02**

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:
Datum:
Northing/Easting: 5664185.969 , 698471.12
Elevation: 411.0 m
Alignment:
Station/Offset:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Date(s) Drilled: November 8, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% W% WL % (20 40 60 80)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10	8 5 5 6	10		7	0		Loose to compact, sandy GRAVEL, poorly graded, damp to saturated, brown. *(continued)*			400
11										
12	7 12 4 4	16		8	0					399
13										398
14	9 11 9 9	20		9	10				{G:75 S:25 F:}	397
							14.33m			
15	30 32 33 21	65		10	0		Very dense, GRAVEL, poorly graded, brown.	GP		396
							15.54m			
16										395
17										394
18										393
19										392
20										

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

Final Depth of Hole: 15.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-03

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Datum: Alignment:
Northing/Easting: 5664219.895 , 698526.849 Station/Offset:
Elevation: 412.33 m

Date(s) Drilled: November 9, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 W% 40 60 WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							Compact to dense, sandy GRAVEL, poorly graded, damp to saturated, grey to brown.			412
1	10 8 4 4	12		1	20				{G:65 S:35 F:}	411
2										410
3	10 9 3 4	12		2	0					409
4										
5	9 8 8 7	16		3	10			GP	{G:80 S:20 F:}	408
6	10 8 7 6	15		4	0					407
7										406
8	5 5 6 5	11		5	10				{G:75 S:25 F:}	405
9	20 18 17 18	35		6	20				{G:75 S:25 F:}	404
10							9.75m			403

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

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

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-03

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:

Date(s) Drilled: November 9, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Datum: Alignment:
Northing/Easting: 5664219.895 , 698526.849 Station/Offset:
Elevation: 412.33 m

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% W% WL % (20 40 60 80)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10	15 20 17 15	37		7	70		Compact to dense, SAND, trace fines, poorly graded, damp, brown. *(continued)*		{G: S:100 F:}	402
11										401
12	13 14 16 19	30		8	60			SP	{G: S:95 F:5}	400
13										399
14	14 17 17 21	34		9	75				{G: S:95 F:5}	
							14.17m			398
							Very dense, GRAVEL and SAND, trace fines, poorly graded, brown.	GP		
15	39 50	50 for 3"		10	25		15.15m		{G:50 S:45 F:5}	397
16										396
17										395
18										394
19										393
20										

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

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

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-04

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:
Datum:
Northing/Easting: 5664263.486 , 698599.104
Elevation: 414.0 m
Alignment:
Station/Offset:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Date(s) Drilled: November 9, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS (S / H)	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 — W% 40 60 — WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							Loose to compact, sandy GRAVEL, poorly graded, damp, brown.			414
1	8 5 5 9	10		1	0					413
2								GP		412
3	11 12 13 9	25		2	25				{G:70 S:30 F:}	411
4							4.11m			410
	18 23 28 44	51		3	10		Very dense, sandy GRAVEL with cobbles, poorly graded, damp to saturated, grey to brown.		{G:80 S:20 F:}	
5										409
6	34 52	R		4	40				{G:40 S:55 F:5}	408
7								GP to SB		407
	75	R, >50 for 3"		5	15				{G:60 S:35 F:5}	
8										406
9	39 50	R, >50 for 2"		6			9.05m		{G:60 S:35 F:5}	405
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: 9.1 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-05

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:

Date(s) Drilled: November 10-11, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Datum: Alignment:
Northing/Easting: 5664293.267 , 698657.714 Station/Offset:
Elevation: 414.61 m

DEPTH (m)	DRILLING DETAILS (S P T)	▲ SPT "N" (BLOWS/300 mm) ▲ W_P% 20 — W% 40 60 — W_L% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							Compact, sandy GRAVEL, poorly graded, damp, brown.			414
1	15 10 8 4	18		1	20					413
2										412
3	7 9 9	18		2	0			GP		411
4										410
5	16 12 12 7	24		3	0					

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: 11.7 m
Depth to Top of Rock: 9.3 m

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

SUMMARY LOG

Ministry of Transportation and Infrastructure

Project: **Yellowhead Highway 5 Badger CVSE Pullout**

Location:

Prepared by: 221266-27 Ecora Engineering & Resource Group

Logged by: Reviewed by:

