CITY OF COLWOOD
3300 Wishart Road | Colwood | BC V9C 1R1 | 250 294-8153
planning@colwood.ca | www.colwood.ca

File: DPA00004 - Grading Works at Lot I & Lot J Beachlands

DEVELOPMENT PERMIT AMENDMENT DPA00004

THIS PERMIT, issued **August 2, 2024,** is,

ISSUED BY: **CITY OF COLWOOD**, a municipality incorporated under the *Local Government Act*, 3300 Wishart Road, Victoria, BC, V9C 1R1

(the "City")

PURSUANT TO: Section 490 of the *Local Government Act* , RSBC 2015, Chapter 1

ISSUED TO: RPSP BEACH FRONT NOMINEE LTD
305-111 WATER ST
VANCOUVER BC V6B 1A7

(the "Permittee")

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1. This Natural Hazards (Steeply Sloped) Development Permit Amendment applies to those lands within the City of Colwood described below, and any and all buildings, structures, and other development thereon:

   LOT J, SECTION 53, ESQUIMALT LAND DISTRICT, PLAN VIP58414, & SEC 54
   LOT I, SECTION 54, ESQUIMALT LAND DISTRICT, PLAN VIP58414
   METCHOSIN RD

   (the "Lands")

2. This Development Permit Amendment regulates the development and alterations of the Land, and supplements the "*Colwood Land Use Bylaw, 1989*" (Bylaw No. 151), to ensure the Natural Hazard considerations for tree removal and grading works are consistent with the Natural Hazard guidelines for areas designated as "Steeply Sloped" in the City of Colwood Official Community Plan (Bylaw No. 1700).

3. This Development Permit is **NOT** a Building Permit or a subdivision approval.

4. This Development Permit Amendment is issued subject to compliance with all of the bylaws of the City of Colwood that apply to the development of the Lands, except as specifically supplemented by this Permit.

5. The Director of Development Services or their delegate may approve minor variations to the schedules attached to and forming part of this Development Permit Amendment, provided that such minor variations are consistent with the overall intent of the original plans and do not alter the environmental conditions of the development authorized by those plans.

6. If the Permittee does not substantially start the construction permitted by this Permit within 24 months of the date of this Permit, the Permit shall lapse and be of no further force and effect.

7. The development is to be constructed in accordance with the following plans and specifications, which are attached to and form as part of this permit:

Schedule 1	Arborist Report prepared by D. Clark Arboriculture revised July 24, 2024.
Schedule 2	Tree Site Plan prepared by D. Clark Arboriculture, revised July 24, 2024.
Schedule 3	Geotechnical Report prepared by GeoPacific Consultants Ltd. dated October 3, 2023.
Schedule 4	Grading Plan prepared by OnPoint Project Engineers Ltd. dated March 25, 2024.
Schedule 5	Stormwater Management Memo prepared by OnPoint Project Engineers Ltd. dated June 20, 2024.
Schedule 6	Erosion and Sediment Control Plan prepared by Corvidae Environmental Consulting Inc. dated July 2024.

8. This Development Permit Amendment contains additional documents required as part of Development Permit DP000025.

9. This Development Permit Amendment, in combination with Development Permit DP000025, authorizes the removal of 19 trees and associated grading works. The Lands shall not be altered, nor any buildings or structures constructed, except in accordance with the following conditions:

GENERAL

9.1. The following permits issued on the Lands by the City of Colwood apply, remain valid and are in no way diminished by this Development Permit:

9.1.1. DP000005 – Multifamily Development in Lot 1 of Area 2 Beachlands; and

9.1.2. DP000009 – Presentation Centre at 298 Beachlands Blvd.

9.1.3. DP000025 – Tree Removals and Grading Works at Lot I & Lot J Beachlands

TREE MANAGEMENT CONDITIONS

General

9.2. All recommendations from the Arborist Report prepared by D. Clark Arboriculture (Schedule 1) must be followed and only varied with written consent from the Director of Development Services.

Tree Protection

9.3. All protection measures for retained trees must be in accordance with the revised Arborist Report prepared by D. Clark Arboriculture (Schedule 1) and only varied with written consent from the Director of Development Services.

9.4. The Tree Protection Zone must be installed in accordance with the revised Arborist Report (Schedule 1) and Tree Site Plan (Schedule 2) prepared by D. Clark Arboriculture and be inspected by the Project Arborist.

9.5. An updated Tree Protection Plan prepared by the project arborist must be submitted to the City for approval if any changes to the Tree Protection Zone are proposed, to the satisfaction of the Director of Development Services.

9.6. Prior to the issuance of the Development Permit, the Permittee has provided the City with a written letter of engagement from a certified arborist, agreeing to:

9.6.1. Oversee impacts on the site and ensure compliance with the recommendations contained in Schedules 1 and 2; and

9.6.2. Perform a final inspection and submit an inspection report to the City confirming substantial compliance with Schedules 1, and 2.

NATURAL HAZARDS CONDITIONS

General

9.7. All works shall adhere to the assessment and recommendations contained in the Geotechnical Report prepared by GeoPacific Consultants (Schedule 3) and be in substantial compliance with the Grading Plan prepared OnPoint Project Engineers Ltd (Schedule 4) and be completed under the guidance and approval of a Geotechnical Engineer.

9.8. Prior to the issuance of the Development Permit, the Permittee has provided the City with a written letter of engagement from a professional Geotechnical Engineer, agreeing to:

9.8.1. Oversee impacts on the site and ensure compliance with the recommendations contained in Schedules 3 and 4; and

9.8.2. Perform a final inspection and submit an inspection report to the City confirming substantial compliance with Schedules 3, and 4.

Stormwater Management

9.9. Stormwater management shall be in accordance with the approved Stormwater Management Plan prepared by OnPoint Project Engineers Ltd. (Schedule 5).

Erosion and Sediment Control

9.10. Erosion and sediment control shall be in accordance with the approved Erosion and Sediment Control Plan prepared by Corvidae Environmental Consulting Inc. (Schedule 6) with Environmental Monitoring provided by a Qualified Environmental Professional.

9.11. Prior to the issuance of the Development Permit, the Permittee has provided the City with a written letter of engagement from a Qualified Environmental Professional, agreeing to:

9.11.1. Oversee impacts on the site and ensure compliance with the recommendations contained in Schedules 6; and

9.11.2. Perform a final inspection and submit an inspection report to the City confirming substantial compliance with Schedules 6.

ISSUED ON THIS 2 DAY OF AUGUST, 2024.

JOHN ROSENBERG, A.Sc.T.
DIRECTOR OF ENGINEERING AND DEVELOPMENT SERVICES

Schedule 1

D. Clark Arboriculture
2741 The Rise Victoria B.C. V8T-3T4
(250)474-1552 (250)208-1568
clarkarbor@gmail.com
www.dclarkarboriculture.com

Arborist Report for Development Purposes
Re: Proposed Development, and Construction

Site Location: Beachlands Bluff, Colwood BC
Ryan Senechal ON-1272AT, TRAQ, BC WDTA 3013P
March 6th, 2024

Revision 1: July 24, 2024

March 6th, 2024
Revision: July 24, 2024

For Darby Hunt, Turnbull Construction Project Managers
Unit 308 – 780 Blanshard Street
Victoria, BC, V8W 2H1
Re. Proposed Development, and Construction at Beachlands Bluff

1.0 - Scope of Work

D. Clark Arboriculture has been retained by Turnbull Construction Project Managers to provide an initial tree inventory and report and tree management plan for Protected trees that may be conflicting with proposed site grading and construction of homes and amenities, and to produce a Tree Protection Plan for the Beachlands Bluff property on Metchosin Rd. as per the requirements of the City of Colwood.

The Arborist's assignment in this project is to gather site and tree information in areas identified by our client and to make recommendations on:

- Tree suitability for retention
- Protection measures required for retained trees
- The requirement for tree removal where conflicts are likely to cause disturbances or injuries that destabilize or severely degrade tree health

The Tree Protection Plan includes preventative best management practices for retaining trees through construction activities and may include physical protections, the production of correspondence and markups for the benefit of the project team, and arborist supervision of works that encroach on established Tree Protection Zones (TPZs). The arborist will also support inspection and mitigation needs should a tree or trees identified for retention be injured during the project. Ongoing monitoring will be conducted to ensure preventative protection measures such as fencing and signage are maintained, and to identify any damages or disturbances that have occurred.

2.0 - Summary

During our site work on August 3rd and 4th, 2023, a total of (87) trees were initially inventoried in 2 areas of the lot (Figure 1). Only trees that are of a Protected size under City of Colwood's Urban Forest Bylaw No. 1735, 2018 were inventoried. Several multi-stemmed trees that were tagged during our site visit were not reflected in the final inventory as they were later determined to be undersized based on Colwood's multiple stem diameter formula. A third area of the lot (Figure 3) was surveyed by myself (Ryan Senechal) and Miche Hachey on January 31st, 2024 to determine if additional Bylaw Protected trees were within the grading footprint. No additional trees were identified as being in direct conflict. Grading may encroach on eastern bluff trees, and measures have been outlined in 6.0 and 7.0 of this report to address those potential disturbances.

Bylaw Protected trees (19) run along a bluff edge at the east side of the property adjacent a service road currently in use for site earthworks and these trees are required to be removed as they fall within planned grading. An additional strip of (57) Bylaw Protected trees at the crest of a slope on the southern-most side of the property have been retained with tree protection recommendations outlined in this report.

A report revision completed on July 24th, 2024, includes changes to tree protection measures including the locations and extents of tree protection fencing. The tree protection fencing modifications are not anticipated to reduce the levels of protection from disturbance and injury to protected trees that have been outlined in the previous Tree Protection Plan

(D. Clark Arboriculture, March 6, 2024). Fencing installation in accordance with this report revision's recommendations (Figure 2) has been completed as of July 24, 2024 (Figures 3-6). Trees #58-86 identified to be removed in a previous report (D. Clark Arboriculture, March 6, 2024) have been felled, and stumps remain. Arborist supervision requirements have been revised to reflect Tree Protection Plan changes.

Table 1. Summary of Tree Inventory and Recommendations

Tree Ownership	Protected Trees	Protected Trees Removed	Protected Trees to be Retained	Replacement Trees Required
Onsite trees	76	19	57	38

3.0 - Introduction and Methodology

Ryan Senechal and Miche Hachey attended the site on August 3rd and 4th, 2023 to inspect and inventory on-property trees of a Protected status that have potential to be disturbed or injured by proposed construction. An initial report was submitted for this project on September 26th, 2023, and this subsequent arborist report was completed by Ryan Senechal on March 6th, 2024.

Tasks performed include:

- An aerial site map was generated indicating tree locations (Figure 1).
- A visual inspection of (76) protected trees and (11) unprotected trees was completed. An additional area was surveyed on January 31st, 2024 (Figure 3) to determine if Bylaw Protected trees were in that area.
- Information gathered included ID, species, diameter at breast height (DBH), tree height, bylaw protection status, crown width, health condition, structural condition, and condition notes.
- Trees were tagged using numerically stamped aluminum discs.
- Tree height was measured to the nearest metre with a Trupulse 200 Laser Rangefinder. Canopy width was estimated to the widest point. Diameters were measured with a fabric tape.
- Tree locations were provided by On Point Project Engineers Ltd. and are adapted in orthographic imagery in this report.
- A Tree Protection Plan (attachment) implementing local site and species knowledge and Industry Best Management Practices[1].
- Photos of the site.

On July 24th, 2024, a revision to this report was produced by Ryan Senechal outlining proposed changes to tree protection fencing locations. Work conducted as the southern slope has concluded and there are no works planned that would require tree protection fencing to be installed for trees #1-57.

Tasks performed include:

- A site visit was conducted on July 13th, 2024, to support installation crews with tree protection fencing layout.
- Updated plans provided to us by our client were reviewed to evaluate potential conflicts with protected trees.
- A modified plan for the physical location and extents of tree protection fencing was generated (Figure 2) for this report revision, and as a revised Tree Protection Plan (July 24, 2024). The revised fencing location and extents in the Tree Protection Plan reflects the completion of works at the south slope, steep slope safety concerns, and areas where there are no protected trees present.
- Tree protection measures were revised in parts 6.0 and 7.0 of this report reflecting the removal of remaining stumps from removed trees #58-86, and to note the completion of works at the south slope area where protected trees #1-57 are located.

[1] Matheny et al. (2023). Managing Trees During Site Development and Construction: Best Management Practices, Third Edition.

Figure 1 – Aerial view of property and tree locations (March 26, 2024)

Beachlands Bluffs Tree Inventory - August 29, 2023 - Coordinates Provided by On Point Project Engineers Ltd.

- Retain Tree
- Remove Tree

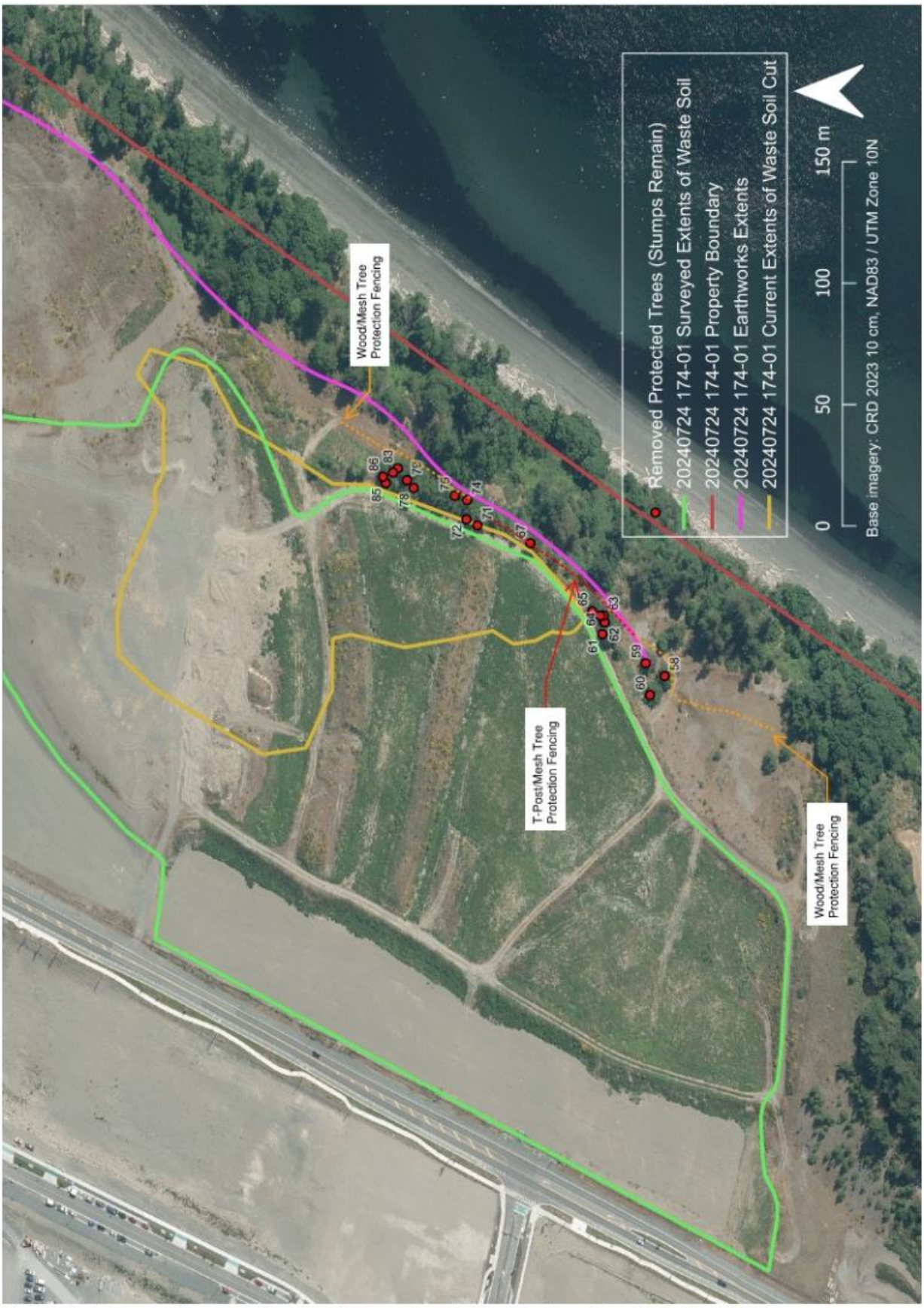


Figure 2 – Removed trees and revised tree protection fencing locations (July 24, 2024)

4.0 - Tree Inventory

Beachlands Bluff Inventory of Trees										
#	Species	DBH (cm)	Height (m)	Width (m)	PRZ (m)	Structural Condition	Health Condition	Bylaw protected	Recommendation	Condition Notes
1	Garry oak	17	7	7	2	good	good	Yes	Retain	Small deadwood
2	Garry oak	19	8	6	2.3	fair	fair	Yes	Retain	50% live foliage
3	Garry oak	14	8	5	1.7	fair	fair	Yes	Retain	25% live, suppressed
4	Garry oak	7	6	4	.8	poor	poor	Yes	Retain	25% live foliage, suppressed
5	Garry oak	11	4	6	1.3	fair	fair	Yes	Retain	30% live foliage, suppressed
6	Douglas fir	43	13	9	5.2	fair	fair	Yes	Retain	Below average needle density and yellowing colour indicate stress and decline
7	Douglas fir	74	18	10	8.9	fair	fair	Yes	Retain	Average needle density and colour
8	Arbutus	20	8	6	2.4	fair	fair	Yes	Retain	Small deadwood, multi stem
9	Garry oak	10	5	4	1.2	poor	poor	Yes	Retain	10% live foliage, suppressed
10	Garry oak	9	4	3	1.1	fair	fair	Yes	Retain	30% live foliage, suppressed
11	Garry oak	29	8	10	3.5	poor	fair	Yes	Retain	Multiple primary branch failures, dieback, over extended branch, in contact with ID7
12	Douglas fir	30	11	7	3.6	fair	fair	Yes	Retain	Small deadwood, average needle density and colour
13	Garry oak	8	2	3	1.0	fair	fair	Yes	Retain	30% live foliage, suppressed
14	Garry oak	6	2	3	.7	fair	fair	Yes	Retain	30% live foliage, suppressed
15	Garry oak	9	4	3	1.1	fair	fair	Yes	Retain	Tip dieback, 30% live foliage, suppressed
16	Garry oak	4	2	2	.5	fair	fair	Yes	Retain	Suppressed sapling
17	Garry oak	21	7	3	2.5	fair	fair	Yes	Retain	50% live foliage, suppressed
18	Douglas fir	35	11	5	4.2	fair	fair	Yes	Retain	Poor live crown ratio, average needle density and colour
19	Garry oak	5	2	2	.6	fair	fair	Yes	Retain	Suppressed sapling
20	Douglas fir	41	20	8	4.9	poor	poor	Yes	Retain	Poor live crown ratio, average needle density and colour.
21	Douglas fir	54	22	10	6.5	fair	fair	Yes	Retain	Average needle and colour
22	Arbutus	6	2	1	.7	fair	fair	Yes	Retain	Suppressed sapling
23	Arbutus	11	5	3	1.3	good	good	Yes	Retain	/
24	Douglas fir	58	26	10	7.0	fair	fair	Yes	Retain	Newly formed top. over extended lateral branches. average needle density and colour
25	Arbutus	6	3	3	.7	fair	fair	Yes	Retain	Suppressed sapling
26	Arbutus	9	5	3	1.1	fair	poor	Yes	Retain	Dead top, 10% live foliage

#	Species	DBH (cm)	Height (m)	Width (m)	PRZ (m)	Structural Condition	Health Condition	Bylaw protected	Recommendation	Condition Notes
27	Arbutus	11	6	4	1.3	fair	fair	Yes	Retain	Small dead branches
28	Arbutus	14	4	2	1.7	poor	critical	Yes	Retain	Only live growth is basal sprouts
29	Arbutus	5	2	3	.6	fair	fair	Yes	Retain	Suppressed, spreading form
30	Arbutus	9	4	4	1.1	fair	fair	Yes	Retain	Suppressed, spreading form
31	Douglas fir	46	21	8	5.5	fair	fair	Yes	Retain	Below average needle colour and needle density. indication of stress.
32	Arbutus	90	20	18	10.8	fair	good	Yes	Retain	Minor decay at base, multiple codominants, included bark, elongated primary branches, minor top dieback. good foliage density and wound response
33	Arbutus	64	15	8	7.7	fair	fair	Yes	Retain	Basal decay, multi stem, moderate small branch dieback
34	Bigleaf maple	30	18	10	3.6	fair	fair	Yes	Retain	Suppressed, uneven branch distribution, minor small branch dieback
35	Douglas fir	43	21	10	5.2	fair	fair	Yes	Retain	Healthy upper crown, uneven branch distribution, minor needle dieback
36	Arbutus	55	18	11	6.6	poor	poor	Yes	Retain	Large dead primary branches, poor foliage density
37	Arbutus	33	12	8	4.0	poor	critical	Yes	Retain	Only live growth is basal sprouts
38	Douglas fir	31	20	9	3.7	good	good	Yes	Retain	Good branch distribution, average needle density and colour
39	Arbutus	71	16	12	8.5	fair	fair	Yes	Retain	Moderate branch dieback, canker, basal decay, codominants
40	Douglas fir	46	19	10	5.5	good	fair	Yes	Retain	Suppressed lower branches and minor dieback, otherwise good needle density and colour
41	Douglas fir	31	12	8	3.7	good	good	Yes	Retain	Good branch density and distribution, average needle colour and density
42	Arbutus	78	20	18	9.4	fair	fair	Yes	Retain	Codominants and included bark at base. moderate low branch dieback. good foliage density and health in upper canopy. good wound response.
43	Arbutus	30	14	9	3.6	fair	fair	Yes	Retain	Moderate small branch dieback, suppressed, canker and basal decay
44	Arbutus	32	10	8	3.8	poor	poor	Yes	Retain	Severe basal canker, decay, branch dieback
45	Arbutus	35	18	14	4.2	fair	fair	Yes	Retain	Minor canker, moderate branch dieback in interior crown
46	Arbutus	34	18	13	4.1	fair	fair	Yes	Retain	Basal decay, moderate interior branch dieback
47	Douglas fir	43	20	15	5.2	fair	fair	Yes	Retain	Average needle density and colour
48	Arbutus	23	12	7	2.8	fair	good	Yes	Retain	Basal cavity, minor branch dieback
49	Arbutus	50	18	15	6.0	fair	fair	Yes	Retain	Moderate basal canker, small branch dieback
50	Arbutus	41	14	14	4.9	poor	poor	Yes	Retain	Severe basal canker and decay. 25% live foliage.
51	Arbutus	86	18	20	10.3	poor	poor	Yes	Retain	Severe dieback. 10% live foliage remains
52	Arbutus	50	9	9	6.0	poor	poor	Yes	Retain	Moderate canker and foliar blight, moderate dieback.
53	Arbutus	34	2	2	4.1	poor	poor	Yes	Retain	Severe dieback. 10% live foliage remains
54	Garry oak	16	4	4	1.9	fair	fair	Yes	Retain	Minor foliar injury likely from exposure on steep slope

#	Species	DBH (cm)	Height (m)	Width (m)	PRZ (m)	Structural Condition	Health Condition	Bylaw protected	Action	Condition Notes
55	Garry oak	15	3	3	1.8	fair	fair	Yes	Retain	Foliage density below average
56	Arbutus	21	5	6	2.5	poor	fair	Yes	Retain	Severe canker and dieback of primary stem
57	Arbutus	52	8	8	6.2	fair	fair	Yes	Retain	Multi stem, moderate dieback
58	Douglas fir	42	12	10	N/A	good	good	Yes	Tree has been removed	Good branch distribution, low interior needle density
59	Douglas fir	47	12	11	N/A	fair	good	Yes	Tree has been removed	Reiterated top, lower branch mechanical wounding, over extended low branches
60	Douglas fir	45	12	13	N/A	very good	very good	Yes	Tree has been removed	Full density, good needle colour
61	Douglas fir	30	11	10	N/A	good	fair	Yes	Tree has been removed	Low branch dieback, below average needle density and colour
62	Douglas fir	30	12	8	N/A	good	fair	Yes	Tree has been removed	Below average needle density and yellowing on water side. lower branch dieback.
63	Douglas fir	36	12	8	N/A	good	fair	Yes	Tree has been removed	Below average needle density and yellowing on water side. lower branch dieback.
64	Douglas fir	31	12	8	N/A	good	fair	Yes	Tree has been removed	Below average needle density and yellowing on water side. lower branch dieback.
65	Douglas fir	37	12	10	N/A	good	good	Yes	Tree has been removed	Average branch density and needle colour
67	Douglas fir	43	12	12	N/A	fair	fair	Yes	Tree has been removed	Codominant top. good needle density, and branch distribution. Wind exposure from ocean. steep slope.
71	Douglas fir	31	10	9	N/A	poor	fair	Yes	Tree has been removed	Side of roadway. Numerous mechanical wounding on base and throughout trunk. sap oozing. Broken hanging branches under 4cm in sizes.
72	Douglas fir	30	10	8	N/A	poor	fair	Yes	Tree has been removed	On roadway/steep slope. codominant stem at base. included bark. minor broken branches. Big leaf maple wrapped around stem. competing.
74	Douglas fir	31	16	13	N/A	good	good	Yes	Tree has been removed	On steep slope. Minor die back. Naturally thinner canopy due to competing vegetation.
75	Douglas fir	32	18	4	N/A	good	fair	Yes	Tree has been removed	On steep slope. Thinner presence of foliage on water side.
78	Bigleaf maple	33	14	9	N/A	fair	good	Yes	Tree has been removed	On steep slope. Gravel backfill on base. mechanical injury on trunk. included bark

#	Species	DBH (cm)	Height (m)	Width (m)	PRZ (m)	Structural Condition	Health Condition	Bylaw protected	Action	Condition Notes
79	Douglas fir	46	16	12	N/A	fair	fair	Yes	Tree has been removed	On steep slope, codominant stem with included seam at approximately 11m height.
83	Douglas fir	30	17	9	N/A	good	Fair	Yes	Tree has been removed	At bottom of steep slope. Needle density rated poor. Minor foliage die back
84	Douglas fir	32	18	9	N/A	good	fair	Yes	Tree has been removed	On Steep slope. needle density rated fair. Minor sized dead broken branches
85	Douglas fir	33	17	12	N/A	fair	good	Yes	Tree has been removed	On roadside. steep slope. fill of gravel and soil pushed up to base of trunk to approximately 30 cm height. Good needle density
86	Douglas fir	31	17	8	N/A	good	good	Yes	Tree has been removed	On steep slope. minor dead branches.

DBH-Diameter at Breast Height. Measured at 1.4m from the point of germination. Where the tree is multi-stemmed at 1.4m, the DBH shall be considered 100% of the three largest stems, rounded to the nearest cm.
PRZ-Protected Root Zone. The PRZ shall be considered 12x the DBH, rounded to the nearest 10 cm.

5.0 - Site Description

The Beachlands Bluff property is a former gravel/sand quarry with patches of remaining mixed age deciduous and coniferous forest. Species composition at the south side of the property on sandy soils and sloped terrain is a mixture of young lodgepole pine to the west and on the south and southeast, juvenile Garry oak, and a small number of mature Douglas fir and Arbutus. To the east along the steeper slopes at the crest of the bluff are primarily bigleaf maple coppices, Douglas fir, and red alder (on more recently disturbed areas). Both areas observed were moderately degraded, for example, localized vegetation loss and erosion caused by recreational activities. Site earthworks were ongoing during our initial survey, and much of the vegetation visible in 2021 and 2023 CRD aerial imagery has been removed for remediation and grading purposes.

The City of Colwood's Royal Beach Sub Area Plan and Waterfront Stewardship Plan were reviewed as part of this assignment.

Figure 3 – Wood frame tree protection fencing at the edge of the eastern bluff

Figure 4 – Wood frame tree protection fencing at the edge of the eastern bluff

Figure 5 – Stumps remaining to be removed with arborist supervision

Figure 6 – T-post and mesh tree protection fencing on steep slopes above the eastern bluff

6.0 - Grading and Proposed Construction Conflicts with Trees

6.1.1 - Cut/fill grading requirements present potential disturbance or injury to Protected trees on the eastern bluff. This includes compaction from heavy equipment, root system injury from excavation or stockpiling of materials, and destabilized root systems from removal of adjacent stumps. Tree protection measures in part 7.0 of this report are required to be implemented through all stages of the project to minimize disturbance and injury to protected trees.

6.1.2 - Erosion and sediment control measures, environmental monitoring, and tree fencing requirements are outlined along the eastern edge of the lot[2]. Tree protection fencing guidance and locations defined in the Tree Management Plan (D. Clark Arboriculture, July 24, 2024) shall be considered the minimum standards of protection. All areas outside of the scope of D. Clark Arboriculture's fencing locations will meet part 2.2 of the Erosion and Sediment Control Plan (Corvidae Environmental Consulting, July, 2024).

7.0 - Tree Protection Plan

7.1.0 - Scheduling of planned work requiring arborist supervision is recommended to be 5 days advance notice. A minimum notification of 48 hours is required.

[2] Corvidae Environmental Consulting Inc. July, 2024. Erosion and Sediment Control Plan.

7.1.1 - Updated grading plans indicate encroachment distances in relation to retained trees on the south slope are acceptable to remove the requirement for tree protection fencing. Any future works required that encroach within 15 m of protected trees at the top of the south slopes are required to engage the project arborist before any work commences. Plans are required to inform the arborist of potential disturbances from proposed works. Recommendations will be provided and outlined in the form of a memorandum to be provided to our client.

7.1.2 – Stumps of trees along the slope to the west of the bench at the east bluff require arborist supervision during removal. A ripper excavator attachment is required to minimize root pull during stump removal that might destabilize protected trees at the top of the bluff.

7.1.3 - A Tree Protection Zone (TPZ) is required to be installed following stump removal at the top of the eastern bluff. Fencing will be installed at the grading edge to prevent vehicle and worker access that might disturb root systems and degrade growing conditions for trees on the eastern bluff. Specific locations and extents are outlined in the Tree Management Plan (July 24, 2024).

7.1.4 - Fencing for the TPZ must be either securely anchored metal T-posts, or 2x4 posts and framing, paneled with securely affixed orange snow fence or plywood, or continuous temporary jobsite fencing (metal) secured with bailing wire or zip ties. Fencing will incorporate highly visible signs that include "TREE PROTECTION AREA-NO ENTRY" (See appendix for an example). The area inside TPZs is restricted to workers, equipment, and storage of materials. Areas outside the tree protection fence will remain open for passage, as work areas, and for storage of materials.

7.1.5 - Tree protection measures will remain in place for the duration of the project unless they are amended and documented by the project arborist.

7.1.6 - Tree protection measures will not be amended in any way without approval from the project arborist. Any additional tree protection measures will be documented in a memo to City of Colwood and our client.

7.1.7 - Work inside the established TPZ of any retained tree identified in this plan for any reason will take place under the supervision of the project arborist or their designate. Root disturbance and injury mitigation techniques may be specified by the arborist including, but not limited to the use a hydro-vac or Airspade®, a finishing bucket on an excavator removing shallow volumes of soil under constant arborist guidance, or digging using hand tools to expose roots for inspection. Any roots damaged or injured inside TPZs may trigger the requirement for a tree risk assessment to evaluate tree stability.

7.1.8 - Site servicing and road building may conflict with TPZs. Plans will require review for conflicts with retained trees by the project arborist when plans are produced.

7.1.9 - Any pruning of protected trees during the project will be performed by an ISA (International Society of Arboriculture) Certified Arborist guided by industry best management practices and specifications prepared by the project arborist.

7.1.10 - Landscaping has potential to disturb or injure tree within the TPZ. All protection measures outlined in the Tree Protection Plan extend to landscaping activities. Any changes will be approved by the project arborist with amendments to the report and plan documented in correspondence to the city and the developer.

8.0 - Role of the Project Arborist

8.1.1 - No aspect of this Tree Protection Plan will be amended in whole or in part without the permission of the project arborist. Any amendments to the plan must be documented in memorandums for the City of Colwood, and for the developer.

8.1.2 - The project arborist must approve all tree protection measures before construction is to begin.

8.1.3 - A site meeting including the project arborist, developer, project supervisor and any other related parties to review the tree protection plan will be held at the beginning of the project.

8.1.4 - The developer may keep a copy of the Tree Protection Plan on site to be reviewed and/or circulated to all relevant project participants. The project arborist is responsible for ensuring that all aspects of this plan, including violations, are documented in memorandums and circulated to the City of Colwood and to the developer.

9.0 - Replacement Trees and Achieving Tree Minimum

The City of Colwood requires replacement trees be planted for every bylaw protected tree removed, and securities are required for the protection of retained and replacement trees. No additional trees have been identified for removal and replacement, or for retention as part of this report revision (July 24, 2024).

Thank you for the opportunity to comment on these trees.
Should any issues arise from this report, I am available to discuss them by phone, email or in person.
Regards,

Ryan Senechal

UBC Master's of Urban Forestry Leadership (MUFL)
ISA Certified Arborist ON-1272A
ISA Tree Risk Assessment Qualification
BC Wildlife & Danger Tree Assessor #3013P

Disclosure Statement

An arborist uses their education, training and experience to assess trees and provide prescriptions that promote the health and wellbeing, and reduce the risk of trees.

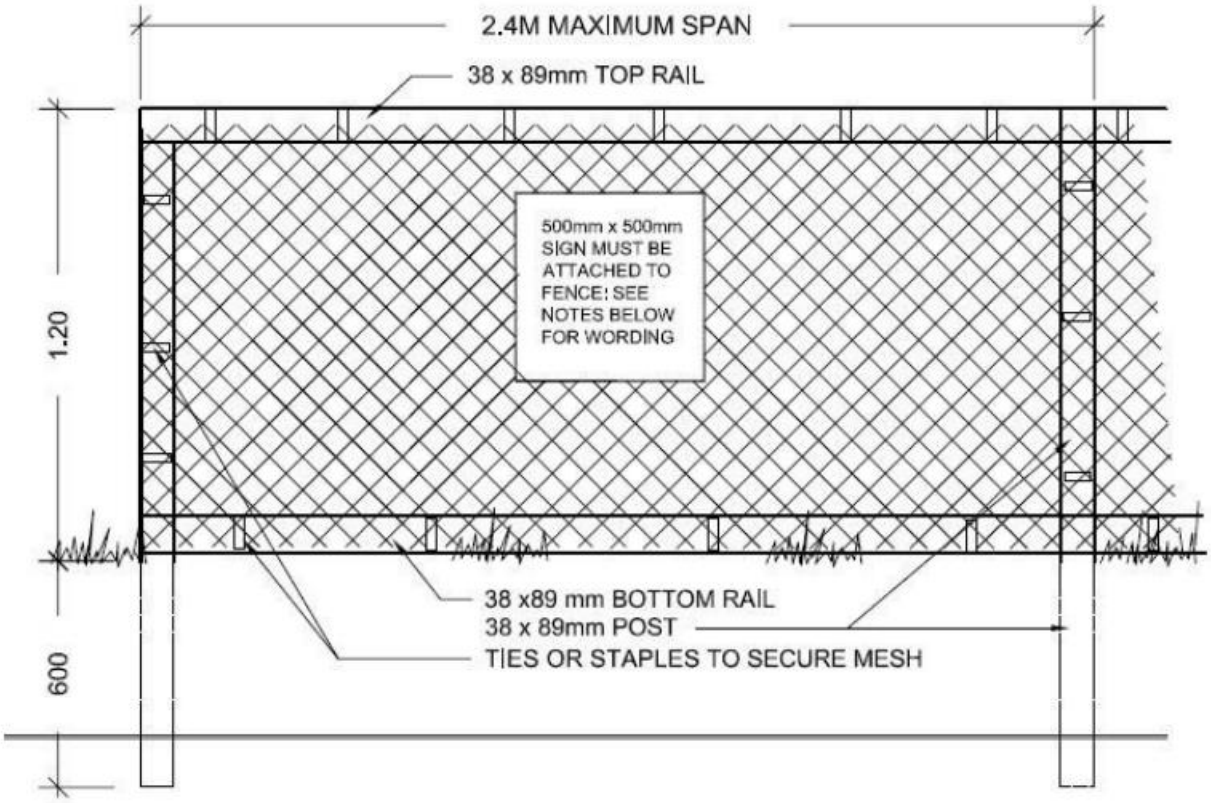
The prescriptions set forth in this report are based on the documented indicators of risk and health noted at the time of the assessment and are not a guarantee against all potential symptoms and risks.

Trees are living organisms and subject to continual change from a variety of factors including but not limited to disease, weather and climate, and age. Disease and structural defects may be concealed in the tree or underground. It is impossible for an arborist to detect every flaw or condition that may result in failure, and an arborist cannot guarantee that a tree will remain healthy and free of risk.

To live near trees is to accept some degree of risk. The only way to eliminate the risks associated with trees is to eliminate all trees.

Assumptions and Limiting Conditions

- Altering this report in any way invalidates the entire report.
- The use of this report is intended solely for the addressed client and may not be used or reproduced for any reason without the consent of the author.
- The information in this report is limited to only the items that were examined and reported on and reflect only the visual conditions at the time of the assessment.
- The inspection is limited to a visual examination of the accessible components without dissection, excavation or probing, unless otherwise reported. There is no guarantee that problems or deficiencies may not arise in the future, or that they may have been present at the time of the assessment.
- Sketches, notes, diagrams, etc. included in this report are intended as visual aids, are not considered to scale except where noted and should not be considered surveys or architectural drawings.
- All information provided by owners and or managers of the property in question, or by agents acting on behalf of the aforementioned is assumed to be correct and submitted in good faith. The consultant cannot be responsible or guarantee the accuracy of information provided by others.
- It is assumed that the property is not in violation of any codes, covenants, ordinances or any other governmental regulations.
- The consultant shall not be required to attend court or give testimony unless subsequent contractual arrangements are made.
- The report and any values within are the opinion of the consultant, and fees collected are in no way contingent on the reporting of a specified value, a stipulated result, the occurrence of a subsequent event, or any finding to be reported.



TREE PROTECTION FENCING

Tree Protection Fencing Specifications:

1. The fence will be constructed using 38 x 89 mm (2" x 4") wood frame:
   - Top, Bottom and Posts. In rocky areas, metal posts (t-bar or rebar) drilled into rock are acceptable.
   - Use orange snow fencing mesh and secure to the wood frame with "zip" ties or galvanized staples. Painted plywood or galvanized fencing may be used in place of snow fence mesh
2. Attach a roughly 500 mm x 500 mm sign with the following wording: **TREE PROTECTION AREA- NO ENTRY**. This sign must be affixed on every fence face or at least every 10 linear metres.


Schedule 2
Wood/Mesh Tree Protection Fencing
T-Post/Mesh Tree Protection Fencing
Wood/Mesh Tree Protection Fencing
85
86
83
78
79
75
72
74
71
67
61
64
65
62
63
60
59
58
Removed Protected Trees (Stumps Remain)
20240724 174-01 Surveyed Extents of Waste Soil
20240724 174-01 Property Boundary
20240724 174-01 Earthworks Extents
20240724 174-01 Current Extents of Waste Soil Cut
0
50
100
150 m
Base imagery: CRD 2023 10 cm, NAD83 / UTM Zone 10N

Schedule 3

GEOPACIFIC CONSULTANTS

P (250) 381 2134
geopacific.ca
2nd Floor, 3351 Douglas Street
Victoria, B.C. V8Z 3L4

RPSP Beach Front Development Manager Ltd.
c/o Turnbull Construction Project Managers
13450 102nd Avenue
Surrey, B.C
V3T 5X3

October 3, 2023
File: 21385
R0

Attention: Crystal Loreth

Re: Geotechnical Investigation Report – Beachlands 'Area 3' Detailed Slope Setback Analysis
Beachlands Development, Metchosin Road, Colwood, B.C.

1.0 INTRODUCTION

We understand that a phased mixed use development is proposed for the above-referenced site in Colwood. This report relates to the lands identified as Area 3 as shown on the CD30 Zone Map, which is provided in Appendix F following the text of this report. Based the design information provided, the proposed development within Area 3 would consist of single family and attached homes constructed in phases. As such, we understand that the development would include various grading works, new roadways, parking areas and civil services.

We further understand that an assessment of the site is required in accordance with the 2018 B.C. Building Code, enacted in April 2020, and EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023). Geotechnical requirements for this assessment are stipulated in EGBC's guidelines for Landslide Assessments in British Columbia. (March 1, 2023) and require preparation of a geotechnical report confirming the ground conditions and stability of the property. As such, we have completed a slope stability assessment, which is presented in Section 7.0 below and Appendix C, following the text of this report.

This report provides geotechnical and slope stability recommendations for the proposed development, based on our field investigation, site investigation information provided by others, our slope stability assessment, and our experience in the immediate area.

Following the review of our investigation data and slope stability analyses, we are of the opinion that the proposed development is feasible and the stability of the bluffs/slope, located along the southeast frontage of the site, can be maintained in a safe manner provided that all of the recommendations provided herein are incorporated into the design and construction.

This report has been prepared exclusively for our client, for their use, the use of others on their design team as well as for the City of Colwood for use in the development and permitting process. The slope stability assessment has been carried out in accordance with the development agreement, which requires a detailed slope setback assessment and landslide assessment.

2.0 SITE DESCRIPTION

The Beachlands (previously referred to as 'Royal Beach' in documentation provided before August 1st, 2023) are located east of Metchosin Road, between Perimeter Place and Farhill Road in Colwood B.C. The site is comprised of several lots, with an approximate area of 135 acres. The site is bounded by Metchosin Road to the west, the Pacific Ocean to the east and residential developments to the north and south. The site was formerly utilized as a large aggregate quarry, and has been significantly regraded due to quarry activities between 1900 and 2008.

The site is generally underlain by dense sand and gravel of the Colwood Delta deposit, followed by dense glacial deposits, all over Quadra Sand deposits at depth. The site also contains several areas with deep variable fills/pond sediments (up to 15 m thick), due to previous gravel quarrying activities. The fills and pond sediments are generally located within engineered embankments/containment/environmental remediation facilities.

The east boundary of the site includes relatively steep coastal bluffs toward the north and south ends of the property. The middle portion of the property is relatively flat. The bluffs range from shallow gradients (5 to 10 degrees) to steep gradients (40 degrees plus) and are up to 50 m in height at the south end of the property. It should be noted that runoff from the adjacent Royal Bay development area drains though the middle portion of the site, in a dedicated runoff channel.

In addition, GeoPacific attended the site on May 31st, 2022. At that time, the site was visually reviewed and photographed, beginning at the north end of the site, finishing with the south end of the site. The crest and toe of all steep bluff slope areas were observed. At the time of our review, there was no evidence of previous slope instability at the crests or toes of the bluffs. Based on the observation of natural soil outcrops, the bluffs consisted of lightly cemented, dense to very dense, grey-beige sand and gravel. We have also reviewed available air photographs of the site, dating back to 1926, as well as the review of available Lidar information provided in the B.C. Lidar Portal.

In early 2023, GeoPacific attended the site in to conduct several MASW surveys and additional sonic/CPT investigation. The results of our MASW surveys, and sonic/CPT drilling programs are presented in reports under separate cover.

The site location relative to the surrounding area, as well as geotechnical boreholes completed to date, are shown on our Drawing No. 21385-01, in Appendix D, following the text of this report.

3.0 REVIEWED THIRD PARTY DOCUMENTS

We have reviewed the following documents by Westmar Advisors Inc.:

- **APRIL 5th, 2023 'COASTAL EROSION STUDY' (Appendix A)**

We have reviewed the following documents by Thurber Engineering Ltd.:

- **MAY 22nd, 2019 'GEOTECHNICAL SETBACK ASSESSMENT'**
- **APRIL 24th, 2023 '2022 DEEP SONIC SITE INVESTGATION AT THE BLUFFS GEOTECHNICAL REPORT' (Appendix E)**

We have reviewed the following documents by OnPoint Project Engineers Ltd.:

- **APRIL 5th, 2023 'ROYAL BEACH REGRADING PLAN' (Appendix G)**
- **AUGUST 28th, 2023 'BEACHLANDS - GEOTECHNICAL SECTIONS' (Appendix B)**

4.0 FIELD INVESTIGATION

GeoPacific completed an investigation of the soil and groundwater conditions at the site on March 21st to 23rd, 2023, using a track-mounted sonic drill supplied and operated by Blue Max Drilling of Courtney, B.C. The site investigation consisted of 4 Cone Penetration Test (CPT) soundings, supplemented with 11 sonic tests holes. In addition, 7 Dynamic Cone Penetration Tests (DCPT) were conducted to assist in determining the in-situ relative density of the surficial soils.

The sonic test holes were advanced to depths of between 3.0 m and 18.7 m below current site grades. The CPT soundings were advanced to depths of between 6.6 m and 17.6 m below current site grades, to effective refusal in the dense to very dense sand and gravel.

Prior to our investigation, a BC One Call was placed, and Municon West Coast cleared the utilities at the test hole locations. All test holes were backfilled and sealed in accordance with provincial abandonment requirements following classification, sampling, and logging.

The test hole logs and the approximate locations of the test holes completed by GeoPacific are presented in Appendix D following the text of this report.

In addition, GeoPacific Consultants has reviewed previously completed geotechnical investigations of the subsurface soil conditions for the site as noted in Section 3.0 above. The investigations were conducted by others to provide subsurface soils information that can be used to assess the slope stability and structural capacity of the materials on site. The test hole logs and the approximate locations of the test holes completed by others are presented in Appendix E following the text of this report.

