THURBER ENGINEERING LTD.

March 9, 2023 File No.: 34837

BC Ministry of Transportation and Infrastructure
4B-940 Blanshard St
Victoria, BC V8W 3E6

Attention:, Crystal Bleackley, P.Eng.

CERVUS CREEK BRIDGE REPLACEMENT
GEOTECHNICAL ENGINEERING INPUT – 100% DESIGN

Dear Crystal:

At the request of BC Ministry of Transportation and Infrastructure, Thurber Engineering Ltd. (Thurber) has prepared this letter summarizing our geotechnical input for the Cervus Creek Bridge Replacement Project. This work has been carried out under our "As and When Geotechnical Engineering Services" agreement Contract No. 861 CS 1195.

This report supersedes Thurber's reports titled "Cervus Creek Bridge Replacement Geotechnical Input for Approach Embankment Design" dated October 5, 2022 and "Cervus Creek Bridge Replacement Geotechnical Engineering Input - 50% design" dated August 23, 2022.

It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

The Cervus Creek Bridge is located approximately 24 km east of Gold River, BC on Highway 28. The proposed replacement bridge will be constructed at about the same horizontal and vertical alignments as the existing bridge with some modifications to the existing road and the existing slope geometry. Associated Engineering Ltd. (AE) provided us with 100% design drawings dated March 3, 2023 showing the proposed bridge and approach configuration and the Ministry provided bridge design drawings dated January 20, 2023.

The bridge design drawings provided by the Ministry show that the bridge will have a single 40 m long span comprising steel girders supported on steel pipe pile foundations. The abutment foundations each will have a row of five 762 mm OD steel pipe piles with 19 mm thick walls spaced at 2.3 m centre-to-centre. The design drawings show that the underside of the pile cap is approximately 3.7 m below the existing grade and the bottom of the creek channel is approximately 4.8 m below the underside of the pile caps. We have been provided a 1.6 m scour depth by Associated Engineering Ltd.

The Ministry provided the two pile loading conditions shown in the table below.

	Shear	Moment	Axial
Load Condition 1	920 kN	1070 kN · m	1750 kN
Load Condition 2	-1110 kN	-1690 kN · m	1750 kN

The highway design drawings provided include cross sections at 10 m intervals along the project alignment. The approach embankments within the project boundaries extend approximately 130 m to the west and 140 m to the east of the bridge. We understand that the existing highway embankments typically have 1.2 horizontal:1 vertical (1.2H:1V) to 2H:1V slopes and are up to 8 m high. AE has informed us that in the areas where the embankment will be modified, slopes steeper than 2H:1V may be necessary to ensure the embankment stays within the highway right-of-way. These altered slopes will typically need to be 1.8H:1V and up to 1.5H:1V locally. This memo provides recommendations for modified embankments with slopes varying from 2H:1V up to 1.5H:1V. Unmodified slopes were not analysed as a part of this stability assessment.

Section 6.9 of the Ministry's supplement to the 2019 Canadian Highway Bridge Design Code (CHBDC) states that an assessment of unaltered existing embankments and natural slopes is only required on a case-by-case basis as requested by the Ministry. The Ministry informed us that they do not require an assessment of unaltered slopes on this project. A slope is considered unaltered if the proposed embankment modifications do not significantly affect its factor of safety for global stability.

2. GEOTECHNICAL CONDITIONS

In 2020, WSP conducted a preliminary geotechnical investigation for the proposed project and prepared a geotechnical report titled "Highway 28 Bridges Geotechnical Data Report", which included two sonic holes at the Cervus Creek bridge crossing (SH20-01 and SH20-02). In 2021, Tetra Tech conducted an investigation, the results of which are summarized in the report titled "Becker Hammer Drilling – Cervus Creek Bridge, Elk River Bridge, Heber River Bridge Geotechnical Data Report". This report included two Becker test holes (TH21-03A and TH21-03B). The conditions encountered during the drilling investigations consisted of compact to very dense sand and gravel. Groundwater was encountered at a depth of 7.6 m. For completeness, the test hole logs from these reports are attached. Please refer to the WSP and Tetra Tech reports for complete information.

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3. GEOTECHNICAL RECOMMENDATIONS

3.1 Embankments

3.1.1 Slope Stability Methodology

The Ministry informed us that the bridge is a major route structure, and we have a considered typical consequence factor and a typical degree of understanding for the design of the embankments. Accordingly, the required minimum static factor of safety (FS) for embankments is 1.54 as described in Table 6.2b the BC the Ministry Supplement to the 2019 CHBDC.

Section 6.14.9.1 of the 2019 CHBDC requires that the seismic performance of slopes and embankments meet a pseudostatic FS of 1.3 for no less than half of the required peak ground acceleration (PGA), which for a major route bridge is the 1 in 475-year return period seismic hazard. The 2019 CHBDC and The Ministry supplement specifies that under this seismic hazard, 100% of the travelled lanes must be available for use inside the embankment bridge influence zone and 50% of the travelled lanes must available outside the embankment bridge influence zone.

Our seismic slope stability analysis used a seismic horizontal acceleration greater than one-half of the PGA. The 1 in 475-year return period PGA was obtained from NBC 2015 Seismic Hazard Calculator and is attached.

Our slope analysis is based on the attached cross section drawings provided by Associated Engineering and the geotechnical conditions described by WSP and Tetra Tech. The existing embankments are between 3.6 m and 8 m high and sloped at between 1.2H:1V and 2H:1V. We analysed sections that are proposed to be modified with slopes steeper then 2H:1V. We considered the critical slip surface that must meet the required static and seismic performance criteria is the slip surface daylighting at the fog line (i.e. the edge of outer travelled lane).

The stability assessment was completed using the limit equilibrium analysis software Slide2, published by Rocscience. The entry and exit ranges were set assess the FS for slip surfaces at or within the fog lines of the proposed road alignment. A traffic surcharge of 16 kPa was applied within the travelled lanes.

The results of the slope stability analyses show that the proposed slopes are expected to meet the design criteria. In areas where the slopes must be steeper, there is an increased risk of shallow slope failure, however, the critical zone meets the required FS as described above.

We assessed the following typical sections:

1) Section 302+50 – With and without nominal embankment reconfiguration at the slope crest (up to 0.3 m of crest widening)
2) Section 302+60 – A typical modified embankment with 1.8H:1V slopes
3) Section 304+30 – A modified embankment with 1.5H:1V slopes

The two analysis of section 302+50 indicate that the existing slope has an FS of 1.25 and the reconfigured embankment has an FS of 1.23. It is our opinion that this nominal reduction (2%) is not significant and as such the reconfiguration is not considered to be a modified embankment.

The analysis of the typical modified embankment with 1.8H:1V slopes used the section at Sta. 302+60, which the tallest embankment section. The analysis indicated that the static is FS is 2.26 and the seismic FS is 1.46. The embankment widening was assumed to be completed with compacted well-graded granular fill.

Section 304+30 was the only section provided that has slopes steeper than 1.8H:1V. The embankment is about 4 m high and has 1.5H:1V slopes. The embankment widening was assumed to be completed with compacted well-graded granular fill. The proposed modifications at this section meet the required static and seismic FS.

The Slide2 outputs from these three sections are attached.

3.1.2 Embankment Design Input

We recommend considering modified embankments to be those with changes to the profile of the slope and crest of 0.3 m or more. Modified approach embankments should be constructed at 2H:1V where there is enough room within the existing right of way.

Prior to fill placement we recommend the surface be stripped of existing organic material to expose mineral soils. We recommend that embankment fill consist of 75 mm minus well-graded granular fill with less than 5% fines, such as well-graded base course. For slopes inclined at 2H:1V or flatter, the fill should be compacted to at least 95% standard Proctor maximum dry density (SPMDD) in maximum 300 m thick loose lifts. For slopes inclined steeper than 2H:1V and up to 1.5H:1V, the fill should be compacted to at least 98% SPMDD in maximum 300 mm thick loose lifts. Areas where fill is placed should be overbuilt and cut back to design profile to make sure the finished slope face is properly compacted. The Ministry's 2020 Standard Specifications requires that embankments and fill placement on slopes must be terraced in steps 1.5 m wide, with heights varying from 0.75 m to 1 m depending on the slope angle required by the right of way.

As mentioned above, slopes steeper than 2H:1V are at increased risk of shallow slope movement. In the Ministry's Manual of Erosion Control and Shallow Slope Movement, shallow slope failure is described as slumping and flow of mass, typically coming to rest a short distance down the slope in ditches or drainage courses. Shallow slope failures are more likely in winter months with higher ground water level. Shallow slope failures can be mitigated by planting deep-rooting vegetation with sufficient time to become established before winter.

3.2 Pile Foundations

Based on the anticipated subsurface conditions, we recommend drilling the piles to the minimum required embedment (i.e. maximum pile toe elevation) for lateral stability followed by installation with an impact hammer. Impact driving would continue until the following conditions are reached:

- The pile is installed to the estimated embedment depth for axial resistance provided below and the pile driving termination criteria is met; or,
- Pile driving encounters practical refusal.

Practical refusal and the pile driving termination criteria will depend on the hammer configuration and accordingly will be provided after the hammer has been selected.

If practical refusal is encountered, PDA testing will likely be of limited value. Accordingly, we recommend carrying out PDA testing only if the pile driving does not meet the pile driving termination criteria by the time the pile is installed to the estimated embedment depth required for axial resistance.

We suggest an APE D46 diesel hammer or equivalent be considered for installation of 762 mm diameter pipe piles. Impact hammer selection will need to be reviewed by Thurber prior to pile installation and may need to be revised based on the final required geotechnical resistances of the piles.

3.2.1 Axial Resistance

Per the 2019 CHBDC and the Ministry Supplement to the 2019 CHBDC, it is our opinion that the degree of understanding from the investigation is typical. As such, we recommend using a geotechnical resistance factor of 0.4 for non-seismic design. Accordingly, an unfactored resistance of 4375 kN is required to attain the required factored ULS resistance of 1750 kN,

To achieve the required axial resistance, we anticipate that the open-ended piles will need to reach embedment lengths of about 16 m below pile cap depth. We recommend installing open-ended piles to facilitate drilling to the minimum required embedment for lateral stability.

3.2.2 Input for Lateral Pile Design

Lateral pile design and analyses were carried out using the software program LPILE by Ensoft. The analysis includes development of p-y curves, assessment of the pile response to the loads provided by the Ministry and evaluation of the pile embedment required for lateral stability.

Our recommended p-y curves for lateral pile design for the 762 mm diameter piles are attached. For structural model sensitivity checking, we recommend doubling and halving the stiffnesses of the equivalent soil springs given to reflect the uncertainty in the estimated soil stiffness.

We recommend applying p-multipliers to account for pile group effects following the CHBDC. Figures C6.22 – C6.24 from the CHBDC Commentary showing side-by-side and line-by-line group efficiency factors should be referenced during structural design.

The pile response (i.e. shear and bending moment plots) to the loads conditions provided by the Ministry is attached.

To determine the minimum required pile embedment to achieve the required lateral resistance, LPILE analyses were completed using the loads provided by the Ministry and applying a lateral

geotechnical resistance factor of 0.5. We recommend using a minimum pile embedment of 11 m for lateral stability.

3.3 Seismic Site Class

Based on the results of the investigation, we anticipate that the subsurface conditions will generally comprise granular soil at the Cervus Creek Bridge location. We recommend using Site Class C for structural design.

The seismic hazard for the site was obtained from NBC 2015 Seismic Hazard Calculator. The calculator output is attached for reference. The calculator provided a site-specific peak ground acceleration (PGA) for site Class C of 0.376 g for the 1 in 2,475-year return period earthquake. This PGA was used to evaluate the seismic wall pressures given below.

Based on the results and interpretation of the investigation, the site is not considered to be susceptible to liquefaction under the design earthquake.

3.4 Lateral Soil Pressures

We have calculated the at-rest, passive and active lateral earth pressures under static loading conditions and the active lateral earth pressures on yielding and non-yielding walls under seismic conditions.

The non-seismic lateral earth pressures can be calculated as an equivalent hydrostatic pressure using an equivalent fluid density of 4.3 kN/m^3 for yielding walls (active soil pressures) and 6.8 kN/m^3 for non-yielding walls (at-rest soil pressures). Non-yielding walls should have a minimum 12 kPa lateral pressure to account for compaction of soil near the wall. Compaction induced lateral pressures and those due to surcharge loading are not additive. The passive earth pressure can be calculated using an equivalent fluid density of 75.6 kN/m^3. We recommend applying a resistance factor of 0.5 on the passive resistance to calculate the ULS resistance. These values assume a soil unit weight of 18 kN/m^3 and an active earth pressure coefficient (K_a) of 0.24, an at-rest earth pressure coefficient (K_o) of 0.38 and passive earth pressure coefficient (K_p) of of 4.20.

The seismic active pressures acting on yielding walls can be calculated using an equivalent fluid density of 6.8 kN/m^3. The seismic active pressures acting on non-yielding walls can be calculated using an equivalent fluid density of 9.6 kN/m^3. Because of the location of the resultant of the seismic force is uncertain, we recommend calculating the total seismic force and applying it as both a uniform pressure distribution and an equivalent hydrostatic fluid pressure (i.e. a triangular distribution).

4. CLOSURE

We trust this information meets your present needs. If you have any questions, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.

