

Council Update #5 – IFHMP

Coastal Flood Protection Strategy

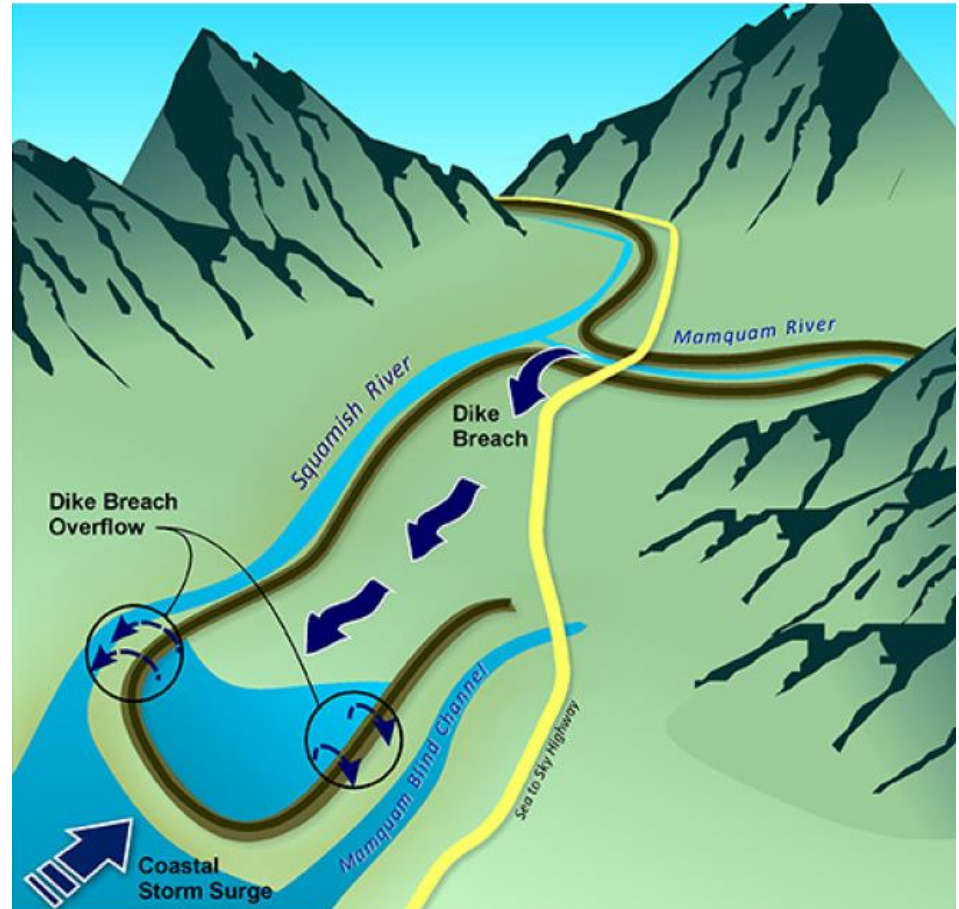


Background

- 2014 – Council adopted a methodology for coastal flood levels
- 2015 – Project team calculated sea dike height using methodology between 4.7-5.4m
 - Council concern over height
- Project team re-evaluated

