



**SFU** SIMON FRASER UNIVERSITY  
THINKING OF THE WORLD  
ADAPTATION TO CLIMATE CHANGE TEAM

# GREEN WATERFRONT DESIGN CHARRETTE REPORT

## ACKNOWLEDGMENTS

This report was prepared by West Coast Environmental Law, with assistance from Robert Barrs, MODUS Planning, Design and Engagement, and George Benson. The charrette was organized by West Coast Environmental Law with assistance from Adaptation to Climate Change Team (ACT) – SFU, MODUS, graduate students from SCARP-UBC and SFU’s School of Public Policy, and participating municipalities (City of Vancouver, City of North Vancouver, District of North Vancouver, District of West Vancouver and District of Squamish). Planning and design experts provided additional support (see Part V for a complete list). Cory Dobson, City of Vancouver, and James Allan, District of West Vancouver, provided charrette participants with background information about the subject neighbourhoods.

In addition, more than 40 invited charrette participants, including staff from participating municipalities, provincial representatives and local design experts provided their time, expertise and insights to assist in developing the design ideas presented in this report.

The idea to have a design charrette to explore green strategies to build resilience to sea level rise in communities around the Burrard Inlet came from collaborative meetings of staff from participating municipalities, facilitated by West Coast Environmental Law and ACT-SFU.

West Coast Environmental Law is grateful for the generous support of the Real Estate Foundation of BC, the Vancouver Foundation, the Bullitt Foundation and the Law Foundation of BC, and our ongoing collaboration with Deborah Harford and ACT-SFU. We would also like to acknowledge of staff from City of Vancouver and District of West Vancouver in preparing this report, and to thank the City of Vancouver for hosting the charrette at Creekside Community Centre, and the City of Vancouver and the City of North Vancouver for providing additional funding.



The Bullitt Foundation



West Coast is a non-profit group of environmental law strategists and analysts dedicated to safeguarding the environment through law. We believe in a just and sustainable society where people are empowered to protect the environment and where environmental protection is law. For almost 40 years, we have played a role in shaping BC and Canada’s most significant environmental laws, and have provided support to citizens, First Nations, and communities on practically every environmental law issue imaginable.



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## PART I

# Introduction

The Green Waterfront Design Charrette brought together design experts and staff from five British Columbia municipalities, including planners, engineers, sustainability specialists, emergency managers and biologists. Working collaboratively, they explored how shifts in land use and building design could support community resilience to sea level rise, focusing on responses that developed green infrastructure and provided opportunities to protect and restore coastal ecosystems, and maintain valuable natural shoreline amenities.

## WHY DO WE NEED A GREEN WATERFRONT DESIGN CHARRETTE?

### Rising seas in the Lower Mainland expose local vulnerability

Local governments in coastal communities around the world need to prepare for sea level rise, a climate change impact that is sometimes called “a slow-moving emergency.” The waters are not rising overnight, but neither can we quickly get out of the way, in prime coastal areas dense with people, development and infrastructure. In British Columbia, 2011 technical guidance from the Province<sup>1</sup> suggested that coastal communities in BC should be preparing for 0.5 metres of sea level rise (SLR) by 2050, one metre by 2100,

and two metres by 2200. Local governments and other authorities in BC that regulate development and provide local services have been grappling with how to translate this guidance into practice ever since.

Despite the futuristic ring to the provincial projections, the 50-100 plus year life span of most buildings and infrastructure means that planning and decisionmaking for coastal areas needs to account now for this new challenge. At the same time, given the uncertainty around sea level rise projections (primarily the rate of change),<sup>2</sup> we need to look at approaches that can also be adapted over time. Ideally, decisions that are made now will support future resilience, and will not lock us into responses that turn out to be inadequate and difficult to modify, financially unsustainable, or even maladaptive, i.e. worsening the impacts of climate change on the built and natural environment and the people who live there.

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<sup>1</sup> Ausenco Sandwell (2011) Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use, Guidelines for Management of Coastal Flood Hazard Land Use. Available online at: [http://www.env.gov.bc.ca/wsd/public\\_safety/flood/pdfs\\_word/guidelines\\_for\\_mgr\\_coastal\\_flood\\_land\\_use-2012.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/guidelines_for_mgr_coastal_flood_land_use-2012.pdf)

<sup>2</sup> Ibid.

Protection and restoration of natural shorelines and habitats can be an effective, and cost-effective way to buffer coastal communities against the impacts of rising sea levels, while also preserving recreational, aesthetic and real estate values.



Bulthead removal at Jericho Beach, Vancouver. Photo courtesy Nick Page and Green Shores SCBC.

In the Lower Mainland, Coast Salish Nations have lived in coastal communities for millennia, successfully and sustainably. Yet more recent settlement in the region over the past 150 years has contributed intensive industrial development and urbanization more or less indiscriminately along the shoreline. Often this latter development has radically altered the soft edges of the natural shoreline to create hard edges that accommodate industrial and commercial uses and privately owned residential property. Dikes, sea walls, bulkheads, piers, riprap and other types of armoring allow the location of buildings and other structures near sea level and lower, in locations that may already be vulnerable to the sea.<sup>3</sup> Now that sea levels are rising these areas are further exposed, both to

incremental inundation and storm surges. Hard armoring tends to increase erosion and can also have negative impacts on adjacent property.<sup>4</sup>

## Protection and restoration of coastlines offers resilience to rising seas

Most attention to date regarding sea level rise in the Lower Mainland has been directed to the costs and logistics of raising existing dikes and related structures and maintaining the protection they provide for both urban and rural properties in the region.<sup>5</sup>

However, particularly for areas not currently protected by dikes, including most of the coastline in and around Burrard Inlet and Howe Sound, we have the opportunity to consider more resilient approaches.

A growing body of research and practice supports the protection and restoration of natural shorelines and habitats as an effective, and cost-effective way to buffer coastal communities against the impacts of rising sea levels, while also preserving recreational, aesthetic and real estate values.<sup>6</sup> A study from the Green Shores initiative verified the effectiveness and relative affordability of these types of approaches on the south coast of BC.<sup>7</sup> Combining the protection and restoration of shorelines and estuaries with adaptive design approaches for the built environment allows us to start thinking about coastal communities that will bend, but not break in the face of climate change impacts and sea level rise.



<sup>3</sup> A 2009 assessment, for example, found that approximately 65% of the shoreline of the Burrard Inlet (190 km) has been hardened with riprap or a retaining wall. See Burrard Inlet Environment Action Program (2009) Burrard Inlet Shoreline Change – Baseline Assessment, available online at: [http://www.bieapfremf.org/pdf/burrard\\_inlet\\_shoreline\\_change-baseline\\_assessment\\_dec\\_09.pdf](http://www.bieapfremf.org/pdf/burrard_inlet_shoreline_change-baseline_assessment_dec_09.pdf)

<sup>4</sup> See for example, New York State Department of Environmental Conservation, Shoreline Stabilization Techniques, available online at: <http://www.dec.ny.gov/permits/67096.html>

<sup>5</sup> Delcan (2012) Costs of Adaptation – Sea Dikes and Alternative Strategies, available online at: [http://www.env.gov.bc.ca/wsd/public\\_safety/flood/pdfs\\_word/cost\\_of\\_adaptation-final\\_report\\_oct2012.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/cost_of_adaptation-final_report_oct2012.pdf)

<sup>6</sup> Ariana E. Sutton-Grier, Kateryna Wowk and Holly Bamford (2015) Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems 51 Environmental Science and Policy 137. Available online at: <http://www.sciencedirect.com/science/article/pii/S1462901115000799>

<sup>7</sup> Grant Lamont, John Readshaw, Clifford Robinson and Phillippe St-Germain (2014) Greening Shorelines to Enhance Resilience, An Evaluation of Approaches for Adaptation to Sea Level Rise. Available online at: [http://www.stewardshipcentrebc.ca/PDF\\_docs/reports/Greening\\_Shorelines\\_to\\_Enhance\\_Resilience.pdf](http://www.stewardshipcentrebc.ca/PDF_docs/reports/Greening_Shorelines_to_Enhance_Resilience.pdf)

## Breaking down human barriers and working collaboratively also supports resilience

Reshaping our coastal communities to rely on natural features and adaptive design requires shifts in land use planning, engineering and urban and structural design. Planning and development at the local government level usually compartmentalizes these functions, making it challenging to alter existing



patterns of development and consider different approaches to coastal flood risk mitigation. As well, municipalities often lack opportunities to share ideas and experiences with other municipalities. The Green Waterfront Design Charrette brought together municipal staff responsible for a range of planning and development functions with design specialists (engineers, landscape architects and architects) having expertise in coastal flooding and green waterfront design. The Charrette provided a collaborative setting for participants to learn about green design options and look at three real-life neighbourhoods currently undergoing or slated to undergo redevelopment planning processes.

## Charrette objectives

Focussing on green infrastructure and adaptive design to sea level rise in and around the Burrard Inlet, Charrette objectives included:

1. Developing design ideas, concepts and strategies that can help inform planning processes, as well as creating opportunities to share knowledge and ideas across different departments and municipalities and with local experts;
2. Increasing understanding among municipal staff, provincial representatives and in the professional design community of the opportunities and benefits related to green infrastructure and adaptive design approaches in the context of sea level rise;
3. Identifying key technical and legal considerations requiring further investigation to support implementation of new urban designs that will improve community resilience to sea level rise; and
4. Identifying other actors and decisionmakers that should be engaged in coastal land use planning and community development processes.



## Participants

Participants in the Charrette included staff from five municipalities (City of Vancouver, District and City of North Vancouver, District of West Vancouver and District of Squamish, approximately 40 people), invited members of the design and consultant community, provincial representatives from the Ministry of Community, Sport and Cultural Development (Cathy LeBlanc) and the Climate Action Secretariat (Thomas White). The Charrette was organized by West Coast Environmental Law and the Adaptation to Climate Change Team at Simon Fraser University, with facilitation and assistance in preparation and recording from MODUS Consulting, as well as faculty and graduate students from the School of Community and Regional Planning at the University of British Columbia, and the School of Public Policy at Simon Fraser University (see Part V).

A professional design team (see Part V) brought discussion and ideas to life with graphic representations, many of which are reproduced in Part III of this report.

## Charrette outline

### DAY 1

Morning presentations to provide context and relevant information covered the following topics:

- Coastal engineering, sea level rise and related infrastructure considerations;
- Predicted levels and rates of sea level rise in the Burrard Inlet and False Creek;
- Legal and socio-economic considerations;
- Ecological considerations; and
- Specific urban design challenges related to sea level rise adaptation.

In the afternoon of Day 1 participants worked in interdisciplinary groups of 6-8 people per table to explore opportunities and challenges related to sea level rise and possible responses.

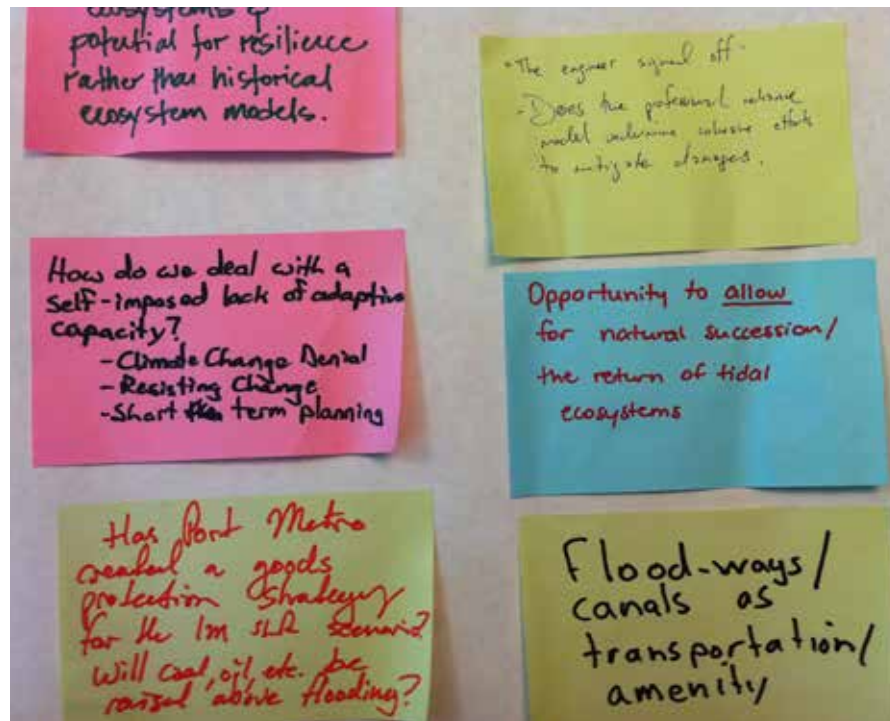
- Three neighbourhoods were considered:
- False Creek Flats, City of Vancouver (commercial/industrial);
- Ambleside, District of West Vancouver (mixed use commercial/residential); and
- Erwin Drive, District of West Vancouver (residential).

Each table focused on a single neighbourhood and considered how and whether different adaptation approaches (protect, accommodate or retreat) could support resilience in that neighbourhood. In a plenary session at the end of Day 1 each table (seven in total) presented their key findings and design ideas.



## DAY 2

On Day 2, the professional design team reconvened with a smaller subset of the municipal and provincial representatives. After reviewing the previous day's results, and considering input from visualization specialists (Dr. Stephen Sheppard and David Flanders, Collaborative for Advanced Landscape Planning, University of British Columbia) and a real estate expert (Richard Wozny, Site Economics), participants divided into three groups to produce the design scenarios for each neighbourhood that are reproduced in Part III of this report.



## PART II

# Expert presentations

During the morning of Day 1, all charrette participants convened for a series of expert presentations. The goal was to lay the groundwork for the design work that would follow, by setting out the basics of sea level rise impacts in BC, the types of risk that we are facing, and considerations when incorporating these risks and related uncertainties into local government planning. The existing legal framework for municipal planning and regulation, and proposed changes by the Province were also covered. Further presentations looked at social and cultural vulnerabilities relevant to sea level rise, and urban design responses from other jurisdictions. This was followed by a description of natural coastal ecosystems in the South Coast region, the way that urban development has already affected natural shorelines, and opportunities to build natural resilience. The session concluded with some lessons learned from early implementation of sea level rise adaptation policies in Vancouver and Squamish.

Excerpts from the presentations are included in this section as follows:

1. John Readshaw (SNC-Lavalin Inc.), *Designing the Green Waterfront*;
2. Tamsin Lyle (Ebbwater Consulting), *SLR: What does it mean?*
3. Deborah Carlson (West Coast Environmental Law), *Law & Policy Context*;
4. Thomas White (Climate Action Secretariat, Govt. of BC), *SLR guidelines amendment*;
5. Deborah Harford (Adaptation to Climate Change Team – SFU), *Social vulnerability and adaptation*;
6. Jeremy Keating (UBC-SCARP), *Adaptation through urban design*;
7. Nick Page (City of Vancouver), *SLR impacts on shoreline ecosystems*; and
8. Tamsin Mills (District of Squamish), *Planning for a liveable and wetter future*.

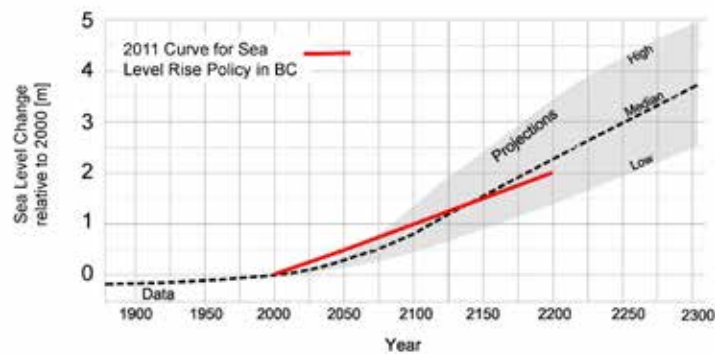
# DESIGNING THE GREEN WATERFRONT

John S. Readshaw, P. Eng.

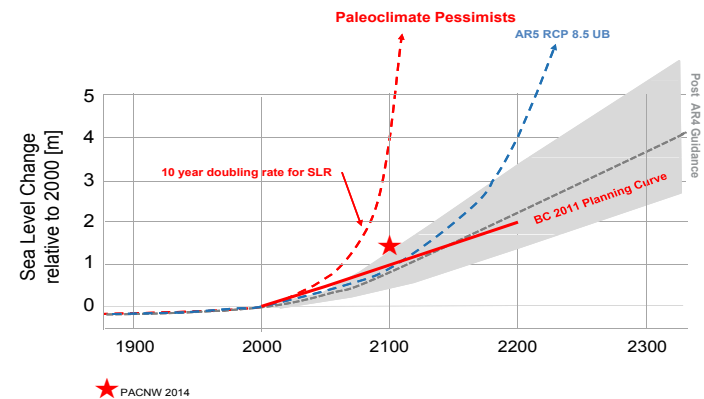
Manager, Coastal Engineering and Dredging, SNC-Lavalin Inc.

## What we know about climate change and sea level rise

Climate scientists continue to learn more about the processes and pace of climate change, including new modeling results from the IPCC cycles, measured melting rates of polar ice sheets, trends in summer arctic ice loss, and insight from the paleoclimate record, which tells us what happened the last time the earth warmed rapidly. It is clear that sea level rise projections should be revisited and frequently revised. At present, the rate of observed sea level rise is trending upwards, consistent with a 10 year doubling rate. Sea level rise projections for BC prepared for the provincial government in 2011 estimated 1 m of sea level rise by 2100. This projection should likely be modified upwards, together with estimates for post-2100.



BC SLR Guideline (2011)



Updated Planning Curves

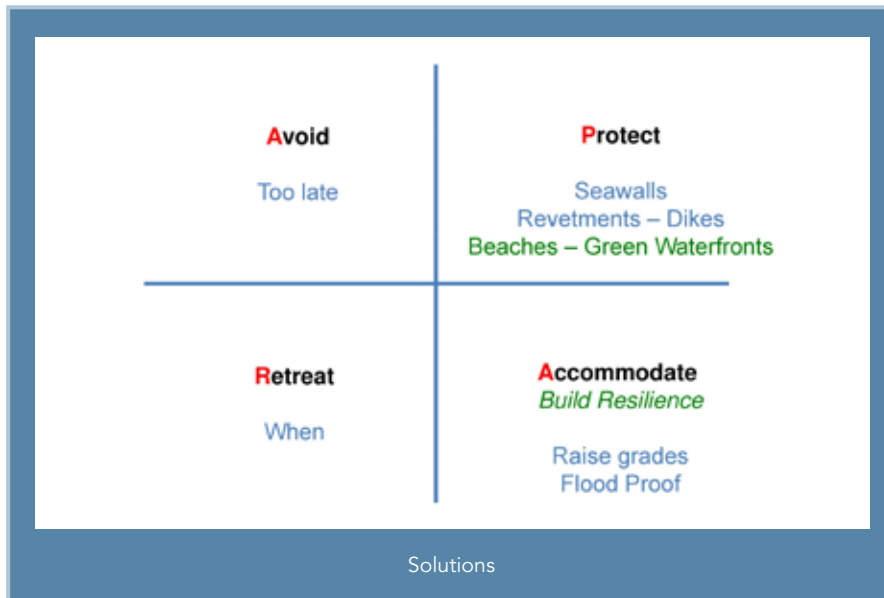


What are we going to do?

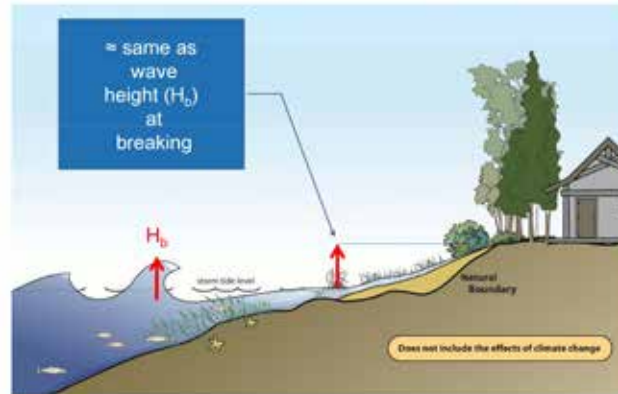
## Adaptation options

Adaptation responses are often characterized as Avoid, Protect, Accommodate or Retreat. Each type of response has advantages and disadvantages, and not all are always available in a particular situation. For example, in coastal areas that are already highly developed, as is the case in much of the Lower Mainland, it is often not possible to avoid the impacts of rising sea levels without significant implications.

Coastal areas have always been exposed to intense storms and storm surge, but sea level rise means that these events will become more commonplace.

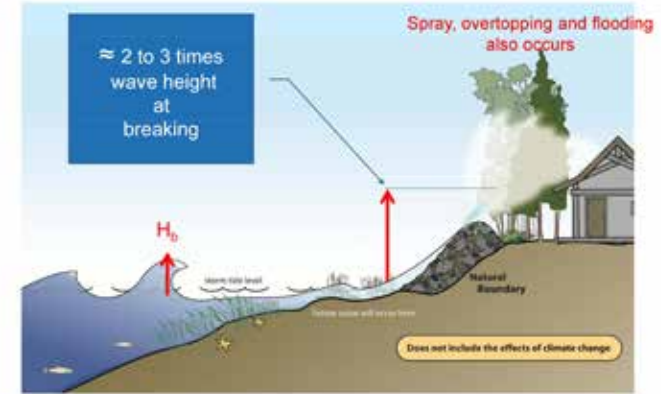


### Gentle Slopes - Beaches



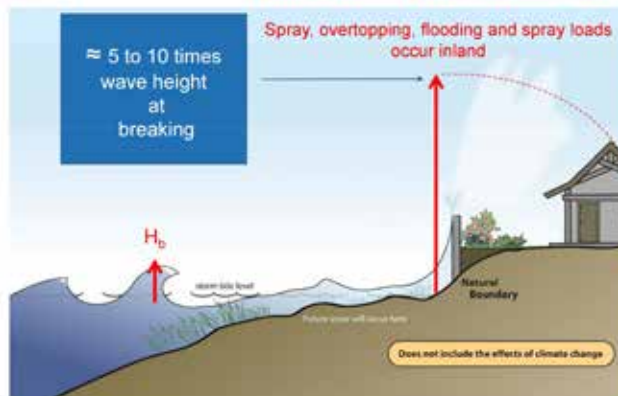
Design and Wave Effects

### Steep Slopes - Revetments



Design and Wave Effects

### Sea Walls



Wave Effect and Structures

## Hardening the shoreline can worsen the impact of waves

Hard armouring solutions are often used to protect coastal development. In practice they typically create steep slopes and barriers that increase the wave effects near the shoreline, and over time may lead to scouring of the shoreline, seaward of the barrier. These effects may be increased as sea level rises.

## Consequences of overtopping of different hard structures

As the frequency of the sea coming over the crest of hard structures increases, impacts escalate, beginning with nuisance flooding and temporary closures, and progressing to include severe property damage and increasing risk to human lives. It is usually expensive to increase the height of hard structures once they are built, as this may require additional land acquisition or simply not be technically or practically feasible.



### CONSEQUENCES:

Start of Damage to Seawall (Building Structural Elements)  
 Ponding of Water  
 Pedestrians uncomfortable or wet

Overtopping at 1 to 0.01 L/s/m



### CONSEQUENCES:

Stone Seawall damaged in many places  
 Flooding in properties on lee side of the road  
 Roadway unsafe for pedestrians

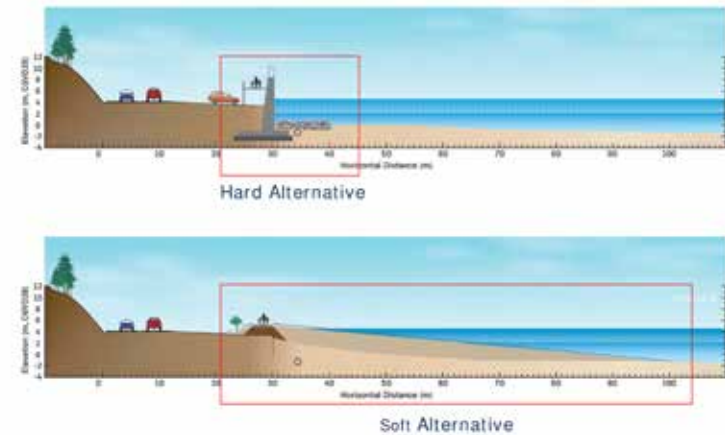
Overtopping at 100 L/s/m

## Evaluating soft shore alternatives – SCBC Green Shores Program

An alternative to hard armoring is to use approaches that mimic natural coastal features to absorb the wave energy and reduce impacts. Working with the Stewardship Centre of British Columbia, engineers from SNC-Lavalin looked at three case examples to compare soft and hard approaches. Each was designed to protect coastal development from one metre of sea level rise, and costs were compared.



Case Example 1



Case 1: Protect Options



Marr Creek – District of West Vancouver

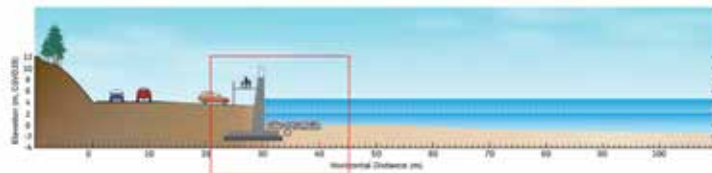


Case Example 2

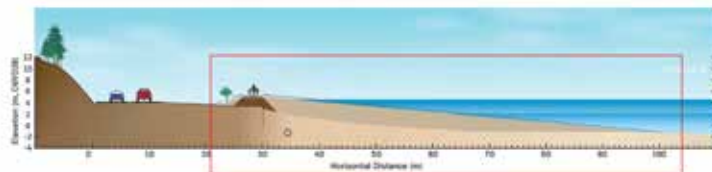
Private Residence – East Coast Vancouver Island



Case Example 3



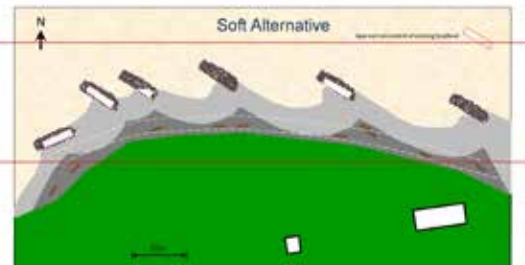
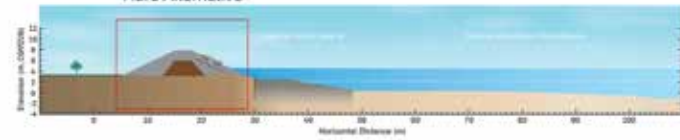
Hard Alternative



Soft Alternative

Case 2: Protect Options

Hard Alternative



Case 3: Protect Options

Case Example		Hard Alternative	Soft Alternative	Comment
1	Seawall / Gravel or Sand Beaches	\$33,000/m	\$10,000 - \$14,000/m	Depending on choice of sand or gravel/pebble/cobble.
2	Seawall / Inter-tidal and Sub-Tidal Reefs	\$35,000/m	\$25,000/m	Does not include cost of maintaining dry high tide access on existing walkway. Does not include the sunk costs of existing rock features already on site.
3	Standard Dike / Headland - Beach System	\$8000/m	\$4000/m	Does not include sunk cost of existing headland beach system

Notes: includes 40 per cent contingency  
Not included: land acquisition costs - upland costs - environmental offsets - seismic improvements

### Cost Effectiveness

Can provide security against Flooding

Can provide safety to personnel and pedestrians

Do provide an positive environmental service

Are cost effective (70% to 30 % cheaper than hard alternatives)

### Green Waterfronts

While soft alternatives show potential for cost savings and other advantages, there are other implications to be considered in implementation of all solutions.