Steven Coulter, M.Sc., P.Eng.
Principal Engineer

Thurber Engineering Ltd.
Permit to Practice #1001319

McKenzie Douglas, EIT
Junior Geotechnical Engineer

Attachments

- Statement of Limitations and Conditions (1 page)
- Test Hole Logs - TH21-03A, TH21-03B, SH20-01, SH20-02 (14 pages)
- Associated Engineering Ltd. R1-964-1042 – Cross Sections (3 pages)
- Slide Outputs (10 pages)
- NBC 2015 Seismic Hazard Calculator (1 page)
- Lateral pile p-y data (1 page)
- Shear and moment diagrams (2 pages)

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STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client, the BC Ministry of Transportation and Infrastructure (MoTI) and Authorized Users as defined in the MoTI Special Conditions Form H0461d. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Any use which an unauthorized third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any unauthorized third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

LIMIT OF CONSTRUCTION
P.O.T. 300+80.000
T/E TO EXISTING
N 5526515.987
E 299558.917

TO GOLD RIVER
PAVEMENT EDGE
64°08'50"
301
PAVEMENT EDGE
HIGHWAY 28
300 LINE
302
303
304
TS 301+00.486
Ls 50.000
Θs 0°34'23"
SC 301+50.486

REMOVE EXISTING BARRIER
FROM STA. 303+15.736 TO STA. 304+20.593
REMOVE EXISTING BARRIER
FROM STA. 302+95.672 TO STA. 304+00.027
CERVUS CREEK BRIDGE No. 7318
DESIGN BY MOTI

CERVUS CREEK

300 LINE - HIGHWAY 28
POT 304+38.505 =
30 LINE - ACCESS ROAD
P.O.T. 30+38.911
N 5526289.107
E 299639.255

R 2500.000 Lt
Δ 12°25'27"
Tc 272.122
Arc 542.110
Ec 14.767

R 30.000 Lt
53°18'53"
Tc 15.060
Arc 27.915
Ec 3.568

PAVEMENT EDGE
EC 30+36.013
TH21-03A
TH21-03B
EDGE
POT 30.00
30 LINE
327°39'52"
PI 30+23.158
ACCESS ROAD
BC 30+08.098
PI 304+22.937

LEGEND
Testhole locations by Tetra Tech (2021)

NOTES
1. Based on Drawing No. R1-964-121, "Cervus Creek Bridge No. 7318 Replacement, Highway 28" dated October 16, 2020.

ISSUED FOR USE

0 50m
Scale: 1:1,000 @ 11"x17"

CLIENT
BRITISH COLUMBIA Ministry of Transportation and Infrastructure

TETRA TECH

HWY 28 BECKER DRILLING
CERVUS CREEK, ELK RIVER, HEBER RIVER BRIDGES

CERVUS CREEK BRIDGE

PROJECT NO.	DWN	CKD	REV
TRN.VHWY03225-04	RH	EE	0
OFFICE: VANC	DATE: May 5, 2021		

Figure 3

Q:\Vancouver\Drafting\Transportation\PAVE\TRN.PAVE\03225-04.001 TH Plan R0a.dwg [FIGURE 3] May 05, 2021 - 11:30:36 am (BY: HALL, ROBERT J.)

SUMMARY LOG

Drill Hole #: **TH 21 - 03 A**

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Hwy 28 Bridges, Becker Drilling Exploration**

Location: Cervus Creek Bridge, WBL, East Abutment

Prepared by: 704-TRN.PAVE03225-04 Tetra Tech, Inc.

Logged by: EE Reviewed by: AW

Datum: Alignment:

Northing/Easting: 5526250.399 , 299794.165 Station/Offset:

Elevation: 250.69 m

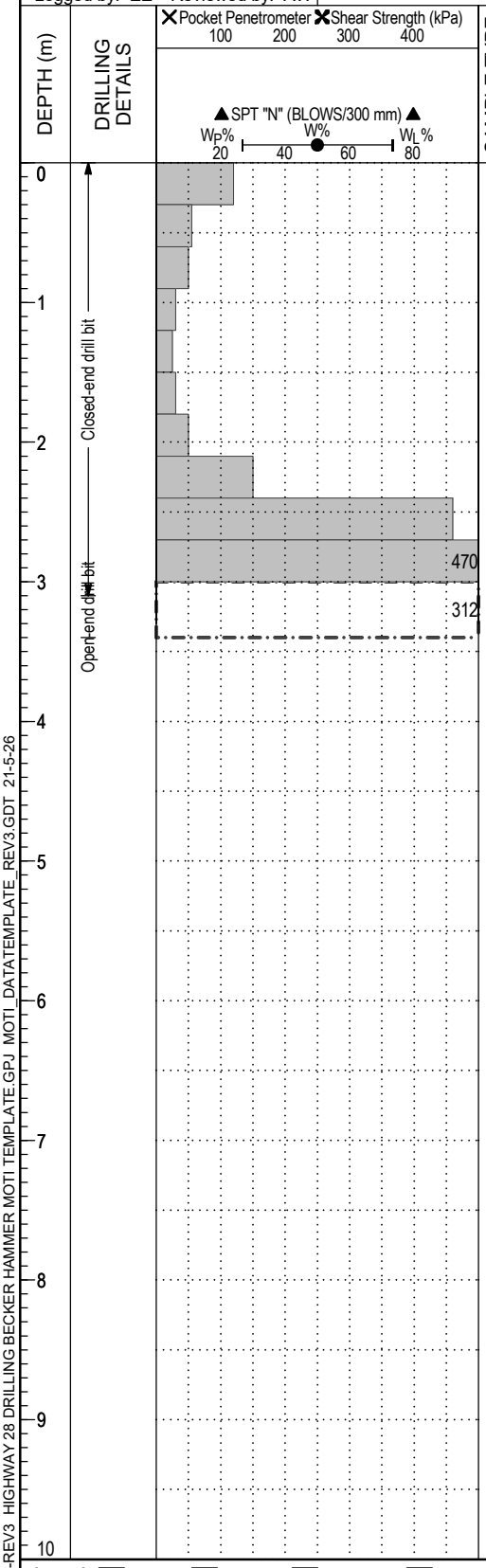
Date(s) Drilled: 2021-04-11

Company: Foundex Explorations Ltd.

Driller: Bill Ivens, Chris Griffin

Drill Make/Model: HAV 180 Becker Hammer

Drilling Method: Becker Hammer Drilling



SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate *{G % S % F %}*	ELEVATION (m)
	1						250
	2						
	3						
	4						249
	5						
	6						
	7						248
	8						
	9						
	10						247
	11					End of Borehole at 3.3 m, Becker Hammer Refusal. Backfilled with pea gravel, betonite, and sealed with cold mix asphalt. Borehole location measured on field relative to local landmarks.	246
							245
							244
							243
							242
							241

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: 3.3 m
Depth to Top of Rock:

MOTI-SOIL-REV3 HIGHWAY 28 DRILLING BECKER HAMMER MOTI TEMPLATE.GPJ MOTI_DATATEMPLATE_REV3.GDT 21-5-26

SUMMARY LOG

Drill Hole #: **TH 21 - 03 B**

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Hwy 28 Bridges, Becker Drilling Exploration**

Location: Cervus Creek Bridge, WBL, East Abutment

Prepared by: 704-TRN.PAVE03225-04 Tetra Tech, Inc.

Logged by: EE Reviewed by: AW

Datum: Alignment:

Northing/Easting: 5526251.005 , 299795.372 Station/Offset:

Elevation: 250.66 m

Date(s) Drilled: 2021-04-11 to 2021-04-12

Company: Foundex Explorations Ltd.

Driller: Bill Ivens, Chris Griffin

Drill Make/Model: HAV 180 Becker Hammer

Drilling Method: Becker Hammer Drilling

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 Drillers Estimate {G % S % F %}	ELEVATION (m)
0	Closed-end drill bit			1						250
1				2						
				3						
				4						249
				5						
2				6						
				7						248
				8						
				9						
3		198		10						
		150		11						247
		159		12						
		140		13						
4				14						
				15						246
		107		16						
				17						
5		115		18						
		118		19						245
		133		20						
6		130		21						
		103		22						244
		109		23						
		119		24						
7				25						
	7.6m 2021-04-11	122		26						243
				27						
8		107		28						
		144		29						242
		183		30						
9		207		31						
		150		32						241
10		179		33						

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: 27.7 m

Depth to Top of Rock:

MOTI-SOIL-REV3 HIGHWAY 28 DRILLING BECKER HAMMER MOTI TEMPLATE.GPJ MOTI_DATATEMPLATE_REV3.GDT 21-5-26

SUMMARY LOG

Drill Hole #: **TH 21 - 03 B**

Ministry of Transportation and Infrastructure

Project: **Hwy 28 Bridges, Becker Drilling Exploration**

Location: Cervus Creek Bridge, WBL, East Abutment

Prepared by: 704-TRN.PAVE03225-04 Tetra Tech, Inc.

Logged by: EE Reviewed by: AW

Datum: Alignment:

Northing/Easting: 5526251.005 , 299795.372 Station/Offset:

Elevation: 250.66 m

Date(s) Drilled: 2021-04-11 to 2021-04-12

Company: Foundex Explorations Ltd.

Driller: Bill Ivens, Chris Griffin

Drill Make/Model: HAV 180 Becker Hammer

Drilling Method: Becker Hammer Drilling

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 / Drillers Estimate {G % S % F %}	ELEVATION (m)
10	Open-end drill bit	212		34					Becker Hammer Refusal	240
		167		35						
11		258		36						239
		131		37						
		130		38						
12				39						238
				40						
				41						
13				42						237
		119		43						
				44						
14				45						236
				46						
				47						
15				48						235
				49						
				50						
16				51						234
				52						
				53						
17				54						233
				55						
				56						
18		119		57						232
		113		58						
				59						
19				60						231
				61						
				62						
20		108		63						
				64						
				65						
				66						

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: 27.7 m

Depth to Top of Rock:

MOTI-SOIL-REV3 HIGHWAY 28 DRILLING BECKER HAMMER MOTI TEMPLATE.GPJ MOTI_DATATEMPLATE_REV3.GDT 21-5-26

SUMMARY LOG

Drill Hole #: **TH 21 - 03 B**

Ministry of Transportation and Infrastructure

Project: **Hwy 28 Bridges, Becker Drilling Exploration**

Location: Cervus Creek Bridge, WBL, East Abutment

Prepared by: 704-TRN.PAVE03225-04 Tetra Tech, Inc.

Logged by: EE Reviewed by: AW

Datum: Alignment:

Northing/Easting: 5526251.005 , 299795.372 Station/Offset:

Elevation: 250.66 m

Date(s) Drilled: 2021-04-11 to 2021-04-12

Company: Foundex Explorations Ltd.

Driller: Bill Ivens, Chris Griffin

Drill Make/Model: HAV 180 Becker Hammer

Drilling Method: Becker Hammer Drilling

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 Drillers Estimate {G % S % F %}	ELEVATION (m)
20	Open-end drill bit	117		67						230
		109		68						
		118		69						
21				70						
		177		71						229
		235		72						
22		174		73					Becker Hammer Refusal	
		109		74						228
				75						
23		132		76						
				77						227
				78						
24				79						
				80						
				81						226
		120		82						
25		196		83						
		214		84						225
		170		85						
26		123		86						
		208		87						224
		120		88						
27		285		89						
		145		90						223
		611		91					End of Borehole at 27.7 m, Becker Hammer Refusal. Backfilled with pea gravel, betonite, and sealed with cold mix asphalt. Borehole location measured on field relative to local landmarks.	
28										222
29										
30										221

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: 27.7 m

Depth to Top of Rock:

MOTI-SOIL-REV3 HIGHWAY 28 DRILLING BECKER HAMMER MOTI TEMPLATE.GPJ MOTI_DATATEMPLATE_REV3.GDT 21-5-26

LEGEND

APPROXIMATE SONIC HOLE LOCATION

wsp	PROJECT: HIGHWAY 28 BRIDGES, GOLD RIVER BC CERVUS CREEK				
	TITLE: BOREHOLE LOCATION PLAN				
	CLIENT: BC MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE				
FIGURE NO.: 2a	DATE: DECEMBER 2020	FILE NO.: 201-08573-00	SCALE: NTS	DRAWN BY: LM	REV NO.: -

WSP Canada Inc., 1935 Bollinger Road, Nanaimo, B.C., V9S 5W9 Phone: 250/753-1077

Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: **SH20-01**

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, NE abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526247.225 , 299788.218 Station/Offset:

Elevation: 250.77 m *Coordinates Surveyed May 20, 2021*

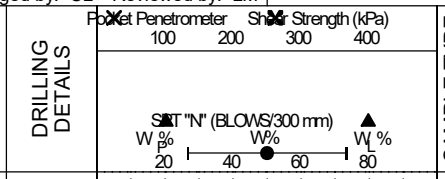
Date(s) Drilled: 11-23-2020 & 11-24-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic



DEPTH (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	SLOTTED PIEZOMETER	ELEVATION (m)
0					ASPHALT (Fill) (approximately 200 mm thick). 0.2m	AC			
					CRUSHED STONE (Fill).	SB	Between 0.2 m and 13.7 m poor recovery in drill runs and split-spoons due to high gravel and/ or cobble content in soils.		
1									250
					1.52m				
2		SS1	8		GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 120 mm), trace sand and silt, dark brownish grey, moist, loose (Fill).	GP	{G:89 S:10 F:1}		249
		GS1					**Sieve** (Sa#GS1) G:89% S:10% F:1%		
3		SS2	8				{G:89 S:10 F:1}		248
		GS2					{G:89 S:10 F:1}		
4									247
		SS3	17				SPT on cobble, value not representative. {G:89 S:10 F:1}		
5					5.18m				246
		GS3			GRAVEL, fine to coarsed grained, sub-rounded to sub-angular, maximum particle diameter 50mm - 75 mm, trace sand and silt, dark grey, moist, compact to dense.	GW	**Sieve** (Sa#GS3) G:98% S:2% F:0%		245
6		SS4	8				{G:98 S:2 F:0}		
		GS4					{G:98 S:2 F:0}		244
7									
		SS5	21				{G:98 S:2 F:0}		243
8					8.08m				
		GS5			sandy GRAVEL, fine to coarse grained sand, fine grained gravel, sub-rounded to sub-angular, (maximum particle diameter 19 mm - 25 mm), trace silt, light greyish brown, moist, dense to very dense.	GP-GM	**Sieve** (Sa#GS5) G:70% S:24% F:6%		242
9		SS6	38				**Sieve** (Sa#SS6) G:65% S:29% F:6%		
									241
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

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 31.1 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-01**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, NE abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526247.225 , 299788.218 Station/Offset:

Elevation: 250.77 m *Coordinates Surveyed May 20, 2021*

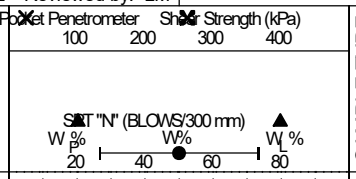
Date(s) Drilled: 11-23-2020 & 11-24-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic



DEPTH (m)	DRILLING DETAILS	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	SLOTTED PIEZOMETER	ELEVATION (m)
10						10.06m SAND, fine to coarse grained, some silt, moist, dense to very dense. - Between 10.2 m and 11.5 m, gravelly and some cobbles (maximum particle diameter 130 mm, sub-rounded to sub-angular).		**Sieve** (Sa#GS6) G:28% S:56% F:16% *{G:28 S:56 F:16}*		240
11			GS7			- Between 11.5 m and 15.8 m, SILT and SAND some gravel. Thin (circa 3 mm to 8 mm thick) laminations of light grey silt.		**Sieve** (Sa#GS7) G:13% S:40% F:47%		239
12						- Between 12.0 m and 12.2 m, some cobbles (maximum particle diameter 140 mm, sub-rounded).				
13			GS8					*{G:13 S:40 F:47}*		238
14			SS8	79			SM1	*{G:13 S:40 F:47}*		237
15	15.1m		GS9					*{G:13 S:40 F:47}*		236
			SS9	89				*{G:13 S:40 F:47}*		
16			GS10					*{G: S:70 F:30}*		235
17			SS10	79				*{G: S:70 F:30}*		234
18			GS11			17.53m sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 150 mm), some silt, light grey, moist, dense to very dense.		**Sieve** (Sa#GS11) G:65% S:22% F:13%		233
			SS11	20						
19										232
20			GS12							231

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

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 31.1 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-01**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, NE abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526247.225 , 299788.218 Station/Offset:

Elevation: 250.77 m *Coordinates Surveyed May 20, 2021*

Date(s) Drilled: 11-23-2020 & 11-24-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer 100 200 / Shear Strength (kPa) 300 400 / 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 %}	SLOTTED PIEZOMETER	ELEVATION (m)
20							sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 150 mm), some silt, light grey, moist, dense to very dense. *(continued)*		*{G:65 S:22 F:13}*		230
21		R		SS12	20		-Below 21.0 m, some sand				229
22											228
23		4		GS13					**Sieve** (Sa#GS13) G:85% S:11% F:4%		227
24		R		SS13	55			GM1			226
25											225
26		8		GS14			-At 25.9 m, sandy		**Sieve** (Sa#GS14) G:57% S:31% F:12%		224
27		R		SS14	40						223
28											222
29		8		GS15					**Sieve** (Sa#GS15) G:76% S:13% F:11%		221
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

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 31.1 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-01**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, NE abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526247.225 , 299788.218 Station/Offset:

Elevation: 250.77 m *Coordinates Surveyed May 20, 2021*

Date(s) Drilled: 11-23-2020 & 11-24-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 / 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 %}	SLOTTED PIEZOMETER	ELEVATION (m)
30		R	SS	SS15	56		sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 150 mm), some silt, light grey, moist, dense to very dense. *(continued)*				220
31							31.09m End of borehole at 31.1m. 50 mm diameter standpipe installed.				219
32											218
33											217
34											216
35											215
36											214
37											213
38											212
39											211
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

Legend Installation: Sand, Grout, Cement, Bentonite, Drill Cuttings, Slotted, Slough, Piezometer

Final Depth of Hole: 31.1 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-02**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, SW abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526233.37 , 299761.75 Station/Offset:

Elevation: 251.08 m *Coordinates Surveyed May 20, 2021*

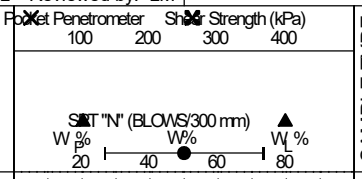
Date(s) Drilled: 11-24/ 25 /30-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic



DEPTH (m)	SOIL DESCRIPTION	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
0	ASPHALT (Fill) (approximately 200 mm thick). 0.2m					AC		251
	CRUSHED STONE (Fill). 0.61m					SB		
1	sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles (maximum particle diameter 120 mm), trace silt, dark grey, moist, loose to compact (Fill).							250
2	12	SS	SS1	4			{G:75 S:20 F:5}	249
	-At 2.4 m, trace sand	GS	GS1				**Sieve** (Sa#GS1) G:90% S:9% F:1%	
3	8 3					GM		248
4								247
	8	GS	GS2				**Sieve** (Sa#GS2) G:61% S:32% F:7% SPT3 terminated on cobble. N value not representative.	
5	8	SS	SS3	0				246
	SAND, fine to coarse grained, maximum particle diameter 25mm - 37.5mm, some silt, dark brownish grey, moist, loose to compact. 5.2m							
6	6 23	SS	SS4	17		SM1	**Sieve** (Sa#SS4) G:0% S:84% F:16%	245
	45	GS	GS4				{G:91 S:5 F:4}	
7	gravelly COBBLES, fine to coarse grained, sub-rounded to sub-angular, maximum particle diameter 75mm - 100mm, trace fine to coarse grained sand, trace silt, dark brownish grey, wet, loose to compact. 6.71m							244
8	20 64	SS	SS5	58		GP-SB	{G:91 S:5 F:4}	243
		GS	GS5				**Sieve** (Sa#GS5) G:91% S:5% F:4%	
9								242
	15 R	SS	SS6	64			**Sieve** (Sa#SS6) G:57% S:37% F:6%	
	GRAVEL and SAND, fine to coarse grained, sub-rounded to sub-angular, trace silt, dark grey, moist, loose to compact. 9.14m 9.6m					GP-GM		
10								

Legend

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

Final Depth of Hole: 30.5 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-02**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, SW abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526233.37 , 299761.75 Station/Offset:

Elevation: 251.08 m *Coordinates Surveyed May 20, 2021*

Date(s) Drilled: 11-24/ 25 /30-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic

Pocket Penetrometer Shear Strength (kPa) 100 200 300 400

SPT "N" (BLOWS/300 mm)

W % P 20 40 W% 60 W_L % 80

DEPTH (m)	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
10		GS6			SAND and SILT, fine to coarse grained, (thin circa 5 mm to 10 mm thick laminations of light grey silt), dark brownish grey, moist, dense to very dense. *(continued)*		*{G: S:56 F:44}*	241
11		SS7	67			SM4	**Sieve** (Sa#SS7) G:% S:56% F:44%	240
		GS7					*{G: S:56 F:44}*	
12		GS8			12.19m		No SPT at 12.0 m due to termination of preceding drill run on cobble.	239
		SS8	25		GRAVEL and COBBLES, fine to coarse grained, sub-rounded to angular, maximum particle diameter 170 mm, trace sand and silt, dark grey, moist, dense to very dense. 12.65m	GP	*{G:90 S:5 F:5}*	
13		GS9			SILT and SAND, fine to coarse grained (thin circa 5 mm to 10 mm thick laminations of light grey silt), trace gravel (fine grained, maximum particle diameter 9.5mm - 12.5mm), dark brownish grey, moist, hard.		**Sieve** (Sa#GS9) G:1% S:42% F:57%	238
14		SS9	75		- Between 13.4 m and 13.7 m, trace cobbles (maximum particle diameter 110 mm).		*{G: S:45 F:55}*	237
		GS10				ML	*{G: S:45 F:55}*	
15								236
		SS10	83				*{G: S:45 F:55}*	
16					-Below 16.0 m, sandy			235
		GS11			16.61m		*{G:1 S:24 F:75}*	
17		SS11	40		sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 140 mm), trace silt, dark grey, moist, dense to very dense.			234
		GS12			- Below 17.4 m, cobbley		*{G:60 S:35 F:5}*	
18		SS12	0					233
19								232
20								

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

Final Depth of Hole: 30.5 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-02**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, SW abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526233.37 , 299761.75 Station/Offset:

Elevation: 251.08 m *Coordinates Surveyed May 20, 2021*

Date(s) Drilled: 11-24/ 25 /30-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400	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)
20		4			GS13			sandy GRAVEL, fine to coarse grained, sub-rounded to sub-angular, some cobbles, (maximum particle diameter 140 mm), trace silt, dark grey, moist, dense to very dense. *(continued)*		*{G:85 S:10 F:5}*	231
21		R			SS13	0		- Below 21.3 m SAND and GRAVEL, trace boulders (maximum particle diameter 400mm).			230
22											229
23											228
24					GS14				GP	*{G:55 S:40 F:5}*	227
		R			SS14	4		- Between 24.4 m and 24.7 m circa minimum 300 mm diameter boulder of dark grey basalt. Drill cored through boulder.			
25											226
26					GS15					*{G:60 S:35 F:5}*	225
27		R			SS15	25					224
28											223
29		9			GS16					*{G:55 S:40 F:5}*	222
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: 30.5 m

Depth to Top of Rock:

SUMMARY LOG

Drill Hole #: **SH20-02**

Ministry of Transportation and Infrastructure

Project: **As & When Geotechnical Services, Highway 28 Bridges**

Location: Cervus Creek Bridge, SW abutment (Highway 28 SW bound lane)

Prepared by: 201-08573-00 WSP Canada Inc.

Logged by: CL Reviewed by: LM

Datum: UTM Zone 10U, NAD 83 Alignment:

Northing/Easting: 5526233.37 , 299761.75 Station/Offset:

Elevation: 251.08 m *Coordinates Surveyed May 20, 2021*

Date(s) Drilled: 11-24/ 25 /30-2020

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: LS 250 MiniSonic

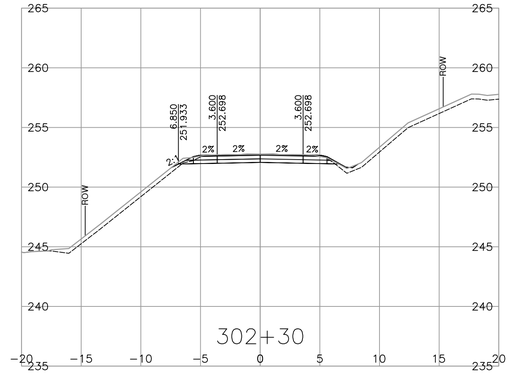
Drilling Method: Sonic

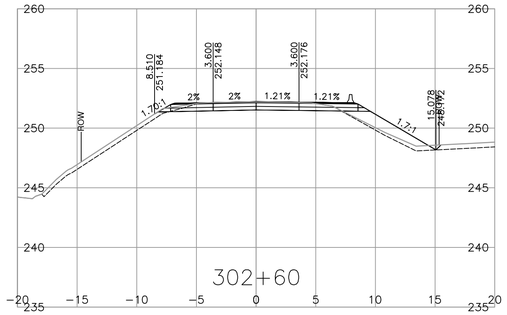
DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer Shear Strength (kPa) 100 200 300 400 / SPT "N" (BLOWS/300 mm) W_P % 20 W % 40 60 W_L % 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	ELEVATION (m)
30							30.48m		No SPT at 30.0 m due to broken 150mm drill casing.	221
							End of borehole at 30.48m. Backfill with drill cuttings, bentonite seals as per the groundwater protection act and asphlat at surface.			
31										220
32										219
33										218
34										217
35										216
36										215
37										214
38										213
39										212
40										

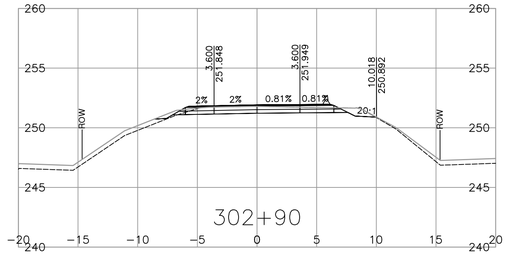
Legend Sample Type: A-Auger; B-Becker; C-Core; G-Grab; V-Vane; L#-Lab Sample; S-Split Spoon; O-Odex (air rotary); W-Wash (mud return); T-Shelby Tube

