Preparing for Sea Level Rise
Climate Change Adaptation Strategy Update

Council Presentation // November 2nd, 2016
Outline

- Background and Context
- Coastal Flood Risk Assessment Overview
- Coastal Flood Risk Assessment Phase 1 and 2
- Phase 2 High Level Options by Area
- Next Steps & Recommendations
Despite local efforts, global greenhouse gas emissions keep growing.
Extreme weather events cost Canadian insurers $3.2B in 2013

“Once climate change becomes a defining issue for financial stability, it may already be too late.”

By 2100 the direct economic losses to the region due to floods could exceed $30B and adaptation costs will approach $10B.

*Lower Mainland Flood Management Strategy and B.C.*

*UK Floods 2014*
CLIMATE CHANGE ADAPTATION STRATEGY
Impacts from sea level rise include increased coastal flooding, erosion and storm damage.

Actions: Complete a Coastal Flood Risk Assessment and develop a City-wide Sea Level Rise Response Plan.
Guiding Principles for Sea Level Rise Adaptation

- Use the best available science and practice adaptive management
- Seek adaptable, green and robust solutions that can be phased over time
- Seek “no regret” actions with co-benefits
- Pursue funding strategies based on value and equity
- Take a risk-based approach
- Be resilient by providing redundancy
Sea Level Rise - Causes

- 2015 warmest year on record (since 1880)
- 90% of new, excess heat is stored in the oceans – Thermal Expansion
- Melting of land ice (glaciers) – Antarctica and Greenland

Credit: JohnEnglander.net
Rising sea level is “the single most profound geological change in recorded human history” *John Englander, 2016*

- Not a possible or a probable but a question of WHEN
- Amounts are unpredictable
- Unstoppable and irreversible for centuries
- Good news: slow so we can plan and adapt but must think BIG and FLEXIBLE enough
Context: King Tide flooding Jericho
Context: King Tide flooding Seawall
Context: King Tide flooding Seawall
Fraser Basin Council
Lower Mainland Flood Management Strategy

Provincial
Amendment to Flood Hazard Management Guidelines

Federal
National Disaster Mitigation Program & National Flood Mapping Standards Project
## Coastal Flood Risk Assessment (CFRA) Overview

<table>
<thead>
<tr>
<th>PHASE</th>
<th>Description</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flood hazard today and in 2100 What is at risk and potential losses</td>
<td>2012</td>
</tr>
<tr>
<td>VBBL</td>
<td>Flood Construction Level from 3.5m to 4.6m</td>
<td>2014</td>
</tr>
<tr>
<td>2</td>
<td>Develop response options for 11 areas and compare options</td>
<td>2015</td>
</tr>
</tbody>
</table>
CFRA – Phase 1
Current and Future flood hazard
With increasing sea level rise our risk grows significantly

Extreme Storm Event, High Tide 2020
Future Flood Hazard Mapping

Extreme Storm Event, High Tide 2100
Identifying Elements at Risk

COMMUNITY DATA MAP

Infrastructure
People
Economy/Assets
Environment
Phase 1 Outcome: FCL from 3.5m to 4.6m
CFRA – Phase 2
Seek Flexible, Adaptive and Robust Solutions
Phase 2 Process – Preliminary Evaluation

Generate Approaches

Define Evaluation Criteria

Compare Approaches against Criteria

Explore Trade-offs between Approaches
## Phase 2 – Stakeholders Involved

<table>
<thead>
<tr>
<th>CITY STAFF</th>
<th>EXTERNAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parks</td>
<td>BC Hydro</td>
</tr>
<tr>
<td>OEM</td>
<td>BC Government</td>
</tr>
<tr>
<td>Planning</td>
<td>City of Surrey</td>
</tr>
<tr>
<td>Engineering</td>
<td>CMHC (Granville Island)</td>
</tr>
<tr>
<td>Social Planning</td>
<td>Metro Vancouver</td>
</tr>
<tr>
<td>Facilities</td>
<td>Port Metro Vancouver</td>
</tr>
<tr>
<td></td>
<td>TransLink</td>
</tr>
<tr>
<td></td>
<td>University of British Columbia</td>
</tr>
<tr>
<td></td>
<td>Urban Development Institute</td>
</tr>
</tbody>
</table>
CFRA Phase 2: Preliminary Evaluation of Approaches

