CRITICAL INFRASTRUCTURE AND FLOOD RISK MANAGEMENT

Preparedness and Vulnerabilities of Flooding on Critical Infrastructure for the Squamish Nation

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Introduction

Critical infrastructure refers to the essential systems and services that support the functioning of a community, including transportation, healthcare, energy, telecommunications, and water. These systems are highly interconnected, meaning that disruption in one sector can have cascading impacts on others, especially during extreme events such as flooding. In the context of Squamish Nation, flood risk is increasing due to climate change, changing hydrological patterns, aging infrastructure, and ongoing population growth. Flooding can significantly impact critical infrastructure by damaging physical assets, disrupting access to essential services, and isolating communities. These risks are particularly important for Squamish Nation, whose reserve lands are located within or near flood-prone areas and are influenced by the planning and infrastructure decisions of neighboring jurisdictions. As a result, flood impacts are not confined to a single area but are multi-jurisdictional, affecting both on-reserve and off-reserve lands and intersecting with other territories.

This report aims to support the Squamish Emergency Planning and Response Team by examining how critical infrastructure sectors are addressed within flood risk management planning. The objectives of this report are to:

- Identify key players and governance structures across federal, provincial, and local levels
- Assess existing policies, strategies, plans, and legislation related to flood risk management across sectors
- Evaluate how different sectors plan for mitigation, preparedness, response, and recovery
- Analyze interdependencies and impacts of flooding on infrastructure and access to services
- Assess the extent to which Indigenous communities, including Squamish Nation, are recognized and included in planning frameworks
- Identify key strengths, gaps, and areas of concern in current approaches to flood risk management

By reviewing a range of regional, provincial, and local documents, this report highlights important insights to support more coordinated, inclusive, and resilient approaches to critical infrastructure planning.

Overview of Important Documents

Integrated Flood Hazard Management Plan (IFHMP)

This document was prepared by Kerr Wood Leidal Asssociated Ltd. in association with Cascade Environmental Resource Group Ltd. and SNC-Lavalin for the District of Squamish. Its purpose is to update the community's 1994 flood management strategies by providing a new suite of policy, planning, and structural tools to mitigate flood risk. The report summarizes major findings related to river and coastal flood hazards while proposing draft updates to the Official Community Plan and the local Floodplain Bylaw. It aims to reduce overall flood risk fairly for all floodplain users while identifying sustainable opportunities for continued economic and social development.

Sea to Sky Multimodal Evacuation Plan

This document is a collaborative effort led by the Resort Municipality of Whistler and the District of Squamish. Its primary purpose is to establish a shared framework, agency roles, and operational procedures for the coordinated mass evacuation of an entire community. The plan addresses complex mass transportation issues, accounting for various modes of travel, including road, rail, air, and ferry, to move people to safety. The document consists of a Guidance Document for overall strategy, an Operational Evacuation Plan for step-by-step implementation, and GIS maps to visualize spatial data for evacuation operations.

Community Risk Assessment

This document was written by the District of Squamish in 2015 to give a detailed picture of the social, natural, built, and economic environments of the community. The document's purpose is to identify and analyze specific hazards, risks, and vulnerabilities to provide a foundation for prioritized resource allocation in emergency management. It assesses threats such as floods, earthquakes, and utility failures, rating them from low to high risk based on their potential impact. This report serves as the root of the District's emergency planning structure, informing the direction of subsequent response and mitigation.

All Hazards Plan: Community Risk Assessment (AHP)

This document was written by the Squamish Emergency Program and approved by the District's Chief Administrative Officer. The purpose of this strategic document is to provide direction for implementing risk-based emergency management and to ensure the district meets its municipal legislative obligations for safeguarding the population. This document serves as a "tool box," as it outlines the response concept of operations and clarifies roles and responsibilities for all municipal departments during a disaster. The plan adopts an "all-hazards approach," meaning the same management strategies and response structures are used regardless of the specific hazard.

BC The All-Hazard Plan

This document was written and is maintained by Emergency Management British Columbia, which serves as the lead coordinating agency for the provincial government's emergency management activities. The primary purpose of this strategic document is to provide a unified basis for responding to the dangers and risks posed by all types of hazards throughout the province. It outlines a provincial all-hazards methodology that is compatible with the British Columbia Emergency Management Systems. The plan details the operational structures and responsibilities of the Provincial Emergency Coordination Centre and Provincial Regional Emergency Operations Centres, while defining the collaborative roles of provincial ministries, local authorities, federal agencies, and non-governmental organizations in order to increase life safety and community resiliency.

BC Emergency Management System

This document was produced by the Government of British Columbia through Emergency Management BC. The purpose of this guide is to provide a standardized framework for emergency management across the province, ensuring that all ministries, Crown corporations, and local authorities use common terminology and processes. It described a comprehensive approach organized into four phases: mitigation, preparedness, response, and recovery. The guide is intended to enable practitioners in both the public and private sectors to assess, develop, and strengthen their own emergency management programs through a unified provincial standard.

Transportation

Transportation infrastructure, including roads, rail, and ferry systems, is a critical component of flood risk management because it supports mobility, economic activity, emergency response, and evacuation during hazard events. The governance of this infrastructure is shared across multiple levels of government. The federal government provides national coordination, funding, and resilience frameworks, while the Province of British Columbia holds primary authority over highways, rail coordination, and emergency management. At the district level, local governments are responsible for managing roads, land-use planning, and implementing flood risk measures. Across these levels, transportation systems are recognized as interdependent networks in which disruption to roads, rail lines, or ferry access can significantly affect evacuation, supply chains, and access to critical services. However, although the importance of transportation is clearly emphasized, there is limited detail on how each mode, particularly at the local level, will be systematically protected from flood impacts, highlighting a gap between strategic recognition and detailed implementation.

In Squamish, transportation infrastructure operates as a multimodal system in which road access is dominant, but rail and ferry connections play important supporting roles in mobility, goods movement, and emergency evacuation. Highway 99 functions as the primary lifeline and evacuation corridor, with local roads such as Government Road and Loggers Lane ultimately dependent on this single connection, increasing vulnerability when access is disrupted. Rail infrastructure and ferry docking points, including Darrell Bay and Porteau Cove, are identified as alternative options to support emergency movement when road capacity is limited. The documents focus on evacuation, emergency access, and multimodal coordination and recognize that transportation corridors cross flood-prone areas and have experienced past damage. However, a key gap remains, as the plans identify vulnerabilities and limited egress but do not provide a detailed, road-by-road or mode-specific flood adaptation strategy, leaving long-term resilience planning for transportation infrastructure incomplete.

Document Collection and Methodology

This study employed a structured document collection approach using multiple search strategies. First, a full-text search was conducted using the Google search engine with queries such as “flood risk management in British Columbia,” “flood risk management in Squamish,” “flood risk management in Canada,” “flood risk management and critical infrastructure,” “flood risk management and transportation infrastructure,” and “roads, bridges, highway flood risk management.” Second, a keyword-based search was carried out on official government websites, including the Government of Canada, Government of British Columbia, Public Safety Canada, Ministry of Transportation and Transit, and the District of Squamish. Key search terms included “flood,” “flooding,” “floodplain,” “hazard,” “critical infrastructure,” “transport,” “transportation,” “road,” “highway,” and “bridge.” To expand the document set, snowballing

(following embedded links within documents and websites) and backward citation chaining (reviewing referenced sources within documents) were used to identify additional relevant plans, policies, and reports. All collected documents were then organized according to governance levels: federal, provincial, and district.

The collected documents were analyzed using a qualitative document analysis approach, supported by keyword-based scanning and manual text mining. A consistent set of keywords "flood," "flooding," "floodplain," "hazard," "transport," "transportation," "road," "highway," "bridge," "evacuation," and "access route" was used to identify relevant content across documents. Documents that did not contain relevant information on flood risk or its connection to infrastructure were excluded, while those demonstrating relevance were included for detailed analysis. While some documents contained dedicated sections on transportation infrastructure, most addressed these issues indirectly within broader flood risk or emergency management contexts. Additionally, many documents were not solely focused on flood risk management, requiring careful interpretation to extract meaningful insights.

To ensure consistency and comparability, findings were systematically organized into a table based on key analytical categories: Vulnerability and Risk Assessment; Prevention and Mitigation; Preparedness and Response; Recovery and Adaptation; Governance and Actors; and Policies, Programs, and Plans. This structured approach enabled the identification of relationships between flood risk management and transportation infrastructure across different governance levels.

Roads

Road infrastructure, including highways and bridges, is the backbone of transportation systems and a critical component of flood risk management because it supports everyday mobility, emergency response, and evacuation while maintaining regional connectivity. In British Columbia, major highway corridors such as Highway 99 are identified as highly vulnerable to flooding, with sections exposed to inundation and limited alternate access, increasing risks to connectivity and movement of goods and people. In Squamish, this vulnerability is more pronounced due to the community's reliance on Highway 99 and a limited number of bridges crossing the Squamish, Mamquam, and Cheakamus rivers, which act as essential links within a constrained valley network. Damage or failure of these highways and bridge crossings during flood events can isolate communities, restrict emergency access, and disrupt evacuation routes. While local planning emphasizes improving emergency access, secondary connections, and reducing dependence on a single corridor, there remains a gap in detailed, road, highway, and bridge specific flood adaptation strategies needed to ensure long-term resilience. Key actors include the BC Ministry of Transportation and Infrastructure (MOTI) and Emergency Management BC at the provincial level, and the District of Squamish (Public Works and Operations) at the local level.

Review of Key Plans and Risk Assessment Reports

This section reviews key plans and technical reports that address flood risk management for road infrastructure in Squamish. It focuses on how roads, highways, and bridges are managed across different phases of flood hazard events, including mitigation, preparedness, response, and recovery, while highlighting governance structures, vulnerabilities, and existing gaps in planning.

Integrated Flood Hazard Management Plan

The plan is intended to reduce flood risks, support sustainable development, and guide decision-making for managing flood hazards in Squamish (pp. 1-2). The district is located at the head of Howe Sound, where five major rivers converge, placing much of the community, including key urban areas, within flood hazard zones as shown in figure 1 (p.i). As a result, critical transportation infrastructure such as roads, highways, and bridges is also located within these floodplains, and most people rely on regional transportation routes that cross these areas for employment, recreation, and essential services (p. 2-1). This creates a strong dependency on infrastructure that is inherently exposed to flooding, making transportation systems particularly vulnerable to disruption during flood events.

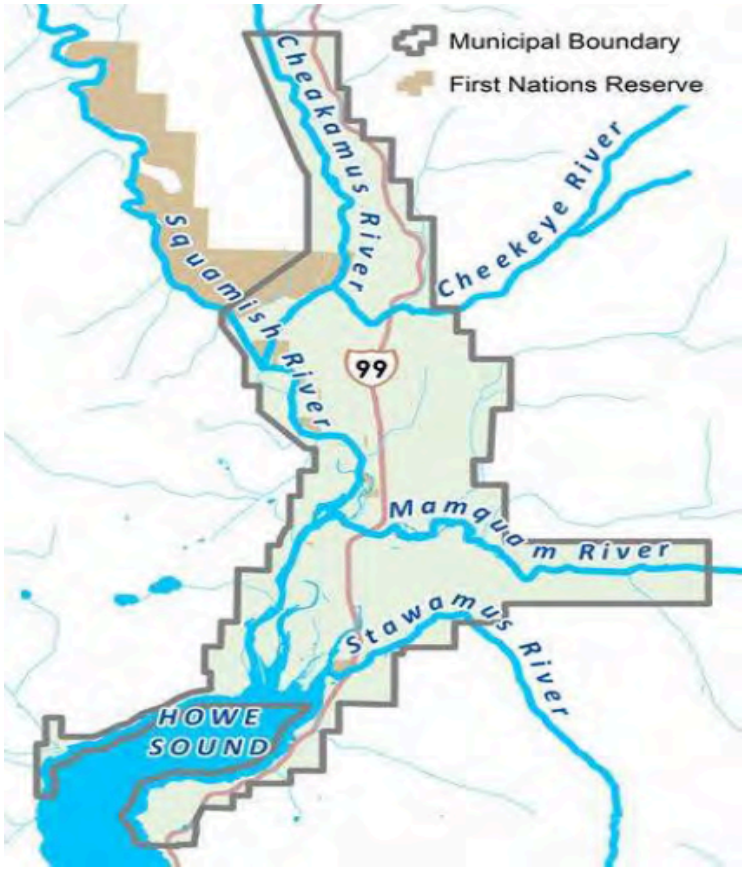

Figure 1. The District of Squamish faces flood hazards from five mountain rivers and the ocean.

Flood hazards, including river flooding and debris flows, pose significant risks to transportation infrastructure by damaging roads, blocking bridges, and cutting off access routes. For example, debris floods can partially block major bridges such as Highway 99, CN Rail, and Mamquam Forest Service Road crossings (pp. 3-7), while flooding can compromise access routes, damage bridges, and disrupt emergency response and local economic activities (pp. 3-8). Critical access points such as Fergie's Bridge, Paradise Valley Road, and the Bailey Bridge are particularly vulnerable, with past events showing complete loss of access due to bridge washouts (pp. 3-6; pp. 7-11). Additional risks include repeated flooding of roads like Valley Drive and limited hydraulic capacity of bridge openings, increasing the likelihood of overtopping during major floods (p. 136). These impacts highlight the importance of integrated flood risk management measures such as dike upgrades, infrastructure improvements, and coordinated planning. Flood risk management in Squamish involves multiple agencies, including the District of Squamish, Squamish Nation, and provincial bodies such as the Ministry of Transportation and Infrastructure (pp. 1-3–1-4), while policies and programs such as the Official Community Plan, Zoning Bylaw, Floodplain Bylaw, and the IFHMP itself guide the protection and resilience of transportation infrastructure in flood-prone areas (p. i; p. 1-1).

