# TECHNICAL MEMORANDUM

**DATE** 9 September 2024 **Reference No.** 1895826-029-TM-Rev0

**TO** Sandra Liddell, AScT, Engineering Projects Manager
District of Saanich

**FROM** Matt Neale, MEng, P.Eng. **EMAIL matt.neale@wsp.com**

**CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK) BANK STABILIZATION, SHORT-TERM REMEDIATION DESIGN MEMORANDUM, SAANICH, BRITISH COLUMBIA**

## 1.0 INTRODUCTION

WSP Canada Inc. (WSP), formerly Golder Associates Ltd., has been retained by the District of Saanich (the District) to provide geotechnical and coastal engineering services related to ongoing shoreline erosion below Cordova Bay Road in PKOLS (Mount Douglas Park). The purpose of this memorandum is to present analysis and recommendations for short-term remediation of the slope.

PKOLS is located on the east coast of Vancouver Island on Haro Strait, within the District of Saanich. PKOLS is one of Saanich's signature parks and is a popular recreation destination and important ecological resource. The project is of interest to many stakeholders and users of the park. The park includes approximately 1 km of shoreline characterized by high eroding bluffs, with gravel and cobbles beaches and limited informal protection at the toe of the bluffs. Cordova Bay Road is located at the top of the bluffs and closely borders their crests, particularly in the northern portion of the site. There are also erosional gullies adjacent to the road on the upper slope. A site plan is included in Figure 1 following the text of this memorandum. Past studies have shown that the bluffs are actively receding, and that the road is potentially at risk of being impacted. Cordova Bay Road is the primary access road along the coast between PKOLS and Haro Strait. Monitoring and engineering design work at PKOLS has an extensive history and has been ongoing since the 1980s.

The scope of work for short-term remediation design is outlined in WSP's 2022 proposal (WSP Golder 2022) and includes slope stability analysis, preliminary design recommendations, preparation of preliminary design drawings, and a construction cost estimate. Short-term remediation is intended to temporarily limit the risk to Cordova Bay Road and an existing buried water main within the right-of way while a long-term solution is developed. The short-term remediation will focus on only the highest risk areas and is not intended to stop the erosion process in the long-term. WSP's 2020 project progress memorandum (Golder 2020) presents recommendations to the District for the short-term, medium-term, and long-term.

WSP's 2022 proposal also included a factual geotechnical and geophysical report as well as annual bluff monitoring supported by LiDAR surveys and site inspections for a period of three years. The factual geotechnical and geophysical report is presented under separate cover (WSP 2024). The first annual LiDAR survey was completed on 21 February 2024 and the first annual site inspection was completed on 24 April 2024. A technical memorandum presenting the bluff monitoring results is in progress and will be presented under separate cover.

# 2.0 SURVEY MONITORING

As part of the bluff monitoring scope, WSP retained Volatus Unmanned Services Inc. (Volatus) to conduct an airborne LiDAR survey and collect aerial imagery within the project area. Volatus completed the survey on 21 February 2024 using a DJI Matrice 300 RTK drone under the supervision of WSP staff. The accuracy of the survey is understood to be within 20 mm.

WSP conducted a change detection analysis between this 2024 LiDAR and previous 2019 LiDAR provided to WSP by the District. The purpose of this change detection is to identify areas of the slope that may have undergone displacement, failure, and/or erosion over the past five years. Note that the original source of the 2019 LiDAR is not certain and appears to have a reduced sampling frequency compared to the 2024 LiDAR. For this reason, there is some additional uncertainty in identifying small changes between 2024 and 2019.

Figures 1 to 4 following the text of this report presents the results of the change detection analysis. Figure 1 shows a plan view, with the elevation changes represented by different colours in 0.5 m increment ‘buckets’. Areas that lost elevation are represented by warm colours, with the loss magnitude increasing with redness. Areas that gained elevation are represented by cool colours, with gain magnitude increasing with degree of dark blue. Note that the bucket from 0.0 to 0.5 m gain is represented by no colour. The background photo for Figure 1 was taken during the drone survey. Figures 2 to 4 present critical slope cross-sections comparing LiDAR collected in 2024, 2019, and 2017.

Review of the change detection drawings revealed two main areas that have experienced slope deterioration over the past five years:

1) **Mid-slope scarp from Station 11+60 to 12+40 (Photo 1 in Attachment 1).** The head scarp appears to have receded about 1 to 4 m over a slope length of about 75 m. The change detection appears to show some soil deposition immediately below head scarp, but it is also possible that failed material had been deposited on the beach below the slope toe and subsequently been washed away by wave action. This area of the slope has lacked vegetation cover for many years.

2) **Slope toe failure at Station 9+45 (Photo 2 in Attachment 1)**. An area about 8 m wide, 5 m long, and 2 to 5 m deep appears to have failed near the toe of the bluff.

It was observed that the gullies on the upper slope adject to Cordova Bay Road do not appear to have experienced significant deterioration, failure, or erosion over the past five years based on the LiDAR surveys. Additionally, there appears to have been a minor slope failure at the toe of the slope at Station 8+50, but this is outside of the park boundary for PKOLS (Mount Douglas Park).

# 3.0 SLOPE STABILITY ANALYSIS

## 3.1 Analysis

WSP carried out a stability assessment of the bluffs at three critical locations (Stations 9+70, 11+80, and 12+20 represented by Sections B, G, and I, respectively, in Figures 1 to 4) using the limit equilibrium slope stability software Geostudio 2023.1.2 Slope/W version 23.1.2.11. The purpose of this slope stability analysis was to assess the short-term stability of the global slope, slope scarps, and slope toe. Additionally, the stability of wattle fences, which are a potential short-term remediation solution, were modelled. Wattle fences are short retaining walls constructed with living plant materials that can be installed using traditional hand tools (Polster 2016). Polster Environmental Services Ltd. (Polster) has provided various bioremediation recommendations for the project site over the past decades (Polster 2009; Polster 2016). Their two reports are included as Attachment 2.

## 3.2 Site Conditions

WSP defined the stratigraphy of the cross-sections primarily based on the results of the 2023 geotechnical and the geophysical factual report (WSP 2024). Additionally, WSP considered physical observations from previous site visits and review of previous slope stability analysis (Thurber 2000) during definition of the stratigraphy. The primary soil and rock units are summarized in Table 1. Refer to the geotechnical and geophysical factual report (WSP 2023) for further detail on the soil units and Attachment 3 for the stratigraphy of the cross-sections.

**Table 1: Summary of Stratigraphic Units**

| Unit | Description |
|---|---|
| Fill | Road pavement and underlying sand and gravel road fill. |
| Upper Till-Like | Gravelly sand with occasional cobbles and varying fines content, inferred as dense and comprising a till-like cap over the Sand layer. |
| Sand | Poorly graded, fine to medium sand with trace gravel, inferred as dense and may represent Quadra Sands. |
| Silt | Low plasticity silt with trace sand, inferred as hard. |
| Lower Till-Like | Gravelly clayey silt to silty clay, slight to low plasticity, inferred as hard and comprising a basal till-like layer over bedrock. |
| Bedrock | Competent gneiss bedrock. |

The parameters used in the slope stability analyses are summarized in Table 2. These parameters are based on drilling observations, previous testing completed by Thurber (2000), back analysis, and WSP's experience in similar soils. Cohesion values listed for the soils are likely due to capillary tension inducing negative pore pressure above the water table. This apparent cohesion can become compromised if the slope were to become fully saturated and is likely a catalyst for the slope deterioration where moderate to heavy seepage is evident. The assumed piezometric surface is based on the piezometer readings in BH23-01 and BH23-02 (WSP 2024) and observations of seepage on the slope face. Only static conditions were assessed, as pseudostatic analysis based on earthquake loading is outside of the scope of short-term slope stability analysis.

Living vegetation, such as trees, bushes, and grasses, can provide slope stability benefits by protecting the soil from surficial erosion, absorbing water, and providing apparent cohesion in the soils near surface due to their root structures. Wattle fences are one such bioremediation solution that provides these benefits. To assess the impact of the wattle fences on slope stability, WSP assumed that that vegetation would provide an apparent cohesion of 20 kPa within the top 0.5 m of soil, based on literature review of strength provided by vegetation (Haji and Osman 2008; Ning et al. 2023).

**Table 2: Summary of Selected Slope Stability Parameters**

| Unit | Unit Weight, γ (kN/m$^3$) | Cohesion, c (kPa) | Friction Angle, φ (deg) |
|---|---|---|---|
| Fill | 19 | 0 | 35 |
| Upper Till-Like | 20 | 10 | 40 |
| Sand | 19 | 4 | 42 |
| Silt | 19 | 10 | 40 |
| Lower Till-Like | 20 | 30 | 40 |
| Bedrock | 29 | 50,000 | 0 |

## 3.3 Results

The results of the slope stability analysis are shown in Table 3 and Attachment 3. The results are presented in terms of factor of safety, which is the ratio of forces resisting slope failure to those inducing slope failure. A FS value of 1 indicates imminent slope collapse, with a FS of 1.5 generally accepted by the geotechnical engineering industry as the minimum acceptable for long-term static conditions.

**Table 3: Slope Stability Analysis Results (In Terms of Factor of Safety)**

| Condition | Station 9+70 Section B | Station 11+80 Section G | Station 12+20 Section I |
|---|---|---|---|
| Global slope | 1.40 | 1.22 | 1.11 |
| Slope toe | Not applicable | 1.46 | 1.17 |
| Mid-slope scarp | 1.09 | 1.07 | 1.07 |
| Mid-slope scarp with wattle fences | 1.21 | 1.12 | 1.18 |

Note that these slope stability analysis results are based on slope geometry at the time of the LiDAR survey on 21 February 2024, and do not account for changes in slope geometry that may occur due to subsequent erosion and/or slope displacement. Additionally, there is uncertainty in the magnitude of the FS due to the uncertainty of the input parameters. The results are especially useful in assessing the relative stability of different scenarios.

The FS of the global slope varied from about 1.1 to 1.4, with the FS decreasing in the steeper portions of the slope. While these FS values do not indicate immediate risk to the stability of the global slope, they are below the industry standard FS value of 1.5, and so should be addressed with a long-term solution.

Recent inspections of the project area have found instances of subvertical slopes at the slope toe, as in Section I and shown in lower portion of Photo 1 and in Photo 3 in Attachment 1. The slope stability analysis results at the toe of the slope indicated a FS between 1.2 and 1.5. Note, however, that these slopes are subject to high seepage pressures, coastal wave action, and other coastal processes that may impact their stability.

Slope stability analysis of the existing mid-slope scarps indicated a FS between 1.0 and 1.1, indicating that these areas are susceptible to shallow slips surfaces in the short-term. The analysis also indicates that the wattle fences would increase the FS by about 0.1, which would reduce, but not eliminate, the risk of failure in the short-term. Note that the slope stability analysis only incorporates the increase of near-surface cohesion due to the wattle fences, and does not include its other benefits, such as water absorption and erosion protection. The wattle fences would also protect the soils on the slope from environmental deterioration due to wet-dry cycles, freeze-thaw cycles, and riling, which can act the reduce the strength of affected soils. In this way, wattle fences would help to maintain the high strength of the natural soils at depth within the slope.

# 4.0 SHORT-TERM REMEDIATION DESIGN

The intention of the short-term remediation design is to stabilize the slope for up to about five (5) years while a long-term remediation solution is developed. For this reason, the short-term remediation design is only targeting the highest-risk areas of the project area that have the highest likelihood of impacting Cordova Bay Road and the existing water pipeline.

Based on recent site observations, slope stability analysis, and LiDAR survey information, WSP recommends addressing the below two areas with short-term remediation.

1) Mid-slope scarp from Station 11+60 to 12+40 (Photo 1 in Attachment 1).

2) Gully headwall area on upper slope from Station 10+80 to 11+00 (Photo 4 in Attachment 1).

WSP recommends addressing these areas with wattle fences. Wattle fences involve installing live local plant species using hand tools. Refer to the Polster reports in Attachment 2 for more information on wattle fences. This bioremediation option provides immediate near-surface support due to the benching of the wattle fences and the shear resistance of their implanted stakes. The support provided by the vegetation will improve with time as the wattle fences continue to grow and as other species move into the area. As previously mentioned, wattle fences also improve the stability of the slope through erosion protection and water absorption and protect deeper soils from deterioration due to environmental factors. Additionally, given that the wattle fences can be installed with hand tools and use natural material, WSP believes that this solution will be less disruptive and more attractive to the District and the public compared to other traditional engineering alternatives.

Figures 5 and 6 following the text of this report present preliminary drawings showing the proposed plan area of the wattle fences and two cross-sections. The estimated total length of wattle fences in 3990 m, comprising 3350 m allocated to mid-slope scarp from Station 11+60 to 12+40 and 640 m to the gully headwall on the upper slope from Station 10+80 to 11+00. The benching shown on Figure 6 will be created using existing exposed soil and will not require soil import. Note that the extent of the wattle fences in the selected treatment areas is based on preliminary discussion that WSP has had in recent months with Polster. WSP accompanied Polster on a site visit on 5 June 2024, following which Polster provided more detailed recommendations on wattle fence distribution and plant species. Therefore, the wattle fence distribution shown on Figures 5 and 6 is subject to change in a future version of this memorandum. This will also affect the costs discussed in Section 5.

Consideration was given to addressing other gullies on the upper slope that approach Cordova Bay Road. However, given that they did not appear to show significant displacement between 2019 and 2024 based on the LiDAR surveys and that they have been consistently well-vegetated, WSP judged these gullies to be lower risk compared with the conditions observed in the gulley between Station 10+80 to 11+00. While this gully has also not shown significant displacement based on the LiDAR, the slopes are relatively steep and generally sparse of vegetation, and so pose a higher risk of erosion and/or slope failure. Therefore, this area would likely benefit from installation of the wattle fences.

Other slope areas with recent failure activity, such as at the toe of the slope at Station 9+45, do not appear to pose an elevated risk to Cordova Bay Road in the short-term. The slope angle is shallower in this area and the crest of the slope is not anticipated to be affected within the next five years should retrogression continue at a similar rate as from 2019 to 2024. Additionally, the slope failures at the toe of the slope are interpreted to be related to high seepage gradients and wave action at the toe of the slope, which would require a more rigorous design solution than wattle fences. Slope stability issues at the slope toe would be more appropriately addressed with a long-term solution. In the meantime, however, failures at the slope toe will continue to lead to slope retrogression and eventually pose a risk to the road in the long-term.

Implementation of the wattle fence solution does not imply that these areas will not face future slope stability challenges. There are still several active processes that are ongoing that are contributing to slope instability, namely high seepage pressures, coastal erosion, and surface water runoff. As failures continue to occur at the slope toe, this will likely lead the retrogression of the mid-slope and eventually upper slopes. The timing of any such failures is uncertain, but the LiDAR suggests about 1 to 4 m of retreat in the Station 11+60 to 12+40 area between 2019 and 2024. Any post-installation failures at the slope toe could affect the success of the wattle fence installations, especially from Station 11+60 to 12+40. Erosion due to surface runoff appears to have improved in recent years due to the blocking or extension to the slope toe of drainage pipes that previously drained onto the upper slope. Surface water drainage onto the upper slope should continue to be prevented.

## 5.0 COST ESTIMATE

WSP engaged their internal Applied Solutions team, which specializes in construction and cost estimation, to prepare a Class 4 cost estimate in general accordance with the Association for the Advancement of Cost Engineering International (AACEI) Recommended Practice No. 17R-97: Cost Estimate Classification System – Cost Estimating and Budgeting (AACE International, 2019). Class 4 estimates are generally prepared based on conceptual level designs and supporting project information with the level of project definition typically at 1% to 15% complete, with a target level of accuracy between -30% to +50%.

WSP’s opinion of probable cost is presented in Table 4. This table should be read in conjunction with the full technical memorandum detailing the basis, methodology, and assumptions of this assessment, included as Attachment 4 of this memorandum.

Note that as of 2024, Polster is estimating wattle fence construction at $100 per linear metre, up from about $40/m in 2009 (Polster 2009) and $50/m in 2016 (Polster 2016). This price is understood to include Polster’s costs and their hiring of a subcontractor to complete the work. This price does not include other costs, such as WSP’s supervision during construction. Refer to Attachment 4 for a more detailed description of assumptions.

**Table 4: Opinion of Probable Cost**

| Item | Description | Total |
|---|---|---|
| 01 | Contractor Mobilization/Demobilization | $6,208 |
| 02 | Wattle Fencing Supply and Install | $548,730 |
| 03 | Construction Facilities | $11,898 |
| 04 | Site Supervision | $56,098 |
| 05 | Office Management | $63,865 |
| 06 | Traffic Control | $25,544 |
| | **SUB-TOTAL EXCLUDING CONTINGENCY** | **$712,343** |
| | Suggested Contingency Allowance @ 20% | 142,468 |
| | **TOTAL ESTIMATED COSTS INCLUDING CONTINGENCY(1)** | **$854,811** |
| | **Accuracy Range Low (-30%)** | **$598,368** |
| | **Accuracy Range High (+50%)** | **$1,282,216** |

1. Excluding federal and provincial taxes

# 6.0 CONCLUSION

Based on recent site investigations, site inspections, survey interpretation, and engineering analysis, WSP recommends wattle fences be installed in two areas as short-term remediation of the eroding slope below Cordova Bay Road in PKOLS (Mount Douglas Park). These two areas are the mid-slope scarp from Station 11+60 to 12+40 and the upper slope gully from Station 10+80 to 11+00, as identified in Figure 5. WSP believes that these two areas pose the highest risk to the stability of Cordova Bay Road in the short-term. Wattle fences are short retaining walls built out of living plant materials that will improve the stability of near-surface slip surfaces, protect against erosion, absorb moisture, and maintain the strength of deeper soils. Wattle fences are installed by hand and will promote plant growth, with the result being a natural setting appropriate for a park.

The intention of the short-term remediation is to address these highest risk areas while a long-term solution is developed. The processes that have contributed to slope instability over the past decades continue to remain active and will continue to cause retrogression of the slope. WSP recommends that a suitable long-term remediation plan is developed to manage the risk to Cordova Bay Road and its associated infrastructure.

## 7.0 CLOSURE

We trust that the contents of this report meet your current requirements. Should you have any questions of require clarification on the contents of this report, please contact the undersigned.

**WSP Canada Inc.**

Matt Neale, MEng, P.Eng.
*Geotechnical Engineer*

Randy Williams, P.Eng.
*Senior Principal Geotechnical Engineer*

MJN/RW/cdg

Attachments: Figures
Attachment 1 – Key Photos
Attachment 2 – Polster Reports
Attachment 3 – Slope Stability Figures
Attachment 4 – Cost Estimate

https://wsponline.sharepoint.com/sites/gld-1895826/6 deliverables/issued to client_for wp/1895826-029-tm-rev0/1895826-029-tm-rev0_short-term remediation-09sep_24.docx

WSP Canada Inc.
Engineers & Geoscientists BC
Permit #1000200

# 8.0 REFERENCES

AACE International. 2019. Association for the Advancement of Cost Engineering International (AACEI) Recommended Practice No. 17R-97: Cost Estimate Classification System – Cost Estimating and Budgeting.

Golder Associates Ltd. 2020. Cordova Bay Road Shoreline Erosion: Project Process. Reference 1895826-021-TM-RevB. 30 November 2022.

Haji, F.J. and Osman, N. 2008. Shear Strength of a Soil Containing Vegetation Roots. Japanese Geotechnical Society, Soils and Foundations, Vol. 48, No. 4, p. 587-596.

Ning, P., Xia, X., and Jiang, Y. 2023. An Estimation Model of the Ultimate Shear Strength of Root-Permeated Soil, Fully Considering Interface Bonding. Forests 2023, Vol. 14, No. 4, p. 819.

