Integrated Flood Hazard Management Plan

River Flood Mitigation Strategy - Finalization

Council Update #9

June 14, 2016

SQUAMISH

KERR WOOD LEIDAL consulting engineers

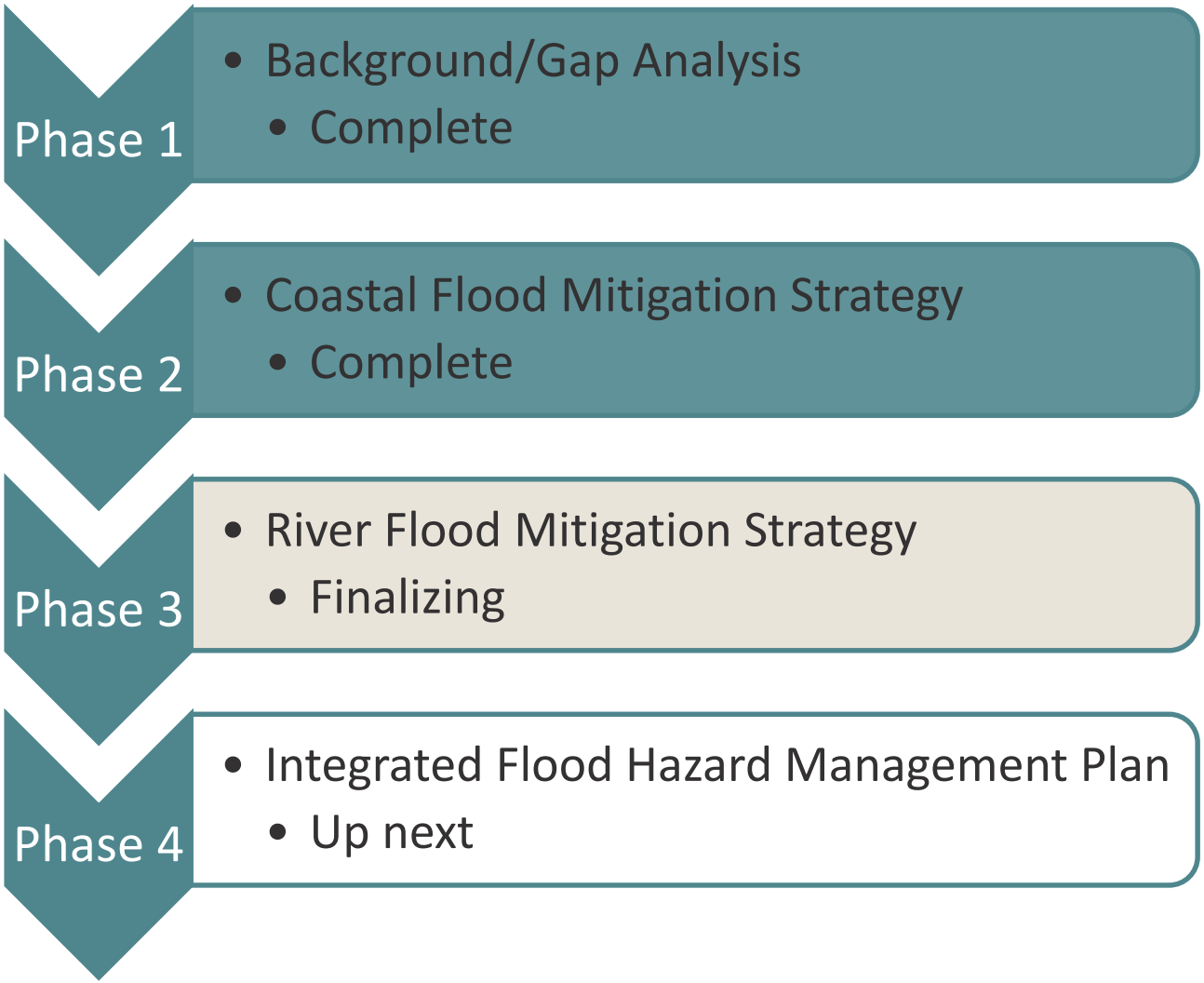
Arlington Group Planning + Architecture Inc.

Agenda

- Brief Summary
- Outstanding issues
- Interim Policy
- Questions/Discussion

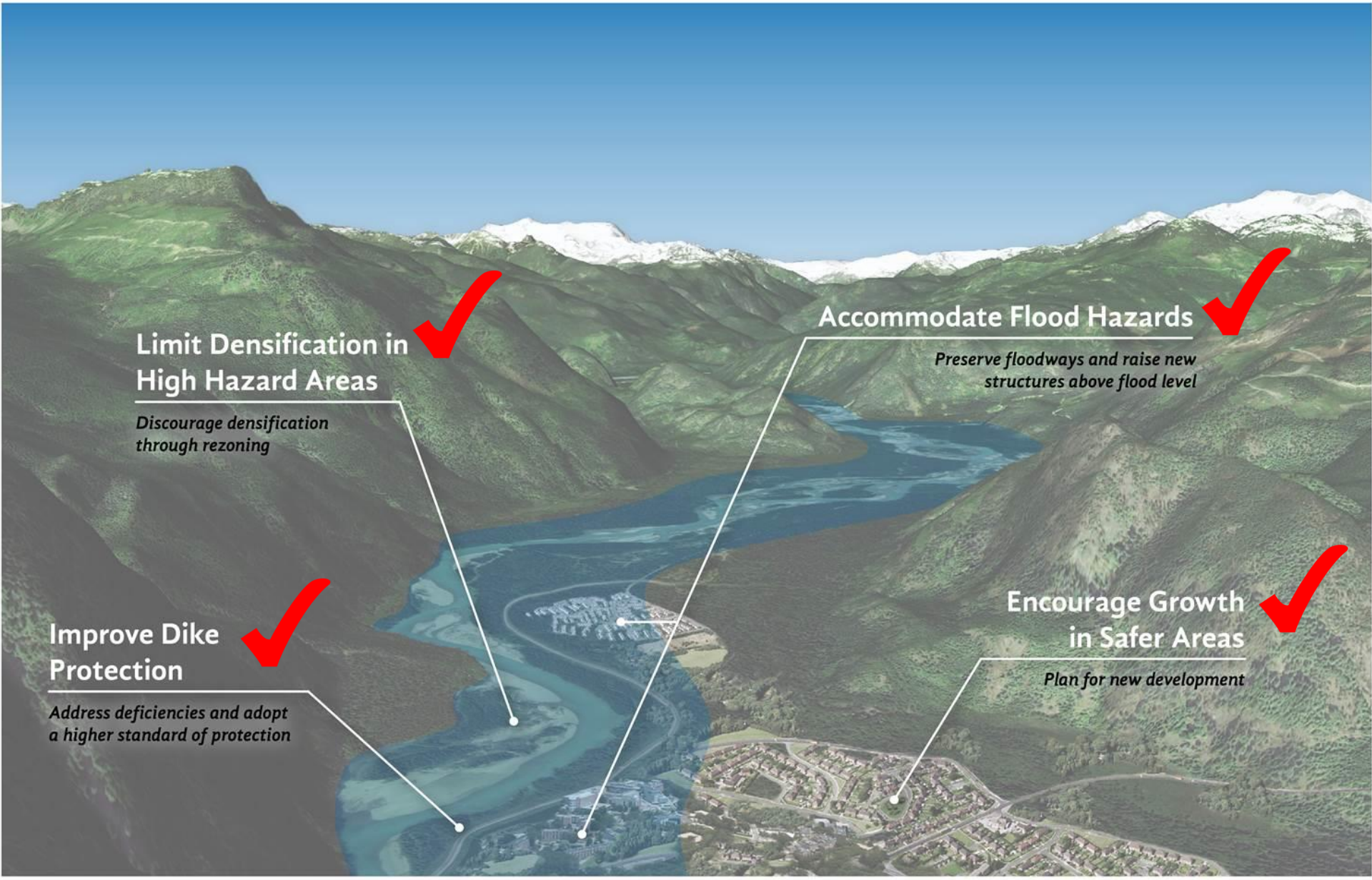
SQUAMISH

Integrated Flood Hazard Management Plan



SQUAMISH

River Mitigation Strategies

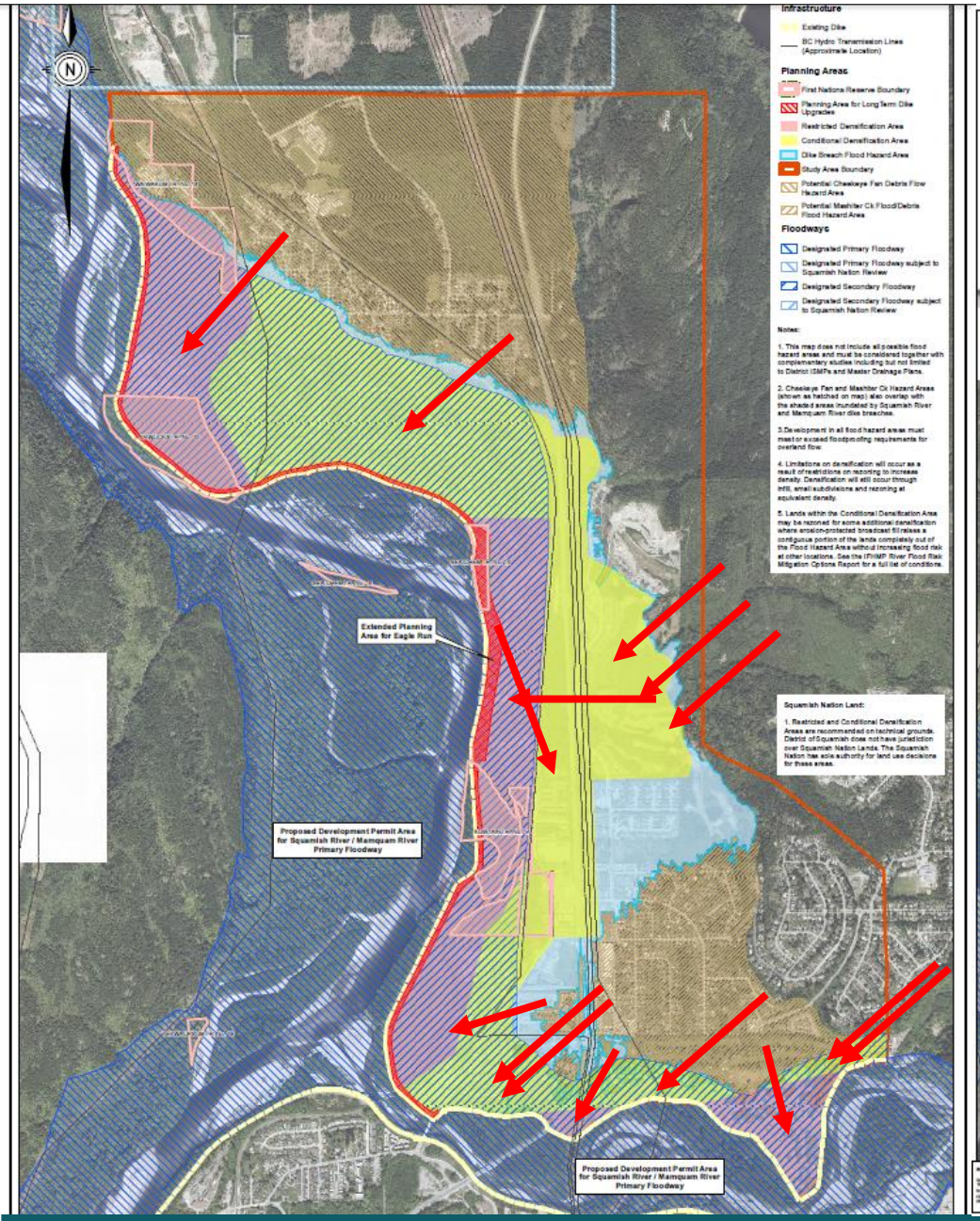


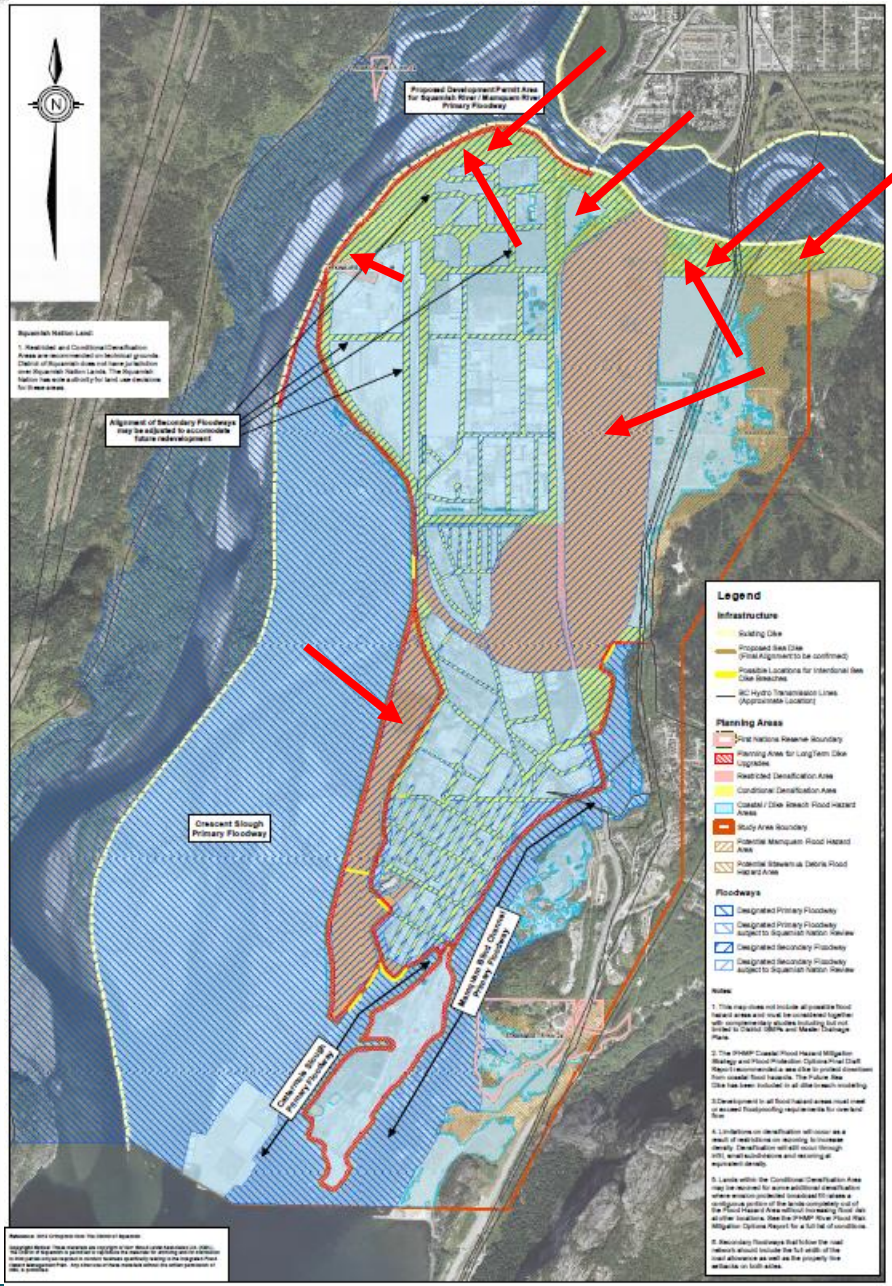
Land Use Mitigation Options

	Option
Retreat	1A- Complete Retreat
	1B - Wide-Scale Retreat
	1C - Localized Retreat – Highest Risk Areas
	1D - Localized Retreat – West of Judd Slough
	1E - Managed Retreat of Key Facilities
Avoid (for High Hazard Floodways)	2- Avoid All Further Development
	3A – Limit Densification Through Rezoning
	3B – Conditional Densification Through Rezoning – OCP Residential Neighbourhoods
	3C – Conditional Densification through Rezoning - All Areas
	4A – Limit Densification Through Rezoning – Reduced Area
	4B – Conditional Densification Through Rezoning – Reduced Area
	5A – Allow Densification Through Rezoning - All Areas – Unique Concepts
	5B – Allow Densification Through Rezoning – OCP Residential Neighbourhoods
	5C - Allow Densification Through Rezoning – All Areas
Attack	6 – Attack Strategies

SQUAMISH

Item 1: Conditional/Restricted Densification Areas





Item 2: Densification Conditions

Previous Conditions

- Fill entire development area
- Provide erosion protection for the fill
- Fill cannot significantly affect floodway capacity
- No environmental impacts that cannot be mitigated as part of the development
- Cannot significantly transfer risk
- If next to dike, upgrade the dike frontage and provide SROW to 1:500 year standard
- QP/QEP certify the above

Modified Condition

Add: Preserve an unreduced 30m buffer to the natural boundary of all natural watercourses

Additional Conditions

- Ensure that designated floodways receive permanent dedication
- Limit density to two unit dwelling for rezoning proposals that don't have a safe evacuation route
- Satisfy an independent third party peer review, if and when needed.