District of Squamish Community Risk Assessment

The purpose of this report is to guide practical steps in preparedness, response, recovery, and mitigation to reduce the likelihood and impacts of emergencies (p. 4). The report highlights the vulnerability of road transportation infrastructure to flood risks in Squamish. The road transport network includes Highway 99, five key bridges, 137 km of paved roads, and 82 km of gravel roads, forming the main transport system of the region (p. 14). Due to the region's geography, connector roads and bridge crossings can be washed out, leading to community isolation during flood hazards (p. 9). The road network, centered on Highway 99 and supported by arterial roads and multiple river-crossing bridges, is particularly exposed, as low-lying roads are prone to repeated flooding, and failures can restrict emergency access and disrupt critical services (p. 14). As illustrated in figure 2, Highway 99 serves as the primary north–south corridor with limited alternative routes, showing how flood impacts at key points can severely affect connectivity. Since roads and highways are classified as critical infrastructure essential for regional transport (p. 10), their protection is central to risk management. Flood mitigation measures such as dike upgrades, pump stations, riprap reinforcement, and installation of a water level monitoring station at Fergie's Bridge help reduce risks and maintain functionality (p. 15). Key agencies involved include the District of Squamish, Public Works, and provincial authorities (e.g., the Ministry of Transportation and Infrastructure), while policies and programs such as the Public Works Asset Management Plan and emergency management frameworks guide flood risk management and infrastructure resilience.

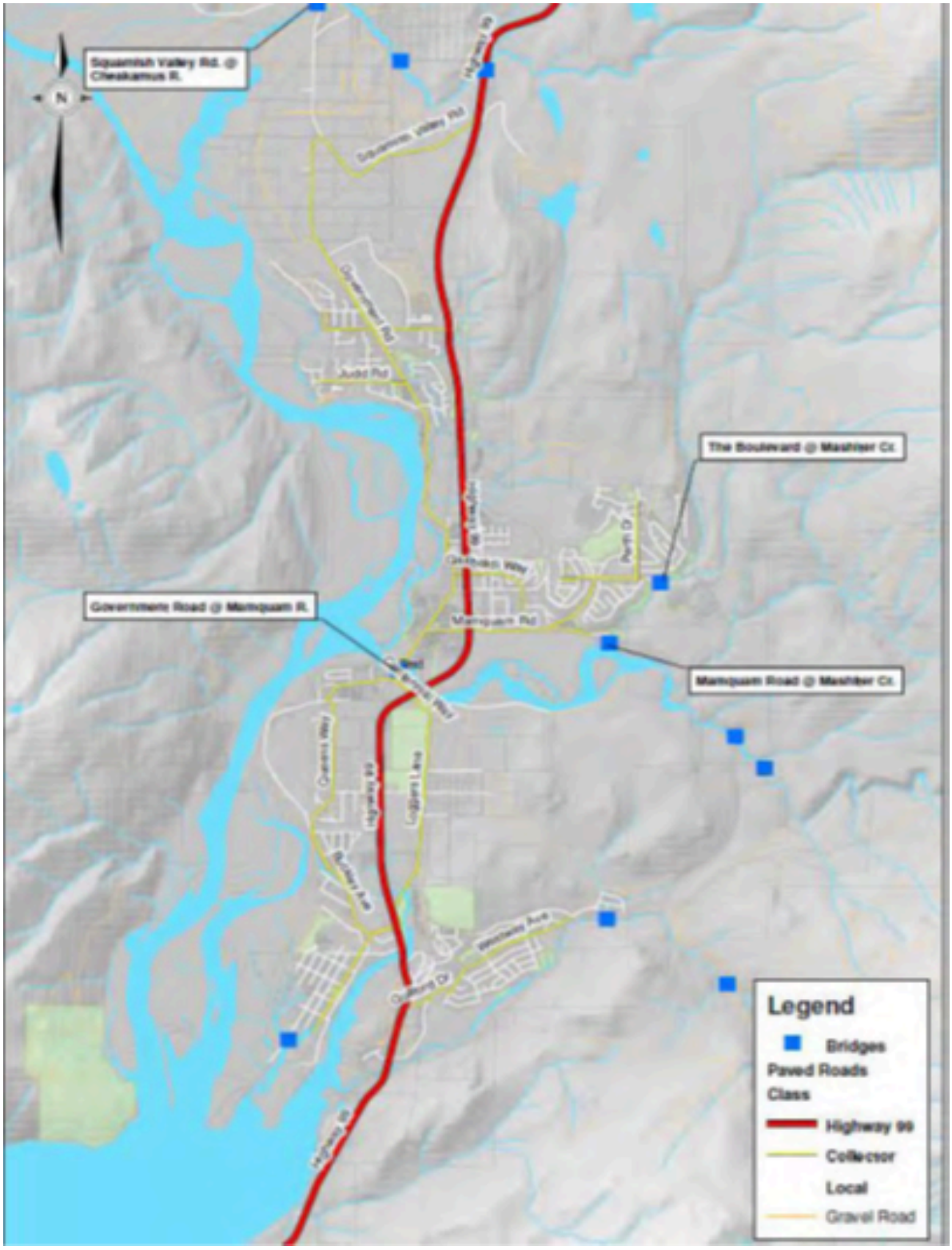

Figure 2. Road System Assets

[Squamish – Lillooet Regional District Flood Hazard Mapping and Risk Assessment]

The purpose of this report is to assess flood hazards and risks in the upper Squamish River Valley in order to support flood mitigation planning, emergency response planning, and flood-resilient infrastructure development (p. 1). The project area is located along the Squamish River Valley, where the Squamish Valley Road runs parallel to the river within the floodplain and serves as the main transportation route through the valley, as shown in figure 3 (p. 2). Roads are a critical infrastructure in the valley because the Squamish Valley Road is the only access route for local residents, hydropower facilities, recreation sites, and forestry operations. Flooding can interrupt access for the duration of the flood and during road repairs (p. 24).

Figure 3. Project location and watershed map

A qualitative analysis was conducted by overlaying roads with floodplain maps to determine the length of road affected in different flood events. Figure 4 shows that the length of road flooded increases from 4 km in a 20-year flood event to 26 km in a 500-year flood event, indicating increasing exposure and potential transportation disruption during larger flood events (p. 24). In addition to flooding, bank erosion and channel migration pose risks to infrastructure located close to the river, particularly along the Squamish Valley Road, where bank protection measures may be required (p. 30).

Flood Scenario	Length of Road Flooded (km)
20-year	4
50-year	14
100-year	19
200-year	22
500-year	26

Figure 4. Length of road flooded in each flood scenario (all roads)

Flood risk management in the Upper Squamish Valley involves the Squamish–Lillooet Regional District (SLRD), Emergency Management BC, provincial agencies, technical consultants, and local stakeholders responsible for flood planning, emergency management, and infrastructure protection (p.iii, 1). Flood management is guided by provincial flood hazard and mapping guidelines, land-use and flood construction level policies, emergency management planning, and the Emergency Management BC Disaster Mitigation Program (p.iii, 1).
District of Squamish All Hazards Plan

The purpose of this plan is to provide a coordinated framework for emergency management in the District of Squamish, including prevention, mitigation, preparedness, response, and recovery (p. 16). The plan outlines the role of the operations department in maintaining roads, drainage systems, and flood protection infrastructure and responding to flood emergencies to reduce flood risk and protect the community (p. 52). During flood emergencies, the operations department acts as the lead response agency and coordinates flood protection operations. Their responsibilities include (p. 53):

- Maintain and repair roads and clear debris
- Manage traffic, road closures, and evacuation routes
- Maintain dikes and drainage systems
- Carry out flood protection activities (sandbagging, pumping, excavation)
- Temporary road construction and transportation restoration after floods

- Provide equipment, vehicles, and staff for emergency response and Emergency operation centers (EOC)
- Work with RCMP on traffic control during emergencies

These operations are supported by other municipal departments and transportation agencies, where Development and Planning Services provide technical support on traffic management and road use during emergencies (p. 50), and BC Transit supports emergency operations by providing transportation for evacuations, maintaining transit service in unaffected areas, and supporting Emergency Operations Centre (EOC) operations (p. 70).

Sea to Sky Multimodal Evacuation Plan

This plan establishes a coordinated framework of roles, responsibilities, and actions to safely evacuate communities such as Squamish and Whistler during major hazards, including floods (p. 3) . Flood events can trigger partial or mass evacuation by cutting off access routes and disrupting transportation networks (p. 10) . Road infrastructure, particularly Highway 99, plays a critical role as the primary evacuation corridor, although its effectiveness is constrained by limited capacity, bottlenecks, and the absence of parallel alternative routes (pp. 20–21, 33, 59) . Evacuation efficiency depends heavily on traffic management strategies such as lane adjustments, detours, signage, controlled access, and temporary traffic control measures used to optimize flow and reduce congestion during emergencies (pp. 59–60) . While alternative modes such as marine, rail, air, trails, and Forest Service Roads are considered, they are largely supplementary due to physical and operational limitations (pp. 32–34) . Flood and evacuation planning involves multiple agencies, including District of Squamish, Squamish Nation, RCMP, BC Transit, Ministry of Transportation Management and Infrastructure, and Emergency Management of BC (p. 6) . Overall, the plan emphasizes that managing road capacity, ensuring coordinated traffic control, and maintaining access for emergency services are essential for effective evacuation under flood-related disruptions (pp. 20, 59–60).

Provincial and federal plans are summarized in Table 1, which compares key aspects of flood risk management, including vulnerability and risk assessment, prevention and mitigation, preparedness and response, recovery and adaptation, governance and actors, and relevant policies, programs, and planning frameworks.

Provincial agencies, particularly the BC Ministry of Transportation and Infrastructure (MOTI), play a leading role in flood risk management for road infrastructure, while federal involvement is mostly guidance-based. The plans focus strongly on emergency response and recovery, such as road closures, traffic management, and rapid restoration. However, detailed long-term, road-specific adaptation and prevention strategies remain limited.

Resources	Vulnerability and Risk Assessment	Prevention and Mitigation	Preparedness and Response	Recovery and Adaptation	Governance and Actors	Policies, Programs and Plans
Provincial						
BC Highway Flood Recovery Projects	Flooding and landslides damaged highways and transportation routes (including Highway 99), disrupting transportation networks.	Some sites include slope stabilization, culvert replacement, and infrastructure improvements to increase resiliency.	Temporary repairs were completed quickly to reopen roads and restore transportation access after the flood disaster.	Long-term reinstatement and reconstruction of critical transportation infrastructure damaged by the 2021 flood event.	BC Ministry of Transportation and Infrastructure (MOTI): collaboration with local governments, Indigenous communities, contractors, and stakeholders.	Long-term highway reinstatement program and transportation resilience planning after extreme weather events.
TranBc-Current road advisories and information	-	-	Provides travel advisories and road closure information; directs travelers to DriveBC and EmergencyInfoBC during events such as floods affecting highways.	-	BC Ministry of Transportation and Transit (TranBC).	-
Reconnecting Roads After Massive Flooding (PMI case study)	2021 atmospheric river flooding in BC damaged highways (including Highway 99), bridges, and disrupting transportation networks.	-	The government prioritized reopening critical transportation routes and restoring connectivity after the flood disaster.	Roads and bridges were repaired and rebuilt to restore transportation and supply chain connections.	BC Ministry of Transportation and Infrastructure; engineers, contractors, emergency responders, and government agencies.	Project management strategy for infrastructure recovery.
TranBC – What Happens After a Washout Hits a Highway (BC)	-	-	After a washout, the highway is closed, traffic control and detours are implemented, and engineers assess damage and safety risks.	Road reconstruction includes rebuilding the road base, replacing culverts, and reopening the highway after repairs.	BC Ministry of Transportation, geotechnical engineers, maintenance contractors, environmental teams.	-
FNHA – Heavy rainfall raises flood risk and road closures	Heavy rainfall and flooding can cause highway closures (including the Sea to Sky region) and travel disruption.	-	Emergency alerts, evacuation orders, travel advisories, and emergency planning during flood events.	-	First Nations Health Authority (FNHA), EmergencyInfoBC, DriveBC.	-

