qathet Regional Coastal Flood Adaptation Strategy
FINAL TECHNICAL REPORT

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28 November 2022

Cover Photo: Aerial view of the qathet Regional District coastline, 23 June 2022.
Image by Ebbwater Consulting Inc.

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Certification

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Revision History

Revision No.	Date	Author of Record	Description	Remarks
1	10 Nov 2022	Tamsin Lyle, P.Eng.	Draft Report	Provided to Working Group for Comment
2	28 Nov 2022	Tamsin Lyle, P.Eng.	Final Report	Provided to qathet Regional District

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Ebbwater would like to acknowledge that this report was written at the Ebbwater Consulting Inc. office (and home offices), which are located primarily on the unceded traditional territories of the xʷməθkʷəy̓əm (Musqueam Indian Band), Sḵwx̱wú7mesh (Squamish Nation), and səlilwətaɬ (Tsleil-Waututh Nation); we are grateful to be guests of these Nations. We also acknowledge that project activities occurred in the Territory of the Tla'amin Nation.

The analyses were completed, and the report written by a multi-disciplinary team as follows:

- Tamsin Lyle, M.Eng., MRM, P.Eng. (Principal of Ebbwater) was the project technical lead, which included directing hazard mapping enhancements, developing engineering-based components of the adaptation strategy options, and writing large sections of the strategy documents.
- Erica Crawford, MA (SHIFT Collaborative) led the development, coordination, and delivery of the engagement sessions, as well as managing feedback and writing results. Her support team included Deanna Shrimpton and Devon Francis, and graphic design was done by Mia Hansen.
- Robert Larson, M.Sc., P.Ag. (Ebbwater) managed the project including supporting the development of the engagement activities and materials, and report-writing.
- Tamsin Mills, M.Sc., RPP (Independent Consultant) was the project's planning lead, which included review of policy and regulatory context and development of planning-based adaptation strategy components.
- Yinlue Wang, M.Sc. (Ebbwater) conducted technical analyses and mapping.

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List of Acronyms

AEP	Annual Exceedance Probability
AR5	IPCC 5th Assessment Report
BC	British Columbia
CDF	Coastal Douglas Fir
CEPF	Community Emergency Preparedness Fund
CFAS	Coastal Flood Adaptation Strategy
CoPR	City of Powell River
DFA	Disaster Financial Assistance
DP	Development Permit
DPA	Development Permit Area
EGBC	Engineers and Geoscientists British Columbia (formerly APEGBC)
EMBC	Emergency Management British Columbia
ENSO	El Niño Southern Oscillation
FCL	Flood Construction Level
FHALUMG	Flood Hazard Area Land Use Management Guidelines
GFDRR	Global Facility for Disaster Risk Reduction
GIS	Geospatial Information System
GSSD	Green Shores Shoreline Development
HHWLT	Higher High Water Large Tide
IPCC	Intergovernmental Panel on Climate Change
LG	Local Government
LGA	Local Government Act
LUP	Land Use Plan
LiDAR	Light Detection and Ranging
MOTI	Ministry of Transportation and Infrastructure
NB	Natural Boundary
NOAA	National Oceanic and Atmospheric Administration
NRCan	Natural Resources Canada
OCP	Official Community Plan
PARAR	Protect, Accommodate, Retreat, Avoid, and Resilience
PDO	Pacific Decadal Oscillation
PSC	Public Safety Canada
QGIS	Quantum Geographic Information System
QP	Qualified Professional
qRD	qathet Regional District
RAAD	Remote Access to Archaeological Data
RCP	Representative Concentration Pathway

RGS	Regional Growth Strategy
RIBA	Royal Institute of British Architects
RSLR	Relative Sea Level Rise (more commonly referred to as SLR)
SLR	Sea Level Rise
SoVI	Social Vulnerability Index
UBC	University of British Columbia
UBCM	Union of British Columbia Municipalities
UNDRR	United Nations Office for Disaster Risk Reduction (Formerly UNISDR)
USA	United States of America
WWTP	Waste Water Treatment Plant

1 Introduction

Coastal floods and erosion matter. People whose homes are inundated or damaged will remember for the rest of their lives. Landscapes are changed forever, and local, regional, and national economies suffer. The total residential flood risk in Canada is estimated at $2.9 billion per year (Public Safety Canada, 2022). The qathet region is no stranger to flood and erosion damages having experienced many coastal storms in the last two decades (Tetra Tech 2018).

The qathet Regional District (qRD), Tla'amin Nation, and the City of Powell River (CoPR), have recognised the need to adapt to these changes and have previously conducted foundational work, including a coastal risk assessment and coastal flood mapping. With support from the British Columbia Community Emergency Preparedness Fund (CEPF), in early 2022 the qRD retained Ebbwater Consulting Inc. (Ebbwater) to conduct a next phase of work. The goal was **to engage with rights holders, stakeholders, decision makers, and the public to build understanding, explore adaptation options, and develop a strategy to increase resilience to coastal hazards in the region**. To complete the Regional Coastal Flood Adaptation Strategy (CFAS), Ebbwater partnered with SHIFT Collaborative (Shift) to lead the design and delivery of the communications and engagement process.

The written project deliverables are as follows:

- This *Technical Report* is a companion document to the *Overview Report*. This *Technical Report* is primarily aimed at practitioners who will be working with the three project partners to implement the strategy. It provides background materials, details on methodologies, and detailed results including the feedback from engagement. The recommendations section provides detailed practical considerations and links to relevant resources.
- The *Overview Report* provides a condensed version of the project outcomes. It was written for decision makers and the public – it summarizes the contents of this *Technical Report*.

1.1 Problem Statement

All the coastline in the qathet region is subject to flood waters and damaging wave action to varying degrees. Previous studies conducted for the regional district identified preliminary areas of high risk with consideration of the hazard profile combined with an understanding of the people, infrastructure, and mapped cultural assets that might be impacted by the hazard. This work also highlighted regional challenges specific to a coastal community with no road connections to the rest of the province. For example, frequent ferry cancellations, and damages to the linear road system have caused disruption (see Sub-section 2.2.1).

Although relative sea level rise (SLR) projections for the region are relatively modest (see Sub-section 3.1.1), damages will increase with climate change. And although there is limited literature on the potential increase of storminess in the region, emerging science supports an increase in the frequency and severity of atmospheric rivers and other large climate processes (teleconnections), which can bring changes in air pressure and wind, which in turn affect coastal surges and waves (see Sub-section see Sub-section 3.1.1). There is also anecdotal evidence of observed changes to backshore terrestrial changes.

The climatic changes that are likely to disrupt the existing bio-physical setting (see Sub-section 2.1.1) will most certainly increase the likelihood for secondary erosion impacts (see Sub section 3.1.3). There is a need at this time to acknowledge and understand these hazards and risks, and more importantly to act through planning and adaptation.

In addition to the common-sense imperative to adapt to changing seas, Provincial guidelines encourages local governments to plan for flood hazards with consideration of future climate change (see Sub-section 4.1.1).

1.2 Moving Forward

The qathet Regional Coastal Flood Adaptation Strategy (CFAS) is a multi-year initiative that builds on past work and will require future phases for implementation. Figure 1-1 shows an overview of the strategy's phases and timelines.

Figure 1-1: Regional CFAS overview of phases and timelines.

This project established the groundwork for the strategy through a range of supporting tasks and activities (see Section 1.4). The project was guided by a working group that included representatives from the qathet Regional District, Tla'amin Nation, and the City of Powell River.

In recognition of the systemic challenge of climate impacts and climate adaptation, the project explored many dimensions of challenges and opportunities. As shown in Figure 1-2 this report explores a variety of coastal hazards. These occur in the context of three separate but ultimately linked jurisdictions and requiring input from a diversity of disciplines ranging from coastal science, to engineering, to planning. Throughout the project we engaged with and learned from decision-makers, the public, and practitioners.

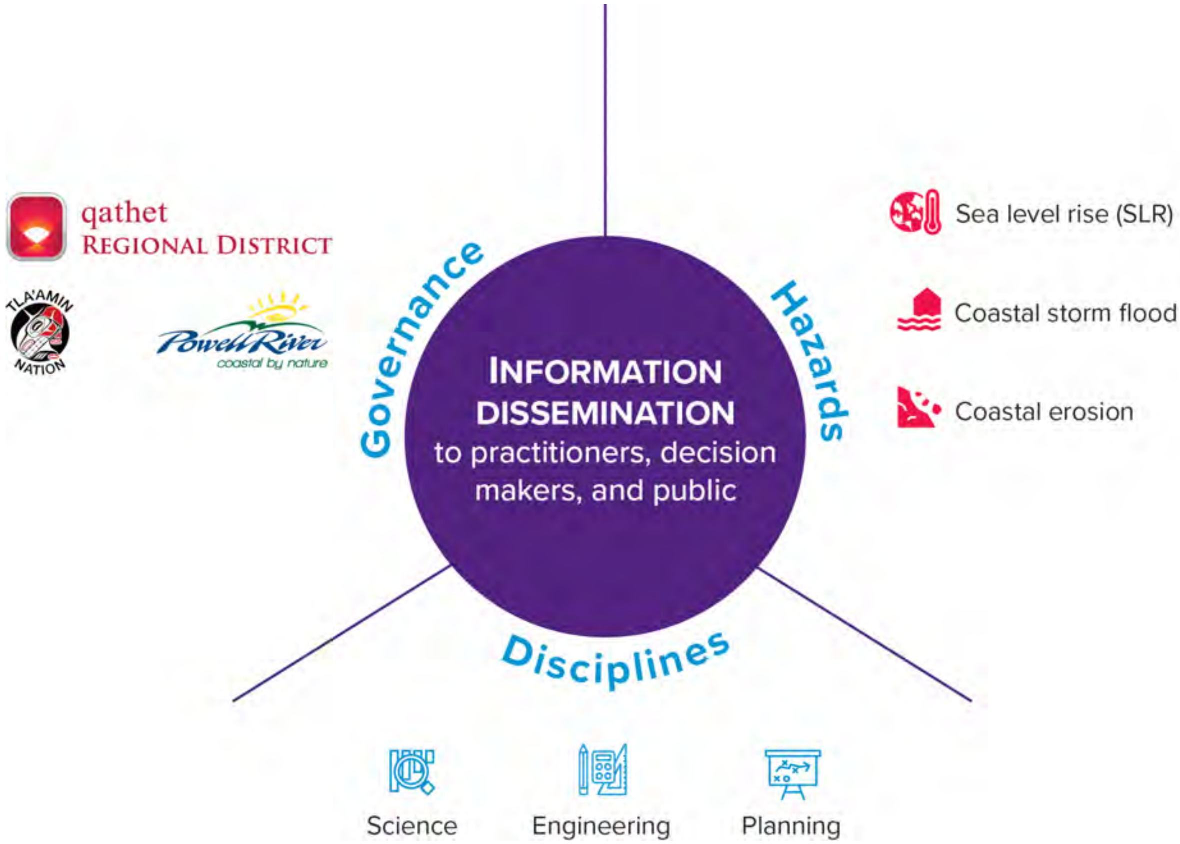


Figure 1-2: Overview of the type of information, and the audiences considered, for this project.

1.3 Project Objectives

To achieve the project goal, the project team collectively defined the following objectives:

1. Support collaboration of neighbouring governments and stakeholders to strengthen capacity.
2. Analyse and enhance flood risk mapping and identify possible coastal adaptation options.
3. Engage with the public to raise awareness and define community values to inform decisions.
4. Develop guiding principles to inform the identification of preferred coastal adaptation options.
5. Prepare a strategy with regional and local considerations, and practical timelines for action.

Considering the varied timeframes required for action, the strategy was broadly designed to support the region by:

- Setting the course to move together by developing clear and consistent educational, guidance, and regulatory tools to reduce coastal flood risk.

- Increasing resilience in communities in the face of potentially rapid bio-physical and socio-economic changes.

1.4 Project Approach

The project methods consisted of three multi-disciplinary supporting tasks for the development of an adaptation strategy: policy review, risk-based analyses, and decision support (Figure 1-3). The supporting tasks were iterated and refined through multiple phases of engagement activities, which was a critical component of the project (see Sub-section 1.4.1). The supporting tasks shown in Figure 1-3 fed into the development of two versions of strategy reports. Detailed methods and results for each activity are explored later in this report.

Figure 1-3: Summary of methods and basis for developing the adaptation strategies outline.

1.4.1 Engagement Activities

Engagement included working group participants, as well as rights holders, stakeholders, decision makers, and the public. The goal was to raise public awareness of the project, obtain input on community values and preferences, and gather feedback on a proposed range of coastal adaptation options. The overall engagement plan is outlined in Figure 1-4.

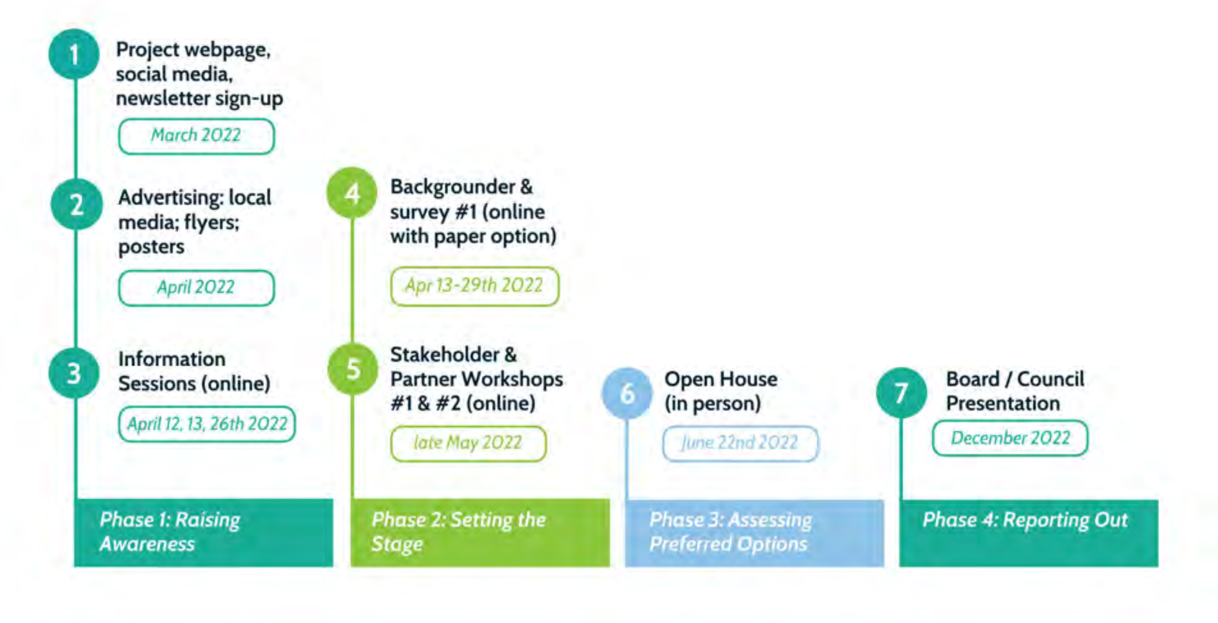


Figure 1-4: Overall engagement plan outline.

To advertise the project information sessions and survey, we produced radio advertisements and published announcements in magazines, newsletters, and newspapers. We printed over 11,000 2-page flyers that were mailed-out to residents, and also posted project posters. The project website was a key resource for information dissemination. The engagement activities culminated with an in-person event held at Willingdon Beach Park on 22 June 2022. The event included a presentation as well as interactive booths where attendees were invited to review results and proposed strategies, ask questions of the project team, and share their feedback and ideas (Figure 1-5). Local media covered the event in the Peak newspaper. More details on the engagement methods are found in Appendix D.

Figure 1-5: A project team staff member discusses with a member of the public.

1.4.2 Assessment Scales

To reconcile the vast coastline length within the project area and the need to consider specific factors for local areas, two spatial scales were used. The activities and analyses conducted at these two scales are described below.

- **Local Scales:** Given the complexity of such a large and varied area, we focused on a limited number of local areas that together illustrate the range of land use policy and regulation as well as bio-physical and socio-economic conditions we need to consider across the region. These "archetype" areas were developed in discussion with the project partners and leveraged earlier work that had previously identified areas of high risk along the coast. The archetype areas provided a more practical, place-based, understanding upon which to assess hazard and exposure. Per the project proposal, four archetype areas were selected based on a review of 13 candidate areas (these are shown and labelled in Figure 2-1).
- **Regional Scale:** All the engagement activities were conducted based on participant representation for the project area. The broad concepts presented, and the adaptation actions explored, are intended to be considered for local areas across the project area.

1.5 Project Report Structure

As described at the outset, this report is meant as a companion to the *Overview Report*, and describes in detail the background, methods, results, and recommendations related to the full project. It is intended as a reference, rather than a report to be read end-to-end.

The next section of this technical report provides project information on the project setting and relevant recent studies (Section 2). Next we present information on coastal flood and erosion risk to support a general understanding of the development of the strategy (Section 3). We then provide details on the supporting tasks (i.e., policy review, risk-based analyses, and decision support) (Section 4), which is followed by details on the engagement feedback (Section 5). This is followed by the recommended adaptation strategy, which includes the *Guiding Principles*, regional and enabling approaches, approaches to reduce risk and build resilience, place-based adaptation actions, specific approaches by jurisdiction (Section 6). The conclusion (Section 7) is followed by a glossary and list of references.

The appendices to this report are supplements to the three supporting tasks and the engagement feedback as follows:

- Appendix A: Policy Review – Background Notes
- Appendix B: Risk-Based Analyses – Detailed Methods and Results
- Appendix C: Decision Support – Strategies and Scenario Planning
- Appendix D: Engagement Feedback – Methods and Survey Results

2 Project Background

The following sections provide background information regarding the project setting and relevant recent studies.

2.1 Setting

The Tla'amin Nation Territories, including the qRD and member municipalities, are located on the edge of the Georgia Strait, and have nearly 800 km of coastline (see blue line in the inset map of Figure 2-1). The project area consists of all these coastal areas including Texada and Lasqueti, and many smaller Islands. Hugging the coast, Highway 101 (Sunshine Coast Highway, see red line in Figure 2-1) meanders through the area and is the main transport route that connects the various communities. The area is inaccessible by road to the lower mainland and is dependent on air transportation and ferry services from the City of Powell River and Saltery Bay (Figure 2-1).

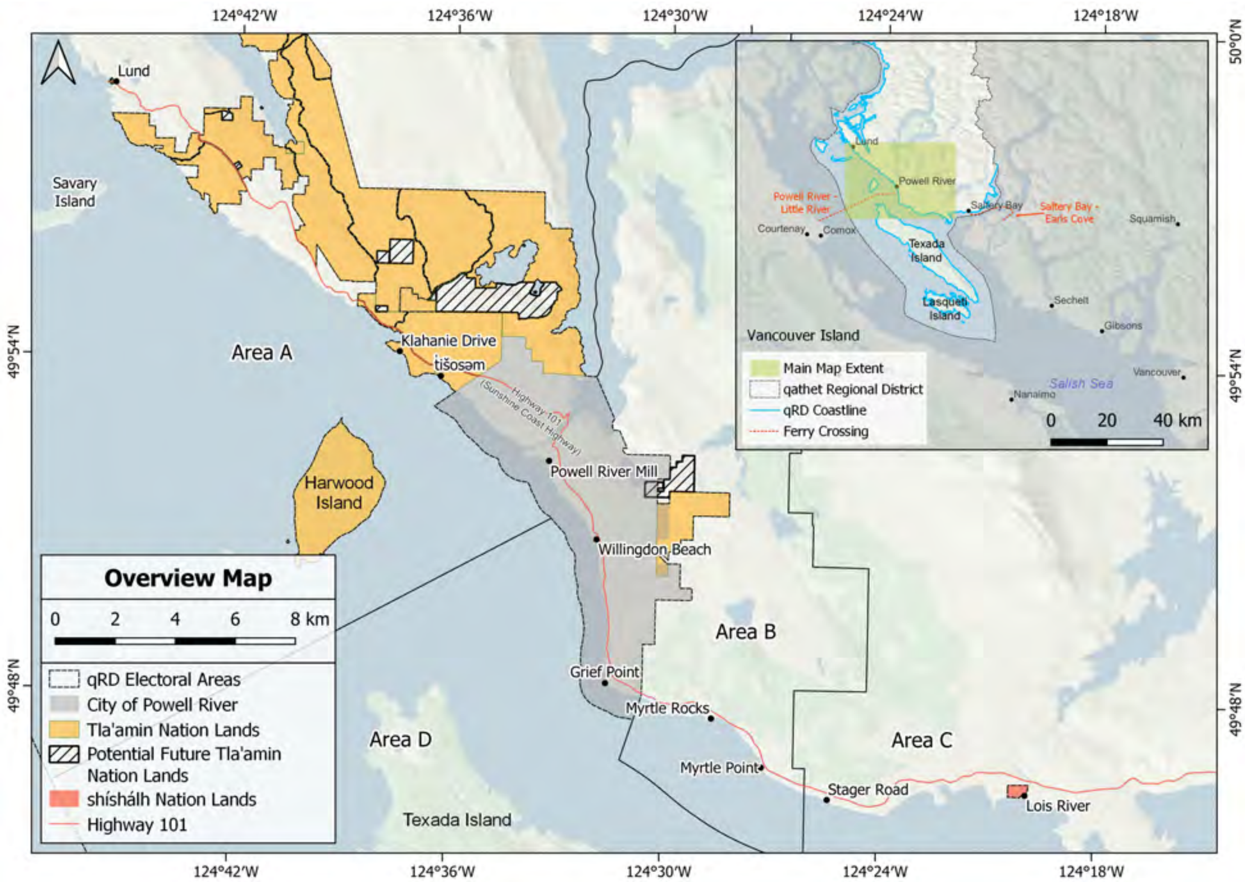


Figure 2-1: Regional project area, as well as candidate and final archetype areas used.

2.1.1 Bio-Physical

The last retreat of the continental glaciers, which ended approximately 7000 years ago, considerably altered the landscape in the project area. Relatively steep, irregular shorelines, and side channels were formed (see Figure 2-2 for an example). These features can act as protection from coastal flooding. However, they are also unstable: a substantial proportion of shorelines are composed of glacial deposits lacking a source of sediment and sedimentary rock cliffs and bluffs subject to wave action (Tetra Tech, 2018).

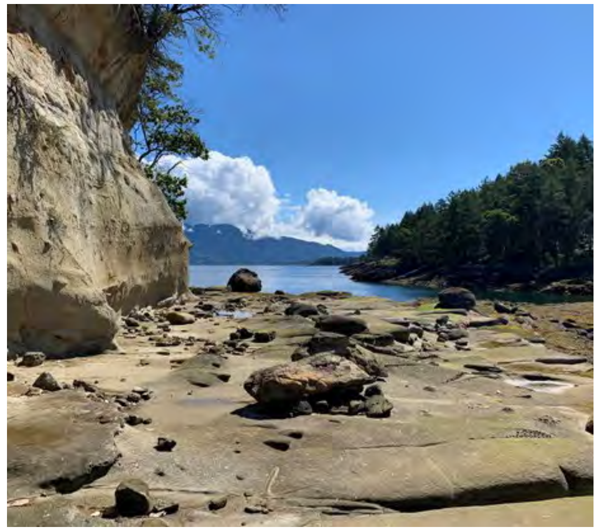


Figure 2-2: Example shoreline with combination of erodible and rocky material. Source: Tetra Tech 2018.

The region's shorelines are located in the Coastal Douglas Fir (CDF) biogeoclimatic zone and lie in the rain shadow of Vancouver Island and the Olympic Mountains. The majority of forests that are found today in the CDF have regenerated after logging that occurred at the turn of the century over 100 years ago (Meidinger & Pojar, 1991). During the fall, winter, and spring months the area is relatively moist with saturated air masses from the Pacific west coast and Salish Sea. During these seasons, the area receives higher levels of precipitation with a peak in January (138 mm on average)[1]. High winds and storms are also frequent during these months. Coastal influence on lower elevation areas near the sea moderates year-round temperatures. Shoreline areas receive very little snow in winter and summers are typically quite dry (Little, 2012). Daily average temperature in the region ranges from approximately 5 degrees Celsius in January to 19 degrees Celsius in August. (Tetra Tech, 2018). Changes to the bio-physical setting are being disrupted by sea level rise caused by climate change (see Sub-section 3.1.1).

2.1.2 Socio-Economic

The Tla'amin Nation people of today are descendants of a rich heritage with a history in the area that stretches back well over 4000 years[2]. All their economic and political systems, along with their spirituality, were based on their relationships with the traditional territory of their ancestors. This consisted of numerous permanent and temporary settlements, and many of which were along coastal areas. Today, the majority of the Nation's members live in the main village site in ɬiʔɬǰosəm. The Tla'amin Nation's traditional Territory spans 400 km^2 and includes most of the project area. Chapman & Patrick (2021) describes the Tla'amin traditional resource

[1] Based on climate normal data from 1981 to 2010 (Tetra Tech, 2018)

[2] Tla'amin Nation. Weblink: https://www.bcafn.ca/first-nations-bc/vancouver-island-coast/tlaamin-nation. Accessed 14 September 2022.

use in the area, and the Tla'amin Nation has been self-governing since 2016[3]. The unique relationship that the Tla'amin Nation has with the land is also shared with the shíshálh Nation. Their traditional territory includes the southeastern portions of the project area. The shíshálh Nation has been self-governing since 1986[4].

Following European settlement, conflict, and colonial policies and practices, the First Nations families endured hardship through loss of land, resources, and cultural connection. Today, the qRD and the CoPR have a government-to-government relationship with Tla'amin Nation[5]. The project area contains a total population of 21,496 people (all population numbers are from 2021 Census). This includes 6,197 people in the qRD Electoral Areas; 13,943 people in the CoPR; 797 people from the Tla'amin Nation; and 21 people from the shíshálh Nation. Economic activities range from pulp and paper to mining and mineral processing, logging, fishing, and tourism. There are many commercial fisheries including salmon and shellfish.

2.2 Relevant Recent Studies

In recent years, the project partners have conducted extensive work to increase resilience in the region. The sections below summarize technical and planning-based studies that qRD completed that laid the groundwork for this project. The most important work has been the completion of the detailed flood mapping and erosion potential ranking.

2.2.1 Coastal Hazard and Risk Mapping

In 2018, Tetra Tech conducted an overview coastal risk assessment of the qRD. This was followed-up with more detailed mapping in 2021 and 2022. These studies are summarized below.

2.2.1.1 Overview Coastal Risk Assessment

For the Tetra Tech (2018) overview assessment, flood extents were derived for several large rare coastal scenarios. The worst scenario assessed included a high tide condition, a storm surge with an annual exceedance probability (AEP) of 0.5%[6], waves from the southeast, and 0.5 m of sea level rise. Tetra Tech then assessed elements-at-risk within those extents, to identify priority areas in the region.

[3] Tla'amin Nation – Community. Weblink: https://www.tlaaminnation.com/community/. Accessed 14 September 2022.
[4] Welcome to shíshálh Nation. Weblink: https://shishalh.com/. Accessed 14 September 2022.
[5] This project is part of the collaboration and reconciliation pathway that the qRD and the CoPR are taking with the Tla'amin Nation. Weblink: https://www.ubcm.ca/sites/default/files/2021-08/Tlaamin_PowellRiver_20190909.pdf. Accessed 8 November 2022.
[6] The AEP indicates that the storm event has a 0.5% chance of occurring in any given year. It is based on *Provincial Guidelines* for the design flood and is equivalent to a storm surge with an indicative return period of 200 years.

Key findings from the overview assessment were as follows:

- There were 16 coastal hazard events that were identified and documented in the last 100 years.
- For the worst scenario assessed, there was an estimated 408 people, and 504 buildings, exposed. The estimated replacement cost for the structures and contents exceeded $215 Million.
- There were 38 critical, 22 commercial, 1 cultural, and 32 regional assets exposed with potential losses estimated at nearly $500 Million.
- Five main areas of Highway 101 were exposed to inundation.
- In the past 10 years, 10 BC Ferry cancellations occurred between Comox and Powell River due to wind events.

Recommendations included updating emergency response plans, conducting detailed risk assessments, and partnering with provincial and private entities (e.g., Ministry of Transportation and Infrastructure (MoTI), BC Ferries, private marine operators) to conduct a vulnerability assessment focused on transportation and utility infrastructure. The overview assessment was used to identify priority areas for future mapping.

2.2.1.2 Detailed Flood and Erosion Hazard Mapping

Following on the initial work, approximately 200 km of priority coastline length was mapped in detail (Tetra Tech 2021, 2022), on the mainland and islands. The modelling included similar parameters to what was used for the Tetra Tech (2018) work, but was more detailed and comprehensive. They assumed a coastal storm surge with 0.5% AEP and a wind-wave event having a 0.5% AEP, applying a joint-probability approach. This was combined with a high high water large tide (HHWLT). Based on *Provincial Guidelines* and a review of regional crustal uplift rates, Tetra Tech considered SLR of 1.0 m (with no crustal uplift) for the year 2100. Bathymetric data was obtained for the project to be merged with existing LiDAR data. The areas of study are shown in Figure 2-3.

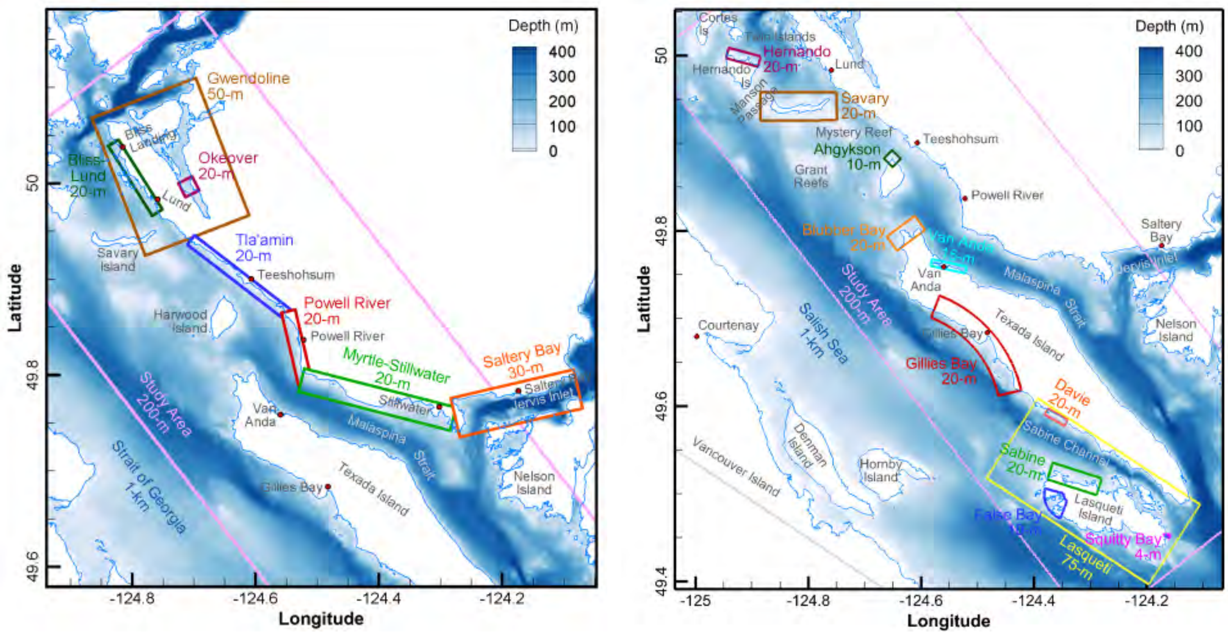


Figure 2-3: Study areas for the Tetra Tech Mainland (left) and Islands mapping projects. Source: Tetra Tech (2021, 2022).

The tide and storm surge scenarios were uniform across the project area. However, extreme wind and wave conditions were based on estimates for localized "domains" (outlined with the different coloured polygons shown in Figure 2-3). Figure 2-4 shows an example map showing the flood hazard water level elevations for a selected area in the southern portion of the mainland.

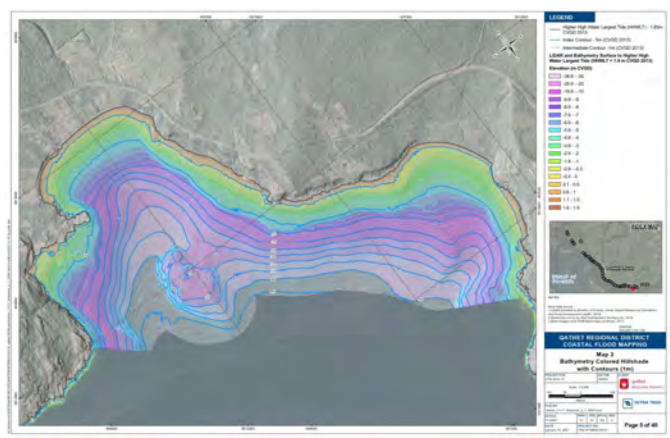


Figure 2-4: Example flood mapping image produced by Tetra Tech (2021).

The potential erodibility of shorelines were ranked based on six main variables (shoreline type, back beach geology, slope angle, vegetation cover, storm exposure, and specific field observations). The 4-point ranking scale consisted of "very low, "low", "moderate", and "high"[7]. For the areas studied on the mainland, 7% of shoreline length was ranked as "high". For the areas studied on the islands, 12% of shoreline length was ranked as "high" (see Table 2-1).

[7] Almost 20% of the shoreline studied was unranked.

Table 2-1: Summary of erosion potential for priority areas. Adapted from Tetra Tech (2021, 2022).

Ranking Description	Mainland (110 km assessed)	Islands (95 km assessed)
Very Low	52%	51%
Low	21%	9%
Moderate	19%	15%
High	7%	12%
Unranked	11%	8%

2.2.2 Land Use Plan Engagement

In 2020, the qRD completed a feasibility study to identify available land use and regulatory options to progress a number of regional initiatives including flood and erosion management. This was followed-up by a consultation program that occurred in late 2021, which involved in-person and virtual meetings for Electoral Areas A, B, and C, as well as Savary Island (Arlington Group and EPI, 2022). Close to 300 people participated in the consultations and nearly 1000 residents, renters, business owners, and employees responded to a survey (the responses represented approximately 20% of the combined population surveyed). Concern for coastal areas at risk was among six concerns that approximately 20% of the respondents listed.

3 Coastal Flood and Erosion Risk

This section provides background and supporting information on coastal flood and erosion risk including understanding of the hazards and their components, risk and resilience concepts, flood governance in BC, and coastal adaptation.

3.1 Understanding Coastal Flood Hazards

The British Columbia (BC) coastline is exposed to a number of coastal flood hazards; a hazard is a process or phenomenon that may cause damage. Coastal storm-driven flood hazards in the qRD arise when water levels are higher than normal in the Strait of Georgia. During these events, water level is a function of many components as shown in Figure 3-1. Though scientists know that sea level rise (SLR) is occurring, the rate of change is unknown and the uncertainty in projections is large (see Sub-section 3.1.1). Nevertheless, SLR is steadily increasing high tide water levels. Storm surge includes wind and wave set-up (see Sub-section 3.1.2), which create wave effects (see Figure 3-1). The water level components shown in Figure 3-1 range from being more or less predictable (i.e., deterministic versus probabilistic, respectively).

In addition to affecting total water levels, many components of coastal storms have significant associated forces that can damage the shoreline and assets on it. Erosion action can be induced by storms (and the associated wave effects) and creates a significant secondary hazard (Sub-section 3.1.3).

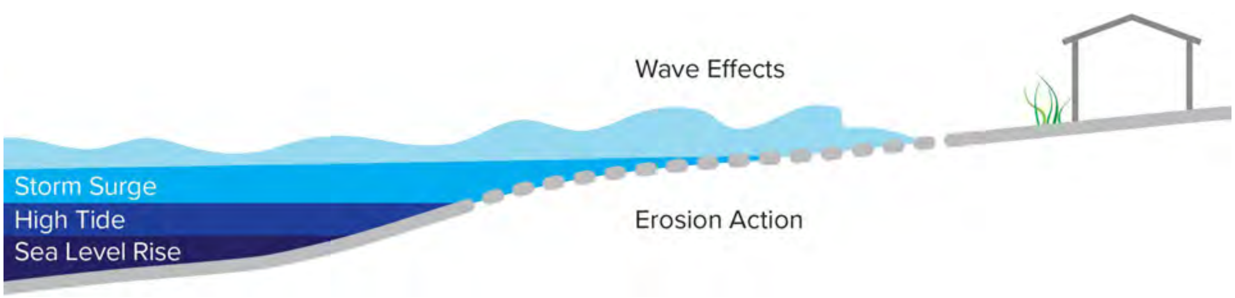


Figure 3-1: Coastal storm flood water level influences.

The following sections describe the various influences of coastal water levels in more detail.

3.1.1 Sea Level Rise

Around the world, sea levels are rising due to the melting of ice caps and glaciers with climate change, and the expansion of ocean water caused by warming (Union of Concerned Scientists, 2015). Variations in local sea level rise occur due to differences in topography, gravitational forces, and ocean currents; the west coast of North America generally experiences lower than average global SLR rates.

Relative sea level rise (RSLR) is a function of the rise in sea level compared to vertical changes resulting from geological processes (land subsidence or uplift over time) (Figure 3-2).

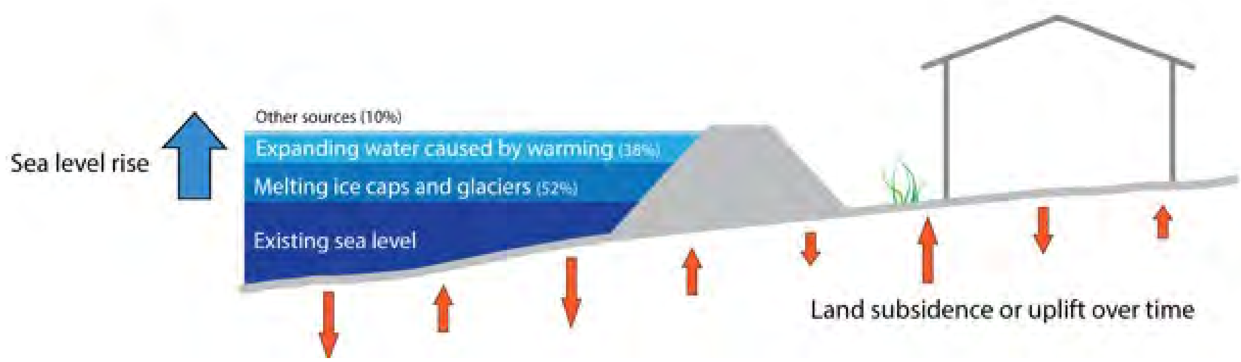


Figure 3-2: Drivers of RSLR including components of SLR and land subsidence or uplift—estimates of factors contributing to SLR are based on Union of Concerned Scientists (2015).

SLR [8] is a quasi-deterministic process (i.e., the upward trend is known, but the rate of change is unknown) and the uncertainty in projections is large. For example, a global study projected SLR of several metres on a time scale of 50 to 150 years (Hansen et al., 2016). The study considered the possibility that the Greenland and Antarctic ice sheets would melt; this has begun and is assumed to be a non-linear process.

The most recent SLR projections for Canada are based on the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report (AR5)[9]. For the project area, the median projection for the year 2050 from the AR5 shows an increase of approximately 1 cm in SLR based on the median of Representative Concentration Pathway (RCP) 8.5. This is considered the "business-as-usual" greenhouse gas emissions scenario. However, projections for the year 2100 for the same RCP shown an increase of approximately 26 cm, with most scenario projections falling in the range of -10 cm to + 55 cm (Figure 3-3). Projections for an "enhanced" RCP 8.5 scenario, which considers an enhanced meltwater source from West Antarctica (explained above), increases the projection to approximately 100 cm for the year 2100. The increases are relative to the 1986 to 2005 period (James, Robin, Henton, and M. Craymer, 2021)[10]. The *Professional Practice Guidelines* and the *Provincial Guidelines* both propose 1 m of SLR by 2100 (see Figure 3-4).

[8] In this report, references to sea level rise (SLR) usually refer to relative sea level rise (RSLR).

[9] The AR6 has been released, but local data for the project area has not yet been uploaded to climatedata.ca.

[10] The refined data are from James et al. (2021) was obtained from Climate Data for a Resilient Canada. Weblink: https://climatedata.ca/explore/variable/slr/?coords=49.79855248452189,-124.31373596191408,10&geo-select=&rcp=rcp85-p95&decade=2100&rightrcp=disabled. Accessed 14 December 2021.

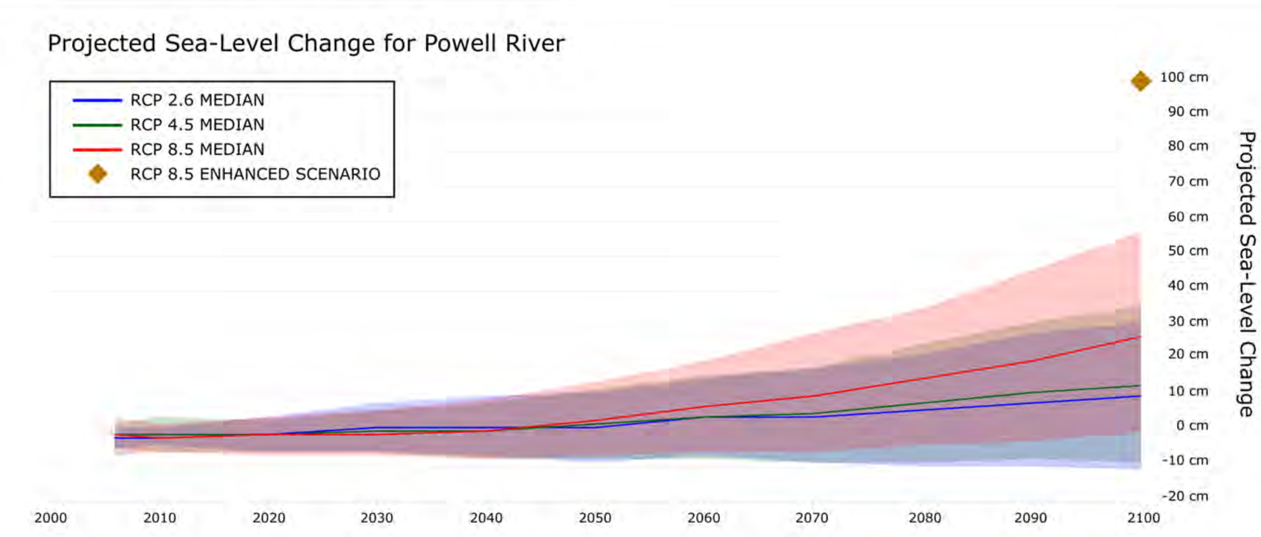


Figure 3-3: Relative sea level rise projection for Powell River area to the year 2100. Source: climatedata.ca.

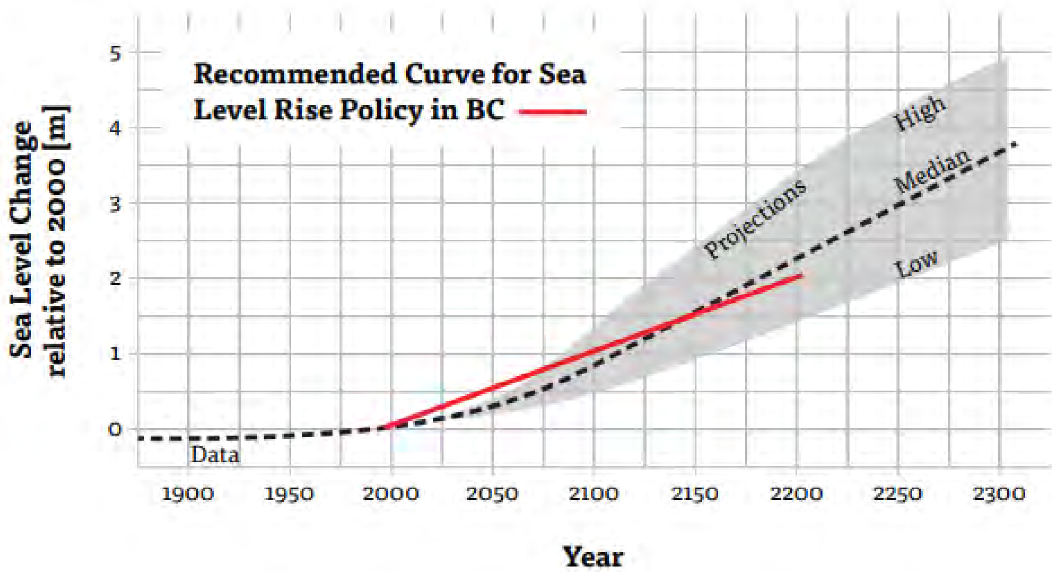


Figure 3-4: Projections of global SLR and BC policy. Source: Ausenco (2011).

Climate change and SLR must be considered to determine total water levels resulting from storm hazards. It should be noted that there is limited information to inform changes to the storm hazard intensity (sometimes called storminess) and frequency off the west coast of Canada as a result of climate change (see more information below). At present, the guidance is to continue to use historic records to inform flood hazard assessments and mapping.

3.1.2 Tides, Storms, Waves, and Global Weather Processes

Compared to SLR, tides, storms, and waves occur on daily to weekly timescales. They are readily observed and more details on each are provided below. In addition, we present some high-level information on larger global processes that affect weather, and therefore coastal storms.