### Timelines:

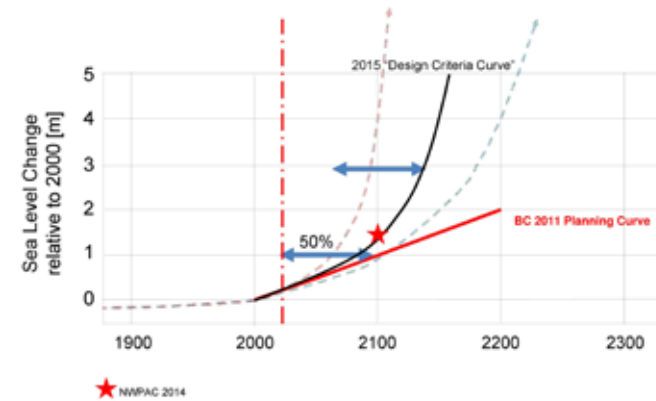
- **Planning and Design:** 5 -10 year
- **Funding Approval:** ?
- **Land Acquisition:** ?
- **Approvals and Tendering** ?
- **Construction:** 5 years
- **Typical Project Service Life for Coastal Structures:**  
50 – 100 years

USE 75 YEARS AS THE TOTAL PLANNING AND SERVICE LIFE

### Challenges - Implementation

## Considering options

Solutions planned today for current sea level rise projections may prove to provide only 50 per cent of their expected service. New solutions to face updated projections may provide even less service. Investments in new infrastructure may assume useful service for 50 to 75 years. Based on updated sea level projections, decisions to make significant investments in hard and soft armouring merit close scrutiny. Hard structures may need replacement partway through their projected lifespan and will need to deal with even faster rates of sea level rise in the future.



Challenges - Implementation



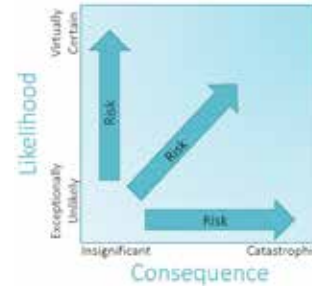
What do we really do?



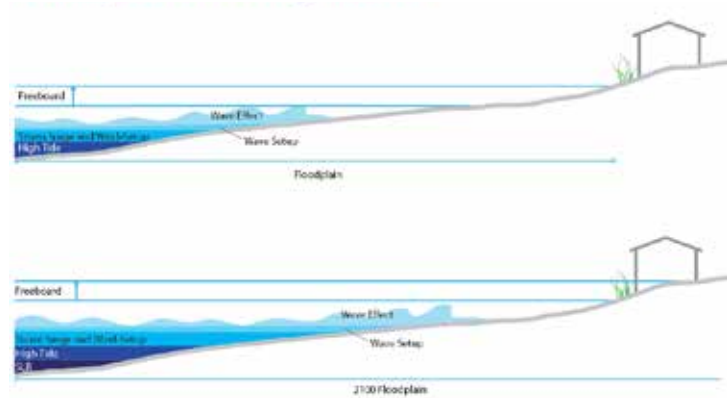
A Little Context: Creekside Under Water

## SLR: WHAT DOES IT MEAN?

Tamsin Lyle, P.Eng.  
Principal, Ebbwater Consulting



Coastal Flood Risk in Vancouver



SLR Basics: Floodplains moving inland

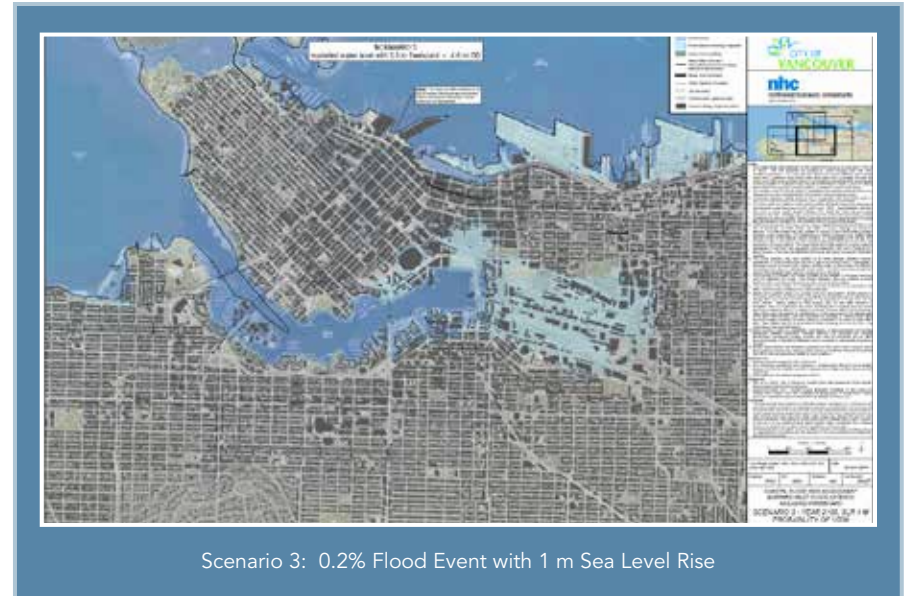


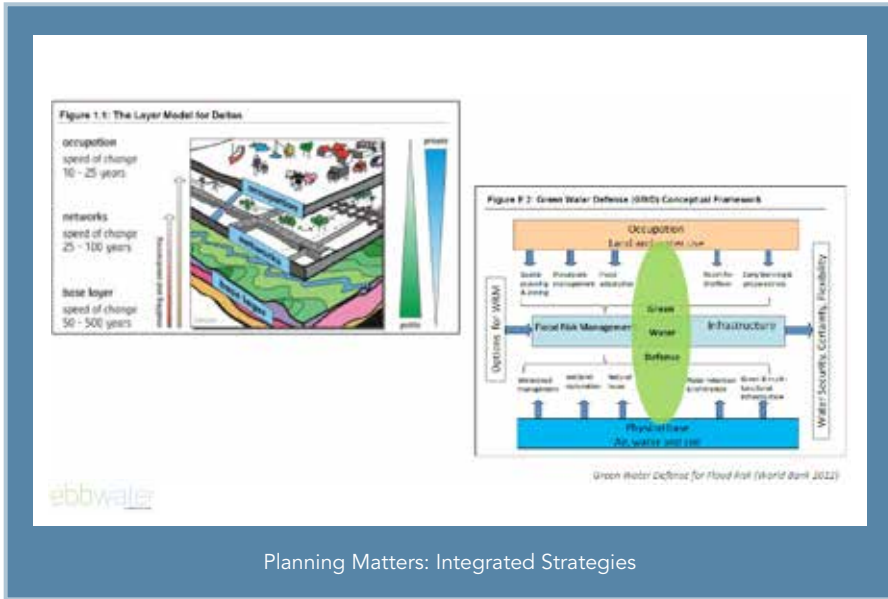
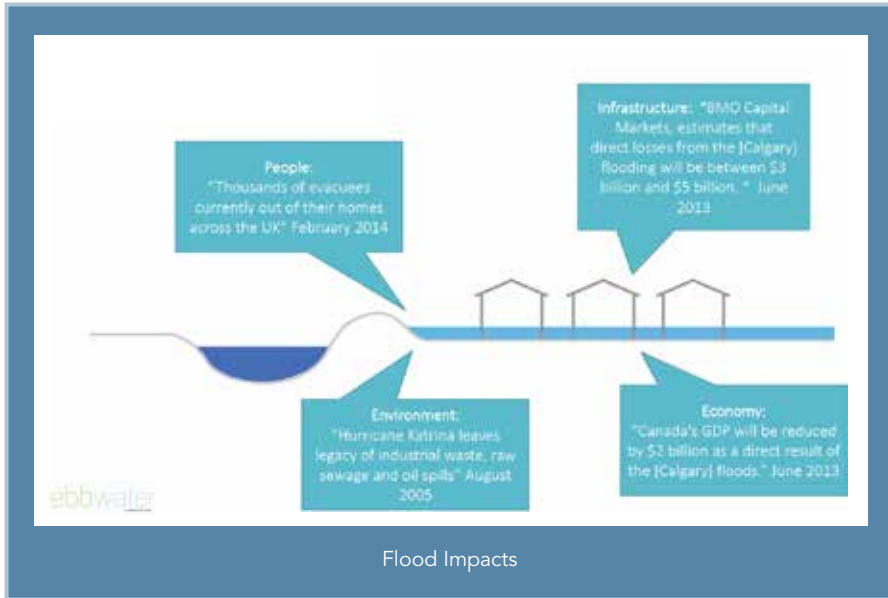
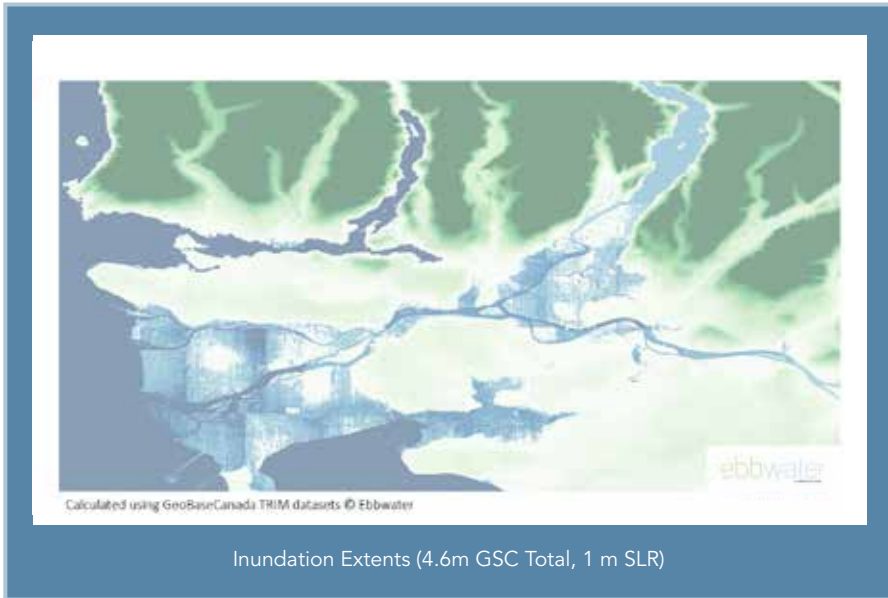
Science World, December 2013 King Tide



Ambleside, December 2012 Storm Event  
Cansetta.com image

Two Design Conditions... That are also shifting in time...

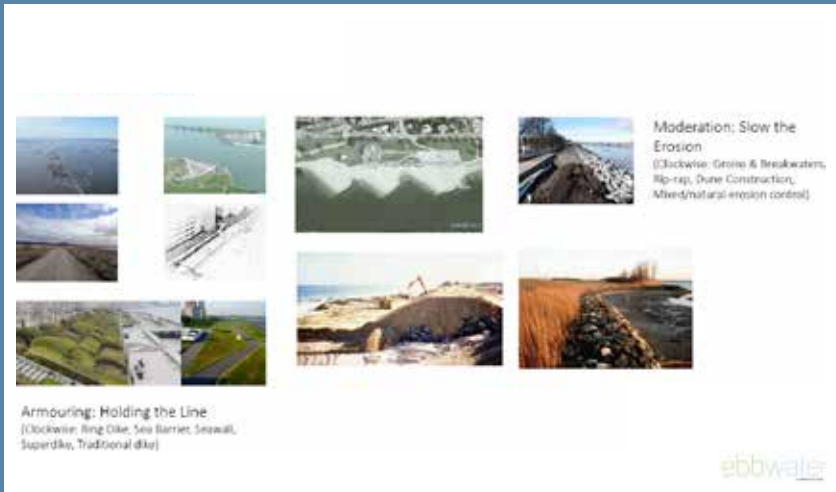




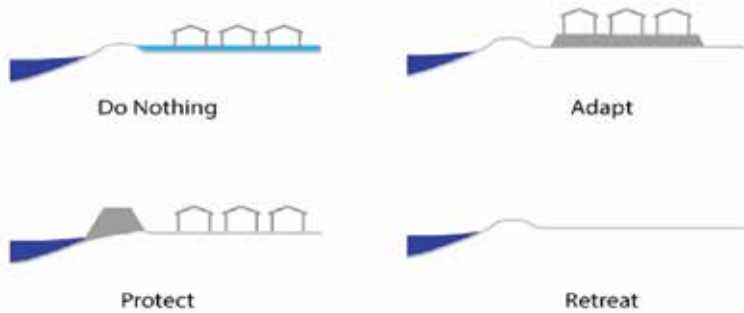
- Plan for risk not hazard
  - Consequences matter
- Embrace uncertainty
  - Strive for adaptive solutions that will work under many climate and development futures
  - Avoid solutions that are single-minded or that remove future options
- Enable resilience
  - Focus on recovery



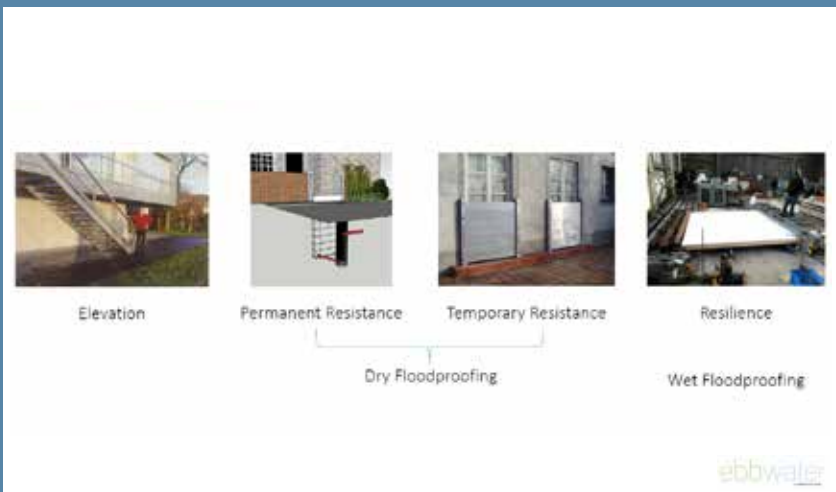
BMPs from Around the World



Engineering: The Hard Stuff



How Do We Do This? Adopt a Best Mix of Strategies



Building Controls: Do-It-Yourself Options

Creative Ideas: For your Imagination

ebbwater

- Warning system
- Evacuation and response planning
- Education (public and media)
- Recovery plans

- Acquisition (developed and undeveloped land)
- Relocation (property and infrastructure)
- Retreat
- Transfer of development potential
- Regulation of land use
- Covenant on title
- Right to flood
- Building code

Regulatory Options: For the Planners | Emergency Management: Increased Resilience

ebbwater

Flood Risk Planning: An adaptive process

ebbwater

2011 Great Japan Earthquake and Tsunami

Reassess: We're all fallible

ebbwater




## GREEN WATERFRONT DESIGN CHARRETTE: LAW & POLICY CONTEXT

**Deborah Carlson**

Staff Lawyer, West Coast Environmental Law


Local governments have tools that can be used to manage coastal flood risks, but none of these tools were designed to manage the risks associated with sea level rise which will change significantly over time. As well, the existing tool box may not be adequate to implement soft shore alternatives.



### Provincial guidance

#### Flood Hazard Land Use Management Guidelines

- \* Consider flood plain mapping
- \* 3.5.1 – Strait of Georgia:
  - \* 15 m setback from natural boundary
  - \* FCL = 1.5 m above natural boundary of sea
- \* Under review by Province
- \* “Draft” technical guidance in 2011 says 1.0 m sea level rise by 2100, 2.0 m by 2200






### Local government powers to regulate in the floodplain

- \* Local Government Act, s.910
  - \* Can set flood construction levels (FCLs) and setbacks
  - \* FCL = underside of floor: residential/commercial/storage of goods
  - \* Can set different FCLs for, e.g. different uses, areas
- \* Must “consider” provincial guidelines
- \* Exemptions (need covenant):
  - \* If meet provincial guidelines
  - \* Certified “safe” by qualified professional
  - \* Prior non-conforming uses also exempt
- \* Vancouver Charter, s.306 (cc)
  - \* Designate floodplain
  - \* Ensure that elevation or design will reduce or eliminate the risk of flood damage and require covenant



### Provincial compensation regime (based on historical conditions)

#### Compensation and Disaster Financial Assistance Regulation



- \* repair/rebuild/replace, up to \$300,000
- \* relocation possible, but no land costs
- \* if in designated floodplain, no compensation unless structure met provincial guidelines
- \* available to homeowners, small business, farms (for structures) and charitable organizations



## Other legal issues

- \* Jurisdiction – the foreshore is provincial, what is impact of changing high water mark?
- \* Floodplain mapping, what is 1:200 year flood?
- \* Impacts on adjacent property: nuisance, negligence
- \* Opportunities to use DPAs for site-specific guidelines
- \* Infrastructure liabilities in case of failure
- \* S.35 Canadian Constitution – Aboriginal Title and Rights



## Reducing risks through resilience

- \* Acting now – risk reduction is more cost-effective than disaster recovery (e.g. 1:4)
- \* Natural infrastructure increases resilience, has co-benefits, may cost less – e.g. Green Shores study shows 30-70% less costly than hard infrastructure for same performance



Image: rebuildbydesign.org



*"I'm not saying we have to build the city today for 2100. I'm only saying we shouldn't take measures now that become problems for the people living in 2100."*

Klaus Jacob, Climate Scientist,  
Columbia University

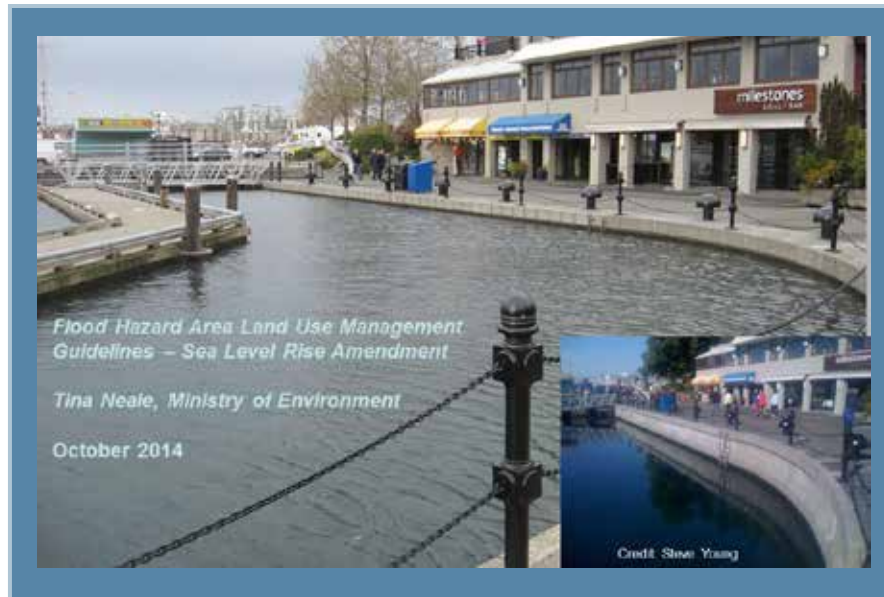
## SLR GUIDELINES AMENDMENT

**Thomas White**

Manager, Climate Risk Management  
BC Climate Action Secretariat

**Slides by Tina Neale**

Ministry of Environment



Flood Hazard Area Land Use Management Guidelines are provincial policy intended to minimize injury and property damage resulting from floods

*Local Government Act* – LGs "must consider" guidelines

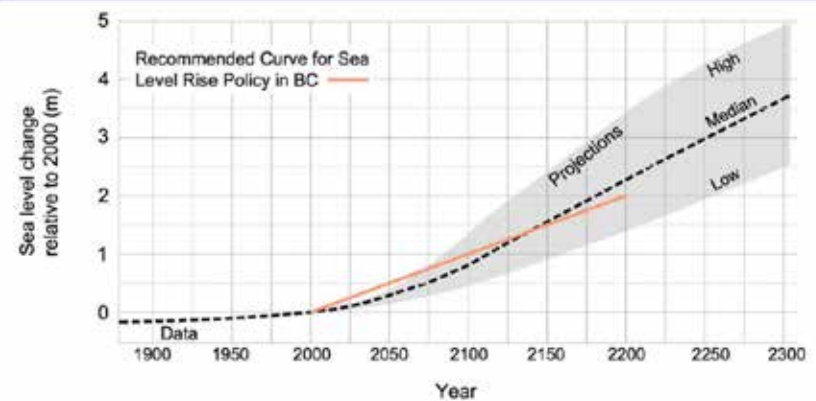
Compensation and Disaster Financial Assistance Regulation – determining "properly flood protected"

Intended to support land use and development decisions broadly

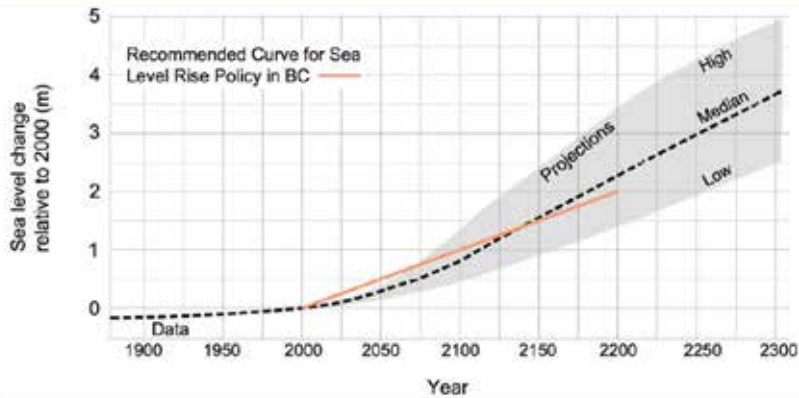
Specify setbacks and FCLs with option for site-specific variations with professional report.



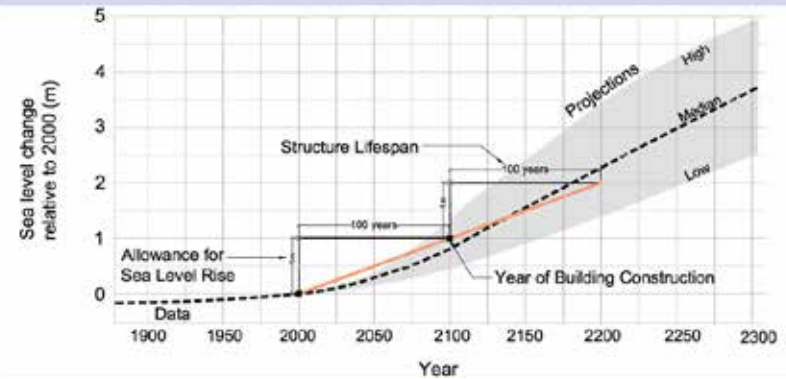
Plan for 1m sea level rise by year 2100, adjusted for local conditions (e.g. vertical land movement)



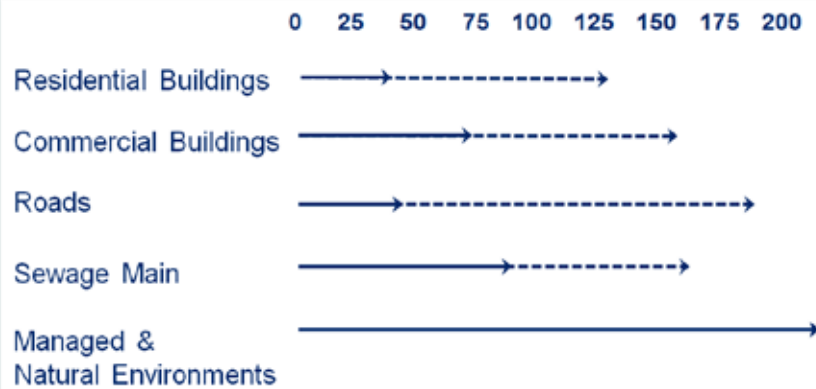
Plan for 1m sea level rise by year 2100, adjusted for local conditions (e.g. vertical land movement)



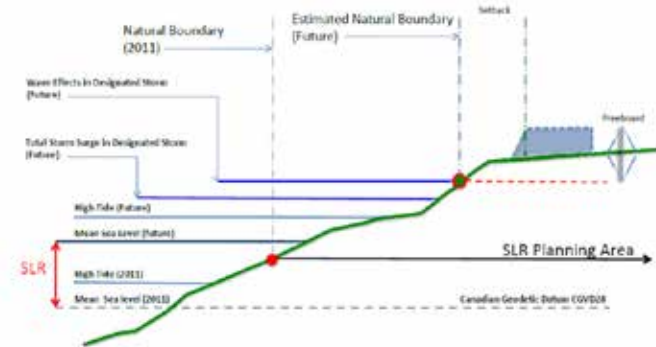
Goal is to ensure that development is safe throughout its lifespan



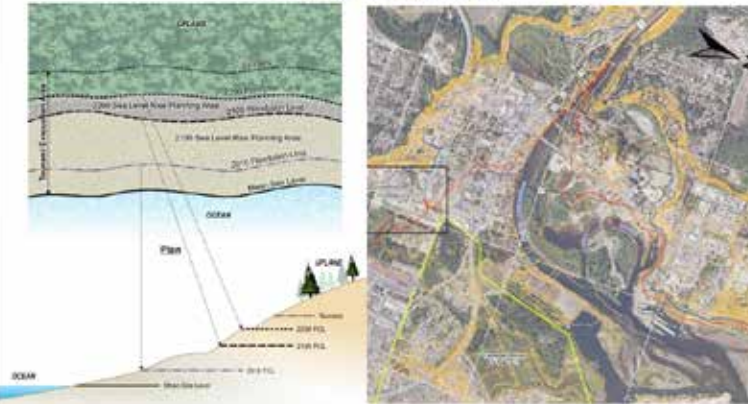
Lifespan of development should determine the sea level rise planning horizon



Current approach relies on the natural boundary; new approach estimates the location of future natural boundary with SLR



Sea level rise planning area is the area between the current natural boundary and the future estimated natural boundary



## Draft Amendment Highlights - General

*In the absence of more site-specific studies or information, these guidelines are the recommended provincial minimum requirements for land use management in flood hazard areas.*

Current Guideline	Amendment
No sea level rise	Sea level rise planning encouraged
Flood hazard based on designated flood with a 1:200 annual exceedance probability	SLR to 2100 for buildings, zoning, subdivisions SLR to 2200 for land use adaptation 1:200 return period water level for combined high tide and storm surge

## Draft Amendment Highlights - Flood Construction Level

Current Guideline	Amendment
<p><b>Strait of Georgia:</b> 1.5m above elevation of natural boundary</p>	<p>Greater of FCLs calculated based on tsunami hazard or:</p> <ul style="list-style-type: none"> <li>Sea level rise to year 2100</li> <li>Land uplift/subsidence to 2100</li> </ul>
<p><b>Outside Strait of Georgia:</b> Determined by site-specific analysis of tsunami hazard (professional report)</p>	<ul style="list-style-type: none"> <li>1:200 water level for high tide + storm surge for design storm</li> <li>Wave effects for design storm</li> <li>Freeboard</li> </ul>

## Draft Amendment Highlights - Setbacks

### Current Guideline

#### Strait of Georgia:

- Buildings: 15m from natural boundary
- Fill/dikes: 7.5m from natural boundary (non-erodible)
- Erosion hazards may require increased setbacks
- Special conditions for coastal bluffs

#### Outside Strait of Georgia:

Determined by site-specific analysis of tsunami hazard (professional report); minimum 30m

### Amendment

#### Strait of Georgia:

- 15 m from estimated location of future natural boundary based on:
- Sea level rise to year 2100
  - Land uplift/subsidence to 2100
  - 1:200 water level for high tide + storm surge for design storm
  - Wave effects for design storm
  - Freeboard

#### Outside Strait of Georgia:

Determined by site-specific analysis of tsunami hazard (professional report); minimum 30m from estimated location of future natural boundary

## Next steps in amendment process

- Review submissions from local governments
- Possible additional analysis, studies and review
- Development of additional guidance
- Revise proposed amendment
- Final publication



Thank you!

