



Alberni-Clayoquot Regional District

ALBERNI VALLEY & BAMFIELD SERVICES COMMITTEE MEETING WEDNESDAY, NOVEMBER 4, 2020, 10:00 AM

Committee Attendance: The Committee will attend in person in the ACRD Board Room, 3008 Fifth Avenue, Port Alberni, BC and/or via Zoom.

Public Attendance: the public are welcome to attend the meeting via Zoom Webinar by registering at: https://portalberni.zoom.us/webinar/register/WN_u3Rh8ToSPydMlxQ0J6-Xg

Watch the meeting live at <https://www.acrd.bc.ca/events/4-11-2020/>

AGENDA

	PAGE #
1. <u>CALL TO ORDER</u>	
Recognition of Territories.	
Notice to attendees and delegates that this meeting is being recorded and livestreamed to YouTube on the Regional District Website.	
2. <u>APPROVAL OF AGENDA</u> <i>(motion to approve, including late items requires 2/3 majority vote)</i>	
3. <u>ADOPTION OF MINUTES</u>	
a. Alberni Valley & Bamfield Services Committee Meeting held September 2, 2020	3-6
<i>THAT the minutes of the Alberni Valley & Bamfield Committee meeting held on September 2, 2020 be adopted.</i>	
4. <u>REQUEST FOR DECISIONS & BYLAWS</u>	
a. REQUEST FOR DECISION Alberni Valley Curbside and Recycling Depot Contract Extensions	7-10
<i>THAT the Alberni Valley and Bamfield Services Committee recommend that the ACRD Board of Directors authorize the CAO to negotiate and execute a contract extension with Waste Management for curbside recycling collection in the Alberni Valley until March 31, 2021 with the ability to extend up to October 31, 2021.</i>	



Alberni-Clayoquot Regional District

MINUTES OF THE ALBERNI VALLEY & BAMFIELD SERVICES COMMITTEE MEETING HELD ON WEDNESDAY, SEPTEMBER 2, 2020, 10:00 AM

Due to COVID-19 pandemic, meeting conducted via Zoom video/phone conferencing

DIRECTORS PRESENT: John McNabb, Chairperson, Director, Electoral Area "E" (Beaver Creek)
Bob Beckett, Director, Electoral Area "A" (Bamfield)
Tanya Shannon, Director, Electoral Area "B" (Beaufort)
Penny Cote, Director, Electoral Area "D" (Sproat Lake)
Dianne Bodnar, Director, Electoral Area "F" (Cherry Creek)
Sharie Minions, Mayor, City of Port Alberni
Debbie Haggard, Councillor, City of Port Alberni
John Jack, Councillor, Huu-ay-aht First Nation

REGRETS: Wilfred Cootes, Councillor, Uchucklesaht Tribe Government

STAFF PRESENT: Douglas Holmes, Chief Administrative Officer
Wendy Thomson, General Manager of Administrative Services
Jenny Brunn, Acting General Manager of Community Services
Julia Martin, Administrative Assistant
George Rose, IT Manager

The meeting can be viewed on the Alberni-Clayoquot Regional District website at <https://www.acrd.bc.ca/events/2-9-2020/>

1. **CALL TO ORDER**

The Chairperson called the meeting to order at 10:06 am.

The Chairperson recognized the meeting this morning is being held throughout the Nuu-chah-nulth territories.

The Chairperson reported this meeting is being recorded and livestreamed to YouTube on the Regional District website.

2. **APPROVAL OF AGENDA**

MOVED: Director Shannon

SECONDED: Director Jack

THAT the agenda be approved as circulated.

CARRIED

3. ADOPTION OF MINUTES

a. Alberni Valley & Bamfield Services Committee Minutes – June 17, 2020

MOVED: Director Shannon

SECONDED: Director Jack

THAT the minutes of the Alberni Valley and Bamfield Services Committee meeting held on June 17, 2020 be reviewed.

CARRIED

b. Alberni Valley & Bamfield Services Committee Minutes – August 11, 2020

MOVED: Director Jack

SECONDED: Director Cote

THAT the minutes of the Alberni Valley and Bamfield Services Committee meeting held on August 11, 2020 be reviewed.

CARRIED

4. CORRESPONDENCE FOR ACTION/INFORMATION

5. REQUEST FOR DECISIONS & BYLAWS

a. Request for Decision regarding Bylaw R1029-3 Tipping fee for Commercial Mixed Recyclables at the Alberni Valley Landfill

MOVED: Director Jack

SECONDED: Director Haggard

THAT the Alberni Valley and Bamfield Services Committee recommend that the Alberni-Clayoquot Regional District Board of Directors approve adopting Bylaw R1029-3, Alberni Valley Landfill Tipping Fee and Regulation Amendment, 2020 to include a rate for Commercial Mixed Recyclables at the Alberni Valley Landfill at \$200/tonne with a \$15 minimum charge.

CARRIED

b. Request for Decision regarding Port Alberni Maker Space – Letter of Support

MOVED: Director Haggard

SECONDED: Director Minions

THAT the Alberni Valley and Bamfield Services Committee recommend that the ACRD Board of Directors approve a letter of support for the Port Alberni Maker

Space's grant application to the Project Based Labour Market Training Program under Work BC Employment Services for the interior upgrades for the leased area of the upstairs of 3rd Avenue Recycling Depot.

CARRIED

6. REPORTS

- a. **Update on the Bamfield Free Tipping Fee Pilot Program**
- b. **Other Reports**

MOVED: Director Beckett

SECONDED: Director Cote

THAT the Alberni Valley & Bamfield Services Committee recommend that the ACRD Board of Director extend the Bamfield Free Tipping Fee Pilot program for one more year.

CARRIED

The Acting General Manager of Community Services reported staff are working on upgrades at the Alberni Valley Landfill to allow for organics diversion.

MOVED: Director Cote

SECONDED: Director Jack

THAT the Alberni Valley & Bamfield Services Committee receives these reports.

7. LATE BUSINESS

8. QUESTION PERIOD

Questions/Comments from Zoom meeting attendees.

In order to provide the public with an opportunity to ask questions or provide input to the Board of Directors respecting a topic on the agenda, the Regional District set up an email address responses@acrd.bc.ca. The Corporate Officer reported there were no questions or comments received from the public with respect to the meeting today.

9. ADJOURN

MOVED: Director Jack

SECONDED: Director Beckett

THAT the meeting be adjourned at 10:42 am

CARRIED

Certified Correct:

John McNabb,
Chairperson

Wendy Thomson,
General Manager of Administrative Services



REQUEST FOR DECISION

To: Alberni Valley & Bamfield Committee
From: Jenny Brunn, Interim General Manager of Community Services
Meeting Date: November 4, 2020
Subject: Alberni Valley Curbside and Recycling Depot Contract Extensions

Recommendation:

THAT the Alberni Valley and Bamfield Services Committee recommend that the ACRD Board of Directors authorize the CAO to negotiate and execute a contract extension with Waste Management for curbside recycling collection in the Alberni Valley until March 31, 2021 with the ability to extend up to October 31, 2021.

THAT the Alberni Valley and Bamfield Services Committee recommend that the ACRD Board of Directors authorize the CAO to negotiate and execute a contract extension with Waste Management for operation of the 3rd Avenue Recycling Depot until May 31, 2021 with the ability to extend up to November 30, 2021.

Desired Outcome:

That the existing curbside recycling collection services contract be extended in order to align with the implementation of 3 stream collection within the City of Port Alberni and to provide more time to prepare a new request for proposal (RFP)s for the 3rd Avenue Recycling Depot and remaining electoral area curbside recycling collection service.

Background:

In September 2019, the ACRD extended the Curbside Recycling Collection and 3rd Avenue Depot Contract until November 30, 2020 to synchronize with the implementation of organics diversion for the City of Port Alberni (CPA). The start of 3 stream collection by the CPA is anticipated to begin between March and June of 2021. The contract extension has been separated into 2 separate documents to facilitate the transition of CPA curbside recycling from the current contract through the ACRD to being directly provided by the CPA. The proposed curbside extension allows flexibility to end the contract between March 31st and October 31st, 2021. An RFP for curbside collection of the remaining residential recycling contract for properties in Beaver Creek, Teshahat and Hupacasath, will need to be issued prior to the end of this contract extension.

The 3rd Avenue Recycling Depot recently reopened on October 1st, 2020 after renovations to meet safety requirements and reduce handling of materials. This has changed the scope of work required at the Depot, eliminating the need for expensive bailing and handling equipment to be provided by the contractor. An updated RFP incorporating social and strategic procurement principles needs to be created and issued for operation of the 3rd Avenue Depot. Currently, staff resources are not available to undertake this work, therefore an extension of the existing contract is required. The proposed extension allows for an additional 6 months with allowance for an additional 6-month extension up to November 30th, 2021.

Time Requirements – Staff & Elected Officials:

Staff time will be required for coordinating the transition of recycling collection in the city to the new 3-stream cart system, procurement of curbside recycling collection for the remaining households, and for tendering the 3rd Avenue Recycling Depot Operations including development, issue and award of an RFP.

Financial:

The contract extensions propose a 3% increase in pricing. The estimated monthly contract cost for curbside collection

will be \$25,398 with revenues from Recycle BC of \$26,666. The estimated monthly costs for the depot contract will be \$15,250 with anticipated revenues from Recycle BC and stewardship programs of approximately \$6,500 per month. The shortfall in revenues will be subsidized with landfill tipping fee revenues.

Policy or Legislation:

As per the ACRD Officers Delegation Bylaw. The current depot and curbside recycling contract contains language that allows for an extension.

Submitted by: 

Jenny Brunn, Interim Manager of Community Services

Approved by: 

Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer

ADDENDUM TO AGREEMENT

Between

Alberni-Clayoquot Regional District

(the “Regional District”)

And

Waste Management of Canada, Corp..

(“Waste Management”)

This is an addendum to the Agreement between the Alberni-Clayoquot Regional District and Waste Management of Canada, Corp., for the Curbside Collection and Transportation of Comingled Recyclable Materials from single family homes and multifamily dwellings.

The parties intend to amend the current agreement, under the same terms and conditions as written in the current agreement, adding an extension to the term, with the new term of agreement ending March 31, 2021 and adding revised pricing.

The Term may be extended by the Alberni-Clayoquot Regional District for additional two (2) month increments upon mutually agreeable terms to the Parties (increments not to exceed Oct 31, 2021). The Alberni-Clayoquot Regional District shall notify the Contractor of its decision to approve the additional extension and the length of the extension no later than March 1, 2021. The monthly amounts payable to “Waste Management”, covered under this agreement will remain in effect until March 31, 2021.

Proposed Rates:

Contract Service	New Monthly Collection Rate Per Household, Per Month
Curbside Recycling Collection and Transport	\$3.08

Agreed to by the parties on this 28th day of October, 2020.

On behalf of the ACRD:

On behalf of Waste Management:

(signature)

(signature)

(print name/position)

David Millman, Area Manager
(print name/position)

ADDENDUM TO AGREEMENT

Between

Alberni-Clayoquot Regional District

(the “Regional District”)

And

Waste Management of Canada, Corp..

(“Waste Management”)

This is an addendum to the Agreement between the Alberni-Clayoquot Regional District and Waste Management of Canada, Corp., for the Management and Operation of the 3rd Avenue Recycling Depot.

The parties intend to amend the current agreement, under the same terms and conditions as written in the current agreement, adding an extension to the term, with the new term of agreement ending May 31, 2021 and adding revised pricing.

The Term may be extended by the Alberni-Clayoquot Regional District for up to an additional six (6) months, with mutually agreeable terms to the two Parties. The Alberni-Clayoquot shall notify the Contractor of its decision to approve the extension and the length of the extension no later than March 1, 2021. The monthly amounts payable to “Waste Management”, covered under this agreement will remain in effect until May 31, 2021.

Proposed Rates:

Contract Service	New Monthly Rate for the Operation of the Depot
Depot Operations	<p>\$15,250.00</p> <ul style="list-style-type: none"> • Depot services may be terminated at any time.

Agreed to by the parties on this 27th day of October, 2020.

On behalf of the ACRD:

On behalf of Waste Management:

(signature)

(signature)

(print name/position)

David Millman, Area Manager
(print name/position)



REQUEST FOR DECISION

To: Alberni Valley and Bamfield Services Committee
From: Jenny Brunn, Interim General Manager of Community Services
Meeting Date: November 4, 2020
Subject: Review of Municipal Solid Waste Tipping Rates

Recommendation:

THAT the Alberni Valley and Bamfield Services Committee recommend that the staff complete a follow-up review of rates after the implementation of Organics Diversion in the City of Port Alberni.

Desired Outcome:

To ensure rates support effective solid waste management and diversion.

Background:

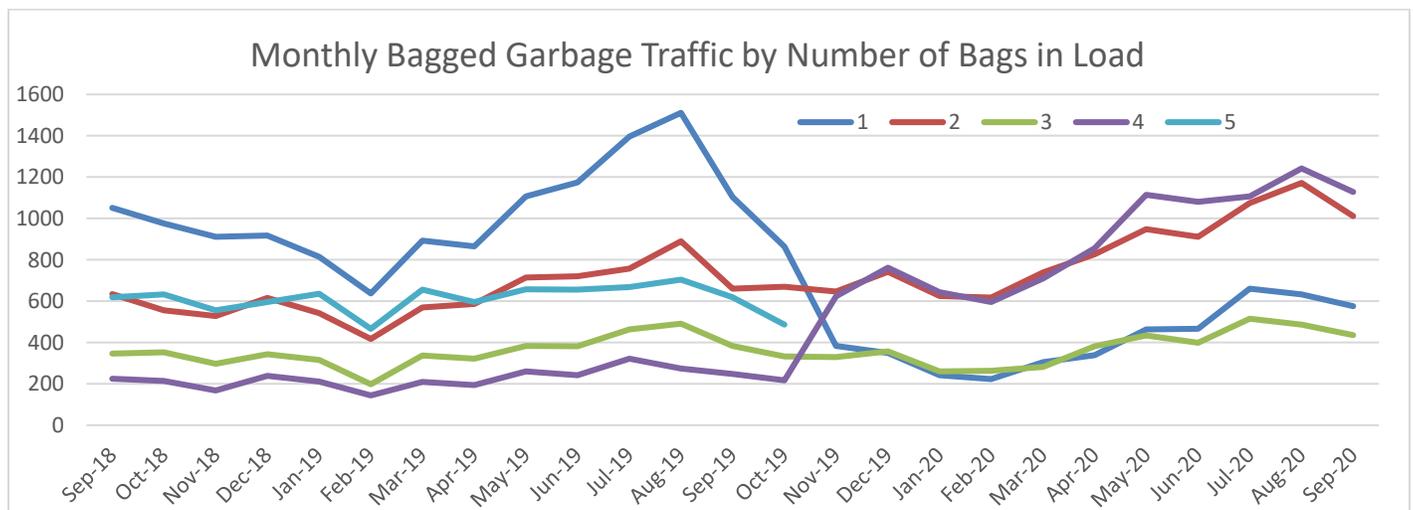
On November 1st, 2019, the MSW (municipal solid waste) tipping fees were updated to address a number of issues.

1. Weighed MSW (loads over 83kg) – rates were increased from \$120/tonne with a \$10 minimum to \$130/tonne with a \$12 minimum.

The weighed rate was increased to keep consistent with neighbouring regional districts and to deter waste hauling in from out of region. ACRD and landfill staff also worked with commercial haulers in the fall of 2019 on a staged enforcement of double charges for loads that contain recyclable material as it was suspected that some loads may be coming from out of region to avoid penalties imposed in other jurisdictions. We have seen an average decrease in commercial garbage tonnage of 25% since these changes have been implemented. Current neighbouring landfill rates are \$140/tonne in the Comox Valley Regional District (CVRD) and \$130/tonne in the Regional District of Nanaimo (RDN).

2. Bagged MSW – (Loads under 83kg) - rates were increased from \$2 per bag with no minimum charge to \$3/bag with a \$6 minimum charge.

The bagged rate was increased to reflect the cost of managing garbage, to be consistent with neighbouring regional districts and to reduce traffic at the landfill.



Minimum rates in neighbouring areas are \$8 in the RDN and \$10 in the CVRD. Initially after this change, ACRD and landfill staff did receive feedback and complaints from some residents but have received minimal feedback in the past 6 months. The percentage of traffic bringing 1 bag of garbage has reduced from 35% to 15% of the bagged waste traffic. The majority of self-haul bagged traffic now brings 2 bags or 4 bags. There has been an overall decrease of 13% in traffic hauling bagged garbage.

Discussion

One of the main reasons that a minimum charge was instituted for MSW was to address the high volume of residential self-haul traffic by encouraging fewer trips and/or the use of a collection service. Each trip requires staff time and supervision at the scale house and in the public tipping area and contributes to line-ups that affect all landfill users. Although there has been an overall reduction of 13% in bagged waste traffic, the temporary closure of 3rd Avenue Recycling Depot at the beginning of the pandemic resulted in increased traffic at the AVL since April. Summer months saw a 60% increase in recycling traffic to over 2500 trips per month. As 3rd Ave Depot has only re-opened on October 1st, we do not have enough data to indicate that this recycling traffic has completely shifted back to the 3rd Ave Depot.

Proposed landfill upgrades to the public tipping area are expected to improve traffic management and reduce line-ups at the landfill. The implementation of curbside organic and yardwaste collection in the City of Port Alberni is also expected to reduce traffic to the landfill. This will be important to ensure that commercial haulers and city trucks are not unnecessarily delayed in their collection routes during their landfill trips. An additional dedicated commercial scale is being considered as an option but traffic data following the implementation of organics diversion in the City of Port Alberni must be collected to determine if this high capital, operating and replacement cost is warranted.

Increases and changes to tipping fees generally result in feedback and complaints from the public. A significant amount of staff time is required to communicate upcoming fee changes and interact with the public during the adjustment period which usually lasts 3 to 6 months. This is one of the reasons to limit the number of changes as much as possible while still ensuring that rates are set to support effective solid waste management and diversion. With the recent and upcoming changes, it is recommended that further data is collected and rates be reviewed once the city of Port Alberni organics diversion program has been implemented.

Financial:

Total revenues at the AVL were reduced between fall 2019 and spring 2020 as a result of reduced waste from the commercial sector that we assume is a result of deterring the import of mixed loads from out of region. Further, the landfill saw a drop in residential garbage generation in the early months of the year from reduced economic and human activity resulting from COVID-19. However, from May forward, residential waste generation has increased as people have shifted their purchases from travel to home renovations and upgrading material possessions. The resulting 2020 revenues are expected to meet budget projections even with a drop in the commercial waste sector.

Submitted by: 

Jenny Brunn, Interim General Manager of Community Services

Approved by: 

Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer



Request for Decision

To: Alberni Valley and Bamfield Services Committee

From: Mike Irg, GM of Planning and Development

Meeting Date: November 4, 2020

Subject: Somass Watershed Flood Management Plan

Recommendation:

That the Alberni Valley and Bamfield Services Committee:

1. Receive the staff report;
2. Recommend to the Board of Directors that staff investigate mitigation options; and
3. Recommend to the Board of Directors that staff provide options for applying the 200-year flood plain maps within the Electoral Areas of the ACRD.

Desired Outcome:

To provide staff direction on next steps which involve separate ACRD services: the first, rural planning and building inspection for land use and flood construction mapping; the second, regional planning for multi-jurisdictional mitigation grant applications and/or studies.

The purpose of this report is to present the Plan to the Committee, make the Plan publicly available and to answer initial questions from Directors. If supported by the Committee, staff will present options to the Board of Directors for applying the new 200-year flood plain mapping to all new construction through existing flood elevation mapping in the Zoning Bylaw.

Next Steps:

- 1/ presenting the Plan to the Directors and making the report public,
- 2/ providing the report to the City of Port Alberni, Tseshaht First Nation and Hupacasath First Nation,
- 3/ posting the report on the ACRD website,
- 4/ reviewing options for implementing recommendations in the Plan and reporting back to the Board,
- 5/ allocate resources in the 2021 budget based on Board direction,
- 6/ Considering whether outside expertise is required to provide education on Plan implementation.

Summary:

The Somass Watershed Flood Management Plan was funded through a National Disaster Mitigation Program grant of \$500,000 with equal contributions from the Federal and Provincial Governments. The work and report was done by Northwest Hydraulic Consultants Ltd. and completed in the spring of 2020. EMBC has reviewed the work and signed off on the report (September 29, 2020 letter attached) and all of the grant funds have been spent.

New flood maps have been prepared which update and significantly increase the area covered by flood mapping. These maps apply new flood construction levels for the portions of the Regional District covered by the mapping. The ACRD is responsible for land use and building inspection in the Electoral Areas of the ACRD. The City of Port Alberni, Tseshahst and Hupacasath would be responsible for applying the flood construction levels in their jurisdictions.

The report also included two examples of flood mitigation scenarios: one for the outlet of Sproat Lake and the other for Highway 4 and Tseshahst First Nation.

Policy and Legislation:

Section 524 of the *Local Government Act (LGA)* sets out the requirements for regulating flood plain areas. The attached Flood Hazard Area Land Use Management Guidelines provides direction to local governments on establishing regulations in flood prone areas. This includes options for flood plain bylaws, development permit areas and setbacks in zoning bylaws. The area OCPs must include general policy statements regarding lands subject hazardous conditions.

Time Requirements – Staff & Elected Officials:

The Somass Watershed Flood Management Plan was a substantial project and required a significant amount of staff time to oversee. Staff time will be required to oversee the implementation of the flood maps and new flood construction levels. Within the ACRD, this will involve both planning and building inspection staff.

Staff recommends that the ACRD investigate mitigation options. If the Board supports this recommendation, resources and staff time will need to be included in the 2021 budget to investigate grant opportunities and research mitigation options recommended in the Plan.

Financial:

The grant to complete the Somass Watershed Flood Mapping Flood Management Plan was for \$500,000. Staff time was in addition to the grant. Based on the Board’s direction for implementation and mitigation, staff time and resources will be required.

Attachments:

Attached to the staff report is the Somass Watershed Flood Management Plan final report, Appendix F Flood Mapping Methodology, Appendix G Flood Mitigation and Adaptation Planning, Province of BC Flood Hazard Area Land Use Management Guidelines, and the EMBC Project Completion Letter.

Hard copies of the maps will be available at the meeting. The maps are large files and are difficult to read on a screen. If directors are not able to attend the meeting in person, staff can arrange to meet with Directors or the public, to review the maps at the ACRD office.



Submitted by: _____
Mike Irg, MCIP, RPP, GM of Planning & Development



Approved by: _____
Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer



SOMASS WATERSHED FLOOD MANAGEMENT PLAN

FINAL REPORT

Prepared for:



Alberni-Clayoquot
Regional District

Alberni-Clayoquot Regional District Office
3008 5th Avenue
Port Alberni, BC, V9Y 2E3



Prepared by:

Northwest Hydraulic Consultants Ltd.
405 – 495 Dunsmuir Street
Nanaimo, BC, V9R 6B9



01 May 2020

NHC Ref. No. 3003140

SOMASS WATERSHED FLOOD MANAGEMENT PLAN

FINAL REPORT

Prepared for:

Alberni-Clayoquot Regional District
Port Alberni, BC

Prepared by:

Northwest Hydraulic Consultants Ltd.
Nanaimo, BC

01 May 2020

NHC Ref No. 3003140

Report Prepared by:



Faye Hirshfield, Ph.D., P.Ag.
Hydrologist

Ashley Dudill, Ph.D., EIT
Project Engineer

Natalia Leon Barrios, M.Sc.
Hydrotechnical Specialist

Laura Ramsden, M.Sc., EIT
Coastal Engineer

Report Reviewed by:



Graham Hill, P.Eng.
Principal



Dave Mclean, Ph.D., P.Eng.
Principal

DISCLAIMER

This report has been prepared by **Northwest Hydraulic Consultants Ltd.** for the benefit of **Alberni-Clayoquot Regional District** for specific application to the **Somass Watershed Flood Management Plan**. The information and data contained herein represent **Northwest Hydraulic Consultants Ltd.** best professional judgment in light of the knowledge and information available to **Northwest Hydraulic Consultants Ltd.** at the time of preparation, and was prepared in accordance with generally accepted engineering practices.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by **The Alberni-Clayoquot Regional District**, its officers and employees. **Northwest Hydraulic Consultants Ltd.** denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

CREDITS AND ACKNOWLEDGEMENTS

The authors would like to thank Larry Cross from Catalyst Paper Corp. for providing assistance with accessing water level sensors and sharing water data for Great Central Lake, Stamp River and Sproat Lake. Staff from the Nanaimo WSC branch provided historical data and information regarding the deactivated Sproat Lake station. Murphy’s Sport Fishing provided background information regarding historical flooding and high water marks and kindly provided access to their property for the duration of the study so NHC staff could undertake consistent set up of base station equipment for surveys. Murphy’s also contributed to the bathymetric survey work by providing jet boats and operators with extensive knowledge of the Somass River Basin.

Appreciation is extended to the following personnel for allowing NHC to access their land and install water level sensors for this study: members of the Tseshaht First Nation, property owner Janice Carter, property owners on Sproat Lake, The Port Alberni Port Authority, BC Parks, staff at Robertson Creek Hatchery and Island Timberlands.

The following NHC personnel participated in the study:

Graham Hill, P.Eng.	Project Principal Engineer
Faye Hirshfield, Ph.D., P.Ag.	Project Manager & Hydrologist
Dave McLean, Ph.D., P.Eng.	Technical Advisor
Monica Mannestrom, M.Sc., P.Eng.	Technical Advisor
Neil Peters, M.Sc., P.Eng.	Technical Advisor
Wil Hilsen, P.Geo.	Senior Review Geomorphology
Ashley Dudill, Ph.D., EIT	Fluvial Geomorphology
Andrew Nelson, M.Sc.	Fluvial Geomorphology
Todd Bennett, P.Eng.	Senior Review Hydraulic Modelling
Natalia Leon-Barrios, M.Sc.	Hydraulic Modelling Lead
Kathleen Horita, EIT	Project Engineer
Grant Lamont, M.A.Sc., P.Eng.	Senior Review Coastal Engineering
Laura Ramsden, M.Sc., EIT	Coastal Engineer
Malcolm Leytham, Ph.D., P.Eng.	Senior Review Hydrology
Rachel Hay, M.Sc.	Hydrology
Sarah North	Senior Review GIS and Mapping
Ben Humphreys	GIS Analyst
Christine McKim	CAD and GIS support
Will Skitmore	Senior Surveyor
Peter Kirillo	Field Survey Lead
Simon Gauthier-Fauteux	Field Surveys and Geomorphology support
Kathryn Dell	Administrative support

Lanarc 2015 Consultants Ltd. (Lanarc) worked as a sub-consultant on the project. Lanarc lead the public and stakeholder consultation, and mitigation planning process aspects of the project. The following Lanarc personnel participated in the study:

Jana Zelenski, MLA, BCSLA, IAP2

Senior Landscape Architect and Environmental Planner

David Reid, BLA, BCSLA, FCSLA

Senior Landscape Architect and Environmental Planner

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1 PROJECT SNAPSHOT

Name: Somass Watershed Flood Management Plan

Location: Port Alberni, Vancouver Island, British Columbia

Agency: Alberni-Clayoquot Regional District (ACRD)

Funding: National Disaster Mitigation Program and Emergency Management British Columbia

Goals: Develop up-to-date flood mapping.
Understand and guide watershed management planning using a science based approach.

- Objectives:**
1. Develop an official 200-year Designated Floodplain Map for the Somass River system.
 2. Develop a comprehensive hydraulic modelling tool that can be used to evaluate flood mitigation measures.
 3. Develop flood mitigation concepts that can provide integrated water management planning along the river system.
 4. Undertake consultation with stakeholder groups.

Approach: Collaborative, multi-phase approach, including stakeholder and public consultation.



Timeline: November 14, 2018 – March 31, 2020

This Report: The summary report provides a high level overview of the methods undertaken to complete flood mapping for the Somass Basin. Report sections include: Somass watershed overview, flood history, surveys, hydrology, geomorphology, hydraulic modelling, coastal assessment and wave modelling, flood maps, initial mitigation concepts, stakeholder consultation and recommended next steps. This material has been selected and condensed from a series of technical appendices which are located at the end of this report.

2 THE SOMASS WATERSHED

The Somass River system, situated in the Port Alberni Valley, is one of the largest on Vancouver Island and drains into the Alberni Inlet. The basin covers approximately 1,426 km² with elevations from sea level to 2,034 meters. It encompasses the Stamp, Ash and Sproat River systems, and includes Great Central and Sproat Lakes (Figure 1). The Somass Estuary lies at the north end of the Alberni Inlet, which extends inland approximately 40 km from Barkley Sound. The climate is dry in the summer and wet in the winter. The City of Port Alberni has a population of approximately 17,700 people and a surrounding regional population of 7,400 people. Port Alberni and the surrounding area is the traditional territory of the Tseshaht and Hupacasath First Nations.

The Somass River system is subject to four types of flood hazards:

- 1) Riverine floods generated by extreme winter precipitation combined with snowmelt in response to Pacific low pressure systems crossing Vancouver Island;
- 2) Coastal flooding in winter months generated by extreme high tides combined with storm surges.
- 3) Flooding on Sproat Lake and Great Central Lake due to high lake levels, wind effects and wave runoff;
- 4) Tsunamis, triggered by subduction zone earthquakes in the north Pacific offshore from Vancouver Island. The most recent major event occurred on March 27, 1964. This present study does not include an assessment of tsunami hazards.

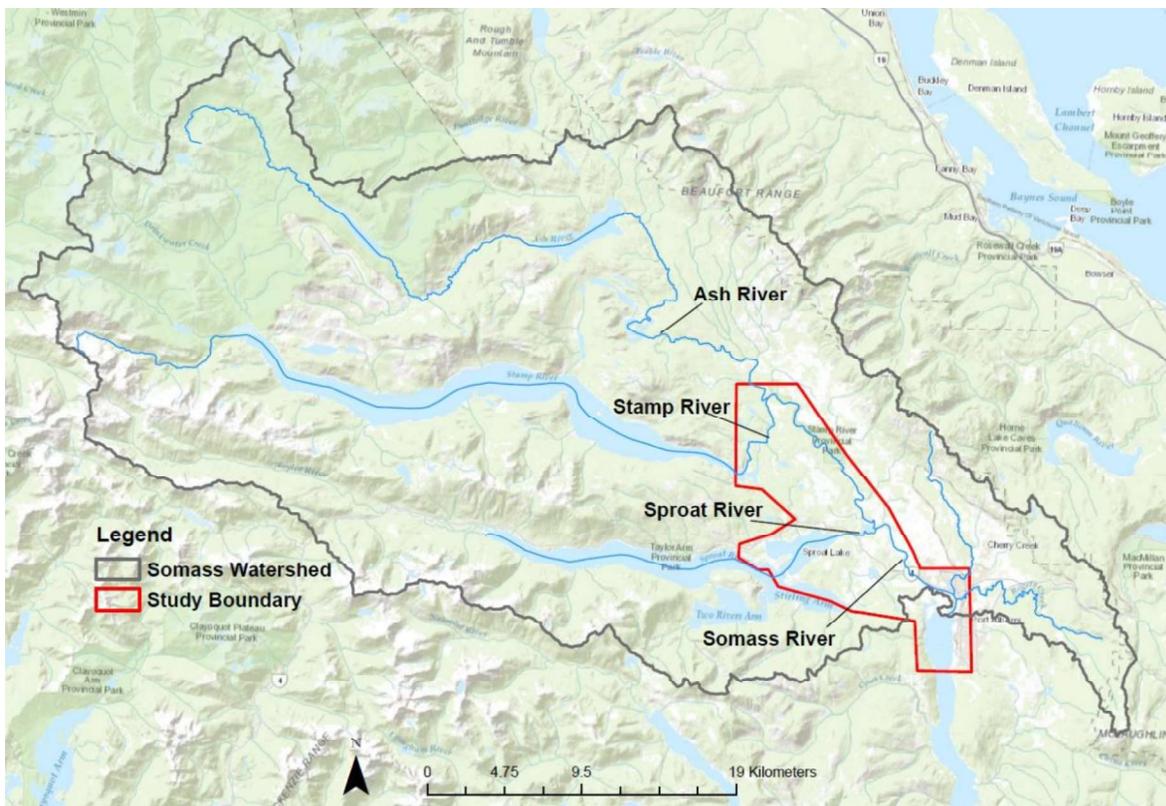


Figure 1 Overview of the Somass watershed. The study boundary, which covers jurisdiction of the ACRD is indicated by the red line.

