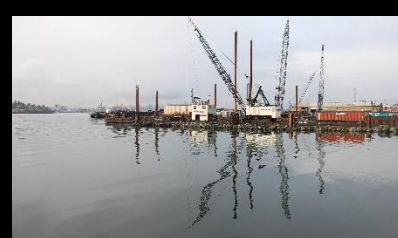




Sea Level Rise Doesn't Stop at Jurisdictional Borders: Collaboration on the North Shore



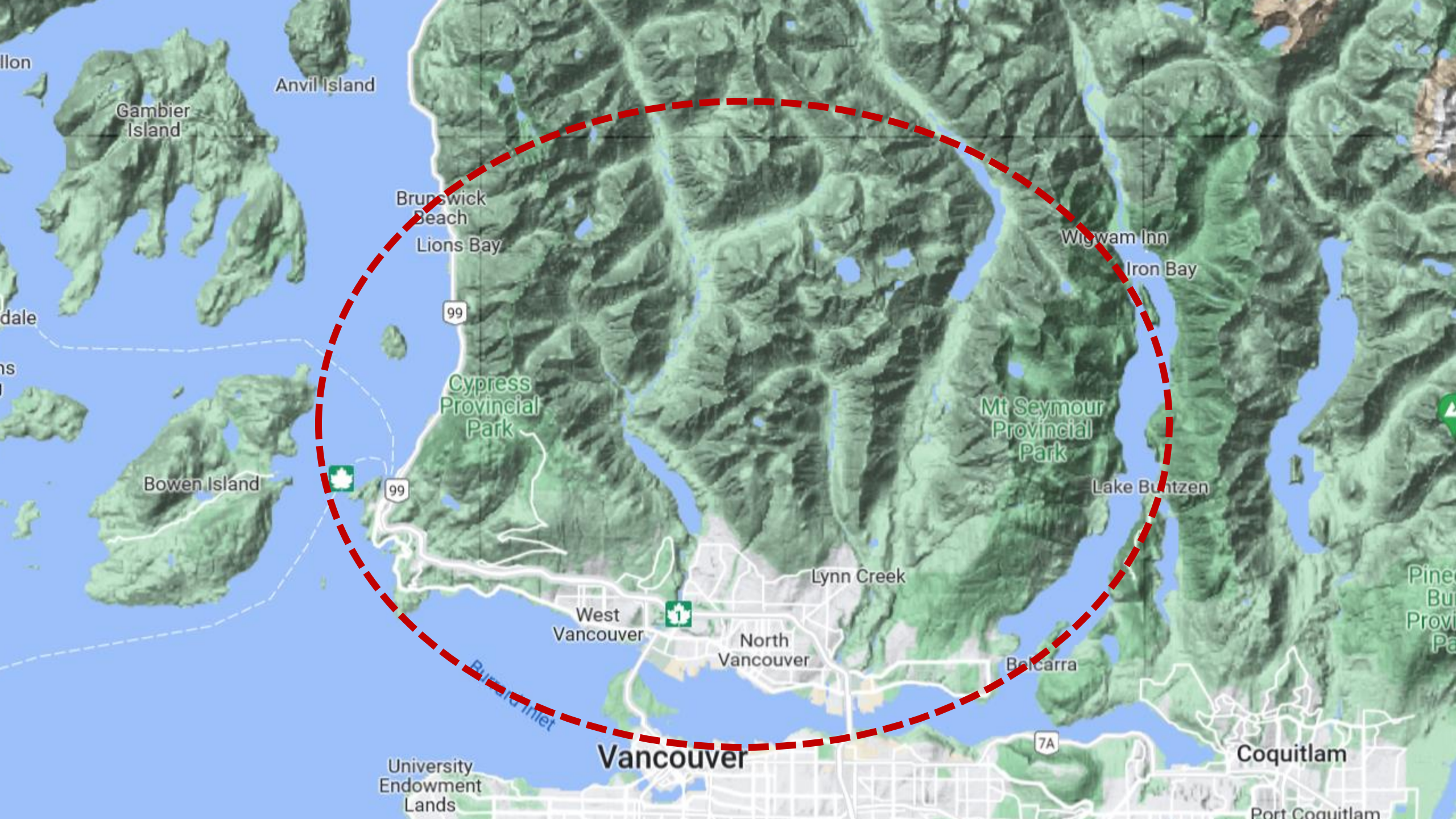


Developing the Strategy: Overview & engagement



A red lifeguard chair stands on a sandy beach in the foreground. In the background, a coastal town with houses and boats is nestled at the base of a large, forested hillside. The sky is overcast with soft, diffused light.

North Shore Sea Level Rise Risk Assessment & Adaptive Management Strategy



Anvil Island

Gambier Island

Brunswick Beach

Lions Bay

99

Cypress Provincial Park

Bowen Island

99

West Vancouver



North Vancouver

Lynn Creek

Vancouver

University Endowment Lands

Wigwam Inn

Iron Bay

Mt Seymour Provincial Park

Lake Buntzen

Balcarra

7A

Coquitlam

Port Coquitlam

Burrard Inlet

North Shore Sea Level Rise Strategy



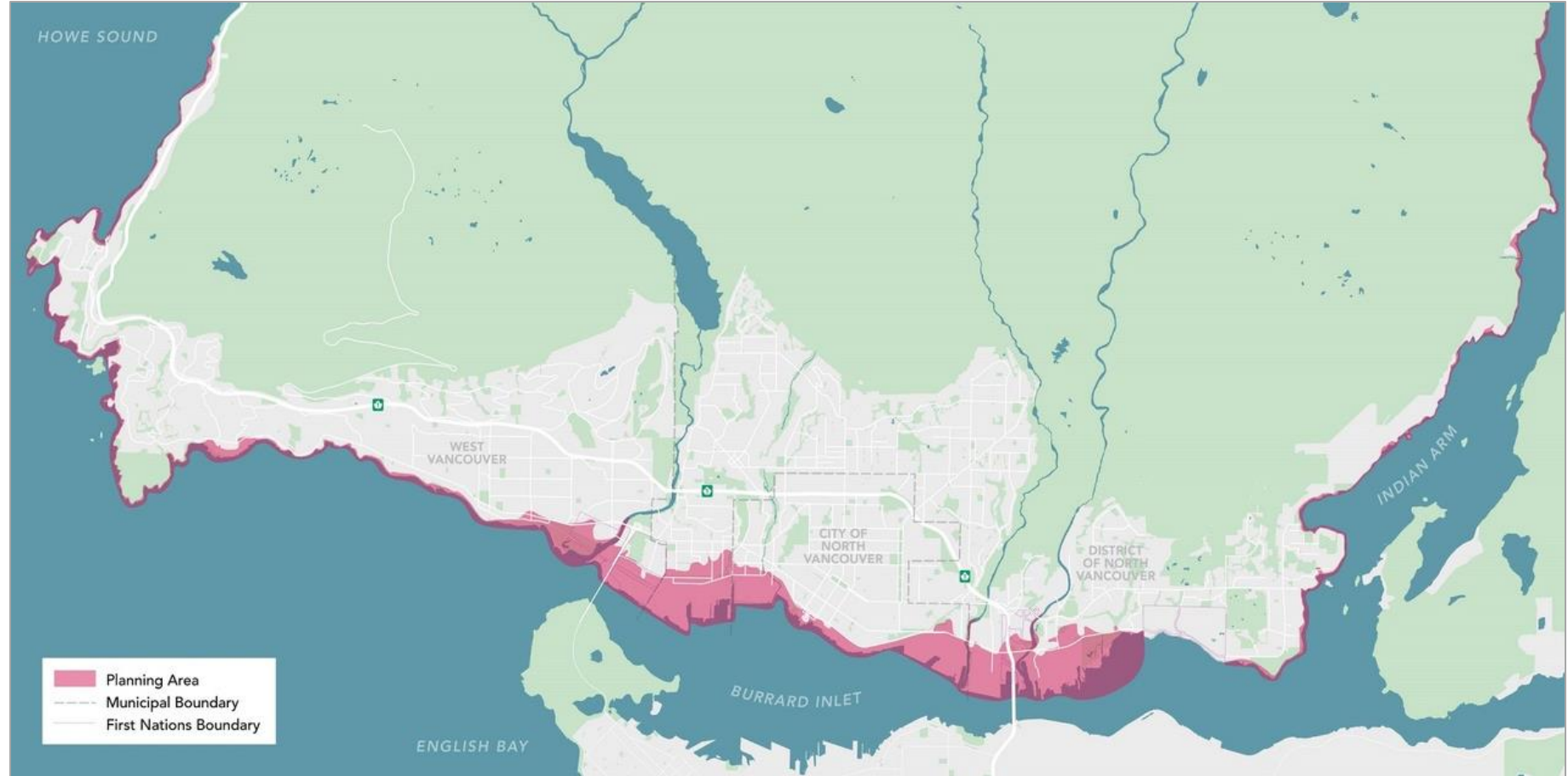
Skwxwú7mesh
Úxwumixw
Squamish Nation



Consultant:

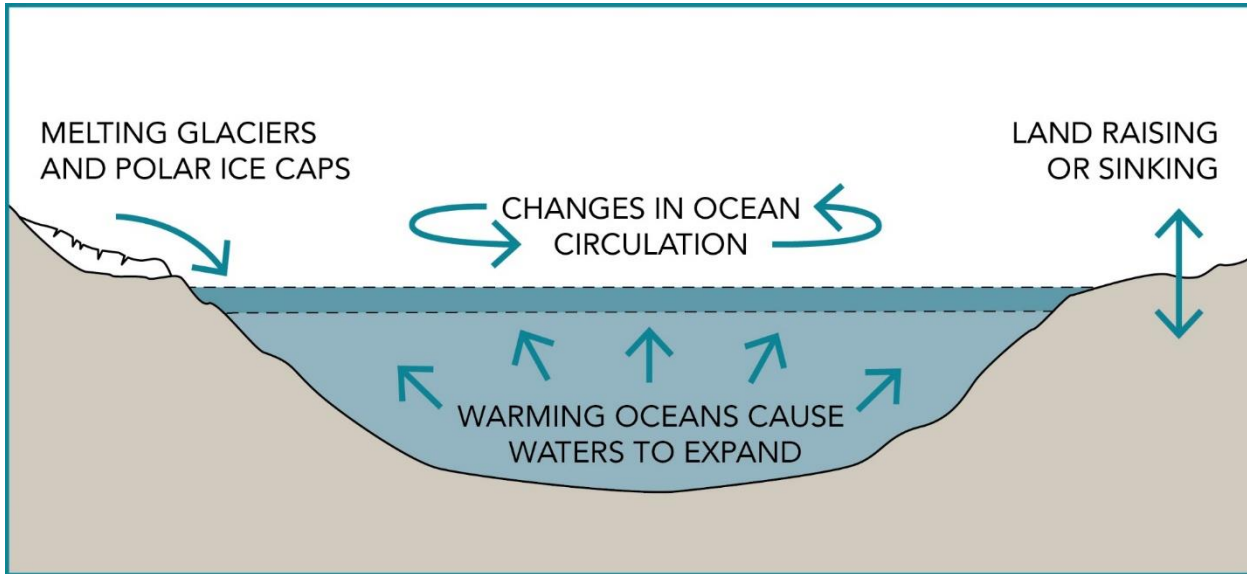


KERR WOOD LEIDAL
consulting engineers

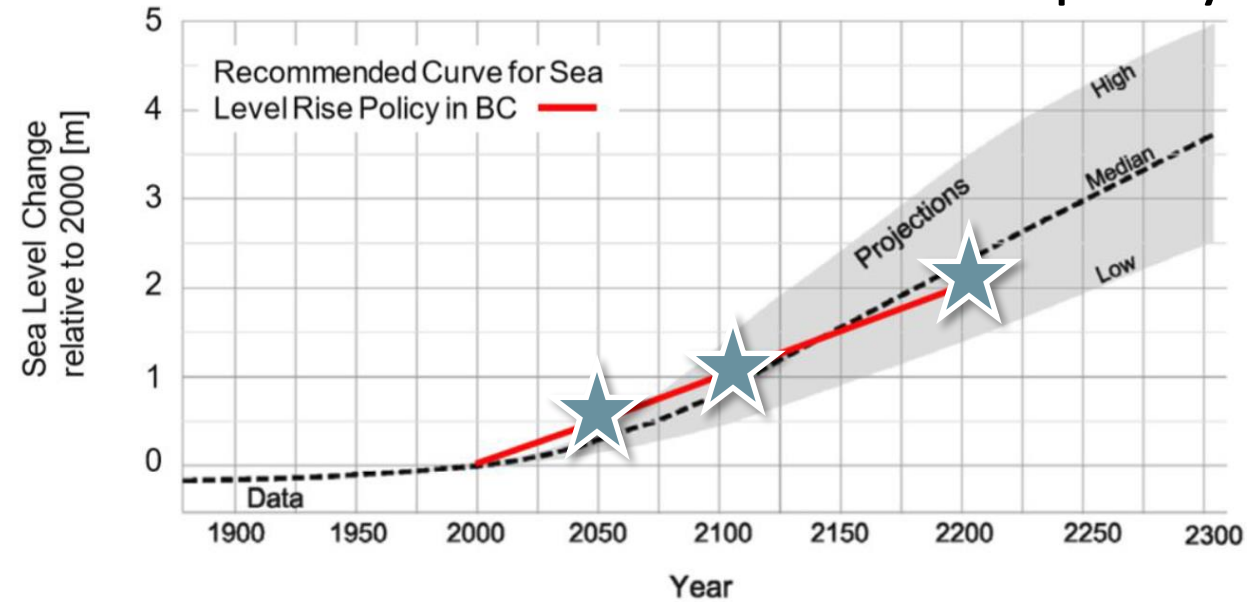


Sea Level Rise

Causes of sea level rise

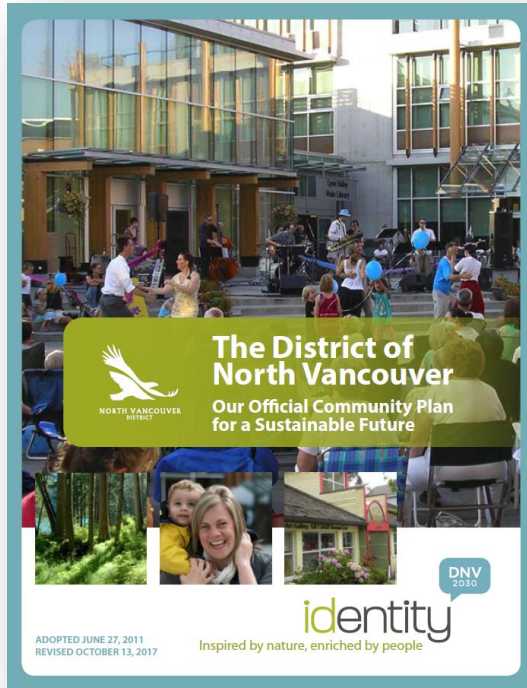


Provincial policy



(MOE/Ausenco Sandwell, 2011)

Policy Context

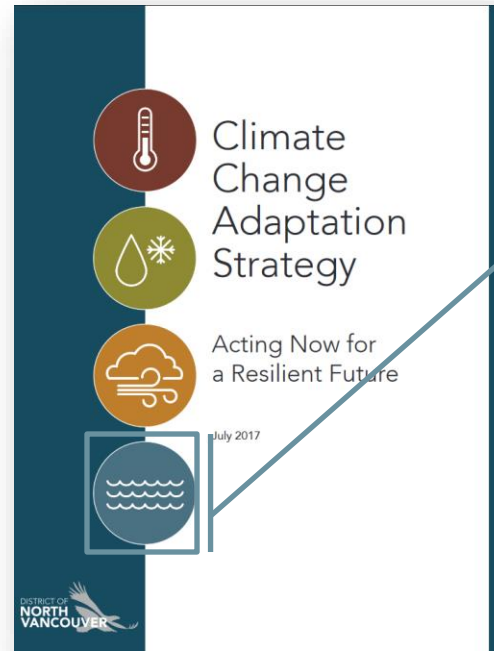


Official Community Plan

- Climate change objectives & policies

Adaptation →

Mitigation →



Climate Change Adaptation Strategy

Sea Level Rise



Community Energy and Emissions Plan

Process



Sea Level Rise

PHASE 1-3

Technical Analysis

SUMMER 2018 - SPRING 2019

- Review context
- Identify coastal flood hazards
- Assess vulnerability and risk

