



APPLYING LESSONS FROM HOME FLOOD PROTECTION TO ENHANCE RESIDENTIAL EARTHQUAKE PREPAREDNESS: A CANADIAN PERSPECTIVE



Supported by:



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The Intact Centre on Climate Adaptation (Intact Centre) is an applied research centre at the University of Waterloo. The Intact Centre was founded in 2015 with a gift from Intact Financial Corporation, Canada's largest property and casualty insurer. The Intact Centre helps homeowners, communities and businesses to reduce risks associated with climate change and extreme weather events. For more information, visit: www.intactcentreclimateadaptation.ca

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Executive Summary

Natural catastrophe risk management considers ‘risk’ to be a product of a combination of three components:

- **Hazard** (physical event causing damages),
- **Exposure** (valuable assets including human life located in places that can be adversely affected by hazards), and
- **Vulnerability** (predisposition to be adversely affected by hazards due to a lack of resistance or inability to adapt).

While we cannot control the occurrence of a natural hazard (earthquake, tsunami, hail storm, heavy precipitation event, etc.), we can manage or control the expression of risk by reducing the other components -- the exposure and vulnerability of people and structures that would potentially be impacted.

Flooding and earthquake are two natural hazards for which there is substantial interest in managing risk. These hazards share many similarities: both hazards can manifest as low-probability, high-severity events; both can damage residential property and cause injury, and both are eligible for protection through voluntary insurance coverage. Additionally, reducing residential risk (vulnerability and exposure) for both flood and earthquake hazards hinges on motivating and changing homeowner (consumer) behaviour. Accordingly, **initiatives that have successfully motivated homeowners to reduce their flood risk may be used to motivate homeowners to reduce earthquake risk.**

This report examines lessons learned from the **Home Flood Protection Program** (HFPP), developed by the Intact Centre on Climate Adaptation, that may apply to motivating homeowners to protect their homes from earthquake. The HFPP was established in 2018, to provide a means to reduce residential flood risk.

Best practices from the program, highlighted in this report, offer easily-implementable solutions which often draw on community and not-for-profit partnerships, and engagement with professional associations and their members who interact directly with homeowners/ households to affect change.



Risk is a product of a combination of:

Hazard
(physical event causing damages),

Exposure
(valuable assets including human life located in places that can be adversely affected by hazards), and

Vulnerability
(predisposition to be adversely affected by hazards due to a lack of resistance or inability to adapt).

Best practices and lessons learned from the HFPP suggest that the following three initiatives could be effective for encouraging homeowners to take protective action and reduce earthquake risk at the level of the home:

1. **Engage with professional associations in the residential sector and offer training and resources for association members so they can educate homeowners on how to better protect their properties from earthquake.** Professional Associations would include, but not be limited to, the following (also

shown in Figure ES-1 below):

- Canadian Real Estate Association
- Canadian Association of Home and Property Inspectors
- Insurance Brokers Association of Canada
- Mortgage Professionals of Canada, and
- Appraisal Institute of Canada



Members of these associations, with the exception of home appraisers, often interact with homeowners (one-on-one), and effectively serve as advisors in real estate transactions and home ownership processes. While engaging with homeowners as part of regular business, these professionals would have the opportunity to discuss earthquake risk.

Drawing on the experiences of flood risk mitigation, historically, professionals from these associations would not have engaged with homeowners on risk-related matters. However,

large-scale flooding and wildfire disasters in the last decade (e.g., Canada’s 2023 wildfire season, 2021 B.C. floods, 2019 Quebec/Ontario/New Brunswick floods, 2017 Quebec floods, 2016 Alberta floods, 2013 Fort McMurray, Alberta Wildfire) have brought disaster risk to the forefront of the media, resulting in increased public awareness and concern. Additionally, 10% of Canadians homes are in areas deemed to be at high

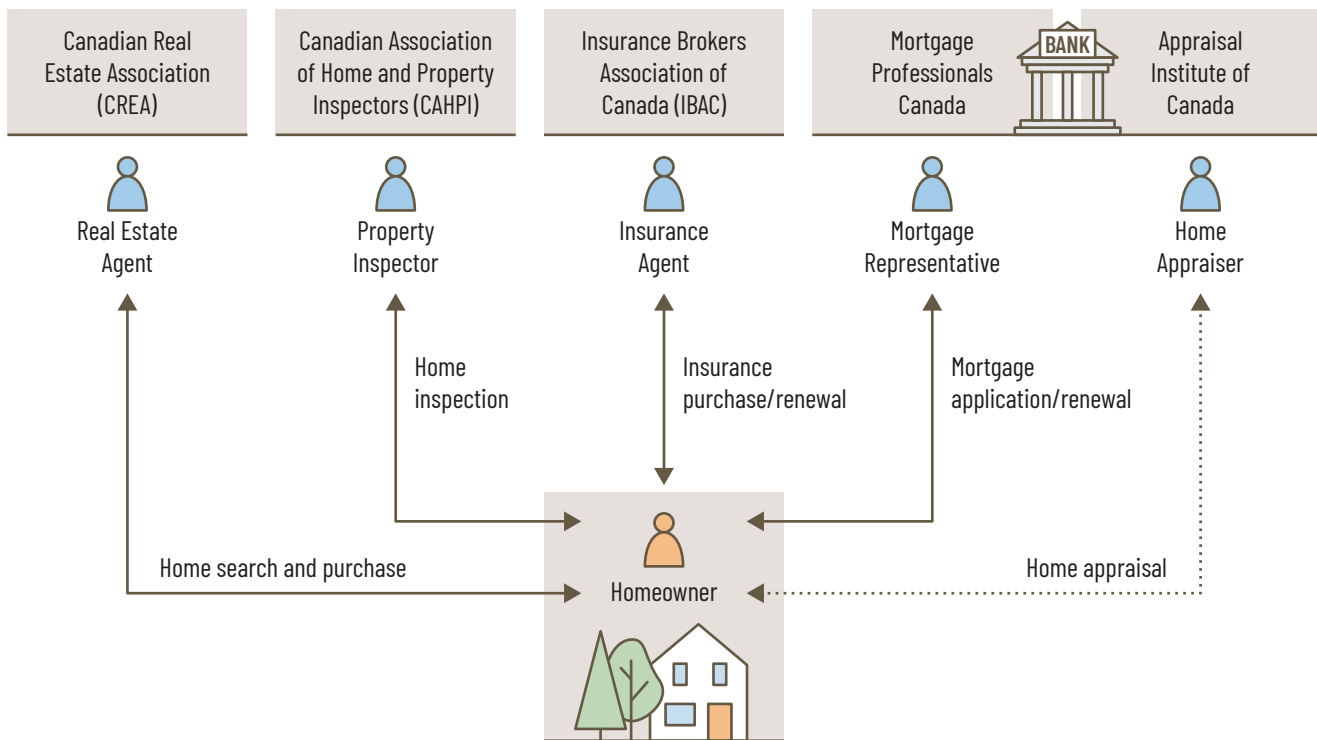


Figure ES-1: Consumer (homeowner) interactions in the home ownership process.

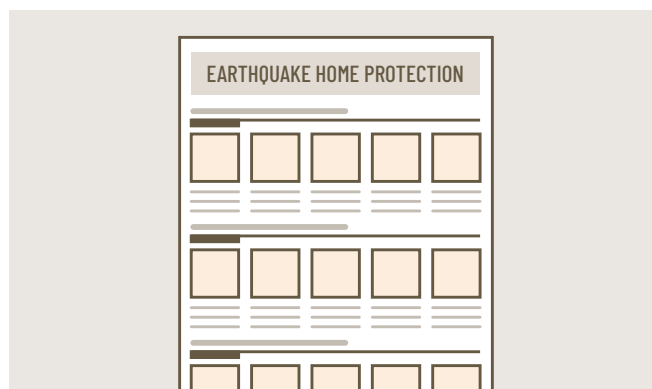
risk of flooding and are currently uninsurable for flood (PSC, 2022a) -- this raises awareness of flood hazard. Intact Centre field assessments indicate that flood risk potential is now discussed through various channels and processes, including real estate and homeownership processes. It is therefore envisioned that similar engagement on earthquake risk could take place via the same professional associations and members.

In the case of home appraisers, who engage with financial institutions and not homeowners, those trained in earthquake risk could provide better informed home valuation services, which strengthens the appraisal process and benefits homeowners and other stakeholders indirectly.

Training programs for professional associations (e.g., insurance brokers) could include topics such as:

- Earthquake risk awareness
- Opportunity for earthquake insurance, with a recommendation for homeowners to talk with a licensed insurance representative to learn more
- Protective actions that can be taken around the home to reduce the risk of property damage and personal injury in the event of an earthquake
- What to do before, during, and after an earthquake (preparing for an emergency)

Research studies can be conducted with homeowners to understand factors influencing earthquake insurance purchase. The demand-side considerations and learnings related to earthquake insurance purchases can then be added to training programs for insurance brokers and other professionals who directly support homeowners in the home ownership process.



2. Develop and circulate an earthquake home protection infographic to reach greater numbers of homeowners and households in earthquake risk zones.

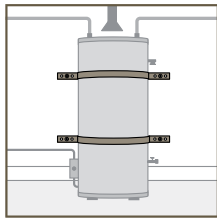
This can motivate them to secure and prepare their homes against earthquake damage, and minimize the risk of personal injury in the event of an earthquake. Figure ES-2 presents a sample infographic, listing examples of practical actions that can be taken to reduce earthquake risk for residential properties, with actions categorized into different levels of complexity.

The infographic would raise awareness of earthquake risk and summarize, in an easy-to-understand format, meaningful actions that can be taken in and around a home to prepare against potential earthquake damage. Actions can be categorized into different levels of complexity to show their relative effort and cost for implementation, and support homeowner decision-making. Actions could be implemented in a step-wise fashion, from simple to more complex. Content for the infographic could be obtained from earthquake authorities like the Government of B.C., the Insurance Brokers Association of B.C. (IBABC), and the California Earthquake Authority. The benefit of the document is it would “help homeowners and households to help themselves” to reduce their earthquake vulnerability.

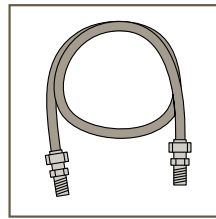
Figure ES-2: Examples of Practical Actions to Reduce Earthquake Risk for Residential Housing

EXAMPLES OF PRACTICAL ACTIONS TO REDUCE EARTHQUAKE RISK FOR THE HOME

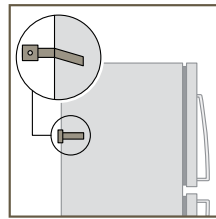
Home Interior: Complete Simple Upgrades



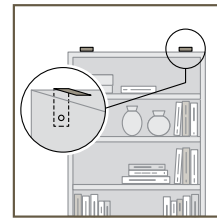
- 1** Water heaters braced using authorized strap kit.



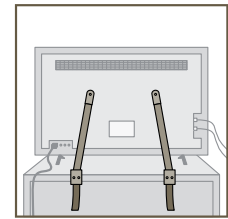
- 2** Flexible connection for gas appliances.



- 3** Ovens and refrigerators strapped to walls.



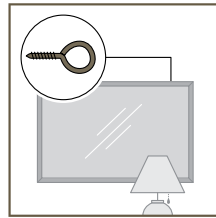
- 4** Cabinets and bookcases secured to wall studs.



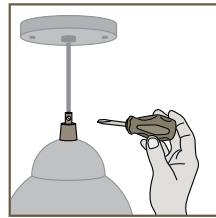
- 5** Televisions, computers, other electronics strapped down.



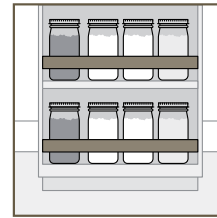
- 6** Heavy objects not hung over beds.



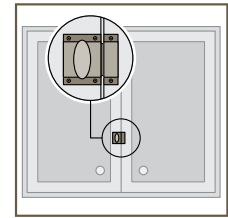
- 7** Heavy mirrors and pictures on walls anchored with wire eye screws into studs.



- 8** Ceiling fans, pendant lights and other hanging fixtures secured.

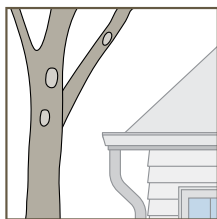


- 9** Breakables and valuables moved to lower shelves with lip guards.

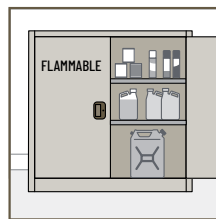


- 10** Latches on cabinet doors (so they don't fly open).

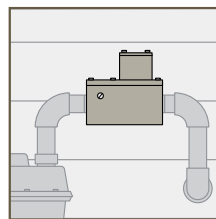
Home Exterior: Complete Simple Upgrades



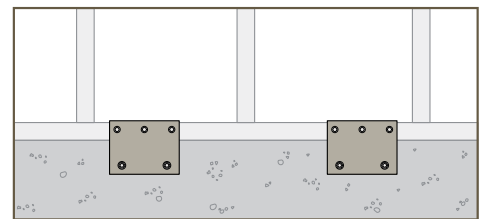
- 1** Tree limbs adjacent to home and garage are pruned.



- 2** Flammable products stored securely away from house in locked cabinets with latches.



- 1** Automatic gas shut-off valve installed (triggered when there are strong vibrations).



- 2** Home's foundation retrofitted (as needed) with anchoring to reduce possibility of house sliding off its foundation.

Local governments, industry partners, and not-for-profits across Canada could add their logo to an earthquake protection infographic and distribute it to homeowners through utility bills and property tax mailings, councillors' newsletters, newspapers, social media, and electronic newsletters.

Local governments, industry partners, and not-for-profits across Canada could add their logo to an earthquake protection infographic and distribute it to homes through utility bills and property tax mailings, councillors' newsletters, newspapers, social media, and electronic newsletters.

3. Implement door-to-door outreach for targeted communities in earthquake risk zones, to educate homeowners/households about risk, opportunity for earthquake insurance, practical measures to protect homes against earthquake damage and injury, and what to do before, during, or after an earthquake.

Red Cross volunteers (and other not-for-profit community groups) could receive training and conduct door-to-door outreach at homes in earthquake risk zones, to educate homeowners



and households about protecting homes against earthquakes, and what to do in the event of an earthquake. They can also recommend that homeowners speak with a licensed insurance representative to learn more about earthquake insurance. Resources can be left with residents.

Research has shown that outreach campaigns conducted by the Red Cross have materially augmented existing efforts of governments, insurance companies, and other not-for-profits by catalyzing protective behaviour of homeowners to reduce aspects of extreme weather risk (Evans and Filippi, 2020).

Considering that earthquake risk zones are distinguished by higher physical risk, where there may also be social vulnerabilities, employing targeted earthquake risk communication (through door-to-door outreach) may be of value, as communication could be tailored for the needs of specific audiences. Door-to-door outreach to vulnerable populations would enable them to access information that might otherwise be unavailable.