3.1.2.1 High Tides (deterministic)

Tides are the periodic rise and fall of the ocean surface. Tide levels vary throughout the day, but are also subject to longer-term cycles, caused primarily by the relative positions of the sun, moon, and Earth. The maximum tidal elevation occurs once every 18.6 years in BC, but the level comes close to this for a few tides each year. These yearly large tides are often referred to as king tides.

3.1.2.2 Storm Surge (probabilistic)

A storm surge is a localized increase in water levels due to low-pressure systems in the atmosphere (storms). As these systems move from the Pacific into coastal water, the reduced localized atmospheric pressure on the ocean causes the water levels to rise. Storm surge includes wind and wave set-up, which is associated with strong local onshore winds blowing over shallow water. This wind blows the water onto the shore resulting in a localized increase in the water level as the water is “piled up” against the shore.

3.1.2.3 Wave Effects (probabilistic)

Wind-generated wave effects are a key component of coastal flooding. Waves develop as wind blows across the ocean. When consistent waves blow across a large distance without obstruction, known as the fetch distance, waves grow. The length and strength of winds as well as the direction of the winds and therefore the fetch affect the size of waves. These deep ocean waves then move onshore.

The local wave effect is dependent on the shoreline characteristics and exposure at a given location. Shallow, gentle slopes are more effective at dissipating wave energy and lower the magnitude of wave effects (also called wave runup), which is manifested as overtopping or splashing (see Diagram A in Figure 3-5). Steeper slopes or vertical features such as a rocky bluff or steep cliff cause relatively higher wave runup (see diagram C in Figure 3-5).

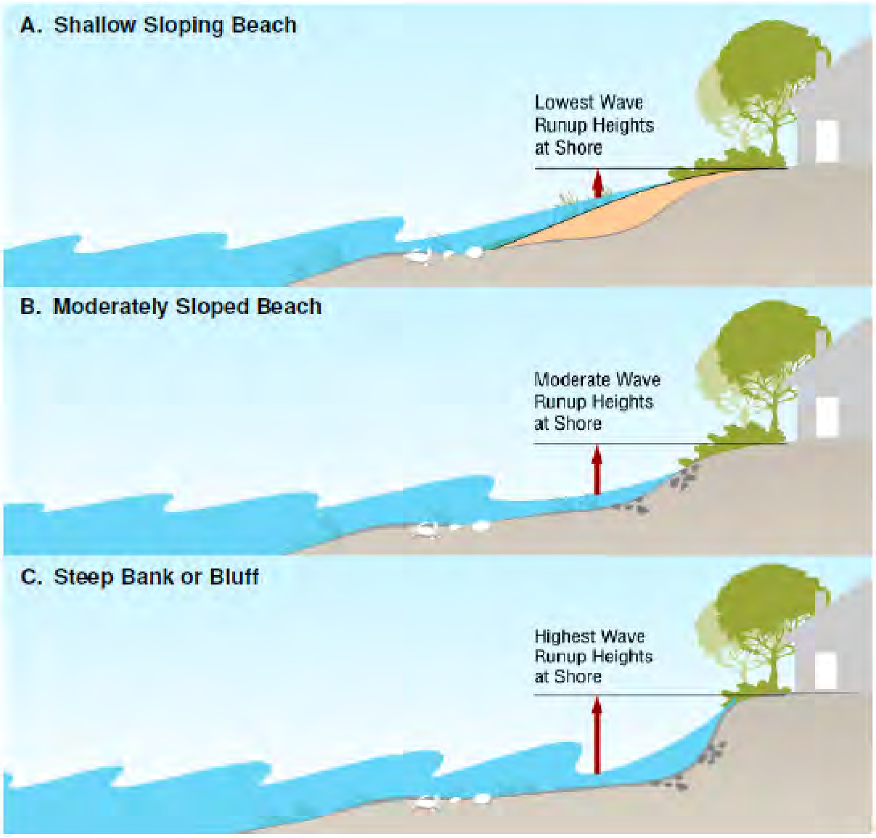


Figure 3-5: Effect of different shoreline slopes on wave runup. Source: KWL (2021) (used with permission).

3.1.2.4 Global Weather Processes

Inter-annual climate variation refers to cyclical shifts in climate conditions due to global atmosphere-ocean circulations (teleconnections), for example the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO). Variations of sea level with these oscillations are mostly due to changes in water temperatures and the resulting expansion or contraction of sea water. These sources of “natural variability”, however, are also affected by climate change, and are increasingly linked with greater intensity and extremes in coastal waves in the Pacific region (Boucharel, Almar, Kestenare, & Jin, 2021).

3.1.3 Erosion Action

Coastal erosion describes the loss of land due to the net removal of sediment or bedrock (UNISDR, 2017). Erosion occurs due to the storm-driven processes shown in Figure 3-1, along with longer-term geomorphological processes (e.g., glacial, tectonic, and fluvial events A shoreline's susceptibility to erosion is dependent on the frequency and magnitude of these processes as well as the shoreline materials. Rocky shorelines are more resistant to erosion than soil shorelines (Tetra Tech, 2018). Figure 3-6 shows example property-level impacts.

Figure 3-6: Erosion on waterfront property on Savary Island (photo taken on 13 November 2017). Source: Bud Graham.

Based on a global-scale study, human activities such as building coastal structures and clearing coastal ecosystems are a dominant driver for changes in coastal erosion. These activities have led to increasing movement of sediment and a net loss of land (Mentaschi, Vousdoukas, Pekel, Voukouvalas, & Feyen, 2018)[11].

In developed areas, erosion protection measures such as rip rap slopes and seawalls can influence flooding and wave effects and can lead to increased beach erosion and bank destabilization over time (Kerr Wood Leidal Associates Ltd., 2021). Climate change is expected to accelerate erosion on Canada's coasts (Eyquem, 2021).

3.2 Flood Hazard Components

A natural hazard such as coastal flooding is generally defined by considering a hazard profile, which is made up of the flood hazard magnitude and associated characteristics (onset, depth, velocity, etc.) and the likelihood (probability) of the hazard occurring. From a technical perspective, risk management professionals generally consider the risk associated with an event to be the product of the probability of it occurring and the consequences (Section 3.3 provides a non-technical discussion on risk and resilience).

An understanding of the hazard profile is important when considering planning and response so that adaptation options target different types of floods (e.g., rare or frequent, deep or shallow,

[11] The study found that the overall surface of eroded land has been estimated to be about twice the surface of gained land, based on satellite imagery for the period 1984 to 2015.

etc.). A full flood hazard assessment requires an understanding of what will flood, and how likely this is. The work conducted as part of this project considered a variety of hazard scenarios to support the concept of a hazard profile, and future risk profiles.

3.2.1 Likelihood and Magnitude

Likelihood (the probability that a flood of a certain size will occur) and magnitude (the size of a flood) are two defining characteristics of flood. These are inversely proportional to each other; large events occur rarely, and small events more frequently (see Figure 3-7). Frequent but small floods present very different risks than rare and large floods. Best practice for flood management is to consider multiple events (from smaller, more frequent events through larger, rarer events).

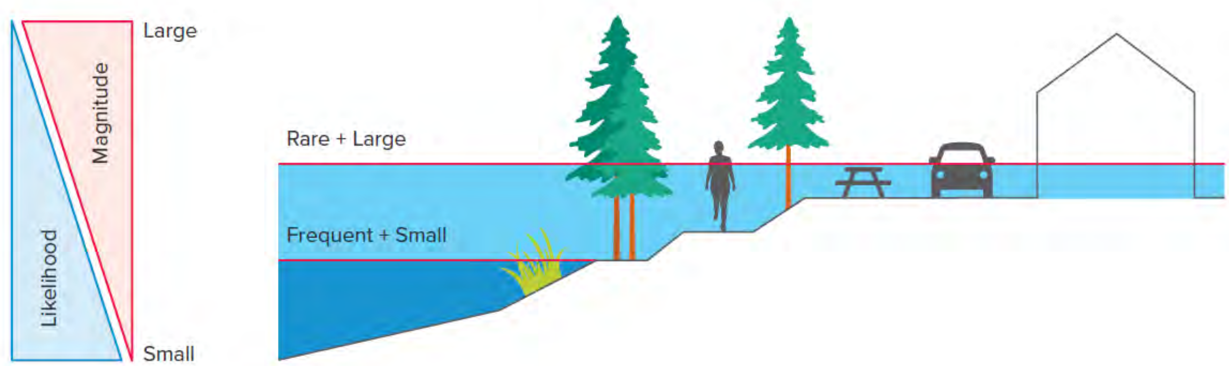


Figure 3-7: Simplified relationship between flood hazard likelihood and magnitude.

Flood magnitude is measured in elevation for lake or coastal flooding. Likelihood is generally defined or presented as an Annual Exceedance Probability (AEP), which is the probability of an event of a given size occurring or being exceeded in any year, described as a percentage. For example, a 0.5% AEP event, has a 0.5% chance of occurring or being exceeded in any given year[12].

Another way to think about flood likelihood is through the use of encounter probabilities, where it is possible to calculate the likelihood of encountering an event of a given size over a defined time period—for example, the length of an average mortgage (25 years). For instance, there is a 93% chance that a 10% AEP flood will occur over this time period, and there is a 12% that a 0.5% AEP flood will occur (Table 3-1). Understanding the likelihood of an event, as well as the encounter probability of an event, can support decisions related to flood management.

[12] This is sometimes referred to as a 1/200 or 200-year event. However, this is misleading, as it infers that once an event of this size has occurred, it will not occur again for 200-years, which is not the case.

Table 3-1: Encounter probabilities for various flood likelihoods.

Annual Exceedance Probability (AEP)	Indicative Return Period	Encounter Probability of Occurrence in 25 years	Encounter Probability of Occurrence in 50 years	Encounter Probability of Occurrence in 75 years	Encounter Probability of Occurrence in 100 years
10%	Once every 10 years	93%	99%	100%	100%
2%	Once every 50 years	40%	64%	78%	87%
1%	Once every 100 years	22%	39%	53%	63%
0.5%	Once every 200 years	12%	22%	31%	39%
0.2%	Once every 500 years	5%	10%	14%	18%

3.2.2 Depth and Power

In addition to the total volume of water associated with a flood event, how the water spreads and moves over the floodplain is an important consideration.

Flood depth is a big determinant of how much damage is caused. Nuisance flooding in a basement, for example, is very different from moderate (>30 cm) or severe (>2m) flooding, which can respectively cause significant to sometimes unrecoverable damage. Depth generally, but not always, decreases with distance from the water source.

Powerful waves on the shoreline of the coast have additional energy that can cause erosion and other damage to assets within the wave zone.

3.2.3 Spatial Scale

The spatial scale (how widespread or localized flood and erosion are) will matter for response and recovery. Large regional events that affect many communities at once may stretch resources, whereas a small, localized event on one shoreline reach or area might be more manageable, if it is a location with good access and response systems.

3.2.4 Onset and Duration

The characteristic of temporal scale (how quickly it happens, when, and how long it lasts) is an important consideration. The onset time is directly related to the efficacy of many temporary flood mitigation actions, as these are only effective if they are put in place in time.

Further, it is important to consider how long an event will last, and therefore how long water will be in contact with elements on the flood plain. In general, the damage associated with flood is less for shorter events, whereas if a building is wet for days or weeks the structural damage will be severe and may require that the building be destroyed.

3.3 Risk and Resilience

Coastal areas inundating shorelines are not in themselves a problem. It is when flood waters interact with things we care about on the floodplain and cause negative consequences that we have cause for concern. This project uses the concepts of risk and resilience to support a holistic understanding of flood and the adaptation options that can be taken to mitigate its damages.

The following sections discuss how the hazard information, explained in the previous section, is used within the context of a risk assessment.

3.3.1 Key Terms

Risk is the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society, or a community, determined probabilistically as a function of hazard, exposure and vulnerability (UNDRR, 2017a).

As illustrated in Figure 3-8, risk is defined by the total area of a triangle, whose vertices are **hazard** (in this case flood), **exposure** (the things people, organizations, and stakeholders care about that are exposed to floodwaters) and the **vulnerability** of these things being damaged by floodwaters.

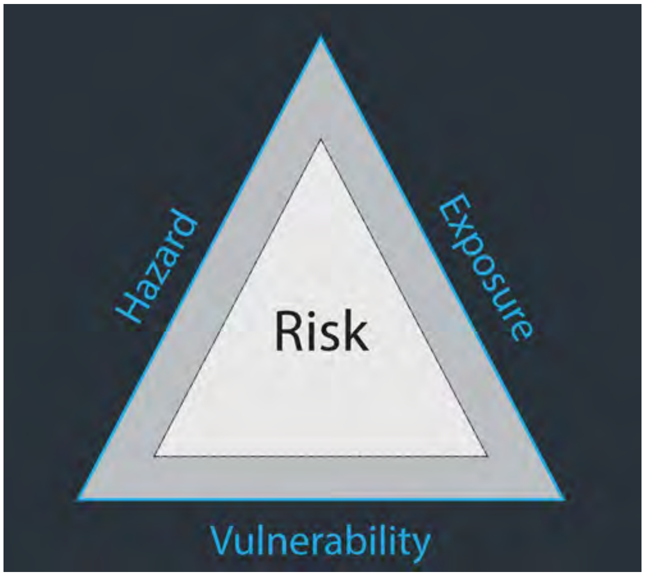


Figure 3-8: Risk as a function of hazard, exposure, and vulnerability. Based on (GFDRR, 2016).

There are three levers to increase OR reduce risk. Hazard, exposure and/or vulnerability reduction can all play a role in overall risk reduction. This more complex, but important take on flood mitigation, means that there are many more tools available to support risk reduction.

In the last hundred or so years, many western governments have focused on trying to stop water from interacting with assets through the construction of large engineering works. This effectively limits risk reduction options to one of three possible levers.

3.3.2 Dynamic Risk

Risk is not static. It can both increase and decrease with time. The challenge is that given present day pressures, two vertices are trending outwards, increasing the overall risk (Figure 3-9). Climate change is affecting the frequency and severity of flood events, increasing the overall hazard, and development pressures and trends mean that more people and things are being placed in flood hazard areas (i.e., increased exposure).

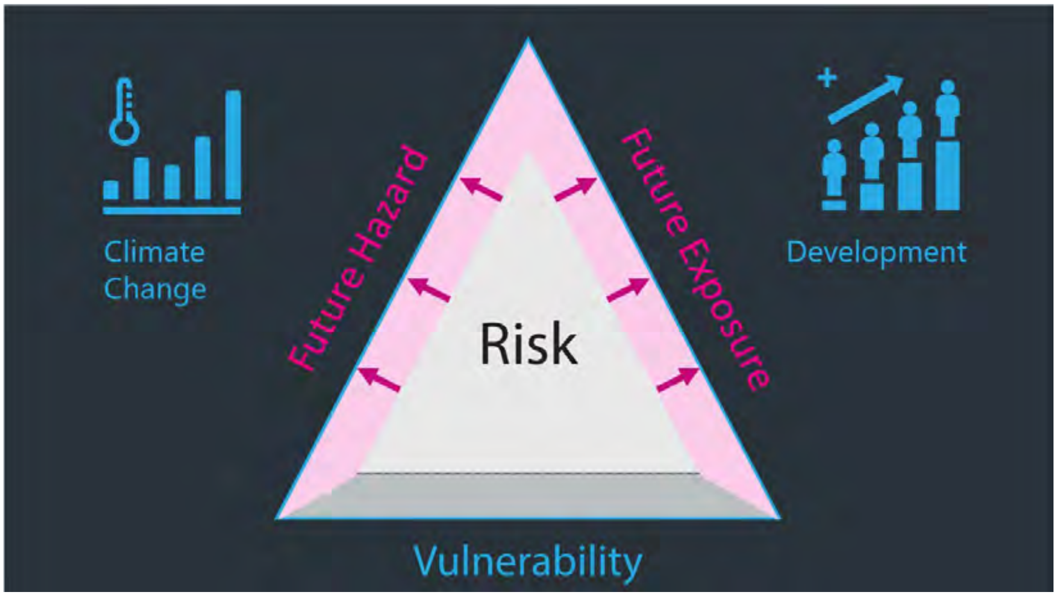


Figure 3-9: Increasing risk with climate change and increased development.

While risk is tending to increase, there is still opportunity to arrest the increase, especially as it relates to increased exposure. And, of course, there is still opportunity to reduce risk through careful considerations of actions that reduce future hazard, exposure and/or vulnerability.

3.3.3 Systemic and Wide-Ranging Risk

Floods and disasters are extremely complex. Society has become acutely aware of this through experiencing the COVID-19 pandemic. Impacts have been felt widely, to human health, but also to local and global economies. And, impacts have not been felt equally, some people have faced insurmountable challenges, whereas others have had limited impacts. These discrepancies are linked to differences in vulnerability (described in Sub-section 3.3.1) and resilience. **Resilience** is defined as the "ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management." (UN, 2016; UNDRR, 2017a)

Even when risk reduction measures are taken, risk from natural hazards can never be completely eliminated. This is known as **residual risk**. Additional or complementary measures, such as flood insurance, are designed for this purpose.

3.3.4 Impacts or Consequences

Impacts from coastal storm floods can affect communities in different ways; this is influenced by the values that are shared among individuals in that community. In the table below we provide example impacts in terms of a broad set of indicators: people, economy, environment, culture, and critical infrastructure. Note that there is no "correct" way to think about impacts, other than understanding that they can be very diverse, and that impacts overlap between indicators. This holistic way of thinking about impacts is critical when weighing solutions.

People	People are affected in a range of ways by flood and erosion. This may include people who are injured or suffer other health effects (e.g., trauma or stress), are evacuated or displaced, or suffer due to compromised livelihoods (e.g., their uninsured house is damaged or they lose their job).
Economy	Flood and erosion can cause potential economic losses through property and equipment damage and other far-reaching consequences. This includes repairs to public and private infrastructure, and losses due to reduced revenues (e.g., tourism operators, accommodations, businesses and food sectors) following a flood.
Environment	Flooding is an important component of many ecosystems and is a naturally occurring process; green spaces can provide positive benefits by absorbing flood waters. On the other hand, flood may lead to the overflow or discharge of contamination sources into the environment, or cause damage to environmentally sensitive areas. Contamination may include sewage and fuel spills from flooded septic systems and storage buildings.
Culture	The cultural life of a community may experience various impacts due to flood and erosion. This includes both Indigenous and non-Indigenous cultural sites, historic uses, beach access points as well as recreational spaces, trails, and sacred areas. It can also include community centres, schools, and other important gathering places.
Critical Infrastructure	Flood and erosion can impact many types of infrastructure that is regarded as necessary for communities to function. This can include transportation infrastructure such as ferry docks and highways, as well as health services, emergency response (police, fire), and government facilities. Utilities such as power systems, water and wastewater, and telecommunications are also critical.

Figure 3-10: Summary of coastal flood and erosion impacts for a set of indicators.

3.3.4.1 Cascading Impacts

Many impacts can have cascading consequences that are felt far beyond what is touched by the actual floodwaters. For example, damage to a ferry dock affects the communities and supply chains that are dependent on service from that station. Similarly, one localized disruption from a flooded road or power transmission pole affects a whole network. Remote areas have few alternative systems, meaning that these disruptions can severely reduce access to services and goods such as medical care, schools, and food (Figure 3-11).

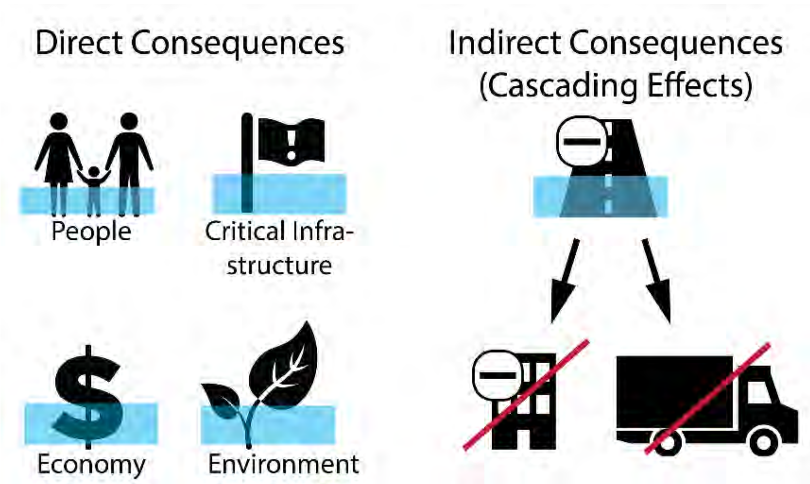


Figure 3-11: Direct and indirect impacts of flood and erosion hazards.

3.3.4.2 Coastal Squeeze

As relative sea levels rise, land areas decrease in size. Prior to human settlement in coastal areas, coastal ecosystems adapted to rises in relative sea level by shifting further inland to higher elevations. Following human settlement, fixed infrastructure such as homes and seawalls limit the landward migration of coastal habitats, effectively "squeezing" them out. These relative changes are tracked using the concept of the "natural boundary" between the sea and land (see Appendix A for more details).

Coastal squeeze is an example of cascading impact affecting the environment indicator. Coastal ecosystems often act as coastal protection by storing water and diffusing wave energy. The nature-based coastal protection is lost due to coastal squeeze, exacerbating coastal flood hazards (Eyquem, 2021).

3.3.5 Sendai Framework

Sendai is the global blueprint for reducing disaster risk and increasing community resilience. The goal of Sendai is to "prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures… to strengthen resilience". The framework is thus

Figure 3-12: Four priorities of the Sendai Framework for Disaster Risk Reduction.

multi-disciplinary and follows four priorities (Figure 3-12). This project's activities fit within Priorities 1 and 2.

The Sendai Framework recognizes that humans are at the centre of disasters. I.e., not only are humans responsible for increasing hazards, hazards themselves are not problematic unless they interact with humans. The framework thus places human decisions at the centre of disaster risk reduction, and advocates for a risk-based approach to managing multiple hazards (i.e., all-hazards approach).

3.4 Coastal Adaptation

Adaptation is defined as "the adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change" (UNDRR, 2017b). Adaptation actions are the things that people, and organizations can do to reduce risk to natural hazards.

In BC, 64% of the population lives within 10 km of the coast. This population (approximately 3 million people), represents 63% of Canada's coastal population (Eyquem, 2021). Although the field of coastal adaptation guidance is in its infancy in Canada, better understanding is required to support actions now.

The following sections discuss key concepts to understand and implement coastal adaptation. We first discuss the evolution of flood management, and this is followed by a few best practices. We then discuss key elements of decision-making processes that can be used to review, select, and implement options. Finally, provide an overview of coastal flood adaptation options.

3.4.1 Evolution of Flood Management

To better understand how risk reduction can inform adaptation options in the qathet region, it is useful to think about how flood management has evolved in recent history. Sayers et al. (2013) describes this evolution in terms of six generalized stages, which apply to the project area (Table 3-2).

Table 3-2: The evolution of flood management and the general change in flood risk (adapted from Sayers et al. [2013]).

Icon	Stage / Description of Actions
	A willingness to live with floods • Individual and small communities adapt to nature's rhythm.
	A desire to use the floodplain • Fertile land in the floodplain is drained. • Permanent communities are established. • Local uncoordinated dikes are constructed
	A desire to control flood flows and defend against flooding • Large-scale structural approaches (dikes, dams, and other controls) are planned and implemented.
	A desire to reduce flood damages • A recognition that engineering alone has limitations. • Effort is devoted to increasing resilience of communities.
	A desire to manage risks effectively • A recognition that budgets are limited and not all problems are equal. • Risk management is seen as a means to target limited resources.
	A desire to promote opportunities and manage risks adaptively • Adaptive management used to work with uncertainties in future climate change, demographics, and funding.

3.4.2 Best Practice

In many regions where development pressures, like those experienced by the qRD, are occurring around the world, governments' abilities to find solutions to reduce risk are constrained by their path dependence. This has led decision makers to be "locked-in" to past policies and actions that favoured engineered structural approaches to flood management (Parsons, Nalau, Fisher, & Brown, 2019). The evolution of flood management described in Table 3-2 can help decision makers disrupt the path dependence and get on a risk reduction pathway. We discuss below two key concepts that are particularly relevant to the qRD.

3.4.2.1 Consider a Suite of Options

Reliance on structural measures in the past can no longer be considered as "fail-safe" alternatives. Rather, coastal adaptation should consider a full suite of options that consider reducing the main components of risk (see Figure 3-8):

Reducing local flood hazards through land stewardship. This can include maintaining and restoring natural assets and systems (e.g., watersheds, wetlands, riparian areas, natural waterways) to help reduce flooding.

Reducing local exposure to flood hazards through land use management. This can include encouraging or requiring types of land use in flood hazard areas that will prevent or reduce potential damage. For example, a green space would be less affected by flooding than a new subdivision.

Reducing local vulnerability through building management. This can include regulations and strategies that make structures and belongings less susceptible to damage when floods occur. For example, using flood-resistant materials for the ground floor of a building.

As well, options to increase resilience (see Sub-section 3.3.3), should complement the above. In this regard, there are three broad options that can be applied:

Education and awareness – homeowner guides, flood and climate change education, neighbourhood preparedness programs, and other learning resources.

Emergency response – early warning systems, temporary barriers, and other flood response programs.

Insurance and disaster financial assistance – managing financial risks where no other mitigation strategies are available.

There are a number of resources that can guide practitioners to understand more about applying risk- and resilience-based options to coastal flood and erosion management. The *"Coastal Risk Reduction and Resilience"* report was developed in the USA and outlines an integrated planning approach (T. Bridges et al., 2013). In Canada, the *"Coastal Flood Risk Assessment Guidelines for*

Building and Infrastructure Design: Supporting Flood Resilience on Canada's Coasts" supports the development of risk-based studies with a focus on identifying exposure reduction options (National Research Council, 2020). The *"Natural and Structural Measures for Shoreline Stabilization"* report outlines practical solutions (SAGE, 2015).

3.4.2.2 Shift Toward Nature-Based Solutions

In addition to providing protection against coastal flooding and erosion, nature-based solutions provide multiple co-benefits including improved biodiversity and human well-being and carbon sequestration. At the global level, *"Words into Action: Nature-Based Solutions for Disaster Risk Reduction"* provides policy and practical guidance that align with the Sendai Framework (see Sub-section 3.3.4) (UNDRR, 2021). The *"International Guidelines on Natural and Nature-Based Features for Flood Risk Management"* (T. S. Bridges et al., 2021) and the *"Guidance for Considering the Use of Living Shorelines"* (NOAA Living Shorelines Workgroup, 2015) provide more technical information.

The **Green Shores Shoreline Development** program supports property owners and managers in the construction of nature-based erosion protection and restoration works. This program has received increasing provincial funding in recent years. The project's guiding principles are to preserve and restore physical processes, maintain, or enhance habitat function and diversity, prevent, or reduce pollutants entering the environment, and avoid or reduce cumulative impacts. Proponents can enroll in the program to partake in the certification process, which can facilitate project permitting.

In Canada, vegetation- and sediment-based natural solutions (e.g. dune restoration, cobble berms) have been underutilized in the past compared to grey infrastructure (e.g. seawalls, breakwaters) (Eyquem, 2021). The *"Nature-Based Solutions for Coastal and Riverine Flood and Erosion Risk Management"* (Vouk, Pilechi, Provan, & Murphy, 2021) review paper was developed to address this issue and launch more technical development in this area of practice. In BC, the Green Shores Shoreline

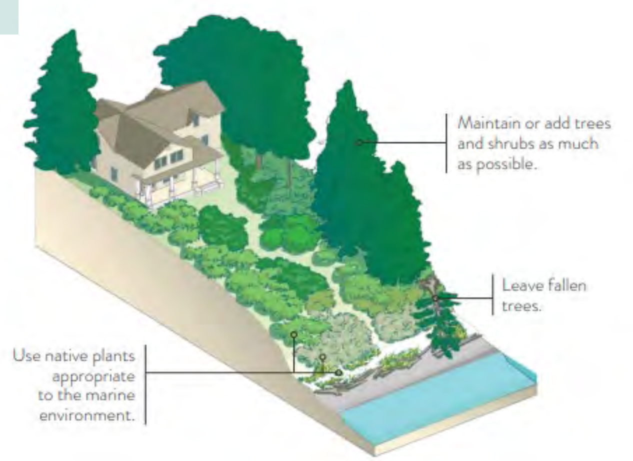


Figure 3-13: Example good design techniques using nature-based solutions. Source: Blair, Brzozowski, Hafey, & Roddan, n.d.).

Development (GSSD) Program[13] (see green box on previous page) was developed to incentivize the implementation of nature-based solutions.

In the qRD, the "*Your Marine Waterfront*" guide (Blair, Brzozowski, Hafey, & Roddan, n.d.) was developed to support home owners in protecting their property while promoting healthy shorelines. It outlines site assessment characteristics, introduces design techniques, and provides other helpful information such as choosing a professional for the permitting process (Figure 3-13 on previous page).

3.4.3 Options Overview and Decision-Making

The selection of preferred adaptation options often comes down to values-based tradeoffs. For example, is it better to accept the loss of tax revenues from increased development in the floodplain by holding the land and developing park spaces, or to accept the occasional costs associated with response and recovery to the increased development areas? Should government help a location become more resilient to occasional floods, or try to prevent it from ever getting wet? These questions have no technically optimal answers. An informed consultation, conducted within a defined decision process explained above, of this kind requires communication about what the choices might entail and analysis of how these choices might affect the things people value the most.

To support complex discussions about values, choices, and tradeoffs we can think of five broad conceptual adaptation options: Protect, Accommodate, Retreat, Avoid, and Resilience-Building (i.e., PARAR). The following sections summarize the conceptual options, and more details are found in Appendix C. Within each option there are a range of actions that could be implemented, and the options themselves are interconnected. An overall coastal flood adaptation strategy would likely include a combination of actions from many, or all, of these conceptual options.

3.4.3.1 <u>Protect</u>

This conceptual option reduces the hazard by restoring previous, enhancing existing, or constructing new nature-based features to reduce the power of the hazard and guard areas and community assets (see Eyquem (2021)). In addition to these "green" measures that are sediment- or vegetation-based, protection also includes "grey" (engineered) structures. The option's concept is visually summarized in Figure 3-14.

Figure 3-14: Visual conceptualization of the Protect option.

[13] Weblink: https://stewardshipcentrebc.ca/green-shores-home/gs-programs/gssd/. Accessed 12 June 2022.

Typical example actions focus on technical disciplines and include:

- Enhancement of natural offshore features (e.g., island restoration), or construction of offshore features (e.g., sea barrier) to help reduce wind and wave action.
- Planting shoreline or submerged vegetation such as salt marshes and sea grasses to absorb wind and wave energy.
- Constructing sea walls to prevent waves from reaching shorelines.

3.4.3.2 Accommodate

This conceptual option uses a range of actions to allow flooding to occur with minimal damage or consequence. It is sometimes described as a "living with water" strategy, in the sense that humans adjust their behaviours and built environment to accommodate the presence and movement of water. The option's concept is visually summarized in Figure 3-15.

Figure 3-15: Visual conceptualization of the Accommodate option.

Typical actions for this option range through educational, planning, and building options, and they include:

- Establishing development permit areas and setbacks to make space for water.
- Using Flood Construction Levels to raise the height of the damageable components of structures.
- Retrofitting infrastructure, buildings, and communities over the natural building cycle.

3.4.3.3 Retreat

This conceptual option (also called managed retreat) reduces exposure by moving existing structures out of flood risk areas. The option's concept is shown visually in Figure 3-16.

Figure 3-16: Visual conceptualization of the Retreat option.

Typical actions for this option are policy-based and include:

- Moving high-risk structures out of flood-prone areas.
- Opportunistic buyouts as homes and businesses come up for sale over time, with more aggressive buyouts as hazard becomes greater with climate change.
- Opportunistic removal of roads, other infrastructure, and contaminants as land is vacated.

3.4.3.4 Avoid

This approach prevents or limits development within the floodplain through planning tools. These actions reduce risk by not putting things we care about in the way of flood or erosion impacts. The option's concept is shown visually in Figure 3-17.

Figure 3-17: Visual conceptualization of the Avoid option.

Typical actions for this option are based on planning and regulation and include:

- Developing tools such as flood bylaws so that rules and practices are consistent across the region.
- Establishing sea level rise planning areas to avoid building critical infrastructure in flood-prone areas.
- Integrating future flood hazard area considerations within guidance documents such as regional growth strategies and official community plans.

3.4.3.5 Resilience-Building

In contrast to the previous four adaptation strategies, resilience-building is less about reducing risk and more about helping communities bounce back from flood events. It covers all aspects of work with the community to enhance its ability to cope with and recover from flood events, and the cumulative effects of change. The options's concept is shown visually in Figure 3-18.Figure 3-17

Figure 3-18: Visual conceptualization of the Resilience-Building option.

Typical actions for this strategy range from education to policy-based approaches and include:

- Engaging broadly in city and community planning to build understanding and capacity of the community to address risk and build resilience (individual and collective).
- Grow social connectedness (with emphasis on care for vulnerable populations).
- Developing robust emergency preparedness and response plans (e.g., flood monitoring and warning systems) to limit damages during a flood event.

3.5 Summary

The background and key concepts about coastal flood and erosion hazards, risk and resilience, and coastal adaptation shared in the previous section are necessary to the development of the Regional CFAS. Specifically, they were used as frameworks to the reviews, analyses, and assessments conducted within the supporting tasks.

4 Supporting Tasks for the Development of an Adaptation Strategy

The supporting tasks described in the following sections are intentionally multi-disciplinary. This approach was taken to consider a wide range of technical and planning data, and to be able to disseminate information to a wide audience (i.e., practitioners, decision makers, and the public as shown in Figure 1-2). Appendices A, B, and C provide supplemental details to each supporting task, respectively.

4.1 Policy Review

This section includes an overview of the legislative, regulatory, and other authorities held by the various levels and types of governments involved. This is followed by a high-level review of policies and regulations related to flood and erosion management within the qRD, Tla'amin Nation, and City of Powell River. The review enables us to better understand the opportunities and challenges associated with selecting and implementing adaptation options.

In the context of flood and erosion management, Figure 4-1 shows a simplified schematic of the overlapping jurisdictions within the foreshore between federal, provincial, and local governments. Local governments generally have jurisdiction on the backshore areas up to the natural boundary, where Provincial jurisdiction begins. In reality, the jurisdictional overlaps between Provincial and Federal governments, including First Nations, is more complex. This graphic by West Coast Environmental Law Association (2018), provides more details linking specific legislation to different sea, foreshore, and land features.

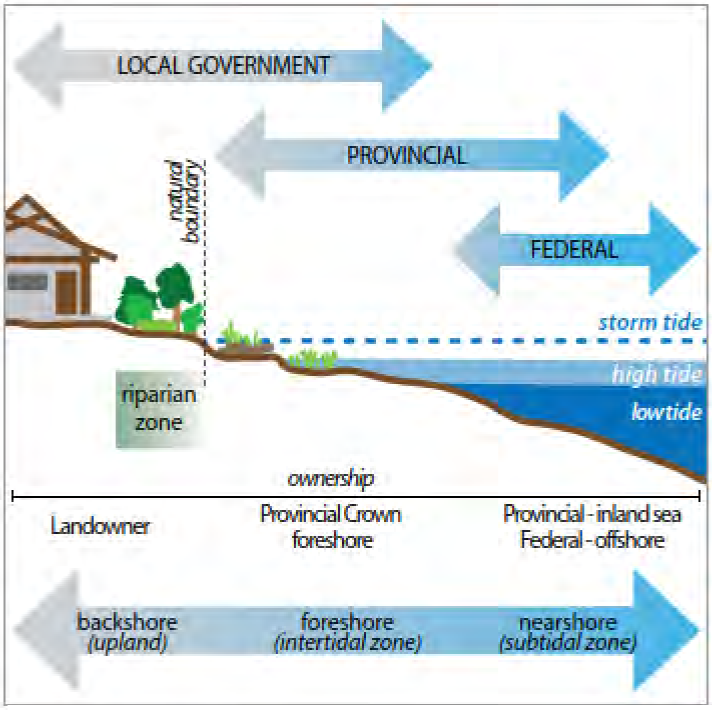


Figure 4-1: Simplified schematic of overlapping foreshore jurisdictions (Texada Island OCP).

4.1.1 Provincial Guidelines and Regulations

In 2011, the Government of BC commissioned a number of reports that provide guidance for land use planning and mapping in consideration of coastal flood hazards and SLR (Ausenco Sandwell 2011a, 2011b, 2011c; Kerr Wood Leidal 2011). Collectively, these documents are referred to as the *Provincial Guidelines*. The guidance in these documents was further refined in the Association of Engineers and Geoscientists British Columbia (APEGBC) Professional Practice Guidelines for

Flood Mapping in BC, released in 2017 and referred to in this report as the *Professional Practice Guidelines* (APEGBC, 2017). The CEPF grant program requires consideration of these guidelines.

The *Local Government Act (LGA)* provides provisions that enable local governments to manage development in relation to lands prone to flooding including the authority to designate a floodplain by Bylaw and set flood construction levels and setbacks for flood management. In doing so, the local government must *consider* the Provincial Flood Hazard Area Land Use Management Guidelines (FHALUMG) (BC Ministry of Forests Lands and Natural Resource Operations, 2013). The guidelines are intended to minimize injury and property damage resulting from flooding and are linked to the Provincial Compensation and Disaster Financial Assistance (DFA) Regulation. If LGs designate a floodplain, places damaged by a flood are not eligible for the DFA. More details on the LGA and the FHALUMG are provided below, respectively.

4.1.1.1 Local Government Act

Where flood mapping is available, the *Local Government Act* [2004] (LGA) statute provides both policy and regulatory provisions that can be implemented as stand-alone provisions or collectively to form a framework to effectively manage flood hazard areas. Specific tools available under the LGA relevant to natural hazard management are summarised in Table 4-1.

Table 4-1: Summary of regulatory tools for local government within Local Government Act.

Regulatory Tool	Description
Regional Growth Strategy (RGS) Bylaw	Is a strategic plan that defines a regional vision for sustainable growth. Objectives and policies can be incorporated into an RGS to prepare for flooding and climate change. RGS are developed by regional districts in collaboration with member municipalities.
Official Community Plan (OCP) Bylaw	Is a guiding policy document used to inform land use decisions. OCPs can include policies in support of climate adaptation and risk reduction. OCPs are developed by local governments through engagement with residents.
Development Permit Areas (DPAs)	Are designated in OCPs as areas requiring special treatment. The LGA identifies for what purpose a DPA can be differentiated, including for the protection of development from hazardous conditions like flooding [Section 488]. Hazard DPAs are generally triggered by alterations to the land associated with development activities. DPAs must include contributions or objectives that justify the designation and must also provide guidelines for developers and homeowners to meet the requirements of the DPA.

Regulatory Tool	Description
Flood Bylaw	If a local government considers that flooding may occur on land, the local government may adopt a bylaw to designate a floodplain area and specify flood levels for it, establish setbacks and construction elevations for habitable space and for landfill within the flood hazard area [Section 524]. The Provincial FHALUMG must be considered in setting out the bylaw. Most often, applications for building permits trigger floodplain bylaw requirements.
Zoning Bylaw	Land use zoning bylaws are used to regulate the use of individual parcels of land, including parcel configuration, the density of the land use, and siting and standards of buildings and structures [Section 479]. These bylaws have been used historically for flood hazard areas to ensure public safety is maintained by limiting the types of uses associated with those lands. Zoning bylaws may need to be edited to be consistent with floodplain requirements. For example, height relaxations may be required if building to FCL.
Subdivision Bylaw	Subdivisions must also meet the "safe for the intended use" stipulation. The Land Title Act provides the authority for local approving authorities to require reports from qualified professionals in areas prone to hazards, including flooding. Standards for subdivision design that take into consideration sea level rise can be established by local governments (within the *Provincial Guidelines* and *Professional Practice Guidelines*). In the case of regional districts, the Approving Authority for subdivision is the Ministry of Transportation and Infrastructure, who is required to consider the *Provincial Guidelines* and *Professional Practice Guidelines* to determine the conditions for subdivision approval.
Local Building Bylaw	Section 56 of the Community Charter provides authority for building officials to require reports by qualified professionals before permitting building in the case of hazards areas such as flood prone areas. There is also provision under [Section 694] of the LGA for a local building bylaw or permit process to require floodproofing. Generally, these are no longer used as the updated BC Building Code has some provisions for floodproofing and any additional conditions can also be integrated into a flood bylaw. It should also be noted that the National Research Council of Canada and partners are working to incorporate new floodproofing standards into future iterations of the Canadian

Regulatory Tool	Description
	Building Code. The National Research Council recently published a guide on design for flood resistant building.

The examples below provide more specifics about how different sections of the LGA would apply within the context of developing flood hazard related bylaws and development permit areas.

LGA section 524 allows local governments (LGs) to designate land as a flood plain and by bylaw specify setbacks and flood construction levels. In making the bylaw, the local government must *consider* the provincial guidelines. The bylaw can specify provisions for different areas, zones, uses, siting circumstances, types of buildings etc.

LGA Section 524(7) allows LGs to exempt a person from the bylaw in relation to a specific parcel, use, building or structure if a Professional Engineer or Geoscientist submits a report certifying the land is *safe for the use intended*. In granting an exemption, the LG can require a section 219 restrictive covenant in favour of the LG. We note that the legislation currently requires that the Professional Engineer or Geoscientist have experience in *geotechnical* engineering, whereas the relevant expertise is *coastal, hydrotechnical,* or *geomorphological.*

LGA Sections 490, 498 and 542 do not allow a development variance permit, development permit or Board of Variance respectively to vary a floodplain specification in a section 524 floodplain bylaw.

LGA Section 500 allows for a tree cutting permit area to be established if the area is subject to flooding, erosion, or land slip.

LGA Section 463 allows for withholding of building permits for 30 days while a floodplain bylaw is under development. It is unclear if this would apply to a review of said bylaw. In dealing with building regulations, the Community Charter establishes the authority to require geotechnical reports if flood hazard exists.

The Land Title Act Section 86 outlines that a subdivision approving officer can refuse approval of a subdivision plan if the land is subject to, or could reasonably be expected to be subject to, flooding, erosion, or land slip. The approving officer can require a report certified by a Professional Engineer or Geoscientist that the land is safe for the use intended and require entry into a section 219 covenant (see note above regarding Engineer experience). Similar provisions are available under the Strata Property Act and the Bare Land Strata Regulations.

4.1.1.2 Flood Hazard Area Land Use Management Guidelines

The following paragraphs outline sections of the FHALUMG that are relevant to guiding the development of flood hazard related bylaws and development permit areas.

Setbacks: A few considerations control how setbacks are used and determined:

- Keep development away from areas of potential erosion and restricting the flow capacity of the floodway.
- Subdivision and development should require restrictive covenant stipulating that any future reconstruction must meet the FCL and setbacks in force at the time of redevelopment.
- The setback should be the greater of 15 m from the future estimated natural boundary (NB) of the sea at 2100 or the landward location where the natural ground elevation contour is equivalent to the year 2100 designated flood level and future FCL (extent of the year 2100 FCL)[14].
- Setback requirements should not be reduced unless serious hardship exists, and no other reasonable option is available:
  - A valid hardship should only be recognized where the physical characteristics of the lot (e.g., exposed bedrock, steep slope, the presence of a watercourse, etc.) and size of the lot are such that building development proposals, consistent with land use zoning bylaws, cannot occur unless the requirements are reduced.
  - The economic circumstances or design and siting preferences of the owner should not be considered as grounds for hardship.

Sterilization: On existing lots, if meeting the setback considerations noted above would sterilize the lot (i.e., not allow even one of the land uses or structures permitted under the current zoning), the development approving official may agree to modify setback requirements as recommended by a suitably Qualified Professional experienced in coastal engineering, provided that this is augmented through a restrictive covenant stipulating the hazard, building requirements, and liability disclaimer.

Safe use of the land: Based on references to Section 219 of the Land Title Act, it is recommended that the covenant specify conditions that would enable the land to be safely used for the use intended. In addition, the following conditions should be included:

- Waiver of liability in favour of the LG
- Priority over any financial charges requested against the property
- Covenant modification agreement

[14] Please note that there is no methodology presented to calculate the future estimated natural boundary and many LGs are struggling to implement this.

- Affidavit for witness

FCL (Flood Construction Level): Keep living spaces and areas used for storage of goods damageable by floodwaters above flood levels. Calculated using designated flood (0.5% AEP) and designated flood level (water surface elevation of designated flood).

Training works to protect one property: Construction may require an access easement/right of way and ongoing maintenance program. It should be designed by a Professional Engineer and assured through covenant.

Multiple scenarios: The following need to be considered when developing and conducting modelling assessments:

- A FCL may require a flood hazard assessment by a suitably qualified Professional Engineer who is experienced in coastal engineering following *Professional Practice Guidelines*. Changes in risk due to sea level rise must be considered (i.e., 0.5 m by 2050, 1 m by 2100, 2 m by 2200) with the year 2100 recommended for new development or subdivision.
- Methods to calculate the FCL include modelling a 0.5% and 0.2% AEP flood by probabilistic or combined method including sea level rise, uplift or subsidence, wave effects and freeboard.

