McElhanney

BEST MANAGED COMPANIES CANADA

Tree Risk Assessment, & Cultural Modified Trees Identification, Initial Data Collection and Reporting Gulf Islands National Park Reserve of Canada

Canal Road

Pender Island, B.C.

2022-04-11 | Revision #0

Submitted to: Ministry of Transportation and Infrastructure Contract: 851 CS 1013A
Prepared by: McElhanney

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Our Passion.

Revision	Description	Date (YYYY-MM-DD)	Issued By	Reviewed By
0	Original	2022-04-11	LS	JP

Contents

Appendices

1. Introduction & Project Understanding

McElhanney Ltd. was asked to complete an initial Tree Risk Assessment and a Cultural Modified Trees (CMT) Identification for an approximate 2.5 hectares of a natural forested area located upslope (South) of the Canal Road on South Pender Island, B.C (see Figure 1).

During my March 22nd, 2022, site visit, and in conjunction with the inventory, trees were assessed for risk, on a limited visual assessment basis. This initial Tree Risk Assessment was completed using the "Parks and Recreation Sites" module standards before the active construction begins. For the construction phase and after the removal of the forest cover the new created forest edge shall be assessed for safety at that time and using the "Forest Harvesting and Silviculture Module".
The initial Cultural Modified Trees Assessment was completed using the Culturally Modified Trees of British Columbia A Handbook.

This assignment is designed to support the upslope realignment and emergency recovery of the Canal Road due to a potential landslide. The pavement cracks are benign monitored and the traffic on this section of Canal Road is restricted to one lane alternate, one car only at the time (see Figure 2). This potential landslide and the pavement cracks are located near the Gulf Islands National Park Reserve of Canada boundary (latitude: 48.75938; longitude: -123.22617), but the proposed road realignment location is inside the park boundary and into a private lot to the West.

The proposed construction works will include forest cover removal, rock basting, excavations, soil grading and construction of the new section of the Canal Road. Timber cruising of the stand volume proposed for removal is not included in this assignment.

Figure 1. Canal Road on South Pender Island, BC with area of interest outlined in red (Google Image - North oriented, not to scale).

Figure 2. Canal Road on South Pender Island, BC - image of the longitudinal pavement crack and steep terrain above the road (view from the West to the East).

2. Definitions

- **DBH** – diameter at breast height. The diameter of trunk measured to the nearest centimetre at 1.4 metres above ground level.
- **Dripline** – Indicates the radius of the crown spread, measured in metres, from the centre of the tree to the dripline of the longest limbs.
- **Dangerous tree** – "means a tree that is a hazard to a worker due to its location or lean, its physical, damage, overhead conditions, deterioration of its limbs, stem or root system, or any combination of these conditions."
- **Suspect trees –** "are any live or dead tree with a visible defect which could cause failure of the tree, either whole or in part, for the applicable level of disturbance."

Definitions are as per Wildlife/Dangerous Tree Assessor's Course Workbook, Parks & Recreation Site Course Module Updated January 2019, Ministry of Environment & Climate Change Strategy.

Descriptive information for each identified tree is recorded in the tree inventory table (*Table 1*). The locations and retention/removal recommendation for each assessed tree is detailed on the attached tree retention/removal plan in *Appendix A*.

3. Tree Inventory Methodology

Tree Risk Rating: For the purpose of this report, the tree size, tree structural condition, tree class and activity level of disturbance (LOD) were assessed and recorded in the tree inventory. Based on these characteristics and the Wildlife/Dangerous Tree Assessor's Course Workbook criteria an overall risk rating and management action were assigned to each assessed tree.

For ease of identification in the field, orange timber mark paint and blue ribbon were used to each tree (see tree photos). Each tree was visually examined on a limited visual assessment basis. The following information was included in the tree inventory table (*Table 1*).

- Tree ID Tag #
- Tree location
- Onsite / Offsite"
- Species, Common Name and Botanical Name
- DBH (cm), Crown Radious (m), Est. Ht (m)
- Wildlife value (L, M, H)", Wildlife Use
- Heritage tree
- Distance to target (m)
- Decay Class Tree, Level of Disturbance (LOD)
- Insecurely Lodged or Hung-up Limbs / Tops, Highly Unstable Tree
- Tree Defects Comments
- Management Action Retain / Remove

Cultural Modified Trees: Using the Culturally Modified Trees of British Columbia Handbook specification, a walkthrough of the assessment area was completed for a Level I CMT Recording which includes CMT location, type, and frequency. As per Culturally Modified Trees Guidelines, Level I record is appropriate for preliminary investigation and inventories with the following steps:

- Pre-field Assessment and Permit Applications
    - Regional Archaeological Overview Assessments (AOAs), which may include predictive modeling
    - CMT modeling
    - Previous archaeological assessments.
    - Forest-stand data
    - Orthophotography demonstrating previous disturbances.
- Identification
- Recording
- Survey Sampling and Field Collection and
- Reporting

All construction activities requiring blasting, excavation or grade changes within the Critical Root Zone (CRZ) of retained trees shall be supervised by the project forester/arborist, and any root pruning required shall be performed by the project forester/arborist. The construction impact of the tree's overall health and/or structural condition for each subject tree will be based on the professional opinion of the project forester/arborist. The factors considered in the impact rating include but are not limited to:

- Quantity of root volume removed versus overall root volume (estimated by species, age, size, soil condition).
- Tree species, age, size, and existing condition.
- Previous root pruning/removals associated with historic construction activities.
- Pre-existing condition factors such as decay, pruning, leans, stress indicators, etc.
- Quantity and quality of the rooting space.

Figure 3. Spotted areas with old growth characteristics were identified.

Table 1. Tree Inventory – before construction phase for both Tree Assessment Areas "A" and "B".

Tree ID #	Tree location Onsite / Offsite	Species Common Name	Species Botanical Name	DBH (cm)	Crown Radious (m)	Est. Ht (m)	Wildlife value (L, M, H)	Wildlife Use	Heritage tree	Target / Distance (m)	Decay Class Tree	Level of Disturbance (LOD)	Insecurely Lodged or Hung - up Limbs / Tops	Highly Unstable Tree	Tree Defects	Comments	Danger / Safe (for recorded LOD)	Management Action Retain / Remove
1	Onsite B	Western redcedar	*Thuja plicata*	32	N/A	14	L	Feeding	No	Assessment area	4	Very low risk	No	No	Dead tree	Tree located at the western boundary	Safe	**No action required / Retain**
2	Onsite A	Douglas fir	*Pseudotsuga menziesii*	30	3	12	L	Feeding	No	Assessment area and Road / 6m	2	2	No	No	Tree lean Dislocated root plate	Tree rooted on the shallow soils on top of the rock. Tree leaning N on near tree over the road	Danger	**Remove**
3	Onsite B	Douglas fir	*Pseudotsuga menziesii*	42	N/A	24	M	Feeding	No	Assessment area	5	Very low risk	No	Yes	Tree lean Decayed roots	Tree is leaning SW on the adjacent tree. Despite the "very low risk" LOD, we recommend removal concurrent with tree #2.	Danger	**Remove**
4	Onsite B	Douglas fir	*Pseudotsuga menziesii*	58	N/A	16	H	Feeding Perching	No	Assessment area	6	Very low risk	No	No	Broken and missing top Dead limbs Fungal fruiting bodies	This tree has a high value wildlife value and can be retained until stand removal.	Safe	**No action required / Retain**
5	Onsite B	Douglas fir	*Pseudotsuga menziesii*	48	5	26	M	Perching	No	Assessment area	2	Very low risk	No	No	Tree lean	Tree rooted in the rock with and associated of phototropic and unstable terrain 60 % lean W but corrected and live appears stable now.	Safe	**No action required / Retain**
6	Onsite A+B	Western redcedar	*Thuja plicata*	48	4	24	L	Perching	No	Assessment area	2	Very low risk	No	No	Tree leans and partially dislocated root plate	Tree rooted in the shallow soil and associated of phototropic and unstable terrain 60 % lean NE but corrected and live appears stable now.	Safe	**No action required / Retain**

NOTES:

- Subject trees were marked with orange timber marking paint and with blue ribbon attached around the lower trunk.
- Identified trees were triangulated for their location by the project forester and were not legally surveyed

4. Site Information

The subject site that is approximately 2.5 hectares in size consists of a second growth natural regenerated forest stand in the Coastal Douglas-fir Biogeoclimatic zone, Moist Maritime (mm) subzone with a combination of 01, 04 and 06 variants (Land Management Handbook 28, 1994). The terrain is variable sloping 10 to 150% North, with some areas appears to be unstable. The soil is in general shallow on the steeper sections and deeper at the base of slope near the road at the eastern half. The multi-layer forest stand is composed of 50% Douglas fir, 40% Western redcedar, 5% red alder and 5% bigleaf maple. The range of heights for the mature trees is 12 to 34 m, the range of tree diameters is 18 to 90 cm. The estimated age of the stand is more than 90 years with some trees acquiring old growth characteristics (see Figure 3). This stand appears to be spot burned more than 90 years ago (estimated).

During the site visit I observed signs of unstable terrain like trees with “pistol butts” and large pieces of rock that appear have rolled from above (see figures 4 and 5).

Signs of laminated root rot, Schweinitzii root and butt rot were also identified. This aspect needs to be taken in consideration when selecting trees to be retained along the proposed new forest edge.

All inventoried trees with their biophysical characteristics are recorded in the Tree Inventory Table above. Sample images of the site conditions and trees were also included in this report.

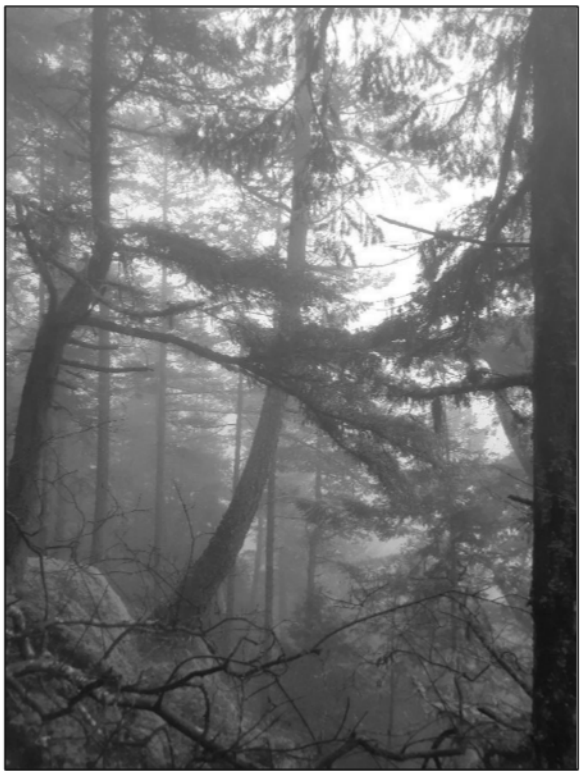


Figure 4 and 5. Trees with their structure and overall form that has been impacted by unstable terrain.

5. Tree Risk Assessment and Recommendations

As stated in the introduction of this report, the initial tree risk assessment was designed to cover the period before the construction begins and was completed using the “Parks and Recreation Sites Module” standards. Due to its proximity to the existing road, area “A” was assessed for a “Level of Disturbance 2” (LOD 2). This level of disturbance is appropriate for trees in striking distance of frequent-use paved roads such as this section of Canal Road. For the same period and before forest clearing and construction activity begins, tree assessment area “B” where planned activity is site assessments and surveys the level of disturbance adopted was “Very Low Risk” (see Appendix C).

During my site visit, and considering the above, I identified six (6) suspect trees that present visible defects.

These trees were assessed for risk, on a limited visual assessment basis, and in the context of the current land uses. Two trees were deemed to be danger trees that would require hazard abatement to eliminate present and/or future risks (within a 1-year timeframe of the tree inventory or before any significant storm event) (see Figures 6 & 7).

- **Remove tree #2** with a dislocated root plate and leaning over the road.
- **Remove tree #3** with a pronounced lean and decayed roots. This tree is leaning SW on the adjacent tree. Despite the "very low risk" LOD, we recommend removal concurrent with tree #2.

Figure 6 and 7. Tree #2 and tree #3 proposed for removal.

For clear-cutting of the trees from area ”A”, the harvesting contractor will remove all trees, so there is no need to apply this tree risk assessment for that phase.

For the active construction phase the newly created forest edge along the northern boundary of the area “B” shall be assessed for safety before the rock blasting, excarnation and soil grading activities begin. For that phase, the tree risk assessment shall use the “Forest Harvesting and Silviculture Module” with a LOD 3&4. This new created forest edge shall be also wind proofed to ensure trees retained along this new section of the road will be stable with a reduced risk of them being up rooted or bent over the road.

6. Cultural Modified Trees (CMT) Assessment

During the site visit, both tree assessment areas “A” and “B” were surveyed for CMTs. The large component of mature Western redcedar and the proximity to the ocean is favorable for creation of CMTs, however I was not able to identify with certainty any trees that qualify under this category. I identified Western redcedar trees with similar scars as CMTs, but in my opinion those scars were produced by partial root rot and surface fires or other mechanical factors like falling trees or rolling rocks. Some trees present scars that were completely closed so, I was not able to identify any marks produced by tools. To document these findings, I attached photographs taken during my site visit (see Figure 8, 9, 10 and 11).

Figure 8 and 9. Trees with their structure and overall form that has been impacted by responses to historical damage and stress, no conclusive CMT identified.

Figure 10 and 11. Trees with their structure and overall form that has been impacted by responses to historical damage and stress, no conclusive CMT identified.

Figure 12. Image of the interior of the forest stand with a large Western redcedar component.

7. Limitations of Report

This field review report was prepared by McElhanney for the exclusive use of the Client and may not be reproduced, used, or relied upon, in whole or in part, by a party other than the Client without the prior written consent of McElhanney. Any unauthorized use of this report, or any part hereof, by a third party, or any reliance on or decisions to be made based on it, are at the sole risk of such third parties. McElhanney accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report, in whole or in part.

Foresters/arborists are professionals who examine trees and use their training, knowledge, and experience to recommend techniques and procedures that will improve a tree's health and structure or to mitigate associated risks. Trees are living organisms whose health and structure change and are influenced by age, continued growth, climate, weather conditions, and insect and disease pathogens. Indicators of structural weakness and disease are often hidden within the tree structure or beneath the ground. The arborist's review is limited to a visual examination of tree health and structural condition, without excavation, probing, resistance drilling, increment coring, or aerial examination. There are inherent limitations to this type of investigation, including, without limitation, that some tree conditions will inadvertently go undetected. The arborist's review followed the standard of care expected of arborists undertaking similar work in British Columbia under similar conditions. No warranties, either express or implied, are made as to the services provided and included in this report.

The findings and opinions expressed in this report are based on the conditions that were observed on the noted date of the field review only. The Client recognizes that passage of time, natural occurrences, and direct or indirect human intervention at or near the trees may substantially alter discovered conditions and that McElhanney cannot report on, or accurately predict, events that may change the condition of trees after the described investigation was completed.

It is not possible for a forester/arborist to identify every flaw or condition that could result in failure, nor can he/she guarantee that the tree will remain healthy and free of risk. The only way to eliminate tree risk entirely is to remove the entire tree. All trees retained should be monitored on a regular basis. Remedial care and mitigation measures recommended are based on the visible and detectable indicators present at the time of the examination and cannot be guaranteed to alleviate all symptoms or to mitigate all risk posed.

Immediately following land clearing, grade changes or severe weather events, all trees retained should be reviewed for any evidence of soil heaving, cracking, lifting or other indicators of root plate instability. If new information is discovered in the future during such events or other activities, McElhanney should be requested to re-evaluate the conclusions of this report and to provide amendments as required prior to any reliance upon the information presented herein.

8. Company Information

WorkSafe BC #	200094159
General Liability	ACE INA Insurance Company, Policy No: CGL 524064: $3,000,000
Errors & Omissions	Certain Underwriters at Lloyds as arranged by Lockton Companies LLP, Policy No: GLOPR 1601496: $3,000,000
City of Surrey Inter-Municipal Business License (Metro West)	148615, expires November 26, 2022.

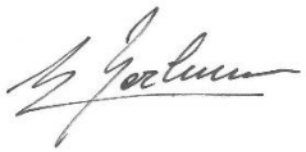
9. In Closing

We trust that this report meets your needs. Should there be any questions regarding the information within this report, please do not hesitate to contact the undersigned.

Yours truly,

McELHANNEY LTD.

Prepared by:



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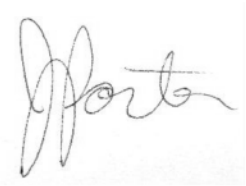

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10. References

Bulletin 27 – Culturally Modified Trees Guidelines, V1 March 22, 2017, Government of BC.

Culturally Modified Trees of British Columbia Handbook for the Identification and Recording of Culturally Modified Trees / Prepared by Archaeology Branch B.C. Ministry of Small Business, Tourism and Culture for the Resources Inventory Committee March 2001 Version 2.0.

Dunster, J.A., E.T. Smiley, N. Matheny, and S. Lily. 2017. Tree Risk Assessment Manual, International Society of Arboriculture (ISA).

Green, R.N., Klinka, K. 1994. A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region. Land Management Handbook Number 28. Province of British Columbia Ministry of Forests.

Wildlife/Dangerous Tree Assessor's Course Workbook, Parks & Recreation Site Course Module Updated January 2019, Ministry of Environment & Climate Change Strategy.

APPENDIX A:
TREE MANAGEMENT PLAN (TMP)

APPENDIX "A": TREE MANAGEMENT PLAN (TMP)

LEGEND

Tree Resource Legend
- Tree assessment area A
- Tree assessment area B
- Additional private property area (not part of this assessment)
- Tree assessed for risk rating
- Tree #4 — ID of tree assessed for risk rating

FOR DISCUSSION ONLY

CL. & GR. TOTAL THIS SHEET= 0.0 ha

ALIGNMENT	CLASSIFICATION	DESIGN SPEED
CANAL ROAD (L100)	MINOR RURAL (IT)	50 km/hr

INFORMATION ON EXISTING UNDERGROUND FACILITIES MAY NOT BE COMPLETE OR ACCURATE. McELHANNEY, ITS EMPLOYEES AND DIRECTORS ARE NOT RESPONSIBLE NOR LIABLE FOR THE LOCATION OF ANY UNDERGROUND CONDUITS, PIPES, CABLES OR OTHER FACILITIES WHETHER SHOWN OR OMITTED FROM THIS PLAN. PRIOR TO CONSTRUCTION CONTRACTOR SHALL EXPOSE LOCATIONS OF ALL EXISTING FACILITIES BY HAND DIGGING OR HYDROVAC AND ADVISE THE ENGINEER OF POTENTIAL CONFLICTS.

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TMP Prepared by: April 8, 2022

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BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 1:500 (0 5 25m)

CAD FILENAME R1-NNN-100
PLOT DATE 4/1/2022

REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

PLAN

CANAL ROAD REMEDIATION

STA. 100+085.000 TO STA. 100+424.939

J. PINTO
SENIOR DESIGNER
DATE 2022-04-01

DESIGNED A. PAN DATE 2022-04-01
QUALITY CONTROL B. OYSTENSEN DATE 2022-04-01
QUALITY ASSURANCE J. PINTO DATE 2022-04-01
DRAWN G. HAROON DATE 2022-04-01

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
153CS0766	12478-000	1	R1-1025-101	A

APPENDIX B:
SITE PHOTOGRAPHS

Photos 1 & 2. Tree #1 images of the lower trunk and top.

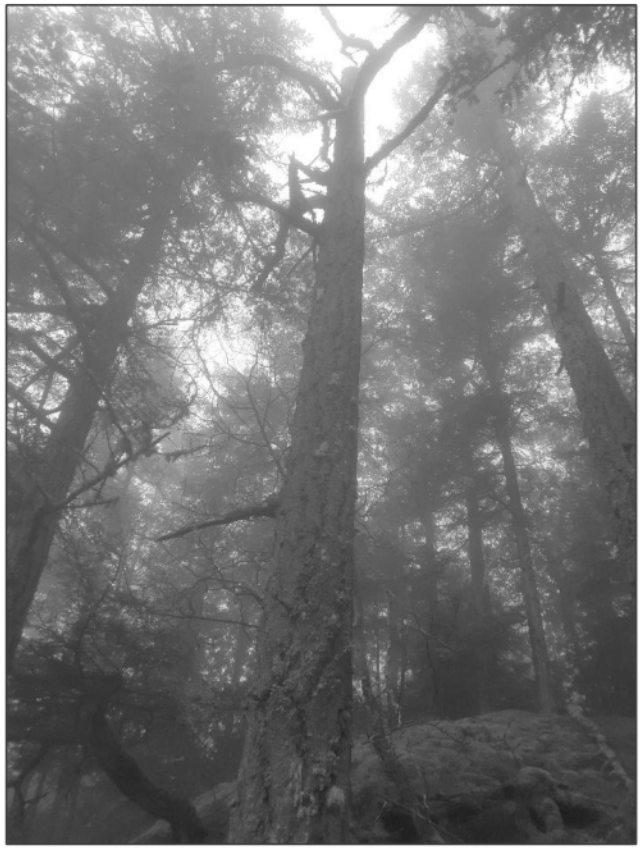


Photo 3 & 4. Tree #4 lower trunk and top images. High value wildlife tree.

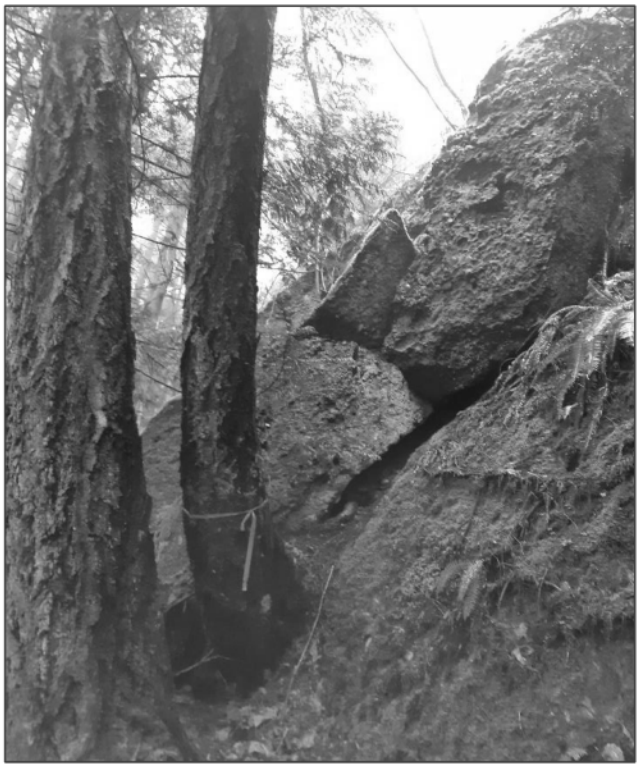



Photo 5 & 6. Tree #5 images of the base of trunk anchored in the rock and leaning trunk (corrected).

Photo 7 & 8. Tree #6 images of the lower and upper trunk leaning but corrected.


Photo 9 & 10. Signs of Schweinitzii root and butt rot were identified.

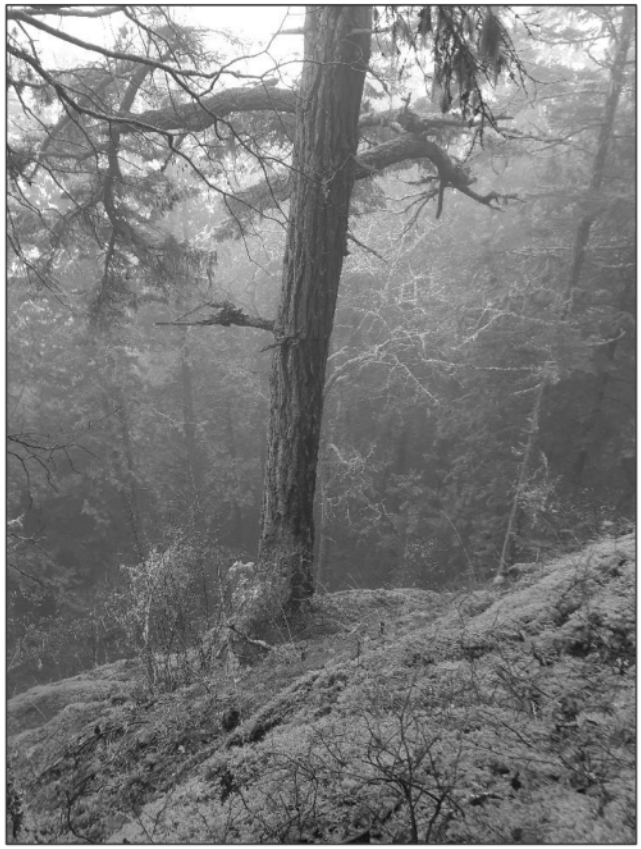



Photo 11 & 12. Trees growing on superficial soil, overview image.

APPENDIX C:
WDTA REFERENCE FORMS

WDTAC – Parks and Recreation Sites

Table 1. Levels of Disturbance for Workers and Visitors at Recreation Sites

Level of Disturbance*	Example Types of Work Activities	Wind Speed Equivalency (km/h)	Example of Target & Exposure Levels
Very Low Risk (No pre-work site inspection required)	• Forest surveys, stand recce, tree marking, road & cutblock layout, foot travel • General light vehicle travel (pickups, ATV's)	N/A	• Hiking trails (e.g., Backcountry trails)
1 (Table 3)	• Tree planting and brushing • Campsite maintenance • Tree pruning (stems <20 cm dbh) • Use of light-duty machinery (e.g., weed whips, brush saws, lawn mowers, bobcats where there will be no digging which could disturb tree root systems/stability) • Heavy (>5500kg GVWR) vehicle travel on a constructed and maintained resource road • Trail construction with hand tools • Fire control with hand tools and/or water hoses	<40	• Hiking trails with interpretive signs • Motorized trail use (ATV, snowmobile) • Trail lookouts and viewpoints • Rest stops alongside hiking trails • Wheel chair trails
2 (Table 4)	• Heavy (>5500kg GVWR) vehicle travel on a trail or overgrown road • Maintenance or construction activities without heavy equipment (e.g., small machines such as "bobcats") • Tree pruning (stems >20 cm dbh) • Spacing or slashing (stems <15 cm dbh) • Tree bucking		• Parking lots (paved or compacted roads) • Day use picnic sites • Public beach/swimming areas • High-use trails (e.g., tour bus groups) • Roadside viewpoints, rest stops • Portable/temporary toilet facilities • Portable/seasonal kiosks • RV sani-stations
3** (Table 4a)	• Tree falling (any tree >15 cm dbh) • Tree yarding (winching or other ground system) • Use of light and intermediate helicopters where workers are exposed to rotor wash (e.g., helipads) • Maintenance or construction activities with heavy equipment (including rubber tire backhoe where digging could affect tree root systems/stability)	40–65	• Campgrounds and amenities • Playgrounds • Permanent buildings/facilities
4 (Table 5)	• Harvesting operations in structurally damaged stands (e.g., wildfire burns) • Blasting • Use of medium and heavy helicopters where workers are exposed to rotor wash	+65	

* A dangerous tree assessment is only valid for the lowest level of disturbance at which the assessment has been done.

** If trees CANNOT be felled and yarded away from adjacent standing timber, then default to Level 4 disturbance.

Table 1A. Influence of Wind Speed on Level of Disturbance

Wind Speed (km/h)	Description	Level of Disturbance Equivalency
0–40	**light breeze** (dust and loose paper raised; small branches move) to **fresh breeze** (small trees sway; tops of large trees sway)	1–2
40–65	**strong breeze** (small branches fly in the air; whole trees in motion; resistance felt when walking against wind)	3
65+	**gale** (branches broken off trees; walking impeded)	4

Table 1B. Helicopter types

Helicopter Category	Passenger Capacity	Lift Capacity
Type 1 (Heavy)	15+	Exceeds 2720kg (6000 lbs)
Type 2 (Medium)	9 – 14	1135 – 2720kg (2500-6000 lbs)
Type 3 (Intermediate)	5 - 8	680 – 1134kg (1500 – 2500 lbs)
Type 4 (Light)	1 - 4	Not exceeding 680kg (1500 lbs)

The following listing provides examples of common aircraft by helicopter type, and is a useful guide when determining the appropriate level of disturbance for the type of aircraft being used.

Light Category: Jet Ranger (Bell 206), Hughes 500, Hiller 12, EC 120, R22 & R44

Intermediate Category: Long Ranger, A-Star (AS350), Bell 407, EC 130

Medium Category: K-Max, Bell 204, 212, 205

Heavy Category: Bell 214, Kamov, Sikorsky 61 & 64, BV 107 & 234

Summary of Assessment Requirements

All work activities EXCEPT those defined as "very low risk" require a pre-work inspection by a qualified person to determine if there are any trees that might endanger workers. A summary of activity level assessment requirements is shown below.

- **Very Low Risk (VLR) Activities** — No pre-work site inspection is required.
- **Level 1 Disturbance Activities** — A pre-work inspection by a qualified person is required. If trees with significant tree hazards (see Table 3) are observed, the appropriate safety procedures must be taken before work activities begin.
- **Level 2, 3 or 4 Disturbance Activities** — A pre-work inspection by a qualified person is required. If "suspect" trees (see Table 4, 4A, 5) are identified by a qualified person, then further assessment by a certified danger tree assessor is required and the appropriate safety procedures must be taken BEFORE work activities begin.

Steps Required to Determine Tree Danger Rating:

1. Determine the level of ground disturbance and visitor exposure (refer to Tables 1, 1A, 1B)
2. Conduct a site assessment overview (refer to Table 2)
3. Conduct tree assessments (refer to Tables 3, 4, 4A and 5)
4. Make the appropriate safety decision (Safe or Dangerous)
5. Provide documentation and communicate safety procedures

Table 2. Site Assessment Overview (for all tree species)

Site/Stand Factors	Hazard Indicators/Influences
Stand history and condition	• evidence of past tree failure • disturbance history (natural or human-caused, including wildfire damage; age, condition and location of mechanically harvested "stubs") • general age, condition and density • tree species composition • evidence of root and/or stem diseases
Common rain, snow and ice conditions	• high snow or ice loading • high rain fall periods
Flooding	• high water table • evidence of water damaged/decayed roots • area prone to flooding
Windthrow potential	• topography • prevailing winds • evidence of significant windthrow • area of high or recent exposure • stems with height/diameter ratio >100 (i.e., very tall, slender stems) • saturated soils • shallow soils • restricted rooting depth • fine textured soils
Crown condition	• stress cone crop • thinning foliage • chlorosis • rounded crown • small live crown (<20% of tree height)
Resinosis	• higher than normal stem or basal pitch flow
Tree lean	• trees recently leaning due to windstorm, root damage, shifting root mat or other causes
Additional site-specific factors	• based on local knowledge (e.g., soil or slope instability)

Table 3. Danger Tree Assessment Process for Level 1 Disturbance Activities – Significant Hazard Indicators

D = Dangerous	**D if tree has one or more of the following significant tree hazard indicators that are at risk of imminent failure:** • **Insecurely lodged trees or insecure hang-ups:** i) Insecurely lodged trees (a tipped tree that is likely to shake free of the support trees and fall to the ground); or ii) Dislodged but hung-up limbs or tops (consider size and height above ground) at risk of shifting free during light winds or other tree motion • **highly unstable tree:** Examples: i) >50% tree cross-sectional area damaged or decayed; or ii) Spongy snags with heart rot conks along the majority of the length of the stem (e.g., class 5-6 conifers or class 4 deciduous) or soft snags (e.g., class 7-8 conifers or class 5 deciduous); or iii) >50% lateral roots damaged or with advanced decay • **recent lean** toward work area AND decayed root system (>50% of roots have advanced decay) or damaged and lifting anchoring soil layer (consider soil conditions and anchoring)
S = safe	all other trees

Wildlife Tree Value Rating

Wildlife Tree Value	Characteristics
HIGH a high value tree has at least two of the characteristics listed in the adjacent column and, where possible, is within the upper 10–15% of the diameter range distribution for the site	• internal decay (heartrot or natural/excavated cavities present) • a sound, firm stem shell • crevices present (loose bark or cracks suitable for bats) • large brooms present • active or recent wildlife use (feeding, nesting, denning) • tree structure suitable for wildlife use (suitable for large nest, hunting perch sites, bear den, etc.) • largest trees for site (height and/or diameter) and veteran trees • locally important wildlife tree species • favourably located for use by wildlife
MEDIUM	• large, stable trees that will likely develop two or more of the above attributes
LOW	• trees not covered by high or medium categories

Note: Under section 34 of the *Wildlife Act*, no tree with an active nest or the nest of an eagle, peregrine falcon, gyrfalcon, osprey, heron or burrowing owl can be disturbed.