Resources	Vulnerability and Risk Assessment	Prevention and Mitigation	Preparedness and Response	Recovery and Adaptation	Governance and Actors	Policies, Programs and Plans
Provincial Flood Emergency plan	-	Safety & maintenance of forest service roads (FSR); safety & protection of highway, road and bridge; clear drainage infrastructure; inspection patrols	Deploy staff to PECC and PREOC; urgent assistance to first nations & local authorities; supply equipment and construction material for highway; establish alternate routes; install road flood warning signs	-	FLNRORD*, MOTI, PECC*, PREOC*, First nations and local authorities	Emergency Program Act, BC Emergency Management System (BCEMS), Water Sustainability Act (WSA)
Climate Change Engineering Vulnerability Assessment of Three British Columbia Highway Segments	Assesses vulnerability of highway infrastructure to climate change (extreme precipitation and flooding); identifies infrastructure components at risk from flooding, drainage failure, and extreme weather.	Recommends infrastructure upgrades, improved drainage systems, design changes, and engineering measures to reduce vulnerability to extreme precipitation and flooding.	Includes infrastructure management, maintenance practices, operations planning, and monitoring of infrastructure performance under climate impacts.	Provides recommendations for adaptation, infrastructure upgrades, and long-term resilience planning for transportation infrastructure.	BC Ministry of Transportation and Infrastructure (BCMOTI), engineers, climate scientists, and consultants	Climate adaptation guidance, infrastructure planning standards
Lower Mainland Flood Management Strategy Phase 1 Summary Report	Highway 99 to Squamish vulnerable to flooding; flood could disrupt roads, emergency services, and supply chains	Flood protection infrastructure, dike upgrades, land-use planning, and infrastructure protection planning to reduce flood risk.	Emergency planning for transportation disruption, alternative routes, emergency access planning, and coordination among agencies.	Restoration of transportation networks, infrastructure repair, and long-term adaptation planning to improve infrastructure resilience.	Government of Canada, Province of BC, local governments, public and private organizations	Lower Mainland Flood Management Strategy, floodplain mapping programs, flood mitigation programs, and infrastructure planning policies.
Federal						
Guide for Resilient Infrastructure: Protecting Communities and Infrastructure from Flooding	Identify infrastructure in flood-prone areas; assess culvert and drainage capacity; evaluate bridge scour risk; consider future flood levels and climate change impacts	Pave gravel roads to reduce washouts, install drainage systems, increase culvert capacity and road surface curvature, elevate or relocate roads and bridges, reinforce bridges	Maintain emergency access routes, monitor infrastructure during floods, conduct emergency road repairs and debris removal	Repair damaged roads and bridges; retrofit infrastructure; upgrade drainage systems; relocate infrastructure from high-risk areas	Indigenous Services Canada, First Nations governments, community infrastructure planners and engineers	Infrastructure flood resilience and climate adaptation planning guidance

Table 1. List of provincial and federal plans

*FLNRORD-Ministry of Forests, Lands, Natural Resource Operations and Rural Development, PECC (Provincial Emergency Coordination Centre) ,PREOC (Provincial Regional Emergency Operations Centre)

Ferries

Ferries are considered critical infrastructure during flood hazards because they provide connectivity when land-based transportation networks are blocked or damaged by floods. They function as a vital lifeline for evacuation and emergency response. Ferries in BC are primarily owned and operated by BC Ferries. There are some but very few routes that are operated by local First Nations, such as the Lax Kw'alaams First Nations, who operate from Prince Rupert to Lax Kw'alaams. BC Ferries used to be a Crown corporation in the past, but in 2003, the company turned into an independent entity. While BC Ferries is now an independently managed, publicly owned company, they still work closely with the BC government and are a regulated contractor under the Coastal Ferry Act.

Flood risk prevention and mitigation

BC Ferries does not currently have any flood mitigation strategies or any hazard mitigation strategy at all. The company does mention strengthening their fleet resiliency, but there is no mention of how they plan to do so or what specifically they plan to build resiliency for. The company does have a Facilities Maintenance Unit Redevelopment Project that is focused on modernizing the existing maintenance facility in Richmond, BC. The project aims to include seismic upgrades, flood mitigation measures, stormwater management, and energy efficiency optimizations. However, this project is taking place in their Richmond maintenance facility and is less relevant to Squamish flood hazards.

Since BC Ferries does not have any current hazard mitigation strategies, they are not working with the Squamish Nation or any Indigenous community to mitigate flood hazards. Their Indigenous relations are relatively surface-level, with goals to have mutually respectful relationships, support culture and art on vessels, and have economic participation from Indigenous peoples.

Preparedness and response

BC Ferries themselves do not have an emergency plan or evacuation plan. Nor do they have any publicly available information on how they would recover if any emergency were to happen to their vessels or facilities. However, in the Sea to Sky Multimodal Plan, ferries are used as a transportation method in case of an emergency. In the plan, two Squamish terminals, Darrell Bay and Porteau Cove, are the two potential terminals that could be used for emergency evacuation. The document also mentions that Woodfibre LNG has plans to build a second private ferry dock at the Darrel Bay site. While one or more ferries are included in the plan, BC Ferries does not offer direct services to the evacuation zone. BC Ferries has never tested docking at the Squamish terminals and is unlikely to ever risk docking in Squamish. The terminals do not have a roll-off gangway, so vehicles cannot enter the ferries, but the terminals could board foot passengers in case of an emergency.

Railways

The railway is an important critical infrastructure that is vulnerable to flood hazards. Railways can be an important mode of transportation during an emergency when roads and highways are blocked or damaged by flooding. The railways in BC are owned and operated by several stakeholders. The main decision makers are Canadian National (CN) Rail, British Columbia Railway Company (BCRC), the BC Province, and the federal government. While CN Rail used to be a Crown corporation, it is currently a for-profit private company. All other stakeholders are Crown corporations or government entities.

Flood risk prevention and mitigation

CN Rail does not mention flood risks or any hazard mitigation plans. All prevention and mitigation plans for railways are created or supported by the government. The Jimmy Jimmy (Judd) Slough-Dyke Upgrade is a dyke upgrade to raise 900 meters of the Squamish River dyke on private land between Wai'wakum Reserve and Aik'wuck's. This upgrade is intended to protect significant and regional infrastructure that includes the CN Rail mainline. As seen in Figure x, the dyke upgrade would protect the CN mainline that is south of the Stawamus River, along the Mamquam Blind Channel crossing and along Buckley Ave. While the project was not proposed specifically to protect the rail line, the rail line was a major factor in the prioritization of this dyke.

The federal government also has a Rail Climate Change Adaptation Program that includes several projects across the country to address the risks that climate change poses to Canada's rail network. The program has five projects that are located along the BC railways. A few of these projects include the Washout Hazard Risk Assessment and Monitoring System Deployment, Remote Sensing Integration for Geohazard Management, Monitoring of Flood Risks on Rail Bridges in Southern BC, and Improving Bridge Resiliency. These projects focus mainly on monitoring the risk of hazards, mainly flooding, in and around the rail lines.

Preparedness and Response

None of the main decision-makers for the railways has an evacuation or recovery plan for when emergencies happen. However, the Sea to Sky Multimodal Evacuation Plan includes rails as a mode of transport during emergencies. The plan states that CN Rail has indicated that they are willing to assist where they can in case there is an emergency. The railway tracks are parallel to the highway corridor throughout the evacuation zone. There is also a working rail connection between Vancouver and North Vancouver that would allow rail assets from Vancouver to travel up to the Sea to Sky. However, rail use is fairly slow; it takes about two hours to travel from Squamish to North Vancouver; therefore, relying on rail as a transportation mode is not ideal.

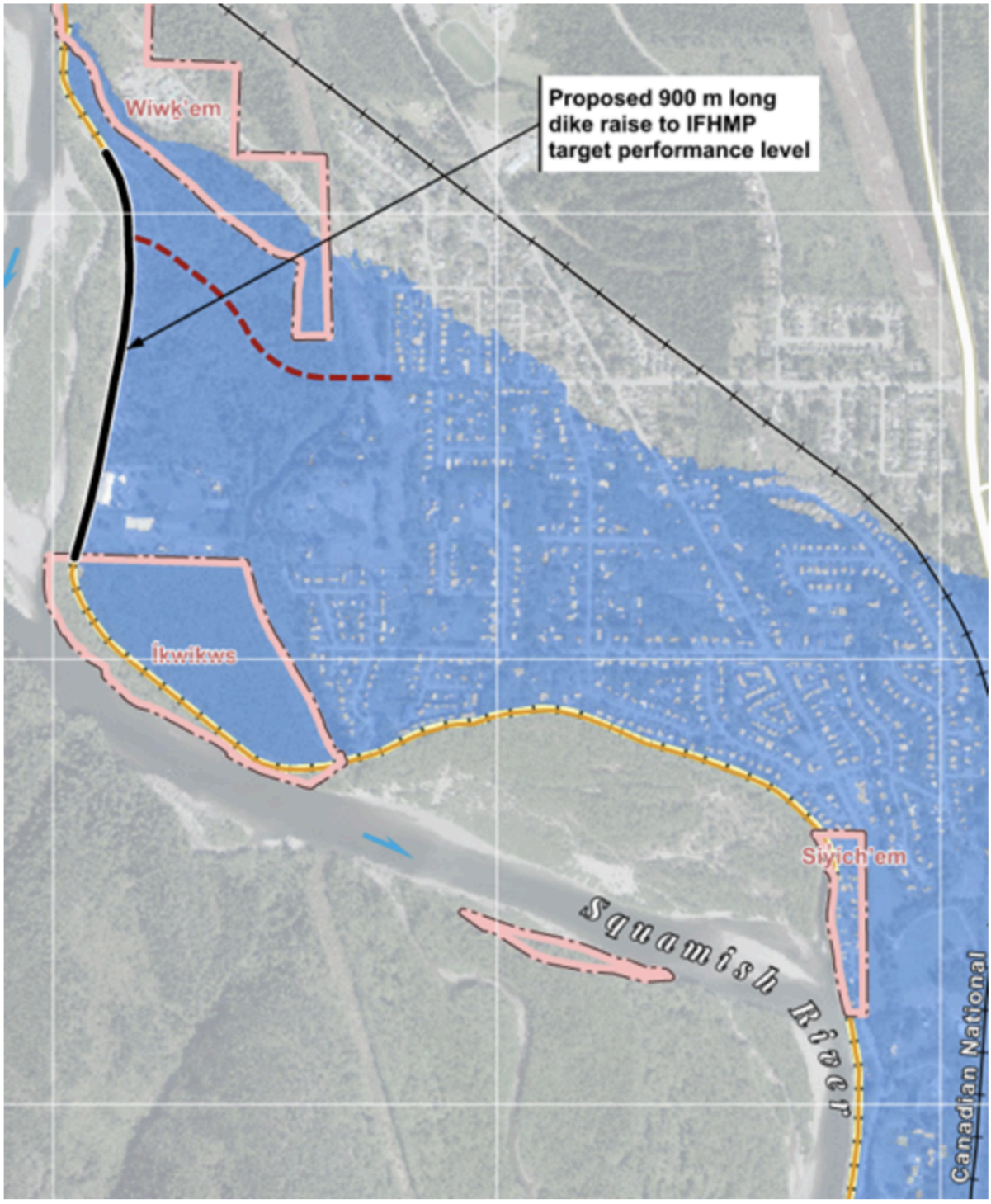

Figure 5. Proposed location of the Jimmy Jimmy (Judd) Slough Dyke upgrade

Key Takeaways

- There is strong preparation for emergency response and evacuation, including traffic control, road closures, and coordination among agencies such as the District of Squamish, BC Transit, and provincial authorities.
- Provincial and district actors (e.g., Ministry of Transportation and Infrastructure, District of Squamish, Emergency Management BC) are actively involved in maintaining and restoring road access and infrastructure during flood events.
- Transportation systems, especially Highway 99 and key bridges, are clearly identified as critical but highly vulnerable, with heavy reliance on a single corridor increasing the risk of isolation.
- There is limited preparation in terms of detailed, road- and bridge-specific flood adaptation and long-term resilience planning, with more focus on response than prevention.
- Multimodal options such as rail and marine transport are considered for evacuation, but they remain secondary and constrained, reinforcing dependence on roads.
- BC Ferries needs to create flood risk mitigation strategies that include the voices of the Squamish Nation.
- The railways are somewhat protected through dykes and remote sensing; however, there are still areas where the rail line is susceptible to flooding and washout events.
- Both the railways and ferries are transportation options for evacuation. However, they both face some drawbacks and uncertainties. The railway is slow, taking roughly two hours to get from North Vancouver to Squamish, and BC Ferries is unsure if their ferries can fit at the Squamish terminals.
- Indigenous communities, including the Squamish Nation, are recognized in planning frameworks, but there is limited explicit detail on Indigenous-led planning or tailored evacuation strategies, indicating a gap in meaningful inclusion.

Health

Health is considered an essential critical infrastructure during flood hazards because healthcare facilities must remain operational to treat not only pre-existing patients but also new patients who get injured during the flood hazard. Hospitals face high risks during flood hazards, such as interruption of electricity and water, which may force evacuation or closure. The main decision makers for health in Squamish are the Squamish General Hospital (SGH), which is under Vancouver Coastal Health (VCH), and the District of Squamish.

For this section, keywords such as "health," "hospitals," "flood hazard," and "emergency response" were input into Google to see the initial results. Within documents, we did an initial text search with keywords like "hospitals," "health," and "emergency response." Then we scanned through the documents to identify any healthcare-related contributions that did not contain any of the keywords to understand the context of where the keywords were situated.

Prevention and Mitigation

The VCH does not have any flood mitigation strategies specific to the SGH. However, in the Disaster Preparedness in Store by GreenCare they mention that the VCH and Health Emergency Management British Columbia have added emergency shipping containers filled with supplies and equipment to support three days. As of 2023, there is an emergency shipping container next to SGH and Hilltop House (HTH). These shipping containers are built for several natural hazards such as floods, fires, power outages, and other extreme events.

Squamish also has an Integrated Flood Hazard Management Plan that has general flood mitigation tools for the Squamish area. While health is generally included, the plan does not explicitly mention flood mitigation strategies for hospitals or other healthcare facilities. It is also important to note that the SGH is a fairly small hospital and cannot handle large numbers of patients at a single time and must move overflow patients to other hospitals.

