ATTACHMENT 4

REGIONAL DISTRICT OF NANAIMO

Little Qualicum River Flood Mapping

Overview Report - May 2022

KWL File No. 536.021-300

Prepared by:

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Acknowledgements

The Little Qualicum River Flood Mapping project was led by the Regional District of Nanaimo (RDN) as part of its Sea Level Rise and Climate Adaptation Program. Technical work was led by Kerr Wood Leidal Associates Ltd. (KWL), with engagement and reporting support from Integral Group.

We would like to extend our gratitude to all stakeholders and study participants who have provided time, knowledge, and information to assist in this study.

- Regional District of Nanaimo
- Town of Qualicum Beach
- Qualicum First Nation
- BC Ministry of Forest, Lands, Natural Resources Operations and Rural Development
- Department of Fisheries and Oceans
- Qualicum Beach Streamkeepers
- Wilderness Committee – Mid Island Chapter
- Qualicum Beach Residents' Association
- Pacific Rainforest Adventure Tour & Neighbours of Little Qualicum River
- Cedar Grove RV Park & Campground
- Island Corridor Foundation

The project team respectfully acknowledges and recognizes the Coast Salish Nations whose territory we live, work and play in.

For more information about the Little Qualicum River Flood Mapping project, or the RDN's broader flood management program contact:

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Contents

Key Terms

Adaptation	Process of undertaking procedures, actions, and/or developing structures to moderate potential negative impacts of climate change, while taking advantage of potential new opportunities.
Climate change	A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.
Floodplain	An area of low-lying ground adjacent to a river or ocean that is subject to flooding. Floodplains are often characterized by a relatively flat topography. Also referred to as the regulatory floodplain.
Flood Construction Level	The flood level specified in a floodplain bylaw that is used to establish the elevation of the underside of a wooden floor system or top of a concrete slab for any habitable area.
Flood Extent	Flood extent refers to the geographic reach of flood waters over land.
Flood Hazard Mapping	Maps that provide information on the hazards associated with defined flood events, such as water level, water depth, and velocity.
Flood Level	The maximum elevation of the water surface for a given flood scenario. On regulatory floodplain maps, flood levels may include freeboard to inform Flood Construction Levels (FCLs) specified in floodplain bylaws.
Freeboard	A vertical distance added to water surface elevations to account for scientific uncertainty in hydraulic and hydrological variables, the potential for waves and surges, and other natural phenomena. A freeboard of 0.6 m has been included in establishing the 200-year return period regulatory floodplain level for the Little Qualicum River.
Regulatory Floodplain Maps	Flood maps used for regulatory purposes, such as defining flood levels for floodplain bylaws and informing official community plans. For the Little Qualicum River, the regulatory river floodplain mapping is based on inundation mapping for the 200-year return period flood under climate change conditions incremented by a freeboard allowance of 0.6 m to establish the flood levels and associated floodplain limits.
Return Period Flood Event	A way of describing the probability of a flood event having a specific intensity or size. For example, a 10-year return period flood event is expected to occur, on average, once every 10 years (or, in other words, three times over the course of a 30-year mortgage). Another way to think of flood frequency and severity is by "annual exceedance probability", which is the inverse of a return period, meaning that a 10-year event could instead be thought of as having a 10 percent chance of occurring in any given year. Return period is not the strict frequency of an event. In other words, if a 10-year return period event occurs this year, there is still a 10 percent probability that it will occur next year as well.
Resilience	The ability of a system, community, business, or natural environment to anticipate, prevent, withstand, respond to, and recover from a hazard in a timely an efficient manner.
Risk	The chance of injury or loss as defined as a measure of the probability and severity of consequences from a hazard such as flooding. Consequences can range broadly and include adverse effects to health, property, the environment, or other things of value.
Storm Surge	A temporary increase in water level caused by low atmospheric pressure and winds.

Introduction

In B.C., local governments, including the Regional District of Nanaimo (RDN), are responsible for land use management, including the management of land use in relation to natural hazards, which includes flooding. To better understand flood hazards, the RDN is currently leading a series of studies on the Little Qualicum River, Englishman River, Nanaimo River, and the coastal zone. The studies are part the RDN's broader Sea Level Rise and Climate Adaptation Program[1] and build on the region-wide flood risk assessment[2] completed by the RDN in 2019. These studies will provide updated riverine floodplain maps to inform flood management planning, now and into the future.

This report summarizes key outcomes from the **Little Qualicum River Flood Hazard Mapping Project**, including updated floodplain maps and key resources property owners can use to become more flood ready.

