

# CAMPBELL RIVER

## Sea Level Rise

### Action Plan



City of  
Campbell  
River

February 10, 2020



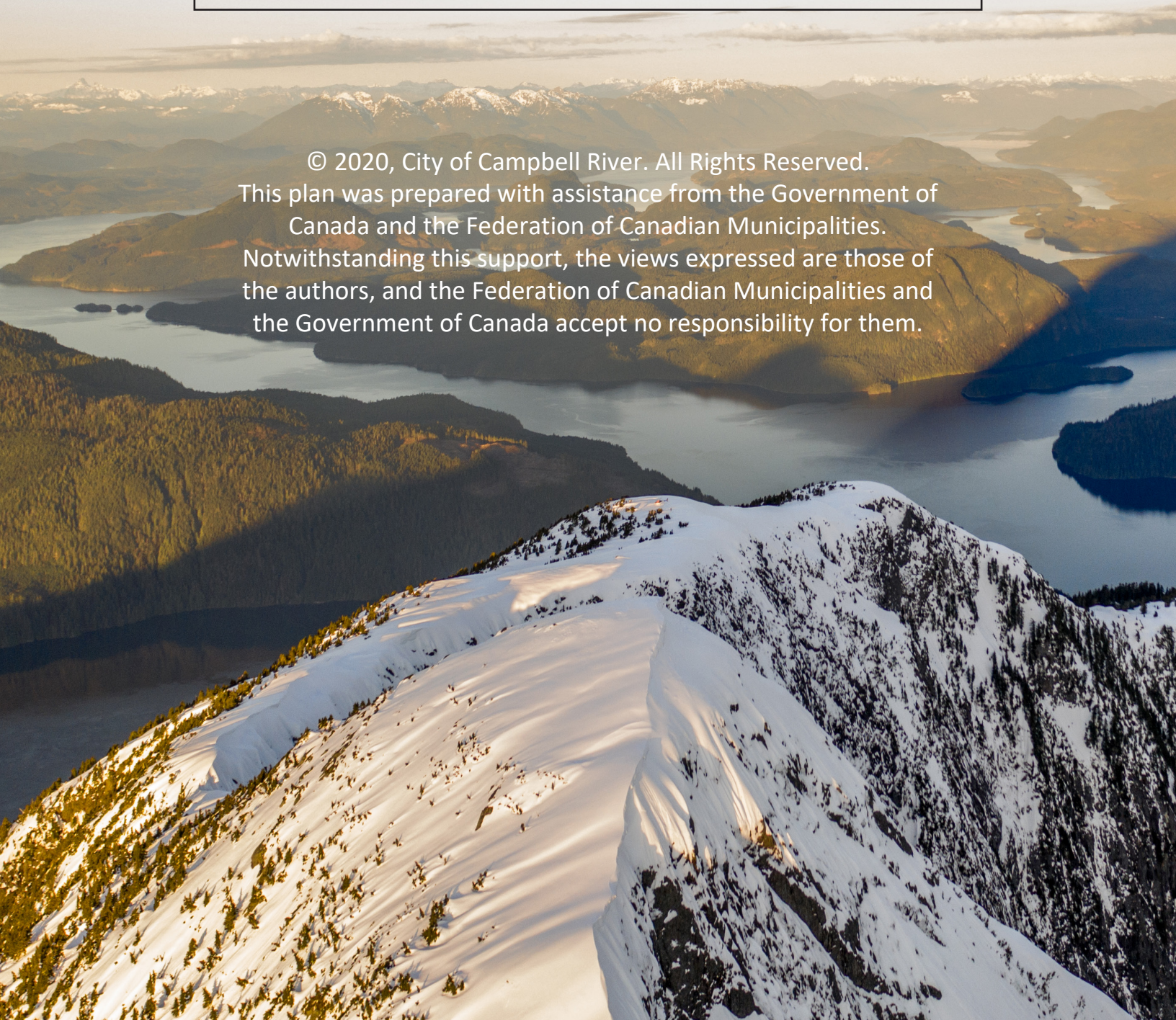
## ACKNOWLEDGMENTS

The City of Campbell River thanks the Federation of Canadian Municipalities, the Union of British Columbia Municipalities and the Pacific Institute for Climate Solutions, for funding support. Without their contributions the Sea Level Rise Action Plan would not have been possible. We also appreciate the photography partnership with Destination Campbell River.

The community of Campbell River has grown and prospered thanks to the natural abundance of this region, the traditional territory of the Laichwiltach people.

© 2020, City of Campbell River. All Rights Reserved.

This plan was prepared with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are those of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.





# TABLE OF CONTENTS

- Executive Summary** ----- 5
  
- 1.0 Background And Context** ----- 6
  - 1.1 Introduction ----- 7
    - 1.1.1 What is a Sea Level Rise Action Plan?* ----- 8
    - 1.1.2 Why a Sea Level Rise Action Plan?* ----- 8
  - 1.2 Context ----- 9
    - 1.2.1 Policy Context* ----- 9
    - 1.2.2 Community Context* ----- 10
  
- 2.0 The Science of Sea Level Rise** ----- 12
  - 2.1 Global Sea Level Rise ----- 13
  - 2.2 Local Sea Level Change ----- 14
  - 2.3 Provincial Guidance ----- 15
  
- 3.0 Understanding and Preparing** ----- 16
  - 3.1 Understanding ----- 17
    - 3.1.1 Campbell River Rising Seas* ----- 17
    - 3.1.2 Technical Assessment* ----- 18
    - 3.1.3 Risks of Inaction* ----- 20
  - 3.2 Preparing ----- 21
    - 3.2.1 Regulation* ----- 21
    - 3.2.2 Built Adaptation* ----- 22
    - 3.2.3 Adaptation Scale* ----- 23
  
- 4.0 Priority Actions** ----- 24
  - 4.1 Regulation ----- 26
    - 4.1.1 Implement Flood Construction Levels* ----- 27
    - 4.1.2 Additional Regulatory Updates* ----- 27
    - 4.1.3 Policy Updates* ----- 28
    - 4.1.4 Finances* ----- 29
  - 4.2 Technical Work/Capital Projects ----- 30
    - 4.2.1 Ecological* ----- 31
    - 4.2.2 Campbell River estuary* ----- 32
    - 4.2.3 Downtown Area* ----- 32
    - 4.2.4 General* ----- 32

- 4.3 Capacity Building ----- 34
  - 4.3.1 *Internal/Stakeholder Capacity Building* ----- 35
  - 4.3.2 *Neighbourhood scale adaptation* ----- 35
  - 4.3.3 *Community Engagement/Consultation* ----- 36
- 4.4 Administration ----- 37
- 4.5 Adaptation Partnering ----- 39
  - 4.5.1 *First Nations Partnering Program* ----- 40
  - 4.5.2 *Adaptation Partnering Strategy* ----- 40
- 4.6 Priority Actions Summary Table ----- 41
- 5.0 References** ----- 44
- Appendix A** ----- 47



## EXECUTIVE SUMMARY

Campbell River lies on the east coast of Vancouver Island adjacent to the Strait of Georgia. At the northern end of the city is the Campbell River, a heritage river that provides important spawning habitat for many species of Pacific salmon. The Campbell River meets the sea at the Campbell River estuary, a valued ecological and recreation area. The community benefits from its location on the coast and the services provided by the diverse local ecosystems. However, living on the coast also presents challenges. Intense storms bring high winds and waves that cause flooding, erosion and damage to property and infrastructure. As climate change causes global average sea level to rise, these risks are expected to increase and new challenges will arise.

In 2017, the City of Campbell River launched the multi-year planning initiative *Campbell River Rising Seas*, to investigate the risks to the community from 0.5m and 1m of global average sea level rise (SLR). Numerous technical studies were completed. The results identified land at risk of flooding during intense storms with rising sea levels, recommended flood construction levels for vulnerable areas, and feasible adaptation options to address risks. An extensive public engagement program was developed to increase understanding about sea level rise and investigate community values and priorities.

The Sea Level Rise Action Plan is the final component of the *Rising Seas* project. This is a long-term planning tool to guide community wide adaptation over the next 30 years. It summarizes the risks to the community if no action is taken, identifies priority actions to address risks, and provides a mandate for future policy, regulatory, and bylaw changes. The priority actions area generally into five categories:

- ▶ **Regulatory/Policy**
- ▶ **Technical studies/Capital works**
- ▶ **Capacity building**
- ▶ **Administration**
- ▶ **Adaptation partnering**

Sea level rise is a gradual process, but it is also accelerating and the exact pace at which it will occur throughout the rest of this century is uncertain. Proposed implementation time lines address this uncertainty by strategically planning priority actions to ensure:

- ▶ Future development and land use decisions in vulnerable areas consider sea level rise
- ▶ Large scale adaptation projects are incorporated into other planned construction, or implemented as needed, allowing time to assess the pace of sea level rise
- ▶ Relevant scientific information is monitored so that plans can be updated if the data



# BACKGROUND

&

# CONTEXT







## 1.1 INTRODUCTION

Since time immemorial, the coastal and riverine ecosystems of Campbell River have provided not only a means of survival, but also a way of life for residents. Prior to European colonization, the Laich-wil-tach First Nations inhabited the lands surrounding the Campbell River, relying on the salmon rich waters as a source of food and transportation. When Europeans settled here, the networks of rivers facilitated the development of the logging industry, while the sea remained the only means of access to the area for decades. Over the years, the importance of these ecosystems became more apparent, both commercially and recreationally (figure 2). Fishing enthusiasts flocked to the “Salmon Capital of the World” and the Discovery Passage, between Campbell River and the Discovery Islands, became part of the busy Inside Passage shipping route.

Today much of Campbell River is concentrated on lands only four metres above sea level, and the urbanized coast extends more than 15 kilometres. This provides many benefits like beautiful views, public beach access, and recreation opportunities.

Living so close to sea level also presents challenges. Intense winter storms can cause coastal erosion and flooding in low lying areas, risks that will increase with climate change and sea level rise. Also, the intense urbanization of the coast has degraded foreshore ecosystems, and those that remain will be under increased pressure due to sea level rise. Campbell River is preparing to adapt to future sea level rise. We are taking proactive measures to identify what needs to be done to protect important natural assets like the foreshore and the coastal ecosystems we rely on.



### 1.1.1 What is a Sea level Rise Action Plan?

Campbell River’s sea level rise action plan (SLRAP) is the foundation that will guide community wide sea level rise adaptation over the next 30 years. It outlines the risks to the built, natural, and social environments, identifies actions to address these risks, and outlines strategic implementation.

Overarching objectives:

- ▶ **Ensure sea level rise is considered in all future decision making and infrastructure projects**
- ▶ **Facilitate a strategic approach to sea level rise adaptation**
- ▶ **Encourage foreshore protection that preserves and/or enhances foreshore ecology**
- ▶ **Increase community resilience to climate change impacts**



Figure 2. Coastal ecosystems provide recreational opportunities, a means of food, and income. Oct 2016 (top), Sept 2001 (bottom)

### 1.1.2 Why a Sea Level Rise Action Plan?

Many variables contribute to the rate of sea level rise, and we cannot predict exactly how high, and how soon our shoreline will be affected. However, higher seas will significantly increase the flood risks already experienced by the community, if no action is taken. The SLRAP is a long-term planning tool that is expected to be implemented over the next 30 years, allowing the City to monitor how sea level rise progresses and update the plan accordingly. Adaptations are planned strategically, with larger scale adaptation projects timed to be incorporated into other construction projects, or constructed one phase at a time. Adaptation will require the collaborative effort of many different City departments, other organizations, and community members. By laying out priority actions for the next several decades, the City has time to coordinate different groups, pursue funding, and obtain necessary permits.

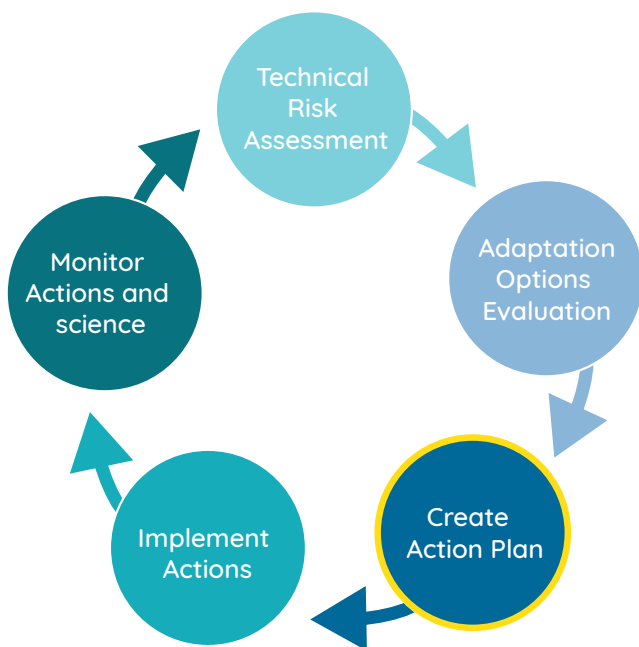


Figure 1. General framework for the Campbell River sea level rise planning process



## 1.2 CONTEXT

### 1.2.1 Policy Context

The City has many plans, regulations, bylaws, and policies that contribute to the management and development of the foreshore and adjacent inland properties. The following table summarizes City documents to update in anticipation of future sea level rise (SLR).

Table 1. Summary of City documents that should be updated to account of for the impacts of SLR.

Item	Purpose	Relevance to Sea Level Rise
Official Community Plan (OCP) (updated 2017)	Establishes a 50-year vision for the community, setting objectives and policies to guide land use planning and management.	Land uses and guidelines for development in vulnerable areas may need revision. Settlement patterns may need to change.
Marine Foreshore Habitat Assessment and Restoration Plan (NHC, 2011)	Assesses the natural processes and ecosystems of Campbell River's shoreline to inform foreshore management.	Existing risks to coastal ecosystems will change and in some cases increase.
Integrated Storm Water Management Plans (Urban Systems, 2004 - 2006)	Summarizes recommendations for storm water management across the city, and provides a framework for prioritizing among recommendations.	The burden on storm water systems will increase, worsening existing issues and possibly creating new challenges.
Campbell River Estuary Management Plan (Qu'West Consulting Services, 2002)	Provides a framework for managing and restoring the Campbell River estuary.	Estuarine ecosystems and the services they provide will be affected.
Waterfront Property Acquisition Strategy (2015)	Presents a framework for prioritizing waterfront lots that could be acquired by the City in the future.	Consider incorporating vulnerability to SLR and human hazard when determining priority parcels.
Refresh Downtown Strategy (2017)	Provides a conceptual design framework for the downtown area to guide future development, and identifies priority projects for the downtown.	Provides an opportunity for adaptation to be incorporated into planned construction projects.
Zoning Bylaw (2019)	Defines permitted development and land use across the city.	Certain land uses may no longer be appropriate in vulnerable areas.
Strategic Parks Plan (2012)	Provides direction to improve the standard of parks in Campbell River.	Adaptation may be needed for parks adjacent to the waterfront to ensure their longterm use.

Item	Purpose	Relevance to sea level rise
Climate Adaptation Plan (anticipated 2020)	Identifies Campbell River’s vulnerability to climate change and actions to address the associated risks.	SLR is one of the risks that Campbell River will face as a result of climate change.
Subdivision and Development Servicing Bylaw (2010)	Regulates the subdivision of land and the provision of works and services in the subdivision of land.	Subdivision of land in vulnerable areas may require further restrictions, or may no longer be desirable.
Tye Spit Lease Area Plan (2014)	Defines the terms of lease agreements within the Tye Spit Lease Area.	This document is updated as Development Permit Guidelines and the Zoning Bylaw are updated — which should be updated to anticipate future SLR
Management Plan Baikie Island Reserve (2002)	Provides direction for the restoration and stewardship of the Baikie Island Reserve in the Campbell River estuary.	Ecosystems and species within the Reserve will be under increased pressure, and management of vulnerable habitat will need to be updated.