Preparedness and Response

While the SGH does not have its own flood evacuation plan, it is included in the Squamish All Hazards Plan (AHP)**.** The plan goes over how each healthcare affiliate will act in case of an emergency. The SGH will implement their emergency plan that will provide emergency health care services and refer overflow patients to Lions Gate Hospital or Vancouver General Hospital. The Diamond Head Medical Centre will implement its emergency plan and provide emergency healthcare services and refer overflow patients to the SGH or Lions Gate Hospital. If the SGH is damaged or unreachable, local medical partners are expected to assist in setting up a field hospital. St. John Ambulance has the resources for communication, mobile canteen services, and first aid and will assist first responders. Lastly, the Operations Department is responsible for maintaining road networks and water systems. In an emergency, they will maintain flood control measures and clear roads when necessary.

Key Takeaways

- The SGH has emergency shipping containers that have three days' worth of emergency supplies.
- The SGH and other healthcare facilities need structural upgrades to protect themselves against flooding and other natural hazards.
- The healthcare centers are small, so during an emergency, it is important to refer overflow patients to larger hospitals so the hospitals can focus more on the immediate threats.

Energy

BCHydro and FortisBC are the two major energy companies providing Squamish and the Squamish Nation with power and heating. Existing flood hazard assessments and mitigation strategies for BC Hydro and FortisBC facilities highlight both current protections and remaining gaps in flood-specific planning. It also highlights the role of emergency preparedness and collaboration with the Squamish Nation in supporting resilient energy infrastructure.

Data Collection and Methodology

All policies, reports, and posts from BC Hydro and FortisBC, as well as the Squamish OCP and Community Risk Assessment, were searched with keywords flooding, flood hazard, and debris flow.

Vulnerability of Critical Infrastructure to Flooding

The Squamish Community Risk Assessment lists the BC Hydro substation (Cheekye Station) located along Highway 99 as a vulnerable area to debris flow. They propose three risk management strategies:

1. Stronger hazard/risk direction in the OCP to direct land use planning and growth management with hazard impacts in mind
2. Establish comprehensive evacuation plans for multiple hazards, and multihazard impact scenarios, including hazard monitoring and alert systems
3. Implementation of engineered structural mitigation

No BCHydro or other critical infrastructure is listed as being within a vulnerable area for flood hazards.

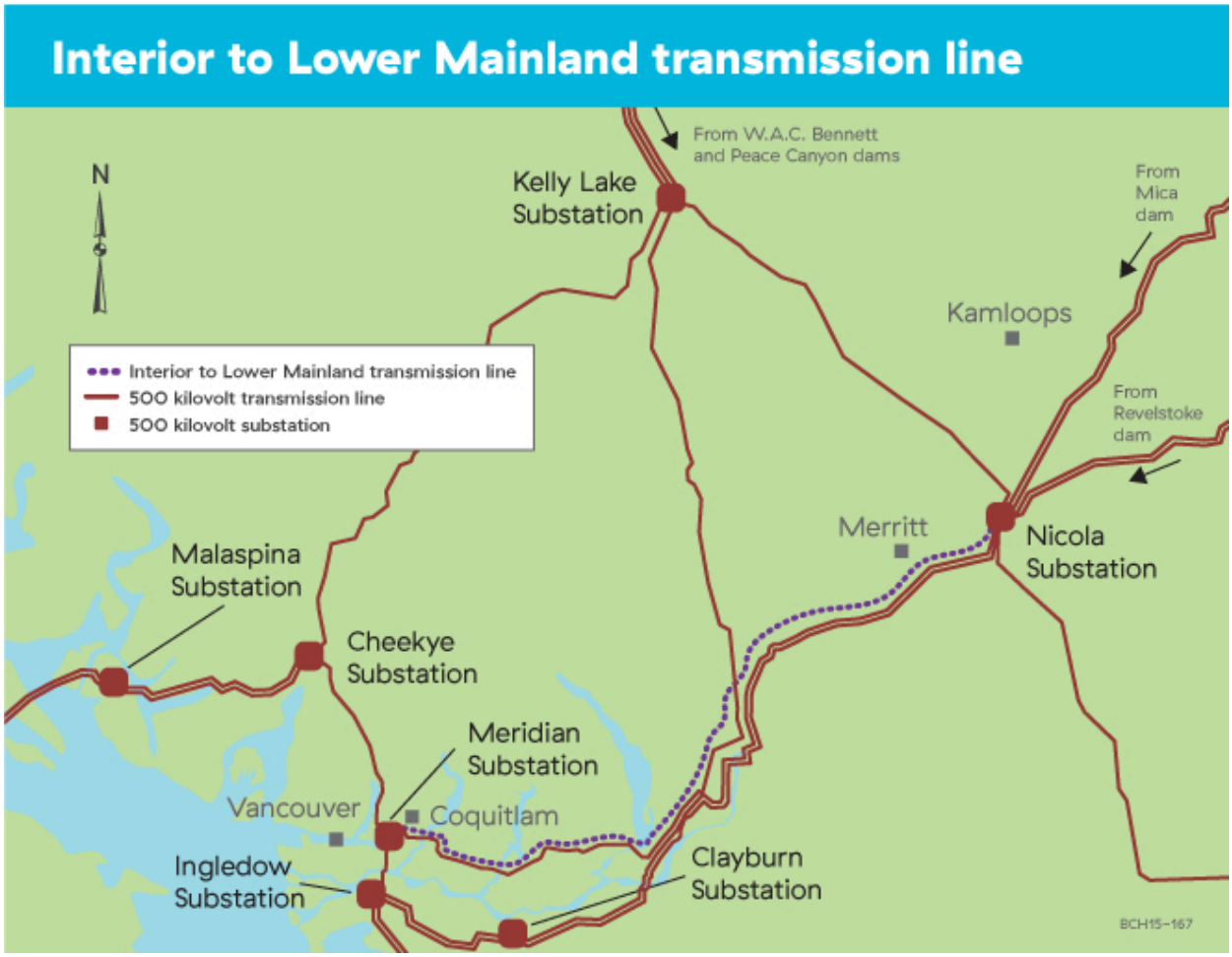

Figure 6. Map of BC Hydro Substations, including the Cheekye Substation in Squamish and the Meridian Substation in Coquitlam, both of which reside in Squamish Nation.

Flood Risk Mitigation Measures to Protect Critical Infrastructure

In Appendix A of the Woodfibre LNG Project, which responds to public comments, it is stated that Woodfibre LNG conducted a flood, debris flow, and debris flood hazard assessment of the Woodfibre LNG Project site in December 2021. Furthermore, they state that if required, based on these results, debris flow mitigation measures such as diversion and catchment structures will be designed by qualified registered professionals. No recent updates have been made regarding the results of their flood hazard assessment or anticipation of diversion and catchment structures. However, this project has only recently begun building infrastructure, and therefore future updates may hold more answers.

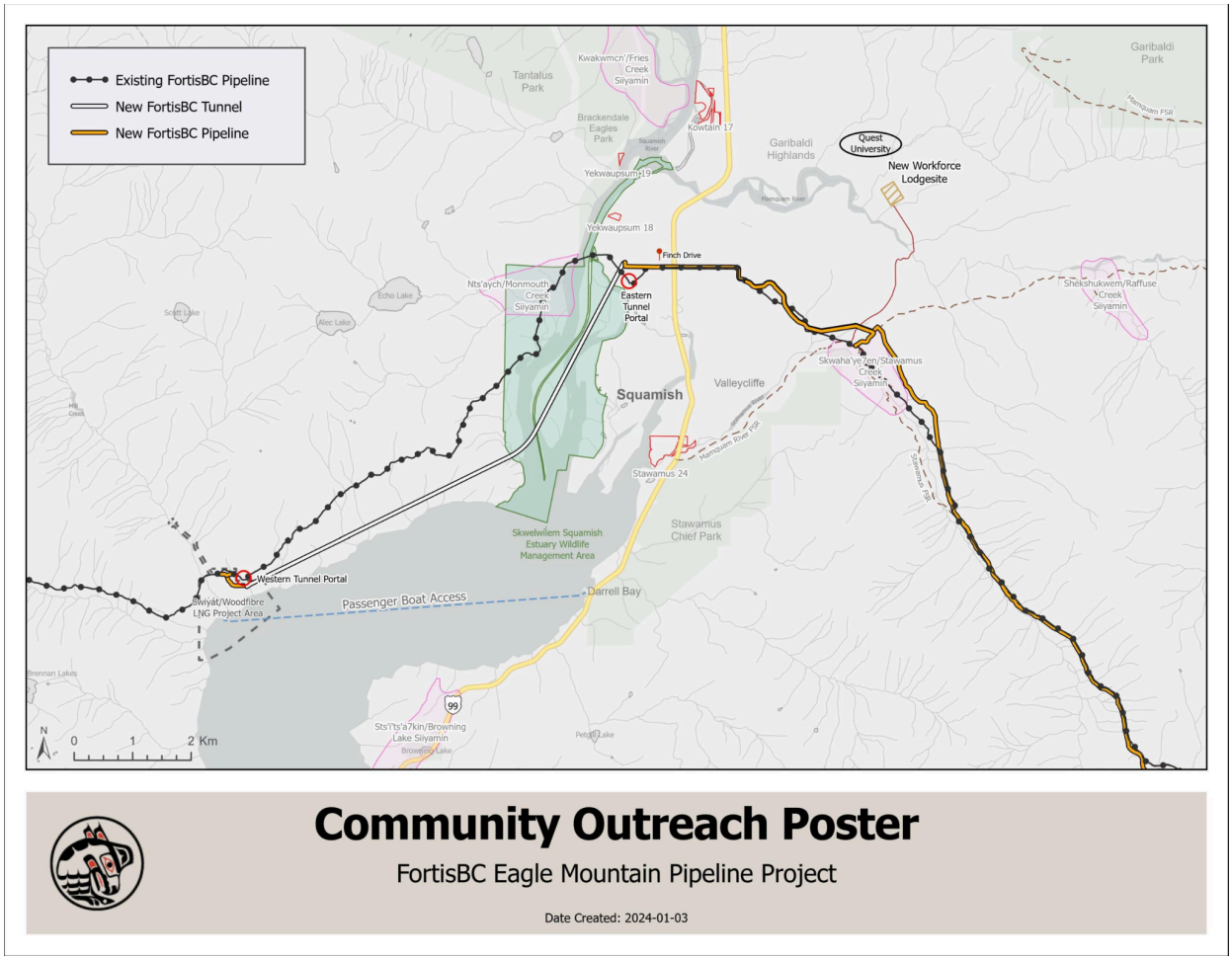

Figure 7. Location of new Eagle Mountain-Woodfibre gas pipeline spanning Coquitlam to Squamish.

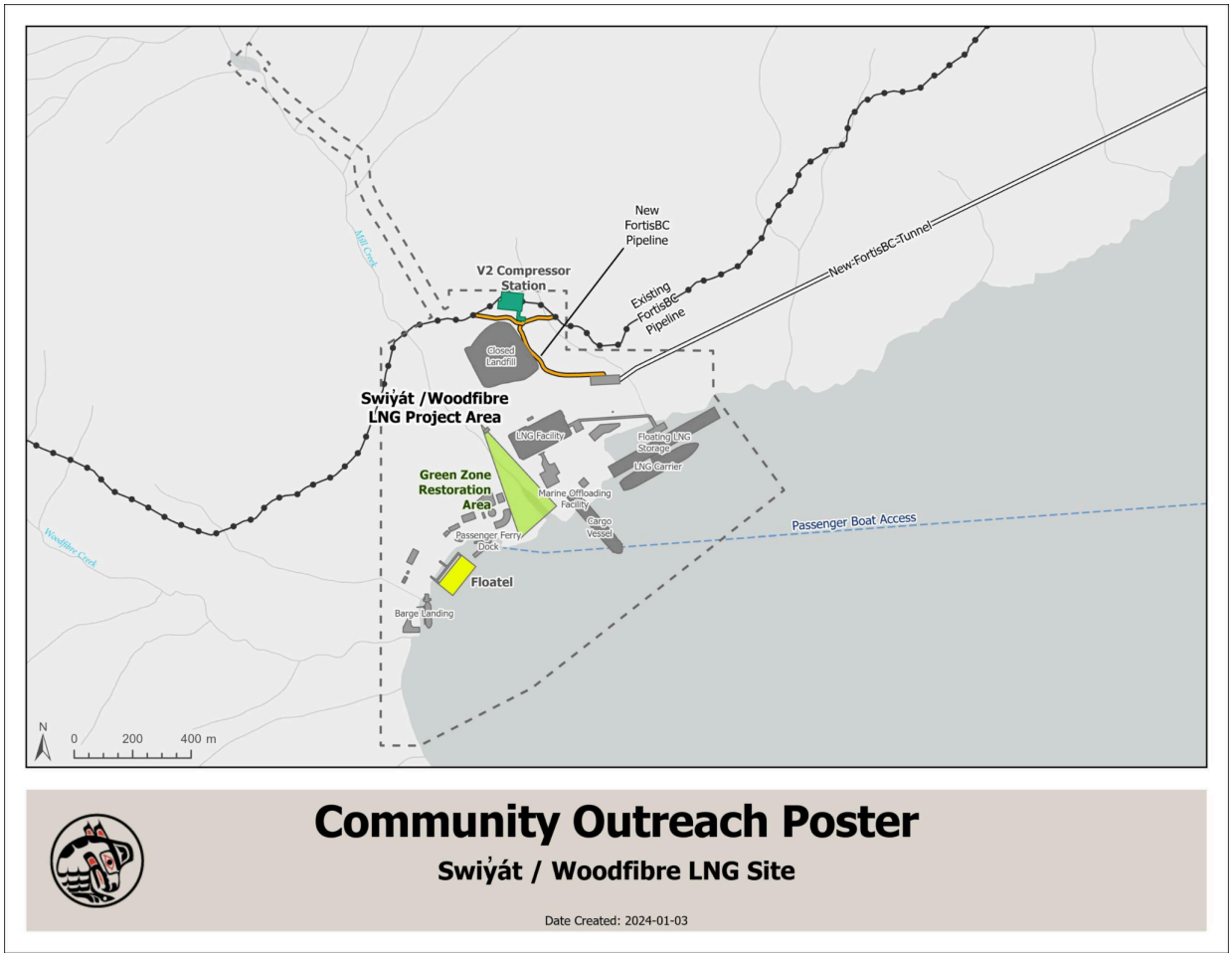

Figure 8. Location of the new Woodfibre LNG site residing on Swiýát, an ancestral village site in Squamish Nation.