4.1.2 Comparison of Partner Area Land Use

Due to their differing relationships and authorities relative to the Province of BC, the qathet Regional District, Tla'amin Nation, and City of Powell River have different legislative and policy frameworks. This means that the ability for each to manage flood and erosion issues is different. We conducted a comparative review of policies, regulations, and other issues related to flood and erosion to better understand differences. These can be used as a basis to move forward more practically as a region to create a more consistent approach where possible.

The **qathet Regional District** completed engagement activities regarding land use planning in 2021 (as stated in Sub-section 2.2.2). This was documented in the Let's Talk Land Use (Arlington Group and EPI, 2022), which offered good overarching context for our review.

Other key documents reviewed from the qRD included[15]:

- Electoral Area A Official Community Plan (2015)
- Savary Island Official Community Plan (2006), and Dune and Shoreline Studies (2003)
- Electoral Area B Official Community Plan (2012) and Zoning Bylaws
- Electoral Area C Official Community Plan (2012)

[15] A full list of qRD documents is available here: https://www.qathet.ca/land-use/plans-zoning/.

- Texada Island Official Community Plan (2019), and Zoning Bylaw (1982)

We conducted cursory reviews of the natural hazard identification study for Electoral Area A (2013), as well as the landslide and fluvial hazard studies that were conducted for Electoral Areas B and C (2015), and Electoral Area D (2016).

The **Tla'amin Nation** has developed land use plans (Dillon Consulting Ltd., 2014; Tla'amin Nation, 2010), a watershed protection plan (Chapman & Patrick, 2021), and a Land Use Planning and Zoning Law (2016)[16]. The 2010 Land Use Plan (LUP) is the primary document guiding land use decisions for the Nation and was the key document we reviewed.

Documents reviewed from the **City of Powell River** included the Sustainable Official Community Plan (2014)[17], Marine Asset Management Plan (2013)[18], Parks and Trails Master Plan (2020), Integrated Community Sustainability Plan (2015)[19], Building Bylaw (2007)[20].

Table 4-2 provides a summary comparison of a range of policies, regulations, and other issues related to flood and erosion for each of the partner jurisdictions. We note that this comparison is a messy process with a few instances of overlap and lack of specificity, which makes direct comparisons challenging.

Table 4-2: Summary of policies related to flood and erosion management in the project partner areas.

Policy / Regulation / Issue	qathet Regional District	Tla'amin Nation	City of Powell River
Sea Level Rise and Ecological Sensitivity Considerations	OCPs promote the avoidance of clearing, altering or developing the waterfront within 30 metres of the natural boundary of the sea as per guidelines in the provincial publication "Coastal	The LUP recommends considering SLR of 1.2 m and associated policies.	OCP states that flood construction requirements should follow Provincial guidance (1 m SLR by the year 2100).

[16] Weblink: https://www.tlaaminnation.com/wp-content/uploads/2016/11/Land-Use-Planning-Zoning-Law.pdf. Accessed 23 March 2022.
[17] Weblink: https://powellriver.civicweb.net/filepro/documents/15308/?preview=72422. Accessed 23 March 2022.
[18] Weblink: https://powellriver.civicweb.net/document/8310/. Accessed 23 March 2022.
[19] Weblink: https://powellriver.civicweb.net/document/32785/. Accessed 23 March 2022.
[20] Weblink: https://powellriver.civicweb.net/document/604/. Accessed 23 March 2022.

Policy / Regulation / Issue	qathet Regional District	Tla'amin Nation	City of Powell River
	Shore Stewardship: A Guide for Planners, Builders and Developers."		
Foreshore Protection[1]	OCPs promote retention of native vegetation and forest cover within 30 m of natural boundary, promote soft-shore and Green Shores approaches to shoreline stabilization, and recommend site-level assessments by a qualified professional prior to development in coastal areas.	The LUP states that sensitive area and marine management area boundaries are based on 30 m on the water side of the natural boundary (defined as where terrestrial vegetation occurs).	The OCP objective is to "Retain freshwater and coastal marine areas in their natural state as well as accommodate shoreline protection structures and minor structures that complement riparian uses."
Setback Distances from Shoreline	OCPs recommend a 30 m setback from the natural boundary.	The LUP recommends a 30 m setback from the natural boundary.	OCP indicates a 15 m setback.
Flood Construction Levels	OCPs recommend site-level assessment by qualified professional to establish safe flood construction levels.	The Shore Hazard Area is defined in the LUP as 0 m to 3 m vertical distance. The FCL is defined as 2 m from the natural boundary	The Building Bylaw requires an application to show any setbacks from the natural boundary or minimum floor elevation requirements as established in land use regulations.

Policy / Regulation / Issue	qathet Regional District	Tla'amin Nation	City of Powell River
Development Adjacent to Steep Slopes	OCPs promote retention of native vegetation and forest cover on steep slopes and recommend site-level assessment by qualified professional to establish safe setbacks from steep slopes.	The LUP recommends a setback that is 3 times the height of the bluff but can be relaxed with a QP report.	The OCP recommends a setback of 3 times the height of the bluff, or as determined by a QP report.
Development Permit Area Stipulations	The Savary Island Shoreline DPA requires a report by QP with reference to the Thurber Dune Study setbacks. Area A Natural Hazards DPA requires a site-level assessment by QP with reference to Electoral Area A (Malaspina/Okeover Inlet) Identification of Natural Hazard Areas Study.	A development permit (DP) is used to approve the location, size, and use of any parcel or any building on a parcel. A DP is required before applying for a building permit and for any construction or landscaping within 300 ft of a water body.	A 2020 staff report recommended the establishment of a Marine Foreshore DPA.
Restrictions on Subdivision Development	Recommend site-level assessments by QP prior to subdivision approval.	None	None
Covenant	Recommend Section 219 Covenants prior to subdivision	A restrictive covenant in favour of the Nation is	OCP policy 5.4.2 (c) The City will encourage the use of

Policy / Regulation / Issue	qathet Regional District	Tla'amin Nation	City of Powell River
	approval with no build and no clearing covenant areas (setbacks from sea and/or setbacks from top of steep slopes) based on site-level assessments.	required to relax setbacks where they would prevent construction as per the current land use (as per FHALUMG).	a conservation trust or covenant on title to protect lands that are environmentally sensitive.
Archaeological Site Considerations	OCPs recognize First Nation's interests in protecting archaeological and cultural resources and expanding the inventory of known sites within the region. OCPs support collaboration with First Nations and the Province to learn from and protect archaeological resources. The qRD has a protocol agreement with Tla'amin Nation.	Cultural and environmental area guidelines in the LUP indicate that professional assessment and surveys are required for all major projects. These need to be conducted during preliminary planning phases, indicating known or potential cultural sites within or adjacent to the project area.	Appendix A of the OCP sets out a referral process for proposed developments and land use applications. The CoPR has a Protocol agreement with Tla'amin Nation.
Parks and Conservation Area Considerations	OCP DPAs encourages natural state or nature reserves in hazardous areas.	Sea Walk/Greenway along the shoreline provides recreation.	Park Master Plan and OCP Environmentally Sensitive Areas all indicate conserving hazardous areas

Policy / Regulation / Issue	qathet Regional District	Tla'amin Nation	City of Powell River
			naturally or in parks as possible.
Public Education	Your Marine Waterfront Adapting to Climate Change on the BC Coast Green Shores for Homes	Leasehold Residential within shore hazard zone requires further education and awareness.	The OCP refers to the 2003 Coastal Shore Stewardship guide (Province of BC, 2003).

Notes:

1 – Setbacks are usually based on a distance from the natural boundary. However, the natural boundary concept is unclear due to dynamic processes like sea level rise (see Sub-section 3.3.4.2). This leads to inconsistency in definitions between jurisdictions.

4.1.2.1 Key Findings

The comparison of partner areas confirms that the policies, regulations, and other issues related to flood and erosion management within the project area is varied and complex. The following are two key messages resulting from the review:

- There is a range of regulatory styles across the partner areas.
- The project area generally does not have many regulations related to erosion and flood hazard that are enforceable.

In addition to the range of regulatory styles, peoples' views regarding land use planning differ across the region. For example, based on recent qRD land use engagement activities (Arlington Group and EPI, 2022), people in nearly all areas of the qRD want less regulation. However, the opposite is true for residents of Savary Island.

The policy context poses challenges to achieve consistency in flood and erosion management across the region. This highlights the need to make decisions in a transparent fashion, based on the best information available. This includes the consideration of risk-based analyses.

4.2 Risk-Based Analyses

Risk is a function of hazard, exposure, and vulnerability (see Sub-section 3.3.1). We built on existing hazard and exposure data analysis conducted by Tetra Tech to support and inform a more fulsome discussion on adaptation strategies. This included delineating hazard extents for a small coastal storm flood event, selecting archetype areas, studying exposure and impacts, and producing results for the illustrative archetype areas. These analyses are summarized below.

4.2.1 Flood and Erosion Hazard Assessment

Using the recently developed large coastal storm flood hazard extent layers for the project area (Tetra Tech 2021, 2022), we developed a screening-level small coastal storm flood hazard extent layer. The layer is representative of a coastal storm with an AEP of 2%[21] on the basis that most residents in the qRD likely can remember such an event from their recent memory. Understanding the potential impacts between "small but frequent" versus "large but rare" flood events over time provides a basis for a more nuanced understanding of risk across the project area. It is best practice to consider multiple scenarios, however, provincial guidance only requires the provision of one extreme flood scenario.

We also mapped the areas affected by the high tide plus 1 m of SLR, to assess areas that are likely to be wet on a daily basis in the future. The layers are shown, along with the large coastal storm flood layer (described in Sub-section 2.2.1 and in the Tetra Tech reports) in the figures in Sub-section 4.2.4. The method used to the derive the layer is described in Appendix B. Finally, erosion hazard was obtained from Tetra Tech (Tetra Tech, 2021, 2022) (see Sub-section 2.2.1).

Mapping and analysis of the enhanced flood and erosion hazard layers provided the following insights:

- The small flood layer complements the large flood layer, providing a high-level understanding of the range of potential coastal flood hazard extents that could be experienced in the project area.
- The estimated small flood has a probability of occurrence that is 40 times greater than the modelled large flood; the small flood could substantially impact certain exposed elements, raising risk levels in specific areas.
- Shoreline areas that are exposed to the small flood extent are more susceptible to erosion as they are inundated, and subject to coastal storm processes, much more frequently compared to the large flood.

[21] This storm has an indicative return period of 5 years.

4.2.2 Archetype Areas Selection

Given the long length of the qRD shoreline, we focused on 13 candidate local areas that could be used to represent the larger coastline. The following areas were chosen based on previously calculated risk metrics from Tetra Tech (2018) and discussions with the project team: Lund, Savary Island, North Scuttle Bay, Klahanie Drive North, ṫišosəm, Powell River, Willingdon Beach, Grief Point, Myrtle Rocks, Myrtle Point, Stager Road, Lois River, and Kent's Beach. Through a step-wise process, we assessed these candidate local areas further using the additional hazard information we produced (described in Sub-section 4.2.1). Based on that assessment, we chose four archetype areas as representative local areas for the project[22].

The objective in identifying the archetype areas was to simplify the complex interacting factors that contribute to risk and resilience at local scales. Together, the archetype areas encompassed a range of physical, social, environmental, and policy characteristics. For example, they were:

- Within all three partner lands.
- Located on the mainland and an island areas.
- Exposed to a range of assets and things that people care about.
- Subject to higher levels of flood or erosion compared to other areas.

The four archetype areas were Lund, ṫišosəm, Grief Point, and Savary Island. Note that the choice of archetype areas did not indicate prioritization of these areas for planning purposes. To further convey the notion that the archetype areas were meant to represent a range of risk factors throughout the project area, we gave them "illustrative archetype" names. Lund was illustrative of a place referred to as "The Docks". Together, ṫišosəm and Grief Point were illustrative of a place referred to as "Oceanside Living". Savary Island was illustrative of a place referred to as "Island Sanctuary".

4.2.3 Exposure and Impacts Study

Following best practice, we considered exposure to characterize the potential impacts to flood and erosion hazards based on a range of indicators including people, economy, environment, culture, and critical infrastructure (Appendix B contains details on the dataset sources).

The exposure and impacts study was mostly conducted for the illustrative archetype areas. However, at the regional scale we analysed the archaeological sites within the project area (data were obtained from the Provincial Remote Access to Archaeological Data (RAAD) database). A key finding was that approximately 85% of those sites are located within the small flood hazard extent. Given that floods of this magnitudes are approximately 40 times more frequent compared

[22] This approach has been used in other studies to simplify understanding of diverse coastal areas for adaptation decision-making (e.g. Magnan et al., (2022)).

to the large flood hazard extent (see Sub-section 4.2.1), these sites are particularly vulnerable to erosion action.

For each illustrative archetype area, we also considered characteristics related to the people living in these areas. For that analysis, we used the Social Vulnerability Index (SoVI) database[23]. The database uses 2016 census data and a population exposure model. To our knowledge, the SoVI database is the most recent and comprehensive data set of social vulnerability in British Columbia (BC). More details on the analysis are found in Appendix B including the exposure layer data sources.

4.2.4 Archetype Area Results

The enhanced flood and erosion hazard layers as well as the exposure and impacts data were assessed in more detail to consider risk profiles for each of the illustrative archetypes. These include summaries, in the form of maps and semi-quantitative narratives, of the hazard and potential impacts to key indicators. The maps show extents for the small and large coastal storm flood hazard layer. The high tide layer is also shown to consider areas that would be wet on a daily basis. SLR is included for the shorter and longer terms (i.e., 0.27 m for the year 2050, and 1.0 m for the year 2100). Erosion hazard is shown for one illustrative archetype (Island Sanctuary) where this was ranked as "high".

4.2.4.1 "The Docks"

This archetype is illustrative of a more urban area on the mainland with shared governments (e.g., qRD and Tla'amin Nation). The hazard of concern is flood and Figure 4-2 summarizes the high-level risk profile. Images and key impacts are shown in Figure 4-3. All images are courtesy of Tetra Tech 2018, unless indicated otherwise.

[23] The database was obtained directly from staff at Natural Resources Canada (NRCan).

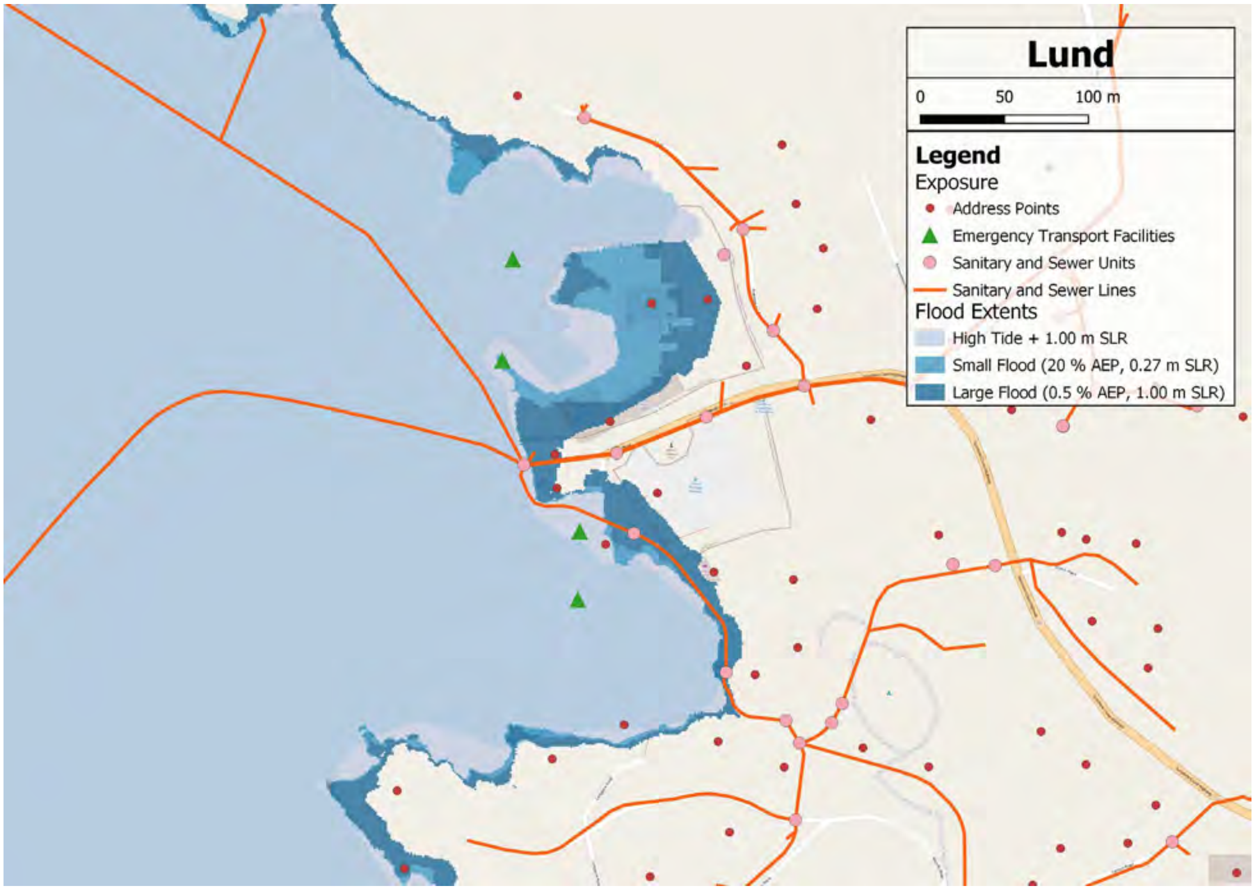
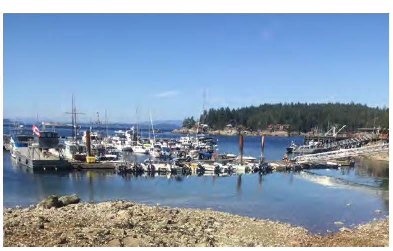


Figure 4-2: Map of "The Docks" area. Note that address points are indicative only and do not necessarily represent the presence of a home.



People (many older) and homes exposed to small and large floods

Commercial properties (resort, shops) exposed to small and large flood

Regional transportation hub (water taxi service, helipad)

Sewer outfall infrastructure exposed to coastal storms

Important community and recreational hub

Figure 4-3: Images and high-level impacts for “The Docks". Images courtesy of Tetra Tech 2018.

4.2.4.2 “Oceanside Living”

This archetype is illustrative of more urban areas on the mainland. It is based on separate areas with respective governments (e.g., City of Powell River and Tla’amin Nation). The hazard of concern is primarily flood. Figure 4-4 and Figure 4-6 summarize the risk profile with maps. The hatched line in the map in Figure 4-4 is a flood hazard layer that was delineated as part of the Tla’amin Nation’s Land Use Plan (Tla’amin Nation, 2010). Images and key impacts are shown in Figure 4-5 and Figure 4-7.

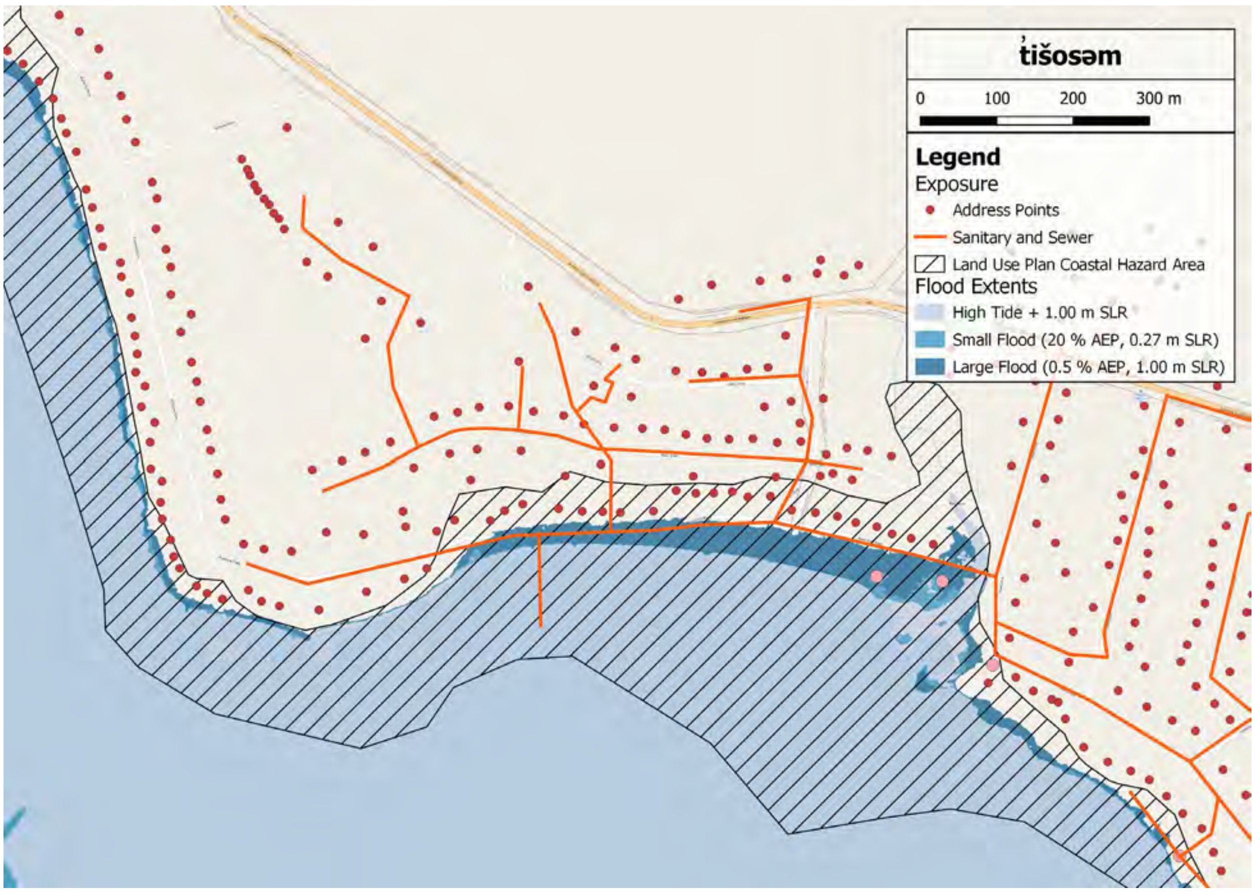


Figure 4-4: Map showing the first illustrative archetype area for “Oceanside Living”. Note that address points are indicative only and do not necessarily represent the presence of a home.

Source: Image © 2022 CNES / Airbus via Google Earth

- Relatively older population
- Recreational sea walk
  Archaeology sites (applies everywhere)
- Wastewater treatment plant, outfall, septic
  Waterfront road
- Sliammon estuary, fish hatchery

Figure 4-5: Images and high-level impacts for the first illustrative area for "Oceanside Living ". Images courtesy of Tetra Tech 2018.

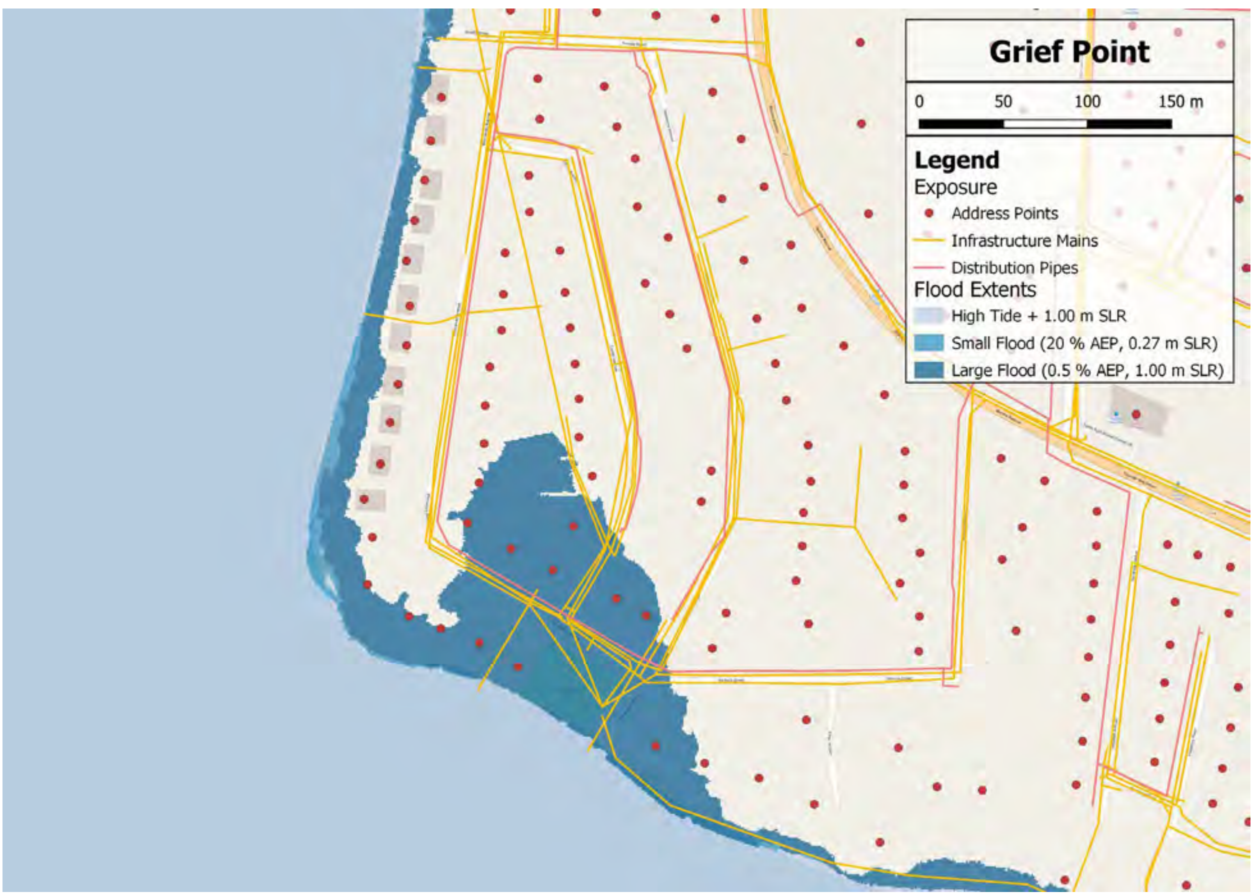


Figure 4-6: Map showing second illustrative archetype area for "Oceanside Living". Note that address points are indicative only and do not necessarily represent the presence of a home.

- Higher number of people and homes exposed to large flood
- Recreational beach access and areas
  Archaeology sites (applies everywhere)
- Blue Heron sensitive habitat
  Small park
- Stormwater and sanitary systems,
  Telecommunications poles,
  Gas distribution, Roads

Figure 4-7: Images and high-level impacts for the second illustrative area for "Oceanside Living ". Images courtesy of Tetra Tech 2018.

4.2.4.3 “Island Sanctuary”

This archetype is illustrative of a rural island area governed by the qRD. The hazard of concern is erosion and Figure 4-8 summarizes the high-level risk profile. Images and key impacts are shown in Figure 4-9.

Figure 4-8: Map showing the illustrative archetype area for “Island Santuary”. The red line denotes a “very high” erosion potential. Note that address points are indicative only and do not necessarily represent the presence of a home.

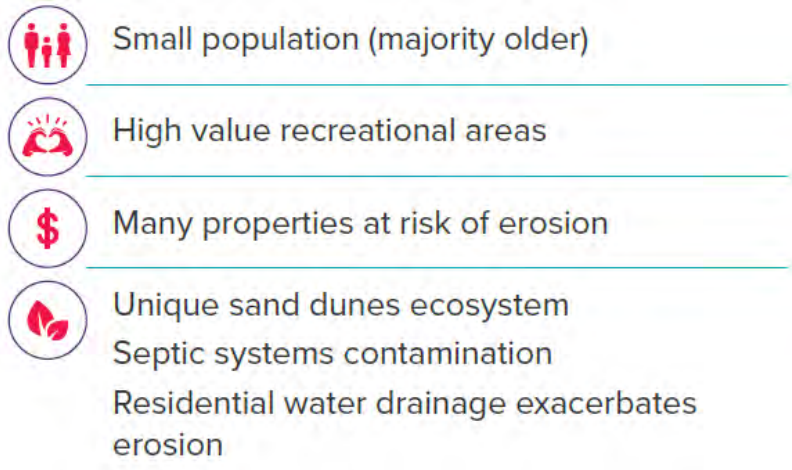


Figure 4-9: Images and high-level impacts for "Island Sanctuary". Images courtesy of Tetra Tech 2018.

4.3 Decision Support

As noted earlier, flood is a systemic problem with infinite potential impacts, and therefore decision making to support flood risk reduction requires consideration of the many tradeoffs associated with flood. These include considerations to risk reduction (e.g., the potential number of structures that would or wouldn't be damaged, the potential for mortality, etc.) as well as commonly used criteria for government decisions (e.g., cost, public and/or political will, etc.).

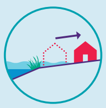
Below we discuss practical considerations and planning scenarios that were developed to support working through some of the issues described above. We also introduce decision tools that could be used in the next phase of work.

4.3.1 Practical Considerations

Flood and erosion mitigation is not straightforward, if it was, simple solutions would already have been implemented. Drawing on the engagement process (see Section 5), challenges to each of the PARAR strategies, as relevant to the project area, were identified as described in Table 4-3.

Table 4-3: Initial practical issues when considering applying PARAR options to illustrative areas.

PARAR Option	Description of Issues
Protect 	• Necessary where lacking space to retreat – can be combined with accommodate, but protection is faster so can be first step. • Prioritize for key infrastructure that's difficult to move like lift station/WWTP, harbour infrastructure (e.g., The Docks). • Necessary for archeological sites that can't be relocated (e.g., Oceanside Living).

PARAR Option	Description of Issues
	• Need to consider who will manage/upkeep protection strategies like archeological sites and rip rap – current sites not being well managed due to low capacity (e.g., Oceanside Living). • Need to consider costs – implementing Green Shores in a park is expensive – may need grant funding (e.g., Oceanside Living).
Accommodate 	• Necessary where lacking space to retreat – can be combined with protect, but protection is faster so can be first step. • Implement over time, integrate into repairs/renovations/renewals
Retreat 	• Not a possibility in areas where land is already limited (e.g., Island Sanctuary). • Need to think about where it is possible for developments to be relocated to. • Prioritize retreat of critical infrastructure where protect isn't an option, but consider how to navigate disruption of services during relocation (e.g., sewer system). • Public has some level of control over infrastructure retreat (Oceanside Living). • May be possible for homeowners to retreat within their own properties (Island Sanctuary). • Buy-out is very expensive so should be last resort.
Avoid 	• Not much vacant space to avoid development – more useful to limit densification (i.e., carriage houses) through bylaws and rezoning. • Presence of many little lots means ability to develop without restrictions (Island Sanctuary). • Use OCP process for avoid options (Island Sanctuary). • Avoid building on sand dunes (Island Sanctuary).
Resilience-Building 	• Build awareness of area's vulnerability and expected impacts. • Education/awareness-building is especially important in areas with lack of appetite for regulation. • Consider how to educate transient people (e.g., Island Sanctuary). • Consider how people may react based on their second home vs. their primary home. • Bring in subject matter experts to public meetings, like insurance experts, to help residents make better decisions.

PARAR Option	Description of Issues
	• Encourage community-based resilience building through education and social connectedness. • Consider insurability: o Many homeowners do not have insurance because of high costs. o Residents unsure how insurance companies view risks on islands.

4.3.2 Planning Scenarios

To explore some of the tensions associated with the potential selection of an individual PARAR option, as well the concept of applying multiple options simultaneously to build resilience, planning scenarios were developed and discussed.

Four planning scenarios were developed to describe hypothetical high-level approaches that would take the community in different directions:

- Scenario 1: Neighbourhood Resilience
- Scenario 2: To Each their Own
- Scenario 3: Regional Regulation
- Scenario 4: Assessment, Reliance, and Retreat

The scenarios were informed by tensions that we learned about through the engagement feedback. They represent a combination of less government regulation (i.e., the "carrot" approach) versus more government regulation (i.e., the "stick" approach), as well as collective versus individual action (Figure 4-10). Appendix C provides a narrative for each scenario that describes what different adaptation strategies implemented could look like "on the ground". Through exploring these contrasting narratives with participants, we gained insight into tradeoffs and preferred strategies here in the region (see Section 5.2). Scenario 2 is most representative of current conditions in the project area.

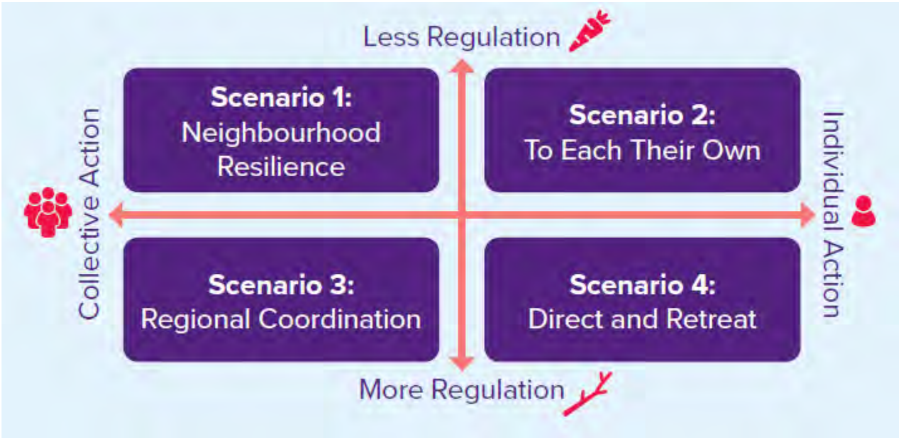


Figure 4-10: Planning scenarios considered.

4.3.2.1 Scenario Scoring

The planning scenarios were "scored" by the consulting team, based on the holistic criteria to support conversations around tradeoffs.

The criteria, based on a mix of best practice and feedback from the engagement process, were as follows:

- Culture and lifestyle
- Environment, nature, and biodiversity
- Financial and economic impacts
- Critical infrastructure
- Private property

The criteria were scored on a generalized 4-point scale, relative to current conditions and assuming the scenario plays out in the future. The scoring descriptions ranged from "far worse", "slightly worse", "slightly better", and "much better" (Table 4-4).

Table 4-4: Illustration of potential tradeoffs between planning scenarios.

Criteria	Scenario 1: Neighbourhood Resilience	Scenario 2: To Each Their Own	Scenario 3: Regional Collaboration	Scenario 4: Direct and Retreat
Culture and lifestyle	Slightly better	Slightly worse	Much better	Slightly better
Environment, nature and biodversity	Slightly better	Far worse	Slightly better	Slightly better
Financial and economic impacts	Slightly worse	Slightly worse	Slightly worse	Slightly worse
Critical infrastructure	Slightly better	Slightly better	Slightly better	Slightly better
Private property	Slightly worse	Slightly worse	Slightly better	Slightly worse

Appendix C contains more details about the rationale for the scores shown in Table 4-4. Note that the results are based on an overview analysis and do not consider important nuances. For example, Scenario 2 may provide seemingly better benefits to residents on an individual basis over the short term (which is why this scenario most closely resembles current conditions); however, inferior conditions are likely to develop over the longer term (especially for the environment, nature, and biodiversity criteria). Similarly, the effects of Scenario 1 may not be obvious in the short term, but this could be offset with long term benefits (especially regarding culture and lifestyle, and environment, nature and biodiversity). Scenario 1 and Scenario 4 have similar scores, but these would be different if criteria scoring were completed for different timescales.

The key takeaway from this assessment is that when scenarios are appropriately evaluated based on a range of criteria, tradeoffs will appear when considering one scenario versus another. This highlights the need for values and priorities to be identified. In this way the tradeoffs can be better understood, leading to more informed selection of preferred adaptation solutions.

Example Resource:

Modelling tools are becoming increasingly available to support local governments with the selection of coastal adaptation options. We conducted a preliminary review of the documentation for the Coastal Toolbox (CT) (David Suzuki Foundation, 2021)[24] to assess its potential application in the project area. Appendix C details contains more details on our review.

The CT is a GIS-based analytical tool that can be used to compare the effects that different shoreline natural asset alternatives can have on shorelines (including comparing dollar costs). This is achieved through preliminary evaluations of coastal storms, beach erosion, offshore wave propagation, flooding, and structural damage.

Figure 4-11 shows an example of how the model's components can be used to tune model parameters to simulate the effects of different natural asset management alternatives.

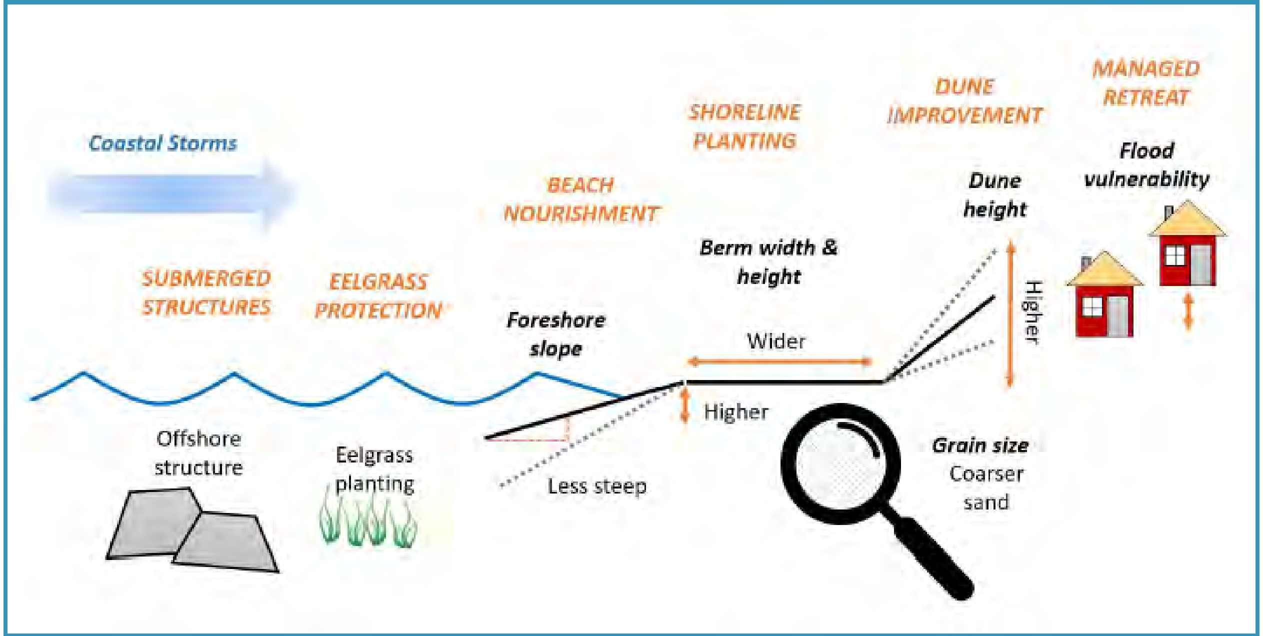


Figure 4-11: Example application of the CT program (Source: David Suzuki Foundation 2021).

Based on our review we conclude that the CT is a powerful, relatively user-friendly, tool. Apart from requiring an ESRI ArcGIS licence, it is freely available and open source. Technical components are required to be produced and input to the program, meaning that municipal planning staff need support from a qualified professional to use it. This is advantageous as a

[24] Weblink: https://mnai.ca/media/2021/11/MNAI-Coastal-Asset-Guidance-Doc-cover-101-combined.pdf. Accessed 7 June 2022.

qualified professional should be involved in the process to better consider important technical nuances and limitations of the program, to support the interpretation of results.

We recommend that the tool be considered for use within the project area in a future phase of work. Knowledge of this tool is useful when considering the recommended adaptation strategies provided in Section 6. We note that the objective of the tool's use should be to explore scenarios, and not to inform engineering design.

4.4 Summary

The risk-based analyses that were summarized in this section highlight the complexity of planning and technical information that is necessary to consider in the development of the strategy. This information was iterated and refined through the engagement feedback to provide a more integrated understanding of the issues.

5 Engagement Feedback

Through the engagement activities (see Sub-section 1.4.1 and Appendix D), we gathered and synthesized feedback that would inform the recommended adaptation strategy (Section 6). This section first summarizes the feedback in terms of impacts (i.e., what have residents experienced recently?). We then outline values, priorities, and tradeoffs. This is followed by the consideration for a range of adaptation options and actions.

5.1 Recent Observations and Experiences

The following graphics illustrate key themes heard from survey and information session participants about biophysical, social, economic, and cultural changes they have seen happening in the region recently. This visual summary was compiled and shared as part of the Partner & Stakeholder Workshops, to provide a collective reflection of current trends and drivers that are part of the context we are planning within. This also reflects some of the things about the area that are most important to people.

5.1.1 Bio-physical Changes

Figure 5-1 to Figure 5-3 summarize biophysical changes that range from infrastructure damage to weather patterns.

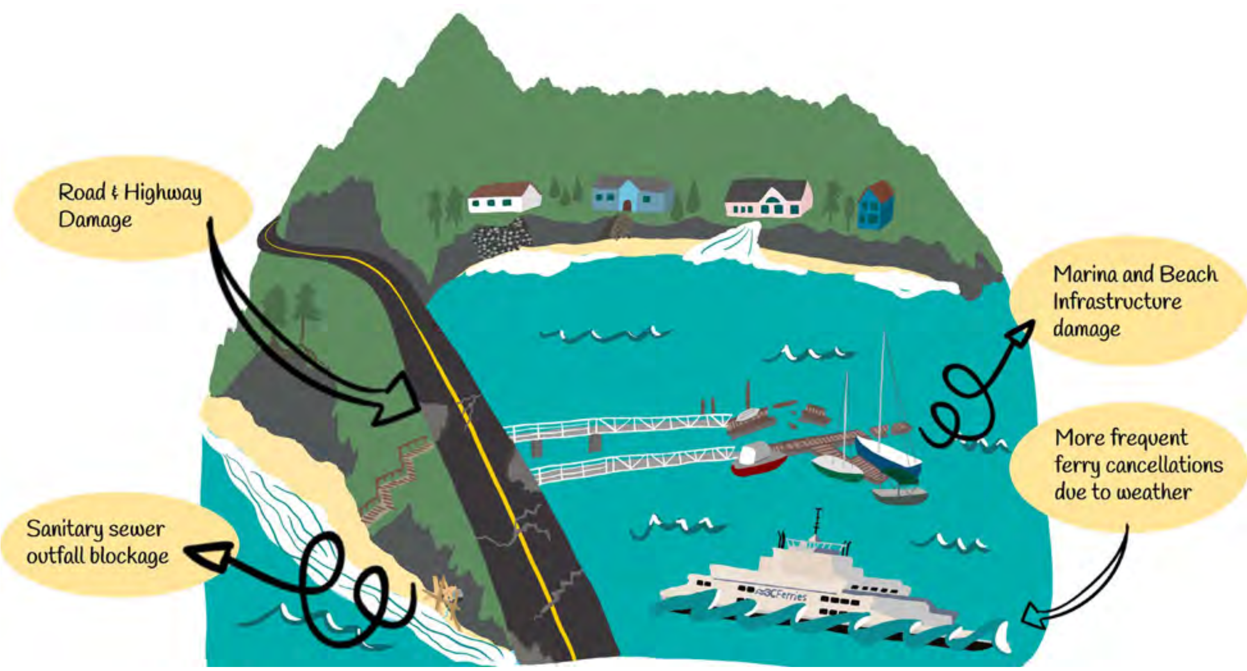


Figure 5-1: Infrastructure damage and destruction.

Figure 5-2: Beach erosion and shoreline changes.

Figure 5-3: Weather patterns.

5.1.2 Socio-Economic Changes

Figure 5-4 to Figure 5-8 summarize social, economic and cultural changes that range from demographics to social dis-cohesion.

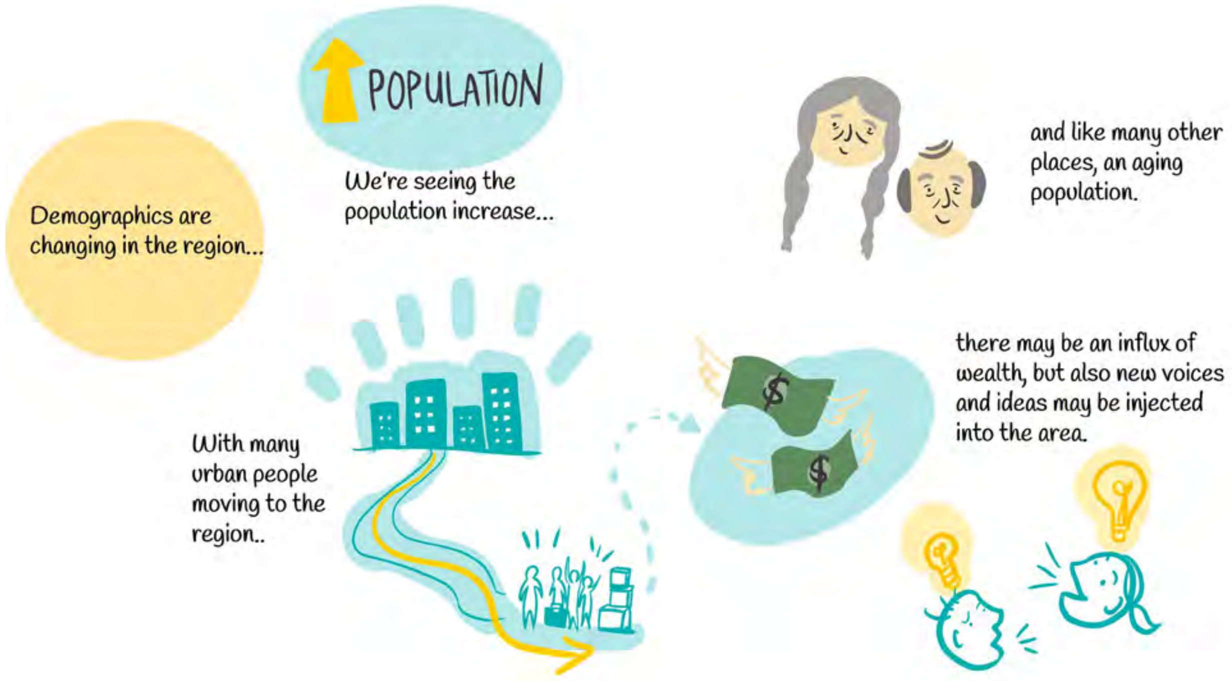


Figure 5-4: Example aspects of demographic changes.

