September 27, 2023

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Via Email: LRoddan@qathet.ca

qathet Regional District
2815 McCausland Road
Powell River, BC V8A 0S2

Attention: Laura Roddan

Subject: Savary Island Slope Hazard Study

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) has been engaged by the qathet Regional District (qRD) to complete a Slope Hazard Study for Savary Island.

Specifically, Tetra Tech has been engaged to:

- Develop criteria for evaluating the location of potential hazardous slopes for Savary Island.
- Delineate potentially hazardous slopes and provide recommended set-back and clearance areas from these slopes.
- Prepare a map(s) showing potentially hazardous areas.
- Prepare a report summarizing the study approach and results.
- Present results to the qRD Regional Board of Directors.

2.0 STEEP SLOPES ASSESSMENT

2.1 Background Review and Defining Potentially Hazardous Slopes

There is no universally accepted definition of what constitutes a hazardous slope from a slope instability perspective as slope stability is a function of several independent variables (e.g., stratigraphic profile, groundwater conditions, etc.). However, some general assumptions can be made regarding slopes that are generally considered more at risk of having or developing hazardous instability. As part of our assessment, we have reviewed relevant background information within Tetra Tech's archives and in the public domain that has included:

- Existing slope development studies and policies within British Columbia with a focus on municipalities and regional districts around the Strait of Georgia including:
  - qathet Regional District
  - City of Powell River
  - City of Campbell River
  - Sunshine Coast Regional District

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  - District of North Vancouver
  - City of Nanaimo
  - City of Colwood
  - Comox Valley Regional District
- Other slope stability studies and assessments of hazards affecting slope stability (e.g., flooding and sea level rise) including:
  - Savary Island Dune and Shoreline Study (Thurber, 2003)
  - Guidelines for Management of Coastal Flood Hazard Land Use (Ausenco Sandwell, 2011)
  - Flood Hazard Area Land Use Management Guidelines (Ministry of FLNRORD, 2018)
  - qathet Regional District Coastal Flood Mapping: Phase 1 - Mainland (Tetra Tech, 2021)
  - qathet Regional District Coastal Flood Mapping: Phase 2 - Islands (Tetra Tech, 2022)
  - Potential Slope Hazard Development Permit Areas - City of Powell River (Tetra Tech, 2023).
- Aerial photographs, geological maps, lidar and topographical contour data publicly available for the area.

2.2 Data Used in Evaluation of Hazard Areas

A summary of the data used in evaluating potential slope hazard areas includes:

- 2019 lidar data flown and processed by the BC Provincial Government.
- 2017 aerial photographs provided by the qathet Regional District.
- The 2000 highest high water level tide (HHWLT), the 2100 HHWLT projection and slope erosion potential provided in Tetra Tech's qathet Regional District Coastal Flood Mapping: Phase 2 - Islands project (Tetra Tech, 2022).
- Criteria developed for slope hazard development permit areas for the City of Powell River (Tetra Tech, 2023).

3.0 GEOLOGY AND EROSION POTENTIAL

The following text presents a summary of the geological and geomorphological information presented in the qathet Regional District Coastal Flood Mapping: Phase 2 - Islands (Tetra Tech, 2022) report.

3.1 Geomorphology

Savary Island is positioned in the Strait of Georgia which lies below the lower slopes of the Coastal Mountains where historically the main geomorphological mechanisms have included glacial, coastal, and fluvial processes. Glacial processes had previously been the dominant geomorphological mechanisms that shaped the landscape through erosion and deposition as glaciers moved south and over the region and then receded back into the mountains during the last glacial retreat.

The isostatic rebound and tectonic uplift that has occurred since the last glacial retreat has meant that sea level was higher than present-day. Like glacial ice, coastal and fluvial processes have also previously shaped the landscape through erosion and deposition during previous high sea levels and their subsequent decrease relative to the present-day topography. Currents and waves continue to shape the islands and are now the dominant geomorphological process.

Aside from geomorphological processes, the resistance of soil and rock substrates to erosion has also influenced the geomorphological development of the shoreline. Rocky shorelines are considerably more resistant to erosion than soil shorelines. Likewise, dense to very dense glaciomarine, glaciofluvial and glacial till deposits are slightly more resistant to erosion than very loose to compact modern fluvial and marine deposits.

All these factors need to be considered when studying the future morphology of the coastline and the susceptibility of any given area to coastal erosion or aggradation.

3.2 Geology

Tetra Tech (2022) identified six main geological units on Savary Island and a brief description of each unit and relative susceptibility to erosion is presented in the sections below. A minor update to the mapped surficial geology units delineating the extent of surficial sand dunes has been undertaken as part of this study. Mapping has been undertaken in accordance with the guidelines and nomenclature outlined in Howes and Kenk (1997). The updated surficial geology map is shown in Figure 1.