Threats of Flooding From Critical Infrastructure

The Squamish Community Risk Assessment lists the Daisy Lake Dam as a moderate-level hazard, which could cause immense damage and loss of life if this were to occur. They highlight the lowest-lying areas as more vulnerable to any emergency release or dam failure scenario. Emergency release occurs during flooding events or severe storms where water levels exceed the maximum capacity of the dam. BC Hydro has mapped eight inundation scenarios to assist emergency planning. The community risk assessment proposes three risk management strategies:

1. Develop and rehearse comprehensive evacuation plans, including vulnerable populations.
2. Continue coordination and communication with BC Hydro to ensure knowledge of dam status remains current.
3. Consult BC Hydro to develop an early warning notification system and a more streamlined communication system to the public.

Emergency Preparedness and Response

FortisBC has a Flood Preparedness fact sheet for how to protect natural gas and electric appliances if you're at risk of flooding, as well as how to stay safe after you've returned from evacuation. This fact sheet highlights tips for restoring your equipment and appliances after a flood. Similarly, BC Hydro has a Flood Electrical Safety Information guide with tips on what to do during an evacuation order and what to do after you return home from an evacuation. Both the FortisBC and BC Hydro guides provide an emergency line to contact for any further questions about preparing for or restoring after flooding.

Relationship with Squamish Nation

FortisBC has a long-standing positive relationship with the Squamish Nation, which began during the lead-up to the 2010 Whistler Olympics when Fortis upgraded their natural gas line to Whistler. This partnership was built on addressing the cultural and spiritual values of the Squamish Nation regarding their traditional territory. The Squamish Nation signed environmental assessment agreements in 2015 for a new Woodfibre LNG compressor station in 2016 for the Eagle Mountain-Woodfibre gas pipeline. Squamish Nation representatives led an independent technical review of environmental issues and community engagement stated in the Environmental Update August 28, 2019. Also included in this update, Condition 4.12 Binding Mitigation Measures states that the Squamish Nation will have representatives on working groups with both Woodfibre and Fortis to oversee compliance with Environmental Conditions in the Squamish Nation Environmental Assessment Agreements. In the How Squamish Nation and Partners Made History blog post by FortisBC, they mention that having a direct, independent, Indigenous-led review allowed for more direct two-way communication and a better understanding of their environmental and cultural priorities in the project.

The history between BC Hydro and the Squamish Nation is more complex; however, recent projects have achieved more collaboration between the two. Particularly the new Capilano substation, which was built almost entirely by Squamish Nation businesses, and the Box Canyon Hydro project, which shares the provincial revenue with the Squamish Nation. A story feature Rooted in Reconciliation: Honouring land, legacy, and community in North Vancouver posted by BC Hydro highlights the creation and ceremony for a new welcome figure carved by artists Delmar Joseph Jr. and his sister Siobhan Joseph next to the newly rebuilt Capilano Substation as a display of the relationship they're building.

Figure 9. Ceremony for a welcome figure placed next to the newly rebuilt Capilano hydro substation.

Key Takeaways

- BCHydro needs more flood risk mitigation measures, especially pertaining to dam leakage caused by severe storm events
- Look out for future updates of flood risk and mitigation for FortisBC Woodfibre LNG projects.
- Both BCHydro and FortisBC have detailed and accessible emergency response plans.

Telecommunications

Telecommunications infrastructure in Canada is governed through a multi-level framework involving the federal government, provincial authorities, and private service providers. At the federal level, the Government of Canada holds primary regulatory and oversight authority through key legislation, namely, the Telecommunications Act, the Broadcasting Act, and the Radiocommunication Act. Two central institutions that implement this are Innovation, Science, and Economic Development Canada (ISED) and the Canadian Radio-television and Telecommunications Commission (CRTC) (Government of British Columbia, 2026). The provincial government does not directly regulate telecommunications but plays an important role through control of public assets, infrastructure access, building codes, and providing subsidies for expanding connectivity in underserved areas (Government of British Columbia, 2026). Alongside public actors, the telecommunications landscape in Western Canada is dominated by three major private providers: TELUS, Rogers Communication, and Bell Canada, which are responsible for building, maintaining, and operating critical telecommunications infrastructure.

Data Collection and Methodology

This report examined how telecommunications are addressed in emergency planning through reviewing publicly available emergency plans from the Government of British Columbia website. The terms “telecommunication” and “communication” were scanned. Plans containing these terms were identified, and relevant sections related to critical infrastructure and emergency management were filtered for further analysis. To complement this, information was collected from official websites of the major providers, including news updates and publicly available materials on emergency response and preparedness. The collected information was organized into tables for each company to outline their approaches to infrastructure protection. A comparative table was then created to assess the differences across the three companies based on four areas: preparation, mitigation, individual support, and Indigenous collaboration. However, this report is limited to publicly accessible information; the companies may have internal emergency plans and protocols that are not disclosed.

Provincial

Given the importance of communication systems during emergencies, this section examines the extent to which these plans explicitly address telecommunications infrastructure within emergency planning. By reviewing how telecommunications is referenced, it becomes possible to assess whether this is adequately considered in provincial preparedness and strategies.

BC Emergency Management System (2016)

The first mention of telecommunications in this plan appears under identifying stakeholders, where it is grouped with other critical systems such as energy and technology (p. 26). Government actors and critical infrastructure owners are expected to build redundancy, protect systems, and support emergency response and recovery efforts, including providing updates on service disruptions (p. 27). Under the Mitigation Tools and Activities, the plan mentions how the province would reduce risks in terms of infrastructure by including the upgrading of telecommunications and fibre-optic lines among seismic retrofitting of bridges and schools, and construction and maintenance of dikes (p. 36).

Emergency Operations Center (EOC) - Operational Guidelines (2nd Edition)

The Communication Plan section outlines the procedures within the broader British Columbia Emergency Communication Plan, which generally discusses nets, equipment, permanently assigned frequencies, and task assignment of personnel from ministries and agencies (p. 2-12). However, the plan itself does not appear to be publicly accessible, limiting the ability to assess its specific provisions and level of detail. Nevertheless, this section mentions how at a minimum, telecommunication systems are required to support communication between Incident Command Posts or Department of Operations Centers (DOC), as well as with Provincial Emergency Program (PEP), Provincial Regional Emergency Operations Centre (PREOC), and other EOCs as needed. While the plan does not explicitly provide detailed guidance on how telecommunications infrastructure should be protected or managed during emergencies, this is somewhat understandable, as the document functions primarily as a procedural guideline focused on coordination and communication rather than infrastructure planning.

All Hazard Plan BC

Below are the areas where telecommunications are mentioned:

- Under the Provincial Central Coordination, the Emergency Coordination Centre (ECC) operates as a 24-hour hub that monitors and reports emergency incidents across the province and coordinates with regional and provincial emergency operations when needed. In this context, telecommunications is referenced in terms of maintaining the flow of information between agencies, particularly if local communications are disrupted (p. 26).
- The Federal Government, under Public Safety Canada, offers federal support during emergencies. Upon request from the province, PSC coordinates with other agencies for the needed resources. Within this framework, Innovation, Science and Economic Development Canada (formerly Industry Canada) is identified as providing situational awareness of critical telecommunications infrastructure (p. 42).

- Under the Ministry of Forests, Lands, and Natural Resource Operations, telecommunications is identified as one of the resources the ministry can provide during an emergency response. Telecommunications equipment is listed alongside personnel, supplies, aviation support, and weather information, highlighting its role in supporting on-the-ground operations (p. 49).
- Shared Services BC is responsible for providing technological and logistical support during emergencies. They likewise support ministries and public sector organizations in maintaining and restoring essential services, including managing requests for technological resources during emergency activations. It also provides technical advice and assistance in acquiring telecommunications infrastructure, equipment, systems, services, and computers (p. 55).

In the provincial plans, telecommunications is often treated as a supporting resource, rather than a distinct category of critical infrastructure. They also generally prioritize enabling communication rather than explicitly protecting telecommunications infrastructure. Detailed guidance on infrastructure hardening, restoration, or long-term resilience is largely absent, mainly due to it being left to the responsibility of the telecommunications companies.

Telecommunication Companies

This section examines how TELUS, Rogers Communications, and Bell Canada address emergency preparedness and response, based on publicly available information, to understand their approaches to preparation and mitigation, supporting affected communities, and Indigenous collaboration during crisis events. The location of cell towers is presented in the image below, with TELUS dominating in number around the Squamish Nation territory.

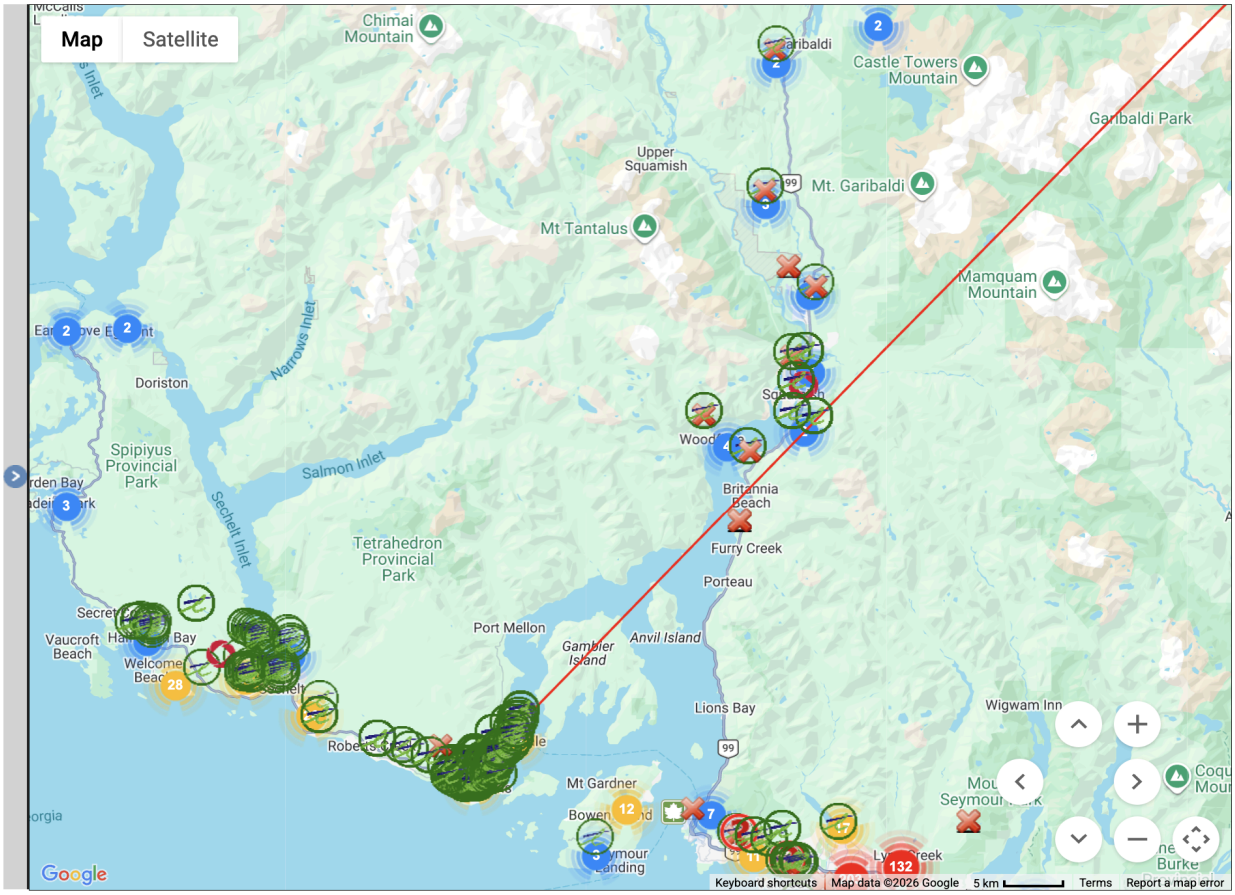

Figure 10. TELUS, Rogers Communication, and Bell Canada cell tower locations from the [Canadian Cell Tower Map](#).

TELUS

Out of the three companies, TELUS has the most publicly available information about how they demonstrate their efforts in planning during emergency events. The company outlines a structured approach to emergencies through its [Incident Management Ecosystem](#), which covers their emergency response before, during, and after an event. Before emergencies, the focus is on preparedness through network design, including multiple network backbones, 11 distributed network cores to avoid single points of failure, and extensive fiber deployment to improve reliability. During emergencies, they activate dedicated response teams, operate emergency generators, and deploy portable technologies and satellite-connected systems to maintain connectivity. After emergencies, efforts shift toward restoring full service, assessing damage, and strengthening infrastructure to improve future resilience.