Floodplain Mapping

Floodplain maps help us better understand and manage flood risks. These maps show where water will flow during a flood event and what land could be affected by different size floods under current and future climate change conditions. They provide an important tool local governments use to develop policies and regulations to protect private property, public infrastructure and preserve natural habitats from flood hazards today and into the future. Floodplain maps are used to support flood management and to increase community resilience through:

- **Land use planning**, including updating policies and regulations to reduce flood risks. For example, if you are planning a development, a site-specific flood risk assessment may be required to identify measures that will protect people and property from flooding and lower the impact of development on the natural environment.
- **Emergency planning and response**, including providing information on flood scenarios, and at-risk areas.
- **Strategic infrastructure planning**, by understanding which community assets are at risk and developing strategies for managing risk through flood proofing and relocation over time.
- **Public education by sharing information** about how property owners and residents can become flood ready.

In B.C., local governments may, by bylaw, designate flood prone areas as a "regulatory floodplain", supported by mapping information aligned to provincial guidelines and professional engineering standards. The RDN's current regulatory floodplain maps for the Little Qualicum River, Englishman River, and Nanaimo River were produced by the provincial government between 1984 to 1997. An update to these maps is needed to consider future climate change impacts and to make use of recent advancements in topographic data collection and hydraulic modelling techniques. Updating the RDN's regulatory floodplain map will provide a visualization of predicted water levels and their locations to help communities and individuals adapt to our changing environment gradually over time.

[1] www.rdn.bc.ca/sea-level-rise-adaptation-program

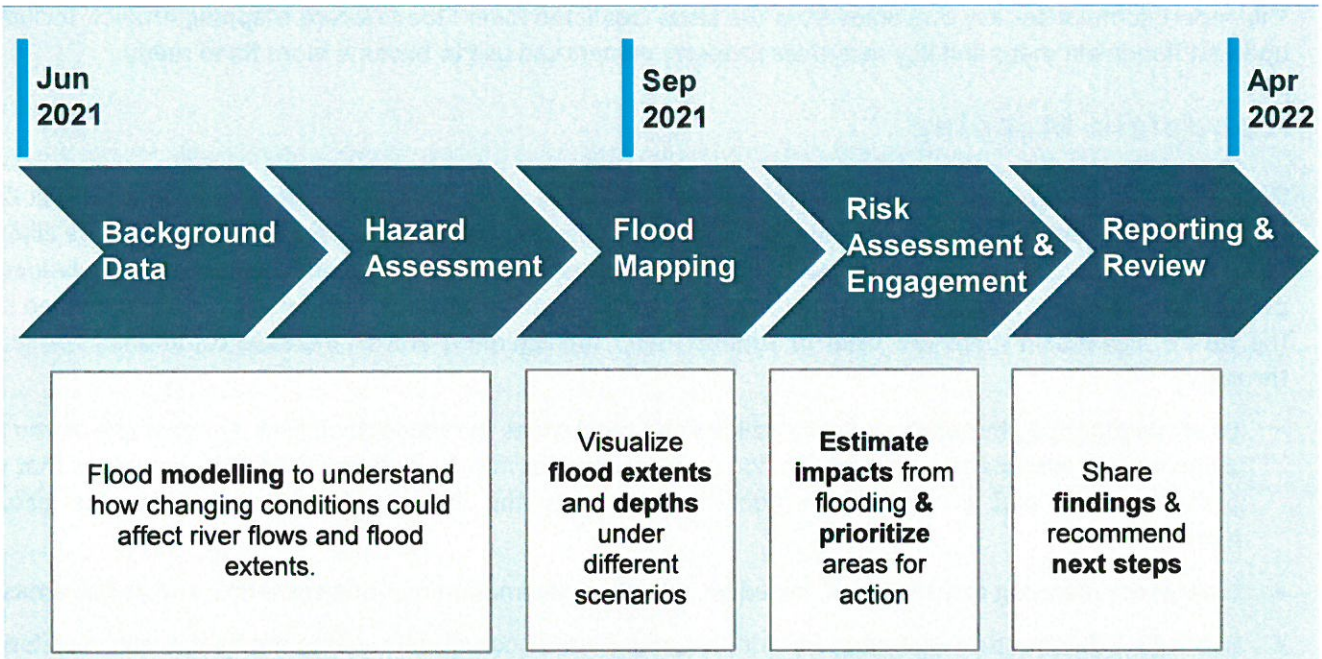
[2] www.rdn.bc.ca/sites/default/files/inline-files/RDN%20Flood%20Report%20FINAL_0.pdf

About the Little Qualicum River Flood Hazard Mapping Project

The key objective of the Little Qualicum River Flood Hazard Mapping Project ("the project") is to provide updated regulatory river floodplain maps to support flood management planning and to increase public awareness of flood hazards.