Wildlife Tree Uses The following codes can be used to document the types of recent uses observed:

CN – Cavity Nest ON – Open nest F – Feeding M – Mark tree D – Denning P - Perching

Table 4. Dangerous Tree Criteria for Level 2 Disturbance Activities

NOTE: *Any tree defects as described in the boxes below will be rated as DANGEROUS for level 2 disturbance. Trees with lesser defects can be rated SAFE for level 2 – take care to not brush trees and to fall and yard away if possible.*

Defect Category	Species Group	
	Douglas-fir, larch, pines, spruces	**Western redcedar, yellow cedar**
Hazardous top (HT)	• **Class 2 to 5 trees:** Defective top (any size; e.g., secondary top) **where structural weakness is evident; OR** • **Class 4 and 5 trees:** Defective top (e.g., secondary top) >30% of tree height	• **Class 2 to 5 trees:** Defective top (any size; e.g., secondary top) **where structural weakness is evident**
Dead limbs (DL)	• Dead limbs >10 cm diameter **with structural weakness** • Hung-up limbs	• Dead limbs >15 cm diameter **with structural weakness** • Hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on dead branches with evidence of decay, cracking or failure (dead branches and brooms may be on the ground)	n/a
Split trunk (ST) (includes frost, lightning, wind- and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending >50% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire, machine, and animal damage or butt rot)	>25% of tree cross-sectional area damaged, burned, scarred or fractured	>50% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to Douglas-fir, larch and ponderosa pine)	**Class 6–8 trees:** Large pieces of bark or sapwood separated and sloughing from bole of tree*	• Bark n/a • Long slabs of sloughing sapwood hanging from bole of tree
Butt and stem cankers (CA)	>50% of butt or stem circumference as a perennial canker face	n/a
Fungal fruiting bodies (CM) ** (conks and mushrooms)	• **Any heartrot fungus present** **Exception:** For veteran and dominant trees, if *Porodaedalea pini* conks present BUT NO other visible defects/damage to stem that allow oxygen exchange (e.g., broken top, scarring, nest cavity, etc.) = SAFE; • Sap-rotting fungi present on any tree <30 cm dbh where saprot depth is >5 cm	n/a
Tree lean (TL) (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Tree lean (TL) (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection (RI)	Occurrence of any of the following: root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots	Occurrence of any of the following; root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots
Detailed Tree Assessments	STEM TEST: Average sound stemwood shell thickness <30% of tree radius (i.e., AST < RST) ROOT TEST: More than half of the roots are >50% decayed or rotten	

NOTE: Structural weakness includes decay, cracking, breakage, embedded bark or cracking at forks or multiple stem unions, presence of conks, stem scars, and woodpecker cavities.

* In Douglas-fir and ponderosa pine, treat sloughing sapwood according to the bark failure potential criteria.

** If identity of wood decay fungus cannot be determined (e.g., saprot or heartrot), then default to Dangerous rating. Where *Porodaedalea pini* is present, if the stem has structural damage such as a broken top or scarring which allow oxygen exchange or other stress indicators (e.g., resinosis, damaged roots), **OR** if there are conks distributed along the bole length, then default to Dangerous rating.

Table 4. Dangerous Tree Criteria for Level 2 Disturbance Activities

NOTE: *Any tree defects as described in the boxes below will be rated as DANGEROUS for level 2 disturbance. Trees with lesser defects can be rated SAFE for level 2 – take care to not brush trees and to fall and yard away if possible.*

Defect Category	Species Group	
	Hemlock, true firs	**Broad-leaved deciduous**
Hazardous top (HT)	• **Class 2 to 5 trees:** Defective top (any size; e.g., secondary top) where structural weakness is evident; OR • **Class 4 and 5 trees:** Defective top (e.g., secondary top) >20% of tree height	• **Class 2 to 5 trees**: Top (any size) as a fork, co-dominant or multiple stem **where structural weakness is evident; OR** • Where a dead top is >20% of the tree height
Dead limbs (DL)	• Dead limbs >10 cm diameter **with structural weakness** • Hung-up limbs	• Dead limbs >10 cm diameter (including "scaffold branching") **with structural weakness** • Hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on dead branches with evidence of decay, cracking or failure (dead branches and brooms may be on the ground)	n/a
Split trunk (ST) (includes frost, lightning, wind- and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire, machine, and animal damage or butt rot)	>25% of tree cross-sectional area damaged, burned, scarred or fractured	>25% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to cottonwood >50 cm dbh)	n/a	**Class 5 trees:** Large pieces of bark separated and sloughing from bole of tree
Butt and stem cankers (CA)	n/a	>50% of butt or stem circumference as a canker face on a dead tree
Fungal fruiting bodies (CM) * (conks and mushrooms)	• **Any heartrot fungus present** • Sap-rotting fungi present on any tree <30 cm dbh where saprot depth is >5 cm	• **Any heartrot fungus present** **Exception:** *P. tremulae* on live trembling aspen; apply alternate safe work procedures; • Sap-rotting fungi present on any trees <30 cm dbh where saprot depth is >5 cm
Tree lean (TL) (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Tree lean (TL) (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection (RI)	Occurrence of any of the following: root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots	Occurrence of any of the following; root pull; lifting root mat; visible decay or damage to roots affects >50% of lateral roots
Detailed Tree Assessments	STEM TEST: Average sound stemwood shell thickness <30% of tree radius (i.e., AST < RST) ROOT TEST: More than half of the roots are >50% decayed or rotten	

NOTE: Structural weakness includes decay, cracking, breakage, embedded bark or cracking at forks or multiple stem unions, presence of conks, stem scars, and woodpecker cavities.

* If identity of wood decay fungus cannot be determined (e.g., saprot or heartrot), then default to Dangerous rating.

Table 4a. Dangerous Tree Criteria for Level 3 Disturbance Activities

NOTE: *Any tree defects as described in the boxes below will be rated as DANGEROUS for level 3 disturbance. Trees with lesser defects can be rated SAFE for level 3 – take care to not brush trees and to fall and yard away if possible.*

Defect Category	Species Group	
	Douglas-fir, larch, pines, spruces	Western redcedar, yellow cedar
Hazardous top (HT)	• **Class 2 to 5 trees:** Defective top (any size; e.g., secondary top) **where structural weakness is evident; OR** • **Class 4 and 5 trees:** Defective top (e.g., secondary top) >30% of tree height	• **Class 2 to 5 trees:** Defective top (any size; e.g. secondary top) **where structural weakness is evident**
Dead limbs (DL)	• Dead limbs >10 cm diameter **with structural weakness** • Cracked, decayed, broken or hung-up limbs	• Dead limbs >15 cm diameter **with structural weakness** • Cracked, decayed, broken or hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on live or dead branches AND evidence of decay, cracking or failure	n/a
Split trunk (ST) (includes frost, lightning, wind- and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood	• **Class 2 and 3 trees:** Crack or split >2 cm wide extending >50% of tree diameter into stem **AND** evidence of decay in surrounding stemwood • **Class 4–8 trees:** Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire, machine, and animal damage or butt rot)	>25% of tree cross-sectional area damaged, burned, scarred or fractured	• **Class 2 and 3 trees:** >50% of tree cross-sectional area damaged, burned, scarred or fractured • **Class 4–8 trees:** >25% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to Douglas-fir, larch and ponderosa pine)	Large pieces of bark or sapwood separated and sloughing from bole of tree	• Bark n/a • Long slabs of sapwood hanging from bole of tree
Butt and stem cankers (CA)	>50% of butt or stem circumference as a perennial canker face*	n/a
Fungal fruiting bodies (CM) ** (conks and mushrooms)	• **Any heartrot fungus present** **Exception:** For veteran and dominant trees, if *Porodaedalea pini* conks present BUT NO other visible defects/damage to stem that allow oxygen exchange (e.g., broken top, scarring, nest cavity, etc.) = SAFE; • Sap-rotting fungi present on any tree <30 cm dbh where saprot depth is >3 cm	n/a
Tree lean (TL) (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	• Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope) • For candelabra-branched trees, where candelabras are predominantly on lean side of tree—lean >10% toward target/work area and tree has rooting problems
Tree lean (TL) (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection (RI)	Occurrence of any of the following: root pull; lifting root mat; visible damage or decay to roots affects >25% of lateral roots	Occurrence of any of the following; root pull; lifting root mat; visible damage or decay to roots affects >25% of lateral roots
Detailed Tree Assessments	STEM TEST: Average sound stemwood shell thickness <30% of tree radius (i.e., AST < RST) ROOT TEST: More than half of the roots are >50% decayed or rotten	

NOTE: Structural weakness includes decay, cracking, breakage, embedded bark or cracking at forks or multiple stem unions, presence of conks, stem scars, and woodpecker cavities.

*/** Footnotes can be found on page 8 (on reverse).

Table 4a. Dangerous Tree Criteria for Level 3 Disturbance Activities (concluded)

NOTE: *Any tree defects as described in the boxes below will be rated as DANGEROUS for level 3 disturbance. Trees with lesser defects can be rated SAFE for level 3 – take care to not brush trees and to fall and yard away if possible.*

Defect Category	Species Group	
	Hemlock, true firs	Broad-leaved deciduous
Hazardous top (HT)	• **Class 2 to 5 trees:** Defective top (any size; e.g., secondary top) **where structural weakness is evident; OR** • **Class 4 and 5 trees:** Defective top (e.g., secondary top) >20% of tree height	• **Class 2 to 5 trees:** Defective top (any size) in the form of a fork, co-dominant or multiple stem **where structural weakness is evident; OR** • Where dead top >20% of tree height
Dead limbs (DL)	• Dead limbs >10 cm diameter **with structural weakness** • Cracked, decayed, broken or hung-up limbs	• Dead limbs >10 cm diameter **with structural weakness** • Cracked, decayed, broken or hung-up limbs
Witches' broom (WB)	Brooms >1 m diameter on live or dead branches AND evidence of decay, cracking or failure	n/a
Split trunk (ST) (includes frost, lightning, wind- and impact-induced cracks)	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of advanced decay in surrounding stemwood	Crack or split >2 cm wide extending >25% of tree diameter into stem **AND** evidence of decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire, machine, and animal damage or butt rot)	>25% of tree cross-sectional area damaged, burned, scarred or fractured	>25% of tree cross-sectional area damaged, burned, scarred or fractured
Thick sloughing bark or sloughing sapwood (SB) (bark applicable to cottonwood >50 cm dbh)	n/a	Large pieces of bark separated and sloughing from bole of tree
Butt and stem cankers (CA)	n/a	• >20% of butt or stem circumference as a perennial canker face* • >50% of butt or stem circumference as a canker face on a dead tree
Fungal fruiting bodies (CM) ** (conks and mushrooms)	• **Any heartrot fungus present; OR** • Sap-rotting fungi present on any tree **<60 cm dbh** where saprot depth is >6 cm	• **Any heartrot fungi present** **Exception:** *P. tremulae* on live trembling aspen; apply alternate safe work procedures; • Sap-rotting fungi present on trees **<60 cm dbh** where saprot depth is >6 cm
Tree lean (TL) (for class 1–3 trees)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >15% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Tree lean (TL) (for class 4–8 trees)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)	Lean >10% toward target/work area AND tree has rooting problems (e.g., damaged roots; shallow, compacted or wet soils; cracked or lifting root mat; steep slope)
Root inspection (RI)	Occurrence of any of the following: root pull; lifting root mat; visible damage or decay to roots affects >25% of lateral roots	Occurrence of any of the following; root pull; lifting root mat; visible damage or decay to roots affects >25% of lateral roots
Detailed Tree Assessments	STEM TEST: Average sound stemwood shell thickness <30% of tree radius (i.e., AST < RST) ROOT TEST: More than half of the roots are >50% decayed or rotten	

NOTE: Structural weakness includes decay, cracking, breakage, embedded bark or cracking at forks or multiple stem unions, presence of conks, stem scars, and woodpecker cavities.

* Perennial cankers are generally circular to lens-shaped cankers that can persist for years, and slowly expand at about the same rate as the radial growth of the affected live tree. They gradually take on a sunken appearance as tissues under the dead cambium do not grow along with the surrounding wood. They are sometimes called "exploding cankers."

** If identity of wood decay fungus cannot be determined (e.g., saprot or heartrot), then default to Dangerous rating. Where *Porodaedalea pini* is present on Douglas-fir, larch, pines and spruces, if the stem has structural damage such as a broken top or scarring which allow oxygen exchange or other stress indicators (e.g., resinosis, damaged roots), **OR** if there are conks distributed along the bole length, then default to Dangerous rating.

Table 5. Danger Tree Assessment Process for Level 4 Disturbance Activities

When conducting Level 4 disturbance assessments, only the following four types of trees are rated safe. All other trees will be rated Dangerous for Level 4 activities.

Level 4 Disturbance

S = **Safe** if tree is one of the following:

- class 1 tree (all species)
- class 2 trees with NO structural defects (all species) (usually wind- or snow-snapped green trees, very light fire scorching).
- class 2 cedars with LOW failure potential defects (refer to table below)
- class 3 conifers with NO structural defects (tree recently killed by insects, climate or light intensity fire —these will have no structural damage or decay)

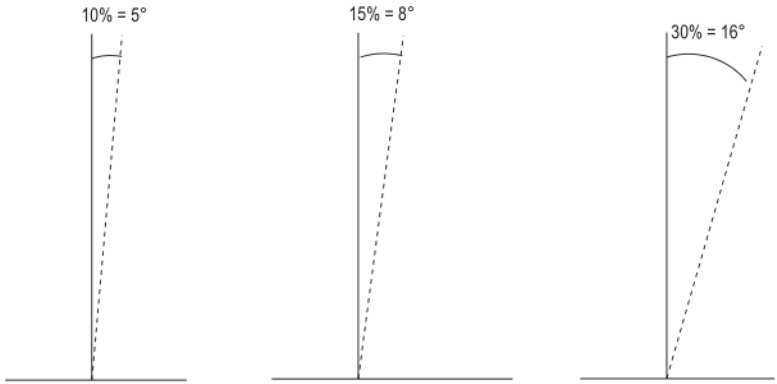
D = **Dangerous** all other trees (fall tree; create a no-work zone; or remove hazardous parts)

NOTE: Any leave tree that is damaged during the work activity must be reassessed if work is to continue within reach

Class 2 Cedar Trees Are Safe for LOD4 if They Fit the Following Criteria:

Defect Category	Western redcedar, yellow cedar Low Failure Potential
Hazardous top (HT)	Defective top (e.g. secondary top, spike) <30% of tree height with **no evidence** of decay, cracking, failure or other structural weakness
Dead limbs (DL)	Dead limbs (no size limit) with **no evidence** of decay, cracking or failure
Split trunk (ST) (includes frost, lightning and wind-induced cracks; does not include dry checking)	Crack or split >2 cm wide extending <50% of tree diameter into stem; **no evidence** of decay in surrounding stemwood
Stem damage (SD) (includes scarring, fire damage, machine damage, animal damage or butt rot)	<50% of tree cross-sectional area damaged, scarred or fractured with **no evidence** of decay in remaining stemwood
Tree lean (TL)	Lean <30% (16°) toward target/work area and tree has no rooting problems
Lean (TL) — candelabra branched trees (where candelabras are predominantly on lean side of tree)	Lean <10% (5°) toward target/work area and tree has no rooting problems
Root inspection (RI)	**No visible problems:** no root pull or lifting root mat. Any visible structural damage to roots only affects <25% of lateral roots (remaining roots undamaged)
Average stemwood shell thickness (for Detailed Tree Assessment)	Total sound stemwood shell thickness >30% of tree radius

Tree Lean Comparisons



Safety Procedures (for "suspect" trees that have been assessed)

S
- tree safe to work around, retain tree—no removal or modification necessary
- mark tree as **Safe** (tag, paint or flagging as appropriate)
- monitor tree if appropriate

D
- remove tree
- remove dangerous part(s) of tree
- install flagged no-work zone (hazard area)
- mark tree as **Dangerous** (tag, paint or flagging) if marking is required for work activity or site
- inform workers of location of no-work zones (hazard area) and trees marked as **Dangerous**.

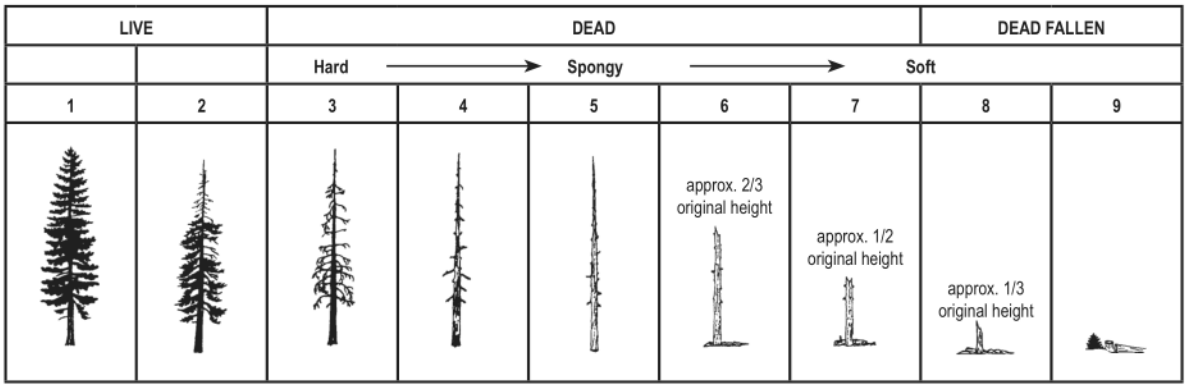
GENERAL GUIDANCE

Conks: Extend the dangerous decay level 3m below the location of the lowest conk.

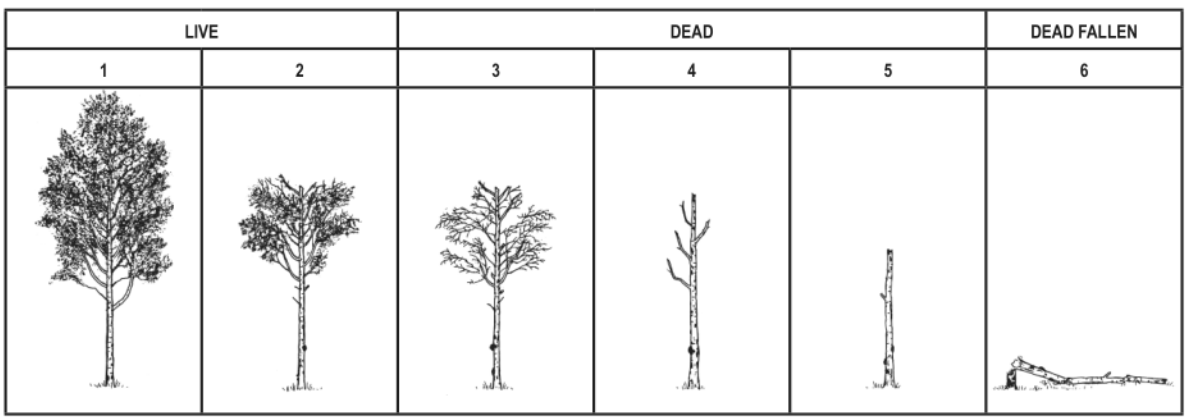
Cavity Nests: Extend the dangerous level of decay 1m below the lowest cavity hole.

No Work Zones (NWZ): must be flagged on the ground; generally 1.5 times the length of the longest dangerous defect, adjusted (larger or smaller) based upon site specific conditions.

Decay Class Comparison for Conifers and Hardwoods



* This classification system does not recognize root disease trees specifically. Such trees become unstable at or before death.



Notes

What is a Dangerous Tree?

A dangerous tree is any tree (regardless of size) that is hazardous to people or facilities because of:

- location or lean
- physical damage
- overhead hazards
- deterioration of limbs, stem or root system
- a combination of the above.

Common Tree Species Name and Codes

Tree Species	Code Symbol
Douglas -fir	Fd
Western larch	Lw
Lodgepole pine	Pl
Yellow pine	Py (Ponderosa pine)
Western white pine	Pw
White spruce	Sw
Engelmann spruce	Se
Sitka spruce	Ss
Subalpine fir	Bl
Amabilis fir	Ba
Grand fir	Bg
Western hemlock	Hw
Western redcedar	Cw
Yellow cedar	Yc
Black cottonwood	Ac
Trembling Aspen	At
Paper birch	Ep
Red alder	Dr
Bigleaf Maple	Mb

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CANADA BEST MANAGED COMPANIES

Basic Impact Assessment

Parks Canada
Version IAA 2019

1. PROJECT TITLE & LOCATION

Canal Road Realignment, South Pender Island, Gulf Island National Park Reserve

2. PROPONENT INFORMATION

Parks Canada Project Manager:

Kyle Motiuk, Asset Manager Gulf Islands National Park Reserve of Canada, 250-637-4593 (cell); *kyle.motiuk@pc.gc.ca*

Sibylla Helms, Resource Management Officer Gulf Islands National Park Reserve of Canada, 250-6617246; sibylla.helms@pc.gc.ca

Project Plan/Design Company Project Manager:

Chad Bengert, Project Manager, McElhanney; s.22 ,s.22
s.22

Project Owner, Environmental Representative:

Joanne Letkeman, Regional Manager Environmental Services, Ministry of Transportation and Infrastructure; 236-468-1984; *joanne.letkeman@gov.bc.ca*

3. PROPOSED PROJECT DATES

Planned commencement: 2022-08-01

Planned completion: 2023-04-30

4. NOTICES ON REGISTRY

Registry Title: MoTI (Ministry of Transportation and Infrastructure) - Canal Road Realignment, South

Pender Island

Project notice posted on Registry: 2022-03-10

Reference Number: 83464

5. PROJECT FILE NUMBER (Internal/Registry)

GI21-11.

6. PROJECT DESCRIPTION

Following extreme rainfall events in November 2021 a section of Canal Road on South Pender Island experienced significant damage and is subject to potential landslide or slope failure (**Photo 1**). The current roadway is unstable and was not built for long-term sustainable use or current traffic volumes. The BC Ministry of Transportation and Infrastructure (MOTI) will realign a portion of Canal Road to provide a safe and stable roadway and to minimize the possibility of future failures occurring. The road realignment will be adjacent to the existing roadway.

The project is located on the north side of South Pender Island. The approximate latitude and longitude of the center of the site are 48°45'32"N 123°13'30"W, respectively. The western limit of construction is approximately 240m east of the intersection of Canal Road and Mt Norman Trail Access. Project location and limits of construction are shown on Figure 1.

The length of the road to be reconstructed is approximately 412 m. Total area occupied by the project is approximately 8,620 m^2 with 5,360 m^2 of new disturbances (e.g., slope excavation and new road surface). Approximately 4,650 m^2 of disturbance will occur within the Gulf Islands National Park Reserve (GINPR).

Works included under this project include:

- Mobilization and Demobilization of all personnel, equipment, materials, and other resources necessary to execute the project;
- Provision of traffic signage and traffic control;
- Clearing and grubbing from the south edge of the existing asphalt;
- Slope reprofiling by excavation and/or controlled blasting on the slope face (south side of road);
- Construction of a two-lane road (approximately 6.1 m in width);
    - Includes excavation, grading and sloping, placing sub-base materials, compaction and paving (on new construction and transition to existing road);
- Construction of 0.6 m of paved shoulder and 0.6 m of gravel shoulder on the north side and south side of the newly constructed section of road;
- Construction of 3.0 m wide catchment ditch on the south side between road and toe of slope; and,
- Construction of a 44 m long retaining wall on south side of the road (Station 1002+91 to Station 1003+35).

The project will be conducted using MOTI industry standard construction methods and best management practices (i.e., *2020 Standard Specifications for Highway Construction [*MOTI 2020*]).* The most recent design plans are included in Appendix 3.

The project is anticipated to commence in August 2022, with construction being completed in April 2023.

7. EXISTING SITE CONDITIONS

A desktop review of existing information was conducted using publicly available databases and mapping services to characterize the vegetation, wildlife and wildlife habitat, aquatic resources, and fish and fish habitat at the project site. A field visit was conducted on February 17, 2022 by Hemmera biologist Sarah Wyness, R.P.Bio. to ground truth the results of the desktop review. Representative photographs from the field visit are provided in Appendix 1.

The GINPR is one of Canada's newest national parks and includes protected land on fifteen of British Columbia's Southern Gulf Islands. Beaumont / Mount Norman Park is part of the GINPR and is located on South Pender Island, adjacent to the project site. Access to the Mount Norman trails is off Canal Road on the north end of South Pender Island.

South Pender Island is moderately (more than 50%) fragmented by rural residential development and agricultural land (B.C. Conservation Data Center 2014a). Development is relatively light, with little recent forest clearing, and more than 75% of natural or semi-natural vegetation (B.C. Conservation Data Center 2014a). Canal Road provides access to most areas on the north side of the island and connects South Pender Island to North Pender Island.

Vegetation

The project site is within the Coastal Douglas-fir Moist Maritime (CDF mm) subzone. Vegetation within the CDF mm subzone is typically dominated by Douglas-fir (*Pseudotsuga menziesii*), western redcedar (*Thuja plicata*), grand fir (*Abies grandis*), bigleaf maple (*Acer macrophyllum)*, western flowering dogwood (*Cornus nuttallii*), and mountain hemlock arbutus (*Arbutus menziesii)*. The understory is dominated by salal (*Gaultheria willon*), dull Oregon-grape (*Mahonia nervosa*), ocean spray (*Holodiscus discolor*) and *Kindbergia oregana.*

The project site encompasses two provincially red-listed ecosystems, Grand Fir / Dull Oregon -grape and Douglas-fir / dull Oregon-grape. The Douglas-fir / dull Oregon-grape ecological community is spread over much of South Pender Island. This coniferous forest is mostly comprised of young (70%), and mature (27%) Douglas-fir dominated forests, with components of old forest (~3%) and veteran trees (B.C. Conservation Data Center 2014a). Co-occurring tree species include grand fir, arbutus, western redcedar, bigleaf maple, and red alder (*Alnus rubra*) (B.C. Conservation Data Center 2014a).

The Grand Fir / Dull Oregon -grape ecosystem is mostly young forest of deciduous and coniferous tree species, with portions of mature forest and a small area of veteran trees (B.C. Conservation Data Center 2014b). The typical vegetation associated with the Grand Fir / Dull Oregon-grape ecosystem includes western redcedar, red alder, Douglas-fir, bigleaf maple, and grand fir over an understory of red alder, salal (*Gaultheria willon*), dull Oregon-grape (*Mahonia nervosa*), trailing blackberry (*Rubus ursinus*),

oceanspray, wall lettuce (*Lactuca muralis*), sweet-scented bedstraw (*Galium triflorum*), hairy honeysuckle (*Lonicera hispidula*), Alaska oniongrass (*Melica subulata*) and sword fern (*Polystichum munitum*) (B.C. Conservation Data Center 2014b).

Table 1 includes vegetation species listed under Schedule 1 of the *Species at Risk Act* (SARA) and COSEWIC known to occur within the GINPR. The CDC Internet Mapping tool, BC Species and Ecosystems Explorer, and Parks Canada's Biotics Web Explorer were used to determine potential occurrences of these species at or near the project site. No sensitive vegetation species have been previously documented at or immediately adjacent to the site.

Table 1. Vegetation species in GINPR listed under SARA Schedule 1 and COSEWIC

Common Name	Scientific Name	SARA Legal Status	COSEWIC Status
Contorted-pod Evening-primrose	*Camissonia contorta*	Endangered	Endangered
Foothill Sedge	*Carex tumulicola*	Endangered	Endangered
Slender Popcornflower	*Plagiobothrys tenellus*	Threatened	Threatened

During the field visit, vegetation at the project site was observed to be predominantly young coniferous forest (trees ranging approximately 0.10 to 0.30 m diameter at breast height (DBH)), with some mature trees present (approximately 0.5 m to 0.8 m DBH) (**Photo 2** and **Photo 3**). Vegetation observed at the site included Douglas fir, western red cedar, salal, moss, western sword fern, and ocean spray.

Mature western red cedar, Douglas fir, and big leaf maple trees were observed within the slide zone, with very limited understory vegetation comprised mainly of sword fern and patches of moss (**Photo 4**). The project site was well shaded with high canopy closure at the slide location. Groundcover was predominantly moss, sword fern, salal, and decaying red alder. Some evidence of forest fire burns was observed.

Invasive plant species observed along the roadside, mostly on the north side, included common foxglove (*Digitalis purpurea*), common cat's-ear (*Hypochaeris radicata*), and scotch broom (*Cytisus scoparius*) (**Photo 5**). No evidence of invasive plant species was observed west of the roadway.

No SARA-listed vegetation was observed during the field visit. However, non-detection does not preclude absence; the field visit was not conducted during optimal vegetation survey season, nor was a species at risk-specific survey conducted.

Water

An unnamed watercourse (**Photo 6**) is located at the western extent of the project site, approximately 155 m east of the Mount Norman Trail Access. Provincial mapping of this watercourse indicates that it is a first-order watercourse with its headwaters originating in GINPR approximately 650 m from its marine confluence. The Fish Inventory Data Queries database and BC Habitat Wizard online mapping tool did contain any information regarding fish and fish habitat associated with the watercourse.

Based on observations during the field visit, the channel flows through a culvert (approximately 0.6 m) beneath the existing road, and flows northeast, eventually discharging into the ocean (**Photo 7** and **Photo 8**). The watercourse is approximately 1.5 m wide with a gradient of approximately 50%. At the time of the field visit, the depth of the water was observed to be shallow (<0.1 m) with step-pool morphology. Banks were poorly defined, and substrates were dominated by gravels and cobbles.

Characteristics of the unnamed watercourse (e.g., shallow, first-order stream without a lake at the headwater and gradient of 50%) make it unlikely that fish are present in this watercourse. Gradients greater than 20% typically exclude presence of most fish species (BC Ministry of Forests 1998).

Current design plans do not include works within the wetted channel of the unnamed watercourse. However, the western limit of construction for the project is approximately 30 m east of the unnamed watercourse.

A roadside ditch was observed on the south side of Canal Road (**Photo 9**). The ditch was less than 0.3 m wide, appeared to be ephemeral, and flowed through an existing culvert that was approximately 0.3-0.4 m diameter.

Terrestrial Wildlife

A variety of wildlife have potential to be found at the project site, including birds, mammals, reptiles, and amphibians. Because the project site is an active roadway, much of the wildlife use is likely transient and accustomed to traffic disturbances. However, the forested areas adjacent to the road right-of-way may provide suitable habitat for activities such as foraging, nesting and security.

There are 23 wildlife species listed under Schedule 1 of SARA and COSEWIC known to occur within GINPR. Table 2 lists wildlife species listed under Schedule 1 of SARA and COSEWIC with potential to interact with the project. The list was compiled using information provided by Parks Canada and by querying the CDC Internet Mapping tool, BC Species and Ecosystems Explorer, and Parks Canada's Biotics Web Explorer for GINPR. A search of the Government of British Columbia online mapping tool HabitatWizard indicates that there is no critical habitat for federally listed species within or near the project site.

Table 2. Wildlife Species in GINPR listed under SARA Schedule 1 and COSEWIC

Common Name	Scientific Name	SARA Legal Status	COSEWIC Status
Birds			
Ancient Murrelet	*Synthliboramphus antiquus*	Special Concern	Special Concern
Band-tailed Pigeon	*Patagioenas fasciata*	Special Concern	Special Concern
Barn Swallow	*Hirundo rustica*	Threatened	Threatened
Common Nighthawk	*Chordeiles minor*	Threatened	Special Concern
Evening Grosbeak	*Coccothraustes vespertinus*	Special Concern	Special Concern
Olive-sided Flycatcher	*Contopus cooperi*	Threatened	Special Concern

Common Name	Scientific Name	SARA Legal Status	COSEWIC Status
Peregrine Falcon pealei subspecies	*Falco peregrinus pealei*	Special Concern	Special Concern
Western Screech Owl	*Megascops kennicottii kennicottii / kennicottii macfarlanei*	Threatened	Threatened
Barn Owl	*Tyto alba*	Threatened	Threatened
Mammals			
Little brown myotis	*Myotis lucifugus*	Endangered	Endangered
Insects			
Edwards' Beach Moth	*Anarta edwardsii*	Endangered	Endangered
Georgia Basin Bog Spider	*Gnaphosa snohomish*	Special Concern	Special Concern
Reptiles/Amphibians			
Northern Red-legged Frog	*Rana aurora*	Special Concern	Special Concern
Sharp-tailed Snake	*Contia tenuis*	Endangered	Endangered
Wandering Salamander	*Aneides vagrans*	Special Concern	Special Concern

The Parks Canada *Impact Assessment Pathway Decision* for the project, approved January 27, 2022, contains information on natural resources occurring or potentially occurring on Parks Canada lands at the project site (prepared by Morgan Davies, Resource Management Officer, on January 20, 2022). Based on this communication, the following species at risk have potential to occur at or near the project site:

- There are records of two bird species at risk within 100-500 m of the site. Band-tailed pigeon (*Patagioenas fasciata*) (SARA Special Concern) was detected in 2009 and olive-sided flycatcher (*Contopus cooperi*) (SARA Threatened but recommended for down-listing to Special Concern in 2018) was detected 2009-2013 and 2016. There is potential for both species to breed and/or forage at the site.
- Potential nesting habitat for barn owl (*Tyto alba*) (SARA Threatened) and two subspecies of western screech-owl (*Megascops kennicottii kennicottii /M. kennicottii macfarlanei*) (SARA Threatened) exists at or adjacent to the site. Barn owls require open foraging habitat with an abundance of small mammal prey, and nearby protected cavity sites for nesting (Government of Canada 2011). Western screech-owls are cavity nesters and are often found nesting in black cottonwoods (*Populus trichocarpa*) but may also nest in trembling aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), ponderosa pine (*Pinus ponderosa*), and water birch (*Betula occidentalis*) (B.C. Ministry of Environment 2016a).
- A small number of bats including little brown myotis (*Myotis lucifugus*) (SARA Endangered) have been detected in GINPR. Many bat species (including little brown myotis) preferentially roost in older forest stands (Barclay and Brigham 1996). Foraging habitat and potential maternal colony habitat for little brown myotis exists within or adjacent to the site.

