

Integrated Flood Hazard Management Plan

River Flood Hazards & Mitigation Concepts

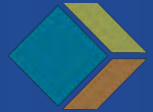
Council Update #8

March 22, 2016



KERR WOOD LEIDAL
consulting engineers

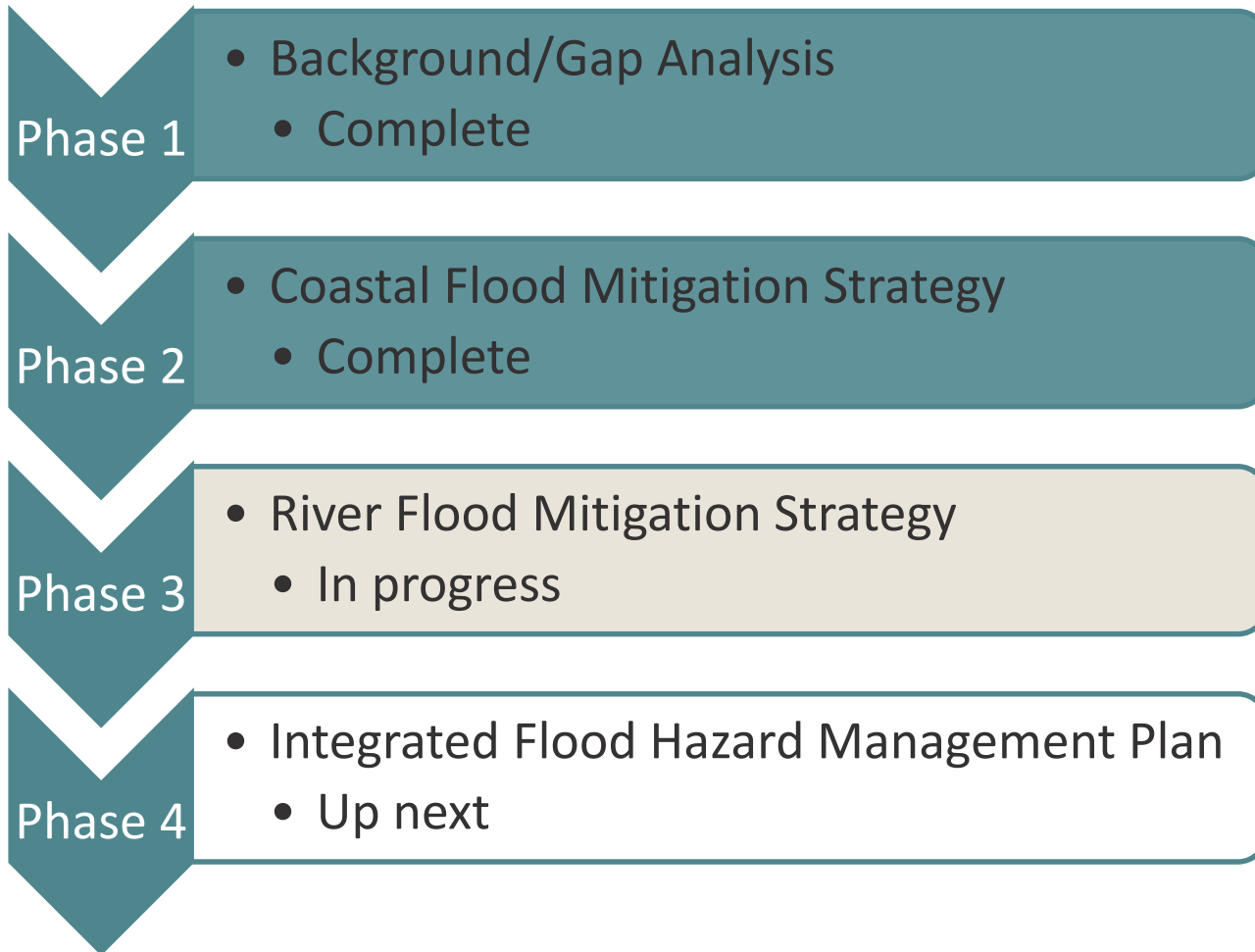
Arlington
Group
Planning + Architecture Inc.



Agenda

- Project overview
- Land Use Mitigation Options
- Council Feedback on Options
- Deferral Period