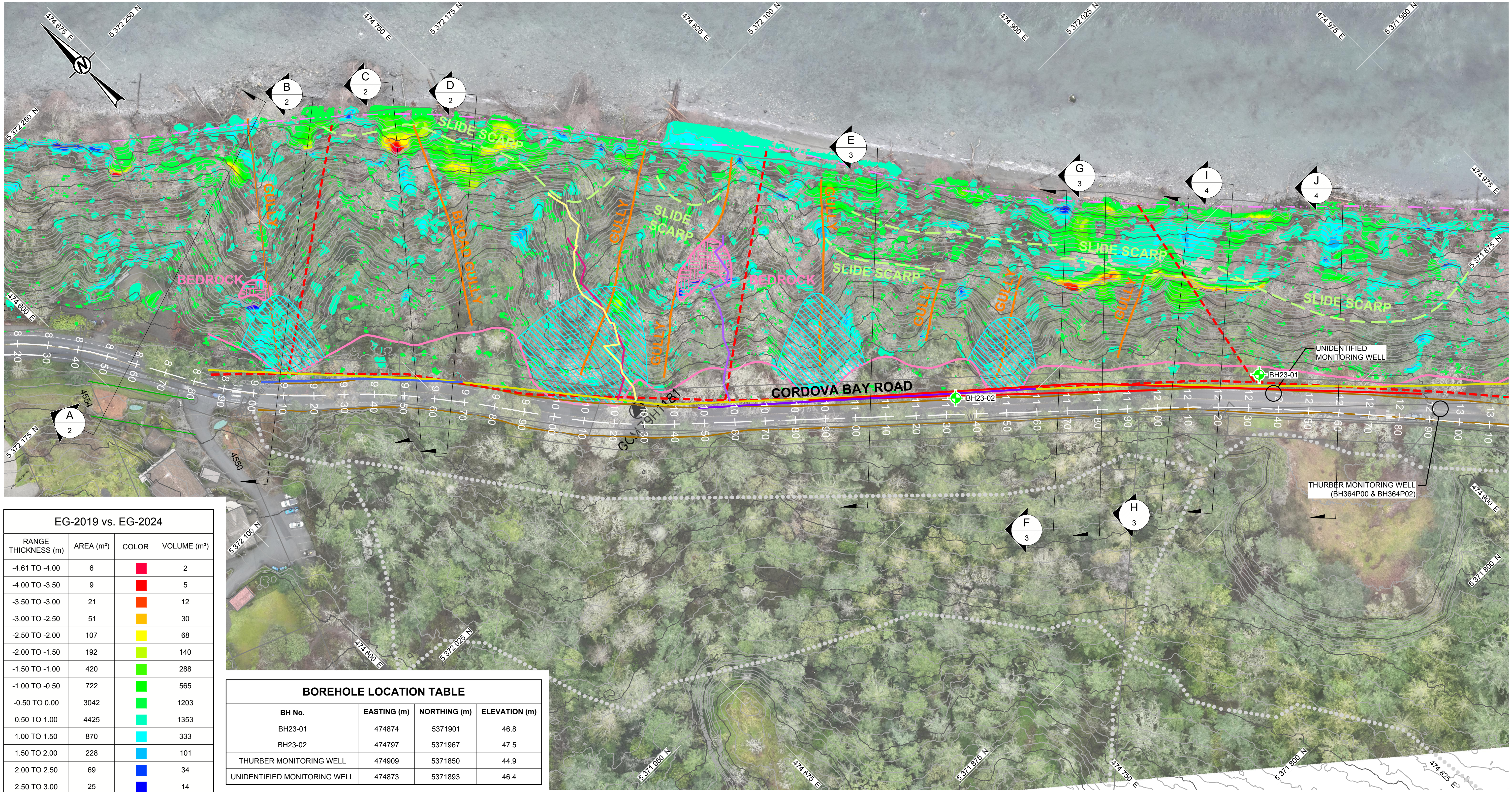
Polster Environmental Services Ltd. 2009. Restoration Options: Lower Mount Douglas Slopes: District of Saanich Parks. March 2009.

Polster Environmental Services Ltd. 2016. Mount Douglas Park: Shoreline Slope Restoration Suggestions. November 2016.

Thurber Engineering Ltd. 2000. Mount Douglas Park Slope Stability at the Railing, Assessment and Conceptual Stability Measures. Corporation of the Municipality of Saanich. File: 14-8-74, 28 August 2000.

WSP Golder. 2022. Proposal: Saanich Bank Stabilization – Mount Douglas Park: Geotechnical Engineering, Coastal Engineering & Geophysics Services. File CX22511862-001-P-Rev3. 18 November 2022.

WSP. 2024. Report: Cordova Bay Road in PKOLS (Mt Douglas Park) Bank Stabilization: Geotechnical Services. File 1895826-028-R-Rev0. 13 February 2024.




| EG-2019 vs. EG-2024 | | | |
|---|---|---|---|
| RANGE THICKNESS (m) | AREA (m²) | COLOR | VOLUME (m³) |
| -4.61 TO -4.00 | 6 | | 2 |
| -4.00 TO -3.50 | 9 | | 5 |
| -3.50 TO -3.00 | 21 | | 12 |
| -3.00 TO -2.50 | 51 | | 30 |
| -2.50 TO -2.00 | 107 | | 68 |
| -2.00 TO -1.50 | 192 | | 140 |
| -1.50 TO -1.00 | 420 | | 288 |
| -1.00 TO -0.50 | 722 | | 565 |
| -0.50 TO 0.00 | 3042 | | 1203 |
| 0.50 TO 1.00 | 4425 | | 1353 |
| 1.00 TO 1.50 | 870 | | 333 |
| 1.50 TO 2.00 | 228 | | 101 |
| 2.00 TO 2.50 | 69 | | 34 |
| 2.50 TO 3.00 | 25 | | 14 |
| 3.00 TO 3.50 | 13 | | 4 |
| 3.50 TO 3.98 | 3 | | 0 |

## BOREHOLE LOCATION TABLE

| BH No. | EASTING (m) | NORTHING (m) | ELEVATION (m) |
|---|---|---|---|
| BH23-01 | 474874 | 5371901 | 46.8 |
| BH23-02 | 474797 | 5371967 | 47.5 |
| THURBER MONITORING WELL | 474909 | 5371850 | 44.9 |
| UNIDENTIFIED MONITORING WELL | 474873 | 5371893 | 46.4 |

**LEGEND**

- 2024 EXISTING GROUND CONTOURS (SEE REFERENCE 3)
- EXISTING TRAIL
- ROAD
- PROPERTY LINE
- TOP OF BANK
- TOE OF BANK
- WATER WORKS
- STREET LIGHT
- SANITARY SEWER
- STORM SEWER
- BEDROCK
- PROPOSED BOREHOLE LOCATIONS (SEE NOTE 3)

**NOTES**

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE SYSTEM IS UTM ZONE 10, HORIZONTAL DATUM: NAD83.
3. LOCATION OF BOREHOLES ARE BASED ON HANDHELD GPS, +- 5 m ACCURACY.
4. EXISTING GROUND CONTOURS SHOWN AT 1 m CONTOUR INTERVAL.
5. GEOPHYSICS LINES BASED ON FIELD RECORDED GPS SURVEY INFORMATION.

**REFERENCES**

1. SLOPE OBSERVATIONS AND TOE OF BANK BASED ON THURBER DRAWINGS 11946-101, 11946-102 AND 11946-103. DATED MAY 17, 2016. ORIGINAL SCALE 1:500.
2. TOP OF BANK INTERPRETED BASED ON 2024 LiDAR.
3. 2024 LiDAR DATA AND BACKGROUND IMAGE COLLECTED BY VOLATUS UNMANNED SERVICES INC. ON 21 FEBRUARY 2024, RECEIVED 5 MARCH 2024.
4. UTILITY INFORMATION DOWNLOAD FROM DISTRICT OF SAANICH DATA CATALOGUE. DATE DOWNLOADED: 16 JANUARY 2023.



0 25 50
1:1,250 METRES

CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILISATION

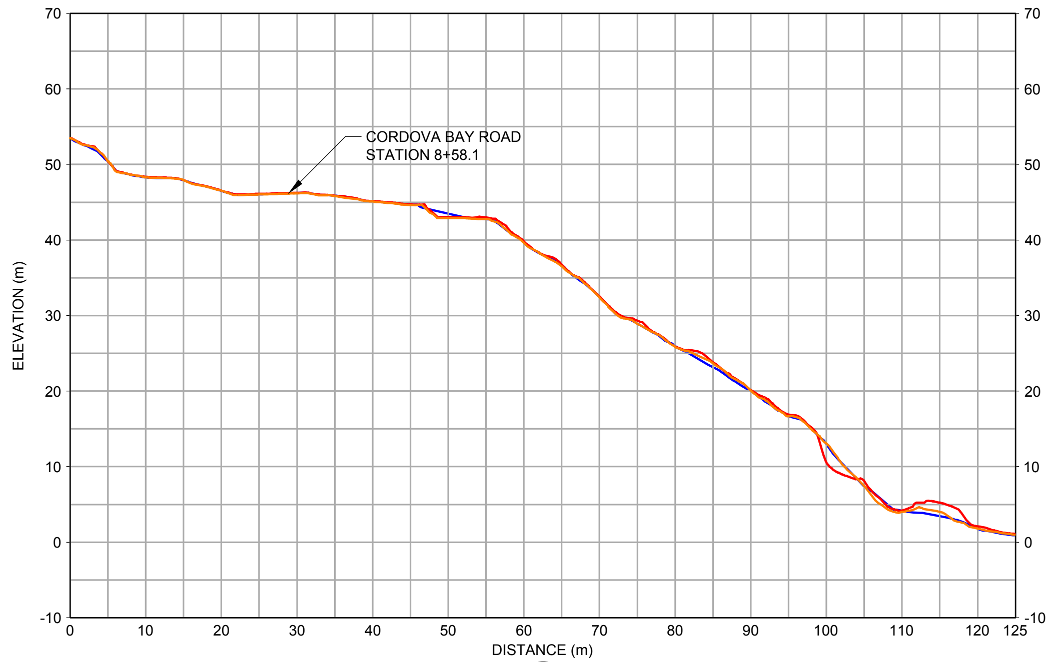
CONSULTANT
wsp

| | |
|---|---|
| YYYY-MM-DD | 2024-09-06 |
| DESIGNED | M.NEALE |
| PREPARED | M.HEAL |
| REVIEWED | M.NEALE |
| APPROVED | R.WILLIAMS |

TITLE
**BOREHOLE LOCATION PLAN**

| PROJECT NO. | PHASE/TASK/DOC | REV. | FIGURE |
|---|---|---|---|
| 1895826 | 2300/2301/029 | 0 | 1 |

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B
25 mm

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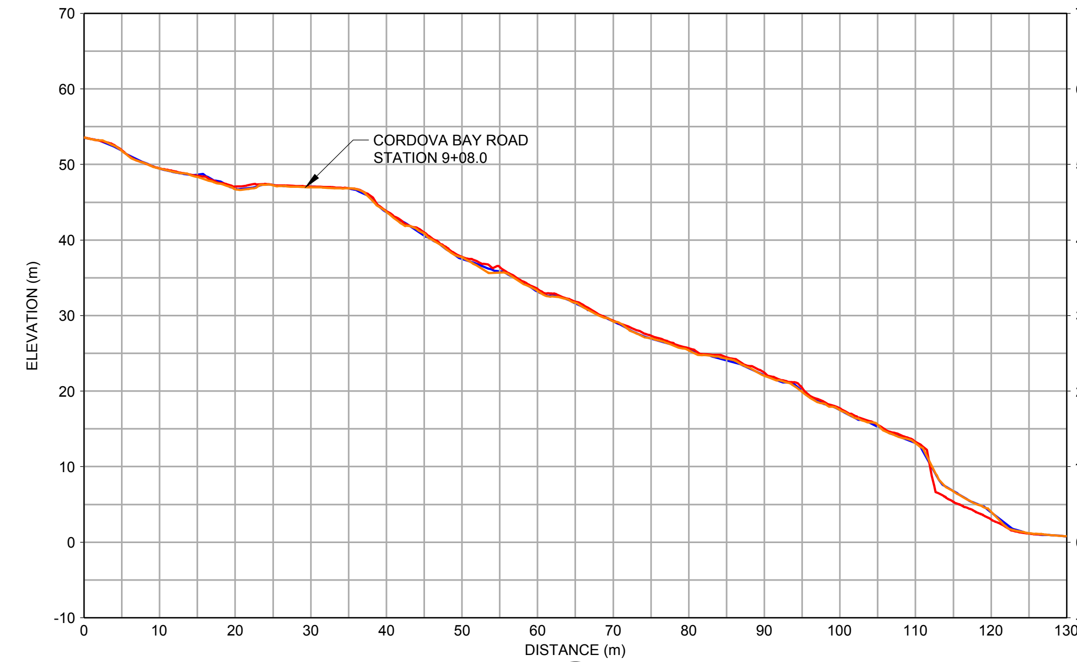


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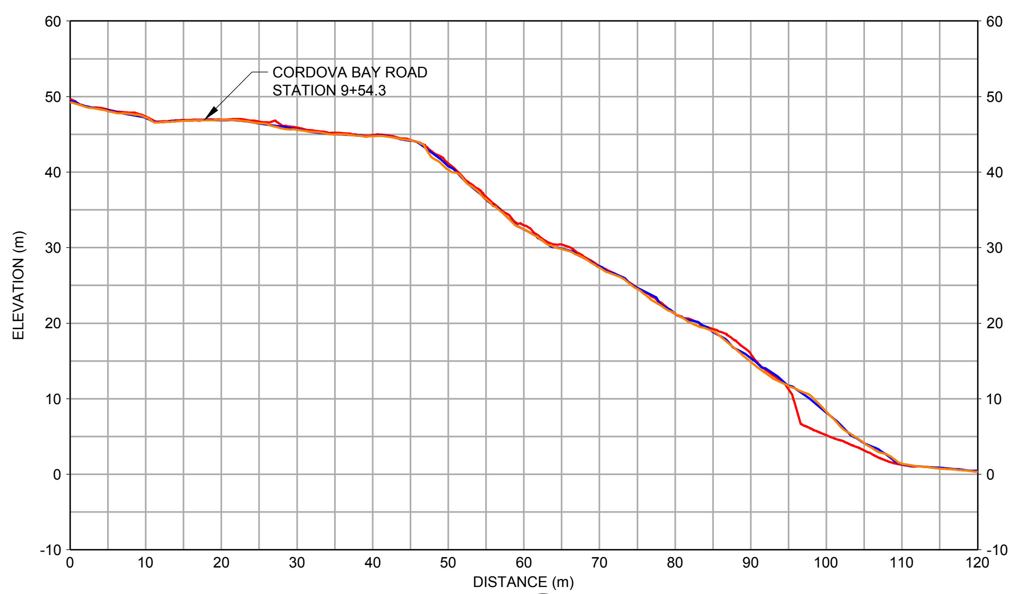


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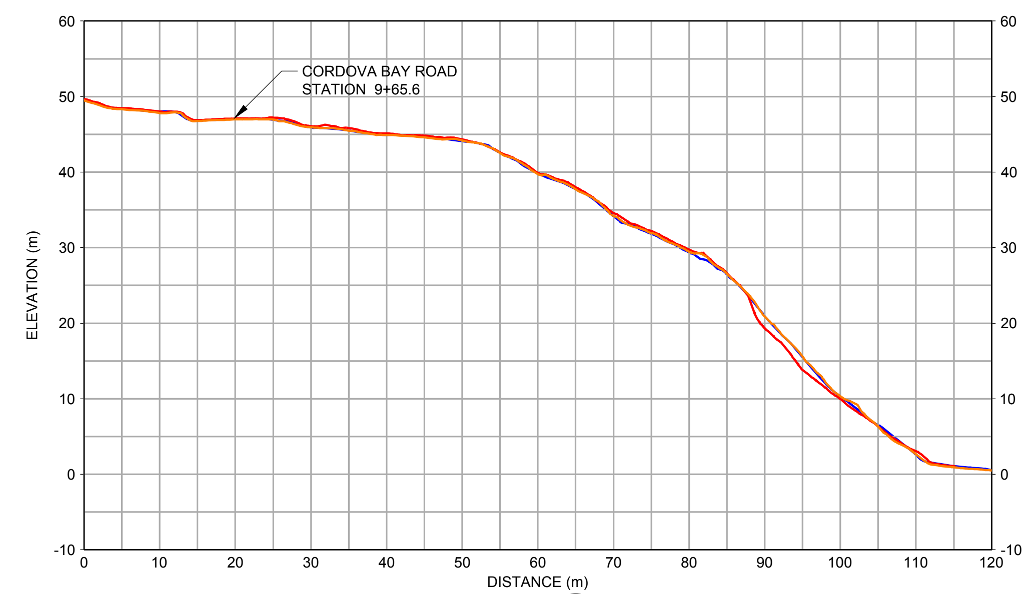


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0 25 50
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**LEGEND**

- 2017 LiDAR
- 2019 LiDAR
- 2024 LiDAR

**NOTES**

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.

**REFERENCES**


1. 2017 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 15 MAY 2018.
2. 2019 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 18 JANUARY 2023.
3. 2024 LiDAR DATA COLLECTED BY VOLATUS UNMANNED SERVICES INC. ON 21 FEBRUARY 2024, RECEIVED 5 MARCH 2024.