In terms of mitigation and preparedness, TELUS invests in both physical and technological resilience. This includes deploying backup generators, solar-powered cell towers, and portable solutions such as Cell on Wheels (COWs) and Rapid Deployable Temporary Network (RDNT) systems to maintain connectivity during emergencies (TELUS, 2023; TELUS, 2024). The company is also proactively building a TELUS PureFibre footprint using a fiber-optic cable, which is 85 percent more energy-efficient than copper, making it less prone to disruptions during emergencies (TELUS, 2024). Additional measures include building network redundancy and upgrading infrastructure to handle increased traffic demand during disruptions.

In addition, TELUS provides individual support by waiving fees, offering data top-ups, and supporting evacuation centers with Wi-Fi access and satellite phones for responders (TELUS, 2020). Importantly, the company also collaborates with local Indigenous Nations, notably through partnerships such as its work with the Nisga'a nation to develop community-owned telecommunications infrastructure and provide technical training (TELUS, 2023). They were likewise the only company that has an Indigenous Reconciliation Action Plan, where they have targets such as expanding TELUS broadband networks to at least 20 Indigenous lands by 2025 (TELUS, 2025a). And according to their Indigenous Reconciliation & Connectivity Report 2025, they have expanded connectivity to 23 Indigenous lands and 7 communities (TELUS, 2025b).

Rogers Communications

Rogers Communications does demonstrate efforts in preparing for emergency events, although its approach appears less comprehensive compared to TELUS based on publicly available information. In terms of mitigation, Rogers focuses on maintaining network operations during disruptions, such as proactively fueling generators during power outages and coordinating with government agencies to ensure access to critical sites (Rogers, 2023). However, there is limited publicly available detail on broader preparedness strategies, such as infrastructure hardening or pre-deployment of emergency technologies.

For individual support, the company has taken steps to maintain connectivity for affected populations, including opening WiFi hotspots to all users regardless of carrier and waiving service fees for impacted customers (Rogers, 2023). In terms of Indigenous collaboration, the company has a $1 billion Rural and Indigenous Connectivity Fund dedicated to connecting more rural, remote, and Indigenous communities (Rogers, 2022). Rogers also is committed to expanding connectivity through investments in fiber, fixed wireless access, and 5G infrastructure, notably in projects along Highway 16, also known as the Highway of Tears, where many Indigenous (MMIW2S+) women have gone missing or have been found murdered to improve safety and coverage (Rogers, 2022). However, unlike TELUS, there is no publicly available framework for detailed emergency planning.

Bell Canada

From the two other companies, Bell Canada has the most limited information available. As opposed to Rogers, which has more focus on mitigation, Bell has a stronger emphasis on preparedness and operational continuity. In terms of preparedness, Bell conducts daily network reviews to monitor stability and ensure readiness for potential disruptions (Bell Canada, 2024b). The company also prepares their critical infrastructure, such as wireless cell sites, data centers, and central offices, by maximizing battery life and ensuring that generators and fuel supplies are readily available. Priority is given to maintaining power at key locations, including major fiber routes and public safety communication systems. For individual support, Bell focuses on enabling communication for emergency responders through services such as mobile broadband, public safety land mobile radio (LMR), and interoperability systems (Bell Canada, 2024a). However, compared to TELUS and Rogers, there is little publicly available information on broader customer support measures (e.g. waiving of fees or public Wi-Fi access), Indigenous-specific initiatives, and a clear emergency plan.

Below is a comparative table to summarize each provider's initiative. A link to the signal coverage map to show 5G, 4G, and Low-Power Wide-Area (LPWA) signal strength is likewise embedded in the table.

Initiative	TELUS	Rogers Communications	Bell Canada
Mitigation	Deployment of generators & solar-powered cell towers; Rapid Deployable Temporary Network (RDNT) technologies; portable cellular towers; upgrading public Wi-Fi at evacuation centers.	Proactively fueling generators; maintaining access to sites during outages.	Ensuring generators have fuel during and immediately after events.
Preparedness	TELUS PureFibre footprint (fibre-optic cable); network upgrades for high traffic.	-	Year-round network review; maximizing battery life at cell sites, data centers, and central offices.
Individual Support	Data top-ups; waiving fees; satellite phones for responders; upgrading public Wi-Fi services at evacuation centers.	Opened Wi-Fi hotspots for impacted residents; waived wireless and residential services.	Mobile broadband for first responders, Public Safety LMR networks, and LMR Interoperability.
Indigenous Collaboration	Indigenous Reconciliation Action Plan; partnership with Nisga'a Nation	Rural and Indigenous Connectivity Fund; expanding 5G along Highway 16	-
Signal Coverage Map	TELUS	Rogers Communication	Bell Canada

Table 2. Comparison between the three providers.

Key Takeaways

- Telecommunications is recognized as important in emergency management, but preparedness varies across sectors and actors.
- Telecommunications is treated as part of broader systems, with little focus on protection, maintenance, or restoration during emergencies.
- Provincial plans prioritize communication as a function rather than telecommunications as critical infrastructure needing targeted investment.
- All providers maintain essential operations during disruptions.
- Only TELUS has a fully developed and publicly available emergency plan covering before, during, and after events.

Water

Drinking Water and Wastewater infrastructure are core aspects of community health, environmental protection, and economic stability. As defined by the Canadian Infrastructure Council, water and wastewater systems encompass fresh water sources such as rivers, lakes, springs, and groundwater, alongside physical and natural infrastructure including dams, reservoirs, wetlands, treatment plants, pipes, pumps, and sewage systems for draining stormwater. For the purposes of this analysis, the focus will be on reservoirs, groundwater well fields, and treatment infrastructure, which support safe drinking water and effective wastewater management.

Water infrastructure systems are vulnerable to flooding due to their physical locations and dependence on water systems. Many wastewater treatment plants are most often located by flood plains and bodies of water to minimize the distance treated effluent must travel before discharge. But this can expose facilities to damage during flood events, which are expected to increase in frequency and severity across Canada. Flooding can overwell collection and drainage systems, resulting in overflows and the release of contaminants into the environment. Water quality entering treatment can be affected during floods as runoff carries sediments, agricultural chemicals, industrial pollutants, and urban debris into source waters. Aging water infrastructure can exacerbate these vulnerabilities.

In the context of the District of Squamish, the Integrated Flood Hazard Management Plan, (IFHMP) models the flood scenarios on local systems and found that existing dikes do not provide the protection needed for a 200-year return period flood. Damages from such a failure would cause millions in damages and displace residents. The IFHP stated, "The loss of municipal facilities like fire halls, pump stations, and the wastewater treatment plant would create widespread hardship throughout Squamish." This assessment demonstrated the need to consider water infrastructure resilience to flooding.

Data Collection and Methodology

Data collection began by identifying the geographic and jurisdictional scope of water infrastructure relevant to Squamish Nation reserves and the surrounding municipalities. Squamish Nations lands were mapped to determine the corresponding water source, treatment facility, and service provider for each location. From this list a comprehensive document search was conducted for publicly available plans, strategies, reports, and agreements pertaining to water infrastructure in the Squamish Valley, Metro Vancouver, and, to a lesser extent, the Sunshine Coast.

Documents collected included water licensing agreements, integrated hazard management plans, climate action plans, water master plans, drinking water management plans, wastewater management plans, annual water quality reports, well protection plans, and service agreements. Federal and provincial legislative frameworks were also reviewed to establish the statutory baseline against which municipal and regional plans could be evaluated

The documents were imported into NVivo qualitative analysis software, where a structured keyword query framework was applied to identify passages relevant to flood hazard, infrastructure vulnerability, resilience, and emergency response. The query parameters were as follows:

- Flood Hazard: "flood" OR "storm surge" OR "sea level rise" OR "extreme precipitation"
- Infrastructure Vulnerability: "infrastructure" OR "system failure" OR "damage" OR "disruption" OR "river crossing"
- Resilience: "resilience" OR "adaptation" OR "infrastructure upgrade" OR "capacity" OR "redundancy"
- Emergency Response: "boil water" OR "do not drink" OR "emergency response" OR "contingency"
- Squamish: “First Nation” OR “Indigenous” OR “Reconciliation’ or “Squamish Nation”

Each flagged passage was read in full context for accurate interpretation and to extract relevant information. Supplementary searches were conducted for spatial data and infrastructure maps for use in spatial analysis. This included the provinces’ Drinking Sources in BC Map, Metro Vancover’s Water Service Map, and the district of Squamish’s Water Main Map.

Main Players

Drinking water governance in Canada is complex. Primary oversight rests with the provincial governments while municipalities support the day-to-day processes of treatment distribution and infrastructure maintenance. In British Columbia Responsibility is jointly held by the Ministry of Health, which oversees water quality, policy development, and public health safety, and the Ministry of Water, Land and Resource Stewardship, which manages source water protection, water licensing, and watershed stewardship. Municipalities are the primary service provider, a role enforced and sported by the regional Drinking Water Officer Who holds authority under the Drinking Water Protection Act.

Federally, Health Canada helps coordinate and set standards through the development of the Guidelines for Canadian Drinking Water Quality, which is done in partnership with provincial and territorial jurisdictions. Indigenous Services Canada is responsible for funding and supporting water systems on First Nations reserve lands. Notably, Bill C-61, the proposed Act respecting water, source water, drinking water, wastewater, and related infrastructure on First Nation lands, was introduced to the federal parliament in 2023 but was terminated following the prorogation of parliament in January 2025, leaving a legislative gap in federal oversight of First Nations water infrastructure.

In Squamish, traditional territory falls under two main municipal landscapes. The District of Squamish owns and operates the municipal water system serving five Squamish Nation reserves: St'á7mes (Stawamus 24), Yékw'apsem (Yekwaupsum 18), Kaw̓tín (Kowtain 17), Siy̓ích'em (Seaichem 16), and Wíwk'em (Waiwaikum 14). The Cheakamus 11 reserve, situated outside the District of Squamish's service area, currently lacks connection to the municipal system and imports water; negotiations and planning for connection to the District of Squamish system are underway. Metro Vancouver is the water provider for the Capilano Indian Reserve No. 5, Mission Indian Reserve No. 1, Seymour Creek Indian Reserve No. 2, and the Seȟáḵw (Kitsilano 6) development. The Chekwelp 26 and 26A reserves, though currently unoccupied, fall within the service territory of the Sunshine Coast Regional District and Town of Gibsons, which draw from Aquifer 560.

Review of Key Plans, Policies, Strategies and Legislation

Federal Framework

On a federal level, Indigenous Services Canada provides an Emergency Response Plan for Drinking Water Systems in First Nations Communities document, which is designed to assist in developing community-based emergency response plans specific to drinking water systems on reserve lands. This document states that local Emergency Management Plans are intended to encompass a wide spectrum of emergencies and responses, including floods and failures of community infrastructure.

This document provides guidelines for emergency response action for flood-related drinking water emergencies:

- *Notify the Chief and Council.*
- *Notify all users regarding the potential for water contamination, loss of pump, power, etc.*
- *Notify all users to boil suspect water to a "rolling boil" (approximately 2 minutes) or to disinfect the water as recommended by the local health official.*
- *Contact government agencies (below) for advice and assistance.*
- *Make arrangements for an alternate water source to be made available to system users if necessary—e.g., bottled water, bulk hauler, storage tank, etc.*
- *Purge and disinfect lines (as directed) after conditions return to normal.*

Contact:
Local health practitioners, including the EHO, Circuit Rider, Drinking Water Officer, Tribal Council representative, Aboriginal Affairs and Northern Development Canada, Environment Canada, Provincial Emergency Preparedness Branch, Fisheries and Oceans Canada, and others as necessary, depending on severity"

Provincial Legislation

British Columbia's Drinking Water Protection Act (DWPA), supported by the Drinking Water Protection Regulations, establishes the legal framework applicable to all water systems serving more than one domestic dwelling within the province. The act sets standards for water suppliers, supports the creation of drinking water protection plans, and employs Drinking Water Officers to order infrastructure improvements through assessment response plans. Section 10 of the Act mandates that prescribed water supply systems must maintain written emergency response and contingency plans to be activated in the event of emergencies or abnormal operational circumstances affecting the water supply system or drinking water source. Drinking Water Officers hold authority to order suppliers to review and update these plans.

With respect to flooding, Section 16 of the DWPA addresses floodproofing requirements for drinking water wells. Regulations require that owners or operators of wells providing drinking water to floodproof those wells in accordance with established standards. Drinking Water Officers may also order the floodproofing of other wells within the same well-recharge zone or wells that may otherwise affect the drinking water source. These provincial provisions establish a baseline that can be expected to inform and constrain municipal and regional planning documents.

District of Squamish Documents

The District of Squamish sources its municipal water primarily from the Powerhouse Springs well field, which draws from the Ring Creek Aquifer. The system also maintains the Stawamus River and Mashiter Creek as emergency backup surface water sources, though these have not been utilized regularly due to water quality concerns and associated boil water advisories. The District's water system comprises fifteen pressure zones, nine storage reservoirs, four pump stations, thirty-five pressure-reducing valves, approximately 146 kilometers of watermains, 8,700 service connections, and 650 fire hydrants. The district is in the process of updating its two water regulation bylaws.