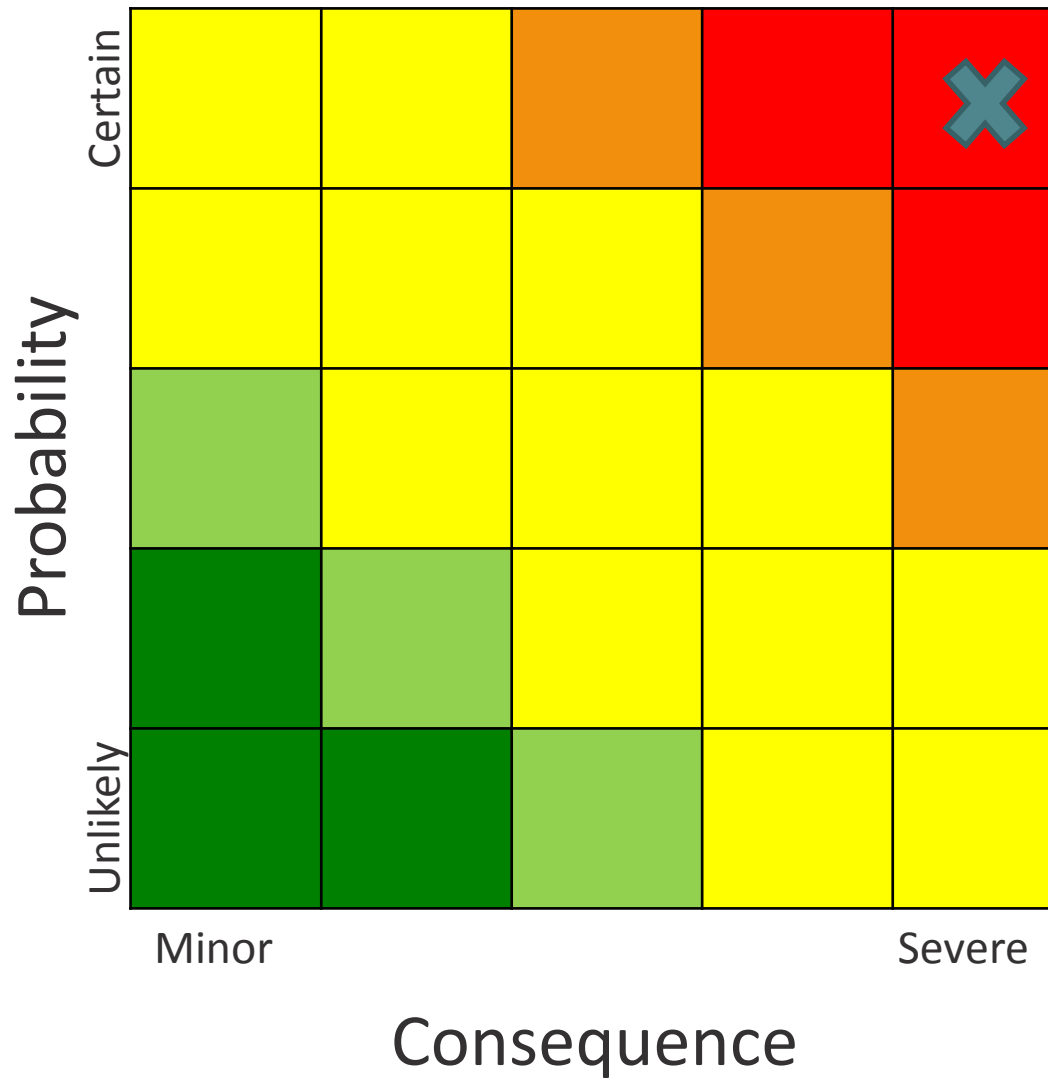
Integrated Flood Hazard Management Plan



Guiding Principles

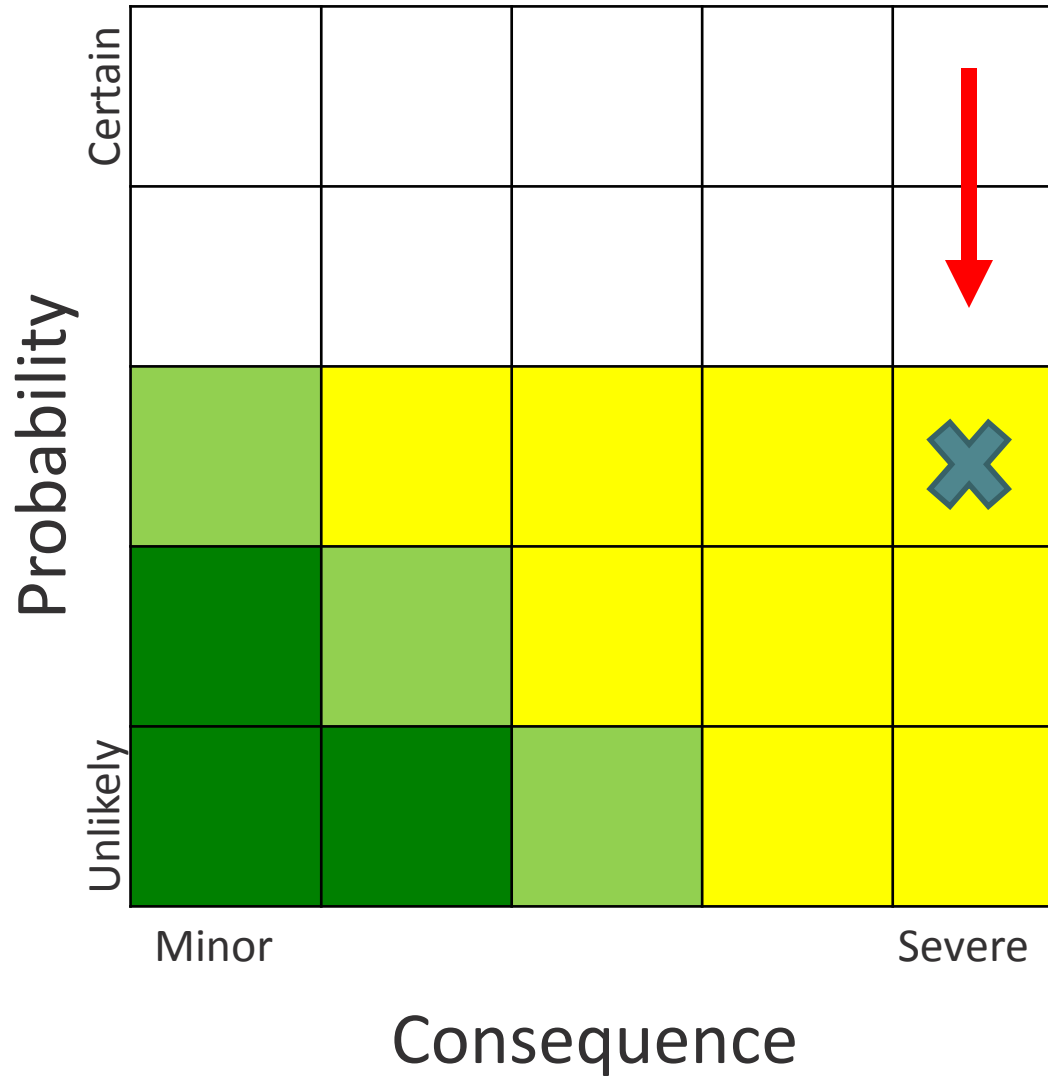


Risk & Mitigation Strategies



Community in
floodplain with no
protection

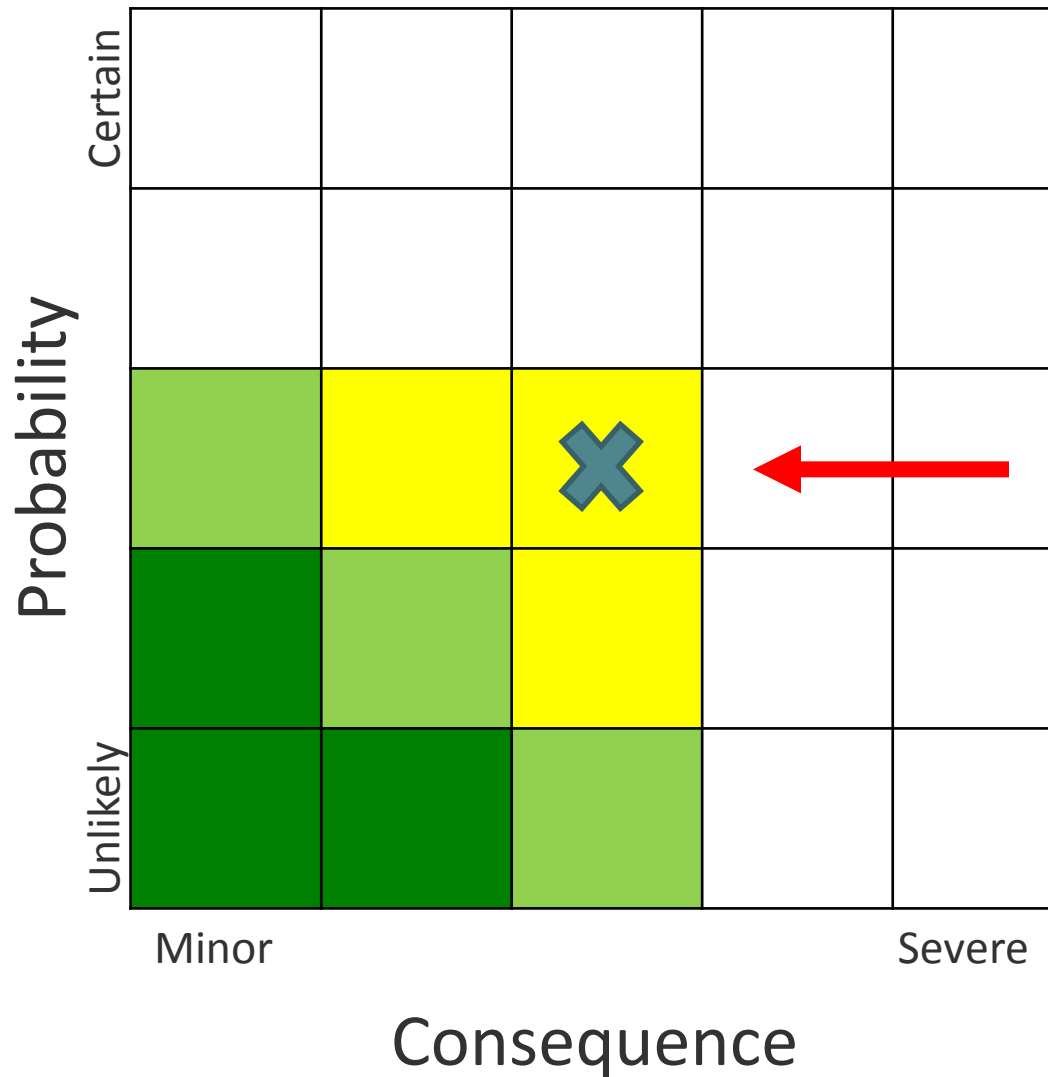
Risk & Mitigation Strategies



Protect

- Dikes

Risk & Mitigation Strategies



Protect

- Dikes

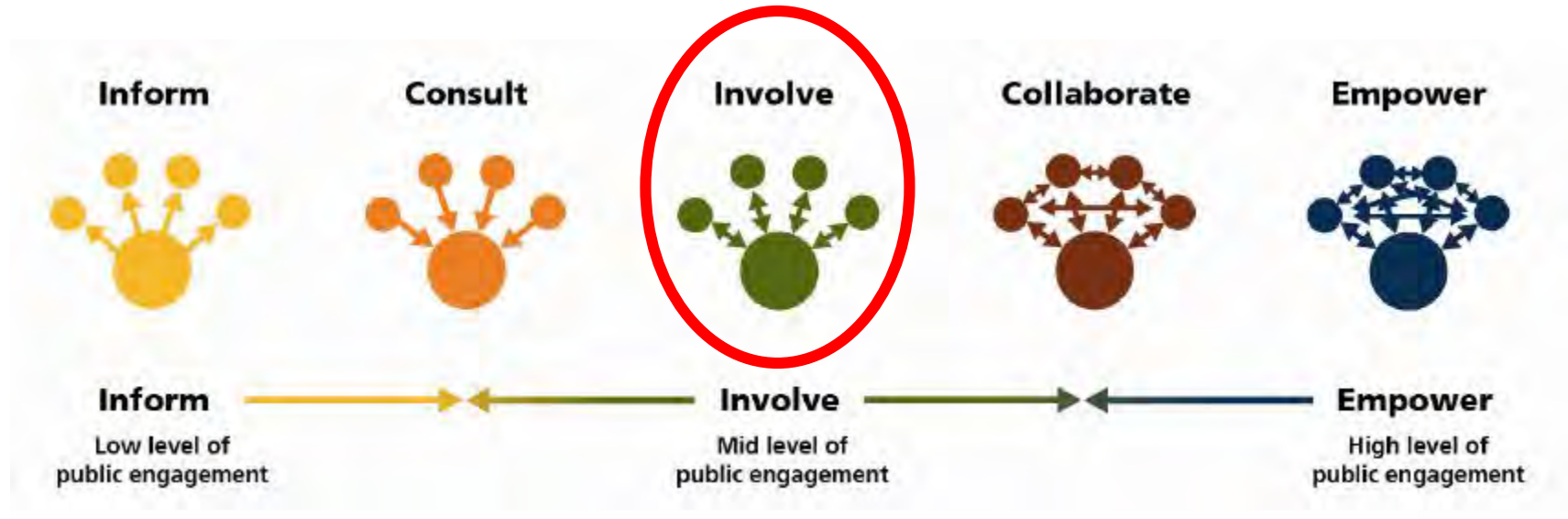
Accommodate

- FCL

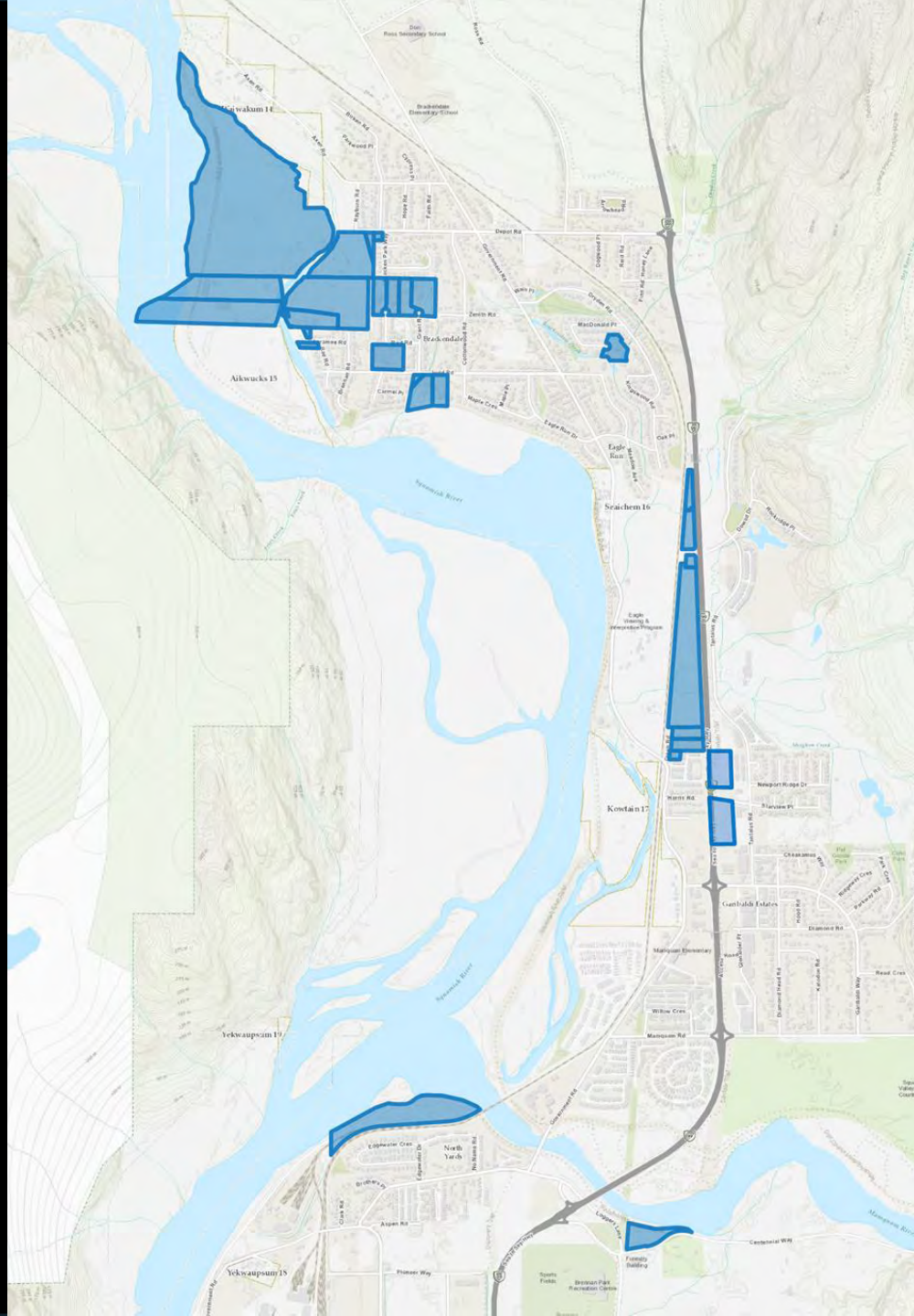
Avoid

- Growth outside floodplain

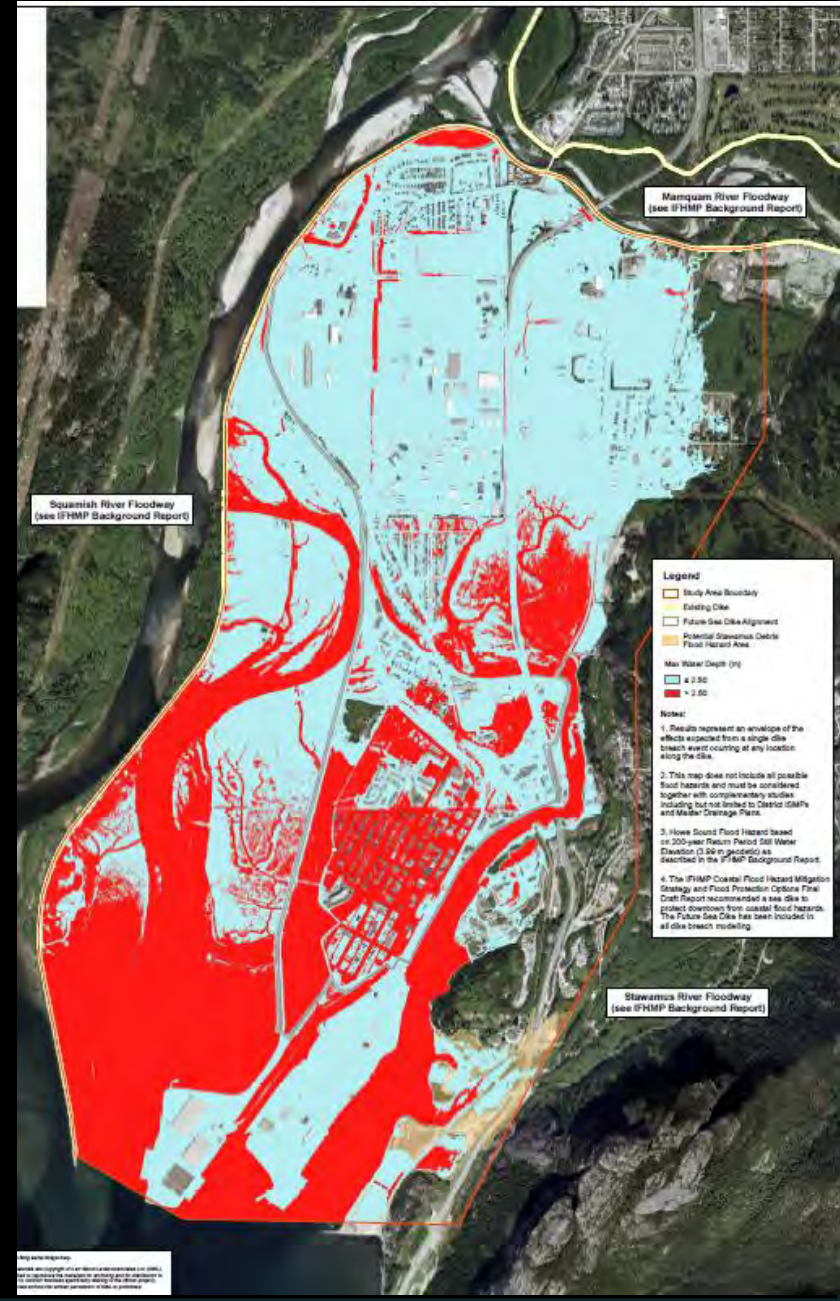
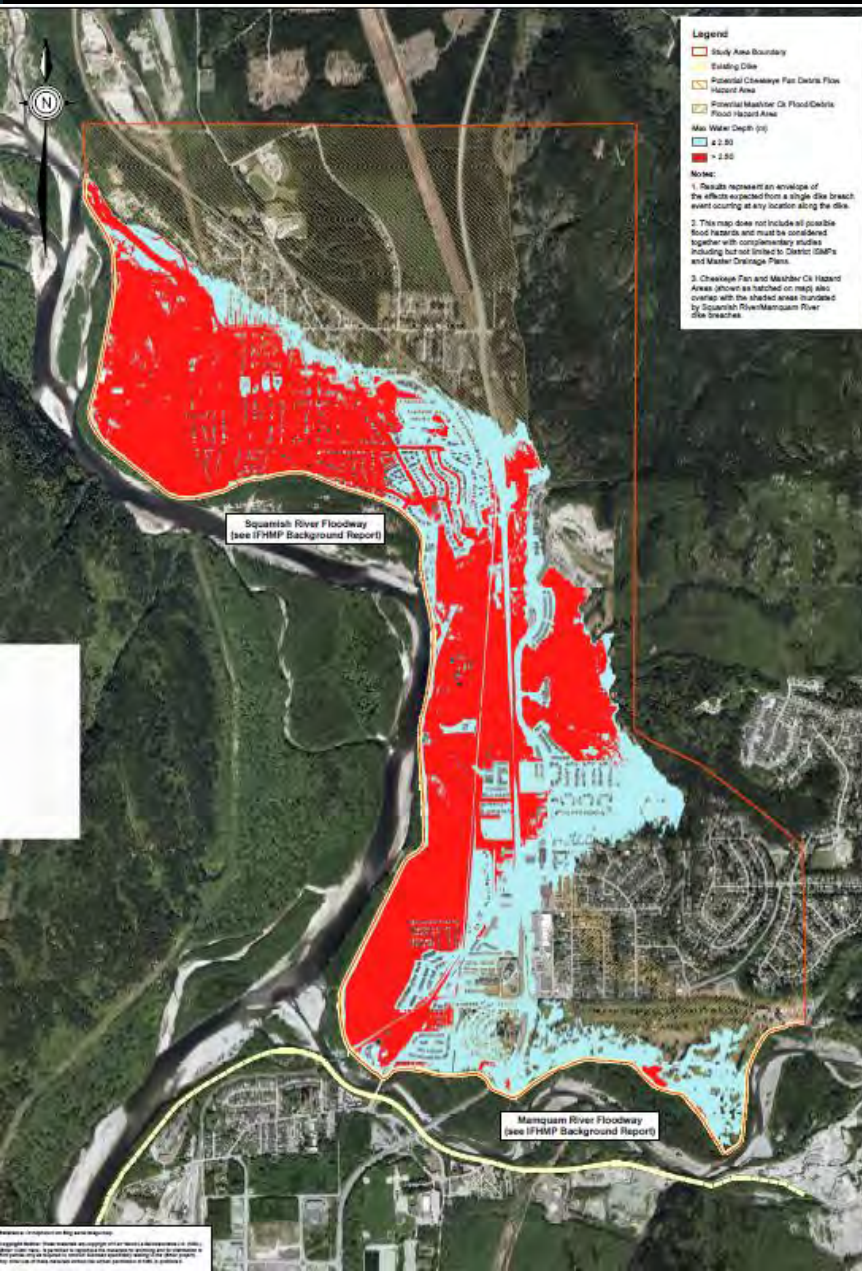
Public Engagement



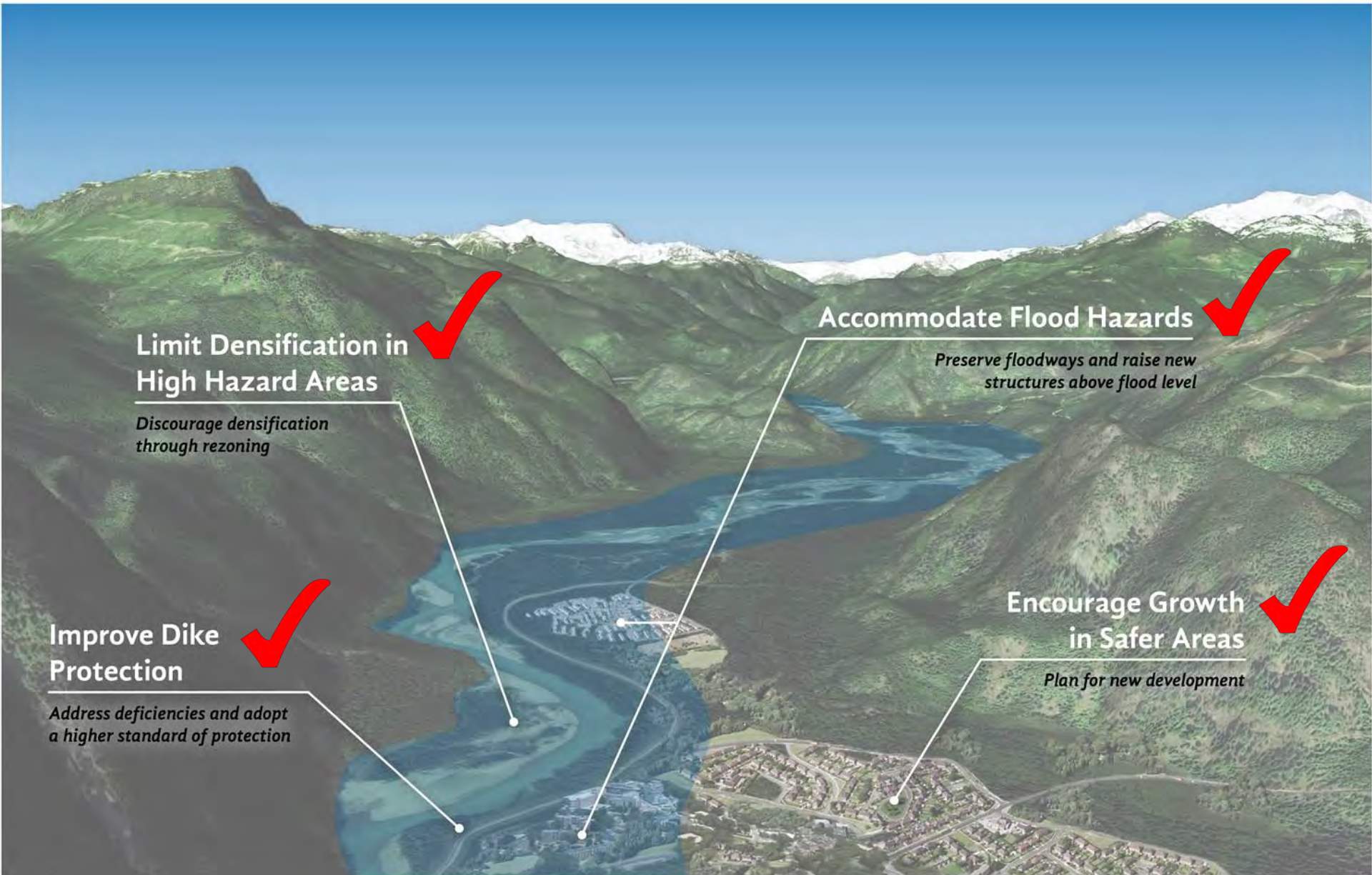
Month	Activities
Ongoing	Personal communication with stakeholders
Feb 24	Public Open House, Social Media, Survey
March 2	Squamish Nation Chiefs and Council Presentation
March 14	Highly Affected Development Stakeholders