CLIENT
DISTRICT OF SAANICH

CONSULTANT
WSP

| | |
|---|---|
| YYYY-MM-DD | 2024-09-06 |
| DESIGNED | M.NEALE |
| PREPARED | M.HEAL |
| REVIEWED | M.NEALE |
| APPROVED | R.WILLIAMS |

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK) BANK STABILISATION

TITLE
**CROSS-SECTIONS 1 OF 3**

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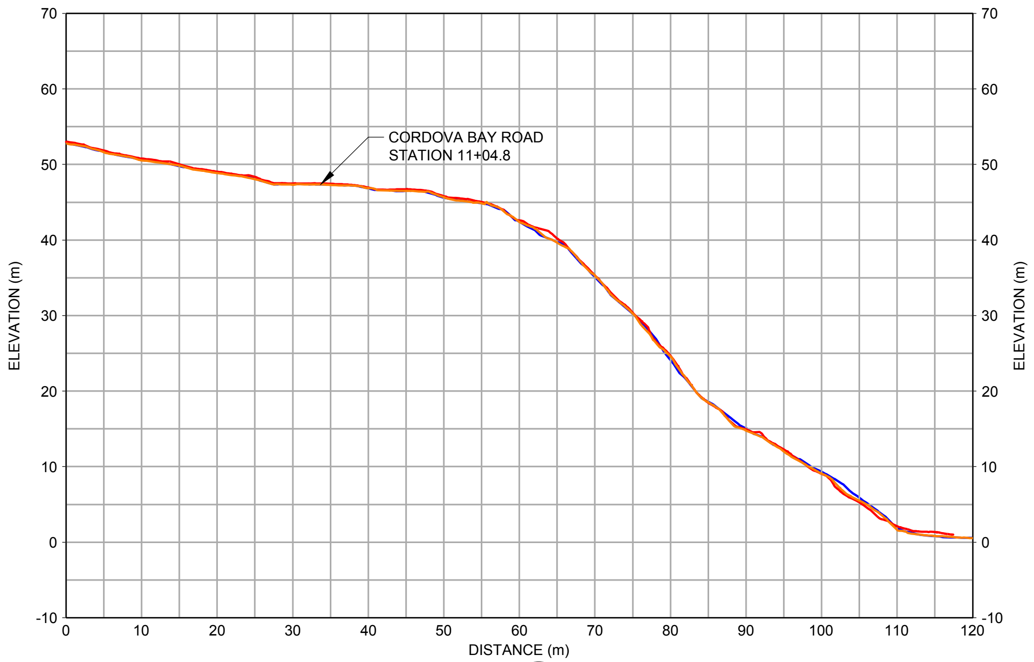


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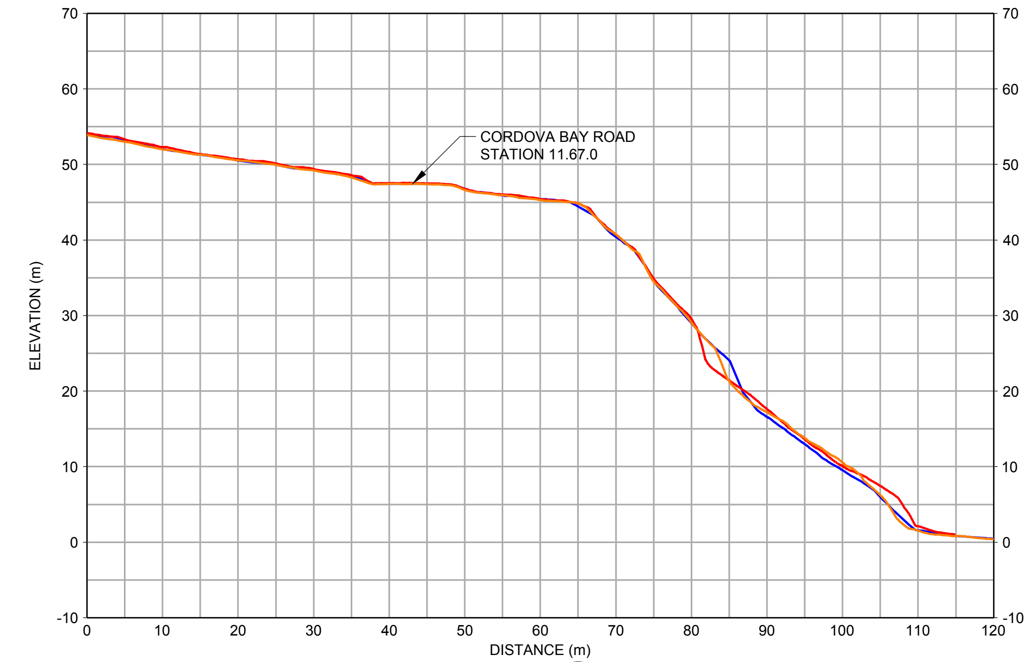


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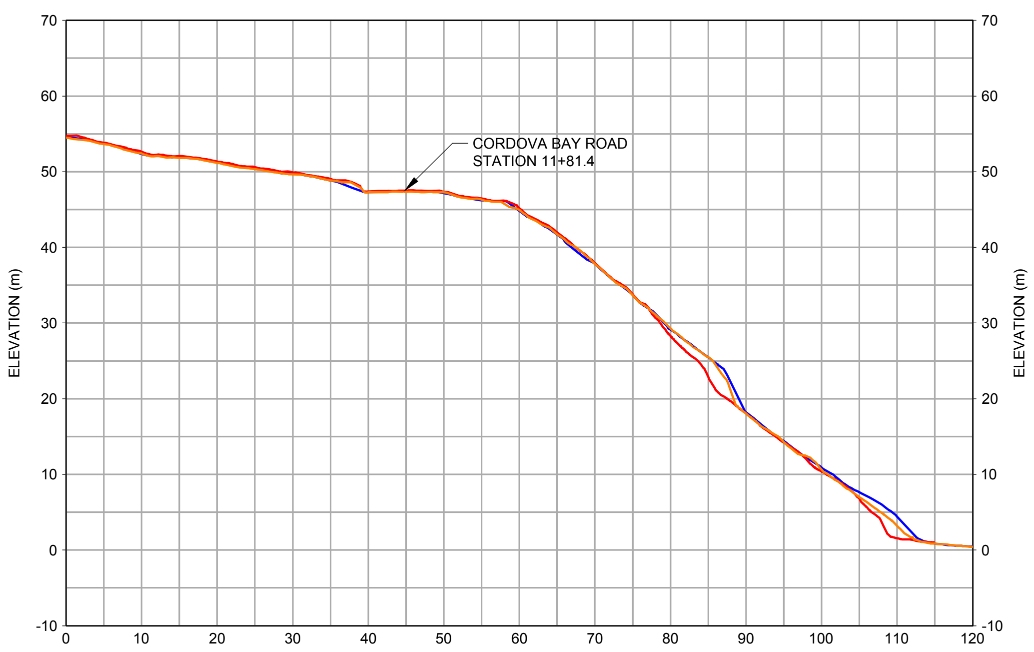


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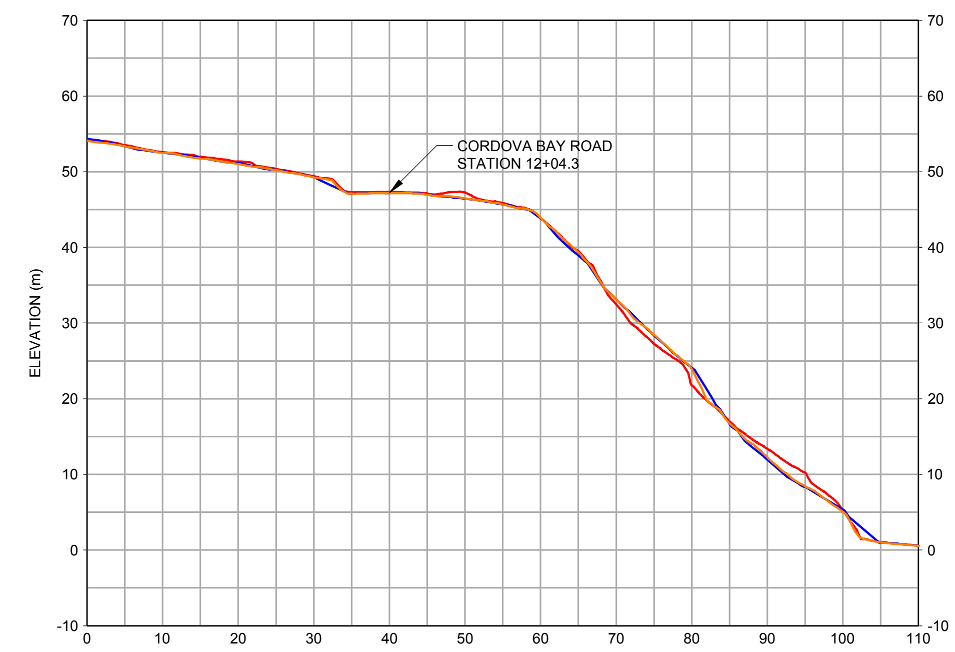


SCALE 1:1,000 m H/1 CROSS-SECTION

0 25 50
1:1,000 METRES



**LEGEND**

- 2017 LiDAR
- 2019 LiDAR
- 2024 LiDAR

**NOTES**

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.

**REFERENCES**

1. 2017 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 15 MAY 2018.
2. 2019 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 18 JANUARY 2023.
3. 2024 LiDAR DATA COLLECTED BY VOLATUS UNMANNED SERVICES INC. ON 21 FEBRUARY 2024, RECEIVED 5 MARCH 2024.

CLIENT
DISTRICT OF SAANICH

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-09-06 |
| DESIGNED | M.NEALE |
| PREPARED | M.HEAL |
| REVIEWED | M.NEALE |
| APPROVED | R.WILLIAMS |

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILISATION

TITLE
**CROSS-SECTIONS 2 OF 3**

| PROJECT NO. | PHASE/TASK/DOC | REV. | FIGURE |
|---|---|---|---|
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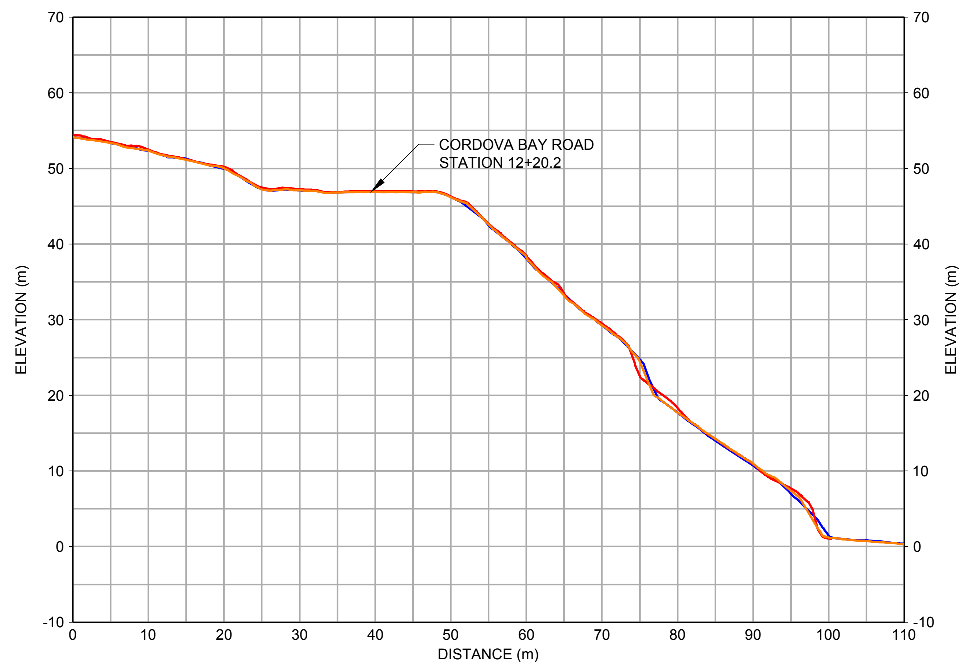


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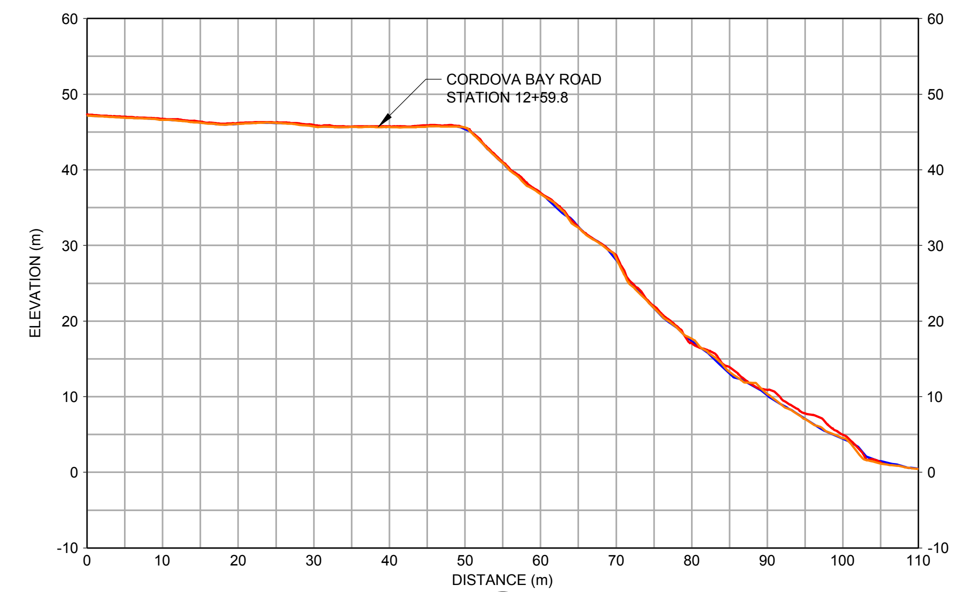


SCALE 1:1,000 m — J / 1 — CROSS-SECTION

0 25 50
1:1,000 METRES



**LEGEND**

- 2017 LiDAR
- 2019 LiDAR
- 2024 LiDAR

**NOTES**

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.

**REFERENCES**

1. 2017 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 15 MAY 2018.
2. 2019 LiDAR DATA PROVIDED BY CLIENT, RECEIVED 18 JANUARY 2023.
3. 2024 LiDAR DATA COLLECTED BY VOLATUS UNMANNED SERVICES INC. ON 21 FEBRUARY 2024, RECEIVED 5 MARCH 2024.

CLIENT
DISTRICT OF SAANICH

CONSULTANT
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| YYYY-MM-DD | 2024-09-06 |
| DESIGNED | M.NEALE |
| PREPARED | M.HEAL |
| REVIEWED | M.NEALE |
| APPROVED | R.WILLIAMS |

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK) BANK STABILISATION

TITLE
**CROSS-SECTIONS 3 OF 3**

| PROJECT NO. | PHASE/TASK/DOC | REV. | FIGURE |
|---|---|---|---|
| 1895826 | 2300/2301/029 | 0 | 4 |


## LEGEND

- PROPOSED AREA FOR WATTLE FENCE (APPROXIMATE)
- 2019 EXISTING GROUND CONTOURS (SEE REFERENCE 3)
- PROPOSED WATTLE FENCE
- EXISTING TRAIL
- ROAD
- TOP OF BANK
- TOE OF BANK
- WATER WORKS
- STORM SEWER

## NOTES

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE SYSTEM IS UTM ZONE 10, HORIZONTAL DATUM: NAD83.
3. EXISTING GROUND CONTOURS SHOWN AT 1 m CONTOUR INTERVAL.

## REFERENCES

1. SLOPE OBSERVATIONS AND TOE OF BANK BASED ON THURBER DRAWINGS 11946-101, 11946-102 AND 11946-103. DATED MAY 17, 2016. ORIGINAL SCALE 1:500.
2. TOP OF BANK OBTAINED FROM J.E. ANDERSON SURVEY FILE No. 31348. DATE OF SURVEY: MAY 29, 2018. ORIGINAL SCALE 1:1500.
3. 2024 LIDAR AND IMAGERY DATA PROVIDED BY CLIENT, RECEIVED 2024-03-05.
4. UTILITY INFORMATION DOWNLOAD FROM DISTRICT OF SAANICH DATA CATALOGUE. DATE DOWNLOADED: 16 JANUARY 2023.

NOT FOR CONSTRUCTION

0 10 20
1:600 METRES



CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
SAANICH, BANK STABILISATION

TITLE
**SHORT TERM REMEDIATION PRELIMINARY DESIGN**

CONSULTANT
wsp

| | |
|---|---|
| YYYY-MM-DD | 2024-08-15 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | MN |
| APPROVED | RM |

| PROJECT NO. | PHASE/TASK/DOC | REV. | FIGURE |
|---|---|---|---|
| 1895826 | 2200/2203/029 | 0 | 5 |

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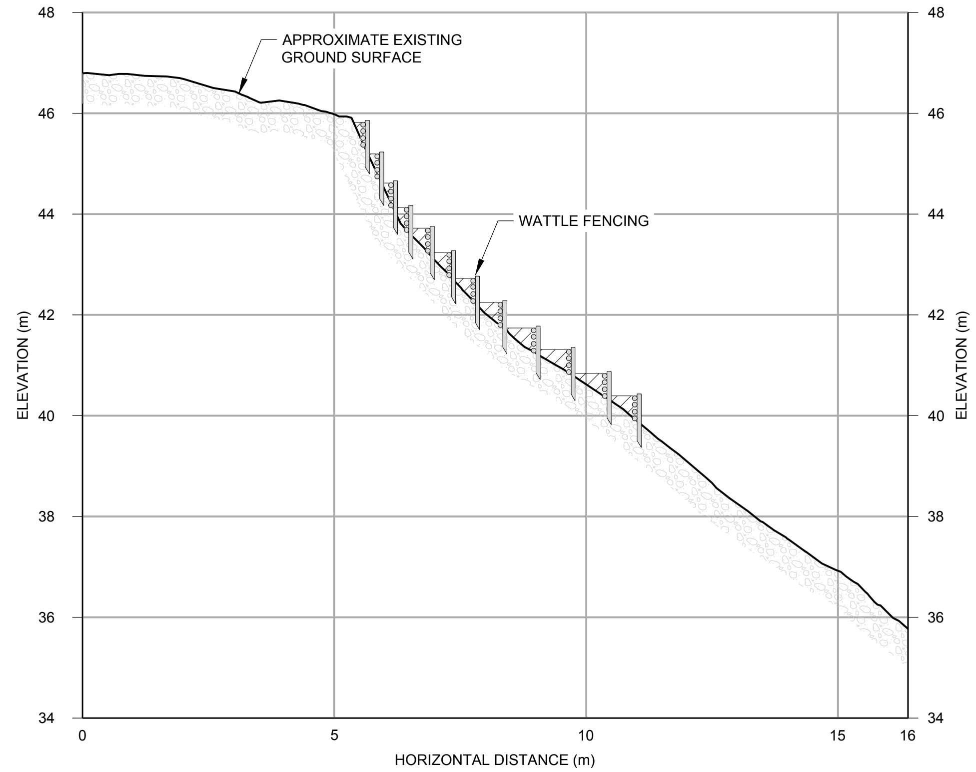
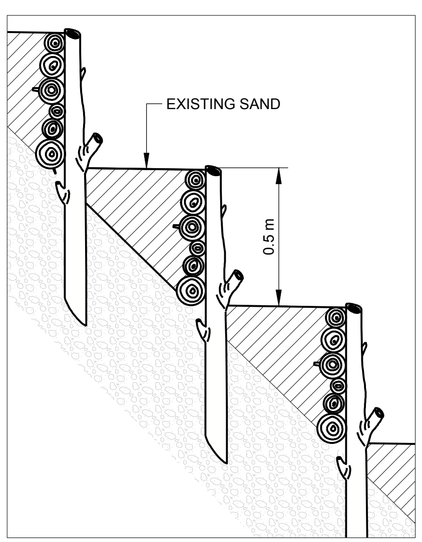
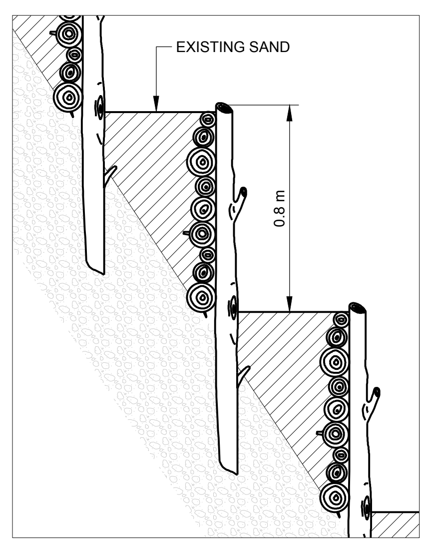
Path: \\corp.pbwan.net\CA\CAVIC600\CAD-GIS\Client\District_of_Saanich\Mount Douglas Park (transferred)\99_PROJECTS\1895826\2200\2203\Doc029\02_PRODUCTION\DWG\ | File Name: 1895826_2200_2203_029_06 - Site Plan.dwg | Last Edited By: gld_ryjames Date: 2024-08-15 Time:11:35:40 AM | Printed By: gld_ryjames Date: 2024-08-15 Time:11:39:25 AM