The reality is that climate change and extreme weather-related flood risk will continue to get more challenging across many regions of Canada (IPCC, 2021). The good news is that guidance and solutions have been developed in Canada, that can help homeowners reduce flood risk.

While earthquakes are not climate-related hazards, commonalities exist between these hazards. Leveraging the rich learnings and best practices from home flood protection can help advance earthquake risk management in Canada. Consumer behaviour change in the realm of earthquake risk is not only possible but may be simple to achieve. A closer look at best practices in the subsequent sections of this report explains practical and meaningful ways that consumer behaviour and earthquake risk management in Canada may be improved.



1.0 Introduction

1.1 Purpose and Scope

This report examines how experience gained in motivating homeowners to protect their homes from flooding – which began in earnest across Canada in 2015, through the Home Flood Protection Program (HFPP) (Evans & Feltmate, 2019) – may be applied to limit earthquake risk exposure of homeowners living in Canada’s major earthquake zones. The properties considered in this work include detached, semi-detached, and townhouse dwellings.

Motivating factors for taking action to limit residential flood risk and earthquake risk are analogous in several regards. Both hazards can manifest with low to high impact, and can cause property damage and injury for residents. For both hazards, risk-mitigating solutions exist. In the case of residential flooding, it has been established, as highlighted in this report, that when

homeowners receive guidance to lower their risk, that they will adopt those actions in a step-wise manner as time and budgets permit. A common barrier to homeowners/tenants taking action to limit their flood risk is generally not one of willingness, but rather “not knowing what action to take”. Similarly, given the comparable nature of earthquake to flooding – both are caused by acts of nature and both can result in substantial residential damage and injury, it is reasonable to postulate that a homeowner, upon receiving informed guidance, would take action to limit their vulnerability to earthquake risk.

The output from this report can enrich the knowledge base for earthquake risk management, and inform methods and approaches for motivating consumer decision-making in the direction of greater protection and preparedness for earthquakes.

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1.2 Climate Change and Extreme Weather Events

To appreciate how actions to reduce home flood risk may apply to reducing earthquake risk for the home, it is beneficial to review why and how home flood protection guidance evolved in Canada.

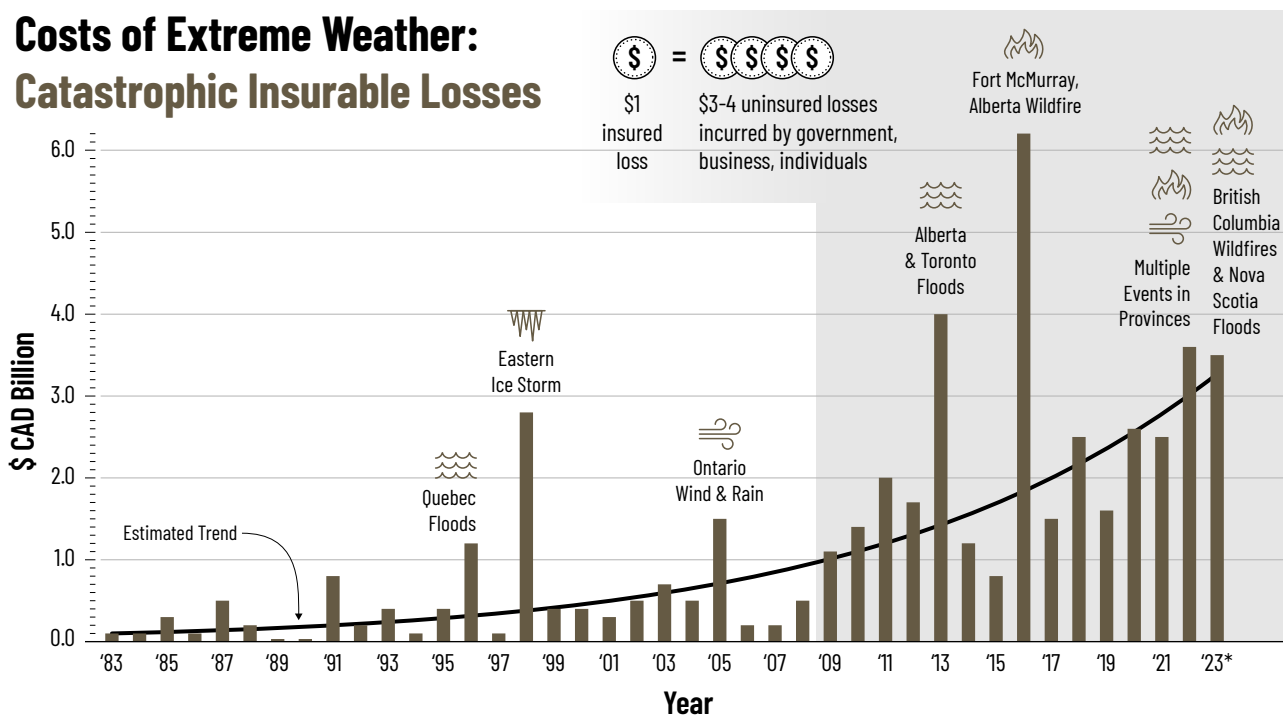
The HFPP was developed in 2015 to limit the impacts of increasingly severe home flooding. It was observed that home flooding is becoming more prevalent and financially costly due to more intense precipitation events (driven by climate-change), loss of natural infrastructure in communities (e.g., forests, fields, and wetlands) that otherwise acts as a “sponge” to soak up precipitation and runoff, and growing exposure (population growth, urbanization, and densification) leading to more people and assets at risk (Warren & Lulham, 2021).

The discussion that follows explores trends in extreme weather and the case for climate change adaptation in Canada.

Canada’s climate is changing. Research has shown that the country is warming at twice the global rate (and 3 times faster in the north), with effects manifesting through more frequent and extreme weather – rainfall, drought, excessive heat, and wildfire, as well as through slower onset changes such as rising sea level and permafrost thaw (Bush & Lemmon, 2019). These impacts bring increasing costs to governments, business, and all people living in Canada, with the worst costs experienced directly by individual households (Sawyer et al., 2022)

Catastrophic loss, defined as cost from a severe event that is greater than \$25M, is measured annually in

Costs of Extreme Weather: Catastrophic Insurable Losses



Source: IBC Facts Book, PCS, CatIQ, Swiss Re, Munich Re & Deloitte

Note: *2023 preliminary values in 2023\$ CAD, corrected for inflation and per capita wealth accumulation.

Figure 1: Catastrophic Insurable Claims (\$ Can/billions) in Canada, 1983-2022. Brown bars represent loss + loss adjusted expenses. Note: Claims have been normalized for inflation (\$2022) and per capita wealth accumulation.

Canada. There is an accelerating upward trend in recent insurance claims for catastrophic loss (Figure 1). According to the Insurance Bureau of Canada, as of 2023, insured damage from natural catastrophes and severe weather events has exceeded \$3 billion for the second year in a row (IBC, 2024). 2023 ranks as the fourth-worst year for insured losses in Canada, with 2022 as the third-worst year (IBC, 2024). More than 50% of these losses are attributable to water-related damage (IBC, 2023, January 18). In the preceding period, from 2011-2020, catastrophic insured loss averaged \$2.3 billion per year (IBC, 2023). Comparatively, in the period from 2001-2010, only \$675 million in average annual insured loss was realized. And in the earliest measurement period from 1983-2000, \$440 million in average insured loss was recorded (IBC, 2023).

Flooding is Canada's most common and financially costly natural disaster (IBC, 2023). In addition to changes in the intensity, duration and frequency of precipitation events, Canada's exposure to flooding is also increasing as a result of asset concentration (building) in flood-prone areas (Public Safety Canada, 2022a).

In response to increasing flood risk, the Intact Centre on Climate Adaptation has developed cost-effective and broadly applicable guidelines to reduce flood risk at the level of the home, existing communities, new communities, commercial real estate, and for homes situated along Atlantic and Pacific coastlines. Lessons from the development of these guidelines can be applied to earthquake risk.



1.3 Earthquake Risk in Canada

Prior to examining solutions that are effective for encouraging homeowners to flood-protect their residences – and how those practices may translate to limiting residential-level earthquake risk – a review of earthquake risk in Canada provides valuable context.

Earthquakes occur in all regions of Canada, however there are several areas in the country that have higher probability of seismic activity:

1. Western zone (southwestern British Columbia), and
2. Eastern zone (southeastern Ontario-southern Quebec-Atlantic region), that wraps around the Ontario-Quebec border

from the Ottawa Valley to the St. Lawrence River Valley and includes the Atlantic Canada coast, and a

3. Northern zone (spanning the Yukon, Northwest, and Nunavut Territories, and Arctic Islands).

Natural Resources Canada has developed seismic hazard models for the country, over the course of many decades. These models yield seismic hazard values that are used in the National Building Code, to design and construct buildings that are intended to keep occupants safe during earthquake shaking (Natural Resources Canada, 2021; Hobbs et al., 2023).

Figure 2. presents a simplified seismic hazard map for Canada, based on a recent Canadian Seismic

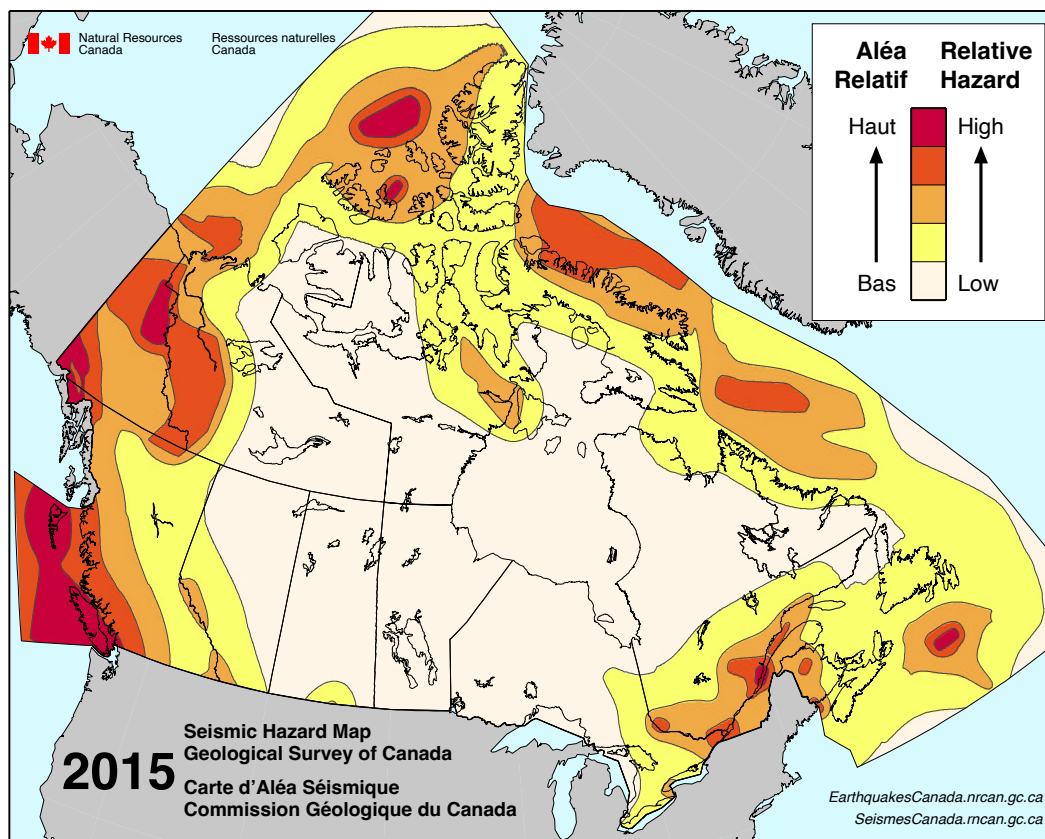


Figure 2: Simplified Seismic Hazard Map for Canada showing areas that have a higher probability of experiencing damaging ground motions caused by earthquakes.

Hazard Model (Natural Resources Canada, 2021). The map shows areas of higher probability (more likelihood) of experiencing strong earthquake shaking (ground motion) that might damage one-to two-story buildings, at various locations across the country. The difference between highest and lowest hazard regions is a factor of 30 -- the probability of strong shaking (that could cause significant damage in a fraction of one to two-story buildings) is 30 times greater in regions of highest hazard, than in regions of lowest hazard. More specifically, the model estimates that in a 50-year period, there is a:

- 30 per cent probability of an earthquake strong enough to cause significant damage in the highest hazard regions (e.g., in the western zone), a
- 5 – 15 percent probability of an earthquake causing significant damage in the moderate hazard regions (e.g., in the eastern zone), and
- < 1 per cent probability of significant damage within the lowest hazard regions (AIR Worldwide, 2013; Natural Resources Canada, 2021).

Earthquake ‘risk’ describes the probability that earthquake shaking will cause damage, casualties, or other negative impacts. It depends on the level of earthquake hazard, the exposed structures or people, and the vulnerability of those structures or people. Large cities within seismic hazard zones face risk to urban infrastructure and buildings, which can result in very large losses, but small communities also face proportional risk (Hobbs et al., 2023). A national seismic risk model was developed for Canada and used to assess seismic risk at the neighborhood level, for all settled areas in the country (Hobbs et al., 2023); the model identified both large and small communities with a high ‘seismic risk index score’, including Montreal (QC), Vancouver (BC), Duncan (BC), Victoria (BC), and Saanich (BC), as well as the Yukon Territory which had a relatively high expected economic loss when normalized by the territorial asset (exposure) value.

This suggests that within earthquake hazard zones, communities of all sizes may face damage and loss.

Earthquakes present economic risk for Canada. A high-magnitude (strong) earthquake could result in significant losses for households, business, and governments. Ensuring appropriate insurance coverage, combined with physically preparing homes to reduce earthquake impacts, are two means of limiting earthquake risk at the residential level. Planning for emergencies is a third means to prepare individuals and communities in advance of a potential earthquake event.

Insurance Coverage to Limit Risk

There is benefit in achieving and maintaining high insurance take-up rates for catastrophic events like earthquakes, because insurance coverage provides protection against loss and injury, and improves community resilience (Kelly et al., 2020). The insurance protection gap (the portion of total economic losses resulting from a natural catastrophe that are not covered by public or private insurance) is a concern for regulators and insurers globally because it means reduced ability by individuals, businesses and communities to recover from a disaster, and increasing pressure for governments and those affected to bear the cost of recovery. Within Canada, the Insurance Brokers Association of BC (IBABC) and its member organizations have raised concern about the earthquake protection gap, noting that a major earthquake would create financial hardship for individuals, business and communities and impact Canada’s entire economy (IBABC, 2024).