3.2.1 Marine

Marine deposits refer to sediments deposited in salt or brackish water bodies by settling from suspension or deposited in the littoral zone through shoreline processes of wave action and longshore drift since the last glacial retreat. Offshore deposits tend to be finer-grained clay, silt and sand that are moderately well to well sorted. Littoral marine sediments consist of well sorted and rounded gravel and sand.

The distinction between glacio-marine and marine soils has generally been made based on density with the less dense materials interpreted as representing marine deposits. Given the significant change in sea level that the area has experienced since the last glacial retreat, marine deposits could be found across the range of elevations considered in this study.

When considering susceptibility to erosion marine deposits represent one of the most susceptible units as they tend to be less dense with less consolidation. Marine clay deposits laid down since the last glacial retreat at higher elevations can be more resistant to erosion than coarser grained fractions.

3.2.2 Eolian

Eolian deposits are wind-blown sediments that generally consist of medium to fine-grained sand and coarse silt that commonly form dunes. Within the study area eolian deposits are likely to have been formed following the last glacial retreat in coastal areas where erosion of sandy deposits has provided a steady supply of sand. Areas of both active and inactive dunes are present within the study area.

Eolian deposits are considered to be the most susceptible to erosion relative to the other units due to their unconsolidated nature, low density, and relative uniformity of grain size.

3.2.3 Till

Till consists of materials deposited directly by glacial ice and can be transported either within, on, or in front of the ice but is not modified by any other agent of transportation. The composition of tills is highly variable and dependent upon source material and mode of deposition. Generally, till in the area consists of a dense to very dense non-stratified mixture of gain sizes from clay to boulders set within a matrix of sand, silt, and clay.

Till tends to be dense to very dense making it less susceptible to erosion relative to the other soil units. Although it is considered to have a similar susceptibility as glaciofluvial and glacimarine deposits, overall, its resistance to erosion will likely be slightly greater because of its compaction and the presence of a fine-grained matrix.

3.2.4 Glaciofluvial

Glaciofluvial refers to materials deposited by glacial meltwater streams either directly in front of, or in contact with glacier ice. Outwash deposits, such as plains and terraces that do not have characteristic ice contact features may also be mapped as glaciofluvial deposits if the geological history indicates a glacial source. Sediments generally range from non-sorted and non-bedded gravel made up of a wide range of particle sizes to moderately well sorted materials.

These materials tend to be dense to very dense and are therefore generally considered to be less susceptible to erosion than deposits of marine, fluvial and colluvial origin. These deposits are considered to have the same susceptibility to erosion as glaciomarine deposits with variations dependent on density and grain size distribution. That is, coarser grained deposits of sand and gravel are likely to be more susceptible to erosion than deposits with a dense fine-grained matrix.

3.2.5 Glaciomarine

Glaciomarine refers to sediments of glacial origin deposited in a marine environment near glacier ice. This includes materials that settled from suspension, submarine gravity flows and settled particles released by melting of both floating ice and ice shelves. Deposits range from massive diamictons with a wide range of grain sizes to stratified well sorted sand, silt, and clay. Ice rafted drop-stones and lenses of till or glaciofluvial sediments may be grouped with these deposits. Abrupt changes in texture are common along with marine shells and casts.

These materials tend to be dense to very dense and have susceptibility to erosion considered to be similar to glaciofluvial materials and till.

3.2.6 Bedrock

On Savary Island there is single rock outcrop at Mace Pt of the igneous granitic rocks observed along most of the mainland portion of the qRD coastline.

Bedrock may have varying resistance to erosion based on composition and discontinuities. However, relative to the other largely unconsolidated geological units, bedrock is the least susceptible to erosion by several orders of magnitude and is considered non-erodible within the time frame being considered for this study.

3.3 Erosion Potential

Thurber (2003) suggested erosion rates of negligible to 0.4 m/year around Savary Island with average rates of 0.41 m/year and 0.25 m/year for the south and north shores of Savary Island, respectively. A detailed assessment and review of erosion rates was not part of this study. However, the assessment of erosion potential undertaken in Tetra Tech 2022 was used to inform the assessment of the slope hazard areas in this study.

To differentiate erosion potential, Tetra Tech (2022) developed an erosion ranking system to include six main variables which include:

- Shoreline Type
- Back Beach Geology
- Slope Angle
- Vegetation Cover
- Storm Exposure
- Specific Field Observations

Each of these six variables were given a maximum score based on Tetra Tech's assessment of their hypothetical contribution to erosion potential. Table 3-1 outlines all six variables and their allocated points. Each variable was then evaluated for shoreline segments. The scores from all six variables for each segment were then summed with possible scores ranging between 0 and 140. Shoreline segments were then ranked according to their total score as having Very Low, Low, Moderate or High erosion potential. A higher score indicates a stretch of coastline with a higher erosion potential.