PHASE 4

Adaptation Actions Development

SUMMER 2019 - WINTER 2020

- Explore adaptation approaches
- Develop adaptation concepts and action areas

PHASE 5

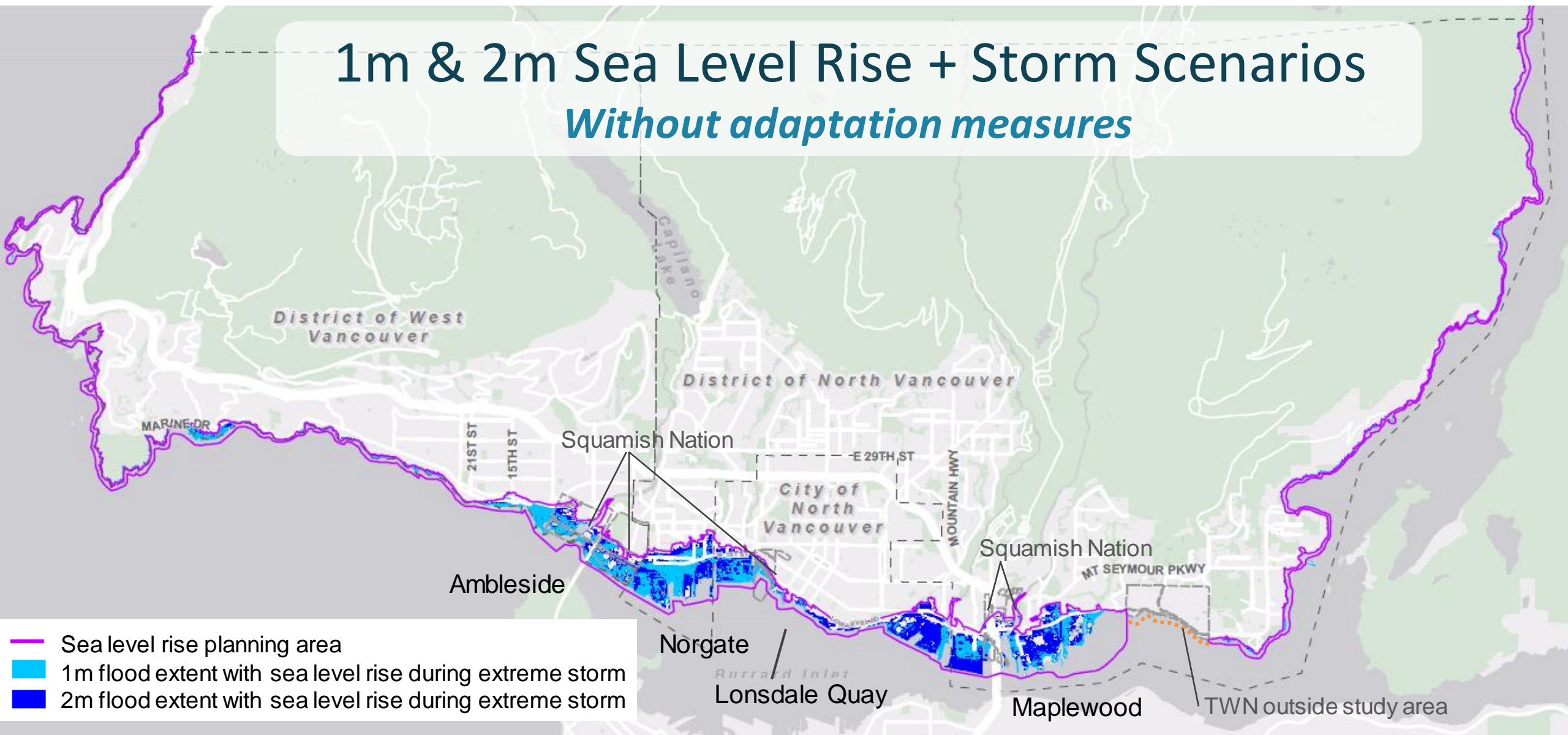
Final Strategy

2020

- Refine adaptation concepts and action areas
- Finalize strategy

1m & 2m Sea Level Rise + Storm Scenarios

Without adaptation measures

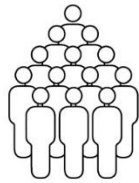


North Shore Consequences

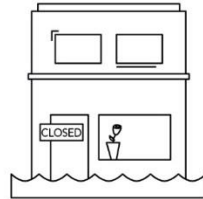
Without adaptation measures

1m

sea level rise



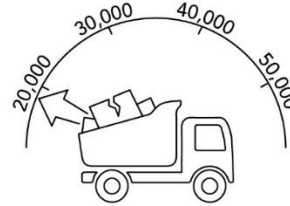
1,300+
residents could
EXPERIENCE
FLOODING



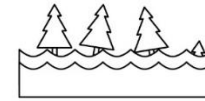
450+
businesses could
EXPERIENCE
FLOODING OR
POWER OUTAGE



~\$900
million
IN BUILDING
DAMAGE



~19,000
tonnes of
BUILDING
DAMAGE
DEBRIS



~80
hectares of
parkland
AT RISK OF
FLOODING

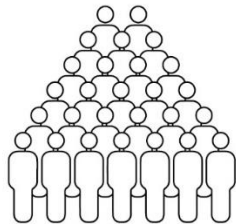


~40
Cultural and
heritage places
AT RISK OF
FLOODING

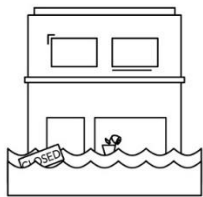
During major storm (10% annual probability), whole study area

2m

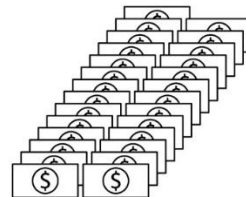
sea level rise



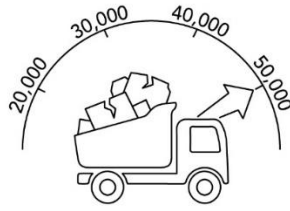
2,700+
residents could
EXPERIENCE
FLOODING



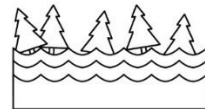
~1,900
businesses could
EXPERIENCE
FLOODING OR
POWER OUTAGE



~\$2.7
billion
IN BUILDING
DAMAGE



~50,000
tonnes of
BUILDING
DAMAGE
DEBRIS



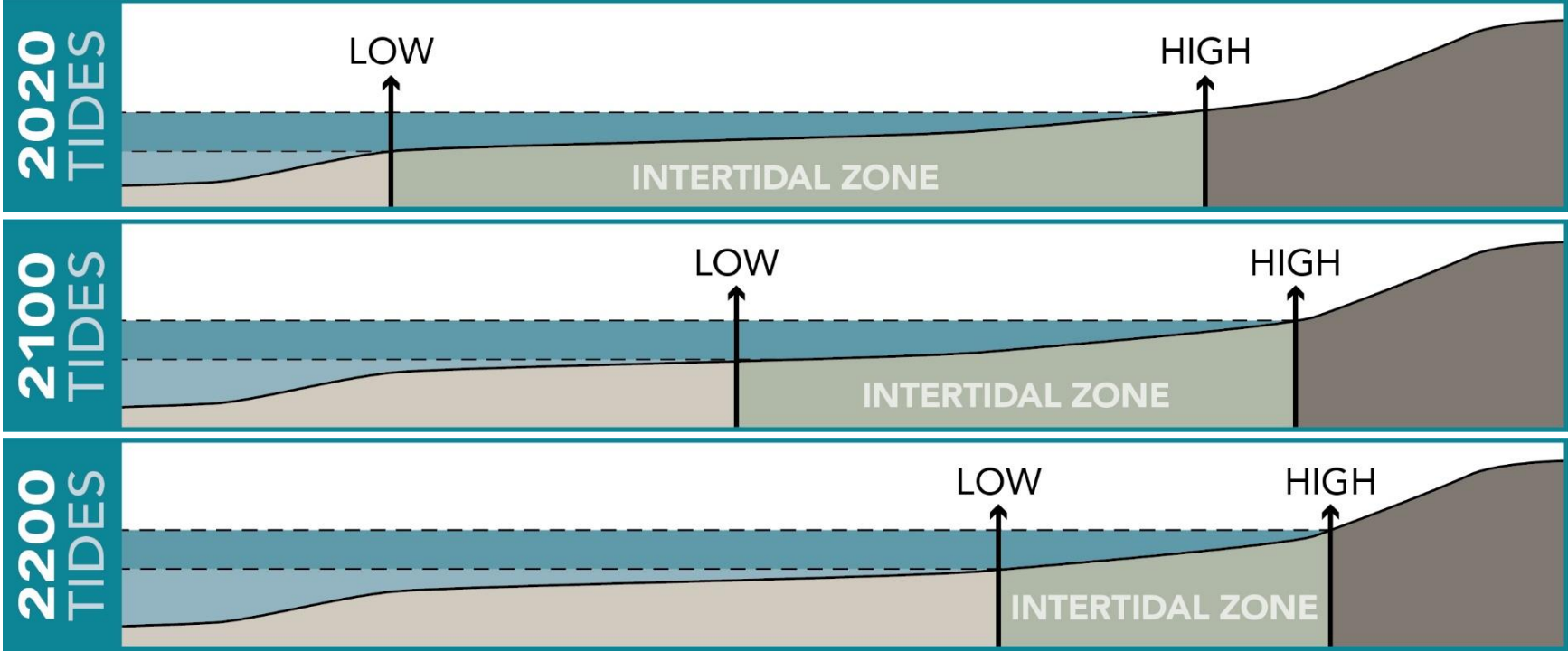
~105
hectares of
parkland
AT RISK OF
FLOODING



~50
Cultural and
heritage places
AT RISK OF
FLOODING

During extreme storm (0.5% annual probability), whole study area

Consequences: Intertidal Habitat



Engagement & Communication



Preparing our North Shore communities for rising sea levels



Engagement & Communication

- Digital-first webpage



Accommodate

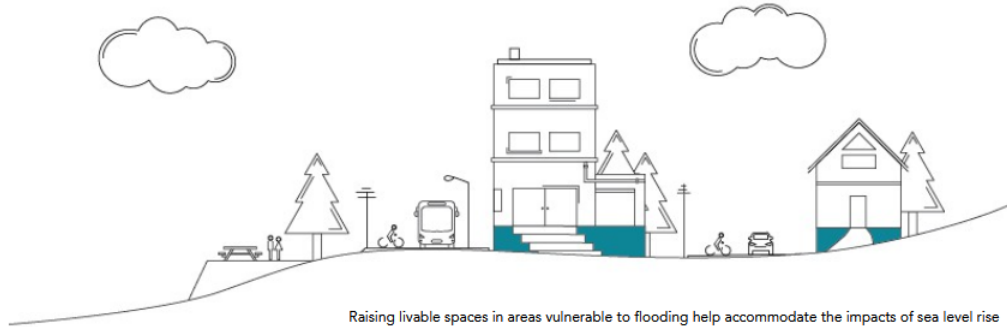
Focus on non-structural adaptation measures, including consciously acknowledging flood risk, defining how much risk we are willing to tolerate, and raising livable spaces in areas vulnerable to flooding.