The project focuses on mapping and assessing river flood hazards in the Little Qualicum River floodplain northeast of Highway 19. The study area includes properties in the RDN's Electoral Area G (including the Surfside service area), the Little Qualicum Hatchery, and a small portion of the Town of Qualicum Beach.

The project involved five key stages of work:

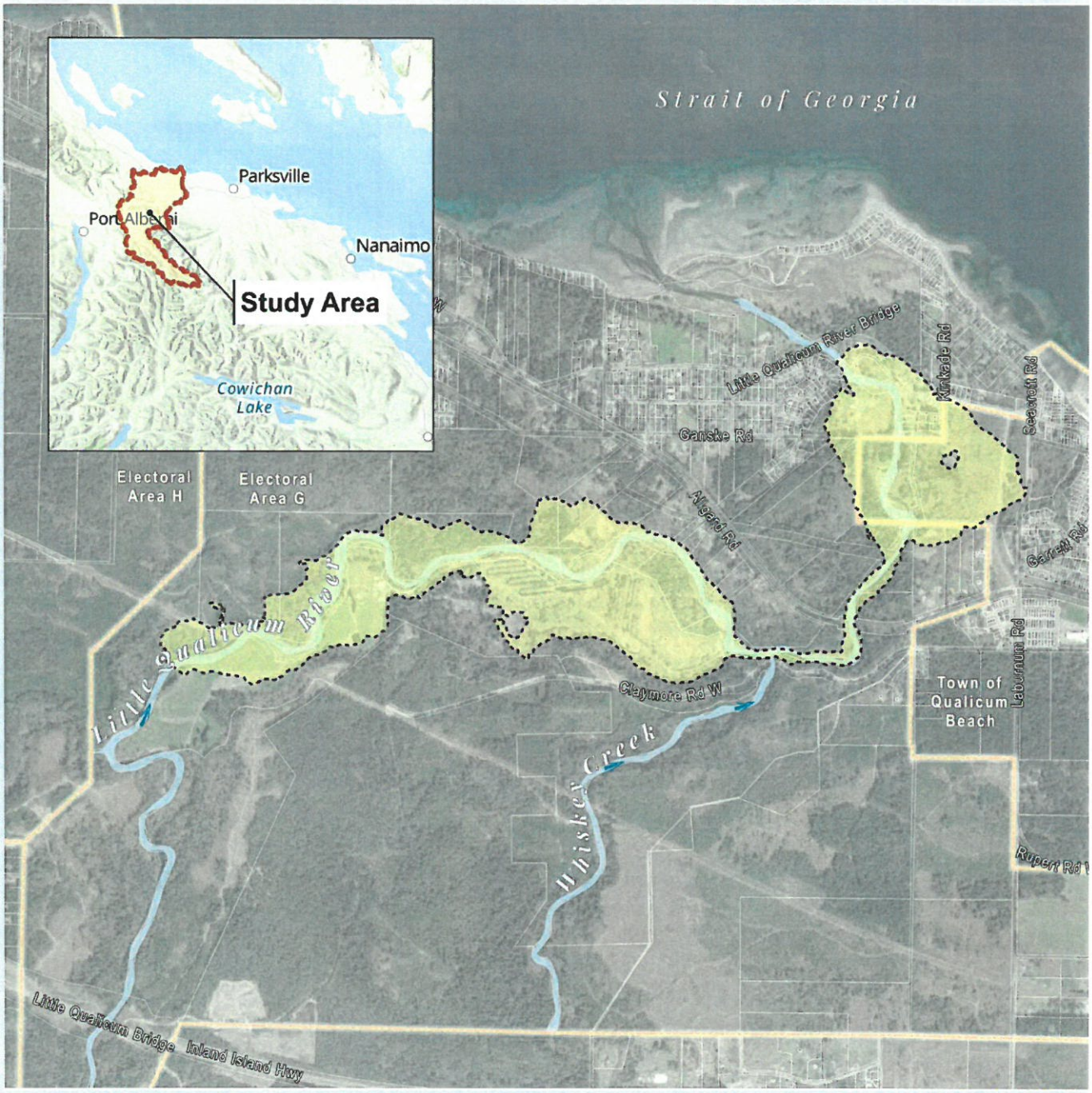


Note: completion of the Little Qualicum River Flood Hazard Mapping Project was delayed due to the flood response and recovery efforts following the November 2021 atmospheric river flood events experienced within the RDN and other regions of the Province.

The project involved computer modelling to analyze river characteristics and estimate how high flood waters could rise under different flood scenarios. These scenarios included flood events that may have lower water levels but happen more often (i.e., once every 10 years) and more extreme and rare flood events (i.e., once every 200 years).