SCALE 1:150 A 6 CONCEPTUAL SECTION A




TYPICAL WATTLE DETAIL (0.5 m RISE)
NTS




TYPICAL WATTLE DETAIL (0.8 m RISE)
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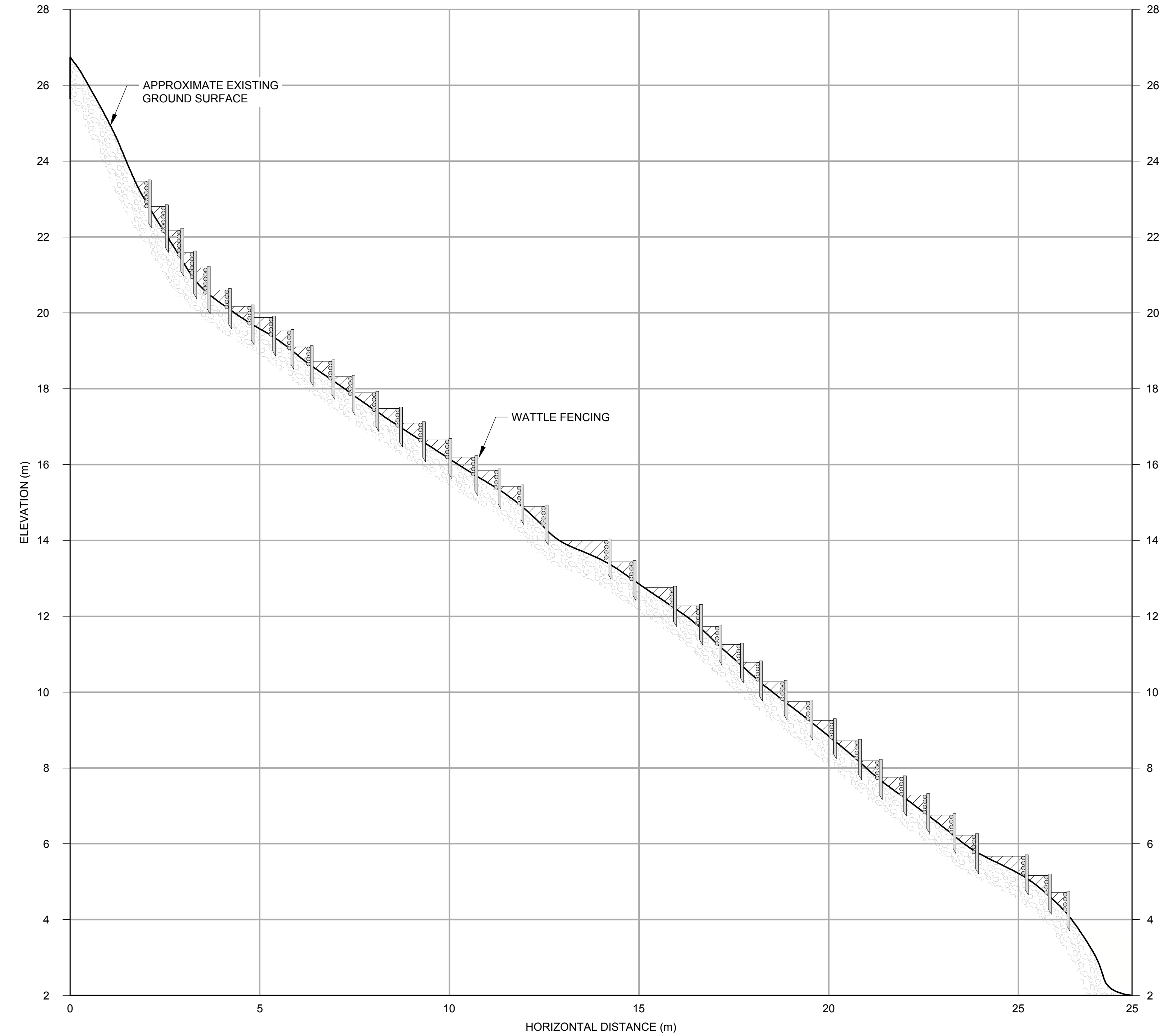



SCALE 1:150 B 6 CONCEPTUAL SECTION B

**REFERENCES**

1. FEBRUARY2024 EXISTING GROUND SURFACE BASED ON LIDAR DATA PROVIDED BY CLIENT, RECEIVED 2024-03-05.
2. WATTLE DETAILS BASED ON A SCHEMATIC PRODUCED BY POLSTER ENVIRONMENTAL SERVICES LTD.

**NOTES**

1. ALL UNITS ARE SHOWN IN METRES UNLESS NOTED OTHERWISE.
2. EXISTING GROUND SURFACE IS APPROXIMATE

NOT FOR CONSTRUCTION

0 2.5 5
1:150 METRES



CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
SAANICH, BANK STABILISATION

TITLE
**SHORT TERM REMEDIATION PRELIMINARY DESIGN**
**CONCEPTUAL SECTIONS**

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-08-15 |
| DESIGNED | MN |
| PREPARED | RTJ |
| REVIEWED | MN |
| APPROVED | RW |

| PROJECT NO. | PHASE/TASK/DOC | REV. | FIGURE |
|---|---|---|---|
| 1895826 | 2200/2203/029 | 0 | 6 |

**ATTACHMENT 1**

# Key Photos

**Photo 1: Exposed mid-slope sand bluff scarp from Station 11+60 to 12+40 (taken 27 March 2023).**

**Photo 2: Slope toe failure at Station 9+45 (taken 24 April 2024).**

**Photo 3: Steep toe slope at about Station 12+10, looking east (taken 27 March 2023).**

**Photo 4: Gully headwall on upper slope from Station 10+80 to 11+00 (taken 27 March 2023).**

**ATTACHMENT 2**

# Polster Reports

# RESTORATION OPTIONS
## LOWER MOUNT DOUGLAS SLOPES
## DISTRICT OF SAANICH PARKS

PREPARED FOR:


**THURBER ENGINEERING LTD.**
**#100 – 4396 WEST SAANICH ROAD**
**VICTORIA, BC**
**V8Z 3E9**


PREPARED BY:


**POLSTER ENVIRONMENTAL SERVICES LTD.**
**5953 DEUCHARS DRIVE**
**DUNCAN, BC**
**V9L 1L5**


MARCH, 2009

## INTRODUCTION

Shoreline erosion with subsequent slope instability has long been a problem on the lower eastern slope of Mount Douglas in Saanich ever since Cordova Bay Road was built across the upper slope. Various treatments have been employed over the years but have failed to satisfactorily address the problem of toe erosion coupled with longshore drift. Although soil bioengineering has been investigated several times over the past 20 years as a treatment for this site, the potential to apply soil bioengineering solutions to the failing slope has been limited due to toe erosion.

Recognition of the problems with toe erosion has led to the current plans presented by Sandwell to construct angled groynes and fill the beach to protect the shore from erosion. Although this is expected to eliminate the erosion of the slope toe, the face of the slope will continue to ravel until a stable angle is reached. Plans have been developed for installation of horizontal drains to help ensure the global stability of the slope above the new shoreline revetments. However, the over-steepened segments of the slope will continue to ravel until they reach a stable angle.

Soil bioengineering is the use of living material to perform some engineering function (Gray and Leiser 1982). With the global stability of the lower Mount Douglas slope, soil bioengineering can be used to treat the ravelling faces of the slopes. This brief report presents soil bioengineering options for treatment of eroding slopes within the Phase 1 treatment area defined by Sandwell. The sites are identified and numbered starting from the north end of the project area. The soil bioengineering treatments that could be used to treat the sites are presented below as are estimates of the quantities and costs. Recommendations for the implementation of the soil bioengineering treatments are provided.

## SITE DESCRIPTION

Mount Douglas Park lies in the Moist Maritime subzone of the Coastal Douglas-fir biogeoclimatic zone (Green and Klinka 1994). This area has warm dry summers and mild wet winters. Natural disturbance regimes that involved large wildfires every 300 to 500 years created fire-maintained forests of Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) (Roemer 1972). Without recurring fires, the vegetation shifts to Western Hemlock (*Tsuga heterophylla* (Raf.) Sarg.) and Western Redcedar (*Thuja plicata* Donn *ex* D. Don in Lamb). Disturbance vegetation is dominated by Red Alder (*Alnus rubra* Bong.) and Bigleaf Maple (*Acer macrophyllum* Pursh). Understory vegetation is dominated by Swordferns (*Polystichum munitum* (Kaulf.) K.B. Presl) and Salmonberry (*Rubus spectabilis* Pursh). Unfortunately, English Ivy (*Hedera helix* L.) has established in one area while scattered Holly (*Ilex aquifolium*

L.) occur on the slope. Both of these plants threaten the ecological integrity of the vegetation on the slope and should be removed through a systematic invasive plant management program.

The surficial materials on the lower Mount Douglas slope have been described in detail in other reports (Thurber Engineering Ltd. 2000). This information will not be repeated here except as it impinges on the revegetation designs described below. In summary, a hard clayey silt is overlain by Quadra sediments (Yorath and Nasmith 1995). The hard clayey silt is impenetrable to roots and thus vegetation cannot get firmly established on this material where slopes are steep. Where slopes are less than about 2:1 (H:V) or 26°, the weathered clayey silt will remain on the slope with a protective vegetation cover. Where slopes are steeper, any change in the moisture conditions or vegetation cover can result in slumping of the weathered surface materials on the hard clayey silt surface. The Quadra formation deposits lie stratigraphically above the hard clayey silt. These sands and gravels were deposited as an outwash plain during continental glaciation about 25,000 years ago. Above the Quadra sediments the Vashon tills form a cap that often protects the Quadra sediments from erosion. In cases where the Vashon till is disturbed, the Quadra sediments can be easily eroded, often causing problems.

## SOIL BIOENGINEERING TREATMENTS

Soil bioengineering can be used to treat many of the exposed eroding slopes on the lower part of Mount Douglas once the toe erosion problem has been solved. Soil bioengineering treatments (wattle fences) were used in the late 1980's to treat the eroding Quadra sediments of the Point Grey cliffs at the University of British Columbia. Photographs 1 and 2 illustrate the treatments that were used on the Point Grey cliffs.


**Photograph 1 and 2.** Wattle fences were used to treat the Quadra sediments of the Point Grey cliffs. The average in-situ slope is 70°. Growth of the pioneering species used to construct the wattle fences started a successional processes that will see these slopes vegetated forever.

Wattle fences (Figure 1) are short retaining walls built of living cuttings of willow (*Salix* spp.), cottonwood (Populus balsamifera L.) and red-osier dogwood (*Cornus stolonifera* Michx.). The cuttings will sprout and grow, changing the conditions on the slope so that other plants can establish. In addition to the growth of the cuttings used in the wattle fences, and by reducing the effective slope angle, the wattle fences create stable platforms on which vegetation can establish. The species used in construction of wattle fences and other bioengineering structures are pioneering species. These create conditions that encourage establishment of other later successional species such as Douglas-fir and possibly Western Redcedar. By initiating the natural successional processes, the wattle fences start a process that will ensure the treated site remains vegetated forever.

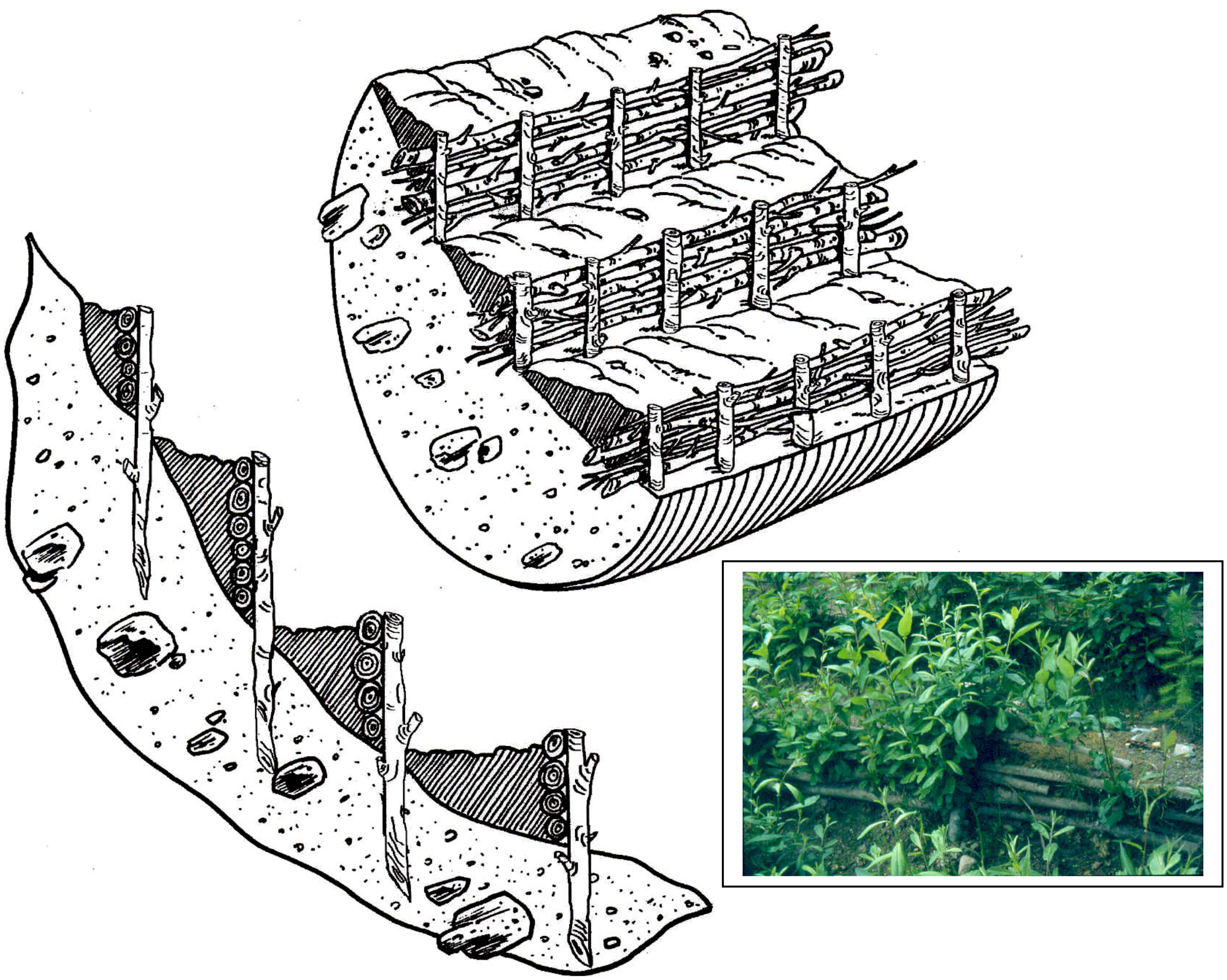


**Figure 1.** Wattle fences are short retaining walls built of living cuttings. Both the stakes and the horizontal pieces will sprout and grow (inset) providing a dense growth of pioneering species on the slope.

Locations where excess near surface groundwater is causing slope stability problems can be treated using live pole drains (Figure 2). Live pole drains are bundles of living cuttings (willow, cottonwood and red-osier dogwood) that are used to convey water safely from wet areas. As the cuttings sprout and grow they tend to bind the soil holding the slope in place. Live pole drains have been found to continue to drain moisture from wet areas for many years. The root systems grow out into the surrounding soil and the voids created by the drains are maintained. As with wattle fences, the pioneering species used to construct live pole drains create conditions that encourage the growth of later successional species. Photographs 3 and 4 show the placement of live pole drains in a seeping wet area and the subsequent growth of the cuttings used to construct the drain. The drains function for many years, holding the slope in place and naturally conveying the water to the surface (Photographs 5, 6 and 7).

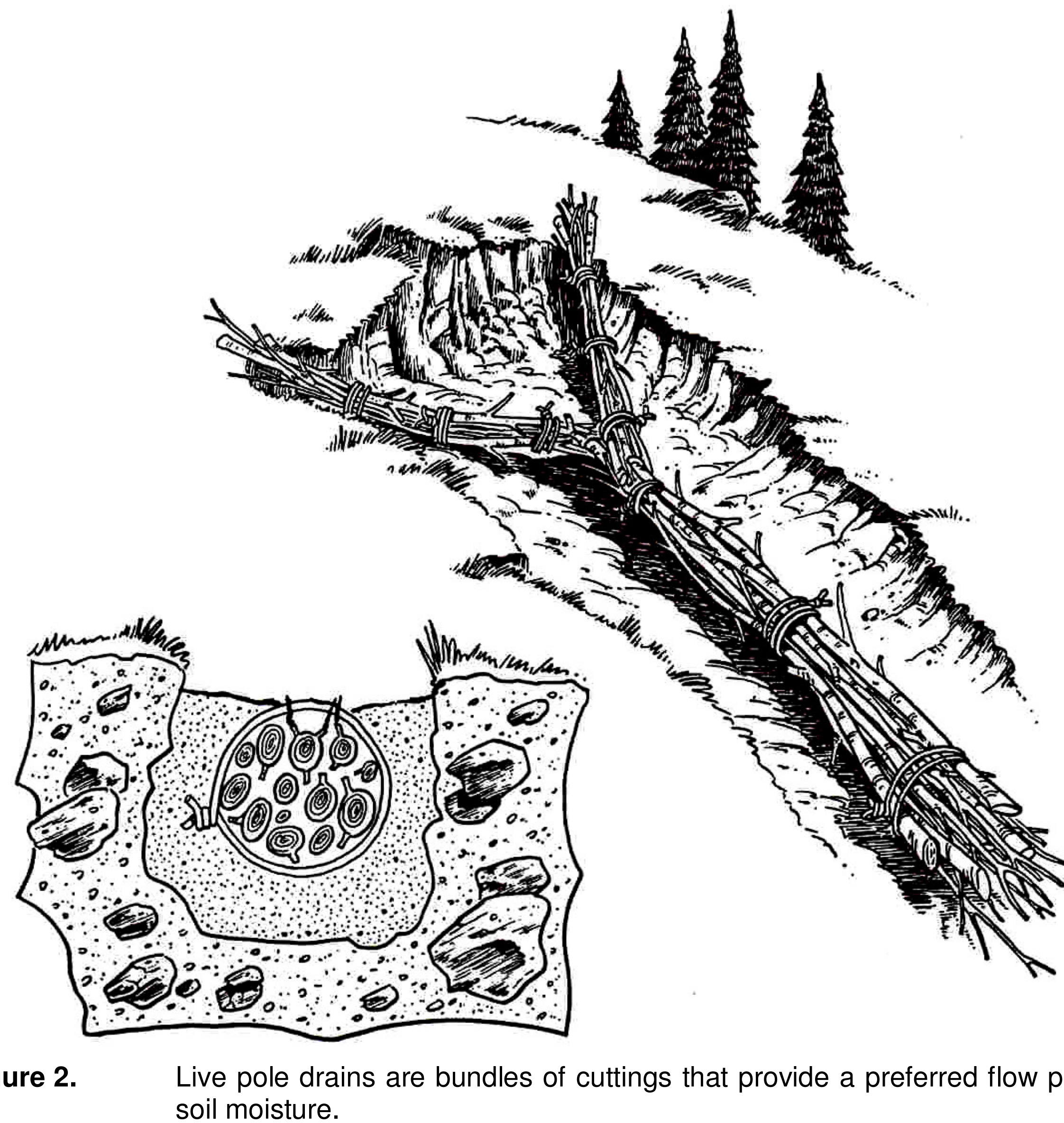


**Figure 2.** Live pole drains are bundles of cuttings that provide a preferred flow path for soil moisture.

**Photograph 3 and 4.** Live pole drains are used to treat slumping wet areas by providing a preferred flow path for soil moisture. The cuttings used in the drain sprout and grow while the drain continues to function to drain soil moisture. The photographs below show this drain 1 year and 14 years after installation.

**Photograph 5, 6 and 7.** Live pole drains provide drainage immediately and one year after installation (left). They continue to drain the slope 14 years after installation (right upper and lower) as well as creating habitat for later successional species to invade (right lower).

## ESTIMATED QUANTITIES AND COSTS

Wattle fences and live pole drains can be used to treat failing slopes in the Phase 1 test area. Table 1 lists the location, estimated quantities and expected costs for these treatments. Costs for bioengineering work range from about $20/linear meter to about $50/linear meter depending on the economic climate at the time. An estimated cost of $40/m is used for this study. However, this could change when the bids for the work are actually received from qualified contractors. In addition to the costs directly attributable to conducting the work, design and supervision would add an estimated 20% to the costs.