5.0 SUBSURFACE CONDITIONS

5.1 Published Geology

According to the "Quaternary Geological Map of Greater Victoria" – (Geoscience Map 2000-2) The region is underlain by the Colwood Delta and Outwash Plain consisting of "interbedded sand and gravel of the raised Late Pleistocene delta and outwash plain." The proposed development is located within the area described as "fill in reclaimed gravel pit within the Colwood sand and gravel."

According to "Northern Vancouver Island - Geology" – (Map 2013-NVI-1-1) published by Geoscience BC, the region is understood to be underlain by Quaternary Cover. The Quaternary Cover is described as consisting of "alluvium, glaciofluvial gravels, sand and till."

5.2 Soil Conditions

The site is generally underlain by dense granular fills, up to 9 m thick, followed by dense sand and gravel of the Colwood Delta deposit, followed by dense glacial deposits, all over Quadra Sand deposits at depth.

Based on our site investigation and site investigation work completed by others, the site is partially underlain by former sediment ponds and associated variable fills/pond sediments at the southeastern end of the site, up to 15 m thick locally, due to previous gravel quarrying activities.

A general description of the soils encountered by others and during our investigation is given below, based on the test hole logs and geotechnical information provided in Appendix D and E following the text of this report.

GRANULAR FILL

At the surface, the site is generally underlain by granular fills, consisting of compact to dense coarse-grained sand with trace silt overlying dense to very dense sand and gravel with trace silt. In general, the granular fills are noted to be moist, brown in colour and up to 9 m thick.

FINE GRAINED VARIABLE FILL (POND SEDIMENTS)

Where encountered, the granular fill is underlain by fine grained variable fill. The material is understood to have been deposited by settling ponds resulting in the variable material encountered during our investigation. The material was predominantly mineral in nature, with varying composition from mainly granular to mainly clayey. The fine-grained variable fill (pond sediments) generally consisted of fine-medium grained silty sand, sandy silt to silty clay, compacted to various densities with trace to some interbedded lenses of gravel. The depth of fine-grained soils is generally in the range of 1.5 m to 15 m thick. The fill in general was noted to be stiff to very stiff, and moderately to heavily over consolidated.

SAND and GRAVEL

The fills are underlain by dense to very dense native sand and gravel. The gravel content was noted to vary across the site. The sand and gravel stratum was encountered at several test hole locations, where refusal of the CPT was encountered, or auger runs were terminated. At TH23-1, within 'The Landing' area, native very dense sands and gravels (lightly cemented till) were encountered near surface, underlying a thin layer of granular road base, correlating with the till like sand and gravel encountered during deep sonic drilling completed in Area 3.

5.3 Groundwater Conditions

Based on our site investigations, test hole logs by others, and our experience in the area, the groundwater in the area is deep. Therefore, we do not expect to encounter free groundwater at depths contemplated for development. However, we expect that some perched groundwater may be encountered as seepage from the surficial fills and sandier zones within the fine-grained variable fills. For the purposes of this report, we have assumed a static groundwater table between 10 m geodetic (along the west bound of the site, where site grades are approximately level with Metchosin Road) to 0 m geodetic (along the east bound of the site, where site grades are approximately sea level). The position of the groundwater level and the extent of seepage can be expected to vary seasonally, with generally higher water levels and heavier flows expected in the wetter winter and spring months.

6.0 DISCUSSION

6.1 General Comments

In general, the observed granular fills and pond sediments were noted to extend to depths up to 17.5 m below exiting grades (at the southern end of the site), over very dense native sand and gravel.

Portions of the site are underlain by former sediment ponds and associated firm to very stiff fine grained variable fills (pond sediments) up to approximately 15 m thick locally. Based on the observed conditions, over consolidation ratios, and calculated shear strength values, the fine-grained variable fills (pond sediments) are considered to have low compressibility under the anticipated ground stresses for the proposed site servicing and grading, thus do not require any special treatment from a geotechnical perspective.

Based on recent drill-based site investigations, the subsurface conditions in the bluff and bluff park areas consist of either dense granular fills and/or over consolidated pond sediments over dense, lightly cemented glacial till at depth. As noted previously, some of the fills are proximal to the steep slopes that form the southeast boundary of the site. The pond sediments are not considered susceptible to liquefaction or excessive settlement under load.

Review of the available historic air photos of the bluff areas indicate minimal coastal erosion and/or mass wasting events have occurred since 1926. Photograph of the slope in 1949 and 2021 as well review of the available lidar from BC Lidar Portal indicate that the bluffs have not been noticeably altered or excavated, and have remained in approximately the same formation for +- 75 years, with the angle of repose of the very dense sand and gravel/glacial till being approximately 45 degrees. The slopes and related vegetative cover have been maintained at globally stable inclinations, and minimal signs of shallow or deep-seated instability have been noted.

We note that the site is currently undergoing re-grading, in accordance with the April 5th, 2023 'Royal Beach Regrading Plan' by On Point Project Engineers, presented in Appendix G following the text of this report. The regrading works are being completed under the supervision of GeoPacifc. Our recommendations for site grading are presented under a separate cover.

The subsurface soils present on site are not expected to be prone to liquefaction or other forms of ground softening under the design earthquake defined under the 2018 British Columbia Building Code (BCBC).

It is our opinion that the proposed development within Area 3 may be safely developed with the geotechnical setbacks as defined in Section 7.0 of this report.

We note that site-specific analyses will be completed by GeoPacific for each building area. The additional analyses would be completed in stages, including the necessary Landslide Assessments in accordance with the British Columbia Building Code, and as required under the Development Agreement.

We confirm, from a geotechnical point of view, that the proposed development is feasible provided that the recommendations outlined in the following sections are incorporated into the overall design and construction, and the site may be safely utilized for the purpose intended.

6.2 Stress History Analysis

Our stress history analysis indicates that the fine-grained variable fills observed at CPT23-01, 02 & 04 are generally heavily over consolidated between depths of 1.0 m to 6.0 m, 5.8 m to 9.0 m and 2.2 m to 7.0 m respectively, below current local grades. The pond sediments observed at CPT23-03 were generally heavily over consolidated between depths of 2.5 m to 9.0 m overlying moderately over consolidated sediments between 9.0 m to 17.5 m below exiting grades.

An over consolidated soil is defined as a soil which has experienced a higher vertical stress imposed on it in the past than what is currently imposed on it at present. Soils can also become over consolidated due to "apparent over consolidation" which results from aging, creep, and chemical reaction effects. The over consolidation of a soil is defined by the Over Consolidation Ratio (OCR). For example, a soil with an OCR of 3 has experienced, or is behaving as if it has been loaded to 3 times its current in situ stress. Over consolidated soils are generally subject to smaller elastic post construction settlements when compared to normally consolidated soils (OCR=1). The degree of over consolidation versus depth has been estimated using a generally accepted empirical algorithm (Schmertmann, 1974). The results of the OCR interpretation are presented in Appendix D.

7.0 SLOPE STABILITY ASSESSMENT & RECOMMENDTIONS

7.1 Slope Stability Analysis

We have completed a slope stability assessment for the proposed residential subdivision at the above reference site. The slope stability assessment was completed under static and seismic conditions in accordance with the 2018 BC Building Code (BCBC) and EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023). Based on EGBC's guidelines for *Landslide Assessments in British Columbia (March 1, 2023), Table B-6 of Types of static and seismic slope stability,* the site is considered as Class 2.

Subsurface stratigraphy and soil strength parameters were interpreted based on our geotechnical field investigation, experience in the area and test holes logs completed by others.

We utilized topographic drawings provided by On Point Project Engineers Ltd. to create sections through the proposed development and existing slopes. Six (6) critical sections were determined and analyzed, and are labeled Section 1, 2, 2.1 3, 4 and 5. Sections 1 through 5 are shown in Appendix B, following the text of this report. Section 2.1 was included to represent the area on site with the steepest gradient, and is considered a critical section in our slope stability analysis.

In addition, we utilized recommended relative sea level rise (RSLR) and bluff toe recession values provided in the Westmar Advisors Ltd. April 5th, 2023 'Coastal Erosion Study', presented in Appendix A, following the text of this report, in order to model the effects of future potential sea level rise and bluff toe erosion on the proposed development.

A conservative 24 kPa surcharge of uniformly distributed load was applied to model the effects of proposed future development. We have reviewed the grading drawings prepared by On Point Project Engineers Ltd. dated April 5th, 2023, and proposed site grading was taken into consideration during our analysis. In addition, we utilized the recommended Relative Sea Level Rise (RSLR) and bluff toe recession estimates from the April 2023 Westmar 'Coastal Erosion Study'. The analysis does not consider potential bluff toe erosion mitigation measures as described in the Westmar report. The stability assessment was carried out using the software program SLOPE/W (2021), which employs the Morgenstern-Price limit equilibrium method. The Morgenstern-Price method is a widely accepted and industry-standard approach for conducting slope stability analysis in geotechnical engineering. It provides a systematic framework to assess the stability of slopes, embankments, and retaining walls. This method takes into account various factors such as soil properties, groundwater conditions, and external loads to determine the safety of a slope or structure against potential failure.

Our analysis has considered the evaluation of the current stability of the site and the effects of the proposed development on the global stability of the slope under both static and seismic conditions in accordance with EGBC's Guidelines for Legislated Landslide Assessment in B.C. (Revised March 2023).

It is our opinion that the proposed site works will result in a net improvement to the site from a slope stability and overland erosion perspective. Surface water collection and detention will form a part of the new civil design, thus reducing the volume of runoff and seepage experienced at the slopes, improving overall slope stability, as the site works progress. In addition, the latest grading plans (presented in Appendix G following the text of this report) indicates that up to 8 m of material is to be cut from the crest of the southern bluff area, which provides a significant load reduction at the crest of the slope.

The results of our SLOPE/W analysis are presented in Appendix C following the text of this report. The summary of slope stability analysis results is presented in Table 1 below. Plan and section views of the slopes have been included in Appendix C, following the text of this report.

Table 1: Summary of GeoStudio Output and Recommended Habitable Development Setbacks

Section/Station #	Factor Of Safety (Static)	Seismic Yield Coefficient	Recommended Setback From Property Line (m)
1	**1.58**	**0.30**	**-**
2	**1.52**	**0.26**	**44**
2.1	**1.52**	**0.27**	**51**
3	**1.60**	**0.29**	**51**
4	**1.50**	**0.27**	**43**
5	**1.59**	**0.30**	**25**

The slope stability assessment under seismic conditions was undertaken in accordance with the 2018 BC Building Code (BCBC). The 2018 BCBC was addressed using EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023).

EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023) and the 2018 British Columbia Building Code (BCBC) recommend utilizing the peak ground acceleration based on the 1:2,475 year design earthquake referred to in NBC 2015 as a conservative approach for slope stability analyses. Where the seismic factor of safety is not met with the full peak ground acceleration, the EGBC guideline requires a probabilistic method of analysis to determine seismic slope displacement from each earthquake source type contributing to the hazard at a specified response spectral acceleration. EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023) recommend that 15 cm or less be considered as a tolerable seismic slope displacement.

We used a probabilistic approach to determine seismic slope displacement from each earthquake source types contributing to the hazard at a specified response spectral acceleration. The results indicate that the predicted slope displacements are less than the acceptable threshold limit of 15 cm under all source of earthquakes under the 2,475 year return period seismic event, which is determined as the tolerable slope displacement by EGBC's guidelines.

As per EGBC guidelines, the minimum factor of safety for static analysis is 1.5 for permanent developments. Slope stability results for static conditions indicate that the minimum factor of safety for the proposed development exceeds 1.5 under static conditions.

The stability analysis indicates that the possibility of a deep-seated failure which extends within the proposed subdivision property lines of the site is unlikely under both static and seismic conditions, considering the 2018

BCBC design earthquake, and provided that our recommendations outlined in this report are adhered to, the site can be used safely for the use intended. For the proposed structures constructed in accordance with the recommendations described in this report, the property meets the requirements for development established in EGBC's guidelines for Landslide Assessments in British Columbia (March 1, 2023), and the site is safe for the use intended.

7.2 Permanent/Temporary Lot Grading and Site Drainage

Exterior finished grades as well as any new surfaces, such as slabs or patios, should be graded such that all water runoff is discharged in a controlled manner. Water should be directed to catch basins, ditches or swales and connected to the site storm water disposal system and released away from the bluffs.

Storage of temporary fills (including spoil piles) should be kept a distance away from the crest of the slope equal to the height of the slope in a given area. All stockpiles should be covered with poly sheeting. Any permanent lot grading must be approved by GeoPacific Consultants.

Perimeter drains should direct water to a stormwater system located offsite, or at the base of the slope via a controlled stormwater discharge system. Under no circumstances is water to be directly discharged to or over the slope.

7.3 Landscaping

Exposed soil slopes should vegetated to mitigate erosion and other forms of near surface instability. The presence of vegetation aids in increasing the stability of the slope against shallow instabilities. This is accomplished by the root systems which provide cohesion to the soil as well as remove water from the surficial soil layers, which increases the effective stress in the soil.

Addition of large trees to the slope and top of bank is not recommended, as the increased weight would be far more detrimental than any benefit gained by the presence of the root structure. However, certain small trees could be advantageous. Planting should be done in coordination with the environmental engineer and/or slope bio-remediation expert.

Removal of some trees and vegetation will be required on order to meet the proposed site grading requirements. Vegetation should be maintained until such time that it is required to be removed. Removal of any trees or vegetation on the slope is to be completed under the supervision of GeoPacific.

7.4 Slope Stability

We expect that the forested zones along the bluffs are to remain undisturbed in an effort to maintain the stability of the slope. The slopes within these forested zones are at an inclination in the range of 1:1 (Horizontal:Vertical).

While our review of slope stability indicates that the slopes to the tributaries are stable, we recommend activities and disturbance on and around the slopes adjacent to the future developments, drainage or grade alterations, and retaining wall construction should only be done under the advice and recommendations of a Geotechnical Engineer with experience in slope stability evaluations.

In addition, we have reviewed the locations of the proposed passive walking trails in the bluffs park area. The proposed walking trails are considered safe for the use intended. Recommendations for development and construction of the bluff park areas will be provided under a separate cover.

The slopes should remain vegetated as much as possible, as this will aid in the near surface stability of the slopes by providing cohesion to the soil and removing water from the surficial layers. In the event that any vegetation loss is evident, stabilization measures are to be completed by the property owner to maintain the slopes, under the direction of a qualified Geotechnical Engineer. The disposal of any debris and/or organic waste in the forested zones is not recommended. The debris would increase the loading on the slope while also reducing the drainage capacity of the soil which may induce surficial slope instability.

The geotechnical engineer should review finalized development plans to ensure the recommendations above are adhered to well in advance of construction.

8.0 CONSTRUCTION MANAGEMENT PLAN

The proposed residential development involves extensive site re-grading. The site re-grading will be constructed in phases, under the supervision of GeoPacific. We will review construction activities to ensure that all vegetation that exists on the steep slope will be left without disturbance as much as possible, or remediated if any disturbance occurs.

We note that the site is currently undergoing re-grading, in accordance with the April 5th, 2023 'Royal Beach Regrading Plan' by On Point Project Engineers, presented in Appendix G following the text of this report. The regrading works are being completed under the supervision of GeoPacifc. Our recommendations for site grading are presented under a separate cover.

Weather conditions are not expected to affect the construction, as the proposed development is sufficiently setback so as not to impact slope stability. In our opinion, construction activities can be completed during the wet weather months provided proper erosion and surface water management is implemented. GeoPacific will conduct periodic site visits to confirm there are no impacts to site safety and slope stability.

9.0 GEOTECHNICAL STANDARD ASSURANCES

GeoPacific has carried out the necessary surface and subsurface investigations that we consider necessary for the design and supervision of this project.

GeoPacific will provide the supervision of the geotechnically related aspects of the project such that the development does not compromise the stability of the site or lands which are adjacent or nearby. It should be appreciated that GeoPacific is not responsible for actions taken by third parties on neighbouring lands or actions at the site that go against our recommendations.

In GeoPacific's opinion, the proposed development will not increase the risk of mass wasting events, such as landslide, mud flow, and debris torrent, along the existing slopes/bluffs.

We confirm that we have been retained to supervise the geotechnical aspects of the design and construction of the development, and upon completion of the work, GeoPacific will confirm in writing that we have fulfilled our

design and supervision undertakings. In the event our involvement is terminated for any reason by our client, we will immediately notify the municipality in writing of that fact. A Landslide Assessment Assurance Statement will be provided under a separate cover.

10.0 DESIGN REVIEWS AND CONSTRUCTION INSPECTIONS

As required for Municipal "Letters of Assurance", GeoPacific Consultants Ltd. will carry out sufficient field reviews during construction to ensure that the Geotechnical Design recommendations contained within this report have been adequately communicated to the design team and to the contractors implementing the design. These field reviews are not carried out for the benefit of the contractors and therefore do not in any way affect the contractor's obligations to perform under the terms of his/her contract.

It is the contractors' responsibility to advise GeoPacific Consultants Ltd. (a minimum of 48 hours in advance) that a field review is required. Requirements for geotechnical field reviews are and will continue to be provided in site/parcel-specific geotechnical reports, presented under a separate cover.

It is critical that these reviews are carried out to ensure that our intentions have been adequately communicated. It is also critical that contractors working on the site view this document in advance of any work being carried out so that they become familiarized with the sensitive aspects of the works proposed. It is the responsibility of the developer to notify GeoPacific Consultants Ltd. when conditions or situations not outlined within this document are encountered.

11.0 CLOSURE

This report has been prepared exclusively for our client for the purpose of providing geotechnical recommendations for the design and construction of the proposed development. The report remains the property of GeoPacific Consultants Ltd. and unauthorized use of, or duplication of this report is prohibited.

We are pleased to be of assistance to you on this project and we trust that our comments and recommendations are both helpful and sufficient for your current purposes. If you would like further details or would like clarification of any of the above, please do not hesitate to call.

For:
GeoPacific Consultants Ltd.

Reviewed by:

Alireza Ansari, M.A.Sc., EIT
Geotechnical Engineer-in-Training

Matt Kokan, M.A.Sc., P.Eng.
Principal

James Carson, B.A.Sc., P.Eng.
Project Manager

APPENDIX A –

APRIL 2023 - WESTMAR 'COASTAL EROSION STUDY'

WESTMAR ADVISORS

Memorandum

Client	**RRSP Beach Front Development Manager Ltd.**	
Project Name	Colwood Royal Beach - Coastal Assessment	
Project No.	1230250-P01	
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Attention	Grant Turnbull	Turnbull Construction Project Manager Ltd.
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Subject	Royal Beach Development, Colwood - Coastal Erosion Study	

1 Introduction

Planning and design of the Royal Beach Development in Colwood, British Columbia, requires a determination of building setbacks from the bluffs along the adjacent shoreline; in turn, this requires an estimate of recession of the toe of the bluffs due to coastal erosion taking account of sea level rise (SLR). In order to meet these requirements, Northwest Hydraulics Consultants Ltd. (NHC) provided preliminary estimates of bluff toe recession (Ref. 12), and these were subsequently used as inputs to a slope stability analysis so as to determine preliminary setbacks (Ref. 14).

In the above context, Westmar Advisors Inc. (Westmar) has been retained by RRSP Beach Front Construction Manager Ltd. to undertake an independent assessment so as to recommend updated values of recession of the toe of the bluffs.

This memorandum estimates relative sea level rise (RSLR), corresponding to SLR minus local land uplift, to the end-year of the project, taken as 2100, and it develops updated estimates of bluff toe recession needed to determine setbacks. Beyond the estimation of bluff toe recession, this study also identifies potential mitigation measures with respect to bluff toe erosion, and it assesses elevations above which coastal flooding due to storms and tsunamis should not occur.

2 Reference Materials

The following references are relied upon in this study.

1) AECON. 2013. Modelling of Potential Tsunami Inundation Limits and Runup. Report to Capital Regional District, 14 June 2013.

2) Associated Engineering Ltd. 2021. Capital Region Coastal Flood Inundation Mapping Project, Task 2 – Sea Level Rise Modelling and Mapping Report, Version 2.0, Report to Capital Regional District, October 2021.

3) Associated Engineering Ltd. 2021. Capital Region Coastal Flood Inundation Mapping Project, Task 3 – Tsunami Modelling and Mapping Report, Version 2.0, Report to Capital Regional District, October 2021.

4) BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC MFLNRO). 2018. Amendments to Sections 3.2.6, 3.5 and 3.6 of: *Flood Hazard Area Land Use Management Guidelines, BC Ministry of Water, Land and Air Protection, May 2004*. January 2018.

5) CAN-EWLAT. Canadian Extreme Water Level Adaptation Tool, available at: https://www.bio.gc.ca/science/data-donnees/can-ewlat /index3- en.php. Hosted by Bedford Institute of Oceanography on behalf of Fisheries and Oceans Canada (DFO) and other departments/organizations.

6) City of Colwood. 2022. Official Community Plan. Bylaw 1700 Amended September 26, 2022.

7) ClimateData.ca. Data portal available at: https://climatedata.ca. A collaboration between Environment and Climate Change Canada and other organizations.

8) Isaacson, M. 2022. Relative Sea Level Rise Contributions to Flood Construction Levels in British Columbia. Canadian Journal of Civil Engineering, Vol. 49, No. 9, September 2022, pp. 1532-1542.

9) Limber, P. W., Barnard, P. L., Vitousek, S., & Erikson, L. H. 2018. A Model Ensemble for Projecting Multidecadal Coastal Cliff Retreat During the 21st Century. Journal of Geophysical Research: Earth Surface, Vol. 123, pp. 1566–1589.

10) MacLennan, A, and Johannessen, J. 2018. An assessment of Long-Term Bluff Recession Rates in the Puget Sound and Salish Sea, Salish Sea Ecosystem Conference 2018, Seattle, Washington, April 4, 2018.

11) Northwest Hydraulic Consultants Ltd. 2018. Coastline Erosion Study. Report to the City of Colwood, 23 April 2018.

12) Northwest Hydraulic Consultants Ltd. 2019. Royal Beach Coastal Assessment. Report to Seacliff Properties (RB) Ltd.,16 April 2019.

13) Northwest Hydraulic Consultants Ltd. 2019. Royal Beach 2018-2019 Monitoring. Report to Seacliff Properties (RB) Ltd., 27 May 2019.

14) Thurber Engineering Ltd. 2019. Royal Beach Development, Colwood, BC – Geotechnical Setback Assessment. Report to Seacliff Properties (RB) Ltd., May 22, 2019.

3 Site Description

Figure 1 provides an aerial view of the intended location of the Royal Beach Development and its vicinity, including the adjacent shoreline. The figure includes an identification of the property boundary of the development (yellow line). As apparent in the figure, most of the development will occupy a former mining site (shown as barren land in the figure). Mining activities at this site ceased in 2007.

Figure 1 – Aerial view of site showing property line, reference stations, and photograph locations (Google Earth)

The figure also shows the locations of various stations (red circles) and photograph locations (white plus signs) that are referred to in this memorandum. The ten stations correspond to locations at which NHC (Ref. 12) provided initial estimates of bluff toe recession; and the seven photograph locations are those from which photographs provided in this memorandum were taken.

Westmar undertook a site visit on January 16, 2023, to assess the shoreline and the bluffs. Figure 2 to Figure 7 show general views of the shoreline and bluffs at locations along the shoreline, progressing from the south-southwest towards the north-northeast (subsequently referred to as progressing from the south to the north). At the time of the visit, the tide level was approximately 1.2 m below HHWLT (higher high water large tide). Figure 2 shows the shoreline and bluff at location P1 (see Figure 1), typical of the forested bluff along the southern portion of the shoreline. The bluff reaches an elevation of about 40 m GD in this vicinity. In this memorandum, GD denotes Geodetic Datum, which corresponds to the datum CGVD2013. Figure 3, taken at location P2, shows a similar view of the bluffs further along the shoreline where the bluff height is somewhat lower, and Figure 4, taken at location P4, shows the bluffs further to the north, as the forested slope transitions to an exposed bluff with height decreasing towards the north. Moving further north, Figure 5 and Figure 6 show views of the shoreline in this vicinity of Stations 6 to 8, where the backshore[1] includes a very low, steep bluff (about 2 m in height) above which the land slopes gradually up to an elevation of about 10 m GD. With respect to this area, Figure 5 shows riprap placement at location P5, while Figure 6 shows an exposed backshore at location P6. Finally, Figure 7 shows the bluff at the northern portion of the property. (Observations of the erosion potential of the toe of the bluffs along the shoreline are provided in Section 7.2.)

Figure 2 - View of shoreline at location P1

Figure 3 - View of shoreline at location P2

Figure 4 - View of shoreline at location P4

Figure 5 - View of shoreline at location P5

[1] Backshore refers to the area of the shore lying between the high tide level and the highest elevation affected by severe storms with high tides.

Figure 6 - View of shoreline at location P6

Figure 7 - View of shoreline at location P7

4 General Approach

A general overview of bluff retreat mechanics and modelling is provided below, following by an outline of the approach adopted in this study.

Retreat of coastal bluffs is a complex phenomenon that depends broadly on wave action in combination with high water levels, bluff geology, and beach characteristics. Wave action in combination with high water levels, influenced by SLR, erodes the toe of the bluff and removes eroded sediment so as to enable future erosion; bluff geology, influenced by hydrology and vegetation / tree cover, determines the resistance to erosion and the extent of mass-wasting that delivers material to the base of the bluff; and beach characteristics, including sediment size distribution, the slope and width of the beach, and the elevation of the beach berm, affect erosion and sediment removal due to waves.

Bluff recession is highly episodic, both with respect to toe erosion due to waves in extreme storms occurring at high tides, and with respect to subsequent bluff mass-wasting, often associated with heavy rainfall leading to discrete slope failures separated by long periods of little or no change. As well, bluff recession is spatially variable, often over very short distances.

In summary, the mechanisms causing erosion are complex, recession rates exhibit significant temporal and spatial variations, and there is a high degree of uncertainty in predicting recession rates. Even so, a range of models has been developed to estimate long-term bluff recession rates. Thus, Limber et al. (Ref. 9) provide a review of a wide range of models that have been developed to estimate long-term rates taking account of SLR. In general, these entail assumptions by which wave action removes material at the bluff toe of the slope, and the bluff profile is adjusted through recession.

The approach to be adopted for this development project is to obtain first estimates of bluff toe recession, and then to apply these to a geotechnical analysis of slope stability to determine the required setbacks. This memorandum relates to the former aspect only. More specifically, the bluff toe recession values have been developed through three steps as follows:

i) a determination of the anticipated extent of SLR, which is dependent on a specified end-year for the project;

ii) a consideration of beach processes and bluff erosion potential that inform the modelling that is undertaken; and

iii) a development of toe recession estimates based on suitable assumptions and modelling.

These three steps are considered in Sections 6, 7, and 8, respectively.

It is noted that an alternative approach would be to rely on the relevant BC Guidelines (BC MFLNRO, Ref. 4), which provides simplified requirements for minimum setbacks with respect to "*lots with coastal bluffs.*" However, these do not consider the particulars of beach and bluff mechanics and so provide highly conservative values. In any event, Clause 3.5.5.4 of the BC Guidelines states: "*The setback may be modified provided the modification is supported by a report, giving consideration to the coastal erosion that may occur over the life of the project, prepared by a suitably qualified Professional Engineer experienced in coastal engineering.*" Thus, any setback requirements provided in the Guidelines are considered to be superseded by the coastal and geotechnical analyses and recommendations contained in the various engineering reports relating to this project.

5 Project Timeline

The focus of this memorandum is on an assessment of bluff toe recession estimates associated with SLR. A key prerequisite to such an assessment is a confirmation of the end-year of the project at which SLR is to be estimated. This has been established in accordance with the relevant BC Guidelines (BC MFLNRO, Ref. 4) and is consistent with Section 10 of the Development Agreement (April 27, 2021) with the City of Colwood for the Royal Beach Development, which affirms that matters relating to the foreshore are to be dealt with in accordance with these Guidelines.

Thus, Clause 3.5.2 of the Guidelines states: "*Requirements for buildings, subdivision, and zoning should allow for sea level rise (SLR) to the year 2100.*" Therefore, this study is based on the SLR value obtained for the year 2100 relative to 2023.

It is noted that Clause 3.5.2 also states: "*Land use adaptation strategies as set out in Official Community Plans (OCPs) and Regional Growth Strategies (RGSs) should allow for sea level rise to the year 2200 and beyond.*" Because of this statement, a potential end-year of 2200 for this project may be contemplated. However, while this statement refers to OCPs, it does not imply that the project's development should be based on SLR to the year 2200, and there are several reasons why this is unwarranted. First, infrastructure and land development projects are typically developed on the basis of a design life of 50 to 75 years, and it would be inconsistent for this one aspect of the project's design to be based on a design life of some 180 years, whereas all other aspects of the design would be based on a much shorter design life. Second, if deemed necessary, mitigation measures to reduce or eliminate bluff toe erosion associated with SLR, as contemplated in Section 7.3, may be implemented well before the end-year 2100, negating any need to rely on a later end-year of 2200. It is also noted that, while the City of Colwood OCP (Ref. 6) provides helpful climate change adaptation strategies and marine shoreline guidelines, it does not require SLR estimates to the year 2200.

Based on the foregoing, it is affirmed that this project is required to be designed, and should be designed, on the basis of SLR to the year 2100. However, whether or not some toe erosion mitigation measures are introduced over the next few years, it is recommended that the need for such measures or additional measures be assessed in the future, ideally every 10 years, based on updated information on SLR, bluff toe erosion and bluff stability conditions.

6 Relative Sea Level Rise

Attention is now given to developing a suitable estimate of SLR for this project. Based on statements in the relevant BC Guidelines (BC MFLNRO, Ref. 4), it has been commonplace to select an SLR value of 1 m

for the year 2100. However, those statements are reproduced from earlier guidelines published in 2011 and are now considered superseded. (The Guidelines recognize this possibility: "*The scenario is intended to be reviewed every 10 years or sooner if there is significant new scientific information*".)

In fact, extensive information, data and methodologies have become available since the publication of the earlier 2011 guidelines, including detailed information on projected SLR, land uplift / subsidence rates across BC that are also needed, and a consistent probabilistic treatment of uncertainties relating to future SLR. Thus, modern data portals incorporating these have been developed by Environment and Climate Change Canada and others, relying on contributions by Natural Resources Canada, given at climatedata.ca (Ref. 7), and by the Department of Fisheries and Oceans (DFO) and others, termed CAN-EWLAT (Ref. 5). Isaacson (Ref. 8) has provided a detailed review, justifying in particular the DFO approach in lieu of the one provided in the BC Guidelines.

There are three considerations that need to be taken into account in developing an updated estimate of SLR to be applied in this project. First, since SLR is required relative to the current time, whereas the 1 m SLR value referred to in the BC Guidelines correspond to an SLR over 100 years, it is an estimate for the end-year of this project relative to the current time that needs to be obtained.

Second, while SLR refers to an increase in mean sea level because of climate change, relative sea level rise (RSLR) refers to SLR minus local land uplift, and so is more relevant to assessing potential impacts of increasing coastal water levels. Both portals mentioned above takes account of this uplift, which increases with time and which varies spatially.

Third, the RSLR values need to correspond to a consistent probabilistic treatment of uncertainties in RSLR projections. That is, it would be inconsistent to adopt a highly conservative estimate of SLR, such as 1 m, corresponding to an unduly low exceedance probability, relative to the exceedance probabilities entailed in the choice of other parameters. The resulting values of RSLR, termed the "vertical allowance" as adopted by Small Craft Harbours, DFO, are now available at many stations through DFO's CAN-EWLAT portal (Ref. 5) on the basis of recent RSLR data / modelling.

Based on the CAN-EWLAT portal, the vertical allowance for this project is obtained as 0.57 m for the nearest station at Victoria. The corresponding value at the second nearest station at Sooke is 0.56 m, indicating low spatial variability in this area. Therefore, an RSLR value of 0.57 m is adopted for this study.

7 Coastal Processes and Bluff Erosion Potential

7.1 Beach Processes

As a general summary of erosion processes, sediment transport along a shoreline may include: longshore transport (i.e., sediment movement parallel to the shore) associated primarily with waves approaching the shoreline obliquely and the resulting longshore currents; onshore-offshore transport, whereby offshore transport is associated with storms occurring at high tides transporting beach materials offshore, while onshore transport is associated with more modest conditions between storms driving sediment so as to rebuild a beach; and, contingent on the availability of sediment, intermittent erosion of the backshore so as to provide a sediment source for the beach. Overall, over the long term sediments are deposited onto the backshore by erosion, and coastal processes act so as to remove these.

Detailed descriptions and information of the coastal processes specific to this beach are contained in three NHC reports (Refs. 11, 12, 13). Taken together, they contain significant descriptions and information for this site, including: sediment size distributions; the longshore transport of sediment; the onshore-offshore movement of sediment; the erosion potential of the bluffs during more severe storms coinciding with high tides; the measurement of, and changes to, beach sectional profiles; and changes to coastal

processes associated with the end of mining operations in 2007. These descriptions provide suitable background information on beach processes and sediment movement patterns sufficient to inform their impacts on estimates of bluff toe recession.

7.2 Bluff Toe Erosion Potential

The modelling of bluff recession depends on a continual supply of sediments to the backshore through bluff erosion. Therefore, an assessment of the erosion potential of the bluffs is needed. As mentioned, Westmar undertook a site visit to assess the condition of the bluffs, and attention is now focussed on their current state in the context of their potential erosion in the future.

Figure 8 to Figure 11 show views of the base of the bluffs at four locations, while Figure 5 and Figure 6 show views of the low-lying portion of the shoreline near Stations 6 to 8. Considering these in progression from south to north, Figure 8 shows a view of a near-vertical bluff base at location P1, exhibiting an exposed portion of the bluff base susceptible to future erosion, Figure 9 shows the bluff base at location P2 where the bluff slopes directly to the beach, and Figure 10 shows the bluff at location P3 (just past the northern end of the forested portion of the bluffs), showing erodible materials sloping down to the beach. Figure 5 and Figure 6, taken at locations P5 and P6 respectively, show the portion of the shoreline with a very low, steep bluff above which the land slopes upwards more gradually. In particular, Figure 5 shows riprap placement at location P5, while Figure 6 shows an exposed backshore at location P6. Finally, Figure 11 shows the base of the bluff near the northern end of the property, indicating a more gradually sloping bluff near the backshore, with erodible materials sloping directly to the beach.

Overall, the bluffs along the entire shoreline are susceptible to base erosion, with subsequent mass-wasting so as to provide an ongoing sediment source. However, the responsiveness of the bluffs to toe erosion is variable.

Figure 8 - View of bluff base at location P1

Figure 9 - View of bluff base at location P2

Figure 10 - View of bluff base at location P3

Figure 11 - View of bluff base at location P7

7.3 Potential Mitigation of Toe Erosion

Mitigation measures relating to bluff toe erosion may be introduced for some portions of the shoreline over the next few years as may be considered appropriate, and/or over the longer term (well before the end-year 2100) as may prove necessary. These will need to recognize the marine shoreline guidelines contained within the City of Colwood OCP (Ref. 6), and should be considered in conjunction with mitigation measures relating to slope stability.

Different mitigative measures may be adopted for different portions of the shoreline. For the low-lying portion of the shoreline near Stations 6 to 8, currently riprap protection is provided at the south end of this portion (Figure 5), there is no such protection at the north end of this section (Figure 6), and there is degraded riprap in between (not shown). Given the current, degraded state of this portion of the shoreline, and the likelihood of significant pedestrian traffic accessing the beach here in the future, it is anticipated that the degraded / partial shoreline protection in this area may be replaced by an aesthetic shore protection scheme, for example, entailing smooth, rounded rocks with vegetative cover, with suitable pedestrian access to the beach, and that there will be landscaping improvements to the land above the backshore. These steps will eliminate or significantly limit erosion potential in this area.

The remainder of the shoreline includes forested or vegetated bluffs along the southern portion (e.g., Figure 8 and Figure 9), exposed portions (e.g., Figure 10), and a lower-sloped portion at the northern end (e.g., Figure 11), such that different mitigative measures may be adopted for different portions. Potential schemes for different portions may range from various harder to softer protection options, generally consistent with the OCP guidelines, that would together assure shoreline resilience, maintain marine habitats, and give attention to sediment retention.

Harder options may include a retaining wall, revetment, or rip-rap protection for bank stabilization, for example incorporating rounded, suitably sized boulders with opportunities for riparian plantings; and various rock formations, including rock mounds, rock clusters and rock groynes suitably designed to reduce wave energy impacts, enhance habitat values, and create low energy zones to promote the accumulation of sand and pebbles. Softer protection options may include anchored drift logs, native plantings, gravel berms, sand replenishment, and slope recontouring (e.g., at the northern end).

Any mitigation measures to limit or prevent toe erosion should be undertaken in conjunction with measures to promote slope stability. These include retention of trees, shrubs and vegetation, drainage improvements including diversion of rainwater and runoff, native plantings, minimizing off-trail pedestrian traffic, and perhaps incorporating limited hard measures as may be necessary.

The implementation of remediation measures relating to toe erosion and relating to slope stability must be based on the recommendations of suitably qualified Professional Engineers experienced in coastal engineering and in geotechnical engineering, respectively.

The potential mitigation measures identified in this section have not been taken into account in estimating toe recession values along the shoreline.

8 Toe Recession Estimates

Bearing in mind the complexity and unreliability of developing toe recession estimates, two simplified approaches have been adopted to developing updated estimates. The first is based on NHC's results (Ref. 12) that are suitably modified, and the second is based on a simplified recession model relating to the "equilibrium profile" method, but with a reduced level of conservatism. These are considered in turn, and recommendations of bluff toe recession estimates are then provided. It is noted that bluff toe recession estimates have not been developed widely for sites in BC, so that there is little or no ability to reference studies for other locations in developing the present estimates.

8.1 Method A – Modifications to NHC Results

NHC (Ref. 12) has provided a preliminary assessment leading to estimated bluff recession at the ten stations indicated in Figure 1 based on two different approaches. For Stations 6 to 8, corresponding to the low-lying portion of the shoreline, the recession was estimated by the "Bruun rule", which applies to a "low-lying beach profile." This is based on considerations of an equilibrium beach profile, such that this profile is shifted upward and landward by a distance related to SLR. For the remaining stations (Stations 1 to 5, 9 and 10), where bluffs are present, the formulation was developed by considering five different methods applicable to bluff recession and weighing them equally after discarding outliers. These methods include a "modified Bruun rule", a related "mass balance" method, two methods based on a suitable extrapolation of historical recession rates, and a consideration of changes to wave runup elevations associated with SLR. Results were provided for both 1 m and 2 m SLR scenarios. As expected, the results vary widely, reflecting a range of uncertainties, and thus NHC provided lower, median and upper sets of results.

There are two ways in which modified estimates of toe recession have been developed from the NHC results, one relating to the assumed degree of conservatism in the results, and the other relating to an updated value of RSLR as adopted in this memorandum.

First, as described by NHC, there are a series of conservative assumptions made in the various models used. These include assumptions relating to beach materials and characteristics, eroded sediment movement, and the high responsiveness of the bluffs to toe erosion (as one example, vegetation and trees will tend to limit this responsiveness; and as another there is often a lag of several years between toe recession and subsequent bluff recession). Since a safety factor will be incorporated into the bluff stability analysis used to determine setbacks, and since mitigation measures relating to slope stability may be implemented well before the assumed end-year 2100 should they prove necessary, there is no need to rely on undue conservatism in the estimates of toe recession. Therefore, in order to reduce the level of conservatism adopted in the NHC modelling methodology, this study has relied on the average of lower and median sets of NHC results, and not on the median set of results.

Second, there is a need to interpolate the NHC results to the lower RSLR identified in this memorandum, rather than rely on an SLR of 1 or 2 m. Thus, the relevant NHC results have been interpolated so as to correspond to the 0.57 m RSLR value used in this study. On the above basis, updated bluff toe recession values for the ten stations have been obtained as presented in Table 1 in Section 8.3.

8.2 Method B – Simplified Bluff Recession Model

As an alternative, Westmar has developed a simplified equilibrium profile model, denoted Method B, whose results provide an alternative to those of Method A. Given the complexity and unreliability of developing toe recession estimates, Methods A and B are each taken to be equally valid.

Method B is based on the assumption that the current long-term recession rate continues indefinitely and is supplemented by an additional recession on account of RSLR, assuming that the beach profile remains unaltered over the long term. This is similar to the "maximum runup" model described by NHC (Ref. 12), but considers wave runup to be unaffected by RSLR, so that the toe of the bluff is elevated by the RSLR value. As well, this method relies directly on measurements of beach slope, rather than on estimates of wave climate. Thus, the bluff toe is shifted upward by the RSLR, and landward by an amount that is consistent with an unchanged beach slope at the toe. However, the method also relies on various conservative assumptions as with the other models considered by NHC, especially with respect to the responsiveness of the bluff to toe erosion, and therefore an adjustment that reduces this level of conservatism is necessary. Such an adjustment has been made by referencing the adjustment adopted in developing Method A, whereby the median set of results is reduced to the average of the lower and median sets of results. Furthermore, this simplified model does not take account of bluff height, and therefore a suitable adjustment for Stations 6 to 8 that correspond, in effect, to very low bluff heights is made. Again, this adjustment has been made by referencing the influence of bluff height as obtained within Method A.

In order to apply this model, estimates of the current long-term recession rate and of the beach slope are required. The former has been taken as 10 cm/yr, based on the NHC report (Ref. 12) that refers to an earlier study that estimates current rates to be 5 to 15 cm/yr, and as well based on a report (MacLennan & Johannessen, Ref. 7) that considered 106 bluff recession sites in Puget Sound and the Salish Sea, and found that the median long-term recession rate was 7.3 cm/yr. The beach slopes have been obtained from the measurements presented by NHC (Ref. 13). On the basis of the foregoing, bluff toe recession values for the ten stations have been obtained as presented in Table 1 in Section 8.3.

8.3 Summary Results

Based on the foregoing, the bluff toe recession values based on Methods A and B, as well as the recommended values for the ten stations are given in Table 1. It turns out that the differences between the two sets of estimates are fairly modest, with the Method A estimates higher than those of Method B for all 10 stations. While the predictions based on each of Methods A and B are considered equally valid, the recommended values are taken to be the higher of the predictions based on the two methods. Therefore, the recommended values in fact correspond to the results based on Method A.

Table 1 – Estimates of bluff toe recession estimates for ten stations

Station	*Location (m from Station 1)	Bluff Toe Recession (m)		
		Method A	Method B	Recommended
1	0	12	9	12
2	132	12	9	12
3	358	11	9	11
4	500	12	9	12
5	704	13	9	13
6	916	7	5	7
7	969	8	6	8
8	1121	8	6	8
9	1267	14	10	14
10	1557	15	10	15

* Station 1 is located near the south property line and is 855m from the base station (not shown in Figure 1) identified in NHC (Ref. 13)

It is anticipated that the information provided in Table 1 will be used in a future study of slope stability in order to develop the required setbacks. Such a study will presumably entail slope stability analyses at a series of sections that may not coincide with the 10 stations identified above. The bluff toe recession values to be used at those sections may readily be obtained by an interpolation of the values at adjacent stations as provided in Table 1.

9 Coastal Flooding Elevations

Beyond the estimation of bluff toe recession, it would be appropriate to identify elevations above which coastal flooding due to storms and tsunamis should not occur, in the context of the lower elevation portions of the property. Therefore, attention is now given to developing estimates of maximum elevations associated with coastal flooding due to storms and tsunamis.

9.1 Coastal Flooding Due to Storms

The elevation above which coastal flooding due to storms should not occur is taken to correspond to the 1-in-200-year combined tide plus storm surge elevation plus RSLR to the end-year 2100 plus a suitable value of wave runup for the 1-in-200 year storm. [This elevation, along with the addition of a freeboard of 0.6 m, is equivalent to the Flood Construction Level described in the BC Guidelines (BC MFLNRO, Ref 4)]

Typically, the wave runup may be expressed either as $\overline{R}$, which is the mean runup of all the waves in an extreme storm, or as $R_{2\%}$, which is the runup value that is exceeded by 2% of the waves in an extreme storm. The former is relevant with respect to elevations that may encounter limited inundation during the

extreme storm, whereas the latter is relevant with respect to elevations that should encounter occasional wetting only during the extreme storm.

A comprehensive study by Associated Engineering Ltd. (AE) (Ref. 2) for the Capital Regional District (CRD) provides relevant information along the entire CRD shoreline, including results specific to the Royal Beach site. Based on that study, and taken in conjunction with a RSLR of 0.57 m to the year 2100, the resulting elevation based on $\overline{R}$ (with respect to limited inundation) is obtained as 3.2 m GD, while the elevation based on $R_{2\%}$ (with respect to occasional wetting only) is obtained as 4.6 m GD.

9.2 Tsunami Flooding

Reference is made to a 2013 AECON report (Ref. 1) that provides a maximum water elevation of 2.7 m GD for a tsunami generated by an earthquake with a magnitude of 9.0 occurring in conjunction with HHWMT (Higher High Water Mean Tide), without RSLR. HHWMT rather than HHWLT is typically used with respect to tsunami elevations since the probability of a tsunami occurring in combination with HHWLT is unduly remote. AECON recommended that this value is increased by 50% to account for "*uncertainty related to the magnitude of the earthquake event, variations in tide condition, and variability of available topographic information.*" Without RSLR, this would lead to a maximum water elevation of 4.1 m GD.

Subsequent to the AECON study, AE (Ref. 3) undertook detailed tsunami modelling across the CRD for 11 different tsunami sources / events. Of these, the second-most severe event, labelled "*Cascadia Subduction Zone - Northern Segment*", corresponds to an earthquake magnitude of 8.5 to 9.0, and is estimated to have a return period of 500 to 600 years. This is considered the most relevant to establishing the maximum water elevation. For this earthquake, again occurring in conjunction with HHWMT, the maximum water elevation at the project site is found to be 3.6 m GD. When a RSLR value of 0.57 m is added, this leads to a maximum water level of 4.2 m GD.

