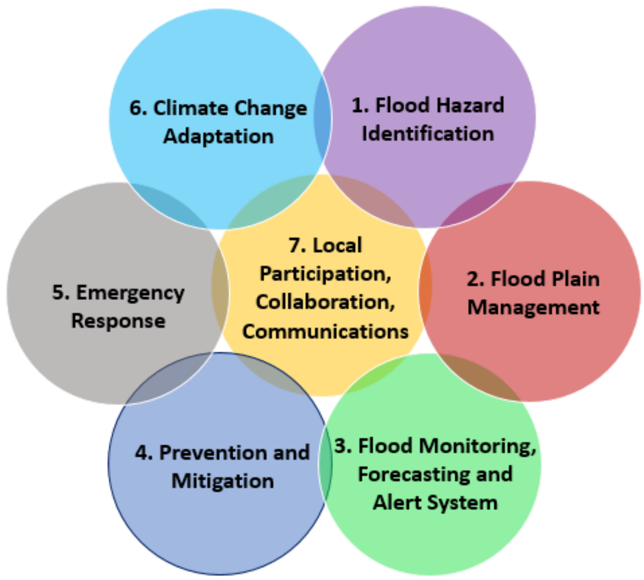
Newfoundland and Labrador Flood Management Strategy



Water Resources Management Division

Department of Environment and Climate Change

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1. Introduction

Flooding is a natural environmental process and is often caused by heavy rainfalls, coastal flooding, ice jam, rapid snowmelt runoff, and combinations of these factors. Floods can cause considerable damage to property and infrastructure, threaten human lives and cost millions in emergency assistance, clean-up and remediation.

The Province of Newfoundland and Labrador has a long history of flooding, with incidents of varying severity being reported frequently since the early 1900s. Flood damage is an increasing problem in Newfoundland and Labrador because of increasing population density around water bodies and the higher values of water-front property. As per the 2012 "Flood Risk and Vulnerability Analysis Project" report, more than 267 communities in the Province have been affected by flooding, causing over $262 million in damage over the past 64 years. The report is available at https://www.gov.nl.ca/ecc/files/Flood-Risk-and-Vulnerability-analysis-Project.pdf. Reducing exposure to flood risk is the most cost effective way to minimize flooding related vulnerabilities, future compensation expenses and re-building expenditures.

Flood Management Strategy

This flood management strategy (FMS) lays out the components being implemented by the Province to reduce exposure to flood risk. The major goals of Newfoundland and Labrador's FMS are:

- To protect communities and reduce personal hardship and economic loss from floods;
- To identify flood hazard and conduct vulnerability analysis;
- To develop monitoring, forecasting and alert systems for minimizing flood damage to properties, infrastructure and the environment;
- To coordinate and manage land use, infrastructure, and construction in flood plains;
- To address climate change adaptation challenges.

Newfoundland and Labrador's FMS is based on a multi-barrier approach and consists of seven components as shown in **Figure 1**.

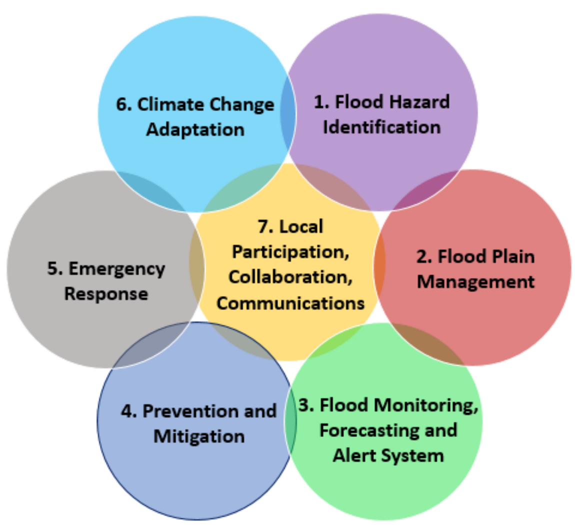

Figure 1: Newfoundland and Labrador's Flood Management Strategy (FMS) Framework

In the 2020 Intact Centre for Climate Adaptation "Climate Change and the Preparedness of Canadian Provinces and Territories to Limit Flood Risk" Report received an A grade for Flood plain mapping, Flood Risk assessment and Sustainable flood management.

The seven components are described in more detail in the following sections:

2. Flood Hazard Identification

The first step of any FMS is the identification of flood hazards. The major components of Flood Hazard identification are *Flood Risk Mapping, Flood Vulnerability Analysis and Flood Events Inventory*

2.1. Flood Risk Mapping

The Department of Environment and Climate Change has a mandate to undertake Flood Risk Mapping (FRM) under Section 33 of the *Water Resources Act* SNL 2002 cW-4.01 in order to minimize flood damage in flood prone communities. Flood risk maps are important planning tools for government and the communities in terms of land development, infrastructure investment, and sustainability.

FRM delineates flood risk areas along streams, lakes and coastal areas using design flood levels established from flood hazard studies, and is a predictive tool that shows the area, extent and frequency of flooding. The locations of buildings, properties and infrastructure are also included in the FRM to reflect their risk levels. Reliable and accurate FRM coupled with good planning of land use and infrastructure can help prevent flood damage, reduce economic losses, and protect public safety.

Flood risk maps are based on flood events associated with the 1:20 and 1:100 annual exceedance probability (AEP). The 1:20 and 1:100 AEP corresponds to the 5% and 1% risk of flooding in any one year. The Floodway corresponds to the 1:20 AEP and the Flood Fringe corresponds to the 1:100 AEP.

Flood risk areas were initially mapped under the Canada-Newfoundland Flood Damage Reduction Program (CNFDRP). Work under this program was carried out from 1981 to 1993. Work under the CNFDRP consisted of undertaking hydrotechnical studies, identifying and mapping flood risk zones and then implementing policies to limit future flood susceptible development in those areas. From 1993 to 1996 further flood studies were carried out under the federal-provincial "*General Agreement Respecting Water Resource Management*". This was a comprehensive agreement that included along with Flood Damage Reduction Program, groundwater management, watershed and water quality management, flow forecasting systems, water conservation economics, estuary and aquaculture management studies. Flood risk areas were mapped for 37 communities under these two programs.

After the end of CNFDRP, the first major FRM undertaken by the Province was the "Hydrotechnical Study of Stephenville" (Hatch, 2009) that was started in 2008 and completed in 2009. The Town of Stephenville (population 6,500), suffered record flooding in 2005 and the need for a new FRM study was identified in 2008. While undertaking the 2009 study the Water Resources Management Division (WRMD) realized the outdated nature of CNFDRP maps was a challenge for climate adaptation in the Province. Comparing the 2007 rainfall Intensity Duration Frequency (IDF) curve with the 1990 IDF curve for Stephenville it was evident that the 100-year 24-hour rainfall had increased 13%. Environment and Climate Change Canada's Atlantic Climate Change Office had released downscaled modeling results for Stephenville in 2008. The worst-case scenario showed a 35% increase in 100-year 24-hour rainfall by 2050 resulting in a 55% increase in flows in Stephenville. Consequently to address climate change, the Stephenville FRM study used a climate change IDF in addition to the existing 1:20 AEP and 1:100 AEP 24-hour IDFs to map 1:20 AEP, 1:100 AEP and 1:100 climate change AEP flood zones. The "Hydrotechnical Study of Stephenville" was the first provincial flood risk map in the country to include a 1:100 climate change AEP flood zone.

The Province's FRM studies are publicly available. Public can assess the map to understand the risk level of certain locations before starting any new development. The related information can be found at: https://www.gov.nl.ca/ecc/waterres/flooding/frm/

The Province maintains a priority list for FRM. Communities are prioritized based on the following 5 criteria:

- The current FRM is older than 10 years;
- There are no Climate Change Flood Zones;
- The previous FRM is not available in a digital format;
- New areas need to be added to the FRM;
- The community has requested for FRM in writing.