Figure 5-5: Example aspects of economic and land use changes.

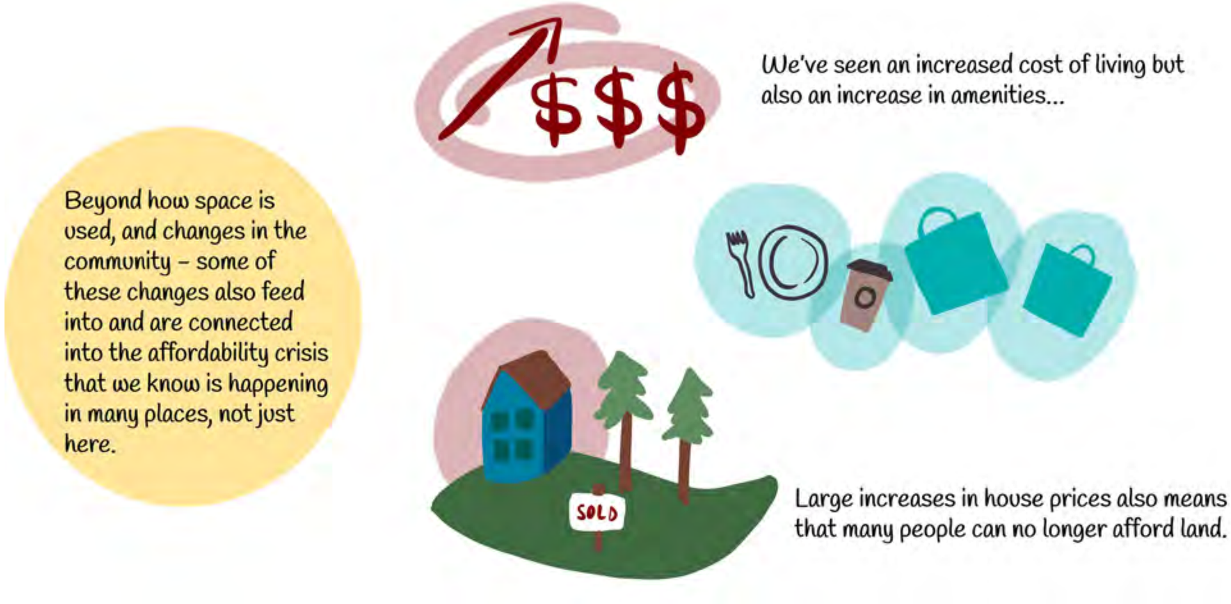


Figure 5-6: Example aspects of the affordability crisis.

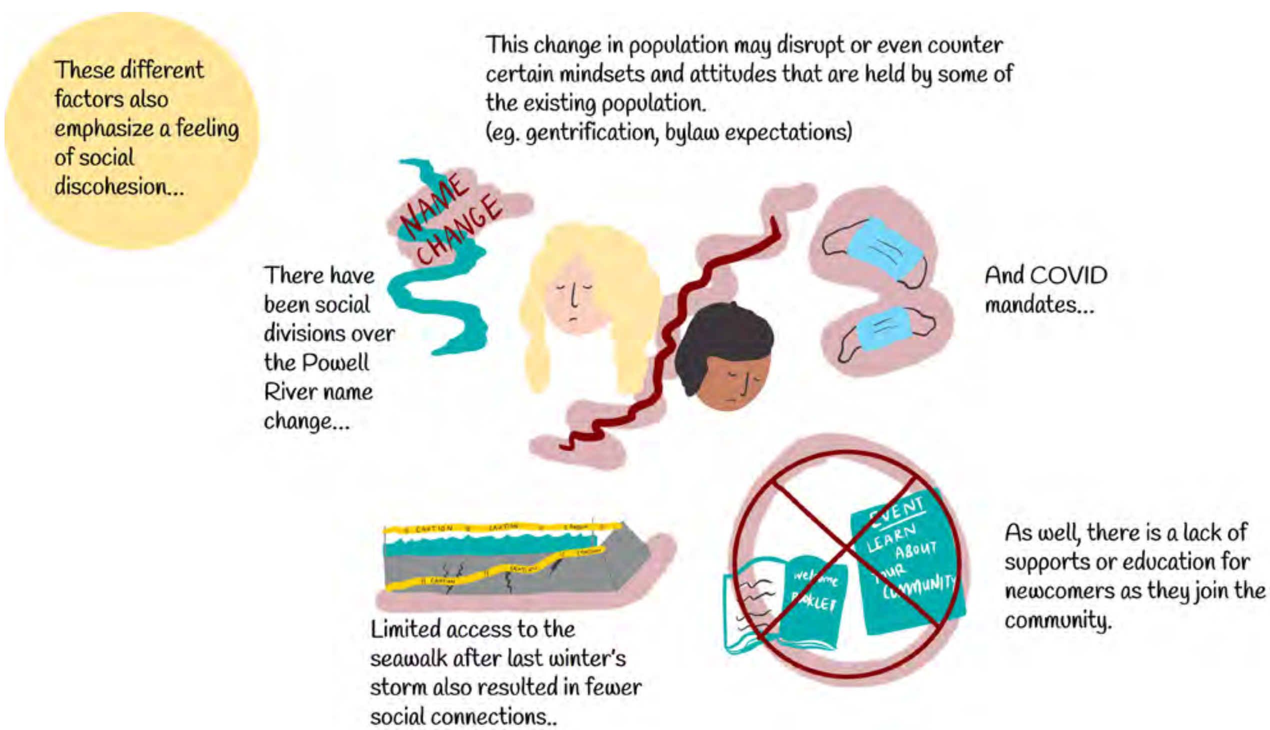


Figure 5-7: Example aspects of social dis-cohesion.

Figure 5-8: Example social, economic, and cultural change nuances experienced by the Tla'amin Nation.

5.2 Values, Priorities, and Tradeoffs

Already in the above visual summary, we can see key values being expressed in the form of changes in things that people appreciate and notice. A number of questions and formats were used to elicit values and priorities from participants, and provide insight into possible tradeoffs. Thematic results for each of these questions are shown in Figure 5-9.

Figure 5-9: Illustrating the collective values voiced by participants in the community survey.

5.2.1 What Do You Value About Living In A Coastal Region?

Key Themes (number of responses in parentheses)

- Environment, nature, biodiversity (23)
- Lifestyle, recreation & access to nature (21)
- Weather and climate (6)
- Beauty and aesthetics (6)
- Traditional territory (3)

Figure 5-10. Word cloud response to "What do you value about living in a coastal region", from government information session.

5.2.1.1 What Makes For A Resilient Region?

Key Themes

- Being Prepared and Informed (19)
- Strong Relationships (13)
- Flexibility and Creativity (7)
- Values-based (6)
- Strong Local Governance (4)

Figure 5-11. Word cloud response to "What makes for a resilient region?" from public information session.

5.2.1.2 What do we need to preserve, restore and let go of, for future generations?

Table 5-1 provides some insights to values-based questions regarding preservation/restoration versus loss.

Table 5-1: Table 5-1What do we need to preserve, restore and let go of, for future generations.

Questions	Participant Comments
Preserve, enhance or improve…	• Public & recreational access to shoreline and nature • Functioning infrastructure, supply lines, access • Healthy ecosystems, water, habitat, harvesting • Coordinated approach and collective action • Land and water stewardship • Archaeological and cultural sites, practices and uses • Cultural shift: living with water, reducing risk over time, adapting to changes • Freedom; maintain options & flexibility for as many as possible • Economic security (food security, local economy, tax burden) • Low government involvement / trust in government and democratic process • Awareness (appreciation for nature; climate action; understanding risks & change; …)
Let go of…	• Property / structures in hazard zones • Some ecological features / existing shoreline / heritage sites • Self-interest / consumptive attitudes; some freedom & individual choice

Questions	Participant Comments
	• Global capitalism (oil- and gas-based; export of raw materials) • Some types of infrastructure and development patterns (e.g. high density, large/private homes) • Idea that we can protect everything, as is, at all costs; nothing: we need to maintain everything as is

5.2.1.3 What matters most when choosing between adaptation options?

Figure 5-12 shows survey responses when participants were asked about choosing between adaptation options.

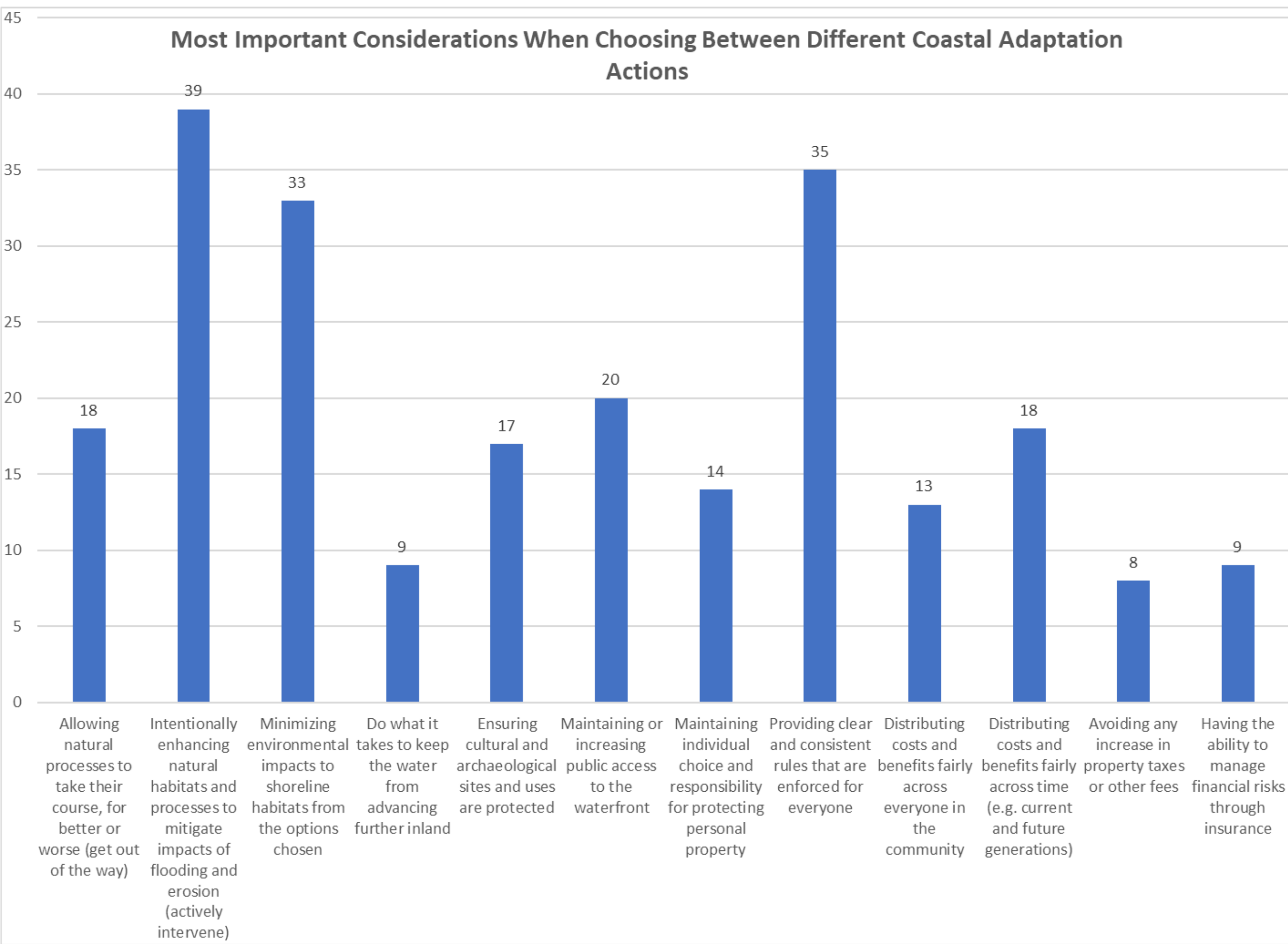


Figure 5-12. Bar chart of survey responses to "Most Important Considerations when Choosing Between Different Adaptation Actions".

The three most popular responses were:

- Intentionally enhancing natural habitats and processes to mitigate impacts of flooding and erosion (actively intervene)
- Providing clear and consistent rules that are enforced for everyone, and
- Minimizing environmental impacts to shoreline habitats from the options chosen.

This was followed by:

- Maintaining or increasing public access to the waterfront
- Allowing natural processes to take their course
- Distributing costs and benefits fairly over time
- Protecting cultural and archaeological sites and uses

Certain answers differed slightly between respondents from different jurisdictions (Tla'amin Nation had 3 respondents, which is not comparable to CoPR and qRD, which had 23 and 24 respectively). CoPR respondents valued "providing clear and consistent rules that are enforced for everyone" slightly more than qRD respondents (70% CoPR respondents versus 58% of qRD respondents), and also valued "maintaining individual choice and responsibility for protecting personal property" slightly more than qRD residents (34% of CoPR respondents versus 17% of qRD respondents). Lastly, qRD respondents valued "minimizing environmental impacts to shoreline habitats from the options chosen" slightly more than CoPR respondents (67% of qRD respondents versus 57% of CoPR respondents).

The most important considerations also differed depending on how close to the shoreline that respondents lived (either within 100 metres of the shore or further away). Waterfront inhabitants indicated a higher preference for minimizing environmental impacts to shoreline habitats (71% of waterfront residents vs 52% of those further away). Waterfront residents also preferred measures that would spread the costs of protecting private property across the community (32% vs. 16%) and across time (43% vs 21%). Residents who live further from the coastline value maintaining public access to the waterfront more (50% vs 29% of waterfront residents), and allowing natural processes to take their course, for better or worse (50% vs 18% of waterfront residents). They also preferred maintaining individual choice and responsibility for protecting personal property (38% vs 18% of waterfront residents). The differences between waterfront and non-waterfront residents is illustrated in some comments provided in Figure 5-13.

Figure 5-13: Priorities of waterfront and non-waterfront residents.

Lastly, many survey respondents have lived in the region for more than 15 years and had slightly different preferences than that of more newly arrived residents (between 1 to 5 years). Long-time residents preferred maintaining individual choice and responsibility for protecting personal property more than newer residents (31% versus 17% of residents arriving in the last 1 to 5 years). They also valued maintaining or increasing public access to the waterfront (41% of longtime resident respondents versus 25%). More recent arrivals valued clear and consistent rules for everyone (83% versus 63% of longtime residents).

When asked what else, if anything, is important to consider when choosing between adaptation actions, participants noted:

- Responsibility and accountability
- Public engagement and education
- Planning and action
- Informed and strategic solutions
- Recognize that change is happening

5.2.1.4 Tensions and Tradeoffs

From the first round of engagement (info sessions and survey) we began to recognize some of the values held by residents in the region, for which there are inherent tensions. These are shown in Table 5-2.

Table 5-2: Key tensions and tradeoffs.

Protect what can't be replaced (e.g., environment, cultural sites)	------------	Protect whatever is most important now
Take a coordinated, consistent approach	------------	Maintain individual freedom
Prioritize funding to protect things that benefit the most people or greatest good (infrastructure, economy, environment)	------------	Prioritize funding to benefit individual choice and benefit
Emphasize collective responsibility and action	------------	Emphasize personal responsibility and action
Maintain options & flexibility over time	------------	Do what makes sense at this time and let future generations figure things out
Learn to live with water and adapt to change	------------	Resist change at all costs

A number of participants expressed the sense that change was needed, or even inevitable, and that we need to find ways to adapt and embrace this process in order to participate more actively in how the future unfolds. One participant shared this sentiment: "Let go of idea that we must protect everything as it is at all costs. We need to get better at adapting to a new way of doing things." Yet another said, "No sense fighting what can't be prevented. Choose appropriate battles that can be at least partly won." Although very few comments emphasized resistance to change, at least one voiced this perspective when discussing what could be let go for future generations: "They need it all, just like we have it. I don't want to deprive a future generation of anything about this beautiful place."

Many people mentioned the tension between individual actions and the impacts this can have on collective values (e.g., installing rip rap on one property, that has negative impacts for neighbouring properties as well as ecological and cultural values). At the same time, individual property owners at times expressed a sense of powerlessness because they did not wish to infringe on other important values but did not know how else to preserve their home or property. One participant framed this as a call to action: “We can let go of the "my property, my choice" mentality and work together to determine what needs to be done to protect the land for future generations.”

Two themes were particularly common in the early engagement results (level of government intervention, and the emphasis on individual versus collective action) and so we used these to frame the “planning scenarios” below. Through further dialogue and exploration in the stakeholder and partner workshops, we were able to understand more of the nuance and variation in some of these themes, which translated into some of the *Guiding Principles*.

5.3 Considering a Range of Adaptation Options and Strategies

5.3.1 Priority Impacts and Preferred Strategies: Archetype Areas

To consider the qathet region’s long coastline, we developed a set of three “archetype areas” that together represent different combinations of characteristics, including:

- Qathet Regional District, Tla’amin Nation, and City of Powell River lands.
- Island and mainland areas.
- More rural and more urban settings.
- A range of land uses and values.

The archetype areas (The Docks, Oceanside Living, and Island Sanctuary) are illustrative, providing tangible examples of conditions in the region and what could be at risk. Each area is affected by flood and erosion hazards differently, and they help us consider the range of impacts (i.e., to dwellings, infrastructure, environmentally sensitive areas, archaeology) in the region. These areas were used throughout the engagement process to gather input and feedback from participants about their preferences, priorities and possible tradeoffs when considering coastal impacts and possible solutions. This provides a basis to think about adaptation strategies that could be applied to the region as a whole (over the short- and long-term).

Participants were asked to choose which impacts they were most concerned about in each archetype area and why, and also which of the conceptual options (protect, avoid, retreat, accommodate and resilience-building) they felt would be most effective in this situation. The top responses are summarized in Table 5-3.

Table 5-3: Priority impacts and preferred impacts for each of the illustrative archetypes.

Area	Priority Impacts	Preferred Approaches
The Docks	• Flooding and erosion impacts to sewer and transportation **infrastructure / services** • **Economic** impacts to the community, and • **Ecological** impacts (shoreline habitats, etc.).	• Accommodate • Avoid • Resilience-building
Oceanside Living	• Flooding and erosion of access roads and **infrastructure** servicing the area • **Ecological** impacts (heron and other shoreline habitats, etc.) • The remaining six options all received a lower but similar number of responses suggesting that a greater **range of values** and impacts need to be considered in such settings.	• Avoid • Accommodate • Protect
Island Sanctuary	• Ecological impacts • Erosion and flooding impacts to **homes and property** • **Cultural** impacts (archaeological sites, historical uses)	• Protect • Avoid • Resilience-Building

Infrastructure and services were a priority for many participants, which reflects on a core role of governments and the **widespread benefits** (and impacts) of ensuring that infrastructure and services are resilient. The **irreversibility of some impacts** (ecological, cultural, access to nature) was repeatedly stressed by participants, emphasizing that such impacts should be prioritized. "Once it's gone we'll never get it back." There was also a lot of concern with economic and financial impacts to the region and individuals, along with an emphasis on **property owners (commercial and residential) taking responsibility for their investments and choices**. In the case of The Docks in particular, equally strong views were expressed in support of prioritizing economic values or environmental values, above other values. This is an area where particular attention might be paid to exploring options that could make both more resilient.

Based on discussion and consideration of impacts and priorities in the archetype areas, the following list summarizes the key impacts and values that participants wish to address through coastal adaptation strategies:

Priority Impacts:

- Enhance resilience of public infrastructure
- Maintain healthy ecosystems, water, habitat and harvesting
- Protect cultural and archaeological sites and uses
- Maintain public access to waterfront
- Build economic security
- Maintain supply lines and access routes
- Enhance opportunity and well-being for future generations

Considerations for the proposed conceptual adaptation options (protect, avoid, retreat, accommodate and resilience-building), as well as specific adaptation actions, are included in Appendix C.

5.3.1.1 Exploring Future Directions: Feedback on Planning Scenarios

Through the first round of engagement some key tensions surfaced, as reflected in the quotes in Figure 5-14. Participants in the second stakeholder and partner workshop discussed the benefits and drawbacks of the different planning scenarios and were then asked which scenario they felt provides the best direction for the region at this time. Over half of participants (11) chose Scenario 3 – Regional Collaboration, with 7 participants choosing Scenario 1 – Neighbourhood Resilience, and 2 choosing Scenario 4 – Direct and Retreat. No participants chose Scenario 2 – To Each Their Own (which was closest to how things are currently being done). This suggests that **more collective approaches are favourable, and that a range of actions that include regulations should be considered**.

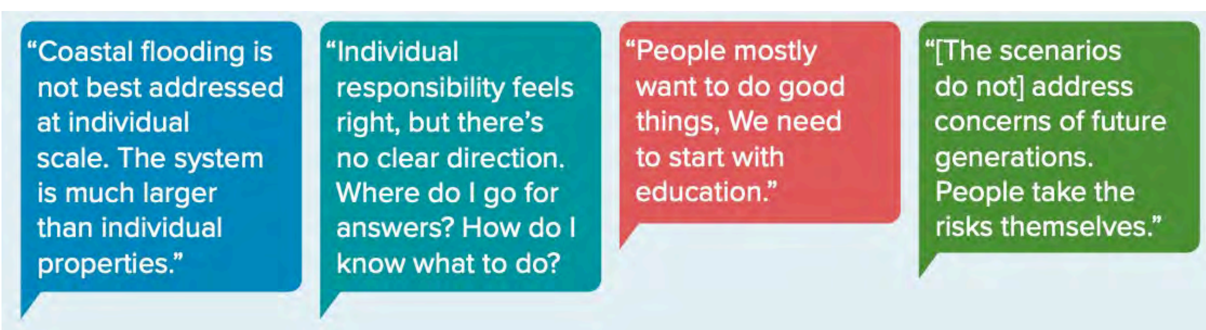


Figure 5-14: Key themes identified through engagement and explored using planning scenarios.

Participants reflected that there is **little desire for the status quo** – participants agree that change is necessary. There was a desire to put "all options" back on the table - so as to not do something too soon, or too late

Financial supports are an important consideration. People want to do the right thing but can't necessarily afford to. Collaborating on common projects could help to attract funding.

Collective action is needed to adequately address the scale of these issues. This is better done at a neighbourhood or regional scale, especially for addressing cultural and environmental values. Relying on individual responsibility requires a lot of education and we're not there yet – individual actions affect others and the community. There is value in standardizing expectations and making liabilities clear. Young people tend to be more likely to seek and understand collective action relative to individual.

Some individuals will push back against **regulations**. This can be mitigated by giving people choice from within an approved list of options, and by investing in education prior to regulation. Such changes need to consider fairness, and be approached carefully as the prospect of regulations can lead to people rushing out to do things they won't be allowed to in the future.

Flood/erosion are "quiet" topics in the region compared to fire and other hazards. **Education is key** to all of these approaches. Many people want to do good things. Education makes it easier for people to make better choices – it is easy to implement in the short-term and can support introductions of government regulations. For example, educating property owners on respecting cultural sites will reinforce regulations.

5.4 Preliminary Principles

The engagement process provided a rich set of ideas and feedback that has helped to shape the strategies being proposed for the region. Key themes were also distilled into a set of preliminary principles that were used to guide the adaptation strategy. A description of each preliminary principle is provided below.

Take a coordinated, consistent approach as a region. While the contexts and tools available to jurisdictions in the region differ, there are great benefits to aligning around shared goals and messaging as a region, to provide clarity and predictability to individuals to enable them to make better choices. Coordinating as a region around certain projects and funding applications could lead to greater success and efficiency. A clear theme from workshop participants was that collective approaches will be more effective than individual ones, even though this may be challenging. Enabling mechanisms (e.g., joint plans, shared standards, education & training, financial incentives, neighbourhood-level capacity-building, etc) could be an effective focus for regional cooperation.

Act in the best interests of future generations. There was a clear desire from participants to make decisions that will maintain values and opportunities for the next generations. This framing also seemed to help participants imagine what's at stake in the future, and therefore what is important to include in decision-making now.

Defend and enhance what cannot be replaced (e.g., ecosystems and cultural sites and uses). While participants had differing opinions on exactly which values were most important in different situations, a common perspective was the need to prioritize things that cannot be replaced, including ecosystems, cultural sites and uses.

Prioritize funding to protect things that benefit the most people or greatest good. Similarly, participants consistently expressed a desire to prioritize values that provide benefit to many people (infrastructure, ecosystems) or that have wide-ranging potential for impact (e.g., economy).

Emphasize personal responsibility for private property. And while there was a desire for fairness and consideration in relation to supports for private property and assets, these ranked lower than other values. Many participants expressed the opinion that personal responsibility in relation to private property impacts was important, but also that property owners should be supported through education, tools and options so that they could make the right decisions for themselves.

Prioritize tools that enable individual and collective action. Participants repeatedly emphasized that people generally want to do what's good for themselves and others, and just need the support to do so. These supports could include public education, incentives, support, coordination, and guidance.

Use regulations where that is the best tool. The three jurisdictions in the region have different approaches and tools available to them for requiring particular actions or behaviours. While it is recognized that many people in the region prefer a non-regulatory approach, in some circumstances regulation is the most effective option and should be considered where feasible. While not all jurisdictions will be able or willing to implement identical regulations, there is also the option of agreeing to targets or goals in common, and working towards these using the tools available to each.

Maintain a certain level of flexibility and choice at a site level. There is great value in allowing individuals to exercise their own choice and creativity in developing appropriate solutions. At the same time, in some cases it may be necessary to guide individual actions by defining an acceptable range of options, but allowing for choice between them, in order to achieve shared goals.

Learn to live with water, accept some losses and adapt to change. A general theme expressed throughout engagement was a recognition that change is happening and there is a need to work with this and actively adapt. Participants in the workshops were clear that the status quo approach to coastal risk is not sufficient, and that through working together we can find better ways forward.

Take a phased approach over time, including:

- Emphasize Accommodate, Avoid, and Resilience-Building in early phases.
- Use Protect only where necessary, and with an emphasis on soft, low impact, green options.
- Work towards Retreat later in time, where / as needed.
- Maintain options and flexibility over time, and proactively create the conditions to take bigger steps later on.

Throughout the engagement process all approaches were discussed and considered for their merits in addressing the wide range of situations present along the coast. In the near term, the Accommodate, Avoid and Resilience-building approaches were generally seen to be the most useful, especially as awareness and capacity in relation to coastal resilience grows. Protect will be the appropriate measure in a limited number of situations (in particular for important infrastructure), but more natural solutions are desirable where possible. It is wise to plan ahead so that infrastructure can be moved or made more resilient during periods of replacement or upgrades. While Retreat was not seen as the most feasible or appropriate option in the short-term, it was recognized that it should be maintained as an option and continue to be discussed, with thought being given to where relocation could happen in the future.

5.5 Summary

Feedback on the supporting tasks for the development of an adaptation strategy (Section 4) was obtained during the engagement activities. The engagement was iterative, which allowed us to refine the outputs and reach the project goal. In Section 6 we further distill the information obtained during the engagement activities, such as developing the *Guiding Principles*.

6 Recommended Adaptation Strategy

The region has begun to address coastal flooding and erosion issues. And through this current project the partners have worked to increase understanding about the present-day and future risks as well as the many challenges and tradeoffs associated with addressing coastal hazards in a changing climate. This section outlines a mix of high-level and tangible and practical next steps that can be taken by the project partners and others to address immediate challenges, as well as prepare to make some challenging decisions in future.

The recommended actions are wide-ranging and are based on best practices and guiding principles discussed in Section 6.1. This is followed by some actions and approaches that should be taken as a region, ideally with alignment and engagement between each jurisdiction. The project aims to align the three governments in their general adaptation approaches but notes that each government will likely apply different tools at different times. We also provide actions and approaches that could be taken at a local site scale in Section 6.3 that are also based on the *Guiding Principles.* These concepts are then re-presented using the framing of the different archetype areas (The Docks, Oceanside Living, and Island Sanctuary) used in the stakeholder and public engagement. Finally, additional notes are provided in Section 6.5 to support each jurisdiction, who each have different existing regulations and policies, on specific actions they can take.

6.1 Guiding Principles

The engagement process provided a rich set of ideas and feedback to shape the strategies being proposed for the region. Key themes from the engagement were distilled into a set of seven *Guiding Principles* that have been used to inform the recommended strategy and are intended to be a helpful decision-making guide as this strategy develops and changes over time.

The *Guiding Principles* are meant to be considered and balanced when deciding on specific actions to be taken in the future. Some of the principles may seem to contradict one another, such as taking a consistent, coordinated approach and maintaining flexibility and choice. This is not in error, but a reflection of the different values that exist simultaneously, and not always harmoniously. These are places where tradeoffs must be made when making specific decisions, to best balance the set of values that the community holds.

The seven *Guiding Principles* are as follows:

1. Take a coordinated, consistent approach as a region.
2. Act in the best interests of future generations.
3. Collectively grow our ability to be flexible and adaptive in relation to coastal change.
4. Defend what cannot be replaced (e.g., ecosystems and cultural sites and uses).
5. Prioritize funding to protect things that benefit the most people or greatest good.

6. Enable and incentivize individuals to reduce their risk:
    - Prioritize education and incentives.
    - Use regulation where that is the best tool.
    - Maintain a certain level of flexibility and choice at a site level.
7. Take a phased approach over time:
    - Emphasize Accommodate, Avoid, and Resilience-Building in early phases.
    - Use Protect only where necessary, and with an emphasis on soft, low impact, green options.
    - Work towards Retreat later in time, where / as needed.
    - Maintain options and flexibility over time, and proactively create the conditions to take bigger steps later.

The *Guiding Principles* are reflected in the strategy recommendations. The recommendations are organized into different groupings based on whether they are targeted at the region as a whole or are actions that can be taken by individuals or individual governments. Further, the recommendations are loosely organized based on the PARAR framework presented earlier in the report.

6.2 Regional and Enabling Approaches

The region has great diversity in the level of risk from flood and erosion hazards, and in the tools available to manage these risks in the different jurisdictions. The following six regional and enabling actions are provided to align approaches (as per the first *Guiding Principle)*, guide the project partners on issues that are best managed at a regional scale, and enable individual and collective action across the area. We also provide relative indications of the priority, timing, and effort needed for each action, and where available, we have provided some resources and examples from other jurisdictions and regions.

6.2.1 Co-ordination and Leadership

Priority	High
Timing	1-2 Years
Effort	Low

Given much of the work to plan for and implement adaptation actions will be carried out by individual local governments, other levels of government, or even individual property owners it is important to have governance mechanisms in place to support moving together as a region. This includes leveraging existing political and public will to advocate with senior governments for actions that will support improved coastal resilience in the region (e.g., changes to legislation and regulation, funding, etc.). To build on the momentum of the current project and ensure that long-term goals are met, we recommend the following:

1. Create the opportunity for collaboration to move towards consistency, while recognising the unique cultures, governance models, and regulatory styles within each jurisdiction. Some approaches to this might include:
    a. Addition of a standing or occasional item related to climate adaptation and coastal resiliency, within Community to Community to Community (C3) Forums. This would create an opportunity for senior staff to provide updates to elected officials on progress made and challenges encountered with regards to the implementation of the regional CFAS.
    b. Respect existing protocol agreements and land use harmonization policies (through government-to-government meetings) prior to the implementation of any major decisions related to coastal erosion and flood management, especially for any structural works near jurisdictional boundaries.
    c. In the longer-term, on the assumption that capacity increases, consider the development of a staff-level working-group (like the working group that guided this project) to support alignment on land use and land regulation approaches to flood and erosion risk mitigation.

6.2.2 Land Use and Buildings

Priority	Medium
Timing	5-10 Years
Effort	Medium

Overall, the project partners should aim for policy consistency in the region. Currently the three governments have different setbacks and shore zone regulations and policies. Moving toward a more consistent alignment of approaches will ease collaboration between residents, contractors, and government staff. The following recommendations are made:

1. Work towards consistent approaches for land use along the shore (e.g., appropriate land uses and development guidance) through amendments to Official Community Plan (OCP), Land Use Plan (LUP) and other land use policies.
2. Work towards consistent permitting and enforcement of building controls (e.g., flood proofing and flood construction levels) through amendments to OCP, LUP and other land use policies.
3. Work with the Province (the approving authority) to support consistent permitting for parcel level protective measures in the foreshore.
4. Work with the Province to educate residents and support permits for parcel level protective measures that prioritize soft/naturalized approaches over hard engineering (e.g., stacked rock walls, seawalls) approaches.
5. Work with the Province to educate residents and support consistent and comprehensive permitting for archaeological site assessments to minimize potential impacts from flood mitigation works. The Tla’amin Nation is prepared to send cultural monitors to observe and advise on any land alteration near the shoreline. The qRD and the City of Powell River

should collaborate with First Nations to create a clear and consistent process to follow within their respective jurisdictions.

Figure 6-1 provides an example from the District of Squamish (Kerr Wood Leidal Consulting, 2015) of an integrated flood hazard management plan ties in with land use and buildings.

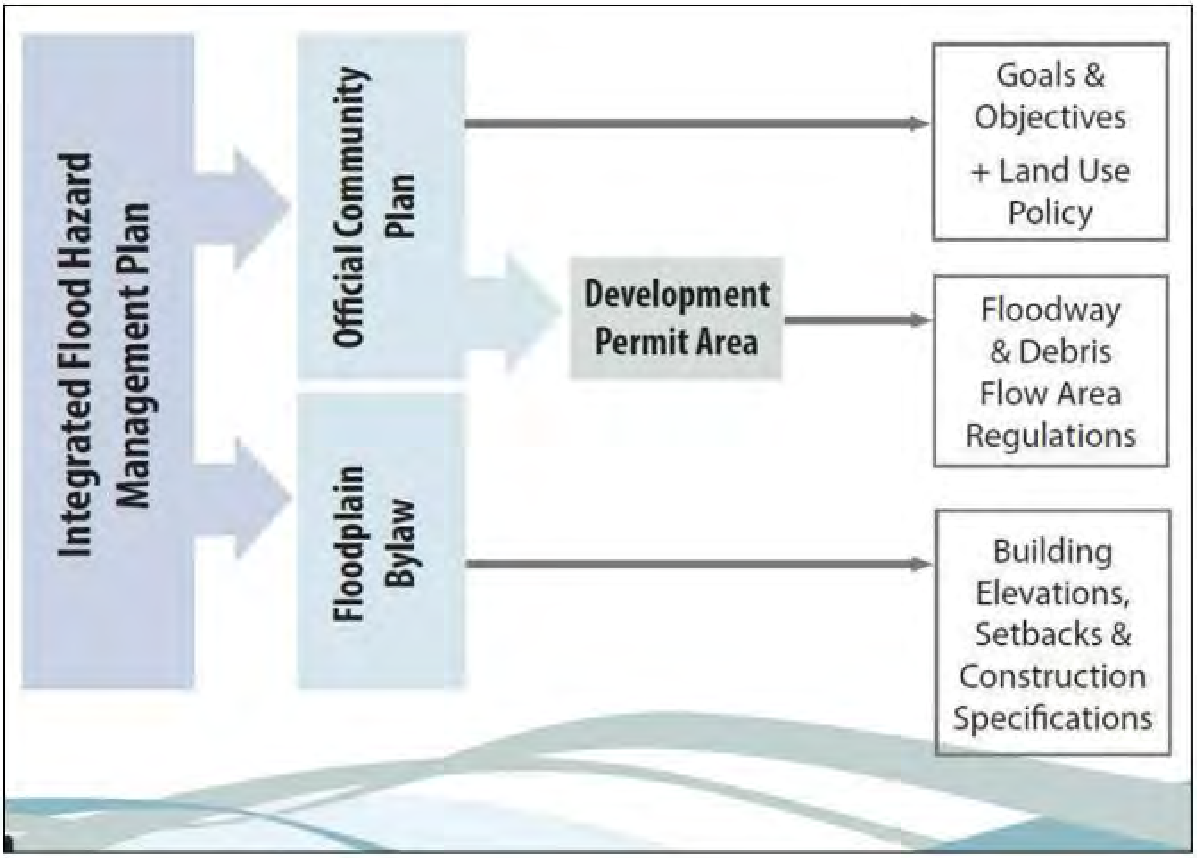


Figure 6-1: Example Framework for an Integrated Flood Hazard Management Plan. Source: KWL (2015).

Example resource: Learn about the K'ómoks First Nation Cultural Heritage Investigation Permit process to apply a similar approach in the project area.

6. Consider land stewardship as a flood management approach in concert with structural measures. Governments should identify and protect or restore natural systems that help buffer the magnitude and impact of coastal flooding. A future step for the region may be to build on existing species at risk and high value habitat mapping to understand where these areas overlap with high hazard areas and where there would be mutual benefit in protecting areas.

6.2.3 Infrastructure

Priority	Medium
Timing	1-10 Years
Effort	Low

As a region, all residents and jurisdictions rely on some common infrastructure such as roads, docks, water supply, etc. The reliability of this infrastructure in the face of climate change will be tested. Over the longer-term, flood thresholds and maintenance costs of infrastructure that is regularly flooded will need to be weighed against retiring the assets in favour of more flood-adapted systems. To minimise future damage and disruption of this infrastructure the following recommendations are made:

1. Hold a cross-partner workshop that includes Provincial partners and utilities (e.g., BC Ferries, Ministry of Transportation and Infrastructure (MOTI), BC Hydro, telecommunications companies) to discuss risk and support future proofing of regional infrastructure and potential cascading impacts and interdependencies. Share the flood mapping and this report with these service providers.
2. To improve asset management, project partners and other critical infrastructure service providers (e.g., BC Ferries, MOTI, BC Hydro, etc.) should align policies and procedures to explicitly account for a review of hazard and risk over the lifecycle of the asset. Condition assessments or new siting of facilities and infrastructure should consider the flood and erosion hazard mapping.

> **Example resource:** Incorporate climate change in asset management using tools such as the FCM introduction to climate resilience and asset management and BC focussed Climate Change and Asset Management: A Sustainable Service Delivery Primer.

6.2.4 Resilience and Capacity Building

Priority	Medium
Timing	1-10 Years
Effort	Medium

In addition to approaches that support active change to mitigation approaches, it is equally important to consider enabling approaches (e.g., capacity building) as well as longer-term approaches that will support improved recovery after climate events. The following recommendations related to resilience and capacity building are made:

1. Work with the construction, earthworks, and environmental assessment industries in the region to understand best practices and existing or new guidelines or regulations. Provide experts and resources related to archaeological and cultural sites, siting of buildings and septic fields, and design of parcel level protective measures.

> **Example Resource:** No known examples of such a course or framework exists. However, the VOI Training Group offers similar type courses in Canada that could be used as a template.

2. Include a standing agenda item on natural hazard risk in set meetings with regional partners or consider an annual review with all partners.

Example resource: Northeast Climate Resilience Network

3. Include a regional coastal flood response plan as part of regional emergency response planning and encourage homeowners to work with neighbours to develop emergency supply kits and enable neighbourhood-level resilience networks.

Example resource: Ucluelet Block Party

6.2.5 Public Education and Communication

Priority	Medium
Timing	1-10 Years
Effort	Medium

Flood risk reduction and climate resilience are "whole-of-society" challenges. Approaches to mitigate risk must bring in broad sectors, including the public, to both support the implementation of approaches and to spread the responsibility for action. A few recommendations to increase public education in this field include:

1. Currently there are a few guidebooks for residents regarding coastal development that are on the qRD website. These resources include the Canadian Edition of the Washington State "Your Marine Waterfront", the "Adapting to Climate Change on the BC Coast" videos, and the "Green Shores for Homes" website). Consistency of communication and recommended approaches across the region could be improved. Some considerations include:
    a. Cite guidebooks for coastal development on websites.
    b. Identify best management practices for coastal parcel-specific protective measures.
    c. Assess and disseminate archaeological and cultural site density along the waterfront and measures to protect them.
    d. Prepare and disseminate flood preparedness guidance.
    e. Prepare and disseminate guidance on siting septic fields in floodplains.
2. Make flood and erosion maps available to the public. Many local governments have now disclosed new flood hazard mapping publicly without significant issue (e.g., Squamish, Saanich, Victoria, Dawson Creek, etc.). Consider the following lessons learned:
    a. Clearly articulate in simple terms the scenario that is being depicted (what year, how much sea level rise, etc.).
    b. Provide illustrative information on what the water level includes (high tide, storm surge, sea level rise, etc.).
    c. Include limitations on the mapping (e.g., modelling and SLR projections uncertainty, suitability for regional planning or detailed design, and what

additional knowledge or investigations are required to achieve a desired suitability).

d. Explain how mapping is being used by local governments to address any current and future flood risk.
e. Link to resources to support risk reduction

Example Resource: Public installations related to the changing sea level have been effective internationally to raise awareness of the evolving hazard and shoreline. See the UBC Public Engagement Toolkit for Sea Level Rise. Citizen involvement in King Tide photo submission or interactive science campaigns have also been used to raise awareness and garner interest in new mapping etc.

6.2.6 Monitoring and Updates

Priority	Medium
Timing	1-10 Years
Effort	Low

The above recommendations are premised on the work completed for this report, and are based on current climate and SLR projections, as well as the senior government policies and guidelines (e.g., direction from the Province to plan for 1 m of SLR). As highlighted through this project, there is considerable uncertainty in many driving issues around climate risk and adaptation. As such it is important to keep abreast of any changes:

1. Monitor climate projections periodically (e.g., once per year through climatedata.ca and consult with the Pacific Climate Impacts Consortium) to understand how the science and modelling is evolving.
2. Monitor any changes to the B.C. Flood Hazard Management Land Use Guidelines. Consider a review cycle for flood hazard mapping and associated regulations of every 5 years.

6.3 Approaches to Reduce Risk and Build Resilience to Coastal Hazards

The four approaches described below illustrate how coastal flood and erosion risk can be managed over time.

6.3.1 Don’t make it worse

The OCP and LUP processes should be used to identify areas to limit growth and infill or identify areas to remain in lower risk land use designations. Flood prone areas and environmentally sensitive areas such as the foreshore are typical places to limit growth.

Example resource: Other jurisdictions in BC with similar challenges have begun to identify hazard areas and create policy direction on land use within them. For example, the City of Courtenay Official Community Plan (2022) (page 50) includes strong language on limiting (avoiding) growth in flood hazard areas as identified on flood maps. Similarly, the District of Squamish OCP (2018) designates high hazard areas as limited industrial land use and directs growth away from hazardous areas including consideration of how the hazard will change with climate change. As a more nuanced approach that allows for local variations, he Comox Valley Regional District Regional Growth Strategy (2018) states "all new development within established floodplain areas should only be supported where technical analysis by a qualified professional has been undertaken to ensure that lands are safe for use, development will not impact floodplain functions, and construction levels include safety factors to account for climate change and potential sea level rise and associated extreme storm surges".

New infrastructure, especially critical public infrastructure, should be sited outside of hazardous areas as much as possible.

Example resource: South of the border, strategic plans have explicitly identified this as a challenge. The King County Comprehensive Plan (2016) states, "site new critical public facilities outside the 500-year floodplain", and similarly in the Puget Sound Vision 2050 (2018) they have "Address rising sea water by siting and planning for relocation of hazardous industries and essential public services away from the 500-year floodplain". In Canada, the Region of Peel includes this "considering the location and design of regional human services facilities, including those related to communications, energy, and water infrastructure, to minimize vulnerabilities related to a changing climate" in its Climate Master Plan (2019). And, finally in a nearby the jurisdiction the District of Squamish OCP (2018) contains the following language: "Do not rebuild critical infrastructure in flood hazard or other hazard areas".

Currently in the region, individual site protective measures are constructed at the shoreward property line or in the foreshore area. Excavation and construction activities can result in several consequences including transfer of risk to neighbouring properties; impacts to the intertidal zone from scour and erosion; loss of habitat; pollution from runoff; and loss of sites of cultural significance.

Project partners should work with the Province (the approving authority) to include environmental guidelines for work on the foreshore. To capture new and renovated site level protective measures on existing sites, building bylaws, soil movement bylaws or land use plan specifications could stipulate a lower threshold for a "structure" requiring a permit or specific triggers for moving soil in the waterfront area. More frequently, development permit areas are being used to guide development along the shoreline. These actions should be combined with workshops conducted with experts in erosion management to earth works contractors and residents in specific areas.