[Tina.Neale@gov.bc.ca](mailto:Tina.Neale@gov.bc.ca)

<http://www.env.gov.bc.ca/cas/adaptation/index.html>

## SOCIAL VULNERABILITY AND ADAPTATION

**Deborah Harford**

Executive Director

Adaptation to Climate Change Team (ACT),  
Simon Fraser University

The extent of damage from climate change depends to a great extent on vulnerability:

### Exposure

- E.g. geography/energy infrastructure

### Sensitivity

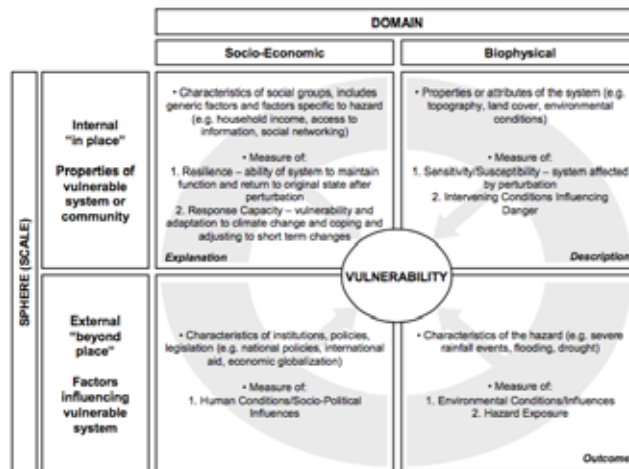
- E.g. vulnerable population groups/continuity of systems

### Adaptive capacity

- Information
- Expertise and networks
- Fiscal capacity
- Political support



Aspects of "Vulnerability"



(Hebb and Mortsch, 2007 modified from Fussler 2007)

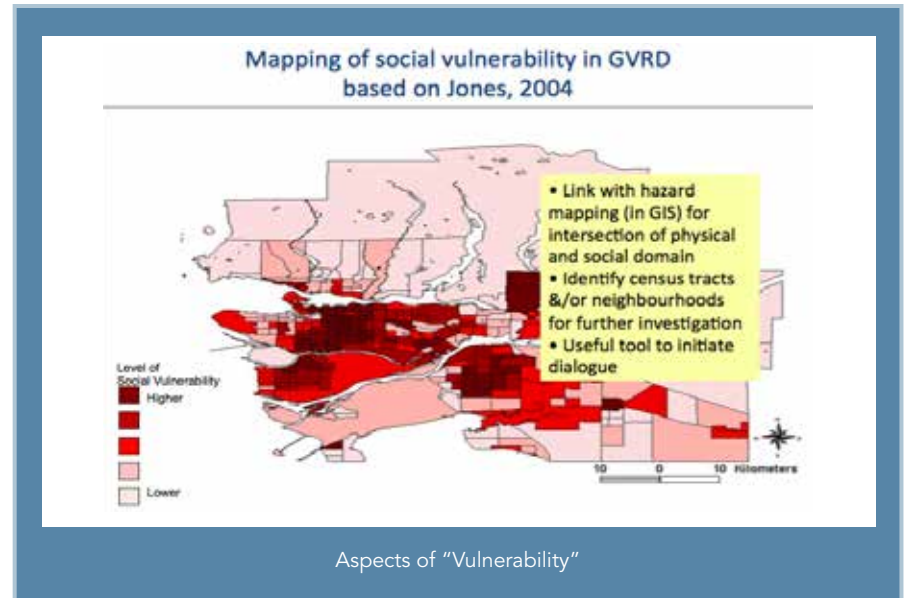
Approach builds upon traditional hazards methods & incorporates socio-economic analysis:

- Enhances information for planning & management
- Broadens appreciation of determinants of vulnerability & links to adaptation
- Interaction with practitioners & community through indicators & maps
- "Hot" spots identified for further neighbourhood analysis with survey instruments

Social Vulnerability Analysis for Adaptation Planning

Indicator	Variable
Age	% Population age 19 and under
	% Population age 65 and over
Gender	% Female population
Ethnicity	% With no knowledge of official languages
	% Population recently immigrated (2001-2006)
Social status	Average dwelling value
	Average household income
	Prevalence of low income (those spending 20% more than average on necessities)
	% Population who rent their dwelling
Household arrangement	% of income retained from government transfers
	% Labour force (age 15) unemployed
	% Population with high school education or less
	% Population with university education
	% Single-parent families
	% Households with one person
	% Main mode of transportation is public transit
Built environment	Population density
	% House type is apt 5+ stories built before 1980
	% Period of home construction is before 1970
	% Housing in need of major repair

SoVI: Selected indicators and variables

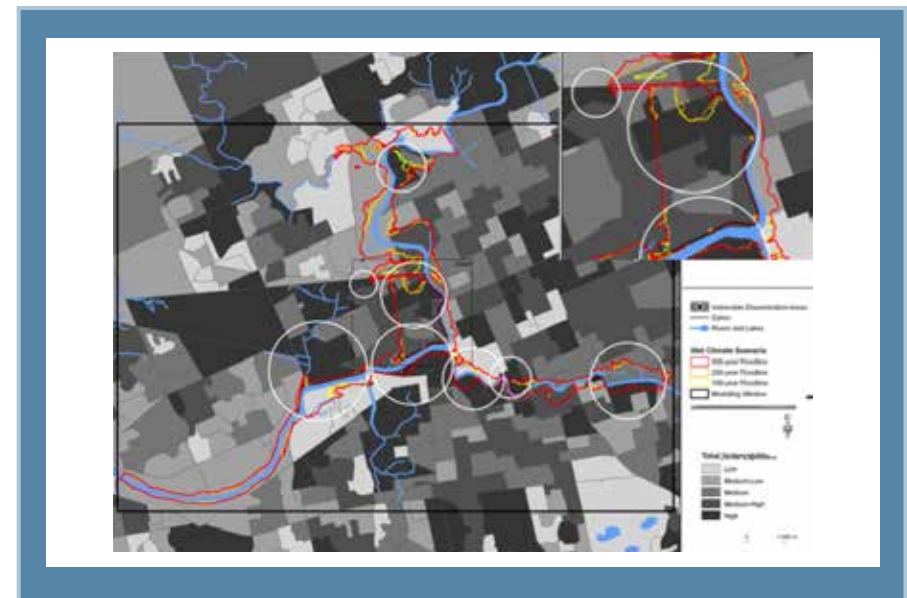


Aspects of "Vulnerability"

• Population and dwelling counts estimated based on the proportion of the Dissemination Area (DA) flooded

Floodline	Climate Scenario	Area (m <sup>2</sup> )	Change in		No. Homes Flooded	No. Buildings Flooded	Proportion Affected (Census Data)	
			Area (m <sup>2</sup> )	%			Pop.	Dwellings
100-year	Historic	5,291,440			1,141	34	7,701	3,969
	Dry	3,930,436	-1,361,004	-25.7	68	18	4,881	2,521
	Wet	5,595,988	+304,548	+5.8	1,249	42	7,949	4,109
250-year	Historic	5,858,976			1,376	58	8,474	4,381
	Dry	5,101,848	-757,128	-12.9	1,059	33	7,351	3,802
	Wet	6,116,988	+258,012	+4.4	1,486	59	8,745	4,543
500-year	Historic	6,268,729			1,560	71	9,119	4,740
	Dry	5,362,852	-905,877	-14.5	1,155	36	7,717	3,988
	Wet	6,567,292	+298,563	+4.8	1,690	83	9,388	4,886

Area, People and Structures Affected



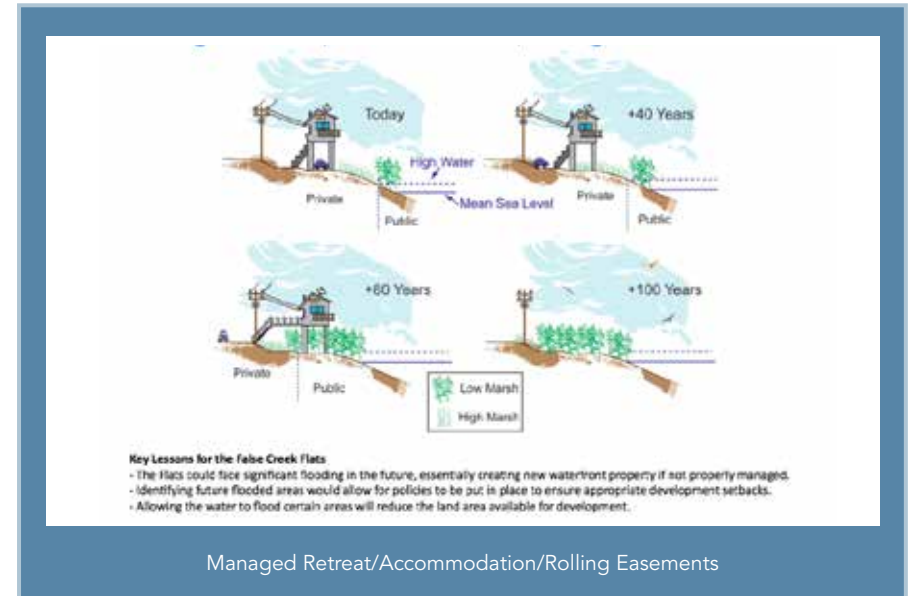
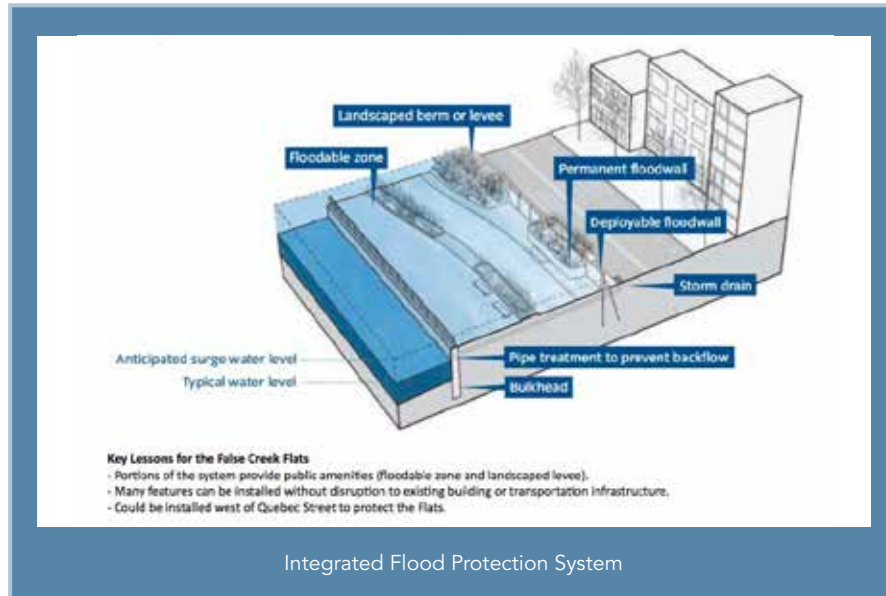
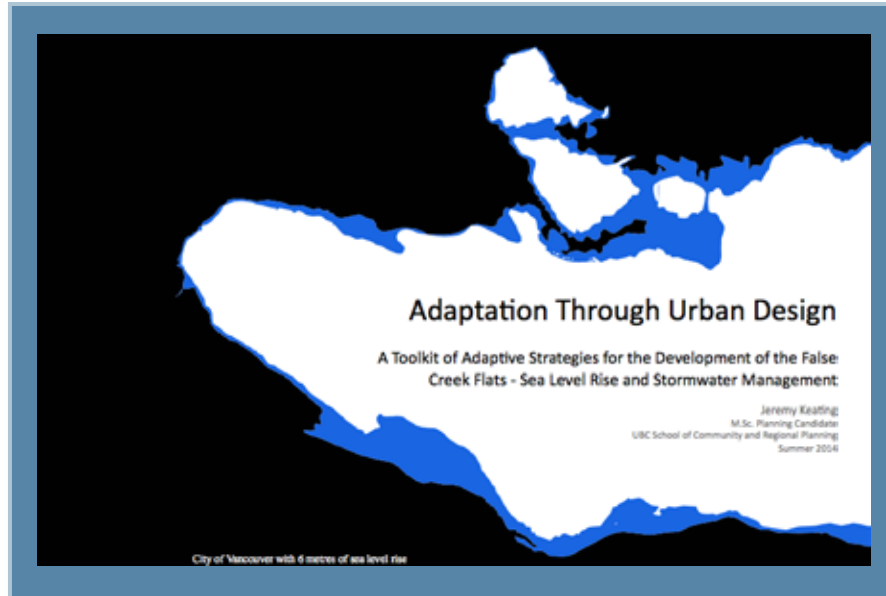


## ADAPTATION THROUGH URBAN DESIGN

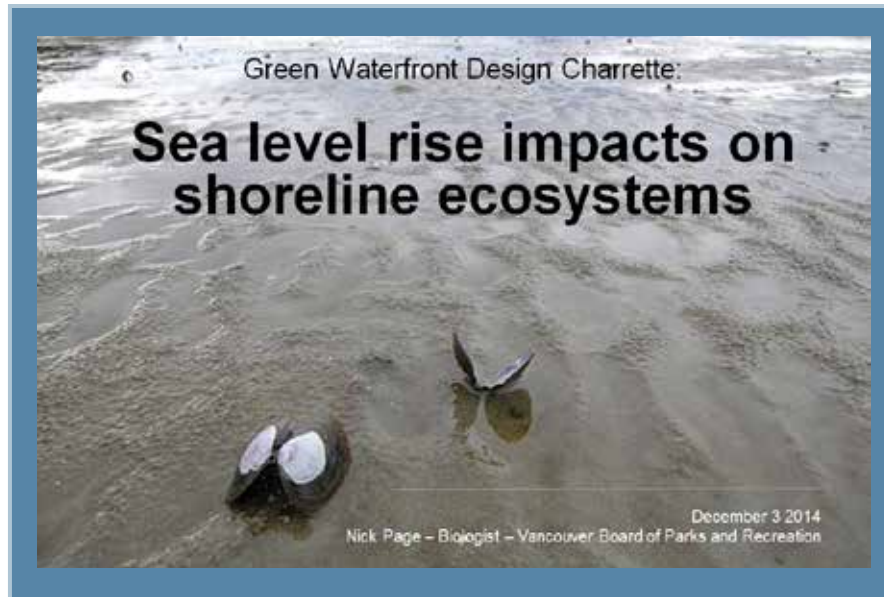
**Jeremy Keating**

M.Sc. Planning Candidate

UBC School of Community and Regional Planning







## SLR IMPACTS ON SHORELINE ECOSYSTEMS

Nick Page

Biologist, Vancouver Board of Parks & Recreation

1. Many natural shoreline ecosystems are resilient to sea level change

- Sea level change has been constantly affecting shorelines for millions of years.
- Marine species are often adapted to dynamic habitats (mobile or rapidly colonize).
- Habitats are often elevation based and are also mobile if they have room to move.
- Some shoreline habitats can respond to sea level rise; rates of sediment deposition in salt marsh may be higher than seal level rise.



Howe Sound sea level was 150 m higher 9,000 to 10,000 years ago



Average Puget Sound salt marsh accretion rates are 3.6mm/yr (compared to mean predicted SLR rate of 5.5 mm/yr).

## 2. Marine ecosystems will be affected by system-wide stressors

- Changes in ocean temperature, salinity, and acidity (pH) will cause major disruptions to marine ecosystems.
- Food webs will be disrupted and species composition will change.
- Acidification may major effects on the life cycle of plankton, invertebrates, and some fish.
- These effects are highly uncertain but likely to be severe or catastrophic.



Fraser River Sockeye Salmon Migration Routes



Extent of intertidal wetlands in North Vancouver in 1947

### 3. Many impacts occurred historically

- Early development in Metro Vancouver was accompanied by extensive loss of intertidal wetlands, filling, and diking.
- Many shorelines are now armoured or diked.



273 ha of wetland and shoreline habitats were lost in False Creek between 1910 and 1920



New Brighton Park June 1961



Point Grey residences at 4.8 m tide

#### 4. “Coastal Squeeze” is a critical issue in urban areas

- Coastal squeeze is defined as intertidal habitat loss which arises due to the high water mark being fixed by a defence and the low water mark migrating landwards in response to sea level rise.
- Parks and public lands often have the highest remaining ecological values but are often considered to be less important than private lands.



Jericho Park Shoreline Restoration (2012)



SEFC Habitat Island (2009)



New Brighton Park (2010)

## 5. Many opportunities to do things better

- Shoreline restoration is an option for some sites to restore ecosystem values or increase resiliency.
- Growing number of examples of green infrastructure approaches in Metro Vancouver for creating stable, beautiful, and ecologically productive shorelines.



New Brighton Saltmarsh (2016?)

## PLANNING FOR A LIVEABLE AND WETTER FUTURE

### Tamsin Mills

Senior Sustainability Specialist, City of Vancouver (current)  
Planner, City of Squamish (former)



Planning for  
a liveable  
and **wetter**  
future



SQUAMISH

Outline



- How much? Where will it go?  
What's in the way?
- OCP and Policy Direction



Strategic Planning

- Options Analysis
- Community Engagement



Strategic Planning

- Incorporate FCL considerations in other studies (Viaducts, False Creek Flats)
- Lack of contiguous streetscape at future FCL
- Crawlspace exclusions
- Maximum Heights
- Transitions



Strategic Planning: Regulatory and Site Specific



SQUAMISH

Implementing FCLs: Crawlspace and heights



SQUAMISH

Implementing FCLs



SQUAMISH

Implementing FCLs: Multi-Family and Commercial



SQUAMISH

Implementing FCLs: Relationships

Raised terraces respond to an increase in Sea Level Rise construction levels and provide secure semi-private outdoor spaces for the residents. A

- Raising new phases of large redevelopments
- Seawall up section by section with designs for more increase

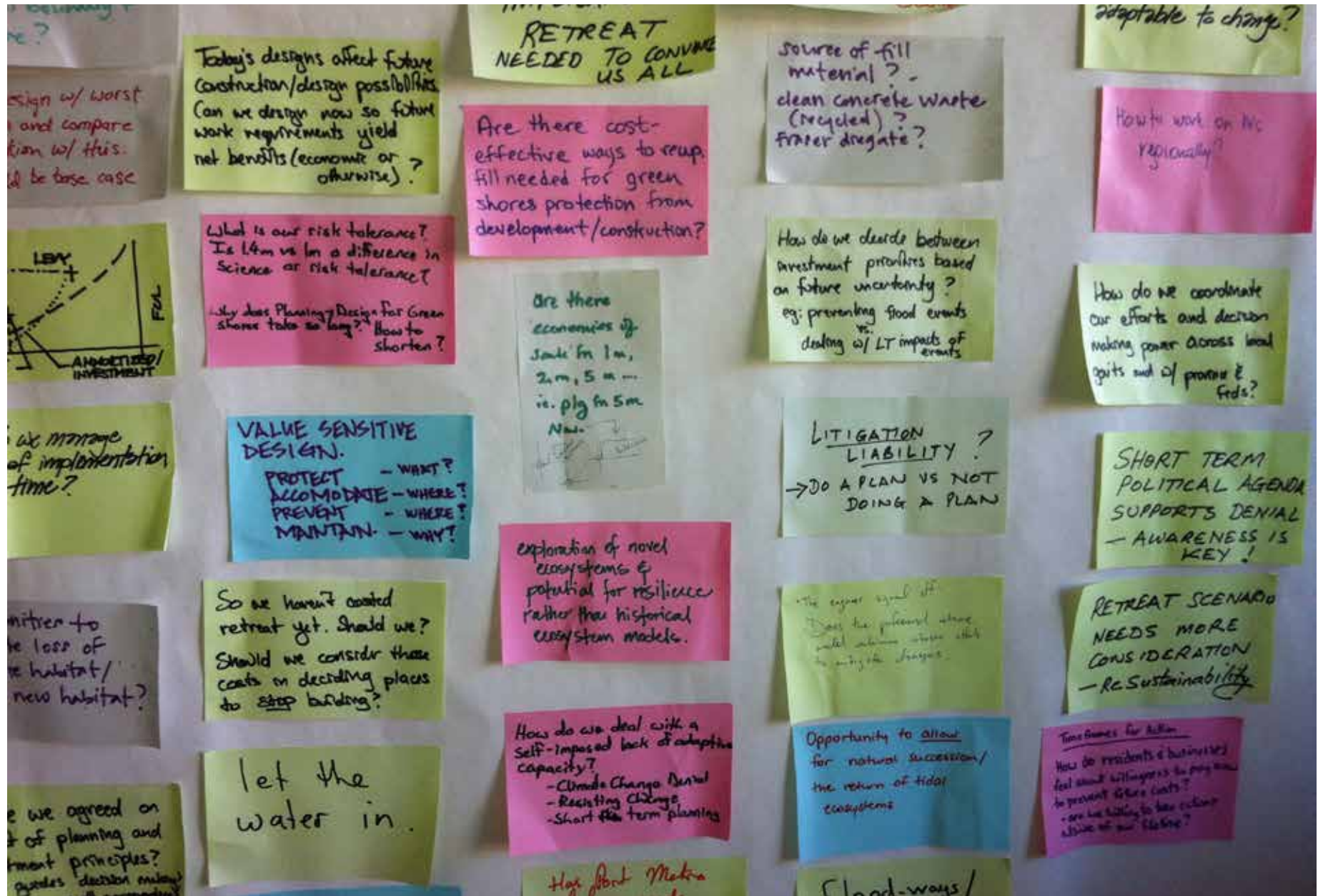
Implementing FCLs: Large Assemblies, Seawall

Strategic Planning and Current Pressures

SECTION A-A

Water is brought into coastal communities in a controlled way

Inspiration



## PART III

# Ideas to address sea level rise

Three neighbourhoods were chosen to explore green design ideas to address sea level rise in a way that reflects the diversity of urban development in waterfront areas. Each neighbourhood was at or nearing the stage of new planning processes for medium or long-term redevelopment.

One neighbourhood was primarily industrial/commercial lands (False Creek Flats in the City of Vancouver), another was mixed-use commercial /residential (Ambleside in the District of West Vancouver) and a third was residential (Erwin Drive in the District of West Vancouver). Together it was felt that these three neighbourhoods offered a good cross-section of the planning and design challenges facing local governments in coastal BC in areas with existing development. All three also had extremely high property values, which could be less of an issue in other coastal communities, but would nonetheless likely be a factor throughout the Lower Mainland and in some areas of Vancouver Island.

Bringing a broad range of professional expertise and perspectives to the table, charrette participants looked at sea level rise responses through the lens of enhanced liveability for residents, vibrant commercial uses, maintaining important industrial functions, as appropriate, and protecting and restoring coastal ecosystems. In the afternoon of the first day, tables with 8-10 participants considered pros and cons related to different types of sea level rise adaptation strategies for one of the neighbourhoods, including

protect, accommodate and retreat. By the end of Day 1 they had identified a number of strategies that seemed like good, green options for their subject neighbourhoods. On Day 2, a smaller group of local staff reconvened with the core professional design team to prepare more detailed concepts and drawings for the design ideas. Part III documents the process from Day 1 and the outcomes from Day 2 for each of the three neighbourhoods.

Although it was not specifically suggested to participants as a requirement, all the design ideas that emerged were approaches that showed how the neighbourhoods could evolve to respond to changing sea levels by phasing in changes in land use and building design. Over time the neighbourhoods would grow to be both greener and more resilient. This seems compatible with adaptive management, by allowing flexible responses to uncertainties around the rate of sea level rise, without tying communities down to pay for expensive barrier approaches that may or may not be effective or necessary in future conditions.



- Celebrate the Historic Creeks and Shoreline
- Develop Cost-Effective Natural Solutions to Storm Water Management
- Explore a Habitat Corridor & Improved Natural Conditions
- Find Solutions to Mitigate the Challenges of Sea Level Rise & Flooding
- Creatively Address & Respond to Soil Conditions

Map Legend:  
 - Historic Shoreline  
 - 1950s Creek Level  
 - Present Creek Level - 10 ft. Above  
 - 1950s (2000) - Present Creek Level (100%) - 5.00m H.P.  
 - 1950s (2000) - Present Creek Level (100%) - 10.00m H.P.  
 - 1950s (2000) - Present Creek Level (100%) - 15.00m H.P.