The current priority list is presented in **Table 4** in **Appendix 3**. The process for a FRM study to be undertaken for a community is as follows:

1. The study area must have a history of flooding impacting development,
2. The community makes a written request for a new (or updated) study to the Department,
3. The Department reviews the request,
4. Approved requests are added to the priority list for Flood Risk Mapping,
5. When a budget is approved for FRM, communities are contacted, prior to the commencement of the study, for input and for a commitment that they will apply the Provincial Policy for Flood Plain Management once the FRM has be completed.

2.2. Flood Vulnerability Analysis

In 2012, a comprehensive Flood Risk and Vulnerability Analysis was undertaken to:

- Understand the historical context of flooding in the Province;
- Understand land use changes to watersheds in the Province;
- Identify potential impacts of the changing climate;
- Identify communities vulnerable to flooding that should be considered for new or updated FRM studies;
- Identify communities vulnerable to flooding that should be considered for flood forecasting and flood warning systems; and,
- Identify flood risk mitigation and/or adaptation opportunities.

The results of the Flood Risk and Vulnerability Analysis are presented in the "Flood Risk and Vulnerability Analysis Project" report available at:

https://www.gov.nl.ca/ecc/files/Flood-Risk-and-Vulnerability-analysis-Project.pdf

In Appendix A of the "Flood Risk and Vulnerability Analysis Project" report a detailed prioritization of 530 communities for new FRM is presented.

2.3. Flood Events Inventory

The Flood Events Inventory (FEI) is a database of flood and storm events, which have occurred in the Province since 1900. A flood event is defined as the effect of a storm event on a single community, and is equal to one record in the inventory. A storm event, however, is an event that initiates at least one flood event. Therefore, a single storm event can be associated with multiple flood events, with an example being a Hurricane that affected many areas of the Province. The inventory contains information such as the flood event number, storm event number, community name, region name, water body name, amount of rainfall, amount of snow fall, surge height, ice jam height, etc.

The database has been compiled through a review of information collected through flood risk studies, flood investigations and reports published in local, regional and national media. The FEI is critical for identifying areas that have a history of flooding. The FEI is updated when new information is collected through flood risk studies. The FEI is available at https://www.gov.nl.ca/ecc/files/Fall-2014-Flood-Inventory-1.pdf

3. Flood Plain Management

Land use within flood plains involves tradeoffs between flood risk and development. Flood risk takes the form of danger to health and safety, financial costs associated with property damage and degradation of water resources and the environment. Some factors associated with flood risk such as flow velocity, upstream inundation, erosion potential or environmental impacts may be severe. Consequently, new land development should therefore be restricted or prohibited. However, where conditions are not as severe, some types of development and land use may occur safely provided certain terms and conditions apply. Flood plain management is undertaken by implementation of a Policy for Flood Plain Management (WRMD, 2014).

The development of land in flood plains has historically taken place in many areas of the Province probably due to a natural tendency for settlers to utilize land that is near bodies of water. Unfortunately, the potential for flooding is often recognized only after it is too late. The basic operating premise of the Policy for Flood Plain Management is that these problems will not materialize if development is regulated.

Under the Canada - Newfoundland Flood Damage Reduction Program, both governments agreed that public funds would not be used or provided for development projects in flood risk areas. To identify these areas, flood risk mapping studies were carried out for flood impacted communities in the Province. Without exception, the main recommendation in each study was that the implementation of proper flood plain management policies would minimize flood risk. The specific flood plain management policy for Newfoundland and Labrador, “Policy for Flood Plain Management”, was first issued in 1996. In 2010, climate change flood plains were added to the policy.

In general, it is the policy of the Department of Environment and Climate Change that flood plains and the buffer zone (a zone of land that is in its natural state and that is intended to separate developed areas from bodies of water to provide basic protection of water resources) be preserved and left in their natural state. Recognizing that this is an ideal that would hinder significant benefits that could be derived from certain development in a flood plain and outweigh all risk of loss, damage or peril, this policy for flood plain management views any application to avail of land in flood risk areas in decreasing order of preference. The policy also takes climate change into consideration.

Any development in an area designated as a flood plain, flood risk area, or climate change flood zone must have prior written approval by the Department. A flood plain is the area around a body of water that water levels will rise above in the case of a 1:100 AEP flood. Development of land in a flood plain is generally discouraged as it both exposes the development to the danger of flooding, and exposes the water body to potential contamination from the development. The reasons for restricting development in flood plains include:

- Preventing loss of life, injury, and other personal hardship;
- Minimizing damage to property, infrastructure, and environment;
- Preventing the degradation of water resources;
- Maintaining a waterway’s flow capacity;
- Minimizing the disruption of day-to-day activity; and
- Minimizing cost to taxpayers.

Any Crown land within a flood plain will not be transferred to any private developer or municipality. Other undeveloped land in a flood plain will be discouraged by zoning regulations, planning around such areas in early stages, and by removing subsidies and other economic incentives or public funding from such areas. Where development in a flood plain has already occurred or is unavoidable, flood proofing measures will be taken to reduce potential damages, and it will be made sure that development does not impede the flow of water. Any renovation or alteration of an existing development in a flood plain that involves increasing the floor area will be considered in the same way as a new development. It is also Department policy to account for a predicted increase in flow due to climate change when considering these situations.

The Department's overall role in flood plain management includes but is not limited to:

- Evaluating applications to develop in flood plains made under Section 48 of the *Water Resources Act*;
- Carrying out hydrotechnical studies, flood risk analyses, and FRM, to the extent possible with the limited funds and resources available;
- Monitoring areas known to be at high risk of flooding in order to provide flood warning and flood status reports;
- Providing the public with material to help reduce flood damage such as flood data, flood risk maps, and guidelines for flood proofing;
- Providing technical expertise and assisting Emergency Services in the event of a flood emergency;
- Flood forecasting using computer models and real time data.

Some specific descriptions related to the policy for flood plain management have been provided below:

3.1. Categories of Flood Plain Development

Although the Department's policy is to preserve the natural state of flood plains, there are some projects that have benefits that outweigh the risk of developing in flood plains and other flood risk zones. Such projects are considered as one of nine categories that are ranked in order of preference to the Department, where higher ranked categories are more likely to be considered acceptable than low ranked categories. The ranked categories, from highest to lowest, are as follows:

1. Temporary alterations in or near a flood plain, or in the water body itself;
2. Non-structural uses such as parks, pastures, or wildlife habitat enhancement;
3. Structures related to use of water resources such as wharves, boathouses, or stormwater discharges;
4. Minor structural projects that only involve soil disturbance such as trails, transmission lines, and roads, given that the grade of the land is unaffected;
5. Other structures where there will be a change in the grade of the land, but no building will be constructed;
6. Industrial uses related to marine shipping or fishing;
7. Other industrial and commercial developments;
8. Institutional developments such as hospitals, senior's homes, and schools;
9. Residential and other institutional development.

3.2. Hydraulic structures

Hydraulic structures are a separate category of development that exists outside the preference ranking. They include structures that are meant to interact with the flow of water such as dams, bridges, dykes, culverts, and canals.

These structures are still subject to Section 48 of the *Water Resources Act* and must be approved by the Department. Hydraulic structures must be designed so that they do not adversely affect a body of water's ability to convey flow, as a reduction of flow capacity can increase flood risk in the surrounding area. Dams impact flow in a body for water by nature, so new areas of flooding and their impacts must be fully assessed by the proponent.

3.3. Types of Flood Plains

Flood plains may be designated as different types such as floodways, floodway fringes, and climate change flood zones. Floodways are areas that will flood under a 1:20 AEP flood event, floodway fringes are areas that will flood under a 1:100 AEP flood event, and climate change flood zones are areas that are predicted to be at risk of flooding when the effects of climate change are considered. The different categories of development may not be permitted or may only be permitted with special conditions depending on the type of flood plain they've been proposed for. The effects of the type of flood plain on the category of development can be seen in **Table 1**.

