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CLIMATE CHANGE AND THE PREPAREDNESS OF CANADIAN PROVINCES AND YUKON TO LIMIT POTENTIAL FLOOD DAMAGE

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PARTIE 2 – ARTICLE COMPLET

1. INTRODUCTION

Purpose of the Report

The purpose of this report is to profile key findings from a survey administered to 10 Canadian provinces and Yukon to assess their preparedness to limit potential flood damage relative to current (2016) and future (2030) major precipitation events.

Background

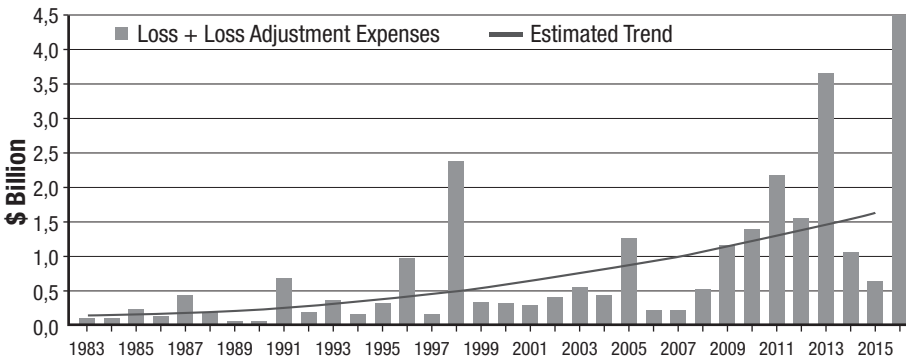
As of December 2015, Canada and 194 other countries reached the Paris Agreement, which intends to limit the rise in the global average temperature to well below 2°C (relative to the pre-industrial benchmark), with an aspirational goal to limit warming to 1.5°C.¹

The Paris Agreement also recognizes that all levels of society have a role to play in responding to climate change, including government, citizenry and business. Both climate mitigation and adaptation actions are recognized as critical components of the agreement. Specifically, the signing parties made a commitment to adapt to current and future climate change impacts through enhancing adaptive capacity, strengthening resilience and reducing vulnerability.²

As noted by the Office of the Auditor General of Canada, climate change scientists expect severe weather events to become increasingly more frequent and intense in the coming years. This will have significant physical, social and economic impacts, resulting in long-term costs and disruption of everyday life.³ The federal government spent more on recovering from large-scale natural disasters over the past six years, than in the previous 39 years combined.⁴

The increasing costs of extreme weather to the Canadian economy can also be seen in the rise of catastrophic insured losses from natural disasters (Figure 3). As per the Insurance Bureau of Canada, “payouts from extreme weather have more than doubled every five to 10 years since the 1980s. For each of the past six years, they have been near or above \$1 billion in Canada.”⁵

FIGURE 3 *Catastrophic Insured Losses From Natural Disasters in Canada (1973-2016)*



2016 figures are preliminary
 Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte
 Values in 2015 \$ CAN"

Floods Threaten Economic Competitiveness

The cause of the majority of these insured catastrophic losses is water-related damage. For example, costs of the 2013 flooding in Alberta were estimated at more than \$6 billion, including \$1.9 billion of insurable losses.

Accordingly, climate-related risks, including flooding, have been found to pose a threat to the global financial system. These risks have been recognized by major global economic organizations, including the Financial Stability Board (an international body that monitors risk in the global financial system), the G20 (a group of 20 major economies), the Organization for Economic Co-operation and Development, and others.⁶

The Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework) adopted by the United Nations Member States (includes Canada) recognizes four priorities for action in addressing catastrophic events: 1) understand disaster risk; 2) strengthen disaster risk governance to manage disaster risk; 3) invest in disaster risk reduction for resilience; and 4) enhance disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction. Specifically, the need to strengthen disaster preparedness for response, take action in anticipation of events, and ensure capacities are in place for effective response and recovery at all levels is emphasized by the Sendai Framework.⁷ The extent to which Canada is prepared to address climate-related risks, including severe floods, will define its long-term competitiveness. Failure to address these risks will result in continued economic losses (Figure 3) and will threaten Canada’s status as a safe country in which to invest and do business.

Methodology

The United Nations Secretariat of the International Strategy for Disaster Reduction (UN/ISDR) defines “preparedness” as, “the capacities and knowledge developed by governments, professional response organizations, communities and individuals to anticipate and respond effectively to the impact of likely, imminent or current hazard events or conditions.”⁸

Within the context of this definition, a literature review (UN/ISDR 2008, Hémond & Robert 2012, Kundzewicz et al. 2014 and Quarantelli 1998) identified key factors against which the flood preparedness of Canada’s provinces and Yukon can be assessed:

- **Relevance:** flood prevention, protection, mitigation and response options should be realistic and sensitive to the environment in which they are implemented (accordingly, 12 assessment categories, noted below, are further defined into sub-categories, reflecting the nuanced nature of flood preparedness approaches-based on location, nature of flood risk and other differentiating factors);
- **Practicality:** technical-and cost-effectiveness, or the ease with which flood prevention, protection, mitigation and response options can be implemented;
- **Effectiveness:** the degree to which flood prevention, protection, mitigation and response options being implemented reduce flood risks and related damages; and
- **Urgency:** the degree to which flood prevention, protection, mitigation and response options, if not implemented, increase the threat to human well-being and economic continuity.

Based on a further literature review (Auditor General of Canada 2016, Insurance Bureau of Canada 2015, Kovacs and Sandink 2013, Simpson 2006, Swiss RE 2010, U.S. Department of Homeland Security 2007, Vlotman et al. 2007, Werritty 2006 and Wilby and Keenan 2012), the following 12 evaluative categories were established to assess the flood preparedness of the Canadian provinces and Yukon:

1. Floodplain Mapping	7. Transportation Systems
2. Land-use Planning	8. Electricity Supply
3. Drainage System Maintenance	9. Drinking Water Systems
4. Sustainable Flood Management	10. Wastewater Systems
5. Home Adaptation Audit	11. Public Health and Safety
6. Commercial Property Adaptation Audit	12. Emergency Preparedness and Response

Where appropriate, these 12 evaluative categories are further defined to reflect the nuanced nature of flood management (Table 1). N/A denotes Not Applicable (i.e. no sub-categories were applicable).

The survey was administered over a five-month period (December 2015 to April 2016) to subject matter experts from various provincial and territorial ministries, departments, and agencies. As per the survey questionnaire, five response options could be selected by survey participants. Options ranged from A (highest possible score) to E (lowest possible score) to reflect the corresponding levels of flood preparedness relative to each of the 12 evaluative categories. If none of the pre-defined answers were considered appropriate by survey participants, the option N/A (Not Applicable) was recorded.

Survey Participation

A contact list of government officials with subject matter expertise relevant to the 12 categories of flood preparedness was initially compiled, based on information provided on the official provincial and Yukon websites. Following this compilation, an e-mail invitation to participate in the survey was sent to deputy ministers of provincial and Yukon ministries or departments. Deputy ministers then identified subject matter experts within their jurisdictions best suited to respond to flood preparedness survey questions; or, deputy ministers themselves elected to respond.

TABLE 1 *Twelve Evaluative Categories and Sub-Categories for Flood Preparedness*

TWELVE EVALUATION CATEGORIES	SUB-CATEGORIES
1. Floodplain mapping	Coastal communities
	Municipalities and rural communities
	Aboriginal communities
2. Land-use Planning	Municipalities and rural communities
	Agricultural lands
	Mine, oil and gas sites
	Oil and gas pipelines
	Aboriginal lands
	Riparian zones
3. Drainage System Maintenance	Natural and man-made watercourses
	Railroads
	Highways and roads
	Agricultural lands
	Forest lands
	Solid waste landfills
	Abandoned contaminated sites
4. Sustainable Flood Management	N/A
5. Home Adaptation Audit	N/A
6. Commercial Property Adaptation Audit	N/A
7. Transportation Systems	Railroads
	Highways and roads
8. Electricity supply	N/A
9. Drinking Water Systems	N/A
10. Waste Water Systems	N/A
11. Public Health and Safety	Health service delivery
	Safety of communities located in close proximity to pipelines
	Safety of communities located in close proximity to abandoned contaminated sites
12. Emergency Preparedness and Response	Emergency response
	Petroleum supply
	Telecommunications
	Electricity supply

In general, survey questions were addressed to ministries and departments involved in flood prevention, protection, mitigation, and emergency response management. Periodically, government officials invited the participation of local conservation authorities and Crown corporations. In total, 103 subject-matter experts provided their responses to survey questions via e-mail or phone interviews. Fourteen of 117 government officials originally contacted to participate in the survey declined to participate.

Many efforts were undertaken to minimize data response errors – through careful questionnaire design, testing, and a data validation process (i.e. data collected during interviews was reviewed and validated for accuracy by survey participants within each provincial and territorial ministry or department).

Data Analysis

Both quantitative and qualitative data analysis methods were used to interpret the data collected during the survey. All comments provided by the responders during the review process were analyzed qualitatively. Quantitative methods were used to assign progressive positive integer values to each survey response. The progressive structure of the scale was developed in such a way that each successive item was treated as indicating a “better” response than the preceding value, from E to A. N/A responses were not included in the overall score calculation for a particular factor, nor in the calculation of the individual score of each province or territory.

To ensure data validity, survey responses were sent to respondents who validated their responses internally with peers/colleagues. No further verification pertaining to the validity of responses was undertaken. The survey results are presented in two ways:

1. Graphical representation of flood preparedness for each of the 10 Canadian provinces and Yukon, juxtaposed to the average (national) flood preparedness score relative to the 12 evaluative categories (Executive Summary, Figure 2).
2. Scores for each of the assessed factors for each of the 10 Canadian provinces and Yukon, along with selected commentary in Chapter 2.

2. KEY FINDINGS

2.1 Floodplain Mapping

The Canadian National Disaster Mitigation Program (NDMP) defines flood mapping as “the delineation of flood lines and elevations on a base map, which typically takes the form of flood lines on a map that show the area that will be covered by water, or the elevation that water would reach during a flood event. The data shown on the maps, for more complex scenarios, may also include flow velocities, depth, other risk parameters and vulnerabilities.”⁹

Floodplain mapping indicates flood-prone areas, where risk and hazards associated with flooding are high. Accordingly, new development may be restricted in areas designated as floodplains by federal, provincial and territorial governments through the use of municipal zoning regulations.

In Canada, various design flood criteria standards are used for delineating flood-prone areas. The minimum standard is the 100-year flood, which is the flood flow with a 1-in-100 chance of occurring in any given year.

In some provinces, the standards are more stringent. For example, Saskatchewan uses the 500-year design flood; British Columbia, a 200-year design; and Ontario uses the 100-year design or regional storm events, such as Hurricane Hazel, which exceeded the 100-year design flood.¹⁰ Design flood criteria standards are not explored as part of this survey.

Since floodplain maps are an important tool to understand flood risks, they must be updated regularly to provide reliable information on flood risk management and local development.

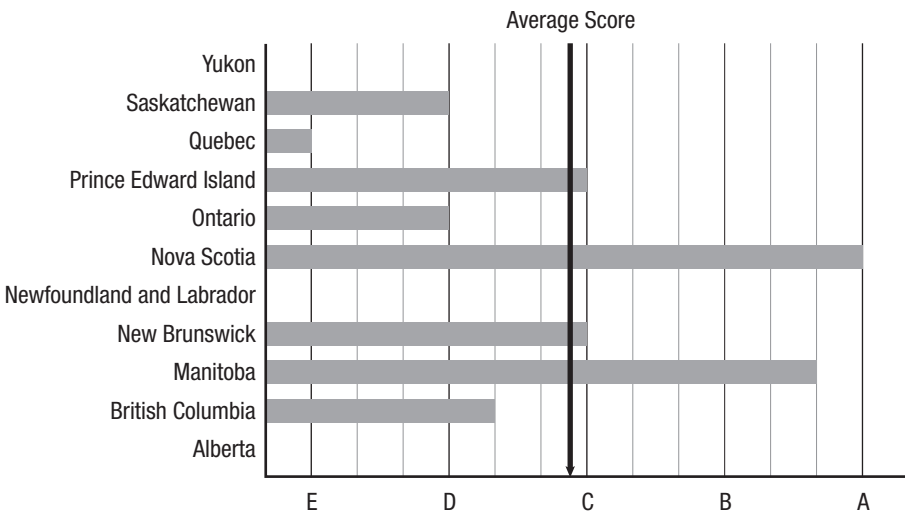
Questions that follow explore the extent of provincial support for floodplain mapping across three types of communities: (1) communities located along the shores of major lakes and along Canada’s coast, (2) flood vulnerable municipalities and remote communities, and (3) communities located on aboriginal land. These three types of communities were selected for the survey analysis, as they tend to exhibit higher flood and hazards risks.

Coastal Communities

Survey Question 1A: Relative to flooding of coastal communities, what policy does your province have in reference to floodplain mapping development and updating?

- A. Our province provides technical and financial assistance to local governments to ensure that coastal floodplain maps are developed and projected to 15-25 years to model future sea level rises.
- B. Our province provided technical and financial assistance to local governments, and coastal flood plain maps were updated within the last 5 years.
- C. Our province provided technical and financial assistance to local governments, and coastal flood plain maps were updated within the last 5-15 years.
- D. Our province provided technical and financial assistance to local governments, and coastal flood plain maps were updated over 15 years ago.
- E. Our province updates coastal floodplain maps on an “as-needed” or ad-hoc basis.

■ FIGURE 2.1A *Flood Plain Mapping, Distribution of Scores for Coastal Communities*



Note: Alberta, Yukon and Newfoundland and Labrador selected the N/A response for this survey question; accordingly, their responses were not included in the scoring above. By way of background, Alberta and Yukon indicated that they have no coastal communities. Newfoundland and Labrador indicated that although it does not typically provide such funding, it did conduct flood risk mapping studies for coastal areas in Stephenville in 1996 and 2009.

Coastal Communities – Commentary Provided

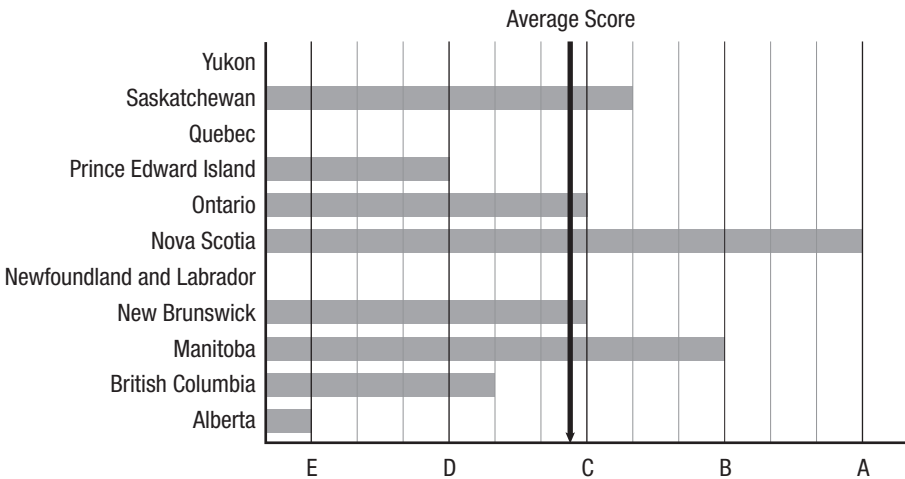
- British Columbia indicated that provincial flood hazard maps were last updated prior to 2001. Through legislative change, this responsibility was assigned to local governments in 2002-2003. Currently, floodplain mapping effort is coordinated by a consortium of agencies led by the Fraser Basin Council (which is funded through member agencies – typically local governments). One explanation for dated flood hazard maps may be a belief that the likelihood of receiving disaster relief funding from the province is lower, if local governments have updated flood hazard maps and flooding has occurred in these flood hazard areas. In other words, the local governments in British Columbia may not have positive incentives to update and develop new flood hazard maps.
- Manitoba developed a robust LIDAR map of Lake Winnipeg, which provides data for floodplain modeling, flood risk area identification and analytics.
- New Brunswick indicated that while there is no province-wide set of coastal flood hazard mapping, some coastal flood hazard mapping was conducted by coastal municipalities. In some cases, these efforts were financially supported by the province, under the Environmental Trust Fund. Where coastal flood hazard mapping was undertaken, it is up-to-date (i.e. flood hazard maps were created or updated within the last five years).
- Nova Scotia administers a Municipal Climate Change Adaptation Planning program (MCCAP), which provides technical and financial support to more than 50 local governments to develop climate change action plans. These plans, in most cases, include some form of mapping of future sea level rises and coastal flood risks.
- Quebec indicated that it provides technical assistance but not financial support to municipalities for the development of floodplain maps.

Municipalities and Rural Communities

Survey Question 1B: Relative to flooding of municipalities and rural communities, what policy does your province have in reference to floodplain mapping development and updates?

- A. Our province provides technical and financial assistance to local governments to ensure that floodplain maps for municipalities and rural communities are developed and forward projected to 15-25 years in the future to model future floods.
- B. Our province provided technical assistance to local governments, and floodplain maps for municipalities and rural communities were updated within the last 5 years.
- C. Our province provided technical assistance to local governments, and floodplain maps for municipalities and rural communities were updated within the last 5-15 years.
- D. Our province provided technical assistance to local governments, and floodplain maps for municipalities and rural communities were updated over 15 years ago.
- E. Our province updates floodplain maps for municipalities and rural communities located in flood-prone areas on an “as-needed” or ad-hoc basis.

■ **FIGURE 2.1B** *Floodplain Mapping, Distribution of Scores for Municipalities and Rural Communities*



Note: Newfoundland and Labrador, Quebec, and Yukon selected the N/A response for this survey question; accordingly, their responses were not included in the scoring above. By way of background, Newfoundland and Labrador indicated that several flood risk studies were recently prepared by the province, in some cases, in partnership with the federal government. However, new studies are dependent upon budgetary requests put forward by governmental departments. Yukon indicated that the territory is in the process of developing its flood hazard mapping ability. Some flood hazard maps were developed by Yukon Energy Corporation for the communities located downstream from Yukon Energy hydro structures. Quebec indicated its municipalities are responsible for the management of flood risk areas, including floodplain mapping.

Municipalities and Rural Communities – Commentary Provided

- Alberta indicated the Canada-Alberta Flood Damage Reduction Program, initiated in 1989, expired in 1999 before flood hazard studies and mapping were completed for all of the original candidate communities. The province continues to produce studies and mapping under the separate and independent Flood Hazard Identification Program (FHIP).
- New Brunswick indicated most flood hazard mapping produced over the last 10 to 15 years documents historic floods rather than predicts future flooding. All of the flood hazard mapping produced by the province was solely prepared for riverine flooding.
- Nova Scotia indicated the re-negotiation of the 2010-2015 Gas Tax Agreement between the provincial and the federal governments expanded the category of eligible gas tax projects (unique to Nova Scotia) to include capacity building. The capacity building element allows municipalities to use gas tax funds for: floodplain and coastal flood hazard mapping; data collection and analysis; and other studies designed to help the local government delineate and understand the geographical range of climate and weather impacts, based on predicted weather and climate trends. Nova Scotia's Statement of Provincial Interest (SPI) states that municipal planning documents must delineate flood-prone areas. Accordingly, municipalities are required to prepare development controls and regulations (bylaws) that restrict development in these areas. As a result, municipalities in Nova Scotia have taken proactive steps to prepare stormwater management plans which include mapping areas that are sensitive to flooding. While municipalities are responsible for developing and maintaining floodplain maps, provincial planners do meet with municipal officials and assist in the development of stormwater plans and municipal planning documents when asked for technical advice. In many cases, municipalities use consulting firms and rely on the advice of technical experts to provide an appropriate flood-return period for their unique circumstances. There is no provincially mandated period of time respecting how often municipal floodplain maps should be updated. In general, they are updated when conditions on the ground demonstrate that existing mapping no longer reflects the true limit of the area flooded.

- Ontario defines standards, policy and regulatory framework for the development of riverine floodplain mapping in Ontario. Conservation authorities work with municipalities to develop and update floodplain maps and implement riverine floodplain management programs. Funding for this work is currently provided by municipal governments. The frequency of occurrence of floodplain mapping work ranges by municipality across the province. **According to the 2015 inventory of floodplain mapping across conservation authorities, 34,275 km of riverine area was mapped (excluding the Great Lakes' shorelines and inland water bodies). However, it is estimated that almost 75 percent of current Ontario floodplain maps require updating. Most rural areas of the province have not been updated in 25 years.**
- As per the Statements of Provincial Interest, Saskatchewan requires all official community plans and zoning bylaws to include floodplain mapping policies and zoning regulations that prohibit development from locating in the flood way of the estimated 500-year peak water elevation. When a municipality updates its official community plan and zoning bylaws, the older floodplain mapping is also reviewed for validity and purposeful use, to assess whether and how it can be utilized to delineate floodway and flood fringe areas.