Floodplain Depth



Squamish / Mamquam Mitigation



Limit Density in High Hazard Areas

Discourage densification through rezoning

Accommodate Flood Hazards

Preserve floodways and raise new structures above flood level

Encourage Growth in Safer Areas

Plan for new development

Improve Dike Protection


Address deficiencies and adopt a higher standard of protection


Land Use Mitigation Options

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

Land Use Mitigation Options

Retreat	Option
	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

 Lower Risk
Less dev.
potential

 Higher Risk
More dev.
potential

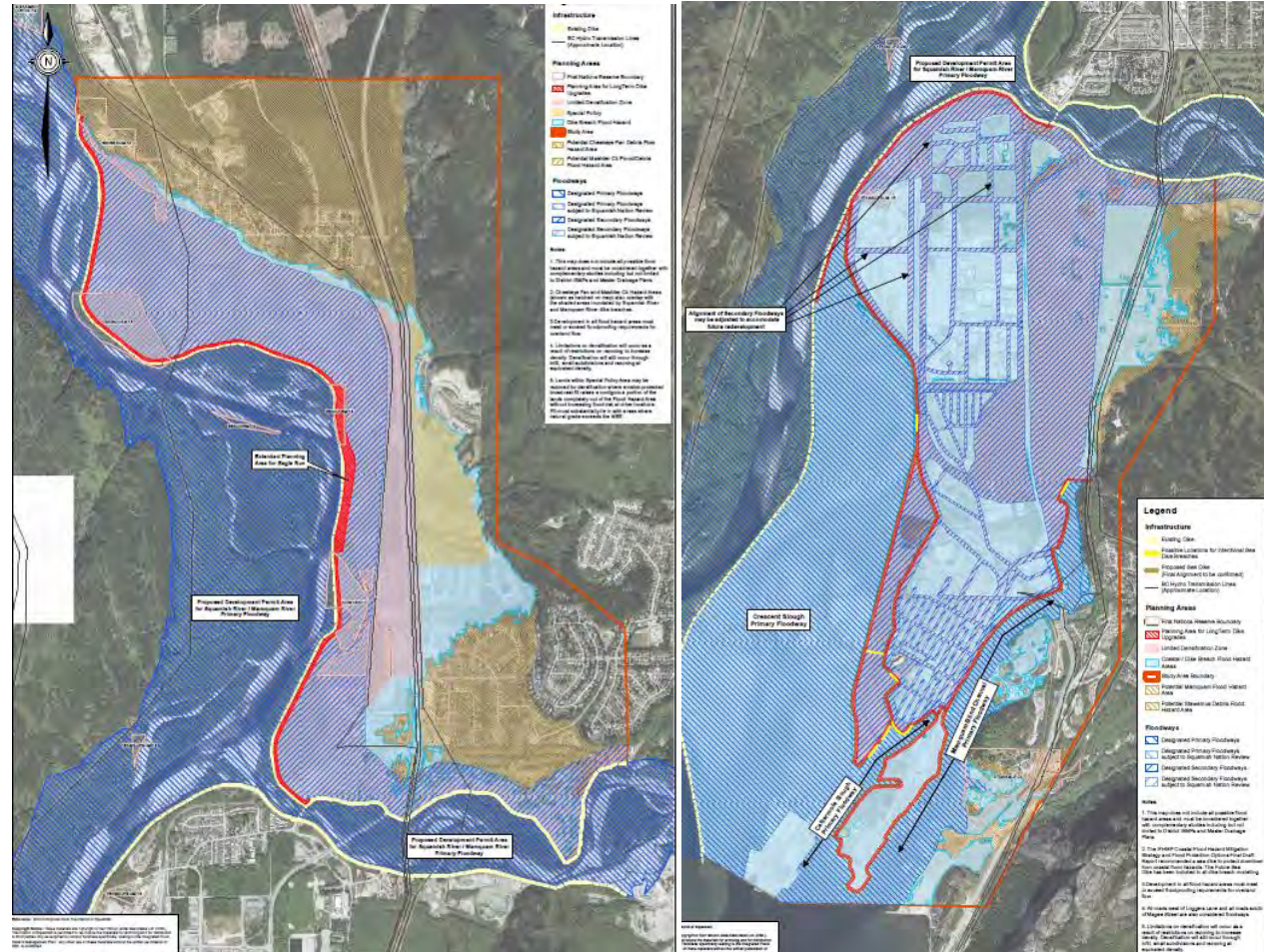
Option 3A – Limit Densification Through Rezoning

Benefits:

- Maintains existing development rights
- Improves public safety
- Reduces community risk
- Preserves environmentally sensitive areas
- Encourages growth in low/no hazard areas
- Limits transfer of risk

Drawbacks:

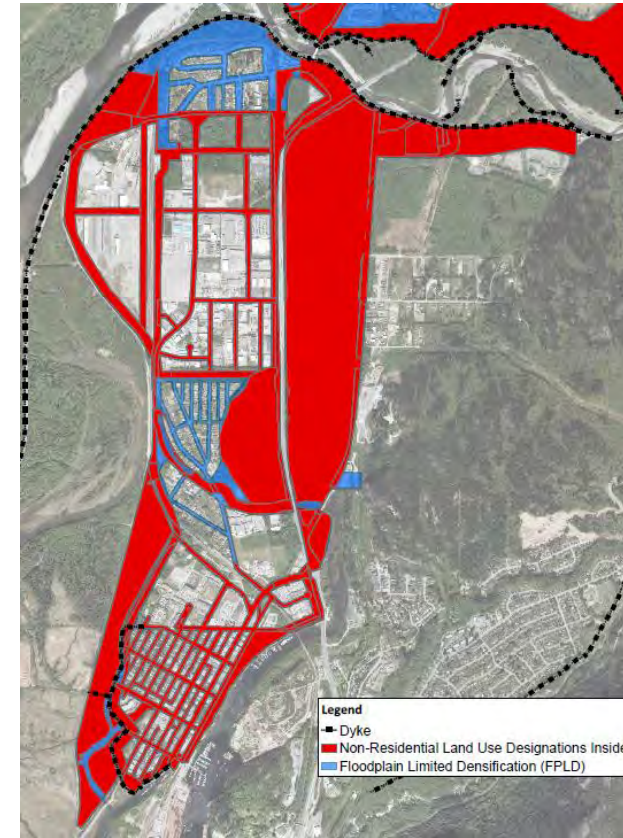
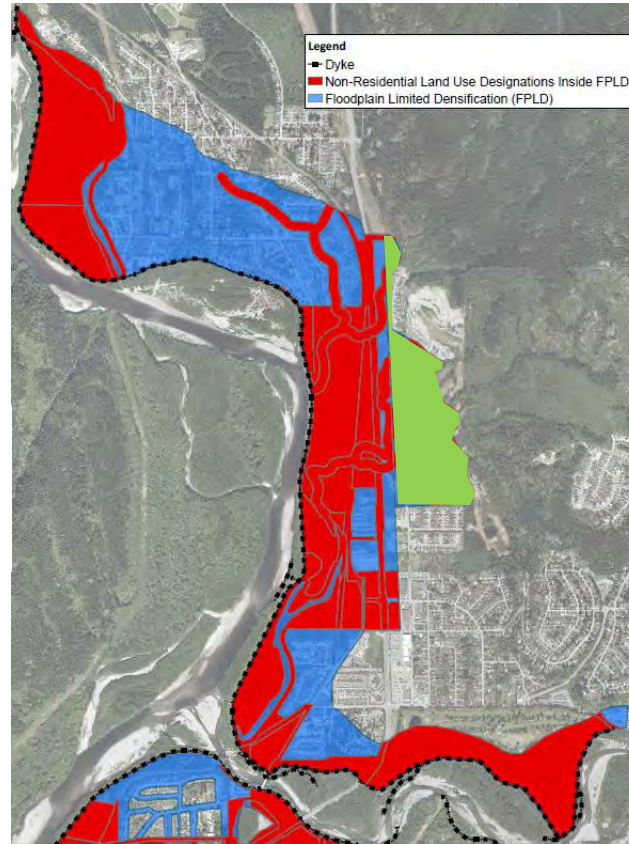
- Reduces land base for high-density development
- Loss of economic benefit to landowners
- Still increases risk/consequences



Option 3B – Conditional Densification – OCP Residential Neighbourhoods

Concerns for Densified Development

1. Risk to future residents
2. Increasing flood levels
3. Environmental impacts
4. Transfer of risk
5. Dike inadequacy

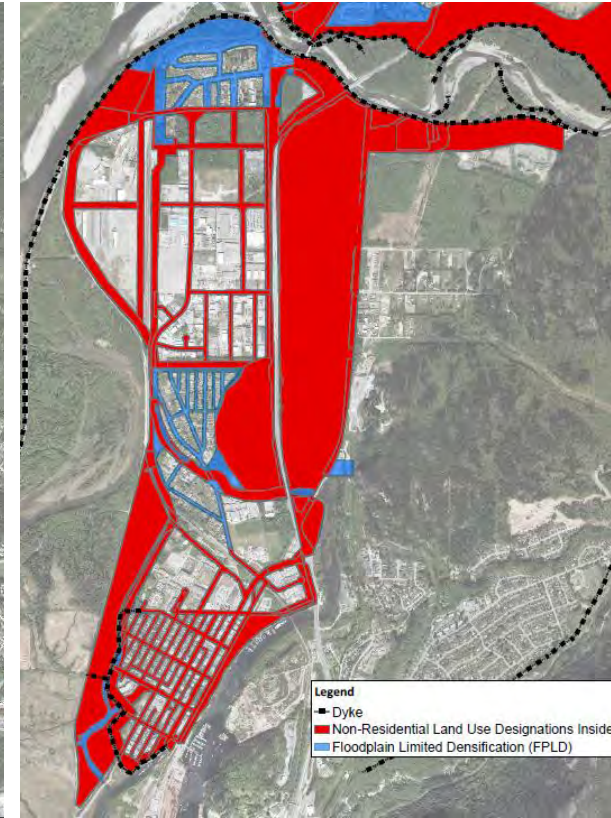
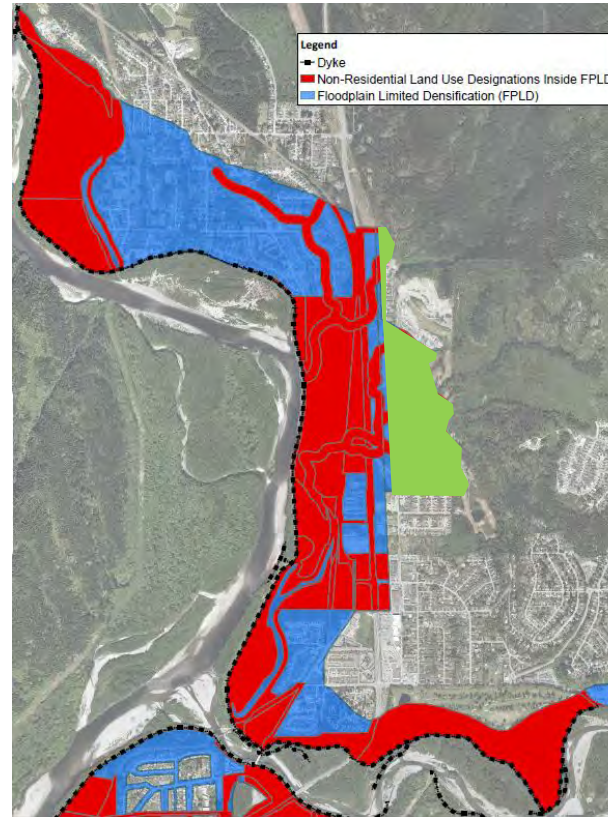


Option 3B – Conditional Densification

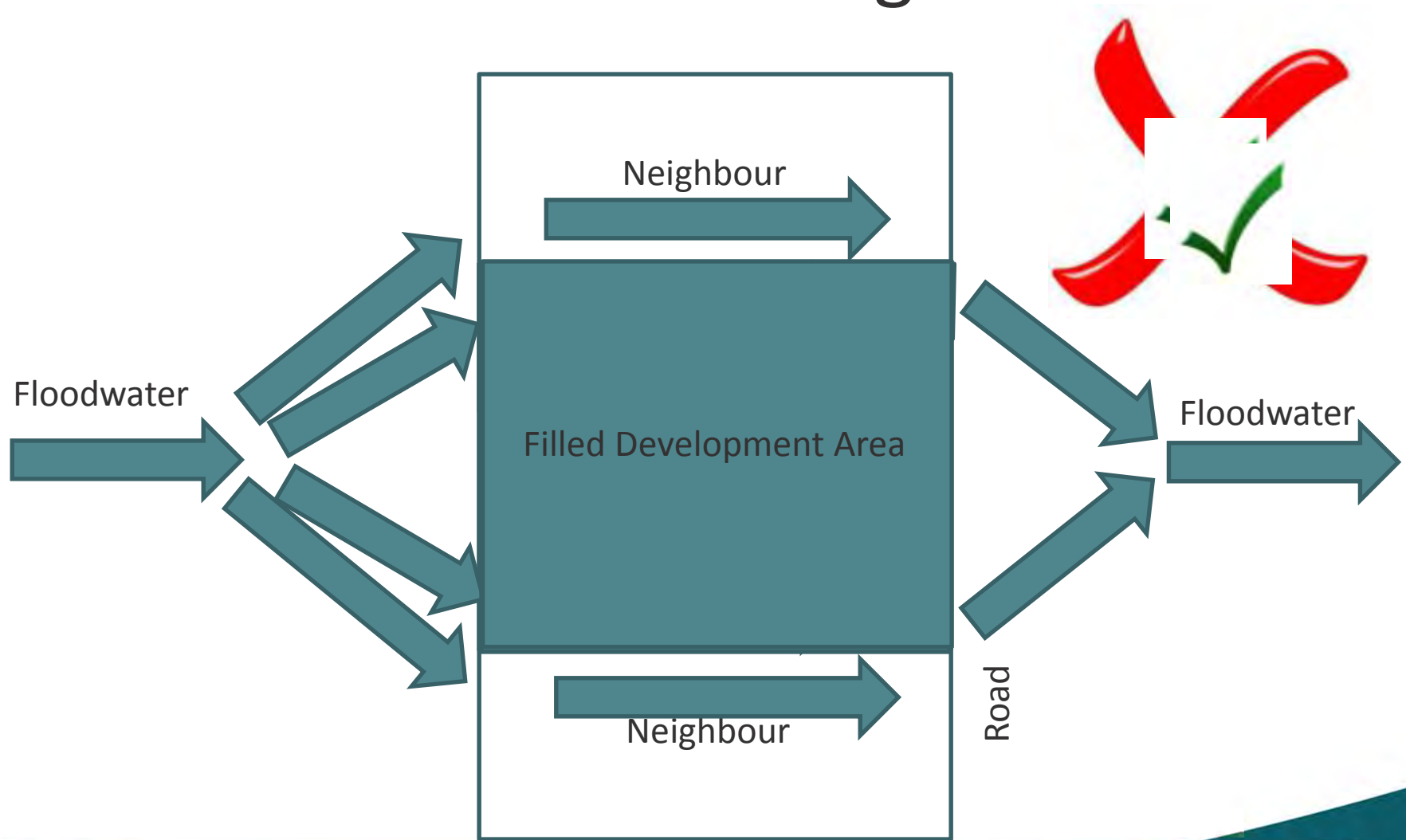
– OCP Residential Neighbourhoods

Conditions

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



Option 3B – Conditional Densification – OCP Residential Neighbourhoods



Option 3B – Conditional Densification – OCP Residential Neighbourhoods

Benefits:

- Provides opportunity to densification
- Economic development opportunity for developers/land owners
- Reduces many negative repercussions of densification

Drawbacks:

- Significant costs for flood-proofing
- Cumulative impacts
- Doesn't encourage growth in low/no hazard areas
- Complex review
- Doesn't address evacuation concerns
- More people/infrastructure in vulnerable area

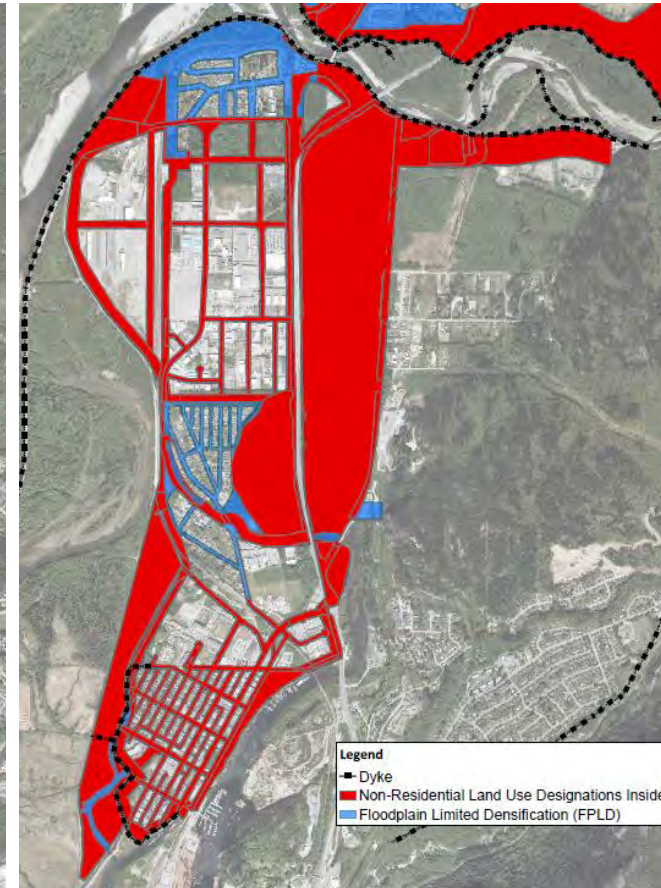
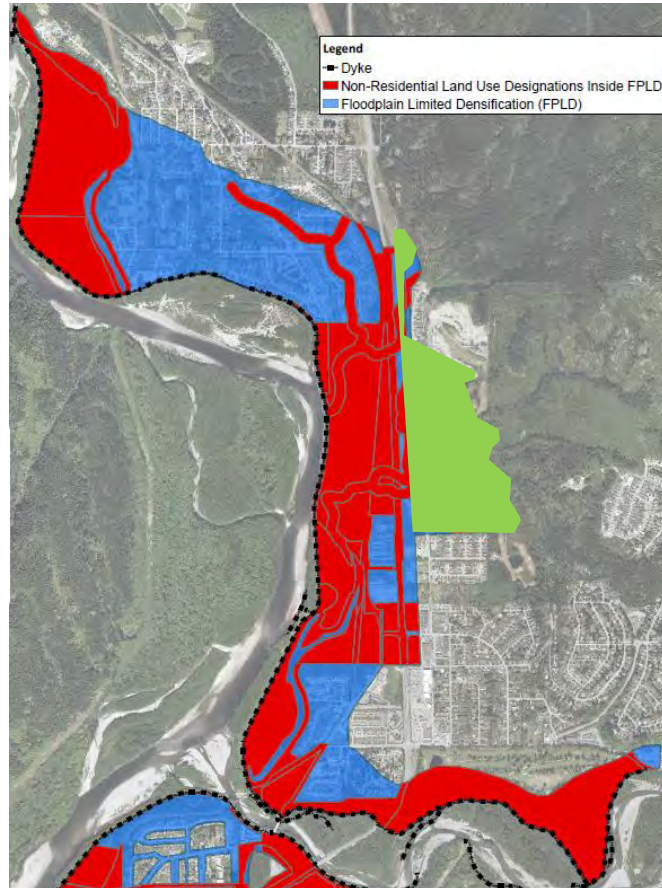
Option 3C – Conditional Densification – All Areas

Benefits:

- Same as 3B but provides greater land base

Drawbacks:

- Same as 3B with the following additions
- Higher risk
- Greater environmental impacts
- Requires extension of municipal services (not Smart growth)



Options 4/5

Description: Trims back area/approach for limiting densification through rezoning

Benefits:

- Provides opportunity to densification
- Economic development opportunity for developers/land owners

Drawbacks:

- Increase community risk
- Evacuation concerns
- Transfer of risk
- Doesn't encourage growth in low/no hazard areas

Options allowing densification in Greenways & Recreation Corridors

- Higher risk
- Greater environmental impacts
- Constrains post-disaster retreat potential
- Not Smart Growth

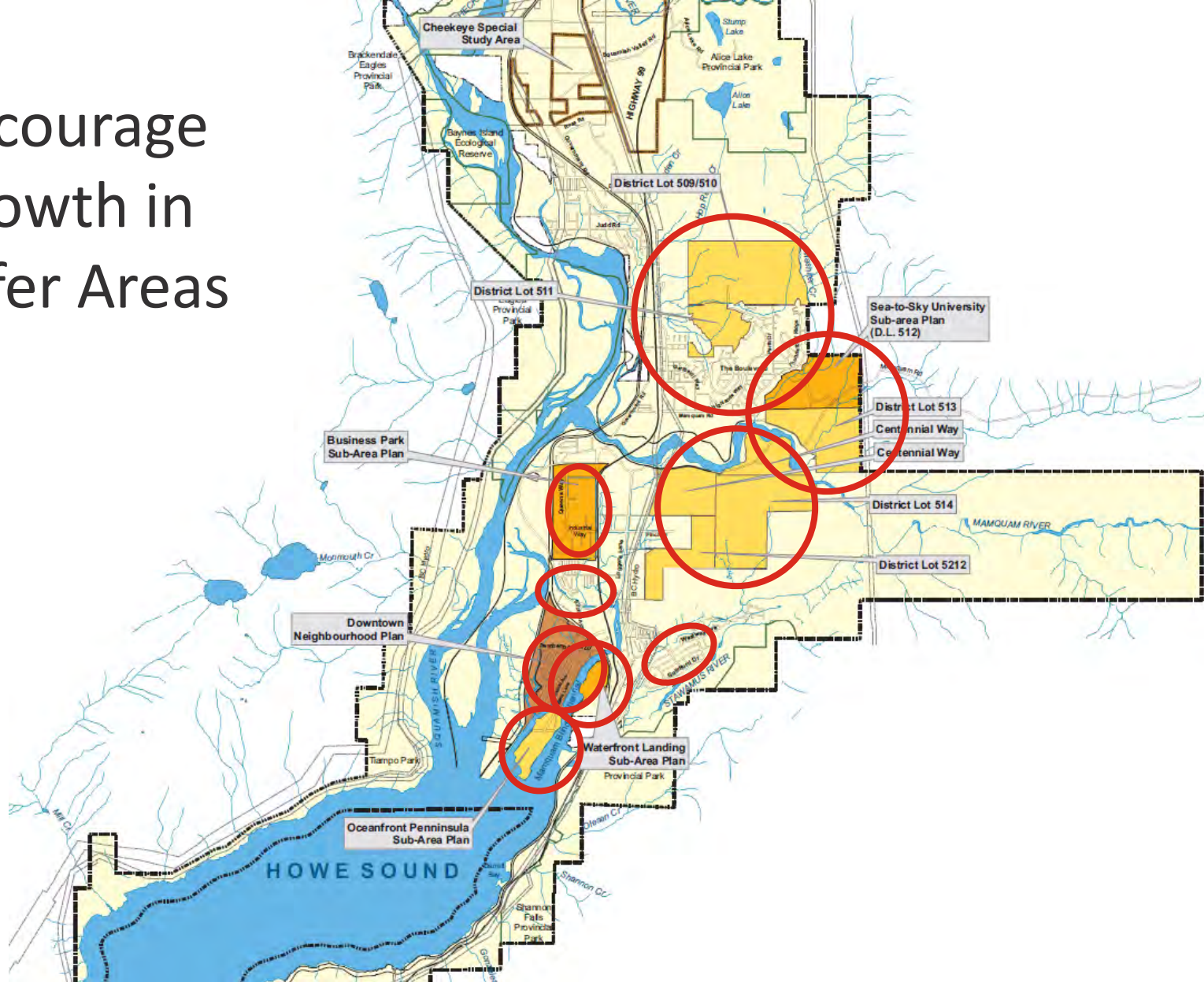
Recommendations

Greater Development
Greater Risk



	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
Attack	5B – Allow Densification Through Rezoning – OCP Residential Neighbourhoods
	5C - Allow Densification Through Rezoning – All Areas
	6 – Attack Strategies

Encourage Growth in Safer Areas

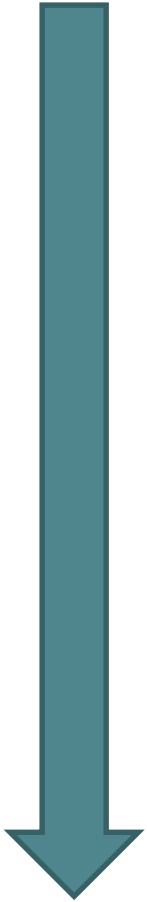


IFHMP Next Steps

Now

- Direction from Council on options
- Finalize plan
- Council endorsement
- Phase 4 Implementation
 - Further public engagement
 - Floodplain bylaw and OCP policy
 - Timing and funding of dike upgrades

Aug
2016

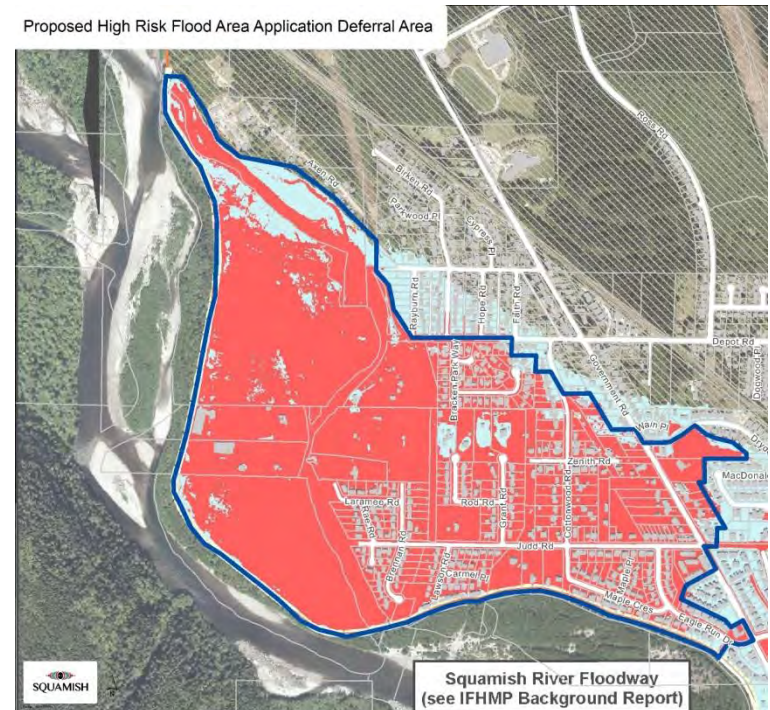


Questions/Discussion

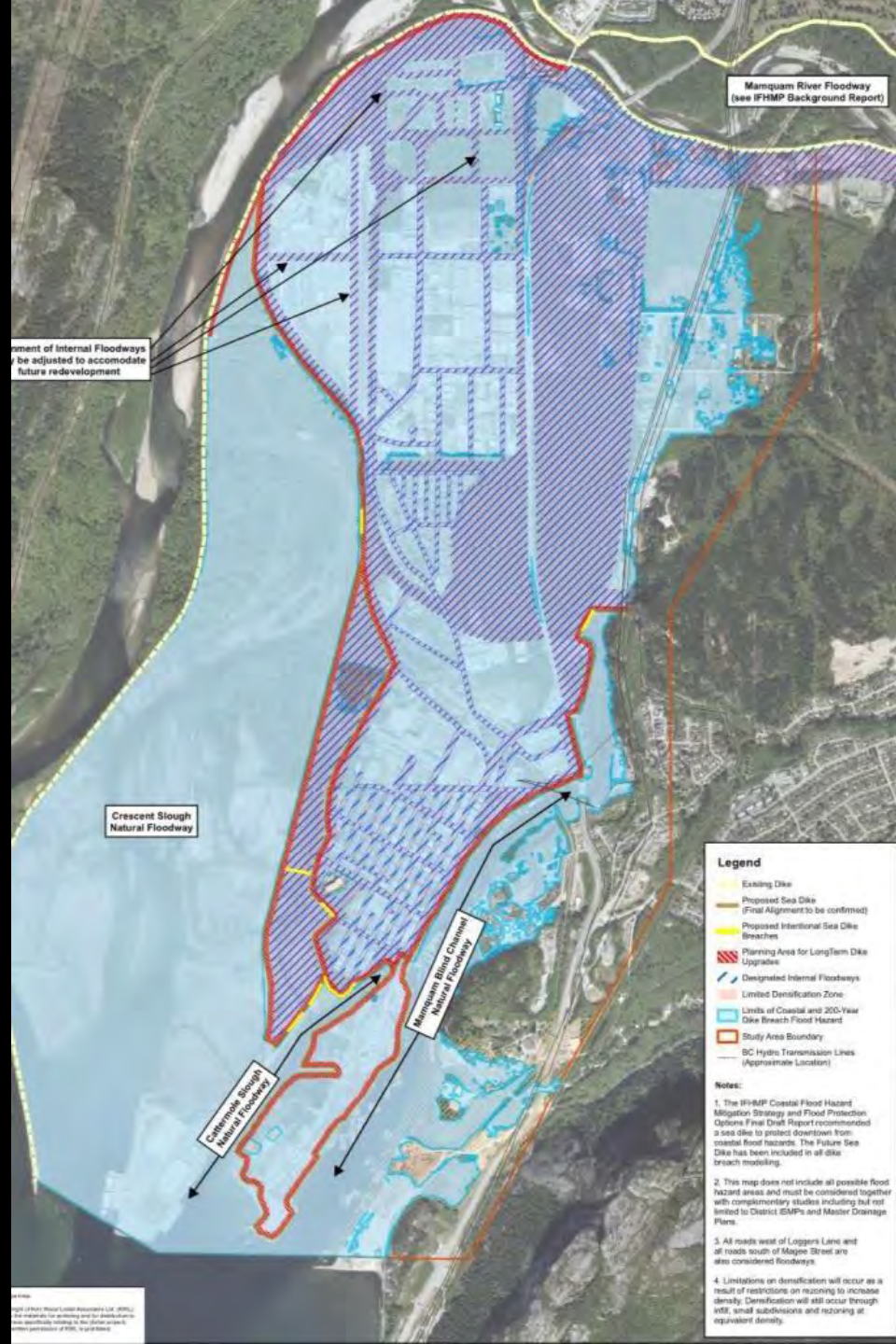
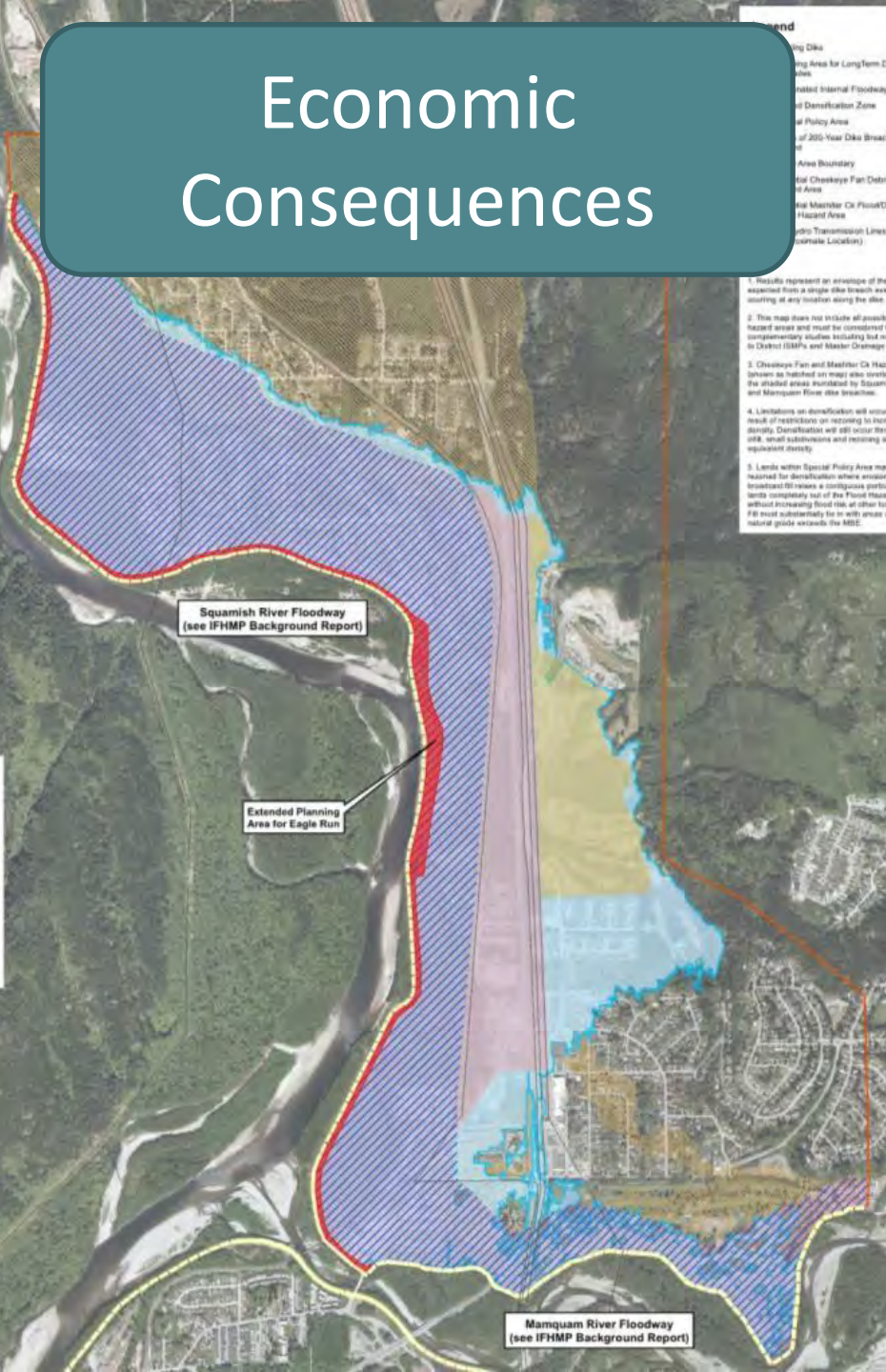