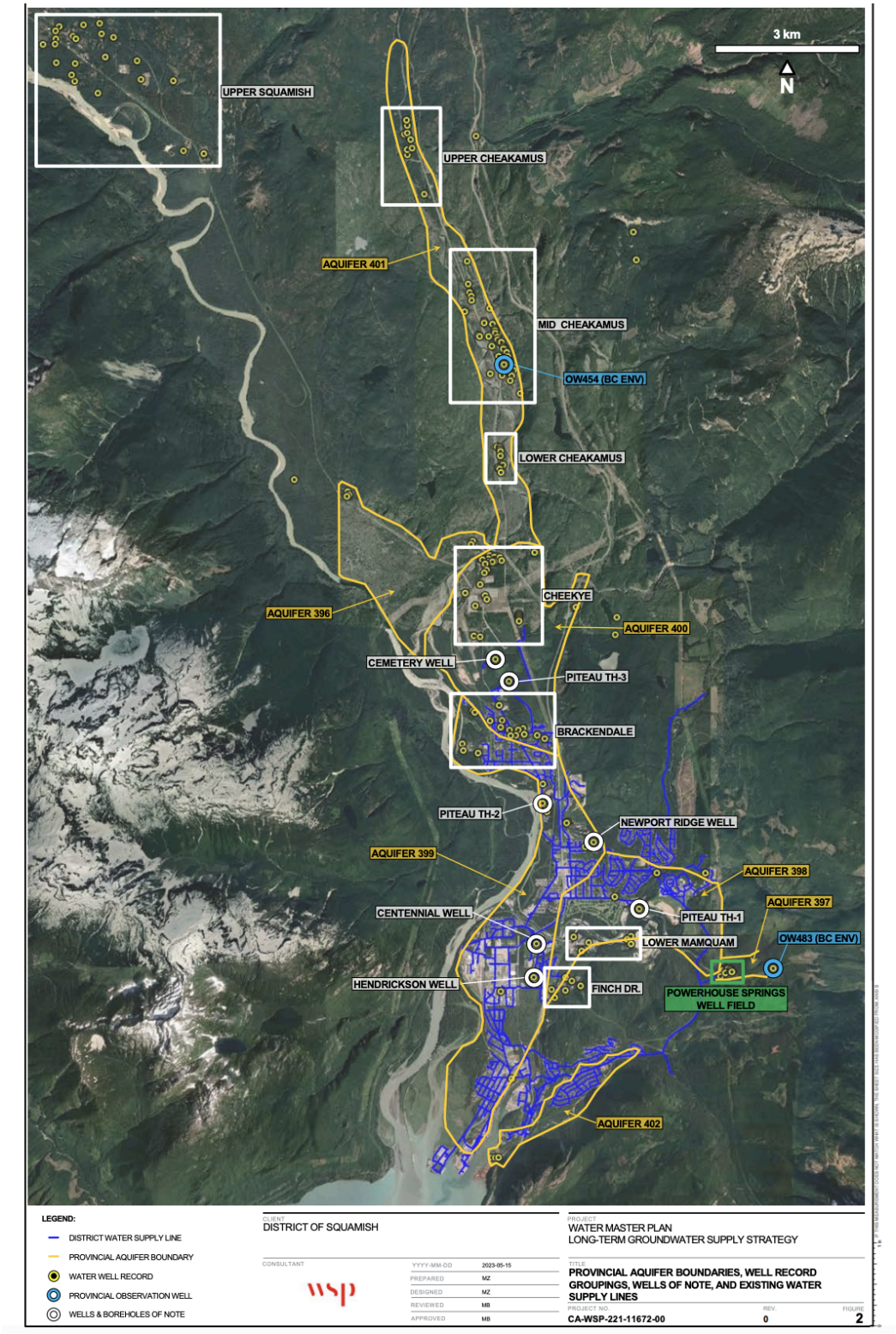

Figure 11. District of Squamish Water Supply and Well Map from the [The 2023 Long-Term Ground Water Supply Strategy Update]

The 2024 Water Master Plan Update serves as the District's primary strategic document for drinking water infrastructure planning. Its stated purpose is to present an updated snapshot of the distribution network and guide the prioritization of infrastructure upgrades and renewals in a strategic and cost-effective manner. The plan acknowledges several flood-related vulnerabilities in the current system configuration. Notably, the transmission mains between Powerhouse Springs and the University Zone involve three creek crossings: two over the Mamquam River and one over Ring Creek. The document explicitly states that “falling trees, high river flows and debris flows pose a hazard to the suspended supply line crossings” and recommends that “alternative supply lines are considered to increase the security of the future supply or upgrades are made to the conveyance infrastructure downstream of the well field”

The plan identifies that a separate well field would mitigate susceptibility to localized power outages or contamination events at Powerhouse Springs, though it cautions that the candidate area is "prone to flooding and contamination due to nearby industrial land uses." It puts forward an action item to conduct assessments of existing major water transmission supply lines from Powerhouse Springs in relation to seismic, flood, and wind event susceptibility, which is budgeted at $150,000. The plan recommends constructing a new transmission main from Powerhouse Springs to the north and abandoning the existing Mamquam River crossing to address reliability concerns. The plan notes that historical boil water advisories have been associated with turbidity spikes during heavy rain events in fall and winter months, which they directly link to flooding and extreme precipitation.

The related 2023 Long-Term Ground Water Supply Strategy Update Provides an analytical report that evaluates groundwater quality, compares withdrawals with recharge, and recommends further modeling to understand climate impacts on aquifer dynamics. It is scoped specifically for the District of Squamish and does not address broader flood risk or adaptation measures but does provide spatial data.

The Powerhouse Springs Well Protection Plan exists to protect the municipal water supply by defining protection areas, identifying potential contaminants, and developing management and contingency plans to guide land-use decisions and water-resource stewardship. The stakeholder matrix explicitly lists the Squamish Nation alongside the District of Squamish, provincial ministries, and community groups as a core participant in the well-protection committee. The plan identifies flooding as one of several contingency scenarios that require coordinated response actions. It mandates immediate public notice, potential well shut-in, and alternate water-source planning if flooding threatens the spring source or introduces contamination. It acknowledges that high-rainfall runoff raises turbidity levels, which can reduce chlorination effectiveness and may necessitate consideration of alternate treatment options for emergency sources. If contamination is suspected, the plan requires mitigation through either boil water notices for microbiological contamination or do-not-drink notices for chemical contamination.

The 2024 Drinking Water Quality Report is the District's most recent annual compliance document under the DWPA and its permit to operate. It summarizes ongoing sampling plans, infrastructure upgrades, and system undertakings. The report contains no specific flood mentions; it confirms that boil water advisories, though not issued in 2024, remain part of the District's emergency response framework. The report also explicitly acknowledges that the District's system serves the five Squamish Nation reserves within District boundaries

The Integrated Flood Hazard Management Plan, which is described at the start of this report, provides an assessment of water infrastructure vulnerability in the district. The plan warns that if the main Squamish River dike breaches during a 200-year return period flood, the expected economic damages exceed $450 million and would cause the displacement of nearly sixty percent of residents. The plan identifies the loss of municipal facilities, including the wastewater treatment plant, as a potential cause of widespread hardship. The Jimmy Jimmy (judd) Slough Dike Upgrade helps protect the wastewater treatment plant and several major drainage pump stations.

The Wastewater Treatment Plant Expansion and Improvements project documentation explicitly addresses flood resilience. The District acknowledges that existing treatment units "are approaching end of life and do not meet current seismic and flood protection design considerations." The new post-disaster infrastructure is being designed to "withstand seismic and flood events," a priority framed as "of critical importance in light of recent catastrophic flooding events across British Columbia." The upgraded facility will include a new secondary clarifier and concentric ring bioreactor, which increases treatment capacity and creates system redundancy to enhance flood resiliency.

Metro Vancouver Documents

Metro Vancouver's water system serves as the backbone for the region, including four Squamish Nation reserves within the service area. The system sources water from the Capilano and Seymour Reservoirs, with Coquitlam Reservoir providing supplemental supply. Treatment primarily occurs at the Seymour-Capilano Filtration Plant, capable of treating up to 1.8 billion liters per day, and the Coquitlam Water Treatment Plant, which treats approximately 380 million liters daily.

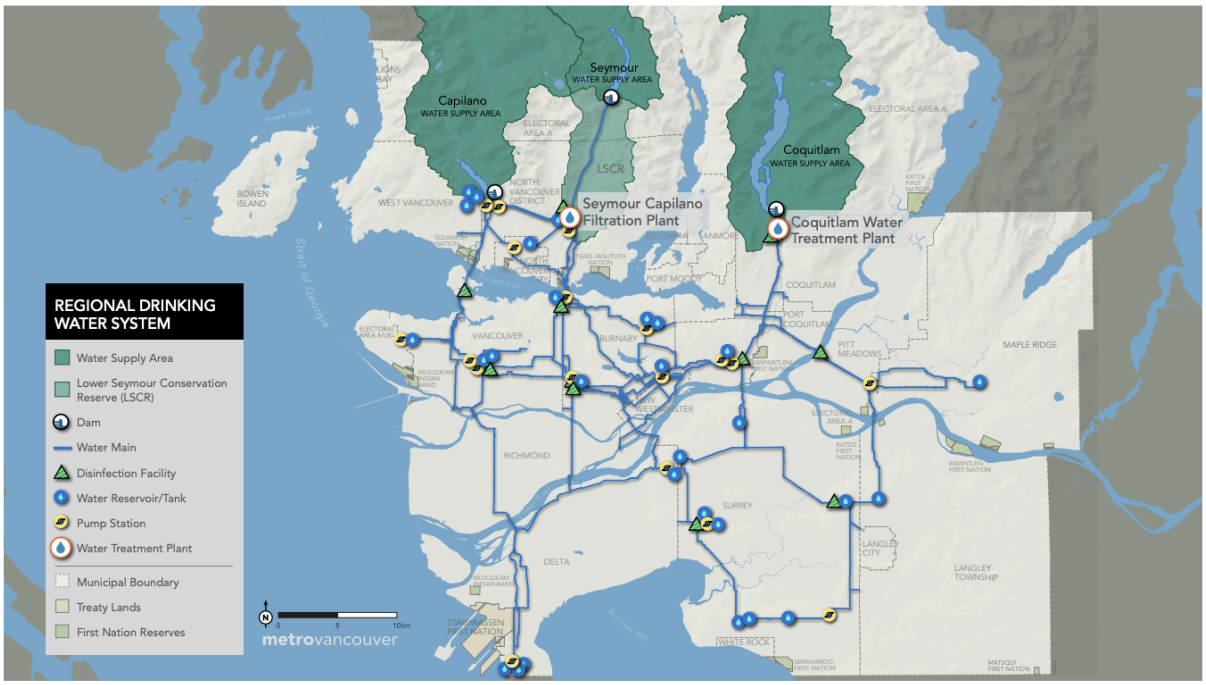

Figure 12. Metro Vancouver's Drinking Water System from the Water and Wastewater Infrastructure Primer

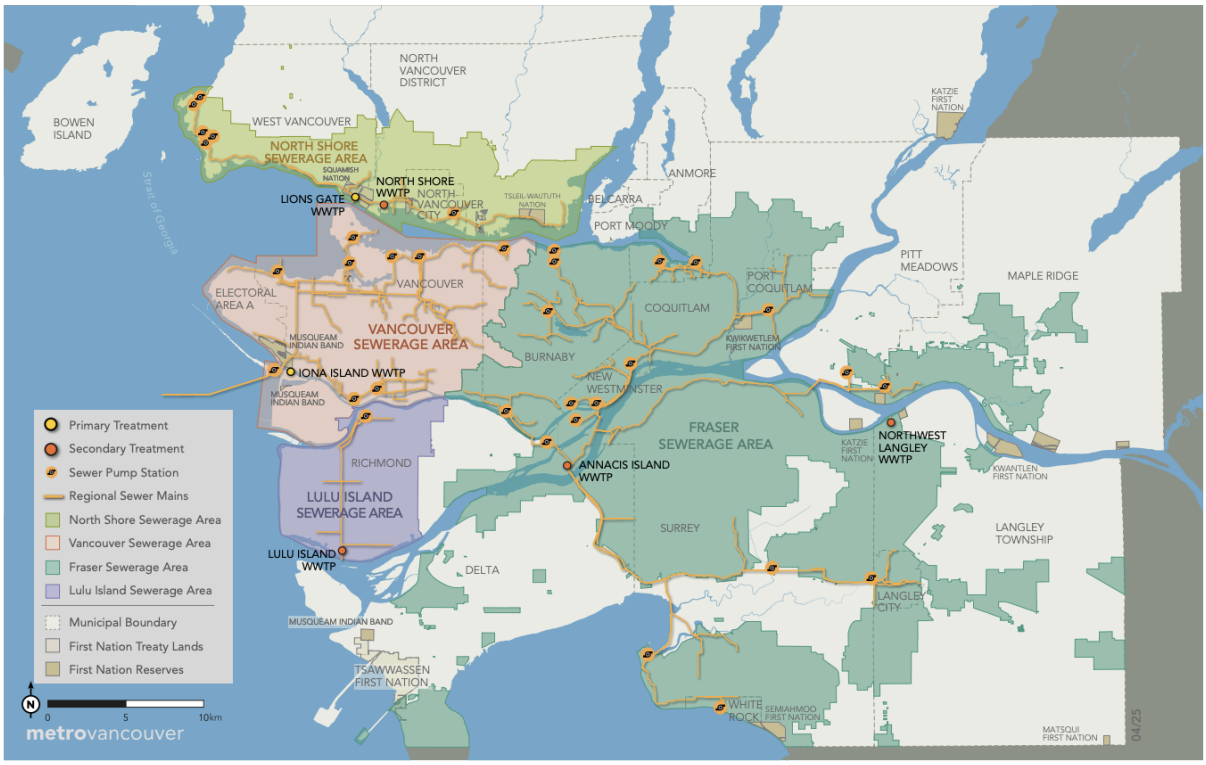

Figure 13. The 4 sewage areas of Metro Vancouver's regional liquid waste from the [Water and Wastewater Infrastructure Primer]

The Drinking Water Management Plan 2026 is Metro Vancouver's ten-year regional strategy, organized around five goals and defining coordinated actions to deliver high-quality drinking water, maintain uninterrupted service, manage costs, protect the environment, and develop a skilled workforce. The plan was developed through a multi-year engagement process involving First Nations, member jurisdictions, government agencies, and other stakeholders; embedding of Indigenous input across priority areas; and a stated commitment to including cultural and traditional knowledge in planning

Under the priority area of a "Resilient Water System," the plan stresses the need to anticipate, withstand, and recover from climate extremes, including floods. It acknowledges that severe weather events and flooding, intensified by climate change, have the potential to disrupt power supply to water system infrastructure. While Metro Vancouver's gravity-fed system currently provides some insulation from power-related flood impacts, the plan notes that increased future pumping requirements will heighten dependency on reliable power. The plan lists actions including increasing system redundancy, updating emergency response plans, improving rapid-response capability for water-quality changes caused by flooding, and implementing adaptive treatment and monitoring protocols to address flood-driven source-water impacts.