Context

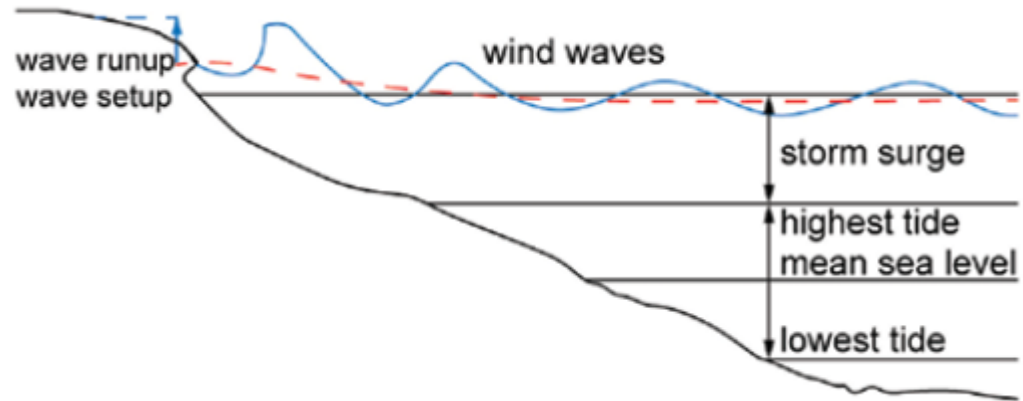
- Squamish is a complex environment
 - River/Coastal flood hazards
- Sea dike height will influence building FCL recommendations due to 'bathtub effect'
- Lower sea dike =
 - Lower consequences during river dike breach
 - Higher probability/consequence of coastal flooding
- Setting sea dike height requires a careful balance



Coastal Engineering Basics

- Coastal Flood Construction Level determined by several components:

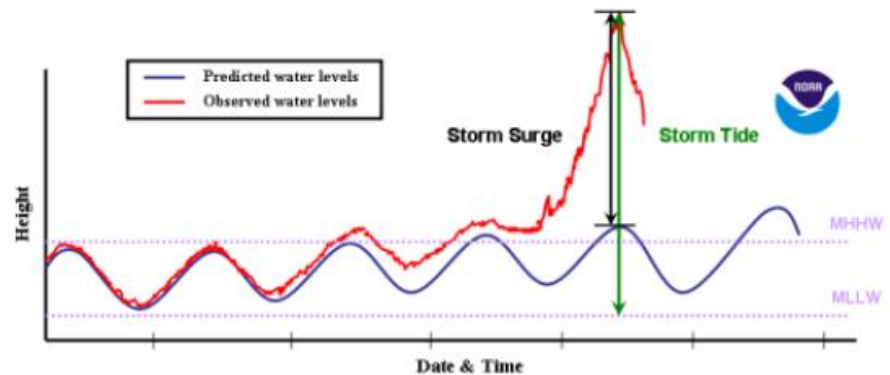
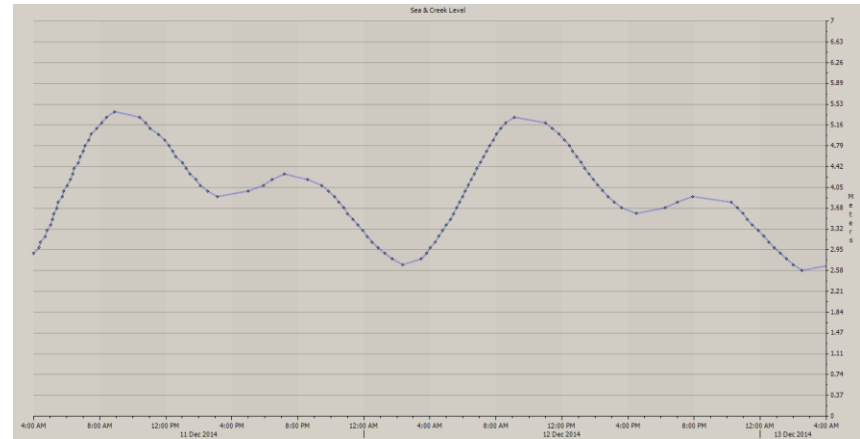
- Astronomic tide
- Storm surge
- Wind/wave setup
- Uplift/subsidence
- Sea Level Rise (SLR)
- Wave effects/Freeboard



- Significant judgment is required to determine the appropriate combination of these factors
 - Various international/Provincial methods (Joint vs Combined probability, various return periods ranging from 1:200 to 1:10,000)
 - In 2014, Squamish adopted a coastal flood level consisting of:
= 1:200yr 'Joint probability' for Tides/Storm Surge + 1m SLR Yr 2100 + Local effects (wind, subsidence, local surge) + 1:200yr wave effects + freeboard = 3.99m + wave effects/freeboard

Component – Tide/Surge

- Tide/surge are independent
- 1:200 yr 'Joint probability' less than High tide + 1:200yr surge
- 1:200yr return period = same standard as river dikes, no precedent for lower
- Chosen least 'conservative' standard & method
- Mathematically determined with great accuracy = little uncertainty
- No recommended change



Component - Sea Level Rise

- Provincial Government recommends 1m (3ft) sea level rise by 2100, 2m (6ft) by 2200
- There is uncertainty – could be higher, could be lower
- Using best guidance available. Widely adopted.
- Recommendation: No change. Follow implementation plan.