Deferral

- **THAT** staff continue deferral of new and instream Zoning and OCP amendments within high risk flood areas in Brackendale (as defined by the map presented at the October 20, 2015 Regular Council meeting) until the next Committee of the Whole meeting at which the IFHMP is discussed.



Economic Consequences



Brackendale

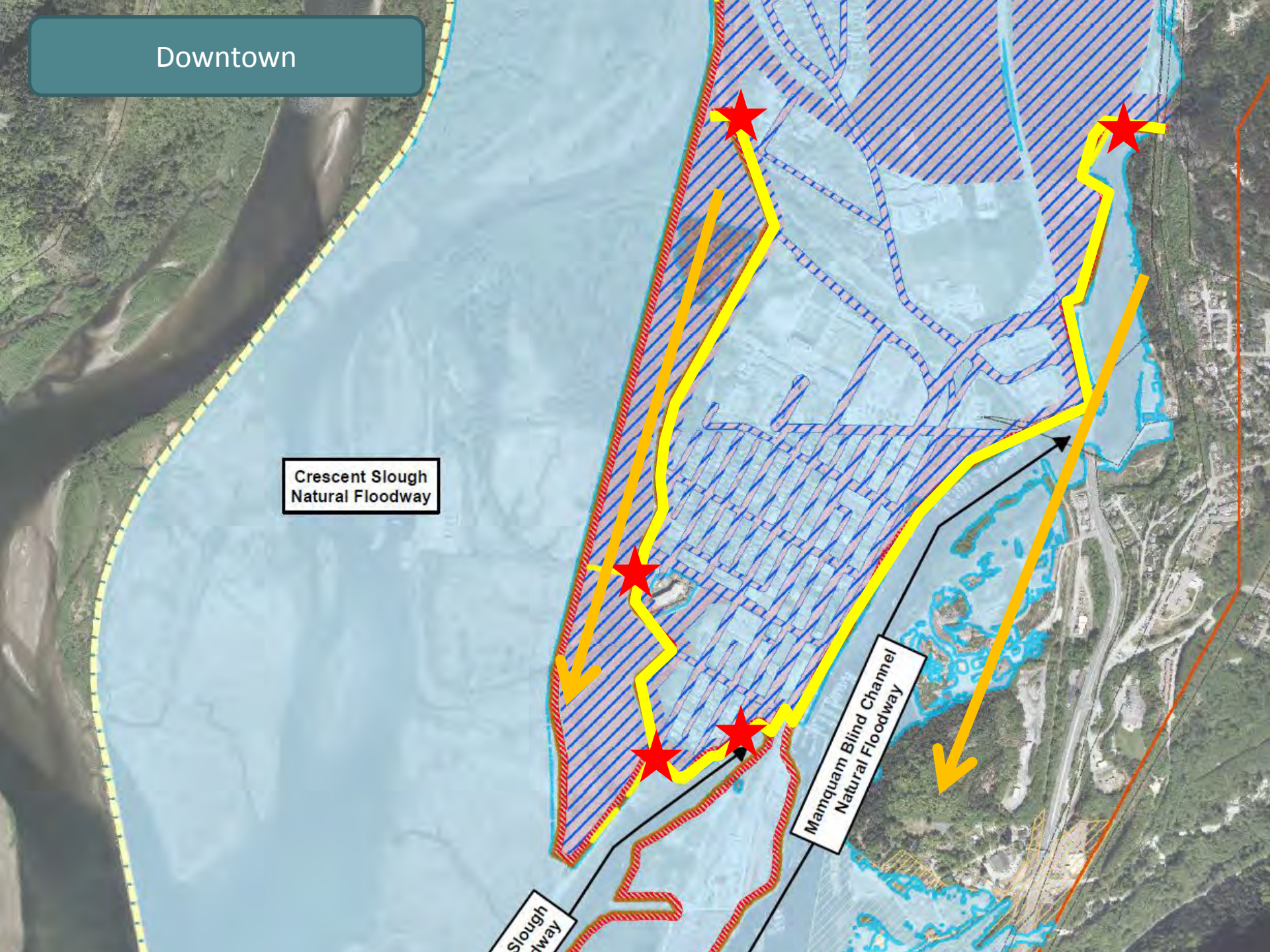


Downtown

Crescent Slough
Natural Floodway

Mamquam Blind Channel
Natural Floodway

Slough
Floodway





KERR WOOD LEIDAL
consulting engineers

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

Figure 2-12

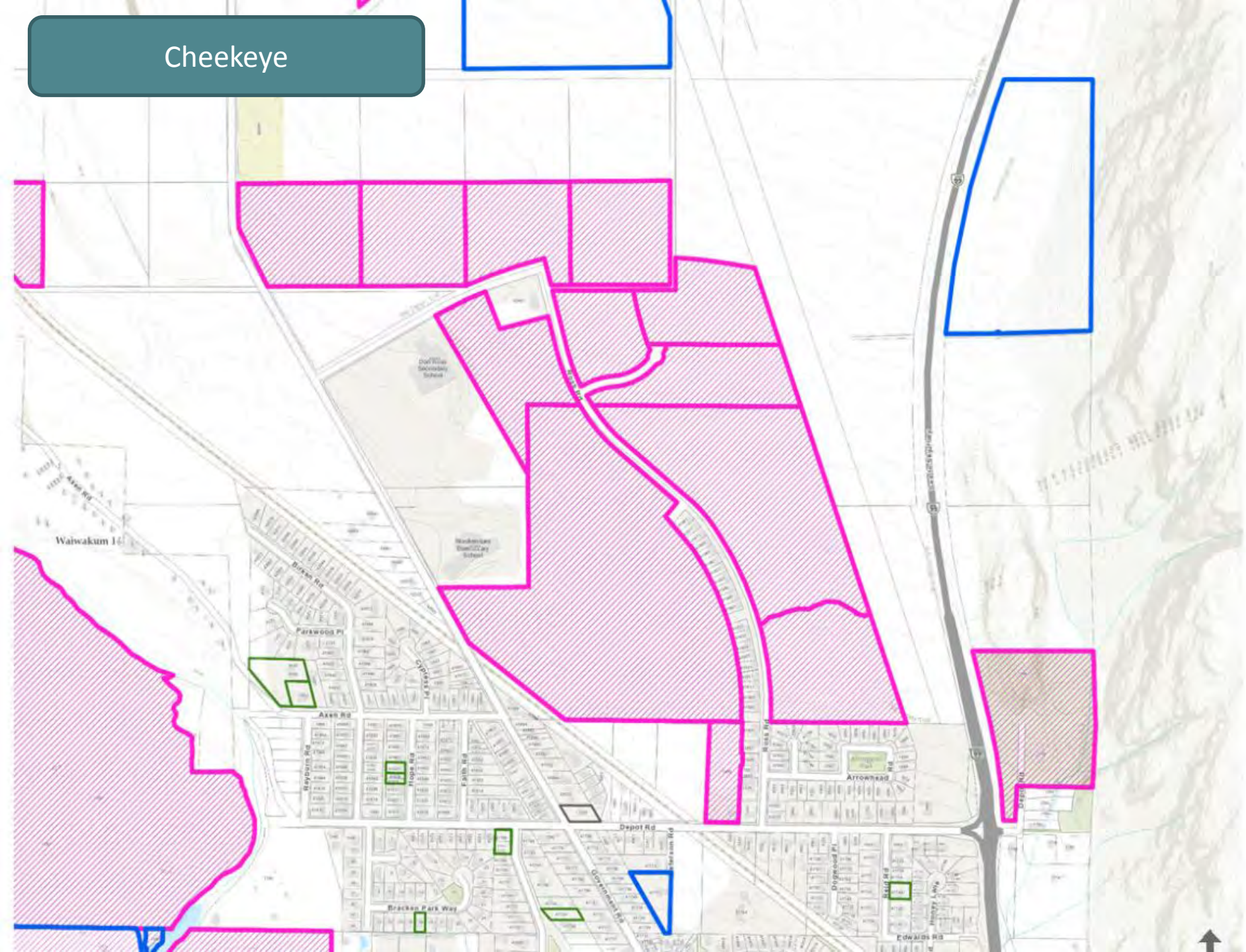


400 0 400 (m)
1:8,000

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

Figure 2-13

Cheekeye



New Dike Alignment

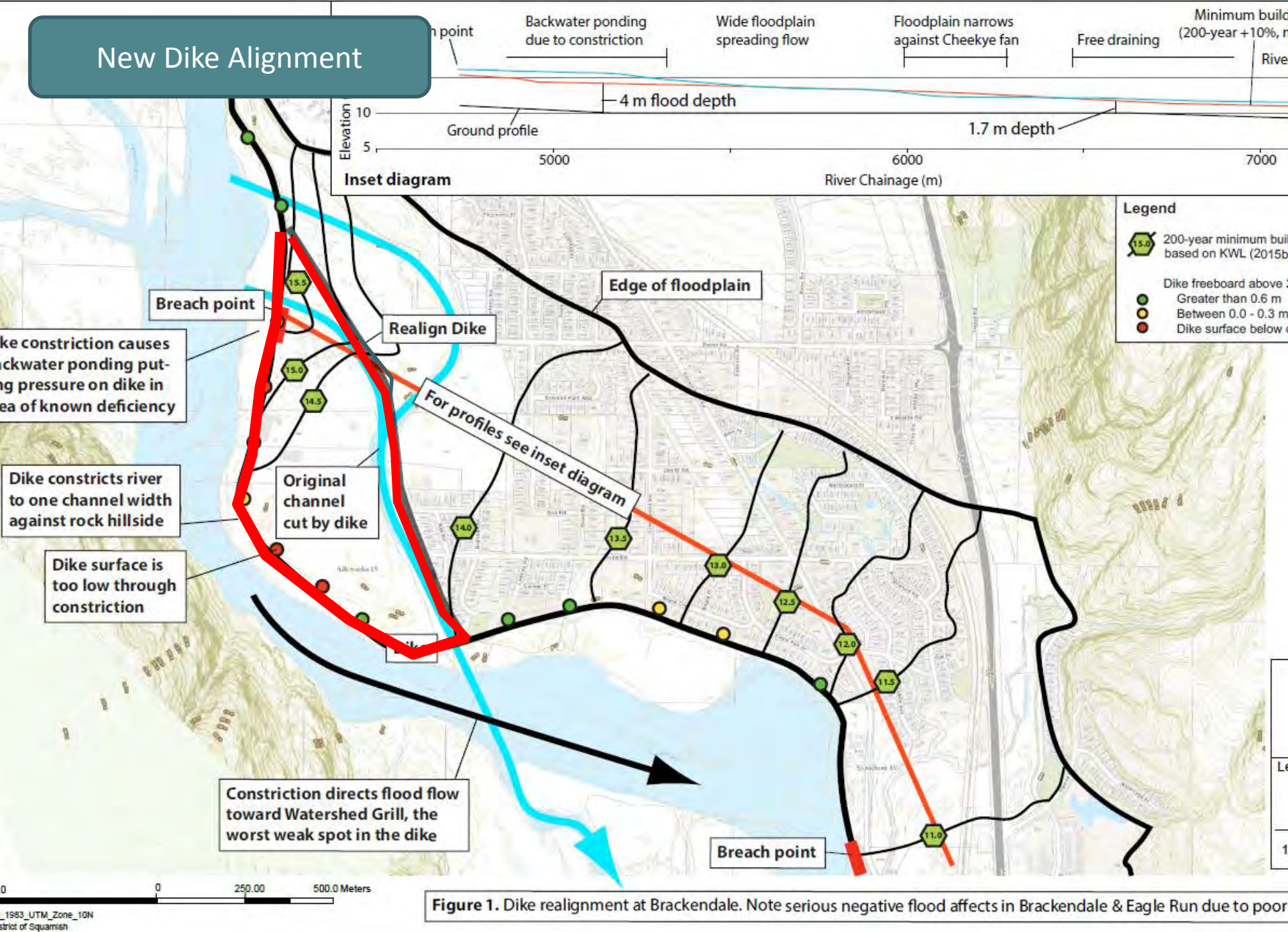


Figure 1. Dike realignment at Brackendale. Note serious negative flood affects in Brackendale & Eagle Run due to poor