In Canada, the earthquake protection gap is sizable. For a strong (9.0 magnitude [1/500 year]) earthquake in British Columbia, total economic loss could reach \$75 billion; the projected outcome for the residential sector is that \$20 billion or 80% of residential losses would be uninsured (AIR Worldwide, 2013). For a similarly probable (7.0 magnitude [1/500 year])

earthquake in the Quebec City-Montreal-Ottawa corridor, total economic loss could reach \$61 billion, with \$19 billion or 97% of residential losses uninsured (Public Safety Canada, 2023; AIR Worldwide, 2013).

At present, residential earthquake insurance coverage in Canada is low, as most residents in earthquake risk zones are uninsured or under-insured for earthquakes (PSC, 2023). In Quebec, less than 5% of households have earthquake insurance, and in British Columbia, 40-70% of households have earthquake insurance (PSC, 2023). Coverage for earthquake isn't included in a standard home owners insurance policy but is usually available to be purchased as an optional, add-on to an existing policy (IBC, 2024).

Key challenges related to earthquake insurance include increased costs of earthquake insurance, increased earthquake deductibles and reduced insurance capacity – effects resulting from the need to meet updated Office of the Superintendent of Financial Institutions (OSFI) earthquake guidelines (IBABC, 2024). Additionally, because earthquake is considered insurable, losses are not eligible for government Disaster Financial Assistance (IBABC, 2024).

Preparing Homes to Limit Earthquake Impacts

Earthquake shaking can cause physical damage to the structure and contents of a home. Inside a home, furniture and household objects can tip and fall, causing damage and injury to occupants (heavy furniture and household objects falling on people have shown to be a major cause of injury following severe earthquakes) (Peek-Asa et al., 1998). Natural gas lines can be torn from their connection points inside a home, which has the potential to cause a fire or explosion if the gas is ignited. Structural damage to homes can occur if the home is not anchored to its foundation appropriately.

Meaningful and cost-effective actions can be

implemented to better prepare a home against potential earthquake damage (CEA, 2020); these actions range from securing objects inside a home to retrofitting a home's foundation. They can decrease the risk of personal injury (Peek-Asa et al., 1998) and property damage, and can enhance overall resilience (CEA, 2020).

1.4 Similarities and Differences between Flood and Earthquake Risk

Flooding and earthquake risk in Canada share similarities and differences. An examination of these is beneficial to establish a basis from which lessons learned from flooding can be applied to earthquake.

Flooding is the most frequent and financially-costly natural disaster in Canada (PSC, 2022a). As a rainfall-related event, it can occur in any region of the country, in urban centres or rural countryside, and at any time of year (PSC, 2022b). Floods have affected hundreds of thousands of people in recent decades (PSC, 2022b), and currently, 10% (1.5 million) of Canadian homes are at high risk of flooding and are uninsurable (for optional overland and sewer back-up coverage) (PSC,

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2020a). Further description of the types of residential water damage and flood insurance coverage is provided in Section 2.4.3 of this report.

Two of the most common causes of weather-related flooding are 1) accumulation of winter precipitation that leads to spring thaw runoff, and 2) heavy precipitation events – occurring more frequently and with greater intensity due to climate change (PSC, 2022b; ECCC, 2022). Climate change warms atmospheric air which holds more moisture and imparts greater energy to the Earth’s atmospheric system, and this fuels heavy precipitation events (greater intensity, duration, and/or frequency) (UNEP, 2020).

Weather-related flooding may be categorized further as 1) pluvial (surface water and flash flooding caused by heavy rainfall, independent of an overflowing body of water), 2) fluvial ((body of water such as a river, lake or stream overflows its banks and floods surrounding land), and 3) coastal (seawater inundation along the coast, caused by storm surges and tsunamis).

Climate change exacerbates flood risk. In addition to a warming climate, other factors exacerbating flood risk (exposure and vulnerability) in Canada include:

- a.** Increasing population and urban development
 - Risk is concentrated in large urban centres with higher population density, (PSC, 2022a); additionally, urban centres are the “fastest growing areas in the country, and home to more than 70% of Canada’s population” (PCS, 2020a, p.23)
- b.** Infrastructure development and aging infrastructure
 - Civil infrastructure has been designed and constructed under the assumption of climate stationarity (MDPI, 2023).
- c.** Asset concentration in flood-prone areas
 - Many Canadian cities and towns are built along shorelines and coastlines, on or near

floodplains (PSC, 2022a); there are “more than 6.5 million Canadians living along coastlines” (PSC, 2022a, p.23)

The cost of flooding in Canada is on the rise. Total residential flood risk is estimated to be \$2.9 billion per year (PSC, 2022a), and the cost to the Canadian economy is expected to be “greater than \$30 billion in the years leading up to 2050” (GDH, 2022, p.1). The average cost of restoring a flooded basement is \$43,000 (Bakos et al., 2022).

Flood maps are used to show the areas covered by water during real or potential flood events. There are different types of flood maps, including flood hazard maps (regulatory maps that guide land use planning) and flood risk maps (showing social, economic, or environmental impact that communities may face during a flood event). In general, these maps are essential to understanding and managing a community’s flood risk, as they convey flood probability, facilitate informed land-use planning decisions, and highlight potential impact on physical assets and people. Because not all floods are equal in magnitude, duration or effect, describing flooding in terms of a recurrence interval provides more context. A common recurrence interval is a 100-year flood, which designates that a given area (on a flood map) has a 1% chance of flooding, in any given year.

When comparing flooding to earthquakes, the origins of each are different. Flooding manifests at the ground surface and earthquakes originate within the earth’s crust. Earthquakes are caused by the sudden and tremendous release of energy that gets stored within single, or between neighbouring tectonic plates of the earth’s crust, as plates move slowly and constantly in the lithosphere (solid outer part of the earth). As noted above, earthquakes can occur in all regions, but there are areas in the country with higher probability of seismic activity, as shown in Figure 2. In contrast, flooding can occur broadly across the country. Whereas weather-related flooding may be anticipated following

snow melt or heavy rainfall, earthquakes cannot be predicted and generally occur with little to no warning (Government of Canada, 2024). The rates of earthquakes in a particular region can be expressed in terms of probabilities and can be estimated.

Small earthquakes (with low magnitude and energy released) occur often and last only a few seconds (Government of Canada, 2021). The Geological Survey of Canada records about 5,000 earthquakes in Canada each year, with most of them small and not felt by humans (AIR Worldwide, 2013); in general, only about 50 of the 5,000 are felt (PSC, 2023). Infrequent and larger earthquakes have occurred – about 24 significant earthquakes in the last three centuries that were widely felt (AIR Worldwide, 2013).

Flooding and earthquake have some commonality in expression. Small-scale flooding can occur often, and small (undetectable) earthquakes occur routinely. As well, both of these hazards can also manifest as high-severity, low-probability events, meaning that when higher magnitude/higher severity events do occur, they do so less frequently. And when they do occur with high severity, they can result in substantial property damage and injury.

One area of difference between flooding and earthquake is that in general, **heavy precipitation and flood risk is increasing in many parts of the country, with flooding occurring more frequently and becoming more severe** (Government of Canada, 2022), whereas earthquake rates are consistent and fluctuation of earthquake rates is normal, although detection and reporting of earthquakes have improved due to advances in technology and communication (USGS, n.d.). Flooding has increased by 300% since the 1960s, and the five most destructive floods in Canadian history have occurred between 2010 and 2021 (Government of Canada, 2022). A recent study examining future risk found that 40 of Canada's 100 most populated cities (such as Toronto and Montreal) are at high risk of

flooding under climate change; 45-60% of these cities will experience increases in the magnitude of flooding in the future and 25-60% of them will see changes in flood timing (frequency) (Gaur, et al., 2018).

Although rates of earthquake are not increasing, earthquake risk is changing as a result many factors including a demographic shift to an aging population, increasing urban population density, accumulation of physical assets in earthquake-prone areas, and more dependence on utilities and services including power, water, telecommunications, and transportation (PSC, 2023).

Provision of insurance is another area where flood and earthquake have commonality. Insurance is offered as voluntary, additional residential coverage for both flooding (for overland water and sewer back up flooding) and earthquake damage. With respect to homeowners' insurance policies, common home insurance covers water damage caused by leaks and pipe bursts, but doesn't cover flooding caused by weather-related events including lake or river overflow, heavy rainfall accumulation and rapid snowmelt, ground water seepage, and/or sewer system backups, so additional flood insurance (overland and sewer backup coverage) must be purchased by homeowners. Both flood and earthquake insurance are not required by law or by the majority of mortgage lenders, therefore consumers have a choice about whether or not to purchase coverage (Kelly et al., 2020).

Flooding and earthquake share several commonalities, and drawing on these similarities, it is plausible to anticipate that experiences in managing flood risk could provide insight into better managing earthquake risk. By reviewing best practices and lessons learned from the Intact Centre's Home Flood Protection Program (HFPP), those practices with merit and transferability to earthquake risk management can be identified. This is described in this report.



Door-to-door risk reduction education campaign (Canadian Red Cross, 2023)

2.0 Best Practices to Encourage Households to Reduce Flood Risk that are Transferable to Reducing Earthquake Risk

Intact Centre’s research in home flood protection was reviewed to identify mechanisms and approaches for motivating homeowners to reduce risk, which could apply to motivating preparedness for earthquake. The section below presents insights, best practices, and lessons learned from the Intact Centre Home Flood Protection Program and highlights areas where there is potential transferability to earthquake risk management. This includes consideration of opportunities for:

- Increasing awareness of earthquake risk
- Increasing earthquake insurance take-up rates, and
- Strengthening protection/resilience of homes in earthquake risk zones in Canada

2.1 Working with Municipalities and Not-for-Profits to Develop Behavior Change Programs that Increase Home Flood Protection for Households

Intact Centre employs a risk-based, integrated approach known as ‘flood risk management’ (FRM), for developing solutions to manage the impacts of flooding. This aligns with the flood management approach of many countries over the last decade, including Canada, the United States and the United Kingdom (Golnaraghi et al., 2020; Bubeck et al., 2017). In practical terms, with FRM, structural measures (such as barriers, dykes, embankments and bioswales) may be needed, but on their own, are not enough to manage flood risk. Non-structural measures are also needed.



They play an important role in reducing the impact of flood events on property and people, and can include:

- Risk communication,
- Public awareness,
- Preparedness and protection,
- Flood forecasting and warning,
- Land use bylaws and zoning,
- Property purchase and relocation, and flood insurance (Krueger, 2022; Golnaraghi et al.; 2020, Henstra & Thistlethwaite, 2017)

Changing the behaviour of individuals, such that they are motivated and follow through on implementing

protection for flooding, is an important factor for successful FRM. To this end, the Intact Centre has worked with municipalities and not-for-profits since 2015 to co-design and deliver behaviour change programs that increase the uptake of preventative action to reduce flood risk and complement existing community-based initiatives. Table 1 summarizes three Intact Centre Home Flood Protection Program initiatives that have led to changes in homeowner behavior. The table also proposes analogous programs/initiatives for earthquake risk management. The subsequent sections provide additional details on the programs.

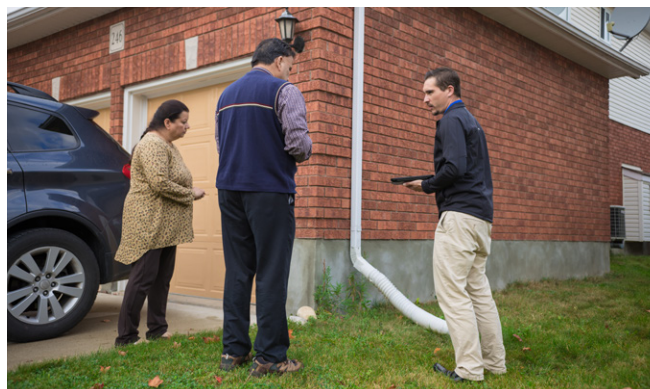
Table 1: Intact Centre Home Flood Protection Program initiatives that encourage homeowners to change behaviour to reduce flood risk, and the proposed role of analogous programs to reduce earthquake risk.

Program	Description	Role in promoting home flood protection and insurance	Proposed role in promoting earthquake protection and insurance
1. Home Flood Protection Program Assessments	In-person assessments of residential property-level flood risk and one-on-one education on actions that can be taken around the home to reduce flood risk.	<p>Educate homeowners/households about visible flood risks inside and outside their home (such as lot grading and downspout discharge directed towards a home's foundation, basement floor drain obstruction, and lack of maintenance of sump pump or back-water valve).</p> <p>Provide an opportunity for homeowners and assessors to review priorities for action to reduce property-level flood risk. Provide self-help resources to guide residents in completing identified actions to reduce risk.</p> <p>Assessments also provide opportunity to educate homeowners about common types of home flood insurance coverages, common gaps in coverages, and encourage homeowners to work directly with their insurance representative to match their needs with available coverages.</p>	<p>An earthquake protection assessment program can be implemented to educate homeowners/households about earthquake risk in their geographic area and specific risks on their properties. Homeowners/households can review priority actions that could help reduce property-level earthquake risk. Self-help resources could be provided.</p> <p>Assessments can also provide opportunity for assessors to educate homeowners/households about opportunity for earthquake insurance and encourage homeowners to work directly with their licensed insurance representative to match needs with available insurance coverage.</p>

Program	Description	Role in promoting home flood protection and insurance	Proposed role in promoting earthquake protection and insurance
2. Circulating the “Three Steps to Cost-effective Home Flood Protection” Infographic	<p>Municipalities distribute the infographic in property tax notices, mailbox flyer drops, postings at community centres, newspapers, and on websites and other social media platforms.</p> <p>The infographic can also be shared by community service providers such as firefighters, and by banks, retailers, and insurance companies.</p>	Assist households by illustrating in an easy-to-understand infographic, how to reduce home flood risks (following a step-wise, cost-effective approach).	An infographic could be developed and circulated to households to illustrate ways to reduce the impact of earthquakes at the property-level.
3. Door-to-Door Outreach Campaigns	Red Cross volunteers receive training in practical, cost-effective home flood protection and emergency flood preparation, and then go door-to-door in high-risk communities to talk with homeowners and tenants about how to proactively protect homes from flooding, as well as how to prepare for emergencies.	<p>Red Cross volunteers educate homeowners and tenants about flood risk; discuss what actions have already been taken to limit flood risk; encourage taking additional protective action (property-level action and insurance coverage); and convey information about how to prepare for potential flood emergencies.</p> <p>Third-party self-help resources, including community-based programs and support services are provided.</p>	Door-to-door outreach campaigns could be developed and implemented for communities at high-risk of earthquake , to educate homeowners and tenants about earthquake risk, discuss preventive actions that can be taken to reduce risk (property level action and opportunity for earthquake insurance, with a recommendation to talk with a licensed insurance representative), and convey information about what to do before, during and after a potential earthquake. Third-party educational/ self-help resources can be provided.