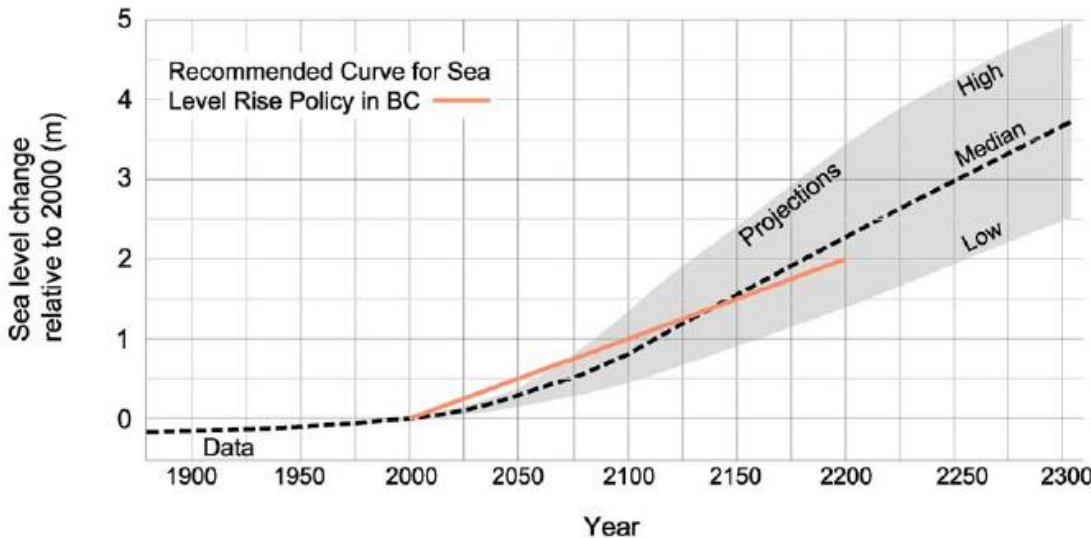
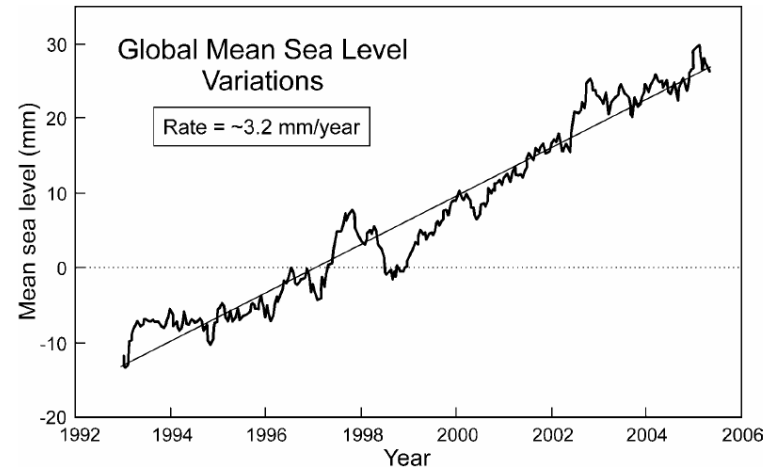
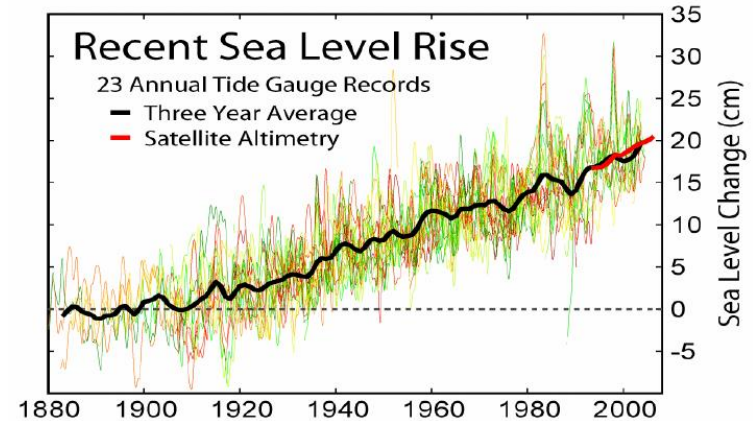