- Northern Red-legged Frogs (*Rana aurora*) (SARA Special Concern) are very likely to occur at the site and may breed at the site. Adults in low elevation areas of coastal British Columbia may begin breeding in January or February (B.C. Ministry of Environment 2015). Breeding occurs in a variety of permanent and temporary freshwater bodies, including potholes, ponds, ditches, springs, marshes, margins of large lakes, and slow-moving portions of rivers (B.C. Ministry of Environment 2015). Terrestrial habitat commonly includes second-growth forests (B.C. Ministry of Environment 2015).
- Critical habitat for sharp-tailed snake (Contia tenuis) (SARA Endangered) has been identified on South Pender Island, near Greenburn Lake but not at the project site. Sharp-tailed snake typically inhabit relatively open-canopy woodlands dominated by Douglas-fir, Arbutus, and/or Garry Oak within the Coastal Douglas-fir Biogeoclimatic Zone (COSEWIC 2009). They are often found near the forest edge or small openings on rocky outcrops and hillsides; occupied sites are usually south facing to provide thermoregulation and have willow soils and leaf litter (COSEWIC 2009). Although not documented in the area, preferred habitat is available on the rocky slope adjacent to Canal Road at the project site. Several cases of road-mortality have been observed on Pender Island (B.C. Conservation Data Centre 2014c).

During the field visit, wildlife trails were observed running parallel with the road (**Photo 10**). A wildlife tree was also observed on the south side of the road near the east extent of the site (**Photo 11**), as well as bones from an unknown mammal (**Photo 12**). No SARA listed species were observed during the field visit.

Cultural Resources

The Coast Salish people – the Saanich and the Songhees – have hunted and fished around Pender Island for thousands of years (Fitzsimmons 2016). Site specific cultural features are not known from the project site currently based on a simple desktop review.

An Archaeological Impact Assessment (AIA) is being conducted for the project to better identify potential sites of concern but had not been completed at the time of writing. Should the AIA identify any cultural resources that would affect the effect analysis conducted herein, the BIA will be updated and Parks Canada notified.

There are no heritage buildings, historical sites or other designated cultural features within the project site.

Visitor Experience

The project area is adjacent to the Beaumont Park of the GINPR and is near the Mount Norman peak and trails. Beaumont Park is one of the most popular marine parks in the Gulf Islands. The park offers various recreational opportunities including camping, picnicking, fishing, paddling, swimming and hiking. Walking trails connect the park with Mount Norman, the highest point on Pender Island.

Visitors to GINPR typically do not utilize the project site for recreation. However, access to Mount Norman is via Canal Road and will be disrupted. Canal Road will remain open to traffic but lane closures and traffic control will be required to conduct project works. It is expected that there will be traffic delays throughout the project.

8. VALUED COMPONENTS LIKELY TO BE AFFECTED

Potential Valued Components (VCs) for the project were identified using the *Effects Identification Matrix* (Appendix 2) following a desktop review of environmental information and field visit using professional judgement, experience, and available best management practices. The VCs are elements of the natural or human environment that are present near the project and would be subject to potential interactions with project activities.

Valued components for which project activities may have an effect include:

- Air
- Soils and Landforms
- Surface Water
- Fish
- Vegetation
- Terrestrial Wildlife
- Archaeological Resources (unidentified)
- Visitor Access and Experience
- Human Safety

The geographic area assessed included the limits of construction for the project (Figure 1) for all VCs. This study area was considered appropriate because of the limited scale of project activities. Road construction activities, even those including slope excavation and blasting, are typically routine in nature and conducted using well-established best management practices that minimize project impacts.

Assessment of effects are limited to the pre-construction (site preparation) and construction phases of the project. Once construction is complete and Canal Road resumes operation, effects to the environment are expected to be similar to pre-project conditions. No decommissioning of the project is anticipated in the foreseeable future. Should decommissioning be required a separate Impact Assessment would be conducted.

The effects of the project on natural or cultural resources are not expected to cause adverse effects to

- Indigenous peoples (e.g., physical and cultural heritage, current use of lands and resources for traditional purposes and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance);
- Health, social and economic conditions of Indigenous and non-Indigenous peoples;
- Characteristics of the environment important to key visitor experience objectives; and
- A listed Species At Risk or their critical habitat.

No indirect effects from the project are anticipated given that the tasks are of a routine nature and all will take place in or immediately adjacent to an existing transportation corridor. The natural environment in transportation right-of-ways is well understood and is considered to be previously disturbed.

***Note**: Should the AIA reveal a previously unknown archaeological or culturally significant site, the project may have direct or indirect effects not currently identified in this BIA.*

9. EFFECTS ANALYSIS

Air

1. Air quality may be impacted during construction of the Project as a result of emissions from vehicles, emissions from mobile equipment and generators.
2. Air quality may be negatively impacted by airborne particles or dust generated by construction activities such as grading and blasting.

Soil and Landforms

1. Project activities such as grading, excavation and grubbing (stump pulling) may disturb and expose soils, and can lead to compaction, erosion, or sedimentation.
2. Accidental spills (e.g., chemicals, fuel, etc.) during construction contaminate soil and negatively impact soil quality.
3. Landforms will be permanently altered by the road realignment and excavation and/or blasting of the slope face on the south side of the road.

Surface Water

1. Accidental spills (e.g., chemicals, fuel, etc.) during construction may enter the unnamed watercourse and negatively affect water quality. Fish, if present, may be harmed or killed by physical contact with deleterious substance and/or because of habitat degradation.
2. Project activities may disturb soils that may mobilize to the unnamed watercourse. Sediment mobilization can negatively affect water quality (i.e., increased turbidity from sediment/soil disturbances during construction).

Fish

1. Aquatic life may be negatively affected in and downstream of the unnamed watercourse near the project site should an accidental spill of harmful substance, or if substantial sediments enter the unnamed watercourse. Fish can be physically harmed (e.g., gill abrasion, chemical exposure) or experience degraded habitat quality.
2. Fish and aquatic wildlife (amphibians) may be negatively affected (e.g., physiological response, behavioural avoidance) by blasting activities that occur close to a watercourse.
3. Aquatic habitat may be destroyed or harmfully altered if construction activities occur within or adjacent to a watercourse (i.e., the riparian zone).

Vegetation

1. Project activities (e.g., clearing and blasting for new highway alignment, equipment movement, material laydown, construction works) will reduce the extent of existing vegetation. Vegetation clearing and tree felling, as well as slope excavation and blasting, will be required for the new road alignment.
2. Vegetation may be damaged by material laydown, equipment movement or personnel movement.
3. Vegetation in the immediate vicinity of the proposed project may be affected by dust accumulation caused by construction activities.
4. An accidental spill of a harmful substance on site could affect surrounding vegetation.

5. Rare vegetation species (see Table 1) have potential to be encountered, though none have been documented at the project site. Although the habitat preferences of the species identified in Table 1 suggest it is unlikely they will be encountered at the project site, rare vegetation may be disturbed or destroyed by project activities.
6. Colonization of non-native and/or invasive species may occur as a result of equipment not properly cleaned prior to coming to a site.
7. Occurrences of existing weeds and non-native, invasive species may be spread which may adversely affect the integrity of existing ecosystems and native vegetation. Invasive species identified at the project site include invasive and non-native vegetation including, scotch broom, common foxglove, common cat's-ear.

Wildlife

1. Mortality of individuals (i.e., road-kill) during mobilization or construction.
2. Avoidance behaviors from local wildlife, including rare species, may occur as a result of increased noise and human presence from project activities resulting in disruption or impediment to wildlife movement.
3. Vegetation removal and soil disturbance (especially the slope excavation) may result in disturbance or destruction of habitat. Project activities may overlap the nesting season (typically March 15 to August 15) and could impact nesting activities. Work conducted during the nesting season will require pre-construction nest sweep to identify bird nests that may be affected.
4. Local wildlife may be harmed or killed by an accidental spill of a harmful substance at the project site. Physical contact with substance contact Wildlife may be physically harmed from physical contact with substance, become sick from ingesting substances after attempting to clean themselves or become sick by feeding in contaminated areas. An accidental spill may also cause habitat degradation or reduced ecosystem function that negatively affects wildlife.
5. Dust generated from work activities may affect air quality, having a short-term negative effect on local wildlife.
6. Garbage and waste generated by the construction activities may attract local wildlife and lead to human-wildlife interactions.

Archaeological Resources (unidentified)

1. Unknown cultural resources (e.g., unidentified archaeological sites) may be affected by project activities such as excavation, vibrations during blasting activities, or reprofiling works.

Visitor Access and Experience

1. Traffic delays are likely to occur during the project.
2. Visitors may experience temporary increased noise and vibration during blasting activities.
3. Visitors may experience a temporary decrease of air quality because of increased dust or emission from equipment.
4. Viewscapes within GINPR are not expected to be altered. Viewscapes along Canal Road will be altered by the road realignment and slope reprofiling.

Human Safety

1. There is potential for accidents/injury to occur to project personnel, public using Canal Road and/or GINPR users during the project. Project activities or elements such as moving equipment, open trenches, tree felling, blasting activities etc. have the potential to cause physical injury or death.
2. Overall, the project is expected to have a positive effect on safety by improving Canal Road conditions.

10. MITIGATION MEASURES

General

1. The project will conform to MOTI's Standard Specifications for Highway Construction, *Section 165, Specifications for Protection of the Environment,* unless otherwise stated in the Special Provisions of the tender package.
2. The Contractor will be required to prepare an Environmental Protection Plan (EPP). The EPP will be developed in accordance with industry best practices and will comply with all applicable federal and provincial legislation. The EPP will include, but is not limited to:
    a. An Access Plan that will identify access routes, type of equipment used for various construction phases, and lay down areas in order to prevent/minimize disturbance to vegetation and soils. Lay down areas will occur on paved and/or hardened surfaces.
    b. Details on how the work limits will be marked and what procedures will be employed to ensure work outside these limits does not occur and to ensure that the environment is not impacted or damaged by workers or construction equipment beyond the work limits.
    c. An Erosion and Sediment Control Plan (ESCP) to prevent erosion and minimize sediment mobilization at the project site. The ESCP will outline appropriate erosion and sediment control measures for the site and include a plan for dewatering, if required.
    d. A Spill Response Plan will be prepared by the Contractor and will detail the containment, storage, security, handling and use of deleterious materials, disposal of empty containers, surplus product or waste generated in the application of these products. The Spill Response Plan will include a list of products and materials to be used or brought to the work site that are considered or defined as hazardous or toxic to the environment.
    e. An Emergency Response Plan that outlines procedures to follow in the case of an emergency (e.g., wildlife encounter, equipment malfunction/failure, fire or blasting incident).
    f. A Fire Prevention Plan which describes the fire prevention equipment (fire extinguishers etc.) and procedures on site in the event of a fire.
3. On-site monitoring is a key component of ensuring that the mitigations provided in this document and in the EPP are implemented properly (e.g., appropriate location and correct installation) and function as intended. A qualified environmental professional should be retained as the Environmental Monitor (EM) to provide guidance on implementing the recommended measures and, if necessary, to develop additional mitigation measures if the need arises. For this project full-time environmental monitoring by the EM is likely not necessary based on the observed site conditions and on the proposed project works. On-site personnel can monitor the site daily, and the EM carry out inspections at regular intervals (as agreed upon by MOTI, Parks Canada and the EM) as well as additional inspections in advance of predicted rainy periods, during heavy rains, and during key phases of site preparation and construction.

4. An on-site ESO may be assigned by Parks Canada to provide periodic and unscheduled site visits to ensure that *project activities occurring within GINPR* are conducted in accordance with all identified environmental protection measures (including, but not limited to those within this document, applicable legislation and construction Best Management Practices). The Contractor is responsible for undertaking environmental monitoring and follow up reporting of remediation works such that criteria in Parks Canada Approvals and the EPP are being adhered to.
5. The EM will have the authority to halt any work that does not comply with regulatory requirements or causes adverse environmental impacts. Failure to comply with or observe environmental protection procedures may result in the work being suspended pending rectification of the problems.
6. All Project works will be conducted in accordance with all applicable legislation, regulations and/or approvals including, but not limited to, the *Fisheries Act*, *Migratory Birds Convention Act, Species at Risk Act* and *Canada National Parks Act*. Project activities are not anticipated to contravene any of these acts if appropriate mitigation is applied. At this time the project does not require any authorizations under these acts.
7. The Contractor must obtain all necessary permits prior to the commencement of Project activities.
8. It is expected that all staff and contactors will understand and comply with all National Park regulations while conducting activities within GINPR.

Spill Management and Hazardous Materials

1. The EPP will contain a section specific to Spill Management. Spill response plans should include spill prevention and spill reporting requirements along with step-by-step procedures for responding to potential spill incidents.
2. Appropriately sized and stocked spill kits will be on site and each piece of equipment. The kits will be suitable for the quantities and types of material in use and stored at the site. They should be capable of dealing with 110% of the largest potential spill. All staff should be aware of their location(s) on site and trained in spill response procedures.
3. Stationary equipment should be placed within secondary containment capable of catching all of fluids in the event of a spill (e.g., place within a plastic or metal tray). Motorized equipment should be parked over a surface capable of containing leaks and minor spill (e.g., plywood, heavy plastic sheeting) or, at a minimum, parked over an impervious surface such as asphalt.
4. Hydrocarbon and coolant storage, if required on site, will be within an impermeable containment facility capable of holding 110% of the storage tank contents. This may be achieved through the use of double-walled storage tanks or constructing a containment berm out of durable material. These containment basins will be inspected daily for leaks and wear points, kept clean and any measurable rainwater removed and disposed of appropriately. If practical, the containment area should be covered to prevent infilling with rainwater. Where leaks and/or wear points are found, they will be repaired promptly to restore full containment.
5. Contractors will ensure that small containers (i.e., jerry cans) will be stored in a secure location, protected from weather. These containers must be designed solely for the purpose of storing and pouring fuel and will not be more than 5 years old. Containers must not leak and must be sealed with a proper fitting cap or lid.
6. The refueling area (if one is required) should be located at least 30 m from any watercourse, if possible. A spill containment kit immediately accessible and personnel should be knowledgeable in its use.

7. Two people should be present during refueling (one person conducting fueling/ready to stop spill source and one person ready to deploy spill containment).
8. Hydraulic fluids for on-site equipment will be biodegradable in case of accidental loss of fluids.
9. Hazardous materials must be labelled and disposed of according to the Workplace Hazardous Materials Information System criteria and the Transportation of Dangerous Goods (TDG) Regulations.
10. A spill of reportable quantities to ground, or of any amount to water, of a substance that is toxic, polluting, or deleterious to life will be immediately reported to Emergency Management BC (EMBC) 24-hour phone line at ***1-800-663-3456*** and to Parks Canada Dispatch and the ESO/EM.

Machinery and Equipment

1. Equipment and machinery should be in good operating condition, clean (power washed), free of leaks, excess oil and grease and non-native plant species. Equipment leaking or producing excessive exhaust should be repaired or replaced. Any detected leaks from equipment on site will be addressed immediately and absorbent pads will be used under equipment with chronic leaks. Equipment stored overnight should be stored on tarps with appropriate containment if required.
2. Machinery should be situated to minimize track movement.
3. Equipment servicing and maintenance should not occur on site.
4. Refueling of equipment should occur on land at least 100 m from any watercourse, where possible. Where 100 m is not possible, a location as far as possible from the watercourse should be chosen. Topographic features and slope should be considered. The refueling area should have a spill containment kit immediately accessible and personnel should be knowledgeable in its use.
5. Vehicles and equipment should be parked at least 10 m from any watercourse either on the road or on previously disturbed or hardened surfaces in order to avoid trampling roadside vegetation and compaction of soils.

Air Quality and Noise

1. Dust-generating activities should be minimized as much as possible during windy periods.
2. If dust suppression is necessary, water should be used in a controlled manner (to avoid sediment mobilization).
3. No burning of oils, rubber, tires and any other material should take place on site.
4. Stationary emission sources (e.g., portable diesel generators, compressors, etc.) should be used only as necessary. Equipment and vehicles should be turned off when not in active use to reduce noise and air pollution.
5. All equipment, vehicles and stationary emission sources should be well-maintained and used at optimal loads to encourage minimal noise and air emissions.
6. The Blaster of Record will ensure the blast zone is clear of people and wildlife prior to detonation. Materials to be blasted may be covered with suitable material (i.e., blast mats), if necessary, to control fly-rock.
7. To minimize noise and dust generation, blasting activities should be conducted according to industry best management practices and tender specifications. Contractors should determine appropriate charge size, pattern design and spacing to create efficient blasting and minimize frequency/size of detonation while accomplishing the task.
8. Blasting products that may produce high residual nitrogen concentrations (such as ANFO) should not be used.

Soils and Landforms

1. Existing access routes and storage sites should be utilized where possible. Previously disturbed and stable (hard surface) are preferable.
2. Minimize the movement of equipment by planning work and situating in locations to maximize efficiency.
3. Limit access and movement to only necessary personnel and equipment.
4. Schedule earthworks for dry weather whenever possible and halting works during periods of inclement weather (e.g., significant wind or rain).
5. Minimize the area of soil exposed at any one time by: phasing construction activities; retaining vegetation as much as possible; and, once construction works are completed, stabilize the exposed soils as soon as possible using temporary measures such as mulch, erosion sediment control blankets, hydroseeding, and/or plastic sheeting or planting long-term vegetation (if during the appropriate time of year).
6. Erosion and sediment control measures, as described in the ESCP, should be installed prior to work starting and checked by the EM. Ensure additional erosion and sediment control materials are readily available on-site such as (but not limited to) rock, gravel, grass seed, silt fencing, staking, polyethylene sheeting, etc. When significant rainfall is encountered, then additional measures may be required to minimize erosion and sedimentation potential.
7. Routinely inspect erosion and sediment control measures to ensure they are functioning as intended.

Surface Water and Fish

Mitigation measures 1 to 23 and 35 to 38 are applicable to minimize potential effects to surface water and fish. In addition, the following measures should be applied:

1. Although instream works are not currently part of design plans, any work conducted in or within 30 m of the unnamed watercourse should be conducted during the period of least risk timing, if possible, to protect fish and amphibians, including their eggs, juveniles, spawning adults, and/or the organisms upon which they feed. The reduced risk timing window for all species on Vancouver Island is June 15 to September 15. No fish sampling was conducted in the unnamed stream and, given its steep slope and willow depths it is unlikely that fish are present.
2. Minimize disturbance to riparian vegetation. Should vegetation that contributes to fish habitat be removed, restore the vegetation as soon as possible.
3. Conduct blasting activities to meet or exceed the standards outlined in Department of Fisheries' and Ocean's (DFO's) "Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters" (Wright and Hopky 1998)
4. Maintain the natural hydrological regimes during all phases of activity where possible.

Vegetation

Mitigation measures 1-18, 23, 32 to 34, 36 and 40 are applicable to minimize potential effects to vegetation. In addition, the following measures should be applied:

1. Minimize vegetation clearing or disturbance as much as possible. The area(s) to be cleared should be clearly marked with highly visible materials (i.e., flagging tape, snow fencing) to ensure equipment operators are aware of the area they are to work in.
2. Equipment operators should work carefully to ensure they do not cause mechanical damage to trees and other vegetation outside the designated clearing area.

3. Avoid felling mature trees (DBH >30 cm) where possible.
4. Mark danger trees and clearly establish “no-work” zones.
5. Minimize bare soil exposure (e.g., cover stockpiled material with tarps, plant native species, cover with natural mulch/ground coverings) and restore all temporarily disturbed areas as quickly as possible to discourage invasive plants from establishing. A seed mix approved by both MOTI and Parks Canada should be used.
6. Use clean fill (i.e., fresh crushed) to minimize potential introduction of invasive plants.
7. Train employees on identification, safe removal, and disposal of invasive and noxious weeds.

Wildlife

Mitigation measures 1-18, 29, 30, 39 to 41, and 43 to 45 are applicable to minimize potential effects to wildlife. In addition, the following measures should be applied:

1. Conduct work outside sensitive wildlife periods (nesting, rutting, breeding, etc.) as much as possible. Avoid vegetation removal that will affect trees used by birds (both migratory and non-migratory) and other wildlife (e.g., bats), wherever possible while they are breeding, nesting, roosting, or rearing young.
    a. Environment Canada’s General Regional Nesting Period for Vancouver Island, Zone A1 is mid-March to mid-August (Government of Canada 2018).
    b. The maternity period for bats when non-volant pups may be present in tree roosts typically occurs from early May to late August (B.C. Ministry of Environment 2016b).

Table 3: Environmental Timing Windows Table

<table>
<tr><th></th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Fish</td><td colspan="6">AVOID INSTREAM WORK</td><td colspan="3">Least risk window for work in and around freshwater:
June 15 – Sept 15</td><td colspan="3">AVOID INSTREAM WORK</td></tr>
<tr><td>Birds</td><td colspan="3">Reduced risk for harm to birds</td><td colspan="4">AVOID VEGETATION REMOVAL
Bird Nesting Period:
Mid March - Mid August</td><td colspan="4">Reduced risk for harm to birds</td></tr>
<tr><td>Bats</td><td colspan="5">Bat in Hibernacula</td><td colspan="3">Bats Nursing Pups
Early May-Late August</td><td></td><td colspan="2">Bat in Hibernacula</td></tr>
<tr><td>Sharp Tailed Snake</td><td colspan="2">Avoid disturbance of Hibernacula</td><td colspan="3"></td><td colspan="3">Peak: breeding, young Mitigate Road mortality</td><td></td><td colspan="2">Avoid disturbance of Hibernacula</td></tr>
</table>

2. Where works are required to occur within sensitive wildlife periods, such as bird nesting or bat maternity, an appropriately qualified professional (AQP) will be required to assess the complexity of habitat, species presence, timing, and nature of work to determine if activities can be permitted without harm to sensitive wildlife. The AQP will develop a site-specific plan in accordance with ECCC guidelines.

3. If vegetation clearing is required during the nesting season, a pre-disturbance survey must be conducted by an AQP to identify any breeding, nesting, roosting or rearing birds and determine species-specific BMPs.
4. In addition to conducting a pre-disturbance nest survey, trees felled during the nesting period may require a Restricted Activity Permit from PCA. The Contractor should consult with PCA to determine the need for and specific requirements of a RAP.
5. If the nest of a bird afforded year-round protection is found (e.g., raptors), regardless of whether it is active, an AQP must determine if there is potential for the nest to be directly affected by Project construction activities (i.e., if the nest will be removed)
6. The Contractor or person with primary responsibility for the site, is responsible to notify all personnel, including any sub-contractors, of the buffer zone, conduct activities as directed to minimize disturbance, and remain outside of its boundaries.
7. The EM will monitor the area during construction to confirm the established buffer zone is effective. If there is evidence that buffer is ineffective (e.g., continued agitation/guarding behaviour, frequently leaving the nest) work must stop immediately and the buffer zone adjusted by the AQP. The buffer zone can only be removed upon confirmation from the EM and/or AQP that young have left the nest.
8. Where catchment ditch clearing is required, an AQP should inspect ditches with water for breeding amphibians. Schedule such clearing activities to avoid sedimentation during periods where larvae or eggs may be destroyed, where possible.
9. Avoid felling wildlife trees, where possible.
10. PCA will be notified immediately in the event of human-wildlife interactions, or activity or encounters with bears, cougars, or any species at risk. In the event of encounters with dens, litters, nests, carcasses (road kills), bear activity or wildlife encounters in or around the project site, the EM, ESO and Departmental Representative will be immediately notified. Other wildlife-related encounters will be reported within 24 hours. Provide training for site personnel and subcontractor in reporting procedures of incidental wildlife observations and techniques for avoiding interactions with wildlife.
11. Feeding, harassment or destruction of any wildlife is strictly prohibited.
12. Wildlife encountered at or near the project site will be allowed to passively disperse without undue harassment. Because of the potential for an encountered snake or amphibian species at risk (i.e., sharp-tailed snake, northern red-legged frog), notify the EM and delay work until advised otherwise.
13. Store all food, food waste, fuels, oils, lubricants, sanitary waste, and other wildlife attractants in sealed containers. Avoid mixing food waste with construction waste; collect waste regularly for regular off-site disposal.
14. Install wildlife crossing/roadkill prevention signage and other traffic calming measures (i.e., reduce speed signs, speed bumps, etc.) to inform visitors to reduce speed and mitigate the potential for roadkill.
15. Prior to blasting, “sweep” the work area and maintain a continuous watch for wildlife that may be present. If wildlife is present, stop work until the wildlife have passed through the area and/or have been hazed out of the area by the EM, representative of Parks Canada or appropriately qualified biologist. The sweep will be done as soon before blasting and as close to the blasting as can be safely achieved. Binoculars will be used where needed.

Archaeological Resources (Unidentified)

1. Complete an Archaeological Impact Assessment (AIA) prior to construction commencing to inform mitigation measures.

2. Develop and implement an Archaeological Chance Find Procedure (if it is not included in the AIA).
3. Have cultural monitors present during any ground disturbance activities.
4. If previously unknown artifacts or features are encountered, cease work in the immediate area, and notify the EM who will make appropriate notifications. Should the chance find occur within GINP, Parks Canada's Terrestrial Archaeology Section will be notified. The PCTAR will provide advice and assessment of significance that will in turn determine what will be required to mitigate the chance find. Leave artifacts in place until a Parks Canada archaeologist has been consulted.

Visitor Access and Experience

Visitor access and experience will be temporarily disrupted during the project. Implementing the mitigation measures to protect natural and cultural resources (i.e, mitigation measures 1 to 67) will contribute to the project being completed efficiently which will minimize effects to this VC. In addition, the following mitigation should be applied:

1. Continuously review and update the "Traffic Control Plan" to reflect the current stage of construction.
2. Canal Road and Mount Norman Access Road will remain open throughout the project, but lane closures and traffic control will be required. Provide measures for protection and diversion of traffic including provision of flagpersons, erection of barricades, erection of warning and directional signage (i.e., posted speed limits, speed bumps, etc.).
3. Provide a minimum of 24 hours notification for any lane closures.
4. Maintain access to property and trail head on Mount Norman Access Road, including overhead clearances for use by emergency response vehicles.

Changes to the viewscape with GINPR are anticipated to be unchanged. Changes to the viewscape along Canal Road as a result of a new road alignment and slope reprofiling on the south side of the road will be permanent and cannot be mitigated. However, these changes are not considered to represent a significant change from existing viewscape conditions.

Human Safety

Mitigation measures 2, 9 to 18 and 29 are applicable to minimize potential effects to public. In addition, the following measures should be applied:

1. All personnel will be instructed to abide by all applicable Work Safe BC guidelines and will complete a project-specific worker safety orientation prior to working on site.
2. All personnel will wear the personal protective equipment (PPE) appropriate for the task being completed.
3. Ensure public safety at all times including off hours.
4. Public access to the active work area will be denied during project activities.
5. No fires are permitted at the project site and adequate fire response equipment will be available to respond to accidental fires.
6. In case of fire, personnel will immediately take action to extinguish the fire if safe to do so. If the fire cannot be extinguished 911 will be called.

11. OTHER CONSIDERATIONS

☐ **Comments received from public/stakeholder engagement**

☒ **Indigenous peoples engagement or consultation**

Local Indigenous communities were engaged early in project design; 14 bands with potential interest in the project area were identified. Pender Island Indian Reserve #8, home to members of the Tsawout and Tseycum First Nations, is located approximately 1.7 km south of the project site. On December 8, 2021, MOTI's Indigenous Relations Advisor, Morganne Franssen, provided an initial project notification letter to local Indigenous Group describing the project and inviting comment and participation. On December 23rd, an Environment, Archaeology and Geotechnical update letter was sent to Indigenous communities. MOTI's Archaeology consultant, Wood, also sent a Notice Of Intent to local Indigenous Groups for their planned Archaeology Impact Assessment with a request for First Nation participants. Comments from Indigenous communities have been focused on concern for impacts to cultural or archaeological resources potentially present at the project site. Tsawout First Nation and Malahat Nation have provided cultural monitoring during Geotech and environmental field investigation activities, to date. MOTI will continue to consult with First Nations throughout the design phases of the project.

☒ **Surveillance (Environmental Monitoring)**

As per mitigation #3, a qualified environmental professional should be retained as the Environmental Monitor (EM) to provide guidance on implementing the recommended measures and, if necessary, to develop additional mitigation measures if the need arises. For this project full-time environmental monitoring by the EM is likely not necessary based on the observed site conditions and on the proposed project works. On-site personnel can monitor the site daily, and the EM carry out inspections at regular intervals (as agreed upon by MOTI, Parks Canada and the EM) as well as additional inspections in advance of predicted rainy periods, during heavy rains, and during key phases of site preparation and construction. The EM will be available via phone and/or email to respond to environmental incidents and provide guidance for enacting the requirements of the project, including the EPP.

Each monitoring event (both those conducted by the EM and any on-site representative) will be documented to record compliance with the project requirements, as well as any areas of concern and incidents and actions taken to resolve them. Photographs will be taken as additional documentation.

☒ **Follow-up monitoring**

The EM should conduct a final site visit to evaluate the effectiveness of mitigation measures implemented during the project and to ensure that site conditions have been restored as close as reasonably possible, to pre-construction conditions.

At this time there is no anticipation of regulatory requirements for follow-up monitoring.

☐ **SARA Follow-up monitoring**

12. SIGNIFICANCE OF RESIDUAL ADVERSE EFFECTS

Residual adverse effects (i.e., negative effects that remain after taking into account "the implementation of technically and economically feasible mitigation measures" (CEAA 2016)). Residual effects are characterized based on qualitative descriptions of five key criteria (Table 4).

Table 4: Residual Effects Criteria

Criteria	Rating Term	Definition
Magnitude	Negligible	Effect will produce no detectable change from baseline conditions.
	Low	Effect is within range of baseline conditions or natural variation.
	Moderate	Effect is at or slightly exceeds baseline conditions or the limits of natural variation.
	High	Effect will produce a notable change beyond baseline conditions or the upper or lower limits of natural variation.
Geographic Extent	Project Area	Effect is limited to the immediate Project area.
	Local	Effect includes the Project area and extends to an area immediately surrounding it (Project area + 1 km buffer).
	Regional	Effect has implications to Region (Project area + 5 km buffer).
	Broad	Effect has implications beyond Region.
Duration	Short Term	Effect present during Project activity or for a short period after (i.e., <3 months).
	Medium Term	Effect remains after Project activity is complete (i.e., multiple seasons or 3 months to 2 years).
	Long Term	Effect remains well beyond end of activities (i.e., >2 years).
Frequency	Once	Effect occurs once.
	Intermittent	Effect occurs more than once but without regularity.
	Continuous	Effect occurs continuously.
Reversibility	Non-reversible	Effect will not be reversed when activity ceases.
	Partially Reversible	Effect will be partially reversed when activity ceases.
	Reversible	Effect will be reversed when activity ceases.

Once the criteria are determined for the residual effect, significance is determined. While the Canadian Government provides some broad guidelines (under the previous *Canada Environmental Assessment Act* and the current *Impact Assessment Act)*, there is no prescribed methodology to determine significance.

Hemmera has used a three-part matrix to standardize assessment of significance. **Step 1** includes rating magnitude, geographic extent and duration. These three criteria were selected as the foundation for significance because if these occur at the low end of their ratings, other criteria are also likely to be low. As magnitude of impact increases, extent of an effect widens or persists for longer, the potential for significance increases.

Effects that are *Potentially Significant* based on magnitude, geographic extent and duration continue in **Step 2** where frequency and reversibility are considered. Effects that occur repeatedly and cannot be reversed are more likely to be significant than those that occur sporadically and are reversible. In this step, only effects that are reversible are considered Not Significant; all other effects are considered *Significant* and continue to Step 3.

Finally, in **Step 3**, the likelihood of occurrence for *Significant* residual effects is evaluated based on professional judgement and experience with similar past environmental effects. A proponent may consider *Significant* residual effects to be acceptable when the likelihood of it occurring is low.

