

Skw̓xwú7mesh/Squamish Flood Planning: adapting to climate change

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What is happening?

The District of Squamish is a vibrant, rapidly growing community located at the end of Átl'ka7tsem/Txwnéwu7ts/Howe Sound, where five major river systems converge (Squamish, Mamquam, Cheakamus, Cheekye and Stawamus). The location of Skw̓xwú7mesh/Squamish at the head of Átl'ka7tsem/Txwnéwu7ts/Howe Sound, surrounded by rivers, presents unique community challenges.



A view along the Squamish River dike upgrade, undertaken in 2019. (Credit: David Roulston)

What is the current status?

Due to its location and low-lying elevation, Skwxwú7mesh/Squamish faces a high risk of flooding from extreme weather events, such as heavy precipitation and storm surges. This risk is especially important for the significant portion of new development occurring within the floodplain. Due to the combination of ongoing floodplain development and the presence of natural flood hazards (e.g., rivers), the District of Squamish initiated an Integrated Flood Hazard Management Plan (IFHMP) in 2014 (see Resources). This plan provides a blueprint for safe and sustainable community growth that accounts for flood risks. The IFHMP was adopted in 2017 and has received provincial, national and international awards (Silver Award from the Planning Institute of British Columbia [PIBC]; Award of Excellence from the Canadian Consulting Engineering Awards; Award of Merit from

the International Federation of Consulting Engineers [[FIDIC](https://www.fidic.org/), [fidic.org](https://www.fidic.org/)]) for its ground-breaking and comprehensive work.

The IFHMP included a comprehensive mitigation program with over 100 recommendations, including new land use policy, flood regulations for new development and a prioritized capital plan to build and upgrade dikes. Since adoption of the IFHMP, Skwxwú7mesh/Squamish has been ambitiously implementing recommendations, as detailed in the “What can you do?” section, below.

Significant work remains; however, Skwxwú7mesh/Squamish is proceeding with confidence that the community is using the best planning tools available to manage flood risks.

What are the potential impacts of climate change on Squamish flood planning?

Climate change is anticipated to have significant impacts on flood risk in the District of Squamish. The IFHMP considers anticipated impacts and includes specific measures to mitigate additional flood risk posed by climate change. In accordance with provincial guidance, Skwxwú7mesh/Squamish is planning for 1 m of sea-level rise by 2100 and 2 m by 2200.

In addition, an allowance of 10% has been added to peak river flows to account for increased precipitation and runoff. These climate change impacts are taken into consideration in the IFHMP's dike upgrade plans and new development regulations, which require that buildings be elevated to consider anticipated flood levels.