SQUAMISH

Item 2: Densification Conditions

Issues:

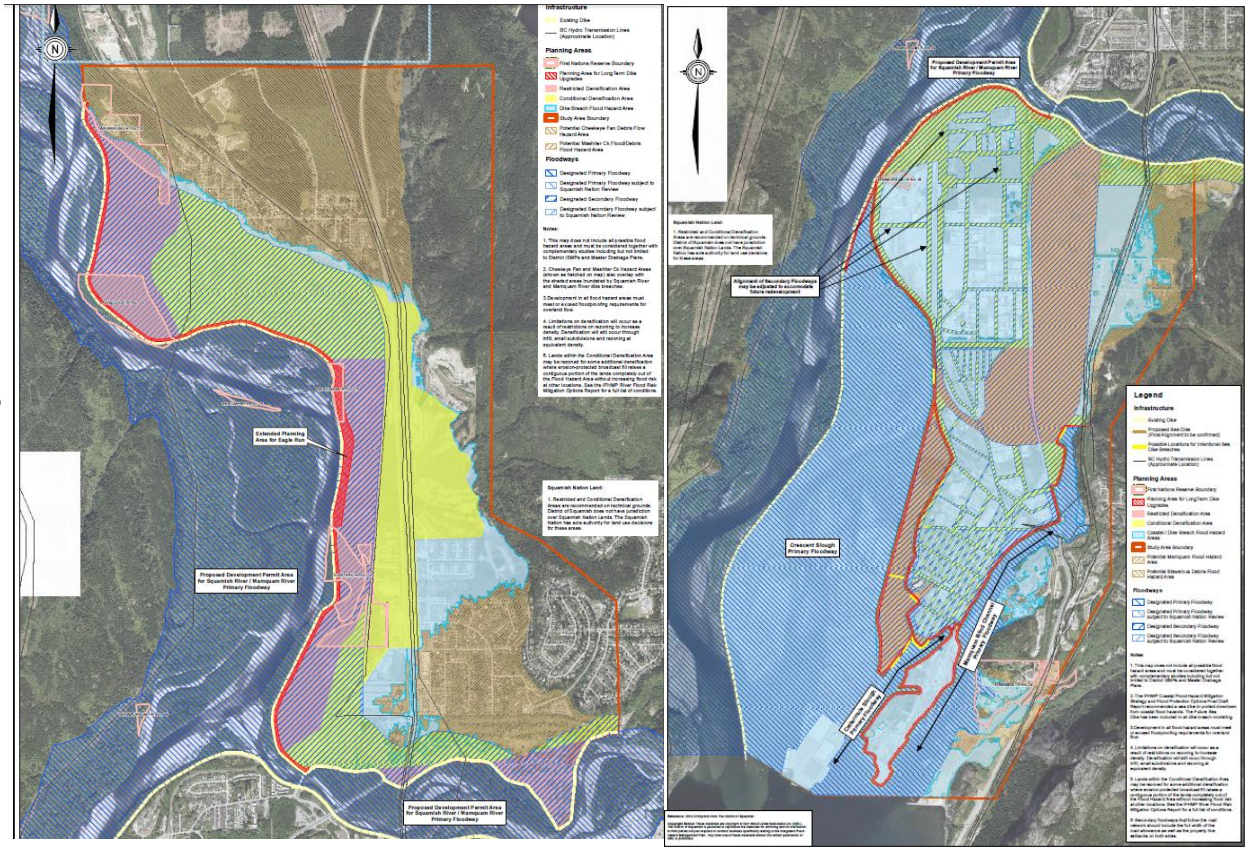
- No boundaries placed on level of densification
- Could result in significantly more people in high risk areas
- More people in high hazard areas = reduced community resiliency

Recommendation:

- Limit density to two unit dwellings for rezoning proposals that:
  - Do not border ‘safer’ areas of the floodplain, and/or
  - Cannot provide an evacuation route to high ground that passes only through safer areas

Supported:

- Allow up to townhome zoning anywhere in conditional dens. area



SQUAMISH

Item 2: Densification Conditions

Conditions:

- Fill cannot significantly affect floodway capacity
- Cannot significantly transfer risk

- BC= fill must not adversely affect floodway capacity or transfer risk
- 4 US states have adopted a 'no measurable increase' policy < 0.03m (1")
- 4 US states have adopted compromise positions = 0.06m-0.15m (2-6")
- US National Flood Insurance Program establishes < 0.3m (1 ft)

- 'No measurable increase' would likely preclude any densification
- Economic damage from 0.3m inundation = 20% of structure value

- IFHMP proposes compromise position
  - < 0.15m cumulative impact, < 0.1m impact for any single development

- Will require flood modeling to confirm in many cases

SQUAMISH

Item 3: Implementation of Conditions

- Considered DPA
- OCP Policy
  - QP flood hazard report
    - Modelling: floodway capacity, transfer of risk
  - QEP report ensuring environmental impacts mitigated
  - Reports registered on title
    - Required prior to building permit occupancy.
  - Third-party peer review at District discretion

SQUAMISH

Item 4: Dike deficiency/future subdivision

Challenges:

- Option 3B opens up greater subdivision potential in high risk areas where dike is below Provincial standard

Recommendation:

- APEGBC guidelines → Defer approval of any large subdivision (> 3 lots) within high hazard areas until upstream dikes meet 'standard/adequate' dike definition

Rationale:

- Public expectation that new lots are protected to Provincial standard
- Potential liability

Implications:

- 2 active files affected

Alternate Option:

- Council can adopt a land use regulation that allows for subdivision with knowledge of the hazard

Item 5: Dike Cost

- Cost estimate for recommended upgrades=
  - Total = $47M

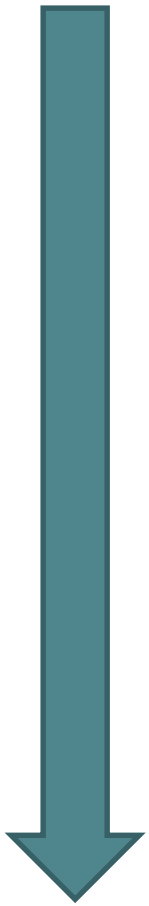
- Squamish River 1:500yr return period dike estimate = $35M
- Grand total = $82M

- Recommendations:
  - Prioritized/schedule upgrades in final phase
  - Adopt policy to begin planning for 1:500yr dike standard for the Squamish River dike

SQUAMISH

IFHMP Next Steps

Now



Sept 2016

- Direction from Council on 5 items
- Council endorsement for finalizing report and moving to phase 4
- Phase 4 Implementation
  - Further public engagement
  - Floodplain bylaw and OCP policy
  - Timing and funding of dike upgrades

SQUAMISH

Recommendation

That Council approve the following resolution:

That staff consider the recommendations contained in the Integrated Flood Hazard Management Plan River Flood Risk Mitigation Options Report when assessing rezoning applications located within the 'Restricted Densification' and 'Conditional Densification' areas of the Squamish River / Mamquam River Floodplain in the interim until the current Official Community Plan project is completed.

Recommendation

That Council approve the following resolutions:

THAT the District of Squamish finalize the River Flood Risk Mitigation Options report prepared as part of the ongoing Integrated Flood Hazard Management Plan (IFHMP) based on feedback received from Council

Items for Resolution

1. Restricted/Conditional densification areas.
2. Density limitations where no safe evacuation.
3. Floodway conveyance/transfer of risk evaluation.
4. Subdivisions downstream of non-standard dikes.
5. Adoption of policy to begin planning for 1:500yr return period dike.

SQUAMISH

Recommendation

That Council approve the following resolution:

That staff consider the 10 conditions contained in the Integrated Flood Hazard Management Plan River Flood Risk Mitigation Options Report when assessing rezoning applications located within the 'Conditional Densification through rezoning' area of the Squamish River / Mamquam River Floodplain in the interim until the current Official Community Plan project is completed.

Financial Impacts

- Contacted Squamish lenders re IFHMP
  - Squamish Savings
  - RBC
  - BMO
  - Scotia
  - CIBC
  - Blue Shores
- Asked if flood hazard information or designations would impact financing

SQUAMISH

Financial Impacts

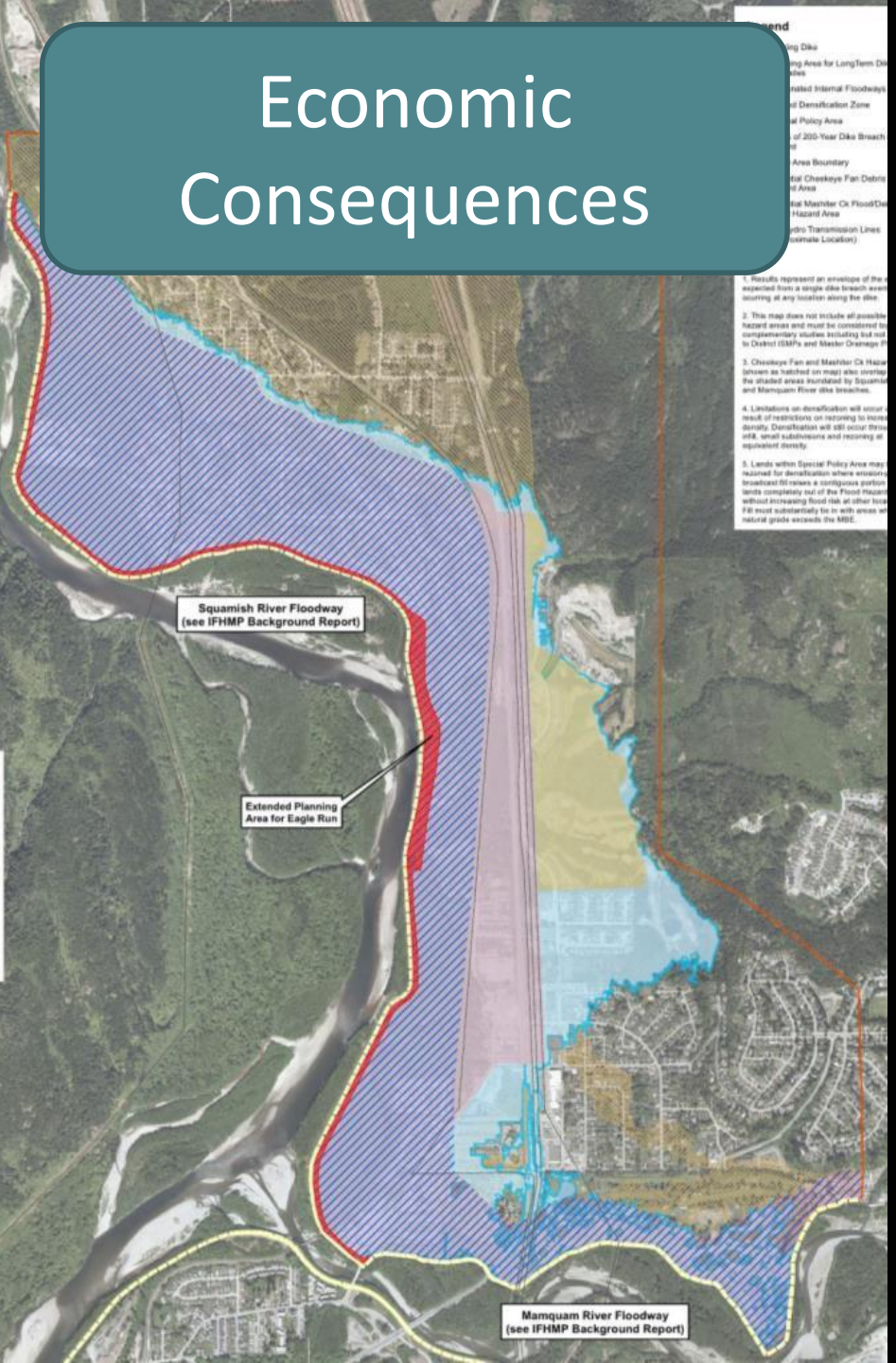
- Lending based on ability to service debt
- Reliance on appraisals
- Recognition of floodplain
- Assumption: DoS sets appropriate standards
- Flooding considered insurance issue
- CMHC Insurance is a determinant.