Example resource: West Vancouver's Foreshore DPA (2022) includes an environmental assessment for any new structures/surfaces within 15 m of the Natural Boundary. Soft or natural landscaping is preferred, and hard armouring approaches are only approved if a Qualified Professional (QP) determines soft approaches are not appropriate.

Development permit areas are often used for steep slopes to avoid landslides and erosion. Consider implementing a steep shoreline development permit area that introduces appropriate setbacks, water management, and monitoring and maintenance. Include guidelines on water management to ensure stormwater is not directed off steep slopes and vegetation management to reduce removal of anchor vegetation and plant with native species. The DPA should prohibit removal of trees near or on the steep slope.

6.3.2 Limit erosion by restoring and mimicking natural systems

Recognize that erosion is effectively irreversible and can be catastrophic. Natural shorelines are effective at limiting this erosion at large scales and should be maintained. The natural shoreline approach contrasts with engineered slopes that can exacerbate larger scale erosion whilst trying to protect individual sites.

All governments in the project area have existing designations of the foreshore as “sensitive”, this could be leveraged in future.

Example Resources: Several other jurisdictions in the region have begun to work on shoreline restoration. The District of West Vancouver has a foreshore restoration project, as does the City of Vancouver for the New Brighton park area (shoreline habitat restoration project). And across the Strait, the City of Nanaimo has an Estuary Management Plan (2006) that is beginning to incorporate sea level rise.

As a future step for the region, increased understanding of areas with important natural assets along the coastline could be gained through an comprehensive assessment.

Example Resources: The District of West Vancouver has conducted a similar assessment and now has a natural assets booklet.

To move forward the idea that soft shoreline approaches are effective, acquire funding to support implementing a demonstration project for soft shoreline erosion and flood management practices along a public shoreline. This might be the restoration of native plant species or the placement of natural offshore barriers for highly erosive locations.

Example Resources: The City of Campbell River has recently implemented some soft shoreline restoration projects on their shoreline.

6.3.3 Manage for current risk with temporary measures while reducing vulnerability over time

Retrofitting existing buildings/structures to address flood hazard is challenging. The greatest opportunities lie in evolving the building stock by incorporating updated flood standards during redevelopment. In the interim, temporary flood barriers could be deployed to protect buildings that are flood prone, based on forecasts for high tides and/or large storms. More permanent flood defense measures such as breakwaters are an option. However, these are only recommended in high-risk situations where there is a rationale for the high expense.

As an immediate action across the region, the flood hazard mapping and related information should be shared among staff and with consultants working on capital projects. Asset managers can work together to identify priority infrastructure and buildings in the flood prone areas, starting with critical infrastructure, that may require resilience upgrades either at renewal or renovation.

Example Resources: Although regulation through bylaws and/or Development Permit Areas (DPAs) were not preferred at this time, many others are actively using these tools. For example the District of Squamish Flood Management Bylaw (2022) establishes Flood Construction Levels (FCLs), setbacks and construction specifications. The District has also established right-of-ways for future sea dikes if necessary. Similarly, Parksville's Coastal Protection DPA (2013) has guidelines for lands within 30 m of the coastline, and uses a Section 219 covenant on title, and requires that FCLs be established by a qualified professional.

Over the longer term, repair costs of infrastructure that is regularly flooded will need to be weighed against retiring the assets in favour of more flood-adapted systems.

6.3.4 Retreat from high-risk areas over the long-term

Over the longer term those engaged in the project strongly supported including retreat among alternative approaches as opposed to continued efforts to keep the water out. As sea level rises and protective measures are built to stop the water, intertidal areas, habitat, beaches, and important ecosystems are squeezed out.

The retreat approach can be accomplished through several potential pathways. In the USA following super storm Sandy, government buy-out programs were introduced through voluntary and regulated mechanisms. Buy-out programs can occur following several flood events or proactively over years. Another pathway, which is also practiced in the USA, is a rolling easement. Over time, site level protected measures would be regulated and removed allowing the water to move in. Structures could be removed at the owner or government expense with potential for compensation.

In B.C., riparian rights currently run with upland properties along the foreshore and include the right to protect the property from erosion. Any protection that extends beyond the natural boundary requires Crown approval. As land erodes, and the natural boundary moves inland, it becomes Crown land. Sea level rise has yet to challenge the extent of riparian rights associated with erosion protection. Another retreat pathway is relocation of properties in the flood hazard area to upland areas. This could include physical relocation or some transfer of property rights. A

Canadian example is the relocation efforts in Grand Forks after the 2018 floods, which was facilitated by funding from the Federal Disaster Mitigation and Adaptation Fund.

Example resource: In the District of Squamish (OCP) they have addressed the problem using a two-pronged approach dependent on the criticality: "develop a long-term strategy for managed retreat from vulnerable areas which includes: i. opportunistically retreating existing development to restore adequate flood setbacks from watercourse; and ii. Prioritizing the removal of key facilities and critical infrastructure outside of flood hazard areas at the end of their current life cycle". And, as an example of a community that has retreated post-disaster, the City of Grand Forks flood mitigation program has, with the financial support of senior governments bought-out the highest risk properties in the City, and is working to return this area to a more natural state to better manage future floods.

In the interim, each jurisdiction can develop a list for long-term acquisition of the known highest hazard properties (see Section 3.3) for both retreat, and potential use as a public resource (e.g., park).

6.4 Place-Based Adaptation Actions

As an alternative way to understand the recommended strategy, this section outlines preliminary recommended strategy options for the three illustrative archetypes areas. We present our understanding of existing plans that drive the planning contexts in each archetype area, as well as proposed options for two timelines. The short- to mid-term is associated roughly with the present day to the year 2060, and the mid- to long-term is associated roughly with the period 2060 to 2100.

The actions and strategies are not listed to indicate an absolute order of importance or priority. However, the order is meant to emphasize potential differences in importance when comparing the different archetypes, and the implementation time scale. For example, avoid actions are more commonly implemented in the short-term, and retreat actions take more time for full implementation over the long-term. In the short-term, existing contexts mean that a wider range and combination of recommended actions are required to achieve coastal adaptation, compared to the long-term. Therefore, there are longer lists associated with short-term versus long-term actions below.

6.4.1 The Docks

Potential actions for "The Docks" are focused on accommodate, protect, and avoid conceptual options.

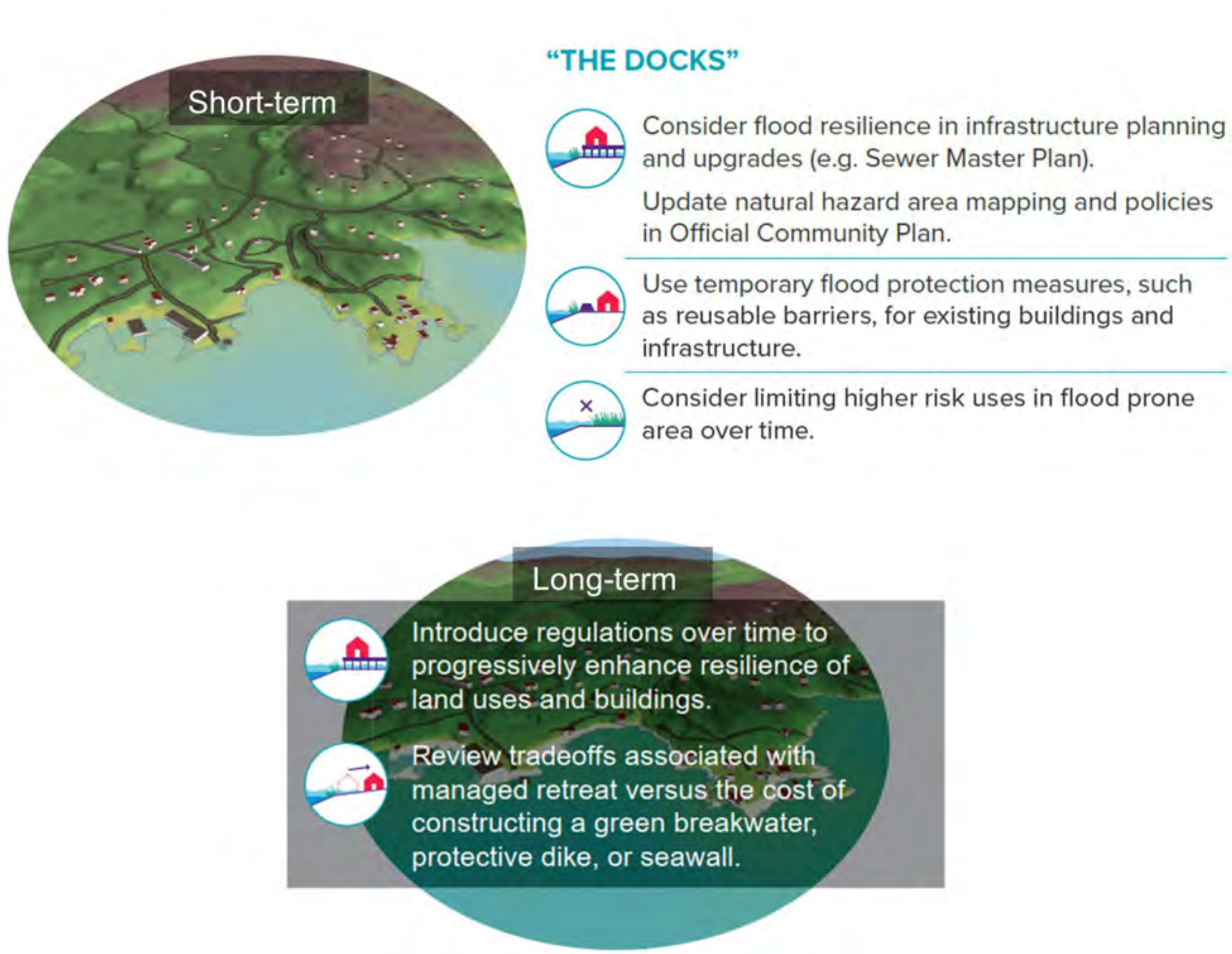


Figure 6-2: Short- and long-term adaptation actions for "The Docks".

Table 6-1: Example specific adaptation actions considering the Lund local area.

Short- to Mid-Term	Mid- to Long-Term
• Consider floodplain mapping in Sewer Master Plan for outfall design, lift station function, etc. during flood. Identify upgrades over time for flood resilience. • Temporary flood protection measures can be used for existing commercial buildings and infrastructure on Tla'amin land. • Tla'amin land – extend LUP flood hazard area to include this area. New buildings and major renovations to FCL and setback. Consider land use designation limiting residential use.	• Consider green breakwater to protect existing buildings and infrastructure. • qRD: consider zoning to regulate setbacks and FCL and potentially limit infill along the residential areas in the flood hazard zone. • Consider retreat vs. cost of protection via dike.

Short- to Mid-Term	Mid- to Long-Term
• qRD: amend OCP to add recommended FCL and potentially make setback consistent across the region (currently 30 m)	

6.4.2 Oceanside Living

The "Oceanside Living" recommended actions are focused on avoid, accommodate, and resilience conceptual options. Figure 6-3 indicates how these conceptual options could be used at a high-level over the short- and long-terms. Table 6-2 and Table 6-3 provide more specific place-based actions that consider the context at the tišosəm and Grief Point local areas, respectively.

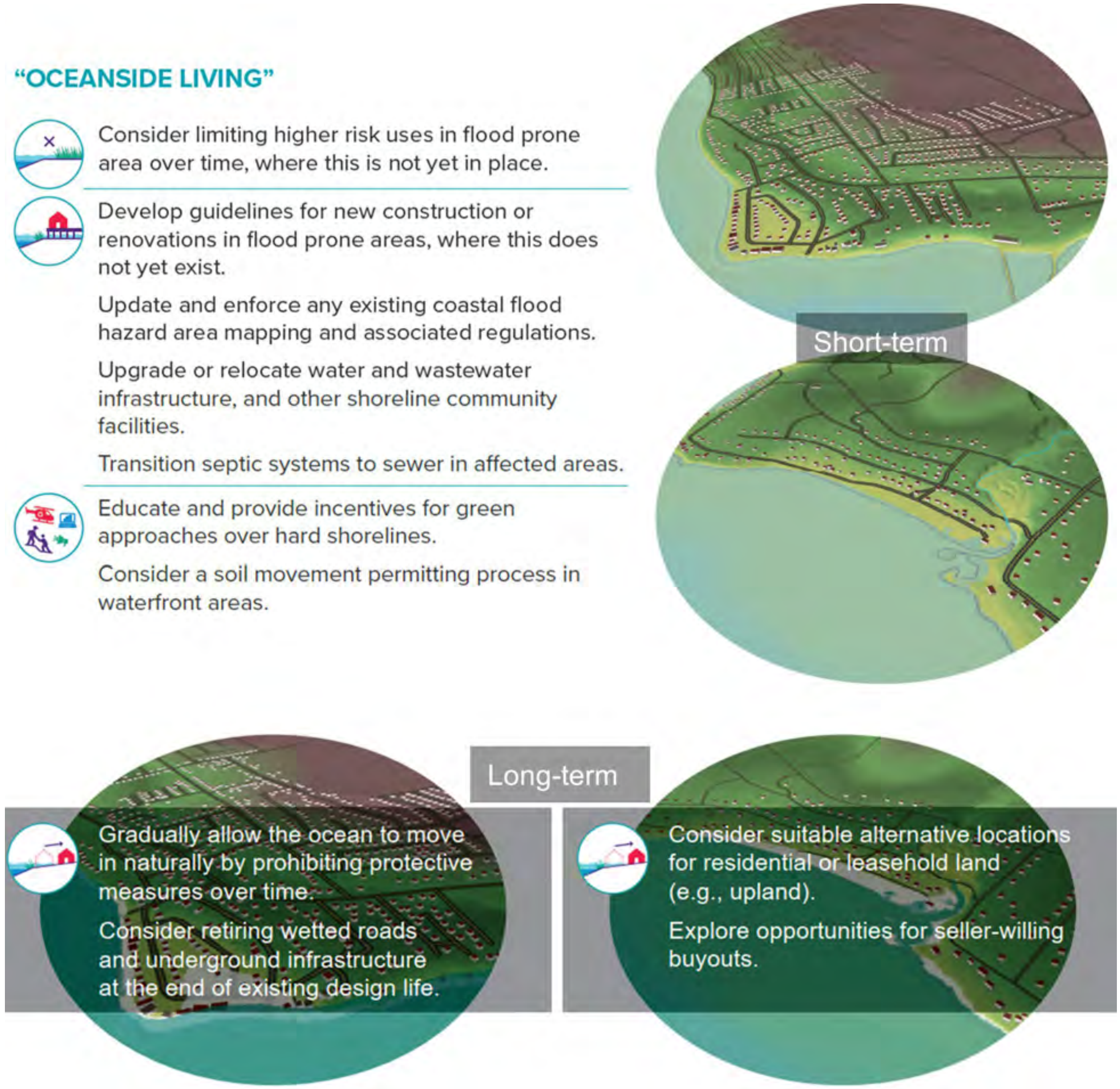


Figure 6-3: Short- and long-term adaptation actions for "Oceanside Living ".

Table 6-2: Example specific adaptation actions considering the tišosəm local area.

Short- to Mid-Term	Mid- to Long-Term
• Enforce existing land use plan regulations (FCL/Setback) in flood hazard area as new applications arise. • Educate and inform leaseholders regarding softer shoreline protection. • Update mapping, flood construction levels and	• Already planned – connect Klahannie drive to sewer system to get off septic • Obtain legal opinion on identification of leases that at the end of the lease

Short- to Mid-Term	Mid- to Long-Term
setbacks in the land use plan to be consistent with regional approach, recent mapping and Provincial flood management guidelines. • Specific assessment of critical infrastructure (WWTP) and shoreline community facilities for resilience measures.	structures may be removed or leased land relocated to suitable upland location. • Identify alternative locations for leasehold land.

Table 6-3: Example specific adaptation actions considering the Grief Point local area.

Short- to Mid-Term	Mid- to Long-Term
• Limit addition of risk in flood prone area through zoning bylaw (not adding density – carriage houses etc.) • Move forward with conversations regarding the marine foreshore DPA – include guidelines for setbacks/FCLs/protective measures • Consider requiring QP certification in the interim to DPA completion. QP would need to refer to most recent mapping and studies. • Opportunity to broaden definition in building bylaw section 5.2.2 for retaining structure exemption in the flood hazard zone/oceanfront to require building permit. • Consider developing a soil movement bylaw/permit – could include request for QP sign off if in the floodplain (e.g., the Village of Pemberton requires QP sign off for site alterations within the floodplain). • CoPR staff can notify the Tla'amin Nation when work near the water is being performed and request a cultural monitor.	• Prevent individual protective measures through regulation (with years of notice). • As water levels rise over time, remove structures that prevent property from flooding and allow the natural boundary to move inward[25]. One example in the US is through rolling easements. • Explore opportunities for seller-willing buyouts. • Consider retiring wetted roads at the end of existing design life.

6.4.3 Island Sanctuary

The "Island Sanctuary" potential actions are focused on accommodate, resilience, and managed retreat conceptual options. Figure 6-4 indicates how these conceptual options could be used at

[25] Riparian rights would currently allow structures to remain, but this may change with sea level rise. Costs would be at owners' expense but the CoPR should advocate with the Province to seek compensation.

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a high-level over the short- and long-terms. Table 6-4 provides more specific place-based actions that consider the context on Savary Island.

Figure 6-4: Short- and long-term adaptation actions for "Island Sanctuary".

Table 6-4: Example specific adaptation actions considering the Savary Island local area.

Short- to Mid-Term	Mid- to Long-Term
• Partner with Savary Island Land Trust to host workshops and develop information for property owners. Include insurance and erosion management subject matter experts. • Consider refreshing the Thurber Dune Study with consideration of climate change and to provide DPA guidance. • Refresh engagement on DPA for 2023 OCP. Include guidelines on water management (i.e., no outfalls	• Continue with education and DPA including enforcement. • Remove at-risk structures (edge of cliff) at owners expense (private parcels will shrink).

Short- to Mid-Term	Mid- to Long-Term
discharging to cliff faces). • Explore zoning for the area and protection of trees bylaw during OCP refresh (latter requiring permits for tree cutting to reduce erosion). • Share guidance on products and best practices for erosion management with contractors in the area. • Consider planting south bank with native species in collaboration with Ministry of Forests, Tla'amin Nation and Savary Island Land Trust. Combine with program to eradicate Scotch Broom.	

6.5 Specific Approaches by Jurisdiction

As noted throughout this report, each jurisdiction has specific challenges and different policies and regulations in place. With this in mind, some specific actions, that follow the spirit of the *Guiding Principles* and the recommendations above, are provided for each individual jurisdiction.

6.5.1 qathet Regional District

Electoral area OCPs in the region include reference to hazard areas and specifically erosion and flood hazard areas. Setbacks are generally 30 m. As OCPs are reviewed, climate change impacts on hazardous areas such as the evolution of flood prone areas can be included. Over time, zoning can be implemented where appropriate to regulate the flood construction levels and setbacks included in OCPs.

Savary Island was identified in this study and others as having particular concerns related to erosion, especially on the south shoreline. The Savary Island Dune and Shoreline Study completed by Thurber Engineering in 2003 was used as a basis for a development permit area (DPA) in the Savary Island OCP. The DPA has not been implemented and to do so will require an update to the dune and shoreline study. qRD should consider engaging on a renewed erosion and flood hazard management DPA during the 2023 OCP update referencing an updated engineering study with setbacks. A tree protection bylaw would be a further consideration to regulate tree removal on or within a distance of slopes. If zoning is considered during the OCP update, setbacks from top of slope can be incorporated.

Example Resources: Several jurisdictions with BC have enacted steep slope regulations. These include Sechelt DPA 4 (2010), Abbotsford Steep Slope DPA (2016), District of North Vancouver Steep Slope DPA Brochure (2014).

6.5.2 Tla'amin Nation

The Tla'amin Land Use Plan already includes a range of flood hazard tools including a flood hazard area, FCLs and setbacks. The tools can be updated to both reflect the latest flood hazard mapping associated with this project and to align with partners in the region. Common coastal flood risk reduction for sites includes constructing habitable area to specific elevations (FCLs), a setback from the shoreline, mechanical systems and electrical panels above flood levels, guidance on fill, etc. A process for review and enforcement of the regulation will support implementation and consistency.

6.5.3 City of Powell River

An existing issue along the BC coastline is property owners constructing parcel specific measures to protect from erosion and flooding. These interventions can have negative impacts on the sensitive foreshore ecosystems, impact cultural sites common on the waterfront and transfer flood risk to neighbouring properties. Several opportunities exist to improve this issue. The CoPR building bylaw does not currently require a permit for retaining structures under a certain height. Section 5.2.2 could be amended to reduce the height of structures requiring permits. Another or concurrent approach as laid out in the 1 September 2020 report to Council on the Foreshore DPA is to establish a soil movement bylaw requiring a permit for excavation. The Comox Valley Regional District works closely with the K'omoks Nation to encourage applicants to voluntarily apply for the Nation's Cultural Heritage Investigation Permit required within 200 m of a watercourse and all areas with archaeological potential. The City of Powell River already does something similar and could notify the Tla'amin Nation and request a cultural monitor when excavation is planned. Foreshore DPAs are becoming more prevalent and include terms to guide appropriate shoreline protection and require qualified professional sign off. (e.g., West Vancouver Foreshore Development Permit Area).

The current coastal flood hazard study signifies new hazard information. If applicable, an interim policy could be put in place to catch renovations and site level protective works prior to completion and adoption of a DPA and associated regulations. The District of Squamish approved interim policies in a similar situation associated with debris flow hazard, and the District of Ucluelet also approved an interim policy (specific to Tsunami) after publication of new flood hazard maps.

7 Conclusion

With climate change effects including sea level rise, the qathet region will continue to experience coastal flood and erosion hazards with impacts to a range of exposure indicators. The qathet region is responding to this challenge by taking a risk-based approach, within the context of the Regional Coastal Flood Adaptation Strategy. The goal of this project was to engage with rights holders, stakeholders, decision makers, and the public to build understanding, explore adaptation options to increase resilience to coastal hazards in the region.

The project was completed by addressing the project's five main objectives, as follows:

1. **Support collaboration of neighbouring governments and stakeholders to strengthen capacity.** We held several meetings with the project Working Group consisting of members from the qRD, Tla'amin Nation, and the City of Powell River who helped steer the project. We also held an information session and two workshops with project stakeholders to obtain critical feedback.
2. **Analyse and enhance flood risk mapping and identify possible coastal adaptation options.** We built upon previous technical work to better understand a range of coastal flood scenarios, including developing a small flood hazard extent. Using illustrative archetypes, we also considered erosion potential to produce risk profiles that can be used to support risk-based decisions.
3. **Engage with the public to raise awareness and define community values to inform decisions.** We provided various information exchange opportunities through presentations, website content, a survey, and an in-person event to hear from the public and disseminate project information.
4. **Develop guiding principles to inform the identification of preferred coastal adaptation options.** Through the engagement activities, we identified values, priorities, and tradeoffs, which we combined with the technical information and policy review to develop strategy recommendations. These were reviewed and refined with input from the project Working Group, and formed the *Guiding Principles* for strategy development.
5. **Prepare a strategy with regional and local considerations, and practical timelines for action.** The strategy recommendations tackle the complexity of the issues by providing several avenues for action. These include regional approaches (including estimated priority, timeline, and effort) to place-based actions and specific approaches by jurisdiction.

The strategy recommendations have highlighted the need for new approaches in coastal flood and erosion management. This project and accompanying reports and resources will support the qRD and project partners to move together thoughtfully by developing clear and consistent educational, guidance, and regulatory tools to reduce coastal flood risk in the region.

Glossary

Term	Definition	Source
Adaptation	Adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. It refers to changes in processes, practices, and structures to moderate potential damages or to benefit from opportunities associated with climate change.	United Nations Office for Disaster Risk Reduction (UNDRR)
Annual Exceedance Probability	The probability associated with exceeding a given flow rate at least once in any given year. For example, a 1% annual exceedance probability flood event has a 1% chance of occurring in any given year.	
Coastal Flood Adaptation Option	A solution to mitigate coastal flood impacts. This could include a number of strategies such as protect, accommodate, retreat, avoid, and resilience-building.	
All-Hazards	Referring to the entire spectrum of hazards, whether they are natural or human-induced. Note: For example, hazards can stem from geological events, industrial accidents, national security events, or cyber events.	Public Safety Canada (PSC)
All-Hazards Approach	An emergency management approach that recognizes that the actions required to mitigate the effects of emergencies are essentially the same, irrespective of the nature of the incident, thereby permitting an optimization of planning, response, and support resources.	PSC
Assets, Asset-At-Risk, (exposed and vulnerable element)	Refers to those things that may be harmed by hazard (e.g., people, houses, buildings, or the environment).	RIBA
Climate Change	A change in the state of the climate that can be identified (e.g., using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer.	IPCC

Term	Definition	Source
Consequence Indicator	Describes groupings of generalized assets (e.g., environment, culture, affected people, economy, and disruption). Provides a means of assessing impacts (qualitative) and consequences (quantitative) by specifying the information used.	
Erosion	Occurs when land is lost or displaced due to the action of coastal flooding (waves, currents, tides, wind-driven water) and debris transport.	
Exposure	The situation of people, infrastructure, housing, production capacities, and other tangible human assets located in hazard-prone areas.	UNDRR
Flood	Overflowing of water onto land that is normally dry. It may be caused by overtopping or breach of banks or defenses, inadequate or slow drainage of rainfall, underlying groundwater levels, or blocked drains and sewers. It presents a risk only when people and human assets are present in the area where it floods.	Royal Institute of British Architects (RIBA)
Frequency	The number of occurrences of an event in a defined period of time.	PSC
Geohazard	A hazard of natural geological or meteorological origin (i.e., this does not include biological hazards). It includes floods, fluvial (erosion), debris flood, debris flow, landslide and rockslide related processes and hazards.	
Hazard	A potentially damaging physical event, phenomenon, or human activity that may cause the loss of life, injury, property damage, social and economic disruption, or environmental degradation. Hazards can include latent conditions that may represent future threats, and can have different origins: natural (geological, hydrometeorological, and biological) or be induced by human processes. Hazards can be single, sequential, or combined in their origin and effects. Each hazard is characterized by its location, intensity, frequency, and probability.	UNDRR
Hazard Assessment	Acquiring knowledge of the nature, extent, intensity, frequency, and probability of a hazard occurring.	Modified (NDMP)

Term	Definition	Source
(Natural) Hazard	Natural process or phenomenon that may cause loss of life, injury, other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.	UNDRR
Likelihood	A general concept relating to the chance of an event occurring. Likelihood is generally expressed as a probability or a frequency of a hazard of a given magnitude or severity occurring or being exceeded in any given year. It is based on the average frequency estimated, measured, or extrapolated from records over a large number of years, and is usually expressed as the chance of a particular hazard magnitude being exceeded in any one year.	RIBA
Magnitude	Refers to the size or extent of a geohazard event. In this project, it relates to the likelihood of a flood. A flood event with small likelihood will have a large magnitude, and vice versa.	
Mitigation	Relates to options, strategies, or measures that are used to directly reduce risk from natural hazards.	
Quantitative Risk Assessment	A risk assessment that is completed using quantified or calculated measures of risk.	UNDRR
Resilience	The ability of a system, community, or society exposed to hazards to resist, absorb, accommodate, and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.	UNDRR
Risk	The combination of the probability of an event and its negative consequences.	UNDRR

Term	Definition	Source
Risk Assessment	A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods, and the environment on which they depend. Risk assessments (and associated risk mapping) include: a review of the technical characteristics of hazards, such as their location, intensity, frequency, and probability; the analysis of exposure and vulnerability, including the physical, social, health, economic, and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities, with respect to likely risk scenarios. This series of activities is sometimes known as a risk analysis process.	
Risk Management	The systematic approach and practice of managing uncertainty to minimize potential harm and loss.	UNDRR
Risk Tolerance	The boundary of risk-taking outside of which a community or organization is not prepared to venture.	UN (Adapted from Kamioka & Cronin (2020)
Scenario	The specifications of a modelled event (e.g., hazard type, temporal and spatial extent, magnitude, likelihood). In this project, relates to flood hazards, which are loosely attributed to likelihoods and associated scores to calculate risk.	
Vulnerability	The characteristics and circumstances of a community, system, or asset that make it susceptible to the damaging effects of a hazard.	UNDRR

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Appendix A: Policy Review – Background Notes

qathet Regional Coastal Flood Adaptation Strategy

Appendix A: Policy Review – Background Notes

Contents

1 Introduction

The qathet Regional Coastal Flood Adaptation Strategy (CFAS) is a partnership between the City of Powell River (CoPR), Tla'amin Nation, and qathet Regional District (qRD). The project built on a previous overview coastal risk assessment (Tetra Tech, 2018) and more detailed coastal flood mapping and erosion assessment (Tetra Tech, 2021, 2022). Ebbwater was retained by the qRD to complete the Regional CFAS by presenting coastal flood information in a meaningful way to build resilience. This was achieved in part by conducting three supporting tasks for the development of an adaptation strategy (i.e., policy review, risk-based analyses, and decision support).

This document presents background notes for the policy review task, which had the goal of improving the understanding of land use and regulatory tools currently being used, or available, in each of the project partner areas (see Section 4.1 of the main report). Key land use planning concepts are first presented (Section 2). This is followed by review notes of relevant land use policies in the qRD, Tla'amin Nation, and CoPR (Section 3). A short conclusion follows (Section 4), with a list of references.

2 Key Land Use Planning Concepts

In British Columbia, land use policy related to flood and natural hazards is guided by two ways to determine areas exposed to hazards. Flood Construction Levels (FCLs) are part of technical considerations that are used to establish flood hazard areas. Similarly, Sea Level Rise Planning Areas consider future changes due to climate change. The technical and regulatory background on these two concepts is presented in the sections below.

2.1 Flood Construction Level

In British Columbia (BC), an FCL is an elevation used in planning to establish the elevation of the underside of a wooden floor system (or top of concrete slab) for habitable buildings (Figure 1). It includes a freeboard (for safety) to account for uncertainties in the analysis.

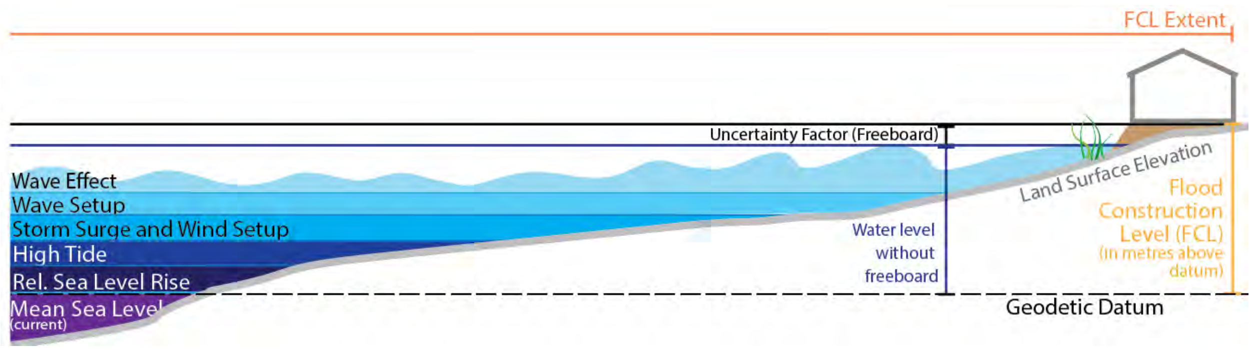

Figure 1: Conceptual drawing of the Flood Construction Level (FCL).

As time goes on, the FCL and the flooded extent it defines will change due to relative SLR (Figure 2).

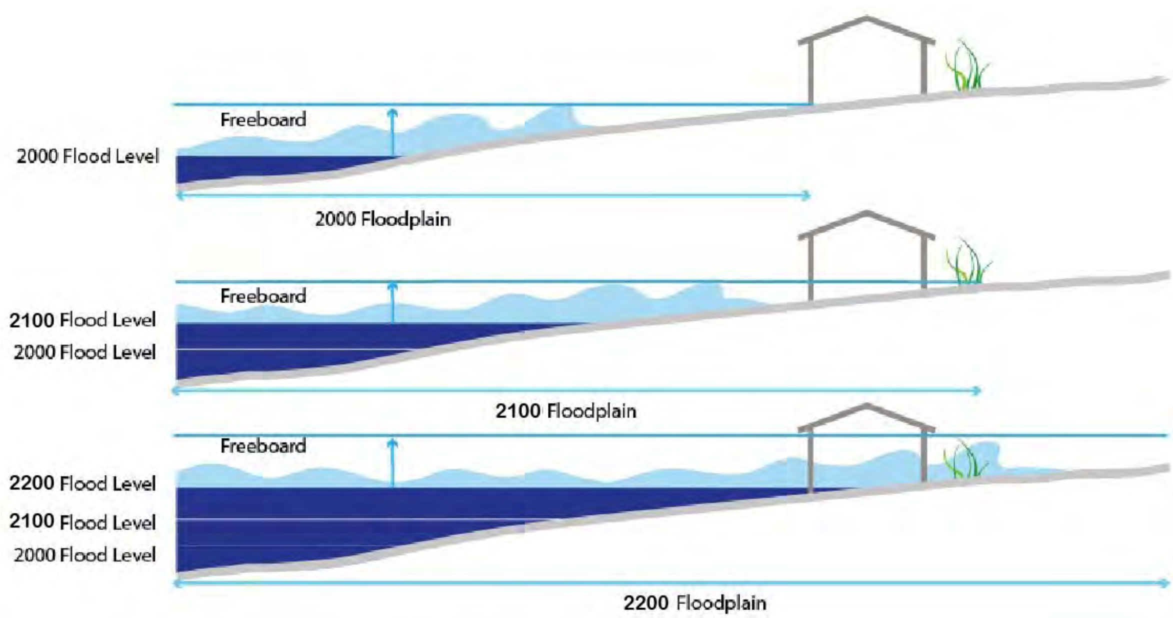

Figure 2: Increase in flood construction level (FCL) with sea level rise (SLR).

2.2 Sea Level Rise Planning Areas

SLR Planning Areas are used to show the change in flood extent over time and may be designated by local governments, by bylaw, as flood hazard areas. SLR Planning Areas show likely future flood extents considering SLR (Figure 3). Due to changes associated with SLR, both the natural boundary and SLR Planning Area are subject to change, and will require revision and updates over time. The latest update to the *Provincial Guidelines* suggests that as a minimum, the FCL for the year 2100 should be established for areas not subject to significant tsunami hazard.

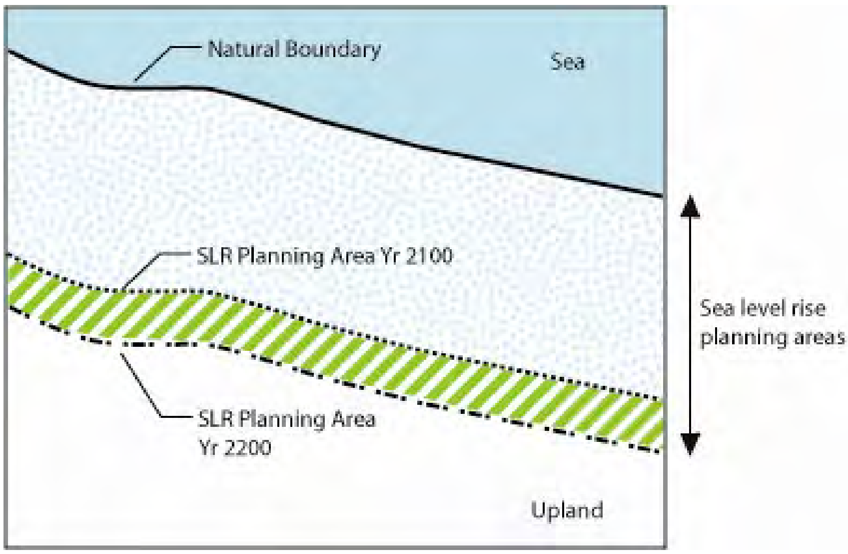

Figure 3: Sea Level Rise Planning Area example (Figure from Ausenco Sandwell 2011a, 2011b, 2011c).

SLR Planning Areas reach from the natural boundary of the sea landward to the contour elevation of a future FCL. The natural boundary is defined in the *Provincial Guidelines* as[1]:

> *The visible high watermark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks, thereof, in respect to vegetation, as well as in respect to the nature of the soil itself. For coastal areas, the natural boundary shall include the natural limit of permanent terrestrial vegetation. In addition, the natural boundary includes the best estimate of the edge of dormant or old side channels and marsh areas.*

[1] Local governments interpret the definition of the natural boundary in slightly different ways (see footnotes in Section 3).

3 Partner Area Land Use Policy Notes

The following sections provide notes from a review of land use policies and regulations found in documents for the qRD, Tla'amin Nation, and CoPR. The notes provided the consulting team with background information that was considered when developing the strategy recommendations of the main report. As such, these are intended as raw reference materials to support a baseline understanding of flood and erosion policy in the region. The main report contains a summary of the policies described in the sections below, as well as references and links to the reports reviewed.

3.1 qathet Regional District

The following brief overall notes are provided:

- There are no zoning regulations in 75% of Electoral Areas A, B, C and D.
- There is no building bylaw or Subdivision Servicing Bylaw.
- Electoral Area OCPs mention policies for shoreline areas and several have hazard/sensitive area.
- DPAs exist, including Savary Island's shoreline DPA, Electoral Area A Natural Hazard DPA.
- The lack of land use regulations (zoning, building, subdivision) means the application of these is largely by choice.
- The qRD website provides all the hazard studies as summarized below and the "Your Marine Waterfront" Canadian Edition guidebook.
- The sections below summarize documents reviewed for Electoral Areas A, B, C, and D.

3.1.1 Electoral Area A

3.1.1.1 OCP (2015)

- Land use is limited by the ability to accommodate a well and septic disposal system.
- Foreshore land use designation applies in areas below the natural boundary or high water mark of the ocean[2].
- Relevant policies include (page 22 of OCP):
  - Avoid clearing/developing within 30 m of natural boundary.
  - Retain and restore natural shoreline vegetation.
  - Encourage Green Shores for Homes.
  - Discourage armouring shorelines.
  - Where unavoidable, hard structural shoreline protection should be supported when installed within the property upland of the natural boundary.

- Discourage protection measures that will cause erosion or damage to adjacent properties.
- Subdivision applications require a geotechnical analysis of the shoreline.
- New development on slopes or bluffs require a Qualified Professional (QP) to design protective measures.
- Encourage private property owners to complete a self-assessment process on DFO website prior to developing in the foreshore area.

- Natural Hazard DPA II Map 5:
  - Discourage development on land that may be subject to hazardous conditions such as erosion or flooding.
  - Encourage lands subject to flooding to be left in a natural state or used for parks or nature reserves[3].

3.1.1.2 Lund Watershed Zoning Bylaw (2019)

- All zones contain a prohibition of any use which results in the escape or disposal of a waste product or storage of materials which would constitute a drinking water health hazard harmful to the sustained purity and flow of water in the watershed.
- The bylaw applies to less than 50 properties, which is less than 10% of the Electoral Area A population.

3.1.1.3 Savary Island OCP (2006)

- Environmentally Sensitive Areas and Hazard Lands:
  - Natural state or environmental covenant may be required as a condition of rezoning, subdivision, etc.
  - Public beach access should be limited to existing points of beach access and/or sections of shoreline that are low profile.
- Marine Resource policies:
  - Section 2.2.b – Construction of shoreline protection features such as seawalls and groynes shall be discouraged.
- Climate Change:
  - Section 9.1 and 9.2 – qRD will work with islanders to prepare for sea level rise by encouraging Development Guidelines for shoreline areas.
- DPA areas:
  - North and South Shores, Active Dune Areas, and Ecologically Sensitive areas.
  - A QP report is required that indicates that building siting is safe from erosion hazard for a minimum of 50 years (this is derived from the dune study).

[3] Focus area is steep slopes (small area) and there are requirements for a QP report.

- o Shoreline protective measures (for erosion) cannot be established without appropriate permits and licenses.

3.1.1.4 Savary Island Dune and Shoreline Study (2003)

- Includes recommendations for least costly hazard prevention concepts (these are not included in the DPA).
- Setbacks of 15 m, and 30 m to 40 m are recommended for 50, 60, and 200 years.
- 7.5 m setback from natural boundary on bedrock-controlled shoreline around Mace Point – protect from flooding due to wave run-up.

3.1.2 Electoral Area B

3.1.2.1 OCP (2012)

- Contains DPA for Riparian Area Regulations.
- Climate Change section includes SLR impacts. Policies include preparing for SLR by promoting provincial guidelines for building setbacks from the sea.
- Section 2.5.5.2 – Where necessary and subject to approval by MOE a floodplain management plan or flood setback and elevation bylaw may be implemented to provide greater local control.
- Section 2.5.5.5 – Any lands subject to flooding should, wherever possible, be left in a natural state or used for park or nature reserves.
- Advocacy policies: Section 2.5.8.8. – Encourages adherence to the "Coastal Shore Stewardship a guide for planner, builders"… for a 30 m setback from the natural boundary.
- Discourages armouring.

3.1.2.2 Zoning Bylaws

- Exist for 3 areas that includes approximately 25% of Area B population.
- The focus is protecting rural lifestyle and the aquifer and water quality.

3.1.2.3 Area B and C Landslide and Fluvial Hazards Study (2015)

- Recommendations include adopting landslide and fluvial hazard DPAs.

3.1.3 Electoral Area C

3.1.3.1 OCP (2012)

- Policies are very similar to Electoral Area B.

- Includes Natural Hazard Policies with recommended site-level assessment by a Qualified Professional (QP) prior to development on hazardous lands (Map 7).

3.1.4 Electoral Area D

3.1.4.1 Texada Island OCP (2019)

- Climate change section policy (h) – Ensure information from high-level risk assessment (including SLR) is accessible and available to the community.
- Coastal Areas: Promote forest cover within 30 m of the natural boundary.
- Recommend site level assessments by a QP to inform coastal development and ensure FCL and setbacks.
- Similar for Natural Hazards policies that focus on steep slopes.

3.1.4.2 Texada Island Watershed Protection Bylaw (1993)

- Stipulates a 30 m setback from watercourses and wetlands.

3.1.4.3 Texada Zoning Bylaw (1982)

- The general siting provision is that no building or structure shall be sited less than 15 m from the natural boundary of any watercourse (30 m if water source). A watercourse includes sea, ocean, tidal water, lake, creek, river etc.

3.2 Tla'amin Nation

The Nation has the most land use regulations relating to coastal hazard of all three governments. The following brief notes are provided:

- Development permits followed by building permits are required for construction and/or landscaping in areas within 300 ft of a water body and hazard/sensitive areas (includes 30 m from shoreline).
- A specific Shore Hazard Area is included and defined as anything up to 3 m above the natural boundary until such a time as a coastal flood map is available.
- Setbacks are 30 m from the natural boundary and FCL is 2 m vertical from the natural boundary.

3.2.1 Tla'amin Land Use Plan (2010)

- Applies to land use development on Teeshohsum (Sliammon IR1) and Ahgykson (Harwood Island IR2).
- Section on climate change recognizes storm damage to coastal housing and infrastructure and SLR of 1.2 m will result in permanent flooding of low-lying areas.
- A permit is required for most land development and construction.

- A development permit is required before applying for a building permit. It is required to approve the location, size, and use of any parcel or any building on a parcel for any construction or landscaping within:
    - 300 ft of a water body.
    - Identified hazard area of sensitive area (this includes 30 m from the shoreline).

3.2.1.1 Land Use Designations: Sensitive Area and Marine Management Area

- Includes areas from the natural boundary and out to the sea.
- Uses include protected environment areas and cultural areas.

3.2.1.2 ɬišosəm (Teeshohsum) Zoning

- Shoreline zoning includes Leasehold residential (Klahanie Drive), Tla'amin Residential and Community Facility (fish hatchery).
- Sensitive Areas include estuaries, edge of the sea and intertidal zone, coastal bluffs, etc. with the following provisions:
    - Section D.13 – Setbacks are 30 m from the natural boundary[4] out to the sea and 15 m from known cultural sites.
    - Section D.14 – Structures in sensitive areas are allowed where they have no impact on any sensitive feature (including landscaping).
- Hazard Area Guidelines include the following:
    - Shore Hazard Area and Steep Slope Area – a surveyor needs to confirm the delineated areas.
    - Section D.25 – Until such a time that a specific study is available delineating the extents of coastal hazards including SLR and climate change impacts, the Shore Hazard Area is any land that lies between 0 and 3 vertical metres above the natural boundary of the sea[5].
    - Section D.27 – Changes to the 30 m setback:
        - May be increased on a site-specific basis in areas of exposed erodible beaches and in areas known to have erosion hazards.
        - Bluff setback is typical and can be relaxed with QP report.
    - Landfill or structural support for a coastal development or type of development shall be permitted a setback of 15 metres (50 feet) from the natural boundary of the sea where the sea frontage is protected from erosion by a natural bedrock formation or works designed by a professional engineer and maintained by the owner of the land.
    - FCL is 2 m vertical from the natural boundary.

[4] The natural boundary is defined as the limit of permanent terrestrial vegetation.
[5] A map of the hazard area includes 0-4 m above the natural boundary.