**RESPONSE APPROACHES**

- **Adapt**
- **Protect**
- **Retreat**

**CONSIDERATIONS**

- **PEOPLE**
- **ENVIRONMENT**
- **ECONOMY**
- **IMPLEMENTATION**
CFRA Phase 2: It is important to consider WHEN an option should be implemented.
Precedent: Dry-line New York City
Precedent: Rotterdam

RIVER AS TIDAL PARK
CONNECTING CITY AND RIVER
Precedent: NYC design competition
Precedent: Rotterdam

Layered landscapes (with slope)
5 Focus Areas - Preliminary Response Approaches

1. False Creek
2. Fraser River Industrial
3. Southlands
4. Jericho/Locarno
5. Kitsilano
EXAMPLE: False Creek

Three Approaches

**Protect**
- With Sea Barrier

**Protect**
- With Raised Seawall

**Adapt**
- Multiple Tools
EXAMPLE: False Creek

PROTECT with sea barrier

closed 3-4 days/yr; increasing over time
~10m high
360m wide
EXAMPLE: False Creek

PROTECT with sea barrier

Ramspol, the Netherlands: Storm Surge Barrier Example

Source: boxbarrier.com
8.6 km long seawall to be raised to FCL of 4.6m

On average 2.3m of height increase is required
EXAMPLE: False Creek

ADAPT with planning tools

- Additions make up for lost space
- Deployable flood shields and temporary stairs
- Convert 1st floor residential to commercial
- Fill or floodproof

[Diagram showing various changes and adaptations for flood protection, including additions, flooding, and conversion of residential to commercial use.]
EXAMPLE: False Creek

ADAPT with planning tools

Door fitted with flood gate
Flood proof glass
Cut off to close sewage outflow
EXAMPLE: Fraser River Industrial

Three Approaches

- Protect With Shoreline Dike
- Protect With Inland Dike
- Adapt Multiple Tools
Fraser River Industrial: Protect with shoreline Dike

Figure 1-13 Example Sea Dike for 2100 – West Richmond
elevations: CGD
Fraser River Industrial: Protect with Inland Dike
Fraser River Industrial: Adapt with Multiple Planning Tools

Image from: Brooke Peninsula Project Assael Architecture Limited, UK
EXAMPLE: Southlands

Three Approaches

Protect With Dike

Adapt Multiple Tools

Managed Retreat
Southlands: Protect with Dike
Southlands: Managed Retreat

Legend
Building Age
1900 - 1910
1910 - 1920
1920 - 1930
1930 - 1940
1940 - 1950
1950 - 1960
1960 - 1970
1970 - 1980
1980 - 1990
1990 - 2000
2000 - 2010
2010 - 2011
Floodplain
Public Streets

Musqueam First Nation
Southlands: Adapt with Multiple Tools

Temporary Flood Barriers (England)

Image from: McFarland Marceau Architects Ltd. North Vancouver Outdoor School, Squamish, BC
EXAMPLE: Jericho

Four Approaches

- Protect With Park Dike
- Protect With Road Dike
- Adapt Multiple Tools
- Managed Retreat
Jericho: Protect with Park Dike
Jericho: Protect with Road Dike
Jericho Example: Fine Grained Shoreline Planning
Jericho: Example of a Resilient Park
EXAMPLE: Kitsilano
Three Approaches