Datum: Alignment:

Northing/Easting: 5664293.267 , 698657.714 Station/Offset:

Elevation: 414.61 m

Drill Hole #: TH18-05

Date(s) Drilled: November 10-11, 2018

Company: Sea to Sky Drilling

Driller:

Drill Make/Model: Mobile B53

Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS	SPT "N" (BLOWS/300 mm) W_P% 20 40 W% 60 W_L % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
5							Compact, sandy GRAVEL, poorly graded, damp, brown. *(continued)*			
							5.49m			
							Very dense, GRAVEL and SAND, poorly graded, poorly graded, damp, grey to black.			409
6	23 63	R		4	40			GP-SP		
										408
7										
	90	R		5	10		7.32m Very dense, GRAVEL and SAND with fines, damp, grey to black, likely fractured bedrock.			407
8								GP-GM		
										406
9	100	R		6	15					
							9.3m Bedrock.			405
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: 11.7 m

Depth to Top of Rock: 9.3 m

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: TH18-05

Project: **Yellowhead Highway 5 Badger CVSE Pullout**
Location:

Prepared by: 221266-27 Ecora Engineering & Resource Group
Logged by: Reviewed by:

Datum: Alignment:
Northing/Easting: 5664293.267 , 698657.714 Station/Offset:
Elevation: 414.61 m

Date(s) Drilled: November 10-11, 2018
Company: Sea to Sky Drilling
Driller:
Drill Make/Model: Mobile B53
Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS (S T)	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 — W% 40 60 — WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10							Bedrock. *(continued)*			
								Bedrock		404
11										
										403
							11.73m			
12										
										402
13										
										401
14										
										400
15										

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: 11.7 m
Depth to Top of Rock: 9.3 m

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Project: **Yellowhead Highway 5 Badger CVSE Pullout**

Location:

Prepared by: 221266-27 Ecora Engineering & Resource Group

Logged by: Reviewed by:

Datum: Alignment:

Northing/Easting: , Station/Offset:

Elevation: 410.99 m

Drill Hole #: TH18-07

Date(s) Drilled: November 11, 2018

Company: Sea to Sky Drilling

Driller:

Drill Make/Model: Mobile B53

Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS SPT	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 W% 40 60 WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0							Compact, GRAVEL, grey.			410
1	9 9 18 4	27		1	0			GP		
1.83										
2							Loose to compact, sandy GRAVEL, with cobbles, damp to saturated, grey and brown.			409
3	6 5 7 5	12		2	0					408
4	10 12 7 5	19		3	10				{G:80 S:20 F:}	407
5										406
6	19 15 12 13	27		4	20				{G:60 S:40 F:}	405
7										404
8	5 4 4 14	8		5	0					403
9	11 3 4 5	7		6	10			GP	{G:80 S:20 F:}	402
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: 15.5 m

Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

BRITISH COLUMBIA — Ministry of Transportation and Infrastructure

SUMMARY LOG

Project: **Yellowhead Highway 5 Badger CVSE Pullout**

Location:

Prepared by: 221266-27
Ecora Engineering & Resource Group

Logged by: Reviewed by:

Datum: Alignment:

Northing/Easting: ,

Station/Offset:

Elevation: 410.99 m

Drill Hole #: TH18-07

Date(s) Drilled: November 11, 2018

Company: Sea to Sky Drilling

Driller:

Drill Make/Model: Mobile B53

Drilling Method: Wash Rotary

DEPTH (m)	DRILLING DETAILS (S P T)	▲ SPT "N" (BLOWS/300 mm) ▲ Wp% 20 — W% 40 60 — WL % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate {G % S % F %}	ELEVATION (m)
10	4 3 3 4	6		7	0		Loose to compact, sandy GRAVEL, with cobbles, damp to saturated, grey and brown. *(continued)*			400
11										
12	8 8 7 8	15		8	20				{G:75 S:25 F:}	399
13										398
14	8 6 12 12	18		9	0					397
15	17 16 12 14	28		10	25				{G:65 S:35 F:}	396
							15.54m			
16										395
17										394
18										393
19										392
20										

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

Final Depth of Hole: 15.5 m
Depth to Top of Rock:

MOTI-SOIL-REV3 221266-27 LOGS.GPJ MOTI_DATATEMPLATE_REV3.GDT 5/9/23

Appendix E

Traffic Data Report

Daily Volume from 08/22/2022 through 09/08/2022

names: Little Fort South 21-011NS - NY

Seasonal Factor Grp: Highly Seasonal
Daily Factor Grp: Highly Seasonal

tion: Route 5, 0.5 km south of Route 24, Little Fort

	Sun, Aug 21, 2022			Mon, Aug 22, 2022			Tue, Aug 23, 2022			Wed, Aug 24, 2022			Thu, Aug 25, 2022			Fri, Aug 26, 2022			Sat, Aug 27, 2022		
	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S
00:00							48	31	17	59	34	25	67	38	29	46	27	19	58	37	21
01:00							47	29	18	43	22	21	47	28	19	42	33	9	36	23	13
02:00							41	24	17	48	22	26	41	22	19	46	18	28	23	11	12
03:00							43	21	22	42	22	20	47	24	23	37	17	20	41	19	22
04:00							71	26	45	64	29	35	59	26	33	56	27	29	44	21	23
05:00							107	67	40	109	59	50	114	70	44	118	71	47	82	50	32
06:00							216	122	94	208	112	96	195	92	103	174	86	88	133	74	59
07:00							275	113	162	281	135	146	310	137	173	266	122	144	222	122	100
08:00							323	168	155	247	117	130	316	151	165	282	131	151	305	173	132
09:00							379	190	189	373	193	180	420	230	190	440	240	200	418	256	162
10:00							411	200	211	427	229	198	473	262	211	473	236	237	471	281	190
11:00							464	266	198	479	253	226	525	277	248	483	265	218	511	298	213
12:00				549	296	253	485	244	241	406	208	198	508	265	243	601	324	277	490	268	222
13:00				574	295	279	421	170	251	419	218	201	500	247	253	553	291	262	491	231	260
14:00				569	262	307	520	291	229	505	231	274	561	274	287	587	289	298	489	230	259
15:00				631	344	287	472	255	217	494	260	234	542	261	281	526	259	267	476	220	256
16:00				527	285	242	494	283	211	450	247	203	505	256	249	510	236	274	464	228	236
17:00				451	228	223	422	214	208	467	230	237	432	213	219	445	225	220	425	191	234
18:00				359	157	202	299	138	161	298	150	148	393	182	211	421	192	229	314	130	184
19:00				252	109	143	221	95	126	231	127	104	273	135	138	254	149	105	199	91	108
20:00				185	81	104	175	94	81	182	74	108	188	97	91	193	105	88	151	71	80
21:00				116	53	63	111	55	56	146	63	83	146	68	78	140	81	59	106	43	63
22:00				90	46	44	90	54	36	104	50	54	139	63	76	113	61	52	75	32	43
23:00				71	37	34	73	45	28	76	33	43	76	38	38	73	32	41	55	22	33
Total				4,374	2,193	2,181	6,208	3,195	3,013	6,158	3,118	3,040	6,877	3,456	3,421	6,879	3,517	3,362	6,079	3,122	2,957
Peak Vol							464	266	211	484	266	226	525	280	262	504	271	237	538	317	221
Peak Fct							.859	.731	.812	.84	.821	.897	.82	.729	.936	.797	.816	.76	.885	.777	.969
Peak Hr				:	:	:	11: 00	11: 00	10: 00	10: 30	10: 30	11: 00	11: 00	9: 30	10: 45	9: 30	9: 30	9: 15	10: 30	10: 30	10: 30
Peak Vol				637	344	333	520	291	261	546	274	274	576	285	309	616	344	306	505	268	295
Peak Fct				.852	.723	.858	.788	.742	.919	.982	.878	.815	.832	.792	.931	.851	.729	.823	.831	.657	.934
Peak Hr				13: 30	15: 00	14: 15	14: 00	14: 00	13: 15	14: 45	14: 45	14: 00	14: 15	12: 45	14: 15	12: 30	12: 30	13: 45	13: 30	12: 00	13: 30
aily Fct				1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
xle Fct				.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500
ılse Fct				2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
sonal Fct				.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618