# FALSE CREEK FLATS, CITY OF VANCOUVER

## Introduction

False Creek Flats (the “Flats”) is a low-lying area in Vancouver located just east of Science World. Originally the area was connected to False Creek as a tidal estuary, a natural drainage basin for five major creeks, including China Creek and Brewery Creek. The mud flat, shallows and surrounding forest supported rich biodiversity and are part of the traditional territories of the Musqueam, Squamish and Tsleil-Waututh First Nations. After European settlement the forest was cleared and industrial operations were concentrated in the area. By the early 1900s the marsh lands were given over to railways so that the lands could be filled and rail lines constructed to service industrial operations. Development of the uplands included diversion of the creeks into a system of pipes and drains that now run underneath the Flats to reach False Creek.

Today two rail yards running east to west dominate the site, providing a connection to the Port of Vancouver to the northeast, and inland to the east. The Flats has a mix of light industrial, educational, and institutional uses. There are seven educational institutions, 30 technology and research companies, 11 recycling companies, and a large cluster of food assets and businesses. Providence Health Care recently announced that it would be developing land it owns on the western edge of the Flats as a large new health care facility to replace St. Paul’s Hospital, currently located on higher ground on Burrard Street, one of Vancouver’s central thoroughfares.

## Sea level rise in False Creek Flats

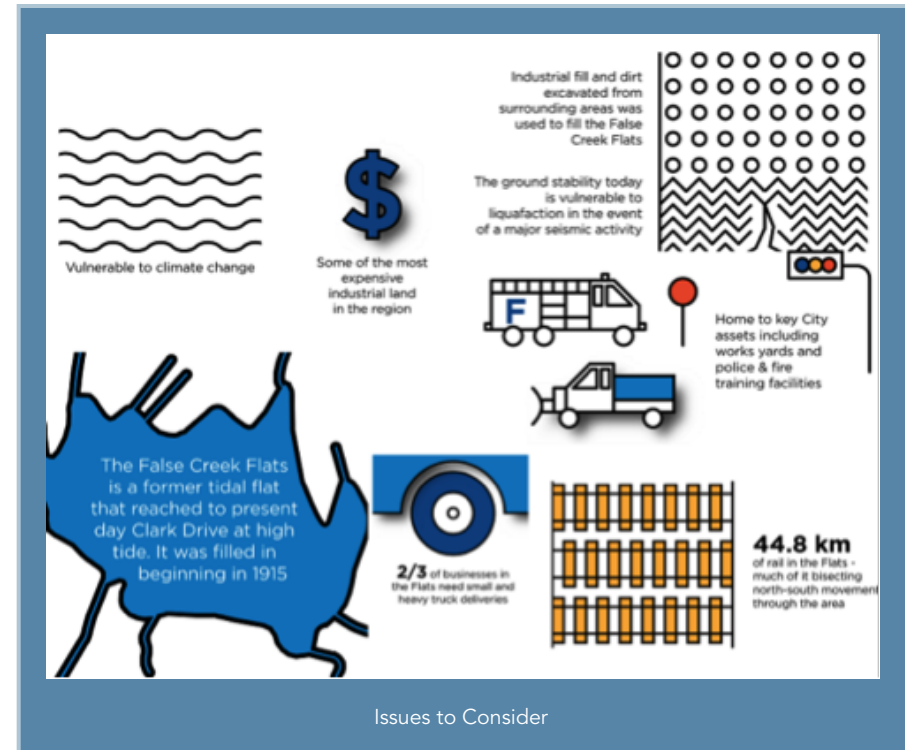
- With 1 m sea level rise and a 1:500 year storm event, most of the Flats would be inundated.
- The area is almost entirely within the floodplain designated by the City of Vancouver in 2014, meaning Flood Construction Levels (FCLs) are presently 4.6 m.
- Increasing water levels in False Creek may also challenge the gravity-based storm sewer system.



In this aerial image, the blue areas show parts of False Creek Flats that were formerly tidal mud flats and part of the original estuary area, corresponding roughly to the area now at risk from sea level rise.

## CHALLENGES IN FALSE CREEK FLATS...

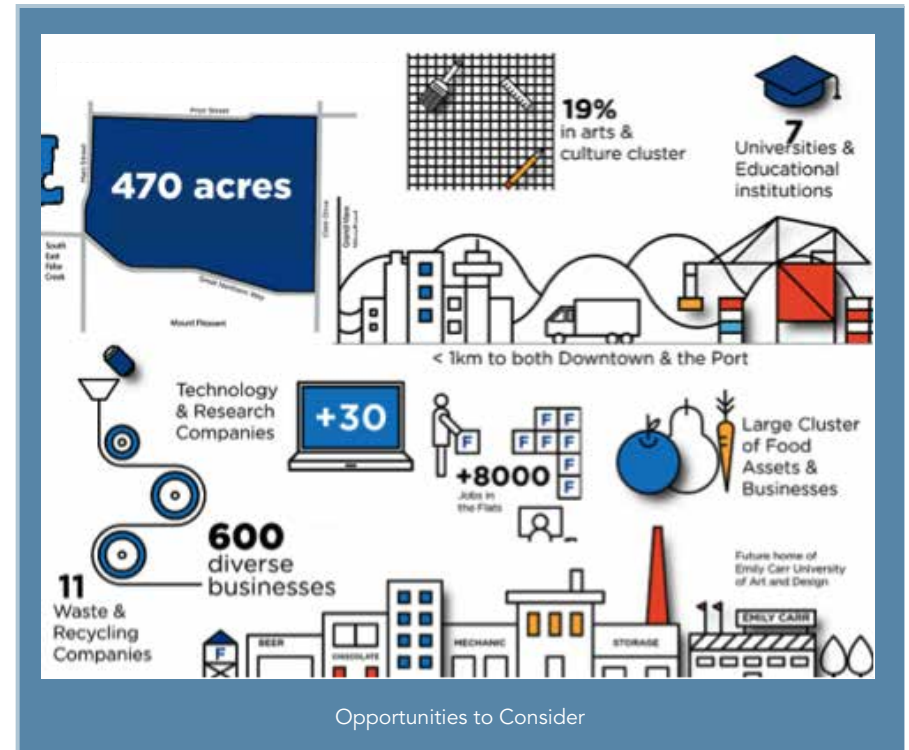
- Maintaining industrial uses is important because of shortage of industrial land and proximity of Flats to port and downtown Vancouver.
- East-west rail yards make north-south travel difficult with limited road or pedestrian connections. Railways are subject to federal jurisdiction and more difficult to engage.
- A major seismic event could cause soil liquefaction and serious structural damage to buildings and infrastructure because of the large amount of fill in area.
- More work is needed to understand the degree and nature of soil contamination.
- There is very poor biodiversity and no tree canopy in the area.
- Upland stormwater drainage must be addressed. At present relying on gravity and one pump station, but may be insufficient as water table rises.
- Public transit exists only at the periphery, Millennium Line infrastructure cuts across the Flats without any stations.
- Emergency services including Vancouver Police have facilities in the Flats, but exit across railway lines sometimes cut off.





## OPPORTUNITIES IN FALSE CREEK FLATS

- Existing low-lying rail lines could function as temporary flooding areas.
- Much of the False Creek sea wall needs to be replaced and Science World is nearing the end of its lifespan.
- Daylighting China Creek could allow it to store water during a flood event, subject to concerns re: soil contamination.
- Fill sourced from projects like proposed Broadway transit could be used for SLR adaptation purposes in the Flats.
- Large parcel size offers greater scope for adaptive design.
- The need to adapt to SLR and the large knowledge-cluster in the Flats create opportunities for experimentation and innovation with water and how we live with it.
- Existing transportation infrastructure, such as Quebec Street, could be modified to act as a barrier with soft edges, similar to a Tokyo 'super-dike'.
- Old building stock may be redeveloped in innovative ways, or provide opportunities to consider long-term retreat.
- Land use can be phased and re-shaped over time using medium to long term strategies to address SLR.



## FALSE CREEK FLATS AND SEA LEVEL RISE: PROTECT, RETREAT, ACCOMMODATE?

Participants first considered protect, retreat and accommodate options for each site.

### A. PROTECT

PROS: Can maintain existing levels of density, capital costs predictable (if SLR predictable...)

CONS: Very expensive, early failure if SLR accelerates, severe consequences if failure, may further compromise marine habitat

### Build a sea gate/berm and dike around False Creek

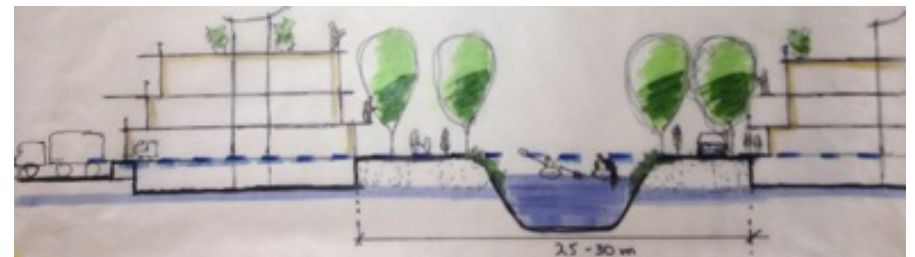
Because False Creek is relatively sheltered, one idea was to build a sea gate at the Burrard Bridge where the inlet narrows, with the aim of protecting all of the neighbourhoods around the inlet to the east, including the Flats. Similar to the Thames Barrier in London, UK, a sea gate would be designed to close during high water to provide temporary protection against storm surges during extreme weather events, rather than providing protection to incremental sea level rise over time. A provincial study has already projected costs for a sea gate to be about \$25 million. Alternatively, a permanent berm could include fish gates and allow for tidal exchange.

Despite reservations about the longer term usefulness of these strategies as sea level increased, some participants suggested that short to medium term protection might buy time to progressively elevate the buildings around False Creek. Others found the cost significant, with potentially minimal benefits over the medium to long term. A sea gate or berm would only be effective for longer term sea level rise if a continuous dike was built around False Creek. This would be expensive, and would use land that is currently valuable public space.

### Create a Quebec Street dike and allow controlled water ingress

Participants also explored the idea of raising Quebec Street between False Creek and the Flats as a dike, but one that let water in and out from the Flats to False Creek in a controlled way. For example, a tunnel or culvert system running under the street could allow water to flow directly into the Flats without flooding the buildings located between the eastern edge of the Flats and the water. For that to work, Quebec Street would likely have to be elevated. Water directed into False Creek Flats during an extreme event could possibly be allowed to flood railways on a temporary basis.

An alternative would be an impermeable barrier between False Creek and the Flats. To be effective this would have to be quite deep, which would be challenging from an engineering and cost perspective. As well, due to water seepage and rainfall/upland drainage, the water table would likely rise at the back of the dike (on the Flats side).



Controlled water ingress to certain parts of the area could be used for natural waterways, with flood-proofed and adaptive first-floors, ready for any amount of water to come in during extreme events.



Current site configuration of False Creek Flats with 3, 4, and 5 metre contour lines shown

A softer approach to protecting False Creek Flats could involve eventually closing Quebec Street to vehicles. This would make it possible to raise and naturalize False Creek's shoreline to provide a buffer to sea level rise. Active transportation would still be allowed along Quebec Street. Housing would need to be adapted to higher water levels. Again, this is challenging as many residential buildings obtain access to parking from Quebec Street.

Participants also discussed creating a salt marsh inland behind Science World. It was noted that green approaches offer protection that is 'self healing' and would not require significant restoration after flooding.

## B. RETREAT

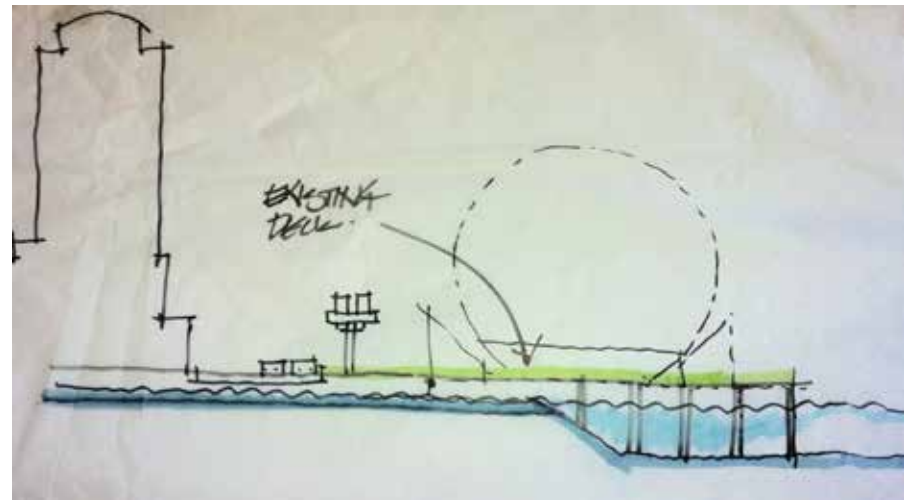
**PROS:** Permanent and safe solution, long term costs may be lowest, habitat restoration can buffer inland areas

**CONS:** Very expensive in short term, would lose valuable industrial land and port-rail connection, recent developments would be underwater, rate of sea level rise still uncertain

### Planned retreat

In light of uncertainty around the rate of sea level rise, and the possibility of accelerated sea level rise as outlined in the morning presentations, participants explored whether some areas could over time be actively exposed to rising seas. Options discussed ranged from an absolute pull-back and restoration of the Flats as mudflats, to retreating in certain vulnerable areas and hardening others. Most participants agreed a full retreat was both technically and politically impossible.

Participants envisioned a partial retreat strategy that would be based on current zoning and built-up areas, perhaps making it a priority to protect the False Creek residential areas, or by trying to follow the natural geography of the area. The most vulnerable areas are the western end of the Flats near False Creek, and the lowest elevation areas on the eastern side.



Controlled water ingress to certain parts of the area could be used for natural waterways, with flood-proofed and adaptive first-floors, ready for any amount of water to come in during extreme events.

## C. ACCOMMODATE

**PROS:** May offer most flexibility over time, can be implemented in phases, provide water access within neighbourhoods, new green space, greater range of responses  
**CONS:** Contaminated soil may not be suited to flooding without remediation, gradual responses may not be in time, raising roads, sidewalks and infrastructure may be complex

Accommodating sea level rise would mean letting water into the area, adapting the built environment and supporting the restoration of natural features and habitat.

### Raise up the Flats

One idea was to progressively elevate the whole neighbourhood of the Flats over the next 100 years as sites are redeveloped. Eventually the entire area would be raised 1 or 2 metres or more. Part of this could also be done as over-decking on the railway lines.

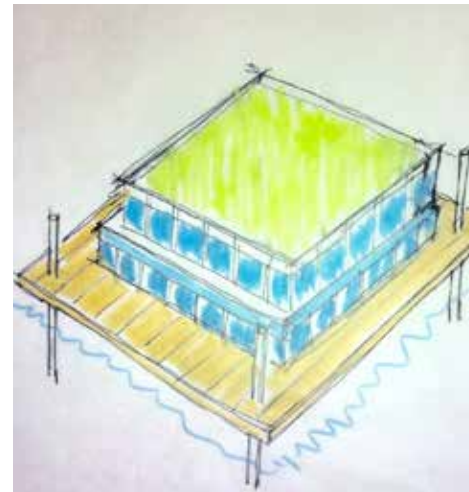
Even with elevation of the built environment, major concerns about upland water draining into the Flats during extreme weather events suggest that elevation alone may not be an adequate solution.

### Vertical retreat

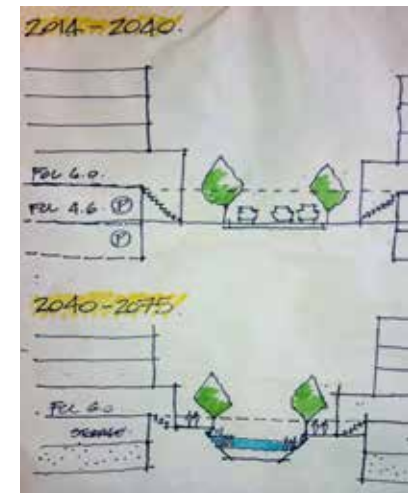
There was significant discussion about the idea of 'vertical retreat' through a combination of land-use planning and building design. The built environment would be designed so that as sea level rose, lower levels of existing buildings could accommodate flooding. For example, eventually the new FCL would be the second floor of existing buildings. Another option would be first floors with very high ceilings with the floor being raised over time. Mechanical rooms would either need to be relocated over time or initially installed at higher levels. At the same time, higher density would be encouraged in areas of the Flats with higher elevations, along the southern edges.

## Market-led adaptation

Participants considered what might happen if the City gave notice that it would provide services to protect the area from sea level rise only up to 2100, leaving it up to property owners and developers to find solutions to extend current uses beyond that date. As a property owner in the area, the City would still be engaged, and it isn't clear what obligations it might have regarding roads and other infrastructure. Limiting services could risk sending a signal that the area is not valued over the longer term for its existing uses as industrial land or as a transportation hub. It may be useful, however, to consider what types of signals the City could send to property owners and developers through zoning, developing and building requirements that would encourage evaluation of SLR risk by property owners and more autonomous adaptation responses.



New water-adaptive structures could rest on the water as docks, barges, or other structures - potentially creating more low-cost green-industrial space

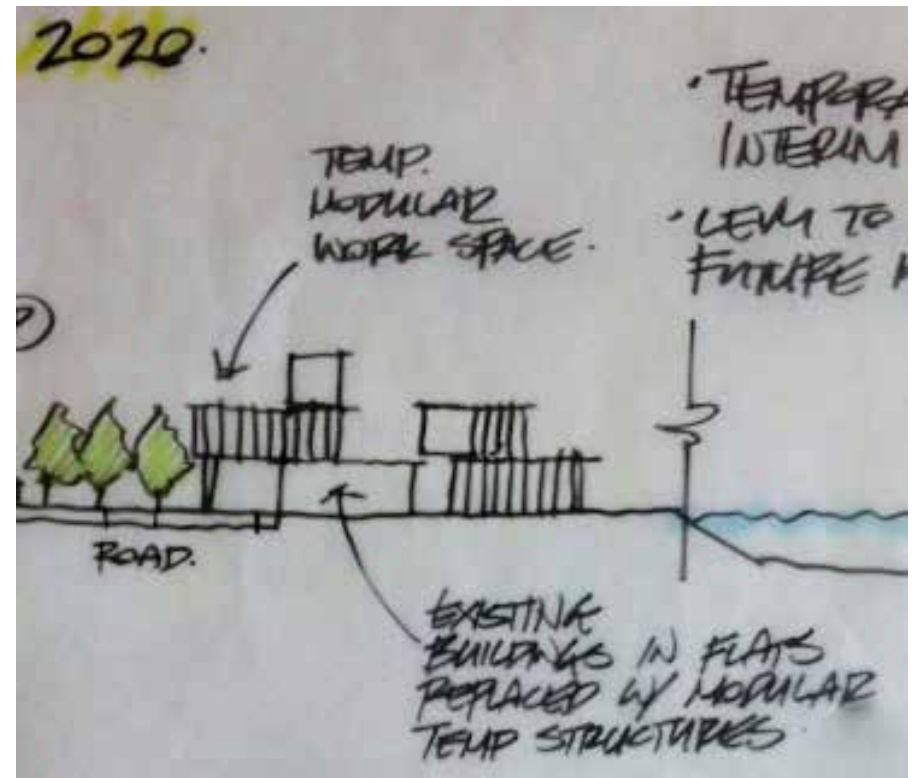


Vertical retreat: over time, lower levels of buildings are re-purposed to accommodate flooding on a temporary, and eventually permanent basis. Electrical and other building systems are located on higher floors.

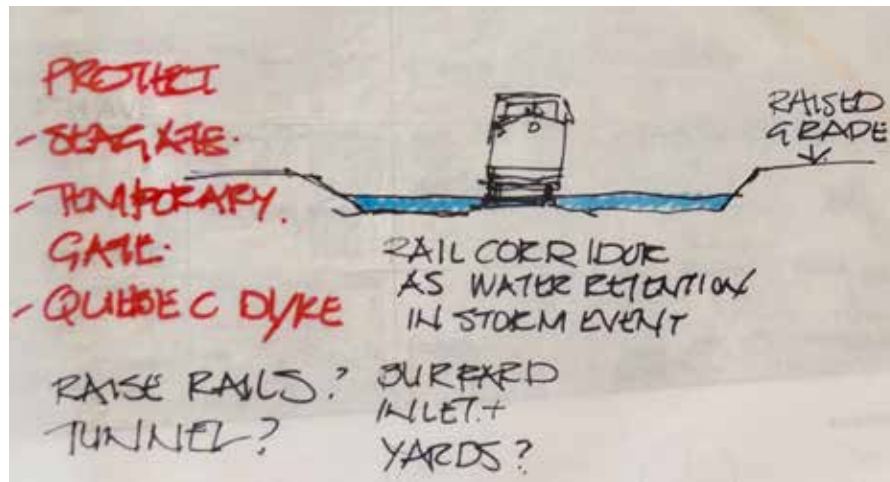
## DAY 1 SUMMARY: ADAPTIVE STRATEGIES FOR FALSE CREEK FLATS

From DAY 1 discussions and sketching, participants identified a number of possible adaptive strategies that could help make the Flats resilient to sea level rise:

- Using land swaps of private and public land to shift the City-owned property into areas most vulnerable to flooding to allow the City to support measures to transition these areas to accommodate water;
- Using old building stock as an opportunity to phase out high-intensity, low-flexibility structures, and to shift development towards structures that not only are highly responsive to rising water conditions, but also having lower energy and ecological footprints (e.g. portable structures that could exist off-grid in so-called "Genesis Zones");
- Vertical retreat of individual buildings over time, using basements and parking garages to receive incoming flood water on a temporary basis, eventually to be permanently filled with water, or sealed off;
- Creation of graduated-risk zoning areas where risk of flooding and lower levels of service (e.g. not water or electrical grid connections) would create an incentive for high flexibility, light industrial projects;
- Progressive honeycombing of density with accompanying treatment of edges to support flood resilience alongside lower elevation areas exposed to inundation;
- Daylighting of streams to reconnect newly naturalized areas where water has been let in with restored hydrologic and ecological systems, in order to benefit from upland riparian restoration and potentially decrease vulnerability of Flats to flooding from upland areas;
- Using blueways, i.e. a canal system, to 'let the water in' and create new connectivity within the Flats;
- Installing flood protection such as a sea gate, a temporary flood gate or a berm created along Quebec Street in order to protect the flats from the effects of sea level rise and storm surge during extreme events, while still allowing controlled water ingress, with water levels in the Flats expected to increase over time.



Industrial uses could be maintained in temporary, modular structures that would replace aging industrial building stock, with short to medium term leasing arrangements,



## DAY 2 SYNTHESIS: EMERGING IDEAS FOR FALSE CREEK FLATS

The first step that the team agreed upon was a wide-ranging, in-depth soil contamination study. Any future attempts at greening the area should address the level and type of existing contamination. As well, the overall approach would be to proceed in phases, using a mix of strategies that could take advantage of existing development and geography to protect some areas, accommodate SLR through vertical retreat, and shift land use in other areas highly exposed to flooding risk. Two high-level scenarios for future development and re-development emerged from discussions and exploration of possible options. A shared theme was the implementation of adaptation strategies over time to gradually reshape and redefine a new, resilient Flats.

## SCENARIO 1: GENESIS ZONES AND VERTICAL RETREAT

### Manage industrial land value and access by removing old building stock

The City could swap certain portions of land it owns for the lands in the interior of the site. Since many of the buildings in the Flats are nearing the end of their lifespan, those on City lands could be removed and the land not conventionally redeveloped, helping to avoid inflation of land values. In certain cases, this could allow for phytoremediation. Parts of the sewer and electrical grid would also be removed at this time, paving the way for green industries that would exist “off-grid” to utilize these lands in a nimble, adaptive way. This would serve the dual purpose of providing cheap industrial lands for start-ups (“Genesis Zones”) and promoting the development of self-sustaining waste, electricity, and other sustainable technologies in the area.

### Possible trigger points for phased actions

- Contamination study & remediation
- Changes in storm flows/water table
- Updated information about rate of sea level rise

## Build controlled entry points for the sea

Through 'vertical retreat,' the waterfront could be pulled back to a raised Quebec Street, allowing a softer edge along this part of the shoreline and reducing the negative impacts of a more conventional hard barrier (including overspray and puddling). This greening of the shoreline, including the eventual removal of Science World (currently near the end of its building lifespan), would allow the restoration of riparian zones in the area, as seen with Habitat Island. Using Tokyo-style 'super-dikes' with soft edges, but high-tops, Quebec Street would act as a barrier, with water allowed to flow underneath a bridge, through what is currently the McDonalds at the corner of Terminal and Main, and into the Flats.

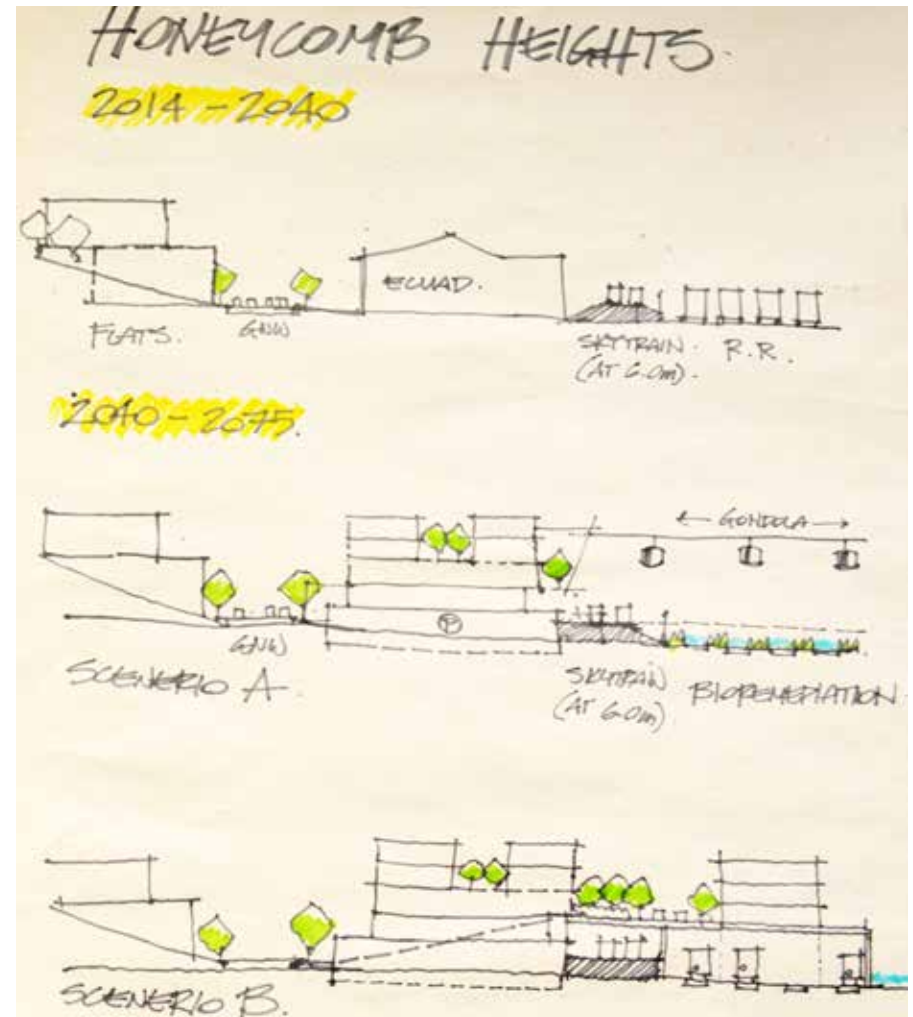
## Use SLR to create greener businesses and more resilient communities

Genesis Zones in the most vulnerable interior areas of the site would either transition from private ownership to the City, or could be held by industrial owners in new forms of relatively affordable tenure that would be consistent with retreat and decommissioning of the area over the long term. As the water rose, there would also be opportunities for barges and other water-based residential and commercial structures. Along the south edge of the site, participants envisioned a new neighbourhood called "Honeycomb Heights". Fill from the expected Broadway Corridor subway system would be used to shore up the heights of the area to an FCL of 6 m. Using an over-decked Broadway Subway as a berm, a solid barrier between the incoming water and the educational facilities along Great Northern Way would be secured. Honeycomb Heights would incubate innovation by hosting educational institutions and evolving green-technology firms in mixed commercial and light industrial spaces.