Aboriginal Communities

Floodplain mapping for Aboriginal Peoples of Canada (or Indian, Inuit and Métis peoples of Canada) who reside on-reserve falls within federal responsibility. Provincial governments have a general responsibility for Aboriginal Peoples living off-reserve (in urban communities). To understand the process of floodplain mapping for aboriginal communities, this survey question was addressed to provincial ministries, departments and agencies responsible for indigenous affairs.

Survey Question 1C: Relative to flooding of aboriginal communities, what policy does your province have in reference to floodplain mapping development and updates?

- A. Our province provides technical and financial assistance to local governments to ensure that floodplain maps for aboriginal communities are developed and forward projected to 15-25 years in the future to model future floods.
- B. Our province provided technical assistance to local governments, and floodplain maps for aboriginal communities were updated within the last 5 years.
- C. Our province provided technical assistance to local governments, and floodplain maps for aboriginal communities were updated within the last 5-15 years.
- D. Our province provided technical assistance to local governments, and floodplain maps for aboriginal communities were updated over 15 years ago.
- E. Our province updates floodplain maps for Aboriginal communities located in flood-prone areas on an “as needed” or ad-hoc basis.

Note: Five of the surveyed provinces (Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island and Saskatchewan) and Yukon selected the N/A response for this survey question; accordingly, graphical representation of the responses and the overall score calculation for this particular question was omitted (and, by extension, not included in individual score calculations).

Aboriginal Communities – Commentary Provided

- Alberta noted, floodplain mapping is underway in the province and includes mapping of two reserve lands as part of the initiative. Historically, floodplain mapping stopped at the reserve border.
- Manitoba indicated it has recently initiated discussions with federal and aboriginal governments on how to improve: flood forecasting, preparedness, response, public communications and operation of flood control structures.
- New Brunswick indicated floodplain mapping is developed on an annual basis across its First Nations communities. The province financially supports establishment of river monitoring stations in First Nations communities and actively administers erosion hazard policies. There are 15 First Nations communities located in the province which apply the same floodplain mapping process and approaches as other New Brunswick communities.

- Newfoundland and Labrador indicated the province has no aboriginal communities where flooding is an issue.
- Nova Scotia indicated floodplain mapping on aboriginal land is under federal jurisdiction.
- Ontario indicated conservation authorities will partner with various organizations to complete floodplain mapping; for example, conservation authorities have worked with aboriginal communities to support floodplain mapping projects.
- Prince Edward Island indicated that its two island aboriginal communities (Abegweit First Nation and Lennox Island Mi’Kmaq First Nation) operate within federal jurisdiction. However, the province confirmed that LIDAR data was used for mapping flood risk hazard zones for these communities, as they are vulnerable to coastal erosion and storm surge flood risks.
- Saskatchewan indicated the Water Security Agency works with First Nations on flooding issues and floodplain mapping, where applicable.
- Yukon indicated it intends to develop floodplain mapping tools, and that it will include aboriginal communities in this exercise.
- **Most responses indicated the federal government would be the most appropriate responder to questions on Aboriginal Peoples.**

2.2 Land-use Planning

Land-use planning can be used to reduce flood risk through prohibiting or restricting development in floodplains and within flood-prone areas. The following questions address land-use planning aspects relative to flood risk reduction across the following seven land uses:

1. Municipalities and rural communities	4. Oil and gas pipelinst
2. Agricultural lands	5. Aboriginal lands
3. Mine, oil and gas sites	6. Riparian zones
	7. Forested lands

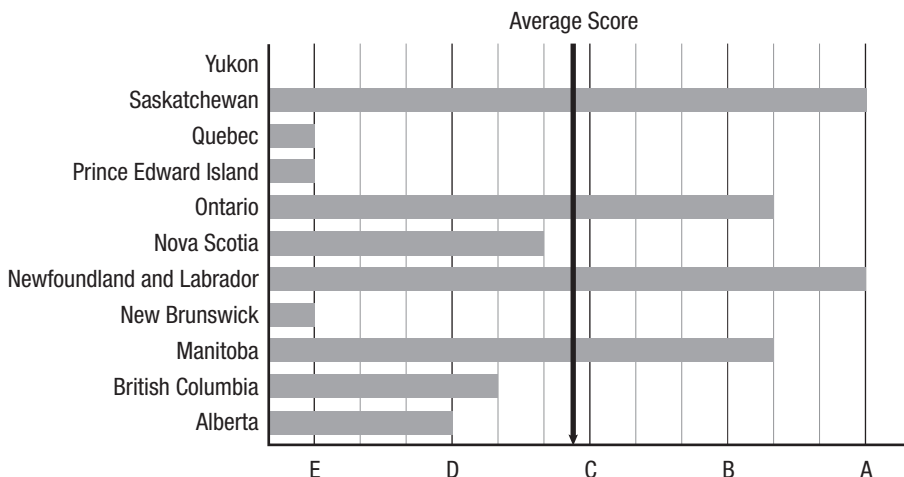
Municipalities and Rural Communities

- Land-use planning in Canada is carried out under various legislations and policies and applied by a range of decision makers, including: provincial and territorial government departments, boards and agencies, and municipal governments. According to Natural Resources Canada, local governments manage the risks of flooding through a variety of practices, including: adoption and enforcement of bylaws; operation of transportation, utilities and other public infrastructure; and administration of an emergency management and response system. **Land-use planning is one of the most effective processes to minimize flood risks to municipalities and rural communities.¹¹ In general, municipal governments maintain the responsibility and authority for local land-use planning and development on all private lands within their boundaries.**

Survey Question 2A: Within your province, in reference to new residential, commercial, and infrastructure development in municipalities and rural communities, to what degree does the potential for flooding factor into siting?

- A. Our provincial regulations stipulate that any history of flooding in an area would serve as a recommendation to the local government to negate new development.
- B. Our provincial regulations stipulate that flooding in an area over the last 50 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 50-year floods.
- C. Our provincial regulations stipulate that flooding in an area over the last 20-50 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 20-50 year floods.
- D. Our provincial regulations stipulate that flooding in an area over the last 10 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 10-year floods.
- E. Our provincial regulations do not stipulate that past flooding in an area should factor into siting development.

■ FIGURE 2.2A *Land-use Planning, Distribution of Scores for Municipalities and Rural Communities*



Note: Yukon selected the N/A response for this survey question; accordingly, Yukon's responses were not included in the scoring above. By way of background, Yukon currently does not have flood risk maps that would identify flood-prone areas, or legislation that speaks specifically to flood risks.

Municipalities and Rural Communities – Commentary Provided

- In Alberta, the Flood Recovery and Reconstruction Act enables municipalities to control, regulate or prohibit any use or development in a floodway. There is an exemption for municipalities with significant development already in a floodway (such as Fort McMurray and Drumheller). The act also sets out provisions for municipalities to rebuild communities in a manner that limits the potential for future flood damage.
- British Columbia noted, land-use planning is a responsibility of local governments. As per the Local Government Act, local governments are not obligated to designate floodplains, or to zone the land accordingly. The province noted, it only reviews risks associated with land proposals for rural communities' unincorporated areas (where flooding may be considered a risk) as appropriate.
- Manitoba designates flood hazard areas and outlines flood-proofing criteria for structures located within the Red River Valley. For developments outside the Red River Valley, local governments are responsible for land-use regulations. Currently, a 1-in-100-year flood event is used as a design standard. The province is expected to evolve this standard to a 1-in-200-year flood event.

- New Brunswick indicated that development approvals are a municipal responsibility, where local rules may be applied (e.g. zoning by-laws, conditions attached to building permits, and others). New Brunswick's Coastal Areas Protection Policy is applied when a development is located in the coastal zone (as defined by the policy), and development approval is required from the province (e.g. Watercourse and Wetland Alteration Permit or Environmental Impact Assessment). The Coastal Areas Protection Policy requires that development be set at a minimum elevation above the average of the high tides. Inland flooding may be a factor in siting projects, as part of the review under the Environmental Impact Assessment.
- Nova Scotia indicated municipalities have jurisdiction over land-use planning, and in this capacity, municipal councils are responsible for determining the most appropriate places for development. The province noted, municipal officials are aware of the impacts of flooding on property. The local governments use development tools such as subdivision plans, development permits and development zones to restrict development in flood-prone areas. The Municipal Climate Change Adaptation Planning (MCCAP) process has elevated awareness at the provincial level and the role that land-use planning plays in protecting development from flooding. The Statement of Provincial Interest provides provincial context for municipal development in flood-prone areas.
- Ontario policies prohibit or restrict new residential, commercial, and infrastructure development in municipalities and rural communities within regulatory floodplains. Local conservation authorities and municipalities implement these policies through land development applications. The province has developed a Special Policy Area floodplain management approach that is used in limited circumstances, where other floodplain management approaches are not considered feasible or practical. Generally, the approach is applied to existing developed areas within communities that have historically existed within floodplains. Fundamentally, this approach “grandfathers” historic development, such as the downtown cores of towns and cities built along rivers and well-established prior to any floodplain management or land-use planning policies by the government. Creating or altering Special Policy Areas requires provincial ministry approvals from the Ontario Ministry of Municipal Affairs and Housing, and the Ministry of Natural Resources and Forestry.

- Quebec indicated regional municipalities must identify zones where land use is subject to specific restrictions because of the risks to public health, safety and well-being. The municipalities must consider protection of fauna and flora within the floodplains and within zones with natural hazards: (1) zones with flooding beyond the riverbanks (during the period of melting snow), following ice jams or torrential rains; (2) erosion caused by water, ice or wind; (3) landslides consisting of soil or rock, simple or composite; and (4) sinking of the ground (due to the consolidation or compaction of the soil), cave-ins (due to the collapse of the roof of subterranean cavities), avalanches, earthquakes and other reasons. However, there are no requirements to adjust flood zones based on new flood events as they emerge.

- Saskatchewan indicated the Statements of Provincial Interest Regulations require all official community plans and zoning bylaws to include floodplain policies and zoning regulations that prohibit development in the floodway of the estimated 500-year peak water elevation. For development in the flood fringe, flood-proofing measures are required to be 0.5 meters above the estimated 500-year peak water elevation. As per Bill 27 of the Flood Recovery and Reconstruction Act, a floodway is defined as more than one meter of flooding, or more than one cubic meter per second of flow. A flood fringe is defined as less than one meter of flooding and less than one cubic meter of flow. The province has an interest in ensuring the safety and security of individuals, communities and property from natural and human-induced threats. To assist in meeting public safety interests, the province requires that all planning documents and decisions shall:
 - Identify potential hazard lands and address their management;
 - Limit development on hazard lands to minimize the risk to public or private infrastructure;
 - Prohibit the development of new buildings and additions to buildings in the floodway of the 500-year flood elevation of any watercourse or water body;
 - Require flood-proofing of new buildings, and additions to buildings, to an elevation 0.5 meters above the 500-year flood elevation of any water course or water body in the flood fringe; and
 - Locate subdivisions, transportation infrastructure, and public works to minimize, mitigate, or avoid threats to the community from wildfire, or other emergencies.

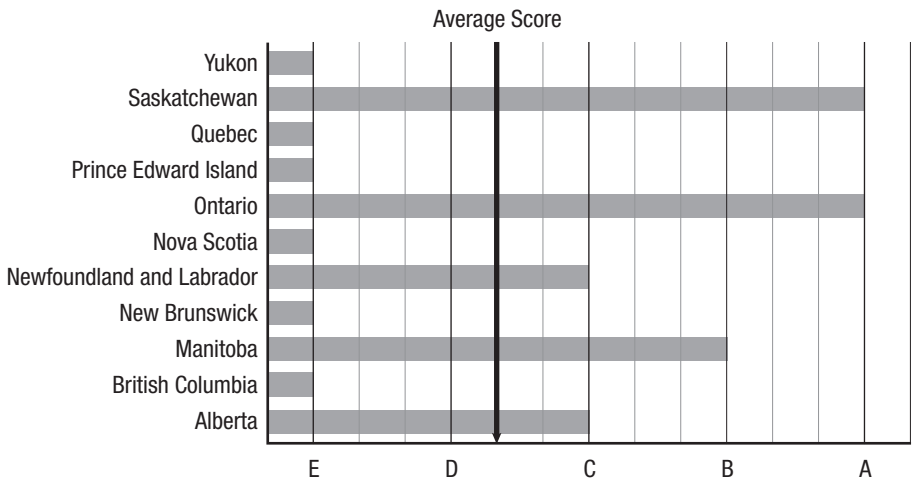
Agricultural Lands

In Canada, approximately 7% of the total land base is used for agriculture development.¹² Many of Canada’s most productive agricultural areas are on, or adjacent to, floodplains. Accordingly, the survey focuses on provincial guidelines and regulations that provide the basis for approvals of farmstead and agricultural-use buildings within flood-prone areas.

Survey Question 2B: Within your province, in reference to new agricultural development, to what degree does the potential for flooding factor into siting structures such as farm dwellings, livestock housing, pesticide and agricultural waste storage?

- A. Our provincial regulations stipulate that any history of flooding in an area would serve as a recommendation to the local government to negate new development.
- B. Our provincial regulations stipulate that flooding in an area over the last 50 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 50-year floods.
- C. Flooding in an area over the period of the past 20-50 years would negate siting structures, or infrastructure would be established to limit the potential for 20-50 year floods.
- D. Our provincial regulations stipulate that flooding in an area over the last 10 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 10-year floods
- E. Our provincial regulations do not stipulate that past flooding in an area should factor into siting.

FIGURE 2.2B *Land-use Planning, Distribution of Scores for Agriculture*



Agricultural Lands – Commentary Provided

- Alberta noted, current legislation focuses on a 1-in-30-year flood risk for agricultural buildings like barns, manure storage, and pens. Outbuildings, workshops and dwellings are not subject to agricultural regulation but are controlled by municipalities. However, the province is in the process of drafting new legislation, which would use a 1-in-100-year event to prohibit new development for agricultural facilities within the 100-year flood hazard area.
- British Columbia indicated there are no provincial regulations that specifically pertain to siting of agricultural buildings in relation to flood hazard areas. This is because local governments are responsible for all siting requirements.
- Manitoba indicated no development is recommended in an area subject to flooding, unless it is protected to a level of 0.67 meters of freeboard (i.e. additional capacity) above a 1-in-100-year flood level, as per its current legislation and provincial land-use policies. The province is planning to introduce regulations that would ensure future developments take into consideration the entire watershed.
- New Brunswick indicated aspects of agricultural land use that are within the purview of the province. Specifically, the storage of pesticides and building permitting are regulated through the Department of Environment and Local Government. Siting of the new livestock operations is regulated through the Department of Agriculture, Aquaculture and Fisheries. While the Livestock Operations Act does not specifically preclude development on land subject to flooding, it does allow the registrar to impose terms and conditions regarding environmental protection. Agricultural lands adjacent to parts of the New Brunswick coastline (particularly the southeast) are protected from flooding by coastal wetlands backed by a series of dikes. Maintenance of these dikes in the face of climate change and sea level rise is an important consideration for reducing flood damage.
- Nova Scotia noted, there are no flood-related land use policies that address agricultural land use. In Nova Scotia and New Brunswick combined, there are 364 km of dikes protecting a total of 32,350 ha of agricultural land (excluding dikes constructed by private landowners, industries and communities). At the present

time, the primary mandate of the province is to protect agricultural land protected by dikes. However, residential and commercial development has taken place on adjacent lands – which may also be vulnerable to dike overtopping or breaching. The province uses the predicted 2055 sea level rise estimates as a minimum for designing dikes that primarily protect agricultural land.

- Ontario’s policy prohibits or restricts agricultural development, including siting structures such as farm dwellings, livestock housing, pesticide and agricultural waste storage, in regulatory floodplains. These areas are defined by historic and potential future flood events. Conservation authorities and municipalities implement these policies in development applications.
- Prince Edward Island indicated its rivers and streams are small and tend to have small floodplains. Infrastructure issues on river floodplains are minimal and are generally left to the owner to resolve. During the development approval process, developers and planners are encouraged to propose development plans that address surface drainage issues and are not at risk to surface flooding. Where flooding is an issue, engineered storm water management plans are often required. Coastal flooding due to storm surge is a much larger issue for PEI. Mapping of coastal flood risk areas has recently been completed by the province, but has not yet been incorporated into provincial regulations. Currently, the province provides coastal flood risk and erosion assessments to developers, so that they can incorporate this information into new subdivision design. Flood risk development stipulations may be included in the provincial regulations, subject to subdivision and development regulations that will be revised in the next few years.

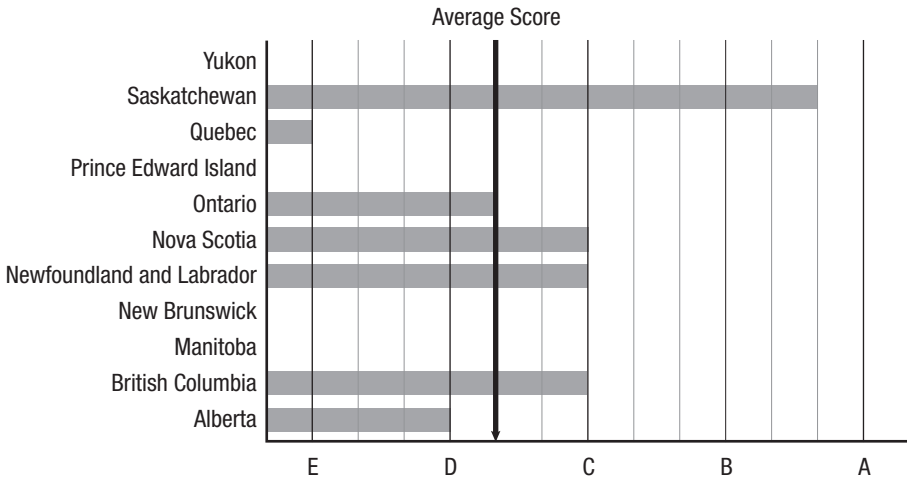
Mine, Oil and Gas Sites

The average operating life of a mine in Canada is relatively short, generally lasting 15-20 years.¹³ However, the entire process of opening and closing a mine requires activities that might continue significantly longer, including remediation of the mine site to avoid environmental contamination once the site is closed. Mine site flooding may lead to the release of harmful chemicals into the environment, threatening public safety and the ecological integrity of surrounding areas (e.g. soil, water and groundwater contamination).

Survey Question 2C: Within your province, in reference to new pits and quarries, development of mining/oil gas exploration sites, to what degree does the potential for flooding factor into siting?

- A. Our provincial regulations stipulate that any history of flooding in an area would serve as a recommendation to the local government to negate new development.
- B. Our provincial regulations stipulate that flooding in an area over the last 50 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 50-year floods.
- C. Flooding in an area over the period of the past 20-50 years would negate siting structures, or infrastructure would be established to limit the potential for 20-50 year floods.
- D. Our provincial regulations stipulate that flooding in an area over the last 10 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 10-year floods.
- E. Our provincial regulations do not stipulate that past flooding in an area should factor into siting.

FIGURE 2.2C *Land-use Planning, Distribution of Scores for Mine, Oil and Gas Site Development*



Note: Manitoba and Prince Edward Island government officials declined to participate in this survey question; New Brunswick and Yukon selected the N/A response for this survey question; accordingly, their responses were not included in the scoring above. By way of background:

Mine, Oil and Gas Sites – Commentary Provided

- *New Brunswick indicated that the document “Responsible Environmental Management of Oil and Natural Gas Development” includes the following requirements for the industry (to be implemented as conditions to Approvals and Certificates of Determination issued under existing legislation): gas conditioning plants and compressor stations (including related fill) are not permitted within flood-prone areas. Well pads are not permitted in flood-prone areas unless: (a) it is demonstrated to the regulator that construction can take place without significant changes to existing flood levels and flow velocities; (b) the surface of the well pad is set at an elevation that is above the flood elevation; and (c) access to the well pad is designed to be passable during a flood event. Pipes and access roads are not to be permitted within flood-prone areas, except as part of a crossing that has received a permit under the Watercourse and Wetland Alteration Regulation – Clean Water Act.*
- *Yukon stated that the province does not have flood risk maps in reference to mine sites; there is no specific territorial legislation that addresses flood risk measures at mine sites.*
- British Columbia noted, as part of the Environmental Assessment Process for new mining or quarry development, proponents are required to assess all risks, including flood risks. Additionally, mine site owners/operators are required to have emergency plans in place, which again take all risks into account, including flood risks. This would be required as part of the permitting process under the Mines Act and the Environmental Management Act.
- Nova Scotia’s provincial regulations stipulate that environmental impacts (including hydrological impacts) must be included in the recommendation for an approval/rejection of a particular development. Other provincial regulations require local governments to negate new development within an area delineated as the 20-year flood zone.
- Ontario indicated that requirements for upstream oil and gas sites do not specifically require flood risk evaluation to be a factor in siting. However, provincial technical requirements for these sites may inherently provide some protection against the effects of flooding (e.g. mandatory setbacks, storage of fluids in tanks and other measures). Provincial technical requirements are set out in the “Oil, Gas and Salt Resources Provincial Operating Standards” document.