The scores corresponding with a Very Low to High erosion potential ranking system are shown in Table 3-2 and the erosion potential around Savary Island is shown graphically in Figure 1.

Table 3-1: Erosion Potential Ranking System

Variable and Rating Criteria Descriptions	Ranking Score
Shoreline Type	
Mud and Sand	10
Sand and Gravel	10
Gravel to Cobbles	8
Gravel to Boulders	6
Anthropogenic	N/A
Rock - Total Score nominally fixed at	
Geology Back Beach Type	
Eolian	15
Recent Fluvial	10
Recent Marine	10
Glaciofluvial	8
Glaciomarine	8
Till	5
Anthropogenic	N/A
Slope Angle	
> 40°	15
15° - 40°	5
0° - 15°	0

Variable and Rating Criteria Descriptions	Ranking Score
Vegetation Cover of Back Beach	
Bare Soil	10
Grassed	8
Bushes	5
Forested	0
Storm Exposure - Maximum Modelled Wave Height (m) within 250 m of Shore	
>4 m	40
3 - 4 m	30
2 - 3 m	20
1 - 2 m	10
0 - 1 m	5
Field Observation Modifiers	
Major slope instability (20+ m slope)	40
Minor slope instability (<20 m slope)	10
Thurber 2003 Erosion Rate > -0.3 m change	10
Thurber 2003 Erosion Rate -0.1 to -0.3 m change	5
Small river delta observed (> 250 m wide)	-5
Large river delta observed (< 250 m wide)	-10
No relevant observation	0

Table 3-2: Erosion Potential Ranking System

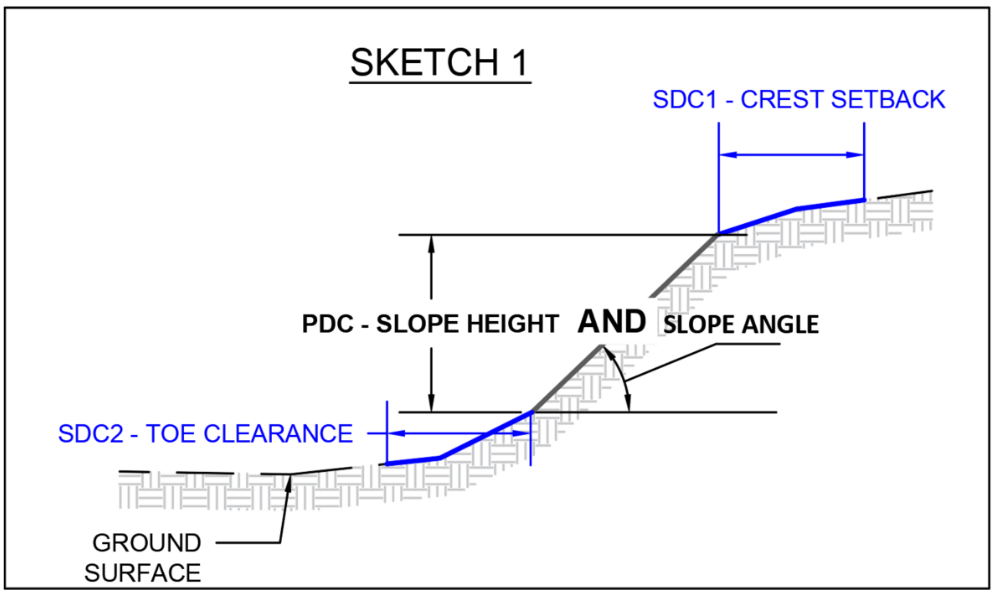
Ranking Description	Ranking Score
Very Low	0 - 20
Low	20 - 45
Moderate	45 - 70
High	70 - 125
Unranked	NA

4.0 SLOPE HAZARD AREA EVALUATION CRITERIA

Based on the review of the background information listed in Section 2.1, criteria have been developed to evaluate areas with slope hazard potential. These criteria are presented below and summarized in Table 3-1. Criteria have been developed for three main slope types: rock slopes, coastal soil slopes, and inland soil slopes.

The primary delineation criteria (PDC) used to identify the primary slopes with potential hazard areas include slope angle and slope height. Secondary delineation criteria (SDC) used to add an additional buffer to the primary area include a set-back from the crest and clearance from the toe of the potentially hazardous slopes (see Sketch 1). This secondary area is applied to include areas that could be impacted by regression of instability at the crest of the primary slopes and potential runout at the toe of the primary slopes.

Data from flood modelling to a potential 2100 sea level rise and 2019 LiDAR data was heavily relied upon throughout this analysis. Given this, the estimated design timeframe for these slope hazard areas is approximately 80 years.