Table 1: Effects of Flood Plain Type on Development Categories

Category	All Flood Plains***	Where Flood Plains are Designated****		
		Floodway	Floodway Fringe	Climate Change Flood Zone
1	Permitted	Permitted	Permitted	Permitted
2	Permitted	Permitted	Permitted	Permitted
3	Permitted	Permitted	Permitted	Permitted
4	Permitted	Permitted with conditions*	Permitted with conditions*	Permitted with conditions*
5	Permitted with conditions*	Permitted with conditions*	Permitted with conditions*	Permitted with conditions*
6	Permitted with conditions*	Permitted with conditions*	Permitted with conditions*	Permitted with conditions*
7	Not Permitted	Permitted with conditions**	Permitted with conditions*	Permitted with conditions*
8	Not Permitted	Not Permitted	Not Permitted	Not Permitted
9	Not Permitted	Not Permitted	Permitted with conditions*	Permitted with conditions*

* See Section 2.4 for special conditions
** See both Sections 2.4 and 2.5 for special conditions
*** Areas designated by town based on history of flooding
**** Designated areas proofed by the Minister

3.4. Special Conditions for Development

For entries in **Table 1** that are permitted only with special conditions, the following conditions apply in addition to the usual conditions associated with development under the *Water Resources Act*:

- The ground floor elevation of the structure must be above the 1:100 AEP flood level, and above the climate change flood zone where designated;

- The structure must not obstruct or displace any water in a way that worsens flooding for other properties;
- The structure and any associated utilities must be designed and constructed in accordance with the Department's flood proofing guidelines;
- Entrances and exits of the building must be safe to use without hindrance in the event of a flood;
- The facility and site must not be used to store any potential pollutants such as fuels, pesticides, or other chemicals;
- Other conditions which may be appropriate for specific projects that may be included in a permit issued under Section 48 of the *Water Resources Act*.

3.5. Special Conditions for Development in Coastal Areas

There are some cases in coastal areas where a floodway will be at risk of flooding mainly due to effects of the ocean such as extreme high tide and backwater effects, which lead to flood of low flow velocities. Due to the low flow velocities and the desirability of these areas for tourism related developments such as eateries, attractions, and information booths, such developments may be permitted under the following conditions:

- Only a tourism-related structure and its associated utilities are permitted. This does not include accommodations such as motels or hotels.
- The tourism-related structure and its associated utilities would not be eligible for flood disaster compensation.

3.6. Disaster Compensation

Where FRM has been done for a community, the information from the mapping must be incorporated into the municipal plan for the community, if one exists. Zoning for the community must also be done such that different types of flood plains and flood risk zones are restricted to only having permitted types of development.

Where FRM does not exist, communities are encouraged to complete a flood risk map of the area using the Department's standard methods.

If FRM cannot be completed, communities should plan to have a minimum setback distance from bodies of water for any future developments to provide some measure of safety and recognize the potential for flooding.

Any development made in a flood plain or flood risk zone that was done without approval or does not conform to the Department policy will not be eligible for any flood disaster compensation available through the government. Exception will be provided where the development was lawfully established prior to the area being designated as a flood plain.

In the event that victims of a flood are provided compensation through the government, the Department will encourage victims to put the compensation towards relocating rather than rebuilding or repairing property damaged by the flood. If the Department approves of rebuilding or repairing damaged property in a flood risk zone, then the compensation must be put towards appropriate flood proofing measures before anything else. Individuals living or operating businesses in a flood risk area may not have flood insurance available, or may find it prohibitively expensive. Therefore it is recommended by the Department that people in this position implement flood proofing measure and prepare an emergency plan.

4. Flood Monitoring, Forecasting and Alert System

Flooding is a natural event, but often has devastating effects on our lives and properties. These can be minimized by proper planning, real-time monitoring, state-of-the-art flood forecasting and flood alert systems, and appropriate flood control strategies.

The Province has made progress in flood preparedness through the establishment of a provincial flood forecasting center. Precipitation, temperature and flow data are remotely collected from rivers and downloaded to provincial government computers in St. John's in near-to-real-time via satellite. Here, using state-of-the-art technology in hydrologic modelling, hydraulic modelling, and data management, as well as local observations, forecasts of river flows and water levels for up to 72 hours are determined.

This information is used as a part of a "Multi-Barrier Action Plan for Public Safety against Floods" to forecast if a flood is likely to occur. A flood is defined as the situation in which the water levels in the river are going to overtop the riverbanks. If the water levels in the river are forecasted to overtop the riverbanks, this information is relayed to Emergency Services Division (ESD) for appropriate action as may be necessary in a potential flooding situation.

This is shown in **Figure 2** below:

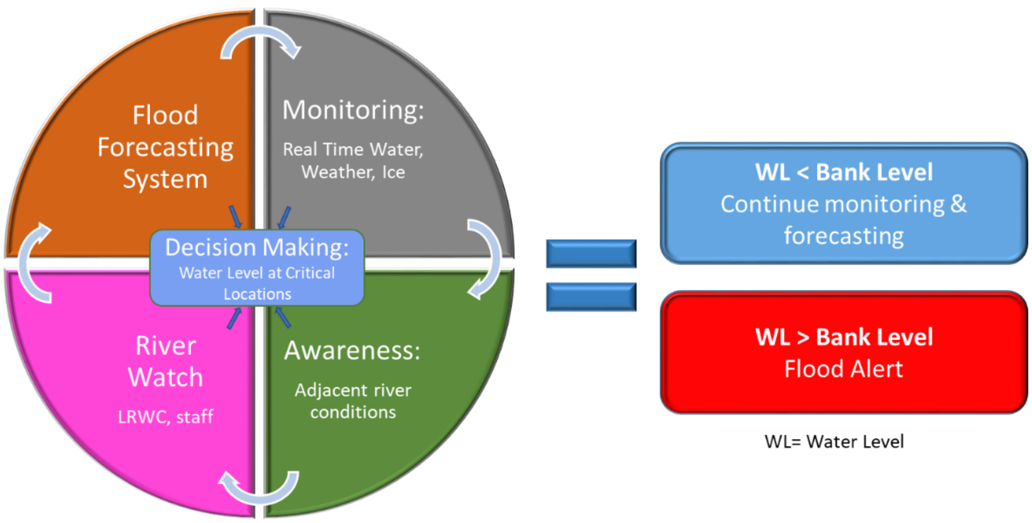

Figure 2: Multi-Barrier Action Plan for Public Safety against Floods

WRMD operates three flood-forecasting systems and two flood alert services:

- Exploits River Flood Forecasting System (Badger Flood Forecasting Service)
- Humber River Flood Forecasting System
- Churchill River Flood Forecasting System
- Hurricane Season Flood Alert System
- Community Forecast Precipitation Alert System

4.1. Exploits River Flood Forecasting System (Badger Flood Forecasting Service)

Flooding has occurred on several occasions at Badger since the early 1900's. The floods are caused by excessive frazil ice formation in the Exploits River due to high winds and low temperatures when the ice front is at or is passing

Badger. This causes an ice jam in the river and in turn causes the river to spill its banks resulting in a flood. The ice cover forms near Grand Falls and travels upstream to Red Indian Lake.

WRMD has carried out river flow monitoring and flood forecasting for Badger since the 1977 flood. A computer simulation model called the “Ice Progression Model” currently used by the Division for flood forecasting was developed to simulate ice conditions on the Exploits River. This model was developed as part of the study “Hydrotechnical Study of the Badger and Rushy Pond Areas (Fenco Newfoundland, 1985)” and further refined in the study “River Ice Modelling Study Exploits River at Badger (Fenco MacLaren, 1995)

The Badger Flood Forecasting Service is initiated in December of each year and extends until the end of March or until it is confirmed the ice cover no longer poses a threat of flooding to the Town.