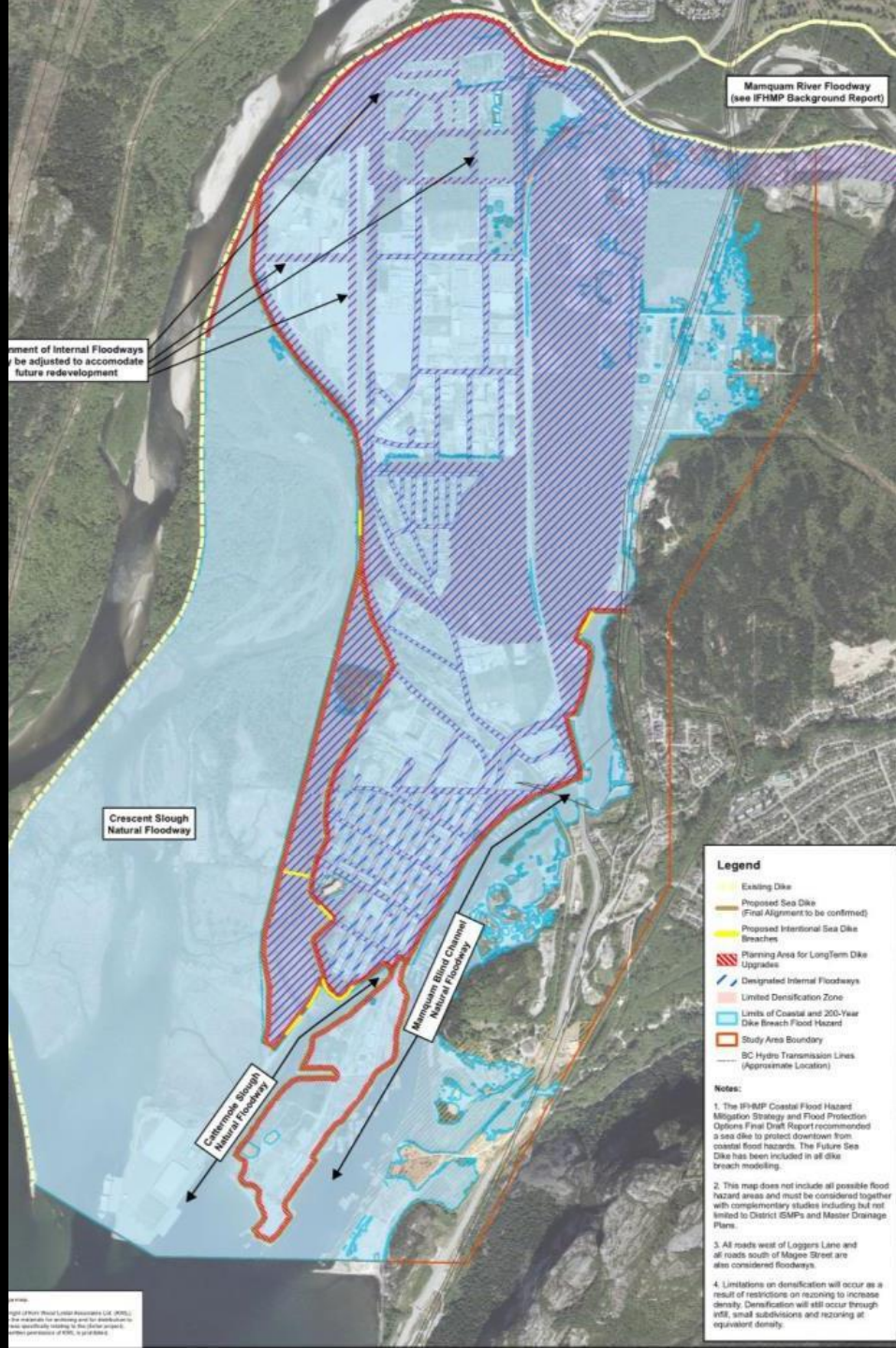
Upper Floodplain Infill

- Rough theoretical potential at existing zoning
- Does not consider constraints or infrastructure
- Assumes 1 dwelling unit per lot
- Assessed unbuilt lots and lots 1400 m^2 or larger (double RS-1 minimum)
- RL lands
  - 5 unbuilt lots and 7 potential lots
- RS
  - 110 theoretical potential lots, realistically much less

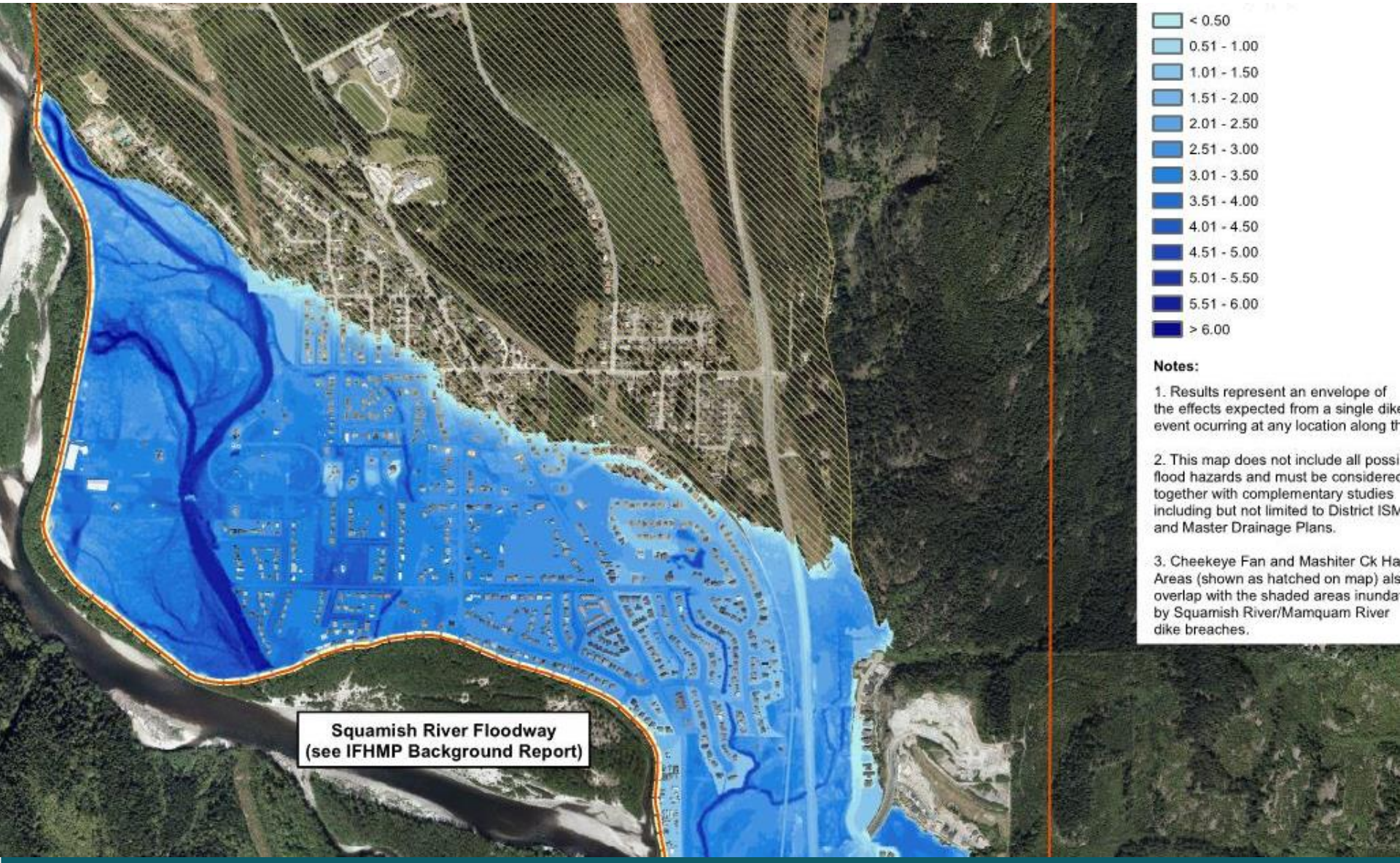
SQUAMISH

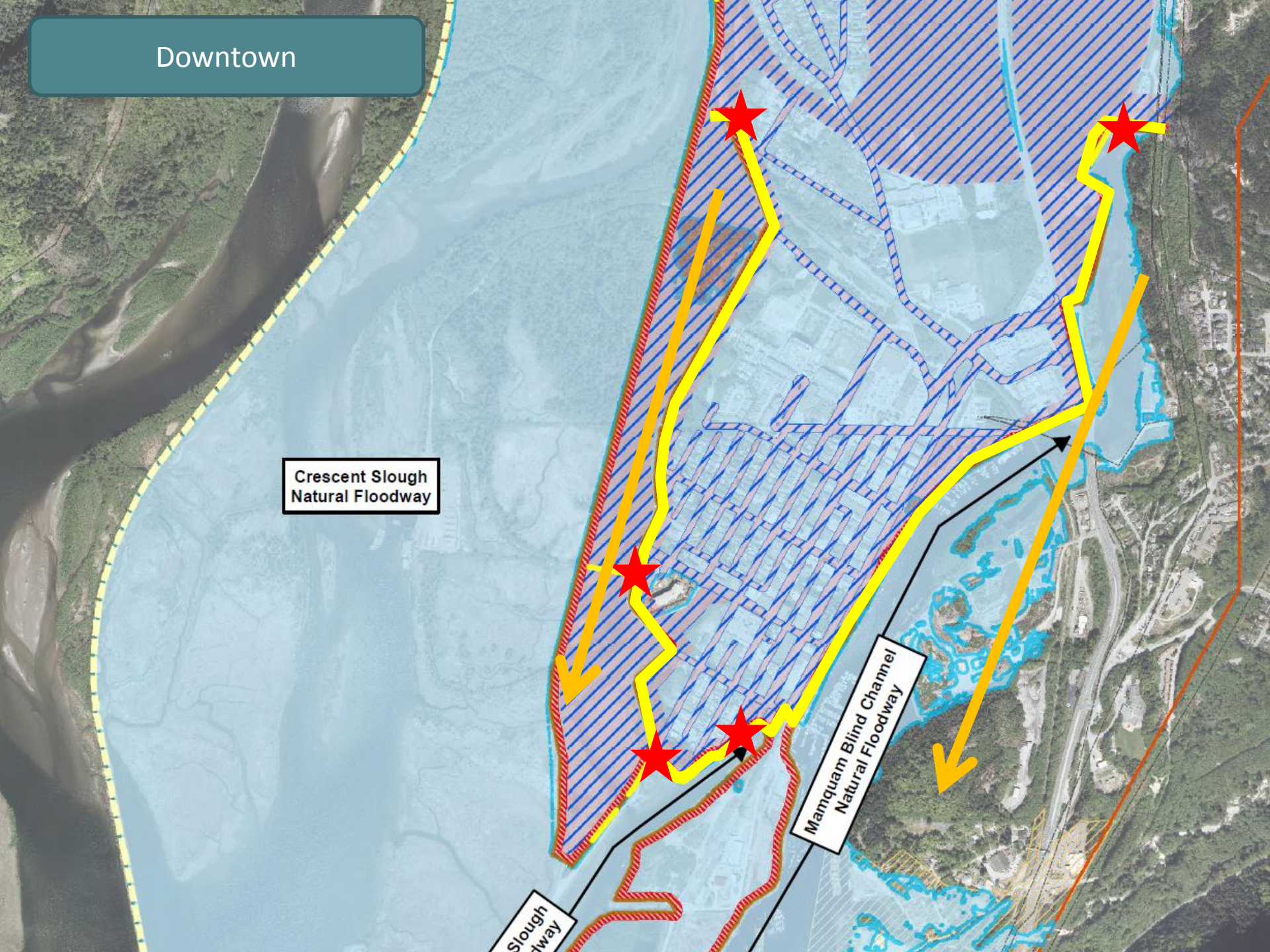
Economic Consequences



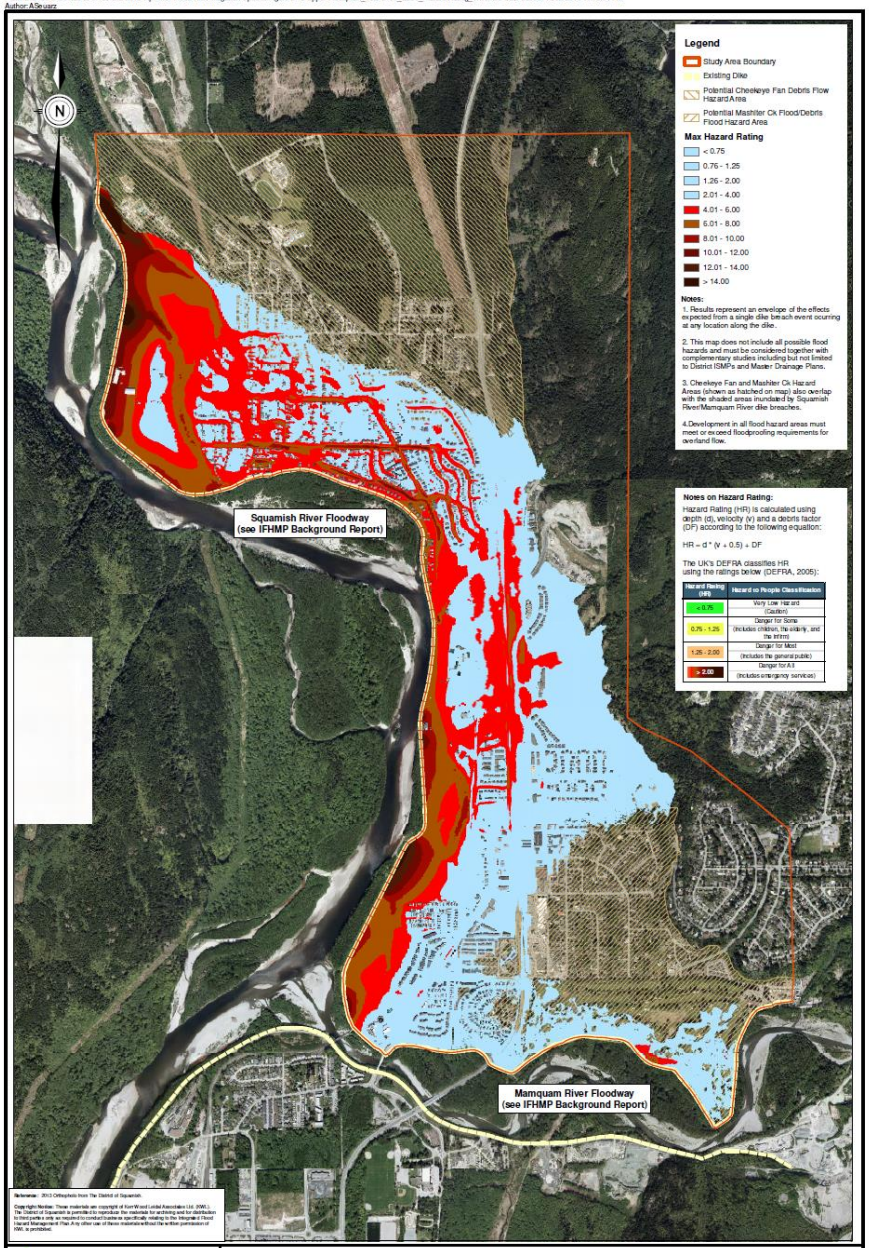


Brackendale




Downtown
Crescent Slough
Natural Floodway
Mamquam Blind Channel
Natural Floodway

Path: O:\0400-0499\463-278\430-GIS\MXD-Rpt\River Flood Risk Mitigation Options\Figure 2-12 Upper Floodplain_Year 2100_Q200_Hazard Rating_4HR.mxd Date Saved: 19/02/2016 11:16:54 PM
Author: ASeuarz



KERR WOOD LEIDAL consulting engineers
©2016 Kerr Wood Leidal Associates Ltd.