2.1.1 Home Flood Protection Program Assessments

Home Flood Protection Program Assessments were developed as part of Intact Centre’s 2019 Home Flood Protection Study (Evans and Feltmate, 2019). During the study (spanning 2017-2019) pilot implementations were conducted in three municipalities: Toronto, ON, Burlington ON, and Saskatoon SK, by contracted Home Flood Assessment professionals from AET Group, and the results became the foundation for for Intact Centre’s Home Flood Protection Program (HFPP) (Evans and Feltmate, 2019). National best practices for reducing a home’s physical vulnerability to urban flooding, and national and international best practices for raising awareness and driving action to reduce flood risk, were identified and



incorporated into the study design, including the HFFP assessments. Best practices are summarized in Table 2.

The Home Flood Protection Assessment consisted of a 60–90 minute guided risk identification service provided to study participants, which included homeowners of

detached, semi-detached and row houses. Homeowners (and tenants, granted permission from landlords) accompanied University of Waterloo-trained Assessors as they examined flood risks outside and inside the home and asked participants about relevant home maintenance practices. The service included sharing a report of findings (with a score for the home's physical features and maintenance compared to nationally-recognized best practices), a comprehensive set of self-help resources, and providing homeowners with an optional 15-minute follow-up conversation with the assessor. Homeowner participants were surveyed at three months and six months post-assessment, to learn what actions they undertook to increase flood protection on their properties, plans for taking additional actions (flood risk retrofits), the barriers they encountered that

limited action, and what would enable them to take additional action.

Limited funding was available in the pilot communities to offset costs for the assessments (residents paid on average \$0 to \$125). As part of the assessment, free online resources in the form of home flood protection fact sheets and video links were made available on the program's webpage. Other local resources were provided, including links to local municipal flood protection subsidies and tips for selecting local contractors to do flood protection retrofit work. A customized outreach strategy was implemented in each of the three communities in collaboration with local municipalities, conservation authorities (in Ontario), community groups and insurance providers.

Table 2: National and international best practices for raising awareness and driving action to limit flood risk, observed in the 2019 Intact Centre Home Flood Protection Study, and incorporated into the design of Home Flood Protection Assessments (Evans and Feltmate, 2019).

Behaviour Change Theme	Element
Messaging Impact Educational messages on flood risk reduction are most likely to be taken seriously by residents when the messages:	Come from a trusted source (federal, provincial, municipal governments, conservation authorities)
	Are simple and easy to understand
	Are repeated by a wide variety of trusted sources
	Provide neighbourhood-specific flood risks from rising river levels (riverine), rising lake levels and wave action (coastal) or urban flood risk (water flowing over the ground or backing up through sewer systems).
	Provide site-specific information about what can be done to reduce risk at an individual home (conducted via third-party assessments)
	Are vetted by trusted local people (knowledgeable neighbourhood members, family or friends, local contractors or hardware store staff)
	Provide opportunities for residents to participate in discussion and decision-making processes (e.g., face-to-face meetings and conversations)
Maximizing Action Residents will take action to a greater extent, to protect their homes from flooding, when residents have:	Free access to third-party educational information about flood risk reduction best practices (e.g., fact sheets, how-to-videos, self-assessment checklists, seasonal maintenance checklists, questions to ask insurance providers, tips for selecting contractors, and tips for accessing local subsidies)
	Financial support for key flood risk reduction actions that are relevant within a municipality
	A simple subsidy application process that requires little time to complete, provides instant rebates and provides application support services for residents
	Insurance rate adjustments to homeowners and tenants who have reduced their flood risk

Over 500 HFPP assessments were completed, by 12 UW trained flood risk assessors (employed by AET Group Inc.) over two years. Data collected by the program (via follow-up surveys) showed that 79% of residents completed at least one new action to protect their home from flooding within 3 months of having the home flood protection assessment, and 71% completed at least two actions within 6 months. This indicates the program is effective in helping residents make progress on protecting their home from flood risk.

79% of residents completed at least one new action to protect their home from flooding within 3 months of having the home flood protection assessment, and 71% completed at least two actions within 6 months. This indicates the program is effective in helping residents make progress on protecting their home from flood risk.

Key findings from the Home Flood Protection study are provided in Table 3, and application to earthquake risk management is noted.

Table 3: Key findings from Intact Centre Home Flood Protection Assessments and Application to Earthquake Risk Management.

Topic	Key Findings for Flood Risk Protection	Application to Earthquake Risk Management
Communication	Governments, not-for-profits, and insurance companies should use broad-based communication tactics to engage all homeowners/households in Canada on flood risk. This is needed because all homes are at increased risk of flooding due to climate change-induced severe precipitation. Targeted communication tactics should be used in high-risk areas. Note - targeted communications are tailored and relayed to a specific audience, taking into account geographic, social, and demographic contexts (Krueger, 2022). Communications must also be relevant and practical to residents based on the type of building they live in and their authority to make changes to the property itself (owner versus tenant).	Since earthquake risk is limited to three main zones in Canada, targeted communication methods may be of value for governments, not-for-profits, insurers, and industry associations seeking to engage with homeowner/households.
Risk mapping	Where possible, homeowners and tenants should be provided with access to accurate, easy-to-understand, and up-to-date flood risk maps. They can use this information to make informed decisions about taking action to reduce risk. The current challenge is that many existing flood maps in Canada are out-of-date and have not incorporated urban development and the impacts of climate change (ICLR, 2019). The federal government has invested in the Flood Hazard Identification and Mapping Program (FHIMP) to complete flood hazard maps for higher-risk areas in Canada (2022, May 17). The development of a public flood risk portal to make flood risk information more accessible to Canadians is being explored (Public Safety Canada, 2022a).	Homeowners and tenants could be provided with access to up-to-date earthquake hazard maps to make informed decisions about action (insurance coverage + protective measures) to reduce risk.

Topic	Key Findings for Flood Risk Protection	Application to Earthquake Risk Management
Rental property	Tenants are often overlooked. Efforts should be made to engage landlords and tenants of basement rental properties and provide flood protection and emergency preparedness information and support. This enables provision of safer and more reliable basement rental units in Canada.	Engaging landlords and tenants of basement rental properties and providing earthquake protection and emergency preparedness information may be of value. This would enable provision of safer and more reliable basement rental units.
Qualified contractors to provide risk reduction services	Homeowners reported challenges in finding qualified contractors that could complete retrofits for flood protection in a timely manner. Efforts should be made to increase the number of qualified contractors who can install and maintain retrofit protection.	Increasing the number of qualified contractors able to implement property-level measures to reduce the risk of damage and injury, may be of value.
Training programs on risk awareness and risk reduction – for organizations that engage with the public	Training programs providing education on how to reduce flood risk, should be available to organizations that engage with the public. Organizations could include realtors, mortgage brokers, insurance agents, municipal and conservation authority staff, not-for-profits, and landlord-tenant associations.	Training programs, providing education on earthquake risk and how to reduce risk, could be made available to organizations that engage with the public – such as realtors, mortgage brokers, insurance agents, municipal staff, not-for-profits, and landlord-tenant associations, working in B.C. and ON/QC markets.
Professional risk assessment tools and services	<p>Homeowners identified that they wanted greater access to third-party information and assessment services for reducing flood risk.</p> <p>A nationally applicable tool and training program to support on-site flood risk assessments should be made available to qualified professionals, such as home inspectors across the country.</p> <p>Note – this may be combined with the general risk reduction training program listed above.</p>	A nationally-applicable tool and training program to support on-site residential earthquake risk assessments could be made available to qualified professionals, such as home inspectors working in B.C. and ON/QC markets.
Third-party information resources	<p>Access to trustworthy, third-party information resources is valued by homeowners, especially when intending to complete flood protection retrofits on their own (without a contractor).</p> <p>Homeowners requested “trustworthy information from a source that is not trying to sell a particular product or service” (Evans & Feltmate, 2019), and resources produced by government, not-for-profit, and academic organizations were preferred. The need for greater access to third-party how-to videos and fact sheets were noted.</p> <p>Significant, cost-effective opportunities exist for organizations to share third-party home flood protection information within organizations’ networks. For example, industry associations (for home inspectors, home appraisers, mortgage brokers, realtors, and insurance brokers) could share third-party information on flood risk protection with association members, who pass this information to clients.</p>	<p>Trustworthy, third-party information resources on earthquake risk management (including opportunity for earthquake insurance with a recommendation to speak with a licensed insurance representative, and actions that can be implemented around the home to reduce the risk of damage and injury) may be of value to households in earthquake risk zones.</p> <p>Similarly, opportunities exist for professional organizations to share third-party earthquake risk protection information within organizations’ networks. These organizations include professional industry associations for home inspectors, home appraisers, mortgage brokers, realtors, and insurance brokers. Members of these organizations can pass information on to clients.</p>

Topic	Key Findings for Flood Risk Protection	Application to Earthquake Risk Management
Financial support	Financial subsidies that offset costs for implementing flood risk reduction projects and motivate action, are of value. This includes support in the form of municipal funding to complete flood risk assessments, rebates at retail stores for items like downspout extensions and sump pump backup power systems, and insurance discounts for taking actions to reduce flood risk.	<p>Financial subsidies to support property-level earthquake risk reduction actions may be of value. These subsidies would be most effective for homeowners and communities that are well-informed about local earthquake risk and the measures (including earthquake insurance) that can be taken to reduce risk.</p> <p>Subsidies could include municipal grants and rebates to complete earthquake risk assessments; rebates at retail stores for items like flexible connections for gas appliances, straps, latches, braces, and anchors for furniture and appliances; and insurance discounts for taking action to improve structural integrity of homes, increase resilience and reduce risk of damage and injury, in the event of an earthquake.</p>

Since earthquake risk is limited to three main zones in Canada, targeted communication methods may be of value for governments, not-for-profits, insurers, and industry associations seeking to engage with homeowners and tenants.

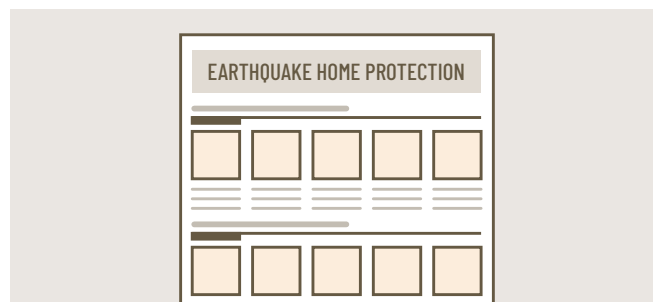
There was a need to build capacity for home flood protection assessments following the 2019 pilot studies (described above in Section 2.1.1), to enable services to be offered nationally. To support this, the Intact Centre developed a 5-day (40-hour) climate change and home flood protection assessment education course in collaboration with Seneca and Fleming Colleges. From 2019-2021 this course taught individuals from across Canada (with previous building science and home inspection knowledge) how to complete a Home Flood Protection Assessment and provided access to assessment and reporting software for successful graduates.

2.1.2 Circulating the “Three Steps to Cost-effective Home Flood Protection” Infographic

Infographics can be used to motivate homeowners to take action on their properties to reduce the risk of climate change and extreme weather events,

including flooding. This type of educational material can be distributed to homeowners/households through various channels, within communities.

The Intact Centre created an infographic called: Three Steps to Cost-effective Home Flood Protection, as shown in Figure 3, to convey practical, step-wise guidance on how to address the most common flood risks. The research findings from the Home Flood Protection Program, including the measures described in this infographic, informed development of the CSA Z800-18 Guideline on Basement Flood Protection and Risk Reduction (CSA, 2018).



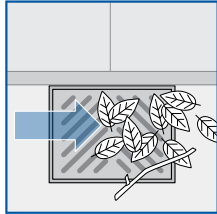
This one-page resource presents a series of 15 actions that homeowners and tenants can take to reduce their risk of basement flooding and lower the cost of cleanup if flooding does occur. Actions are conveyed in an

Figure 3: Three Steps to Home Flood Protection Infographic.

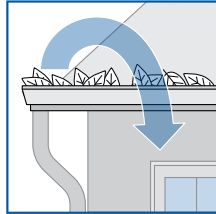
THREE STEPS TO COST-EFFECTIVE HOME FLOOD PROTECTION

Step 1: Maintain what you've got at least twice per year

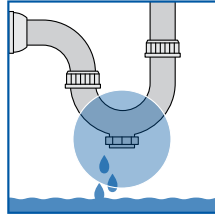
Do-it-yourself, \$0



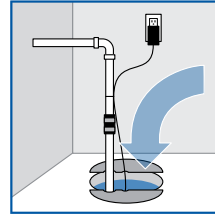
1 Remove debris from nearest storm drain or ditch and culvert



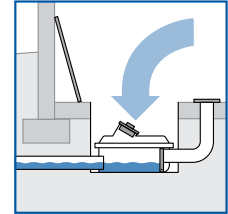
2 Clean out eaves troughs



3 Check for leaks in plumbing, fixtures and appliances



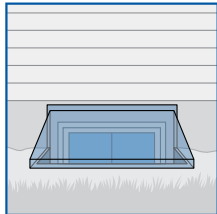
4 Test your sump pump



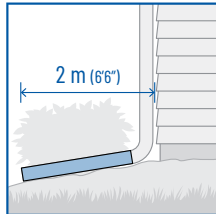
5 Clean out your backwater valve

Step 2: Complete simple upgrades

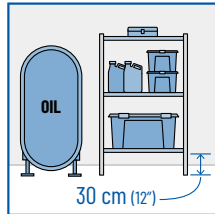
Do-it-yourself, for under \$250



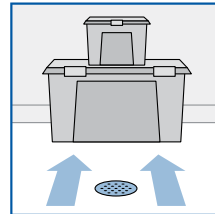
1 Install window well covers (where fire escape requirements permit)



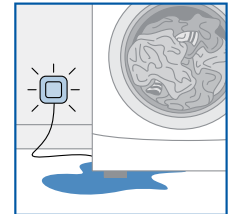
2 Extend downspouts and sump discharge pipes at least 2 m (6'6")



3 Store valuables and hazardous materials in watertight containers and secure fuel tanks



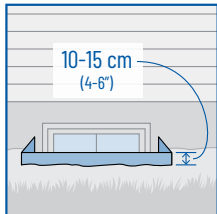
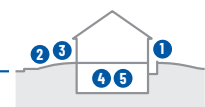
4 Remove obstructions to floor drain



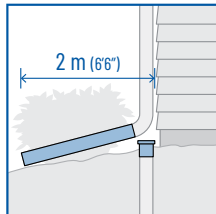
5 Install and maintain flood alarm

Step 3: Complete more complex upgrades

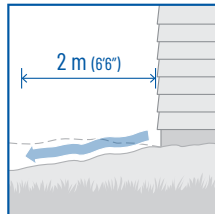
Work with a contractor, for over \$250



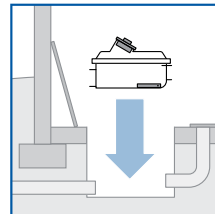
1 Install window wells that sit 10-15 cm above ground and upgrade to water resistant windows



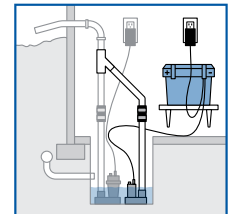
2 Disconnect downspouts, cap foundation drains and extend downspouts to direct water at least 2 m from foundation



3 Correct grading to direct water at least 2 m away from foundation



4 Install backwater valve



5 Install backup sump pump and battery

easy-to-understand graphic format and grouped into 3 categories according to cost and complexity. The first category is for simple, zero-cost, do-it-yourself maintenance for plumbing, water management devices, and rainwater management. The second category is simple do-it-yourself upgrades for the interior and exterior of the house (less than \$250), and the third category is for more complex upgrades (greater than \$250) which may require a contractor.