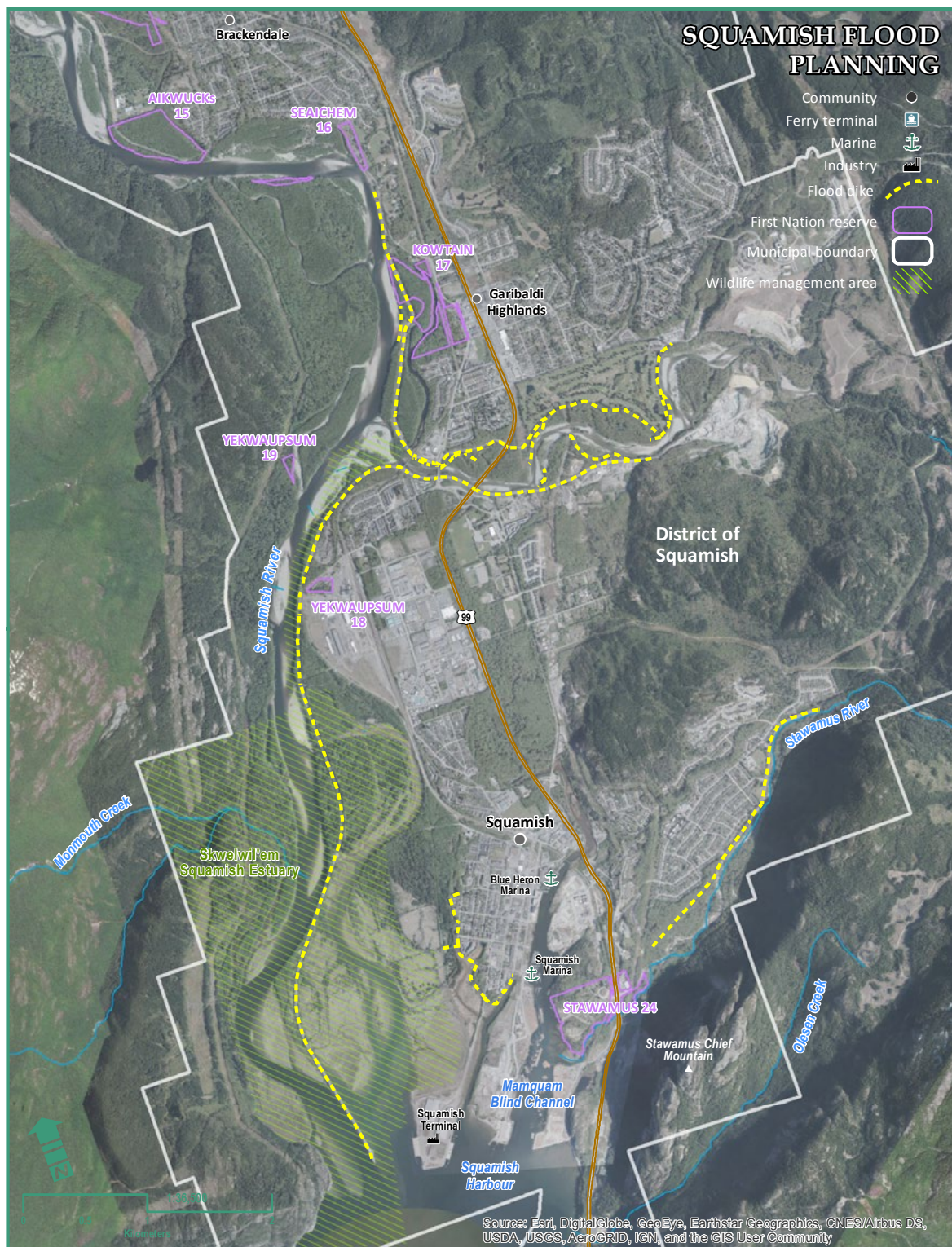


Figure 1. Flood dikes throughout the District of Squamish.¹



A view from the Squamish River training berm to the Squamish estuary. (Credit: David Roulston)

What has been done since 2017?

The table below reports on progress made on recommended actions from the previous 2017 article, where identified. Many of these require ongoing action.

2017 ACTION	ACTION TAKEN
GOVERNMENT ACTIONS AND POLICY	
Improve strategic dike protection for the community using techniques that reflect an environmentally sensitive approach.	In 2019, a 1-km long, \$4-million upgrade to the Squamish River dike in Brackendale to divert excess water was completed (Figure 1). A dike master planning process has also been initiated to prepare a dike upgrade plan for the eagle viewing area/Siyich'em Reserve in Brackendale (see Resources). In 2020, the building of 200 m of new sea dike is planned along the Mamquam Blind Channel (an inlet of Átl'ka7tsem/Txwnéwu7ts/Howe Sound) beside Xwu'nekw Park. Further dike upgrades are planned through redevelopment of private waterfront lands.
Manage development in flood hazard areas through updated Official Community Plan (OCP), DPA guidelines, bylaws, etc.	In 2017, the District adopted the community's first Floodplain Bylaw (see Resources), which establishes flood construction levels (the elevation that habitable areas must be lifted to) and building setbacks from watercourses and dikes.

2017 ACTION	ACTION TAKEN
<p>Limit continued densification in the highest hazard areas.</p>	<p>In 2018, the District’s OCP was updated (see Resources), which adds strong policy for community flood management and environmental protection; discourages new development in the highest flood risk areas; and directs new growth to lower risk areas. The OCP also includes a Development Permit Area that designates critical floodways through the town and establishes regulations for new development within those areas to avoid increasing flood risk over time.</p>
<p>Action and policy to reduce greenhouse gas emissions and meet or exceed current targets.</p>	<p>The Council of the District of Squamish recently declared a Climate Emergency. The District is focused on maintaining carbon neutrality within corporate operations as part of the commitment to the Climate Action Charter (CAC) (see Resources). This is an initiative developed by the Province of B.C. to encourage municipalities to work towards carbon neutrality within their corporate operations. The District is committed to the CAC initiative and has actioned updates within the OCP in support of this. Specific climate change mitigation measures that the District is undertaking include:</p> <ul style="list-style-type: none"> • Developing a Community Carbon Marketplace, allowing the District to offset corporate emissions with local emission-reducing projects. • Establishing a citizen-led Climate Leadership Team that will work with the Mayor, Council and a Consultant to develop a Community Climate Action Plan that will provide insights into Squamish’s greenhouse gas emission sources, establish bold actions to reduce emissions and capitalize on available economic opportunities to work towards carbon neutrality. • Preparing a Community Energy and Emissions Plan (CEEP). • Encouraging compact land use patterns that support complete communities, infill development, a diversity of transportation options and a greater mix of land uses. • Emphasizing active transportation and public transit as an essential part of the District transportation and land use network. • Ensuring that high-density employment areas are easily accessed by active transportation and transit networks, and that local employment opportunities provide alternatives to lengthy vehicle commutes. • Supporting and advocating for the implementation of effective regional transit services. • Facilitating the development and coordinated management of low impact alternative and renewable energy sources such as solar, bioenergy, geothermal, wind power, micro hydro, small-scale hydro, or run-of-the-river hydroelectric projects. • Reducing greenhouse gas emissions associated with landfill operations.