Table 5: Significance Rating Criteria

Step 1: All residual effects included			
Impact Magnitude	**Geographic Extent**	**Duration**	**Significance**
Negligible	Any	Any Duration	Not Significant
Low	Any	Any Duration	Not Significant
Moderate	Project Area	Any Duration	Not Significant
	Local	Short-term	Not Significant
		Medium-term	Not Significant
		Long-term	*Potentially Significant*
	Regional	Short-term	Not Significant
		Medium-term	*Potentially Significant*
		Long-term	*Potentially Significant*
	Broad	Short-term	Not Significant
		Medium-term	*Potentially Significant*
		Long-term	*Potentially Significant*
High	Project Area Local	Short-term	Not Significant
		Medium-term	Not Significant
		Long-term	*Potentially Significant*
	LSA Regional	Short-term	Not Significant
		Medium-term	*Potentially Significant*
		Long-term	*Potentially Significant*
	RSA	Any Duration	*Potentially Significant*
	Broad	Any Duration	*Potentially Significant*

Step 2: *Potentially Significant* effects continue below		
Frequency	**Reversibility**	**Significance**
Once	Reversible	Not Significant
	Partially Reversible	*Significant*
	Non-Reversible	*Significant*
Intermittent	Reversible	Not Significant
	Partially Reversible	*Significant*
	Non-Reversible	*Significant*
Continuous	Reversible	Not Significant
	Partially Reversible	*Significant*
	Non-Reversible	*Significant*
Step 3: *Significant* effects continue below		
Likelihood	**Description**	
Low	Effect unlikely but could occur	
Medium	Effect likely but may not occur	
High	Effect will likely occur	

For most potential effects of the project it is anticipated that there will be ***no significant adverse residual effects*** to natural resources (including species at risk), Indigenous rights as established by section 35 of the Constitution Act, 1982, or cultural resources a result of the proposed project provided all mitigation measures discussed in this report are followed.

However, the permanent alteration of landscape and changes to viewscape due to the road realignment and slope reprofiling is a permanent effect that cannot be mitigated and is a residual effect. Based on the criteria and methodology summarized in Tables 4 and 5, the permanent alteration of landscape is considered to be ***not significant***:

Interaction	Residual Effect	Step 1				Step 2			Step 3
		Magnitude	Geographical Extent	Duration	Significance	Frequency	Reversibility	Significance	Likelihood
Air Quality and Noise									
Landforms will be permanently altered by the road realignment and excavation and/or blasting of the slope face on the south side of the road.	Permanent alteration of landscape	Low	Project Area	Continuous	Not Significant	-	-	-	-

13. EXPERTS CONSULTED

Department/Agency /Institution:	**Date of Request:** YYYY-MM-DD
Expert's Name & Contact Information:	**Title:**
Expertise Requested:	
Response:	

14. DECISION

Taking into account implementation of mitigation measures outlined in the assessment, the project is:

☒ not likely to cause significant adverse environmental effects.
☐ likely to cause significant adverse environmental effects.

FOR SARA REQUIREMENTS:

☒ Residual adverse effects to species at risk are not likely, and therefore, the SARA Permit Decision Tool was not required

15. RECOMMENDATION AND APPROVAL

Prepared by: IA author: Andrea Au, B.Sc., BIT Environmental Specialist Hemmera Envirochem Inc. IA Reviewed by: Shawneen Walker, B.Sc., R.P.Bio., P.Biol. Senior Environmental Assessment and Permitting Lead Hemmera Envirochem Inc.	Date: March 24, 2022 Date: March 24, 2022
Recommended by: Project leader (name):	Date:
Approval Signature: Name & position (*Field Unit Superintendent, Director of a Waterway)*:	Date:

16. REFERENCES

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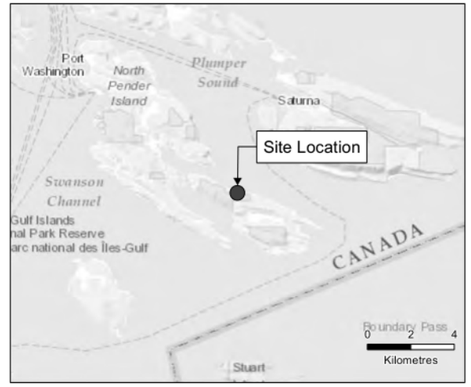
Figure 1: Project Overview

Canal Road BIA
Canal Road, South Pender Island, BC

Project Overview



Legend

- Scotch broom
- Wildlife tree
- Existing Road Edge
- Proposed Road Edge
- Watercourse
- Property Line

Notes

1. All mapped features are approximate and should be used for discussion purposes only.
2. This map is not intended to be a "stand-alone" document, but a visual aid of the information contained within the referenced Report. It is intended to be used in conjunction with the scope of services and limitations described therein.

Sources

- Contains information licensed under the Open Government Licence - Province of British Columbia
- Aerial Image: ESRI World Imagery
- Inset Basemap: ESRI World Topographic Map

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Hemmera
An Ausenco Company

BRITISH COLUMBIA Ministry of Transportation and Infrastructure

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Appendix 1: Photographs

Photo 1 Canal Road - western limit of site with road failure observed. Photo taken looking east on February 17, 2022.

Photo 2 Representative photo of young coniferous forest upslope of Canal Road. Photo taken looking east on February 17, 2022.

Photo 3 Representative photo of coniferous forest observed upslope of Canal Road. Photo taken looking south on February 17, 2022.

Photo 4 Mature trees observed upslope of Canal Road. Photo taken looking north on February 17, 2022.

Photo 5 Scotch broom observed just east of existing culvert on north side of Canal Road. Photo taken looking northeast on February 17, 2022.

Photo 6 Unnamed watercourse that crosses Canal Road; looking upstream from the south side of Canal Road. Photo taken looking south on February 17, 2022.

Photo 7 Unnamed watercourse at culvert outlet on north side of Canal Road. Photo taken looking south on February 17, 2022.

Photo 8 Unnamed watercourse looking downstream from the north side of Canal Road; looking towards the confluence with the ocean. Photo taken looking north on February 17, 2022.

Photo 9 Roadside ditch observed on the south side of Canal Road. Photo taken on February 17, 2022.

Photo 10 Potential wildlife trail; parallels road, approximately 30 m south. Photo taken looking east on February 17, 2022.

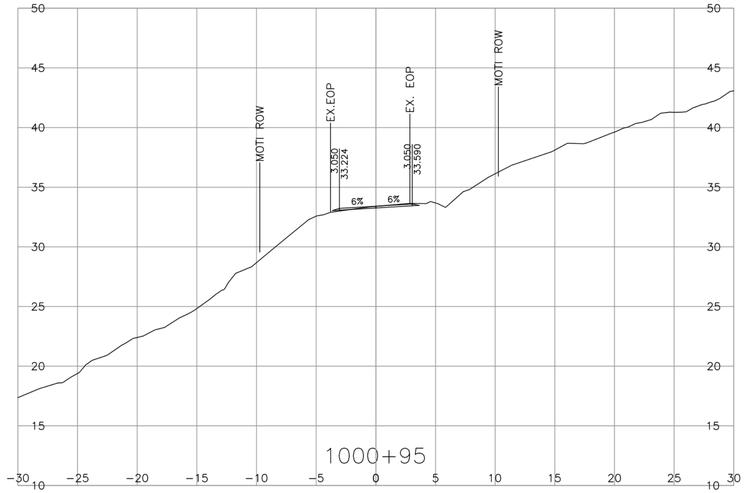
Photo 11 Wildlife tree (decay class ~7) with visible holes. Photo taken looking south on February 17, 2022.

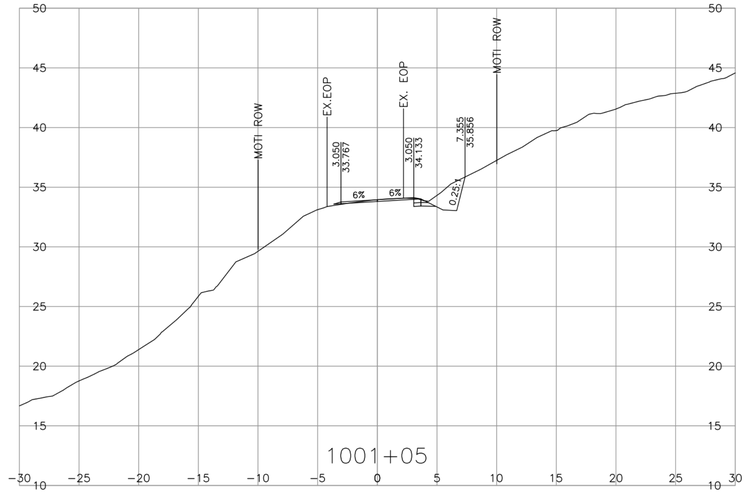
Photo 12 Wildlife bones, potentially a young deer dear, observed on the south side of Canal Road, near the east extent of the site. Photo taken February 17, 2022.

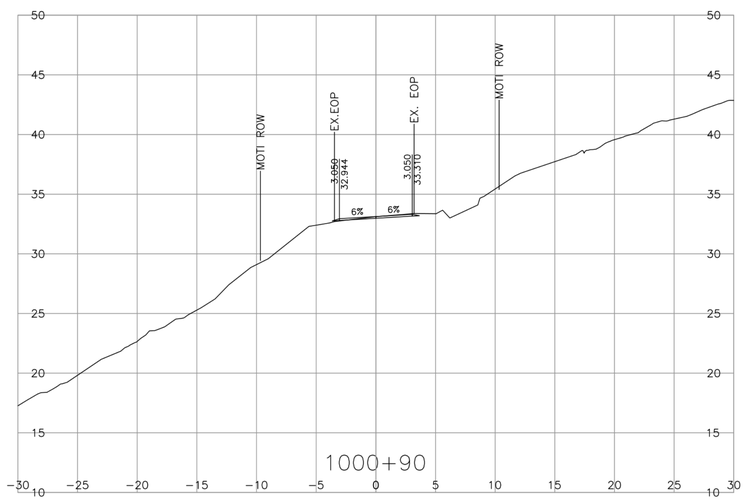
Appendix 2: Effects Identification Matrix

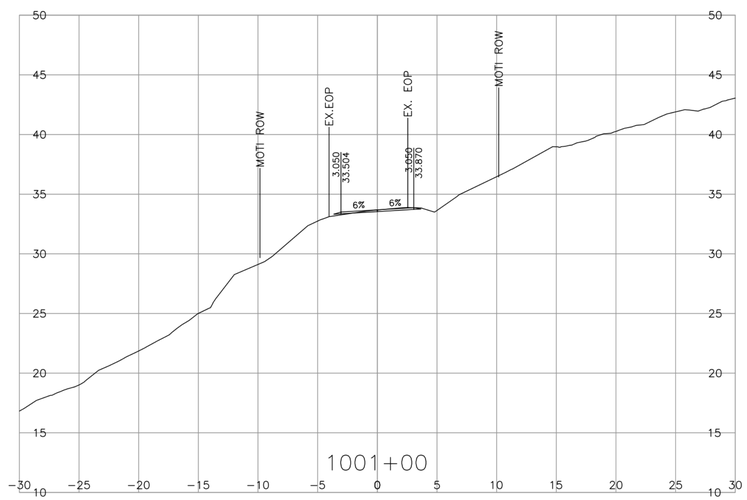
Table A: Direct Effects									
	Valued components potentially directly affected by the proposed project phases								
	Natural Resources						Cultural Resources		
	Air	Soil & Landforms	Surface Water	Fish	Vegetation	Terrestrial Wildlife	Archaeological Resources	Visitor Access and Experience	Public Safety
Associated Activities									
Supply and storage of materials		x	x		x	x	x	x	x
Vegetation clearing		x	x	x	x	x	x	x	x
Waste disposal						x		x	x
Blasting	x	x		x	x	x	x	x	x
Excavation		x	x	x	x	x	x	x	x
Grading		x	x	x	x	x	x	x	x
Backfilling		x					x	x	x
Use of machinery/ generators	x	x				x	x	x	x
Transport of materials/ equipment	x	x				x	x	x	x
Use of chemicals/ hazardous material	x	x	x	x	x	x			x
Paving	x	x	x					x	x
Maintenance		x				x		x	x
Planting/Seeding					x	x			
Vehicle Traffic	x								

Appendix 3: Design Drawings









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REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

SENIOR DESIGNER
DATE 2022-04-01

DESIGNED A. PAN DATE 2022-04-01
QUALITY CONTROL B. OYSTENSEN DATE 2022-04-01
QUALITY ASSURANCE J. PINTO DATE 2022-04-01
DRAWN G. HAROON DATE 2022-04-01

CROSS SECTIONS

CANAL ROAD REMEDATION

STA. 10+000.000 TO 20+000.000

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
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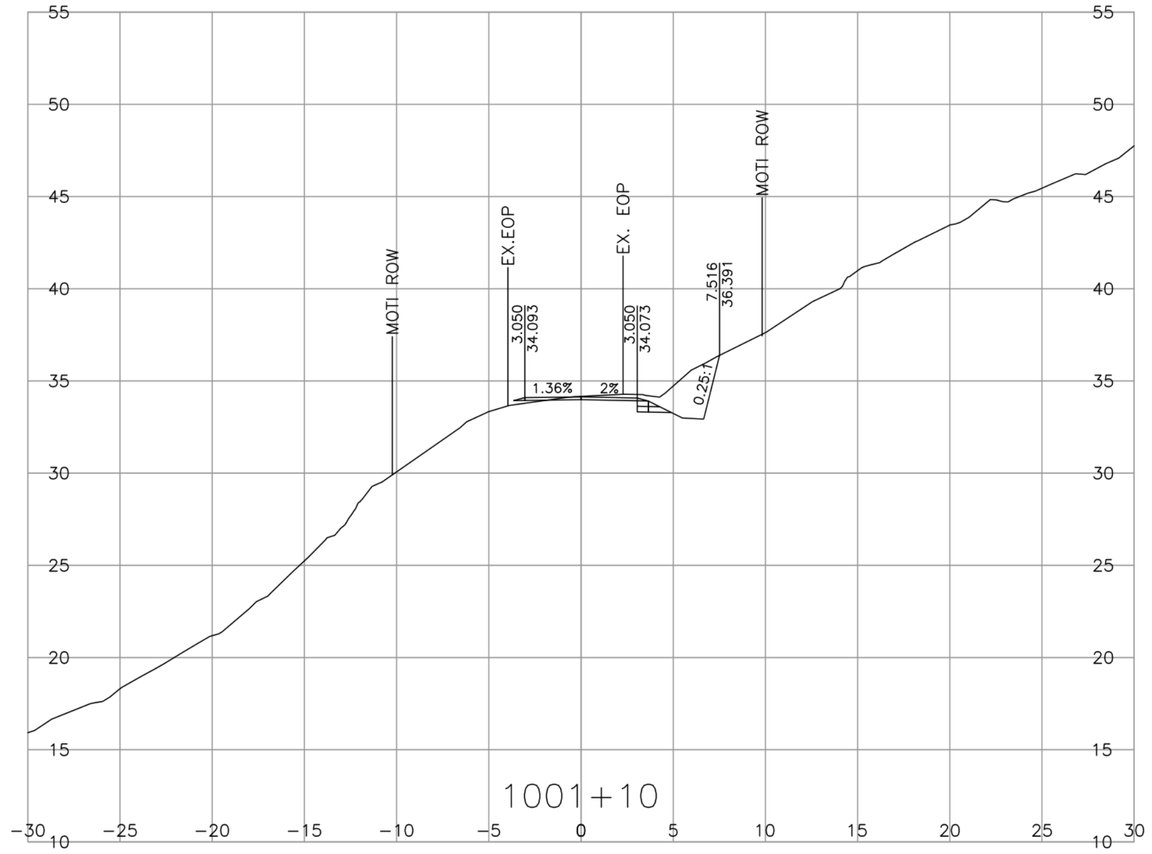

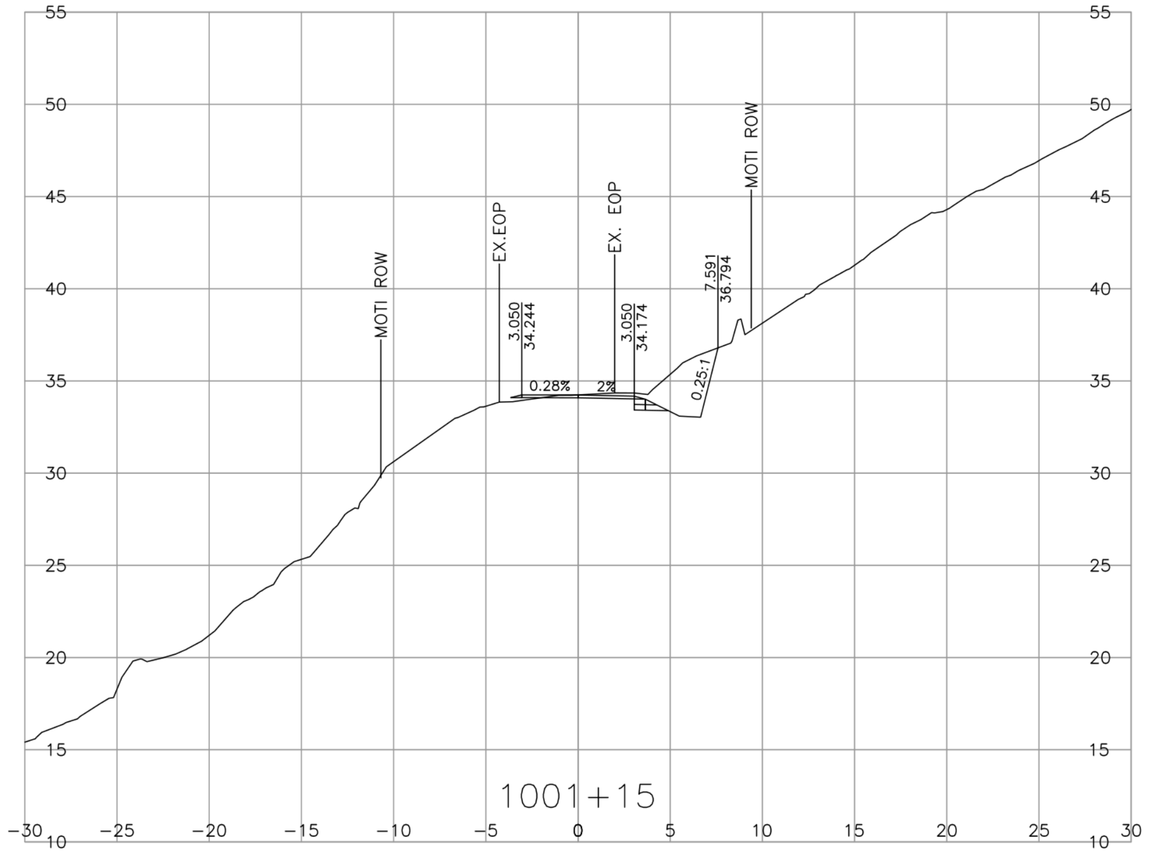

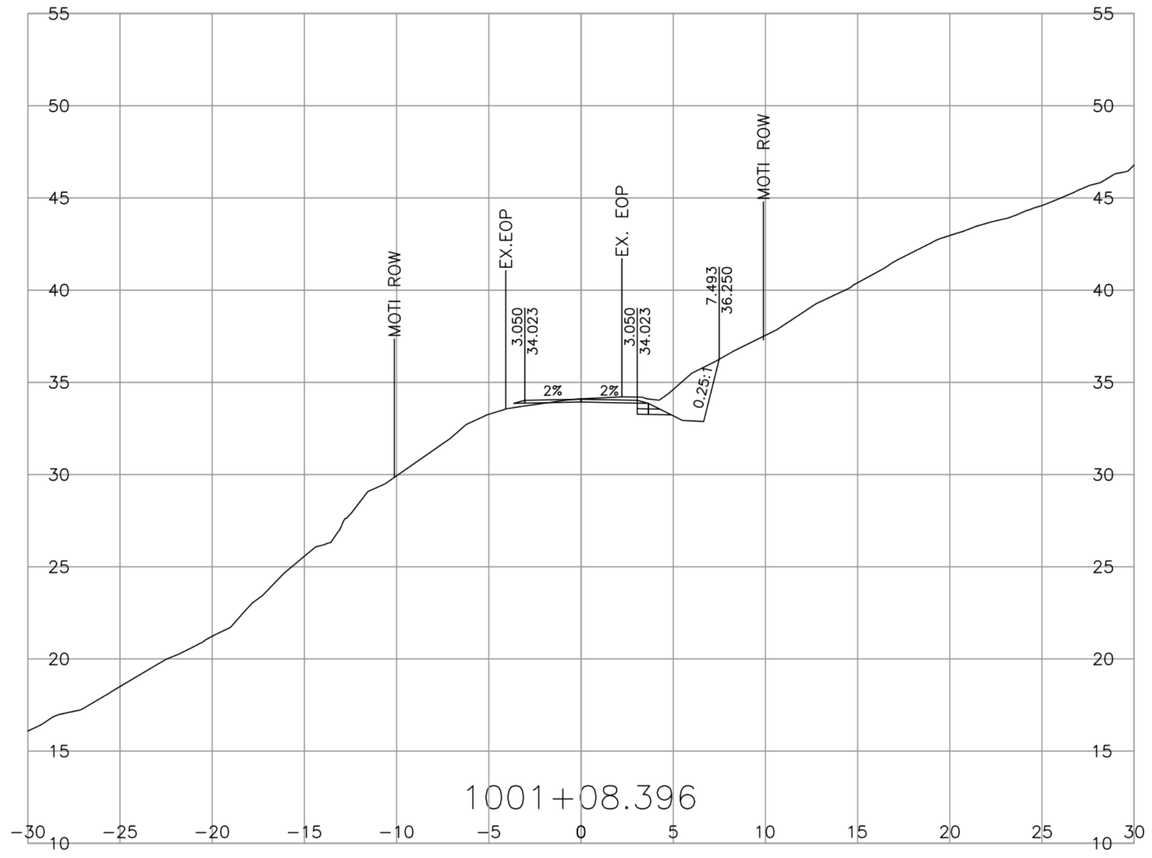

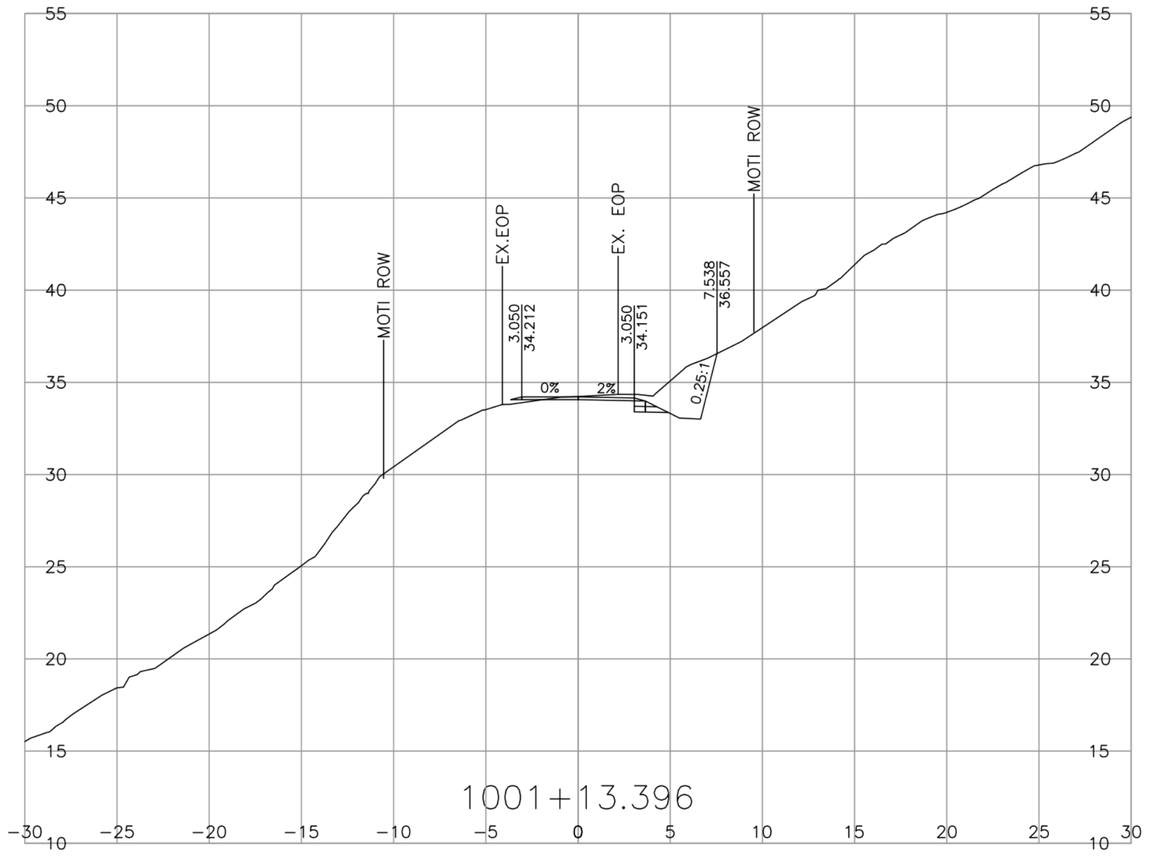

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REV	DATE	REVISIONS	NAME
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BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

J. PINTO
SENIOR DESIGNER
DATE 2022-04-01

DESIGNED A. PAN DATE 2022-04-01
QUALITY CONTROL B. OYSTENSEN DATE 2022-04-01
QUALITY ASSURANCE J. PINTO DATE 2022-04-01
DRAWN G. HAROON DATE 2022-04-01

CROSS SECTIONS

CANAL ROAD REMEDATION

STA. 10+000.000 TO 20+000.000

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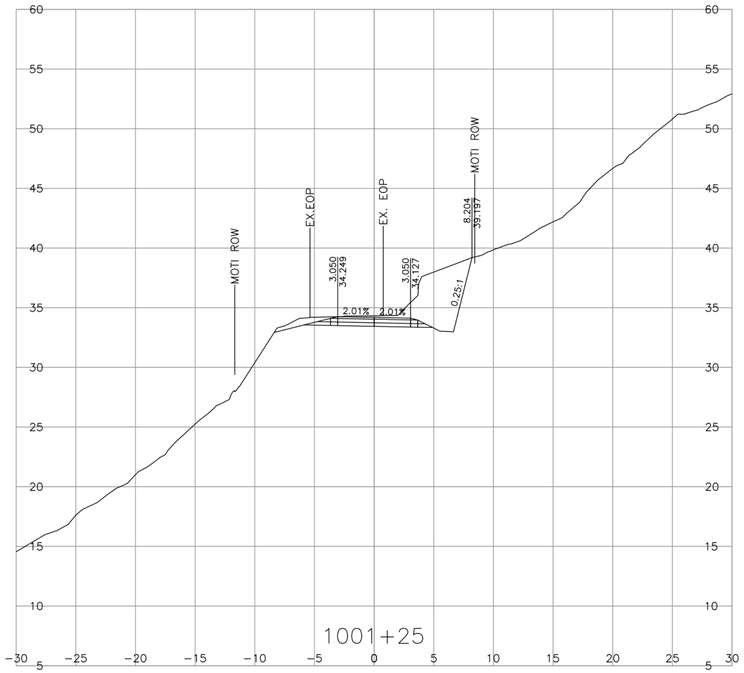

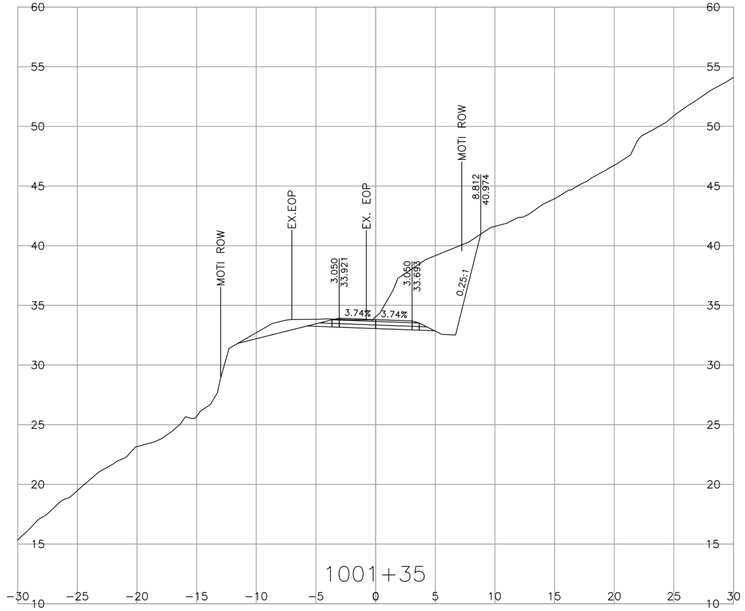

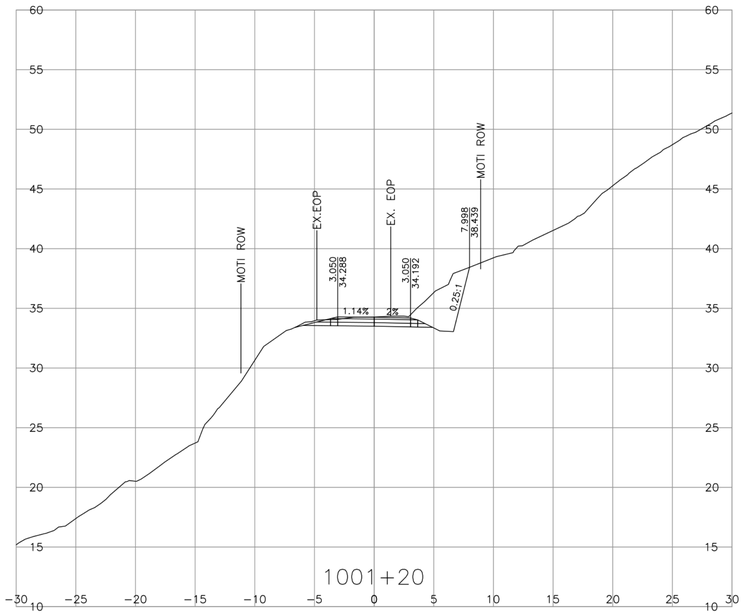

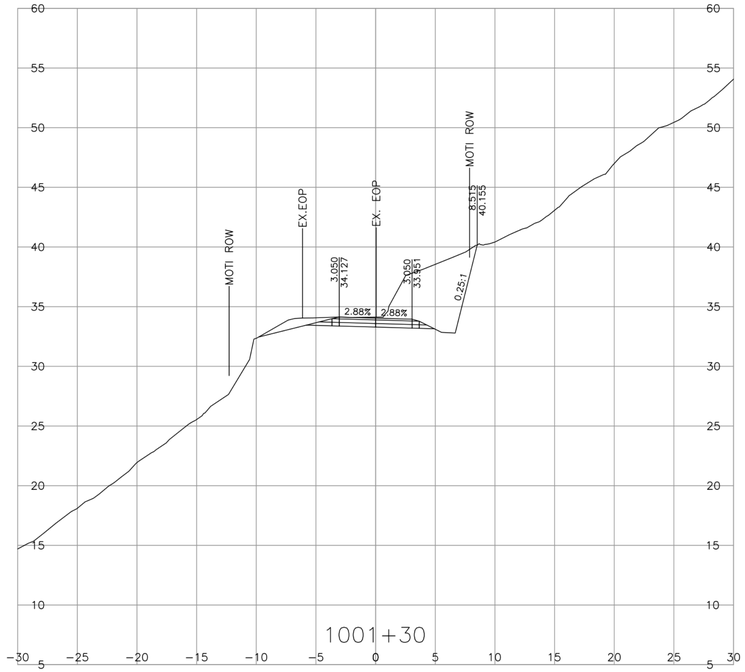

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REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

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CROSS SECTIONS

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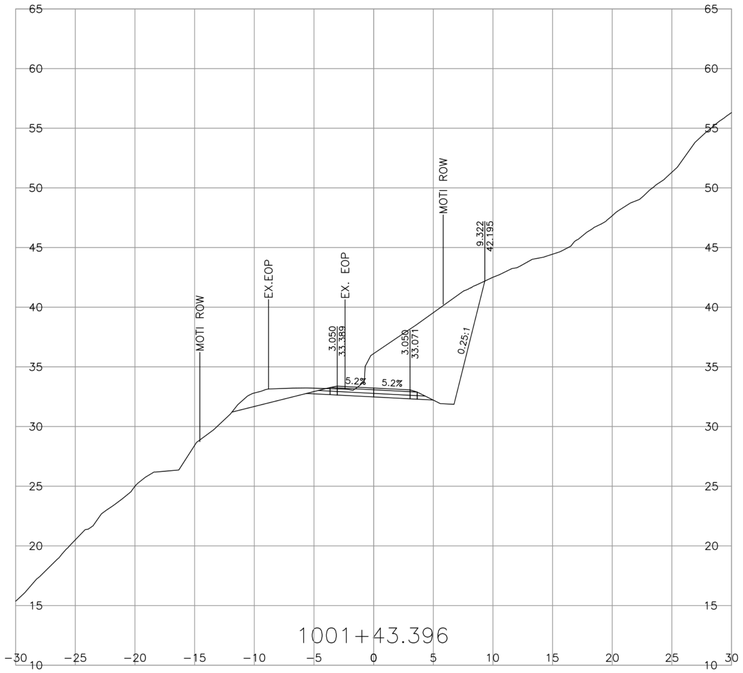