- Saskatchewan indicated flood risk is a factor that is considered through the Environmental Impact Assessment (EIA) process for new developments. Each proposed development is evaluated on a sitespecific basis, and approval includes evaluation of mitigating factors (such as engineering controls) to address flood risks, along with any other risks identified. However, EIA does not stipulate the frequency of flooding that is allowable, nor what level of flooding would specifically prohibit a development. The province also enacted Hazardous Substances and Waste Dangerous Goods Regulations that prohibit the storage of hazardous substances and waste dangerous goods in areas prone to flooding (using the 1-in-500-year storm event as the design criteria).
- Some respondents pointed out that **lack of funding for floodplain mapping and the sparse number of meteorological and hydrometric stations in Canada limit their ability to evaluate the risks of future floods, thus creating uncertainty in flood risk modeling** – even if such modeling is requested through the environmental assessment processes.

Oil and Gas Pipelines

Pipelines are the most common method of transporting liquids and gases and are the only method to transport natural gas. Generally, pipelines that cross provincial borders are regulated by the federal government, and pipelines that are entirely within one province are regulated by their provincial authority. Provincially regulated lines include the smaller natural gas distribution pipelines that go to every house equipped with a natural gas furnace or water heater. Alberta, for example, regulates more than 400,000 km of pipelines.¹⁴

Survey Question 2D: How does the province co-operate with the owners and operators of new infrastructure development in reference to oil and gas pipeline development?

- A. During the permit application process, a flood risk assessment based on the latest flood risk information provided by provincial authorities is performed by the applicant, and validated by the regulator. The application is then certified by a 3rd party flood risk management agency.
- B. During the permit application process, a flood risk assessment based on the latest flood risk information provided by provincial authorities is performed by the applicant. The application is then certified by a 3rd party flood risk management agency.
- C. During the permit application process, a flood risk assessment based on existing floodplain maps is performed by the applicant, and validated by the regulator. The application is then certified by a 3rd party flood risk management agency.
- D. During the permit application process, a flood risk assessment based on existing floodplain maps is performed by the applicant. The application is then certified by a 3rd party flood risk management agency.
- E. During the permit application process, a flood risk assessment is conducted by provincial regulators.

Note: Manitoba government officials declined to participate in this survey question. Eight provinces and Yukon selected the N/A response for this survey question; accordingly, graphical representation of the responses and the overall score calculation for this particular question was omitted (and, by extension, was not included in individual score calculations).

Oil and Gas Pipelines – Commentary Provided

- **British Columbia** noted, flood risk assessment may be part of the permitting process under its Hazard, Risk and Vulnerability Analysis (HRVA), which provides the basis for local planners to create effective emergency response and contingency plans to respond to pipeline incidents. In addition, the permit application includes a risk assessment to determine what level of risks there are and how the applicant will apply any needed mitigation strategies. Risk assessment includes evaluation of flood-prone areas that may impact the pipeline. This is in line with the Association of Professional Engineers and Geoscientists of BC (APEGBC) statement that professional engineers take into account rising water levels. If the footprint of a proposed pipeline intersects the right of way of a regulated dike, then this intersection would require an approval through the Dike Maintenance Act. British Columbia also noted, for pipeline projects, proponents may undertake floodplain mapping. The proponents must evaluate flood risks and flood elevations

related to a flooding, high water, or pipeline stream crossing locations. The BC Oil & Gas Commission provides support to the sector with seasonal readiness information, in co-operation with other provincial and national agencies.

- New Brunswick noted, oil and gas projects typically trigger an assessment under the Environmental Impact Assessment (EIA) Regulation. Accordingly, the proponent may be required to address flood risks as part of the EIA.
- Nova Scotia noted, during the permit application process, flood risk assessment is performed by the applicant and is validated by the regulator. This flood risk assessment is based on the latest flood risk information provided by provincial authorities. Third-party certification for flood risk assessment is not always required.
- Ontario noted, the development of gas and oil pipelines is regulated through the National Energy Board established by the federal government. Some pipeline developers have, in the past, contacted conservation authorities regarding potential flooding concerns, but this is not a consistent practice. For example, several conservation authorities in Eastern Ontario are involved in a review of the Trans-Canada Pipeline.
- Quebec is participating in a public hearing {Bureau d'audiences publiques sur l'environnement (BAPE)} held under a section of its Environment Quality Act regarding the Quebec section of the TransCanada Energy East Pipeline Project. The hearing seeks to secure government action to prevent or attenuate the potential effects of hydrocarbon transport on public health and safety.
- Saskatchewan noted, when proposing a pipeline license application, the pipeline operator must identify potential risks (including water stream crossings along the pipeline corridor) and must also meet the minimum requirements for the design, construction, testing, operation, maintenance and repair of pipelines, in accordance with the most recent version of CSA (Canadian Standards Association) Standard Z662, Oil and Gas Pipeline Systems, unless otherwise approved by the minister.
- Most respondents indicated that the primary responsibility for maintaining reliable and safe pipelines rests on pipeline operators. **However, current provincial regulations do not specifically require companies involved with the design and construction of pipelines to perform a flood risk assessment based on the latest flood risk information provided by provincial or local authorities.**

- Some respondents also shared a concern that gathering lines are generally owned by small-to medium-sized private companies, which are less rigorous in evaluating flood risks during pipeline design and construction phases. Moreover, in some cases, these smaller companies are unable to identify and repair construction faults (which can also increase the risk of pipeline rupture during flooding).

Aboriginal Lands

Across Canada, various federal and provincial governments recognize the importance of the participation of aboriginal communities in land-use planning, environmental assessment and protection of wildlife habitat.¹⁵ This question pertains to the role that provincial and territorial governments play in land-use planning on aboriginal land.

Survey Question 2E: Within your province, in reference to new residential, commercial, or industrial development on aboriginal land, to what degree does the potential for flooding factor into siting?

- Our provincial regulations stipulate that any history of flooding in an area would serve as a recommendation to the local government to negate new development.
- Our provincial regulations stipulate that flooding in an area over the last 50 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 50-year floods.
- Flooding in an area over the period of the past 20-50 years would negate siting structures, or infrastructure would be established to limit the potential for 20-50 year floods.
- Our provincial regulations stipulate that flooding in an area over the last 10 years would serve as a recommendation to the local government to negate new development, or to establish infrastructure to limit the potential for 10-year floods.
- Our provincial regulations do not stipulate that past flooding in an area should factor into siting.

Seven provinces and Yukon selected the N/A response for this survey question; accordingly, graphical representation of the responses and overall score calculation for this particular question was omitted (and, by extension, was not included in individual score calculations).

Aboriginal Lands – Commentary Provided

- Alberta noted, the provincial government has no jurisdiction on reserves; however, Siksika Nation LIDAR maps were developed to show which homes were located in the flood zone. While these maps are not provincially recognized, they were, nevertheless, used to determine which houses needed to be relocated and to justify to the federal government why this relocation was required.

- Nova Scotia noted, although the federal government determines siting on aboriginal lands, provincial regulations apply if the proposed development is anticipated to have downstream/ off-reserve environmental impacts (including hydrological impacts). As per the Environmental Assessment Act, these impacts must be included in the recommendation for an approval/rejection of development by provincial and federal governments.
- Ontario noted, conservation authorities partner with many groups to implement floodplain management; for example, conservation authorities have worked with aboriginal communities to support floodplain management. The provincial government, through the Ministry of Natural Resources and Forestry, is the lead in addressing provincial response to flood issues within aboriginal communities in the province.
- British Columbia expressed a concern that dikes on First Nations lands may be of lower standards than those regulated under the provincial Dike Maintenance Act. This may pose a threat to safety, as these dikes become the “weak link” in the flood protection chain.

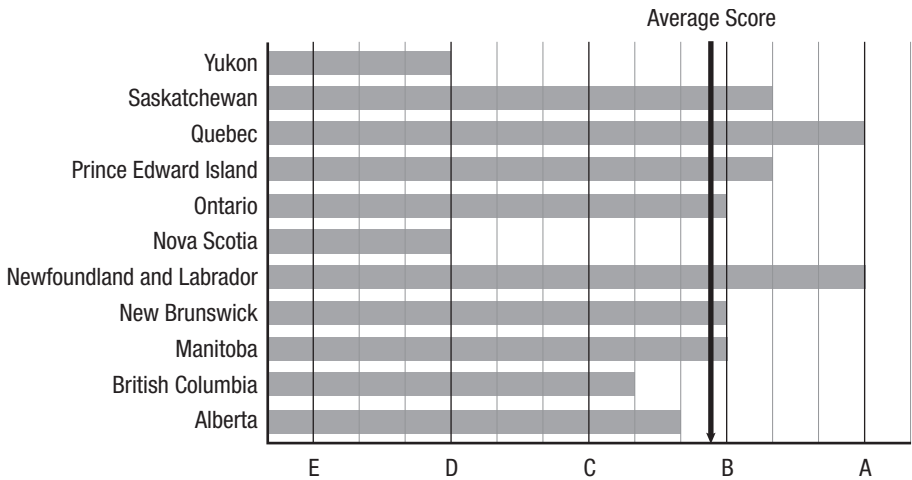
Riparian Zones

A riparian zone is defined as the land adjacent to streams, rivers, lakes, ponds and wetlands. With no definite boundaries between the body of water and drier upland areas, riparian zones are frequently flooded. During floods, riparian areas slow water flows, reduce the size of a flood further downstream, and minimize the destructive power of fast-flowing water.

Survey Question 2F: In reference to new residential, commercial, industrial, and infrastructure development, what policy does your jurisdiction have regarding to the natural riparian zone protection?

- A. A province-wide policy is in place to ensure that riparian zones are clearly defined, and their protection is enforced through various provisions and direct cooperation between local and provincial authorities. Riparian protection strictly prohibits new development.
- B. A province-wide policy is in place to ensure that riparian zones are clearly defined, and their protection is enforced through limited cooperation between local and provincial authorities. Riparian protection ensures limited and sustainable development.
- C. A province-wide policy is in place to provide guidance on riparian zones assessment, and their protection is delegated by the province to the local authority. Riparian protection is under the jurisdiction of the local government.
- D. A province-wide policy is in place to define riparian zones and policies, and their protection is delegated by the province to the local authority without provincial involvement. Riparian protection is under the jurisdiction of the local government.
- E. No relevant policies are in place to ensure riparian protection is considered during the planning process.

FIGURE 2.2F *Land-use planning, Distribution of Scores for Riparian Zone Protection*



Riparian Zones – Commentary Provided

- British Columbia indicated that the Forest and Range Practices Act and the Oil and Gas Activities Act provide protection of riparian areas located on Crown land. On privately managed forest land, riparian protection is provided through the Private Managed Forest Land Act. Moreover, additional protection may be provided to municipal areas through the Riparian Areas Regulation, which is a regulation under the Fish Protection Act.
- Manitoba indicated that the Provincial Planning Regulation requires development to be set back at least 15 meters upslope from the normal high water mark of lower order drains and retention ponds, and at least 30 meters from the normal high water mark for natural water bodies. Planning authorities can apply these requirements to protect riparian areas and to provide the framework for local development plans, which represent agreements between local and provincial governments as to how and where development is to occur.
- Ontario indicated that through the implementation of Section 28 of the Conservation Authorities Act and the Provincial Policy Statement under the Planning Act, the province ensures riparian zones are clearly defined. Their protection is enforced within these Acts through various provisions calling for direct cooperation between local and provincial authorities. Accordingly, the protection of riparian zones is implemented at the local level by conservation authorities and municipalities.
- Prince Edward Island indicated that The Watercourse and Wetland Protection Regulations establish regulated buffer zones (riparian zones) that are 15 meters in width along all watercourses and wetlands throughout the entire province. Municipal authorities must adhere to these provincial laws within their boundaries. The regulations prohibit development in the buffer zones and provide protection for vegetation.
- Saskatchewan indicated that any development that occurs in the: water bed (the portion of the water body covered by water), bank (the rising ground bordering a water body, that serves to confine the water to the channel or bed), boundary (the end of the riparian zone of a water body), or any discharge with adverse effects on the water body, is subject to the 2010 Environmental Management and Protection Act. Saskatchewan also requires that an Aquatic Habitat Protection

Permit be obtained prior to beginning any development work. The Aquatic Habitat Protection Program protects habitat from cumulative impacts that may arise from development projects or activities – large or small, conducted in or near water, within the province.

- The Territorial Lands (Yukon) Act specifies that “no title land grants” shall be given in the 30-metre ordinary High Water Mark Reserve Area of all water bodies.
- Respondents noted, **the cumulative effects of human activities within riparian areas significantly increase the magnitude of flood losses, and they expressed an opinion that more stringent regulations across all levels of government are required to protect existing riparian areas from further destruction.**

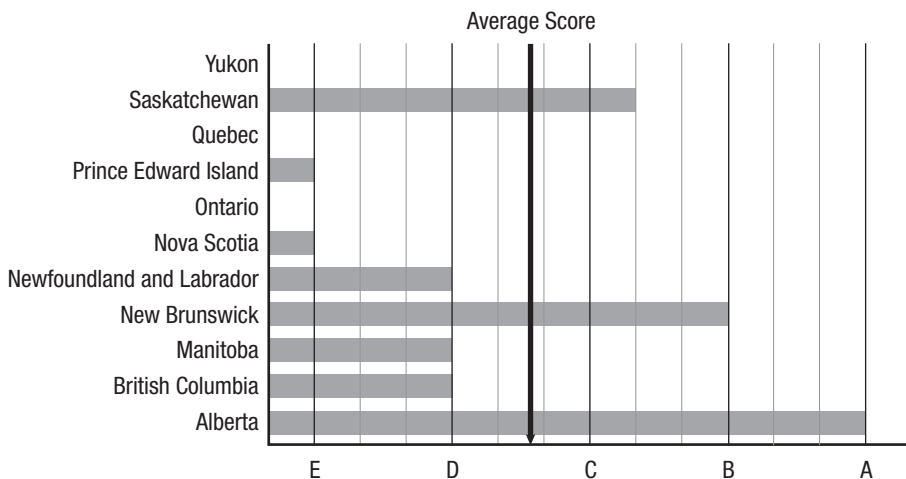
Forest Lands

Excessive logging and conversion of forested areas into other land-use types alters the density of a forest, its canopy and its soil. These significant changes to forest lands impact runoff and accelerate the erosion process. Fragmentation of forests, caused by development, reduces the stability of water body banks and impacts downstream flooding.

Survey Question 2G: In reference to forest management on Crown lands, what policy does your jurisdiction have regarding the effects of forestry activities on riparian forests, wetlands, and stream banks?

- A. During the license approval process, an environmental assessment investigating the effects of forestry activities on riparian forests, wetlands, and stream banks is performed by the applicant, and validated by the regulator. The application is then certified by a 3rd party agency.
- B. During the license approval process, an environmental assessment investigating the effects of forestry activities on riparian forests, wetlands, and stream banks is mandated by provincial authorities. It is conducted by a 3rd party agency.
- C. During the license approval process, an environmental assessment investigating the effects of forestry activities on is then certified by a 3rd party agency.
- D. During the license approval process, an environmental assessment investigating the effects of forestry activities on riparian forests, wetlands, and stream banks is conducted by provincial authorities.
- E. An environmental assessment investigating the effects of forestry activities on riparian forests, wetlands, and stream banks is not a factor for the license approval process.

■ FIGURE 2.2G *Land-use Planning, Distribution of Scores for Forest Lands*



Note: Ontario, Quebec and Yukon selected the N/A response for the survey question; accordingly, these responses were not included in the scoring above.

Forest Lands – Commentary Provided

- New Brunswick indicated that the province is moving from an intensive operations monitoring approach to a “results-based framework,” where standards, objectives and performance indicators are clearly outlined for forest operations on Crown land, and forest operations must demonstrate compliance with the indicators for sustainable forest management. Third-party audits by a licensed certification body are required, and audit performance indicators are jointly decided with the regulator.
- In Nova Scotia, over a half-million hectares of forest, or roughly 15% of the provincial forest, has been clear-cut since the 1990s. In 2011, the Nova Scotia government committed to reducing the amount of clear-cutting in the province by 50% in five years and shifted some silviculture (the growing and cultivation of trees) funding toward more sustainable forestry practices. This was done despite strong opposition from big players in the forest industry.
- Ontario noted, forest management operations on Crown lands are not normally subject to individual environmental assessments (EAs) but rather take place under an exemption to the Ontario EA Act (Declaration Order MNR-75) that imposes a number of conditions, including the development and review of various policies. The policy

regarding the effects of forestry on riparian forests, wetlands, and stream banks is primarily contained in the “Forest Management Guide for Conserving Biodiversity at the Stand and Site Scales.”

- Unlike many other provinces, only about 10% of Prince Edward Island’s forest is located on public land. Work on this land is done by a combination of government crews and private contractors who bid on work through public tender. Environmental assessments are not done prior to forest management activity on public land. Work in riparian or otherwise sensitive forests is more likely to be done by government crews rather than private contractors. In all cases, a pre-intervention management plan is required, which takes into consideration site-specific issues or implications, such as possible impacts on riparian forests or associated habitats. The Prince Edward Island’s Watercourse and Wetland Protection Regulations apply to all watercourses, wetlands and adjacent land, regardless of land use or ownership. In terms of tree vegetation, the regulations prohibit the cutting down of live trees and shrubs within 15 meters of a watercourse or wetland. The natural forest type for the province is termed “Acadian” forest. Permits may be obtained to cut trees in the 15-metre buffer zone, where the trees are diseased, or when the purpose of the cutting treatment is to regenerate an “Acadian” forest stand. Clear cuts are not permitted, and heavy equipment must remain outside the 15-metre buffer zone. Permits are generally not given to convert a forested buffer zone to a non-forested buffer zone.
- From a flood preparedness point of view, Saskatchewan indicated that there is little concern arising from its forestry activities. This is because of the relatively flat landscape, the small percentage of a watershed that is logged at any time, and the small percentage of watersheds that flow onto developed land. Accordingly, there is little potential for forest management to contribute to flooding problems. Riparian forest management is generally addressed through buffers, as incorporated into Forest Management Planning.
- Yukon noted, under Section 23 of the Forest Resources Regulation, the Forest Management Branch has established management guidelines and standards identifying operating procedures for forest resource harvesting and related activities, as described in timber harvest plans, woodlot plans, or site plans. When developing forest plans, wetlands will be identified according to one of five wetland classes – bog, fen, swamp, marsh, and shallow water – in accordance with the Canadian Wetland Classification System (CWCS). Bogs, fens and swamps shall be identified on all site plan maps.

- **Respondents indicated that conversion of forest to agricultural land uses remains the largest cause of deforestation in Canada.** Deforestation in Western Canada due to oil and gas, mining, and transportation sectors' activity was also noted to result in severe negative impacts on riparian forests and wetlands.
- Some respondents indicated that clear-cutting affects riparian reserves around streams. Better management of riparian ecosystems is needed, as current management of riparian forests through the use of fixed-width buffers may not be enough to limit impacts of clear-cutting on water quality and runoff.

2.3 Drainage System Maintenance

The conveyance capacity of drainage systems has a significant impact on flooding. Accordingly, construction, operation and maintenance of drainage systems must take into account climate change impacts. The following seven questions pertain to the provincial and territorial regulations and policies which apply to the drainage of:

1. Natural and Man-Made Watercourses	5. Forest Lands
2. Railroads	6. Solid Waste Landfills
3. Highways and Roads	7. Abandoned Contaminated Sites
4. Agricultural Lands	

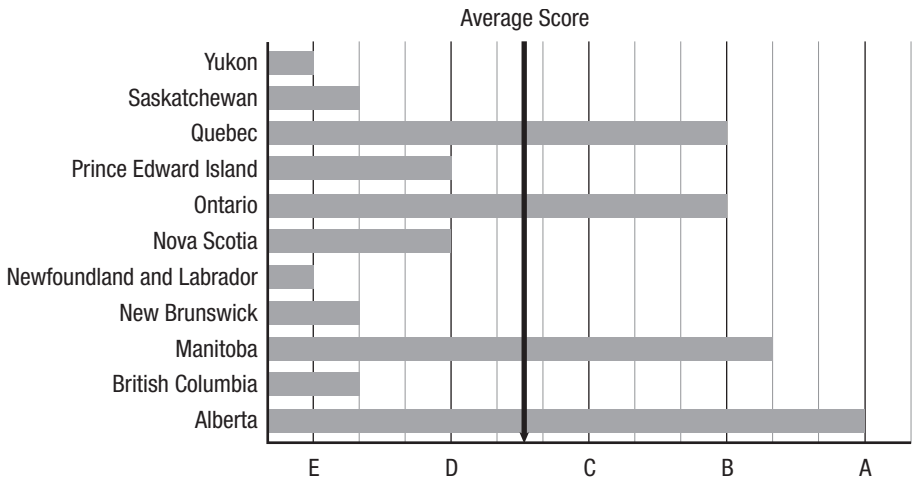
Natural and Man-Made Watercourses

A natural watercourse is defined generally as a stream of water which flows along a channel with beds and banks, for a sufficient time to give it substantial existence (e.g. rivers, creeks and streams).¹⁶ A man-made watercourse is entirely engineered (e.g. a canal or a ditch).¹⁷ Inappropriate drainage of natural and man-made watercourses may significantly increase flood risk potential.