Pros

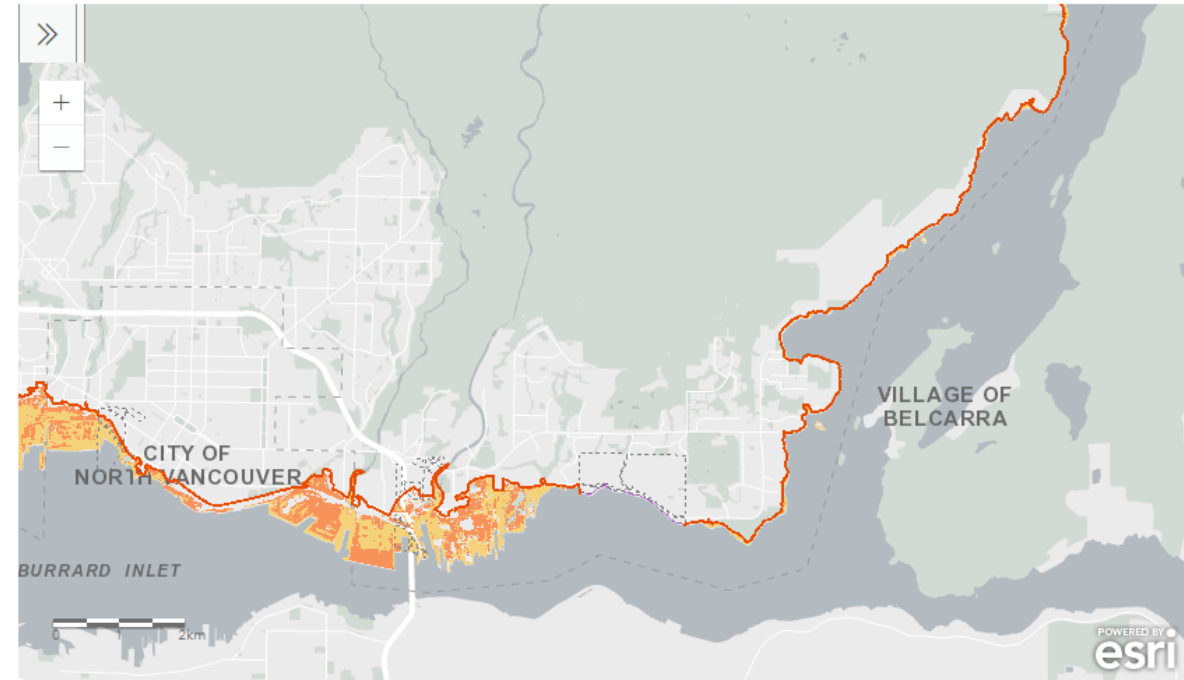
Well-suited for gradual implementation in pace with redevelopment and infrastructure upgrades.

Cons

Implementation pace is limited based on the timing of development and infrastructure upgrades, potential for elevated risk, and difficulty assessing risk tolerance.



Raising livable spaces in areas vulnerable to flooding help accommodate the impacts of sea level rise

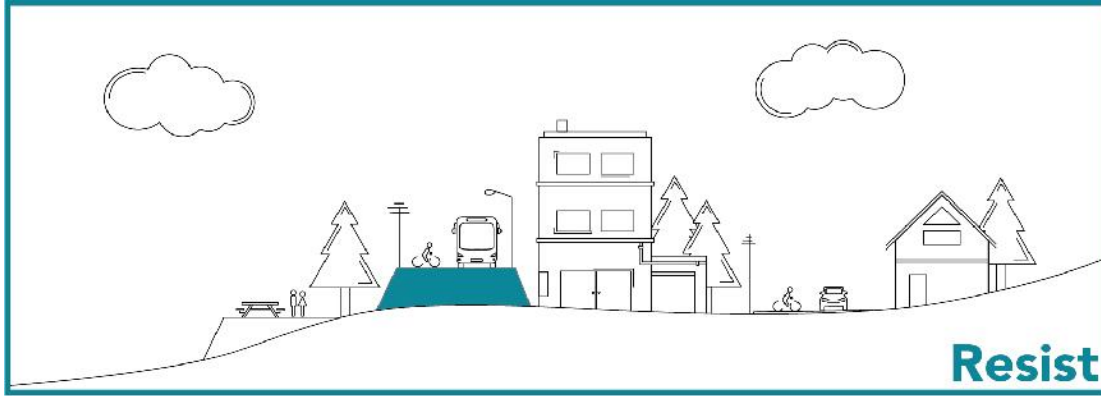


MAP | Areas anticipated to be flooded during an extreme storm with a 1 metre (light orange) and 2 metre (dark orange) rise in sea levels, if we don't adapt. Actual coastal flooding may vary, depending on shoreline characteristics and wave effects. ([How we developed this map](#))

[Explore larger map](#)