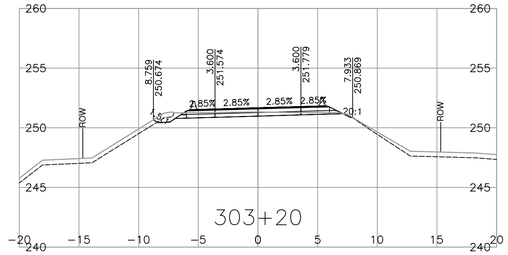
Final Depth of Hole: 30.5 m

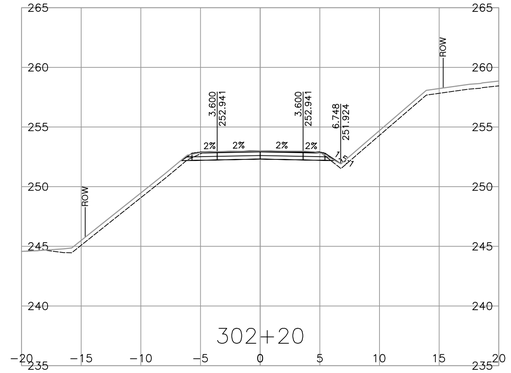
Depth to Top of Rock:

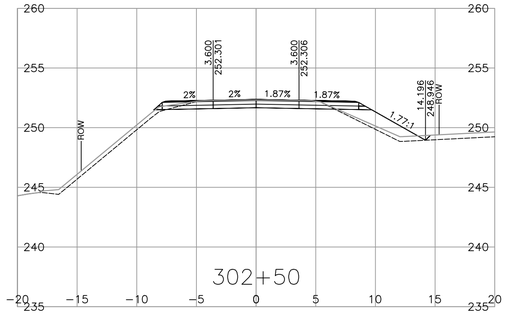


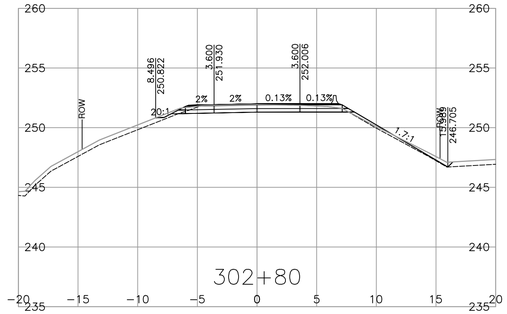


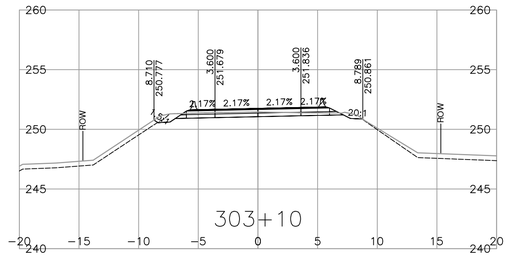


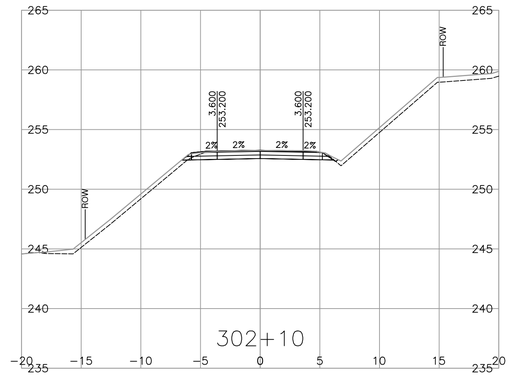


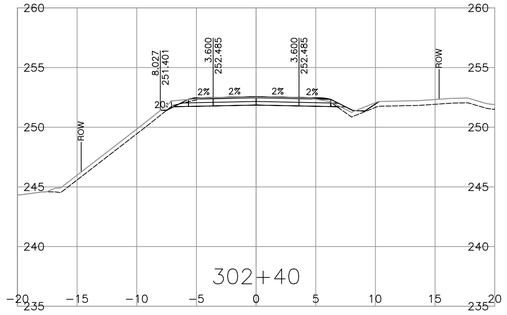


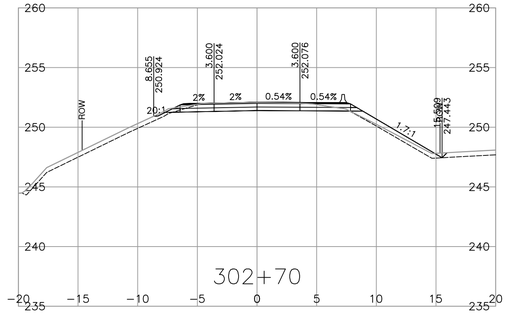


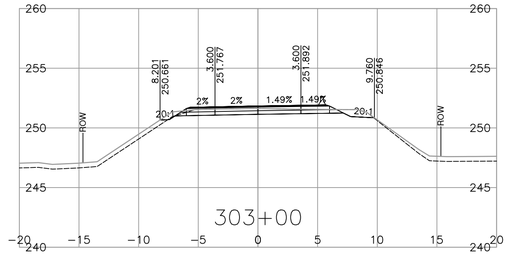












Associated Engineering

SCALE 0 2 1:250 12m

CAD FILENAME R1-964-1041

PLOT DATE 2023-01-27

REV	DATE	REVISIONS	NAME
A	2022-07-12	50% DETAILED DESIGN	SB
B	2022-10-14	90% DETAILED DESIGN	SB
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BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY DESIGN AND GEOMATICS ENGINEERING

CROSS SECTIONS

CERVUS CREEK BRIDGE
HIGHWAY 28

SHEET 1 OF 3

SHAUN BIDULKA, P. ENG.
ENGINEER OF RECORD
DATE 2023-01-27

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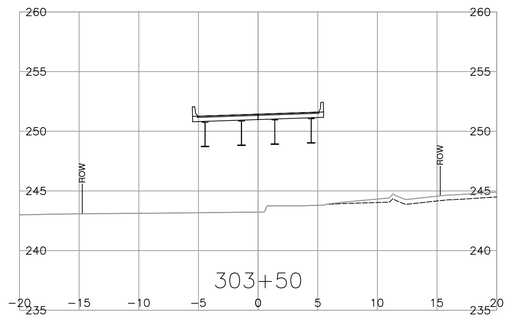
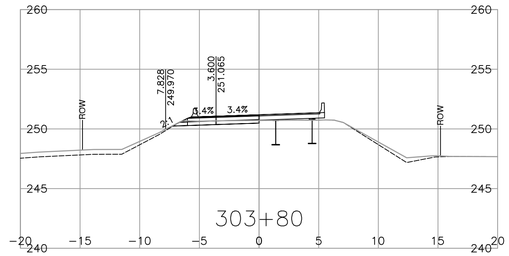
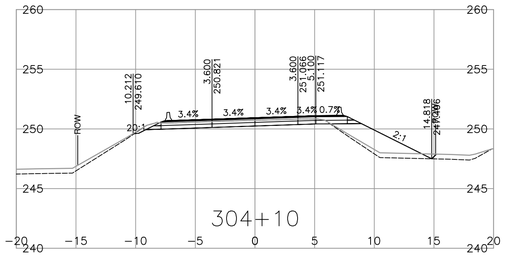
QUALITY CONTROL S. BIDULKA DATE 2023-01-27
QUALITY ASSURANCE P. TSANG DATE 2023-01-27
DRAWN H. YIN DATE 2023-01-27

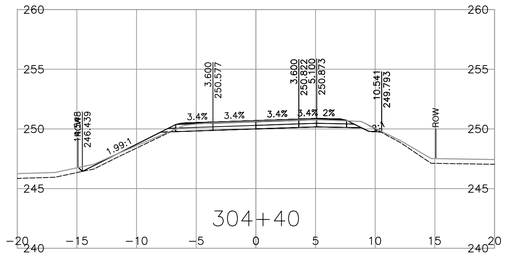
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
2020-2947-00	16850-0003	1	R1-964-1041	C

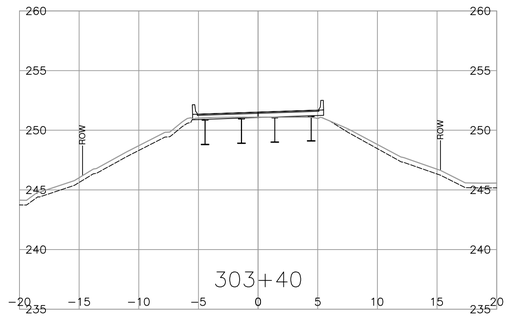
PLOT DATE: 2023/01/24 Q:\2020-2947-00\civil\model\Hwy28_CervusCr_GROUND\DrawingProduction\1000_DesignSections\R1-964-1041_1043.dwg

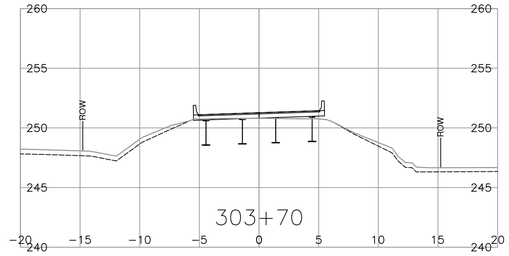


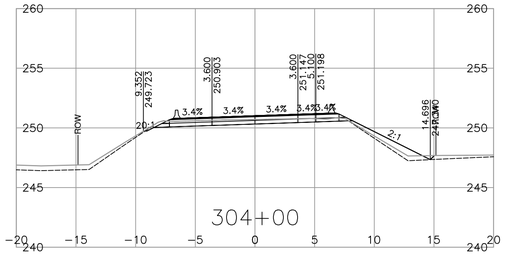


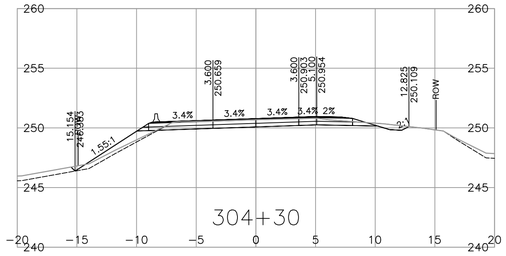


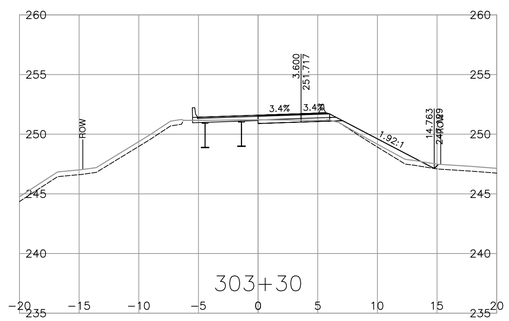


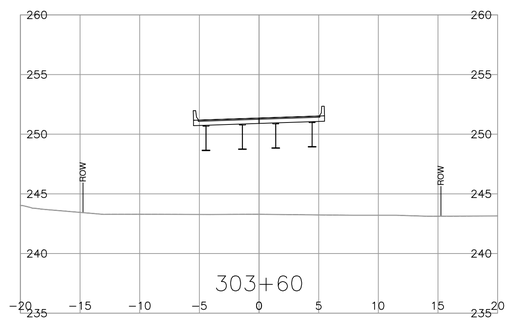


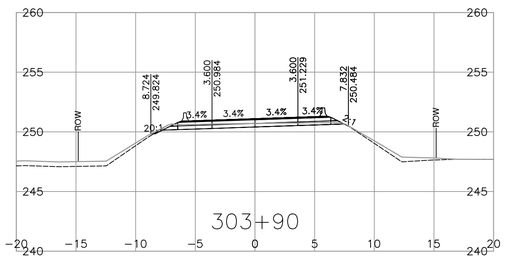


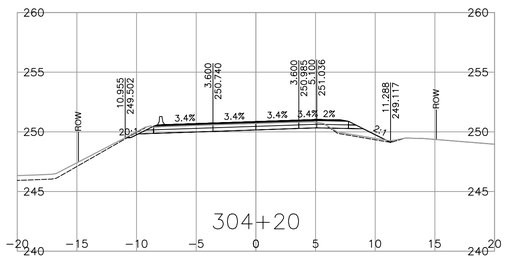












PLOT DATE: 2023/01/24 Q:\2020-2947-00\civil\model\Hwy28_CervusCr_GROUND\DrawingProduction\1000_DesignSections\R1-964-1041_1043.dwg

Associated Engineering

SCALE 0 2 1:250 12m

CAD FILENAME R1-964-1042

PLOT DATE 2023-01-27

REV	DATE	REVISIONS	NAME
A	2022-07-12	50% DETAILED DESIGN	SB
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HIGHWAY 28

SHEET 2 OF 3

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DRAWN H. YIN DATE 2023-01-27

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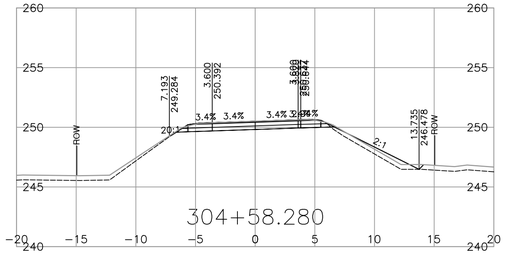