Survey Question 3A: In reference to the water drainage capacity of natural and man-made watercourses, what policy does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure that water courses (e.g. culverts, weirs, sluices) remain free of debris and obstructions, and reviews of the adequacy of clearing efforts are conducted annually
- B. A province-wide policy is in place to ensure that water courses (e.g. culverts, weirs, sluices) remain free of debris and obstructions
- C. A province-wide policy is in place to mandate that water courses are cleared of debris and obstruction during times of the year when the potential for flooding is high
- D. A province-wide policy is in place to mandate that water courses are cleared of blockages on an “as needed” basis
- E. No relevant policies are in place to ensure that water courses remain free of debris and obstruction

FIGURE 2.3A *Drainage System Maintenance, Distribution of Scores for Natural and Man-Made Watercourses*



Natural and Man-Made Watercourses – Commentary Provided

- Alberta indicated that the Expedited Authorization Process for Flood Recovery (EAPFR) set up in the southern region of the province following the 2013 flood, included debris removal, erosion damage repairs and mitigation efforts against future flooding.

- Nova Scotia noted, it works closely with municipalities on drainage system maintenance issues to introduce guidance and best practices (as opposed to enforcing regulations). This work extends to drainage capacity issues for natural and man-made watercourses, where the province works with municipalities to implement best practices for flood preparedness. In addition, municipalities develop their own internal policies for effective drainage systems maintenance, and many of their plans speak to the importance of advanced precautionary procedures prior to a predicted event.
- Quebec indicated that, according to the municipal powers provided in Article 105 of the Municipal Powers Act, when informed of the presence of an obstruction that threatens the safety of persons or property, a regional county must carry out the work required to restore the normal flow of water from a river.
- Saskatchewan noted, funding assistance is available to rural municipalities to clear natural watercourses of silt and debris.
- Respondents indicated that areas upstream and downstream of rivers are connected and must work together to tackle future flood risks. **A shift from site-based to watershed-wide solutions in flood risk management is needed.** Respondents noted, flood risk management on a watershed scale is more effective in the long term, less damaging to the environment, and opens up a much wider range of solutions that may also be cheaper to implement.

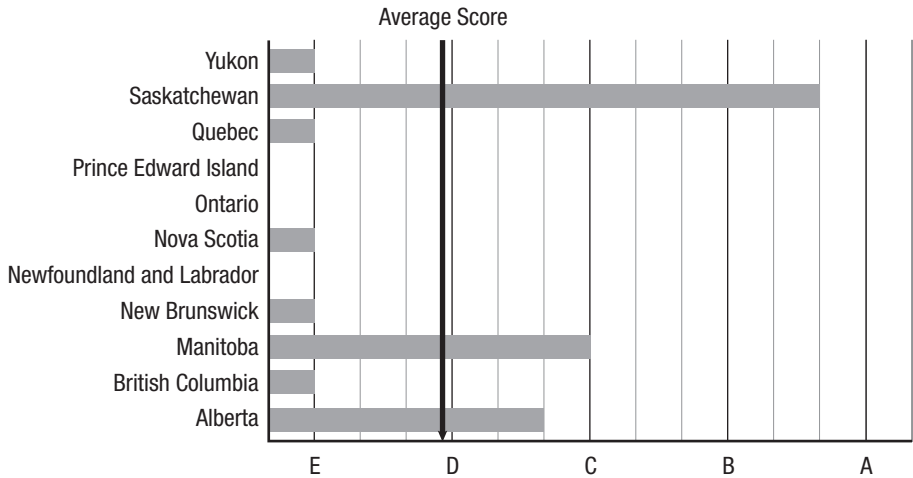
Railroads

Railroad infrastructure is climate sensitive and is expected to be significantly affected by flooding in the future. The use of ditches and culverts, alongside and under train tracks, are integral to the control of surface water flow, particularly during periods of spring run-off or heavy rainfall.¹⁸ This question explores the role of provincial and territorial governments in supporting railroad flood preparedness.

Survey Question 3B: In reference to the capacity of railroad drainage structures, what level of policy does your jurisdiction have in place as a regulatory requirement for existing railway structures?

- A. A province-wide policy is in place to ensure railroad drainage structures (surface and subsurface) remain free of debris and unwanted water, and the policy is in operation, as confirmed by regular inspections.
- B. A province-wide policy is in place to ensure railroad drainage structures (surface and subsurface) remain free of debris and unwanted water.
- C. A province-wide policy is in place to mandate that railroad drainage structures (surface and subsurface) are to be cleared of debris and unwanted water during times of year when the potential for flooding is high according to the corresponding provincial policy.
- D. A province-wide policy is in place for railroad drainage structures (surface and subsurface) to be cleared on an “as needed” basis according to the corresponding provincial policy.
- E. No relevant policies are in place to ensure that railroad drainage structures (surface and subsurface) remain free of debris and unwanted water.

FIGURE 2.3B *Drainage System Maintenance, Distribution of Scores for Railroads*



Note: Newfoundland and Labrador, Ontario and Prince Edward Island selected the N/A response for this survey question; accordingly, their responses were not included in the scoring. Respondents provided the following comments:

- Newfoundland and Labrador and Prince Edward Island indicated that they have no provincially regulated railroads.
- Ontario noted, Transport Canada regulates and sets standards for railways in Canada. Although there are provincial floodplain policies for crossings of watercourses and drainage structures, railways are not required to meet these standards.

Railroads – Commentary Provided

- Alberta indicated that railroad drainage requirements are specified in the Railway (Alberta) Act and in the “Standards for Carrying out a Works” from the Code of Practice for Watercourse Crossings, under the Water Act and the Water (Ministerial) Regulation. Specifically, the Railway (Alberta) Act stipulates that “a person carrying out the construction, repair, maintenance, or removal of any track or structural facility in respect of any railway shall ensure that there is constructed and maintained proper and adequate ditches and drains that are connected with ditches, drains, drainage works, and watercourses on the land over which the track crosses or on which the structural facility is located so as to provide sufficient outlet to drain and carry off water in such a manner that the existing natural drainage and any existing artificial drainage of the land is not obstructed or impeded.” The “Standards for Carrying out a Works” further stipulates that “debris disposal, cleanup, and initial stabilization must be carried out as part of the works. The capacity of any culverts and bridges in a watercourse crossing must ensure that enough freeboard is provided to pass floating debris and ice without affecting the stability of the watercourse crossing or creating a potential for a blockage of the flow of the water body and the capacity of any culverts and bridges in a watercourse crossing must ensure that the increase in any back-flooding does not result in flood damage to private and public property.”
- British Columbia indicated that all provincial railways must comply with the safety criteria specified in the provincial, and in the provincially adopted federal legislative requirements. These requirements call for railway companies to operate and maintain their railway systems, including drainage systems, within an approved set of safety standards.
- Manitoba indicated that the province does an annual inspection of drains, if a portion of the railway lies within a provincial waterway.
- New Brunswick indicated that any new or modified railway crossing of a watercourse requires a permit under the Watercourse and Wetland Alteration Regulation – Clean Water Act.

- Saskatchewan indicated that the Ministry of Highways and Infrastructure administers parts of The Railway Act applicable to provincially-regulated railways. These include short-line railways that begin and end within the province; it excludes Canadian National and Canadian Pacific railways. Furthermore, the Ministry of Highways and Infrastructure developed the Saskatchewan Track Safety Standards (revised January 2013) to guide safe operation of provincially-regulated railways. These standards require: drainage structures with the capacity to allow suitable drainage for expected maximum water flows, vegetation on railway property to not obstruct drainage, and railway operators to inspect bridges and culverts at least once per year. The Ministry of Highways and Infrastructure conducts a track inspection program annually, to ensure railways meet these standards.
- Several respondents highlighted the importance of a railroad drainage systems inspection, pointing out some of the negative consequences of inadequate drainage system maintenance. For example, investigation report R13W0124, released by the Transportation Safety Board of Canada, determined that inadequate water drainage led to the collapse of an embankment that caused the derailment of a VIA Rail (VIA) train near Togo, Saskatchewan on April 28, 2013. It was determined that a culvert at the derailment location had been blocked by an ice plug for some time. The plugged culvert, in combination with a sudden, rapid melting of surface snow in the area, led to water saturation and destabilization of the embankment. The embankment began to fail prior to the passage of the train.
- On April 28, 2013, a Canadian Pacific Railway freight train, proceeding westward from Wilkie, Saskatchewan to Hardisty, Alberta, derailed 17 cars loaded with potash at Mile 80.7 on the Hardisty Subdivision, near Provost, Alberta. Approximately 350 feet of track was destroyed. The investigation report R13E0069, released by the Transportation Safety Board of Canada, found that the limited capacity of the drainage system beside the tracks led to the saturation of the track bed and created a void under the tracks. As the heavily loaded train crossed that section of the tracks, the weakened track structure failed, resulting in a derailment.

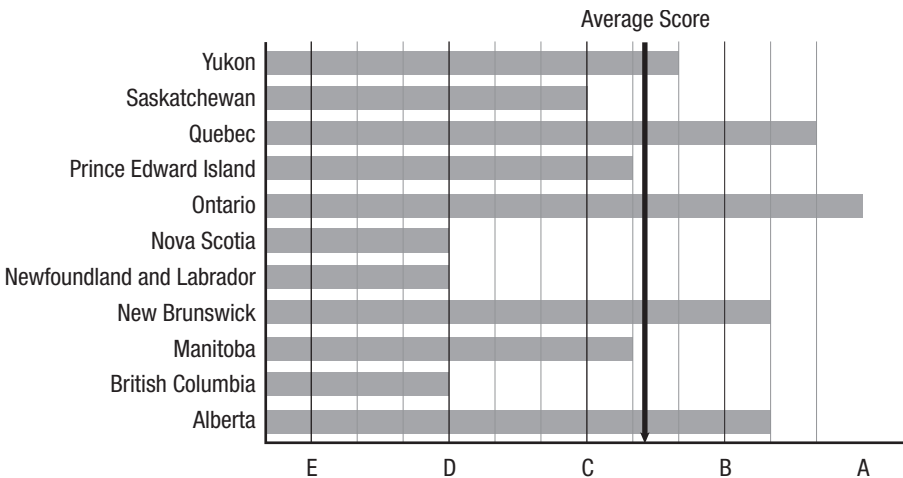
Highways and Roads

Highways and roads continue to be the dominant mode of transport for the movement of goods in Canada. The flooding of highways and roads, and the washouts of bridges, roads and parts of highways all generate considerable costs for restoration and repair, and they contribute to thousands of road collisions every year.¹⁹

Survey Question 3C: In reference to the drainage capacity of provincial highways and roads (excluding resource and forest service roads), what level of program does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure highway and road drainage pipes, culverts, and ditches remain free of debris, and the policy is in operation as confirmed by regular audits.
- B. A province-wide policy is in place to ensure highway and road drainage pipes, culverts, and ditches remain free of debris.
- C. A province-wide policy is in place to mandate that highway and road drainage pipes, culverts, and ditches are cleared of debris during times of the year when the potential for flooding is high.
- D. A province-wide policy is in place to clear highway and road drainage pipes, culverts, and ditches on an “as needed” basis.
- E. No relevant policies are in place to ensure that highway and road drainage pipes, culverts, and ditches remain free of debris.

FIGURE 2.3C *Drainage System Maintenance, Distribution of Scores for Highways and Roads*



Highways and Roads – Commentary Provided

- Alberta indicated that while the province maintains provincial roads, it outsources highway maintenance. Accordingly, there may be issues with monitoring and auditing of contractors' maintenance activities.
- Ontario indicated that transportation routes are regularly monitored. Each region in the province manages its respective area, including contracts for highway maintenance. For local roads, municipalities operate their own drainage systems using provincial standards and guidelines. Conservation authorities use their technical capacity to support this work at the municipal level.
- Prince Edward Island indicated that the province experienced major flooding in 2014, and many culverts are being reviewed and enlarged following this flood event.
- Quebec noted, the province has a rigorous management program for maintenance and audit of drainage assets, including culverts and adjacent ditches. The province is in the process of developing similar programs for other storm drainage facilities.
- Saskatchewan ensures highway and road drainage systems are effective through the following actions:
 - Cleaning out debris from bridges or culverts;
 - Removing silt deposits that have accumulated in ditches in the highway right-of-way, so original drainage patterns can be restored;
 - Removing debris in drainage channels to permit drainage;
 - In the spring, opening bridges and culverts blocked by snow or ice;
 - Removing snow from drainage channels in highway right-of-way, to permit drainage;
 - Repairing any damaged culverts;
 - Removing beaver dams in drainage channels in the right-of-way, with the cooperation of Saskatchewan Environment (SE) and the Department of Fisheries and Oceans (DFO); and
 - Restricting beavers from plugging culverts by placing “beaver guards” over culvert ends.

- Yukon indicated the territory inspects drainage pipes, culverts, and ditches to ensure proper drainage along its roads and highways. The territory also makes sure ditches are clear of debris, with special emphasis placed on ensuring any brush cleared from highway right-of-ways is kept clear of the ditches. Most of these efforts are not formalized in policy, but are undertaken as operational practices. Yukon's road forepersons understand that such measures are necessary to ensure both the integrity of the transportation network and the safety of the travelling public, and these expectations are clearly communicated to them by the territory. For culverts that are 150 cm in diameter or more, inspections are formalized, and they are subject to regular inspection intervals, as part of the bridge inspection policy.
- Some respondents pointed out that **the clogging of the drainage pipes, culverts and ditches by debris and fine-grade soil is one of the most important maintenance issues in the current drainage systems. Accordingly, more attention must be given to drainage improvements and maintenance.**
- Several participants indicated that municipal roads and county roads are the responsibility of local authorities; shifting responsibilities to local governments without proper funding increases the flood vulnerability of transportation systems in remote communities and small municipalities.

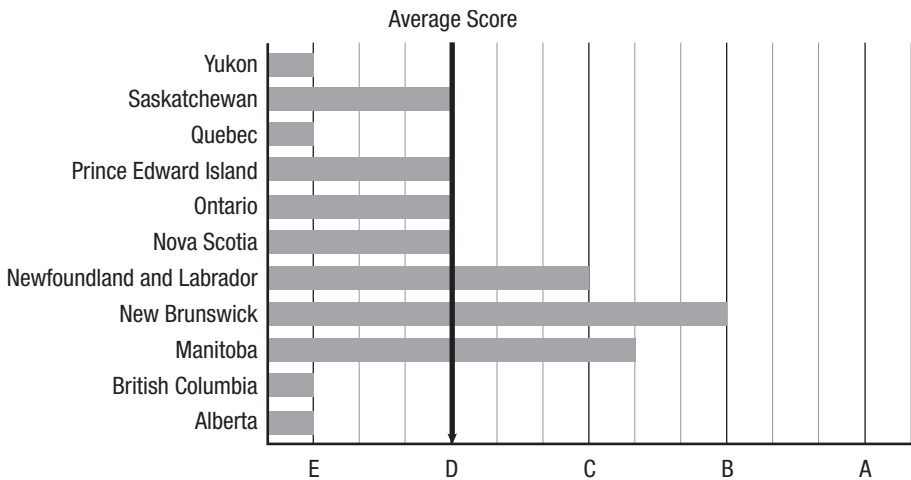
Agricultural Lands

As agricultural land use in Canada has increased, extensive tile drainage networks (artificial drainage in the form of horizontal subsurface drains) and ditch systems have been developed to move water more efficiently off the land and into stream channels. However, loss of hydrologic storage on watersheds and in floodplains, and poor drainage maintenance, increase the severity of floods.²⁰

Survey Question 3D: In reference to the drainage capacity of agricultural systems, what level of policy does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure agricultural drainage systems (surface and subsurface) are properly functioning, and the policy is in operation as confirmed by audits.
- B. A province-wide policy is in place to ensure agricultural drainage systems (surface and subsurface) are properly functioning.
- C. Our jurisdiction encourages owners/managers of agricultural lands to inspect drainage systems (surface and subsurface) during times of the year when the potential for flooding is high
- D. Our jurisdiction encourages owners/managers of agricultural lands to inspect drainage systems (surface and subsurface) on an “as needed” basis.
- E. No relevant policies are in place to ensure agricultural drainage systems (surface and subsurface) function properly during floods.

FIGURE 2.3D *Drainage System Maintenance, Distribution of Scores for Agriculture*



Agricultural Lands – Commentary Provided

- Alberta noted, provincial legislation and policy require provincial approvals for agricultural drainage works. The approval holder is required to operate and maintain drainage systems as legislated. However, there is no requirement for inspection of drainage systems, or other actions, during flood events.

- British Columbia noted, oversight on dike and drainage activities is the local government's role. However, the province acknowledges that water quality, which is under provincial regulation, is often affected by runoff from agricultural lands.
- Manitoba indicated agricultural drainage networks are a shared responsibility between provincial and local governments. Agricultural land owners are responsible for inspecting drains on their own land.
- New Brunswick indicated The Agricultural Land Protection and Development Act defines a drain as “a channel, open ditch, tile drain, grassed waterway, or conservation structure to remove surface or sub-surface water” and prohibits the interference of the passage of water without the consent of those whose land is served by the drain. Responsibility for the monitoring, maintenance and repair of the dikes, dams, aboiteaux (gated sluices) and common drainage on approximately 37,000 acres of agricultural land – protected by tidal control infrastructure in the southeastern part of the province – was recently transferred to the Department of Transportation and Infrastructure. Inspections are regularly carried out by the Department of Transportation and Infrastructure at both high and low water conditions.
- Newfoundland and Labrador indicated that the Environmental Farm Planning Program provides guidance to farmers on the importance of undertaking annual inspections and maintenance of farm drainage systems. In addition, a Farm Drainage Specialist works closely with farm producers to help with installation of new drainage systems and advise on the appropriate maintenance and inspection of existing drainage systems.
- Ontario indicated agricultural drainage systems are developed according to the provincial standards and guidelines of Food and Rural Affairs of the Ministry of Agriculture. Inspection and management of these systems is generally based on the needs of landowners and road authorities. Conservation authorities encourage the inspection and maintenance of agricultural drainage, so as to avoid flooding issues.
- Prince Edward Island indicated factsheets are available describing how to conduct regular maintenance of agricultural drainage systems. The Department of Agriculture and Fisheries offers a program under Growing Forward 2 that assists farmers with the construction of surface drainage structures to control runoff.
- Quebec noted, the maintenance of drainage systems is at the discretion of farm owners.

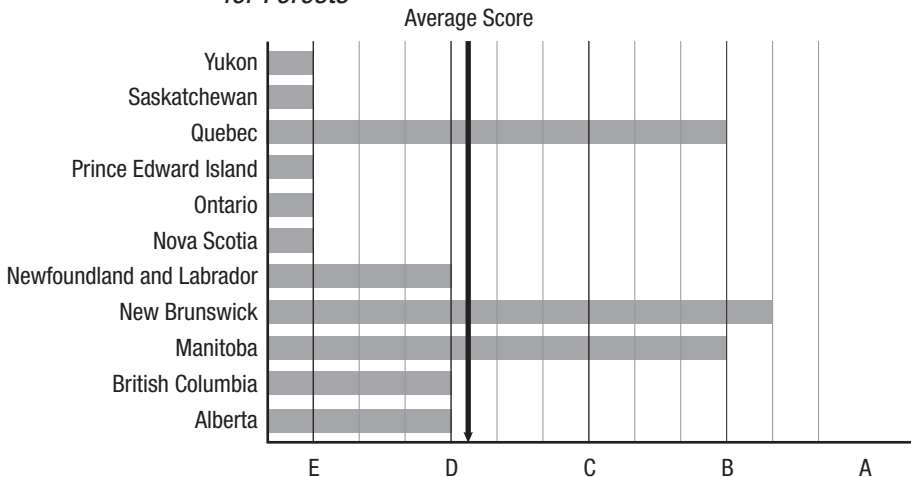
Forest Lands

As part of forest management, man-made drainage systems, such as ditches and sedimentation ponds, are utilized to drain excess water to existing streams or outlet channels during flood events. Regular ditch maintenance is required, to ensure that flood water runoff is reduced and the risk of mud flows and landslides is minimized. Accordingly, maintenance of forest drainage systems is an important factor in decreasing the probability of flooding.²¹

Survey Question 3E: In reference to the capacity of man-made drainage systems of forests under provincial jurisdiction, what level of policy does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure man-made drainage systems are properly maintained, and the policy is in operation; as confirmed by regular inspections.
- B. A province-wide policy is in place to ensure man-made drainage systems are properly maintained.
- C. A province-wide policy is in place to ensure man-made drainage systems are properly maintained during times of year when the potential for flooding is high.
- D. A province-wide policy is in place to ensure man-made drainage systems are properly maintained on an “as needed” basis.
- E. No relevant policies are in place to ensure forest man-made drainage systems are properly maintained.