The Ice Progression Model calibration was quite often difficult since there were only a few vantage points on the riverbank where ice observations could be made. Ice observation was enhanced in a major way by the use of space satellite based RADAR imagery starting in 2003. The accurate location of the ice front reduces the uncertainty associated with the timing of the flood. The use of RADAR imagery for accurate location of the ice front represents a major improvement in the flood forecast capability for the residents of Badger. The RADAR images have proved themselves to be absolutely essential to the successful ice progression modelling and calibration effort.

From December 2003 to March 2008, the WRMD obtained satellite RADAR imagery from the ENVISAT and RADARSAT polar orbiting satellites. This RADAR imagery service was provided by C-CORE under the Polar View initiative of the European Space Agency’s Global Monitoring for Environment and Security (GMES) program. These RADAR Images were used in an operational sense to determine the location of the ice front. The utility of RADAR imagery for ice observation provided several important advantages over volunteer observations and / or optical imagery. RADAR offers: a “big picture” view, all weather operation (sees through rain, snow and fog), and twice daily observations if needed. Before December 2003, ice observations were limited for the most part to volunteer observations made by Town officials and paper mill staff.

Since December 2008, the WRMD has also been able to access RADAR imagery from RADARSAT-2, the world’s most advanced commercial C-Band synthetic aperture radar satellite. This has been made possible through a partnership with the Government of Canada. As part of its responsibilities under the Emergency Management Act, Public Safety Canada coordinates the Government of Canada’s emergency management activities with the provinces and territories, and provides support to provincial and territorial emergency management activities. Through a Memorandum of Understanding with the Canadian Space Agency, Public Safety Canada has established protocols that are successfully enabling the WRMD to work in concert with the Government Operations Centre to use RADARSAT-2 data for river ice monitoring. The continuing success of this new partnership will provide the WRMD with world class data to meet its emergency management needs.

A new flood forecasting system is under development. The new flood forecasting system will use a hydrological model runner (HEC-HMS), and a river ice model (RIVICE), in a HEC-RTS environment, to simulate possible ice-jam backwater and open water levels, for the next three days. The Ice Progression Model will also be used in parallel.

More information on the Exploits River hydrometric, climate and snow monitoring stations, the satellite imagery and the flood forecasting is available at https://www.gov.nl.ca/ecc/waterres/flooding/badger/

4.2. Humber River Flood Forecasting System

Since the early 1900’s, communities, including Deer Lake and Steady Brook, have developed along the Humber River. Every year some flooding occurs along the Humber River, while usually minor, the potential for significant flooding exists, as occurred in 1969 and 1981.

Flood risk mapping studies for the communities of Deer Lake and Steady Brook were carried out under the Canada-Newfoundland Flood Damage Reduction Program in the late 1980’s. These studies analyzed causes of previous floods, defined flood events a return period of 20 years (5% chance in any year) and 100 years (1% chance in any year), considered remedial measures, and produced flood risk mapping. These studies have been updated in 2020 through the National Disaster Assistance Program.

Generally, flooding along the Humber River is a result of the combined effects of precipitation and snowmelt, occurring during the spring-runoff period. The WRMD operates a flood forecasting service during the period. When a flood forecast is greater than the defined flood event, there is a potential for flooding. When the potential for flooding exists, the WRMD informs ESD and the communities situated along the Humber River for appropriate action. Currently, the WRMD operates two flood forecasting models, a dynamic regression (DR) model and a neural network (NN) model.

For the last number of years, the Humber River flood forecasting model operated by the WRMD was the DR model. The DR model, which was developed in-house, uses a number of observed hydrometric and weather parameters to stochastically forecast river flows for up to three days. In 2009, the NN model was developed for the WRMD. The model does not require any forecast weather parameters and accounts for snowmelt through the degree-day parameter. The NN model is capable of forecasting one-day flow.

Both the DR and the NN models have divided the Humber River into three reaches coincident with the hydrometric stations: the Upper Humber Above Black Brook, Upper Humber Near Reidville, and Humber River At Humber Village Bridge. Documentation outlining the DR and NN flood forecasting models is available, through the links below;

DR-https://www.gov.nl.ca/ecc/files/waterres-flooding-picco-1997-dynamicregressionmodel-humber.pdf

NN - https://www.gov.nl.ca/ecc/files/waterres-flooding-cai-2009-neuralnetworkmodel-humber.pdf

A new flood forecasting system is under development. The new flood forecasting system will use a hydrological model (HEC-HMS) and a hydraulic model (HEC-RAS), in a web based HydrologiX environment, to simulate open water levels, for the next three days. More information on the Humber River hydrometric, climate and snow monitoring stations and the flood forecasting is available at https://www.gov.nl.ca/ecc/waterres/flooding/humber/

4.3. *Churchill River Flood Forecasting System*

The Churchill River in Labrador is susceptible to flood risks arising from climatic conditions that can result in the impedance of water flow due to ice formation and breakup. A recent ice related flood event in 2017 that affected the communities of Happy Valley – Goose Bay and Mud Lake led to the Government of Newfoundland and Labrador to initiate a project to identify the flood risks and implement a flood forecast system to provide early warning to water resource engineers and the communities.

As one of the first fully operational ice-jam flood forecasting systems in Canada, the Churchill River Flood Forecasting System was developed and operated by the Government of Newfoundland and Labrador to forecast real-time ice-jam floods along the lower Churchill River in Labrador, Canada. The system consists of a hydrological model (HEC-HMS), a hydraulic model (HEC-RAS) and a river ice model (RIVICE), in a web based HydrologiX environment, to simulate possible ice-jam backwater and open water levels, for the next three days. The model is embedded in a Monte-Carlo framework to provide ensembles of backwater level profiles, from which exceedance probabilities are derived. A hydrological model of the basin upstream of the Churchill River's lower reach forecasts the runoff used as an upstream boundary condition for the river ice model.

Space-borne remote sensing imagery provides an indication of the remaining extent of the ice cover along the reach upstream of the potential ice-jamming stretch. This provides an estimate of the volume of ice that is available to form jams. All data acquisitions and feeds and model runs are fully automated and synchronized to provide daily forecasts of the ice-jam flood hazard, always three days ahead of time. The model was tested successfully for the spring 2019 and 2020 breakup event.

More information on the Churchill River hydrometric, climate and snow monitoring stations, the satellite imagery, ice thickness monitoring and the flood forecasting is available at https://www.gov.nl.ca/ecc/waterres/flooding/lc-flood-warning/

In an ongoing research project with Defence Research and Development Canada (DRDC) a Community Flood Risk Awareness Index Model is being researched and developed for the CRFFS. The Community Flood Risk Awareness Index Model will be based on developing a Multi-Criteria Decision Analysis Model. It is modeling process that involves the ranking and weighting of factors that would lead to identifying the impact of flooding to the community such as the flooding of important roads or could be aggregate to a geographic areas such as the catchment. It will improve WRMD's ability to determine, evaluate and communicate the flood hazard and exposure to residents of Mud Lake and Happy Valley-Goose Bay.

4.4. Hurricane Season Flood Alert System

In Newfoundland and Labrador, floods in the fall of the year are the most costly in terms of flood damages. Below is a graph with a seasonal breakdown of Disaster Financial Assistance Arrangements (DFAA) Damage Estimates. As illustrated in **Figure 3**, the fall events result in the greatest dollar value flood damages.