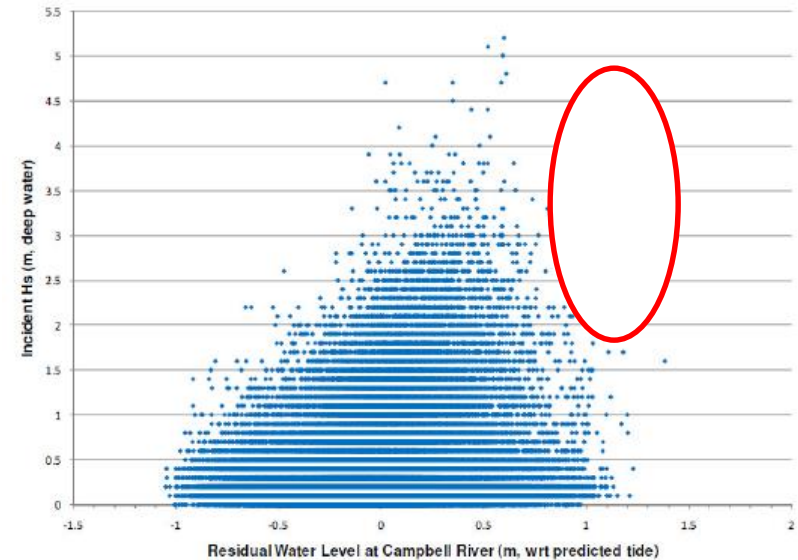
Figure 3-1: Projections of Global Sea Level Rise

Coastal Components – Local Effects

- Local effects = wind setup, local surge, subsidence
 - Value = 0.3m
 - Downtown Squamish founded on river deposits. Survey records suggest land is subsiding.
 - 0.14m settlement predicted by Year 2100
 - Surge in Squamish has been measured higher than regional surge.
 - Significant analysis has been invested to reduce ‘local effects’ as low as reasonable.
 - More analysis might not help.
- Recommendation:
 - No change recommended

Coastal Components – Waves/Freeboard

- Wave effects from 1:200 year wind event
 - Wave effects = 0.1m-1.3m (0.3ft – 4.3ft)
 - 1:200 year winds during 1:200 yr tide/surge is likely a conservative assumption
 - Dike height varies significantly with acceptable 'overtopping rate'
- Freeboard
 - BC standard = 0.6m
 - Accounts for uncertainties (i.e SLR, larger than 1:200yr events, wave model)
- Previous Assumption:
 - Choose overtopping rate based on land use behind dike and add freeboard
- New Assumptions:
 - 1) Accept higher overtopping rate of 10 L/s/m at all locations
 - 2) Combine waves/freeboard by using greater of:
 - Minimum 0.6m freeboard, OR
 - Wave effects with 10 L/s/m