The Water and Wastewater Infrastructure Primer is an overview of climate-change strategies for Metro Vancouver's water and wastewater systems. It calls for meaningful engagement, dialogue, and collaboration with First Nations as part of regional reconciliation efforts and cites the need for joint partnerships on climate-resilient water infrastructure. The primer identifies flooding as a primary climate hazard, stating that "flooding events can overwhelm collection and drainage systems, leading to sewage overflows and the release of contaminants into the environment or damaging critical infrastructure by flooding facilities and overwhelming drainage systems." It notes that wastewater treatment infrastructure located near shorelines is at risk from sea level rise and storm surge and that wetter weather causing more frequent and severe turbidity events can overwhelm existing treatment processes at both existing filtration plants. The primer calls for flood resilience through larger hydraulic capacity, enhanced storage, rapid recovery capabilities, climate-hazard risk identification, prioritization of vulnerable projects, green infrastructure, and emergency response planning for extreme weather events.

The Climate 2050 Strategic Framework is Metro Vancouver's document for achieving a carbon-neutral, climate-resilient region. It states that extreme precipitation will increase localized flooding, threatening both wastewater and drinking-water infrastructure, with sewer overflows and damage to treatment plants expected. The framework stresses the need for infrastructure upgrades, climate-risk assessments, and protective measures against sea-level rise and storm surge. It emphasizes that local government infrastructure, including reservoirs, pipes, pumps, treatment plants, and drainage systems, is foundational to the region's economy and quality of life and that incorporating climate change into infrastructure planning, design, and operation is essential to maintaining these services.

The Water Supply Outlook document looks at the long-term planning horizon. It concludes that Metro Vancouver's water storage reservoirs are expected to continue reliably refilling each fall and winter under climate change scenarios. However, it emphasizes that expansion of water supply infrastructure will be required to meet the needs of a growing population and to respond to climate impacts, including flooding. The document notes that severe weather events and flooding can disrupt power supply and that natural hazard risks facing the region include flooding, although it focuses heavily on earthquakes.

The Drinking Water Management Plan Update Draft: Strategies and Actions presents proposed strategies that are currently open for public feedback. Under the draft strategy "Advance Planning and Designing for Resilience to Natural Hazards and Climate Change Impact including flooding," potential actions include increasing system resilience to natural hazards and extreme temperatures, advancing water system redundancies to prepare for infrastructure failures, improving power resilience through diverse energy sources and storage options, defining supply commitments and redundancy requirements, and advancing design requirements such that new infrastructure is resilient to climate change.

Finally, the Seńákw Services Agreement between the Squamish Nation and the City of Vancouver, while not primarily addressing flooding, demonstrates the operational relationship between the Nation and municipal service providers. The agreement includes provisions for soil densification and preparation along the existing seawall alignment to provide a competent base for future flood protection works, including a potential dike system to mitigate sea level rise. This provision shows how infrastructure agreements can incorporate flood adaptation measures in the context of development-focused service arrangements.

Sunshine Coast Documents

The Chekwell 26 and 26A reserves on the Sunshine Coast fall within the service territory of the Sunshine Coast Regional District and the Town of Gibsons, which draw water from Aquifer 560. The Town of Gibsons has enacted an Aquifer Protection Development Permit Area bylaw, though it contains no explicit flood mentions. The 2023 Watershed Agreement, a 10 year-plan and the 2025 *One Water Strategy* provide a water use planning framework for Aquifer 560. While the *One Water Strategy* contains no references to flooding, it explicitly identifies the Squamish Nation as a collaborative partner in pursuing water objectives, stating that "creating this shared direction for water use planning will help align the Town and the SCRD with their water sharing agreement and will help with more effective engagement with the Squamish Nation and WLRS, who govern the groundwater resource." This establishes a governance foundation upon which future water infrastructure planning could be built should the nation pursue development or return to these reserves.

Preparedness and Mitigation

Preparedness and mitigation strategies for water infrastructure in the Squamish region vary across jurisdictions, reflecting differences in infrastructure, governance capacity, and planning. At the most proactive, the District of Squamish has embedded flood considerations directly into its wastewater infrastructure renewal program. The Wastewater Treatment Plant Expansion and Improvements project designs new treatment units as post-disaster infrastructure capable of withstanding seismic and flood events. This is a mitigation investment that moved beyond planning into physical infrastructure hardening.

The District's 2024 Water Master Plan identifies specific flood vulnerabilities in the transmission system, particularly the Mamquam River and Ring Creek crossings, and budgets for vulnerability assessments of these assets. The plan's recommendation to construct a new transmission main and abandon the existing Mamquam River crossing constitutes a concrete mitigation action designed to reduce flood-related service disruption risk. However, these actions remain at the planning and study stage. The Powerhouse Springs Well Protection Plan mandates immediate public notification, potential well shut-in, and alternate water-source activation if flooding threatens the spring source. The plan demonstrates awareness of the cascading water quality impacts that flooding can trigger. However, the plan does not specify physical floodproofing measures for the well field itself beyond operational response protocols.

Metro Vancouver's planning documents demonstrate a high level of flood hazard awareness and articulate clear strategic directions for resilience-building. The Drinking Water Management Plan 2026 organizes flood-related work under the "Resilient Water System" priority and lists actions including increasing system redundancy, updating emergency response plans, and improving rapid-response capability for water-quality changes caused by flooding. The Water and Wastewater Infrastructure Primer calls for flood resilience through larger hydraulic capacity, enhanced storage, and rapid recovery capabilities. The Climate 2050 Strategic Framework identifies the need for infrastructure upgrades and protective measures against sea-level rise and storm surge.

However, a close reading shows that while seismic resilience is addressed with specific engineering standards and investment commitments, flood resilience receives comparatively less detailed treatment. The plan's flood-related actions lack the specificity and committed timelines found in the seismic resilience sections. This suggests that flood preparedness, while recognized as important, has not yet been operationalized to the same degree as seismic preparedness in Metro Vancouver's planning.

While all jurisdictions acknowledge flood risk to water infrastructure in general terms, the translation of that acknowledgment into specific, funded, and scheduled mitigation actions remains uneven. The District of Squamish's wastewater treatment plant upgrade and dike upgrades stand as the clearest example of concrete flood mitigation investment that helps water

infrastructure. Other planned actions, vulnerability assessments, transmission main rerouting, and redundancy enhancements remain largely in the planning and study phase. The gap between acknowledged risk and implemented mitigation warrants continued attention.

Emergency Response and Recovery

The actions taken in the immediate aftermath of a flood event to maintain or restore water services until permanent repairs can be effected are addressed through a combination of regulatory requirements, operational protocols, and emergency planning frameworks across the jurisdictions serving Squamish Nation reserves.

At the provincial level, Section 10 of the Drinking Water Protection Act establishes the statutory requirement for water suppliers to maintain written emergency response and contingency plans to be implemented in the event of emergencies affecting the water supply system or drinking water source. This legislative baseline ensures that all municipal and regional water systems serving Squamish Nation reserves are legally obligated to have pre-established temporary measure frameworks in place. The federal Emergency Response Plan for Drinking Water Systems in First Nations Communities template provides specific operational guidance for flood-related temporary measures. The prescribed actions include notifying system users regarding potential contamination or service loss, issuing boil water advisories where microbiological contamination is suspected, contacting relevant government agencies for technical advice and assistance, and making arrangements for alternate water sources such as bottled water, bulk haulers, or storage tanks. The protocol further requires purging and disinfecting lines once conditions normalize. This guidance, while directed at First Nations water systems on reserve, establishes a best-practice benchmark applicable across jurisdictions.

The District of Squamish's Powerhouse Springs Well Protection Plan operationalizes these requirements at the local level. The plan specifies response measures for flooding scenarios, including immediate public notice through boil water or do not drink advisories depending on the nature of suspected contamination, potential well shut-in to prevent contaminated water from entering the distribution system, and activation of alternate water-source planning. The plan's attachments include draft templates for public notices and a policy manual outlining tasks, responsibilities, and contact information for emergency scenarios. The District's 2024 Drinking Water Quality Report confirms that boil water advisories remain an active component of the emergency response framework, even though none were issued in the reporting year.

The maintenance of Stawamus River and Mashiter Creek as emergency backup sources, while not utilized in the past decade due to water quality concerns, does, in theory, provide an alternate supply pathway if the primary Powerhouse Springs source were compromised by flooding. However, the association of these surface sources with boil water advisories during high-turbidity events, which are the conditions that flooding would create, suggests that this redundancy may not be operational in a true flood emergency. The 2024 Water Master Plan's

recommendation to develop a separate well field acknowledges this limitation and seeks to establish more robust source redundancy.

Metro Vancouver's emergency response framework for temporary flood measures is articulated across multiple planning documents. The Drinking Water Management Plan 2026 lists improving rapid-response capability for water-quality changes caused by flooding as a specific action item. The Water and Wastewater Infrastructure Primer calls for emergency response planning for extreme weather events and emphasizes the need for rapid recovery from rainstorms. Metro Vancouver's gravity-fed system configuration provides operational resilience that may reduce the need for certain temporary measures, such as emergency power for pumping, during flood events. The Climate 2050 Strategic Framework identifies the need for regularly reviewing and updating emergency response plans and contingency plans to better prepare for extreme weather events, explicitly linking temporary measure planning to climate adaptation. The document emphasizes that maintaining essential services vital for health and safety during and after extreme events requires proactive planning for temporary operational modes.

A gap across all jurisdictions is the absence of detailed, scenario-specific temporary measure protocols for flood events of varying magnitudes. While the regulatory requirement for emergency response plans is clear, and while high-level temporary measures such as boil water advisories and alternate water sourcing are identified, publicly available documents do not contain the kind of detailed operational playbooks, such as specifying trigger thresholds, resource pre-positioning, mutual aid agreements, and recovery timelines, that would characterize a full emergency response measures framework. This may be because such operational details are typically contained in confidential emergency response plans, which are not publicly disclosed for security reasons. However, the lack of visible, specific temporary measure planning in public-facing documents limits external accountability and community awareness.

Key Takeaways

- Water and wastewater infrastructure is recognized as essential in emergency management and flood planning, but the translation of risk acknowledgment into funded, scheduled mitigation actions remains uneven across jurisdictions.
- Flood vulnerabilities in the District of Squamish's transmission system, particularly the Mamquam River and Ring Creek crossings, are identified in planning documents, but recommended upgrades remain at the study stage rather than implemented capital projects.
- Metro Vancouver's planning documents demonstrate sophisticated flood risk awareness, but operationalization of flood resilience lags behind seismic resilience in specificity and committed investment.
- Source redundancy exists on paper, but historical water quality issues during high-turbidity events undermine the reliability of these alternatives.

- Governance fragmentation across federal, provincial, regional, and municipal jurisdictions, intersecting with Squamish Nation reserves across three distinct service territories, creates coordination challenges for comprehensive flood resilience planning.
- Squamish Nation is included in stakeholder matrices and engagement processes for some key planning documents, but inclusion remains consultative rather than constituting formal co-governance.

Conclusion

The assessment of critical infrastructure in Squamish shows that while there are existing efforts to prepare for emergencies, the level of readiness and coordination varies significantly across sectors. Transportation systems such as ferries, rail, and roads highlight uneven approaches, where some have mitigation strategies while others rely more heavily on evacuation or external support. Similarly, essential services like healthcare, telecommunications, and energy tend to have general emergency plans but lack hazard-specific strategies, particularly for flooding. Water infrastructure demonstrates relatively strong technical resilience, yet remains constrained by limited redundancy and fragmented governance. Across all sectors, a common issue is the lack of integrated planning and clear coordination among different levels of government, agencies, and other key actors. These gaps are especially concerning given the interconnected nature of infrastructure, where failure in one system can affect others. Strengthening resilience in Squamish will require more comprehensive, coordinated, and place-based planning that prioritizes not only mitigation and response but also governance, equity, and long-term system reliability.

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