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%

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

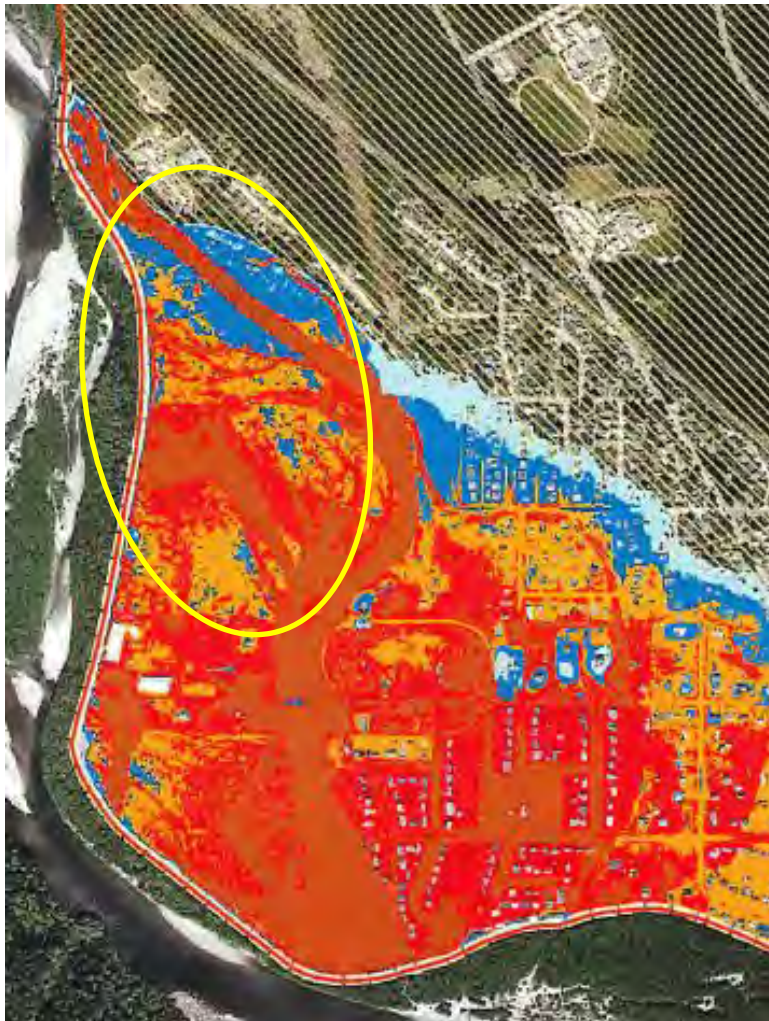
Funding Proposal

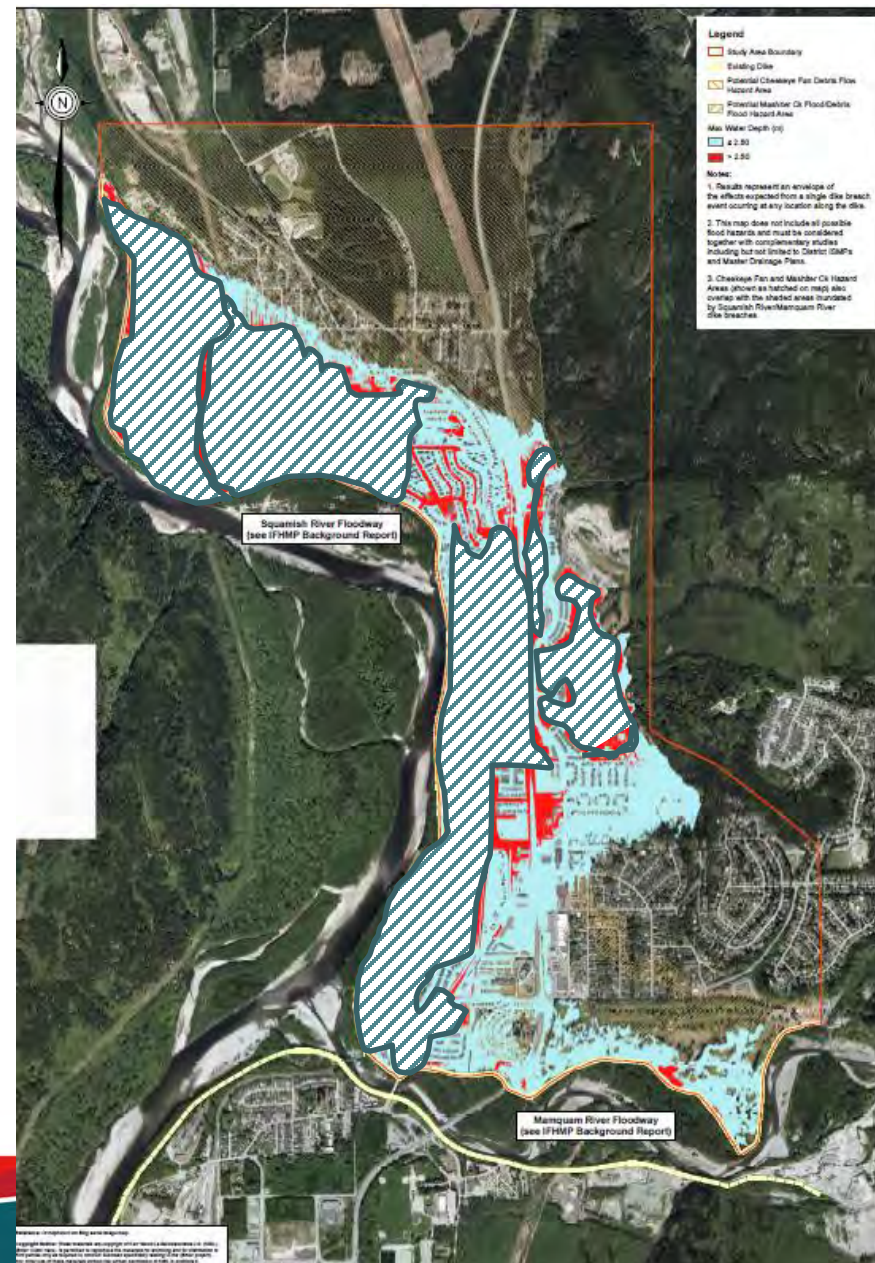
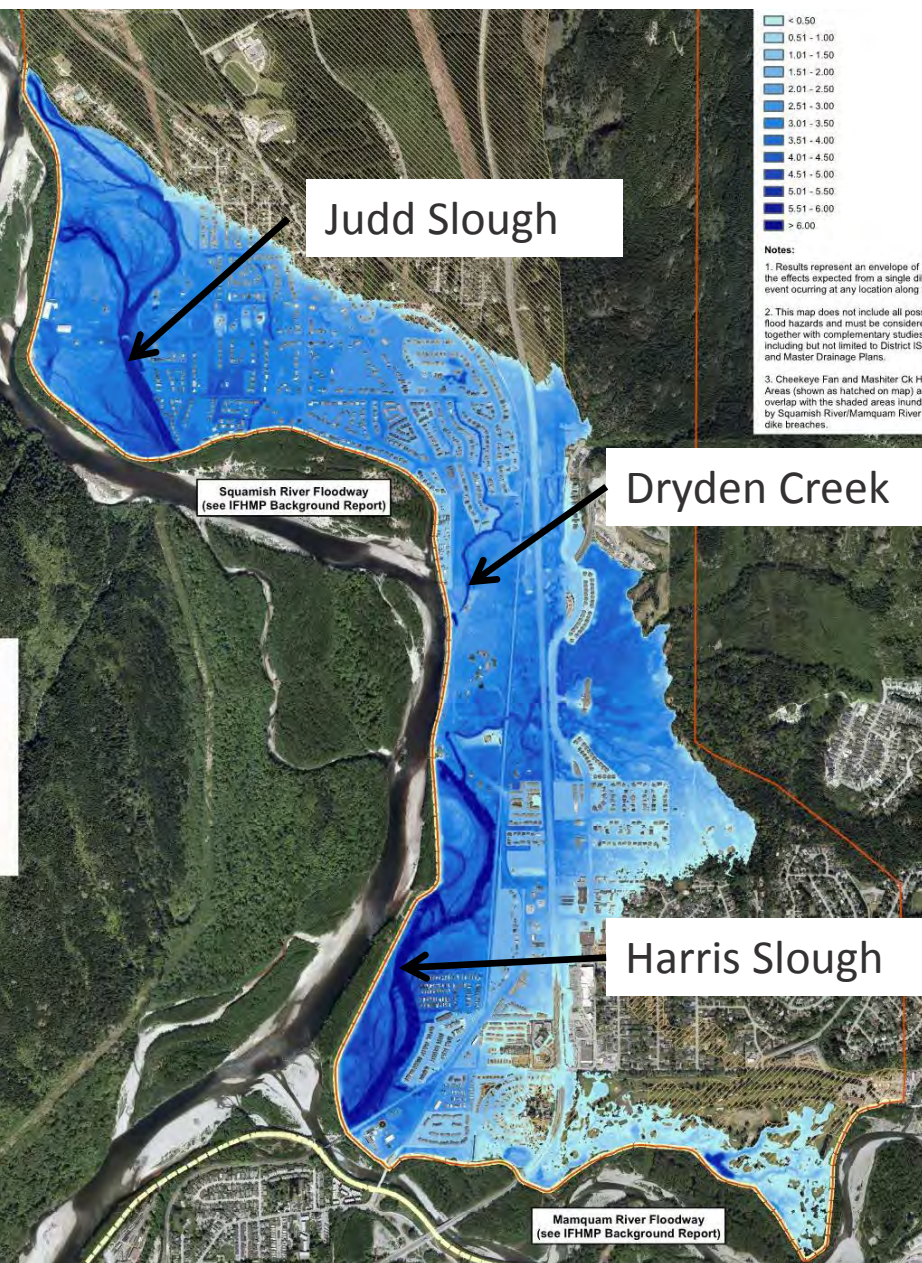
- 1) Cost recovery agreement for municipal infrastructure (sewer/water/roads)
 - District benefits are unclear
- 2) District supplies dike and fill material
- 3) Funding options: create new Flood Protection Utility, DCC exemptions
 - District benefits are unclear,
 - DCC legislation