Adaptation Approaches

Likely a combination of approaches

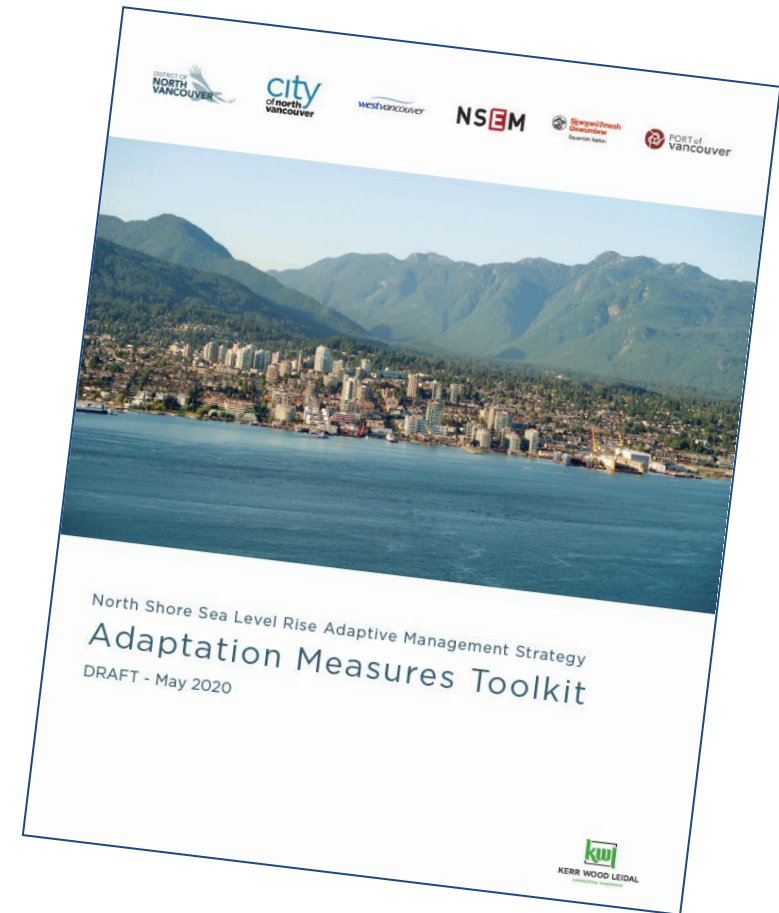


Community Workshops



North Shore Adaptation Measures Toolkit

- Toolkit tailored to North Shore context
- 26 adaptation measures



Adaptation Measures Toolkit Examples



Nature-based measures for waves & erosion



Storm water management



Land raising



Land reshaping



Building flood-proofing

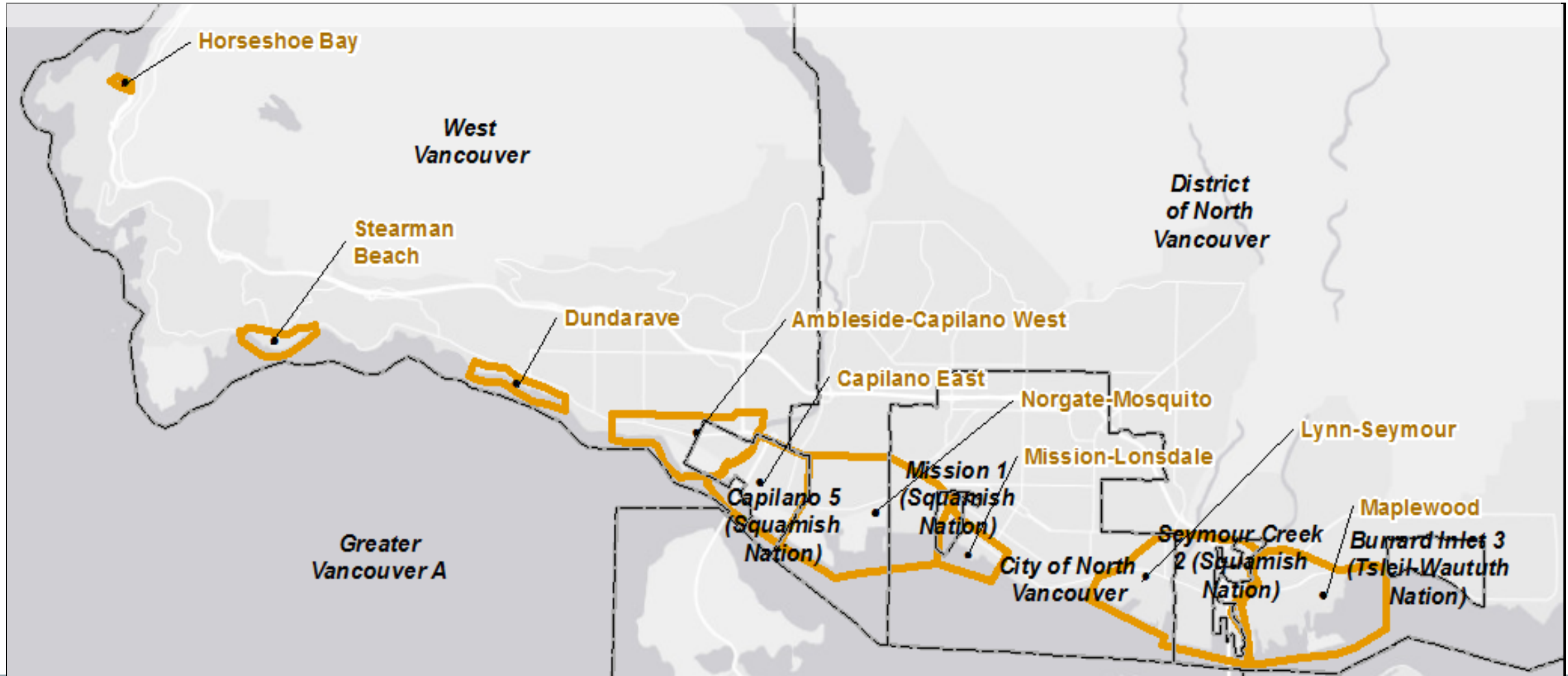


Setback dike



Pump stations

Comprehensive Adaptation Planning Zones



Implementation Actions

1. Continue North Shore sea level rise working group
2. Build knowledge and fill gaps
3. Create Comprehensive Adaptation Plans
4. Update regulations & policies
5. Continue building public awareness
6. Coordinate with other governments



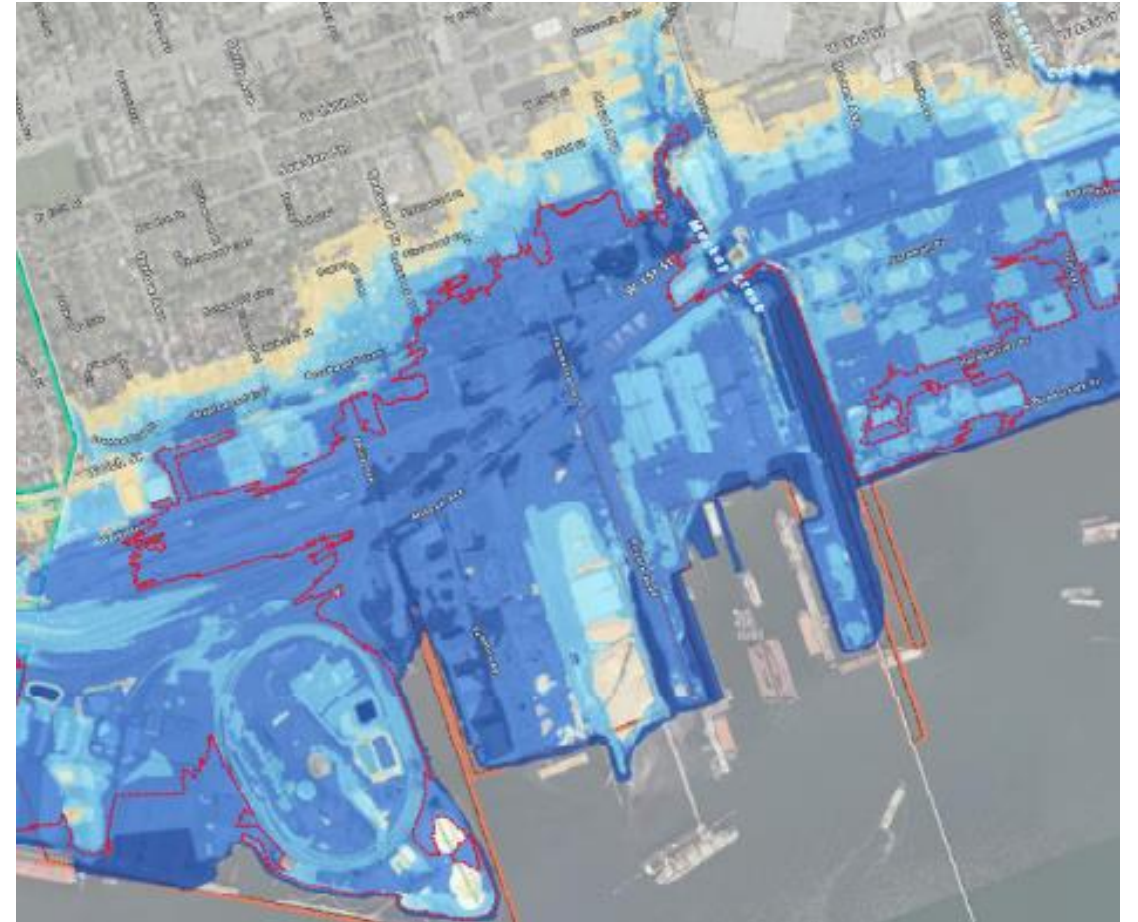
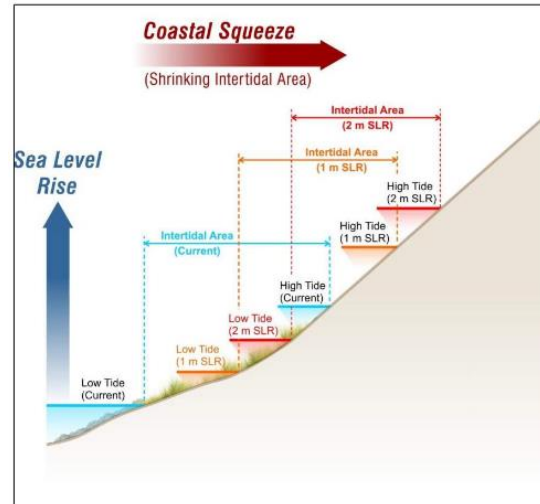