    - Below the FCL, there can be no mechanical equipment or habitable floor space. All enclosed areas below the FCL must have pedestrian ingress and egress.
  - Existing coastal lots and buildings: where setbacks prevent construction and where it is not possible to provide sufficient protection through works designed by a Qualified Professional, the approving officer may a) agree to modify setback requirements augmented through a restrictive covenant stipulating the hazard and liability disclaimer, or b) agree to waive other setback yard requirements as required by any other building and construction bylaw.
- Community facilities – parks and recreation:
  - Consideration for the Sea Walk and Greenway along the shoreline (Scuttle Bay to Gibson's beach) include, "Portions could be developed to protect sensitive lands from storm surges".
  - Some existing facilities are along waterfront road where FCL applies (e.g., church, waterfront park, Sliammon Fish hatchery). Community facility inventory states that the hatchery needs renovation/upgrade.

3.3 City of Powell River

The following brief overall notes are provided:

- Policies dictate that ocean-front development should consider 1 m of sea level rise (SLR) but this policy does not include mapping or requirement for a QP report.
- The OCP requires a 15 m setback from the ocean or top of the bank (whichever is greater). It is not clear if CoPR staff have a system to ensure this is captured at building permit or subdivision approval. In the OCP, there is a 'water' land use designation, which extends from the natural boundary to 305 m (1000 ft) into the water. Shoreline protection is an allowed use.
- The Tidal/Saltwater Riparian Areas Policies include some suggestions regarding shoreline protective measures. Development at the top of steep bluffs have the standard required setback of 3 times the height of the bluff in horizontal distance from the toe of the slope. Staff may require a QP report.

3.3.1 Official Community Plan (2014)

3.3.1.1 <u>General Policies</u>

- Section 3.6.2 (g) – Any development of the waterfront lands will be undertaken with consideration and respect for the natural environment and adjacent historic neighbourhood.
- Section 3.8.2 (f) – All waterfront developments and subdivisions that require a park dedication shall include parkland and green space along the waterfront and along trail corridors as shown on Schedule B and Schedule H.

- Section 3.6.2 (h) – The City will explore the concept of waterfront land for a marine-based business park (proposed for the former golf course lands).
- Section 7.2.2 (e) – When considering development applications, accessible public access to watercourses and lakeshores shall be maintained and enhanced for public enjoyment. Council supports public access to shorefronts every 200 meters through visual access and signed public pathways so that each of Powell River's four neighbourhoods maintains a minimum of one accessible beach access point with amenities such as ramps, benches, and gathering spaces. Where accessibility improvements are made, a continuous smooth surface from the accessible parking spot to the accessible trails, gathering/spectator areas, and beach access areas is required.

3.3.1.2 Climate Change Policies[6]

- Section 5.3.2 (f) – Make infrastructure, asset management, and capital expenditure decisions with fundamental considerations for climate change mitigation and adaptation, and energy resiliency.
- Section 5.3.2 (c) – Update minimum flood construction requirements to incorporate a projected sea level rise of one metre based on Provincial guidance. (Note: FCLs have not been determined).

3.3.1.3 Land Use Designation – Water

Associated with from natural boundary to 305 m offshore. Applies to shoreline protection structures and minor uses below the natural boundary that complement riparian land uses designated for Urban Residential, Parks, Schools & Green Space, Resource and Agriculture uses.

- Permitted Uses:
  - Section 4.14.2 (a) – Shoreline and intertidal protection structures to reduce coastal erosion and to dissipate incoming wave energy due to sea level rise and storm surges are permitted.
  - Section 4.14.2 (b) – Structures that complement and are accessory to adjacent riparian uses including docks, floats, boat mooring and boat launching are permitted.
  - Section 4.14.2 (c) – The existing Beach Gardens Marina is recognized.

3.3.1.4 Land Use Designation – Environmentally Sensitive Areas (includes riparian areas and wetlands)

- General Policies:

[6] The City of Powell River has a Climate Change Mitigation and Adaptation Steering Committee.

- Section 5.4.2 (d) – Encourage acquisition, use of covenant or conservation trust to protect sensitive areas.
- Section 5.4.2 (f) – Council will consider a new DPA for protection of the environment (no DPA currently).

- Tidal/Salt Water Riparian Areas Policies:
  - Section 5.5.2 (a) – All development along the shoreline of Malaspina Strait must plan for a sea level rise of 1.0 metre and associated storm surge and coastal erosion.
  - Section 5.5.2 (b) – Except for shoreline protection measures and marine based structures such as ferry terminals, aquaculture facilities, breakwaters and moorage facilities, new buildings must be located a minimum of 15 metres from the natural boundary.
  - Section 5.5.2 (c) – Minimize the degradation of natural systems through steps such as protecting the foreshore from erosion, by retaining embankment vegetation and through construction that does not require vertical sea walls.
  - Section 5.5.2 (d) – All shoreline protection measures should include environmentally sustainable practices such as the retention and restoration of natural shoreline vegetation, and landscaping strategies that require little or no revetment and minimize erosion but augment bank stabilization, in conformance with the guidelines contained in the 2003 Federal/Provincial publication entitled Coastal Shore Stewardship: A Guide for Planners, Builders and Developers (qathet uses Your Marine Waterfront Canadian Edition).

3.3.1.5 <u>Land Use Designation – Hazard Lands</u>

- 5.6.2 (a) – Lands subject to flooding should, wherever possible, be left in a natural state or used for parks, or natural preserves.
- 5.6.2 (b) – There is a setback of 15 m from the natural boundary or top of bank of the ocean, lake, stream (see Schedule F).
- 5.6.2 (c) – The setback for steep bluffs is 3 times the height horizontally measured from the toe. Staff may ask for a QP report.
- DPAs for Riparian Areas is specific to freshwater environments.

3.3.2 Marine Asset Management Plan (2013)

- 20-year planning period is considering levels of service, infrastructure condition and budget.
- Risks identified included: king tides and major storm effects on aging infrastructure.
- Next steps include developing infrastructure risk management plan.
- Not clear but appears that coastal flooding was not considered in the plan.

3.3.3 Parks and Trails Master Plan (2020)

- Relevant areas are existing beaches and water access points.
- Public rights of way are underutilized as they are not easily recognizable as public space (recommendation is to improve this with signage).
- Park acquisition and dedication should be prioritized in areas that are identified as sensitive ecosystems (e.g., Wildwood bluffs area).
- Improve boat launch at Gibson's beach.

3.3.4 Sustainability Plan (2015)

- Policy recommendations:
  - Protect ocean natural shoreline ecosystems and property from SLR.
  - Develop new bylaws that minimize risks of future climate change threats.
  - Adopt an adaptation plan.

3.3.5 Building Bylaw (2007)

- A building permit is not needed for retaining structure less than 5 ft in height.
- The building bylaw refers to a minimum setback from a water body and minimum floor elevation as included in land use regulation[7].

[7] Did not see a reference to a minimum floor elevation in the document.

4 Conclusion

Land use policies and regulations within the project area are diverse. This leads to a range of policy styles to manage flood and erosion management. This document provided background on key land use planning concepts, and a review of specific policies and regulations within the three project partner areas. The information was summarized in Section 3.1 of the main report and was a basis to develop the project's recommended strategies.

References

Ausenco Sandwell. (2011a). Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use - Draft Policy Discussion Paper. Prepared for BC Ministry of Environment.

Ausenco Sandwell. (2011b). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use - Guidelines for Management of Coastal Flood Hazard Land Use*. Prepared for BC Ministry of Environment.

Ausenco Sandwell. (2011c). Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use - Sea Dike Guidelines. Prepared for BC Ministry of Environment.

Tetra Tech. (2018). Powell River Regional District Overview Coastal Risk Assessment. Prepared for the Powell River Regional District.

Tetra Tech. (2021). qathet Regional District Coastal Flood Mapping Phase 1 - Mainland. Prepared for the qathet Regional District.

Tetra Tech. (2022). qathet Regional District Coastal Flood Mapping Phase 2 - Islands. Prepared for the qathet Regional District.

Appendix B: Risk-Based Analyses – Methods and Results

qathet Regional Coastal Flood Adaptation Strategy

Appendix B: Risk-Based Analyses – Details

Contents

1 Introduction

The qathet Regional Coastal Flood Adaptation Strategy (CFAS) is a partnership between the City of Powell River (CoPR), Tla'amin Nation, and qathet Regional District (qRD). The project built on a previous overview coastal risk assessment (Tetra Tech, 2018) and more detailed coastal flood mapping and erosion assessment (Tetra Tech, 2021, 2022). Ebbwater was retained by the qRD to complete the Regional CFAS by presenting coastal flood information in a meaningful way to build resilience. This was achieved in part by conducting three supporting tasks for the development of an adaptation strategy (i.e., policy review, risk-based analyses, and decision support).

This document outlines the method and results for three screening-level risk-based analyses, which were used to support information presented in Section 4.2 of the main report. The analyses provide improved understanding of risk in the project area by better characterizing the 3 components of risk: hazard, exposure, and vulnerability (see Section 3 of the main report).

The description and objectives for each analysis are as follows, and they are detailed in Sections 2, 3, and 4 of this document, respectively:

1. **Hazard Mapping of Frequent Flood Scenarios.** It is best practice to consider multiple flood scenarios within risk assessments. The objective was to complement the existing mapping of a large rare coastal storm flood by considering small but frequent coastal storms as well as areas to be more permanently inundated due to high tides. Understanding the potential impacts between "large but rare" versus "small but frequent" flood events over time provides a basis for a more nuanced understanding of risk across the project area.
2. **Exposure Assessment of Local Areas.** Given the long length of the qRD shoreline, Ebbwater focused analyses on a few local areas that could be used to represent the larger project area coastline. The objective was to simplify the complex interacting factors that contribute to risk and resilience at local scales. The assessment provided a basis to share tangible, place-based, examples with project participants. We screened 13 areas of higher priority. At the end of the process, we defined 4 archetype areas having a mix of geographic and jurisdictional characteristics (see Section 4.2 of the main report for details).
3. **Vulnerability Analysis of Archetype Areas.** People are at the heart of change that is required to implement coastal adaptation. Further, during a disaster event, vulnerable people (such as the elderly) are likely to be more challenged to stay safe. Therefore, we conducted an overview analysis of vulnerability indices within the local areas. The objective was to obtain additional insights on a range of social and demographic factors to inform discussions about adaptation strategies.

Section 5 of this document contains a short conclusion, which is followed by a list of references.

2 Hazard Mapping of Frequent Flood Scenarios

In this section, we explain how we produced the extent layers that are representative of a small storm flood, and compare these layers with the large storm flood layer produced by Tetra Tech. Please see Section 3 of the Technical Report for a review of coastal flood hazards.

2.1 Rationale

International best practices for natural hazard management (e.g., UNDRR 2015) promotes the consideration for a range of scenarios (from small to large, in the present-day and in the future). Small, frequent coastal storms can affect exposed elements more often than do large, rare coastal storms. Sea level rise (SLR) will also exacerbate high water level conditions during small floods. The combination of SLR and small coastal storms can also have a greater relative impact on storm-driven erosion (Leonardi et al., 2016)[1]. Therefore, the consideration of multiple scenarios with different hazard extents can provide a more comprehensive understanding of the hazard profile in the qRD.

2.2 Approach

To complement the existing hazard mapping, we developed an approach that balanced the following two factors:

- Technical effort required to generate new information.
- Effectiveness at providing insights into the nuances of multiple hazards scenarios.

We selected a coastal storm surge with a 20% annual exceedance probability[2] (AEP) as the basis for developing the small coastal storm flood layer. This AEP was selected based on the assumption that most residents in the qRD likely can remember such an event from their recent memory. Below we describe the water level components that were estimated, and the GIS processing steps that were taken to produce the layer.

2.2.1 Water Level Component Estimates

We applied a screening-level method by using the Tetra Tech (2018, 2021, 2022) approach as a basis to make assumptions for each of the coastal storm flood components shown in Figure 3-1 of the main report, as follows:

- **Sea Level Rise:** We used the median projection for the business-as-usual greenhouse gas emissions scenario for the year 2050.
- **Tide:** The small coastal storm flood was assumed to coincide with a higher high water large tide (HHWLT).

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[1] The study found that storms that have a probability of occurring multiple times in a year are those causing the most salt marsh deterioration.
[2] This storm has an indicative return period of 5 years.

- **Storm Surge:** The storm surge water level was obtained from Provincial guidelines based on the AEP. The small storm surge water level was 33% lower than the large storm surge water level.
- **Wave Effects:** Based on the above, a factor of 33% was applied to estimate the water level caused by wave effects.

Table 2-1 summarizes the technical differences between the large and small flood extents developed by Tetra Tech and Ebbwater, respectively.

Table 2-1: Technical summary of large and small coastal storm flood layers, including reference sources.

	Coastal Storm Flood Extent	
	Large	**Small**
Development note	Produced by Tetra Tech.	Produced by Ebbwater, based on the large flood extent produced by Tetra Tech and other changes described below.
Likelihood	0.5% AEP (200-year indicative return period)	20% (5-year indicative return period)
SLR	1.00 m, following Ausenco (2011)[1].	0.27 m (based on the median projection for RCP 8.5 for the qRD area obtained from climatedata.ca for the Powell River location)[2].
Tide	1.85 m (HHWLT)	1.85 m (HHWLT)
Storm Surge	1.25 m, following KWL (2011) for the Georgia Strait.	0.83 m, following KWL (2011) for the Georgia Strait.
Wave Effects	Includes separate analyses for winds, extreme waves, and wave runup for different areas.	Applied same ratio of differences in storm surge relationship to estimate differences in wave effects.

Notes:

Water levels are based on the CGVD2013 datum.

1. Though this was based on the Provincial guidelines, 1 m of SLR coincides with the maximum projection for RCP 8.5 for the qathet RD area obtained from climatedata.ca[3]. The projection includes the effects from enhanced warming that causes melting from the Antarctic Ice Sheet, which is considered a conservative estimate.
2. The projection was obtained from the climatedata.ca portal for the qathet RD area. https://climatedata.ca/explore/variable/slr/?coords=49.828570914213344,-124.53260421752931,12&geo-select=&rcp=rcp85-p95&decade=2100&rightrcp=disabled. Accessed 4 March 2022.

2.2.2 GIS Processing

A few processing steps were completed using open-source QGIS mapping and analysis software to generate the flood extent from water elevations that were calculated in a point cloud (a set of data points in space).

The steps are summarized as follows:

- Produced a water elevation grid (raster layer) using an inverse distance weighted interpolation.
- Calculated the difference between the interpolated water elevation grid and the LiDAR digital elevation model received from qRD.
- Reclassified the elevation difference raster with binary values, depending on their positive or negative values.
- Prepared and clipped the binary grid to the Tetra Tech large flood extents layer, to match the sea water extents.
- Created a polygon (vector layer) of the clipped grid.
- Reviewed and post-processed the layer to adjust or remove isolated flood areas that were not adjacent to the major flood extents.
- Refined the layer, based on discussions with Tetra Tech, for the four archetype areas.

The small flood layer was based on the technically robust flood layer produced by Tetra Tech. However, the small flood layer is screening-level and should only be considered as *representative* of a small flood.

2.3 Flood Layers Comparison

Compared to the large coastal storm flood layer, as expected the small coastal storm flood extent layer has a smaller extent, and the differences vary from one area to another. Site-specific and project area differences are discussed below.

2.3.1 Site-Specific Differences

Local site characteristics, such as terrain and shoreline shape, are important to consider when comparing the flood hazard potential from small versus large storms. For example, the Grief Point area located in the City of Powell River is relatively flat (Figure 2-1a). This means that the large coastal storm flood affects a relatively large area. The Stager Road area in qRD Electoral Area C is relatively steep (Figure 2-1b). Here, the difference between the small and large flood extents is less. This is because the waves from the large flood "run out of space" as they collide with the steeper slopes. However, the added wave energy during large storms creates conditions that make the shoreline more susceptible to erosion. The Grief Point and Stager Road areas are shown on a regional map in Figure 3-1. Figure 2-1 shows satellite imagery with flood layers to compare and contrast the flood extents and the slopes more clearly. The two flood extents are compared for additional local areas in Section 3.

Comparison of Small and Large Flood Extents for Two Archetype Areas

a) Grief Point Park (shallower slope area)

b) Stager Road (steeper slope area)

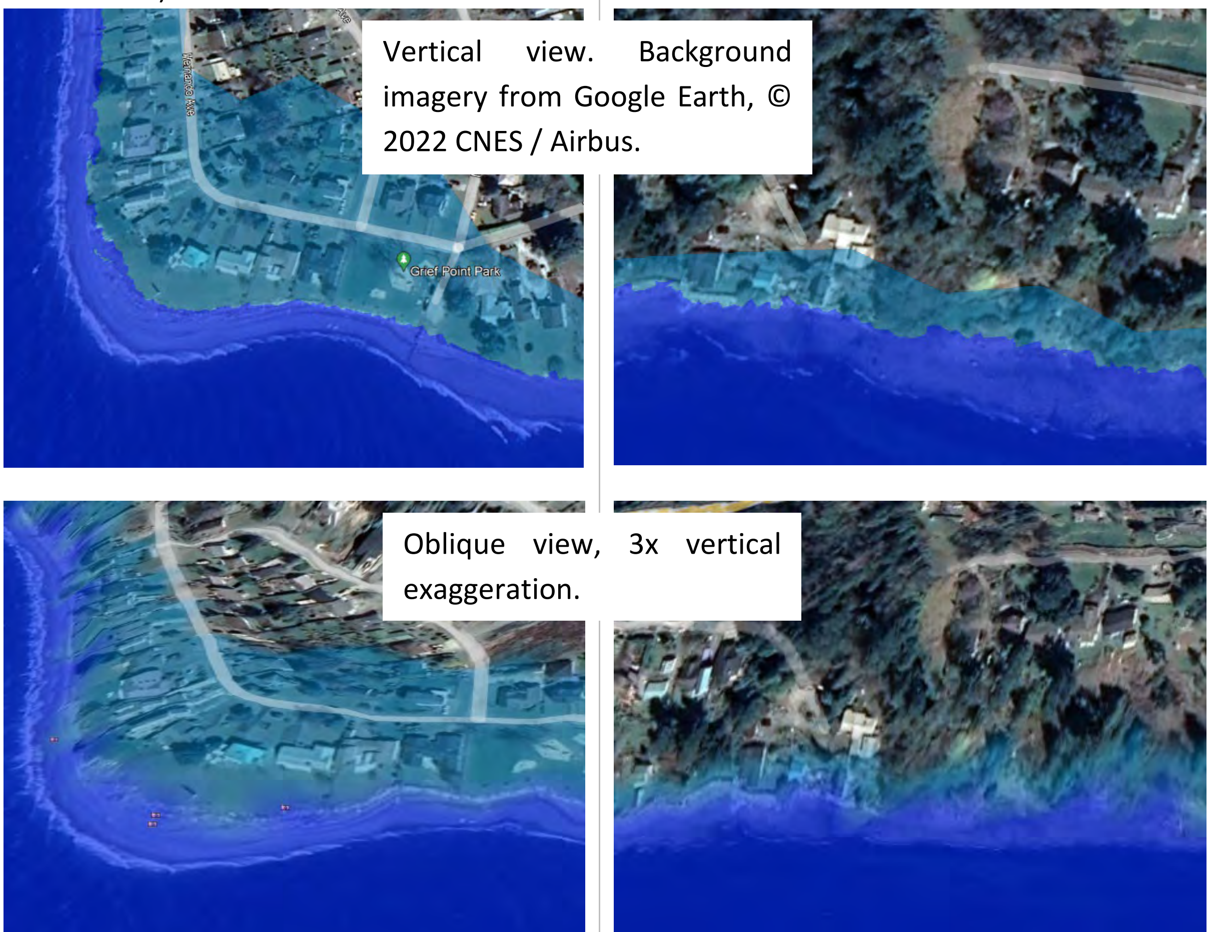

Figure 2-1: Comparison of large and small flood extents in relatively shallower and steeper slope areas in City of Powell River and qRD Electoral Area C, respectively). The large flood extent is shown as the paler blue, and the small flood is shown as the darker blue.

2.3.2 Project Area Differences

Using address points as a proxy for the location of dwellings, approximately 4% of those affected by the large flood are also affected by the small flood. This is a relatively small proportion and suggests that the statistical risk to this type of asset is low. However, when we consider archaeological sites, approximately 85% of those affected by the large flood are also affected by the small flood. This highlights the importance in considering a range of elements exposed to both small and large floods. Furthermore, the small flood is 40 times more likely to occur in any given year compared to the large flood. The repeated action of waves running up on shore can cumulatively displace land and remove substantial amounts of sediment in susceptible areas.

2.3.3 Key Messages

Mapping and analysis of the small coastal storm flood hazard extent provides the following insights:

- The small flood layer complements the large flood layer, providing a high-level understanding of the range of potential coastal flood hazard extents that could be experienced in the project area.
- The larger probability of occurrence of the small flood suggests that it could substantially impact certain exposed elements, raising risk levels in specific areas.
- Erosion potential should further be considered, especially where elements are exposed to the small flood.

The above insights are useful when considering candidate local areas for more detailed assessment, discussed in the next section.

3 Local Areas Hazard and Exposure Assessment

This section describes how we applied a screening-level approach to identify candidate local areas to support project discussions on adaptation strategies.

3.1 Overview of Areas Considered

The Tetra Tech (2018) report identified 9 areas where there is "more significant coastal flooding potential" and where there is "higher existing risk". Therefore, for this analysis we started by considering these areas, which were (roughly listed from northwest to southeast): Lund, North Scuttle Bay, Powell River Mill, Willingdon Beach, Grief Point, Myrtle Point, Myrtle Rocks, Kent's Beach, and Lois River. Based on informal discussions with the project team and Partners, we reviewed additional areas including Savary Island, Klahanie Drive North, ṫišosəm, and Stager Road (Figure 3-1).

For the above long list of 13 areas considered, we created a short list of 8 areas that collectively represented the project area based on the following characteristics:

- Tla'amin Land, City of Powell River land and a range of qRD electoral areas.
- Island and mainland areas.
- More rural and more urban settings.
- Varied coastal flood and erosion hazards.
- Exposed elements (things that "we care about" that are in the hazard area).

For the short-listed candidate local areas, we assessed the hazard and exposure profiles in more detail (see Section 3.3). For hazard, we considered susceptibility to the large and the small storm flood extents[4] (see Section 2) as well as the erosion potential.

[4] We also mapped the HHWLT on its own for the four archetype areas (which were considered in more detail) to gain an understanding of the areas that would be wet on a daily basis over the long term (i.e., year 2100). For the two areas located in Tla'amin Nation Lands, we also mapped the coastal flood hazard area delineated with the 2010 Land Use Plan.

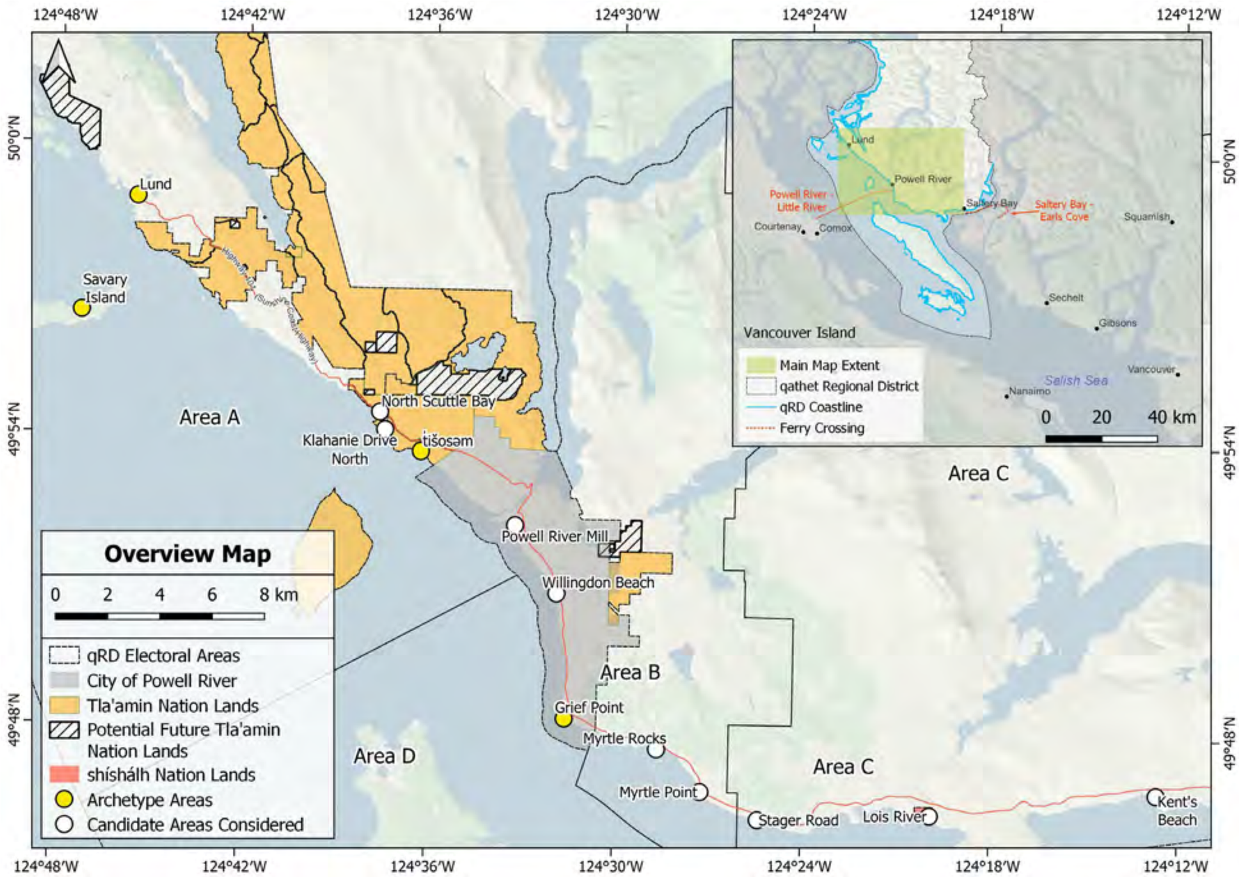

Figure 3-1: Long list of candidate local areas considered (shown using circles), and archetype areas assessed in more detail (highlighted in yellow).

3.2 Exposure Data Sets

We considered proxy data sets that could be used to characterize how the coastal storm floods could affect a range of elements such as people, infrastructure, and other assets (cultural, environmental). Some of the proxy data sets were the same as those used in Tetra Tech (2018) (e.g., address points, environmentally sensitive areas), and others were based on additional data that Ebbwater obtained for this project (e.g., utilities and critical infrastructure data). Table 3-1 lists the datasets used to support the exposure mapping analyses.

Table 3-1 Datasets used for exposure mapping in this project.

Dataset Type	Dataset Name	Data Source
Affected People	Address Points	Received from qRD
Critical Infrastructure	Infrastructure Mains in the City of Powell River	Received from qRD

Dataset Type	Dataset Name	Data Source
	Distribution Pipes in the City of Powell River	Received from qRD
	Emergency Transport Facilities	Received from qRD. Dataset was used in Tetra Tech 2018 Coastal Risk Assessment Project
	Sanitary and Sewer	Received from qRD and Tla'amin Nation
Culture	Archaeological and Heritage Sites	Received from the Provincial Archaeology Branch
Economy	Land Parcels	Received from qRD. Dataset was used in Tetra Tech 2018 Coastal Risk Assessment Project
Environment	Conservation Lands	BC Data Catalogue

3.3 Assessment Results

Table 3-2 summarizes the hazard and exposure profiles for the 8 short-listed candidate local areas (see columns 2 and 3). The name and key geographic characteristics of the candidate local areas are presented in the first column. Table 3-2 is followed maps and images of each area with annotations highlighting key elements from Table 3-2.

Table 3-2: Candidate local area characteristics and distinctions.

Area Name and Key Geographic Characteristics	Hazard Descriptions	Exposed Elements
Lund ***Jurisdiction:*** **Tla'amin Nation and qRD Area A** ***Setting*: More urban**	Predominantly low-lying area means that a substantial proportion is within the small flood extent.	Lund harbour contains important emergency boat launches and a heli pad, as well as water taxi to Savary Island. Several commercial properties (e.g., resort and shops) are exposed. A qRD sanitary outfall requires upgrades. Portions of all archaeological sites are within the small flood extent.

Area Name and Key Geographic Characteristics	Hazard Descriptions	Exposed Elements
Savary Island ***Jurisdiction:*** **qRD Area A** ***Setting:*** **Rural / Island**	Relatively shallow slopes mean that even the small flood covers a large proportion of area. Erosion potential is relatively high.	Many dwellings (most of which are second homes or cottages) are exposed. The unique sand dunes environment contains several plant species-at-risk.
North Scuttle Bay ***Jurisdiction:*** **Tla'amin Nation** ***Setting:*** **More rural**	Coastal storm waves along the north side of the bay lap up against the relatively steep slopes. Erosion potential is relatively high (north of the bay) and low (in the bay).	Specific locations of Highway 1 are exposed, along with a few leaseholder properties (both north of the bay). Portions of all archaeological sites are within the small flood extent.
Klahanie Drive North ***Jurisdiction:*** **Tla'amin Nation** ***Setting:*** **More rural**	Slopes are moderate on the ocean front, and shallow in Scuttle Bay.	Many dwellings (zoned as leasehold residential) are exposed to the large flood. Community boat launches, beach access points, and the sea walk are exposed to the small flood. Homes are on septic (but could be integrated into the sanitary system in future). Portions of all archaeological sites are within the small flood extent.
ṫišosəm ***Jurisdiction:*** **Tla'amin Nation** ***Setting:*** **More urban**	Erosion potential ranges from moderate to high. The large flood hazard extent does not reach the first row of homes; however, the coastal hazard area from the Tla'amin Nation 2010 Land Use Plan does.	Portions of the wastewater outfall are in all flood hazard extents. The waterfront area is an important cultural site, with a few amenities such as a park and the fish hatchery. The small flood extent affects areas in the Sliammon Creek estuary. Portions of all archaeological sites are within the small flood extent.

Area Name and Key Geographic Characteristics	Hazard Descriptions	Exposed Elements
Grief Point ***Jurisdiction:* City of Powell River** ***Setting:* More urban**	Shallow slopes means that the small flood covers a large area.	A substantial number of properties exposed to the large flood, as well as roads, gas distribution pipe, infrastructure mains, and telecom pedestals. The park is exposed (this is an opportunity to absorb the energy of flood waters). Blue heron is a species-at-risk. Portions of all archaeological sites are within the small flood extent.
Myrtle Point ***Jurisdiction:* Area C** ***Setting:* Rural**	Shallow slopes in many areas means that flood extents are relatively larger; moderate erosion south of the point.	Many home, and access roads to them, are exposed to the small flood. Septic systems are potential sources of contamination.
Stager Road ***Jurisdiction:* Area C** ***Setting:* Rural**	Area contains predominantly steeper slopes and bluffs with high erosion potential.	A small number of dwellings are exposed to the large flood; however, a larger proportion of properties and access roads are exposed to impacts from erosion.

Note: Based on archaeological mapping data obtained from the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD), most of the areas contain pre-contact archaeological heritage sites that are exposed to the hazards.

Figure 3-2 to Figure 3-9 show the coastal flood hazard extents, exposed elements, and annotations highlighting important considerations for the 8 candidate local areas. The map figures are accompanied by images taken from sea level (all images credited to Tetra Tech).

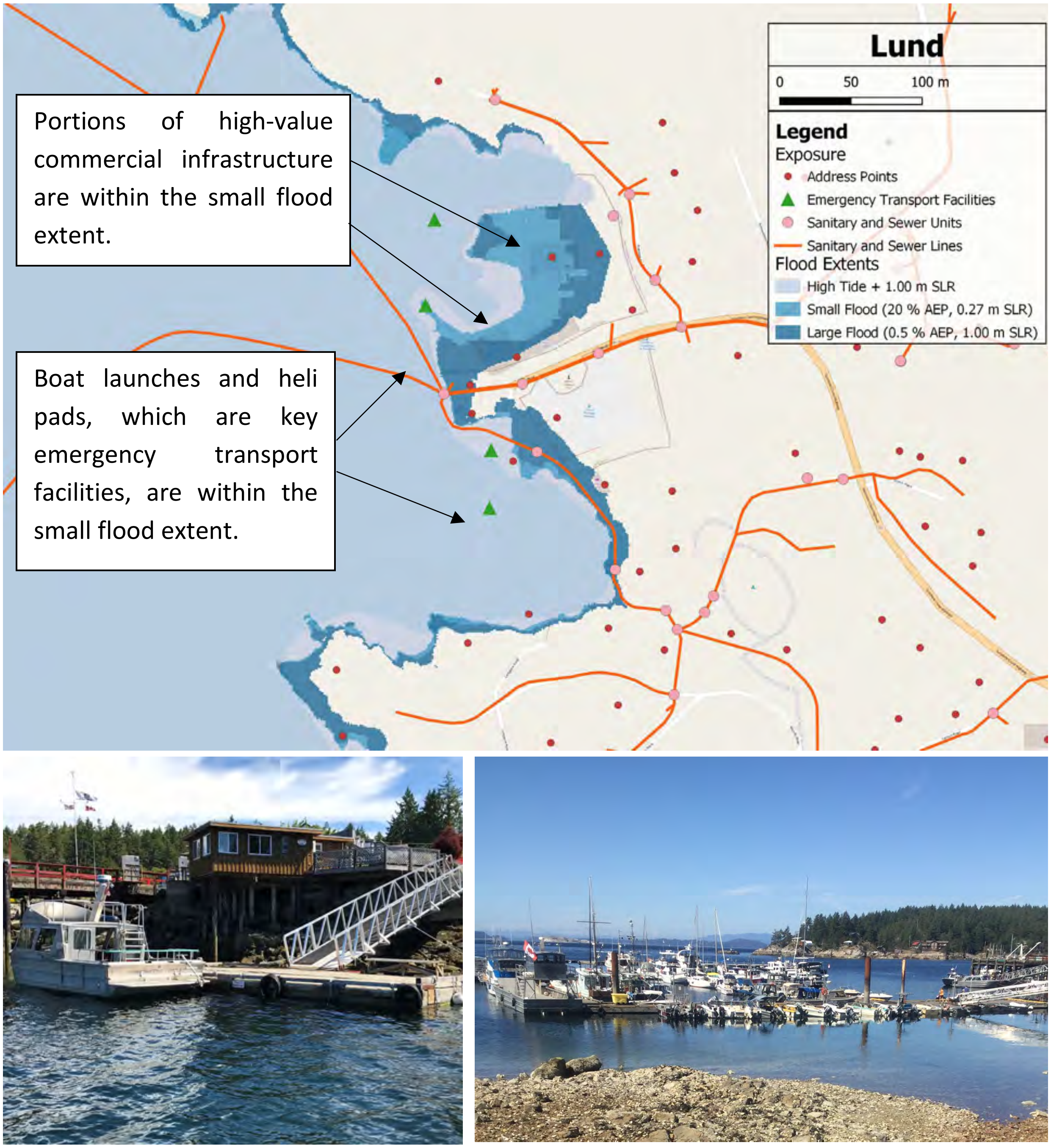

Figure 3-2: Lund area (Tla'amin Lands and qathet Regional District Electoral Area C).

Figure 3-3: Savary Island area (qathet Regional District Electoral Area C).

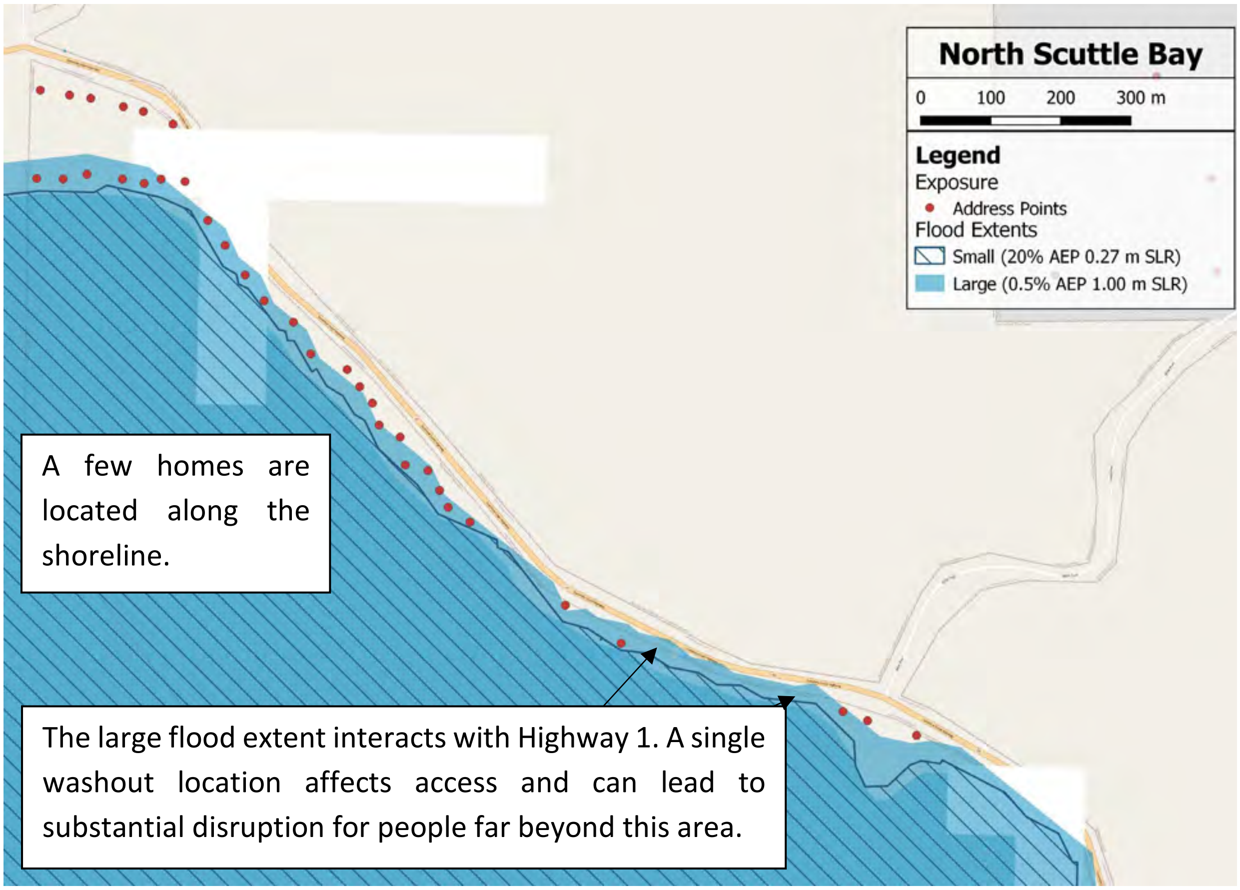

Figure 3-4: North of Scuttle Bay area (Tla'amin Lands). Note that the HHWLT is not shown on this map as this local area was not considered for the later analyses. The large and small flood extents are approximate only; these were refined later in the process for the selected archetype areas.

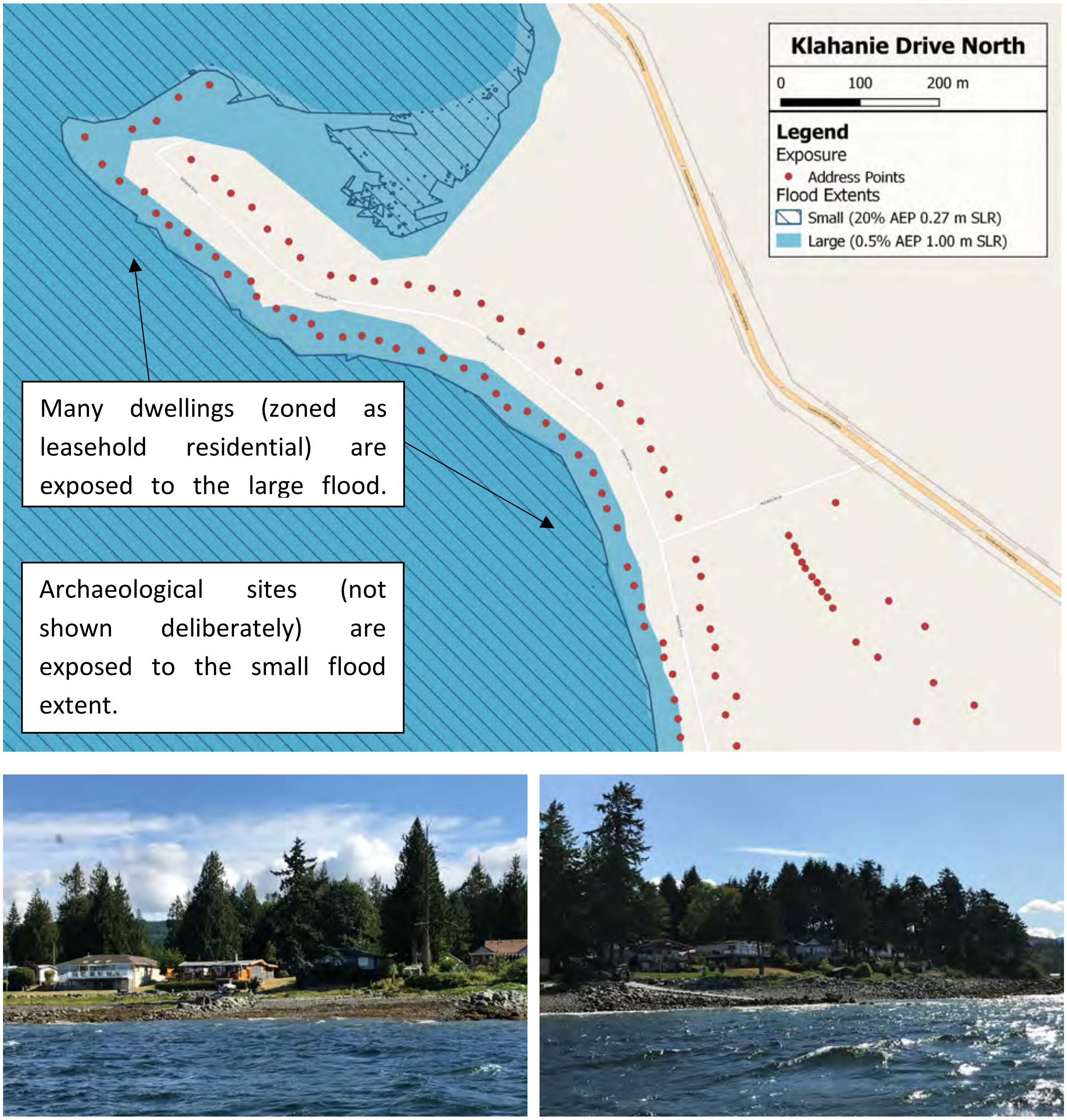

Figure 3-5: Klahanie Drive North area (Tla'amin Lands). Note that the HHWLT is not shown on the Klahanie Drive North map as this local area was not considered for the later analyses. The large and small flood extents are approximate only; these were refined later in the process for the selected archetype areas.

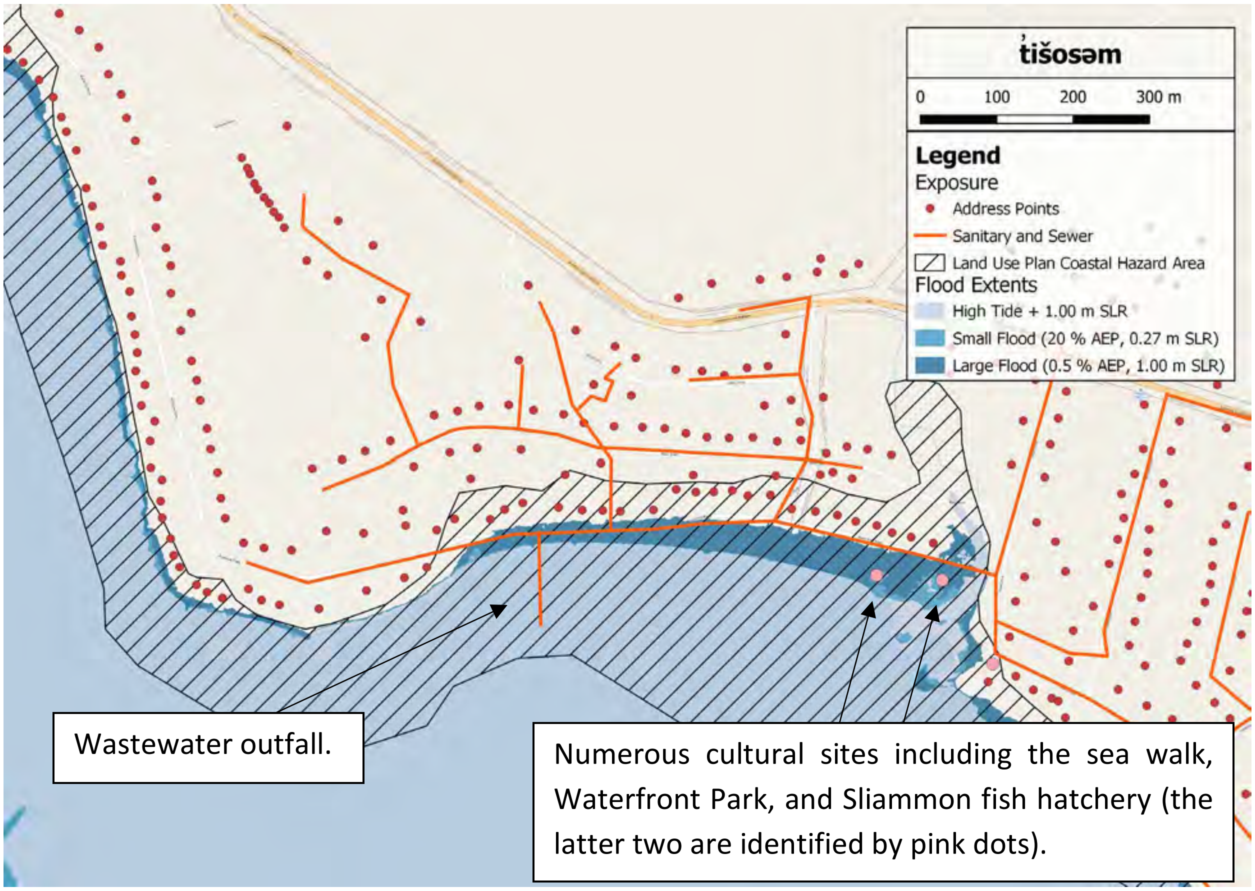

Figure 3-6: ṫišosəm area (Tla'amin Lands).