What can you do?

A detailed overview of recommended actions relating to climate change is included in *The path to zero carbon municipalities* (OWHS 2020). In some cases, no progress was identified on previous recommended actions; these remain listed below.



Individual and Organization Actions:

- Become familiar with the current IFHMP. Be aware of flood hazards in your area and be prepared for an emergency at your home and workplace.



Government Actions and Policy:

- Conduct further studies on impacts of flood control on environmental processes and continued alternatives that work with nature.
- Continue to raise awareness of flood risks and responsible watershed stewardship.
- Incorporate latest climate change hazard assessments into emergency response planning.
- Complete complementary flood studies for unique hazards beyond the scope of the IFHMP as funding permits.
- Maintain a toolkit (e.g., models, guidelines, and best practices) to support staff analysis and recommendations to Council.
- Promote closer relationships with stakeholders from the river headwaters to Átl'ka7tsem/Txwnéwu7ts/Howe Sound to facilitate working together.
- Continue to renew the IFHMP every five to 10 years.
- Begin planning for opportunistic retreat of key facilities and infrastructure from high flood hazard areas at the end of their service life.

Methods

The IFHMP was completed by a multi-disciplinary team of engineers (i.e., civil, hydrotechnical, geotechnical, coastal), planners and environmental professionals. The plan was prepared in four phases as follows:

- **BACKGROUND/GAP ANALYSIS.** This phase included an in-depth review of previous flood studies, data, and flood policy from around the world. The review was summarized in a Background Report (see Resources).
- **COASTAL FLOOD MITIGATION STRATEGY.** This phase evaluated coastal flood hazards and prepared a coastal flood mitigation strategy, including a conceptual design for a sea dike surrounding Sk̓wx̓wú7mesh/Squamish's coastal perimeter (see Resources).
- **RIVER FLOOD MITIGATION STRATEGY.** This phase evaluated river flood hazards, including utilization of a state-of-the-art two-dimensional floodplain model to determine how fast and deep floodwaters would move through the floodplain (see Resources).
- **INTEGRATED FLOOD HAZARD MANAGEMENT PLAN.** This phase brought together technical work completed in the first three phases into a comprehensive final plan (see Resources).

Public engagement was a central element of this plan and included three public open houses, numerous on-line surveys and workshops and several presentations to Sk̓wx̓wú7mesh Úxwumixw/Squamish Nation and District of Squamish Councils.

Following completion of the IFHMP, the District completed a Quantitative Risk Assessment (not available online) for the Squamish River floodplain, which evaluated risk to loss of life and economic risk. The study indicated a high level of risk to both loss of life and economic loss in Sk̓wx̓wú7mesh/Squamish and reinforced the importance of implementing the measures developed in the IFHMP.

Resources

This list is not intended to be exhaustive. Omission of a resource does not preclude it from having value.

District of Squamish Integrated Flood Hazard Management Plan Background Report. Available at: https://squamish.ca/assets/IFHMP/09252017/63a63fc5e6/FINAL-SquamishIFHMP-BackgroundReport_20170913.pdf

District of Squamish Coastal Flood Hazard Mitigation Strategy. Available at: https://squamish.ca/assets/IFHMP/09252017/e51255a3e4/FINAL_SquamishIFHMP-Coastal-Flood-Risk-Mitigation-Options_20170912.pdf

District of Squamish River Flood Hazard Mitigation Strategy. Available at: https://squamish.ca/assets/IFHMP/09252017/0d6609c9a4/FINAL_SquamishIFHMP-RiverFloodRiskMitigationOptions-20170915.pdf

District of Squamish Integrated Flood Hazard Management Plan. Available at: <https://squamish.ca/yourgovernment/projects-and-initiatives/completed-projects/2018-completed-projects/floodhazard/ifhmp-2016/>

Eagle Viewing Area/Siyich'em Reserve Dike Master Plan. Available at: <https://squamish.ca/yourgovernment/projects-and-initiatives/eaglesiyichemdike/>

District of Squamish Floodplain Management Bylaw No. 2676. Available at: <https://squamish.civicweb.net/filepro/documents/19302?preview=162725>

District of Squamish OCP and Zoning Bylaws. Available at: <https://squamish.civicweb.net/filepro/documents/68132>

B.C. Government Climate Action Charter. Available at: <https://www2.gov.bc.ca/gov/content/governments/local-governments/climate-action/bc-climate-action-charter>

References

¹ Beaty F, van Riet W, Wareham B, Schultz J. Howe Sound/Átl'ka7sem Map [Internet]. Ocean Wise and David Suzuki Foundation; 2019. Available from: <http://howsoundconservation.ca>

Acknowledgements

The IFHMP was completed by:

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