Note that a 50% increase to this value is not considered necessary, since the AE results are based on a much finer grid size than that adopted by AECON, and as well because the probability of occurrence is already very low. (The most extreme event considered by AE leads to a maximum water level of 6.0 m GD, but this has a return period of the order of 2,500 years, and so is considered too remote to be relevant.)

10 Conclusions

Based on its assessment, Westmar Advisors recommends that the bluff toe recession values for the 10 NHC sections should be based on a project end-year of 2100 with respect to SLR and should be taken as those shown in the right-hand column of Table 1. For the low-lying portion of the site, corresponding to Stations 6 to 8, these range from 7 m to 8 m, while for the remaining stations these range from 11 m to 15 m.

Beyond the estimation of bluff recession, this study also identifies potential mitigation measures with respect to toe erosion, and it assesses elevations above which coastal flooding due to storms and tsunamis should not occur. These elevations are obtained as 3.2 m GD with respect to limited inundation during an extreme storm, 4.6 m GD with respect to occasional wetting only during an extreme storm, and 4.2 m GD with respect to maximum tsunami water levels.

End of Memorandum

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APPENDIX B –

AUGUST 2023 - ON POINT PROJECT ENGINEERS 'BEACHLANDS – GEOTECHNICAL SECTIONS'

NOTES:
1. SURFACE SHOWN IS EXISTING GROUND FROM 2022 UAV SURVEY
2. POINTS SHOWN ARE FROM NORTHWEST HYDRAULIC CONSULTANTS (NHC) 2016 REPORT "083631 NHC RoyalBeach Final - R0", THEN SCALED TO MATCH GROUND COORDINATES USING SCALE FACTOR 1.000393337076
3. ALIGNMENT APPROXIMATES HIGH TIDE LINE (FROM 2016 LIDAR DATA) AND DOES NOT MATCH NHC ALIGNMENT
4. AIR PHOTO FROM OCTOBER 2022

1:1000 0 20 40m

2023-08-28
ISSUED FOR INFORMATION

ONPOINT PROJECT ENGINEERS LTD.

Contractor must check and verify all dimensions and conditions on site and report any discrepancies to engineer prior to proceeding with work.

DO NOT SCALE THE DRAWING

No	ISSUED DESCRIPTION	DATE	No	REVISED DESCRIPTION	DATE	SIGN
1	ISSUED FOR INFORMATION	2023-08-28				

DESIGN: AA
DRAWN: AA
ENGINEER: AE

SEAL PERMIT TO PRACTICE

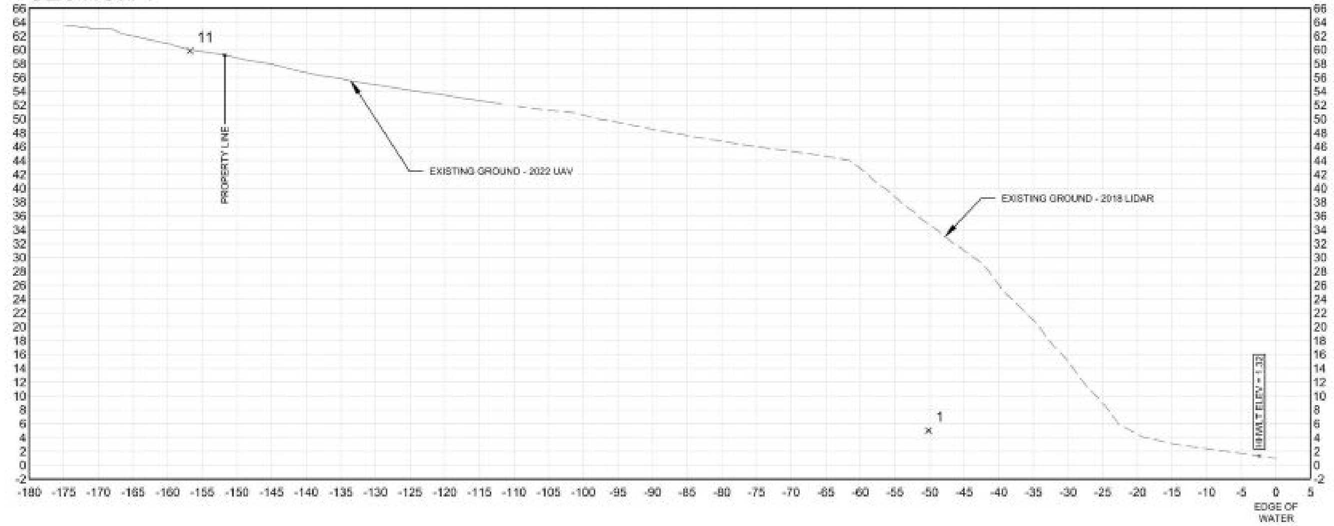
SEACLIFF PROPERTIES
RELIANCE PROPERTIES
the beach lands

BEACHLANDS - GEOTECHNICAL SECTIONS

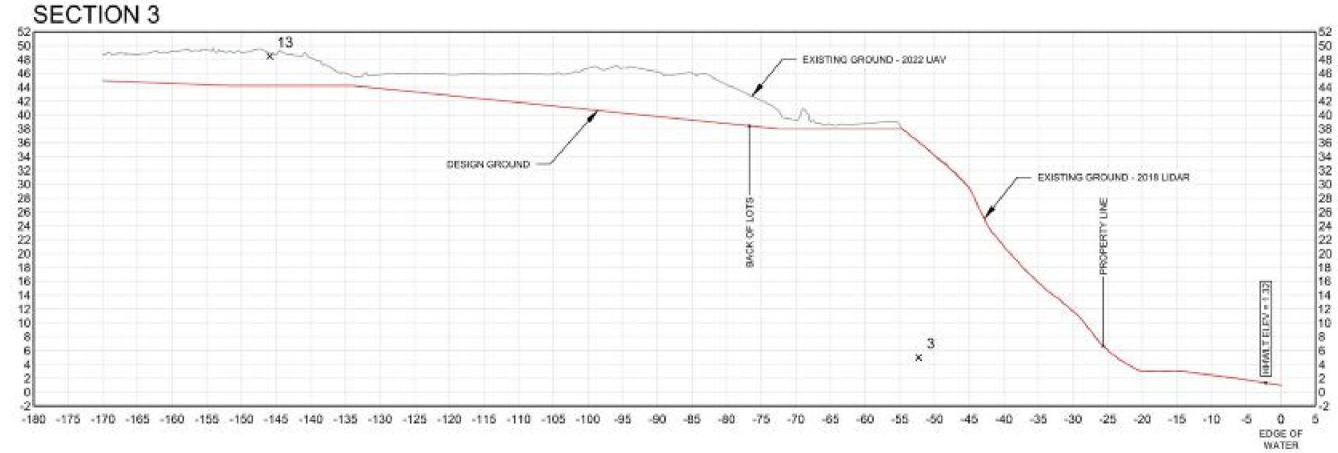
SECTIONS PLAN

ON POINT PROJECT No.: 174-01
GOVERNING AUTHORITY FILE No.: ----
SHEET 1 OF 2
REV: ----
ON POINT DRAWING No.: 174-01-SK455

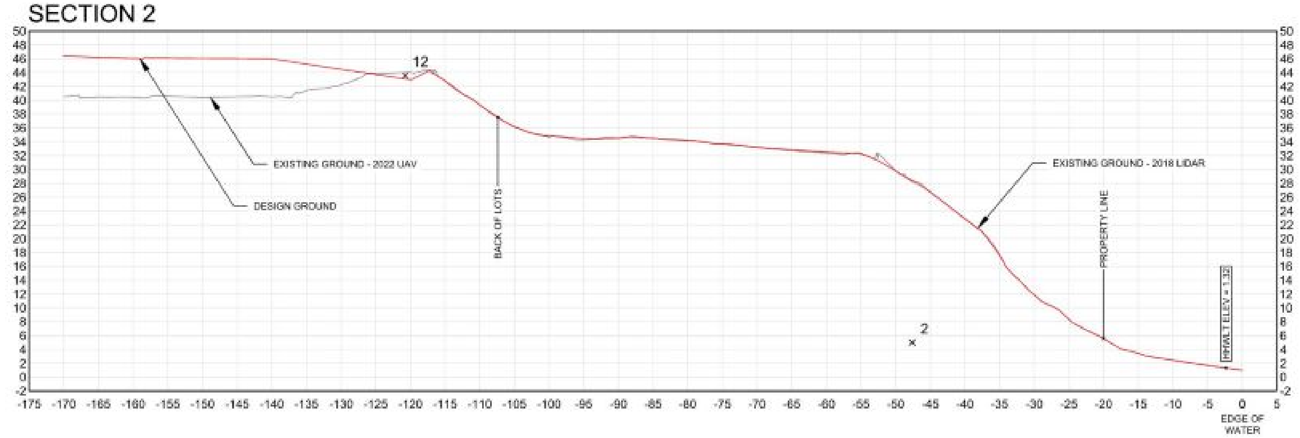
SECTION 1



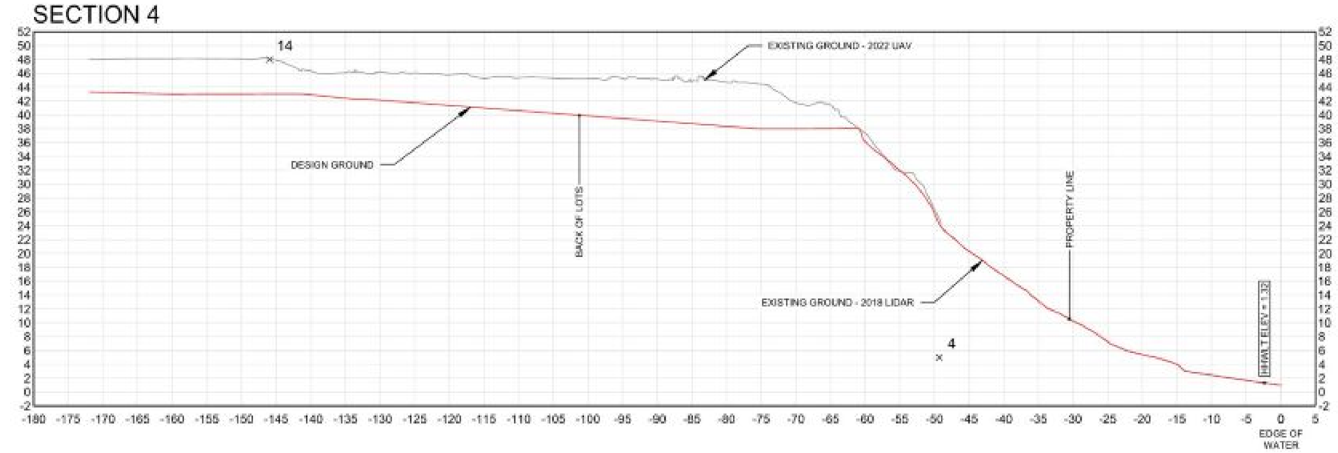
SECTION 3



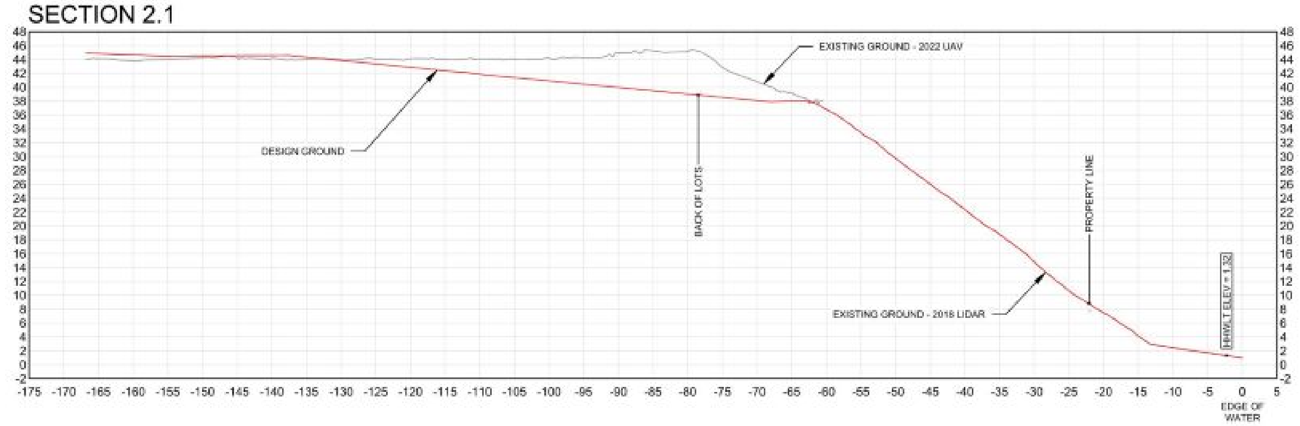
SECTION 2



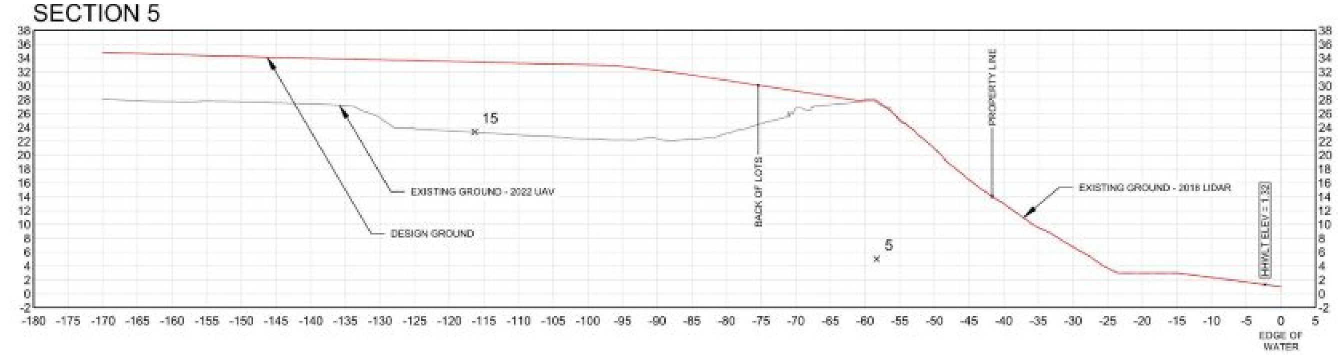
SECTION 4



SECTION 2.1



SECTION 5



NOTES:

1. POINTS SHOWN ARE FROM NORTHWEST HYDRAULIC CONSULTANTS (NHC) 2019 REPORT "3003631 NHC RoyalBeach Final - R0" , THEN SCALED TO MATCH GROUND COORDINATES USING SCALE FACTOR 1.00039333705
2. HIGHER HIGH-WATER LARGE TIDE (HHWLT) ELEVATION IS 1.48m IN CGVD2013 AND 1.32m IN CGVD28. DATA FROM "Colwood Waterfront Stewardship Plan - Detailed Engineering Analysis" DATED MARCH 2023

1:500 0 10 30m

2023-08-28

ISSUED FOR INFORMATION

ONPOINT PROJECT ENGINEERS LTD.

Contractor must check and verify all dimensions and conditions on site and report any discrepancies to engineer prior to proceeding with work.

DO NOT SCALE THE DRAWING

ISSUED No.	DESCRIPTION	DATE	REVISED No.	DESCRIPTION	DATE	SIGN
1	ISSUED FOR INFORMATION	2023-08-28				

DESIGN:
DRAWN: AA
ENGINEER: AE

SEAL PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
the beach lands

BEACHLANDS - GEOTECHNICAL SECTIONS

SECTIONS 1 - 5

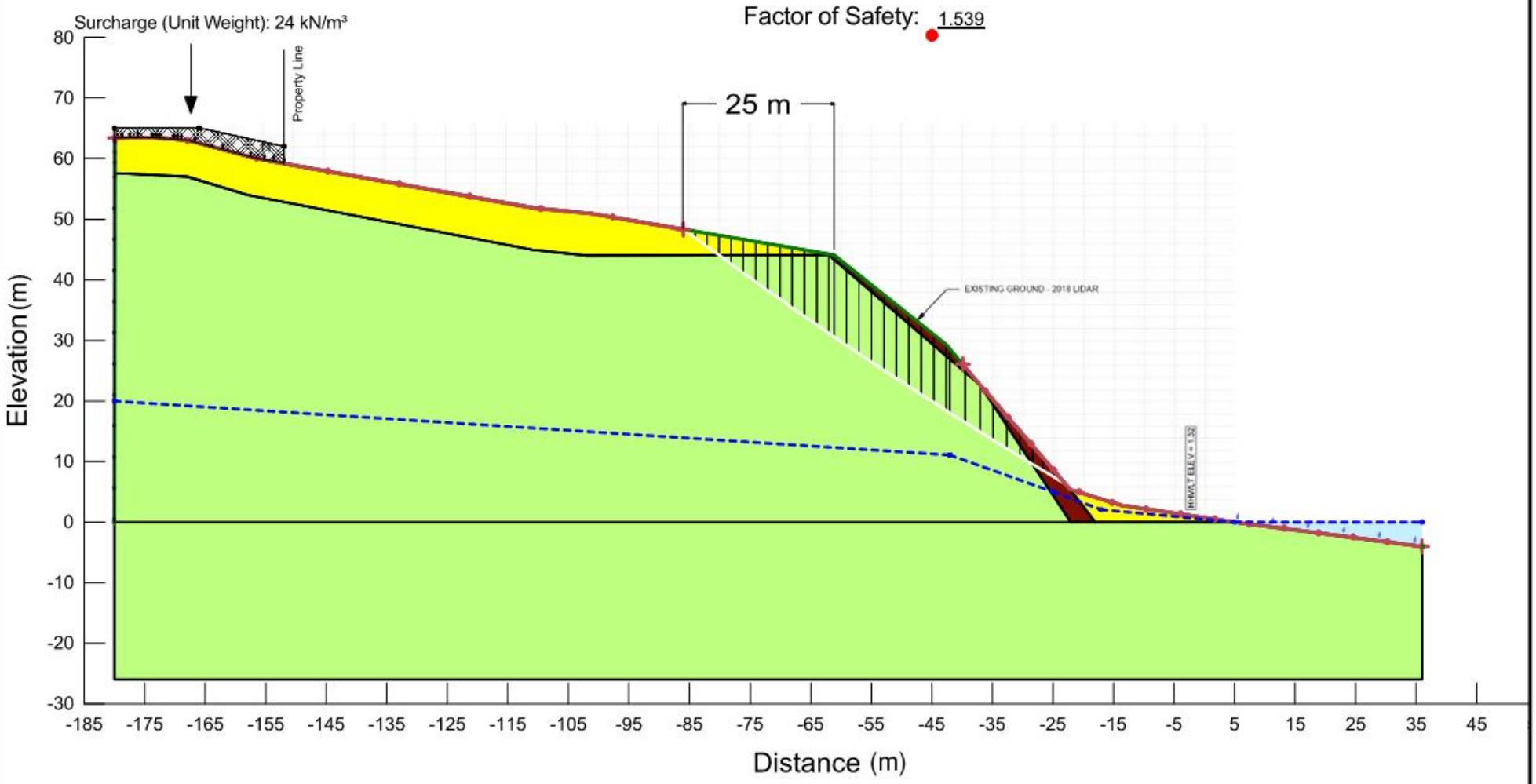
ON POINT PROJECT No. 174-01
GOVERNING AUTHORITY FILE No. -----
SHEET 2 OF 2
REV ----
ON POINT DRAWING No. 174-01-SK456