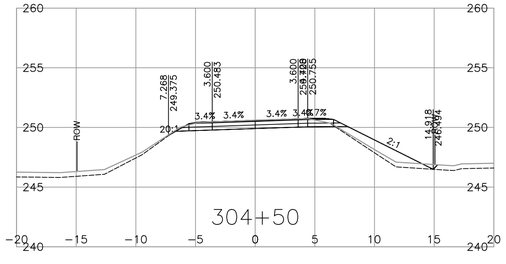

PLOT DATE: 2023/01/24 Q:\2020-2947-00\civil\model\Hwy28_CervusCr_GROUND\DrawingProduction\1000_DesignSections\R1-964-1041_1043.dwg

Associated Engineering

SCALE 0 2 1:250 12m

CAD FILENAME R1-964-1043

PLOT DATE 2023-01-27

REV	DATE	REVISIONS	NAME
A	2022-07-12	50% DETAILED DESIGN	SB
B	2022-10-14	90% DETAILED DESIGN	SB
C	2023-01-27	100% DETAILED DESIGN	SB

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
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CERVUS CREEK BRIDGE
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FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
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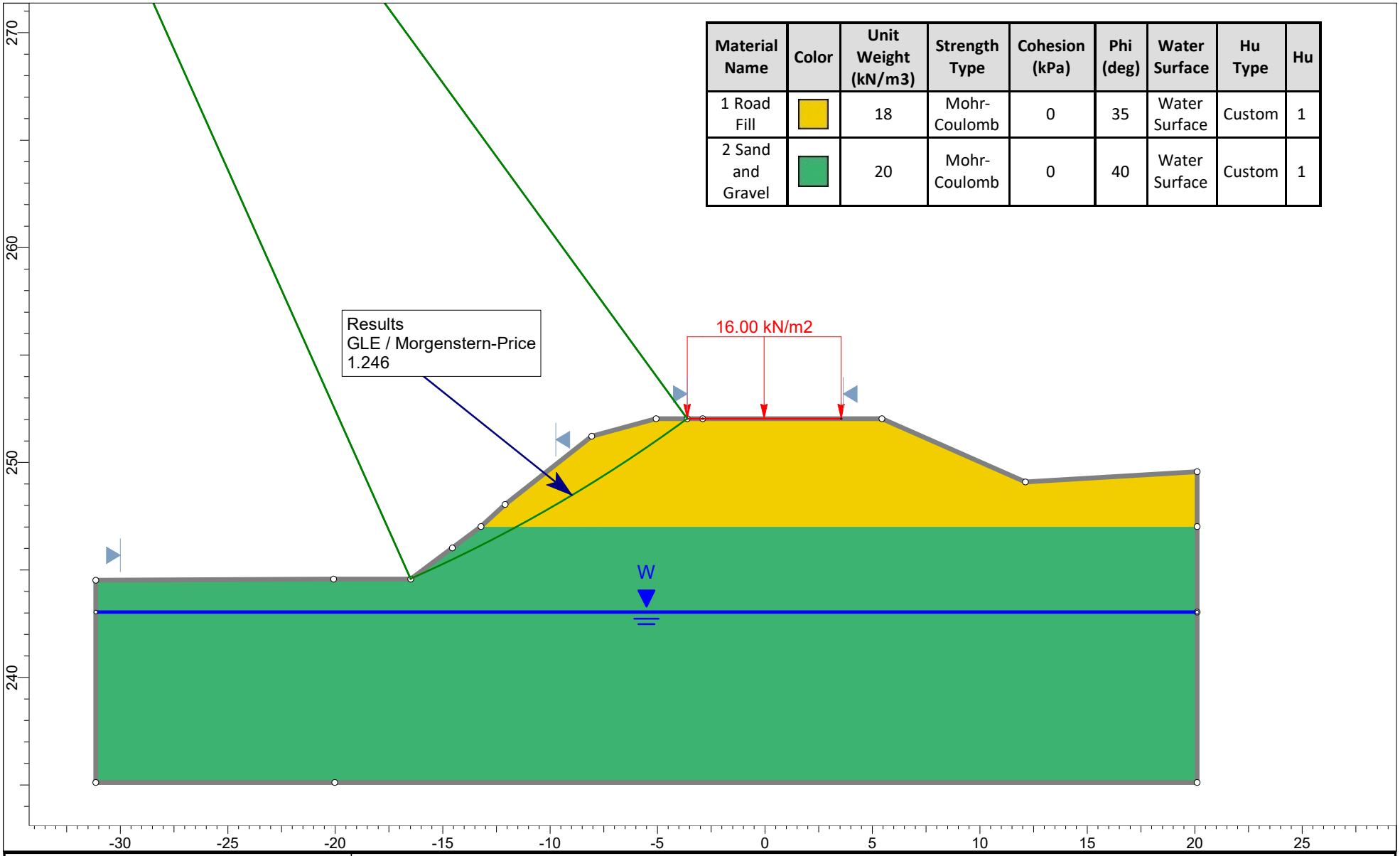
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

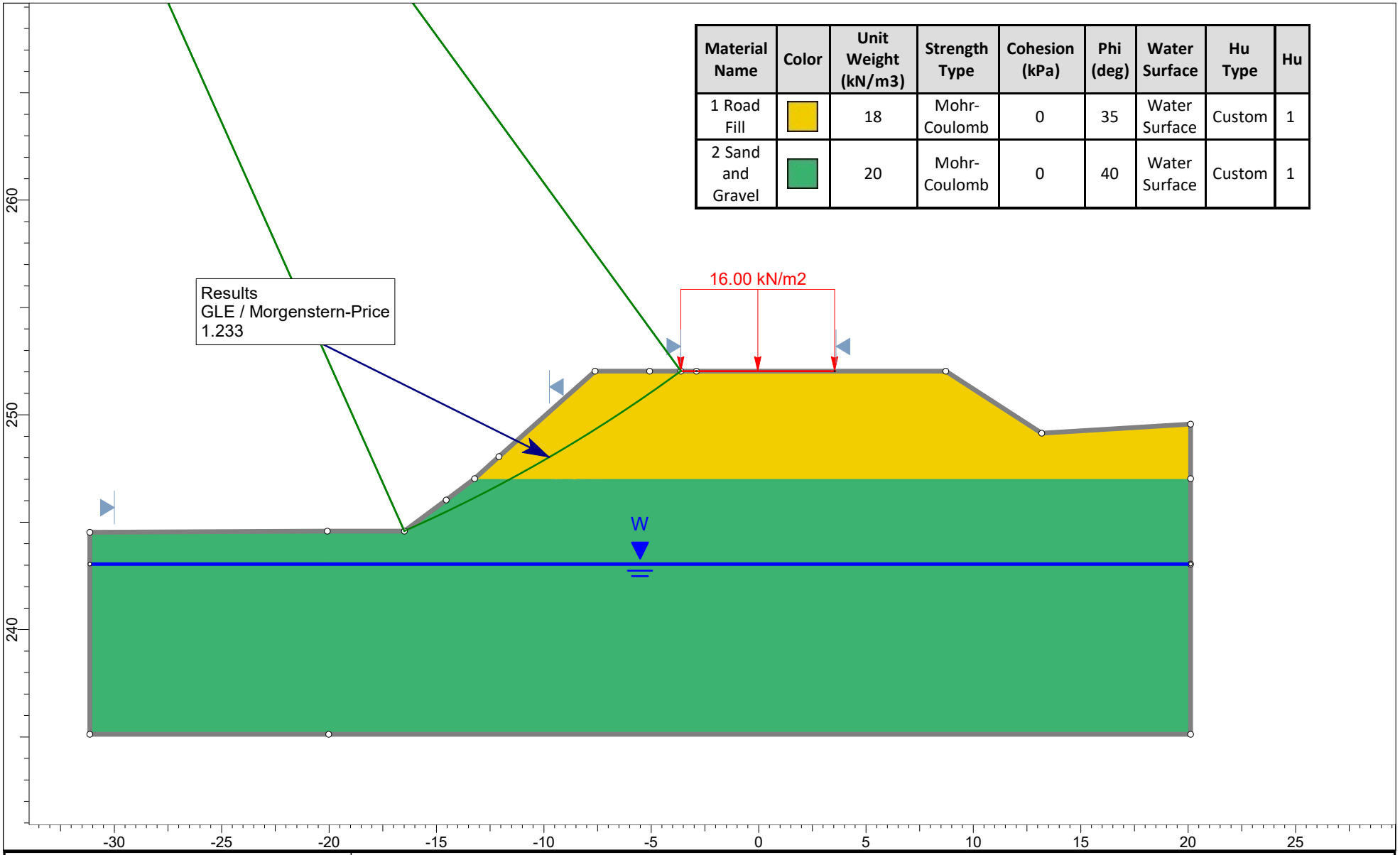


THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 2 - 302+50	Scenario	Static
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

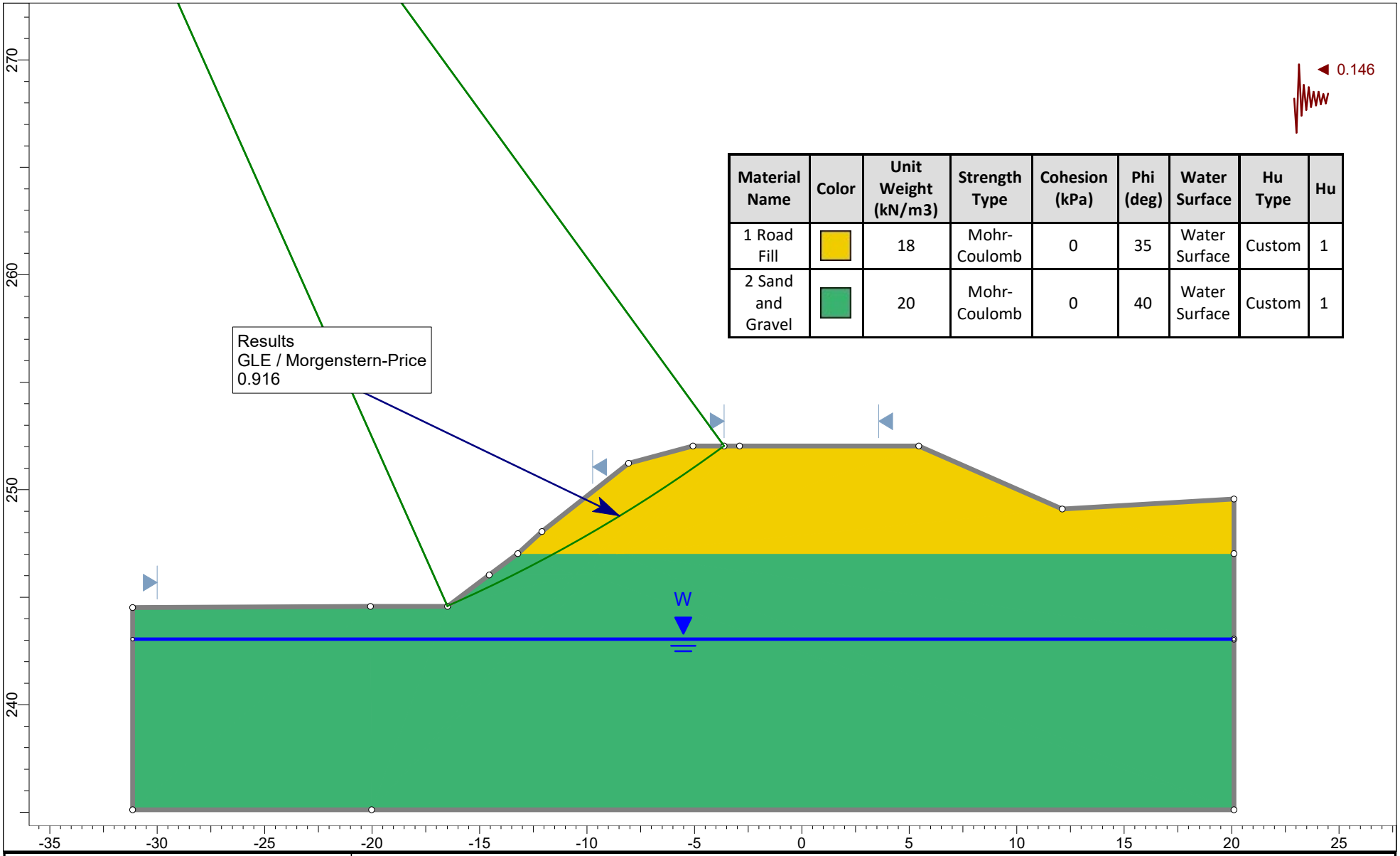
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1



THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 2 - 302+50	Scenario	Static
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