Infographics can be used to motivate homeowners to take action on their properties to reduce the risk of climate change and extreme weather events, including flooding. Such educational material can be distributed to homeowners/households through various channels, within communities.

When infographics are distributed there is not a built-in mechanism to track uptake, but anecdotal evidence suggests the resource is well-received by homeowners. Analogous (quantitative) evidence is drawn from the 2019 Home Flood Protection Study described above (Section 2.1.1), where similar information (to that which is presented in the infographic) was shared with households and it was found to motivate them to take action. As stated previously (p. 25, paragraph 1), this 2019 study demonstrates that when homeowners are informed about risk and risk mitigation measures, it supports action.

The Intact Centre has worked with businesses, utilities and municipalities in Canada to identify ways to distribute the infographic to homeowners. It is currently sent out with property tax notices (twice per year) and utility bills (monthly) in some municipalities. Municipalities also feature the infographic in newspaper ads and social media campaigns. Some examples of

distribution campaigns are:

- Energy+ Inc. electricity distribution utility in Brantford, Cambridge, and the Country of Brant – distributed a cobranded ‘Three Steps’ document to 66,000 customers in Spring 2021 social media and online bill campaigns.
- City of Charlottetown, PEI – featured the ‘Three Steps’ document in newspaper ads, utility bills, and social media campaigns in 2021; target audience was 36,000.
- Ecko-Jay Realty, Ontario – distributed the ‘Three Steps’ infographic in a print newsletter that went out to 10,000 homes and posted the digital version on their website in 2022.

When homeowners are informed about risk and risk mitigation measures, it supports action.

Similar campaigns with businesses, utilities and municipalities could be developed to disseminate an “Earthquake Risk Protection” Infographic to homeowners and tenants. The infographic could summarize key actions that could be taken to make homes more resistant to earthquake impacts (example actions are provided in section 2.4.1).

The infographic could also be distributed using an app, similar to the Home Flood Protection Check-up App -- this is a free app that asks users whether or not they have completed or plan to complete each action on the “Three Steps” infographic, and includes distribution and impact data tracking mechanisms. The app is described in Section 2.4.2 (p. 44) of this report.

2.1.3 Door-to-Door Outreach Campaigns

The Intact Centre has worked with the Canadian Red Cross (CRC) to develop online and in-person training, and user-friendly resources that volunteers can use when communicating flood risk information door-to-door with both homeowners and tenants living in single-family, duplexes and rowhouses, in areas of higher flood risk.

The Intact Centre collaborated with CRC on a research study (“Door-to-Door Flood Protection Education Program (FPEP)”) that tested a new CRC outreach initiative focussed on **reducing disaster risk**, rather than the traditional CRC effort of deploying disaster response and recovery teams following a natural disaster (Evans & Filippi, 2019). For this study, 40 CRC volunteers engaged over 1,000 residents in three communities in British Columbia, Alberta, and Ontario, by delivering flood protection education and collecting feedback at the door, and following up one month later with a telephone survey for a subset of participants, to collect additional feedback.



Results from the study demonstrated that motivation to reduce flood risk comes from multiple influences. The majority of residents speaking with CRC volunteers at

the door noted that they had completed some flood risk reduction activities before the outreach conversation and the majority were prompted to take additional actions following the conversation – the “CRC door-to-door conversations with residents catalyzed behaviour to reduce home flood risk and prepare for emergencies” (Evans & Filippi, 2019, p. 7). Key findings were:

- **Receptivity for Discussing Flood Risk Reduction:** 86% (of 1000 residents) were interested in speaking with CRC volunteers about home flood protection; 73% of residents ranked the value of the information provided as “good” or “very good”.
- **One Action to Reduce Flood Risk:** 88% of participants noted (in ‘at-the-door’ conversations) that they had completed at least one action to reduce their flood risk as a result of earlier or on-going flood risk education provided within their community.
- **New Flood Risk Actions:** 61% of respondents (representing 33 residents) who completed the one-month follow-up survey noted they had completed at least one new action to reduce flood risk since speaking to a CRC volunteer at the door, and 79% of survey respondents planned to complete at least one additional action within 6 months.
- **Volunteer Trainer Perceptions:** 100% of CRC volunteers felt their contribution was appreciated, and 92% saw value in expanding this work to other communities across Canada.

The Canadian Red Cross pilot programs demonstrated the ability to “materially augment existing efforts of governments, insurance companies, not-for-profits, retailers, and friends and neighbours, to help residents reduce home flood risk and prepare for emergencies” (Evans & Filippi, 2019, p. 7).

The implications of this work are substantial with respect to earthquake risk management – it is envisioned that door-to-door outreach by the CRC (or similar agencies) could significantly augment community educational efforts, to increase awareness of earthquake risk and motivate residents to take action to reduce risk. Earthquake risk reduction actions may include earthquake insurance coverage, preventive actions to reduce property damage and injury at the level of the home, and property purchase and relocation decisions.

The Canadian Red Cross pilot programs demonstrated the ability to “materially augment existing efforts of governments, insurance companies, not-for-profits, retailers, and friends and neighbours, to help residents reduce home flood risk and prepare for emergencies” (Evans & Filippi, 2019, p. 7).

2.1.4 Behavior Change Insight and Best Practices – External Research

In addition to the 2019 Intact Centre Home Flood Protection Study (Evans and Feltmate, 2019), additional studies provide insight into changing homeowner behaviour to increase awareness, followed by actions, to limit household flood risk.

2.1.4.1 National Attitudes and Opinions on Flood Risk

A national survey (Ziolecki et al., 2020) of 2,500 people in Canada’s 10 provinces and territories, who live in areas at high risk of recurrent flooding, found that:

- 97% of respondents believed homeowners have

responsibility to protect their property from flooding

- Only 6% know they were living in a designated flood risk area
- The majority (81%) of respondents had not reviewed flood maps for their community
- About half of respondents (47%) reported they were not concerned about flooding
- Most (57%) did not have flood insurance
- A quarter (26%) reported that their insurance representative had discussed potential options for home flood insurance
- Most (55%) had not taken steps to protect their property, such as installing a sump pump, and
- Respondents believed the responsibility of communicating flood risks lies with multiple stakeholders, including all levels of government, insurance companies and real estate professionals (Ziolecki et al., 2020, p. 4).

The results suggest that more work is needed to communicate flood risk and motivate action for reducing risk through non-structural measures (raising awareness of risk, implementing property-level flood protection, flood insurance, land use regulation, etc.) (Ziolecki et al., 2020).

2.1.4.2 Risk Communication

Risk communication is a tool that municipal governments use to facilitate action by residents to manage flood risk (Krueger, 2022). Communicating on flood risk links flood management evidence and expertise (from subject matter experts) to implementation of local-level solutions and

development of flood resilience (Rollason et al., 2018). It also informs the public about the role they can play in reducing flood risk (Krueger, 2022).

Communicating on earthquake risk is equally important – it educates about earthquake threat and encourages preparation and implementation of risk mitigation measures that reduce vulnerability (Martin, n.d.). Earthquake communication is distinct from other hazards in that people will have less experience with earthquakes compared to other disasters since large earthquakes strike less frequently; this leaves communicators with, “more of a hill to climb to provide motivational proof to help achieve desired behaviour changes” (Martin, n.d., p13-8). In addition to the frequency versus severity issue, geographic-specific information needs to be conveyed (Martin, n.d.).

Risk communication (for all hazards) is thought to be a necessary component of risk management (McComas, 2006). The 2015 Sendai Framework on Disaster Risk Reduction -- adopted by United Nation member states, and advocating for the reduction of disaster risk and losses in lives, livelihoods, health and assets -- prioritizes improving hazard information availability and accessibility for all (United Nations, 2015).

Risk communication helps to raise awareness, motivate and reinforce behaviours concerning a specific risk, and facilitate the involvement of many actors in decision-making (Höppner et al., 2012). There is evidence that, “flood risk communication can positively influence individuals’ decisions to implement structural flood risk mitigation measures and to purchase flood insurance” (Botzen et al., 2013; De Boer et al., 2014; and Haer et al., 2016, as cited in Krueger, 2022, p. 16). Thus, those engaging with homeowners should communicate guidance and expectations to motivate individuals to act (Krueger, 2022).

Kruger (2019) highlights several best practices from international research on flood risk communication (Höppner et al., 2012; Maidl & Buchecker, 2015; O’Sullivan et al., 2012; Rollason et al., 2018):

- **Audience Specific:** Flood risk information should be tailored to specific audiences, considering demographic and geographic characteristics.
- **Non-Technical Communication:** Flood risk communication should be communicated using simple, non-technical language.
- **Public Trust:** Public trust in the communicator is an important determinant of the relevancy and efficacy of the flood risk message.
- **Public Risk Perception:** Addressing the public’s risk perception is important for developing effective flood risk communication strategies.
- **Two-Way Dialogue:** Consultation with the public through a two-way dialogue is preferable to one-way communication because it fosters transparency and credibility of the flood risk communicator to the public (Kruger, 2022, p. 25-26).

“you have to have personal contact with that person, and you have to convince them in person. It’s very unlikely that you can motivate people to get personally prepared simply with media” (Municipal flood risk communicator, personal communication, 2022; as cited in Kruger, 2022)

Neighbourhoods and communities with high flood exposure may require **targeted flood risk communication**, which considers demographic,

social, and geographic vulnerabilities (Kruger, 2022). The Kruger (2022) study on effective flood risk communication in Canada (qualitative data collected from municipalities and other stakeholders that communicate flood risk to households) suggested that personal communication is a pre-requisite for motivating emergency preparedness, with one study participant stating: “you have to have personal contact with that person, and you have to convince them in person. It’s very unlikely that you can motivate people to get personally prepared simply with media” (Municipal flood risk communicator, personal communication, 2022; as cited in Kruger, 2022).

The same study identified that partnering with community groups capitalizes on existing connections between residents and groups, adding value by improving the quality and impact of messaging (Kruger, 2022).

Considering that earthquake risk zones are distinguished by higher physical vulnerability, and may also have social and demographic vulnerabilities, employing targeted earthquake risk communication may be of value.

In the study of municipality and other stakeholder experiences on flood risk communication, Kruger (2022) identified several household barriers for learning about, and taking steps to prepare for flooding; these are listed below. Of these, barriers 1-9 may apply to earthquake risk communication.

Barriers to awareness include:

1. Knowledge (knowledge of flood risk, flood risk types, technical knowledge)
2. Lack of prior flood experience

Barriers to preparedness include:

3. Cost of residential flood risk preparedness

4. Knowledge of residential flood risk preparedness measures
5. Lack of personal responsibility for flood risk mitigation
6. Temporal distance from a flood event (time elapsed since a flood event)
7. Apathy toward flood risk
8. Denial of flood risk
9. Fatalism about flood risk preparedness

Barriers to both awareness and preparedness include:

10. Emotional barriers (fear, trauma) to flood risk awareness and preparedness
11. Social and cultural barriers to flood risk awareness and preparedness
12. Systemic barriers to flood risk awareness and preparedness
13. Other priorities outcompeting flood risk awareness and preparedness
14. The ‘levee effect’ (infrastructure enables inaction) (Kruger, 2020, p.59)

2.2 Homeowner Insurance Purchases

Residential water damage insurance in Canada consists of different coverages. Homeowners are typically covered for sudden and accidental damage caused by the escape of water from plumbing pipes, appliances, or fixtures, as part of standard home insurance policies. Optional coverage is available (as endorsements) for two additional types of flooding: ‘sewer back-up’ and ‘overland flooding’. Sewer back-up can occur when urban sewer lines become pressurized during a storm – the build-up of pressure causes water to reverse direction and back up through the main outflow pipe in a house, and emerge through basement drains, drains in sinks or showers, or up through toilets (Contant, 2022). Overland flooding occurs when water runs over the ground surface and through doors and windows into a home. Overland flood coverage became available

in 2015 when massive floods in southern Alberta in 2013 prompted insurers to offer it; take-up rates have grown steadily and today about half of Canadian policy holders have this coverage (Contant, 2022).

A homeowner would purchase home insurance (which includes water damage coverage for plumbing and appliance leaks) at the time of home purchase, and update the coverage as needed. Some factors that may lead homeowners to update flood coverage include direct experience of flooding, knowledge about recent local/regional flooding events, and greater knowledge of flood risk and preventive actions to reduce risk.

Exploring consumer demand for flood insurance may provide valuable insight into factors that influence earthquake insurance purchases, and how consumers can be motivated to obtain earthquake insurance coverage. The Intact Centre investigated demand-side considerations for the purchase of optional flood insurance during the Intact Centre 2019 Home Flood Protection Study (Evans and Feltmate, 2022). Survey findings are described below.

Ninety-one households were surveyed three months

after having completed a home flood protection assessment and asked if they made changes in their flood insurance policy coverages. Sixty-five households (71% of those surveyed) responded. Results showed that **engaging in two-way conversation positively influences homeowners' understanding of available optional insurance coverage and has the potential to influence decision-making in the future:**

The majority of households (86%) made no changes to insurance policy coverage after 3 months, 9% made changes, and 5% declined to comment.

In general, households reported having a higher level of knowledge on water damage insurance -- for overland flooding, sewer back-up, plumbing/fixtures leakage, and groundwater seepage -- after participating in the home flood protection assessment. Insurance knowledge:

- 'Increased substantially' for 26%
- 'Increased moderately' for 31%
- 'Increased slightly' for 49%
- 'No change' for 29% and
- 'Not sure' for the remaining 3%



Households noted the following barriers to understanding water damage-related insurance coverage:

- ‘Lack of information about all options for coverage provided through my broker’ (35%)
- ‘Confusing or lengthy insurance documents’ (35%)
- ‘Other barriers’ (35%)
- ‘Lack of clear information provided by agent or broker’ (23%)
- ‘Lack of time’ (12%) and
- ‘Taking action was a low priority’ (12%), with multiple responses permitted for the question

Supports needed to overcome barriers to understanding water damage-related insurance coverage were:

- ‘Clear information provided by agent or broker’ (94%)
- ‘Unbiased flood insurance options provided in an easy-to-understand summary’ (80%)
- ‘Short and easy to understand insurance policy documents’ (75%)
- ‘Easy to understand videos or fact sheets’ (54%), and
- ‘Improved ability to get in touch with agent or broker’ (8%), with multiple responses permitted for the question

Following the 2019 Home Flood Protection study (Evans and Feltmate, 2019) and in response to the insurance coverage findings, Intact Centre worked with the Insurance Brokers Association of Canada (IBAC) to develop a training program for insurance brokers. The course strengthens brokers’ knowledge and skills to work with clients to reduce home flood risk and match risk with available insurance coverages. In terms of what could be applied to the realm of earthquake insurance, it may be advantageous to implement a similar, simple research study whereby insurance brokers and other professionals can engage with homeowners to better understand demand-side considerations for earthquake insurance purchases. The learnings could then be incorporated into training

and resources for professionals who directly support homeowners/households in homeownership processes.