### 1.2.2 Community Context

Sea level rise planning in Campbell River is a complex process. With more than 15 kilometres of urbanized coastline, the risks and impacts are as many and varied as the options that exist to address them. Technical analysis has identified these risks and the range of feasible solutions. Selecting the most suitable option requires understanding community values and priorities. Public engagement has been an important part of the City's sea level rise planning, and community feedback has helped guide recommended adaptation options for Campbell River. An important part of public engagement is equipping the community with knowledge. Understanding the scientific basis of sea level rise and projected effects in Campbell River, helps people make informed decisions to benefit current and future generations.

To facilitate community understanding, the City developed sea level rise Primers on:

- ▶ **The scientific basis of sea level rise**
- ▶ **Projected risks in Campbell River**
- ▶ **Options available to the community**

In addition, community members attended more than 10 hours of public workshops (Figure 3). Participants learned about sea level rise, engaged in discussions about adaptation, and examined the pros and cons of different options. The City also ran a youth engagement program and presented to local First Nations. A summary of the public engagement process can be found in Appendix X of the Technical Background Report available on the City's website at<sup>1</sup>



Figure 3. Photos from the public workshops held for the City's sea level rise planning project  
1. <http://www.campbellriver.ca/planning-building-development/sea-level-rise/background>



An aerial photograph showing a dense forest of evergreen trees on the left, a rocky beach in the middle, and clear blue water on the right. The text is overlaid on the image in white boxes.

THE SCIENCE

OF

SEA LEVEL RISE



## 2.0 THE SCIENCE OF SEA LEVEL RISE

### 2.1 GLOBAL SEA LEVEL RISE

Since the end of the 19th century scientists have been recording sea level in various locations, using tide gauge and, later, satellite measurements. Observations of changing sea level over time and significant long-term trends have been separated from natural variability. Scientists have determined that since the beginning of the 20th century global average sea level has been rising at an accelerating pace (IPCC, 2019; Cazenave, Palanisamy, & Alblain, 2018), and it is the overwhelming consensus of the scientific community that this phenomenon is largely due to human induced climate change (Cook et al., 2013; Dangendorf et al., 2015; Rahmstorf 2007).

Climate change is causing the global average temperature to rise rapidly which affects ocean water volumes in two major ways:

1. Thermal expansion of water: when water is heated it takes up more space
2. Loss of land based ice mass due to increased melting

Sea level rise occurs slowly in response to rising temperature. Even if we drastically reduce our green house gas emissions tomorrow, sea levels will continue to rise for many decades (Rahmstorf, 2007). **The question is not whether sea levels will rise in the future, but how much they will rise, and how rapidly.**

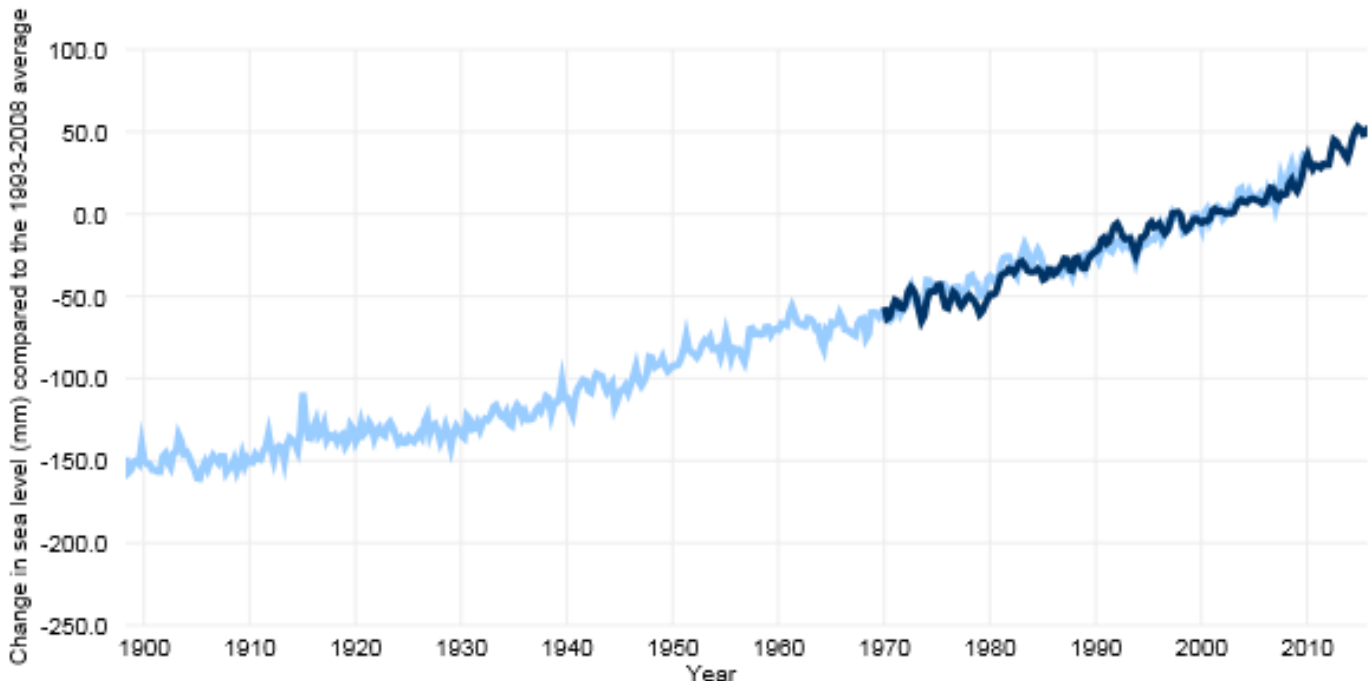


Figure 4. Global average change in sea level from 1900 - 2010. light blue represents data from tied gauge measurements while dark blue represents data from satellite measurements. Graph taken from NOAA<sup>1</sup>

1. National Oceanic and Atmospheric Association

## 2.2 LOCAL SEA LEVEL CHANGE

To determine the potential effect of climate change on sea level in a given area two main factors must be considered:

- ▶ **Projected global sea level rise**
- ▶ **Regional and local factors**

Campbell River is fortunate to be located in an area where land weighed down by glaciers during the last ice-age is slowly rising back up. Scientists describe this as uplift due to glacial isostatic rebound. This offsets some of the sea level rise driven by climate change.

Currently, Campbell River rises at a rate of approximately 4 millimetres every year, while global average sea level rose approximately 3.6 millimetres per year between 1993 and 2015 (IPCC, 2019). To date, local uplift has kept slightly ahead of sea level rise. With the rate of global sea level rise accelerating, in the very near future the rate of sea level rise may be expected to surpass land uplift. This means Campbell River would experience a net increase in local sea level. Local uplift was accounted for in all of the sea level rise studies for Campbell River.

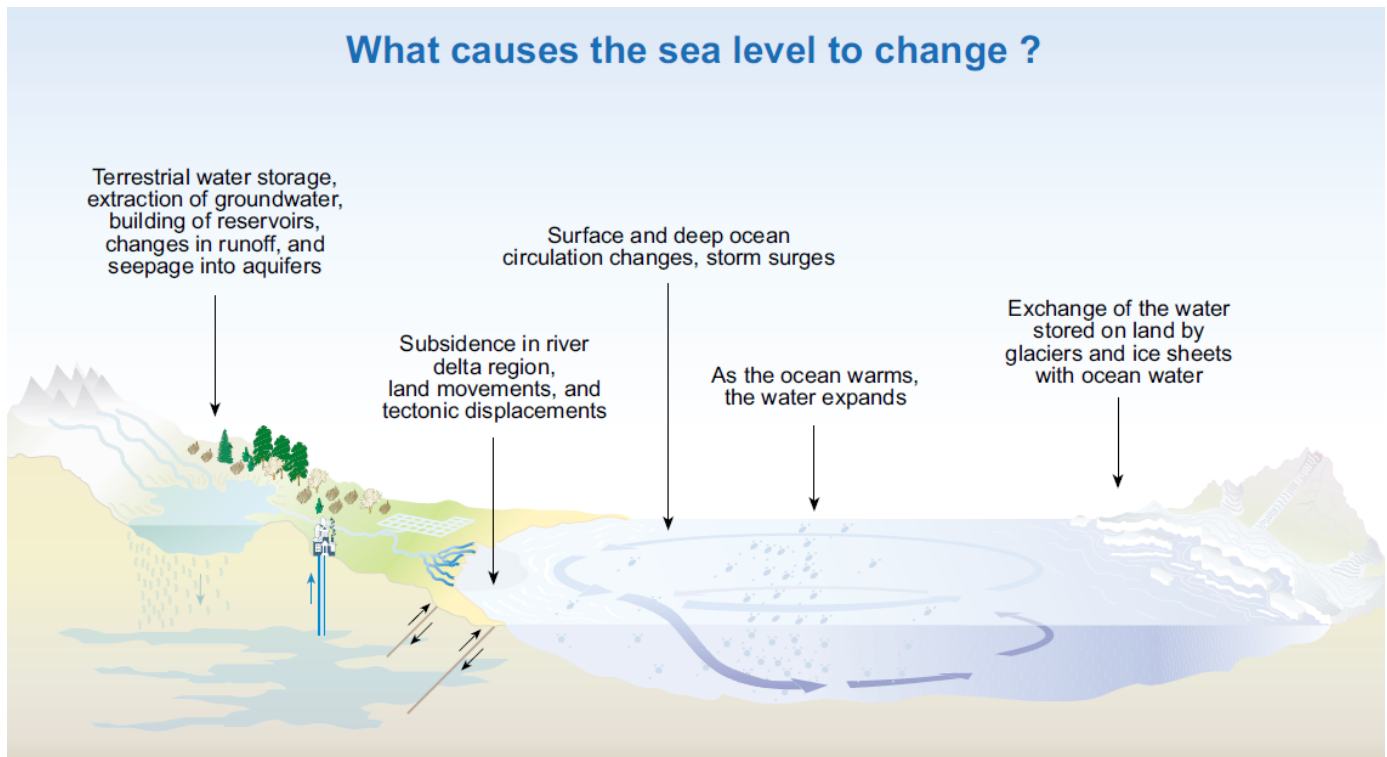


Figure 5. Global, Regional, and Local Factors that influence changes in sea level IPCC<sup>1</sup> Third Assessment Report: Synthesis Report 2001.

1. The Intergovernmental panel on Climate Change is an intergovernmental body of the United Nations that is dedicated to providing regular scientific assessments on the current stat of knowledge about climate change.



### 2.3 PROVINCIAL GUIDELINES

The Province of B.C. recommends municipalities adopt the projection in figure 6 as a guideline for sea level rise planning. The recommended global mean sea level rise allowances have been selected on the high end of projections in the short term and below average projections for the distant future. This ensures that communities are well prepared for the near future, while allowing time to assess the progression of sea level rise and monitor emerging science, revising estimates if necessary. Figure 6 is a projection based on likely scenarios however, it is possible SLR could exceed the upper bounds of the projection. Also, recent scientific information suggests this projection may be conservative, even for likely SLR scenarios (Sweet et al., 2017; The Arlington Group Planning + Architecture Inc., 2013; Ausenco Sandwell, 2011). Acknowledging the potential for significant sea level rise in the future, municipalities can adjust their land use and settlement patterns to avoid significant risks.

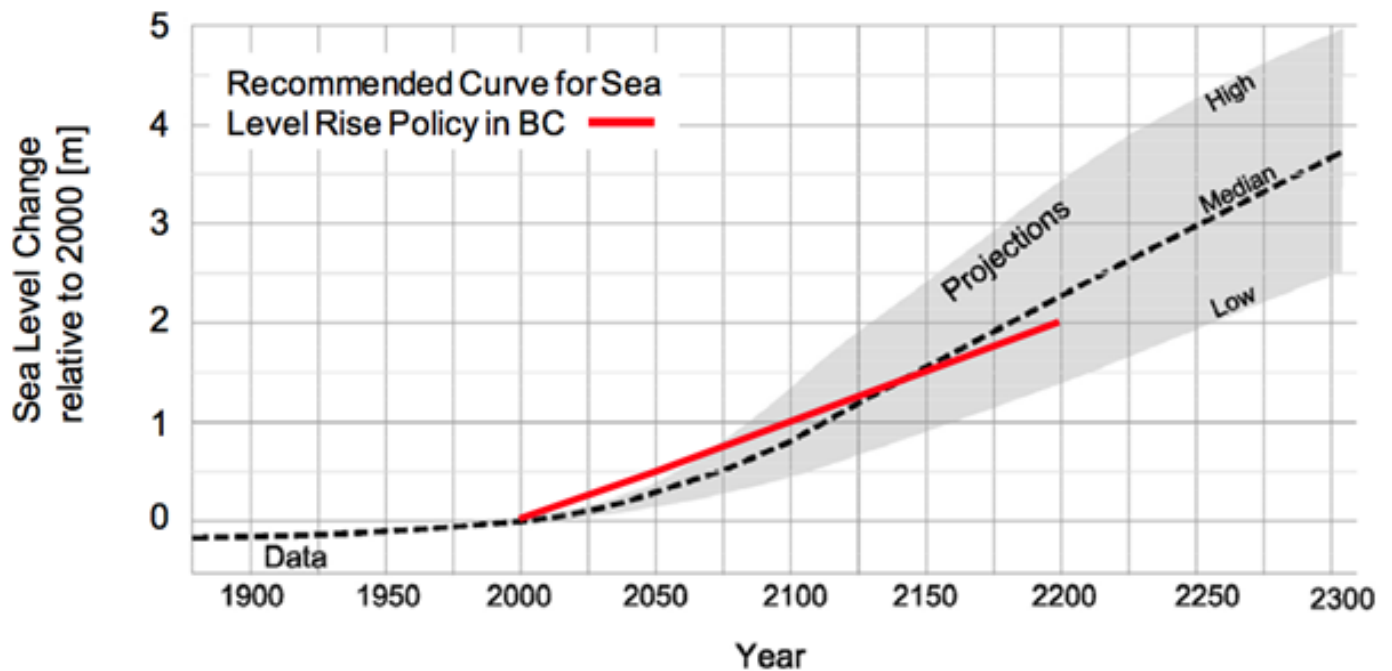


Figure 6. Sea level rise planning curve recommended by the Province of British Columbia Ausenco Sandwell, 2011.





UNDERSTANDING

&

PREPARING



### 3.1 UNDERSTANDING

As a seaside community, Campbell River already deals with risks associated with coastal storms such as, flooding, erosion, and damage to infrastructure and property. Sea level rise is expected to increase existing risks and in some cases introduce new hazards.