FIGURE 2.3E *Drainage System Maintenance, Distribution of Scores for Forests*



Forest Lands – Commentary Provided

- Four provinces and Yukon selected option E for this survey question, indicating they have no relevant policies to ensure that man-made drainage systems in their forests are properly maintained.
- Alberta indicated that under Alberta’s Forest Planning Standard and Operating Ground Rules, forest companies are required to build drains where forest roads cross streams within their areas of operation. These stream crossings must have adequate capacity to convey flow during 1-in-100- year storm events. Companies are further required to regularly inspect these crossings to ensure they are functional. To protect public safety, companies must also ensure the crossings are in stable condition for forestry trucks and other users of forestry roads to be able to pass over the crossings safely.
- New Brunswick indicated that drainage systems are installed according to provincial standards. The Crown Lands and Forests Act is the legal foundation of public (Crown) forest management in the province. Regular inspections are performed on the designated Crown forest roads. Secondary forest road crossings receive fewer inspections and are maintained on an “as needed” basis.
- Nova Scotia commented the installation of manmade drainage systems in forests must abide by the Forests Act and requires certification of the installer. A Certified Installer is a person who has completed rigorous training in placement, sizing, grade, and site preparation for watercourse crossings. Application for watercourse installations must be made to the Department of Environment and granted approval prior to commencement of activity.
- Quebec indicated that the Forests Act guides forestry standards for Crown land. It requires regular users of forest watercourses to ensure they are free flowing. Government officials conduct inspections, when forest management activities are carried out on Crown lands.

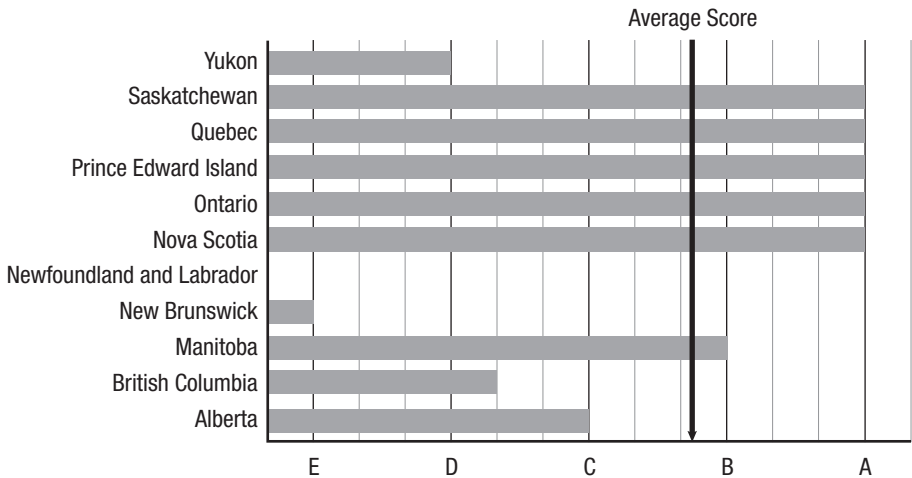
Solid Waste Landfills

According to Statistics Canada, in 2012, Canada generated 25,013,204 tonnes of solid non-hazardous waste. Municipal solid waste collection, diversion (recycling and composting) and disposal operations are the responsibility of municipal governments; the provinces and territories are responsible for approvals, licensing and monitoring of these operations.²²

Survey Question 3F: In reference to the drainage capacity of solid waste landfills, what level of program does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure dikes, embankments, and drainage structures maintain sufficient capacity, and the policy is in operation as determined based on audits.
- B. A province-wide policy is in place to ensure dikes, embankments, and drainage structures maintain sufficient capacity.
- C. A province-wide policy is in place to mandate that owners/operators check drainage structures to maintain sufficient capacity during times of the year when the potential for flooding is high.
- D. A province-wide policy is in place to mandate owners/operators to check that drainage structures maintain sufficient capacity on an “as needed” basis.
- E. No relevant policies are in place to ensure drainage structures maintain sufficient capacity.

FIGURE 2.3F *Drainage System Maintenance, Distribution of Scores for Solid Waste Landfills*



Note: Newfoundland and Labrador selected the N/A response for this question; accordingly, its response was not included in the scoring above. No commentary provided.

Solid Waste Landfills – Commentary Provided

- Alberta indicated that as per Waste Control Regulation (A.R. 192/96), drainage structures must be designed to convey and divert both run-on and run-off water for 1-in-25-year 24-hour storm events (run-on water is water that has not come in contact with an active landfill; run-off water is water that has come in contact with

an active landfill). Landfill drainage structures must be inspected by the landfill owners after such storm events, and the run-off water must be held and tested prior to release. Alberta noted, as a recommended best management practice, landfill facilities should not be developed within floodplains or areas that would flood during a 1-in-100-year flood event. However, these best management practices are not prescribed in legislation, code of practice, or in any of the landfill standards. Moreover, a landfill application must include topographic information of the proposed landfill site and evidence that the landfill site is suitable. Although many of the existing landfills predate departmental oversight, generally there are very few existing landfills that are located in low lying areas. Also, as per the Municipal Government Act (Section 664), landfill development is restricted in areas that are subject to flooding.

- Ontario indicated the development and operation of solid waste landfills is regulated by the Ministry of Environment and Climate Change. This Ministry ensures drainage issues are addressed in the development of solid waste landfills. Should the Ministry have concerns regarding flooding in a solid waste landfill site, and if that flooding is associated with lands regulated by conservation authorities, the Ministry will seek input from the relevant conservation authority on how to address flood risks.
- Quebec indicated that Article 14 of the Regulation Respecting the Landfilling and Incineration of Residual Materials (REIMR) prohibits the installation of an engineered landfill in the flood zone of a watercourse or body of water that is within the 1-in-100-year flood line delineation. Furthermore, Article 30 of the REIMR requires that landfills be designed to prevent surface water from penetrating into the drop zones where residual materials are stored, or into any another residue collection system. In summary, landfills are located outside 1-in-100-year flood zones, and measures to ensure drainage of surface water are a provincial requirement.

Abandoned Contaminated Sites

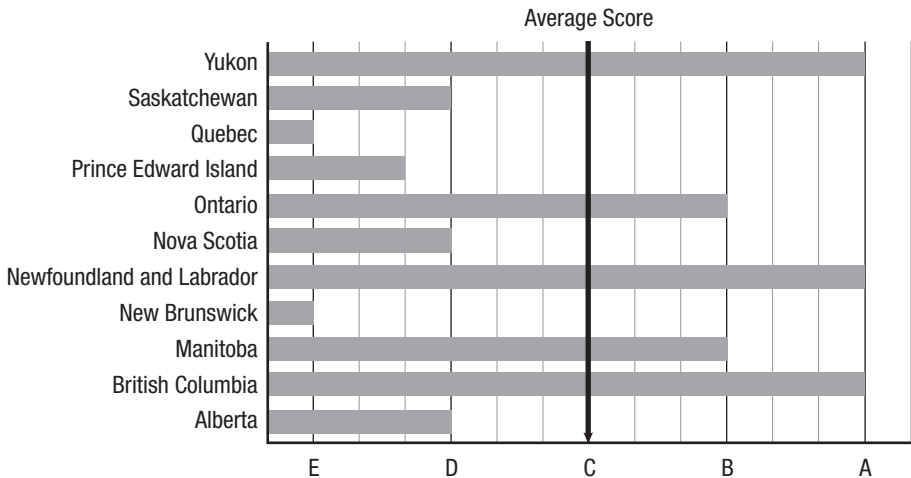
According to the definition adopted by the Government of Canada, a contaminated site is “one at which substances occur at concentrations (1) above background (normally occurring) levels and pose, or are likely to pose, an immediate or long term hazard to human health or

the environment, or (2) exceeding levels specified in policies and regulations.”²³ Of particular concern are the abandoned, neglected or orphaned mine tailings sites in flood-prone areas, where neglect of water diversion structures and/or flooding beyond design capacity may result in inundation and potential waste spills into the environment. It is estimated that there are 30,000-50,000 provincial and territorial abandoned and contaminated sites.²⁴

Survey Question 3G: In reference to the drainage systems of abandoned contaminated sites, what level of program does your jurisdiction have in place?

- A. A province-wide policy is in place to ensure dikes and other drainage structures maintain sufficient capacity, and that the policy is in operation as confirmed by regularly scheduled file audits.
- B. A province-wide policy is in place to ensure dikes and other drainage structures maintain sufficient capacity, and the policy is in operation, as confirmed by ad hoc field audits.
- C. A province-wide policy is in place to ensure that dikes and other drainage structures maintain sufficient capacity during times of the year when the potential for flooding is high.
- D. A province-wide policy is in place to mandate owners/operators check that drainage structures maintain sufficient capacity on an “as needed” basis.
- E. No practices are in place to ensure drainage structures of abandoned contaminated sites maintain sufficient capacity.

FIGURE 2.3G *Drainage System Maintenance, Distribution of Scores for Abandoned Contaminated Sites*



Abandoned Contaminated Sites – Commentary Provided

- Alberta noted, drainage structures depend on the nature of the activity, whether it was originally approved, or whether there is an ongoing risk management plan in place for the site. For approved activities or activities that require ongoing risk management, surface water runoff will be addressed as part of the approval, where needed; drainage structures cannot be decommissioned without prior approval.
- Nova Scotia's Contaminated Sites Regulations and its Environment Act have a polluter pay principle. Accordingly, under the regulatory process, individual property owners/the person responsible are required to retain the services of a site professional to manage the risks. The Environmental Emergency Regulations allow the province to take measures, in the event that the person responsible is unknown, unable or unwilling to manage the risks under the regulatory process, and there is potential for significant adverse effects.
- Ontario indicated the management of contaminated sites is regulated by the Ministry of Environment and Climate Change. This ministry ensures that management of the contaminated sites addresses drainage concerns. Should the ministry have concerns regarding flooding, and if potential flooding is associated with lands regulated by a conservation authority, the ministry will seek input from the conservation authority. Another area of provincial oversight is ensuring the long-term physical stability of tailings dams and other containment structures, as per the Mine Rehabilitation Code of Ontario. Under this code, proponents must follow the requirements of the "Dam Safety Guidelines," published by the Canadian Dam Safety Association. Additionally, water control infrastructures are regulated by the Ministry of Natural Resources and Forestry, under the Lakes and Rivers Improvement Act.
- Saskatchewan noted, requirements for abandoned contaminated sites are site-specific and depend on the nature of the facility and associated risks. Typically, dikes and drainage structures are required to be inspected regularly, as per individual permit conditions. However, each site has its unique requirements, depending on the specific risks identified through permitting.
- **Some respondents noted, collaboration between different levels of government and private owners is needed to remediate contaminated sites as well as the watersheds located downstream.**

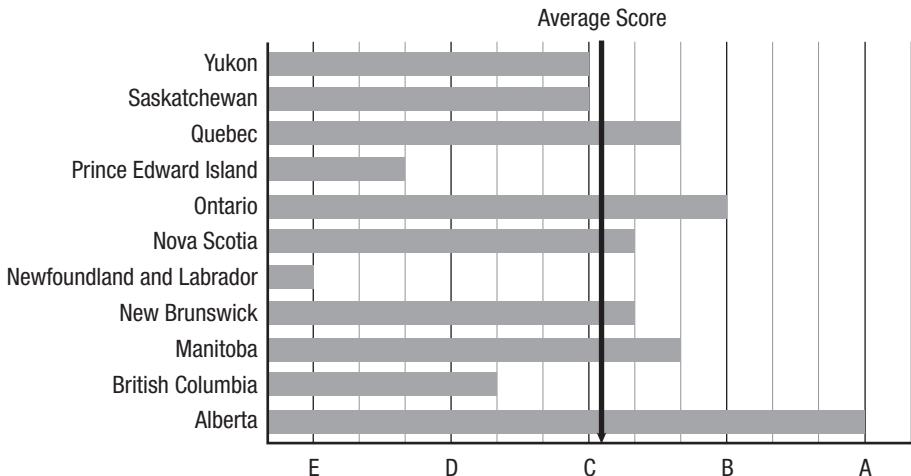
2.4 Planning and Implementation of Sustainable Flood Management

According to the Government of Scotland (which pioneered the concept of sustainable flood management), sustainable flood management means planning at a catchment level and considering natural land-use management techniques, such as floodplains and restored wetlands, as important components of flood management.²⁵

Survey Question 4: In reference to the natural capacity of floodplains to mitigate flooding, what level of program does your jurisdiction have in place?

- A. Our jurisdiction provides financial assistance to local governments to implement programs of restoring and maintaining the natural capacity of floodplains, focusing on relocation of pre-existing development out of the floodplain, on conservation and restoration of wetlands and riparian areas.
- B. Our jurisdiction provides guidance to local governments on programs of restoring and maintaining the natural capacity of floodplains, focusing on prevention of new development on floodplains, on conservation and restoration of wetlands and riparian areas.
- C. Our jurisdiction provides guidance to local governments on programs for maintaining the natural capacity of floodplains, focusing on conservation of wetlands and riparian areas.
- D. Our jurisdiction currently reviews provincial policies and programs to restore and maintain the natural capacity of floodplains to mitigate flooding.
- E. Our jurisdiction is not involved in the development of programs to restore and maintain the natural capacity of floodplains to mitigate flooding.

■ FIGURE 2.4 *Sustainable Flood Management, Distribution of Scores*



Planning and Implementation of Sustainable Flood Management – Commentary Provided

- British Columbia provides assistance to Cowichan Valley Regional District (CVRD). In partnership with Cowichan Tribes, the City of Duncan, and the District of North Cowichan (DNC), the province retained Northwest Hydraulic Consultants (NHC) to update existing floodplain mapping and develop an Integrated Flood Management Plan for the Lower Cowichan-Koksilah River floodplain, including its major tributaries. The province is exploring whether it will pay for land acquisition, or provide funding to reallocate dike infrastructure to re-establish marshland.
- Newfoundland and Labrador noted, the province participates in the Interdepartmental Land Use Committee (ILUC) to review and comment on any proposal or policy within government for the restoration of floodplains.
- **Ontario noted, limited provincial funding is available to address the restoration and maintenance of natural capacity in the floodplains. Municipalities sometimes fund these initiatives through the conservation authorities, whereby they work together to promote integrated watershed management and develop watershed plans that recognize the natural capacity of floodplains to attenuate flooding.**
- Prince Edward Island indicated that it does not use floodplain mapping, since coastal flooding and storm surge are the predominant flood concerns in the province (as opposed to riverine flooding). At this point, the province does not have a program to encourage flood-resistant construction of infrastructure or the re-positioning of infrastructure away from flood hazard areas. The question of whether to include flood risk stipulations in provincial regulations is under discussion, as subdivision and development regulations are due to be revised.
- Quebec indicated that Article 53.13 of the Law on Planning and Development (LAU) provides the Minister of Sustainable Development, Environment and Climate Change (MDDELCC) with the power to request an amendment to land-use planning and development, if the development:
 - does not respect the policy of the government under Article 2.1 of the Environment Quality Act regarding bank protection policy, coastal areas and floodplains;

- violates the limits of a floodplain located in the territory of the competent body; or
- does not provide adequate protection for riverbanks, shorelines, and floodplains, given peculiarities of the environment.

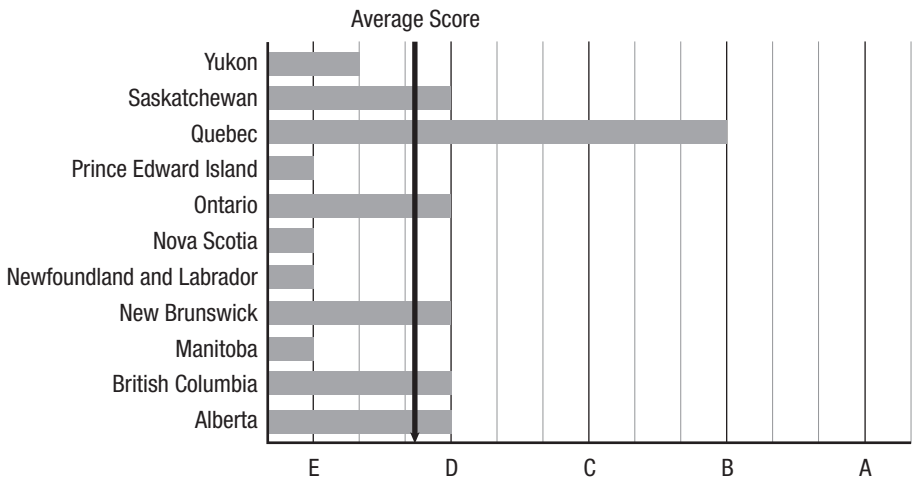
2.5 Home Adaptation Audit

To help homeowners assess their vulnerability to flooding and identify effective action to minimize the risk of basement flooding, some local authorities in Canada offer programs and subsidies for flood inspection/home adaptation audits. This question pertains to the support of such programs on the provincial level.

Survey Question 5: In reference to helping home owners limit the probability of household/basement flooding, what level of program does your jurisdiction have in place?

- A. Our jurisdiction provides a subsidy to home owners (> 50% cost) to home owners to be applied to a Home Adaptation Audit Program.
- B. Our jurisdiction provides a minimal subsidy (< 50% cost) to home owners to be applied to a Home Adaptation Audit Program.
- C. Our jurisdiction provides financial assistance to communities to develop a Home Adaptation Audit Program.
- D. Our jurisdiction provides guidance to communities in helping them to develop a Home Adaptation Audit Program (or equivalent).
- E. Our jurisdiction is not involved in the development of a Home Adaptation Audit Program.

■ FIGURE 2.5 *Home Adaptation Audit, Distribution of Scores*



Home Adaptation Audit – Commentary Provided

- Four provinces selected option E for this survey question, indicating they are not involved in the development of a Home Adaptation Audit Program.
- Ontario indicated household and basement flooding is a municipal responsibility, and programs vary across the province, with conservation authorities involved in some parts of the province. Funding is not available on a provincial basis.
- Quebec indicated regional county municipalities (MRCs) and local municipalities govern the structure, buildings, and major works located in flood zones and delineate flood zones.
- Saskatchewan noted, although the province does not work directly with homeowners in floodproofing their basements, it works with local jurisdictions to help them prepare emergency plans for their communities. The province offers limited information in the form of handouts and brochures, as well as information on the provincial website, with links to useful information from other agencies.
- Yukon Housing Corporation may approve low interest loans for property owners who apply for flood prevention measures on their properties.

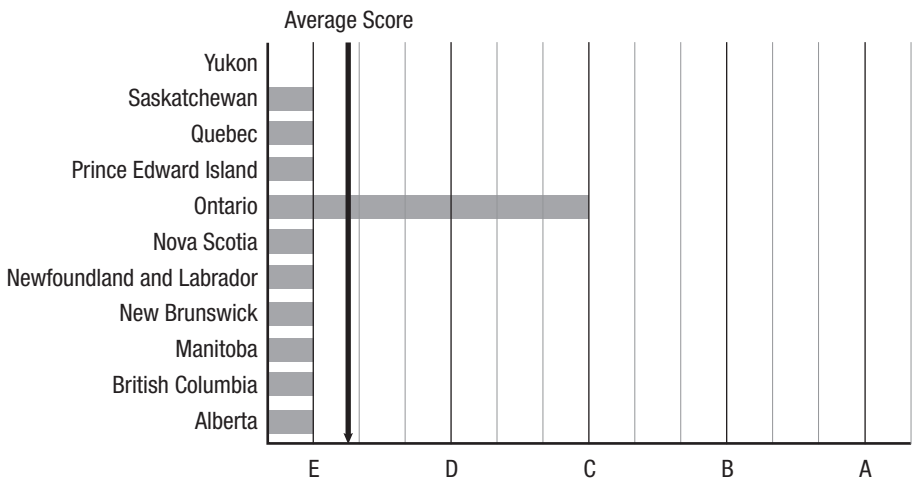
2.6 Commercial Property Adaptation Audit

To help businesses assess their vulnerability to flooding and identify effective action to minimize the risk of flooding, some local authorities in Canada offer programs and subsidies for flood inspection/commercial property adaptation audits. This question pertains to the support of such programs on the provincial level.

Survey Question 6: In reference to helping commercial real estate owners/managers limit the probability of flooding of commercial properties, what level of program does your jurisdiction have in place?