## Build a new relationship with water

By 2050, water could slowly be allowed to flow into the Flats in a dendritic pattern. It was assumed railways would remain in the Flats. However, an

opportunity was seen to combine the CN and BNSF rail yards into one rail yard south of Industrial Avenue. China Creek could then be daylighted so that it would flow through the Flats along the north side of the combined yard. Over the longer term, with over-decking on top of the rail yards, there would be significant infill development opportunities.





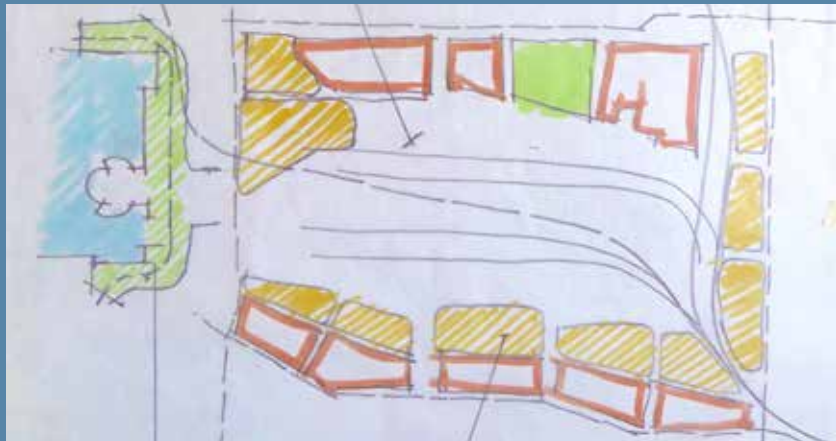
## Honeycombed density

Progressing into the 2060s and 2070s, vertical retreat would occur along Quebec Street and in the Honeycomb Heights, with adaptive structures and other flexible land-uses in now advanced Genesis Zones, and re-naturalized creeks and riparian areas would start to grow in along the dendritic cuts in the centre of the Flats, producing new north-south connectivity.

By 2100, significant soil remediation could have been undertaken in the Flats and new green industry fully embedded in the area. The northern portions of the site would remain food distribution centres, but interior parts of the site, including the fingers of land along the day-lit creeks would be focal points of green industry and of SLR-adaptive technology and design.



By 2050 water is allowed into the centre of the Flats in a controlled manner, with daylit streams and new north-south connectivity via LRT. There is now one combined rail yard south of Industrial Avenue. Genesis Zones (yellow) expand.



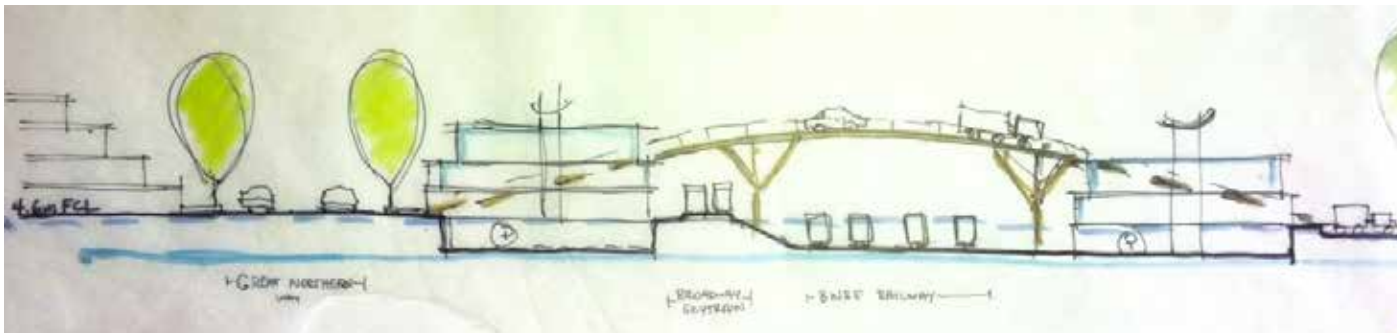
Genesis Zones (yellow) allow experimental building forms to emerge on City-owned lands where building stock is aging and needs to be replaced. These locations are also incubators for new sustainable technologies.



In the 2060s and 2070s, vertical retreat along Quebec Street and in the Honeycomb Heights accompanies new, more established adaptive structures in the Genesis Zones. Re-naturalized creeks and riparian areas become more established.



SCENARIO 1: GENESIS ZONES & VERTICAL RETREAT. By 2100, False Creek Flats is reconfigured with dendritic patterns of water ingress, day-lit creek, railway overpasses and increased density of light industry, and more parkland.



Over-decking built over vulnerable areas, such as the railways, could mitigate impacts of water ingress and create significant development opportunities.

## SCENARIO 2: THE BIG MOVE

### Create a new transit hub in the eastern Flats

Currently the Flats are bisected east-west by two rail yards, which restricts north-south connectivity. The existing transit hub at Science World to the west of the Flats does not provide ready access to the Flats, and is also in a location that is very vulnerable to the impacts of sea level rise. A proposed solution was to shift the transit hub to the eastern edge of the Flats, while at the same time reconfiguring the railyards eastward and southward, and overcoming some of the fragmentation presently existing in the Flats. This would also allow greater flexibility to design flood protection measures at the western side of the Flats.

### A canal/blueway system in the Flats

Assuming that it could be technically challenging and prohibitively expensive to completely protect the lowlying Flats from sea level rise over time, creating a flood gate or other adaptable barrier at the eastern side, behind Science World was proposed. This would be designed to protect the Flats from the effects of extreme events, but would not ultimately prevent water from entering the Flats during normal conditions as sea level rises over time. The water would be accommodated by a series of canals or a blueway system in the Flats that would create new connectivity and transportation opportunities. Structures along the blueways would gradually be modified to accommodate increased water levels. This system of blueways and adjacent flood ways would be one way of addressing the challenges associated with elevating roads and sidewalks as Flood Construction Levels (FCLs) for buildings are raised over time.



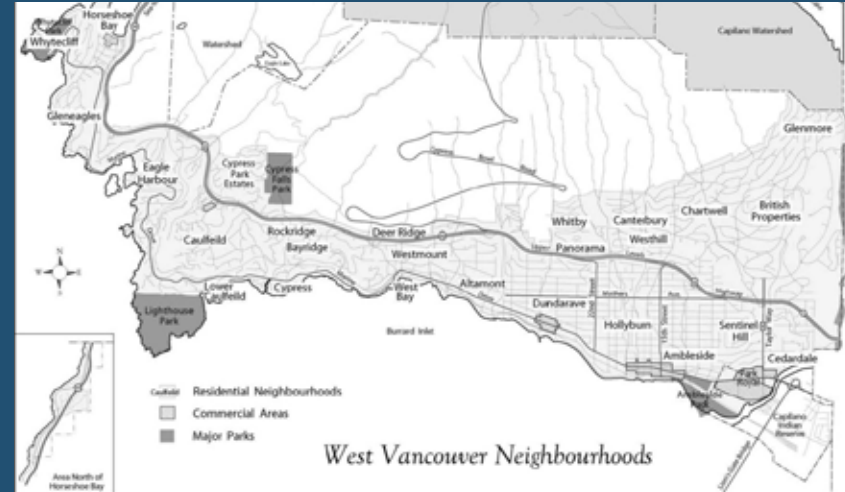


SCENARIO 2: THE BIG MOVE. Another possible land-use configuration of False Creek Flats by 2100 would see the Skytrain station moved to the east to create a new transit hub and increase available lands in the western portion of the Flats. Floodgates to mitigate the impacts of extreme events would be built behind Science World, and a canal system would create connectivity throughout the Flats and with adjacent areas





Ambleside Context



Community Context



# AMBLESIDE, DISTRICT OF WEST VANCOUVER

## Introduction

Ambleside is the major commercial and cultural hub of the District of West Vancouver (DWV). It is home to some four-hundred and fifty commercial businesses, a major east-west transportation artery (Marine Drive), and extensive public uses, including parks, boat-launches, the Centennial Seawalk, the public library and other amenities. The CN rail line (operated under a long-term lease with the Province) divides the beach area from the rest of Ambleside. The line is actively used by freight trains and a tourist train to Whistler (the Rocky Mountaineer).

Ambleside is likely to face intense and expensive challenges because of sea level rise. Though most of West Vancouver is high enough to avoid significant flooding from rising seas, some areas of Ambleside are just above sea level. Scouring (erosion from wave action) is already happening along beach-side properties and the rail line, and will increase over time. Although Ambleside was once part of the Squamish Nation's food gathering network, with rich fishing and foraging, it is presently a manicured landscape with few undisturbed areas, aside from the two creeks, McDonald and Lawson. These creeks empty into the Burrard Inlet at the shoreline and have seen successful riparian restoration efforts by the District of West Vancouver (DWV). Protecting these riparian areas and valued public space along the shoreline is very important to the community. Conventional hard armouring responses to sea level rise would have negative impacts on the shoreline and the riparian areas, and offer little to no extended adaptive capacity as sea level rises. Charrette participants agreed that relying solely on rip-rap or cement barriers carried significant costs and offered no long term assurances of protection and security.

## Sea level rise in Ambleside

- Sea level rise will lead to increased erosion along the waterfront—already there is evidence of scouring in front of residential properties along the rail line; area is exposed to storm surge
- The existing rail line forms a coincidental dike, but its semi-porous base allows for saltwater intrusion that pools on the upland side of rail line
- Lower elevation lands vulnerable to SLR form a natural amphitheatre which curves landward of the rail line all the way up to Marine Drive

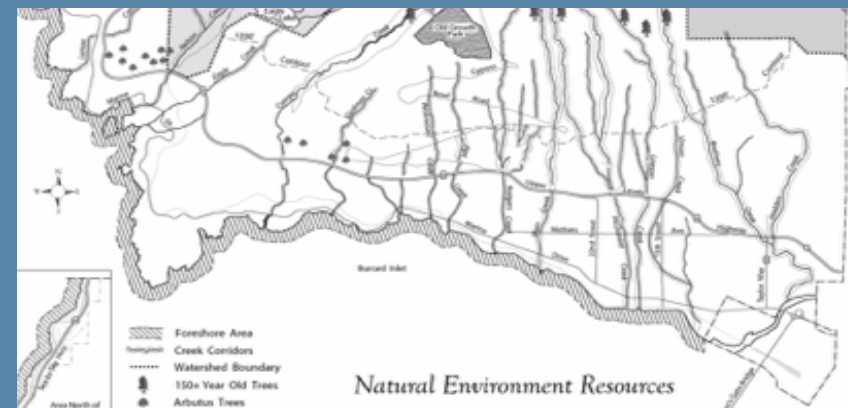


## CHALLENGES IN AMBLESIDE...

- Beachfront public land, including the expansive public shoreline and significant areas of commercial land are at near sea level;
- The intensity of wave action associated with SLR will expose many waterfront areas of Ambleside to erosion, including road and rail infrastructure, housing commercial and institutional amenities, and ecological restoration areas.
- The CN line runs through Ambleside parallel to the shoreline, dividing the waterfront from the upland commercial areas. The line connects to resource routes as far north as Tumbler Ridge, and CN long term plans are unknown.
- Ambleside has more than 450 businesses, and is the economic and cultural hub of DWV.
- Ambleside has several parks, the District Library and the Ferry Building Gallery. Public lands in upland areas may be under pressure if there is a push to shift commercial areas further upland;
- Marine Drive, running east-west through Ambleside, is a major traffic artery in DWV;
- Several creeks drain into the Ambleside area, potentially combining with SLR and storm surge to increase flood risk.

- **Current Council priorities include: Ambleside: Waterfront and Town Centre; Natural environment; and Climate Action and OCP Review.**
- **Streetscape Standards for Ambleside recently adopted.**
- **Ambleside Waterfront Study underway following Council policy from the 1970s of buying private lands to provide contiguous park from Ambleside Park to 18<sup>th</sup> Street.**
- **Current zoning and OCP adopted in 2008 following Ambleside Town Centre Strategy Report.**
- **AC1 and 2 zoning allows for up to 1.0 FAR, or 1.75 with CACs and complying onsite vehicle parking, up to 3 storeys or 4 storeys on larger sites.**
- **OCP designates three 'special sites' for consideration of building higher than 4 storeys.**
- **Engineering challenges with meeting required onsite vehicle parking due to threat of flooding and high ground water (and very expensive).**

Current Policy/Initiatives and Challenges

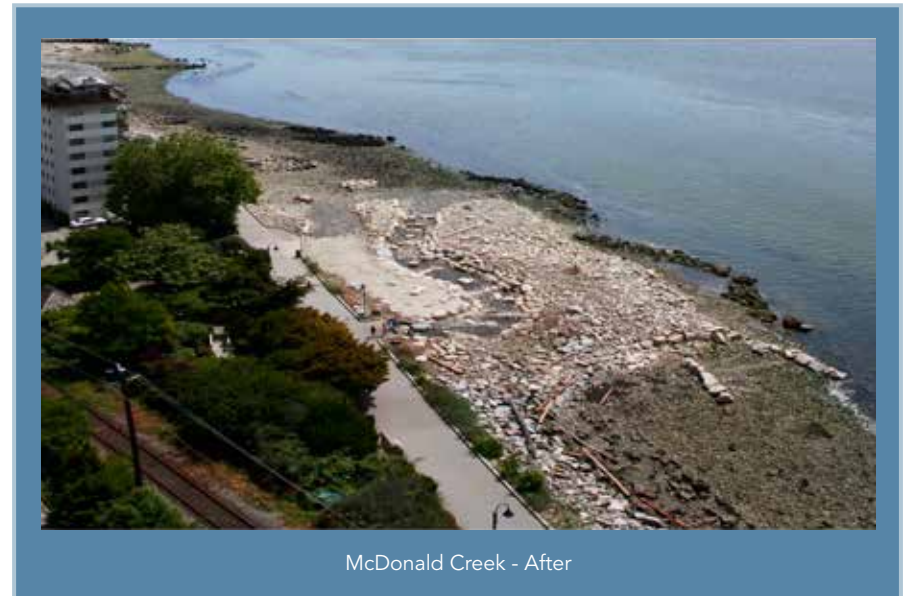
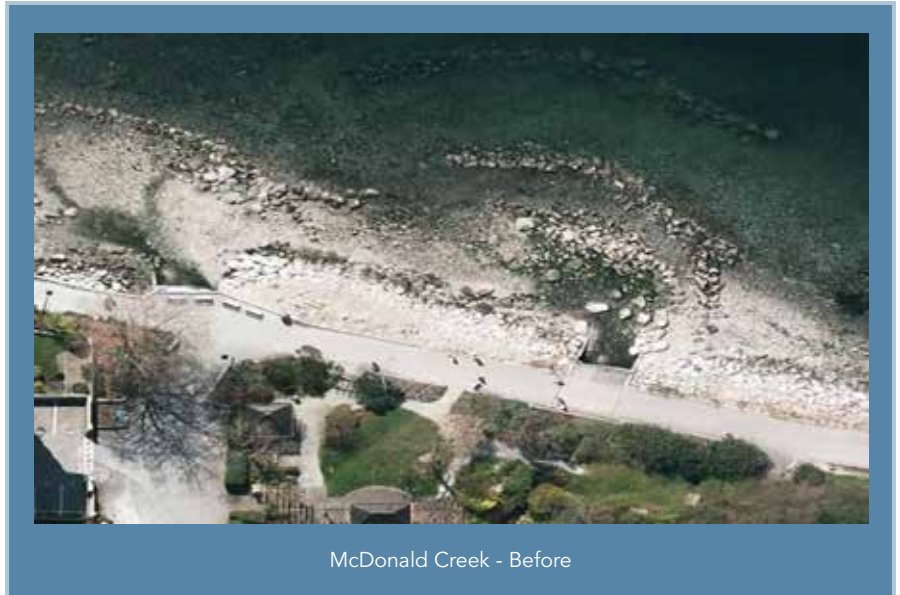


Existing streams and other ecological features of West Vancouver (District of West Vancouver, Official Community Plan - Section 6 'Natural Environment' (West Vancouver, 2005), Pg. 87).



## OPPORTUNITIES IN AMBLESIDE

- Lands exposed to SLR, while vulnerable, are small in area compared to higher elevation land in DWV;
- DWV owns most of the frontage lots and has a head lease over the foreshore, so can actively manage the shoreline and adjacent area for SLR;
- A new development just east of Ambleside will have 4.5 m FCLs and could be an opportunity to demonstrate SLR adaptation to the public;
- DWV has worked to restore streams, particularly Lawson and MacDonald Creek. This may reduce combined flood risk from sea level rise/storm surge and upland sources;
- Grassroots support for ecological restoration is strong through groups like the West Vancouver Streamkeepers;
- Armouring and elevation could transform the rail line into a dike to provide protection;
- Ambleside's importance to the culture, economy, and identity of West Vancouver means public investments to manage SLR could win community support;
- The sea walk along the waterfront is very well used. New forms of public space, designed to be inundated, may be created, similar to Rotterdam's water plaza. SLR adaptation can be public engagement;
- Strengthening the connection to beachfront public amenities with SLR adaptive design could invigorate the commercial area south of Marine Drive, and increase the connection between shoreline and commercial areas.



## AMBLESIDE AND SEA LEVEL RISE: PROTECT, RETREAT, ACCOMMODATE?

Participants first considered protect, retreat and accommodate options for each site.

### A. PROTECT

**PROS:** The rail line could become a hard barrier; DWV owns most of land below the railway and could “sacrifice” this public land if desirable; protection may be attractive to property owners and tenants above the rail line; Ambleside is the commercial heart of West Vancouver and Marine Drive is a major transportation corridor; offshore barrier reefs can lower wave energy and provide habitat.

**CONS:** Creating a hard barrier will lead, eventually, to the loss of a very popular public shoreline amenity over time, in a municipality where much of shoreline is bounded by private property and not accessible; there is uncertainty around long term planning for railway line; the seaward area is exposed to extreme weather events and storm surges that will challenge hard edged protective structures; need to determine who would pay and long term viability of rail line as a protective barrier.

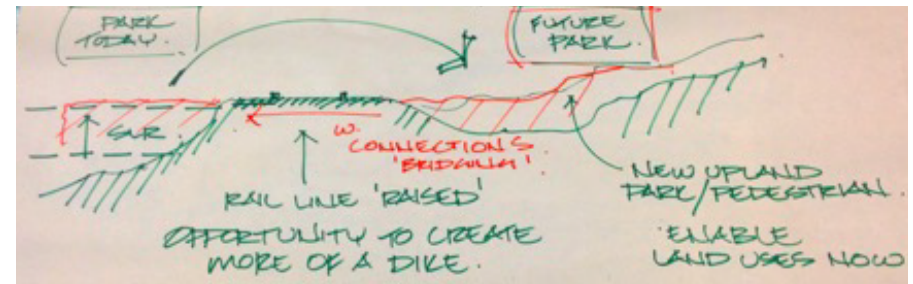
### Using the railway line as a dike

The prominence of the rail line through Ambleside, paralleling the shoreline at a raised grade, suggested it could do double duty as a protective barrier. Currently, the line is at about 3.5 – 4.0 metres above sea level, but its base is porous. If the rail line could be armoured or otherwise adapted to SLR as a barrier, DWV could potentially implement adaptive measures on the seaward side, including the foreshore (relying on its authority under the Head Lease), to allow the shoreline to migrate landward as sea level rises.

Though using the rail line as protection seemed to be an attractive option, participants discussed the uncertainty around the railway company’s plans for investment in the line over the longer term.

### Breakwaters and barrier islands

Offshore barrier reefs and breakwaters were suggested by a number of Day 1 participants, and were seen to have multiple benefits, such as diffusing wave energy before it made contact with the shore, and providing new marine habitat.



Proposed alterations to the physical profile of Ambleside to use the railway as a dike.

### B. RETREAT

**PROS:** Enhanced public waterfront amenities; connection to park could support invigorated commercial areas.

**CONS:** Loss of some commercial, residential lands, short-medium term land acquisition costs.

Though retreat raises obvious political and economic challenges, a partial retreat phased over time offers opportunities to increase resilience and vibrancy of commercial areas while encouraging riparian restoration and creating a greener waterfront with more natural coastal form and function.

## Following the coastline

Participants looking at the contour lines on the map of Ambleside observed a natural amphitheatre opening to the sea that suggested a gradual retreat of buildings and uses landward and upward. Rather than fighting the water and allowing the aesthetic, commercial, and ecological values related to the vibrant shoreline to decline, why not welcome it and attempt to draw new

benefits? Participants envisioned the rail line elevated on a trestle that would be designed to act as a breakwater. Seaward beaches would be naturalized and exposed. Though this option was seen as a shift from the current neighbourhood configuration, there was lively discussion about the possibility of creating greater connectivity between citizens and the ocean.

DWW's experience in managing the foreshore through the head lease means it has expertise in shoreline management and restoration, but much of the lower elevation land that is part of the natural amphitheatre is currently in private hands. Obtaining the right to manage these lands (though acquisition, for example), and in time to prepare for rising sea levels, would be expensive. Densification of higher elevation lands could potentially provide amenity contributions.



Ambleside current site configuration, with 5, 6, and 7 metre contours (blue, pink and orange lines).

## C. ACCOMMODATE

### Adapted infrastructure

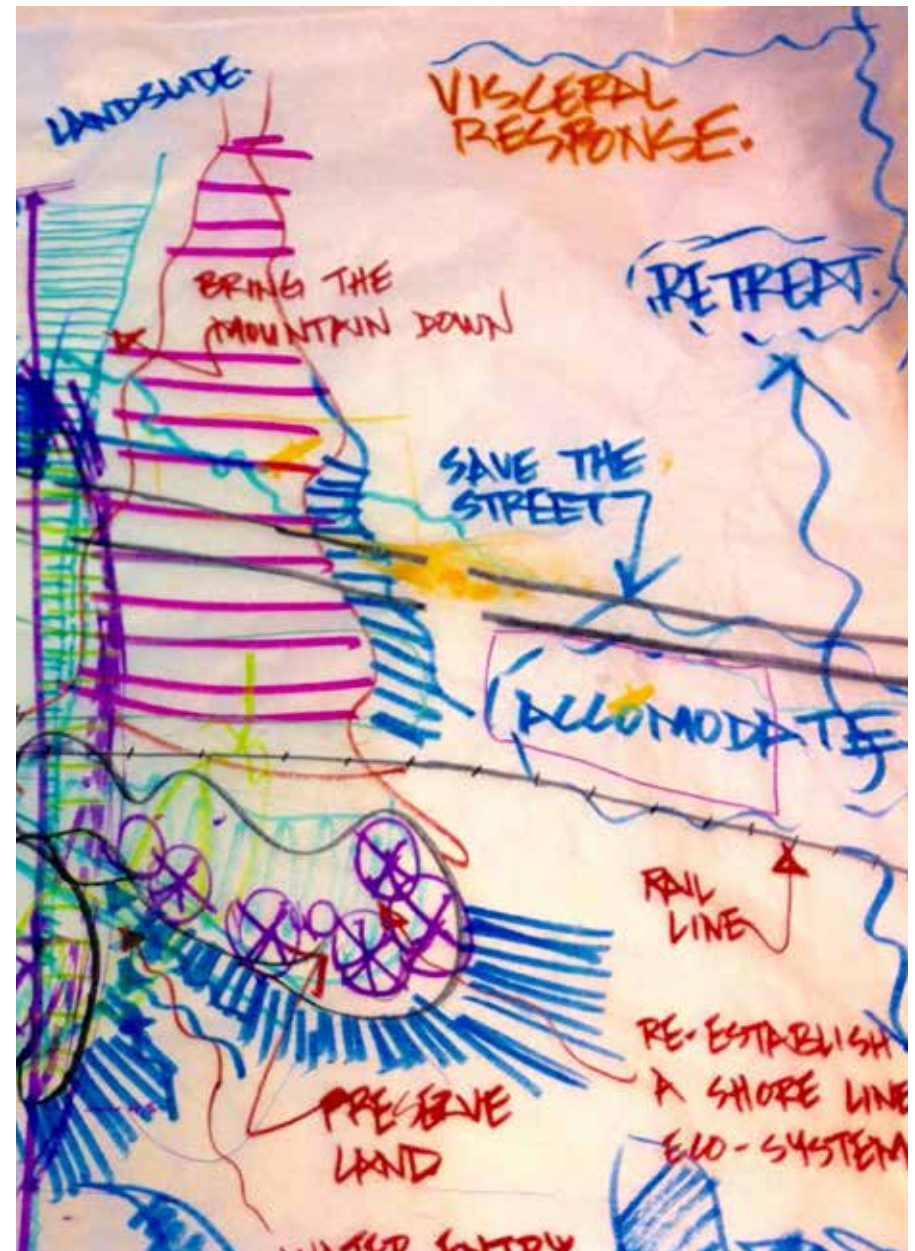
Accommodation could be part of a varied strategy where certain areas were protected and others designed to allow water in. Participants identified the railway as a critical component of any future design. CN's willingness to explore accommodation options would be an important factor. Presently the rail bed is porous and would not be an absolute barrier to rising sea levels.