APPENDIX C –

SEPTEMBER 2023 GEOPACIFIC SLOPE STABILITY ANALYSIS

APPENDIX C – SECTION 1 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 1 (Static)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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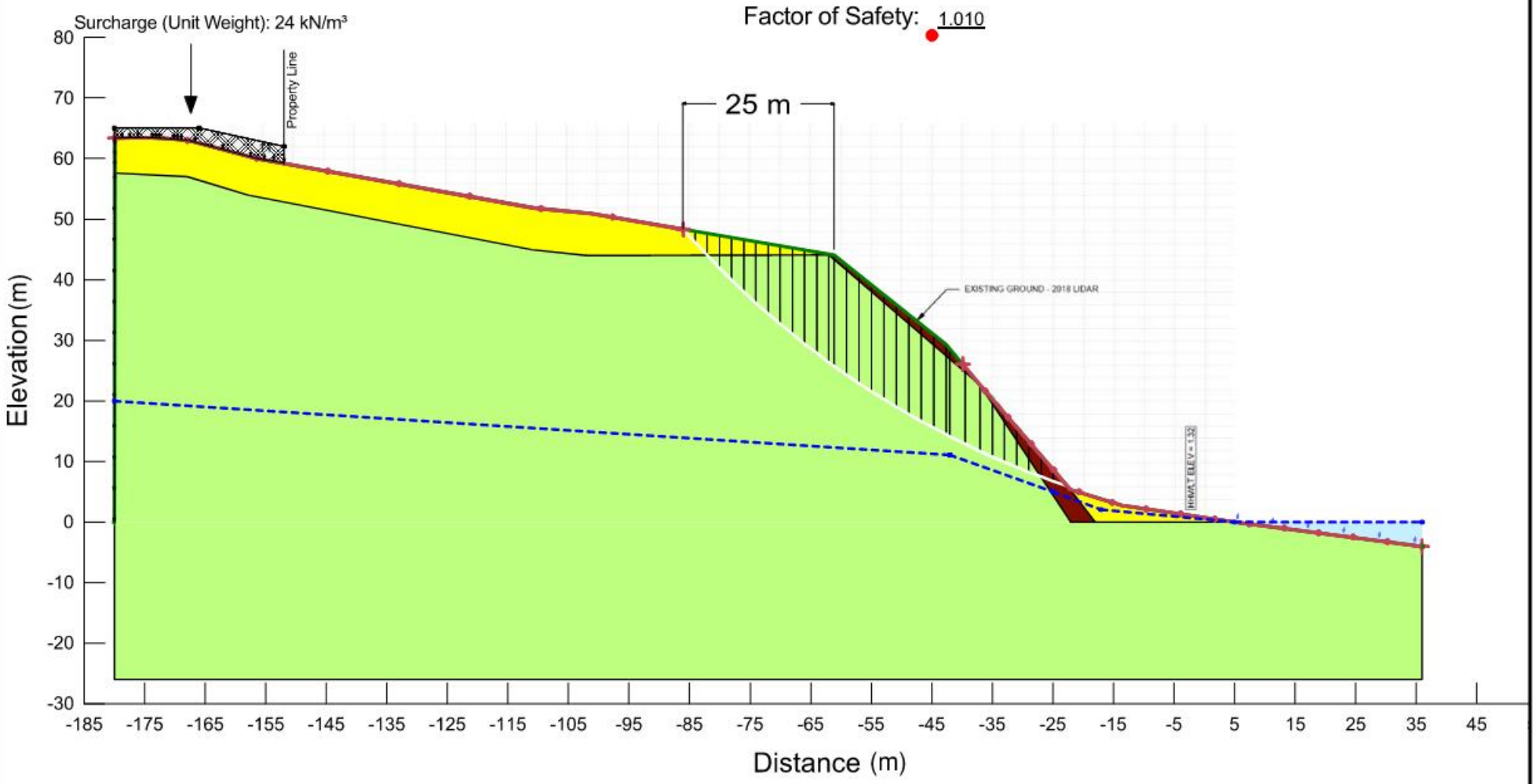
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 1 (Seismic)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.27	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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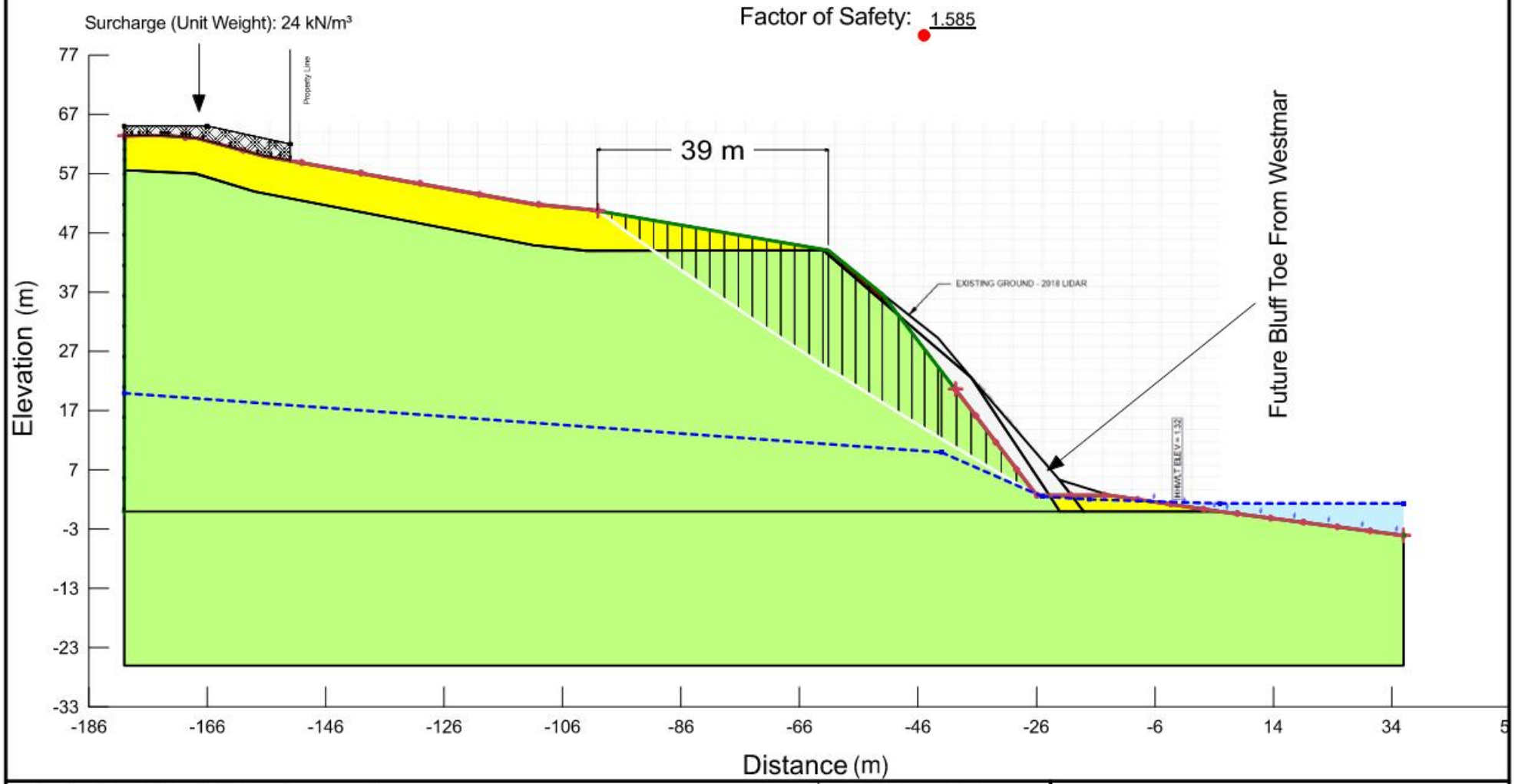
APPENDIX C – SECTION 1 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 1 (Static)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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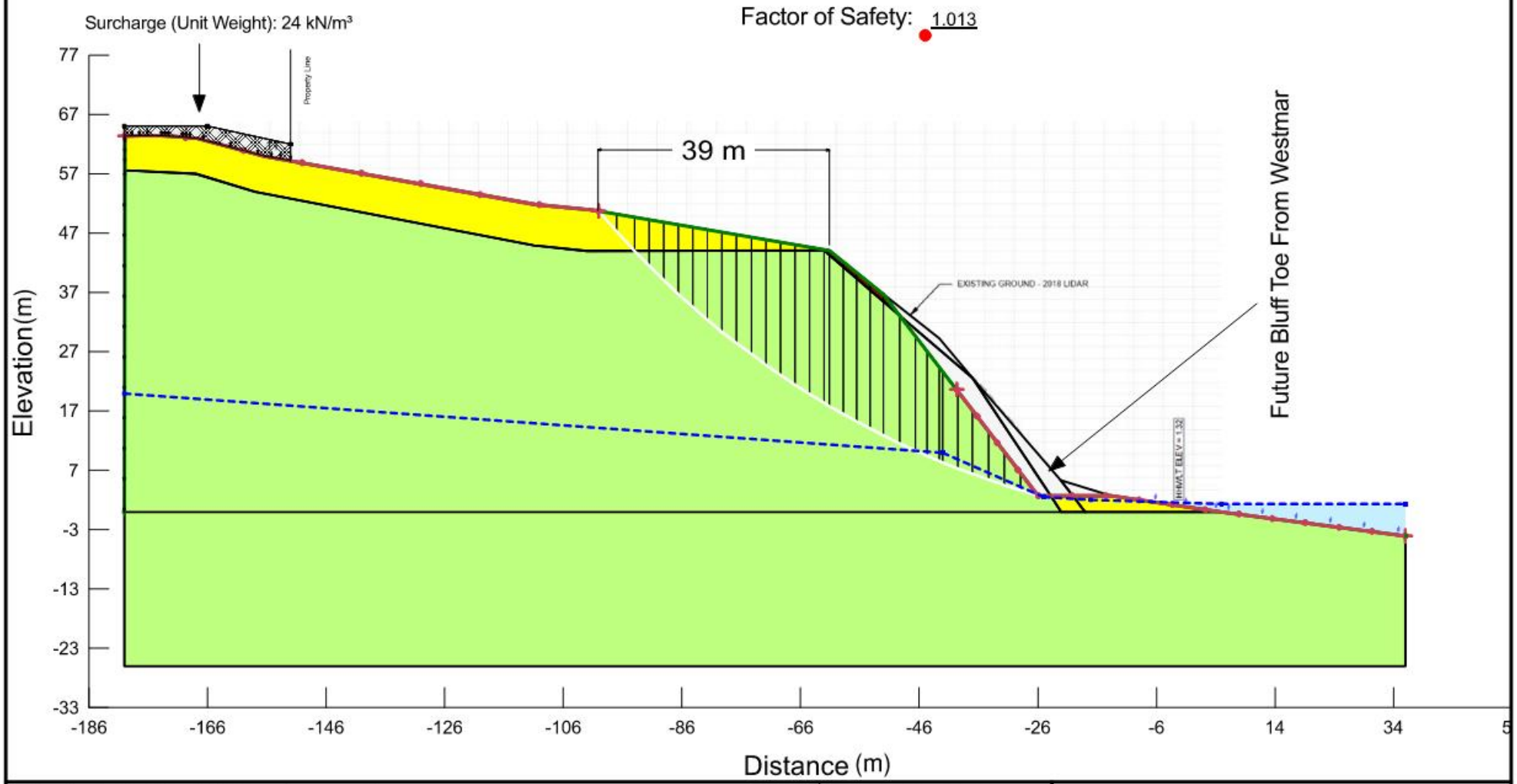
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 1 (Seismic)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.3	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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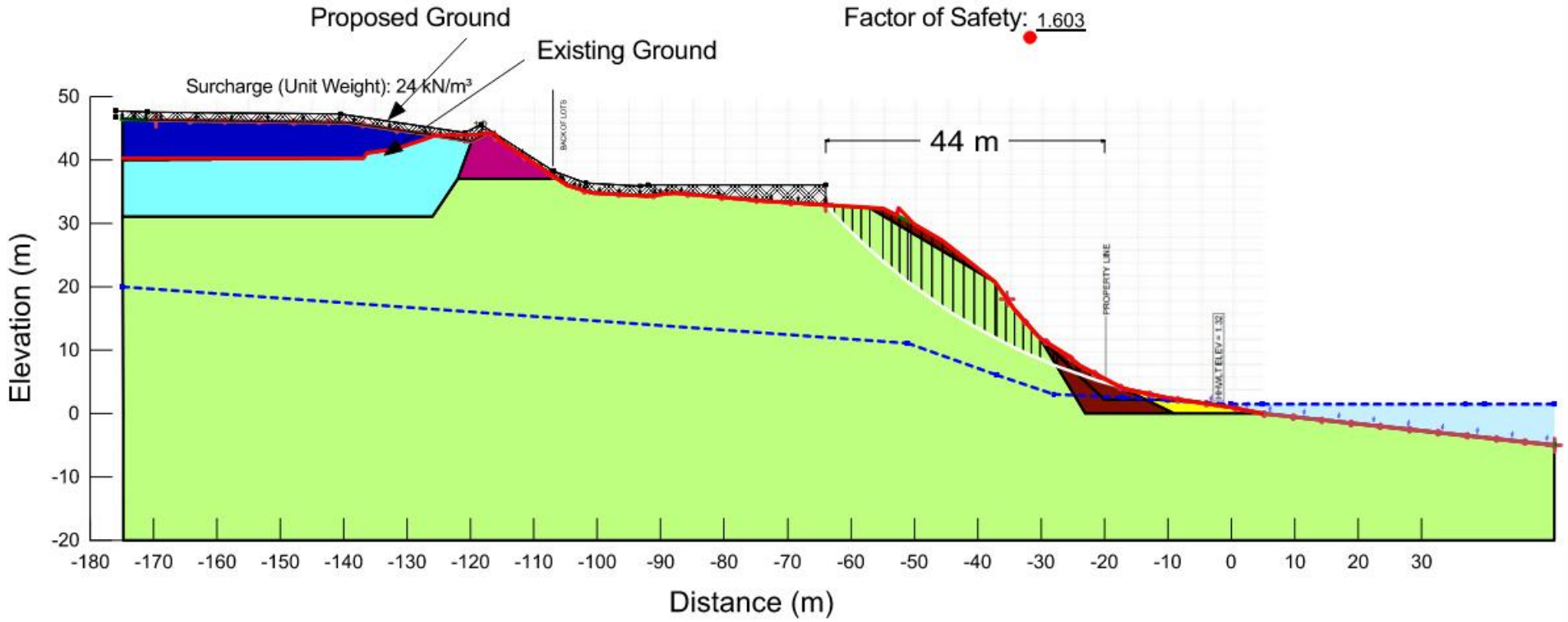
APPENDIX C – SECTION 2 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Engineered Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section2 (Static)	Date: Sept. 29, 2023
Method: Morgenstern-Price Horz Seismic Coef.:	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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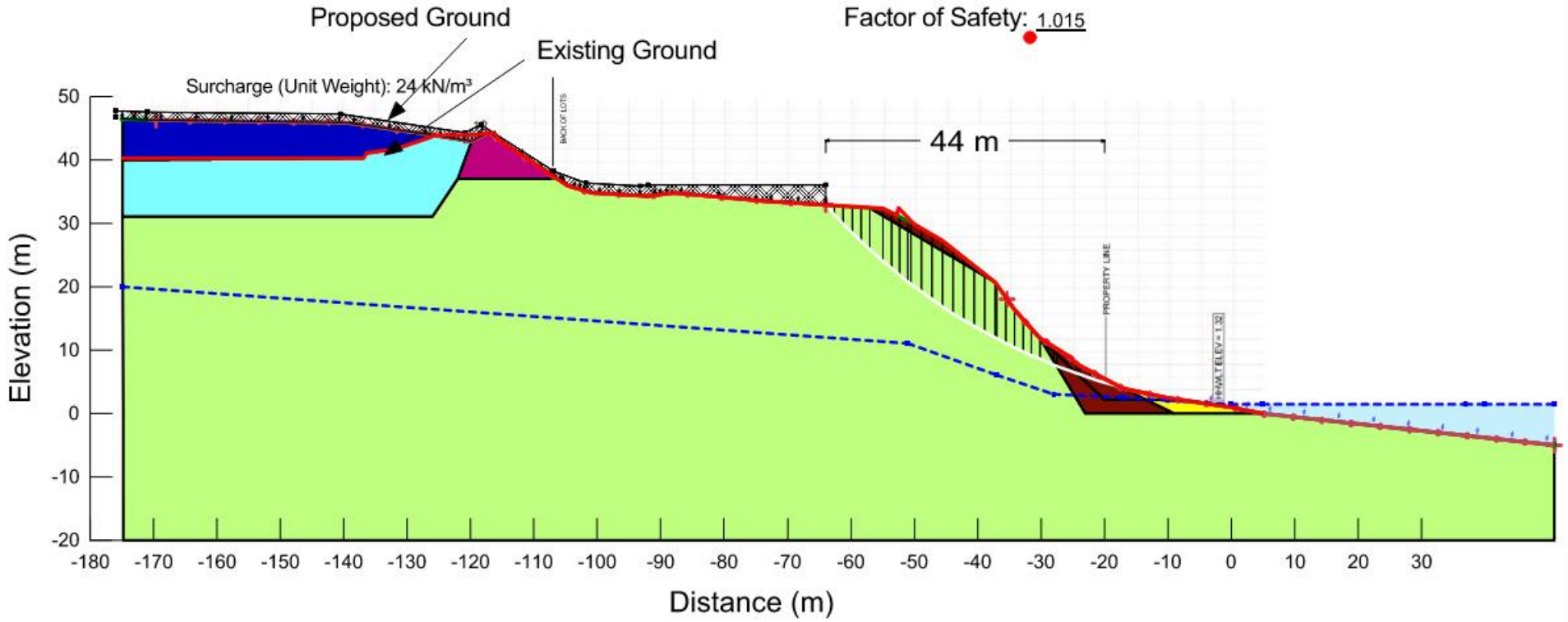
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Engineered Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section2 (Seismic)		Date: Sept. 29, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.28	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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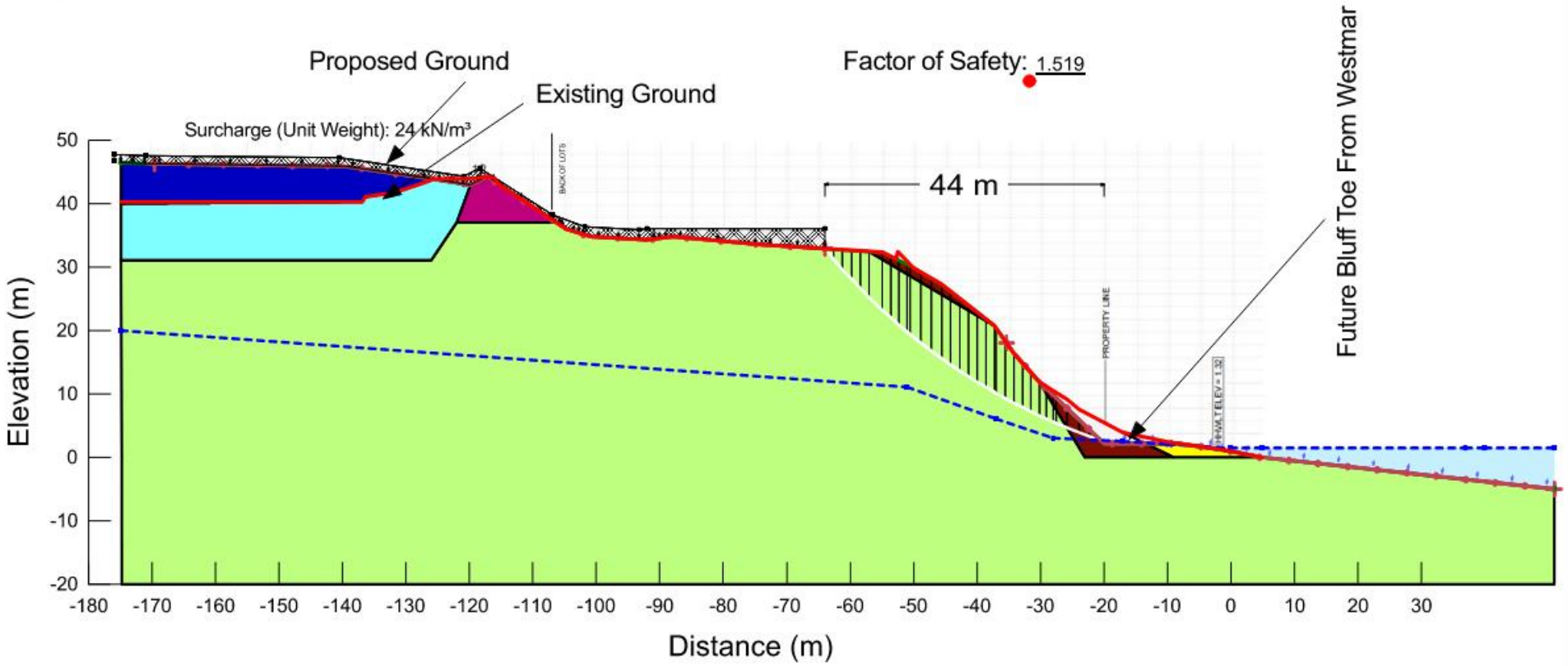
APPENDIX C – SECTION 2 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Engineered Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section2 (Static)	Date: Sept. 29, 2023
Method: Morgenstern-Price Horz Seismic Coef.:	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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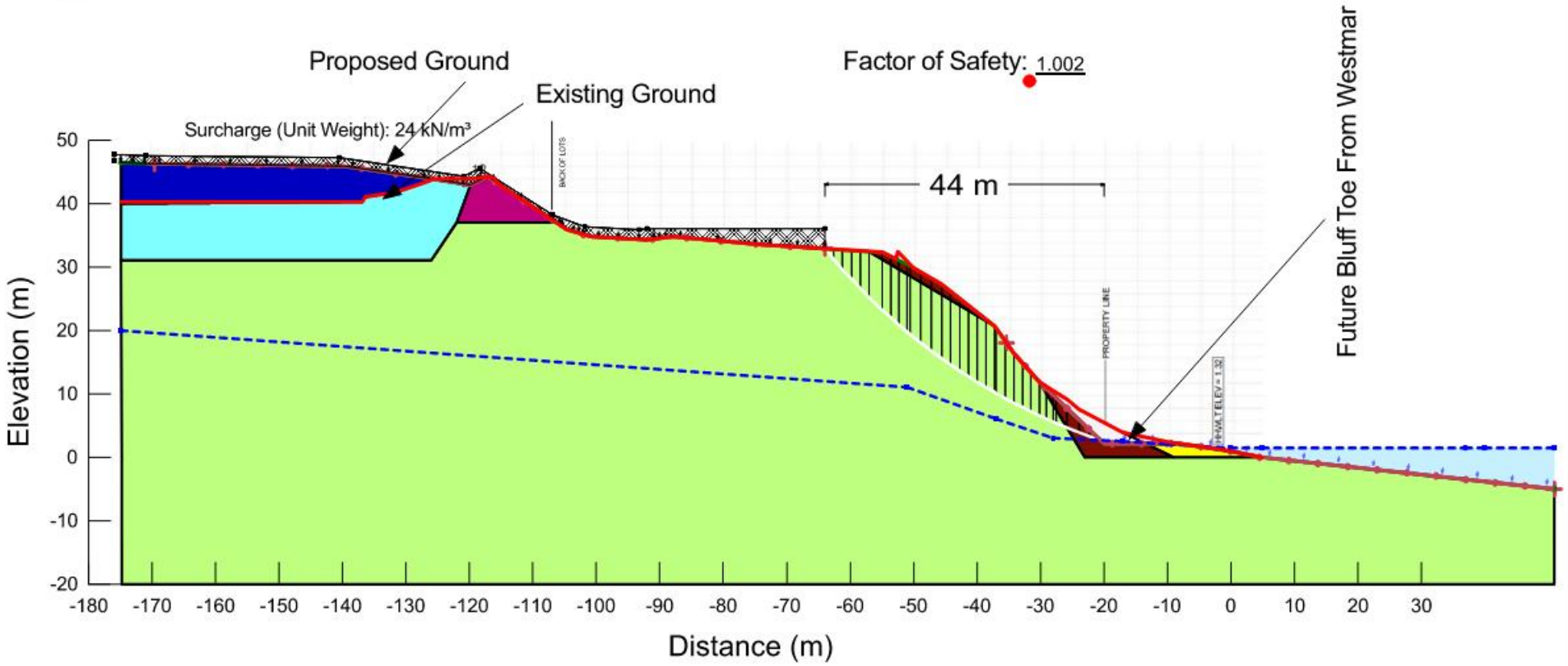
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Engineered Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section2 (Seismic)	Date: Sept. 29, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.26	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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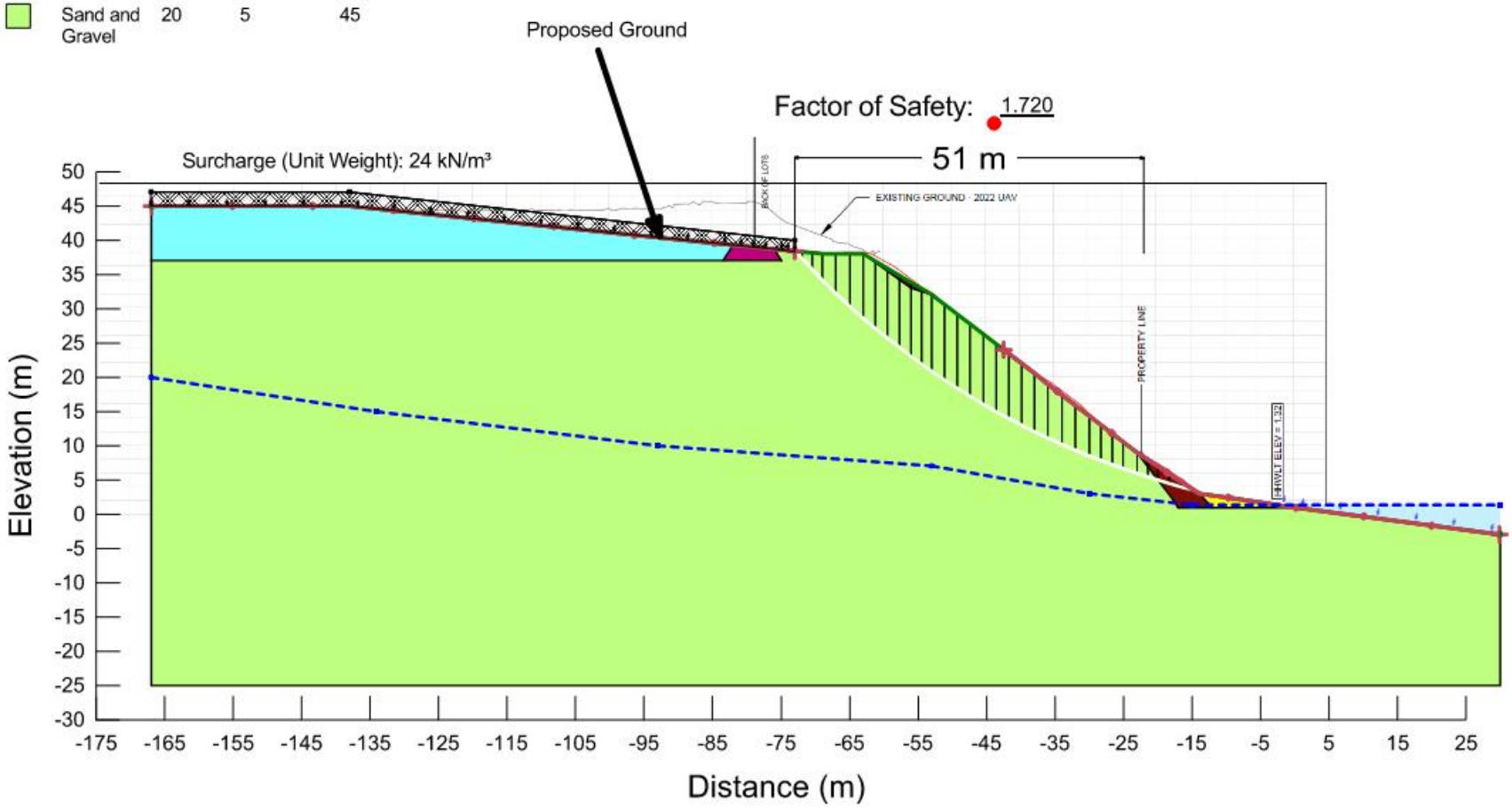
APPENDIX C – SECTION 2.1 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 2.1 (Static)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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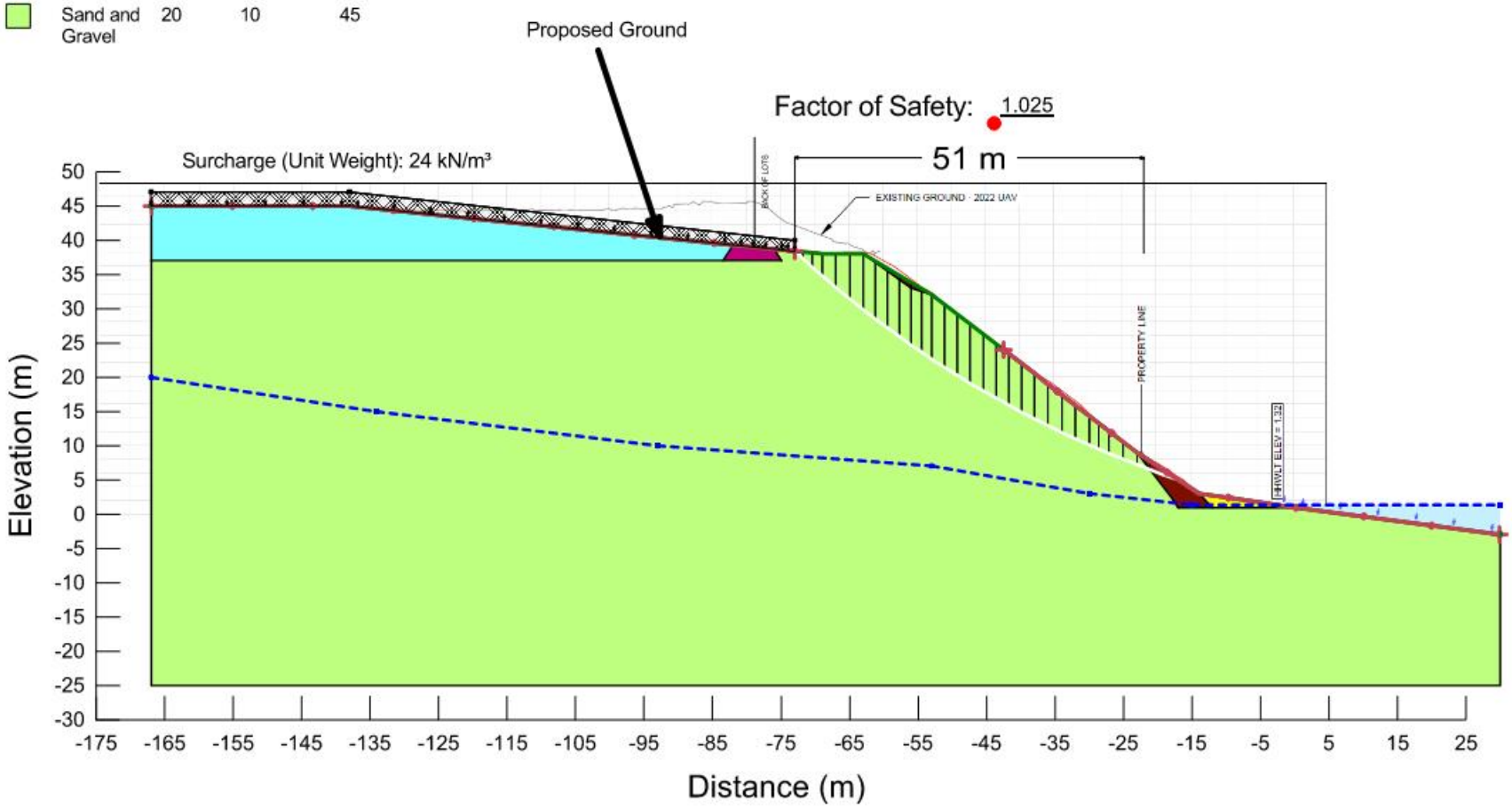
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 2.1 (Seismic)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.31	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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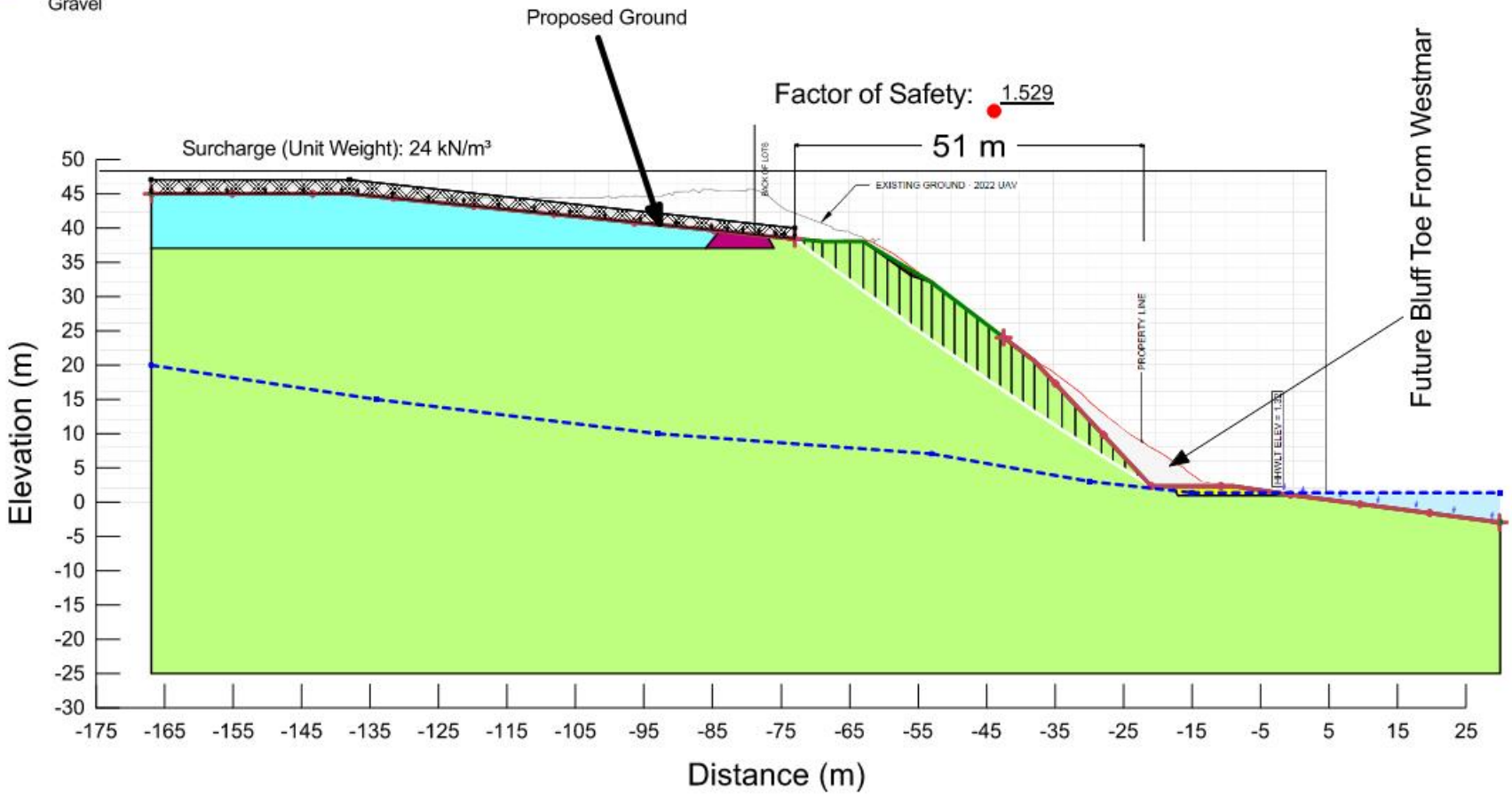
APPENDIX C – SECTION 2.1 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 2.1 (Static)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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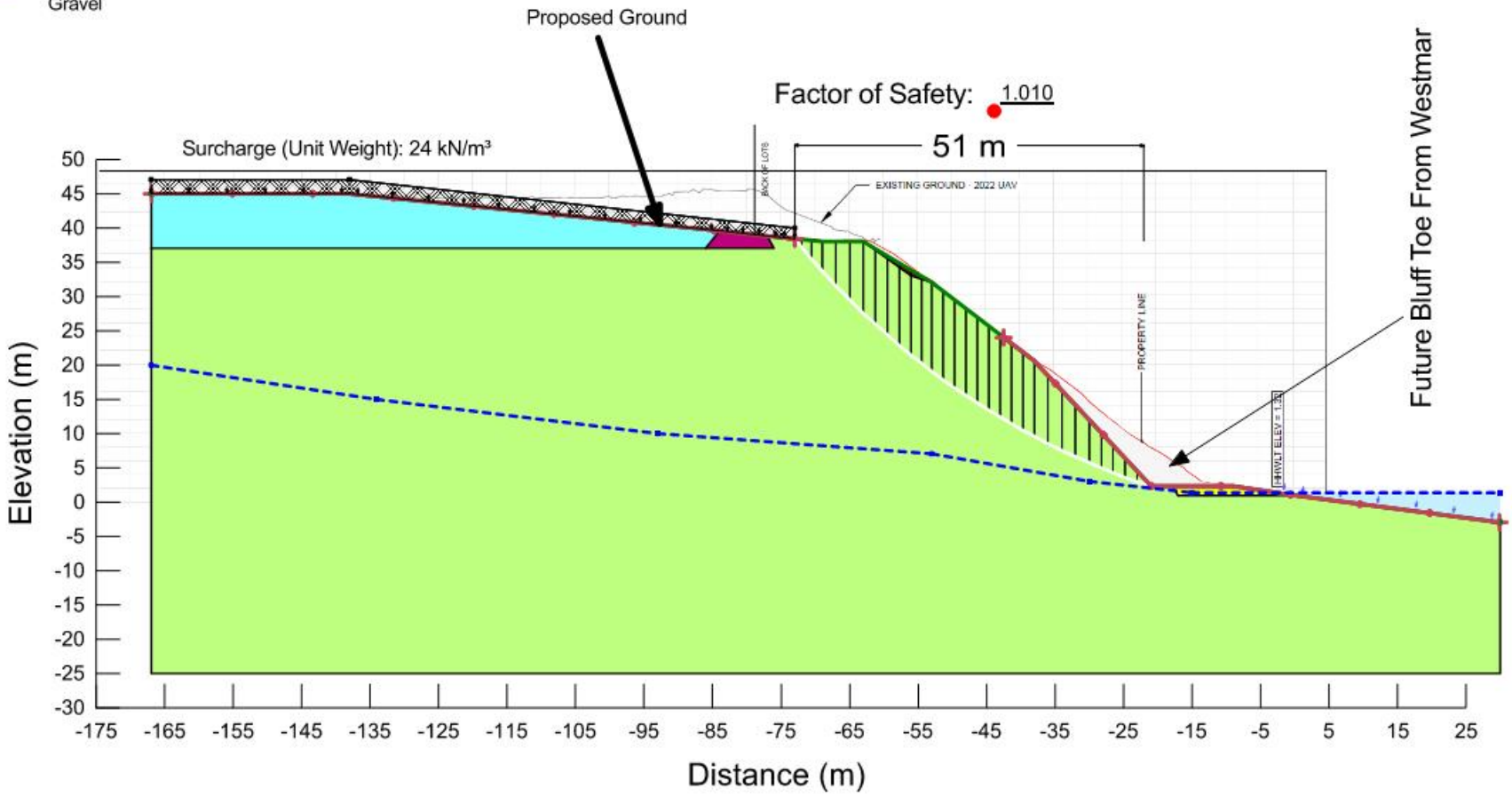
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 2.1 (Seismic)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.27	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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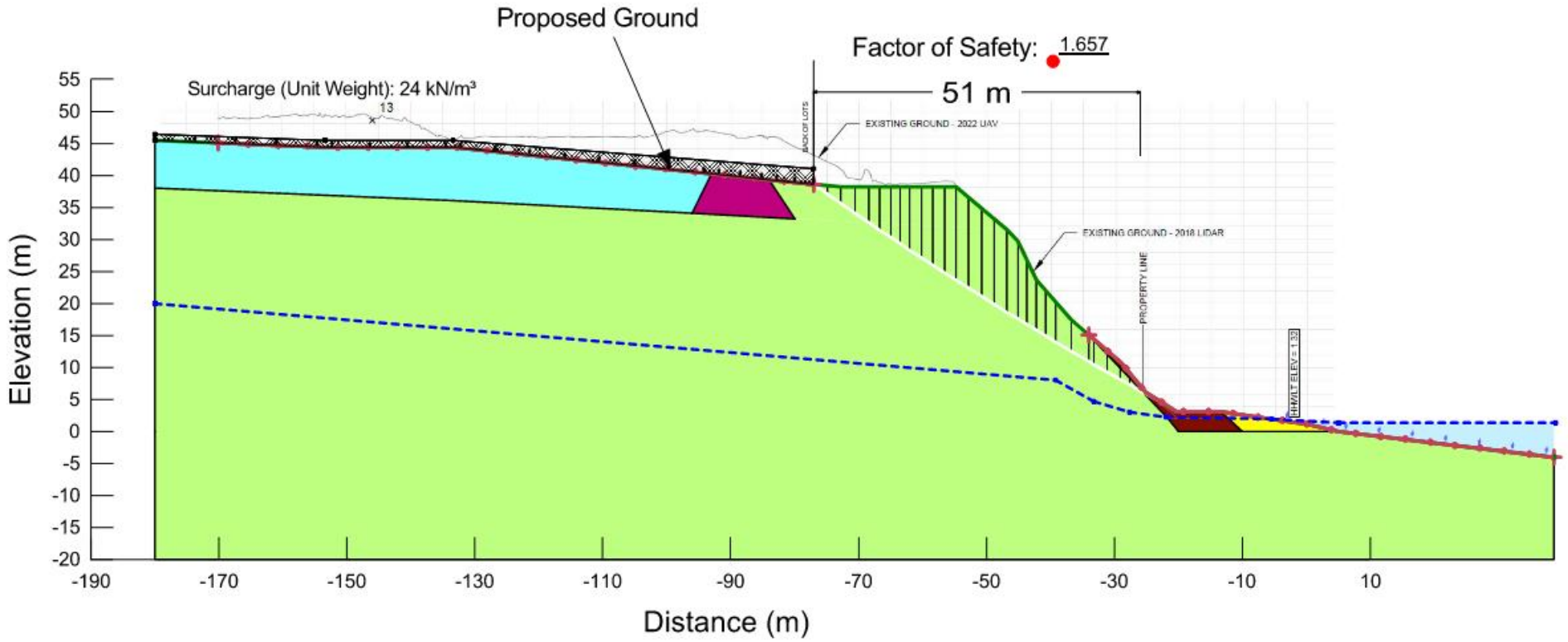
APPENDIX C – SECTION 3 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 3 (Static)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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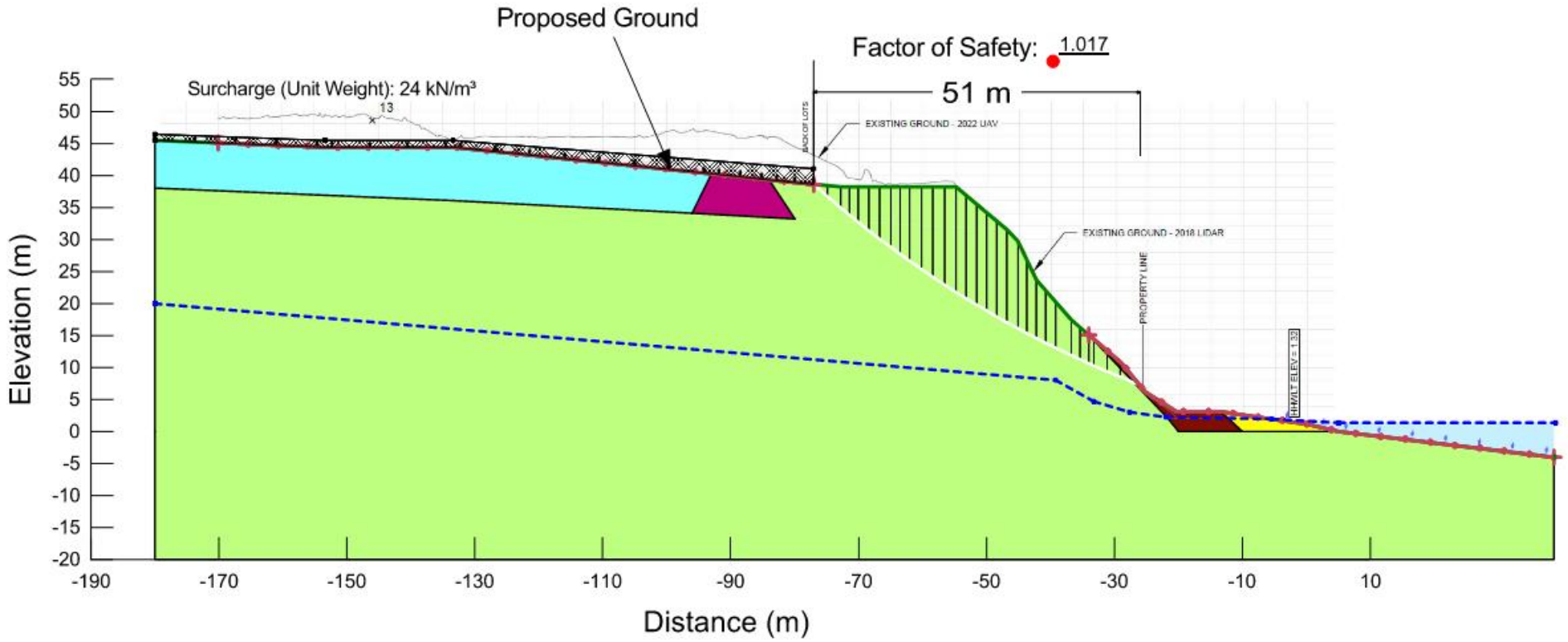
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 3 (Seismic)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.3	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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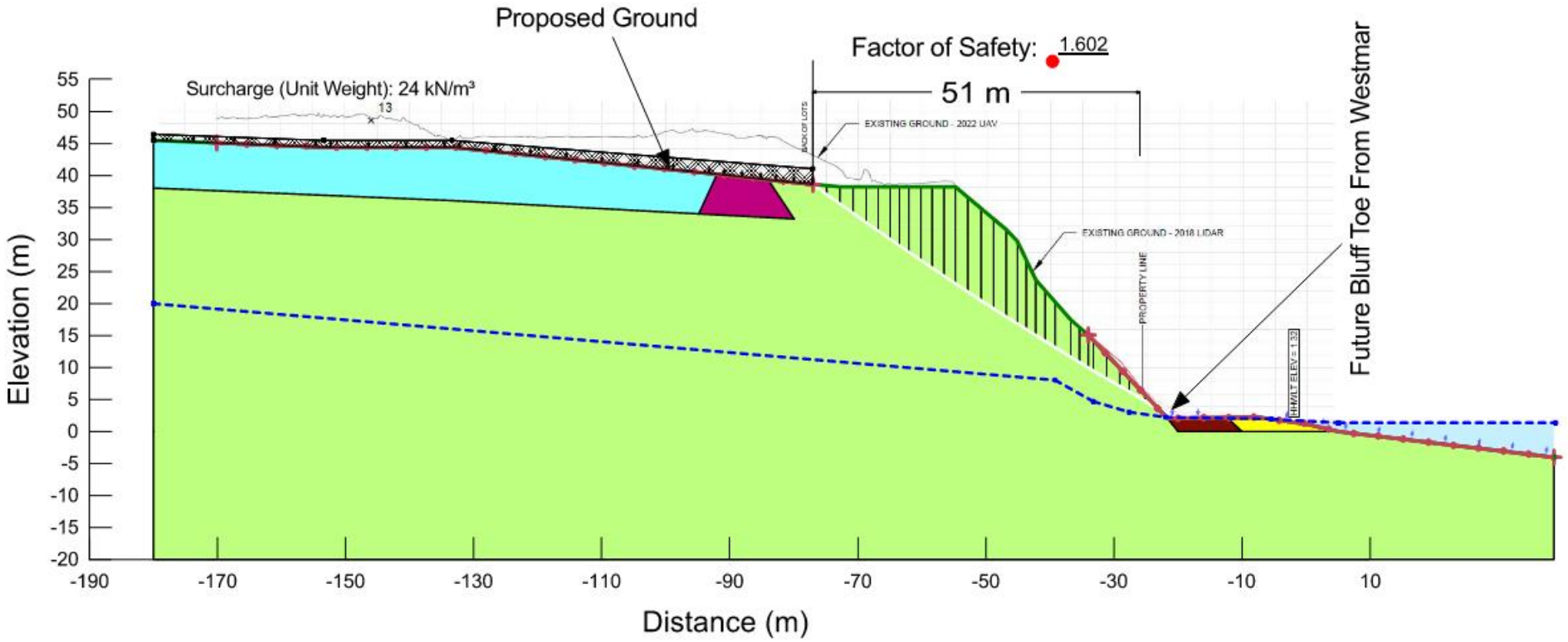
APPENDIX C – SECTION 3 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 3 (Static)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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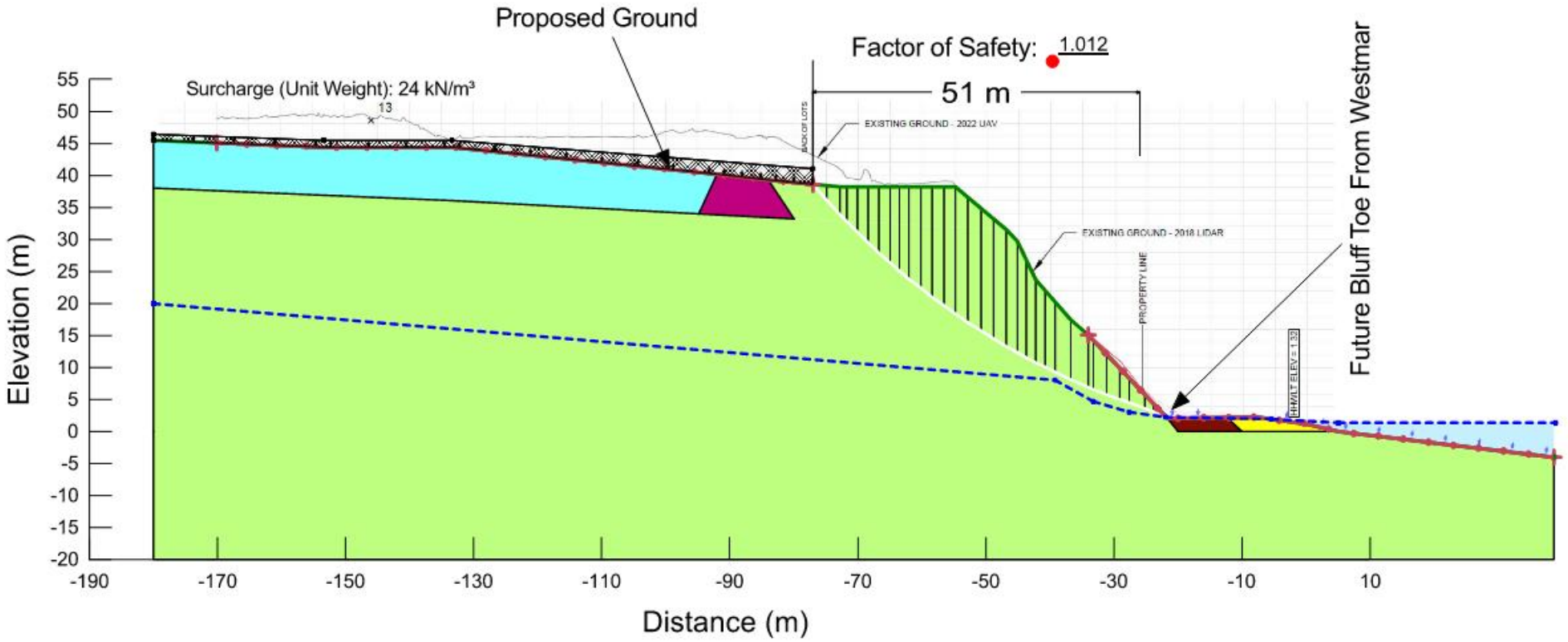
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Colluvium	19	0	32
	Dike Fill	19	0	32
	Pond Sediment	16	0	23
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 3 (Seismic)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.29	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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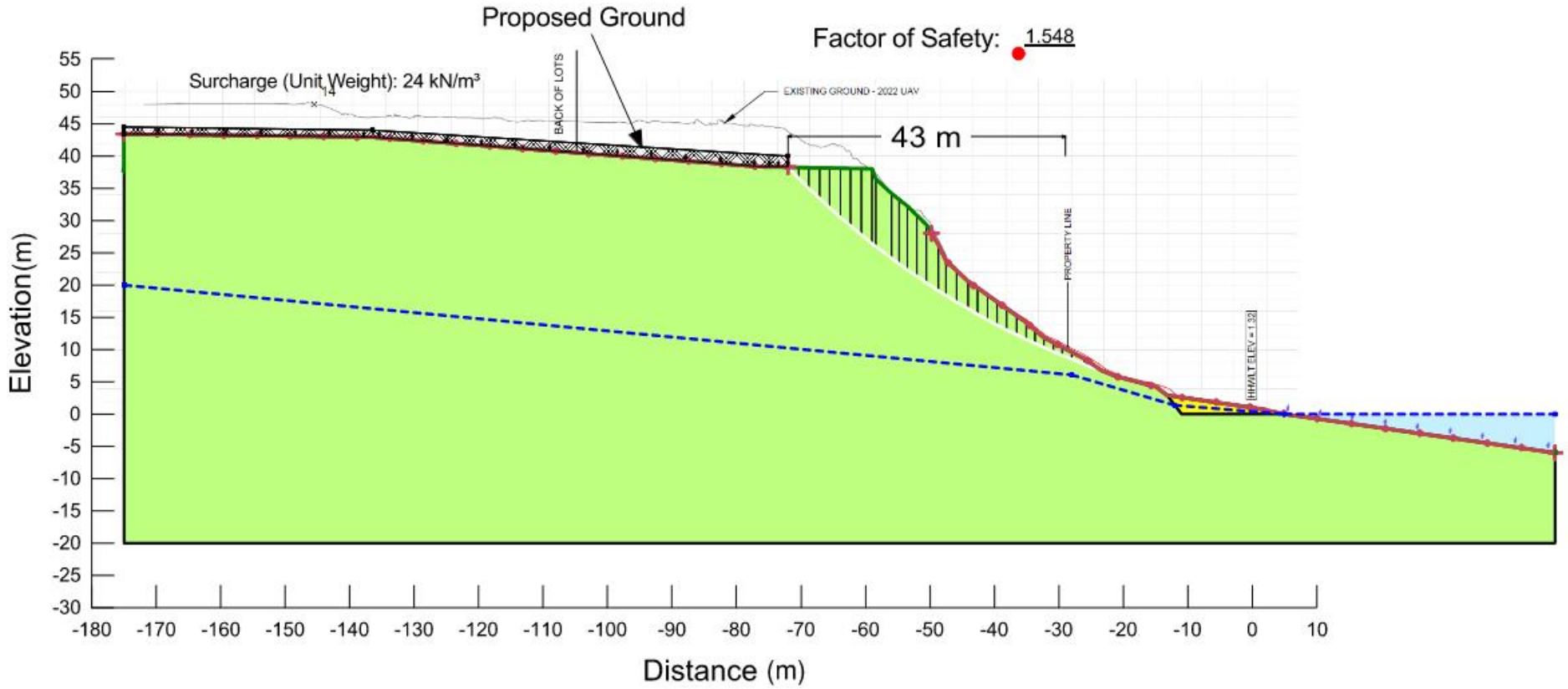
F 604.439.9189

APPENDIX C – SECTION 4 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 4 (Static)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.:	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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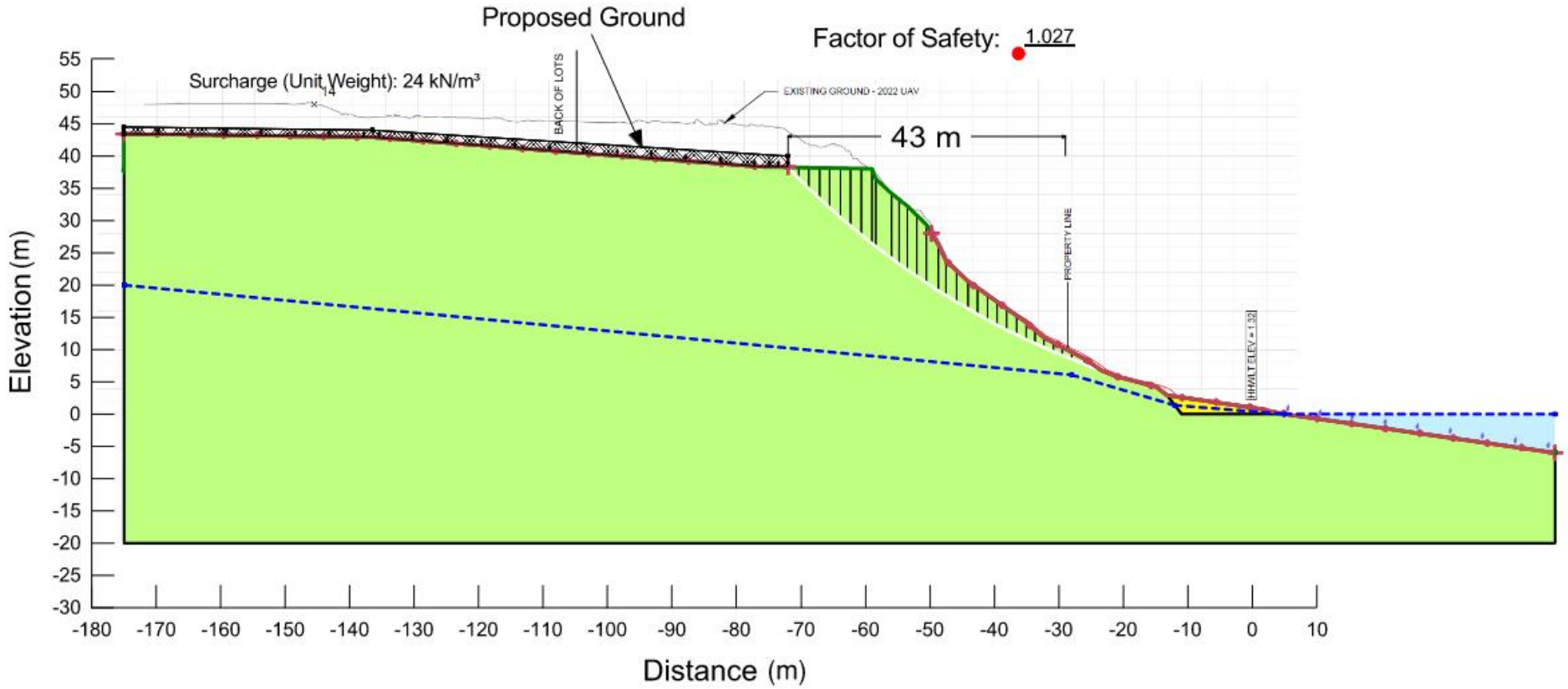
F 604.439.9189

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement		**Job No.: 21385**
Model: Slope Stability Section 4 (Seismic)		Date: Sept. 20, 2023
Method: Morgenstern-Price	Horz Seismic Coef.: 0.27	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.		Analysis by: AAn

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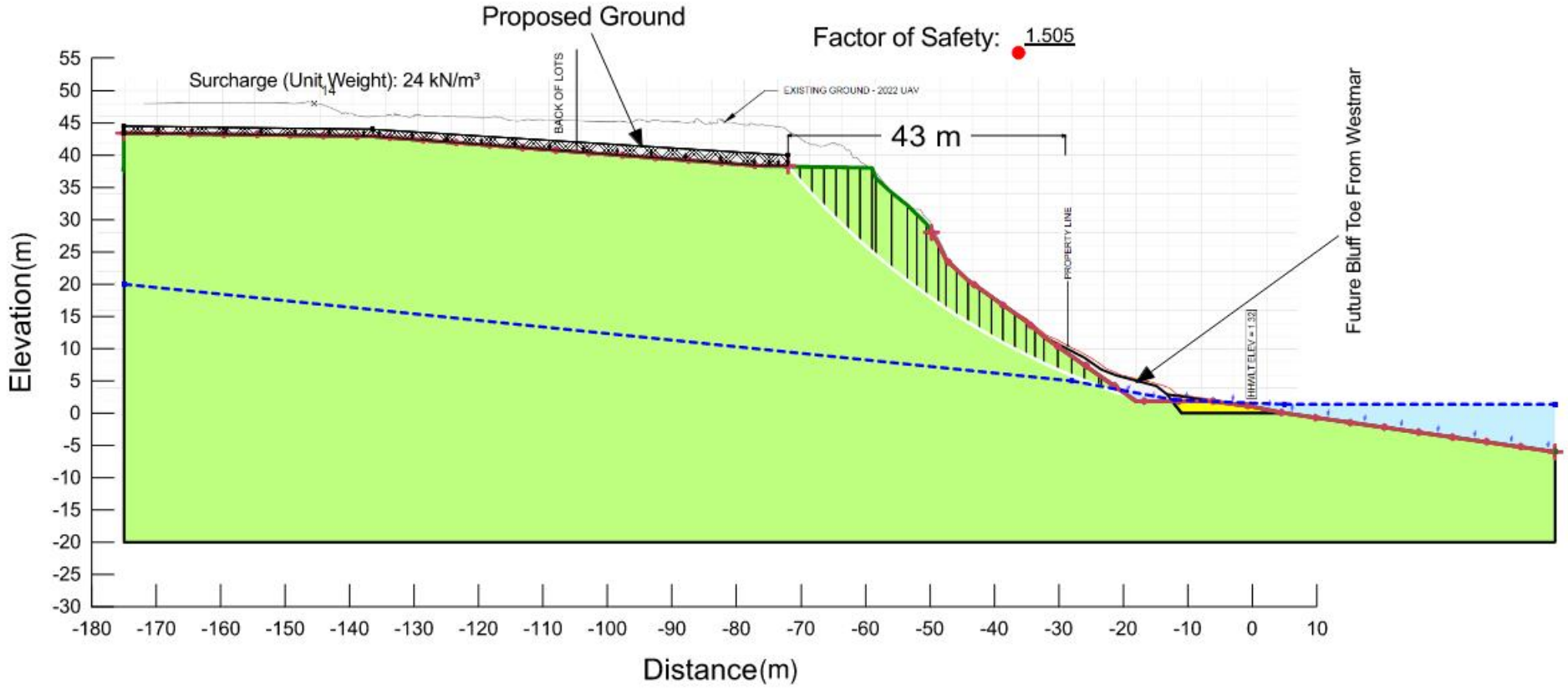
APPENDIX C – SECTION 4 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 4 (Static)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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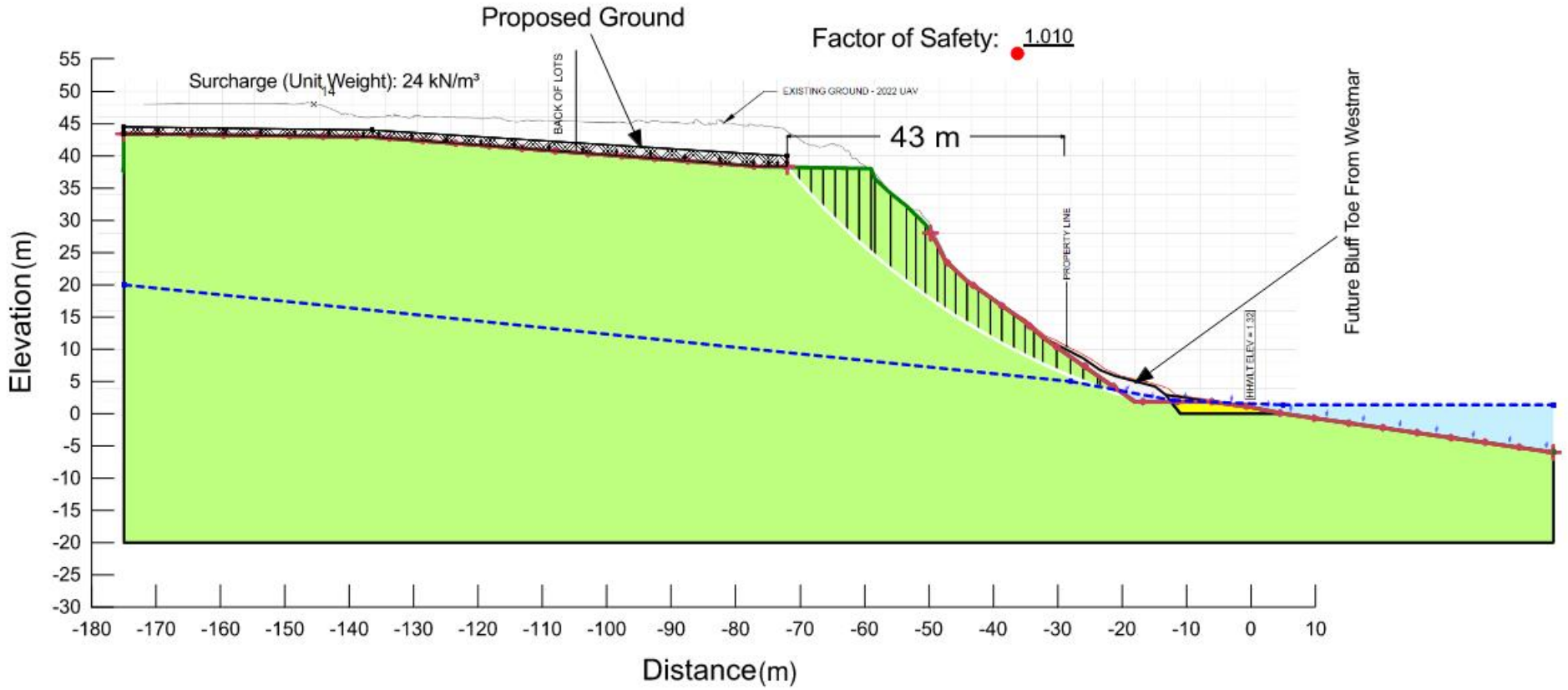
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 4 (Seismic)	Date: Sept. 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.26	Scale : 1:980
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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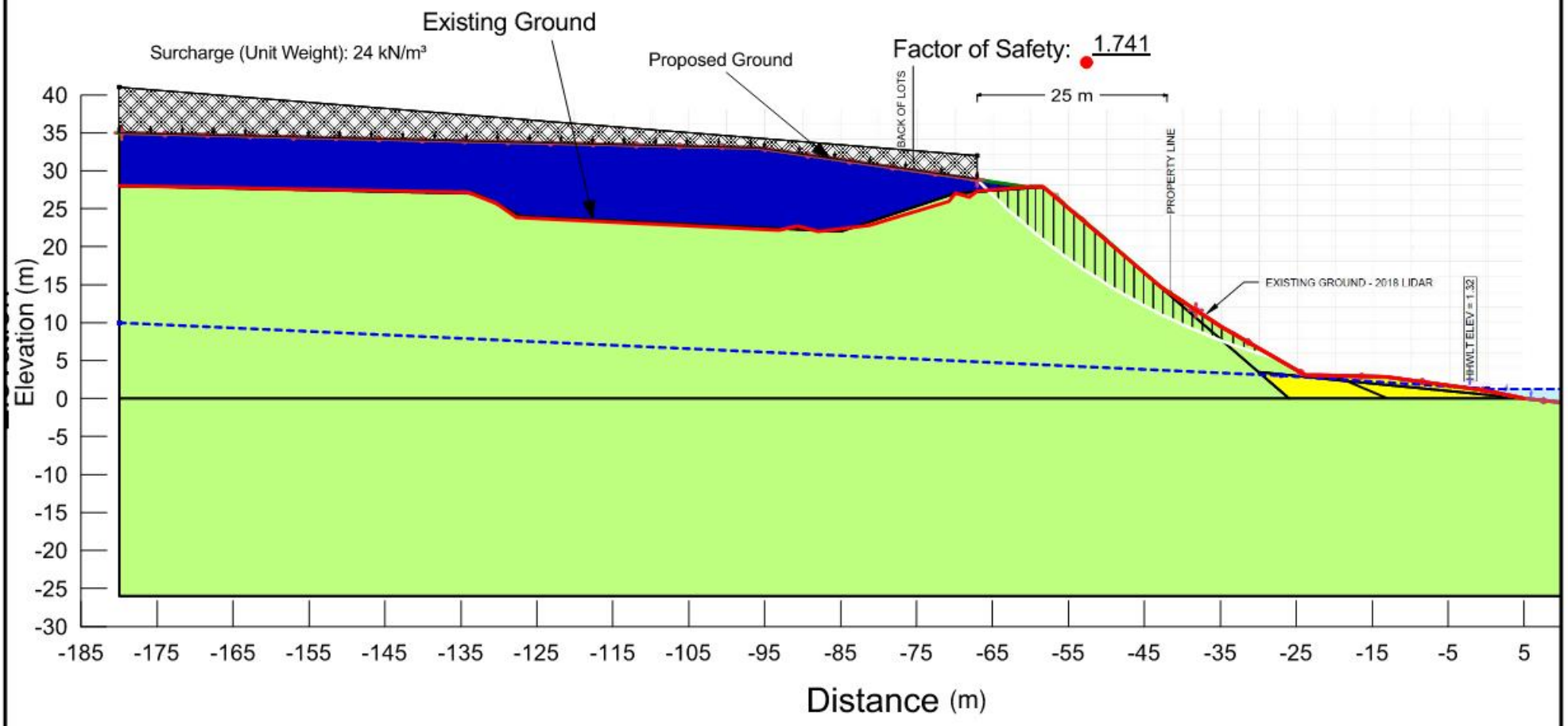
APPENDIX C – SECTION 5 (NO TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Engineered Fill	19	0	35
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 5 (Static)	Date: Sept 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0	Scale : 1:791
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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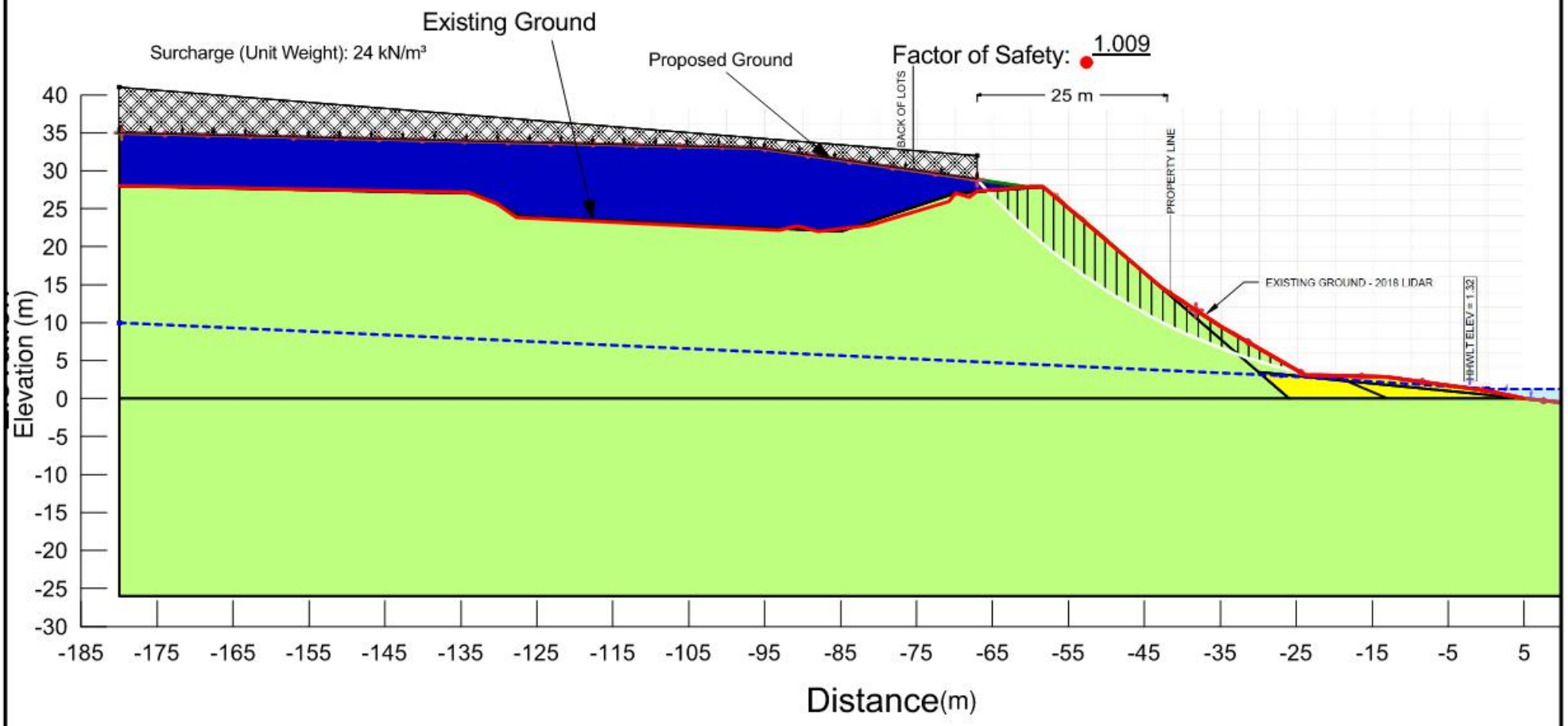
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Engineered Fill	19	0	35
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 5 (Seismic)	Date: Sept 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.36	Scale : 1:791
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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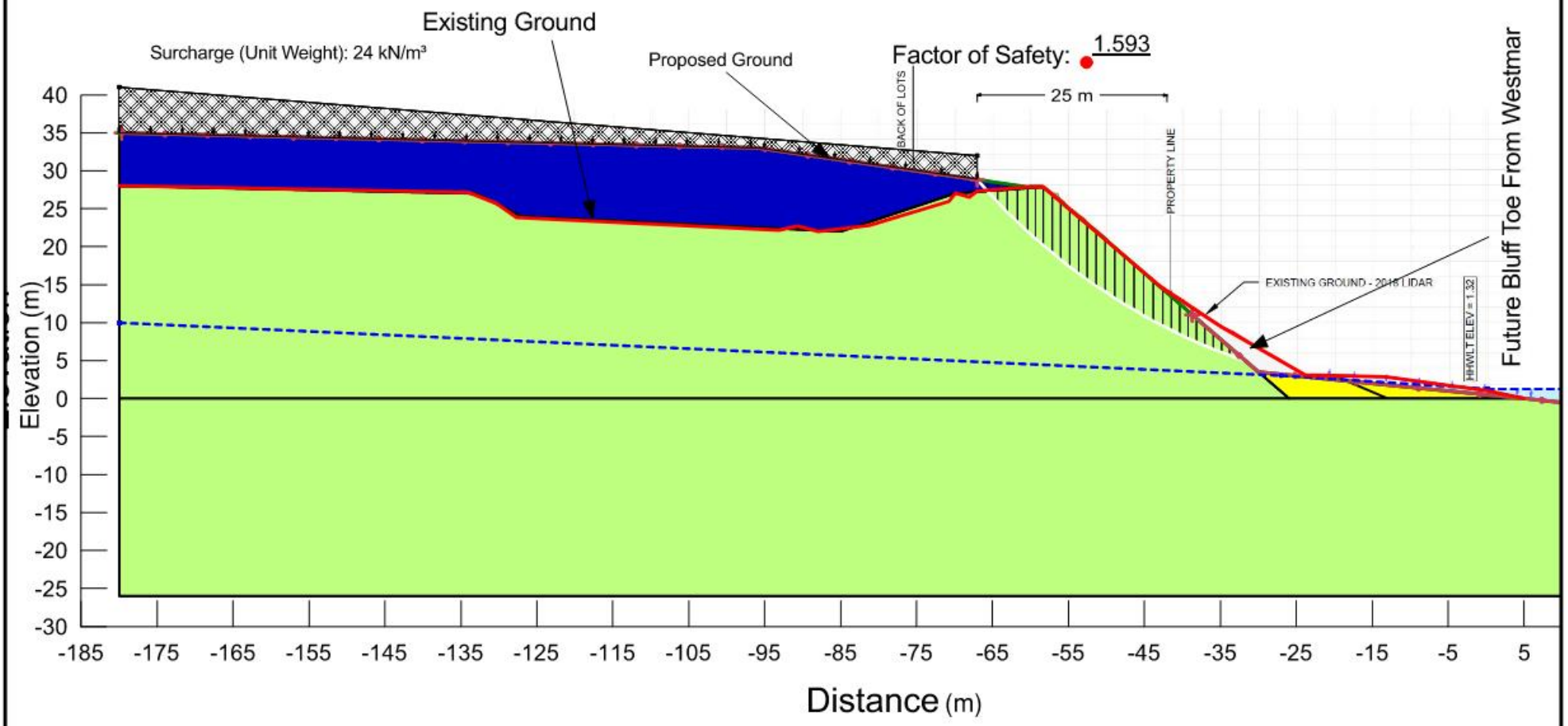
APPENDIX C – SECTION 5 (WITH TOE RECESSION)