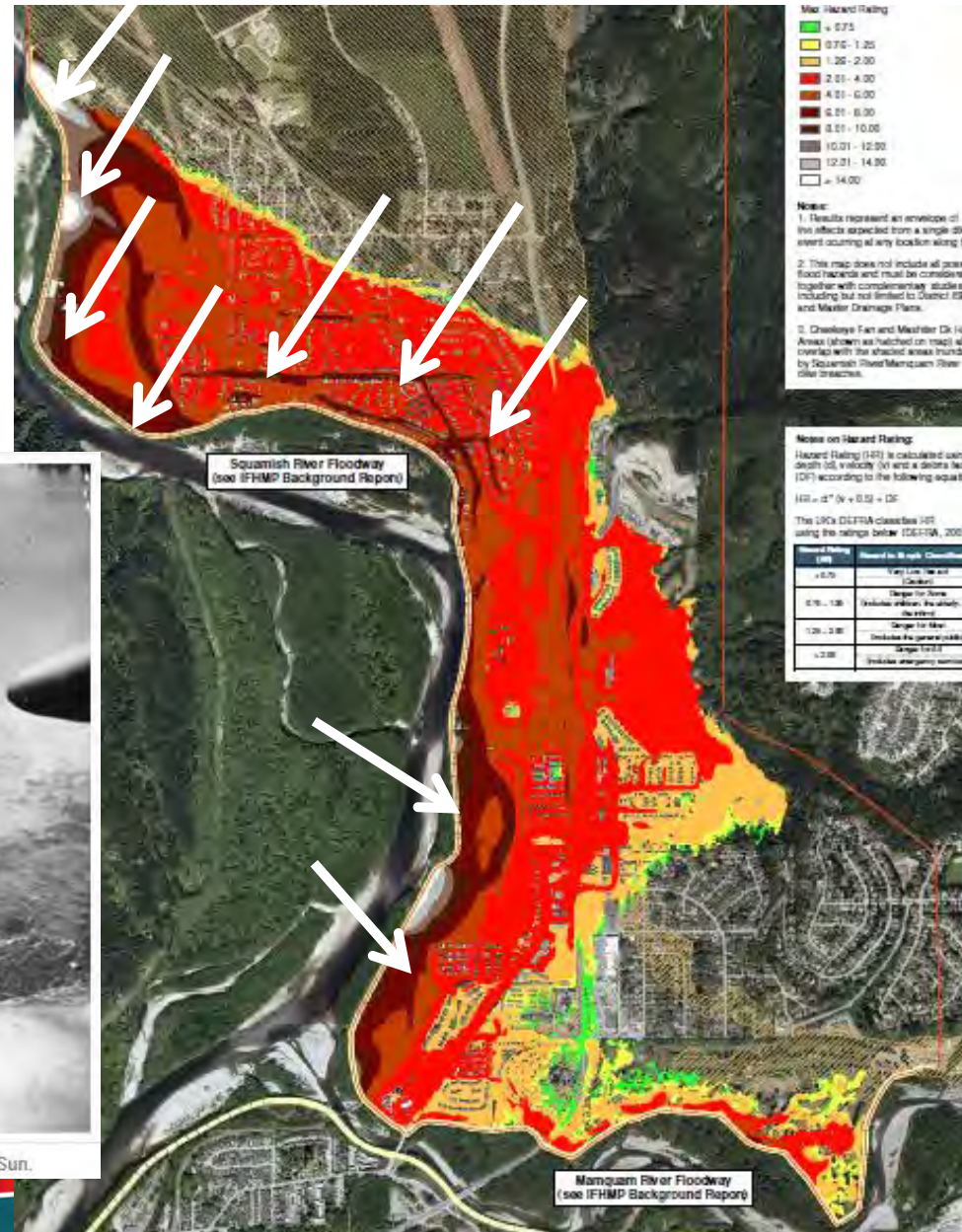
1050 Depot Rd Information

- 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

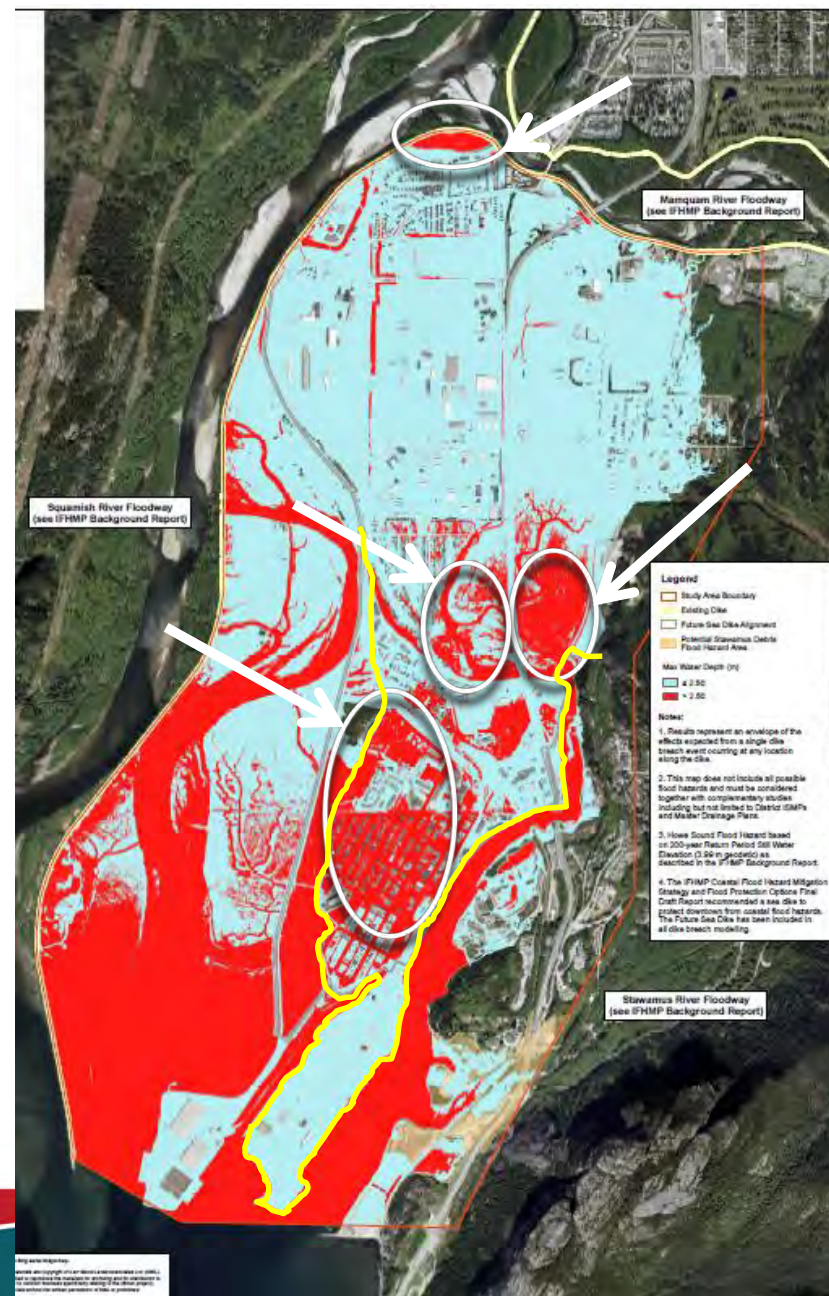
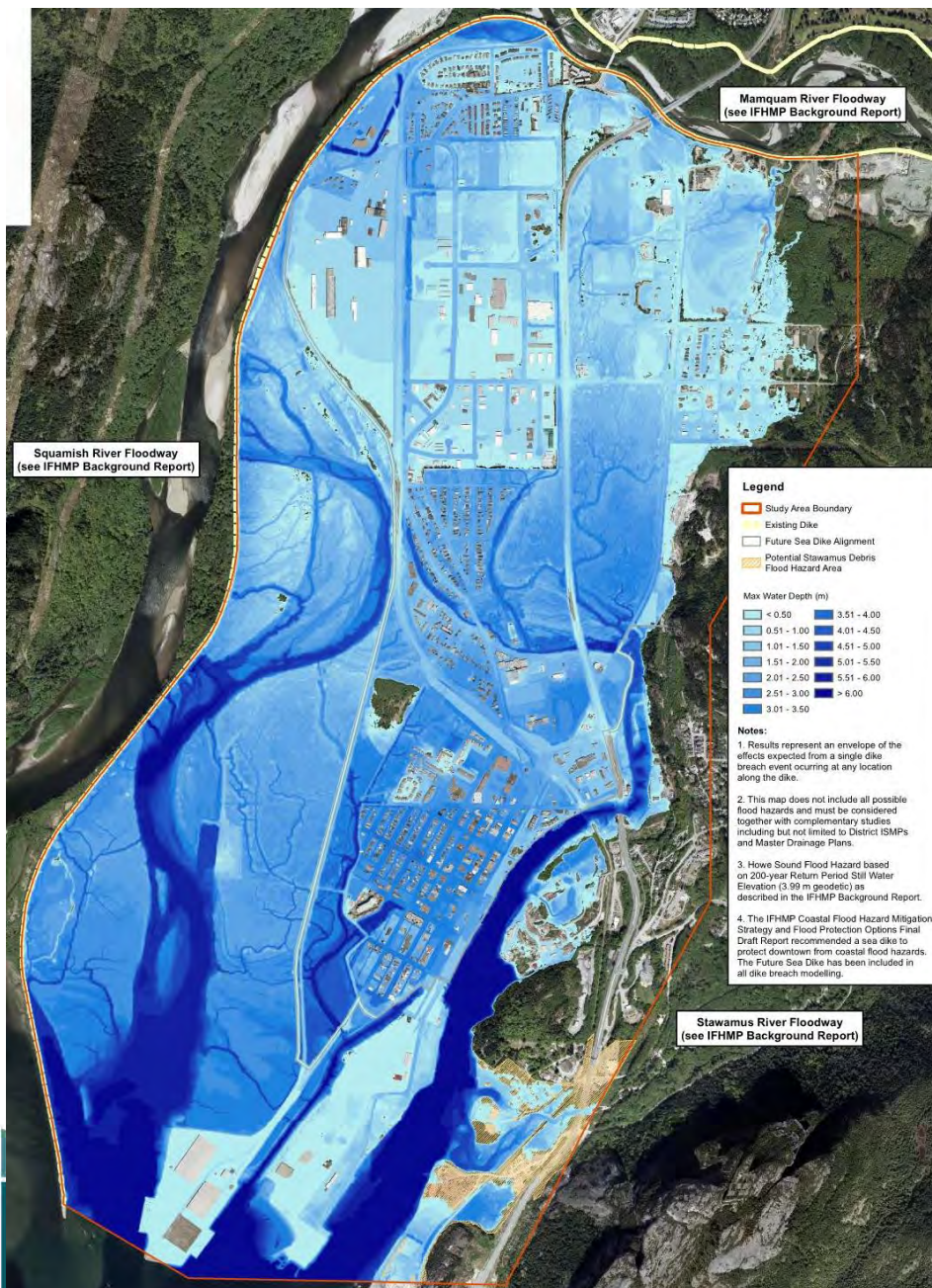






June 3, 1948: The Fraser River flood at Hatzic Lake where the dike broke. Photo: Dave Buchan/Vancouver Sun.





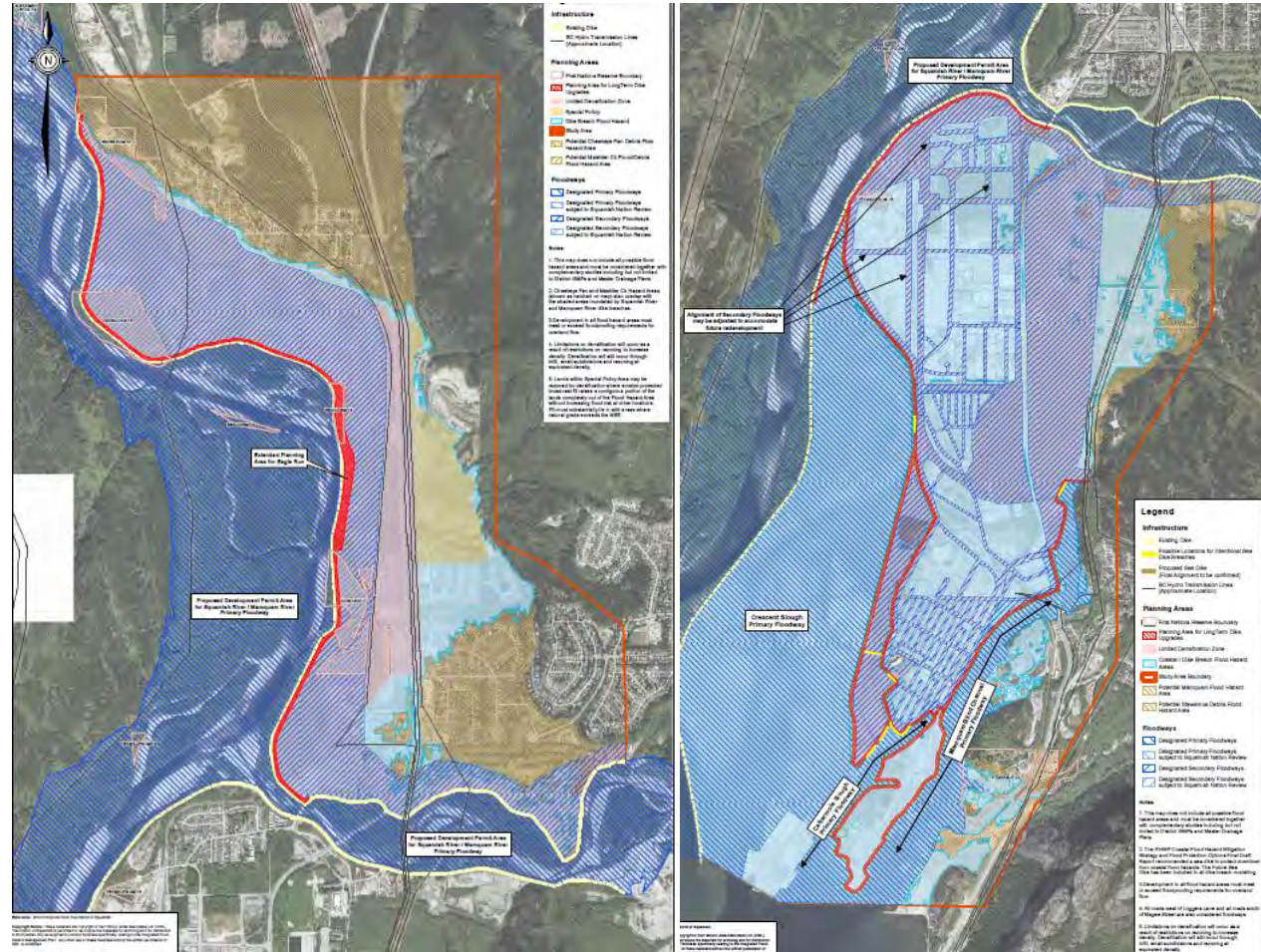
Option 2 – Avoid All Further Development

Benefits:

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

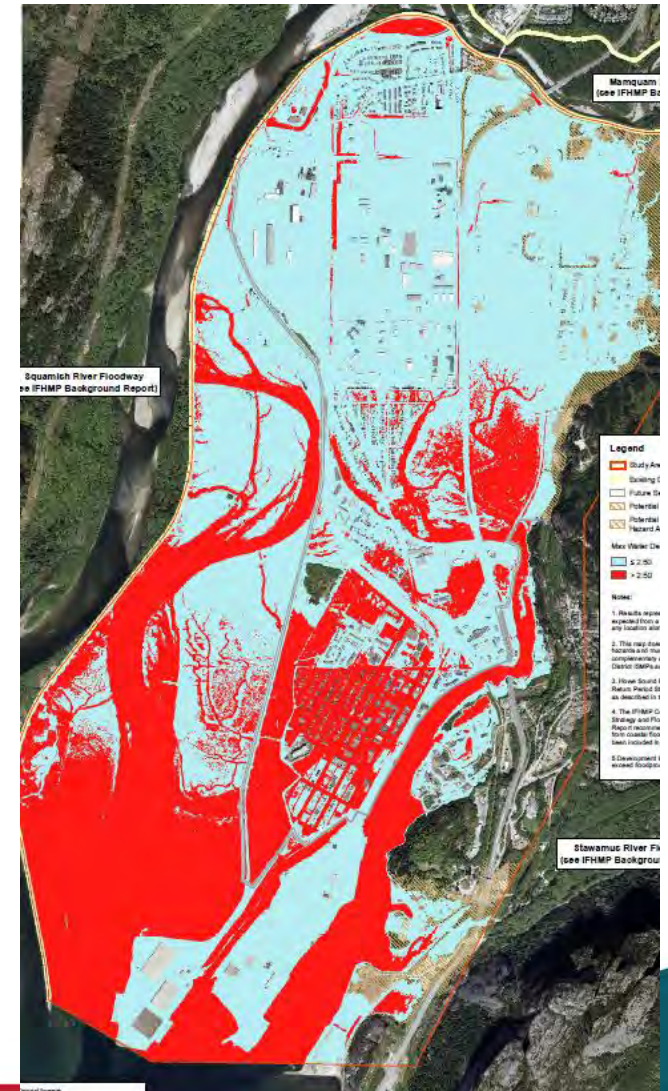
Drawbacks:

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



Option 4A – Limit Densification Through Rezoning – Reduced Area

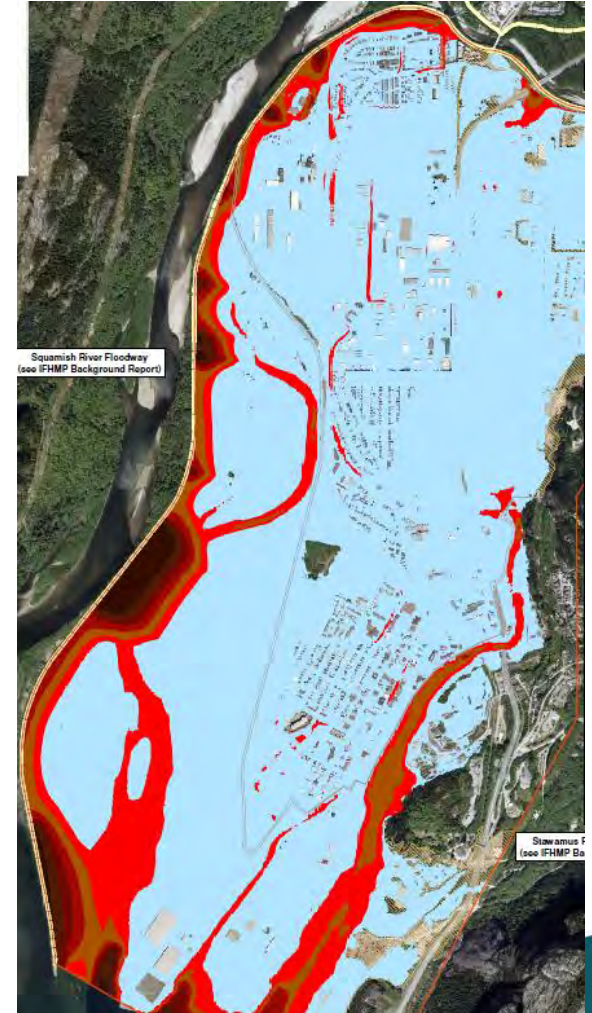
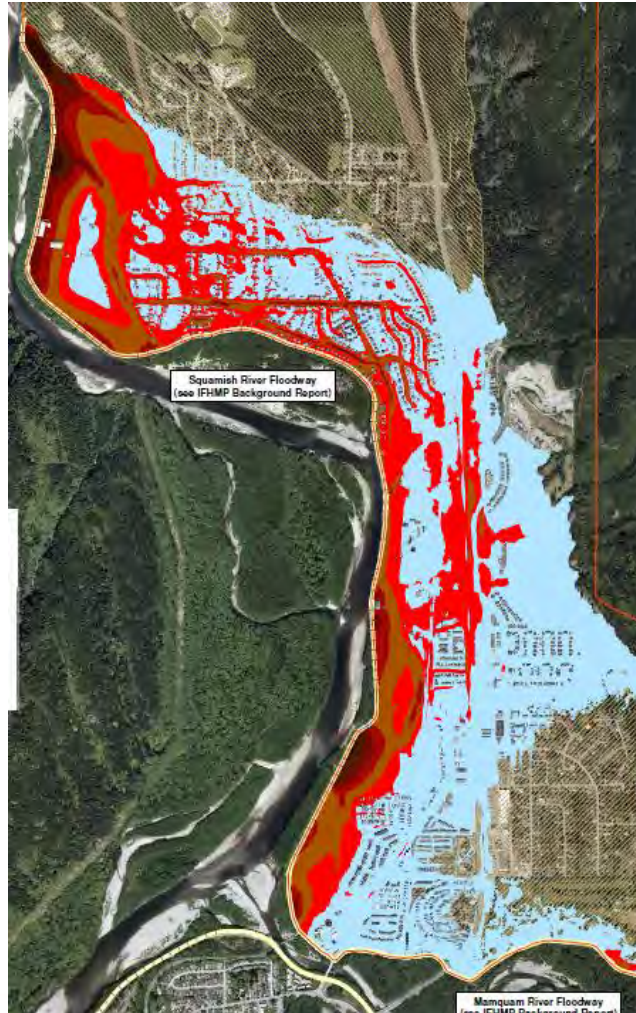
Options:
1) Depth



Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

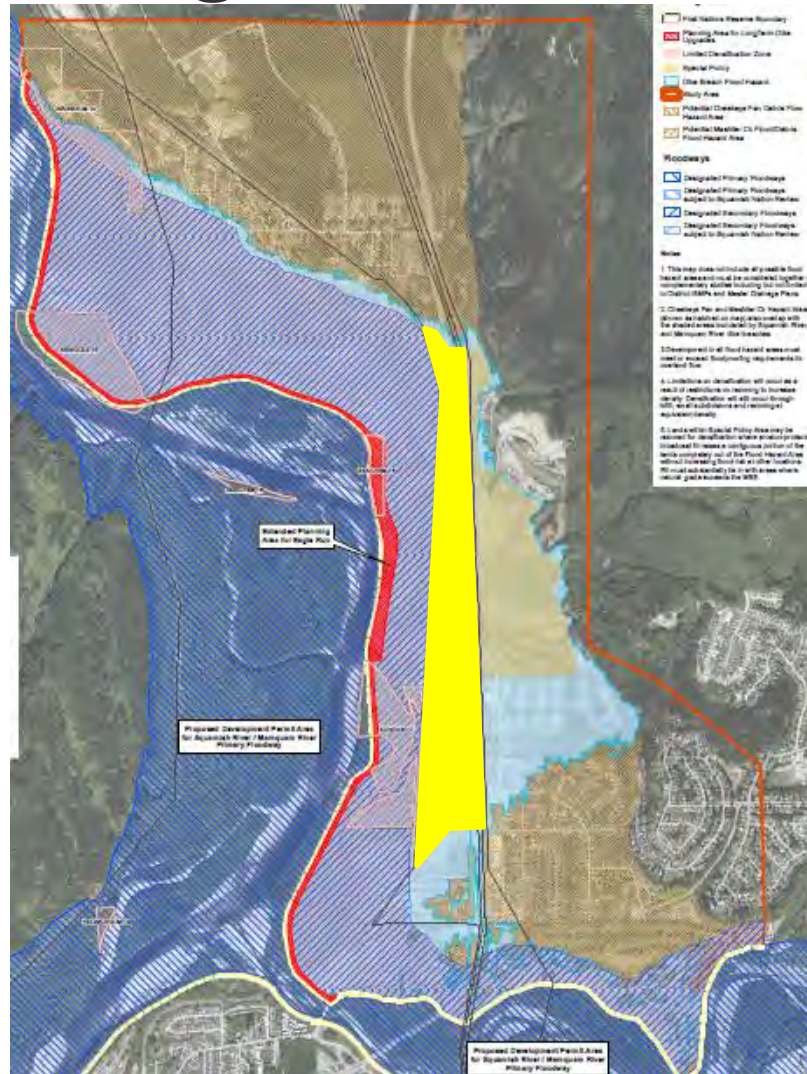
- 1) Depth
- 2) Hazard Rating



Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

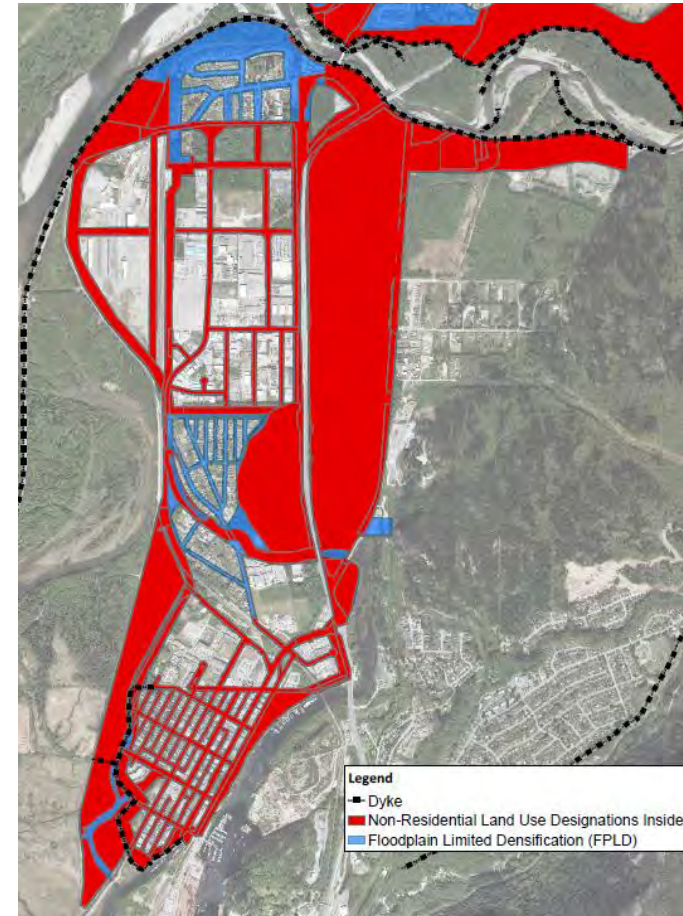
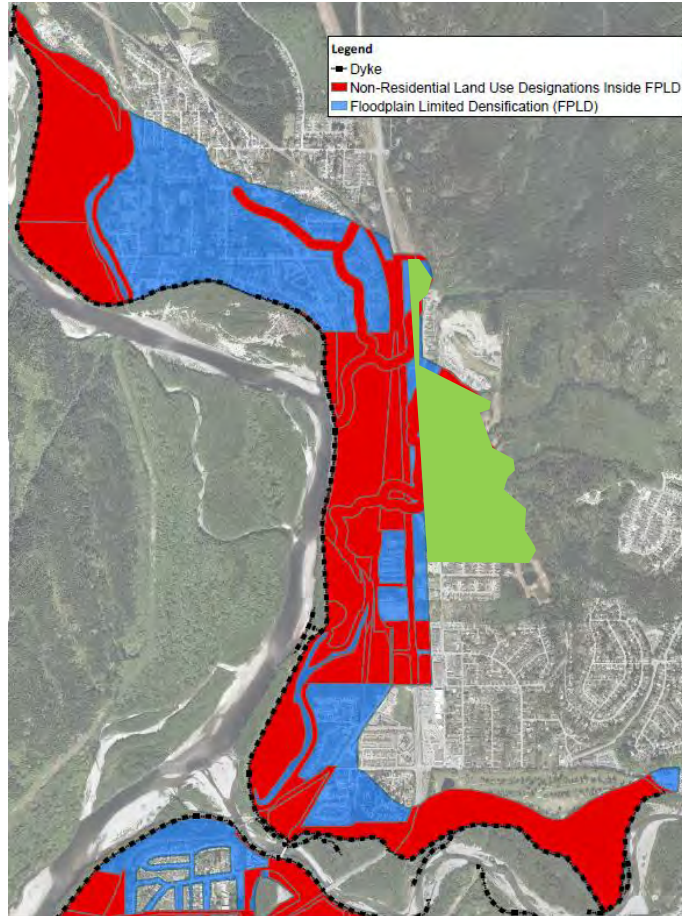
- 1) Depth
- 2) Hazard Rating
- 3) Floodways



Option 4A – Limit Densification Through Rezoning – Reduced Area

Options:

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



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

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

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

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

Benefits:

- Avoids constraining floodway

Drawbacks:

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



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

Benefits:

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

Drawbacks:

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



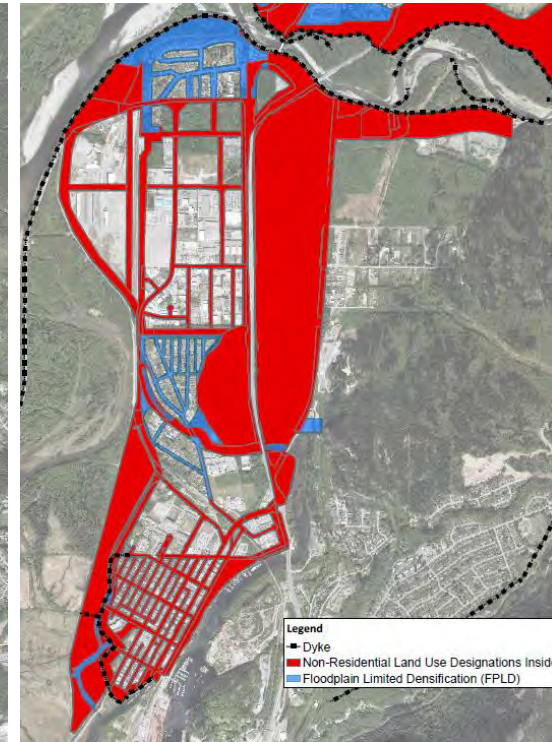
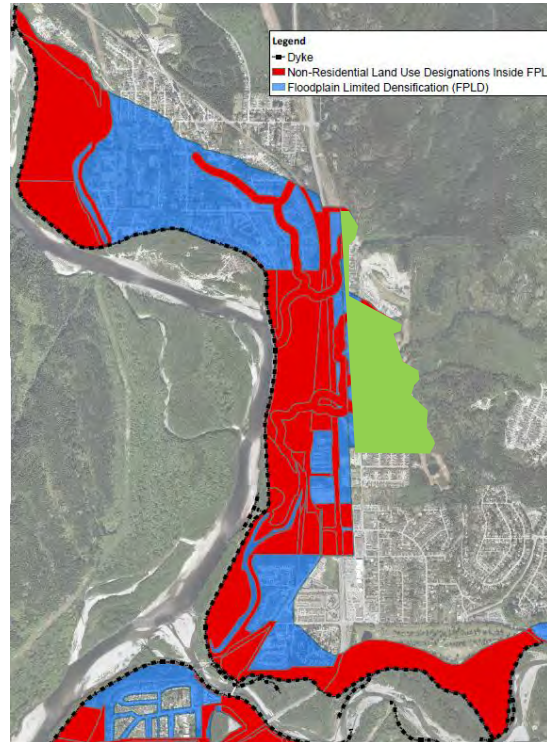
Option 5B – Allow Densification Through Rezoning – Residential Neighbourhoods

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



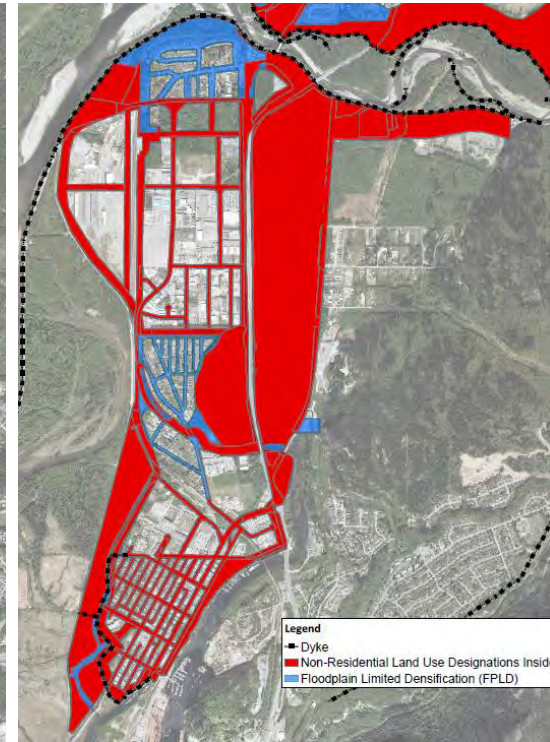
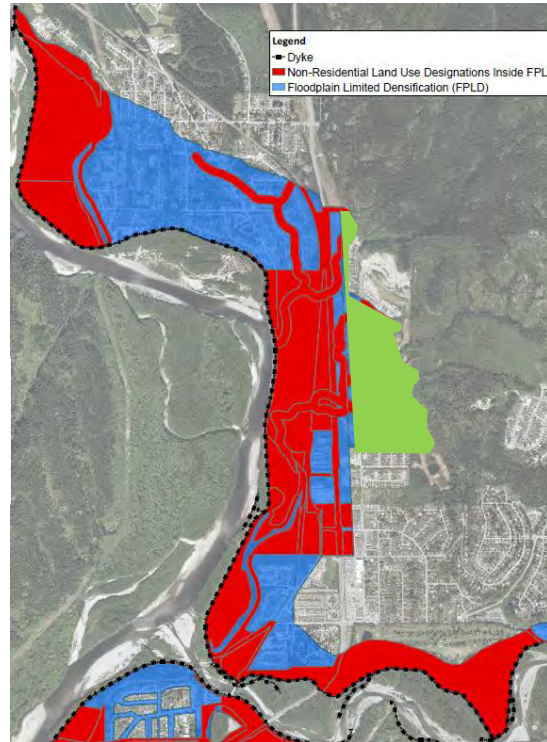
Option 5C – Allow Densification Through Rezoning – All Areas

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

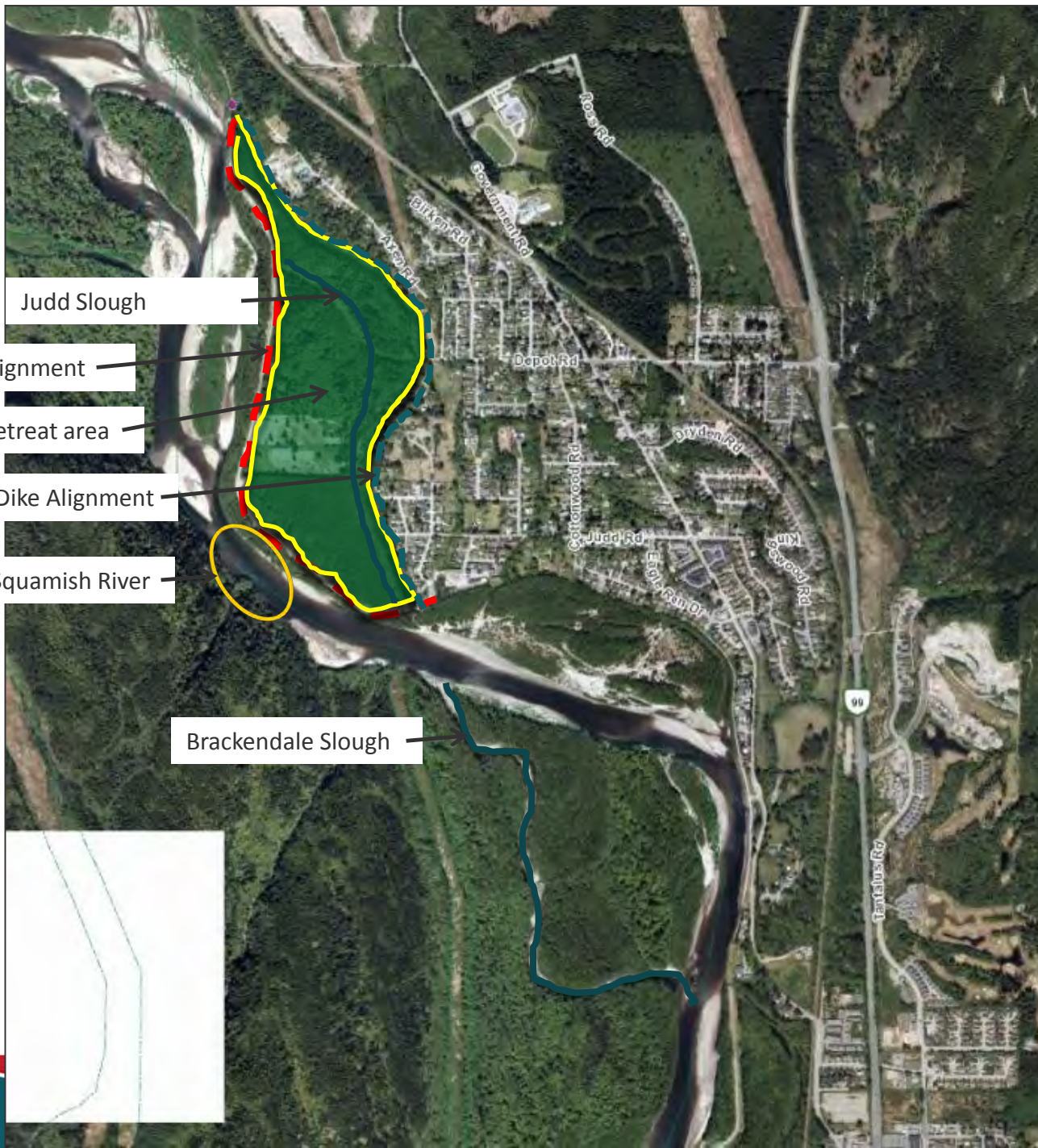


1:200 Year Dike Cost

- 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

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