Daily Volume from 08/22/2022 through 09/08/2022

names: Little Fort South 21-011NS - NY

Seasonal Factor Grp: Highly Seasonal
Daily Factor Grp: Highly Seasonal

tion: Route 5, 0.5 km south of Route 24, Little Fort

	Sun, Aug 28, 2022			Mon, Aug 29, 2022			Tue, Aug 30, 2022			Wed, Aug 31, 2022			Thu, Sep 1, 2022			Fri, Sep 2, 2022			Sat, Sep 3, 2022		
	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S
00:00	37	18	19	40	27	13	57	30	27	56	37	19	59	39	20	72	49	23	64	35	29
01:00	35	18	17	33	19	14	48	27	21	72	39	33	39	20	19	48	25	23	31	18	13
02:00	11	5	6	27	14	13	26	18	8	39	15	24	40	20	20	44	24	20	42	20	22
03:00	19	8	11	35	20	15	52	23	29	48	22	26	60	27	33	36	16	20	49	21	28
04:00	33	15	18	56	35	21	60	32	28	58	27	31	53	30	23	60	21	39	50	25	25
05:00	35	14	21	111	74	37	104	61	43	93	61	32	84	40	44	93	48	45	54	27	27
06:00	121	46	75	195	120	75	187	105	82	204	107	97	189	93	96	181	86	95	103	48	55
07:00	179	78	101	237	126	111	242	118	124	284	148	136	267	145	122	277	125	152	147	65	82
08:00	335	146	189	307	173	134	362	177	185	351	187	164	334	176	158	311	156	155	297	132	165
09:00	508	216	292	383	255	128	380	213	167	369	202	167	390	189	201	399	205	194	330	159	171
10:00	645	251	394	503	264	239	429	234	195	432	222	210	456	237	219	514	272	242	506	243	263
11:00	599	330	269	520	316	204	460	243	217	518	298	220	463	251	212	521	268	253	498	257	241
12:00	586	311	275	570	321	249	465	237	228	479	244	235	570	288	282	545	277	268	454	229	225
13:00	597	294	303	515	263	252	420	223	197	515	225	290	574	271	303	569	286	283	435	207	228
14:00	600	298	302	514	258	256	450	224	226	529	250	279	530	221	309	558	244	314	470	237	233
15:00	519	255	264	537	268	269	471	218	253	521	218	303	540	217	323	558	249	309	448	232	216
16:00	456	221	235	502	256	246	515	273	242	486	225	261	522	271	251	456	209	247	366	174	192
17:00	404	198	206	416	199	217	408	221	187	413	188	225	438	220	218	390	217	173	312	181	131
18:00	333	166	167	350	175	175	265	123	142	337	157	180	365	191	174	332	183	149	283	163	120
19:00	258	139	119	247	119	128	251	120	131	275	106	169	260	133	127	316	193	123	218	113	105
20:00	180	86	94	190	79	111	169	80	89	204	95	109	259	122	137	254	133	121	125	62	63
21:00	121	75	46	126	57	69	135	68	67	137	70	67	175	99	76	158	75	83	71	36	35
22:00	76	38	38	105	49	56	90	40	50	104	57	47	175	100	75	107	54	53	51	23	28
23:00	60	32	28	60	34	26	66	37	29	90	51	39	94	58	36	79	42	37	51	27	24
Total	6,747	3,258	3,489	6,579	3,521	3,058	6,112	3,145	2,967	6,614	3,251	3,363	6,936	3,458	3,478	6,878	3,457	3,421	5,455	2,734	2,721
Peak Vol	661	330	394	521	316	239	467	253	217	518	298	220	498	268	234	541	284	259	508	265	263
Peak Fct	.918	.833	.857	.83	.775	.854	.898	.878	.889	.881	.856	.764	.72	.736	.713	.914	.91	.841	.934	.895	.865
Peak Hr	10: 30	11: 00	10: 00	9: 45	11: 00	10: 00	10: 15	10: 15	11: 00	11: 00	11: 00	11: 00	10: 45	10: 15	10: 45	10: 30	10: 15	10: 30	10: 15	10: 15	10: 00
Peak Vol	633	337	305	570	321	279	548	317	258	553	274	326	578	288	336	587	286	333	480	245	238
Peak Fct	.92	.834	.897	.885	.863	.861	.835	.714	.827	.772	.659	.832	.835	.742	.8	.906	.872	.946	.916	.756	.804
Peak Hr	12: 15	12: 15	13: 45	12: 00	12: 00	13: 15	16: 15	16: 15	15: 15	15: 30	15: 45	14: 45	13: 15	12: 00	13: 30	14: 30	13: 00	14: 30	12: 15	12: 15	12: 45
aily Fct	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
xle Fct	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500
ılse Fct	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000
sonal Fct	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.618	.769	.769	.769	.769	.769	.769	.769	.769	.769