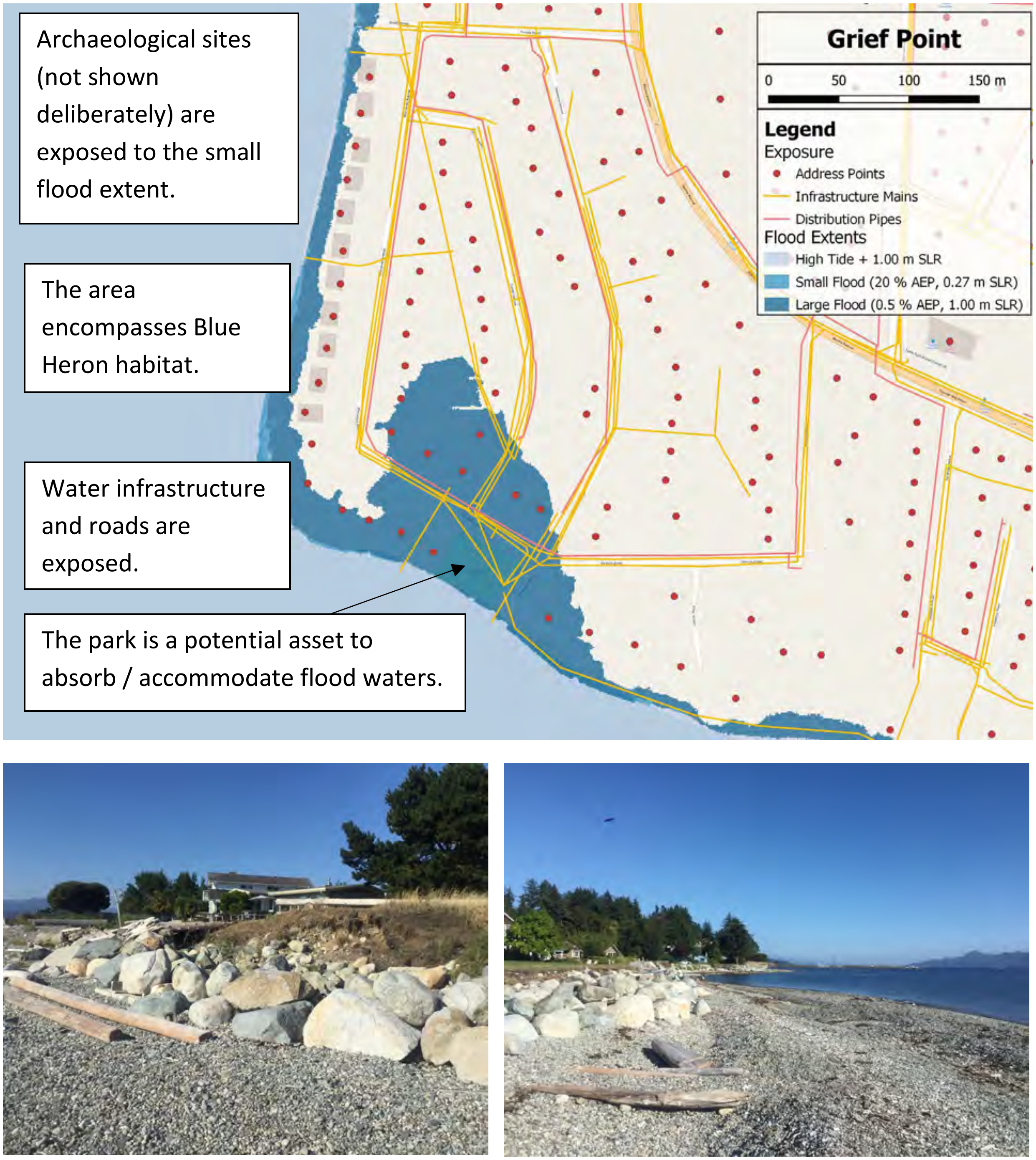

Figure 3-7: Grief Point area.

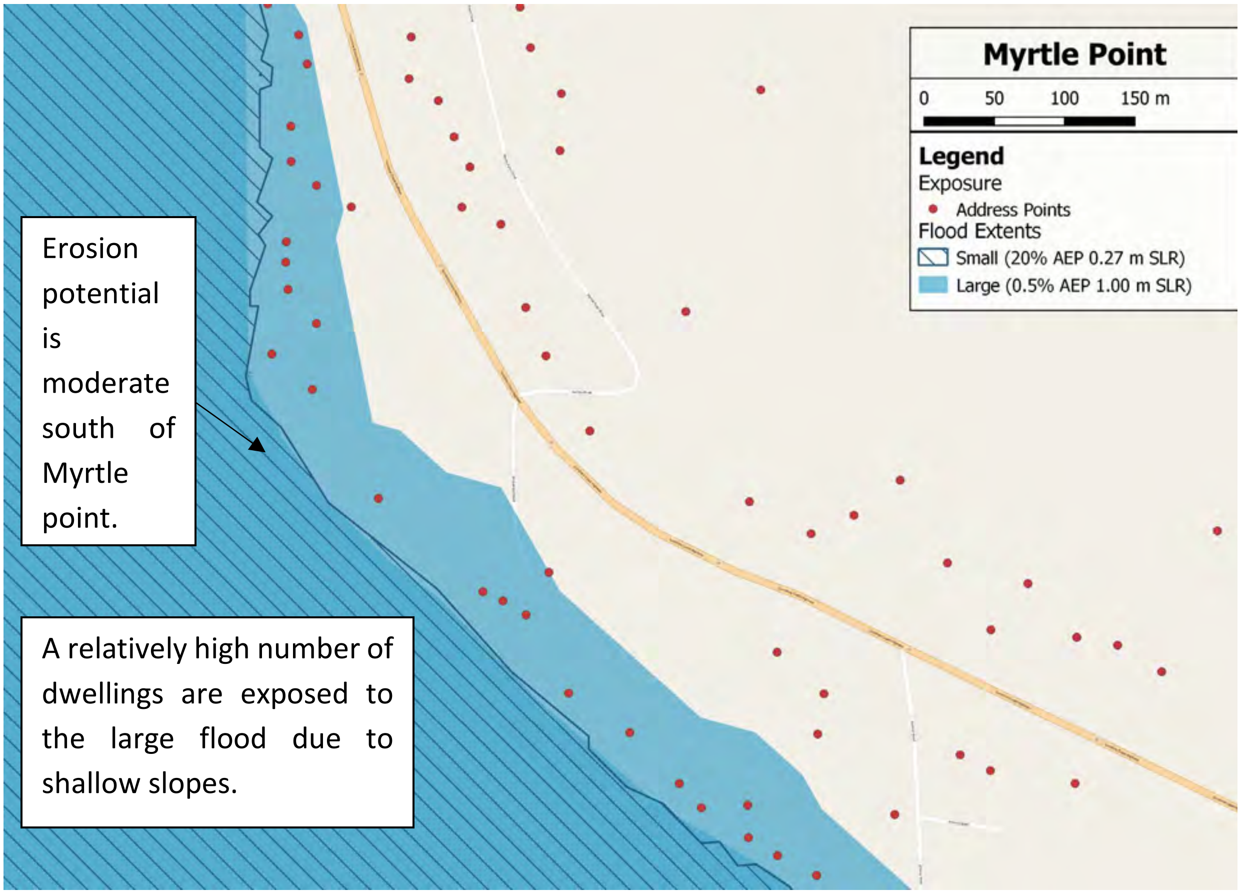

Figure 3-8: Myrtle Point area. Note that the HHWLT is not shown on this map as this local area was not considered for the later analyses. The large and small flood extents are approximate only; these were refined later in the process for the selected archetype areas.

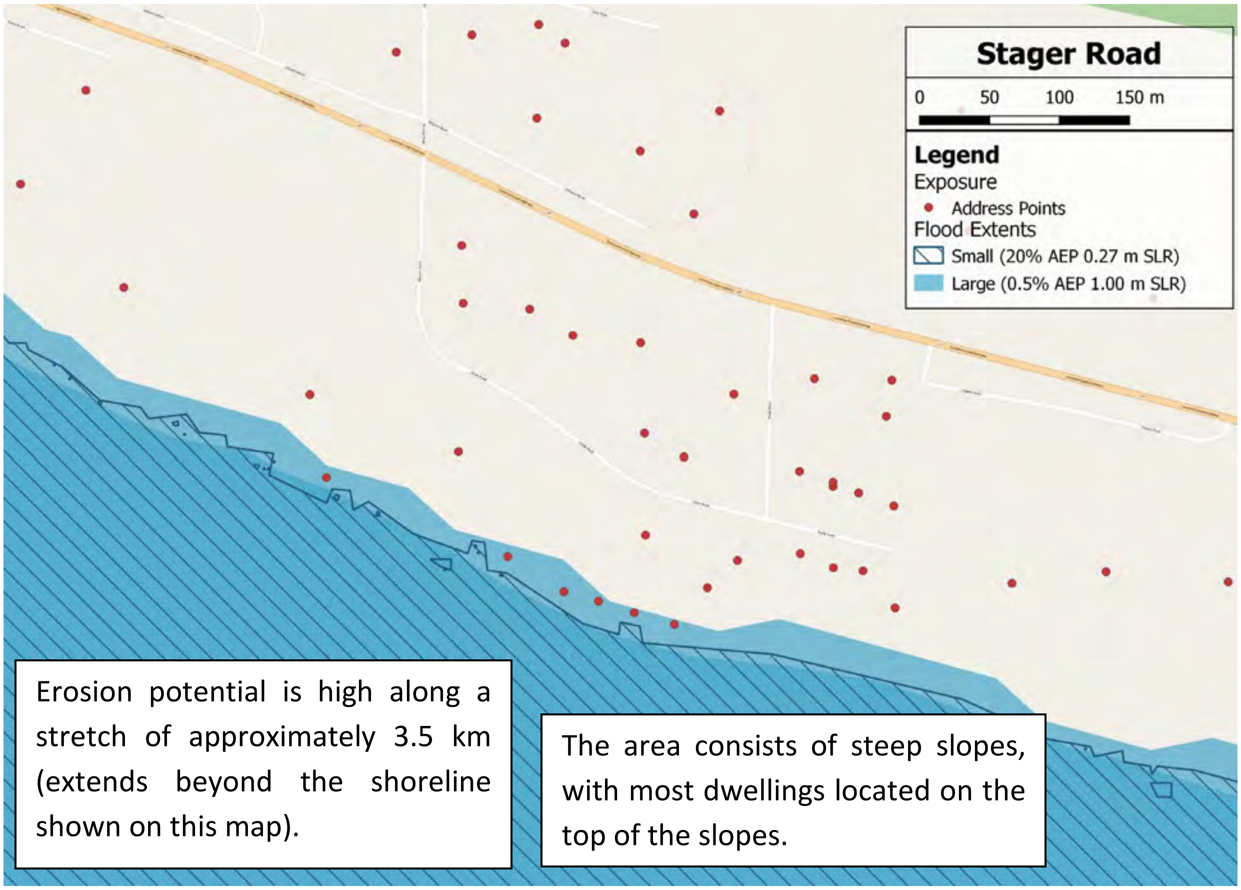

Figure 3-9: Stager Road area. Note that the HHWLT is not shown on this map as this local area was not considered for the later analyses. The large and small flood extents are approximate only; these were refined later in the process for the selected archetype areas.

3.3.1 Illustrative Archetypes

Out of the 8 local areas assessed, the following 4 were selected as archetypes: Lund, ƛišosəm, Grief Point, and Savary Island. These were chosen to reduce the local areas considered while encompassing key characteristics of the region (see bullet list in Section 3.1). We further simplified the process of considering local areas by defining 3 "illustrative archetypes". The objective with this step was to create a balance in considering local areas in more realistic versus more illustrative ways. Table 3-3 outlines the advantages and disadvantages of these approaches.

Table 3-3: Advantages and disadvantages of realistic and illustrative contexts for consideration.

Context Type	Advantage	Disadvantage
Realistic	There is a potential for people to better grasp discussions about adaptation, tradeoffs, etc. with their tangible knowledge of an area and how it might change (this is especially true if they are intimately familiar with the area).	There is potential for people to focus on individual and specific features, properties, etc. of an area, which can distract discussions aimed at conveying high-level concepts.
Illustrative	More easily conveys the idea that a range of contexts exist along the coast. Allows for certain aspects to be emphasized to highlight issues that are critical to adaptation discussions.	There is a potential for discussions to feel more abstract, which can be more challenging for people to imagine potential adaptation strategies.

The illustrative archetype areas were as follows:

- "The Docks": This area roughly represented the local area of Lund.
- "Oceanside Living": This area roughly represented the local areas of ṫišosəm and Grief Point.
- "Island Sanctuary": This area roughly represented the Savary Island local area.

Further analyses were conducted for the local areas associated with the illustrative archetypes to refine the risk-based understanding of these areas, including vulnerability.

4 Vulnerability Analysis

Evidence indicates that people exposed to disasters such as floods is increasing faster than their vulnerability is decreasing (UNISDR, 2015). During a flood event, people and communities with high social vulnerability are more likely to have limited capacities to be resilient. Best practice dictates that vulnerability (including social vulnerability) be considered within the development of climate adaptation plans (CCME, 2021). For example, areas of higher social vulnerability may benefit from the implementation of plans and strategies that can decrease social vulnerability.

To characterize the spatial variation of social vulnerability across the 4 archetype areas, we utilized the social vulnerability index (SoVI) database developed by Natural Resources Canada (NRCan, 2020). Section 4.1 provides background on the database, and this is followed by the high-level analysis, results, and limitations of the analysis.

4.1 SoVI Database

To our knowledge, the SoVI database is the most recent and comprehensive data set of social vulnerability in British Columbia (BC). The database uses 2016 census data and a population exposure model. Ebbwater received the database in 2020 and was granted permission to utilize the data (see Section 4.4 on limitations).

The SoVI database includes metrics that reflect general housing conditions (density, suitability, tenancy, etc.), family structure (living conditions, dependent relationships, etc.), individual autonomy (a person's ability to make and act on decisions themselves), and financial agency (the monetary means to act without social assistance). Vulnerable conditions are considered significant in an area when the metric values are larger than the statistical mean plus 1 standard deviation when compared with the entire dataset[5].

4.2 Analysis

We screened the SoVI database metrics and applied judgement and information from the literature (i.e., see Campbell, Roper-Fetter, & Yoder, 2020) to select those that were most likely to be relevant to this project context.

For the Lund, Savary Island, ṫišosəm, and Grief Point areas we analyzed the following six metrics:

- Visible minority
- Indigenous population
- People with no official language ability
- People without secondary school education
- Median household income

[5] The dataset that we had access to was for the province of BC. Future versions of the data will be Canada-wide.

- Median age of population

The metric values were extracted from the database in QGIS, and these were assessed based on the large flood extent modelled by Tetra Tech (2021)[6]. Where a focus area included more than one SoVI spatial unit (based on the 2016 census), the metric values of this area were calculated as a weighted average.

The preliminary analysis showed that the differences in the "visible minority" and "no official language" indicators were negligible across the 4 areas. Further, the values for these metrics were far below the BC average. These metrics were dropped from the analysis as they did not provide meaningful insights for the purposes of the project.

For the remaining 4 key metrics, we used the BC average and the sum of BC average and 1 standard deviation as two thresholds for comparison (similar to the method used in NRCan (2020)). For the "median age" metric, BC average plus 2 standard deviations was used as an additional threshold because the metric values for all the areas were larger than BC average plus 1 standard deviation.

4.3 Results

The classification results for the key metrics are summarized in Table 4-1. In the table, "Lower" means that the metric value is lower than the BC average. "Higher" and "Much Higher" means that the values are greater than 1 or 2 standard deviations of the BC average (see table notes for details).

Table 4-1. Summary of SoVI index key metrics for the 4 focus areas (relative to the BC average values).

	Lund	Savary Island	Grief Point	ṫišosəm
Indigenous population[1]	Lower	Lower	Lower	Much higher
No secondary school education[1]	Higher	Lower	Lower	Higher
Median household income[1]	Higher	Higher	Lower	Lower
Median age population[2]	Much higher	Much higher	Higher	Higher

Notes:

1 - "Lower" means the value is below the corresponding BC average; "Higher" means the value is between the BC average and BC average plus 1 sd; "Much higher" means the value is higher than the BC average plus 1 sd.

[6] For this preliminary analysis, the metrics were assessed exclusively based on the large flood extent. The small flood extent was not considered.

2 - "Higher" means the value is between the BC average plus 1 sd and BC average plus 2 sd, and "Much higher" means the value is higher than the BC average plus 2 sd.

The high-level results in Table 4-1 show that the Lund and ɬišosəm focus areas have SoVI values that are higher than the BC average for 3 out of the 4 key metrics. For Savary Island, SoVI values are higher than the BC average for two of the key metrics. In all areas, the median population is older compared to the BC average. This means that the population in those areas is likely more vulnerable to the shocks caused by flood and erosion hazard events (e.g., they cannot mobilize and evacuate as easily as younger people may be). Regarding longer-term solutions, these populations may also have a different understanding of how to approach coastal adaptation. Therefore, based on the metrics we analyzed and compared, integrating vulnerability issues into adaptation strategies is recommended.

4.4 Limitations

Despite being the most comprehensive and recent social vulnerability database in BC, the SoVI database has the following limitations:

1. Although the spatial units are sufficient to capture neighbourhood variations in populated urban areas, the spatial resolution is very coarse in rural areas. For example, the whole of Savary Island is represented as one spatial unit.
2. The 2016 census data is now outdated. As the statistical data from the 2021 census is not yet publicly available, the associated changes in the SoVI analysis results are still unknown.
3. The database is currently unpublished, which reduces the transparency of the analysis.

Given the limitations stated above, we recommend using an updated SoVI database for more detailed and robust analyses of social vulnerability once it is available[7].

4.5 Summary

Results from the vulnerability analysis show that, based on certain metrics, there is a potential for populations in some areas to be more vulnerable compared to other areas. The results from the analysis were incorporated into the archetype area results of the main report to provide a richer understanding of the risk profile for each archetype area (see Sub-section 4.2.4 of the main report).

[7] A new SoVI index is being developed by Public Safety Canada (Personal Communication with Matthew Godsoe).

5 Conclusion

This document presented three technical analyses to support and inform a more fulsome discussion on adaptation to develop recommended strategies for the Regional CFAS. We developed and mapped a small coastal storm flood hazard extent as a basis to obtain a more nuanced understanding of risk across the project area. We assessed the hazard and exposure profiles of local areas as a basis to share tangible, place-based, examples to project participants. This led to selecting illustrative archetypes, for which an additional vulnerability analyse was conducted. Refer to Section 4.2 of the main report to view how the information was incorporated.

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Appendix C: Decision Support – Details

qathet Regional Coastal Flood Adaptation Strategy

Appendix C: Decision Support – Details

Contents

1 Introduction

The qathet Regional Coastal Flood Adaptation Strategy (CFAS) is a partnership between the City of Powell River (CoPR), Tla'amin Nation, and qathet Regional District (qRD). The project built on a previous overview coastal risk assessment (Tetra Tech, 2018) and more detailed coastal flood mapping and erosion assessment (Tetra Tech, 2021, 2022). Ebbwater was retained by the qRD to complete the Regional CFAS by presenting coastal flood information in a meaningful way to build resilience. This was achieved in part by conducting three supporting tasks for the development of an adaptation strategy (i.e., policy review, risk-based analyses, and decision support).

This document provides more detailed background information that was used in decision support activities. We first provide a discussion on conceptual adaptation options (Section 2), which is followed by a discussion of planning scenarios (Section 3). We then provide a review of the Coastal Toolbox and a recommendation for its use in the project area for future phases of work (Section 4). A short conclusion is then provided (Section 5), followed by a list of references.

2 Conceptual Adaptation Options

To support complex discussions about values, choices, and tradeoffs we can think of five broad conceptual adaptation options: Protect, Accommodate, Retreat, Avoid, and Resilience-Building (i.e., PARAR). This section first describes the PARAR adaptation strategies. A few web resources are then provided as reference tools.

2.1 Descriptions

Table 2-1 to Table 2-5 summarize each of the adaptation strategies, including a list of actions that are typically associated with them. High-level opportunities and risks are also provided, although the lists are not comprehensive. The information presented in the "Project Considerations" sections of each table stems from feedback we received during engagement activities.

Table 2-1: Protect option summary information.

Protect

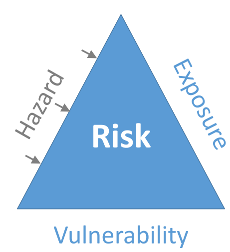
What is it?

Reduces the hazard by building infrastructure to keep floodwater out or by building infrastructure to reduce the power of the hazard and protect areas and community assets.

Typical actions are engineering-based and include:

- Building large structural works such as shoreline and inland dikes, and seawalls.
- Construction of offshore features to help reduce wind and wave action (e.g. sea barrier), or construction of hardened shorelines to reduce the power of wave action on the foreshore.
- Using nature-based approaches such as constructed wetlands and beaches to manage erosion and wave effects; property-level measures can also be considered (although these are also attributed to the "accommodate" strategy).

How do actions reduce risk?



✓ **Pros / Opportunities:**	✘ **Cons / Risks:**
• Nominally protects all assets behind the structure (e.g., homes, critical infrastructure, people, etc.).	• Individual actions to harden the shoreline would have cumulative effects on shoreline function and potentially increase hazard and risk to

Protect

What is it?

Reduces the hazard by building infrastructure to keep floodwater out or by building infrastructure to reduce the power of the hazard and protect areas and community assets.

• Structural works can be enhanced with other amenities such as a bike and pedestrian path. • Opportunity for naturalization and habitat enhancement (though this is limited).	neighbouring locations. • Potential loss of foreshore properties and of beach, depending on design (i.e., the footprint of infrastructure can cause displacement). • Implementation challenges (e.g., acquiring permits and land). • Technical challenges and drainage issues. • Can reduce ease of access to water. • Requires additional measures for redundancy in case of failure. • Moving parts mean more maintenance and greater potential for failure. • Impacts on recreationalists, aquatic habitat, and water quality. • High capital, operation, and maintenance costs. • Reduced aesthetics (e.g. fewer beach views from homes and businesses). • Dikes and infrastructure, although constructed to high design standards, can fail. • Tends to create an entrenched pathway, when a feeling of safety created by the infrastructure results in additional development. • Infrastructure is generally designed to a standard hazard event (e.g., 0.5% AEP flood event), and is therefore not necessarily adaptable to future flood scenarios with climate change.

Protect

What is it?

Reduces the hazard by building infrastructure to keep floodwater out or by building infrastructure to reduce the power of the hazard and protect areas and community assets.

Project Considerations

- Necessary where lacking space to retreat – can be combined with accommodate, but protection is faster so can be first step.
- Prioritize for key infrastructure that's difficult to move like lift station/WWTP, harbour infrastructure (e.g. The Docks).
- Necessary for archeological sites that can't be relocated (e.g. Oceanside Living).
- Need to consider who will manage/upkeep protection strategies like archeological sites and rip rap – current sites not being well managed due to low capacity (e.g. Oceanside Living).
- Need to consider costs – greenshores in a park is expensive – may need grant funding (e.g. Oceanside Living).

Table 2-2: Accommodate strategy summary information.

Accommodate

What is it?

Reduces vulnerability by using a range of actions to allow flooding to occur with minimal damage / consequence. Sometimes described as a "living with water" strategy.

Typical actions range through educational, planning, and building options and include:

- Giving nature the space to adapt gradually over time in natural and undeveloped areas using nature-based approaches such as constructed wetlands and beaches to manage erosion and wave effects.
- Using Flood Construction Levels to raise the height of the damageable components of structures.
- Retrofitting infrastructure, buildings, and communities over the natural building cycle to be flood-resilient.

How do actions reduce risk?

Accommodate

What is it?

Reduces vulnerability by using a range of actions to allow flooding to occur with minimal damage / consequence. Sometimes described as a "living with water" strategy.

- Raising the physical height of municipal services (roads, water, etc.) over time and taking advantage of regular planned infrastructure turnover cycles (e.g. asset management).
- Incorporating flood-resilient design adjustments to building codes, and using options and incentives to help residents and businesses improve property-level protection.

✓ Pros / Opportunities:

- Potential habitat, recreational, and aesthetic gains.
- Very effective when used in combination with other options.
- Reduces overall risk in absence of "protect" options, or in the event of dike/structural failure.
- Can benefit local drainage.
- Can be strengthened by coordinating measures across properties to promote continuity and consistency.
- Very adaptable to future climate change.
- Is incremental in approach, which makes implementation easier.

× Cons / Risks:

- Potential for reduced aesthetics when neighbouring sites are at different elevations or have different treatments of the streetscape.
- Implementation requires coordination among many governmental departments.
- Potential equity issues, depending how it is implemented. For example:
  - new and renovated buildings may be required to adopt higher flood construction levels, but older buildings would remain at risk.
  - Property owners with more financial capacity can afford to make upgrades while others may not have the means.
- Flood Construction Levels (FCLs) do not protect infrastructure, parks, and heritage buildings.

Accommodate

What is it?

Reduces vulnerability by using a range of actions to allow flooding to occur with minimal damage / consequence. Sometimes described as a "living with water" strategy.

Project Considerations

- Necessary where lacking space to retreat – can be combined with protect, but protection is faster so can be first step
- Implement over time, integrate into repairs/renovations/renewals

Table 2-3: Retreat strategy summary information

Retreat

What is it?

Also referred to as Managed Retreat, this strategy reduces exposure by moving existing structures out of flood risk areas.

Typical actions here are policy-based and include:

- Moving high-risk structures out of flood-prone areas.
- Opportunistic buy-outs as homes and businesses come up for sale over time, with more aggressive buyouts as hazard becomes greater with climate change.
- Opportunistic removal of roads, other infrastructure, and contaminants as land is vacated.
- Implementing aggressive renaturalization and restoration.

How do actions reduce risk?

✓ Pros / Opportunities:

- Absolute reduction in risk (i.e., the most effective strategy to reduce/remove risk)
- Potential habitat, recreational, and aesthetic gains.
- Long-term strategy that is effective regardless of sea level rise rates.

✗ Cons / Risks:

- Psychosocial impact to homeowners and businesses who need to move.
- Relatively new concept likely means implementation challenges related to issues of fairness.
- Significant cost; although who pays for buyouts and retreat is unclear.

Retreat

What is it?

Also referred to as Managed Retreat, this strategy reduces exposure by moving existing structures out of flood risk areas.

• No capital construction costs. • No permitting requirements.	• Loss of land. • Would likely require decades to fully implement.

Project Considerations

- Not a possibility in areas where land is already limited (e.g. Island Sanctuary)
- Need to think about where it is possible for developments to be relocated to
- Prioritize retreat of critical infrastructure where protect isn't an option, but consider how to navigate disruption of services during relocation (e.g. sewer system)
- Public has some level of control over infrastructure retreat (Oceanside Living)
- May be possible for homeowners to retreat within their own properties (Island Sanctuary)
- Buy-out is very expensive so should be last resort

Table 2-4: Avoid option summary information.

Avoid

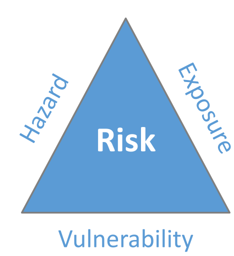
What is it?

Reduces exposure by limiting development within the floodplain through planning.

Typical actions here are based on planning and regulation and include:

- Protection and restoration of natural assets.
- Integrating future flood hazard area considerations within guidance documents such as regional growth strategies and official community plans.
- Creating watershed-based land use authorities and legislation.
- Establishing policy and planning tools such development permit areas, sea level rise planning areas, and setbacks that guide future development to avoid building critical

How do actions reduce risk?



Avoid

What is it?

Reduces exposure by limiting development within the floodplain through planning.

infrastructure in flood-prone areas.

- Developing tools such as flood bylaws to put in place the regional vision.

✓ **Pros / Opportunities:**	✗ **Cons / Risks:**
• Absolute reduction in risk (i.e., the most effective strategy to avoid future increases in risk). • Can be complementary to other strategies. • Natural assets can be protected and restored. • The positive flood management benefits of assets such as wetlands, salt marshes, and estuaries can be realized, reducing adaptation costs.	• Affects long-term economic interests of developers. • Does not address exposure of existing development.

Project Considerations

- Not much vacant space to avoid development – more useful to limit densification (i.e. carriage houses) through bylaws and rezoning.
- Presence of many little lots means ability to develop without restrictions (Island Sanctuary).
- Use OCP process for avoid options (Island Sanctuary).
- Avoid building on sand dunes (Island Sanctuary).

Table 2-5: Resilience-Building strategy summary information.

Resilience-Building

What is it?

Covers all aspects of work with the community to enhance its ability to cope with and recover from a flood event, and the cumulative effects of change.

Typical actions range from education to policy-based approaches and include:

- Engaging broadly in planning for coastal flood risk, to build understanding and capacity of the community to address risk and build resilience (individual and collective).
- Educating and engaging the public about the short and long-term risks, and how they can take steps to improve their physical, social, and psychological resilience.
- Having tough conversations about values, tradeoffs, risk tolerance and change, to develop shared understanding and direction over time.
- Grow social connectedness/capital (emphasis on care for vulnerable populations, shift to a low-carbon economy).
- Developing neighbourhood-level preparedness and resilience-building programs, being mindful of issues of equity.
- Developing supports for dealing with psychosocial impacts of anticipated and experienced impacts.
- Creating flood recovery plans in advance of events, to enable communities to "build back better".
- Developing robust emergency preparedness and response plans (e.g., flood monitoring and warning systems) to limit damages during a flood event.

✓ Pros / Opportunities:

- Very complementary to the other strategies.
- The resulting community-building can help with other sustainability-related objectives.
- Potentially lower-cost if there is buy-in from community leaders, who can galvanize the public.

✗ Cons / Risks:

- Potential for conflict as values are re-evaluated, creating greater awareness of "winners" and "losers".
- Requires a concerted and coordinated effort among civil society groups and government.

Project Considerations

- Build awareness of area's vulnerability and expected impacts.

Resilience-Building

What is it?

Covers all aspects of work with the community to enhance its ability to cope with and recover from a flood event, and the cumulative effects of change.

- Education/awareness-building is especially important in areas with lack of appetite for regulation.
- Consider how to educate transient people (e.g. Island Sanctuary).
- Consider how people may react based on their second home vs. their primary home.
- Bring in subject matter experts to public meetings, like insurance experts, to help residents make better decisions.
- Encourage community-based resilience building through education and social connectedness
- Consider insurability.
  - Many homeowners do not have insurers because of high costs.
  - Residents unsure how insurance companies view risks on islands.

2.2 Web Resources

Table 2-7 presents a few on-line resources, which have been loosely organized according to the adaptation options presented in the previous section.

Table 2-6: Web resources associated with conceptual adaptation options.

Strategy	Resource Name and Hyperlink
Protect (including "Green" approaches)	Natural and Nature-Based Flood Management: A Green Guide
	Dikes and Related Works (BC Floodwise Website)
	City of Richmond Flood Protection
	Puget Sound Innovation Stories (Dike Setback)
	International Guidelines on Natural and Nature-Based Features for Flood Risk Management
	Green Shores Shoreline Development Program
	Your Marine Waterfront: A Guide to Protecting Your Property While Promoting Healthy Shorelines
Avoid	Puget Sound Partnership Projects

Strategy	Resource Name and Hyperlink
	Ontario Conservation Authorities
	US Executive Order 13690
Retreat	Reimagining the Shoreline: Opportunities for Managed Retreat in BC
	Willing seller program in New Jersey
	Quebec buyouts program
	Natural Resources Canada Planned Retreat Approaches
	New Jersey Blue Acres Buy-out Program
	The US EPA Rolling Easements Primer
Accommodate	Retrofitting for Flood Resilience A Guide to Building & Community Design
	Homeowners Guide to Flood Resilience
	City of Brisbane Flood Resilient Homes Program
	Lower Mainland Floodwise Website
	New York City Retrofitting Buildings for Flood Risk Design Manual
	Urban Green-Blue Grids
Resilience-Building	City of Vancouver Resilient Neighbourhoods Program
	City of Vancouver Sea Level Rise Toolkit
	Grand River Conservation Authority Flood Warning System

3 Planning Scenarios

Planning scenarios are descriptions of a high-level approach to flood and erosion management that would take the region and its communities in different directions. This section first provides an overview of the scenarios, and this followed by more details on each scenario.

3.1 Overview

These were developed to prompt discussion regarding some of the tensions, values, and challenges identified by participants in the engagement sessions.

The four scenarios for this exercise were:

- Scenario 1: Neighbourhood Resilience
- Scenario 2: To Each their Own
- Scenario 3: Regional Regulation
- Scenario 4: Assessment, Reliance, and Retreat

The scenarios represent a combination of less government regulation (i.e., the "carrot" approach) versus more government regulation (i.e., the "stick" approach), as well as collective versus individual action (Figure 3-1). Appendix C provides a narrative for each scenario that describes what different adaptation strategies implemented could look like "on the ground". Through exploring these contrasting narratives with participants, we gained insight into tradeoffs and preferred strategies here in the region. Scenario 2 is most representative of current conditions in the project area.

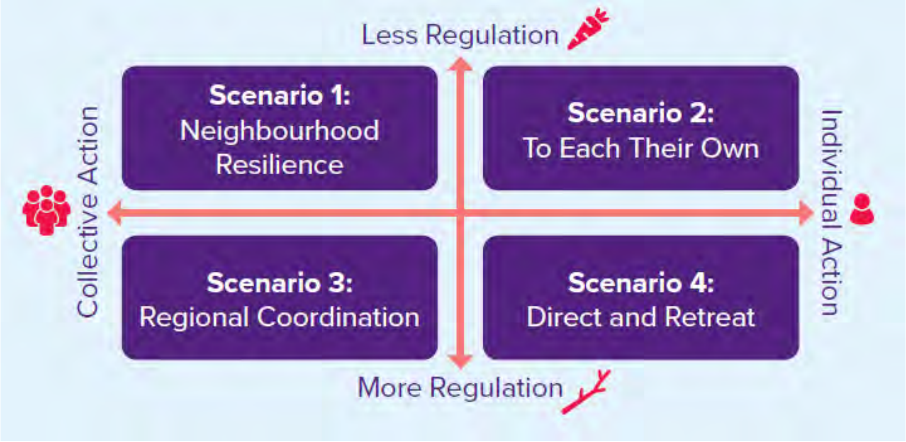


Figure 3-1: Planning scenarios considered.

3.1.1 Narratives and Scoring

Each scenario was summarized by a hypothetical narrative to describe the approach that would be taken under that scenario. The general performance of the scenario was then evaluated, at a high level, based on simplified criteria.

The criteria, based on a mix of best practice and feedback from the engagement process, were as follows:

- Culture and lifestyle
- Environment, nature, and biodiversity
- Financial and economic impacts
- Critical infrastructure
- Private property

The criteria were scored on a generalized 4-point scale, relative to current conditions and assuming the scenario plays out in the future. The scoring descriptions ranged from “far worse”, “slightly worse”, “slightly better”, and “much better”.

The narratives and scoring for each scenario are presented in the following sections. The main report describes how the planning scenarios were used to consider a set of tensions that were identified in the region.

3.2 Scenario 1: Neighbourhood Resilience

3.2.1 What Does This Approach Entail?

Having heard from the community that an increase in regulation is not desirable, the Local Government (LG) focuses on providing information and resilience-building specific to areas with flood-prone futures.

Staff bring flood-prone area property owners, tenants, and community members at large together to provide information such as mapping and best practices for flood management. Staff invite subject matter experts to present information, including on erosion management, insurance challenges in floodplains and cultural site stewardship. Staff provide incentives for community members to work together on area-based solutions to avoid transfer of risk between properties and encourage low impact solutions. Staff also provide templates for neighbours to work together on emergency plans for hazard events including but not limited to flooding.

The LG works with Tla’amin Nation to provide incentives for property owners to have a cultural monitor present when doing any excavation or construction work.

Based on community priorities, the LG pursues maintenance of public access for recreation and economic activity and restores environmentally impacted areas as funding allows. The LG works with interested community groups to attract conservation land trusts to provide support in sensitive coastal areas and applies for funding support to implement protection for critical infrastructure. There is a significant attempt to pursue coordination of neighbourhood actions and public asset interventions.

3.2.2 How Might Scenario 1 Fare Over a Range of Criteria?

Criteria	Comment	Scoring
Culture and lifestyle	Increase in community resilience to a range of events. Cultural sites at some risk.	Slightly better
Environment, nature and biodversity	Encouragement but not regulated.	Slightly better
Financial and economic impacts	Costs largely borne by individuals for their property. Cost for public asset flood resilience.	Slightly worse
Critical infrastructure	Community driven priorities.	Slightly better
Private property	Insurability could be impacted.	Slightly worse

3.3 Scenario 2: To Each Their Own

3.3.1 What Does This Approach Entail?

Having heard the preference for no further regulation, the LG continues the current course of not imposing any regulation or restriction on property owners. Instead, the focus of this approach is on public assets.

The LG completes a review of critical infrastructure and assets in the flood plain and takes a risk-based approach prioritizing assets at highest risk. This means that assets serving many in the community will be prioritized over those serving few. The LG seeks senior government funding for protection or relocation/renovation of assets but has to reallocate capital funds from other community priorities to match funding. Flood management of public assets is not coordinated with private asset interventions.

The LG pursues maintenance of public access for recreation and economic activity with a focus on public land. Over time property owner protective measures block access to public beachfront and create coastal squeeze with disappearing intertidal areas.

Given low LG oversight of projects, known and unregistered cultural sites may be at risk from private property flood management interventions. Provincial permits are required for protective measures in the foreshore area but there are low levels of enforcement.

3.3.2 How Might Scenario 2 Fare Over a Range of Criteria?

Criteria	Comment	Scoring
Culture and lifestyle	Cultural sites likely compromised. Beach access issues over time.	Slightly worse
Environment, nature and biodversity	Impacts could occur now and over time with individual shoreline protection.	Far worse
Financial and economic impacts	Property insurability issues. Commercial/economic hub areas may be impacted over time based on decisions made by property owners.	Slightly worse
Critical infrastructure	Risk based approach to protecting infrastructure.	Slightly better
Private property	Insurability could be impacted.	Slightly worse

3.4 Scenario 3: Regional Regulation

3.4.1 What Does This Approach Entail?

The region works together to develop a common flood management strategy recognizing the best fit approach depending on the site context. A regional risk assessment of infrastructure drives priority applications to senior government for funding support.

The communities decide to pursue consistent land use regulations and guidelines for flood prone areas following the Provincial Flood Management Land Use Guidelines. Official Community Plan (OCP) hazard areas are updated to include the floodplain to 2100 and future land uses are restricted in these areas. Land use designations in these areas favour lower risk uses such as conservation, recreation and resource use. In some flood-prone areas, an increase in risk is reduced through eliminating further density increases over time.

Development permit areas and/or floodplain bylaws are established along some areas of coastline and trigger setbacks, flood construction levels (elevated habitable area), construction guidance, etc. for new development and major renovations. This requires an increase in staffing to process permits and ensure building permits adhere to regulations. In other areas this requires implementation of a comprehensive new regulatory regime. Permits require low impact shoreline development, cultural site stewardship, maintenance of public access and save harmless covenants in favour of the LG. Permit fees recoup the majority of staff costs. Low income and service organization applicants can apply for grants to help cover retrofit costs.

Where protection is the chosen tool, green infrastructure solutions are preferred. The governments work together to attract senior government funding and are successful based on the regional partnership and strategic, risk-based strategy.

Critical infrastructure is relocated inland from the coast or renovated to increase flood-proofing over time.

The LGs invest in coordinated emergency preparedness capacity and region-wide volunteership, as flood events in coastal areas become a more regular occurrence. This includes neighbourhood preparedness programs and regional evacuation and emergency housing networks to support more frequent evacuations.

3.4.2 How Might Scenario 3 Fare Over a Range of Criteria?

Criteria	Comment	Scoring
Culture and lifestyle	Community values such as culture and environmental stewardship consistently upheld. Public investment serves community.	Much better
Environment, nature and biodversity	Explicit protection of the environment	Slightly better
Financial and economic impacts	Significant capital costs to government and potential long term operational and maintenance costs. Burden of permitting largely on individuals.	Slightly worse
Critical infrastructure	Likely to attract senior government funding with coordinated regional approach.	Slightly better
Private property	Higher likelihood of retention of value over time.	Slightly better

3.5 Scenario 4: Direct and Retreat

3.5.1 What Does This Approach Entail?

Local governments impose regulations to capture interventions on coastline private properties with some built-in flexibility.

In the shorter term, reliance is put on property owners to demonstrate that their protective measure, development or renovation is safe for the intended use (does not increase risk) and minimizes impacts to the environment and known or potential cultural sites. Reports from Qualified Professionals (QP) are required and reviewed/ approved by staff. Save harmless covenants and the QP report are attached to parcel title.

In the longer term once flood waters surpass a certain elevation threshold, the LG restricts individual protective measures and public property moves inland as nature takes its course. Structures are removed at the cost of the owner and areas re-naturalized.

LG actions and interventions otherwise focus on public assets and a preference for green versus traditional grey infrastructure approaches where applicable. Each LG works independently to determine how to lower flood risk to critical infrastructure.

3.5.2 How Might Scenario 4 Fare Over a Range of Criteria?

Criteria	Comment	Scoring
Culture and lifestyle	Some individual choice and some caution for impacts	Slightly better
Environment, nature and biodversity	Explicit effort to minimize impacts. Retreat over time ensures public access and intertidal areas maintained.	Slightly better
Financial and economic impacts	Burden of property level solutions on the individual while LG focuses on public assets. Some burden to review QP reports.	Slightly worse
Critical infrastructure	Disjointed regionally but improves resilience over time.	Slightly better
Private property	Short term retention of value. Long term loss of value and land.	Slightly worse

3.6 Summary of Planning Scenarios

The key takeaway from the scenarios assessment is that when they are appropriately evaluated based on a range of criteria, tradeoffs will appear when considering one scenario versus another. This highlights the need for values and priorities to be identified. In this way the tradeoffs can be better understood, leading to more informed selection of preferred adaptation solutions.

4 Review of the Coastal Toolbox

Modelling tools are becoming increasingly available to support local governments with the selection of coastal adaptation options. We conducted a preliminary review of the documentation for the Coastal Toolbox (CT) (David Suzuki Foundation, 2021)[1] to assess its potential application in the project area. The sections below provide a background about the tool as well as a brief analysis on the program, which are used to make a recommendation for future use.

4.1 Background

4.1.1 Purpose

The Coastal Toolbox was developed as part of the Municipal Natural Assets Initiative (MNAI), which is a non-profit organization with a mission to make natural asset management a mainstream practice across Canada. The MNAI have developed tools to measure and manage the contribution of natural systems to communities.

The goal of the CT is:

> *"to help participating local governments identify, prioritize, value and manage key coastal natural assets as part of core local government asset management systems. […] to help municipalities identify their relevant natural assets, understand the value of those natural assets and use that information in municipal planning and management decisions."* (David Suzuki Foundation, 2021).

The CT can be used to conduct evaluations for cost-benefit analyses for coastal ecosystem services. This is achieved through preliminary evaluations of coastal storms, beach erosion, offshore wave propagation, flooding and structural damage. These evaluations should be considered as a "first pass" for natural assets, to provide planners with an idea of whether further studies are worthwhile.

4.1.2 Development Details

The CT was developed by ESSA Technologies Ltd. and CBCL, and the program is free and "open-source". It is a GIS-based simulation and analytical tool. At its core, it is based on the 'Wave

[1] Weblink: https://mnai.ca/media/2021/11/MNAI-Coastal-Asset-Guidance-Doc-cover-101-combined.pdf. Accessed 7 June 2022.

Attenuation & Erosion Reduction: Coastal Protection" component of the InVEST Natural Capital project (Integrated Valuation of Ecosystem Services and Tradeoffs), from Stanford University[2].