Protect With Park Dike

Protect With Road Dike

Adapt Multiple Tools
Kitsilano - Approaches

Protect with Park Dike

Protect with Road Dike

Adapt with Planning Tools
## 2015 High Level Cost Estimate

<table>
<thead>
<tr>
<th></th>
<th>Barrier</th>
<th>Raised seawall</th>
<th>Adapt</th>
</tr>
</thead>
<tbody>
<tr>
<td>False Creek</td>
<td>$500M-$800M</td>
<td>$300M-$400M</td>
<td>$338M</td>
</tr>
<tr>
<td></td>
<td>$9.5M/yr. mtn.</td>
<td>$4M/yr. mtn.</td>
<td>$0.5M/yr. mtn.</td>
</tr>
<tr>
<td>Fraser Industrial</td>
<td>$160M</td>
<td>$55M</td>
<td>$405M</td>
</tr>
<tr>
<td></td>
<td>$107K/yr. mtn.</td>
<td>$107K/yr. mtn.</td>
<td>$0.5M/yr. mtn.</td>
</tr>
<tr>
<td>Southlands</td>
<td>$90M</td>
<td>$990M</td>
<td>$150M</td>
</tr>
<tr>
<td></td>
<td>$66K/yr. mtn.</td>
<td></td>
<td>$0.5M/yr. mtn.</td>
</tr>
<tr>
<td>Park Dike</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jericho</td>
<td>$10M - $24M</td>
<td>$10M - $20M</td>
<td>$620M</td>
</tr>
<tr>
<td></td>
<td>$20K/yr. mtn.</td>
<td>$15K/yr. mtn.</td>
<td></td>
</tr>
<tr>
<td>Park Dike</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitsilano</td>
<td>$4M - $9M</td>
<td>$6M - $15M</td>
<td>$13M</td>
</tr>
<tr>
<td></td>
<td>$7K/yr. mtn.</td>
<td>$10K/yr. mtn.</td>
<td>$0.5M/yr. mtn.</td>
</tr>
</tbody>
</table>
Secondary Focus Areas –
Preliminary Response Approaches

1. Coal Harbour
2. Waterfront Road Area
3. New Brighton Park
4. Stanley Park
5. Point Grey Road
6. Port Lands
Coal Harbour

- Protect With Raised Seawall
- Protect With Structured Wall
- Adapt Multiple Tools
Waterfront Road Area

Concepts from Sean Smith, Port Metro Vancouver
New Brighton Park

Protect
With Dike

Managed Retreat
Stanley Park

Protect
With Raised Seawall

Adapt
Multiple Tools
Point Grey Road

Protect
With
Armouring
Phase 2 Conclusions

- Protect land regardless of use
- Prioritize maintaining natural shoreline for as long as possible and incorporating green infrastructure solutions where possible.
- Enhance amenities where possible
- Phase solutions to obtain best value and provide for course correction as more information is available
Next Steps

Immediate

Short Term

Medium Term

Long Term

2015-2020  2020-2030  2030-2050  2100
Immediate Next Steps

Begin Short Term projects: Jericho, Fraser River, Waterfront Road

Work with other levels of Government:
• Lower Mainland Flood Management Strategy, NDMP funding, First Nations Collaboration

Engagement

Broad: Education - Build Awareness and Understanding

Project-Specific: Deeper dive into area-specific options
Engagement

- **Broad community-wide Education:**
  - Causes and impacts of sea level rise
  - What to expect in Vancouver
  - Options for response

- **Project-specific engagement** (e.g. Southlands)
  - Tell us what you think of the preliminary approaches
  - Other approaches to consider
  - Concurrently explore technical feasibility of options
Immediate Next Steps

- Develop flood warning systems and flood response plans
- Develop an Adaptive Management Strategy and start monitoring
- Limit Critical Infrastructure in floodplains
- Initiate a Financing Strategy
- Preserve Future Options through redevelopment, acquiring space, park planning
Financial Considerations

- **Funding Sources:**
  - Federal Government Funding
  - Provincial Government Funding
  - Regional / local contributions

- **Potential Sources of Regional / Local Contributions**
  - Regional / Local Development Cost Charges
  - Local Improvement Tax
  - New area specific or city-wide fees or levies

- **Next Steps**
  - Start planning now for long term funding mechanisms including advocacy for reliable and predictable Sr. Gov’t funding
  - Area-specific projects will include funding strategy
Recommendation

- Begin broad community education campaign
- Implement immediate next steps
- Initiate short term projects by 2017
  - Concurrent engagement and engineering refinement
- In parallel develop a Sea Level Rise Response Strategy to outline medium and long term actions
  - Project Initiation Dates and Decision Thresholds
  - Project Team Requirements, Roles and Responsibilities
  - Project Funding