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Engineered Fill	19	0	35
	Sand	19	0	32
	Sand and Gravel	20	5	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 5 (Static)	Date: Sept 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0	Scale : 1:791
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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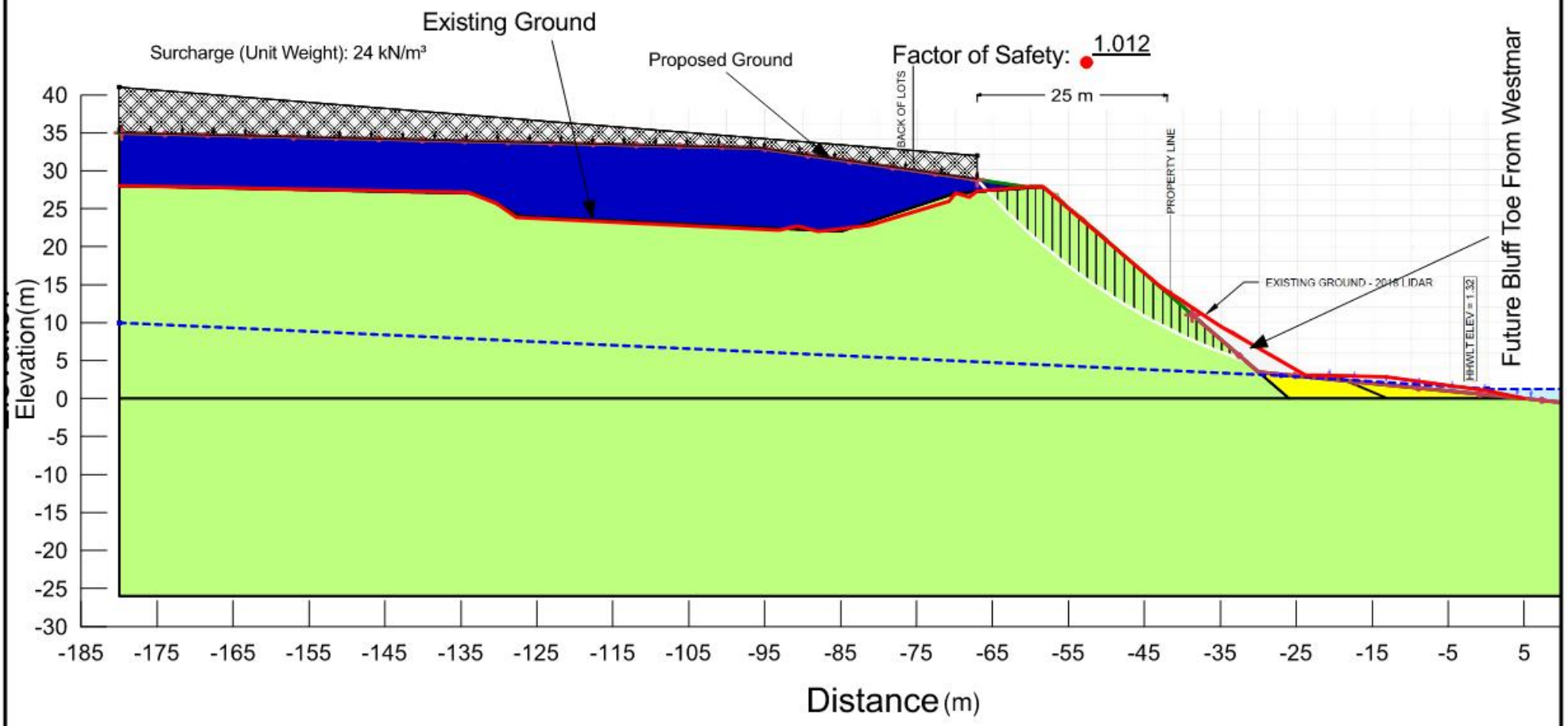
Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Engineered Fill	19	0	35
	Sand	19	0	32
	Sand and Gravel	20	10	45



Project: Residential Developement	**Job No.: 21385**
Model: Slope Stability Section 5 (Seismic)	Date: Sept 20, 2023
Method: Morgenstern-Price Horz Seismic Coef.: 0.3	Scale : 1:791
Site Address : Beachlands Development, Metchosin Road, Colwood, B.C.	Analysis by: AAn

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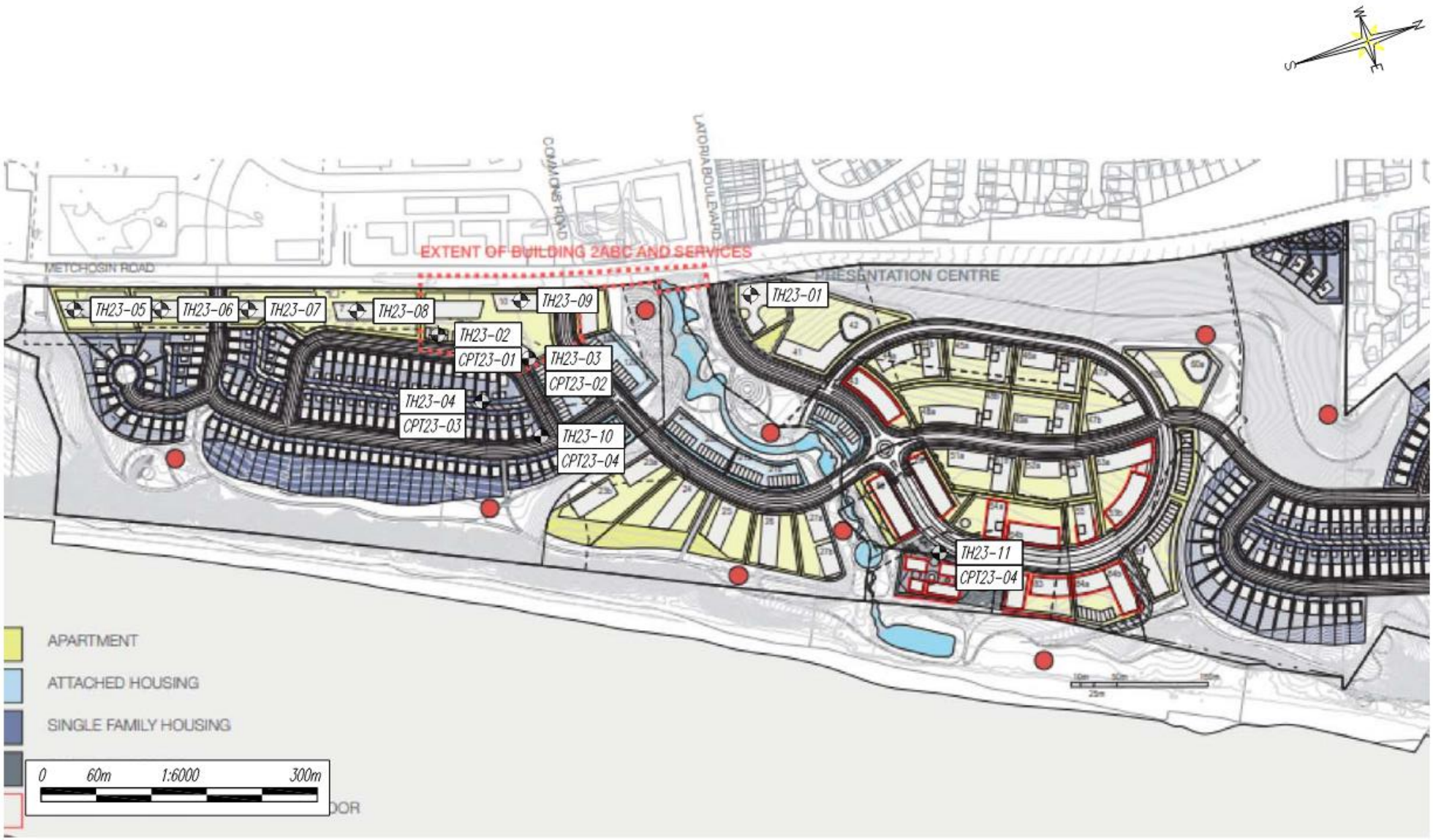
APPENDIX D –

FEBRUARY/MARCH 2023 – GEOPACIFIC TEST HOLE LOGS



LEGEND:

- TH22-XX – TEST HOLE (TH) LOCATION
- CPT23-01 – CONE PENETRATION TEST (CPT) LOCATION

SITE PLAN

1:1500

*TEST LOCATIONS ARE APPROXIMATE

REFERENCE:
omb office of mcfarlane biggar

GEOPACIFIC CONSULTANTS

DATE:	FEBRUARY 7, 2022	
DRAWN BY: P.A.F.	APPROVED BY: R.D.	REVIEWED BY: R.D.
SCALE: AS SHOWN		

ROYAL BEACH DEVELOPMENT
METCHOSIN ROAD, COLWOOD, B.C.
TEST HOLE SITE PLAN

FILE NO.: 21385
DWG. NO.: 21385

REVISIONS:
A.
B.
C.

ORIGINAL PAPER SIZE 8.5"x11"

APPENDIX A - TEST HOLE LOGS

Test Hole Log: TH23-01

File: 21385-B
Project: Presentation Centre Royal Beach Development
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

GEOPACIFIC CONSULTANTS
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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0–3 / 0–1		***SAND and GRAVEL*** Very dense SAND and GRAVEL, some cobbles. Trace moisture. Black to brown.	0.0 – 0.5		>50, >50		
3–10 / 1–3		***SAND*** Compact to very dense SAND some gravel, trace to some silt. Subrounded. Trace moisture. Brown.	0.5 – 3.0	4.7	42, 36, >50, >50		
10–20 / 3–6		Some cobbles at 10' ***GRAVELLY SAND*** Very dense gravelly SAND, many cobbles. Trace moisture. Brown.	3.0 – 6.1				50% sample recovery between 10' to 20'
20–26 / 6–8		***SAND*** Dense SAND some silt. Some moisture. Brown.	6.1 – 7.9	11.5			
26–30 / 8–9		***SAND and GRAVEL*** SAND and GRAVEL, some boulders, Dry. White.	7.9 – 9.1				Powdered rock dust from drilling
30 / 9		End of Borehole	9.1				

Logged: P.A.F.
Method: Sonic
Date: March 21, 2023

Datum: Ground Surface
Figure Number: A.01

Test Hole Log: TH23-02

File: 21385-A
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0 / 0		***SAND and GRAVEL*** Compact to dense coarse GRAVEL and SAND, trace to some slit. Trace moisture. Brown.	0.0				60% sample recovery for 0' - 10'
8 / 2.4		***SANDY SILT*** Very stiff to hard sandy SILT. Some moisture. Brown.	2.4				
10 / 3		***SILTY CLAY*** Stiff to very stiff SILTY CLAY with trace to some sand, trace gravel, trace cobbles, some interbedded layers of gravelly sand mixed with silty clay and trace intermixed black bark. Blue grey and brown.	3.0				
22 / 6.7		***GRAVELLY SAND*** Dense to very dense gravelly SAND with trace to some silt. Some moisture. Brown.	6.7				
30 / 9.1		End of Borehole	9.1				

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.02

Test Hole Log: TH23-03

File: 21385-A
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

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INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
0 / 0		***SAND*** Compact coarse grained SAND, trace roots and grass upper 10'. Trace to some moisture. Brown.	0.0	12.2			20% sample recovery between 0' to 10'
19 / 6		***SILTY CLAY*** Stiff to very stiff SILTY CLAY, trace to some interbedded sandy silt. Moist. Brown.	5.8	32.4 37.8			80% sample recovery between 10' to 20'
31 / 9		***SAND*** Dense to very dense SAND, some gravel, trace silt. Moist. Brown.	9.4				
35 / 10		End of Borehole	10.7				
40 / 12							

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.03

Test Hole Log: TH23-04

File: 21385-A
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		SAND Loose to compact coarse grained SAND. Trace to some moisture. Brown.	0.0				
		SILTY SAND Compact fine grained silty SAND. Some moisture. Brown.	2.4	25.1			
		SILTY CLAY Firm to stiff silty CLAY, med-high plasticity, trace interbedded sand. Moist. Brown.		37.9 42.3			
		SILTY SAND Compact silty SAND. Some moisture. Brown.	8.2 9.1	27.4			
		SILTY CLAY Firm to stiff silty CLAY, med-high plasticity. Moist. Brown. between 55' to 57' material become sandy.		37.9 44.7 37.7			
		GRAVELLY SAND Dense to very dense gravelly SAND. Trace moisture. Grey-brown.	17.4 18.3	28.7			
70 / 21		End of Borehole					

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.04

Test Hole Log: TH23-05

File: 21385-A

Project: Proposed Residential Development 'Building 2ABC'

Client: RPSP Beach Front Development Manager Ltd.

Site Location: Metchosin Road, Colwood, BC

1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
0 / 0		***SAND*** Compact SAND with some gravel. Dry. Gray.	0.0
3 / 1		***SANDY SILT*** Stiff sandy SILT, some clay. Some moisture. Brown.	
10 / 3		***GRAVELLY SAND*** Very dense gravelly SAND. Dry. Gray.	3.0
20 / 6		End of Borehole	6.1
30 / 9			

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40

9, 12, 14, 11, 9, 9, 10, 10, 7, 22, 50

Groundwater / Well

Remarks

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.05

Test Hole Log: TH23-06

File: 21385
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

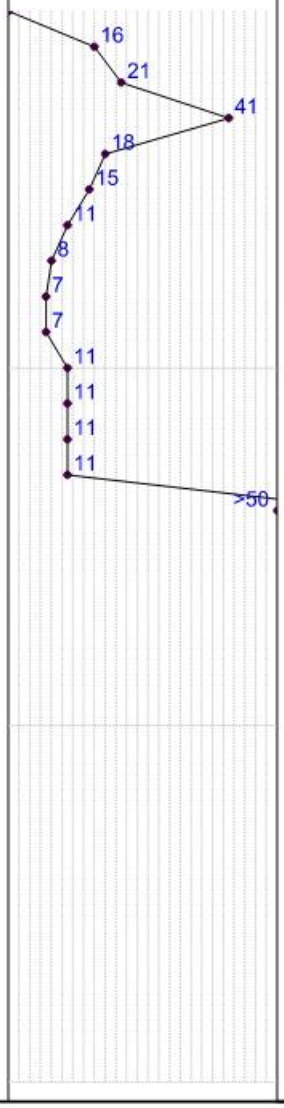
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
0 / 0		***SAND*** Loose to compact SAND, trace to some gravel. Trace moisture. grey-brown.	0.0
8 / 2.4		***SANDY SILT*** Stiff sandy SILT. Moist. Brown	2.4
13 / 4		***SAND and GRAVEL*** Very dense SAND and GRAVEL. Trace moisture. Brown.	4.0
20 / 6.1		***GRAVELLY SAND*** Very dense, gravelly SAND. Dry. Brown.	6.1
25 / 7.6		End of Borehole	7.6

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40



Groundwater / Well

Remarks

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.06

Test Hole Log: TH23-07

File: 21385-A

Project: Proposed Residential Development 'Building 2ABC'

Client: RPSP Beach Front Development Manager Ltd.

Site Location: Metchosin Road, Colwood, BC

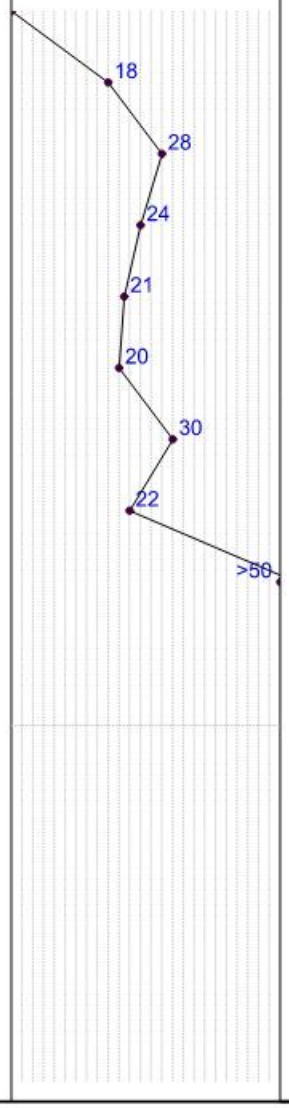
1779 West 75th Avenue, Vancouver, BC, V6P 6P2
Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		GRAVELLY SAND Compact gravelly SAND, trace silt. Trace moisture. Brown.	0.0
		SANDY GRAVEL Very dense sandy GRAVEL. Trace moisture. Brown.	2.3
		GRAVELLY SAND Very dense gravelly SAND. Dry. Gray.	2.7
10 / 3		End of Borehole	3.0

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40



Groundwater / Well

Remarks

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.07

Test Hole Log: TH23-08

File: 21385-A

Project: Proposed Residential Development 'Building 2ABC'

Client: RPSP Beach Front Development Manager Ltd.

Site Location: Metchosin Road, Colwood, BC

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INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
0 / 0 – 1		***SAND*** Loose to compact SAND, trace gravel. Trace moisture. Brown.	0.0
1 / 1 – 4		***SILT*** Firm to stiff SILT with some sand. Moist. Brown.	1.2
13 / 4 – 6		***SAND*** Dense to very dense SAND, trace silt, trace to some gravel. Trace moisture. Brown.	4.0
21 / 6 – 10		***GRAVELLY SAND*** Very dense gravely SAND. Trace moisture. Brown.	6.4
35 / 10 – 11		End of Borehole	10.7

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40

11, 25, 12, 8, 5, 4, 7, 10, 7, 9, 14, 19, 16, 31, 46, >50, >50

Groundwater / Well

Remarks

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.08

Test Hole Log: TH23-09

File: 21385-A
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)	Moisture Content (%)	DCPT (blows per foot) 10 20 30 40	Groundwater / Well	Remarks
0 / 0		Ground Surface					
		SAND Compact to dense coarse SAND, trace silt. Trace Moisture. Brown.	0.0		17, 24, 23, 15, 11, 9, 8, 7, 23, >50		
		GRAVELLY SAND Very dense gravelly SAND. Dry. Grey-brown.	2.7		>50		
		End of Borehole	3.0				

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.09

Test Hole Log: TH23-10

File: 21385-A
Project: Proposed Residential Development 'Building 2ABC'
Client: RPSP Beach Front Development Manager Ltd.
Site Location: Metchosin Road, Colwood, BC

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Tel: 604-439-0922 Fax:604-439-9189

INFERRED PROFILE

Depth (ft / m)	Symbol	SOIL DESCRIPTION	Depth (m)/Elev (m)
0 / 0		Ground Surface	
		SAND Loose to compact coarse grained SAND, trace silt. Trace moisture. Brown.	0.0
9 / 3		***SILTY CLAY*** Stiff silty CLAY with trace to some sand, interbedded sand seams. Moist. Brown.	2.7
22 / 7		***CLAYEY SILTY SAND*** Dense clayey silty SAND. Moist. Brown with some gray.	6.7
24 / 7		***SAND*** Very dense fine grained SAND with some gravel, some cobbles. Dry. White.	7.3
27 / 8		***GRAVELLY SAND*** Very dense gravelly SAND, trace silt. Dry. Gray.	8.2
30 / 9		End of Borehole	9.1

Moisture Content (%)

DCPT (blows per foot) 10 20 30 40

Groundwater / Well

Remarks: Powdered rock dust from drilling

Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.10

Test Hole Log: TH23-11

File: 21385-A

Project: Proposed Residential Development 'Building 2ABC'

Client: RPSP Beach Front Development Manager Ltd.

Site Location: Metchosin Road, Colwood, BC

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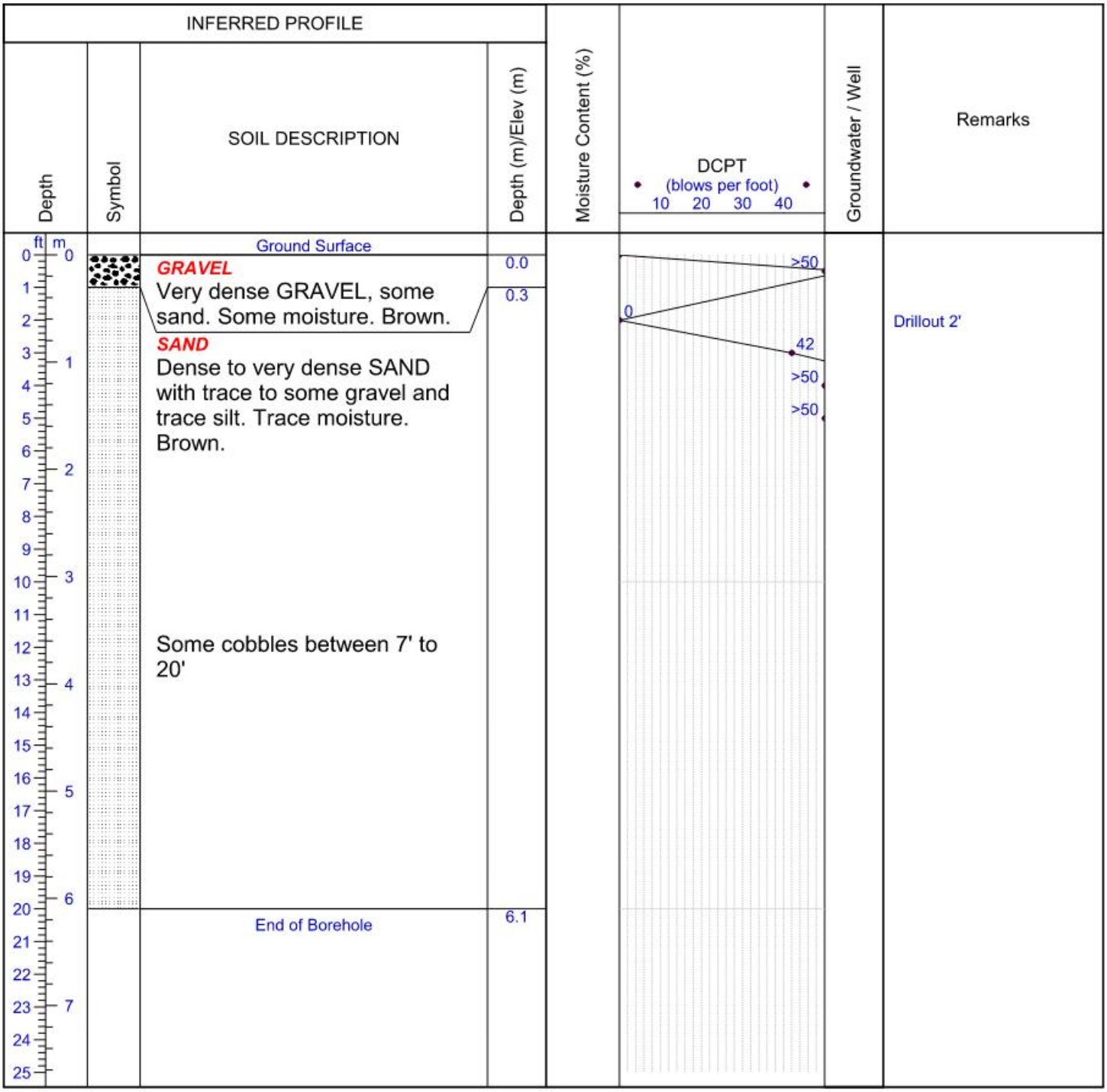


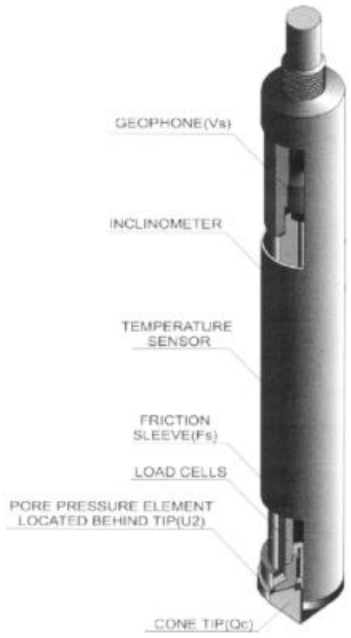
Logged: P.A.F.
Method: Sonic Drill
Date: March 22, 2023

Datum: Ground Surface
Figure Number: A.11

APPENDIX B - ELECTRONIC CONE PENETRATION RESULTS

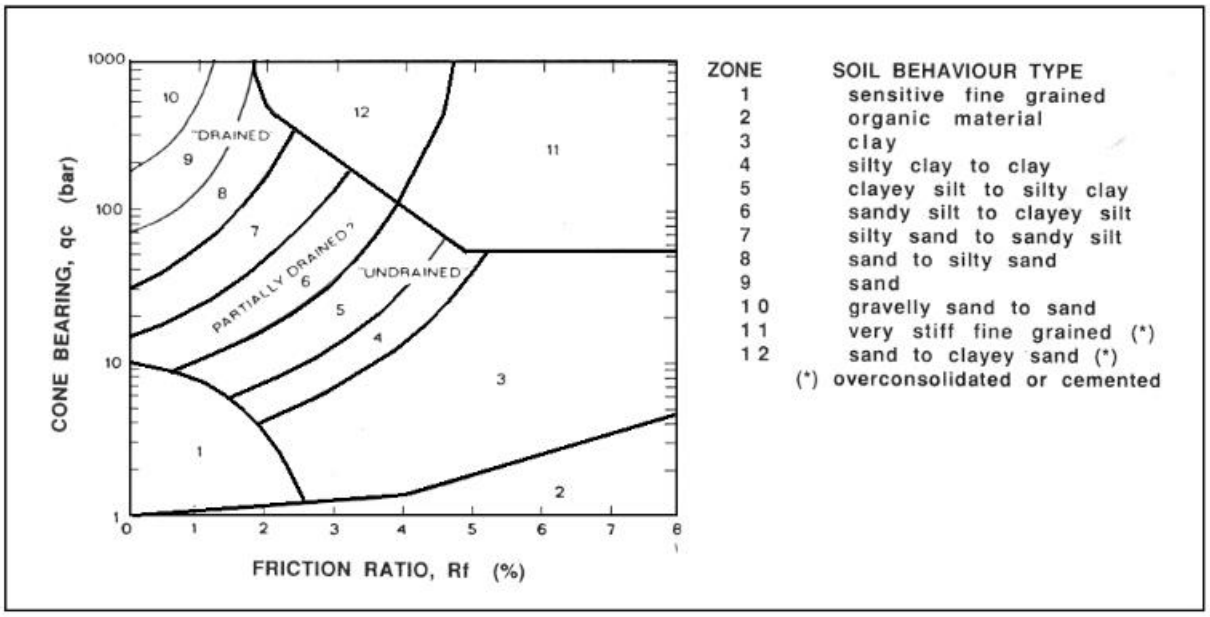
The system used is owned and operated by GeoPacific and employs a 35.7 mm diameter cone that records tip resistance, sleeve friction, dynamic pore pressure, inclination and temperature at 5 cm intervals on a digital computer system. The system is a Hogentogler electronic cone system and the cone used was a 10 ton cone with pore pressure element located behind the tip and in front of the sleeve as shown on the adjacent figure.

Electronic Cone Penetrometer



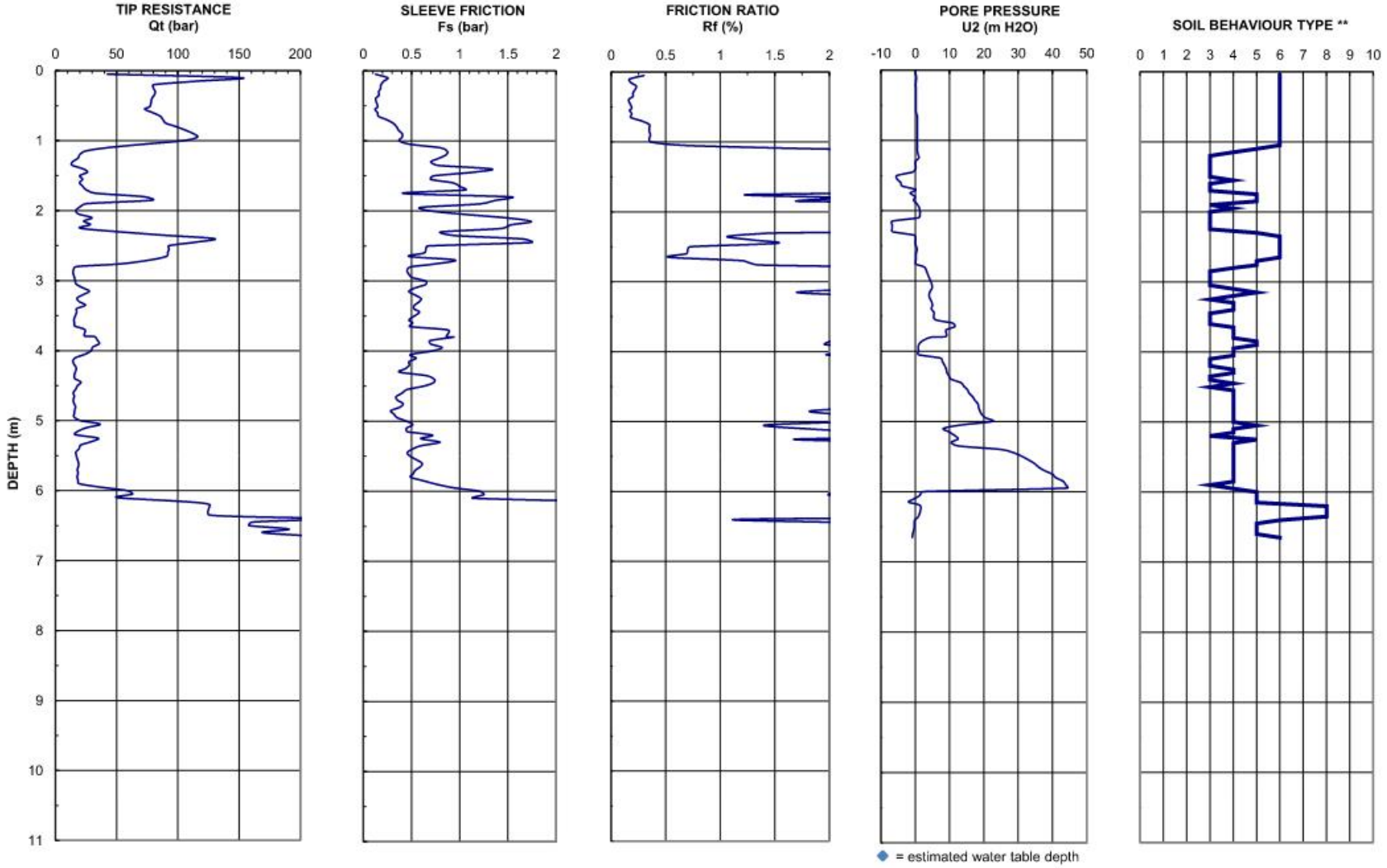
In addition to the capabilities described above, the cone can be stopped at specified depths and dissipation tests carried out. These dissipation tests can be used to determine the groundwater pressures at the specified depth. This is very useful for identifying artesian pressures within specific layers below the ground surface.

Interpretation of the cone penetration test results are carried out by computer using the interpretation chart presented below by Robertson[1]. Raw data collected by the field computer includes tip resistance, sleeve friction and pore pressure. The tip resistance is corrected for water pressure and the friction ratio is calculated as the ratio of the sleeve friction on the side of the cone to the corrected tip resistance expressed as a percent. These two parameters are used to determine the soil behaviour type as shown in the chart below. The interpreted soil type may be different from other classification systems such as the Unified Soil Classification that is based upon grain size and plasticity.



1 Robertson, P.K., 1990, "Soil Classification using the cone penetration test", 1990 Canadian Geotechnical Colloquium, Canadian Geotechnical Journal, Vol. 27, No. 1, 1990

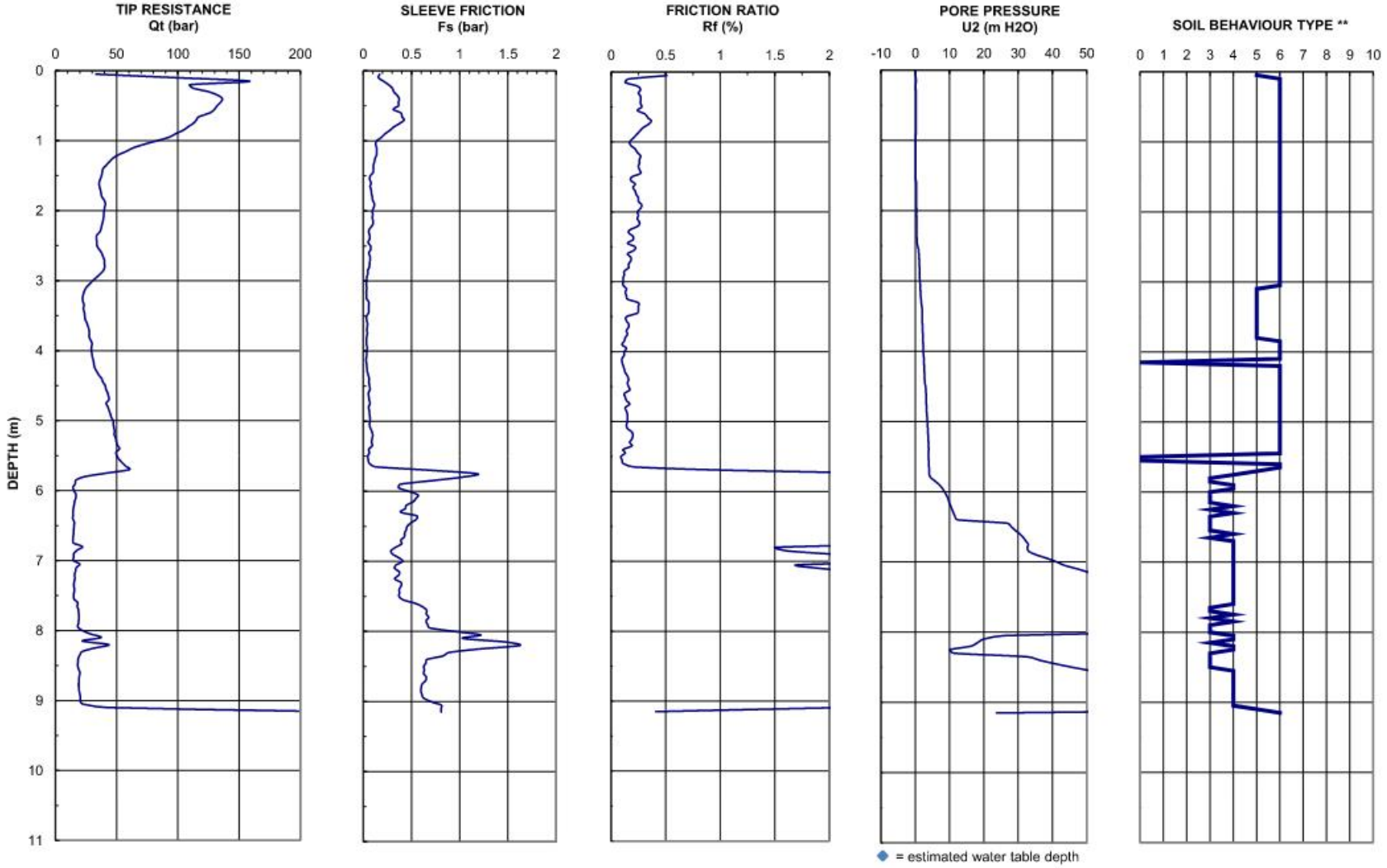
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-01	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: B.01



** Based on Robertson et. al 1990

1 Sensitive Fine Grained
2 Organic Material
3 Clay to Silty Clay
4 Clayey Silt to Silty Clay
5 Silty Sand to Sandy Silt
6 Clean Sand to Silty Sand
7 Gravely Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff Fine Grained

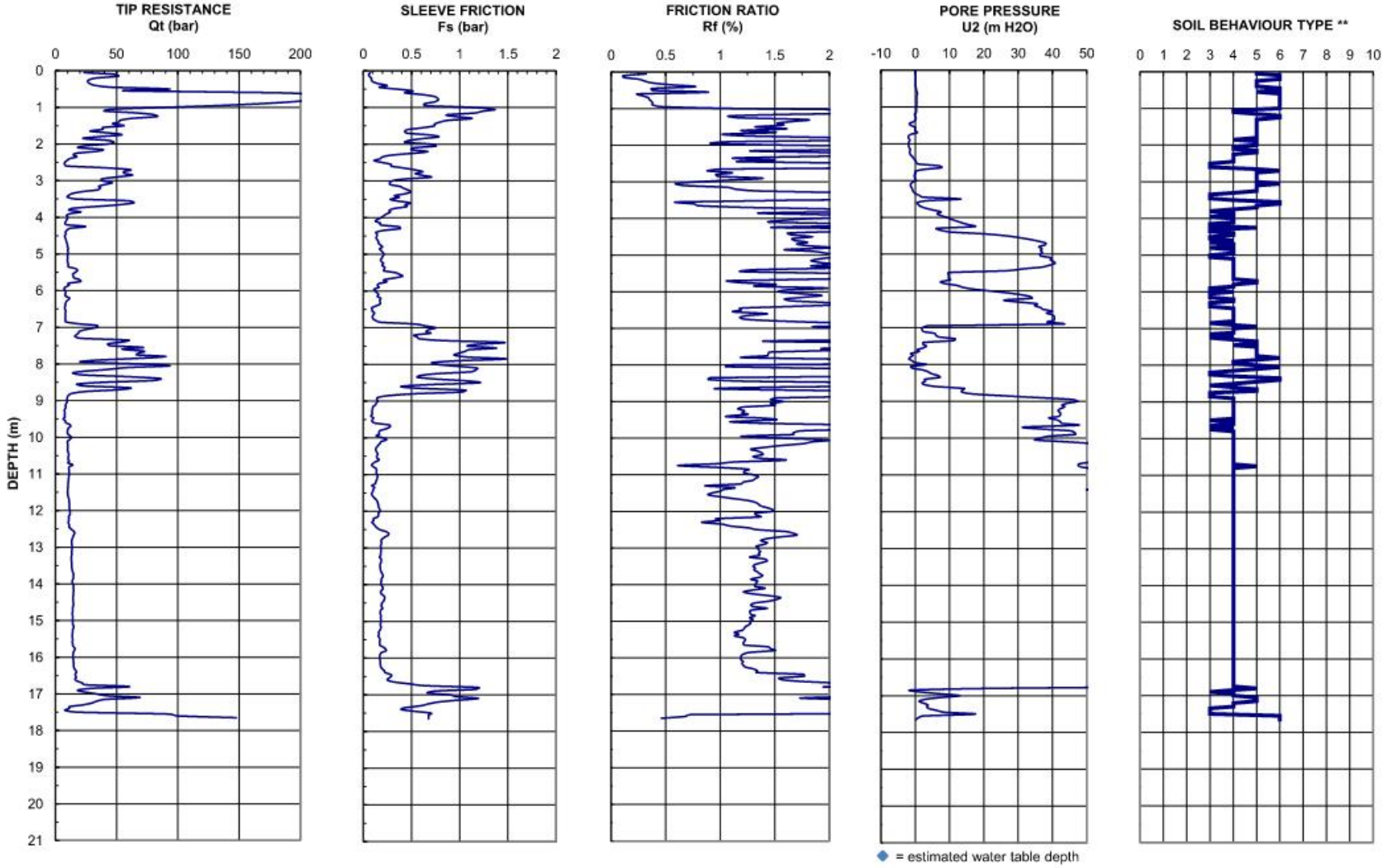
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-02	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: B.02



** Based on Robertson et. al 1990

1 Sensitive Fine Grained
2 Organic Material
3 Clay to Silty Clay
4 Clayey Silt to Silty Clay
5 Silty Sand to Sandy Silt
6 Clean Sand to Silty Sand
7 Gravely Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff Fine Grained

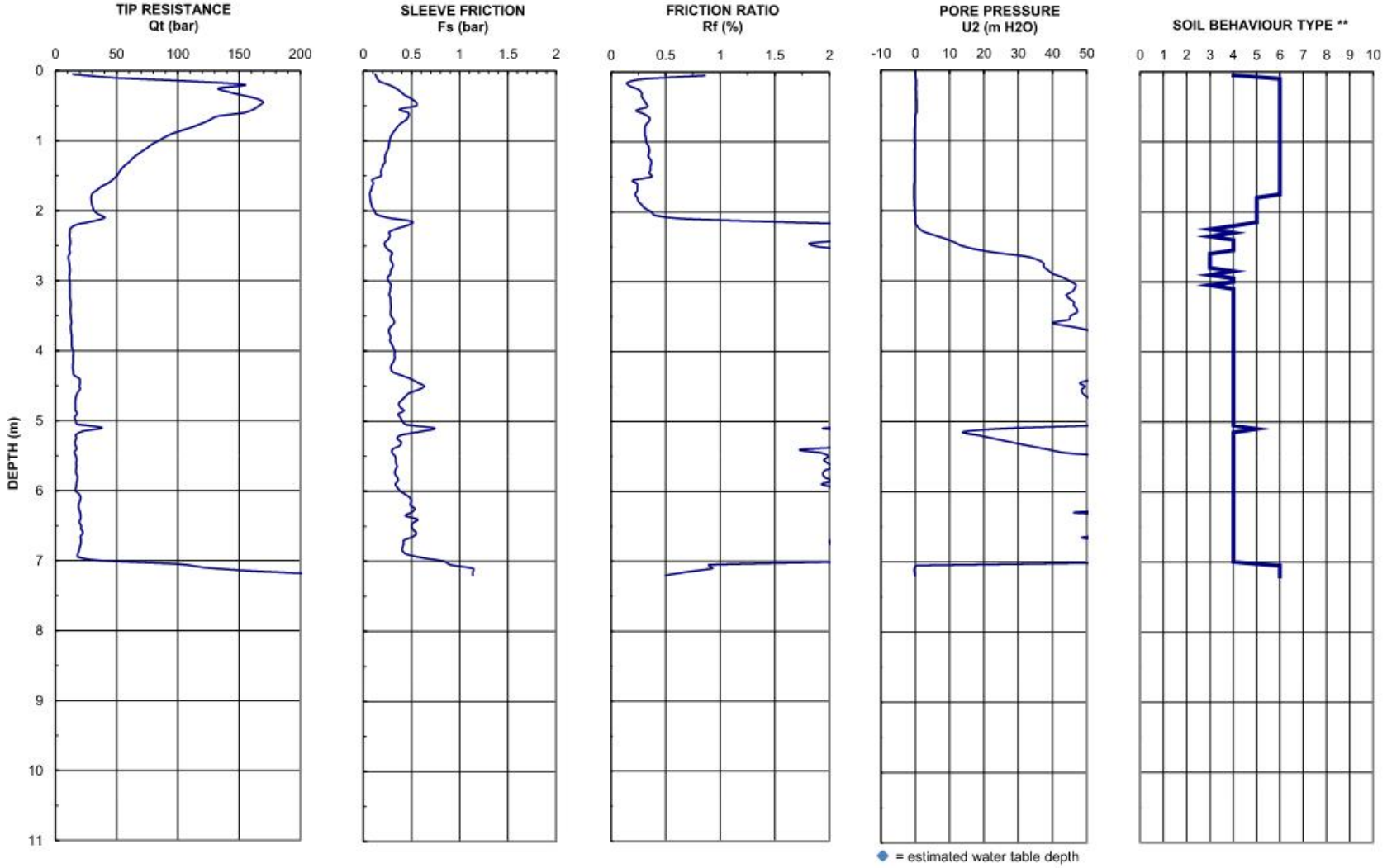
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-03	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: B.03



** Based on Robertson et. al 1990

1 Sensitive Fine Grained
2 Organic Material
3 Clay to Silty Clay
4 Clayey Silt to Silty Clay
5 Silty Sand to Sandy Silt
6 Clean Sand to Silty Sand
7 Gravely Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff Fine Grained

GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-24	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-04	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: B.04



** Based on Robertson et. al 1990

1 Sensitive Fine Grained
2 Organic Material
3 Clay to Silty Clay
4 Clayey Silt to Silty Clay
5 Silty Sand to Sandy Silt
6 Clean Sand to Silty Sand
7 Gravely Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff Fine Grained

APPENDIX C - OVER CONSOLIDATION RATIO ANALYSIS

The over consolidation ratio (OCR) is defined as the ratio between the maximum past vertical pressure on the soil versus the current in-situ vertical pressure. The maximum past vertical pressure is typically caused by the presence of excess overburden which is removed by either natural or man-made reasons. Soil ageing and other chemical precipitation affects can also cause a soil to behave as if it has a higher maximum past pressure, which is sometimes described as pseudo-overconsolidation.