- A. Our jurisdiction has engaged with commercial real estate owners, provided funding to support best practices regarding adaptation, and supports processes of continuous improvement regarding adaptation.
- B. Our jurisdiction has engaged with commercial real estate owners, and provided funding to support best practices regarding adaptation.
- C. Our jurisdiction has engaged with commercial real estate owners, and developed guidance documentation, in reference to adaptation.
- D. Our jurisdiction has engaged with commercial real estate owners in reference to the need to engage adaptation.
- E. Our jurisdiction is not involved in the development of a Commercial Real Estate Adaptation Audit Program.

FIGURE 2.6 *Commercial Property Adaptation Audit, Distribution of Scores*



Note: Yukon selected N/A response option for this survey question; accordingly, its response was not included in the scoring above.

Commercial Property Adaptation Audit – Commentary Provided

- Nine provinces selected option E for this survey question, indicating they are not involved in the development of a Commercial Property Adaptation Audit Program.
- Ontario indicated conservation authorities support commercial real estate owners/managers. To limit the probability of flooding of commercial properties, they provide a comprehensive floodplain management program; the program includes flood forecasting and warning, development review, as well as guidance for floodproofing properties. Limited financial support is also available.

2.7 Flood Risk Mitigation for Transport Systems

“Transportation in Canada is the joint responsibility of all three levels of government, whose efforts are coordinated by the Council of Ministers Responsible for Transportation and Highway Safety. Generally speaking, the federal government oversees international and interprovincial transportation, the provincial governments are responsible for intra-provincial transportation, and the municipal governments manage urban transportation.”²⁶

Transportation systems cannot be easily relocated, redesigned, or reconstructed. In order to reduce economic losses and risks to public safety, the transportation planning process should assess the potential impacts of flooding on transportation systems and consider adaptation actions based on the new climate reality.²⁷

The following two questions relate to flood preparedness for the two modes of transportation:

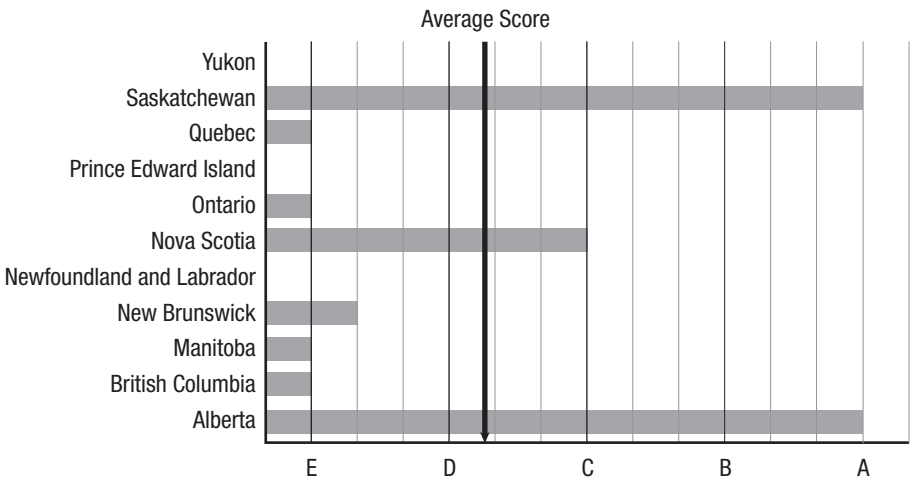
1. Railroads
2. Highways and Roads

Railroads

Survey Question 7A: In reference to helping railroad owners/operators anticipate and mitigate flood risk, what level of program does your jurisdiction have in place?

- A. Our jurisdiction requires railway owners/operators to identify flood risks, develop plans to mitigate risks, monitor the degree to which risks are mitigated, and to implement management systems with the aim of continuous improvement.
- B. Our jurisdiction requires railway owners/operators to identify flood risks, develop plans to mitigate risks, and to monitor the degree to which risks are mitigated.
- C. Our jurisdiction requires railway owners/operators to identify flood risks, and develop plans to mitigate risks.
- D. Our jurisdiction requires railway owners/operators to identify flood risks
- E. Our jurisdiction is not involved with identifying the vulnerability of railways systems to flooding

FIGURE 2.7A *Flood Risk Mitigation for Transportation Systems, Distribution of Scores for Railroads*



Note: Newfoundland and Labrador, Prince Edward Island, and Yukon selected the N/A response for the survey question, noting there are no railroads under their respective jurisdictions. Accordingly, these responses were not included in the scoring above.

Railroads – Commentary Provided

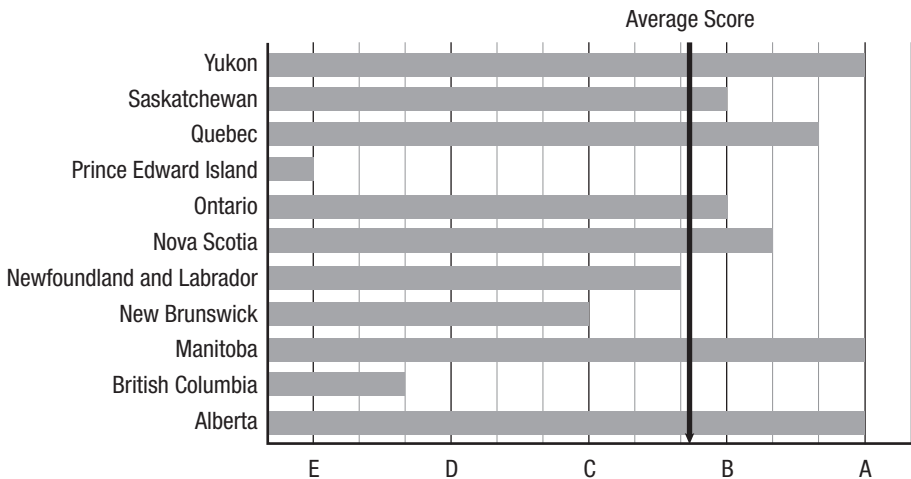
- British Columbia indicated that it does not currently have a dedicated provincial program aimed at flood reduction for railway lines. However, following federal review of the Lac- Mégantic, Quebec, incident, British Columbia indicated the desire to work with railroad owners on risk mitigation (including flood risk). To date, work with railway owners has resulted in some early success; for example, infrastructure improvements now allow for longer and faster trains have been implemented.
- Ontario noted, it engages with rail partners and local municipalities in emergency planning and preparedness for the transportation of dangerous goods. Upon request, conservation authorities support railways in flood risk mitigation efforts by providing flood forecasting and warning tools, infrastructure review, and guidance for floodproofing existing infrastructure. This engagement is in the form of support to provincial railways and is not a requirement of the conservation authorities.
- Saskatchewan noted, there is no formalized process in place to address flood risks, specifically. However, provincially-regulated railways must understand and identify flood risks informally, to meet the demands of the Saskatchewan Track Safety Standards. Accordingly, provincially regulated railways are required to develop safety management plans. The ministry has developed a Provincial Railway Guide PRG 1005, for the development of such safety management plans. The guide identifies that a safety management plan should contain a number of processes, including:
 - develop emergency response plans;
 - conduct risk assessments;
 - implement and evaluate remedial action; and
 - continual improvement in the operation of a safety management plan.
- Respondents noted, some of the privately owned railroad owners barely generate enough revenue to keep rail lines operating. Flood mitigation measures often cost millions of dollars to implement and, therefore, may be financially prohibitive to these smaller players. **Hundreds of railroad lines were constructed in pluvial valleys (often on lands under federal jurisdiction) to take advantage of flat floodplains and avoid costly crossings. Accordingly, the implementation of flood mitigation measures requires federal support.**

Highways and Roads

Survey Question 7B: In reference to helping owners/operators of provincial highways and roads anticipate and mitigate the risk of flooding, what level of program does your jurisdiction have in place?

- A. Our jurisdiction co-operates with owners/operators of highways and roads in flood risk assessment and management, and identifies and financially supports adaptation initiatives.
- B. Our jurisdiction provides risk assessment tools and co-operates with owners/operators of highways and roads in flood risk assessment and in the development of adaptation initiatives.
- C. Our jurisdiction mandates owners/operators of highways and roads to identify flood risks, and it approves and oversees implementation of adaptation initiatives.
- D. Our jurisdiction mandates owners/operators of highways and roads to identify flood risks and approves adaptation initiatives.
- E. Our jurisdiction is not involved with identifying the vulnerability of highways and road networks to flooding.

FIGURE 2.7B *Flood Risk Mitigation for Transportation Systems, Distribution of Scores for Highways and Roads*



Highways and Roads – Commentary Provided

- Alberta noted, the province has authority over provincial highways. However, it also works closely with local authorities to inspect bridges and structures under their control and to provide funding for adaptation measures intended to reduce flood risks.

- Ontario noted, the Ministry of Transportation manages provincial highways and roads for the province. It is the ministry that provides risk assessment tools, such as Intensity-Duration-Frequency curves and updated weather information. As part of the new project approval process, the ministry requires submission of hydrology reports, including flood risk mitigation options. Conservation authorities provide support in the form of floodplain mapping and review of applications, when requested by the ministry.
- Saskatchewan noted, the Ministry of Highways and Infrastructure is the owner and operator of the provincial highway network. It regularly works with the provincial Water Security Agency to assess flood risk to transportation infrastructure in the province.
- Yukon does not have any privately owned highways, nor any contractual arrangements for the operation and/or maintenance of any stretches of highway by private entities. The Transportation Maintenance Branch of the Department of Highways and Public Works is solely responsible for highway operation and maintenance.
- Emergency Measures Organization and Environment Yukon issue an annual detailed hydrological report on flood risks just prior to spring, as well as weekly flood risk assessment reports during periods of high potential flood risk (spring/fall). These reports are monitored and used to align work priorities, in order to mitigate flood risk. If an area is identified as being particularly susceptible to flooding, road crews inspect all drainage infrastructure (culverts, ditches, etc.) in that area to ensure preparedness for any large scale hydrological event.
- In terms of financial support for adaptive initiatives, Yukon undertakes all such measures independently, and allocates the requisite monies from the Community Services departmental budget. Yukon strives to identify highway infrastructure needs and undertakes improvements to the safety and quality of its highways on an ongoing basis. Drainage infrastructure improvement was noted, as a key facet of an ongoing territorial improvement approach to highway operation and maintenance.

- Some respondents indicated more funding should be provided for infrastructure upgrades that consider climate resilience. This is important for infrastructure replacement following flood events, as the “replacement in kind” does not typically consider future flood risks and vulnerabilities from the standpoint of redesign. **To ensure infrastructure is effective to withstand current and future climatic conditions, “replacement in kind” should require incorporation of future flood risks and vulnerabilities during redesign and new construction.**

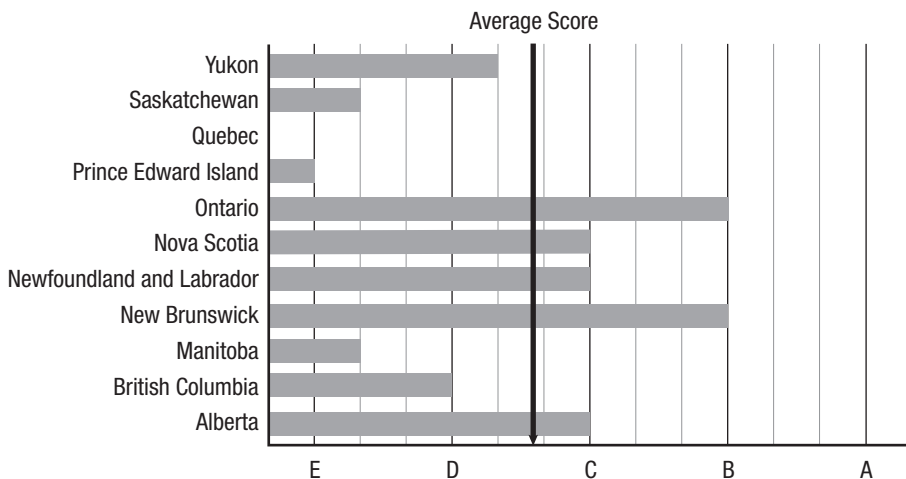
2.8 Flood Risk Mitigation for Electricity Supply

The reliability and continuity of electricity supply relies on integrated generation, transmission and distribution systems. Flooding is a threat to effective performance of these systems, as stormwater can inundate transmission substations, damage power poles and wash out distribution feeders, all of which result in significant restoration and damage repair costs. Moreover, power outages may impact the operation of essential life support systems, including: water treatment plants and sewage pumping stations, hospitals and health care facilities, emergency centres, and transportation and telecommunication systems. This question pertains to the support of flood risk mitigation programs for the electricity sector at the provincial level.

Survey Question 8: In reference to helping owners/managers of power networks anticipate and mitigate risk of flooding, what level of program does your jurisdiction have in place?

- A. Relative to electricity supply, our jurisdiction co-operates with owners/operators of power networks in flood risk assessment and management, identifies and financially supports adaptation initiatives.
- B. Relative to electricity supply, our jurisdiction provides risk assessment tools and co-operates with owners/operators of power networks in flood risk assessment and in development of adaptation initiatives.
- C. Relative to electricity supply, our jurisdiction mandates owners/operators of power networks to identify flood risks, approves and oversees implementation of adaptation initiatives
- D. Relative to electricity supply, our jurisdiction mandates owners/operators of power networks to identify flood risks, and approves adaptation initiatives.
- E. Our jurisdiction is not involved with identifying the vulnerability of power networks to flooding.

■ **FIGURE 2.8** *Flood Risk Mitigation for Electricity Supply, Distribution of Scores*



Note: Quebec selected the N/A response option for this survey question, stating that Hydro-Québec is responsible for the continuity of the supply of electricity. Accordingly, its response was not included in the scoring above.

Flood Risk Mitigation for Electricity Supply – Commentary Provided

- Manitoba noted, the province works with Manitoba Hydro on flood risk mitigation projects. The scope of involvement varies by project type.
- Ontario indicated that conservation authorities support owners/managers of power networks in flood risk mitigation efforts.
- British Columbia noted, the province provides funding for First Nations to establish independent power projects; upon determining required capacity, the province then enables these communities to become power producers.
- In addition to provincial officials, representatives of two public utilities, SaskPower and Yukon Energy, provided responses and commentary to this survey question:
 - SaskPower identified flood risks that may affect its existing facilities, structures, and apparatus and took measures to mitigate flooding based on seasonal flood risks. SaskPower also noted, flood risk is a consideration in the selection of new facility sites.

- Yukon Energy noted, the territorial government stages an annual spring flood briefing; it publishes snow survey bulletins three times a year that include peak flow forecasts. The provincial government is not engaged in the flood risk mitigation effort, as it pertains to electrical supply and generation.

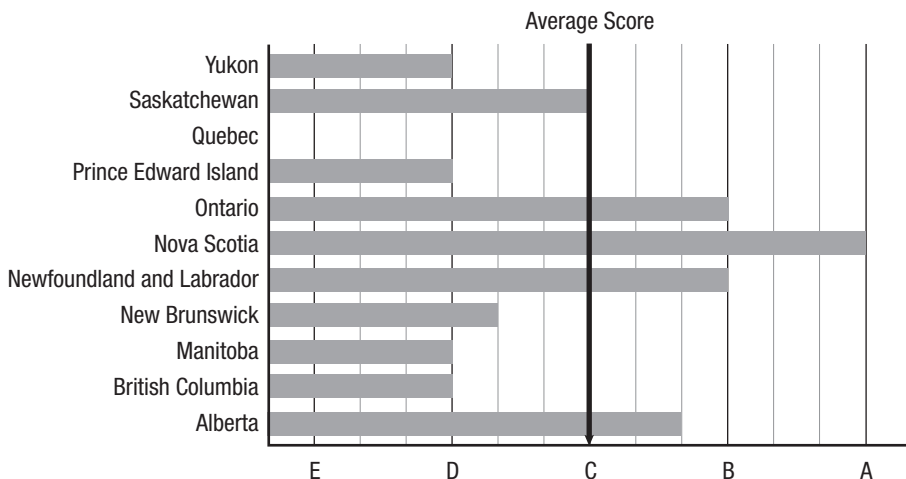
2.9 Flood Risk Mitigation for Drinking Water Systems

Contamination of drinking water is one of the most serious public health threats associated with flooding. Floodwater can quickly transport pathogens, dioxins, heavy metals, cyanide, hydrocarbons, and hazardous chemicals from contaminated sites located in flood-prone or low-lying areas.²⁸ This question explores how drinking water sources are protected from the negative impacts of flooding at the provincial level.

Survey Question 9: To what level has your jurisdiction factored flood mitigation into maintaining the continuity of drinking water supply in municipalities and rural communities?

- A. Relative to drinking water supply, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment and management, identifies and financially supports adaptation initiatives.
- B. Relative to drinking water supply, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment and management, and identifies adaptation initiatives.
- C. Relative to drinking water supply, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment and management, and approves adaptation initiatives.
- D. Relative to drinking water supply, our jurisdiction provides guidance to local governments regarding flood risk assessments and adaptation initiatives.
- E. Our jurisdiction is not involved with identifying flood risk related to maintaining the continuity of drinking water supply.

■ **FIGURE 2.9** *Flood Risk Mitigation for Drinking Water System, Distribution of Scores*



Note: Quebec selected N/A response for this survey question, indicating that water supply management is a municipal responsibility. Accordingly, its response was not included in the scoring above.

Flood Mitigation for Drinking Water Systems – Commentary Provided

- Alberta indicated that the province will provide \$500 million in grant funding over 10 years to: municipalities, special areas, improvement districts, First Nations and Métis settlements. It is intended to help ensure public safety and protect critical municipal infrastructure. This funding is part of the provincial Alberta Community Resilience Program and may include water supply systems protection from flooding.
- British Columbia indicated that each community has its own water purveyor, who has the ultimate responsibility for providing safe drinking water to end users in the province. The purveyor follows the drinking water safety regulations of the Ministry of Forests, Lands and Natural Resource Operations.
- Prince Edward Island indicated the province provides guidance to municipalities regarding water wells and water quality maintenance; however, this guidance is not specific to flood risks. The province indicated that strong controls are in place for groundwater protection, as groundwater is the only source of drinking water in Prince Edward Island.

- Respondents indicated the federal Gas Tax Fund helps local governments address water supply system risks, including the disruption of underground piping during flood events. Municipal governments have the opportunity to apply for funding to assess water treatment plant preparedness. Water treatment plants are assessed for their ability to handle extreme changes in source water quality – created by runoff or significant rainfall.

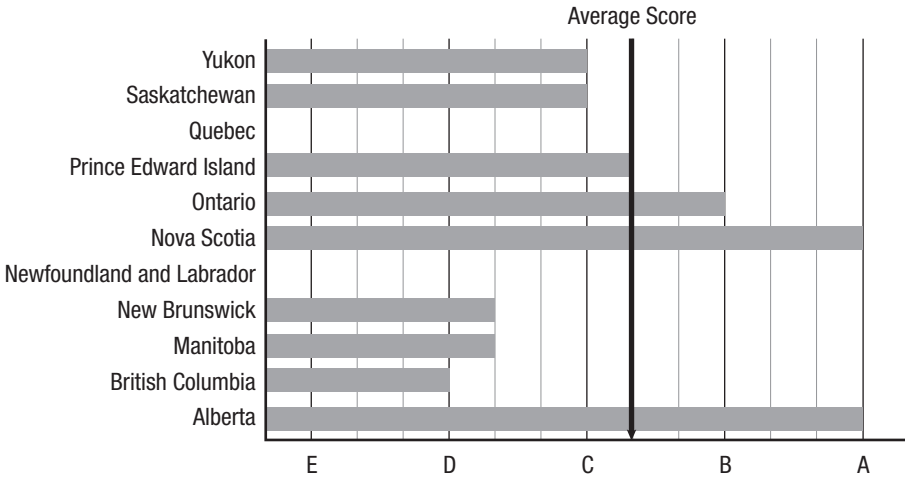
2.10 Flood Mitigation in Wastewater Systems

Wastewater systems provide communities with the critical and essential service of removing contaminants from wastewater. Wastewater treatment facilities are frequently located on floodplains and can be inundated by flood water in the absence of flood mitigation measures. Inundated wastewater facilities can suffer malfunctions and mechanical failures, resulting in environmental spills and contamination of nearby land, waterways and drinking water supplies.

Survey Question 10: To what level has your jurisdiction factored flood mitigation into maintaining the integrity of waste water management in municipalities and rural communities?

- A. Relative to waste water management, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment, identifies and financially supports adaptation initiatives.
- B. Relative to waste water management, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment, and identifies adaptation initiatives.
- C. Relative to waste water management, our jurisdiction co-operates with municipalities and rural communities in flood risk assessment, and approves adaptation initiatives.
- D. Relative to waste water management, our jurisdiction provides support to local governments regarding flood risk assessments and adaptation initiatives.
- E. Our jurisdiction is not involved with identifying flood risk related to waste water management.