Sketch 1: Illustration of primary delineation criteria (PDC) and secondary delineation criteria (SDC) for defining potential slope hazard areas

4.1.1 Rock Slopes

Rock slopes are those where bedrock is present at, or very close (~ 1 m) to the current ground surface. Potential hazard slopes were defined using the following criteria:

- PDC - Slope angle greater than 60% (approximately 30°) and greater than 3 m in height.
- SDC1 - Additional horizontal set-back distance of 7.5 m from the crest or highest elevation of these slopes. This is consistent with other set-backs for rock slopes in the region.
- SDC2 - Additional horizontal clearance distance at the toe of the polygon extending to the current shoreline.

4.1.2 Coastal Soil Slopes

Coastal soil slopes are those comprised of unconsolidated sediments that would be directly impacted by wave action during storm events or by future sea level rise and inundation as evaluated by Tetra Tech, 2022. The slope hazard area polygons around coastal soil slopes include areas with the following criteria:

- PDC - Slope angle greater than 35% (approximately 20°). No height restriction was added for coastal soil slopes on Savary Island given the previously observed coastal erosion on the island and the predominantly sandy nature of most coastal soils. This means every coastal soil slope on Savary Island is considered potentially hazardous.
- The limitations of the digital elevation model used in this analysis mean that some small soil slopes less than 1 m to 2 m in height with slope angles greater than 20° may not have been identified. This means there were locations where no continuous slope with an angle greater than 20° was identified within approximately 15 m of the 2100 highest high water level tide (HHWLT). In these situations, the 2100 HHWLT was assumed to be the crest of the coastal slope for set-back calculation purposes. The 2100 HHWLT was selected as the crest of the coastal slope in these situations as it roughly corresponds to the current natural boundary where coastal erosion has occurred based on field observations made during flood mapping work (Tetra Tech, 2022). A 15 m search radius was used as the Flood Hazard Area Land Use Management Guidelines (FLNRO, 2018) lists a 15 m offset between the toe of the slope and natural boundary as a generalization of where no set-back action is required for future coastal erosion.
- SDC1 - Additional horizontal set-back distance from the crest equal to:
  - In areas of low erosional potential as delineated in Tetra Tech, 2022, a minimum of 15 m **or** slope height + estimated 2100 natural boundary offset, whichever is greater.
  - The 2100 natural boundary offset has been estimated as the horizontal distance between the 2000 highest high water level tide (HHWLT) and the 2100 HHWLT. This offset has been selected under the assumption that migration of the natural boundary will be similar to the projected migration of the 2100 HHWLT relative to the 2000 HHWLT. Slope height is calculated as the crest elevation (i.e., elevation where slope decreases to less than 20°) minus the 2000 HHWLT elevation of 1.85 m. All elevations used in this study are in the Canadian Vertical Geodetic Datum (CVGD).
  - In areas of moderate erosional potential, a minimum of 15 m **or** slope height x 1.5 + 2100 natural boundary offset, whichever is greater.
  - In areas of high erosional potential, a minimum of 15 m **or** slope height x 2 + 2100 natural boundary offset, whichever is greater.
- SDC2 - Additional toe clearance approximately equal to the current shoreline.

4.1.3 Inland Soil Slopes

Inland soil slopes cover all other potentially hazardous slopes not covered by the previous categories. The slope hazard area polygons around creek soil slopes include areas with the following criteria:

- PDC - Slope angle greater than 35% (approximately 20°) and greater than 3 m in height.

- SDC1&2 - Additional horizontal set-back and clearance distances from the crest and toe of 5 m **or** slope height x 1.5, whichever is greater.

Table 4-1: Summary of Slope Hazard Area Criteria

Slope Type	Mapping Criteria to Delineate Potentially Hazardous Slopes[1]
Rock	▪ PDC - slope angle ≥ 60% (~ 30°) **AND** slope height ≥ 3 m. ▪ SDC1 - additional 7.5 m set-back from the crest of the primary area. ▪ SDC2 - additional toe clearance extending to the current shoreline.
Coastal Soil	▪ PDC - slope angle ≥ 35% (~ 20°). ▪ SDC1a - additional crest set-back equal to 15 m **OR** slope height + 2100 natural boundary offset for **low** erosion potential coastline, whichever is greater. ▪ SDC1b - additional crest set-back equal to 15 m **OR** slope height x 1.5 + 2100 natural boundary offset for **moderate** erosion potential coastline, whichever is greater. ▪ SDC1c - additional crest set-back equal to 15 m **OR** slope height x 2 + 2100 natural boundary offset for **high** erosion potential coastline, whichever is greater. ▪ SDC2 - additional toe clearance equal to the location of the current shoreline.
Inland Soil	▪ PDC - slope angle ≥ 35% (~ 20°) **AND** slope height ≥ 3 m. ▪ SDC1 - additional crest set-back equal to 5 m or slope height x 1.5, whichever is greater. ▪ SDC2 - additional toe clearance equal to 5 m or slope height x 1.5, whichever is greater.
Notes: 1 - See Sections 4.1.1 to 4.1.3 for additional explanation	

4.2 Exclusions

For clarity, the following items have not been specifically accounted for in our assessment of possible variables affecting slope stability:

- Tsunami effect on coastal slope soil stability.
- Seismic (earthquake) hazards or related phenomena.
- Wildfire hazards.
- Snow avalanche hazards.
- Human Modification of the Shoreline.