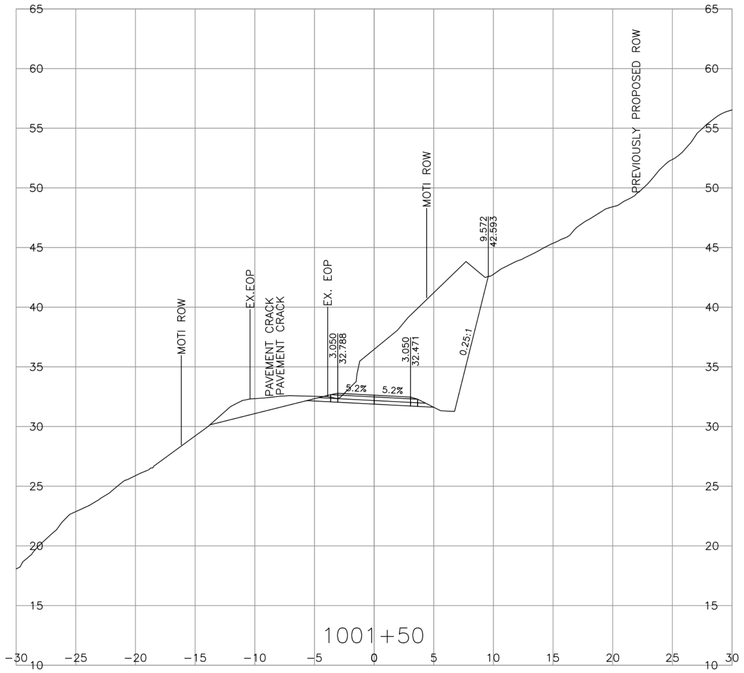

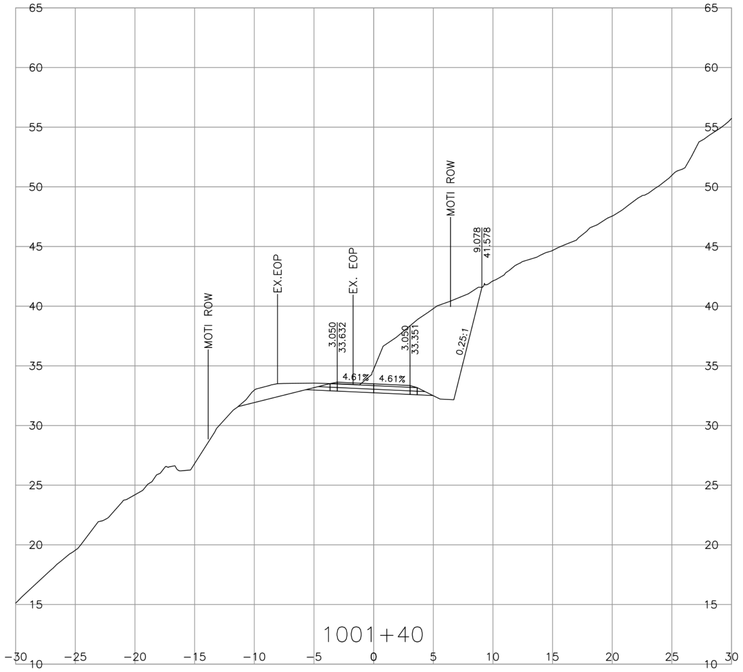

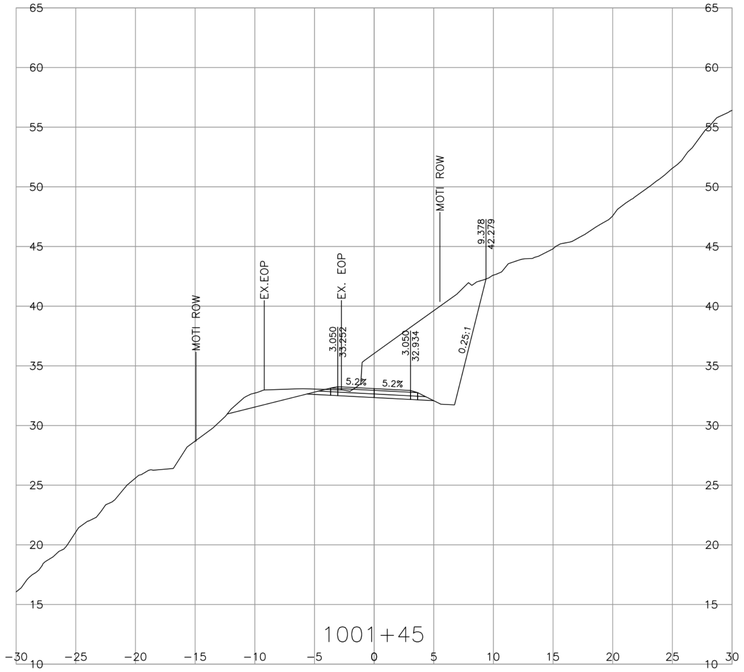

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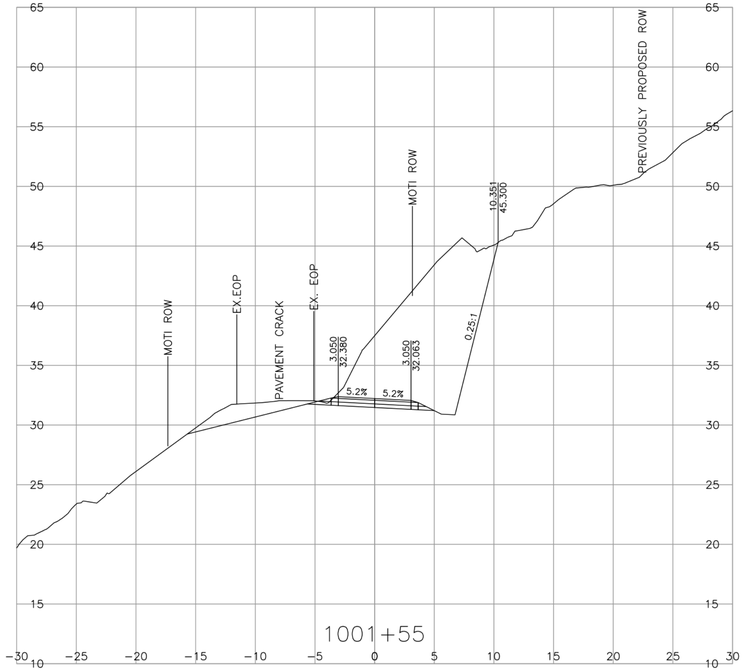

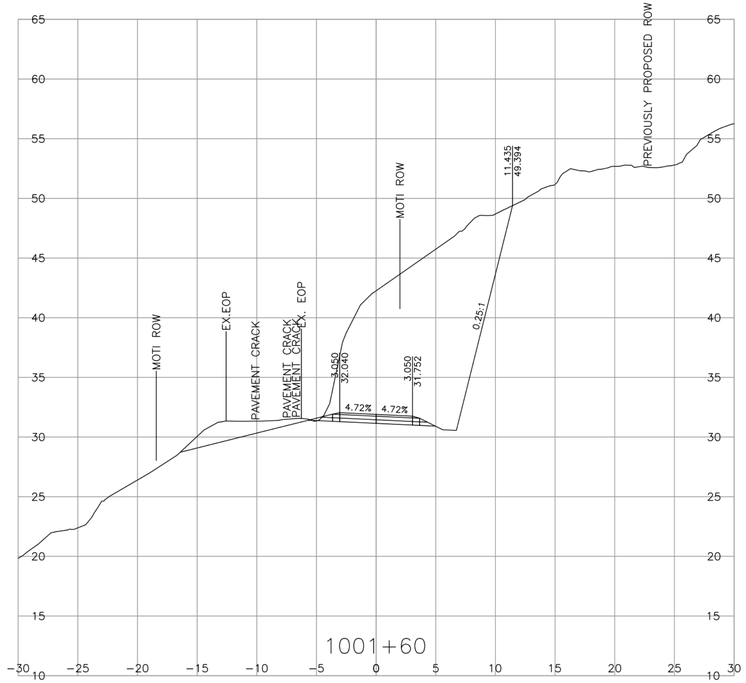

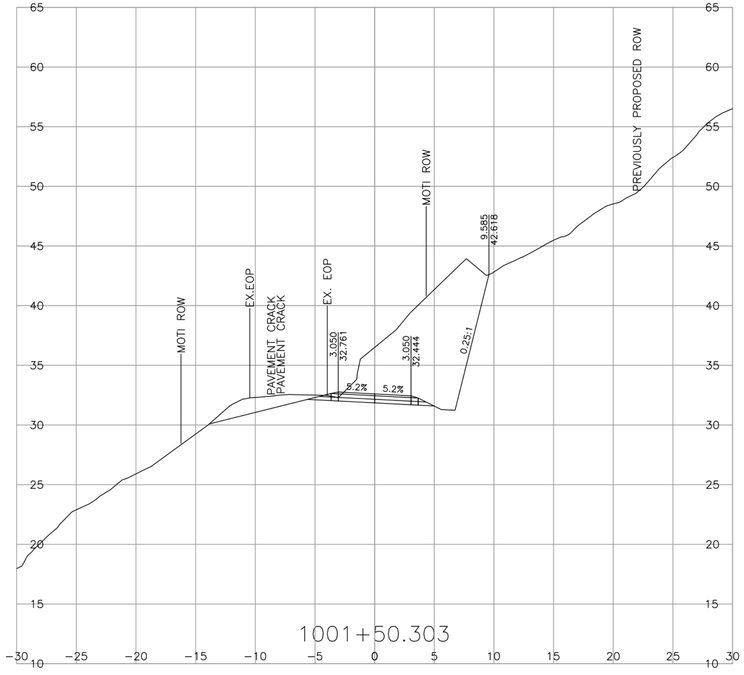

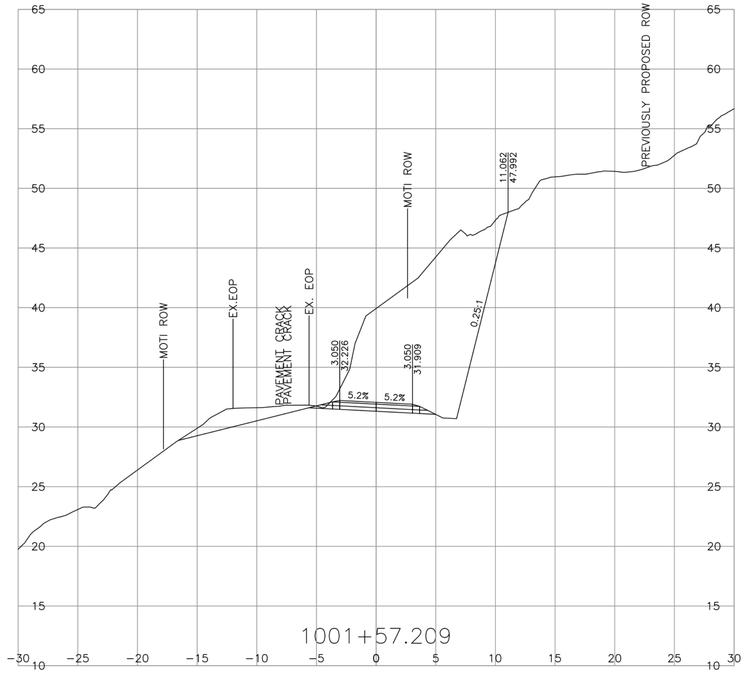

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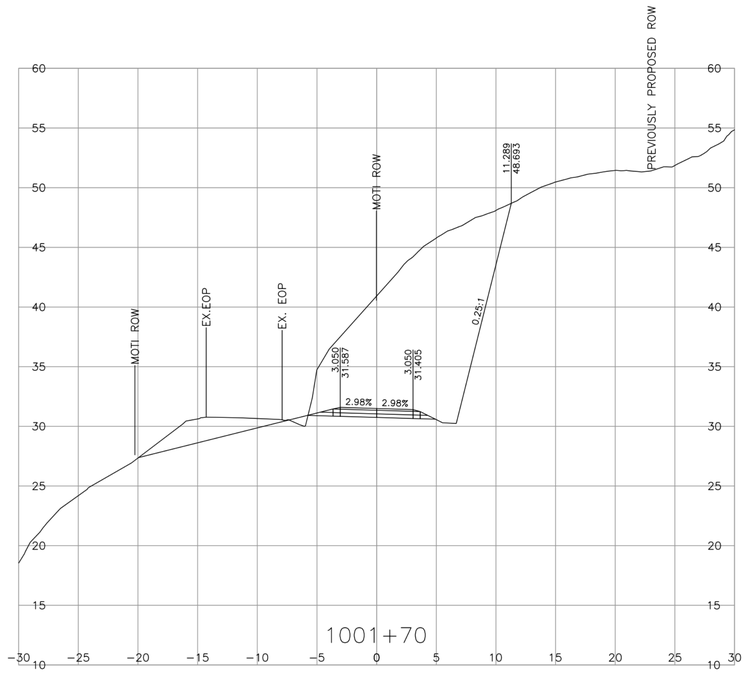

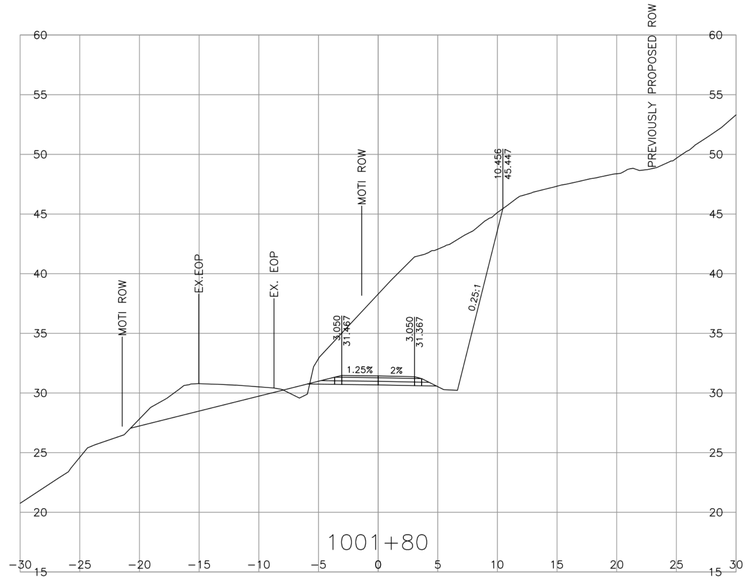

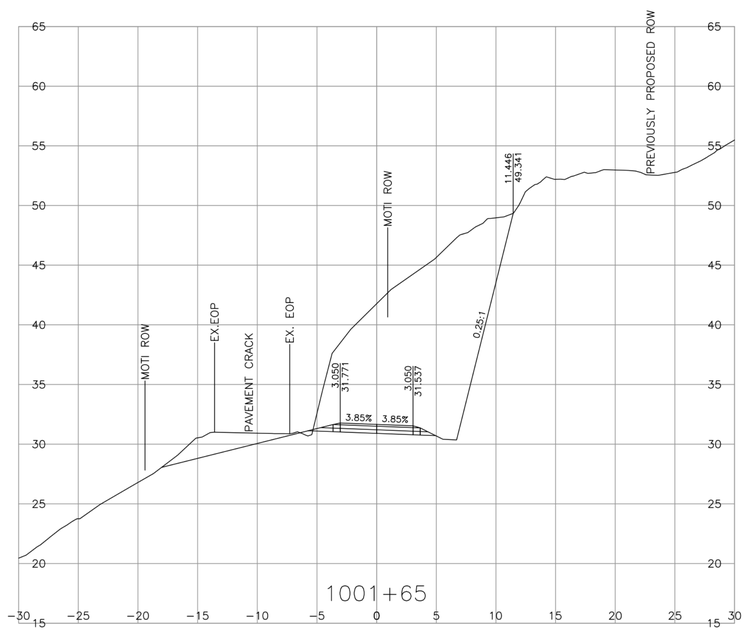

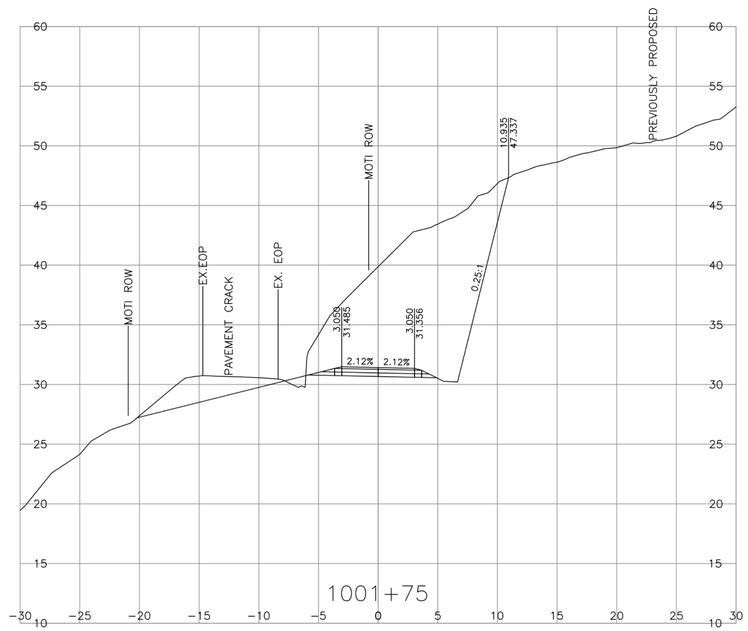

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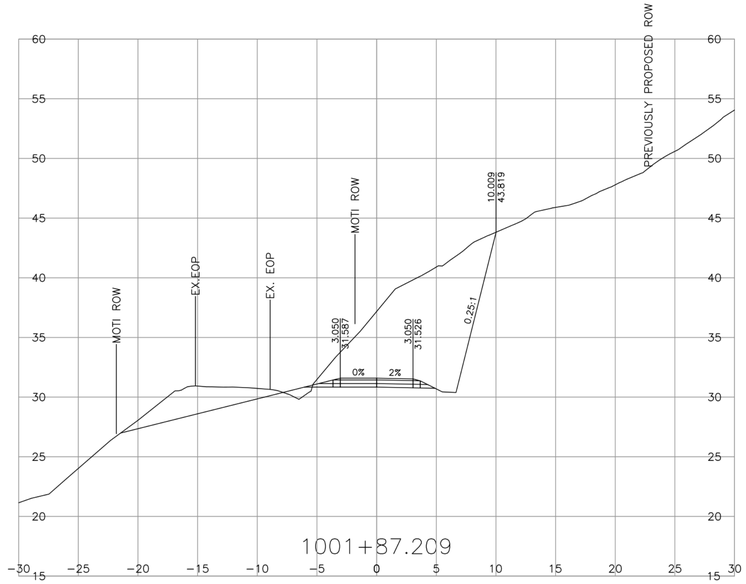

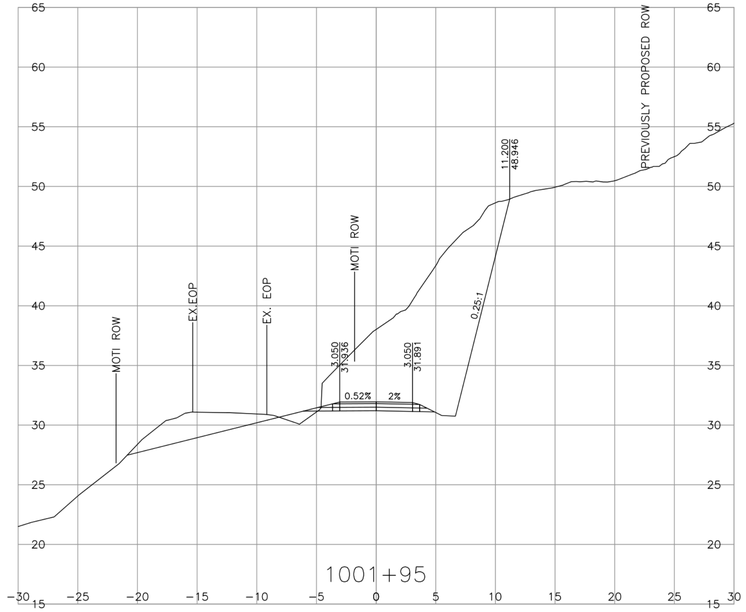

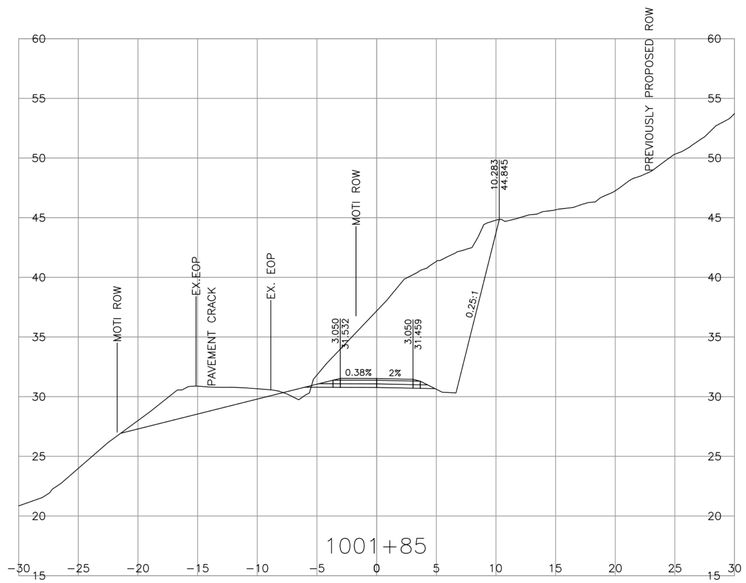

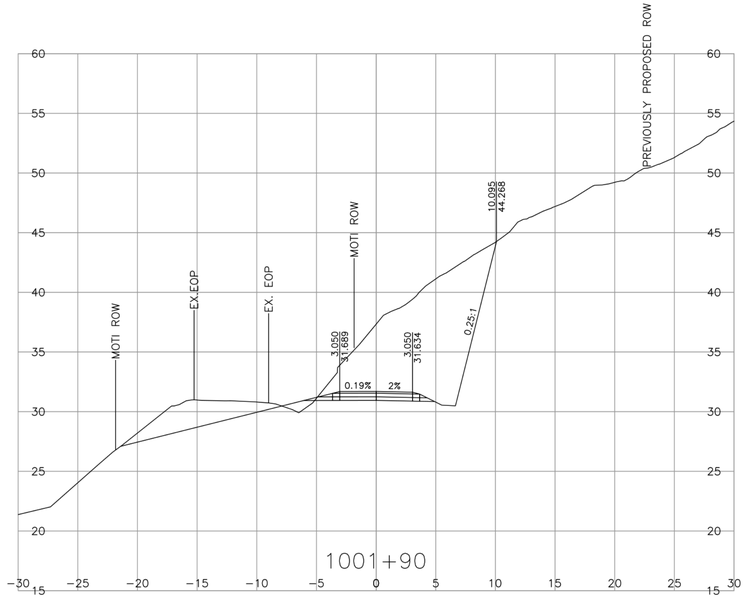

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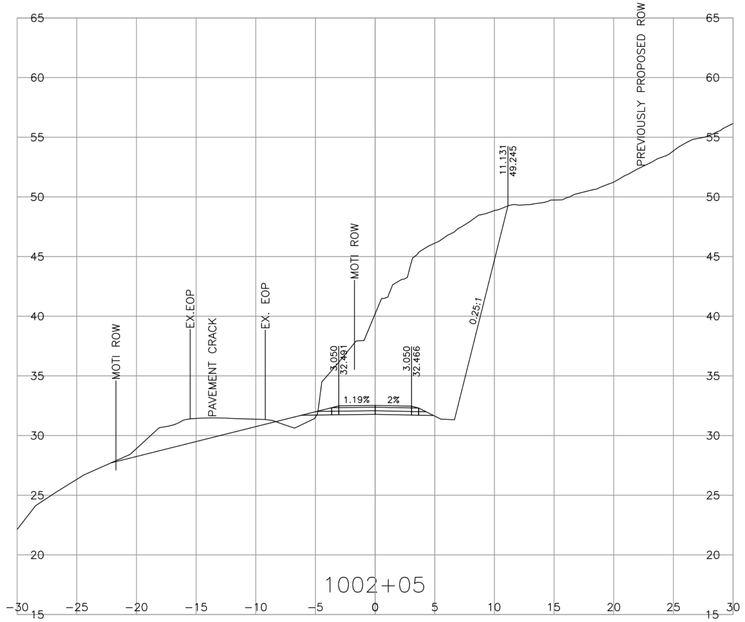

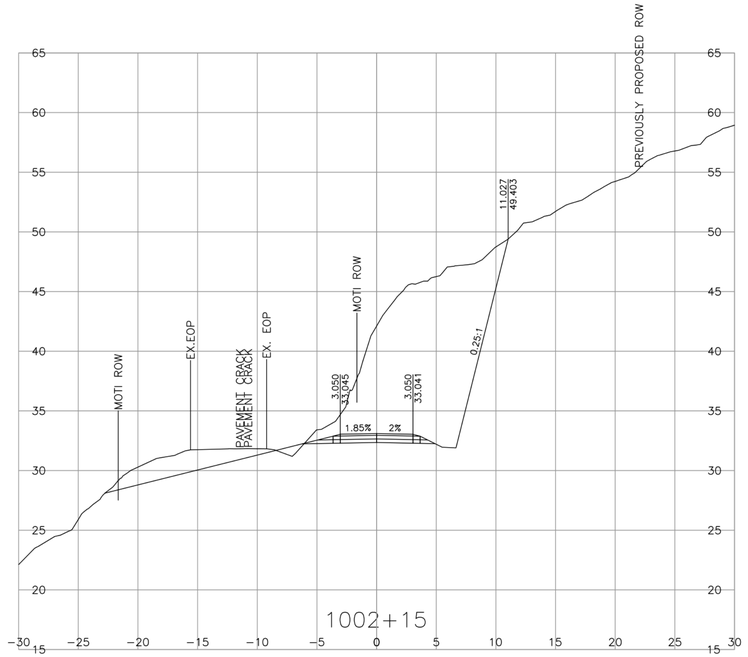

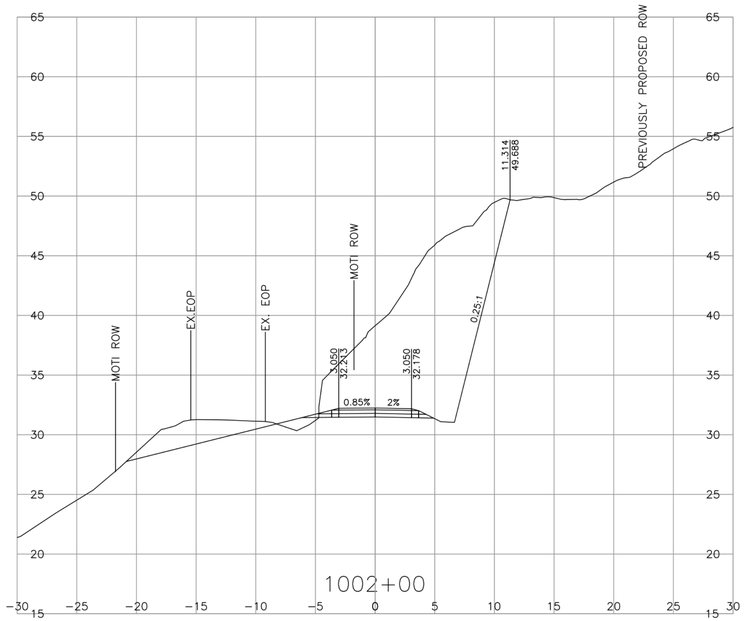

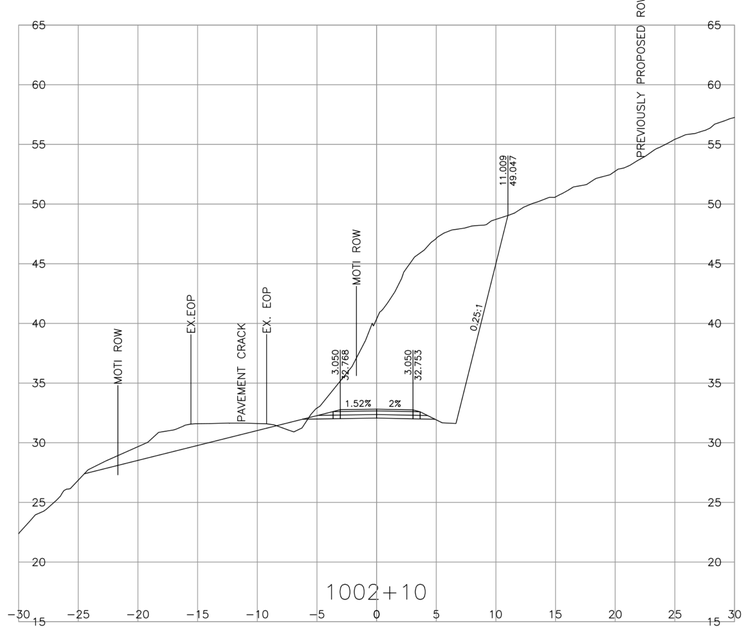

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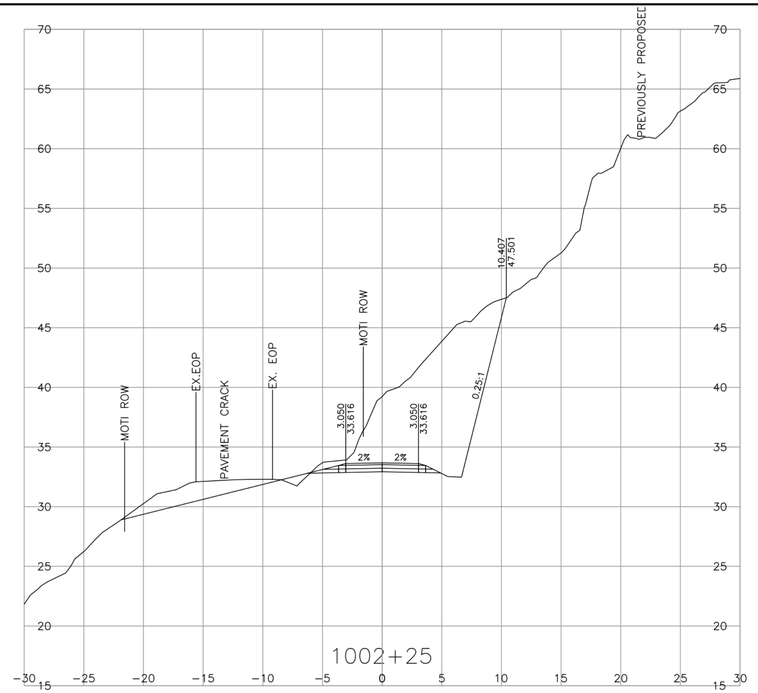

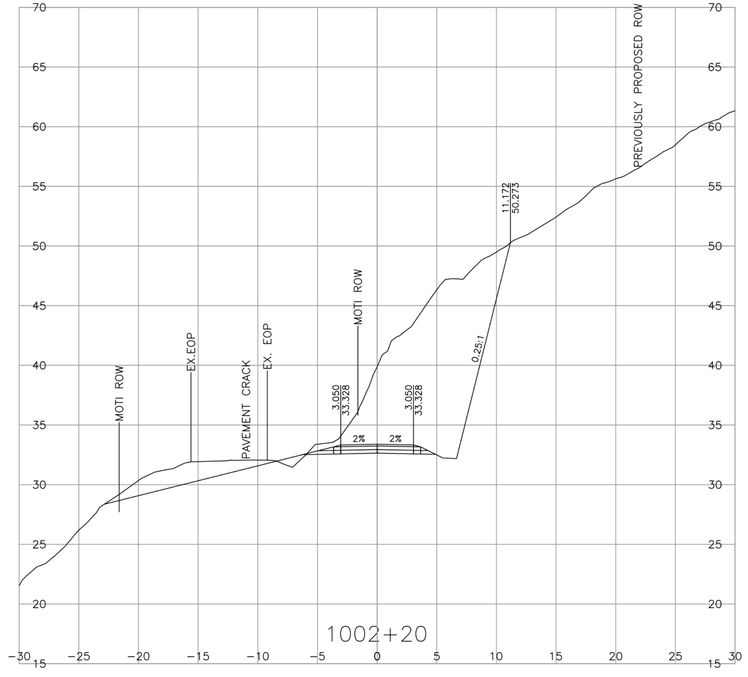

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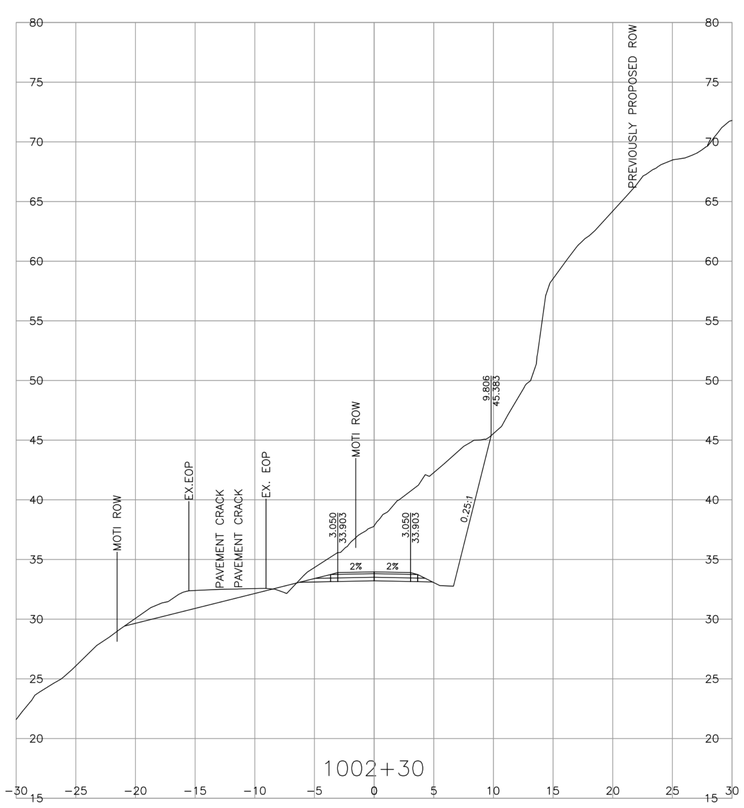