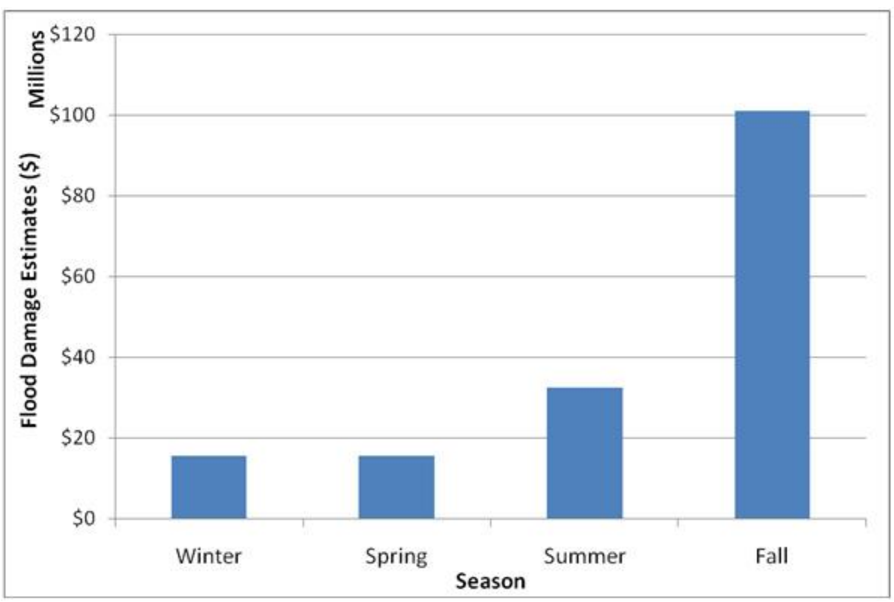

Figure 3: Seasonal flood damage estimates (million dollar)

Season	Flood Damage Estimates ($)
Winter	$15,530,308
Spring	$15,589,602
Summer	$32,388,278
Fall	$101,014,638

Flooding in the fall is typically caused by weather systems that originate as hurricanes. The damage path from hurricane based weather systems is typically widespread as was observed for Hurricane Igor in 2010. Flooding from such weather systems is expected to get worse with climate change.

The Hurricane Season Flood Alert System (HSFAS) is designed to provide 72 hours advance warning to communities impacted by weather systems that originate as hurricanes. It helps communities in the Province prepare for storms and avoid future high-cost expenditures in repairs and damages. This is also a climate change adaptation tool as floods, public safety and climate change are integrally linked.

The HSFAS is based on forecasted precipitation amounts and seeks to provide communities with flood warning services as a key climate change adaptation and public safety tool. Alerts are provided to 45 communities/areas that have FRM studies or have published intensity-duration-frequency (IDF) curves from which precipitation based flood triggers can be derived. For every community, the HSFAS tracks all weather systems 72 hours ahead and generates flood alerts during the peak hurricane months of June to December. Since 2014, all FRM studies are used by the HSFAS to derive precipitation based flood triggers.

The HSFAS Alerts are based on site specific weather forecasts that are generated by WOOD as a result of examining many of the available models from Environment Canada, the US National Oceanic and Atmospheric Administration, and WOOD's in-house implementation of the Weather and Research Forecast model. Examining maximum precipitation predictions from different dynamic models allows WOOD to produce a better forecast of the maximum precipitation potential based on the strength of different models in handling the atmospheric physics of differing weather patterns. Furthermore, WOOD also examines the various model precipitation outputs within a given radius of each community/area. This allows WOOD to identify potential flood situations where a particular model may have accurately modeled precipitation amount or identified a flood situation but erred in the placement of its location.

The WRMD correlates the HSFAS Alerts from Wood with a percentile ranking of current streamflow conditions. This information is sent to ESD who then alert the affected communities and coordinate responses.

The HSFAS Alerts and percentile ranking of current streamflow conditions are available at https://www.gov.nl.ca/ecc/waterres/flooding/hurricane/

4.5 Community Forecast Precipitation Alert System

The Community Forecast Precipitation Alert System (CFPAS) uses weather predictions for the next 72 hours from Environment and Climate Change Canada's (ECCC) 72-hour Regional Deterministic Prediction System (RDPS) and compares them to the 20 yr and 100 yr 12 hr and 24 hr precipitation levels from our flood risk studies and Intensity Duration Frequency Curves.

The CFPAS works in the same way as the HSFAS and covers the same communities except that the precipitations amounts are not revised and adjusted by a live human meteorologist. For the HSFAS the predictions need to be reviewed and adjusted by a live human meteorologist due to the properties of post tropical storms. CFPAS uses the raw forecast from ECCC RDPS instead.

It operates from January 1 to June 1 when the HSFAS is not active. WRMD correlates the CFPAS Alerts with temperature forecasts. This information is sent to ESD who then alert the affected communities and coordinate responses.

5. Flood Prevention and Mitigation

For properties located within a flood plain, the impact of flooding can be reduced or mitigated using appropriate flood proofing measures. Flood proofing is any combination of structural or non-structural changes to buildings or utilities (e.g. Power or sewer lines) that reduces or eliminates damage caused by floods.

Under the Flood Damage Reduction Program a booklet was prepared to help property owners select the most appropriate flood proofing methods for their needs. This is available at https://www.gov.nl.ca/ecc/files/waterres-flooding-floodproofing-protect-your-home-against-flooding-.pdf

Flood proofing methods can be classified as being

1. Preventive flood proofing or Corrective flood proofing
2. Dry flood proofing or Wet flood proofing
3. Permanent flood proofing, Contingency flood proofing, and Emergency flood proofing

Preventive flood proofing measures are more economical than corrective ones because they are applied during the construction of the building. Corrective measures are applied to existing structures, and are still a viable means of reducing flood damages.

Dry flood proofing is preferred by most property owners because the contents of the building are kept dry and there is no need for a cleanup. Wet flood proofing minimizes potential damage by allowing water into the building. Having water inside and outside the building equalizes the water pressure on the walls and floors, and in most cases, results in less structural damage.

Permanent flood proofing measures are usually more effective in reducing flood damages in areas prone to frequent or flash flooding. Always in place, these measures should also be considered for any flood prone area. Some measures include elevation on fill, elevation on piers and columns, installation of closures and sealants on doors and windows, and construction of dykes and berms. Dykes and berms can be used as permanent flood proofing measure, but these should be the last resort as there are various maintenance issues associated with dykes and berms. If dykes and berms are required for certain areas, economic analysis and engineering design analysis have to be conducted before the implementation.

Contingency flood proofing measures are best suited to areas where the depth or risk of flooding is not too great. Contingency flood proofing measures are put into place immediately before the flood, and restrict building access and use for the duration of the flood. These measures are designed to keep floodwaters out, and include such techniques as flood shields, watertight doors and wet flood proofing. These measures are often used in areas where sufficient warning time is provided by flood forecasters or emergency officials to allow flood proofing fixtures to be installed.

Emergency flood proofing measures are most effective in areas expected to have a shallow water depth and a slow rate of water rise during a flood. Emergency flood proofing measures are put into place on short notice. The techniques commonly used involve building dykes or barriers using whatever natural or stored materials may be on hand at the site. Although this work is generally inexpensive, it is hard work and requires a pre-determined plan of action to ensure materials, labour and equipment are available at the time of flooding.

More details on these flood proofing measures are in the flood proofing booklet available at https://www.gov.nl.ca/ecc/files/waterres-flooding-floodproofing-protect-your-home-against-flooding-.pdf

To assist with selection of flood proofing measures, since 2013, all FRM studies require the production of inundation mapping (**Figure 4**) that shows the depth of flooding for 1:20 AEP and 1:100 AEP flood events.