This flood hazard information was used to develop regulatory river floodplain maps and flood hazard maps to better understand flood dynamics across a range of flood magnitudes, including maximum water levels, depths, and velocities. These flood hazard maps were then used to complete a high-level flood risk assessment to better understand how flooding could impact the community and natural areas.

Engagement played an important role in this project. Nineteen representatives from the local community and Qualicum First Nation participated in an online workshop on November 17, 2021, to share their priorities for flood management. The workshop served as an opportunity to start the conversation about flood hazards along the Little Qualicum River. Outcomes from the workshop provide an understanding of peoples' priorities as they relate to current and future flood risks.



Map of Study Area

Project Findings

Flood Hazards in the Region

The lower section of the Little Qualicum River floodplain (e.g., near Riverbend Road) is already vulnerable to flooding. Historic streamflow records show that the river has periodically breached its banks. Today, flood events are becoming more frequent, including floods from December 2014, February 2020, January 2021, and November 2021.

River flooding occurs when river water levels rise above the elevation of banks and flow into neighbouring low-lying areas that are normally dry. River flooding in B.C. is typically caused when snow accumulates in the mountains and is followed by an intense rainfall event that causes rapid snowmelt and river flows to increase quickly beyond the riverbank's capacity. On the east coast of Vancouver Island, river flooding usually occurs in the late fall or early winter as a result of storms carrying moisture from the Pacific Ocean eastward across the Island, causing high intensity rainfall and snow accumulation at higher elevations.

Climate change is projected to cause more severe and frequent flooding due to river flow levels increasing more often. This is because climate change is projected to cause more precipitation in fall, winter, and spring, with warmer average temperatures causing more of this precipitation to fall as rain rather than snow. For this study, climate change was assumed to increase flood flows in the Little Qualicum River by 31 percent by the Year 2100.

Coastal flooding occurs when the flooding is caused by high tides, storm surges, and coastal waves. Climate change is projected to cause a global rise in coastal water levels, further exacerbating coastal flooding issues along Vancouver Island's shoreline. For this study, 1.0 metre of relative sea level rise was assumed for the Year 2100, aligned with provincial guidelines.

Surfside Drive, Area G, January 7, 2022

Riverbend Road, Area G, Cedar Grove RV Park and Campground, November 15, 2021

Photos: Regional District of Nanaimo

River Flood Scenarios

The Little Qualicum River Flood Hazard Mapping project involved detailed modelling and analysis of a range of flood scenarios. Looking at a range of different flood scenarios allows the RDN to understand what flooding could look like under relatively likely, but less severe events and under rare, much more extreme events. This information is important to inform planning for land use and emergency planning and future infrastructure management.

Four river flood scenarios were considered as part of this project and are described in the table below. The 200-year return period flood scenario under future climate change conditions was used to develop the regulatory floodplain mapping.

	Scenario	*Return Period*	*Climate Change (2100)*
1	Rare Flood – Current Conditions	200-year	n/a
2	Rare Flood – Future Conditions	200-year	+ 31% river flow increase + 1.0 m sea level rise
3	More Frequent Flood – Current Conditions	10-year	n/a
4	More Frequent Flood – Future Conditions	10-year	+ 31% river flow increase + 1.0 m sea level rise

What is a "return period flood event"?

No two floods are ever the same. Differences in snowpack, rainfall intensity, influences from climate change, relative timing of river flows and tidal levels and changing shape of river channels are just some of the factors that cause water levels to rise and make each flood unique. Flood specialists use detailed computer models to project what flooding could look like under different conditions. Different flood events are modelled according to their "return period", or the average frequency at which they are expected to occur in a particular area.