The Intact Centre’s work has examined flood risk in geographic areas and for general populations (no focus on different social or demographic groups). A study by the Poverty Institute at Ambrose University in Calgary (Nauta, 2022) examined the impacts of extreme weather (hail storms) on vulnerable populations. This study identified equitable access to insurance as a barrier to building back better and enhancing resilience after a natural catastrophe. Vulnerable communities may face unique challenges in reducing risk through insurance coverage and may be disadvantaged in their ability to recover from events. **Targeted communication efforts could support vulnerable populations in better understanding and accessing needed insurance. This would apply equally to flood and earthquake insurance.**



2.3 Working with National Professional Associations to Develop and Deliver Home Flood Protection Literacy and Advocacy Training Programs for Members

Intact Centre works with several national professional associations in the **residential sector** to develop and deliver home flood protection literacy and advocacy training programs that can be shared with association members. Training courses are 1.5 hours in duration and offered at no cost (free), online. While completion of courses is voluntary at the present time, most courses are certified for continuing professional education credit. The training courses focus on home flood protection, and prepare professionals to advise clients on:

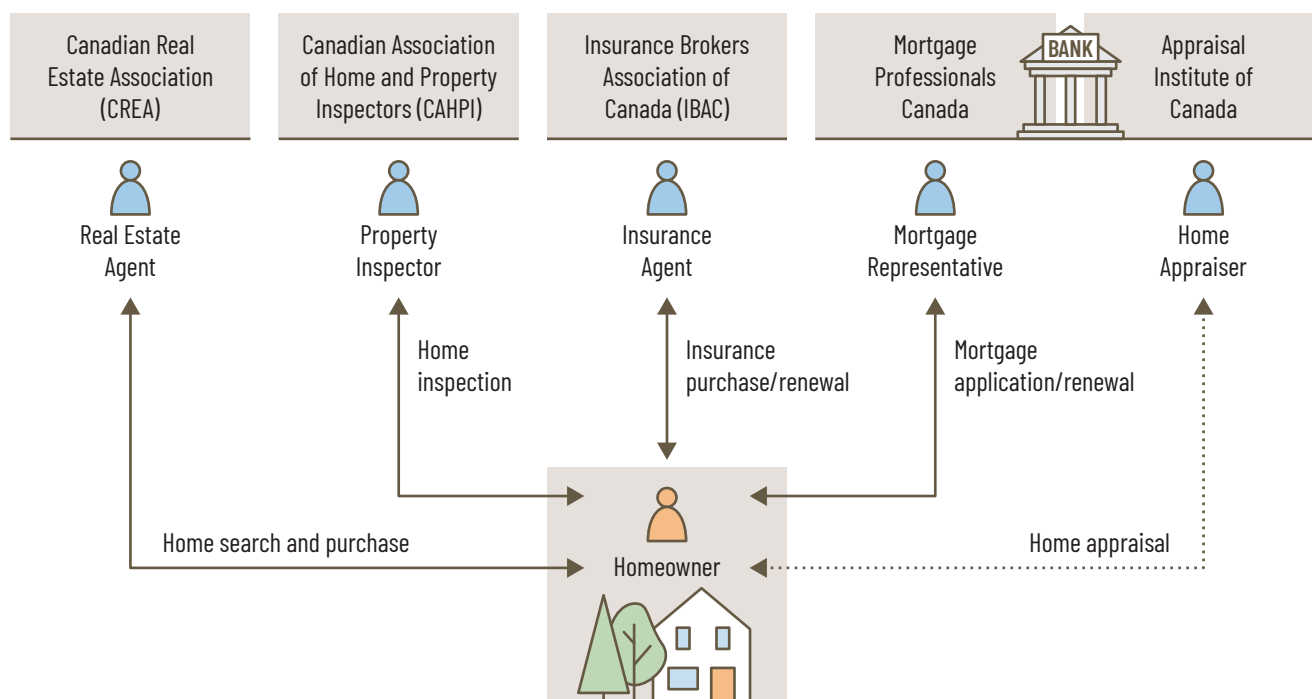
- Flood risk
- How to protect homes from flooding by way of practical, meaningful, cost-effective solutions
- How to access self-help resources, including

information about available home flood protection subsidies and discounts, and

- Questions for homeowners to ask their insurance provider about matching flood risk with available coverages.

Professional associations that offer training with the content above, include the **Insurance Brokers Association of Canada (IBAC)**, **Canadian Real Estate Association (CREA)**, **Mortgage Professionals Canada**, **Appraisal Institute of Canada (AIC)**, and **Canadian Association of Home and Property Inspectors (CAHPI)**. By nature of their work, members of these associations engage directly with homeowners and can motivate homeowner behaviour and effect positive change. Having association members trained in flood risk reduction not only benefits homeowners (in being able to lower risk and safeguard properties and health), but it enables members to advance professionally (gaining continuing education credits for zero-cost), provide better (more-informed, value-add) customer

Figure 4: Consumer (homeowner) interactions in the residential home ownership process.



service to clients, and grow their businesses. Figure 4 illustrates industry professionals with whom a consumer (homeowner) engages during home purchase and ownership processes.

A key factor in this approach is that member professionals serve as trusted advisors to their homeowner clients, as clients navigate through real estate and homeownership processes. This aligns with best practices commonly noted in studies of flood risk communication – that, “consultation with the public through two-way dialogue is preferable to one-way communication because it fosters transparency about flood risk and credibility of the flood risk communicator to the public,” and, “public trust in the communicator is an important determinant of the relevancy and efficacy of the flood risk message” (Krueger, 2022, p. 25-26). Leveraging pre-existing relationships with homeowners to convey information on flood risk has inherent benefits.

This initiative (of working with professional organizations) has been underway for only a few years. As of 2022, approximately 5% of insurance brokers, 23% of home and property inspectors, <5% of

mortgage brokers, and <5% of real estate professionals have participated in training courses on flood risk protection. These numbers are expected to increase. It is also thought that the professionals who do take the training may be highly motivated to put it into practice to demonstrate added value to clients and grow their businesses – therefore a smaller number of highly-motivated professionals may be able to affect larger change in terms of homeowner action.

As of 2022, approximately 5% of insurance brokers, 23% of home and property inspectors, <5% of mortgage brokers, and <5% of real estate professionals have participated in training courses on flood risk protection.

It is important to note that each professional has a significant sphere of influence – in essence, there is a ‘multiplier effect’ for every professional trained. One trained insurance agent, home inspector, or real estate

One trained insurance agent, home inspector, or real estate agent could interact with 100+ clients in a given year, expanding the penetration of knowledge on flood protection and resources across communities.



agent could interact with 100+ clients in a given year, expanding the penetration of knowledge on flood protection and resources across communities. Professional associations with whom Intact Centre

engages to promote home flood protection – with a proposed extension to earthquake protection – are profiled in Table 4. Descriptions of these organizations and Intact Centre’s collaboration follow after the table.

Table 4: Professional organizations engaging with the Intact Centre to promote home flood protection to Canadian households, and their proposed role in earthquake insurance and protection.

Organization	Type of professional and total membership	Role in promoting home flood insurance and protection	Proposed role in promoting residential earthquake insurance and protection
1. Insurance Brokers Association of Canada (IBAC)	Insurance brokers 38,000	Engage in two-way conversation and educate on home flood risk, promote flood insurance coverage, and promote cost-effective, practical actions to reduce the risk of residential basement flooding.	IBAC could develop and deliver free online training courses to educate insurance brokers in markets characterized by earthquake risk. The training could include topics such as earthquake risk awareness, opportunity for earthquake insurance, how to match risk with available coverage, and actions that can be taken in and around the home to reduce the risk of property damage or personal injury in the event of an earthquake.
2. Canadian Real Estate Association (CREA)	Real estate brokers, agents, salespeople 155,000	Engage in two-way conversation and educate on home flood risk, promote flood insurance coverage, and promote cost-effective, practical actions to reduce the risk of residential basement flooding.	CREA could develop and deliver free online training courses for real estate brokers, agents and salespeople working in geographic markets characterized by earthquake risk, to educate on earthquake risk reduction. The training could include topics such as earthquake risk, opportunity for earthquake insurance with a recommendation for homeowners to speak with a licensed insurance representative, and actions that can be taken in an around the home to reduce the risk of property damage or personal injury in the event of an earthquake.
3. Mortgage Professionals Canada (MPC)	Mortgage professionals/providers 15,000	Engage in two-way conversation and educate on home flood risk, promote flood insurance coverage, and promote cost-effective, practical actions to reduce the risk of residential basement flooding.	Mortgage Professionals Canada could develop and deliver free online training courses for mortgage brokers and lenders working in geographic markets characterized by earthquake risk, to educate on earthquake risk reduction. The training could include topics such as earthquake risk, opportunity for earthquake insurance with a recommendation for homeowners to speak with a licensed insurance representative, and actions that can be taken in an around the home to reduce the risk of property damage or personal injury in the event of an earthquake. The information could inform mortgage lending decisions of these professionals, and could be incorporated in educational information packets distributed to homeowners.

Organization	Type of professional and total membership	Role in promoting home flood insurance and protection	Proposed role in promoting residential earthquake insurance and protection
4. Canadian Association of Home and Property Inspectors (CAHPI)	Home inspectors 500 through CAHPI; 1,500 through Carson Dunlop	Engage in two-way conversation and educate on home flood risk, promote flood insurance coverage, and promote cost-effective, practical actions to reduce the risk of residential basement flooding.	Canadian Association of Home and Property Inspectors (CAHPI) could develop and deliver free online training courses to be offered to home inspectors working in geographic markets characterized by earthquake risk, to educate on earthquake risk reduction. The training could include topics such as earthquake risk, opportunity for earthquake insurance with a recommendation for homeowners to speak with a licensed insurance representative, and actions that if implemented in and around the home, could reduce the risk of property damage (or personal injury) in the event of an earthquake.
5. Appraisal Institute of Canada	Home appraisers 5,400	Gain knowledge/ expertise on how to integrate residential flood risk into property appraisals. Appraisers do not directly engage with homeowners. The benefit of having trained appraisers is to more accurately assess the value of residential properties in light of existing and evolving climate-related extreme weather (flood) risks.	Appraisal Institute of Canada could develop and deliver training for appraisers working in geographic markets characterized by earthquake risk, to more accurately incorporate earthquake risk into property valuation.

Insurance Brokers Association of Canada (IBAC)

The Insurance Brokers Association of Canada (IBAC) is a not-for-profit, national organization that represents the collective interests of 11 member associations (representing provinces and one large municipality) and their member insurance brokers; IBAC's mandate includes advocating on behalf of insurance brokers and consumers and promoting a vibrant broker network (IBAC, n.d.). The Intact Centre has worked collaboratively with IBAC to implement a professional training program that supports climate adaptation.

Federal and/or provincial and territorial regulators oversee the training that insurance brokers receive. Enhancing the regulatory framework provides an opportunity to transition what is currently voluntary training, to mandatory training, so that all brokers are knowledgeable on aspects of climate risk.

As noted earlier, flood risk training is currently offered as voluntary continuing education (for professional

credit). Federal and/or provincial and territorial regulators oversee the training that insurance brokers receive. Enhancing the regulatory framework provides an opportunity to transition what is currently voluntary training, to mandatory training, so that all brokers are knowledgeable on aspects of climate risk. To this end, the Intact Centre is currently working with provincial and territorial insurance regulators, to **advocate for mandatory flood protection training as part of the education curriculum for brokers**. This is an important step in advancing licensing requirements for insurance brokers, to ensure they can support clients in building protection at the level of the home, for evolving climate-related extreme weather risks.

Canadian Real Estate Association (CREA)

The Canadian Real Estate Association (CREA) brings together more than 155,000 real estate brokers, agents and salespeople working through 75 real estate boards and associations across Canada. It is one of the largest single-industry professional associations in Canada (CREA, n.d.). CREA advocates for policy that supports and enables home ownership and works to enhance the reputation and skills of realtors through awareness and education (CREA, n.d.).

The Intact Centre has been working with CREA to develop and promote home flood protection training for agents.

Training enables real estate agents to gain knowledge and skills to better advise clients (homebuyers) on flood risk considerations during a home search. Agents can provide greater value, and clients can make better-informed decisions about home purchases and flood protection (insurance options and flood protection retrofit measures for the home and property).

Some real estate agents who have been trained in home flood protection, now offer free home flood protection assessments to their clients as part of their real estate service packages; they absorb the cost of the assessment

in their business model. These agents recognize that providing buyers with a comprehensive flood risk assessment report, and the measures that can be taken to reduce risk, enhances service and benefit for clients.

Real estate is a regulated profession in many provinces and territories. The opportunity exists to advocate and shift voluntary flood protection training, to mandatory, as part of professional licensing requirements for real estate agents. Establishing required training will enable the real estate profession to deliver comparable, consistent value to clients in all markets.

The opportunity exists to advocate and shift voluntary flood protection training to mandatory, as part of professional licensing requirements.

Mortgage Professionals Canada (MPC)

Mortgage Professionals Canada is the country's mortgage industry association; it represents over 15,000 individuals and 1,000 member firms, including mortgage brokers, lenders, insurers and industry service providers (Mortgage Professionals Canada, 2022a). The association's objectives include advocating for member interests on policy and regulatory issues, promoting responsible mortgage industry standards and conduct, and delivering best-in-class training for mortgage professionals (Mortgage Professionals, 2022b). The Intact Centre has worked closely with MPC, to develop and implement voluntary training on flood risk and mitigation measures.

Similar to insurance and real estate, the mortgage industry is regulated by federal and provincial regulators. The opportunity exists to advance **mandatory training for mortgage professionals**, so that as part of licensing,

professionals are knowledgeable about residential flood risk and implications for mortgage financing. This represents an important opportunity for factoring flood risk (and other extreme weather risks) into lending decisions, to safeguard the stability and security of Canada’s financial markets.