Research by Schmertmann (1974) showed the following equation reasonably approximates the OCR of medium plastic to clayey soils:

$$OCR = \left(\frac{\left(\frac{Su / p'oc}{Su / p'nc} \right)^{5/3} + 0.82}{1.82} \right)$$

Su/p'oc = The undrained shear strength to effective stress ratio of the over consolidated soil

Su/p'nc = The undrained shear strength to effective stress ratio of a normally consolidated soil (OCR = 1). Typically = ~0.2

Soils which are subject to loads less than the maximum past pressure of the soil are typically subject to relatively small elastic settlements. Loads which exceed the maximum past pressure on the soil typically cause consolidation which is the gradual settlement of the ground as a result of expulsion of water from the pores of the soil. The rate of settlement and the time to complete consolidation is a function of the permeability of the soil.

The Schmertman equation has been employed to estimate the OCR of the soils with depth employing the CPT data provided in Appendix B and C.

APPENDIX C - INTERPRETED PARAMETERS

The following charts plot the Standard Penetration Test (SPT) values and the undrained strength of fine grained soils based upon generally accepted correlations. The methods of correlation are presented below.

STANDARD PENETRATION TEST CORRELATION

The Standard Penetration Test $N_{1(60)}$ value is related to the cone tip resistance through a Qc/N ratio that depends upon the mean grain size of the soil particles. The soil type is determined from the interpretation described in Appendix B and the data of Table C.1 below is used to calculate the value of $N_{(60)}$.

Table C.1. Tablulated $Qc/N_{1(60)}$ Ratios for Interpreted Soil Types

Soil Type	Qc/N Ratio
Organic soil - Peat	1.0
Sensitive Fine Grained	2.0
Clay	1.0
Silty Clay to Clay	1.5
Clayey Silt to Silty Clay	2.0
Silt	2.5
Silty Sand to Sandy Silt	3.0
Clean Sand to Silty Sand	4.0
Clean Sand	5.0
Gravelly Sand to Sand	6.0
Very Stiff Fine Grained	1.0
Sand to Clayey Sand	2.0

The $Qc/N_{1(60)}$ ratio is based upon the published work of Robertson (1985)[2]. The values of N are corrected for overburden pressure in accordance with the correction suggested by Liao and Whitman using a factor of 0.5. Where the correction is of the form:

$$N_1 = \sigma^{0.5} * N$$

All calculations are carried out by computer using the software program CPTint.exe developed by UBC Civil Engineering Department. The results of the interpretation are presented on the following Figures.

UNDRAINED SHEAR STRENGTH CORRELATION

It is generally accepted that there is a correlation between undrained shear strength of clay and the tip resistance as determined from the cone penetration testing. Generally the correlation is of the form:

$$S_u = \frac{(q_c - \sigma_v)}{N_k}$$

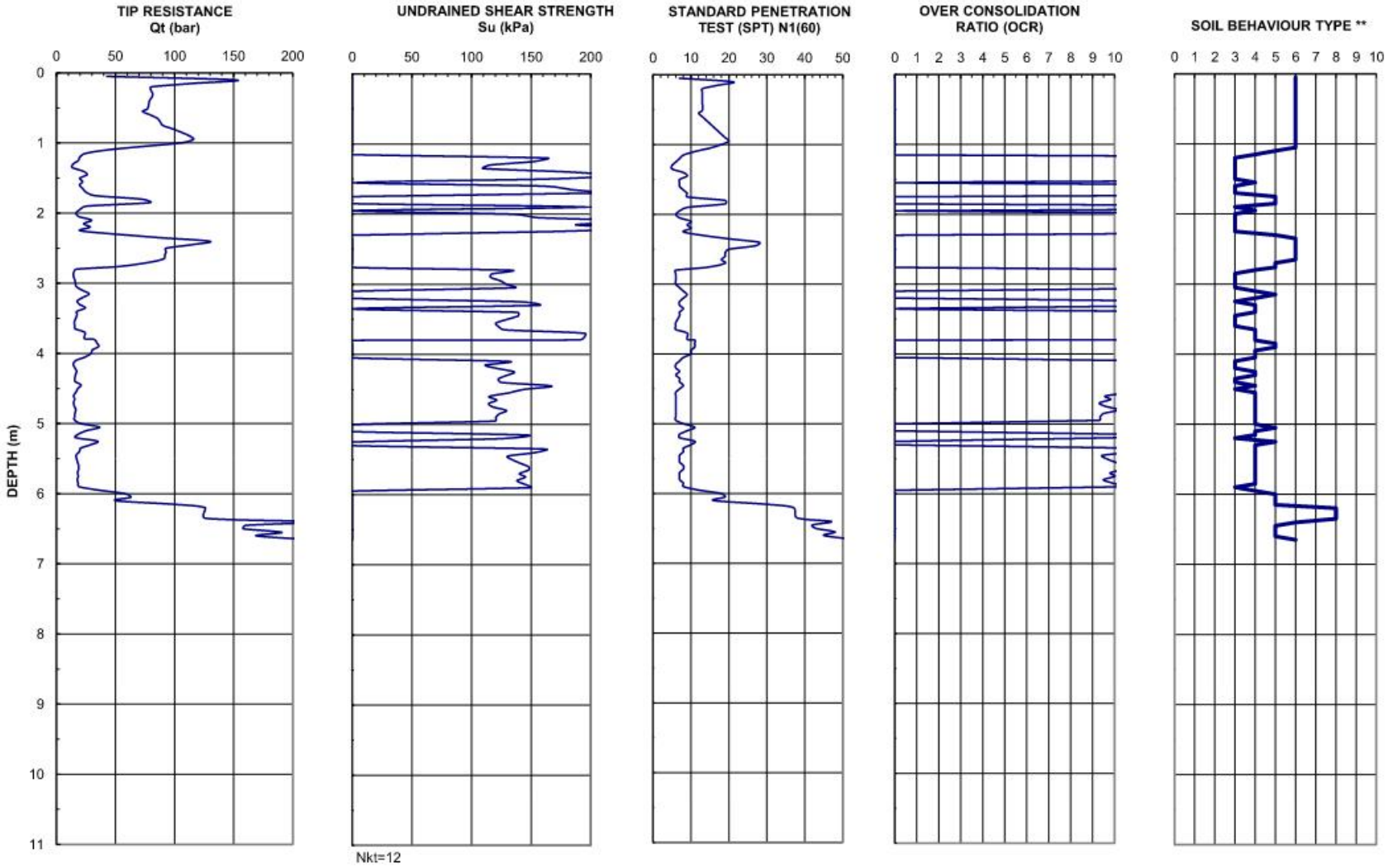
where q_c = cone tip resistance, σ = in situ total stress, N_k = cone constant

The undrained shear strength of the clay has been calculated using the cone tip resistance and an N_k factor of 12.5. All calculations have been carried out automatically using the program CPTint.exe. The results are presented on the Figures following.

---

2 Robertson, P.K., 1985, "In-Situ Testing and Its Application to Foundation Engineering", 1985 Canadian Geotechnical Colloquium, Canadian Geotechnical Journal, Vol. 23, No. 23, 1986

GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-01	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: C.01



** Based on Robertson et. al 1990

1 Sensitive Fine Grained
2 Organic Material
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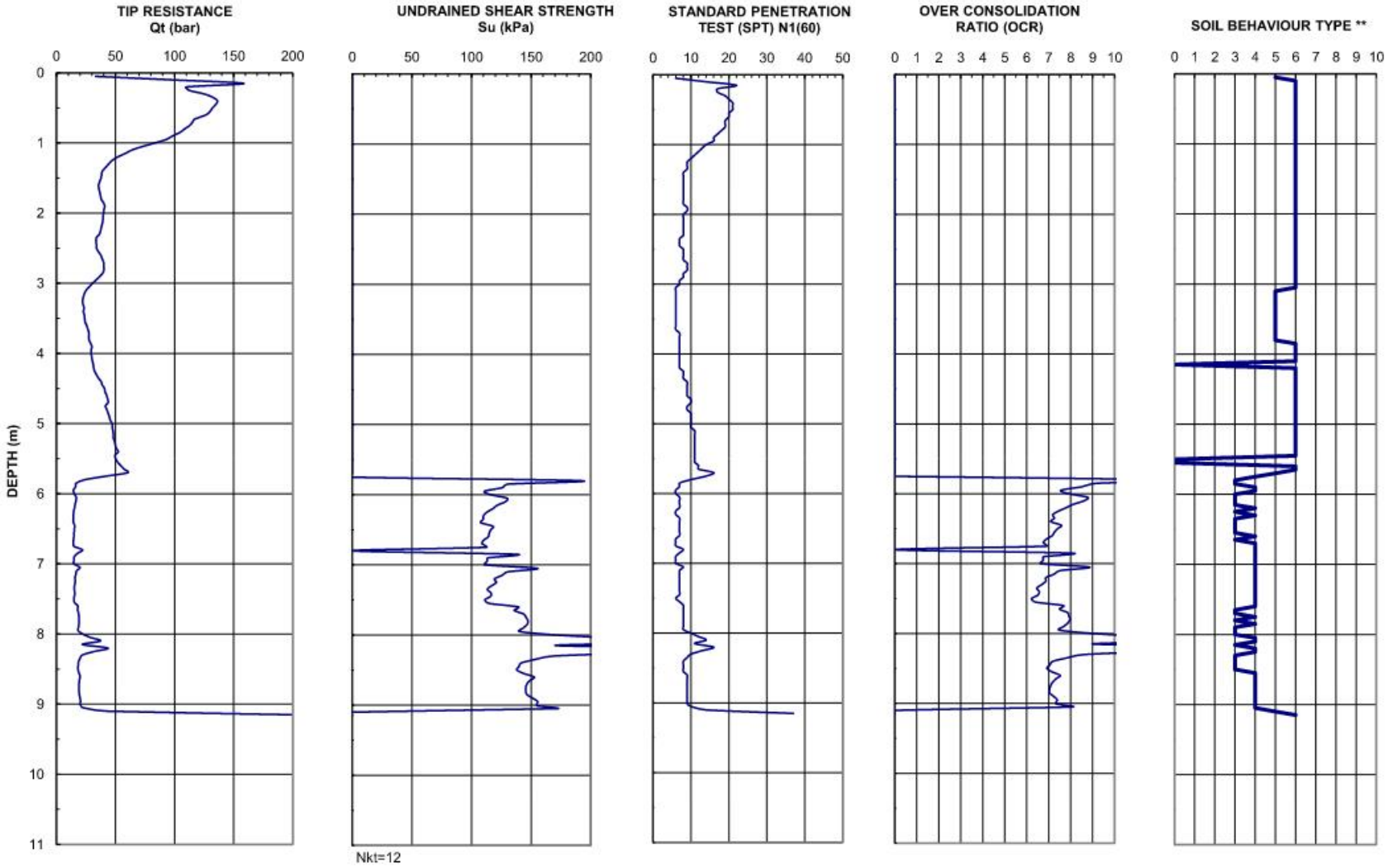
9 Very Stiff Fine Grained

GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-02	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: C.02



** Based on Robertson et. al 1990

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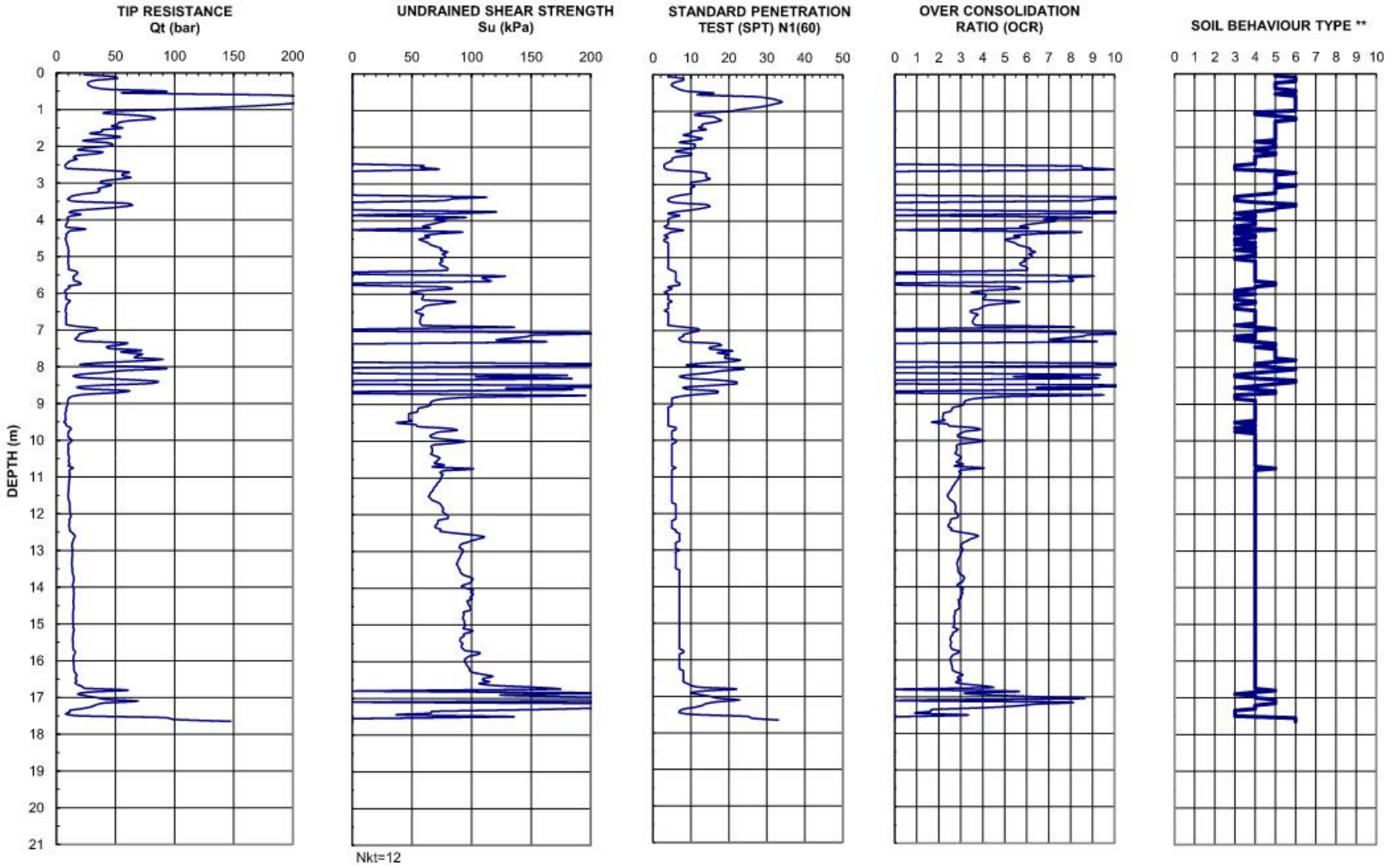
GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-22	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-03	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: C.03



** Based on Robertson et. al 1990

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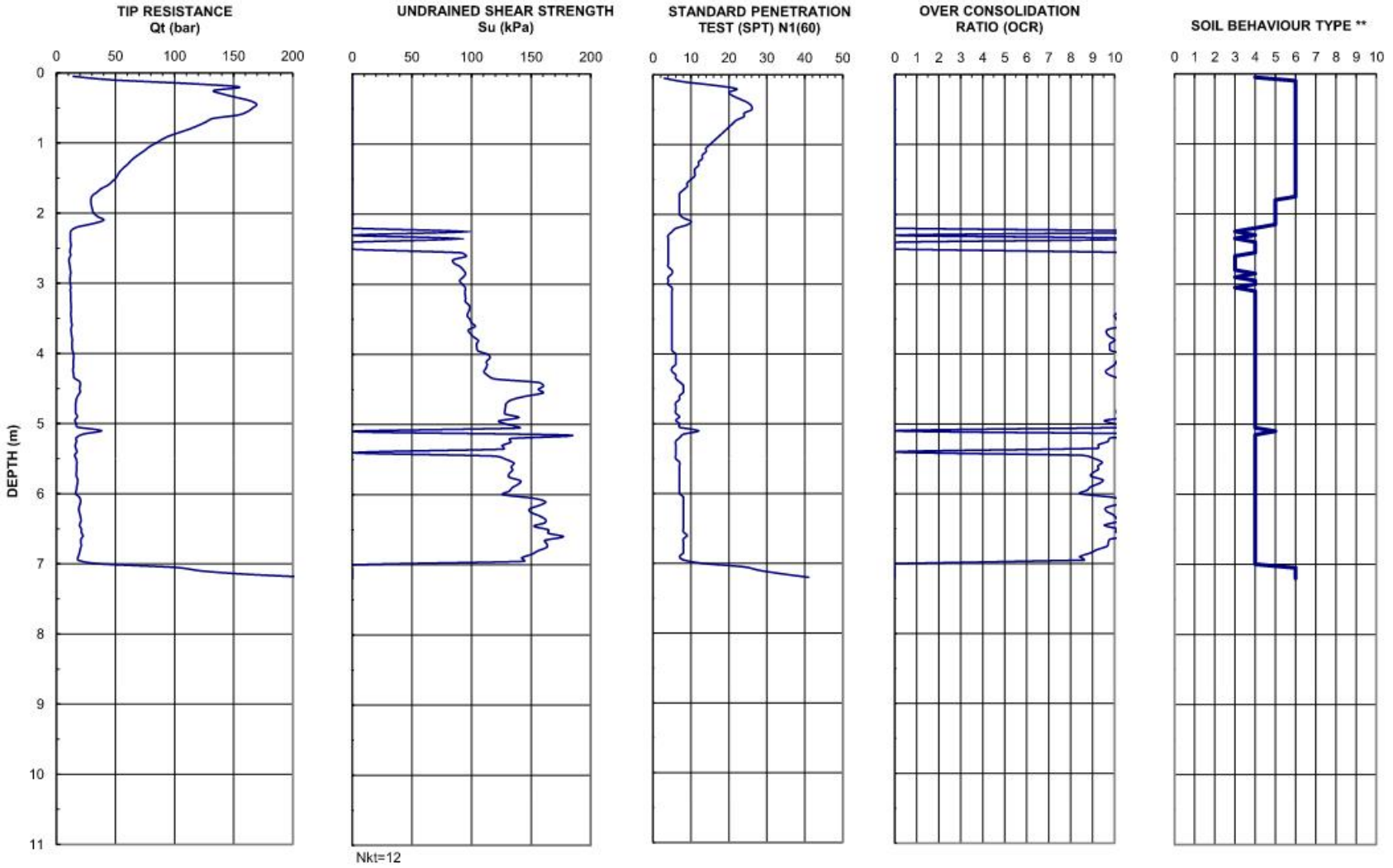
9 Very Stiff Fine Grained

GEOPACIFIC VANCOUVER KAMLOOPS CALGARY	2023-Mar-24	RPSP BEACHFRONT DEVELOPMENT MANAGER LTD	GeoPacific Project #: 21385
	Sounding: CPT22-04	ROYAL BEACH (METCHOSIN ROAD), COLWOOD	Figure: C.04



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7 Gravely Sand to Sand
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9 Very Stiff Fine Grained

APPENDIX E –

APRIL 2023 – THURBER ENGINEERING TEST HOLE LOGS

THURBER ENGINEERING LTD.

Royal Beach Development
October 2022 Royal Beach Bluffs Investigation Site Plan

0 50 100 m

2021 Base imagery obtained from CRD open data
Test Hole locations surveyed by On Point Project Engineers Ltd.
Beach bluff sample locations determined using handheld gps device

FIGURE 1

Date: October 28, 2022

Client: Seacliff Properties Ltd.
File No: 21701
E-File : jbd_QGIS_21701

THURBER

APPENDIX A

2022 TEST HOLE LOGS

Sheet 1 of 4

LOG OF TEST HOLE

TEST HOLE NO.
TH22-12

LOCATION: See Figure 1
N 5361312.4, E 464168.5

TOP OF HOLE ELEV: 38.1 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 19 - 20, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading

DEPTH (m)	10 20 30 40 50 60 70 80 90 100	COMMENTS		SOILS DESCRIPTION	ELEVATION (m)
0	○	Noted water contents possibly influenced by sonic drilling method.	SM	Moist, brown, silty SAND; some gravel, to 50 mm diameter, trace organics.	38
1					37
2	○		GP	Moist, grey-brown, GRAVEL to 60 mm diameter, some sand, trace silt.	36
3				Moist, grey-brown, SAND, some gravel to gravelly to 60 mm diameter, trace to some silt.	35
4	○		SP		34
5	○		GP/SP		33
6					32
7					31
8	○		SP		30
9	○		SP		29
10	○		GP	Moist to wet, brown, sandy GRAVEL to 60 mm diameter, trace silt.	

LOG OF TEST HOLE (NO EST.) 21701_ROYAL BAY_2022 TEST HOLE LOGS.GPJ THURBER_MOM.GDT 22-11-17- THURBER MOM - BC OPERATIONS.GLB

Sheet 2 of 4

LOG OF TEST HOLE

TEST HOLE NO. **TH22-12**

LOCATION: See Figure 1
N 5361312.4, E 464168.5

TOP OF HOLE ELEV: 38.1 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 19 - 20, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DEPTH (m) | DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading | ELEVATION (m)

10 20 30 40 50 60 70 80 90 100

COMMENTS

SOILS DESCRIPTION

Depth (m)	Elevation (m)	Comments	Soils Description
10	28	SM	Moist, grey-brown, SAND, some gravel to sand and gravel to 75 mm diameter, trace to some silt.
11	27		
12	26		
12.5	25.6	SP-SM	
13	25		
14	24		
15	23		
15.7	22.4	GP/SP	
16	22		
17	21		
18	20		
19	19		
19.4	18.7	SP-SM	
20			

LOG OF TEST HOLE (NO EST.) 21701_ROYAL BAY_2022 TEST HOLE LOGS.GPJ THURBER_MOM.GDT 22-11-17- THURBER MOM - BC OPERATIONS.GLB

LOG OF TEST HOLE

TEST HOLE NO. **TH22-12**

LOCATION: See Figure 1
N 5361312.4, E 464168.5

TOP OF HOLE ELEV: 38.1 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 19 - 20, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DEPTH (m) | DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading | ELEVATION (m)

10 20 30 40 50 60 70 80 90 100

DEPTH (m)	COMMENTS	SOILS DESCRIPTION	ELEVATION (m)
20		Moist, grey-brown, SAND, some gravel to sand and gravel to 75 mm diameter, trace to some silt.	18
21			17
22			16
23			15
24	SPT refusal 50+ blows / 16 mm penetration 100% recovery.	SM Moist, grey-brown, very dense, SAND and SILT, trace to some gravel to 60 mm diameter (TILL-LIKE).	14
25			13
26		SM	12
27			11
28			10
29		SM	9
30			

Sheet 4 of 4

LOG OF TEST HOLE

TEST HOLE NO. TH22-12

LOCATION: See Figure 1
N 5361312.4, E 464168.5

TOP OF HOLE ELEV: 38.1 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 19 - 20, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading

DEPTH (m)	10 20 30 40 50 60 70 80 90 100	COMMENTS	SOILS DESCRIPTION	ELEVATION (m)
30	○		SM Moist, grey-brown, very dense, SAND and SILT, trace to some gravel to 60 mm diameter (TILL-LIKE).	8
31				7
32				6
33	○		SM	5
	○		SM	
34				4
35				3
	○		GM/SM	
36				2
37		SPT refusal 60+ blows / 25 mm penetration 0% recovery. Gravel = 6.6% Sand = 57.9% Fines = 35.5%	SM	1
	○			
38			End of Hole at 37.8 m depth. Sonic refusal encountered. Backfill with cuttings, pea gravel, and bentonite.	0
39				-1
40				

Sheet 1 of 4

LOG OF TEST HOLE

TEST HOLE NO. **TH22-13**

LOCATION: See Figure 1
N 5361134.8, E 464069.8

TOP OF HOLE ELEV: 35.5 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 20 - 21, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading

DEPTH (m)	10 20 30 40 50 60 70 80 90 100	COMMENTS	SOILS DESCRIPTION	ELEVATION (m)
0		Noted water contents possibly influenced by sonic drilling method.	Moist, brown, gravelly SAND, trace sand, trace organics, gravel to 40 mm diameter.	35
1				
1.6	○		SP	34
2				
3				33
4				32
4.3			Dry, grey, sandy GRAVEL to 35 mm diameter, trace silt.	31
5	○		Moist, brown, SAND, some gravel to gravelly to 50 mm diameter, trace silt. SP-SM	30
6				
7				29
8				28
8.4	○		SP	27
9				
10				26

LOG OF TEST HOLE (NO EST.) 21701_ROYAL BAY_2022 TEST HOLE LOGS.GPJ THURBER_MOM.GDT 22-11-17- THURBER MOM - BC OPERATIONS.GLB

LOG OF TEST HOLE

TEST HOLE NO. **TH22-13**

LOCATION: See Figure 1
N 5361134.8, E 464069.8

TOP OF HOLE ELEV: 35.5 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 20 - 21, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DEPTH (m) | DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading | ELEVATION (m)

10 20 30 40 50 60 70 80 90 100

DEPTH (m)	COMMENTS		SOILS DESCRIPTION	ELEVATION (m)
10			Moist, brown, SAND, some gravel to gravelly to 50 mm diameter, trace silt.	25
11		GP/SP		24
12				23
			- very stiff 0.1-m-thick sandy SILT layer at 12.5 m depth	
13				22
14			Moist, brown, very stiff to hard, silty CLAY, trace to some sand.	21
15		CL		20
		CL		
16				19
		SM	Moist, grey-brown, very dense, SAND and SILT, trace to some gravel to 75 mm diameter (TILL-LIKE).	
17				18
		GM/SM		
18				17
19				16
20				

LOG OF TEST HOLE

TEST HOLE NO. **TH22-13**

LOCATION: See Figure 1
N 5361134.8, E 464069.8

TOP OF HOLE ELEV: 35.5 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 20 - 21, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DEPTH (m) | DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading | ELEVATION (m)

10 20 30 40 50 60 70 80 90 100

DEPTH (m)	COMMENTS	SOILS DESCRIPTION	ELEVATION (m)
20		Moist, grey-brown, very dense, SAND and SILT, trace to some gravel to 75 mm diameter (TILL-LIKE).	15
21			14
22			13
23			12
24			11
25		Moist, grey-brown, gravelly SAND to SAND and GRAVEL to 60 mm diameter, some silt.	10
26			9
27			8
28			7
29			6
30			

SM
SP
GM/SM
SM
SP
GM/SM
SM

Sheet 4 of 4

LOG OF TEST HOLE

TEST HOLE NO. **TH22-13**

LOCATION: See Figure 1
N 5361134.8, E 464069.8

TOP OF HOLE ELEV: 35.5 m

METHOD: Sonic

DRILLING CO.: Drillwell Enterprises Ltd.

INSPECTOR: BTS

THURBER

CLIENT: Seacliff Properties Ltd.

PROJECT: Royal Beach Development
Area 2 - West Side

DATE: October 20 - 21, 2022

FILE NO.: 21701

REVIEWED BY: JDM

DCPT PENETRATION (blows/300 mm) | SPT PENETRATION (blows/300 mm) | WATER CONTENT (%): ○ Disturbed ● Undisturbed | WATER LEVEL: Plastic Limit — Liquid Limit | SAMPLES: Disturbed, Undisturbed, No Recovery | GRAIN SIZE (%): ▲ Passing #200 sieve, △ Passing #4 sieve | SOIL HEADSPACE READING (ppm): GASTECH reading, PID reading

DEPTH (m)	10 20 30 40 50 60 70 80 90 100	COMMENTS		SOILS DESCRIPTION	ELEVATION (m)
30	○		SP	Moist, grey-brown, gravelly SAND to SAND and GRAVEL to 60 mm diameter, some silt.	5
31	○		SM	Moist brown, SAND, trace gravel to 75 mm diameter, trace silt, cemented.	4
32				Moist, grey, very stiff, silty CLAY to clayey SILT, trace sand, trace gravel to 20 mm diameter.	3
33	⊢○⊣		CL		2
34				Moist, grey, very dense, SAND and SILT, trace to some gravel to 50 mm diameter (TILL-LIKE).	1
35	○		SM		0
36					-1
37	○	Gravel = 8.8% Sand = 51.0% Fines = 40.2%	SM		-2
38					-3
39	○	Gravel = 9.6% Sand = 50.0% Fines = 40.4%	SM		-4
40				End of Hole at 39.6 m depth at planned depth. Backfill with cuttings, pea gravel, and bentonite.	

THURBER

LABORATORY TEST RESULTS

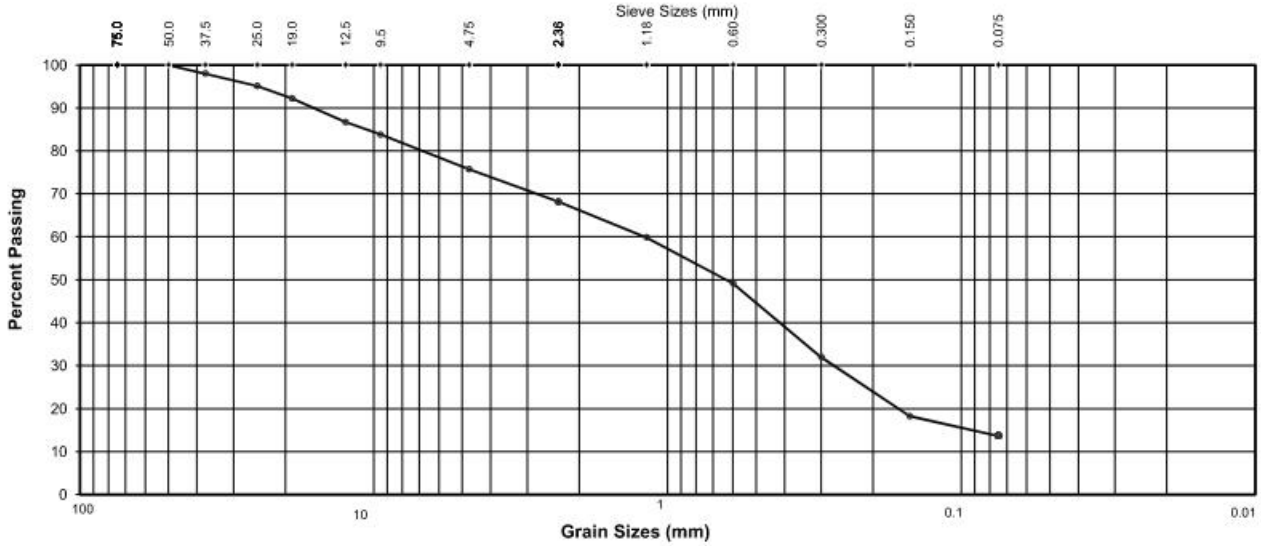
GRADATION ANALYSIS

THURBER ENGINEERING LTD.
Suite 2302, 4476 Markham Road, Victoria, BC V8Z 7X8 Phone (250) 727-2201

Client: Seacliff Properties | Project Number: 21701

Project: Royal Beach Development | Date: 27-Oct-22

Sample Source:	Beach Wall Sample 1	**Date Tested:**	26-Oct-22
Material Type:	Grab sample	**Sampled by:**	BTS / JD
Specification:		**Date Sampled:**	24-Oct-22
Sample Description:	brown, moist, gravelly SAND with some fines	**Test Method:**	ASTM
Water Content As Received:	2.3%	**Series No.:**	22-1



GRAVEL (FROM SIEVE)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	75			
	50	100.0		
	37.5	98.0		
	25	95.1		
	19	92.2		
	12.5	86.7		
	9.5	83.8		
	4.75	75.7		

SAND & FINES (FROM SIEVE & WASH)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	2.36	68.1		
	1.18	59.8		
	0.6	49.2		
	0.3	32.0		
	0.15	18.2		
	0.075	13.7		

SILT AND CLAY (FROM HYDROMETER)			
Silt			
Clay	-		
Total Fines:	13.7%		

Gravel:	24.3%	Percent Crush:	N/A
Sand:	62.0%	Faces Counted:	0
Fines:	13.7%		

Comments:

Checked By: JSH

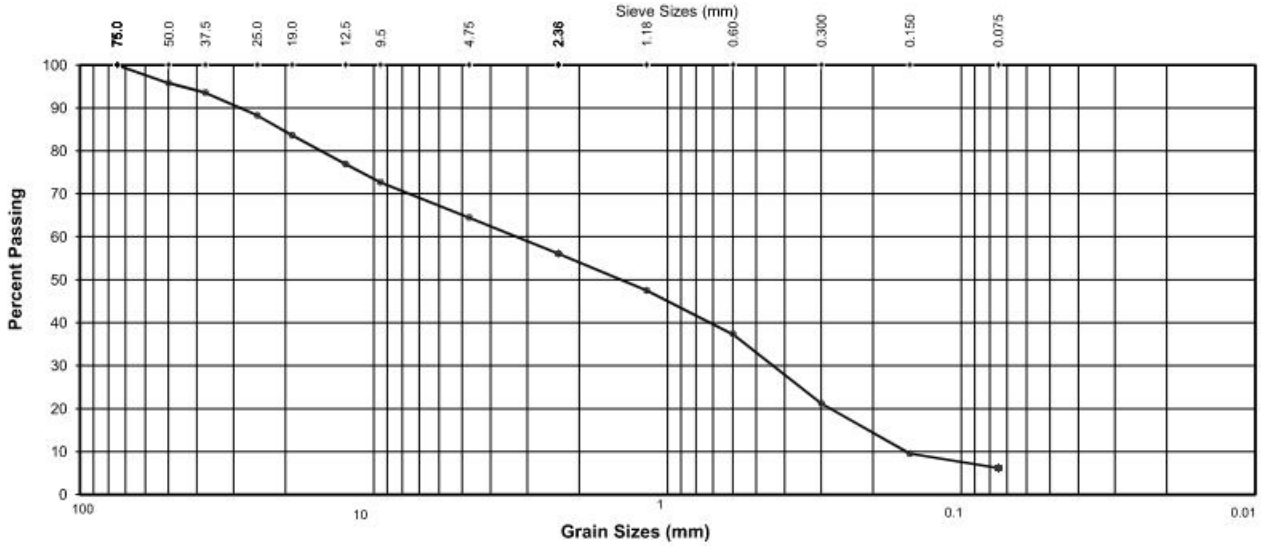
GRADATION ANALYSIS

THURBER ENGINEERING LTD.
Suite 2302, 4476 Markham Road, Victoria, BC V8Z 7X8 Phone (250) 727-2201

Client: Seacliff Properties | Project Number: 21701

Project: Royal Beach Development | Date: 27-Oct-22

Sample Source:	Beach Wall Sample 2	**Date Tested:**	26-Oct-22
Material Type:	Grab sample	**Sampled by:**	BTS / JD
Specification:		**Date Sampled:**	24-Oct-22
Sample Description:	brown, moist, SAND and GRAVEL with a trace of fines	**Test Method:**	ASTM
Water Content As Received:	1.9%	**Series No.:**	22-2



GRAVEL (FROM SIEVE)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	75	100.0		
	50	95.8		
	37.5	93.6		
	25	88.2		
	19	83.6		
	12.5	76.9		
	9.5	72.7		
	4.75	64.5		

SAND & FINES (FROM SIEVE & WASH)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	2.36	56.1		
	1.18	47.5		
	0.6	37.3		
	0.3	21.2		
	0.15	9.5		
	0.075	6.2		

SILT AND CLAY (FROM HYDROMETER)			
Silt			
Clay	-		
Total Fines:	6.2%		

Gravel:	35.5%	Percent Crush:	N/A
Sand:	58.3%	Faces Counted:	0
Fines:	6.2%		

Comments:

Checked By: JSH

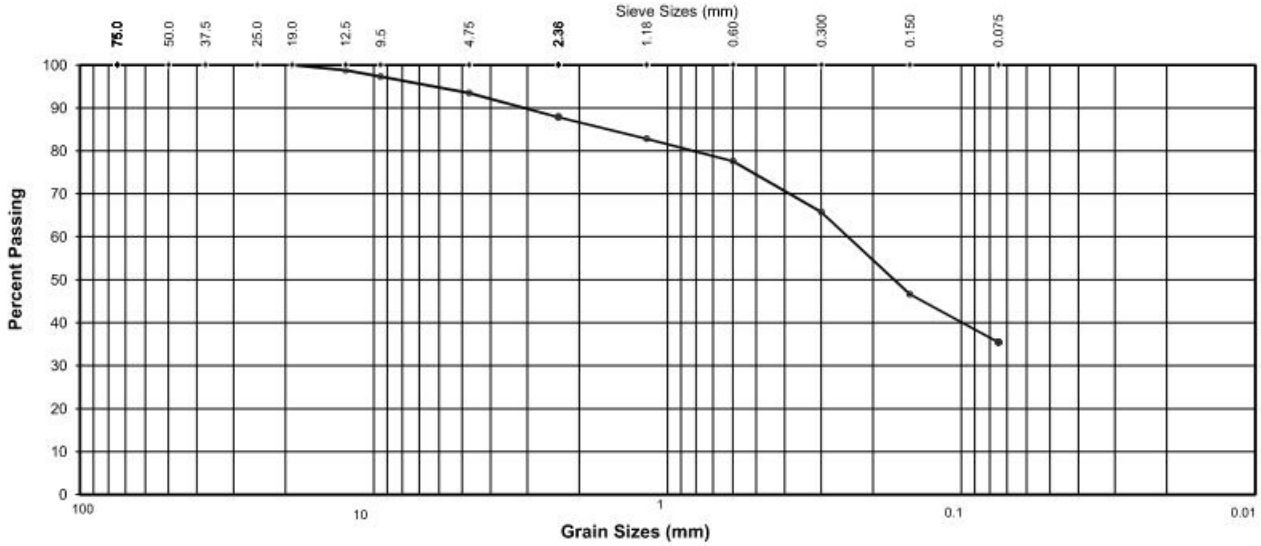
GRADATION ANALYSIS

THURBER ENGINEERING LTD.
Suite 2302, 4476 Markham Road, Victoria, BC V8Z 7X8 Phone (250) 727-2201

Client: Seacliff Properties | Project Number: 21701

Project: Royal Beach Development | Date: 2-Nov-22

Sample Source:	TH22-12, Sa. 19, 120 ft - 124 ft	**Date Tested:**	31-Oct-22
Material Type:	Grab sample	**Sampled by:**	BTS
Specification:		**Date Sampled:**	20-Oct-22
Sample Description:	grey, moist, SAND and SILT with a trace of gravel	**Test Method:**	ASTM
Water Content As Received:	8.6%	**Series No.:**	22-1



GRAVEL (FROM SIEVE)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	75			
	50			
	37.5			
	25			
	19	100.0		
	12.5	98.8		
	9.5	97.3		
	4.75	93.4		

SAND & FINES (FROM SIEVE & WASH)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	2.36	87.8		
	1.18	82.8		
	0.6	77.6		
	0.3	65.8		
	0.15	46.6		
	0.075	35.5		

SILT AND CLAY (FROM HYDROMETER)			
Silt			
Clay	-		
Total Fines:	35.5%		

Gravel:	6.6%	Percent Crush:	N/A
Sand:	57.9%	Faces Counted:	0
Fines:	35.5%		

Comments:

Checked By: JSH

GRADATION ANALYSIS

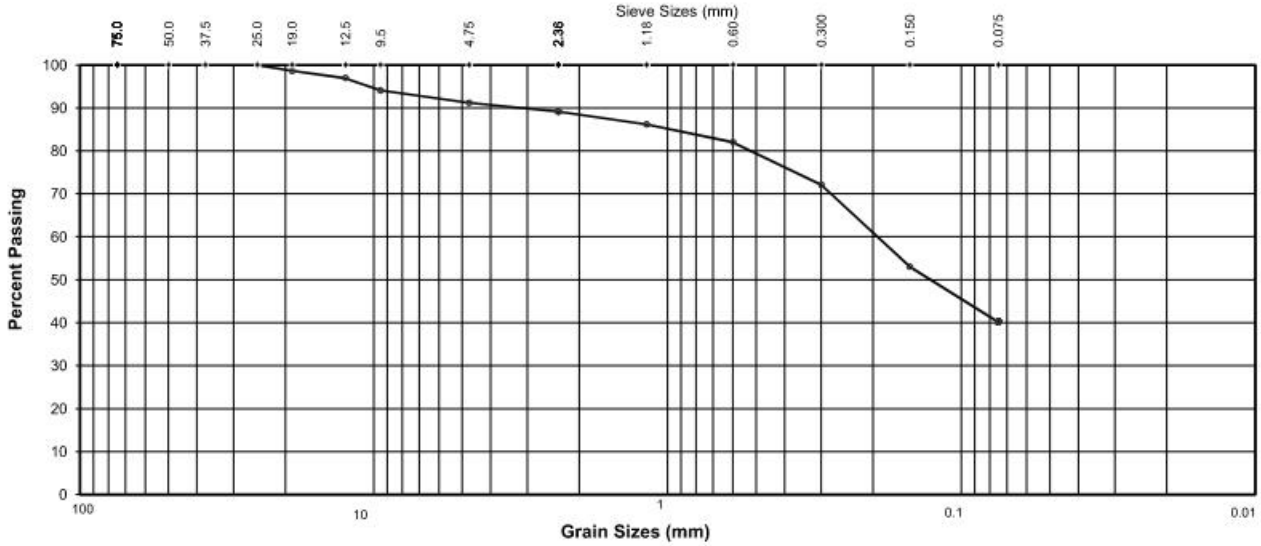
THURBER ENGINEERING LTD.
Suite 2302, 4476 Markham Road, Victoria, BC V8Z 7X8 Phone (250) 727-2201

Client: Seacliff Properties | Project Number: 21701

Project: Royal Beach Development | Date: 2-Nov-22

Sample Source: TH22-13, Sa. 20, 120 ft - 125 ft
Material Type: Grab sample
Specification:
Sample Description: grey, moist, SAND and SILT with a trace of gravel
Water Content As Received: 11.4%

Date Tested: 31-Oct-22
Sampled by: BTS
Date Sampled: 21-Oct-22
Test Method: ASTM
Series No.: 22-2



GRAVEL (FROM SIEVE)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	75			
	50			
	37.5			
	25	100.0		
	19	98.6		
	12.5	96.9		
	9.5	94.1		
	4.75	91.2		

SAND & FINES (FROM SIEVE & WASH)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	2.36	89.2		
	1.18	86.2		
	0.6	82.0		
	0.3	72.1		
	0.15	53.0		
	0.075	40.2		

SILT AND CLAY (FROM HYDROMETER)			
Silt			
Clay	-		
Total Fines:	40.2%		

Gravel: 8.8%
Sand: 51.0%
Fines: 40.2%

Percent Crush: N/A
Faces Counted: 0

Comments:

Checked By: JSH

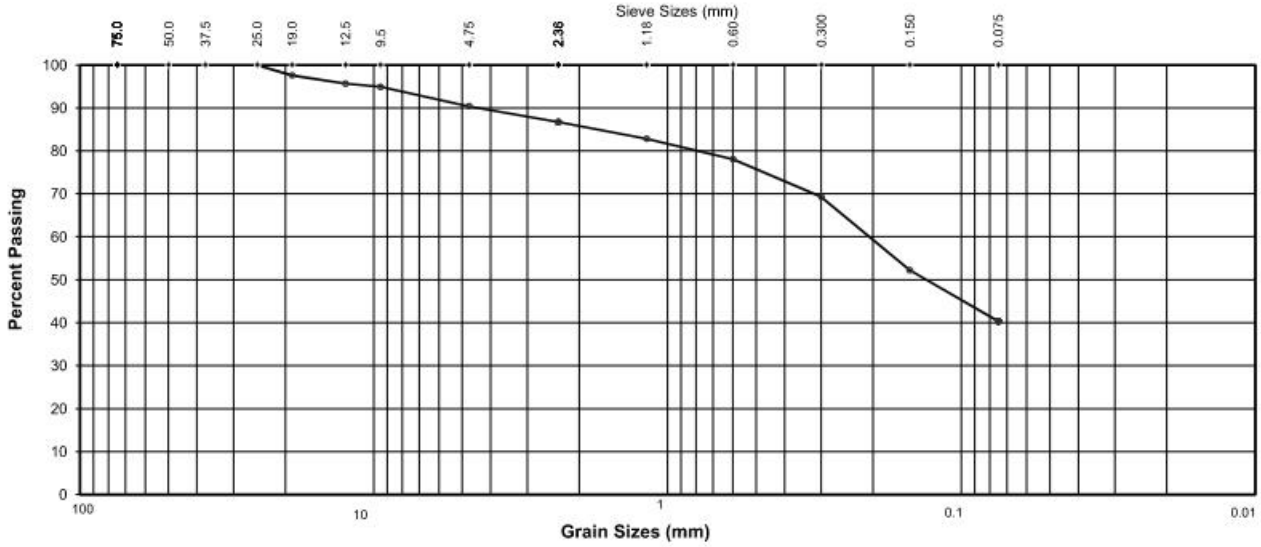
GRADATION ANALYSIS

THURBER ENGINEERING LTD.
Suite 2302, 4476 Markham Road, Victoria, BC V8Z 7X8 Phone (250) 727-2201

Client: Seacliff Properties | Project Number: 21701

Project: Royal Beach Development | Date: 2-Nov-22

Sample Source:	TH22-13, Sa. 21, 125 ft - 130 ft	**Date Tested:**	31-Oct-22
Material Type:	Grab sample	**Sampled by:**	BTS
Specification:		**Date Sampled:**	21-Oct-22
Sample Description:	grey, moist, SAND and SILT with a trace of gravel	**Test Method:**	ASTM
Water Content As Received:	7.8%	**Series No.:**	22-3



GRAVEL (FROM SIEVE)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	75			
	50			
	37.5			
	25	100.0		
	19	97.6		
	12.5	95.6		
	9.5	94.9		
	4.75	90.4		

SAND & FINES (FROM SIEVE & WASH)				
Sieve No.	Opening (mm)	Percent Passing	Gradation Limits Max	min
	2.36	86.7		
	1.18	82.8		
	0.6	78.0		
	0.3	69.2		
	0.15	52.2		
	0.075	40.4		

SILT AND CLAY (FROM HYDROMETER)			
Silt			
Clay	-		
Total Fines:	40.4%		

Gravel:	9.6%	Percent Crush:	N/A
Sand:	50.0%	Faces Counted:	0
Fines:	40.4%		

Comments:

Checked By: JSH

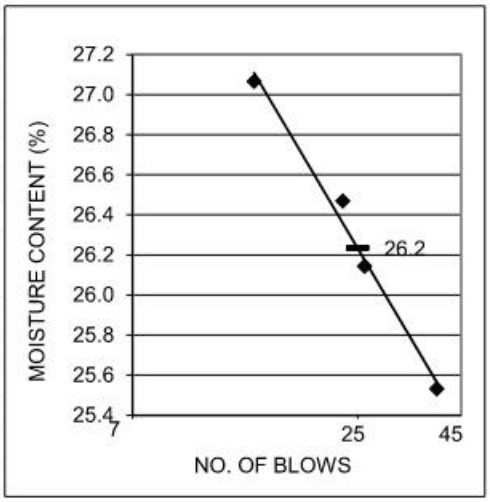
THURBER ENGINEERING LTD.