Results

Design Point	Previously Recommended Elevation (m GD)	New Recommendation (m GD)	Reduction From Previous
A	4.8	4.8	0
B	5.0	4.8	0.2
C	5.4	4.8	0.6
D	5.3	4.7	0.6
E	4.9	4.7	0.2
F	4.9	4.7	0.2
G	5.0	4.7	0.3
H	5.1	4.7	0.4
I	5.2	4.7	0.5
J	4.7	4.7	0
K	4.7	4.7	0
L	4.7	4.7	0
M	4.9	4.7	0.2
N	5.4	4.7	0.7
O	5.4	4.7	0.7
P	5.4	4.7	0.7
Q	5.4	4.7	0.7
R	5.1	4.7	0.4
S	4.8	4.7	0.1
T	4.8	4.7	0.1
U	5.0	4.7	0.3



Implications

- Regulatory - Discussed with IOD → General agreement
- Lower sea dike =
 - lower consequences of river dike breach (bathtub effect)
 - higher probability/consequence of coastal flooding
- Must consider drainage of overtopping water and appropriate dike design to handle overtopping water
- Future emergency response measures (isolate seawall)
- Dike design will influence FCL recommendation's for next generation of development. Future increases to dike height could render near term development too low & vice versa.
 - 'Visioning' decision.

Implementation

Table 5: Priorities for Sea Dike Implementation

Priority	Recommendation	Timing
1	Upgrade all low-lying areas of the dike perimeter to at least 3.3 m geodetic elevation with an engineered standard dike cross-section.	Immediate
2	Implement a Development Permit Area for Coastal Flood Protection Works that establishes requirements and constraints for site development and redevelopment proposals.	Immediate
3	Secure and retain legal land tenure along the ultimate length of the sea dike as properties redevelop or become available.	Ongoing
4	Opportunistically implement segments of sea dike to the Year 2100 crest elevation and configuration as part of ongoing redevelopment.	Ongoing
5	Raise dikes to minimum elevation 4.0 m with sufficient width to allow future capping to design grade.	As funding permits
6	Raise dikes to Year 2100 (1m SLR) design grade and configuration.	Once SLR observations raise still-water design levels beyond 3.3 m.

- Until priority 1 complete, develop emergency response plan
- Interim solutions may also be considered
- All dike designs and planning measures should make provision for Yr 2200 SLR

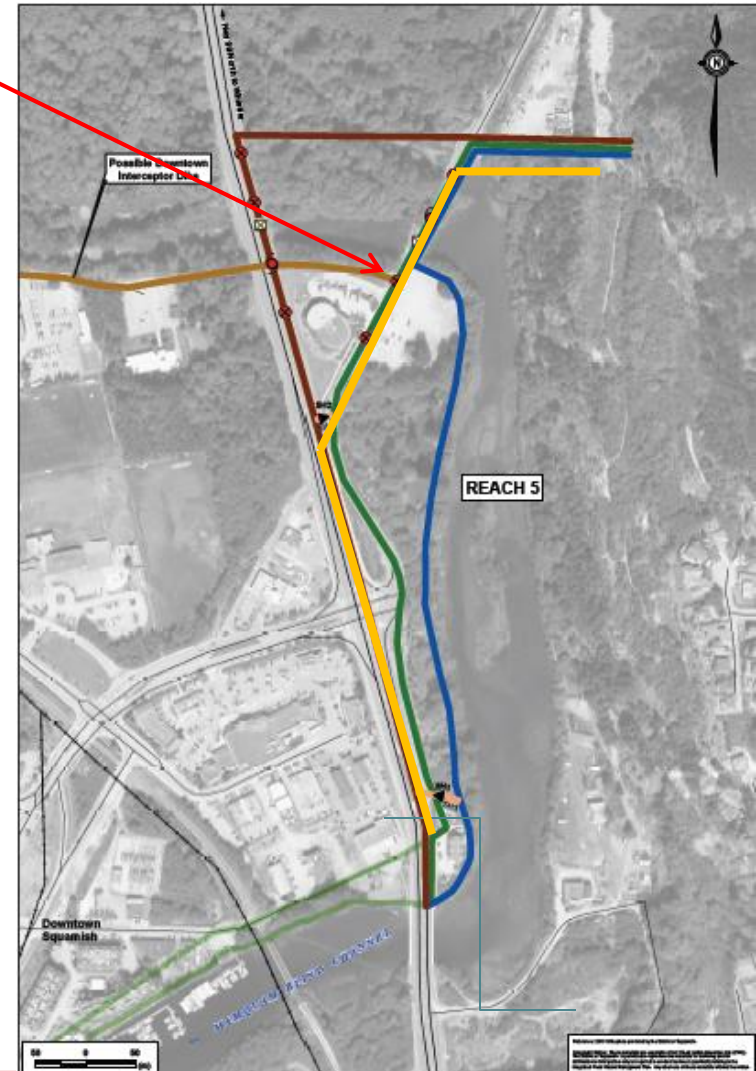
Questions/Discussion?