In conjunction with Mortgage Professionals Canada, the Intact Centre also works closely with the Canadian Mortgage and Housing Corporation (CMHC), which acts as a national housing agency for Canada and aims to make mortgage loans affordable for Canadian residents. The Intact Centre partnered with the Lenders Working Group of CMHC (representing approximately 80% of the mortgage market in Canada), to educate on flood risk and promote the “Three Steps to Cost-effective Home Flood Protection” infographic. It is anticipated that mortgage providers (members of CMHC Lenders Working Group) can support dissemination of the infographic in mortgage applications and renewals across Canada. This is a direct and meaningful way of raising awareness for flood risk among homeowners and encouraging them to implement simple, protective actions around the home to reduce the risk of flooding.

Canadian Association of Home and Property Inspectors (CAHPI)

Canadian Association of Home and Property Inspectors (CAHPI) is a national, non-profit, and self-regulated association of home inspectors. It promotes and strengthens members’ competency and professionalism, and advocates on behalf of professional home and property inspectors across Canada. It also advances national standards for professional development and education for home and property inspectors, and evaluates the competency of inspectors, to protect consumers.

Carson Dunlop, a building inspection consulting firm and a premier developer of home inspection and training and software in North America, is a founding member of the Canadian Association of Home and Property Inspectors (Carson Dunlop, 2022).

The Intact Centre has worked closely with both CAHPI and Carson Dunlop to develop and deliver home flood protection training for property inspectors. Since 2021, Carson Dunlop has also been promoting the Three Steps to Cost-effective Home Flood



Protection infographic. Home inspectors have an option in their software to add a Carson-Dunlop branded version of the infographic as an attachment in client reports. Carson Dunlop appraisers complete a total of 250,000 appraisals per year in North America (100,000 in Canada and 150,000 in the U.S.). This is a sizable market and a meaningful mechanism to reach homeowners who are motivated to make improvements on new home purchases.

Appraisal Institute of Canada

Appraisal Institute of Canada is the industry association for real estate professionals who provide valuation services for residential, commercial and industrial real estate transactions. Opinions of market value are made based on comprehensive research and analysis. They enable property owners, businesses, investors, and governments to make informed decisions on real estate planning and transactions (Appraisal Institute of Canada, 2022).

The Intact Centre has engaged with the Appraisal Institute and provided home flood protection training at national and local area conferences. This training focused on how to integrate flood risk into property appraisals. As well, a step-by-step guide (‘Professional Member Bulletin’) to assist appraisers in integrating property-level flood risk into the appraisal process, has been developed and distributed to members.

Through a partnership with the Appraisal Institute of Canada, the Insurance Bureau of Canada, and the Intact Centre, there is opportunity to integrate flood protection training and resources (e.g., Three Steps to Home Flood Protection, Water Damage Insurance Literacy Infographic, Professional Member Bulletin), into **required home appraisal courses**, including “Green Housing for Appraisers’ and ‘Residential Property Analysis’. This represents an important shift in appraisers’ education and underscores the value of flood risk knowledge and skills to better support the appraisal process.

2.4 Homeowner/Household Resources

The following section describes user-friendly resources for homeowners/households that support building awareness and taking action to reduce risk.

2.4.1 Three Steps to Home Flood Protection Infographic

The Intact Centre has developed and circulated an infographic called, “Three Steps to Cost-effective Home Flood Protection”, shown above in Figure 3. The infographic presents a series of 15 actions, based on the most actionable measures described in the CSA Z800-18 Guideline on Basement Flood Protection and Risk Reduction (CSA, 2018). It can be used to motivate homeowners to reduce their risk of flooding (Moudrak & Feltmate, 2020). Distribution to homeowners/households can be done through many channels including utility bills, property tax mailings, print (newspaper), or online channels such as social media and newsletters.



The benefit of this resource is it “helps homeowners help themselves,” by conveying in one-stop-shopping, many simple, meaningful, and cost-effective flood protection measures for the home, several of which can be implemented over a long weekend. It’s provided by the Intact Centre at no cost, for use by all stakeholder groups. Communities, industry associations, not-for-profits and other stakeholders can individualize it by adding their logos for promotion.

The infographic has been well received by homeowners. Intact Centre’s 2019 Home Flood Protection Study (see p. 21, paragraph 1) provided similar evidence for the value and utility of the infographic -- the study’s follow-up survey showed that 71% of homeowner respondents reported taking two actions six months after receiving in-person home flood protection guidance (Evans and Feltmate, 2019).

An infographic could be developed for earthquake risk management – to motivate homeowners/households in earthquake risk

An infographic could be developed for earthquake risk management – to motivate households in earthquake risk zones to secure and prepare their homes against damage and minimize the risk of personal injury. Content for such an infographic could be drawn from earthquake subject matter experts like the Province of British Columbia, the Insurance Brokers Association of B.C., or the California Earthquake Authority (CEA).

zones to secure and prepare their homes against damage and minimize the risk of personal injury. Content for such an infographic could be drawn from earthquake subject matter experts like the Province of British Columbia, the Insurance Brokers Association of B.C., or the California Earthquake Authority (CEA), who provide the following guidance:

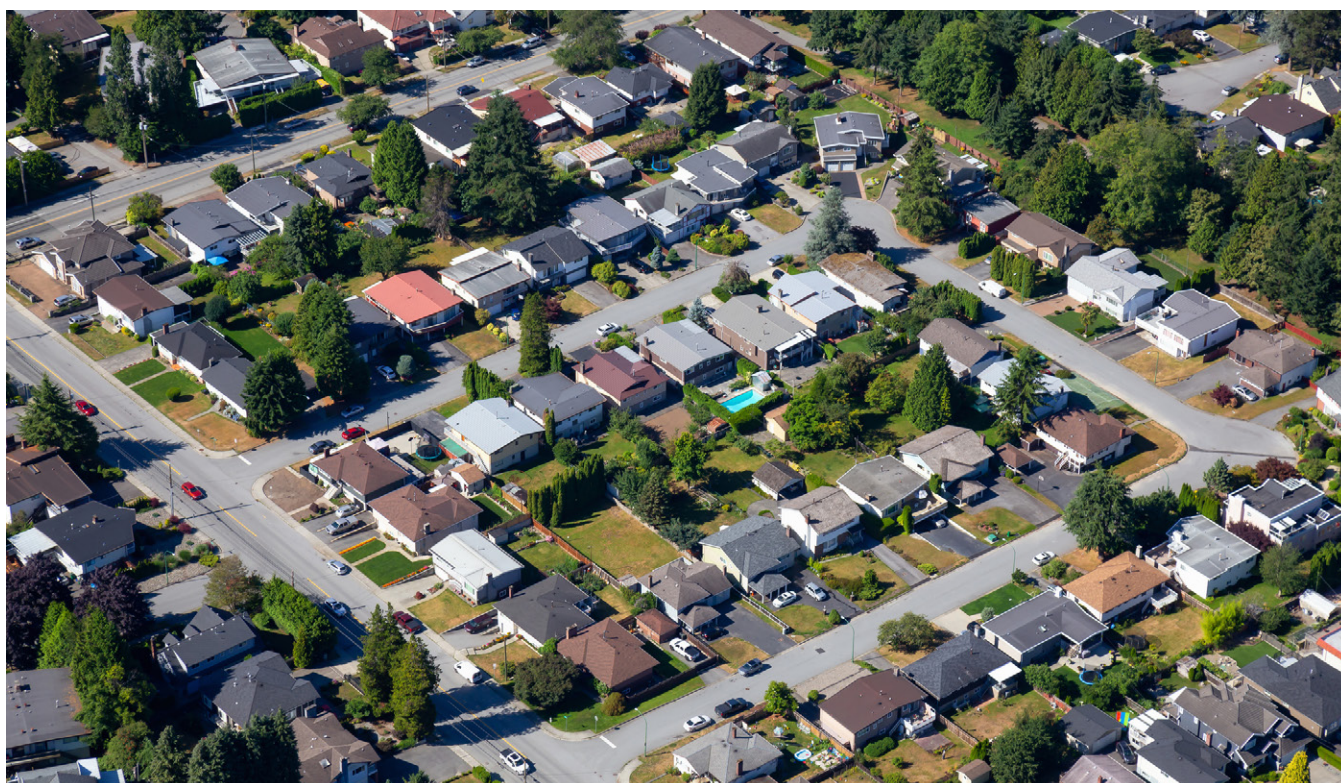


Table 5: Selected actions to secure a home before an earthquake; CEA (2020).

Location	Area	Action
Home Interior	Water heater	<ul style="list-style-type: none"> Water heaters should be braced using an authorized strap kit purchased from a hardware store.
	Kitchen	<ul style="list-style-type: none"> Gas appliances should have flexible connections. Ovens and refrigerators should be strapped to the walls. Latches can be used to keep cabinet doors from flying open during an earthquake.
	Furniture	<ul style="list-style-type: none"> Heavy mirrors and pictures on walls, near chairs and couches should be anchored with wire through eye screws into studs. Beds should be located away from mirrors. Heavy objects should not be hung over beds.
	Bookcases	<ul style="list-style-type: none"> Bookcases and shelves should be strapped to walls to prevent tipping/falling. Cabinets should be secured to wall studs.
	Hanging objects	<ul style="list-style-type: none"> Ceiling fans, pendant lighting and other hanging fixtures should be secured. Heavy objects should not be hung over places where residents spend a lot of time, such as couches in the living room, desks in a home office, or tables in a dining room.
	Electronics and TVs	<ul style="list-style-type: none"> TVs, computers and other expensive and/or hazardous electrical components should be strapped down.
	Small valuables	<ul style="list-style-type: none"> Small breakable valuables should be moved to lower open shelves with lip guards, placed on Velcro adhesives, or placed in locked cabinets.
Home Exterior	Foundation	<ul style="list-style-type: none"> Homes built using 'stem-wall' and 'cripple-wall' may benefit by retrofitting the home's foundation with anchoring to reduce the possibility of the house sliding off of its foundation in an earthquake.
	Gas Shut-off valve	<ul style="list-style-type: none"> Automatic gas shut-off valves that are triggered to engage when there are strong vibrations, may be installed for safety.
	Trees	<ul style="list-style-type: none"> Tree limbs adjacent to a home and garage should be pruned.
	Flammable liquids	<ul style="list-style-type: none"> Weed killers, pesticides, and flammable products should be stored securely away from a house in closed cabinets with latches, on the bottom shelves.

2.4.2 Home Flood Protection Check-Up Web App

The Home Flood Protection Check-Up (Figure 5) is an online tool created by the Intact Centre, to self-assess flood risk at a residential property. This free, user-friendly application asks residents to identify the community and province/territory that they live in and whether they are home owners or tenants, and

then asks whether or not they have completed relevant actions that are included in the “Three Steps” Infographic, to protect their homes from flooding. A confidential, custom report identifies actions that can be taken to reduce risk and provides links to a wide variety of self-help resources (Moudrak & Feltmate, 2020). Featured Intact Centre resources highlight information about retrofitting a home to better protect

it from flooding and questions homeowners can ask their insurance brokers about flood insurance, and how to match risk with available coverage (Moudrak & Feltmate, 2020). Homeowners are also asked if they would like to participate in a 1-month follow-up survey to share new actions taken, actions planned, barriers to taking new actions, what would help them overcome these barriers (enablers). **A similar web application could be developed and supported by provincial and/or municipal governments for earthquake risk management – providing information and suggesting questions homeowners can ask their insurance agents about earthquake insurance, as well as information on simple actions that can be taken around the home (interior and exterior) to reduce damage and injury in the event of an earthquake.**

2.4.3 Flood Insurance Literacy Infographic - Understanding Water Damage Insurance Coverages

The Intact Centre developed a flood insurance literacy infographic (Figure 6) for homeowner audiences, to explain the types of water damage risk for residential properties and the types of water damage coverages that may be available from insurers. This document was reviewed for technical accuracy and was approved by the Insurance Bureau of Canada before public circulation was initiated in 2019. This infographic can be used to raise awareness and as a starting place for conversation between homeowners and insurance providers, about suitable coverage.

It may be advantageous to develop a similar resource (as the “Understanding Water Damage Flood Insurance” infographic) **for earthquake insurance literacy.** This could be developed and promoted by an academic group, not-for-profit, or municipal/provincial government, all of which have no



Figure 5: Home Flood Protection Check-up Web App.

business interest in insurance sales. **The earthquake insurance literacy infographic could be distributed to homeowners to raise awareness of earthquake risks and coverage, and support conversations with licensed insurance representatives about suitable coverage.**

2.4.4 Additional Resources

The impact of natural catastrophes including flooding, wildfire, and earthquake on vulnerable populations in Canada, and their ability to prepare for hazards, is an important area of study. The Inclusive Resilience Project (Wright et al., 2022) -- a collaboration between Partners for Action, the Canadian Red Cross, and Public Safety Canada -- provided insights on barriers to preparedness, and how communication campaigns and community partnerships might be coordinated to more effectively raise awareness and preparedness among vulnerable groups including women, low-income individuals, older adults, Indigenous Peoples,

Figure 6: Flood Insurance Literacy Infographic - Understanding Water Damage Insurance Coverages.



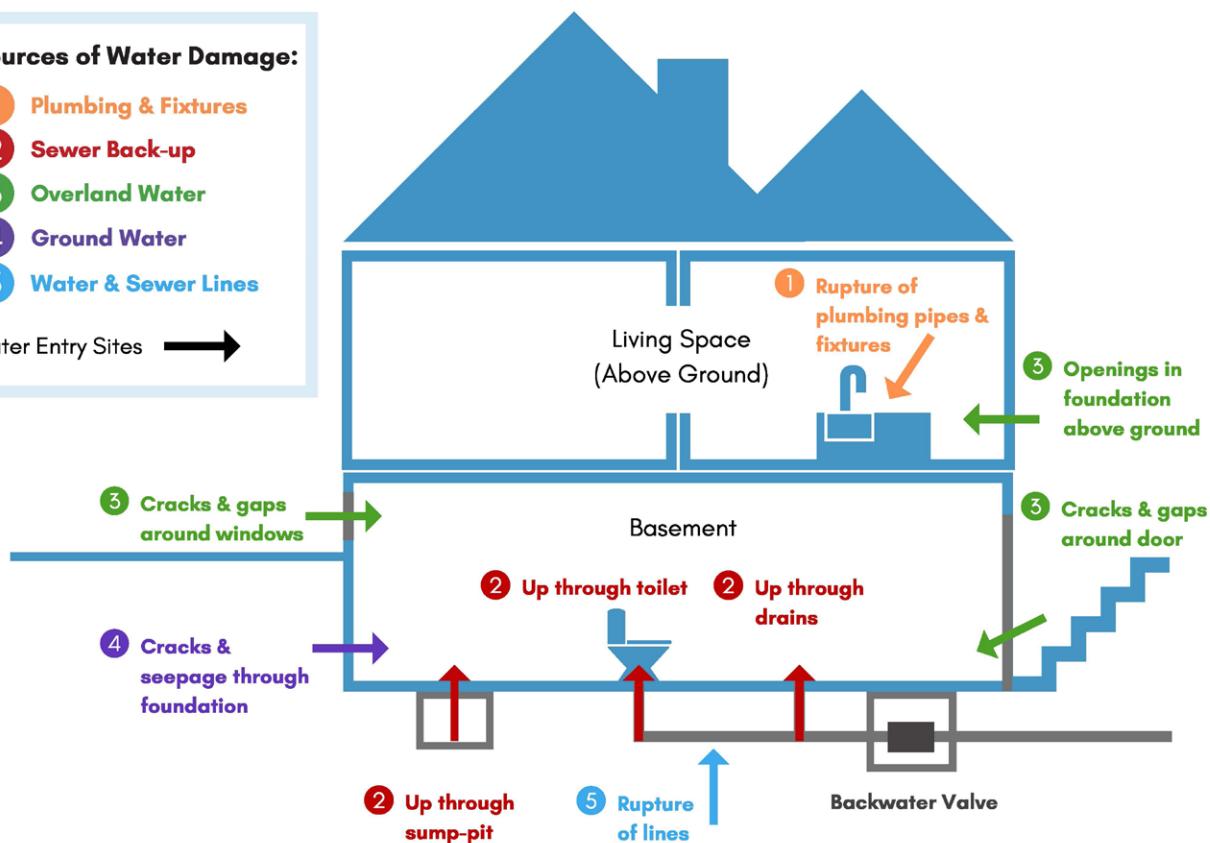
Understanding Water Damage Insurance Coverages

This information is being provided to help you understand the different types of water damage risks at your home and the types of water damage coverages that may be available from insurers. It is intended as a starting place for discussion with your insurer to determine which kind of coverages might be right for you.