#### Potential impacts of sea level rise

- ▶ Increased frequency, intensity, and duration of flooding events
- ▶ Salt water contamination in soil and ground water
- ▶ Damage to infrastructure and public/private property
- ▶ Interruptions of services/business operations (ex. emergency services)
- ▶ Coastal Squeeze that significantly reduces the intertidal zone, an important ecosystem that buffers the coast against storms (Fig. 7)

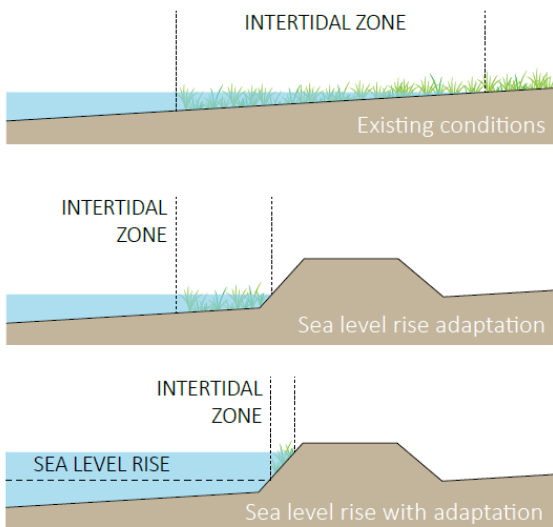


Figure 7. Coastal squeeze due to sea level rise



Figure 8. Damage to Ostler park after the March 12, 2012 storm, where winds gusted up to 137 km/hr.



Figure 9. Flooding downtown during the January 2018 king tide. High ocean water levels prevent water from flowing into the sea through storm drains.

#### 3.1.1 Campbell River Rising Seas

In 2017, the City launched its sea level rise planning initiative ***Campbell River Rising Seas***. The main objectives of the initiative were:

1. Complete a comprehensive technical assessment of the risks to the built, natural, and social environment due to 0.5m and 1.0m of sea level rise
2. Implement an extensive public education and engagement program to discuss community values and priorities

### 3.1.2 Technical Assessment

Sea level rise is a gradual process that, initially, will only be noticeable during brief and infrequent circumstances. The impact of sea level rise may be negligible on calm days, however, when extreme weather events coincide with high tide, even a few centimetres of sea level rise can dramatically increase community risks. Technical studies were commissioned to investigate the impacts of a one-in-200 year storm event in combination with high tides and sea level rise. The entire coastline was studied at a high level, while more detailed analyses were carried out for the Campbell River estuary, Downtown 3.5 acre site and the Painter Barclay, Downtown, Sequoia Park, and Willow Point areas. The results of the studies outline the risks to the community and environment, if no action is taken, provide guidance for future land use planning, and establish a technical foundation for adaptation in Campbell River. The following table summarizes the technical studies carried out for the *Campbell River Rising Seas* initiative.

Table 2. Summary of technical studies

Study	Purpose	Key Findings	Lead Consultant
Downtown Waterfront Site Report (NHC, 2018a)	Explores risks to the proposed 3.5 Acre Downtown Waterfront Site development	<ul style="list-style-type: none"> <li>Flood construction level<sup>1</sup> (FCL) estimate - additive approach is more conservative than joint probability approach</li> <li>current, 2050, and 2100 FCLs</li> <li>The proposed development is expected to experience flooding during one in 200 year events with depths of 0.6m (2050) and 1.8m (2100)</li> <li>Appropriate site drainage, building setbacks, and shoreline protection could effectively reduce the risk of flooding on site</li> </ul>	Northwest Hydraulic Consultants (NHC)
Estuary Assessment (NHC, 2018b)	Investigates the effects of sea level rise, in combination with extreme weather and tides, and river discharges, in and around the Campbell River and estuary	<ul style="list-style-type: none"> <li>Flood extent upstream of the HWY 19 bridge is governed by discharges from the John Hart Dam and Quinsam River</li> <li>Two low areas of particular concern along the Campbell River are, the area near the Campbell River Lodge on the south bank of the river, and the north bank of the river upstream of the HWY 19 bridge</li> <li>A significant amount of people and infrastructure are vulnerable to flood risks after 1m SLR</li> </ul>	NHC

1. Flood construction level (FCL) is the required minimum elevation for the base of a floor structure for habitable floors or for the storage of valuable goods. FCL includes the Design Flood Level, plus Wave Effects, and a Freeboard allowance.



Study	Purpose	Key Findings	Lead Consultant
High Level Coastline Assessment (NHC, 2019a)	Assesses the Campbell River coastline, from Ocean Grove to Duncan Bay. The coast is broken into 14 representative sections and high level FCL estimates for 0.5 and 1m of SLR are determined.	<ul style="list-style-type: none"> <li>FCLs (excluding land sheltered by breakwaters or vertical seawalls) ranged from 4.2m to 6.3m geodetic and 4.5m to 6.6m geodetic for the 0.5m and 1m SLR scenarios respectively</li> <li>FCLs in the Painter Barclay region should be applied with caution. Risks to infrastructure atop the coastal bluff due to erosion associated with SLR should be taken into account</li> </ul>	NHC
Four Key Sites Report (NHC 2019b)	An in depth analysis of effects in four areas: Painter Barclay, Downtown, Sequoia Park, and Willow Point. Adaptation options are modeled in each area to determine feasibility.	<p><b>Painter Barclay:</b></p> <ul style="list-style-type: none"> <li>Beach profile greatly affects wave run up elevations; beaches with a steep bluff at the top have higher wave run-up elevations</li> <li>The Painter Barclay bluff is at risk of significant erosion and subsequent recession</li> </ul> <p><b>Downtown</b></p> <ul style="list-style-type: none"> <li>Without adaptation, Ostler Park is vulnerable to significant flooding after 1m SLR</li> <li>After 1m SLR and no adaptation, waves during a design storm significantly overwhelm the shoreline along Hwy 19A north of the BC Ferries terminal</li> </ul> <p>shoreline along this reach</p> <p><b>Willow Point</b></p> <ul style="list-style-type: none"> <li>Improvements and maintenance of existing rock armouring will continue to protect land between Willow Creek and Jaycee Park</li> <li>Offshore breakwaters combined with beach nourishment is a feasible adaptation north of Willow Creek that provides ecological benefits and public foreshore access</li> </ul>	NHC
Ecosystems and Species at Risk (Madrone, 2019)	Assesses the vulnerability of Campbell River’s natural environment to sea level rise, focusing on the risks to ecosystem services and rare plants and ecosystems.	<ul style="list-style-type: none"> <li>Much of the foreshore ecology has experienced significant disturbances due to human caused foreshore hardening and development</li> <li>A significant number of ecosystems and species in the estuary will be affected, especially if they’re not able to migrate into new locations</li> <li>Forage Fish Indicator Sites had sediments appropriate for forage fish spawning but largely lacked functioning backshore vegetation to protect eggs from dessication</li> <li>Two private wells in the south of town are at significant risk of saltwater intrusion after 1m of SLR</li> <li>Many contaminated sites are at risk of inundation due to 0.5m and 1m of SLR</li> </ul>	Madrone

### 3.1.3 Risks of Inaction

Technical studies identified a significant risk to the community from 0.5m and 1m of SLR, if no action is take. After 1m SLR, intense storm events could see significant, temporary flooding in the downtown (Figures 10 & 11). During heavy rainfall events, heavy river flows cause riverine flooding which contributes to the downtown flood risk (NHC, 2018b).



Figure 10. Projected downtown flooding during a one in 200 year storm after 1m SLR if no action is take. Coastal wave effects not shown. Image from Primer I (Lanarc 2018).

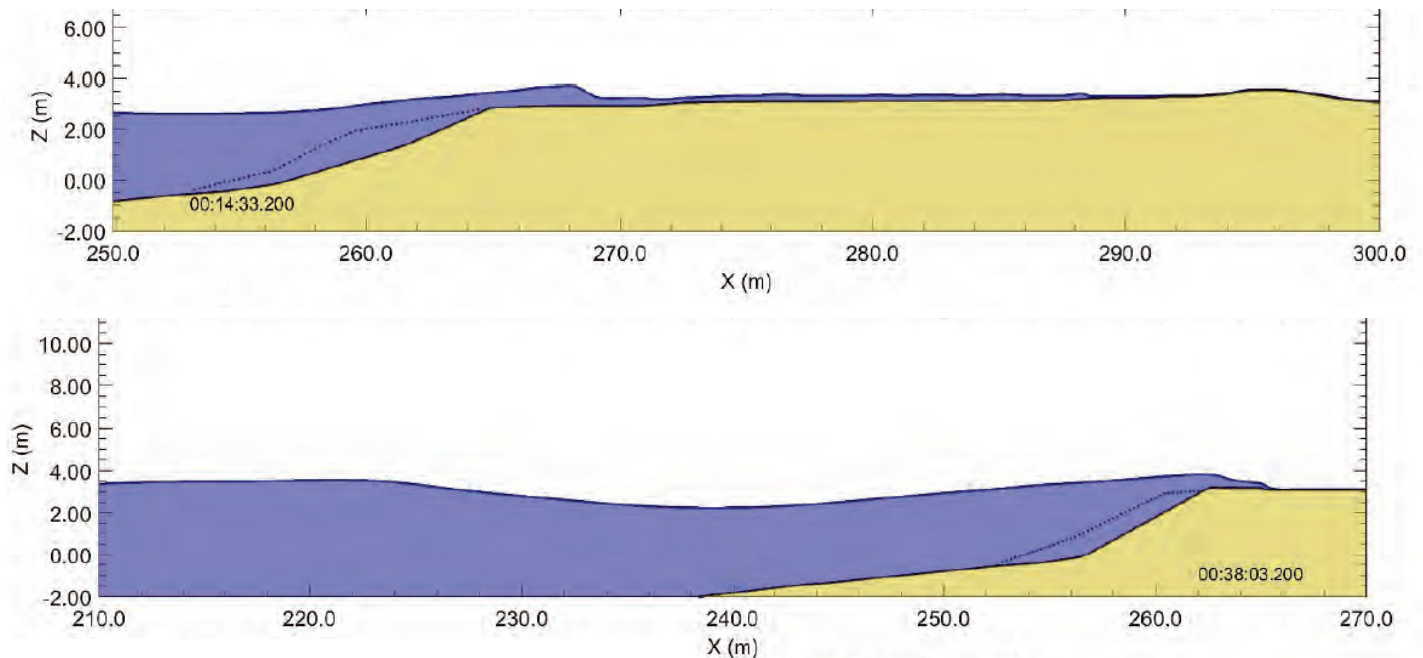


Figure 11. Computer modeling indicates a that waves would significantly overwhelm the shoreline at Ostler Park (top) and along highway 19A (bottom) just north of the BC Ferries terminal, during a one in 200 year storm after 1m SLR if no action is taken.



## 3.2 PREPARING

With over 15 kilometres of coastline no single solution is appropriate for all of Campbell River. Adapting to sea level rise will likely involve built solutions that defend inland areas from coastal hazards, such as those already being incorporated into the Highway 19A upgrades. Changes to regulations and policies that guide development and land use on the foreshore will also be necessary. The Province of BC separates adaptations into four categories based on their methods:



**Protect:** barriers are constructed against flood waters



**Accommodate:** human activities, buildings and infrastructure are modified to accommodate higher seas



**Retreat:** over time, people and infrastructure in floodplains are relocated



**Avoid:** development within floodplains is limited

### 3.2.1 Regulation

Existing waterfront property will be affected by sea level rise and plans for new construction need to anticipate future sea level rise. The City will update existing policies, regulations and bylaws that guide development in areas vulnerable to sea level rise. Amendments will be made to Development Permit Area Guidelines to illustrate how flood protection, setbacks, and shoreline designs could address flood safety and property objectives while reducing harm to the environment. New regulatory tools will also be created, such as a floodplain bylaw. The Bylaw will designate lands that will be affected by sea level rise as floodplain and establish flood construction levels within floodplains. Other existing policy documents will need to be updated to incorporate sea level rise considerations, as outlined in Table 1 on page 7.

The City's existing Foreshore Development Permit Area Guidelines support the most natural approach to shoreline protection. However, once sea level rise is taken into account this is no longer a feasible option in some locations.

### 3.2.2. Built Adaptation

Much of the Campbell River Coastline has been built up with rock armouring for protection, often referred to as a “hard” approach. This can reduce flood risks associated with coastal storms, but, it is harmful to foreshore ecosystems and can impede public access to the water’s edge. If designed improperly, intense storms can undermine rock armouring compromising its ability to protect the foreshore. This has occurred in Campbell River (figure 12). Shoreline adaptations that incorporate natural features can provide protection from coastal storms, along with many other benefits such as, improved foreshore ecology, carbon sequestration and better foreshore access. In many areas it may not be feasible to implement such soft shore approaches alone, particularly where space is limited or the coast is too exposed to storm waves. Hard approaches can be used to reduce incoming waves so that more natural approaches can be used along the shore, as in Figure 13.



Figure 12. Rock armouring damaged by powerful waves at Osler Park during the March 12, 2012 storm (top) and soft shore restoration work that will provide natural shoreline protection, being implemented at Adams Park (bottom).

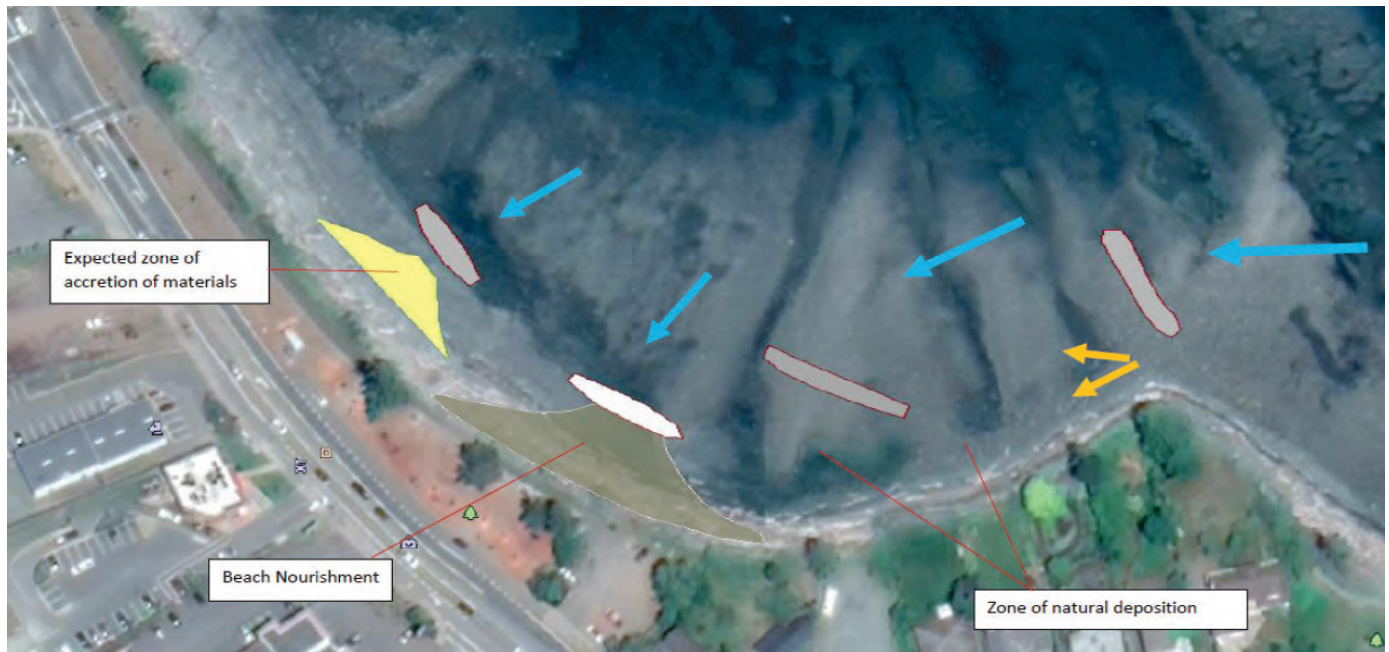


Figure 13. Conceptual adaptation design for Adams Park that employs “hard” engineered off shore breakwaters to support a more natural approach, beach nourishment, along the shore, NHC 2019b.