Daily Volume from 08/22/2022 through 09/08/2022

names: Little Fort South 21-011NS - NY

Seasonal Factor Grp: Highly Seasonal
Daily Factor Grp: Highly Seasonal

tion: Route 5, 0.5 km south of Route 24, Little Fort

	Sun, Sep 4, 2022			Mon, Sep 5, 2022			Tue, Sep 6, 2022			Wed, Sep 7, 2022			Thu, Sep 8, 2022			Fri, Sep 9, 2022			Sat, Sep 10, 2022		
	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S	Road	N	S
00:00	19	10	9	33	15	18	33	16	17	50	29	21	45	27	18						
01:00	30	18	12	25	13	12	32	21	11	37	26	11	51	24	27						
02:00	21	11	10	22	11	11	28	16	12	33	12	21	43	24	19						
03:00	14	6	8	22	9	13	35	17	18	44	18	26	49	29	20						
04:00	24	13	11	28	9	19	62	32	30	57	22	35	57	23	34						
05:00	26	10	16	28	14	14	86	55	31	84	48	36	90	52	38						
06:00	42	22	20	77	50	27	152	83	69	158	84	74	167	91	76						
07:00	105	48	57	156	84	72	232	117	115	251	119	132	245	117	128						
08:00	208	113	95	261	133	128	305	166	139	345	182	163	278	131	147						
09:00	343	187	156	405	211	194	371	192	179	341	169	172	346	179	167						
10:00	450	213	237	560	272	288	371	205	166	417	227	190	434	222	212						
11:00	482	207	275	666	303	363	463	226	237	439	236	203	413	223	190						
12:00	450	223	227	679	341	338	413	210	203	449	226	223	442	233	209						
13:00	427	192	235	649	313	336	460	220	240	410	201	209	383	183	200						
14:00	444	168	276	620	261	359	424	207	217	443	251	192	412	222	190						
15:00	399	158	241	511	207	304	361	205	156	440	215	225	423	202	221						
16:00	339	147	192	511	232	279	364	210	154	447	250	197	486	236	250						
17:00	341	174	167	472	271	201	511	203	308	396	205	191									
18:00	319	175	144	384	178	206	267	114	153	282	134	148									
19:00	220	118	102	250	110	140	186	81	105	252	122	130									
20:00	165	77	88	184	89	95	163	86	77	155	82	73									
21:00	94	40	54	102	52	50	119	53	66	114	56	58									
22:00	59	29	30	80	43	37	106	56	50	82	55	27									
23:00	38	14	24	46	24	22	66	29	37	48	26	22									
Total	5,059	2,373	2,686	6,771	3,245	3,526	5,610	2,820	2,790	5,774	2,995	2,779	4,364	2,218	2,146						
Peak Vol	491	234	275	666	303	363	463	226	237	446	239	207	461	264	212						
Peak Fct	.852	.836	.838	.858	.781	.89	.833	.595	.94	.878	.892	.863	.784	.742	.803						
Peak Hr	10: 15	10: 15	11: 00	11: 00	11: 00	11: 00	11: 00	11: 00	11: 00	10: 30	10: 30	10: 30	10: 30	10: 30	10: 00						
Peak Vol	450	223	279	729	356	373	542	261	338	485	251	240									
Peak Fct	.915	.845	.918	.939	.918	.833	.792	.687	.748	.842	.697	.822									
Peak Hr	12: 00	12: 00	14: 15	12: 15	12: 15	12: 15	16: 30	12: 30	16: 45	14: 45	14: 00	14: 45	:	:	:						
aily Fct	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000						
xle Fct	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500	.500						
ılse Fct	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000						
sonal Fct	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769	.769						