■ FIGURE 2.10 *Flood Risk Mitigation in Wastewater Systems, Distribution of Scores*



Note: Newfoundland and Labrador and Quebec selected N/A response for this survey question, indicating that water supply management is a municipal responsibility. Accordingly, their response was not included in the scoring above.

Flood Mitigation for Wastewater Systems – Commentary Provided

- British Columbia indicated the province is not formally involved in identifying flood risks for wastewater facilities, as this is typically a responsibility of the local governments. Through the Flood Protection Program (FPP), which ended in March 2016, the province provided opportunities to local governments to improve flood mitigation structures and protect drinking water and wastewater facilities. This program was an application-based program, with local governments obliged to identify flood protection priorities in order to be eligible for funding. Through the new National Disaster Mitigation Program, the province will be more involved in flood risk assessment to identify significant issues regionally and provincially.

- Manitoba noted, within the Designated Flood Areas, permanent structures (including wastewater systems) must be provided with flood protection, and lagoon dikes must be constructed to the appropriate flood protection levels.
- Prince Edward Island cooperates with wastewater treatment system operators in assessing flood risks. The province also assists these operators with obtaining federal infrastructure funding to address concerns. Such infrastructure funding is typically provided through a joint effort between the province, federal government and municipalities for projects; municipalities are required to develop asset management plans before seeking this funding.
- **Several respondents indicated that a significant number of remote communities in Canada have no central wastewater systems. These communities often rely on septic systems and discharge sewage water into neighboring water bodies. Respondents stated this is an area of serious concern and requires immediate climate adaptation action.**

2.11 Public Health and Safety

Floods can directly impact public health and safety. Disruption of “normal” health service activities, or delayed access to medical services may pose an immediate threat to human health. If flooding leads to the release of contaminants into the environment, it may pose long-term impacts on human health. The following three questions pertain to provincial and territorial regulations and policies, which relate to the following areas of responsibility:

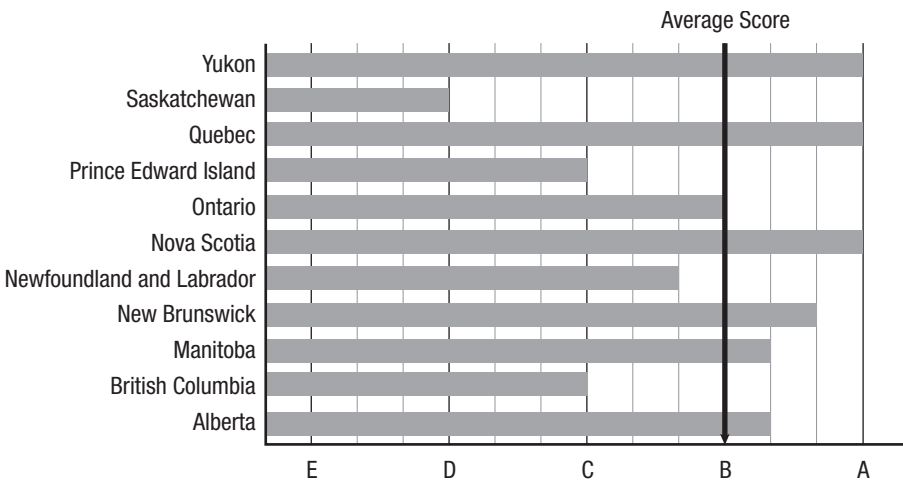
1. Health service delivery
2. Safety of communities located in close proximity to pipelines.
3. Safety of communities located in close proximity to abandoned contaminated sites.

Health Service Delivery

Survey Question 11A: To what level has your jurisdiction factored flood mitigation into maintaining the capacity of hospitals and local public health units to support the continuity of health service delivery in municipalities and rural communities?

- A. To ensure staff and patient safety and continuity of service delivery, our jurisdiction co-operates with owners/managers of hospitals in flood risk assessment and management, identifies and financially supports adaptation initiatives.
- B. To ensure staff and patient safety and continuity of service delivery, our jurisdiction co-operates with owners/managers of hospitals in flood risk assessment and management, and identifies adaptation initiatives.
- C. To ensure staff and patient safety and continuity of service delivery, our jurisdiction mandates hospitals to identify flood risks, and subsequently approves and controls implementation of adaptation initiatives.
- D. To ensure staff and patient safety, and continuity of service delivery, our jurisdiction provides guidance to hospitals regarding flood risk assessment and management
- E. Our jurisdiction is not involved with the development and implementation of flood mitigation strategies for hospitals located in municipalities and rural communities.

■ FIGURE 2.11A *Flood Risk Mitigation for Health Service Delivery, Distribution of Scores*



Health Service Delivery – Commentary Provided

- Alberta indicated that Alberta Infrastructure plans and constructs health facilities, as required by the provincial healthcare authority, Alberta Health Services. Alberta Infrastructure developed the document entitled “Flood Risk Management Guidelines for Location of New Facilities Funded by Alberta Infrastructure.” This document outlines various risk management considerations for all types of critical infrastructure funded by the Government of Alberta, including new health facilities. As per the guidelines, sites for new hospitals, medical facilities and extended care facilities (including ancillary facilities such as power plants, service and maintenance facilities) are required to be 0.5 meters above the 1-in-1,000-year design flood elevation.
- British Columbia has a broad range of publicly funded health services delivered through five regional health authorities, and one provincial health authority that delivers specialized provincial services and Providence Health Care. These health authorities are responsible for: acute care services delivered in hospitals, public health, residential care, community care, mental health services, prehospital emergency services, and a range of other health services. With a few exceptions, British Columbia does not have health care facilities that are at risk of flooding. Health care facilities are typically located on higher ground, or behind a primary dike system (e.g. in the Fraser Valley). These sites also have emergency plans in place, in the event a failure of the primary dike system occurs.
- Flooding is a hazard that Manitoba experiences on an annual basis, and Manitoba’s regional health authorities (RHAs) have been through a number of significant flood events that have required implementation of various mitigation, preparedness, response and recovery measures. All RHAs in Manitoba have dedicated disaster management programs. The province’s disaster management staff works collectively within health regions to ensure appropriate systems, processes, plans and procedures are in place to ensure continuity of all health services. These plans pertain to all hazards and focus on common consequences, with procedures and protocols in place for flood threats. The plans address continuity of care for

patients and staff and all facets of the health sector – from facility to community-based services. The plans are tested on a regular basis and updated accordingly, as per the principles of continuous quality improvement. In addition, “Lessons Learned” reviews are conducted following flood events. The intention of these post-event reviews is to enhance systems and processes, and incorporate lessons learned into future responses.

- New Brunswick noted, the province has health clinics in all 15 First Nations communities. During crises, there is a provincial protocol between First Nations, the province, and the Federal First Nations Inuit Health Branch of Halifax to provide emergency health services.
- The Department of Health collaborates closely with regional health authorities, Ambulance New Brunswick, physicians, and other health sector partners to identify flood and other hazards that pose a danger to the health system or to the health of the public. The Department of Health Emergency Preparedness and Response Branch is responsible for the design, implementation and maintenance of a comprehensive all hazards emergency management program for the provincial health system; it is responsible to effectively prepare for, respond to, and recover from health emergencies, regardless of cause, scope or location. The branch is also responsible for ensuring that functional areas within the health system are able to fulfill their responsibilities under the New Brunswick Emergency Measures Act, and that health system partners have undertaken the necessary preparedness planning to respond effectively to emergencies (including coordinated and integrated actions with other partners).
- Ontario noted, over the last five years, and due to a variety of climate change conditions, the province experienced a number of localized flooding events in northwestern, central and southwestern Ontario. These events highlighted the importance of climate change adaptation and flood preparedness, response, and mitigation. Accordingly, the province, conservation authorities and municipalities are working together to ensure flood risk planning is an important component of emergency management plans. Generally, flooding in Ontario tends to occur in the same locations, around the same time of year, and for the same reasons. This trend has provided sound lessons, learned at all levels of government, to better plan and prepare for floods and their associated social, health, and economic impacts. It is provincial policy in Ontario that new building development associated with institutional services is not permitted in a

floodplain (e.g. hospitals, nursing homes and schools), as it would pose a significant threat to the safety of the inhabitants (i.e. the sick, the elderly, the disabled and the young). Where existing health services are located in flood vulnerable areas, conservation authorities provide support services to address and manage flood risk.

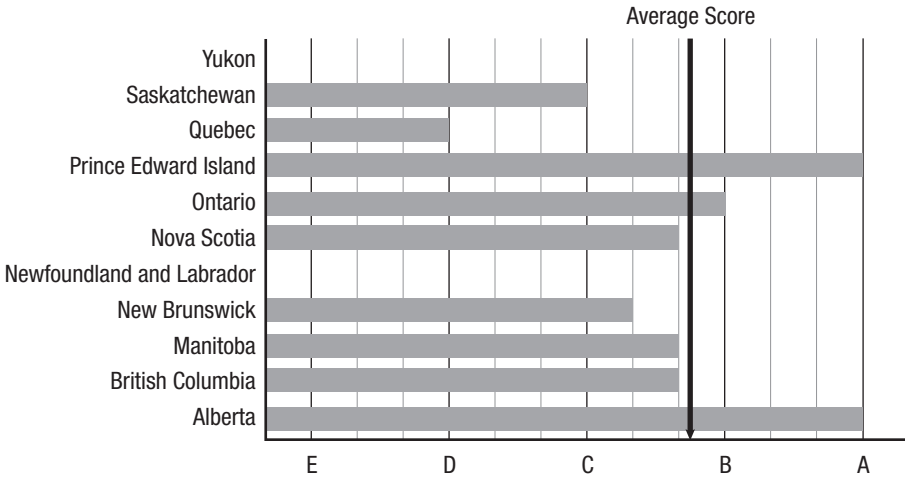
Safety of Communities Located in Close Proximity to Pipelines

Hazardous materials that are typically transported via pipelines include petroleum (crude oil, condensate, natural gas, natural gas liquids and liquefied petroleum gas); petroleum products (products from distilling and processing of crude oil and natural gas liquids); anhydrous ammonia; and ethanol.²⁹ These materials may pose a significant threat to public health and safety, if released into the environment. This question explores provincial and territorial action to protect the public from risks associated with release of these hazardous materials due to flooding.

Survey Question 11B: To what level has your jurisdiction considered flood risk factors in ensuring the health and safety of communities located in close proximity to pipelines carrying hazardous or potentially hazardous materials (i.e. gas, bitumen, oil, produced water)?

- A. To ensure health and safety of people living in close proximity to pipelines carrying hazardous or potentially hazardous materials, our jurisdiction co-operates with owners/operators of pipelines in flood risk assessment and management, identifies and financially supports adaptation initiatives.
- B. To ensure health and safety of people living in close proximity to pipelines carrying hazardous or potentially hazardous materials, our jurisdiction co-operates with owners/operators of pipelines in flood risk assessment and management, and identifies adaptation initiatives.
- C. To ensure health and safety of people living in close proximity to pipelines carrying hazardous or potentially hazardous materials, our jurisdiction mandates owners/operators of pipelines to identify flood risks, and subsequently approves and controls implementation of adaptation initiatives
- D. To ensure health and safety of people living in close proximity to pipelines carrying hazardous or potentially hazardous materials, our jurisdiction provides guidance to owners/operators of pipelines regarding flood risk assessment and management
- E. Our jurisdiction is not involved with developing and implementation of flood mitigation strategy for owners/operators of pipelines located in close proximity to municipalities and rural communities

■ FIGURE 2.11B *Safety of Communities Located in Close Proximity to Pipelines, Distribution of Scores*



Note: Newfoundland and Labrador and Yukon selected N/A response for this survey question, indicating that they have no communities in close proximity to pipelines. Accordingly, their response was not included in the scoring above.

Safety of Communities Located in Close Proximity to Pipelines – Commentary Provided

- British Columbia noted, every oil and gas operator must have emergency management plans that address all relevant operational risks. Through the permitting process, the province examines risk assessments submitted by gas operators, including risks both to the site and those created by the site. These risk assessments form the foundation for design, routing and mitigation strategies and plans. In British Columbia, water crossing regulations do not require that the environmental approval process include a flood risk assessment. However, the mandatory pipeline standard (CSA Z662) requires a risk assessment for all identified hazards.
- New Brunswick requires that all pipeline owners must have their own emergency plans. Environmental impact assessment and emergency management plans are valid throughout all pipeline operations, from the construction to the decommissioning phase.

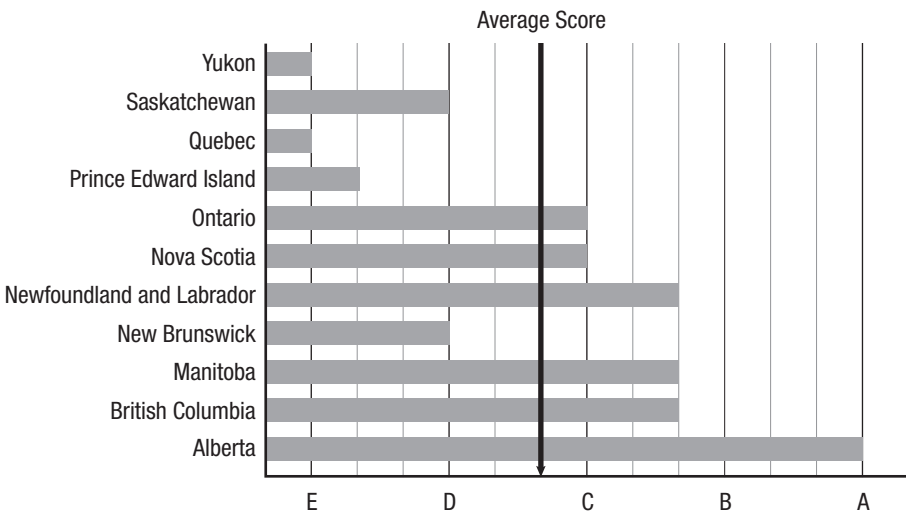
- Nova Scotia pointed out that pipelines carrying hazardous, or potentially hazardous materials, are privately-owned but the province exercises general regulatory supervision over pipelines. The province has developed a network of critical infrastructure partners that enables sharing of information, such as business continuity plans to address critical issues, including flood risk hazards. The location of critical infrastructure, including pipelines, determines the extent of the interaction. The province operates under a graduated response model. If pipelines are located within a municipality, the Nova Scotia Emergency Management Office's regional staff coordinates with the municipality, critical infrastructure partners, and other relevant parties to coordinate the most appropriate emergency management plan.
- Ontario recognizes that private and public partners involved in the transportation of potentially dangerous goods must collaborate on emergency management planning and mitigation opportunities. The province works with large pipeline companies to ensure their emergency management plans are: robust, linked with provincial and municipal plans, exercised and tested on a regular basis, and considered in broad emergency management risk assessment activities. This includes pre-emptive action and mitigation of flood risks.
- Respondents also noted, there are problems associated with corrosion of pipelines abandoned in place, including groundwater and soil contamination. This may have larger impacts, not just on the private landowners of the pipeline sites, but also on the communities located along the route of the abandoned pipelines.
- Some respondents indicated the responsibility associated with public safety rests primarily with the municipalities. **Thus, more collaboration is needed between provinces, municipalities and pipeline owners to ensure adequate emergency management planning for areas where pipelines are laid.**

Safety of Communities Located in Close Proximity to Abandoned Contaminated Sites

Survey Question 11C: To what level has your jurisdiction considered flood risk factors in ensuring the health and safety of communities located in close proximity to abandoned contaminated sites?

- A. To ensure health and safety of people living in close proximity to abandoned contaminated sites, our jurisdiction co-operates with local governments in flood risk assessment and management, and identifies and financially supports adaptation initiatives.
- B. To ensure health and safety of people living in close proximity to abandoned contaminated sites, our jurisdiction co-operates with local governments in flood risk assessment and management, and identifies adaptation initiatives
- C. To ensure health and safety of people living in close proximity to abandoned contaminated sites, our jurisdiction mandates local governments to identify flood risks, and subsequently approves and controls implementation of adaptation initiatives.
- D. To ensure health and safety of people living in close proximity to abandoned contaminated sites, our jurisdiction provides guidance to local governments regarding flood risk assessment and management.
- E. Our jurisdiction is not involved with the development and implementation of flood mitigation strategies for abandoned contaminated sites.

■ FIGURE 2.11C *Safety of Communities Located in Close Proximity to Abandoned Contaminated Sites, Distribution of Scores*



Safety of Communities Located in Close Proximity to Abandoned Contaminated Sites – Commentary Provided

- British Columbia has a Brownfield Redevelopment funding program which includes remediation of contaminated sites.
- Nova Scotia indicated the province requires municipalities to develop climate adaptation plans. These plans have to include identification of hazardous sites and the determination of appropriate mitigation/spill responses, as required for the hazard. Under the contaminated sites regulations, site professionals must develop a conceptual site model, and evaluate and manage risks for all potentially active pathways.
- Ontario engages with communities across the province to identify, plan, and prepare for potential flooding where abandoned contaminated sites are located. This work is led by the Ministry of the Environment and Climate Change. The provincial information is made available to local authorities whose emergency management plans consider: the impact and response action required to address a flooding event where contaminated sites may be affected, and how to contain contaminated areas. The joint provincial and municipal planning work is strengthened through continuous dialogue and community engagement. Contamination risks are managed through: proper land-use planning, strict environmental protection provisions, significant fines for contravention, comprehensive emergency management plans that include contaminated site risk assessments, and the exercising and testing of plans.
- Respondents noted, **the responsibility for abandoned contaminated site inventories falls under numerous governmental departments. This leads to a lack of consistency in the treatment of abandoned contaminated sites across Canada.**

2.12 Emergency Preparedness and Response

Canada's Emergency Management Act sets out the leadership role and responsibilities of the Minister of Public Safety and Emergency Preparedness, including coordination of emergency management activities among government institutions, in cooperation with the provinces and other entities.³⁰ Each province and territory responds to floods in cooperation with local authorities. The following four questions address the overarching provincial and territorial approach to flood-related

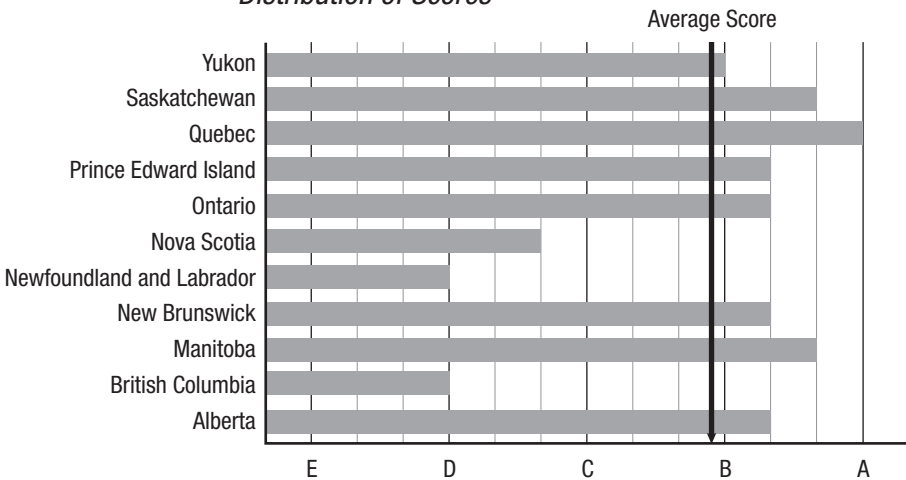
emergency preparedness and response, as well as specific actions to ensure continuous delivery of petroleum and electricity supply, and reliable telecommunication services.

Emergency Response

Survey Question 12A: To what level has your jurisdiction factored flood preparedness to ensure the ability of emergency responders to respond (e.g. fire, police, ambulance and hospitals)?

- A. Relative to emergency responders, our jurisdiction co-operates with local governments in flood risk assessment and management, identifies and financially supports adaptation initiatives, and maintains a system of continuous improvement.
- B. Relative to emergency responders, our jurisdiction provides risk assessment tools and co-operates with local governments in flood risk assessment and in the development of adaptation initiatives.
- C. Relative to emergency responders, our jurisdiction mandates local governments to identify flood risks, approves and oversees implementation of adaptation initiatives.
- D. Relative to emergency responders, our jurisdiction mandates local governments to identify flood risks, and approves implementation of adaptation initiatives.
- E. Our jurisdiction is not involved with identifying flood risk related to ensuring the ability of emergency responders to respond.