**TABLE 1**
**SUMMARY OF ESTIMATED BIOENGINEERING QUANTITIES AND COSTS**

| Site | Location (NAD 83) | Wattle Fences | | LPD | Estimated Costs |
|---|---|---|---|---|---|
| | | Lower | Upper | | |
| 1 | 10 U 474740 5372168 | 10 m | 40 m | | $2,000 |
| 2 | 10 U 474742 5372164 | 50 m | | | $2,000 |
| 3 | 10 U 474757 5372149 | 300 m | | | $12,000 |
| 4 | 10 U 474767 5372130 | 50 m | | 5 m | $2,200 |
| 5 | 10 U 474802 5372084 | | 30 m | 20 m | $2,000 |
| 6 | 10 U 474828 5372056 | 15 m | | | $600 |
| 7 | 10 U 474825 5372055 | 30 m | | | $1,200 |
| 8 | 10 U 474847 5372027 | 400 m | | | $16,000 |
| 9 | 10 U 474873 5371995 | 100 m | | | $4,000 |
| 10 | 10 U 474899 5371965 | 100 m | | | $4,000 |
| 11 | 10 U 474932 5371924 | 100 m | | | $4,000 |
| 12 | 10 U 474969 5371884 | 200 | | | $8,000 |
| 13 | 10 U 474993 5371863 | 250 m | | | $10,000 |
| Totals | | 1605 | 70 | 25 | $68,000 |

## CONCLUSIONS

Soil bioengineering could be an effective means of treating ravelling slopes on lower Mount Douglas once the erosion at the toe is addressed. The northwest orientation and the reasonable substrates combine to create relatively moist conditions that are ideal for a soil bioengineering solution. Successful treatment of comparable slopes at the University of British Columbia as well as in the adjacent Gordon Head area of Victoria suggests that treatment of the subject slopes will be similarly successful. Preparation of a simple tender and securing quotes from qualified contractors would be needed to determine accurate costs although the estimated costs given above are expected to be accurate. The work could be conducted in the fall and winter following the completion of shoreline protection work. Growth would be expected by the following summer. Soil bioengineering treatments will accord well with the park setting of this project.

## REFERENCES CITED


Gray, D.H. and A.T. Leiser. 1982. Biotechnical Slope Protection and Erosion Control. Van Nostrand Reinhold Company Inc. Scarborough, Ontario, 271 pp. (reprinted by Krieger Publishing Co. Malabar, Florida).

Green, R.N. and K. Klinka. 1994. A Field Guide to Site Identification and Interpretation for the Vancouver Forest Region. B.C. Ministry of Forests Research Program. Research Branch. Victoria, 285 pp.

Roemer, H. 1972. Forest vegetation and environments on the Saanich Peninsula, Vancouver Island. PhD thesis. University of Victoria, Victoria, BC. Canada.

Thurber Engineering Ltd. 2000. Mt. Douglas Park Slope Stability at the Railing, Assessment and Conceptual Stability Measures. Completed for the Corporation of the District of Saanich, August 28, 2000.

Yorath, C.J. and H.W. Nasmith. 1995. The Geology of Southern Vancouver Island, A Field Guide. Pacific Section, Geological Association of Canada. Orca Book Publishers. Victoria, B.C. Canada. 172 pp.

# MOUNT DOUGLAS PARK
## SHORELINE SLOPE RESTORATION SUGGESTIONS

PREPARED FOR:

PAUL WILSON
THURBER ENGINEERING LTD.
100, 4396 WEST SAANICH ROAD
VICTORIA BC V8Z 3E9

FAILURE OF THE RIP-RAP REVETMENT AT MOUNT DOUGLAS PARK HAS ALLOWED CONTINUED EROSION OF THE SHORELINE.

PREPARED BY:

DAVID POLSTER, M.SC., R.P. BIO.
POLSTER ENVIRONMENTAL SERVICES LTD.
6015 MARY STREET
DUNCAN, BC, V9L 2G5

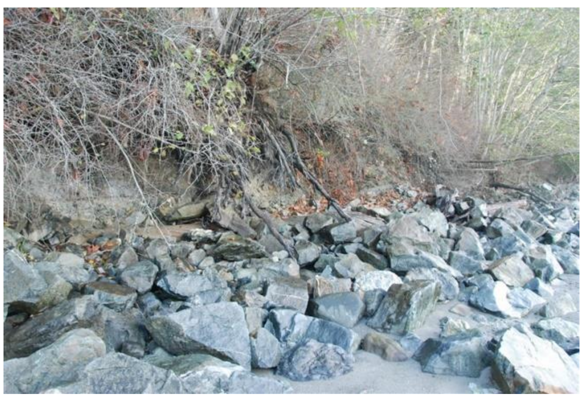
NOVEMBER, 2016

## 1.0 INTRODUCTION

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER 2004). Understanding how natural processes have restored degraded sites provides a useful first step in defining restoration treatments for sites humans have disturbed (Polster 2009). Natural shoreline protection systems have evolved over millions of years to protect coastal areas from excessive erosion. These systems have built-in mechanisms for maintenance as well as repair. This brief report presents strategies that could be applied along the coastal area of Mount Douglas Park as well as suggestions for the steep slope portions of the area that have resulted from the toe erosion.

## 2.0 SHORELINE AND STEEP SLOPE CONSIDERATIONS

The historic rip-rap shore protection that was installed along the beach at Mount Douglas Park is failing to protect the slope from erosion (Photograph 1) and has resulted in the active slumping of the Quadra sediments above (Photograph 2). The key to solving the slope problems is to provide an effective shoreline protection system.



**Photograph 1 & 2.** Failure of the rip-rap shore protection (left) has allowed continued erosion of the toe of the Quadra sediment slope (right). This has resulted in slumping of the slope.

Natural processes have been protecting shorelines for millions of years. The Beach Rye (*Leymus mollis* (Trin.) Pilg.) – Rotting Log shoreline ecosystem (Photograph 3) has evolved over millions of years to provide an effective protection against wave erosion. The rhizomes of the Beach Rye grow into the rotting logs, holding them in place, although with some flexibility maintained. As new logs arrive on the beach, if they are allowed to stay in place they will rot. Then the Beach Rye grows into these logs as well. In this manner the shoreline protection is maintained over the years as logs rot and new logs arrive. Beach Pea (*Lathyrus japonicus* Willd.) is a nitrogen fixing legume that is found in this ecosystem. It provides nitrogen for the Beach Rye and aids in the decomposition of the logs by providing nitrogen for fungi and micro-organisms involved in the breakdown of the logs. The Beach Rye – Rotting Log ecosystem maintains a protective barrier against shoreline erosion even on very active beaches such as on the West Coast of Vancouver Island.

**Photograph 3 & 4.** The natural Beach Rye – Rotting Log ecosystem (left) has been protecting shorelines for millions of years. The ecosystem can be established in coastal areas where wave erosion is a problem (right) such as on Keats Island. The planted Beach Rye is spreading along the logs in this case.

The Beach Rye – Rotting Log ecosystem can be established along non-rock shorelines in a variety of ways. The simplest way is to provide the logs and allow the Beach Rye to move in naturally. In some cases the Beach Rye will need to be planted (Photograph 4). Where Beach Rye is common along the shore it will move in quickly into the rotting log defences. Where shorelines rise steeply from the beach logs can be stacked to protect the shore (Photographs 5 and 6). Using vertical logs to hold the horizontal logs in place allows new logs and woody debris to be placed on top to maintain the Beach Rye – Rotting Log ecosystem in a natural way. New logs would naturally wash ashore on top of the old logs, maintaining the natural shoreline protection functions. Where vertical logs are used to hold the horizontal logs in place (Photographs 5 and 6) the new logs would need to be lifted into place.

**Photograph 5 & 6.** Rotting log walls can be used to protect shorelines where the foreshore rises steeply from the beach. This system shoreline protection system has been in place for many years.

The cost of establishing a Beach Rye – Rotting Log ecosystem to protect the shore system can be broken into the costs associated with the old logs and the cost of machine time to construct the system. In the case of the Mount Douglas shoreline there will be the added cost of moving the failing rip-rap rock from in front of the slope. Old boom logs can often be obtained for the cost of moving them from the booming ground (Photograph 7). The cost for a self-loading logging truck is about $140/hour. These trucks can haul about 25 old boom logs per load. Each log is about 20 m long and 50 cm in diameter. Three logs are suggested for each section of the shoreline treatment with one log on the bottom and two staggered above such as can be seen in Photograph 6. Each segment will cover about 20 m. Photograph 7 was taken at the Ladysmith Log Sort at the head of Ladysmith harbour. The roundtrip between the Mount Douglas area and Ladysmith harbour might take about 5 hours or cost about $700 for the truck. With 3 logs used on the shore, each truckload can carry about 165 m worth of shoreline protection so approximately 2.5 truckloads would be needed to treat the estimated 400 m of shoreline. Since there would be a need to have vertical logs as well, it is reasonable to assume that three loads of logs would be used for this project. The cost of trucking would be about $2,100. There would need to be some way to get the logs and equipment down to the shore so it might be better to consider using a landing barge for this operation. Barge costs are about $1,500/day. An excavator will be needed on the beach to manipulate the logs, remove the old rip-rap and construct the Beach Rye – Rotting Log system. A reasonably sized excavator might cost on the order of $1,500/day and the work might take about 5 days.


**Photograph 7 & 8.** Old boom logs are loaded from the booming ground scrap pile using a self-loading logging truck (left). Beach Rye can be easily planted in sandy soils installed with the old logs.

Beach Rye can be planted in the Beach Rye – Rotting Log shoreline systems (Photograph 8). Beach Rye plugs can be purchased for about $60 for a tray of 50 plants plus an equal amount for planting. Five plants can be planted along each meter of treated area so the cost of the Beach Rye would be on the order $5,000. Since these plants spread readily the number of plants that are needed for the treatment can be significantly less than the number that would be needed to cover the whole area.

The failing rip-rap can be moved off shore to provide a reef that will benefit near shore aquatic organisms. This can be done as the new system is installed so the added cost of removing the old rock will be minimal but might add about 25 percent to the cost of the excavator. Full removal of the old rock would be much more expensive. Permits will be needed to do the work on the beach and to move the rock away from the shore.

Treatment of the slopes above the beach (Photograph 2) can use soil bioengineering systems. Photographs 9 and 10 show a slope composed of Quadra sediments at the University of British Columbia that was treated using wattle fences over the winter of 1988/89. Wattle fences are short retaining walls built of living plant materials. These sprout and grow (Photograph 11) starting the successional process that eventually results in the initiation of a conifer forest on the slope (Photograph 12). Cost for treatment of the over-steepened slopes above the Mount Douglas Park beach would be about $50/m of wattle fencing. A slope such as the one shown in Photograph 2 would require about 15 rows of wattle fencing so a cost of $750 per meter of cliff would be experienced for this area. Careful measurement of all of the various scarps on this slope would be needed to determine a reasonable estimate of the cost of bioengineering on the slopes above the beach.

**Photograph 9 & 10.** Sand cliffs at the University of British Columbia (70°) were treated over the winter of 1988/89 (left). These sprout and grow into a cover of pioneering vegetation (right).

**Photograph 11 & 12.** Growth of the willows used in the wattle fences (left) starts the successional processes that will eventually result in a conifer forest on the slope (right).

## 3.0 CONCLUSIONS

Natural systems of shoreline protection and soil bioengineering treatments on the over-steepened portions of the slope above the beach can be used to treat the area along the Mount Douglas Park shoreline. The Beach Rye – Rotting Log ecosystem can be found throughout coastal areas of British Columbia. This natural shoreline protection system can be re-created by providing the elements of the system in areas where problems are occurring such as along the Mount Douglas Park shore. The over-steepened slopes above the shore can be treated using soil bioengineering systems. Methods have been developed to treat the Quadra sediment slopes that are commonly causing problems along Georgia Basin shorelines. By using natural restoration treatments the recovery methods will build resilient ecosystems that can be relied upon in the uncertain future.

### REFERENCES CITED

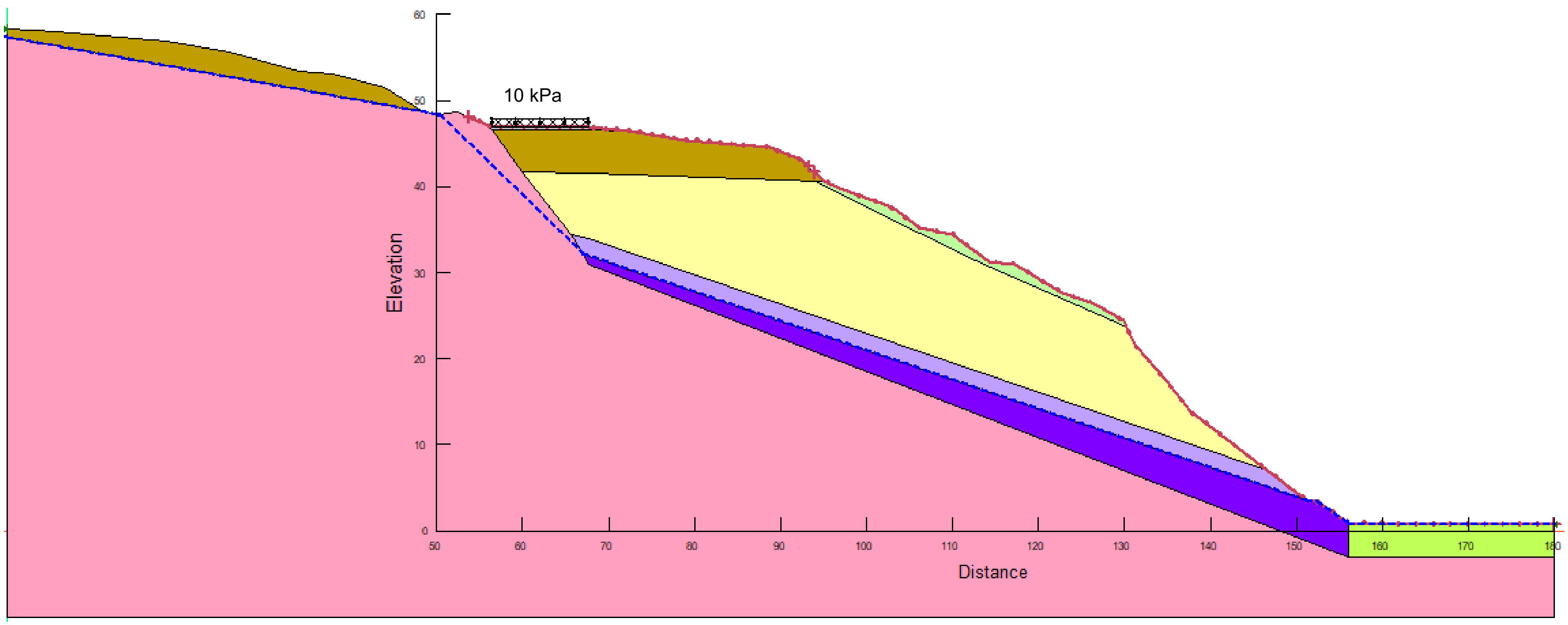

Polster, D.F. 2009. Natural Processes: The Application of Natural Systems for the Reclamation of Drastically Disturbed Sites. paper presented at the B.C. Technical and Research Committee on Reclamation, BC Mine Reclamation Symposium. Cranbrook, B.C. September 14-17, 2009.

Society for Ecological Restoration (SER). 2004. The SER Primer on Ecological Restoration. Version 2. October, 2004. Science and Policy Working Group, October, 2004. Society for Ecological Restoration International. Washington DC. accessed on January 24, 2014 (http://www.ser.org/resources/resources-detail-view/ser-international-primer-on-ecological-restoration).

**ATTACHMENT 3**

# Slope Stability Figures

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

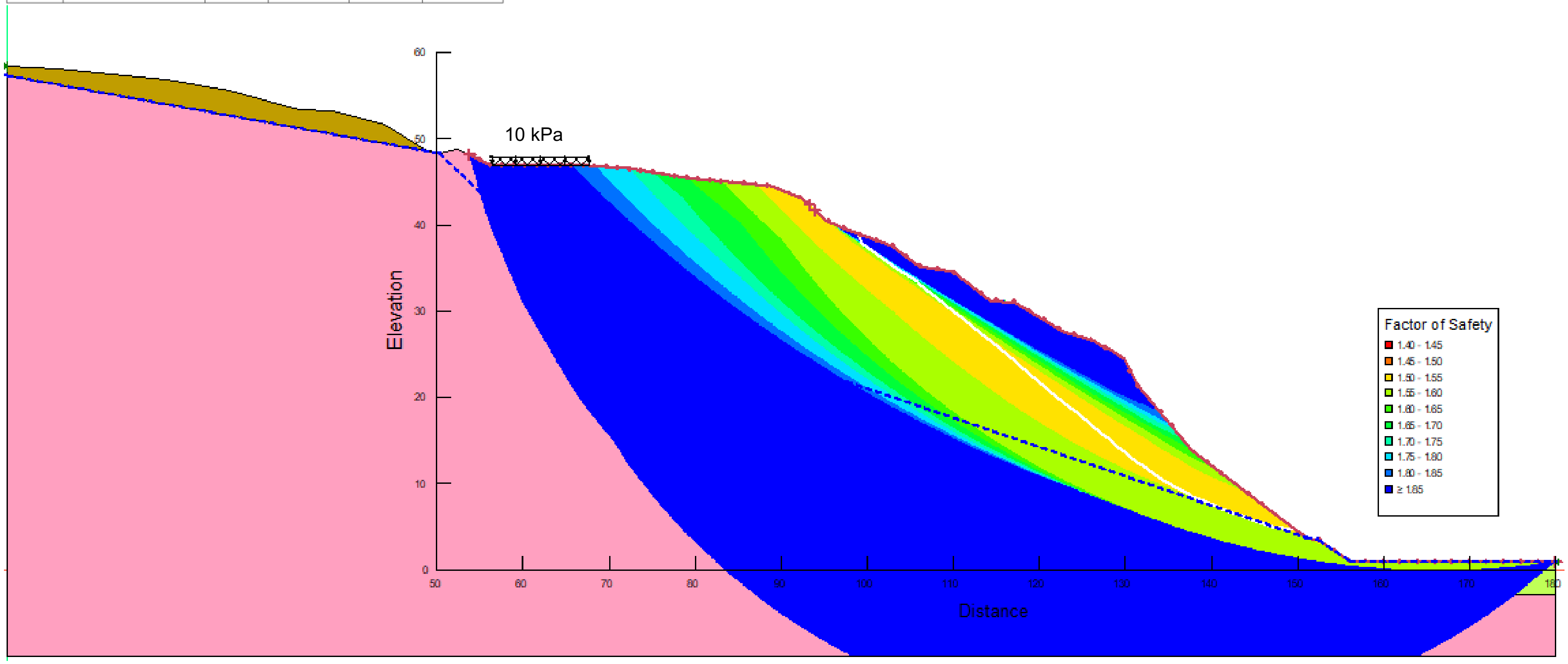
| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 9+70 – SECTION B**
**SLOPE STRATIGRAPHY**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C1** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
| --- | --- | --- | --- | --- | --- |
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |

1.40




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

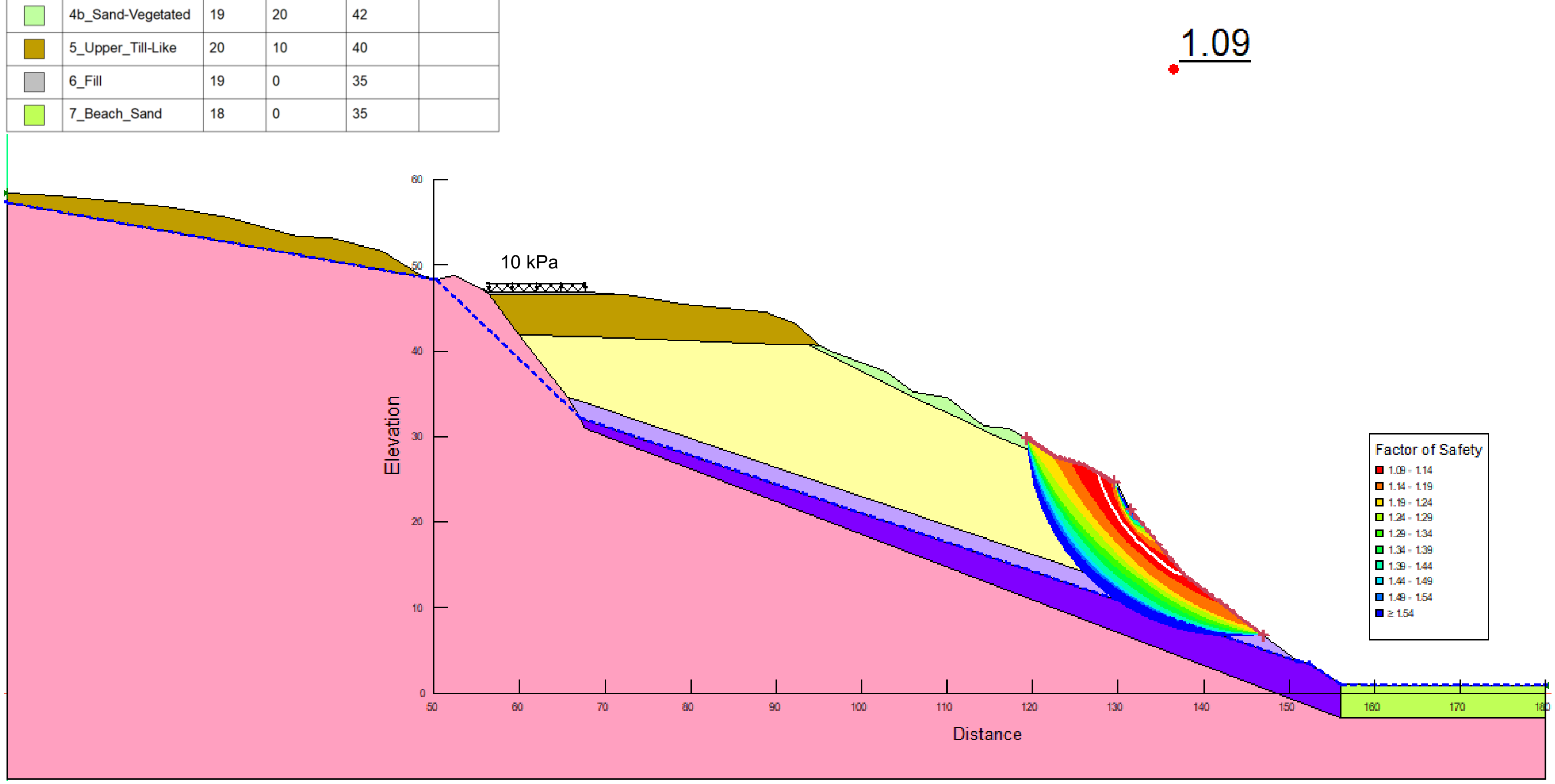
CONSULTANT

| | |
| --- | --- |
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 9+70 – SECTION B**
**GLOBAL SLOPE**

| PROJECT No. | PHASE | Rev | FIGURE |
| --- | --- | --- | --- |
| **1895826** | **2400/2401/029** | **0** | **C2** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

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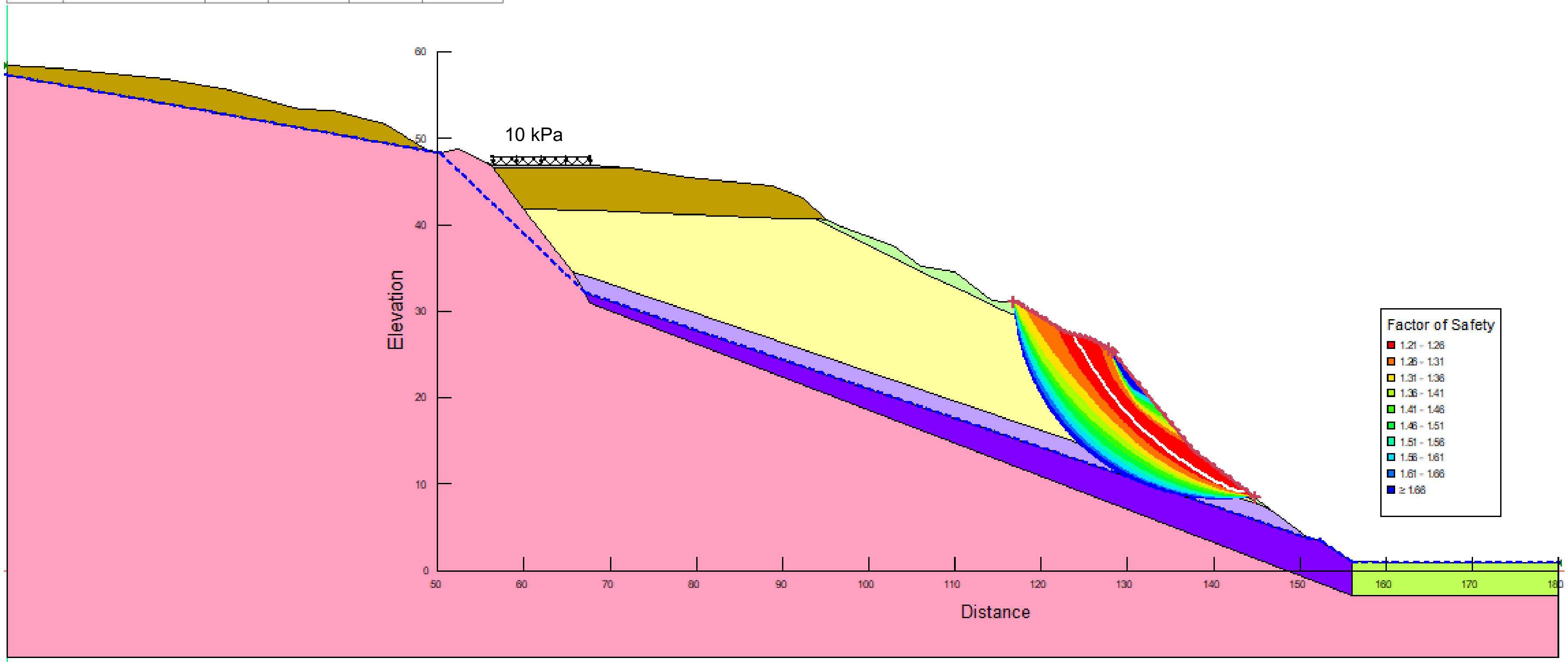
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 9+70 – SECTION B**
**SCARP**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C3** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

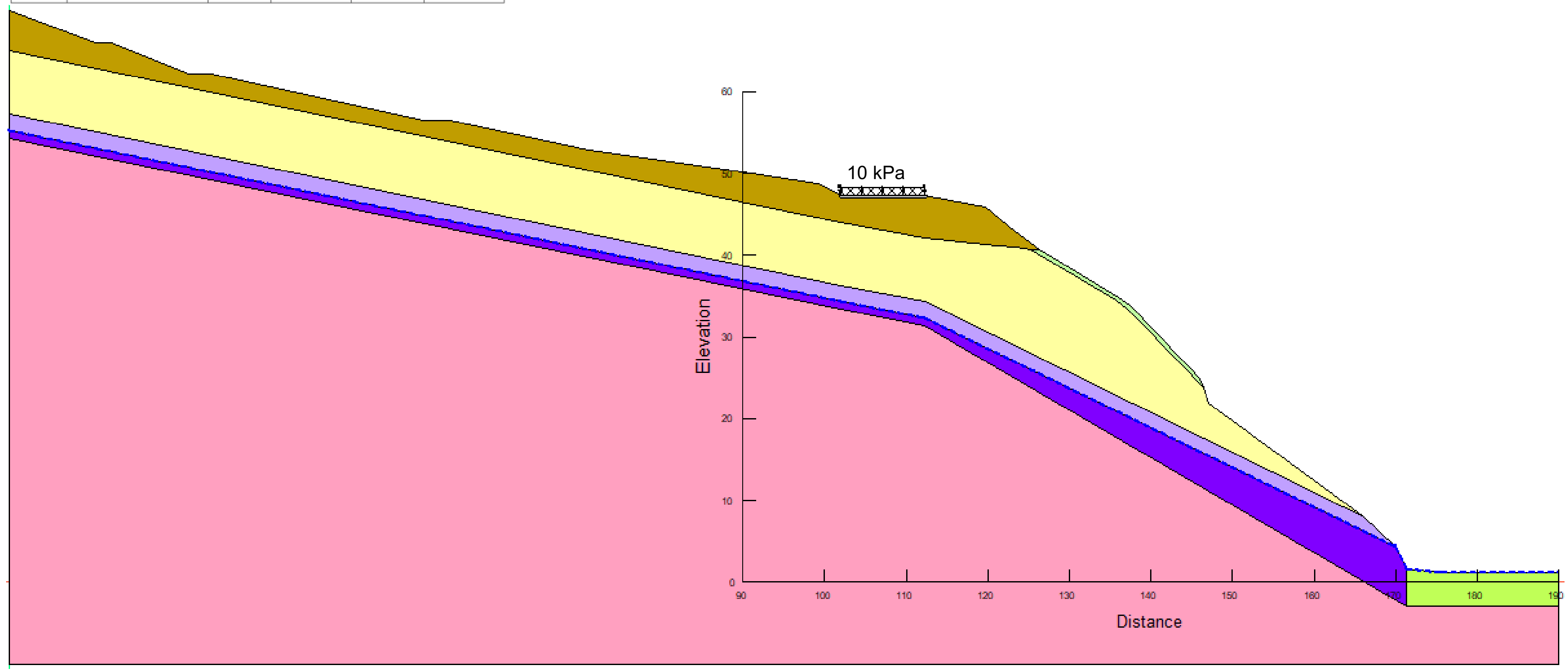
wsp

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 9+70 – SECTION B**
**SCARP WITH WATTLE FENCES**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C4** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

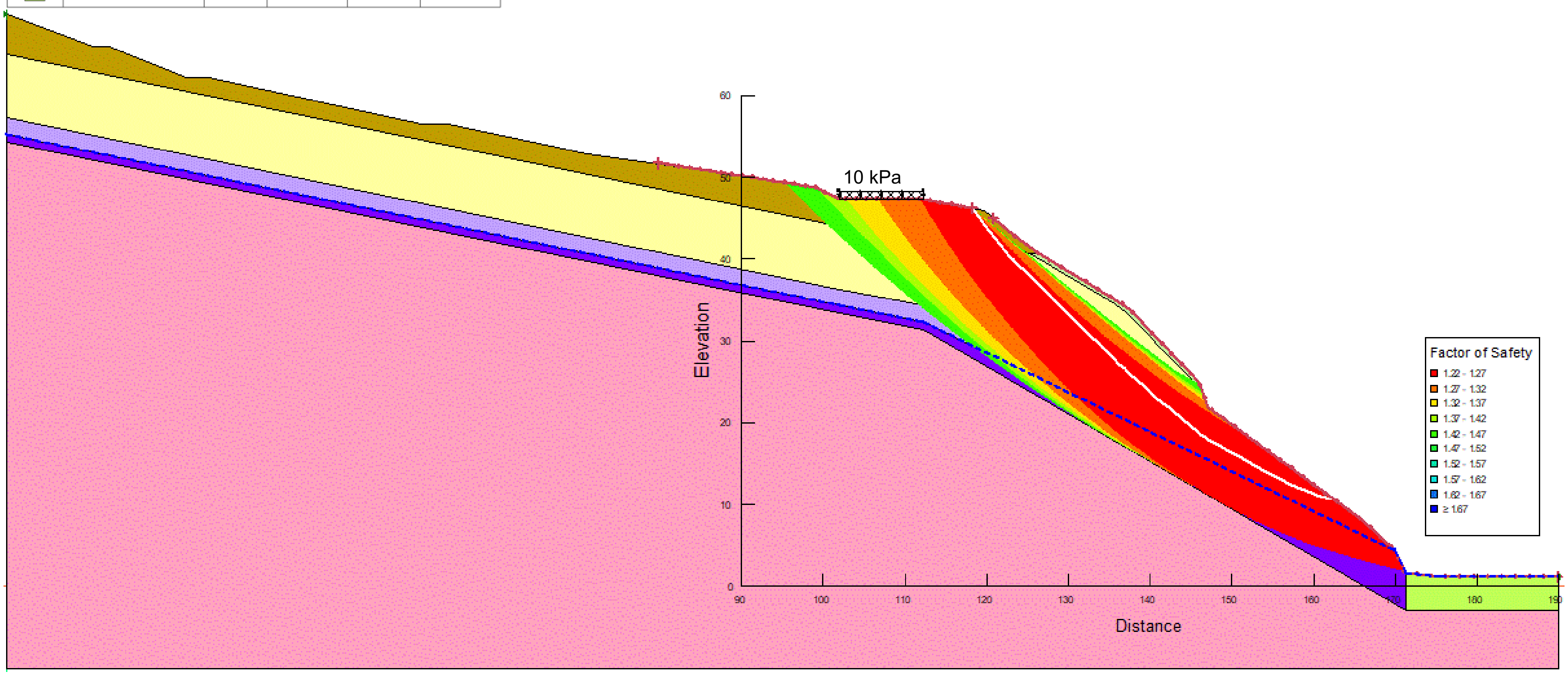
| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 11+80 – SECTION G**
**SLOPE STRATIGRAPHY**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C5** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
| --- | --- | --- | --- | --- | --- |
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |

1.22




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

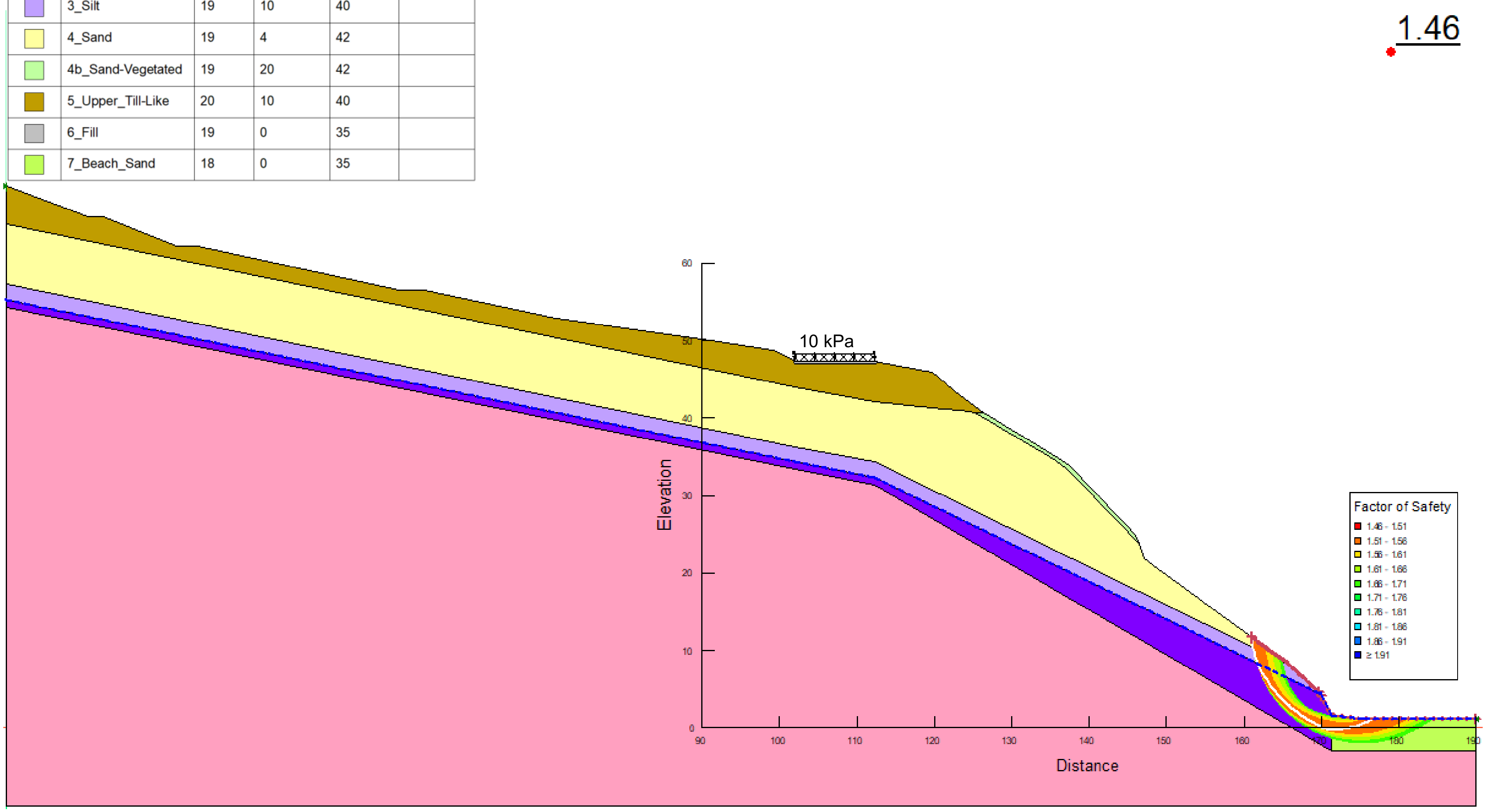
CONSULTANT

| | |
| --- | --- |
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 11+80 – SECTION G**
**GLOBAL SLOPE**

| PROJECT No. | PHASE | Rev | FIGURE |
| --- | --- | --- | --- |
| **1895826** | **2400/2401/029** | **0** | **C6** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

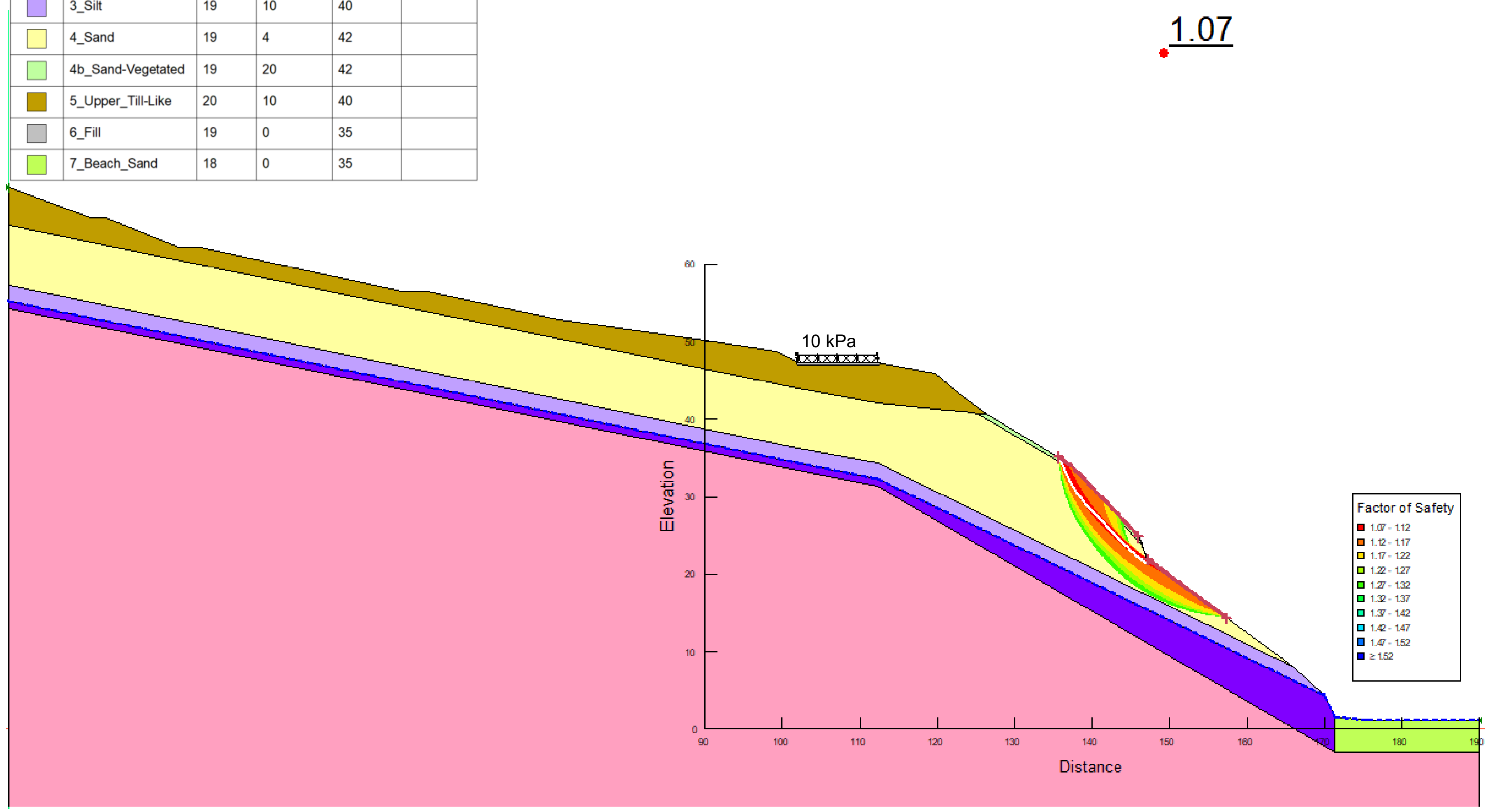
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 11+80 – SECTION G**
**SLOPE TOE**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C7** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