3 FLOOD HISTORY

There have been several significant floods over the past 100 years causing damage to dwellings along the Somass River and buildings in the downtown core along River Road and 3rd Avenue. The largest riverine flood of record took place on January 15, 1961, impacting homes and businesses, with at least 40 cm of water on River Road.¹

Floods causing damage to homes along the Somass River also occurred in 1975, 1992, 2006, 2014 and 2016 Figure 3. The Tseshaht First Nation has declared a state of emergency several times in the past decade due to flooding on their reserve land. Flooding has resulted in the closure of Highway 4, effectively cutting off access to the west coast communities of Ucluelet and Tofino. The largest riverine floods typically occur in the winter and are associated with rain-on-snow events that coincide with high tides. The figure on the next page provides a timeline of significant floods that have occurred in the Somass Watershed.

Homeowners on Sproat Lake have also experienced flooding . The largest recorded flood occurred on February 3, 1992 when lake levels rose to 4.86 m. Recent high water levels during 2014 and 2016 were also comparable to the 1992 event. Great Central Lake is also at risk of flooding from extreme precipitation events . Presently there is a resort and a series of seasonally occupied float homes reside around the shoreline of Great Central Lake.

The Ministry of Environment, Lands, and Parks conducted a floodplain mapping study on the Somass River and some of its tributaries in 1997.¹ The extent of the study is shown in Figure 2. The surveys used in the study were collected in 1992.

The study did not include Sproat Lake, Great Central Lake or the upper Stamp River. The study also did not account for potential climate change or sea level rise. Given that this work is over 20 years old, the hydrological assessments, topographic information and hydraulic modelling methods are re-examined and flood maps are updated in this present study.

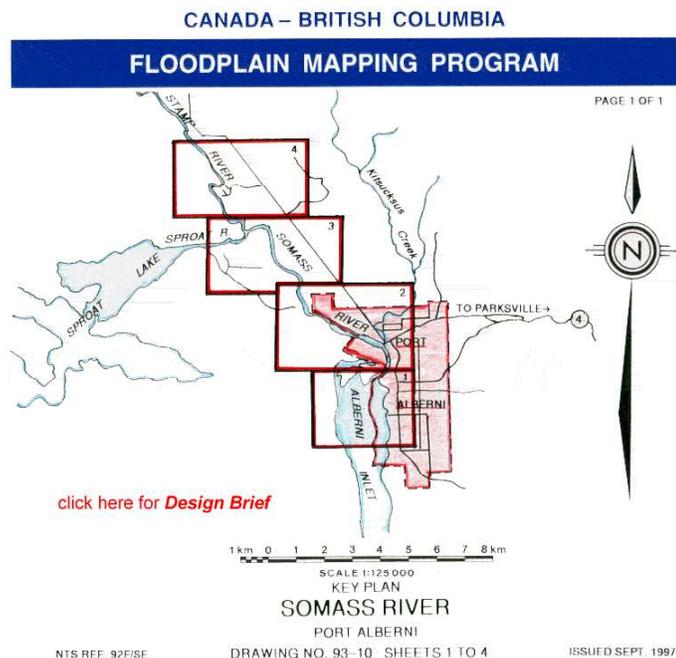


Figure 2 Extent of 1997 Somass River floodplain study.

¹ BC MELP (1997). A Design Brief on the Floodplain Mapping Project for Somass River and Tributaries at Port Alberni, BC (35100-30/100-5229). Prepared by Ministry of Environment, Lands and Parks, Victoria, BC.

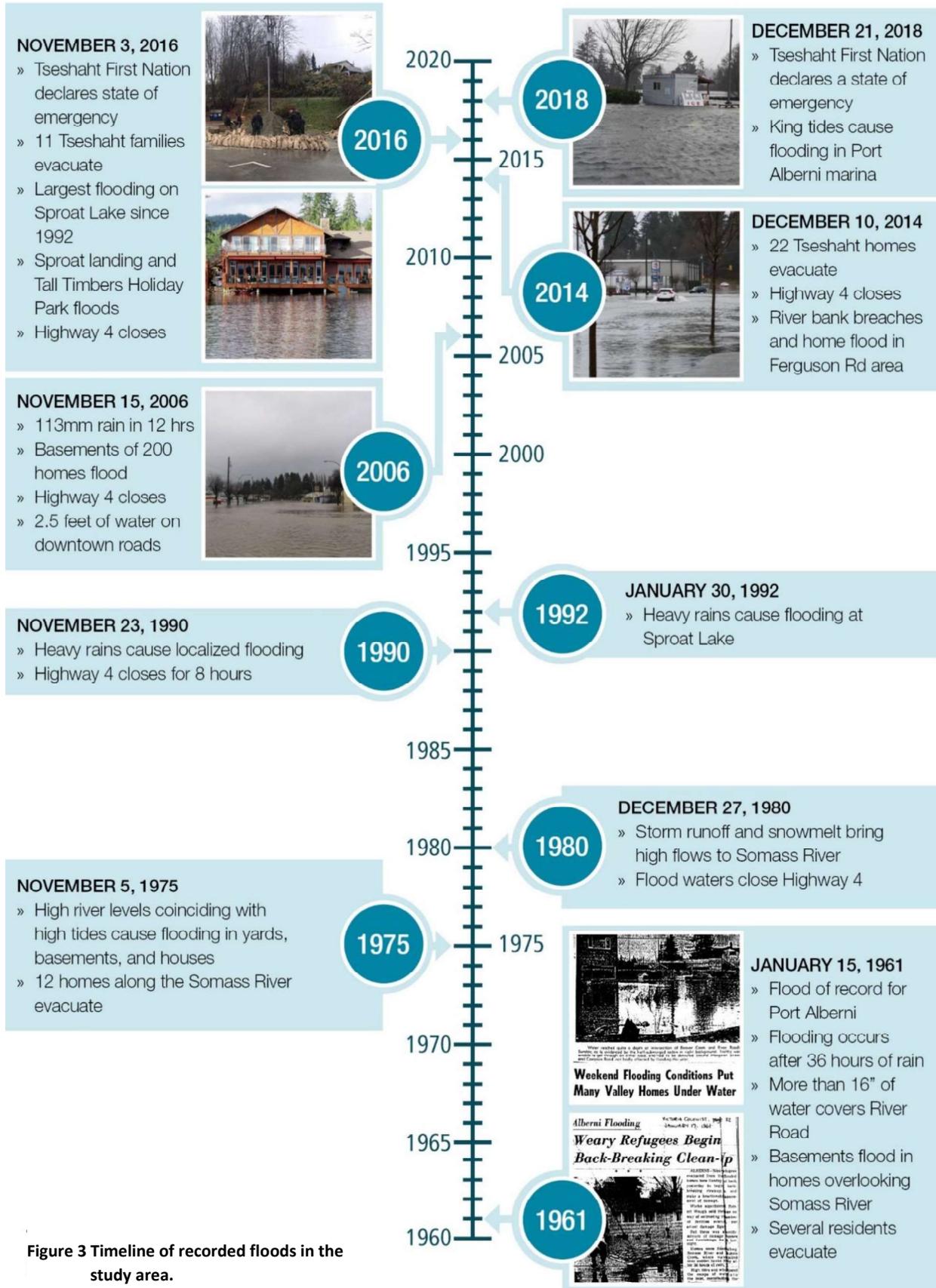


Figure 3 Timeline of recorded floods in the study area.

4 FIELD INVESTIGATIONS AND SURVEYS

NHC undertook a series of surveys to gather information about the Somass basin. The survey information forms the basis of data inputs for the hydraulic models used in this project. Bathymetric boat surveys and terrestrial surveys were completed for input for the hydraulic model. A brief overview of the types of information collected is outlined below. Further technical information is in Appendix A.

Datum:

Several vertical datums are in use in the Somass study area. The Canadian survey and cartography industry has adopted the Canadian Geographic Vertical Datum 2013 (CGVD 2013); the Province of British Columbia is migrating to this datum as new projects come on line. As such, CGVD 2013 was selected for the project.

- Horizontal Datum: North American Datum 83 (NAD83) CSRS 3.0.0.BC.1.NVI
- Projection: UTM Zone 10 North
- Vertical Datum: CGVD 2013
- Geoid Model: CGG2013a

River, Lake and Alberni Inlet surveys:

- Bathymetric surveys are measurements of ground elevations that are underwater. Data is generated with sonar instruments linked with traditional land survey equipment.
- Bathymetric surveys were completed for the Somass, Sproat, and Stamp Rivers, Kitsuksis Creek as well as portions of Sproat Lake, Great Central Lake and the Alberni Inlet (Figure 4).



Figure 4 NHC completing bathymetric surveys on the Somass River.

Terrestrial surveys:

- Terrestrial surveying, also called land surveying, collects elevation and distance information for points on the surface of the Earth. Various terrestrial surveys were completed for this project.
- Bridges in the study area were surveyed along with the Great Central Lake dam and Sproat Lake weir so these structures could be represented in the hydraulic model. A series of hydrometric benchmark surveys were completed in order to shift water level data into CGVD2013 datum.

LiDAR:

- LiDAR (Light detection and ranging) data was used for general terrestrial topography over the study area. LiDAR was flown on September 18, 2018 for the initial study area. Over the course of the project the study boundaries were revised to extend up Kitsuksis Creek and further south into the Alberni Inlet. As such the 2018 LiDAR did not cover the revised study area. LiDAR flown previously on July 16, 2014 was used to supplement the missing areas.

5 HYDROLOGY

A hydrologic analysis was completed for Sproat Lake, Great Central Lake and the main rivers in the Somass watershed. The hydrologic analysis provides the required discharge and water level data for input to the flood models. A brief overview of the hydrologic assessment is provided below. Further technical information can be found in Appendix B.

Real-time water level monitoring:

- 5 hydrometric monitoring stations were installed at various points in the watershed (Figure 5).
- Peak flows were measured during the December 19-21, 2018 storm event (Figure 6).
- Hydrometric data collected at these sites was used to calibrate and verify the accuracy of the hydraulic model.



Figure 5 Water level monitoring station installed on the Somass River.

Review of extreme flood events:

- Extreme flooding in the Somass basin typically occurs from a series of Pacific low-pressure frontal systems generated off the West Coast of Vancouver Island. These storms travel up the Alberni Inlet, bringing large precipitation cells to the Alberni Valley that can lead to flooding.
- The largest flood recorded for the Somass River was on January 15, 1961, measuring 1,150 m³/s, corresponding to a 25-year return period.
- Statistical frequency analysis was completed on Water Survey of Canada gauges to estimate the likelihood of extreme floods. The 200-year flood was estimated and was used to generate final flood mapping.

Climate Change:

- Climate change science was reviewed to estimate how future flows in the Somass Watershed may change by the year 2100².
- Estimations indicate that by 2100 temperatures may increase by 3.5 degrees Celsius and winter precipitation may increase by 17 percent.
- Under warmer winters a greater portion of precipitation may fall as rain instead of snow. It was assumed that under climate change, the Somass discharge may increase up to 20 percent by the year 2100.



Figure 6 Preparing equipment for peak flow measurements on the Somass River during the Dec 2018 storm event.

² PCIC (2019). PCIC Regional Analysis Tool: <https://www.pacificclimate.org/analysis-tools/pcic-climate-explorer>

6 GEOMORPHOLOGY

A geomorphic assessment was completed for the study area within Somass Watershed. This assessment looks at how stable the river channels and banks are over time. River banks were delineated from geo-referenced imagery; air photography was reviewed; historical and recent bathymetric cross sections were compared; and historic hydrometric stage-discharge records were assessed for indications of aggradation or degradation. Channel stability and sediment deposition are important considerations in flood mapping as they influence the accuracy of mapping and the recommended freeboard requirements. A brief overview of the key geomorphic results is provided below. Further technical information can be found in Appendix D.

Effects of sediment on flood levels:

- Sediment supply to the Somass River system is low due to large lakes (Great Central and Sproat Lake) that effectively intercept and store sediment.
- There are only minor sediment inputs from bank erosion and tributaries (Figure 7).



Figure 7 Example of bank erosion in the Stamp River.

Assessment of channel pattern changes over time:

- Lateral and vertical channel changes in the Somass watershed have been low over the past several decades.
- Bedrock controls in upper reaches have limited channel movement; infrastructure development in lower reaches has confined the channel and limited channel movement (Figure 8).

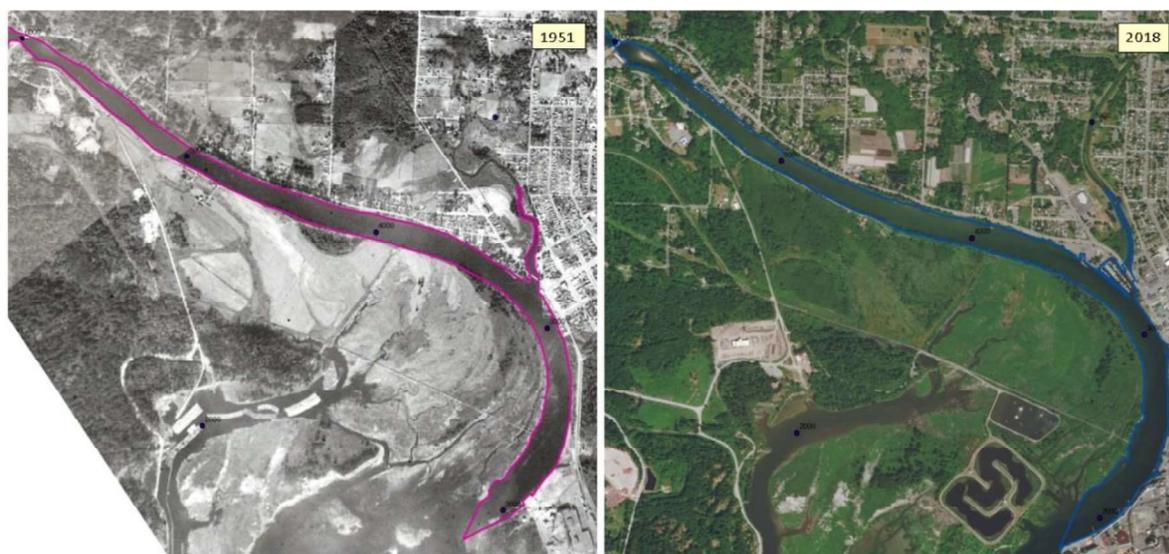


Figure 8 Bank delineation in the lower Somass River.

7 HYDRAULIC MODELLING OF RIVERS

Hydraulic river modelling was completed for three areas in the Somass Watershed (Figure 9):

1. The Somass River and Alberni Inlet
2. Sproat Lake/Upper Sproat River
3. Great Central Lake/Upper Stamp River

Hydraulic model development requires inspecting how well the model can represent real river flows and water levels. This process is called calibration and validation. The model was calibrated on the December 19-21, 2018 high water event and validated on historic records for the Somass River Water Survey of Canada Station. The model was able to simulate 2018 water levels within 0.15 m of observed values. The model was used to simulate present day flows as well as future climate change conditions. The results of the hydraulic model were used to make flood maps. Further technical information on the hydraulic modelling portion of this project can be found in Appendix E.

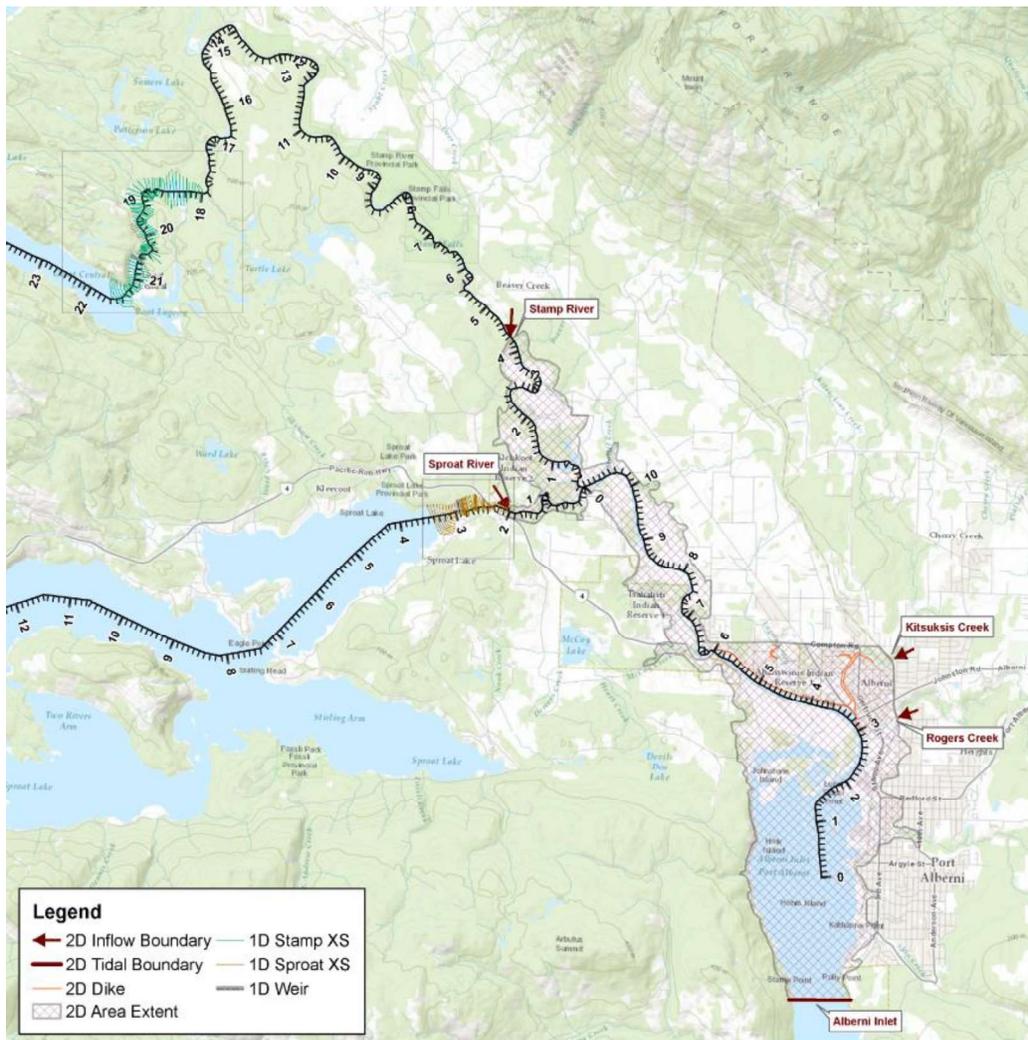


Figure 9 Hydraulic model layout; numbers along reaches identify model stationing.

8 COASTAL ASSESSMENT AND WAVE MODELLING

The coastal assessment portion of this study included review of tide levels for the Alberni Inlet, and wave modelling for Sproat Lake, Great Central Lake, and the Alberni Inlet. The 2D hydraulic model developed for this study requires tide data to simulate flood levels in the lower portion of the Somass watershed and Alberni Inlet. Wave analysis is required to complete flood mapping around shorelines. A brief overview of key coastal and wave modelling results is provided below. Further technical information regarding the coastal assessment can be found in Appendix C.

Coastal flood level assessment and climate change:

- An extreme event analysis was conducted using tide levels for the Alberni Inlet.
- Climate change science and the BC Flood Hazard Guidelines were reviewed to estimate regional sea level rise for the Alberni Inlet by the year 2100.
- Estimations indicate that regional sea level rise for the Alberni Inlet by the year 2100 is 0.83 m.

Wave modelling:

- Wind data for the Alberni Valley was analyzed and used as inputs for the a wave model (SWAN, model version 41.30, Figure 10).
- The potential damage generated by waves depends on the characteristics of the shoreline (riprap versus grassy slope versus beach slope). Shoreline characteristics of the Alberni Inlet, Sproat Lake and Great Central Lake were documented (Figure 11), and corresponding wave effects for defined shoreline reaches were calculated.
- The results of the wave modelling was incorporated into flood mapping for the shoreline areas in the study area.



Figure 11 Example of a rip rap shoreline in the Alberni Inlet.

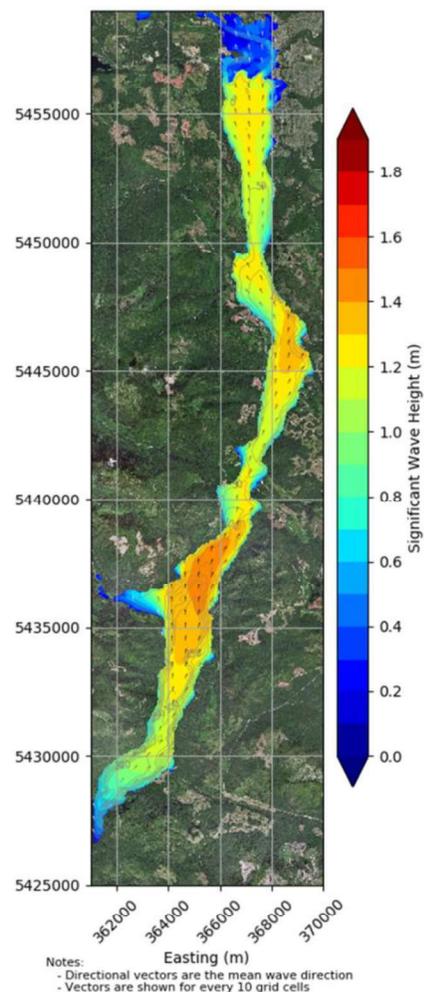


Figure 10 Wave model results for the Alberni Inlet for a 200-year wind event.

9 FLOOD MAPS

A floodplain map delineates the area that can be expected to flood, on average, once every 200 years. There is a 0.5 % chance of the flood event happening in any given year. This 200-year flood is selected based on Provincial guidance³. Two types of floodplain mapping products were produced as part of this study: flood depth maps and designated floodplain maps.

Flood depth maps: Flood depth maps show the estimated flood boundary and associated flood depths under a defined flood event. Four flood depth maps for the study area were developed for scenarios listed in Table 1. The flood depth maps are informational only and are intended for comparing various potential flood scenarios and for providing input for high level planning. They are not to be used for designating floodplains, establishing flood construction levels, designing dikes or any other structures. Freeboard and wave effects is not included in any of the flood depth maps. An example of a scaled down flood depth map for 2100 is shown in Figure 12. Flood depth maps are located in Appendix I.

Table 1 Flood scenarios adopted for this study.

Scenario	Time period/planning horizon	Coastal Climate Change Conditions			Riverine and Lake climate change Conditions	
		Global Sea Level Rise (m)	Uplift (m)	Regional Sea Level Rise (m)	Flood return period	% change in flood discharge
1	2019	0.0	0.0	0.0	1:200-year	0
2	2050	0.5	-0.09	0.41	1:200-year	10
3	2100	1.0	-0.17	0.83	1:200-year	20
4	2200	2.0	-0.34	1.66	1:200-year	20

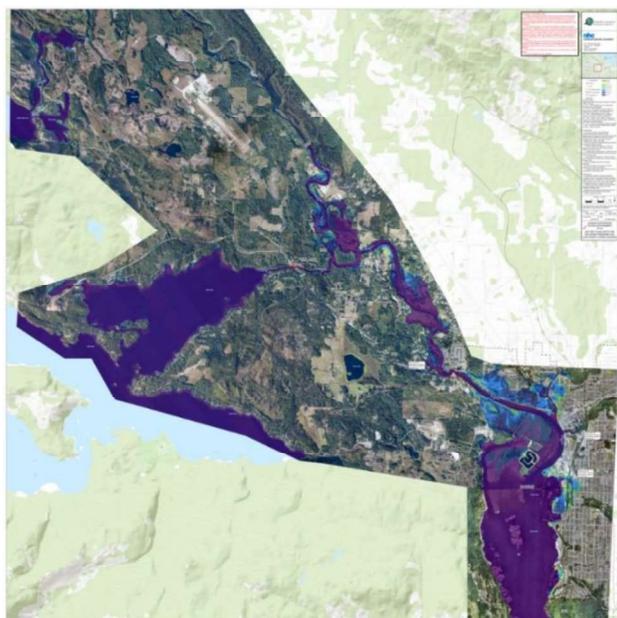


Figure 12 Example scaled-down flood depth map for 2100.

³ EGBC. 2018. Legislated flood assessments in a changing climate in BC. <https://www.egbc.ca/getmedia/f5c2d7e9-26ad-4cb3-b528-940b3aaa9069/Legislated-Flood-Assessments-in-BC.pdf.aspx>

Designated Floodplain maps: Designated floodplain maps show the estimated flood boundary and associated flood construction levels under a defined flood event. A flood construction level is the minimum elevation of the underside of a wooden floor system or top of a concrete slab for habitable buildings in a floodplain. In British Columbia, the standard flood event for which designated flood maps are developed is the 200-year flood with the addition of a climate change factor. For this study the designated floodplain map adopts conditions used for the 2100 timeframe (Table 1). Flood construction zones along the shorelines incorporate wave effects. Flood construction levels also include a freeboard of 0.6 meters and elevations are in CGVD2013 datum. Designated flood maps are displayed at a 1:5000 scale; there are 15 mapsheets for the Somass Watershed that cover the study area. An example of a scaled down designated flood mapsheet for the lower Somass River is shown in Figure 13. Designated flood maps are located in Appendix J.

Designated flood maps are used for establishing flood construction levels and are often incorporated into local bylaws. The designated flood maps are subject to the following limitations:

- The model geometry was kept fixed. In reality, variations may occur, such as bed aggradation or degradation, during a flood event and/or over time. The maps do not provide information on site-specific hazards such as land erosion. Channel obstructions (such as log-jams), local storm inflows, tributary flow, groundwater, or other land drainage can cause flood levels to exceed those indicated on the map.
- Floodplain inundation extents are not established on the ground by legal survey.
- Floodplain maps are an administrative tool that indicate the flood elevations and floodplain boundaries for the designated flood. A Qualified Professional must be consulted for site-specific engineering analysis.

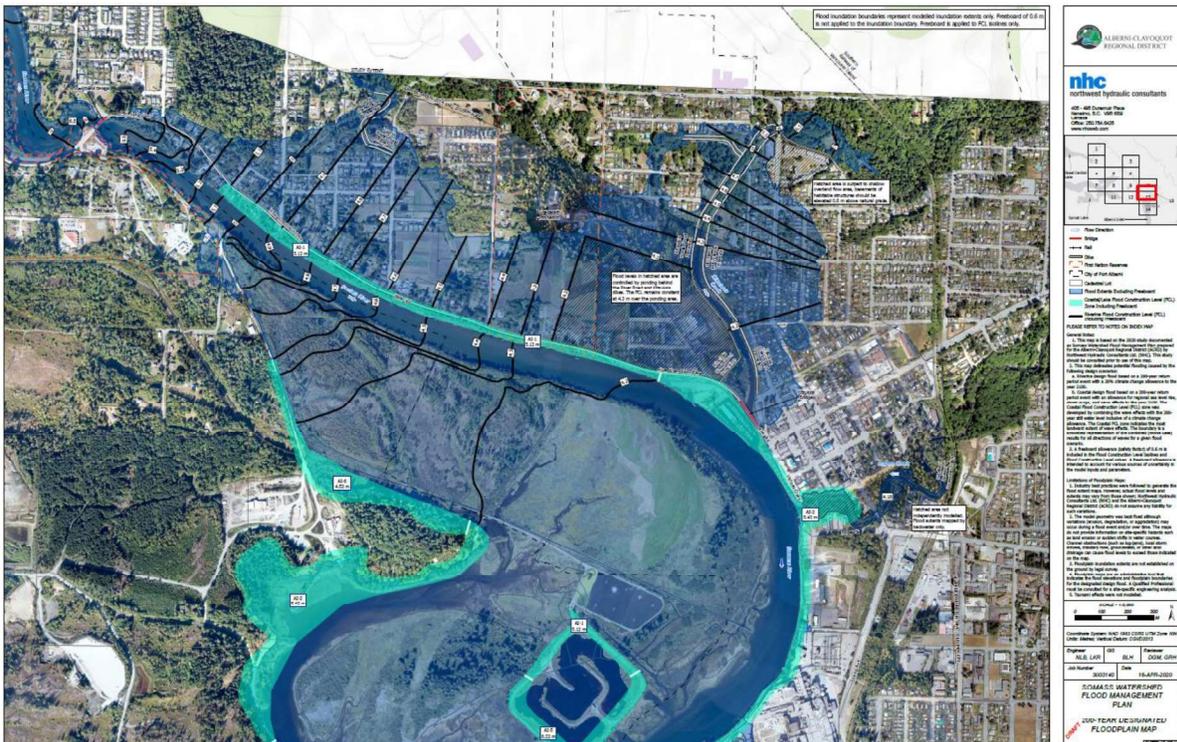


Figure 13 Example scaled-down designated flood mapsheet for the lower Somass River and Alberni Inlet.

10 INITIAL MITIGATION CONCEPTS FOR THE SOMASS WATERSHED

Mitigation Planning:

Flood mapping is a non-structural flood mitigation measure. Structural flood mitigation is another approach that uses engineering measures such as dikes and channel improvements to reduce flood damages. A flood management plan involves developing a comprehensive strategy that includes a mix of non-structural and structural flood mitigation measures to manage flood risks.

There is no “one-size fits all” approach to flood mitigation and adaptation. Communities can investigate and evaluate a range of possible solutions for different parts of the Somass watershed through mitigation planning. Because the Somass watershed is a connected system, a comprehensive approach to mitigation planning ensures selected mitigation measures are effective and do not create unforeseen impacts elsewhere in the watershed.