### 3.2.3 Adaptation Scale

Adaptation methods are broadly divided into two groups based on scale.

**Neighbourhood scale** (figure 14) covers larger areas of coastline and often involves changes to the foreshore to protect foreshore habitats and inland areas. Aims are achieved by:

- ▶ Stabilizing coastal lands from erosion reducing wave energy
- ▶ Stopping the flow of floodwaters
- ▶ Removing development from high-risk locations.



Figure 14. Neighbourhood scale adaptation options

**Building/lot scale** strategies (figure 15) aim to prevent damage to buildings, property within buildings, and to occupants of buildings. Goals can be achieved by:

- ▶ Keeping flood waters out of buildings or lots
- ▶ Avoiding flood waters by raising the elevation of land
- ▶ Preparing structures to accommodate occasional flooding.

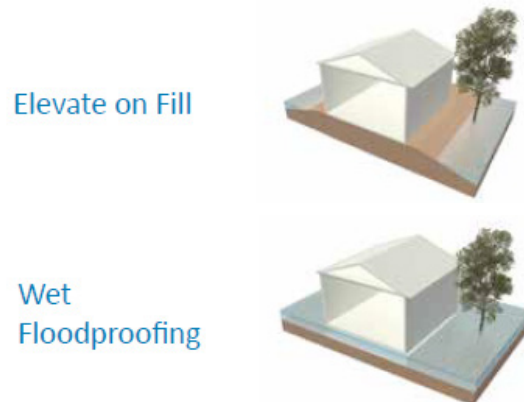


Figure 15. Building/lot scale adaptation options

### Challenges

Neighbourhood and building/lot scale adaptations pose unique challenges. Large scale adaptations that alter the foreshore will require permits or tenures from other regulatory agencies, and potentially riparian rights granted by inland property owners. In some cases, building/lot scale adaptation on one property may negatively affect adjacent properties that re not modified in the same way. Adaption will vary according to many factors, including whether land, or assets being protected, are public or privately owned (map of City owned land vulnerable to sea level rise found in Appendix A).



PRIORITY

ACTIONS





## 4.0 PRIORITY ACTIONS

Sea level rise is a gradual process that will occur over many decades, but action is still required now to reduce risks. By preparing early, the City of Campbell River is able to plan adaptation strategically, allowing time to re-assess the pace of local sea level rise and monitor new relevant scientific information prior to implementing major projects. When possible, adaptations will be scheduled to correspond with other planned construction projects, to reduce costs and increase efficiency.

The slow pace of sea level rise provides some time in the short term for increasing community awareness and planning for funding, tenures, and partnership opportunities. It is important that plans for new infrastructure and buildings anticipate the effects of ongoing sea level rise. Severe and damaging storms could still happen at any time.

Priority actions address anticipated risks associated with sea level rise over the next 30 years.

**The priority actions are broken down into five categories:**

- A. Regulation/Policy**
- B. Technical Studies/Capital Projects**
- C. Capacity Building**
- D. Administration**
- E. Adaptation Partnering**

If the pace of projected sea level rise changes, new relevant scientific data becomes available, or opportunities to integrate with other construction arise, the phasing and timing of actions can be adjusted accordingly.



## 4.1

### A. REGULATION/POLICY

The Province of British Columbia’s Flood Hazard Area Land Use Management Guidelines (BC Ministry of Water, Land and Air Protection, amended 2018) call for coastal municipalities to incorporate projections for sea level rise over the next century into their requirements for buildings, subdivisions, and zoning.

The City currently has a suite of regulatory and policy documents that guide development along the foreshore — to protect human life and property, and reduce harm to the natural environment. These documents must be updated so that new construction and land uses in vulnerable areas account for the projected change in sea level. In addition, City policies, plans and strategies must also incorporate sea level rise adaptation into budgeting and maintenance frameworks.

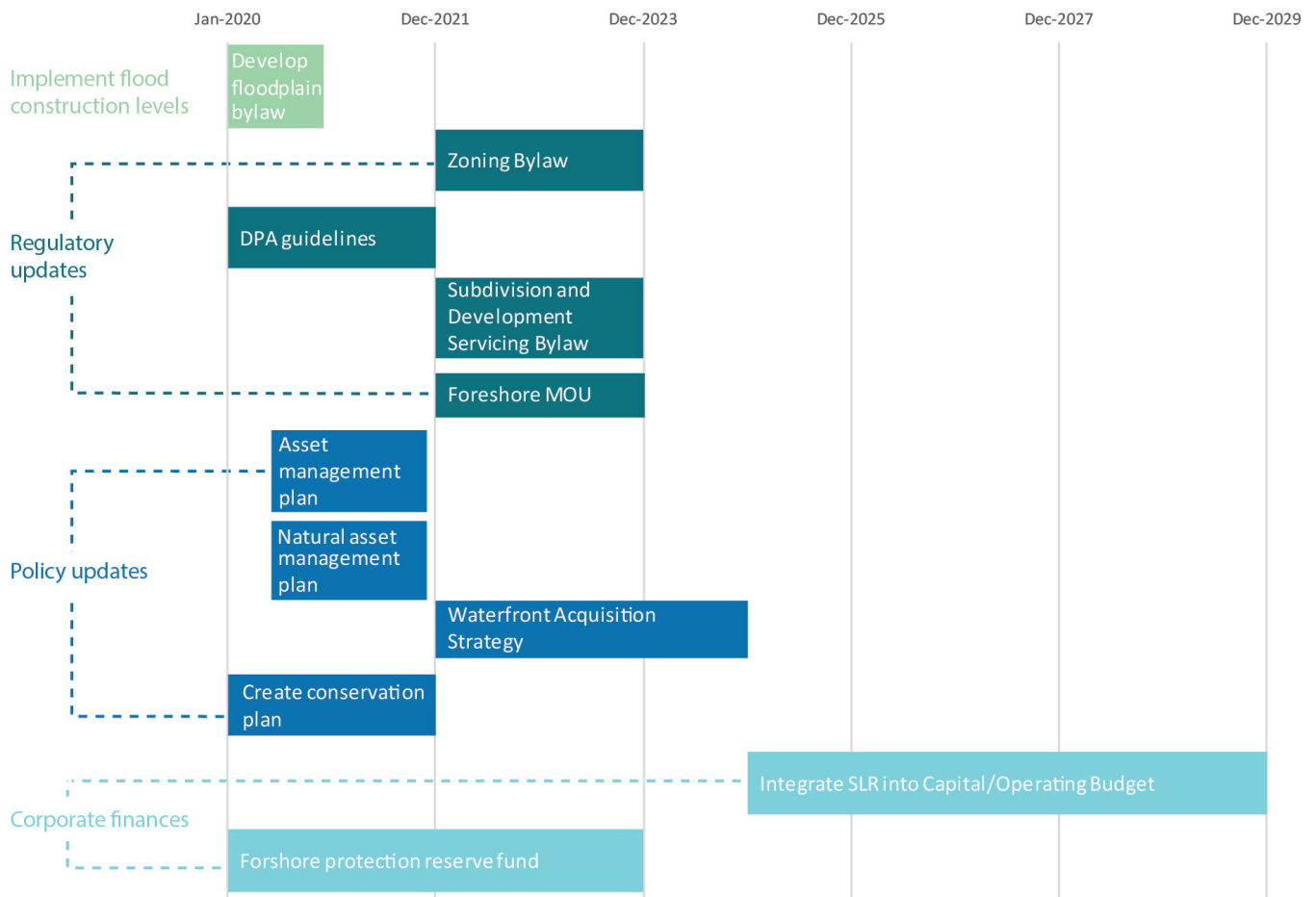


Figure 16. Regulation/Policy Sea Level Rise Priority Actions Summary



### **4.1.1 Implement flood construction levels**

#### **1. Develop Floodplain Bylaw (January 2020 – August 2020)**

Section 524 of the Local Government Act grants municipalities the power to designate land prone to flooding as a floodplain, and to define flood construction levels (FCLs) within floodplains. The Government of British Columbia's Flood Hazard Area Land Use Management Guidelines urge municipalities to develop floodplain bylaws that apply FCLs based on a projected sea level rise of 1 metre by 2100 (BC Ministry of Water, Land and Air Protection, amended 2018).

The City of Campbell River does not currently have a Floodplain Bylaw. Technical studies have identified significant coastal and inland flooding risk to the community after 1 metre of sea level rise, in addition to the periodic flooding experienced today. Because buildings are typically constructed to last 75 - 100 years, development plans for new construction should anticipate significant sea level rise over this time and begin regulating now. To protect human health, safety, and property from future sea level rise, the City should develop a floodplain bylaw that accounts for 1 metre of sea level rise as soon as possible.

### **4.1.2 Additional regulatory updates**

#### **2. Zoning Bylaw updates (January 2022 – January 2024)**

The City may choose to amend the current zoning bylaw to restrict certain types of land uses, or moderate density in areas vulnerable to sea level rise.

#### **3. Development Permit Area updates (January 2020 – August 2020)**

The City has many development permit areas (DPA) that intersect with sea level rise and need to be updated accordingly. These include:

- ▶ Foreshore DPA
- ▶ Hazardous Conditions DPA
- ▶ General Environmental DPA
- ▶ Estuary DPA

The City may also wish to develop a new sea level rise development permit area that defines specific guidelines in vulnerable areas for things such as, property protection on the foreshore, building setbacks, and minimum elevation for lots relative to the flood construction level.

#### **4. Subdivision and Development Servicing Bylaw update (January 2022 - January 2024)**

The City's Subdivision and Development Servicing Bylaw should be updated such that infrastructure, works and services provided in flood-vulnerable areas account for future sea level rise. This is achieved by defining specific design and construction standards within these areas.

#### **5. Foreshore memorandum of understanding (MOU) update (January 2022 – January 2024)**

The City currently has an MOU with the Department of Fisheries and Oceans. This guides maintenance of infrastructure and erosion control projects along the foreshore, to preserve and enhance fish habitat. The MOU should be updated to in anticipation of risks to the foreshore and fish species as a result of sea level rise.

### 4.1.3 Policy Updates

#### 6. Integrate sea level rise into Asset Management Plan

(June 2020 – December 2021)

The City of Campbell River currently has an Asset Management Strategy that provides the framework for a future comprehensive Asset Management Plan. This includes a plan to guide management of all City assets including maintenance and upgrading. The plan will be developed to include consideration of the risks posed by sea level rise, and plans for adaptations and asset maintenance.

#### 7. Create Natural Asset Management Plan (June 2020 – December 2022)

A natural asset management plan recognizes that existing ecosystems provide many services to the community which would otherwise be performed by engineered solutions. For example, storm water management performed by streams and wetlands. The monetary value of ecosystem services can be estimated according to the cost of constructing and maintaining engineered solutions that would perform these functions, or by calculating the amount of damage that occurs when these natural systems are compromised or absent. Although, these estimates don't account for all of the benefits of nature (Figure 17).

A 2013 study found that coastal habitats in the United States protect millions of people and hundreds of billions of dollars worth of property from exposure to coastal hazards (Arkema et al., 2013). Natural assets can require less maintenance and theoretically, no replacement if managed properly.



Figure 17. Nature provides many services to the community, such as recreation and learning opportunities, and habitat for fish and wildlife.

This saves money in the long term compared to the cost of engineered systems. Other governments have recognized the importance of natural assets and are working to improve their management. For example, the Town of Gibsons is developing a Natural Asset Management Plan as part of its overarching Asset Management Plan, and the state of Louisiana launched a progressive Coastal Master Plan in 2012 that includes extensive coastal restoration projects to combat the threat of sea level rise. By taking stock of our natural assets, we can better understand their importance to the well-being and safety of our community and plan to manage them responsibly to ensure they continue to function.



**8. Establish a Conservation plan for plants and ecosystems vulnerable to sea level rise (January 2020 – January 2022)**

The Campbell River foreshore and estuary provide a home for many living things, including four species of rare plants and one rare ecosystem (Madrone 2019). These areas will be affected by future sea level rise, and the longevity of rare natural elements relies on effective management. A conservation plan for plants and ecosystems vulnerable to sea level rise should be created, including details on baseline population mapping and ongoing monitoring of population health for rare plants and ecosystems. Installation, enhancement and maintenance of ecological buffers, potential sources of seeds, and possible propagation and transplant programs should also be investigated.

**9. Waterfront Acquisition Strategy update (January 2022 – January 2024)**

The City has a long-standing, informal goal of land acquisition and parkland development along the waterfront, guided by the 2015 Waterfront Acquisition Strategy. The City may choose to update this strategy to consider vulnerability to sea level rise when prioritizing properties. This could protect human life and property while providing land for implementing neighbourhood scale, natural adaptations. Converting acquired lots into parkland would help restore ecosystem services like, storm water management, carbon sequestration, and pollution removal, provide overall economic and health benefits (Elmqvist et al., 2015)

**4.1.4 Finances**

**10. Integrate sea level rise into capital/operating budget (January 2025 – January 2030)**

As sea level rise progresses, infrastructure on or adjacent to the foreshore may be damaged due to erosion and waves. For example, Campbell River has sewer pipes running along the majority of the shoreline. Maintenance may also become more difficult, as the period when water is low enough to safely access infrastructure decreases. Such considerations should be integrated into the City’s capital/operating budget.

**11. Establish a sea level rise foreshore protection reserve fund (January 2020 - January 2024)**

Although most adaptations involving large scale capital works projects will not be required for many years, significant public investment will be required when the time comes. By establishing a sea level rise foreshore protection reserve fund with annual contributions, the City can prepare for this future investment and ensure the burden of climate change adaptation is shared among generations.

## 4.2

### B. TECHNICAL STUDIES/CAPITAL WORKS PROJECTS

Numerous preliminary studies were carried out for the Rising Seas initiative, which resulted in the identification of areas and ecosystems vulnerable to sea level rise and recommended adaptations. In addition, some studies identified the need for additional data. For example, the Estuary Assessment report (NHC 2018b) found a significant risk of riverine flooding when heavy rain falls necessitate large releases from the John Hart Dam. An in depth investigation of the feasibility of potential adaptations is warranted.

In some areas, sea level rise adaptation will require large scale capital projects. Whenever possible, these will be incorporated into other planned construction projects and otherwise installed in phases over time.

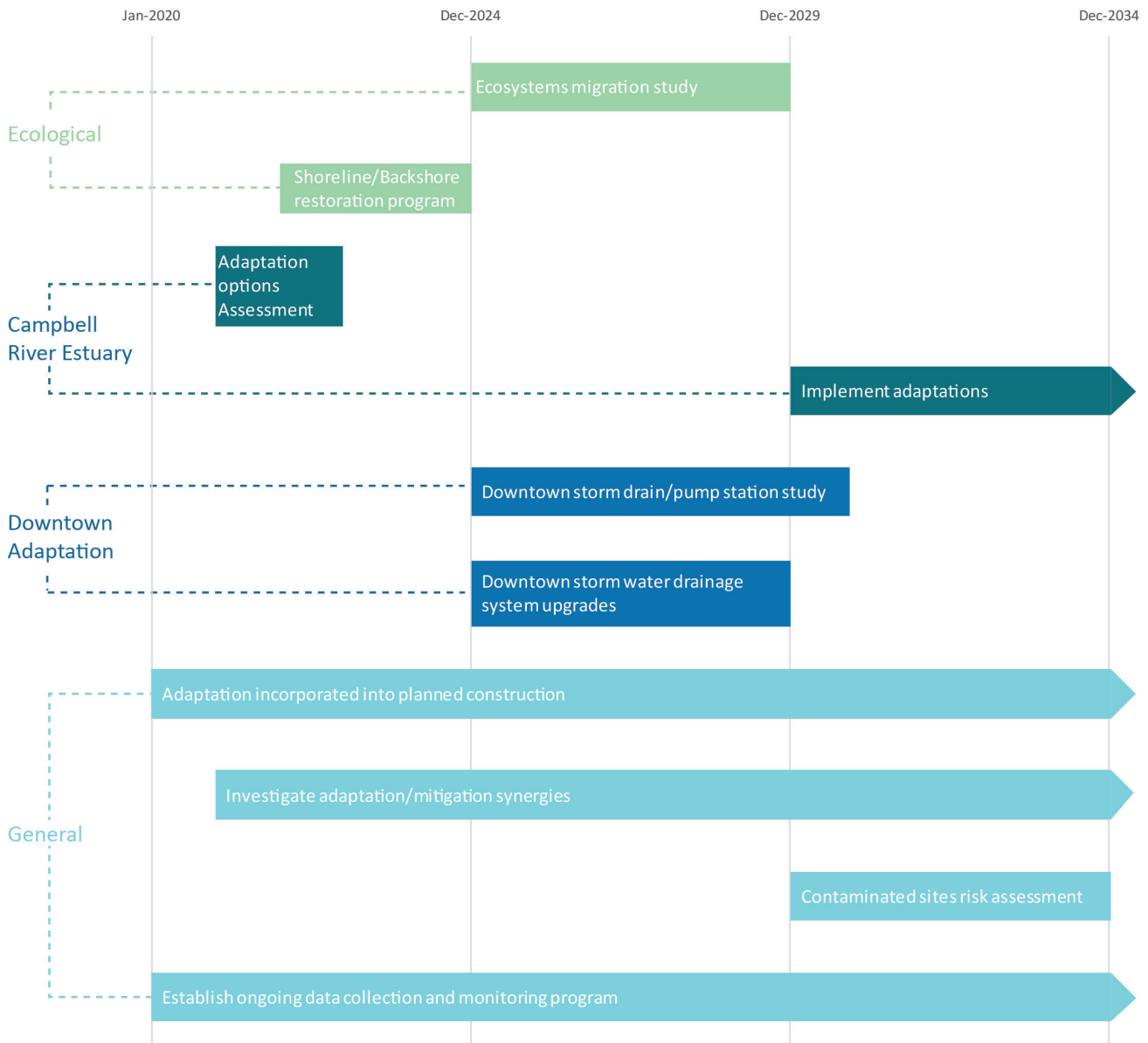


Figure 18. Technical Studies/Capital Works Projects Sea Level Rise Priority Actions Summary



#### 4.2.1 Ecological

##### 12. Ecosystems migration study (January 2025 - January 2030)

The ability of ecosystems to move into new locations as existing habitat becomes unsuitable is highly important for survival. This migration relies on the availability of adjacent habitat for colonization and the ability of ecosystem components to propagate into such areas. Sea level rise will threaten four rare plant species and one rare ecosystem type. The Ecosystem and Species at Risk Report (Madrone, 2019) for the City's *Rising Seas* initiative recognized the importance of ecosystem migration and identified potential migration areas for various habitat types in the Campbell River estuary (Figure 19). An in depth study is required to understand better the likelihood of estuarine ecosystems to colonize these areas, and identify specific priority migration sites.

##### 13. Shoreline restoration program (January 2022 - 2025)

Forage fish are an important source of food for many animals, including some species of salmon. Their survival depends on the availability of suitable foreshore spawning habitat, which is limited along the Campbell River coastline (Madrone 2019). Hardened shorelines and coastal development interrupt the movement of sediments along the beach face and limit the availability of productive backshore habitat. The City has an agreement with the Department of Fisheries and Oceans to undertake soft shore restoration measures along the foreshore. This work should continue and an additional shoreline restoration program should be developed specifically to improve/increase forage fish spawning habitat.

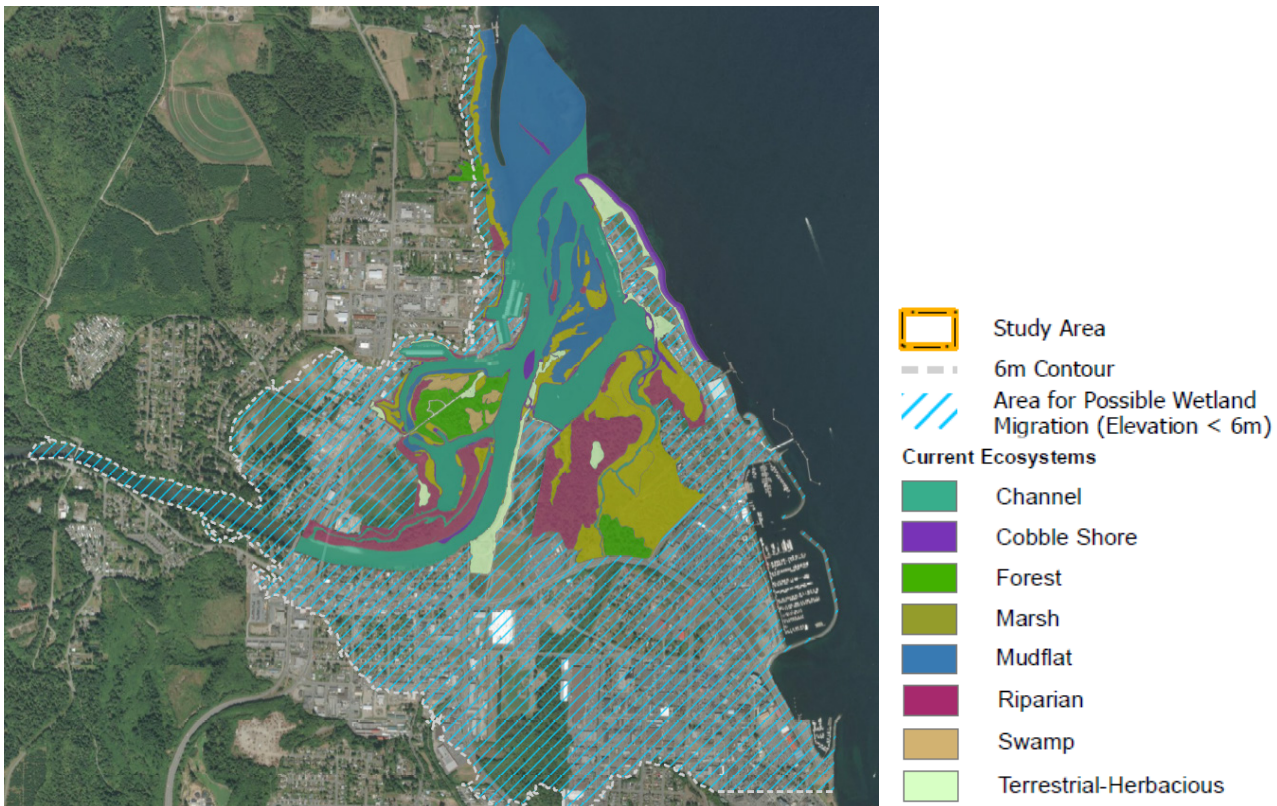


Figure 19. Habitat types in the Campbell River estuary and potential migration areas, Madrone 2019.

#### 4.2.2 Campbell River Estuary

##### **14. Adaptations Options Assessment (January 2021 – January 2023)**

The sea level rise Estuary Assessment (NHC, 2018b) found that when heavy rain and river flows coincide with high tides, storms, and one metre of sea level rise, there is a significant flood risk in and around the Campbell River estuary, and lower reaches of the Campbell River (NHC 2018b). The report also suggests possible options to mitigate flooding risks which require further study to determine feasibility and effectiveness. Additional work should determine all costs and benefits of available adaptation options followed by public consultation to determine community priorities for addressing flooding from the Campbell River and estuary.

##### **15. Implement adaptations (January 2030 – December 2050)**

Under current conditions, heavy rainfall and extreme storms can cause extensive flooding in the Campbell River estuary and surrounding areas, including parts of Campbellton and the Downtown. As sea level rises the area of land vulnerable to this flooding will increase, as well as the depth of flood waters (NHC 2018b). These projections reflect rare circumstances where storms coincide with heavy river flows and high tides. The community is currently able to deal with the minor annual flooding. Therefore, large scale adaptation along the Campbell River/ estuary can be incorporated slowly over time.

#### 4.2.3 Downtown Area

##### **16. Downtown storm drain/pump station assessment (January 2025 – December 2030)**

A detailed study will be required to determine the feasibility of an upgraded downtown storm water drainage/storage system and pump station to address prolonged periods of flooding due to sea level rise.

##### **17. Implement downtown storm water improvements**

##### **(January 2025 - January 2030)**

The City retained consultants to assess the performance of the downtown storm drainage system. Recommended improvements/upgrades identified within the Urban Systems draft report *Downtown Drainage System Assessment* - Updated, dated November 4th 2019, as amended, should be implemented as needed to reduce the duration and frequency of flooding events in the downtown.

#### 4.2.4 General

##### **18. Adaptation incorporated into planned street construction and considered in all City projects within vulnerable areas (Ongoing)**

As construction takes place in areas vulnerable to sea level rise, adaptations area being incorporated. For example, the Hwy 19A upgrades are being built to withstand sea level rise in the near future, and designs allow land to be raised as sea level rise progresses. The City will continue to review all future construction projects in areas vulnerable to sea level rise for opportunities to implement adaptations.



**19. Investigate opportunities to incorporate climate change mitigation into sea level rise adaptation (January 2021 – January 2050)**

Addressing the cause of sea level rise — climate change — is the most effective long-term protection strategy. Scientific literature suggests that there are options to address the impacts of sea level rise while simultaneously reducing the amount of CO2 in the atmosphere. For example, sea grass beds help absorb wave energy, protecting the coast during storms, while also sequestering vast amounts of carbon in their sediments (Ondiviela et al., 2014; McLeod *et al.*, 2011). Investigating opportunities to implement sea level rise adaptations that also help mitigate climate change will increase the community’s resilience and move Campbell River towards the climate action goals established in its Official Community Plan (updated 2017). It is important to note that this type of mitigation will not reverse some effects of climate change.

**20. Contaminated sites risk assessment (January 2030 - January 2040)**

Contaminated sites have high concentrations of compounds capable of causing harm to the environment. A recent report found that a many contaminated sites in Campbell River are located in areas vulnerable to sea level rise (Madrone, 2019). A number of these surround the Campbell River estuary — an important ecological area. Further study is required to confirm the location of contaminated sites and bulk petroleum/hydrocarbon fuels storage in areas vulnerable to sea level rise, and determine the associated risks.



Figure 20. Coastal ecosystems shelter inland areas from waves during storms and create rich habitat for many organisms.

**21. Ongoing data collection and monitoring (January 2020 – January 2050)**

To assess accurately risks to Campbell River as sea level rise progresses, data regarding sea level, weather events, and river/stream flows must be collected and monitored. Hourly rainfall monitoring devices and flow monitors in some of the urban streams would enhance understanding of the relationship between rainfall and stream flow rates, as well as, the effects on flooding and stream habitat. Also, the City should assign certain staff to monitor and analyse this data as well as local sea level and weather data.

### 4.3

## C. CAPACITY BUILDING

According to Human Resources Development Canada (Frank & Smith, 1999):

“Capacity is simply the ways and means needed to do what has to be done. It is much broader than simply skills, people and plans. It includes commitment, resources and all that is brought to bear on a process to make it successful.”

In the context of sea level rise, capacity building involves improving understanding within City departments and among community members. Also, providing assistance with neighbourhood scale adaptations allows community members to exercise agency in climate change adaptation.

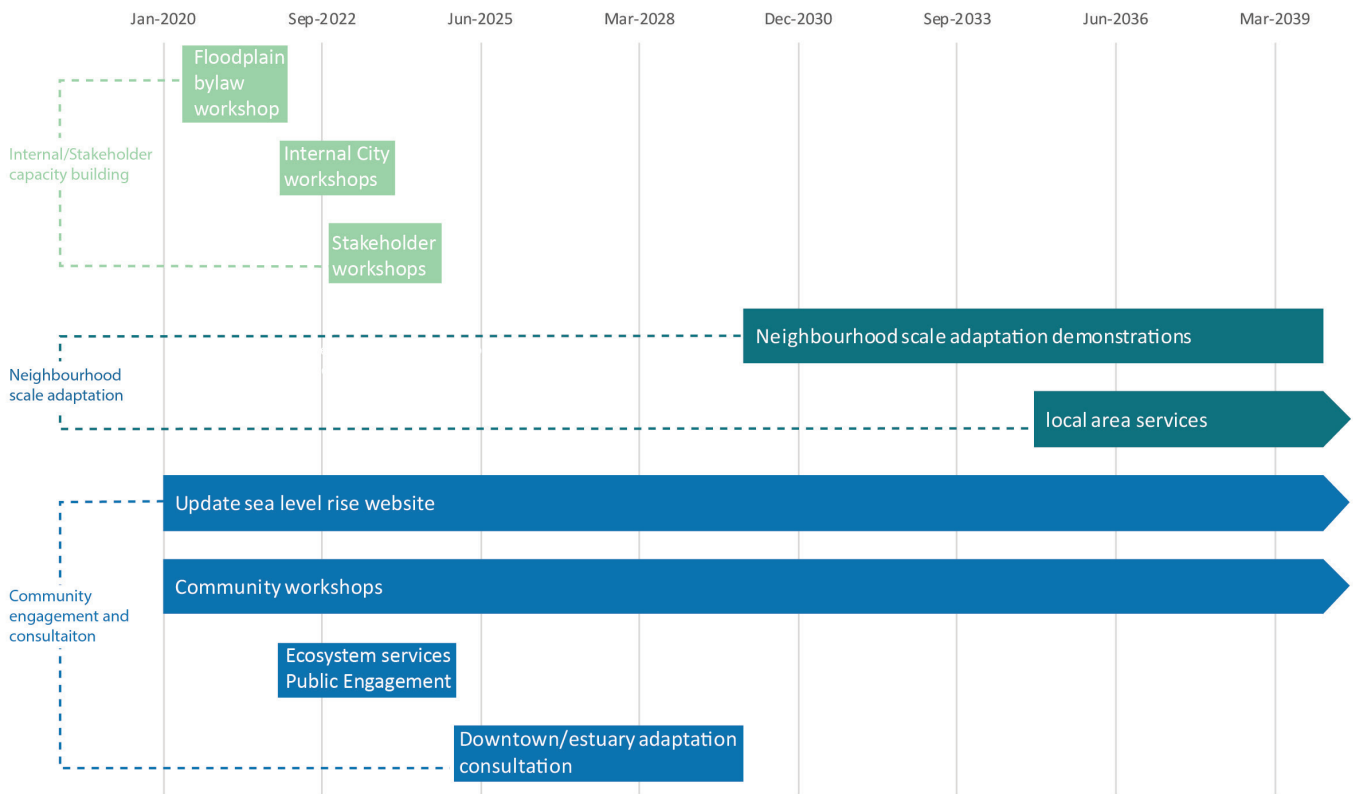


Figure 21. Capacity Building Sea Level Rise Priority Actions Summary



### **4.3.1 Internal/Stakeholder Capacity Building**

#### **22. Floodplain Bylaw workshop (August 2020 – December 2021)**

A workshop will be held to introduce the new Flood Plain Bylaw to builders, developers, engineers, and others. This will help them to interpret and properly apply the Bylaw requirements.

#### **23. Internal sea level rise workshops (January 2022 – January 2024)**

Sea level rise will affect many different types of infrastructure, and has implications for the many ecosystem services on which the community relies. Adaptation will require the coordinated effort of various City departments, and inter-departmental workshops will ensure all staff are aware of the projected impacts, including on ecosystem services, and how the City is planning to adapt. The City also has a sea level rise steering committee that includes members from various departments and a representative from the Strathcona Regional District. City planning related to sea level rise will continue to be reviewed by the sea level rise steering committee to ensure feasibility of projects across departments.

#### **24. Stakeholder workshops (December 2022 – January 2024)**

Workshops will be held to educate various stakeholders in the community about the projected impacts of sea level rise and how the City is planning to adapt.

### **4.3.2 Neighbourhood scale adaptation**

#### **25. Adaptation demonstrations (January 2030 – January 2040)**

Neighbourhood scale adaptation often requires larger areas and investment than individual/lot scale adaptation. However, it allows for coordinated adaptation on adjacent properties and can provide co-benefits such as, improved recreation opportunities and foreshore habitat. A Neighbourhood scale adaptation option was developed for three areas in Campbell River (Detailed in Primer IV):

- ▶ Painter Barclay — Groynes with beach nourishment
- ▶ Sequoia Park — Headlands with pocket beaches
- ▶ Willow Point — Softshore approach

Demonstrations will be held in each neighbourhood to illustrate how adaptations will look/function and the associated costs/benefits.

#### **26. Sea level rise local area services (January 2035 – January 2050)**

Section 210 of the Community Charter grants local governments the power to approve local area services. These are municipal services paid for, at least in part, by a local services tax imposed on benefiting property owners. The City could consider approving local area services for neighborhood scale sea level rise adaptations. Eligible projects should protect inland properties while providing improved public beach access and environmental benefits (e.g. improved back shore vegetation).

### 4.3.3 Community Engagement/ Consultation

#### 27. Update website

(January 2020 – January 2050)

The City will continue to update its sea level rise webpages with information about planning work including new studies, public engagement opportunities, answers to frequently asked questions, and the results of community outreach.

#### 28. Community sea level rise workshops (January 2020 – January 2050)

Choosing the best adaptation options is a values-based exercise. Science can identify the risks we face and the available options, but it is up to the community to decide on priorities when it comes to coastal adaptation. The City will continue to host public workshops and information sessions to inform the community about the City's sea level rise planning work and to seek input on community values and priorities for adaptation, as and when projects are considered.



Figure 22. Participants discussing sea level rise adaptation at the third Rising Seas workshop, May 30, 2019 at the Maritime Heritage Centre

#### 29. Public engagement about foreshore ecosystems services

(January 2022 - January 2025)

Community members value Campbell River's coastal setting, and many care about the health and well being of the natural environment. Historic practices of coastal development have often involved hardening shorelines and clearing trees for unobstructed ocean views, which has damaged coastal ecosystems. Public engagement is required to create awareness about the impacts of such development practices on coastal ecosystems and to educate community members on best practices for restoring and protecting coastal ecosystems in development areas.

#### 30. Downtown and Campbell River estuary adaptation consultation

(January 2025 – January 2030)

The City held a series of public workshops evaluating sea level rise adaptation options, but these did not include a discussion about adaptation along the Campbell River and estuary. Also, workshops were held prior to the downtown storm water system and ecosystems and species at risk studies. Further public consultation should be held to evaluate adaptation options along the Campbell River/estuary, and to share new information from the technical studies. The downtown area has important social and economic functions for the community and is particularly vulnerable to the impacts of sea level rise (NHC 2019b). An in depth public consultation about how the community could approach adaptation in the downtown is warranted.



## 4.4

### D. ADMINISTRATION

Some priority actions are not adaptations themselves, but facilitate efficient, cost-effective, and accurate implementation of other sea level rise adaptations. The City should identify what permits/tenures will be required well in advance of projects, and should monitor for any grant/funding opportunities to subsidize costs. The scientific basis of sea level rise should also be monitored to ensure that adaptation time-lines are current and revised when necessary.

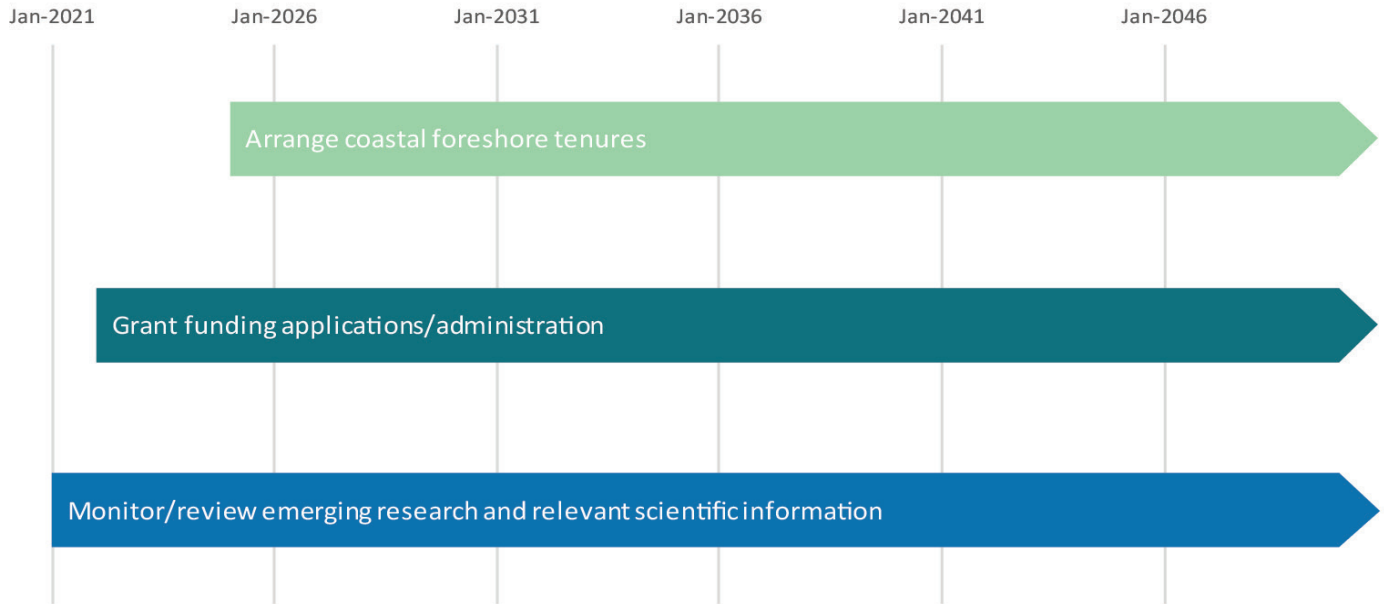


Figure 23. Administration Sea Level Rise Priority Actions Summary





**31. Negotiate coastal foreshore tenures  
(January 2025 – January 2050)**

Many coastal adaptations will require land tenures and approvals from other levels government and regulatory agencies such as, the provincial government and Department of Fisheries and Oceans. The City should identify adaptations that will require such permissions, and seek to secure them well in advance of proposed implementation.

**32. Grant and funding applications  
(January 2022 – January 2050)**

The City should continually monitor and apply for funding/grants related to climate change and sea level rise adaptation.

**33. Monitor/review emerging research  
and relevant scientific information  
(January 2020 – January 2050)**

The overwhelming majority of experts agree that global average sea level is rising and that it will continue to rise, at an accelerating pace, long into the future (Cazenave, Palanisamy, & Alblain, 2018; IPCC, 2019; Rahmstorf, 2007). The exact pace at which this will occur is still uncertain, and it is difficult to predict how global sea level rise will be experienced locally, as many factors such as local wave/wind climate, vertical land movement and ocean circulation influence local water levels (IPCC, 2014). Local governments must continually monitor the emerging science about sea level rise in conjunction with local data about sea level to make informed, evidence-based decisions, and update adaptation strategies accordingly.



## 4.5

### E. ADAPTATION PARTNERING

Climate change and sea level rise are daunting issues, and building a network of support including First Nations, community stakeholders and interest groups can help foster collective action and improve community resilience. It is important to identify potential key partners for sea level rise adaptation and identify opportunities for collaboration, like capital projects or public awareness events.

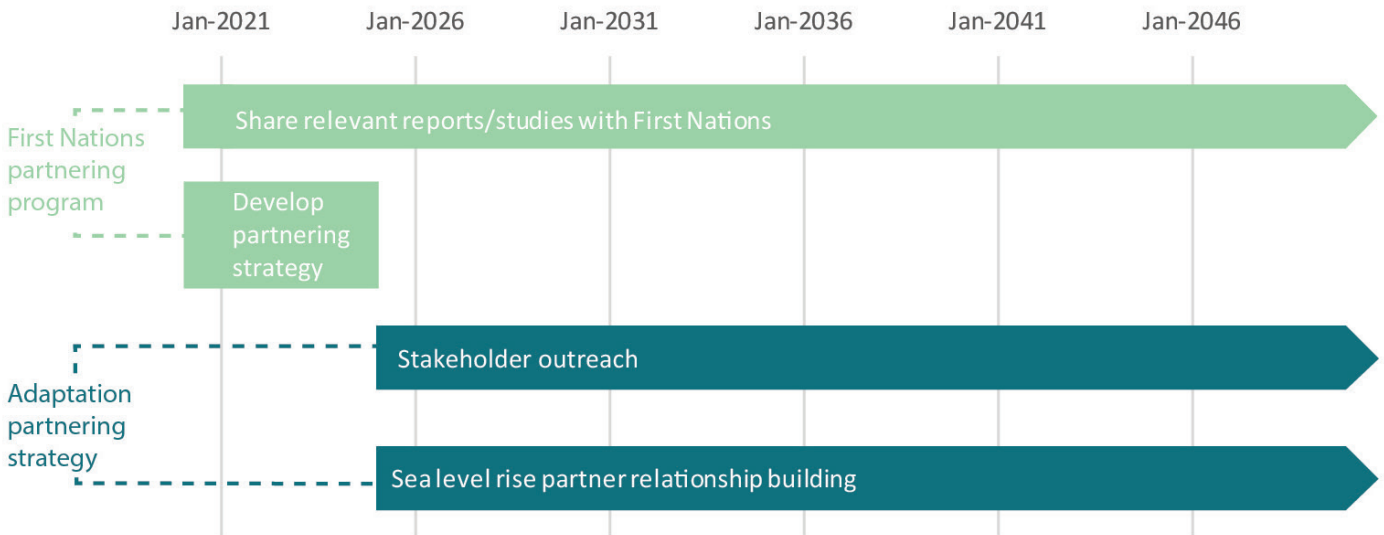


Figure 24. Adaptation Partnering Sea Level Rise Priority Actions Summary



Figure 25. Campbell River has a rich heritage tightly bound to ocean, and the ecosystem services it provides.

#### 4.5.1 First Nations Partnering Program

##### 34. Share relevant reports/studies about sea level rise in Campbell River with First Nations (Ongoing)

Climate change does not conform to municipal boundaries, and many hazards associated with sea level rise will affect both City and adjacent First Nations land. The City has presented the results of sea level rise studies to local First Nations groups and will continue to reach out and share information, as it becomes available.

##### 35. Develop a partnering strategy in collaboration with First Nations representatives

(January 2020 – January 2025)

There may be opportunities for local First Nations and the City to collaborate on sea level rise adaptation along certain sections of the coast. This would provide cost efficiencies and could help increase effectiveness, by coordinating a cohesive approach along the coast. Also, unique funding opportunities may exist for the City and First Nations groups, and partnership would allow pooling of funds and resources. Working with local First Nations, a strategy for collaborative adaptation should be created that identifies:

- ▶ Funding opportunities
- ▶ Potential joint adaptation approaches
- ▶ A framework for communication and information sharing
- ▶ A shared vision for adaptation.

#### 4.5.2 Adaptation Partnering Strategy

##### 36. Stakeholder outreach (January 2025 – January 2050)

Sea level rise will have widespread implications along the coast, environmentally, economically, and socially. This will present opportunities for the City to collaborate with various stakeholders on sea level rise adaptation measures. A strategy should be developed to reach out to potential partners and discuss sea level rise and future adaptation in Campbell River.

##### 37. Sea level rise partner relationship building (January 2025 – January 2050)

Regular meetings should be held between City staff and partners to facilitate an open line of communication. Decision making about collaborative projects should be an inclusive process.



Figure 26. A First Nations totem pole at Sequoia Park serves as a reminder of the original occupants of Campbell River, and the rich diversity of the community.



## 4.6 PRIORITY ACTIONS SUMMARY TABLE

Actions beginning in less than two years (Jan 2020 - Dec 2021)		
Action	Draft implementation time line	Action Category
Create Floodplain Bylaw	Jan 2020 - Aug 2020	Regulation/Policy
Development Permit Area Guideline updates	Jan 2020 - Aug 2020	Regulation/Policy
Develop Natural Asset Management Plan	Jun 2020 - Dec 2022	Regulation/Policy
Integrate SLR into Asset Management Plan	Jun 2020 - Dec 2021	Regulation/Policy
Establish a Conservation Plan for plants and ecosystems vulnerable to SLR	Jan 2020 - Jan 2022	Regulation/Policy
Establish a sea level rise foreshore protection reserve fund	Jan 2020 - January 2024)	Regulation/Policy
Adaptation options assessment		Technical studies/Capital works projects
Adaptation incorporated into planned street construction and considered in all City projects within vulnerable areas	Ongoing	Technical studies/Capital works projects
Establish ongoing data collection and monitoring program	Jan 2020 - Jan 2022	Technical studies/Capital works projects
Floodplain Bylaw workshop	Aug 2020 - Dec 2021	Capacity building
Update website	Jan 2021 - Jan 2050	Capacity building
Community workshops	Jan 2021 - Jan 2050	Capacity building
Monitor/review emerging research and relevant scientific information	Jan 2020 - Jan 2050	Capacity building
Develop partnering strategy in collaboration with First Nations representatives	Jan 2020 - Jan 2050	Adaptation partnering
Share sea level rise reports and studies with First Nations	Ongoing	Adaptation partnering

### Actions beginning in 3 - 5 years (Jan 2022 - Dec 2024)

Action	Draft implementation time line	Action Category
Zoning Bylaw update	Jan 2022 - Dec 2024	Regulation/Policy
Subdivision and Development Servicing Bylaw update	Jan 2022 - Jan 2024	Regulation/Policy
Foreshore MOU update	Jan 2022 - Dec 2023	Regulation/Policy
Waterfront Acquisition Strategy update	Jan 2022 - Dec 2024	Regulation/Policy
Investigate adaptation/mitigation synergies	Jan 2022 - Jan 2050	Technical studies/Capital works projects
Shoreline restoration program	Jan 2022 - Jan 2025	Technical studies/Capital works projects
Workshops for City departments	Jan 2022 - Dec 2024	Capacity building
Stakeholder workshops	Dec 2022 - Dec 2024	Capacity building

### Actions beginning in 5 - 10 years (Jan 2025 - Dec 2029)

Action	Draft implementation time line	Action Category
Integrate SLR into capital/operating Budget	Jan 2025 - Jan 2030	Regulation/Policy
Downtown storm drain/pump station study	Jan 2025 - Dec 2030	Technical assessment/Capital works projects
Ecosystem migration study	Jan 2025 - Jan 2027	Technical assessment/Capital works projects
Implement downtown storm drainage systems improvements	Jan 2025 - Jan 2030	Technical assessment/Capital works projects
Downtown/estuary adaptation consultation	Jan 2025 - Jan 2030	Capacity building
Public engagement about foreshore ecosystem services	Jan 2025 - Jan 2030	Capacity building
Arrange foreshore tenures	Jan 2025 - Jan 2050	Administration
Stakeholder outreach	Jan 2025 - Jan 2050	Adaptation partnering
SLR partner relationship building	Jan 2025 - Jan 2050	Adaptation Partnering



### Actions beginning more than 10 years (Jan 2030+)

Action	Draft implementation time line	Action Category
Implement adaptations (Campbell River/ estuary)	Jan 2030 - Dec 2050	Technical assessment/ Capital works projects
Contaminated sites risk assessment	Jan 2030 - Jan 2040	Technical assessment/ Capital works projects
Adaptation demonstrations	Jan 2030 - Jan 2040	Capacity building
Sea level rise local area services	Jan 2035 - Jan 2050	Capacity building

## REFERENCES

The Arlington Group Planning + Architecture Inc., EBA, a Tetra Tech Company, DE Jardine Consulting, Sustainability Solutions Group (2013). *Sea Level Rise Adaptation Primer A toolkit to Build Adaptive Capacity on Canada's South Coasts*. British Columbia Ministry of Environment

Ausenco Sandwell. (2011). Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use Draft Policy Discussion Paper. *British Columbia Ministry of Environment*

BC Ministry of Water, Land and Air Protection (Amended 2018). Flood Hazard Area Land Use Management Guidelines. Amended by BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (January 2018).

City of Campbell River. (2002). Campbell River Estuary Management plan. Prepared by Qu'west Consulting Services for the City of Campbell River. [http://www.campbellriver.ca/docs/default-source/Document-Library/plans/estuary-management-plan0BFB709D948EE33CE55E48A4.pdf?sfvrsn=b2c68d09\\_5](http://www.campbellriver.ca/docs/default-source/Document-Library/plans/estuary-management-plan0BFB709D948EE33CE55E48A4.pdf?sfvrsn=b2c68d09_5)

City of Campbell River. (2002) Management Plan Baikie Island Reserve.

City of Campbell River. (2004 - 2006). Integrated Stormwater management plans. Prepared by Urban Systems for the City of Campbell River. <http://www.campbellriver.ca/city-services/stormwater>

City of Campbell River. (2010). Subdivision and Development Servicing Bylaw. Bylaw No. 3419. [http://www.campbellriver.ca/docs/default-source/Document-Library/bylaws/3419-subdivision-and-development-2010-consolidated-to-bylaw-3570-2015E5EA09456873.pdf?sfvrsn=89f29f09\\_4](http://www.campbellriver.ca/docs/default-source/Document-Library/bylaws/3419-subdivision-and-development-2010-consolidated-to-bylaw-3570-2015E5EA09456873.pdf?sfvrsn=89f29f09_4)

City of Campbell River. (2011) . City of Campbell River Marine Foreshore Habitat Assessment and Restoration Plan. Prepared by Northwest Hydraulic Consultatns for the City of Campbell River. [https://www.campbellriver.ca/docs/default-source/planning-building-development/report\\_nhc\\_marineforeshore.pdf?sfvrsn=764e6408\\_0](https://www.campbellriver.ca/docs/default-source/planning-building-development/report_nhc_marineforeshore.pdf?sfvrsn=764e6408_0)

City of Campbell River. (2012). Strategic Parks Plan. Prepared by for the City of Campbell River. Prepared by Lanarc for the City of Campbell River. [http://www.campbellriver.ca/docs/default-source/Document-Library/plans/parks-strategic-plan-2012-campbell-river-v2.pdf?sfvrsn=ff0b9809\\_2](http://www.campbellriver.ca/docs/default-source/Document-Library/plans/parks-strategic-plan-2012-campbell-river-v2.pdf?sfvrsn=ff0b9809_2)

City of Campbell River. (2014). Tyee Spit Lease Area Plan.

City of Campbell River. (2015) Waterfront property Acquisition Plan

City of Campbell River. (2017). Refresh Downtown. [http://www.campbellriver.ca/docs/default-source/planning-building-development/cr-refresh-downtown---final---june-2017.pdf?sfvrsn=d7a26108\\_10](http://www.campbellriver.ca/docs/default-source/planning-building-development/cr-refresh-downtown---final---june-2017.pdf?sfvrsn=d7a26108_10)

City of Campbell River. (2019). Zoning Bylaw. Bylaw No. 3250. [http://www.campbellriver.ca/docs/default-source/document-library/bylaws/zoning-bylaw-3250-2006-\(schedule-a-text\).pdf?sfvrsn=fe716508\\_8](http://www.campbellriver.ca/docs/default-source/document-library/bylaws/zoning-bylaw-3250-2006-(schedule-a-text).pdf?sfvrsn=fe716508_8)

City of Campbell River (2017). Campbell River Sustainable Official Community Plan. <https://www.campbellriver.ca/planning-building-development/official-community-plan>



## REFERENCES

- Cazenave, A., Palanisamy, H., & Ablain, M. (2018). Contemporary sea level changes from satellite altimetry: What have we learned? what are the new challenges? *Advances in Space Research*, 62(7), 1639-1653. doi:10.1016/j.asr.2018.07.017
- Cook, J., Nuccitelli, D., Green, S. A., Richardson, M., Winkler, B., Painting, R., . . . Skuce, A. (2013). Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters*, 8(2), 24024. doi:10.1088/1748-9326/8/2/024024
- Dangendorf, S., Marcos, M., Muller, A., Zorita, E., Riva, R. E. M., Berk, K., & Jensen, J. (2015). Detecting anthropogenic footprints in sea level rise. *Nature Communications*, 6(7849)
- Elmqvist, T., Setälä, H., Handel, S., van der Ploeg, S., Aronson, J., Blignaut, J., . . . Stockholm Resilience Centre. (2015). Benefits of restoring ecosystem services in urban areas. *Current Opinion in Environmental Sustainability*, 14, 101-108. doi:10.1016/j.cosust.2015.05.001
- Frank, F., Smith, A. (1999). *The Community Development Handbook: A Tool to Build Community Capacity. Human Resources and Development Canada. Ottawa - Ontario : Human Resources Development Canada.*
- IPCC, 2019: *Summary for Policymakers*. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. In press.
- IPCC, 2014: *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
- Madrone (2019). *City of Campbell River Sea Level Rise - Ecosystems and Species at Risk Assessment*. Prepared by Madrone Environmental Services Ltd. for the City of Campbell River.
- Mcleod, E., Chmura, G. L., Bouillon, S., Salm, R., Björk, M., Duarte, C. M., . . . Silliman, B. R. (2011). A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO<sub>2</sub>. *Frontiers in Ecology and the Environment*, 9(10), 552-560. doi:10.1890/110004
- NHC (2018a). *City of Campbell River Sea Level Rise Study Phase 1 - Downtown Waterfront Site*. Prepared by Northwest Hydraulic Consultants Ltd. for the City of Campbell River.
- NHC (2018b). *City of Campbell River Sea Level Rise Study Phase 2 - Estuary Assessment*. Prepared by Northwest Hydraulic Consultants Ltd. for the City of Campbell River.
- NHC (2019a). *City of Campbell River Sea Level Rise Study Phase 3 - Additional FCL Assessment*. Prepared by Northwest Hydraulic Consultants Ltd. for the City of Campbell River.
- NHC (2019b). *City of Campbell River Sea Level Rise Study - 4 Sites*. Prepared by Northwest Hydraulic Consultants Ltd. for the City of Campbell River.

## REFERENCES

Rahmstorf, S. (2007). A semi-empirical approach to projecting future sea-level rise. *Science*, 315(5810), 368-370. doi:10.1126/science.1135456

Sweet W.V., Kopp R.E., Weaver C.P., Obeysekera J., Horton R., Thieler E.R., ... Zervas C., (2017). Global and regional sea level rise scenarios for the United States. Tech. Rep. NOS CO-OPS 083, Nat. Oceanic Atmos. Admin., US Dep. Comm.



## **APPENDIX A**

### **City owned waterfront properties**

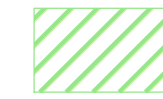




City of  
**Campbell  
River**

# City Owned Waterfront Properties Map #6

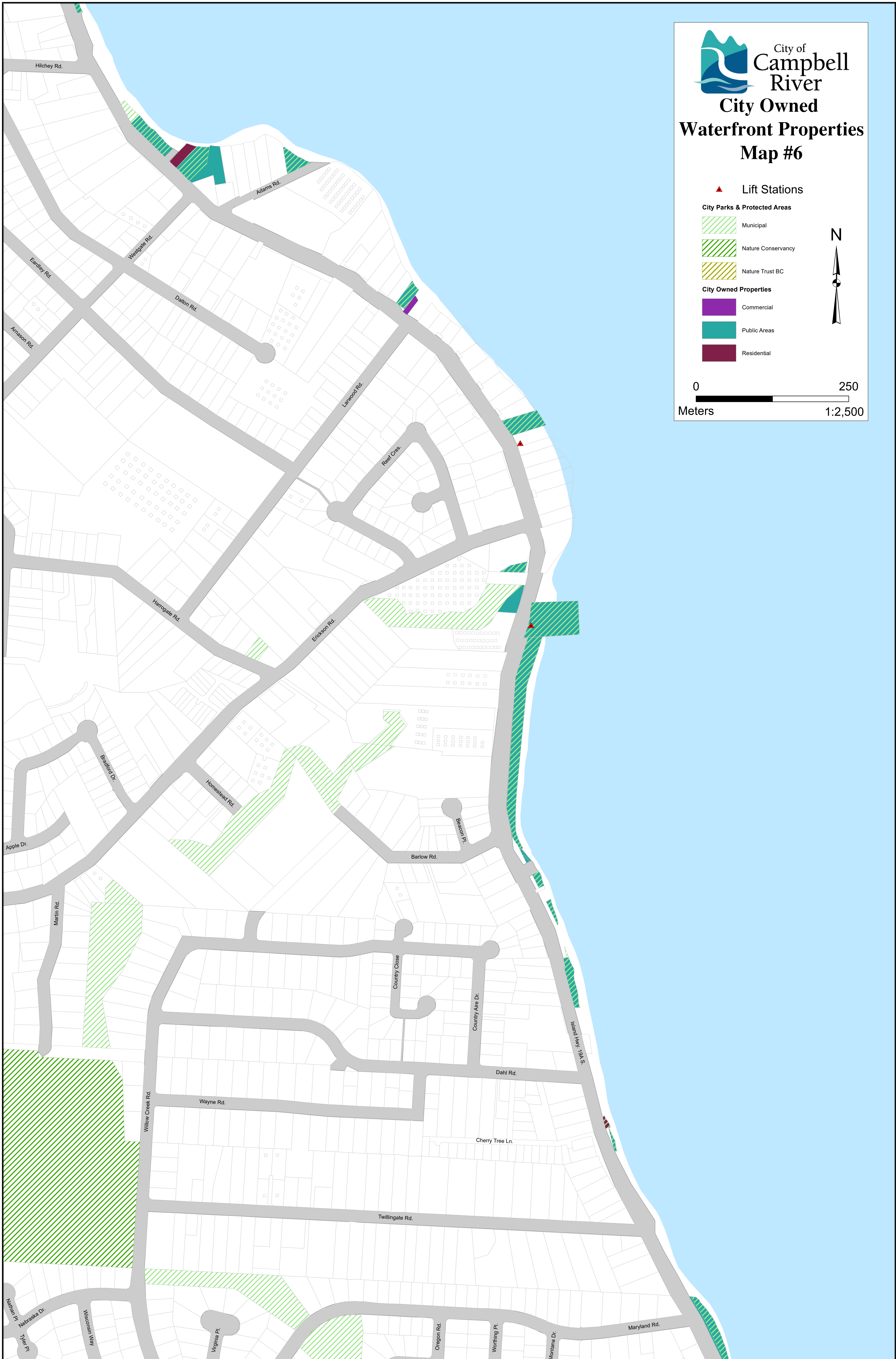
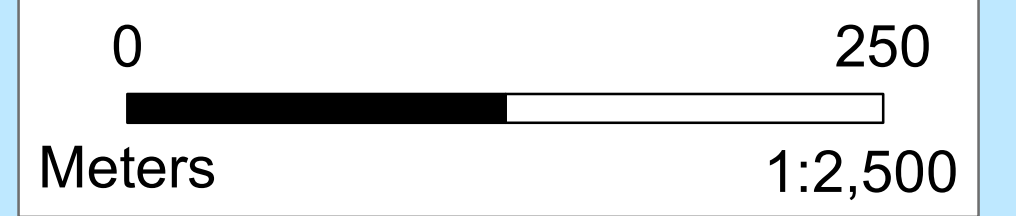
▲ Lift Stations

**City Parks & Protected Areas**

-  Municipal
-  Nature Conservancy
-  Nature Trust BC

**City Owned Properties**

-  Commercial
-  Public Areas
-  Residential










City of  
**Campbell  
River**

# City Owned Waterfront Properties Map #5

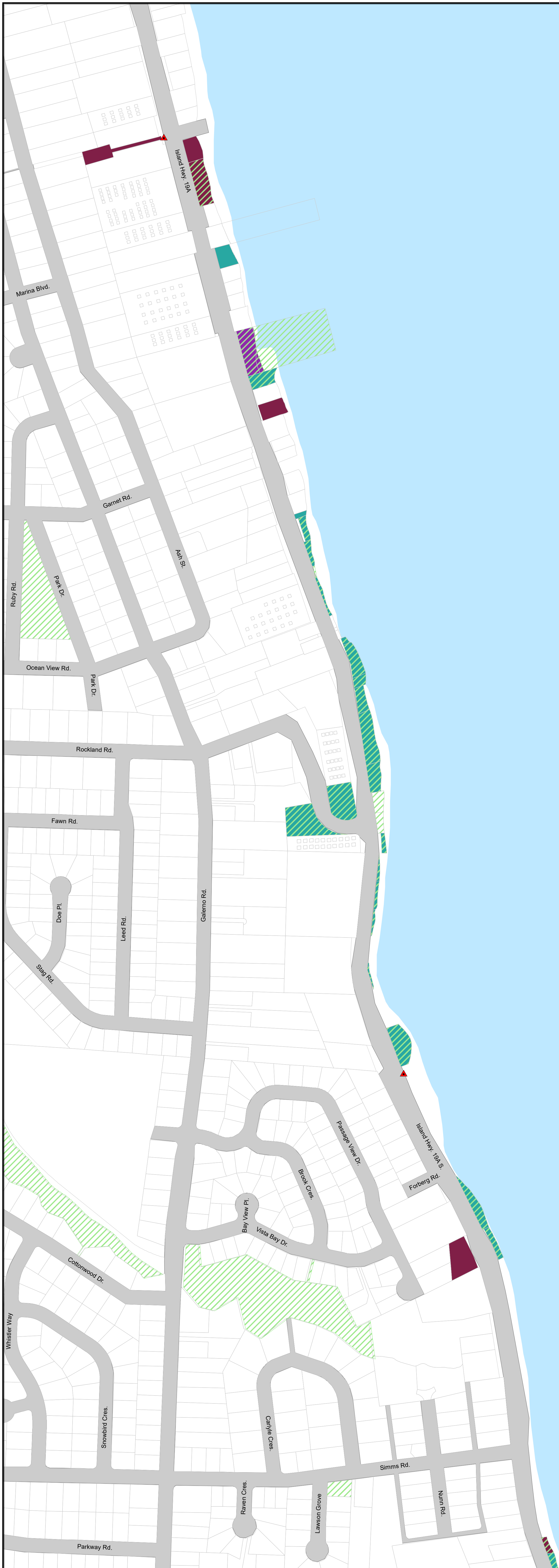
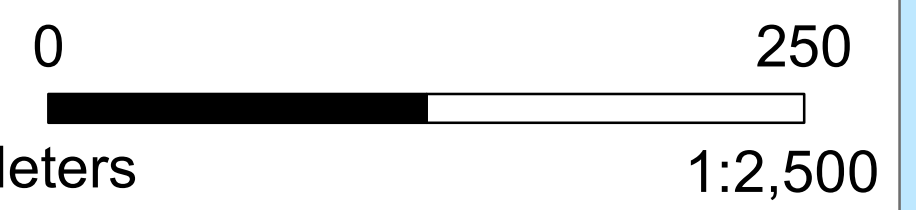
▲ Lift Stations

**City Parks & Protected Areas**

-  Municipal
-  Nature Conservancy
-  Nature Trust BC

**City Owned Properties**

-  Commercial
-  Public Areas
-  Residential







City of  
Campbell  
River

# City Owned Waterfront Properties Map #4

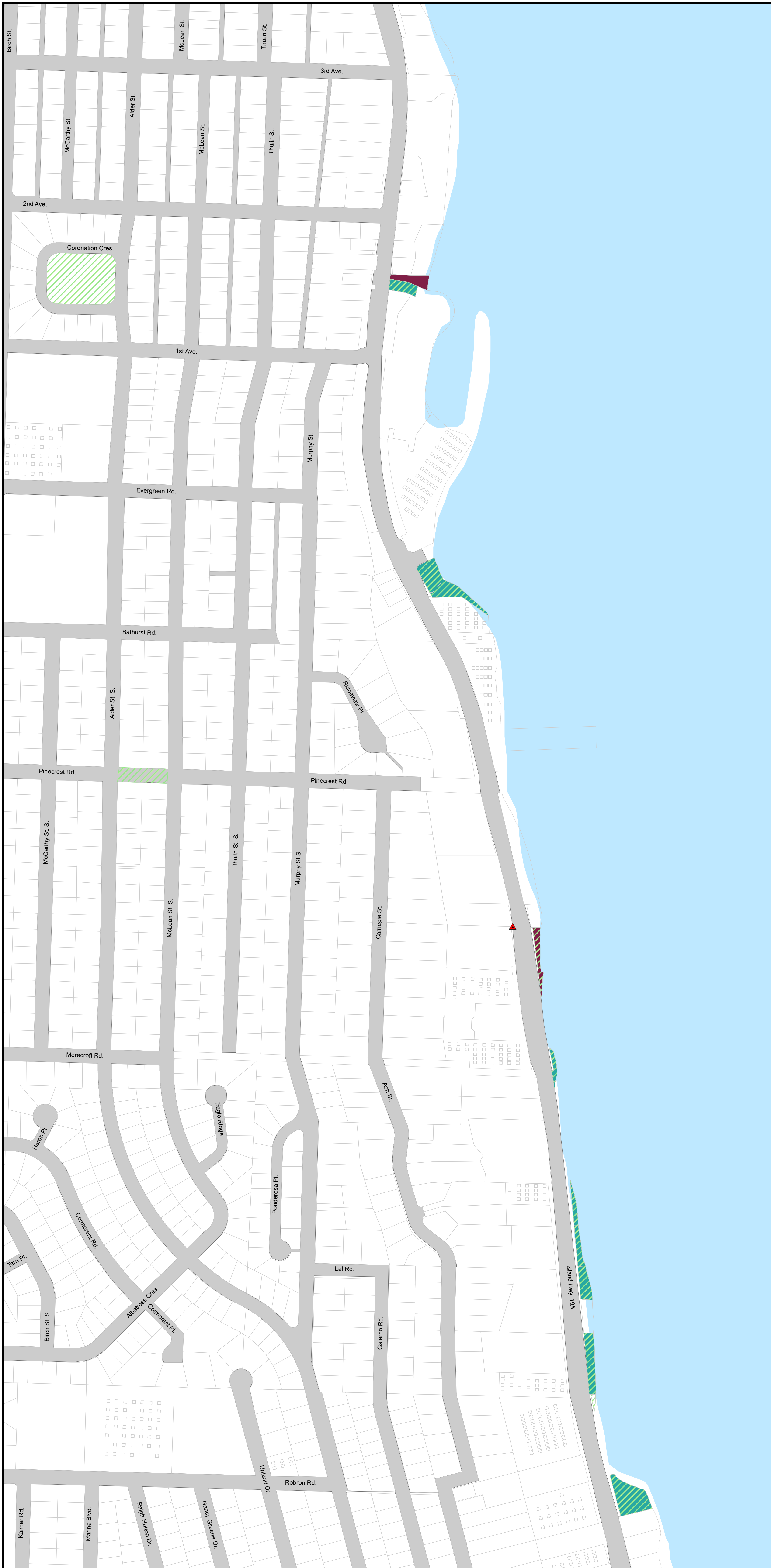
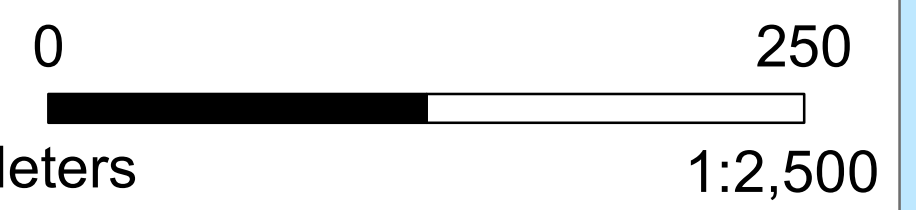
▲ Lift Stations

### City Parks & Protected Areas

- Municipal
- Nature Conservancy
- Nature Trust BC

### City Owned Properties

- Commercial
- Public Areas
- Residential







City of  
Campbell  
River

# City Owned Waterfront Properties Map #3

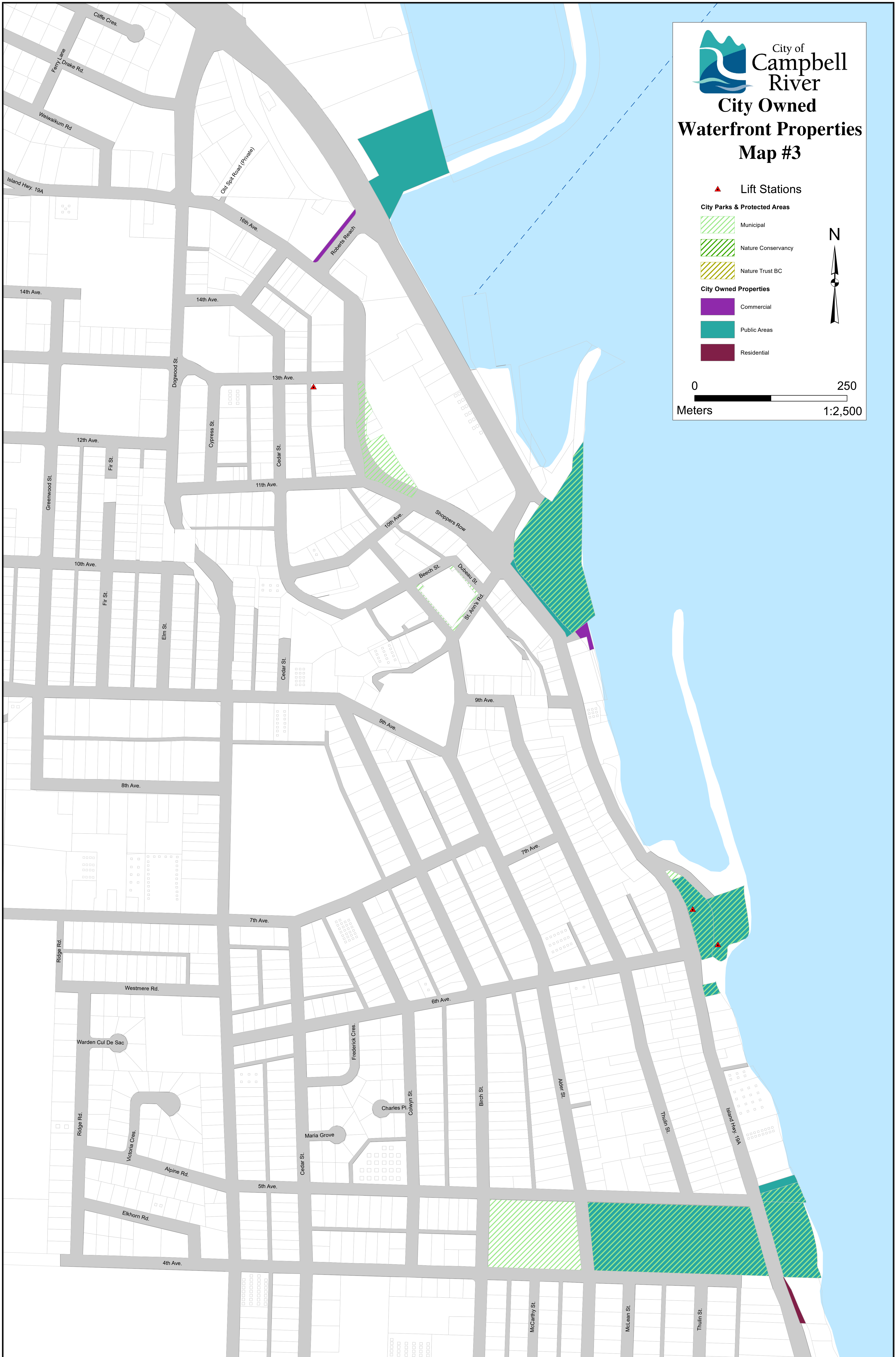
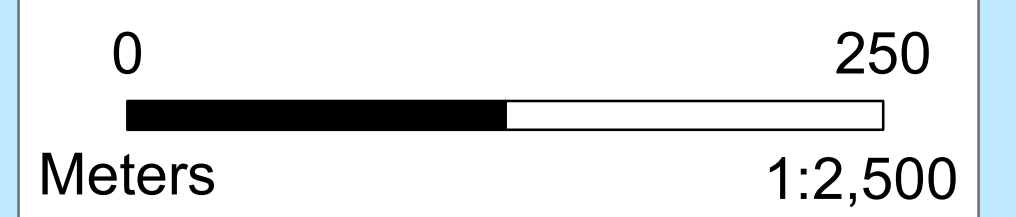
▲ Lift Stations

**City Parks & Protected Areas**

- Municipal
- Nature Conservancy
- Nature Trust BC

**City Owned Properties**

- Commercial
- Public Areas
- Residential










City of  
**Campbell  
River**

**City Owned  
Waterfront Properties  
Map #2**

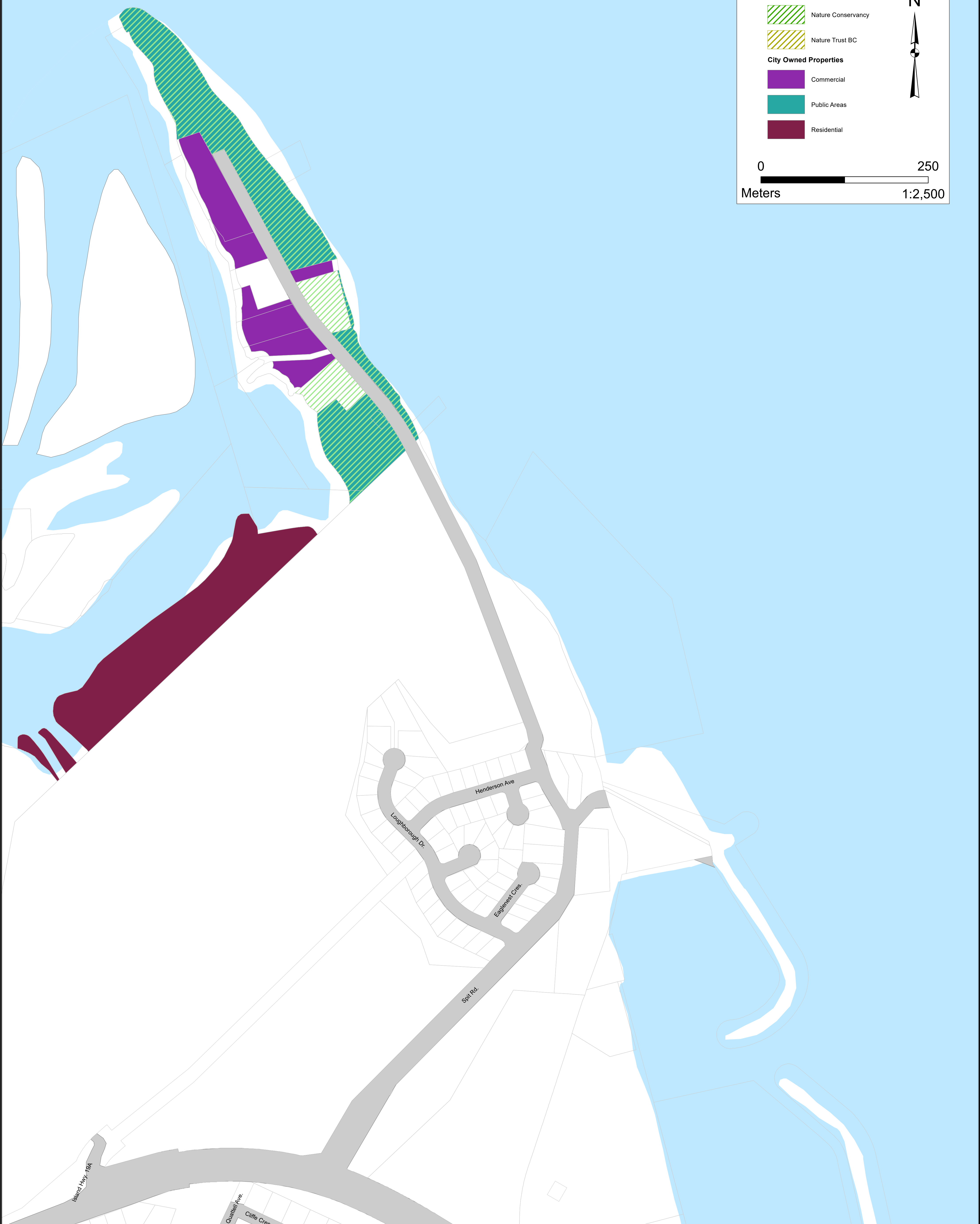
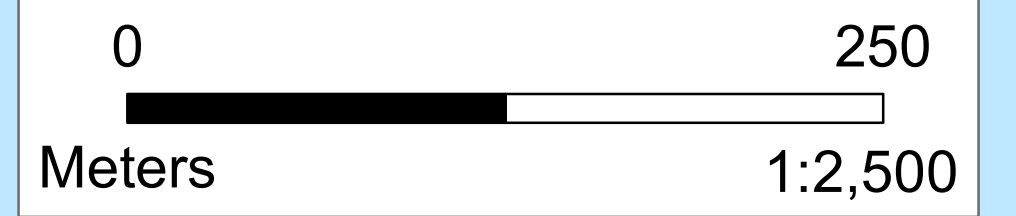
▲ Lift Stations

**City Parks & Protected Areas**

-  Municipal
-  Nature Conservancy
-  Nature Trust BC

**City Owned Properties**

-  Commercial
-  Public Areas
-  Residential







City of  
Campbell  
River

# City Owned Waterfront Properties Map #1

▲ Lift Stations

**City Parks & Protected Areas**

- Municipal
- Nature Conservancy
- Nature Trust BC

**City Owned Properties**

- Commercial
- Public Areas
- Residential