Developing the Strategy: Technical



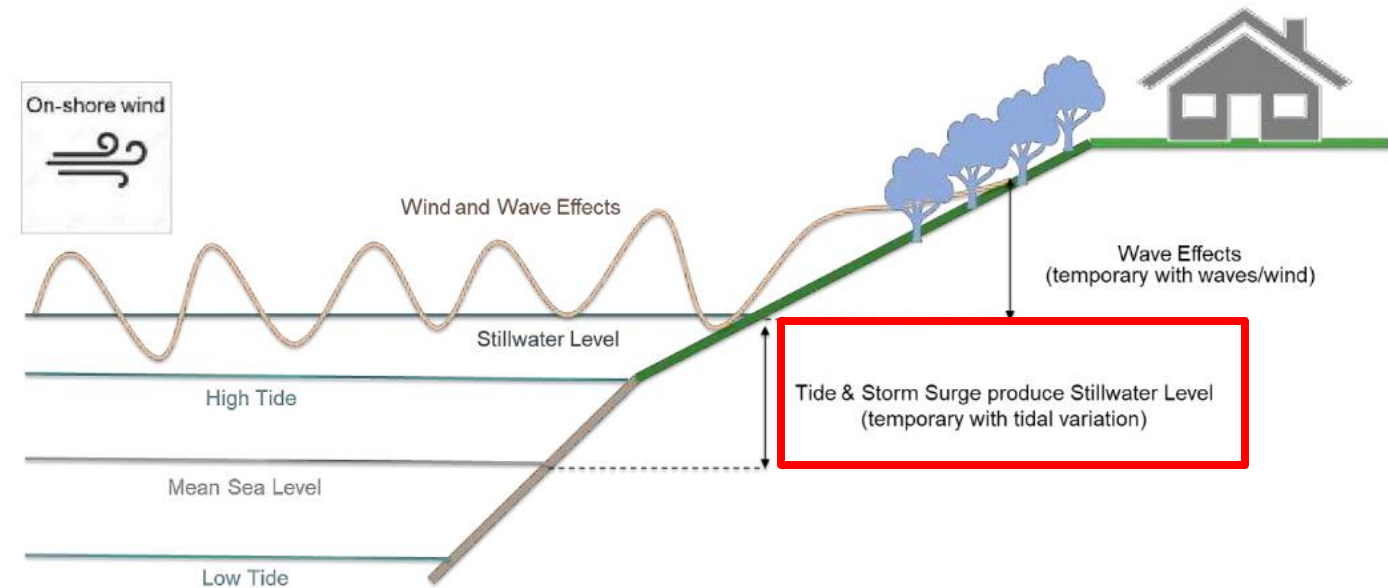
Hazard Assessment

- Flood depth mapping
- Intertidal area change
- Other hazards



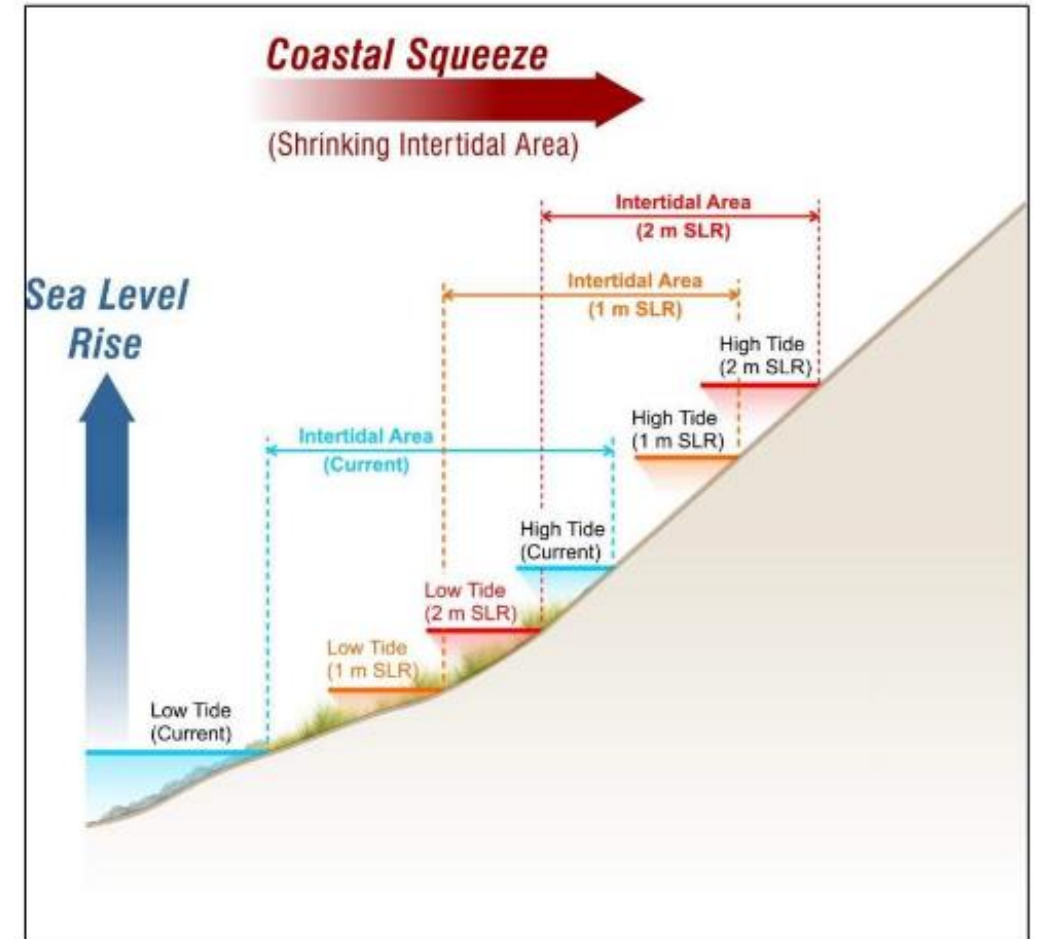
Flood Depth Mapping

- Scenarios: SLR + return-period coastal stillwater elevation
- 2 scenarios selected to drive consequence & risk assessments:
 1. 1 m SLR + relatively frequent flood (10-yr RP)
 2. 2 m SLR + relatively infrequent flood (200-yr RP)



Intertidal Area Change

- Examined two ‘end members’ of potential adaptation approaches: “resist” vs. “managed retreat”
- Very different impacts on intertidal area



Consequence & Risk Assessments

1. Coastal flood consequence assessment

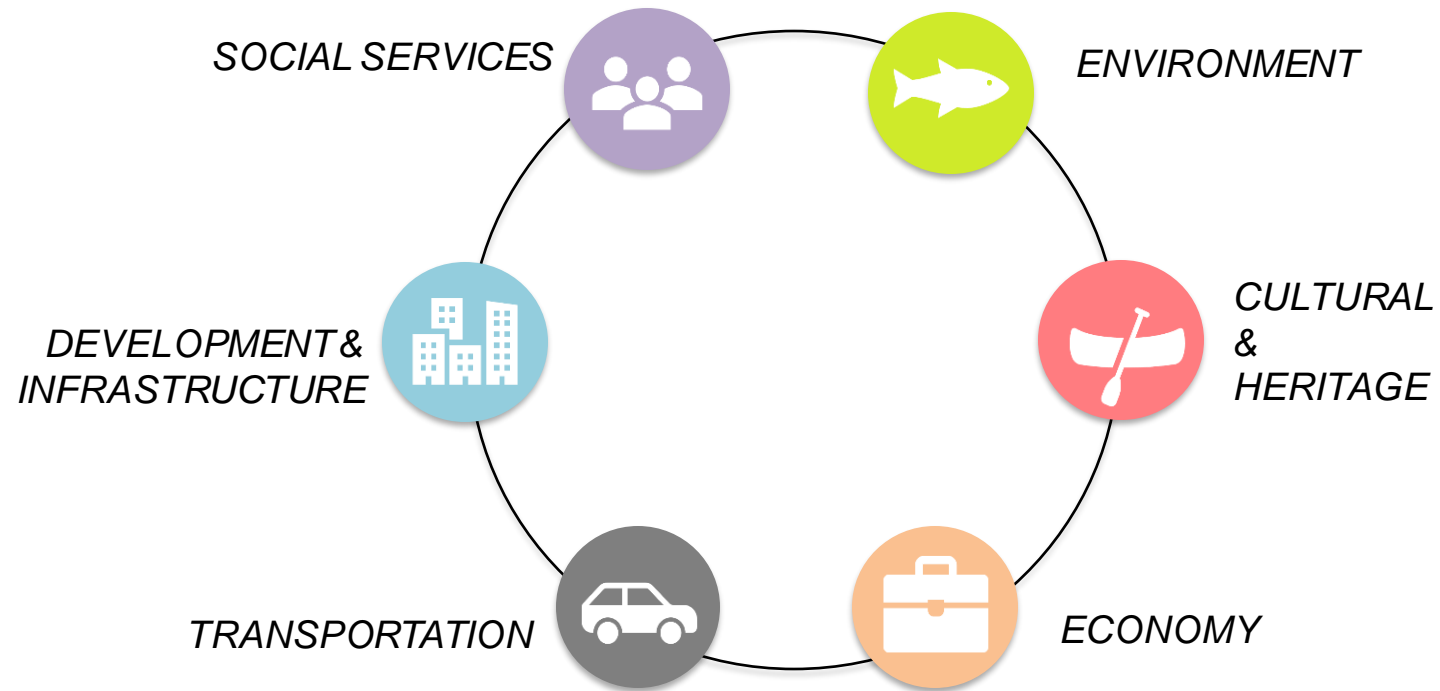
2. Economic disruption assessment (Port of Vancouver)

3. Environmental habitat consequence assessment



Coastal Flood Consequence Assessment

- 6 sectors ->> 24 variables



Consequence Assessment: Sectors & Variables

SOCIAL SERVICES



- Population displaced
- Vulnerable population affected (inundation/power outage)
- Number of exposed (inundation/power outage):
 - Schools
 - Healthcare facilities
 - Services for vulnerable population

BUILDINGS & INFRASTRUCTURE



- Areas of prolonged power outage
- Number of affected (inundation/power outage):
 - First responder facilities (fire, police, ambulance)
 - Band-owned buildings
 - Major port operators
- Number of exposed pump stations

ENVIRONMENT



- Park area exposed
- Debris generated [Tonnes]
- Number of exposed:
 - Hazardous waste storage sites and generating sites
 - Contaminated sites (provincial & federal)
 - Intertidal vegetation areas

ECONOMY



- Direct building damage [CAD\$]
 - Residential, commercial, industrial, governmental
- Business disruption [number of temporary business closures]
 - Major industries

CULTURAL & HERITAGE



- Number of exposed:
- Archaeological sites
 - Historic sites
 - Heritage buildings