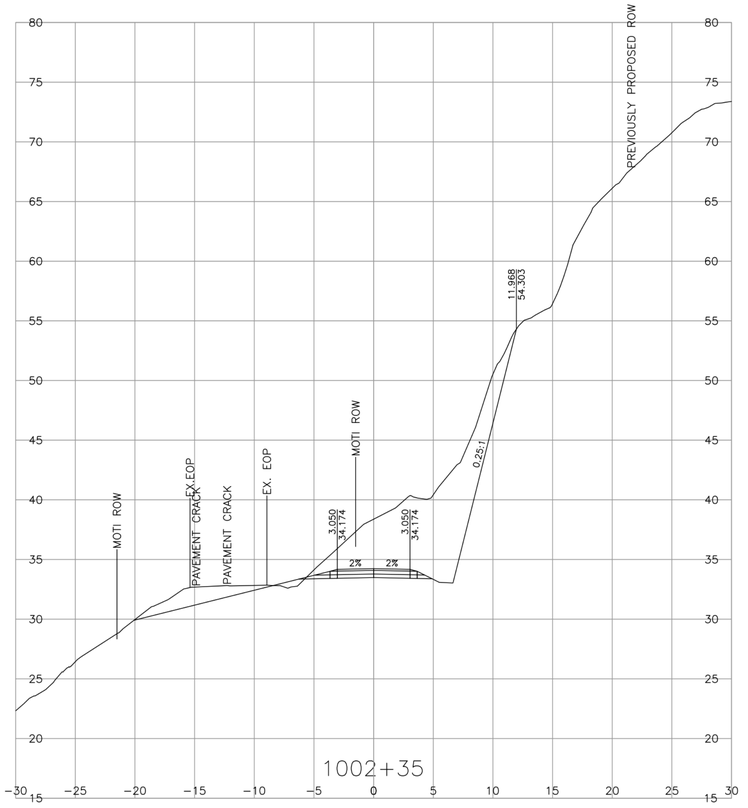

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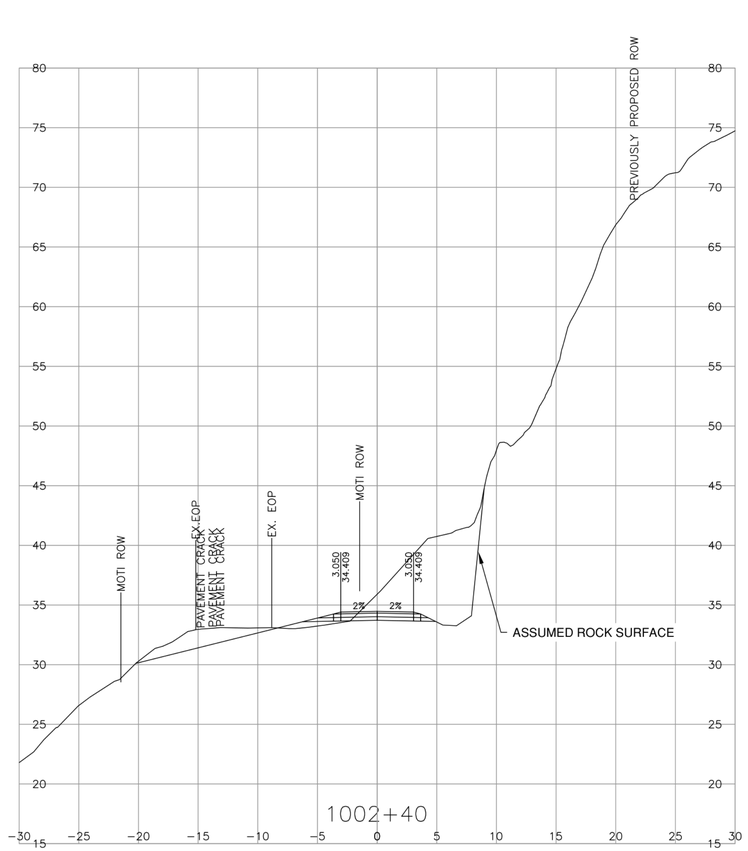

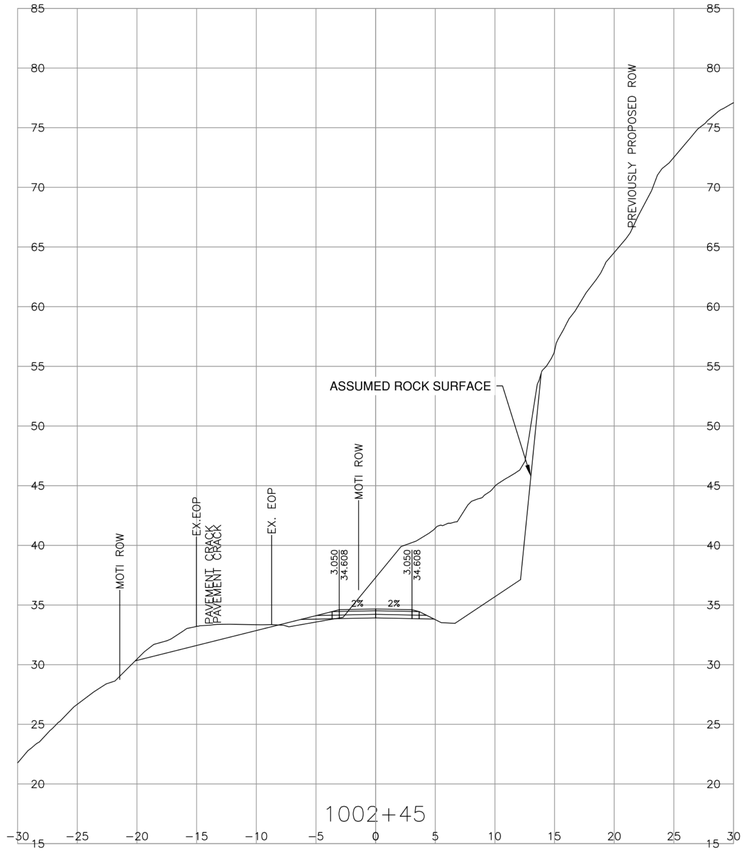

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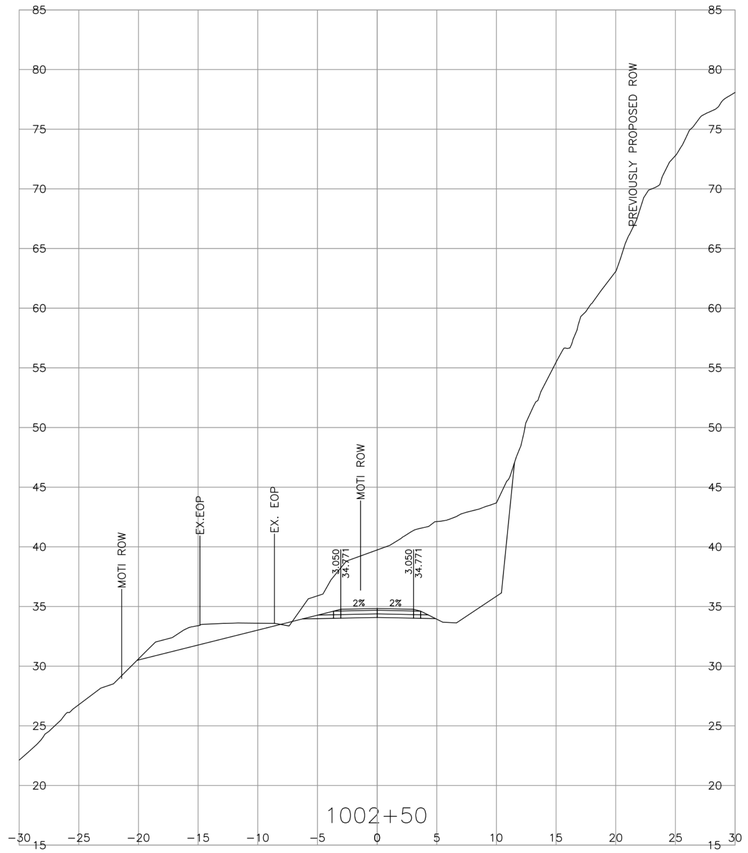

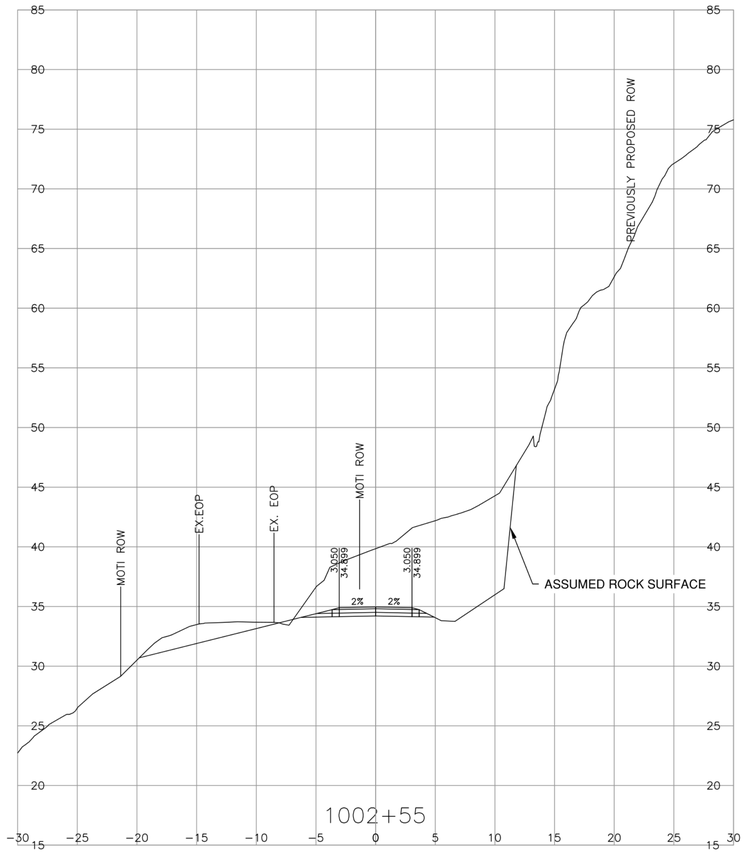

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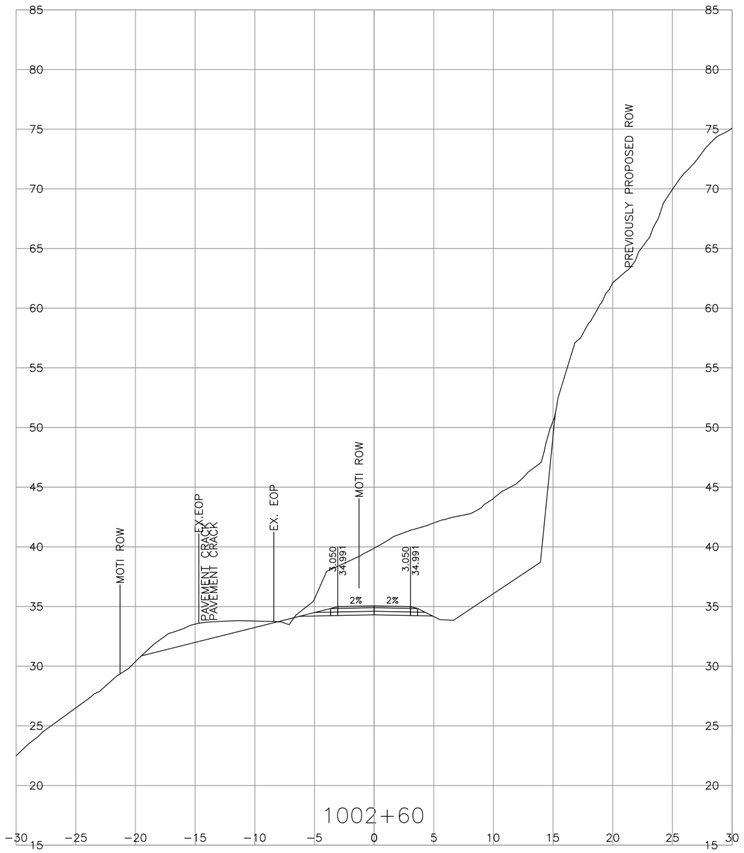

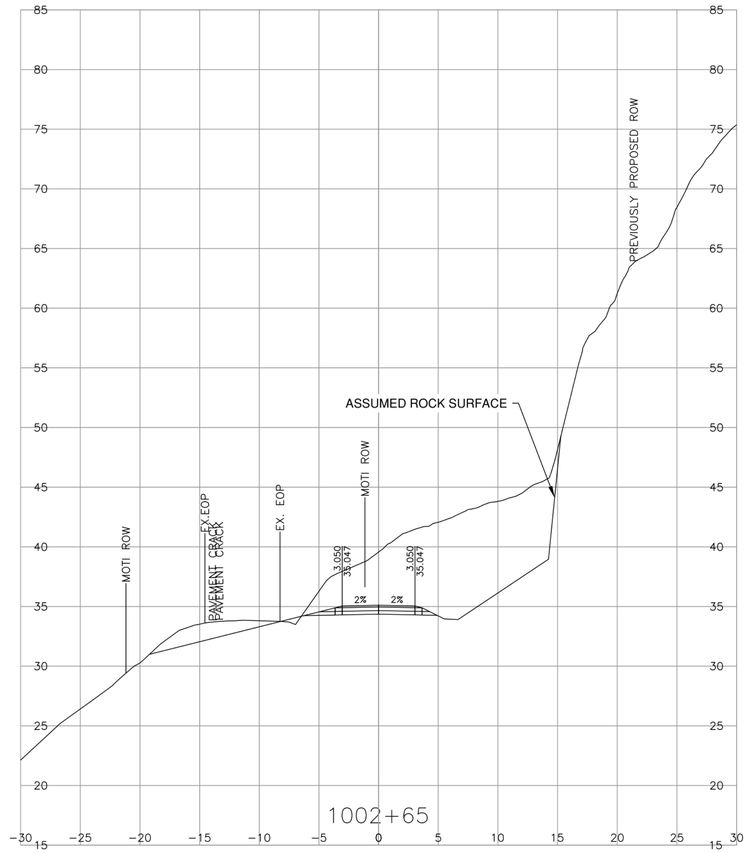

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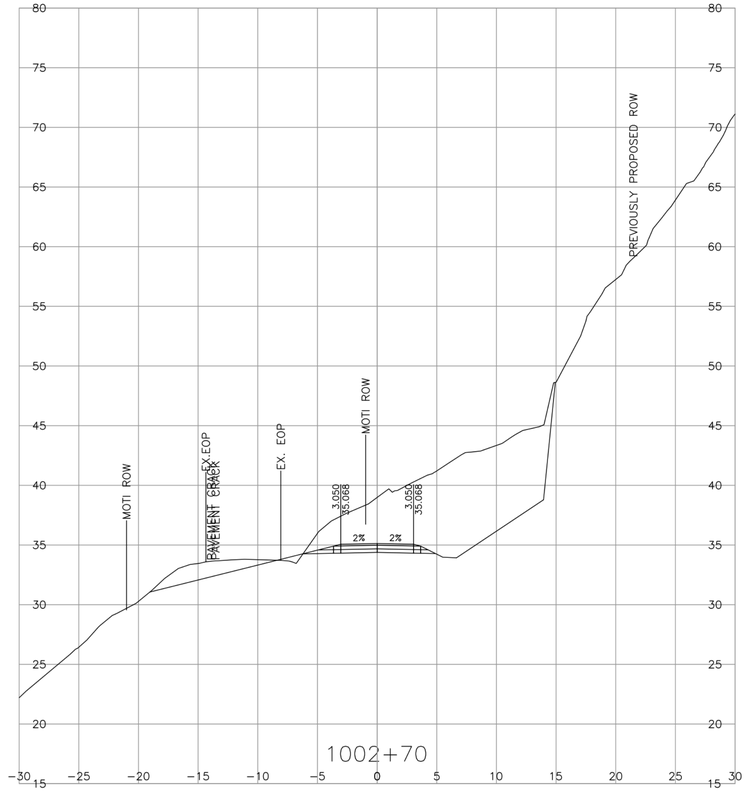

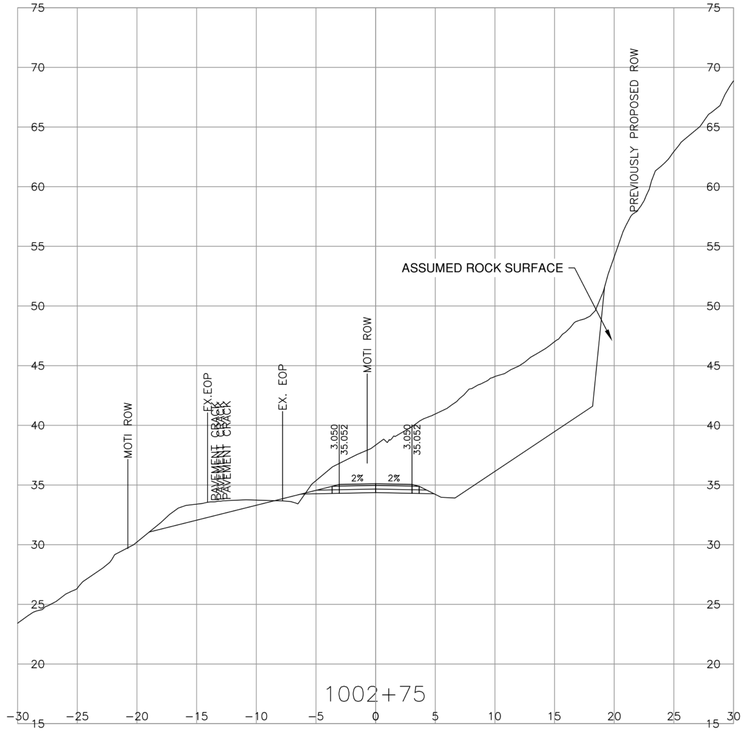

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REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

J. PINTO
SENIOR DESIGNER
DATE 2022-04-01

DESIGNED A. PAN DATE 2022-04-01
QUALITY CONTROL B. OYSTENSEN DATE 2022-04-01
QUALITY ASSURANCE J. PINTO DATE 2022-04-01
DRAWN G. HAROON DATE 2022-04-01

CROSS SECTIONS

CANAL ROAD REMEDATION

STA. 10+000.000 TO 20+000.000

FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
153CS0766	12478-000	1	CROSS-SECTIONS	A

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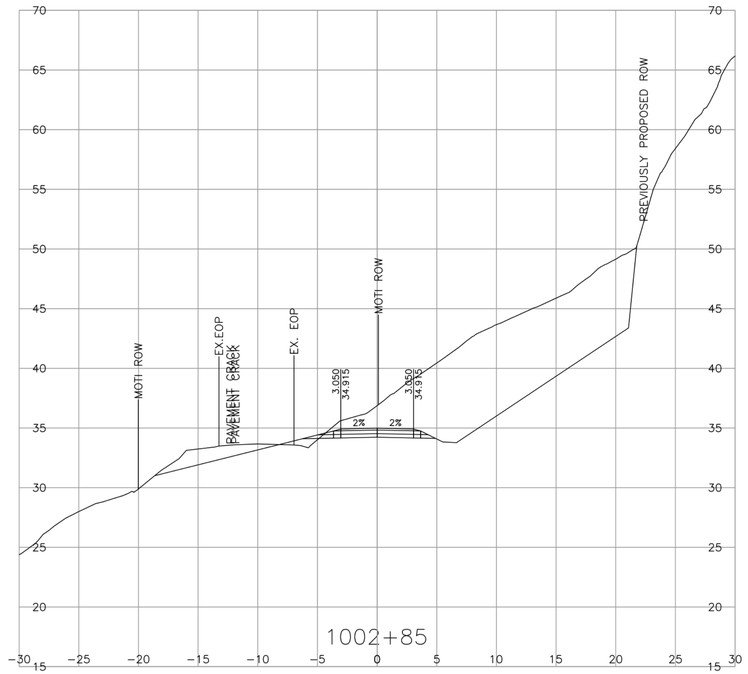

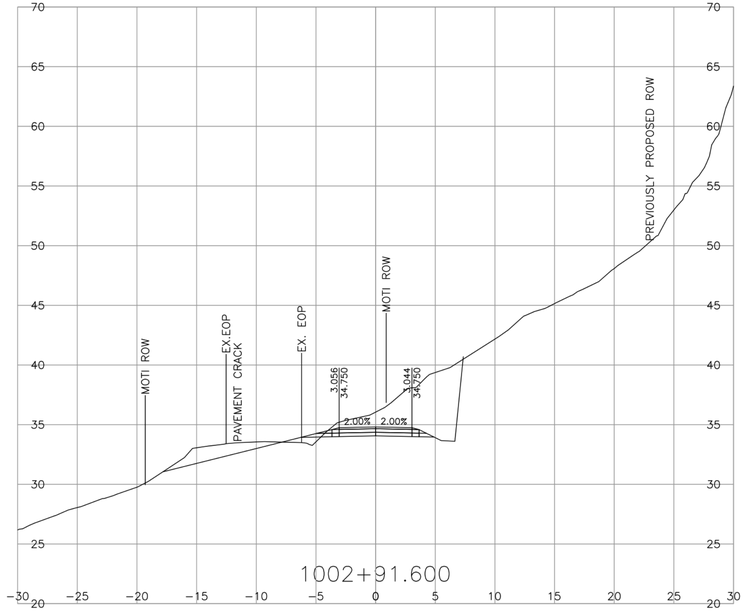

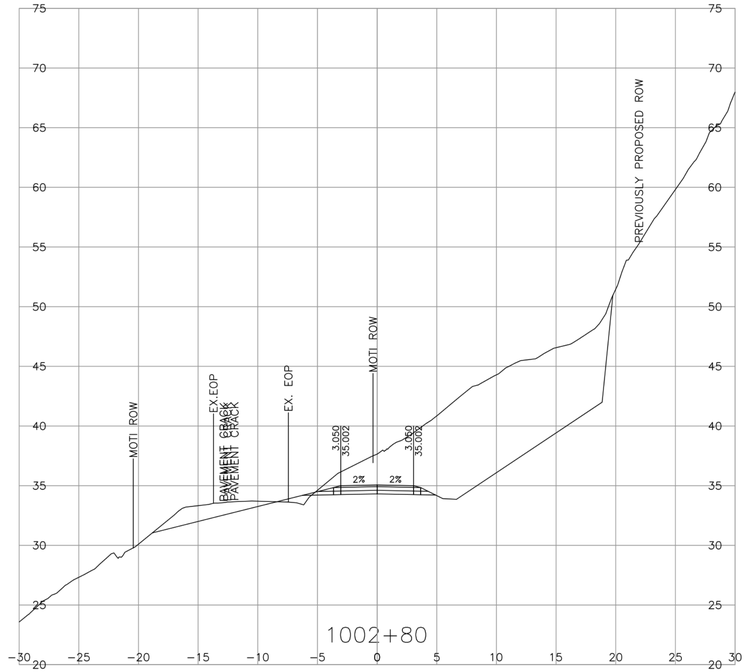

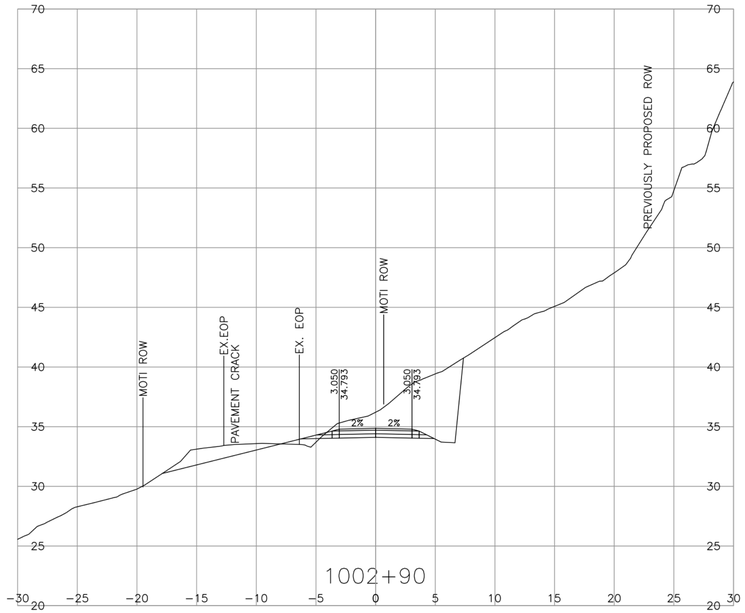

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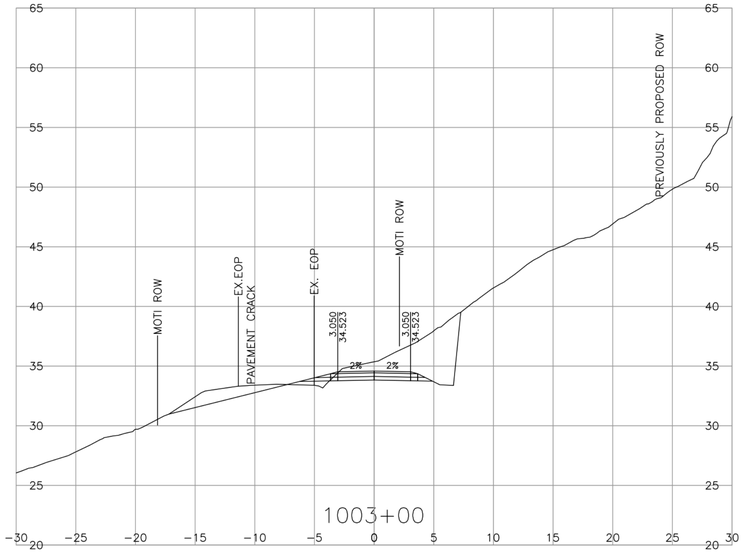

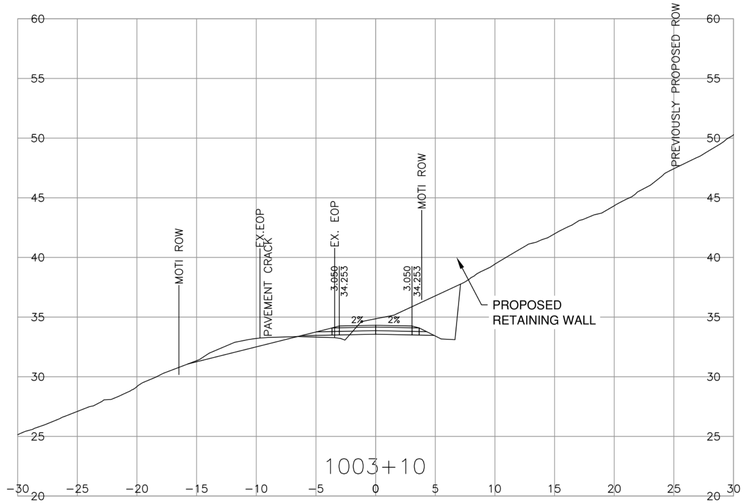

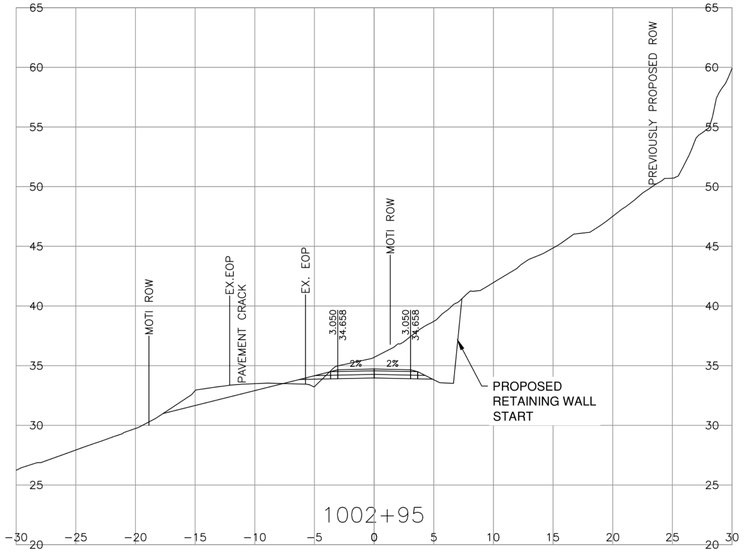

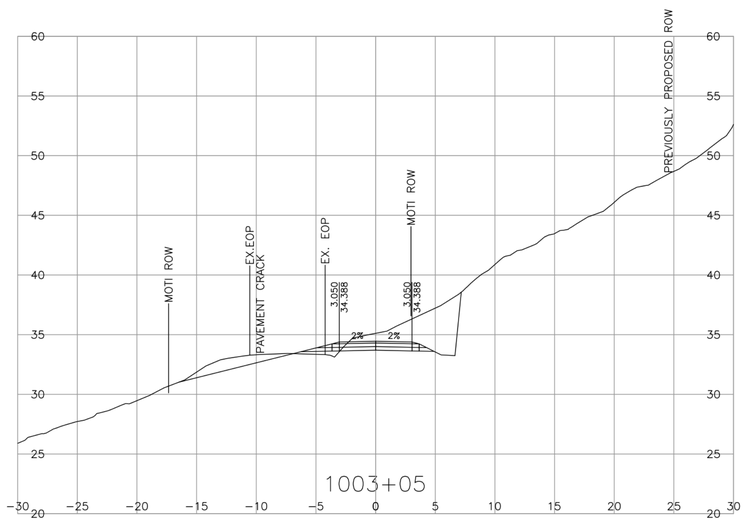

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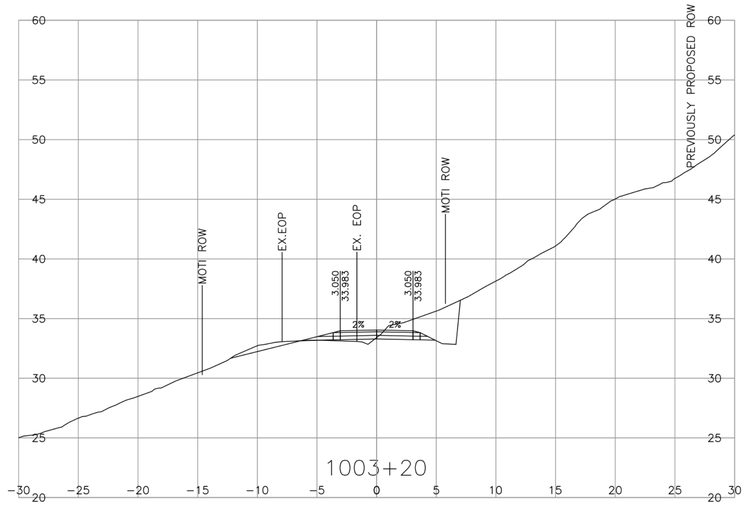