### Increasing upland density

A key principle for accommodation was reciprocity. Agreements by some landowners to pull back closer to Marine Drive along with relaxed parking requirements could be combined with density bonuses, leading to densification along Marine Drive. Both north and south sides of Marine Drive would feature increased density with shopping and amenities, while there would be a new, higher shoreline along the southern edges of what is currently park land.

### Maintaining and enhancing public connections with the shoreline

An advantage of allowing the sea to migrate gradually upland is the opportunity to maintain a shoreline that is publicly accessible and ecologically vibrant. At the same time, if ecological restoration of the shoreline area is to be successful, there will need to be community outreach and management of public access to the area. Careful consideration of upland development, working at a human and pedestrian scale, can help reinforce connections down to the shoreline.



## DAY 1 SUMMARY: ADAPTIVE STRATEGIES FOR AMBLESIDE

From DAY 1 discussions, some key strategies emerged to guide the development of design ideas:

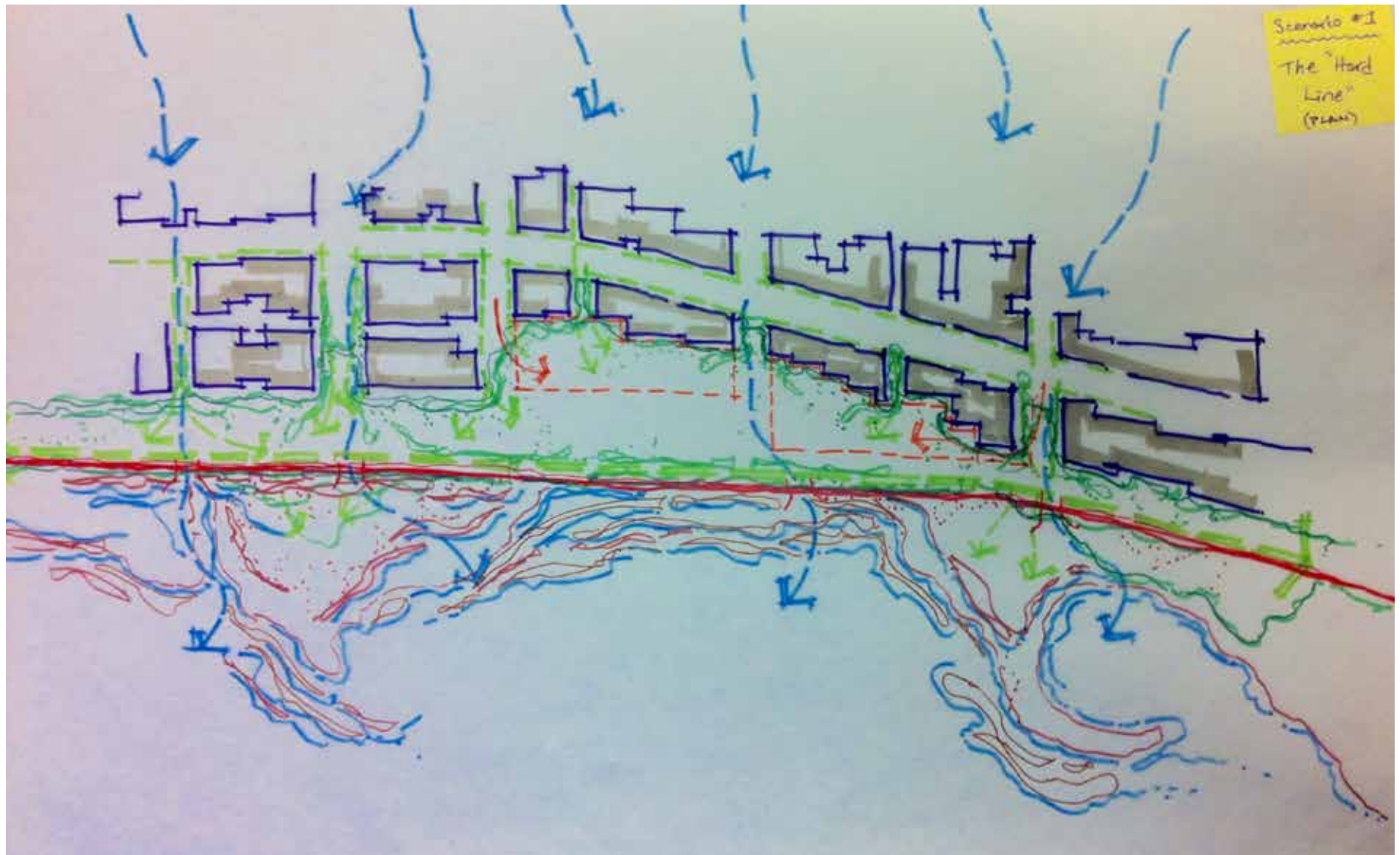
- Be prepared to use existing features of the built environment, such as transit arteries, as protective barriers, i.e. look for integrated solutions where one use can be split into multiple ones;
- Constraints on commercial land exposed to SLR could be offset with increased density in upland areas;
- Wherever possible, water could be integrated into public spaces as a feature, not pushed away;
- Green infrastructure, particularly barrier reefs and shoreline features, could be used as part of protect, retreat or accommodate responses to buffer storm surge and SLR;
- Planning ahead could protect pedestrian access to water and public spaces;
- As an alternative to elevating infrastructure such as roads, which may be expensive, adaptive measures can be used to accommodate temporary inundation, such as designing streets to let water in during major storm surges but being capable of returning to full use quickly afterwards.

*“listen to the natural amphitheatre  
of the land...”*

## DAY 2 SYNTHESIS: EMERGING IDEAS FOR AMBLESIDE

Building upon the general strategies and identified challenges and opportunities of Day 1, three scenarios emerged in Day 2. Each incorporated the existing rail line, but proposed different combinations of protection, accommodation and retreat strategies in the area between the existing shoreline and Marine Drive. Each scenario recognized the value of natural coastal features in buffering the area from the impacts of rising sea levels and increased storm surges. From discussion on both Day 1 and Day 2, it was clear that there would need to be a community-level exploration of values in the context of SLR and its projected impacts in Ambleside to establish priorities and inform more detailed planning.





SCENARIO 1: THE HARD LINE. The red line represents the hardened CN rail line, with protected parkland behind, and densified commercial buildings made possible through transfers of development rights from former sites seaward of the protected line. The rail-dike is perforated to allow upland storm flows to pass through.

## SCENARIO 1: THE HARD LINE

### A rail-dike

The existing rail line would be maintained, acting as a de facto dyke and protecting the Ambleside area from storm surge and SLR. DWV could work with CN to ensure that the line was raised over time from its current approximately 3.5 – 4 metre elevation and the base hardened to increase protection. If CN opted to abandon the line, the District could purchase it and convert it into a waterfront pedestrian walkway/bikeway on top of a reinforced berm.

### Foreshore parks

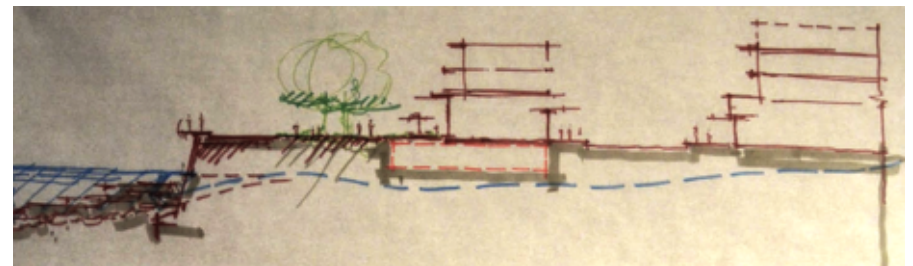
The foreshore area would be restored to a more natural state (e.g. wetlands, intertidal marsh), allowing the intertidal margin to expand and shift over time in response to SLR. Estuarine habitat could be created in this naturalized waterfront park, although the foreshore area might eventually disappear as sea levels rose up to the dike. To add protection against the prevailing winds and storm surge from the southwest, barrier reefs would be constructed beyond the existing foreshore. Public access to the restored shoreline areas would be allowed but constrained to protect habitat values.

### New, raised pedestrian spaces

The city park formerly on the seaward side of the rail line would be shifted north behind the dike, taking over some of the lots formerly used as parking and commercial properties along Bellevue Ave. This could introduce the vibrant pedestrian experience currently enjoyed by the existing seaside park to the upland area, helping to revitalize the commercial district of Ambleside. The reduction in commercial space along Bellevue Avenue would be balanced by additional density for commercial and mixed uses along Marine Drive with new buildings required to have FCLs based on 2100 sea level projections. In order to maintain view corridors and connectivity to the foreshore, the area north of

the rail line would have to be raised over time in tandem with the raising of the rail line/dike (up to the level of Marine Drive at approximately 4-5m elevation). New parking would be created beneath the new park and commercial area upland of the rail line.

With this integration of water and built form, the ocean could become a celebrated feature in the new upland park. Ideas included water plazas (which could retain water in the event of a storm), stairs that double as water-falls, and daylighting of stormwater and upland runoff channels at key collection points.



A hard-edged waterfront, using the rail line or fill, with armoured, higher density buildings along the waterfront, with protective water catchment systems beneath (e.g. floodable garages)



SCENARIO 2: THE HYBRID. The CN line as a raised-trestle, with some development pulled back as far as Marine Drive to accommodate rising sea levels on lower elevation lands. Restored and enhanced estuaries allow build-up of sediment and other materials over time which further buffers the area from storm surges.



## SCENARIO 2: THE HYBRID

### A sheltered bay

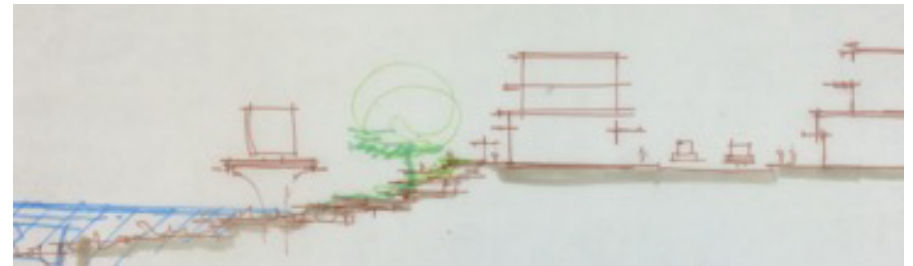
In this approach, the existing rail line would be maintained but its base would be opened up at a key central location, converting it into a trestle. This would soften the hard edge created by the rail line and increase connections and sight lines between the waterfront and the upland commercial area. The remaining length of rail line, with reinforcement, would continue to act as a barrier sheltering the rest of Ambleside area. DWV would need to work with CN to raise the line over time in response to SLR and to maintain pedestrian and vehicular crossings at road intersections. Following the natural, semi-circular contours of the basin, the existing foreshore park would be extended to a limited extent north beyond and beneath the center of the rail line trestle.

### Density for retreat

Directly along the waterfront, reefs would be constructed offshore as protection against the prevailing wind and storm surge from the southwest, and to encourage pedestrian access along the shoreline. More natural intertidal spaces would be created in the foreshore park to absorb water and wave energy in storm events. As sea level increased, traditional park space would retreat up the contours of the now-forming bay, moving up to some of the blocks along Bellevue Avenue currently used for parking and commercial/mixed use development. As in the rail line/dike scenario, one of the desired outcomes would be to add dynamism to the commercial district of Ambleside by increasing its proximity to the very popular park areas. Both the more natural foreshore and upland city park would have the flexibility to be inundated in storm events and still provide some protection to the development behind.

### Natural connections between shoreline and upland areas

While all new development would be built to year 2100 FCL, the land behind the rail line was not raised in this scenario, since the transparent trestle base would allow ground-level sight lines and increase the connections to the water, with the parks providing a natural buffer against SLR and storm surge. Some sculpting of the landscape to restore more natural features and topography would be needed. The participants wanted water to be a celebrated feature in this scenario, with a strong pedestrian connection between the waterfront and upland parks. Water plazas and the creation of additional, exposed upland runoff channels (in addition to the creeks) were also suggested features of the new city park.



The CN Line as a trestle, with a higher shoreline right up to the Commercial on the south-side of Marine Drive



SCENARIO 3: THE SOFT EDGE. The CN line is raised, with water moving as high as Marine Drive during major storm surges. All buildings on the low-lying south side of Marine Drive have gradually been removed and uses accommodated in increased density on the northern side of Marine Drive.

## SCENARIO 3: THE SOFT EDGE

### A new coast

In this approach, the rail line would be maintained, but its semi-porous earthen base would eventually be converted to a reinforced trestle from 14th Ave to 18th Ave. As sea level rose, water could flow in and out under the trestle. This would soften the hard edge created by the rail line and enable a return to a more natural shoreline habitat above and below the rail line that could be maintained with higher sea levels. The trestle would also increase connections and sight lines between the waterfront and the commercial area for the entire length of Ambleside. Pedestrians could access the shoreline underneath the rail line. The commercial area south of Marine Drive from 14th Ave to 16th Ave would over time transition to a new park reflecting the contours of the land and the natural amphitheatre of the area.

### Resilient waterfront for storms and estuarine repair

The waterfront areas would be become a more natural park area with new estuarine habitat, with offshore barrier reefs as protection against the prevailing wind and storm surge from the southwest. The landscape behind the rail line would be sculpted as necessary to gradually step up from the shoreline to the elevation of Marine Drive. Above the rail line, a new city park would be created, with a city square plaza at the base of 15th Avenue. Participants were excited about the possibilities of water being celebrated as the central feature of the area. The entire park would be able to be flooded during storm events, and pedestrian and recreational uses would be encouraged along the water and connected through the trestles of the rail line.

### High density on high ground

Along the higher edges of the parks, development would be focussed on the lots fronting the north side of Marine Drive, where increased density would be allowed. All new development here would be built to 2100 FCLs (adapted as necessary beyond today's 4.5 metres). This would offer protection and at the same time foster greater connectivity to the ocean along Marine Drive. All of the new higher-density developments could see long-term increases in value due to their park frontage and proximity to the water. Marine Drive would not be elevated and could possibly flood during future storm events even with the buffer of the parks, which might lead eventually to a rerouting of this major transportation corridor upland. This was thought to respect the natural aspects of the new shoreline, offer interesting design possibilities, and potentially save costs. Community Amenity Contributions from new density on the northside of Marine Drive would help pay for the new city park. Parking lost along Bellevue Ave could be replaced by underground parking in new developments.



The CN Line as a trestle across Ambleside, with the natural shoreline right up to the south side of Marine Drive, meaning occasional flooding, allowed for by adaptive street surfaces. Density on the north side of Marine Drive is significantly increased, with ground level accommodation of storm surge events.



Erwin Drive Area (Cypress Creek Fan)



# ERWIN DRIVE, DISTRICT OF WEST VANCOUVER

## Introduction

The Erwin Drive neighbourhood is built on the alluvial fan of Cypress Creek, south of Marine Drive, with properties lining the oceanfront as well as the riparian areas of the creek located at the western edge of the neighbourhood. At current sea levels the neighbourhood is already exposed to storm surge from the sea and erosion, as well as upland flooding that can destabilize the creek banks. Historically property owners have responded with ad hoc, site-scale hard armoring which has increased shoreline erosion. The North Shore Emergency Management Office studied the impact of major storms in the area, noting that Ambleside and Erwin Drive represent the two most 'at risk' areas in the District.

To the east is the site of a Department of Fisheries and Oceans (DFO) research lab (Centre for Aquatic and Environmental Research), which may provide an opportunity for redevelopment. Charrette participants pursued design ideas that could lead to a more resilient neighbourhood over the longer term, even with rising sea levels, exploring how to enhance the natural features of the area while protecting and adapting development.

Homes in Erwin Drive are typically valued at several million dollars in the current real estate market, and landowners may have resources to protect their properties. The West Vancouver Shoreline Protection Plan (2012) describes existing erosion problems and documents some of the measures landowners have taken, including raising buildings or further channelizing runoff water.

## Sea level rise at Erwin Drive

- Erwin Drive is a waterfront residential neighbourhood relatively exposed to sea level rise
- Historic armoring on private properties has increased erosion
- Meeting flood construction requirements for sea level rise poses challenges because of setbacks, height restrictions and neighbourhood continuity





## OPPORTUNITIES FOR ERWIN DRIVE

- The assets at risk are mainly private properties. The nearby DFO site is highly water adaptive and has potential for redevelopment.
- Barrier reefs and other protective measures could create new public spaces, aquatic and terrestrial.
- Future riparian or stream restoration, such as widening or increasing the complexity of the creek to slow the descent of the water could enhance alluvial sedimentation, help protect the shoreline from erosion and support marine life.
- DWW can continue to actively manage the foreshore under the terms of its head lease with the Province, and to implement its Shoreline Protection Plan.
- Coordinated, private actions taken across the area could increase resilience in a way that also benefits shoreline ecology without requiring large public expenditures.



Shoreline softening project - Before



Shoreline Project - After

## STRATEGIES TO ADDRESS SEA LEVEL RISE: PROTECT, RETREAT, ACCOMMODATE?

Participants first considered possible protect, retreat and accommodate strategies for Erwin Drive.

### A. PROTECT

While Erwin Drive might seem protected because of its cliffs, the risk of erosion, both from the sea and from Cypress Creek, is a major concern for the area. The risk of liquefaction from earthquakes is a further important consideration because of the alluvial fan at the end of the creek. Protection was seen as a critical part of any action for the area.

### Public-private partnerships

Combining resources from private and public sectors was discussed as a strong possibility for protecting the area. Land owners in the area have a vested interest in maintaining their property and this could be combined with strategic public spending on infrastructure projects on public land, including work on the foreshore managed by DWV.

### Leveraging protection to innovate

Within a supportive framework or incentive system created by DWV, private protective measures could be coupled with public investment to create new public spaces or environmental restoration that would benefit everyone. Opportunities for diving, new boardwalks built on top of barrier islands, or other forms of new infrastructure in the area would all be possibilities.



Erwin Drive current site configuration, with contours showing present elevations. Foreshore erosion may be a risk in coming decades.



## B. RETREAT

Any long-term solution will involve some measure of retreat over time, based on exposure to SLR and risks to properties and people.

### Gradual retreat

New FCLs (4.5 m) in DWV will help to catalyze building practices that can make existing sites safe and habitable, but eventually sea level rise will necessitate shifting development landward. Participants discussed the creation of specific adaptation zones according to elevation and relative exposure to SLR impacts.

Using a graduated approach over several decades, with a variable timeline depending on the rate that SLR increases, regulatory options to encourage houses to move further away from the water should be explored. Over time, upland lots could be reconfigured, and houses in lower lying areas relocated or removed.

### Utilizing public spaces

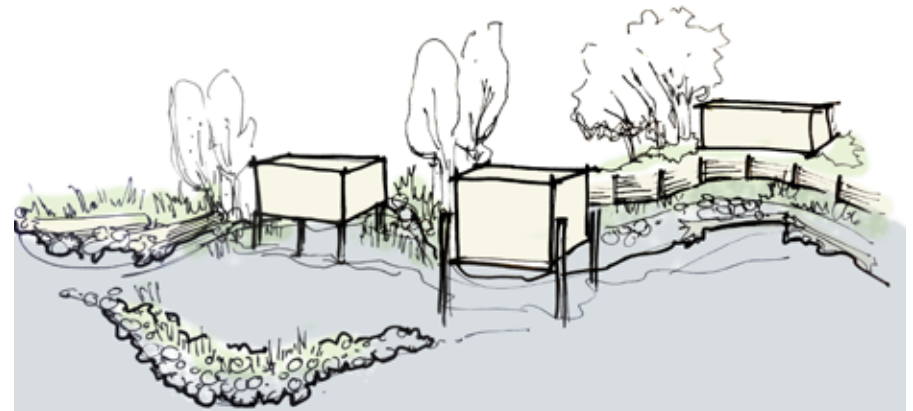
The DFO site is highly exposed land (currently around one metre above sea level). It was proposed that it could be adapted through a partnership between DWV and DFO. Redevelopment could involve innovative floating or raised structures, combined with new research spaces and water-focused recreation opportunities. Temporary defence walls could have slats that are only inserted during periods of high flood risk. The area was seen to offer ways to educate the public about the impacts of SLR and to demonstrate innovative adaptation measures.



Stilt structures

Floating structures

Temporary defense walls



## C. ACCOMMODATE

Both the residential nature of Erwin Drive and existing highly valued views and beach access constrain adaptive responses.

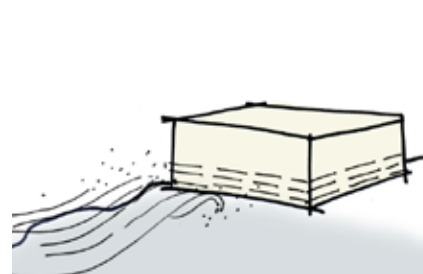
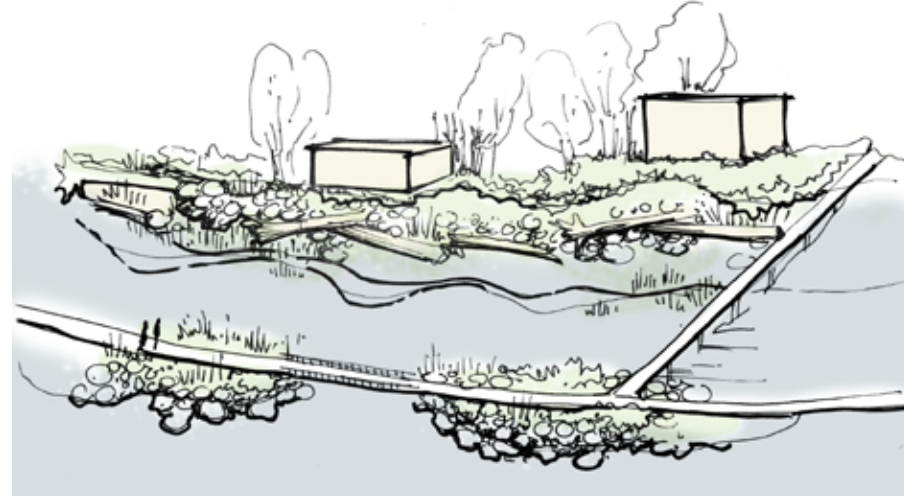
### Multi-use public/protective spaces

Using the foreshore areas and potentially moving into the water to create wave-barriers was not only a way to protect the properties from storm surges, but also opened the possibility of creating new public spaces. Depending on the design used, it would be possible to bring together these uses to create either walking space on top of the wave-barriers, or new diving opportunities on the artificial reefs.

### More flexible options for buildings

New building requirements could be explored in the areas subject to SLR, such as relaxing height restrictions to enable greater use of fill, and/or allowing new adaptive structures that accommodated water. For example, in lowest elevation areas, floating structures and flood-proofed water homes could be used. In areas with more limited exposure to SLR, lower levels could be floodproofed to accommodate temporary flooding or more minimal levels of water. Because this would likely mean increasing building height to maintain existing density, property owners on upland sites would also have height restrictions relaxed in order to preserve ocean views.

Landowner interest and willingness to participate in these new building and site configurations would likely be linked to the rate of sea level rise. Another important factor would be whether protective measures emerge as a viable response, both practically and financially.



**Short-term**  
 - Marine-grade materials  
 - Temporary ground level seal



**Long-term**  
 - Ground floor sealed up

## DAY 2 SYNTHESIS: EMERGING IDEAS FOR ERWIN DRIVE

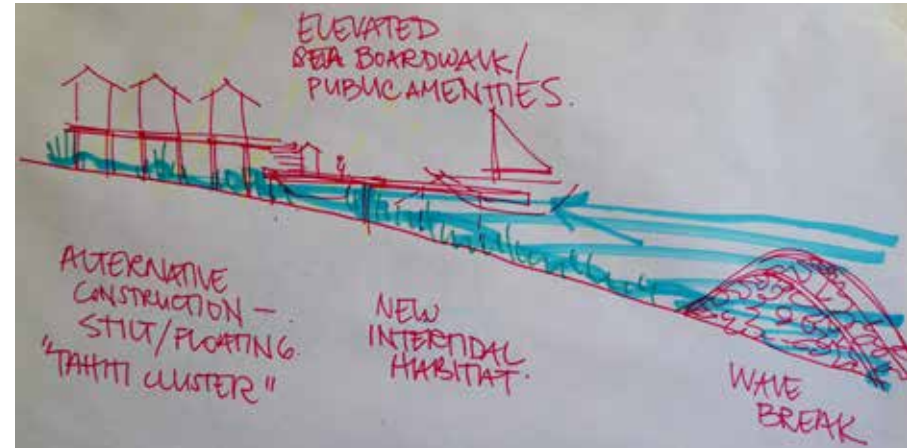
On Day 2 participants developed two distinct visions of how the Erwin Drive neighbourhood could be adapted and protected.

Much of the conversation focused on the degree to which DWV is able to direct the actions of the property owners, many of whom are long-time residents and have the means and possibly the desire to take individual actions for their properties. Participants agreed that protection of the overall shoreline would need to be a DWV priority, but that there were opportunities to combine the resources and actions of private homeowners and the public in a positive way.

General strategies included:

- Prioritise the restoration of streams and creeks as a way to restore sedimentation of the near-shore area and provide multiple benefits to a local ecosystem, from riparian restoration to storm-surge protection, as well as reducing impacts of erosion on waterfront properties;
- Use public lands--such as the DFO research site--as areas to showcase innovative adaptive structures;
- Look for opportunities to combine public and private efforts (e.g., private landscaping and public waterfronts) to double up on benefits;
- Carefully delineate areas most threatened by climate change and incentivize gradual retreat from these areas, potentially through density bonusing, zoning, or other tools;
- Use new protective structures, soft or otherwise, to showcase to the public the importance of climate change adaptation and SLR.