Through consultation with stakeholders, a list of mitigation concepts was identified as listed Table 2. This list is preliminary and should not be considered exhaustive or complete. A goal of this study was to demonstrate application of the hydraulic model to help assess the effectiveness of mitigation concepts. With input from the ACRD, two mitigation concepts (#1 and #2) were selected as example cases. Results are presented in the next section. Additional technical information can be found in Appendix G.

Table 2 Initial list of mitigation concepts for the Somass Watershed.

#	Mitigation concept	Description
1	Modify outlet of Sproat Lake	Explore if changes to the channel at the outlet of Sproat Lake could reduce lake levels during floods
2	Raises sections of Highway 4	Raising sections of the highway above flood levels could reduce impacts and maintain a key transportation route
3	Flood-proof houses upstream of Highway-4 bridge	Raising habitable floors above flood level could help protect buildings from flood impacts
4	Breach Airport Road dike	Breaching the dike could reduce flood levels during low tides, helping to mitigate flooding on the north side of the river
5	Modify Great Central Lake dam structure for flood control	The existing dam could be modified to safely increase storage in Great Central Lake during storm events with slow release following the event
6	Widen Somass River at Highway 4 bridge	The river narrows at the Hwy 4 bridge and widening could help release storm flows faster
7	Raise River Road	Raising would help protect properties behind the dike against increased flood impacts
8	Floodplain retreat	Retreat of key facilities, infrastructure, and land uses to outside of identified flood areas
9	Coastal region retreat and/or flood-proofing	Policy updates to limit new development in floodplain areas or require new developments to meet enhanced flood construction requirements

Example Mitigation Concept #1 - Modify the outlet of Sproat Lake to reduce lake levels during floods:

Over the past 30-years, significant flooding on Sproat Lake has been documented in 1992, 2006, 2014 and 2016, with nuisance flooding affecting lower lying properties in other years. The residents on Sproat Lake have expressed concerns regarding the weir on Sproat Lake contributing to elevated lake flood levels. In order to investigate various flood mitigation options for Sproat Lake, NHC undertook surveys and hydraulic modelling of upper Sproat River.

Four modifications to the outlet of Sproat Lake were modeled to assess the change in Sproat Lake levels. The locations of the 4 modifications are displayed in Figure 14.

1. Weir in place. Opening all the fish windows in the weir (Figure 15)
2. Removing the weir completely from the channel
3. Weir in place and fish windows closed. Widening the channel at a constriction 15m to 40m downstream of the weir (removal of what is locally known as Bob's rock)
4. Weir in place and fish windows closed. Widening a section of channel at a constriction 260 m to 430 m downstream of the weir in the section immediately upstream of the defunct logging bridge.

All modelled water levels for mitigation scenarios 1 to 4 were compared to baseline conditions. The baseline scenario assumes the weir is in place and all weir fish windows are closed during winter flood conditions. Mitigation scenarios 1-3 did not result in substantial reduction in lake levels. Model results indicate that modifying the channel control, under mitigation option 4, would result in the largest reduction in lake levels (up to 0.15 m) during flood flows. Model results indicated that under option 4 the discharge in the river increases by 19 m³/s (6.3% increase) due to less water being stored in the lake.

The reason scenarios 1 to 3 do not affect the lake levels (or discharge) is because these features are backwatered during large flood events. As the lake level rises, the hydraulic control moves downstream to the constriction upstream of the defunct logging bridge.

The feasibility of modifying the channel control needs to be planned with consideration of downstream impacts given the discharge from Sproat Lake increases under this option. Increasing the discharge flowing out of Sproat Lake during flood events could increase flood impacts downstream. Project details for widening the constriction will include environmental assessments, permitting and approvals, construction challenges, funding, property ownership, and others.



Figure 14 Overview of the Sproat study reach.

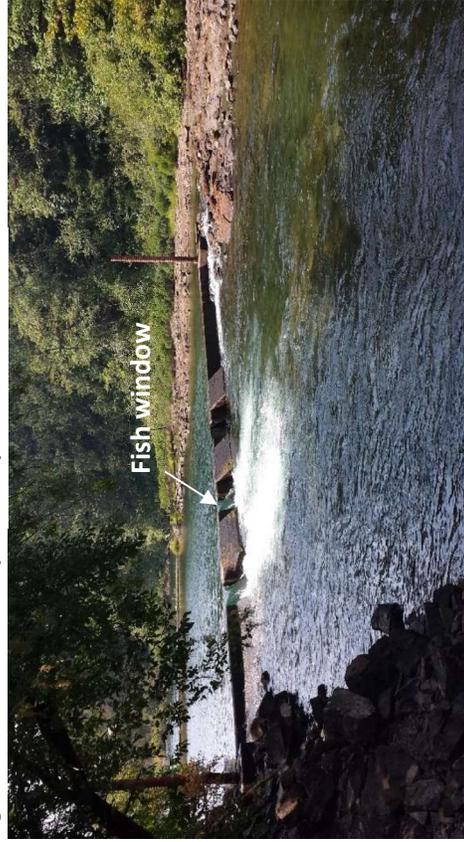


Figure 15 Sproat Lake weir during low flow July 2015, 1 plate removed from fishway opening. Photograph courtesy of Catalyst Paper Corp.

Example Mitigation Concept #2: Raising Highway 4 at Tseshaht First Nation to reduce impacts of flooding:

Sections of Highway 4 between the Somass River bridge and Hector Road have flooded and been closed approximately four times since 2006. The location is shown in Figure 16. This section of the Somass River has a 90-degree bend followed by a constriction at the Somass River bridge. During large floods, water overtops the south riverbank and inundates the highway. Closing this section of the highway cuts off access to the west coast of Vancouver Island. Furthermore, houses on the Tseshaht First Nation are flooded, resulting in the Nation declaring states of emergencies several times.

Model results indicate that approximately a 700 m section of Highway 4 is inundated under the year 2100 designated flood event. Flooding at this section of Highway 4 is primarily due to riverine flows overtopping the riverbank. The tidal influence extends up to the Paper Mill dam falls; however, the tide effects are minimal upstream of the Highway 4 bridge.

The feasibility of raising this section of Highway 4 as a flood management strategy needs to be planned with consideration of impacts to adjacent developments and infrastructure. Part of the design process is to run the hydraulic model with the final design road geometry. Results should be compared to the pre-project conditions to assess hydraulic impacts, if any, to nearby properties. The inundation extents and flood construction level shown in Figure 16 do not consider inflows from McCoy Creek. It is recommended that McCoy Creek hydrology and geomorphology be reviewed, with results incorporated into a site-specific study of potential road upgrades

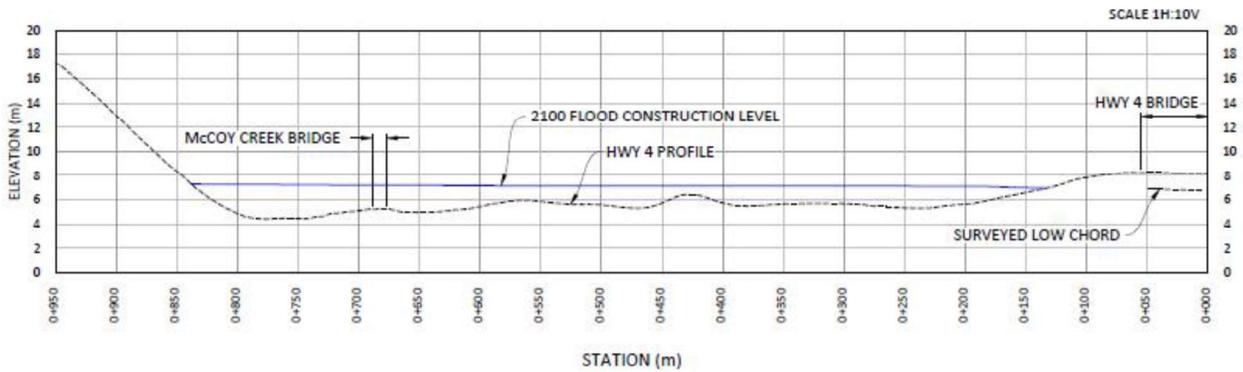


Figure 16 Plan view of the 2100 flood inundation extent at Highway 4.

11 STAKEHOLDER CONSULTATION

An integral part of the Somass Watershed Flood Management Plan was inviting input into the flood mapping process, and initiating conversation around community values, concerns, and perspectives on flood mitigation and adaptation. The engagement process was developed to align with the technical study, and to integrate stakeholder and public input at key points in the process.

Engagement for the Somass Watershed Flood Management Plan occurred from January 2018 to March 2020. A primary audience for this Study was a Technical Working Group. The group included representatives from organizations within the study area as shown in Table 3. This group met twice over the course of the project, providing knowledge and history about the Somass Watershed, reviewing the draft flood mapping process and findings, and discussing mitigation ideas.

Social media outreach also formed part of the engagement process. A project webpage and twitter posts through the ACRD website provided background information and study updates. A mail out letter was sent to residents located in the study area providing information about the study and communicating opportunities to be involved. Information on the project was also covered by local media. The Alberni Valley News published 3 newspaper articles on the project.

A public event was held near the conclusion of the Study to share draft mapping information and gather input and ideas for future exploration of mitigation options.

Detailed information regarding engagement events, stakeholder feedback and public event materials can be found in Appendix H.

Table 3: Technical Working Group Representatives.

TYPE	GROUPS REPRESENTED
Local Government Organizations	<ul style="list-style-type: none"> • Alberni-Clayoquot Regional District • Hupacasath First Nation • Tseshaht First Nation • City of Port Alberni
Federal Government	<ul style="list-style-type: none"> • Department of Fisheries and Oceans
Local Industry	<ul style="list-style-type: none"> • Catalyst Paper Corporation • Mosaic Forest Management • BC Hydro
Stakeholder Groups	<ul style="list-style-type: none"> • West Coast Aquatic • Alberni Valley Enhancement Association • Port Alberni Farmers' Institute • Sproat Lake Home Owners Association • Murphy's Sport Fishing

12 RECOMMENDATIONS AND NEXT STEPS

Floodplain maps have been prepared covering the Somass River, and portions of the Stamp and Sproat Rivers, Sproat Lake, Great Central Lake and the Alberni Inlet. The maps represent the 200-year flood adjusted for climate change and sea level rise conditions in year 2100. The flood maps represent hazards from river and lake flooding along with sea level rise and wave effects. The maps do not represent effects of a tsunami.

The following are recommendations of this study:

- The new designated floodplain maps (Appendix J) should be adopted for flood planning purposes, including establishing flood construction levels. The new designated floodplain maps should replace the existing Province of BC maps which did not consider sea level rise or climate change.
- The flood depth maps (Appendix I) are informational only and intended for comparing various climate change scenarios and for providing input for planning personnel. They are not to be used for designating floodplains, establishing flood construction levels, designing dikes or any other structures.
- The maps should be reviewed after a period of 10 years, or after the occurrence of any extreme flood event. Floodplain maps need to be updated periodically to account for topographic changes, new developments which affect hydraulic conditions, and new information related to future climate change.
- It is recommended that the ACRD continue to communicate the project findings with agencies and organizations that have flood management roles and responsibilities.
- The mitigation concepts modelled in this study are limited in number. The ACRD should broaden the potential options and the combination of options modelled. This process should align with the flood mitigation planning process as outlined in Figure 17 and discussed below.

Next Steps:

A next step in flood management planning for the Somass watershed would be to undertake a flood risk assessment (Figure 17). A flood risk assessment would analyze the potential economic, social and environmental impacts that could result from a defined flood event.

Once a flood risk assessment has been completed, a broad range of flood mitigation options can be considered to reduce the flood risks identified. Once feasible option scenarios are developed and reviewed, these scenarios can then proceed towards an evaluation process. The evaluation process involves technical and sustainability analysis of mitigation options. From this point, a package of mitigation options could be recommended. A funding strategy should be an integral part of implementation planning and should seek local, regional, Provincial, and Federal funding opportunities and partnerships.

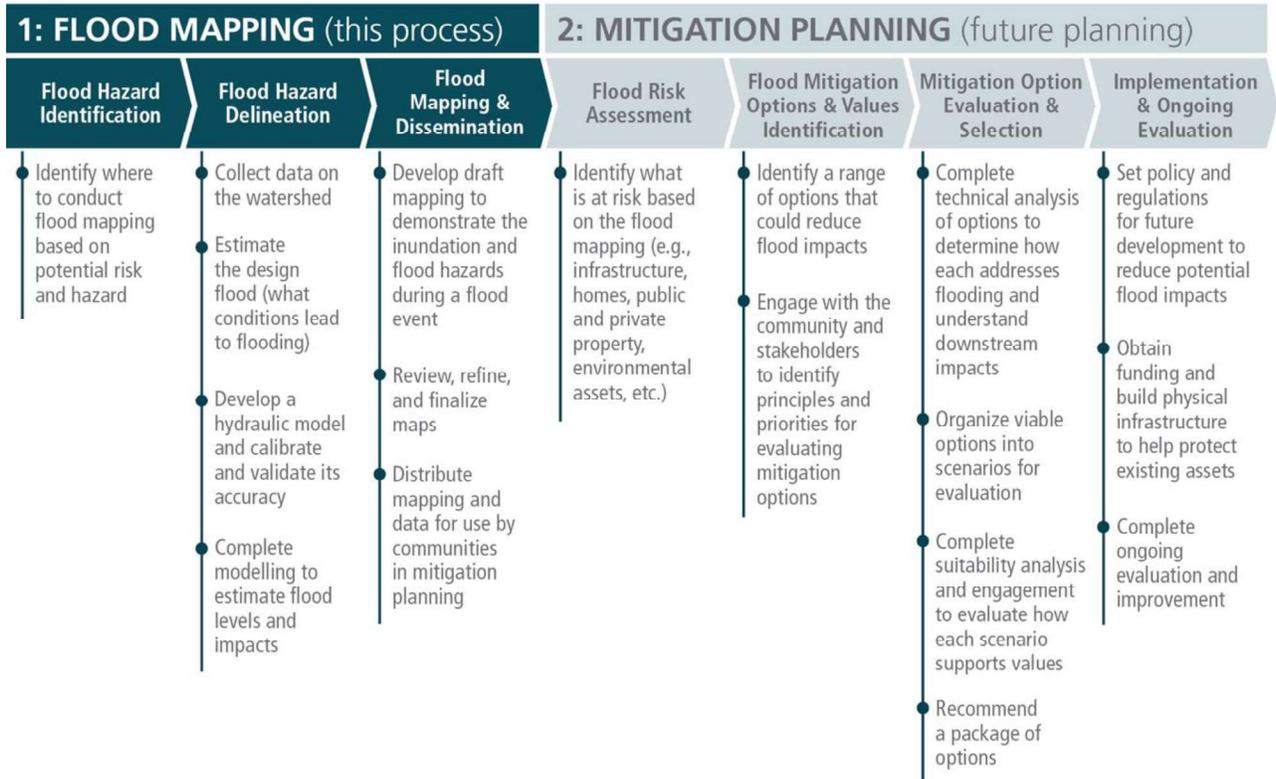


Figure 17 Typical steps undertaken in flood management planning.

APPENDIX F:

FLOOD MAPPING METHODOLOGY

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1 MAPPING OVERVIEW

Two mapping products were developed for this study:

1. Flood depth maps for 4 scenarios as outlined in Table 1
2. 1:5000 regulatory flood maps that cover 15 mapsheets

Digital files for each of the mapping products, compatible with ArcGIS, are provided as part of the results of this study.

The sections below describe the approach take to transfer results from the riverine, lake and coastal modelling into mapping products.

2 FLOOD DEPTH MAPS

2.1 Overview

Flood depth rasters were generated for the Alberni Inlet, lower Stamp, Sproat, Somass, and Kitsucksis Rivers based on the 2D hydraulic model HEC-RAS 5.0.7. Flood depth rasters for the peak of flood events as listed in Table 1 were exported directly from the HEC-RAS 2D model in TIFF format. Flood depth values are in metres. The rasters match the model’s DEM resolution of 0.5 metres.

Flood depth rasters were created in ArcGIS Pro for Sproat Lake and Great Central Lake for the lake boundary conditions as specified in Table 1. Flood depth values for Sproat Lake, Great Central Lake and the Alberni Inlet do not include wave effects, wind setup, seiche or freeboard. Table 2 describes the depth categories displayed on the flood depth maps.

Table 1 Boundary conditions used to generate flood depth maps.

Scenario	Time period	Coastal Boundary Conditions			Lake Boundary Conditions		Riverine Boundary Conditions	
		Global Sea Level Rise (m) ¹	Uplift (m) ²	Regional Sea Level Rise (m) ³	Lake level return period	% change in inflow discharge	Flood return period ⁴	% change in flood discharge
1	2019	0.0	0.0	0.0	1:200-year	0	1:200-year	0
2	2050	0.5	-0.09	0.41	1:200-year	10	1:200-year	10
3	2100	1.0	-0.17	0.83	1:200-year	20	1:200-year	20
4	2200	2.0	-0.34	1.66	1:200-year	20	1:200-year	20

¹ As per the Flood Hazard Area and Land Use Guidelines (BC Ministry of Environment and Climate Change, 2018)

² Uplift is calculated based on tectonic plate interaction.

³ Regional sea level rise incorporates isostatic rebound.

⁴ As per EGBC Guidelines (EGBC, 2018).

Table 2 Description of flood depth categories adapted from (Flood Control Division, River Bureau, Ministry of Land, Infrastructure and Transport (MLIT), 2005).

Depth (m)	Description of Typical Conditions	Legend Color
0 – 0.1	most buildings are dry; underground infrastructure may be flooded	Yellow
0.1 – 0.3	most buildings are dry; walking in moving water or driving is potentially dangerous; underground infrastructure may be flooded	Green
0.3 – 0.5	most buildings are dry; walking in moving or still water or driving is dangerous; underground infrastructure may be flooded	Light Blue
0.5 – 1.0	water on ground floor; underground infrastructure flooded; electricity failed; vehicles are commonly carried off roadways	Blue
1.0 – 2.0	ground floor flooded; residents and workers evacuate	Dark Blue
> 2.0	first floor and often higher levels covered by water; residents and workers evacuate	Purple

2.2 Flood depths on landward side of River Road dike

Flood depths on the landward side of River Road dike varied from the methodology described above. The following describes the flood depth mapping methodology used for the landward side of River Road dike:

- Figure 1 shows the simulated water level in the Somass River adjacent to the River Road dike along with the elevation of the dike crest. Under all scenarios, water from the Somass River overtops sections of the dike at various locations. Once water overtops the dike, it continues to pool on the landward side of the dike as it becomes trapped by both the River Road dike and the Kitsuksis Dike.
- The simulated model outputs are subject to uncertainty. Overtopping points and elevations along the River Road dike are based upon 2019 bathymetry assuming no sedimentation or breaches of the structure. As a conservative measure, the water elevations from the Somass River were extended to the landward side of the River Road dike. For the area east of the Hupacasath First Nation land and south of Pineo road, the depths are controlled by ponding behind the River Road and Kitsuksis dikes. The extents of flooding on the landward side of the dike are defined as the location that the water surface elevations equal the topography elevations.

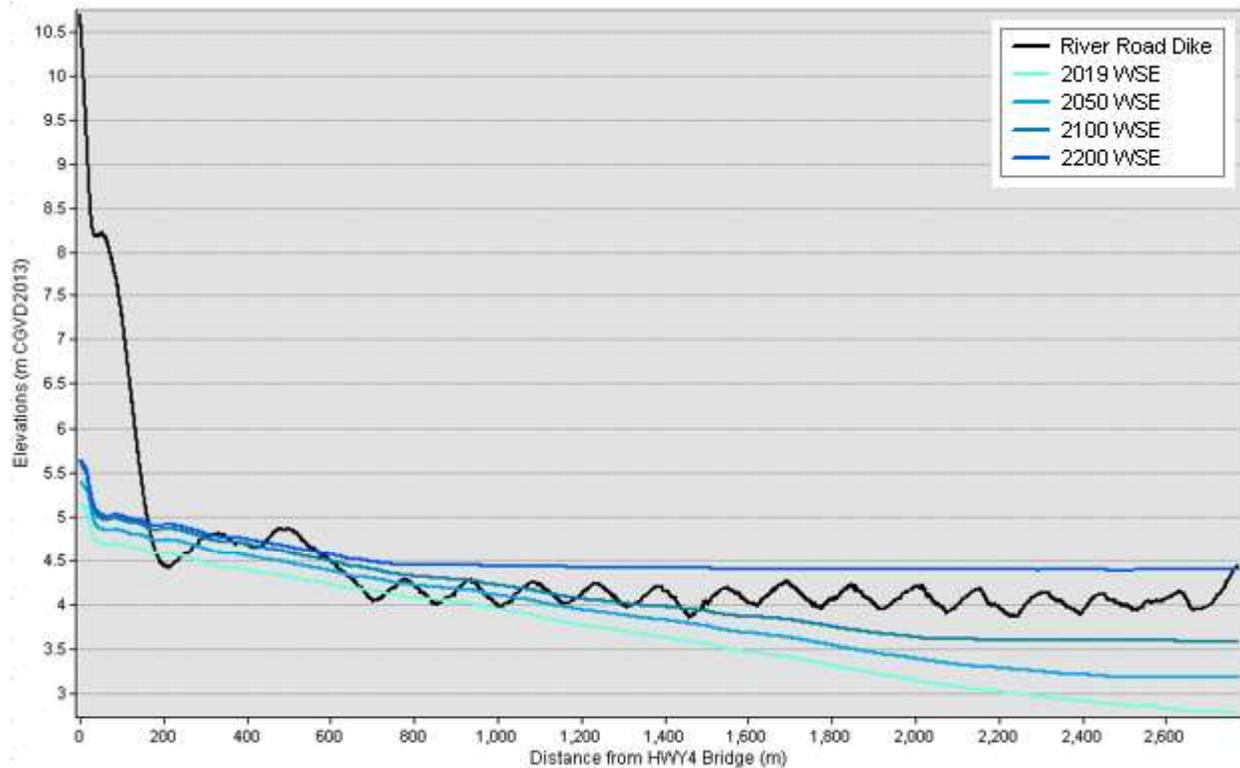


Figure 1 Elevation profile of the River Road dike and model scenarios. Station 0 begins at the Highway 4 bridge and station 2600 ends at the Clutesi Haven Marina.

2.3 Flood depths on landward side of Kitsuksis Dikes

The following describes the flood depth mapping methodology used for the landward side of Kitsuksis dikes:

As a conservative measure, the water elevations from Kitsuksis Creek were extended to the east and west landward side of the Kitsuksis dikes. For the area south of Pineo road, the depths are controlled by ponding behind the River Road and Kitsuksis dikes. The extents of flooding on the landward side of the dikes are defined as the location that the water surface elevations equal the topography elevations. Flood extents on the east side of Kitsuksis Creek, south of Lathom Road were smoothed.

3 DESIGNATED FLOOD MAPS

Designated flood maps were created for the study area, including the Alberni Inlet, lower Stamp, Sproat, Somass, and Kitsuksis Rivers, as well as Sproat Lake and Great Central Lake. The methodology for each component of the Somass basin (river, the ocean, the lakes) varies due to the differences in the hydrodynamic processes for each system. Flood extent polygons are provided for the 2100 Designated Flood scenario in Esri shapefile format.

3.1 Riverine

The workflow to produce these files was as follows. First, polygons were generated in GIS based on flood depth rasters by converting positive flood depths to inundation extent polygons. Then, inundation areas smaller than 100 m² were removed from the extents, and holes in inundation extents smaller than 100 m² were filled in. The polygons were then smoothed to a tolerance of 20 metres except for the area to the east of Kitsuksis Creek; smoothing here had a tolerance greater than 20 metres. These simplifications were done to ensure that a perception of a higher level of data accuracy than exists was not created.

Flood Construction Level (FCL) Isolines include freeboard and were created using the water surface elevation rasters at 0.5 metre intervals for the majority of the study area. Exceptions to this are particularly steep areas (where larger intervals were used), particularly flat areas (where smaller intervals were used), and at the boundaries between map sheets (where a suitable, location-specific value was used). Mapsheets 10, 13 and 15 adopted a 0.1 metre interval as it is the most populated area within the study extent. The isolines have been smoothed to reduce noise and have been snapped to the flood extent polygons. Flood extents on the east side of Kitsuksis Creek, south of Lathom Road were smoothed. The smoothed flood extent line in this area aligned with the extent of flooding on the previous 1997 mapping completed by the Province.

Select areas of some mapsheets were hatched due to the possibility of flooding from bank erosion on sharp river bends. For example, the Stamp River bends sharply to the west immediately downstream of the Alberni Fish and Game Club (Figure 2). The elevation profile of the riverbank and 2100 model scenario water levels is shown in Figure 2. At station 600 m and 750 m the bank is approximately 30 cm above 2100 flood levels. If areas of the bank become eroded during a flood, the hatched area is subject to flooding from overflow from the Stamp River.

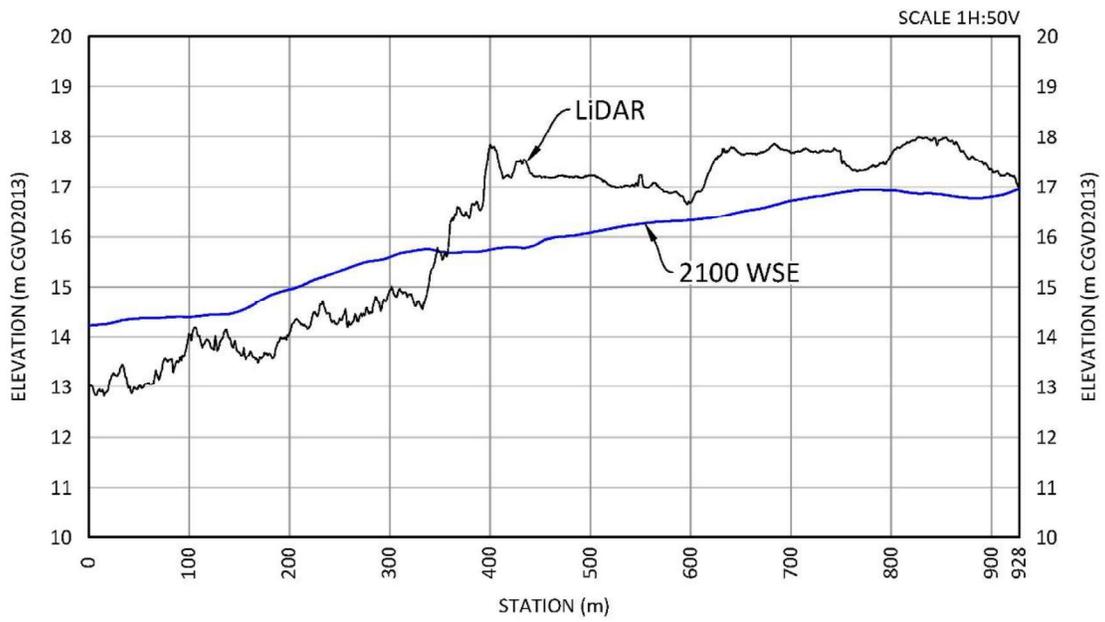


Figure 2 Elevation profile of the Stamp River south bank (taken from LiDAR) and the 2100 model scenario. Station 928 is the most upstream extent.

3.2 Alberni Inlet

Coastal flood mapping for the Alberni Inlet is based on water levels from the 2D hydraulic model results generated in HEC-RAS 5.0.7 for the 200-year return period ocean water level event. The flood extent polygons are based on the outputs from the HEC-RAS model, and do not include wave effects or freeboard.

Coastal FCLs (including wave effects and freeboard) are applicable within the delineated “Coastal Flood Construction Zones”. The methodology for determining the landward extents of these zones are shown in Figure 3. The Wave Breaking Boundary is defined as the location where the 1-in-200 AEP incident wave will break, or the depth equal to half the height of the incoming wave (with a minimum depth of 0.3 m). The Coastal Flood Construction Zone landward boundary is defined as being 30 m landwards from the Wave Breaking Boundary. The Coastal FCL (defined and calculated by shoreline reach in Appendix C) is applicable in the Coastal Flood Construction Zone. Landwards of the Coastal Flood Construction Zone, the FCL is based on the still water elevation exported from the HEC-RAS model in Alberni Inlet plus freeboard.

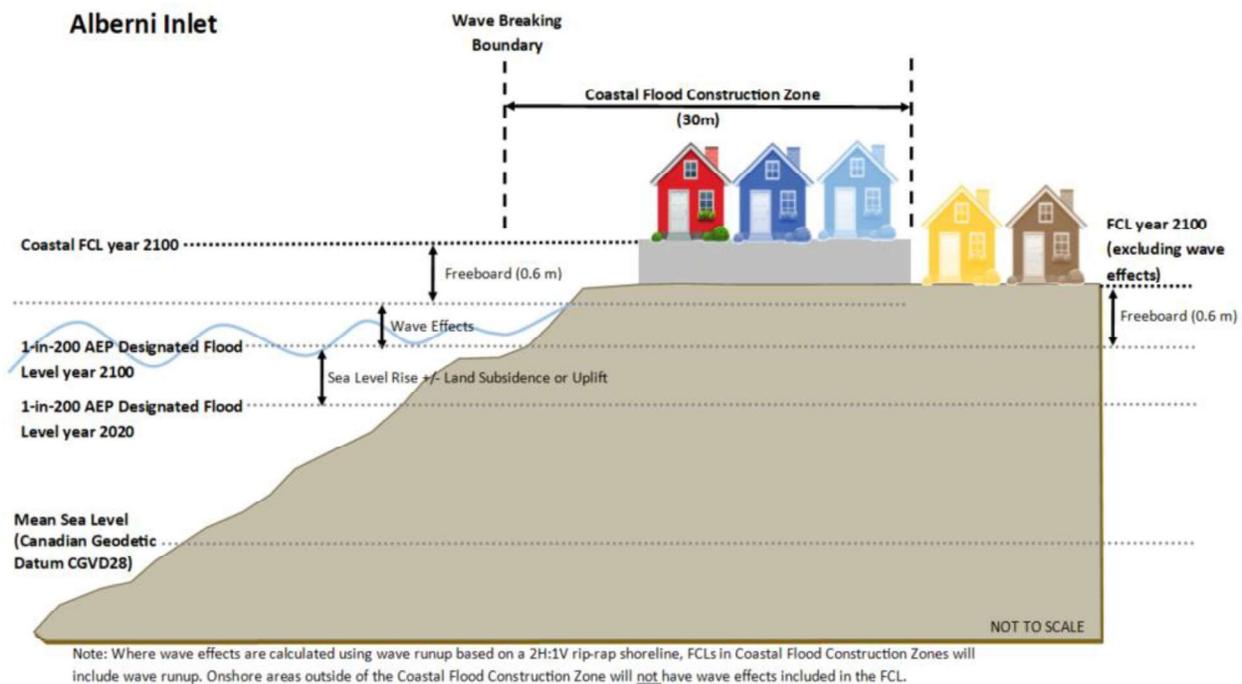


Figure 3 Methodology for determining landward extents of Coastal Flood Construction Zones

3.3 Sproat Lake & Great Central Lake

Still-water lake levels were based on the 1D HEC-RAS model results for the boundary conditions as specified for the 2100 scenario (Table 1). Constant water level rasters were generated in ArcGIS for Great Central Lake and Sproat Lake in order to calculate flood extents along the lake shorelines. The flood extent polygons are based on the still water lake levels and do not include wave effects, wind setup, seiche, or freeboard.