Liquid Limit, Plastic Limit & Plasticity Index of Soils
ASTM D4318

Client:	Seacliff Properties		
Project:	Royal Beach - Deep Sonic Holes		
Project No:	21701	**Date Tested:**	2-Nov-22
Test Hole:	TH22-13 Depth: 49 ft - 50 ft	**Tested By:**	JCE/JSH
Sample No:	5	**Checked By:**	JSH

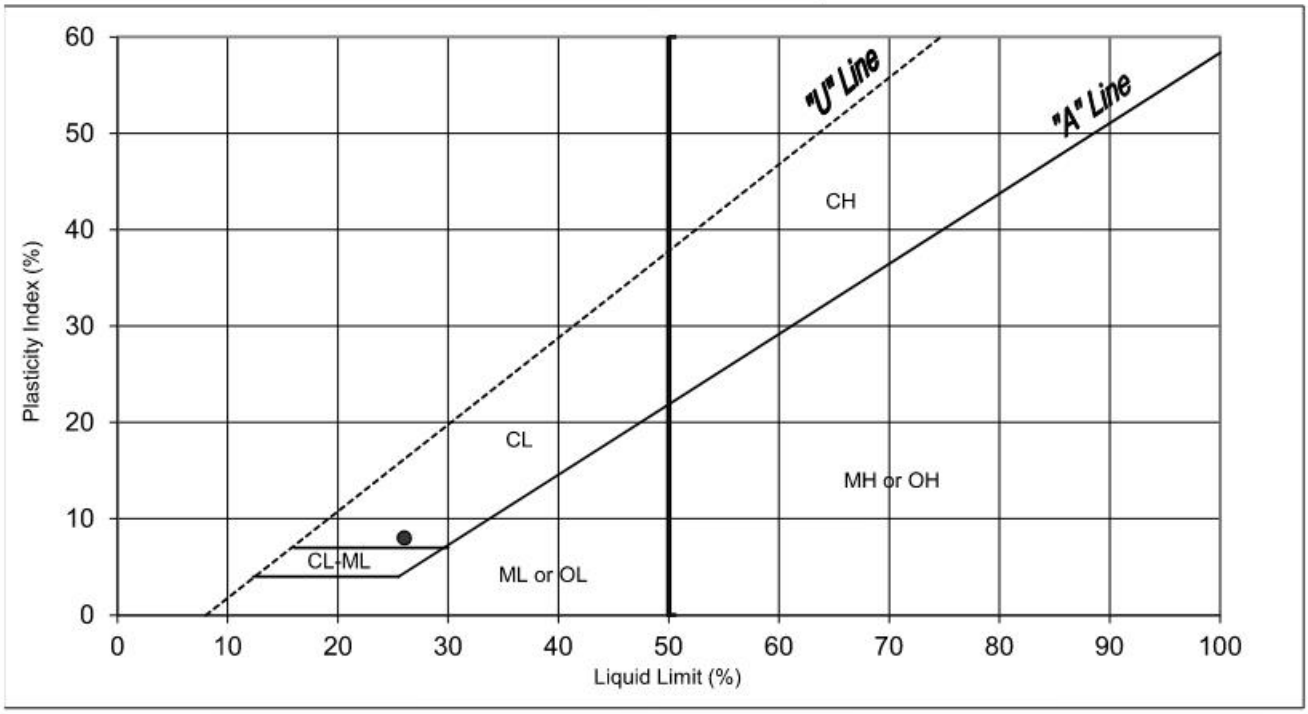
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	39	26	23	14
Container No.	232	220	222	219
Wet Soil + Container	43.25	36.77	43.79	38.95
Dry Soil + Container	37.24	31.97	37.71	33.71
Wt. Of Container	13.7	13.61	14.74	14.35
Moisture Content	25.5	26.1	26.5	27.1



PLASTIC LIMIT

	1	2		**AVERAGE**
Container No.	245	223		
Wet Soil + Container	25.14	25.14		
Dry Soil + Container	23.38	23.31		
Wt. Of Container	13.55	13.2		
Moisture Content	17.9	18.1		**18.0**



REMARKS As received MC % = 21.6

Liquid Limit:	**26**
Plastic Limit:	**18**
Plasticity Index:	**8**
Liquidity Index:	**0**
USC Classification:	**CL**

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thurber.ca

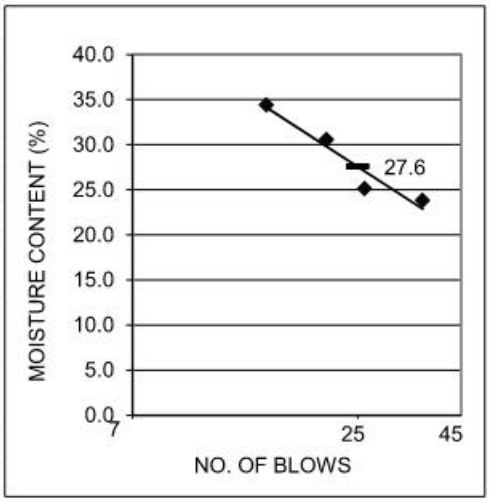
THURBER ENGINEERING LTD.

Liquid Limit, Plastic Limit & Plasticity Index of Soils
ASTM D4318

Client:	Seacliff Properties		
Project:	Royal Beach - Deep Sonic Holes		
Project No:	21701	**Date Tested:**	2-Nov-22
Test Hole:	TH22-13 Depth: 108 ft - 109 ft	**Tested By:**	JCE/JSH
Sample No:	18	**Checked By:**	JSH

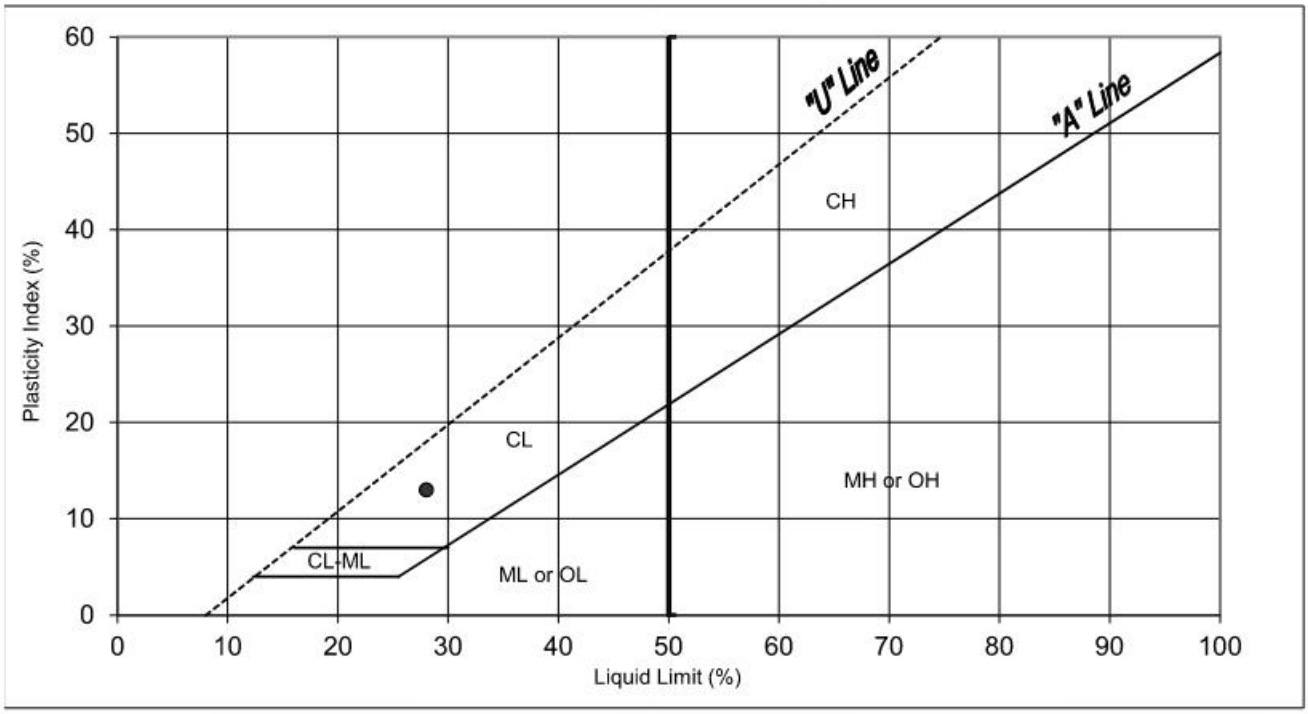
LIQUID LIMIT

Trial No:	1	2	3	4
No of Blows:	36	26	21	15
Container No.	218	258	247	233
Wet Soil + Container	35.05	37.07	41.44	44.35
Dry Soil + Container	31	32.35	34.95	36.51
Wt. Of Container	14	13.57	13.73	13.73
Moisture Content	23.8	25.1	30.6	34.4



PLASTIC LIMIT

	1	2		AVERAGE
Container No.	208	259		
Wet Soil + Container	22.67	21.99		
Dry Soil + Container	21.5	20.91		
Wt. Of Container	13.92	13.52		
Moisture Content	15.4	14.6		**15.0**



REMARKS As received MC % = 19.2

Liquid Limit:	**28**
Plastic Limit:	**15**
Plasticity Index:	**13**
Liquidity Index:	**0**
USC Classification:	**CL**

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THURBER

SELECTED PHOTOGRAPHS

Photo 1. Drillwell advancing sonic drill at TH22-12.

Photo 2. Example of till-like material encountered at TH22-12, depth 36.6 m to 37.8 m bgs.

Photo 3. Drillwell advancing sonic drill at TH22-13.

Photo 4. Example of Colwood sands and gravels encountered at TH22-13, depth 3.0 m to 4.6 m bgs.

Photo 5. Exposure of cemented, till-like material found along Royal Beach (Wall Sample 1).

Photo 6. Chunk of intact till-like soil from 16.3 m depth at TH22-13 following soaking.

APPENDIX F –

CD30 AREA BOUNDARY MAP

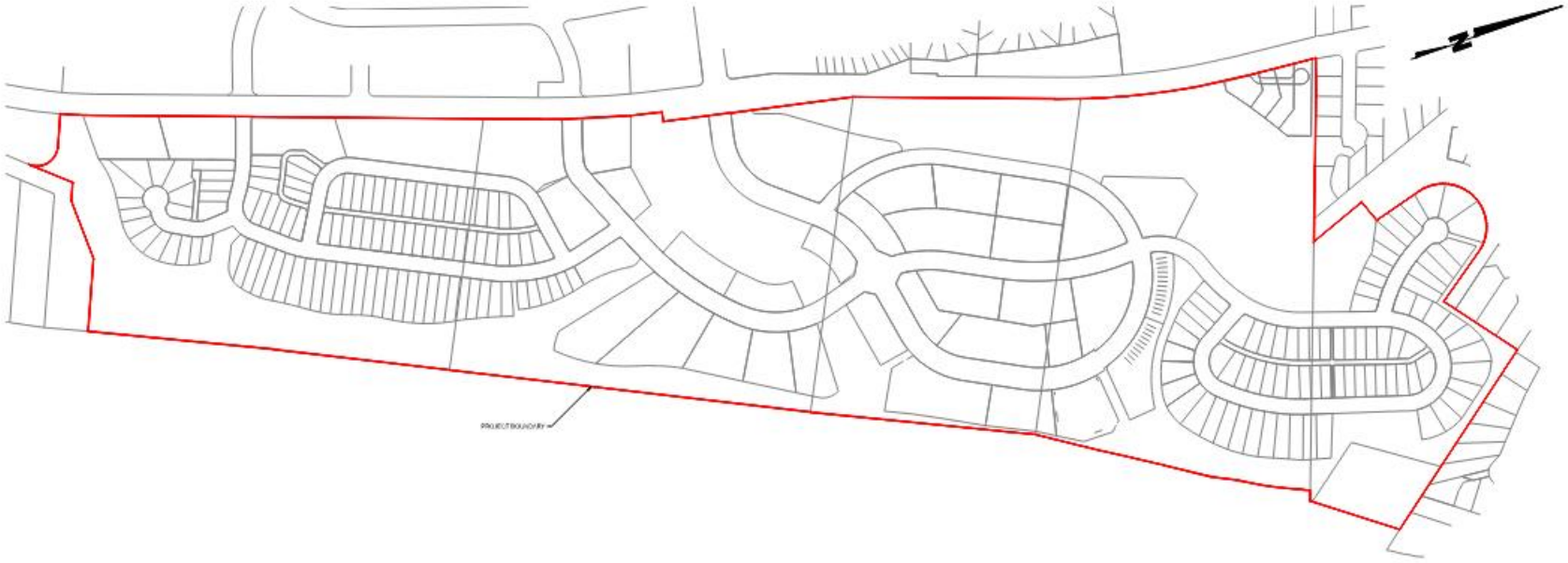
CD30 Area Boundaries

APPENDIX G –

REGRADING PLAN – ONPOINT ENGINEERING 2023

ROYAL BEACH
SEACLIFF
COLWOOD, BC
REGRADING PLAN
APRIL 05, 2023

LOCATION PLAN
N.T.S
COLWOOD, BC



Sheet List Table		
SHEET No.	DESCRIPTION	DRAWING #
1	COVER	C001
2	EXISTING CONDITIONS	C002
3	PROPOSED CONDITIONS	C003
4	OVERLAND FLOW SYSTEM PLAN	C004
5	SECTIONS	C005
6	SECTIONS	C006
7	SECTIONS	C007

1:500

2023-04-05
ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

ISSUED				REVISED			
No.	DESCRIPTION	DATE	BY	No.	DESCRIPTION	DATE	BY
1	RELEASED FOR PERMITS	2023-03-31	AA				
2	ISSUED FOR APPROVAL	2023-04-05	AA				

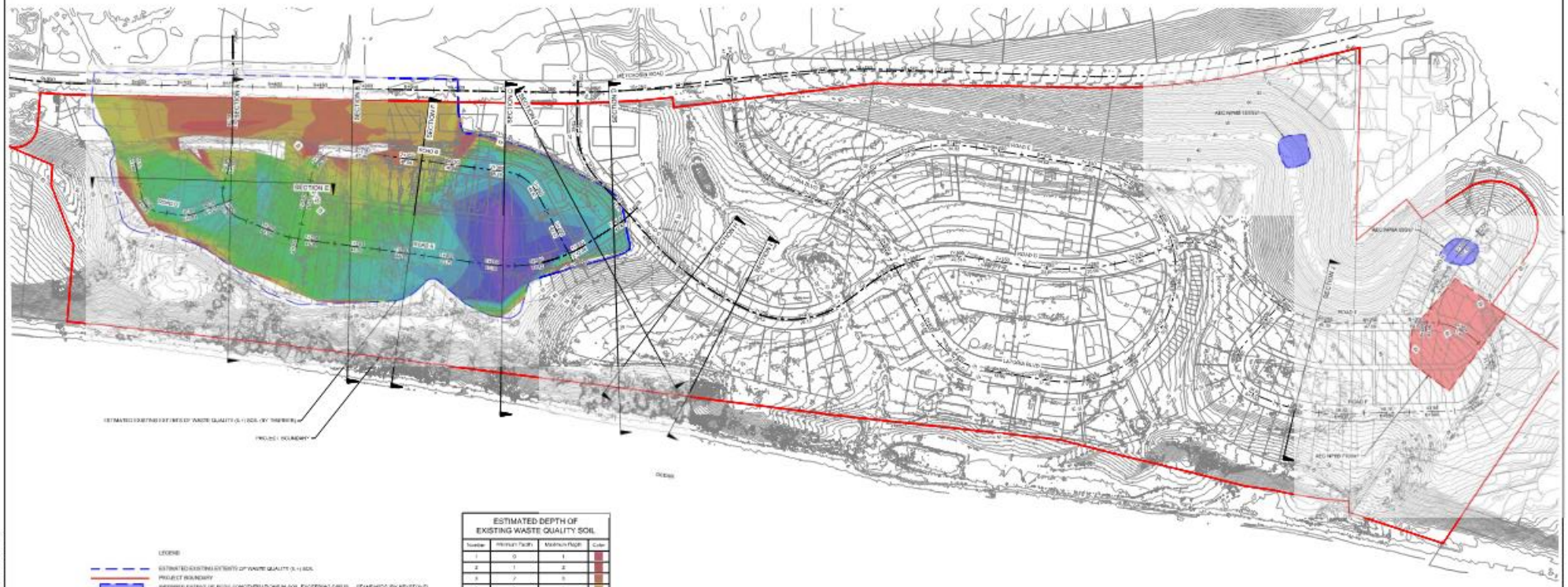
DESIGNER AA
REVIEWED
ENGINEER AE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
ROYAL BEACH IT'S YOUR TIME

ROYAL BEACH
SEACLIFF

COVER

ONPOINT PROJECT No. 174-01
ENGINEERING AUTHORITY FILE No.
SHEET 1 of 7
DRAWING No. 174-01-C001



LEGEND

- ESTIMATED EXISTING EXTENTS OF WASTE QUALITY (L+) SOIL
- PROJECT BOUNDARY
- INFERRED EXTENT OF PCBS CONCENTRATIONS IN SOIL EXCEEDING CSR RL _ STANDARDS (BY KEYSTONE)
- INFERRED EXTENT OF PCBS CONCENTRATIONS IN SOIL EXCEEDING CSR RL STANDARDS (BY KEYSTONE)

NOTE:
1. EXISTING GROUND SURFACE FROM 2022 UAV SURVEY.
2. ESTIMATED EXISTING EXTENTS OF WASTE QUALITY (L+) SOIL BY TRUNDER ENGINEERING (2023).
3. ALL CENTRE LINE ELEVATIONS ARE TO PROPOSED ROAD FINISHED GRADE.
4. WASTE QUALITY (L+) SOIL WILL HAVE MINIMUM 1m CAPPING (m RL).

ESTIMATED DEPTH OF EXISTING WASTE QUALITY SOIL

Number	Minimum Depth	Maximum Depth	Color
1	0	1	
2	1	2	
3	2	3	
4	3	4	
5	4	5	
6	5	6	
7	6	7	
8	7	8	
9	8	9	
10	9	10	
11	10	11	
12	11	12	
13	12	13	
14	13	14	
15	14	15	
16	15	16	

1:800

2023-04-06
ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

No.	ISSUED DESCRIPTION	DATE	INIT.
1	RE-SUBMITTED FOR PERMITS	2023-04-11	AA
2	ISSUED FOR APPROVAL	2023-04-06	AA

No.	REVISED DESCRIPTION	DATE	INIT.

DESIGNER AA
REVIEW
ENGINEER AE

SEA PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
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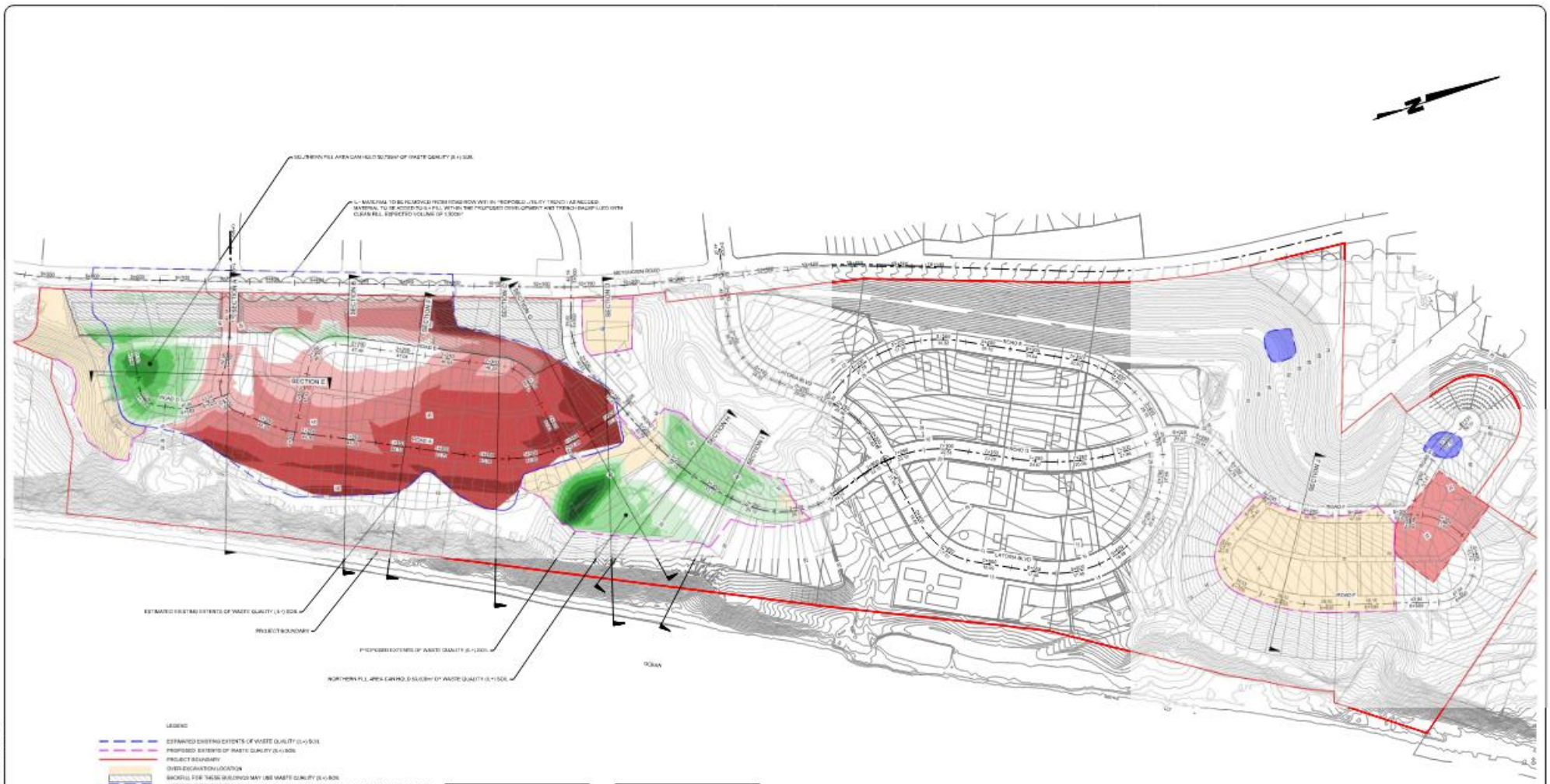
ROYAL BEACH
SEACLIFF

EXISTING CONDITIONS
REGRADING PLANS

ONPOINT PROJECT No. 174-01
REGRADING AUTOCAD FILE No.
SHEET 2 of 7
ISSUED
ONPOINT DRAWING No. 174-01-CS02



NOTE:
1. ALL CENTRE LINE ELEVATIONS ARE FOR PROPOSED ROAD CHISELED GRADE.
2. WASTE QUALITY (0.+) SOIL WILL HAVE MINIMUM 1m COMPLIANT CAPPING MATERIAL

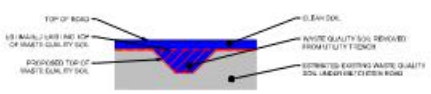
CUT/FILL TYPE	VOLUME
WASTE QUALITY (0.+) SOIL CUT FOR GRADING PLAN	345,745m³
FILL ROOM AVAILABLE FOR WASTE QUALITY (0.+) SOIL IN CURRENT GRADING PLAN (SOUTHERN & NORTHERN FILL AREAS)	184,398m³
OVER-EXCAVATION REQUIRED TO HANDLE REMAINING WASTE QUALITY (0.+) SOIL	161,287m³
FILL ROOM FOR WASTE QUALITY (0.+) SOIL GENERATED THROUGH OVER EXCAVATION (SEE ITEM)	150,739m³

ESTIMATED DEPTH OF WASTE QUALITY SOIL FILL

Number	Minimum Depth	Maximum Depth	Color
1	0	2	
2	2	4	
3	4	6	
4	6	8	
5	8	10	
6	10	12	

ESTIMATED DEPTH OF WASTE QUALITY SOIL CUT

Number	Maximum Depth	Minimum Depth	Color
1	-10	-8	
2	-8	-6	
3	-6	-4	
4	-4	-2	
5	-2	0	



DETAIL A METCHOSIN UTILITY TRENCH
1:200

2023-04-06
ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

No.	ISSUED REVISION	DATE	BY
1	RE-SUBMISSION/MINISTRY OF PERMITS	2023-03-31	AA
2	ISSUED FOR APPROVAL	2023-04-06	AA

No.	REVISED REVISION	DATE	SIGN

DESIGNER AA
REVIEWED
ENGINEER AE

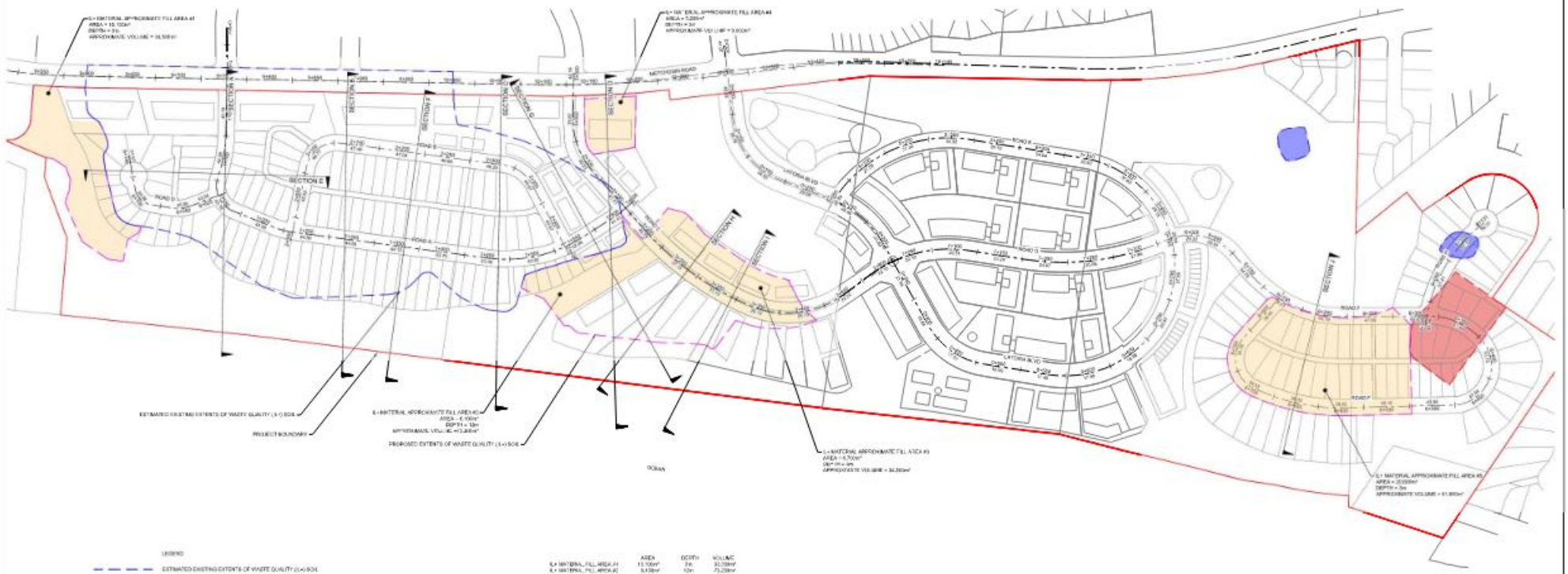
SEAL PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
ROYAL BEACH IT'S YOUR TIME

ROYAL BEACH
SEACLIFF

PROPOSED CONDITIONS
REGRADING PLANS

ONPOINT PROJECT No. 174.01
REGRADING AUTHORITY FILE No.
SCALE: 3 of 7
ONPOINT DRAWING No. 174-01-C503



LEGEND

- ESTIMATED EXISTING EXTENTS OF WASTE QUALITY (LA-1) SOIL
- PROPOSED EXTENTS OF WASTE QUALITY (LA-1) SOIL
- PROJECT BOUNDARY
- OVER EXCAVATION LOCATION
  - INFERRED EXTENT OF PCOC CONCENTRATIONS IN SOIL EXCEEDING CSR N_{LA} STANDARDS (BY KEYSTONE)
  - INFERRED EXTENT OF PCOC CONCENTRATIONS IN SOIL EXCEEDING CSR I_{LA} STANDARDS (BY KEYSTONE)

	AREA	DEPTH	VOLUME
IL+ MATERIAL - FILL AREA #1	13,100m²	7m	91,700m³
IL+ MATERIAL - FILL AREA #2	8,150m²	10m	73,200m³
IL+ MATERIAL - FILL AREA #3	8,150m²	4m	34,500m³
IL+ MATERIAL - FILL AREA #4	1,220m²	3m	9,000m³
IL+ MATERIAL - FILL AREA #5	23,600m²	3m	67,300m³
TOTAL	46,750m²		333,700m³

NOTE:
1. ALL CENTRE LINE ELEVATIONS ARE FOR PROPOSED ROAD CHECKED GRADE.
2. WASTE QUALITY (IL+) SOIL WILL HAVE MINIMUM 1m COMPLIANT CAPPING MATERIAL.

2023-04-06

ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

No.	ISSUED REVISION	DATE	INIT.
1	RE-SUBMISSION/ADDITION OF PERMITS	2023-04-01	AA
2	ISSUED FOR APPROVAL	2023-04-01	AA

No.	REVISED REVISION	DATE	SIGN

DESIGNER AA
REVIEWED
ENGINEER AE

SEAL PERMIT TO PRACTICE

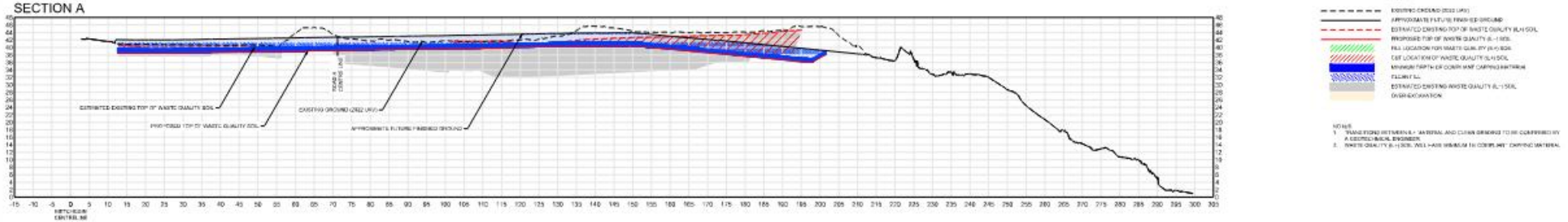
SEACLIFF PROPERTIES
RELIANCE PROPERTIES
ROYAL BEACH IT'S YOUR TIME

ROYAL BEACH
SEACLIFF

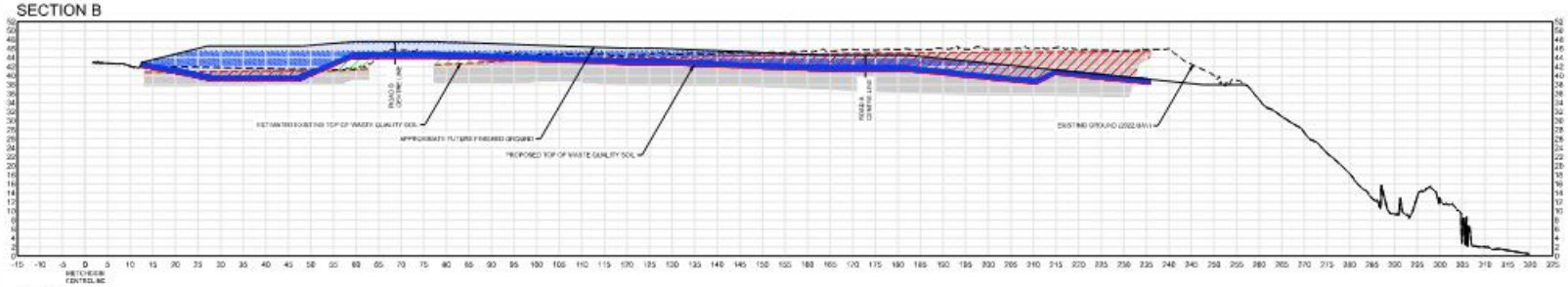
OVER EXCAVATION PLAN
REGRADING PLANS

ONPOINT PROJECT No. 174-01
REGRADING AUTOCAD FILE No.
SHEET 4 of 7
ONPOINT DRAWING No. 174-01-CS04

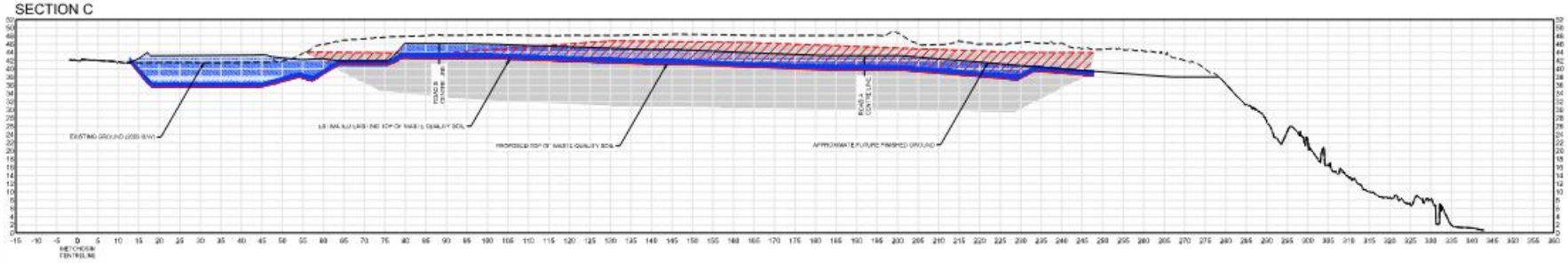
SECTION A



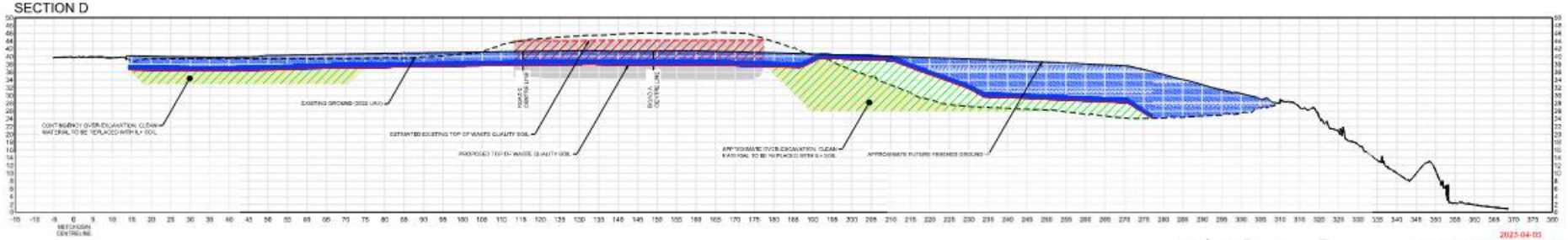
SECTION B



SECTION C



SECTION D



2023-04-05

ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

No.	ISSUED / REVISION	DATE	INIT.
1	RE-EXISTING INFORMATION OF PERMITS	2023-03-31	AA
2	ISSUED FOR APPROVAL	2023-04-05	AA

No.	REVISED / REVISION	DATE	INIT.

DESIGNER AA
REVIEWED
ENGINEER AE

SEAL — PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
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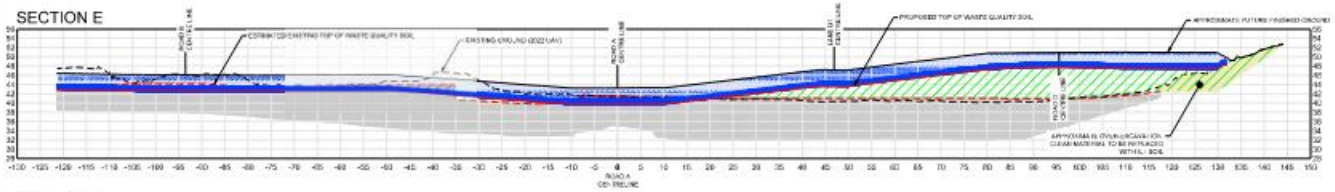
SEACLIFF

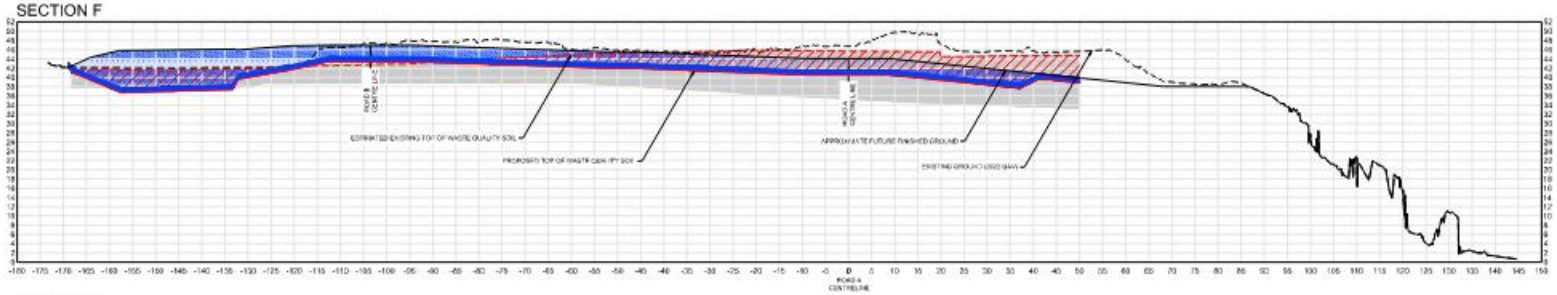
SECTIONS
A-D

ONPOINT PROJECT No. 174-01
ENGINEERING AUTHORITY FILE No.
SHEET 5 of 7
DRAWING No. 174-01-C505

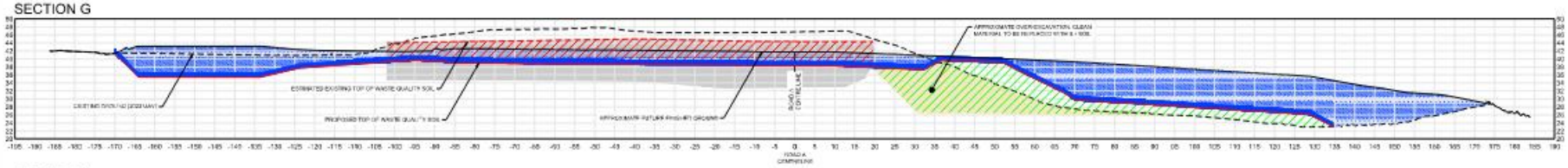
SECTION E



SECTION F



SECTION G



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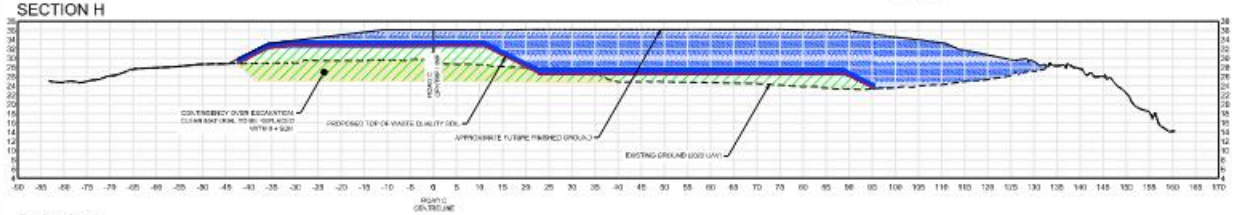

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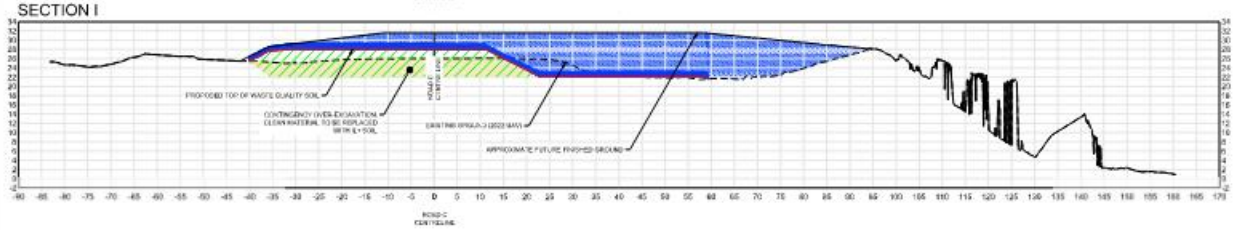


LEGEND

NOTES:
1. TRANSITIONS BETWEEN IL-1 MATERIAL AND CLEAN GRADING TO BE CONFIRMED BY A GEOTECHNICAL ENGINEER.
2. WASTE QUALITY (IL-1 SOIL) WILL HAVE MINIMUM 1m COMPLIANT CAPPING MATERIAL.