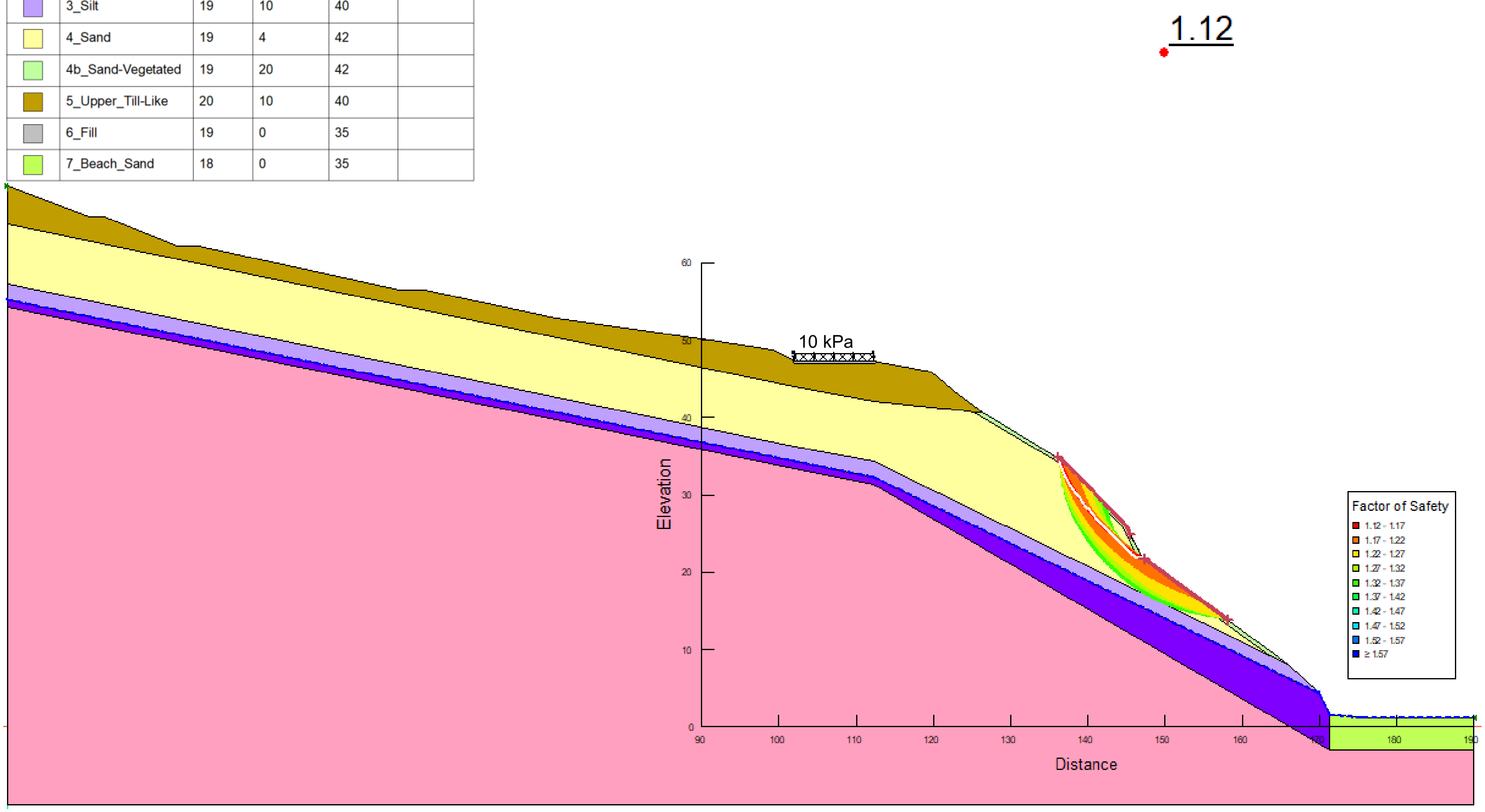
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 11+80 – SECTION G**
**SCARP**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C8** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

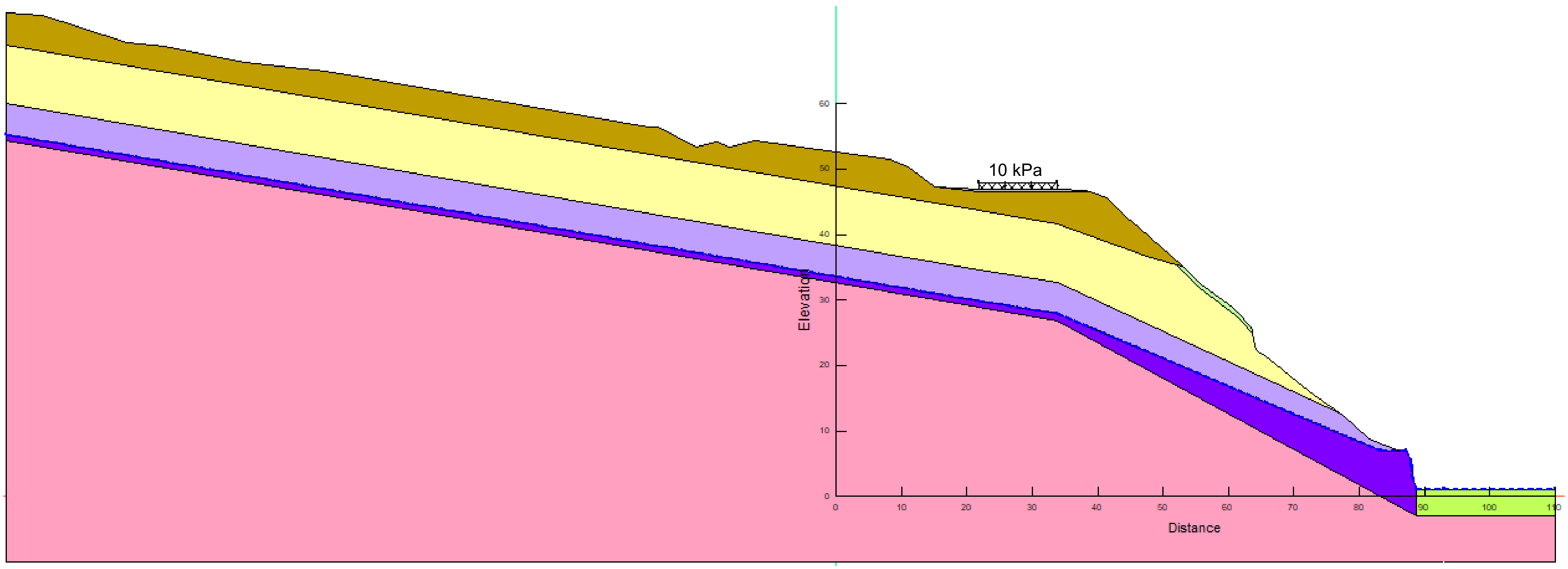
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 11+80 – SECTION G**
**SCARP WITH WATTLE FENCES**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C9** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

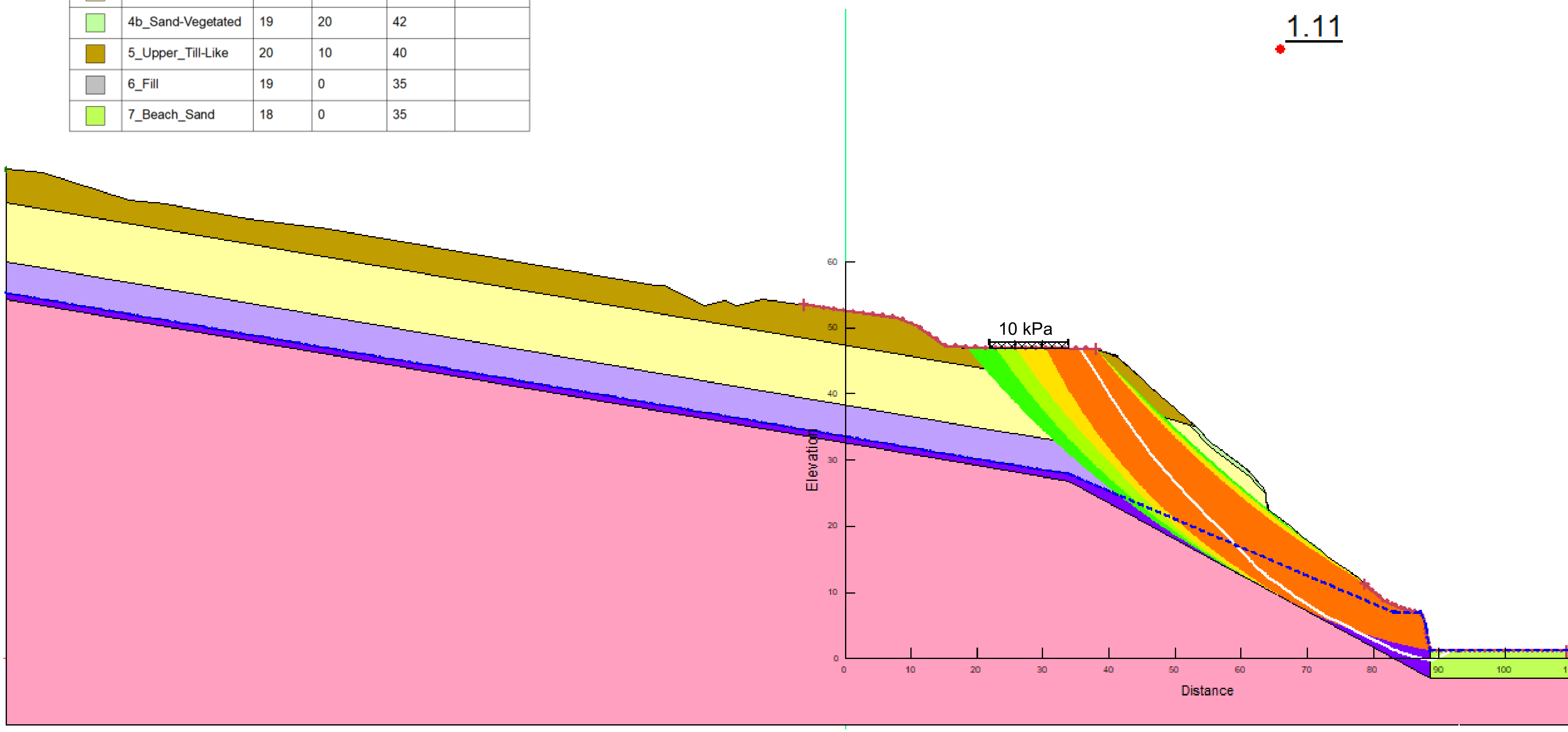
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 12+20 – SECTION I**
**SLOPE STRATIGRAPHY**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C10** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

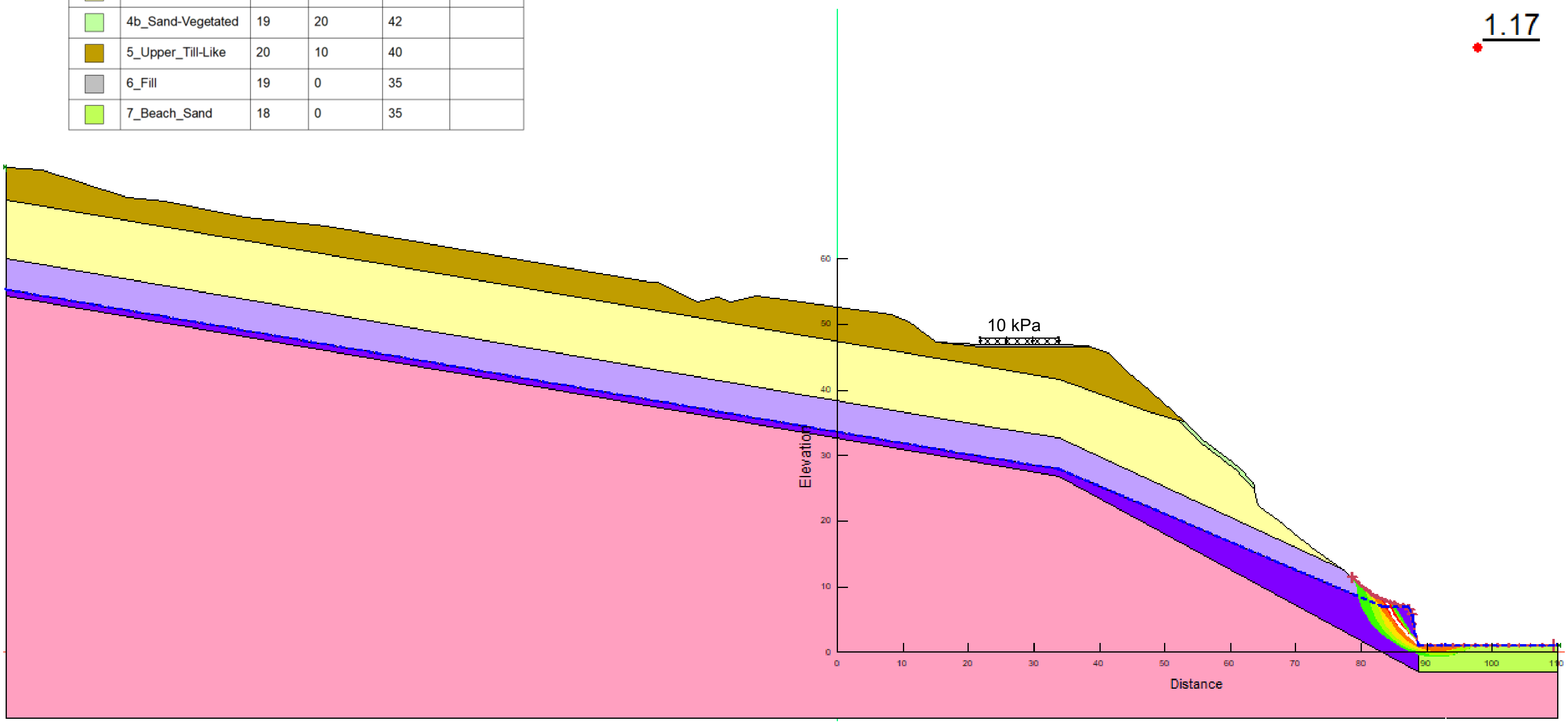
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 12+20 – SECTION I**
**GLOBAL SLOPE**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| 1895826 | 2400/2401/029 | 0 | C11 |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

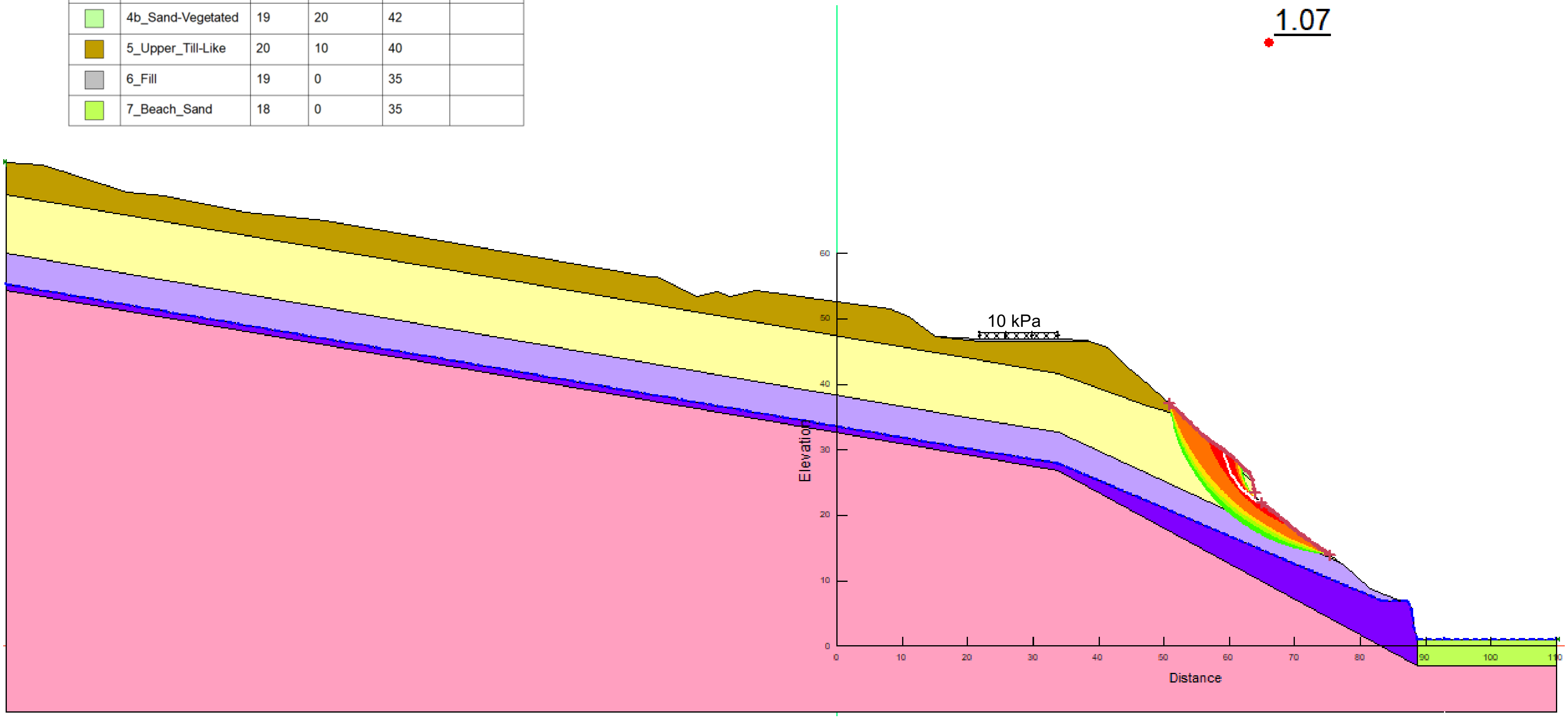
CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 12+20 – SECTION I**
**SLOPE TOE**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C12** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