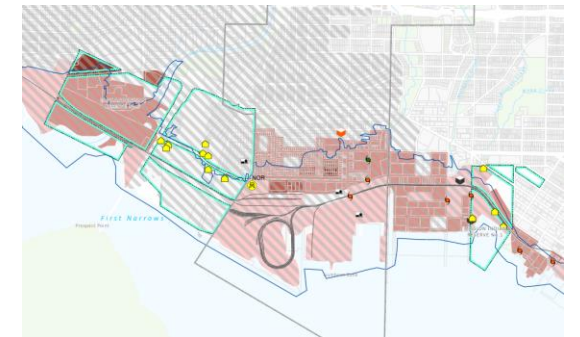
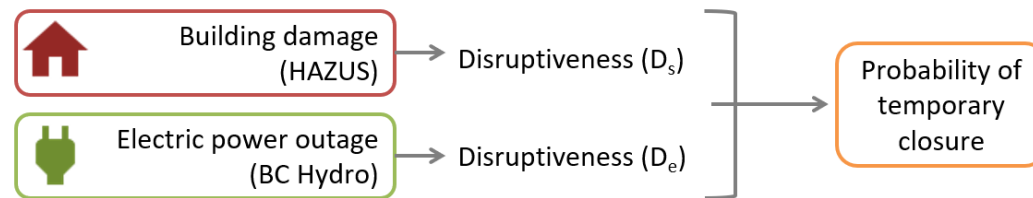
TRANSPORTATION



- Number of exposed:
 - Transit points
 - Bus routes
 - Segments of major routes exposed
 - Segments of emergency response routes
- Gas stations affected by inundation and/or power outage

Consequence Assessment: Methods

1. HAZUS
2. Power outage scenarios
3. Business disruption model
4. GIS exposure analysis



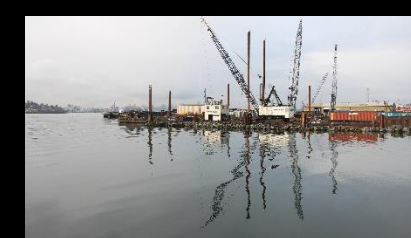
Results: Highlights

- Large consequence even outside of extreme events
- Consequence for more extreme storm + 2 m SLR are on the order of other major disasters (e.g. Calgary 2013)
- Projected impacts of SLR extend well beyond the limits of inundation





Implementing the Strategy



District of West Vancouver – SLR Adaptation

- Waterfront community
- ~800 waterfront properties (single family dwellings)
- Waterfront amenities – parks, seawalk, public beaches, infrastructure/buildings
- Variable topography (High bedrock, low-lying areas, beaches, islands)
- Greater frequency of coastal flooding/storm events/king tides
- High exposure to wind/wave action

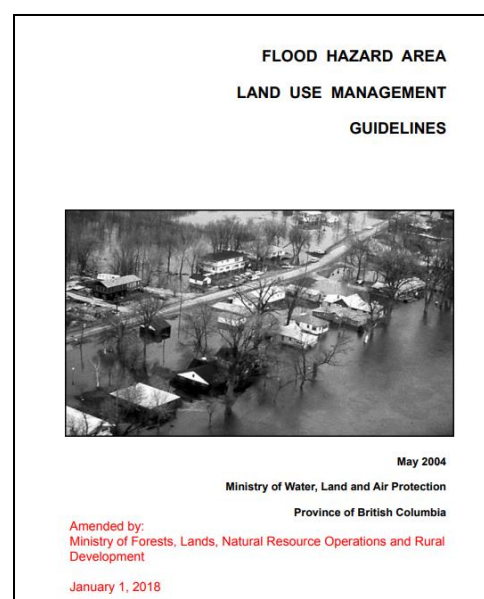


Need to Explore Local Adaptation



Sea Level Rise Policy Development

- Focus – Protection of private properties:
 - Objective – To determine a mechanism to incorporate Provincial guidance for land use planning in flood hazard areas into policy planning
 - Needed an adaptation measure that was feasible for immediate implementation (**using NS Adaptation Measures Toolkit**)
- Flood mapping:
 - Area Flood Construction Levels to define flood hazard zones across coastline (accounting for **wave effects**, topography, bathymetry)
 - Evaluated options to adapt to sea level rise (area and site-specific measures)



Adaptation Approach - Accommodate

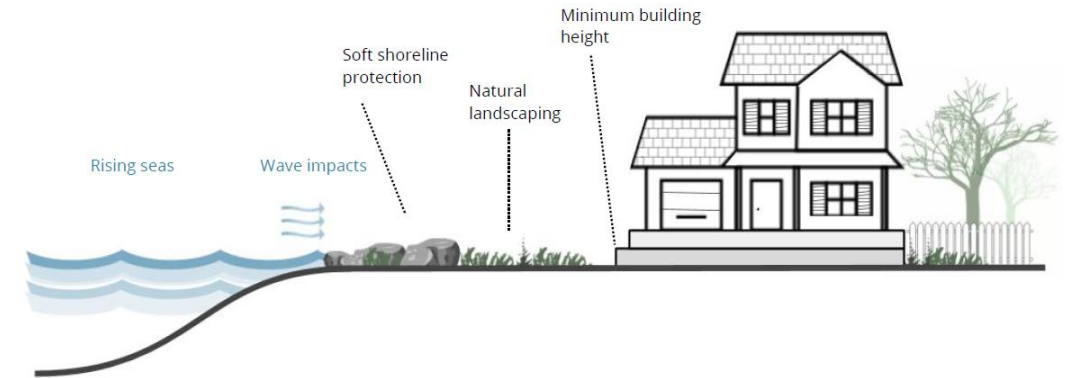
- Chose to “Accommodate” sea level rise for private property development by **land raising** and **flood proofing** livable spaces in areas vulnerable to flooding.



- Evaluated the most appropriate mechanism to require houses to be built to the flood construction level – bylaw, development permit area, etc.

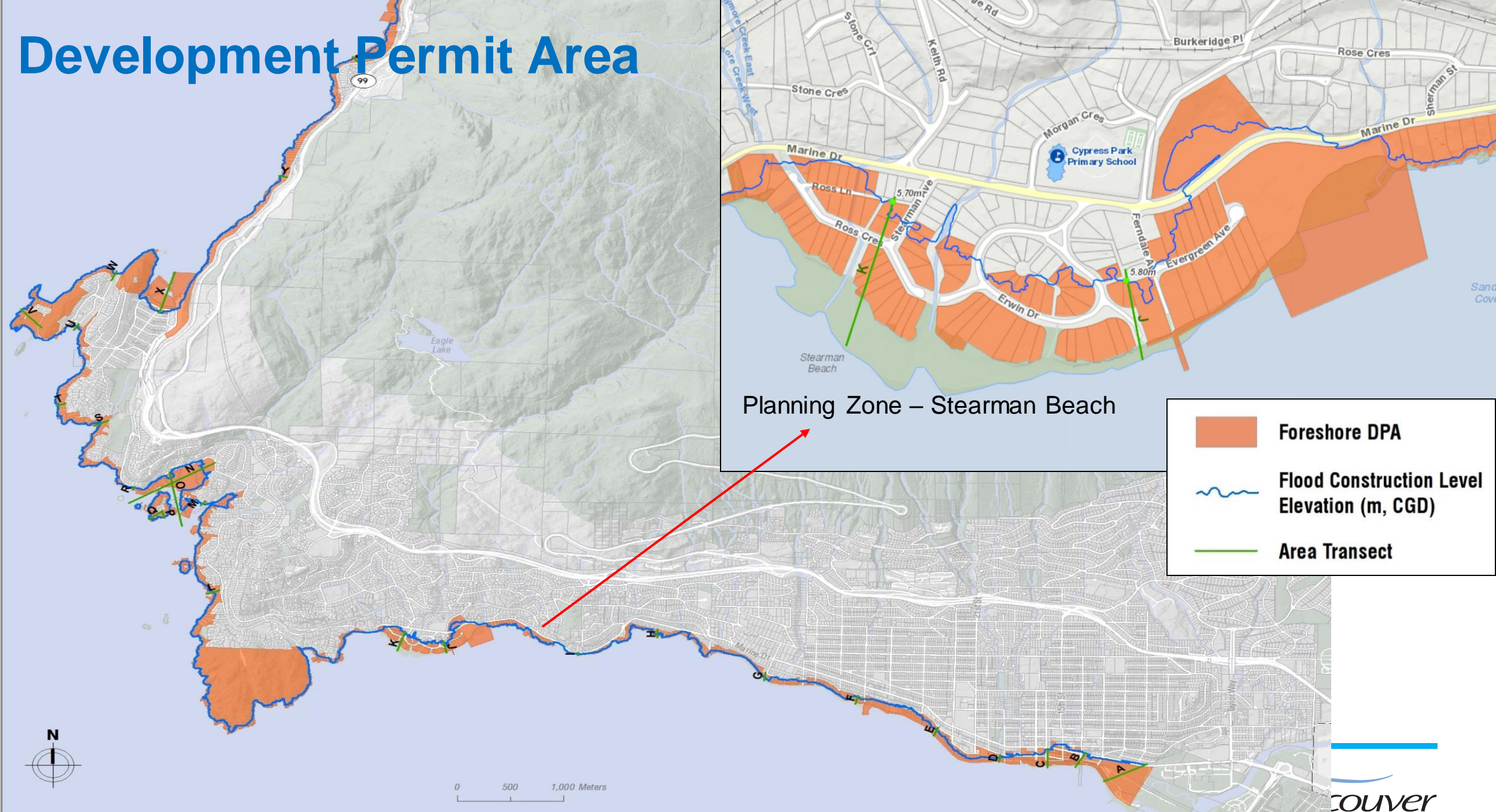
Policy Approach - Development Permit Area (adopted April 2022)