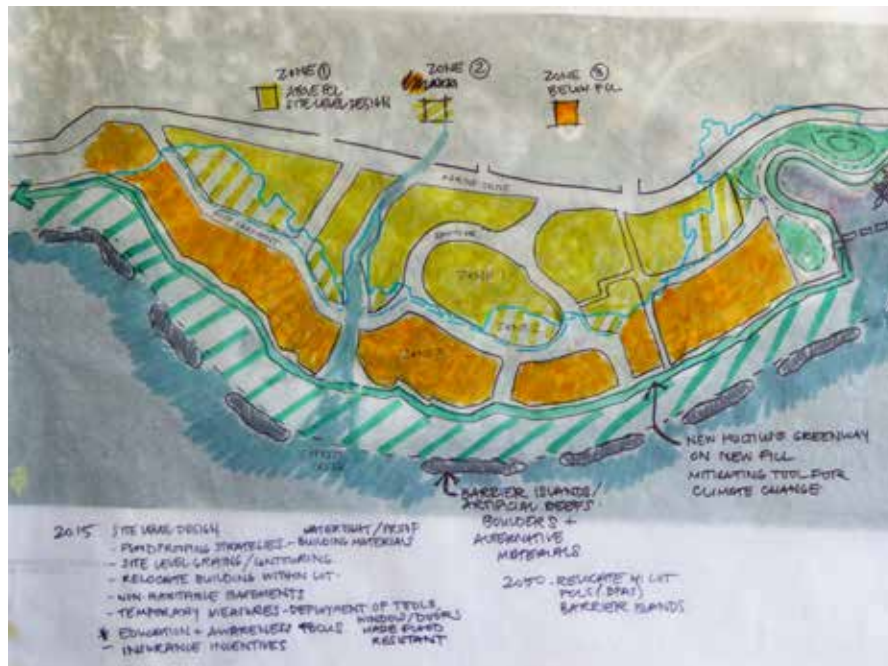
Both scenarios that emerged included the idea of SLR thresholds which would require a qualitative shift in responses over time, from protection to adaptation or retreat.



Changes to the waterfront, either with large-scale grey infrastructure, or 'green' alternatives like barrier reefs, create new public space opportunities.



Gradual infill and adaptations led by the land-owners. The red line represents possible 2100 configuration with raised land.



SCENARIO 1: THE PUBLIC WATERFRONT. Possible SLR-risk zones (Zones 1-3), defined by their exposure to SLR and the application of relevant FCLs. Seaward of the shoreline there are proposed barrier islands or artificial reefs that can reduce wave energy and the impact of storm surges, and offer new nearshore habitat. A new greenway created on top of a berm bounds the southern edge of the neighbourhood, providing both protection and a public recreational amenity.

## SCENARIO 1: THE PUBLIC WATERFRONT

### Graduated Sea Level Rise Planning Zones

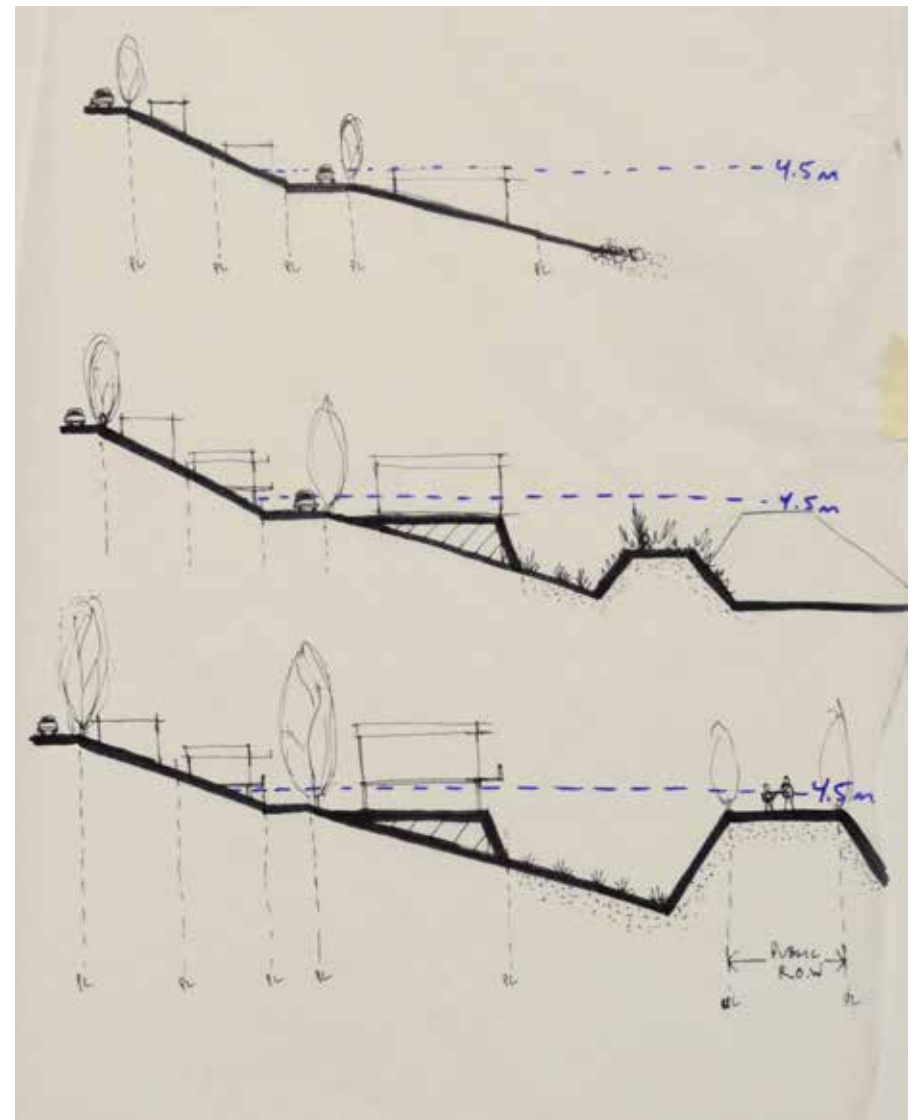
Drawing on the understanding that this area could potentially require FCLs in the range of 5 or 5.5 metres to meet projected SLR for 2100, participants worked towards an accommodating approach that combined soft protection and flood-proofing. Private lands were divided into different “SLR planning zones” where action would be based on relative exposure. These zones would be described in an amendment to the Official Community Plan (OCP). Zone 1 would be lands above the FCL, Zone 2 would be lands at the FCL, and Zone 3 would include the properties closest to the shoreline, below the FCL and most at risk to SLR.

Each zone was assigned a timeline starting from the present. From 2015 onwards, Zones 1, 2, and 3 would undergo wide-ranging public engagement and risk analysis activities. In addition, Zone 3 would have a deeper process of site analysis looking at strategies and design efforts to protect the area. At the same time, in the foreshore areas below Zone 3, a series of barrier islands would be constructed out of boulders and other materials. These islands would host a multi-use greenway, flood-able if need be, and designed to be gradually claimed by the water as sea level rose. The objective was to expand public space near or on the water and to promote the use of non-traditional transportation modes to enjoy the waterfront. The islands would act as a long-term protective measure, even as the water continued to rise, by helping to reduce wave energy.

## Gradual lot reconfigurations

Around 2050 (depending on the rate of actual SLR), the FCLs for all zones would be updated. Site-specific adaptation options for Zones 1 and 2 would now be actively explored, and Zone 3 would now be within a development permit area (DPA) requiring new development to reconfigure sites and structures to ensure safety. Accommodation would also be undertaken at the site level, in order to allow private properties to have viable uses as long as possible. For example, covenants could be required to restrict basement uses, and ground floors could eventually be sealed. Marine grade materials and floodproof construction methods could be employed to allow for faster recovery after storm events. In 2080, this process would be repeated again, increasing setbacks on the lots in Zone 3 to move structures to the highest elevation possible, and likely expanding the DPA to include Zone 2.

At the same time, the DFO site would be used as a pilot project to create a contoured public space with an eventual marina for non-motorised boats. The site would promote public education on the impacts of SLR, emphasizing responses with low environmental impact. Recreational opportunities would bring the public closer to nature.



Progression of the public waterfront, from 2015, to 2050, to 2100, with newly created public spaces along the water.



SCENARIO 2: THE SHARED WATERFRONT. Lot reconfiguration based on expected ingress of water with minimal protection. DFO site in the east is repurposed as a new pilot.

## SCENARIO 2: THE SHARED WATERFRONT

### Retreat makes way for restoration

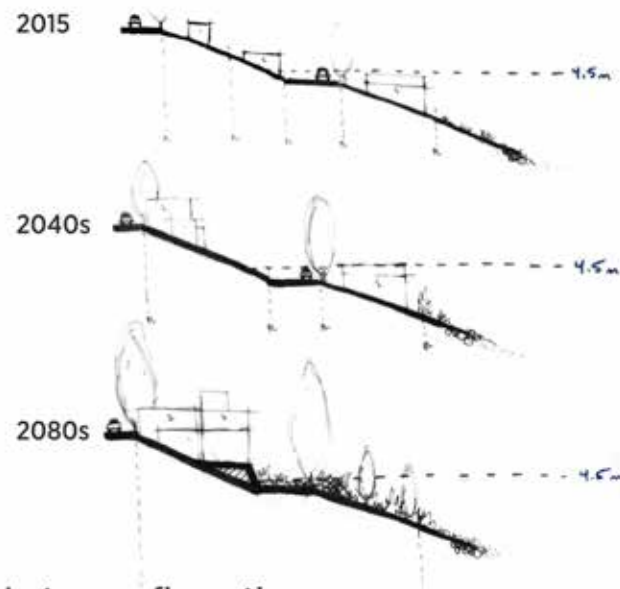
The Shared Waterfront scenario also established three zones: Zone 1 at or above the FCL, Zone 2 near FCL, and Zone 3 below FCL. Retreat has more emphasis in this scenario, however, affecting both public and private properties. Again, the DWV Official Community Plan (OCP) would be amended to describe the different zones as a distinctive area of SLR response. These OCP policies would begin to be shaped and implemented as soon as

possible, including measures to shift land use away from future renovations and rebuilding in Zone 3. DPA guidelines would require that development be located in the least hazardous portion of any given lot. In the public realm, the DWV would cooperate with DFO to pilot structures on stilts at the DFO site to show a range of options for SLR adaptive structures.

Around 2050, there would be re-configuration of the lots in Zones 1 and 2 to make room for new homes. Homes in Zone 3 would be relocated upland to escape the worst impacts of SLR, relying on density transfer mechanisms. As part of this northward, upland movement, some lands would be subdivided or

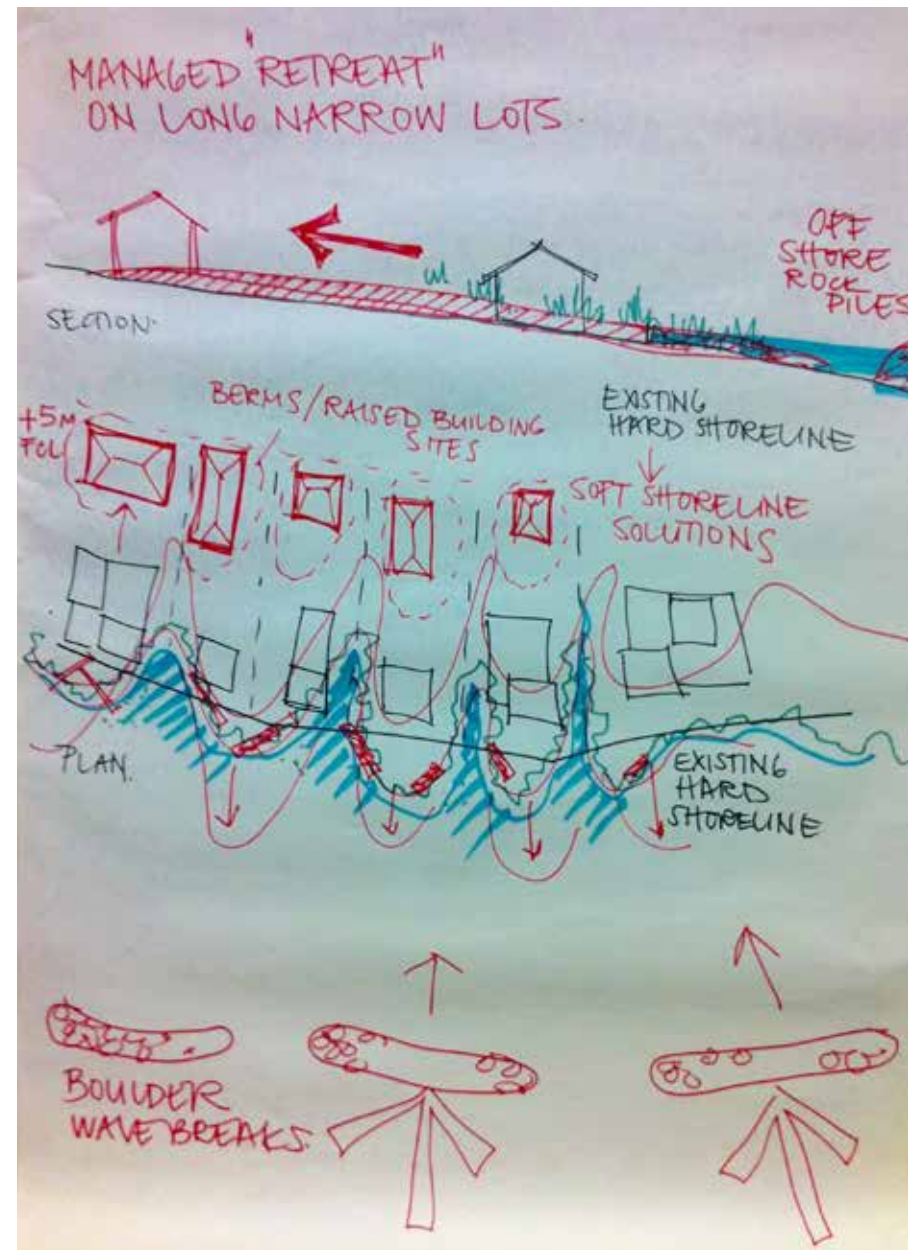
expropriated, with lower-lying portions dedicated and given back to Cypress Creek. Together with further calming measures for the Creek this would allow further alluvial fanning, helping to slow erosion and maintain the vibrancy of the riparian area.

By 2080, incremental measures including re-zoning and transfer of density would have shifted development from Zone 3 and the doubled-up density and lot reconfiguration in Zones 1 and 2 would allow for many of the residents to continue to live in the area. Lots would be longer and narrower. The retreat along the foreshore would have made it possible for DWV to restore shoreline and offshore habitat and to support the development of publicly accessible areas in the marine and waterfront areas.



**Lot reconfiguration**

Progression of the shared waterfront. Houses are gradually pulled back and riparian and shoreline ecology restored.



## PART IV

# Moving forward

The previous section has described how charrette participants, including municipal staff, provincial representatives and local design professionals, developed possible design ideas and directions for three specific neighbourhoods in the Greater Vancouver area that will be affected by rising sea levels (False Creek Flats, Ambleside and Erwin Drive).

In addition, by actively exploring possible responses for these three target neighbourhoods, participants (who collectively offered a very rich range of experience and expertise in local planning and design) offered general insights that are likely to be relevant for other coastal communities in BC, as well as identifying issues that need further investigation.





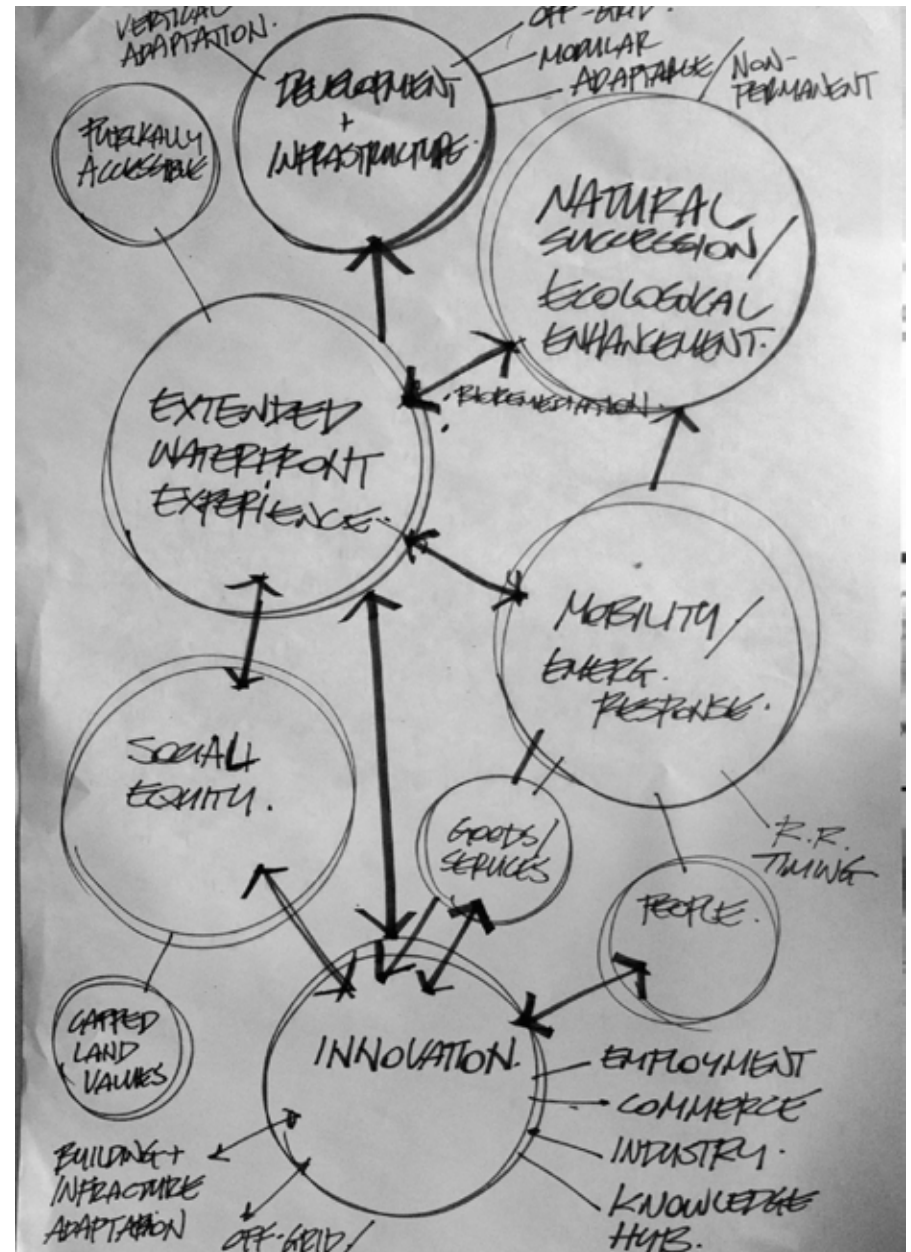
## KEY INSIGHTS FROM THE CHARRETTE

### Uncertainty about the rate of sea level rise can be addressed with adaptable and incremental approaches

Uncertainty around the rate of sea level rise (will it accelerate? when?) exists, but the fact that sea level will continue to rise is not in doubt. The current 1.0 m provincial guideline for 2100 is a milestone, not a destination. Given uncertainty around the rate of sea level rise, major investments to construct protective barriers or other large hard infrastructure responses could be a risky move if the infrastructure turned out to be redundant or, more likely, inadequate, and impractical or expensive to upgrade.

For example, as the presentation from coastal engineer, John Readshaw, illustrated, if a large capital investment were made now in a barrier approach, based on current sea level projections, and sea level rise subsequently accelerated mid-century, this could result in the need to replace the infrastructure midway through its life cycle, well before the initial capital costs had been amortized.

Instead, it may be more prudent to consider nuanced approaches that are resilient in the context of a number of possible SLR scenarios. Incremental change may help buy us time while our understanding of future sea levels becomes more certain. In the context of False Creek Flats, with its valuable, but vulnerable, low-lying lands, the idea of "vertical retreat", where the lower levels of buildings are eventually abandoned or repurposed was proposed. Uses on higher levels would be maintained, and roads could eventually become waterways. Another idea was to develop low cost, temporary structures for industrial, commercial and high-tech uses in areas most threatened by sea-level rise. Relatively cheap prefabricated buildings could be disassembled and moved if necessary, while still allowing a range of uses up until that time.



Rather than simply trying to preserve and protect the status quo, these ideas show that it is helpful to consider how new building regulations and shifts in land use planning can create more adaptable communities to accommodate ongoing change. In West Vancouver, charrette participants proposed sea level rise planning areas where rising seas triggered a series of progressive responses at certain thresholds of sea level. Early, first generation responses would include greater setbacks and floodproof construction. Over time there would be managed retreat to higher ground when risks to property owners and the community became too great. Preparing for each transition could be facilitated through planning and engagement.

## Future projections can be used to troubleshoot present decisionmaking

Sea level rise represents slow-moving, but far-reaching, continuous and permanent change. If we look far enough out in the future and then plan backwards we are less likely to miss things or paint ourselves into corners. While it makes sense for SLR responses to be implemented incrementally, we need to think carefully about pursuing approaches that make sense only in the present or the medium term, particularly if they are costly to construct or if they encourage new development that is going to be vulnerable in the latter part of its lifespan.

In the charrette participants envisioned how neighbourhoods might look in 2100. Working with this longer time horizon and using elevation maps for the locations in False Creek Flats and West Vancouver helped participants gain a new perspective and deeper understanding of the physical realities of neighbourhoods that are otherwise obscured by present development.

In Ambleside, studying the elevation lines, participants like architect Christine Lintott observed a “natural amphitheatre” arcing up to Marine Drive from the present shoreline, in contrast to the linear development of rail, road and buildings that currently parallels the shore and cuts across low-lying lands.

Over time, with sea level rise, these natural contours will be more evident--and relevant--with respect to flood risk and exposure to storm surge and wave action. Recognizing this now offers the possibility of gradual shifts in land use that will make the community more resilient in the future, while still maintaining its cultural, economic and environmental values. As waters rise, the amphitheatre feature can form a small bay that will help shelter waterfront and upland development. Lower lying lands that will be only occasionally flooded can be naturalized and further upland “water plazas” or floodable public spaces can be created, providing both public amenities and flood protection in case of storm surge.



## Working and thinking at different scales is important

Effectively planning for and responding to sea level rise is bigger than solutions for waterfront properties alone. For one thing, today's upland properties could be tomorrow's waterfront. As well, neighbourhoods and regions have delicate balances and links that are physical, economic and cultural, and the most resilient responses will respect and strengthen these. In looking at False Creek Flats, charrette participants acknowledged that its relationship to newly developing and re-developing areas further west along False Creek, as well as upland and southward towards Great Northern Way needed to be taken into account. For instance, a barrier along one of the main streets would protect the Flats, but potentially cut off road access for an adjacent neighbourhood. As well, the future possibility of daylighting one or more of the creeks that previously drained into the Flats (now piped underground) would mean considering how this upland drainage would interact with any solutions designed to adapt the Flats to higher sea levels. Charrette participants explored this in a high-level way in a scenario that they termed "letting the water in".

The Flats also have valuable industrial lands that are a scarce resource for the City of Vancouver, and it was important to keep this in mind when considering options for development and use of the Flats over time, including the need to maintain the existing rail connections, even if the railways were re-configured. Finally, just as boulders from upland construction have already been opportunistically used in shoreline restoration projects in West Vancouver, there may be the possibility of using excavated material from future transit projects in the City of Vancouver as fill in the Flats.

Localized and site-specific considerations are also highly relevant. Existing soil in the Flats is contaminated, and assessment and soil remediation will likely be part of any sea level rise adaptation measures eventually taken for the neighbourhood. Charrette participants also noted that there is design work needed to understand how to address street-level issues arising where new flood construction levels are applied to infill development.

## Multi-purpose responses and multiple benefits are possible

Can a railway be a dike? Can a public square be a water plaza that temporarily holds flood water? Will offshore reefs or vegetation reduce wave energy, and at the same time create marine habitat? Can commercial areas also benefit from an invigorated public connection with the shoreline? All of these questions were answered affirmatively by charrette participants, and are reflected in the design ideas that are featured in this report. Clearly there is huge value in having interdisciplinary teams (planners, engineers, architects, landscape architects, biologists, emergency planners, etc.) consider adaptive responses. This reinforces the usefulness of gleaning ideas from other coastal regions in North America and around the world that are grappling with similar challenges related to sea level rise.



## Sea level rise is an opportunity to revitalize our relationship with the shoreline and the marine environment in urban areas

While projections of rising sea levels highlight “vulnerable” low lying areas and may initially provoke strong community responses, these projections also provide a reasonable guide to sustainable land use over time. We can work with the rising sea by restoring and eco-engineering natural features, such as marshes or offshore reefs, and we can also explore adaptive building designs and aquatic transportation options that will allow us to remain living and working close to the sea.

One of the design ideas developed for the West Vancouver neighbourhood of Erwin Drive explored how shoreline enhancement and restoration could both buffer sea level rise and help increase community understanding about the need to adapt. An existing DFO research site offered the possibility of showcasing innovative adaptive structures as responses to rising seas. New offshore features could create habitat, but also provide new public access to the water and waterfront. Charrette participants for both the Flats and West Vancouver neighbourhoods envisioned greater use of water for individual and collective transportation.

At the same time, it was recognized that there needed to be a balance between maintaining or creating public access to the waterfront, and the protection and restoration of shoreline habitat. The design ideas that emerged from the charrette did not simply move sea walls landward, or suggest higher barriers with walkways, they all explored ways to adapt to sea level rise that made more space for nature, even in the industrial lands of the Flats.

## Retreat can be a long term strategy for selected areas, implemented gradually

Realistically, over time we do need to explore retreat in some areas, but this can be a long term strategy that doesn't need to happen tomorrow. At the same time, it is important context for longer term land use planning, development and re-development.