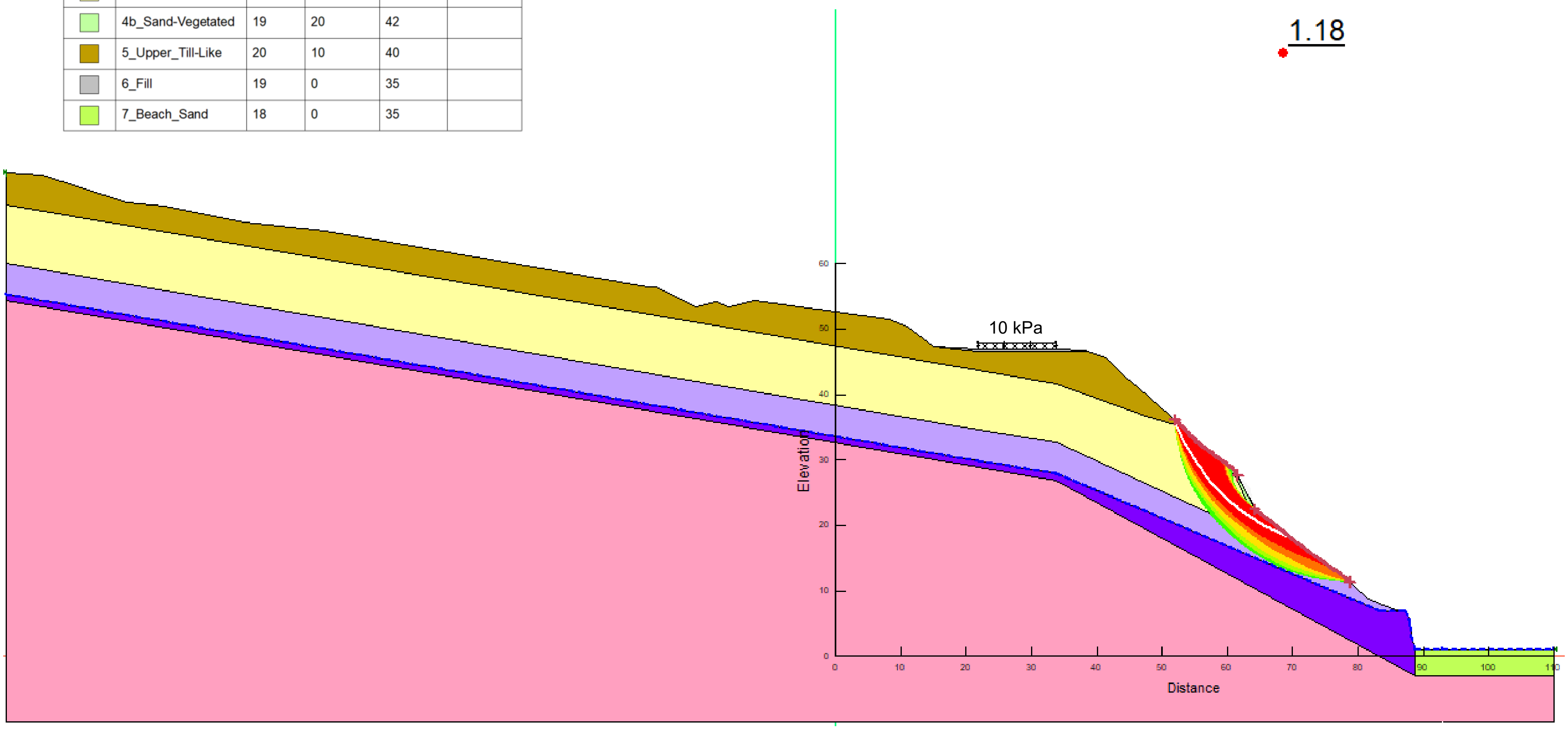
wsp

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 12+20 – SECTION I**
**SCARP**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C13** |

| Color | Name | Unit Weight (kN/m³) | Effective Cohesion (kPa) | Effective Friction Angle (°) | Total Cohesion (kPa) |
|---|---|---|---|---|---|
| | 1_Bedrock | 29 | | | 50,000 |
| | 2_Basal_Till-Like | 20 | 30 | 40 | |
| | 3_Silt | 19 | 10 | 40 | |
| | 4_Sand | 19 | 4 | 42 | |
| | 4b_Sand-Vegetated | 19 | 20 | 42 | |
| | 5_Upper_Till-Like | 20 | 10 | 40 | |
| | 6_Fill | 19 | 0 | 35 | |
| | 7_Beach_Sand | 18 | 0 | 35 | |




CLIENT
DISTRICT OF SAANICH

PROJECT
CORDOVA BAY ROAD IN PKOLS (MT DOUGLAS PARK)
BANK STABILIZATION

CONSULTANT

| | |
|---|---|
| YYYY-MM-DD | 2024-05-22 |
| PREPARED | MJN |
| DESIGN | MJN |
| REVIEW | RW |
| APPROVED | RW |

TITLE
**SLOPE STABILITY – SHORT-TERM REMEDIATION DESIGN**
**STATION 12+20 – SECTION I**
**SCARP WITH WATTLE FENCES**

| PROJECT No. | PHASE | Rev | FIGURE |
|---|---|---|---|
| **1895826** | **2400/2401/029** | **0** | **C14** |

**ATTACHMENT 4**

# Cost Estimate

# TECHNICAL MEMORANDUM

**DATE** August 16, 2024 **Reference No.** 1895826-003-TM-Rev0

**TO** District of Saanich

**CC**

**FROM** Todd McKay and Cameron Ofsoske **EMAIL** todd.mckay@wsp.com cameron.ofsoske@wsp.com

**SAANICH BANK STABILISATION – PKOLS (MOUNT DOUGLAS PARK)**

**BASIS OF ESTIMATE – CLASS 4 CONSTRUCTION COST ESTIMATE**

## 1.0 INTRODUCTION

The District of Saanich has engaged WSP Canada Inc. (WSP) to provide engineering support services including the development of detailed designs and a supporting Class 4 cost estimate for the construction of erosion control measures to help mitigate erosion along a section of Bluff adjacent to the Cordova Bay Road, in PKOLS (Mount Douglas Park). The park includes approximately 1 km of shoreline characterized by high eroding bluffs, with gravel and cobble beaches and limited protection at the toe of the bluffs. Cordova Bay Road is located at the top of the bluffs and closely borders the bluff crests, particularly in the northern portion of the site.

WSP has prepared this Basis of Estimate (BOE) to provide a brief overview of the elements of the estimate, including key assumptions and limitations considered during the development of the estimate. It is understood that the cost estimate may be used by the District of Saanich to support project planning budget approvals and for other project purposes.

## 2.0 PROJECT UNDERSTANDING

It is understood that the slope stabilization design will include the installation of approximately 4,200 lineal meters of wattle fencing to address and reinforce the slope from the actively receding bluffs which are understood to threaten Cordova Bay Road at the top of the bluffs.

The scope of work for the slope stabilization includes the following tasks:

- Mobilization and demobilization of labour, equipment, and materials.
- Installation of wattle fencing.

## 3.0 DESIGN BASIS

The cost estimate has been prepared based on reports and design information produced by WSP. The following documents form the design basis that was used for the slope stabilization cost estimate:

- WSP Canada Inc. - CX22511862-001-P-Rev3-DoS Saanich Bank Stability Mt Doug Park 18NOV_22
- WSP Canada Inc. - 1895826-2300-2301-029_Rev A

# 4.0 ESTIMATE CLASSIFICATION

The cost estimate has been developed following a Class 4 cost estimating methodology in general accordance with the Association for the Advancement of Cost Engineering International (AACEI) Recommended Practice No. 17R-97: Cost Estimate Classification System – Cost Estimating and Budgeting (AACE International, 2019). Class 4 estimates are generally prepared based on conceptual level designs and supporting project information with the level of project definition typically at 1% to 15% complete, although designs may be at a further level of development.

The level of accuracy for the slope stabilisation estimate has been developed based on achieving a Class 4 target level of accuracy of -30% to +50% of the actual contract award price for construction, after the application of contingency; however, this level of accuracy is often influenced by many factors, including the state of construction complexity, number of bidders, market conditions, project location, schedule constraints, etc., which can markedly affect this range.

Class 4 estimates are generally developed using a semi-detailed assembly of cost items and are based on outline specifications and project requirements across most divisions of the work, and typically include semi-detailed labour, equipment, and material cost build-ups.

# 5.0 ESTIMATING METHODOLOGY

The estimating methodology used during the development of the cost estimate has generally been prepared following a deterministic estimating methodology where the properties are well known and are able to be fully determined, i.e., measurement of units multiplied by unit costs or factors. The following methodology has generally been followed during the development of the estimate:

- Preparation of a list of work breakdown items based on the provided quantities and details obtained from the design drawings, specifications, and available project information with assembly of the base estimate using HCSS HeavyBid™ estimating software.
- Assignment of resources to the major cost and work breakdown items with anticipated production rates developed based on the estimator’s judgement, past project performance reference data, historical productivities, in addition to estimated production calculations from HCSS HeavyBid™ estimating software and other productivity data.
- Costs for the major work items have been developed as a bottom-up, crew-based, detailed cost model. The crews required to perform the majority of the various work items have been built-up using a first principles approach, to develop hourly or unit rates. Inclusion of support equipment within a crew has been determined on a per activity basis.
- Direct costs and indirect cost items are differentiated. Construction related indirect costs have been developed based on actual construction requirements and project durations and have been spread across all relevant direct cost work items.

# 6.0 PLANNING BASIS

The cost estimate was developed assuming a Contractor originating from the Victoria, British Columbia area would undertake the slope stabilisation works. It was assumed that the scope of work would be contracted out as a single contract and would be completed over a single construction period.

The labour hours and production rates are based on performing the work during spring, summer, or fall weather conditions with typical working hours based on a 5-day work week.

The following summarizes the anticipated work schedule carried in the estimate:

- Working schedule of 5 days per week at 10 hrs per day.
- Production rates based on a 50 min hour (83% production efficiency) to allow for crew start-up, breaks, and shutdown periods.
- Crew travel time to and from site at 0.75 hours per shift.

Based on the scope of work and anticipated crew productivities the slope stabilization works were estimated to be performed over an approximate 8-week period.

# 7.0 COST BASIS

A number of cost factors for productivity, equipment, labour and materials were used. The following forms the basis used in the development of the estimate:

## Labour Rates

Contractor direct and indirect labour rates used in the estimate have been based on average contractor rates expected from contractors with experience similar types of work. The base rates carried in the estimate assume a non-unionised workforce. Overtime premiums for site-based staff have been calculated based on a premium for working a five (5) day work week at ten (10) hours per day and have been applied as an overtime factor to the labour rate on a per task basis.

## Equipment Rates

Equipment rates have been based on current published British Columbia 2024 Equipment Rental Rate Guide (BC Blue Book), with rates cross-referenced against recent rates from contractors who have experience with similar type civil works, to develop hourly equipment pricing. The unit rates used for equipment pricing are inclusive of fuel, maintenance, and insurance costs.

### Material Pricing

Material elements that form part of the anticipated scope of work have been based on recent supplier quotes, vendor discussions, or from WSP's quote database to provide inferred pricing for material elements that form part of the anticipated scope of work.

Typical contractor mark-up on permanent and construction material supply to site has been carried at 15%.

### Indirect Costs

Indirect costs are defined as those cost that cannot be readily traced back to a specific activity (e.g., direct cost items), and typically includes aspects such as temporary facilities and services, insurance, management services, site supervision and oversight, and consumables associated with direct costs.

Indirect costs have been included in the estimate and have been included as a breakout general cost item.

### Escalation

All pricing dollars presented in the estimate are based on 2024 Canadian Dollars. No escalation has been included in the cost estimate.

### Insurance

Contractor general liability insurance and automobile liability insurance has been included as part of the overall contractor equipment and labour rates. Project specific insurance such as builder's risk / course of construction, wrap up insurance, or other umbrella coverages have not been included in the presented estimates.

### Contract Security

Contract security has been included in the estimate and has been based on the provision of a 50/50 performance, labour, and materials payment bond. Bonding has been carried in the estimate at a rate of $8.00/$1,000.00 of the contract amount.

# 8.0 ASSUMPTIONS AND EXCLUSIONS

## 8.1 Assumptions

The following assumptions have been made during the development of the estimate, as follows:

- Mobilization and demobilization costs have been estimated based on an environmental contractor mobilizing to site from the Victoria area with the works being completed over a continuous period.
- It has been assumed that materials will be taken down to the work areas from the crest of the road. No costs have been included for obtaining beach access for any machinery.

- Costs associated with measures related to specific environmental regulatory requirements and/or authorizations, plans and designs that may be required for this work have not been included within this estimate.
- It has been assumed that there will be reasonable market availability of suitable and competent environmental contractors to provide a competitive bidding environment.

## 8.2 Exclusions

During development of the cost estimate the following items have been specifically excluded from the overall cost estimate, as follows:

- No costs have been included for any wildlife and/or bird nest sweeps prior to any site activities that may be needed within this estimate.
- No costs have been included for planting vegetation within the work areas.
- No costs have been included for any temporary fencing that may be required.
- Engineering investigations, designs, or engineering field services during construction.
- Owner's costs including 3rd party Construction Management services or costs associated with District of Saanich site and office-based personnel and staff.
- Obtaining any permits, authorizations or permissions to undertake the work. It has been assumed that all required permits will be obtained by others.
- Excluding Federal and Provincial taxes and duties.

# 9.0 CONTINGENCY

Contingency is a cost element used to cover the uncertainty and variability within a cost estimate, and for unforeseeable elements of cost within the defined project scope. The contingency amount has been added to the original derived point estimate to achieve a given probability of not overrunning the estimated cost.

Contingencies for risk are generally an aggregate value made up of risks which may increase costs, or opportunities which may reduce costs. Most items in a cost estimate will demonstrate some measure of variation, usually to the high side where the probability of overrun is higher than the probability of underrun.

Based on the scope and nature of the work WSP has identified the following items as having the greatest potential of impacting costs due to variation in quantities and execution including, but not limited to the following:

- Variations in material types and for unforeseen ground conditions during the works.
- Site constraints and challenging access requirements.
- Working alongside public roads and access ways.
- Weather conditions and seasonal variations including potential for weather delays.

Based on the overall scope of work and the potential for unforeseen cost elements related to the slope stabilization works WSP suggests a **contingency allowance of 20%** to cover any project variabilities.

# 10.0 OPINION OF PROBABLE COST

The slope stabilization cost estimate has been developed based on the scope, cost estimate basis, assumptions and exclusions outlined in this document. Actual costs may vary from those presented in the estimate.

The following table presents the opinion of probable costs.

**Table 1: Opinion of Probable Cost**

| Item | Description | Total |
|---|---|---|
| 01 | Contractor Mobilization/Demobilization | $6,208 |
| 02 | Wattle Fencing Supply and Install | $548,730 |
| 03 | Construction Facilities | $11,898 |
| 04 | Site Supervision | $56,098 |
| 05 | Office Management | $63,865 |
| 06 | Traffic Control | $25,544 |
| | **SUB-TOTAL EXCLUDING CONTINGENCY** | **$712,343** |
| | Suggested Contingency Allowance @ 20% | 142,468 |
| | **TOTAL ESTIMATED COSTS INCLUDING CONTINGENCY[(a)]** | **$854,811** |
| | **Accuracy Range Low (-30%)** | **$598,368** |
| | **Accuracy Range High (+50%)** | **$1,282,216** |

(a) Excluding Federal and Provincial Taxes

A detailed summary of the cost estimate is provided in Attachment 1.

# 11.0 CLOSURE

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

**WSP Canada Inc.**

Todd McKay
*Construction Estimator*

Cameron Ofsoske, CEC
*Operations Manager*

TM/CO/cdg

Attachments: Attachment 1 – Estimate Summary

https://wsponline.sharepoint.com/sites/ca-eeasestimating/shared documents/wp/3.0 issued/1895826-003-tm-rev0/1895826-003-tm-rev0-saanich bank stability_mt doug park_basis of estimate_class 4-16aug_24.docx

**ATTACHMENT 1**

# Estimate Summary

# Estimate Summary - Costs and Prices

WSP Canada Inc. 44147 McKay, Todd 

1895826 Saanich Slope Stabilization - Class 4 5/21/2024 2:36 PM

## Direct Biditems

| | | | | | | | | | | | | | Balanced Bid (TO) | | Bid Prices | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manhours | Labor | Perm Materials | Const Materials | Equipment | Subs | O.D.C. | Cont/Allwn | Other | Direct Total | Indirect Charge | Addon Bond | Total Cost | Markup | Total | Markup | Total |
| **100 - Mobilization and De-Mobilization** | | | | **1 LS** | | | | | | | | | | | | |
| 70 | 4,422 | | | 900 | | | | | 5,322 | 33 | 49 | 5,405 | 803 | 6,208.02 | 803 | 6,208.02 |
| 70.00 | | | | | | | | | | | | 5,404.72 | 14.86% | 6,208.02 | 14.86% | 6,208.02 |
| **400 - Wattle Fencing Supply and Install** | | | | **4,200 LM** | | | | | | | | | | | | |
| | | | 470,400 | | | | | | 470,400 | 2,946 | 4,365 | 477,711 | 71,002 | 548,713.11 | 71,019 | 548,730.00 |
| | | | | | | | | | | | | 113.74 | 14.86% | 130.65 | 14.87% | 130.65 |
| **1001 - Construction Facilities** | | | | **2 MO** | | | | | | | | | | | | |
| | | | 10,200 | | | | | | 10,200 | 64 | 95 | 10,359 | 1,540 | 11,898.11 | 1,540 | 11,898.12 |
| | | | | | | | | | | | | 5,179.27 | 14.86% | 5,949.06 | 14.86% | 5,949.06 |
| **1002 - Site Supervision** | | | | **2 MO** | | | | | | | | | | | | |
| 453 | 40,892 | | | 7,200 | | | | | 48,092 | 301 | 446 | 48,839 | 7,259 | 56,098.00 | 7,259 | 56,098.00 |
| 226.68 | | | | | | | | | | | | 24,419.54 | 14.86% | 28,049.00 | 14.86% | 28,049.00 |
| **1003 - Office Management** | | | | **2 MO** | | | | | | | | | | | | |
| 338 | 54,750 | | | | | | | | 54,750 | 343 | 508 | 55,601 | 8,264 | 63,864.89 | 8,264 | 63,864.90 |
| 168.75 | | | | | | | | | | | | 27,800.48 | 14.86% | 31,932.45 | 14.86% | 31,932.45 |
| **1004 - Traffic Control** | | | | **2 WKS** | | | | | | | | | | | | |
| | | | | | 21,898 | | | | 21,898 | 137 | 203 | 22,238 | 3,305 | 25,543.62 | 3,305 | 25,543.62 |
| | | | | | | | | | | | | 11,119.18 | 14.86% | 12,771.81 | 14.86% | 12,771.81 |
| **Direct Totals** | | | | | | | | | | | | | | | | |
| **861** | **100,064** | | **480,600** | **8,100** | **21,898** | | | | **610,662** | **3,825** | **5,666** | **620,153** | **92,173** | **712,326** | **92,190** | **712,343** |

## Indirect Charges

| MHs | Labor | Perm Materials | Const Materials | Equipment | Subcontract | Total |
|---|---|---|---|---|---|---|

| MHs | Labor | Perm Materials | Const Materials | Equipment | Subcontract | Total |
|---|---|---|---|---|---|---|
| 9999 - Indirect Costs / General Conditions | | | | | | |
| | - | - | - | 3,825 | - | 3,825 |
| **Indirect Totals** | | | | | | |
| | **-** | **-** | **-** | **3,825** | **-** | **3,825** |

## Addon/Bond

| Additional Cost | | Addon/Bond Cost |
|---|---|---|
| Lump Sum + or - to Bid Value | 0 % of LS | - |
| Bond from Summary Table | | 5,666 |
| **Totals from Addon and Bond** | | |
| | | **5,666** |

## Summary Information

**Last Summary:** 5/21/2024 2:33:00 PM

**Last Spread:** 5/21/2024 2:33:00 PM