District of Squamish - Integrated Flood Hazard Management Plan
DRAFT River Flood Risk Mitigation Options Report

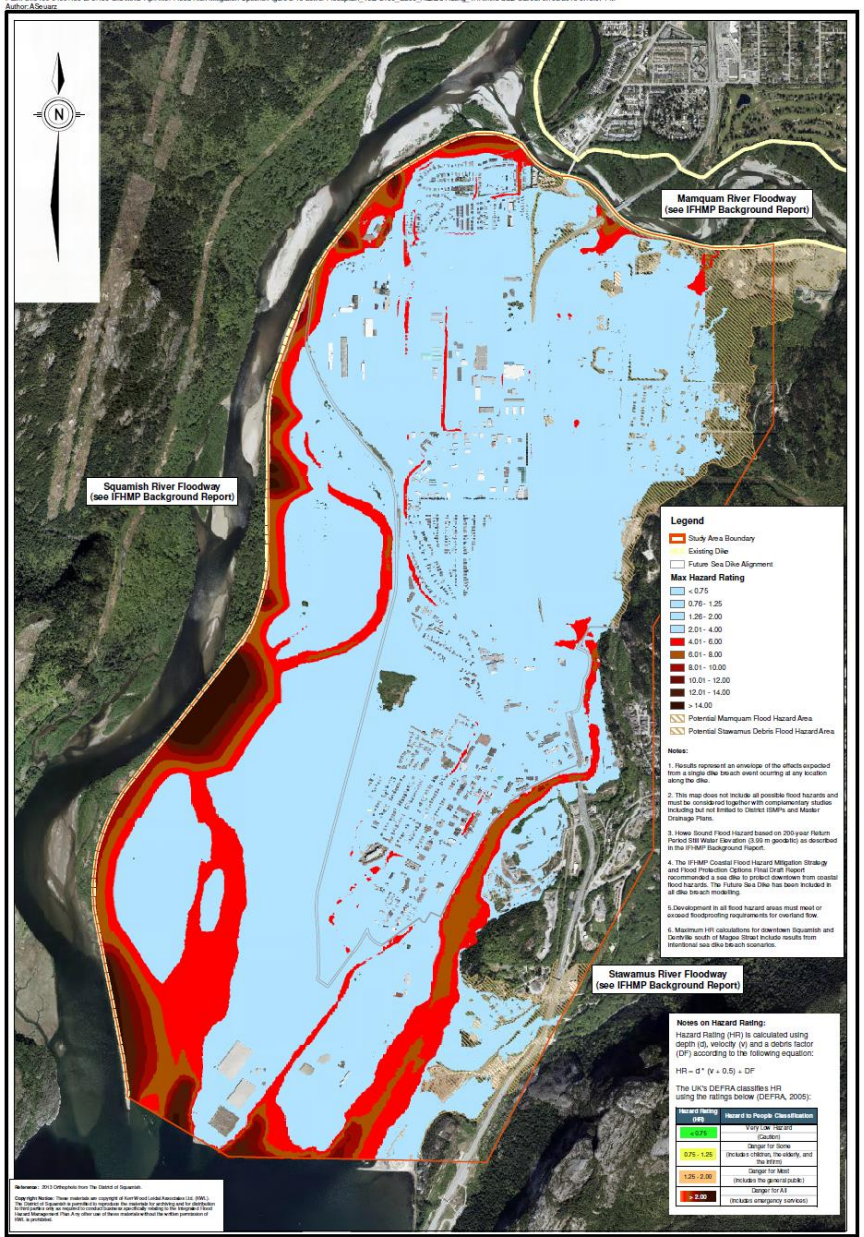
Project No.	Date
463-278	February, 2016

400 0 400 (m)
1:18,000

Preliminary Composite Maximum Hazard Ratings > 4 for Upper Floodplain Dike Breach Scenarios Year 2100 200-Year Return Period Flood

Figure 2-12

Path: O:\0400-0499\463-278\430-GIS\MXD-Rpt\River Flood Risk Mitigation Options\Figure 2-13 Lower Floodplain_Year 2100_Q200_Hazard Rating_4HR.mxd Date Saved: 07/03/2016 6:18:07 PM
Author: ASeuarz



KERR WOOD LEIDAL consulting engineers
©2016 Kerr Wood Leidal Associates Ltd.

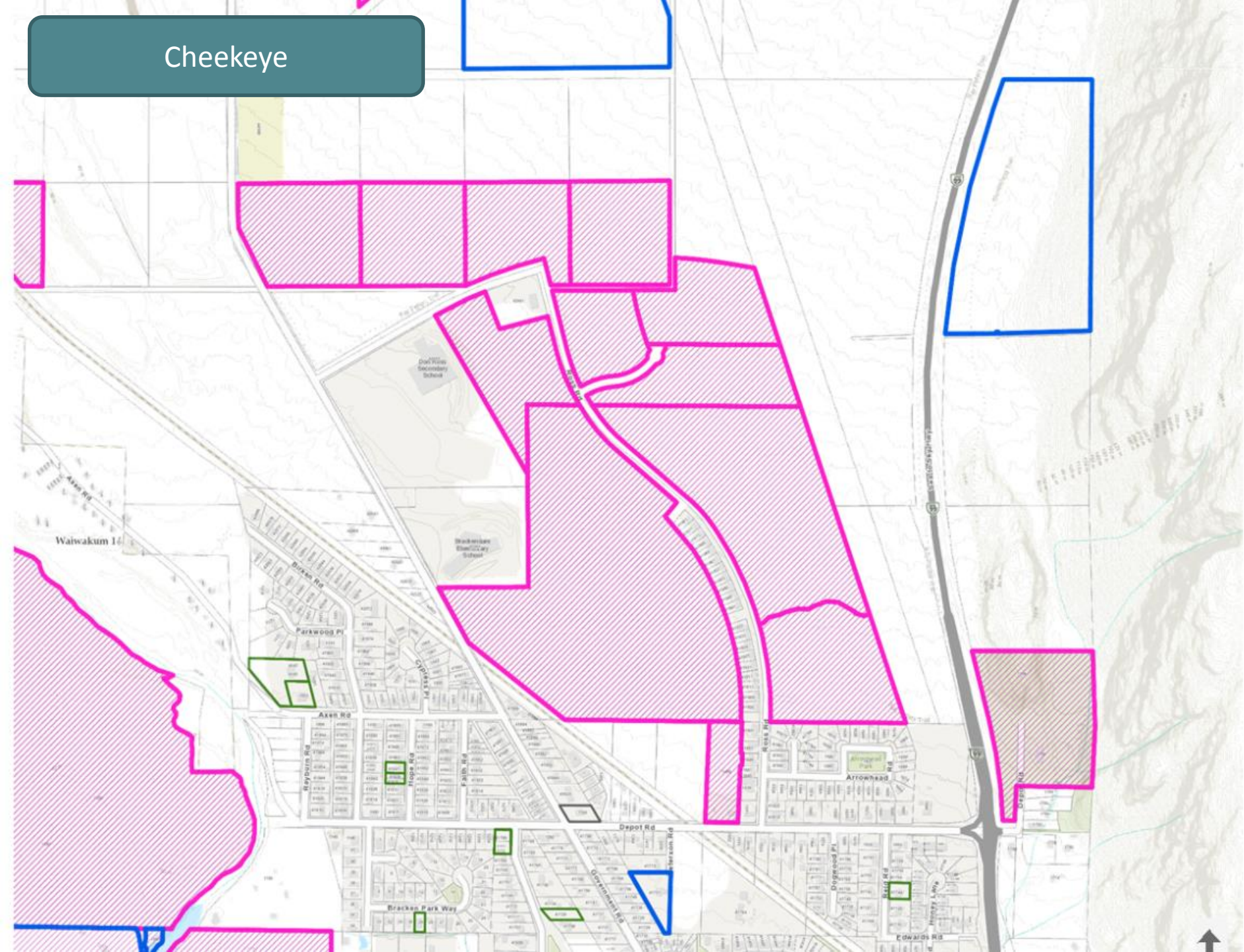
District of Squamish - Integrated Flood Hazard Management Plan
DRAFT River Flood Risk Mitigation Options Report

Project No.	Date
463-278	March, 2016

400 0 400 (m)
1:18,000

Preliminary Composite Maximum Hazard Ratings > 4 for Lower Floodplain Dike Breach Scenarios Year 2100 200-Year Return Period Flood

Figure 2-13


Cheekeye
Waiwakum 14
Axen Rd
Parkwood Pl
Cypress Pl
Hope Rd
Faith Rd
Ross Rd
Arrowhead Rd
Depot Rd
Bracken Park Way
Edwards Rd

New Dike Alignment

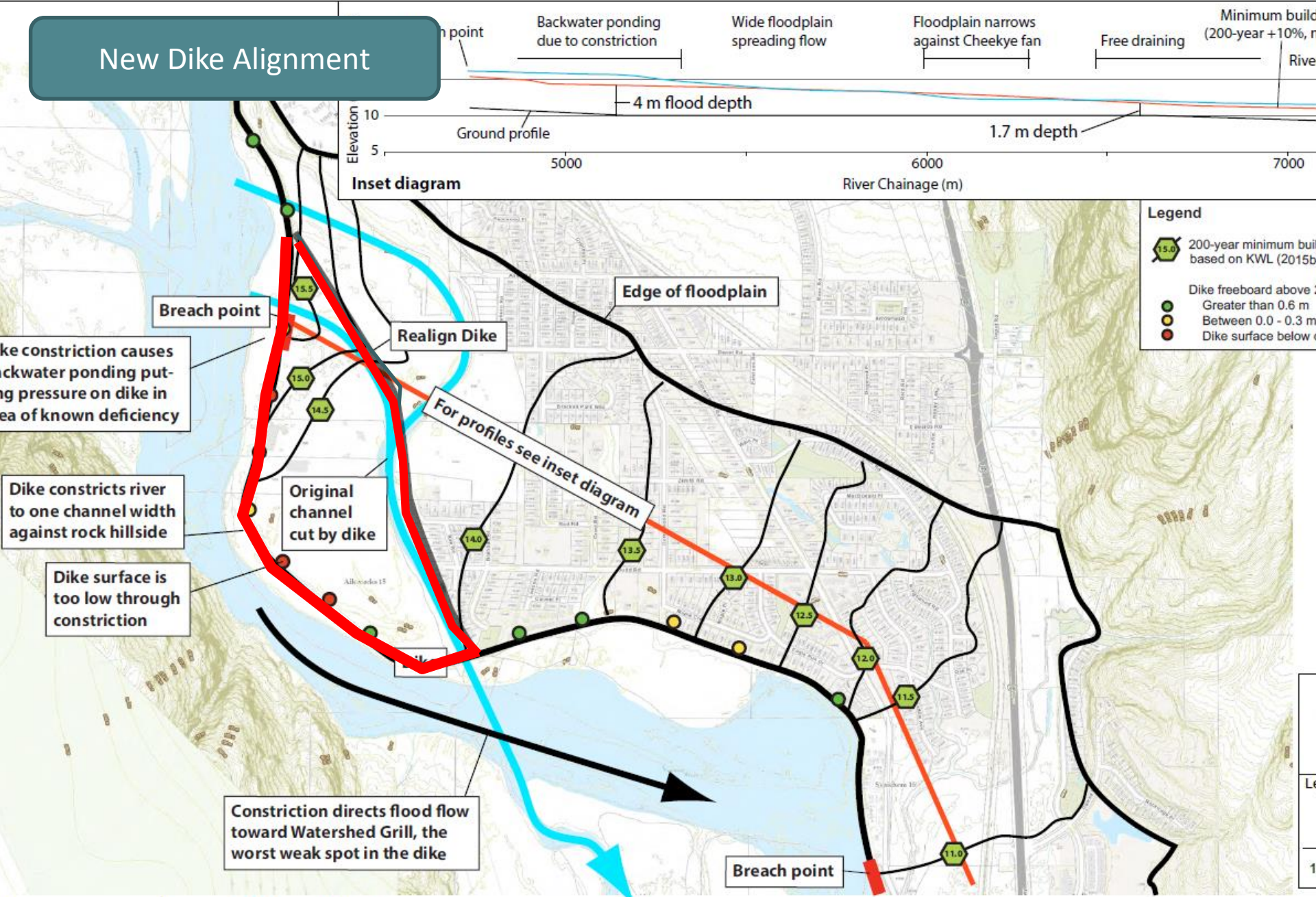


Figure 1. Dike realignment at Brackendale. Note serious negative flood affects in Brackendale & Eagle Run due to poor

Online Survey

- 117 responses

- Support for mitigation strategies:
  - **Protect** (Dikes) 89%
  - **Accommodate** (FCL) 83%
  - **Avoid** (Developing High Risk) 82%
  - **Retreat** (Relocated Development) 33%

- Utilize all practical approaches 90%
- Do not rely on a single approach 92%
- Avoid/discourage intensive development in high risk areas 82%

SQUAMISH

1050 Depot Rd Proposal Concerns

Technical Proposal

1) Fill/development on river side of dike
   - Public safety, environmental, constrain river capacity, O&M concerns, create poor hydraulics, emergency response, Inspector of Dikes

2) Use dike as road/emergency evacuation route for development
   - Public safety, emergency response concerns, inadequate width

3) Reduce dike setbacks for development
   - Public safety, constrains O&M/future work = $, IOD opposition, poor precedent

4) Change rezoning application from RL-1 (min. 2 acre lots) to high density RS/RMH/Commercial zoning (300 lot minimum)
   - Public safety, higher community risk, evacuation

1050 Depot Rd Proposal Concerns

Funding Proposal

1) Cost recovery agreement for municipal infrastructure (sewer/water/roads)
    - District benefits are unclear

2) District supplies dike and fill material

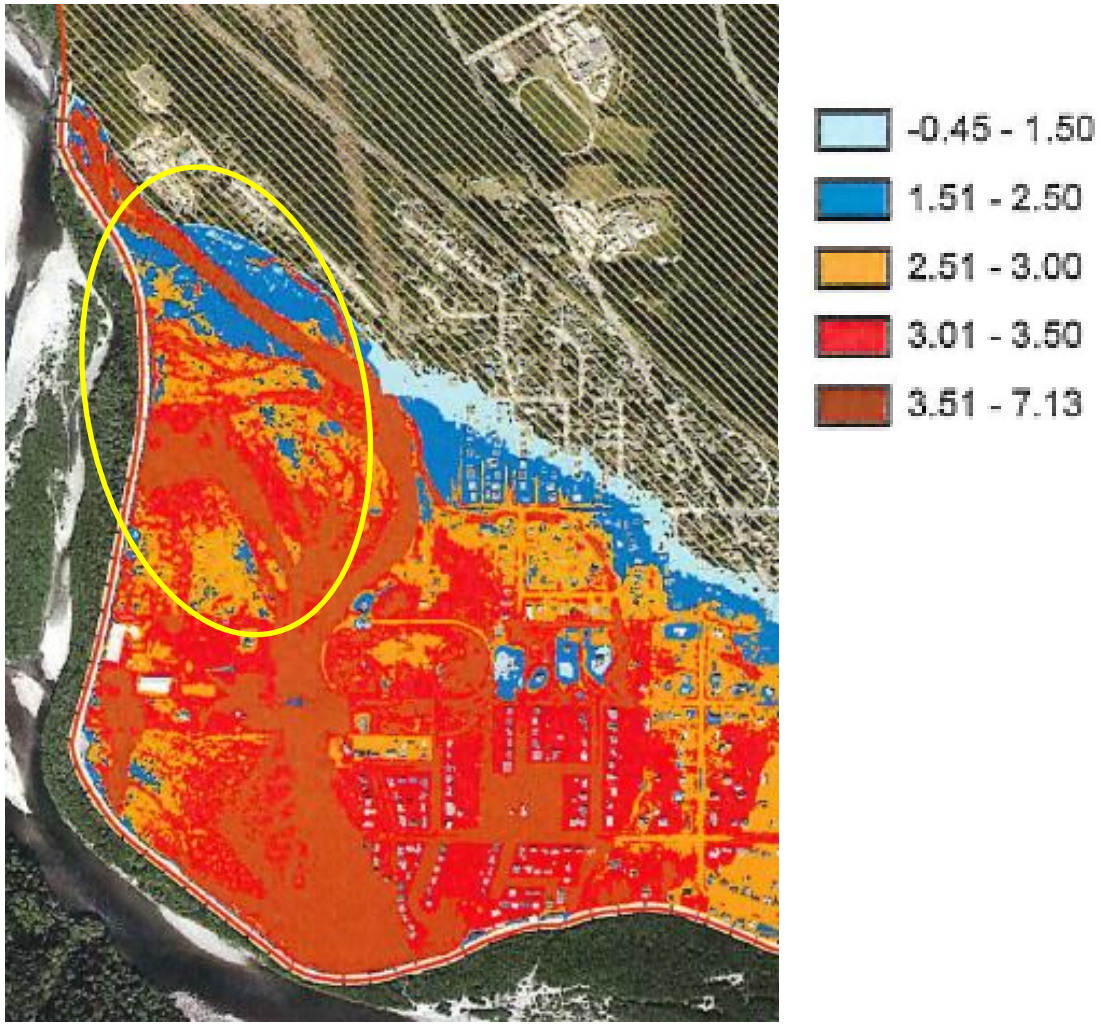
3) Funding options: create new Flood Protection Utility, DCC exemptions
    - District benefits are unclear,
    - DCC legislation

SQUAMISH

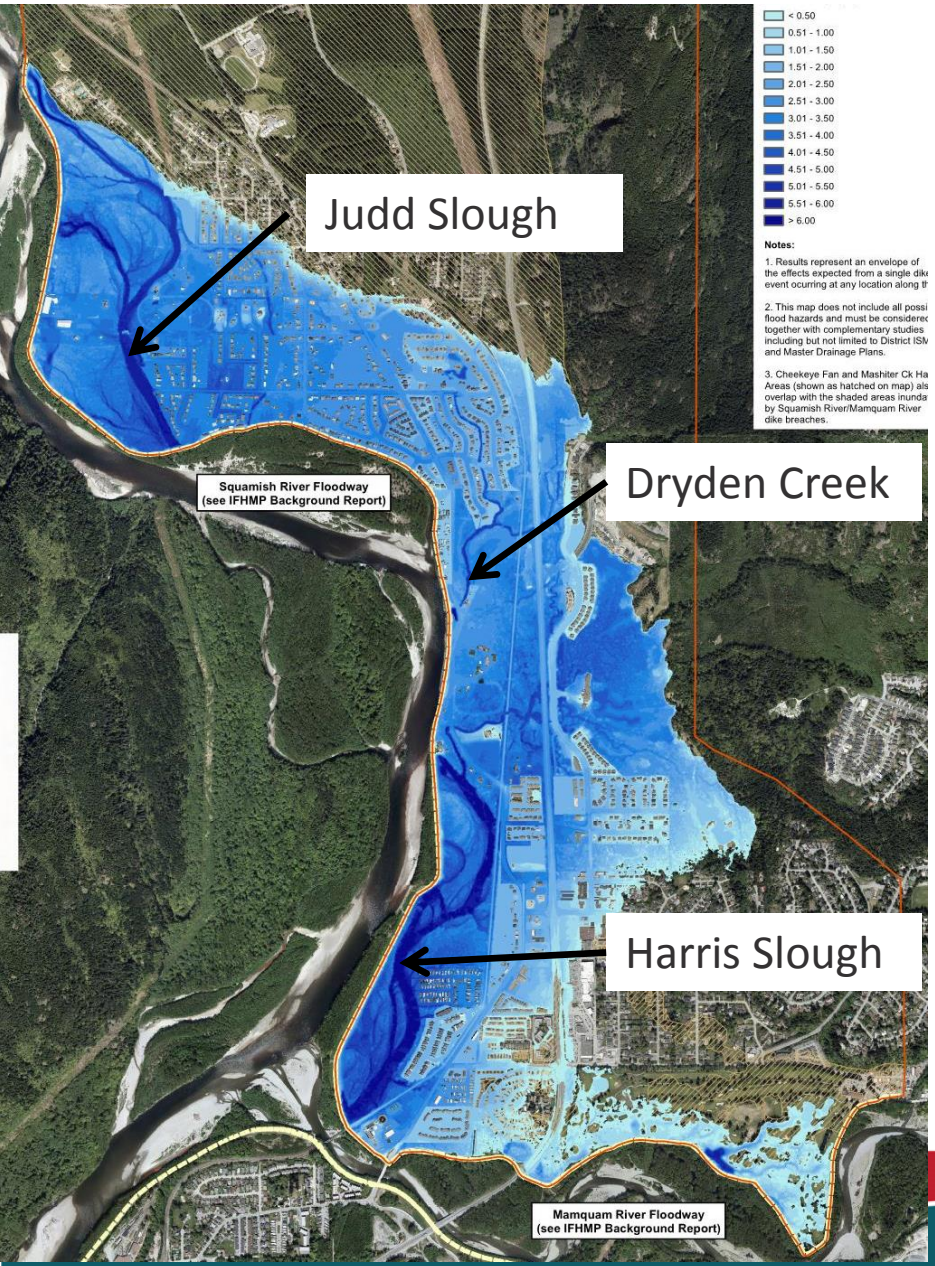
1050 Depot Rd Information

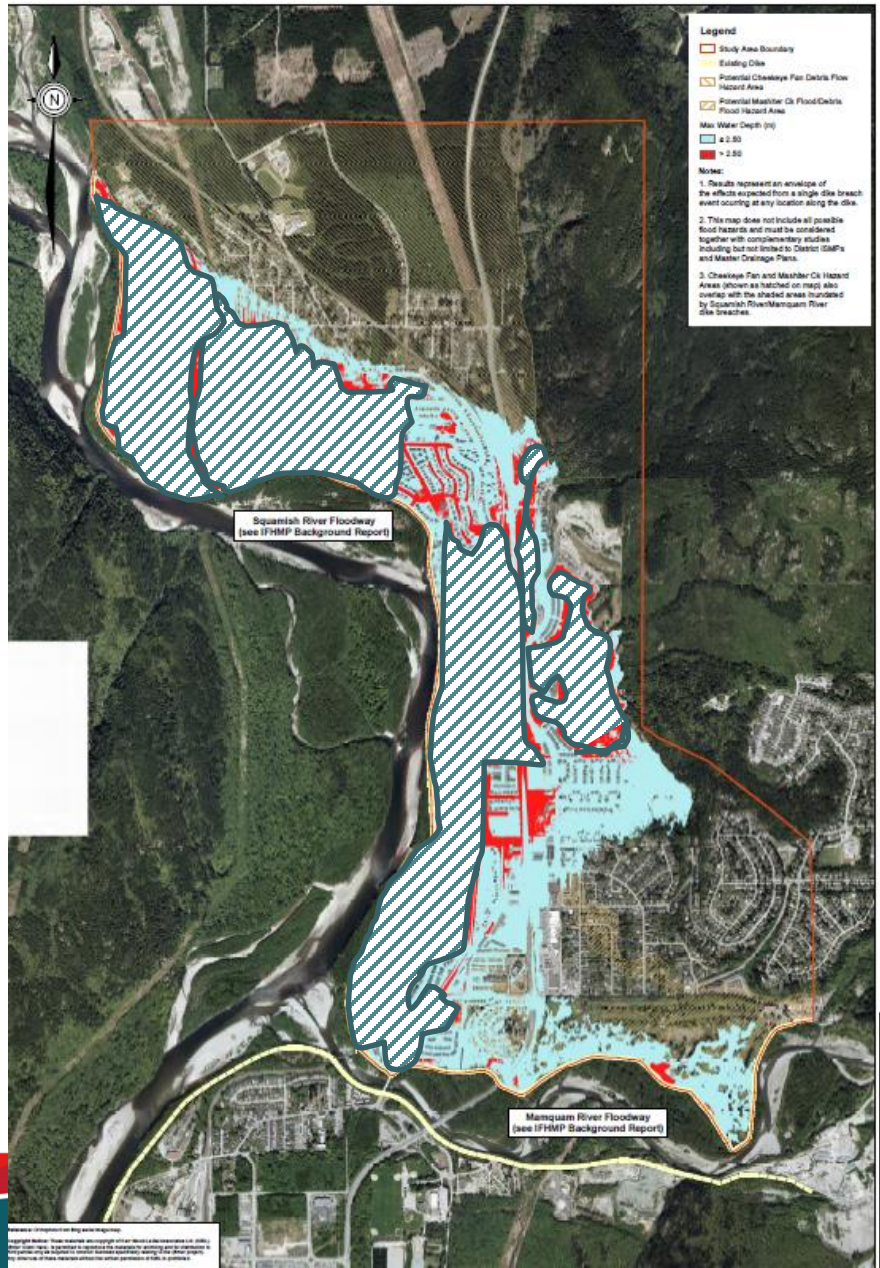
- Land is highest elevation in Squamish floodplain
  - River is also highest.
- Increased structural soundness of dike
  - IOD won't allow, fill not continuous, other issues…
- The dike will never breach
  - Not factually correct
- FCL was 5-6m, now 2-3m
  - FCLs have changed by less than 1m since 1994.
  - Water depth consistently greater than 2.5m

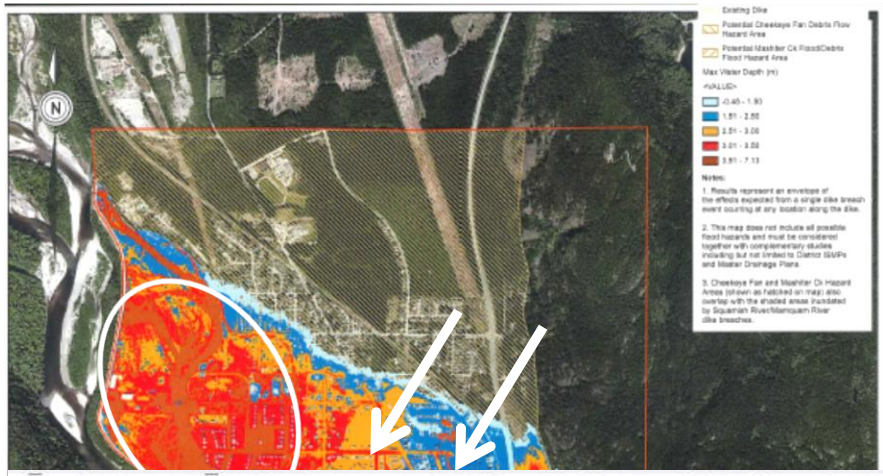
1050 Depot Rd

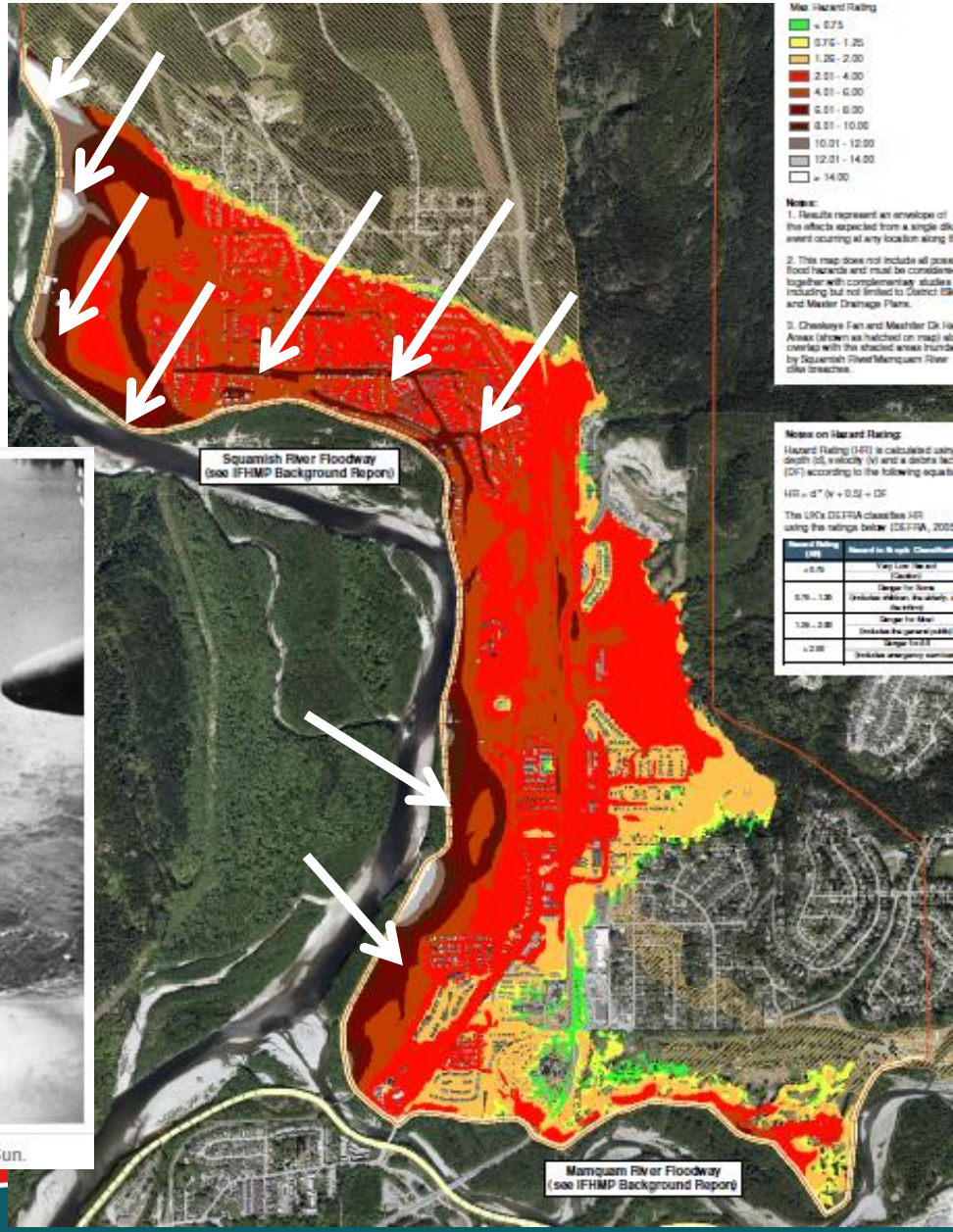


SQUAMISH

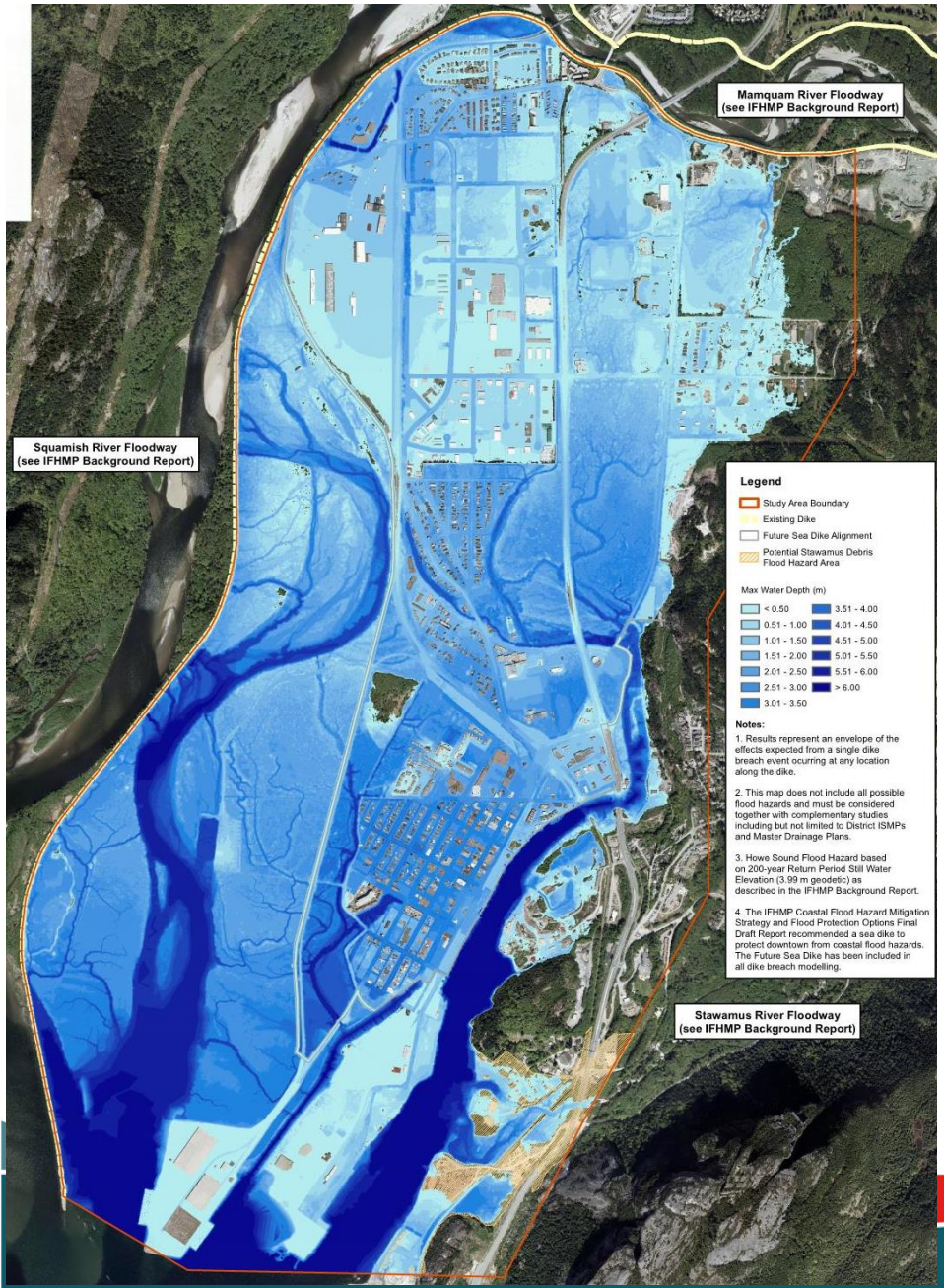

Judd Slough
Dryden Creek
Harris Slough
Squamish River Floodway
(see IFHMP Background Report)
Mamquam River Floodway
(see IFHMP Background Report)
< 0.50
0.51 - 1.00
1.01 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 3.50
3.51 - 4.00
4.01 - 4.50
4.51 - 5.00
5.01 - 5.50
5.51 - 6.00
> 6.00
Notes:

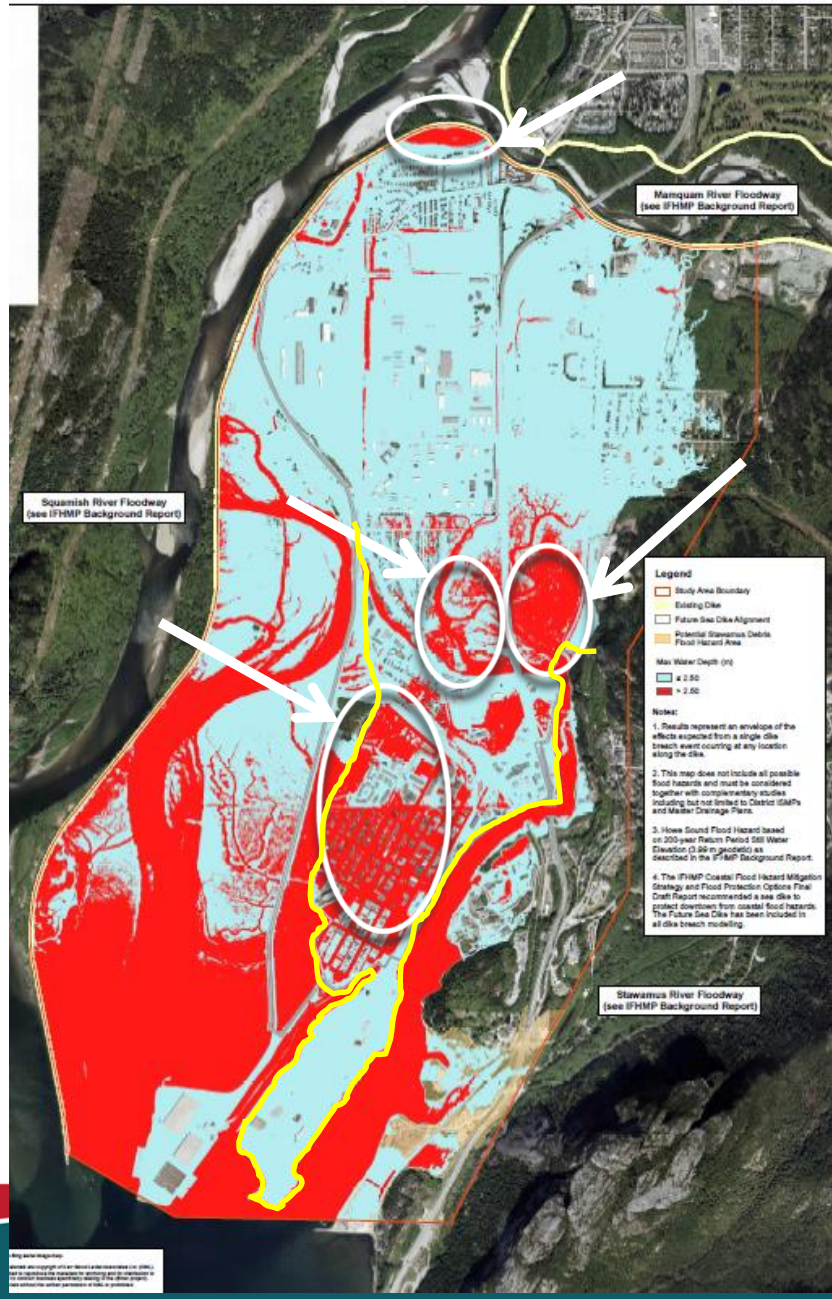

Legend
Squamish River Floodway
(see IFHMP Background Report)
Mamquam River Floodway
(see IFHMP Background Report)





June 3, 1948: The Fraser River flood at Hatzic Lake where the dike broke. Photo: Dave Buchan/Vancouver Sun.


Mamquam River Floodway
(see IFHMP Background Report)
Squamish River Floodway
(see IFHMP Background Report)
Stawamus River Floodway
(see IFHMP Background Report)
Legend
Study Area Boundary
Existing Dike
Future Sea Dike Alignment
Potential Stawamus Debris Flood Hazard Area
Max Water Depth (m)
< 0.50
0.51 - 1.00
1.01 - 1.50
1.51 - 2.00
2.01 - 2.50
2.51 - 3.00
3.01 - 3.50
3.51 - 4.00
4.01 - 4.50
4.51 - 5.00
5.01 - 5.50
5.51 - 6.00
> 6.00
Notes:
1. Results represent an envelope of the effects expected from a single dike breach event ocurring at any location along the dike.
2. This map does not include all possible flood hazards and must be considered together with complementary studies including but not limited to District ISMPs and Master Drainage Plans.
3. Howe Sound Flood Hazard based on 200-year Return Period Still Water Elevation (3.99 m geodetic) as described in the IFHMP Background Report.
4. The IFHMP Coastal Flood Hazard Mitigation Strategy and Flood Protection Options Final Draft Report recommended a sea dike to protect downtown from coastal flood hazards. The Future Sea Dike has been included in all dike breach modelling.


Mamquam River Floodway
(see IFHMP Background Report)
Squamish River Floodway
(see IFHMP Background Report)
Stawamus River Floodway
(see IFHMP Background Report)
Legend
Study Area Boundary
Existing Dike
Future Sea Dike Alignment
Potential Stawamus Debris Flood Hazard Area
Max Water Depth (m)
≤ 2.50
> 2.50
Notes:
1. Results represent an envelope of the effects expected from a single dike breach event ocurring at any location along the dike.
2. This map does not include all possible flood hazards and must be considered together with complementary studies including but not limited to District ISMPs and Master Drainage Plans.
3. Howe Sound Flood Hazard based on 200-year Return Period Still Water Elevation (3.99 m geodetic) as described in the IFHMP Background Report.
4. The IFHMP Coastal Flood Hazard Mitigation Strategy and Flood Protection Options Final Draft Report recommended a sea dike to protect downtown from coastal flood hazards. The Future Sea Dike has been included in all dike breach modelling.

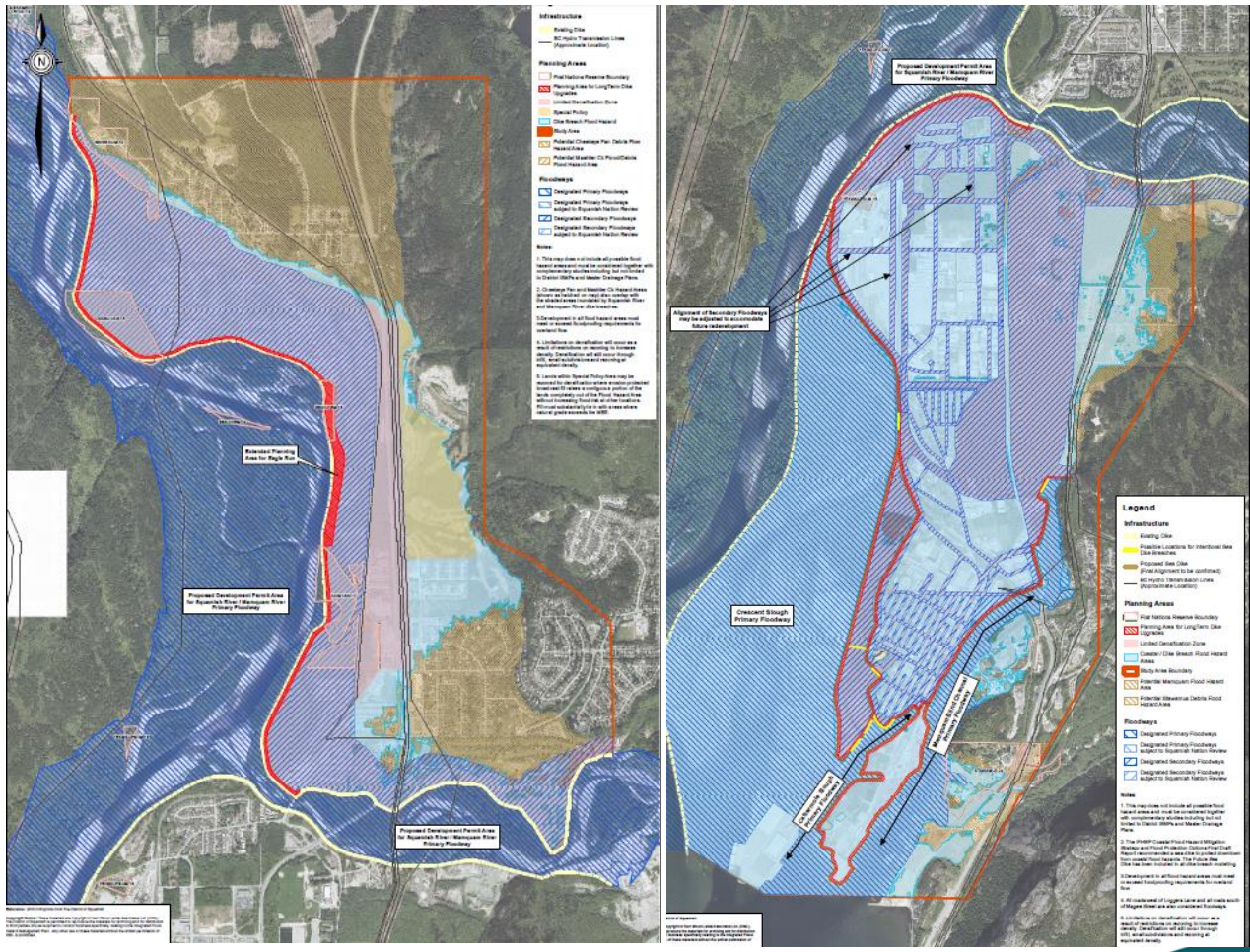
Option 2 – Avoid All Further Development