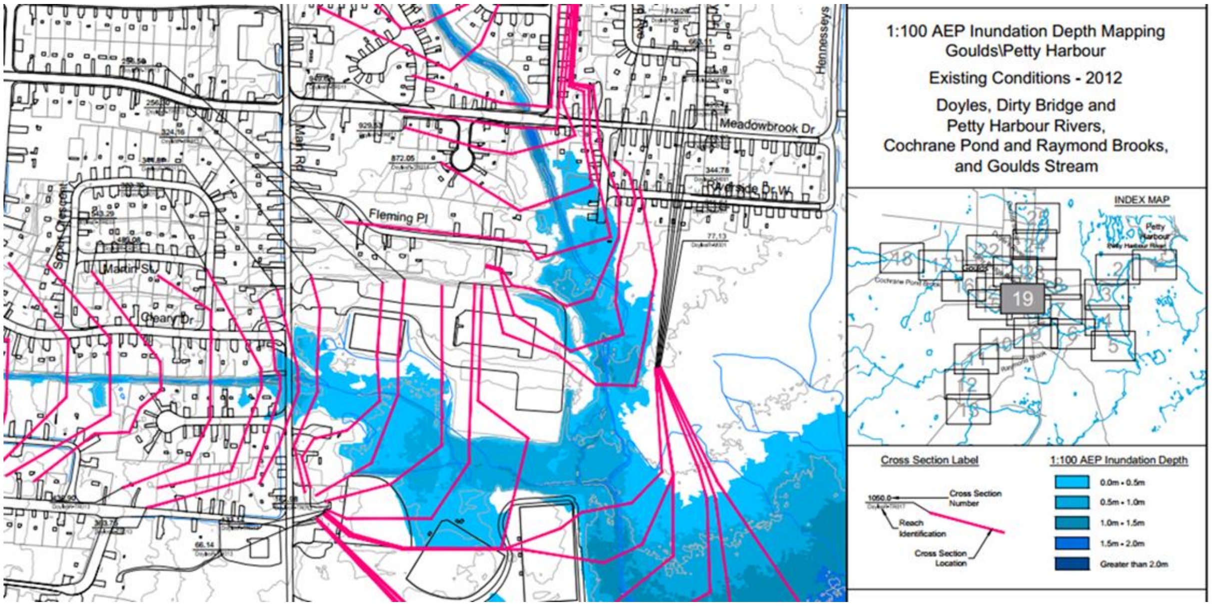

Figure 4: Inundation mapping

6. Emergency Response

In Newfoundland and Labrador, the WRMD provides flood alerts to the Department of Justice and Public Safety – Emergency Services Division (ESD). The ESD then facilitates the dissemination of this information to the impacted municipalities and subsequently coordinates the provincial government's response to assists municipalities – if required.

The ESD is tasked with the implementation of an emergency management strategy designed to develop and maintain a modern and robust emergency management system in the Province, in collaboration with agency partners and stakeholders, in planning against, preparing for, responding to and recovering from emergencies, disasters and fires.

The ESD works toward assisting citizens, communities, partners and governments in preparing to deal with, respond to and recover from fire, emergencies, and disasters to protect the Province's people, environment and property when municipal resources are exhausted. The ESD ensures that all needed agencies are providing the needed support.

The ESD also administers the federal government's Disaster Financial Assistance Arrangements (DFAA) when the Government of Newfoundland and Labrador authorizes a provincial disaster financial assistance program (NL-DFAP) in response to a specific emergency or adverse weather event. This program provides financial assistance related to disaster recovery in accordance with the federal DFAA guidelines for eligible events. More information related to the ESD is available at https://www.gov.nl.ca/jps/

The WRMD works with the ESD to provide flood situation updates and provide expert opinion pertaining to water resources issues. If a Community level Emergency Operation Centre is set up to address a flood situation, WRMD participates as a subject matter expert.

To assist with flood response, since 2013, all FRM studies include flood hazard mapping (**Figure 5**) associated with the 1:20 and 1:100 AEP flood events for current climate and current development conditions based on velocity and depth of flooding.

The flood hazard mapping is based on a classification presented by Mercedes Uden (Royal Haskoning) and Hamish Hall, (Royal Haskoning) at the National Hydrology Seminar 2007: GIS in Hydrology.

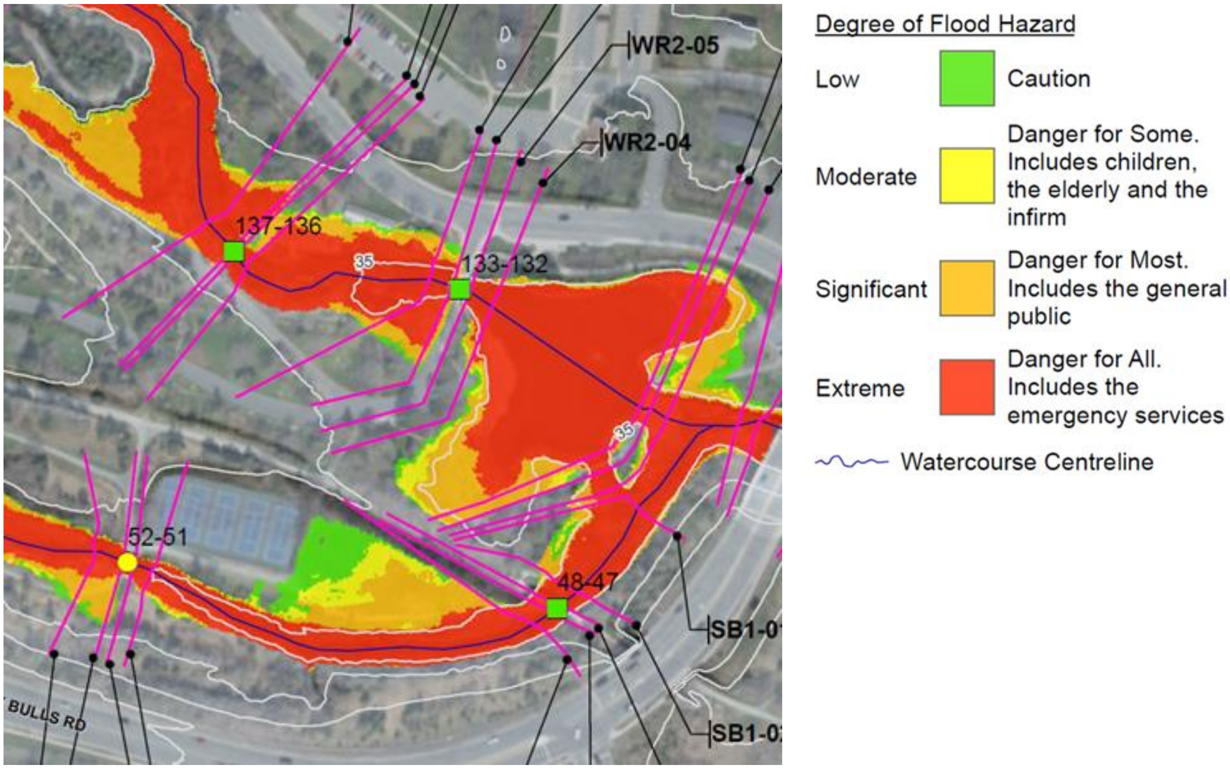

Figure 5: Flood hazard mapping

7. Climate Change Adaptation

Climate change is a critical issue for Newfoundland and Labrador. As a large coastal province with over 90% of the population living along the coastline, Newfoundland and Labrador is exposed to many long term impacts of climate change including sea-level rise, more extreme precipitation events and storm surges, greater coastal erosion, and volatile changes in seasonal weather patterns.

Due to climate change, the frequency and intensity of extreme precipitation events (such as hurricanes) that result in flooding are expected to increase. Climate change altered precipitation patterns will result in new communities experiencing regular floods and communities with existing flooding issues experiencing more intense and extensive flooding incidents. To help support climate change adaptation, the FRM studies are being updated and new ones undertaken using climate change projections. In 2010, the Province included a climate change flood zone in its “Policy for Flood Plain Management” becoming the first Province to integrate climate change into flood plain management policy. All developments in the Province have to be in compliance with the Provincial Policy for Flood Plain Management.

Since 2009, the WRMD has created a new template for integrating climate change into FRM. In addition to a traditional depiction of 1:20 and 1:100 AEP flood lines, this new template or series of steps made it possible to show the effect of climate change on flood zones. Since 2013, all FRM studies use standardized climate change scenarios and corresponding climate change IDF’s from the Province’s most current climate change atlas. The use of standardized climate change scenarios ensures that all climate change scenarios used are relevant to the Province’s climate change adaptation action plan. Since then, all FRM studies are required to address sea level rise for climate change adaptation. Consequently, the climate change condition has to include both precipitation increase and sea level rise.