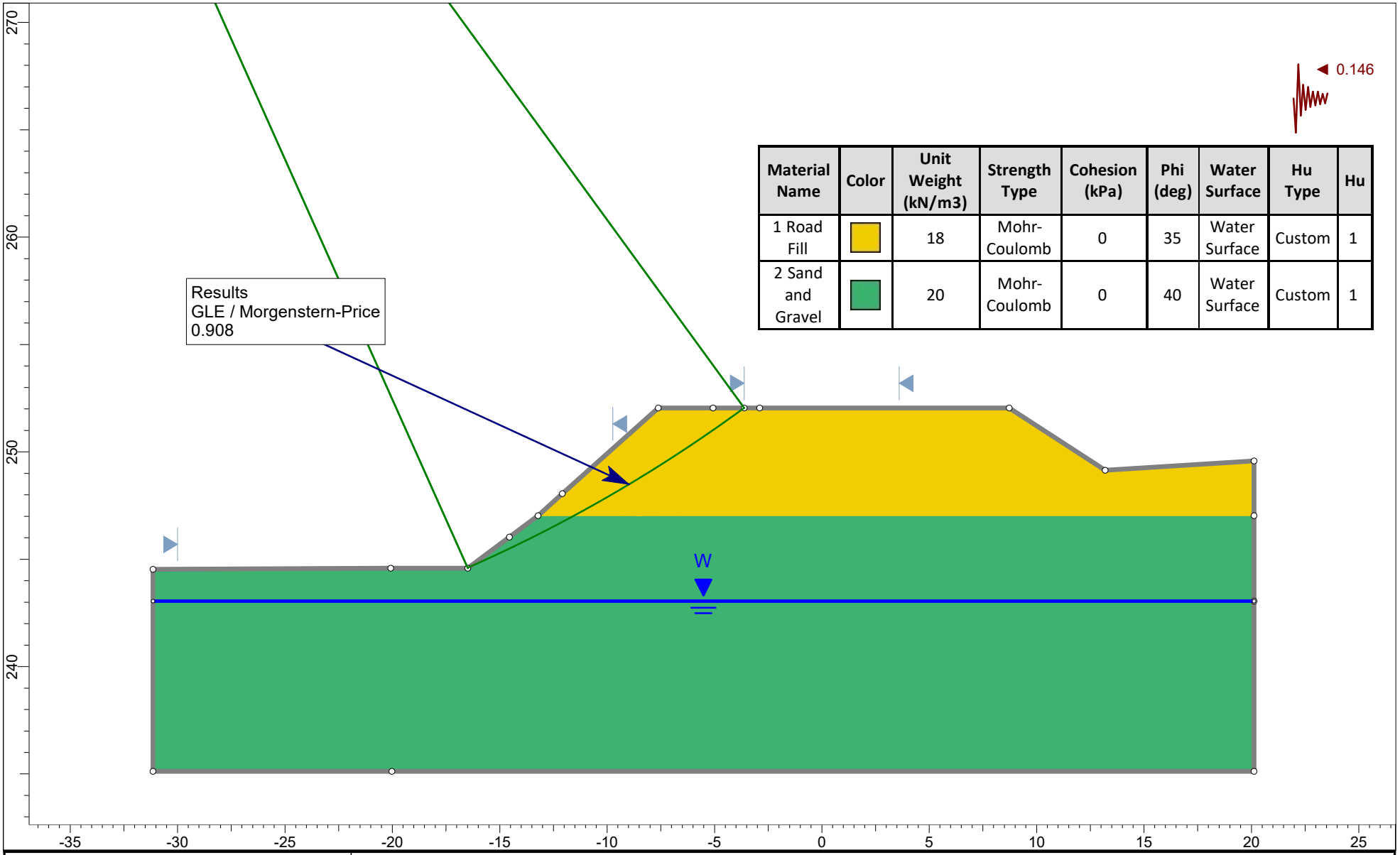


Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 2 - 302+50	Scenario	Pseudostatic
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387



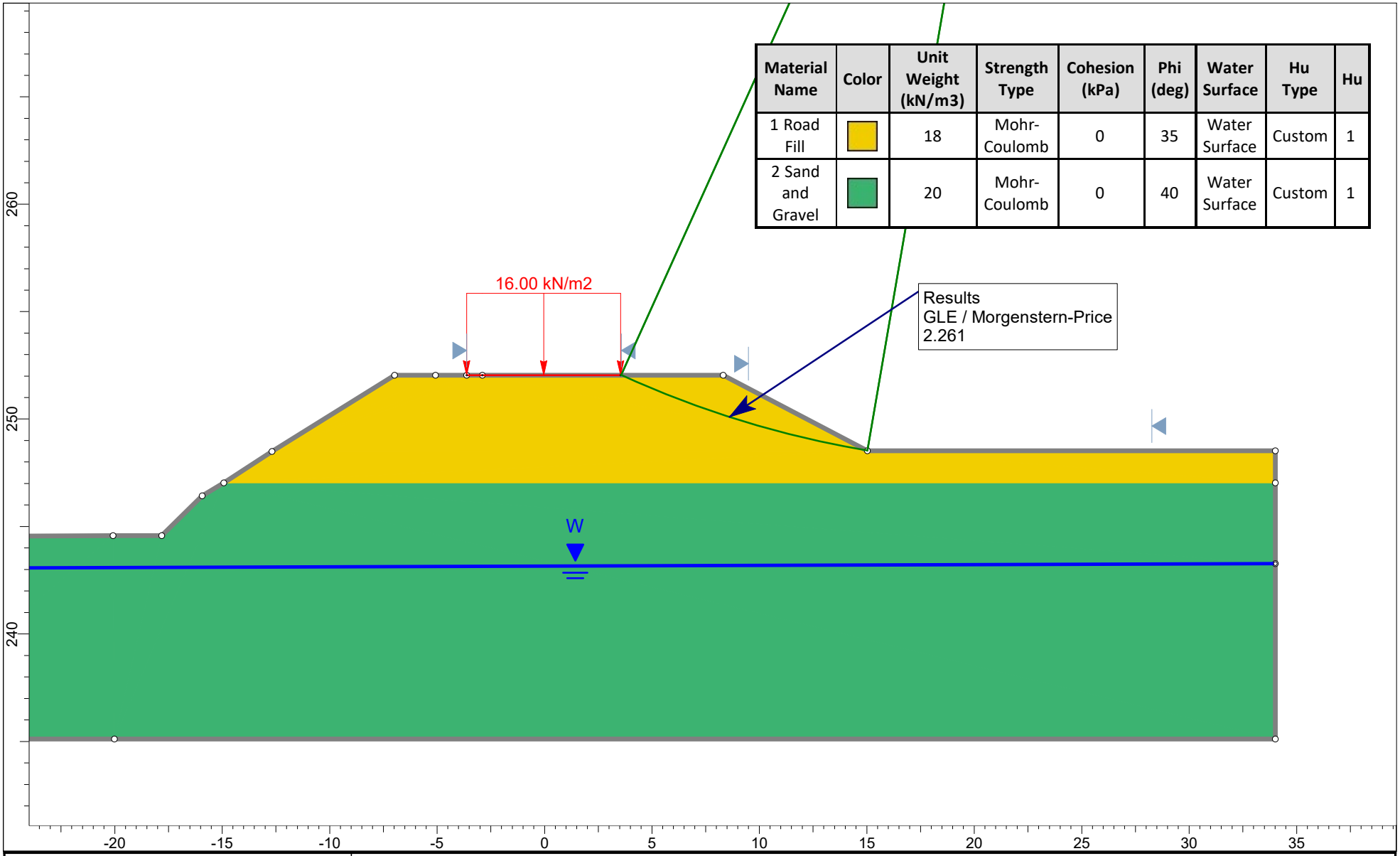
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 2 - 302+50	Scenario	Pseudostatic
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

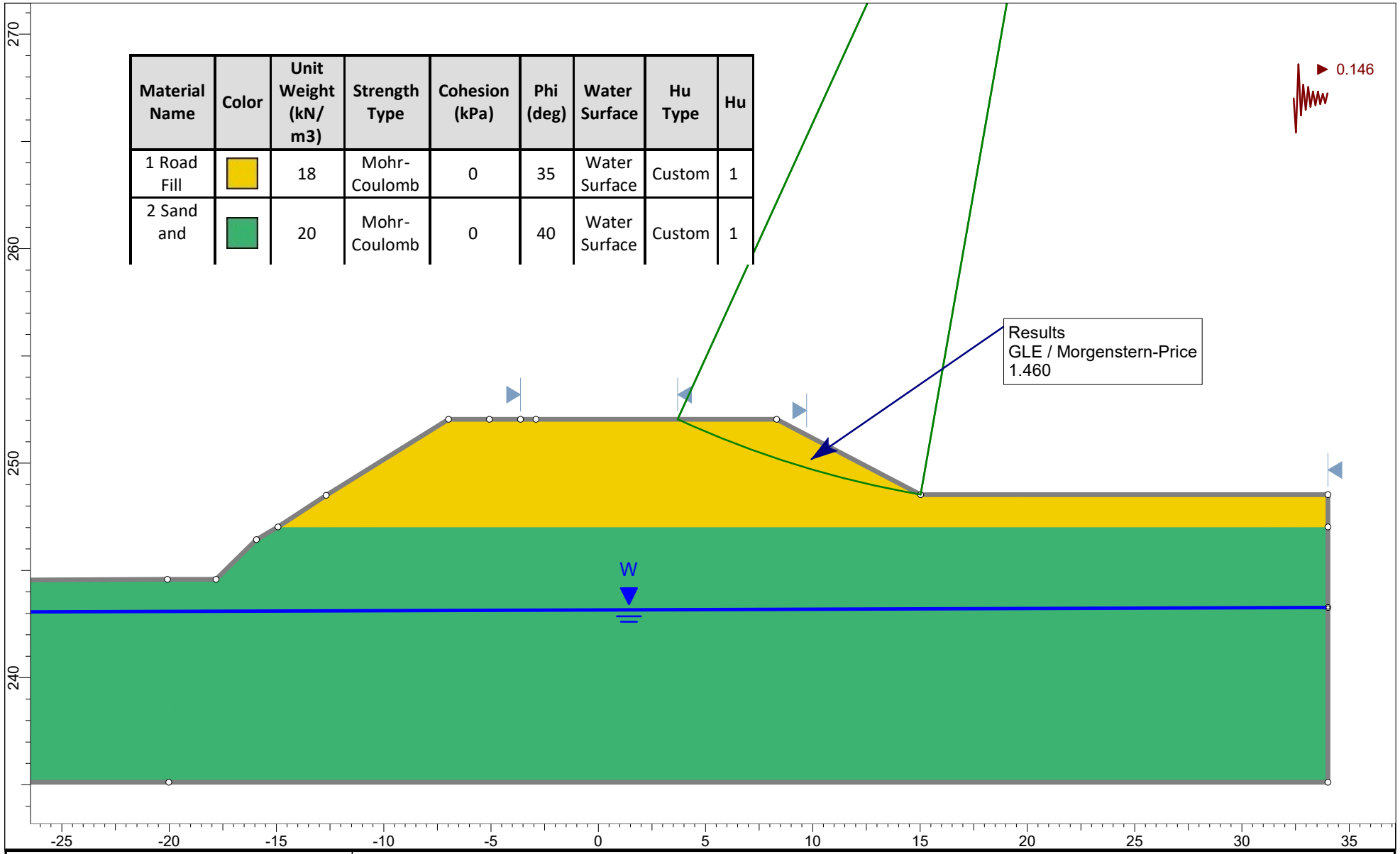


THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 1 - 302+60	Scenario	Static
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

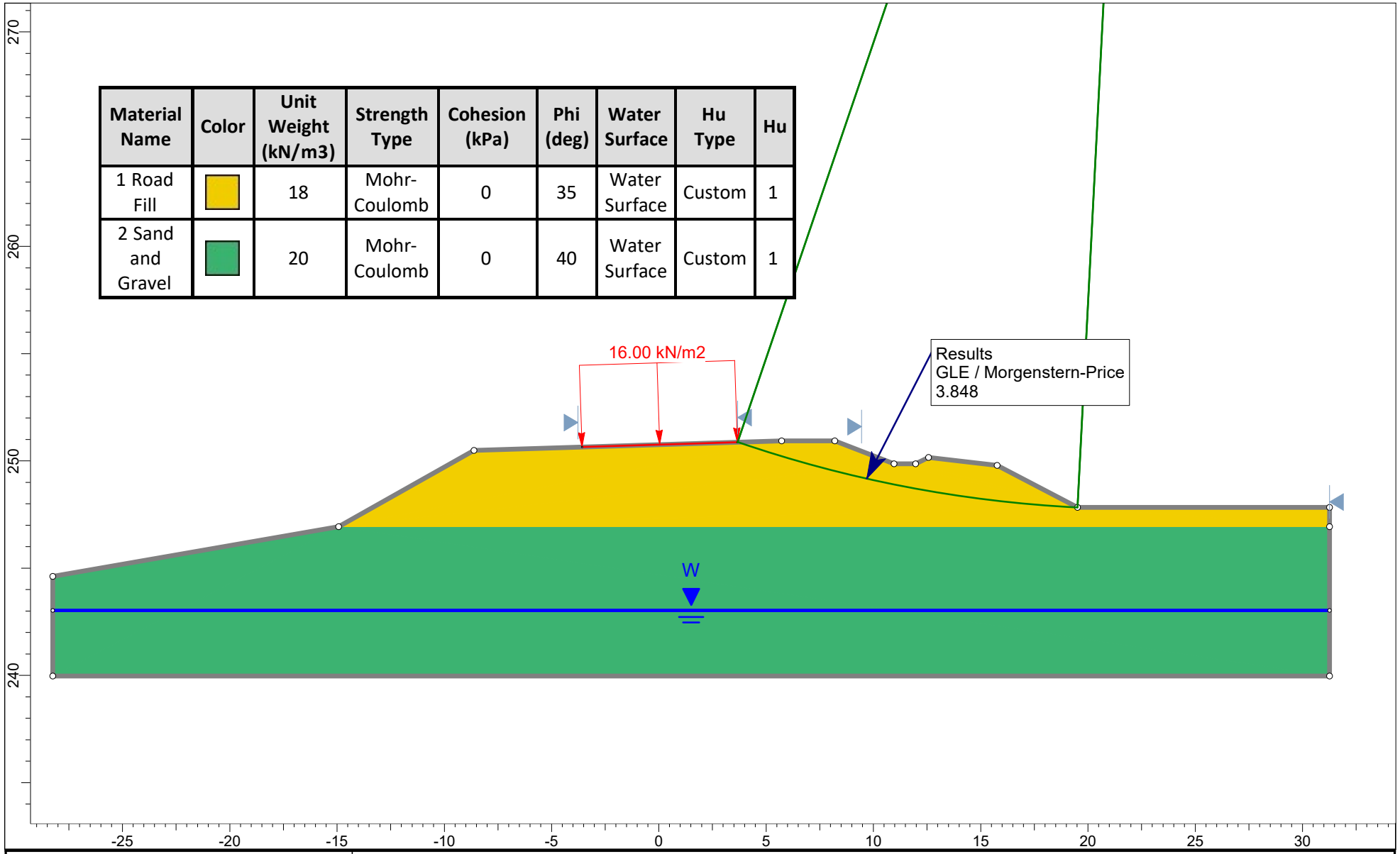


THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 1 - 302+60	Scenario	Pseudostatic
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