5.0 POTENTIAL SLOPE HAZARD AREAS

Based on the criteria listed in Section 3.0, potential slope hazard areas have been delineated and are spatially shown in Figures 2 and 3, attached to this document. An electronic version of the slope hazard areas will also be transmitted to the qathet Regional District with the final stamped version of this report.

Potential slope hazard areas calculated by this study were compared with minimum and maximum erosion rates presented in the Savary Island Dune and Shoreline Study (Thurber, 2003). This comparison generally found that the potential slope hazard areas were either consistent with or slightly larger than the areas that would be theoretically impacted by erosion based on the Thurber 2003 erosion rates.

The potential slope hazard areas shown are not necessarily areas where current slope hazards exist but where there is an elevated risk of hazards occurring. Some general recommendations with respect to existing and future developments within these slope hazard areas include:

- Any proposed new modification, new development, or modification to existing developments within the identified potential steep slope hazard areas should be reviewed by, and have site level assessment undertaken by, a qualified professional. Any further assessment should be completed in accordance with the latest professional practice guideline on landslide assessment in British Columbia released by Engineers and Geoscientists British Columbia (EGBC).
- The assessment should comment on the suitability of the site, estimated erosion rates and safety of the site and include a Landslide Assessment Assurance Statement.
- We recommend that the probability used to evaluate the risk of instability follow the guidelines outlined in EGBC's latest guidelines on landslide assessment in British Columbia. Where no specific probability is listed, we recommend it be 1/2500 years for consistency within the region and with seismic stability requirements.

6.0 LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of the qathet Regional District and their agents. Tetra Tech Canada Inc. (operating as Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the qathet Regional District, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

7.0 CLOSURE

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

Respectfully Submitted,
Tetra Tech Canada Inc.

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
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50076

SEPT 22, 2023

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Tetra Tech, 2023. Potential Slope Hazard Development Permit Areas - City of Powell River. June 27, 2023.

Thurber Engineering Ltd, 2003. Savary Island Dune and Shoreline Study. March 12, 2003.

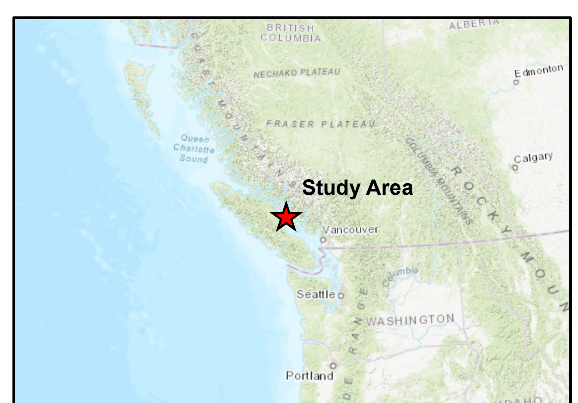
FIGURES

Erosion Potential

- High
- Moderate
- Low

Dominant Surficial Geology

- Marine
- Eolian
- Till
- Glacio-Fluvial
- Glacio-Marine
- Rock



NOTES

Base data source:
- Study location basemap sourced from ESRI World Topographic Map
- Imagery provided by qathet Regional District, dated 2022
- see Howes and Kenk,1997 for a detailed explanation of geological unit label nomenclature. Full reference: Howes, D.E. and E. Kenk. 1997. Terrain Classification System for British Columbia; Version 2; A System for the Classification of Surficial Materials, Landforms and Geological Processes of British Columbia. Ministry of Environment, Lands and Parks.

STATUS
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QATHET REGIONAL DISTRICT POTENTIAL SLOPE HAZARDS

Geology and Erosion Potential Savary Island

PROJECTION	DATUM	CLIENT
UTM, Zone 10	NAD83	qathet REGIONAL DISTRICT

Scale: 1:20,000
400 200 0 400
Metres

TETRA TECH

FILE NO.				
KGEO03893-01 Figure 1.mxd				
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September 21, 2023	ENG.KGEO03893-01			

Figure 1

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Base Legend for Surficial Geology Maps

Shoreline Types

Shoreline types describe the dominant grain size present

Map Units –from approximate youngest to oldest

A **Anthropogenic Material:** Human-made or modified geological materials. Within the study area this consists predominantly or concrete or rock blocks.

C **Colluvial Deposit:** Poorly to non-sorted mixture of rock fragments up to boulder size with silt, sand, gravel and often organic debris deposited by gravity-induced mass movement of upslope materials, including rockfall, rockslide, debris slide, debris flow, creep and slumping.