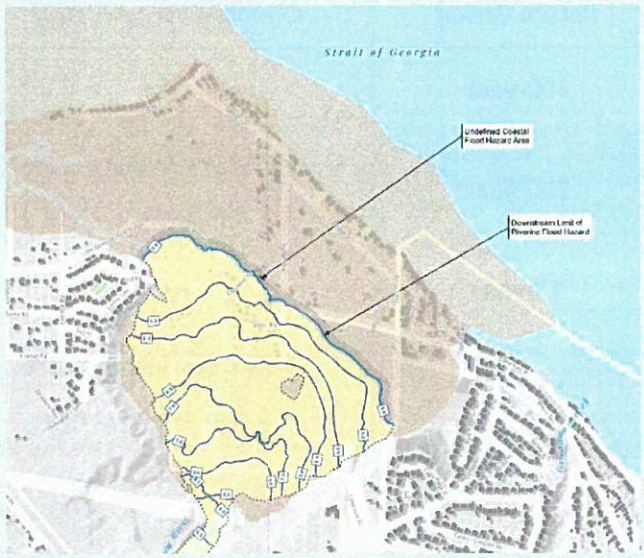
For example, a 10-year return period flood event refers to flood water levels that are expected to occur, on average, once every 10 years. In other words, you could expect to see a flood of this size three times over the course of a 30-year mortgage. A 10-year return period also means that there is a 10 percent chance of the flood happening in any given year, so it is possible for multiple "10-year return period floods" to occur within a 10-year period. In comparison, a 200-year return period flood event is a much rarer and more extreme flood event, expected to occur once in 200 years on average, or has about 1 in 7 chance of occurring over a 30-year mortgage. The 200-year return period flood results in higher water levels extending further across the floodplain and potentially causing more damage to homes and built infrastructure. The 200-year return period is the provincial standard for regulatory river maps in B.C., ensuring a higher level of safety to protect people and building community resiliency to river flood hazards.

Regulatory Floodplain Maps

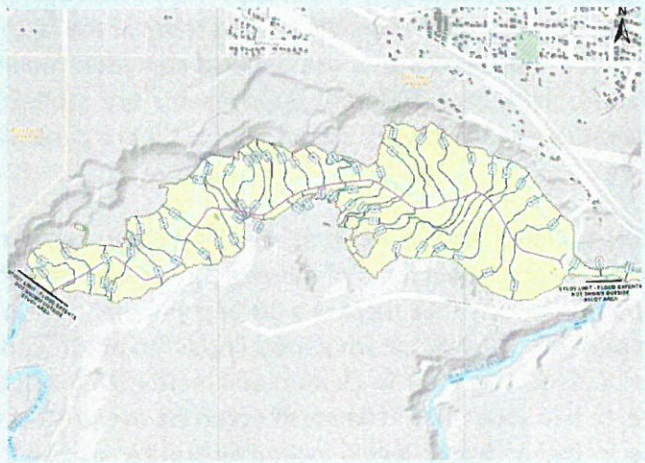
Excerpts from the updated regulatory river floodplain maps for the Little Qualicum River (shown below) will replace the existing regulatory floodplain maps from 1997 and will contribute to the RDN and member municipalities' ongoing efforts to adapt and reduce the risk associated with river and coastal flood hazards.

Excerpts from the updated Little Qualicum River regulatory river floodplain map (Map Sheets 1 & 2). The Little Qualicum River Delta is shaded brown, and the Regulatory River Floodplain is shaded yellow.

Maps images shown here are for illustrative purposes only. Refer to source map for application of information.



Excerpt: Map Sheet 1 of 2



Excerpt: Map Sheet 2 of 2

Key things to keep in mind when reviewing the river floodplain map:

- Aligned with the provincial requirements, the map shows an extreme and rare 200-year "return period" river flood event (expected to occur once every 200 years on average, or once every six or seven generations, but has a 0.5 percent chance of happening in any given year).
- The 200-year return period flood event shown on the map accounts for future climate change impacts, providing flood levels for the year 2100 or almost 80 years from today.
- **Flood levels on the map include freeboard**, which provides an additional buffer to account for uncertainty in the flood level estimations.
- **The flood map shows flood extents** (i.e. how far on land water is expected to reach) **and flood levels** (i.e. the elevation of the water surface) **but does not show flood depths.** This means that many of the areas shown as flooded may experience only shallow flooding.
- **The map does not include the coastal flood hazard area**, as mapping of the coastal flood extent is provided in a separate map available from the RDN. However, coastal impacts on river flooding (including sea level rise) were accounted for in the river floodplain mapping.
- The map does not account for any impacts that existing or future flood adaptation measures could have on flood extents.

Summary of Key Findings

Flood hazard analysis and mapping from this project provide important insights about flood dynamics and risks in the lower region of the Little Qualicum River. Key findings include:

Flood Mapping	• The new regulatory flood maps show flood extents that are similar to those shown in the original 1997 provincial floodplain maps; however, flood levels are higher. • **Low-lying areas in the study area are currently exposed to flood hazards.** Residential areas and vacation properties along Waters Road, Kinkade Road, and Flamingo Drive are particularly exposed to frequent flood events (e.g., 10-year return period floods), as are some properties along Surfside Drive and McFeely Drive during extreme flood events (e.g., 200-year return period floods). • **Climate change is expected to cause more severe flooding to occur more frequently**. By the year 2100, it is expected that relatively frequent flood events (e.g., 10-year return period floods) in the Little Qualicum River will have somewhat similar consequences to extreme and rare 200-year return period flood events of today. Under these future conditions, areas already exposed to flooding may experience deeper flooding, whereas shallow flooding may reach new areas.
Flood Risk Assessment	• **Lands impacted by Little Qualicum River flooding are primarily residential homes, RV campgrounds and resorts.** Key tourist destinations including Riverside Resort, Cedar Grove RV Park & Campground, and Seaview Resort are exposed to flooding under future climate change conditions. • **The Qualicum National Wildlife Area is naturally low-lying and faces flooding under current conditions** but can typically naturally recover from flooding. Further work would be needed to better understand the impact that flooding may have on water quality and species health (e.g., due to road runoff, septic field overflows, erosion, debris, or increased turbidity). • **The Little Qualicum Hatchery is already at risk of flooding.** An extreme flood event today (200-year return period) could cause flood waters to overtop the hatchery's berm near its outlet weir, flooding the hatchery channel, parking lot, and nearby non-residential buildings. In the future, an extreme event that overtops the berm could cause further flooding to this area. There is also a risk that the hatchery berm could breach, which would result in additional flooding at the hatchery but would have minimal impact to flood waters further downstream. • **Road flooding and transportation disruption is a significant, near-term risk.** Waters Road, Kinkade Road, and Flamingo Drive are already exposed to flooding from relatively frequent events (e.g., 10-year return period) today, which could block access and emergency services to properties in the study area.

	• The Surfside Groundwater Wells and Kinkade Road Wastewater Pump Station are expected to be at risk of flooding under future climate conditions (10-year and 200-year return period floods). Flood damages to the groundwater wells could temporarily shut down water supply to homes along Surface Drive and McFeely Drive, and flood damages to the sanitary pump station could cause sewer backups along the Kinkade Road and McFeely Drive sanitary sewer systems.
Geomorphology Assessment	• The Little Qualicum River channel has remained fairly stationary and within a 30-metre riparian buffer over the past 64 years. A 30-metre setback corridor is typical for development to leave room for natural channel movement. Local governments periodically review regulations and may consider if additional setbacks are required in certain locations to ensure public safety and to lower the impact of development on the natural environment.

Flood Management Planning

Existing Flood Management in the RDN

The RDN and member municipalities already have adaptation approaches in place to reduce flood risks across the region, including in the Little Qualicum River floodplain. Existing initiatives within the RDN include:

- Existing regulatory river floodplain mapping for the Little Qualicum River, Englishman River and the Nanaimo River;
- Floodplain Management Bylaw No. 1469[3] (2018, first adopted in 2006), which regulates the construction of new buildings in designated floodplains, including the Little Qualicum River, Englishman River and the Nanaimo River. This bylaw also establishes requirements to assess coastal flood hazards as part of coastal development proposals;
- Flood Risk Assessment Report[4] (2019), which assessed a broad range of river, coastal and stormwater flood hazards across the region;
- Sustainable Site Planning Guide[5] (2020), which provides customized guidance to help property owners and local developers lower the impact of construction, landscaping, and major renovation projects on the natural environment. In some cases, even restore or enhance natural functions to provide habitat, flood protection and better manage stormwater;
- Strategic infrastructure planning and asset management that takes adaptive flood planning into account, now and into the future;
- Emergency Program[6], which provides resources and initiatives for emergency planning and response, including the RDN Emergency Plan, emergency alerts, and evacuation procedures;

[3] www.rdn.bc.ca/bylaws-policies-forms-maps
[4] www.rdn.bc.ca/sites/default/files/inline-files/RDN%20Flood%20Report%20FINAL_0.pdf
[5] www.rdn.bc.ca/sites/default/files/inline-files/RDN-SustSitePlanningGuide-Final-online_0.pdf
[6] www.rdn.bc.ca/emergency-program

- Public outreach & volunteer opportunities[7], including the Neighbourhood Emergency Preparedness Program[8], education and outreach[9], and emergency program volunteers[10]; and
- Emergency Operation Centre (EOC) is activated in the event of a local or regional emergency to provide overall jurisdictional direction, coordination, and resource support. Activation also includes regular updates to the public, such as shelter-in-place and evacuation notices and declaring a state of local emergency.
- Ground Search and Rescue (GSAR)[11] (Arrowsmith and Nanaimo) are dedicated local volunteers who respond to emergency calls, under the jurisdiction of the RCMP. Volunteers are professionally trained to respond to ground (rural and urban) and inland water emergencies. Local GSAR members have assisted in delivering emergency notifications and helping residents evacuate during flood events.

Key Resources for Flood Resilience

There are a number of resources that property owners and households can reference to build flood resilience on their property. Steps you can take to flood-proof your property include:

1. Complete a self-assessment of your home using the University of Waterloo – Intact Centre's home flood protection check-up tool[12].
2. Explore ways to flood-proof your septic system through resources on the RDN website[13].
3. Consider capping your well and learning about the RDN WellSmart program[14] for protecting the supply and quality of your drinking water in the face of flood hazards.
4. Become SepticSmart[15] by learning how to maintain and monitor a properly functioning septic system to avoid septic back up due to heavy rain saturation and clogging from silt and debris from flooding.
5. Sign up for the RDN's emergency alert system[16] to receive notifications about flooding and evacuations right to your cellphone.
6. Look into resources through the RDN's Neighbourhood Emergency Preparedness Program[17], including ways to get involved as a volunteer. Review the RDN website[18] and PreparedBC[19] for helpful information regarding what to do before, during and after a flood.
7. Familiarize yourself with flood safety information. Review the clean-up after a flood[20] information from Island Health and Technical Safety BC's[21] flood safety page.

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[7] www.rdn.bc.ca/emergency-public-education-outreach
[8] www.rdn.bc.ca/neighborhood-emergency-preparedness
[9] www.rdn.bc.ca/emergency-public-education-outreach
[10] www.rdn.bc.ca/emergency-program-volunteers
[11] bcsara.com/
[12] www.intactcentreclimateadaptation.ca/programs/home_flood_protect/resources/
[13] www.rdn.bc.ca/septic-systems
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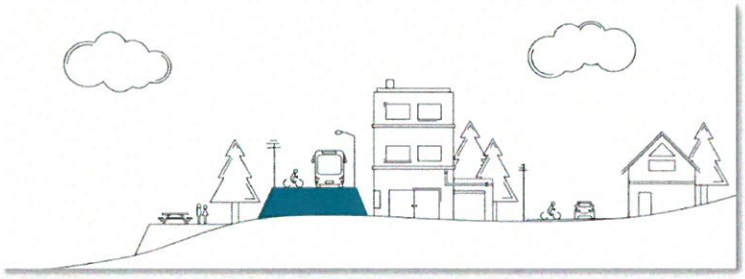
[18] rdn.bc.ca/flooding
[19] www2.gov.bc.ca/gov/content/safety/emergency-management/preparedbc/know-your-hazards/floods
[20] www.healthlinkbc.ca/healthlinkbc-files/clean-after-flood
[21] www.technicalsafetybc.ca/safety-education/flood

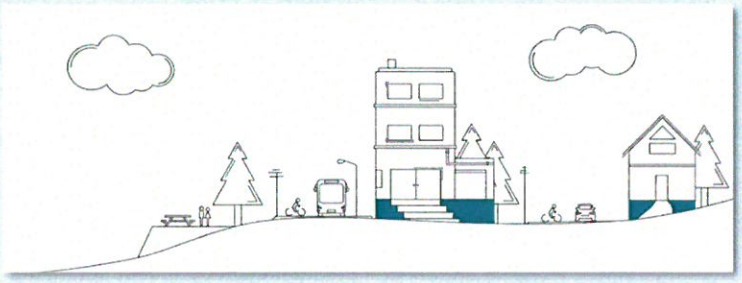
Key Considerations for Future Planning

Communities across B.C. draw on a range of approaches for managing flooding under current conditions and future climate change. The Province of B.C. Sea Level Rise Adaptation Primer[22] (2013) outlined four high level approaches for flood management:

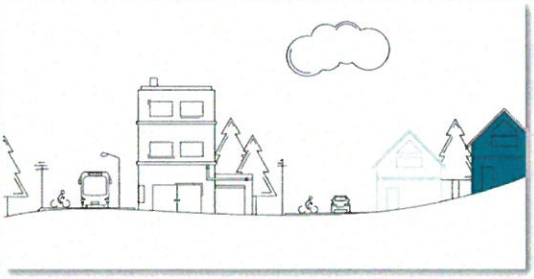
Protect: measures that aim to prevent flooding from occurring. Examples include installing bank protection such as rip rap, dikes, or nature-based approaches such as wetlands and plantings to manage erosion and flood levels.



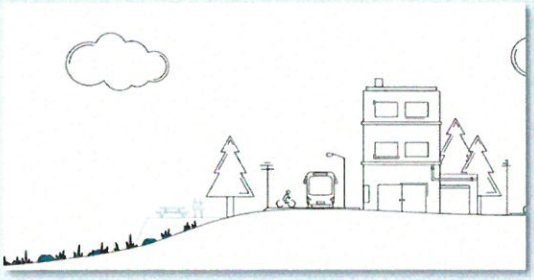
Accommodate: measures that allow flooding to happen but reduce its impact on infrastructure or property. Examples of "accommodate" measures include enabling property-level initiatives to floodproof existing structures or establishing emergency management initiatives for flood hazard areas to protect health and safety and support recovery after flooding events.



Retreat: measures that involve moving existing structures out of flood hazard areas. Examples can include moving high-risk structures and infrastructure out of flood-prone areas in select and extreme cases.



Avoid: measures that aim to manage or reduce the amount of development that happens in flood hazard areas. Examples include establishing policy and planning tools such as Flood Construction Levels (FCLs) and setbacks that guide future development to avoid building in flood-prone areas.



Images Source: District of North Vancouver North Shore Sea Level Rise Risk Assessment & Adaptive Management Strategy (2021)

[22] www2.gov.bc.ca/assets/gov/environment/climate-change/adaptation/resources/slr-primer.pdf

Outcomes from the Little Qualicum River Flood Hazard Mapping project build on existing work to better understand flood hazards to support immediate land use and emergency planning needs and contribute to the next steps in the overall Adaptation Program. Though more work still needs to be done to set priorities, future flood management in the RDN will take a regional approach that considers changing environmental conditions due to climate change. Future work will continue to focus on providing policy, resources and guidance to support appropriate measures at the property and household level. No land alterations have resulted from this project and the RDN is not anticipating that the construction of major flood protection structures will be an outcome from future flood management planning.

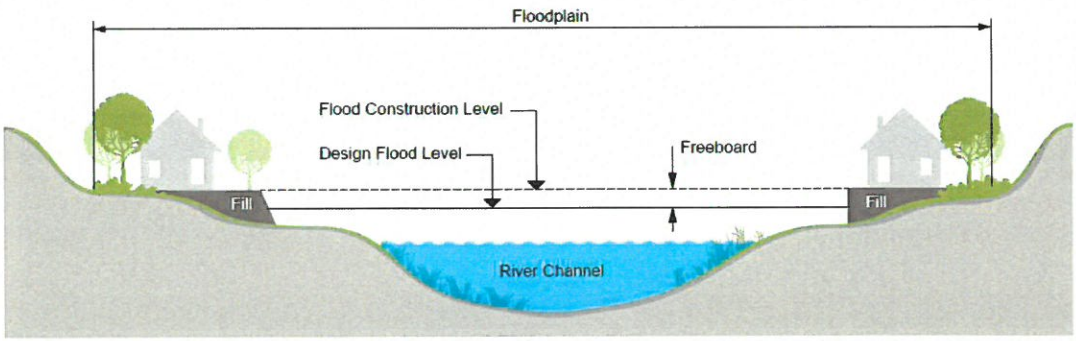
How does floodplain mapping affect me?

Floodplain maps contain a variety of geographical and technical information that identify areas that may be at risk of flooding during severe storms. These types of maps are used to determine if a property (including buildings, structures and infrastructure) is located in a flood prone area. Another key feature of floodplain maps is defined **Flood Construction Levels (FCLs). An FCL is a calculated level of elevation for buildings and structures used to protect development from flood impacts.** When adopted into a land use bylaw, floodplain maps with FCLs become a regulatory tool that define the elevation above which new development must be constructed so the livable area of a home is outside of the flood hazard area.

FCLs are based on the maximum flood level shown on the area's local regulatory flood maps for a 200-year return period flood event under future climate change conditions. FCLs account for flood levels resulting from changing precipitation patterns and sea level rise due to climate change.

Outcomes from the Little Qualicum River Flood Hazard Mapping project will provide updated flood mapping information including updated FCLs that consider climate change through the RDN's floodplain management bylaw. As part of the development approvals process, the floodplain bylaw and maps will be used by development professional (e.g., engineers, surveyors and planners) alongside the recently completed coastal flood hazard maps to assess and determine the flood hazard standards applicable to a property and new building construction.

Eventually, all buildings come to the end of their useful life. New building design and construction provides an opportunity to incorporate the most up-to-date practices to lower the impact of development on the natural environment, reduce energy use, and incorporate safety standards. In designated floodplain areas, FCLs are a key safety measure that property owners will interact with. Due to the rural and low-density zoning near the Little Qualicum River, only a small portion of lands remaining in the floodplain are eligible for subdivision and new development. This means that updating the FCLs will have relatively low immediate impact on homes in the Little Qualicum River area; change is anticipated to occur over time as existing homes are rebuilt.



Little Qualicum Estuary (Photo by Regional District of Nanaimo)

Revision History

Revision #	Date	Status	Revision	Author
2	May 31, 2022	Final	Updated final	RNH / JTM