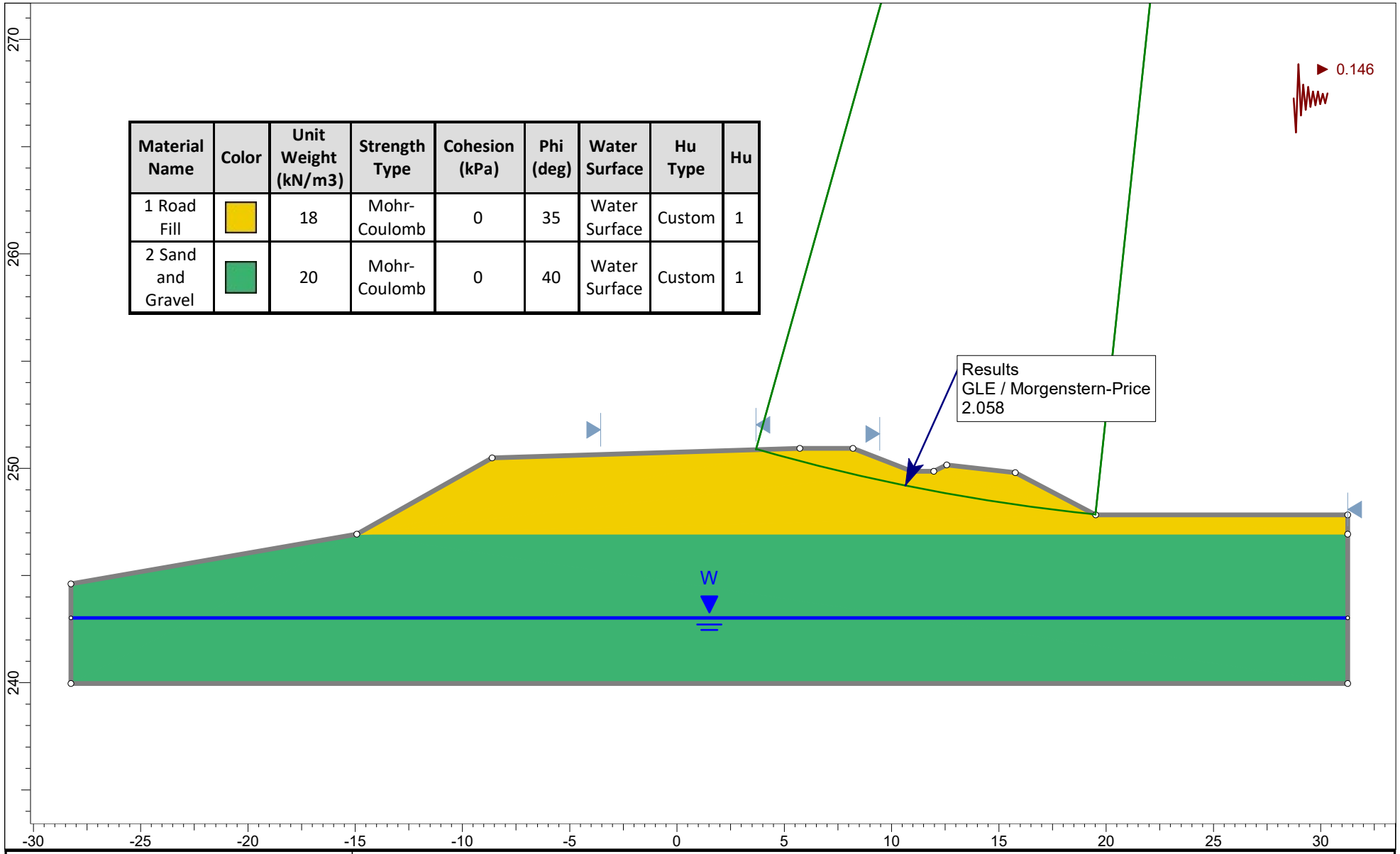


THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 5 - 304+30	Scenario	Static
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

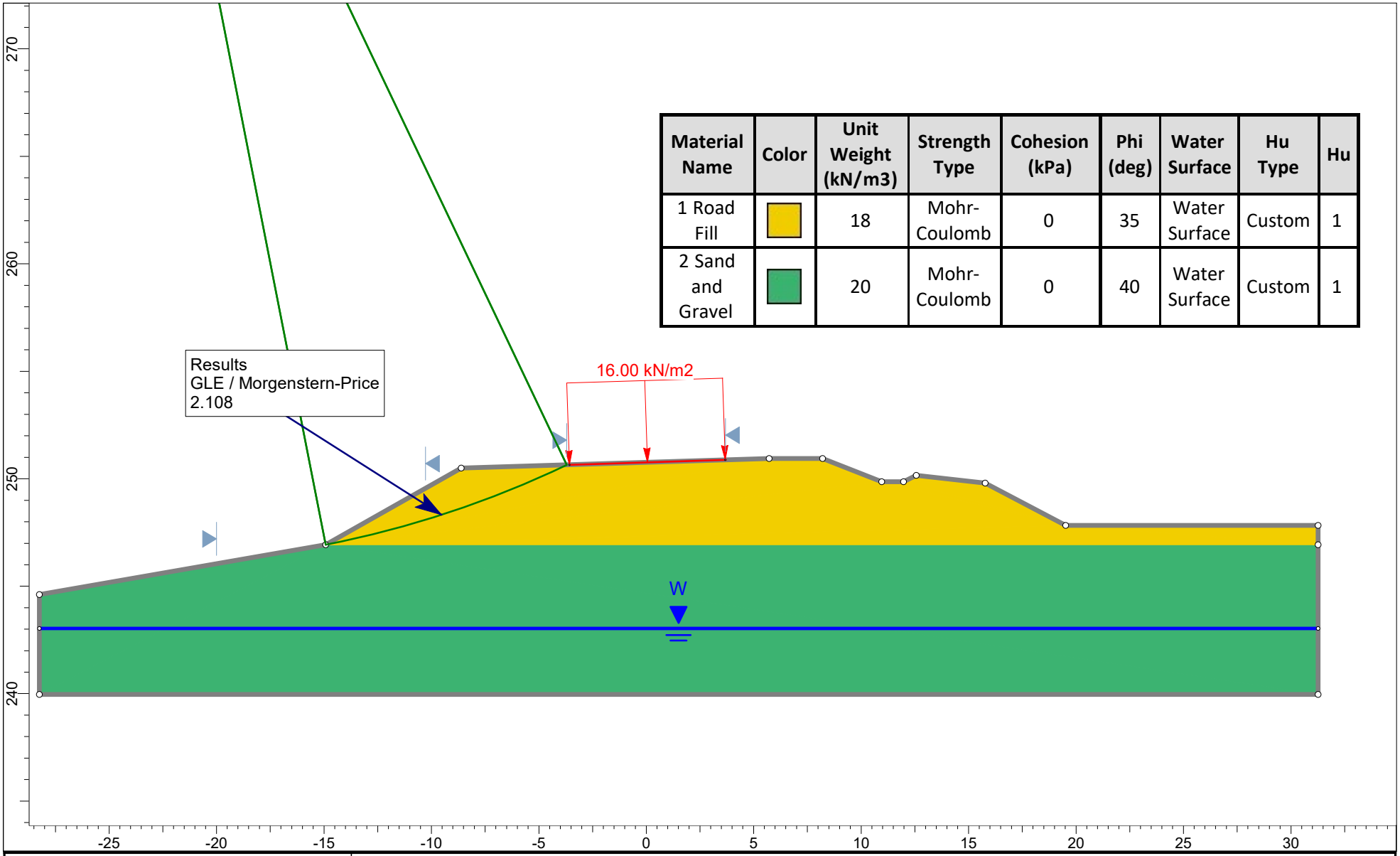


THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 5 - 304+30	*Scenario*	Pseudostatic
Drawn By	MPD	*Company*	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	*Job Number*	34387

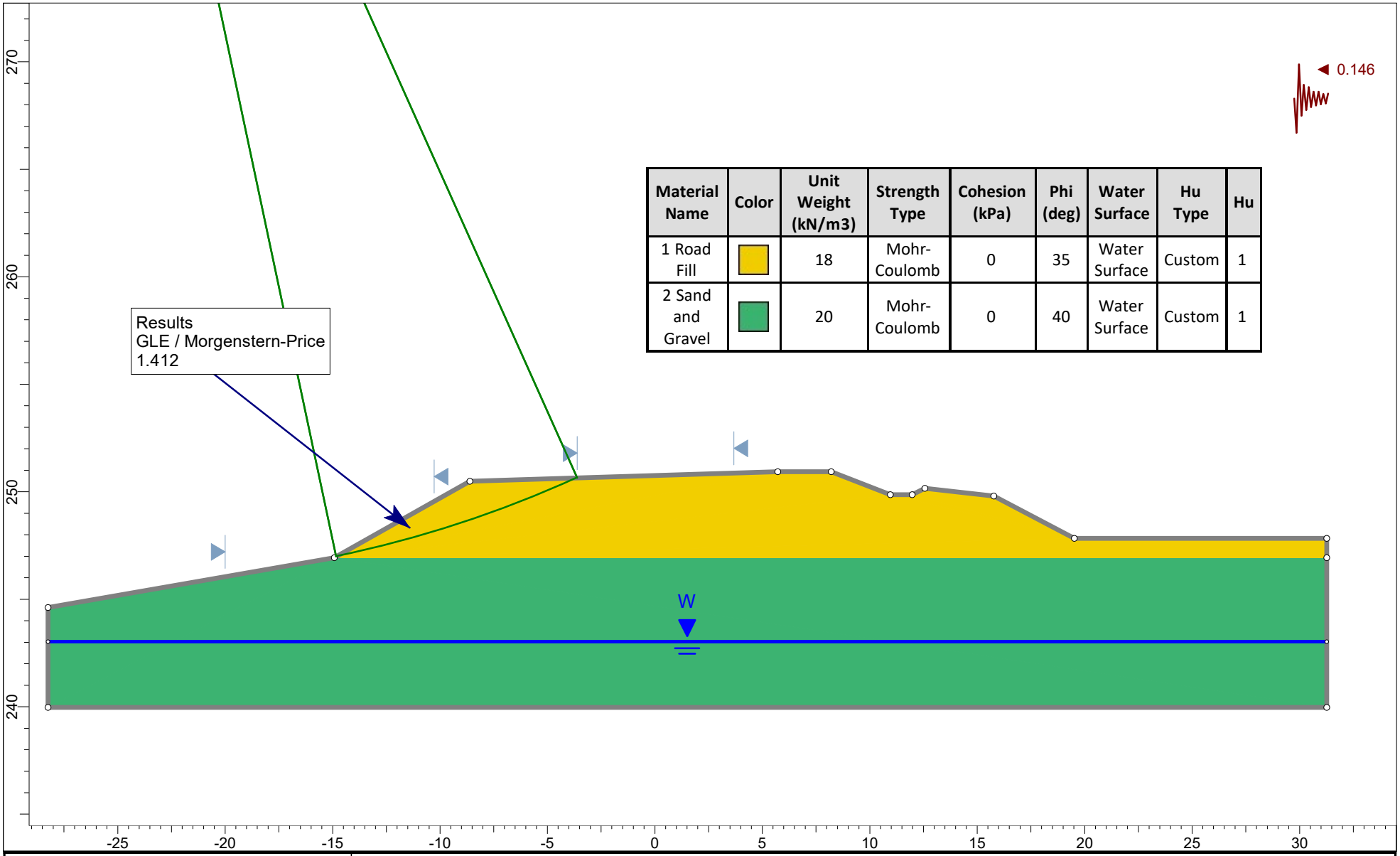
Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1



THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 5 - 304+30	Scenario	Static
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387



Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Water Surface	Hu Type	Hu
1 Road Fill		18	Mohr-Coulomb	0	35	Water Surface	Custom	1
2 Sand and Gravel		20	Mohr-Coulomb	0	40	Water Surface	Custom	1

THURBER ENGINEERING LTD.