E **Eolian**: Wind-blown sediments generally medium to fine grained sand and coarse silt that commonly form dunes. Areas of both active and inactive dunes are present.

W **Marine:** Marine deposits refer to sediments deposited in, or along the edges of salt or brackish water bodies since the last glacial retreat. Materials generally include clay, silt, sand and gravel. Materials are generally moderately well, to well sorted and are very loose to compact.

F **Fluvial Deposit:** Sediment deposited by rivers and small streams in channels or as point bar or overbank deposits (synonymous with alluvial). Generally moderately to well sorted, bedded cobbles, gravel and sand with occasional boulders; silt, clay and organic matter are less common.

WG **Glaciomarine:** Dense to very dense till-like diamicton; often dominated by clay; can be rich in shells; deposited prior to and during the last glaciation.

WF **Glaciofluvial:** Dense to very dense till-like mixture of silt, sand, gravel and cobbles; often material are moderately to well sorted and can be partially cemented; deposited prior to and during the last glaciation.

M **Till:** Dense to very dense poorly sorted sediment (diamicton) deposited directly by ice by lodgment, melt out, or post-melt out gravity flow; generally matrix-supported and compact. Clasts consist of subangular to angular gravel, cobbles and boulders, with a clay to fine gravel matrix.

R **Bedrock:** In-situ bedrock

Textural Terms

- a **blocks:** > 256 mm particle size, angular
- b **boulders:** > 256 mm particle size, rounded
- k **cobbles:** 64 - 256 mm particle size, rounded
- p **pebbles:** 2 - 64 mm particle size, rounded
- s **sand:** 0.0625 - 2 mm particle size
- z **silt:** 2µm - 0.0625 mm particle size
- c **clay:** <2µm particle size
- g **gravel:** mixed of particles > 2 mm in size
- h **humic:** organic-rich soil
- m **mud:** mixture of silt and clay, may contain sand
- y **shells:** soil is predominantly shells
- x **angular fragments:** a mixture of angular fragments > 2 mm

Surface Expressions

- b **blanket:** deposit greater than 1 m thick; minor irregularities of the underlying unit (generally bedrock) are masked but the topographic form is still evident
- f **fan:** a sector of a cone; up to 15º
- h **hummocky**: hillocks and hollows, irregular in plan; 15 - 35°
- m **rolling:** elongate hillocks
- r **ridge(s):** Narrow, elongate and commonly steep-sided feature that rises above surrounding landscape
- t **terraced:** step-like topography
- v **veneer:** deposit less than 1 m thick; minor irregularities of the underlying unit (generally bedrock) are masked but the topographic form is obvious
- w **mantle of variable thickness:** deposit typically 0 to 3 m that fills or partially fills depressions

Delimiters

- / First component more common than second (e.g. Tv/R means till veneer covers 60-75% of polygon area, and exposed bedrock covers the rest)
- // First component much more common than second (e.g. Cbv//R means that a combination of colluvium blanket and colluvium veneer cover 80-95% of polygon area, with bedrock covering the rest)
- . First component approximately equal in proportion to the second.

G:\ENGINEERING\KGEO\KGEO03893-01 Savary Island Landslide Hazard Assessment\GIS\Maps\KGEO03893-01 Figure 1 Legend - Horizontal.mxd modified 9/27/2023 by MURRAY.GAFFNEY

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QATHET REGIONAL DISTRICT
POTENTIAL SLOPE HAZARDS

Nomenclature for Surficial Geology Map Labels

PROJECTION	DATUM	CLIENT
NA	NAD83	qathet Regional District
FILE NO.		TETRA TECH
KGEO03893-01 Figure 1 Legend - Horizontal.mxd		