2023-04-05

ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

No.	ISSUED / REVISED	DATE	BY
1	FOR COORDINATION OF PERMITS	2023-04-01	AA
2	ISSUED FOR APPROVAL	2023-04-05	AA

DESIGNER AA
REVIEWED
ENGINEER AE

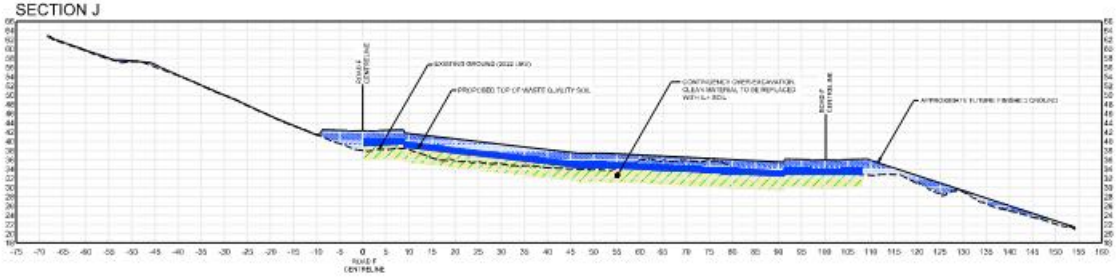
SEACLIFF PROPERTIES
RELIANCE PROPERTIES
ROYAL BEACH IT'S YOUR TIME

ROYAL BEACH
SEACLIFF

SECTIONS
E-I

ONPOINT PROJECT No. 174-01
ENGINEERING DRAWING FILE No.
SHEET 6 of 7
ONPOINT DRAWING No. 174-01-C506

SECTION J



NOTES:
1. TRANSITIONS BETWEEN CL-1 MATERIAL AND CLEAN GRADING TO BE CONFIRMED BY A GEOTECHNICAL ENGINEER.
2. WASTE QUALITY (CL-1) SOIL WILL HAVE MINIMUM 1m COMPLIANT CAPPING MATERIAL

1:100 1 0 1m

2023-04-05
ISSUED FOR APPROVAL

ONPOINT PROJECT ENGINEERS LTD.

DO NOT SCALE THE DRAWING

ISSUED				REVISED			
No.	DESCRIPTION	DATE	BY	No.	DESCRIPTION	DATE	BY
1	ISSUED FOR APPROVAL	2023-04-05	AA				

DESIGNER AA
REVIEWED
ENGINEER AE

SEAL PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
ROYAL BEACH IT'S YOUR TIME

ROYAL BEACH
SEACLIFF

SECTIONS
J-K

ONPOINT PROJECT No. 174-01
ENGINEERING AUTHORITY FILE No.
SHEET 7 of 7
DRAWING No. 174-01-CS07

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Notes: This statement is to be read and completed in conjunction with the Engineers and Geoscientists BC *Professional Practice Guidelines – Landslide Assessments in British Columbia* ("the guidelines") and the current *BC Building Code* (*BCBC*), and is to be provided for Landslide Assessments (not floods or flood controls), particularly those produced for the purposes of the *Land Title Act*, *Community Charter*, or *Local Government Act*. Some jurisdictions (e.g., the Fraser Valley Regional District or the Cowichan Valley Regional District) have developed more comprehensive assurance statements in collaboration with Engineers and Geoscientists BC. Where those exist, the Qualified Professional is to fill out the local version only. Defined terms are capitalized; see the Defined Terms section of the guidelines for definitions.

To: The Approving Authority (or Client) Date: 2023-10-04

Colwood Municipality City Hall

3300 Wishart Road, Victoria BC V9C 1R1

Jurisdiction/name and address

With reference to (CHECK ONE):

- ☑ A. *Land Title Act* (Section 86) – Subdivision Approval
- ☐ B. *Local Government Act* (Sections 919.1 and 920) – Development Permit
- ☐ C. Community Charter (Section 56) – Building Permit
- ☐ D. Non-legislated assessment

For the following property (the "Property"):

Beachlands "Area 3", COR30 Zone Map, Colwood, B.C.

Civic address of the Property

The undersigned hereby gives assurance that they are a Qualified Professional and a professional engineer or professional geoscientist who fulfils the education, training, and experience requirements as outlined in the guidelines.

I have signed, authenticated, and dated, and thereby certified, the attached Landslide Assessment Report on the Property in accordance with the guidelines. That report must be read in conjunction this statement.

In preparing that report I have:

[CHECK TO THE LEFT OF APPLICABLE ITEMS]

- ✓ 1. Collected and reviewed appropriate background information
- ✓ 2. Reviewed the proposed Residential Development or other development on the Property
- ✓ 3. Conducted field work on and, if required, beyond the Property
- ✓ 4. Reported on the results of the field work on and, if required, beyond the Property
- ✓ 5. Considered any changed conditions on and, if required, beyond the Property
- 6. For a Landslide Hazard analysis or Landslide Risk analysis, I have:
  - ✓ 6.1 reviewed and characterized, if appropriate, any Landslide that may affect the Property
  - ✓ 6.2 estimated the Landslide Hazard
  - ✓ 6.3 identified existing and anticipated future Elements at Risk on and, if required, beyond the Property
  - ✓ 6.4 estimated the potential Consequences to those Elements at Risk
- 7. Where the Approving Authority has adopted a Level of Landslide Safety, I have:
  - ___ 7.1 compared the Level of Landslide Safety adopted by the Approving Authority with the findings of my investigation
  - ___ 7.2 made a finding on the Level of Landslide Safety on the Property based on the comparison
  - ___ 7.3 made recommendations to reduce Landslide Hazards and/or Landslide Risks

8. Where the Approving Authority has **not** adopted a Level of Landslide Safety, or where the Landslide Assessment is not produced in response to a legislated requirement, I have:
   - ✓ 8.1 described the method of Landslide Hazard analysis or Landslide Risk analysis used
   - ✓ 8.2 referred to an appropriate and identified provincial, national, or international guideline for Level of Landslide Safety
   - ✓ 8.3 compared those guidelines (per item 8.2) with the findings of my investigation
   - ✓ 8.4 made a finding on the Level of Landslide Safety on the Property based on the comparison
   - ✓ 8.5 made recommendations to reduce Landslide Hazards and/or Landslide Risks
9. ✓ Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections

Based on my comparison between:

[CHECK ONE]

☐ the findings from the investigation and the adopted Level of Landslide Safety (item 7.2 above)
☑ the appropriate and identified provincial, national, or international guideline for Level of Landslide Safety (item 8.4 above)

Where the Landslide Assessment is not produced in response to a legislated requirement, I hereby give my assurance that, based on the conditions[1] contained in the attached Landslide Assessment Report:

A. SUBDIVISION APPROVAL

☑ For subdivision approval, as required by the *Land Title Act* (Section 86), "the land may be used safely for the use intended"

[CHECK ONE]

☑ with one or more recommended additional registered Covenants
☐ without an additional registered Covenant(s)

B. DEVELOPMENT PERMIT

☐ For a development permit, as required by the *Local Government Act* (Sections 488 and 491), my report will "assist the local government in determining what conditions or requirements it will impose under subsection (2) of [Section 491]"

[CHECK ONE]

☐ with one or more recommended additional registered Covenants
☐ without an additional registered Covenant(s)

C. BUILDING PERMIT

☐ For a building permit, as required by the *Community Charter* (Section 56), "the land may be used safely for the use intended"

[CHECK ONE]

☐ with one or more recommended additional registered Covenants
☐ without any additional registered Covenant(s)

[1] When seismic slope stability assessments are involved, Level of Landslide Safety is considered to be a "life safety" criteria, as described in Commentary JJJ of the *National Building Code of Canada (NBC) 2015*, Structural Commentaries (User's Guide – NBC 2015: part 4 of division B). This states:

> "The primary objective of seismic design is to provide an acceptable level of safety for building occupants and the general public as the building responds to strong ground motion; in other words, to minimize loss of life. This implies that, although there will likely be extensive structural and non-structural damage, during the DGM (design ground motion), there is a reasonable degree of confidence that the building will not collapse, nor will its attachments break off and fall on people near the building. This performance level is termed 'extensive damage' because, although the structure may be heavily damaged and may have lost a substantial amount of its initial strength and stiffness, it retains some margin of resistance against collapse."

LANDSLIDE ASSESSMENT ASSURANCE STATEMENT

Matt Kokan, P.Eng.
Name (print)

2023-10-03
Date

1779 West 75th Avenue
Address

Vancouver, B.C. V6P 6P2

604-439-0922
Telephone

receptor@geopacific.ca
Email

OCT 0 4 2023

Permit to Practice
EGBC
1000782

(Affix PROFESSIONAL SEAL and signature here)

The Qualified Professional, as a registrant on the roster of a registrant firm, must complete the following:

I am a member of the firm Geopacific Consultants Ltd.
(Print name of firm)

with Permit to Practice Number 1000782
(Print permit to practice number)

and I sign this letter on behalf of the firm.

Schedule 4

LEGEND:

- 00.0 / 00.0 — PROPOSED FINISHED GROUND ELEVATION / EXISTING GROUND ELEVATION
- 00.0 / 00.0 — PROPOSED FINISHED ROAD ELEVATION / EXISTING GROUND ELEVATION
- 00.00 — ROAD FINISHED GRADE
- *(00.00)* — EXISTING GROUND ELEVATION

SD - STEP DOWN LOT (PAD 3.6m BELOW FINISHED GRADE AT ROAD CENTERLINE)

SU - STEP UP LOT (REAR YARD 3.6m ABOVE FINISHED GRADE AT ROAD CENTERLINE)

LVL - LEVEL LOT (PAD 0.6m BELOW FINISHED GRADE AT ROAD CENTERLINE)

NOTE:
1. EXISTING GROUND FROM 2022-10-22 UAV SURVEY
2. SURFACE SHOWN IS DESIGN GROUND
3. SUBGRADE IS 0.5m BELOW DESIGN GROUND

1:1250 0 25 75m

2024-03-25

ISSUED FOR INFORMATION

ONPOINT PROJECT ENGINEERS LTD.
TEL: 250.478.1575 WWW.ONPOINT.CA
SUITE 111 - 957 LANGFORD PKWY VICTORIA BC V9B 0A5

Contractor must check and verify all dimensions and conditions on site and report any discrepancies to engineer prior to proceeding with work.
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(Ed.n.r.)
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No.	ISSUED DESCRIPTION	DATE	SIGN	No.	REVISED DESCRIPTION	DATE	SIGN
1	ISSUED FOR INFORMATION	2024-01-23	AA	A	UPDATE LABELS	2024-03-25	AA

DESIGNER: AA
REVIEWED:
ENGINEER: AE
SEAL PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
the beach lands

THE BEACHLANDS
SEACLIFF

BLUFFS FINISHED GROUND

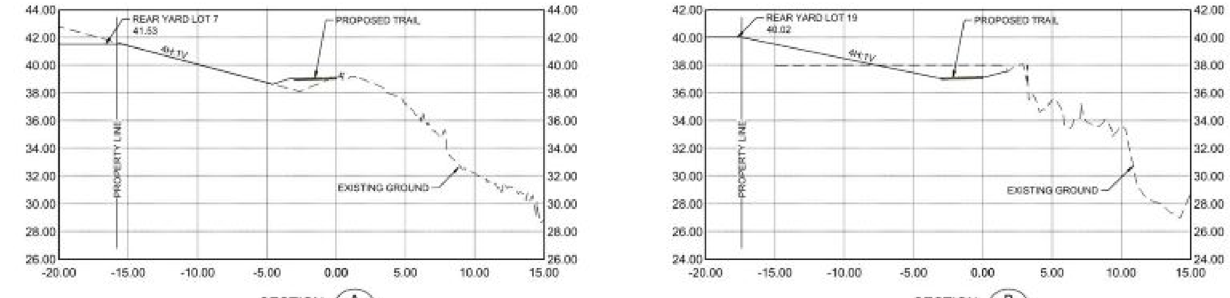
ON POINT PROJECT No. 174-01
GOVERNING AUTHORITY FILE No.
SHEET 1 OF 1
REV A
ON POINT DRAWING No. 174-01-SK466

Docusign Envelope ID: C0BDC92D-0FFE-42CD-ACEC-8F819B7E92D9

Schedule 5

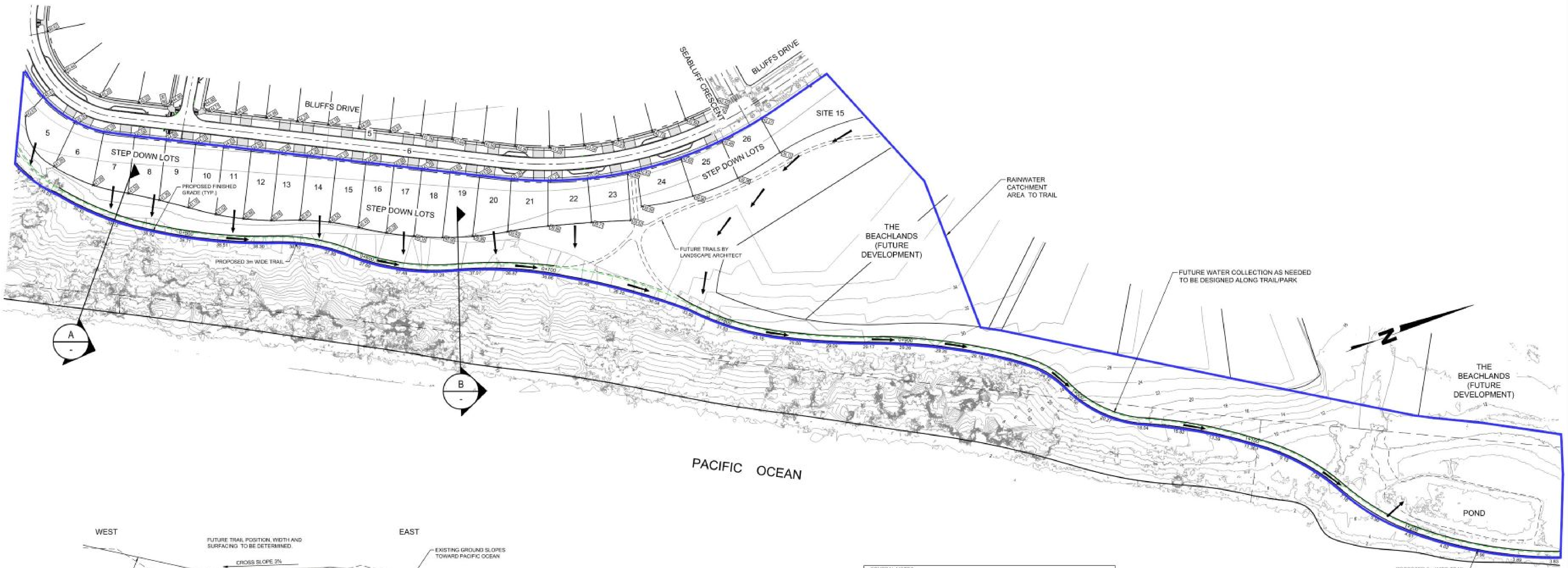
LEGEND

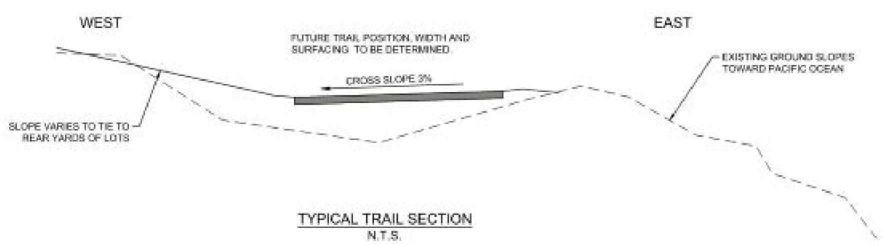
9999	CIVIL LOT NUMBER
99.99	PROPOSED ELEVATION
	PROPOSED ELEVATION AT PROPERTY LINE OR BACK OF SIDEWALK
←	SURFACE DRAINAGE FLOW DIRECTION
- - -	FUTURE WATER COLLECTION AS NEEDED TO BE DESIGNED ALONG TRAIL/PARK



SECTION A
1:250

SECTION B
1:250





TYPICAL TRAIL SECTION
N.T.S.

GENERAL NOTES:

1. TRAILS AND OTHER LANDSCAPE FEATURES ARE SHOWN CONCEPTUALLY AND MAY CHANGE.
2. TRAIL TO SLOPE LONGITUDINALLY SOUTH TO NORTH, FROM LOT 59 TO POND. MAXIMUM LONGITUDINAL SLOPE IS 12%.
3. TRAIL TO INTERCEPT AND CONVEY RAINWATER RUNOFF FROM REAR OF LOTS 5 TO 26 TO POND.

JUNE 20, 2024

FOR INFORMATION ONLY

1:1000 0 20 80m

ONPOINT PROJECT ENGINEERS LTD.

Contractor must check and verify all dimensions and conditions on site and report any discrepancies to engineer prior to proceeding with work.

DO NOT SCALE THE DRAWING

No.	ISSUED DESCRIPTION	DATE	No.	REVISED DESCRIPTION	DATE	SIGN

DESIGN: FC
DRAWN: FC
ENGINEER: AE

SEAL

PERMIT TO PRACTICE

SEACLIFF PROPERTIES

RELIANCE PROPERTIES

the beach lands

THE BEACHLANDS BLUFFS - PHASE 2
SEACLIFF

BLUFFS BANK GRADES AND DRAINAGE

ON POINT PROJECT No. 174-01
GOVERNING AUTHORITY FILE No. -----
SHEET 1 OF 1
REV ----
ON POINT DRAWING No. 174-01-SK10

Schedule 6

EROSION AND SEDIMENT CONTROL PLAN
FOR THE BEACHLANDS BLUFFS - PHASE 2
COLWOOD, BC

PREPARED FOR:

TURNBULL CONSTRUCTION MANAGERS
VICTORIA, BC

CORVIDAE PROJECT # 2023-081
JULY 2024

V 1.1

CORVIDAE
ENVIRONMENTAL CONSULTING INC.

Solution oriented. Protection of the environment. Absolute integrity. Open communication. Respect

TABLE OF CONTENTS

CAVEAT

This Erosion and Sediment Control Plan (ESCP) has been prepared with the best information available at the time of writing, communications with the prime contractor, a site visit, and a review of design drawings and other documentation relevant to the project. This ESCP has been developed to assist the prime contractor in remaining in compliance with relevant environmental regulations, acts and laws pertaining to the project and to identify and mitigate the expected impacts of construction, operation and reclamation activities directly related to the project. The ESCP has been prepared as a resource tool for use specifically by the project construction team; subcontractors to the prime contractor are responsible for complying with the measures detailed in the ESCP. Any use of this ESCP by other parties is done so exclusively at their risk. The author assumes no responsibility for: [i] this ESCP or iterations of this ESCP that are unsigned by the author, [ii] any changes made to this document other than those made or endorsed by the author, or [iii] day-to-day construction compliance.

Report prepared by:

Matt Johnson, CTech
Environmental Manager - Construction
Corvidae Environmental Consulting

REVISION HISTORY

Rev #	Reviewer	Revision Date (YYYY-MM-DD)	Description
V 1.0	Matt Johnson	2024-07-08	To client for review
V 1.1	Matt Johnson	2024-07-08	To client after review comments incorporated

1 INTRODUCTION

Corvidae Environmental Consulting Inc. (Corvidae) has been engaged by Turnbull Construction Project Managers (Turnbull) to provide this Erosion and Sediment Control Plan (ESCP) for the Beachlands Bluffs – Phase 2 earthworks project (the project). This ESCP is in addition to the site-wide ESCP previously submitted by Corvidae[1].

This ESCP is designed to provide Turnbull with a reference document for erosion and sediment control planning, implementation of appropriate erosion and sediment control measures during construction and assist with ensuring compliance with applicable legislation, regulation and guidelines sediment discharge from the site during the course of construction.

This ESCP is intended to be a living document; modifications to methods and placement of erosion and sediment control measures will be undertaken as construction progresses and the site conditions are modified.

The information presented herein is based on a year of experience managing and monitoring erosion and sediment control planning and measures on the subject site.

1.1 SITE CONTEXT

The Beachlands project is located on approximately 17 hectares of land that previously operated as a sand and gravel mine in Colwood, BC. For the purposes of orientation, Metchosin Road is considered to run north-south with the marine environment of Royal Bay to the east.

Bulk earthworks and grading have occurred onsite for the past year and the focus of this ESCP is the subexcavation and final grading (placement of 1 metre of sand) of the east edge of the site – referred to as The Bluffs and located to the east of Bluffs Drive (see grading and drainage drawing[2] in Appendix B).

The marine foreshore is currently protected from site generated turbid stormwater by multiple site features:

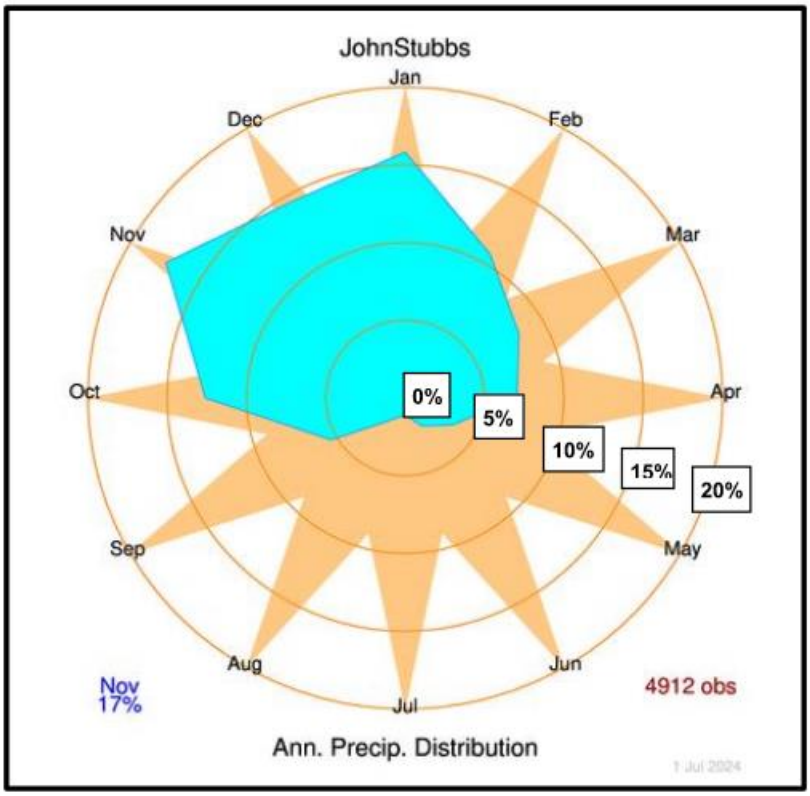
- Excavation to the west of the project perimeter that has resulted in an earthen berm that contains all water to site – Appendix A Photo 1.
- Highly permeable site soils that infiltrate most stormwater event and completely contain the runoff on site.
- An approximately 40 metre wide, steep, vegetated slope the extends from the eastern project limit to the upper high water mark on the beach foreshore. On the upper portion of this slope there is a flat bench ranging from 5 – 10 metres wide – Appendix A Photo 2.

Local weather is a Mediterranean climate with cool rainy winters and dry hot summers. The area historically is very dry from July – Oct; see Figure 1 below for the rainfall distribution pattern at John Stubbs Elementary located approximately 3.0 km from the Site.

[1] 2023. Corvidae Environmental. *Erosion and Sediment Control Pan. Beachlands Bulk Earthworks.*
[2] 2024. OnPoint Project Engineers Ltd. *The Beachlands Bluffs – Phase 2 Seacliff. Bluffs Ban Grades and Drainage. Drawing No. 174-01-SK10.*

Figure1. Average Annual Rainfall Distribution at Colwood Elementary (4 km from project site)[3]

Figure 2 Interpretation: The orange circles with % boxes on them indicate the percentage of annual rainfall. The blue polygon corners indicates how much of the average annual rainfall occurs during that month, e.g. – about 6 % of the annual rainfall is indicated for September and 17% of the average annual rainfall is indicated for November.



1.2 SCOPE OF WORK

Project activities include the following:

- Removal of existing vegetation and organic material within the grading area. Trees have been previously cleared – Appendix A Photo 3.
- Installation of tree protection fencing at the eastern edge of the project area to prevent damage from grading activities to trees on the uppermost edge of the vegetated slope.
- Subexcavation of existing site and grading to final design; grading will create Lots 5 – 26 and Site 15. This involves removing the existing earthen berm and grading site so the stormwater will flow east and north – refer to grading and drainage drawing in Appendix B.
- From the east edge of the of the level residential building lots 5 – 26 and Site 15, grading will result in a 4H:1V east aspect slope that connects to an 800 metre long north draining swale designed to discharge to the existing sediment detention pond at the Royal Bay backshore.

[3] School Based Weather Network – John Stubbs Elementary. Accessed July 3, 2024. Available at: https://www.victoriaweather.ca/station.php?id=128.

2 EROSION AND SEDIMENT CONTROL MEASURES

The implementation of the recommended ESC measures will minimize the introduction of sediment from the project area into the marine foreshore of Royal Bay.

Previous monitoring of erosion and sediment control measures onsite, observed site performance during significant rainfalls (40 mm / 24 hrs) and annual weather patterns have all been factored into the erosion and sediment control measures outlined in this report.

There are areas of steep slope within the grading area that are unsafe to walk on at their current grade (e.g. Lot 8). ESC measures in these areas will be installed when grading has progressed to the stage that make sit safe to do so. Protection of the marine waters will be as per Section 2.3.

In areas where natural topography features exist to control discharge of sediment laden water (earth berms, grade breaks) no additional sediment control measures are required.

2.1 SCHEDULE AND STAGING

Works are scheduled to begin in July, 2024 and be complete prior to the annual onset of consistent rainfall that generally starts in early October as shown in Figure 1. This schedule favors minimal generation of turbid discharge during construction.

If grading activities are not completed by September 15, Corvidae will work with the Turnbull team to identify any additional erosion or sediment control measures that may be required.

2.2 VEGETATION CLEARING, GRUBBING AND STRIPPING

Grubbing and stripping within the grading footprint will be completed by end of July 2024.

Trees to be retained are to be protected during construction by the installation of snow fencing. If grading works are not completed by Sept 15, silt fence is to be installed at the base of the fencing as an additional protective measure against the migration of turbid stormwater offsite to the marine foreshore – Appendix A Photo 4. The timing and need for this additional mitigation measure will be determined by Corvidae in consultation with Turnbull.

If removed trees and shrubs are being chipped onsite, stockpiling the mulch is recommended since the mulch is an excellent material for protecting exposed soil against erosion.

2.3 EXCAVATION AND STOCKPILING

Material excavated within the grading area will be hauled and placed in other areas of the greater project site and then the subexcavated area brought up to grade with a metre of sand. Based on previous observations of site performance during rainfall events, neither of these activities is expected to generate turbid stormwater if rainfall occurs while they are happening.

As the area is excavated and the berm removed, the grade will be sloped to drain west into the main project area so that turbid water does not migrate east to the marine foreshore. This negative grading will be kept in place as long as practical.

The design drainage swale will be constructed to final grade at the earliest practical time in the construction sequence to facilitate water moving north toward the existing detention ponds.

2.4 PRELIMINARY EQUIPMENT LIST

The owners shall have sufficient materials, such as sediment fencing, straw, sandbags, and polyethylene sheeting available on-site for emergency protection measures when required.

Existing onsite stockpiles of these supplies are adequate.

3 ENVIRONMENTAL MONITORING

3.1 ENVIRONMENTAL MONITORING

Environmental monitoring for erosion and sediment control will occur during project works and will be provided by a Qualified Environmental Professional from Corvidae. Monitoring of the Bluffs grading area will be completed during monitoring of the greater project as a whole. Construction activities will be monitored for conformity with the requirements of this ESCP, the main project ESCP and regulatory requirements. Corvidae will work collaboratively with Turnbull and the earthworks contractor to proactively guide construction so that water quality guidelines are maintained for water discharged from site.

The EM will prepare monitoring reports after each monitoring visit that include details regarding:

- Date, time, weather, location.
- Current site activities, site conditions and equipment onsite.
- Communications with onsite crew.
- Photographic records of site conditions.
- Work plan modifications or mitigations required.
- Environmental incidents, impacts and corrective actions taken.
- Water quality monitoring results will be included as applicable.

3.2 WATER QUALITY MONITORING AND GUIDELINES

The EM will complete water quality monitoring to provide due diligence reporting with respect to water discharge from site. See Figure 2 for water quality sampling locations.

A laboratory analysed correlation between Total Suspended Solids (TSS) and Nephelometric Turbidity Units (NTU) was previously developed for the earthworks project on the north side of Metchosin Road and will be used for this project. The correlation is 1mg/L TSS = 1 NTU.

TSS is the parameter used by Fisheries and Oceans Canada to assess sediment in water while NTU is the parameter used by the BC Ministry of Environment and Climate Change Strategy to assess turbidity in water. TSS can only be assessed in a laboratory setting while NTU can be read in the field real-time. Correlating TSS to NTU allows for the use of a digital turbidity meter to be used to sample both TSS and NTU in the field and report results in TSS or NTU as required.

Discharge from site shall meet the applicable Fisheries and Oceans Canada runoff requirements shown in Table 2. NTU guidelines are conservative and in the case of exceedance the Impact Assessment

Model [4] shown in Appendix C will be referred to for determining requirements for construction modification.

Table 2. Fisheries and Oceans Canada Site Runoff Water Quality Requirements (1993)

Regulatory maximum TSS increase above background level* during dry weather operation	25 mg/L
Regulatory maximum TSS increase above background level* during wet weather operation	75 mg/L

*Background will be measured at Sample Site MF-S or MF-N depending on which way the longshore current is moving at the time of sampling.

Figure 2. Water Quality Sampling Locations

[4] Newcombe, C. 2003. JAWRA Journal of the American Water Resources Association, vol. 39, issue 3, pp. 529-544.

APPENDIX A - PHOTOLOG

Photo 1. Subecavation to the west of the project perimeter that has resulted in an earthen berm that contains all water to site.

Photo 2. 10 metre wide bench on upper portion of the approximately 40 metre wide, steep, vegetated slope the extends from the eastern project limit to the upper high water mark on the beach foreshore.

Photo 3. Trees have been previously cleared from the grading area.

Photo 4. Silt fence (black) is to be installed inside the base of the tree protection fencing (green) as an additional protective measure against the migration of turbid stormwater offsite to the marine foreshore. Silt fencing installation can wait until mid-September.

APPENDIX B – GRADE AND DRAINAGE DRAWING

LEGEND

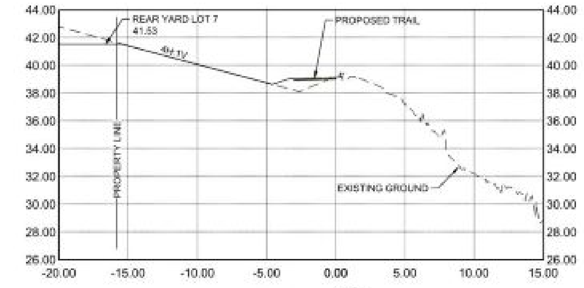
9999	CIVIL LOT NUMBER
99.99	PROPOSED ELEVATION
	PROPOSED ELEVATION AT PROPERTY LINE OR BACK OF SIDEWALK
←	SURFACE DRAINAGE FLOW DIRECTION
- - -	FUTURE WATER COLLECTION AS NEEDED TO BE DESIGNED ALONG TRAIL/PARK

Corvidae Environmental note - In areas where natural topography features exist to control discharge of sediment laden water (earth berms, grade breaks) no additional sediment control measures are required.To be confirmed in the field prior to final grading.

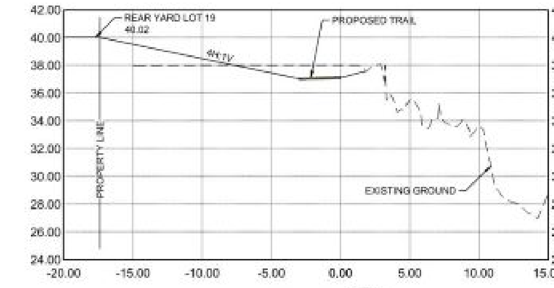
Corvidae Environmental note - To ensure urbid water does not migrate east to the marine foreshore the grade will be sloped to drain west into the main project area as excavation proceeds. This negative grading will be kept in place as long as practical.

Corvidae Environmental note - Cut areas exist between Lot 5 and 23 with very steep slopes in some places (e.g. Lot 8). Areas of steep slope within the grading area that are unsafe to walk on at their current grade will have ESC measures installed when grading has progressed to the stage that makes it safe to do so. To be confirmed with Corvidae.

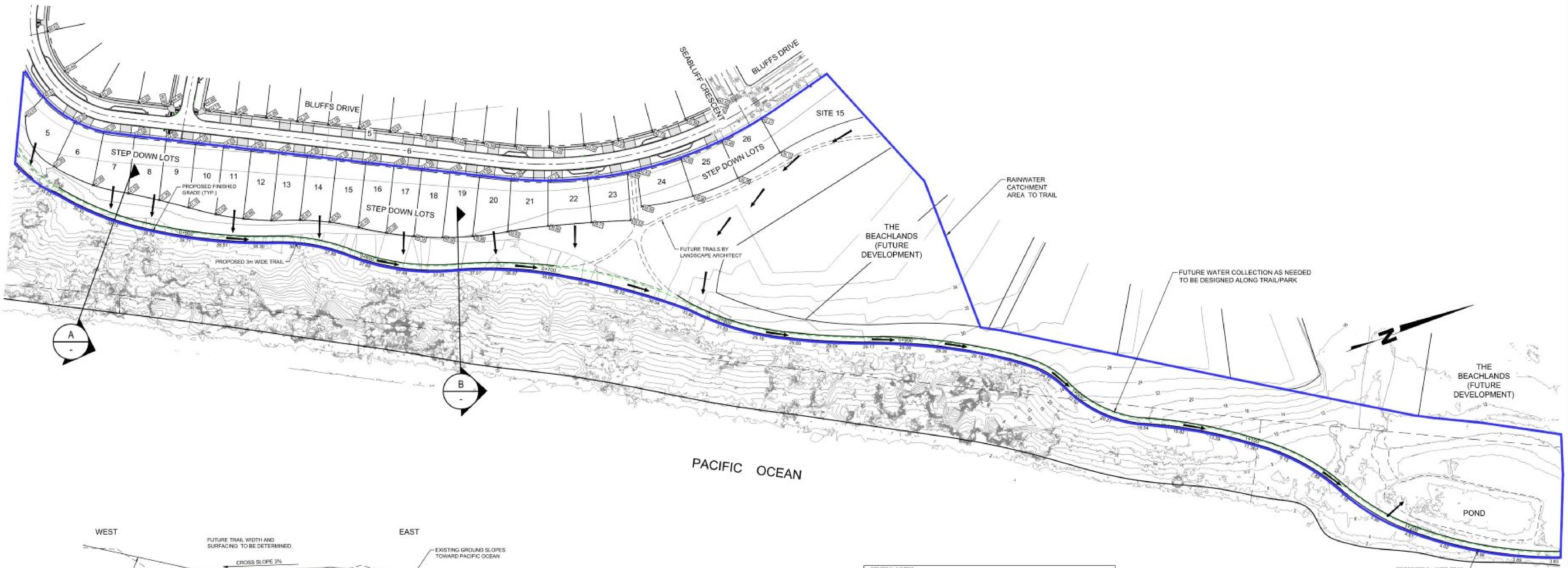
Corvidae Environmental note - Design drainage swale to b econstructed as soon as practical in teh grading process to ensure positive draiange to the north sediment detention pond / away from marine foreshore.

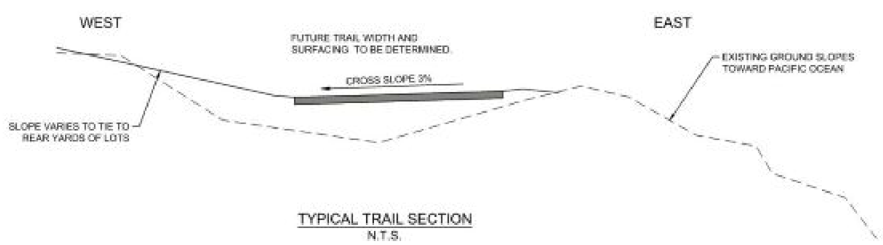


SECTION A
1:250



SECTION B
1:250





TYPICAL TRAIL SECTION
N.T.S.

GENERAL NOTES:

1. TRAILS AND OTHER LANDSCAPE FEATURES ARE SHOWN CONCEPTUALLY AND MAY CHANGE.
2. TRAIL TO SLOPE LONGITUDINALLY SOUTH TO NORTH, FROM LOT 59 TO POND. MAXIMUM LONGITUDINAL SLOPE IS 12%.
3. TRAIL TO INTERCEPT AND CONVEY RAINWATER RUNOFF FROM REAR OF LOTS 5 TO 26 TO POND.

JUNE 20, 2024

FOR INFORMATION ONLY

1:1000 — 0, 20, 80m

ONPOINT PROJECT ENGINEERS LTD.
TEL: 250 475 7075 WWW.OPPEL.CA
SUITE 111 – 957 LANGFORD PKWY VICTORIA BC V9B 0A5

Contractor must check and verify all dimensions and conditions on site and report any discrepancies to engineer prior to proceeding with work.

DO NOT SCALE THE DRAWING

ISSUED No.	ISSUED DESCRIPTION	DATE	REVISED No.	REVISED DESCRIPTION	DATE	SIGN

DESIGN: FC
DRAWN: FC
ENGINEER: AE

SEAL   PERMIT TO PRACTICE

SEACLIFF PROPERTIES
RELIANCE PROPERTIES
the beach lands

THE BEACHLANDS BLUFFS - PHASE 2
SEACLIFF

BLUFFS BANK GRADES AND DRAINAGE

ON POINT PROJECT No. 174-01
GOVERNING AUTHORITY FILE No. -----
SHEET 1 OF 1
REV -----
ON POINT DRAWING No. 174-01-SK10

APPENDIX C – FISHERIES IMPACT ASSESSMENT MODEL

Impact Assessment Model for Clear Water Fishes
Exposed to Conditions of Reduced Water Clarity

Visual clarity of water (*y* BD) and related variables: *alternate* NTU (Δ ntu$_{\Sigma, \Lambda}$)	*z* SD (m)	*preferred* BA (m^{-1})	*y* BD (m)	Duration of exposure to conditions of reduced VISUAL CLARITY (log_e hours): 0	1	2	3	4	5	6	7	8	9	10	Fish reactive distance: *calibrated for trout* ψ BD (cm)	*x* RD (cm)	
				Severity-of-ill-effect Scores (SEV) -- Potential SEV = - 4.49 + 0.92(log_e h) - 2.59(log_e yBD)													
1100	0.01	500	0.010	7	8	9	10	11	12	13	14				1		O
			0.014	7	7	8	9	10	11	12	13	14			1		N
400	0.03	225	0.02	$_P6^\pi$	7	7	8	9	10	11	12	13	14		2		M
			0.03	4	5	6	7	8	9	10	11	12	13	14	3		L
150	0.07	100	0.05	3	$_P4^\pi$	$_P5^\pi$	6	7	8	9	10	11	12	13	5		K
			0.07	2	3	4	5	6	7	8	9	10	11	11	7		J
55	0.15	45	0.11	$_P\underline{1}^\pi$	2	3	4	5	6	7	8	9	10	10	11	6	I
			0.16	$\underline{0}$	$\underline{1}$	2	3	4	$\underline{5}$	6	7	8	9	9	16	17	H
20	0.34	20	0.24	$\underline{0}$	$_P\underline{0}^\pi$	$_P\underline{1}^\pi$	2	3	4	5	6	7	$\underline{8}$	8	24	30	G
			0.36	$\underline{0}$	$\underline{0}$	$\underline{0}$	$\underline{1}$	2	3	4	5	6	6	7	36	42	F
7	0.77	9	0.55	$\underline{0}$	$_P\underline{0}^\pi$	$\underline{0}$	$\underline{0}$	$\underline{1}$	2	3	4	4	5	6	55	55	E
			0.77	$\underline{0}$	$_P\underline{0}^\pi$	$^P\underline{0}_\pi$	$\underline{0}$	$\underline{0}$	$\underline{1}$	2	3	4	4	5	77	66	D
3	1.53	4	1.09	$\underline{0}$	$_P\underline{0}^\pi$	$\underline{0}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	1	2	3	4	5	109	77	C
			1.69	$\underline{0}$	$\underline{0}$	$\underline{0}$	$\underline{0}$	0	0	0	1	2	2	3	169	90	B
1	3.68	2	2.63	$^P\underline{0}_\pi$	$^P\underline{0}_\pi$	$^P\underline{0}_\pi$	0	0	0	0	0	0	1	2	263	104	A
				1	3	7	1	2	6	2	7	4	11	30			
				Hours			Days			Weeks		Months					
				a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*			

y BD Black disk sighting range (m): horizontal measurement in water of any depth (reciprocal of beam attenuation).

ψ BD Black disk sighting range (cm) -- a convenient calibration for measurements made in very cloudy water.

BA Beam attenuation (m^{-1}): measures absorption *and* scattering of light by "water constituents"-- clay *and* colour.

z SD Secchi disk sighting range (m): vertical measurement, usually in deep water.

x RD Trout reactive distance as a function of black disk sighting range (at ≥ 50 lux): this calibration has the form y = a + bln(x) -- where y represents reactive distance (cm), and x represents visual clarity (black disk sighting range, cm), and where a and b are intercept and slope respectively -- such that y = - 68.0546 + 30.8307 ln(x).

NTU Nephelometric turbidity units: a measure of light-scattering by suspended clay particles (0.2 to 5 μm diameter).

Δ ntu$_\Sigma$ Ambient < acceptable *short-term* increase in turbidity ≤ 8-NTU; 0-hour < duration ≤ 24-hours (a guideline).

Δ ntu$_\Lambda$ Ambient < acceptable *long-term* increase in turbidity ≤ 2-NTU; 1-day < duration ≤ 30-days (a guideline).

SEV Severity-of-ill-effect scale: 0 ≤ nil < 0.5; 0.5 ≤ minor < 3.5; 3.5 ≤ moderate < 8.5; 8.5 ≤ severe < 14.5. Impact assessment is based on *net* duration (less clear-water intervals) and weighted-average visual clarity data. Re-current events sum when integrated over relevant intervals: for a year class (a life-history phase, or a life cycle); a population ('year-over-year' events); habitat damage (hours < duration ≤ years); and restoration (year < time ≤ years). For events involving suspended sediment (may include clay), *see* Newcombe and Jensen 1996; References, *over*.

Ideal. Best for adult fishes that must live in a clear water environment most of the time.

Slightly impaired. Feeding and other behaviours begin to change: severity of effect increases with duration.

Significantly impaired. Marked increase in water cloudiness could reduce fish growth rate, habitat size, or both.

Severely impaired. Profound increases in water cloudiness could cause poor 'condition' or habitat alienation.

Areas with least supporting data (1 day to 11 months), or least likelihood of problems (30 months), or both.

$_P\underline{0}^\pi$ Some predatory fish (P) catch more prey fish (π) in clear water ($^P_\pi$) than they do in cloudy water.

$_P\underline{1}^\pi$ Survival of some fishes (e.g. young juvenile Pacific salmon) is enhanced ($_P^\pi$) by natural, seasonal, cloudiness.

$_P\underline{5}^\pi$ Data sources: predator-prey dynamics, *see* Newcombe 2003; References, *over*.

$\underline{8}$ Data sources: severity of ill effects (any SEV with underscore), *see* Newcombe 2003; References, *over*.

aA, kO Row labels (upper case) and column labels (lower case); paired, as shown, these serve as cell coordinates.

Charles.Newcombe@gems5.gov.bc.ca; and jensenj@pac.dfo-mpo.gc.ca (model coefficients)