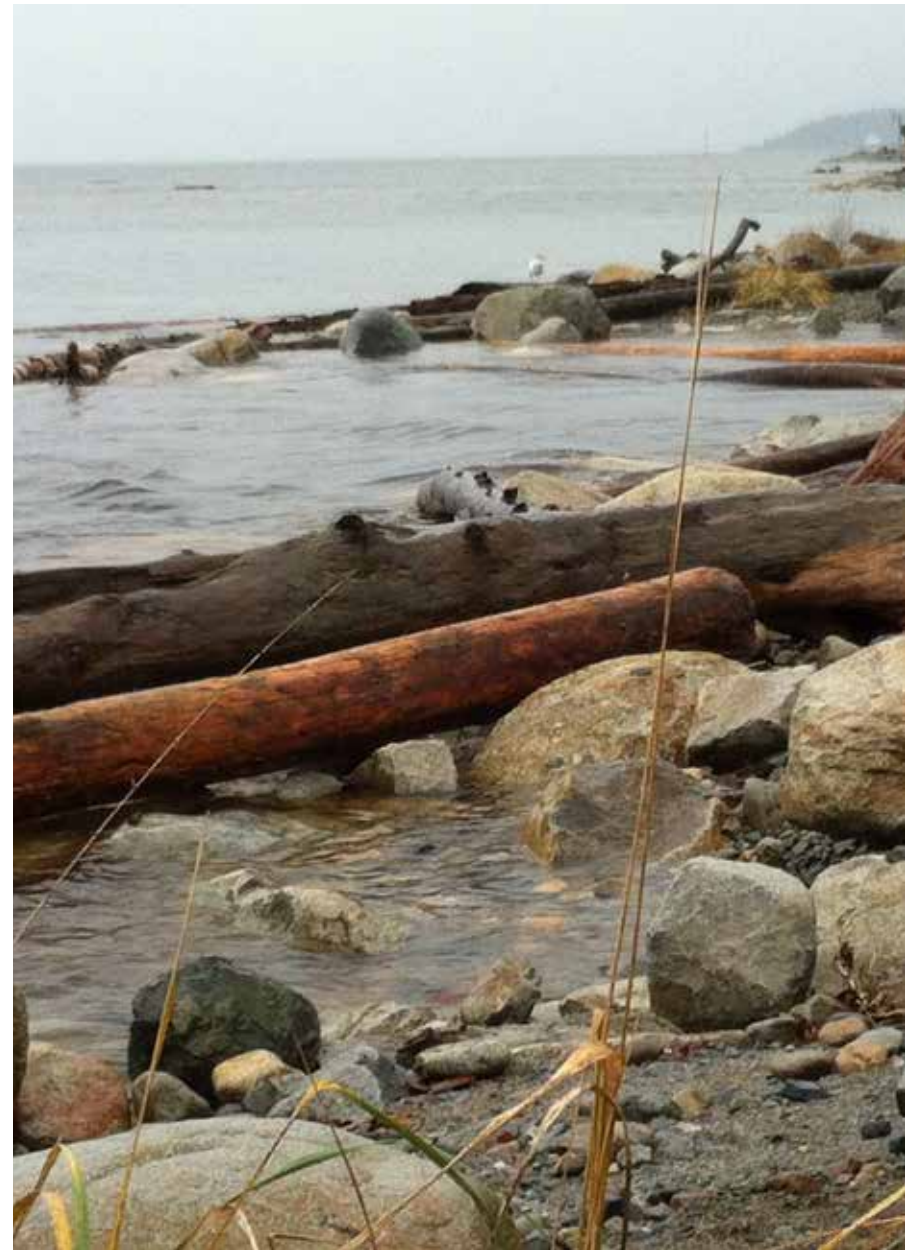
Local planners and developers are experienced with longer term land using planning processes, such as Official Community Plans (OCPs) and Local Area Plans. Local planning is both responsive, addressing dynamics such as growing populations, and proactive, shifting land use over time to create compact, complete communities, for example. However, charrette participants found it challenging to envision how to implement retreat strategies in the context of high waterfront property values, scarce availability of alternative sites, and little or no political mandate. While most of the necessary planning and regulatory tools exist, the practical and political barriers were perceived to be high.

Input from the real estate sector suggested that retreat strategies would need to be supported with strong signals to the development community regarding properties that are subject to development or re-development. Without these signals, the market value of waterfront properties is likely to continue to rise without taking into account potential hazards related to sea level rise. Sea level rise has not been made relevant to current cycles of real estate investment and development, where developers typically buy, build and sell within relatively short periods of time. Signals could take the form of hazardous land designations, accompanied by policies or regulations indicating clearly that the local government will not take measures to protect certain areas of land beyond a given date. Covenants could also be required on the land indicating that the property owner assumed responsibility for managing sea level rise and related impacts.

Another possibility would be to establish requirements for the form and siting of development, as well as landscaping and uses, to shift development landward and to help renaturalize shorelines. The City of Vancouver and other communities in the Lower Mainland have already begun implementing flood construction levels (FCLs) that reflect provincial guidance around sea level rise for 2100. This has resulted in increased FCLs for new development and infill sites. To date however there have not been efforts to shift land use away from coastal areas vulnerable to sea level rise.

Thinking about the future of the Erwin Drive neighbourhood in West Vancouver, charrette participants proposed the use of sea level rise planning areas that would be similar to development permit areas, with some important differences. The goal would be managed retreat over many years. Participants suggested that planning areas could be mapped based on elevation and risk exposure. As sea level rose (and as increasing knowledge about sea level rise made it possible to confirm more specific projections for given future dates), the risk profile of each area would change, triggering processes of risk assessment and planning, and more restrictive development/re-development requirements. Eventually, keeping pace with actual sea level rise, most development would be shifted upland, and any development allowed to remain in exposed areas would be floodproofed.

What is clear from the charrette is that even if there are ways to envision a local government implementing retreat strategies, there will be critical trade-offs that need community input. As discussed below, transparency and community engagement will need to be strong components in the implementation of any adaptation strategy.



## Shifting density and use can be an adaptive measure, but more refined tools are needed

To date, in BC coastal communities where adaptation to sea level rise has been discussed, it appears that protection strategies (improving existing dikes and other structures), and accommodation strategies, such as increased FCLs, have received the most attention. On the other hand, retreat strategies, as discussed above, are challenging to even discuss because of the implications for current property values and ownership.

Although shifting density could be seen as a type of retreat strategy, there are some important nuances that may make it more attractive as an adaptive measure, as explored by charrette participants.

In the Ambleside scenario, participants considered the long term viability of the lowest lying lands and came up with three different visions with varying levels of protection. In each case, the long-term scenario included some measure of retreat from waterfront lands. However, each scenario involved increasing density upland, in a managed way that would allow the Ambleside community to continue to be a vibrant centre within West Vancouver. Participants supported the idea of somehow compensating the owners of lower-lying lands for the loss of the use of those properties. One option would be for the District to simply purchase the properties, as it has already done in the case of several properties that are directly on the waterfront. From a neighbourhood perspective the lost uses could be partly recovered for the community, if desired, through rezoning of upland areas for greater density.

Another option discussed by participants was the possibility of transferring some of the lost uses or density to upland properties, through a mechanism that would see upland owners pay for increased density, if desirable, and owners of the lower-lying lands receive a payment. In BC this kind of density transfer can be accomplished if there is a willing seller and a willing buyer, and a local government willing to rezone. In the United States this type of

arrangement, known as density transfer, can be institutionalized through the creation of a bank or trust purchasing or holding the extra density, and selling it or allowing it to be sold to upland buyers. A covenant is usually placed on the lands where density is decreasing, so that no future development is possible. In BC, with the exception of heritage credit banking in the City of Vancouver, it is not possible for local governments or any other entity to set up this kind of a density transfer mechanism.

In False Creek Flats, instead of shifting density to new upland sites, the idea of vertical retreat on existing sites was explored. This meant moving not upland, but upwards within the same building footprint. Participants proposed that buildings could have lower floors designed to be sealed up over time, or ground floors with very high ceilings that would allow ground floor height to be raised as sea level rose. To encourage these kinds of buildings, relaxing building heights was proposed as a tool. It is likely that it would also be necessary to revise the Building Code to provide for lower level flood proofing and structural soundness.



## Transparency about adaptation challenges and responses will help everyone be more prepared

An important part of building resilient communities will involve governments working with community members to provide information about sea level rise impacts, and to decide, together, how to respond. Once strategies are determined, everyone in the community can plan and invest accordingly.

Local governments in BC have experience with public engagement, of course, particularly around Official Community Plans and other planning processes. In the case of sea level rise, in order for community input to play a role in evaluating trade-offs, there is work to be done to improve public understanding of the impacts of sea level rise on specific neighbourhoods. Conveying the likely timing of impacts in a meaningful way is important, as well as the public and private costs of different adaptation options.

New tools are emerging that can be used for neighbourhood level visualization of future impacts and responses. The Collaborative for Advanced Landscape Planning at the University of British Columbia (CALP) has been one of the leaders in exploring how computer visualizations can help communities understand how climate change impacts will affect them. Their work has also shown that community engagement requires ongoing commitment and resources at multiple stages in the planning process. Lessons from CALP and elsewhere show that communities can adapt to change, but to do so they need to understand that their concerns are being heard and considered.

As well, having engineers, planners, sustainability specialists, biologists, emergency managers and designers all in one room made it possible to explore integrated solutions and understand the limitations and opportunities associated with different adaptive measures. Many charrette participants remarked on how valuable it was to have this interdisciplinary opportunity.

Internal transparency and communication is also important for local governments developing adaptation strategies.



## ISSUES FOR FURTHER INVESTIGATION

### How do we manage the transitions in the built environment as we begin to change development requirements?

Even as we take steps to move towards adapted (and adaptive) communities, we are faced with the challenge that most of the urban waterfront areas in our coastal communities are already built out. Occasionally there will be opportunities for large scale redevelopment, but often city planners and developers will be examining infill sites. This creates challenges in continuity between adjacent buildings, and, as Flood Construction Levels (FCLs) increase, there will be issues around grade changes between buildings and roads, sidewalks and other infrastructure. Already in some jurisdictions where FCLs have been increased there are problems with drainage onto adjacent property as well as aesthetic concerns at street level.

Local planners have expressed concern that when faced with higher FCL requirements developers will push for residential as opposed to commercial space, because it is easier to develop and market a row of townhomes with walk-up entrances, than to design and market commercial space given the same constraints on ground floor elevations. This could have a negative impact on plans to develop new town centres and mixed use areas.

### How do we plan for the interaction of upland drainage and sea level rise in coastal communities?

In addition to sea level rise, projected climate change impacts that will affect the neighbourhoods in the charrette include more extreme precipitation events and different run-off patterns. We need to look at how integrated stormwater management planning processes and related green infrastructure approaches can link up with planning for coastal areas, both shorelines and estuaries.

False Creek Flats is a former mud flats area, as well as being the drainage basin for five creeks from surrounding upland areas. The creeks have been covered by fill and development, and drainage now runs underneath the Flats in a series of pipes. Considering how a changing climate could affect drainage, including both sea level rise and extreme precipitation events, was beyond the scope of the charrette, but participants were quick to note that this was an area that should be explored further.

In West Vancouver (DWV), the waterfront areas are affected by run-off from adjacent creeks. DWV has already done work to re-align and re-naturalize some of its creeks as they meet the sea, but sea level rise and changing rainfall patterns will also necessitate ongoing consideration of the impacts on waterfront neighbourhoods.

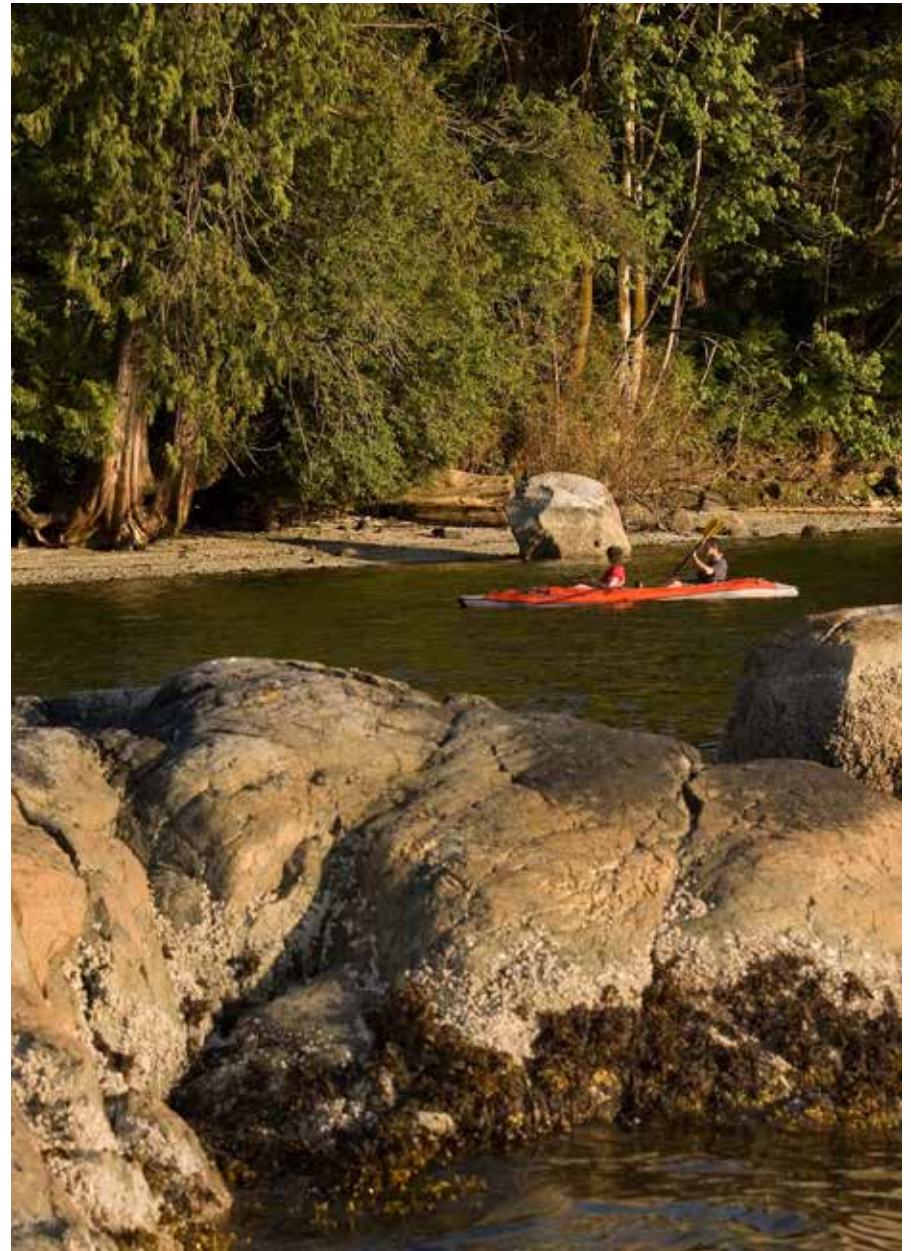
These examples show that it will be important for coastal communities to link up stormwater management planning with coastal planning and design, ideally taking a complete watershed approach to planning and not looking at coastal issues in isolation.



## How do we use asset management practices to value infrastructure in a changing climate, and make sound investment decisions?

Sea level rise and other ongoing changes as a result of climate change may artificially shorten life cycles for conventional coastal barrier infrastructure. The presentation by coastal engineer, John Readshaw, reinforced the need for caution in making new investments in barrier infrastructure such as dikes and sea walls that do not offer flexibility in the case of accelerating sea level rise. Although these types of solutions have appeal, because they appear to be a way to preserve the status quo of existing development, they may not be the best choice if they encourage further investment in floodprone areas and if they need to be replaced sooner than planned.

We also need to understand the value that natural assets and ecosystems can provide in supporting resilience to rising sea level so that this can be included in decisionmaking. Municipalities like the Town of Gibsons are leading the way by including natural capital in asset management. We need better understanding about the costs and performance of ecologically engineered measures, at the neighbourhood scale and beyond. For asset management it will be necessary to develop new methods to monitor and maintain the performance of coastal green infrastructure, both natural, and ecologically-engineered. It is likely to involve several local government areas of specialization (e.g. parks, engineering, sustainability) and a more integrated approach than conventional infrastructure.



## Are existing local government law and policy tools adequate to support needed shifts in design and land use?

To address sea level rise, local governments will be called upon to shift land use patterns and support new urban design, but the tools at their disposal have been shaped to manage community development and liveability in a context where flood risks, for example, remained the same over time. Developing incremental, adaptive approaches to sea level rise may require evolving policy tools as well.

Charrette participants were not formally bound by the limitations of existing regulatory and policy tools for the design ideas presented in this report, but there was some consideration of how the designs could be implemented using existing tools. With respect to protective measures, the primary issues that arose were around funding, given that most large-scale approaches, such as dikes or sea gates would require major capital investments. As noted elsewhere, because barrier projects preserve the status quo, at least temporarily, they are seen as relatively straightforward, if expensive, options. Funding from provincial and federal governments is likely needed to make these projects possible, because there is unlikely to be enough municipal revenue from new development or redevelopment in urban areas that are already built out to fund such large capital projects. It is possible, however, that local area charges or a utility model could be used to provide secure funding where this can be managed politically. Some local jurisdictions already use similar mechanisms to fund dike maintenance and drainage infrastructure.

Where accommodation measures were considered, that is, where participants came up with ideas to maintain some level of property use in areas affected by sea level rise, it was evident that changes to existing regulatory tools were needed. For example, existing BC Building Code provisions and floodplain

regulations and policy do not support buildings that can withstand periodic flooding. The implications for property insurance are also not known.

Regarding measures that involved a managed retreat from areas affected by sea level rise, these are matters that involve political trade-offs, community input and formal consideration. At the same time, assuming that managed retreat and shifting development out of vulnerable areas will be among the coastal adaptation strategies adopted by many communities, for the longer term, more nuanced regulatory powers would be helpful.

At present it is possible for local governments to down-zone land without compensation to property owners, as long as uses are not entirely restricted to public uses. Existing non-conforming uses would be protected, but could not be rebuilt. Over time this would be one way to shift development out of certain areas, but it would be a blunt approach, and would have implications both for property values and municipal taxation. Density transfer was seen as a way to capture some of the value of waterfront property for existing owners, but at present local governments do not have the ability to administer density transfer programs that include banking of density credits, although they can re-zone to support density transfers between two private owners. Another measure that was suggested was a type of development permit area where permitted development would be linked to changes in sea level rise. More investigation is needed to understand how this would work in practice, and if it could be accomplished with existing local government powers.

Some of the legal issues arising from the charrette are considered in more detail in the companion legal brief to this report prepared by West Coast Environmental Law.

## How can different levels of government, and government agencies work effectively together to address sea level rise?

In addition to local governments, many other levels of government and government agencies have legal rights and authority over coastal areas: federal, provincial and First Nations governments, port authorities, railway companies, utilities. At present there is little or no coordination, but sea level rise offers a common challenge and opportunity to cooperate.

The District of West Vancouver has a head lease with the Province that gives it effective jurisdiction over the foreshore, and allows it to actively manage the shoreline and implement adaptive measures. Through its Shoreline Protection Plan it has been gradually naturalizing the shoreline and some offshore areas in a way that is making the community more resilient to storm surges. Other communities will need to work out arrangements with the provincial government if they wish to undertake similar measures. While head leases may not be available, or desirable because of the full range of responsibilities they would entail for local governments, there could potentially be Crown leasing arrangements for foreshore lands that would allow adequate scope for local governments to actively manage aspects of the shoreline and foreshore relevant to local coastal adaptation.

In the case of federal authorities, jurisdiction over fisheries and navigation means that there will be federal engagement in any measures that affect the foreshore or offshore areas connected to waterfront property. At present it is not entirely clear what the future mandate of these authorities will be, and whether the changes to governing legislation made by Bill C-38 (such as reducing fish habitat protection in the Fisheries Act) will be rolled back. Much of the waterfront land around urban communities is also controlled by port authorities, which have a separate planning process and a different set

of interests. There are also railway lands, with rail lines that cut through many urban waterfront areas.

Recent case law has affirmed First Nations rights and interests with respect to their traditional territories. It remains to be seen how this will impact urban areas occupied by settlers, but it is clear that there is an opening for First Nations to play an important role in determining the future management and governance of these areas, including coastal areas, possibly through the application of their own Indigenous laws and principles.

In the Lower Mainland, the Fraser River Estuary Management Program (FREMP) and the Burrard Inlet Environmental Action Program (BIEAP) previously coordinated environmental approvals for projects with marine and coastal impacts. These intergovernmental organizations also supported research such as ecosystem inventories and habitat assessment. However, both were dissolved under the previous federal government and no replacement has been established, leaving no overarching authority or monitoring body for coastal areas in the region.

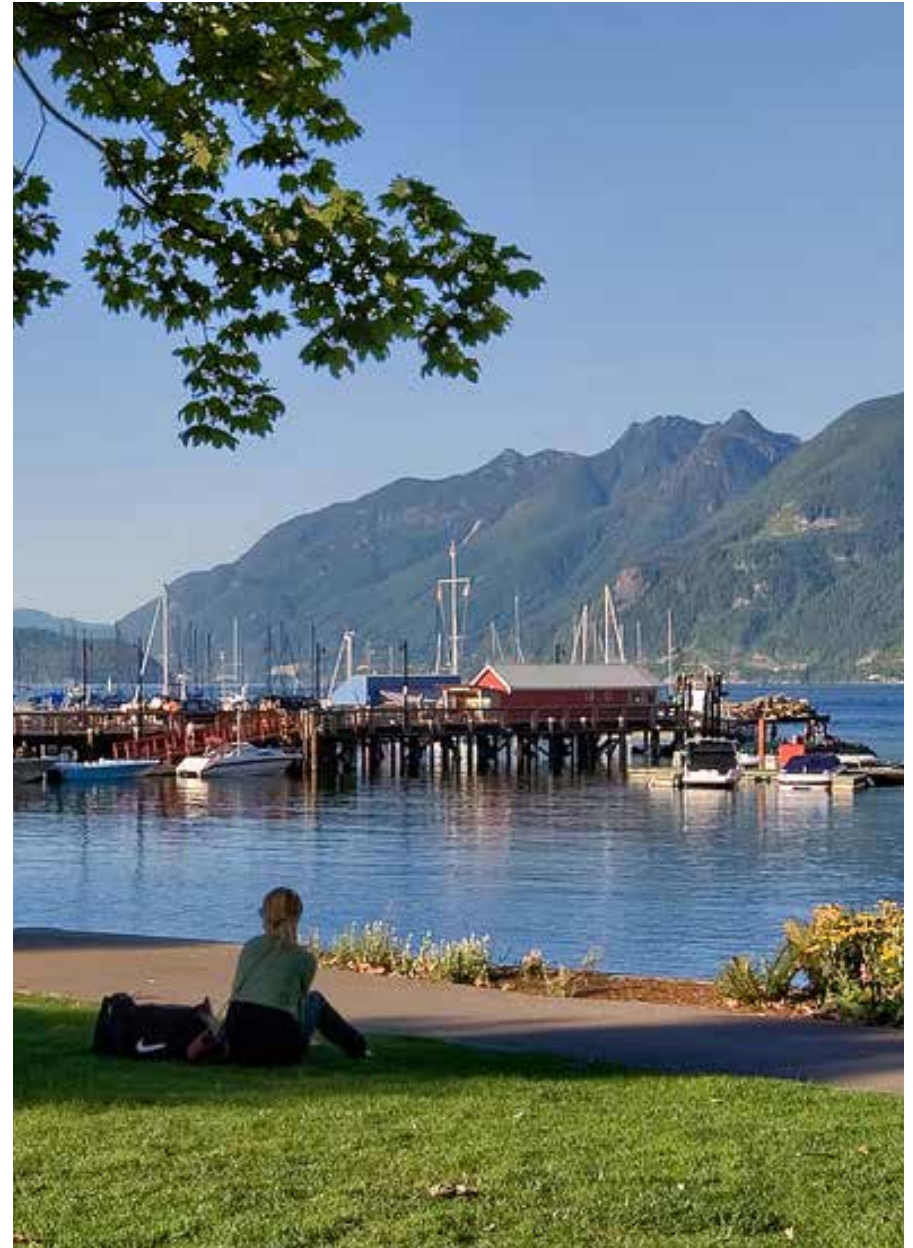
At present there is no mechanism or framework within which to coordinate sea level rise responses among the various authorities that have responsibilities and jurisdiction for coastal areas.



## CONCLUSION

The charrette did produce design ideas, concepts and strategies for addressing sea level rise and increasing community resilience. It isn't clear if the design ideas from the charrette will be incorporated in current planning processes. Even early leader communities are grappling with how to plan and effect change on the ground for a future that will look quite different from past decades along the coastline, thanks to sea level rise. However, it is important to begin the conversation.

1. The charrette brought together experts in green infrastructure and design with local government staff to consider green responses to sea level rise in actual neighbourhoods where the realities of existing development, geography, natural environment and community needs could be explored. As well, through the charrette process and expanded planning time horizon it was possible to demonstrate how green infrastructure could be more adaptive, and offer multiple benefits to the community over time.
2. As detailed earlier in this section, working through design ideas for the three neighbourhoods in the charrette provided many opportunities to consider technical and legal aspects of implementing green approaches to sea level rise, with real-life context. Further consideration of some of these issues, such as tools to shift land use and manage flood hazards, is provided in the legal brief that accompanies this report.
3. The charrette confirmed that developing effective responses to sea level rise in BC coastal communities will require participation of a full range of actors and decisionmakers, including provincial, federal and First Nations governments, port authorities, railway companies, transit authorities, utility companies, property owners, developers, local businesses, insurers and others. Without any overarching authority to manage coastal issues in BC, coordinating these actors and decisionmakers will be challenging.



## PART V

# Resources

## CONTRIBUTORS

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## FURTHER RESOURCES

### General resources

Arlington Group et al., 2013. Sea Level Rise Adaptation Primer, prepared for BC Ministry of Environment.

<http://www.env.gov.bc.ca/cas/adaptation/pdf/SLR-Primer.pdf>

Association of Professional Engineers and Geoscientists, 2012 Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC. <https://www.apeg.bc.ca/getmedia/18e44281-fb4b-410a-96e9-cb3ea74683c3/APEGBC-Legislated-Flood-Assessments.pdf.aspx>

FREMP-BIEAP Habitat Atlas. Available online at: [http://www.cmnbc.ca/atlas\\_gallery/frem-p-bieap-habitat-atlas](http://www.cmnbc.ca/atlas_gallery/frem-p-bieap-habitat-atlas)

Grannis, Jessica, 2011. Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use, Georgetown Climate Center. Available online at: [http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/Adaptation\\_Tool\\_Kit\\_SLR.pdf](http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/Adaptation_Tool_Kit_SLR.pdf)

Province of BC, 2004. Flood Hazard Area Land Use Management Guidelines. [http://www.env.gov.bc.ca/wsd/public\\_safety/flood/pdfs\\_word/guidelines-2011.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/guidelines-2011.pdf)

Province of BC, Flood Hazard Area Land Use Management Guidelines (Draft Amendment, May 2013) [http://www.env.gov.bc.ca/wsd/public\\_safety/flood/pdfs\\_word/amendment\\_to\\_S35\\_36\\_FHALUMG13-05-07.pdf](http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/amendment_to_S35_36_FHALUMG13-05-07.pdf)

West Coast Environmental Law, 2012. Preparing for Climate Change: An implementation guide for local governments in British Columbia, available online at: [www.wcel.org/adaptation](http://www.wcel.org/adaptation)

### Flood Construction Levels/Interim Flood Construction Levels

City of North Vancouver, available online at: <http://www.cnv.org/~media/8F10E7590A774E1691EB852ED981C226.pdf>

City of Vancouver, available online at: <http://former.vancouver.ca/blStorage/11070.PDF>

District of Squamish, available online at: <http://www.squamish.ca/assets/BLDG/interim-FCL-info-09292014.pdf>

District of West Vancouver, available online at: <http://westvancouver.ca/sites/default/files/dwv/assets/home-building-property/docs/construction/sea-level-rise-notice-to-builders-and-owners%28%29.pdf>