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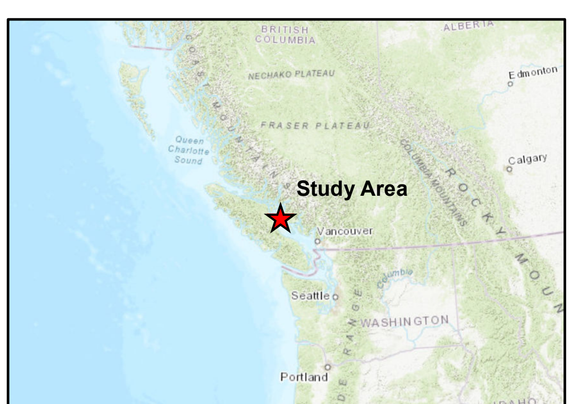
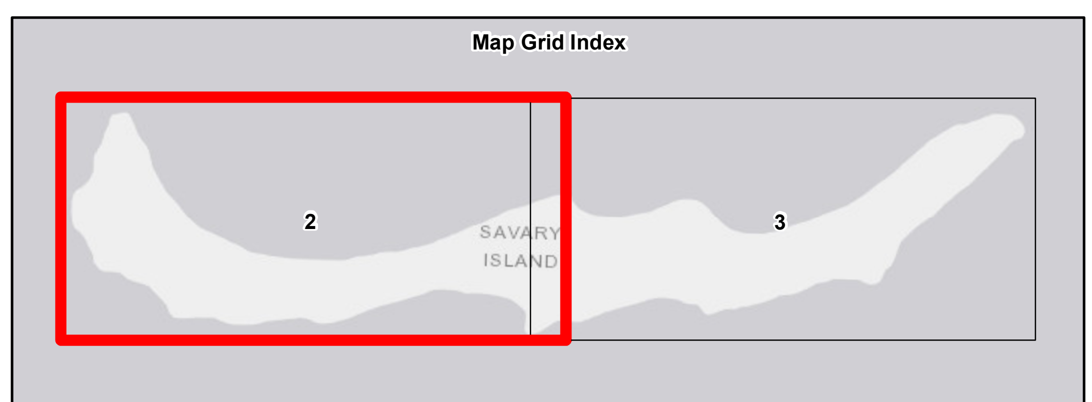
DATE	PROJECT NO.
September 27, 2023	ENG.KGEO03893-01

LEGEND

Potential Slope Hazard Area





NOTES
Base data source:
- Base Maps sourced from ESRI World Light Grey Canvas
- Study location basemap sourced from ESRI World Topographic Map
- Imagery provided by qathet Regional District dated 2022

STATUS
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QATHET REGIONAL DISTRICT POTENTIAL SLOPE HAZARDS

Potential Slope Hazard Areas Savary Island

PROJECTION	DATUM	CLIENT
UTM, Zone 10	NAD83	qathet Regional District

Scale: 1:10,000

200 100 0 200

Metres

TETRA TECH

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KGEO03893-01 Figure 2-3.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-KEL	SWG	GM	GM	0
DATE	PROJECT NO.			
September 20, 2023	ENG.KGEO03893-01			

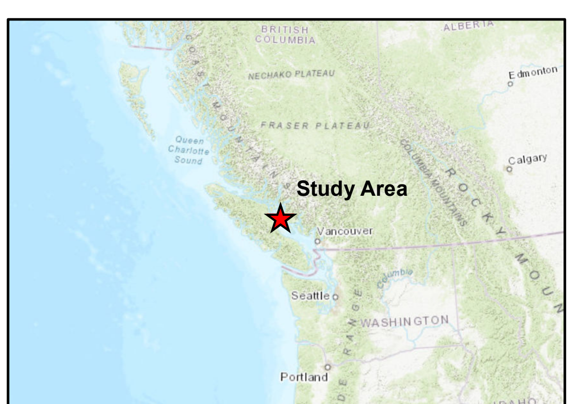
Figure 2

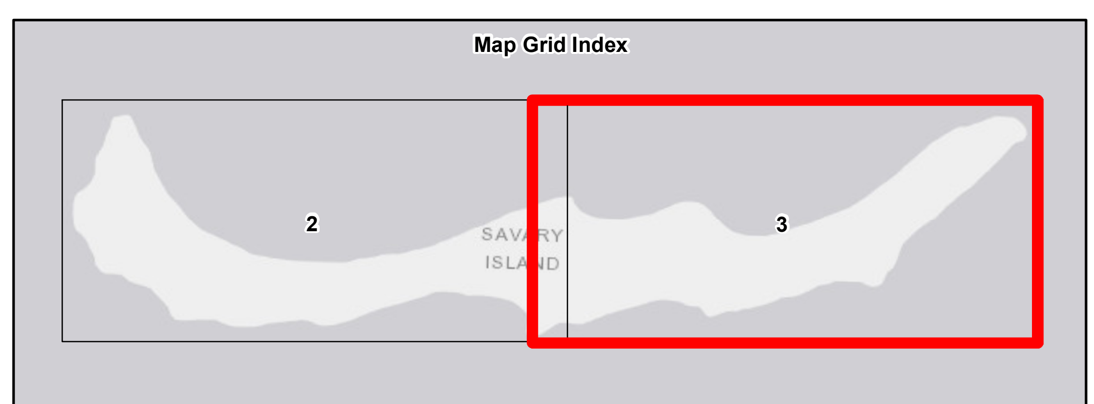
G:\ENGINEERING\KGEO\KGEO03893-01 Savary Island Landslide Hazard Assessment\GIS\Maps\KGEO03893-01 Figure 2-3.mxd modified 9/20/2023 by SHANE.GREENE

G:\ENGINEERING\KGEO\KGEO03893-01 Savary Island Landslide Hazard Assessment\GIS\Maps\KGEO03893-01 Figure 2-3.mxd modified 9/20/2023 by SHANE.GREENE