Since 2015, all FRM studies also account for future land use in determining the climate change flood zone. The future land is captured from the municipalities development and land use plan and is screened in consultation with the municipal council to ensure only likely future development scenarios are included. After flood plain designation, the communities/municipalities have to incorporate designated 1:20 AEP and 1:100 AEP existing climate condition flood risk zones as well as 1:100 AEP climate change flood risk zone into their municipal development plan and land use planning.

Since 2010, all FRM studies in Newfoundland and Labrador require a detailed hydraulic capacity assessment of all existing hydraulic structures for the current and climate change flood flows. This helps the provincial government and municipalities identify which structures have inadequate capacity for current and climate change conditions and helps prioritize infrastructure upgrades supporting flood prevention and mitigation.

8. Local Participation, Collaboration, and Communications

Local participation, collaboration, and communication are important components in flood management strategies. FRM studies are only undertaken on request from municipalities. Municipalities agree to implement the Policy for Flood plain management if their community is selected for FRM.

The FRM is undertaken in collaboration with the municipalities. Municipalities provide a detailed history of their flooding and flooding issues to the consultant and they review the mapping before it is released.

Section 48 permits for development in flood plains are issued only after receiving an approval from the municipality. Section 48 permits are publically available at https://www.gov.nl.ca/ecc/waterres/permits/water-alt/

Where flood forecasting is undertaken, the community provides local observations and feedback. The Local River Watch Committee comprising of residents of both Happy Valley – Goose Bay and Mud Lake is an example of such local participation and communication.

9. Conclusion

The main goals of the Province's flood management strategy are to reduce the human hardship and economic loss associated with floods. The Government of NL is committed to achieving these goals. While the government is responsible for implementing a provincial flood management strategy, all related departments, agencies, organizations, stakeholders, public, and media cooperate to improve the effectiveness and efficiency of the flood management strategy. The expected outcome of the implementation of this provincial flood management strategy is minimizing the flood hazard to human life, communities, and the environment.

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Appendix 1: Comparison of Flood Management across Canada

Introduction

Flood risk management is an essential tool and aims to reduce the risk from flood events to people who are located in flood prone areas. The current state of flood management in different provinces (ten provinces and three territories) across Canada are compared and summarized in **Table 2**.

The major components compared include:

a) if there are flood management strategies available
b) if there are flood management studies conducted
c) if there are the provincial flood standards
d) who or what department is in charge of approval of development
e) if there are flood risk mappings available
f) if climate change effects are considered for flood risk mapping
g) standards for floodway and flood fridge
h) if there are provincial level flood management policies

TABLE 2. COMPARISON OF PROVINCIAL FLOOD MANAGEMENT ACROSS CANADA

Jurisdiction	National (NRCAN)	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Flood management strategy		Lower mainland (2016); Richmond (2019)	Calgary's Flood Resilience Place (2022); Calgary's Flood Resilience Plan (2019); Resilience and Mitigation Framework for Alberta Floods (2013)	N/A	Manitoba Flood Coordination Plan (2019)	Ontario's Flooding Strategy (2020) Flood; Contingency Plan (2019); Ontario Urban Flooding Collaborative Action Strategy (2018)	N/A
Flood management study (case studies/reports)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Flood standard/guideline		-200-year return period or flood of record (Fraser River) - 50-year return period for agricultural land - Freeboard 0.3 m on design peak daily flow and 0.6 m on mean daily design flow (under review)	-100-year return period or flood of record - Flood Hazard Identification Program Guidelines - Flood Hazard Study Management Framework - Calgary: 1:200 - 1:1000 AEP event	500-year return period	- 100-year return period design flood or flood of record - Winnipeg - 1:160 AEP design flood - The Province is expected to amend the standard to a 1:200 AEP flood event.	Varies across the Province: - Hurricane Hazel & Timmins Storm (approx. runoff is 3-5x greater than peak of 1:100 AEP storm); - 1:100 AEP; - or historical/flood of record > 100 year if applicable/approved - Great Lakes Coastal flooding 1:100 +wave uprush (in some	- No published standard - 2007 working document refers to 1: 100 AEP and 1:20 AEP

						areas other criteria may be applicable)	
Approval of development		-Local or Regional Authority -Ministry of Highways in rural areas -No prohibition of development in flood plain as long as FCL met	Local municipality regulates development in designated area within flood fringe	Local government zones and regulates development in designated areas	- Province for Designated Flood Areas: Red River Valley and Lower Red River - Local government and municipalities responsible for other parts of the Province -Land designated under Planning Regulation	Provincial Policies: set high level policies for Flood plains - Municipalities policies to be consistent with Province - Land use policies and zoning set by municipality - Construction/grading to watercourses - Conservation Authority permit and may require municipal approval	Maps implemented through interim control by-law or municipal by-law
Jurisdiction		British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
Flood Risk Mapping	Federal Flood Mapping Framework .pdf	Yes	Yes	Yes (e.g. Moose Jaw; Prince Albert)	Yes	Yes	Yes
Climate change studies on flood risk mapping		Yes (Surrey; Fraser River and Coast)	Flood likelihood maps illustrate cumulative flood risk over 30 years – "Likelihood" is a map layer on the province's flood mapping tool	N/A	N/A	Yes	N/A
Floodway/Flood fringe	In Canada, the Floodway is often defined as having a flood depth above 1 meter and flood	One zone: - Designated Flood Zone (1:200 AEP) - Flood Construction Level	Two zone: - Floodway (no development) - Flood Fringe (development	Two zone: - Floodway (no development) -Flood Fringe (development	Allows development if flood proofed to the higher of 1:100 AEP or flood of record	Floodway/Flood Fringe - definitions in technical guideline (MNRF) and	- Low Velocity Zone (20-100 year) - High Velocity zone (1:20 AEP or less)

	velocity greater than 1 meter per second In Canada, the Flood Fringe Area is often defined as having a flood depth below 1 meter and a flood velocity less than 1 meter per second.		permitted with flood proofing) 0.5 m minimum freeboard	permitted with flood proofing) 0.5 m minimum freeboard	- Floodway is >1m flood depth - References to development to be protected to a level of 0.67 meters of freeboard above a 1:100 AEP flood level	Provincial Planning Policy (MMA) - One Zone (floodway - no or very limited development) - Two Zone (floodway – no development or limited to some uses and - Special Policy Areas (SPA), very limited urban areas where risks are assessed and development is permitted subject to criteria	-Special Planning Zone
Flood plain management policy (Provincial level)		Flood Hazard Area Land Use Management Guidelines	FLOOD RISK MANAGEMENT GUIDELINES FOR LOCATION OF NEW FACILITIES	No specific policy, but mentioned some in: Land Use Planning and Flood Management	No specific policy, but mentioned some in: Provincial Planning Regulation	No specific policy, but mentioned some in: 2014 Provincial Policy Statement, Under the Planning Act	No specific policy, but mentioned in: Protection Policy for Lakeshores, Riverbanks, Littoral Zones and Flood plains

Table 2 Comparison of Provincial Flood Management across Canada (continued…)