4.1.3 Method

The program requires the user to input spatial datasets and it comprises the following 6 main components:

- Cross-shore profile generator
- Natural/built asset scenario
- Wave/storm simulator
- Flood estimator
- Erosion estimator
- Avoided costs/damages[3]

Figure 4-1 shows an example of how the model's components can be used to tune model parameters to simulate the effects of different natural asset management alternatives.

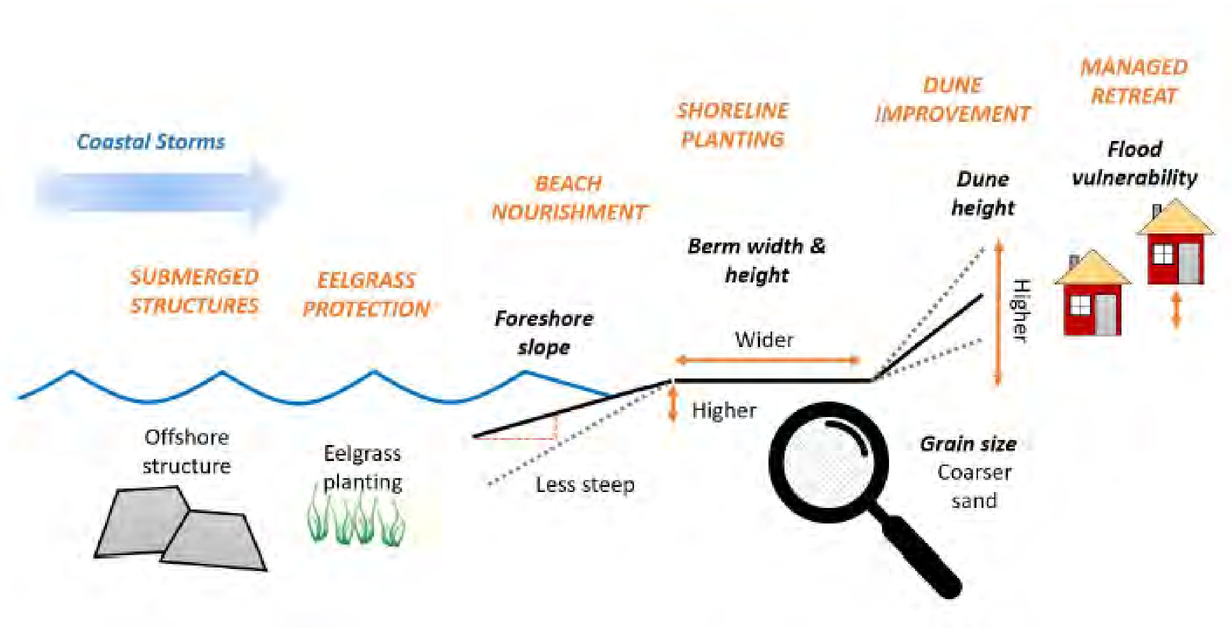


Figure 4-1: Example application of the CT program (Source: David Suzuki Foundation 2021).

The program was pilot-tested in the Town of Gibsons (MNAI, 2021b), which has a rugged coast and Pointe-du-Chêne in New Brunswick (MNAI, 2021a), which has sandy beaches. The

[2] Weblink: https://naturalcapitalproject.stanford.edu/software/invest. Accessed 4 November 2022.
[3] This is based on the Hazus Model. Weblink: https://www.fema.gov/flood-maps/products-tools/hazus. Accessed 4 November 2022.

documentation indicates that the tool's capabilities can potentially oversimplify complex coastal processes, which could lead to incorrect assumptions. As such, it is recommended to have a qualified professional who can better understand these nuances and related limitations, use the program.

4.2 Program Analysis

The CT is a useful first-pass tool that can provide actual numbers to compare scenarios that consider different natural asset management alternatives. However, the user-friendliness of the tool can lead to misuse by those who are not qualified to understand important nuances and limitations related to the technical components. Based on our overview analysis, we provide some specific strengths and drawbacks of the tool's program and components below.

4.2.1 Strengths

Specific strengths of the tool include:

- It has a straight-forward user interface.
- The program is based on relatively detailed descriptions of different natural asset options modelling.
    - This strength comes with the caveat that the descriptions need to be interpreted appropriately (hence the need for a qualified professional).
- The guidance document has clear statements of limitations, assumptions, how sub-tools are developed, what input data is needed and how it can be developed.
- The R code for some tool components is provided on Github for download and adjustment.
- The tool was applied successfully for the Town of Gibsons, and there are likely good lessons learned to improve on its use in the qathet Regional District.

4.2.2 Drawbacks

Specific drawbacks of the tool include:

- The program contains its own modelled flood extents. While these were likely produced with sufficient quality, understanding the limitations of the mapping is critical. Also, the model is unable to be easily adjusted based on new flood maps, should be become available.
- The program provides dollar costs based on the Hazus model to estimate building damages. However, the Hazus model was not developed specifically for the application of considering green infrastructure/natural assets to reduce costs. Further, the Hazus damage curves have been criticized for their non-applicability to the Canadian context (Lyle & Hund, 2017).
- There are many other limitations for each of the natural asset options. There is potential for user misinterpretation.

- While the tool is free and open source, it requires the user to have an ESRI ArcGIS licence.
- To modify or understand the program code, the user must be relatively proficient with R coding.
- Several input data components are necessary to be prepared (e.g., combined topographic and bathymetric digital elevation model (DEM), storm and wave conditions, etc.). This means that technical support is required, and municipal planning staff would not be able to run the model by themselves.

4.3 Recommendation

The CT is a powerful, relatively user-friendly, tool. Apart from requiring an ESRI ArcGIS licence, it is freely available and open source. Technical components are required to be produced and input to the program, meaning that municipal planning staff need support from a qualified professional to use it. This is not necessarily a drawback as a qualified professional should be involved in the process of using the program. Someone with technical expertise needs to better consider important nuances and limitations of the program, to support the interpretation of results. We recommend that the tool be considered for use within the project area in a future phase of work. We note that the objective of the tool's use should be to explore scenarios, and not to inform engineering design.

5 Conclusion

This document discussed information related to conceptual adaptation options, planning scenarios, and the Coastal Toolbox program. These decision support tools were used (or are recommended for use) to develop and progress the Regional CFAS. They were used iteratively within the engagement activities, and the concepts can be continued to be refined in future phases of the Regional CFAS.

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Appendix D: Engagement Feedback – Methods and Survey Results

qathet Regional Coastal Flood Adaptation Strategy

Appendix D: Engagement Feedback – Background and Survey Results

Contents

1 Introduction

The qathet Regional Coastal Flood Adaptation Strategy (CFAS) is a partnership between the City of Powell River (CoPR), Tla'amin Nation, and qathet Regional District (qRD). The project built on a previous overview coastal risk assessment (Tetra Tech, 2018) and more detailed coastal flood mapping and erosion assessment (Tetra Tech, 2021, 2022). Ebbwater was retained by the qRD to complete the Regional CFAS by presenting coastal flood information in a meaningful way to build resilience. This was achieved in part by conducting three supporting tasks for the development of an adaptation strategy (i.e., policy review, risk-based analyses, and decision support). All of these tasks were iterated and refined through the engagement activities and feedback (see Section 5 of the main report).

This document provides background on the engagement activities (Section 2), including details on the methods and summary of the survey, and a short conclusion (Section 3). Attachment 1 provides an example of the outreach materials that were produced to advertise the engagement activities. Attachment 2 contains the quantitative results from the survey.

2 Activities

The engagement activities that are summarized in the following sections were thoughtfully developed in collaboration with the project partners. In the initial weeks of project startup, SHIFT Collaborative produced an engagement plan, which was refined with input from qRD planning staff and Working Group participants (see Section 1.4 of the main report).

2.1 Overview

Engagement included the project Working Group participants, as well as rights holders, stakeholders, decision makers, and the public. The goal was to raise public awareness of the project, obtain input on community values and preferences, and gather feedback on a proposed range of coastal adaptation options. The overall engagement plan is outlined in Figure 1-1.

Figure 1-1: Overall engagement plan outline.

Table 1-1 details the dates, invited participants, and objectives for the key engagement activities. There were six online presentations and workshops, and one public in-person event.

Table 1-1: Details for key points of engagement.

Points of Engagement	Date	Invited Participants	Objectives
	April 13, 2022	General Public	

Points of Engagement	Date	Invited Participants	Objectives
Phase 1, Activity 3. Info Session (online)	April 13, 2022	Staff and Leadership of qRD, Tla'amin Nation and CoPR	• Provide an update on project work and coastal flood risk background. • Overview of coastal flood and erosion risk in the region. • Gather input to support the development of the coastal flood adaptation strategy.
	April 26, 2022	Tla'amin Nation Members and Leaseholders	
Phase 2, Activity 4. Survey	April 2022	General Public, Stakeholders and Partners	• Gather views on a range of values, preferences, and tradeoffs in relation to coastal adaptation.
Phase 2, Point 5. Partner & Stakeholder Workshops (online)	May 19, 2022	People and organizations representing a range of expertise and experience from the community and external organizations.	• Ground-truth and further develop ideas for possible adaptation strategies and actions. • Explore tensions, tradeoffs and possible directions, based on results to date.
	May 25, 2022		
Phase 3, Point 6 Open House (in-person)	June 22, 2022	General public, stakeholders, local government and First Nation government staff and elected officials	• Share and gather feedback on preliminary ideas for adaptation strategies and approach for the RCFAS.

2.2 Methods

The progress of the engagement activities was a constant discussion topic during the 4 meetings held with the project Working Group throughout the project. To advertise the project information sessions and survey, radio advertisements were played on Vista Radio and announcements were published in qathet Living magazine and Nehmotl, Tla'amin Nation's monthly community newsletter. A region-wide mail-out flyer was sent to the door of 11,362 households in the region, inviting them to engagement events. The information sessions were aimed at the general public and Tla'amin Nation members and leaseholders. The on line sessions were recorded and uploaded onto the qRD and TN websites for viewing by interested parties, and opportunities to take part were covered in an article in the Peak. Engagement activities were also advertised through the project website. Attachment 1 provides an example of the content that was included in the advertisements. A project "brand" was used for the project materials, and Figure 1-2 shows how it was applied to create a poster board.

Figure 1-2: A poster board advertising the public in-person event at Willingdon Beach Park Pavilion.

Invitations to take the survey were circulated to over 61 representatives of organizations, sectors, and groups with an interest or stake in coastal flood adaptation. Paper copies were available at the offices of qRD, Tla'amin Nation and CoPR, however no respondents used this method (see Section 2.3 for a summary).

Twenty-one people participated in the next step of the process, which was a set of two Stakeholder and Partner Workshops held online in May (Table 1-2). In addition to the public citizenry and the project partners, participants in these workshops represented the following agencies: BC Ferries, Vancouver Coastal Health, and Shíshálh Nation.

The workshops built on the information gathered in information sessions and the survey, to test and further develop ideas for adaptation approaches and strategies. This included exploring some of the key tensions – including the level of government regulation, and emphasis on individual or collective action – to gain insight into which directions may be feasible and what could be done to customize strategies to work better in this area.

The final step in the process was to present preliminary ideas for adaptation strategies and decision guidance to the public, partners and stakeholders in an in-person event held at Willingdon Beach Park on 20 June 2022. Additional advertising was distributed to the community to raise awareness about this final event with the public. The event included a presentation as well as interactive booths where attendees were invited to review results and proposed strategies, ask questions of the project team, and share their feedback and ideas (Figure 2-3). Local media again covered the event in the Peak.

Figure 2-3: A project team staff member discusses with a member of the public.

2.3 Survey Summary

We received 53 full responses to the survey, and 14 partial responses. Partial responses that responded to the open-ended questions were incorporated into the qualitative data analysis and themed alongside the full responses. Quantitative data from partial responses were removed from the sample. Attachment 2 is a redacted version of the survey that contains the raw quantitative data from full responses. Qualitative data has been included for privacy reasons. All results from the engagement feedback are provided in Section 5 of the main report.

3 Conclusion

Feedback from the engagement activities was a critical component of the development of the Regional CFAS. The project team developed a plan that first informed and educated participants including the public residing in the three project partner areas. More detailed information was shared with a subset of people including decision makers from the three partner areas. A variety of media were used to disseminate information and gather feedback, including online and during an in-person event. Through these activities, the project's tasks (i.e., policy review, risk-based analyses, and decision support) were refined and iterated to inform a more fulsome discussion on adaptation strategies.

Attachment 1 – Mail-out Flyer Distributed to the Residents of qathet Regional District

Important Invitation

qathet REGIONAL DISTRICT

Let's Talk Coastal Adaptation

Get involved in the qathet Regional Coastal Flood Adaptation Strategy!

This spring, the qathet Regional District, Tla'amin Nation, and the City of Powell River are hosting **virtual information sessions, a game night, a survey, and a public workshop** to gather feedback from local residents on the impacts of climate change along our shoreline and what can be done to adapt and build resilience. Join us as we draw on our collective insights to address coastal flood and erosion risk and foster greater resilience in our region.

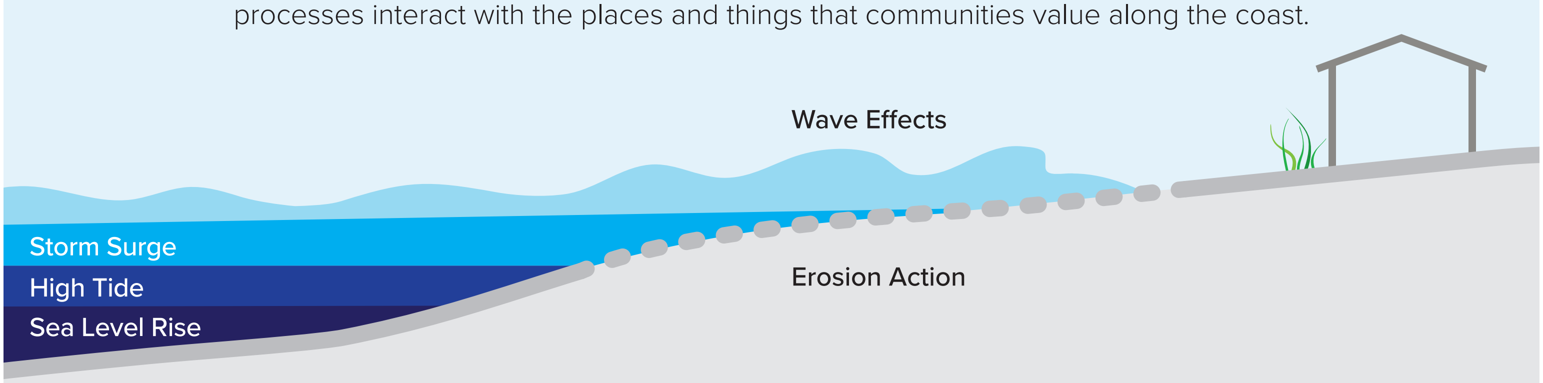
How to get involved:

- Attend an information session, a game night, and public workshop
- Participate in a survey

See reverse side for details!

Adapting to Coastal Hazards

As ocean water rises, coastal communities are more likely to experience flooding than in the past. This is especially the case when sea level rise combines with high tide as well as coastal storms (i.e. storm surge, and wind and wave effects). More frequent coastal storms and rising sea levels can also increase coastal erosion, which acts to remove sediment and rock from the shoreline. Through this work, we will explore how these processes interact with the places and things that communities value along the coast.



Attend Upcoming Events

April 13, 6:30 pm:

Attend an online community **information session** to learn more about coastal flood and erosion risk and share what matters to you. A recording of this presentation will also be available on the website.
qathet_rcfas_info_session.eventbrite.com

Photo: Sina Golchi

April 27, 6:00 pm:

Join us for an online **Flood Resilience Game Night** to practice complex, adaptive decision-making and have some fun! To find out how to attend, please come to the April 13th information session. Please note that capacity is limited to 30 players. Additional observers welcome! For more information about the game, visit **frcgame.com**.

Throughout April:

We are also available to provide **presentations** to community-based organizations at your scheduled meetings in April — please be in touch to request a presentation (see contact information below).

June 22 at Willingdon Park:

A **public workshop** will be held in late June to get together to explore adaptation options and inform proposed strategies.

Complete the Survey

We want to hear from you! Complete the survey to share your concerns, values and what matters most to you regarding coastal adaptation. The survey will be open from **April 13 to April 29, 2022**, available on the website. Paper copies are available upon request.

Scan me to visit the project website

Visit our website to learn more, sign-up for events, find the survey link, and stay up to date:
www.qathet.ca/current_project/regional-coastal-flood-adaptation-strategy

For more information, contact the qathet Regional District planning staff at 604-485-2260 or planning@qathet.ca.

qathet Regional District

Powell River coastal by nature

Tla'amin Nation

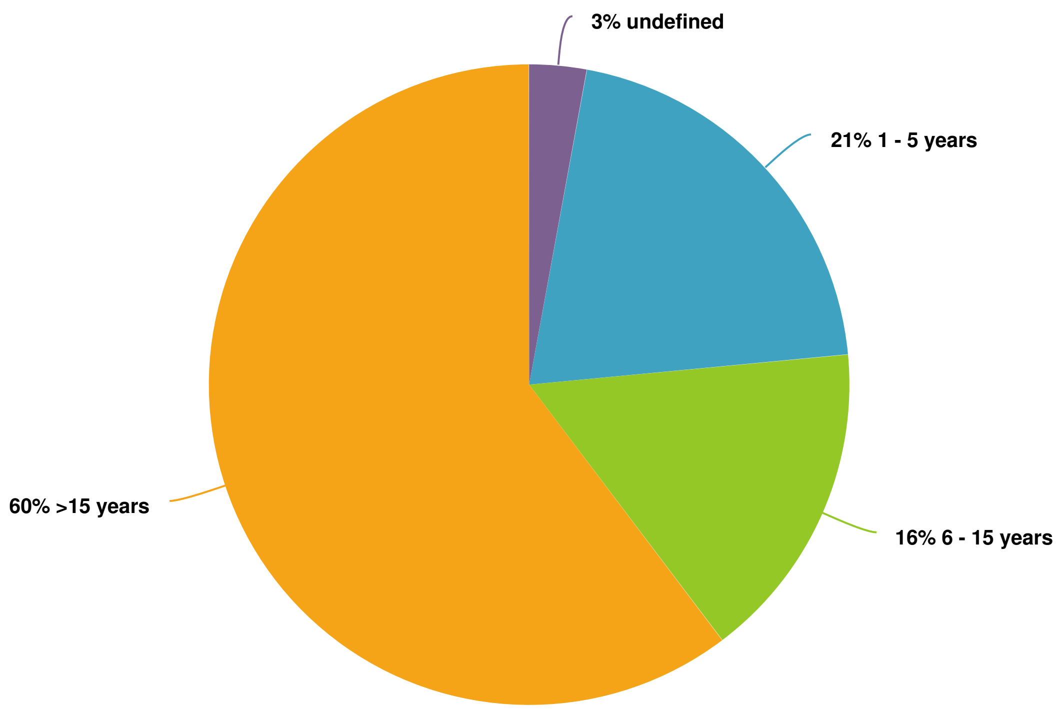
Attachment 2 – Quantitative Responses from Survey

qathet Regional Coastal Flood Adaptation Strategy: Community Survey (April 2022)

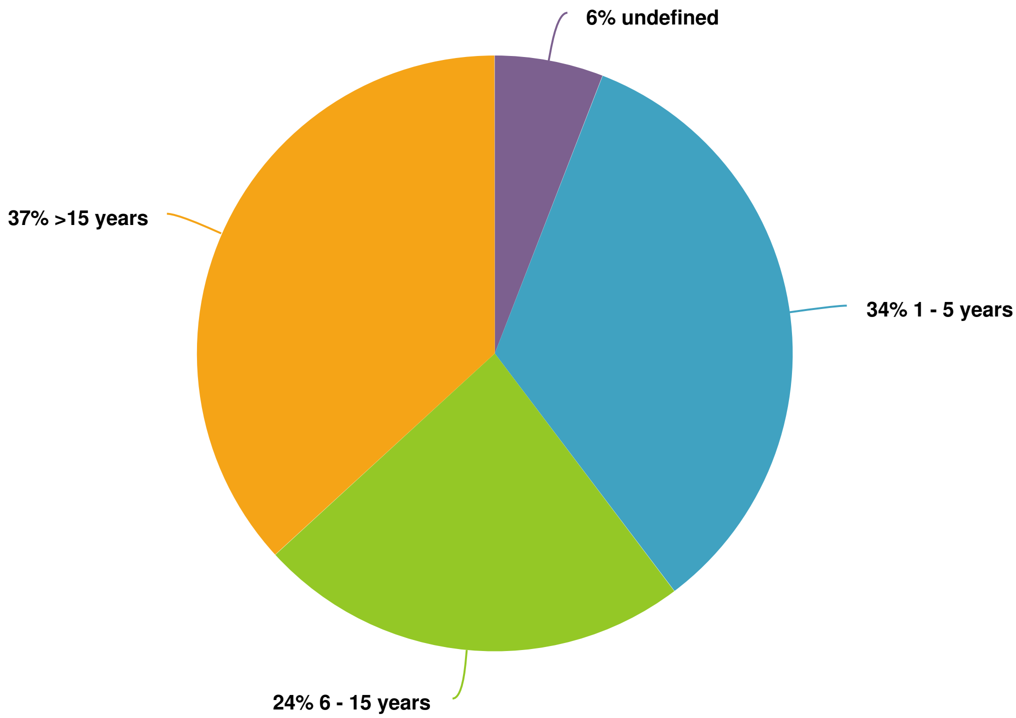
Response Counts

Completion Rate:	**77.9%**	
	Complete	53
	Partial	15
		Totals: 68

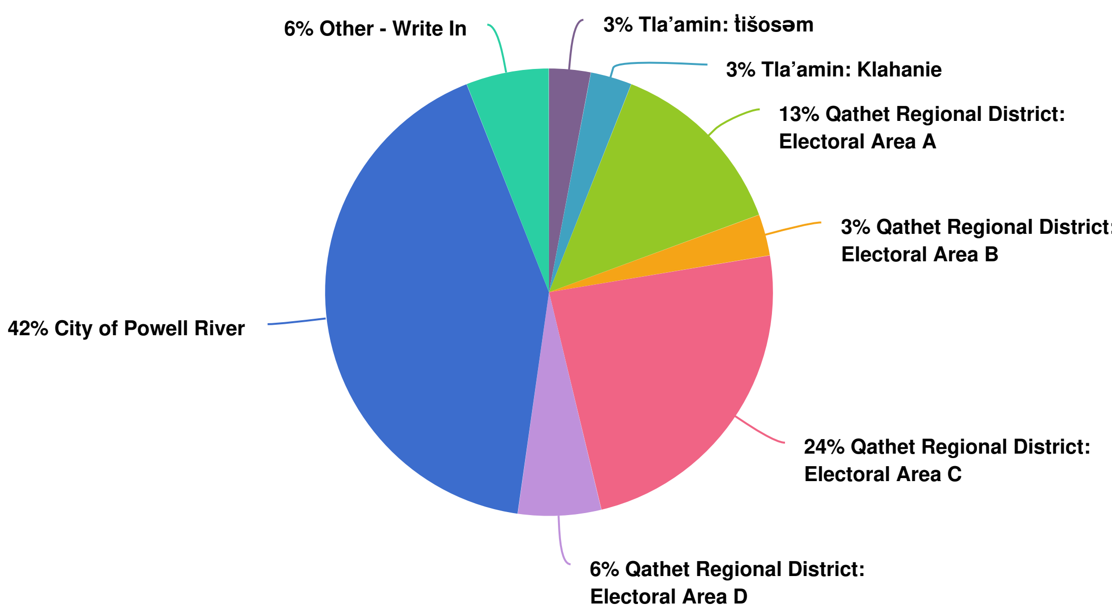
1. How long have you lived in this region?



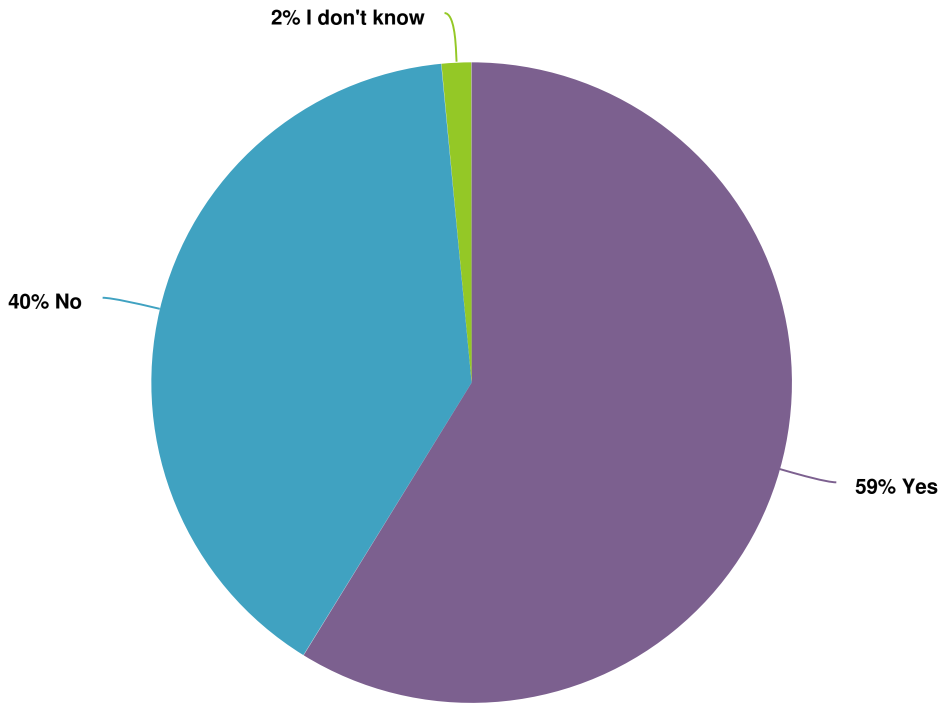
2. How long have you lived in your current place of residence?



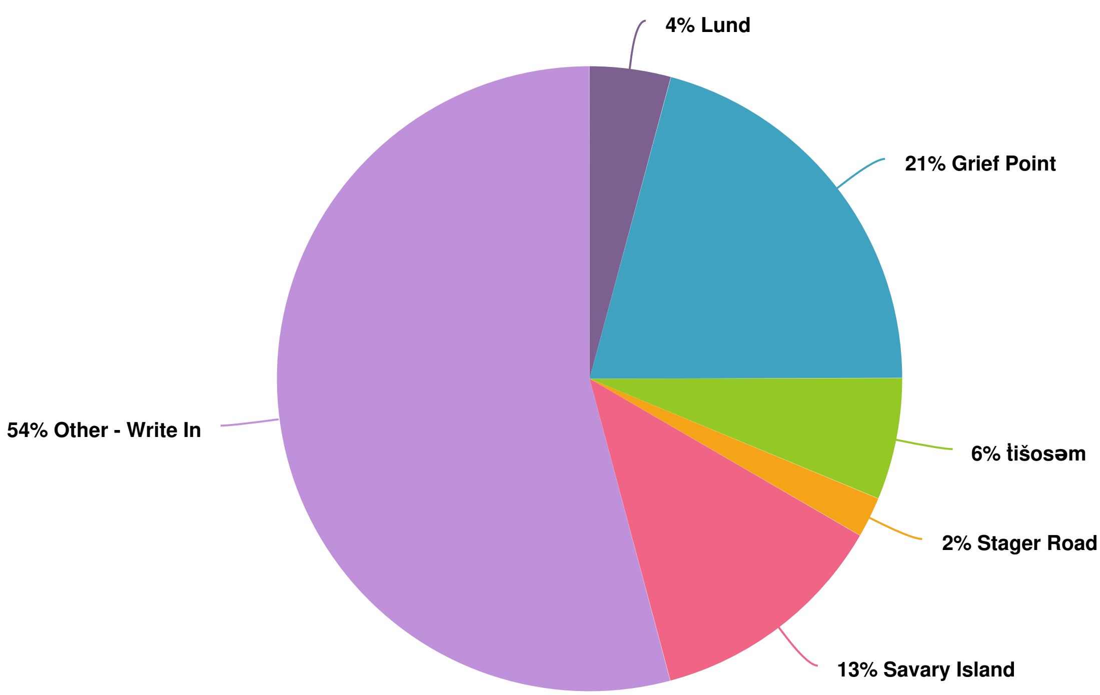
3. In which part of the region do you currently reside?



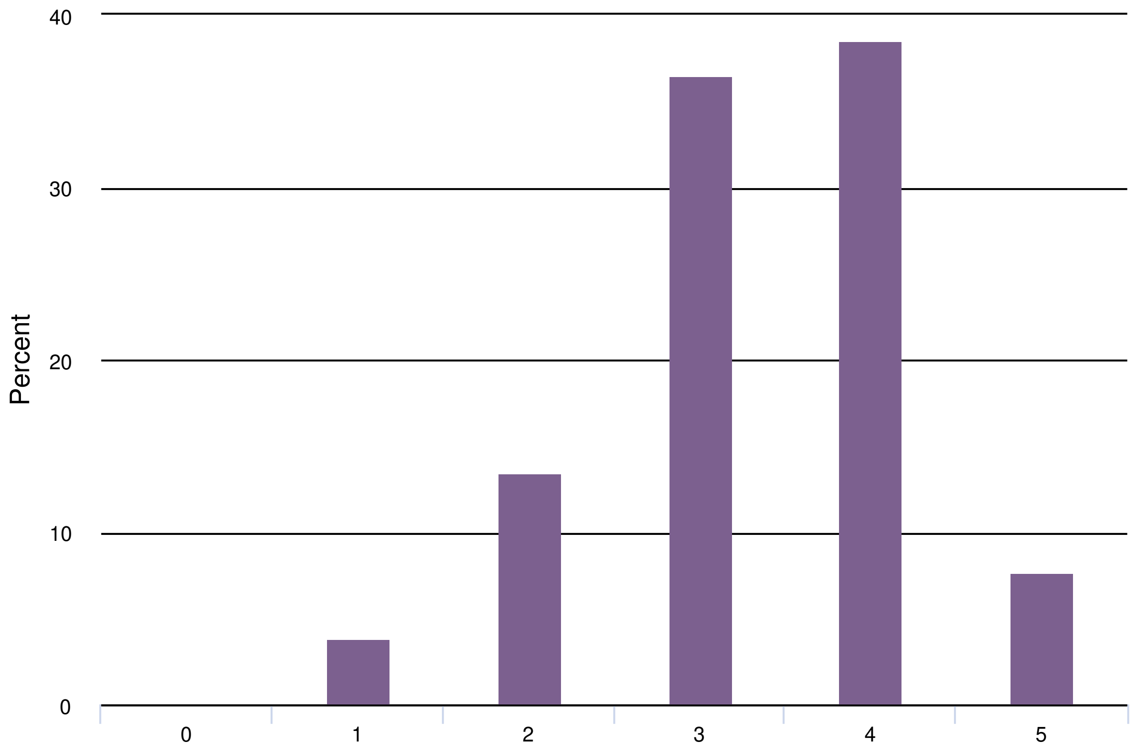
4. Do you live in a coastal location in the region (i.e. within approximately 100 m of the shoreline)?



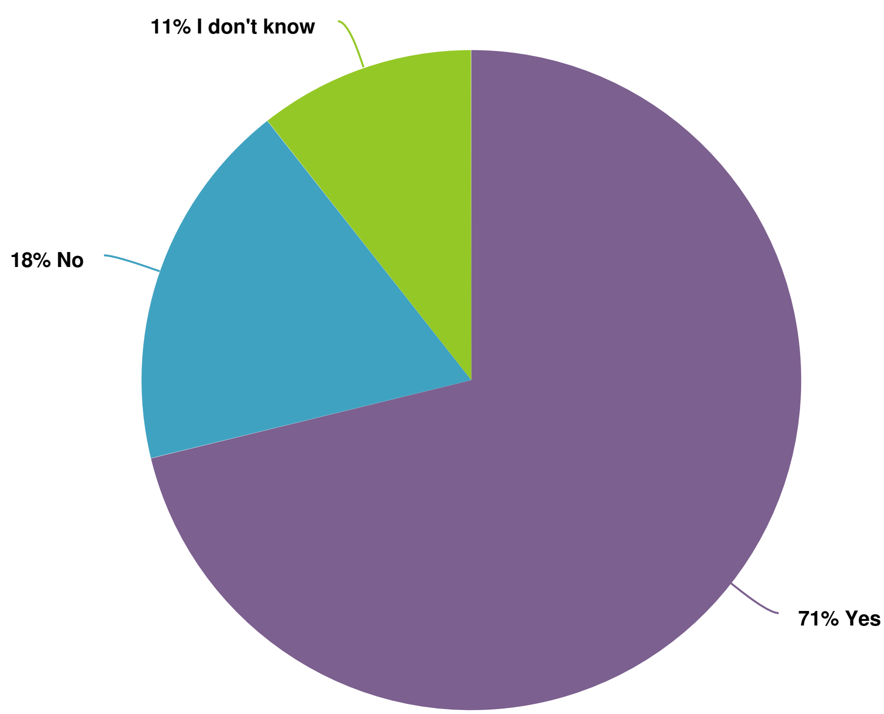
5. If yes, please indicate if you live in any of the following areas. If not, please indicate your neighbourhood / approximate location under "Other."



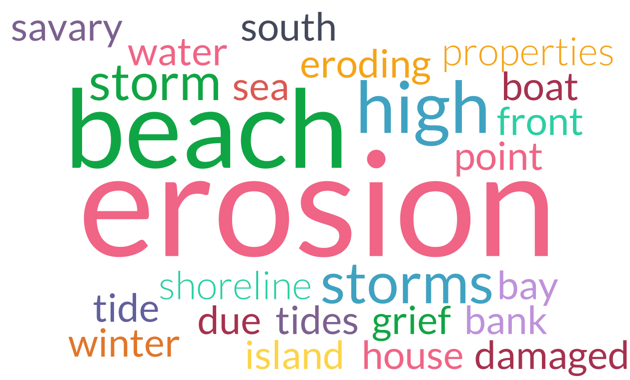
6. How familiar would you say you are with how sea level rise will impact coastal areas like our region? (0 = not at all, 5 = extremely)



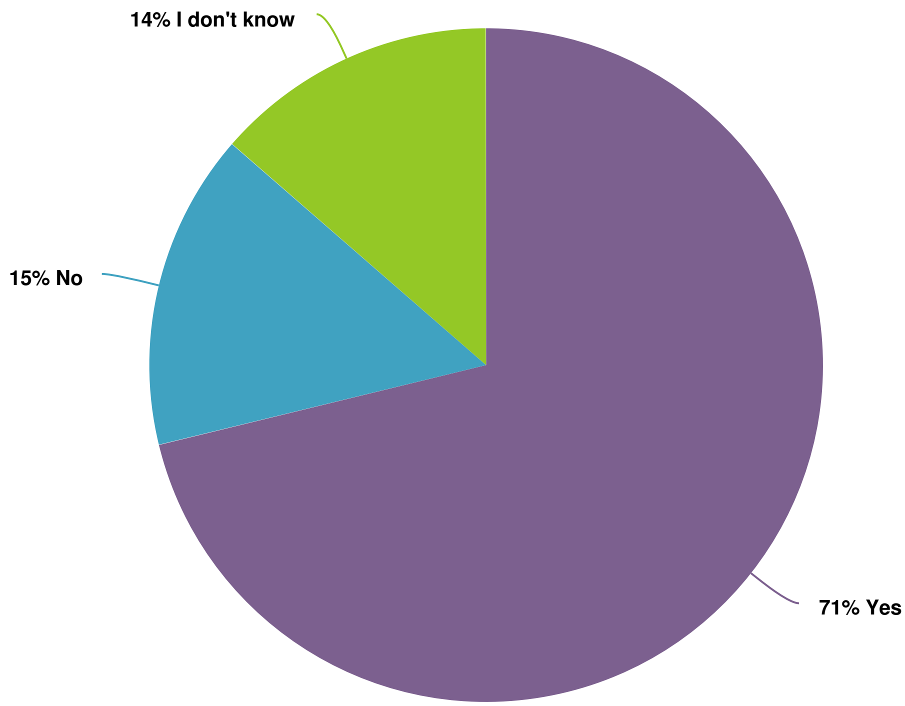
7. Have you noticed any physical or ecological changes in this region that may be caused by sea level rise, major storms and waves, flood or erosion along the coasts?



8. If yes, please describe any changes you've seen, and where they are taking place.

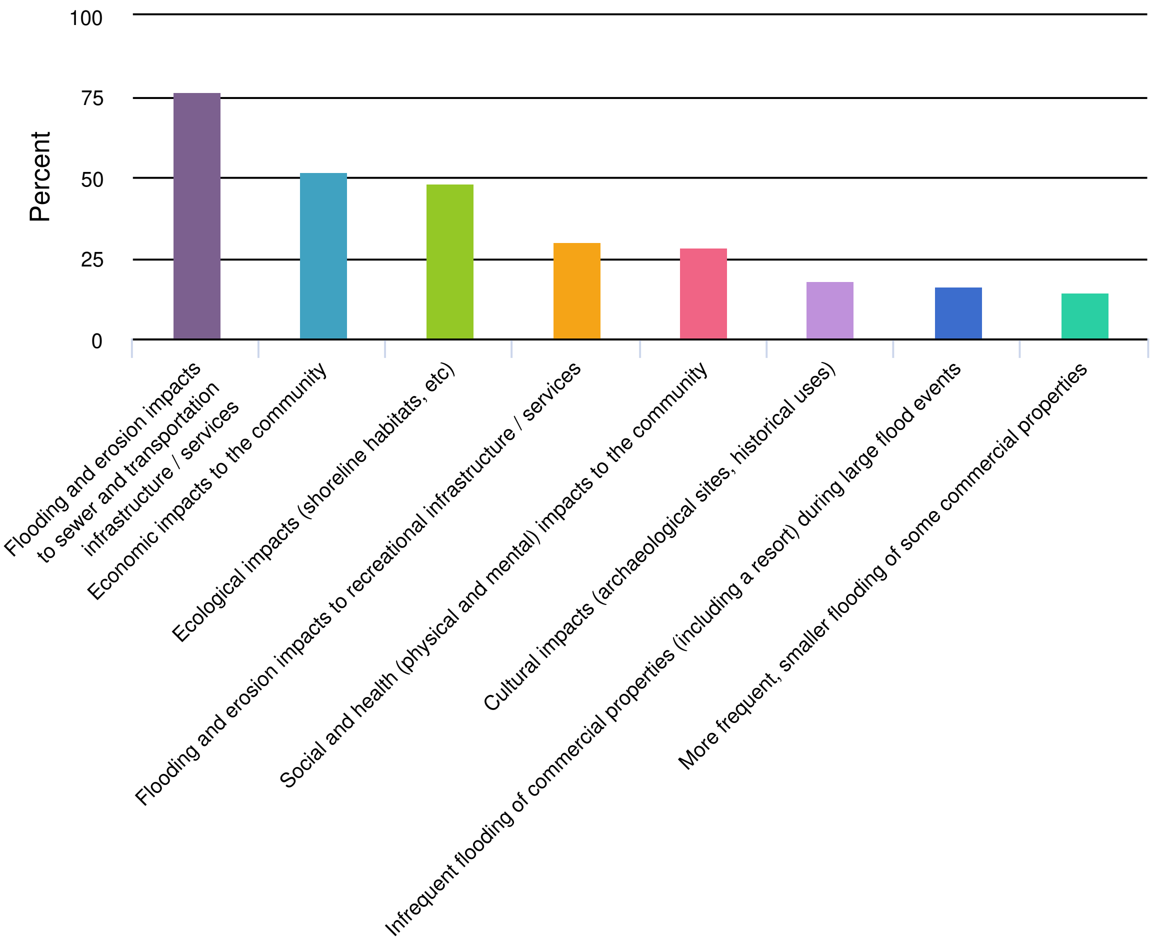


9. Are there any social, economic or cultural changes that have been happening in this region that seem significant to you in recent years ? (e.g. changes in incomes, lifestyle, typical values or behaviours, sense of community, technology, use of coastal areas, connectedness to other places, etc.)



10. If yes, please describe any changes you've seen, and what concerns or excites you about this.

11. In this hypothetical example, what types of impacts would you be most concerned about? (choose up to 3)



12. Please explain why you chose these impacts.

13. In the backgrounder you received, we introduced a range of different ways that we could choose to adapt as sea level rises and flooding and erosion impact coastal areas. In general, which of these alternatives appeals most to you in relation to the example of "The Docks" (choose up to 2)

Value	Percent	Responses
Prevent new building, infrastructure or some land uses from happening in areas at risk of future flooding and erosion impacts (i.e. Avoid)	50.0%	28
Adapt buildings, infrastructure and land uses to allow coastal areas to flood over time without causing negative impacts (i.e. Accommodate)	48.2%	27
Investing in awareness, preparedness and response as a community, so that we can work together well to respond to challenges and bounce back from negative impacts (i.e. Resilience-building)	44.6%	25
Building "green" or artificial barriers to maintain the current location of existing developed areas (e.g. houses, settlements, infrastructure) (i.e. Protect)	30.4%	17
Exploring alternative locations to move homes and infrastructure back from affected shoreline areas (i.e. Managed Retreat)	14.3%	8
I don't know	1.8%	1
Other - Write In	1.8%	1

14. In this hypothetical example, what types of impacts would you be most concerned about? (choose up to 3)

Value		Percent	Responses
Flooding and erosion of access roads and infrastructure servicing the area		58.2%	32
Ecological impacts (heron and other shoreline habitats, etc.)		49.1%	27
More frequent, smaller flooding of homes in first row		27.3%	15
Social and health (physical and mental) impacts to the community		27.3%	15
Flooding of recreational areas (walking trails, parks)		27.3%	15
Economic impacts to the community		25.5%	14
Infrequent but larger flooding for homes in first and second row		23.6%	13
Cultural impacts (archaeological sites, historical uses)		23.6%	13

15. Please explain why you chose these impacts.

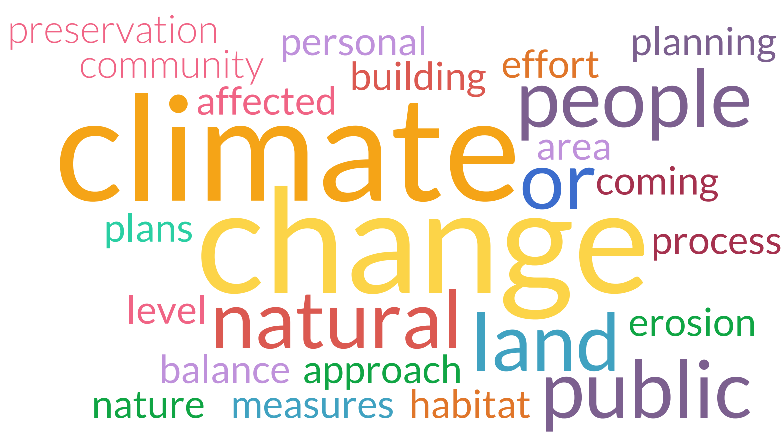
16. In the backgrounder you received, we introduced a range of different ways that we could choose to adapt as sea level rises and flooding and erosion impact coastal areas. In general, which of these alternatives appeals most to you in relation to the example of “Oceanside Living" (choose up to 2)

Value	Percent	Responses
Prevent new building, infrastructure or some land uses from happening in areas at risk of future flooding and erosion impacts (i.e. Avoid)	56.4%	31
Building “green” or artificial barriers to maintain the current location of existing developed areas (e.g. houses, settlements, infrastructure) (i.e. Protect)	40.0%	22
Adapt buildings, infrastructure and land uses to allow coastal areas to flood over time without causing negative impacts (i.e. Accommodate)	40.0%	22
Investing in awareness, preparedness and response as a community, so that we can work together well to respond to challenges and bounce back from negative impacts (i.e. Resilience-building)	32.7%	18
Exploring alternative locations to move homes and infrastructure back from affected shoreline areas (i.e. Managed Retreat)	18.2%	10
I don’t know	3.6%	2
Other - Write In	1.8%	1

17. When choosing between different coastal adaptation actions, which of the following considerations would be most important to you? (Pick your top 5).

Value	Percent	Responses
Intentionally enhancing natural habitats and processes to mitigate impacts of flooding and erosion (actively intervene)	74.1%	40
Providing clear and consistent rules that are enforced for everyone	66.7%	36
Minimizing environmental impacts to shoreline habitats from the options chosen	61.1%	33
Maintaining or increasing public access to the waterfront	37.0%	20
Distributing costs and benefits fairly across time (e.g. current and future generations)	35.2%	19
Allowing natural processes to take their course, for better or worse (get out of the way)	33.3%	18
Ensuring cultural and archaeological sites and uses are protected	31.5%	17
Maintaining individual choice and responsibility for protecting personal property	25.9%	14
Distributing costs and benefits fairly across everyone in the community	25.9%	14
Do what it takes to keep the water from advancing further inland	16.7%	9
Having the ability to manage financial risks through insurance	16.7%	9
Avoiding any increase in property taxes or other fees	14.8%	8

18. What else, if anything, do you feel is important to consider when choosing between different coastal adaptation actions?



19. When you imagine the coastal areas in this region one or two generations into the future (e.g. 20-50 years from now)...

What is one thing you feel we must preserve or maintain for the benefit of future generations?

What is one thing you feel we must restore or improve for the benefit of future generations?

What is one thing you feel we could lose or let go of, that would be of less consequence to future generations?