SLIDEINTERPRET 9.024

Project	Cervus Creek Slope Stability Assessment		
Group	Section 5 - 304+30	Scenario	Pseudostatic
Drawn By	MPD	Company	Thurber Engineering Ltd.
Date	2022-09-19, 9:07:36 AM	Job Number	34387

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

Site: 49.855N 125.786W **User File Reference:** Cervus Creek 2022-06-29 22:15 UT

Requested by: McKenzie Douglas, Thurber Engineering Ltd.

Probability of exceedance per annum	0.000404	0.001	0.0021	0.01
Probability of exceedance in 50 years	2 %	5 %	10 %	40 %
Sa (0.05)	0.410	0.274	0.184	0.068
Sa (0.1)	0.662	0.441	0.292	0.101
Sa (0.2)	0.808	0.543	0.366	0.138
Sa (0.3)	0.846	0.564	0.373	0.139
Sa (0.5)	0.801	0.518	0.331	0.116
Sa (1.0)	0.550	0.346	0.212	0.070
Sa (2.0)	0.347	0.213	0.124	0.036
Sa (5.0)	0.118	0.071	0.039	0.011
Sa (10.0)	0.042	0.025	0.014	0.004
PGA (g)	0.376	0.252	0.167	0.059
PGV (m/s)	0.635	0.404	0.249	0.073

Notes: Spectral (Sa(T), where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s. Values are for "firm ground" (NBCC2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are highlighted in yellow. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. **These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.**

References

National Building Code of Canada 2015 NRCC no. 56190; Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

Structural Commentaries (User's Guide - NBC 2015: Part 4 of Division B)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

THURBER

Cervus Creek TH21-03 762 Piles P-Y Data

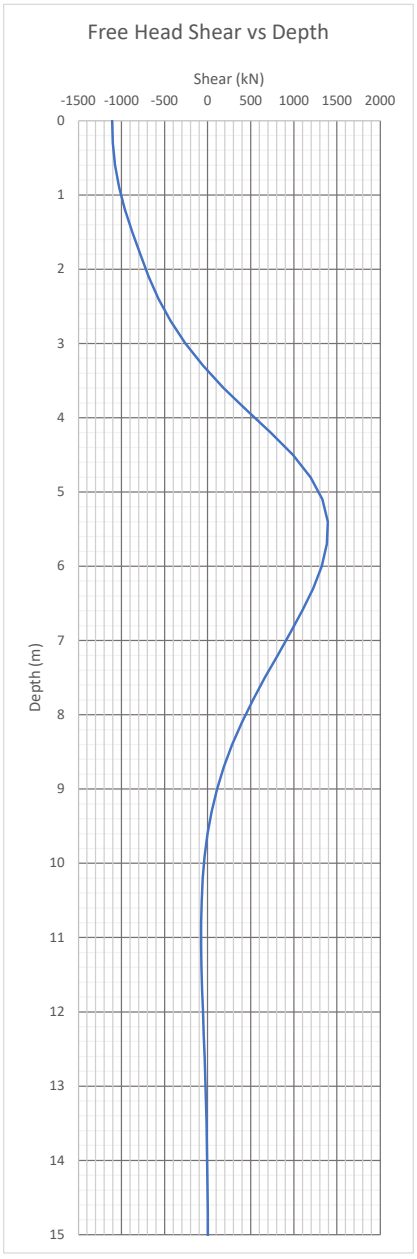
Depth Below Surface (m)															
Depth = 1.00 m		Depth = 2.00 m		Depth = 3.00 m		Depth = 4.00 m		Depth = 5.00 m		Depth = 6.00 m		Depth = 7.00 m		Depth = 8.00 m	
Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	81.27	0.00	115.00	0.00	232.40	0.00	384.91	0.00	522.54	0.00	680.16	0.00	857.75	0.00	1055.33
0.00	142.62	0.00	201.83	0.00	407.84	0.01	675.49	0.01	917.03	0.01	1193.64	0.01	1505.31	0.01	1852.04
0.00	179.82	0.00	254.47	0.00	514.22	0.01	851.69	0.01	1156.23	0.01	1504.98	0.01	1897.95	0.01	2335.12
0.01	199.46	0.00	282.26	0.01	570.38	0.01	944.70	0.01	1282.50	0.01	1669.35	0.02	2105.23	0.02	2590.14
0.01	209.07	0.00	295.86	0.01	597.87	0.01	990.23	0.02	1344.32	0.02	1749.80	0.02	2206.69	0.02	2714.98
0.01	213.60	0.01	302.28	0.01	610.83	0.02	1011.70	0.02	1373.45	0.02	1787.73	0.02	2254.52	0.02	2773.83
0.01	215.70	0.01	305.25	0.01	616.83	0.02	1021.63	0.02	1386.95	0.02	1805.29	0.03	2276.67	0.03	2801.08
0.01	216.66	0.01	306.61	0.01	619.59	0.02	1026.20	0.03	1393.14	0.03	1813.35	0.03	2286.84	0.03	2813.59
0.01	217.10	0.01	307.23	0.01	620.85	0.03	1028.28	0.03	1395.98	0.03	1817.04	0.03	2291.49	0.04	2819.31
0.01	217.30	0.01	307.52	0.01	621.42	0.03	1029.24	0.03	1397.27	0.04	1818.73	0.04	2293.61	0.04	2821.92
0.02	217.40	0.01	307.65	0.01	621.68	0.03	1029.67	0.04	1397.86	0.04	1819.50	0.04	2294.58	0.04	2823.12
0.02	217.44	0.01	307.71	0.02	621.80	0.04	1029.87	0.04	1398.13	0.04	1819.85	0.05	2295.02	0.05	2823.66
0.02	217.46	0.01	307.73	0.02	621.86	0.04	1029.96	0.04	1398.25	0.05	1820.01	0.05	2295.22	0.05	2823.91
0.02	217.47	0.01	307.75	0.02	621.88	0.04	1030.00	0.05	1398.31	0.05	1820.08	0.05	2295.32	0.06	2824.02
0.02	217.47	0.01	307.75	0.02	621.90	0.04	1030.02	0.05	1398.33	0.05	1820.11	0.06	2295.36	0.06	2824.07
0.02	217.47	0.02	307.75	0.02	621.90	0.05	1030.03	0.05	1398.34	0.06	1820.13	0.06	2295.38	0.07	2824.10

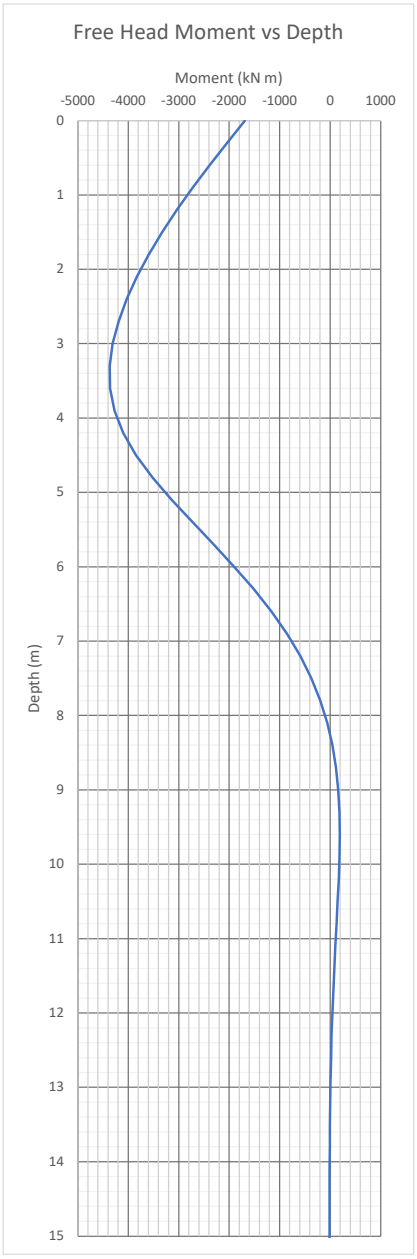
Depth Below Surface (m)													
Depth = 9.00 m		Depth = 10.00 m		Depth = 11.00 m		Depth = 12.00 m		Depth = 13.00 m		Depth = 14.00 m		Depth = 15.00 m	
Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)	Y (m)	P (kN/m)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1272.88	0.00	1510.42	0.00	1767.94	0.01	2045.43	0.01	2329.80	0.01	2467.66	0.01	2605.52
0.01	2233.83	0.01	2650.70	0.01	3102.62	0.01	3589.61	0.01	4088.66	0.01	4330.59	0.01	4572.53
0.01	2816.51	0.01	3342.10	0.01	3911.90	0.02	4525.92	0.02	5155.14	0.02	5460.18	0.02	5765.22
0.02	3124.10	0.02	3707.09	0.02	4339.13	0.02	5020.20	0.02	5718.14	0.02	6056.50	0.02	6394.85
0.02	3274.67	0.02	3885.76	0.02	4548.26	0.03	5262.15	0.03	5993.74	0.03	6348.40	0.03	6703.06
0.03	3345.65	0.03	3969.99	0.03	4646.84	0.03	5376.21	0.03	6123.65	0.03	6486.00	0.03	6848.35
0.03	3378.51	0.03	4008.99	0.03	4692.49	0.04	5429.03	0.04	6183.81	0.04	6549.71	0.04	6915.62
0.04	3393.61	0.04	4026.89	0.04	4713.45	0.04	5453.28	0.04	6211.43	0.04	6578.97	0.04	6946.51
0.04	3400.51	0.04	4035.08	0.04	4723.04	0.05	5464.37	0.05	6224.06	0.05	6592.35	0.05	6960.64
0.04	3403.66	0.05	4038.82	0.05	4727.42	0.05	5469.43	0.06	6229.83	0.05	6598.46	0.05	6967.09
0.05	3405.10	0.05	4040.53	0.05	4729.41	0.06	5471.74	0.06	6232.47	0.06	6601.25	0.06	6970.04
0.05	3405.75	0.06	4041.31	0.06	4730.32	0.06	5472.80	0.07	6233.67	0.07	6602.52	0.06	6971.38
0.06	3406.05	0.06	4041.66	0.06	4730.74	0.07	5473.28	0.07	6234.21	0.07	6603.10	0.07	6971.99
0.06	3406.19	0.07	4041.83	0.07	4730.93	0.07	5473.50	0.08	6234.46	0.08	6603.37	0.08	6972.27
0.07	3406.25	0.07	4041.90	0.07	4731.02	0.08	5473.60	0.08	6234.58	0.08	6603.49	0.08	6972.40
0.07	3406.28	0.07	4041.93	0.08	4731.05	0.08	5473.64	0.09	6234.63	0.09	6603.54	0.09	6972.45

THURBER

Job Number	34837	
Prepared By	MPD	
Load Case	Free Head	
	Fx	-1750 kN
	Fz	-1110 kN
	My	-1690 kN m

Depth (m)	Shear Force (kN)	Moment (kN m)
0	-1110	-1690
0.3	-1102	-2041
0.6	-1074	-2387
0.9	-1026	-2721
1.2	-958	-3036
1.5	-874	-3328
1.8	-782	-3592
2.1	-684	-3826
2.4	-570	-4029
2.7	-430	-4193
3	-259	-4309
3.3	-55	-4369
3.6	184	-4361
3.9	454	-4274
4.2	731	-4102
4.5	989	-3847
4.8	1196	-3518
5.1	1331	-3137
5.4	1392	-2726
5.7	1385	-2306
6	1324	-1898
6.3	1225	-1514
6.6	1099	-1164
6.9	957	-855
7.2	810	-590
7.5	663	-369
7.8	525	-191
8.1	398	-53
8.4	285	48
8.7	189	119
9	110	163
9.3	47	186
9.6	0	192
9.9	-35	186
10.2	-57	172
10.5	-70	152
10.8	-76	130
11.1	-75	107
11.4	-71	85
11.7	-64	64
12	-55	47
12.3	-46	31
12.6	-36	19
12.9	-28	10
13.2	-20	2
13.5	-14	-3
13.8	-8	-6
14.1	-4	-8
14.4	-1	-8
14.7	1	-8
15	3	-8





THURBER

Job Number	34837	
Prepared By	MPD	
Load Case	Fixed Head	
	Fx	-1750 kN
	Fy	920 kN
	Mz	1070 kN m

Depth (m)	Shear Force (kN)	Moment (kN m)
0	920	1070
0.3	912	1358
0.6	884	1640
0.9	836	1911
1.2	768	2164
1.5	684	2393
1.8	592	2594
2.1	494	2766
2.4	380	2907
2.7	240	3010
3	69	3065
3.3	-134	3064
3.6	-369	2996
3.9	-591	2851
4.2	-763	2649
4.5	-887	2400
4.8	-959	2121
5.1	-981	1829
5.4	-961	1536
5.7	-909	1254
6	-833	991
6.3	-742	754
6.6	-642	546
6.9	-539	369
7.2	-439	223
7.5	-344	106
7.8	-258	16
8.1	-183	-50
8.4	-119	-95
8.7	-66	-122
9	-25	-135
9.3	6	-137
9.6	29	-131
9.9	43	-120
10.2	51	-106
10.5	54	-90
10.8	53	-74
11.1	50	-58
11.4	44	-44
11.7	38	-32
12	31	-21
12.3	25	-13
12.6	19	-6
12.9	14	-1
13.2	9	2
13.5	6	4
13.8	3	6
14.1	1	6
14.4	-1	6
14.7	-2	6
15	-2	5