Jurisdiction	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Yukon	Northwest Territories	Nunavut
Flood management strategy	New Brunswick's Flood Risk Reduction Strategy (2014)	N/A	N/A	Newfoundland and Labrador Flood Management Strategy	N/A	N/A	N/A
Flood management study	Yes. e.g. Sensitivity Analysis of Flood Damage Estimates: A Case Study in Fredericton, New Brunswick	Yes e.g. Flood risk assessments (Halifax regional 2018)	Yes e.g. Nova Scotia Flood Mitigation Framework	Yes	Yes e.g. Dawson City region (2010)	N/A	Yes
Flood standard/guideline	- Floodway 20-year - Flood Risk Area 100-year or flood or record (Floodway plus Flood Fringe) - NB Flood Reduction Strategy	- Floodway 1:20 AEP - Flood Fringe 1: 100 AEP	- No standard or regulations exist but limited coastal mapping identifies 1:10, 1:25, 1:50, 1:100 AEP flood elevations for 2050 and 2100 with storm surge - For new developments a coastal hazard assessment is required - Moving to Watershed-based approach	- Floodway (1:20 AEP Zone) - Flood Fringe (1:100 AEP Zone) - Climate Change Flood Zone added to Policy for Flood Plain Management in 2010	N/A	- FDRP maps used 1:100 AEP as minimum	N/A
Approval of development	Local municipality regulates development in designated area within flood risk area - Existing development can be flood proofed.	Areas within flood fringe can be permitted if flood proofed except important infrastructure like hospitals	-Local municipalities responsible for approvals and flood bylaws etc. but only 10% of land mass covered -90% of land approvals still under Government approval authority	Permitted and non-permitted developments in all flood plains are specified and subject to the Province's legislation and policies.	Local Authority	Communities can elect to use the mapping or not use it.	N/A
Jurisdiction	New Brunswick	Nova Scotia	Prince Edward Island	Newfoundland and Labrador	Yukon	Northwest Territories	Nunavut

Flood Risk Mapping	Yes	Yes	Yes	Yes	N/A	N/A	N/A
Climate change studies on FRM	Yes (Moncton, 2011, 2013)	Yes (Halifax, 2009)	Yes	Yes	N/A	N/A	N/A
Floodway/Flood fringe	Two zone: - Floodway (no development) - Flood Fringe (development permitted with floodproofing) - 0.5 m minimum freeboard	Two Zone: Floodway and Flood Fringe	No floodway or flood fringe used but 15 m buffer applies to river and coastal flood plains majority of which are undefined	Three zones: - Floodway (1:20 AEP Zone) - Flood Fringe (1:100 AEP Zone) - Climate Change Flood Zone	N/A	Province - desktop exercise used FDRP mapping to create floodway (> 1m depth) and flood fringe.	N/A
Flood plain management policy (Provincial level)	Proposed provincial policy for development on flood plain	No specific but included in: Statements of Provincial Interests	N/A	Policy for Flood Plain Management	N/A	N/A	N/A

Appendix 2: Comparison of Flood Management Strategies across Canada

From **Table 2**, it seems that only five provinces have their own flood management strategies (or contingency/resilience/coordination plans related to flood management). For comparison purposes, several key components among the 5 different flood management strategies are summarized in **Table 3**.

TABLE 3. COMPARISON OF FLOOD MANAGEMENT STRATEGIES ACROSS CANADA

Jurisdiction	British Columbia	Alberta	Manitoba	Ontario	New Brunswick
Flood management strategy	Two strategies from two regions: 1:Lower mainland (2016); 2:Richmond (2019)	No flood management strategy, but have: 1: Calgary's Flood Resilience Plan (2019); 2: Resilience and Mitigation Framework for Alberta Floods (2013)	Manitoba Flood Coordination Plan (2019)	No flood management strategy, but have: 1:Flood Contingency Plan (2019); 2: Ontario Urban Flooding Collaborative Action Strategy (2018)	New Brunswick's Flood Risk Reduction Strategy (2014)
Flood hazard identification	1 Yes (phase 1- P1*, P2*) 2 Yes	1 N/A * 2 Yes	Yes	1 N/A 2 N/A	Yes
Monitoring, evaluation, analyze and forecast, alert/warning	1 Yes (phase 1- P1*, P2*) 2 Yes	1 N/A 2 Yes	Yes	1 Yes 2 Yes	Yes
Review of current policies, plans, and practices	1 Yes 2 Yes	1 Yes 2 Yes	Yes	1 Yes 2 Yes	N/A
Policy/Strategy/management for Land use, dyke, infrastructure, construction	1 Yes 2 Yes	1 Yes 2 N/A	Yes	1 N/A 1 Yes	Yes
Cost estimate and Cost-sharing	1 Yes 2 Yes	1 Yes 2 Yes	N/A	1 N/A 2 N/A	Yes
Jurisdiction	British Columbia	Alberta	Manitoba	Ontario	New Brunswick
Collaboration	1 Yes (two committees: leadership, advisory) 2 Yes	1 Yes 2 Yes	Yes	1 Yes 2 Yes	Yes
Local participation and Response	1 Yes (Phase 2) 2 Yes	1 N/A 2 Yes	Yes	1 Yes 2 Yes	Yes
Communication	1 Yes	1 Yes	Yes	1 Yes	Yes

	2 Yes	2 Yes		2 Yes	
Prevention and Mitigation options	1 Yes (Phase 2) 2 Yes	1 Yes (e.g. dam gate upgrade; flood barriers; drainage improvement; building new reservoirs) 2 Yes	Yes	1 Yes 2 Yes	Yes
Climate change adaptation	1 Yes 1:500 2 Yes 1:500 (e.g.1m of sea level rise to year 2100; 2m to year 2200)	1 Yes (1:1200 event) 2 N/A	N/A	1 N/A 2 N/A	N/A
Recommendation	1 Yes (Phase 2) 2 Yes	1 Yes 2 N/A	Yes	1 Yes 2 N/A	Yes
Remarks	1 Not a systematic strategy (different projects based management strategy); Establishing the Lower Fraser Flood plain Model	* Alberta has the flood hazard mapping system (not included in the resilience plan)		1 focus on flood resilience 2 mainly focus on urban flooding. The cause: overwhelmed stormwater and wastewater systems creating urban flooding	Objective ➔ challenges➔desired outcomes ➔ actions to achieve

.

Appendix 3. Prioritization list for Flood Risk Mapping

TABLE 4. PRIORITY LIST FOR CLIMATE CHANGE FLOOD RISK MAPPING STUDIES

Number	Area of Study	Year	AutoCad	Shapefile	Need for New FRM
1	Virginia River, Holes-in-Marsh Brook, Outer Cove Brook, Kitty Gail Brook, and Mundy Pond Brook in the City of St. John's	-	-	-	5
2	Baie Verte	-	-	-	5
3	Springdale	-	-	-	5
4	Indian Bay	-	-	-	5
5	Centreville-Wareham-Trinity	-	-	-	5
6	Dover	-	-	-	5
7	Rushoon	1986	Yes	No	1 & 2
8	Cox's Cove	1988	Yes	No	1 & 2
9	Parson's Pond	1988	Yes	No	1 & 2
10	Glenwood-Appleton	1989	No	No	1, 2, & 3
11	Glovertown	1989	No	No	1, 2, & 3
12	Codroy Valley Area	1990	No	No	1, 2, 3, & 4
13	Trout River Area	1990	No	No	1, 2, & 3
14	Shoal Harbour	1995	Yes	No	1, 2 & 4
15	Hodges Cove	1995	Yes	No	1,2 & 4
16	Hickmans Harbour	1995	Yes	No	1 & 2
17	Whitbourne	1996	Yes	No	1 & 2
18	Heart's Delight	1996	Yes	No	1 & 2
19	Winterton	1996	Yes	No	1, 2, & 4
20	Hant's Harbour	1996	Yes	No	1, 2, & 4
21	Ferryland	1996	Yes	No	1, 2, & 4
22	Kippens	1996	No	No	1, 2, 3 & 4
23	Brigus	1997	No	No	1, 2, & 3
24	Stephenville	2009	Yes	Yes	1 & 4

Note:

1. The current FRM is older than 10 yrs.
2. There are no Climate Change Flood Zones.
3. The previous FRM is not available in a digital format.
4. New areas need to be added to the FRM.
5. The community has requested for FRM in writing.

Priority Communities for Flood Risk Mapping