Lake FCLs (including wave effects, wind setup, seiche and freeboard) are applicable within the delineated “Lake Flood Construction Zones”. The methodology for determining the landward extents of these zones is shown in Figure 4. The Wave Breaking Boundary is defined as the location where the 1-in-200 AEP incident wave will break, or the depth equal to half the height of the incoming wave (with a minimum depth of 0.3 m). The Lake Flood Construction Zone landward boundary is defined as being 30 m landwards from the Wave Breaking Boundary. The Lake FCL (defined and calculated by shoreline reach in Appendix C) is applicable in the Lake Flood Construction Zone. Landwards of Lake Flood Construction Zone, the FCL is based on the still water lake level plus freeboard.

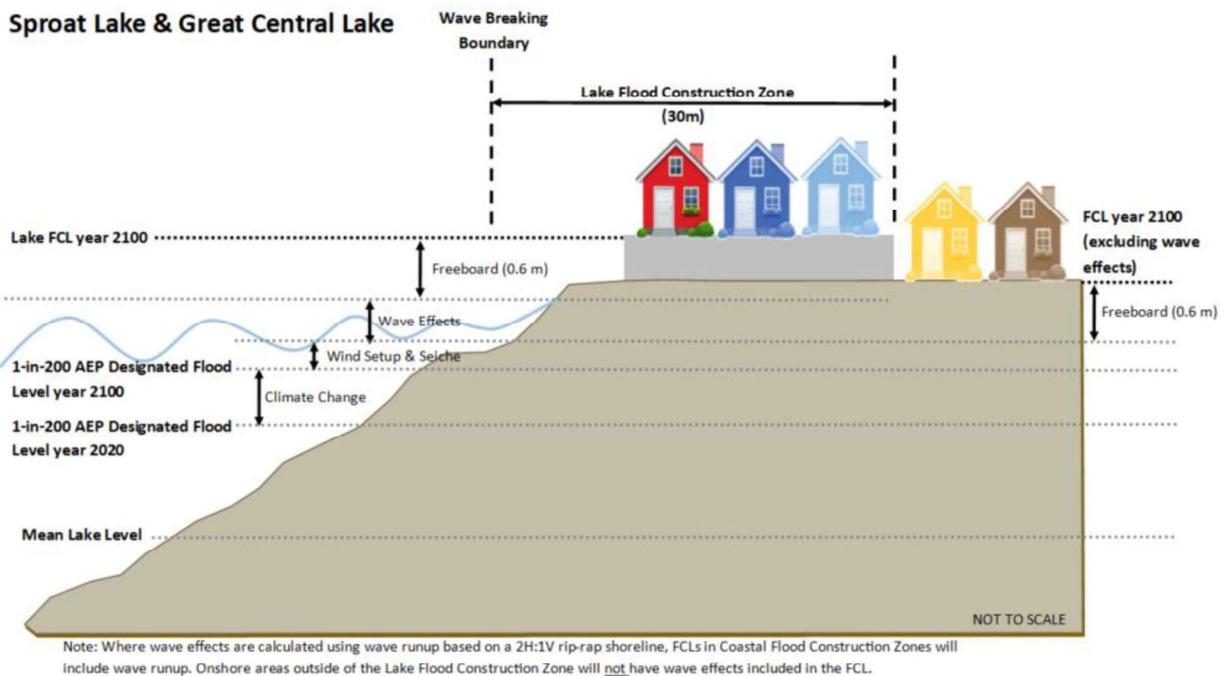


Figure 4 Methodology for determining landward extents of Lake Flood Construction Zones

4 COMPARISON WITH PREVIOUS DESIGNATED FLOODPLAIN MAP

The updated flood inundation extents for Somass River were compared with the previous floodplain maps (BC MELP, 1997). The previous maps were developed in 1997 and were based on a 1D hydraulic model of the channel. To account for uncertainties, a freeboard allowance of 0.6 m was added to the modelled flood levels. In-channel flood levels were then extended across the floodplain assuming open water flow conditions and the absence of all dikes. The updated maps completed for this study use a 2D hydraulic model approach that includes the floodplain, as described in the Hydraulic Modelling appendix. Additionally, the updated model covers a larger area, which includes the Alberni Inlet. Unlike the previous flood extent, the new extent does not include freeboard. Figure 5 shows the comparison of the previous and present flood extents.

Although the two maps (1997 flood map versus present study) show similar inundation extents, this does not mean that the flood levels are equivalent. The updated flood levels account for climate change projections and updated hydrological analyses, which resulted in overall higher modelled levels in comparison to the 1997 levels. However, the extents shown in Figure 5 do not reflect freeboard allowance on the updated levels. Had a freeboard allowance been included, the extents would likely be larger than the 1997 extents (which do include freeboard allowance), especially in low gradient areas.

Despite the extents not reflecting the freeboard allowance, the updated FCL isolines included in the Designated Flood Maps do incorporate a 0.6 m freeboard allowance. Comparing FCLs, as opposed to flood extents, allows for a more direct comparison as both the previous and the present FCLs include freeboard. The updated FCLs are considerably higher in most areas when compared to the previous floodplain maps. Differences of up to 1.4 m were noted upstream of the falls near kilometre 7.5. Table 3 summarizes the differences.

Table 3 Summary of previous vs. updated FCL comparison

Reach	Description
Alberni Inlet and Somass: km 0-13	The Alberni Inlet area was modelled using the newly developed coastal model and was not included in the previous study.
Somass: km 1.3-6	Updated FCLs are generally 0.5 m higher than previous study. On Kitsuksis Creek, the updated FCLs are 1 m higher.
Somass: km 6-7.5	Updated FCLs are slightly higher than previous (difference is less than 0.1 m).
Somass: km 7.5-8.5	Updated FCLs are 1 to 1.4 m higher.
Somass: km 8.5-10	Updated FCLs are 0.5 to 0.7 m higher.
Somass: km 10-11	Updated FCLs are 0.8 to 1 m higher.
Stamp: km 0-1.5	Updated FCLs are 0.6 m higher.
Stamp: km 1.5-2.5	Updated FCLs are slightly higher than previous (difference is less than 0.1 m).
Stamp: km 2.5-4	Updated FCLs are 0.4 m higher.

Note: These are approximate differences to provide a general understanding of the variations between the previous and present maps. They were based on a visual assessment and do not provide a detailed comparison.

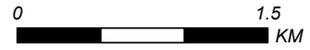


ALBERNI CLAYQUOT
REGIONAL DISTRICT
3008 FIFTH AVENUE
PORT ALBERNI, BC V9Y 2E3



northwest hydraulic consultants

SCALE - 1:45,000



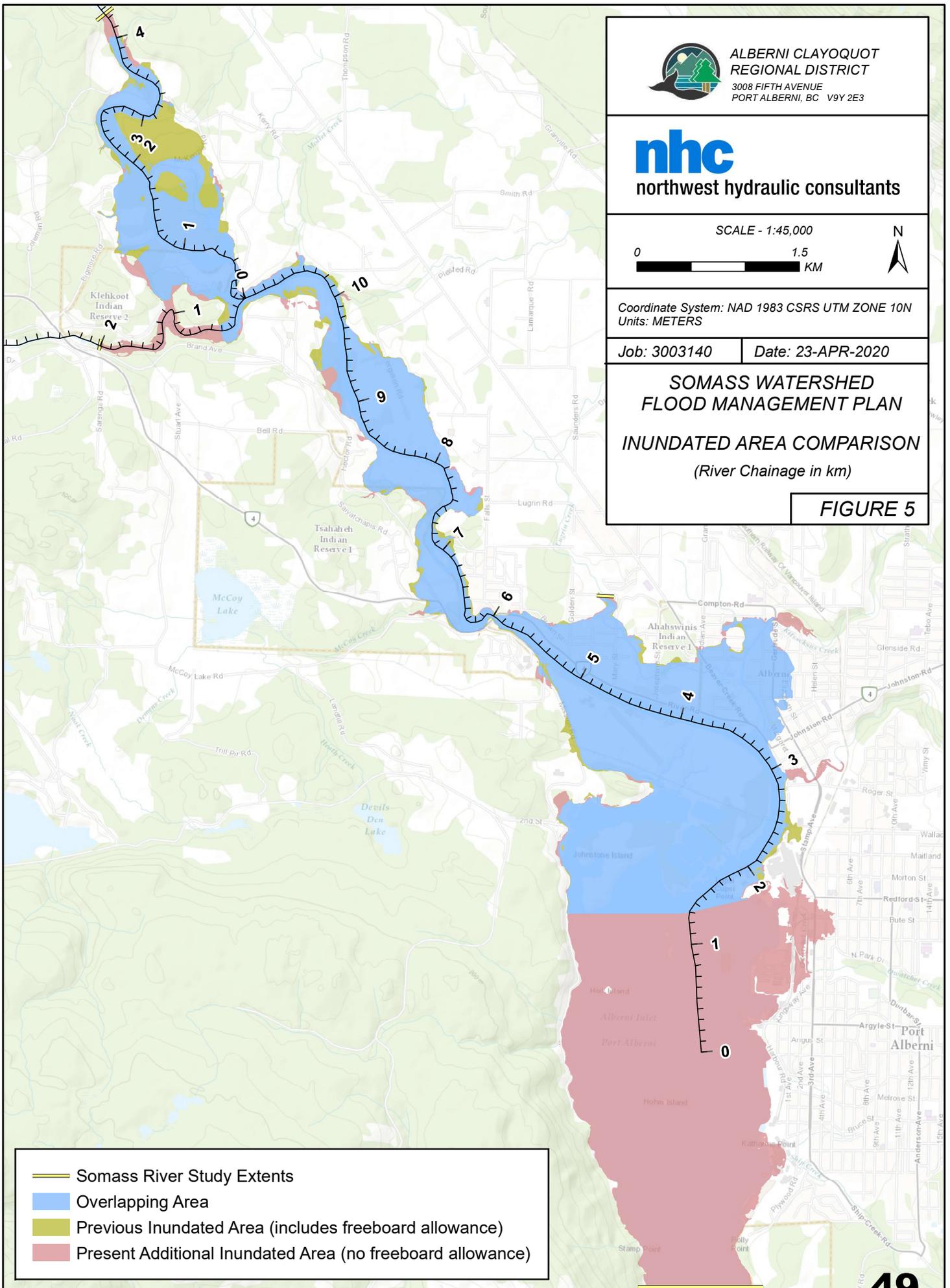
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Date: 23-APR-2020

**SOMASS WATERSHED
FLOOD MANAGEMENT PLAN
INUNDATED AREA COMPARISON
(River Chainage in km)**

FIGURE 5



- Somass River Study Extents
- Overlapping Area
- Previous Inundated Area (includes freeboard allowance)
- Present Additional Inundated Area (no freeboard allowance)

5 ANIMATIONS

Animations were captured directly from the HEC-RAS 2D model in AVI format. The animations show a plan view of depth values (in metres) across the model domain, and throughout the simulation window of two weeks. The timestep used in the animations is 1 hour. A timestamp is included in the upper right corner of the animation.

6 MAP NOTES AND LIMITATIONS

A series of notes and limitations are included on the maps. The following provides additional, more detailed information:

- 1) The flood depth maps are informational only and intended for comparing various potential flood scenarios and for providing input for high level planning. They are not to be used for designating floodplains, establishing FCLs, designing dikes or any other structures.
- 2) LiDAR from 2014 and 2019 along with 2019 bathymetric survey data was used to create a Digital Elevation Model (DEM) of the study area. Major transportation corridors were captured in the DEM, but openings such as underpasses and culverts within embankments were omitted.
- 3) The DEM was used to develop a HEC-RAS (version 5.0.7) 2D and 1D hydraulic model. The model geometry is fixed although variations from erosion, degradation or aggradation may occur over time (particularly during a flood event). Future updates of the DEM and hydraulic model are required. All river channels were assumed to be free of obstructions.
- 4) The HEC-RAS 2D model was calibrated to observed flows and water levels during the 2018 high flow event and validated to a series of historical floods. These historical floods, having return periods in the order 2-25 years, may not inform roughness coefficients for extreme events. There is also uncertainty associated with some of the available validation data.
- 5) **Freeboard is not included** in any of the flood depth maps.
- 6) For the flood scenario mapping, all dikes were assumed to remain intact. If overtopped in the model, overflow will occur, but the dike geometry remains unchanged, preventing a breach from forming. In reality, most overtopped dikes will fail catastrophically. Also, dikes are likely to breach through other failure mechanisms well before they are overtopped. Note that alternative methodology was undertaken to map flood extents on the landward side of River Road dike. See section 2.1 of this appendix for further details.
- 7) Detailed dike crest elevation data is critical for accurate simulation floods. Dikes in the DEM were represented using LiDAR. LiDAR accuracy in general is acceptable, it is unreliable where crests are covered by trees or flood walls are present.

7 REFERENCES

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APPENDIX G:

FLOOD MITIGATION AND ADAPTATION PLANNING

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1 AN INTRODUCTION TO MITIGATION

Flood mapping is a step within the larger process of flood mitigation and adaptation planning. Flood mapping provides a technically sound foundation for identifying, studying, and implementing future mitigation projects to better prepare communities for extreme weather events and flooding. Because a watershed is a connected system, a comprehensive approach to mitigation planning ensures selected mitigation measures are effective and do not create unforeseen impacts elsewhere in the watershed.

This section introduces mitigation planning for communities to consider as they continue in their mitigation and adaptation processes. Figure 1 provides a contextual overview of typical steps in flood mitigation planning. Phase 1, Flood Mapping, includes the process completed to date to create Somass Watershed Flood Mapping. Phase 2, Mitigation Planning, outlines typical steps in mitigation planning that could be considered in next steps.

There is no “one-size fits all” approach to flood mitigation and adaptation. Through mitigation planning, communities can investigate and evaluate a range of possible solutions for different parts of the watershed. This outcome of the mitigation planning process is typically a “package” of recommended and prioritized mitigation measures to be implemented.

Future studies will consider what interventions in the watershed would manage flood risk better than existing conditions. While floodplains will still be required to accommodate flood waters in the future, options might move key land uses out of or above the floodplain, reduce the floodplain footprint by elevating key areas and increasing depth of flood waters in the remaining floodplain, or combinations of strategies.

Each proposed change needs to recognize that the watershed is a system where lowering water levels or increasing the rate of drainage in one area may result in greater inundation or flooding in another area. All solutions need to consider community and environmental values, public safety, and fairness in appropriation of benefits and costs.

The latter sections outline several potential mitigation approaches for the Somass watershed. This list should not be considered complete or exhaustive, nor are any specific mitigations recommended at this stage. Future steps in flood mitigation and adaptation planning will identify a combination of options that meet the specific needs of the communities.

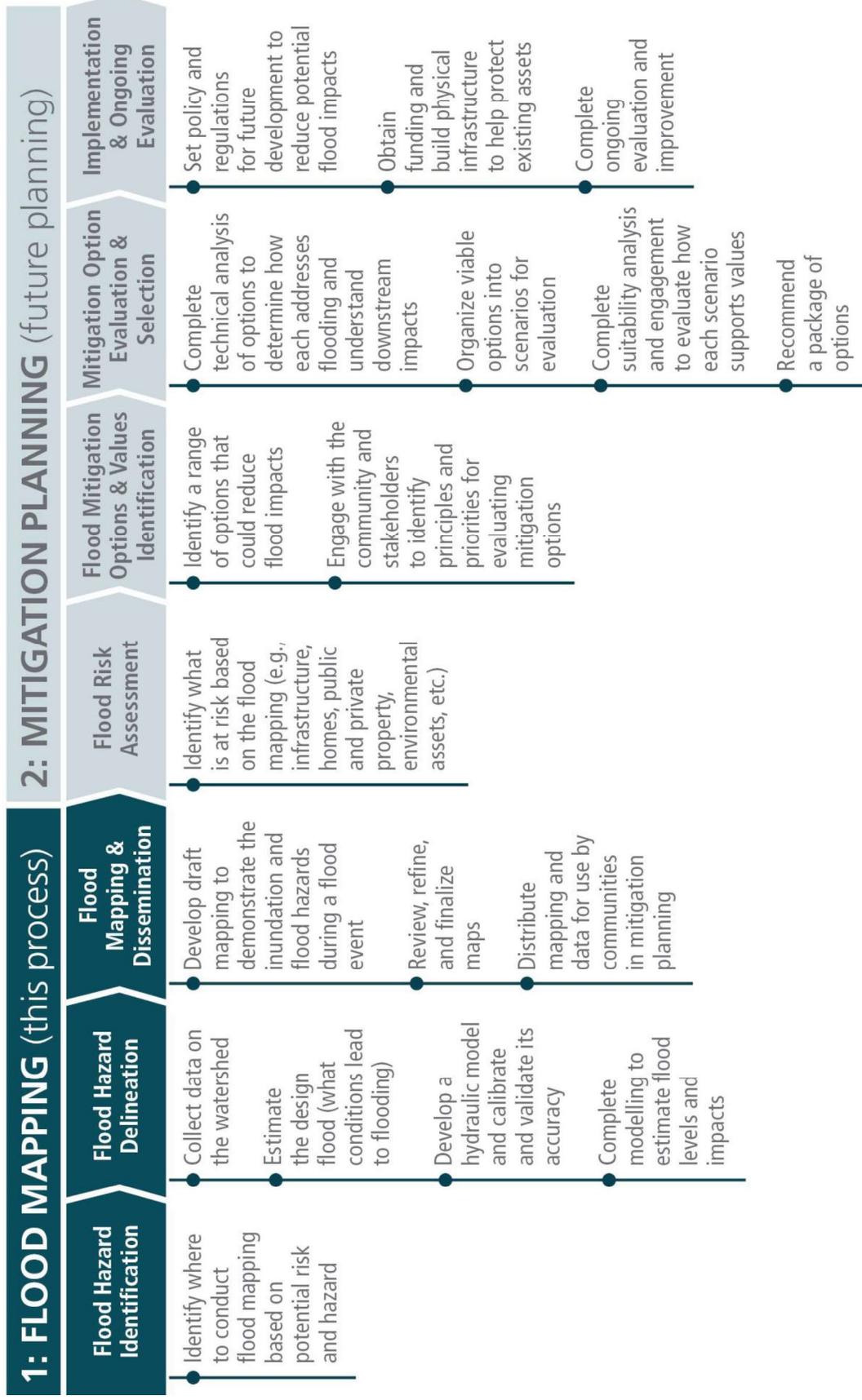


Figure 1 Typical Flood Mitigation & Adaptation Planning Process

Adaptation options may be divided into three levels:

- Watershed Level Mitigation – involve an entire watershed or large part of the watershed
- Community Level Mitigation – have a community- or neighbourhood-scale with public and/or private land
- Property Level Mitigation – undertaken at the building or property parcel scale

Each of the three levels are described below.

1.1 Watershed Level Mitigation

Changes to River Channels or Water Storage

Watershed level mitigations include larger-scale approaches that broadly change water flows in order to reduce flooding or severity of impacts. Examples of watershed level mitigations could include:

- Upstream water storage and release management projects, such as reservoirs and dams, that reduce the severity of flooding during flood events by holding more water in upstream areas and releasing it slowly.
- Modifications to river channels such as removal of constrictions that back-up water flows in certain areas.

Regional partnerships are key as these mitigations are usually large-scale and cost-intensive projects affecting multiple communities, as well as the natural environment. It is critical that watershed level mitigations are assessed to ensure effectiveness and to predict impacts to other parts of the watershed.

1.2 Community Level Mitigation

Community Flood Barriers

Community flood barriers such as dikes can mitigate vulnerable areas by providing a physical barrier to resist flood impacts. Flood barriers are typically best suited for established low-lying areas that require protection from river flooding and where retreat or relocation may be unattainable or highly undesirable. River Road (Hwy 4) and Kitsuksis Creek dike in Port Alberni are examples of existing community flood barriers.

Systems such as flood boxes and pump stations that remove stormwater from areas inland of dikes are typically required to allow flood waters to be properly drained in the event of storm surge or dike overtopping. Flood boxes are designed to close during flood events so that flood waters do not flow into storm drain systems. When water levels fall, the flood boxes open, allowing stormwater to flow out via gravity. In some conditions, it may be necessary to install pump stations to pump excess stormwater over a dike or barrier to exit to the drainage system during flood events. Pumps stations are costly to install and require ongoing operation and maintenance.

The use of community flood barriers requires careful consideration because:

- Costs are high to build, operate and maintain

- Upstream flood levels may be higher caused by constriction of the floodplain
- Downstream flood impacts may be increased by reducing storage areas for flood attenuation
- Failure can be catastrophic to impounded areas
- Environmental impacts can be high
- Impacts such as sightlines and river access can be affected

These systems require regular monitoring and maintenance to ensure they remain structurally sound, including against erosion and earthquake events. Dikes may need to be raised in the future to allow for increased rainfall or sea level rise associated with climate change. A key risk with community flood barriers is that they may support further development in areas vulnerable to flooding and breach or failure can have significant consequences to people living in the area. Because of this risk, Provincial policy recommends that habitable floors in buildings be constructed above flood levels, even if dikes are in place.

Managed Retreat

Knowing extents of flood impacts helps communities make informed decisions about how to locate future land uses, key infrastructure, essential services such as power and water generation and distribution, sewer facilities, emergency services, and emergency travel routes. Choices can be made about relocation to less vulnerable areas during renewal or replacement of assets.

Flood Emergency Response Preparedness & Communications

Emergency evacuation is a key tool for protecting public safety. Continuing to improve evacuation protocols and flood response communications in order to notify residents of imminent flood events is important. Public education in advance, combined with frequent public updates as an event develops, helps communities be prepared to respond.

1.3 Property Level Mitigation

Not allowing development in the floodplain eliminates flood damage however historical development patterns have led to complex relationships between communities and floodplains. Property level mitigations aim to prevent damage to buildings, property within buildings, and to occupants of buildings by keeping flood waters out of buildings or lots, avoiding flood waters by raising the elevation of land, or by building structures that accept and accommodate water.

Updated Floodplain Policy and Property Protection

Property and flood policy measures, such as changes to land use, building regulations, and types of development permitted in flood-prone areas, are an important part of community planning. These measures regulate redevelopment or new development to reduce vulnerability to flooding.

Alternate Construction Methods

Alternate construction methods can be cost-effective and valid options for citizens living in vulnerable areas, notably in locations where flooding is anticipated to be infrequent and/or at lower depths – often

on the fringes of floodplains. Common impacts to buildings in flood-prone areas include private property damage from groundwater, sewer back-up, and overland flooding. When unprotected, impacted systems like electrical, heating and cooling, and sewer can contribute to significant safety concerns and repair costs. Common alternate construction methods are described in Table 1.

Table 1: Common Alternate Construction Methods Used in Flood-Prone Areas

Method	Description & Key Considerations
Elevating Buildings on Fill	<ul style="list-style-type: none"> • During redevelopment or new development, building sites are raised above the flood construction level with the addition of fill. • Best suited for larger lots with low designated flood elevations or sites with existing topography. • Fill placement needs to be contained within property boundaries to avoid encroachment on neighbouring properties or public lands. • The quality of the fill materials needs to ensure structural stability and the ability to withstand flood events.
Elevating Buildings on Piles	<ul style="list-style-type: none"> • During redevelopment or new development, buildings are raised above the flood construction level on piles or extended concrete foundations so that all living spaces are located above the flood construction level. • Pile construction may be more suitable for areas that experience more significant or frequent flood impacts, as water can flow beneath the building with few restrictions. • Pile construction needs to be contained within property boundaries. • Construction can negatively impact the relationship between the building and the ground-level, including potential for accessibility limitations. • It may be possible to retrofit existing structures to pile construction. • Fatigue of piles due to rot of wood or wear of concrete / metal, requires regular monitoring and may require repair or replacement over time.
Protection of Building Systems	<ul style="list-style-type: none"> • Buildings are constructed so that critical systems like utilities are protected from water infiltration by means of relocation, watertight enclosures, or other adaptations. • Common measures include: sealing or relocating external utilities, elevating mechanical equipment and electrical wiring, installing ground fault circuit interrupters, installing tankless water heater, and installing backflow devices. • Building materials, furnishings, and stored goods must be designed to withstand flooding and be suitable for clean-up after a flood. • Best suited for sites that do not have fast-moving flood waters or significant inundation; areas at the outer edge of flood zones that experience infrequent flooding. • Potential challenges related to design approvals and insurance.

2 PLANNING APPROACH TO SELECTING MITIGATION OPTIONS

Future general steps in Phase 2, Mitigation Planning, (see Figure 1) typically include:

- Flood Risk Assessment
- Flood Mitigation Options & Values Identification
- Mitigation Option Evaluation & Selection
- Implementation & Ongoing Evaluation

Each step is described below. A community may choose to refine and adapt a process to suit the specific needs of the study and their community.

2.1 Flood Risk Assessment

The mapping completed through this study identifies locations anticipated to be impacted by flooding during future flood events. A next step in the process is to inventory and evaluate what is at risk if no action is taken. It is likely that some areas subject to potential flooding will have lower risk and impacts, while some areas will have very high risk. A flood risk assessment increases understanding of the potential impacts if mitigation is not implemented and may provide useful information for future prioritization of mitigation measures.

The flood risk assessment may include an inventory and flood-cost summary of elements within flood-impacted areas, including but not limited to, the items listed in Table 2.

Table 2: Common Flood Risk Assessment Items

Topic	Potential At-Risk Features
Communities & People	<ul style="list-style-type: none"> • Impacts to residential neighbourhoods and homes • Safety of local residents • Displacement of local residents • Emergency services access • Social impacts
Infrastructure	<ul style="list-style-type: none"> • Provincial Highways • Local Roads • Bridges • Utility Corridors (e.g., electrical, communications, water, sewer, stormwater) • Sewage Lagoons
Local & Regional Economy	<ul style="list-style-type: none"> • Agricultural impacts • Property values • Movement of goods and supplies • Businesses and commercial areas • Industrial areas (e.g., mills)

Topic	Potential At-Risk Features
Parks & Environment	<ul style="list-style-type: none"> • Parklands • Trails and recreational corridors • Beaches and waterfront recreational areas • Shoreline areas • Fish habitat

2.2 Flood Mitigation Concepts & Values Identification

Once a flood risk assessment has been completed, a broad range of flood mitigation options can be considered to reduce the flood risks identified. This mitigation and options identification process typically involves two key components.

Flood Mitigation Options Identification & Scenario Development

An initial step is to identify a broad set of potentially feasible mitigation options that each could help reduce flooding or flood impacts in the watershed. Section 3 provides an initial list of mitigation concepts for the Somass Watershed that have been captured through the public consultation process. It is anticipated this list could be used as information during the development of a comprehensive flood mitigation options list in future planning.

Typically, this long-list of options is then analyzed and grouped into option scenarios. Each scenario includes a plausible combination of options that together can help address flooding in communities or remove buildings and people from harm’s way. A process for developing scenarios typically includes an initial screening of the “long-list” of options, taking into account local feasibility, functional reliability, financial efficiency, and anticipated environmental and social impacts. Multiple or redundant measures can be used to create a layered approach to address deficiencies of individual measures and to provide adaptability for the future.

Identification of Community Values through Engagement

In conjunction with mitigation options identification, communities may also develop a set of values or principles that indicate how mitigation options should be evaluated. These are typically developed through engagement, distilling “what matters most” for residents, stakeholders, and partners. Measures or criteria can be developed to allow community values to be assessed alongside technical evaluation criteria.

The early identification of community values to support the evaluation of mitigation options helps ensure that flood mitigation measures incorporate community concerns and support ongoing community engagement around potential trade-offs as the process proceeds. Common values often surround the topics of social well-being, environmental protection, economic well-being, recreation and culture, infrastructure protection, and cost / ease of implementation and are customized to reflect the criteria most relevant to the residents, stakeholders, and partners involved.

2.3 Mitigation Option Evaluation & Selection

Once feasible option scenarios are developed and reviewed, these scenarios can then proceed towards an evaluation process that typically involves three key steps.

Technical Analysis of Mitigation Option Scenarios

All scenarios will need to pass a “technically feasible” hydraulic modelling test that shows to what extent the options reduce flood risk impacts and identify downstream or upstream impacts that could occur from implementation. The technical assessment may also include calculation of a cost-benefit ratio for each scenario, and the “residual” average annual damage that large floods could still cause, even with the proposed mitigation measures in place. This information provides an indication of the level of benefit obtained and the level of risk mitigated, supporting more accurate comparison of options. Through this process it may be determined that some options or components of options are not feasible for further study.

Suitability Analysis of Mitigation Options Including Engagement

In addition to technical analysis, a suitability analysis and engagement process should be conducted. This evaluation would be based on community values previously identified. Suitability analysis allows participants to review the technical analysis findings and consider scenarios that may balance values that are important to the public, stakeholders, and partners. The intent of the evaluation is to compare baseline, or “business as usual,” with varied mitigation scenarios.

To support the complex analysis of technical considerations and public values, a Structured Decision-Making process would be advised. A Structured Decision-Making process helps groups, stakeholders, technical experts, and decision-makers think through complex problems. This approach helps build an understanding about resident, stakeholder, and project partner values – what they care about – and how these values influence the development of mitigation approaches and priorities. This type of process supports projects that involve diverse stakeholders with potentially competing values and preferences and require a final decision that is formed through a series of difficult trade-offs.

Figure 2 provides an example ‘heat-map’ summary of a similar evaluation process for a flood management project. The summary is divided into sections on Values, Risk, and Cost/Funding – key values identified by the community for this example.

- **Values Criteria** – include qualitative factors such as People, Economy, Environment, Recreation/Culture, and Infrastructure. This list of values and their relative importance to one another would be refined in consultation with communities, to determine what is important locally. Each value can be defined by a list of detailed criteria, with a key indicator chosen to summarize what is most important (e.g., under “People” the key indicator might be highest number of people protected).
- **Impact and Risk of Failure** – what is the likelihood of failure for each option and the consequences of that failure on vulnerable assets and people? Through the technical analysis, a rating can be provided of overall residual risk after the proposed intervention.

- **Cost and Funding Criteria** – including relative public costs to design and construct (capital costs) and to operate and maintain. Also included are relative values for cost to private landowners, local governments, or businesses including cost of construction and inconvenience or loss of business. Costs may be reduced to local taxpayers by access to co-funding through other agencies or senior governments. In addition, the long-term adaptation cost in anticipation of future on-going climate change can be taken into account for each option.

A baseline of no action is also shown as comparison to how each option performs (better or worse) on each evaluation criteria.