Sources of Water Damage:

- 1 Plumbing & Fixtures
- 2 Sewer Back-up
- 3 Overland Water
- 4 Ground Water
- 5 Water & Sewer Lines

Water Entry Sites →



Home Owner Water Damage Insurance Coverages:

- ✓ **Typically Covered:** Sudden and accidental damage caused by escape of water from plumbing pipes, appliances or fixtures
- ✓ **Optional Coverages:** Sudden and accidental damage caused by sewer back-up, overland and groundwater flow and rupture of water and sewer lines
- ✗ **Typically Not Covered:** Damage created by chronic leaks or poor maintenance and damage that occurs during prolonged absences without regular monitoring

Tenant Water Damage Insurance Coverages:

- ✓ **Typically Covered:** Replacement of personal contents and temporary accommodations while damage is being repaired

and newcomers to Canada (≤ 5 years). The study identified that across all five vulnerable demographics, the top barriers to preparedness were denial and/or indifference, cost, and lack of awareness about the natural hazard risks in the region and a lack of knowledge on how best to prepare for natural hazard events and emergencies.

The Intact Centre is engaging with the Canadian Red Cross to develop equitable resilience education for Canadian residents, for flooding, wildfire, and extreme heat. This will provide vulnerable populations with targeted resources and communication that supports their needs (relative to social and demographic vulnerabilities) for understanding flood (and wildfire) risk and taking action to reduce risk. The Intact Centre is also exploring the development of flood risk

reduction programs for owners/occupants of multi-unit residential buildings.

A key theme that is emerging is the need to co-develop natural hazard risk reduction programs with stakeholders. This is especially relevant for vulnerable communities which benefit from communication that is focused, more personal (two-way, in-person communication), and takes the group's geographic and social dimensions into consideration (Kruger, 2022).

Development of earthquake risk management resources for vulnerable communities in earthquake risk zones is an area that can be further explored to ensure there is equity for opportunities and support for building resilience.





3.0 Challenges/Opportunities to Advance Home Flood Protection: Application to Earthquake Risk

Current challenges and future opportunities have been identified for advancing home flood protection in Canada and are presented in Table 6. Opportunities which have transferability for advancing earthquake protection are noted.

Table 6: Challenges and opportunities to advance home flood protection and their application to earthquake risk management.

Topic	Challenges Related to Home Flood Protection	Opportunity to Advance Home Flood Protection	Opportunity to Advance Earthquake Protection
1. Risk disclosure	Limited access to flood risk maps. Of the maps that are available, most are highly technical and difficult for the public to understand. Most maps also do not include climate change projections.	Publicly accessible, easy to understand, and up-to-date flood risk maps that include future climate change projections.	Publicly accessible, easy to understand, and up-to-date earthquake hazard maps.
2. Professional training	Lack of required (mandatory) risk reduction training for professionals involved in home ownership processes. Current participation in training is voluntary.	Support from professional organizations and governments to make flood protection training mandatory.	Support from professional organizations and governments to encourage or incentivize training on earthquake risk reduction.
3. Financial support	<ul style="list-style-type: none"> a. Limited access to federal/provincial/territorial (FPT) and municipal resilience retrofit subsidies and loan programs. b. Limited access to insurance discounts (e.g., reduced premiums) for reducing lot-level risk. c. Limited access to loan programs from financial institutions, for resilient retrofits. 	Better accessibility to FPT and municipal retrofit subsidies, insurance discounts and loan programs for households to put flood protection retrofits in place.	As applicable, increase access to financial resources and incentives to put simple protection measures in place to reduce damage and injury from earthquake.
4. Building back better	<ul style="list-style-type: none"> a. Inconsistent support from private sector insurance companies and public insurance programs to “build back better” after a loss. 	Encourage private and public sector insurance to promote ‘building back better’ after a flood event, which incentivizes flood resilient best practice guidelines and standards.	Encourage private and public sector insurance to promote ‘building back better’ after an earthquake event, which incentivizes earthquake resiliency best practice guidelines and standards.
5. Building codes	Flood resilient best practice guidelines and standards reflected to a limited degree in national (model) building codes and have been adopted to varying degrees into provincial/territorial building codes.	Support revision of national (model) codes and their adoption into provincial/territorial building codes to incorporate flood resilient best practice guidelines and standards.	Continue to support the update of national (model) codes and their adoption into provincial/territorial building codes to incorporate earthquake resiliency best practice guidelines and standards.
6. Regulating development	<ul style="list-style-type: none"> a. Lack of consistent guidance and enforcement for preventing construction in high-risk flood zones. b. Lack of consistent local bylaws that require new construction and major retrofits to be completed (following a flood event), using resilience best practices. 	<ul style="list-style-type: none"> a. Support enacting regulations and implementing enforcement, that prohibits construction in high-risk flood zones. b. Support enacting local bylaws that require new construction and major retrofits to be conducted using flood resilience best practices. 	Continue to support enacting/enforcing local bylaws that require new construction and major retrofits to be conducted in accordance with earthquake resilience best practices.



4.0 Expert Views on Improving Earthquake Risk Management and Conclusions

Experiences and practices in managing flood risk may provide insight into how earthquake risk can be managed.

Homeowners across Canada can be motivated to reduce their flood risk, as evidenced through more than a decade of work in home flood protection, led by the Intact Centre on Climate Adaptation.

Three principal best practices (or mechanisms) – for motivating homeowners to reduce residential flood risk in Canada -- may be applied to lower residential earthquake risk, in earthquake risk zones in Canada:

1. Engage Professional Associations: Engage professional associations in the residential sector, and offer training and resources for association members so they can educate homeowners about means to better protect properties from earthquake. Professional associations may include, but not be limited to, the following:

- Canadian Real Estate Association
- Canadian Association of Home and Property Inspectors
- Insurance Brokers Association of Canada
- Mortgage Professionals Canada, and
- Appraisal Institute of Canada

Members of these associations interact with homeowners (one-on-one), with the exception of appraisers, and serve as trusted advisors in real estate transaction and home ownership processes. Research shows that when trusted advisors explain hazard risk (such as flood risk) and provide practical guidance on how to protect properties, it supports action.

Associations that provide their members with training and resources on earthquake protection can enable an expanded network of professionals who can teach homeowners in Canada about earthquake risk and motivate them to protect their homes. Home appraisers trained in earthquake risk, though not working directly with homeowners, could provide more comprehensive valuation that serves the interest of owners and lenders alike.

Training programs developed for professional associations could include topics such as:

- Earthquake risk awareness
- Opportunity for earthquake insurance, with a recommendation for homeowners to speak with a licensed insurance representative
- Protective actions that can be taken in and around the home to reduce the risk of property damage or personal injury in the event of an earthquake
- What to do before, during, and after an earthquake (preparing for an emergency)

In addition to sharing knowledge with homeowners, members of professional associations can provide hard-copy and electronic resources such as infographics, other fact sheets, how-to-videos, or web apps to further support homeowner's awareness of earthquake risk and practical ways to reduce risk.

Associations and groups outside the home ownership sector could also be engaged to educate on earthquake risk. These include Indigenous associations, health associations, home builders' associations, tenant advocacy associations, firefighting associations, and retail associations.

2. **Develop an Earthquake Home Protection**

Infographic: Develop and circulate an Earthquake Home Protection infographic to reach greater numbers of homeowners and tenants in earthquake risk zones in Canada.

The infographic would raise awareness of earthquake risk and summarize in an easy-to-understand format, meaningful actions that can be taken in and around a home to prepare the home against potential earthquake damage. Actions can be categorized into different levels of complexity to show the relative effort and cost for implementation, and support homeowner decision-making. Actions can be implemented in a step-wise fashion, from simple to more complex. Content for the infographic could be drawn from earthquake authorities like the Government of B.C., the Insurance Brokers Association of B.C. (IBABC), and the California Earthquake Authority. The benefit of the document is it would “help homeowners/tenants help themselves” to reduce their earthquake vulnerability. Figure 7 provides a sample infographic for residential earthquake protection.

Local governments, industry partners, and not-for-profits across Canada could add their logo to the infographic, and distribute it to homes with utility bills and property tax mailings, councillors’ newsletters, in newspapers or magazines, or through online channels such as social media and electronic newsletters.

3. **Personalize Risk Preparedness:** Implement door-to-door campaigns in high-risk earthquake zones in Canada to encourage homeowners and tenants to prepare for possible earthquakes.

Red Cross volunteers and other trusted, not-for-profit groups like local fire departments and social agencies could receive training and conduct

door-to-door outreach in earthquake risk zones. The aim would be to educate on risk, opportunity for earthquake insurance with a recommendation to talk with a licensed insurance representative, and practical measures to protect homes against earthquake damage and injury.

Research has shown that outreach campaigns conducted by the Red Cross have materially augmented existing efforts of governments, insurance companies, and other not-for-profits by catalyzing behaviour of homeowners to reduce aspects of extreme weather risk (Evans and Filippi, 2019). Personal contact and discussion (at a residential property) can motivate action. Utilizing community groups -- with existing connections with residents -- to deliver education, improves the quality and impact of the messaging (Kruger, 2022). Door-to-door outreach would also enable vulnerable populations to access risk information that might otherwise be unavailable.

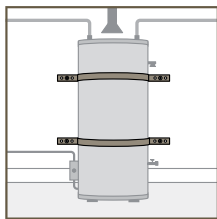
The good news is that implementing earthquake protection is within the grasp of most homeowners. “Management by disaster” can be greatly reduced. When informed about external threats, homeowners (and tenants) are more inclined to take action to protect their properties. This “protective instinct” has been well documented in Canada with respect to residential flood risk. Now, this same reflex could be implemented for earthquake risk, in Canada’s three major earthquake regions in British Columbia and Quebec-Ontario.

By way of professional association members engaging with homeowners, targeted door-to-door outreach campaigns, and the use of educational resources like earthquake home protection infographics, homeowners and tenants have opportunity to enhance their protection for earthquake risk.

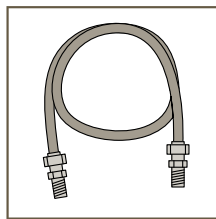
Figure 7: Examples of Practical Actions to Reduce Earthquake Risk for Residential Housing

EXAMPLES OF PRACTICAL ACTIONS TO REDUCE EARTHQUAKE RISK FOR THE HOME

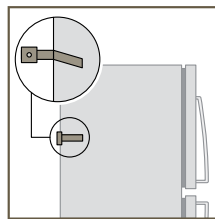
Home Interior: Complete Simple Upgrades



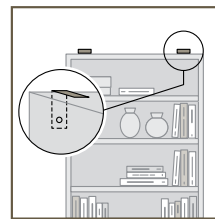
1 Water heaters braced using authorized strap kit.



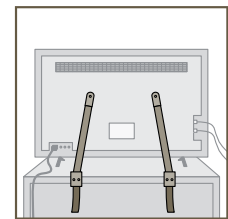
2 Flexible connection for gas appliances.



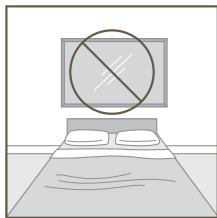
3 Ovens and refrigerators strapped to walls.



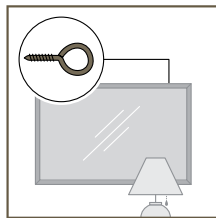
4 Cabinets and bookcases secured to wall studs.



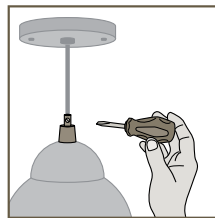
5 Televisions, computers, other electronics strapped down.



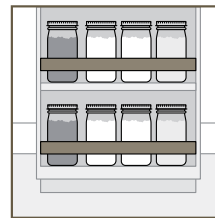
6 Heavy objects not hung over beds.



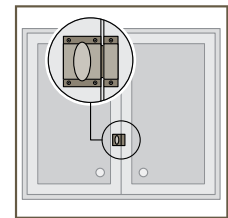
7 Heavy mirrors and pictures on walls anchored with wire eye screws into studs.



8 Ceiling fans, pendant lights and other hanging fixtures secured.

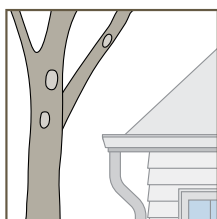


9 Breakables and valuables moved to lower shelves with lip guards.



10 Latches on cabinet doors (so they don't fly open).

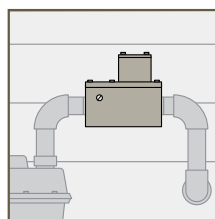
Home Exterior: Complete Simple Upgrades



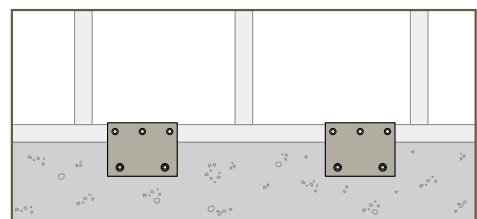
1 Tree limbs adjacent to home and garage are pruned.



2 Flammable products stored securely away from house in locked cabinets with latches.



1 Automatic gas shut-off valve installed (triggered when there are strong vibrations).



2 Home's foundation retrofitted (as needed) with anchoring to reduce possibility of house sliding off its foundation.

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