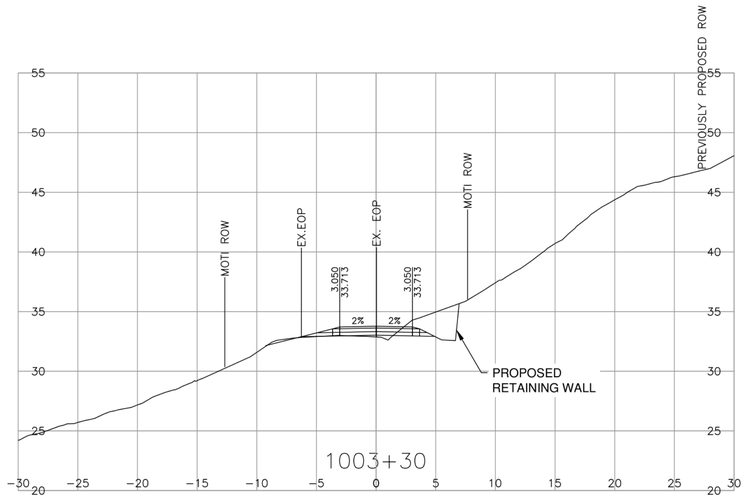

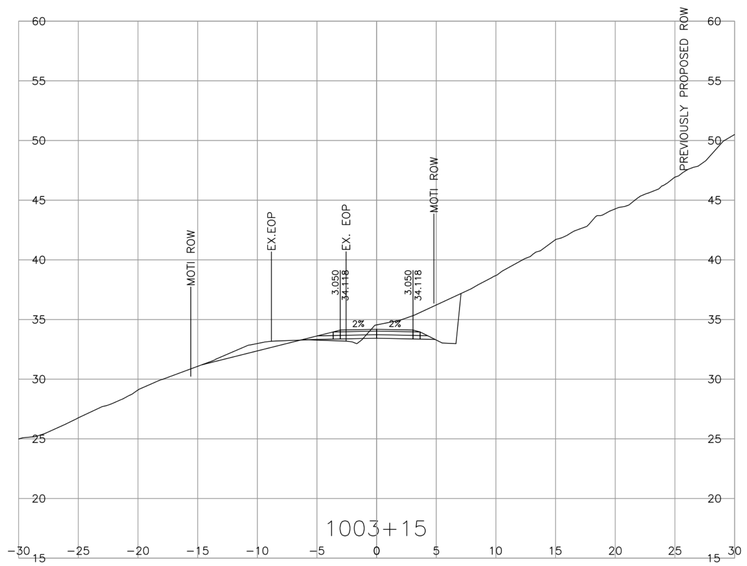

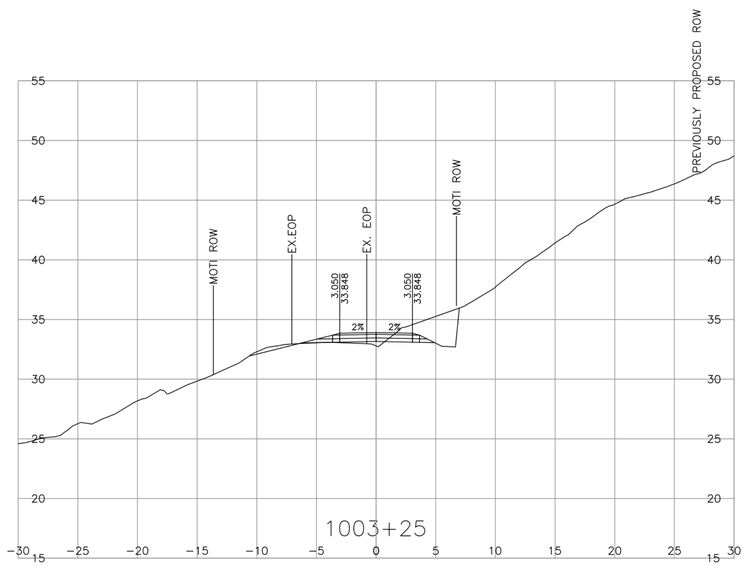

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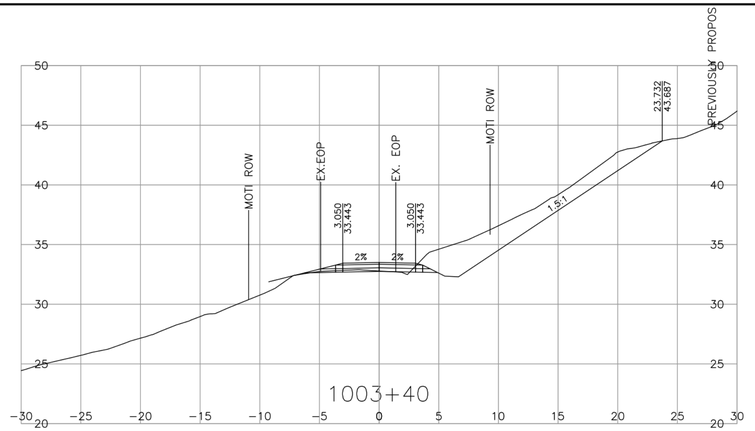

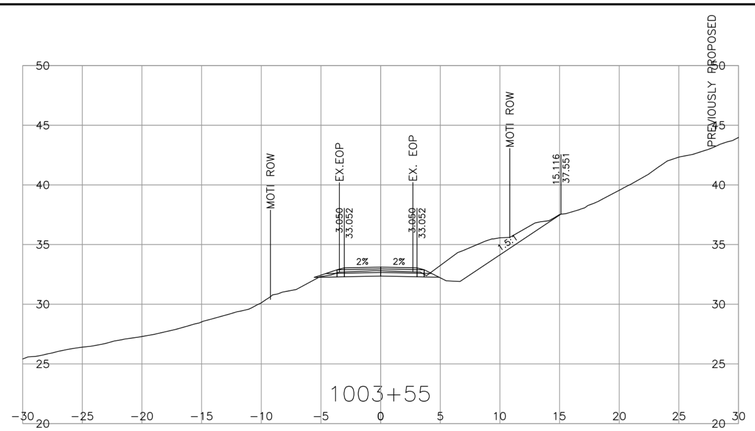

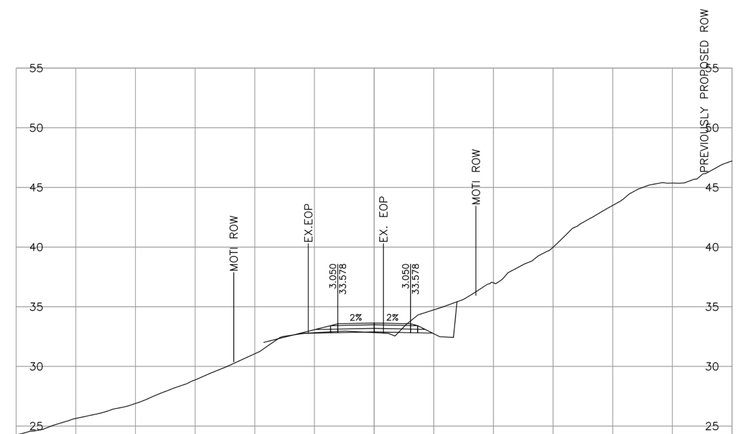

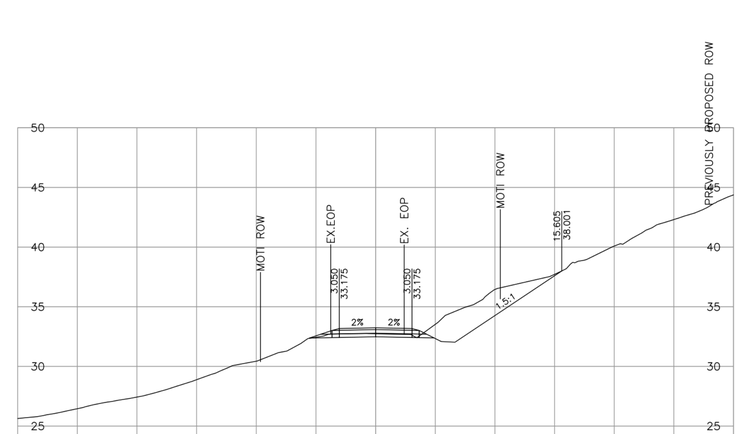

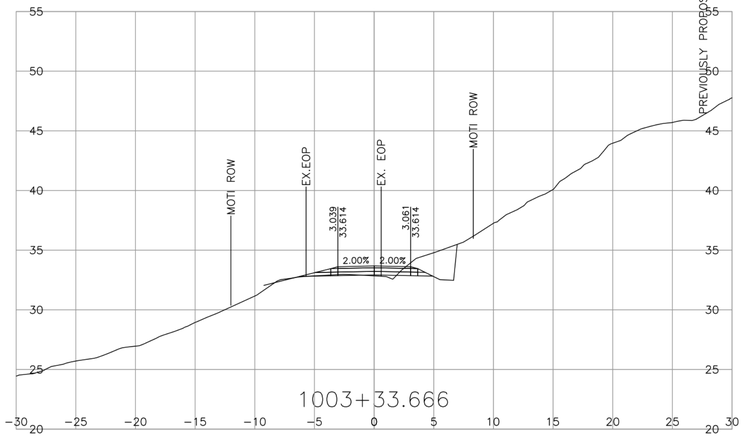

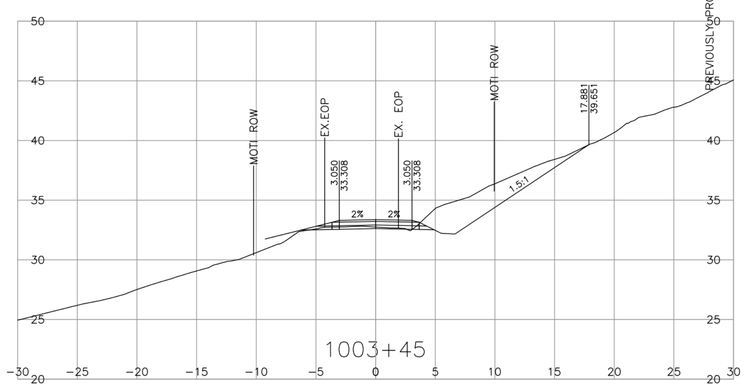

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SCALE

CAD FILENAME CROSS-SECTIONS
PLOT DATE 2022-03-17

REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
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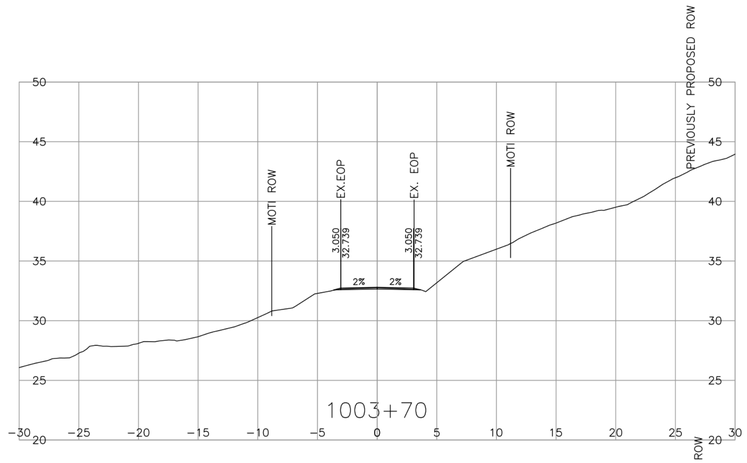

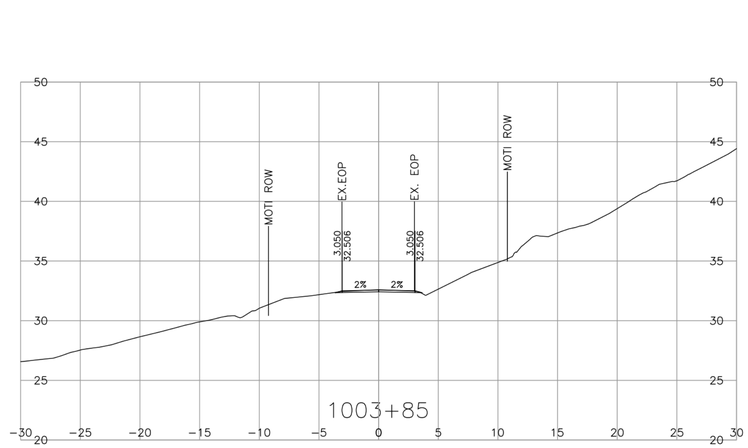

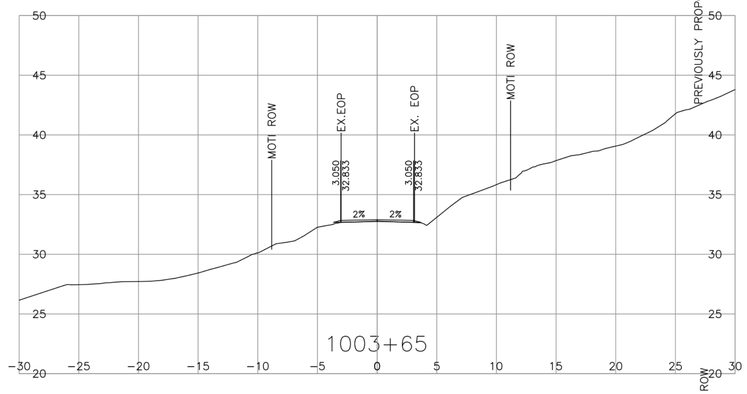

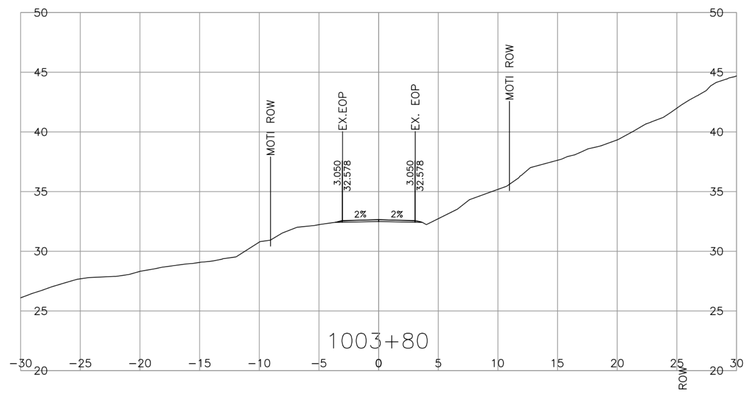

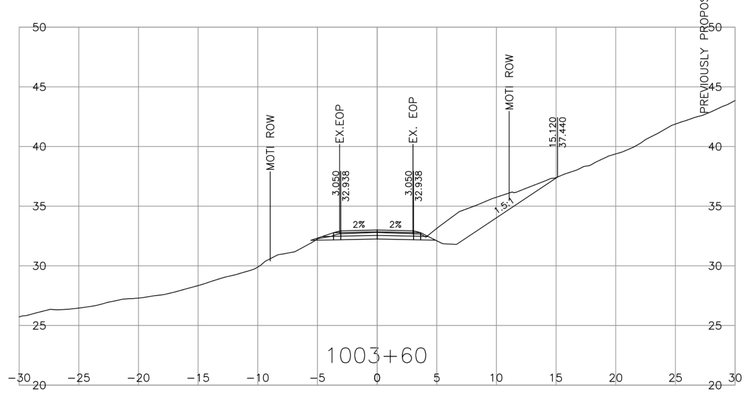

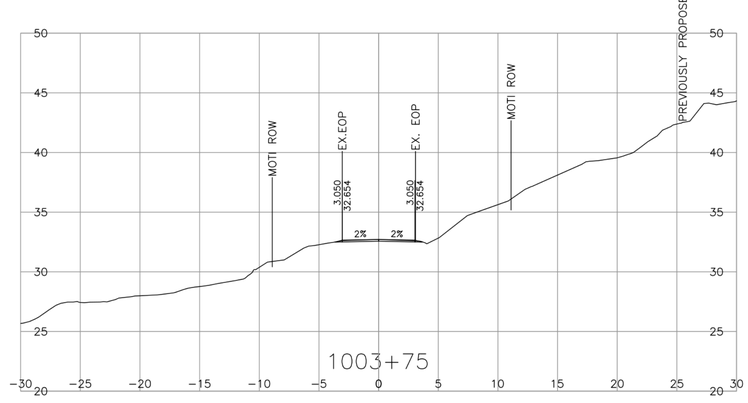

SCALE		CAD FILENAME CROSS-SECTIONS PLOT DATE 2022-03-17	
REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

BRITISH COLUMBIA

MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
NORTHERN REGION
HIGHWAY ENGINEERING AND GEOMATICS

J. PINTO
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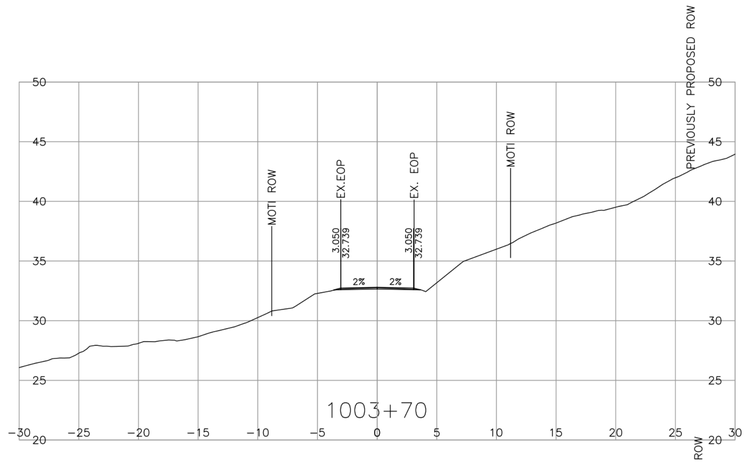
CROSS SECTIONS

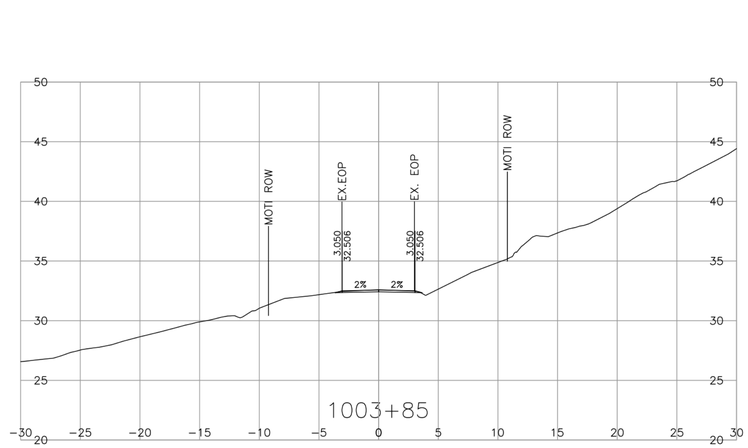
CANAL ROAD REMEDATION

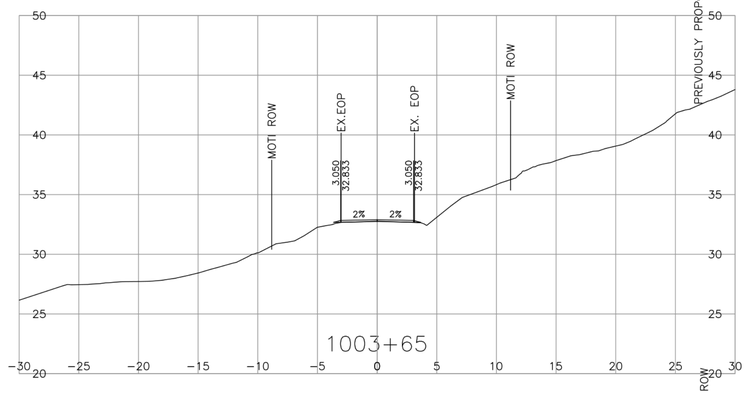
STA. 10+000.000 TO 20+000.000

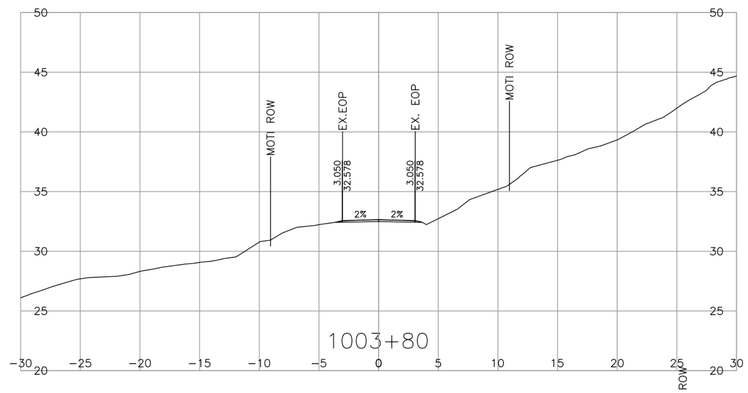
FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
153CS0766	12478-000	1	CROSS-SECTIONS	A

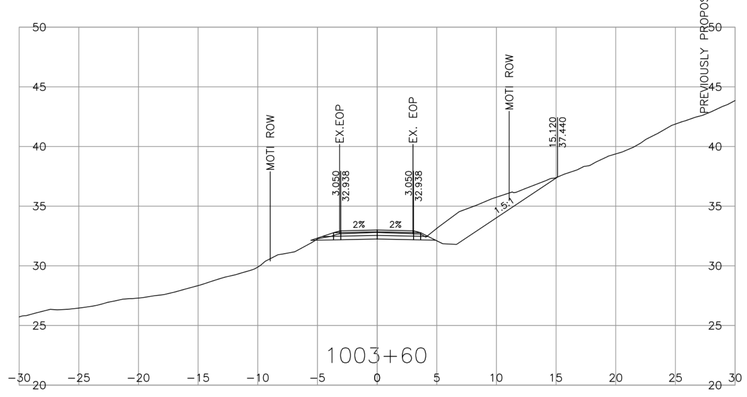
PLOT DATE: 2022/03/17 X:\2121\2121-00865-09 MoTI - Canal Road Remediation\10.0 DRAWINGS\10.3 Engineering\CanalRoad\DrawingProduction\Y300_SketchDrawings\CROSS-SECTIONS.dwg

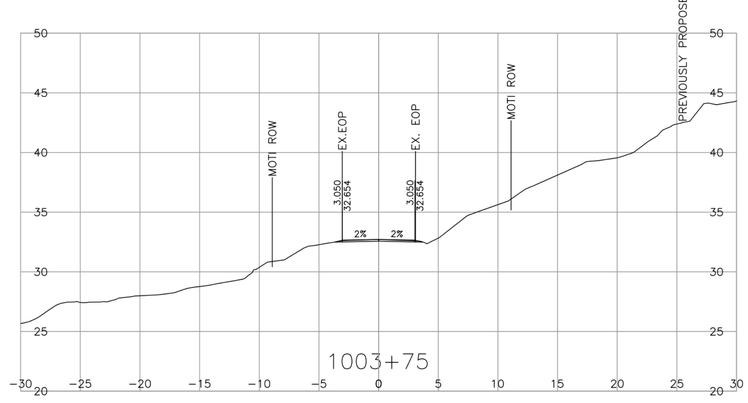












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CANAL ROAD REMEDATION

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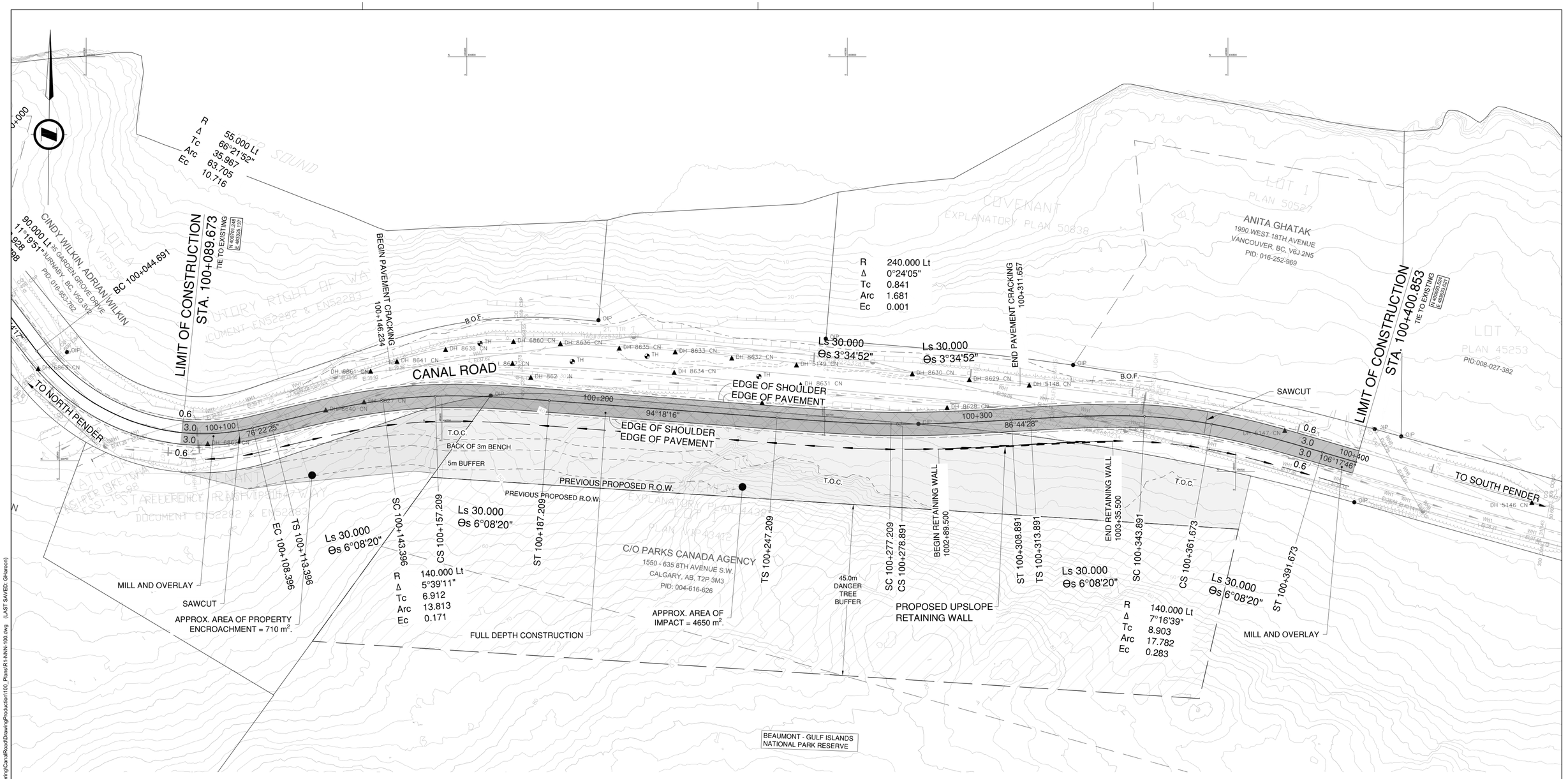

FOR DISCUSSION ONLY

CL. & GR. TOTAL THIS SHEET= 0.0 ha

ALIGNMENT	CLASSIFICATION	DESIGN SPEED
CANAL ROAD (L100)	MINOR RURAL (IT)	50 km/hr

REFERENCE DRAWINGS	
PROFILE	R1-NNN-201

McElhanney
Suite 200
858 Beatty Street
Vancouver BC
Canada V6B 1C1
Tel 604 683 8521

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 5 1:500 25m

CAD FILENAME R1-NNN-100
PLOT DATE 2022-03-17

REV	DATE	REVISIONS	NAME
A	2022-04-01	50% DETAILED DESIGN	J. PINTO

PLAN

CANAL ROAD REMEDIATION

STA. 100+089.660 TO STA. 100+400.853

J. PINTO
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FILE NUMBER	PROJECT NUMBER	REG	DRAWING NUMBER	REV
153CS0766	12478-000	1	R1-NNN-101	A

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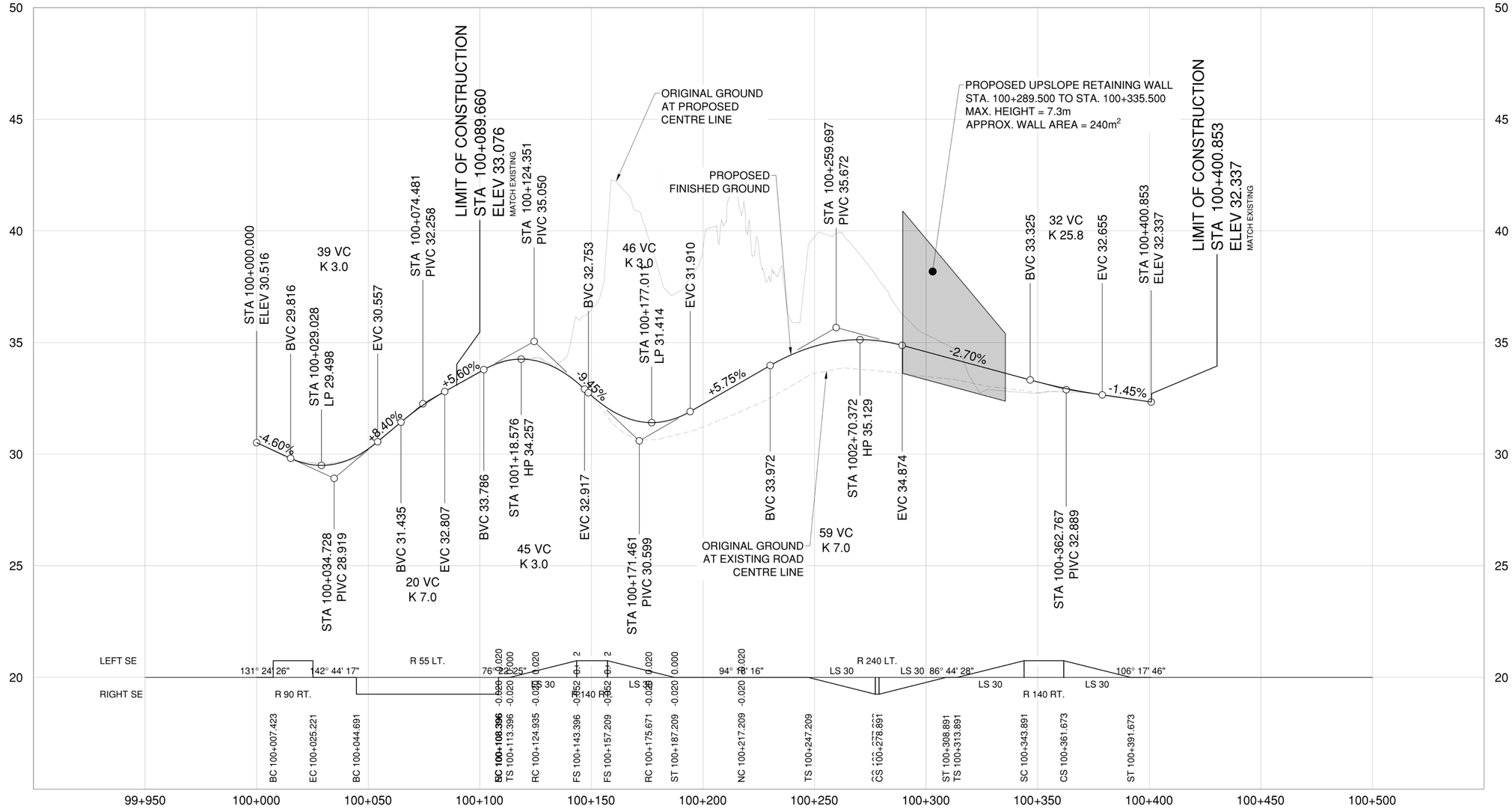

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CANAL ROAD (L100)	MINOR RURAL (IT)	50 km/hr

REFERENCE DRAWINGS	
PLAN	R1-NNN-101

McElhanney
Suite 200
858 Beatty Street
Vancouver BC
Canada V6B 1C1
Tel 604 683 8521

BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE
SOUTH COAST REGION
HIGHWAY ENGINEERING AND GEOMATICS

SCALE 0 10 H 1:1000 50m
0 1 V 1:100 5m

CAD FILENAME R1-NNN-200
PLOT DATE 2022-03-17

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A	2022-04-01	50% DETAILED DESIGN	J. PINTO

PROFILE

CANAL ROAD REMEDIATION

STA. 100+000.000TO STA. 100+400.853

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THURBER ENGINEERING LTD.

May 18, 2022 File: 33450

BC Ministry of Transportation and Infrastructure
2100 Labieux Road
Nanaimo, B.C.
V9T 6E9

Attention: Ryan Gustafson, P.Eng.,

PENDER ISLAND – CANAL ROAD
DESIGN OPTIONS LETTER

Following the atmospheric river events of November 2021, the BC Ministry of Transportation and Infrastructure (MoTI) identified possible worsening of a known active landslide and is now proposing to stabilize this approximately 300 m segment of Canal Road on South Pender Island.

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. This work was completed under Contract No. 861CS1180.

1. BACKGROUND

1.1 Project Description

This section of Canal Road is located approximately 3 km from the Pender Canal bridge, immediately to the east of the Mt. Norman Access Road and bordering the Beaumont-Gulf Islands National Park Reserve. The road is located at the crest of a steep slope, with an average slope angle of about 40° down to ocean (north) and exposed bedrock or colluvium on the upslope (south) side. Crown land and private property are located downslope of the slide and Parks Canada (Mt Norman) on the upslope (south) side.

The roadway in this section has been showing signs of movement for several years due to the existence of tension cracks along and across the roadway that have been observed by local residents and BC MoTI staff.

A field review carried out by MoTI staff on November 23, 2021, observed potential signs of worsened stability due to the recent atmospheric river rainfall events. Thurber was subsequently retained to carry out a field review / emergency call out to provide geotechnical engineering site review and recommendations for this area which was completed on November 25, 2021.

On December 1, 2021, the project transitioned into a Recovery phase, which includes conceptual design of remedial measures for this landslide and installation monitoring instruments to facilitate quantitative review of the slide deformation behaviour.

Traffic is currently being diverted to the upslope lane in a single lane alternating fashion to minimize the exposure of travellers to the actively moving landslide. A risk management approach to load restrictions during and following periods of heavy rainfall is also in place. It is understood that these measures will likely remain in place until the recovery phase is complete.