	Baseline No Adaptation	Option A Parcel Scale Minimum Intervention	Option B Neighbourhood Scale Extensive Intervention	Option C Balanced Intervention / Neighbourhood Priorities
VALUES CRITERIA				
People Highest # Protected	Far Worse	Slightly Better	Far Better	Far Better
Economy Sustained jobs and tax base	Far Worse	No Change	Slightly Better	Slightly Better
Environment Sustained/improved long term	Far Worse	No Change	Moderately Better	Moderately Better
Recreation/Culture Views / access / shoreline	Far Worse	Far Worse	Slightly Better	Far Better
Infrastructure Road / emergency / utility function	Far Worse	Moderately Better	Moderately Better	Far Better
IMPACT AND RISK OF FAILURE				
Overall Risk	Very High	High	Moderate	Low
COST CRITERIA				
Capital Cost to Taxpayers	\$\$	\$\$\$\$\$\$	\$\$\$\$	
CR Operations and Maintenance Effort	\$\$\$\$	\$\$\$\$\$	\$\$\$\$	
Cost/Inconvenience to Private Sector	\$\$\$\$\$	\$\$	\$\$\$	
Partnership Potential (Co-fund)	\$	\$\$\$	\$\$\$\$\$\$	
Future Longterm Adaptation Cost	\$\$\$\$\$\$	\$\$\$\$\$\$	\$\$\$	

Figure 2 Example "Heat-Map" Summary of Flood Mitigation Evaluation Process (example only)

Recommended Package of Options

The evaluation process would provide a multi-faceted evaluation of the opportunities and challenges associated with each potential mitigation option scenario. The outcome would be identification of projects, programs, and policies that could be implemented to address flood risk and impacts and improve resiliency of communities in the floodplain area. The outputs would be organized into a prioritized action plan to work towards funding, implementing, and managing flood mitigation measures.

2.4 Implementation and Ongoing Evaluation

It will be likely too costly to collectively implement all the actions identified at once. It will be important that actions are prioritized to address immediate issues and provide strategic steps towards more complex actions. Some actions, including updated policy and regulations to guide future development will likely be advanced in short-term timeframes. Major infrastructure projects may take longer to fund and implement.

A key factor in successful implementation of projects, notably major infrastructure projects, will be securing funding. A funding strategy should be an integral part of implementation planning and should seek local, regional, Provincial, and Federal funding opportunities and partnerships.

The continual monitoring and evaluation of flood mitigation measures will be important. Monitoring refers to an on-going assessment of the actions and progress made in achieving priorities and targets. Evaluation examines if communities are better adapted to flood management as a result of implemented actions. A strong monitoring and evaluation program supports adaptive management. As part of implementing a robust plan for evaluation, monitoring, and adaptive management should be developed.

3 INITIAL MITIGATION CONCEPTS FOR THE SOMASS WATERSHED

Over the course of this study several mitigation concepts have been identified and recorded. Table 3 and Figure 3 show summarize the concepts; the numbers in the table correspond to locations indicated on the map. This list is preliminary and should not be considered exhaustive or complete. These and other ideas may be explored as communities take future steps in flood mitigation and adaptation planning. The hydraulic model created during this process is an important tool for assessing how mitigation options affect the watershed and flood risk.

Table 3 Initial List of Mitigation Concepts for the Somass Watershed

#	Mitigation Concept	Mitigation Level	Description
1	Modify outlet of Sproat Lake	Watershed	<ul style="list-style-type: none"> Explore if changes to the channel at the outlet of Sproat Lake could reduce lake levels during floods Downstream impacts would need to be considered
2	Raise sections of Highway 4	Community	<ul style="list-style-type: none"> Hwy 4 upstream of the bridge frequently floods during storms, impacting access to the West Coast Raising sections of the highway above flood levels could reduce impacts and maintain a key transportation route
3	Flood-proof houses upstream of Highway 4 bridge	Property	<ul style="list-style-type: none"> Homes in the Tseshaht community are often subject to flooding Raising habitable floors above flood level could help protect buildings from flood impacts
4	Breach Airport Road dike	Community	<ul style="list-style-type: none"> The existing dike constricts the river channel Breaching the dike could reduce flood levels during low tides, helping to mitigate flooding on the north side of the river There could also be environmental benefits to the estuary
5	Modify GCL dam structure for flood control	Watershed	<ul style="list-style-type: none"> The existing dam could be modified to safely increase storage in Great Central Lake during storm events with slow release following the event Environmental impacts would need to be considered
6	Widen river at Highway 4 bridge	Watershed	<ul style="list-style-type: none"> The river narrows at the Hwy 4 bridge and widening could help release storm flows faster Downstream impacts would need to be considered
7	Raise River Road dike and add pump stations	Community	<ul style="list-style-type: none"> The existing Hwy 4 dike is at risk of breach during major storm events Raising would help protect properties behind the dike against increased flood impacts, although provincial guidelines would still recommend that all habitable floors be above flood level (i.e., at least as high as the dike crest) due to high consequence of dike failure Pump stations would be needed to move accumulated stormwater from the protected inland basin over the dike

#	Mitigation Concept	Mitigation Level	Description
8	Floodplain retreat (not shown on map)	Community and/or Property	<ul style="list-style-type: none"> Retreat of key facilities, infrastructure, and land uses to outside of identified flood areas
9	Coastal region retreat and/or flood-proofing (not shown on map)	Community and/or Property	<ul style="list-style-type: none"> Policy updates to limit new development in floodplain areas Require new development to meet enhanced flood construction requirements

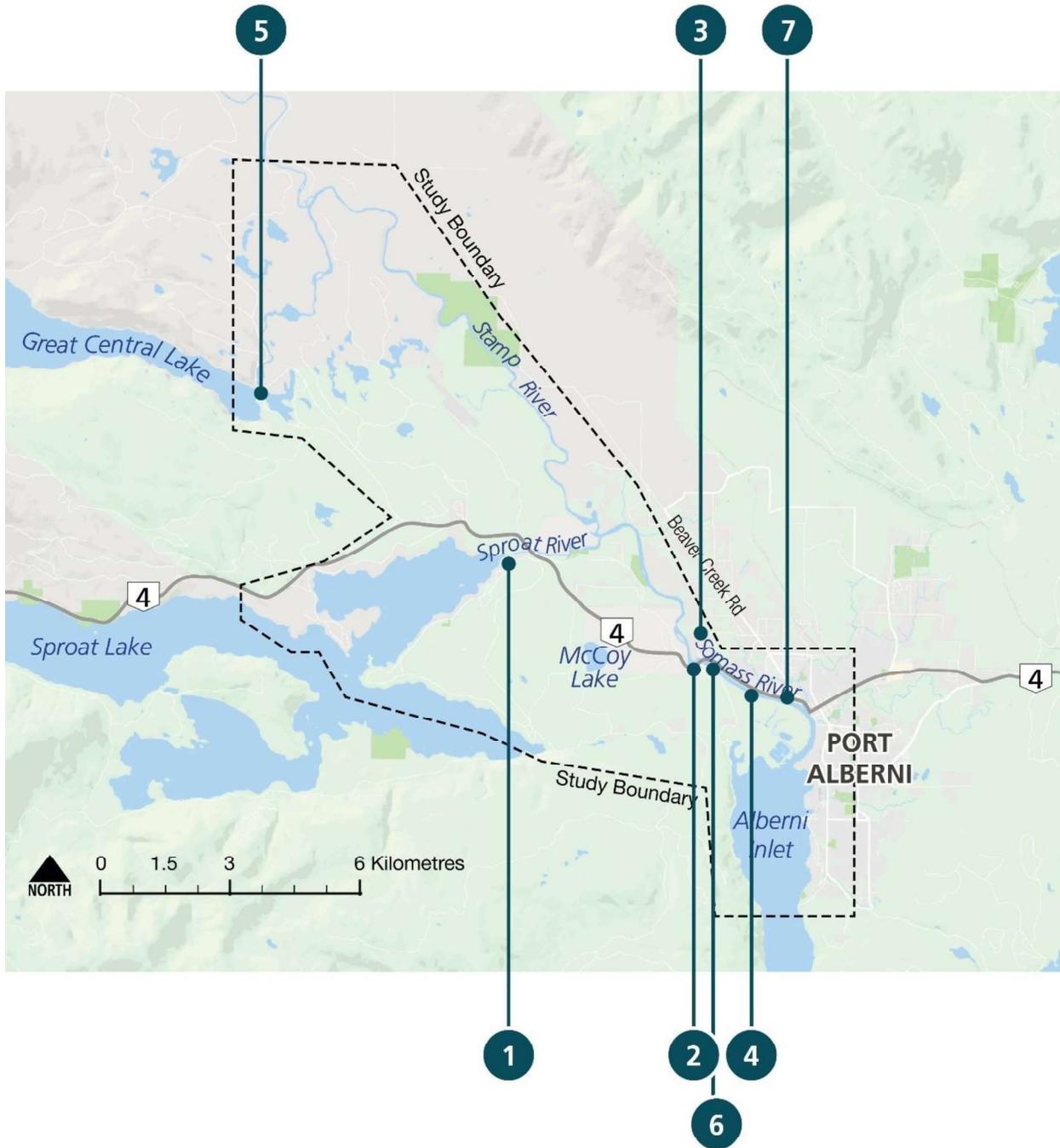


Figure 3 Locations of Initial List of Mitigation Concepts for the Somass Watershed

A goal of this study is to demonstrate application of the hydraulic model to help assess the effectiveness of several mitigation concepts. With input from the ACRD and stakeholder group, two mitigation concepts were selected for the example cases:

1. Modify the outlet of Sproat Lake to assess changes in lake water levels and discharge. The benefits could be to reduce lake flood levels.
2. Raise Highway 4 upstream of the Somass River bridge. This section of highway has been closed numerous times, which cuts off transportation to the west side of the Somass River.

These two mitigation concepts are explored in the next two sub-sections. These concepts are not considered viable options without further assessment. Public engagement is a key component to analyzing the suitability of options against public values and priorities. Additional considerations are costs versus benefits and environmental impacts.

3.1 Potential Mitigation Concept: Raising Highway 4 at Tseshaht First Nation

Sections of Highway 4, between the Somass River bridge and Hector Road has flooded several times in the past decade (Figure 4). This section of the Somass River has a 90-degree bend followed by a constriction at the Somass River bridge. During large floods, water overtops the south riverbank and inundates the highway. This section of the highway has been closed due to flooding approximately four times since 2006. Closing this section of the highway cuts off access to the west coast of Vancouver Island. Furthermore, houses on the Tseshaht First Nation are also flooded and the Nation has declared a state of emergency several times in the past decade.

3.1.1 Modelling Approach

The 2D HEC-RAS model developed for the lower Somass was used for this mitigation option. The model scenario for assessing the road upgrade was the year-2100 flood construction level (FCL) scenario. This scenario adopts the 200-year design flood, with a 20 percent climate change factor in combination with the year-2100 ocean boundary condition. The inflows and bathymetry for McCoy Creek were not included in the model, but for detailed design of this concept they should be factored.

3.1.2 Model Results

The profile of the year-2100 FCL was plotted with the current Highway 4 (Figure 4) profile from the Highway 4 Somass River Bridge to 250 m west of the McCoy Creek Bridge. The final FCL values are listed in

Table 4. The following results are provided:

- Under the 2100 FCL scenario Highway 4 is inundated from Station 0+140 m to Station 0+840.
- Flooding at this section of Highway 4 is primarily due to riverine flows overtopping the riverbanks. The tidal influence extends up to the Paper Mill dam falls; however, upstream of the Highway 4 bridge the tide effects are minimal.
- The road would need to be raised 2.77 m to meet the FCL at the lowest point in the road at Station 0+750.
- Scour and erosion protection will likely be required Station 0+100 to 0+450.
- The McCoy Creek bridge would need to be raised to meet the FCL.

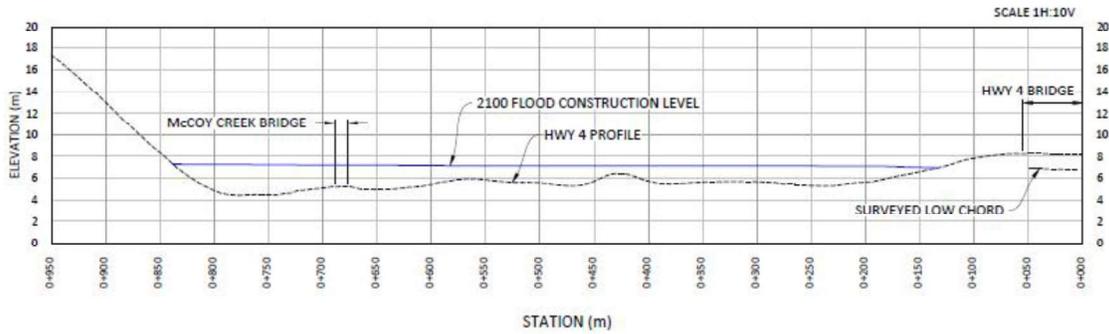


Figure 4 Plan and profile view of Highway 4 and the 2100 FCL.

Table 4 FCL and Highway 4 elevation data for associated road stations.

Station	2100 Flood Construction Level (m, CGVD2013)	Highway 4 elevation (m, CGVD2013)	Average fill required (m)	Scour and erosion protection required?
0+950	7.26	17.32	N/A	No
0+900	7.26	12.98	N/A	No
0+850	7.26	8.35	N/A	No
0+800	7.26	4.88	2.38	No
0+750	7.24	4.47	2.77	No
0+700	7.21	5.11	2.1	No
0+650	7.19	4.99	2.2	No
0+600	7.16	5.45	1.71	No
0+550	7.14	5.85	1.29	No
0+500	7.14	5.58	1.56	No
0+450	7.14	5.73	1.41	Yes
0+400	7.14	5.74	1.4	Yes
0+350	7.14	5.65	1.49	Yes
0+300	7.14	5.67	1.47	Yes
0+250	7.13	5.32	1.81	Yes
0+200	7.10	5.64	1.46	Yes
0+150	7.10	6.61	0.49	Yes
0+100	7.10	7.83	N/A	Yes
0+050	7.10	8.25	N/A	No
0+000	7.10	8.25	N/A	No

3.1.3 Discussion

Raising this section of Highway 4 as a flood management strategy needs to be carefully planned with full consideration of impacts to adjacent developments and infrastructure. Part of the design process is to re-run the model with the final design road geometry. Results should be compared to the pre-project conditions to assess hydraulic impacts, if any, to nearby properties.

Additional erosion and scour protection will likely be required for sections of the road from about Station 1+00 to 4+50. The preferred method of erosion protection for BC coastal rivers is riprap rock armour. Raising the road, along with placing riprap protection, will require a wider road footprint.

The inundation extents and FCL shown in Figure 4 do not consider inflows from McCoy Creek. It is recommended that McCoy Creek hydrology and geomorphology be reviewed, and results incorporated into a site-specific study regarding potential road upgrades. The McCoy Creek bridge will need to be raised to meet the FCL.

3.2 Potential Mitigation Concept: Modification to the Outlet of Sproat Lake

Over the past 30-years, significant flooding on Sproat Lake has been documented in 1992, 2006, 2014 and 2016, with nuisance flooding affecting lower lying properties in other years. The residents on Sproat Lake have expressed concerns regarding the weir on Sproat Lake contributing to elevated lake flood levels. Several ideas have been proposed over the years by the Sproat Lake community, two of which have been discussed by the ACRD and stakeholders over the course of this project:

1. Opening of the weir fish windows during the winter to reduce lake levels and provide more flood storage in the lake.
2. Removal of a section of rock on the left bank 15 to 40 m downstream of the weir, therefore widening the outlet channel and allowing more water to exit during high water levels. This site is known locally as “Bob’s Rock”.

In order to investigate various flood mitigation options for Sproat Lake, NHC undertook surveys of the weir and upper Sproat River in August 2019. Catalyst provided additional survey information for the weir and immediately surrounding bathymetry. Inspection of the channel also identified a narrow constriction from 260 to 430 m downstream of the weir that was identified by the hydrotechnical engineering team as the likely predominant hydraulic control for the lake during floods. A 1D HEC-RAS model was developed to investigate the effects of various modifications to the outlet of Sproat Lake on lake water levels and downstream discharges.

3.2.1 Modelling Approach

A 1D HEC-RAS model was developed for the Upper Sproat River and Sproat Lake. The weir was surveyed and included in the model as an inline structure. Model boundary conditions consisted of lake inflows entering the model’s upstream storage element and water levels at the downstream end.

NHC prepared four Sproat Lake outlet modifications for assessment, as summarized in Table 5. Figure 5 shows a plan view of the study reach with key locations identified. The 2016 flood was the most recent event that resulted in flooding impacts to Sproat Lake. A storage element was added in the model to represent Sproat Lake. The storage element was required to study attenuation effects of the different scenarios. The input hydrograph was scaled such that the 2016 lake outlet discharge matched the WSC gauged flow of 300 m³/s. All scenarios were forced with the same input hydrograph

All modelled water levels for mitigation scenarios 1 to 4 were compared to baseline conditions. The baseline scenario assumes all weir fish windows are closed during winter flood conditions. For option 1, the model weir geometry was modified such that all three fish windows are open. For option 2, the model geometry has the weir removed from the channel completely. For option 3, the channel was widened at a rock protrusion 15 to 40 m downstream of the weir; rock was removed along the left bank. This scenario area is known locally as “Bob’s Rock” (Figure 6, Figure 7, Figure 8). The location and amount of rock for removal was reviewed with Bob Cole (pers. comm.) For option 4, the channel was widened at a constriction 260 to 430 m downstream of the weir (Figure 9, Figure 10, Figure 11). The fish windows were closed for options 3 and 4.

Table 5 Summary of baseline conditions and mitigation scenarios adopted for hydraulic modelling.

Scenario	Description
Baseline	<ul style="list-style-type: none"> • Weir in place • Fish windows closed
1	<ul style="list-style-type: none"> • Weir in place • Fish windows open
2	<ul style="list-style-type: none"> • No weir (weir completely removed from the channel)
3	<ul style="list-style-type: none"> • Weir in place • Fish windows closed • Channel widened from 15 to 40 m downstream of the weir (removal of “Bob’s Rock”)
4	<ul style="list-style-type: none"> • Weir in place • Fish windows closed • Channel widened from 260 to 430 m downstream of the weir (reach immediately upstream of the defunct logging road bridge)



Figure 5 Overview of the Sproat Lake/River study reach. Channel stationing aligns with the model stations of the main report.

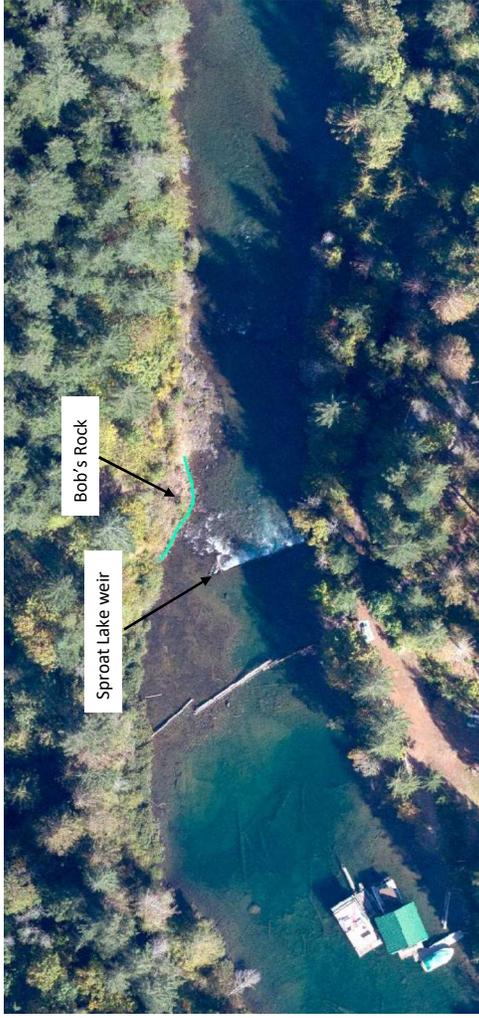


Figure 6 Plan view of Bob's Rock.

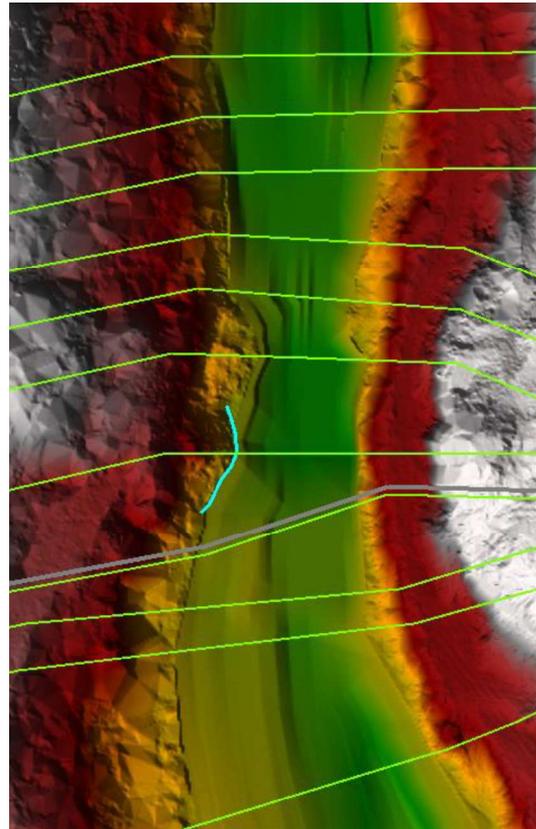


Figure 7 Model geometry showing Bob's Rock in place.

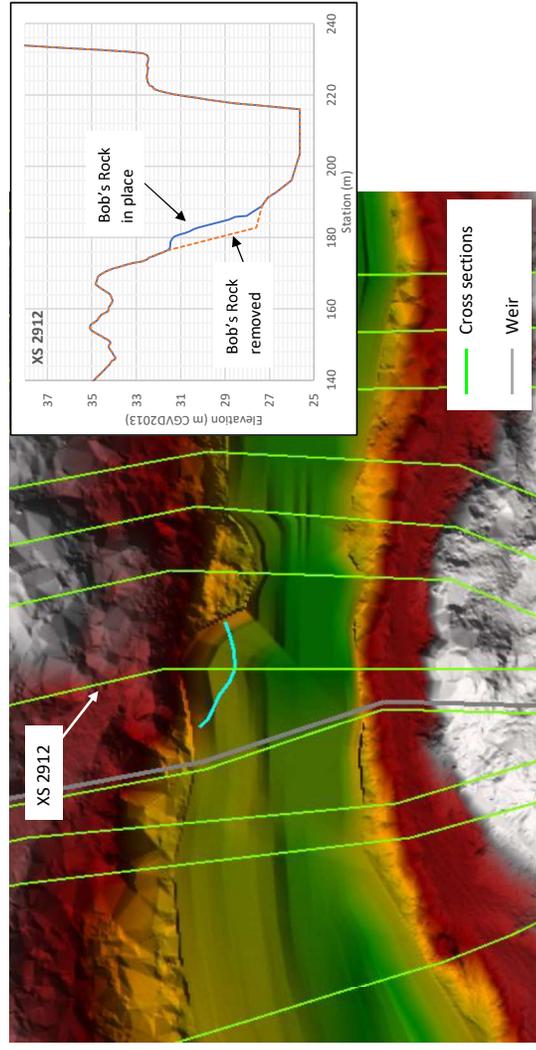


Figure 8 Model geometry showing modification to Bob's Rock. (Inset shows modification to cross sectional geometry.)



Figure 9 Plan view of the channel constriction immediately upstream of the defunct logging road bridge

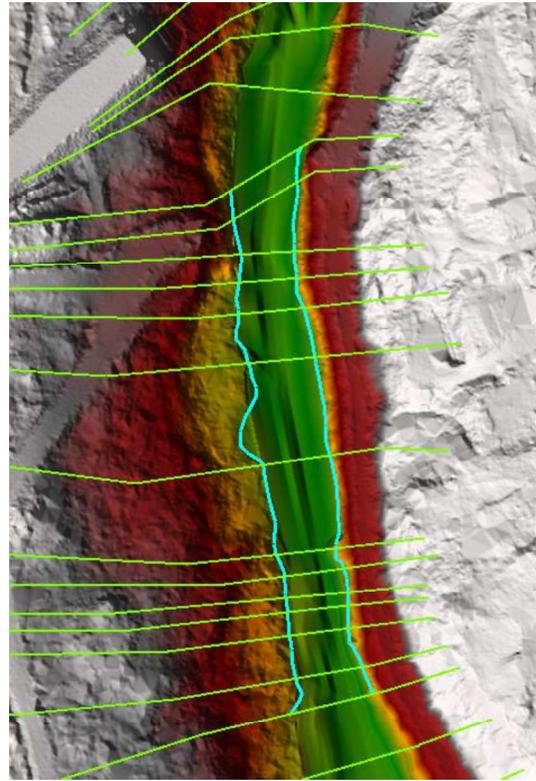


Figure 10 Model geometry showing the constricted channel.

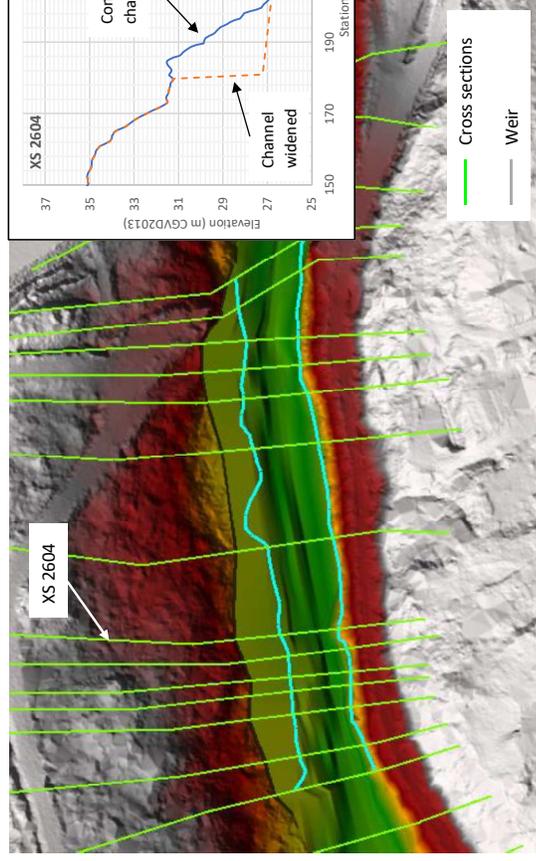


Figure 11 Model geometry showing modification to widen the channel. (Inset shows modification to cross section geometry.)

3.2.2 Model Results

The resulting water surface elevation for all mitigation scenarios was plotted against baseline water levels (Figure 12 to Figure 15). Water elevations at key points (Sproat Lake, upstream of weir, Bob’s Rock and the downstream constriction) are presented in Table 6. The following results are provided:

- **Baseline:** The simulated water level of Sproat Lake under baseline geometry is 31.21 m CGVD2013. This corresponds to a 30-year return period.
- **Scenario 1:** The simulated water levels are essentially the same as baseline conditions. Model results indicate that opening all three fish windows under 2016 flood conditions negligibly lower water levels for Sproat Lake. Lake outlet discharge was the same as for the baseline.
- **Scenario 2:** The simulated water levels are essentially the same as baseline. Model results indicate that removing the weir under 2016 flood conditions negligibly lower water levels for Sproat Lake. Lake outlet discharge was the same as for the baseline.
- **Scenario 3:** The simulated water levels are essentially the same as baseline. Model results indicate that removing Bob’s Rock under 2016 flood conditions negligibly lower water levels for Sproat Lake. Lake outlet discharge was the same as for the baseline.
- **Scenario 4:** The simulated water levels at the outlet of the lake decrease by 0.15 m. The discharge in the river increases by 19 m³/s (6.3% increase).

Table 6 Simulated water surface elevations for the baseline and mitigation options at key points in the study reach as shown in Figure 12-Figure 15.

Scenario	Description	WSE (CGVD2013)				Discharge (m ³ /s)
		Lake	U/S of weir	Bob's Rock	Downstream Constriction*	
Baseline	Fish window closed	31.21	30.96	30.87	30.51	300
Mitigation 1	Fish window open	31.21	30.96	30.86	30.51	300
Mitigation 2	No weir	31.20	30.96	30.86	30.51	300
Mitigation 3	No Bob's rock	31.21	30.97	30.90	30.50	299
Mitigation 4	No hydraulic control	31.06	30.74	30.63	30.15	319

*Note: At upstream end of the modified hydraulic control reach.

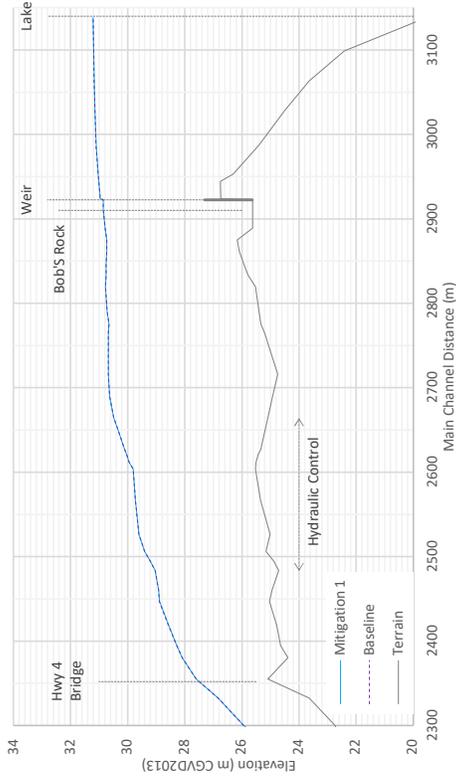


Figure 12 Water level profile for scenario 1 (fish window open) compared to baseline conditions.

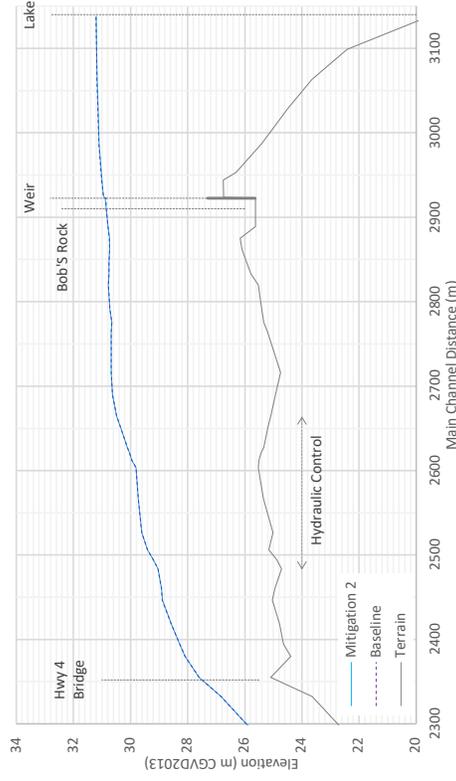


Figure 13 Water level profile for scenario 2 (no weir) compared to baseline conditions.