FIGURE 2.12A *Emergency Preparedness and Response, Distribution of Scores*



Emergency Response – Commentary Provided

- Manitoba noted, during a flood emergency, the province employs the following two actions:
 - Utilizes its network to share minute-to-minute road information (for both provincial and municipal roads) with first-responder dispatch organizations to ensure efficient and safe routing of responders to calls in the flood zone; and
 - Asks communities to identify key transportation routes that should be protected (if possible) to ensure public safety. This becomes an indicator of where recovery priorities should be focused.
- New Brunswick noted, during the Spring Freshet (March to April annually), the province conducts the annual River Watch program, which is a joint undertaking between: the New Brunswick Emergency Measures Organization, the hydrology section of the Department of Environment and Local Government, Environment Canada meteorology, and the New Brunswick River Forecast Centre. This program involves a network of river gauges and cameras, ice observers, as well as staff dedicated to monitoring: river flow rates, water levels in critical areas, the implications of precipitation, and ice jams. Collected information is provided to all stakeholders and the public (via websites and 1-800 information lines) for situational awareness and decision making. In this way, threatened areas can be informed, forewarned, and take preparatory actions to minimize impacts. Where necessary and appropriate, public advisories are generated to inform on developing or current threats. Daily risk assessments are compiled and distributed to stakeholder departments and agencies, to assist in operational decision making. Flood inundation mapping and historical data are also employed to inform planning and preparedness activities.
- Ontario works proactively with all municipal first-responder services to help develop detailed emergency response plans that address a variety of natural disasters, including flooding. First responder services include tactics, incident management, and operational practices in response to community flooding. Exercises to test emergency plans and first-responder services are among the important steps delivered by communities to support an effective response.

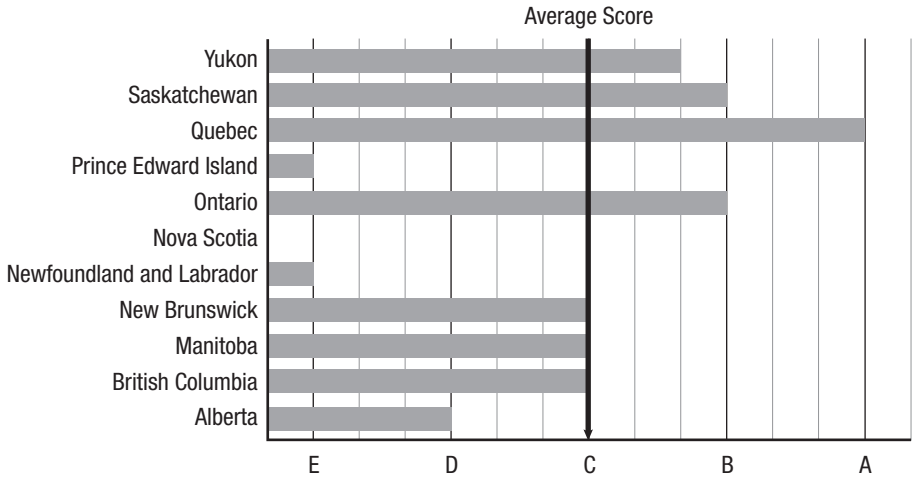
- The Emergency Management and Fire Safety (EMFS) Branch provides communities, fire departments and emergency management organizations in Saskatchewan with programs and services that: (1) protect people, property, and the environment from fire and other emergencies; (2) build local community capacity to respond to emergencies; and (3) enhance public safety across the province.
- The Yukon government provides seasonal flood risk assessments to all communities and emergency agencies, in order for them to take appropriate actions.
- Some respondents indicated that the range of local authority responses can vary dramatically, depending on the severity of a flooding event and the resources available within the local authority.

Petroleum Supply

Survey Question 12B: To what level has your jurisdiction factored flood mitigation into maintaining the continuity of petroleum supply (gas, oil, and diesel) in municipalities and rural communities?

- Relative to petroleum supply, our jurisdiction mandates local governments to identify flood-related vulnerabilities, financially supports adaptation initiatives, and oversees implementation of adaptation initiatives.
- Relative to petroleum supply, our jurisdiction provides risk assessment tools and co-operates with local governments in the development and implementation of adaptation initiatives.
- Relative to petroleum supply, our jurisdiction guides local governments to identify flood risks, approves and oversees implementation of adaptation initiatives.
- Relative to petroleum supply, our jurisdiction guides local governments to identify flood risks, and approves adaptation initiatives.
- Our jurisdiction is not involved with identifying the vulnerability of petroleum supply in municipalities and rural communities to flood risks.

■ FIGURE 2.12B *Emergency Preparedness and Response, Distribution of Scores for Petroleum Supply*



Note: Nova Scotia selected the N/A response for this survey question; accordingly, its responses were not included in the scoring above. The province provided the following commentary:

- The Nova Scotia Emergency Management Office (NS EMO) has developed an extensive network of critical infrastructure partners. Developing these relationships allows sharing of information, including business continuity plans. Together, the partners address issues, including flood risk hazards, in order to coordinate a provincial response. Nova Scotia operates under a graduated response model. The location of the critical infrastructure would determine the extent of NS EMO interaction. Where critical infrastructure is located within a specific municipality, NS EMO regional staff coordinates with the municipality, as well as with the critical infrastructure partners and any other relevant parties, to coordinate the most appropriate response.

Petroleum Supply – Commentary Provided

- Ontario noted, the province works closely with the petroleum industry through the Ministry of Energy. The provincial Emergency Fuel Plan and Emergency Energy Plan apply to flood events, where flooding may cut fuel supply and require alternate transportation, access and deployment of fuel sources. Municipalities are encouraged to work with their energy partners in the private and public sectors; they are urged to be aware of, plan for, and deploy in advance, necessary fuel resources based on known risks and associated Hazard Identification and Risk Assessments (HIRAs). In areas of Ontario where flooding has been prevalent, the province continues to be diligent in working to integrate emergency plans among private and public sector partners, to ensure flooding and the impact to fuel sources are addressed. Ontario’s Critical Infrastructure Assurance Program (OCIAP) focuses on energy supply in Ontario and considers the implications of flooding and fuel supply requirements during an emergency.

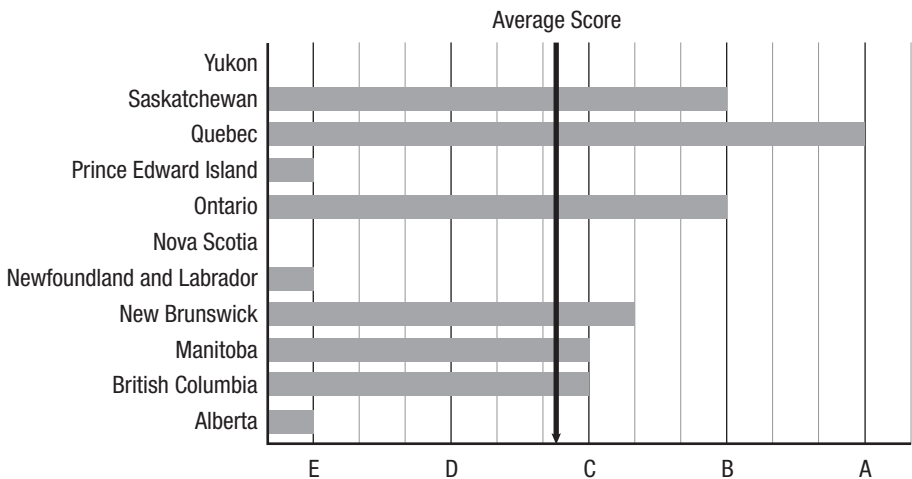
- Saskatchewan indicated that the province is working with the Critical Infrastructure Advisory Network (CIAN), an advisory group of about 30 critical infrastructure owners and operators, government officials and security groups. The goal is to involve representatives from 10 different sectors: finance, water, government, transportation, food, health, manufacturing, energy and utilities, safety, and telecommunications. Together, CIAN advisors engage in the following:
 - Identify linkages and establish effective lines of communication between the Government of Saskatchewan and owners of critical infrastructure, both public and private;
 - Promote education and awareness of issues, including training and exercises;
 - Promote self-sufficiency and resiliency across all sectors, through effective emergency management, security, and business continuity programs;
 - Have a common site that acts as a secure, shared database; and
 - Ensure alignment of provincial critical infrastructure planning with the national and international stage.
- Some responders indicated that **petroleum storage facilities may be located in low lying areas where they may be subject to inundation. As the environmental regulations are strengthened, local jurisdictions will need to ensure that flood issues at these storage facilities are addressed.**

Telecommunications

Survey Question 12C: To what level has your jurisdiction factored flood mitigation into maintaining the continuity of telecommunications networks (phone, internet, and TV)?

- A. Relative to telecommunications, our jurisdiction mandates local governments to identify flood-related vulnerabilities, financially supports adaptation initiatives, and oversees implementation of adaptation initiatives.
- B. Relative to telecommunications, our jurisdiction provides risk assessment tools and co-operates with local governments in the development and implementation of adaptation initiatives.
- C. Relative to telecommunications, our jurisdiction guides local governments to identify flood risks, approves and oversees implementation of adaptation initiatives.
- D. Relative to telecommunications, our jurisdiction guides local governments to identify flood risks, and approves adaptation initiatives.
- E. Our jurisdiction is not involved with identifying flood risk related to maintaining the continuity of telecommunications in municipalities and rural communities.

■ FIGURE 2.12C *Emergency Preparedness and Response, Distribution of Scores for Telecommunications*



Note: Nova Scotia and Yukon selected the N/A response for this survey question; accordingly, their responses were not included in the scoring above.

Telecommunications – Commentary Provided

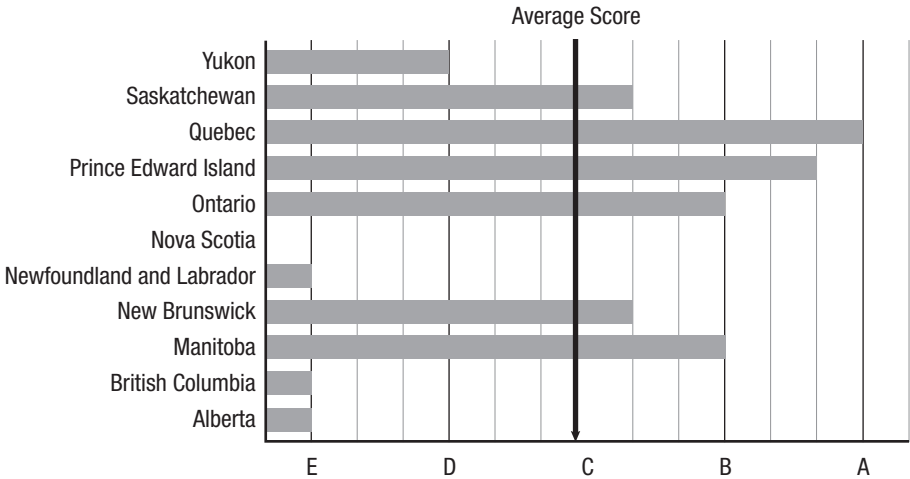
- The Nova Scotia Emergency Management Office (NS EMO) has developed an extensive network of critical infrastructure partners. Developing these relationships allows sharing of information, including business continuity plans; together, the partners address issues, including flood risk hazards, in order to coordinate a provincial response. Nova Scotia operates under a graduated response model. The location of the critical infrastructure would determine the extent of NS EMO interaction. Where critical infrastructure is located within a specific municipality, NS EMO regional staff consults with the municipality, as well as the critical infrastructure partners and any other relevant parties, to coordinate the most appropriate response.
- In Yukon, the local service provider, Northwestel, through normal capital development, operations and maintenance, is aware of flood risks to telecommunications assets across its operating area. It continually takes steps to mitigate and reduce risks to infrastructure, operations and maintenance activities.
- Manitoba noted, each community has created a plan to address its flood risks, including risks to telecommunications sites. The plans include how to work with local property owners to mitigate the community's flood risks. Additionally, the Emergency Measures Organization (EMO) works closely with telecommunications providers to identify vulnerabilities and develop response plans. The province also maintains and operates a radio network that enables responders to communicate directly during network outages. Finally, the province, in partnership with a volunteer organization, has the capacity to use ham radios to establish and maintain communications during a crisis.
- Ontario works closely with telecommunications partners to plan for emergencies affecting their systems, as well as ensure that a back-up energy supply, alternate telecommunication provisions, public alerting, response teams and required support resources are in place. Private broadcasters and Canadian Radio-television and Telecommunications Commission assist Ontario in ensuring that planning related to flood events is integrated and telecommunications are maintained. Through partnerships with the broadcasters, local media, and conservation authorities, Ontario provides early warnings, updated situational awareness, and timely communications to ensure Ontarians are prepared in anticipation of flooding.

Electricity Supply

Survey Question 12D: To what level has your jurisdiction factored flood mitigation into maintaining the continuity of electricity supply?

- A. Relative to electricity supply, our jurisdiction mandates local governments to identify flood-related vulnerabilities, and financially supports and oversees the implementation of adaptation initiatives.
- B. Relative to electricity supply, our jurisdiction provides risk assessment tools and co-operates with local governments in development and implementation of adaptation initiatives.
- C. Relative to electricity supply, our jurisdiction guides local governments to identify flood risks, approves and oversees implementation of adaptation initiatives.
- D. Relative to electricity supply, our jurisdiction guides local governments to identify flood risks, and approves adaptation initiatives.
- E. Our jurisdiction is not involved with identifying flood risk related to maintaining the continuity of electricity supply in municipalities and rural communities.

FIGURE 2.12D *Emergency Preparedness and Response, Distribution of Scores for Electricity Supply*



Nova Scotia selected the N/A response for this survey question; accordingly, its responses were not included in the scoring above.

Electricity Supply – Commentary Provided

- The Nova Scotia Emergency Management Office (NS EMO) has developed an extensive network of critical infrastructure partners. Developing these relationships allows sharing of information, including business continuity plans; together, the partners address issues, including flood risk hazards, in order to coordinate a provincial response. Nova Scotia operates under a graduated response model. The location of the critical infrastructure determines the extent of NS EMO interaction. Where critical infrastructure is located within a specific municipality, NS EMO regional staff consults with the municipality, as well as the critical infrastructure partners and any other relevant parties, to co-ordinate the most appropriate response.
- Ontario provides the Hazard Identification and Risk Assessment (HIRA) and associated risk assessment tools to support community planning and resilience with respect to energy management. Private sector electrical industry representatives are investing in state-of-the-art technology to enhance energy delivery and capacity in Ontario. Ontario also applies lessons learned from the 1998 Ice Storm, the 2003 Blackout and the 2013 Ice Storm, as well as from a number of other weather events that disrupted electricity supply. Lessons learned have resulted in the following:
 - Improved energy storage, including mobile energy storage facilities
 - Alternate energy sources (windmills)
 - Public communication on energy consumption during an emergency
 - Forestry and canopy management
 - Investment in emergency planning and preparedness
 - Exercising of local plans and resources.
- In addition, flood-related electrical outages have raised the need for adequate backup generation, alternative power supply, cross jurisdictional planning and personal preparedness to support public safety. Ontario is working closely with the power industry, local municipalities, and conservation authorities to assist in coordinating efforts to minimize power disruptions during flood events.
- Responders indicated that the **resilience of communities to floods is intrinsically linked to the capacity of power network owners**

and operators to deal with flood damages and disruptions during and after floods. They agreed that the vulnerability of power networks to flooding causes a domino-effect on other critical infrastructure, leading to disruptions in the operation of: water treatment plants, sewage, water pipelines and pumping stations, transportation and other critical systems. The continuity of electricity supply, or lack thereof, impacts the ability of emergency responders to act and to ensure public safety.

- Two public utilities, SaskPower and Yukon Energy, also provided responses and commentary to this survey question:
 - SaskPower provides guidance to local municipalities to ensure local emergency response plans include the risk of sustained power outages due to a variety of potential causes, including flooding. SaskPower works with individual municipalities to test their respective response plans, although it does not approve of adaptation initiatives external to its operations.
 - Yukon Energy noted, the provincial government is not involved in electrical supply and generation, or related adaptation initiatives.

3. Recommendations and Next Steps

The flood preparedness of Canadian provinces and Yukon, relative to the 12 categories of assessment reviewed in this report (p. iv), varies widely. This variance predisposes Canada to financial and social instability that will be realized during major precipitation events. To bring greater uniformity to national flood preparedness, the federal Minister of the Environment and Climate Change should organize a national forum of provincial and territorial counterparts. Business leaders should be invited to this forum, as suggested by survey participants to this report. Invitees should include, at the very least, leaders representing residential and commercial real estate, transportation systems, electricity supply and telecommunications providers.

Additional recommendations to help reduce provincial and territorial flood potential are described below:

Chief Adaptation Officer (CAO): A CAO specific to each province and territory would provide guidance to premiers, municipal leaders, businesses and others on ways and means to limit flood risk. Additionally, the CAO would ensure systems are in place to facilitate resiliency through proactive mitigation measures to reduce flood

risks and minimize impacts in the aftermath of flooding. Recognizing that flooding affects all sectors of society, the dedicated expertise of CAOs would be integral to maintaining the continuity of operations across provinces and territories in light of increasingly challenging extreme weather.

Oversight of Flood Mitigation Responsibilities: Jurisdictional restrictions (i.e. strict national, provincial and municipal responsibilities) should be held to a minimum in reference to flood risk. Recognizing that provincial floods do not stop and start relative to preordained federal, provincial and municipal authority, CAOs would facilitate efforts to ensure that parties responsible for a particular risk act with prudence to limit exposure. For example, a CAO might facilitate a meeting of railway transport companies to ensure they have comprehensive plans to address flood risk exposure.

Audited Flood Preparedness Reports: On a multi-year basis (e.g. every five years), provinces and territories should issue audited public reports that document their state of flood preparedness relative to the 12 categories of assessment considered in this report, and any material areas of challenge that may evolve.

Land-use Planning: Provinces and territories should mandate that development in flood-prone areas be restricted, or that such developments be flood resilient. It is unconscionable that developments are continuing in recognized flood zones, with limited flood mitigation controls in cities across Canada. In the absence of land-use planning that better addresses flood risk, federal Disaster Financial Assistance Arrangement (DFAA) assistance to provinces and territories should be limited. Similarly, property and casualty insurers may limit insurance coverage relative to foreseeable high flood risk.

Build Back Better: All levels of government must consider changing climate and extreme weather projections when financing new, and re-building, infrastructure. Participants noted that often there are funding restrictions for flood repairs post disaster that prohibit incorporation of resiliency measures and a higher level of protection than what was present historically. This may lead to infrastructure being built to inadequate levels of flood preparedness. Thus, where practically and actuarially cost-effective, infrastructure should be re-built to meet new and future-projected climate realities.

The Canadian provinces and Yukon are on a steep learning curve in reference to addressing flood preparedness. Historically, concern related to debilitating flooding was minimal – however, **the risks of the past are not the risks of the present, and certainly not the risks of the future. Establishing Chief Adaptation Officers in provinces and territories should be a priority for governments to address the growing extreme weather challenges.** CAOs should have direct line reporting to premiers, and they should issue periodic reports on the state of flood preparedness. The findings of these reports should be well promulgated, and the public, business community, and all levels of government should be charged with the task of addressing flood risk mitigation deficiencies.

APPENDIX: TOTAL ESTIMATED COST OF FLOODS IN CANADA

As per the Canadian Disaster Database maintained by Public Safety Canada, the total estimated cost of floods in Canada between 1970 and 2015 amounted to \$11,487,160,308 (expressed in 2015 dollars).

PROVINCE	LAND AREA	FRESHWATER	POPULATION	ABORIGINAL POPULATION	URBAN POPULATION	RURAL POPULATION	TOTAL ESTIMATED COST OF FLOODS
	km ²	km ²					CAD (2015)
Alberta	642,317	19,531	3,645,275	116,670	3,030,402	614,855	\$4,099,342,445
British Columbia	925,186	19,549	4,400,057	155,020	3,790,694	609,363	\$462,469,521
Manitoba	553,556	94,241	1,208,268	114,225	874,714	333,554	\$2,867,123,226
New Brunswick	71,450	1,458	751,171	16,120	394,479	356,692	\$269,070,345
Newfoundland and Labrador	73,872	31,340	514,536	19,315	305,566	208,970	\$83,387,348
Nova Scotia	53,338	1,946	921,727	21,895	521,338	400,389	\$52,798,941
Ontario	917,741	158,654	13,873,933	201,100	11,045,785	1,806,036	\$1,122,644,740
Prince Edward Island	5,660	0	140,204	1,515	65,543	74,661	\$8,815,984
Quebec	1,365,128	176,928	7,903,001	82,425	6,368,270	1,534,731	\$1,141,032,482
Saskatchewan	591,670	59,366	1,033,381	103,210	689,983	343,398	\$1,371,862,047
Yukon	474,391	8,052	33,897	6,585	20,562	13,335	\$8,613,227
Estimated Total Cost of Floods in Canada (1970-2015)							\$11,487,160,308

Note: Total Estimated Cost of Floods was calculated as a summation of all flood costs reported through the Canadian Disaster Database from 1970 to 2016. The Bank of Canada's inflation calculator was used to normalize these costs to 2015 Canadian dollars.

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