- Allows LGs to identify locations that need special treatment for certain purposes:
 - protection of development from hazards
 - protection of natural environment






- Benefits of DPA:
 - Raises awareness to homeowners and potential buyers of flood risks
 - Builds resilience from coastal flooding within the community
 - Provides a consistent framework for permitting of development activities
 - Provides flexibility to allow homeowners to explore options for redevelopment
 - Ability to include environmental protection requirements

Development Permit Area



Planning Zone – Stearman Beach

	Foreshore DPA
	Flood Construction Level Elevation (m, CGD)
	Area Transect



0 500 1,000 Meters

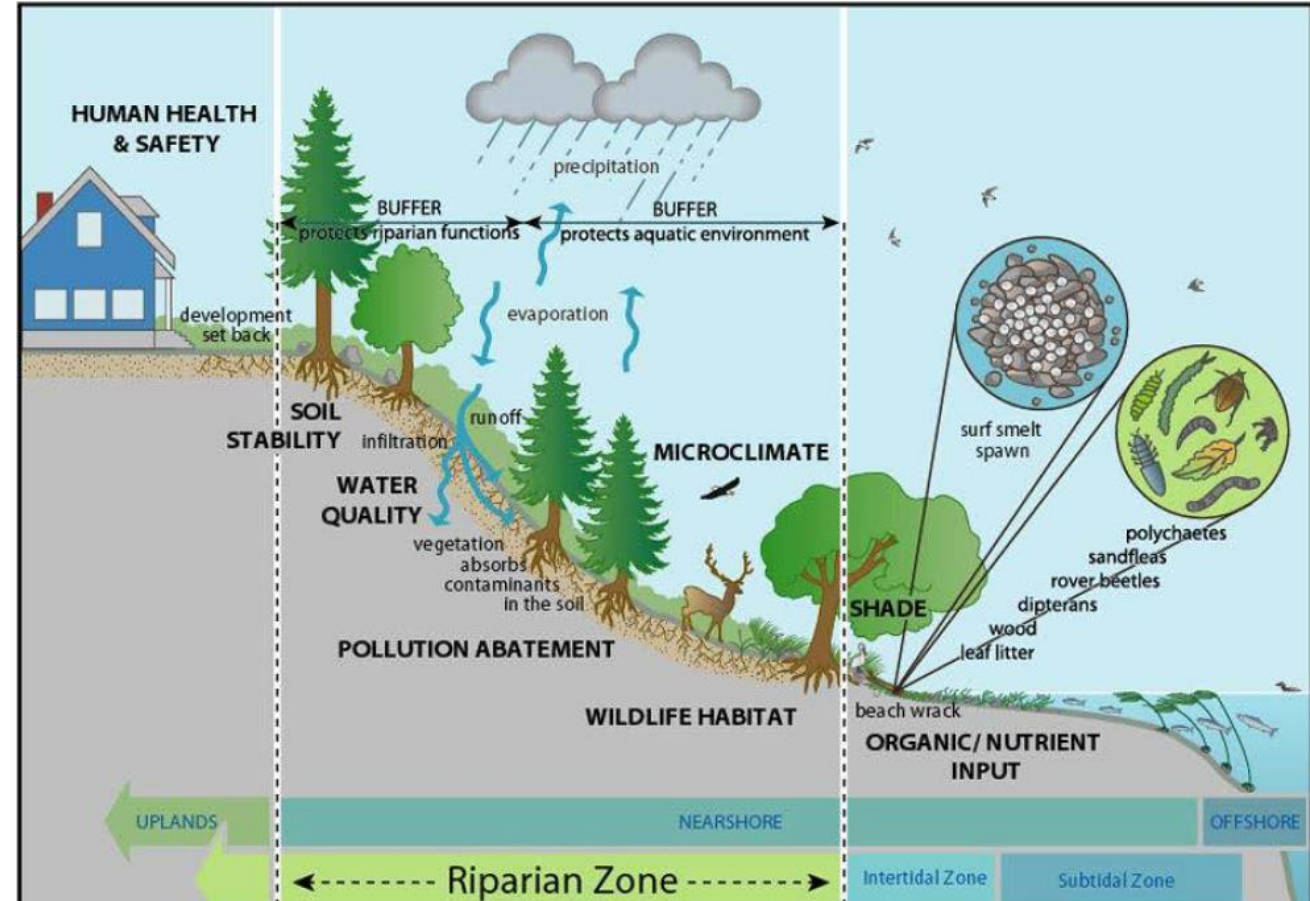
DPA Subdivide or Build Guidelines

- Dwelling needs to be at or above flood construction level (FCL):
 - Provide options to homeowner: use (1) area-FCL provided by District or (2) calculate FCL for a property.
- Additional Requirements:
 - Mechanical infrastructure and access points above FCL or floodproofed.
 - Specifications for fill, if required to increase the grade of the property.
 - Stormwater management accounts for SLR and grade changes.
 - Landscaping and zoning variances - address grade differences, view, privacy, proximity to neighbours.
- DP exemptions (structures allowed below FCL) – follows Provincial guidance.

Protection of Foreshore Habitat

DPA includes protection measures in the riparian “buffer” zone of the intertidal habitat:

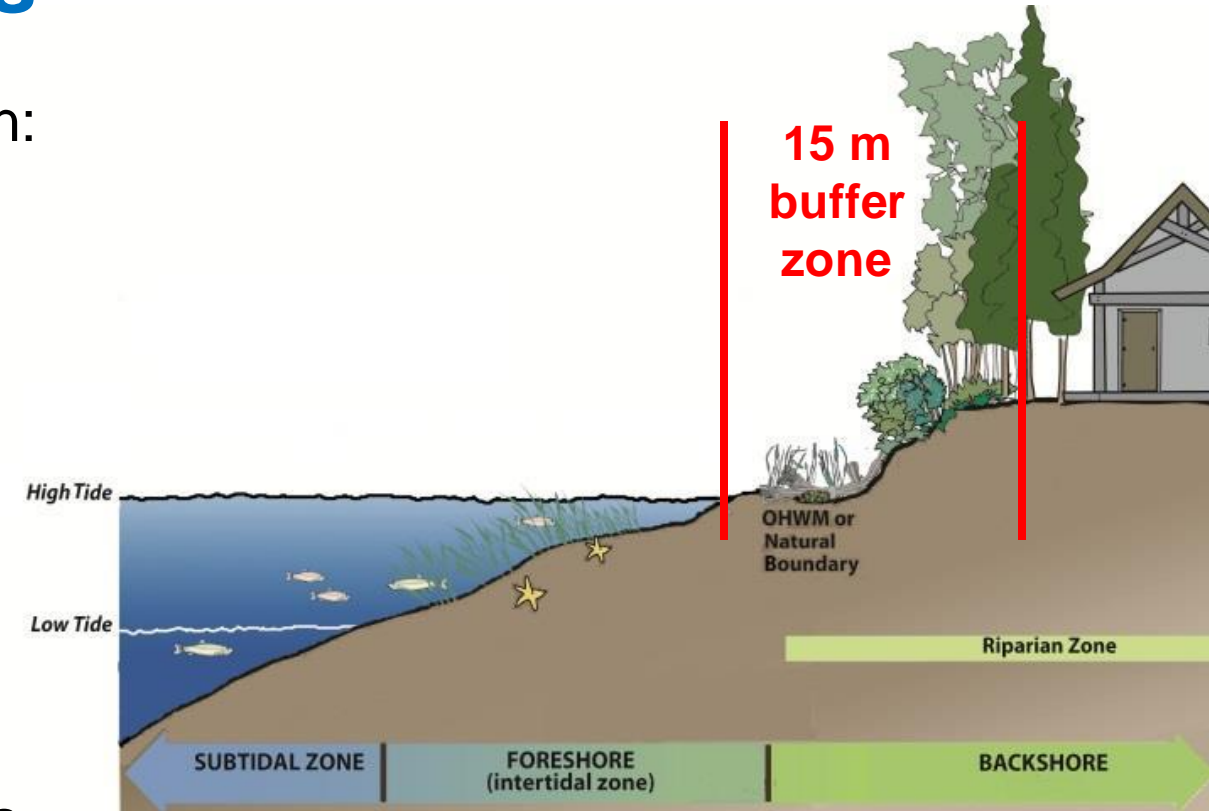
- Impact pathway to fish and fish habitat
- Buffer to protect the function of the ocean from:
 - Pollution and run-off
 - Scour and erosion
 - Ocean debris
 - Loss of habitat



DPA Environmental Guidelines

Within 15 m of the natural boundary of the ocean:

- Required - environmental assessment for new structures/hard surfaces that considers:
 - Retention of sensitive habitat (trees, outcroppings, sand/natural areas)
 - Slope stability
 - Wave/storm impacts on new structures
 - Removal of hard surfaces where possible
- Soft/natural landscaping and building materials.
- “Hard” armouring only where determined that “soft” approaches are not appropriate.
- Bylaw protection of all trees within this buffer zone.





Thank you