Benefits:

- Improved public safety
- Reduced community risk
- Preserves environmentally sensitive areas
- Encourages growth in low/no hazard areas
- Limits transfer of risk

Drawbacks:

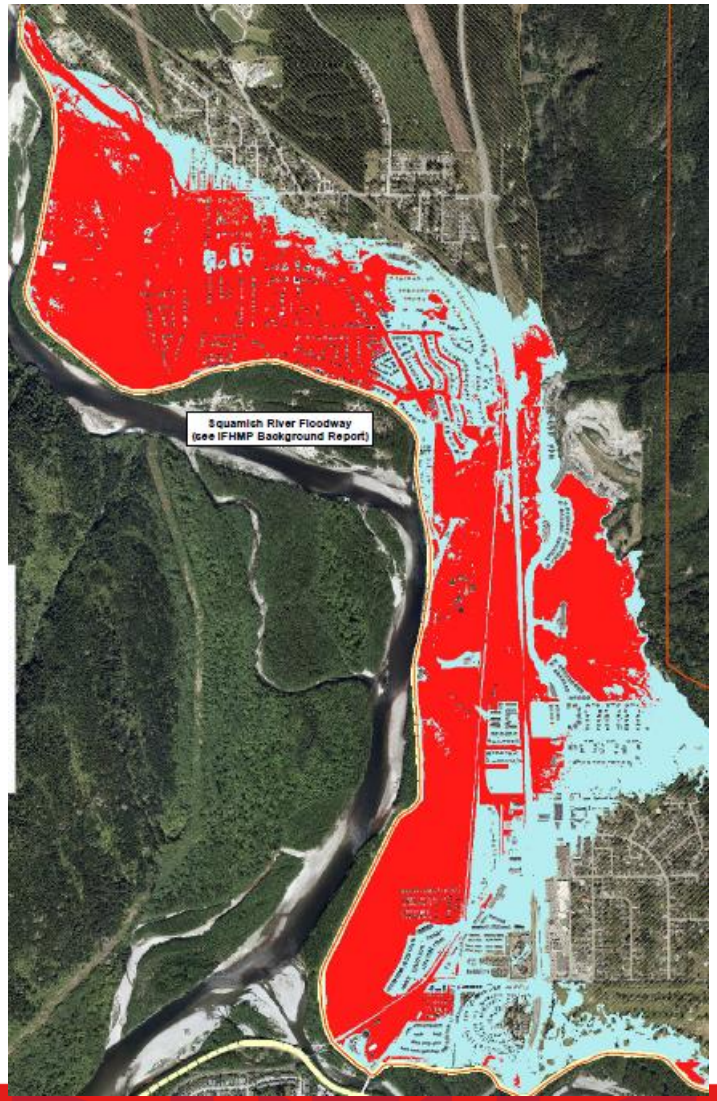
- Reduces land base for high-density development
- Loss of economic benefit to landowners
- Still increases risk/consequences

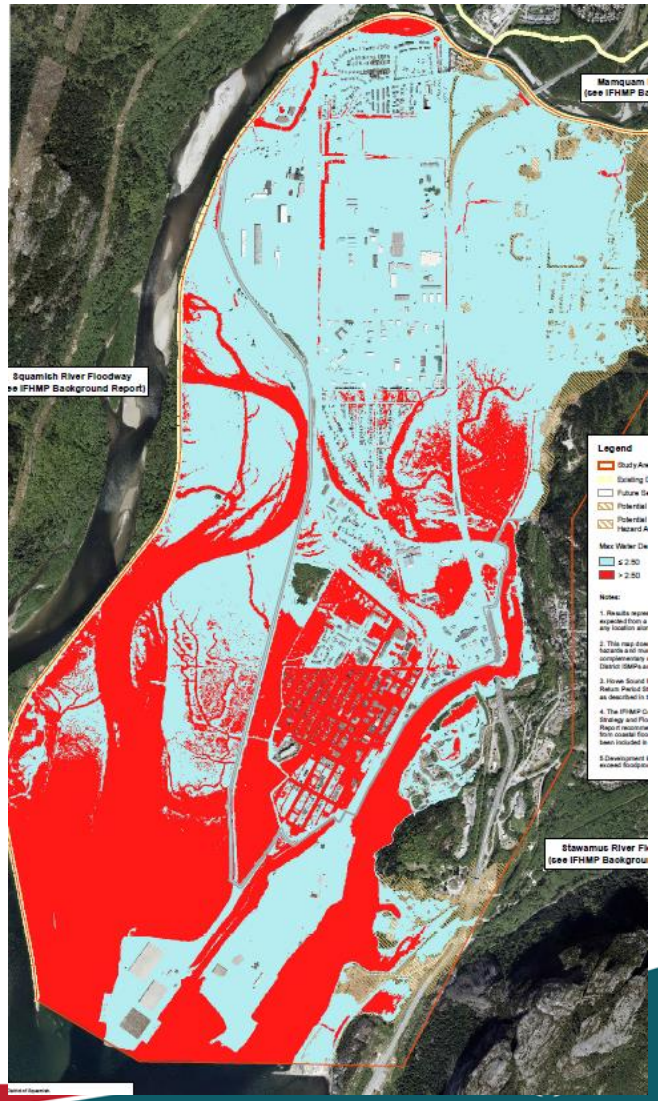


SQUAMISH

Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:
1) Depth

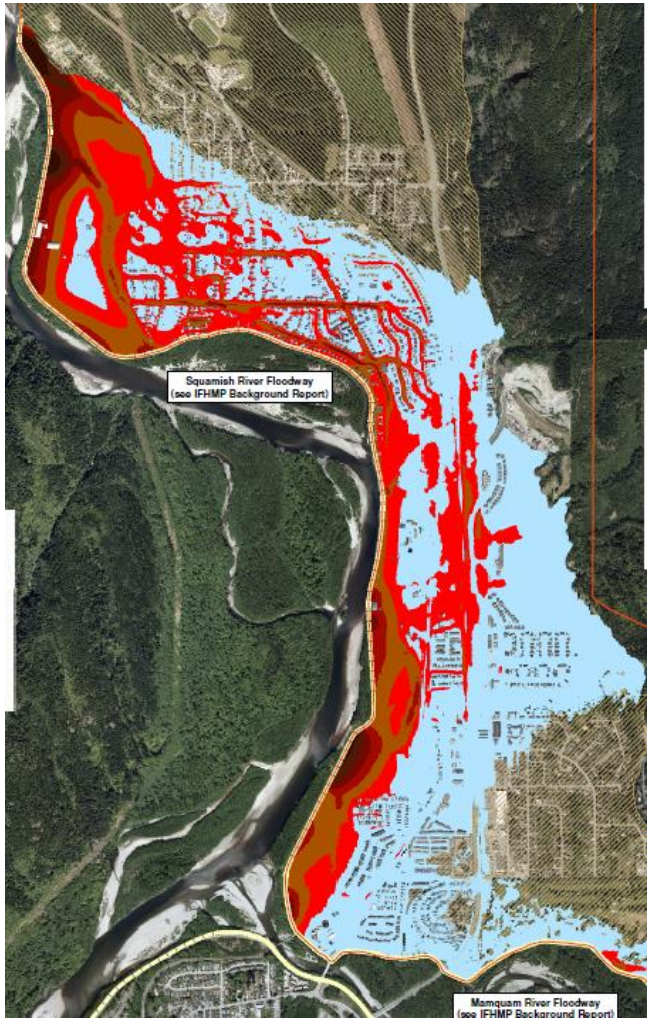


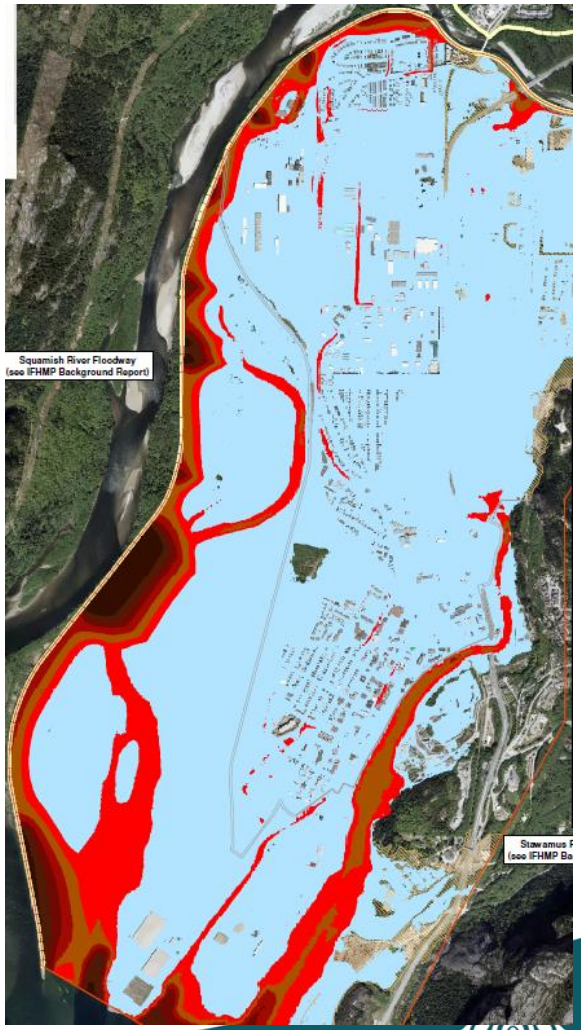


Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

1) Depth
2) Hazard Rating



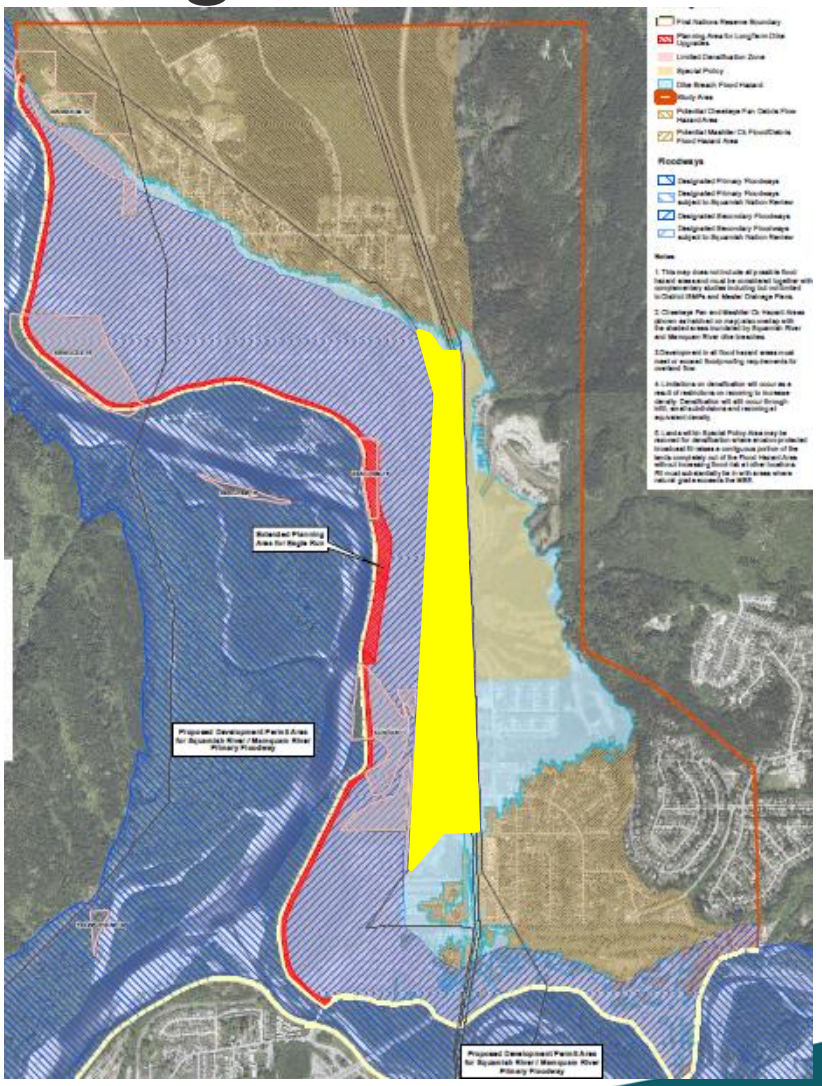


SQUAMISH

Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

1) Depth
2) Hazard Rating
3) Floodways

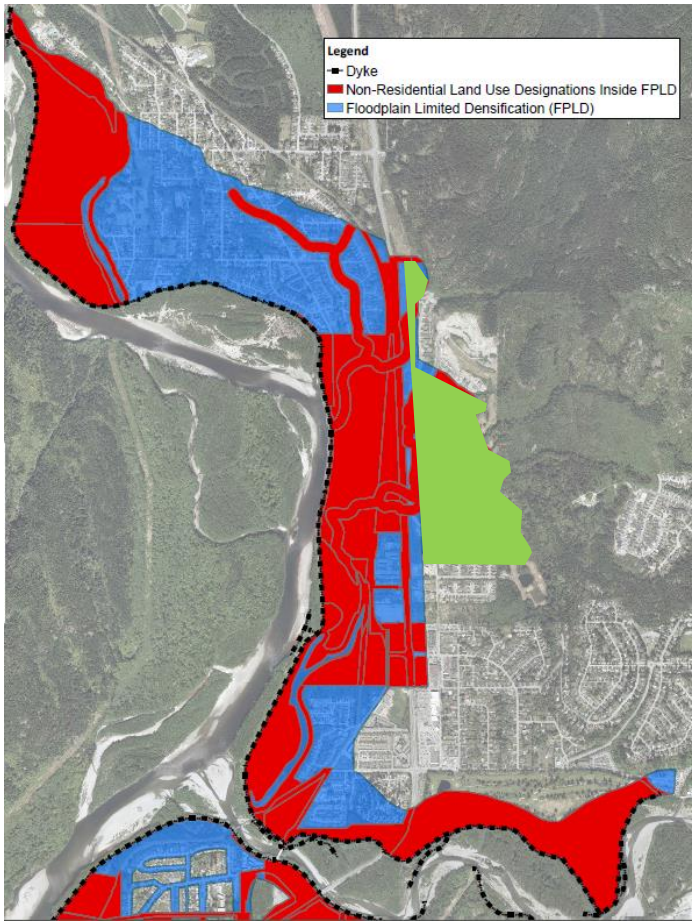


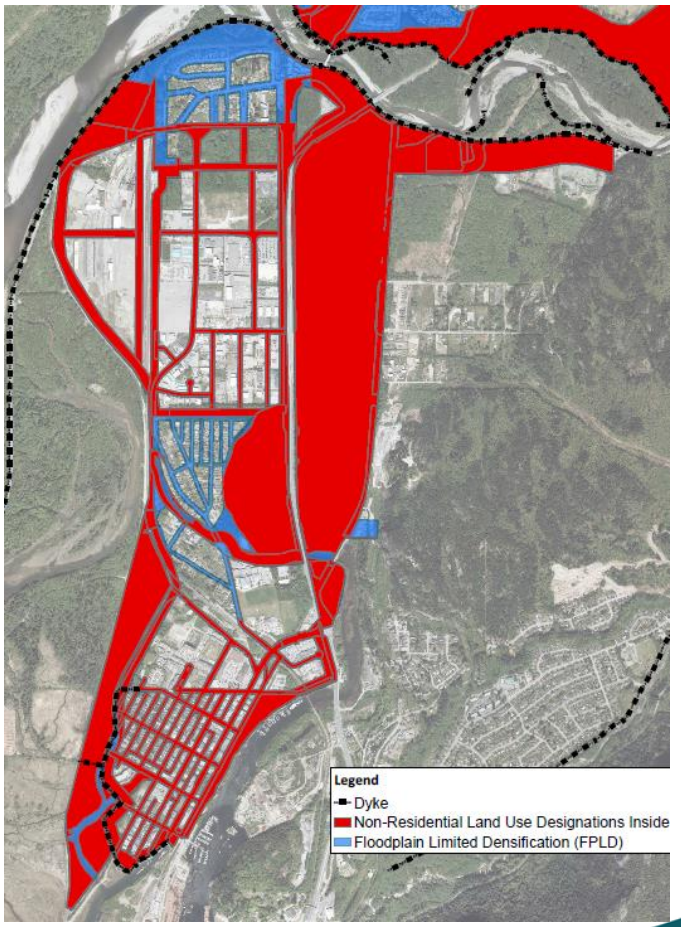
SQUAMISH

Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

1) Depth
2) Hazard Rating
3) Floodways
4) Exempt OCP Residential Neighbourhoods





SQUAMISH

Option 4A – Limit Densification Through Rezoning – Reduced Area

Benefits:

- Provides greater land base for densification
- Economic development opportunity for developers

Drawbacks:

- Higher level of risk
- Departs from Provincial Guidelines
- Technical challenges
  - Constrain flood conveyance
  - Increase/transfer of risk
- Additional modeling would be recommended (budget/time)
- May be considered subjective

SQUAMISH

Option 4B – Conditional Densification Through Rezoning – Reduced Area

Description: Same conditions defined in 3B would need to be met, but applied to a reduced area

Benefits:

- Similar to Options 3B/4A
  - Provides greater land base for densification
  - Economic development opportunity for developers

Drawbacks:

- Similar to Options 3B/4A
  - Higher level of risk
  - Departs from Provincial Guidelines
  - Technical challenges (transfer of risk, constraining floodway)
  - Additional modeling would be recommended (budget/time)
  - Area may be considered subjective

SQUAMISH

Options 4A & 4B

Option 4A: Limit densification – reduced area (different metrics)
Option 4B: Conditional densification – reduced area

Benefits:

- Provides greater land base for densification
- Economic development opportunity for developers

Drawbacks:

- Higher level of risk
- Departs from Provincial Guidelines
- Technical challenges (transfer of risk, constraining floodway)
- Additional modeling would be recommended (budget/time)
- Area may be considered subjective

SQUAMISH

Option 5A – Allow Densification Through Rezoning – All Areas – Unique Concepts

<u>Benefits:</u>

- Avoids constraining floodway

<u>Drawbacks:</u>

- Cost/reliability
- Puts more people/infrastructure
- Constrains post disaster retreat opportunity

SQUAMISH

Option 5A – Allow Densification Through Rezoning – All Areas – Unique Concepts

<u>Benefits:</u>

- Allows some densification through rezoning
- Doesn't place as many people as RS or RMH zoning in hazard area

<u>Drawbacks:</u>

- Requires municipal infrastructure
- Puts more people in hazard area
- Environmental impacts in sensitive areas

SQUAMISH

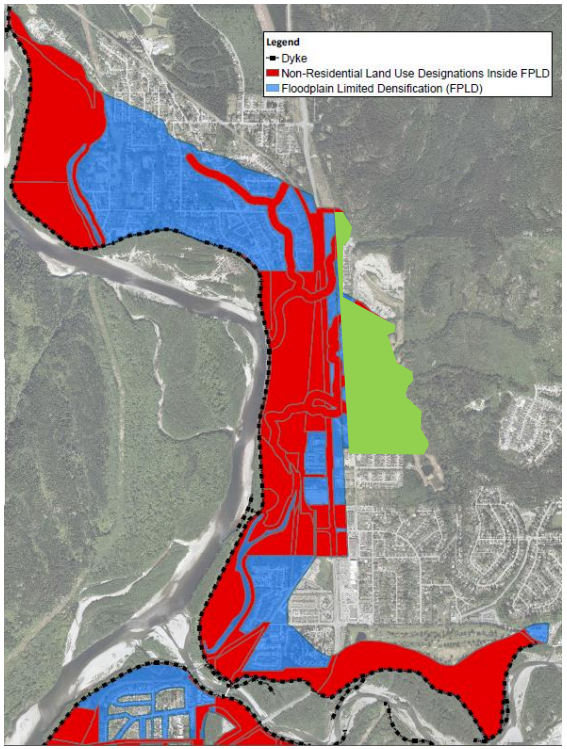
Option 5B – Allow Densification Through Rezoning – Residential Neighbourhoods

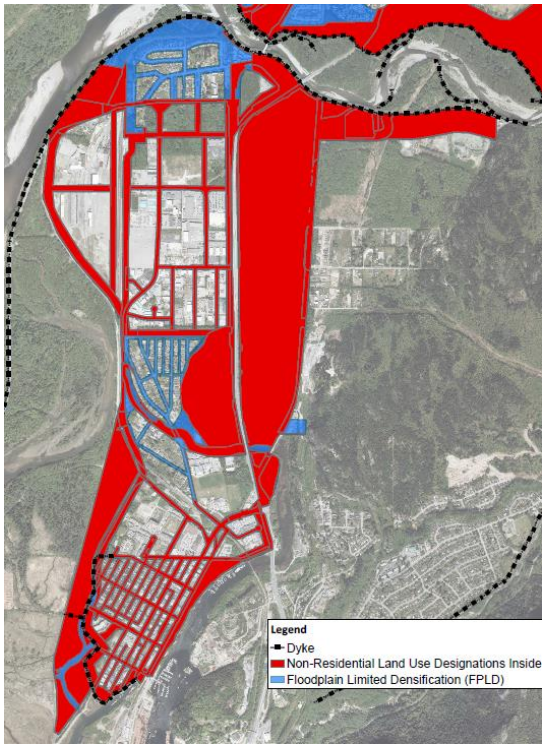
Benefits:

- Allows significant additional lands for densification
- If paired with dike upgrades, can improve level of protection
- Avoids densification Greenways & Recreational Corridors

Drawbacks:

- Puts more people/infrastructure in high hazard areas
- Higher community risk/vulnerability





SQUAMISH

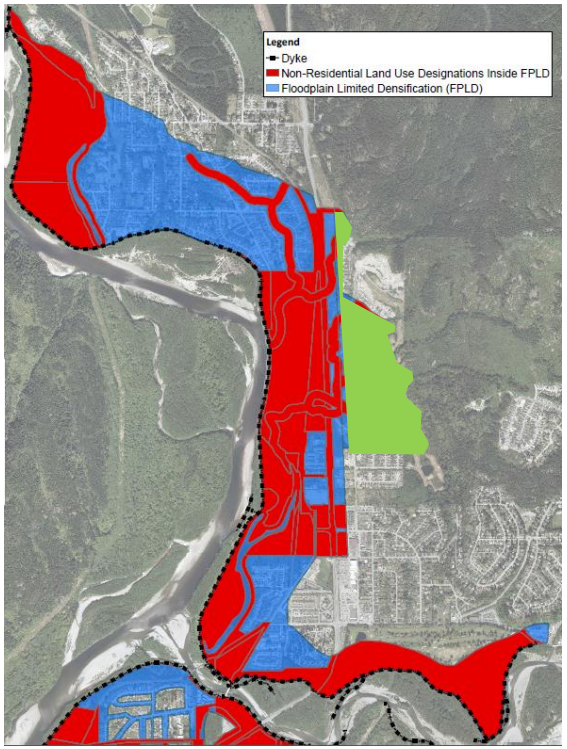
Option 5C – Allow Densification Through Rezoning – All Areas

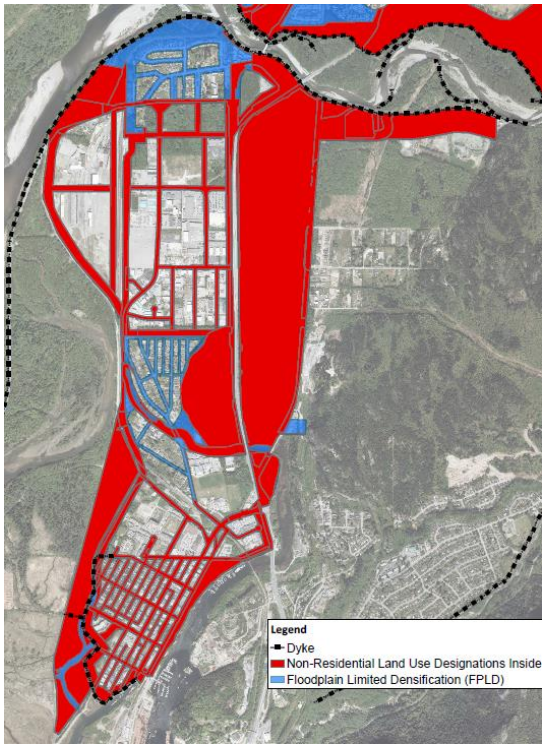
Benefits:

- Same as 5B, but greater lands for densification

Drawbacks:

- Same as 5C but incorporates higher hazard/environmentally sensitive lands
- Environmental impacts in sensitive areas





SQUAMISH

1:200 Year Dike Cost

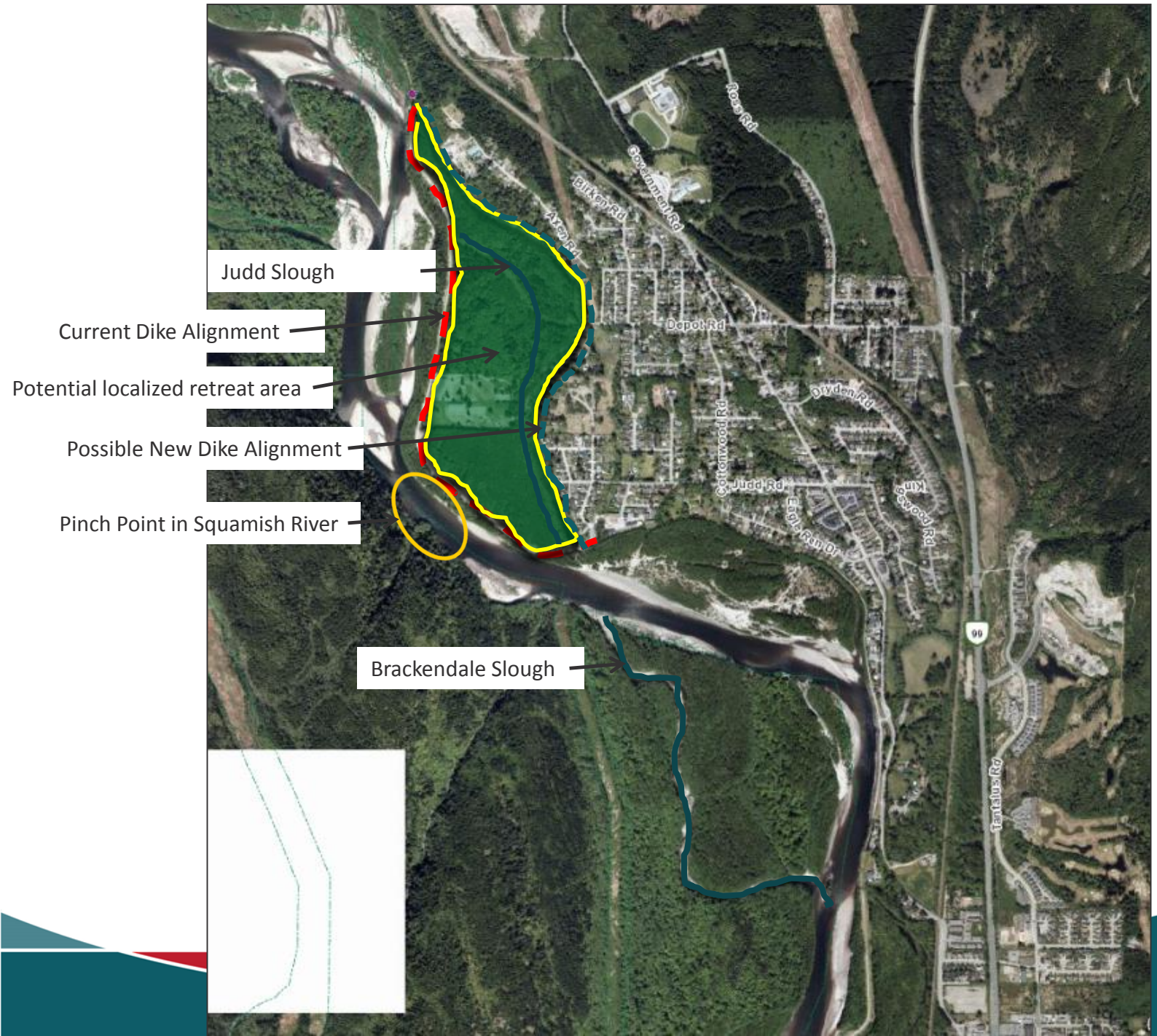
- 1:200 year dike standard Provincially mandated – not a decision point
- Plan to complete in final phase
- Have been completing Comprehensive Dike Inspection
- Need to complete some conceptual/preliminary design work

SQUAMISH

Dike Funding Considerations

- To be reviewed in detail in final phase

- Preliminary Options:
  - Senior Government Grant Funding – Eligible
  - Property taxation – Eligible
  - Local Service Tax – Likely eligible
  - Flood Protection Utility - Possible
  - Community Amenity Contributions – Unlikely
  - Latecomer's Agreement - Ineligible
  - Development Cost Charges – Ineligible


Judd Slough
Current Dike Alignment
Potential localized retreat area
Possible New Dike Alignment
Pinch Point in Squamish River
Brackendale Slough
Depot Rd
Dryden Rd
Cottonwood Rd
Judd Rd
Eagle Run Dr
Tantalus Rd
99

Item 5: Implementation of Conditions

- Proposed Process, QP flood hazard report:
  - Entire development raised with flood-proofing fill
  - Erosion protection for fill
  - Floodway land designated no fill/no develop by covenant
  - Upgrade any dike frontage, provide 1:500 SROW
  - Floodway capacity retained
  - No undue transfer of risk
  - Density limited to single family if:
    - Not bordering safer areas
    - No evacuation route to high ground