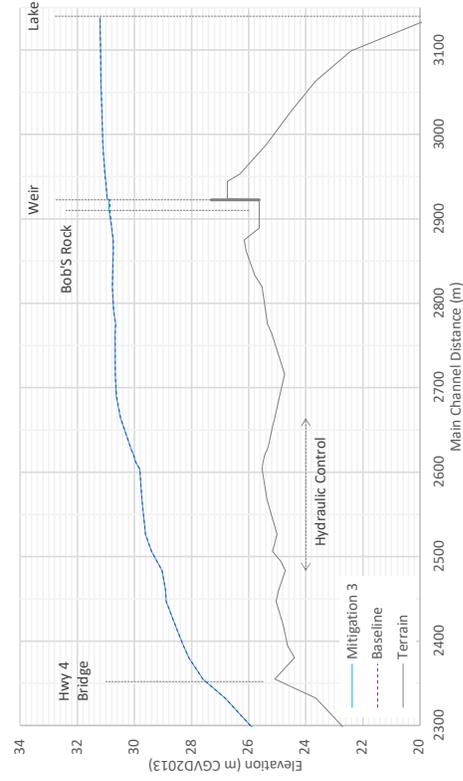


Figure 14 Water level profile for scenario 3 (no Bob's rock) compared to baseline conditions.

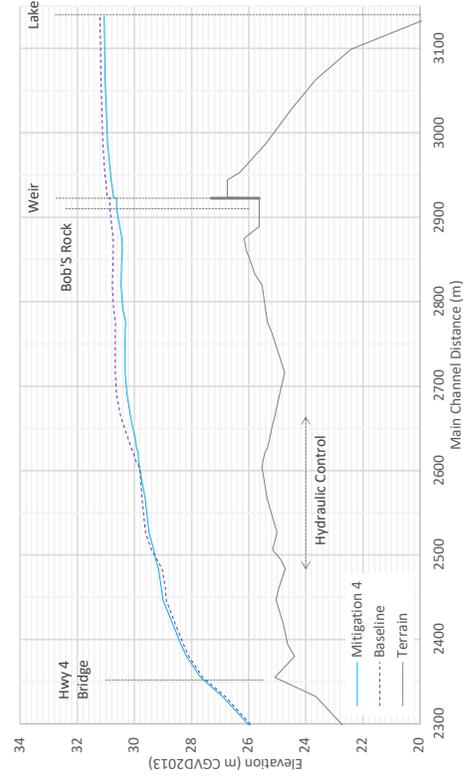


Figure 15 Water level profile for scenario 4 (widened constriction) compared to baseline conditions.

3.2.3 Discussion

Mitigation scenarios 1 to 3 produced negligible reductions in lake levels and unchanged discharge from the lake. The model results indicate that widening the channel constriction (option 4) would result in the largest reduction in lake levels during flood flows; the discharge from the lake would increase 19 m³/s (+6.3%).

The reason scenarios 1 to 3 don't affect the lake levels (or discharge) is because these features are backwatered during large flood events. As the lake level rises, the hydraulic control moves downstream to the constriction upstream of the defunct logging bridge.

The feasibility of widening the constriction upstream of the logging road bridge needs to be carefully planned with full consideration of downstream impacts given the increase in discharge. Increasing the discharge flowing out of Sproat Lake during flood events could increase flood impacts downstream. Potential changes to the flow regime should be reviewed during all flow periods given potential impacts to downstream fisheries and habitat values.

Project details for widening the constriction will include environmental assessments, permitting and approvals, construction challenges, funding, property ownership, and others.

4 SUMMARY OF FLOOD MITIGATION CONCEPTS

There is no “one-size fits all” approach to flood mitigation and adaptation. Through mitigation planning, communities can investigate and evaluate a range of possible solutions for different parts of the watershed. Because a watershed is a connected system, a comprehensive approach to mitigation planning ensures selected mitigation measures are effective and do not create unforeseen impacts elsewhere in the watershed. This outcome of the mitigation planning process is typically a “package” of recommended and prioritized mitigation measures to be implemented.

A goal of this study was to use the hydraulic model to investigate two example mitigation concepts. With input from the ACRD and stakeholder group, the two mitigation concepts were reviewed:

1. Raise Highway 4 upstream of the Somass River bridge, which is frequently flooded during storms. Model results indicated that a 700 m section of Highway 4 should be raised to the year-2100 FCL.
2. Modify the outlet of Sproat Lake to explore if changes to the channel could reduce lake levels during floods. Model results indicated that modifying the constriction in the Sproat River immediately upstream of the logging road bridge section reduced flood water levels in Sproat Lake.

The two mitigation concepts assessed in this work are example applications of the modelling tool. They should not be considered as viable options without further assessments. These assessments should be reflective of a well-rounded mitigation planning process which typically includes 4 phases:

1. Flood Risk Assessment
2. Flood Mitigation Options & Values Identification
3. Mitigation Option Evaluation & Selection
4. Implementation & Ongoing Evaluation

A key factor in successful implementation of projects, notably major infrastructure projects, will be securing funding. A funding strategy should be an integral part of implementation planning and should seek local, regional, Provincial, and Federal funding opportunities and partnerships.

FLOOD HAZARD AREA LAND USE MANAGEMENT GUIDELINES



May 2004

Ministry of Water, Land and Air Protection

Province of British Columbia

Amended by:
Ministry of Forests, Lands, Natural Resource Operations and Rural
Development

January 1, 2018

Amendments:

Section 3.2.6 - August 2011

Sections 3.5 & 3.6 - January 2018

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Introduction to Document and Guidelines

This document provides guidelines intended to help local governments, land-use managers and approving officers develop and implement land-use management plans and make subdivision approval decisions for flood hazard areas.

The goals of the provincial “Flood Hazard Area Land Use Management Guidelines” are to reduce or prevent injury, human trauma and loss of life, and to minimize property damage during flooding events. Experience has shown that regulating land development to keep people out of harm’s way is the most practical and cost effective way of achieving these goals.

The guidelines are based on the policies and procedures established and refined over the life of the provincial flood hazard management program.

These guidelines have been prepared pursuant to section 2 of the *Environment Management Act* and must be considered by local governments in making bylaws under section 910 of the *Local Government Act*.

The guidelines are divided into five sections:

- 1.0 Administration – Flood Hazard Land Use Management
- 2.0 Flood Plain Mapping
- 3.0 Application – By Hazard Type
- 4.0 Application – Land Use Specific
- 5.0 Application – Implementation Measures

The Administration section details ways in which decision-makers can manage flood hazards on a broad or area-wide basis, employing strategies such as flood hazard management plans, bylaws and standards, and during the subdivision process.

The Flood Plain Mapping section details the importance and application of flood plain mapping information.

The Application sections provide the provincial requirements for different types of flooding hazards and different land uses commonly found in BC. These are **minimum** requirements that may be increased by the decision-maker depending on local circumstances.

***In the absence of more site-specific studies or information,
these guidelines are the recommended provincial minimum requirements
for land use management in flood hazard areas.***

For certain areas of the province, more site-specific information may be available for the decision-maker's consideration. Sources of site-specific information that may supplement the guidelines include:

- Historical records and descriptions, particularly of previous flooding events at a specific location;
- Flood hazard delineation or management studies;
- Flood plain mapping;
- Engineering and other studies;
- Local government planning documents, such as Official Community Plans and bylaws; and
- Covenants, at the site or in the vicinity.

In addition, new site-specific studies containing professional evaluation, advice and recommendations including mapping, may be required where the risk to life and property is high, where advice is required to meet provincial flood hazard management guidelines or where modified or new protective works are proposed.

1.0 Administration - Flood Hazard Land Use Management

Local governments should consider broad flood hazard management tools to ensure that future land use will be planned and buildings constructed in a manner that will reduce or prevent injury, human trauma and loss of life, and to minimize property damage during flood events.

Appropriate land use management requirements should be included by the statutory decision-maker at certain stages in the planning process. These include:

1.1 Official Community Plans

Official Community Plans (OCPs) must contain general land use policy statements and maps respecting restrictions on the use of land that is subject to hazardous conditions. OCPs should include statements that endorse and emphasize the need to manage development in flood prone areas in order to reduce impacts on people and property.

Under the provisions of section 877 of the *Local Government Act*, plan policies and a hazard schedule are required. See example Form 1 in Appendix B.

1.2 Bylaws and Development Permits

Flood protection measures can be applied to new buildings, manufactured homes and units, modular homes or structures on existing lots. These measures may be incorporated into local government bylaws and decisions under the authority of:

- 1.2.1 Section 910 of the *Local Government Act*, where a local government may adopt a flood plain bylaw that designates an area as a flood plain, specifies development levels and setback requirements in a designated area and enforces these conditions.
- 1.2.2 Section 919.1 of the *Local Government Act*, where development permit areas may be designated in an OCP for the protection of development from hazardous conditions.
- 1.2.3 Section 920 of the *Local Government Act*, where a development permit area has been designated under the provisions of section 919.1 of the *Local Government Act*, a development permit may specify areas of land that may be subject to flooding, mud flows, torrents of debris, erosion or tsunami that must remain free of development except in accordance with any conditions contained in the permit.
- 1.2.4 Section 903 of the *Local Government Act* where zoning bylaws partition a municipality into sections for different land use purposes. Section 903 can regulate

parcel configuration, the density of the land use, siting and standards of buildings and structures. These bylaws have been used historically for flood hazard areas to ensure public safety is maintained. However it is preferable that a section 910 bylaw be used.

- 1.2.5 Section 694 of the *Local Government Act*, where local building regulations are established or under section 699 where the building inspector considers that construction would be subject to flooding, and flood proofing conditions are not established under 1.2.1 to 1.2.5 above.

A sample bylaw format is provided in Form 2 in Appendix B.

1.3 Requests for Modification of Bylaws

Subject to review by and if acceptable to the local government, a flood plain bylaw may be modified. The local government may alter any bylaw condition to best match the flood hazard provided the level of protection is not altered. This discretion extends to the reduction of elevation requirements, where flood plain mapping exists, by the freeboard, provided the subject property is in the flood plain fringe area and there are no major erosion or channel avulsion hazards in the immediate vicinity.

Prior to agreeing to a modification, other exceptions in the surrounding area should be reviewed to ensure consistency and a summary report prepared. Review by the local government may not support modification on technical grounds but the applicant may nevertheless have demonstrated a hardship.

Setback requirements should not be reduced unless a serious hardship exists and no other reasonable option is available. A valid hardship should only be recognized where the physical characteristics of the lot (e.g., exposed bedrock, steep slope, the presence of a watercourse, etc.) and size of the lot are such that building development proposals, consistent with land use zoning bylaws, cannot occur unless the requirements are reduced.

In order to avoid setting difficult precedents these site characteristics should be unique to the subject property and environs. The economic circumstances or design and siting preferences of the owner should not be considered as grounds for hardship. Before agreeing to a modification, consideration should be given to other options such as the use of alternate building sites, construction techniques and designs (e.g., constructing an additional storey and thereby reducing the size of the 'building footprint').

1.4 Subdivision Approval Process

Under the provisions of section 86 of the *Land Title Act*, the approving officer -- when approving a subdivision which may be subject to flooding or erosion -- may require an

engineering report certifying that the land may be used safely for the intended purpose and/or require the subdivider to enter into a covenant under section 219 of the *Land Title Act* to establish flood plain requirements. Similar provisions are available under the *Strata Property Act* and the Bare Land Strata Regulations.

A section 219 covenant is to be registered under the *Land Title Act* and standard covenant formats are shown by Form 3 and Form 4 in Appendix B. Covenant conditions can be established as per Form 5 or where a bare land strata approval is involved, Form 6.

Where the land proposed to be subdivided may not be used safely an approving officer may withhold consent to approve a proposed subdivision. A form letter for this purpose is provided in Form 7 (See section 1.9).

1.5 Covenant Measures

Where consent for approval of subdivision of flood prone land is sought, the proponent may be required to register a restrictive covenant against the title of the property under section 219 of the *Land Title Act*. It is recommended that the covenant specify conditions that would enable the land to be safely used for the use intended. In addition, the following conditions should be included:

1.5.1 Waiver of Liability

1.5.1.1 Where an approving officer gives consent for approval of subdivision of flood prone land, it is recommended that the owner of the land enter into a covenant, to be registered against the land title, requiring flood proofing of buildings and a waiver of liability in favour of the local government and/or the provincial government in the event of any damage caused by flooding or erosion.

1.5.1.2 The waiver procedure may also be requested in considering requests for amendment of flood proofing bylaws in order to permit construction of a building on a legally existing lot, when such reduction gives reasonable grounds for concern in relation to the flood hazard in the area.

1.5.1.3 Where a situation arises in which consent to subdivision would normally be refused due to a high flooding hazard, but it is nevertheless deemed appropriate to allow the subdivision due to extenuating circumstances, consideration should be given to requiring the 'waiver' clause to cover the existing buildings. This would need to be expressly identified and expressed in the conditions of consent.

1.5.2 Priority Charge

Covenant conditions are to be registered with priority over any financial charges requested against the property.

Priority charges are executed through the use of the "Consent and Priority Agreement," and must be signed by prior charges and all parties to the subsequent charge. This Agreement is included in both Form 3 and Form 4 in Appendix B.

1.5.3 Covenant Modification Agreements

A covenant modification agreement is provided in Form 8 in Appendix B.

1.5.4 Affidavit for Witness

An affidavit for witness to a covenant or modification agreement is only required where requested by the grantor. Therefore, it is only necessary to make such arrangement if requested.

1.6 Requests for Modification of Floodproofing Covenants

Subject to review by and if acceptable to, the approving officer and all parties signatory to the covenant, a covenant may be modified. The approving officer may modify any covenant to best match the flood hazard provided the level of protection is not altered. This discretion extends to the reduction of elevation requirements, where flood plain mapping exists, by the freeboard, provided the subject property is in the flood plain fringe area and there are no major erosion or channel avulsion hazards in the immediate vicinity.

Prior to agreeing to a modification, other exceptions in the surrounding area should be reviewed to ensure consistency and a summary report prepared. Review by the approving officer may not support relaxation on technical grounds but the applicant may nevertheless have demonstrated a hardship.

Setback requirements should not be reduced unless a serious hardship exists and no other reasonable option is available. A valid hardship should only be recognized where the physical characteristics of the lot (e.g., exposed bedrock, steep slope, the presence of a watercourse, etc.) and size of the lot are such that building development proposals, consistent with land use zoning bylaws, cannot occur unless the requirements are reduced.

In order to avoid setting difficult precedents these site characteristics should be unique to the subject property and environs. The economic circumstances or design and siting preferences of the owner should not be considered as grounds for hardship. Before agreeing to a modification, consideration should be given to other options such as the use of alternate building sites, construction techniques and designs (e.g., constructing an additional storey and thereby reducing the size of the 'building footprint').

1.7 Crown Land Dispositions

Under the provisions of section 11 of the *Land Act* and provincial “Flood Hazard Area Land Use Management Guidelines”, conditions are established for attachment to leases and other dispositions, see Form 9 in Appendix B.

1.8 Miscellaneous Administrative Measures

1.8.1 Replot of Lot Lines and Consolidation

1.8.1.1 Where a replot of lot lines is considered to be a technical adjustment and does not increase the buildable sites within the flood plain, then the local government flood plain requirements will apply. The provincial guidelines are stated for information purposes on the restrictive covenant. See Form 10 in Appendix B.

Where a subdivision plan creating a new lot occurs, and this lot is subsequently consolidated with another lot, then flood proofing conditions should be attached to the land title of the subdivided parcels and the separate parcel prior to consolidation.

1.8.1.2 The Registrar of Land Titles may accept a reference or an explanatory plan without an accompanying description, where a new parcel is created by the consolidation of adjoining surveyed parcels. As such, the plan does not require approval of the approving officer and, therefore, may not require the attachment of covenant requirements under the provisions of section 86 of the *Land Title Act*.

1.8.2 Benchmarks

Where an approving officer considers a geodetic elevation necessary, the installation of benchmarks may be a condition of consent to subdivision approval in order to assist in the on-site determination of the Flood Construction Level.

1.8.3 Accretions

The applicable flood hazard requirements should apply to any naturally accreted land that has been legally obtained by the upland waterfront property owner.

1.9 Refusal to Consent

A decision maker may withhold consent to a proposed subdivision, bylaw amendment or Crown land disposition where hazard to 'life and limb' exists and cannot be practically alleviated by structural works maintained by the local government and/or flood proofing.

Examples of situations where consent may be withheld, include proposals located:

- In the floodway,
- In the path of a major channel avulsion,
- In the path of a debris flow,
- In an active erosion area,
- Where flood depths exceed 2.5 metres,
- Where flood velocities exceed 1.0 metre per second, and/or
- Where the provision of safe access and egress is not possible.

2.0 Flood Plain Mapping

Local governments must consider relevant flood plain mapping information in making bylaws under section 910 of the *Local Government Act*, as well as in making related decisions regarding flood hazards, including the establishment of Flood Construction Levels. As such, available flood plain mapping information is incorporated into and forms a part of these Guidelines.

A flood plain map delineates the area that can be expected to flood, on average, once every 200 years (called the 200-year flood). It should be noted that:

- A 200-year flood can occur at any time in any given year,
- The indicated flood level may be exceeded, and
- Portions of the flood plain can flood more frequently.

Flood plain maps show the location of the normal channel of a watercourse, surrounding features or development, ground elevations contours, flood levels and flood plain limits (the estimated elevation and horizontal extent of the high water marks of a 200-year flood).

Flood plain mapping information is available for many settled areas of the province. To access information on availability, including links to on-line maps and ordering instructions, visit the following web site: <http://srmwww.gov.bc.ca/aib/fpm/index.html>

Determination of Designated Flood Levels

The magnitude and water levels associated with the designated flood are determined for each river by using survey and hydrological data.

The magnitude of the designated flood is determined by frequency analysis of past floods supplemented by regional runoff data when required. The water surface profile is then calculated for the designated flood.

The flood plain is delineated by the translation of the flood profile plus freeboard allowance to base mapping to produce the finished flood plain maps.

Historical context

Many of the flood plain maps presently available were developed under a provincial-federal program. The Flood Plain Mapping Program was delivered under the Canada - British Columbia Agreement Respecting Floodplain Mapping from 1987 to 2003. The agreement marked an acceleration of a provincial mapping program that commenced in 1974. Following is a summary of the objectives of the agreement.

The Agreement:

- Restricted both governments from further undertakings (including construction of, or a major addition to, structures or a change in the use of land) in areas that are vulnerable to flooding and are located in designated flood plains;
- Discouraged financial assistance for development of undertakings in flood-prone areas;
- Accommodated measures to encourage local authorities to restrict undertakings in flood-prone areas under their jurisdiction; and
- Required adequate flood proofing measures to have been incorporated into new development in a flood plain after designation to be eligible for disaster assistance.

Other maps, developed under different processes, may be available.

For further information regarding flood plain mapping, please refer to the web site noted above.

3.0 Application - By Hazard Type

Where relevant flood plain maps, and other relevant flood hazard-related information (such as covenants, bylaws, flood hazard maps and engineering reports) exist, they must be considered.

Where such information is not available, the following minimum requirements should be considered to guide development away from higher flood hazard areas and to allow development to proceed in a safe manner in lower risk areas. These minimum requirements should be registered against the land title as a covenant at the time of subdivision, and/or should be incorporated into local government bylaws.

The following guidelines include recommended minimum flood plain setbacks and flood construction levels.

Flood plain setbacks are established to keep development away from areas of potential erosion and avoid restricting the flow capacity of the floodway. Keeping the floodway clear of development can reduce the risk of damage to neighbouring properties and reduce disruptions to natural river processes, leading to a more balanced and economical approach to managing flood prone areas. Setbacks are measured from the natural boundary unless otherwise specified.

Flood Construction Levels (FCLs) are used to keep living spaces and areas used for the storage of goods damageable by floodwaters above flood levels. In some locations FCLs have been established. Otherwise FCLs are typically referenced as an elevation above the natural boundary.

In cases where the FCL has been determined, it should be taken into consideration, together with an appropriate setback requirement.

The designated flood, and the designated flood level, are used in determining the FCL.

The designated flood means a flood which may occur in any given year, of such magnitude as to equal a flood having a 200-year recurrence interval, based on a frequency analysis of unregulated historic flood records or by regional analysis where there is inadequate streamflow data available.

A designated flood level is the observed or calculated water surface elevation for the designated flood and is used to determine the Flood Construction Level.

In the absence of more site-specific studies or information, these guidelines are the recommended provincial minimum requirements for land use management in flood hazard areas.

3.1 Lakes, Ponds, Marsh Areas and Reservoirs

3.1.1 Lakes

Setback –

Buildings, manufactured homes or units, modular homes or structures (referred to as “buildings” in all subsequent clauses) should be setback at least 15 metres from the natural boundary of any lake.

FCL where a designated flood level has been determined –

Areas used for habitation, business, or storage of goods damageable by floodwaters should be constructed within any building at an elevation such that the underside of the floor system thereof is no lower than the designated flood level of the lake plus freeboard allowance.

FCL where a designated flood level has not been determined –

The FCL for lakes over 15 kilometres in length should be 3.0 metres above the natural boundary of the lake, or any pond, backwater, slough, swamp or marsh area affected by the lake.

3.1.2 Small Lakes, Ponds, Swamps and Marsh Areas

Where a lake is less than 15 kilometres in length and where there is no history of severe flooding or concern for shoreline erosion, and for ponds, swamps or marsh areas:

Setback –

Buildings should be setback at least 7.5 metres from the natural boundary of the lake, pond, swamp or marsh.

FCL –

The elevation requirement may be reduced to 1.5 metres above the natural boundary of the lake, pond or adjacent swamp or marsh area.

3.1.3 Bluffs

Setback –

Where the building site is at the top of a steep bluff and where the toe of the bluff is subject to erosion and/or is closer than 15 metres from the natural boundary, the setback

should be a horizontal distance equal to 3.0 times the height of the bluff as measured from the toe of the bluff.

For practical application, this setback condition will require site-specific interpretation and could result in the use of a minimum distance measured back from the crest of the bluff. This setback may be reduced provided the reduction is supported by a report prepared by a suitably qualified professional.

3.1.4 Reservoirs

Setback –

The setback requirements regarding lakes, ponds and marsh areas (clauses 3.1.1, 3.1.2 and 3.1.3) should generally apply to reservoirs. Some reservoirs have established 'safe lines' in their operating plans that may be used to establish the setback, or site-specific analysis may be required. For larger reservoirs, specific setbacks are established.

FCL –

For smaller reservoirs, the FCL is either an elevation of 1.5 metres above the crest of the spillway or is 0.6 metres above the crest of the dam, whichever is greater. For larger reservoirs, reservoir specific FCLs are established.

3.2 Watercourses

It should be noted that the natural boundary for watercourses includes the best estimate of the edge of dormant or old side channels (see definition in Appendix A).

3.2.1 Standard requirements for ordinary watercourses

Setback –

Buildings should be setback at least 30 metres from the natural boundary of any watercourse, except as noted in sections 3.2.2 to 3.2.8 below.

Where standard dikes exist, setbacks shall be as noted in section 3.6 of these guidelines. Where non-standard dikes exist, setbacks should be developed in consultation with the Inspector of Dikes in order to provide right-of-way for any future dike improvements and/or access.

FCL where a designated flood level has been determined –

Areas used for habitation, business, or storage of goods damageable by floodwaters should be constructed within any building at an elevation such that the underside of the floor system thereof is no less than the Flood Construction Level.

FCL where a designated flood level has not been determined –

The Flood Construction Level should be no lower than 3.0 metres above the natural boundary of any nearby watercourse, except as allowed in section 3.2.3 and 3.2.4.

3.2.2 Increased Requirements for ordinary watercourses

The requirements for a watercourse may be increased where a watercourse has demonstrated extensive flooding and/ or has significant bank erosion and/or depth of flooding:

Setback–

The setback requirements may be increased to an amount greater than 30 metres.

FCL –

The elevation of areas used for habitation, business, or storage of goods damageable by floodwaters should be established within any building at an elevation greater than 3.0 metres above the natural boundary of the watercourse.

3.2.3 Requirements for Smaller Streams

The requirements for small streams may be reduced where the following conditions exist:

- Sufficient discharge records are available to establish the designated flood and/or the designated flood can be otherwise estimated as less than 80 cubic metres per second, and
- The watercourse has no significant history of flooding and/or bank erosion, and/or
- The watercourse is not located on an alluvial or colluvial fan, and/or
- It is deemed appropriate by an approving officer.

Setback –

The setback requirement may be reduced to 15 metres from the natural boundary of the watercourse provided the floodway is not obstructed.

FCL –

The elevation of areas used for habitation, business, or storage of goods damageable by floodwaters should be established within any building at an elevation greater than 1.5 metres above the natural boundary of the watercourse.

3.2.4 Requirements for Very Small Streams

For streams not meeting the definition of “watercourse” and where there is no history of flooding and/or bank erosion and where the watercourse is not located on an alluvial or colluvial fan, the setback and FCL requirements shall be at the discretion of the approving officer.

3.2.5 Decreased Requirements for ordinary watercourses

Setback and FCL –

The requirements for may be reduced where the following conditions exist:

- Sufficient discharge records are available to establish the designated flood and/or the designated flood can be otherwise estimated as greater than 80 cubic metres per second, and
- The watercourse has no significant history of flooding and/or bank erosion, and/or
- The watercourse is not located on an alluvial or colluvial fan, and/or
- It is deemed appropriate by an approving officer.

~~3.2.6 Downstream of Dams~~ Refer to Amended Section 3.2.6 (please see next page)

~~Setback –~~

~~Dam upgrading or development restrictions may be necessary if a development proposal increases the Land and Water BC (LWBC) hazard consequence classification for low, high and very high consequence dams (other than dams owned and operated by a major utility). The requirements should be determined on a site specific basis by a professional engineer in consultation with the dam owner and LWBC.~~

~~Clauses 3.2.1 to 3.2.4 should apply downstream of dams rated with a very low consequence classification as determined by LWBC.~~

3.2.7 Culverts and Bridges

Setback –

Use setbacks specified for the size of the watercourse in question.

FCL –

Where, in the opinion of an approving officer, culverts and bridges immediately downstream of a subject property may become obstructed in times of flood and cause ponding upstream of the bridge or culvert, the FCL for the property should be a minimum of 0.3 metres above the crown of the road.



AMENDMENT

Section 3.2.6 – Flood Hazard Area Land Use Management Guidelines

3.2.6 Downstream of Dams

Dam upgrading and/or development restrictions will be necessary if a development proposal increases the dam's Downstream Consequence Classification per Schedule 1 of the BC Dam Safety Regulation.

The extent of dam upgrading and/or development restrictions shall be determined on a site-specific basis by a qualified professional engineer in consultation with:

- Local government planning and approving officials,
- Ministry of Transportation and Infrastructure development approving officials, if the development occurs in a Regional District,
- Ministry of Forests, Lands, and Natural Resource Operations approving officials, if the development is on Crown Land,
- Dam Safety Officer, and
- Dam owner.

For the locations of all dams regulated by the Ministry of Forests Lands, and Natural Resource Operations (MFLNRO) and information about Dam Safety Officers, please visit the BC Dam Safety Program website (www.env.gov.bc.ca/wsd/public_safety/dam_safety).

For developments downstream of dams not listed on the Dam Safety Program's website (e.g. mining dams - impoundments and diversions, sewage lagoons, etc.), it is the responsibility of local government approving officials to get into contact with the dam owner, responsible provincial agency, and if necessary, a qualified professional engineer to determine the extent of dam upgrading and/or development restrictions.

Clauses 3.2.1 to 3.2.4, regarding building setbacks and flood construction levels for watercourses, shall apply downstream of dams rated with a low consequence classification as determined by the MFLNRO Dam Safety Program.

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Where road fills and culverts exist that, if obstructed, may result in significant impoundments and/or serious failure and flooding, consideration should be given to engaging a Professional Engineer to assess the risk and provide site-specific flood protection measures for the downstream property(s).

3.2.8 Meandering and Braided Streams

Setback –

Setback requirements should, at a minimum, meet the requirements noted above for the watercourse size and situation. Where the meandering or braiding is significant, consideration should be given to having the requirements determined on a site-specific basis by a suitably qualified professional.

FCL –

Building levels should be set in accordance with requirements detailed in clauses 3.2.1 through 3.2.7.

3.3 Alluvial Fans

Where possible, development of alluvial fans should be discouraged, and the land should be retained in non-intensive uses such as parks, open-space recreation, and agricultural uses.

3.3.1 Standard Requirements

Consent to develop may be granted by an approving officer:

- Where there is no alternative land available, and
- Where an area of an alluvial fan can be shown to be stable because of hydraulic, physical and/or geological conditions.

This approval should be subject to hazard management and flood proofing requirements determined on a site-specific basis. Such requirements may include but are not limited to:

- Development density regulations,
- The identification of the safe building site(s),
- Building elevation and foundation design requirements,
- The construction of on-site and/or off-site protective works, and
- Land use regulations to prevent the alteration of the terrain and features such as landfills, excavations and the construction of new roads and utilities that would alter the hazard rating for the land.

Where a study of the flooding hazard is not available and the hazard is considered significant, an assessment of the land by a suitably qualified professional should be required.

If consent to develop on an alluvial fan is granted:

Setback –

The setback should be determined in accordance with clauses 3.2.1, 3.2.2 and 3.2.8.

FCL –

Where the hazard is low, the building should be elevated a minimum of 1.0 metres above the general elevation of the surrounding ground on concrete foundation and protected from scour.

3.3.2 Training Works to Protect One Property

Where protective works are to be constructed, an Operations and Maintenance Manual should be prepared, access easements and/or right of ways established and an ongoing maintenance program established prior to final development approval. Works are to be designed by a professional engineer. A professional engineer must certify constructed works. See section 5.7 Training Works.

An ongoing maintenance program may be assured through the addition of relevant requirements to the standard flood proofing covenant specified under section 219 of the *Land Title Act*, if the training works are

- Built on private property, and
- Intended to protect only the property of the person (including a strata corporation) owning the training works and the property on which they are located.

3.3.3 Training Works to Protect Multiple Properties

If the training works, when constructed, will protect multiple properties of more than one person, then an ongoing operation and maintenance program and access to structures must be assured by the local government. Works are to be designed by a professional engineer. A professional engineer must certify constructed works. In addition, the training works require the approval of the Inspector of Dikes and, therefore, that office must be contacted for the requirements and approvals. See section 5.7 Training Works.

Approvals under the provincial *Water Act* and federal *Fisheries Act* are also normally required. Local government may also have other requirements.

3.4 Areas Subject to Debris Flows

Development should be discouraged in areas where local knowledge, experience or studies indicate concern that there may be a debris flow hazard.

3.4.1 Professional Evaluation

Consent to develop may be granted, with standard requirements as established for alluvial fans in section 3.3, where:

- There is no other land available, and
- Where an assessment of the land by a suitably qualified professional indicates that development may occur safely.

See section 5.7 Training Works.