1.2 Subsurface Investigations

MoTI conducted a geotechnical investigation of the site in 2020 to investigate the slide location and soil conditions. Five geotechnical test holes were drilled to depths up to 13.4 m within the roadway. One monitoring well was installed at TH20-03. Draft MoTI test hole logs were provided by MoTI and have not yet been finalized. The test hole location plan can be found following the text of this letter in Figure 1.

Based on Thurber's Geotechnical Work Plan, dated January 19, 2022, two holes have been drilled and the installation of two Shape Acceleration Arrays (SAA's) and a datalogger have been completed to monitor slide deformation.

TH22-1 and TH22-2 are located within the slide area in the westbound lane of Canal Road. Both holes were drilled using a track mounted sonic rig operated by Drillwell Enterprises of Duncan, BC. Soils were logged and sampled by a Thurber representative in the field. A 50 mm PVC pipe was installed in each test holes with a flush mount road box to allow for installation of the SAA's. The SAA's were installed about a week after drilling to allow time for the grout to set. TH22-1 was drilled on January 19th, 2022, and the SAA was installed on January 28th, 2022. TH22-2 was drilled on February 15th and 16th, 2022 and the SAA was installed on February 24th, 2022. Thurber test hole logs are provided following the text of this letter.

1.3 Monitoring and Landslide Activity

The installation of SAA's allows remote monitoring of the deformation with readings being recorded twice daily at noon and midnight.

The observed deformation in the test holes appears to be between depths of 7 m and 10 m below road grade near the transition from colluvial soils to dense glacial till in TH22-1 and within the glacial till in TH22-2. The nature of the movement appears to be tilting and/or sliding in the downslope (north) direction. The stratigraphy is discussed in more detail in Section 1.4 below.

Deformation of the slide is occurring; however, historical rate information is not available to assess if the observed rate is consistent with historical patterns. We understand that the slide has been moving for more than a decade, and therefore, the observed deformation is interpreted as being a creep type deformation pattern. It is not known if the movement is episodic (seasonal, or weather related) or if deformation will occur continuously. Brittle failure of the slide is considered possible, and it could be triggered by external factors or simply accumulated strain along the shear plane.

Based on the active movement of the landslide as demonstrated by the tension cracks and monitoring results, the current slope stability at the roadway has a Factor of Safety (FoS) of about 1.0 and does not meet the required MoTI geotechnical stability criteria.

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1.4 Overview of Geotechnical Site Conditions

The tension cracks at the northwest end of the slide are significant and extend diagonally across the entire roadway. We understand that the maintenance contractor has been filling these cracks with cold patch asphalt at the recommendation of the MoTI geotechnical team to reduce water infiltration.

The slide area at the road level is approximately 110 m long. At the west end of the project area the upslope side of the roadway is comprised of bedrock consisting of Nanaimo group sedimentary conglomerate, shale, and sandstone. The bedrock ridge above the roadway trends at a skew to the roadway in a southeast direction. The east end of the site traverses an inferred colluvial apron that extends 15 m to 25 m above the road elevation.

The slope below the roadway is very steep and exhibits a series of scarps and benches. The slope is about 30 m to 35 m high extending from Canal Road down to the beach with an overall slope of around 40°. The scarps are sloping at about 45° to 55° and the benches are flatter. Some larger trees (0.5 m to 0.8 m diameter) growing on the upper slope show pistol butting or outward lean however this is not universal or dominant. At the east end of the visible cracking, the slopes become somewhat flatter with an increased setback from the crest of the steep slopes.

Boulders are observed on the slopes, beneath trees and adjacent to trees. It is not known if the boulders are part of the natural deposit or were side cast down the slope at the time of roadway construction. Given the presence of the rock fill landing adjacent to the site, it is not anticipated that the roadway is built on a significant thickness of sidecast rock fill and rock excavated for roadway construction may have been used for the landing located at the ocean level.

Existing fill materials encountered within our test holes were generally comprised of a widely graded mixture of gravel and sand with trace to some silt which were typically compact and ranged in thickness from 0.9 m to 1.5 m.

Underlying the fill at both test hole locations, a widely graded silty sand and gravel colluvium with some clay (generally low plasticity) was encountered. This unit was loose to compact and contained trace amounts of organics (rootlets) throughout the entire unit. It typically ranged from approximately 6.5 m to 9.1 m in thickness in the test holes. In TH22-2, till-like inclusions were encountered within a deeper portion of this deposit, bordering the glacial till.

Glacial till-like deposits typically underlay the colluvium and are comprised of dense and widely graded mixtures of silt, sand, and gravel with varying clay content from some clay to clayey. The till was only fully penetrated in TH22-2 and was measured to be 10 m thick. Test hole TH22-1 terminated within the deposit. Atterberg testing was completed on higher fines content samples with the majority testing as low-plastic silts and clays. Therefore, it is our interpretation that this deposit behaves in a non-cohesive manner.

Bedrock was encountered at a depth of 17.4 m in TH22-2. The test hole depths were planned to accommodate the existing length of the MoTI owned SAA instruments and could not be drilled

deeper due to time and logistical restrictions (power shutdown). GSC Map 1553A of Victoria identifies this site as having both De Courcy Formation and Cedar District Formation within the Nanaimo Group which consists of sandstones, conglomerates, shales, and siltstones. At the road level the existing upslope bedrock outcrop consists of predominantly conglomerate and sandstones of the De Courcy Formation. In TH22-2 the bedrock was identified as shale and siltstone at a depth of 17.4 m below existing road grade. We expect that the bedrock encountered at TH22-2 is within the Cedar District Formation which underlies the De Courcy Formation.

Test hole logs and the test hole location plan (Figure 1) are attached following the text of this letter.

2. GEOTECHNICAL DESIGN CRITERIA AND LEVEL OF UNDERSTANDING

Consistent with the BC Ministry of Transportation (BC MoTI) Geotechnical Design Criteria (Technical Circular T-01-15 and T-04-17), the following recommendations have been made with the consideration of the following design guides and codes:

- MoTI Technical Circulars
- CSA S6-14 (Canadian Highway Bridge Design Code, CHBDC)
- MoTI Supplement to CHBDC S6-14
- Publication No. FHWA-NHI-10-024 “Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes” November 2009
- MoTI Technical Bulletin GM02001 Rock Slope Design
- AASHTO 1993 Guide for the Design of Pavement Structures or AASHTO (2004) ME Pavement (Mechanistic Empirical Pavement Design Method Guide)
- Canadian Foundation Engineering Manual (CFEM), Fourth Edition, 2006
- Letter of Agreement between the Ministry of Transportation and Islands Trust dated October 20, 1992

2.1 Degree of Understanding and Consequence Factor

Currently we have completed a geotechnical investigation at this site consisting of two test holes and no bedrock investigation (coring, strength testing). The newly completed test holes supplement the previous completed drilling by MoTI.

We understand that the use of ‘Typical’ degree of understanding for the geotechnical design at this stage of the project is appropriate. It is anticipated that if further geotechnical investigations will be undertaken for detailed design, the incorporation of groundwater level monitoring, drilling at the base of slope and laboratory strength testing, would support changing the use of high degree of understanding.

MoTI has currently assigned a typical consequence to this section of Canal Road.

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3. CONCEPT DEVELOPMENT & ASSESSMENT

3.1 General

The roadway design options were assessed, modified, and refined through a team-based multi-disciplinary approach which included design workshops and interim correspondence (emails and memoranda) between Thurber, MoTI, McElhanney, Hemmera and Wood. A Multiple Account Evaluation (MAE) was developed by McElhanney which weighted each concept against 10 different evaluation criteria consisting of Environmental/First Nations Impacts, Constructability, Construction Cost, Construction Schedule, Geotechnical Risk, Impacts to Parks Canada and Other Property, Maintenance/Lifecycle Cost, Road Geometry/Safety, Structural Risk and Traffic Impacts (including detour).

The following three design concepts were considered:

Concept 1 (Rock Cut Design): Shifting the road alignment to the south to result in the road structure being supported on bedrock through the main segment of the slide. This concept includes a significant encroachment into the adjacent national park reserve.

Concept 2 (Bridge): Construction of a bridge across the slide area which reduces upslope cut requirements. The premise of the option is to avoid any construction outside of the current ROW.

Concept 3 (Slope Stabilization System): Construction of a downslope pile stabilization system to retain existing soils. The premise of the option is to avoid any construction outside of the current ROW.

3.2 Assessment of Concept 1 – Rock Cut

Concept 1 consists of a full shift of the Canal Road alignment south into the existing upslope bedrock by drilling and blasting a rock cut. This alignment is generally well developed by the team and includes 3 m rockfall catchment ditches and assumes 0.25H:1V rock cut slope angles. The rock cut will extend from approximately Sta. 100+140 to Sta. 100+315 which is about 5 m beyond the extent of the existing cracking.

In addition to the toe berm, an upslope retaining wall would be constructed from Sta. 100+295 to Sta. 100+335 where the colluvial apron of overburden material is present upslope of the road.

Geotechnical and structural design complexity is limited as it does not include the construction of a large structure, relative to Concepts 2 and 3 below. We expect that approximately half of the new alignment will be founded on bedrock, however based on the test holes drilled we expect that Sta. 100+220 to 100+315 will not be founded directly on rock and further downslope stabilization measures will be required to meet stability criteria. The MAE table did not thoroughly explore this additional downslope stabilization; however, these are viewed as insignificant compared to Concepts 2 and 3. These stabilization options are described below.

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3.2.1 Downslope Option 1A – Toe Berm

An existing level fill pad is located below the slide area from approximately Sta. 100+215 to 100+300. We anticipate that a toe berm constructed on this level pad could be sufficient to meet stability criteria. This is assessed in Section 4 below. Two properties including crown land on the west side and 9842 Canal Road on the east side would be affected, with access required either from within the right of way or provided through the property at 9842 Canal Road. This is the preferred option as it would provide improved stability with reduced need for structural reinforcement and would also serve as a nearby location to re-use / stockpile blasted material from the above rock cut. The impact to adjacent private property would have to be assessed by the civil, environmental and property teams.

3.2.2 Downslope Option 1B – Slope Stabilization

The other option to meet stability criteria would be to construct a downslope stabilization system from Sta. 100+215 to 100+300 which may include a combination of a retaining wall in conjunction with other slope retention systems such as slope mesh or possible tie-back anchors and piling, similar to Concept 3 below. This can be further developed in detailed design. This option would have reduced impacts to surrounding properties compared to Option 1A.

3.3 Assessment of Concept 2 – Bridge

Concept 2 consists of the construction of an at grade bridge from approximately Sta. 100+141 to Sta. 100+315, which is about 5 m beyond the extent of the existing cracking. The bridge foundations would be founded on pile supported piers or abutments, extending down to bedrock at depths assumed to be between 20 m and 25 m to isolate the roadway from the active slide. Preliminary assessment by the team was not able to identify a viable temporary traffic management scheme that would allow traffic to pass the area during construction within the existing ROW.

Geotechnical risks include the depth to bedrock potentially exceeding the anticipated depth of 20 m to 25 m and the existing and future soil stability needing to be further assessed. Furthermore, the project area is within a high seismic zone and the structure would need to be robust to achieve the required seismic stability.

This option was deemed unfavourable by the project team.

3.4 Assessment of Concept 3 – Slope Stabilization System

Concept 3 consists of a continuous pile and anchor wall on the downslope edge of the existing edge of pavement. Piles would extend from approximately Sta. 100+141 to Sta. 100+315, which is about 5 m beyond the extent of the existing cracking. We assumed that 610 mm diameter steel piles drilled into bedrock and infilled with concrete at 3 diameter centre to centre spacing with an average pile length of 25 m. DCP anchors at one anchor per pile would be installed sub-horizontally on the outside face of the pile wall to tie back into existing bedrock. Anchors would likely to be 36 mm or 43 mm in diameter, 1035 MPa strength, with an average length of 20 m per anchor.

Geotechnical risks include the depth to bedrock potentially exceeding the anticipated depth of 20 to 25 m and the existing and future soil stability needing to be further assessed. Furthermore, the project area is within a high seismic zone and the structure would need to be robust to achieve the required seismic stability

This option was deemed unfavourable by the project team.

4. SLOPE STABILITY ANALYSIS METHODS

Limit equilibrium slope stability analyses were completed for this project using the commercial software Slope/W 2021 (GeoSlope International). The Morgenstern-Price method was used for calculating factors of safety with the method of slices, which includes both force and moment equilibrium.

Thurber assessed the stability of the slopes and retaining walls based on a 'Typical' degree of understanding and a 'Typical' consequence factor as per Table 6.2b provided in MoTI's Supplement to the CHBDC S6-14 dated October 28, 2016. This equates to a minimum Factor of Safety of 1.54 for global stability of permanent slopes.

Under seismic conditions, Major-Routes are subject to a minimum pseudo-static Factor of Safety of 1.1 under the 1:975-year (5% probably of exceedance in 50 years) seismic hazard values for global stability of permanent slopes and embankments according to Table 4.4.6.4 of MoTI's Supplement to the CHBDC S6-14. Retaining walls are subject to seismic performance requirements including non-collapse under the 1:975-year seismic hazard.

Back analysis of the existing slopes was completed to confirm that the strength parameters used in design were appropriate. Due to the current slide conditions, the existing stability condition of the sections within the slide zone (extent of cracking) was assumed to have a factor of safety (FoS) of 1.1 under static (non-seismic) conditions.

The intent of the slope stability analyses at this phase of the project were to identify major constraints relating to external geometry and geotechnical conditions. Detailed design checks have not yet been completed.

All concepts described above intend to achieve the geotechnical design criteria. Concepts 2 and 3 with the inclusion of structures will be more at risk under pseudo-static (seismic) conditions. See Section 5.7 for further assessment of seismic design.

5. PRELIMINARY DESIGN RECOMMENDATIONS

5.1 General

The following provides our geotechnical recommendations to support the preliminary design and cost comparison which were used to select a preferred concept. Generally, only permanent features are addressed although temporary cut slopes were considered at a high level for

potential constructability constraints. Detailed design of the preferred concept is required before the design can be finalized.

5.2 Rock Cut Slopes

We recommend that rock cuts be sloped at 0.25H:1V with 3 m rockfall catchment ditches. For rock cuts greater than 8 m in height the catchment is considered marginal; however, the dimension was selected to provide sufficient catchment as well as to limit encroachment into the park above Canal Road. Detailed design of the rock cuts should include assessment of alternative measures to achieve specified rockfall catchment such as the use of slope mesh.

5.3 Overburden Cut Stabilization

For this phase of design, we recommend that permanent overburden cuts on the upslope side of the roadway should generally be sloped at 1.5H:1V. This will be analyzed in detailed design.

Where bedrock is encountered in the overburden cut slopes, it can be exposed following its natural profile. Exposed rock surfaces should be reviewed by the geotechnical engineer during construction to confirm stabilization requirements.

5.4 Fill Embankment Slopes / Toe Berm

For the proposed Concept 1, Option 1A toe berm embankment, fill construction should be carried out in accordance with the MoTI Standard Specifications for Highway Construction, Section 201.37. We anticipate that the toe berm will be constructed on the fill pad below the roadway and extend from Sta. 100+215 to 100+300 and be sloped at 1.5H:1V.

Preliminary analysis indicates that the toe berm at the west end likely meets the geotechnical design criteria, however available space to the east may limit the size of the berm and needs to be analyzed further in detailed design.

The toe berm should be constructed using blast rock fill in accordance with the Standard Specifications for Highway Construction, Section 201.36.

The subgrade at the toe of the embankments should be free from deleterious, loose/soft, or otherwise unsuitable soils, should be horizontal and should be compacted with a large steel drum vibratory roller where possible. The subgrade should be reviewed by Thurber prior to fill placement and any sub-excavation operations completed, if required.

5.5 Upslope Retaining Wall

For the proposed Concept 1, a retaining wall would extend on the upslope side of the roadway from Sta. 100+295 to Sta. 100+335. The retaining wall would have a maximum height of about 8 m. Depending on the updated ROW and cut extents, the wall could consist of an MSE wall constructed with assumed geogrids 0.7 x the height of wall; however, this minimum length may need to be increased to account for sloping backfill and seismic demands. The temporary cuts

should be assumed to be excavated at 1H:1V starting at the back of the reinforced zone. Consideration could also be given to construction of a shotcrete / soil nail wall or a reinforced soil (soil nailed) slope. These concepts should be developed further in the detailed design phase.

5.6 Downslope Slope Stabilization (Concept 1B)

If Option 1A is not selected for detailed design, slope stabilization of the downslope side of the new roadway will be needed where it is not founded on bedrock. This would likely be a reinforced pile cap with tie-back anchors and piles, similar to Concept 3 discussed earlier.

This option would likely be more costly to construct and maintain compared to the toe berm and would have a limited lifetime depending on the materials used for design. This is offset by the reduced construction footprint and reduced encroachment onto private property.

5.7 Seismic Design

Seismic hazard spectral acceleration values obtained from the NRCAN NBC2015 online calculator are attached. The peak ground acceleration (PGA) for the 2%, 5% and 10% in 50 year probability of exceedance hazards are 0.494 g, 0.359 g, and 0.266 g, respectively. Based on the site investigation data, Seismic Site Class C is generally appropriate for structures at this site founded on dense soil, subject to review for possible structure in detailed design following further site investigation.

It is anticipated that structures (retaining walls, anchors, bridges) would attract significant seismic loads which would control the design. Toe berms and slopes may deform in a seismic event; however, where stabilized to meet the geotechnical design criteria, it is anticipated that the deformation would result in repairable damage to the roadway only.

5.8 Drainage

The site is relatively free draining. However, all gully features in the slope above Canal Road should be anticipated to carry surface flow during heavy precipitation or following snow melt events. Culverts may be required where these features intersect the proposed alignment. Existing culverts should be maintained or replaced as appropriate. Suitable erosion protection measures are required at discharge locations to mitigate erosion of steep slopes.

5.9 Pavement

No analysis of the pavement structure has been completed by Thurber at this early stage, as the design team's attention was focused on addressing the realignment and options analysis. The pavement structure at this site will generally be constructed within the rock cut or on compact colluvium.

Pavement structure should be designed for low volume roads as per the MoTI Technical Circular T-01/15.

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6. FUTURE WORK

For detailed design the following additional geotechnical investigation and analysis is anticipated:

- Test holes at the base of the potential toe-berm and retaining wall, to investigate subgrade conditions and berm stability.
- Test pits or trenches at the base of any downslope retaining walls, to investigate subgrade and cut conditions.
- Test holes between Sta. 100+220 and Sta 100+340 within the upslope ditch of Canal Road to confirm stratigraphy for stability analysis
- Updating the preliminary geotechnical analyses based on the geometry of preferred option and with new geotechnical data including:
    - Static and seismic stability analyses of cut slope walls and retaining walls to confirm designs meet criteria.
    - Pile and tie back anchor design if Option 1B is selected.
    - Mapping and analysis of rock structure, stabilization and rockfall catchment requirements. and
    - Further evaluation of groundwater conditions and how this sensitivity is addressed in the design.

7. CLOSURE

We trust this provides you sufficient information for your needs at this time. If you have any questions or would like to discuss these updated recommendations, please contact us.

Yours truly,
Thurber Engineering Ltd.
J. Suzanne Powell, Ph.D., P.Eng.
Review Principal

Thurber Engineering Ltd.
Permit to Practice #1001319

Warren Wunderlick, P.Eng
Geotechnical Engineer

Jillian Usher, EIT
Junior Geotechnical Engineer

Attachments:

- Statement of Limitations and Conditions
- Figure 1 - Test Hole Location Plan
- 2022 Thurber Test Hole Logs
- NRCAN NBC 2015 Seismic Calculation

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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.

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Pender Island - Canal Road Slide
Testhole and SAA Location Plan

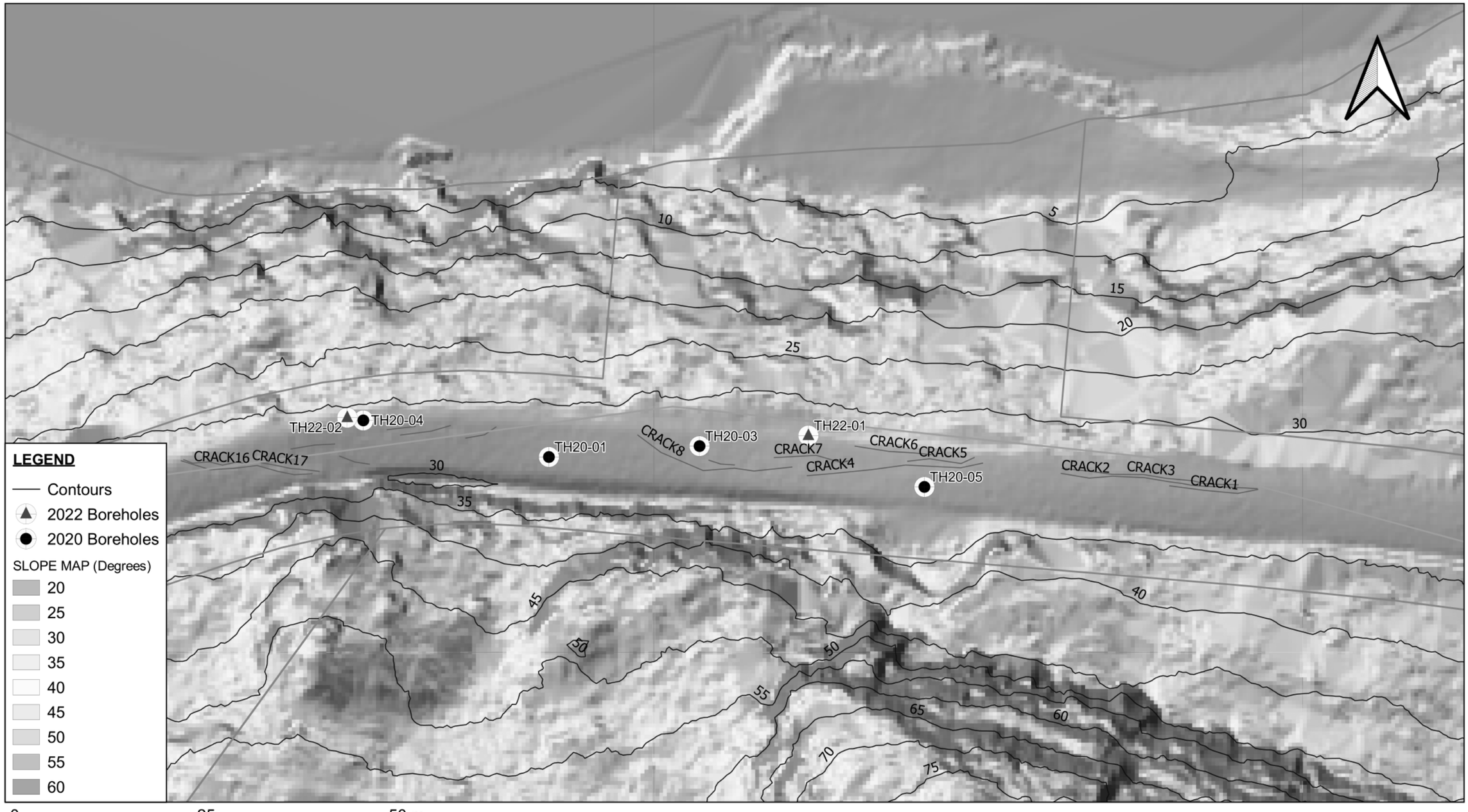

FIGURE 1

Client: BC MoTI
File No: 33450

Date: March 18, 2022

SUMMARY LOG

Drill Hole #: **TH22-1**

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Prepared by: 33450 Thurber Engineering Ltd.

Logged by: JLU Reviewed by: WRW

Datum: UTM NAD 83 ZONE 10U Alignment:

Northing/Easting: 5400722.8 , 483461.9 Station/Offset:

Elevation: *Coordinates taken with GPS*

Date(s) Drilled: January 19, 2022

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: Boart LS250 Sonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 — SPT "N" (BLOWS/300 mm) — Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate {G % S % F %}	MONITORING WELL	DEPTH (m)
0							ASPHALT — 0.15m	AS			0
		8.4		1			GP/SP; GRAVEL and SAND, trace silt, gravel to 40 mm diameter, brown, FILL, moist, compact	GP/SP			
1		12.5		2			0.91m				1
	3 3 4 4	▲ 19.4		3	25		GM; GRAVEL and SAND, silty, trace clay, gravel to 50 mm diameter, trace rootlets, brown, moist, loose	GM			
2		10.0		4			2.44m				2
	9 10 9 8	9.7 ▲		5	54		GM; GRAVEL and SAND, silty, some clay, trace rootlets, brown, sandy clay pockets, COLLUVIUM, moist, compact				
3		7.5		6							3
	15 12 9 7	14.9 ▲		7	58						
4		9.8		8				GM	**Atterberg** (Sa#8): PL:21% LL:30%		4
	9 10 12 10	16.1 ▲		9	63						
5		10.2		10							5
	17 17 16 14	17.7 ▲		11	67						
6							8.23m				6
	Easier drilling 8.2 to 10.1 m depth.	13.0		12			GM; GRAVEL, sandy, silty, some clay, gravel to 40 mm diameter, trace rootlets, grey-brown, moist, loose		**Atterberg** (Sa#12): PL:21% LL:30%		
7	6 5 5 8	▲ 16.3		13	42			GM			7
8											8
9											9
10											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: 19.8 m

Depth to Top of Rock:

Page 1 of 2

MOTI-SOIL-REV-3-MOM-30217 33450_CANAL ROAD_2022 TEST HOLES_MOTI FORMAT.GPJ MOTI_DATATEMPLATE_REV3.GDT 22-4-25

SUMMARY LOG

Drill Hole #: **TH22-1**

Ministry of Transportation and Infrastructure — BRITISH COLUMBIA

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Prepared by: 33450 Thurber Engineering Ltd.

Logged by: JLU Reviewed by: WRW

Datum: UTM NAD 83 ZONE 10U Alignment:

Northing/Easting: 5400722.8 , 483461.9 Station/Offset:

Elevation: *Coordinates taken with GPS*

Date(s) Drilled: January 19, 2022

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: Boart LS250 Sonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400; SPT "N" (BLOWS/300 mm); Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	MONITORING WELL	DEPTH (m)
10		12.1		14			10.06m				10
	65	17.3		15	100		SM/ML; SILT, sandy, gravelly, clayey, gravel to 50 mm diameter, grey-brown, sandy clay pockets, TILL-like, dry to moist, dense		**Atterberg** (Sa#14): PL:19% LL:30%		
11	65 blows / 150 mm penetration.	4.5		16							11
12	52	19.6		17							12
	50 blows / 25 mm penetration.	10.0		18							
13		4.7		19							13
14		11.6		20							14
15								SM/ML			15
		12.8		21							
16		5.0		22							16
17											17
		7.4		23							
18											18
		8.5		24			End of Hole at required depth (19.8 m).				
19							Upon completion of drilling: 50 mm PVC casing installed for SAA installation, backfilled with bentonite-grout. SAA installation on January 28, 2022; Serial Number 247582, active segments from 1.8 m to 19.8 m depth.				19
		10.4		25			19.81m				
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

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

Final Depth of Hole: 19.8 m

Depth to Top of Rock:

Page 2 of 2

MOTI-SOIL-REV-3-MOM-30217 33450_CANAL ROAD_2022 TEST HOLES_MOTI FORMAT.GPJ MOTI_DATATEMPLATE_REV3.GDT 22-4-25

SUMMARY LOG

Drill Hole #: **TH22-2**

Ministry of Transportation and Infrastructure — British Columbia

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Prepared by: 33450 Thurber Engineering Ltd.

Logged by: JLU Reviewed by: WRW

Datum: UTM NAD 83 ZONE 10U Alignment:

Northing/Easting: 5400725.8 , 483402.2 Station/Offset:

Elevation: *Coordinates taken with GPS*

Date(s) Drilled: February 15-16, 2022

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: Boart LS250 Sonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 — SPT "N" (BLOWS/300 mm) — Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING — Drillers Estimate {G % S % F %}	MONITORING WELL	DEPTH (m)
0							ASPHALT 0.15m	AS			0
		8.9		1			GP; .GRAVEL, sandy, trace to some silt gravel to 50 mm diameter, trace rootlets, brown to grey-brown, FILL, moist, compact	GP			
1		2.9		2							1
	10 6 7 5	14.2		3	17		1.52m GM/SM; .GRAVEL and SAND, silty, some clay, contains cobbles to 65 mm diameter, trace rootlets, brown, sandy clay pockets, COLLUVIUM, moist, compact	GM/SM			
2		15.0		4							2
		8.4		5							
3	30 8 7 7	5.6 ▲		6	50						3
		8.6		7							
4											4
	25 26 18 16	10.7 ▲		8	58		- contains till-like inclusions from 4.6 m to 6.1 m depth				
5											5
		9.7		9							
6											6
	12 8 9 17	▲ 23.5		10	58						
		20.4		11							
7							7.01m		**Atterberg** (Sa#11): PL:27% LL:44%		7
		11.0		12			SM; SILT and SAND, gravelly, clayey, gravel to 25 mm diameter, brown, sandy clay pockets, TILL-like, dry to moist, dense				
	38 49 54 68	>> ▲ 19.7		13	100						
8											8
		10.2		14							
9											9
	46 29 55 49	▲ 15.2		15	83						
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: 22.9 m

Depth to Top of Rock: 17.4 m

MOTI-SOIL-REV-3-MOM-30217 33450_CANAL ROAD_2022 TEST HOLES_MOTI FORMAT.GPJ MOTI_DATATEMPLATE_REV3.GDT 22-4-25

Ministry of Transportation and Infrastructure

SUMMARY LOG

Drill Hole #: **TH22-2**

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Prepared by: 33450 Thurber Engineering Ltd.

Logged by: JLU Reviewed by: WRW

Datum: UTM NAD 83 ZONE 10U Alignment:

Northing/Easting: 5400725.8 , 483402.2 Station/Offset:

Elevation: *Coordinates taken with GPS*

Date(s) Drilled: February 15-16, 2022

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: Boart LS250 Sonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (SPT)	Pocket Penetrometer / Shear Strength (kPa) 100 200 300 400 — SPT "N" (BLOWS/300 mm) — Wp% 20 W% 40 60 WL% 80	SAMPLE TYPE	SAMPLE NO	RECOVERY (%)	SOIL SYMBOL	SOIL DESCRIPTION	CLASSIFICATION	COMMENTS TESTING Drillers Estimate {G % S % F %}	MONITORING WELL	DEPTH (m)
10		10.3		16			SM; SILT and SAND, gravelly, clayey, gravel to 25 mm diameter, brown, sandy clay pockets, TILL-like, dry to moist, dense *(continued)*	SM	**Atterberg** (Sa#16): PL:19% LL:32%		10
11	44 35 33 30	19.8		17	83						11
		11.1		18							
12	41 43 78 80	18.7 >>		19	96						12
13		21.8		20							13
14	69 50 blows / 25 mm penetration.	18.6		21	86		14.02m				14
		15.3		22			SM; SILT and SAND, gravelly, clayey, gravel to 25 mm diameter, brown, TILL-like, dry to moist, dense to cemented				
15		20.6		23							15
	110 110 blows / 300 mm penetration.	18.5		24	100			SM			
16		12.6		25							16
		13.5		26							
17	150 150 blows / 300 mm penetration.	15.0 16.0		27 28	100		17.37m BR; BEDROCK				17
		1.0		29							
18											18
19											19
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

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

Final Depth of Hole: 22.9 m

Depth to Top of Rock: 17.4 m

MOTI-SOIL-REV-3-MOM-30217 33450_CANAL ROAD_2022 TEST HOLES_MOTI FORMAT.GPJ MOTI_DATATEMPLATE_REV3.GDT 22-4-25

SUMMARY LOG

Drill Hole #: **TH22-2**

Ministry of Transportation and Infrastructure

Project: **Canal Road - Pender Island Slide**

Location: Canal Road, South Pender Island, B.C.

Prepared by: 33450
Thurber Engineering Ltd.

Logged by: JLU Reviewed by: WRW

Datum: UTM NAD 83 ZONE 10U Alignment:

Northing/Easting: 5400725.8 , 483402.2 Station/Offset:

Elevation: *Coordinates taken with GPS*

Date(s) Drilled: February 15-16, 2022

Company: Drillwell Enterprises Ltd.

Driller: Tyler Parkhouse

Drill Make/Model: Boart LS250 Sonic

Drilling Method: Sonic

DEPTH (m)	DRILLING DETAILS (S P T)	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 %}	MONITORING WELL	DEPTH (m)
20							BR; BEDROCK *(continued)*	BR			20
21											21
22				30							22
							22.86m				
23							End of Hole at required depth (22.9 m). Upon completion of drilling: 50 mm PVC casing installed for SAA installation, backfilled with bentonite-grout. SAA installation on February 24, 2022 Serial Number 247587active segments from 1.6 m to 22.9 m				23
24											24
25											25
26											26
27											27
28											28
29											29
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: 22.9 m
Depth to Top of Rock: 17.4 m
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MOTI-SOIL-REV-3-MOM-30217 33450_CANAL ROAD_2022 TEST HOLES_MOTI FORMAT.GPJ MOTI_DATATEMPLATE_REV3.GDT 22-4-25

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: 48.759N 123.225W **User File Reference:** Canal Road - Pender Island 2022-03-16 15:31 UT