LEGEND

Potential Slope Hazard Area





NOTES

Base data source:
- Base Maps sourced from ESRI World Light Grey Canvas
- Study location basemap sourced from ESRI World Topographic Map
- Imagery provided by qathet Regional District dated 2022

STATUS
ISSUED FOR USE

QATHET REGIONAL DISTRICT POTENTIAL SLOPE HAZARDS

Potential Slope Hazard Areas Savary Island

PROJECTION	DATUM
UTM, Zone 10	NAD83

Scale: 1:10,000

200 100 0 200

Metres

CLIENT: qathet REGIONAL DISTRICT

TETRA TECH

FILE NO.
KGEO03893-01 Figure 2-3.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-KEL	SWG	GM	GM	0

DATE	PROJECT NO.
September 20, 2023	ENG.KGEO03893-01

Figure 3

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

GEOTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this document, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless stipulated in the report, TETRA TECH has not been retained to explore, address or consider and has not explored, addressed or considered any environmental or regulatory issues associated with development on the subject site.

1.8 NATURE AND EXACTNESS OF SOIL AND ROCK DESCRIPTIONS

Classification and identification of soils and rocks are based upon commonly accepted systems, methods and standards employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system or method prevail, they are specifically mentioned.

Classification and identification of geological units are judgmental in nature as to both type and condition. TETRA TECH does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

Where subsurface conditions encountered during development are different from those described in this report, qualified geotechnical personnel should revisit the site and review recommendations in light of the actual conditions encountered.

1.9 LOGS OF TESTHOLES

The testhole logs are a compilation of conditions and classification of soils and rocks as obtained from field observations and laboratory testing of selected samples. Soil and rock zones have been interpreted. Change from one geological zone to the other, indicated on the logs as a distinct line, can be, in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil or rock zone transition elevations may require further investigation and review.

1.10 STRATIGRAPHIC AND GEOLOGICAL INFORMATION

The stratigraphic and geological information indicated on drawings contained in this report are inferred from logs of test holes and/or soil/rock exposures. Stratigraphy is known only at the locations of the test hole or exposure. Actual geology and stratigraphy between test holes and/or exposures may vary from that shown on these drawings. Natural variations in geological conditions are inherent and are a function of the historical environment. TETRA TECH does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of more precise locations of geological units is necessary, additional exploration and review may be necessary.

1.11 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geological materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration. Unless otherwise specifically indicated in this report, the walls and floors of excavations must be protected from the elements, particularly moisture, desiccation, frost action and construction traffic.

1.12 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise specifically advised, support of ground and structures adjacent to the anticipated construction and preservation of adjacent ground and structures from the adverse impact of construction activity is required.

1.13 INFLUENCE OF CONSTRUCTION ACTIVITY

Construction activity can impact structural performance of adjacent buildings and other installations. The influence of all anticipated construction activities should be considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques, and construction sequence are known.

1.14 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geological deposits, the judgmental nature of geotechnical engineering, and the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations may then serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein.

1.15 DRAINAGE SYSTEMS

Unless otherwise specified, it is a condition of this report that effective temporary and permanent drainage systems are required and that they must be considered in relation to project purpose and function. Where temporary or permanent drainage systems are installed within or around a structure, these systems must protect the structure from loss of ground due to mechanisms such as internal erosion and must be designed so as to assure continued satisfactory performance of the drains. Specific design details regarding the geotechnical aspects of such systems (e.g. bedding material, surrounding soil, soil cover, geotextile type) should be reviewed by the geotechnical engineer to confirm the performance of the system is consistent with the conditions used in the geotechnical design.

1.16 DESIGN PARAMETERS

Bearing capacities for Limit States or Allowable Stress Design, strength/stiffness properties and similar geotechnical design parameters quoted in this report relate to a specific soil or rock type and condition. Construction activity and environmental circumstances can materially change the condition of soil or rock. The elevation at which a soil or rock type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geological materials of the type and in the condition used in this report. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil and/or rock conditions considered in this report in fact exist at the site.

1.17 SAMPLES

TETRA TECH will retain all soil and rock samples for 30 days after this report is issued. Further storage or transfer of samples can be made at the Client's expense upon written request, otherwise samples will be discarded.

1.18 APPLICABLE CODES, STANDARDS, GUIDELINES & BEST PRACTICE

This document has been prepared based on the applicable codes, standards, guidelines or best practice as identified in the report. Some mandated codes, standards and guidelines (such as ASTM, AASHTO Bridge Design/Construction Codes, Canadian Highway Bridge Design Code, National/Provincial Building Codes) are routinely updated and corrections made. TETRA TECH cannot predict nor be held liable for any such future changes, amendments, errors or omissions in these documents that may have a bearing on the assessment, design or analyses included in this report.