**Refer to 2018 Amended
Sections 3.5 and 3.6.**

~~3.5 The Sea~~

~~It should be noted that the natural boundary for coastal areas includes the natural limit of permanent terrestrial vegetation.~~

~~3.5.1 Strait of Georgia~~

~~3.5.1.1 Standard Requirements~~

~~Setback~~

~~Buildings should be setback 15 metres from the natural boundary of the sea.~~

~~Landfill or structural support for a coastal development or type of development shall be permitted a setback of 7.5 metres from the natural boundary of the sea where the sea frontage is protected from erosion by a natural bedrock formation or works designed by a professional engineer and maintained by the owner of the land.~~

~~In the case of subdivision the setback should not be reduced unless each building site is located on non-erodible bedrock or local government assumes the maintenance responsibility for works designed by a professional engineer.~~

~~The setback may be increased on a site specific basis such as for exposed erodible beaches and/or in areas of known erosion hazard.~~

~~FCL~~

~~The FCL shall be at least 1.5 metres above the natural boundary of the sea, and higher than any Flood Construction Level established for specific coastal areas.~~

Refer to 2018 Amended Sections 3.5 and 3.6.

~~3.5.1.2 Requirements for Coastal Bluffs~~

~~Setback~~

~~Where the building site is at the top of a steep coastal bluff and where the toe of the bluff is subject to erosion and/or is closer than 15 metres from the natural boundary of the sea, the setback shall be a horizontal distance equal to 3.0 times the height of the bluff as measured from the toe of the bluff.~~

~~For practical application, this setback condition will require site specific interpretation and could result in the use of a minimum distance measured back from the crest of the bluff. This setback may be reduced provided the reduction is supported by a report prepared by a suitably qualified professional.~~

~~3.5.1.3 Requirements for Existing Coastal Lots~~

~~Setback~~

~~In the case of the existing lots, where the above setback distances prevent construction, and where it is not possible to provide sufficient protection through works designed by a suitably qualified professional, the approving officer may agree to modifying setback requirements to permit construction provided this is augmented through a restrictive covenant stipulating the hazard, building requirements, and liability disclaimer.~~

~~3.5.2 Outside the Strait of Georgia Area~~

~~A subdivision application in tsunami prone areas must include a report by a suitably qualified professional who must formulate safe building conditions for each proposed lot based on a review of a summary report titled "Evaluation of Tsunami Levels Along the British Columbia Coast", by Seaconsult Marine Research Ltd., dated March 1988. At a minimum, building conditions should protect improvements from damage from a tsunami of equal magnitude to the March 28, 1964 tsunami that resulted from the Prince William Sound, Alaska earthquake.~~

~~Setback~~

~~Setback requirements should be established on a site specific basis and take into account tsunami hazards.~~

~~Setback from the natural boundary of the sea must be sufficient to protect buildings and must be at least 30 metres.~~

~~FCL~~

~~FCL requirements should be established on a site specific basis and take into account tsunami hazards.~~

~~Reductions to these requirements should only be considered where the building can be built to the FCL on bedrock.~~

**Refer to 2018 Amended
Sections 3.5 and 3.6.**

~~3.6 Areas Protected by Standard Dikes~~

~~Residential, commercial and institutional developments in areas protected by standard dikes are required to comply with full flood proofing requirements for their respective categories.~~

~~*Setback*~~

~~Buildings should be located a minimum of 7.5 metres away from any structure for flood protection or seepage control or any dike right-of-way used for protection works. In addition, fill for floodproofing should not be placed within 7.5 metres of the inboard toe of any structure for flood protection or seepage control or the inboard side of any dike right-of-way used for protection works.~~

~~Any change to these conditions requires the approval of the Inspector of Dikes.~~

~~*FCL*~~

~~Buildings and manufactured homes in areas protected by standard dikes should meet minimum FCLs prescribed for the primary stream, lake or sea adjacent to the dike and the FCL requirements for any internal drainage (minimum ponding elevations).~~

~~3.6.1 Secondary sources of flooding~~

~~Where there are secondary sources of flooding within diked areas, the appropriate requirements as set out in Clauses 3.1 through 3.5 should be applied. These should include consideration of minimum ponding elevations behind the dike to protect against internal drainage.~~

AMENDMENT

Section 3.5 and 3.6 – Flood Hazard Area Land Use Management Guidelines

3.5 The Sea

3.5.1 Background and Reference Documents

The content for this Amendment is drawn primarily from, "Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use", Ausenco Sandwell, report to BC Ministry of Environment, January 27, 2011 (AS (2011b)) and the companion reports, "Sea Dike Guidelines" and "Draft Policy Discussion Paper", also dated January 27, 2011.

These 2011 reports, including terminology, definitions and explanatory figures, supplement this Amendment to the "Flood Hazard Area Land Use Management Guidelines". Definitions for the terms used in this Amendment are provided in Appendix A of AS (2011b). Where there is any inconsistency between the Ausenco Sandwell (2011) reports and this Amendment document, the Amendment document shall govern. These reports are referenced in this Amendment as:

"Draft Policy Discussion Paper" - AS(2011a)

"Guidelines for Management of Coastal Flood Hazard Land Use" - AS (2011b)

"Sea Dike Guidelines" - AS (2011c)

These reports are available on the ministry web page:

http://www.env.gov.bc.ca/wsd/public_safety/flood/fhm-2012/draw_report.html

The definition of and method(s) of determination of Flood Construction Level (FCL) for coastal areas has been modified for the purposes of this Amendment (also see definitions in AS 2011b). The FCL is used to establish the elevation of the underside of a wooden floor system or top of concrete slab for habitable buildings, but does not relate to the crest level of a sea dike.

The management of land use in coastal flood hazards may require flood hazard assessments to be completed by suitably qualified Professional Engineers, experienced in coastal engineering. The standards of practice that these Professionals should follow include those outlined in the most recent revision of the "Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC", first published by the Association of Professional Engineers and Geoscientists of BC (APEGBC) in 2012.

The APEGBC Professional Practice Guidelines describe and provide for use of risk assessment methodologies, however, this Amendment does not consider how risk based approaches might be incorporated into sea level rise area planning, determination of setbacks and FCLs, or long term flood protection strategies. Should local governments, land use managers and approving officers choose to base approval decisions on risk assessments prepared by Professional Engineers, the changes in risk over time due to sea level rise must be fully taken into account.

3.5.2 Design and Planning Time Frame

Requirements for buildings, subdivision, and zoning should allow for sea level rise (SLR) to the year 2100.

Land use adaptation strategies as set out in Official Community Plans (OCPs) and Regional Growth Strategies (RGSs) should allow for sea level rise to the year 2200 and beyond.

3.5.3 Recommended Sea Level Rise Scenario for BC

Allow for Global Sea Level Rise of 0.5 m by 2050, 1.0 m by 2100 and 2.0 m by 2200 relative to the year 2000 as per Figure 1.

Adjust for regional uplift and subsidence using the most recent and best information available. Where no information is available, assume neutral conditions (i.e. no uplift or subsidence).

The scenario in Figure 1 is intended to be reviewed every 10 years or sooner if there is significant new scientific information.

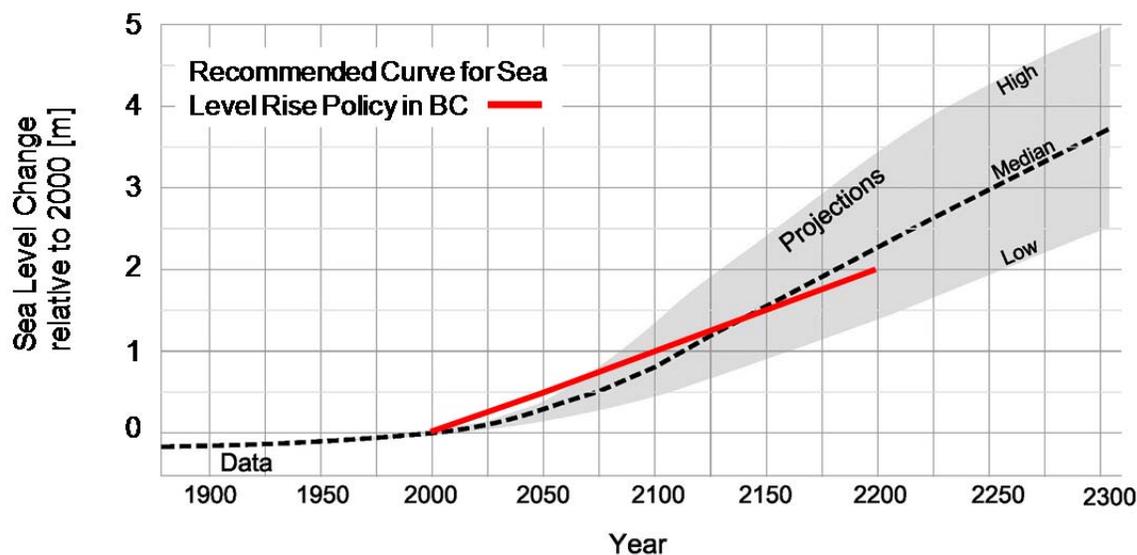


Figure 1. Recommended Global Sea Level Rise Curve for Planning and Design in BC

3.5.4 Sea Level Rise Planning Areas

Local Governments should consider defining SLR Planning Areas and developing land use planning strategies integrating both flood protection (sea dikes) and flood hazard management tools. These areas should include areas exposed to coastal flood hazards, diked areas and inland floodplains adjacent to tidally influenced rivers where potential flood levels will be increased by sea level rise.

As one possible management tool, lands included within SLR Planning areas may be designated by local governments as floodplains under Section 524 of the *Local Government Act*

and if land is so designated, local governments may, by bylaw, specify flood levels and setbacks to address sea level rise.

3.5.5 Strait of Georgia - Areas Not Subject to Significant Tsunami Hazard¹

3.5.5.1 Standard FCLs and Setbacks

The Year 2100 FCL should be established for specific coastal areas by a suitably qualified Professional Engineer, experienced in coastal engineering. This work could be completed as part of regional floodplain mapping, SLR Planning Area studies, or as part of development approval processes. The Year 2100 FCL should be the minimum elevation for the underside of a wooden floor system or top of concrete slab for habitable buildings, and should be determined (see Figure 2) as the sum of:

- The 1:200, or 1:500² Annual Exceedance Probability (AEP) total water level as determined by probabilistic analyses³ of tides and storm surge;
- Allowance for future SLR to the year 2100;
- Allowance for regional uplift, or subsidence to the year 2100;
- Estimated wave effects associated with the Designated Storm with an AEP of 1:200, or 1:500; and
- A minimum freeboard of 0.6 metres.

Alternatively, the Year 2100 FCL can be determined by a more conservative "Combined Method" as described in the Ausenco Sandwell (2011) reports (see Figure 3). Example calculations of FCLs for specific areas in coastal BC are provided in Table 3-2 AS(2011b) where the FCL is determined as the sum of:

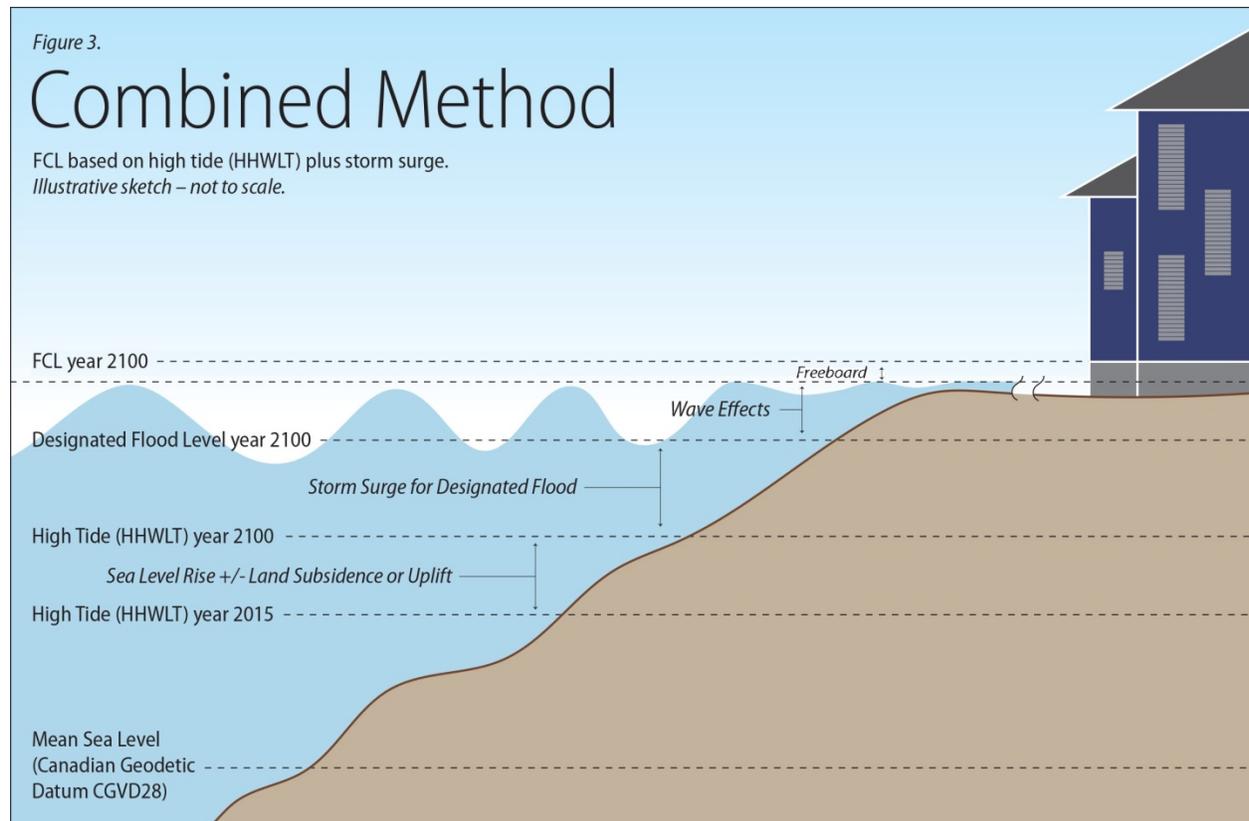
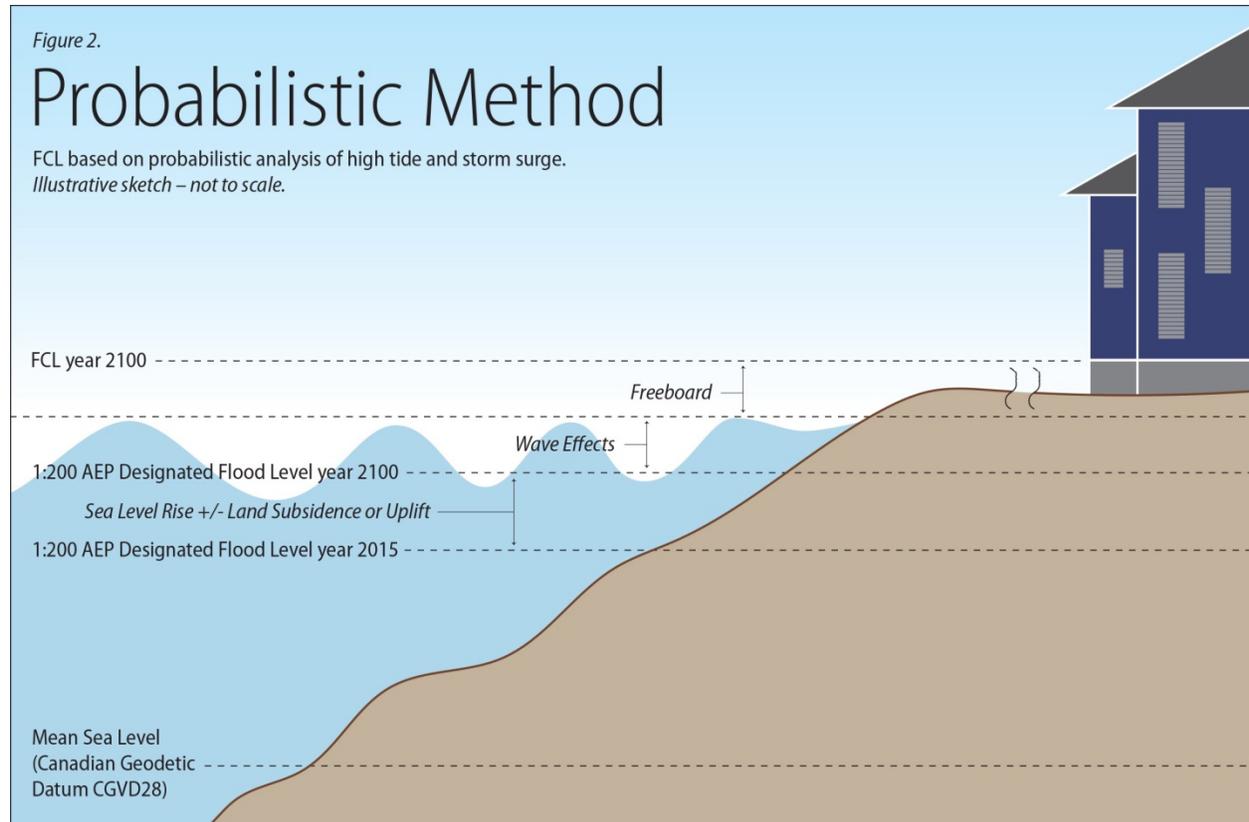
- Allowance for future SLR to the year 2100;
- Allowance for regional uplift, or subsidence to the year 2100;
- Higher high water large tide (HHWLT);
- Estimated storm surge for the Designated Storm with an AEP of 1:200, or 1:500 as per Table 6-1 in AS(2011a);
- Estimated wave effects associated with the Designated Storm; and
- A minimum freeboard of 0.3 metres.⁴

¹ Refers to "Zone E" as shown on the "Tsunami Notification Zones for BC" map published by Emergency Management BC, November, 2015 and includes the Strait of Georgia, Gulf Islands, Greater Vancouver, Johnstone Strait but not including the east side of the Saanich Peninsula and Greater Victoria.

² While a 1:200 AEP is the minimum provincial standard, local governments may decide to adopt more stringent criteria for heavily populated and built-up areas.

³ Because of the variation along the BC Coast in the availability of reliable long term water level gauge data and site specific effects including uplift, subsidence and wave effects, the decision on selection of an appropriate methodology to determine the FCL is up to the local government jurisdiction based on recommendations from a suitably qualified Professional Engineer, experienced in coastal engineering. Where studies are required to determine sea dike design levels, the design level analyses and dike design must be reviewed and approved by the Inspector, or Deputy Inspector of Dikes, as part of the *Dike Maintenance Act* approval process.

⁴ Given that the "Combined Method" provides conservative values for Year 2100 Designated Flood Levels (because the method assumes the Designated Storm occurs in conjunction with a high tide) the freeboard may be reduced from 0.6 m to 0.3 m for this method for situations where the full FCL may be difficult to achieve.



The building setback should be at least the greater of 15 m from the future estimated Natural Boundary of the sea at Year 2100, or landward of the location where the natural ground elevation contour is equivalent to the Year 2100 FCL (refer to Figure 2-2 in AS (2011b) for a definition sketch – except that the Year 2100 Designated Flood Level and future FCL as shown in this sketch can be determined by either probabilistic analyses, or the "Combined Method").

Where the sea frontage is protected from erosion by a natural bedrock formation, the development approving official may agree to modify setback requirements as recommended by a suitably qualified Professional Engineer experienced in coastal engineering. The Professional Engineer should fully consider all aspects of the coastal flood hazard associated with Year 2100 water levels including potential wave, debris and related splash impacts on buildings. This approval should be augmented through a restrictive covenant describing the hazard and building requirements, and including the Professional Engineer's report and a liability disclaimer.

The setback may be increased on a site-specific basis such as for exposed erodible beaches and/or in areas of known erosion hazard.

3.5.5.2 Subdivision

All lots created through subdivision should have viable building sites on natural ground that is above the Year 2100 FCL and comply with the setback guidelines noted above.

To regulate redevelopment at the end of the building lifespan, the development approving officer should require a restrictive covenant stipulating that any future reconstruction must meet the FCL and setbacks requirements in force at the time of redevelopment.

Subdivision may be approved within a Sea Level Rise Planning Area in areas where the natural ground is lower than the Year 2100 FCL where the local government has developed and adopted a long term flood protection strategy completed by a suitably qualified Professional Engineer experienced in coastal engineering and referencing applicable professional practice (APEGBC) and provincial guidelines available at the time. The strategy should incorporate mitigation to address all relevant risks including flood risk due to sea level rise to the year 2200 and beyond⁵ and is to be comprised of **both** raising of ground elevations with fill and adequate provisions for future dike protection, including sufficient land and/or rights of way for the future dike (also see Appendix 1).

Subdivision may also be approved in areas where the natural ground is lower than the Year 2100 FCL where all of the following conditions have been met:

- The subdivision development involves a maximum of 2 lots;
- The site is located on the coastal floodplain fringe adjacent to high ground;
- The building site ground elevations have been raised to the Year 2100 FCL and the fill extends to and is contiguous with natural ground above the Year 2100 FCL;

⁵ The long term flood protection strategy should be reviewed and updated as necessary every 10 years, or as a change to an OCP or RGS warrants. Updates should continue to consider flood risks a minimum of 100 years in the future.

- The fill is adequately protected from the sea by erosion protection works, with consideration of wave impacts associated with Year 2100 sea levels;
- The building setbacks comply with the setback guidelines noted above;
- A suitably qualified Professional Engineer, with experience in coastal engineering has prepared a detailed design for the fill and erosion protection works including a report considering all of the above and has concluded that the site may be suitable for the use intended;
- The Professional Engineers' report forms part of the restrictive covenant registered on the title of each lot; and
- The restrictive covenant registered on title stipulates that the landowners are responsible for maintenance of the erosion protection works on their own land.

3.5.5.3 Development on Existing Lots

Standard setbacks and elevations apply. To regulate redevelopment at the end of the building lifespan, the development approving official should require a restrictive covenant stipulating that any future reconstruction must meet the FCL and setbacks requirements in force at the time of redevelopment.

On existing lots, if meeting the setback guidelines noted above would sterilize the lot (i.e., not allow even one of the land uses or structures permitted under the current zoning), the development approving official may agree to modify setback requirements as recommended by a suitably qualified Professional Engineer experienced in coastal engineering, provided that this is augmented through a restrictive covenant stipulating the hazard, building requirements, and liability disclaimer.

The Year 2100 FCL requirements would still apply to new habitable building construction.

3.5.5.4 Lots with Coastal Bluffs

For lots containing coastal bluffs that are steeper than 3(H):1(V) and susceptible to erosion from the sea, setbacks should be determined as follows:

1. If the future estimated Natural Boundary is located at least 15 m seaward of the toe of the bluff, then no action is required and the setback should conform with other guidelines that adequately address terrestrial cliff and slope stability hazards.
2. If the future estimated Natural Boundary is located 15m or less seaward of the toe of the bluff, then the setback from the future estimated Natural Boundary should be located at a horizontal distance of at least 3 times the height of the bluff, measured from 15 m landwards from the location of the future estimated Natural Boundary.

In some conditions, setbacks may require site-specific interpretation and could result in the use of a minimum distance measured back from the crest of the bluff. The setback may be modified provided the modification is supported by a report, giving consideration to the coastal erosion that may occur over the life of the project, prepared by a suitably qualified Professional Engineer experienced in coastal engineering.

3.5.6 Outside the Strait of Georgia Area - Areas Subject to Significant Tsunami Hazard⁶

Tsunami setbacks and elevations should be required for new lots created through the subdivision approval process. Tsunami hazard requirements and regulations for existing lots may be determined by local governments on a site specific or regional basis.

The "standard" setbacks and elevations in sections 3.5.5.1 to 3.5.5.4 above apply to all coastal areas outside of the Strait of Georgia, except for new subdivisions subject to significant tsunami hazards, in which case the tsunami setbacks and elevations shall apply. Where the tsunami hazard is low, the greater FCLs and setbacks shall apply.

A subdivision application in a tsunami prone area must include a report by a suitably qualified Professional Engineer, experienced in coastal engineering who must formulate safe building conditions for each proposed lot based on a review of recent Tsunami hazard literature including the report, "Modelling of Potential Tsunami Inundation Limits and Run-Up", by AECOM for the Capital Regional District, dated June 14, 2013, plus the historical report, "Evaluation of Tsunami Levels Along the British Columbia Coast", by Seaconsult Marine Research Ltd., dated March 1988.

At a minimum, building conditions should protect improvements from damage from a tsunami of equal magnitude to the March 28, 1964 tsunami that resulted from the Prince William Sound, Alaska earthquake and a possible Cascadia Subduction Zone earthquake.

Setback –

Setback requirements should be established on a site-specific basis and take into account tsunami hazards.

The setback must be sufficient to protect buildings and must be at least 30 metres from the Year 2100 estimated natural boundary.

FCL –

FCL requirements should be established on a site-specific basis and take into account tsunami hazards.

Reductions to these requirements should only be considered where the building can be built to the Tsunami FCL on bedrock.

3.6 Areas Protected by Dikes

Residential, commercial and institutional developments in areas protected by dikes are required to comply with full flood proofing requirements for their respective categories, with a possible exception for development within Sea Level Rise Planning Areas as noted below.

Setback –

Buildings should be located a minimum of 7.5 metres away from any structure for flood protection or seepage control or any dike right-of-way used for protection works. In addition, fill

⁶Refers to "Zones A, B,C and D" as shown on the "Tsunami Notification Zones for BC" map published by Emergency Management BC, November, 2015 and includes the North Coast, Central Coast, and Juan de Fuca Strait including Greater Victoria and the east side of the Saanich Peninsula.

for floodproofing should not be placed within 7.5 metres of the inboard toe of any structure for flood protection or seepage control or the inboard side of any dike right-of-way used for protection works, unless approved by the Inspector of Dikes as part of a dike upgrading plan.

Additional dike right of way and building set back requirements should be defined for Sea Level Rise Planning Areas to accommodate the widening and raising of dikes for sea level rise.

Any change to these conditions requires the approval of the Inspector of Dikes.

FCL –

Buildings and manufactured homes in areas protected by dikes should meet minimum FCLs prescribed for the primary stream, lake or sea adjacent to the dike and the FCL requirements for any internal drainage (minimum ponding elevations). FCLs for diked coastal areas may also be determined through a comprehensive, site-specific dike breach modeling study, completed by a suitably qualified Professional Engineer, and based on a minimum 1:200 AEP sea water level in the Year 2100, inclusion of a minimum 0.6 m freeboard above modelled water levels and conservative modelling assumptions.

Relaxation of FCL requirements for new development in coastal areas protected by dikes may be appropriate for Sea Level Rise Planning Areas where the local government has developed and adopted a long term flood protection strategy completed by a suitably qualified Professional Engineer experienced in coastal engineering and referencing applicable professional practice (APEGBC) and provincial guidelines available at the time (see Appendix 1). This relaxation should be augmented through a restrictive covenant stipulating the hazard and protection strategy, building requirements, and liability disclaimer.

3.6.1 Secondary sources of flooding

Where there are secondary sources of flooding within diked areas, the appropriate requirements as set out in Clauses 3.1 through 3.5 should be applied. These should include consideration of minimum ponding elevations behind the dike to protect against internal drainage.

Amended: October 1, 2016

APPENDIX 1 – LONG TERM FLOOD PROTECTION STRATEGY

Section 3.6 states that "Relaxation of FCL requirements for new development in coastal areas protected by dikes may be appropriate for Sea Level Rise Planning Areas where the local government has developed and adopted a long term flood protection strategy completed by a suitably qualified Professional Engineer experienced in coastal engineering and referencing applicable professional practice (APEGBC) and provincial guidelines available at the time." Similarly section 3.5.2 provides for subdivision approvals in low lying coastal floodplain areas where the local government has developed a long term flood protection strategy. This appendix outlines the steps involved in developing a long-term flood protection strategy and the issues that should be addressed at the various stages of development of the strategy.

1. General

- Relaxation of FCL requirements for new development in the protected area and intensification of development through subdivision of land has significant long term implications. The future reliance on the sea dikes and consequences of dike failure will increase as development occurs and sea level rises. Therefore, the extent of work required to establish a successful long term dike upgrading program is demanding and costly. This approach should only be undertaken where the extent of community development in the floodplain justifies the high cost and level of effort.
- While additional site specific factors and flood hazards may be relevant for specific areas, the criteria and work outlined herein must generally be completed to justify relaxation of requirements.

2. Feasibility Study

The objective of the feasibility study is to help select a conceptual design option or options and to support a decision to proceed with preliminary design for Phase 1. The feasibility study should include the following steps:

- Collect background data and assess information needs including:
 - Wind and wave
 - Geotechnical (including seismic)
 - Land ownership/rights of way
 - Long term subsidence information for the site/area
 - Environmental
 - Proximity and availability of construction materials
- Review regulations and permits required
- Define design parameters
 - Dike safety standards and guidelines
 - Decision on minimum Annual Exceedance Probability (AEP) of design water level
 - Sea level rise scenario(s) and planning horizons (i.e. year 2100 and 2200) based on the Recommended Sea Level Rise Planning Curve presented in Figure 1.
- Develop options and complete conceptual designs. Design options may include:
 - Offshore breakwater, erosion protection and various overtopping designs

- Wide landfills (i.e. "superdike" concept)
- Conventional earth dike (minimal use of floodwall closure sections)
- Sea barrier/tide gate
- other
- Assess adaptability of option for very long term upgrading (i.e. year 2200)
- Assess environmental impact of options
- Assess social impact of options
- Develop cost estimates
- Develop recommendations for detailed engineering and environmental studies
- Prepare draft report
- Define key stakeholders and engage to get feedback
- Complete public consultation process
- Compare alternatives with respect to cost/ social acceptance/environment
- Develop draft short term and long term implementation plans
- Prepare final report
- Present to local government council/board and funding agencies (Province) for approval in principle

3. Preliminary Design for Phase 1

Preliminary design for a Phase 1 of the flood protection program is required to support funding commitments.⁷ The Phase 1 project scope would typically include at least 25% of the dike upgrading work required to meet the year 2100 flood protection requirements.

- Complete detailed engineering studies as recommended by the feasibility study (such as geotechnical, land acquisition, environmental etc.):
- Phasing should be planned so that the minimum design AEP is maintained or exceeded at all times, considering up to date SLR curve information.
- Complete preliminary design for Phase 1
- Prepare detailed cost estimates to support funding commitments by both local and senior governments
- Before any design work is initiated, local governments are encouraged to contact the regional Deputy Inspector of Dikes to discuss proposed design projects.

4. Long Term Flood Protection Strategy

- Outline construction phasing plan – while work can proceed incrementally, preliminary designs and major components (i.e. land assembly) should be completed in no more than 4 phases by 2100. (As previously noted, phasing should be planned so that the

⁷ Where subdivision development is being contemplated in areas where the natural ground is lower than the Year 2100 FCL, the long term flood protection strategy is to be comprised of both raising of ground elevations with fill and adequate provisions for future dike protection. Phasing of land filling and dike construction would be established on a site specific basis.

minimum design AEP is maintained or exceeded at all times, considering up to date SLR curve information.)