Resilient Coasts | Lighthawk

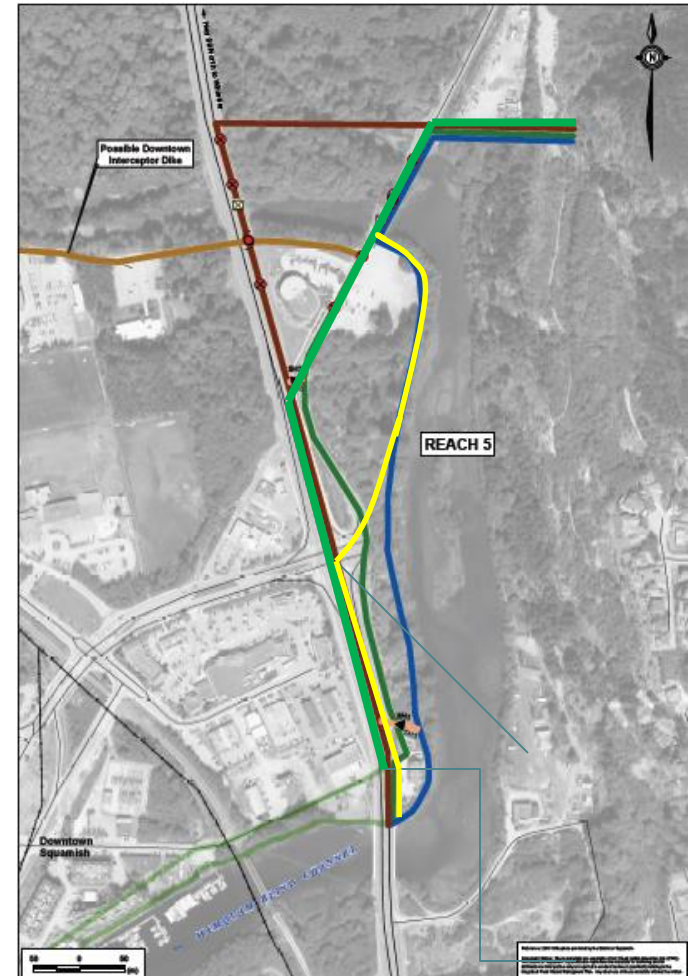
Reach 5 – Upper Mamquam Blind Channel (Hwy 99 to Smoke Bluffs)

- Options: **Previously Recommended**
 - Shoreline – greatest length of new dike/protecting greenspace
 - Highway – least area protected
 - Logger's Lane – minimal benefit south of Cleveland → hybrid makes more sense
 - Hybrid – (benefits/drawbacks below)
- Previous Recommendation: **Hybrid – Hwy 99 to Logger's Lane. Raise Logger's Lane to north MBC – tie to Smoke Bluffs**
- Benefits:
 - Reduces length of new dike = lower cost and environmental impact
 - Less geotechnical challenges
- Drawbacks:
 - Does not protect high value District land



Reach 5 – Upper Mamquam Blind Channel (Hwy 99 to Smoke Bluffs)

- Alternate Options:
 - 1) Defer until detailed review with S2S Forestry retains QP & develops mitigation plan
 - 2) Consider new hybrid (in yellow)
- Considerations:
 - Protects District land which has proposed uses
 - Dike protection has minimal impact on FCL
 - Significant dike footprint may impact S2S setbacks



Typical Dike Section