- Land Ownership and Legal Access – confirm detailed plans to acquire lands for at least Phase 1 as a minimum, and a strategy to acquire lands for Phases 2, 3 and 4 (if needed).
- Dike Operation and Maintenance – prepare detailed operation and maintenance plan.
- *Dike Maintenance Act* (DMA) Approval for Phase 1 – apply for and obtain approval from the regional Deputy Inspector of Dikes
- Financial Plan – confirm funding approval in place for Phase 1 through established cost share programs. Confirm political commitment by both local and senior governments to long term support for the Flood Protection Strategy.

5. Governance

Local governments may wish to establish appropriate governance or committees to provide direction, technical input, and public consultation throughout the process. The province may participate in an advisory capacity, providing guidance and information on provincial policies, standards, regulations and design criteria. The province's participation does not guarantee approval of applications required under the *Dike Maintenance Act*. Applications will be assessed on their own merit and the decision maker will consider the application within the context of the long term strategy.

4.0 Application - Land Use Specific

Where relevant flood plain mapping information and other flood hazard-related information (such as covenants, bylaws, flood hazard maps and engineering reports) exist, they must be considered. Where the province has provided local governments with written documents and/or agreements approving floodproofing conditions that are different from these guidelines, such approved floodproofing conditions are acceptable and are incorporated as part of these Guidelines for the area referenced in those documents.

Where such information is not available, the following minimum requirements should be considered to guide development away from high hazard areas and to allow development to proceed in a safe manner. These minimum requirements should be placed in the form of a covenant against land titles at the time of subdivision, and/or should be incorporated into local government bylaws.

4.1 Agriculture

4.1.1 Farm Dwellings

Whether or not the area is diked, the following guidelines apply.

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

FCL –

Farm dwelling units on parcel sizes 8.0 hectares, or greater, located within the Agricultural Land Reserve, shall be located with the underside of a wooden floor system or the top of the pad of any habitable area (or in the case of a manufactured home the top of pad or the ground surface on which it is located) no lower than 1.0 metre above the natural ground elevation taken at any point on the perimeter of the building.

4.1.1.1 Where required flood proofing is impractical

When establishing conditions for areas within the Agricultural Land Reserve, where required flood proofing is impractical (i.e., greater than 2.5 metres elevation) and where protection is provided by standard dikes, owners of existing parcels of land may be given the option of adopting full flood proofing or adopting an elevation which will provide protection against drainage problems associated with storm conditions (minimum ponding elevation). In return owners must agree to a waiver of financial assistance in the case of flood damage to be registered as a covenant against the land title.

Subdivision in areas of flooding depth greater than 2.5 metres requires that the applicant demonstrate how full flood proofing can be achieved. Agricultural Land Reserve lands which are subdivided under Homesite Severance may be required to have a small parcel less than 8.0 hectares. When such subdivision occurs, each lot created is subject to these guidelines including the remainder.

4.1.2 Livestock Housing

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

FCL --

Open-sided livestock structures do not require flood proofing by elevation.

Close-sided livestock buildings behind standard dikes do not require flood proofing by elevation.

Closed-sided livestock housing not behind standard dikes shall be located with the underside of the wooden floor system or the top of the pad (or in the case of a manufactured home the top of pad or the ground surface on which it is located) no lower than 1.0 metre above the natural ground elevation taken at any point on the perimeter of the building.

4.1.3 Other Farm Buildings

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

FCL –

Flood proofing by elevation is left to discretion of the owner.

4.2 Public Recreation, Institutional Buildings, Parks and Open Space

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply to all structures in this category.

FCL –

Institutional and closed-sided recreational buildings and/or equipment damageable by floodwaters require full flood proofing.

Recreation shelters, stands, campsite washhouses and other outdoor facilities susceptible to only marginal damage by floodwaters do not require flood proofing by elevation.

4.3 Industrial Areas

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

Industrial buildings may be granted special relief from this requirement. Setback requirements for certain industrial activities, such as on-loading and off-loading facilities, where the use of the waterfront is a necessary subsidiary part of the operation and would not adversely affect a floodway or significantly increase flood elevations, may be reduced.

FCL –

Industrial uses, other than main electrical switchgear, shall be located with the underside of a wooden floor system or the top of the pad (or in the case of a manufactured home the top of pad or the ground surface on which it is located) no lower than the FCL minus freeboard. Main electrical switchgear shall be no lower than the FCL.

Elevations noted in guidelines should be used for the installation of fixed equipment susceptible to damage by floodwaters. An exception may be made if a suitably qualified professional determines that appropriate measures can be and are taken to provide protection against damage by flooding and erosion. The approving officer reviewing a proposed subdivision plan must approve this exception.

On-loading and off-loading facilities associated with water-oriented industry and portable sawmills do not require floodproofing. Heavy industrial development located behind a standard dike does not require floodproofing.

4.4 Fish Farms

Setback and FCL –

All facilities should meet setback conditions and be flood proofed to the FCL. Where standard dikes protect fish farm facilities, flood proofing is only required relative to any secondary flooding hazard.

4.5 Ancillary Buildings, Carports, Garages, Entryways and Renovations to Existing Buildings

FCL –

Requirements for flood proofing through the use of elevation may be waived for:

- A renovation of an existing building or structure that does not involve an addition,
- That portion of a building or structure that is to be used as a carport, garage or entryway,
- Other minor buildings such as storage buildings, porches and domestic greenhouses.

4.6 Additions to Existing Buildings

Where a building or structure is legally non-conforming with the floodproofing requirements set out in any pertinent bylaw or covenant, it is acceptable to allow an addition, at the original non-conforming floor elevation, that would increase the size of the building or structure by less than 25 percent of the floor area existing at the time of enactment of such floodproofing requirements, provided that the degree of nonconformity regarding setback is not increased.

4.7 Lots Existing Prior to Bylaw Adoption

Where a lot existed prior to the date of adoption of a bylaw, and is protected by a standard dike, and where the difference between the Flood Construction Level and the ground elevation exceeds 2.5 metres, and where the owner has entered into a restrictive covenant with the local government [This covenant should be drawn up by the local government legal advisor], a building may be constructed, reconstructed, moved or extended and a manufactured home or unit, modular home or structure may be located with the underside of the floor system of any area used for habitation, business or storage of goods damageable by floodwaters to a minimum elevation of two point five (2.5) metres above the average ground elevation in the vicinity of the building site nor less than the minimum ponding elevation established for local drainage behind the dike, which ever elevation is higher.

Note: The actual required building elevation referenced to geodetic datum will therefore vary from site to site, depending on ground elevation.

5.0 Application - Implementation Measures

In addition to the requirements set out in sections 3.0 and 4.0, the following general conditions should apply and be included in a subdivision covenant or local authority bylaw, where applicable.

5.1 Manufactured Homes or Units

Setback –

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

FCL –

Manufactured homes or units should be located on a natural ground surface or on the top of a concrete or asphalt pad that is at or above the Flood Construction Level. An exception may be made where a manufactured home or unit is located on, and secured to, a poured-in-place concrete perimeter footing, in which case the FCL shall apply to the top of the footing wall.

5.2 Furnaces, Electrical and Other Fixed Equipment

FCL –

Areas below the FCL should not be used for the installation of furnaces, major electrical switchgear, or other fixed equipment susceptible to damage by floodwater.

An exception to this guideline is where standard dikes provide building protection. In these cases furnaces and hot water heaters are permitted below the FCL, but main electrical switchgear should be placed above the FCL.

5.3 Parking

Setback–

Setback requirements, based on hazard type as identified in section 3.0, shall apply.

FCL –

As vehicles can be moved to higher ground, floodproofing may not be necessary to prevent damage from floodwater for parking areas, including enclosed underground parking areas, except that, in the case of an enclosed underground parking area, an

unobstructed means of pedestrian ingress and egress must be provided above the FCL. In addition, signs must be posted at all points of entry notifying users that the parking garage is not protected from inundation by floodwaters.

5.4 Elevation by Landfill

Where landfill is used to raise the natural ground elevation, it should be adequately compacted and the toe of the landfill slope should be no closer to the natural boundary than the prescribed setback. In addition, the face of the landfill slope should be adequately protected against erosion from flood flows, wave action, ice or other debris.

The fill must not adversely impact neighbouring properties by increasing the surface water elevation or directing flows toward those properties.

5.5 Depth of Flooding

Subdivision in areas of flooding depth greater than 2.5 metres requires that the applicant demonstrate how full flood proofing can be achieved and how safe ingress and egress can be achieved during the flood.

5.6 Flood Velocities

Subdivision in areas where flood velocities are in excess of 1.0 metre per second requires that the applicant demonstrate how safe ingress and egress can be achieved during the flood.

5.7 Training Works

An approving officer should require details of the design, construction, operation and maintenance of training works prior to final approval of a subdivision. Works are to be designed by a professional engineer. A professional engineer must certify constructed works.

5.7.1 Training Works to Protect One Property

An ongoing maintenance program may be assured through the addition of relevant requirements to the standard flood proofing covenant registered under section 219 of the *Land Title Act*, if the training works are:

- Built on private property, and
- Intended to protect only the property of the person (including a strata corporation) owning the training works and the property on which they are located.

5.7.2 Training Works to Protect Multiple Properties

If the training works, when constructed, will protect multiple properties of more than one person, then an ongoing operation and maintenance program and registered easements and access to structures must be assured by the local government. In addition, the training works require the approval of the Inspector of Dikes and, therefore, that office must be contacted for the requirements and approvals.

Approvals under the provincial *Water Act* and federal *Fisheries Act* are also normally required. Local government may also have other requirements.

An approved Operation and Maintenance manual for the local government is to be prepared as a condition of subdivision approval and a copy is to be sent to the Inspector of Dikes.

5.8 Erosion Protection Works

Where erosion protection works are required, an approving officer should require details of the design, construction, operation and maintenance of erosion protection works prior to final approval of a subdivision or a relaxation of the requirements in a covenant. Works are to be designed by a professional engineer. A professional engineer must certify constructed works.

5.8.1 Erosion Protection Works to Protect One Property

An ongoing maintenance program may be assured through the addition of relevant requirements to the standard flood proofing covenant registered under section 219 of the *Land Title Act*, if the erosion protection works are:

- Built on private property, and
- Intended to protect only the property of the person (including a strata corporation) owning the erosion protection works and the property on which they are located.

5.8.2 Erosion Protection Works to Protect Multiple Properties

If the erosion protection works, when constructed, will protect multiple properties of more than one person, then an ongoing operation and maintenance program and registered easements and access to structures must be assured by the local government.

Approvals under the provincial *Water Act* and federal *Fisheries Act* are also normally required. Local government may also have other requirements.

An approved Operation and Maintenance manual for the local government is to be prepared as a condition of approval.

APPENDIX A - Definitions

Alluvial Fan - The alluvial deposit of a stream where the stream issues from a steep mountain valley or gorge upon a plain or at the junction of a tributary stream with the main stream.

Approving Officer - The appropriate person appointed under the *Land Title Act*.

Commercial Use - A use providing for the sale or rental of goods or services, for personal services, or for the servicing and repair of goods; and includes retail sales, wholesaling in conjunction with retail sales, commercial and government offices, personal services, commercial schools, household services and household repairs.

Debris Flow - The rapid downslope movement descending steep pre-existing drainage channels of water-saturated soil and debris by true flow processes.

Designated Flood - A flood, which may occur in any given year, of such magnitude as to equal a flood having a 200-year recurrence interval, based on a frequency analysis of unregulated historic flood records or by regional analysis where there is inadequate streamflow data available. Where the flow of a large watercourse is controlled by a major dam, the designated flood shall be set on a site-specific basis.

Designated Flood Level - The observed or calculated elevation for the Designated Flood and is used in the calculation of the Flood Construction Level.

Disposition - Disposition of Crown land by certificate of purchase, grant, lease, licence of occupation, right-of-way, or easement under the *Land Act*.

Flood Construction Level - The Designated Flood Level plus the allowance for freeboard and is used to establish the elevation of the underside of a wooden floor system or top of concrete slab for habitable buildings. In the case of a manufactured home, the ground level or top of concrete or asphalt pad, on which it is located shall be equal to or higher than the above described elevation. It also establishes the minimum crest level of a Standard Dike. Where the Designated Flood level cannot be determined or where there are overriding factors, an assessed height above the natural boundary of the water-body or above the natural ground elevation may be used.

Flood plain - A lowland area, whether diked, flood proofed, or not which, by reasons of land elevation, is susceptible to flooding from an adjoining watercourse, ocean, lake or other body of water and for administration purposes is taken to be that area submerged by the Designated Flood plus freeboard.

Flood proofing - The alteration of land or structures either physically or in use to reduce flood damage and includes the use of building setbacks from water bodies to maintain a

floodway and to allow for potential erosion. Flood proofing may be achieved by all or a combination of the following:

1. building on fill, provided such fill does not interfere with flood flows of the watercourse, and is adequately protected against floodwater erosion;
2. building raised by structural means such as foundation walls, columns, etc.;
3. a combination of fill and structural means.

Floodway - The channel of the watercourse and those portions of the flood plains that are reasonably required to discharge the flood flow of a Designated Flood. A minimum required floodway shall be equal to the width of the channel within the natural boundary plus a minimum setback of thirty metres from the natural boundary on each side of the channel or channels unless otherwise approved.

Freeboard – A vertical distance added to the Designated Flood Level. Used to establish the Flood Construction Level.

Habitable Area - Any room or space within a building or structure that is or can be used for human occupancy, commercial sales, or storage of goods, possessions or equipment (including furnaces) which would be subject to damage if flooded.

Heavy Industry - Includes such uses as manufacturing or processing of wood and paper products, metal, heavy electrical, non-metallic mineral products, petroleum and coal products, industrial chemicals and by-products, and allied products.

Inspector of Dikes - An official of the Ministry of Water, Land and Air Protection as defined under the *Dike Maintenance Act*, RSBC 1996, chapter 95.

Institutional Use - A use providing for public functions and includes federal, provincial, regional and municipal offices, schools, churches, colleges, hospitals, community centres, libraries, museums, jails, courts of law and similar facilities; and specifically excludes public storage and works yards, and public utility uses.

Light or Service Industry - Includes such uses as assembly, fabrication and light manufacturing, warehousing, wholesaling and food processing.

Manufactured Home - A structure manufactured as a unit, intended to be occupied in a place other than at its manufacture, and designed as a dwelling unit, and includes mobile homes, and specifically excludes Recreation Vehicles.

Minimum Ponding Elevation - A minimum construction level assigned to reduce possible flood damage due to ponding of local drainage during a severe local storm.

Natural Boundary - The visible high watermark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual and so long continued in all ordinary years as to mark upon the soil of the bed of the lake, river, stream or other body of water a character distinct from that of the banks thereof, in respect to

vegetation, as well as in respect to the nature of the soil itself (*Land Act*, section 1). For coastal areas, the natural boundary shall include the natural limit of permanent terrestrial vegetation. In addition, the natural boundary includes the best estimate of the edge of dormant or old side channels and marsh areas.

Non-conforming - Any existing building located on flood prone land that does not meet flood proofing requirements set out in any pertinent bylaw, regulation or covenant.

Pad – A paved surface on which blocks, posts, runners or strip footings are placed for the purpose of supporting a manufactured home or unit.

Professional Engineer - A person who is registered or licensed under the provisions of the Engineers and Geoscientists Act, RSBC 1996, chapter 116.

Recreation Use - A use providing for indoor or outdoor recreation and includes parks, playgrounds, and sports facilities.

Recreation Vehicle - Any structure, trailer or vehicle used or designed to be used for living or sleeping purposes and which is designed or intended to be mobile on land, whether or not self-propelled.

Setback – A withdrawal of a building or landfill from the natural boundary or other reference line to maintain a floodway and to allow for potential land erosion.

Standard Dikes - Those dikes built to a minimum crest elevation equal to the Flood Construction Level and meeting standards of design and construction approved by the Ministry of Water, Land and Air Protection and maintained by an ongoing authority such as a local government body.

Training Works - Any wall, dike or protective structure used to prevent a stream from leaving its channel at a given location. This includes any debris flow training structures including basins, trash racks, or other works.

Tsunami - A sea wave generated by tectonic or volcanic activity.

Watercourse - Any natural or man-made depression with well defined banks and a bed 0.6 metres or more below the surrounding land serving to give direction to a current of water at least six (6) months of the year or having a drainage area of 2 square kilometres or more upstream of the point of consideration.



September 29, 2020

Mike Irg
Alberni-Clayoquot Regional District
3008 Fifth Avenue
Port Alberni BC V9C 2E3

Dear Mike Irg:

**Re: National Disaster Mitigation Program
#ATEMB1915K060024 – Somass Watershed Flood Management Program**

I am writing to confirm the Alberni-Clayoquot Regional District has fulfilled the contractual obligations undertaken with the Province of British Columbia as set out in the Contribution Agreement, #ATEMB1915K060024, for the above project. As such, the project is deemed completed and the file has been closed.

As part of the agreement, all documents or records pertaining to the project are to be retained for audit purposes and be available for review upon reasonable notice.

We are pleased to have partnered with the Alberni-Clayoquot Regional District on this flood mitigation project to better protect your community.

Sincerely,

Jesse Ferguson
Program Manager
Disaster Mitigation Unit
Emergency Management BC



REPORT FOR INFORMATION

To: Alberni Valley and Bamfield Services Committee
From: Jenny Brunn, Interim General Manager of Community Services
Meeting Date: November 4, 2020
Subject: Review of Flat Rate for Branches and Yard Waste

Background:

At the May 6th, 2020 Alberni Valley and Bamfield Committee meeting, ACRD staff recommended that yard waste rates be changed to a \$5 flat rate for all branches and wood waste with grass and leaves accepted for free. The intent of this change was to simplify the system for residents, better manage the material received onsite, recover costs and better manage traffic at the landfill. The Alberni Valley Air Quality Committee supported this change, and it aligned with the implementation of a FireSmart grant program to support residents in reducing fuel sources from their properties.

Staff committed to monitor the results of this change and report back to the committee in 6 months. Implementation of this change was relatively smooth with significant education and a transitional implementation period. Landfill staff received both positive and negative feedback from residents when the rates were changed. Some residents are happy with the change as it is simpler to keep all branches mixed and pay a flat rate instead of separating branches based on size. One local business has continued to accept loads of branches under 2 inches at no charge, which provides an alternative for those who do not want to pay for small branch drop-off. There has been a minor drop in volumes of material in comparison to previous years which may not be a direct result of this fee change but rather due to COVID and related issues.

The FireSmart program has been challenging to fully implement with staff being redirected to EOC work; however, staff were able to offer a free drop-off event (May 19-23) at 4 locations in the Alberni Valley and curbside collection of yard waste which has received 46 requests and services to date. Staff received an extension to the grant program allowing for additional programs to continue in 2021.

The City of Port Alberni 3-stream waste collection system, which will provide weekly curbside organics and yard waste collection for all residents within city boundaries, will encourage residents to use their curbside green bin for branches and yard waste. This is likely to impact the volume of yard waste received at the landfill, and reduce backyard burning. Phase 3 of the Organics Diversion program will focus on the Electoral Areas surrounding the city and may include curbside collection services for organics and yard waste or other systems such as self-haul and landfill bans.

Financial:

The cost to process woodwaste is approximately \$25/tonne. This includes costs to stockpile this material, chip and transport for use as hogfuel (future end-use will be bulking agent in compost facility). Average revenues for the materials received prior to the rate change in May, ranged from \$5 - \$7/tonne. Since the change, the revenues have averaged out to \$22/tonne. Staff will continue to monitor the costs and revenues to see if the new rate will be a full-cost recovery system over time.

Submitted by: 

Jenny Brunn, Interim General Manager of Community Services

Approved by: 

Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer



REPORT FOR INFORMATION

To: Alberni Valley and Bamfield Services Committee
From: Jodie Frank, Organics Coordinator
Meeting Date: November 4th, 2020
Subject: Alberni Valley Landfill Upgrades

Summary:

ACRD staff have initiated the process for upgrades to the Alberni Valley Landfill and commissioned McGill and Associates Engineering Ltd (McGill) to draft the preliminary design, attached to this report. The upgrades will include improvements to traffic flow for commercial haulers and the public to allow landfill staff to efficiently manage the upcoming transition to 3-stream collection in the City of Port Alberni (CPA) and better accommodate the recently expanded diversion streams.

Background:

As part of the Strategic Priorities Fund, upgrades to the Alberni Valley Landfill have been approved to expand the layout to support organics collection and other diversion streams.

The ACRD is working with McGill, who has drafted the proposed upgrades, to develop a more conducive layout to support the upcoming changes to the City of Port Alberni's waste services and provide a designated transfer area for City trucks to unload curbside material that can be easily transferred to the appropriate processing facilities. The new dedicated public recycling area will allow adequate space for Recycle BC material and the newly expanded stewardship programs including household hazardous waste, electronics, lights and battery collection.

Changes will include designated areas for the following:

- City Transfer area for organics and recycling
- Commercial recycling area
- Improved wood waste area
- Possible commercial vehicle entry access with dedicated scale

An additional dedicated commercial scale is being considered as an option but traffic data following the implementation of organics diversion in the City of Port Alberni must be collected to determine if this high capital, operating and replacement cost is warranted.

ACRD staff has initiated stakeholder consultation meetings on the new site layout with the City of Port Alberni collection drivers as part of the organics implementation process and with commercial waste haulers in the Alberni Valley through separate meetings to gather feedback and input on the proposed site design. The ACRD will also hold focus groups with Alberni Valley residents to discuss the proposed layout to gather any additional feedback and input that may influence the site design. The main feedback that has been incorporated into the redesign thus far includes the following:

- Time and length of line ups
- Improvements to traffic flow
- Separate entry/scale for commercial vehicles

Once the consultation process has been completed, McGill will finalize the site design phase and a tender for construction will be issued with the completion date estimated for the end of February.

Financial:

The estimated value of construction is approximately \$348,000 for the expanded overflow and bin storage area, the dedicated recycling public recycling area, commercial recycling and city transfer area. Adding a dedicated commercial land and scale has an estimated cost of \$186,210. This project is an eligible expense under the Strategic Priorities Fund.

Submitted by: 

Jodie Frank, Organics Coordinator

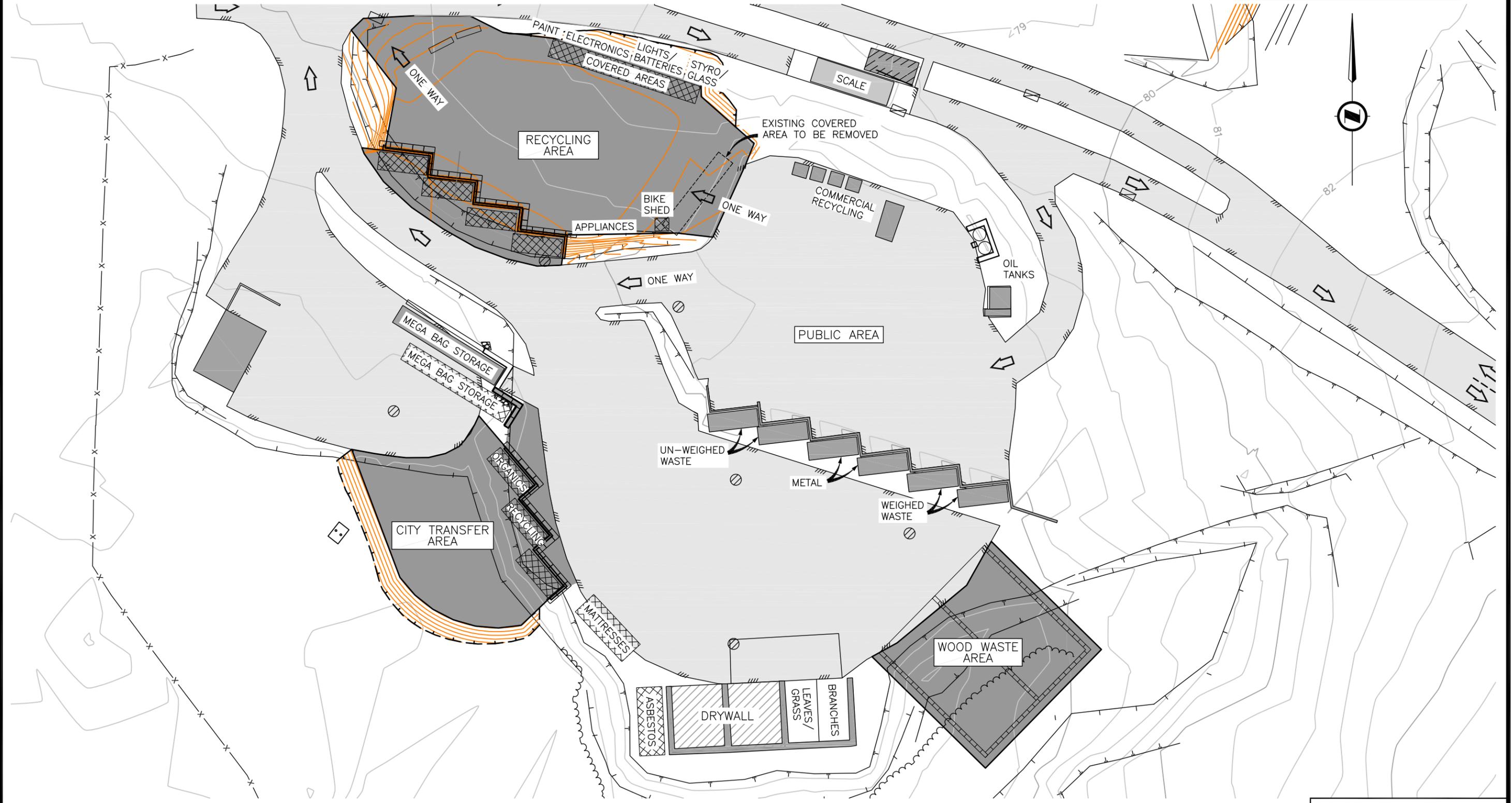
Reviewed by: 

Jenny Brunn, Interim General Manager of Community Services

Approved by: 

Douglas Holmes, BBA, CPA, CA, Chief Administrative Officer

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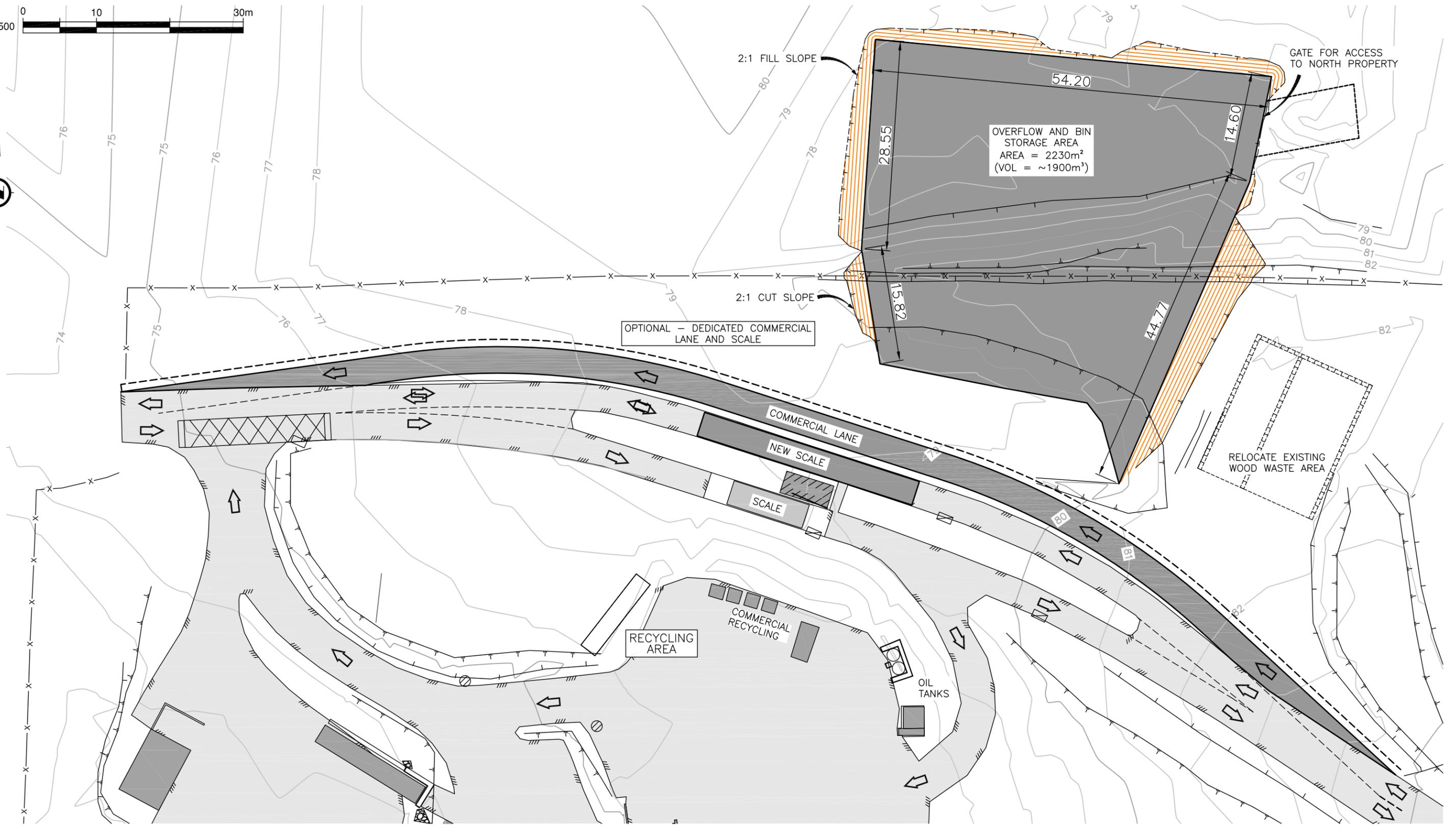
DWG: 4039 - FIG 1			
DESIGN:	BAW		
DRAWN:	CJM		
CHECKED:	BAW		
PROJECT:	M4039		
A	ISSUED FOR REVIEW	2020/01/28	CJM
REV:	DESC:	DATE:	BY:
			SCALE: 1:500



**McGILL & ASSOCIATES
ENGINEERING LTD.**
4610 ELIZABETH STREET
PORT ALBERNI, B.C., V9Y 6L7
telephone: (250) 724-3400 fax: (250) 724-4400
email: office@mcgilleng.com

ACRD ALBERNI VALLEY LANDFILL TIPPING AREA UPGRADES

SEAL:



DWG: 4039 - FIG 2

DESIGN: BAW
 DRAWN: CJM
 CHECKED: BAW
 PROJECT: M4039

DATE: OCT. 2020

SCALE: 1:500



**McGILL & ASSOCIATES
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SEAL:

**ACRD ALBERNI VALLEY LANDFILL
 TIPPING AREA UPGRADES**

A	ISSUED FOR REVIEW	2020/01/28	CJM
REV:	DESC:	DATE:	BY: